

INDUSTRIAL IOT CASE STUDY: ERICSSON SMART FACTORY





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About the GSMA Internet of Things Programme

The GSMA's Internet of Things Programme is an industry initiative focused on:

- COVERAGE of machine friendly, cost effective networks to deliver global and universal benefits
- CAPABILITY to capture higher value services beyond connectivity, at scale
- CYBERSECURITY to enable a trusted IoT where security is embedded from the beginning, at every stage of the IoT value chain

By developing key enablers, facilitating industry collaboration and supporting network optimisation, the Internet of Things Programme is enabling consumers and businesses to harness a host of rich new services, connected by intelligent and secure mobile networks.

Visit gsma.com/iot or follow gsma.at/iot to find out more about the GSMA IoT Programme.

About Ericsson

Ericsson enables communications service providers to capture the full value of connectivity. The company's portfolio spans Networks, Digital Services, Managed Services, and Emerging Business and is designed to help our customers go digital, increase efficiency and find new revenue streams. Ericsson's investments in innovation have delivered the benefits of telephony and mobile broadband to billions of people around the world. The Ericsson stock is listed on Nasdaq Stockholm and on Nasdaq New York.

About the Mobile IoT Innovators

The GSMA Mobile IoT Innovators is the official industry community for LPWA technologies in licensed spectrum. Uniting over 1000 companies and bringing operators, vendors, manufacturers, developers, consultants and end customers together, the Mobile IoT Innovators provide a vibrant ecosystem around Mobile IoT.

To find out more and join for free to receive exclusive benefits, please visit gsma.com/mioti

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Executive Summary

Mobile Internet of Things (IoT) technologies are set to play a central role in the smart factories of the future. Telecoms equipment maker Ericsson is using the cost-effective and reliable connectivity provided by Mobile IoT networks to make its factories in Sweden, Estonia and China more efficient and flexible. Ericsson has found that Mobile IoT and other cellular networks can support a wide range of different manufacturing use cases, making it possible to optimize manufacturing processes via a single communication system.

The Ericsson Panda manufacturing plant in Nanjing uses NB-IoT to connect 1,000 devices within the factory. The connectivity is used to monitor the location of critical assets, the output of workstations, stock levels, environmental factors and the performance of test fixtures and production tools, such as the high precision screwdrivers used on the production line. For these connected high precision screwdrivers, having usage data means the manufacturing operations manager can gauge exactly when these tools need to be recalibrated based on their actual use rather than on a predetermined periodic basis. Ericsson anticipates this solution alone, which only costs US\$20 per screwdriver, will cut manual maintenance work in half, saving US\$10,000 annually.

In general, Ericsson is finding mobile IoT connectivity has major advantages over alternatives. It estimates cables, which are prone to connector failures, can cost up to ≤ 200 (US\$230) per metre to install and maintain, but wireless sensors are simple to retrofit to existing industrial equipment, which can have lifetime of up to 30 years. Moreover, a wireless solution can support flexible production lines, which are configured on-demand and are now a feature of modern manufacturing. Ericsson says this flexibility will become even more important as factories increasingly use automated guided vehicles in place of fixed conveyor belts.

Mobile IoT technologies are particularly well suited to industrial use, as they are reliable, secure and can support a high density of devices. As production plants become increasingly reliant on cloud-based systems for automation and ultimately self-optimisation, Ericsson estimates that a typical smart factory will need to connect 1 device per two square meters.

Ericsson notes that a cellular network can be configured to prioritize data traffic with congestion control, enabling it to support many use cases within the same system. Furthermore, Mobile IoT networks build on a proven, interoperable ecosystem of base-stations and terminals, further strengthening both dimensions.

Over time, the role of cellular networks in manufacturing is set to expand deep into the factory. As production plants are increasingly integrating automated and selfoptimising logistics and supply chains which ensure the timely arrival of resources and allow factories to quickly reconfigure themselves in response to varying demand.

