

# Future Energy Systems

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**Abstract:** One eighth of the world population is still living without access to electricity. Energy supply chain majorly based on electricity is in focus. The shift from centralized to more distributed styles is evident in Smart Grids, Industry 4.0, Industrial internet and IoT, Society 5.0. With integrated communications being major party to smart grids, the information and communication technology integration in energy sector is a necessity. While in the US most of the discussion revolves around Smart Grid, the EU FINSENY project focuses on building the Internet of Energy. More than ever these systems seem to show convergence with ongoing technological developments. Technologies include power electronics on one hand and Information and Communication Technologies on the other. What really matters is the resulting customer value. In Energy systems the value is in integrating Distributed Energy Resources (DER), Energy Storage planning and implementation, interfacing with transmission systems and building a resilient grid. The purpose of this paper is to discuss the challenges, opportunities and standards worth watching.

**Index Terms** Energy System, Electricity, Cloud, Internet of Things, Control Systems, Industrial Internet.

## I. INTRODUCTION

Energy plays a major role in global economic landscape. Electric Power systems are considered part of this critical infrastructure due to the significant role these play in human lives by providing energy to meet home and industrial needs. The fact that power systems involve human lives and expensive infrastructure such as turbines, generators and transformers etc. make their automation mission critical in nature. As per world energy outlook nearly one eighth of the world population is still living without access to electricity [1]. The key drivers of change include de-carbonization, reliability in the face of growing demand, electrification of transportation, empowered customers, market designs and regulatory paradigms. The enabling factors include technology advanced, policies and standards [2]. The electricity supply chain considers, generation, transmission, distribution and consumption aspects. The shift from centralized to more distributed architecture is evident in the evolution. The supply chain consists of primary equipment like turbines, generators, circuit breakers, switches, transformers and so on. The secondary equipment includes power system protection and control equipment, sensors, communication switches, Supervisory Control and Data Acquisition (SCADA), Distributed Control Systems (DCS) which constitute the automation elements.

The protection functions perform voltage and current measurements and application functions act based on these measurements. Power systems require microsecond reaction times and is based on open loop control to isolate the faulty section. The control aspects involve a closed loop control including feedback. These require actions in milliseconds. In the age of Industry 4.0, energy efficiency, electricity supply and sustainability are important [3]. The provisioning of energy subject to increasing resource usage and scarcity and environment concerns point to sustainability. Developing countries like India and China show growth figures up to 25%. The four key trends include, electrification of energy distribution, an increase in energy consumption, more dynamic electric loads and an increase in distributed generation.

The focus of this paper is to present the initial landscape and evolution to future of electricity-based energy systems and have a look at trends observed as future.

## II. INITIAL LANDSCAPE

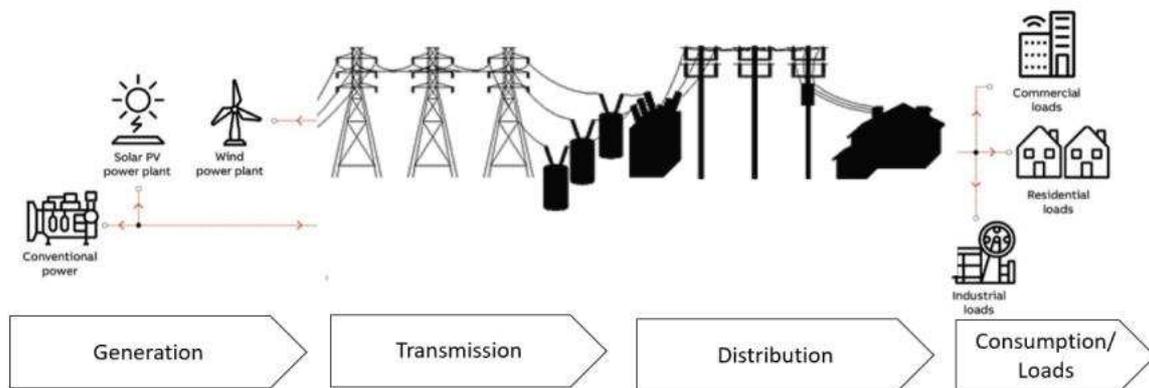


Fig. 1. Electricity Supply Chain.

As in Fig.1, in a traditional landscape, the electricity system is composed of a chain of generation, transmission, distribution and consumption with flow of electricity happening from generation to consumption. Across the world this is highly regulated sector driven majorly by utilities. Major parts of the system are built on Alternating Current (AC). The base loads are served by utilities which perform efficient generation but is less flexible. The traditional electricity supply chain is demand driven. For handling peak load in this system, we normally reserve some generation capacity. The voltage levels vary across the system.

For example, in Europe, the dominant standard generator voltage and frequency is 11 kV and 50 Hz, while in North America, 13.8 kV and 60 Hz is the dominant standard generator voltage and frequency. India uses the 50Hz frequency. Voltage generation is economical at 11 kV and 33 kV. Mostly the voltage generated is 11kV. It can be stepped up and stepped down for example 11 kV to 33, 66 or beyond according to requirements. The nominal voltage generated at Indian power plants range from 11kV to 33kV. When it reaches homes it is 220 volts, alternating at 50 cycles (Hertz) per second. The transformers play an important role stepping up and down voltage across the system. Transmission voltage in India (highest) is 750kV AC and these lines are erected by Power Grid Corporation for interstate connections throughout India. High Voltage DC (HVDC) is also used for transmission at voltages of 500 kV. The primary systems are well supported by automation, including substation automation for transmission and distribution substations including electrical relays, Remote Terminal Unit (RTU), switches and SCADA for local operator. Load Dispatch Centres are located in various parts of the country. The sector is highly standardized by bodies including IEEE, IEC, ANSI and BIS for India and categorized as electrotechnical standards. The system is many decades old and primary intention is to avoiding blackouts. Still major blackouts including the one in India in 2012, and recent incident in U.S, indicate deficiencies in the system. Taking a cue from Albert Einstein’s famous quote– ‘We cannot solve our problems with the same thinking we used when we created them’.

### III. EVOLUTION

There are two major initiatives one driven by Smart Grid in the U.S and another by Future Internet of Smart Energy by EU. The Smart grid vision generally describes a power system that is more intelligent, decentralized and resilient, more controllable and better protected than today’s grid. The five key technologies include Sensing and Measurement, Integrated Communication, Advanced Components, Improved Interfaces and Decision support and Advanced Control [4]. The challenges include the need for:

1. Increase the efficiency of power plants.
2. To reduce stress on the grid resulting from higher demand peaking.
3. Facilitate large percentage of renewables with a stable grid and reliable supply.

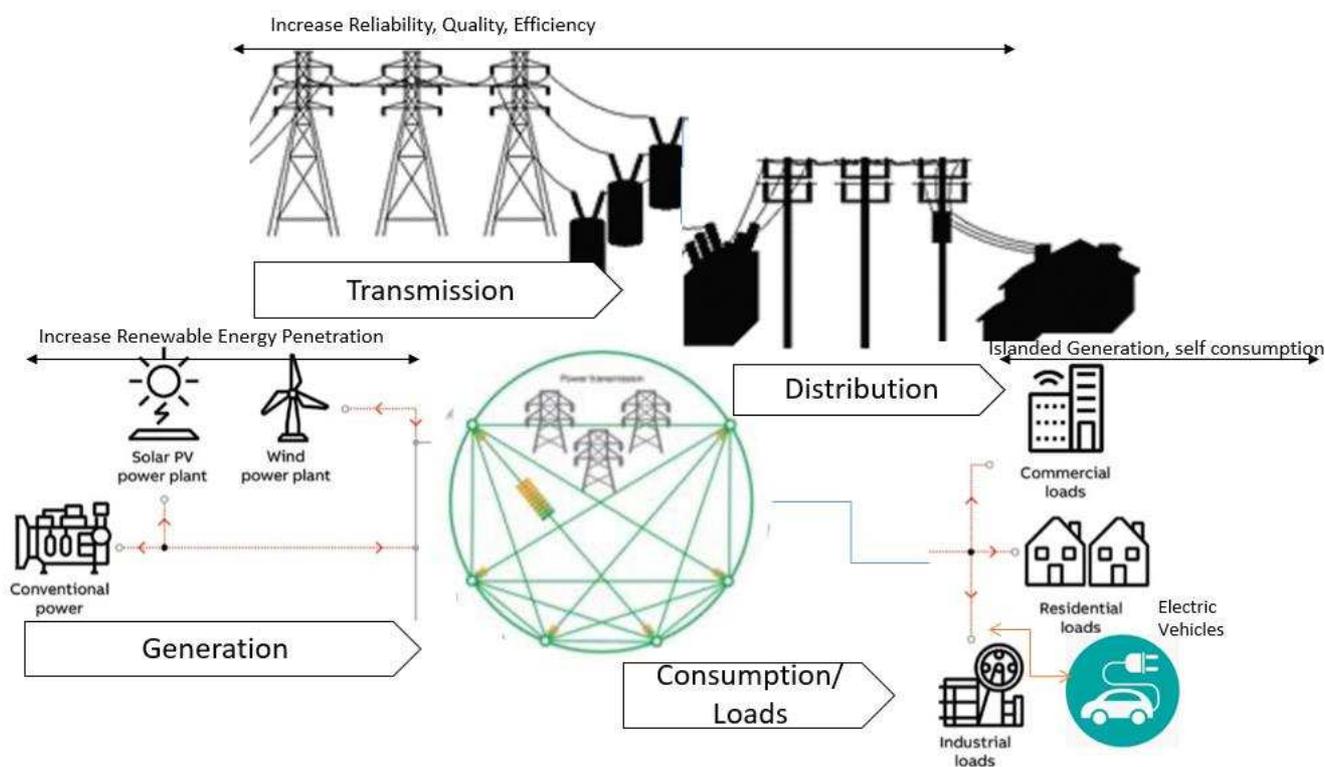


Fig. 2. Distributed/Mesh view of Electricity Supply Chain.

As in Fig. 2, the most important shift is from central to distributed generation. Next is impact of Information and Communication Technologies. These changes render the system in the form of a mesh network, reminding us of contemporary communication networks. Implications to customer include more flexibility, microgeneration, smart devices like smart fridge that switch off when idle. Implications to transmission and distribution includes grid capacity and need for large investments. With electric vehicles and stress on the grid – Stability, Reliability, Fault Tolerance are more important. Implications on generation include shift to sustainable energy supply (future without coal) but also considering reliability of sun/wind (renewables) a challenge. The traditional grid built on demand-based approach needs to be augmented with the right kind of automation systems to be able to take advantage of these advancements. This also necessitates the convergence of Information Communication Technologies (ICT) and Operational Technologies (Control). While control systems see availability, integrity and confidentiality as priorities, the information technology systems see confidentiality, availability and integrity respectively as priorities. The new philosophy focuses on a more distributed approach instead of completely relying on a central grid. On domestic level this would mean:

1. Distributed Generation
2. Distributed Storage
3. Demand Side Management (DSM)

The invention of Rogowski coil (non-conventional) based current and voltage transformers enable significant flexibility in placing and measuring current and voltage. Another consideration is the Intelligent Merging Unit (IMU) which take input from sensors and stream the values enable significant digital capacities like functions of relays be more distributed. Today's fault detection, Isolation and Restoration Strategies requires methods like IEC 61850 GOOSE over ethernet. Wide Area Early Warning Systems (WAMS) using Phasor Measurement Unit (PMU) is another advancement. The resulting measurement from a PMU is termed synchro phasor. A typical PMU can report measurements with very high temporal resolution in the order of 30-60 measurements per second. This helps engineers in analysing dynamic events in the grid not possible with traditional SCADA measurements that generate one measurement every 2 or 4 seconds. The system needs time synchronization as to be able to maintain the sequence of events. New solutions on Demand Side Management (DSM) stand for the modification of consumer demand for energy through various methods such as financial incentives and behavioural change through education. Today, a number of utilities are implementing Advanced Distribution Management Systems (ADMS), that integrates many utility systems and provides automated outage restoration and optimization of distribution grid performance. ADMS functions include automated Fault Location, Isolation, and Service Restoration (FLISR); conservation voltage reduction; peak demand management; and volt/volt-ampere reactive (volt/VAR) optimization.

A large number of stakeholders are part of the system including governments, regulators, consumers, generators, traders, power exchange, transmission and distribution companies, power equipment manufacturing and ICT providers. To consider customer indices The Customer Average Interruption Duration Index (CAIDI) and System Average Interruption Duration Index (SAIDI) are significant.

FINSNEY project envisions, a sustainable energy system combining critical infrastructure reliability and security with adaptive intelligence enabled by future internet. All sectors of economy rely on energy sector [5]. In order to maintain sustainability Europe has committed to 20/20/20 which stands for 20% reduction in greenhouse gas emission 20% renewables and 20% primary energy use reduction. The major challenges on the path include integration of DER, smart buildings and microgrid, engaging and empowering commercial customer to take more active role in energy markets, active shaping of the demand curve, support for EV charging infrastructure with mobile loads and enable new trading and information services in marketplace. Distribution is at the heart of the customer and to make distribution grid smarter it requires:

- A decentralized control monitoring structure across MV and LV Network
- Automation of grid operations
- An autonomous detection of fault condition and mitigation of restoration actions
- Dynamic adaptive mechanisms for active and voltages management of grid constraints
- Improved forecasting of generation and demand for more efficient operations and decision making.

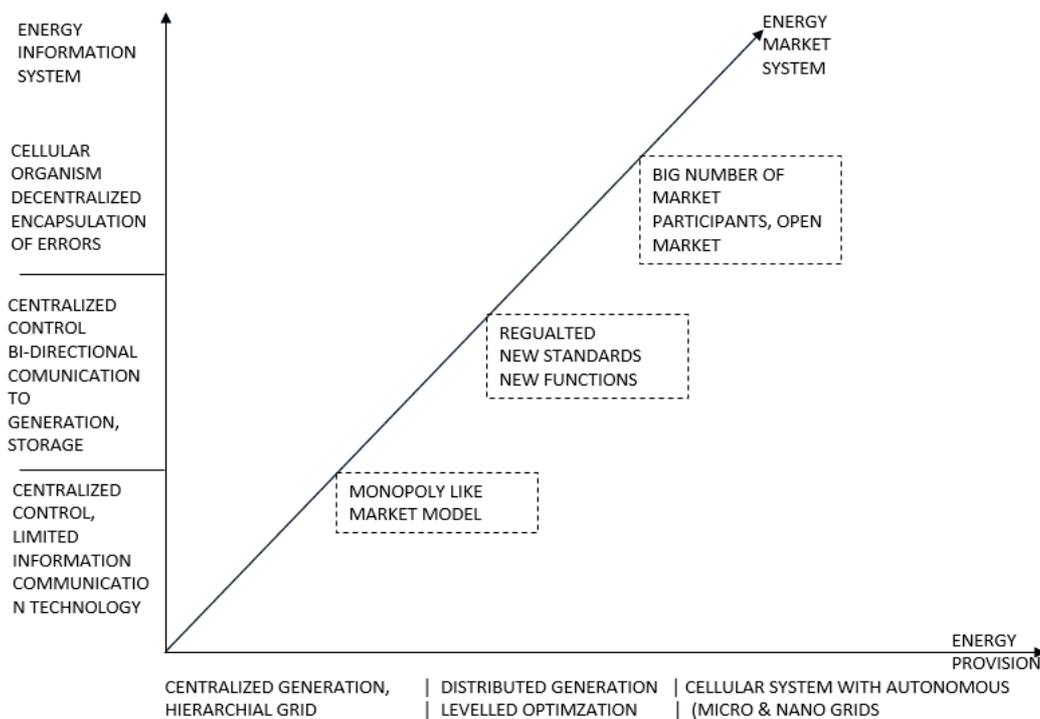


Fig. 3. A representation of trends and characteristics.

Fig. 3, presents a high-level view of evolution from information systems and markets perspective. The critical factors in energy information, market-and power systems evolution include; Reliability, Safety, Security, Adaptability, Utilization and Intelligence. Reliability stands for minimum interruption to supply at all levels. Safety in this context stands for protection from dangerous occurrences. Security and compliance protect from intrusions. The adaptability aspect considers the wide energy sources, and a grid which is capable of self-healing through decision making as local. Improved utilization of assets by monitoring and control, gathering information of relevant customer assets such as to deliver the features are relevant as well. The ICT landscape consists of the evolution of communication networks including Internet of Things (IoT), Internet of Services, Cloud Computing, Fog Computing, coupled with connectivity management, service enablement, security and privacy considerations. Limitations of current internet to perform mission critical applications include the lack of priority guarantees, potential security gaps, and ability to satisfy short and deterministic latency requirements. The considerations in distribution network include microgrids, smart buildings, electric mobility, marketplace for energy. The evolution is also due to aging infrastructure and technology innovations.

The challenges are more apparent in the distribution systems where it is complex to plan, operate and maintain. In these systems, the considerations include integration of renewable energy sources and electric vehicles, energy storage, demand side management, use of power electronic equipment for lighting and drives and response to recent extreme weather events [6,7]. The utilities focus is on customer service, system reliability and operational resiliency. Certain percentage of load support can come from energy storage. This necessitates additions of metering equipment, system monitoring capability and more advanced control and protection technologies. The challenges include:

#### A. Integration of Distributed Energy Resources (DER)

Rooftop solar PV is becoming very popular. Wind Turbines and Fuel cells are other major alternatives. These may or may not be connected to grid. Utility owned DERs might be configured for minimum impact. As such DERs are largely non-dispatchable and do not contribute to system capacity. These are not available for frequency control, but still contribute to capacity deferral.

#### B. Energy Storage Planning and Implementation

The approaches include chemical, thermal and mechanical. Energy storage decouples generation and delivery by time shifting energy in terms of min, hours, days. The benefits include load shaping, peak load deferral, supplement/ backup power, power arbitrage, voltage control and frequency regulation.

### C. Interfacing with Transmission Systems

Historically transmission and distribution are two different systems. With bidirectional power flow, the borders are blurring. The lines between Medium Voltage (MV) and Low Voltage (LV) are seen as converging.

### D. Natural Disasters and their influences

Extreme weather events like tsunami, monsoons destroy equipment and lead to blackouts. Modern weather forecasting provides advance warning letting utilities and operator to plan for infrastructure and redesigns to prevent damage. Underground feeder circuits, building redundant /direct communication paths helps in improving system reliability and minimize service interruptions.

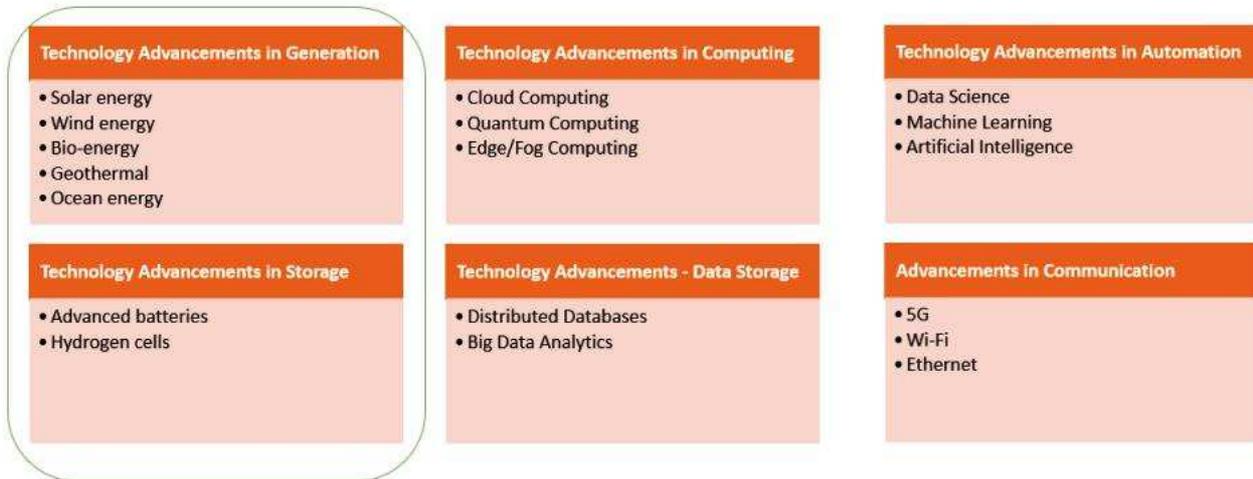


Fig. 4. Microgrids Architecture.

One of the approaches which is involved distributed control and also discusses autonomy is Microgrids [8]. As in Fig. 4, microgrids are electricity distribution systems containing loads and distributed energy resources, that can be operated in a controlled, coordinated way either while connected to the main power network or while islanded. Microgrids closely resemble a hybrid car, where the car is partially driven by electricity and possess storage in form of battery, thereby enabling a continuous supply. Since renewable sources like sun are intermittent, it is important to integrate a reliable source which is not dependent on environmental conditions.

Lessons learnt from deployments across the world include the need of major sensing capability addition, a reliable and secure communication system, interoperability based on standards, data management, visualization, archiving, bad data detection, time synchronization, data confidentiality and sharing. McKinsey reports only 20% of potential usage of data in industrial systems. A distributed intelligence is as well needed. Cyber Security for distribution system and protecting privacy are necessary as new technologies are adopted.

### III. FUTURE

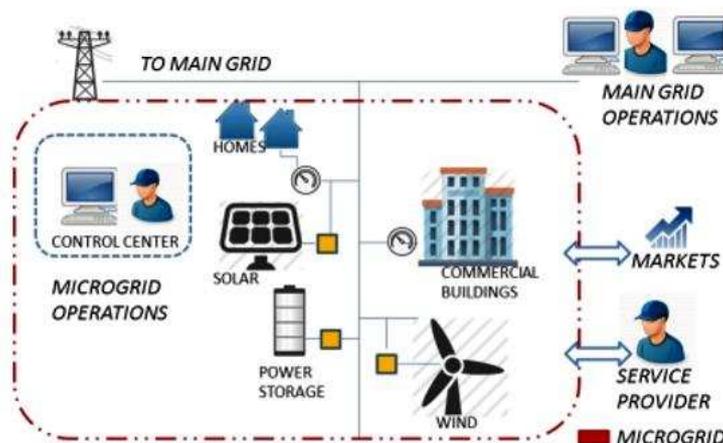


Fig. 5. Technology Advancements relevant in Energy context.

Fig.5, represents some of the advancements relevant to energy context. The two key technology considerations include power electronics which plays a significant role in power flow and stability, while automation mainly driven by significant use of software and electronics or embedded systems. A resilient grid requires intelligence which is achieved using data to insights approach. The compensation systems like Static Synchronous Compensators (STATCOM) using power electronics to control power flow and improve transient stability on power grids is important. Here the Information Communication Technologies like Cloud computing, which provides distributed processing, storage and availability is going to play a major role. Wide area monitoring systems necessitate the needs for Big Data Analytics since the data coming from PMUs is big [9]. The data consists of both operational data and non-operational data. The need for analytics includes data analytics on available data for root cause analysis and streaming analytics based on real-time data. Cyber Physical Systems with their significant capabilities of analysing 'What If' scenarios may also play a major role in the evolution of these systems. Cloud lets data collected to be processed elsewhere, Internet of Things lets us reach every nook and corner unravelling data, while Machine Learning lets us find patterns and relations leading to insights using analytics [10,11]. Artificial Intelligence lets us perceive the environment and perform actions to achieve goals. What really matters is the resulting customer value. In energy context, safety and reliability is also major consideration in customer value. We follow Steve Job's quote; 'You have to start with the customer experience and work backwards towards technology'.

#### IV. EMERGENCE OF STANDARDS AND FRAMEWORKS

Standards include Distributed Generation aspects of IEEE 1547, Substation Automation considerations in IEC 61850, NIST Smart Grid Framework and EU Framework [12,13,14,15]. The major focus is around interoperability and resilient grid. More than smartness the system requires to be resilient so that it can survive the new situations created due to the changes. A major element in this experimentation is the Microgrids. These distributed concepts and the control approaches followed could be scaled to bigger systems. The entire effort can be seen in the context of three aspects of Customer Experience, Handling Uncertainty and towards autonomy. For example, standards like IEC 61850 focuses on interoperability across multiple vendors and enables significant digital capabilities in relays. Another set of standards NERC-CIP and IEC 62351 focus on the Cyber Security Considerations while IEC 62351 focuses on redundancy aspects for reliability and availability in these systems.

#### V. INSIGHTS, OPPORTUNITIES AND APPROACHES

Based on Three Layer Product model by Jan Bosch [16], Fig. 6 provides a representation of technologies and methods. Those which are standardized and stable are becoming a commodity. The differentiation includes latest technologies including big data analysis, virtual generation using power electronics. Experimentation layer involves modelling and simulation and Cyber Physical Systems which will enable faster experimentation and evolution.

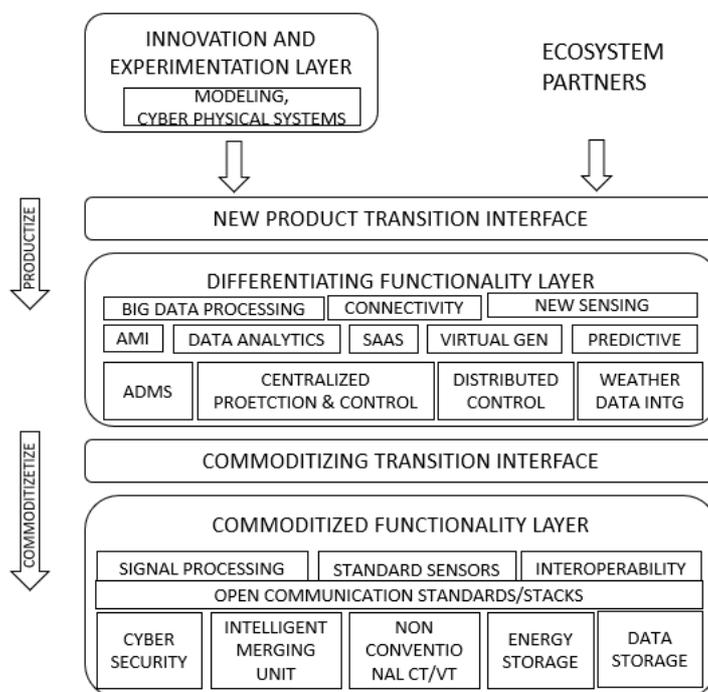


Fig. 6. Energy System Advances seen in Three Layer Product Model.

The capabilities of latest technologies including connectivity would play a major role in the ability for faster experimentation. Power System Standards of IEC 61850 and maps the same to Web protocols like HTTP. Approaches like blockchain are considered in energy trading.

The major improvement involves the theme of sustainability. Sustainable electricity supply chain consisting of clean energy systems and thereby decelerating climate change is in focus. In this context Blockchain technologies are considered to support smart contracts, consensus, encryption and data storage [17]. These systems enable tracking of the energy systems towards clean energy [18].

## VI. SUMMARY

Customer value in the in-energy context includes, safety and reliability in addition to key considerations like interoperability, resilience. The two key technology considerations include power electronics which plays a significant role in power flow and stability, while automation mainly driven by significant use of software and electronics or embedded systems. The systems focus on customer experience, handling uncertainty and creating a path to autonomy. The experimentation in these systems consider factors like Microgrids and also usage of Cyber Physical Systems, Blockchain etc, thus enabling delivery of innovative experiences to customers and enabling sustainability.

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## About the Author



Abhilash is Principal Engineer in Electrification Division- Distribution Automation R&D at ABB based in Bangalore, India. In Product Development for over 20 years, he has been majorly focusing on Architecture and Design of Software Systems. He completed his Bachelors in Mechanical Engineering in 1998, Master's in Software Systems from BITS, Pilani in 2010 and Architecture and Systems Engineering Professional Certificate from MIT Professional Education in 2017. Passionate about building world class systems and products, his interests include Decision Support Systems, Cyber Physical Systems and Innovation and Technology Management. He has 3 granted patents and over 10 publications to his credit. He is a Senior Member of IEEE and Member of ACM.

"The challenge of leadership is to be strong, but not rude; be kind, but not weak; be bold, but not a bully; be thoughtful, but not lazy; be humble, but not timid; be proud, but not arrogant; have humor, but without folly." – Jim Rohn

"A leader is one who knows the way, goes the way, and shows the way." – John C. Maxwell

# Future Automotive E/E Architecture

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In the industrial revolutions of the late 18th and early 19th centuries, it was one new force that created the revolutions. The world is currently undergoing a dramatic transformation, and this transformation mainly due to the confluence of 4 main megatrends.

## Mega Trends

### 1. Urbanization

The residence of the human population, locus of economic activity and dynamism is shifting from rural areas to the cities all over the world. As per the UN, Today, 55% of the world's population lives in urban areas, a proportion that is expected to increase to 68% by 2050. This, combined with the overall growth of the world's population, could add another 2.5 billion people to urban areas by 2050. Many countries are likely to face challenges in meeting the wants of their growing urban populations. The needs for housing, transportation, energy systems, infrastructure, employment, education, and health care will intensify.

### 2. Digitalization

Technologies like Artificial intelligence, Internet-of-Things, etc. have been disrupting the industries all over the world with scale and scope as never before. These technologies are bringing in rapid digitalization of the world and the digitalization is primarily shaped by faster and cheaper computing, reliable interconnectivity, and pervasive cloud functionality. Moore's Law, Metcalfe's Law, and Bandwidth Law are together defining how fast and efficient our computing devices can become, why more digital connections mean greater value for everyone on the network, and how much data we can collect, manage, and process. All the above three are rapidly transforming the world we live in.

### 3. Aging Society

Ageing Society — the inevitable increase in the share of older persons that results from the decline in fertility and improvement in survival — is occurring throughout the world. This demographic transition is more prominent in developed countries. Many countries like Japan have started to see a falling population. The European Commission expects that by 2060, Germany's population will shrink by one-fifth, and the number of people of working age will fall below that of France. The demographic change results in a shift in the social and economic behavior of the population and thus will have an impact on all sectors in the economy.

### 4. Sustainability

Sustainability focuses on meeting the needs of the present without compromising the ability of future generations to meet their needs. The world's ability to sustain billions of more people who are driving carbon-emitting automobiles, consuming more and more food that is derived from dwindling food basket, is creating an imbalance in the equation of the sustainable existence of mankind.

## Enablers

To master the challenges ahead due to the 4 megatrends, the mobility industry is developing the technology enablers that are most easily remembered by the acronym CASE

### 1. Connectivity

The cars are becoming nodes within the internet-of-things. This has transformed the car from being a mere mode of transport to a pod that delivers a new user experience to all its occupants. Connectivity adds to the safety and comfort of a car and has opened new avenues of businesses for all incumbent players. Connectivity has also created vents in the entry-barriers through which Tech giants like Apple and Google have made their entry to the industry.

### 2. Autonomous Driving

Autonomous Driving has the potential to make the commute time more productive, reduce accident rates, increase the mobility for the physically disabled and the elderly, optimizing the traffic on the road.

### 3. Shared Mobility

An excessive number of private cars on the road leads to problems in all urban areas. Traffic congestion, lack of parking space lead to loss of productive time. Shared shuttles and Robo-taxis will likely become more popular in urban areas and there will be several service innovations in this space.

### 4. Electrification

Electric vehicles have the potential to reduce greenhouse gas emissions, and more importantly reduce dependence on petroleum which is a depleting natural resource. Ever tightening emissions standards in all markets around the globe are pushing vehicle manufacturers to plan for more electric vehicles.

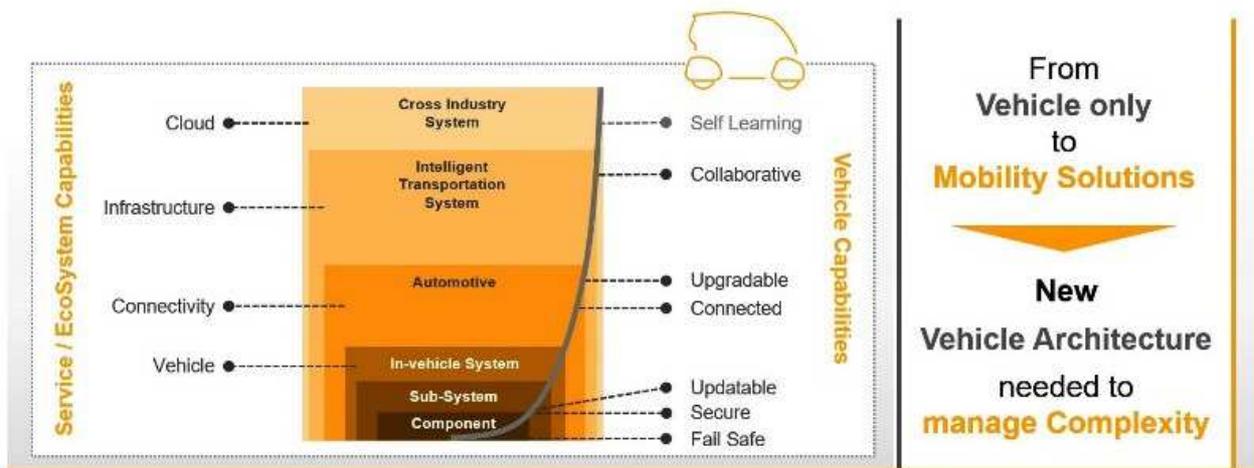
## Solutions

While the mobility ecosystem is expanding more and more, the traditional market players in automotive space have focused on improving the vehicle capabilities and are more prominently focusing on mobility solutions. Software will play an important role in mobility solutions. The future vehicles must be

- **Failsafe**, by being capable of completing its key function even if part of it fails.
- **Secure**, by anticipating, avoiding, detecting, and defending against cyberattacks.
- **Updatable**, by being capable of over-the-air (OTA) updates of the software.
- **Connected**, to the infrastructure, internet, mobile devices, ...
- **Upgradable**, in both software and hardware.
- **Collaborative**, to interact with the Intelligent Transportation System for optimized seamless transportation.
- **Self-learning**, by being artificial-intelligence-enabled.

## Future Automotive Capabilities

From embedded vehicle system to mobility solutions



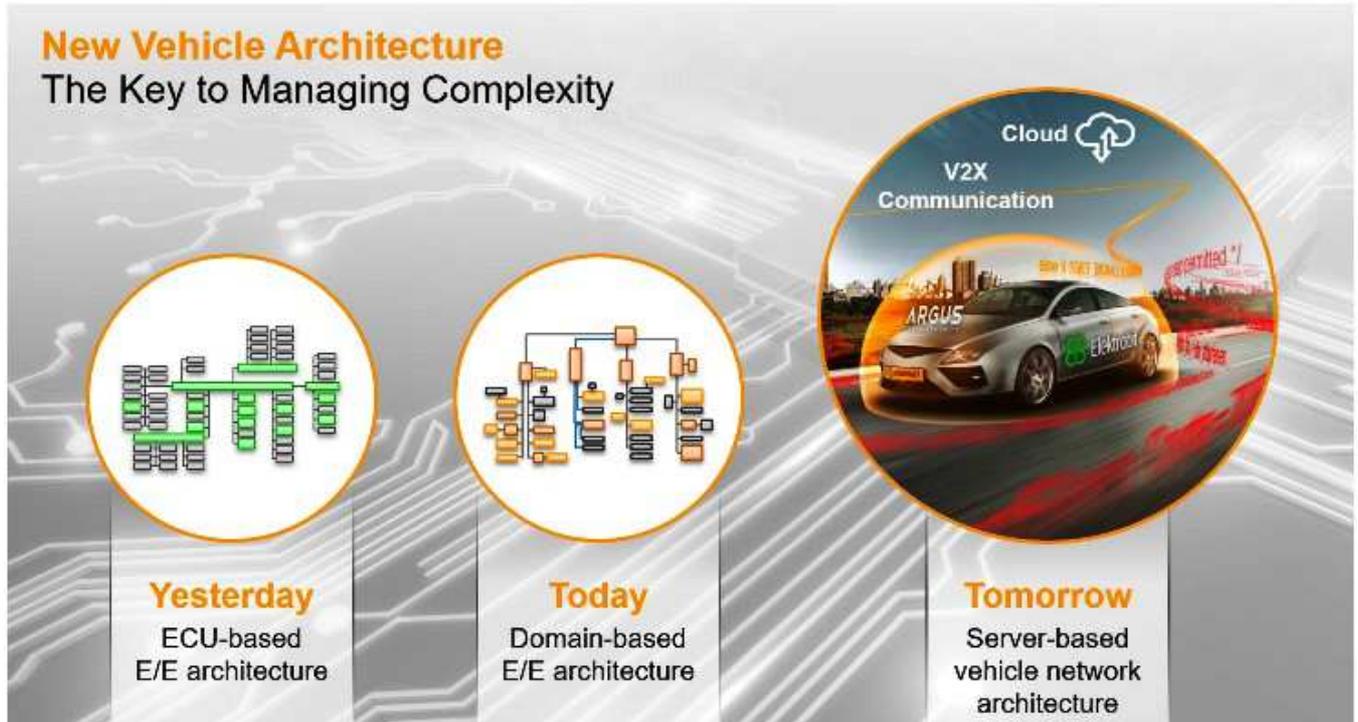
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## The Evolution Of Automotive E/E Architecture

Consolidation of electronic control units (ECU's) is an important trend seen in E/E vehicular architecture. New mobility solutions will require a centralized architecture with fewer individual ECUs. The consolidation is driven primarily by mainly 2 factors

1. Optimality of algorithms for automated driving: The environment-sensing and environment-modeling algorithms for automated driving is most optimal if data from a variety of sensors are fused in a single computing unit.
2. Costs: Consolidation results in decreased costs of computing, less common components (e.g., power supply), less wiring harnesses and consolidated software functions



### Past:

Vehicle E/E architecture of the past had up to 150 electronic control units (ECU's). Most of this ECU's had an embedded microcontroller which controlled actuators, processed sensor signals, controlled mechanical operations (like ignition/injection control) and executed electronic functions (like auto-parking, air-bag trigger). Each function had its own electronic control unit. These ECU's were connected by wiring harnesses and there existed limited interactions between the different ECU's. There was high software-to-hardware integration. This often resulted in vendor locking.

### Present:

Vehicle E/E architecture of today has moved towards more centralized systems with dedicated domain control units (DCUs) or Domain ECU's. Several functions are combined into a domain ECU's to reduce the number of individual ECU's, consolidate functions and simplify the wire harness (e.g. for infotainment, body control). While this evolution will occur across all vehicle domains over time. Infotainment and driver assistance are expected to be the forerunners, as areas of high performance and/or low safety or latency criticality are easier and/or more beneficial to transform.

### Future:

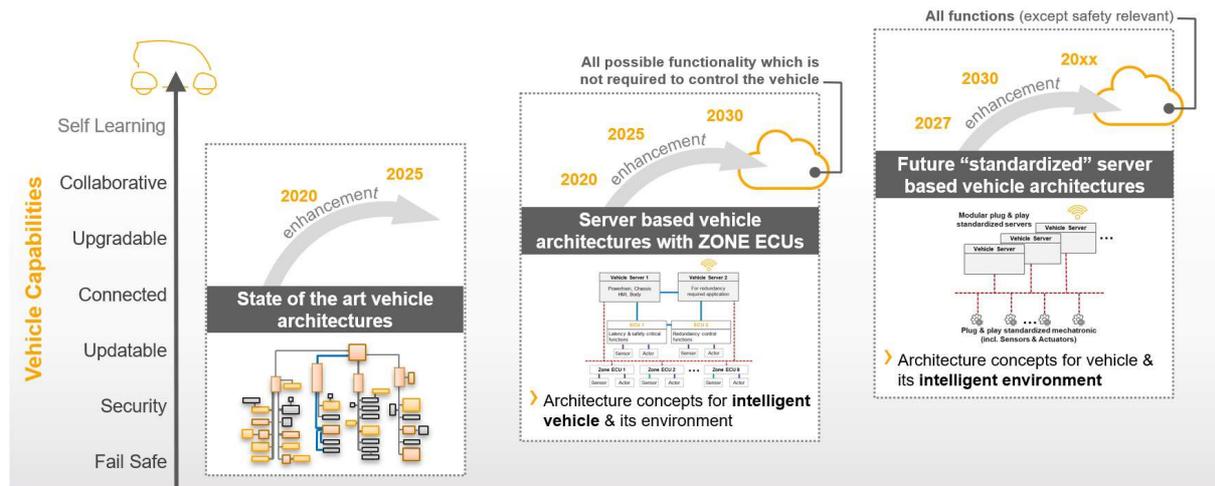
The future server-based vehicle architecture is characterized by a few servers for centralized high-performance-computing. These servers will be closely connected and to the cloud for regular updates as well as for off-vehicle computations. Sensors and actuators are controlled by the central vehicle servers through standardized interfaces. However, this change from today's architecture to the server-based architecture cannot be done in one step. Therefore, an intermediate step will be the server-based vehicle architecture with additional ZONE ECU's and some remaining ECU's for safety-critical applications with strong real-time or latency requirements. (e.g. for Braking or Airbag Control Systems). The Zone ECU's bridge the sensors and actuators of today to the vehicle servers and thus help to reduce the wire harness as they are placed at different zones of the vehicle (e.g. front/rear, side).

The new server-based vehicle E/E network architecture will have 3 main levels:

- A. **Actuator/Sensor level**, which provides pressure, acceleration, position, image, ... data to the computing level and the driver modules for the actuators like valves, motors, inverters, ....
- B. The **computing level** which does the sensor fusion, analytics, planning's and execution of function and services
- C. The **backend** for off-board computing, big data management, AI training, services, ...

# Vehicle System Architecture Transition

From “diversified” to “standardized”

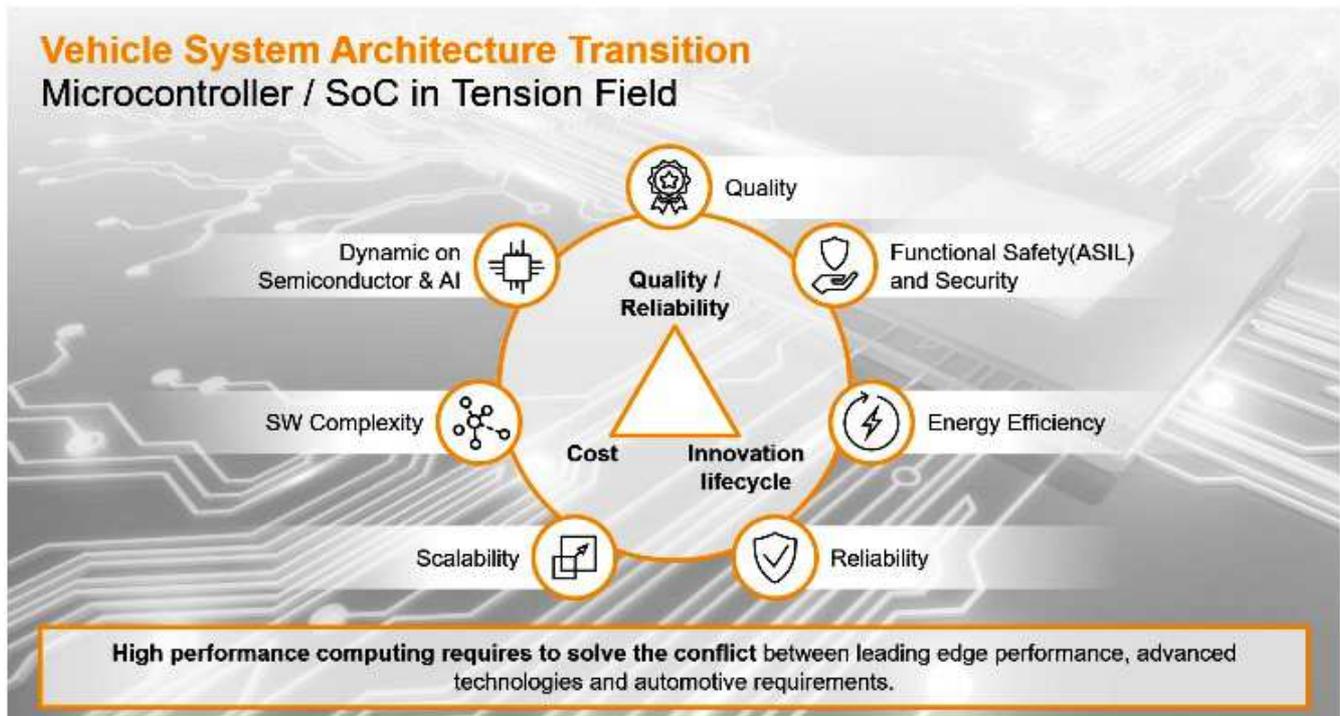


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## Technological Challenges To Evolution Of Automotive E/E Architecture

Automotive-qualified embedded processors of today, do not have enough compute-power to process algorithms like multi-sensor-data-fusion needed for automated driving. The current demonstrators of automated-driving (Level-3), use a combination of high-performance CPUs and GPUs from the consumer industry, and automotive-qualified master ECUs. However, to take these systems to mass-production, there is a need to replace the consumer-class computing engines with automotive-grade eHPCs (embedded HPCs). The need for processing capacity will increase further in future, since moving from Level 3 to Level 4 vehicles needs larger compute power (x2), and even greater (x1.5) while moving from Level 4 to Level 5. eHPCs cannot evolve in computing power as in the classical-HPC world. This is due to the numerous special requirements governing the microcontrollers/Systems-on-chip that are mandatory to be suitable for future automotive applications. These special requirements are depicted in the below picture.



## eHPC - Moving Closer To Reality

Several premium automakers and their suppliers (so-called tier-1's), are already active in ECU consolidation. The European Processor Initiative (EPI) is one effort to build exascale HPC, with automotive being one of the target applications. Currently, 23 partners from ten European countries are in this consortium. The members range from automakers to semiconductor suppliers, corporates doing advanced-developments to researchers-in-academia, thus ensuring diversity. They aim to bring a novel low power eHPC to the automotive market. This eHPC is aimed to be fail-safe, automotive grade, real-time and powerful to be able to address even Level-5 automated driving. The first family, codenamed "Rhea", will come to market in 2021. ARM, RISC-V, and external IPs will be a part of it. It will include a proof-of-concept of an automotive eHPC. EPI plans to deliver the second family, Cronos, in 2022-2023. It will include an automotive eHPC.

## Sectorial Implications Of The New E/E Architecture

- **Standardization and commoditization** of sensors, harnesses, computing hardware like ECU/DCU/Server, and other electronic hardware components likely to happen.
- **The software** will become increasingly prominent. The functionality will be realized through software instead of additional hardware i.e. 'appification' will be seen (e.g., ADAS functions enabled on-demand based on a standardized set of electronic hardware).
- **Service-oriented-architecture (SOA)** will emerge. The architecture will likely be more scalable and reusable across classes of vehicles, applications, and features.
- **Frequent over-the-air (OTA)** updates will become common.
- **Separation of hardware and software** development cycles will happen, thus helping auto-companies speed-up software development.
- **New sourcing models** emerge due to the separation of hardware and software. This will avoid vendor lock-in. For the digital-natives in the market, this can mean that the entry barrier into the automotive industry is lowered further.
- **Further opening of eco-system** with increased co-operation among the players, to share costs and speed up development. We have already started to see happen. Even traditional competitors in the mobility sector are partnering together in the transformational journey.
- **Continuous agile transformation** of organizations will be seen. Generally, automotive companies lag those from other sectors in adopting modern organization models. This will change soon. In a move to make themselves more agile, a leading European automotive-OEM, for example, has embraced a swarm organization, and another major car-OEM underwent a large-scale agile transformation.

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## About the author



Mr. Arun Shankar is Chief Manager at Continental Automotive India Pvt. Ltd, an Indian arm of Continental AG. He manages the Microelectronic-Integration department within Technical Center India, the in-house R&D Center of Continental globally. His department delivers digital ASICs to various internal businesses of Continental. Before this role at Continental, Mr. Arun Shankar started, built and established the Advanced Engineering (AE) department in Bangalore, for Continental's Advanced Driver Assistant Systems (ADAS) business unit. The department strongly contributed to innovation projects related to automated driving and grew to become the largest AE department within the whole business unit globally.

Mr. Arun Shankar has more than 17 years of diversified work experience, spanning across consumer electronics, communication, and automotive electronics industries. During this span, he gained technical expertise in several digital technologies such as digital signal-processing (all of image, video, audio, speech), computer vision, machine learning, multisensor fusion techniques, and embedded software. Mr. Arun Shankar is a lead inventor in several of the 17 US/German patents that list him as one of the co-inventors.

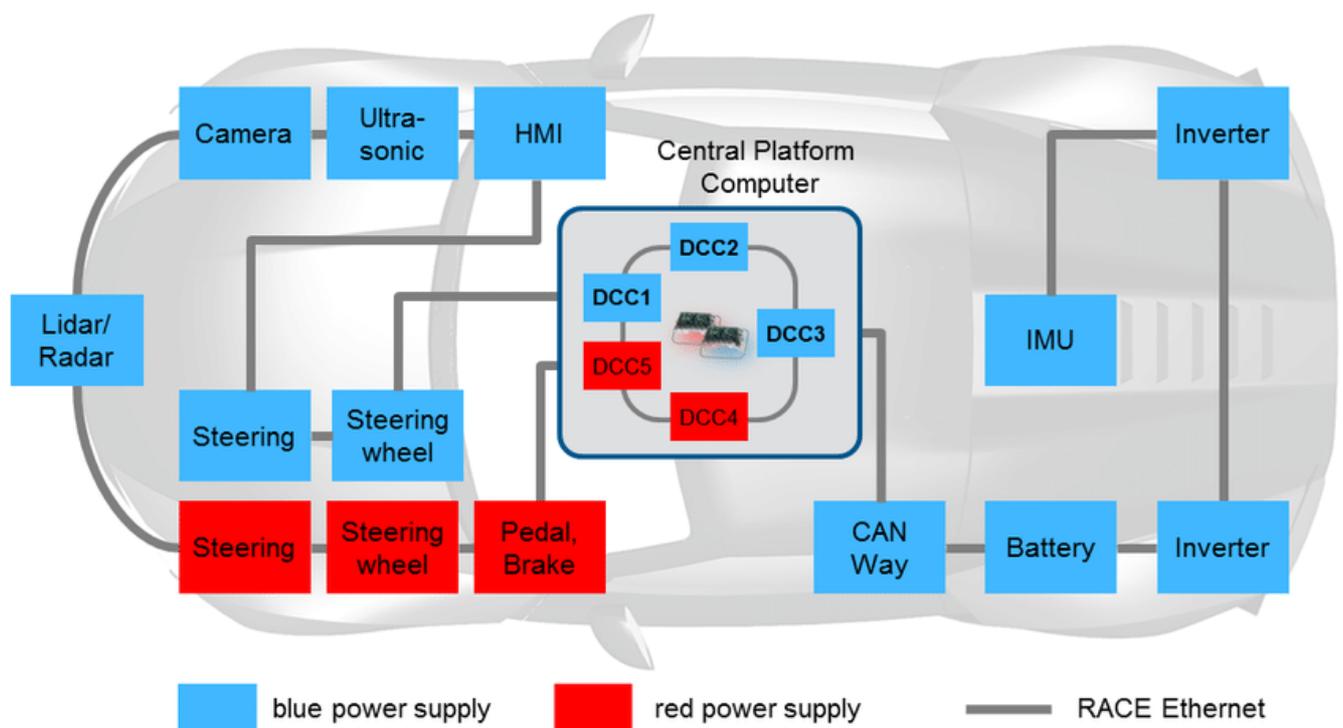
Mr. Arun Shankar was elevated to Senior member grade by IEEE in 2018 and is serving as the Chairman of IEEE-Consumer electronics society for 2019 under the IEEE-Bangalore-Section. Since 2017, Mr. Arun Shankar is also one of the invited business mentors for the India Innovation Challenge Design Contest, which is the country's largest innovation challenge hosted by Industry-Academia-Government collaboratively.

Mr. Arun Shankar is an Electronics and Communication Engineer from the University of Mysore and has also completed an Executive General Management Program from Indian Institute of Management, Bangalore.

*Related Readings*

**An Automated Electric Vehicle Prototype Showing New Trends in Automotive Architectures**

Abstract—The automotive domain is challenged by the increasing importance of Information Technology (IT) based functions. To show the possibilities of modern IT systems, a demonstrator car was developed in RACE (Robust and Reliant Automotive Computing Environment for Future eCars) based on a completely redesigned E/E architecture, which supports the integration of mixed-criticality components and offers features like Plug & Play. This paper presents the architecture and components of this vehicle prototype, which is equipped with modern systems such as Steer-by-Wire without mechanical fall back. It was designed to support future driver assistance systems, e.g. to carry out autonomous parking maneuvers onto an inductive charging station, a task, which is hard to achieve accurately enough for a human driver. Therefore, a special emphasis lies on the description of the sensor set for automated operation



*E/E Architecture with Central Platform Compute*

*Courtesy & Source*

<https://www.researchgate.net/publication/307804303> *An Automated Electric Vehicle Prototype Showing New Trends in Automotive Architectures*

Amazon has placed an order for 1,00,000 electric delivery vehicles with Rivian. The order follows a \$440 million (approx Rs 3119.18 crore) investment made by the online shopping giant in the EV start-up earlier in the year. Amazon led a \$700 million (approx Rs 4962.34 crore) investment round in Rivian in February 2019. The online retailer says that this massive order is the largest ever made in electric delivery vehicles. Rivian has attracted high-profile investments from other firms as well, including Ford – with which it is working to develop future electric vehicles.

# Innovation and IBM

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and

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## Introduction

“Dedication to every clients’ success” and “Innovation that matters, for our company and for the world” are key principles of IBM. How is IBM one of the few companies to survive and thrive for 120+ years through the exponential changes in Information Technology. With many patents, national awards, and Nobel Prizes? Chalk it up to our “Culture of Innovation”, whether it is 26 years of patent leadership, beating human contestants on the “Jeopardy” game show or speeding up knowledge search and analysis for cancer treatments. We will review essential requirements for innovation and differentiating methodologies we use. The emphasis is on not getting in the way of people but directing them towards value, both business and societal.

## Essentials of Innovation

There are four primary elements in an Innovation management program as shown in the Figure 1

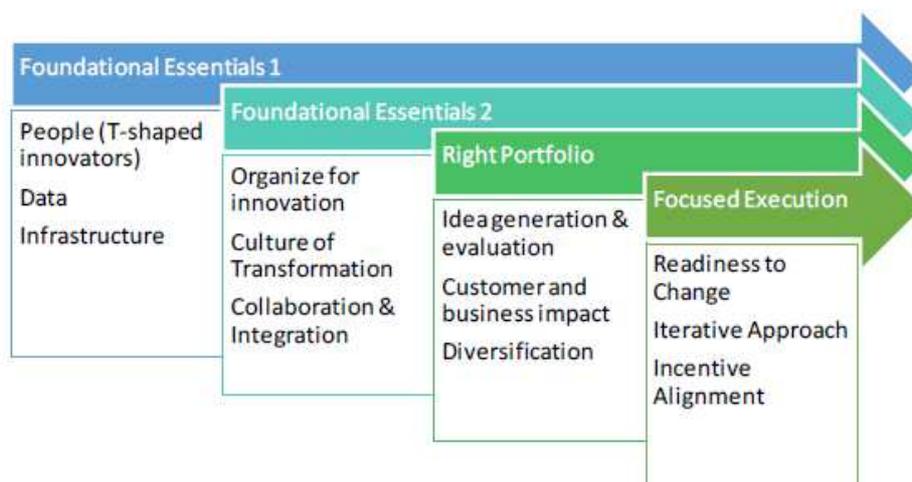


Figure 1: Elements for digital innovation management

First two elements are about preparing the organization for the seeds of innovation.

The first element is more around tangible things like creative people, data preparedness and investment in the right infrastructure.

- Innovative people are at the heart of it, and good news is that everyone can be innovative – it just needs a mix of expertise. When IBM invested in creating the field of Services Research in 2000, we introduced the concept of the “T-shaped” individual - breadth and some experience in many areas and depth in (at least) a few areas, both on business and technical sides. There is also a need for leadership, motivation and creative thinking skills. Nowadays we talk about STEAM rather than STEM - Science, Technology, Engineering, Arts, and Mathematics, because the design of the human interface to efficiently transfer information has become an essential part of designing an application.
- Data preparedness – More often than not, this is the area where we see lot of ideas tripping, especially as most of cognitive technologies need a good history of quality data as the starting point. In many analytics projects, 30-50% of the time may be spent in collecting and curating the data to be uniform, clean, and filtered enough to be able to depend on the results for business-critical decisions. Many companies are proactively investing into data management platform, even when the use case is not completely clear, to enable them to leverage opportunities which will arise in future.

- Infrastructure – People and good quality data will need access to right compute platform to test out the ideas quickly and do the initial prototype. This is where companies need to think about a target platform, which take care of their data needs and computing needs (machine learning/AI/blockchain etc.). “Right” platform is not just about the features, it is also about the scalability – horizontal and vertical. Can we start small with a pilot (“Proof of Concept” or PoC) and quickly productize and scale the platform without much additional work as user base increases (horizontal) or as more components are needed (vertical)? Can the developers collaborate easily? How mature is DevOps capability? etc. Here a standardized development platform and operating environment like IBM Cloud helps reduce the time and resource needed to get to a Minimum Viable Product (MVP).

The three items above greatly reduce time and resource requirements, and improve success rates and value, of any pilot projects that are undertaken.

The Second element is more around the intangible essentials.

- Does the organization structure support innovation? While there is a merit for operational people getting involved in generating innovation ideas and helping them implement it. This normally works well only for small incremental innovation. For the bigger ideas, there need to be a more formal way of supporting innovation.
- Another key element is culture of transformation. Have we banned the phrase “We always did this way” or “Nobody does it that way” from our meetings? Have we created a safe environment for people to share ideas from the science lab to the manufacturing floor? Have we made people comfortable with failure? etc. etc.
- Last but not the least is collaboration. Research has proven that highly successful teams collaborate more. In IBM, we have taken focused efforts to create cross-brand forum like The IBM Academy of Technology, representing IBM’s 200,000-strong technical community, where people from various business units can collaborate on an initiative. Some of the external facing programs give a higher weightage to programs with customer collaboration, thus encouraging teams to find sponsors and champions in the customer organization. Another key investment in our talent is ability to move between different kinds of jobs and re-train for new skills – We have an education and learning unit with a key focus on our own employees.

The Third element is about building a right portfolio of ideas. This requires fostering idea generation, idea management programs to ensure right ideas are taken forward, there is a healthy mix of idea on various dimensions –

- Product/ process/ service,
- Incremental-low hanging/ Radical – world changing
- Solution themes (visibility/ analytics/ cognitive)

These ideas are the seeds – some of which will grow to be big trees in due course of time. We crawl first, then walk and run.

So, now we have the right portfolio of ideas, and the right garden bed for these ideas. What is needed next is an eagle-eyed focus on execution. Some of our major lessons learnt in running innovation programs are:

- Readiness to change: Operations/Business need to be ready to change, and readiness to change cannot be just wished or mandated. We have tackled this challenge by using a 3-in-a-box leadership concept, where all initiatives were led by a business leader, a change management leader and a technical leader. Without active participation by the business unit that will take over the project, the pilot will not grow into a robust plant but instead will die away. One issue here is that for futuristic ideas originating in research teams, existing business units sometimes do not have the skills to run these new programs. In such cases, we transfer an entire team of researchers, designers, programmers, etc., along with the newly developed products, to ensure the success of the new program. These employees can then be “recycled” back into research and development in a few years, coming back with invaluable experience in productizing and working with customers to build business value, (Building their “T-shaped” capability)
- Iterative deployment: It is ok to start small and build in phases. There is no shame in failing early, failing fast, learning, extracting the valuable bits, and moving on. Failure is nothing but an opportunity to decide how to refine the initial idea.
- Incentive alignment: For any significant idea, there will be multiple stakeholders. One of the leadership challenges is to ensure that incentives of all these stakeholders are aligned. We have seen in our experience that we start many innovation programs, where the responsibility of innovation success lies only on the innovation leader (chief innovation officer/chief digital officer etc.). These programs invariably move very slow, as the business has not much skin in it, and they are swamped with their daily operational issues. Further, we have also seen how some of these programs move very fast, when the business leader’s goals are tweaked to add the innovation/digital roadmap success.

