Challenges in Smart Grid Project Execution: View from a Manager

By Chandan Lal Patary

Abstract

Smart grid projects have drastically changing the power industries and consumers over the last couple of years. Due to such Initiatives, the environment is benefiting from reductions in peak demand, the proliferation of renewable power sources, and a corresponding reduction in emissions of CO2 as well as pollutants such as mercury. Consumers are gaining greater control over their energy costs, including generating their own power, while realizing the benefits of a more reliable grid. Utilities are undergoing lower distribution losses, deferred capital expenditures and reduced maintenance costs. Information technology and operation technology converge to close the loop of automation, control and data acquisition and help faster response times, improved business operations with actionable priorities.

"Smart" phone these days means a phone with a computer in it; smart grid means "computerizing" the electric utility grid. Technologies are penetrating much deeper and improving productivity. Large scale technology deployment requires continuous engagement with the customer, and the regulatory environment is stringent with acceptance criteria for successful project completion in the smart grid area.

Smart grid related projects for last couple of years have significantly improved the power grid system. Aging infrastructure, constrained technical resources, pressure on operations and maintenance expenses, compliance requirements, the costs of unplanned outages, and the need for grid reliability are driving investments in asset health management.

- Various product-program-project management challenges handled by the team and how to overcome with speed of execution?
- Stakeholder management (tough customer) and stakeholder's satisfaction with value generation?
- Framework to follow to achieve smarter, more cost effective and more reliable operation?
- Domain challenges, people challenges, technology challenges, process challenges, regulatory challenges to look into which are critical to the project?
- How agile best practices, devops, gamification theme improves agility and in-house operation efficiency?

Keywords: Information technology and Operation technology, Internet of Things

1. Introduction:

Electricity is the most versatile and widely used form of energy and global demand is growing continuously. It has an impact on global climate change. To mitigate this we need to change the electric system significantly. Smart grid is painting a very nice and exciting picture for electric power infrastructure today and for upcoming days. Smart grids will provide more electricity to meet rising demand, increase reliability and quality of power supplies,

increase energy efficiency, and provide ability to integrate low carbon energy sources into power networks. Today's smart grids are much more wired than ten years back. There is an increasing need for grid optimization.

The result will be a grid that is largely automated, applying greater intelligence to operate, monitor and even heal itself. This "smart grid" will be more flexible, more reliable and better able to serve the needs of a digital economy.

There are many different ways to define a smart grid. DECC (Department of energy and climate change) argues that a grid is made smart by:

'…applying information and communications technology to the electricity system to enable more dynamic real-time flows of information on the network, and greater interactivity between suppliers and consumers.'

The EU (European Union) defines a smart grid as:

'…an electricity network that can cost efficiently integrate the behavior and actions of all users connected to it – generators, consumers and those that do both – in order to ensure an economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety.'

Smart grid technology is not a single silver bullet but rather a collection of existing and emerging technologies working together. When properly implemented, these technologies will increase efficiency in production, transport and consumption, improve reliability and economic operation, integrate renewable power into the grid, and increase economic efficiency through electricity markets and consumer participation.

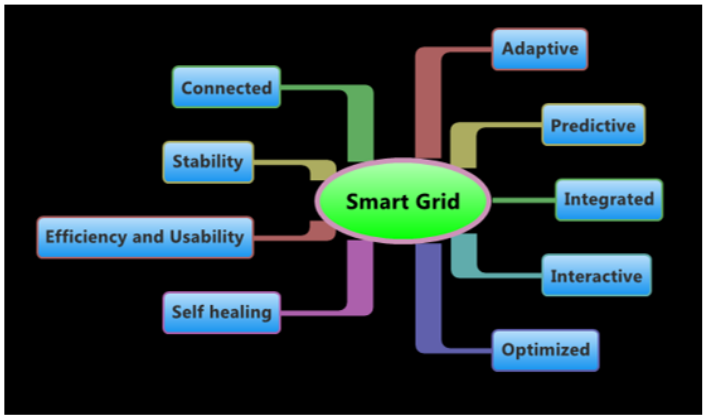


Fig A: When Grid Become Smart

The Smart Grid will provide dynamic, real-time monitoring, control and optimization of grid operations and resources in a number of ways:

- Advanced network visualization, distribution applications and outage defense systems will give utilities the capacity to detect, analyze and restore system faults before they jeopardize system integrity.
- Greater coordination among all participants in the system will trigger better price signals and a more efficient balance between demand and supply.
- Increased physical and cyber security, as well as special protection systems, will warn of security threats before they escalate.

- Significant reductions in residential peak demand energy consumption will be achieved by providing real-time pricing and environmental signals in conjunction with advanced in-home and distributed generation technologies.
- Advanced outage management systems and distribution automation schemes will result in fewer blackouts and local power disruptions along with faster recovery times.

Several smart grid projects has been executed by our team and sample key objective were achieved

- Improve electricity reliability and restoration capabilities
- Improve reliability by up to 30% by areas completed with full smart grid functionality

Achieved by deploying

- Implement Advanced Distribution Management System (ADMS). The goal of Advanced Distribution Automation is real-time adjustment to changing loads, generation, and failure conditions of the distribution system, usually without operator intervention.
- Install remote monitoring equipment at several substations
- Install several automated field switching and monitoring devices on several distribution circuits
- Integrate components to accomplish stated improvements (reliability, monitoring)

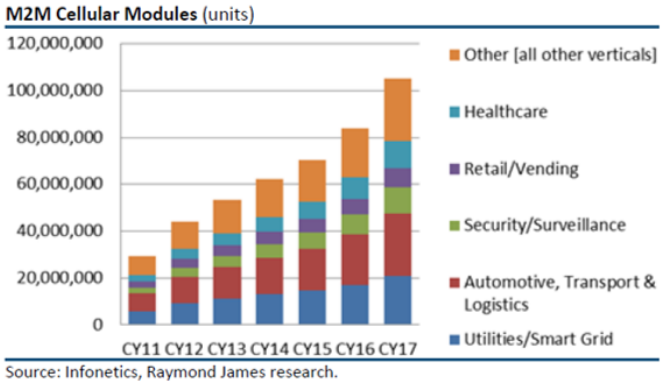


Fig B: Growth of Smart Grid market in coming years

As shown above, based on data from Infonetics, a bit more than 50 million cellular modules were shipped in 2013, with automotive being the largest vertical market, followed by smart grid applications (connected utility meters). The market for cellular modules is expected to grow at a CAGR of 19% over the next several years, as cellular connectivity is baked into an increasing number of machines and devices. *Navigant Research predict investment in microgrids to reach $31 billion in the Asia Pacific region by 2023, the same company has released another report investigating smart grid technologies, and predict that market spending will total $600 billion from 2014 through 2023.*

2. Information Technology and Operation technology Convergence:

To achieve the smartness in the grid system we have to collaborate Information technology with operation technology. Instead of reinventing the wheel, organizations have to reuse solutions available in the market.