Introduction

Factories are getting smarter and smarter. By capturing information in real-time and enabling remote control of machinery, the Internet of Things (IoT) can increase efficiency and enhance the value manufacturers can provide to customers. In fact, the IoT, along with artificial intelligence and cloud computing, is one of the key enablers of Industry 4.0, the term used to describe the next industrial revolution. Industry 4.0 will be characterised by self-optimising production facilities that process a continuous flow of information to automatically adapt to events, such as a supply shortage or a new customer requirement (see Figure 1). Realising this vision will require the factory's central control system to have a detailed digital model of every asset and piece of infrastructure (a digital twin), which can be continually updated in real time.

Figure 1: Industry 4.0 envisions self-optimizing factories



Advances in cellular technologies are now enabling the industrial IoT to expand rapidly. In particular, new Mobile IoT technologies are well placed to serve factories' connectivity needs – they are designed to support a large number of connections in a small area, while also providing excellent coverage.

Delivered through a straightforward upgrade to a 4G (LTE) network, Mobile IoT technologies - NB-IoT and LTE-M¹ – can provide low-power wide-area coverage across industrial plants. As the number of deployments rises, economies of scale are kicking in, cutting the cost of modules which are being used in high volumes. This virtuous circle is further accelerating the growth in Mobile IoT connections. GSMA Intelligence estimates the number of Mobile IoT connections worldwide will rise from 66 million today to 1.8 billion in 2025.

Manufacturing is set to be one of the leading adopters. As the cost of NB-IoT and LTE-M modules fall, it is becoming feasible to connect almost every asset in a factory, allowing production managers to quickly identify and resolve operational challenges arising from the growing pressure to be both efficient and flexible – in the last decades the need for customization is increasing, customers are looking for a broader mix of products tailored to their specific requirements (see Figure 2). Customisation requires operational processes and production lines to be reconfigured quickly, without compromising on safety or quality.



Figure 2: Manufacturing is increasingly meeting the demand for personalised production

Ericsson is exploring three main categories of use cases for the deployment of Mobile IoT in factories:

1. Automation – the production line is remotely controlled using increasingly smart systems hosted in the cloud.

2. Monitoring – the performance of equipment is continually monitored for quality control and to enable predictive maintenance.

3. Tracking – the availability, volume and location of stock and equipment is tracked.

This paper outlines how Ericsson, a leading supplier of telecoms equipment, is harnessing Mobile IoT technologies to improve its own manufacturing processes.

¹ LTE-M (Long-Term Evolution Machine Type Communications) also known as Cat-M1

How Ericsson is making its factories smart

Ericsson factories in Stockholm, Sweden, Tallinn, Estonia and Nanjing, China are fast-tracking the introduction of a new generation of smart manufacturing technologies. By employing Mobile IoT connectivity to improve processes in a real manufacturing environment, Ericsson is aiming to help this new wave of technology enablers to mature more rapidly. Ericsson's factories are employing Mobile IoT technologies in many different ways:

Tracking critical equipment



Ericsson is using NB-IoT-enabled sensors to track if critical equipment has been moved. As a result, key assets can now be located immediately, while paperwork is reduced and there is less risk of important equipment going missing.

Streamlining the Andon System²



Ericsson has installed a wireless Andon system to enable machine operators on its production lines to call for technical support when a quality problem occurs. Historically, this has been an inflexible wireline system in which the shift leader got the call on his or her screen and then had to manually find the right engineer to address the problem. But the new Mobile IoT LTE-M solution uses VoLTE to make a call directly to the right engineer from the line, reducing the lead-time for problem-solving.

Monitoring output of workstations



Ericsson has added sensors³ with NB-IoT connectivity to workstations on its manufacturing lines to enable real-time monitoring and analysis of production data, which can then be used to guide dynamic adjustments to the production plan.

