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What Industry 4.0 means for manufacturing

Sustainability and connectivity: Ericsson Tallinn factory case study

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Introducing agility in manufacturing

Manufacturing is entering Industry 4.0, in which operational technology, information technology (IT) and communications are merging into "cyber-physical systems". It provides manufacturers with the opportunity to utilize advanced manufacturing and IT capabilities together throughout the product life cycle, thereby enabling more efficient and sustainable production processes.

Currently, 94 percent[1] of industrial IoT is wired and expensively retrofitted on equipment, creating data and platform silos. While industries have automated many processes, secure wireless connectivity empowers IoT, making intelligent automation possible and simple on much larger scales. By creating a digital foundation, manufacturing will increase productivity and performance, and limit the level of unnecessary human intervention.
Efficient use of natural resources is important to Ericsson as a global company, and we use circular economy thinking and climate awareness to manage our environmental impacts. This includes those of our company, products and services, as well as the use of information and communications technology (ICT) to reduce the environmental impacts of other sectors.

To prove and measure the positive impacts of the main enabling technologies, relevant use cases within the manufacturing process have been identified, analyzed and deployed in Ericsson's own factories. Cellular IoT is widely deployed in the Ericsson Panda factory in Nanjing, China, and has provided a 50 percent return on investment in the first year.[2] In this report, we share highlights of our analysis and learnings at our factory in Tallinn, Estonia.

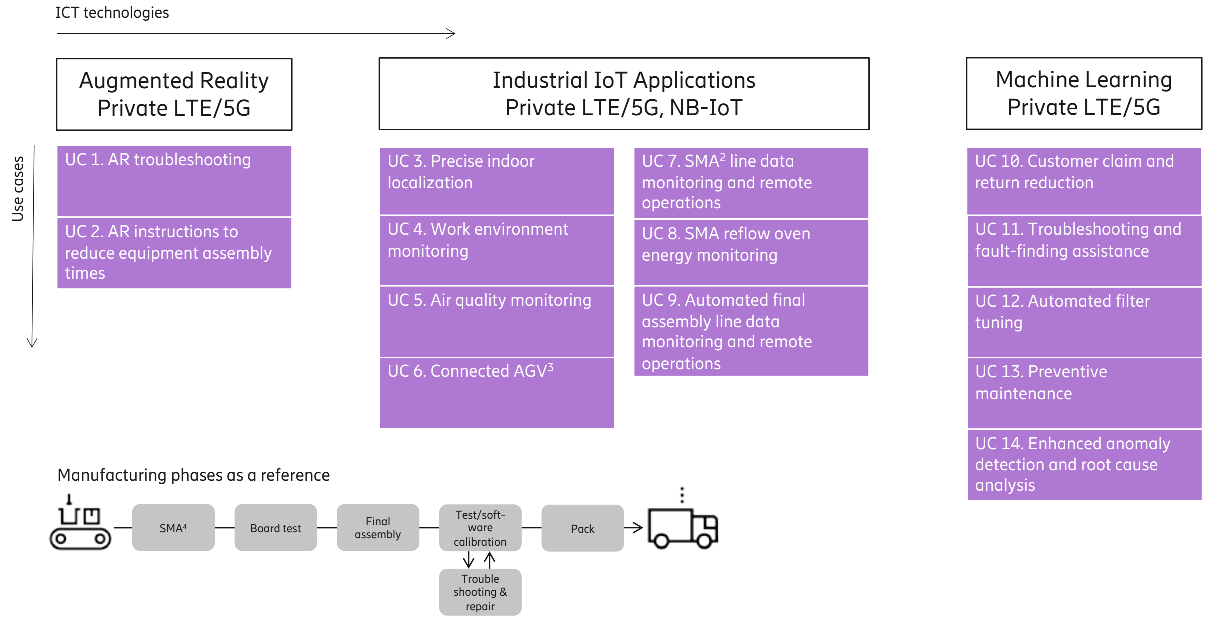
The manufacturing site
The Ericsson Tallinn manufacturing site has set out an ambitious digital transformation program to improve operational efficiency, workplace health and safety, and cooperation with the Product Design Unit to secure integration of design with the manufacturing process.

On the way to a smart manufacturing site, experts from Ericsson identified use cases within the manufacturing process and analyzed their impact from technical, economic, worker safety and environmental perspectives. An agile approach, covering both qualitative and quantitative analysis, was taken to help identify potential benefits per use case for decision-making early in the process.
As the first step, identified use cases were assessed by technical requirements and clustered by enabling technology.