## **Innovation culture and Transformation**

Every organization has perhaps tried several versions of Innovation Programs, either internally or suggested by third parties. It does not matter where the program comes from – without emphasis on cheap, quick, “fail-and-learn”, and matching to the culture of the corporation it is highly likely that the program will not be able to demonstrate value to the business in terms of improved performance and speed of product development, deployment, or improvement.

From IBM’s own wrenching experience with Transformation in the early 1990’s, we have learned the importance of culture transformation, starting at the executive level, executed by the middle management, and being clearly communicated and propagated down to every working individual. The demonstration of a path to “re-skilling” or “new-skilling” through internal education is key because many of the new roles are best filled by loyal employees. This is also discussed above under “Readiness to Change”.

A key issue related to projects we undertake is what NOT to do. With the advent of AI and the potential to outstrip human capability to control it, IBM has focused on both ethics and the individual’s data privacy in reviewing all ideas with an AI Board that considers all these aspects in addition to business value before deciding to proceed.

## **Discontinuous versus Continuous Innovation**

Looking back on IBM’s century of technical invention and discovery, there are two major types of innovation. The first type is “Discontinuous Innovation”, where a lab discovery leads to a new, significantly different, technology and useful product. In the context of inventions related to IT, we have example such as RISC, magnetic memory (Hard-drive storage), silicon-germanium chip technology, and many more. Other inventions of this kind lead to new product areas, such as high-temperature superconductivity (Utilized in the power industry), laser-ablation (Utilized for eye surgery), fractals geometry (Utilized in visual imagery), etc. This is where it is very important to allow “wild duck” scientists to keep tinkering in the lab to come up with these unexpected discoveries.

Cross-collaboration is a key factor here to generate unexpected results. One method we used in IBM Research was to send a coffee cart around the building with free coffee. People would congregate around the cart, talk to each other and exchange ideas, and new concepts would be “invented”! Even the architecture of the IBM T. J. Watson Research Center was designed to encourage scientists to come out of their labs and offices for the outside view and thus meet each other and collaborate.

The second type is “Continuous Innovation”. Scientists and engineers continue to make incremental improvement on a day-to-day basis in an existing product, and over time this results in significant advancements. One of the best examples is Moore’s Law in semiconductor technology. It is actually an observation (“Doubling of density transistor every 2-3 years”) that is a result of mostly continuous innovation (with some discontinuous innovation thrown in), which has resulted in many orders of magnitude improvement in logic/ microprocessor chip transistor density, storage chip, and storage hard-drive bit density and power over the past 6-7 *decades* (This resulted in a modern-day cell phone containing much more memory and processing power than the IBM computers that put Apollo 11 on the moon !).

## **Grand Challenges**

IBM has focused its Innovation around “Grand Challenges”. They help focus the organization around a large visible goal that makes the employees feel good, as well as solving real-world problems which are quickly translated to business value for clients.

This started in the 1960s with IBM computers being part of the Apollo program that put humans on the moon. Another big bet in the 1960s was the IBM360 mainframe, which continues 50 years later to be a huge mainstay of IBM’s (and the world’s) business.

In 2000s, through an IT “Innovation Jam” involving more than 50% of employees, we came up with a new set of grand challenges that became the basis of our “Smarter Planet” program. Examples are reducing wastage in the food supply chain, reducing energy consumption worldwide, improving health outcomes.

One can consider that IBM’s Watson, the competition and Win in “Jeopardy” Game Show on television, its extension into improving analysis for cancer cures (“Watson for Oncology”), and the recent news around IBM Watson “Debater” debating humans, are other examples of such Grand Challenges.

## **Some Examples of Cross Pollination**

Cross-pollination is a method whereby inventions in one area of science turn out to be useful in a completely different and unexpected area. It is the very essence of Innovation!

When IBM Research obtained one of the early excimer lasers for experimentation, scientists from different disciplines got together. They started playing around using it on leftover meat from the cafeteria! They found they could remove layers of tissue without damaging the underlying tissue. This resulted in a technology and patent that became the underlying basis for laser ablation eye surgery! For this work, IBMers James Wynne, Rangaswamy Srinivasan and Samuel Blum received the USA National Medal of Technology in 2013.

As a second example, the techniques of statistical analysis and prediction we had used in our semiconductor manufacturing fab line to improve chip yield were utilized to monitor and help predict premature infant health, to the point that the computers could predict health declines many hours in advance of even expert nurses.

As another example, the chemistry expertise (People, technology, and equipment) that was used to develop photo-sensitive polymers for use in the manufacture of chips was utilized as the basis for creating the first “green” recyclable thermosetting plastics.

As another example, the question-answering inference system that was used by IBM Watson to win “Jeopardy” game show versus humans was used to develop a product (Watson for Oncology) to speed up analysis of patient genomic and drug test data to determine what was likely to be the optimum personalized treatment for patients. While of course the reason for doing the original “Jeopardy” was because of the offshoots of the technology being developed into product, the actual specific results are sometimes a surprise.

### Conclusion

To sum up, Innovation, by its nature, cannot be fully structured; it needs chaos. It’s very difficult to manage chaos, because virtually anything may develop, and the existing organization is only able to recognize and develop a limited set of areas (or markets, etc.). That’s why we need multiple programs and initiatives, each addressing specific elements or sub-elements of the innovation space.

An Innovation leader’s job is to put a loose structure on this seemingly chaotic state and ensure that end to end lifecycle of problem identification, idea generation, incubation, prototyping and operationalizing is maintained.

It’s also critical to BOTH (a) NOT to kill any ideas coming from unexpected places or heading in unexpected directions, and (b) Kill ideas that have been evaluated/prioritized as not beneficial to a business, while convincing the employees to learn from the failure and continue develop other better ideas.

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### About the authors\



Dr. Subbanna is currently Director of Innovation and Technology Evaluation, IBM Corporate Strategy. He is involved in working on developing innovative solutions with and for clients, especially financial and industrial clients. Focus areas are Industry 4.0, Cognitive, and innovation culture. He also works on IBM strategy for future technology development and evaluation, using innovation in technology and business models. His focus is in the area of analytics solutions, client experience, reconfigurable computing systems and IT future workload acceleration. He has talked about Innovation at various international events. Prior to this, Dr. Subbanna was Director of Systems Hardware Intellectual Property Licensing and Partnerships. In 2005, he was Director of Early Technology Development at IBM Albany Nano-Technology Center (ANT), driving the early setup of a global multi-billion-dollar collaborative Research program with the State of New York at the University at Albany. During his 20+ year career in IBM, he has worked on strategy, culture of change, customer satisfaction, intellectual property evaluation and licensing, advanced CMOS process technology and memory development, very high-speed Silicon-Germanium mixed-signal technology, and server technology. He has over 50 publications and 50 patents to his credit, including many invited talks. Dr. Subbanna received his B. Tech in Elec. Eng. from IIT Bombay, and M.S and Ph. D. in Elec. Engg. and Materials Science from the University of California at Santa Barbara.



Dr. Sanjay Prasad is currently employed with IBM India as a Chief Data Scientist and is responsible for AI/Machine Learning applications in industrial sector. Sanjay has rich industry experience and has worked for large organizations like Coal India Ltd, Steel Authority of India Ltd, i2 Technologies etc. He is actively involved in the academic circles and has delivered lectures in institutes like IISc Bangalore and RIMS Bangalore. He also received Emerald Literati Award for Outstanding Reviewer in May 2013. He has developed a strong interest and expertise in Supply Chain Management, Services Engineering, Data Mining, Machine Learning, Game-theoretic modelling and Optimization Modelling. Sanjay received his B.Tech. degree in Mining Engineering from IIT(ISM) Dhanbad in 1993. Following that, he completed PGDM from IIM Ahmedabad and Ph. D. from IIT Delhi.

# Industry 4.0 wave - Relevance of SCADA in an IOT world and journey towards a true digital enterprise

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Industry 4.0 revolution has gained significance as well as mindshare of many organizations. Many organizations are exploring new ways to leverage IoT, its potential, advantages and with expectations to enhance the overall throughput of their existing process automation, by overcoming existing challenges and also integrating the entire value chain of the organization.

The paradigms of businesses have been transformed and disrupted by digitization, and SMAC where the entire value chain is redrawn with every stake holder playing an integrated part. This is best described as the picture alongside.



All along, every segment of an enterprise was an island of processes and information with data exchange happening only on need to know basis, the biggest being the SCADA. Democratization of data in a much federated enterprise is the new age mantra of digitization. Currently in large manufacturing and process oriented enterprises like the Steel, Power, Refineries, the most often asked questions “will IoT replace Supervisory Control and Data Acquisition (SCADA) in a new era for manufacturing?”, “How can IOT help me in leveraging existing SCADA?”, “I already

have process automation, have implemented any a latest technologies to enhance my existing SCADA, do I still need IOT?”.

Integrated organizations are adopting digital blocks to drive a true new age Digital enterprises

Manufacturing is a very mature, highly automated industry where technology adoption curve is very high and steep, also a place where integrated centralized systems like SCADA played a significant role. Since there is a new tsunami of data generated from IoT, which when analyzed creates a whole new value paradigm, existing SCADA systems need to be all the more relevant in not mere running the processes efficiently but to enable upstream and downstream value creation. Creating intelligent systems that **learn, adapt and potentially act autonomously** rather than simply execute predefined instructions is the direction most of the enterprises are heading to.

IOT thus paves a new path and opens new doors to a true digital enterprise by leveraging the internet, interconnected and discreet systems, allowing a strong interface between applications and hardware. SCADA has helped manufacturing industries to monitor and control their processes and provide some sort of semi integrated control, which over the past



decade or so has delivered significant results in decreased operational costs and increased efficiency. The journey of driving efficiencies and operational excellence is never ending. IOT integrated with SCADA just provides that missing link.

SCADA systems have been in use for over 3 decades now. Over the time most of the managers and decision makers in these industries have not adopted the rapid technological changes which have taken place in the process industry. All along SCADA has done a great job in various industries in providing the right data to monitor and manage their and processes primarily delivering efficiencies. It also helped boost

the efficiency of operations and reduce costs. Today just mere optimizing on efficiencies is not enough. With technological advances expanding the range of both systems and monitoring methods, and as the world connects via high speed smartphones, internet and associated cloud technologies, explosion of data on real time basis on every connected component in the process chain, some believe that perhaps SCADA has had its day.

Hence it's all the more natural that there is confusion among professional discussions around the role of Industrial Internet of Things (IIoT) applications. Questions like, "Can IoT replace SCADA?", "Can the two be integrated?" and "What is the difference between IoT, SCADA & PLC?" always arise.

Essentially, IoT should be viewed as a technology that is implemented on top of SCADA. IOT provides the much needed advantages of scalability, data analytics, and standardization and interoperability opportunities which help the alignment of the industry to the rapid changing business demands. IOT is to be seen as beyond SCADA for SCADA.

### SCADA – then and now

First of all, let's take a quick recap of how a typical SCADA works. It is an end-to-end system that receives data from Intelligent Electrical Devices (IEDs) or Remote Terminal Units (RTUs), which are connected to sensors through a communications network. SCADA has the following minimum features:-

- Graphical interface
- Process mimic
- Real time and historic trending
- Alarm system
- Data acquisition and recording
- Data analysis with Report generator

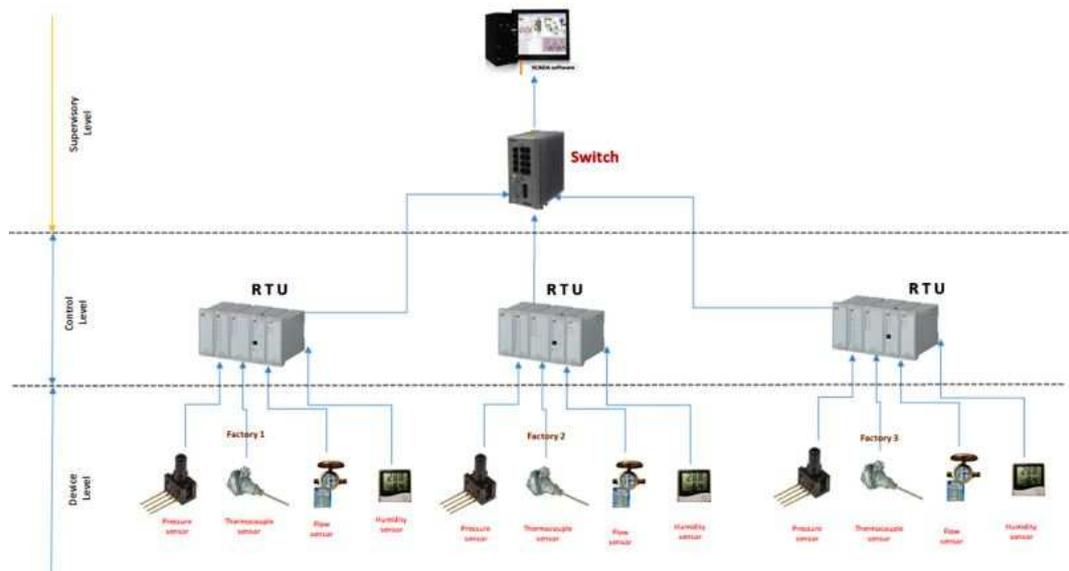
The system then analyzes this data and sends commands back to the field, with individual SCADA applications often working simultaneously. The SCADA systems interfaced with the hardware which typically is the instrumentation and field systems data acquiring systems and telemetry.

- **Standard communication protocol:-**Common communication protocols used in industrial field are: ARCNET, CAN bus, Modbus, PROFIBUS. If SCADA software and hardware devices use same communication protocol, they can talk to each other without any other extra software drivers.
- **Standard data exchange interface :-**Common data exchange interface used in industrial field are: DDE (Dynamic Data Exchange), OPC (OLE for Process Control), Using standard data exchange interface, SCADA software can indirectly communicate with hardware devices via data exchange center of DDE and OPC. The advantage is that irrespective of hardware devices supporting standard communication protocols manufacturers only need to provide one DDE or OPC driver to support most of the SCADA software.
- Native driver

In early days, the SCADA systems were also used to control and monitor processes and interfacing with monolithic mainframe computers like the IBM 3090, VAX/VMS. During that era that architecture of mainframes at the highest layer of EIS, followed by SCADA, then process control computers and lowest being the instrumentation was the key. With the introduction of advanced graphical user interfaces (GUIs) and mass configuration tools, it became more efficient and accurate. :-

SCADA systems mostly comprise:

- **Programmable Logic Controllers (PLCs) and Remote Terminal Units (RTUs):** These are hardware components that interface with the machines and control them. They are responsible for interfacing with sensors in the machines. All parameters that require monitoring are available here. PLCs and RTUs are organization (s) r interfaces to the machine world.
- **Data Acquisition Systems:** These are centralized systems that collect data from PLCs and RTUs. The connectivity could be wired (Modbus, TCP) or wireless. OPC (OLE for Process Control) is a recommended way to connect to organization (s) r hardware.
- **Supervisory Systems:** Systems that allow supervisors to monitor their machines. These systems do real-time condition monitoring, raise alarms when thresholds are breached and ensure that organization(s) r machinery works optimally.
- A Typical schematic diagram of SCADA is as shown :-



### SCADA – the foundation for operational excellence

SCADA systems functioned perfectly for supervisors with very high reliabilities offering the day-to-day monitoring of key processes on what is going on in the factory, on a near real time basis. SCADA systems were much localized and dedicated with proprietary communication, no internet connectivity and there existed a china-wall separation between the application management software of the mainframes, various other enterprise applications, machines in the field and other upstream and downstream systems. Interaction of other enterprise systems with SCADA was in batch mode and mostly manually intervened.

The SCADA system performs some major functions that allows a company to successfully automate complex industrial processes such as human-machine interface (HMI), electrical communication, data acquisition, monitoring, control, data collection, calculation, and report generation. For many industries, all these functions are vital in order to have a stronger control over processes.

With the changes in the business requirements, advancements in the technology, changes in the business environment, significant drop in storage and computing power, there has been a significant demand to drive integrated systems, automated feedback and control right up the business decisions. This is where IoT solutions come in when organization(s) have more macro level questions to ask. Questions like:

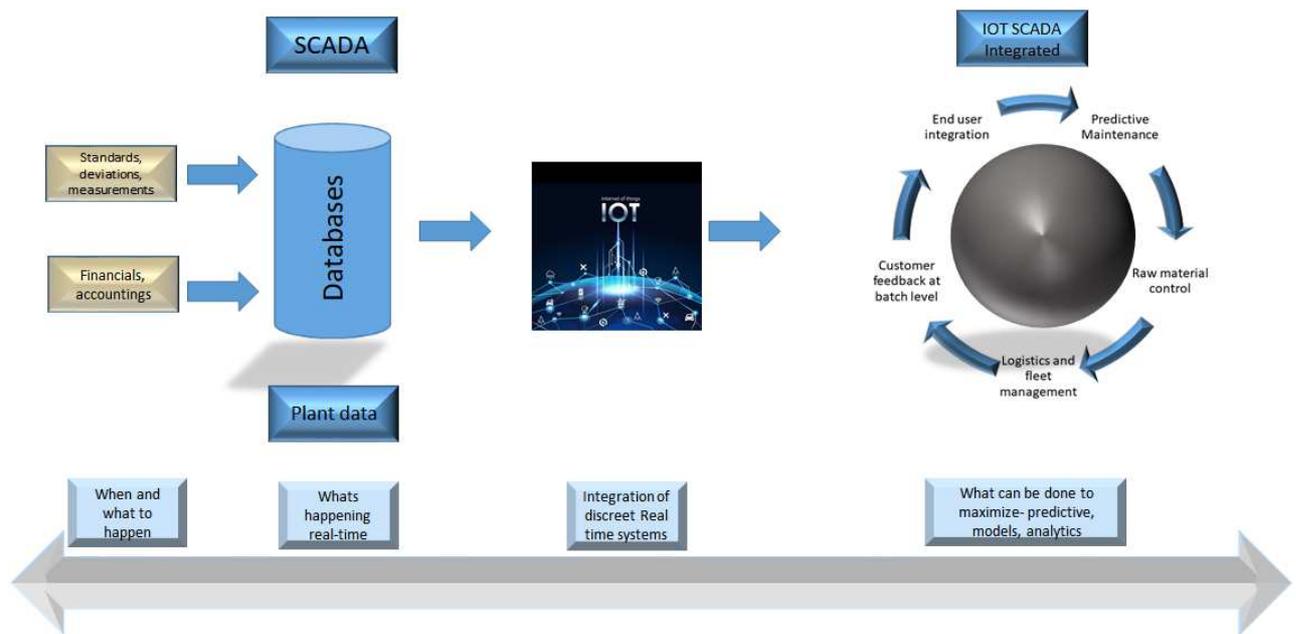
- What is my operational effectiveness across machines, assembly lines and plants? What can I do to improve it?
- What are my bottlenecks, where are they located?
- How can I eliminate these bottlenecks and can I be more proactive and predictive about these?
- What process changes can I do to improve performance, can I make these decisions based on data analytics, past performances, leverage predictive models etc.?
- How can I do a planned vs actual comparison on more factual data and decisions which are driven by analytics?
- Can I predict machine failure? How can I move from calendar-based maintenance to predictive maintenance?
- Can I leverage internet and truly make the entire decision making seamless, anytime anywhere?
- Can I have discreet systems speak and communicate seamlessly?
- Can I connect the upstream systems to the downstream systems on real-time over the internet and enhance the value chain?

These questions are extremely relevant to plant managers, production supervisors, capacity planning personnel and productivity consultants. IoT in manufacturing is meant for this audience

Position of IOT in the world dominated SCADA by can be best illustrated as below

So, SCADA systems which are predominant within heavy asset industries can be reconfigured to adopt the IOT. With three generations of SCADA – standalone, distributed and networked – some industries are starting to utilize what some known as the fourth generation SCADA application. Some also know this to be the Internet of Things.

As the fourth Industrial Revolution is making significant inroads in the consumer behavior and buying patterns, it's time to Re-align the manufacturing processes and get them integrated seamlessly. Implementing fourth generation SCADA with the disruptive capabilities of IoT seems very befitting.

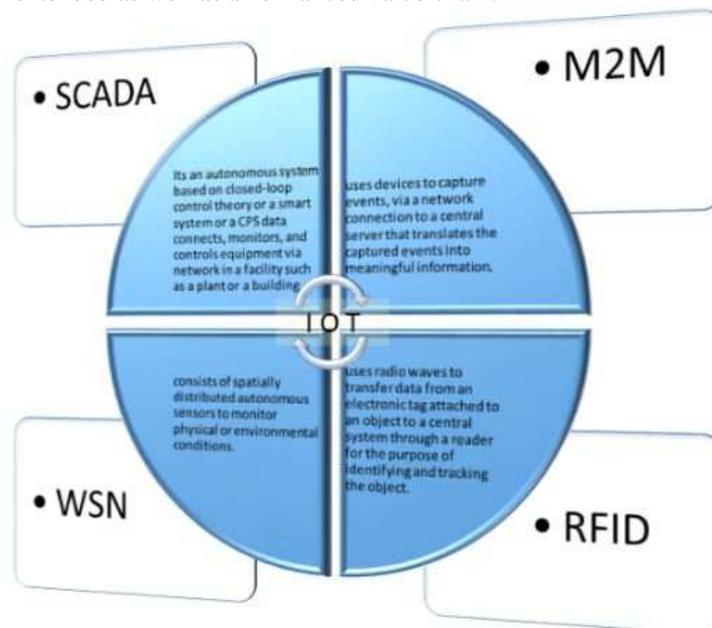


### SCADA a key partner in IoT

IoT begins where traditional SCADA, DCS end.

IoT is complimentary to SCADA and DCS. Rather IOT adds value to SCADA and extends SCADA and its value chain to make business more predictable, reduce cost, wastages and improve profitability. Information generated from SCADA systems acts as one of the data sources for IoT. SCADA's focus is on monitoring and control. IoT's focus is firmly on analyzing machine data to improve organization(s) r productivity and impact organization(s) r top line.

The four pillars of IoT are M2M, RFID, WSNs and SCADA (Supervisory Control and Data Acquisition). These four discreet pillars would have been added at different points in time, with in the advent of IOT all these discreet systems are **being** integrated to deliver an extended as well as an enhanced value chain.



### The Internet of Things (IOT):

The Internet of Things is a culmination of advances in connectivity hardware, data networks, cloud computing and big-data processing. IoT begins where SCADA, DCS, and Historians end.

A typical factory is an extremely heterogeneous environment that has grown organically over several years and in some cases over decades. Some of the challenges seen are:

- Machines with different kinds of PLCs and RTUs that support different connectivity protocols.
- Multiple SCADA systems from different vendors, each controlling a specific line or a set of lines. Machine data is available but there are data islands. SCADA systems also store a finite amount of data so historical data is not preserved for deeper analytics.
- Data is stored but the context of the data, the various “environmental” considerations are not captured
- The SCADA systems are always at a point in time data, Integration and driving analytics for data from SCADA, cognitive data, unstructured data is possible only in the IOT world.
- Legacy machines that are not connected as they lack the right kind of instrumentation.
- Assets like Energy Meters, weather monitors, usage patterns, etc. that have never been connected due to cost overheads. Yet the information that they give out is vital.
- Existing data Historians can be a data source.

IoT platforms act as a federated data store of all these diverse data sets. They give organization(s) a single source of truth for driving business decisions, adapting business demands and initiate automatic production changes both internally and externally on a much more dynamic and informed ways.

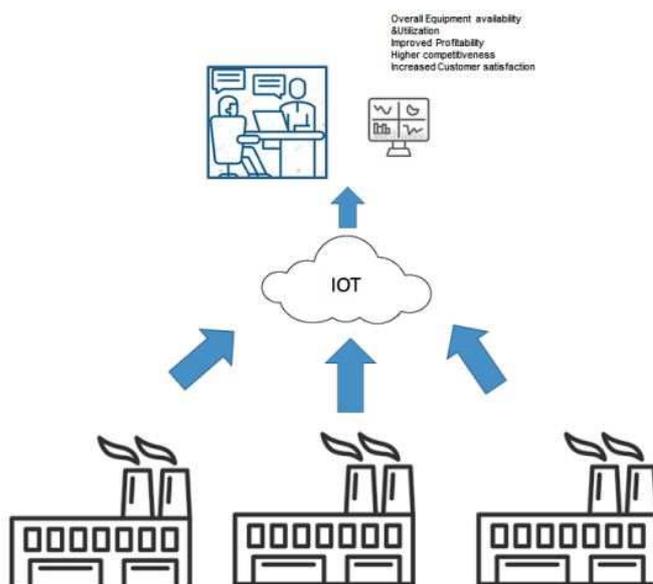
### IoT platforms have the following capabilities.

As IoT gains focus and traction, a lot of existing SCADA systems and Historians are providing IoT like features. However, they can never replicate the capabilities of a platform built ground up with IoT in mind. Along the way, SCADA systems have redesigned themselves to keep up with all the emerging technologies that surround everything. The next big question is how companies, that used traditional SCADA systems, will move to the modern ones, which also include IoT deployments. Well, like any other transformation initiative, a carefully planned strategy is required.

The first step is to identify a right IOT platform which has the ability to provide a diverse set of adapters and connectors that can connect to various machines, SCADA, DCS, and Historians.

- **Metadata driven architecture.** Organization(s) can connect anything: machines, vehicles, barcode readers, solar panels, weather stations and have the ability to process data across all these sources together.
- **Complex Event Processing (CEP):** The ability to do real time complex stream processing of data from multiple sources.
- **Big-data processing and machine learning:** The ability to analyze large amounts of machine data. The ability to apply modern supervised and unsupervised machine learning algorithms to predict outcomes
- **Extreme scale:** The ability to ingest and process massive amounts of machine data. This allows organization(s) to connect anything of relevance.
- **Cloud-first and SaaS first:** Built with the cloud in mind and provides flexible, affordable pay-as-you go plans. Systems that provide the ability go private when the situation demands.
- IOT can create the much needed plat form interface for discreet SCADA’s to interface and interact as shown below

Here are some of the factors organization(s) need to have in mind when migrating to a modern SCADA/IoT system.



- **Device type** – First thing to do is to decide which of the IoT devices will remain in-house and which ones will be moved to the cloud. As most of them are storing valuable information and data, security is essential wherever the devices will be located.
- **IoT Standards** – There are certain IoT standards that organization(s) must take into consideration when moving to modern SCADA systems. Some of them are OMG Industrial IoT standards, which is working with the Data Distribution Service, the Threat and Risk Model standard and the IEEE IoT-related standards, which identifies the common areas between IoT domains.
- **Network Segmentation** – This is a crucial step in ensuring business continuity. We all know that network segmentation can save a business. If something goes wrong, it is better to have only one segment down rather than the entire network.
- **Predictive analysis** – This technology plays a major part in bringing out the best functionality in SCADA systems. Choosing predictive analysis solutions will give organization(s) a glimpse into the future and insight into organization(s) system's weaknesses and solve problems before they become one.
- **Key Use cases:** - Identify the key use cases which have the highest impact on business outcomes, provide significant competitive advantage and also there is a strong ROI and financial justification for such an investment.
- **Define enterprise cloud strategy** – Before deciding which type of cloud organization(s) choose, private or public, organization(s) need to consider which one is the best for organization(s) business needs. Do organization(s) need enhanced security? Then the private cloud might be best. Do organization(s) need speed and scalability? Then organization(s) should consider a public cloud. If organization(s) business requires more than just speed or security, then organization(s) should consider hybrid cloud which comprises a mix of both cloud options.

If one takes a closer look at how existing SCADA is implemented and operational, we can see some preliminary elements of IoT – supervisory control and data acquisition. We can safely say that SCADA represents some of the pillars on which the Internet of Things has been built. However at every new age transition stage, one need to be aware of the current capabilities and limitations of SCADA:-

- SCADA systems are not scalable. The Internet of Things has the ability to bring in and process large amounts of data from things and machines. IoT allows any company to connect any device and third party services. All the data is collected into an IoT platform, accessed securely with login credentials. Several people from companies and industries can access to the data (or subset of data or subset of devices). Even in the cloud, new resources can be generated.
- SCADA is a system used for a day-by-day operations in a control room or similar. Nevertheless there is no data analysis to check the performance, integration with CRMs or ERPs and finally there is no contextual information connected to the SCADA. On the other hand, IoT is all about data analysis, Big Data processing on the top of the data, such as AI algorithms, ML and predictive.
- Protocol such as OPC, OPC-UA and others are the standards today on the industry. On the top of that, on IoT there are a dozen of other protocols that can help industries to get connected or to get real-time notifications. MQTTS, HTTPS or CoaP with TLS can help industries plus bring a security layer needed to encrypt the messages and information.
- Integration among devices and manufacturers are not easy on SCADA systems. Usually in Domestic Automation, organization (s) need to have devices from the same manufacturer with the same version. If that does not happen, it's usually almost impossible to easily integrate devices on the current SCADA. There is no presence of horizontal platforms that are operable across devices. On the other hand, on IoT this is one of the most beneficial features for an industry. Standard protocols such as MQTT enables platforms to communicate with each other even if there is a different vendor.

Ease of installation, reduced cost, increased data accuracy and worldwide remote control and monitoring are all things that IoT offers heavy asset industries. However, as IoT is a relatively new technology in relation to SCADA and PLC, its capabilities are naturally adaptable to modern industry demands. That being said, when SCADA began, it allowed manufacturers' systems to work together in real-time, much like IoT is doing now.

Therefore, it's very much apparent that the strength of SCADA systems and its technological capabilities are still relevant even in industry 4.0. Where it falls short, however, is processing to the rest of a business to create a truly connected ecosystem. The question shouldn't be about getting rid of or replacing SCADA, but rather extending SCADA, into what? Currently, IoT is revolutionizing SCADA by offering more standardization and openness. IoT is also providing scalability, interoperability and enhanced security by introducing the concept of the IoT platform. Essentially, both platforms are used to increase overall productivity by integrating smart maintenance. As well as waste reduction, increase in efficiency, a decrease in downtime and the extension of equipment life.

	Traditional SCADA	IOT
Scalability	In SCADA systems, due to the <b>traditional architecture</b> , the performance is fixed for a given number of devices, cost of extending is prohibitively high and very rigid hard wired protocols which makes newer models difficult to integrate. It's a fixed architecture with a fixed mandate to deliver	IOT implements the Serverless architectures, where the application designs incorporate third-party "Backend as a Service" (BaaS) services, and/or that include custom code run in managed containers on a "Functions as a Service" (FaaS) platform. IOT architecture has the ability to ingest and process a huge amount of data from sensors and allows to connect anything of relevance using protocols like MQTT, HTTPS, XMPP, COAP, REST etc. which is powered by on-demand scalability due to this serverless architecture. IOT is a platform driven architecture, component driven with extensive plug and play features.
Data Analytics	The main SCADA usage is for day-by-day plant operation and ingestion and storage of a finite amount of data without preservation of historical data for deeper analytics. There is history collection and most of the unstructured data is a recent phenomenon.	IOT involves long-term data retention to further analyze the data to predict maintenance schedules, reduce overall downtime, and extending equipment life. On top predictive analysis and preventive maintenance, capabilities are part of it which is supported by Machine Learning, analytics and statistical modeling features module.
Standardization	SCADA systems mostly use OPC for data gathering, it is a standard that has stood the test of time but its major disadvantage is that it relies on DCOM technology and devices cannot collect/exchange data with each other regardless of the footprint.	The primary goal of Industrial IoT is to standardize sensor networks, data gathering, and aggregation. IoT standards such as OPC UA are already being used to define real-time secure communication within a plant having different control devices and sensors from different vendors. Security is baked into IoT standards with support for MQTT, HTTPS, RAML etc.
Interoperability	In SCADA systems, devices not made by the same manufacturer cannot easily integrate. At times, even different versions from the same manufacturer present challenge in making them work interchangeably. Hence SCADA provides distributed business processes which work in silos.	Industrial IoT ecosystems still remain fragmented but there are protocols such as MQTT which enable platforms to communicate across devices regardless of vendor. IOT standards offers a lot of protocols and interfaces which can interact seamlessly, provide literally infinite flexibility to add, drop devices and integrates the hardware and software homogeneously.

Information generated from SCADA systems acts as one of the data sources for IoT. SCADA's focus is on monitoring and controlling. Whereas, IoT is more focused on analyzing machine data to improve organization(s) productivity and impacting organization(s) top line. IoT is essentially a culmination of advances in the connectivity of hardware and data networks that SCADA provides. In short, IoT begins where SCADA and PLC end.

So, while the IoT market is still in early production, it can coexist with SCADA. IoT is bringing about a wave of new business models and technologies that are changing the landscape of SCADA. However, the SCADA paradigm has always been one that is flexible to industry shifts.

### Adapt, Adopt and Integrate

Admittedly, the current legacy SCADA platform is lacking particular innovations, it is monolithic and extremely dedicated and designed to be task oriented with very less options to integration upstream or downstream, the need for IoT would be far more immediate. SCADA is currently being influenced by IoT concepts and solutions that are quickly being integrated into SCADA architecture. This is done so seamlessly that we won't ever notice a difference.

However, SCADA is still currently limited to the factory floor. Data taken from the factory devices are being viewed only inside the plant. Whereas IoT takes that data, offers insights to the users, across the value chain right from the raw materials to the end user and makes it available anywhere, anytime. This, in turn, enables new business models to be created.

### How IoT can help scale up SCADA?

If organization(s) already have a SCADA system in place, organization(s) can integrate the IoT solution with organization(s) SCADA system and collect data from a Data Acquisition Systems (DAS) machine. By leveraging the power and scalability of IoT, organization(s) can use collected data to create a wide range of reports such as Overall Equipment Effectiveness reports, Production Data reports as well as utility reports (gas, water, power).

In the future, it's likely that SCADA systems will evolve into those of IoT. Equipment and PLC will become more intelligent and will be able to integrate different cloud platforms. This will enable new security platforms that will further secure any data that is recorded. This means that improvements that will save money can be performed.

SCADA is more about allowing humans to interact remotely with a process. Whereas IoT is generally used as a machine-to-machine communication tool. Rather than something that exists primarily to present information to a human. That is just a small part of its process. IoT ensures that information is shared with both people and machine, rather than just people. In short, it makes sure that everyone and everything is kept in the loop at all times.

## The comparative analysis

In the end, both SCADA and IoT involve sensors and data acquisition. Although they do differ in many aspects, they both share the one common goal. The optimization of use and, eventually, better control over some devices or a process. The whole idea of a smart grid leads to SCADA and IoT integration. As SCADA is not a full control system, rather a computer system that gathers and analyses real-time data, it is useful in monitoring and controlling a plant or industrial equipment. SCADA primary objective is to control the processes based on the supervisory capabilities, maintain the deviations within limits, gather information about a certain deviation, transmit to a central site and alert the central control center. It will then carry out any necessary analysis and control and display the information in a logical and organized fashion for humans to then interpret and use accordingly.

Since the Internet of Things is made up of a network of physical devices connected via electronic embedding, software setups, sensor-actuators and network connectivity which all act in unison on a set protocol. A set of algorithms and rules, for the objects to connect and exchange data. IoT allows objects to be sensed or controlled remotely across different networking infrastructures. Therefore, it creates opportunities for more direct integration of the physical world into computer-based systems. The IOT also offers the capabilities to integrate batch and real time with a seamless tools of analytics, actuators and intelligent machines. This results in improved efficiency, accuracy and economic benefit and also cuts down on human intervention.

Both platforms offer an abundance of advantages, as well as some vulnerabilities. It is predicted that by 2020, 50 billion devices or things will be connected to the internet. Therefore, the dynamics of an Internet-based control system are becoming a living reality. Industry 4.0 is an era in which emerging trend automation and data exchange in manufacturing technologies are allowing for a shift from traditionally implemented SCADA to an IoT implemented one. With SCADA, cyber-physical systems, the Internet of Things, cloud computing and cognitive computing, Industry 4.0 is an era that will change the dynamics of the entire automation industry.

### Next phase of manufacturing- Has SCADA had its day?

The good news is that SCADA is here to stay and the Internet of Things is the next phase of smart manufacturing that upgrades SCADA by making it more intelligent and smart. IoT complements both distributed control system (DCS) and SCADA by widening existing capabilities like real-time data capturing, anomaly/machine breakdown alerts, real-time control, data logging, data analysis, and visualization.

Let's see how IoT takes SCADA systems to the next level and the traditional SCADA systems stack up

Traditional SCADA	IoT takes it to the next level
Autonomous commands	Data aggregation
Remote monitoring	Predictive analytics (what will happen in the future)
Supervisory control	more informed control based on historic data, patterns and heuristics, Offers prescriptive analytics (What organisation(s) should do and when
Alarms and alerts	Data creates value in multiple applications
Reporting	Enabling analytics, builds predictive models, multiple what-if analyses, new business models
Decrease operations and maintenance costs	

SCADA systems have been doing a great job in monitoring and controlling industrial- and facility-based processes that exist in the physical world, but IoT can process organization(s) r data and bring the intelligence and insights hidden within it.

With the growing number of connected devices, the need for gathering, exchanging and analyzing data has substantially increased. Industrial companies have started observing a growing need for increased interoperability and information transparency to stay ahead of the competition and cut operational costs. Currently, many ISVs provide an IoT platform that is hardware agnostic and use SCADA and other traditional systems as a data source wherein security and supervisory

control are not compromised but enriched within existing infrastructure. Open and secure connectivity options such as AMQP, MQTT, REST, and OPC UA Pub/Sub make such a merged IoT architecture. While SCADA's focus is on controlling and monitoring machines, IoT's focus is on analyzing machine data to increase efficiency that directly impacts a company's bottom line. SCADA works as secure IoT Gateways (or call it Message Oriented Middleware (MOM)), which enables companies to connect edge devices across multiple sites and bring data on a single platform to perform analysis for making better decisions.

At the same time, one should also understand that SCADA has some limitations and that can be overcome with IoT. For example, factories are heterogeneous by nature and it is difficult to manage the disparate nature of the industrial digital ecosystem from a single place. This is where IoT comes into play as it fosters interoperability and data transparency.

Digitization is changing the way manufacturing companies work but SCADA will still be useful in terms of collecting and monitoring the day-to-day operations of a factory or process. IoT empowers SCADA systems and helps manufacturers store an infinite amount of historical data in the cloud for deeper analytics that bring out hidden information to solve long time unresolved problems.

### SCADA in the Smart Factory

The frank reality is that SCADA as an operator interface, and the features that make it obligatory (such as schematic visualization, alarming, data logging, real-time control and the passing of data to data historians), are not going to be completely negated by IoT technology. Not anytime soon. There's no doubt edge computing will begin to engulf certain control features and rationalize the amount of data we choose to push into the cloud over time, but the Industrial Internet of Things will not negate the need to securely open and close valves, start or stop motors or reset an actuator. At least not for assets and processes that require high-speed data collection and control. That's the key. One cannot compare IIoT solely with Data Acquisition (DA), yet forget about Supervisory Control (SC) and the need for reliability, security, fast aggregation and complex data storage. There are of course certain IoT communication protocols, as given below that would need to be present to support the SC + DA elements via the IoT.

Instead of arranging all of the IoT Protocols on top of existing architecture models like OSI Model, the IOT protocols are categorized into the following layers to provide some level of organization:

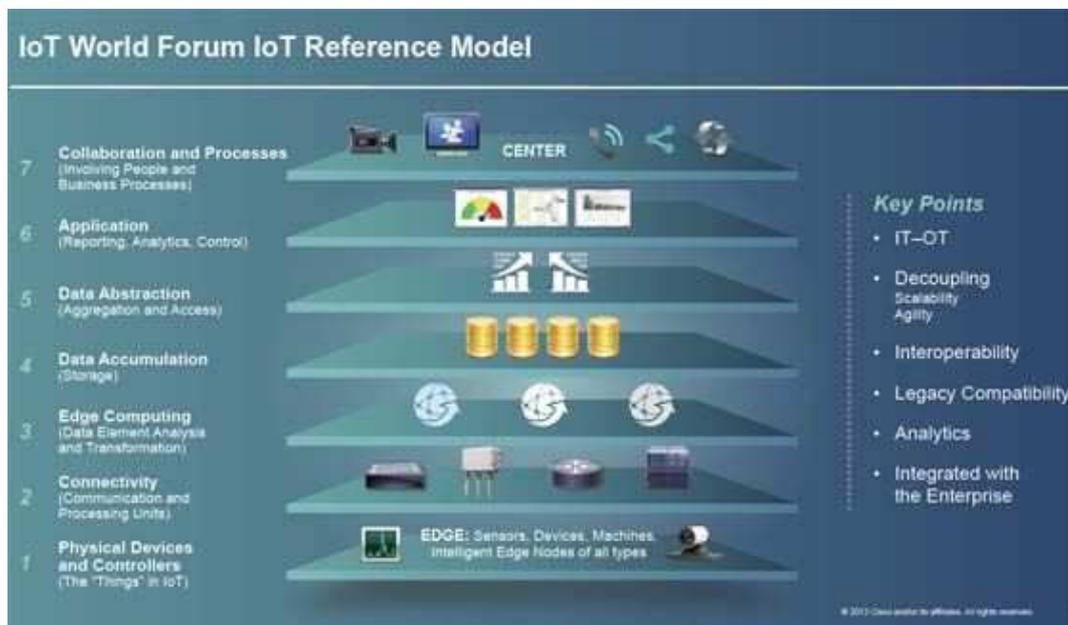
- **Infrastructure :-** (ex: 6LowPAN, IPv4/IPv6, RPL)
- **Identification :-** (ex: EPC, uCode, IPv6, URIs)
- **Communication/Transport :-** (ex: Wifi, Bluetooth, LPWAN)
- **Discovery:-** (ex: Physical Web, mDNS, DNS-SD)
- **Data Protocols :-** (ex: MQTT, CoAP, AMQP, Websocket, Node)
- **Device Management :-** (ex: TR-069, OMA-DM)
- **Semantic :-** (ex: JSON-LD, Web Thing Model)
- **Multi-layer Frameworks :-** (ex: Alljoyn, IoTivity, Weave, Homekit)

### 4th Generation SCADA: Embracing IoT

Some SCADA/Visualization technologies have a propensity to play outside the traditional SCADA / process control arena, and have been doing so for a while. With the rate in which connected devices are gathering, exchanging and analyzing data, the need for interoperability and information transparency has grown. Certain progressive, and hardware agnostic, ISV's have always embraced this need and now natively support key Industrial Internet of Things (IIoT) protocols. Their platforms are able to fulfil the role of a macro-level control and analytical toolset that can unite the IT and OT. Supervisory control and security are not sacrificed but embellished within existing infrastructure.

**SCADA vs. IoT** It is these tools that can and will act as secure IoT Gateways (or Message Oriented Middleware (MOM)), to seamlessly unite edge devices (possibly multi-site) into single analytical view-of-the-world. Remote configuration, open and secure connectivity methods such as REST, MQTT, AMQP and OPC UA Pub Sub are the key to fueling this merged IoT architecture. One of the most apt, yet rudimentary question(s) anyone wanting to bi-directionally control their equipment via the IoT must ask, is, therefore "can, or in the near future will, my current control system platform support open IoT protocols and run natively in the Cloud, without the need for a Virtual Machine (VM) environment?"

To drive rapid adoption and standardizing the entire ecosystem of IOT, the importance of sensors and powerful edge devices was emphasized at the 2014 [Internet of Things World Forum](#) (IoTWF) in Chicago with the introduction of a seven-level [IoT Reference Model](#). The model was developed by the [IoTWF Steering Committee](#), which includes Intel, Rockwell Automation and Schneider-Electric. The lowest level of the reference model consists of physical devices and controllers, and includes sensors, devices, machines and other intelligent nodes.



The heterogeneous nature of the factory of the future paves the way for these additional IoT platforms that can truly unite and manage the disparate nature of the industrial digital ecosystem. After all, interoperability, information transparency and decentralized decisions are three of the four design principles that underpin Industry 4.0 ([Herman et al, 2016](#)).

- **Interoperability** - The ability of machines, devices, sensors, and people to connect and communicate with each other via the Internet of Things (IoT)
- **Information Transparency** - The ability of information systems to create a virtual copy of the physical world by enriching digital plant models with sensor data. This requires the aggregation of raw sensor data to higher-value context information.
- **Technical Assistance** - First, the ability of assistance systems to support humans by aggregating and visualizing information comprehensibly for making informed decisions and solving urgent problems on short notice. Second, the ability of cyber-physical systems to physically support humans by conducting a range of tasks that are unpleasant, too exhausting, or unsafe for their human co-workers.
- **Decentralized Decisions** - The ability of cyber-physical systems to make decisions on their own and to perform their tasks as autonomous as possible. Only in case of exceptions, interferences, or conflicting goals, tasks are delegated to a higher level.

### The 'What Ifs'?

These common trending 'what if' hypotheses which drives the adaption and adoption of IOT in the existing paradigm of SCADA. What if we could...?

- Unite disparate SCADA systems (vendors, versions and protocols)?
- Collect exposed data via web services and IoT communication protocols whilst controlling our process securely in real-time?
- Bi-directionally control a variety of cost-effective IoT devices via a secure IoT Gateway?
- Provision IoT devices and deliver software updates remotely
- Tap into unconnected or ignored energy data sitting in the field or database?
- Apply complex business logic and predictive maintenance algorithms to our operational data and assets without investing in expensive analytical alternatives that require huge data lakes
- Filter inconsequential and subordinate alarms across multiple alarm servers, devices and systems?
- Run post-filtered data, from analytics at the edge, into organization (s) r cloud-based control system

### Conclusion

Digitization is bringing about changes in the way manufacturers operate. For over 20 years, the 'Purdue model' of Computer Integrated Manufacturing has ruled effectively as the foundation of how manufacturing systems are architected, designed and implemented. Its hierarchical, monolithic and isolated model is slowly shifting as a peer-to-peer model of collaboration, interchange and co-existent via the IoT opens up. IOT enhances SCADA into the new world of SMAC,

leverages the power of big data and breaks down the barriers between the decision management systems and the machines. IOT brings SCADA a lot closer to the business relevance and goes beyond mere efficiencies.

### About the author



K. Rajeswar is an independent CXO level advisor on Technology, Strategy and Business excellence. He straddles between Enterprise Technology and Strategy with a clear objective of leveraging technology for every decision. Rajeswar has 30+ yrs of CXO experience in SCADA, Business applications and enterprise architectures, integrating technology into Strategy. He is a regular speaker in academic and industry forums on technology, strategy and business excellence. He can be reached at [rajeswar.rao@gmail.com](mailto:rajeswar.rao@gmail.com), [rajeswar@inspiresolution.in](mailto:rajeswar@inspiresolution.in).

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### Related Readings

**Industry 4.0: the fourth industrial revolution – guide to Industrie 4.0:** Industry 4.0 is the digital transformation of industrial markets (industrial transformation) with smart manufacturing currently on the forefront. Industry 4.0 represents the so-called fourth industrial revolution in discrete and process manufacturing, logistics and supply chain (Logistics 4.0), the chemical industry, energy (Energy 4.0), transportation, utilities, oil and gas, mining and metals and other segments, including resources industries, healthcare, pharma and even smart cities. <https://www.i-scoop.eu/industry-4-0/>

**Industry 4.0 - advantages engineering executives can't ignore:** In an era where interdisciplinary teams are becoming more and more important to the integrated design and manufacturing model, Industry 4.0 holds the promise of the ultimate in teamwork across functional boundaries between design, procurement, manufacturing, and post-sale service. The so-called "Nine Pillars of Technological Advancement" form the framework of Industry 4.0, coming together to automate, integrate, and optimize manufacturing technology. What are the "Nine Pillars"? Here they are: <https://autode.sk/21YuEOZ>

**Industry 4.0 as an evolution, not a revolution:** Industry 4.0 is the way forward for manufacturing enterprises looking to future-proof their businesses. Enterprises will accelerate adoption at scale and fully realize the benefits by understanding fundamental business needs and implementation stages as an evolution with increasing value add. This report explains the logical phases leaders should consider before embarking on their Industry 4.0 journey and help improve the current low rate of successful full scale adoption. <https://infy.com/2X76VwN>

**Industry 4.0: Definition, Design Principles, Challenges, and the Future of Employment:** Industry 4.0 is a term often used to refer to the developmental process in the management of manufacturing and chain production. The term also refers to the fourth industrial revolution. The term Industry 4.0 was first publicly introduced in 2011 as "Industrie 4.0" by a group of representatives from different fields (such as business, politics, and academia) under an initiative to enhance the German competitiveness in the manufacturing industry. The German federal government adopted the idea in its High-Tech Strategy for 2020. Subsequently, a Working Group was formed to further advise on the implementation of Industry 4.0. More at <https://www.cleverism.com/industry-4-0/>

# The world of NDT transitioning from Analog to Digital

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## What is NDT?

In the current competitive environment, quality of production and residual life of assets is of paramount interest to the consumer. There is a growing awareness regarding the need for test solutions that aid in identifying defects or provide an early warning method to help avoid significantly adverse consequences. This has resulted in an increasing market awareness, acceptance and adoption of a breed of mechanical test techniques known as Nondestructive Testing (NDT).

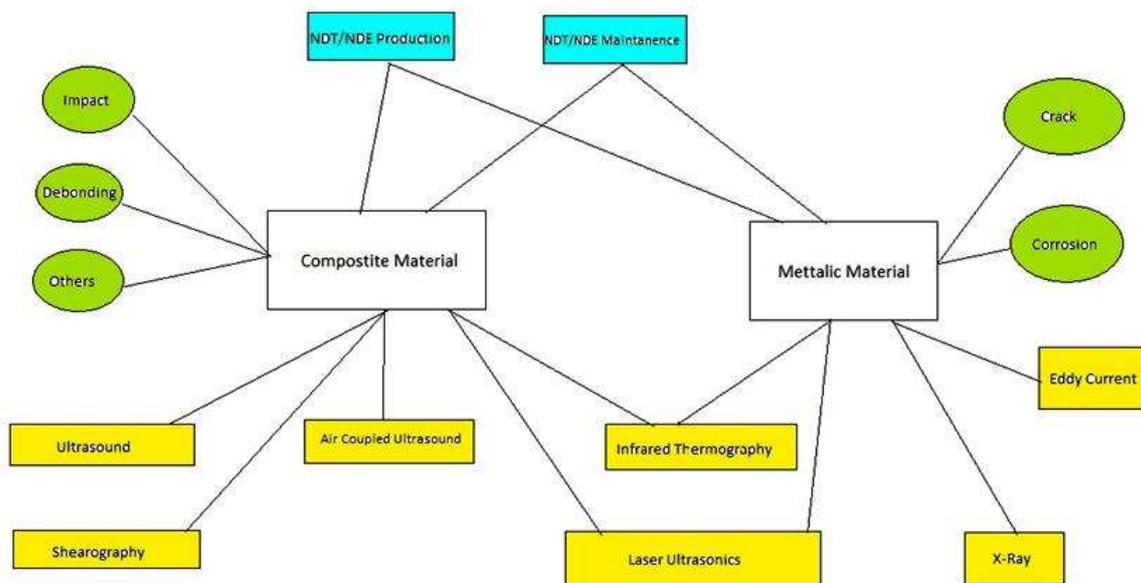
Also known as Nondestructive Evaluation (NDE), NDT refers to the method of examining materials and components in order to identify and quantify defects and degradations in material properties before they result in failure.

The aim of the NDT is to ensure the safe utilization of engineering structures, as well as to ensuring product quality and performance upon production. As the name suggests, the aim is to evaluate defects in objects without having to physically break them up and test them. NDT is used to:

- To determine the quality and integrity of the system / components
- To monitor/ control manufacturing process
- To assess residual life of components
- To ensure safe and secure operation of infrastructure and assets

NDT encompasses a host of non-invasive measurement techniques including ultrasonic, radiography, electromagnetics etc, and draws its origin from a number of other areas of non-invasive measurement including medicine, geophysical prospecting, sonar and radar envelops a group of non-invasive mechanical procedures. The final users of NDT systems are the production/maintenance departments of large

- Energy utilities (Thermal, Nuclear Power Plants)
- Transportation Industry (Railways, Aviation)
- Manufacturing Companies (Product - Automobile), (Process -Fertilizer)
- Oil & Gas (Pipelines, Oil Rigs)



*Fig 1 The boxes in yellow signify the NDT techniques.  
The ovals in green signify the type of defects that could appear*

## NDT Today

The Nondestructive Testing (NDT) industry is transitioning from the analog world to the brave new digital world. Industry trends such as digitization of equipment, greater use of automation and rapid development of new techniques point towards greater use of information technology (IT). With increasing sophistication of NDT techniques and equipment - software is becoming the focus of development.

With the focus expanding from just qualitative inspection, to inclusion of quantitative NDT methods, the need to monitor the number of times a defect appears, and store this information has resulted in the need to develop a new breed of equipment that promote digital storage and transmission of data. The influence of computers in this market, to improve instrumentation has been paramount. The ability to interface recordings from the NDT equipment either to its onboard computer or to a separate industrial computer has resulted in the capability to store large volumes of test records. The industry continues to evolve. At the onset, all the Analog applications were directly translated to Digital and no major conceptual changes were made. Currently the industry is becoming more Software driven as the power of the digital revolution drives further innovation.

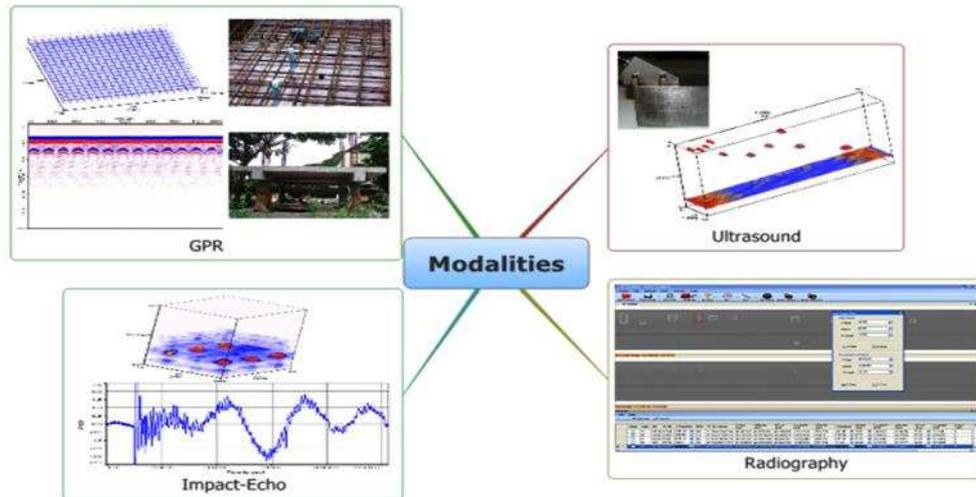


Fig 2 Images from some techniques developed on Lucid's Kovid software platform (the only multi modal software platform in the industry)

This transition can be understood through the evolution in X ray testing and ultrasound inspection which are two of the most widely practised techniques in NDT.

In Radiography, there has been a growing trend towards real time and digital based equipment that replace film, by introducing digital systems. Furthermore, the integration of techniques such as computed tomography (CT) into NDT has started producing results. CT is very important for Additive Manufacturing

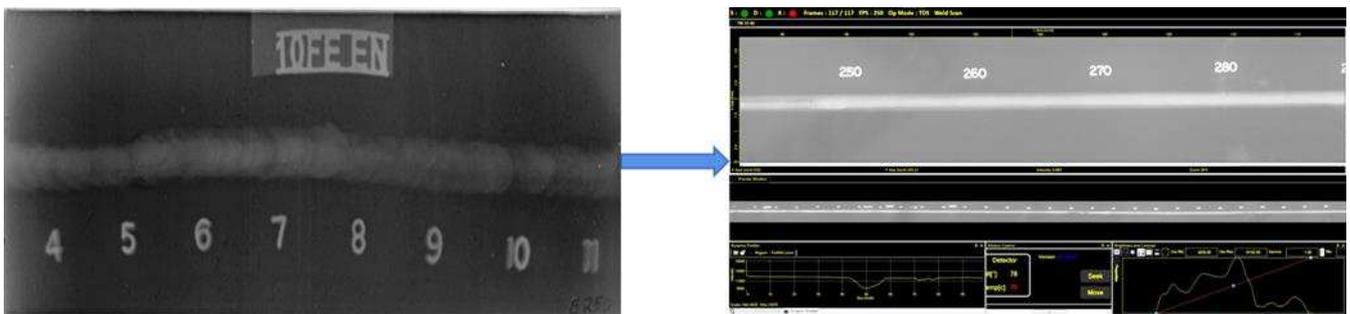


Fig 3 \*Film Radiography (Left)

Digital Radiography (Right)

The increasing use of digital radiography lends itself nicely to automation or semi automation of analysis. This is referred to in industry speak as Assisted or Automated Defect Detection. Almost all of the inspection data acquired is analysed by trained technicians and this is the opportunity/challenge in the new world of digital imaging. The Aerospace industry is a good example to understand this situation. The industry has very high quality standards and has adopted advanced manufacturing practices which has brought down rejection rates to the order of 1% or lower. Yes, many of these parts require 100% inspection (welds for example) and inspectors have to trawl through 100% of the data to identify the bad 1%. Further the use of Digital Radiography has ensured that the images produced are of a consistent and reliable nature which

makes it feasible for an algorithm to interpret. Most digital x ray images are available as Tiff or Diconde formats which eliminates the data compatibility issue. ADR in turn has opened up avenues for Artificial Intelligence (AI) & Machine Learning (ML)

The world of Ultrasound (UT) presents greater challenges and possibly greater rewards as well. The trend that is slowly coming to the fore is the development of specialised applications for inspection of welds, corrosion mapping etc. The medical industry for e.g. has moved to specialised devices as in UT device for a cardiologist or UT device for a gynaecologist. The NDE industry teams has largely used general purpose machines and depended more on the training and skill of the inspectors for the diagnosis. The significantly greater data volumes and complexity of technologies such as advances in Phased Array are leading to a shift away from general purpose machines.

