Transforming Renewables' Operations through IoT

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Renewable Energy companies have experienced a strong growth globally. Over the past decade, the global installed capacity and production from all renewable technologies have increased substantially. 2015 marked a turning point for renewables where led by wind and solar, renewables represented more than half the new power capacity around the world, reaching a record 153 Gigawatt (GW), 15% more than in 2014.

However, with high upfront costs (capex) and long payback periods, there is increased pressure to improve operational productivity and asset uptime. A major operational challenge is to manage larger capacities, with many physical assets, located in widely distributed and extremely remote areas with limited skilled manpower.

IoT powered Renewables

Industrial Internet of Things (IIoT) can be a game changer for the future of renewables. It can fuel innovation and create opportunities by providing actionable insights in real time for improving productivity, increasing efficiency and enhancing reliability.

With IoT, asset data from remote solar and wind farms can be integrated into a cloud-based data platform that would not only provide enterprise-wide visibility but also drive operational improvements by linking engineers to data from remote machines, sensors, and controllers in real time. Most IoT platforms are licensed with little or no setup costs and offer a 'pay as you go' pricing model (vs traditional approach of software licensing, hardware purchase, installation and support), suiting both small and large fleet operators alike.

With the vast options of IoT platforms available, choosing the right platform requires careful consideration. Following are some of the crucial pre-requisites for a robust remote monitoring platform:

- **Availability**

  The IoT Platform should be robust on 2 fronts – data collection and buffering @ site; data storage and analytics in the cloud. Since renewables assets are remote with limited connectivity options (generally a cellular network), the IoT platform should have the ability to buffer data locally in case of failure of communication link with the cloud platform. Once the data is on the cloud, the application needs to be highly robust to ensure the right data is always available to the right person at the right time

- **Scalability**

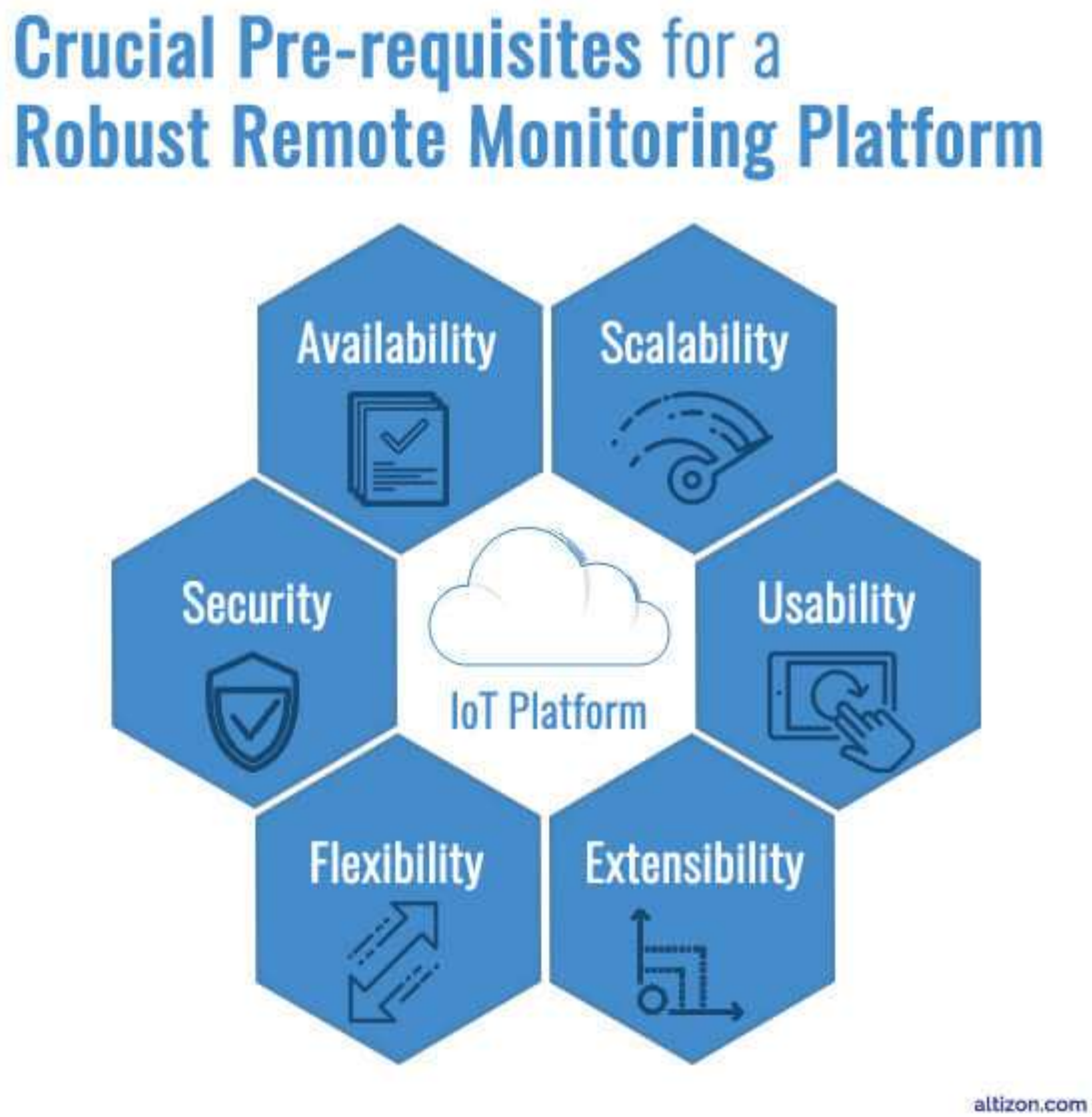
  The high growth of renewables means that scalability of the platform to handle new sites as well increased data from existing sites is an important consideration. Every component of the platform from data collection to storage to analytics needs to scale to accommodate the increasing demands of the users

