How to ensure quality assurance in smart meter rollout

Rajesh Sarangapani, Assistant Vice President – Technology, Cigniti Technologies provides insight into the key factors that contribute towards a guarantee of the quality of smart meters

Over the last decade, the landscape of power generation has been rapidly undergoing transformation from relatively fewer power points of injection to a multitude of distributed power generation and millions of consumption points in addition the timeline between energy generation and consumption is very short so balancing the demand and supply of power has become a challenging mission. In order to solve this challenge we need a system to predict consumption patterns, manage distribution scenarios and strengthen strategies to avoid outages, power thefts and decrease revenue leakage. To manage such a complex ecosystem, IT systems that can automate, track, monitor and control of power flows are the need of the hour.

Smart grid systems are being proposed as a means to improve the effectiveness of demand and supply management by improving predictability, reliability of power generated and transmitted, which in turn, can lead to optimisation of overall costs (per kWh) of power generated.

Smart meter is an electronic device that is intended to be installed at every consumption point to measure power consumption frequently and automatically transmit them to enterprise applications located centrally with the utility providers. The consumption data from smart meters will help manage demand and supply more effectively by utilising near real time consumption data. These meters when deployed will transform the way utility providers' bill their consumers as well as manage complaints and proactively solve faults rather than waiting for the customers to raise tickets.

Why smart meter programs can't be compared to your regular IT roll-outs?

Smart meters program impacts all the three dimensions (people, process, and technology) of enterprises. Some key impacts:

- **Change management:** Sweeping changes may be required to current business process across departments (for example, customer relationship, billing, IT),hence, ensuring that workforce is productive after the change is critical
- **Collaboration:** IT and OT organisations in the enterprise need to come out of the traditional silos and proactively collaborate to ensure that the roll-out is successful
- **Resistance to change:** Smart meter roll-outs impact the end consumers ensuring that consumers awareness is increased in order to minimise the resistance to switch is paramount
- **Compliance:** Multiple business process enhancements need to be made to ensure we meet regulatory requirements
- **Latest technology components:** Emerging technology components (software, hardware, networking infrastructure, etc.) are planned to be deployed and integrated in the overarching enterprise landscape that can disrupt the current operations
- **Trust:** Customers can lose trust due to incorrect billing or data theft post roll-out.

What is unique about smart meter roll-outs that warrant specialised testing focus?

- **Impact on business processes and revenues:** Numerous changes to current business process architecture and new billing or pricing structures or contracts will be introduced that impact the top-line of utilities.
- **Data deluge:** 3,000-fold increase in volume of consumption data processed per year.
- **Security:** Introduction of new edge devices as well some architecture components (that implement security by obscurity) open up the doors for new attack vectors.
- **Data privacy:** Inappropriate access to consumption data from the edge devices can lead to misuse of private information.
- **Availability:** The expectation is zero downtime from the Integrated IT systems.
- **Emerging technologies:** Adoption of cutting edge and emerging technologies create additional quality risks; they need to be proven on the field by testing in real life situations.
- **Interoperability:** The edge devices (Smart Meters from various vendors such as Itron, Cyan), networks like Home Area Networks (HANs) and Wide Area Networks (WANs), and communication technologies (Radio Frequency, GPRS, Wireless) can seamlessly interoperate.

Testing strategies and models that must be adopted to ensure right coverage

To meet the quality goals of smart meter deployments, QA managers will find it beneficial to include the following as part of their overarching testing strategy:

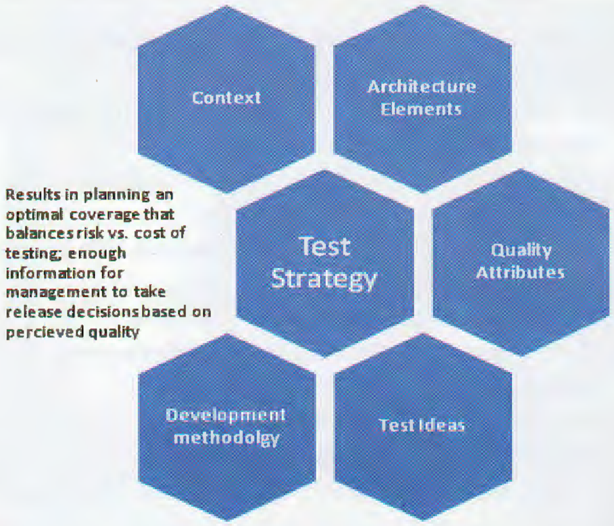
- A test environment that is as similar to the production environment as possible
- A comprehensive set of usage scenarios that mimic a typical operating day
- Integrated test plans that cover interactions with all system elements or components
- Performance tests for normal and peak loads
- Performance tests of normal and degraded communication systems
- Security testing that covers E2E from Meter>Network>Enterprise Application
- Simulation and emulation of operation of multiple devices.

