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How the Internet of Things (IoT) Is Transforming Field Service

A ClickSoftware Business Paper

Summary

Gartner, Inc. forecasts that 6.4 billion connected "things" will be in use worldwide in 2016, up 30 percent from 2015, and will reach 20.8 billion by 2020[1]. This interconnected world will provide a wealth of new opportunities for service organizations. It allows them to connect equipment with technicians' mobile devices and the office in real time, enabling a rapid response to service requests and efficient remote diagnostics. Service is set to become increasingly proactive and cost-effective.

Field service lies at the heart of the Internet of Things (IoT) evolution. Advanced field service management (FSM) software can automatically receive messages from devices, and schedule and dispatch professionals, without any human interaction. But the opportunities for IoT go beyond inbound device signals over the internet. The increase in intelligent service resources, such as drones and autonomous vehicles, offers benefits of machine-to-machine (M2M) communication that promise to transform the service industry.

The Internet of Things

As the internet turns 25 years old, its impact continues to transform communications, industries, and lives. The original framework of point-to-point communication via a network of distributed hubs has evolved from email and dovetailed with advances in electrical and industrial engineering in a transformative way. The era of personal computers has evolved, through mobility and the smart phone revolution, to a point where connected devices take all manner of forms from biological implants to wearable fitness trackers.

Signals sent to and from connected devices are spiraling in volume. Big data management techniques, machine learning, artificial intelligence (AI), and cloud storage have come together to deliver insight from this abundance of data. This increases the opportunities for automating decisions and initiating actions without the need for human intervention. The benefits to organizations are numerous. Remote monitoring applications already save billions in transport and human capital management costs. Add the potential positive impact on customer engagement and its associated business value, and the call to action becomes clear. A complete IoT strategy leads to better and faster decisions throughout the service delivery lifecycle.

[1] http://www.gartner.com/newsroom/id/3165317 - "Gartner Says 6.4 Billion Connected "Things" Will Be in Use in 2016, Up 30 Percent from 2015", November 10, 2015

Market Definitions

The Internet of Things is having major impact across both industrial and consumer sectors, and many bodies of research focus on these separately. We look at the two areas in this way:

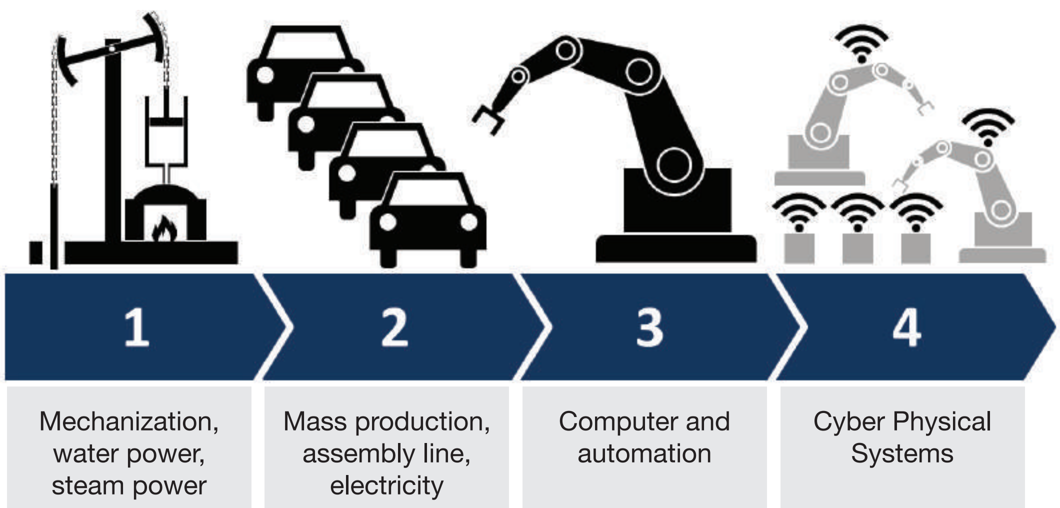
Industrial IoT (IIoT)

IIoT refers to the application of the Internet of Things to the broad manufacturing industry. It's often used interchangeably with the term "Industry 4.0," which refers to the major transformational stages of the industrial economy. Examples of IIoT range from monitoring building management systems and power grids, to tracking manufactured goods as they are shipped.

Consumer IoT (CIoT)

The Consumer Internet of Things (CIoT) consists of technologies that target the home market and consumer electronics. IDC reports[3] that over 8 million US households already use some kind of home automation and control. Typified by remote monitoring capabilities for security, climate control, and remote control of household functions, CIoT also offers promise in areas such as networked home appliances with use cases such as refrigerators that automatically order more milk as needed.