- **Security**

  Millions of devices being connected with an IoT platform means we need to anticipate a proportional number of vulnerabilities. Security has to cover all components of the IoT system:

the asset, the network and the application. Asset /Data source authentication should be done using auto generated key pairs so that the source of data to the platform is 'trusted'. The network connection between the IoT devices and the platform would need to be encrypted with a strong encryption mechanism to avoid potential eavesdropping. End User authentication on the platform should leverage techniques like two-factor authentication, AD integration, etc. to ensure only valid users have access to the data

Fig 1.1



- **Usability**

  Deploying IoT platform at scale, the success will be measured by the usability and the end user experience. With emphasis on 'usability' and responsiveness – the platform must have intuitive UIs and 'self-service' Dashboards with user interaction and exploration via interactive visualizations, search and natural-language query technologies. Native Geospatial integration is particularly useful in renewables where assets are widely distributed. Increased usability will reduce 'time to insight' and the business users can achieve what is needed with minimal training.

- **Flexibility**

  Every enterprise will require unprecedented collaboration across various teams – operations, maintenance, planning, IT, CXO, vendors, etc.; hence the need of an end to end flexible architecture to monitor and maintain endpoints. The choice of a vendor agnostic (interoperable) and flexible platform can help connect heterogeneous devices and diverse machines seamlessly while allowing the users to build applications on top of it with maximum ease. Features like 'edge computing' could allow vast volumes of data to be collected and analyzed, but only relevant information to be transmitted to the cloud, thereby reducing response time and optimize bandwidth requirements.

- **Extensibility**

  The IoT platform must score high on easy application extensibility to support addition of future functionality to support unforeseen business challenges and constantly evolving operational requirements. This also ensures that the investment is 'future proof' and need not be replaced to support an evolving multivendor and distributed middleware environment

IoT examples in renewables

Wind and Solar farms are equipped with hundreds of sensors that generates large volumes of data. This data is useful not only for operating the plant, but also contain key clues on asset health and reliability. The use of Machine Learning (ML), for instance, can help a utility check for irregularities in operational performance, leading to the prediction of a potential failure before it happens. ML helps analyse data and discern patterns and hints that operators might have missed due to volume, speed and complexity of the data. Following are couple of examples:

- **Performance Optimization of Solar farms:**

  Components of solar panels are subjected to huge stress due to extreme weather conditions. This results in failure of panels, conductors, fuses, etc., leading to potential loss of generation. Machine Learning can help calculate predicted power by tracking dependent parameters like irradiance, temperature, humidity, etc.

  This predicted power is then compared with actual generated power, and deviations are notified over email, SMS to the right personnel leading to proactive detection of anomalies and reduction in controllable losses. Repeated issues with a panel/ set could be escalated to engineering for design validation and fixes.

- **Predictive Maintenance in Wind Energy:**

  Wind Turbines have evolved rapidly over the years to generate more power with less wind and with greater reliability. The average WTG ships with 100s of sensors, whose data when mined successfully could be hugely beneficial. IoT platforms allow one to capture and map these sensors to create a 'virtual twin' of the physical asset.

