



V&V Strategy for IOT Adoption in the Retail Industry



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The Retail Industry - An era of disruptions and constructions

Digital revolution has enabled the online presence of a range of retailers, and on the other end urged participation from broad spectrum of consumer base. The Internet of Things (IoT) is taking the impact of digitization ahead with new trends being set by cognitive computing, distributed commerce, augmented reality and possible use of drones in the retail sector. With big opportunities come bigger challenges and more important becomes the efficient usage of enabling technologies. For good customer experience, it is critical that the systems work as the customers expect them to and there rigorous testing of the IoT systems plays a differentiating role.

This paper describes a comprehensive approach to evaluate the test strategy followed for deployment of latest digital technology, specifically IoT and introduce a framework for qualitative and quantitative benchmarking of the systems.

Connected devices are dramatically reshaping the entire retail industry by adding more intelligence to the objects that surround us in a retail experience — everything ranging from cameras, sensors, beacons, utility meters to home automation. The devices will produce enormous amounts of data that companies can leverage to improve their operations, serve customers better, and create entirely new ways of doing business. The IoT movement offers retailers opportunities in three critical areas: **Customer Experience, the Supply Chain, and New Channels and Revenue Streams.**

Improving the customer experience

Retail consumer experiences are converging into “Internet of Me,” that describes an interconnected environment in which businesses are building products and services to be designed for, created for, and specifically centered on the individual. So, the focus is more on Personalized experience, instead of generic user. There is a need to connect with customer at personal level to enhance the in/out-store experience, i.e. recreating a persona of customer based on his demographics, location and buying interests and offering a personalized shopping experience while protecting the privacy.

Creating new channels and revenue streams

The true power of IoT lies in the opportunities it presents to retailers to create new revenue streams or, in some cases, build entirely new channels. Connected platforms would give retailers another direct channel to customers, generating a potential gold mine of customer data relevant to the respective retail consumption. The data when analyzed on a macro scale, will help retailers to drive more targeted offers, build more relevant products and offer new services such as automated replacement of products based on the customers’ consumption or by monitoring perishable dates.

Optimizing supply chain operations

Connected devices and products provide retailers with the opportunity to help optimize operations in the face of a more complex supply chain, increasingly important digital channels, and more demanding customers. IoT enabled systems can improve the precision of inventory tracking and data visualization technologies make it easier for employees to track products across the supply chain. From a business perspective IOT ecosystem helps to adjust pricing in real-time. Internet-enabled smart tags can help to manage prices on promotional, low-turnover or higher-demand items and also across channels to verify prices are consistent between online and brick and mortar stores.

IOT adoption in the Retail industry

Based on our analysis of important retail industry aspects, we identified the Use-cases which will drive the first wave of IoT adoption:

- Improving the customer experience
 - Digital Signage - Deliver a better shopping experience
 - Vending machines - Modern, intelligent vending systems
 - POS Point of Sales - Personalize the point of sale
- Creating new channels and revenue streams
 - Kiosk- Attract customers and promote sales
 - Responsive Retail - Adapt to changing customer preferences
- Optimizing supply chain operations
 - Retail Ecosystem- A secure platform powering a range of smart solutions
 - RFID assisted inventory movement and tracking

The challenge for testing in the IoT era

Let's take an example around **improving the customer experience** and consider a Beverage Dispenser. Without IoT, following are the simplified steps to get your favourite drink:

1. User goes to beverage dispenser
2. User selects her preferred option
3. User enjoys the drink

To provide personalized user experience, there is a potential of a dynamic UX (User Experience) and the opportunities for producing valuable data. Following are the important system aspects:

- Must be able to change UI based on human presence
- Must be able to collect and analyze data
- Provisioning of right sensors, network and positions to identify user persona
- Mechanism to collect data sets on (1) Persona (2) Context (3) Interaction and (4) Consumption
- Machine learning solution to analyze captured data sets and provide intelligence to UX to configure

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- Dynamic UX
 - Machine Learning
 - Data Elements
-