Figure 1: Evolution of the Industrial Economy[2]



[2] Source: Christoph Roser, AllAboutLean.com

[3] IDC's 2016 Consumer Internet of Things Survey

Market Size

Figure 2: Internet of Things Units Installed Base by Category (Millions of Units), Worldwide[4]

	2014	2015	2016	2020
Units Installed	3,807	4,902	6,392	20,797

This growth is driven by rapid increase in connected devices (as noted in the table above) and their improving intelligence. Remote monitoring and device management passes along contextual information (such as heat, vibration, capacity, location, or state) in a proactive way to a central alert system. From there it can be analyzed against operational criteria. As the computational intelligence within internet-connected devices increases, so will their ability to request and receive support. Gartner predicts that by 2018, 6 billion things will request such support. This is a major driver for field service in the future as we'll see throughout this paper.

Components in the IoT stack

The IoT stack not only has a number of technical layers and enabling protocols for network communication, but it also extends from hardware to applications and processes. At a high level, the components of the IoT stack are as follows:

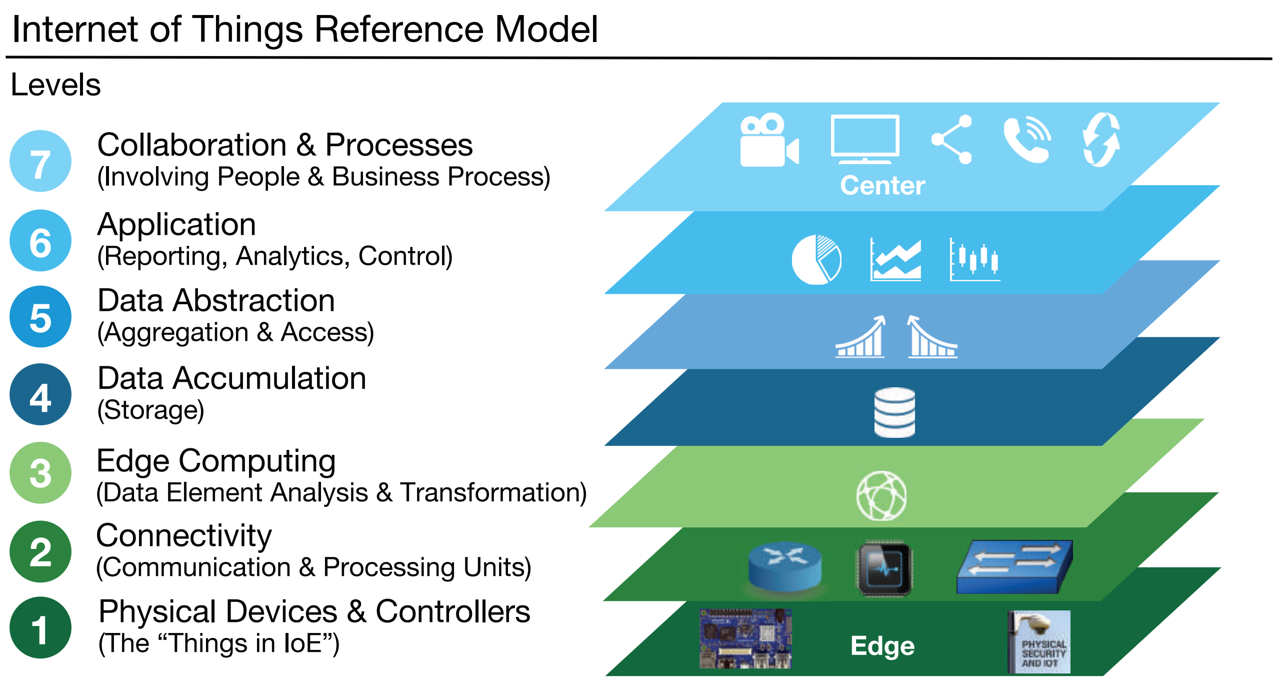
- **Physical devices and Controllers:**
  The connected devices or "things" themselves and the low-level hardware components such as sensors and actuators.
- **Connectivity**
  The ability for "things" or low-level hardware components to become internet-enabled. There are multiple technology enablers in this layer, ranging from Bluetooth Low Energy to LTE-A to WiFi Direct and many more.
- **Edge Computing**
  IoT generates massive amounts of data that can clog networks with bursts of activity. By using Edge Computing to decentralize data aggregation and data intensive functions, organizations can reduce the amount of data that is shuttled back and forth. This not only reduces data transport costs, but can also decrease latency and application responsiveness.
- **Data Accumulation**
  The enormous amounts of information generated from the sensor network need to be stored, managed, and archived with associated governance and security considerations.
- **Data Abstraction**
  The raw data itself needs to be sliced, diced, aggregated, and curated at an appropriate level of abstraction and frequency for it to serve the goals of applications and users.
- **Application**
  Applications provide the interfaces that give visibility into trends, reports, and anomalies. They also offer control of the hardware components and incorporated business rules to act on particular inbound signals.
- **Collaboration and Processes**
  The business processes, systems, and organizational teams that make decisions and execute actions based on outputs from the application layer of the stack.