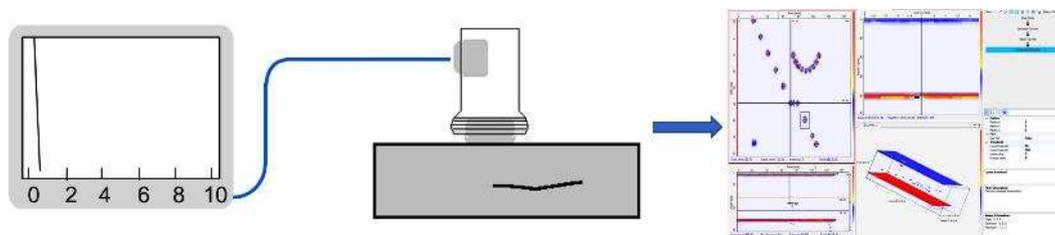


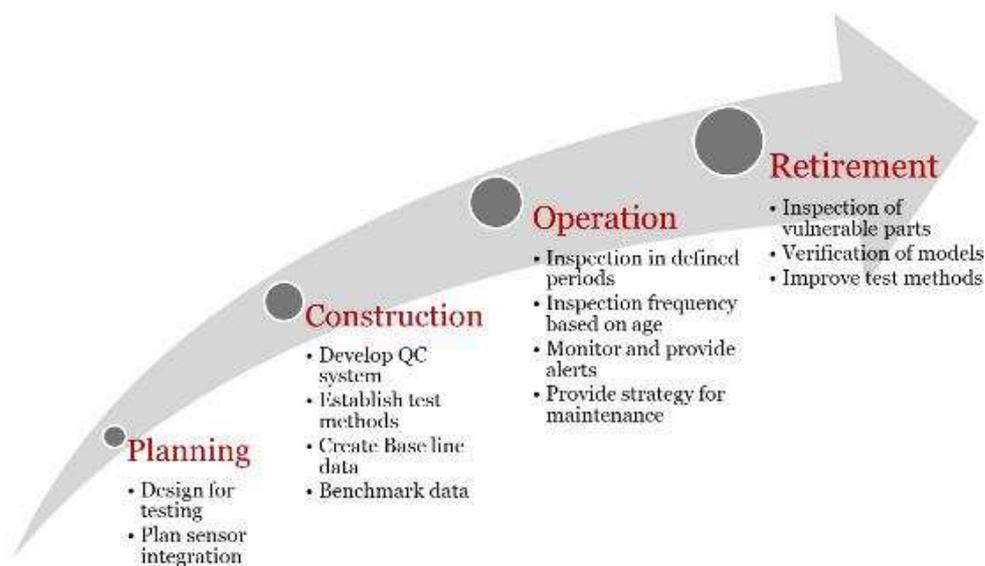
Fig 4 Analog UT (Left) Digital Ultrasound (Right)

### NDT in Asset Integrity Management

NDT inspections are utilized throughout a facility or products' lifecycle. This cradle-to-grave approach is an important element of asset integrity management. Furthermore, NDT inspections provide historical data about the facility's process units and provide information on how often a component should be inspected, repaired, or replaced. Inspection intervals and tests may be changed depending on where the equipment is in its lifecycle (e.g. newly manufactured equipment vs. aging equipment). Performing multiple assessments throughout the equipment's lifecycle may seem expensive. However, inspections conducted at specific intervals may end up saving an organization millions of dollars if testing reveals threats and equipment is repaired before shutting down the facility or experiencing a catastrophic failure. When planning an NDT inspection, there are four considerations one should account for:

1. The type of damage mechanism to be inspected for
2. The minimum detectable flaw size, shape, and orientation of the defect
3. Where the defect is located (surface or internal)
4. The sensitivities and limitations of the NDT method

With the above factors considered, operators can optimize facility production and increase personnel and environmental safety.



Fig, 5 Role of NDT in various stages of life cycle management of an asset

## The Future of NDT

With the industry driving towards digital NDT techniques there comes a need for better storage of data (Cloud), automation of inspections (Automatic Defect Recognition), AI and Robotics to make NDT easier for users and customers alike. Cloud services for NDT data will enhance and simplify the exchange of data between the inspectors performing the test and auditors that are taking decisions based on the results shown by the inspector. Access to information from remote sites and instantaneous decision making to rectify/reject parts produced, or infrastructure will increase the quality standards, reduce costs and minimize safety concerns. It will also be easier to pull up history of a job to check the maintenance requirements for any authorized personnel.



*Fig 6 – NDT on the Cloud*

Production cycles are getting shorter and shorter and the market is calling for faster Ramp-up times. The development of Automated Defect Recognition (ADR) systems, which detect errors automatically after a human did a component-specific parameterization is in the forefront. This will reduce the time taken to complete Inspections and get you more accurate indications without the human error to account for. ADR is starting to be featured in high critical areas with positive feedback and a recognition rate of about 90% being seen. Through the combination of robotics, 3D sensors and image registration a high positioning repeatability can be achieved without additional components. This system will now be combined with the new AI solutions, reducing the ramp-up process from several days to a few hours.

There are several new opportunities in testing of new materials in both traditional and non-traditional NDT applications. As we move to faster and more complex productions, the advancements in NDT will follow.

Another stride being taken towards the future is NDT inspection through Unmanned Aerial Vehicles (UAVs) or drones. The drone-based NDT inspections provides a wide range of possibilities that take advantage of the mobility of the drone as well as the non-destructive nature of the tests. Drones also are extremely flexible and can be fitted with different types of pay loads that can perform multiple NDT inspections giving comprehensive data of a wide variety. They are also able to access hard to reach and hazardous locations that need to be inspected. Data can be collected remotely with the inspector positioned at a safe distance. For e.g, these tests can help the oil and gas companies to identify defects and reduce the rate of failures and unplanned shutdowns.

The future of NDT is digital, robotic and automatic.

### About the author



Madhusudan is the Director of Lucid Software Ltd., a company founded by IIT alumni. Lucid provides software for the global Nondestructive Testing (NDT)/Nondestructive Evaluation (NDE) industry. Lucid's focus is on industries where safety is a critical issue and secure operations are a must. These include Nuclear Power, Aerospace, Civil Engineering Infrastructure, Oil and Gas. Lucid has developed a number of Assisted Defect Recognition (ADR) algorithms for automation of analysis that enhance operator productivity and increase reliability of inspections.

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# A Review for Assessment on Solar Panel Degradation

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## Abstract

The installation of solar panels is now being carrying out not only in cities, but also in rural and backward regions all over the world, especially in India. The aim is to achieve rural electrification in a self-contained manner in remote areas, which may or may not have access to the grid. In this context, it becomes very important to ensure that the installed solar panels last for the number of years they have been designing for, typically 25 to 30 years. For solar panel technology to be an economically viable alternative for conventional electricity, it is essential that they last at least this long. However, inclement weather, pollution, unevenly distributed illumination, high humidity and widely varying temperatures can all have a deleterious effect on solar cells. In this paper, solar panel degradation and its causes are discussed, as it is the important topic of interest.

## Introduction

The solar power industry is seeing a massive expansion in India. The amount of power generated from solar increased from 2,650 MW during the middle of 2014 to over 22 GW as on by the end of 2018, which is an eightfold increase in four years. In fact, India has achieved the 20 GW mark in 2018, four years ahead of the originally envisaged plan. [1], [2] Two of the reasons for this is that the efficiency of solar cells has seen major improvement, their mass production capacities have been enhanced and therefore solar cell technology has become much more cost effective.

Solar technology has evolved over the last 3 decades, and *laboratory based* degradation analysis reports for the early solar panels are available from the 1970s. However, the first large scale PV solar modules were only installed approximately 25 years ago. Therefore, there are relatively fewer publications on field modules and their degradation patterns over the *complete lifetime* of the solar cells. This, coupled with the different types of solar cell technologies coming up in the market, makes it rather difficult to come up with an estimate of the best technological choice, vis a vis longevity and performance. However, this article is an attempt to present to even the lay readers the different solar cell technologies available, followed by the parameters, which should be keep in mind, when investing in solar cell technology. It is important to note that we are seeing an exponential growth in solar cell R & D, and therefore, many of the issues highlighted in this article may be resolved in the next few years, as the technology matures further.

The solar panel performance is acceptable if the solar panel is giving at least 80 % of the rated output. If the output falls below this, it is considered to be degraded, and most warranties from the solar cell companies will cover the period of 25 years of operation at 80 % output. However, according to an US report, reclaiming warranties in the event of solar panel failure has proved to be tricky in the past, because many of the small-scale solar panel manufacturers were not able to sustain their business and filed for bankruptcy between 2007 and 2012. Naturally, it becomes almost impossible to reclaim damages from a company after liquidation. Therefore, it is recommended to install solar panels from reputed companies. Luckily, present field based studies on crystalline solar cells have shown that more than 70 % of the solar panels last their full lifetime.

The solar cells, which were install three decades earlier, were based on crystalline silicon. Silicon was the original material used to manufacture solar panels. In the last three decades, many other materials based on the photoelectric effect have been develop for solar cell technology. The table 1 [3] gives an overview of the various solar cell technologies being researched at present. Along with the type of the technologies, it also shows the typical values of their yields. The highest efficiency is that of the monocrystalline solar cells. Silicon mono-crystals are grown by the Czochralski process, and sliced into thin wafers. They are then chemically etched, subjected to diffusion, metal contact deposition and given antireflection coatings. These cells, despite having the highest yields, are much more difficult to manufacture in bulk, and hence the polycrystalline solar cells are used in most solar panels today. The polycrystalline silicon cells consist of multiple small silicon crystals. It is obtained by solidifying a large block of molten silicon to orient crystals in a fixed direction. This block is then sliced into wafers and used to create the solar cells. Their yield is 4 to 5 % lower than monocrystalline solar cells, but the ease of manufacture offsets this demerit. Amorphous silicon material, used in thin film solar cells, has a disordered structure and even though the manufacturing processes are cheap, their efficiency, as shown in table 1, is much lower than crystalline silicon. This material can only be used as thin films.

The Cadmium Telluride (CdTe) thin film solar cells are cheaper and easier to manufacture than silicon cells, and have a high conversion efficiency of around 20 %, but are restricted by their toxicity and the resultant need for responsible

disposal. Cadmium is a suspected carcinogen and moderately poisonous for humans and animals. Commercially, the 20% conversion efficiency of CdTe cells is possible because they have an ideal band gap of 1.45 eV. However, grain boundary defects in the thin films can affect the movement of minority charge carriers and decrease the efficiency of the solar cells.

CIS and CIGS also belong to the category of thin film technologies, and show a lot of promise. They are also reported to be more robust than many other thin film technologies, and do not degrade easily. However, the presence of the element Indium, which is hard to find, may restrict the mass production of these material. Further, the robustness and resistance to degradation of thin film technologies when subject to the elements are still a matter of research.

Gallium Arsenide solar cells have a structure similar to silicon, and are lightweight. They have a direct band gap as opposed to the indirect band gap of silicon, which enables efficiency in light absorption and emission. They also have better tolerance towards high temperatures, and are expected to replace silicon technology in concentrated solar power applications. However, they are more expensive to manufacture. It is envisaged that this might be an excellent material for space application where, performance, not cost is the criteria.

Organic solar cells are bio-degradable and an interesting option, however the current low efficiencies prohibit their use in commercial solar panels. Nano wires based solar cell technology is still very much in the research domain, yet it is touted as the solar panel choice of the future. This is because the theoretical limits to a silicon solar cell efficiency is around 28 %, and as can be seen from table one, the solar technology of today is already hovering around 25 %. It is expected that nanomaterials would push the boundaries of the maximum solar cell efficiency further. However, until this happens, it is clear that silicon based solar technology, which currently account for more than 80 % of the solar infrastructure today, will continue to be the first choice of consumers.

**Table 1.** Various Solar Cells and its efficiency [3].

Solar Cell Type	Commercial Conversion efficiency %
Monocrystalline silicon cells	25 ± 0.5
Polycrystalline silicon cells	20.4 ± 0.5
Amorphous silicon cells	10.1 ± 0.3
Cadmium Telluride cells (CdTe)	18.3 ± 0.5
Gallium Arsenide (GaAs)	
Copper, Selenium and Indium cells (CIS)	19.3
Copper Indium, Gallium and Selenium cells (CIGS)	19.6 ± 0.6
Organic solar cells (thin-film)	10.±0.3
Nanowires based solar cells	13.8

The basic structure of the solar panel is shown in Figure 1. It consists of the solar cells covered by a polymer encapsulated. The front is covered by tempered glass bordered by a frame, and the back has a back sheet connected to a junction box. The solar cells consist of photovoltaic cells and diodes with interconnects in series or parallel. The encapsulated is usually ethylene vinyl acetate (EVA) or a clear silicone. The back sheet is usually composed of a stiff material such as Tedlar. The glass front cover is often coated with Transparent Conductive Oxides (TCOs) to enhance the solar ray's absorption onto the cell. Each of these components are subject to the various environmental stresses, primarily UV radiation, humidity, mechanical erosion and temperature. Listed below are the most common forms of degradation of the solar panel. The defects generated due to degradation tend to result in reduced module output, safety issues and sometimes result in complete failure before the full lifetime of the solar cell.

The various types of degradation for solar cell modules are broadly listed as [5] :

**Degradation due to moisture intrusion**

Moisture intrusion into solar panels can cause a host of issues. It can lead to chemical reaction with the EVA encapsulated under UV light and high temperatures, leading to the formation of acetic acid. The acetic acid can cause the discoloration of the encapsulated. The color changes to yellow and finally brown. The uneven distribution of this discoloration leads to partial shading of the solar cells. This can be potentially hazardous because it can cause the cell under the shaded region to go into reverse bias, creating a high resistance region. The dissipation of heat here gives rise to hot spots, which can damage the functioning of the cell. The acetic acid itself can also corrode the solar cell material. Many manufacturers, in their haste to reduce the cost of the solar cell unit, tend to use cheap polymers, which tend to absorb moisture easily, and lead to higher risk of long-term failure. It has been reported that the only way to reduce moisture intrusion is to have a layer of desiccants at the interface between the glass and the frame. Some papers have reported better results when EVA is replaced by clear silicone, which also has the bonus of having better spectrum of light transmission.[6]

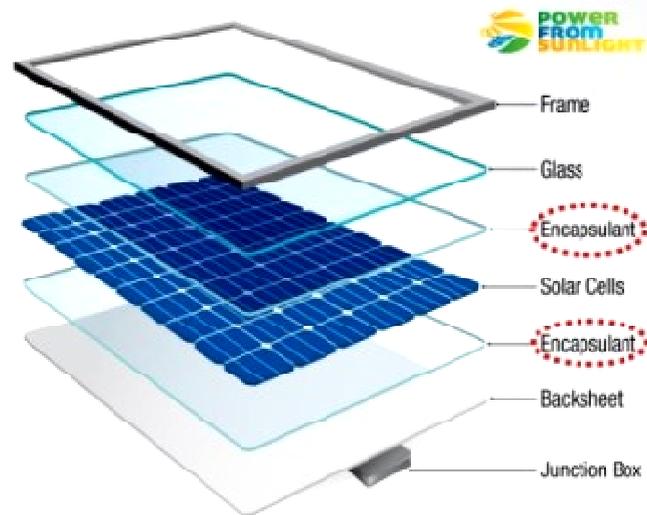


Figure 1. Components of the solar panel [4].

### Degradation of packaging materials

Cracks in the glass can occur, especially during transportation and setting up of the solar panel. The back sheet, made of TEDLAR, has a possibility of getting warped and discolored. However, these are comparatively rare occurrences as compared to the encapsulated browning. While buying units, do check if the glass covering of the solar cell panel is made of tempered glass. Tempered glass is more likely to be able to withstand harsh weather conditions for long periods without damage, and is highly recommended.

### Loss of adhesion of the solar panel encapsulant

Loss of adhesion or delamination of the encapsulated introduces air pockets within the structure. This has two-fold effect; it helps moisture entry into the panel, and creates a change in the refractive index, which reduces the amount of light into the solar cell, thus affecting the electrical performance and electrical safety of the solar panel. A report on the degradation modes of a set of solar panels from China listed delamination as the single most important cause of degradation. However, well-manufactured solar panels attend to the lamination aspect, and silicone technology is one, which can be layered on top of the solar cell, leading to better adhesion.

### Degradation of cell/module interconnects because of thermo-mechanical fatigue

Solar cell assemblies have silver bus bars connected to copper strips, via various automated or semi-automated soldering technologies. These solders act as mechanical supports, heat dissipation path and electrical interconnects on the solar panel. Some amount of residual stress remains in the soldering joint due to the manufacturing processes, and further stress can occur due to thermal cycling tests carried out on the module, as well as high temperature regions. The coefficient of thermal expansion of the silicon substrate is different from those of the metals, and hence when these panels are subjected to wide changes in temperatures, thermo-mechanical induced non-linear deformation of these interconnects is possible, which over time can build up cumulatively, causing failure.

### Degradation of semiconductor device

The photovoltaic cell itself is least likely to fail due to manufacturing defects, as this is the part of the panel which manufacturers are most concerned about. However, many of the solar cells, which were installed 20+ years ago, had thicker semiconductor. Enhancement in efficiencies have made manufacturers cut down on the thickness of the crystalline solar cells. The resistance of thin film solar cells under adverse atmospheric conditions are still a matter of research. It is expected that materials such as gallium arsenide, which has more improved material properties as compared to silicon, may perform well in thin film form as well. Field studies after some more years are expected to shed light on the particular challenges of thin film solar cell technology. Another form of degradation related to the semiconductor device is Potential Induced Degradation (PID), which actually affects the encapsulated. This is caused due to the voltage difference between the series solar cells, which creates electric stress across the encapsulated material. Once again, it is important to use an encapsulated, which can withstand long-term low level of electric stress.

### Erosion of front glass coating

The front glass can be coated with grime and dust, bird droppings etc. It also takes the brunt of storms, rain and atmospheric pollution. All this can cause the Transparent Conductor (TCO) coating to erode. This lowers the efficiency of the solar cell by reducing the amount of light absorbed into the glass. Current solar cell modules have special UV protection enabled glass and encapsulated, which should be checked. Regular cleaning of the glass should be initiated, and special attention should be given to the installation of the panel so that partial shading of the panel due to surrounding

structures does not occur. It is important that the frame should also be airtight, so that moisture does not seep in and cause damage.

After becoming familiar with the common causes of degradation, let us look at a couple of the studies, which assess the severity of each of these modes in real life studies. The Figure 3 displays a survey in China, which looks at the percentage of each degradation mode present in the solar cell modules. It shows that delamination and discoloration of the encapsulated together constitute 54 % of the degradation. Another study, which looks at the causes of failure in 1865 solar modules in Arizona, USA, showed that the primary cause of solar panel failure is due to browning of solar panel encapsulation.

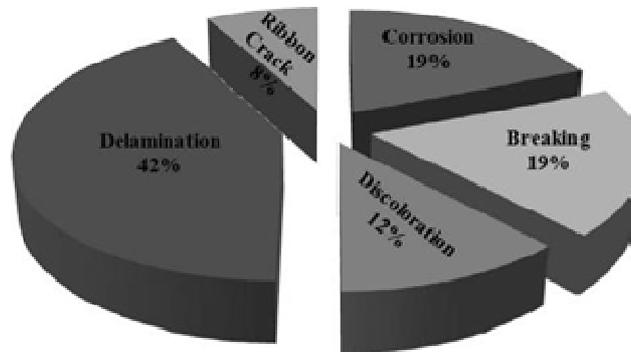


Figure 2. Silicon PV modules: representative of degradation modes in 2012 [5].

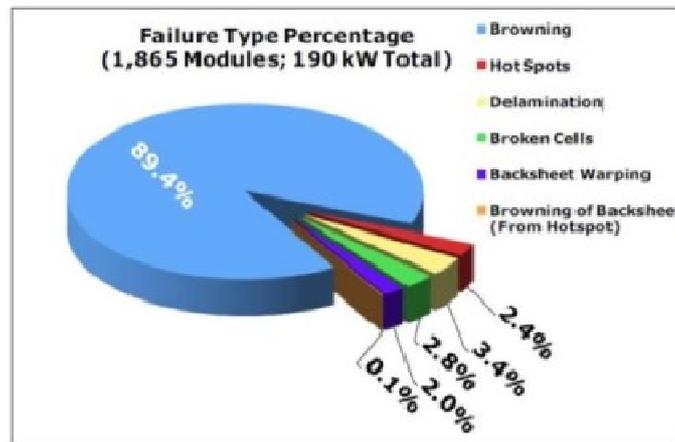


Figure 3. American solar cell degradation modes [7], [8].

Finally, a list of the various modes of solar cell degradation is reported in Figure 4, along with their respective percentages.

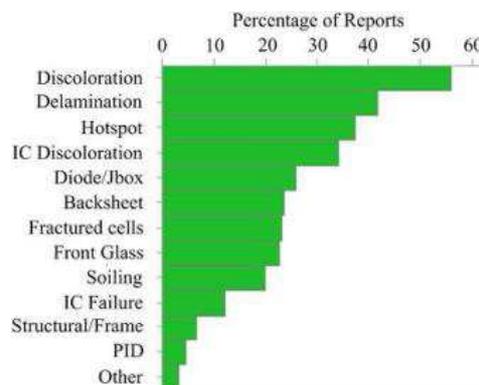


Figure 4. Solar cell degradation reported statistics.

The percentage of various degradation modes reported in literature [3]

## Conclusion

From these studies, it can be seen that the technological challenges at present are centered mostly on the encapsulated, which is the cheapest part of the solar panel. Even though EVA is the most prevalent encapsulated in the solar panel market today, it is highly recommended to transition to a silicone based encapsulated. By paying a little attention to the quality of the components of the solar panel system, rather than only their electrical specifications and costs, we can make a more judicious choice for our 25-year investment in free and renewable solar energy.

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# Solar Photo-Voltaic Modelling using Intelligent Algorithms

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## Abstract:

The modelling of Solar Photovoltaic (PV) plays an important task in the calculation of the predictable power from a solar PV module. The precise modelling of Solar PV is a tedious task since certain parameters are not given in Manufacturer's datasheet. These unknown parameters such as diode saturation current ( $I_0$ ), shunt resistance ( $R_p$ ), series resistance ( $R_s$ ), ideality factor ( $a$ ), and Photo generated current ( $I_{pv}$ ) are used to estimate the electrical characteristics from the Solar PV under different conditions of temperature and irradiance. Intelligent Algorithms have employed to optimize the unknown parameters in the Solar PV Module under different environmental conditions.

## Introduction:

The exhausting nature of non-renewable energy sources has driven the world into the energy crisis. As an outcome, the practice of renewable energy sources like solar, wind, and tidal are providing a better solution for the problem [1]-[2]. Among the renewable energy sources, solar energy has identified as favourite due to inexhaustibility, non-polluting nature, and maintenance free. Most solar cells are manufactured using crystalline silicon; it can be able to convert 14-20% of sunlight into electricity. The correct modelling of solar PV Module is required before the hardware implementation part. The worldwide researchers found that MATLAB and PSPICE is appropriate software for solar PV modelling [3]. A Solar PV manufacturers have given inadequate model parameters such as open circuit voltage ( $V_{oc}$ ), short circuit current ( $I_{sc}$ ), the voltage at maximum power point ( $V_{mp}$ ), and current at maximum power point ( $I_{mp}$ ), Current temperature coefficient, Voltage temperature coefficient. For modelling the solar panel using single diode model, the model parameters such as shunt resistance ( $R_{sh}$ ), series resistance ( $R_s$ ), ideality factor ( $a$ ), diode saturation current ( $I_0$ ), Photo generated current ( $I_{ph}$ ) are mandatory. However, these parameters are not given in manufacturer's datasheets. The calculation of precise values of model parameters is crucial owing to nonlinearity in the PV characteristics [4]-[6]. Initially, Conventional Techniques such as Gauss Seidel and Newton Raphson method have been employed for parameters optimization. However, these methods are tedious and time consuming [7]-[8]. Hence, considering the above facts, intelligent algorithms such as Particle Swarm optimization, bacterial foraging algorithm, and several other algorithms have been applied recently to extract the unknown parameters.

## Basic Elements of Solar PV Modelling:

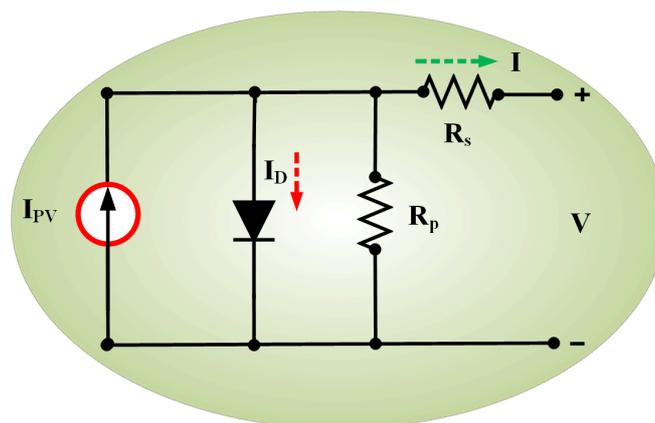


Figure 1. Single diode solar cell model

The single diode PV cell consists of a current source along with an anti-parallel diode, series resistance, and shunt resistance. The Equivalent circuit defines the entire V-I curve of a PV Cell, Module or an Array as a function of operating conditions. The Operating Conditions implies Irradiance and Temperature. A precise model predicts the V-I curve as accurate as a real time graph at a particular point. Short circuit current and Maximum Power Point (MPP) of the PV modules varies linearly with solar irradiance. The open-circuit voltage and MPP point of the PV module will vary according to temperature changes. The values of parallel and series resistance are an important factor to fix the MPP point of the PV module.

## Advantages of Intelligent Algorithms compared to the conventional techniques:

The solar PV Module unknown parameters are extract using various Intelligent Algorithms.

**Computation Time:** The intelligent algorithms have taken less time to achieve the convergence point compared to the conventional techniques such as Gauss Seidel and Newton-Raphson Method.

**Accuracy:** The convergence accuracy is high in intelligent algorithms compared to conventional techniques.

**Iterations:** The number of iterations to reach the optimum point is very less in Intelligent Algorithms compared to the conventional techniques.

**Local optima:** The problem of local optimum is lesser in intelligent algorithms due to random search.

**Error:** The percent error is lesser in Intelligent Algorithms compared to conventional techniques.

Numerous intelligent algorithms in literature have tried to extract exact PV parameters since the convergence to the global optimum has not been assured with these techniques. Thereby, in recent years, an additional concept such as hybrid bee pollinator, predator-prey is incorporated with the existing intelligent algorithms to optimize the unknown parameters with global optimum conditions.

## Conclusion

This paper provides a wide observation towards the advantages of accurate solar PV modelling before the installation part. It has been attained with the help of intelligent algorithms, which optimize the unknown parameters in the solar PV module with high accuracy and convergence speed, without sub optimal traps. These parameters decide the current and voltage from the solar PV module under different environmental conditions.

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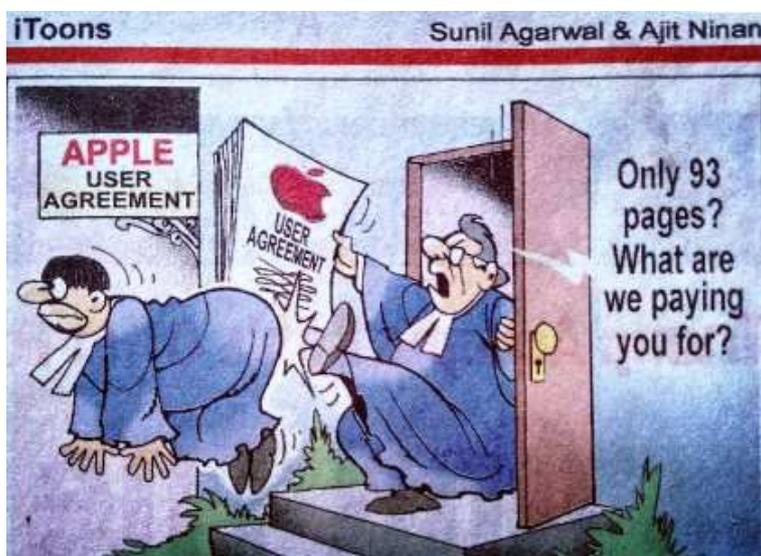


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# Development of a Fog Computing Based Data Analysis Platform for Real-Time Monitoring of Water Quality

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## Introduction

Water quality depends on various climatic factors and variation of water quality can be observed due to season change. Water parameters such as pH, dissolved oxygen, temperature are the basic water features and those features need to be monitored in real – time for various water applications such as agriculture, fishery and aquaculture based water applications [1,2,3]. Water quality monitoring is an essential need for the human being. Fog computing is a part of an IoT based system framework and the goal of this fog computing is to generate a notification in real-time. Fog enabled IoT platform can analyse sensor generated data in real-time and user can get a notification about the condition of the water system [5]. Water quality monitoring comprises of several case studies and based on those applications sensing of various water parameters may vary. Here, we have highlighted two specific case studies such as drinking water quality monitoring and fishery based water quality analysis under fog computing environment. Fog computing comprises the computation and decision generation using smart fog devices. Fog device is a concept of an intelligent computation platform, where sensed data can be computed and based on data computation notifications can be generated.

## IoT Based System Architecture

Figure 1 describes the fog computing based IoT framework for water quality monitoring. The fog computing framework consists of three layers such as sensing layer, computation layer and cloud layer [4].

### Sensing Layer

Sensing layer consists of several sensor nodes and each sensor node is composed of several sensors, data acquisition unit and communication module.

### Fog Layer

Fog layer is composed of several gateway devices. Each gateway device performs data acquisition from sensor nodes and performs data analysis inside each gateway device.

### Cloud Layer

Cloud layer performs data analysis and generates decision report for each of the individual sensor nodes. Cloud layer is the upper layer of the computation platform and cloud maintains a large sensor based database for performing trend analysis on those acquired features.

## The Need for Real-Time Water Quality Analysis for Drinking Water and Fish Water

Water quality depends on various water parameters such as temperature, dissolved oxygen, pH value and conductivity of a water body. The main challenge in agriculture and pisciculture system is that to identify a proper usage of a particular water body and which is suitable for a particular crop farming and pisciculture breeding respectively.

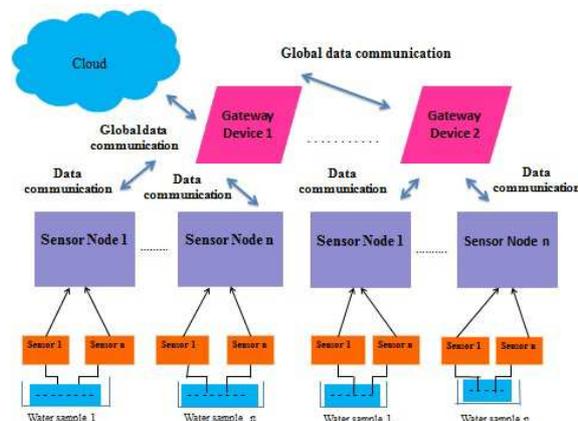


Figure 1: Fog Computing based System Framework

Another main challenge of water quality monitoring is that, if unwanted solid compounds get dissolved at a particular region of a water body, there is a possibility of water pollution due to those elements. If pollution occurs at a particular position of a water body, it can spread over the large area of the water body and this can affect the life cycle of aquatic organisms. In rural areas due to water pollution drinking water resources get polluted and this pollution can't be identified by human beings. Real-time fog device based notification generation can detect water pollution and save the life of aquatic organisms.

IoT nodes can perform data acquisition from different positions of the water body and collect various features such as temperature, humidity, pH, dissolved oxygen and conductivity. The collected data in real-time is sent to the fog device for monitoring the water system's condition. Each fog device is connected to a cloud platform and sends data of a particular region of the water body to the cloud platform for performing data analysis. Cloud platform can generate a seasonal trend of water quality, based on data analysis. This seasonal trend will help to predict the condition of the water system and to take a right decision based on seasonal changes. In contrast to cloud based analysis the real-time monitoring of the water system using the handheld fog device helps the authority to take a decision in real-time.

Fog inspired IoT system has various application areas such as agriculture based applications, health IoT based applications, smart farming based applications etc. Here, we are concentrating about fog inspired water quality monitoring for drinking water quality analysis and fishery based water quality analysis.

**The Data Processing and Analytics in Fog and Cloud End**

Generated sensor data from different sensor nodes is processed inside the fog device and inside the cloud platform to generate a decision. Fog device performs real-time data analysis and cloud performs trend analysis based on stored dataset.

**Fog Based Data Analysis**

To incorporate the intelligence inside a fog device a learning model is built within the fog device. The device learning is performed in two steps such as learning model building and the verification of that model using several unknown test cases. The performance metrics such as test case accuracy is noted for each of the verification phases. Based on those noted accuracy the modification and tuning of various learning parameters are performed. Here, we have described the concept of handheld fog devices for drinking water quality monitoring and for fishery based applications respectively. The device verification phase can be performed by a group of expertise people of that particular field. Based on the consent of the expertise group the learning model can be modified.

**Cloud Based Data Analysis**

Cloud based data analysis is also known as global data analysis. Global data analysis is performed inside the cloud platform, where data from different fog nodes are stored and analysed for report generation. Figure 4 describes cloud based sensor database which contains IoT node ID, Sensor ID, fog node ID, Local Timestamp, Global Timestamp and Latitude and Longitude of the deployed IoT node. Cloud based data analysis is required for the field of monitoring of a large water body. Inside the cloud platform as data from different fog nodes can be gathered and cloud end data analysis model can generate a decision report for each of the IoT nodes based on their locations with respect to a particular fog node. From cloud end data analysis user can get a view of the water system for each of the locations of the water body.

**Applications in Daily life**

Fog computing based system can be used in various applications such as fruit quality monitoring, water quality monitoring, smart farming based applications etc.

**Drinking Water Quality Monitoring Based Application**

Drinking water is an essential element in our daily life and monitoring of drinking water quality is also an important aspect in our daily life.

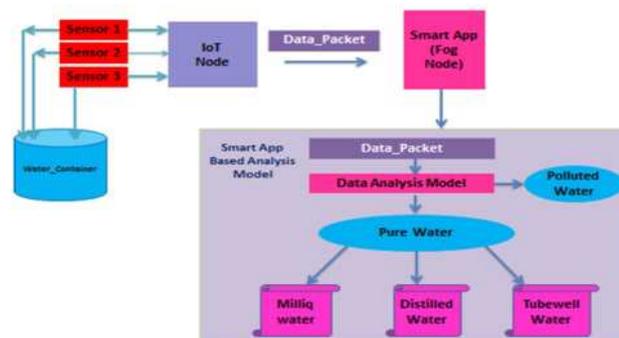


Figure 2: Fog Computing Based Drinking Water Application

We have proposed an IoT based intelligent system, which can predict the probable usage of a water sample and can predict whether that water sample can be used in drinking purpose or not. Figure 2 describes the concept of handheld device for drinking water quality analysis. The handheld device is intelligent enough to decide whether a particular water sample can be used as drinking water purpose or not.

### Fishery Based Applications

Water quality monitoring is an essential thing for agro based communities. In pisciculture water quality monitoring is the most essential need. We have devised an IoT based intelligent system which can decide the kind of fish farming suited for a given water body. Here, we have proposed a concept of open hardware based handheld device, which can perform data analysis in real-time. With the help of the handheld device, shown in Figure 3, user can decide whether the water body is suitable for a specific type of fish breeding or not. Various fishery based applications such as carp breeding and prawn breeding depend on the quality of a water sample and our fog device can help on such decisions.

### Quality Monitoring of Fruits

Gas sensing based fruit quality monitoring can be performed using a handheld fog device. Fruit quality monitoring can help to detect the quality of a food and how much it is perishable. This real-time fruit quality detection can reduce the wastage of fruits.

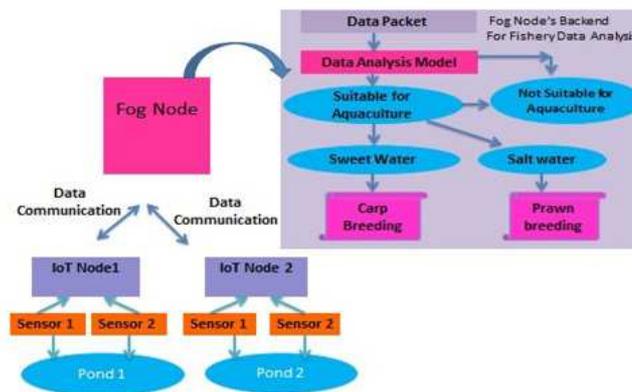


Figure 3: Fog Computing Based fishery Application

### IoT Based End to End Security Model

IoT based system is composed of several IoT nodes and fog nodes and each node performs data communication between them. IoT based End to End security comprises device authentication, end to end data encryption using lightweight data encryption and data integrity based model design. To perform data communication between each of the IoT nodes and a specific fog node, each IoT node must be authenticated to the fog node. The legitimate IoT node and fog node can perform data communication between them. To authenticate each of the IoT nodes and fog node lightweight device authentication approach can be used. The data packets generated by each of the IoT nodes are encrypted using data encryption technique and is sent to the fog node. The concept behind the data encryption is that only legitimate fog nodes can decrypt the data packet and that data packet is saved inside the fog nodes for performing data analysis. Inside the fog nodes the integrity of that data packet is maintained.

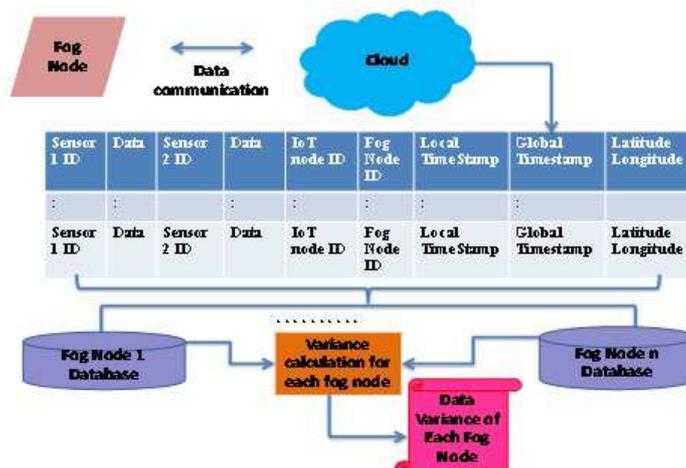


Figure 4: Cloud Based Data Analysis

## Conclusion

Our objective is to incorporate big data based computation inside a small fog device. Here, we have described the concept of a fog device for two applications such as drinking water quality analysis and fishery based applications. In future our plan is to build cloud based trend analysis model using large datasets. The cloud based data analysis model will also generate seasonal trends of a system for various IoT based applications.

## Acknowledgement

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# Blue Economy - Opportunities for India

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## INTRODUCTION

The global population which is expected to exceed 8 billion by 2030 will require 30% more water, 40% more energy and 50% more food. More than 40% of the world population live within 100km from the coastline, and it continues to be in the uptrend. The Organisation for Economic Cooperation and Development (OECD) estimates the gross value added to global output from the oceans shall be ~ US\$ 3.5 trillion in 2030 and shall supporting more than 40 million jobs. Considering the strategic importance of the oceans, the United Nations (UN) has allocated a total global Exclusive Economic Zone (EEZ) of ~137 million km<sup>2</sup>, including ~ 12, 11.3, 8.5 and 2.3 million km<sup>2</sup> to France, US, Australia and India, respectively. Based on the foundations of the 2012 Rio + 20 UN Conference on sustainable development, the global community announced its commitment on the Sustainable Development Goals (SDG) 2030, in which Goal 14 relates to the sustainable development of the Ocean resources by which the economic activity is in balance with the long-term capacity of the ocean ecosystems, remain resilient and healthy. The importance of sustained utilization of the ocean resources is stressed by the UN declaring 2021-2030 to be the decade of Ocean Science for Sustainable Development.

The pillars essential for transforming the traditional “Ocean and marine economy” to a “Blue” or “Sustainable” economy require appropriate governance in the sustained utilization of the ocean, coastal and marine economies, vision, technology, management, monitoring and time-bound regulatory reforms. The blue economy is thus based on resilient systems, persistent innovation and advances in achieving integrated ecological, economic and social well-being. Hence the fast emerging blue economy paradigm with its components shown in Table 1 requires proper estimation of the size of the opportunity, nature of risks involved, identification of sustainable ocean asset investment, investment framework, and scaling up the capital investments of the blue industries.

Table.1. Components of the Blue Economy

Type of Activity	Ocean Service	Industry
Extraction of non-living resources	Minerals	Seabed Mining
	Energy	Oil and natural gas
		Renewables
Harvesting of living resources	Fresh water	Desalination
	Seafood	Fisheries
		Aquaculture
Marine biotechnology	Pharmaceuticals, Chemicals	
Ocean commerce	Transport and trade	Shipping
		Port infrastructure and services
	Tourism and recreation	Tourism
Coastal Development		

Understanding the strategic importance, different national and global initiatives are underway to develop a future roadmap for blue economy with measurable outcomes and special budgetary provisions. Subsequent to the leadership of the Small Island Developing States (SIDS) and the coastal nations which advocated Blue Economy, the major countries including Australia, Brazil, U.K., U.S., Russia and Norway have developed their National Ocean Policy and established hierarchal institutions at federal and state levels for ensuring progress in the blue growth. With the blue economies of the United States, China and the European Union estimated to be ~US\$1.5, 0.1, and 0.5 trillion, respectively, it is expected that blue economy could significantly contribute to India’s vision of becoming a US\$ 10 trillion economy by 2030.

## OPPORTUNITIES FOR INDIA

India with a coastline of 7517 kms and 1208 islands has 13 major ports, 200 notified minor and intermediate ports. The EEZ includes 1.64 million km<sup>2</sup> near the Indian mainland and Lakshadweep, and 0.66 million km<sup>2</sup> in the Andaman and Nicobar Island area. Considering its strategic interest, India is currently seeking to extend its EEZ to 563kms, by which the total EEZ area will equal its land area. India is a key member in the Indian Ocean Rim Association (IORA), an inter-governmental organization comprising of 21 member states and 9 dialogue nations aimed in strengthening regional cooperation and sustainable development within the Indian Ocean region. The IORA blue economy dialogue held in Goa in Aug 2015 passed the Goa declaration stressing the need to identify the thrust areas of the blue economy. During 2018,

National Institution of Transforming India (NITI), the Indian Government’s apex policy think-tank conducted discussions with all the stakeholders to identify the potential areas of the blue economy which are to be placed on the national strategic focus and to formulate policies for blue growth. Several initiatives have been initiated the Ministry of Environment & Forests and Climate Change (MoEF & CC), Ministry of Earth Sciences (MoES), Ministry of Shipping and other organisations. They include the Deep Ocean Mission, Integrated Coastal Zone Management, Sagarmala, Sagar and Mausam which focuses on the deep ocean resource exploration, marine spatial planning, port development, maritime security and improving livelihood opportunities for coastal communities. In order to synergize the multi-ministry efforts which are engaged in silos, seven working groups are formed by the Government of India (Fig.1) to formulate robust recommendations to capture the huge potential and opportunities in this sector. Thus sustainable, integrated, inclusive and people centric policy for Blue Economy is being evolved by India and the policy statement states that “The blue economy refers to exploring and optimizing the potential of the oceans and seas which are under India’s legal jurisdiction for socio-economic development while preserving the health of the oceans”.



Fig.1. Seven working groups under Indian Government

## NON LIVING RESOURCES

### Blue Minerals

The developments of the coastal and offshore mineral resources are complimentary for the industrial and economic growth. The coastal placer minerals, such as ilmenite, magnetite, zircon are extensively available on the Kerala, Tamil Nadu, Andhra Pradesh, Orissa and Maharashtra coasts and near shore waters. The Geological Survey of India (GSI), Atomic Mineral Division (AMD) of the Atomic Energy Department and the CSIR-NIO have been involved in exploration and survey of these minerals. The status of the onshore exploration for heavy mineral placers in India is shown in Fig.2. The reserves including ilmenite, rutile, garnet, zircon, kyanite and sillimanite are estimated to be ~ 600, 30, 60, 35, 2 and 4 million tons, worth approximately US \$ 120 billion. The deep blue mineral resources include the seafloor polymetallic sulfides around the hydro-thermal vents, cobalt-rich crusts on the seamounts and the polymetallic manganese nodules on the abyssal plains. The polymetallic nodules comprise of manganese, nickel, copper, cobalt, molybdenum, rare earth metals, and traces of elements of commercial interest, including platinum and tellurium. The seafloor sulphides are rich in copper, gold, zinc, lead, barium, and silver. The cobalt-rich crusts contain manganese, iron and a wide array of trace metals including cobalt, copper, nickel, and platinum. About 247, 1.82, 10.47 and 9.5 million tons of manganese, cobalt, nickel and copper are located in waters depths ranging from 5000 to 6000m as polymetallic nodules in the Central Indian Ocean Basin (CIOB), hydrothermal sulphides in the southern Indian Ocean and cobalt crusts in the Afanacy Nikitin sea mount area (Fig.3)

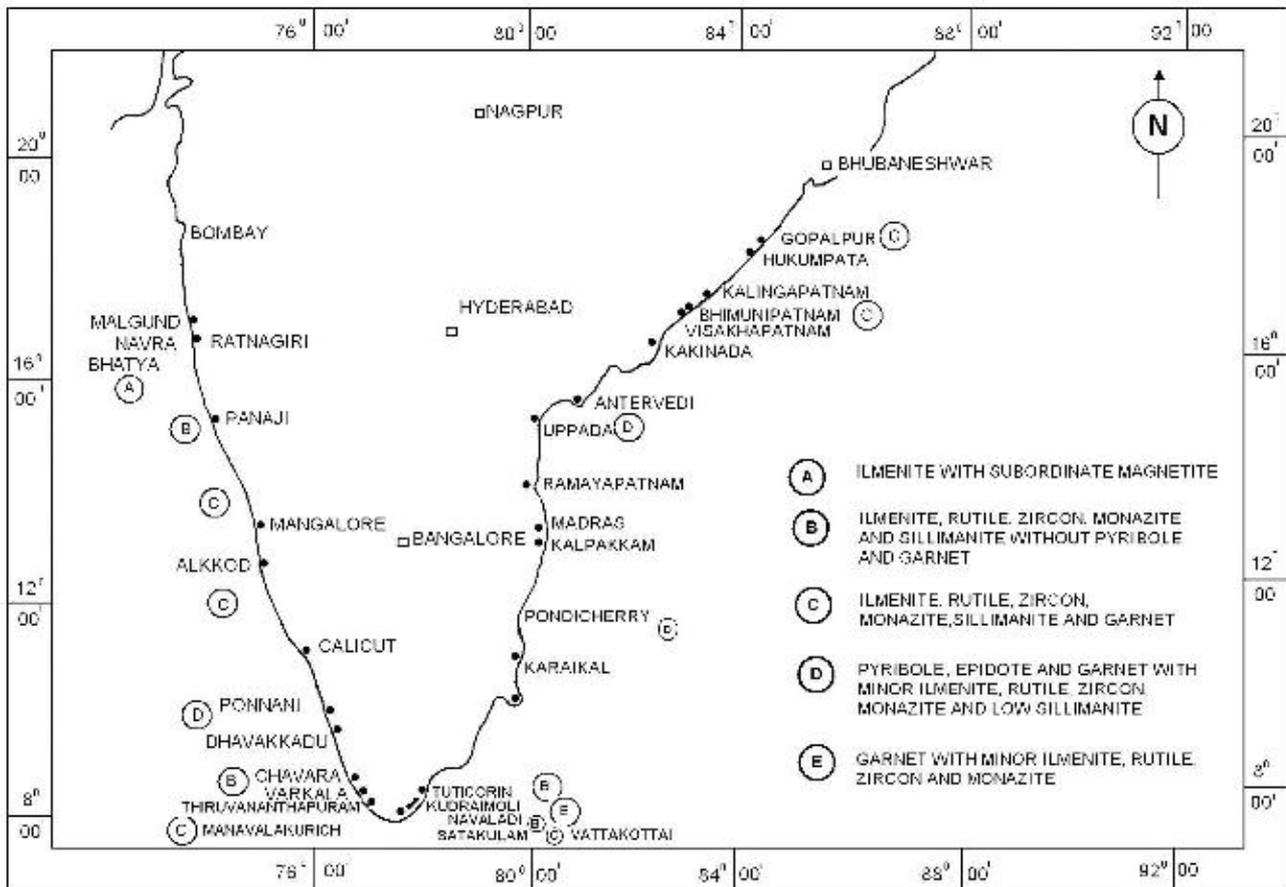


Fig.2. Status of placer deposits exploration in India

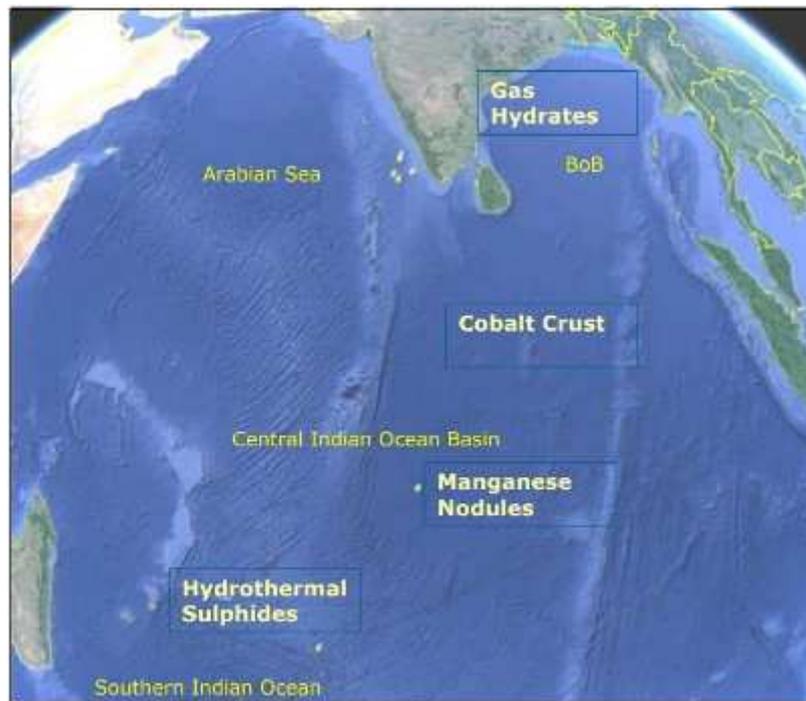


Fig.3. Minerals and energy resources in the Indian Ocean

For carrying out demonstration mining, India has been allocated an area of 75000 km<sup>2</sup> and 10,000 km<sup>2</sup> in the polymetallic nodule and hydrothermal sulphide sites, respectively. After carrying out field demonstration of a crawler-based mining machine at about 500m water depth, the MoES-NIOT has undertaken the development of a 6000m depth-rated demonstrative polymetallic nodule mining machine. Other associated systems including a 6000m depth-rated electric work-class Remotely Operated Vehicle (ROSUB 6000) and an in-situ deep ocean soil tester which are being used upto 6000m

water depths. In order to understand environmental impacts of deep ocean mining and to generate base line data, deep ocean moorings are being developed by NIOT and CSIR-National Institute of Oceanography (NIO). The development of metallurgical processes for extraction of metals is developed by CSIR-Institute for Mineral and Material technology (IMMT) and CSIR-National Metallurgical Laboratory (NML). The development of a battery-powered 6000m depth rated scientific human-occupied submersible with an operational endurance of 12 hours and weighing ~ 20 tons is being undertaken by NIOT.

### Blue hydrocarbons

About 26 sedimentary basins in India covering about 3.14 million km<sup>2</sup> host 28 billion tons of conventional hydrocarbons. About 67% of these resources are located offshore. The Mumbai High hosts about 9.2BT, the sedimentary basin with an area of 1.3 million km<sup>2</sup> in the east and west coasts of India spanning from 400m water depth up to the EEZ hosts about 7 BT, and the rest of the resources are concentrated in the Krishna-Godavari (KG), Cauvery and Kerala-Konkan basins. The KG basin hydrocarbon production accounts to ~ 40% of the India's in-house production. In order to foster the natural gas production from deep waters, wells have been established in the KG basin at 2483m water depths. For effective exploitation of the ultra-deep waters, Indian government has planned to invest about US\$10 billion in the deep water projects in the KG basin.

About 1684TCM of methane gas are identified to be sequestered as gas hydrates in the continental settings in 100-300m below the sea floor at water depths ranging between 800-3000m. Considering the strategic importance of the natural gas hydrates, the National Gas Hydrate Program (NGHP) led by the Directorate General of Hydrocarbons (DGH) and supported by Oil and Natural Gas Corporation (ONGC), major oil companies and national scientific organizations including NIOT, the National Geophysical Research Institute (NGRI) and the National Institute of Oceanography (NIO) has performed two detailed drilling expeditions in the Krishna-Godavari (KG), Mahanadi, and Andaman convergent margin and confirmed the presence of large, highly saturated gas hydrate accumulations in the coarse-grained sand-rich depositional systems in the KG basin (Fig.4). Plans are being discussed for establishing a pilot scale well in the KG basin for long term production capability assessment..

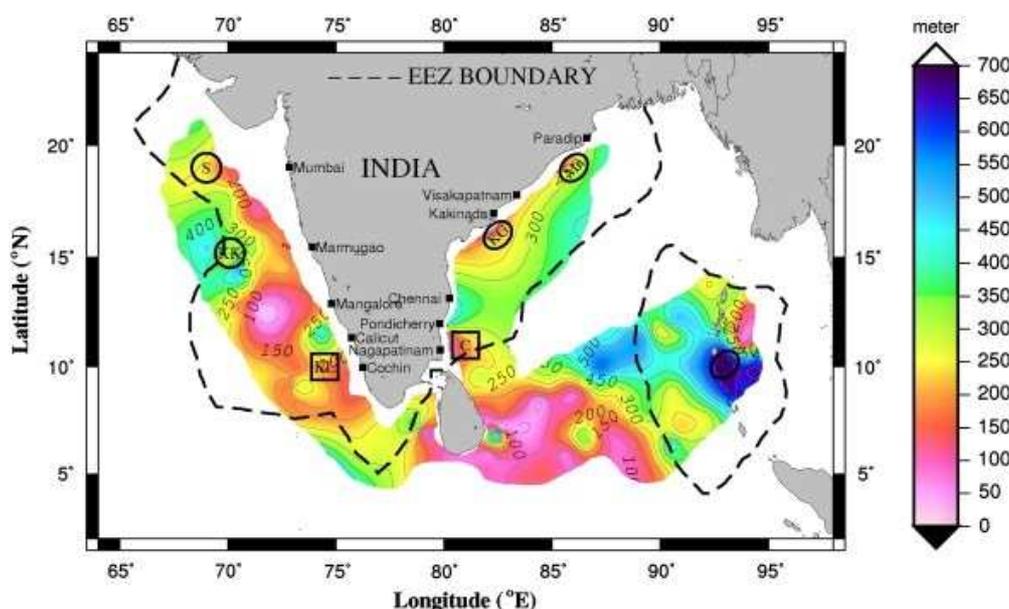


Fig.4. Location of major gas hydrate provinces of India

### Renewable Energy

Sustainable marine energy plays a vital role in the economic development and climate adaptation. Offshore regions have tremendous potential to provide renewable energy, viz. offshore wind, waves, ocean currents including tidal currents and thermal energy. About 350GW of offshore wind energy is estimated within the EEZ of India. For fostering the growth of the offshore wind energy, the National Offshore Wind Energy Authority is established for carrying out resource assessment in the EEZ. The offshore wind resource assessment by the MoES-Indian National Center for Ocean Information Systems (INCOIS) based on the long-term satellite wind data (Fig.5) indicates high wind energy potential off-Kanyakumari, Gujarat offshore, Rameshwaram and Jakhau.

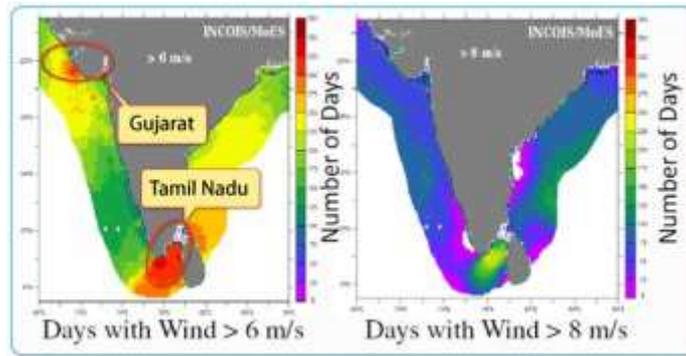


Fig.5. Offshore wind energy resource assessment

For carrying out wind speed, direction, temperature and humidity measurements at 20m elevation from the sea level, LIDAR-based data collection platforms are installed by NIOT and MNRE-National Institute of Wind Energy (NIWE) in the Gulf of Kutch and Gulf of Khambhat. Other ocean energy technologies which are in various stages of development include marine current, wave power and ocean thermal energy conversion (OTEC) face stiff competition from other onshore options. The development on these technologies at NIOT has successfully crossed laboratory stage, improving understanding of complexities involved along the way. Wave energy devices and hydrokinetic turbines have been successfully demonstrated in the open sea by NIOT. Some locations in the Andaman Islands revealed high water current potential and suitable scaled up hydrokinetic turbines are being developed. India being a tropical country has a good potential for Ocean Thermal Energy Conversion (OTEC). The sea water temperatures are observed to be stable and are prevailing continuously throughout the year, making it ideal for a base load energy plant. An OTEC powered desalination system has been taken up by NIOT which will be set up in Lakshadweep islands. India is a member of the International Energy Agency-Ocean Energy Systems (IEA-OES) Group and has taken up activities for accelerating the growth of ocean energy systems in the Asian region.

### Ocean Desalination

Securing adequate quantities of clean water to meet the needs of the growing population is a major challenge. Coastal communities are increasingly turning to the sea to meet their drinking water needs, while in inland there is a tendency for groundwater to become increasingly brackish over time. NIOT has designed and implemented Low Temperature Thermal Desalination (LTTD) plants of 100 m<sup>3</sup>/day capacities in the three Islands in the Union Territory of Lakshadweep, where a long cold water is used to draw water from water depth around 300m using a high density polyethylene pipe (Fig.6). The plants which are operating over a decade have proved multiple socio-economic advantages including health of the island community. Efforts are underway for installing LTTD-based desalination plants in six more islands of India. Efforts are also undertaken for realizing combined power and water production.

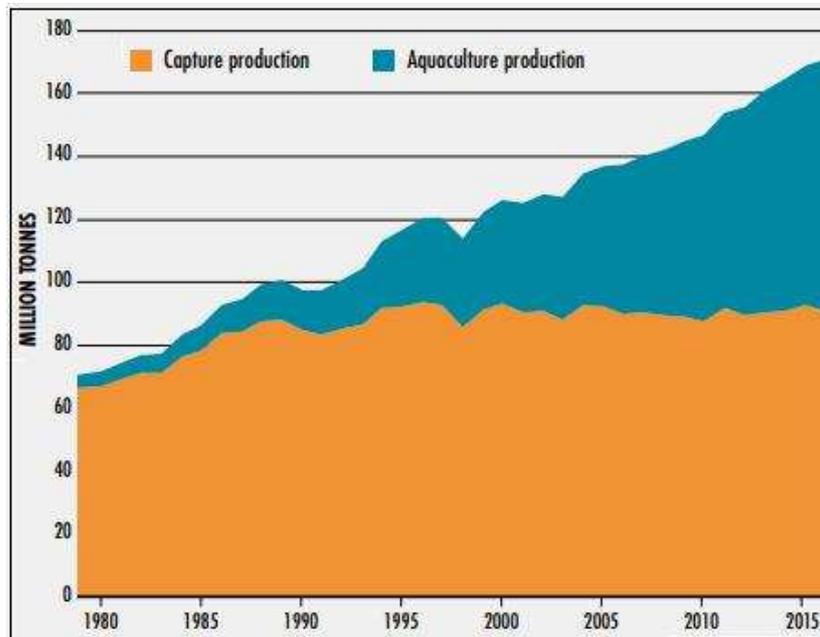


Fig.6. Desalination plant in Agatti Island of India

## LIVING RESOURCES

### Seafood- Fisheries, Aquaculture and Pharmaceuticals

Effective and sustained marine bio-prospecting is essential for pursuing human health, offering sustainable supply of high quality food, developing sustainable sources of energy alternates to the conventional hydrocarbons, new industrial products and processes with low greenhouse gas emissions. Hence development of sustainable fisheries and aquaculture is an essential component of the blue economy. The global contributions of the biomass production from marine, aquaculture and inland waters are represented in Fig.7.



