Capturing value from the Industrial Internet of Things (IIoT)

A Machfu Whitepaper

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The Industrial Automation industry is in the midst of a significant paradigm shift.

Abstract: In spite of the capabilities of the emerging cloud platforms, advances in software functionalities and the lowering of hardware costs, there continues to be many barriers in scaling the industrial IoT market. We lay out the barriers and scaling problems in detail and conclude with how Machfu's device platform solves these problems.

The advent of the Industrial Internet of Things (IIoT) is changing how we accumulate and analyze data. This new data is **enabling** organizations to increase their field worker productivity and improve asset efficiency by leveraging data across the enterprise. In spite of the fact that there have been **big reductions** in hardware costs, **inreased** software capabilities and cloud platforms there continues to be **a big** barrier to scaling **Industrial Automation**. In this paper, we present specific use cases for the Electricity Distribution market. The ideas, howev-er, apply to the broader industrial automation markets.

The United States Department of Energy's vision is to create a "Smart Grid" that uses digital technology to improve reliability, resiliency, flexibility, and efficiency of both the economics and energy of the grid. Historically, Utilities have used a specific set of grid sensing, control and automation functions tailored to the electric grid application space. The majority of these systems have their roots in what today **are** considered to be aging technologies. In addition, the existing grid system significantly lags Internet based systems because Utilities replace their grid technology products every few decades. This is vastly different than in the present consumer realm where it is common to update technology every few years. These Utility industry practices result in an infrastructure that is dominated by legacy and proprietary systems with a reluctance to adapt to new open-standards-based paradigms that facilitate moving to a modern Smart Grid.

In an effort to bring IoT and advanced interoperability to the power grid**,** the SGIP announced the OpenFMB™ and the US DOE Volttron™ Platform. These projects' goals are to define distributed applications and open interfaces that enable interoperable data exchanges between power systems devices on the electric grid's field area and home area networks. The data will be exchanged using internet protocol (IP) networking, Internet of Things messaging protocols, and standardized common semantic models, to enable secure, reliable, and scalable communications and peer-to-peer information exchange between devices on the electric grid.

While these new IoT initiatives have great promise to significantly improve grid performance, it will take time to displace the deeply entrenched existing technologies used throughout the grid today. The transition will require new software defined IoT Gateways that support the emerging semantic models and simultaneously provide connectivity to the existing infrastructure enabling a graceful and cost effective transition.

The IoT edge gateways will face many challenges in moving legacy infrastructure to new systems that publish device data using semantic models that interpret the devices at the edge and translate them to the cloud. Some of the key issues integrating existing field devices include:

- Legacy devices use standardized protocols and the device's native register mapping is highly dependent on the product type and is vendor specific. Therefore, each device requires custom mapping from the native registers to the open APIs being developed by OpenFMB.
- Security of existing devices is clearly insufficient and inadequate. The new gateway edge connected devices **must** use PKI methods to ensure integrity and trust with enterprise infrastructure. They must meet the guide lines of NISTIR 7628 to enable compliance with regulatory, IT and corporate policies.
- There are many standardized connectivity and networking interfaces. The possible combinations and permutations grow rapidly. Multiple interface types (both wired and wireless) need to aggregate data at the edge IoT gateway.
- Many legacy proprietary radios exist in the market. There is a need for software defined modems that enable the edge gateway to aggregate data from many different existing radios types. They should provide a path for new private/public radio solutions.
- There are currently multiple IoT protocols for publishing data to the cloud infrastructure and more will appear in the rapidly evolving IoT networking space. Gateways need to simplify the process of using IoT protocols to publish data from the many possible combinations of device APIs, networking interfaces, security policies and industrial protocols.
- It is important that the legacy infrastructure and the new, evolving IoT in-frastructure have the ability to simultaneously support security upgrades and run applications in gateways.

Gateway based solutions that solve these problems at scale should include the following:

1. **A software platform that abstracts the details of developing applications.** The APIs should decouple application logic from device-specific interfaces, protocols and data models. This allows application developers to shorten their methods for accessing, configuring and operating edge gateways from the internal implementation details of the edge device.
2. **Standardized and open development tools** that permit large communities of developers to rapidly create many new innovative IIoT applications, similar to how consumer applications were developed on smart phones.
3. **An enterprise facing application management framework** (similar to an application store infrastructure for consumer smart phone apps) that will enable thousands of applications to be managed and deployed based on compliance with regulatory, IT and corporate policies.

The new IoT gateways emerging in the market must cost effectively provide wireless and wired connectivity that enables the unification of modern web-based applications and traditional SCADA infrastructure at scale. The platform needs to simplify the development of "Edge Applications", enabling them to be rapidly created and integrated,

reducing development time to weeks or days. This allows enterprise applications to access edge data to gain insights from diverse sources for business insights, process improvement and new business models. Edge applications also greatly lessen the need for wireless bandwidth to send terabytes of data to the cloud for processing.