Ericsson Tallinn manufacturing site – key facts

Ericsson Supply Site Tallinn is one of Ericsson's largest manufacturing units, including R&D-related activities and volume production.
The main products are part of the Ericsson Radio System family and the Tallinn site is engaged in the development and launch of new digital and radio products, product industrialization and test system development.
Ericsson Supply Site Tallinn was established in 2009. Today there are 2,100 employees, of 45 different nationalities. The total area of the factory is 23,000sqm, excluding external logistic partners (an additional 23,000sqm). The company in Estonia makes up 6 percent of the country's exports.

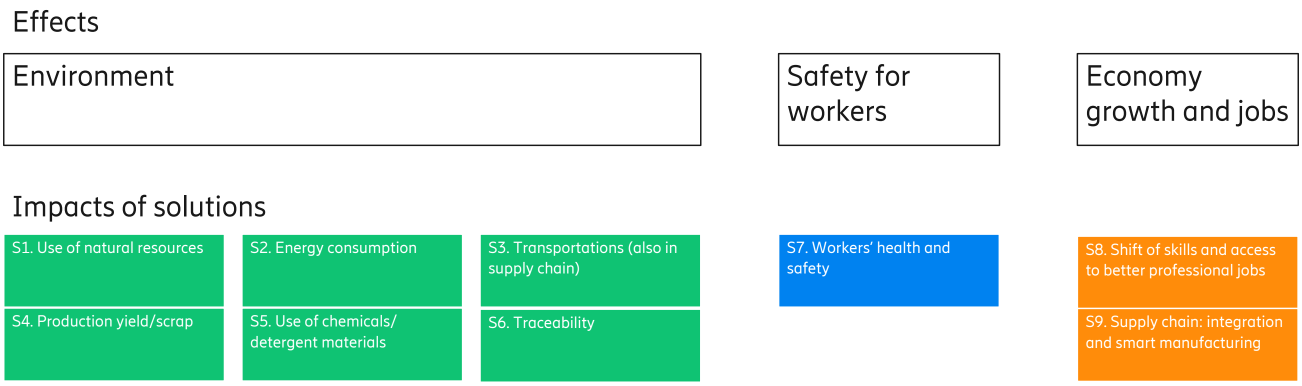
Figure 1: ICT enabling different use cases



[1]According to HMS Industrial Networks' annual study
[2]For more information, see www.ericsson.com/en/networks/cases/cellular-iot/cellular-iot-enables-smart-factories/industry-4-0
[3]Automated guided vehicle
[4]Surface mounting assembly

The second step was to come up with a general approach to deal with the complexity of technology and sustainability impact analysis. The chosen approach was inspired by MapLauncher[3], an interactive dashboard built to structure complex flows and interdependencies. In this second step, we analyzed sustainability effects on manufacturing in three categories – environment, safety for workers, and growth in economy and employment. These categories were agreed by Ericsson sustainability and Tallinn factory experts.