*Fig.7. Growth trend of fisheries and aquaculture*

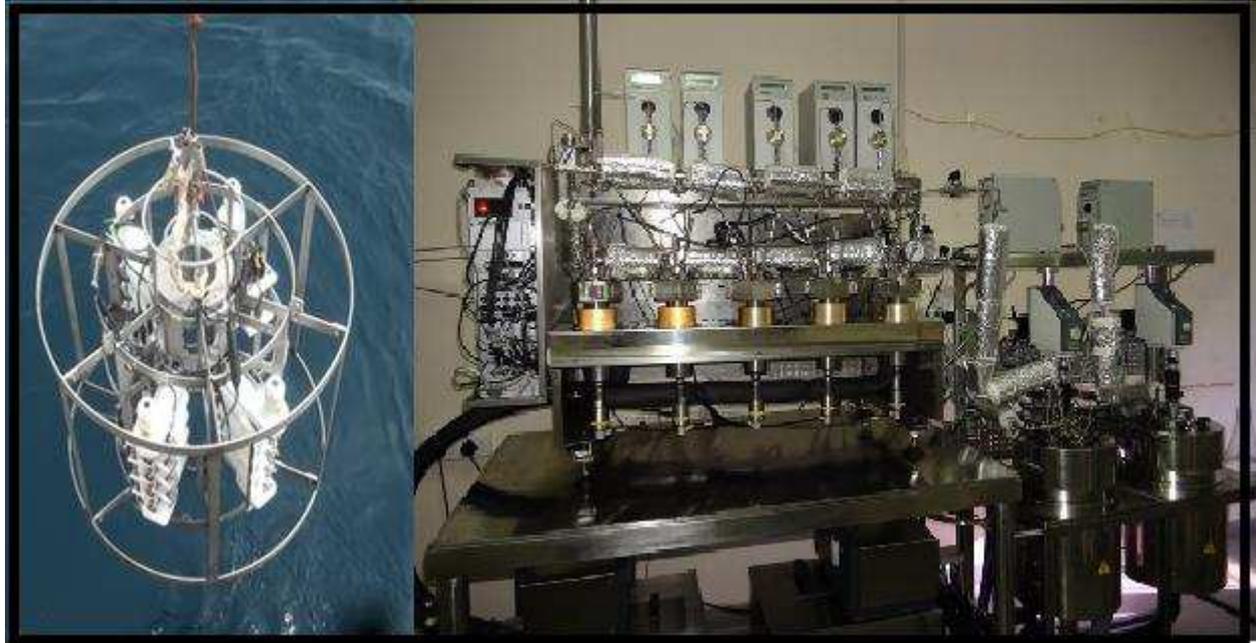
With over 2.4 lakh fishing crafts, 6 major fishing harbors, 62 minor fishing harbors, 3432 fishing villages 1511 landing centers and employing 4 million fishing population, India stands 3<sup>rd</sup> in global fish production. More than 50 different types of fish and shellfish products are exported to 75 countries. The sector contributes 1.1% of the national GDP and creates annual export earnings of about US\$ 5 billion. Out of total fish production of 6.4 million tons, marine contributes 3 million tons and production from about 73,000 km<sup>2</sup> of inland water bodies is about 3.4 million tons.

It is identified that potential fish production could be up to 8.4 million tons, a 30% increase from the current production. As a part of motivating deep sea fishing, the integrated development and management of fisheries provides subsidies for conversion of fishing trawlers into deep sea fishing vessels. With the aid of Indian satellite based oceanography, INCOIS provides reliable and timely advisories on the Potential Fishing Zones with specific references to more than 500 fish-landing centers along the Indian coast and also for the algal blooms at near real-time for assessment of primary productivity. Programs are undertaken by MoES- Center for Marine Living Resources and Ecology (CMLRE) to address the biogeochemistry of the eastern Arabian Sea and biological responses including fishery resources in the northern Indian Ocean region through systematic survey. In order to increase the marine finfish production, multi-point moored 9 m diameter open sea cages made of high density polyethylene capable of withstanding turbulent sea states (Fig.8) are developed and demonstrated by NIOT.



*Fig.8. Open sea fish cages in Andaman Islands*

The Department of Biotechnology (DBT) through various research centres is carrying out activities including fish genomics and transcriptomics, fish and shellfish diseases, immune-stimulants and antimicrobial peptides. Development of bioactive molecules, biomaterials, biosurfactants, DNA bar coding and molecular taxonomy, cell lines and diagnostics were also pursued through adoption of molecular tools and techniques. The marine-microalgae, which are the key for the food, nutritional, cosmetic, pharma and bio-fuel industries, are being studied at NIOT. For fostering the studies on the applications of the deep sea piezophilic micro-organisms in the health and medical sectors, a deep ocean microbial sampling and incubation system capable of bringing the deep-ocean micro bio-resources to the surface and incubating them by maintaining their ambient pressure (Fig.9) is established in NIOT.



*Fig.9. Deep sea sampling and microbial culture facility*

## **OCEAN COMMERCE**

### **Trade and Transport**

In India, during 2018, the major ports with a capacity of 1.45 BT handled 0.7 BT and non-major ports handled ~ 0.5 BT. With the total vessel fleet of 1400 with gross registered tonnage (GRT) of ~ 10 million tons, ~ 451 vessels with a capacity of 88% is used for overseas trade and ~ 938 coastal vessels are used for ferrying goods within the country. The inland waterway transport is an economical means of domestic transport. Out of ~ 0.6 million km of navigable waterways in the world, China, Russia, Brazil, Europe, and USA share 18, 16, 8, 7 and 8% .

In India, the contribution of waterways in the domestic transport is <1% compared to China and US which stands at 24% and 6%, respectively. In order to accelerate the ocean commerce and transport, the national maritime development programs worth US\$ 11.8 billion are being implemented. Considering the need for efficient, eco-friendly and economical domestic freight services utilizing the coastal and inland waterways, a national perspective plan, Sagarmala, aimed in the port modernisation, effective port connectivity, port-led industrialization is formulated in 2016 by the Ministry of Shipping (Fig.10). Under the Sagarmala Programme, the government has envisioned a total of 189 projects for modernisation of ports involving an investment of US\$ 22 billion by the year 2035. The successful realization the program, involving an infrastructure mobilization of US\$ 60 billion, aspires to reduce the logistics costs for EXIM and domestic cargo by US\$ 6 billion annually, double the share of waterways, boost exports by US\$ 110 billion, create 4 million direct jobs, 6 million indirect jobs, and increase the commercial vessel fleet to 1600 by 2025.

### **Tourism**

Tourism is an important source of foreign exchange and is tied to the social, economic, and environmental well-being of many countries. Coastal and ocean-related tourism comes in many forms and includes dive tourism, maritime archaeology, surfing, cruises, ecotourism, and recreational fishing operations. Sustainable tourism can be part of the blue economy, promote conservation and sustainable use of marine environments and species, and generate income for local communities, and maintain and respect local cultures, traditions, and heritage. The United States, Spain and Thailand top the list in tourist count, while France, United States and Spain leads in terms of the number of international visitors. India's 43% of the coastline with sandy beaches, 11% with rocky land and 31 mangrove areas are potential tourist hubs. In India tourism industry contributed 2% to the total GDP and is projected to reach 6.4% by 2022. In 2017, ~ 10.4 million foreign tourists visited India, mostly coastal places, earning \$27 billion. The government has undertaken 17 coastal development projects across the country in the past four years.

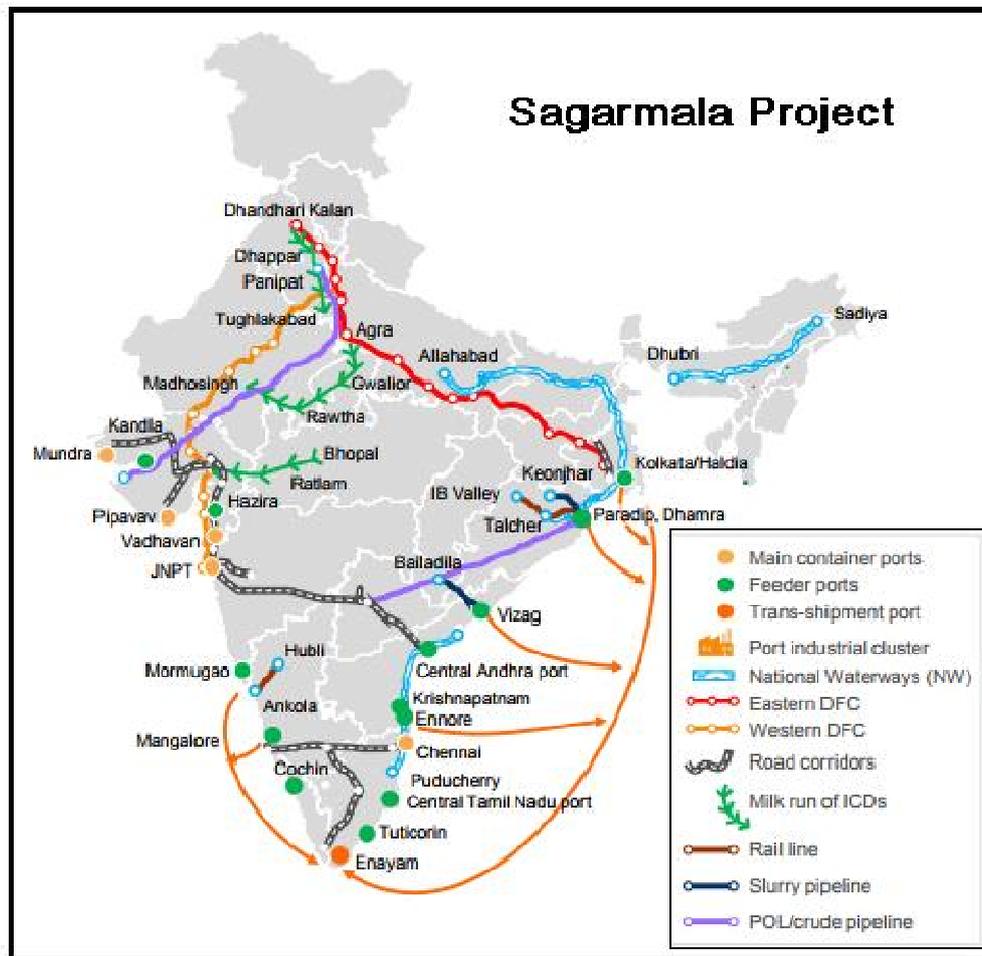


Fig.10. Efficient evacuating network under Sagarmala

## CONCLUSION

With its enormous resources, oceans are the ultimate frontier which shall help to transform the economy of the society from scarcity to abundance. With the extended Exclusive Economic Zone, India's Ocean jurisdiction equals to the land area. Hence an integrated approach with long term vision, technology, management, monitoring, and time-bound regulatory reforms are essential for building a sustained blue economy for India. It is beyond doubt that the upcoming blue economy shall serve as a growth catalyst for the robust Indian economy envisioned to reach US\$ 10 trillion by 2030.

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## About the authors



Dr. M. A. Atmanand, currently the Director of National Institute of Ocean Technology has done pioneering work in the area of deep sea technologies in India. He took his undergraduate degree in Instrumentation & Control from University of Calicut, Master's and doctorate degrees from Indian Institute of Technology, Madras. He led a team of engineers for the design and development of underwater crawler for deep sea operation which was tested at a depth of 5200 m and India's first Remotely Operable Vehicle which was later tested at a depth of 5289m water depth. He has also guided various indigenization programmes for Ocean observation and under water systems. He has published about 100 papers including International Journals, International conferences, National Conference and authored multiple book chapters. He received IEEE Oceanic Engineering presidential award in 2016, National Geoscience award 2010 from Ministry of Mines and the International Society for Offshore and Polar Engineers (ISOPE) Ocean Mining Symposium award in the year 2009. He is an Associate Editor of IEEE Journal of Oceanic Engineering. He is the founder Chair of IEEE Oceanic Engineering Society in India. He has served IEEE Madras Section in various capacities.



Dr. Purnima is a senior scientist heading the Energy and Fresh Water group in the National Institute of Ocean Technology, India. She has coordinated many first- ever projects in ocean energy and desalination. She has a tremendous contribution in the setting up of the first ever ocean thermal gradient based desalination plant at Kavaratti island in the Lakshadweep group in the Arabian Sea which has helped transform the lives of the small island community which had a serious lack of drinking water. For this work she was awarded the Vishwakarma Medal in 2006 by the Indian National Science Academy. This success led to more plants in islands and offshore. She is now attempting to scale up the technology and power such plants using ocean renewable energies. She has a PhD in Civil Engineering from Duke University, USA. She is on many committees of the Indian Government, related to water and renewable energy.



Dr. M V Ramanamurthy Scientist-G is currently Director, National Centre for Coastal Research (NCCR), Ministry of Earth Sciences. He also looks after the groups of Ocean Structures/ Island Desalination, and Coastal and Environmental Engineering at National Institute of Ocean Technology, Chennai His area of specialization include Port and Harbour Structures, Wave Structure Interaction Studies, Offshore and Coastal Hydrodynamics, Coastal Engineering & Measurements and Coastal process modeling including tsunami & storm surge and Integrated Coastal and Marine Area Management. His qualification include B.E (Civil), M.Tech (Planning), CEPT, Ahmadabad, M.Tech and PhD in Ocean Engineering, IITM, Chennai. He started his career in 1991 at Vishakhapatnam Port Trust as a Design Engineer in 1997 at Engineers India Ltd as Senior Engineer, in 1999 at Ministry of Earth Sciences, ICMAM-PD, Scientist-D to Scientist – F and at NIOT from 2009 as Scientist-G. The awards received by him include National Geo Science Award 2010, Ministry of Earth Sciences Award 2006. and American Bureau of Shipping Award 1997 at IIT Madras. His has more than 38 publications in international Journals, 7 in International/National Conferences. He is a member of various national committees of the Indian Government related to CRZ, BIS, Member CPDAC and President Ocean Society India.



Dr. G. A. Ramadass is a Scientist-G in National Institute of Technology (NIOT), Chennai. His research areas include Deep Sea Technology, Underwater Acoustics and Marine Instruments. At NIOT he is the head of the Deep Sea Technology Group. In 2010 he won the National Geoscience award under the Exploration of Oil and Natural Gas category and National meritorious invention Award – 2019 by Government of India for the development and usage of underwater vehicle for deep sea mineral exploration and shallow water biodiversity studies. He led NIOT team during the 34<sup>th</sup> Indian Scientific Expedition to Antarctica in February- March 2015. Polar Remotely Operated Vehicle (PROVe), developed indigenously at NIOT, was used for exploration in the lake and shelf area of Antarctica during this expedition. A doctorate from Indian Institute of Technology, Madras he handled technology development programmes leading to products and patents. He has been the Chief Scientist of 15 cruises and scientific explorations on-board various research vessels His recent work includes publications in the international journals, international conferences and four international patents.



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Lake Baikal, Siberia, Russia during winter and summer. As an exploration geologist he has participated and led cruise programs in ships namely and published more than 30 research articles in international and national journal apart from five chapters in books and two patents. As a team member, recipient of National Geo-Science Award – 2010 and National meritorious invention Award – 2019 by Government of India for the development and usage of underwater vehicle for deep sea mineral exploration and shallow water biodiversity studies.



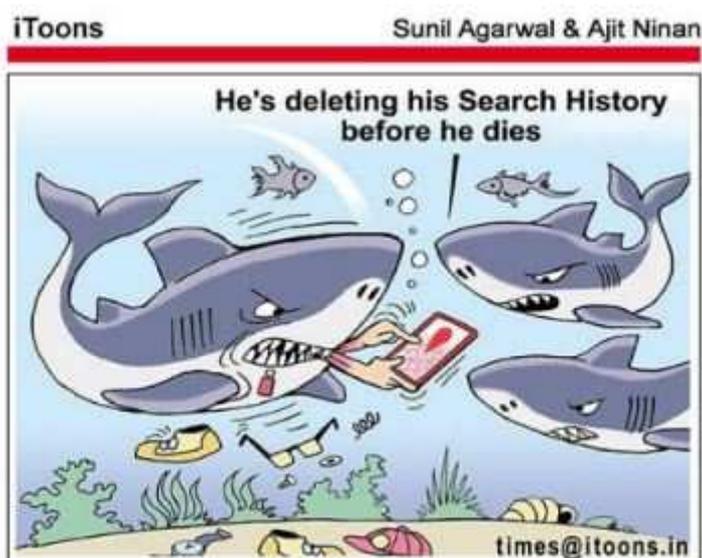
K A Gopkumar Kuttikrishnan has been with NIOT since 2013 leading the efforts in developing a deep sea mining system for harvesting polymetallic nodules from depths up to 6000 m. A marine engineering professional, has worked with the Navy in various responsibilities of operations, R&D and perspective planning.



Dr. N. Vedachalam is currently Scientist-F at the National Institute of Technology (NIOT), Ministry of Earth Sciences, Chennai, India. His 24 years of experience covers industrial power, process, offshore, and subsea domains. The technical exposure includes development of multi-megawatt power electronic converters, control systems, and energy storage for the long step out deep-water enhanced hydrocarbon recovery systems; ocean renewable energy systems including ocean thermal energy conversion (OTEC), wave energy systems and subsea grids for tidal energy farms; subsea intervention systems including deep-water work class remotely operated vehicles; and industrial power generation, utilization and boiler control systems. He was the Secretary of IEEE Ocean Engineering Society- India Chapter, Executive Member of Marine Technology Society- India Section and Senior Member-Bureau of Indian Standards. He has about 60 publications in science citation indexed international journals, holds one international and two national patents in the areas of subsea robotics, subsea process and gas hydrates production. He received National meritorious invention Award in 2019 for the development and usage of underwater vehicle for shallow water biodiversity studies.



Dr. G. DHARANI, MSc, M Phil, PhD is currently Scientist-F & Group Head In-Charge of Marine Biotechnology in National Institute of Ocean Technology, Chennai, India, Email: dhara@niot.res.in. His research interests include Plankton Ecology & Biology and Marine Biotechnology. Since he joined in NIOT in 1998 he has contributed to various projects of NIOT in various capacities. He has about 38 international publications, 63 conference papers, authored 16 book chapters, holds four patents and 200 DNA sequences. He received the Young Scientist Award, for outstanding contribution in the field of Ocean Sciences, Ministry of Earth Sciences, Government of India, Delhi, 2010. Best Paper Award, National Conference on “Biotechnological Approaches to Alternate Energy (BAAE-08) at IIT Chennai, 2008; Best Paper Award, in the International Conference on Recent Advances in Marine Antifouling Technology, NIOT, 2006.



## Technology Innovation Center

*(An organisation's ability to learn Technology and translate that learning into action)*

**Mr. Madhukar Srivastava**  
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**Smart City Mission** and **Digital India**, are two most ambitious programs, campaigned by the Government of India to ensure that eGov services are made available to citizens by making the country digitally empowered through technology interventions. While the **Smart Cities Mission** is an innovative drive for economic growth and improve the quality of life of people by enabling and harnessing technology as a means to create smart outcomes for citizens, and thus opportunities to improve lives, the **Digital India** program is drawn with a vision to transform India into a digitally empowered society and knowledge economy.

Smart World & Communication business vertical of Larsen & Toubro has been leading the market as MSI (Master Service Integration) in the areas of Smart City, City surveillance, ITMS (Intelligent traffic management systems), Smart Elements (Solid Waste Management, Smart Light, Smart Infra, Smart grid, Smart Parking, Environmental Sensor, and Command & Control Centre etc.), and Telecom infrastructure.

To sustain the technology leadership, we at Smart World & Communication, have fostered an innovative conceptual platform that serves the purpose of the business objectives with much impetus. The Center has been set up by L&T SWC is 'state-of-the-art' Innovation Center to upscale the Technological prowess of L&T SWC and align best possible solution exploiting the range of product & technologies, in a multi OEM environment.

**"Technology Innovation Center (TIC) is an Innovation lab to upkeep a design thinking culture and unlock the potential of millennial technologies, making us stronger in the Digital World."**

*Our future growth relies on competitiveness and innovation, skills and productivity... and the only way you survive is you continuously transform into something else. It's this idea of continuous transformation that makes you an innovation company*

### Objective of TIC

- Technological Capability & Competency development through Innovation labs, Research, & training programs
- Design and Development of Smart City Technology Lab with all Solution Prototypes
- Collaboration with Institutions and Industries in India and abroad, to inculcate Design Thinking Culture

**Technology Innovation Center** accelerate opportunities, deepen relationships, and foster innovation.

- Showcase what is possible with digital transformation and IoT
- Build solutions with partners and start-ups, and engage in rapid prototyping
- Invest and partner with start-ups, accelerators, and universities



*State of the art -Technology Innovation Center*

The **Command and control center (CCC)** for the campus has been designed in an area of 5000 sq. ft, with replicating the scenario of smart city within 27 Acres, and as such major smart elements having been deployed and integrated with two CCC platforms.

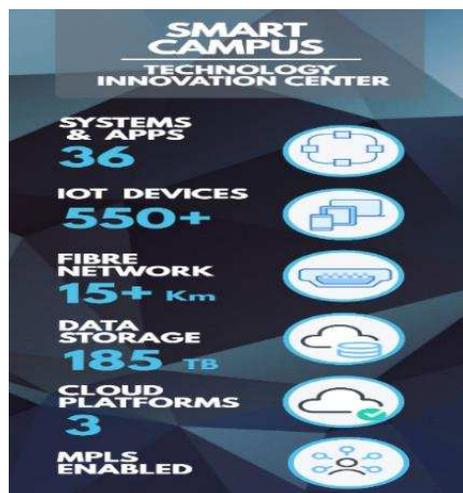
The interior and ambience have been carefully designed as per the occupational use and controlled lighting systems have also been in such a way to position the right ambience.

The entire space has been categorized into three zones, based on its usage:

- The **elevated floor** is for Technical/Operational use, comprising “Test Zone’ and ‘Command Centre’.
- The lowered floor is “Interactive zone’ used for interactions, discussions & presentations.
- The third zone is “Data center” located in the center as a central point of the design, and is positioning it as unique circular design.

The baffle ceiling denotes the data flow spreading from center to multiple directions in entire network. The baffle ceiling with undulation is for ‘acoustic’ to balance the echo.

The colors of **Technology Innovation Center** are picked rationally as Orange, blue and white respective to balance the vibrancy, tranquility and neutrality of the ambience.



Each wall being dedicated for different technology domains, the right and left wall for IOT, the wall at the entrance for robotics and the wall at the exit for ‘Artificial Intelligence’ strikes a futuristic look to the design. The glass partitions deliver a sophisticated look to the ambience. The lighting can be set to 16 million colors along with dim and brightness control capability. The colors of the lights can be changed by scanning any live movement or a taken picture as well. The lights can also synchronize with the sound decibel of the environment and flick accordingly.

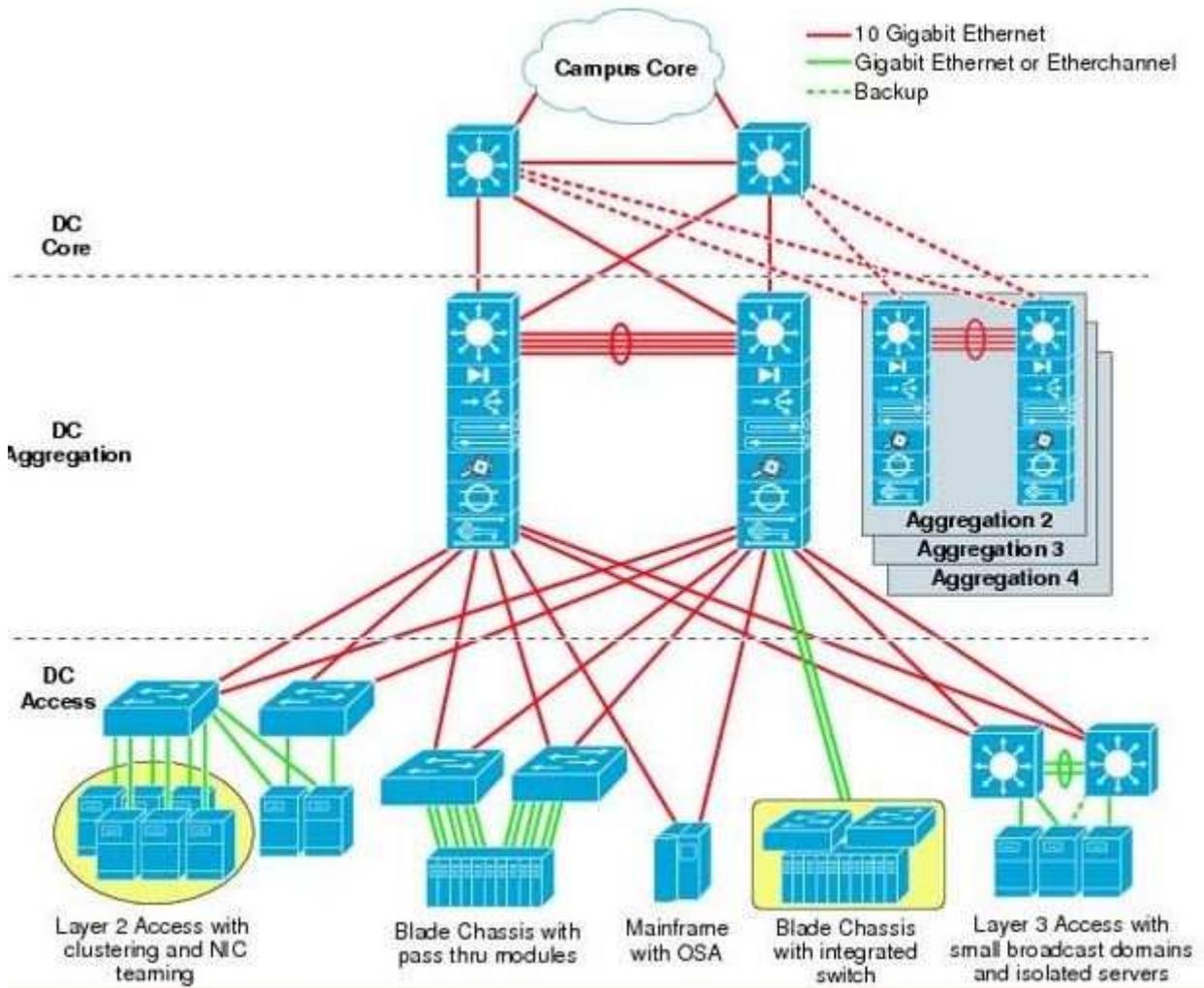
The **functional design** of Technology Innovation Center is conceptualized with the intention of creating the replica of the Smart City, Core Networks based on MPLS services with three Data Centers, transforming the entire campus as smart campus. High level description of the networks created is as per below:

- Deployment of 35+ systems, with 550+ IOT devices & smart elements
- Network created with almost 15+ Kms Optical fibre cable based network within L&T Chennai Campus
- Core network with MPLS services, connecting three 3 Nos. of Data Center and all POPs
- Three Nodal Data Centres (TEC DC, TCTC DC, CCTV DC)
- Cloud Solution (Amazon AWS, Microsoft Azure, CtrlS)
- Command and Control Centre

The Technology Innovation Center and Smart Campus has been developed with following technologies, architecture and provides services offering as per below:

#### Architecture using MPLS Network

- Two Cisco core routers (ASR 920 & ASR 903) are placed to which the core switch is connected.
- All the Core routers are configured on MPLS protocol. This forms the Core ring. OSPF protocol is enabled between the Aggregation switch to Core router.
- The Aggregation switches connected to the Cisco Core routers and have redundant links with each other, so that if one link fails or terminated
- The campus perimeter switches are divided into 3 access rings. Each access ring has a maximum of six switches. The two extreme perimeter switches in each ring, aggregates the traffic to the aggregate switch. Each switch in the core ring is enabled with the RSTP



TIC – High Level Network Architecture

### Communication Technologies deployed

All kind of communication technology are implemented in the smart campus namely-

- **LoRa**  
(Low Range digital wireless data communication technology)
- **ZigBee**  
(ZigBee is an IEEE 802.15.4-based specification for low-cost, low-power wireless IoT networks and is used to create personal area networks with small, low-power digital radios)
- **Bluetooth**  
(Bluetooth is a wireless technology standard for exchanging data between fixed and mobile devices over short distances using short-wavelength UHF radio waves)
- **LAN**  
(A local-area network (LAN) is a computer network that spans a relatively small area)
- **GSM**  
(GSM (Global System for Mobile communications) is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation (2G) digital cellular networks)
- **Li-Fi**  
(Li-Fi is a wireless optical networking technology that uses light-emitting diodes (LEDs) for data transmission)



Communication Technologies at TIC

## Command and Control Centre

The Integrated Command and Control Center (ICCC) acts as the “nerve center/ brain” for operations management, day-to-day exception handling and disaster management. It also provides insights by processing complex data sets at an aggregated level to derive intelligence for improved planning and policy making. The ICCC is envisaged to aggregate information across multiple applications and sensors deployed across the city, and then provide actionable information with appropriate visualization for decision makers

The ICCC @ TIC, has a holistic view of all the smart elements deployed in the campus, monitoring of the surveillance system and analytics with dashboard. Multiple Use Cases are defined for decision support engine for the campus for day to day management, thus transformed the campus as SMART.

At Technology Innovation Center (TIC), we have deployed ICCC from two major OEMs namely Trinity and Cisco.

- READY-TO-GO platform from Trinity, a home-grown Indian ICCC application for Smart Cities
- Agile & Scalable Command & Control Centre platform with capacity to integrate +50 IoT systems
- Cisco Kinetics for Cities (CKC) is a Global ICCC platform for Smart Cities
- Native & Open IoT layer for Direct device integrations
- Integrated Collaboration Solution for seamless communication with various technologies, instantly



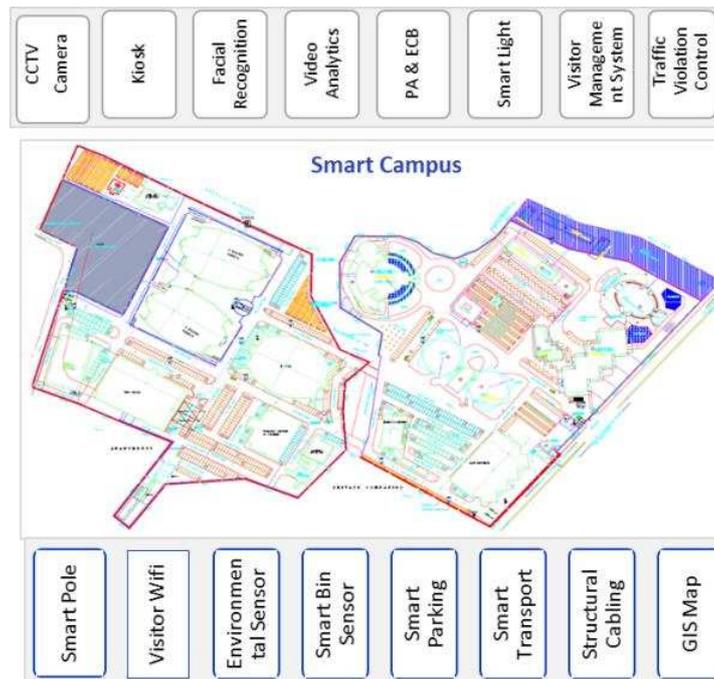
*Integrated Command and Control center Platform - Trinity*



*Cisco Kinetics for Cities – ICCC Dashboard*

## Smart Elements deployment within L&T Campus

We have deployed most of the Smart Elements within campus, and integrated with Command & Control Center for making 27 acres of Green campus as “**Smart & Intelligent campus**”, by having analytics, API based Application integration for dashboard SOP & Use-cases. Some of the system use-cases are discussed below which are implemented at L&T’s Smart Campus.



*The L&T Campus - a 'Smart City's Living Prototype'*

### **Data Centers and Cloud– Accelerating a digital future**

The Data Centers are positioned with hybrid solution of 'on premise' and Cloud. We have positioned three physical Data Centers in two diversified locations/buildings and one in TIC site. Three cloud service providers have been integrated to have complete diversity and redundancies, to enable us to have POC (Proof of concept) testing in all possible scenarios.

The **Technology Innovation Center** has positioned a high impact platform, cutting across stakeholders in all the three dimensions viz. Our Customers, OEM Partners, and Employees, thereby intent is to exploit cutting-edge technologies for positioning new innovative solutions. The Technology Innovation Center will also enable us in driving our vision with following Value Drivers

#### **Technology & Innovation**

- Lead Adopter of New Technologies
- Technologies for all Biz. Verticals
- Product/Technology Benchmarking Business Support
- Niche Knowledge Transfer Platform
- PoC Lab and Live Simulators
- Product Validation

#### **Learning & development**

- Platform for Skill Enhancement
- Learner profile: hands-On
- Cloud & Security Technologies

#### **Delivery Excellence**

- AR based Virtual Support
- Tutorials, MOOC, Videos
- Process Viewpoints
- Analytics & Prediction Learning
- Interoperability Tests

#### **Product Development**

- Collaboration with Young-minds
- Co-Create Standards & Patents
- Open Source Product Development
- White Labelled Product Tuning

## Use Cases Development

- Outcome based Integrations
- Product Validation
- Start-up Incubator
- Re-usable Artifacts

With such a state-of-art infrastructure, we at L&T announced to have certainly acquired the Technological strength through in-house capability building, innovations and best-in-class solutions, and give our employees an edge to lead the market with technology leadership. Once again I would like to reiterate that Technology Innovation Center (TIC) is an Innovation lab to upkeep a design thinking culture and unlock our potential, making us stronger in the Digital World.

## About the author



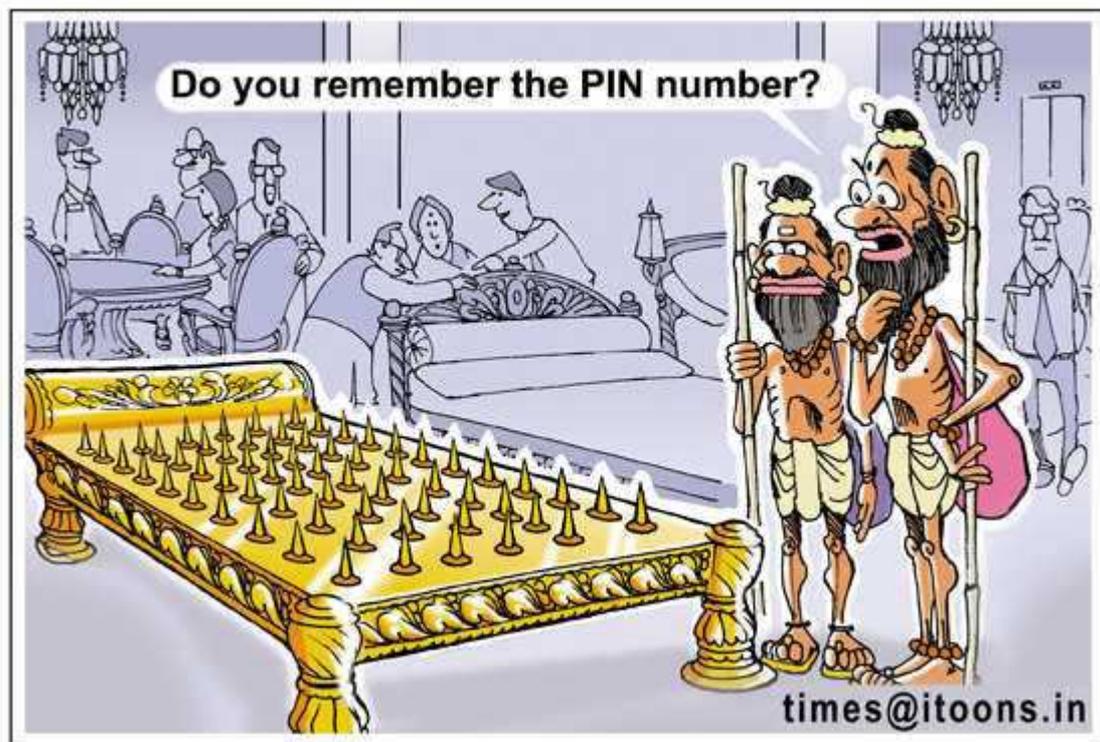
Madhukar is a telecom professional with over 33 years of experience and proven abilities in overall business management including P&L, strategic business development with core strengths in Planning & Engineering, Service deliveries, and Program Management of large geographically dispersed projects. He has created strong value proposition as Master System Integrator, across Public & Private sectors and ambitious projects like Digital India, Smart cities etc. Core strengths lie in motivating and leading large teams to deliver high impact performance.

Currently responsible for technology & Solutions as CTO with 'L&T- Smart World & Communication', and leading a team of Pre-Sales Engineering and Technology and as such contributing with wide experience and always demonstrating leading-by-example.

Prior to L&T, Madhukar worked with Sterlite as Business Head and prior to that in a leadership positions with renowned Indian telecom organizations like R Jio, Bharti Airtel Ltd, Tata VSNL and Dept of Telecommunications/ Bharat Sanchar Nigam Ltd. He belongs to 1985 batch of Indian Telecom Services, and has been awarded with "Sanchar Seva Padak" in May 2004, for outstanding contribution to Telecom

iToons

Sunil Agarwal & Ajit Ninan



# An Overview of Deep Learning in Smart Grids

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## Introduction

In recent years, with the growth of the computational methods particularly in case of data management and analysis several machine learning (ML) approaches has been implemented in various industries. According to the current situation most of the researchers have concentrated their studies on deep learning (DL) because deep learning has been treated as one of the emerging areas for feature extraction and handling huge amount of data where machine learning methods fail. Altogether, artificial intelligence encloses with numerous subfields, counting as machine learning, deep learning, computer vision, neural network and natural language processing etc. Deep learning utilizes massive neural networks with a lot of layers of processing units, for advances in computing power and enhanced training techniques to learn versatile patterns from huge quantity of data. Common applications include image and speech recognition. Deep learning is implemented through neural network. The motivation behind neural network is the biological neuron. Generally, deep learning is a sub-branch of machine learning and machine learning is also another sub-branch of artificial intelligence as given in the figure1.

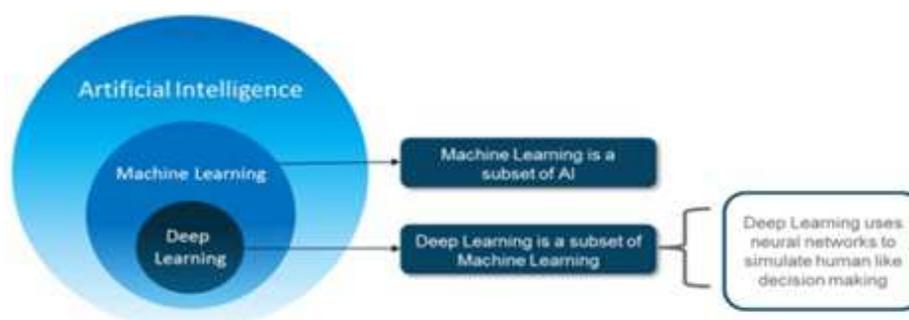


Figure 1: Depiction of AI, ML, DL

## The biggest advantages of deep learning are:

- Deep learning gives better performance on dissimilar troubles that significantly outperforms other solutions in diverse domains. This take in speech recognition, language, computer vision, playing games etc.
- Deep learning overcomes the limitation of machine learning methods in case of feature extraction that means it takes less time.
- For adopting new type of problems in upcoming days deep learning architecture performs well.
- Robustness to natural variations in the data is automatically learned.

○

## Importance of deep learning over machine learning

- Machine learning is not enough capable for managing high dimensional data wherever input & output is relatively large.
- Deep learning has sufficient power for managing the high dimensional data as well as to focus on the exact features by themselves. This procedure is known as feature mining.
- Deep learning can do better than traditional methods. For example, in image classification, deep learning algorithms gave 41percent more correct result than machine learning algorithm and gave 27 percent more accurate in facial recognition and lastly 25 percent in case of voice recognition.

## Deep learning works in smart grids

For electricity data analysis industries were adopted novel methods like machine learning, fuzzy logic, data mining, artificial neural network (ANN),support vector machine (SVM) and genetic algorithm etc. to get better outcomes for estimating the exact electricity demand and also used these methods to forecast both energy production and consumption. Among all methods deep learning plays a vital role in smart grids applications.

## Smart Grids (SG)

According to digital technology "grid" is recognized as the electric grid and it is bi-directional communication line of network between consumers and utility. Now a days electricity disturbance is common problems which cause a series of failures such as in banking sector, communications, traffic, and security etc. For this purpose smart grid technology is implemented based on varieties of artificial intelligence approach. This scheme gives permission for supervising, investigate, organize and communication within the supply chain to assist progress effectiveness, shrink energy utilization and cost, and make best use of the transparency and reliability of the energy supply chain. The smart grid system overcomes the drawbacks of traditional electrical grids where smart net meters concept has been implemented in earlier days. The concept of smart grid approach not only concentrates on utilities and technologies but also focuses on the consumer choices regarding their consumption of electricity energy.

The layout of smart grids is as follows in figure 2.



Figure 2: Powers ahead with smart grids

Smart grid is totally a new concept for all researchers in comparison with traditional electricity grids. The smart grid is the renovation of the electricity flow system. So this theme takes a significant role in the research society. Smart grid is the mixture of information and all digital communication approaches by means of power grid systems to facilitate two way communication and power flow that can boost safety, reliability, and effectiveness of the power scheme. In addition we can say that smart grid is the arrangement of tools, systems and procedure to manufacture power grid intelligent and computerized. Due to huge amount of data collection in each and every moment from different sources, it is necessary for all power companies to take responsibilities of all collected data and find out the clear knowledge about electricity consumption behaviors which is shown in block diagram 3 below. So deep learning algorithm is required for feature extraction and data analysis. Most of the studies were done on smart meter data for instance load outline, customer classification, load predicting and anomaly detection. For doing improved understanding of electricity utilization, flexible demand management and useful energy control smart meter data analysis are essential.

According with the advancement of smart grids the United States Department of Energy recommend four types of technology such as:

- Technologies regarding measurement and intelligent.
- Another approach is automated flow of communication among constituent of the electric grid and their Integrations.
- Computerized controls for division and repairs.
- Enhanced organization management dashboards and decision support software

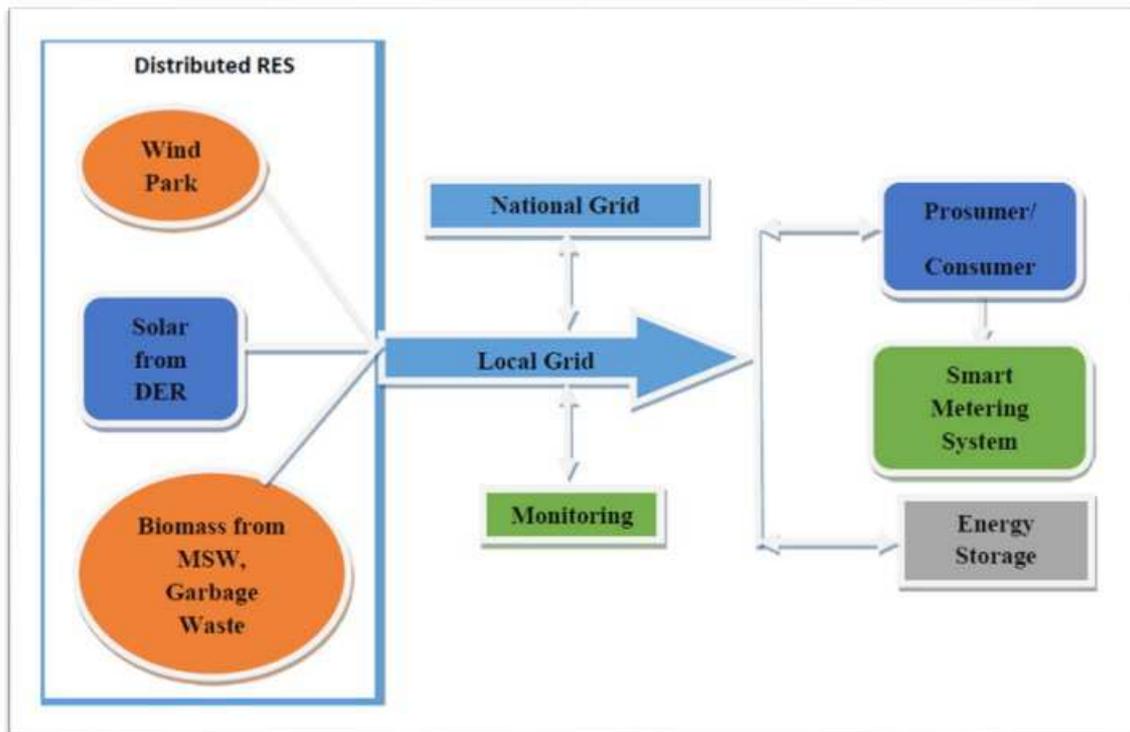


Figure3: Block diagram of smart grids

RES, DER and MSW stand for renewable energy source, distributed energy resource and municipal solid waste respectively in figure 3.

**The important benefits related with the smart grid include:**

- Electricity flows of transmission are much more proficient.
- When power disturbances of electricity arise smart grids approach gives quicker resolution.
- Smart grid approach provides minimum power and operation cost for consumers.
- Reduced peak demand, which will also help lower electricity rates.
- Improved bonding of customer-owner power generation systems, counting renewable energy systems
- Enhanced the security feature.

**Challenges of smart grids**

Although smart grid has numerous profits still there are lots of challenges in its achievement. Smart grids occupy a lot of stakeholders who are in charge of dissimilarity aspect of the energy system and sorry to say, the synchronization and rate of adoption of the novel tools happens at diverse paces. The vast investments required for together the infrastructure and new devices are also a hurdle to adoption. Lastly, regulatory obstacle and jurisdictional topic issues present important challenges that must be overcome.

**Conclusion**

From literature studies, it is revealed that most of the researchers concentrated their experiment on smart grids using artificial learning and machine learning methods. Still it is a challenging factor for all. Therefore a novel enhanced model has been adopted based on deep learning to solve more complex problems of smart grids which have not been yet solved by machine learning methods. By increasing the number of layers in the well-known artificial neural networks, nowadays we are referring to deep neural networks as the principal direction in deep learning. This algorithm has immense application potential in case of smart grids but researchers are still struggling on their studies on deep learning techniques due to many hidden layers are included in this algorithm. Numerous problems required to be studied in deepness, for example, for a specific use case which structure of deep learning is preferable and how many layers are appropriate for the particular problem and also concentrate on security of power system.

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**Education is the passport to the future, for tomorrow belongs to those who prepare for it today. – Malcolm X**

**The roots of education are bitter, but the fruit is sweet. – Aristotle**

**Education is what remains after one has forgotten what one has learned in school. – Albert Einstein**

# Let's Play To Learn

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“Tell me and I forget. Teach me and I remember. Involve me and I learn”

-Benjamin Franklin

**Acknowledgement & Gratitude:** My deepest gratitude to the almighty God, parents, well-wishers, friends, colleagues, teachers and students who in various different ways have helped me embark this journey of teaching and learning specifically in the path of play/games. I continue to be a learner in this path and wish to share my experiences in my journey, various different experiments and what I learnt from them and also the work of several other educationists, practitioners, researchers in this field.

**Context Setting:** My first detailed research publication on Play/Game based learning occurred in 2018 when I submitted my work for the 9th National Teachers Science Congress, held at Ahmedabad in Dec 2018[P1]. Later, I had an opportunity to expand on that work when I presented a second paper in “Future of Learning Conference 2.0” held at IIM-Bangalore in January 2019[P2]. Ever since then, I have further experimented and expanded consultancies in this field and researched deeper into this topic and I am now collating all of them into this article. In one sense, each piece will build on top of the previous work, while retaining what still holds good and adding/replacing newer evidence.

**Article specific thank you note:** A very big thanks to HR Mohan (IEEE) for providing this opportunity to contribute to the newsletter. Sivapriya and Sankalpa, the students with whom I got to work in the last few months, also deserve their thanks to the extent they could contributing in editing and adding value to this newsletter.

## Introduction

With the world grappling with an exponential rate of change, continuous learning is a must. Despite the wide availability of low cost, high quality learning, learners and trainers struggle. This could be due to reasons such as, purely theoretical knowledge being taught, the content not being customized for an individual learner’s ability, the grading system and its detrimental impact on learning as well as the focus on one’s intellectual development at the cost of their emotional maturity. These approaches are by and large unidirectional and does not involve peer to peer or student-teacher interactions. Learning happens successfully only when the learner gets engaged.

Play or game or activity based learning an alternative may be the solution to these issues. Play facilitates a *flow or happiness* state (Mihaly Csikszentmihalyi) that separates the joy of learning from the anxiety and boredom it may cause.

A game provides continuous motivation and enables fun during the learning process (overcoming difficulty/monotony). In a game/play, failure/loss is not seen as a taboo. Play encourages (Stanford Psychologist Carol Dweck) *growth mindset* thereby encouraging learner to repeat the learning (persistence). While playing a game, people are actively involved interact with each other, thereby encouraging collaboration and peer learning. Games addresses all types of learners in VARK (Visual, Auditory, Read-Write, and Kinesthetic) domain. It is possible to design games for varying abilities of learners with sufficient motivational elements to help them stay involved. Leading Psychologists and Educators (Peter Gray) have started increasingly started emphasizing the role of play in learning. The good news is any kind of content – concept, terminology, process flow, rules could be adapted into play/game form at fairly low costs.

When we look at different cultures and philosophies across the world, specifically the Western, Indian and Japanese settings, on what constitutes a system of effective learning, we find some broad commonalities and it is very interesting to note that play/game based learning enables the environment that is conducive for those learnings.

Play, much beyond learning effectively forms the essence of building life-skills in an individual. In today’s world, much beyond the academic and aptitude skills, building entrepreneurial skills and life skills is of utmost importance. There is evidence to show that play forms the foundation of these skills too.

Given its multitude of benefits, it is worthwhile to frame policies or facilitate processes that encourage educators to incorporate these techniques. In a nutshell, let us all *Play to Learn*.

## Effective Teaching-Learning-Processes through the Ages

In the ancient times, prior to the Industrial Revolution or maybe until paper based modes of documentation was invented, learning was enabled through practice and apprenticeship. This refers to learning of any kind. For example, if someone

wanted to pursue medicine back in the day they became an apprentice under a practicing doctor. They observed, assisted and learnt as they saw the doctor in action. The doctor would check the patient, prescribe medicines, perform some minor surgeries etc. All of these skills were learnt by observing, listening and asking questions. The doctor also would also take some time off and explain a little bit of theory about how things work. But it never started with just plain old theory and lectures!

Over a period of time, the juniors would also get to do some real work. Gradually with time, they would get to do more regular tasks and in longer periods of time until they master the art. The same story holds good for all professions - artists, engineers, accountants, lawyers, singers and every other profession as well.

It was always *Learning by Doing*. There was of course observing, peer and instructor interactions and maybe a little bit of theory.

Even today, skills like driving a car, riding a cycle, swimming, cooking are taught and learnt this way. However for larger professional fields like engineering, medicine, commerce, law etc., somehow we have moved away from this approach and instead ended up building curriculums, large institutions, and institutionalized the pedagogy to books, lectures and theory. At this stage, we're not sure when and how this exactly happened.

Indian civilization, which is one of the oldest in the world, is rich in its literature and examples. To quote one shloka here along with its meaning. [A1]

**आचार्यात् पादमादत्ते पादं शिष्यः स्वमेधया ।  
सत्रह्यचारिभ्यः पादं पादं कालक्रमेण च ॥**

*One fourth from the teacher, one fourth from own intelligence,  
One fourth from classmates, and one fourth only with time.*

From the western world, Charles Jennings proposed a 70/20/10 model [A2], where he talks about how 70% of learning happens on the job, 20% with peer/social interactions and 10% through classroom/theory.

Japanese Martial Arts - ShuHaRi [A3] system is one where for the student to learn martial arts, there is no need to learn theory. It just starts with imitation, blindly doing what master does, which then gradually moves into assimilation and innovation phase.

However, the reality is that we are surrounded by an unhelpful form of pedagogy be it book based, theories, lectures or instructional learning. How do we deal with this reality and learn better at it for the sake of both teachers and learners?

Even if for a moment, let us assume that the lecture/instruction based pedagogy is the only one available. There are several aspects that determine the success of instructional/lecture/power point based teaching/training. Two of the most important ones are

a) Characteristics of the instructor/teacher/trainer - Their energy levels/positivity/ability to engage the different participants by actively listening, being patient and empathetic to different levels of learners' interest/difficulty levels in grasping topics and last but not the least, making the class fun, light-hearted. Hardly about 10% of the instructors possess these most of these traits. This might look surprising but if we look and reflect on the teachers whom we recollect from school/college days, it would match this number.

b) Method of delivery (Case in point PowerPoint) - A common problem with humans is that we often want to transmit all the information we know to others and think that we have enabled learning. Far from the truth. Even experts fall into this trap. And so, most power points are full of text, information and often run into too many slides. It is far from effective. There is only some information that the learner can grasp and digest in a given duration. PPTs therefore are just aids/tools for highlighting some key words/phrases. A good power point would actually have a lot of relevant visuals (pictures/cartoons/caricatures. Whatever form...) that supplement text. Once again, we have just about 5-10% power points that get well prepared.

So, considering (a) and (b), the instructional learning is by and large rendered ineffective. Note: This is not a criticism against instructors. Instructors could well be very knowledgeable in the field...but it is one thing to KNOW and it is a very different thing to TEACH/TRANSMIT knowledge.

The good news is that slowly at-least some educationists have started realizing the flaws of this system and have come up with alternative frameworks.

### **Alternatives to Instructional/Lecture Based Pedagogy**

The best form of teaching-learning process continues to be apprenticeship/experiential learning. There is nothing more superior to that. However that is a very expensive proposition today and would need lots of investments and trained practitioners. What could be the next best? It is simulations. Simulations either through basic software or through advanced AR/VR could provide the learner the experiential learning to some reasonable extent. But then again, we land up with the practical constraint of costs.

We find quite a few positive alternatives to supplement the existing pedagogy of lecture or instructional learning. Story-telling, audio-visuals and role-plays are forms that are effective and engage the learner. Play/Game based learning is also a form that is certainly worth looking into and in this article, we will see why this could be a more universal approach than the others in terms of cost-effectiveness and ease of implementation.

Before getting started with this, it is worthwhile reflecting on the article “How to Learn Anything - Sonmez 10 step system” by Charles Chu (A15) where a very refreshing perspective on learning process captured in this article, and the importance of PLAY in it.

The author summarizes towards the end as follows

It looks something like this: play → study → teach → play → study → play → study → teach ... and so on. //

The other big lesson? Learning is about play.

### **Why Play/Game Based Learning?**

There are many reasons why play/game-based learning is impactful over instructional learning. We will try and see a few key reasons.

#### **a) Fail-Safe Learning -> Persistence -> Growth Mindset**

One of the biggest challenges in a classroom is for the trainer/teacher/instructor to make the learners participate - Share their comments, ask questions. No matter how friendly and non-judgmental the instructor is, there is always this inhibition amongst the participants and there will always be a set of learners who do not participate. The underlying reason is simple but extremely important to understand. “What if I ask a silly question, what if I make an incorrect comment, what would others think of me?” We do not want to look bad for whatever reason in front of a crowd and hence prefer to keep silent. Going beyond classroom participation, the assessments also deeply drive the feeling that some people are good based on the marks/grades they score and others are not as good. But how does one get over this?

Here is where game/play based learning comes in very handy. A game, by its very nature has players leading/lagging at different stages, based on points scored or progress achieved. A wrong answer or a move is not seen as a failure and seen more in the fun spirit and the player is curious to understand why they went wrong.

Rich Delgado (2015) in this article talks about how organizations are using gamification as a technique to help their workers overcome the fear of failing [A4] He specifically quotes the words of the gamification thought leader Gabe Zicherman in this extract below.

Kevin Shane (2012) in another article [A5] talks about how games in education help children learn by failing. The snippet below is an extract from that article that talks about how games provide a fail-safe environment to learn through mistakes.

Two related aspects of creating a fail-safe learning environment are that it encourages learner to persist and cultivates growth mindset. Incentivizes Persistence: During the process of learning, specifically while encountering newer subject/topics/concepts that are perceived monotonous or difficult by the learner, it is important to persist - i.e. read and try learning the same topic repeatedly to get better clarity. But given that the subject/topic is already perceived as difficult, it is all the more difficult to make the learner persist without motivations/rewards. Here is where game or gamification concepts help. For instance, a game can be designed by encouraging the player to take multiple clue cards to attempt the answer to the same question. Encourages Growth Mindset: The famous Stanford psychologist Carol Dweck came up with the famous Growth Mindset, [A16] that is very key and fundamental to learning. It is making the learners believe that they can improve, no matter where there are. It focuses on measuring the effort, not the result. Often the school system measures the result (or even if they try not to, various different factors like exams, grades/marks, self-imposed peer pressure among students, parents and the entire ecosystem gives a lot of focus on results, not just absolute performance but relative

performance. The end result is that learning suffers. We need to realize and remind ourselves constantly that learning is the end goal. Exams and other measurement mechanisms are just one measure of the learning. Carol, in her work (which she has captured in the book “Mindset”) focuses on effort. Now, in order to put in efforts, especially for learners who find the topics difficult, it needs motivation beyond the normal and in continuous doses. Here is where games provide a big positive environment. They provide a fail-safe environment, motivate the learners with points and encourage to continue the learning journey.

An excellent commencement at California State University by Randall Fujimoto (2012) on how games/gamified environments help us handle the most difficult challenges of humans – That of encouraging them to fail, fail, fail (try, try, try again) to learn but in a fun way and that of persisting with efforts continuously. [A6]

**b) Immersive Learning -> Fun -> Happiness -> Flow State:**

All of us have experienced moments where we get lost completely in some activity. We are so immersed in the joy of it that time seems to come to a standstill or rather, we lose track of time. For some, it could be singing, for others it could be reading books, running, painting or any other thing. This phenomenon is called being in a state of Flow.

But what percent of our Teaching-Learning process can we correlate with the Flow state? Learning, by and large continues to be burdensome or a drudgery (for most people), with the exception of a fraction of people. How would it be if we could make Learning Immersive, into a Flow State?

We always remember those teachers or learning experiences that have fun associated with it. But is there a science and logic behind it? It is and there are a lot of articles talk about how the brain responds positively to fun. Let us understand them from some articles and research work done. In the dissertation titled “A Model of Flow and Play in Game-based Learning: The Impact of Game Characteristics, Player Traits, and Player States” [A7] by Davin Pavlas in 2010, the relationship between flow state, serious games and learning was examined. The following table and figures are from that dissertation.

First let us study what Csikszentmihalyi listed as flow factor and what the outcomes were.

Table 1: Flow factors, adapted from Csikszentmihalyi, 1990 and Nakamura & Csikszentmihalyi, 2002

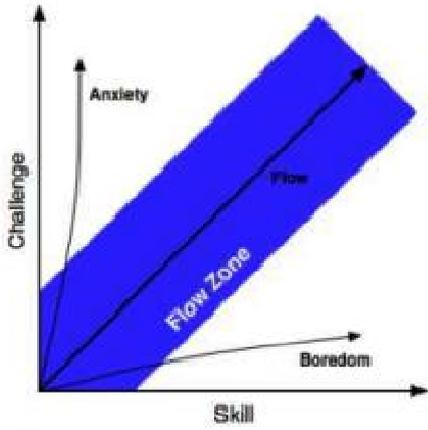
Flow Requirements & Outcomes	
A task to accomplish	Intense engagement
Ability to concentrate on a task	Intrinsic motivation
A sense of control over actions	Receptiveness to information
Deep but effortless involvement	Merging of action and awareness
Clear task goals	Loss of concern for the self
Immediate feedback	Altered sense of time
Matched challenge and skill	

If we reflect on any good game, they have all of these and hence flow is inherently built into a game. A special point to elaborate is about the feedback aspect in the learning context. Feedback, both positive and improvement oriented is an essential component of learning. In the traditional classroom style teaching and assessment methodology, there is a fairly large gap between the time a concept is taught in class and the time that the learner is assessed on it. (Be it in the form of classroom tests, exams etc.). One of the biggest advantages of a game-based learning methodology, is that games by design incentivize correct actions and incorrect actions immediately in the form of points/rewards or progress and so as a part of the learning process, instantaneous feedback is received by the learner.

