PERFORMANCE TESTING INTERNET OF THINGS (IOT)

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Internet of things (IoT) is a network of systems, devices, and sensors which are connected and this connectivity enables these objects to share the data. It is a platform which allows to manage the data and controls the devices remotely based on the requirement.

The IoT has gained momentum in the recent years due to Internet availability, cloud evaluation, and micro services evaluation. According to Gartner, IoT connected devices are growing at 30 percent year-on-year and there will be 20 billion devices connected by 2020 (more than human population). IoT business is growing at 22 percent year-on-year and will reach US$3010 billion. People, government, and business will be hugely affected by IoT in the coming years resulting in smart cities, smart homes, smart hospitals, and so on.

IoT devices produce data continuously. This data needs to be saved and analyzed for future decisions and these decisions may be immediate or may be taken later by using business intelligence (BI) analytics. IoT helps in improving the operational performance and cost optimization. So achieve this, IoT systems must be built for high performance and scalalability. To measure these two key attributes of an IoT application, it is important to understand the business value for which it is built. In addition, to measure performance, it is necessary to simulate real-world workload models, which can be created using business requirements, historic data and future growth require-ments, type of devices, network conditions, usage patterns, and geographic spread. Application usage patterns are arrived by analyzing the IoT application logs for peak hours and normal hours. Using these data points, different workload conditions (real-world load test / simulation) can be created for peak usage, normal usage, future growth, and daylong / multiday simulations.

IoT performance testing (PT) is little different from traditional performance testing. Following table illustrates differences between traditional PT vs IoT PT.

Some of key differences between traditional PT and IoT PT:

Key differences	Traditional PT	IoT PT
Simulation	Simulation of users	Simulation of devices / sensors
Scale	Few hundred users to few thousand users	Few thousand devices to few million devices
Amount of data	Sends and receives large amount of data per request	Sends and receives minimal data per request but data is shared continuously with time interval
Protocols	Uses standard protocols to communicate	Uses non-standard and new protocols to communicate
Requests / responses	In most of the cases, users create the requests and receive the response	Generally IoT devices create the requests and receive response as well as request, and provide response
BI	Only few applications have BI as part of testing	BI will be a part of IoT; needs to measure performance by applying loads on IoT app

Because of these differences, IoT PT poses a lot of challenges to performance engineers. Below sections will describe different challenges posed by IoT applications and Infosys solution elements for each of the challenges.

Performance testing challenges

Protocols and performance testing tool

IoT does not have standard protocol set to establish the connectivity between IoT application and devices. IoT protocols used range from HTTP, AllJoyn, IoTivity, MQTT, CoAP, AMQP, and more. These protocols are still in the early phases of development and different IoT solution vendors come up with specific protocol standards (sets). These protocols are continuously evolving with IoT applications. Since these are new technologies / protocols, and current performance testing tools may or may not support them.

Geographical spread and network conditions

IoT devices / sensors are spread across the world and use different networks to connect to the IoT servers to send and receive the data. As part of performance testing, there is need to simulate devices from different locations (to simulate latency) with required network technologies like 2G, 3G, 4G, Bluetooth, etc.

Load conditions

It is necessary to load test the applications by simulating real-world conditions. These patterns are complex in nature and it will be extremely difficult to collect and predict the data. To recreate real-world load conditions, we may land up simulating millions of devices.

Real-time decision making

Some IoT implementations may require the data from a device that needs to be processed at runtime and based on the data received, the corresponding decision is taken. These decisions are generally notifications / requests to different devices / sensors or different systems which perform particular action. As part of testing, these notifications / requests need to be monitored for performance (time taken to generate the notification / request from the data received by IoT application).

IoT application monitoring and BI processing

Monitoring is essential for any application.

It helps understand the system behavior under real-world conditions. For IoT applications, both the application and the backend BI systems need to be monitored. This will help understand data processing, both in terms of the volume and accuracy.

Infosys IoT PT solution

Infosys created a comprehensive framework using JMeter to support all the needs of IoT PT.

Protocols and performance testing tool

Infosys selected JMeter as performance test tool to conduct PT. JMeter already has support to most of the IoT protocols like HTTP, CoAP, AMQP, MQTT and Kafka. As IoT is an emerging area, new protocols are being developed over the time. To on-board new protocols Infosys has come up with a protocol framework using protocol SDK and extending the JMeter. Using these JMeter extensions, scripts can be prepared to simulate new protocol requests and devices.

Geographical spread and network conditions

To simulate geographical spread, JMeter is integrated with cloud solutions like Amazon web services (AWS) to setup the load generators across different geographies. Using AWS integration, JMeter is able to generate the traffic from different locations of the world to IoT application to mimic the geographical spread and network latency.

Infosys has in-house IP-based solution, Infosys Network Simulation tool (iNITS), to simulate different network conditions required for any requests which use transmission control protocol (TCP). We have integrated iNITS solution with JMeter to simulate different network conditions required by IoT PT.

Load conditions

To collect the accurate real-world scenarios, Infosys developed different tools / frameworks like non-functional requirements (NFR) questionnaire, workload modeling tools, and others. These tools / frameworks reduce the requirement gathering and collect the information more accurately.

To simulate millions of devices, JMeter integrated with cloud using automated scripts. These scripts will create required number of load generators in cloud, setup the JMeter, copy the scripts, test data, execute the results, collect the results, shutdown the LG's which are created, and process the results.

Real-time decision making

Notifications, which are sent to other devices / sensors / systems, need to be monitored using stubs / service virtualization technologies. IoT application logs are collected and analyzed for processing time and response time of the real-time processing and decision making scenarios under different load conditions.

IoT application monitoring and BI processing

Infosys created predefined process / performance metrics collection to monitor the systems (Web / app / database layers) deployed in cloud and data center. These metrics are analyzed to uncover possible performance bottlenecks. If BI systems were built using batch jobs, then enough test data needs to be created using performance test scripts and the batch jobs executed to monitor the BI system. If real-time BI systems were implemented using hot channels then, BI systems need to be monitored as a part of different performance tests by generating different amount of data per second / minute / hour. Using this approach, IoT applications are comprehensively monitored and performance results are benchmarked against different load conditions.

IoT PT resources

Infosys presently has 1200+ performance testing resources having experience in testing different types of applications, technologies, and tools. And more than 500 employees have working experience on JMeter.

Infosys has dedicated resources who are trained on IoT performance test frameworks (JMeter, new protocols, network simulation, and IoT monitoring). These resources continuously explore the opportunities to improve the framework, tool, and protocols supported.

Infosys IoT PT – Key features and benefits

Features		Benefits
Support for different communication protocols such as HTTP, REST over HTTP, MQTT, AMQP, CoAP, Kafka and Web Sockets.	01	As solution is based on open source tool, no License cost for performance test tool and cost for network simulation only.
Supports different network simulations for all type of Protocols.	02	Faster time to market.
Supports cloud based load generation. Automated scripts available to generate the load from cloud.	03	No need to have hardware as device simulation can be done from Cloud.
Framework is available to onboard new protocols.	04	Quick onboarding of new protocols.

Conclusion

Infosys created a compressive solution for IoT performance testing, which covers specific needs / demands of IoT. Currently, solution supports all leading IoT protocols and network simulations. Infosys IoT performance solution is very cost-effective when compared to any standard performance test tool.

We have dedicated workforce trained on IoT performance testing to support the growing demands of IoT PT. Using Infosys IoT PT solution, clients can save 80 to 90 percent tool cost and reduce go-to-market time by 20 percent.

References

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