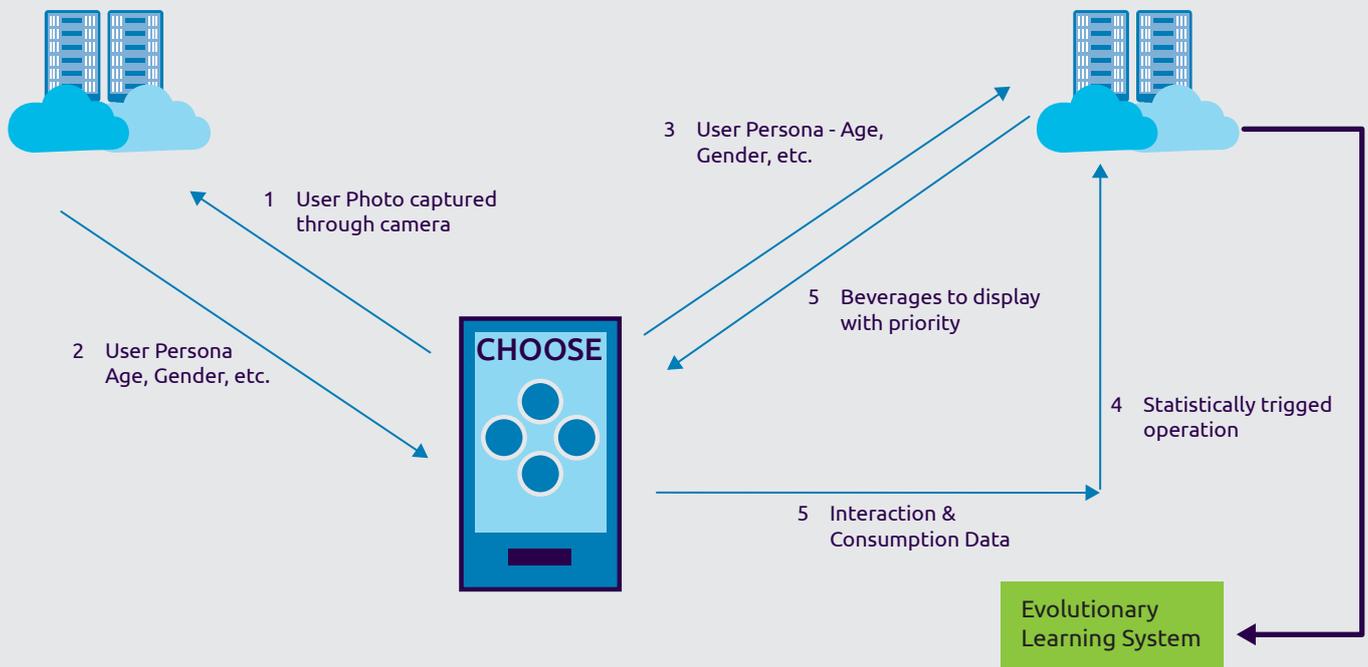


Fig: Sample Use- case: beverage display priority changing based on Machine Learning and UX optimized based on persona.

To have an engaging user experience in this use-case, following are essential:

1. Context:

- *Technology stack:* Camera, Sensor, Network, iBeacon;
- *Demography:* Country, State, City;
- *Place:* Mall, Office, Restaurant;
- *Season:* Summer, Spring, Fall, Winter;
- *Time:* Time of the day;
- *Day:* Weekend, Weekdays, Holidays;
- *Usage:* One user, long queue

2. Persona:

- *Age Group:* Kids, Young, Senior Citizens
- *Gender:* Male, Female, Other
- *Emotions:* Happy, Sad, Angry

3. Interaction:

- *Display options as per Persona and Context*

4. Consumption of drink

Another example is the Amazon GO store, where the concept utilizes several technologies, including computer vision, deep learning algorithms, and sensor fusion to automate much of the purchase, checkout, and payment steps associated with a retail transaction. The store concept is seen as a revolutionary model that relies on the prevalence of smartphones and geofencing technology to streamline the customer experience, as well as supply chain and inventory management efficiencies.

In such a scenario Testing of the system is going to be a constant challenge. The testing will vary based on the user interface/ experience, machine learning, data analytics inputs. Testing needs to be adaptive. Test script, test assets need to configure during run time based on possible permutation and combination of the user preference.

IOT Testing and our Point Of View

To seize the IoT high ground, QA organizations need to view testing at all layers of connected ecosystem. QA organizations need to elaborate the paradigm shift required in testing in order to embrace the technology changes applicable to products and services offered in wide spectrum of IoT.