The figure that follows describes what all factors contribute to the flow state both from the player traits as well as features of the game. A well-designed game can result in a flow state, which causes immersion in the learning process and enjoyment, resulting in learning.

The Figure enclosures

(Fig\_Flow\_Skill\_Challenge\_Relationship, Fig\_Flow\_4\_channel\_model, Fig\_Flow\_Player\_In\_Game\_States\_Behaviours from this paper illustrate and help us understand the underlying dynamics better.



: Skill-challenge relationship (adapted from Chen, 2007)

Fig\_Flow\_Skill\_Challenge\_Relationship

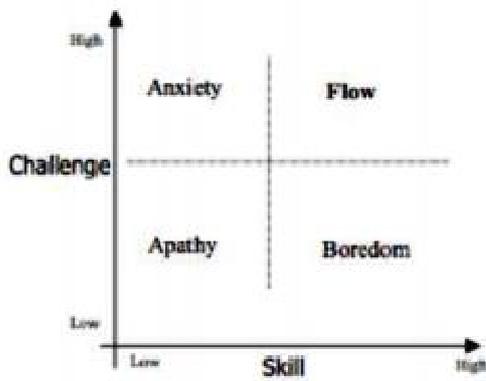
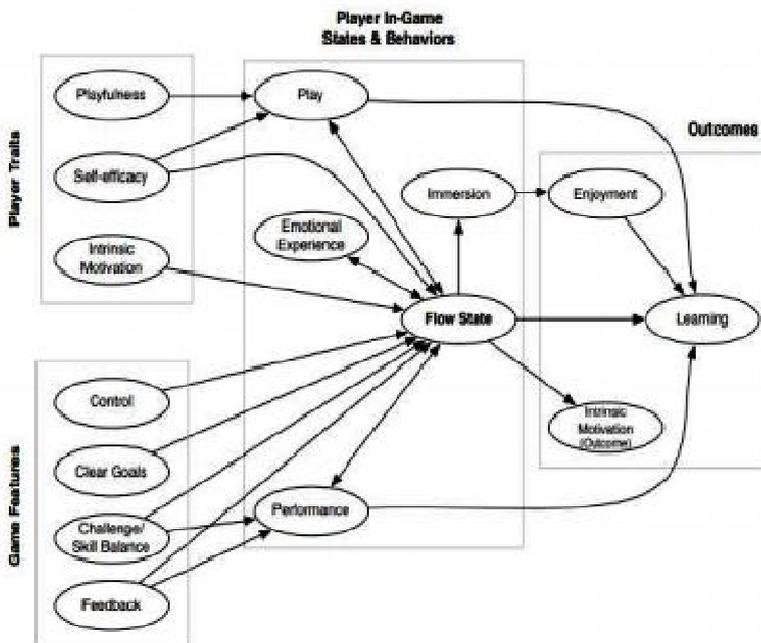


Figure 2: Four channel model of flow (reproduced from Guo, 2005)

Fig\_Flow\_4\_channel\_model



Fig\_Flow\_Player\_In\_Game\_States\_Behaviours

Both the figures above are extracted from the same article that analyses flow and explains how the player traits and game features work together resulting in end user learning. Another research in this space can be studied from the journal titled “How people learn while playing serious games: A computational modelling approach” Wim Westera [2016] plots out the following diagram (Fig\_Flow\_Causal\_Model\_Of\_Learning\_Upon\_Engaging\_In\_Game) that correlates how knowledge is gained in the context of game play. It correlates various different factors at work resulting in knowledge gain.

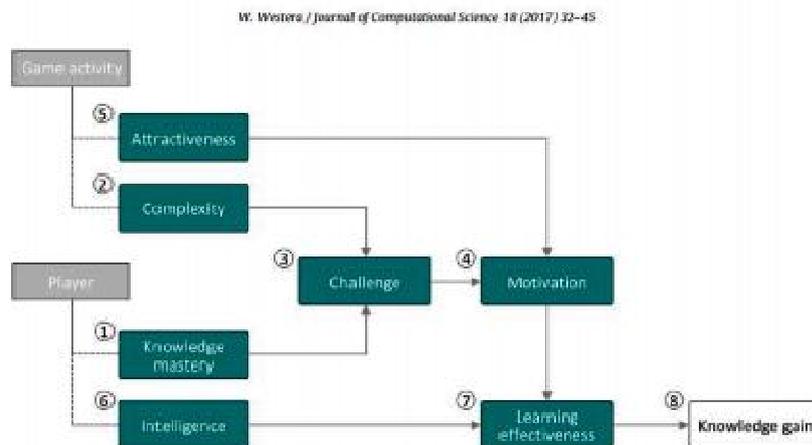


Fig. 2. Causal model of learning upon engaging in game activity.

Fig\_Flow\_Causal\_Model\_Of\_Learning\_Upon\_Engaging\_In\_Game

### c) Learner centricity:

In a typical instructional learning setup in educational institutions and also that continues in the corporate world, there is a one-size-fits-all approach. Content is the same for all and the instructor does not have the mandate or the time to understand that each learner has a different inclination, level and learning capacity when it comes to the prior awareness of the topic being discussed. Depending on all of these the learning happens to varying degrees. When we use games as a mechanism to deliver learning, it is possible to design multiple levels of play for the same concept – so for instance if there are Level 1 learners, they take a certain version of the game, Level 2 and Level 3 and so on. Once the learners master a certain level, they can then take up the next level of game and learn more advanced concepts. In this article (A8) the author talks about how the 4 different learning styles – Visual, Auditory, Read Write and Kinesthetic are well addressed by using games and game mechanics. Here is a snippet of the conclusion from that article. //Without Games, school for children (and teachers) would be boring and ineffective in terms of long term learning. ....Making learning fun with educational games and activities will help keep everyone involved, engaged and entertained while developing essential skills not taught on a paper or in a book//

### d) Social Emotional Skills & Peer Learning

A large part of today’s teaching/training involves imparting the domain/subject knowledge and often ignores the social emotional skills. Learners need to actively participate and interact with each other and not just with the instructor. Instructional learning setups typically are between the teacher and one student. Games by nature facilitate interaction between participants and that too in small groups. During the play, there is a healthy interaction between the participants in discussing concepts and processes that are being explained as a part of the flow. Knowledge is not one-way flow. It flows between the learners, from the teacher to the student and student also back to the teacher. The best role that a teacher can play today is that of a facilitator, enabling knowledge flows of different kinds. In all the approaches that have been followed, there is always a blended mix of learners across different levels of expertise/departments/classes and background. So, the knowledge flow and information exchange were very rich in nature. (A9) In their paper, “Promoting Social and Emotional Learning with Games: Its fun and we learn things” [2009] Sue Roffey and Robyn Hromek tabulate the following set of traits as related to Social Emotional Learning (SEL)

- recognizing and labelling personal feelings, strengths, and values
- knowing how to regulate and express feelings effectively and safely
- having a prosocial orientation to others, which is not bound by prejudice
- being able to read and take account of the emotional content of situations
- being responsible to oneself and others and making ethical decisions
- being able to set goals in both the short and longer term
- problem-solving skills, especially in the domains of personal coping and interpersonal relationships
- focusing on the positive
- respect for others, including valuing diversity
- treating others with care and compassion
- good communication skills
- knowing how to establish, develop, and maintain healthy relationships that promote connection between individuals and groups
- being able to negotiate fairly
- having skills to deescalate confrontation and manage conflict well
- being prepared to admit mistakes and seek help when needed and
- having personal and professional integrity demonstrated by consistently using relational values and standards to determine conduct

They further make an observation saying that teaching these skills are complex and the choice of pedagogy is extremely important. These skills help in developing values and building everyday behaviors. It is not just individual well-being but also of healthy relationships with others and caring communities. If we look at it beyond technical, domain and other aptitude skills, there is a huge need to develop these traits as we teach the regular skills. Play/Games are one excellent way to do them

### Experimental findings about the benefits of Play

Ever since 2011, I have been exploring, experimenting Play/Game based pedagogy for learners in various different subjects and topics across ages, demographics, economic background and curricula for active learner engagement. In this period of about close to 8 years, I have found that a lot of adults in corporate training and children in educational settings, have found play based methodologies to be highly effective in overcoming most challenges. Games enabled interactions thus enabling peer learning and social-emotional skills. Games could be designed at multiple levels catering to most learner types. From his experience with both adult and student learners, play has been able to positively impact learning 90% of the time by inculcating interest and creating curiosity in diverse topics. Here are some sample illustrations and case-studies. Not all of them might have quantitative and detailed metrics. But providing to the extent they are available.

Challenges	Intervention	Impact & Feedback
<p><b>Fortune 500 Insurance Company IT Offshore unit:</b></p> <ul style="list-style-type: none"> <li>- Newcomers and the existing workforce feeling unmotivated and stressed, leading to attrition in their overall performance</li> <li>- Clients were unhappy with the knowledge levels of the associates</li> <li>- Client BAs were also retiring and there were no plans to hire replacements, instead they were looking to outsource it to vendor IT companies.</li> </ul>	<p>A series of insurance related board and card games along with visual artefacts were created for the benefit inducting newly joining employees to teach them concepts, terminologies and process flows relevant to the domain.</p>	<p><i>“Very impressed with the visualization of complex topics and made simple. Thrilled with the level of creativity, ownership and teamwork”</i>, a SVP Commercial Business Line client commented on the entire experience.</p>

<p>The internal cost control change management for a <b>Large IT Organization's Business unit</b> with over a thousand senior managers</p> <ul style="list-style-type: none"> <li>- New managers found it difficult to understand cost control</li> <li>- Formal training sessions organized were not effective and poorly attended</li> <li>- Most people did not understand the intent, did not understand terminologies, concepts, processes.</li> </ul>	<ul style="list-style-type: none"> <li>- Business terminologies issue was tackled by adapting popular games</li> <li>- Problems in understanding concepts and process flows were modelled in the form of a variety of games</li> <li>- The front line delivery leads were reached out to directly and various different concepts related to cost control were explained using games using facilitated sessions, visual models and board games designed to explain revenue forecasting cycle process</li> <li>- Empathy debates were conducted for delivery leads and finance leads to understand the point of view from one another</li> </ul>	<p>Refer Fig.1 &amp; Fig. 2</p>
<p><b>Internal People Career Management Communication Team</b> in the period of Jun 2012 to Oct 2015</p>		<p>Very positive employee engagement and learning in all cases reported. In the retail accounts, appreciations received from external client senior management. Impacted approximately 2000+ employees</p>
<p><b>FundsIndia Personal Finance Awareness Session</b> during March 2018</p> <p>Personal Financial education sessions are boring. Power points and spreadsheets can only do so much.</p>	<p>We built a game "MyLastPayCheck" where players can invest in six different investments with their last Pay Check and get actual returns with weekly cards making them go through different scenarios in life in the form of a Board/Card Game</p>	<p>The session was received with great appreciation since users could experience the risk-return correlation, types of financial instruments in a fun-filled way</p> <p>Refer Fig. 3</p>

**Play/Game Based Subject Learning Facilitation for Middle Schoolers** in the domain of Social Sciences/Sciences/Math during Apr 2018-Sep 2018  
 School subject learning becomes boring/difficult for most children from class 5. How do we keep the children engaged so that they enjoy the process?

After intense research, identified about 20 of the board/card games readily available in the market and conducted workshops.  
 Facilitation:  
 · 4-6 students form one team and choose one game to play  
 · Facilitator briefs rules and play starts for approx. 45-60 min  
 · Multiple parallel groups of play happen simultaneously  
 · Groups record learnings/feedback post each game.

Refer Fig. 5

Refer Fig 4



Fig 1 - Corporate\_Cost\_Control\_Client\_Feedback

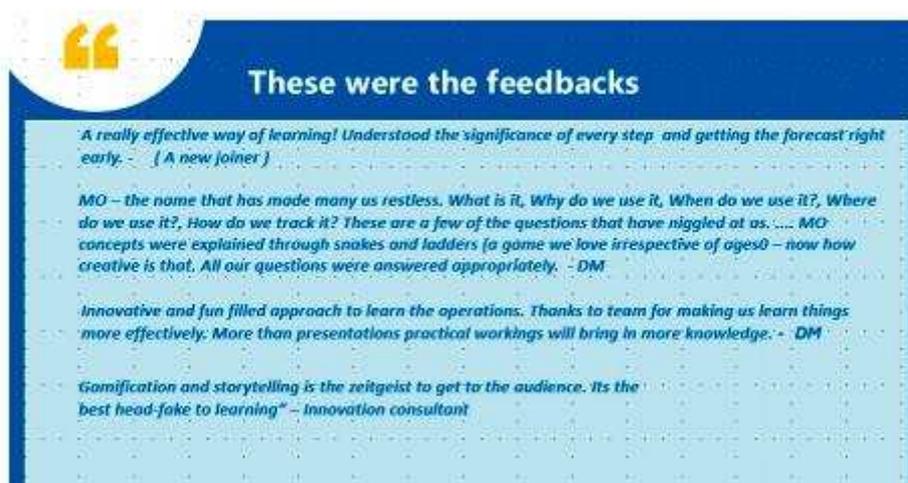


Fig 2 -Corporate\_Cost\_Control\_Employee\_Feedback

## Client Feedback

"We had a wonderful experience working with The Gamification Republic - specifically Santhosh and Kartic. We collaborated with them to create a new investment related board game. It was an effort from scratch - conceptualization to finished product. Santhosh and Kartic led the whole effort, took our inputs assiduously and created the game concept. They worked with us subsequently to refine the game, define various aspects of it, and come out with the product. Right through the process, the effort was professional, thorough, and thoughtfully meticulous. Once the game was created, they accompanied us to a workshop where the game was played by first-time players. It was very well-received and people really got into it and enjoyed the experience.

Santhosh and Kartic understand the principles of game design at a great depth and are very innovative with their ideas. It was a pleasure working with them as much as it was a joy to play the game they developed.\*

thanks,  
Srikanth (CEO-FundsIndia)

Fig 3 -Corporate\_Insurance\_Client\_Feedback

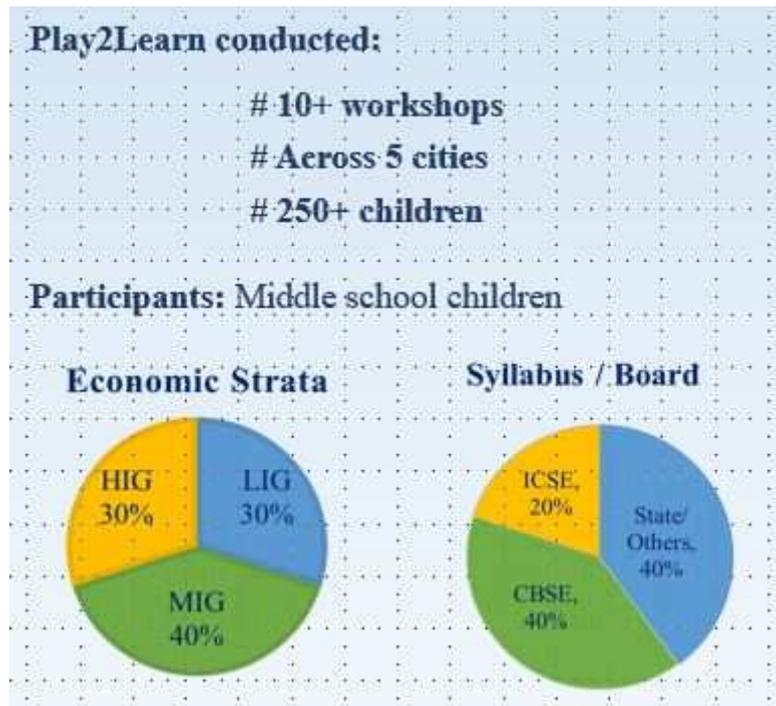


Fig 4 -Play2Learn\_Workshop\_Children\_Infographic\_Economic\_Strata\_BoardSyllabus

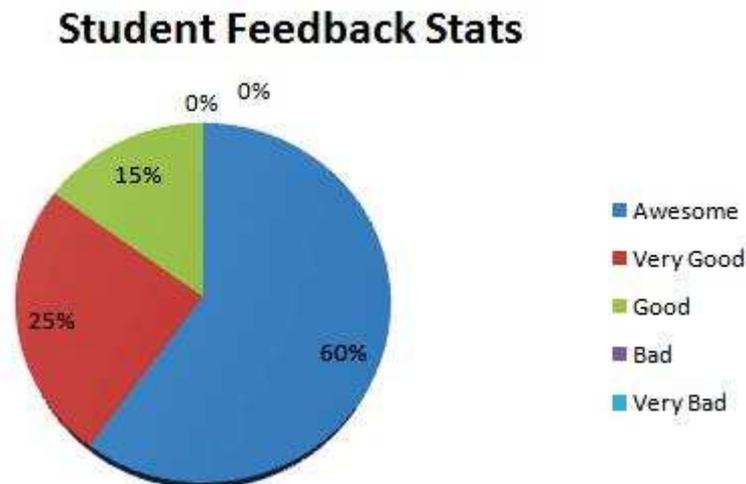


Fig 5 -Play2Learn\_Workshop\_Children\_Feedback\_Quantitative

Some more invaluable feedback from young minds:

*“It is a beautiful way to learn and wish it could be applied in schools so that students understand. It is amazing, the way you learn it” -Varsha (Class 6, PS) “It was nice, interesting interacting with others on board games.... Not only did we play games, we also got a chance to create games...”*

*-Abhinav (Class 9, DAV Boys Gopalapuram) “Loved the workshop. This shows we can learn by playing. Liked all the subjects that I thought were boring” -Ananya (Class 6, Boaz Public) “Workshop was very interesting. Made us like the subjects we did not like by playing games” -Sanjana (Class 7, Vidya Mandir) “Outstanding. Wish it continued for 10 more hours” -Merlin Vennila (Class 8, St. Michaels Academy) Parents were also equally excited! “My daughter liked entire ambience and it got her thinking on how to extend memory, clue-do, monopoly, spot-it games on to a Math-Science Framework” - Chatura (mother of Riya, class 6)*

Figures 6,7,8,9 and 10 provide examples of games created for various different corporate initiatives in the field of insurance, cost-control and personal finance awareness domains.

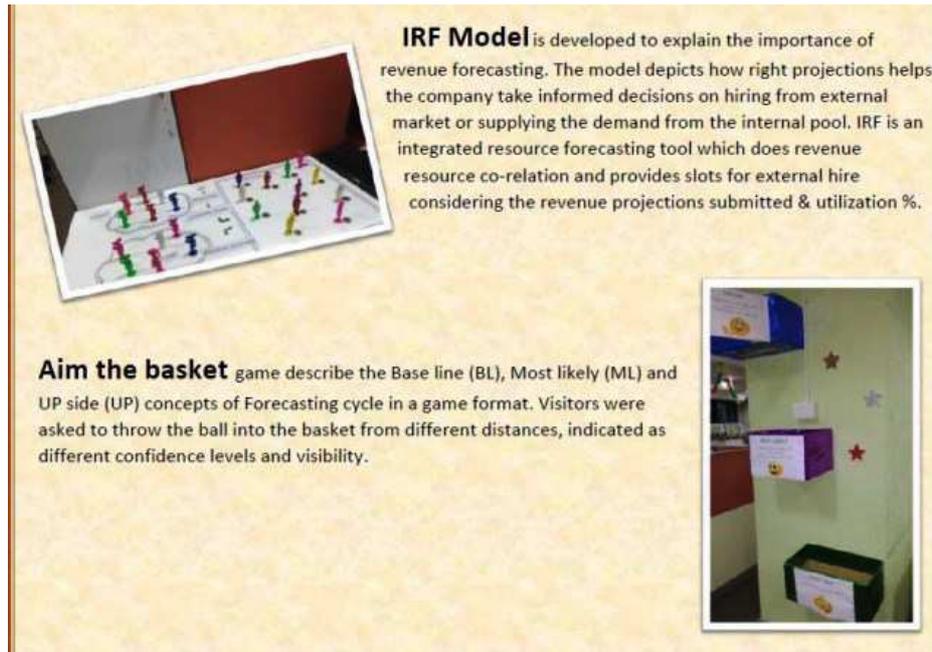


Fig 6 Corporate\_Cost\_Control\_Revenue\_Forecast\_Games



Fig 7 -Corporate\_Insurance\_Board\_Game

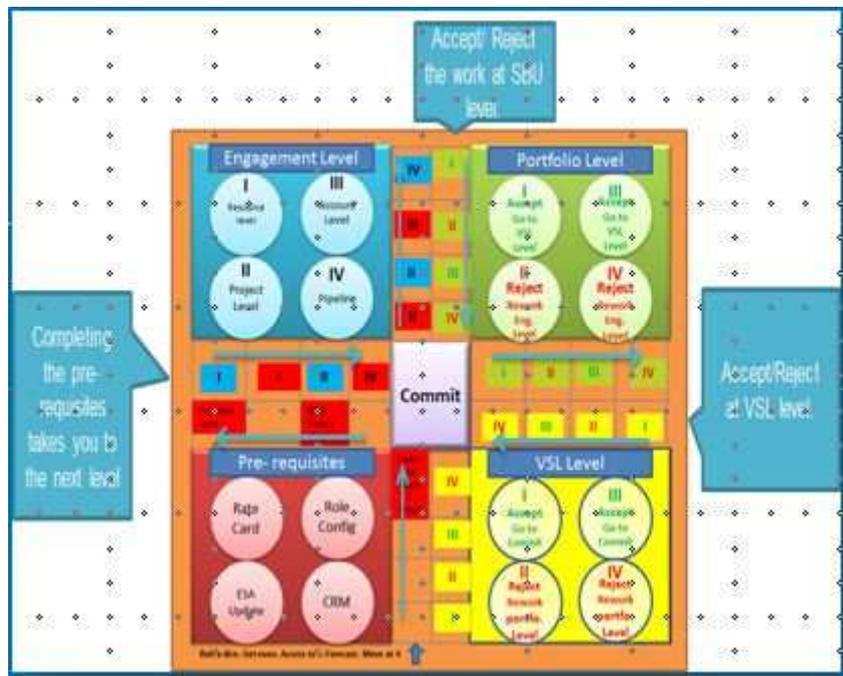


Fig 8 Corporate\_Cost\_Control\_Revenue\_Forecast\_Game2.jpg



Fig 9 - Corporate\_Cost\_Control\_Games.jpg

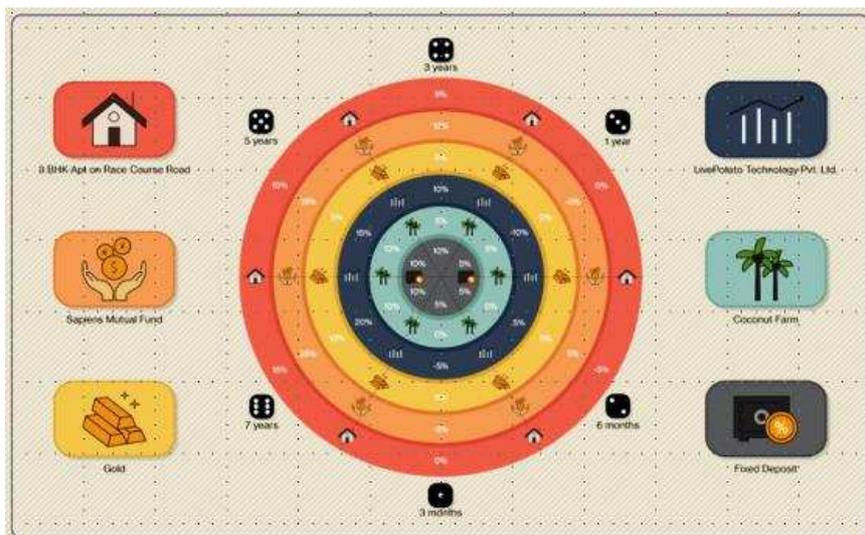


Fig 10 -FundsIndia\_Personal\_Finance\_Awareness\_Board\_Game

These are just some samples. Play/Game based learning has been experimented in undergraduate programs, both in engineering as well as in marketing and has shown very positive results. Here are links that have supporting material. (A10, A11, A12, A13, A14)

## Conclusion

With my personal experiences across varied different audiences over multiple years, both in the corporate and educational institutions associated with strong research work available, I feel that games/play in education as a pedagogy will be extremely beneficial to all kinds of learners. It is extremely important that educators of all kinds use this in their mix of teaching pedagogies and curriculum development that would result in increased learner engagement across segments.

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[http://www.academia.edu/2404072/Promoting\\_Social\\_and\\_Emotional\\_Learning\\_With\\_Games\\_Its\\_Fun\\_and\\_We\\_Learn\\_Things](http://www.academia.edu/2404072/Promoting_Social_and_Emotional_Learning_With_Games_Its_Fun_and_We_Learn_Things)

A10 - [https://www.linkedin.com/posts/karticv\\_majaaa-playtest-play2learn-activity-6570661904665149440-hA0t](https://www.linkedin.com/posts/karticv_majaaa-playtest-play2learn-activity-6570661904665149440-hA0t) (MOP Vaishnav college - Marketing Game)

A11 - [https://www.linkedin.com/posts/karticv\\_independenceeve-disrupttraditionallearning-activity-6568486699943460864-zILS](https://www.linkedin.com/posts/karticv_independenceeve-disrupttraditionallearning-activity-6568486699943460864-zILS) (Chennai Business School - Marketing Game)

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<https://www.linkedin.com/pulse/effectiveing-change-communication-using-games-kartic-vaidyanathan/>

### About the author



Kartic Vaidyanathan is a play/game-based learning advocate. As a part of his Play2Learn initiative, he works with corporates and educational institutions and helps them transform learning through games. Through his work, many teams have created and experienced the power of simplified, fun-filled, collaborative and engaging learning. Prior to this, he has worked for over two decades in corporates (IT Majors – Cognizant/Infosys). He is a B.Tech (IIT Madras) and Exec MBA (IIM-Bangalore) and has a certification in Gamification (University of Pennsylvania – Coursera)

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About Play2Learn: <https://www.linkedin.com/pulse/what-services-do-we-offer-part-play2learn-mini-wip-vaideyanathan/>

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### *Related Readings*

**Gamification:** Gamification is the application of game-design elements and game principles in non-game contexts. It can also be defined as a set of activities and processes to solve problems by using or applying the characteristics of game elements. Gamification commonly employs game design elements to improve user engagement, organizational productivity, flow, learning, crowdsourcing, employee recruitment and evaluation, ease of use, usefulness of systems, physical exercise, traffic violations, voter apathy, and more. A collection of research on gamification shows that a majority of studies on gamification find it has positive effects on individuals.[4] However, individual and contextual differences exist. <https://en.wikipedia.org/wiki/Gamification>

**The Appeal of Gamification in UX Design:** Gamification, as a 21st-century UX phenomenon, is a powerful tool for designers to drive user engagement for several reasons. Firstly, you use it to inject fun elements into applications and systems that might otherwise lack immediacy or relevance for users, and incentivize them to achieve goals. Users enjoy challenges, whether challenging themselves (e.g., using step-tracking devices) or trying to win awards (e.g., virtual “trophies” for completing work-based e-learning). Secondly, the dynamics designers incorporate in successful gamification serve as effective intrinsic motivation, themselves – meaning users engage with the system because they want to. For instance, Foursquare/Swarm promotes users to “Mayors” of establishments after so many visits, enabling them to vie for top place while enjoying meals, shopping, movies, etc. Inspiring users by introducing gamification into an existing system demands designers to apply gameplay and the structure of rules and goals to “serious” tasks exactly as users would want to see. You can gamify systems in many ways, from countdowns to encouragement for completing x percent of a task, with the ultimate goal of making everyday tasks less mundane while sparking users to become actively interested in attaining goals. People enjoy interactivity and satisfying their curiosity, and designers can employ a suitable social element to increase their engagement. <https://www.interaction-design.org/literature/topics/gamification>

**Gamification In Education:** Today's learners are digital natives and have new profile. They grew up with digital technologies and have different learning styles, new attitude to the learning process and higher requirements for teaching and learning. Teachers are facing new challenges and have to solve important issues related to the adaptation of the learning process towards students' needs, preferences and requirements. Teachers have to use different teaching methods and approaches that allow students to be active participants with strong motivation and engagement to their own learning. Modern pedagogical paradigms and trends in education, reinforced by the use of ICT, create prerequisites for use of new approaches and techniques in order to implement active learning. Gamification in training is one of these trends. The aim of the current work is to study and present the nature and benefits of gamification and to provide some ideas how to implement it in education. Full paper at <http://bit.ly/2IZGJUe>

**Gamification and the Future of Education:** It is a forward-looking report that explores how the mechanics and dynamics commonly found in games can be applied in the educational context to improve educational outcomes. At the core of this report is an important policy puzzle: what role does gamification, as a pedagogical innovation, play in the future of education? In the attempt to solve this puzzle, this report addresses four fundamental questions: How has gamification evolved? How has gamification been applied? What are its advantages and drawbacks? And what strategies and policies are necessary for gamification to be incorporated successfully in education? Full Report at <http://bit.ly/2kYpClj>

# ML Model Management using Python Django Web Framework

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## Why Machine learning:

Machine learning is a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention.

For Any Industry to be a market leader in the current competitive world, it needs to quickly and automatically produce models that can analyze bigger, more complex data and deliver faster, more accurate results – even on a very large scale. And by building precise models, an organization has a better chance of identifying profitable opportunities – or avoiding unknown risks.

## Python for Machine Learning:

Python is widely considered as the preferred language for teaching and learning ML. Few Reasons are as below:

### 1. Simple to Learn:

You can quickly pick up on the language and start using it for AI development rather than wasting too much time/effort in learning the language.

### 2. Great Library Support:

A great choice of libraries is one of the main reasons Python is the most popular programming language used for AI. ML requires continuous data processing, and Python's libraries let you access, handle and transform data. The Most popular libraries include Scikit-learn, Pandas, Keras, Tensorflow, Matplotlib, NLTK.

### 3. Platform independent:

Python is not only comfortable to use and easy to learn but also very versatile. It can run on any platform including Windows, MacOS, Linux, Unix and many more.

### 4. Readability:

Python is very easy to read so every Python developer can understand the code of their peers and update them accordingly.

### 5. Open Source:

Python is open source and hence anyone can pick it and start using.

### 6. Strong Community Support:

Since Python is opensource, a lot of Python documentation is available online as well as in Python communities and forums, where programmers and machine learning developers discuss errors, solve problems, and help each other out

All these factors make Python the preferred language for ML.

## Challenges of Hosting an ML based Solution:

We have the data, A good Python based ML algorithm which does the inference/Prediction with a very good confidence. Great!

Now comes the next question. How do we host this solution for prediction? we should be able to send a request (typically a web request) and get a prediction/recommendation as a response.

A web application or a Rest framework is usually written in java/dot net or any other web technologies and the major challenge is the cross-language communication between the web technologies and the python.

Let us consider a prediction application written in java-based web technology. Every time a request comes to the web server for Training/Prediction, the java thread needs to communicate with the Python ML algorithm - which is a standalone process, for the following:

- Provide Training data
- Wait for the python algorithm to finish to get the result
- Preloading the model before the prediction request comes
- Once trained, Manage the generated Models (storing, sending, uploading etc.)
- Retrieve the prediction outcome and any other response parameters returned by python.

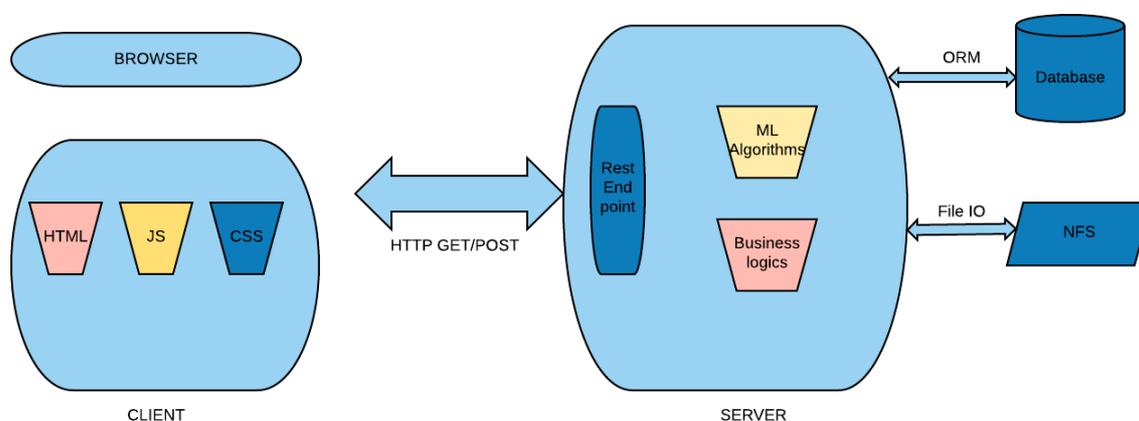
The overhead involved in managing the above tasks can be quite a lot and hence we might need a better technology to manage these barriers.

### Python Django To the Rescue!

What if we had a web-based technology that is completely written in python. Since there would be no cross-language communication, the above overheads could be managed more efficiently. That exactly is what Django does.

### Django Framework:

Django is a high-level Python web framework that encourages rapid development and clean, pragmatic design. It takes care of much of the hassle of web development, so you can focus on writing your app without needing to reinvent the wheel.



As shown in the Diagram above, Django is based on MVC architecture. Below are the main components:

#### 1. View:

It is the Front end of the framework which sits on the client browser. Django supports HTML, CSS, Javascript as the main UI technologies.

We could also integrate Angular framework into Django with few simple changes.

#### 2. Model:

The Model is responsible for managing the Data of the application. Django is capable of connecting to various databases through its ORM, thus managing in storage and retrieval of the data.

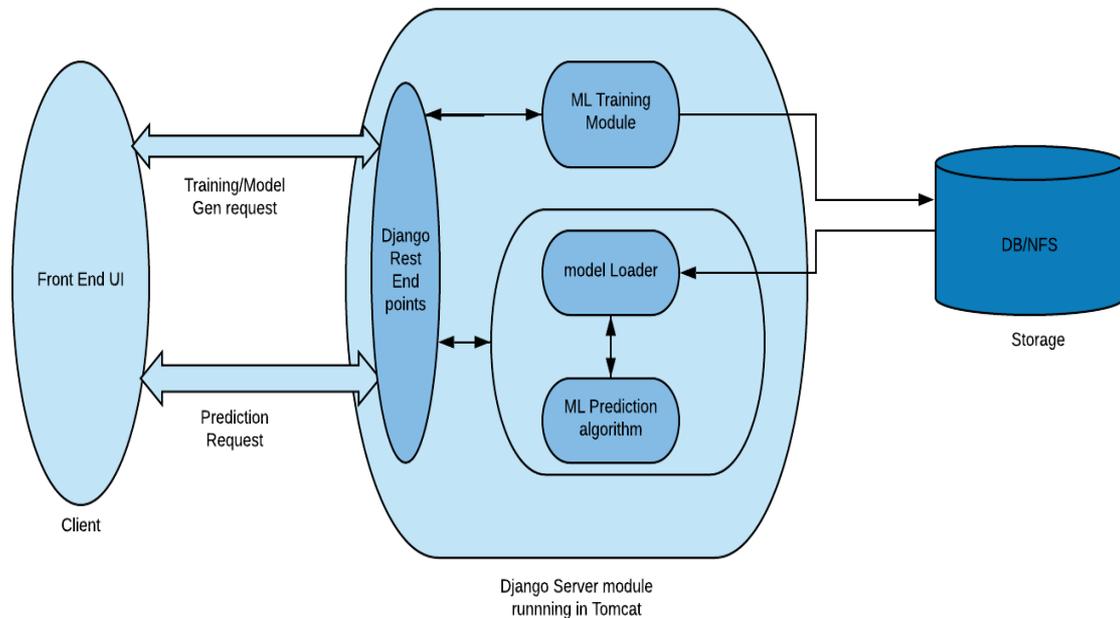
In a microservice Environment with NFS, Django can also mount and store/retrieve data from NFS.

#### 3. Controller:

Controller is responsible for all the business logic and transformation/manipulation of the data. In our ML use case, this is where all the ML based algorithm should sit.

### Django from a ML Use Case:

Having known about Django, let's see how we can leverage it for an ML use case.



As shown above, the two main Aspects of ML use case would be:

### Training/Model Generation:

- The Request for training (single or multi-tenant) would be intercepted by a Rest endpoint controller and handed to an ML based training module algorithm.
- The algorithm generates a model (a protobuf or a pickle file) as output.
- This Model is stored in either Database, NFS, or sent via rest call to any storage server.

### Inference/Prediction:

- The Request for Prediction is again intercepted by a Rest handler and is sent to Prediction algorithm.
- The module shall first load the relevant model from the Storage.
- Once the Model is loaded to memory, the Prediction runs, and the outcome is sent back in the response

### **Model Management in Django:**

The backbone of any ML solution is managing the created ML Models. The success of any realtime prediction engine depends a lot on how efficiently we manage the models (in a single or multi-tenant environment). Model management involves, storing, retrieving, updating, deleting models from a pool of models available.

### **Storing the models:**

Here are some of the ways we can achieve this using Django.

#### **Store in a Database:**

Django can Directly interact with an underlying Database with minimal configurations using its ORM.

Hence DB is a good choice for storing and retrieving the models.

We can store the model in a table as a payload with some metadata information (model configurations).

In a multi-tenant environment, it could be stored with tenant information as well. While retrieving, we could retrieve the relevant model from the tenantId passed.

We could also have a list of (pool of) models for a tenant and choose the best model based on the criteria selected.

#### **Store in a Disk/NFS:**

We could also store the models in the server File system and access through fileIO.

If the Django is running on a microservice infrastructure with NFS mounted and auto mirroring, then there is hardly any risk of disk crash/ data loss.

In a multi-tenant environment, one strategy of storing the models would be by creating a folder for each tenant with the folder name as the tenantId. This way we could go and fetch the exact model for the tenantId passed.

### **Store in a Storage Server:**

The Model could also be stored/Retrieved from a dedicated Storage Server. Django can make an API call through its Django Rest Framework and store/retrieve the relevant model.

### **Loading the Model:**

The Models could be either preloaded to memory when the Django server starts or Loaded to memory as and when a request for prediction comes.

Preloading the model to memory is a good idea to use when the models are bulky and takes some time to compute/load. Also, if there are only few models to be loaded, then preloading would greatly help in reducing the prediction time (the overhead of loading the model for each request would not be there).

When a Django server comes up, it reads its **urls.py** for all the routing patterns and initializations. If the model loading call is plugged in here, it gets executed during the server start-up.

If working in a multi-tenant environment with a pool of models for each tenant (and the models are light), the models could be loaded when a request comes for prediction. Django also provides Caching mechanism which could be leveraged for loading the models.

### **A Django Admin page:**

In addition to all the above, we could also build a simple admin UI using Django Template or by integrating Angular with Django. The UI could list down all the models for a tenant.

We could also provide few actions like deleting, uploading, downloading, activating models etc.

These actions are not hard to implement since the Django UI can easily make an Api call to Django server for the details.

### **Django Alternatives:**

As Python is gaining a lot of popularity with growing ML use cases, lots of python-based web frameworks are being developed and are available to choose from. The major ones include:

- Tornado
- Flask
- Pyramid
- TurboGears

Each one of them have their own advantages and disadvantages. Most of the framework listed above are Microframeworks. Hence, they may not be suitable for bigger full-stack web development.

Django stands out among these frameworks for the rich features it has to offer. Following are some of them:

- Django is a Full-stack web framework
- It has the best community support among the lot with extensive documentation and examples. Hence it is the most preferred language for bigger applications.
- It follows the standard MVC pattern.
- one managing script (“manage.py”) that can be used for performing most of the framework specific actions
- custom object-relational mapping (ORM) for communicating with the database
- a large number of external modules, e.g. Django REST Framework, Django CMS, Django Channels (websockets).

### **When not to Use Django:**

Even though there are lots of advantages of using Django as the preferred web technology for ML usecases, there are also few cases where It is advisable not to use them.

- If your app is UI heavy. Although we could integrate Django with Angular by few tweaks, it is not quite straight forward. Also, we may not be able to use the full strength of Angular or any other powerful third-party UI frameworks
- Django needs the developer to have the complete knowledge of the framework. Not all the Data science members would be comfortable with that.

- Django is usually preferred for bigger applications. If your use case is very simple, then a lightweight web framework like Flask would be better than Django.
- Even though Django is opensource and has a good community support, it may not be as good as other web technologies(java/j2ee) which have very robust framework and community support.
- If you are running in a docker environment, there might be chances that the Django is not supported.

### References:

Complete Django Documentation: <https://docs.djangoproject.com>

### About the author



Ranjith holds around 12 years of experience building enterprise and cloud applications for various domains. He has worked in companies like cognizant, IBM. He is currently working as senior software engineer for Ariba Data Enrichment Team in SAP Ariba.

His interests are towards building java/j2ee based solutions in docker, machine learning concepts. He loves travelling, sports and movies.

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# Data Ethics: The Moral behind Data

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## Introduction

Data Science is one of the most prominent emerging domain in the world these days. To make life comfortable and smooth various researches are going in and around Data Science. One very important aspect comes with this is ethics. Data should be handled ethically, if not, leads to furthermore issue for individual and organization. At present with the rapid societal and technological revolution, notions like ‘confidentiality,’ ‘impartiality,’ and ‘representation’ are redefined. We are living in an era where fake news propagates at a faster rate than the truth, our societies are at an acute moment. At this juncture, we need to have discussions about our individual and mutual responsibility to handle data ethically.

Data Ethics (DE) is treated as one of the most important challenge of moral problems related to data. As, Data is generated and utilised at significant rate of 2.5 quintillion records every day, handling it carefully is very important. Individuals are being defined by how & where they eat, commute, use Internet and time span of all the online activities. Society is in the midst of a “data revolution,” where individuals and organizations can stack and analyse huge amounts of data. Data Analytics can bring across amazing findings and innovations which can empower the society: from applying machine learning to healthcare research to binding data to build smart cities.

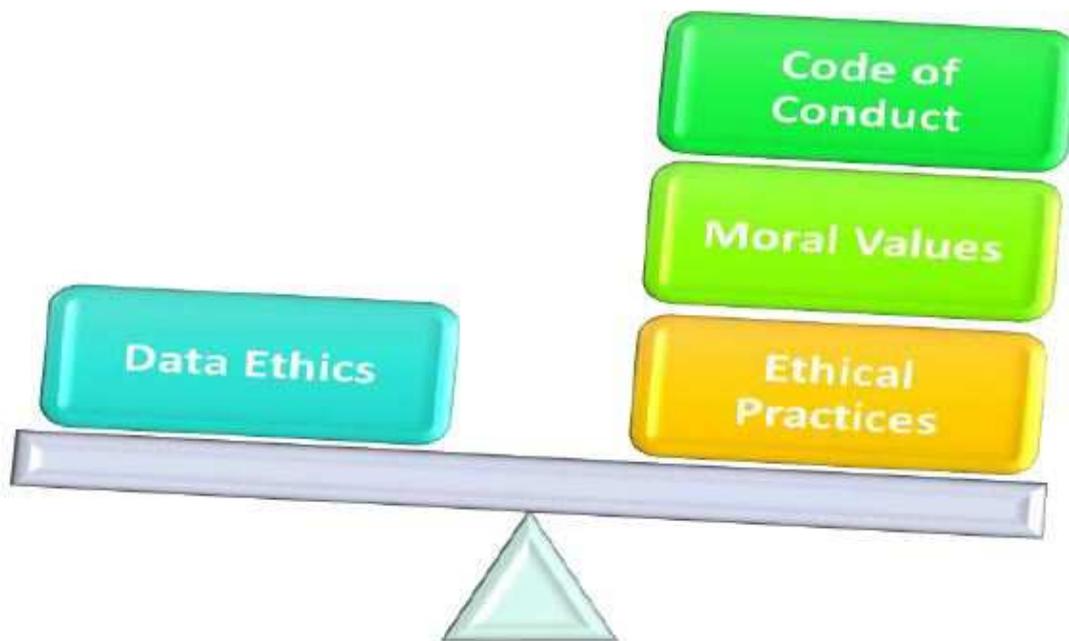
An essential aspect of DE is, to use Data Science correctly. Enormous prospects are provided by Data science for betterment of private and public life. Unfortunately, such prospects are also connected to substantial ethical challenges. The size of data (mostly private) is continuously growing. The users are relying on recommendation algorithm to investigate the data. This investigation helps users to choose appropriate products from a variety of available products. The recommendation system is the major ethical challenge faced by an individual, as one may not be willing to share his or her online behaviour. This leads to gradual reduction of human involvement but raise concern related to accountability and adherence to the human rights, as sharing private data is unethical.

Appropriate use of data presents various opportunities to provide finest possible services to the users. Though these new opportunities come with new challenges, DE plays key role in resolving these challenges. Individuals and organizations are bound to abide with the principles of DE. There are various legal obligations imposed, when it comes to DE. These obligations differ with the type of data and the source from where it is received. Higher Education Institutes are including DE in curriculum to coach the younger generation of the country to understand importance of DE and obey it.

## Data Ethics Outline

The purpose of this outline is to create responsible data usage culture in the society where social media practise is at its peak. Figure 1 shows the authors view on the facts which need to be balanced by users concern with DE. In the figure a scale is shown, balancing the facts to maintain the DE. Information technology providers can understand the core ethical obligation of the data involved and propose their offerings appropriately.

- **Ethical Practices:** Now a days it is mandatory for organizations to train the employees on General Data Protection Regulation (GDPR), even governments are taking initiative to train the citizens about ethical data usage.
- **Moral Values:** No matter which country you belong to, the moral value associated with data will be similar based on the domain and complexity of the data. Primary moral value of the data is privacy, followed by ownership, trust and respect.
- **Code of Conduct:** Code of Conduct is decided by the government and the organizations, based on what is considered as appropriate and inappropriate for them. It may be possible, what is appropriate for one may not be the same for the other.



**Figuer 1: Component of Data Ethics**

### **Need of the Data Ethics**

Responsible usage of data is the need of the hour. According to the study conducted in 2019, there are 3.48 billion social media users with an increase of an average of 8% every year. The social media user population has radical increase but most of the users are unaware of the DE principles. World's internet users spend on an average 6.5 hrs a day online. Google is the most visited website with first rank, followed by YouTube and Facebook.

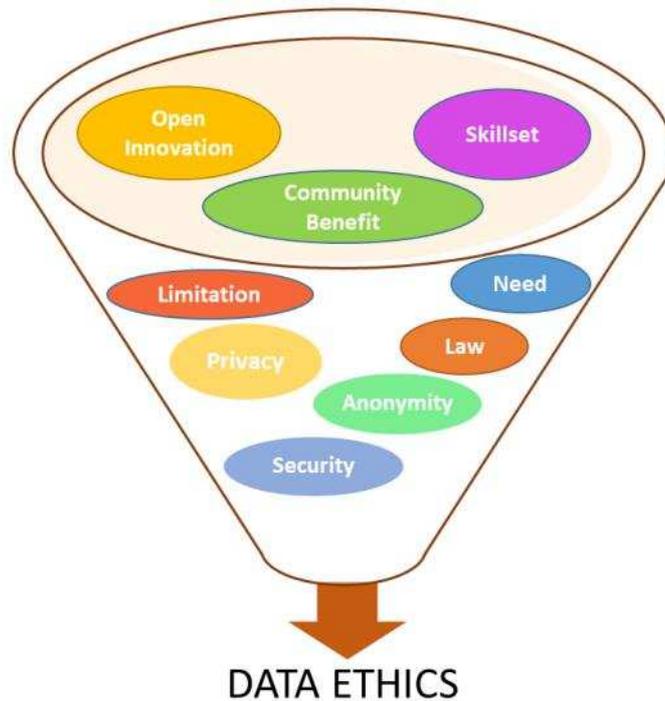
Today's technology is utilised at a faster rate due to the influence of social media and automation everywhere. In this era of Data, it is very important to have set moral rules for DE. DE is required pertaining to creation, storing, managing, processing, distribution and utilisation of data. DE is also required for the algorithms and resultant practices such as programming, hacking, professional codes and innovation. DE is the need of the hour in order to devise and endorse ethically respectable solutions.

As per the study conducted by DataReportal [6], in Indian context for the total population of **1.361 billion** the mobile subscriptions are **87%**, **41%** population uses Internet and **23%** population are active social media users. The active social media users have increased by **25%** in India as compared to the year **2018**. In the Indian context average online time per user is **7 hr 47 m**, **89 %** of Indian internet users prefers mobile messengers, with **WHATSAPP** and **FACEBOOK** as most preferred apps. Considering the kind on usage catered by the Indian population there is a need for a set of rules to be followed so that the individuals can contribute their share of DE.

### **Data Ethics Characteristics**

These DE Characteristics is presented to encourage ethical data usage on the core values of the Public Service Code of ethics like integrity, honesty and objectivity - in order to deliver better services and information policy. It will present authors view about the rules and the principles regulating the usage of the data by an individual or an organization.

The speed at which technology is changing, we need to monitor that the moral issue related to the data are addressed considering ethical value of data usage. It requires suitable guideline which will help data practitioners to use data responsibly without any ethical issues. The proposed guideline will help the government, policy makers and the public sector to handle data responsibly and understand the process to support the ethical usage of data. As diverse data is utilised by individual and organization for different purpose, many ethical challenges are encountered. These challenges always comes with data, but still there is no black and white rules which everyone will agree upon.



**Figure 2: Data Ethics Characteristics**

The key features shown in **figure 2** includes various elements which needs to be considered when working with the data like Skillset, Open Innovation, Community Benefit, Privacy, Anonymization etc.

### **Data Ethics for Individual**

The data can be utilised by individual for personal research & innovation, individual growth, business forecasting & prediction. As a responsible citizen we should follow certain DE such as:

#### **Key 1: Support vigorous practises and consider your expertise**

Individual should work within their skillset recognising where the domain expertise is required so that, knowledge transfer can be planned. Awareness is the key for individual such as knowing about data, consistent practices e.g. multidisciplinary team, expert opinion, accountability of algorithm, testing under different conditions, reproducible design.

#### **Key 2: Support Open Innovation and Open up Opportunity for all**

Individuals involved in design and development should be transparent about the tools, data and algorithms used to achieve the goal. This helps other researchers to inspect the findings and appreciate the novelty of the work.

### **Data Ethics for Public and Private Sector**

Whenever there is a requirement to follow DE principles by public service providers or data practitioners the following key points should be considered.

#### **Key 1 - Begin with the data prerequisite and the community benefit**

The data when utilised in effective way has the potential to transform how public services are delivered. We must always be clear about what we are trying to achieve for users by the data available to provide better services. Need and expected public benefit analysis is prerequisite before starting the work with the data. It will help data users to take right approach. Clear user needs help the government and organization to understand the problem. Considering the DE Principles holistically help us ensure public benefit.

#### **Key 2 - Awareness about Legal challenges and Code of conduct:**

Government across the geographies are in the process of making strategies for data usage. Organizations and service providers should abide the law followed by the judiciary. To obey this an organization must understand the significant laws and codes of conduct which is applicable to the type of data usage. In case of doubt expert opinion is sagacious.

#### **Key 3 - Use Data as per Need**

The data must be used in proportion to the user requirements. Only necessary data should be used which is required for attaining desired outcome. Over usage of data may slowdown the processing and increase the waiting time to achieve the

desired result. In order to understand that the intended data is proportionate to the need, officials should consult public or take advice from ethical committees and experts.

#### Key 4 - Understand the limitations of the data

Different type of data have different set of limitation imparted for the data sharing and usage. Government should clearly mention the data sharing and usage policy for different sector like civil services, health service, population, social etc. It is the responsibility of a government official to use data considering its limitation.

#### Conclusion

With the use of data comes the misuse of the data. DE is essential when we talk about individual, private or public sector. DE principles helps us understand different perspective of right and wrong usage of the data. In any case, where data is involved prior to initiating the work with the data, we should always consider the user need and community benefit. Clear user need gives deep understanding of the problem. Many public services can use data analysis to operate and improve the services, provide new services, testing new and existing policies. So that, it can help officials to identify the impact of new policies, area of improvement and the needs as per the geographic patterns.

All the officials and individuals involved in data practices must be aware of legal challenges and code of conduct implicated to data usage. The Personal Data Protection Bill, 2018 (PDPB) [1] ensures protection of individuals' personal data and regulates the collection, usage, transfer and disclosure of the data. PDPB clearly states the legislation related to the different type of data, like personal, personal sensitive, data portability, cross border transfer of personal data etc. The Data practitioners and Leaders often speak about the questionable and illicit sharing, collection and usage of sensitive data. To drive change and hitch the positive impacts of the data, we need collective effort. These efforts need to reach beyond academia and industry to general public, to make this world a better place to live. These conversations should not be in symposia, conferences or workshops but also over the dining tables everywhere.

*The discussion in the article is authors view about data ethics.*

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“You can have data without information, but you cannot have information without data.” – By Daniel Keys Moran

“Torture the data, and it will confess to anything.” – By Ronald Coase

“Data really powers everything that we do.” – By Jeff Weiner, CEO of LinkedIn

# Using AI to Prevent Vision Loss for Millions Globally

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## A Global Healthcare Challenge:

As per the World Health Organization (WHO) the number of people with diabetes worldwide has almost quadrupled in the last several decades - from 108 million in 1980 to over 422 million people today. By 2040 that number is projected to grow to over 640 million. (1)

Diabetes leads to many complications including greater risk of heart disease, stroke and diabetic retinopathy (DR) which can lead to vision impairment and blindness. It is estimated that from a third to half of those with diabetes, or from 150 to 210 million people worldwide have some stage of DR. In addition, an estimated 10% or 40 million people with diabetes have DR that is considered vision-threatening (VTDR). This makes DR the leading cause of preventable blindness in working age adults worldwide.(2)

The risk of vision impairment and vision loss can be greatly reduced if DR is detected and treated in its early stages. Currently, detecting DR requires a trained eye doctor to examine color photos of the fundus region of the retina for tiny lesions and other vascular abnormalities caused by diabetes. This is a manual and time-consuming process, that requires expensive equipment and trained professionals. Unfortunately, many developing countries have an acute shortage of both specialists and resources to screen everyone at risk.

In India, for example, there are over 72 million people with diabetes and an estimated 25 million are afflicted with DR and 7 million with VTDR.(3) However, India a nation of 1.3 billion, only has 15,000 ophthalmologists - or a mere 9 specialists per million population. Similarly, Kenya, with a population of 48 million has less than 100 ophthalmologists, and Angola, with a population of 29 million has less than 20. In addition, to the shortage of trained professionals, many people afflicted with DR live in remote areas with little or no access to an eye care clinic or a screening center. (4)

As a result, diabetic retinopathy has become a global healthcare challenge. The good news is that AI offers a way to automate many aspects of DR detection and screening that can potentially help address this challenge.

## How AI Can Help:

Recent advances in deep learning – a branch of AI that uses deep neural networks have been very successful in a large variety of tasks including voice and natural language processing, as well as image recognition and classification. A breakthrough in image classification was achieved in 2012, in the ImageNet Challenge which requires identification of 1000 different categories of objects in a dataset containing millions of images. Since then the best AI models have achieved an accuracy of over 96% in the image classification task – exceeding the best human accuracy levels.(5)

Many of these AI models have now been adapted successfully for use in a variety of medical image diagnosis tasks such as melanoma, breast, lung cancer detection and diabetic retinopathy.

In particular, a team at Google published results in 2016 of a study for detecting DR working with doctors in India and the US. The results show that their AI model's performance for DR detection and grading its severity was on-par with that of ophthalmologists. Their model had a combined accuracy score of 0.95, which was slightly better than the median of the 8 ophthalmologists consulted (measured at 0.91). (6)

## Proposed Solution:

While an AI model can automate the screening process for DR, it is by no means intended to replace doctors. Trained professionals will always be essential for validating the AI model and for counseling, follow-up and treatment of patients.

The ideal system should combine AI, technology and human expertise in ways that can complement each other. In order to address the global DR challenge, the system design should satisfy the following objectives:

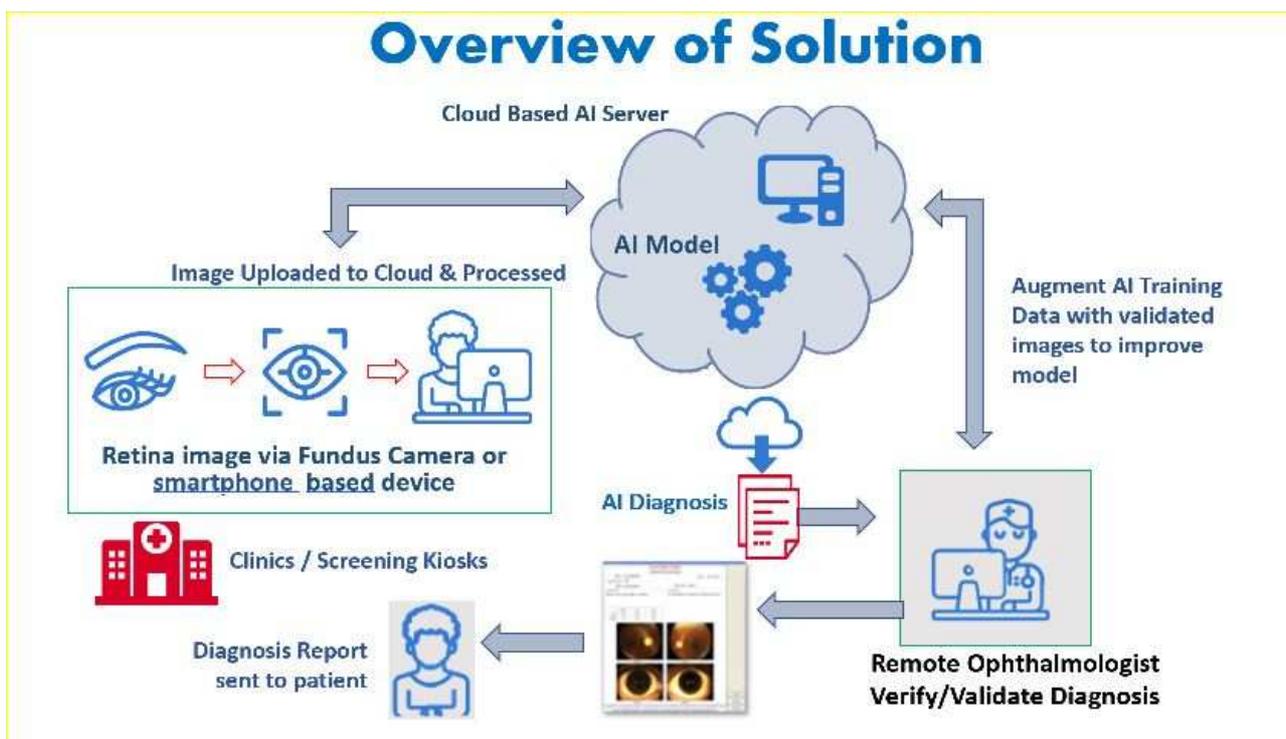
- i) Provide the capability to be deployed in remote and underserved areas.
- ii) Provide the capability to capture retinal images with a low-cost device.
- iii) Use AI to automate routine screening of DR for majority of the cases.
- iv) Allow remote diagnosis by trained professionals when required for cases that are difficult to diagnose with AI, allow experts to validate the AI diagnosis, and allow them to interact and counsel patients.

