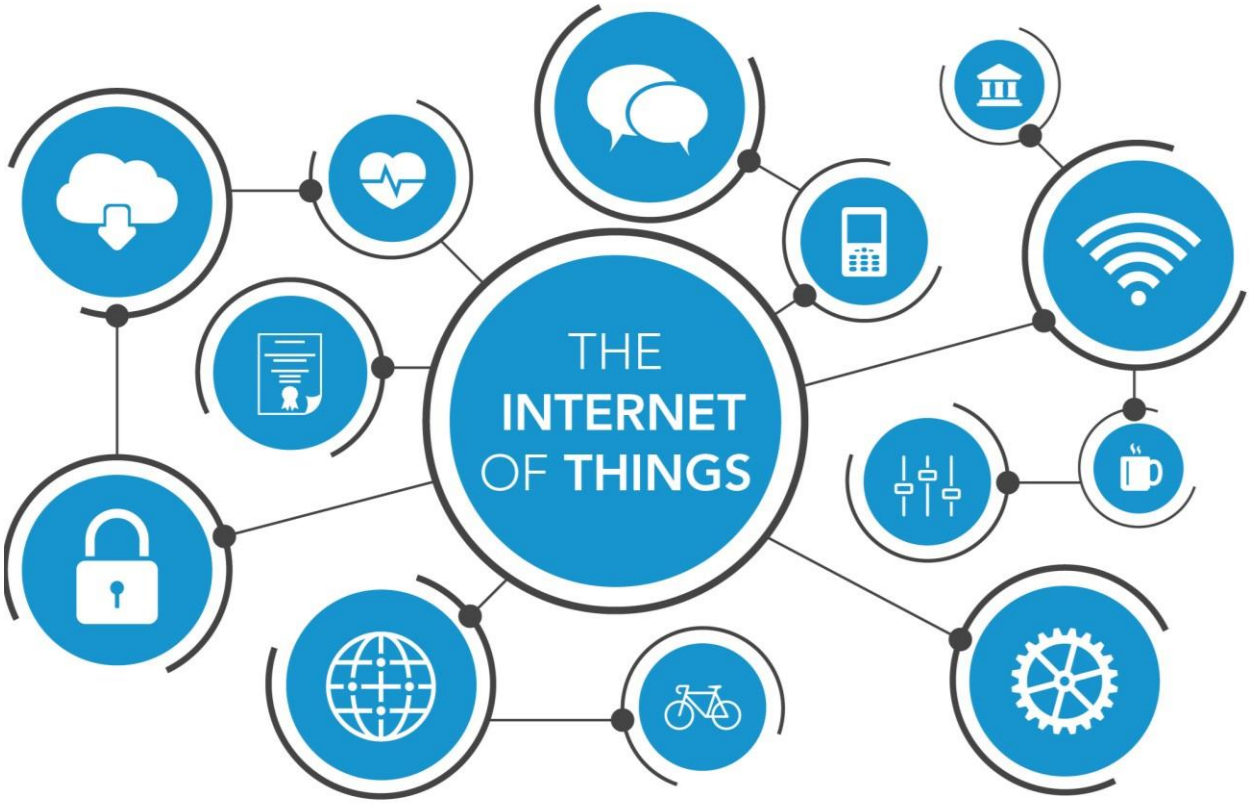
IOT as a Service!

New paradigms for a hyper-connected world.

Vidyasagar Nallapati, Anandh Venkatraman | Dell Technologies



Introduction

There is no choice over where we will reach based on the road we choose. IOT as a service is one such path that exist for enterprises who are looking for one.

After the last three decades of accelerated socio-economic growth with science and technology, there is the next wave of disruption. Internet of Things (IoT) is changing the way we communicate with everyday things. With real, practical products and services gaining importance in our day to day activities starting from fitness trackers to automating homes, offices the wave is already there.

The business forecast of IoT market is already impactful at a global level. For the next, five to ten years Gartner estimates a benefit of USD 2 trillion in 2020[2], IDC Estimates USD 1.7 trillion in 2020[1], and McKinsey estimates growth to go around USD 4 trillion to USD 11 trillion. The clear statistic is the there is

a growth and curve is steep. For catering this forecasted growth, Gartner notes that IoT and the business models associated are not enterprise ready.

The platform of platforms approach towards designing, development, deployment, and operationalization of various IoT applications and Business Processes would be a solution for this.