² Andon system – a signalling system used to notify for support in manufacturing.
³ Sensors sourced from Mouser Electronics Inc https://www2.mouser.com/



Environment monitoring



In some factories, environmental conditions, such as humidity levels and air temperature, need to be maintained within certain parameters. Although wired sensors can monitor the climatic conditions, NB-IoT has made it cost-effective to use wireless sensors, which can be deployed easily and then moved from place to place, as required.

Monitoring the contents of material boxes



Ericsson is adding NB-IoT-connected pressure sensors to storage boxes to enable real-time monitoring of how full they are. Previously, the material level in the boxes had to be measured manually and then recorded by scanning barcodes.

Calibrating high-precision screwdrivers



In its 40,000-square metre plant manufacturing radio equipment in Nanjing, China, Ericsson Panda Communication employs many high-precision screwdrivers. The screwdrivers, which cost US\$1,500 each, require routine calibration and lubrication based on utilisation times.

"They need to be calibrated to the right torque in order to secure quality and performance of our products," says an Ericsson Panda spokesperson. "The interval of the calibration is related to the number of operations the screwdriver has done. As there is no counter in the screwdriver there is no way of knowing the number of operations an individual screwdriver has done. Because of this, the calibration has been done with a fixed time interval."

Whereas this maintenance was a manual procedure performed periodically and documented in hand-written logs, the high-precision screwdrivers have now been fitted with real-time motion sensors attached to NB-IoT modules. Every eight hours, the modules transmit about 100 bytes of data indicating how much they have been used in the preceding period.

The data is then captured in Ericsson Panda's private cloud system, which makes automatic calculations and analysis about the tools' utilization and condition status. The cloud-based quality-monitoring system also indicates when certain thresholds are reached, enabling predictive maintenance that extends the service life of these expensive screwdrivers considerably. To develop the solution, Ericsson integrated a motion sensor from ADI with an NB-IoT module from Simcom. As the cost is only about US\$20 per device, the factory now plans to completely phase out manual tracking. Ericsson Panda anticipates improved detection of human errors will reduce maintenance material expenses by US\$1,000 each year, while manual maintenance work will be cut in half, saving US\$10,000 annually. "By connecting our high-precision screwdrivers, we will see a 50% return on investment in year one. And, breakeven is reached in less than 2 years," said Tomas Qvist, President, Nanjing Ericsson Panda Communication.

5G factory in Stockholm. As a result, Ericsson can better track maintenance and perform calibration to optimise the radio frequency (RF) performance of the test fixtures. The NB-IoT-connected monitors are necessary because the number of logical tests tracked in the fixtures' software does not represent the true number of physical connections. The NB-IoT enabled solutions can prevent the fixtures from being overused and RF performance is lost. The result is a reduction in maintenance costs and improved testing performance.

Optimising test fixtures

Ericsson is using NB-IoT to monitor the number of connections being handled by the test fixtures in its

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Tomas Qvist, President, Nanjing Ericsson Panda Communication

How manufacturing benefits from Mobile IoT

For manufacturers, mobile IoT connectivity has several key advantages over alternatives. Whereas Ericsson estimates cables, which are prone to connector failures, can cost up to €200 (US\$230) per metre to install and maintain, wireless sensors are simple to retrofit to existing industrial equipment, which can have a lifetime of up to 30 years. Ericsson has found that a Mobile IoT system can yield potential savings of approximately €200 (US\$230) per added sensor when adding a simple sensor to the shop floor.

Moreover, cables have to be fixed in place, meaning they cannot support flexible production lines, which are configured on-demand and are now a feature of modern manufacturing: The Ericsson factory in Tallinn changes lines every other week. In a similar vein, cables are not well suited to connecting moving assets or free-standing objects, such as rotating, moving machines and portable tools and materials. By contrast, a wireless solution offers full mobility and flexibility, enabling the manufacturer to collect intelligence throughout the site. Ericsson says this flexibility will become even more important as plants replace fixed conveyor belts with automated guided vehicles, a market that will triple by 2024, according to some forecasts⁴.