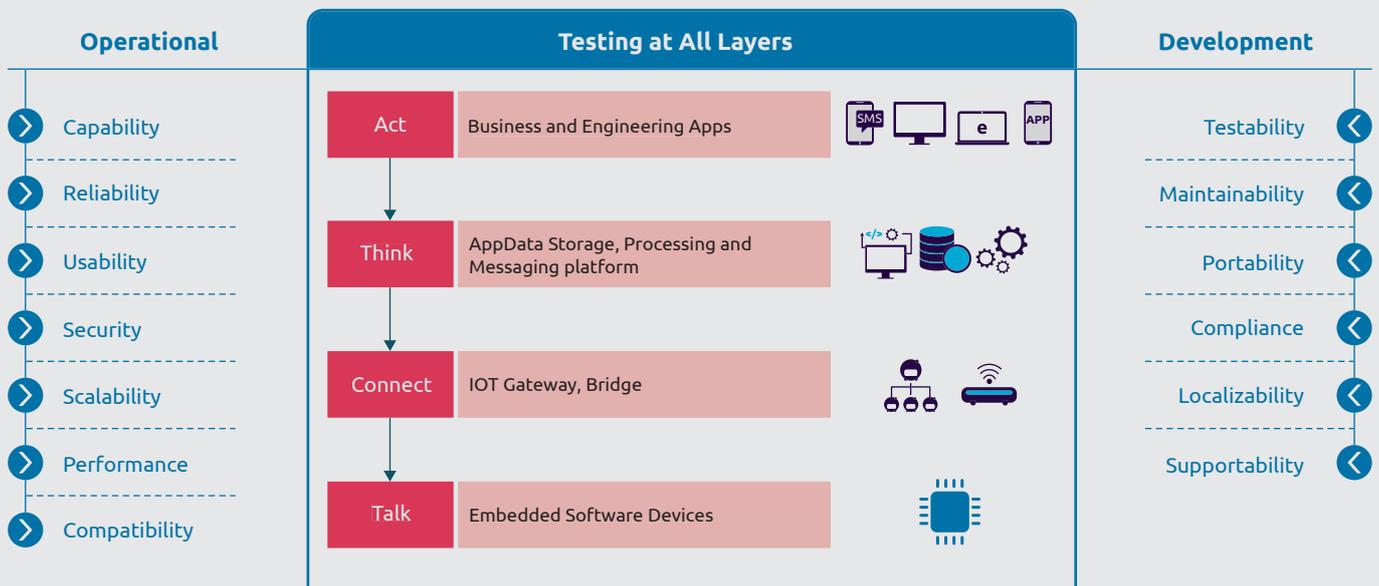


Fig: IoT Testing : Our Perspective

To take care of the complexity which comes with the connected ecosystem, it is important to check the integrity across all layers while keeping focus on the operational and development quality criteria.

Test focus – Complete systems

Connectivity services encompass the entire connected solution components from device to service delivery platform, data store and analytics, OTA and Security and Identity Management, and applications. The focus is to test from an end-to-end

perspective, to ensure that the complete system promises to deliver the expected performance and user experience with integrity.

The following figure represents a blueprint of the “Connected System” solution for retail and probable test focus at each layer.