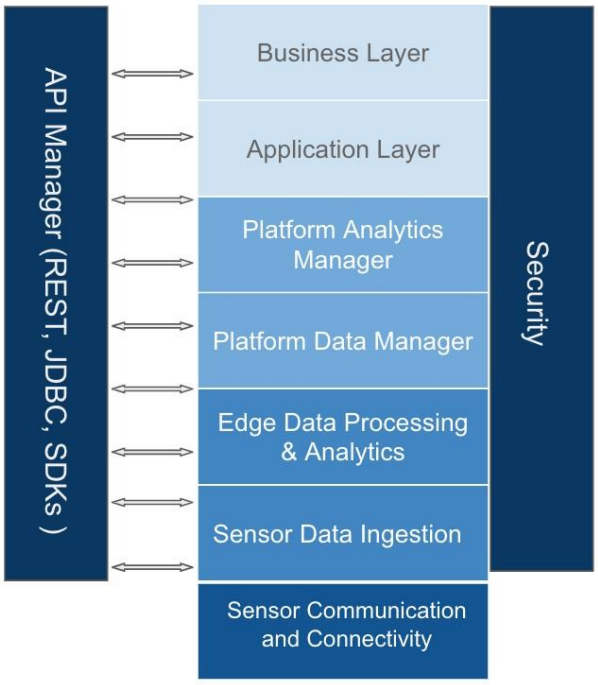
Value Proposition

The Internet of Things has come a long way, from hacks to research projects to efficient, sustainable everyday products, services and applications capturing customers imagination and driving a technological revolution. While the industry is trying to realize the full benefits of this ecosystem, the enterprises should address the challenges faces by sensor hardware providers, big data platforms, service integrators, application developers and end users.

Some of the problems to be solved adding to the value proposition of the ecosystem are:

- Solutions Fragmentation
- Data Security and privacy
- Integration of information technology (IT) and operational technology (OT) infrastructure
- Concept of ubiquitous device connectivity to the internet
- IoT investment justifications, in terms of base cost and recurring cost
- Interoperability and standards

Solving this would require a layered architecture of having abstractions as in below layer architecture with the capability of modular scale-out architecture, an extensible deployment mechanism and ease of maintenance.



Platform of platforms

There is a need to have a holistic solution, reference architecture to cater most of the enterprise IoT needs. This solution while handling most of the IoT solutions should also be flexible enough for handling cross-industry applications, hence a platform of platforms.

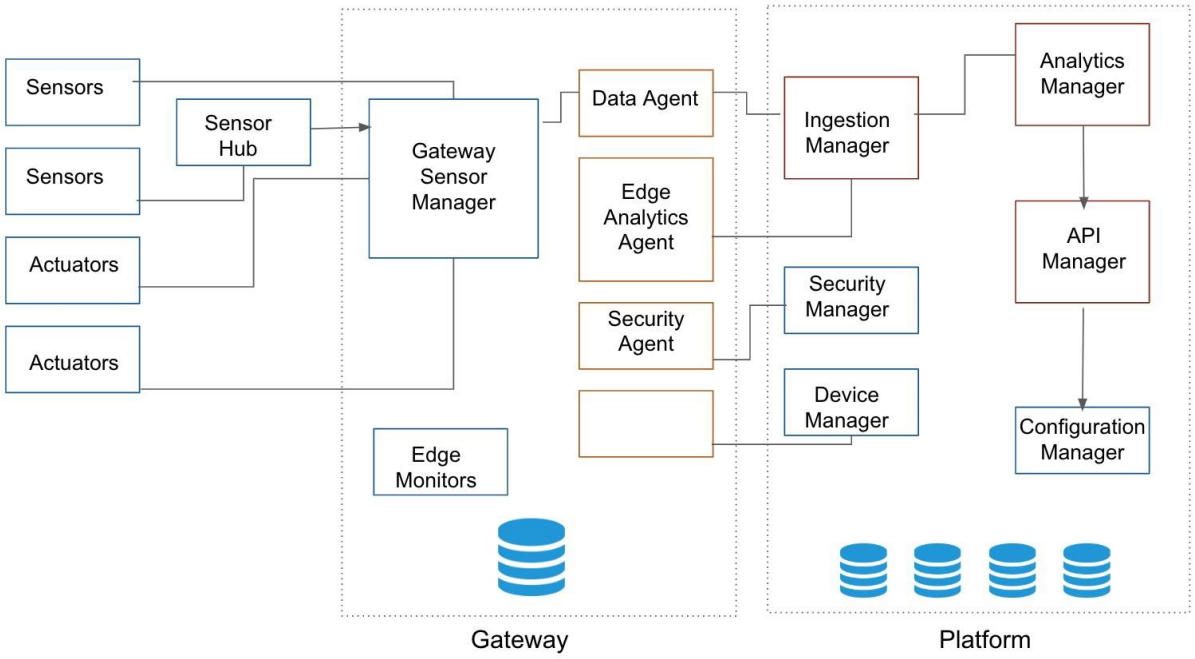
Our approach on the solution to this problem for applications in capturing from several enterprises and telemetry data sources, processing of petabytes of byte-sized datasets originating from various sensors, advanced machine learning system for recommending actions based on real-time analysis and connecting the end user business systems