Traditional approaches for industrial edge connectivity are based on developing custom embedded solutions that require re-engineering for each use case. The introduction of new cost effective high performance hardware platforms such as the TI's Beagle Bone, Raspberry PI and Intel's Edison make cost effective Linux hardware platforms available today. High volume consumer markets like wearables and smart phones are driving the performance of next generation Linux platform. They simultaneously provide chip/module based connectivity solutions while lowering hardware cost at Moore's law pace. Now, what is needed is an open industrial device platform that consolidates and simplifies application development and porting using a diverse proven set of tools and communication technology.

Google underestimated the potential of the Android market impact in 2010 ex-ceeding their 3 year volume estimates by 485%. Today Android has a 83% global market share with a robust ecosystem of suppliers that have cumulatively shipped over 2 billion devices and developers that have created over 1.6 million applications resulting in over 100 billion application downloads. The cumulative learning from the transformation of the consumer smart phone market can be used as a template for driving Industrial IoT.

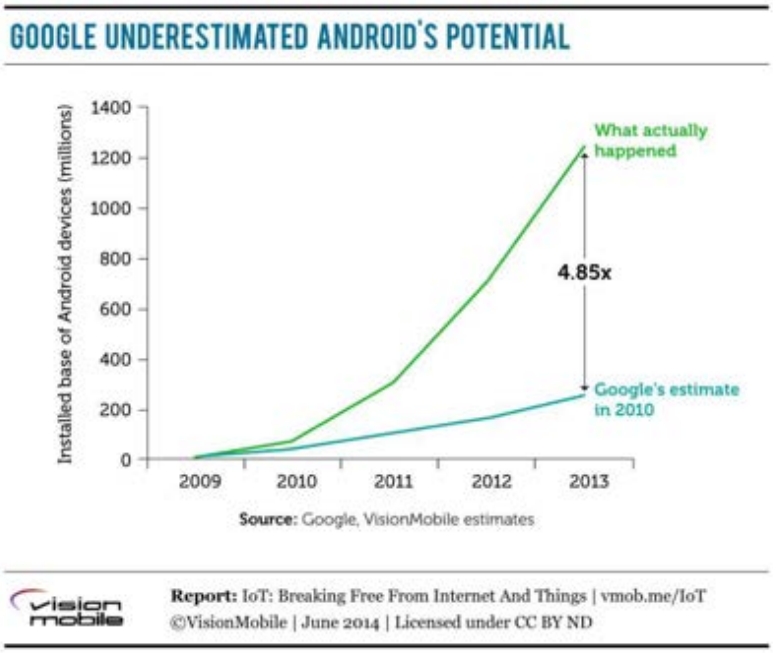

Figure 1: A standardized platform can create a large market and tremendous innovation.

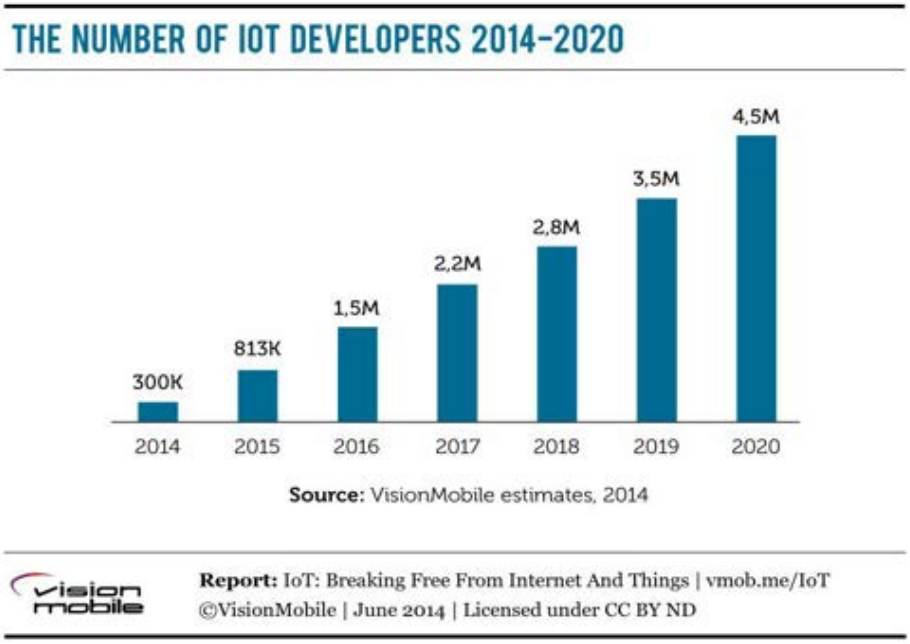

Figure 2: Many IoT developers are required to meet IoT growth projections.

The Smart Grid community is working to define standardized architecture and models. Leveraging SGIP's and the US Department of Energy's IoT initiatives will create many new IoT solutions and make it possible to deploy 100s of millions of secure edge devices and sensors. In addition, a standardized and accepted application develop-ment framework similar to what Android did in the consumer markets will stimulate a global ecosystem of developers and create the many edge adaptor applications required to map existing proprietary devices into a unified system with a common standardized semantic language.