In 2018, we launched a project to use AI for early detection of DR in India to meet the above objectives. The project was proposed at the ITU/UN AI for Good Summit in Geneva in May 2018.(7) The proposal was aligned with the objective of the conference which was to use AI to accelerate the achievement of the UN’s Sustainable Development Goals (SDGs), in the area of health. It was also presented at the ITU/WHO Focus Group on AI for Health (FGAI4H) at Columbia university in NYC, in Nov 2018, (8) and the proposal was accepted as one of the first eight use cases of AI for health by the ITU/WHO. (9)

**Solution Overview:**

An overview of the solution and its major components is as follows:

- Patient’s retinal images are captured via fundus cameras at local screening centers or clinics and are uploaded via the web to a cloud-based server for further processing. A low-cost device that can be attached to a mobile phone for image capture of the retina is also being proposed for remote areas where no clinical facilities exist.
- A cloud-based web application for patient registration and data entry, image capture and uploading, integration with the AI model, remote diagnosis by trained specialists, as well as patient reporting, messaging and notification.
- Automated DR Detection: The AI model runs on a remote server and automatically processes and classifies the image as gradable or not and if gradable whether it is referable DR or not along with the probability (or confidence level) of the classification.
- Remote Diagnosis: Eye-care professionals can login remotely to the web application to review and validate the AI diagnosis, add notes, provide referral to a specialist, follow-up and treatment options. The system design will also incorporate the ability to fine-tune the AI algorithm based on corrections of diagnosis errors by the specialists.
- Integrated administrative, reporting, and messaging for patient communication, system performance reports, and overall statistics.



**Implementation:**

We partnered with a leading teleophthalmology company in India with over 275 screening centers in 22 states that screens over 25,000 patients a month for DR. It has a national network of ophthalmologists who perform the screening and diagnosis of DR remotely via a cloud-based application.

The creation of an AI model requires a sufficiently large dataset of images labeled with the actual diagnosis classifications previously obtained from human experts. The labeled data is then used to train an AI model using supervised learning.

The model uses a convolutional neural network (CNN), and the training process fine tunes the weights of the network to minimize the error between the predicted classification and the ground truth. A part of the dataset, called the validation data, is not used for training, but used to validate the performance of the AI model on unseen data.

We started by first creating a dataset of approximately 90,000 images from our teleophthalmology partner, that had been graded by licensed ophthalmologists into one of the following categories: non-gradable, no retinopathy, mild NPDR, moderate NPDR, severe NPDR, and PDR, along with presence or absence of DME. The non-gradable category implied a low-quality image that could not be graded and assigned a diagnosis. All images were obtained with appropriate informed consent and anonymized prior to use in training.

For the purposes of the first phase of this project the scope was limited to determining if the DR was referable or not. Therefore, the images were regrouped as:

- i) Non-gradable
- ii) Non-referable DR – which included No retinopathy and mild NPDR and
- iii) Referable DR – which included Moderate NPDR, Severe NPDR, PDR, and DME.

Approximately 80% of the dataset was used for training the model and 20% used for validation or testing of the model's performance.

The model was trained till it reached 92% accuracy on the validation dataset. The sensitivity of the model at the end of training was 92% and specificity 93%. Sensitivity refers to the proportion of positive (referable DR) cases that the model identifies correctly, and specificity refers to the proportion of negative (non-referable DR) cases that the model identifies correctly.(10)

The AI model is currently being further tested and validated with real data while it is undergoing field testing. The level of accuracy achieved by the model during testing is comparable to ophthalmologists and is considered acceptable for screening of DR. In addition to internal validation, the AI model has also been submitted to the ITU/WHO's Focus Group on AI for Health, which has the goal of benchmarking AI for health algorithms and provide a neutral, independent assessment of performance. (11)

### **Challenges Faced:**

In designing the system, we faced several challenges:

- i) **Data Curation:** The first challenge was to ensure that the data used for training the AI algorithm was clean. This is necessary to ensure that the trained model is accurate in making predictions on new images. Many large real-world datasets contain invalid data and labels. For example, in our case the data contained many anterior (outside) images of eyes. Images also varied in quality and included out-of-focus and low-quality images. We created a separate AI model to remove invalid and very low-quality images from the training dataset. This improved the overall accuracy, sensitivity and specificity of the AI model.
- ii) **Speed and Scalability:** Design objectives for the AI system included fast prediction and scalability to hundreds of locations. By fine-tuning the model and parameters, we achieved a response time of less than a second on returning a prediction from the model. The system is hosted on Google Cloud Platform (GCP) infrastructure, to ensure scalability when deployed across hundreds of locations.
- iii) **Data Privacy, Security & Compliance:** We designed the system to comply with Indian regulations, confidentiality and security by using informed consent, data privacy anonymization, and encryption, as proposed by the Digital Information Security in Healthcare Act ("DISHA") and the Personal Data Protection Bill, 2018. India does not yet have formal regulations on using AI for health but requires all diagnostic reports to be reviewed and signed by a licensed doctor. Since the AI system will be used in assistive mode, all reports will be reviewed and validated by an ophthalmologist.

### **Results:**

The AI solution has achieved clinically acceptable levels of accuracy in initial testing and field trials in India and is ready for deployment on a larger scale. While regulatory approval for fully automated screening is being sought it will be used in an assistive mode as follows:

- i) **Improve screening throughput:** Currently 15% to 20% of images uploaded are non-gradable or invalid due to operator error. The AI system can instantly catch these errors and require the operator to capture a gradable image. This will reduce delays in diagnosis and improve overall throughput by 15% to 20%.

- ii) Triage and prioritize screening: The AI system can identify higher risk cases and prioritize based on DR severity – with PDR, severe, and moderate cases receiving immediate attention and priority screening. This will improve overall level of care for those most at risk of vision loss.
- iii) Quality Assurance: In cases where the AI and ophthalmologist's diagnosis differ, the case can be automatically assigned to a second ophthalmologist for further review. This will improve overall accuracy and decrease errors.

We also plan to conduct field trials of the model in countries in Africa, and the far east where there is an acute shortage of ophthalmologists. Future plans include obtaining FDA and EMA approvals for launch in USA and Europe.

### **Conclusion:**

An integrated system using AI can be deployed at scale and be effective for early detection and screening of DR, a major cause of preventable blindness worldwide. AI based systems for detection of DR offer the following potential benefits:

- Bridge the shortage of healthcare professionals and provide access to screening where none exists.
- Increase overall efficiency and scalability of current screening methods.
- Provide earlier detection of DR thereby preventing vision loss for millions.
- Decrease overall health-care costs via earlier interventions when it is easier and less expensive to treat these diseases.

AI based systems would be very useful in countries such as India and developing nations in Africa and elsewhere which lack professionals and infrastructure to screen everyone at risk of vision loss.

With over 420 million people afflicted with diabetes worldwide and 148 million with DR, and the numbers increasing each year, AI powered systems will be critical to address the global healthcare challenge of DR and prevent vision loss for millions globally.

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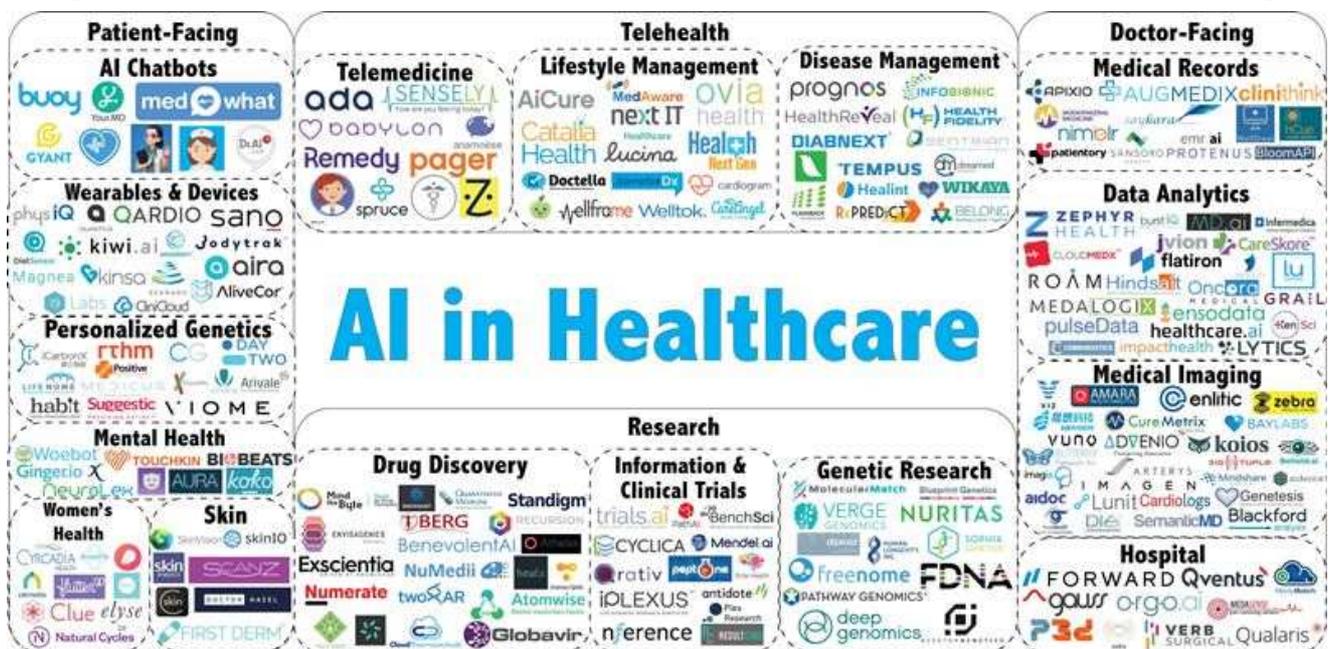
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## About the Author:



Arun Shroff is a serial entrepreneur who has founded and grown multiple technology companies in USA and India. He is founder/CEO of Xtend.AI, a startup using AI to solve global health challenges in health and other domains. He is also a co-founder/CTO at Medindia.net, one of India's top health websites, empowering consumers, patients and doctors with information and tools to better manage health. Arun serves as a topic lead at the ITU/WHO Focus Group on AI for Health - a UN / WHO initiative for benchmarking AI and creating a global community on AI for health. Arun is also a Director of Technology & Innovation at STAR Associates, USA providing strategic and advisory services to early stage technology companies in AI, Robotics, Blockchain, cybersecurity, health and telemedicine.

Arun has been an invited speaker and expert on AI and technology at conferences globally including at the AI for Good Summit in Geneva, at the ITU/WHO Focus Group in New York, at Wilton Park, UK, at Apollo Hospitals, Chennai, and IIT Madras. Arun also volunteers with many non-profits including MOHAN USA, where he is a founding trustee and an advisor at MOHAN Foundation - both promoting ethical organ donation and IIMPACT, an education NGO for girl children in India's poorest villages. Arun has a B.Tech from IIT Madras, an MBA from IIM, Ahmedabad, and M.S. in Computer Science from Penn State University, and certifications in Machine Learning & AI/Deep Learning from Stanford & Coursera.



Source & Courtesy: AI in Healthcare: Industry Landscape  
<https://techburst.io/ai-in-healthcare-industry-landscape-c433829b320c>

**Artificial intelligence in healthcare: past, present and future:** Artificial intelligence (AI) aims to mimic human cognitive functions. It is bringing a paradigm shift to healthcare, powered by increasing availability of healthcare data and rapid progress of analytics techniques. We survey the current status of AI applications in healthcare and discuss its future. AI can be applied to various types of healthcare data (structured and unstructured). Popular AI techniques include machine learning methods for structured data, such as the classical support vector machine and neural network, and the modern deep learning, as well as natural language processing for unstructured data. Major disease areas that use AI tools include cancer, neurology and cardiology. We then review in more details the AI applications in stroke, in the three major areas of early detection and diagnosis, treatment, as well as outcome prediction and prognosis evaluation. We conclude with discussion about pioneer AI systems, such as IBM Watson, and hurdles for real-life deployment of AI. <http://bit.ly/2kYdvoj>

**Artificial Intelligence in Healthcare: the Ultimate Guide:** Artificial intelligence (AI) plays a role in many industries, from banking and cybersecurity to product design and healthcare. The benefits of leveraging technology in healthcare have the power to impact both your facility and patients. Some implementations include diagnostic capabilities and predicting disease, customized treatment plans, enhanced electronic health records and more. This guide has everything you need to know about artificial intelligence in healthcare. <http://bit.ly/2mulRoj>

# Big Data In The Bigger World Of Agriculture Today

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Recent decades have witnessed a dramatic growth in technological advancements, particularly since the rise of the Internet and its applications in everyday life. If we stop and look around, one could observe that technology has touched every aspect of human life, be it education, communication, food, health or lifestyle. Technology, in its diverse forms and shapes, is enabling humans to achieve more with less, and has provided an even bigger platform to innovate. This rapid explosion of technology has also resulted in a surge in big data around us.

Big data is described as both structured and unstructured data that is too “big” to be processed by traditional data processing systems. The “big” part of this term is characterized by the magnitude of its 5 Vs, which are volume, velocity, variety, veracity and value. With the steady increase in the use of the Internet of Things and mobile technology, copious volumes of data is being produced each day using these devices. [A recent report by International Data Corporation \(IDC\)](#) (1) forecasts that by the year 2025, nearly 41.6 billion connected IoT devices will be generating 79.4 zettabytes (ZB) of data. The pictures we take using the latest smartphone cameras, our dietary patterns that we record using health and fitness apps, our browser history in web applications, our commands to home automation and smart devices, each of our social media activity, and videos captured by surveillance units all form only a minuscule part of the projected 79 ZB of digital information that is analyzed extensively to deliver business intelligence the world over.

## Big Data In The Era Of Agriculture 4.0

The Fourth Agricultural Revolution is characterized by digitisation of farms worldwide and the consequent data-driven farming as a result of increased use of modern technologies such as farm monitoring and management gadgets, soil sensors, remote sensing. The innovative application of technological tools has enabled the collection and processing of invaluable ground agri-data, allowing various stakeholders in the agri-ecosystem to arrive at highly informed decisions. This combination of technology and big data analysis has further facilitated farmers to monitor crop in real-time and achieve higher efficiency and profitability in farm and business operations with as minimum input as possible, thereby maximizing crop performance.

**MAXIMISING PER ACRE VALUE**

**THE FUTURE OF FARMING IS HERE!**

- Structure Your Farm Data
- On-the-go Reporting & Actionable Insights
- Plug in Big Data & AI/ML  
Weather, Satellite and Proprietary Algorithms
- Extreme Configuration & Automation of Field Work, Crop Advisory, PoP, Trainings, Events, Compliance and Certifications
- Enhance Engagement and Encourage Meaningful Interactions between Field Officers, Agronomist, Farm Managers & Agronomist
- Connect your Drone, Sensors and Machines on same platform [future]

**BUSINESS OUTCOME:**  
Improve Efficiency, Productivity & Sustainability across your Business

**OPERATIONAL OUTCOME:**  
Build Predictability, Visibility & Control in your Ag Supply Chain

CropIn

Although many were apprehensive of infusing technology with agriculture, the benefits and the effects of the agri-tech have clearly outweighed the uncertainty. Data analytics has marked the path for increased efficiency, strengthened productivity and better sustainability of resources. Today, the agriculture sector is in the spotlight for multi-million dollar investments by governments, development agencies and private entities, to uplift the farming community and advance agricultural production. Recent industry figures indicate that there has been [an increase of over 40% in the amount of global investment in agri-food technology in 2018](#). (2) Considering agriculture was one of the last sectors to adopt technology, the applications of big data here are large and plentiful. Some of the widely-used ones are as follows:

**Precision Farming:** IoT sensors empower farmers to monitor their crops minutely and analyse how the soil, climate, water and other inputs affect its growth. These sensors reduce the amount of muddy feet required on field, and serve as eyes at a ground-level and provide farmers with vital crop intelligence that could make a significant difference to the yield and its nutritional value. [GPS-enabled drones and farm machinery assess crops for areas that need attention](#) (3) and facilitate automated application of agrochemicals exactly and only where required, thereby ensuring optimal use of agri-inputs.

**Yield Prediction:** Capturing plot-level pre-harvest farm data, including those of crop stresses such as changes in weather conditions, pests and diseases at different points of the crop cycle allows farmers and agribusiness to predict the yield in real-time and plan post-harvest operations accordingly to ensure minimum wastage. Furthermore, other players in the agri value chain can use this data to make calculated decisions for their business operations.

**Risk Mitigation:** Agribusinesses and lending institutions in particular are now able to combine remote sensing with big data analytics from a farm level to forecast the plot's performance or the chances of a crop failure in order to [mitigate risks and make well-informed business or lending decisions](#). (4) Pre-configured rule-based alerts can enable farmers to reduce the impact of or, to an extent, even prevent crop losses due to pest attacks or crop diseases by anticipating and preparing in advance. This capability is of critical importance today in light of the negative impact of climate change on agriculture.

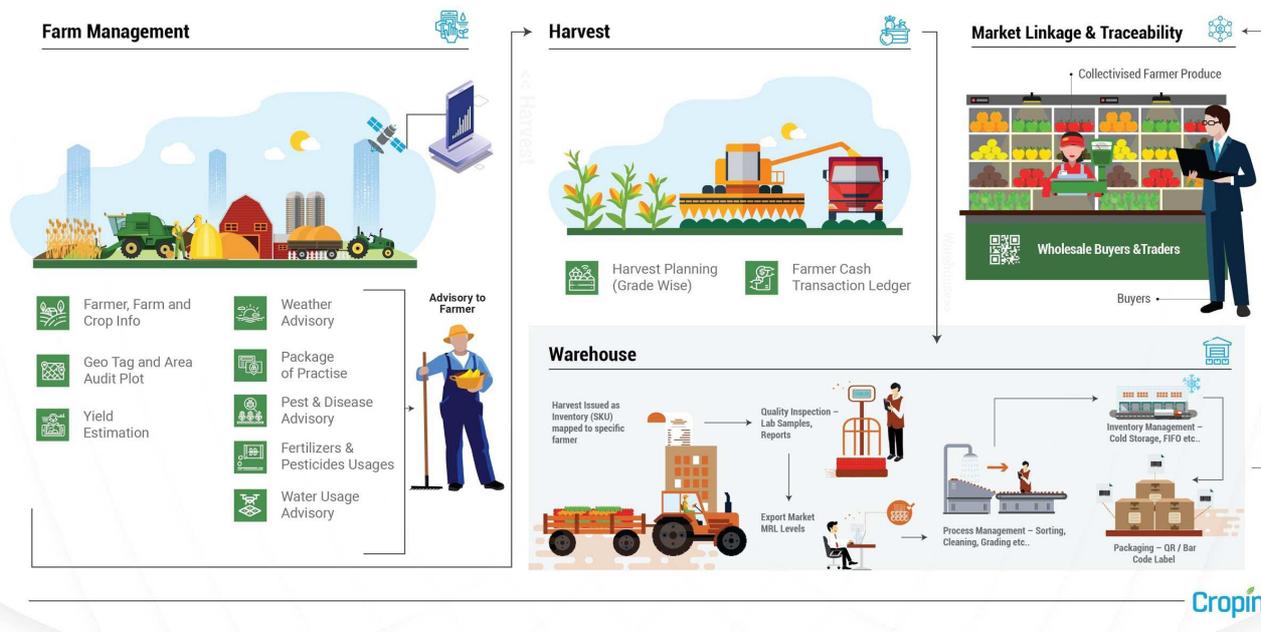
**Loss Reduction:** Big data analytics allow farmers and key players in the supply chain to track the produce and ensure efficient and quick movement along the chain to prevent losses due to spoilage. The potent use of artificial intelligence in combination with remote sensing can be witnessed in large farms, where drones are optimized to spot problem areas, or identify crop ripeness for a perfect harvest. In addition, predictive models constructed on farm data can provide the right solutions for efficient food distribution and cut down food wastage.

**Supply Chain Management:** Multi-stakeholder platforms today have the unique potential to bring together different players in the agri-ecosystem such as food processors, retailers and distributors for a highly-collaborative functioning. This reduces dependency on individual agents, and instead promotes a more transparent and productive operations. Moreover, import/export regulations are now better monitored thanks to digital records of farm operations that indicate crop quality and nutrition value.

**Farm-to-Fork Traceability:** With increased awareness among consumers and [their demand to know the source of their food](#), (5) more and more agribusiness and food brands are ensuring traceability of their products. Capturing data right from sowing to distribution allows brands to go back and track the movement of the produce or the product and identify issues if any, and it also allows concerned consumers to rest assured that the product has been ethically and sustainably sourced.

## Farm to Fork Solutions

Supply Chain Solution



**Sustainable Farming:** Leading-edge technologies such as drones, remote sensors, Internet of Things, and artificial intelligence consume big data in its various forms intelligence that is progressively improving sustainability in agriculture. In a world of growing population and diminishing resources, these technologies are ensuring optimum use of land, water

and other resources to provide for global demands without taking away too much from future generations. They also provide practical and scalable solutions that aid in conserving natural resources, which in turn sustains agriculture.

## Impact

The effect of big data in agriculture is far-reaching and we are only in the nascent stages of exploring its applications in agriculture. Big data has proven to be fruitful in developed nations where adoption of technology is already at an all-time high, and it also has much to offer to rural and smallholder farmers, who have just begun their foray into smart farming. Big data coupled with other modern technologies have streamlined agriculture into a sector that is highly capable of providing much more even with the current limitations to farming.

Big data analytics provides the agri-ecosystem with in-depth insights that educate farmers about their crop and soil, and help them understand their unique relationship with the ecosystem. This knowledge facilitates them to make significant changes in the way they farm, to produce crops that are healthier, bountiful and more nutritious. The analysis of decades and centuries worth of data has allowed researchers, scientists and agronomists to forecast crop stresses and recommend practical solutions to prevent excessive crop loss. Furthermore, farmers are now able to sow and harvest their crops at a time that is favourable for a generous harvest.

Diverse applications of agri-food technology are now able to analyse records from the past and the present to advise farmers and agribusiness on the precise quantity of produce that needs to be cultivated to match consumer demands. Farmers can thus reduce food waste by producing only what is required, thereby saving time, money and resources. Technological innovations in the supply chain can further [reduce food losses estimated to be worth \\$1.5 trillion by 2050](#), (6) by enhancing and optimizing processes involved in logistics, storage, and distribution.

In research stations and laboratories, the data collected from the farm during the length of the cultivation cycle is also being used to develop seed varieties that are climate-resilient, high-yielding and require minimum inputs. On the fields, agri-tech solutions are monitoring farms day and night each day with minimum human intervention. Satellite monitoring, sensors, drones, and other unmanned agricultural systems thus reduce the dependence on physical manpower on one hand, and improve accuracy and productivity on the other.

If there is one sector that affects every individual on the planet, it has to be agriculture. Big data thus has a profound impact on the lives and lifestyles of people across demographics. In such manner, data captured from farm to fork plays a critical role in realizing the Sustainable Development Goals as defined in the 2030 Agenda for Sustainable Development. [Enhancing agricultural productivity results in food security](#) (7) for all and improved livelihood for the farmers. Developing nations that can produce more can also provide better facilities to the marginalized farming communities, thus raising their standard of living. An increased yield with existing resources also helps to safeguard the ecosystem by ruling out the need for more land by clearing forests, which further aids our battle against climate change.

Modern technologies time and again have proved their ability to adapt to the needs of different sectors regardless of how traditional they are. Agri-tech, still in its nascent stages, is expanding its reach to leverage the abundance of big data in the agri-ecosystem to provide unique solutions for diverse global problems, and ensure quality food, feed and fibre for all.

[CropIn Technology](#)'s (8) platform consumes agri big data from remote sensing technologies and ground data to power its AI/ML models, thus enabling an interconnected network of all stakeholders in the agriculture ecosystem to analyze and interpret data and derive real-time actionable insights on standing crop. Businesses use CropIn's agri-tech solutions to effectively drive their initiatives around Digitization, Compliance, Sustainability, Predictability and Traceability. The AI-driven insights generated in CropIn's platform through satellite imagery, ground sensors, and weather data not only provide food growers with a better understanding of the land under cultivation, it also helps in improving our understanding of cultivable land for the future. The historical and real-time data present a wealth of information that can help governments and developmental agencies make meaningful, forward-looking policy decisions.

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## About the author



Kunal Prasad is the co-founder and COO at CropIn Technology. He has over 13 years of experience in technical and management arena with substantial work in sales and business development, project management, product and customer experience. Kunal's strengths lie in his strong team management skills and his tenacious attitude that has helped CropIn reach out to over 2.1 million farmers in 46 countries. He is passionate about working on improving farm productivity, climate resilience, sustainability and food security. He has extensive experience in working with government bodies, development aid agencies, co-operatives and farmer groups globally. He believes that farming should be data-driven and collaborative, and so he is on a mission to digitize 20 million farmers by 2022.

## Related Readings

**Big Data in Smart Farming – A review:** Smart Farming is a development that emphasizes the use of information and communication technology in the cyber-physical farm management cycle. New technologies such as the Internet of Things and Cloud Computing are expected to leverage this development and introduce more robots and artificial intelligence in farming. This is encompassed by the phenomenon of Big Data, massive volumes of data with a wide variety that can be captured, analysed and used for decision-making. This review aims to gain insight into the state-of-the-art of Big Data applications in Smart Farming and identify the related socio-economic challenges to be addressed. Following a structured approach, a conceptual framework for analysis was developed that can also be used for future studies on this topic. The review shows that the scope of Big Data applications in Smart Farming goes beyond primary production; it is influencing the entire food supply chain. Big data are being used to provide predictive insights in farming operations, drive real-time operational decisions, and redesign business processes for game-changing business models. Several authors therefore suggest that Big Data will cause major shifts in roles and power relations among different players in current food supply chain networks. The landscape of stakeholders exhibits an interesting game between powerful tech companies, venture capitalists and often small start-ups and new entrants. At the same time there are several public institutions that publish open data, under the condition that the privacy of persons must be guaranteed. The future of Smart Farming may unravel in a continuum of two extreme scenarios: 1) closed, proprietary systems in which the farmer is part of a highly integrated food supply chain or 2) open, collaborative systems in which the farmer and every other stakeholder in the chain network is flexible in choosing business partners as well for the technology as for the food production side. The further development of data and application infrastructures (platforms and standards) and their institutional embedment will play a crucial role in the battle between these scenarios. From a socio-economic perspective, the authors propose to give research priority to organizational issues concerning governance issues and suitable business models for data sharing in different supply chain scenarios. Full Review Paper at <http://bit.ly/2ktoVAp>

**Data Science in the Indian Agriculture Industry:** Agriculture is the backbone of the Indian economy, but the industry currently needs more support than any other. India is a country of over a billion people in population, out of which, over 70% of the population lives in the rural areas. With 40% of the country's workforce, agriculture is a major industry and an influencer of the Indian economy. Despite this, its contribution to the \$2.3 trillion economy is just a meager 16% of the entire GDP. Agriculture in India lacks institutional attention, support from banks in terms of loans and farmer welfare schemes, and suffer from a myriad of disasters like depleting groundwater levels in rural areas, climate change, unpredictable monsoon or lack of it, droughts, floods, unfair price fixing policies of produce, migration of farmers towards the cities in search of better paying jobs, and more. Agriculture is one sector responsible for feeding every individual, but the people involved in it are the last to be taken care of. After failing institutions, time has indeed come for technology to take over the change. With newer problems cropping up every day in the most inevitable indigenous sectors, it is high time we resort to emerging technologies for solutions. Full Post at <http://bit.ly/2m15EGS>

**Big Data and Climate Smart Agriculture - Status and Implications for Agricultural Research and Innovation in India:** Climate change will increase the vulnerability of agricultural production systems, unless scientists and farmers reorient their present approaches toward making them climate smart or climate resilient. The integration of recent developments in big data analytics and climate change science with agriculture can greatly accelerate agricultural research and innovation for climate smart agriculture (CSA). CSA refers to an integrated set of technologies and practices that simultaneously improve farm productivity and incomes, increase adaptive capacity to climate change effects, and reduce green house gas emissions from farming. It is a multi-stage, multi-objective, data-driven, and knowledge based approach to agriculture, with the farm as the most fundamental unit for both strategic and tactical decisions. This paper explores how big data analytics can accelerate research and innovation for CSA. Three levels at which big data can enhance farmer field level insights and actionable knowledge for the practice of CSA are identified: (i) developing a predictive capability to factor climate change effects to scales relevant to farming practice, (ii) speeding up plant breeding for higher productivity and climate resilience, and (iii) delivery of customized and prescriptive real-time farm knowledge for higher productivity, climate change adaptation and mitigation. The state-of-art on big data based approaches at each of the three levels is assessed. The paper also identifies the research and institutional challenges, and the way forward for leveraging big data in research and innovation aimed at climate smart agriculture in India. Full paper at <http://bit.ly/2m1iHbi>

# Speech Analytics – Use cases in Service Centers

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## Customer Experience

Providing exceptional Customer Experience is a bed rock of Businesses and one of the most important factors for its success. The customers interact with the Enterprise through variety of channels. In order to make this touch points impactful, contextual and interactive yet cost effective, the Enterprises are increasingly resorting to self-service based services that leverages Big Data and Artificial Intelligence based solutions.

Managing Customer relationships and sentiment through traditional CRM systems are inadequate in the age of multi-channel, open market and accelerated decision-making scenarios in which the current customers operate. The trends, tastes and preferences are changing more dramatically with the advent of B2B e-commerce platforms and business operations 24x7.

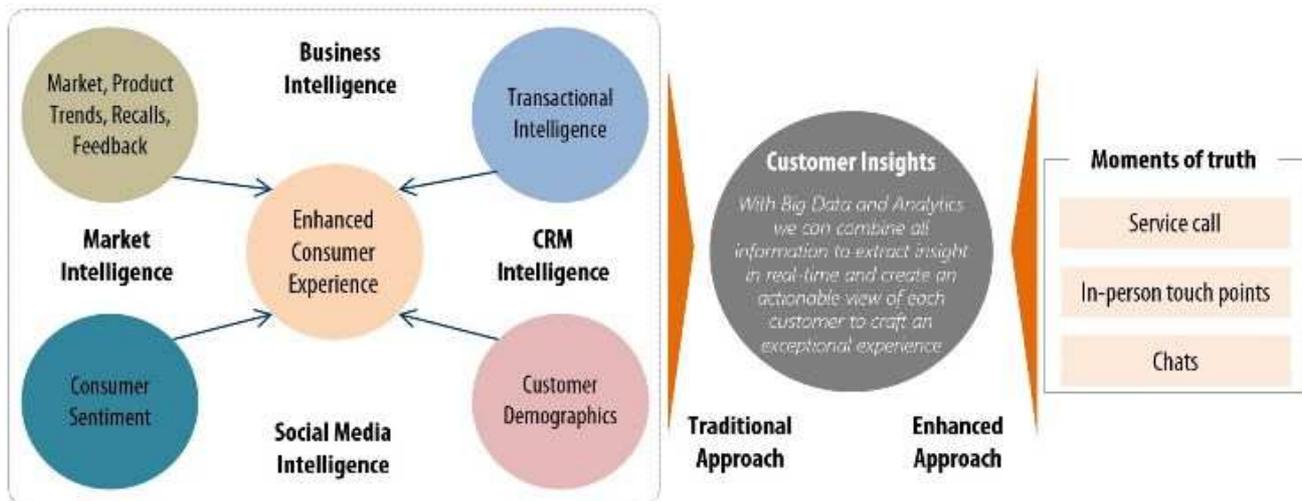


Fig1: Customer Experience and the role of Intelligences

The key pillars of Customer Intelligence come from the four pillars of

1. Market Intelligence: This gives the signals from the market
2. Business Intelligence: Gives out the past behavior of the consumers
3. Social Intelligence: Indicates the sentiments and current thinking of the customers
4. CRM Intelligence: Provides customer transactions for a rich context of their behavior.

These four pillars are traditional and retrospective and hence needs to be enhanced to leverage rich information emanating from all the sources by integrating multi-Intelligence data. Increasingly, more intelligence data is unstructured in text formats, video and audio. The technologies of Big Data and Artificial Intelligence paves way to innovative solutions to build solutions that could deliver exceptional Customer experience.

## The Role of Customer Service Centers

Most enterprises experience the “moments of truth” at the time of customer service (for instance, a lost or stolen credit cards, inbound sales call, feedback on products/service, a canceled flight, a damaged piece of clothing, or investment advice) when customers invest a high amount of emotional energy in the outcome. These interactions have a dramatic impact on the Customer experience. Analyzing these interactions can give deeper insights into process, performance, and customer experience issues.

Customer service centers are dominated by voice interactions between customers and service center agents, who are the face of the company. In general, the audio call data is archived for reference and not mined for customer interactions and extract value from them. It is exhausting to hear the tapes; hence this source of rich data is routinely ignored. Often this data is never accessed, unless there is a special situation such as an escalation or a dispute. Most information is hidden and should be mustered from the customer call data.

Typically, conversations such as below dialogues are lost forever due to not utilizing the speech to text conversion solutions.

- Repeat interactions where the customer indicated they reached before  
Sample phrases: “called earlier,” “called twice already,” “third time I called,” “spoke to someone yesterday,” “couldn’t get through,” “had to call back,” “have to keep calling”
- Repeat calls where the customer indicated their issue had gone unresolved  
Sample phrases: “keeps happening,” “never heard back,” “hasn’t resolved it,” “having the same issue,” “been more than a week,” “I’ve been waiting,” “was supposed to call/email me”
- Interactions where customers complain or express dissatisfaction  
Sample phrases: “frustrating,” “you people,” “ridiculous,” “misleading,” “annoying”
- Interactions where customers express appreciation  
Sample phrases: “you’ve been so helpful,” “thank you for caring,” “you deserve a raise”
- Interactions where agents were unwilling to help the customer  
Sample phrases: “end of my shift,” “not my problem,” “I don’t handle that,” “that’s our policy,” “can’t give that out”

### Speech Analytics

Speech Analytics should help organizations enrich customer interactions, improve business processes, and optimize their work forces to enhance loyalty, increase revenue, mitigate risk, and manage operational costs.

Of all the cognitive senses - Vision, Speech, Smell, Touch and Taste do not lend themselves for equally for analysis by Computers. The signals that can be measured, captured and stored in some digital format - Vision, Speech are detected, sensed and recorded and are currently being computationally handled. Various human systems are modelled. Vision has innumerable applications.

Speech and Voice Analytics are also exciting fields ripe with opportunities for the application of Natural Language Programming and Neural Networks. The enterprises are rapidly finding use cases that could leverage Speech Analytics.

The process of Speech Analytics starts with speech recognition, identifying various phonetics, accents, tone, mood, mixed language; which creates very challenging problems for Research. The traditional models of speech transcription are slow, labor intensive, error prone and cumbersome. Speech Analytics can be of two variants:

#### *Archival Analysis:*

This is accomplished by mining intelligence from thousands of recorded calls/chats essential for pinpointing cost drivers, trends, and opportunities; identifying strengths and weaknesses with processes and products; and understanding how the products/services are perceived by the marketplace.

It helps in identifying trending inquiries and provides a very rich “sandbox” to uncover various scenarios to develop triggers as well as identifying common pain points of the customers.

Many archival analytics were deployed successfully over the years in Enterprises. To enhance these applications to include real-time speech analytics allows much deeper insights and ability to respond to market conditions more appropriate.

#### *Synchronous Analysis:*

This may be considered as Real-time speech analytics. It can leverage indicators within the call conversations and analyzes them to proactively identify opportunities and guide these conversations towards the desired outcome that are beneficial to both the customer and the business – as the calls are in progress. These analytical solutions may guide the contact center agents by providing contextual guidance just at the right instance – when they need it, in real-time. Presenting actionable information in real-time with the right context provides a clear and significant competitive advantage. The solution is especially critical when dealing with compliance, regulations and industry mandates. Increasing customer retention and First Contact Resolution.

This is accomplished real-time and continuously monitored and tracked; which allows the service center the ability to provide superior customer engagement, handle situations at the right time to mitigate attrition and escalations.

The Architecture of a Speech Analytics solution

The Speech Analytics solution has is an intricately connected heterogenous software platforms, streaming and APIs. It also uses Machine Learning Artificial Neural Networks and NLP. The enabling components of this solution are illustrated in the diagram below:

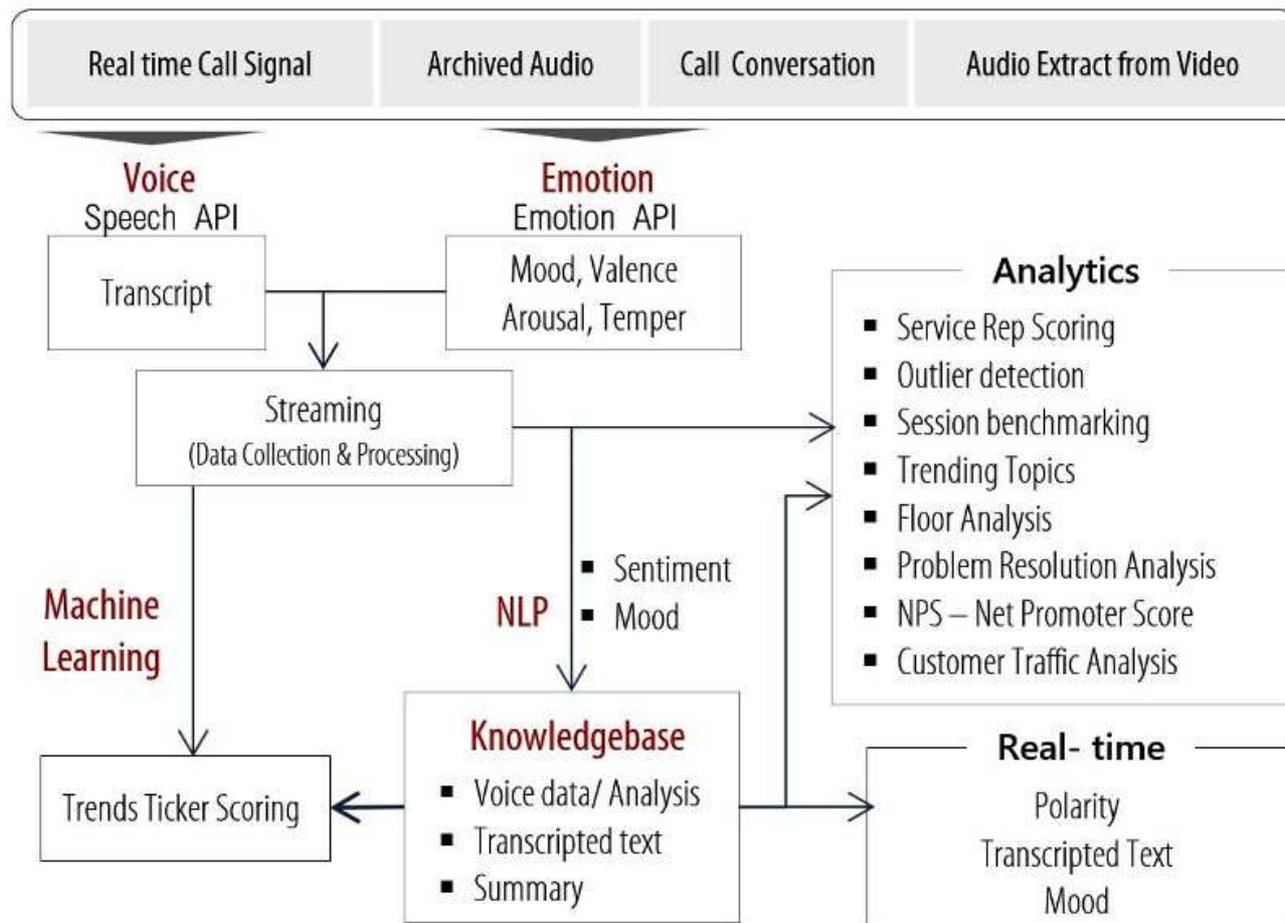


Fig2: Components of a Speech Analytics System

**Streaming:**

The Streaming module is handling by a Big Data infrastructure like Spark and will employ two APIs.

**Voice Transcription**

Convert voice to text using Statistical machine translation techniques and Sentiment of the customer (Meaning). *Capture the voice stream by applying various text and audio processing techniques. Understand the sentiments as well as mood of the conversation for a customer service call.*

One to transcribe the audio chat and the other to extract the mood or emotion. This functionality is achieved through Emotion API. It also deciphers the feelings and the meaning of a conversation.

Monitor calls as they happen by detecting words phrases and key topics of conversation. Audio sniffer with configurable keywords can also be used for escalations.

**Creating and enhancing the Knowledgebase**

- Two-way voice data (Customer and Support Executive)
- Results of voice analysis (quantitative and qualitative)
- Transcribed Text
- Polarity, Sentiment, Word cloud
- Summary and conclusions

**Analytics**

- *Agent Quality Scoring* – Score service center agent on various compliance parameters to enhance the quality assurance practices. This will also help to identify training and resource re-allocation requirements.

- *Topic Detection:* Provide sophisticated conversational analytics to automatically identify, group, and organize the words and phrases spoken during calls into themes, helping to reveal rising trends and areas of opportunity or concern. The solution should identify themes automatically, continually refine them, and add new themes over time.
- *Performance Analysis of the Service center:* Should process thousands of unstructured data rapidly. Analysis of this information should provide information about customer sentiment, up-sell and cross-sell opportunities.
- *Real-time Mood Analysis* – Analyze mood (Emotions) of the customer in a conversation. Customer service will enhance tremendously by knowing the moods of the customer and intensity of conversation which will allows taking necessary actions to provide better service for the customer.

### AI and ML Techniques in Speech Analytics

Various AI, ML and NLP techniques are used in this solution. The flow of Analysis of a Speech Analysis system is represented in the diagram below:

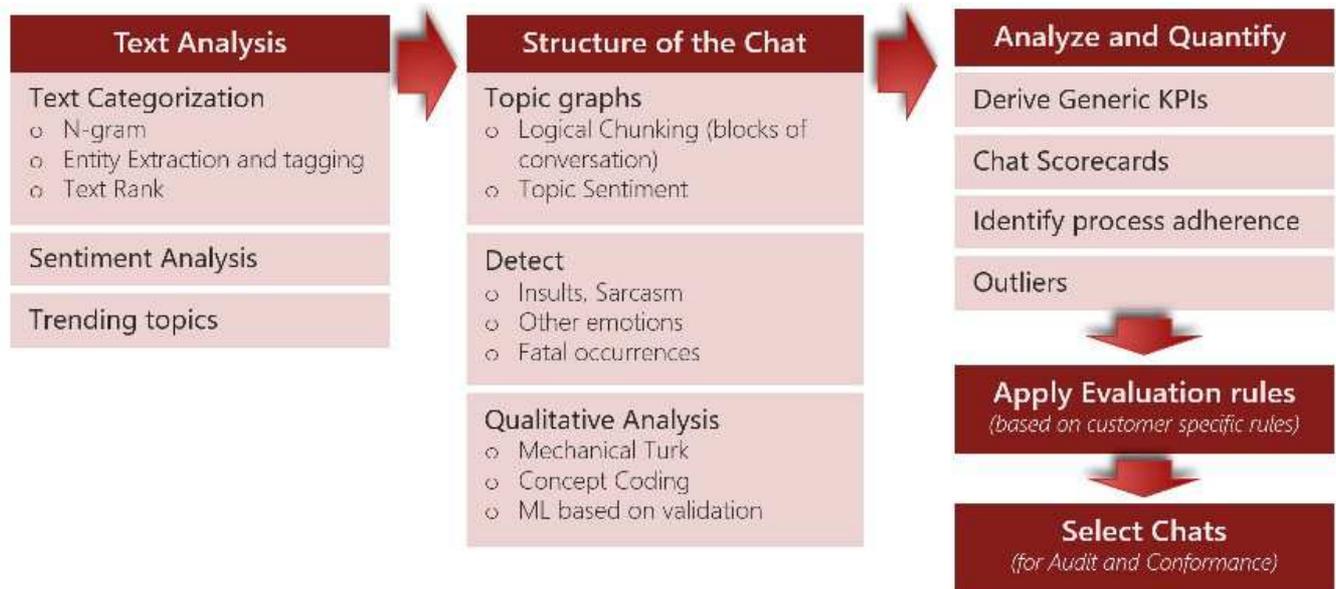


Fig3: Text Analysis Components for a Conversation

Major benefits for a Service Center:

Analytics has a great potential to enhance customer perception by pre-emptive actions that will result in preventing customer dissatisfaction and increase customer delight; achieving a superior service center performance. The following are some tangible benefits of the system:

#### Enhanced Customer Handling

Customer service will enhance tremendously by knowing the moods of the customer and intensity of conversation which will allows taking necessary actions to provide better service for the customer.

- Quickly resolve customer issues thus improving Customer Experience. Analytics can be used to predict “Call Reason” or identify the “Next Best Action”
- Proactively address needs thus arresting Customer Attrition by tracking the trending issues and access most relevant answers
- Predict consumer demand: Prevent- Prepare- Respond - Recover Structure through anticipated future behaviors
- Adapt recommendations through 80% Recommended Resolutions achieved through Information Retrieval, Content Management and Wikis
- Recommend and help fine-tune products and services thus help enhance revenue by up-selling and cross selling. Speech analytics may enable the agents to handle customer resistance while selling. The solution may identify a customer’s eligibility, the potential product of his interest.

#### Smooth Operations

The efficiencies will further improve by knowing the trending call center enquiries and deploying the right person for answering the right issue.

- Call Forwarding to most appropriate Staff
- Help to Identified Most Efficient Employee to take up the calls
- The Best CSR handling a given customer: Recommender and matching
- Create Lasting relationships by improving Service Quality
- Implement effective self-service and help reduce Operating expenses
- Ensure incoming calls are retained, engaged and serviced: Adaptive and Smart IVR

Final thoughts:

Competitive advantage of a company often depends on anticipating and addressing market needs faster than the competitors. Calls received by the service center can give a telling indicator about your business and market.

- Serves as an early warning system to identify issues before they escalate and impact a large cross-section of customers. Speech analytics can be used successfully to identify if escalation was required during a call and effectively guide the agents to transfer the call to a supervisor if the situation warranted.
- Speech Analytics can be a great transformational agent not only for the contact center but across sales, marketing, compliance, IT and any other customer-facing departments.
- Helps you optimize customer engagement and service strategies by revealing trends and opportunities
- Drives adherence to compliance by quickly revealing regulatory breaches and failure to adhere to internal policies.

The combination of post call and real-time speech analytics significantly improves pre-emptive actions that will result in preventing customer dissatisfaction and increase customer delight; and achieving a superior contact center performance.

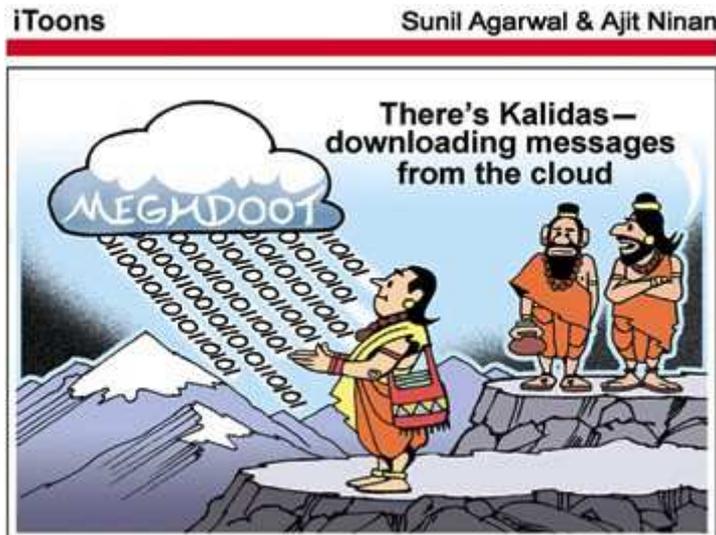
About the authors



Surya Putchala is CEO, ZettaMine Labs. He provided thought leading consulting solutions to Fortune 500 Clients for over 2 decades. He is passionate about areas related to Data Science, Machine Learning, High Performance Cluster Computing and Algorithms. He held senior leadership roles with large IT service providers. He graduated from IIT Kharagpur.



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# Potential of Integrated Data Geography as a new Systems Engineering Approach

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This article introduces the concept of "Integrated Data Geography (IDG)" approach which stems from the concept of Integrated Geography or Integrative Geography (IG). IG in its definition is the branch of geography that describes and explains the spatial aspects of interactions between human individuals or societies and their natural environment, called coupled human–environment systems [1-2]. Basically geography is of two types, spatial (i.e., environmental geography), and, human geography. The third advent is integrated geography which is of course assimilation or coupling of these two information to gain a holistic or connectionist view of the system as a "integrated system". For example, social and religious practices of a human group at a particular geographical location might have been rooted from the need to withstand geo- environmental pressure within that particular geographical location. Therefore, if we find the same practice prevalent in some very distant geographical location, then possibility of migration of same human race may be mooted upon.

Continuing with the concept of IG, we thought that it might also be interesting to employ this approach as an additional component of Systems Engineering to get more in-depth information about the system through pulling in already reported (i.e., results of publications) pieces of information and putting them together under a framework of Data Science, whereas, Data science is a "concept to unify statistics, data analysis, machine learning and their related methods" in order to "understand and analyze actual phenomena" with data [3]. It employs techniques and theories drawn from many fields within the broad areas of mathematics, statistics, information science, and computer science, in particular from the sub-domains of machine learning, classification, cluster analysis, uncertainty quantification, computational science, data mining, databases, and visualization.

In the backdrop of a huge amount of research reports being cumulatively piled up daily as publications, it appears to be necessary to tap this huge information treasure for effective analysis of a system from a Systems Engineering View. Proposal of this approach is distinctly different from Meta Analysis approach which deals with statistical summarization of same System Property or System Issue worked upon and published by various researchers. The systems engineering approach being proposed here stands on the premise that, for a particular system, its different issues or properties worked upon and published by different group of researchers may be judiciously combined to achieve a particular new Systems Engineering goal about this system without doing any further experiment or work on this system. As already stated, under current circumstances, a substantial amount of reports of already performed research on different subsystems of a particular system appears to make such approach plausible. For further clarification on this proposed approach, following examples may be found to be useful.

First example is about phishing in biometrics based personal identification. For attempt of phishing in a fingerprint based personal identification system, the target may be to detect data-defect for a typical personal fingerprint. In this regard, it may fail for a particular type of derived data or feature, but may be successful in detecting phishing attempt through use of different features and combining different feature-outputs under rules of assimilations.

Second example is a VLSI design which is waiting to be optimized as target hardware or diagnosed after a fault. For both of these cases, the standard practice is to achieve it through trials and not under any established systems engineering framework or anything similar to IDG.

Third example is an automobile system which is to be optimized for the purpose of the intended users (say Defense) or diagnosed after a defect. For this purpose also, no data science or systems engineering framework is practiced.

Fourth example is of medical diagnostic or therapeutic system, where it is of frequent need to assimilate information obtained from various tests towards diagnosis and subsequent planning of treatment.

To give a mathematical framework of this concept, it may be said:

For a pool of logical lemmas,

$L = \{L_i\}$ , for  $i = 1, 2, \dots, N$ ,

if,

- i) all of these logical lemmas serve as supports to prove our proposition to build a theorem,  $T = f(L)$  for  $f$  is a function in broader sense which is derived through judiciously made inter-connectivity of all the members of  $L$ , and also,
- ii) these lemmas represent complimentary form of necessary and sufficient proof of  $T$ ,

we may consider the analysis of the system is compatible and doable under the paradigm of IDG. From the above-representation although it appears to be very obvious and commonly practiced method of analysis, which is actually so among crime-investigators or detectives, use of logical lemmas in Science and Engineering is yet to be formally introduced.

The following argument appears to further strengthen the basis of such new Systems Engineering component along with its difference from the existing Data Science approaches. One such example is, Meta Analysis, which is a statistical analysis possible under a condition that all different published results should have been produced under nearly same methodological steps only so that a statistical estimate of an intended goal parameter may be obtained. However, in IDG it is not mere estimation of a parameter, but to obtain necessary and sufficient support from outcomes (i.e., Logical Lemmas in technical sense) of analysis of different sub-data's extracted from different sub-systems of the whole system to assert about the proposed behaviours of the system. To say geographically, these sub-datas can be thought of representatives of different entities (like human) attached to different geographical part of the data derived from different sub-systems. Since the data in this regard may be even a typical nominal scale data (e.g., a class decision), therefore, the reach of this approach is supposed to be beyond the scope of usual Systems Engineering approach. The need of such IDG approach is increasing day by day due to availability of results of huge amount of experimentation being carried out over a system.

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# How to win Core Projects for the Offshore Center from the Head Office

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*This article is excerpted from the author's Amazon #1 Best Seller Book "Leading and Motivating Global Teams: Integrating Offshore Centers and the Head Office" published by CRC Press, USA*  
<https://www.amazon.in/dp/1498784747?tag=tafrboinpvt-21>

A large number of global companies are outsourcing projects to distant countries. A number of them are running Offshore Centers in these countries. These companies have augmented their project teams in their global Head Office (HO) with the Offshore Center teams. The projects are distributed across the Offshore Center and HO, with the managers in the Offshore Center and the managers in the HO leading their respective project teams.

The HO management of some global companies thinks that their Offshore Center teams are not capable and experienced enough to be able to execute core and complex projects. Hence, they offload only simple projects to the Offshore Center. For example, if the company is developing products then it will offshore only projects such as adding simple features to products and maintenance of legacy products, but will not offshore projects for developing core features of the products. The value addition of the Offshore Center to company's revenues is then low. Further, since the Offshore Center does not offer opportunities to work on challenging projects, it is unable to hire, retain, and motivate good talent, especially capable and experienced professionals.

This article suggests some techniques for the Offshore Center managers to convince the HO management to offer them high-value, core, and complex projects, which can significantly increase the contributions of the Offshore Center to the company's revenues and help the Offshore Center hire, retain, and motivate excellent talent.

We start by presenting the problems faced by the Offshore Center if it is offloaded only peripheral projects. We then suggest techniques using which the Offshore Center managers can convince the HO management to offload core and complex projects to the Offshore Center. We conclude by discussing the benefits accrued to, both, the Offshore Center and the global company as a whole if core projects are offloaded to the Offshore Center.

## **I. Problems in only offshoring Peripheral Projects**

The approach of the HO management of offshoring only some peripheral projects creates a number of problems in the Offshore Center:

1. The teams in the Offshore Center are capable enough to deliver on more complex and challenging assignments. Since they are being offloaded only simple and low-revenue generating projects, it severely limits the Offshore Center's contributions to the company revenues. The Offshore Center then keeps growing in terms of adding more employees but it fails to add significant value to the company. The full potential of the Offshore Center teams is not realized.
2. Since the employees in the Offshore Center are working on low level tasks/projects, much below their capabilities, they become demotivated. Their job expectations are not being met with the lack of challenges and opportunities in their jobs. They are demoralized, which reflects in lower productivity, and it results in severe negative impact on the deliverables of the Offshore Center. Such demoralization even causes attrition of experienced, senior, and capable Offshore Center employees, who decide to join companies that give them opportunities to work on more challenging projects.

Thus, the Offshore Center has severe problems in motivating and retaining its core employees.

3. Experienced and capable technology professionals in the industry prefer to join companies that offer them opportunities to develop core products and work on complex, challenging, and exciting projects. Since the company's Offshore Center does not offer such opportunities, such professionals refuse to join it.

Further, it becomes even more difficult to attract experienced managers from the industry since they are managing large and highly complex projects in their current jobs. These senior managers refuse to join an Offshore Center where they would only have opportunities to manage some small and peripheral projects.

Hence, the Offshore Center can recruit only mediocre performers with low experience levels, both in the technical and managerial ladders. The presence of such a weak team in the Offshore Center results in decreased productivity and output of the center. Thus, the cost-saving benefit of offshoring becomes quite low for the company.

Any company must realize that if its Offshore Center is expected to make any significant contributions, then it must have capable and experienced managers and technical professionals.

4. The basic purpose of the decision of the HO management to offshore only peripheral projects was that these projects would be successfully executed by what they assumed as “mediocre professionals” in the Offshore Center. The irony is that with all the factors discussed above, even such peripheral projects start failing in the Offshore Center!

Let us consider the example of an Offshore Center being offloaded only projects to maintain large legacy products of the company.

Since capable and experienced technical professionals and managers refuse to join the Offshore Center, their team then consists only of mediocre professionals with low experience. The HO management expects such a team to deliver on the supposedly simple maintenance projects.

The HO management fails to realize even maintenance projects can have some complex requirements, which the inexperienced and mediocre talent in the Offshore Center will fail to handle:

- Customers keep demanding additional features in legacy products. Some of these features can be complex, which can be implemented using only new, advanced, and complex technologies. Since the Offshore Center team lacks professionals with expertise and experience in advanced technologies, the team fails to deliver on these tasks.
- The project teams are supposed to fix bugs (defects) being reported in the legacy products. Customers keep changing the environment of deployment of the products and that can sometimes result in exposing some complex defects in the products. If such defects are reported, then the project team would need to have capable and experienced technical professionals who can understand the complete architecture of the product to make modifications to effectively solve the bugs, without impacting the functionality of the other features of the product. Unfortunately, the Offshore Center team would not have such experts among them and would fail to solve such bugs effectively, much to the displeasure of the customers.
- The management efforts required to effectively manage a maintenance project are no less than the efforts required to manage a development project. The project manager of a maintenance project needs to understand the new features requirements of multiple customers, collapse similar requirements of multiple customers into singular features, evaluate the impact of each of these features in consultation with the product management, select the set of features to be implemented, and manage the teams to implement these features within the customer-defined schedules. Further, the manager is continuously fire fighting multiple critical bugs being reported by key customers in the existing features of the product. He or she not only needs to manage resolving these bugs within very tight deadlines but also needs to use his or her strong negotiation skills to keep the customer’s concerns under control until the solutions are delivered.

These complex project management tasks can be fulfilled only by an experienced and capable project manager. However, since the Offshore Center fails to attract or retain such managers, its projects cannot be effectively managed. Thus, the team fails to deliver even on supposedly simple tasks of fixing defects and adding features to legacy products.

## **II. Techniques to convince Head Office to offload Core Projects to the Offshore Center**

Thus, the Offshore Center needs to be offloaded core projects to overcome the above mentioned challenges. The Offshore Center management should share requisite details with the HO management to destroy their myths of lack of excellent talent in their country who can execute core projects.

The Offshore Center management should share the following details to convince the HO management to offshore core and complex projects to their teams:

### **i) Showcase expertise and experience of the Offshore Center employees**

The Offshore Center management should share the profiles of their key and senior technical and management employees with the HO management, highlighting their expertise and vast experience in handling large, core, and complex projects. Even if these employees could not get opportunities to work on such core projects in the current company, they would have worked on such projects in their past companies, which should be highlighted.

The Offshore Center management should not only showcase the existing talent in the Center but should also highlight the expertise of excellent talent available in the industry in the vicinity of the Center, who can be attracted to join the Offshore Center in the near future.

The HO management will then gain confidence that the Offshore Center teams have the strengths and experience to execute core and complex projects.

## ii) **Gain advance knowledge of projects, to train talent**

The Offshore Center management should work closely with the HO management to get *advance information* on upcoming core projects of the company and should then prepare their teams for winning such projects. For example, the Offshore Center managers should work closely with the HO product management to get advance information on new key products being planned and should develop as much information as possible about the core features of these products. The Offshore Center managers should then train and groom their teams extensively in the business domains of these products and in the technologies to be used for implementing the core features of these products.

The Offshore Center team should then develop prototypes for some of the core features of the product that use new, advanced and complex technologies. Such prototypes will demonstrate to the HO management the fact that the Offshore Center team has deep expertise in complex technologies required to implement core features of the product.