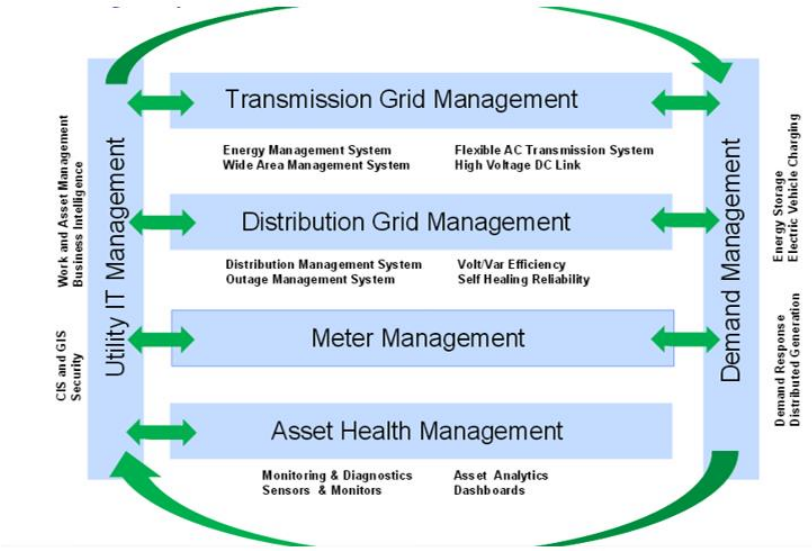


Fig C: Smart Grid Pillars

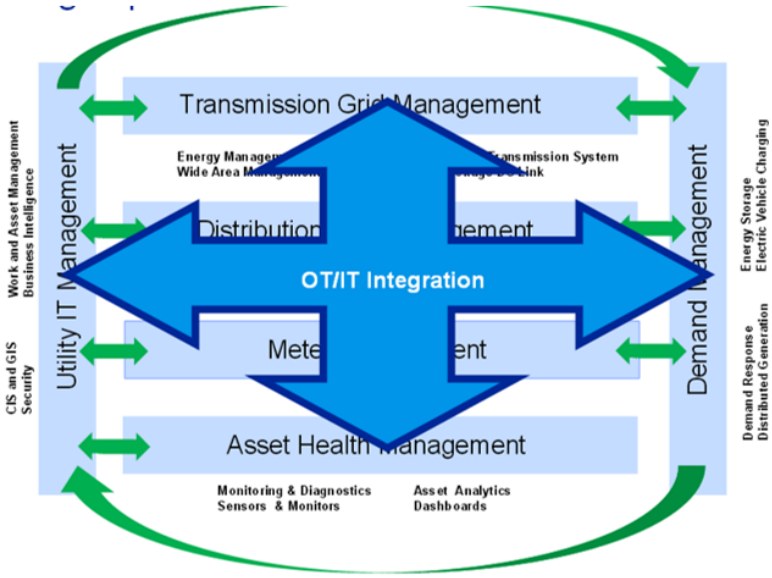


Fig D: Operation Technology and Information Technology convergence. According to Gartner, IT/OT convergence is inevitable.

3. What are the Solutions for the Smart Grid?

By eliminating silos which exist between IT and OT, organizations can enable data sharing that will enhance system performance. IT/OT convergence enables distribution organizations to keep external stakeholders better informed about their electric service.

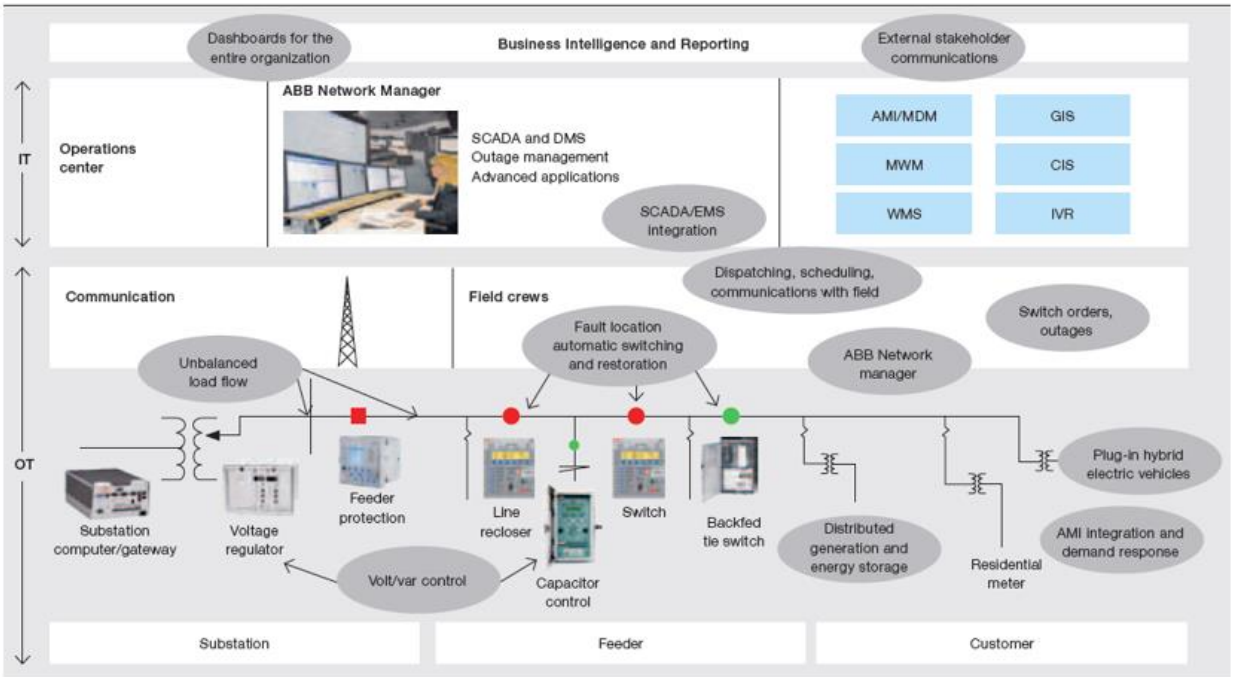


Fig E: IT/OT systems used in an electric distribution system. The applications indicated in the bubbles are made possible by IT/OT integration.

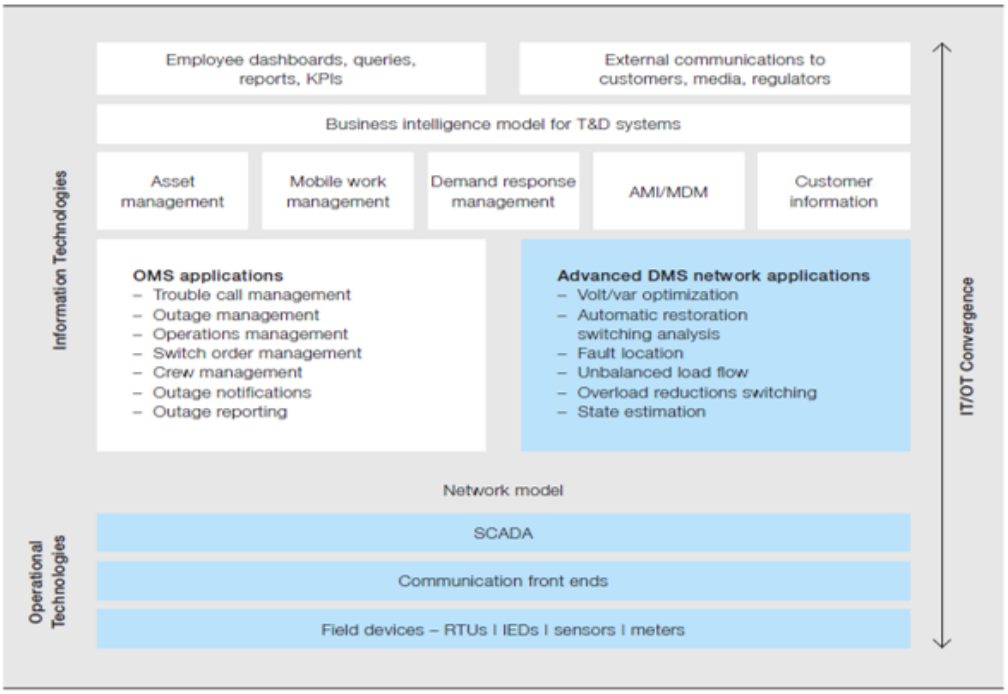


Fig F: IT/OT convergence enables distribution organizations to keep external stakeholders better informed about their electric service.