Figure 2: Sustainability value enabled by cellular wireless connectivity



Note: Approach inspired by MapLauncher

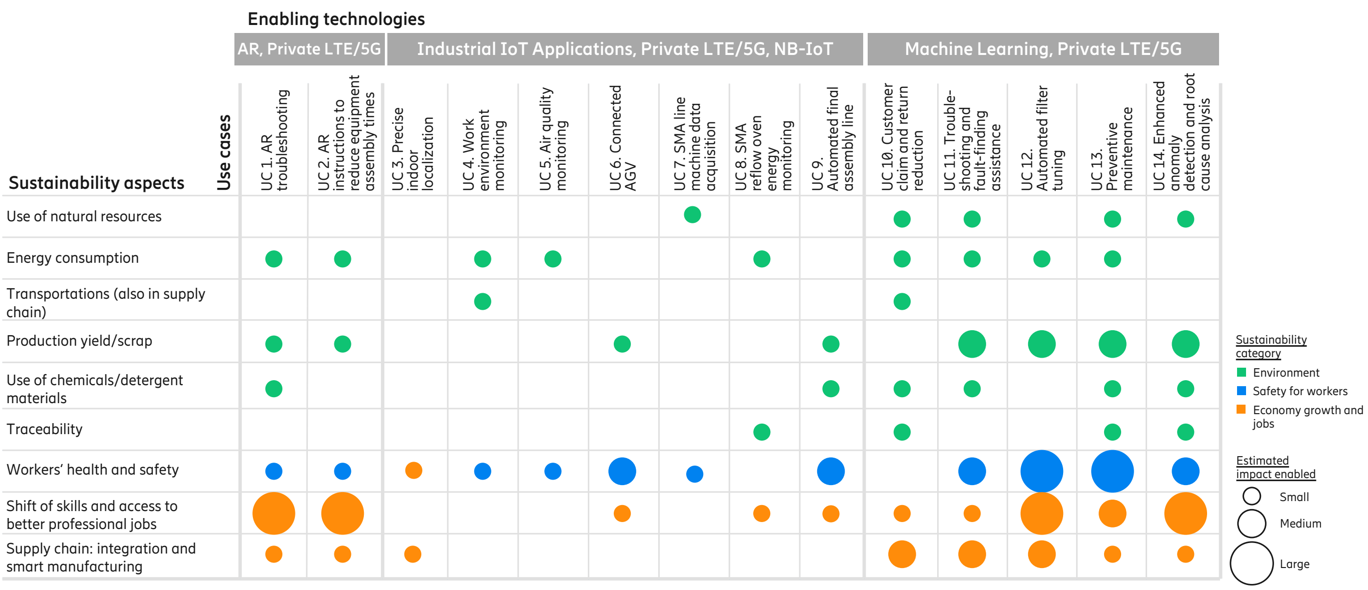
To identify the most interesting use cases and to uncover the value of digital technologies in the manufacturing sector, our manufacturing and sustainability experts assessed all use cases against different sustainability categories. Estimated improvement percentages were provided as a comparison to the current situation and used for decision making for the next steps of the factory digital transformation.

Most use cases enable reduced energy consumption in production activities, improvements in the amount of yield and scrap, and reduced transportation due to a smaller number of claims. Future deployment of Machine Learning is expected to boost improvements even further.

Most use cases also enable improvements in worker well-being and safety, reaching relevant impacts with automated guided vehicles (AGVs), robotics and Machine Learning. Augmented Reality (AR), IoT and Machine Learning are the key enabling technologies for use cases that facilitate workers to perform activities empowered by tools, increasing quality and efficiency and enhancing professional skills. Suppliers' activities, which include component packaging and product transportation, also benefit from these use cases, with improvements such as reduced transportation costs, delivery time and mistakes.

The next step in our analysis consists of confirming or refining the estimations with actual figures, leveraging on pilot outcomes and obtaining full deployment measurements.

Figure 3: Potential impact enabled by digital technologies per use case and sustainability category



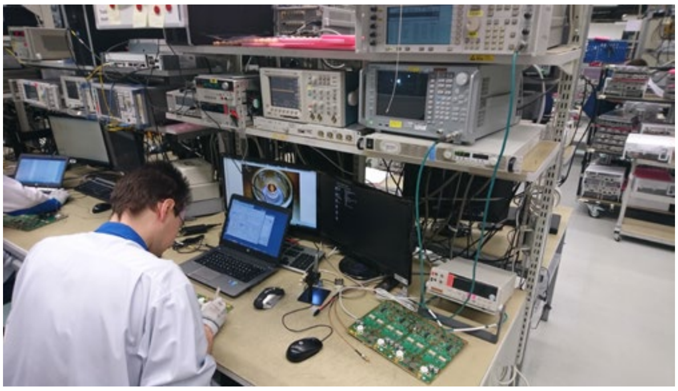
Note: Sustainability aspects may be correlated. Different bubble sizes are intended to denote importance per use case; as such, they do not reflect absolute numbers, i.e. bubble sizes for different use cases cannot be directly compared.

[3] www.maplauncher.com

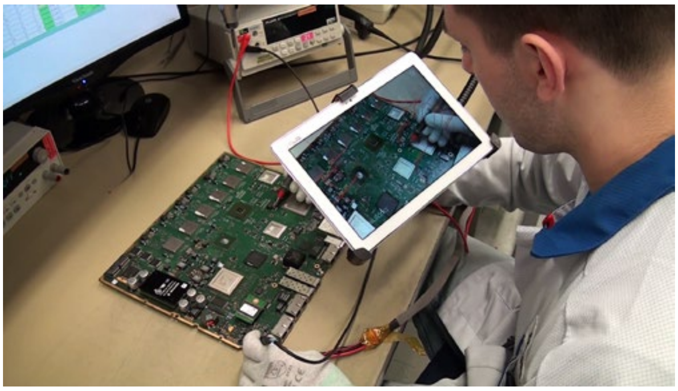
The impact of selected use cases

The manufacturing industry can reap significant benefits by capitalizing on the use cases that have been tested and proven.