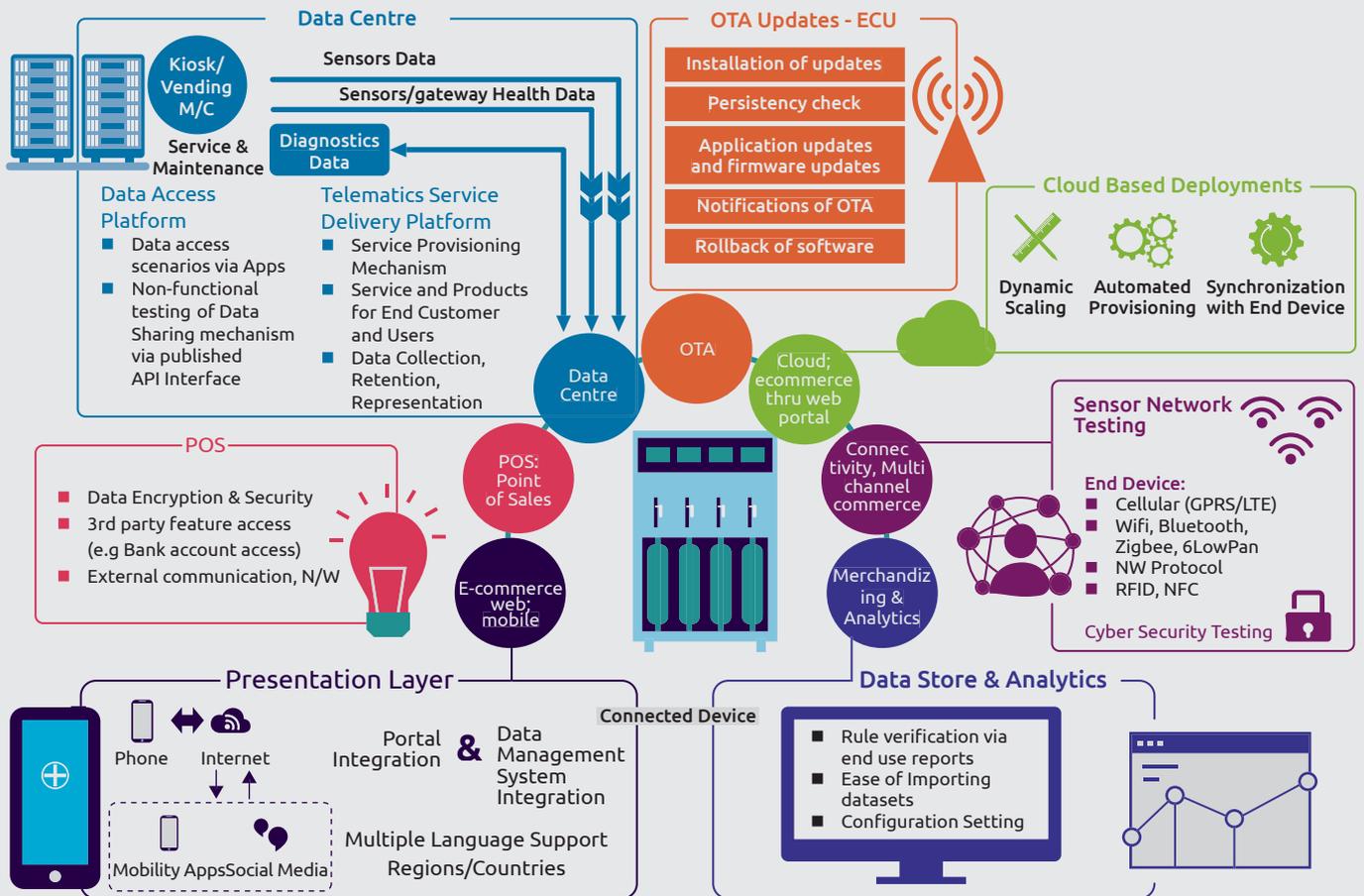


Fig: Blueprint of a Connected System for Retail

It is also important to weigh the emphasis on the quality criteria to be applied on each layer of a Retail IOT implementation. Of course, the emphasis will differ based on the actual IOT implementation details and the target use-cases.

IoT Elements	Sensor/ POS	Application / ecommerce web; mobile	Network/ Connectivity multi-channel commerce	Data center
Quality criteria				
Capability	Y	Y	N	N
Usability	Y	Y	N	N
Security	Y	Y	Y	Y
Performance	N	Y	Y	Y
Compatibility	Y	Y	N	N
Reliability	Y	N	N	N
Scalability	N	N	Y	Y

Need of IOT Test Strategy

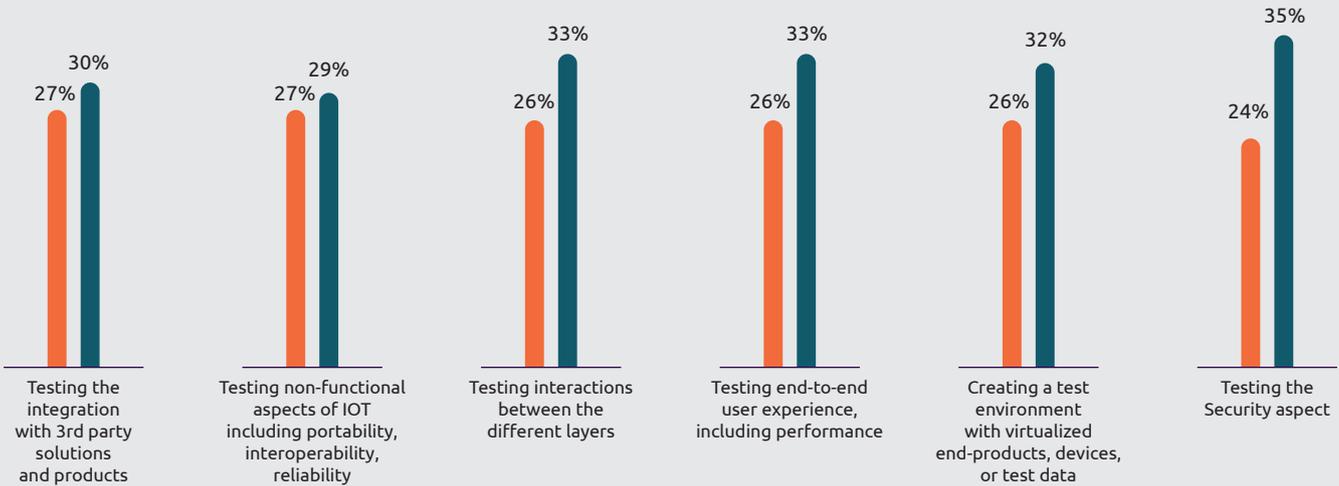
IOT adoption in organizations remains high. However according to Capgemini's World Quality Report (WQR) 2016 - 2017, the percentage of companies that do not have specific strategies for IOT testing has decreased from 56% in 2016 to 51% in 2017. We believe that IOT test strategy is imperative, because testing these smart connected solutions demands a much more complex scope than traditional software testing and so organizations must pay attention to define the test strategy for system testing.