There is an increasing trend to use data from OT systems, like automation and SCADA systems, in combination with IT systems for workforce process efficiency improvements and better decision-making.

4. Smart Grid Project Benefit:

Environmental sustainability and ways of limiting carbon emissions have led to increased interest in smart grids. Potential benefits include the conversion of unplanned outages into planned outages and many more.

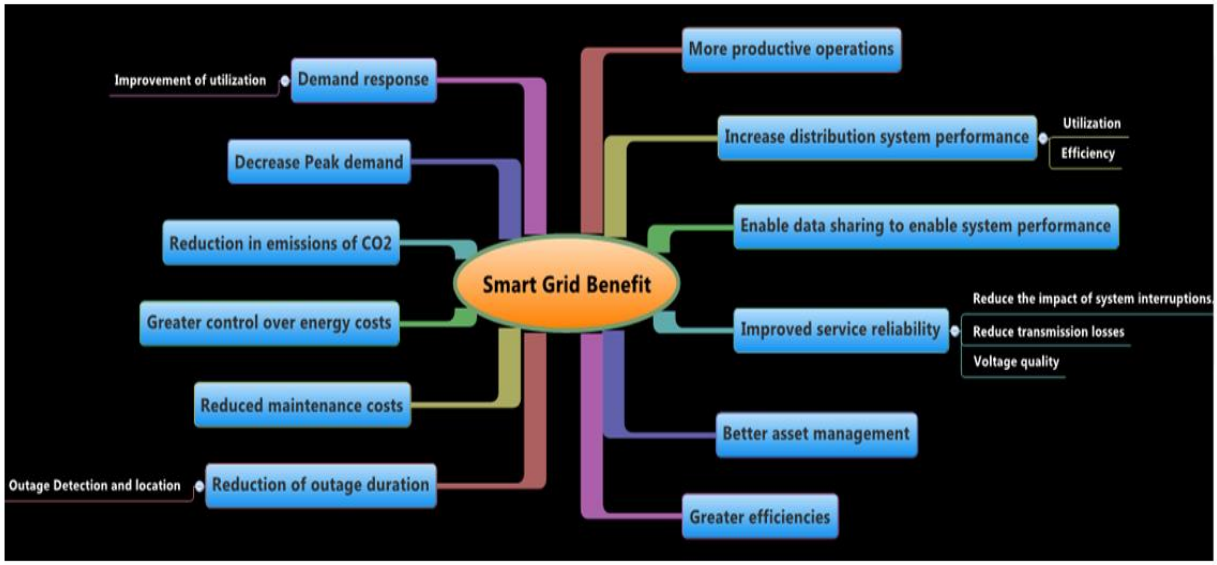


Fig G: The transition to a fully implemented smart grid brings a host of benefits in an often symbiotic relationship

Fig G: Demonstrates various benefits that everyone will get once grids become smart. I wish I can discuss each point elaborately but it would cover the whole paper.

5. How we will convert traditional grid to a Smart Grid?

Fig H: Captures possible ways a grid can become smart. There could be many more but this is what has been captured in this paper based on my experience.