Augmented Reality troubleshooting (UC1)
Troubleshooting of circuit boards is a highly skilled and time-consuming job. Around 50 percent of the total time is typically spent on searching for information from documents, manuals and schematics. The first solutions were generated in 2016, and the factory developed an in-house proof of concept (PoC) to validate ideas. In this PoC, AR is used to place instructions on top of what the operator or troubleshooter sees when inspecting circuit boards.
Testing results show that, with AR troubleshooting, average fault detection time could be reduced by 15 percent, which is significant due to high troubleshooter workload and skill level requirements in this area. Due to the availability of better-quality information with AR, there are likely to be fewer component replacements, leading to energy consumption savings, as well as reduced chemical use and scrap. Using AR technology also increases the skill level and value of engineers.
Additional value can be generated using the tool in multiple locations globally, as well as within one factory.



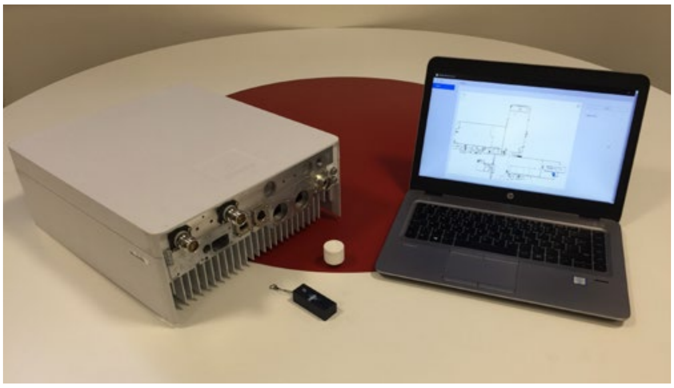
Before, engineers had to look up instructions and manuals on the workstation PC



Now, instructions are shown as an overlay on a tablet screen or AR headset

Precise indoor localization (UC3)
Keeping track of unique components, prototype products and expensive equipment in the factory is a critical but often manual and time-consuming process, because the manufacturing site is a complex mix of labs, testing areas, warehouses, troubleshooting areas, and production and packaging lines. If assets are not located in time, there is a risk of project and production delays.
The precise indoor localization system helps to automate and digitalize asset tracking inside the factory. It significantly reduces the risk of project delays due to extensive time spent on manual tracking and availability of the assets. The initial estimates show 25 percent efficiency gains compared to manual asset tracking.

Before, products with specific serial numbers needed to be searched for and tracked manually in an open hall



Now, a sensor can be mounted onto the products, locating them with centimeter-level precision in the factory

Work environment monitoring (UC4)
A safe and healthy working environment is fundamental to our commitment to conduct business responsibly. IoT sensors enable monitoring of the working environment, which helps safeguard workers' well-being, and better temperature regulation, which decreases energy costs.

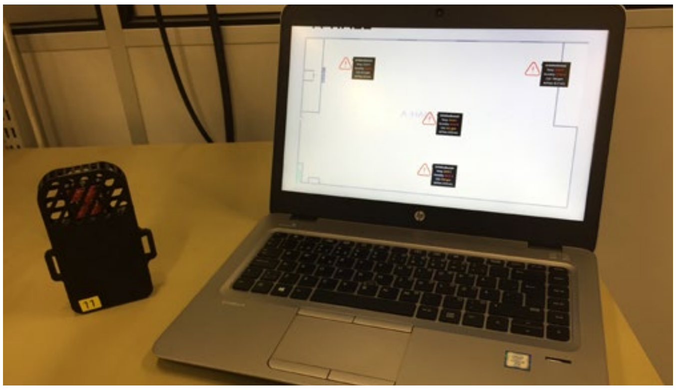
With this monitoring, expert estimates are that 10 to 20 percent of heating costs can be reduced with better coordination of cooling (air conditioning) with gas heating, which also results in lower CO2 emissions.

Furthermore, such a monitoring system improves workers' well-being by way of near-real-time detection of pollutants, which makes it possible to respond proactively.

During an internal hackathon at the Tallinn manufacturing site, the need for better working environment monitoring was identified and within three months a PoC was developed, which included sensors, a cloud-based application and a graphical user interface. To validate the idea, 12 sensors were deployed on the shop floor as well as in the office environment, measuring temperature, humidity, air flow and carbon dioxide level of workers breathing out. The data showed areas where the microclimate needed to improve, and actions were taken to renovate those areas.