Strategies to test in an Internet of Things environment (Capgemini's World Quality Report 2016 - 2017)



In the absence of a consistent test strategy, the report points out the following common challenges with testing products in the internet of things environment.

■ 2017 ■ 2016



To have the holistic approach towards testing of IOT implementation, it is important to check whether all quality criteria and their measurements are defined for each layer. IOT Test strategy assessment framework will help the testing team to identify and check whether all quality criteria are covered through different testing types to ensure test coverage across each layer. This framework will help in assessing both green field implementations as well as current system upgradation to IOT ecosystem.

IOT Test Strategy assessment framework: A Snapshot

IOT test strategy assessment framework should consist of questionnaires, guidelines and checklists for comprehensive check at each IOT layer. The framework should enable and enforce test coverage across the layers. It should be a gap analysis tool and drive recommendations on next steps to be charted out.

Sensor/perception layer (TALK):

Check for

- Anticipated scale of implementation (scalability) in terms of number of devices
- Details on gateway specifications, with respect to maximum number of sensors - their types and speed of data streaming that the gateway is capable of handling
- The functions expected from devices and sensors. For example: monitoring only, reporting and logging, remote operation, analytics etc.

- How the gateway is being integrated with different sensors. Which communication protocol is being used between 'Gateway and sensors' on one side and 'Gateway and data storage' on other side
- The types of devices in-use and usage of multiple communication protocols across these devices/ gateways
- Various parameters and types of data related to the device health, that are captured by the device
- How the device (sensor/ gateway) management is done at the middleware level
- The security provisions (policy, framework) used at device level

Assessment at this layer helps to check whether we have all testable items listed and identified the corresponding testing type required to test each parameter independently.

- Whether Validation is taken care of: Device Hardware, Embedded Software, Interaction between devices, Basic device Testing (Start/Stop/Restart/Interrupt), Error Handling, Calculation and calibration
- Whether performance validation is taken care of: Data transmit frequency, Multiple request handling, Synchronization, Interrupt testing, Device performance, Consistency validation
- Whether Security and data validation is taken care of: Validate data packets, verify data loses or corrupt, Data encryption/ decryption, Data values, Guarding against eavesdropping, data loss, and link failure

Connectivity layer (Connect)

Check for:

- The data transmission / bandwidth requirements for the following type of IoT deployment (Device - gateway, gateway - Cloud):
 - sensors need to report real-time (mission-critical data)
 - sensors need to report data (but not necessarily in real time)
 - sensors function in silo - no great integration needed
- The network connectivity and range requirements: short range (wifi, BT-LE, etc.), within cellular coverage, outside of cellular coverage (satellite coverage)
- The multi-protocol data communication - between endpoint devices and gateways; between gateways and cloud
- Whether the gateway can handle multi-directional encrypted communications

This assessment helps to identify need of simulation inside test labs, for scenarios which are controlled, repeatable and cannot be tested on field.

Data store layer (Think)

Check for:

- The different analytics to run on the data captured
- The data privacy requirements of end-users
- The response time requirements
- Whether data/ business rules/ report validation is in place to check interoperability on various hardware platforms
- Whether the cloud component/ data layer, supports encrypted communications including security certificates to prevent data from being exposed in transit

Application/ Presentation layer (ACT)

Check for:

- Whether App or portal testing is being taken care of, to validate different services. Are services provisioned based on different roles.
- Whether support to multiple regions, languages, smart devices are available.
- Through APP/ portal, how is the device (sensor/ gateway) management being done.
- Whether validation of Identity management is in place to authenticate the user through valid certificates.

Conclusion

A complete and holistic IOT test strategy is important for the success of the IOT implementation. Our Test Strategy Assessment Framework, helps in identifying the right testing type and test focus area for each layer of IOT implementation. This approach helps to reduce the complexity due to varied technology and unbound scope of IOT ecosystem under test.



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