IoT and Field Service

As the definitions around IIoT and CIoT show, there are ramifications for field service in both areas. Products that are being serviced are equally likely to be consumer goods or elements of a manufacturing eco-system in the context of business-to-business field service. The consumer and business areas are also intertwined as IoT adds a strong feedback loop that connects product usage and the associated service requirements to the manufacturing process itself. For example, wear and tear levels in real-world conditions can feed into product development through a network of sensors and influence the manufacturing process accordingly. CIoT and IIoT are worthwhile segmentations to assess the market at a more granular level. But there are opportunities for innovation in IoT across the field service landscape. Furthermore, areas such as Bring Your Own Device (BYOD) and ghost IT also create fuzzy

[4] http://www.gartner.com/newsroom/id/3165317 - "Gartner Says 6.4 Billion Connected "Things" Will Be in Use in 2016, Up 30 Percent from 2015", November 10, 2015

Figure 3: IoT World Forum IoT Reference Model



lines between consumers individually and as part of an enterprise. The opportunity for field service is broad and not constrained to any sub-segment of the market.

Signals *from* the Sensors

The most obvious application of Internet of Things in field service is the ongoing analysis of remote sensors that indicate a need for service. Common use cases include ATMs and elevators communicating the need for service, for example. Typically, these sensors communicate through the layers of the stack. An application could generate a ticket into the field service management system. This ticket would generate a work task, which can be automatically scheduled based on the characteristics of the case and the resources available.

One factor is where data intelligence fits into the stack. At the beginning of the IoT revolution, before the phrase was coined (in 1999, by Kevin Ashton when working at Procter & Gamble), connected devices were unsophisticated. For instance, the first "internet device" was a toaster that could be turned on and off over the internet[5].

Unsophisticated sensors can readily communicate a health check signal, with this signal presented in the application layer and service initiated accordingly. But, as IoT evolves, the more sophisticated data management outlined in the IoT reference model can be decentralized. Likewise, devices can communicate more information over the network. Signals evolve from binary (working / not working), into conditional logic (if the number of toasts > 10,000 and heating coil temperature > 140c then communicate a certain signal), and beyond, into much more sophisticated logic.

As the volume and complexity of sensor data grows, the ability to process this data in the cloud becomes another driver in the IoT revolution. With the vast amount of sensor data available, more sophisticated machine learning techniques can be leveraged to indicate a need for service. For example, machine learning models can establish the likely indicators (e.g. usage levels, speed, pressure) submitted from a single device that correlate with an increased probability of imminent failure, based on patterns established in millions of other data points already collected. These data points could also be external (e.g. operating environment temperature), as well as internal, to paint

[5] http://www.livinginternet.com/i/ia_myths_toast.htm

a holistic picture of all the influential factors. Moreover, additional context can change the nature of a service requirement. For example, the urgency assigned to a proactive maintenance call for a commercial air conditioner may diminish if there are other functioning units for the same building. Imagine a fast food location with one beverage fountain ready for service, while three others are working properly.

Reactive vs Predictive

The increasing intelligence of devices and the hardware layer also impact the approach to service associated with the device. While unsophisticated devices can signal a need for service in the event of a system failure, the richer data from intelligent sensors enable a shift from reactive to proactive service. For example, indicators of failure enable long range service maintenance planning so devices can be kept running continuously and efficiently with an optimized cost profile. From a resource optimization perspective, this is of course preferable to responding, at high cost, to a sudden failure.

This point brings up a significant differentiator in IoT-based field service. In addition to developing machine learning models to learn more about the service chain, leading field service organizations excel at optimization in the context of organizational business goals. This optimization is important regardless of the sophistication of the information the sensors generate in the network. Even in a simple example, with a service requirement to address a non-functioning device, organizations with optimization solutions can automatically schedule that service to ensure the appropriate balance of metrics, such as SLA compliance and field service professional overtime. And, with additional sophistication in the IoT sensor data to support more proactive use cases, this schedule optimization is just as important to business success.