While these ideas may seem grand in scale the benefits of creating standardized platforms is enormous. Cisco released a study called IoE Economy predicting that $14.4 trillion of value (net profit) will be at stake globally over the next decade, driven by connecting. the unconnected — via the Internet of Everything (IoE). GE similarly estimates values of the industrial Internet's benefit at $15.2 trillion of incremental GDP by 2030 in the Industrial Internet Study.

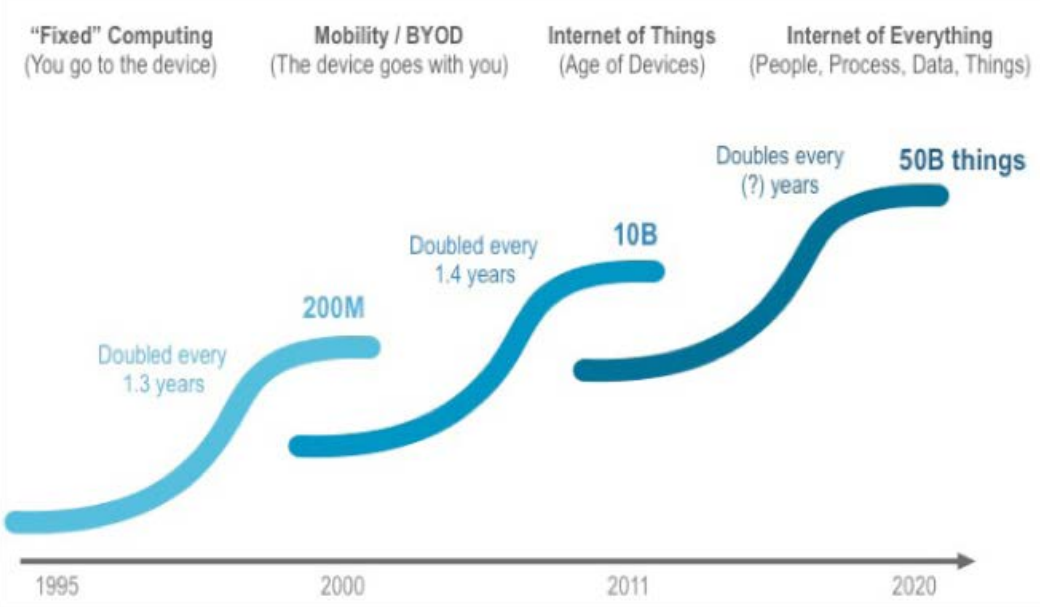

Figure 3: Internet Growth is Occurring in Waves

The IIOT Edge Gateway

The IoT Edge Gateways **need to** provide many features that simplify the development of "Edge Applications" by reducing the time to create and integrate them reducing development time from months or years to weeks or even days. Consequently, enterprise applications are able to access edge data and gain insights from diverse sources. The **value** of edge applications drive business results across the enterprise.

The platform, **needed** to enable rapid development of industrial IoT applications **should have** features that include:

- Client/Server RESTful architecture simplifying application development
- Well-defined Java APIs for accessing, configuring and operating edge devices abstracting developers from the internal implementation details of the edge device.
- Platform/language independence so that system implementations can solely focus on developing web-based applications.

- Support for modern IoT protocols such as CoAP, MQTT, AMPQ, DDS enabling publish and subscribe messaging
- Embedded industrial protocol support for DNP3, Modbus, BACnet, etc. simplifying integration with existing field devices
- Extensive power management enabling line and battery powered applications
- Applications that are hardware vendor independent, this future proofing and enabling long life cycle products. This will also enable software to take advantage of ever increasing processing power.
- Easy to deploy self-provisioning capabilities minimizing training needed for installation
- Support for an application management framework, like an App store in the consumer world, enabling a highly scalable enterprise infrastructure

An open standardized IIoT platforms provides a path to a broad set of impactful enterprise scale applications. It enables IIoT growth similar to what occurred in the personal computer markets in the early 1990s and the smart phone markets 20 years later.

Authors:

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John has 20 years of experience and subject-matter expertise in developing innovative solutions for Utility, Oil & Gas, Water/Waste Water, Traffic, Rail, Heavy Industrial and Commercial markets. He is credited multiple patents associated with the application of communication technologies in the industrial scape and actively participates in the SGIP and IEEE802. Previous positions include Wireless Center of Excellence Leader for GE Digital Energy and VP of Engineering for MDS.

Tim Winter
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Tim, the architect of the Machfu device platform, has over 20 years of experience in the IoT & M2M space developing strategy and architecture to realize wireless networking platforms with expertise in IP networking, protocol stacks, Android and embedded Linux. At Eka Systems as Chief Architect he guided wireless mesh network development teams in a fast paced start-up environment that was sold to Cooper in 2010 . In consulting roles he has led the implementation of end-to-end embedded communication systems for GE, AT&T and Mueller water using cellular and private wireless technologies. He was the editor at the IETF standards body for the RPL routing protocol and for IPv6 networking for large-scale Smart Grid and other device networks.