Then, when the HO management decides to distribute the project tasks of developing such a new product among the HO and the Offshore Center, the Offshore Center managers can bid for implementing the core features of the product by highlighting the expertise developed by their teams and by demonstrating their prototypes. The HO management can then compare the strengths of the Offshore Center team and the HO team in implementing various core features of the project and will decide to offload implementation of these features to the team with better strengths to deliver them successfully. Since the Offshore Center team will have developed expertise in implementing core features of the product, implementation of a large number of these core features will be offloaded to the Offshore Center for execution. Thus, the Offshore Center management will be able to win core and complex projects for their teams.

Thus, the Offshore Center teams would always have a mix of core projects and some peripheral projects, similar to the HO teams.

## III. **Benefits of offshoring Core Projects**

Offshoring of core projects will result in multiple benefits for, both, Offshore Center and the global company as a whole.

The opportunities to work on core and complex projects would help motivate and retain capable and senior Offshore Center employees. Further, the Offshore Center can attract highly capable and experienced technical professionals from the industry by highlighting the challenges being offered on its core and technologically advanced projects. Similarly, highly experienced managers from the industry would also join the Offshore Center since they would get opportunities to manage large, core, and complex projects.

The Offshore Center can then build strong teams around these capable and senior professionals and deliver on complex and large projects. Since the Offshore Center teams would now be working on core and high-revenue generating projects of the company, they would significantly add to the revenues and profits of the company.

Further, the presence of these experienced and strong professionals would also help the Offshore Center to deliver on its peripheral projects by overcoming the challenges mentioned in Section I.

Section I discussed an example where the Offshore Center team working on a legacy product maintenance project was unable to solve critical bugs or implement additional complex features in the product. The reasons for such failures were that the Offshore Center could not hire or retain capable and experienced technical professionals who could understand the complete product architecture and apply their knowledge of new and advanced technologies to deliver on these tasks.

Since the Offshore Center would now also be running complex new product development projects, it would have been able to attract and retain a number of experienced and capable technical professionals to work on such core projects.

Whenever the inexperienced team members working on the maintenance project would have needed help on the complex tasks on their project, they could have easily asked questions from these highly capable core technical professionals. Since these core technical professionals have extensive expertise in advanced technologies, they would have easily helped the maintenance project team by providing them solutions to their problems. Thus, the Offshore Center would be able to successfully deliver on the maintenance projects tasks of resolving critical bugs and adding technologically advanced additional features to the product.

Further, Section I discussed the problems faced in successfully managing maintenance projects caused by the absence of experienced and capable managers in the Offshore Center. Again, since the Offshore Center would now have highly experienced and strong managers for managing core and complex new product development projects, these experienced managers can help and guide the managers of the maintenance projects in meeting their project management objectives. The managers of maintenance projects would then get the requisite support to allow them to manage their teams for successfully implementing additional features in the legacy products and for resolving the customer-reported critical bugs within tight schedules to the satisfaction of the customers.

Thus, the full potential of Offshore Center teams would be realized, and they would be able to successfully deliver on all their projects, ranging from core and complex product development projects to maintenance projects.

### About the author

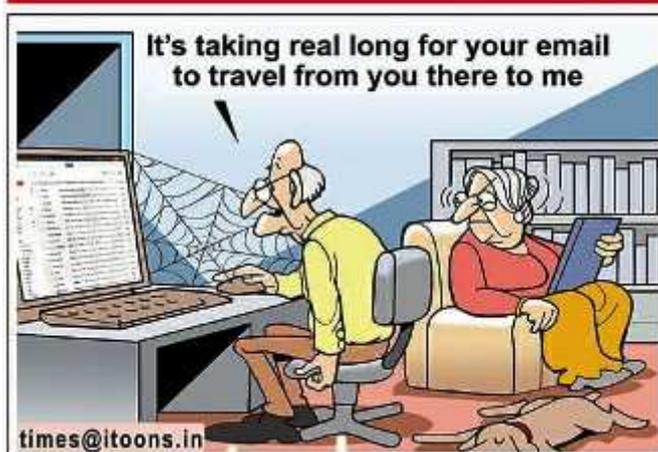


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iToons Sunil Agarwal & Ajit Ninan



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# Is India Future Ready?

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*Sharing my vision for India to become the Future-Ready and Future-Proof Nation in the world*

## History of Smart City or Smart Nation

The concept of a smart city dates back to 1960s and 1970s when the community analysis bureau started using computer databases, infrared aerial photography, and cluster analysis for data collection, issuance of reports and resource allocation to the areas that required them the most for fighting off potential devastations or reducing poverty. Since then, three different generations of 'Smart Cities' have emerged.

**a. Smart City 1.0:** In the smart city, 1.0, many cities enhanced their infrastructure using sensing technology and data analytics to efficiently manage the urban assets (public transit, water and waste systems, and roads). This connected infrastructure vision comprises the physical assets connected via sensor technology that will generate vast streams of valuable data from smart streetlights, parking meters, and even trash receptacles.

**b. Smart City 2.0:** The smart city 2.0, in contrast, is the dawn of the next-gen urban evolution. Some of the advanced forward-thinking cities began to go beyond mere infrastructure by tapping the wisdom of their visitors and residents. Therefore, the smart cities of tomorrow will involve not only the Government but also the visitors, citizens, and business in an intelligent, connected ecosystem developed on a sensor-based physical infrastructure.

**c. Smart City 3.0:** In the third generation of smart city 3.0, it focusses on enhancing the citizen experience by functioning at the intersection of the 3Ds - Data, Digital, and Design (human-centred). The objective its to enable better decision-making through the use of data for the respective stakeholders - Citizens, Government, and Business. The focus of any smart city became its people and providing benefits such as - Better quality of life; Economic competitiveness for attracting talent and industry; Focus on environment and sustainability. This model embraced a citizen co-creation to address the issues of equality and for building a smart community with social inclusion.

In a nutshell, a 'Smart City' is a city that has developed specific technological infrastructure which enables the city to collect, aggregate, and analyze real-time data and has made a concerted effort to use the data for improving the lives of its residents. Smart City initiative comprises of three key components - Information and Communication Technologies (ICTs) for generation and aggregation of data; analytical tools which convert data into usable information, and organizational models which encourage innovation, collaboration, and application of that information to solve public problems.

According to Harrison "Smart City is an instrumented, interconnected, and intelligent city. Instrumented referred to the collection and integration of real data in real-time from the use of sensors, applications, personal devices, and other resources. Interconnected referred to the integration of all such data into a computing platform that provides a set of services. Finally, intelligent referred to the complex elements, such as analytical calculations, modelling, optimization, and visualization of services for better operational decisions."

Although there is a lack of globally accepted definition, it is possible to describe the characteristic features of a Smart City, which services could improve its level or degree of "intelligence", and its essential aspects. The three main elements of intelligence are defined as follows:

a. The effectiveness refers to the ability of a city to effectively provide private and public services, such as citizens (senior citizens, workers, and students), corporate, and non-profit organizations. Therefore, a smart city is not in itself 'intelligent', but by the public value, it creates for its people.

b. Environmental benefits refer to improving the quality of the environment in big cities. One of the critical pillars of the smart city is to prevent degradation of the environment. Hence, it is necessary to conduct major studies regarding energy consumption, water pollution, air or traffic regulations. Therefore, a smart city must focus on these solutions to preserve the quality of the environment.

c. Innovation refers that a smart city must apply cutting-edge or next-gen technologies to improve the quality of the main components so that better services are offered. Therefore, technology is the central aspect of a city's intelligence.

Thus, the intelligence of a city's component can improve if they are transformed into innovative and effective tools which are not harmful to the environment. This offers the public value. However, the above three factors are not good enough to

increase public value. Hence creating public value should be the ultimate goal of a 'Smart City,' which requires that all initiatives and projects be targeted to the citizen. The concept of "Public Value" is complex and includes several dimensions.

- a. Creating both social and economic values that are different to unite at times, enter into conflict with each other.
- b. Creating value for different stakeholders, that might have various expectations that are not always compatible with each other.
- c. Building value regarding various dimensions of life in the city, which might also imply understanding what the priorities and real needs are?

According to the World Economic Forum, "India's economy will overtake the US by 2030 with a GDP of 46.3 trillion next only to China and also will be the world's youngest major economy. In just twelve years, India will undergo a startling transformation. By 2030, around 77% of Indians will be under the age group of 44, and most of those will be under 25. The country will also have more than 1 billion internet users. Every second, three more Indian go online for the first time. Consumer spending will quadruple, rising to nearly \$5.7 trillion in 2030."

However, the economy still faces significant challenges. By 2022, Due to its young demographic, there is a huge demand for massive employment. About 100 million new jobs must be created in the manufacturing and services sectors by 2030. To achieve this, more than half of Indian workers will need reskilling to close a widening skills gap and raise the participation of women in the workforce. India still has some of the most polluted cities in the world. India will need to boost spending on infrastructure and reduce growing economic inequality and ensure its fast-growing economy is inclusive.

### **Why and what is the need for building a Smart City?**

Today, the centuries-old model of cities are reaching their limits since the city growth is skyrocketing inequality. We are in a situation wherein the Economic, Political, and Social Environment is fractured. Many citizens distrust the official elected to act on their behalf, and the government red-tape is seemingly unable to provide effective and efficient services. Therefore, the crux of the problem; we continue to build and develop cities that are net contributors to the very issues we are seeking to solve. Our cities are getting bigger; the commute times are getting unreasonably longer; the impact on the environment is getting worse. So, what do we do? We build bigger roads and provide services further away from where people habitat and do not take cogent environmental action. This is a 'Global' challenge. Countries like India, China, and Africa vividly illustrate the need for 'Smarter Solutions' to deal with the massive population growth; rural to urban migration, and resource depletion. Therefore, there is an urgent need to transform our cities not just once, but continuously rapidly.

### **What does it take for India to be a future-ready city?**

We think being future-ready means embracing technology. It is the most powerful tool we have to improve infrastructure, help meet sustainability goals, enhance economic opportunities and raise the bar for the quality of life. However, India will have to lay down the plans for building a Digital Nation involving governments, the private sector and civic community to forge new partnerships; that means every Government, business, and industry should come forward to accelerate its digitalization efforts for developing solutions and capabilities that will propel the cities and nation forward.

*The key domains required for building a Smart and Digital City are as follows:*

**1. Smart Infrastructure:** Digital Management of Infrastructure: According to Cambridge Centre, "In a world where infrastructure is truly smart, sensing technologies are embedded in infrastructure, and the equipment or device interacts with it. These sensors are connected to a communication backbone which enables real-time data acquisition and analysis. The information gathered is analyzed, interpreted, and delivered as reliable, robust, and meaningful information to the infrastructure providers, who can then make better-informed decisions about the structural health and maintenance of their assets." The smart infrastructures comprise of several operators from different domains of activity, such as energy, public transport, public safety and security. They deploy and operate "Cyber-Physical Systems", that are data controlled equipment which interacts with the physical world. The usage of cyber-physical devices (software-controlled devices that interact with the physical world). Therefore, a Smart Infrastructure is a lens through which the future is seen. It is about the self-driving cars that recognize one another, bridges that can detect their own weaknesses, power grids that exchange data with home appliances, in a nutshell, all cyber-physical infrastructure system that makes cities smart through digital transformation. Smart infrastructure is the backbone of a city, driven by a wireless sensor network. Similarly, studies on power grids describe smart infrastructure as the backbone of the distribution grid made of an intelligent energy subsystem, a smart information subsystem and a smart communication subsystem that all work together to deliver desirable results such improved longevity, adaptability, and efficiency of services provided to the businesses and consumers. In short, Smart Infrastructure is a transitioning process from a state of stillness to a state of 'intelligence' which refers to the ability to improve the performance by responding purposefully to the changes in its environment.

Even though the industry is working towards building the smart infrastructure, there are potential barriers which require to be addressed:

- a. Government:** No overarching governmental structure exists currently to manage multimodal, multi-agency changes that are currently proposed or underway.
- b. Investment:** Greater smartness inevitably involves greater integration, which requires huge investments for changing or retrofitting the infrastructure
- c. Data quality and Management:** With the increasing need to share information, it is important to come up with standards to assess data quality and privacy concerns.
- d. Privacy:** There many different ways in which people provide information to get some value back.
- e. Vulnerability:** The price of connectedness may be vulnerable to new kinds of attacks. Hence, security and resilience need to be built into the systems.
- f. Lifetime:** Electronic sensors embedded into the physical environment can start to limit the lifetime of the infrastructure.

**2. Smart and Green Buildings:** Smart A smart building is any structure that uses automated processes to automatically control the building's operations, including heating, ventilation, air conditioning, lighting, security and other systems. A smart building uses sensors, actuators and microchips, to collect data and manage it according to a business' functions and services. This infrastructure helps owners, operators and facility managers improve asset reliability and performance, which reduces energy use, optimizes how space is used and minimizes the environmental impact of buildings. Green building (also known as **green construction** or **sustainable building**) refers to both a structure and the application of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from planning to design, construction, operation, maintenance, renovation, and demolition. This requires close cooperation of the contractor, the architects, the engineers, and the client at all project stages. The Green Building practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. In India, the percentage of respondents doing the majority of their projects green is expected to nearly double by 2021, from 28% to 55%. New green buildings in India is being driven mostly by environmental regulations and healthier buildings. The need for more public awareness about green is the top challenge faced and also the lack of educated green building professionals.

**3. Smart Farming:** Agro-Economy is critical for India's success of becoming a trillion-dollar economy. According to WEF, India is salient because, unlike its East and Southeast Asian neighbours, rapid economic growth has not been inclusive enough to reduce the numbers of Indians living in poverty. India contains the largest number of poor people in the world: 270 million, [according to the World Bank](#).<sup>(1)</sup> Employment growth is critical in low-productivity agriculture, which accounts for nearly three-quarters of the sparse population. However, automation threatens to create more unemployment. Public policy must be directed toward increasing the productivity of poor people rather than just offering handouts. As more young men are migrating from rural poverty to urban areas to seek employment, they are contributing to a rapid feminization of agriculture. Women, primarily dependent on agriculture, perform most of the backbreaking labour. Their low productivity in agriculture, itself increasingly affected by climate change, demands action by policymakers. Any transformation of agriculture requires removing the constraints on women. Digital India's strategic cornerstones, the Common Services Centres, are meant to provide access points for delivery of various electronic services to villages, to promote digital and financial inclusion, encourage rural entrepreneurship, and build rural capacities and livelihoods, offering a bottom-up approach to social change, particularly among India's rural citizens. New technologies enable small farmers to shift from input-intensive to knowledge-intensive agriculture. Precision agriculture can improve the timeliness of planting, secure the best market prices through market information and e-market reforms, provide fertilizer subsidies via direct bank transfers that eliminate or reduce the cost of financial intermediaries and improve agricultural extension.

Here is a case study of New Zealand on the "Futuristic Farms that will feed the World" which India desperately needs to adopt. If you need to feed the world in 2050 the next 40 years the world needs to produce the same amount of food as it did over the last 8,000 years which indicates the pressure on the food system. We are facing a considerable challenge. With the growing population, the change in consumption behaviour, the climate crisis; how do can we secure our food production? The real secret is sustainable production. It should be with fewer inputs, fertilizer, water, and pesticides. Otherwise, we will destroy our planet. The security of food systems is one of the world's most pressing challenges. The story of how a small country became an unexpected food superpower, and number two world's food exporter could be the solution to adapt to build a sustainable and greenhouse farming in India. [Link here](#) (2)

**4. Smart or Digital Education:** According to the Planning Commission of India, "Education is the most important lever for economic, social, and political transformation. A well-educated population, equipped with relevant knowledge, skills, and attitudes is essential for social and economic development in the 21st century. Education is the most potent tool for socio-economic mobility and a key instrument for building an equitable and just society. Education provides skills and competencies for economic well-being. Education strengthens democracy by imparting to citizens the tools needed to participate fully in the governance process. Education also acts as an integrative force in society, imparting values that foster social cohesion and national identity. Recognizing the importance of education in national development, the Twelfth Plan places an unprecedented focus on the expansion of education on significantly improving the quality of education imparted and on ensuring that educational opportunities are available to all segments of the society."

India's education system needs a quantum shift. The quality of education has a direct bearing on any economy. With some 240 million students or nearly 20% of the Indian population in school, their quality of learning or lack of it assumes significance for the competitiveness of the country. The ASER report shows that Indian children have a vast learning deficit. This poor learning outcome in India is despite the Right to Education (RTE) Act. Besides, India has the [third-largest](#) (3) higher education system in the world, after the US and China, according to the World Bank. However, in terms of expenditure per student as well as per teacher, India falls behind. In the last decade, access to higher education has improved as more IITs, IIMs and central and state-level universities have been established. However, this proliferation has also raised concerns about an imbalance between excellence and inclusion.

Today's students are exposed to digital technology right from birth and do best in an interactive environment – where learning is experiential and involves high levels of sensory stimulation. We need to build this as standard into India's curriculum. Rote learning, worksheets, and lecture-based teaching are no longer appropriate. At the same time, administrative tasks and processes have increased the burden on teachers. We must ease this burden, freeing our educators to focus on what they do best. We need our education systems to teach the skills Indians need for a 'Digital Economy'. Globalization and technology advancements are rapidly changing skills requirements. Tomorrow's graduates will primarily be employed as knowledge workers in our services-based economy. We need to give them the skills to succeed in this very different work environment. Moreover, we need to make the most of our dwindling talent pool, by offering world-class education to every Indian child – regardless of socio-economic status.

Smart and digital learning aims to provide a holistic learning methodology to students using modern technology to enable them for a rapid and fast-changing world where adaptability is critical. Smart education offers a paradigm shift in the way students access education. It is not just a change in the delivery of education; it is much more than that. With radical transformations in technology, the teachers of today can have a hard time processing what the future will be in the next 20 years from now. Smart Education solves this conundrum by using state-of-art technology, helping both teachers and students prepare themselves for tomorrow. A smart or digital education can be done in a physical or virtual environment or both. It can also be summarised as the use of smart devices to augment the learning outcome of the traditional education system.

A Smart/Digital, multi-disciplinary student-centric education system – linked across schools, tertiary institutions and workforce training, using:

- Adaptive learning programs and learning portfolios for students
- Collaborative technologies and digital learning resources for teachers and students
- Computerized administration, monitoring and reporting to keep teachers in the classroom
- Better information on our learners
- Online learning resources for students everywhere.

Therefore, Smart Education provides an opportunity to transform India's education system to - Empower teachers and administrators; Engage effectively with students, and build a workforce with high-value global skills to become future-ready.

**5. Smart Healthcare:** India's healthcare sectors has become the largest verticals both in terms of employment and revenue. Healthcare comprises Hospitals, Clinical trials, Medical devices, Telemedicine, Outsourcing, Medical Equipment and Health Insurance. The healthcare market in India is expected to reach US\$ 372 billion by 2022, driven by a rising income level, greater health awareness, increased precedence to lifestyle diseases, and better access to Insurance has created a strong demand in the market. The hospital industry in India is expected to grow at CARG for 16-17 per cent to reach Rs 8.6 trillion, which has created attractive opportunities.

The number of doctors has increased from 8,27,006 to 8,41,104 in 2017, enabling the rising Manpower. Last but not least, the world's largest Government-funded healthcare schedule - Ayushman Bharat the National Health Protection Scheme to support healthcare policies. The private sector has emerged as a vibrant force behind India's healthcare industry. Bringing in the blend of both international and national repute accounting for 74% of India's total healthcare expenditure. Telemedicine is also fast-emerging in India. Major hospitals such as Narayana Hrudayalaya, AIIMS, Apollo have adopted telemedicine service and have signed for many public-private partnerships (PPP). Further, the presence of world-class hospitals and skilled medical professionals has strengthened India's position as a preferred destination for 'Medical Tourism' globally as the cost of surgery in India is about one-tenth of that is in the US or Europe. India's competitive advantage also lies in the increased success rate of Indian companies in getting the Abbreviated New Drug Application (ANDA) approvals.

***Smart healthcare should cover the following:***

- a. Right treatments to be provided at the right time, in the right place, and for the right patient.
- b. Clinicians use technology to diagnose more accurately and treat the illness and deliver care.
- c. The ecosystem care delivery stakeholders communicate effectively and efficiently and use information.
- d. Patient data is centralized and accessible to the relevant stakeholders within the industry
- e. Patients are actively engaged and are informed in their treatment plan.
- f. New cost-effective treatment models make healthcare available for everyone, including those who can't afford.
- g. Improvement in efficiency reduces waste.

***The emerging technologies that could reshape healthcare are as follows:***

According to McKinsey report, "Healthcare innovation is occurring at an unprecedented pace. The Center for Drug Evaluation and Research in the Food and Drug Administration (FDA) approves double the average annual number of novel drugs as it did a decade ago. 11 Among the therapies approved in 2017, 15 were first-in-class, indicating that they had a unique mechanism of action; another 18 address rare or orphan diseases. Some could dramatically improve the precision of diagnostics and the ability to personalize treatments (for example, through biomarkers), which could help reduce the significant variability in outcomes achieved by standard therapies. In the past two years, genuinely individualized treatments have been approved, ones that genetically modify patients' immune cells to battle leukaemia and lymphoma. 12 Curative therapies could substantially alter the nature and length of the delivery system demands from patients with chronic illnesses, potentially creating downstream savings. Furthermore, the care delivery requirements of some novel treatments could make possible, more convenient and affordable care in or closer to patients' homes.

Novel drugs are just one of nine emerging technologies that are reshaping healthcare in multiple ways—how consumers access it, how and which providers deliver it, and what health outcomes are achieved. Some of these innovations are specific to healthcare; others are more advanced in nonhealthcare sectors but hold tremendous potential in healthcare.

**1. *Connected and cognitive devices:*** Portable, wearable, ingestible, and implantable devices can monitor health information, engage patients and their community of caregivers, and deliver therapies autonomously.

**2. *Electroceuticals:*** Small implantable devices can alter the nervous system's electrical impulses to treat a variety of diseases.

**3. *Targeted and personalized medicine:*** Novel drug therapies that use a patient's own cells or deliver targeted genetic material can often treat disease more successfully than small-molecule or protein-effector drugs can.

**4. *Robotics:*** Next-generation robots could enable minimally invasive approaches and ease the physical burden of surgeries. Advanced robotics could also expand automation beyond specimen and material transport within the hospital to facilitate instrument handling and other tasks within the operating room.

**5. *3D printing:*** This technology can produce customized, 3-dimensional structures composed of biological and industrial materials, in the process of creating organ replacements, personalized prosthetics, and precision medication dosages.

**6. *Big data and analytics:*** Platforms and applications that store, transmit, and analyze continuously expanding medical data sets can be used to identify patients who are candidates for highly targeted therapies. In the future, physiological data recorded by robots during procedures could be leveraged to improve both medical education and surgical planning. As more data becomes readily available—some sources suggest an annual growth rate in available data of 48 % —the opportunity to better collect data and translate it into actionable insights is increasing.

**7. *Artificial intelligence (AI):*** Technologies that convert analytical insights into cognitive engagement solutions can enhance diagnosis, improve predictive interventions, and optimize clinical productivity.

**8. *Blockchain:*** This decentralized digital ledger technology holds the potential (with clear and simple use cases 15 ) to enable more secure transactions, more confidential patient data sharing, and more democratized data access, which could allow other technologies to better leverage data (for example, provider directories that can be rapidly updated with new network structures).

**9. *Robotic process automation (RPA):*** The automation of repetitive tasks (including the majority of claims processing) via simple rules or heuristics has the potential to enhance productivity rapidly.

While we cannot predict precisely how quickly each technology will emerge and scale in healthcare, each has the potential to have a significant impact over the next five to seven years. Among the factors that will influence the speed of change are the pace of innovators, the appetite of incumbents for change, and the rate at which regulations adapt to technology."

One of the significant challenges in Health care is the workforce challenges that are being felt across more and more countries. Staffing shortages are evident in several hospital specialties (emergency medicine and geriatrics) and general practice; there are also growing nursing shortages across both health and social care. Compounding the problem is a scarcity of leaders with strategic, next-generation skills to guide and support the transformation to becoming patient-centric, insight-driven, and value-focused organizations.

What stands in the way of more rapid progress in the move toward augmenting today's workforce? One factor may be that many leaders of health care provider organizations anticipate that the scale and pace of change will overwhelm their workforce and complex current talent issues. What these executives may not be considering is that technology-fueled shifts

in the nature of work represent a tremendous opportunity to help resolve today's challenges and build tomorrow's capabilities and element the red-tapes and make "Healthcare affordable and available for everyone."

**6. Smart Mobility:** Smart mobility is a revolutionary and emerging concept in the way of thinking how we get around; that is Safer, Cleaner, and Efficient which refers to "zero carbon emissions, no accidents, and zero ownership." What is smart about sitting in traffic or missing the train? Smart urban mobility, however, can be smart, and increasingly it is the individual on the street who makes the difference. People fed-up with congested cities with carbon foot-prints are innovating smart mobility with next-gen mobile technologies and intuitive apps which integrate enhanced infrastructure, public transportation, and car-pooling services. Smart mobility's primary focus is also on the green environment - be it electric cars or more bike lanes. In a nutshell, smart mobility solutions cause less congestion, improved access to public transportation, and clean-air.

One of the pillars of economic development for any country is the 'State-of-art Transportation Network', is critical to the national infrastructure. However, it has been a significant cause of greenhouse gases and efforts are ongoing to reduce the carbon foot-print to address environmental issues and decrease their dependence on fossil fuels. India is still following BS-IV as against EURO 6 implemented in European countries, which is equivalent to BS-VI.

Government across the world is battling to tackle issues traffic congestion and the rising levels in pollution. They recognize that these factors are leading to a negative impact on society. With people spending an enormous amount of time in commuting, there is a need for developing a "Smart Transportation Network" powered by real-time traffic updates, forecast, automatic asset monitoring, and best route planning based on weather conditions. All this is combined under the umbrella of Smart Mobility. The focus has shifted from merely building new capacity to using the existing capacity intelligently by using the next-gen technology to optimise the current asset performance. In India, over 30% of the population lives in the cities, and this number is expected to rise to 87% by 2031. To support this phenomenal growing urbanization, it has become essential to have smart transportation systems. The study by NITI Aayog along with Rocky mountain institute found that with the help of an electrically powered, connected mobility system, India can save up to 37% of carbon emissions by 2030.

The Government of India (GOI) has an ambitious target to make India 100% 'Electric Vehicle' (EV) nation by 2030. Its various programs, including FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles), are the steps towards achieving this goal. The Government is allowing the adoption of smart mobility options by cutting down taxes on the lithium-ion batteries which are used in the EVs. Under the 'Smart India Mission', the GOI is committed to make more investments in public transportation systems and initiate transit-oriented development across 100 cities. This will make the transport network well-connected, energy-efficient, and also substantially reduce the pollutions levels. Nagpur, with its 200 EVs, including buses, taxis, e-rickshaw, and autos, has earned the tag of India's first city with electric mass mobility system. India's quest for smart mobility has made the country a hot spot for international companies to offer their latest technologies such as pod taxis, hyperloop, electric vehicles, cable cars and ropeways.

Advanced data analytics, autonomous vehicles, and smart systems are the critical technology/solutions for the future development of transport and operations. The roads and transportation system will be optimized, making the traffic smoother, public transport more reliable and comfortable — the air cleaner with less need for private cars. Three main elements characterize most new urban public transportation solutions: more on-demand transport, the highly-effective use of digital innovation, and more electric-powered options. Moreover, all of these solutions need a well-rounded concept that covers the "last-mile" to exploit every level of the urban environment. The best approach to effective urban public transportation will be a mix that offers plenty of choices to commuters. Cities are, therefore, exploring urban public transportation on all levels: at ground level, underground, and above ground. Often referred to as a "3D" transport concept, the idea is to utilize and harmonize all options to cut down on congestion.

#### *E.g., - Singapore Driverless Mass Rapid Transit (MRT)*

A growing number of residents (over [5.6 million people](#)) (4) and vehicle population (almost [1 million](#)) (5) motor vehicles) have brought Singapore's [Land Transportation Authority](#) (LTA) (6) and the Intelligent Transportation Society Singapore (ITSS) together to create an intelligent transport system to improve commuters' travel.

Singapore's Smart Mobility 2030 strategic plan is an example of a smart plan that focuses mainly on transportation. The project aims to be informative, interactive, assistive, and to use green mobility. The LTA and ITSS have outlined three key strategies to achieve their goals:

1. To implement innovative and sustainable smart mobility solutions.
2. To develop and adopt intelligent transport system standards.
3. To establish close partnerships and co-creation.

### ***Therefore, the road to the future of smart urban mobility:***

Whatever solutions a city will choose to solve its unique urban mobility challenges, the approach will be holistic, shared, and deeply embedded in digital technology. Only when planners embrace diverse ways of getting around, whether on e-scooter, above ground, or in an on-demand shuttle, will commuters feel free and enjoy moving through their city. Based on the innovation trends and disruptive forces in urban mobility, it is realistic to envision a future scenario when smart city residents and visitors enjoy a wider range of affordable, -multimodal, on-demand mobility options; and conventional cars and ownership practices are replaced by shared electric and autonomous vehicles.

**7. Smart Manufacturing:** Making India an intelligent and smart manufacturing hub through the, "Make in India" to "Make Digitally in India." The vision behind Mr Modi's flagship program "Make in India" launched in 2014 was a progressive step towards positioning India as the hub of manufacturing in the world. India's demographic advantage vs increased labour cost in China has presented India with a golden opportunity to demonstrate our strength in the manufacturing sector. However, in the roadmap of this initiative, there are underlying areas where the Government's attention is required to be diverted aggressively. Digital transformation of the manufacturing unit is one of the most critical aspects of it. In the pursuit of achieving operational excellence, the decision-makers of the manufacturing firms must have real-time data of their assets and processes. Manufacturing units are flooding existing systems with a plethora of data, and the process of converting this data into meaningful information through cutting-edge digital technologies is the fundamental goal of digital transformation. In 2012 General Electrics (GE) introduced the "Industrial IoT" (IIoT). IIoT applies IoT to manufacturing by integrating big data analytics, machine learning, harnessing sensor data and automation.

India has to move from manufacturing hubs of Industry 1.0 and 2.0 to Industry 4.0 or beyond. Smart Advanced Manufacturing and Rapid Transformation Hub (SAMARTH) - Udyog Bharat 4.0 is an Industry 4.0 initiative of the Department of Heavy Industry, Government of India under its scheme on the enhancement of competitiveness in Indian Capital Goods sector. The initiative aims to raise awareness about the Industry 4.0 amongst the Indian manufacturing industry through demonstration centres. Currently, there are four centres which include IITD-AIA Foundation for Smart Manufacturing; Center for Industry 4.0 (C4i4) Lab at Pune; Smart Manufacturing Demo & Development Cell at CMTI; and IISc Factory R&D Platform in Bangalore.

Indian Engineering Exports have been growing at 10% variation, but the Engineering Exports as a percentage of ASEAN and World Exports is stagnating at 0.8-1% over the last 15 years. This is because the majority of engineering goods originated from low or middle-level products. Department of Commerce, Ministry of Commerce and Industry has given to the apex engineering body, a mandate to set-up a technology centre to enable MSMEs to benefit from the various next-gen technologies. India also requires to close a quality gap faced with the best-in-class and leapfrogging to emerging technologies; which will enable export quality products. Hence EEPC India technology centre gains ground.

Smart manufacturing has been defined as the fully-integrated, collaborative manufacturing systems that respond in real-time to meet the changing conditions and demands in the factory, in the supply-chain network, and customer needs. Smart Industry is a synonym for Industrial transformation in the fourth industrial revolution within which smart manufacturing de-facto fits. Industry, the manufacturing business, manufacturing companies and even manufacturing processes are in full transformation. This is mainly due to increasing automation, [digital transformation](#), (7) the bridging of digital and physical environments (*as enabled by IoT or the Internet of Things*), evolving industrial and [manufacturing technologies](#), (8) the intensive usage of data/analytics, industry and manufacturing challenges, human, economic and societal evolutions and demands and the integration of information technology and operational technology (*IT and OT*).

The IISc is building India's first smart factory in Bangalore with a seed funding from Boeing Company. Bosch, a German auto component manufacturer, will begin implementation of intelligent manufacturing at its 15 centres in India which I assume is already launched. Digital literacy of India has shown significant pace in the last decade. Therefore, it is important to understand the Career

- ***Integration Between Data and Process*** - The most crucial aspect of digitalizing any unit is to define the complex process of machines through simple algorithms. The algorithms which not only explains the basics of the process but equipped decision-makers to apply cutting edge technologies like predictive analysis and digital twinning to improve the overall efficiency of operation.
- ***Interoperability*** - Interoperability and the IoT are prominent enablers for data collection and its better use by manufacturers. Many are investing heavily in tools for leveraging and analyzing this newfound asset. At the core of interoperability is the ability for users to access information from multiple sources in one seamless application.
- ***Faster time-to-value*** – The term coined by General electric endorses digital transformation by defining a standardized way to connect machines, data, and people with a consistent interface for superior user experience, dynamic scalability, and extensibility to grow functionality as business needs evolve

***Proposed Framework for Smart manufacturing Unit:*** Researchers and industry leaders around the world have been trying to integrate Cloud technology with manufacturing field. The impact is visible in additive manufacturing level but not so on

subtractive manufacturing. In the manufacturing field, different organizations use different software for their work. To sort this issue, a generic Cloud-based system approach can be understood from the below framework. The resistance towards new technology is an eventuality, and thought leaders in this industry need to penetrate this education through simple but effective frameworks.

**Conclusion and Future Direction:** Smart Manufacturing is in its early stage of development. Even though a good amount of research and development has been going on; its principal focus remained to the additive manufacturing sector and seldom in other industries like subtractive manufacturing. Also, the amount of research work happening in India in this area is far lesser as compared to other countries like China or the USA. Hence its widespread application is not made available yet. Since in Cloud technology everything is treated as a service, even small manufacturers or those who want to focus on core work only can use it by taking Cloud or Infrastructure as a service from third-party service providers. The system architecture proposed here is generic in nature and can be customized or modified.

There is an excellent future available in this field; many of the Smart Manufacturing platforms developed are still in the embryonic stages. With the use of IoT technologies, AI/ML, proposed for Cloud-based manufacturing systems can be further improved. One may integrate new technologies like IoT, along with predictive and preventive analytics, to make it more automated as the future variations, and possible applications are enormous.

**8. Smart Energy:** Digital transformation is transforming companies across diverse sectors, societies, and lives. All this is taking place thanks to the connected era of devices, intelligent systems, human-machine interface, and products. The same is true for the power sector as well, which was traditionally asset focused and utility-driven.

In recent years, the terms "Smart Energy" and "Systems" is used to express the approach that is broader than the term "Smart Grid." The Smart Grids primarily focus on the electricity sector; Smart Energy Systems take an integrated, holistic approach on the inclusion of more sectors (Electricity, Buildings, Heating, Cooling, Industry and Transportation) and enables for the identification of more affordable and achievable solutions for the transformation into future renewable and sustainable energy solutions.

India is the second most populated country in the world, contributing to 6% of the world's primary energy consumption. Due to rapid urbanisation and burgeoning urban population, there will be serious implications on energy consumption and subsequent carbon emissions. Cities face a series of complex interconnected challenges across different sectors (Mobility, built environment, waste & water management, and public services) and it is critical to re-look at these challenges by integrating the principles of 'smart energy management' for achieving sustainable and low-carbon urban development.

Managing the energy footprint of cities is one of the most challenging goals, and with the evolution and transformation of existing cities into smart cities, smart energy management thus becomes an integral component of urban transformation. India's urban population growing from 31.6% to 57.7% by 2050, there will be further implications on energy consumption patterns and subsequent GHGs emissions (UN, Dept of Economic and Social Affairs). Therefore, the task of managing and reducing energy-related carbon emissions is often challenging for urban developers and needs to be addressed in various sectors to ensure an integrated approach to energy management.

"Smart energy management (SEM) is a component of smart city development aiming at a site-specific continuous transition towards sustainability, self-sufficiency, and resilience of energy systems, while ensuring accessibility, affordability, and adequacy of energy services, through optimised integration of energy conservation, energy efficiency, and local renewable energy sources. It is characterised by a combination of technologies with information and communication technologies that enables the integration of multiple domains and enforces collaboration of multiple stakeholders while ensuring the sustainability of its measures."

The Government of India (GoI) has been developing policies and programs to guide the mainstreaming of SEM in urban planning. To meet the energy needs of citizens and reduce carbon emissions, the Indian Government has adopted a two-pronged approach, i.e., focusing on supply and demand. On the generation side, greater use of renewable energy, mainly solar and wind, is being promoted. On the demand side, efforts are being made to improve energy efficiency through a variety of innovative policy measures that fall within the umbrella of the 2001 Energy Conservation Law.

An uninterrupted power supply is a crucial element for the development of the Smart City. The smart cities mission focuses on reliable power quality, climate protection, and economic efficiency. Utilities have been analysing the existing network and planning for the modernisation of the distributed infrastructure. However, several other measures such as the replacement of conventional substations, quick-to-install, reliable, maintenance-free, and compact substations or e-houses; the replacement of overhead networks with underground cables; the use of intelligent switching devices, smart metering and billing, and smart electrical storage systems are required. The Government has launched several initiatives such as the National Smart Grid Mission (NSGM), the Ujwal Discom Assurance Yojana (UDAY) and the Integrated Power Development Scheme (IPDS).

India plans to implement the smart grid projects, promotion of electric vehicles, development of microgrids, the installation of grid-connected solar rooftop systems, training and capacity building, along with enhancing consumer engagement. Further, there is a pressing need for advances in geographic information system (GIS), mobile, and information technologies such as cloud computing and data analytics which could transform the utility industry. The Government also needs to formulate regulations for decentralised power and provide incentives for producing renewable energy to implement smart energy initiatives.

The way forward for achieving the integrated 'Smart Energy Management' is to a) Integrate policy governance and effective decision making. b) Government to provide better infrastructure and resources for technological advancements. c) Develop information, education, and communication (IEC) strategies for stakeholder engagement and management. d) Establish performance goals for effective implementation and monitoring. The conclusion is that the Smart Energy System concept represents a scientific shift in paradigms away from single-sector thinking to a coherent energy systems understanding on how to benefit from the integration of all sectors and infrastructures.

**9. Smart Banking:** Powerful forces are reshaping the Banking Industry - Customer expectations, regulatory requirements, technological advancements, economics and demographics are together creating an imperative to change. Banks today need to get ahead of these challenges and reinvent to win in the next era of 'Digitization.' Banks must not only execute on the imperatives of today but also radically transform to innovate themselves for the future. Today's challenges are that nearly most of the bankers view attracting a new customer as one of their top challenges over the next couple of years. Banks are hungry for growth and finding a new customer base. However, banks also recognise the need to deepen their customer relationships and focus on more specific customer outcomes. Therefore enhancing customer service is the number one investment priority for the banks globally. However, in the rapidly developing emerging and Asian markets, where big and established banks have less dominance. Bankers report that retaining existing customers and attracting talent in the face fierce competition and new market entrants are also the top challenges. R&D, Innovation and New product developments are the top investment priorities in these regions.

The Bank of Hindustan and the General Bank of India were established in the late 18th century but did not survive for very long. The British presidency government then established the Bank of Calcutta, Bank of Bombay, and Bank of Madras which were merged in 1921 to form the Imperial Bank of India. In 1955 it became the State Bank of India and is the oldest surviving bank in India. Several banks have been established pre and post-independence. In 1935 the Reserve Bank of India was established, and it was nationalized in 1949. That same year the Banking Regulation Act was passed, which authorized the Reserve Bank of India to regulate, control and inspect all banks in India. It also stipulated that RBI will have to authorize the establishment of any new banks.

Technological innovation began in the Banking sector back in the 1980s. Since the establishment of the ICICI Bank, digitization in the banking industry has been commendably fast. Banks offering many services over the internet has resulted in the growth of banking sector in India. Banks have been able to expand their customer base, provide additional services, and ensure that customers can handle a number of banking tasks over the internet in the comfort of their homes or offices. If you are a banker, online shopper, tech-savvy person or even a regular bank customer, you must have heard the word "digital banking". Interestingly, most people have a different take on digital banking. There is a lot more to digital banking than just a few features that we can see on the surface. Digital banking is converting the brick and mortar banks into more greener and efficient places to operate. There are a plethora of options that people can opt for when it comes to banking. Now people can check their bank account details, pay their bills online, transfer money to other accounts, and all of this can be done from the very comfort of their home. All that the people need for banking these days is an internet connection.

***When wearables become implants used for real-time payments, will the credit unions and banks still be consumer's primary financial institutions? To thrive in a dynamic environment, they should do this following:***

- a. Tune into the changing expectations and preferences of consumers.
- b. Embrace the full potential of Artificial Intelligence (AI) in personalisation and other financial applications.
- c. Keep up the pace with what the major brands are doing in and out of banking, relating to the consumer experience.

Tomorrow's banking consumers are the segment born between 1979 - 1995 called 'Millennials' who will become the largest age-based demographics, and retail banking providers should carefully note their preferences, and behaviour as they approach middle-age and their spending power would grow exponentially. Millennials have had access to smartphones for most of their adult lives. Generation Z can't remember life without these pocket-size digital tools since younger consumers are so comfortable with mobile technology. Hundreds of mobile financial applications such as Mint or Venmo have gained traction disrupting the status-quo in banking and have challenged the financial institution to keep pace.

Research has shown that the younger generation does seem to be brand loyal and tend to be even more faithful to "Convenience." Millennials or young consumers embrace a do-it-for-me culture - hence the label - "lazy"). Even older generations have adopted — and come to expect — “do-it-for-me” digital solutions across many aspects of their lives, from one-click purchases to ordering rideshares through Uber or Lyft.

AI has the potential for a multitude of practical applications in the banking industry. Already it is being used to reduce payments fraud, improve service through personalization, and assist consumers with financial decisions (e.g., investments). Banks and credit unions must embrace the AI-driven “do-it-for-me” revolution and take their place along with other consumer industries that have firmly embraced AI-related technologies.

Many large banking institutions are well along this road already. They recognize that financial institutions have a massive advantage in this emerging new world of AI. Banks and credit unions have a wealth of valuable consumer data drawn from account records and transaction histories. This data is the essential “raw material” that fuels artificial intelligence engines; it’s how AI creates more personalized, streamlined experiences across a range of devices and banking services.

Facebook recently said that it would allow users to transfer money through its messenger service. This is further proof that boundaries between banking and technology products are fast dissolving. Payment providers such as PayPal and Square have already made a mark abroad. The more popular payment firms in India reportedly have more users than the entire market of active credit card users. The marriage of technology with financial services can be seen in recent joint ventures between telecom companies and Indian banks to pitch for payments banks.

Indian banking regulators have been partial to traditional banks that they can control with reasonable ease. Moreover, they have been suspicious of other financial intermediaries because of fears that these shadow banks could threaten the stability of the financial system. Fintech or ‘Financial Technology’ has become a buzzword in financial circles through Fintech Partnerships. Fintech players the world over are challenging the status quo of the financial services industry by bringing in a fresh take on problems faced by customers, as seen through the lens of technology. The unprecedented growth in the fintech sector in India is a direct result of rapidly changing demographics and consumer behaviour, underpinned by the need for convenience. India is fast becoming a digital economy with over a billion mobile phones, 330 million internet users (c.94% on wireless devices), and 240 million smartphones.

The future generations might not have ever to visit a bank, and even if they have to, they might visit a small consumer-friendly digital bank cafe that runs on cutting edge technology. It is exciting to wonder what the future of banking might be. As of now, smart banking is making banking for us easier and making traditional banks who are adapting with next-gen technology, more relevant with each passing day.

**10. Smart Water and Waste Management:** Water resources are under pressure from continuing population growth and urbanisation, rapid industrialisation, and expanding and intensifying food production, particularly in developing countries and in urban areas. Urban populations may nearly double from current 3.4 billion to 6.4 billion by 2050. Growing population and climate changes sweeping across the globe have put untold pressure on water networks. According to UN, as of March 1st 2018, there were 7.6 billion human beings on the planet, and this number will rise to around 10 billion by 2035 – all increasing demand on precious water resources. An ageing infrastructure that is overly stressed by a rapidly increasing population, torrential rains and flooding is the root cause of leaks and bursts in pipes. Many Indian cities, including Bangalore, Mumbai, Delhi and parts of Haryana are already facing these issues. Not only does this water loss and contamination affect an organisation by increasing operational costs and failing to provide 24x7 water, but, it also has a significant impact on the environment. The solutions for putting an end to this water loss are furiously sought.

Smart technology in the water sector consists of four components: a) Digital output instruments (sensors and meters), which collect and transmit data in real-time; b) Supervisory Control and Data Acquisition (SCADA) systems, which process information, and remotely operate and optimise systems; c) Geographic Information System (GIS) which store, analyse, and manage spatial information and d) Software application, which support modelling infrastructure and environmental systems by managing and reporting data to improve design, risk management, and decision-making. Today almost three-quarters of the world's waste ends up in landfill, imposing enormous environmental costs and squandering opportunities to extract value through recycling and reuse.

The improvement of the urban waste collection service and, in general, the achievement of more efficient management of the waste, is one of the main challenges that the cities face, mainly due to the population growth. Thus, smart waste management is a critical factor in smart cities.

Within the public services – priority element of a smart city – waste management, is a fundamental pillar. To understand its importance, we must take into account that the management of urban waste is composed of different stages, from the collection and transport to its treatment. Being the collection the critical factor to achieve this efficient management of municipal waste for two reasons, its costs and its logistic component. Mainly, we must focus on reducing costs, as it is [exceptionally costly](#), since it involves many workers and vehicles as well as improving the planning of waste collection, since having a high logistical component, allows a wide margin of improvement through solutions that business intelligence can bring.

According to Swachh Bharat Mission (Urban) data for 2018, 43% of the total urban wards in India are now segregating their waste at the source (Sambyal & Agarwal, 2018). In 2017, door-to-door collection coverage increased from 53% to

80% (ibid.). In cities such as Panaji, Indore, Mysore and Muzaffarpur, there is a waste separation system, wherein separated waste is brought to the processing centre. Then, compost is made from wet waste, while only inert waste goes to the landfill. Sambyal (2016) elaborates that Alappuzha in Kerala prioritises segregation and reuse of waste at the household level, making it one of the cleanest cities in India. It has accomplished decentralised waste management; 80% of the households now own biogas plants and pipe composting systems. As part of the Clean Home Clean City programme, Alappuzha launched Thumburmuzhi in 2013, a model aerobic composting plant that composts animal carcasses (Sambyal, 2016).

A key challenge facing the waste sector in India is the need to increase the workforce at the collection level. Waste segregation is a significant obstacle and remains a daunting task. Despite the existing intelligent mapping and routing technologies, the segregation of waste, especially at the household level, is still limited. The sector requires a higher utilisation of economical and user-friendly technical solutions. Another core issue in the sector is the lack of accountability and transparency resulting from the monopoly and control of a small number of private companies. Due to the limited knowledge of stakeholders (sometimes corruption) and the lack of innovative solutions, the methods used are not the optimal for effective waste management. Therefore, it is important to develop capacity building and awareness programs for responsible authorities and relevant citizens to respond to behavioural changes and incorporate smart practices into the waste management sector.

**11. Smart Governance:** Smart governance or good governance are two sides of the same coin. The use of the internet and digital technology is creating a progressive government- public partnership, strengthening government institutions and integrating all sections of society. Information and Communication Technology (ICT) has become an integral part of our lifestyle. Without the internet and digital technology, modern lifestyle is unimaginable. Whether it is transportation, telecommunications, healthcare, security, education, almost every segment of society is dependent on ICT. E-governance and involvement of the public in decision-making process is the most important aspect of smart governance.

'Smart city governance' contributes to developing a framework for building new, smart governance models addressing the challenges of the digital society, collaborative governance, information sharing, citizen engagement, transparency and openness. The diverse ecosystem of stakeholders requires smart cities to define governance clearly. City leaders, regional governments, transportation districts, corporate and non-profit partners and, depending on the funding model, state and federal agencies may all participate in establishing and executing a smart city vision. Stakeholders should be able to articulate their responsibilities and ensure that appropriate information flows to the right decision-makers. Establishing accountability upfront and creating mechanisms to drive timely decisions are also critical. Therefore SMART refers to :- S = Standardizing, M = Monitoring, A = Accounting, R = Rethinking, T = Transforming.

*According to the Smart City Guideline, The strategic components of area-based development in the Smart Cities Mission are city improvements (retrofitting), city renewal (redevelopment) and city extension (greenfield development) plus a Pan-city initiative in which Smart Solutions are applied covering larger parts of the city.*

**a. Retrofit:** Retrofitting will introduce planning in an existing built-up area to achieve Smart City objectives, along with other objectives, to make the existing area more efficient and liveable. In retrofitting, an area consisting of more than 500 acres will be identified by the city in consultation with citizens. Depending on the existing level of infrastructure services in the identified area and the vision of the residents, the cities will prepare a strategy to become smart. Since existing structures are largely to remain intact in this model, it is expected that more intensive infrastructure service levels and a large number of smart applications will be packed into the retrofitted Smart City. This strategy may also be completed in a shorter time frame, leading to its replication in another part of the city.

**b. Redevelop:** The redevelopment will effect a replacement of the existing built-up environment and enable co-creation of a new layout with enhanced infrastructure using mixed land use and increased density. Redevelopment envisages an area of more than 50 acres, identified by Urban Local Bodies (ULBs) in consultation with citizens. For instance, a new layout plan of the identified area will be prepared with mixed land-use, higher FSI and high ground coverage. Two examples of the redevelopment model are the Saifee Burhani Upliftment Project in Mumbai (also called the Bhandi Bazaar Project), and the National Building Construction Corporation is undertaking the redevelopment of East Kidwai Nagar in New Delhi.

**c. Greenfield:** The greenfield development will introduce most of the Smart Solutions in a previously vacant area (more than 250 acres) using innovative planning, plan to finance and plan implementation tools (e.g. land pooling/ land reconstitution) with provision for affordable housing, especially for the poor. Greenfield developments are required around cities to address the needs of the expanding population. One well-known example is the GIFT City in Gujarat. Unlike retrofitting and redevelopment, greenfield developments could be located either within the limits of the ULB or within the boundaries of the local Urban Development Authority (UDA).

**d. Pan-city:** The pan-city development envisages application of selected Smart Solutions to the existing city-wide infrastructure. Implementation of Smart Solutions will involve the use of technology, information and data to make infrastructure and services better. For example, applying Smart Solutions in the transport sector (intelligent traffic

management system) and reducing average commute time or cost to citizens will have positive effects on productivity and quality of life of citizens. Another example can be waste water recycling and smart metering, which can make a substantial contribution to better water management in the city.

*To summarise, for India to become "Digital India" the following framework needs to be followed - Digital Economy, Digital Government, Digital Industry, and Digital Society by Accelerating digitization of existing sectors; Competing by integrating the ecosystems to grow India's competitiveness and foster new ecosystem that is digitally enabled; Transforming by developing the next-gen digital industry as the growth engine.*

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### Smart Banking:

- <https://techtzpah.com/iot-financial-services-industry-fsi-introduction/>
- <https://techtzpah.com/internet-of-things-iot-retail-banking-2020/>

## About the author



Rajashree Rao (Shree) is a globally acclaimed Industry Thought leader, visionary, advisor, principal consultant, and mentor in next-gen technologies - AI, Cloud Computing, Data Analytics, Robotics, Industry 4.0, IoT, IIoT, Blockchain, and Smart Cities/Nation across industry verticals. After working for 20 years in the corporate across the regions, she is back to her roots to venture onto the next biggest growth market in the world. Shree brings with her the diverse industry experience of working with IBM, Intel, and SAP, leading and influencing the technology adoption within the Singapore Government and Public Sector for building the Smart City and Smart Nation Initiatives in the APAC region. Shree has recently joined Rolls-Royce as the Head of Partnerships and Ecosystem (APAC) at R<sup>2</sup> Data Labs based out of Bangalore. Shree is a passionate technologist who challenges the industry and technology providers to innovate and think out of the box since she believes that Technology's principal goal is to enable an individual, organization, city, or a nation to retrofit their existing system/business model/solutions/infrastructure, which will empower and transform the way people live, and work in the era of digital transformation.

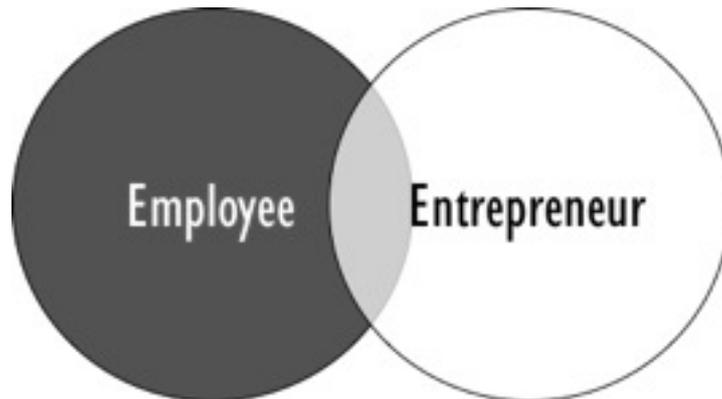
She also holds various awards for having built trusted Business Partner relationships. Shree is also an enthusiastic and fervent Speaker and Writer in the Next-Gen Technologies (<http://www.techtzpah.com/>) Leadership, Entrepreneurship, Life-lessons (<https://zenlighted.wordpress.com/>), and Self. Shree is a Graduate (Hons.) from Bangalore University in Business Management and has a diploma in Computer Science - Ecommerce. She enjoys international travel, cooking and is in the constant pursuit of the spiritual. She is also passionate about women's empowerment and spends her free time working with women and women's organizations.

# Employee or Entrepreneur

**Mr. Sudeendra Koushik**  
Chief Innovator & Co-Founder PRASU  
[sudeendra.koushik@ieee.org](mailto:sudeendra.koushik@ieee.org)

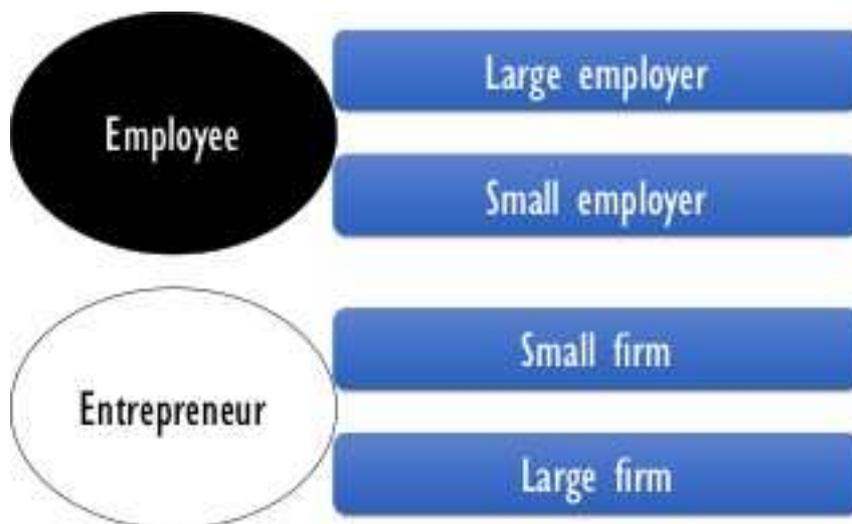
There is a clear need to clarify what it means to be an employee versus to be an entrepreneur. Very often young students or experienced professionals, are unsure which path to follow. Given the situation in India and the increasing number of start-ups this question is more common now than a few years ago. The situation can be a very confusing one for experience professionals and young professionals alike as they look to find their sweet spot. The working professionals wonder if they should to continue as an employee or find their way as an entrepreneur. The graduating students are under pressure to choose between a job and a starting a start-up, in addition to the questions from their parents and family.

There are some similarities between being an entrepreneur or an employee. Some of the skills and attributes are common. Obviously there are many differences too between them.

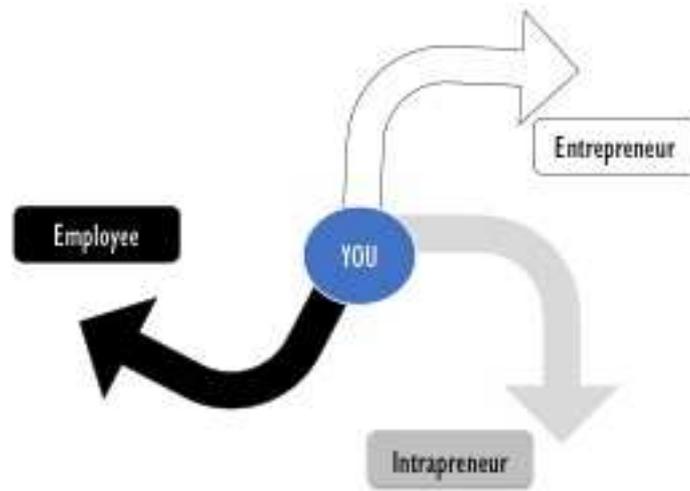


Having said that it is not a simple choice to make. Whichever choice one makes, it can keep coming back to the point to assess whether the other path would have been better. Making a choice between them is tricky to many. And keeping that choice can be even more tricky for many, depending on the circumstances of their employment.

As an employee one can be working for a large or a small employer. Similarly as an entrepreneur though everyone starts small, one can exercise the choice of growing or not. In the process one can stay relatively a small firm, which can happen with a consultancy firm or one can grow their venture into a large company.

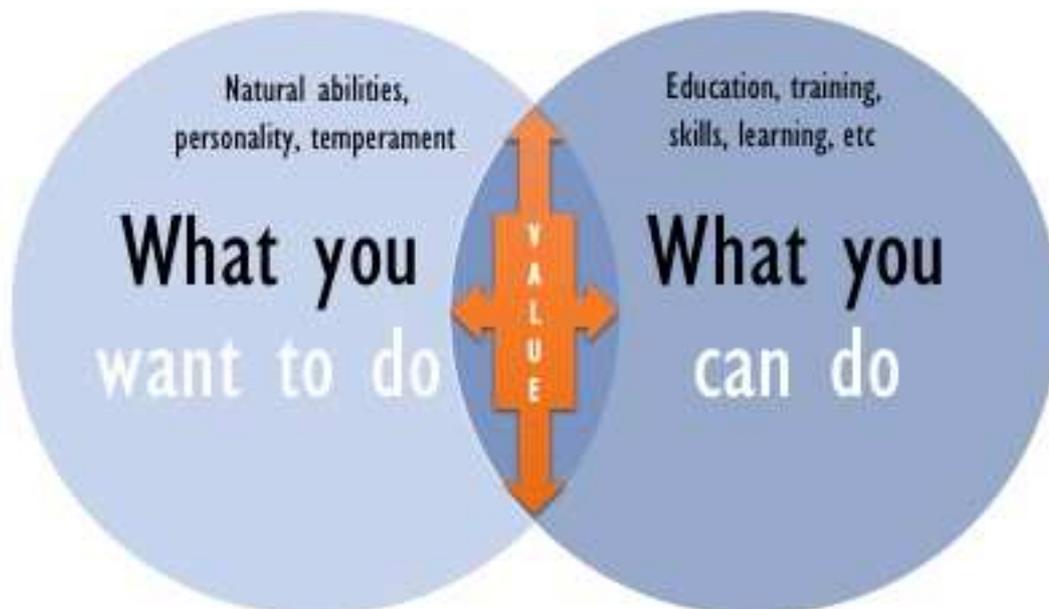


That essentially offers three paths – Entrepreneur – of a small or large company, Employee of a large or a smaller firm and Intrapreneur in an organisation, typically of larger size.