To unlock the potential of speed and automation, decision criteria must be determined and incorporated into a system flexible enough to handle the variety of data inputs and scenarios. Top field service software providers can offer a scheduling solution that incorporates countless data elements into the scheduling algorithm. The full intelligence provided by the IoT network determines the appropriate service schedule for a device, including inspection, preventive maintenance, and repair. If required, it's possible to incorporate a review of these IoT-generated telematics by a field service professional for additional human oversight.

The data aggregated from IoT networks and service management solutions help prioritize maintenance in other ways. When devices fail in spite of sensor readings that indicate good health, a robust FSM solution can detect commonalities that indicate the need for proactive maintenance work. For example, if printing machines fail unexpectedly after only 1000 hours' use, a service solution that aggregates actuals can identify that the same new fuses are a common factor among all failing machines. Even without human interaction this can trigger an ad hoc maintenance program to replace the fuses on all affected machines – ordered in priority according to the number of hours remaining until the 1000 tolerance is reached.

As sensor data grows, the ability to process this data in the cloud becomes another driver in the IoT revolution.

In another use of the aggregated data, businesses can analyze failure rates and service contract history. This can help field service organizations understand the ideal times for servicing assets based the data they are seeing through their sensor network. This information can also help inform manufacturers of warranty timelines and guidance for customers.

Taken together, it's clear that these inbound IoT signals can provide a wealth of data both simple and more sophisticated. This can drive IoT-based field service toward dramatically greater levels of customer responsiveness, quality, and productivity.

Signals *to* the Sensors

Networked systems can do more than allow devices to communicate with centralized hubs. They also facilitate two-way communication so hubs may communicate with the connected "things." Connected devices can be service agents or available resources in a service chain. This has massive implications for the service industry.

The growth of autonomous and semi-autonomous service agents could change the world as we know it. Drones and self-driving cars are set to be major components in the service management world. Both have hurdles to overcome for broader adoption, but a sophisticated IoT-friendly solution anticipates scheduling these assets as a machine needing service, and as a machine providing service.

The connected nature of drones makes them simple to locate and deploy. They can be used to deliver a part to a customer or to a field service professional on site, where the economics and other trade-offs are in line with organizational objectives. And this is a major consideration. Autonomous and semi-autonomous vehicles are options in service delivery. They have cost implications, customer service implications, and other characteristics that need to be assessed when determining how to deploy them. An IoT-compatible service solution should enable businesses to schedule resources based on organizational business imperatives. It should be able to optimize the components of service delivery and schedule either human capital, machines or service agents (such as drones) at the appropriate time.

Servicing Sensors

The growth of networked devices and sensor technology has other impacts on the service industry. We have seen that field service management solutions can deploy IoT resources as part of the service lifecycle. For example, they can schedule a drone to inspect a wind turbine, and they can schedule a machine for downtime so that a technician is able to repair it when they arrive on site.

Ironically, the increasing volume of these sophisticated devices means the need for more service. More devices, with increasing sophistication, bring increased maintenance, service and repair requirements. The ultimate evolution of this phenomenon will be a network of service agents, deployed automatically based on predictive artificial intelligence and machine learning to keep the service chain moving through maintenance and repair. Sometimes field service professionals will be part of the future service chain, and sometimes they will not. IoT enables a self-healing service delivery lifecycle based on the combination of M2M and pattern recognition.