For such a demanding QA scenario, Smart Meter testing demands a heuristic combination and strategic integration of the components explained below. The components tend to overlap into each other and might demand additional integrations depending on the scale of the business environment.

Here is a simple heuristic model that explains how to develop a testing strategy that allows optimal test coverage.

Architecture elements: To ensure impeccable QA, the testing strategy should encompass the fundamental components in the ecosystem.

- **Platform:** The ecosystem has a combination of multiple



hardware and software interactions (for example, HAN or NAN, communication infrastructure and protocols, RF devices) to achieve the business transformation.

- **Interfaces:** There are multiple touch points that support the smart metering architecture: Head-end to meter data management systems, Head-end to Customer Information Systems and smart meter hardware specific interfaces, for example, optical port, user interfaces (IHD), etc.
- **Data:** The business transformation is underpinned by the accessibility of critical data (consumption and other data dimensions to help maintain system of records) from the edge systems (meter end points) to the centre (backend end enterprise systems). The input or output data are key interactions that need specific test procedures to ensure coverage.

Quality attributes: In a smart meter, some of the attributes are implicit. In addition to the assessment of specified quality attributes, intensive testing is essential to uncover the attributes that tend to disrupt the production environment.

- **Compliance and regulatory:** Multiple compliance requirements, for example, FCC, and code of practices that providers need to comply with during meter deployments
- **Data privacy:** Consumption and customer data is handled in accordance with the Data Privacy Act.
- **Interoperability and compatibility:** As smart meter deployments happen, the ecosystem will have multiple communication nodes as well as devices from various manufactures. Interoperability of these devices will become critical to allow consumers switch between providers.
- **Scalability and performance:** Millions of end nodes transmit data back to head-end resulting in an unprecedented volume. The system's scalability will be an important factor that needs attention under different operating environments (normal and degraded).
- **Security:** Increased surface area of attack due to expansion of the enterprise perimeter could result in threats that the secured enterprise systems need to mitigate. These threats could result in data theft, power outage (small or localised, large) and attacks that lower the confidence in the overall trust.

Test ideas: Design tests that help to weed away faults in the system.

- **Feature or flow:** Componentise the system into multiple functions or sub-functions and design tests to verify the specifications, design scenarios that will go through the various states as well as user journeys that would be executed during an operational day
- **Problem:** Design tests that would result in critical defects that impact the system availability
- **Automated:** Design tests that can take structural inputs (state diagrams, impact analysers, data generators, pair-wise tools)and produce test cases
- **Workload:** Design tests that would test an operational day, peak day, as well breaking point to understand the limitations
- **Entitlement:** Design tests that would verify all the Service Level Agreements (SLAs) or Operational Level Agreements(OLAs), compliance, implicit, and explicit requirements
- **Domain:** Design tests that would validate boundary, representative, and invalid or valid conditions.

Methodology: In the smart meter ecosystem, the methodology is expected to be conducive to balance cost, quality, and schedule constraints.

- **Iterative practices:** Transition services from the current waterfall methodology practices to more iterative development or test methods for incremental development
- **Test phases:** Develop multiple test phases that simultaneously complement each other
- **Tools:** Testing tools and utilities that help build efficiencies and lower the Total Cost of Ownership (TCO) for testing
- **Regression packs:** Build automated regression testing packs to ensure risk mitigation in change management
- **Test management:** Use analytics and predictive tools to provide insights into go-live readiness
- **Test environment:** Build close to 'real life' environment that includes hardware and software virtualisation.

Conclusion

When compared to traditional IT systems, the smart meter ecosystem is completely different with a life span in the range of 2-3 decades, deployment cycles of 2- 5 years, hundreds of servers, thousands of nodes and millions of end nodes.

By standardising power distribution, smart meters bring together the business interests of energy and utilities companies, the growth roadmaps of the governments and the demands of the global economy. It should not come as a surprise that smart meter quality assurance will play a crucial role in the adoption of energy policies based on predictable demand and sustainable models of distribution.

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