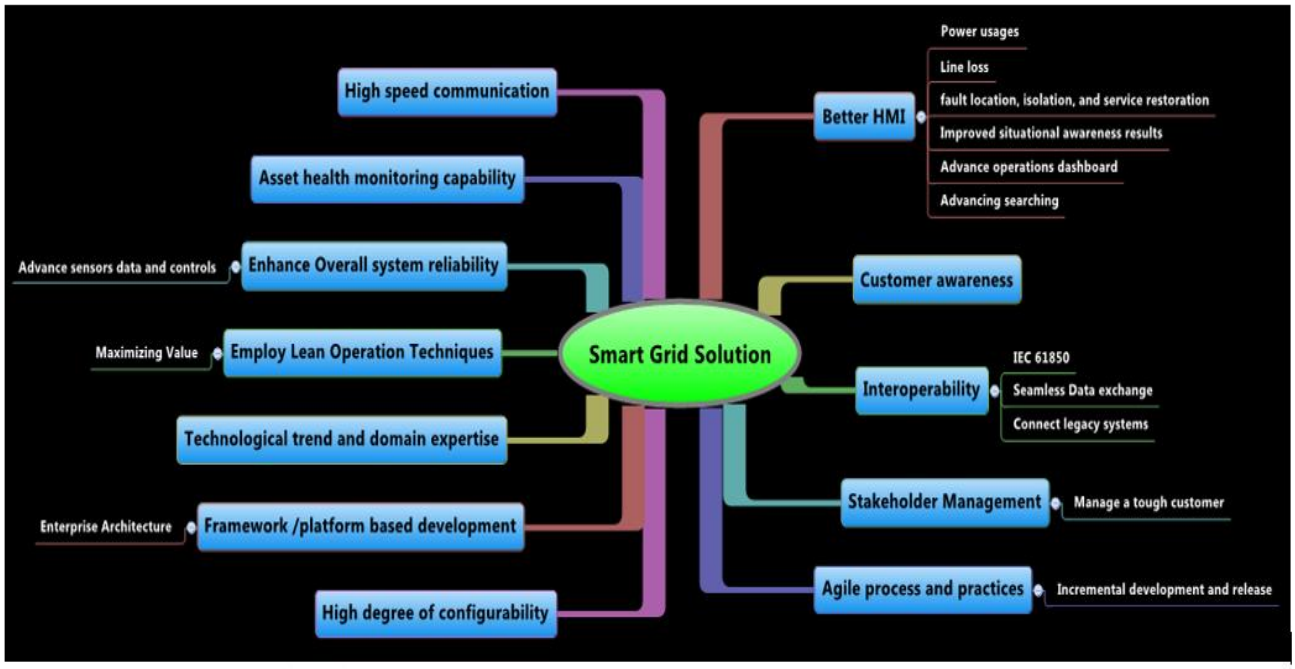


Fig H: Achieving smart solution for Grid

6. Challenges smart grid projects are facing?

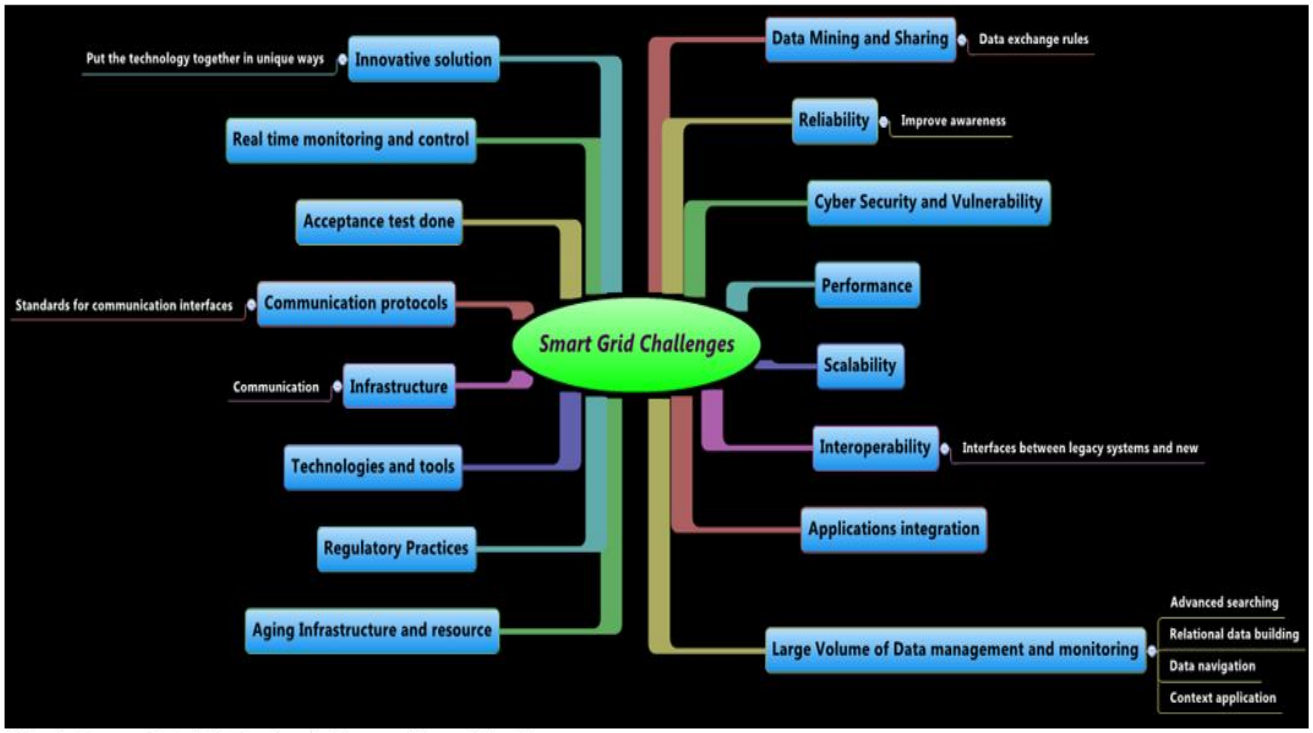


Fig I: Smart Grid Project Execution Challenges

Fig I: demonstrates various challenges smart grid solution provider faces. There could be many more but this has been capture based on my knowledge. All these factors are heavily influences for a better solution and development.

7. Internet of Things and Smart Grid:

Internet of Things has been considered as the third wave of the information industry after computer, Internet and mobile communication network. These "things" (People, Location of the objects, time information of the objects, and condition of the objects) of the real world shall seamlessly integrate into the virtual world, enabling anytime, anywhere connectivity.

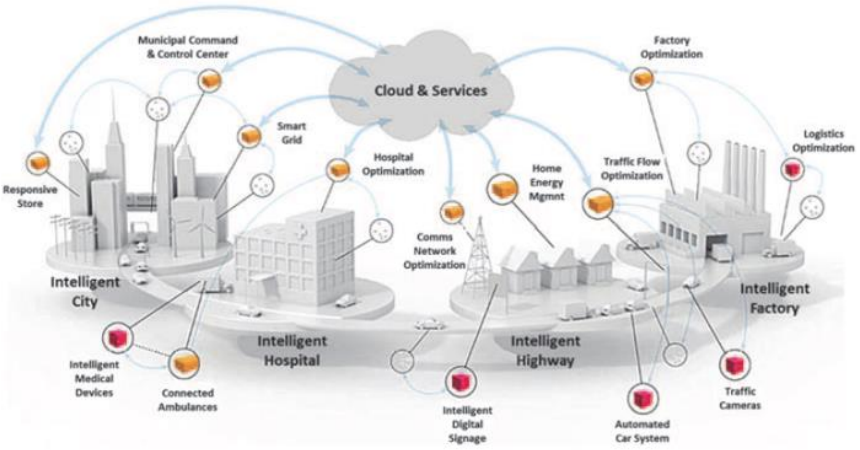


Fig J: Internet of Things: Intelligent Systems Framework (Source: Intel)

Fig J demonstrates a world where billions of objects can sense, communicate and share information, all interconnected over public or private Internet Protocol (IP) networks. These interconnected objects have data regularly collected, analyzed and used to initiate action, providing a wealth of intelligence for planning, management and decision making which is going influence heavily smart grid project in future.

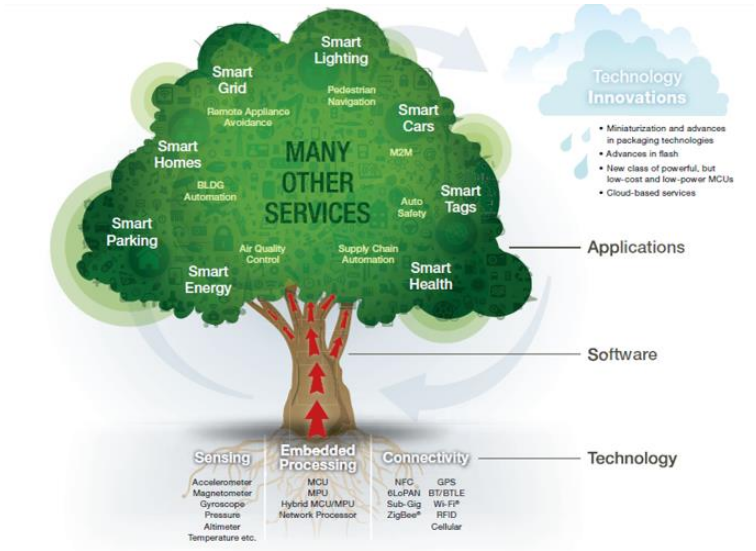


Fig K: Smart Planet (Internet of Things)

Internet of things used in a smart grid is the inevitable result of the development of information communication technology (ICT) to a certain stage. In Smart Grids networked embedded devices are making the electricity grid itself, the homes, the factories etc. smarter, enabling and increasing the collaboration among them. It will be able to effectively integrate infrastructure resources in communications and electrical power system, make the

information and communication services operate for electrical power system, increase the level of power system information, and improve the utilization efficiency of infrastructures in the existing power system.