The essential difference between the three roles is the mindset. The key point is how one sees a given situation as at any given point of time. A typical employee sees a risk more often than not while an entrepreneur looks at the same situation and spots an opportunity.

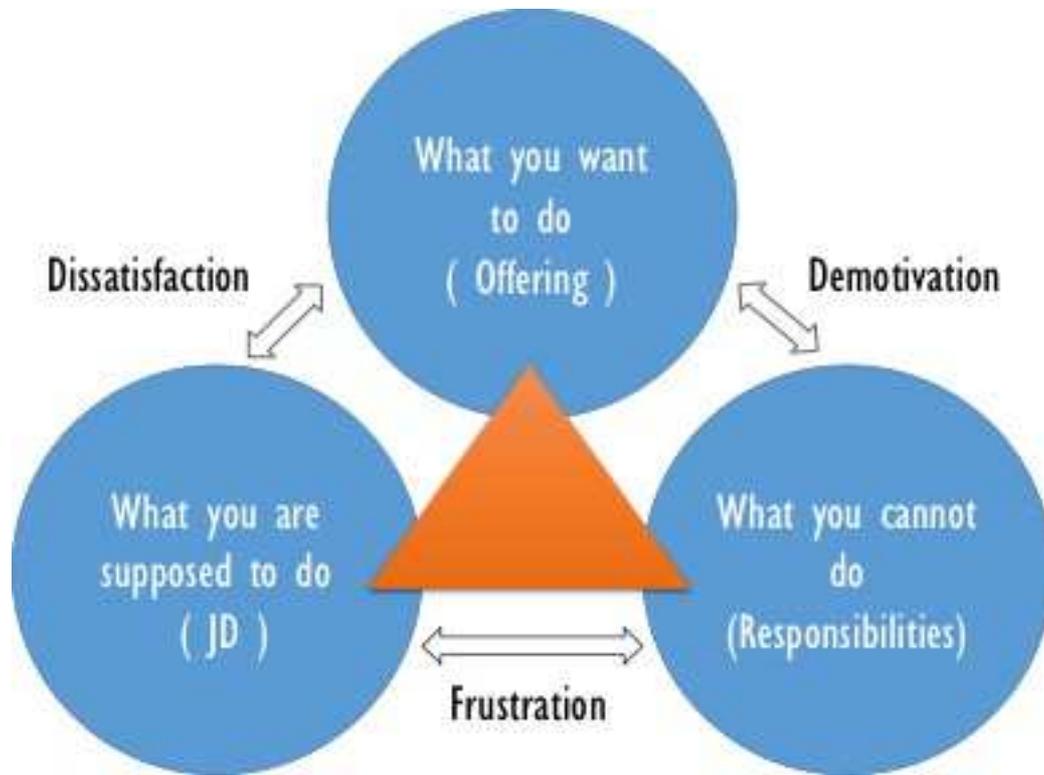
The starting point to make a choice should be knowing very clearly what you can do and what you want to do. The overlap of these two aspects creates the value you can create. The former is about the skills, learning, training etc and the latter is about your temperament, natural abilities, preferences, personality etc.



From there one needs to know what value they offer and combine with what the needs are. The intersection of these two aspects determines the worth of your choice. As an employee what you offer has to match with what is needed by the employer. As an entrepreneur what you make should be needed by the market.

What's in it for me is crucial in both aspects. When this fit is good, the stability of the choice is higher. As an employee what you give could be time and what you get could be money. An entrepreneur what you give could be more than time and you could more wealth in return than an average employee. But the relationship between what you give and what you get is not linear in both cases on being an employee or entrepreneur. For an entrepreneur the curve can take many forms from very good to very bad returns.

Having a good job description for either an employee or entrepreneur is key. If what you want to do doesn't match to that job description, it leads to dissatisfaction in your role which eventually leads to poor performance. If you cannot do what the job demands, then it leads to frustration. This when the other side looks greener. On the other hand if you cannot do what you want to do this will make room for demotivation which ultimately makes you dysfunctional in that role.



The professional growth is more rounded as an entrepreneur and mostly this is needed to be an effective entrepreneur. However as an employee the skills and professional growth is close to your areas of responsibility.

There are many parameters that separate entrepreneurs and employees such as salary which is not guaranteed, fixed or even regular, absence from work needs more planning, working hours which can be as many hours needed as an entrepreneur, guarantee of income and even guarantee of work, career path, designation that won't change much as an entrepreneur, stress levels because of the previous points, risk and reward equation which are skewed towards risk for an entrepreneur and most importantly decision making process is very heavy for an entrepreneur compared to a typical employee.

The skills needed are aligned though not in depth. Some of the skills that are key to making the choice of being an employee or entrepreneur are leadership, negotiation, strategizing, marketing your work, customer management, regulatory awareness, dealing with ambiguity and ability to stay connected to society and social life.

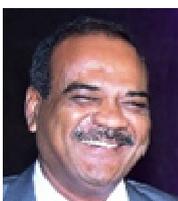
There are more differences between being an employee or entrepreneur. Freedom and responsibility is one important difference, security of money and wealth and growth along with risk and reward is another differentiation.

If employment helps you manage a living, entrepreneurship helps you manage life. While employment is about what you can do, entrepreneurship is about what all you can do. As an employee you give a slice of yourself, while as an entrepreneur you give yourself because employment is mainly about a part of your time and entrepreneurship is about your entire energy.

Before making a choice one should identify a role, a role model and very clearly understand why that role and role model resonates with them. They can then experiment even part-time to get a real feeling of what they think is true. One should also be very clear what they bring to the table and that has to be real value added stuff. There should also be a clarity of what their growth plans are which can help decide to be an employee or an entrepreneur.

What one should avoid doing is to change from one to the other when they are unhappy without knowing the reasons for that or when they are unsure.

#### About the author



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- Chief Innovator & Co-Founder PRASU (Innovation Consulting company), [www.PRASU.biz](http://www.PRASU.biz)
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- Member Board of Governors, IEEE Technology & Engineering Management Society (TEMS)
- Chairman IEEE Technology & Engineering Management Society (TEMS) Bangalore and India

- Vice Chairman Industry Activities IEEE India Council
- Chairman IEEE Bangalore 2018 / Member Asia Pacific Committee on Innovation
- TEDx <https://www.youtube.com/watch?v=gSedDHKEtKA/>
- LinkedIn <https://www.linkedin.com/in/sudeendrakoushik>
- Book <https://www.amazon.in/Conversation-Innovator-You-Sudeendra-Koushik-ebook/dp/B01N3AJOXN>

Mr Koushik has been a passionate and practicing Innovator & technology professional throughout his career of 26 years, with more than 20 national & international patents in various stages. Koushik has served in Philips Global Development Centre, Singapore, Philips Advanced Systems Laboratory & Philips Innovation Centre, Eindhoven, The Netherlands, Philips Innovation Centre, India, HCL as Practice Director Innovation, and TTK prestige as Vice-President and Head of Innovation.

As the Chief Innovator and co-founder of PRASU, Mr Koushik advises major companies such as Bosch, Continental, General Motors, Mercedes Benz, Volvo etc. on Innovation & also links academia and Industry through workshops and technical talks on Innovation, and has developed a syllabus for academia.

Areas of specialisation: Innovation for Business, Innovation Strategy, Intrapreneurship, IP & Patents, Technology & Innovation Competence Management, Converting ideas to new Products and Services, Product design, Product Development & Realisation, Mentoring start-ups, Technical Manager Mentoring & Coaching

### *Related Readings*

**The Atlas of Innovation for Economic Stability:** The Atlas of Innovation for Economic Stability presents 63 examples of policy, program and technology innovations that promote economic stability for individuals, communities, firms and countries, with an emphasis on the welfare of poor and vulnerable people worldwide. We found strong and diverse innovation in India, Kenya and the United States. Indonesia stands out for the use of data and innovation tools in government, and Brazil ranks high for public safety-related domains. The majority of innovations are privately provided and enabled by mobile technology and data, although we identified several pockets of significant government and donor participation in catalyzing or scaling innovation. This publication was funded by The Rockefeller Foundation. To download / see an interactive report <https://www.fhi360.org/resource/atlas-innovation-economic-stability>

**18 pros and cons of being an employee vs. being an entrepreneur:** Both being an employee and being an entrepreneur have their own advantages and disadvantages. Entrepreneurs are often portrayed as happy and free, risk takers that have the benefits of controlling their own time and income. They often have uncapped potential earning and can jump from industry to industry using and developing business skills that ultimately add to their success and experience.

In the real light of day though, many entrepreneurs fail. They don't have the guaranteed income and work available that a contracted employee can enjoy. Unfortunately, they often don't have a team of colleagues to rely and depend on, a paycheck to cash at the end of every month, a company car and medical insurance, and a chance of career progression within the same company in exchange for years of service.

From the complexities of registering your company through to arduous tax returns, failures, fallouts and business pitfalls. The life of an entrepreneur is not as star-studded as people would believe when they see the word appear in the press. However, the diversification available to those that chase their dreams with new inventions and madcap ideas can often lead to self-satisfaction and an abundance in confidence that will help across all areas of life. In today's western society there is more and more opportunity for people to succeed and thrive as a freelancer and entrepreneur. The growth of the internet, remote working and artificial intelligence ... Along with the advancements in broadband and WIFI technology are making international freelancing easier and easier. Below we'll discuss the advantages and disadvantages available to both the entrepreneur and the employee. Full Post at <http://bit.ly/2kWXmj8>

**12 Important Differences Between Employees and Entrepreneurs:** There are two types of workers in any organization: Workers with an Employee Mindset & Workers with an Entrepreneurial Mindset. Some people surround themselves with the pre-planned deadlines. Some people prefer to work on their pre-planned future goals. It does not matter whether you are working for a company or not. What matters most is your mindset. On the basis of these two categories, let us look at 12 major differences between an Employee and an Entrepreneur. Full Post at <http://bit.ly/2kMe1Gc>

**30 Ways to Become a More Successful Entrepreneur:** Owning your own business gives you a sense of freedom and empowerment. You can build things and watch them grow. Entrepreneurs make decisions for themselves, realize their creative visions, and develop lasting relationships with other entrepreneurs, customers, and vendors. It's a great way to live. That's why I've founded so many companies — I can't get enough. That's why I've put together these tips to help you to become more successful. Full Post at <https://neilpatel.com/blog/become-successful-entrepreneur/>

# How to bridge the gap between Employability & Employment - A thought

**Dr. S. Sridhar**

Ex. President and Vice Chancellor, Dr. K. N. Modi University, Rajasthan

[drssidhar@yahoo.com](mailto:drssidhar@yahoo.com)

1. Hypothesis: Every admitted student is capable
2. Present situation: Normally engineering courses cost about 8 Lakhs for 4 years in private colleges. After finishing the course there is no guarantee of getting good job ! After the course, getting a job with salary 20k pm is also waste , as compared to money spent for the course. Today even science degree or Arts degree students get 20k in many clerical govt jobs or digital online jobs.
3. My thought: First two years the fundamental subjects related to the discipline with outcome based education method, are to be taught. Next two years the students should have the option of selecting only industry oriented skilled courses with hands on experience by Industrial experts under Industry Institutions Interaction basis with placement oriented way. To achieve this, institutions should follow the method of NTU, Singapore, where every Professor is Director in 4 or 5 companies and thereby the students can be easily packed with jobs. Institutions should have more funded Labs by industries, carry out industrial projects in the form of consultancy work and thereby the students are to be associated with projects execution from third year onwards. The computing power in the institutions should be utilised for product developments with research focussed projects useful for society.
4. For higher studies aspiring students, more research focus should be given by doing creative and innovative work from 3rd year onwards under the guidance of a Professor, by publishing papers in Scopus indexed journal or web of science to meet the standard , so that they are ready for PhD programmes further as per their expectation.
5. For entrepreneurs, special focus similarly has to be given through establishing incubation centres, and gradually creating a company with short term and long term goals. This is the need of the hour today!

Conclusion : Admitted student is placed with decent job or packed for higher studies or developed as an entrepreneur through the aforesaid method !

## 6. Views of different Stakeholders :

**Annette Indralal:** <https://www.linkedin.com/in/annette-indralal-a516aa84>

In my opinion, Skill development is very important for every graduating student. If given the industrial exposure, the student will be very clear in choosing their field of interest. Instead of the traditional lab experiments there can be a way to interact with relevant industries and the opportunities that each subject has out in the market. Also faculties should take the initiative and interest to be more than a teacher (mentor, trainer, interactive discussions about the present situation in the industries, career guidance, etc).

## **Vineeth A: Executive member at CSD ROBOCON NITK**

But the problem is , after 2 years of studying engineering subjects(in current methods) many BTech students including me are in no position to judge themselves that whether they want to go to higher studies or industry or become an entrepreneur . If such person chose either of them , one would be narrowing down his/her path and may be what if like he /she wanted to persue other as their career . So I guess , college environment in the first two years must be modified and then if govt installs this type of education you have suggested , that would be really great for one's future including the nation's.

**Koushik CV:** <https://www.linkedin.com/in/koushik-cv-b24297ba>

I swear by OBE and I have been propagating the concept through training hundreds of engineering college faculty! I agree with your approach that OBE is the most effective way to match industry skill requirements with student competencies! It is applicable not only to the engineering and related courses but also to all other instructional activities that involves learning! It is the most effective way to mould students to the precise requirements of the outside world, be it placement, higher studies or entrepreneurship! I suggest that UGC or other designated authority must develop primers/learning resources for engineering faculty and students to refer to and become more conversant with the OBE concept!!

**Suraksha R V:** <https://www.linkedin.com/in/surakshary>

OBE is what exactly we need Sir. I think our focus should be on getting corporate ready. We need to implement everything we learn or else it'll be a waste. For getting ready for employment, we need to do live projects as and when we learn. In the first year of my engineering, we learn subjects that we aren't interested in despite choosing a specific branch. A CS or IS student studying mechanics and other branches' subjects is waste of time. They are basically studying them just to pass that semester. So it's of no use. And hence, I think this system in which we study something not related to our branch isn't productive, I believe. Also, many don't know the importance of internships in the first year itself. So, the college should spend some time, once in a while in creating awareness about this among 1st year students and also guide them in landing internships.

**Siva Kumar:** <https://www.linkedin.com/in/siva-kumar-62a4a535>

To be frank I really wanted to comment on one of your post I saw recently. It was about restructuring the engineering curriculum. I'm an M.Tech student from IIT Kanpur in Aerospace engineering with a specialization in propulsion. It is very difficult to get an admission in IITs, and come out from there with a degree. Still I am unemployed, looking for jobs. And not just me, placements were very less, this year only 3/10 people got place from propulsion. Out of these three 2 are placed in coaching institute. We are coming in iits with big aspirations, and now.. In a nutshell, our educational system needs to rethink about structural change for engineering academics. we are not scientist to learn everything. We are engineers, we build things. Outside india, there is very good tie up between industry and academia where students are part of many industrial projects and by working with them they will gain the experience, where in India the professors are actually selfish, making the students to work for their personal scientific research gains, and to get more paper work published and for their growth. Thank you sir, and have a great day ahead.

**Shivam Nagpal:** <https://www.linkedin.com/in/shivamnagpal>

I agree with your thoughts on outcome based education. It will help students to figure out their area of interest to work much earlier and they can strengthen their skills. Students will get a gist of work they will be doing in future. It will also help Industries as they will be more confident about hiring students.

**Sanjay Adhikari, Founder at Embedkari, Bengaluru, Karnataka, India**

Great advice Sir . I got one from Aman Goel today with excellent study plan for CSE students <https://embedkari.com/2019/07/30/advice-for-those-cse-students-who-learned-nothing-in-college-but-now-wish-to-work-at-google/>

**Namratha M, Research Scholar at NIT Trichy**

1. Outcome based education main impact would be better quality of placements 2. Projects would help students explore new things 3. Students are exposed to the industry environment and hence it is easier for them to adjust to their work culture 4. Skill set of the student is strengthened further.

**Ramchandra Palakodeti, Sr Consultant at CCiTRACC ; Sr Mentor for Career Development & Sr Life Planner, Hyderabad, Telangana, India**

Its the way to go and we need to address "how industries especially the likeminded and good ones can cope with so many thousands of graduates" how are they going to accommodate so many students ? We have to figure out this to make it practical and feasible

**Venkata Ramana Ratnakaram, Chief Information Technology Officer at Candidbrains, Hyderabad, Telangana, India**

#candidbrains has been established based on the similar strategy. We are providing employment skill training on Information Technology. We are going to hit the market in 2020 to disrupt education, learning and recruitment domains

**Prof.(Dr.) Devendra Pathak, Vice Chancellor at Om Sterling Global University**

Very practical solution in the contemporary crisis of galloping unemployment. Your suggestions open up two- pronged possibilities of job and self-employment.

## Rajesh Khanna, Professor at Thapar Institute of Engineering and Technology, Patiala, Punjab, India

Outcome based education plays an important role for student as well for instructor. Instructor can align his teaching and assessment methods easily by using course learning outcomes. As per your hypothesis the program level outcome will help student to choose right path. In all these cases the outcomes should be clearly observable and measurable.

### About the author



"Best Scholar " awardee by Department of Technical Education, TN Govt on 24th Aug., 2010 by Hon'ble Minister of Higher Education, by appreciating educational and research activities, with a cash prize of Rs.25,000/- & a certificate

- Ph.D (1984) from the School of Computers and Systems, JNU, Delhi, India
- Guided so far 20 PhD scholars and all are awarded degrees
- Published so far 178 research papers in national / international journals / conferences
- Total experience 41 years in Education, Research and Industry. Worked as Vice Chancellor in 3 universities
- Carried out 42 Software and Hardware projects for Sharjah International Airport during the span of 5 years
- 30 R & D projects for ONGC, India during the span of 15 years
- Awarded with research titles like , RMR(USA), RZFM(Germany), RACI(Paris) and reviewer for IEEE journals and other international ones.
- Authored two books on "Distributed DBMS" (ISBN 81-7758-177-5) as a joint author with Ozsu, University of Alberta, Canada, Pearson publications and another book on "Datamining" (ISBN 81-7758-785-4) jointly with Canadian Professor Dunham are released as impression 2006 AND 8 books by Lambert publishers Germany
- Prepared International / National Conference proceedings as Editor in Chair.
- Chaired IT Seminars in California organised by INFORMIX, UK, PARIS, NICE, ACI CONFERENCE, NAU, Dubai, UAE Universities

Awards: Honoured with national and international awards periodically

### *Related Readings*

**Employment & employability: India's dual challenges:** On February 1, 2018 the government will present one of the most anticipated budgets of its tenure. However, most of the young Indians worry about the employment opportunities in the country. In a top-tier engineering college in the eastern part of India, more than 600 students are worried. They have not found jobs through the campus placement process. Everyone has sent out feelers to the family to explore options through the family network. Several of them do not have the luxury. They have loans to settle. Should they become entrepreneurs? Can Budget 2018 address these concerns adequately? According to the World Bank, over 30% of Indians between the ages of 15 and 29 are NEETs, "not in education, employment or training". In 2016, National Skill Development Corporation trained more than 550,000 workers. Only 12% of these trainees found jobs. How will Budget 2018 address job creation? Full Post at <https://abhijitbhaduri.com/2018/01/25/employment-employability/>

**Youth in India: Challenges of Employment and Employability:** Using the NSSO Employment and Unemployment Survey Rounds as the basis, this paper examines questions of unemployment, employment and human capital formation among Indian youth belonging to various social and religious groups across different regions since the advent of the economic reforms in the early 1990s. The paper argues for strengthening measures to create decent employment on a large scale and for improving the education and skill levels of youths with a greater focus on those belonging to the marginalised groups of Indian society. Download the paper from <http://bit.ly/2m883zp>

**National Employability Report Engineers, 2019:** In the fifth Edition of NER, Aspiring Minds finds that the employability of Indian engineers has not changed on aggregate level since 2010 – we call it 'Stubborn Unemployability'. This calls for systemic long term changes in higher education in India. Furthermore, the report compared the skills of Indian engineers with those in other countries and also looked into whether Indian engineers are acquiring new age skills in areas like AI, mobile, cloud and web. In a first, the report looks quantitatively into the reasons for low employability and makes detailed recommendations for change. Summary: Only 3.84% of engineers are employable in software-related jobs at start-ups; Around 3% engineers possess new-age skills in areas such as AI, Machine Learning, Data engineering and Mobile technologies. On an aggregate level, employability in these areas is around 1.5-1.7%; A much higher percentage of Indian engineers (37.7%) cannot write an error-free code, as compared to China (10.35%); and Only 40% of engineering graduates end up doing an internship and 36% do any projects beyond coursework. <http://bit.ly/2kZ9i3V>

# Build a Micro Product - Expand Your Software Skills

**Mr. Dorai Thodla**

CTO of iMorph Innovation Center Pvt Ltd

[dorait@gmail.com](mailto:dorait@gmail.com)

## What is a Micro Product?

A micro product is the smallest useful product you can build in a few months. Your micro product can be a software tool(1), a web application (2), a mobile application or a game.

In this article, we will discuss how building a micro product can expand your skills as a Software Engineer.

## Why you may want to build a Micro Product?

There are several reasons to build a micro product. We list three here.

- Use it as a first step in learning how to build products.
- To start a small revenue stream doing side projects.
- To satisfy your creative urge.

If you are a software engineer, building a micro product may be one of the most powerful expressions of your idea.

Here are a few more reasons. Building a micro product will:

1. Help you build several skills including user interaction design, testing, deployment, hosting.
2. Help you become a full stack engineer (3).
3. Improve your ability to think about the bigger picture - a whole product instead of parts.
4. Help you understand how to focus on the most important aspects of an application.
5. Teach you how to make lots of micro decisions.

But most of all, it will increase your confidence in building an end to end application.

## How to go about building your first micro product?

You should build the first version of the product for your own use. Once you are satisfied, you can share it with others.

Here are a few steps.

1. Make a list of your ideas (the more ideas you have, the better).
2. Describe each idea (focus on what the idea is and why you are building a product).
3. Select one idea.
4. Make a list of high level features.
5. Mark each feature as essential, desirable or nice to have.
6. Create a list of development tasks and prioritize them.
7. Write code and tests to build usable versions of the product.
8. Test each version and write simple release notes.
9. Iterate 7-8 till you get the product you want.

Let us work through an example step by step.

### *Make a list of your ideas.*

We will start with a few ideas.

- A Word game
- A News Assistant
- A Writing Assistant

Why do you start with an idea list? Why can't we start with just one? It is a good practice to start with a few ideas and go through a process of selection. We are starting with 3 ideas but you can start with more. In our product bootcamps, we start with 10 or more ideas.

### *Describe each idea*

Once you have an idea list, you describe each idea. What is your idea and why are you interested in building this as a micro product?

Word Game: A word game is a simple web app. We present a user with a random list of 6 letters. In 3 minutes, they need to create as many 3, 4, 5, 6 letter words as possible from these 6 letters.

You can play this game to test your vocabulary. A web version of the game may be a great tool to gamify learning English.

News Assistant: A News Assistant gathers news based on your interests and stores them for easy access. You can browse through the news items reading summaries, filter them using keywords or visualize them as keyword clouds.

A News Assistant can save you a lot of time by collecting information from online news portals, clustering them by keywords, removing duplicates and summarizing the news using Machine Learning algorithms.

Writing Assistant: A Writing Assistant helps you write better. It can be a simple chatbot or browser extension.

A Writing Assistant can be useful to people for whom English is a second language. A web version of the Writing Assistant can gather analytics from an entire class of students and cluster categories of errors to help an English teacher.

### ***Building the Micro Product***

If you are building it for others to use, you can choose a platform based on your target users. You can pick one of the following approaches based on your skills. Build it:

- As a desktop application
- As a Web Application
- As a Browser Extension
- As a Mobile Application

### ***Select one Idea***

How will you pick one to work on? To keep things simple, we will evaluate the idea based on three parameters.

1. Will it be useful?
2. Can I build it in 2 to 3 months?
3. Does it help many people?

Your answers to each one of these questions may be - Yes/No/Not sure. We will assign scores (1 for Yes, 0 for No and 0.5 Not Sure)

Here is one version of the table.

<b>Micro Product</b>	<b>Will it be Useful?</b>	<b>Can I build it in 3 months?</b>	<b>Does it help many people?</b>	<b>Score</b>
Word Game	Yes	Yes	Not sure	2.5
News Assistant	Yes	Yes	Yes	3.0
Writing Assistant	Yes	No	Not sure	1.5

Based on our evaluation, we will pick News Assistant. In the rest of the article, we will go through the steps of building a News Assistant.

We kept this process of idea list and evaluation simple. You may have a bigger list of ideas and many other evaluation parameters. For example, If you want to start a product business, you may have other columns - business potential, size of the market, ability to reach potential customers, etc.

### ***Make a list of features of the product***

We decided on the News Assistant. So let us make a list of high level features. To keep your first micro product simple, we will narrow the scope to Technology News.

A News Assistant needs to:

1. Identify technology news sources
2. Gather news from the sources and store the news items in a database
3. Remove duplicates
4. Extract summaries from each news item and store it in the database
5. Extract keywords from the news text and store the list of keywords along with the news item
6. Create a simple view to show news headlines and summaries
7. Create a simple keyword search
8. Create a clickable keyword cloud so that when a user clicks on the keyword, all the news items containing the keyword are displayed

### ***Prioritize Features***

You are the first user of the product. What would you like to have the most? I grouped the features into three categories:

1. Essential
2. Desirable
3. Nice to have

<b>Feature</b>	<b>Category</b>
Identify technology news sources	Essential
Gather news from the sources and store the news items in a database	Essential
Remove duplicates	Desirable
Extract summaries from each news item and store it in the database	Desirable
Extract keywords from the news text and store the list of keywords	Nice to have
Create a simple view to show the headlines and summaries	Essential
Create a simple search view to filter news items by keywords	Desirable
Create a clickable keyword cloud so that when a user clicks on the keyword, all the news items for that keyword are displayed	Nice to have

The essence of the News Assistant is to help us consume news (in our case technology news) more effectively.

This kind of table is a good starting point for validating features. In later versions we can show it to a few people and get their feature requests, and add them to the list.

### ***Create a list of development tasks***

The next step - going from features to developmental tasks should come easy to you. One good approach when you are building micro products is to use open source libraries/modules as much as possible.

Here are the high-level tasks for the News Assistant.

1. For each news source, find out whether they provide an RSS (4) feed or an open API (5). It is preferable to use RSS. In fact, work only with news sources that provide RSS in the first version of the product.
2. Store the name of the news source, its URL and the URL of the RSS feed in a database table.
3. For each news source, retrieve the latest news items. Store each news item as a separate row in a table.
4. Use an auto-summarizer (6) to extract summaries for each news item. If you cannot find a good auto-summarizer, use tools to extract the first paragraph of the news item. Store the summary along with the news item.
5. Extract keywords (7) from the news item. There are several open source libraries and services that can help you with this.

6. Create a simple view of the news items with their headlines and summaries. If you can extract keywords, you can display them as tags along with the summary
7. Detect semantic similarity (8) between news items and eliminate duplicates. There are libraries you can use for doing this.
8. Collect all the keywords(extracted in step 5) and create a keyword cloud. When a user clicks on a keyword, search all the news items that contain the keyword and display them.

Divide your development into two week code sprints (9). At the end of each sprint, aim to have a testable/usable product. Start with essential features and then expand to include others (desirable).

There is joy in seeing your product gradually taking shape.

### ***Hosting your Product on the Cloud***

Once you build your product and test it, you can make it available on the Cloud (10). You can use any of the Cloud Providers like Amazon, Microsoft or Google. Many of these services have a free tier you can use while developing and testing it with a few people. You can also host them on Virtual Private Servers

You can show your product with the essential features to get some feedback.

### **Conclusion**

In this article, we covered how to build a micro product. You start with an idea list, pick one idea based on your own selection criteria, start building the product and testing it. You will iterate through several things - the end-user interface, the organization of the modules and even the libraries.

Make sure you use a version control system to version your releases. Each release should have a release note, sources, database schema, images, etc. It should be easy for you to go back to an earlier version if you ever need to.

Once you have a satisfactory product use it for a while. You will come up with your own list of changes and new features. Add them to an issue list and tag them as bugs or features.

Building a micro product can be an enriching experience. You will go through many of the same steps as building a much larger product but will do everything on a smaller scale. You will use shorter development cycles and many iterations.

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### **About the author**



Dorai Thodla, is the CTO of iMorph Innovation Center Pvt Ltd. Dorai has over 40 years of experience in the software industry. He was responsible for creating and managing products in his four startups. He enjoys building product skills through boot camps and workshops. He divides his time between technology strategy consulting and building micro products. You can reach Dorai at <https://www.linkedin.com/in/doraihodla/> and [dorait@imorph.com](mailto:dorait@imorph.com)

**“Creativity is seeing what everyone else has seen, and thinking what no one else has thought.”**

**– Albert Einstein**

**“Creativity involves breaking out of established patterns in order to look at things in a different way.”**

**– Edward de Bono**

# Engineering Success with English

**Mr. T K Arunachalam**

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A good command of English is essential for Indian students entering the engineering sector. In fact this year's National Employability report for Engineers carried out by India's *Aspiring Mind's* highlights the importance of English language skills to remain competitive in the job market in this sector. The report looks at employability by roles and in one section it looks at the skills needed to carry out the role of Technical Content Developer. One thing that really struck me about this section was the fact that the report found that just 51.57% engineers possessed the required domain knowledge and only 17.75% had the required English skills meaning the employability in this role stands at just 12.15%.

These figures are staggering and I think it's clear that there is an increasing need for Indian students planning to enter the engineering sector to be able to communicate well in English. This will help them have a positive experience of the sector and allow them to thrive as they climb up the career ladder.

This creates an ever-growing demand for employers and education institutions to understand the challenges of learning English in the workplace, so suitable support can be put in place. However, this is a complicated area.

A group of our experts at Cambridge Assessment English set out to find some of the answers with the study 'English at Work: Global Analysis of Language Skills in the Workplace'. The survey looked at the importance of English in the global economy. More than 5,300 employers from 38 countries took part including representatives from India. We also analysed 20 different industrial sectors including manufacturing and engineering. So, what did we find out?

## **Is English significant for my organisation?**

Generally we found that in countries and territories where English is an official language, 97% of employers said that English is significant for their organisation.

## **What about the engineering sector?**

The survey received 483 responses from the manufacturing and engineering sector which helps us to paint a really good picture of what's going on in the sector. We looked at the percentage of employers from the different sectors who said that English was significant for their organisation. In the manufacturing and engineering 97% of respondents from countries or territories where English is an official language said that English was significant for their organisation.

## **What level of English do I need to do my job?**

The English at Work survey also looked at what level of English is required in different industries. For the manufacturing and engineering sector 13% said you need a native level of English, 49% said you needed an advanced level of English, 30% said intermediate and only 5% said a basic level of English.

I think it's very clear from these findings that organisations working in the sector place a huge importance on a high level of English language skills to carry out a job. But how can people improve their English language skills for the workplace?

## **Learning English with Cambridge Assessment English**

Cambridge Assessment English (CAE), helps people learn English and prove their skills to the world. This includes working with individuals and global organisations to help them achieve their goals. One really good way of improving English skills for the workplace is to take a qualification test that covers the skills you need for success.

The Cambridge English Qualifications are in-depth exams that make learning English enjoyable, effective and rewarding. The qualifications have been designed to help professionals develop the English language skills to communicate confidently in an international workplace. The demand for these qualifications continues to grow and they are accepted and trusted by thousands of leading employers and organisations worldwide. I think the secret to the success of CAE qualifications for business is that they are based on authentic situations, giving people the skills to communicate in real-life business scenarios. The Speaking test for example is taken face to face with our expert examiners, so students will develop the ability to express their opinion, present their ideas and negotiate in an international workplace.

Three of CAE's popular exams in this space are B1 business Preliminary, B2 Business Vantage and C1 Business Higher. As the names suggest these qualifications are all aimed at different levels of the Common European Framework of Reference for Languages – which is an international way of measuring language ability.

### What can people expect from the different levels?

B1 Business Preliminary is a qualification that shows an individual has mastered the basics of business English. The business qualifications then move up to B2 Business Vantage – which is a qualification, will help people when applying for new jobs, getting a promotion or to develop their career. The highest level business qualification we develop is the C1 Business Higher – this qualification gives people the practical language skills they need to operate confidently at a senior level in global business.

### What is the best way to learn English?

Two of the best ways to learn English is to start as young as possible and immerse yourself in as many authentic English language materials as possible. Thankfully since the advance of the internet, it's even easier than ever to read English language newspapers, books, play games in English and it even helps if you listen to music in English!

Cambridge Assessment English are in detailed discussions with technical societies around the world to make available the Business English qualifications to the members. Preparing for these exams help them to develop their workplace communication skills and enhance their employability. CAE also offer lots of free preparation materials on its website and also has a Facebook page for learning English that gives tips to millions of people around the world on a daily basis.

It's a really exciting time to be entering the engineering sector but it's not without its challenges. With the right motivation, skills and approach, I'm sure the next generation of Indian engineers will make a huge impact.

### About the author



Arunachalam leads the South Asia office of the Cambridge Assessment English, (earlier known as Cambridge English Language Assessment), which he was instrumental in setting up in 2005. The South Asia office manages the operations for India, Nepal, Sri Lanka, Maldives, Bhutan and Bangladesh. He has a Master of Arts (MA) from University of Cambridge and is an alumnus of Loyola College, Chennai. He has worked with the British High Commission, India as an adviser for Education as well as with the British Council, India. In his current role, he leads the team that supports the English language learning and assessment for schools, higher education institutions, corporates as well as the teacher development. Arunachalam supports and guides various ministries of Education in the South Asia region in the area of English language development and is instrumental in building enduring partnerships between Cambridge and institutions in South Asia. An avid marathoner, he recently completed the Tata Mumbai Marathon.

### Related Readings

**25 English Idioms and Phrases That Are Commonly Used in Business:** You're sitting in the conference room with your coworkers, waiting for a meeting to start. As some coworkers pour themselves cups of coffee, others are chatting among themselves. Someone is saying she has to **cut corners** to finish her report on time. Someone else is talking about how a difficult customer has kept him **running round in circles**. In workplace conversations, you'll notice that business idioms and phrases like the above are being used all the time. To be able to participate actively in these conversations, you need to master the idioms and phrases commonly used in business. That's exactly what we're going to do here in this post at <http://bit.ly/2m7cHh3>

### 40 Useful Business English Expressions

- 800 pound gorilla** - the biggest, most powerful group or company. **Example:** "If we follow our plan to make this new software, we're going to have a lot of competition, including from the 800 pound gorilla, Microsoft."
- (a rising tide that) lifts all boats** - something that helps all people or all groups. **Example:** "We're only number three, but the current economic growth will lift all boats, so we're sure to make a profit this year."
- an old hand** - a person who has long experience, especially in one place. **Example:** "He can help us set up a company in Beijing. He's been working in China for many years and speaks Chinese fluently. He's an old China hand."

For full list, pl. visit <http://bit.ly/2kJtlmV>

# My Reflections on being a Software Engineer

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Software Engineer! Software Engineer is well-known as a common job title to address anyone working in Information Technology. However there is more to it. Most of us are software engineers with different flavors. And most of us do not know how and why we ended up becoming one. I am happy to share my reflections on being a software engineer and why I became one.

I, like many others did a Bachelors in Computer Science & Engineering in Chennai, Tamil Nadu with a goal to become a Software Engineer. However, on finishing my undergrad, I moved to Qatar with a motivation to explore the vast field and figure out what I like.

I had started my journey with an internship at Qatar Computing and Research Institute, where I single handedly worked on a project. I was exposed to new libraries, frameworks and concepts in the process. I worked on developing an app which visualizes insights by mining Twitter data. I enjoyed developing the data visualization element of the project, most.

I decided to pursue a Masters in Computer Science at Qatar University and get more perspective. Through the program, I was exposed to different areas of computing. I went on to pursue data visualization as my research topic. I also had started working on a project where I had the opportunity to pursue research and development in data visualization and human computer interaction.

Reading research papers, framing hypothesis, designing experiments, developing the charts (using d3.js, three js) and iterating based on the user feedback, had become my work routine. The exposure to research and my hands-on experience with the visualization libraries and frontend frameworks was a good takeaway for me.

All through my postgrad, I have had long thoughts about my career path. I was deciding if I should pursue research or get in to development. Upon reflecting on my experience so far, I somehow decided to get in to development. And now, after becoming a habitat of the coding and software engineering ecosystem, I look back to reflect on why I chose to be a software engineer and what it means to me.

Simply put, my developer journey began from the day I started enjoying the computer lab classes in my school, where I was introduced to the World of Web by designing web pages with HTML and flash. I still remember how exciting it was when I wrote my first web page or created my first flash animation.

I was never a student who topped the class. I was rather the student who simplified concepts and explained it to her fellow mates. I picked on to that and got in to volunteering with IEEE during my undergrad.

I remembered several such events that I organized, spoke and contributed. Some of the events were held at national and international scales, with India Council, Women in Computing and Women in Engineering. I had also received a Richard E Merwin scholarship from IEEE Computer society in for my contributions, which inspired me to keep going.

The opportunities I got included meeting prodigies like Vint Cerf, who co-designed the TCP/IP Protocol. There were a lot of moments where I got inspired and wanted to share those learnings, so that inspire others.

Thus I understood that: an engineer is a person who is a problem solver. He thinks, reflects and continues to learn. The opportunities I got and the events I did, have helped me establish an engineering mindset.

I believe humans grow and expand in groups and so, through events I practice collaborative learning. I believe that learning is an ongoing process that has no end. It is an essential element of life. I am happy that as a software engineer I can act on my beliefs, everyday.

## About the author

Wafa Waheeda is a Software Engineer at Qatar Computing and Research Institute. She is a visual thinker who believes in tackling problems with simplicity. She enjoys collaborative learning and heads multiple tech communities in Doha. More about her at <https://about.me/wafawaheeda>

# Indian Women in Engineering - Past, Present, and Future

**Dr. Shantha Mohan**

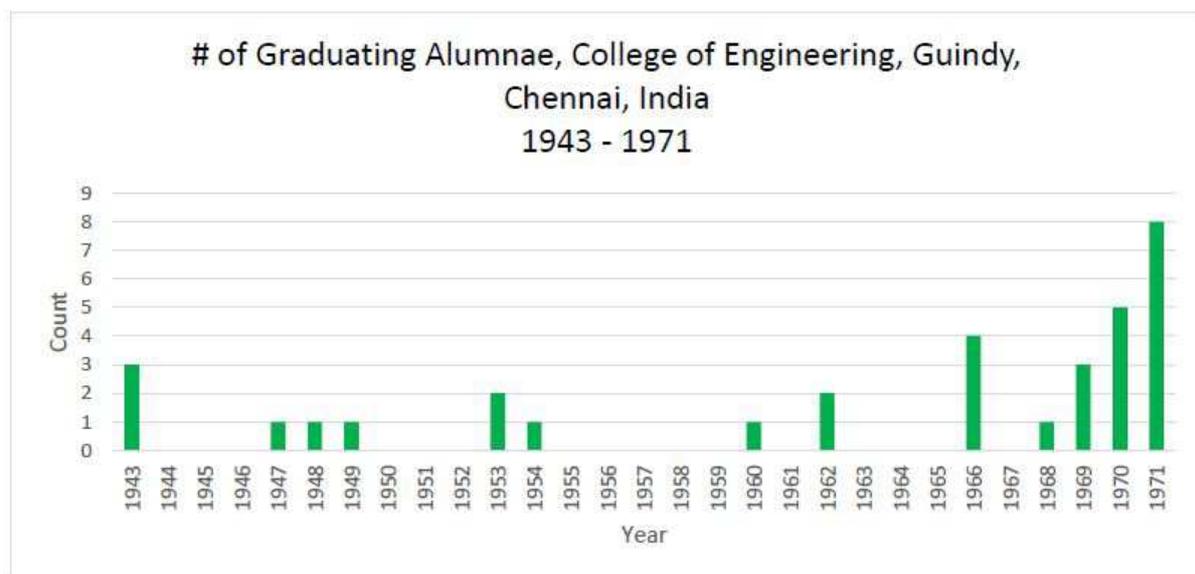
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In the early twentieth century, we considered engineering education a man's prerogative. Civil, electrical, and mechanical engineering were the main engineering disciplines. Today, engineering encompasses many more specializations such as computer engineering, software engineering, and computer science. Many women have successful careers in these disciplines, and the future looks bright for Indian women in engineering.

## The 1940s - 1980s

Medicine was a suitable field of education for women even as early as the late 1800s. Engineering was not. The first Indian woman to graduate with a medical degree was Anandibai Joshi in 1886. In India, the first set of engineering women graduated from the oldest engineering college in India, College of Engineering, Guindy (CEG), Chennai (1), in the 1940s. Around the same time, there was a woman who graduated from Pune Engineering College. But we know little about her. When writing the book "[Roots and Wings: Inspiring Stories of Indian Women in Engineering](#)", I found the statistics of how many women graduated each year from CEG fascinating.



This represents the conditions that existed in India in those decades. Many of the very early Indian women engineers pursued engineering because their fathers or families wanted them to do so. Their fathers or brothers were engineers. They encouraged the girl in the family, who was very good at mathematics and physical sciences, to pursue engineering. A. Lalitha, the first woman electrical engineer of India once said, 'Electrical engineering runs in my blood. My father, four brothers, nephew, and son-in-law are all electrical engineers.'



*The first set of women graduates of CEG: P.K. Thressia, Leelamma George, and A. Lalitha  
Image courtesy of Syamala Chenulu*

CEG produced some of India's first women engineers in their fields. Rajyalakshmi was the first woman to graduate with a telecommunications degree in 1948 and worked in All India Radio. The first woman to graduate with a mechanical engineering degree in 1966 was Sarojini, who went into her family business.

Because the women were rare in the field that was predominantly men, they felt accepted, though considered exceptions. Many of them were happy to consider advancing in their careers secondary to that of their husbands. Several of them worked in the Government of India establishments, which treated them fairly by transferring them to the same locations as their husbands to keep them together. Some of them received help from the extended family structure, with aunts and uncles lending helping hands.

A few of these early pioneers did not marry and devoted their entire lives to their careers or social services. One of the first set of women who graduated from CEG, P.K. Thressia became the first lady chief engineer in Kerala's Public Works Department (PWD).

Many early female engineers became technical educators. There were several CEG graduates who became principals of women's polytechnics and also principals of colleges.

At the tail end of the period in the book is one of the globally successful early engineers, Radha Ramaswami Basu. A distinguished alumnus of CEG, she graduated in 1971.



*Radha Ramaswami Basu*  
*Image courtesy of Radha Basu*

Radha migrated to the USA, pioneered the entry of Hewlett-Packard into India in the then-nascent IT industry, and became a serial entrepreneur. In 2006, Radha and her husband Dipak launched Anudip Foundation, a social enterprise in India, to address critical livelihood needs of youth and young women of rural and urban India through information technology. She is still going strong with her social enterprise iMerit Technology in West Bengal.



*Vinita Gupta*  
*Image courtesy of Knowledge@Wharton*

Vinita Gupta, a distinguished alumnus of the University of Roorkee, (now Indian Institute of Technology Roorkee) 1973, also migrated to the USA and founded Digital Link Corp. (later named Quick Eagle Networks) and took it public, the first Indian-born American woman to do so. She sits on the boards of Palo Alto Medical Foundation in California, the Indian School of Business, and the Cancer Prevention Institute of California.



*Jayathi Murthy*  
*Image Courtesy of UCLA*

Dr. Jayathi Murthy, a distinguished alumna from IIT Kanpur graduated in 1979 with a degree in mechanical engineering. Her Ph.D. is from the University of Minnesota. She became the dean of the UCLA Henry Samueli School of Engineering and Applied Science in 2016. Her academic career started at Arizona State University as an assistant professor of mechanical and aerospace engineering. Other universities that shaped her career include Carnegie Mellon, Purdue, and The University of Texas at Austin. She also had industry experience at Fluent, Inc. There, she led the development of algorithms and software.

## **The 1980s – Present**



*Padmasree Warrior*  
*Image Courtesy of LinkedIn*

Many Indian female engineers who graduated in the 1980s have become globally successful. Padmasree Warrior is one of them. She received a bachelor's degree in chemical engineering from the Indian Institute of Technology, Delhi, in 1982 and a master's degree in chemical engineering from Cornell University. She has won many awards for her leadership in the tech industry and has held many board positions. She is on the boards of Microsoft, Spotify and Thorn (formerly DNA Foundation).



*Kalpana Chawla*  
*Image Courtesy of Wikipedia*

Dr. Kalpana Chawla graduated in 1982 with a bachelor of science degree in aeronautical engineering from Punjab Engineering College, India. 1982. In 1988, she received a Ph.D. in aerospace engineering from The University of Colorado. In 1989, she started working at NASA Ames Research Center. In 1994, she became an astronaut candidate. Her first flight in space was in November 1997 on the space shuttle Columbia, where she was a mission specialist. Her second flight was in 2003, which failed on its way back to earth and claimed her life.



*T.V. Geetha*  
*Image Courtesy of Guindy Times(2)*

Dr. T.V. Geetha, who graduated from CEG in 1982 with a degree in Electronics, did a Ph.D. in Natural Language Processing from Anna University in 1992. She headed the computer science department between 2003-2006, and also in 2013. She became the first woman dean of CEG. In 2000, she received the Young Scientist award from the Government of Tamil Nadu. She is the author of many technical and research papers.



*Janaki Akella*  
*Image courtesy LinkedIn*

Dr. Janaki Akella, also a 1982 graduate, is a distinguished alumnus of CEG. In December 2018, the Board of Directors of Southern Company, a leading energy company, elected Dr. Janaki Akella as an independent director, joining the Operations, Environmental and Safety Committee and the Business Security Subcommittee. Akella has served as the Business Leader, Digital Transformations at Google since 2017. She has also held various positions with McKinsey & Company. She earned a doctorate from Carnegie Mellon University and a bachelor's degree from the College of Engineering in Guindy, India.



*Vanitha Muthayya*  
*Image Courtesy: India Today*

Vanitha Muthayya, a 1985 graduate of CEG headed India's second lunar mission. A celebrated electronics system engineer from the UR Rao Satellite Centre, she is the author of many papers on satellite communications. In 2006, she received the best woman scientist award from the Astronautical Society of India. The science journal *Nature* has named her as one of the five scientists to watch out for in 2019.



*Sarita Adve*  
*Image Courtesy: <https://anitab.org/profiles/abie-award-winners/sarita-adve/>*

Dr. Sarita Adve, who received a B.Tech. in Electrical Engineering from IIT-Bombay in 1987 and a Ph.D. in Computer Science from the University of Wisconsin-Madison in 1993 is a celebrated innovator and educator. She has received many awards. The *Anita Borg Institute Women of Vision award in innovation* is one of them. The Association for Computing Machinery (ACM) and IEEE Computer Society (IEEE-CS) awarded her the *2018 ACM/IEEE-CS Ken Kennedy Award (3)*“ for research contributions and leadership in the development of memory consistency models for C++ and Java, for service to numerous computer science organizations, and for exceptional mentoring.”



*Ponni K.*  
*Image Courtesy: IIM Bangalore*

Ponni K is Head, Global R&D Laboratories, Nokia, Bengaluru. She received the *Women Technologist of the Year 2019 award* from IEEE/Smart-Tech. She received her B.E. in computer science from Regional Engineering College, Trichy, (now National Institute of Technology) and an MBA from IIM-B.



*Bhargavi Sunkara*  
*Image Courtesy: LinkedIn*

Bhargavi Sunkara graduated from Jawaharlal Nehru Technological University in 1990 with a bachelor's degree in electrical and electronic engineering and a masters' degree in electrical engineering from Texas A&M University in 1994. She played various technology roles at Satyam Computers, MCI, Texas Instruments, Microsoft, and American Express, before becoming the Head of Corporate Technology at BNY Mellon, Pune.

The percentage of Indian women engineers rose dramatically, from almost 5% in 1980 to close to 30% in 2011.(4) We can attribute this growth in women to the growth in the computer industry and the introduction of degrees in computer engineering, software engineering, and computer science.

While the number of Indian women engineering graduates has grown substantially over the past decade, the percentage of women in the workforce has been declining on the whole (5), and those working in the technical fields follow a similar trend. Almost 40% of women engineering graduates are unemployed.(6)

The article "A Look at Gender Bias in India" (7) talks about a study which revealed both men and women feel bias at work in some form or the other, leading to attrition. India's Shops and Establishments Act (SEA) was one reason women felt discriminated against. The article concluded:

"When employees face bias in the workplace, they feel less engaged, are less satisfied with their jobs, and are more likely to consider leaving. We see these outcomes from both men and women engineers in India."

### **The Future**

It is a wonderful time for women to enter the workforce. The corporate environment has become more aware of the importance of cultivating women leaders. Corporate cultures are becoming more inclusive, more diverse. Today's women have grown up in a world that values gender equality much more than in the past. They are much more confident, independent, knowledgeable, and driven to succeed. There are amenities available to working women today – someone to do your shopping, services to deliver food, etc. – that make it possible for women to spend more time on their careers if they choose to. There is also more support for women, from women, understanding that together we go further.

Organizations such as SWE India (<https://india.swe.org/>), IEEE Women in Engineering (<http://wie.ieeeer10.org/>), and AnitaB.org India (<https://anitab.org/about-us/india/>) have all been very active in promoting the participation of women in engineering. SWE's *WE Local* initiative promotes meeting locally and learning socially. The *WE Local India*, which has plans to meet on April 2020 in Bengaluru (8) aims to support programs for women in all stages of their working life from graduation through retirement.

Women engineers who are graduating today will become tomorrow's engineering leaders. The advances in technologies such as the Internet of Things (IoT), autonomous vehicles, robotics, artificial intelligence and machine learning, space exploration, and genetic engineering are all fields that can benefit from the women engineers' mindset.

My goal in writing *Roots and Wings*: <https://notionpress.com/read/roots-and-wings> was to put engineering women role models in front of girls to highlight that women could do anything they choose to. I continue to showcase such women on social media such as *Roots and Wings*: <https://www.facebook.com/IndianWomenEngineers/> and *Women of College of Engineering, Guindy*: <https://www.facebook.com/cegwomen/>

The introductory chapter of *Roots and Wings* called out the need for participation by women in the workforce and the support they need from society:

"Critical events in women's lives such as marriage, babies, and elder care interrupt women's work life. Coming back to work from that interruption in these fast-changing days is hard. It is important that women refresh their skills and re-enter the world of work if they are to make progress. The life stories in this book show examples of women resourcefully navigating such interruptions to find their way back to successful careers. Women need support from their parents, their spouses, and the society, to achieve their dreams and goals—the support that men already get! The enterprises that employ them also have a role to play in supporting the career and meeting the special needs of their female workers. The institutions reap the benefits of women's contributions when they support them during the practically unavoidable breaks in their careers and their re-entry into the workforce after such breaks. The larger society also stands to enjoy the contributions facilitated by such support (9)"

In the 2011 Knowledge@Wharton interview, Vinita Gupta (10) says:

“Change has come, but it is not sufficient. We are somehow too slow to change our habits. I feel passionately about this. The way we raise our girls is different from the way we raise our boys. And it is different not because we want it to be different. It’s different because we are victims of our habits. Internally we know the boy has to launch himself in the world, he has to be able to make a living and so on. We have a different way in helping this boy grow up within the four walls of the home. But we don’t give a girl much freedom in thinking.”

This may still be true in 2019.

Here is what I tell my female engineer mentees who are just starting out in their careers:

“When it comes to your career, ignore gender. Be focused. Have great aspirations and work towards them. Put excellence and quality into everything you do. Stay current on technical advances. Build yourself a strong support network - starting with your spouse if you have one. Find a mentor, a sponsor, who can help you grow. Let your work speak for itself, but make sure you are visible in the organization and your chosen industry. Don’t be afraid to beat your drum. (11)”

Indian women are highly flexible, courageous, determined, ambitious, and have a high degree of emotional intelligence. In tomorrow’s globally connected world, they will go very far.

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## About the author



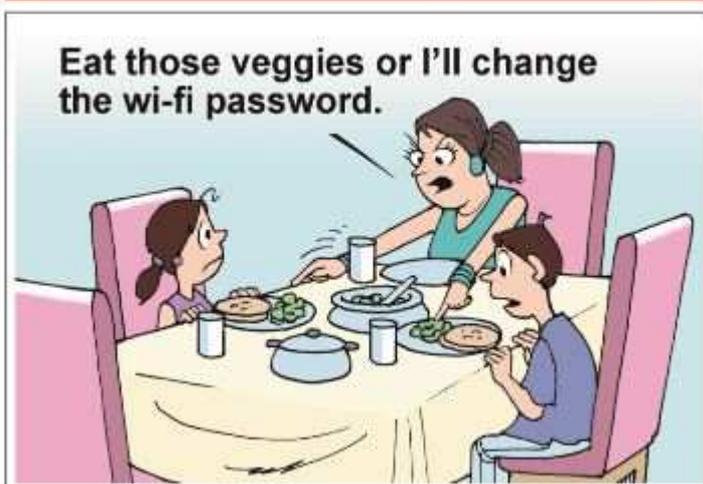
Dr. Shantha Mohan is a senior software engineering leader and entrepreneur, with a proven track record of growing and mentoring technical teams and generating ROI for customers across the globe. Retail Solutions Inc., the company she co-founded, is a leader in retail analytics in the Consumer Packaged Goods (CPG) domain. She ran product development for the company and scaled the product development team across the world and delivered multiple analytic applications. Prior to Retail Solutions, she has over 20 years of experience focusing on mission-critical systems to support semiconductor and other high value-added manufacturing. At Consilium, now part of Applied Materials, she managed the development of three generations of manufacturing execution systems that are mission-critical, highly scalable, and highly available. Companies such as Intel, AMD, and Infineon depend upon them for their manufacturing.

In her current role as Executive In Residence at the Integrated Innovation Institute, Carnegie Mellon University (CMU), Shantha co-delivers courses, contributes to curriculum design, and mentors students in their projects and practicums.

Outside CMU, she guides students and startups and provides career advice in product management and software development careers. She is the author of *Roots and Wings: Inspiring Stories of Indian Women in Engineering*.

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The Times of India

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# TECH BITS

## Software Testing Metric

Software Testing Metric is defined as a quantitative measure that helps to estimate the progress, quality, and health of a software testing effort. A **Metric** defines in quantitative terms the degree to which a **system, system component, or process** possesses a given attribute. The ideal example to understand metrics would be a weekly mileage of a car compared to its ideal mileage recommended by the manufacturer. Test Metrics Glossary

- Rework Effort Ratio = (Actual rework efforts spent in that phase/ total actual efforts spent in that phase) X 100
- Requirement Creep = ( Total number of requirements added/No of initial requirements)X100
- Schedule Variance = ( Actual efforts – estimated efforts ) / Estimated Efforts) X 100
- Cost of finding a defect in testing = ( Total effort spent on testing/ defects found in testing)
- Schedule slippage = (Actual end date – Estimated end date) / (Planned End Date – Planned Start Date) X 100
- Passed Test Cases Percentage = (Number of Passed Tests/Total number of tests executed) X 100
- Failed Test Cases Percentage = (Number of Failed Tests/Total number of tests executed) X 100
- Blocked Test Cases Percentage = (Number of Blocked Tests/Total number of tests executed) X 100
- Fixed Defects Percentage = (Defects Fixed/Defects Reported) X 100
- Accepted Defects Percentage = (Defects Accepted as Valid by Dev Team /Total Defects Reported) X 100
- Defects Deferred Percentage = (Defects deferred for future releases /Total Defects Reported) X 100
- Critical Defects Percentage = (Critical Defects / Total Defects Reported) X 100
- Average time for a development team to repair defects = (Total time taken for bugfixes/Number of bugs)
- Number of tests run per time period = Number of tests run/Total time
- Test design efficiency = Number of tests designed /Total time
- Test review efficiency = Number of tests reviewed /Total time
- Bug find rate or Number of defects per test hour = Total number of defects/Total number of test hours

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**Facebook picks 6 winners for Ethics in AI research awards in India:** The project winners, focused on areas like governance, cultural diversity and operationalising ethics. The project was open to academic institutions, think tanks, and research organisations registered and operational in India

**Bengaluru to get AI-powered traffic signals soon:** The new AI cameras will study traffic density and decide on how much time to allow vehicles to clear a signal. This will save fuel and give motorists an idea about when they can move.

**Google announces a new AI research centre in India:** The centre coming up in Bengaluru, called Google Research India, will focus on advancing fundamental computer science research to develop tools that can be used by government and private entities.

**Google Assistant to be available to Indian users without internet:** The virtual assistant will be available to people who have the most basic cellphone with no internet access. A 24x7 telephone line on Vodafone-Idea telecom networks could be dialled by users to access the service. Google has been testing the line in Lucknow and Kanpur.

**IIT-Kharagpur students build home-rechargeable three-wheeler:** A team of students and professors at the Indian Institute of Technology, Kharagpur has built 'Deshla', an electric three-wheeler that can be charged at home

**Maharashtra govt ties-up with Zipline to deliver medicines via drones:** The initiative will be supported through a grant from Serum Institute of India (SII). Zipline will establish about 10 distribution centres across Maharashtra in phases.

**MIT researchers create programmable ink to let objects change colours when exposed to ultraviolet light:** The 'PhotoChromleon Ink' uses a mix of photochromic dyes that can be sprayed or painted onto the surface of any object, including shoes, cars or phone cases. The process can take about 15-40 minutes, depending on the shape of the object.

**40% Indians fear losing job for controversial posts online:** According to a study by McAfee, 40% Indians agreed that they could be fired from their jobs for controversial content on their social media. About 25.3% admitted they did not know how to change the privacy settings of their profiles, while over half the users in India have at least one dormant social media account.

**YouTube awards 8 Indian creators with YouTube Learning Fund:** The fund is supporting the development of high-quality learning content, covering topics like English language training, environmental science, political science, among others.

## Guidelines for IEEE India Council Newsletter Article

As all the matter submitted will be reformatted as per the newsletter style, please follow the general guidelines given below for the articles sent to IEEE India Council Newsletter.

Article content: The article should be of general interest, explaining the concepts, using cases, and/or illustrating technological trends or other areas of interest to IEEE.

Length: 4-5 pages in about 2500 words. (Longer articles will also be considered)

Format: Word document file format; Single Column; Single Spacing & Text in Times Roman Font in size 10 Point; Headings & Sub Headings can be differentiated wither by colour / making them bold / italics as case may be.

Please keep minimum level of indentations while formatting the article. Aligning to the left is always welcome.

Pictures: Apart from embedding the pictures in appropriate places in the article, please send them as individual jpg files.

References: To be numbered and listed at the end of the article (please do not include in individual pages). Pl. do not use formatting with superscript for references. Include the ref no in parentheses and provide details at the end of the article.

Please do not embed the URLs of websites into the text. Provide explicit URL

Please provide also, the following for inclusion in the article.

1. Full affiliation of the author(s) with email id.
2. Author(s) picture in jpg.
3. Author(s) profile (as running text), a brief one in about 150-200 words.

Please note the articles provided are re-formatted to suit the newsletter page layout.

The articles are not peer reviewed and also not checked for plagiarism from our end. Hence please verify the facts presented and check your material for potential copyrights and intellectual property rights violation.

To get an idea of the type/nature of articles and the publishing style, please refer to past issues of the newsletter at [http://sites.ieee.org/india\\_council/newsletter/](http://sites.ieee.org/india_council/newsletter/) If further clarifications are required, pl. contact the editor HR Mohan by email at [ieee.icnl@gmail.com](mailto:ieee.icnl@gmail.com)

Please send the article along with the requested info by email to [ieee.icnl@gmail.com](mailto:ieee.icnl@gmail.com), the exclusive email id for the newsletter.

The Editor's decision is final

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