Reference Architecture

Over the last few years, we have worked on developing several IoT ecosystems in energy, traffic, healthcare, and automotive. While designing, developing and creating market-ready architecture, we have developed a cohesive IoT PaaS solution keeping in mind rapid design, seamless integration and scalable deployment as the principle. The application pretext for this platform to have capabilities for data streaming, smooth ingestion, event processing, and analytics, elastic hardware and software computing, machine learning compatibility and end-user application integrations. The data flow across a generic IoT framework would be:

1. Sensors convert Analog Signals to Digital
2. Sensors on one of the edge protocols like Bluetooth, Zigbee, Bacnet or through the internet would communicate with Gateway
3. Gateway ingests the data and converts to a more translatable protocol like MQTT

4. Edge Software like liota, EdgeXfoundry could be used to convert to HTTPs based REST API's
5. Edge Analytics based on the source system could be part of Edge Software
6. From the backend processing servers, the data through HTTPS is fetched using a messaging bus
7. Event Processing is done the data while it is in the stream or specific stream analytics would be carried out
8. Data would then flow into two streams via Lambda Architecture, one batch storage another real-time analysis
9. Machine Learning algorithms would be trained on the batch storage for patterns and also applied to the real-time systems for the recommendation
10. IoT data would be made available through secured HTTPs based REST Services or Database connections
11. End-user applications would run on the real-time data sources for actions and batch data sources for patterns



Various Components of a generic IoT System would be:

Sensor Communications and Connectivity

The platform must support multi-protocol communications and connectivity support. Sensors are connected to the primary stream systems by either a direct internet connection if sensors are wifi enabled. Otherwise, a gateway like Dell Gateway 5100 acts like an edge server, that communicates with sensors in various protocols. Edge nodes are responsible for the connections to any sensors, actuators, control systems and

assets. For controlling the sensors too, the gateway acts as an interface. Hence a reliable and stable portal is the first touch point for this architecture.

Edge Data Manager

The primary role of gateway software after connecting with sensors is to tag them through a sensor management layer. Registering of the sensors, creating specific IDs, and connection management is the core component of the edge sensor manager. Once the sensors are designated, the data from sensors will be normalized to a standard format like MQTT. Either the data in the sensors is stored for edge analytics or will be exposed as JDBC connections or HTTPS based REST calls for further processing.

Edge Analytics

Analytics on edge systems becomes critical where the business critical information needs information in low latency, for example, video analysis systems that need to do the analytics on real-time or healthcare systems that require to make calculations on the gateway. Hence, edge gateways also have an analytics component like EdgeXFoundry deployed to serve the edge analysis component.

Platform Data Manager

Platform Data Manager is the data center component that acts as a backend platform service to handle:

- Data Ingestion: Ingestion manager caters to both real-time and batch-processing needs of the sensor data, in the Lambda architecture,
- Data Pre-processing: Standardization, Normalization, Verification, of the the data are done as part of the platform ingestion
- Data Aggregations: Raw data is converted into aggregated data marts for analysis and analytics at data manager

Platform Analytics Manager

Analytics Manager works on the information there in the data lake ingested and preprocessed through the data manager, and various analytics performed over the data in data lake like:

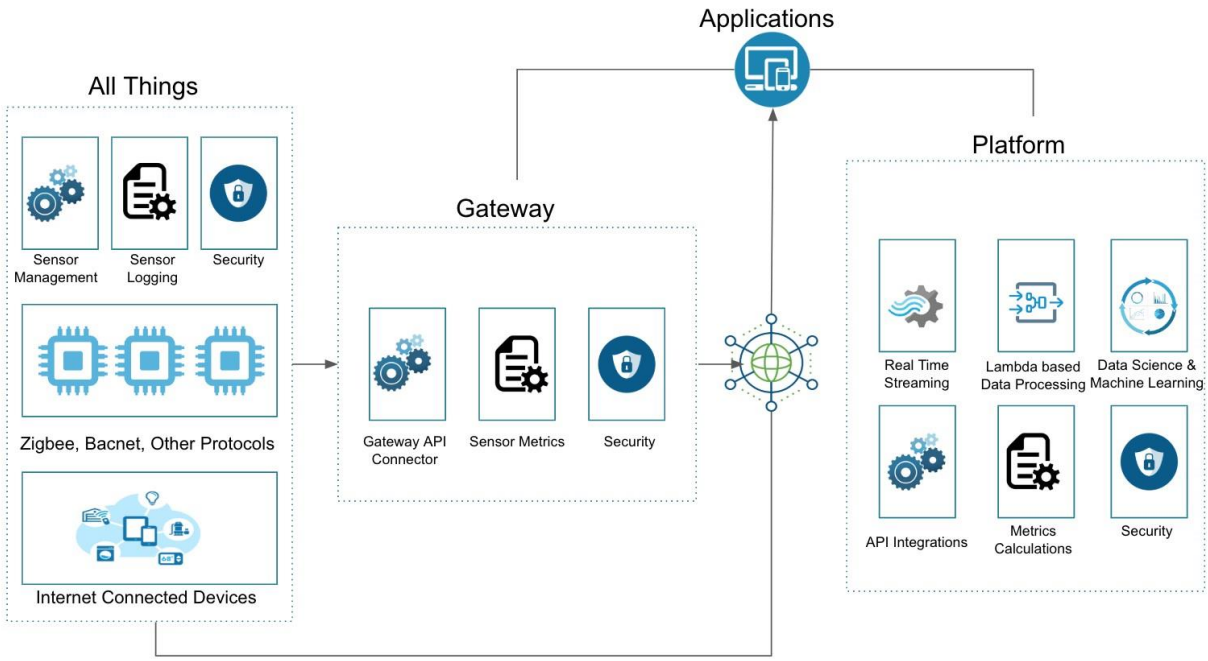
- Correlation Analysis: Eg. how to change the ambiance of the room according to the weather outside
- Forecasting: Eg. Energy forecasting - Predictive Analysis:
- Prescriptive Analysis: Eg. Automatic Demand Response Systems

Application Manager and Business Layer

From the data after analysis and analytics, the Platform needs to support Business needs with various end-user applications using these could be plugging using PaaS systems like Pivotal Cloud Foundry.

Security Layer

At various system integrations security and encryption of data is very prominent, hence different touch points of data across the platform, a security protocol is enabled and logged for the understanding of further lineage and audit.



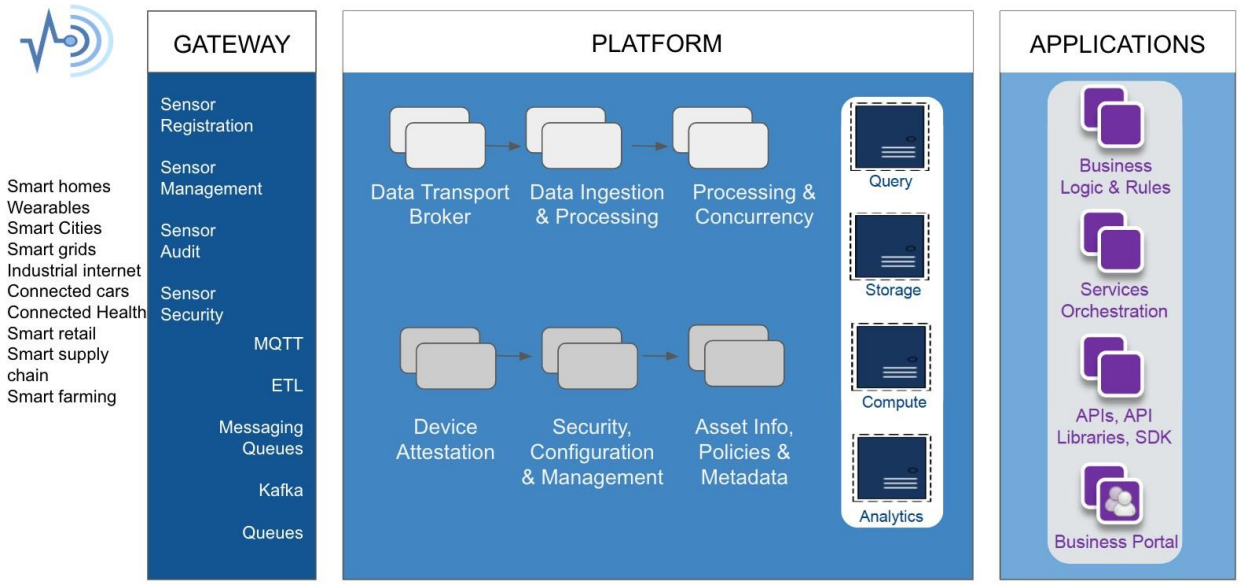
End to End IoT Solution

New IT Revolution is Underway, over the last few years, there have been advancements on scale-out architecture, distributed systems, cloud platforms and the end to end big data platforms and the next would be an IoT platform designed for enterprises.