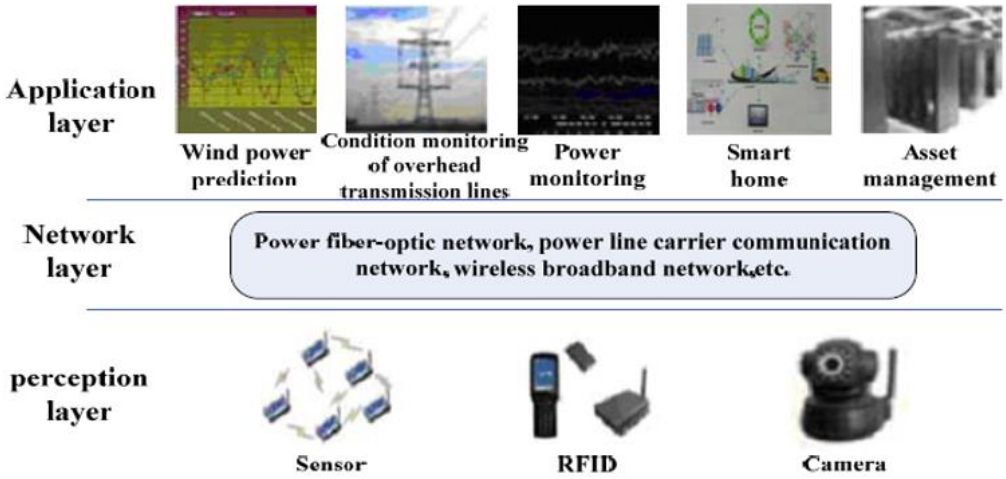


Fig L: Basic Architecture of IoT in Applications of Smart Grid

IOT three layers, first, miniaturization, with computers components becoming smaller and smaller, enabling practically anything to be connected anywhere, anytime. Second, an overcoming of the limitations of the mobile telephony infrastructure. And thirdly, a proliferation in the applications and services that make use of the vast amount of information created via the IoT.

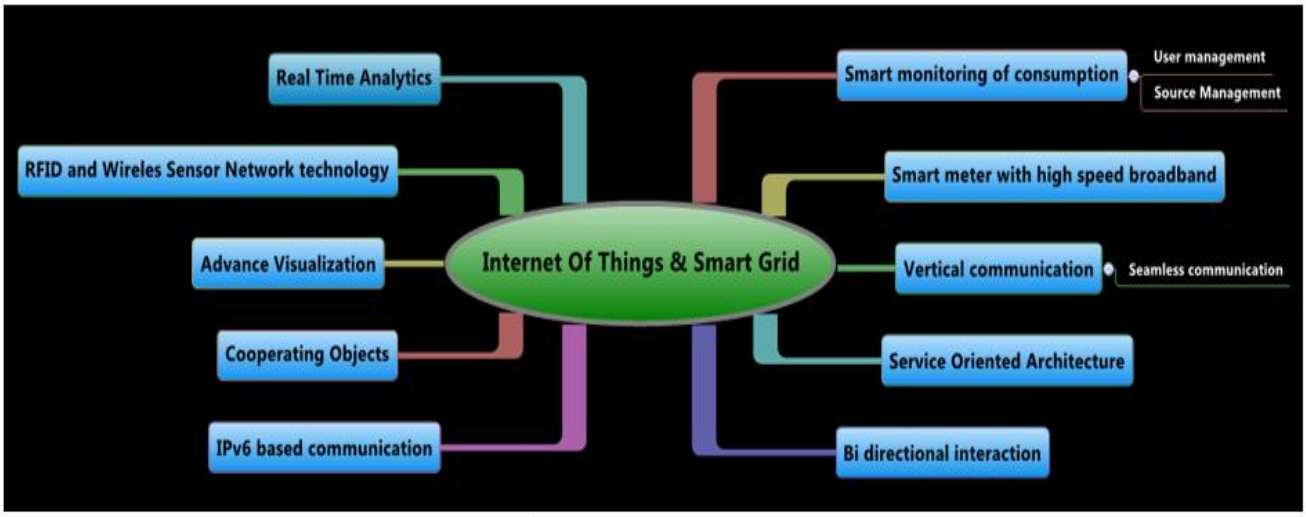


Fig M: Internet of Things and Smart Grid

Fig M explains various major factors influencing the internet of Things solution in context of smart grids. Smart Grid developers should keep an eye on the IOT.

8. Operator Room at Grid Station:

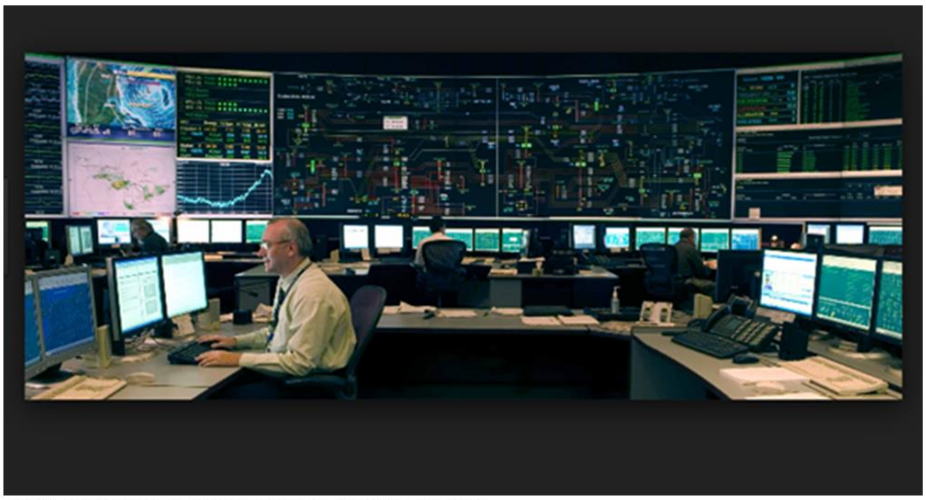


Fig N: Application of Advance Human Machine Interface

Complete information at fingertips is available for proper decision making. Advanced Human Machine Information (HMI) software which display in wall-mounted multiple display monitors for visibility, even minor granular information, are very helpful for quick and effective decisions, also available in mobile. Smart grid operations will provide a comprehensive view of the distribution system, including system status and monitoring control, outage response, planned work, optimal equipment loading, improved control over distributed generation, energy storage and demand response resources.

9. Security:

Security is one of the important aspect of smart grid solution which need separate dedicated focus and discussion in today's world. As we know smart grid is a huge complex network composed of millions of devices and entities connected with each other. Such a massive network comes with many security concerns and vulnerabilities. It is also important to explore the vulnerabilities that smart grids have created. Hooking up critical systems to a network has opened up a number of amazing possibilities, but it has also connected aging infrastructure and SCADA (supervisory control and data acquisition) systems to modern IP networks. Anything with an IP address can be hacked, and the odds shoot way up when that infrastructure is out of date, poorly protected, or both.

Old and outdated legacy system need to upgrade to comply security aspect.

Device-to-device communication in control systems is vulnerable to data spoofing where the state of one device affects the actions of another.

Security solutions on the host, on the routers, and on the switching platforms and specialized security solutions such as firewall, VPN, authentication, and IPS solutions is needed.
Validate claimed security capabilities through hands-on security and vulnerability testing using testing scenarios that are traceable to our security requirements.

To best implement security, build it in and validate it during the planning and selection phases rather than try to add it during or after deployment adopt a culture of ***"cyber security responsibility."***

Vendors should establish policies and processes for:

- Threat modeling the architectures and designs
- Source code validation
- Product testing
- System testing

These topics should be an embedded part of the product and system software development and quality processes. Post release it is required that vendors provide at least the following services to support end users throughout the system lifetime:

-Patch validation
- Antivirus validation
- Vulnerability management and mitigation

10. Predictability about the Future through Technology?

Minority Report (2002) presents a future of increasing electronic surveillance, big data, personalized advertising, and it analyzes the role of media in a future state where electronic advancements make its presence nearly boundless, decision making will be very quick as the data availability will be in the finger tips already we are realizing the same. Operation Excellency, predictability will improve. Going forwards Three Vs will influence the technology (Volume, Velocity and Variety).