  The user can then apply instream (real-time), batch (historical), ad-hoc (use defined) or machine learning analytics to mine this sensor data. Using ML, users can create a multivariate model that correlates parameters like wind speed, direction, rotor speed, gear box temperatures, vibrations, power output, etc. and learns their cause and effect relationship. This can help in early detection of abnormal operating behaviour (like underperforming WTGs) or impending failures (like gear box failure).

What can Enterprises learn from this?

The vanguard Enterprises must understand that while IoT is crucial for any digital transformation to follow, there are many ways to architect Internet of Things implementations.

IoT platforms in general, offer a **robust, scalable, secure, flexible, user friendly** platform for capturing sensor data and turning it into actionable insight that delivers greater safety, efficiency and reliability. But only a **complete IoT platform** can augment your current capabilities and help sustain competitive advantage.

As such it is a prerequisite for the CXOs to identify the IoT service providers (with the most flexible architecture) based on proven IoT skills, experience and their industry expertise.

Customers and Enterprise needs will change. Hence no one single reference architecture can be used as a blueprint for all possible implementations.

In an overview of the **blueprint of the IoT Architecture**, Gartner has recently highlighted the basic architectural components. According to Gartner, at the highest level, there are essentially four tiers to the basic architecture for IoT:

- Things
- Gateway
- Cloud
- Enterprise

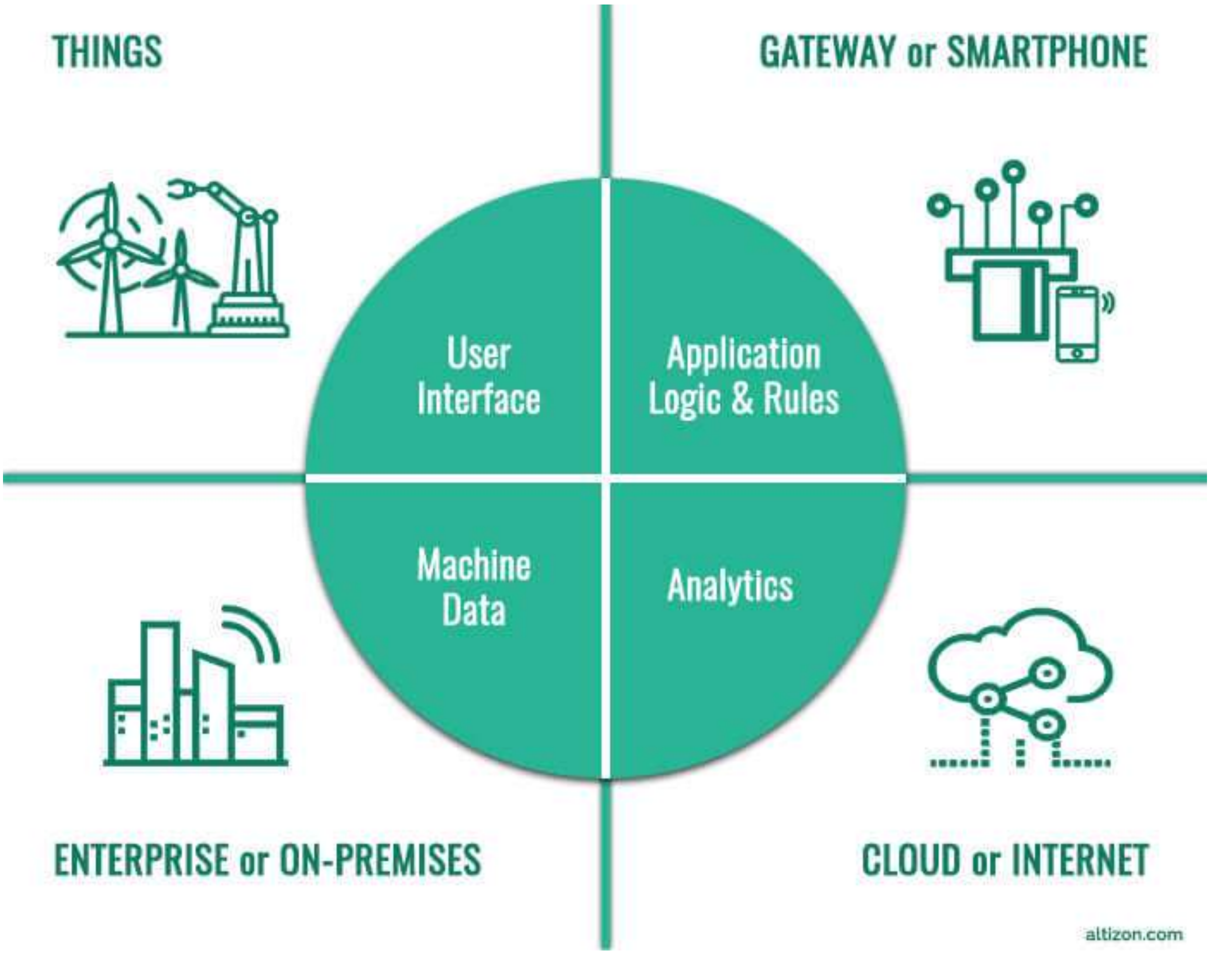
Refer to Fig 1.2: The 'High Level Architecture for the IoT Implementation'