Smart layout planning enables simple and fast production line reconfigurations to cater for the increasing requirements of mass customization and on-demand production. Depending on the measured conditions, some areas can be identified as unsuitable for manned work, but still appropriate for machinery usage or storing goods.

Before, displays showing humidity and temperature would be mounted on the factory wall



Now, cloud-based information is gathered from different sources across the whole factory

Connected AGV (UC6)
Picking up and transportation of components is a very labor-intensive, costly and recurring task across warehouse and production line flows. The use of connected AGVs to dispatch components from warehouses to production lines can ease this pain by saving time, eliminating rework (they provide greater accuracy than humans) and reducing the risk of damaged components (they have a positive impact on yield/scrap) thereby reducing resource waste, as well as having a positive impact on worker safety.

Three AGVs are currently being tested; two are in active use and one is being used in development. Each AGV moves 17km a day, reducing the high risk of work-related disease associated with standing.

When moving around the factory, connected AGVs communicate with production lines and warehouses, and can quickly react to notifications about required material and components. Fleet management functionality like route optimization – i.e. looking at which AGV is closer to a specific order – would make sense with a larger number of AGVs in operation.

Cellular capabilities in context

Through cellular connectivity, almost every asset in a factory can be connected and managed to solve operational challenges.

Intelligent production line automation calls for a fast, stable, secure and simple communication solution. Communication aspects have hence been considered critical since early analysis of digital factory transformation.

With the new standards in cellular connectivity, cellular networks meet a range of requirements to support different manufacturing use cases, making it possible to securely and efficiently optimize manufacturing variables with one communication system. They allow massive real-time 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.

In comparison, a fixed cable network is mainly restricted to supporting critical applications for stationary machines, and Wi-Fi to supporting non-critical (massive) applications. In both cases, scaling connected operations is not feasible, as cables are costly to install and maintain, and Wi-Fi cannot sustain high network performance.

The smart manufacturing site will have an average of 1 connected device every 2 square meters (average data from different manufacturing sites[4]). Applying this estimate on the Tallinn manufacturing site results in a staggering total of 11,500 connected devices. Cellular technology (LTE/5G) is the only way forward, because in the future there will be so many IoT devices deployed with different demands on connectivity. Cellular capabilities will include:

- Low and predictable latencies, even with a heavy load and many users
- Quality of service to guarantee low latency and bit rates
- More deployment flexibility for sparse and dense options
- Mobility capabilities to ensure a smooth handover between base stations
- Flexible scaling of network capacity, depending on demand
- Reliability of device interoperability
- The full deployment of multiple use cases, involving a large number of sensors and devices, requires LTE/NB-IoT/5G cellular capabilities in order to ensure reliability and security. Hence, we are piloting the use of private LTE to enable smart manufacturing in a real telecom equipment manufacturing environment. The target is to deploy full private LTE and 5G.

[4]Realizing smart manufacturing, Ericsson Mobility Report (June 2018)

Key insights

To address most pain points and gain value in plant operations, the connectivity foundation must be as robust, reliable and future-proof as possible.

Manufacturing is moving toward wireless connectivity, allowing a flexible production line instead of linear manufacturing processes. The combination of electrification and wireless communication enables full flexibility beyond AGVs, and the promise of low latency, high bandwidth and a deterministic network is attracting industries to dare to move away from cables.

Industries have hit a wall in cabled connections, and there has been an explosion in the number of different access communication technologies like Wi-Fi, LoRa, ZigBee, Bluetooth and ultra-wideband (UWB). 5G shows great promise as a single infrastructure so powerful that it can serve massive, critical and industrial automation use cases.

An agile approach, covering both qualitative and quantitative analysis, helps to identify the potential benefits per use case, including the sustainability-, technology- and business-related benefits of supporting early decision-making on where to invest.

To address most pain points and gain value in plant operations, the connectivity foundation must be as robust, reliable and future-proof as possible. The performance of cellular technology (LTE) has the capacity to give transparency and control to all connected assets by supporting a higher density of devices and faster, more secure transmission of data.

The evolution to 5G will push the envelope, multiplying performance standards and supporting even heavier data analytics and autonomous services for networked cells and facilities. The transition to 5G will be seamless and bring software-upgradable, future-proof solutions, while offering long life cycle management to already-deployed radio products.

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