Ericsson believes the most suitable wireless technology for industrial use is cellular, as it offers a higher level of reliability and security than alternatives and can support a higher density of devices. Cellular systems are designed to only admit and manage trusted identities and data in the network and are based on global 3GPP standards with strong security mechanisms.

Ericsson also notes that a cellular network can be configured to prioritize data traffic with congestion control, enabling it to support many use cases within the same system. By comparison, industrial Wi-Fi is a highly fragmented market, characterised by many separate commercial solutions.

⁴ http://www.dcvelocity.com/articles/20170125-report-global-agv-sales-will-nearly-triple-by-2024/

Conclusions and next steps

For manufacturers, connectivity is fast becoming a critical enabler. Ericsson estimates that a typical smart factory will need to connect 1 device per two square meters, as it seeks to harness the potential of the following technologies:

- **Nobotics that self-configure**
- Intelligence in a private cloud
- Augmented reality for quicker, accurate testing
- Digital twins for design, simulation and planning
- Autonomous guided vehicles for faster material handling
- Real-time tracking of workers and moving assets for safety and optimisation.

Therefore, a manufacturer needs to be able to support multiple systems, such as collaborative robots and digital twins, simultaneously. Ideally, these assets are managed by a single communication platform serving a private cloud-based management system, which can provide a complete plant overview and can aggregate intelligence from all areas of the factory. By testing the technologies in its own factories, Ericsson has found that Mobile IoT and other cellular networks can support a wide range of different manufacturing use cases, making it possible to securely and efficiently optimize manufacturing variables with a single communication system. Cellular networks allow for massive data collection and analytics, increasing intelligent automation on the factory floor and enabling adaptive production. Cellular connectivity also enables fast and cost-efficient production line changes, as well as integration and optimization of contributing workflows.

Ericsson forecasts that the vast majority of cellular connections in a smart factory will use Mobile IoT technologies, such as NB-IoT and LTE-M as shown in Figure 3.

Figure 3: Mobile IoT will account for most cellular connections in smart factories



ESTIMATED SHARE OF DIFFERENT TYPES OF CONNECTED DEVICES REQUIRED TO SUPPORT USE CASES AT A TYPICAL SMART MANUFACTURING SITE

High bandwidth, low/predictive latency 5G Low to high bandwidth 4G Limited data size, high update rate **NB-IoT/Cat-M1** Limited data size, low update rate **NB-IoT/Cat-M1**

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LTE-M and NB-IoT Mobile IoT technologies are available now and will be included in the future 5G cellular specification. Low power connections for smart factories and the benefits as described in this report can already be achieved.

Ericsson believes the wide bandwidth, consistently low latency and ultra-reliability offered by 5G connectivity will help factories achieve high-levels of automation. For example, 5G technologies could be used to support the transmission of large data volumes and real-time critical data, between robots on the production line and the cloud (see Figure 4). "Connectivity requirements in a factory are very dependent on the use case and application, and so the network also needs to support service differentiation," says Sebastian Elmgren, Portfolio Manager Smart Manufacturing, Advanced Industries, Ericsson. "Some use cases are possible to address with evolved 4G technology, while others such as production and robot control may require latency between 1 and 10 milliseconds, which can only be achieved with 5G technology," as shown in Figure 4.

Figure 4: Different levels of latency requirements in industrial automation



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Sebastian Elmgren, Portfolio Manager Smart Manufacturing, Advanced Industries, Ericsson Regardless of whether 4G or 5G connectivity is used, Ericsson says the quality of service (QoS) mechanisms in cellular networks will become more and more valuable. "The importance of this will increase as manufacturers are digitalized and demand more networked capabilities beyond their sites to include logistics, suppliers and other factories. The success of manufactured products in the market depends on continuous customer feedback and co-creation. Where we collaborate with our own factories and industry partners to set the foundation for smart wireless manufacturing with 4G and soon 5G" Erik Josefsson, Head of Advanced Industries, Ericsson.

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