Fig O: Application of Big Data, Advance Human Machine Interface

11. Aging infrastructure:

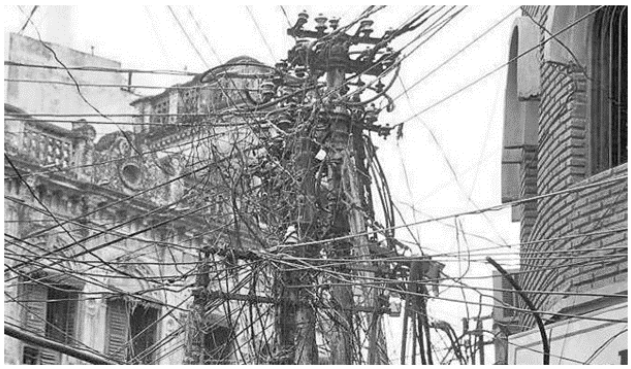


Fig P: Challenges to implement Smart Grid Solution

Aging is inevitable, and the electricity grid is no exception. Much of our equipment is beyond its design life. There comes a time when utilities must take advantage of new technologies—not just to maintain the grid, but to maximize its performance.

Grid modernization is an initiative and investment. Aging transmission and distribution (T&D) infrastructure is a critical issue for electric utilities, resulting in the need for utilities to make decisions regarding the replacement, repair, or refurbishment of their assets under a constrained investment environment and other factors.

12. Requirement Engineering:

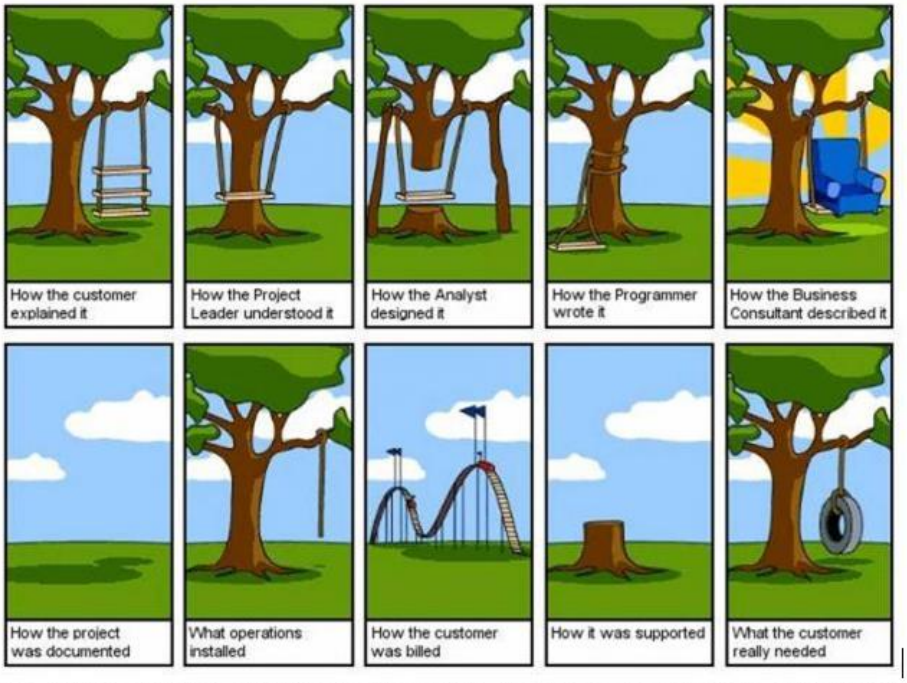


Fig Q: Requirement Management, How to avoid such situation?

What we have experienced is that requirement management is very critical, crucial area, where we need to focus extensively. Defining what the problem really is, and what kind of solution will satisfy the stakeholders — a task known as requirements analysis — is one of the most important aspects of successful software development: building an otherwise perfect system that does not meet stakeholder needs is not very useful. Improvement in this area helps us to become Lean in downstream execution. Software product development was undergone most of the time the above scenario. Organizations are trying various mechanisms to avoid the above stated Fig Q situation.

Team has to avoid such situation with proactive, high level collaboration with end user. Build an in house customer like environment where customer visit certain interval to view the latest developed software and comment. A strong product management team helps to reduce such confusion and build the expected product asked by the end user.

13. Controlled Stage Gate Model for Large System Product Release:

Large scale multi-year project execution like smart grid projects have to pass through the stage gate model below to get approval from all the engaged stakeholders and demonstrate the progress to get the acceptance for go ahead. The stringent exit criteria to pass the gates

should justify the investment and progress. Teams follow Gate 2 and gate 4 as a scrum process which is incremental build and delivery model. No big bang or surprise.

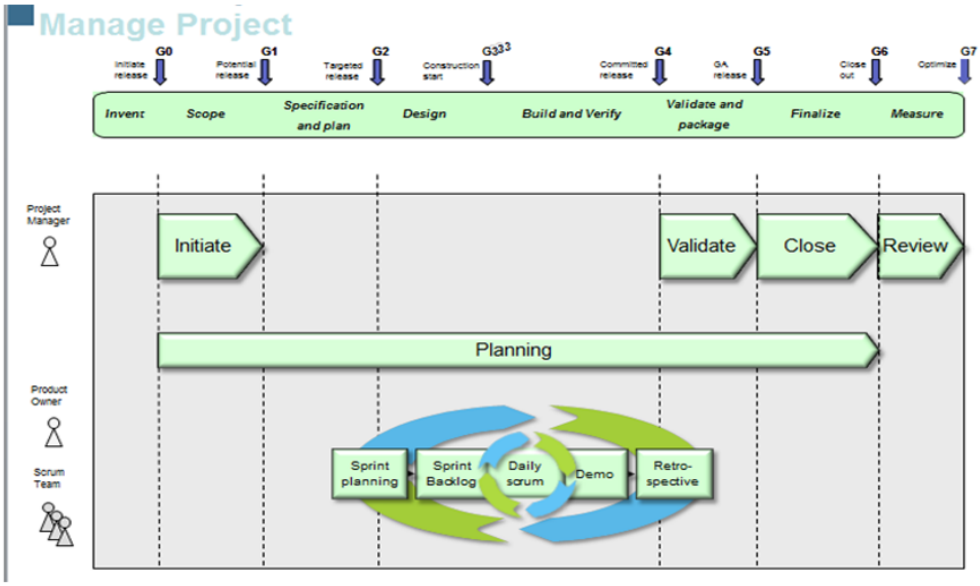


Fig R: Product Development Stage Gate Review Process, Integrated with Agile concept

14. Innovation Value Chain:

Innovation is the only way organization can survive in today's changing technological era. Companies need to identify where the **weak links** are and either create new roles for employees to help strengthen the **link** – and/or when hiring new candidates seek those who will be able to address weakness in their 'innovation chain'. To come up with a leapfrog technological solution, an organization has to run through various ideas in a rapid productization environment, tested through field deployment and refined if required.