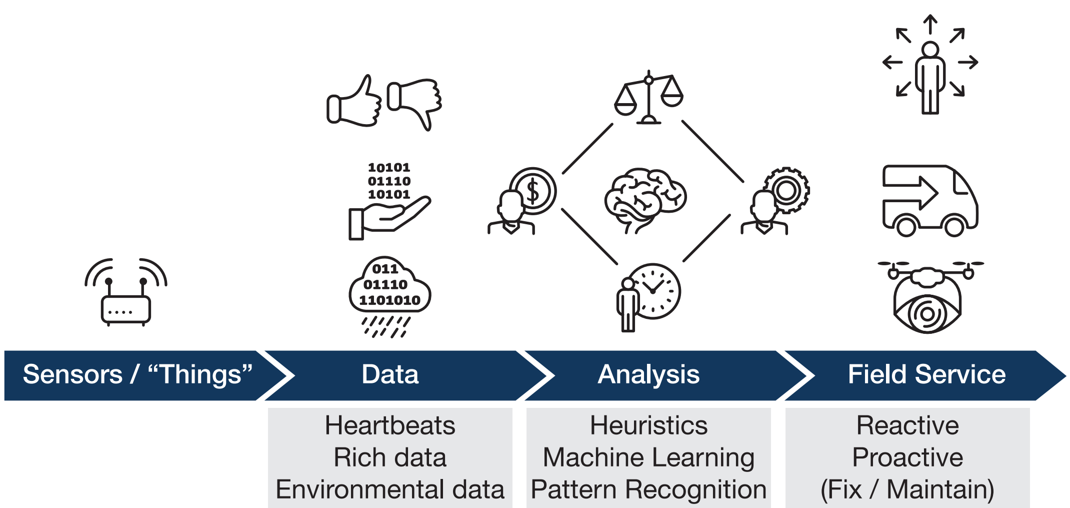
Field Service and IoT

We've established the service implications of connected devices generating information about their state, and we've looked at the opportunities to incorporate "things" themselves as resources that can be scheduled. These two aspects of the IoT market represent a demand component and a supply component.

In the matching of the demand and supply, innovative field service organizations will uniquely incorporate a variety of data and the sophistication of a human decision. This enables artificial intelligence to make the right business choices.

Gartner predicts that the demand for service requests from IoT devices will rise significantly. These individual service requests may be reactive or predictive, urgent or low priority. Likewise, they may have minimal context or contain a wealth of sensor based data. The value lies in using that information appropriately in real-life service decisions. For example, while it seems to make sound business sense to be proactive with maintenance calls, the costs and benefits of alternative approaches still need to be assessed to make sure the decision is in line with business goals.

Figure 4: The Role of IoT in Service Execution



Top organizations will incorporate any and all relevant information into the algorithms used to schedule and manage the execution of work. Moreover, the algorithms should accommodate the multi-dimensional data associated with the 'supply' side of the equation. In other words, all characteristics of the different service options can be assessed according to business goals as part of the schedule optimization.

As we've seen, the ability to generate service requests in an optimal schedule is only one part of the puzzle. The best organizations will also fulfill the promise of the supply side of service agents, with the ability to schedule these resources where they are the most applicable solution. There should be focus on transforming signals into information that is consumable and into decisions that are actionable.

Conclusion

The forecasts for the IoT market sound like hyperbole. McKinsey Global Institute[6] research estimates that the impact of the Internet of Things on the global economy might be as high as $6.2 trillion by 2025. However, when one considers the impact of IoT in manufacturing, healthcare, digital cities, and autonomous vehicles, the technology is undoubtedly transformational. Based on simple sensors, advances in network technology and distributed systems have given rise to another, non-human communication revolution. Device signals of varying sophistication inform humans and machines alike of current status, while predictive systems infer future status.

As with all technological sea changes, the phrase "we don't know what we don't know" holds true. IoT represents transformative technology, but also combines with other emerging technologies such as augmented and virtual reality. A successful IoT strategy for industrial and/or consumer applications must work today and be flexible enough to accommodate whatever comes next. As the industry discovers the specific uses of the technology, new applications will emerge.

However, some things are certain:

- As IoT evolves, the scale of data involved will require greater levels of automation and artificial intelligence. Simple rules for proactive service will be insufficient to reflect human decision making, and must be accompanied by 'fuzzy' logic that incorporates a myriad of decision criteria.
- The context around the machine (e.g. weather, other machines in the area, or business hours) is equally critical to the telematics that come directly from the machine. The ability to understand and apply the information is prerequisite to its practical application.
- As machines become more intelligent and connected, they will play a greater role as an asset to be serviced and provide a service.

With the right goals, a plan, and tools on your side, IoT can go well beyond an inflated buzzword. It should be something that provides practical value every day to your customers. This brings value to your service organization, your company, and eventually our mission—to transform service into a core part of company strategy.

[6] http://www.mckinsey.com/industries/high-tech/our-insights/the-internet-of-things-sizing-up-the-opportunity

About ClickSoftware

ClickSoftware is a global leader of automated workforce management and optimization solutions for the service enterprise.

Available via the cloud or on-premises, our solutions provide organizations with end-to-end visibility and control over the entire service process, while providing them with tools to drive their business forward by optimizing forecasting, planning, scheduling, mobile workforce management and customer communication.

ClickSoftware solutions boost productivity and increase customer satisfaction, while decreasing overall service costs. ClickSoftware is the number one choice to deliver control over the entire service process, while providing superb business performance to organizations of all sizes, in all service sectors.

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