Choosing the right architecture starts with deliberately selecting where the application logic, data and analytics need to reside in the high-level architecture.

Major IoT Architecture Types

- Thing centric Architecture
- Gateway centric Architecture
- Cloud centric Architecture
- Enterprise centric Architecture

Fig 1.2: High Level Architecture for the IoT Implementation



On the basis of the

(1) Presentation layer (User Interface),
(2) Application logic and rules (embedded on the thing itself or residing in a gateway, cloud or centralized control system),
(3) Machine Data and
(4) Analytics

the Enterprises can choose the best fit architectural style for their needs.

Overview of the Architecture Types:

- **Thing centric Architecture**
  - Bulk of the user interface, application logic, data storage and analytics reside on the 'Things' itself
  - Often deployed by **'Data historians'** that store for local capabilities: local storage and analytics
  - Gateway may or may not be required
  - Capabilities like Remote Asset Management can come from the Cloud or Enterprise (On Premise)

- **Gateway centric Architecture**
  - Majority of computing resources reside on the gateway

- Some of the application logic is embedded on the 'Things'
- The Cloud or Enterprise resources can be used to centrally issue commands for 'remote device management' however most of these commands will be processed in the gateway

- **Cloud centric Architecture (SaaS: Most recommended)**
  - Employs cost effective thin-client architecture in which the client is supported by cloud resources (Application logic and Data Management)
  - 'Things' and Gateway are operated from the Cloud
  - Cloud can be leveraged by organization to build and extend the Applications onto devices like the smartphone

- **Enterprise centric Architecture**
  - Most Suitable for on-Premise "Legacy Machines" where the majority of the application logic, data storage and analytics are held within the Enterprise
  - Integration between the 'Things' and Enterprise happens directly

The CXOs/CDOs (Chief Data Officers) can use these components and blend them to create hybrids or different architectures that can be used in different parts of the business.

But there is no right answer. Sometimes a cloud based architecture could be a perfect choice as a low cost and less complex option. And other times it may raise latency issues.

Highlighted by Gartner (Report - May 2016), the main criteria used to select the best fit will vary depending upon:

(1) Users and Implementation
(2) Connectivity and Technical Requirements
(3) Cost
(4) Data and Security

Fig 1.3: Selecting an Architecture Type will depend on the below mentioned Four Drivers:

Users and Implementation • Greenfield or Brownfield Implementation • User Needs • Integration Needs • Channel • Resource and Skills Constraints	**Connectivity and Technical Requirements** • Reliability and Quality of Service • Real Time Performance • Distance and Physical Constraints • Speed and Quality of Connection • Power Requirements
Cost • Cost of Hardware, Software and Data	**Data and Security** • Privacy • Security • Amount of Data

Source: Gartner (May 2016)

CIOs, operational teams and chief digital officers (CDOs) can use these architecture styles as starting points. Given most enterprises have multiplicity of systems, the reference architecture can help guide the CIOs to identify the best IoT platform which can account for a variety of changing technologies, models, demands and solutions.

The Way Forward: Market Direction

Having established that IoT has the potential to transform and change Operations for Energy and Utilities firms, the key focus point is to implement an **end to end solution**.

Even with so many adoption challenges - mainly around new skills and competencies required, the demand for IoT **enabled Advanced Analytics** is ever increasing. Whether the leading trigger is reducing operational costs or optimizing performance, the market will witness the dynamic shift from analysing the information to acting on the information.

More than half of the enterprises worldwide will adopt **managed or cloud-based BI and analytics** solutions to **support sustainable green energy goals**. And while the hygiene elements for the required platform – the architecture and the features are essential, it's the improved business outcomes that will build a stronger case.

By applying the understanding gained with the business model and mapping them to relevant business metrics like Operational Efficiency, Price-to-Performance Ratios etc. the **economic inertia** will go away.