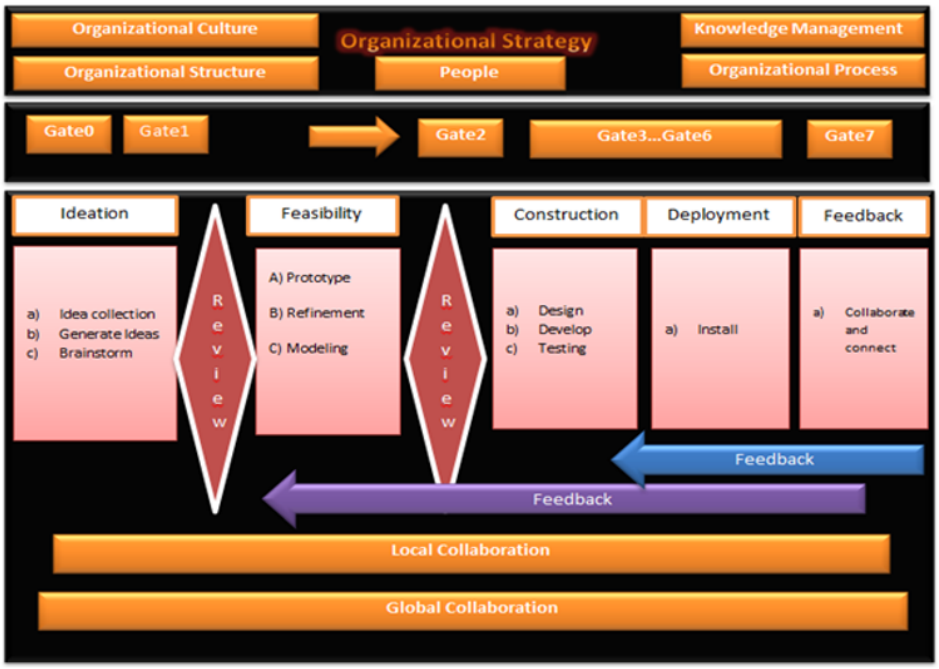


Fig S: Innovation Framework with Stage Gate Model

As the utilities will move towards Smart Grid; there will be a mandate for new skill sets to bridge the gap and to develop new skills in analytics, data management and decision support. To bring such a change utilities have to think creatively and provide an innovative and creative solution. Innovation needs a structural process to channel the ideas into the business.

15. DevOps and Continuous Delivery:

Fig T: Rapid Development and Release with Effective Collaboration

Development organizations and Operation organizations have to collaborate for rapid solution development and deployment. With a DevOps process, a team will have accelerated software delivery and reduced time to get customer feedback. The best way to develop a product for a stakeholder is to involve stakeholders at the initial stage, show and build, change if required and progress with consultation. A high configuration based product is highly acceptable for smart grid projects. Platform development which can be reused and extensible as a service to cater multiple scenarios, which can communicate with heterogeneous modules, is highly appropriate for a smart grid project. DevOps encourages extreme collaboration for a better product. The end user has to continuously, frequently get the software, use the same and provide feedback.

16. Stakeholder management:

Fig U: Managing a tough and Smart Customer

To successfully execute a smart grid project we need smart, tough customers. Consider defining Service Level Agreements (SLAs) with vendors. Clearly distinguish between

present-day versus future roadmap capabilities. A tough customer is a boon for product stability, architectural stability. A smart knowledgeable customer will help various ways to build a solid product which caters to various scenarios which can be reused in other customer cases. We need to ensure we build a process that we truly understand, that our customer values, and we deliver value constantly better than our competitors do. We build a control system which is innovative and customer centric. ***Produce only the product requested.***

17. Achieving Agility Factors:

Rapid program development and delivery is a must for today's rapidly changing world. Various steps have to be taken to develop rapid software product for smart grid project and to continuously refine the process for maturity. Agility is a must for the product development team to capture the market.

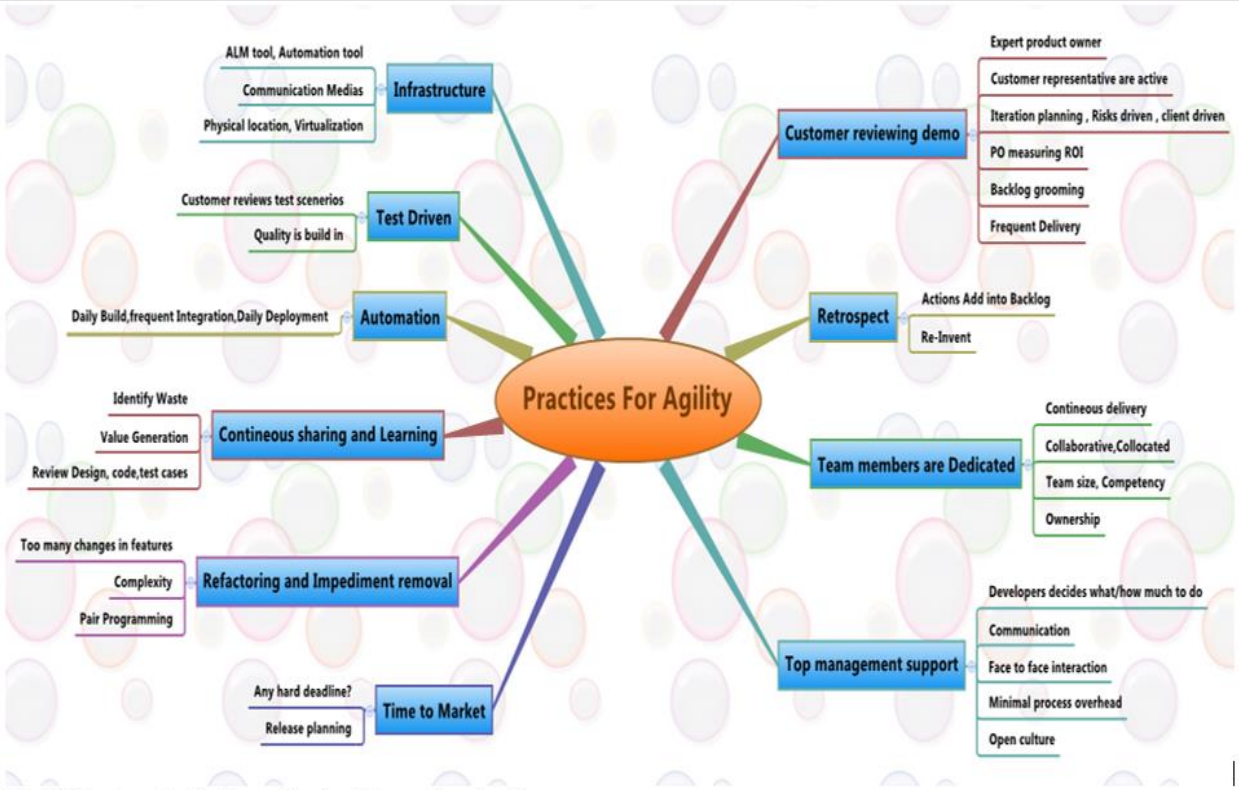


Fig V: Factors to Achieve Project Execution Agility

Fig V demonstrates the agility factors team should try to improve the speed of the execution and improve the operation excellence.