This platform would need to comprise various paradigms for software advancements and also cater to business functions and applications.

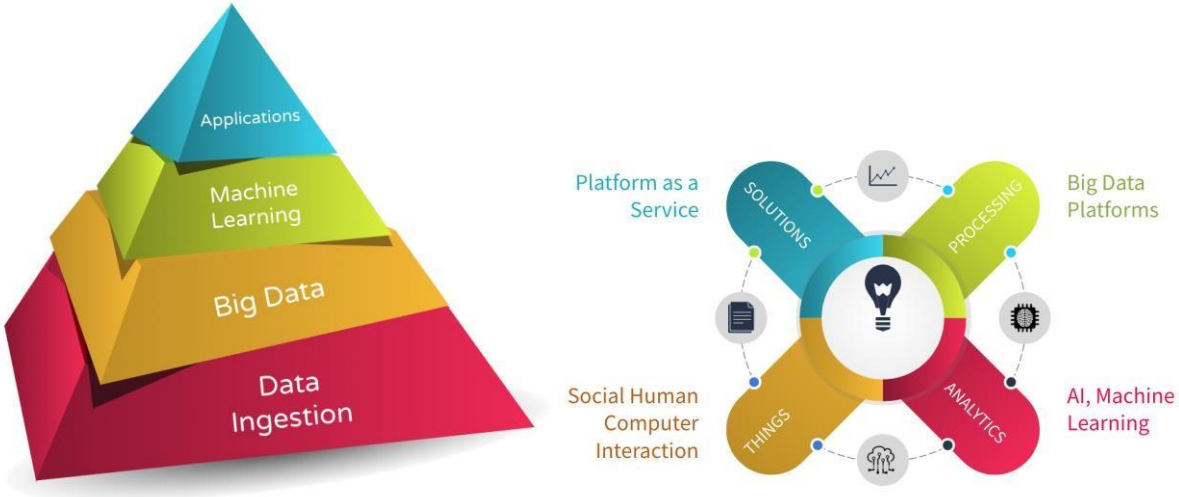
- Edge Ecosystem catering various sensor ecosystem
- Scale-out hardware ecosystem
- Distributed Systems and Big Data Ecosystem
- Real-time streaming and processing engine
- Data Science and Machine Learning
- Platform as a Service for Business Applications

This generic platform will have the capabilities from sourcing the sensor information, realtime ingestion in a distributed system based hardware and software, data processing and normalization of the data, data science and insights, and lastly end user applications running on the platform as a service.



Conclusion

Internet of Things, distributed systems, advanced data engineering, machine learning and advancement in application development is changing the enterprise ecosystem. There is machine generated, hence well-structured new petabytes of data that is arriving every second, machine runs. Applications on this data require a historical understanding of this data and real-time analytics for determining patterns and recommendations. This ecosystem hence demands an enterprise-ready end to end platform, covering systems from edge to on-premise systems to cloud application systems.



A platform from a business perspective should be designed for enhancements in sensor ecosystem support, the speed of data gathering and processing, development cost, deployment time, maintenance ease, scale-out architecture and application design support for various existing PaaS ecosystems. This technology

stack should handle the volume, velocity, and variety of big data and would need to run advanced machine learning algorithms at this scale and speed.

Existing open-source software systems to provide individual solutions, however at enterprise level the complexity of integrations, independent scaling challenges, and incompatible software versions causes issues. By developing several ecosystems for IoT solutions, solving various problems across various domains and delivering stronger customer engagement and focusing on business goals, applications development and scale, we have put across our technology blueprint and a vision forward.

About the Authors:

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	**Vidyasagar Nallapati**: Vidyasagar works as an advisory consultant at Dell EMC Consulting in the Big Data and Data Science team. Vidyasagar has been with Dell EMC from last four years, delivered projects across verticals and geographies across the world. He loves all the things mathematics, statistics, machine learning, developer tools, automation and anything that will make systems better and easier, which brought him to data science, system architecture, building large scale distributed services and designing rock-solid data pipelines.