18. Strong Product Management Capability:

Product management team should be Spending time with customers, watching them use the product and competitive products, understanding more about their needs, and coming up with ideas to solve their unsolved problem. Product Manager should responsible for discovering and defining a product that is useful, usable and feasible. Collaborative way across teams and departments in order to bring new products to market or maintain and increase the profitability of existing products by adding innovative features and enhancements.

A strong product management team solves many issue well ahead than discovering as a field issue. A product manager should also be a **customer manager**. Do we know our customer, where they live? What they need in another 5 to 10 years etc. We need to build process to understand customer, which is a constant value generation activity.

Customer interviews: going around and asking people what they need.
Customer workshops: bringing together a group of stakeholders to discuss requirements. Workshops are particularly useful when various classes of stakeholders exist, with different and sometimes conflicting wishes; identifying the contradictions and discussing them openly helps understand and resolve them.

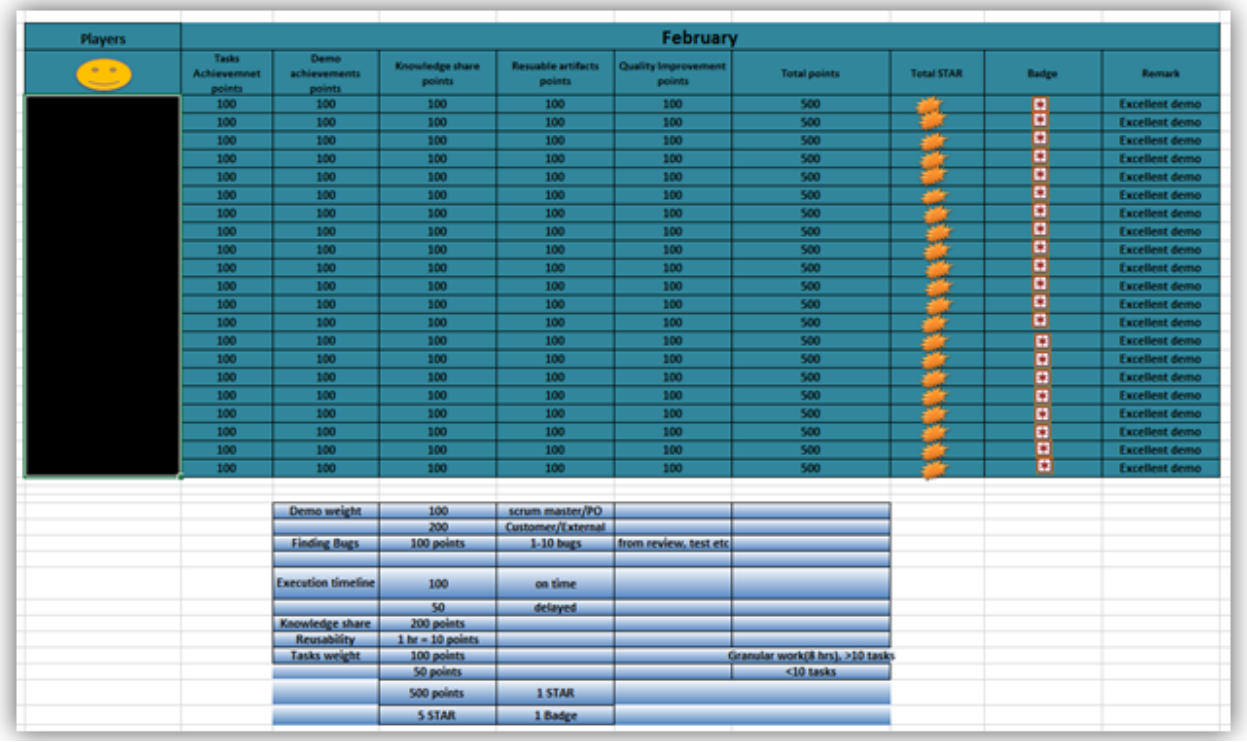
Customer or representative of the customer writes the acceptance criteria and later approve the same for acceptance test (*customer-facing tests)* so that formal approval happen. User acceptance test is a subset of acceptance test which should be done, our experience tell that it is a must.

19. Gamification to Increase Participation and Engagement:

The concept of gamification has reached a broad acceptance as a solution for better engagement and improved participation for businesses. Participation and user engagement drive business value. While participation builds lasting relationships and impacts fundamental business objectives, customer engagement will ensure business success. Smart grid project desperately need participation from all types of user to know benefit of the project and value they will get once they adapt the solution.

Fig W: demonstrates the leaderboard team were using to increase the certain dimension of the team issue through gamification. How do we engage end user or customer to participate in our development process for an expected product they were asking.Gamifying the process helps to increase the engagement.

Fig W: Leaderboard for Gamification



Players	February								
☺	Tasks Achievemnet points	Demo achievements points	Knowledge share points	Resuable artifacts points	Quality improvement points	Total points	Total STAR	Badge	Remark
[redacted]	100	100	100	100	100	500	★	▣	Excellent demo
[redacted]	100	100	100	100	100	500	★	▣	Excellent demo
[redacted]	100	100	100	100	100	500	★	▣	Excellent demo
[redacted]	100	100	100	100	100	500	★	▣	Excellent demo
[redacted]	100	100	100	100	100	500	★	▣	Excellent demo
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[redacted]	100	100	100	100	100	500	★	▣	Excellent demo
[redacted]	100	100	100	100	100	500	★	▣	Excellent demo

Demo weight	100	scrum master/PO		
	200	Customer/External		
Finding Bugs	100 points	1-10 bugs	from review, test etc	
Execution timeline	100	on time		
	50	delayed		
Knowledge share	200 points			
Reusability	1 hr = 10 points			
Tasks weight	100 points			Granular work(8 hrs), >10 tasks
	50 points			<10 tasks
	500 points	1 STAR		
	5 STAR	1 Badge		

20. Conclusion:

In this paper an attempt has been made to analyze the key challenges in implementing a Smart Grid project; there could be many more. I could not elaborately explain all the points, however the figures captured main points which we are experiencing in different contexts. To reap the expected benefits from smart grid projects, a team has to excellently follow the items mentioned above. Steep organization hurdles, significant process complexities and difficult governance issues have to be identified and these impediments removed from the system. The team has to create a compelling vision to execute the smart grid projects so that target expectations are met.

It needs a huge investment and time to execute such large scale projects targeted for the smart grid market. Justifying its implementation however requires a full understanding of the long term benefits it can bring to customers, utilities and societies in terms of minimizing the cost and improved customer service. In addition to these benefits it would play important role in addressing global issues like energy security and climate change.

Extreme collaboration:

Satisfied customer:

Success will follow ……

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Mr. Chandan Lal Patary is currently working as an agile coach and Global Program manager at ABB. He has deep experience in developing Software products across various domains and has successfully executed many Projects. Chandan has worked on domain like Healthcare, Aerospace, Building automation, Power automation, Industrial Automaton under real time mission critical product development to large scale application development. Chandan has 16+ years of industry experience. He is certified PMP from 2008, Green Belt certified holder from 2005. Chandan is an agile practitioner and Certified Scrum Master from 2011. Chandan holds a Bachelor's from National Institute of Technology (National Institute of Technology –Agartala, Tripura) in Electrical Engineering-1998. He has completed one year Executive General Management program from Indian Institute of Management-Bangalore, Karnataka in 2007. He has published several management papers. He can be reachable through email: patarychandan@gmail.com and LinkedIn.