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5G business value

A case study on real-time control in manufacturing

An Ericsson Consumer & IndustryLab Insight Report
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Contents

Methodology
This case study is part of an Ericsson 5G for Industries series where we look more closely at the actual business values associated with introducing 5G mobile connectivity.

Information, if not otherwise stated, is based on discussions and interviews with the Fraunhofer Institute for Production Technology (IPT) carried out as part of a study conducted from January to March 2018.

Generally, the assumptions in this report are based on estimated typical values emerging from these discussions. For the business value calculations, these assumptions are likely to be on the conservative side.

About Consumer & IndustryLab
Ericsson Consumer & IndustryLab delivers world-class research, strategic design concepts and insights for innovation and sustainable business development. We explore the future of consumers, industries and a sustainable society in regards to connectivity by using scientific methods to provide unique insights on markets, industries and consumer trends. Our knowledge is gained in global consumer and industry research programs, including collaborations with renowned industry organizations and world-leading universities. Our research programs cover interviews with over 100,000 individuals each year, in more than 40 countries – statistically representing the views of 1.1 billion people.

Ericsson's industry collaborations
Ericsson is proud to work with multiple industries on 5G use cases to ensure we develop the right technology for real-world applications, and to help industries understand how 5G can accelerate innovation. Today we are collaborating with 22 industry partners to define the use cases for 5G technology.

In March 2015 we launched 5G for Sweden, a research and development program with industry and academic partners including Volvo, Boliden, SICS, Scania, Saab and SKF. The program applies telecoms technology in industrial processes, products and services. One pilot project has used 5G technology for communication and remote control operations to find productivity and safety solutions in the Swedish mining industry, an industry traditionally considered to have a hazardous operational environment. The program has also established strategic partnerships with the main technical universities in Sweden, as well as a close cooperation with Swedish government and Vinnova, the Swedish innovation agency.

In September 2015 we announced 5G for Europe, a program to deliver research, innovation and industrial pilots enabled by 5G. Industries forming part of this project include transport and automotive, manufacturing, and energy and utilities. The 5G for Europe program spans 7 countries and 10 institutions and the BLISK case study covered in this report forms part of this program.

In February 2017 Ericsson and Intel launched the 5G Innovators Initiative (5GI^2) in the US. 5GI^2 will connect equipment manufacturers, technology companies, industry leaders and universities to test 5G network and distributed edge technologies, with the aim to accelerate the adoption of 5G wireless and infrastructure innovation. Honeywell, General Electric and the University of California, Berkeley are the first participants to join the initiative.

The next generation of manufacturing

The next wave of industrial productivity is known as Industry 4.0. Encompassing technologies centered on automation, business information and manufacturing systems, the Industry 4.0 vision includes connected production where all components are tracked and configured in a self-managing system.

Mobile communications and the introduction of 5G could become significant enablers for Industry 4.0. Allowing connectivity and automation on the factory floor on an unprecedented scale would transform the manufacturing sector.

In one of the initiatives, Fraunhofer IPT and Ericsson have collaborated to research new methods for improving process control and discovering manufacturing failures more promptly.

The research has looked specifically at the manufacture of bladed disks (BLISKs), which are important components of turbines such as aircraft jet engines. Consisting of a rotor disk and multiple blades around its edge (see Figure 1), BLISKs are one of the most demanding metal processing applications.

In this case study we uncover the value, in terms of both economic and sustainability value, for using 5G technology in the production of BLISKs.

Figure 1: The milling of a BLISK

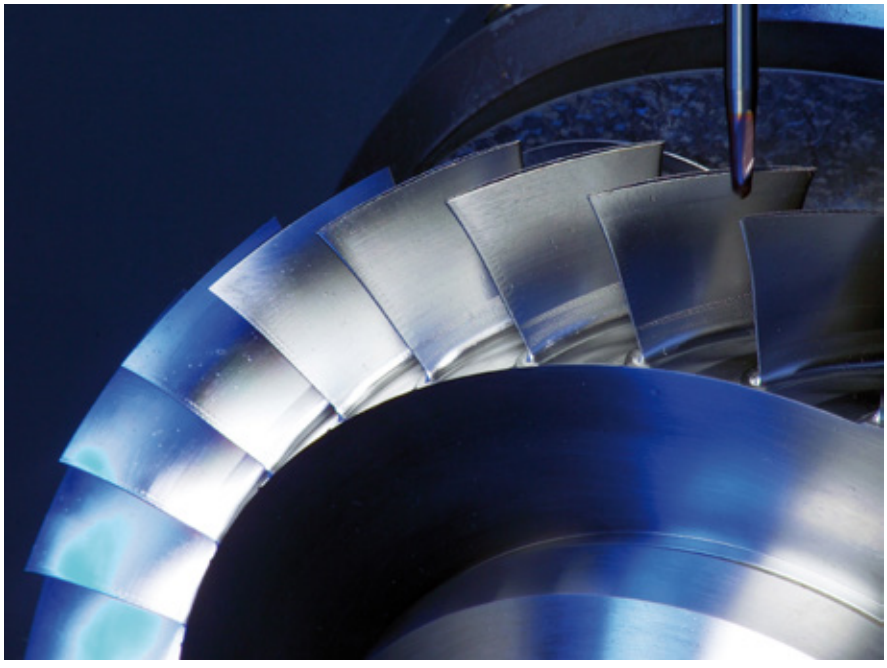


Image source: Fraunhofer IPT

Key insights

1. Introducing 5G mobile communications into industrial manufacturing processes can both address pain points and release great value.
   - The 5G-enabled BLISK case study alone could create annual savings of approximately EUR 27 million for one single factory, and up to EUR 360 million globally.
2. While the BLISK case is an extreme example, similar challenges exist within the manufacturing industry as a whole; vibration and "chatter" during milling is a very common problem.
3. There are approximately 5 million industrial sites in Europe alone, compared with a total of 4 million mobile base stations in the world.[1]
   - Equipping each industrial site with mobile communications opens up large opportunities for operators to expand their business.

[1] https://rod.eionet.europa.eu/obligations/721

Putting 5G to the test

The BLISK case presents a clear business opportunity for 5G to support Industry 4.0. By tackling production challenges with 5G solutions, both BLISK manufacturing and industry in general can reap the rewards.

The opportunity
There is an opportunity to improve manufacturing processes by enabling connectivity through smart sensors and real-time transmissions. The benefits of these technologies alone justify the installation of a private enterprise cellular network in a factory and the value potential is considerable.

Once a 5G network is established, a truly automated factory can be realized. An array of connected devices such as machines, sensors, materials and robots can be managed through one standardized network, with the correct latency and bandwidth allocated as necessary. This is where the greatest opportunity lies for operators.

The challenge
The BLISK milling process today presents several challenges, not least that of ensuring maximum quality. Given there have been instances of failing BLISKs which have led to severe accidents, ensuring maximum quality in the production process is essential to guarantee safety of the product.[2]

A key aspect of current BLISK production – and metal processing in general – is that the process is very difficult to monitor, meaning the end result is not known until milling finishes. Given the milling process can last a full day but is capable of reaching 100 hours or more, and rework is often as high as 25 percent, the overall production time is high.

Milling issues, such as vibration patterns affecting the end result, could be revealed by monitoring the process in real time. This data could then be used to instantly optimize the milling process, limiting the need for rework. This type of early detection will also bring significant savings, as costs increase the longer failures go undetected. Failure detection is a challenge that exists throughout the manufacturing industry as a whole, though the BLISK case is a more acute example. Vibration and "chatter" during milling is a very common problem, which seems to occur in an unpredictable manner even in stable serial production.[3]

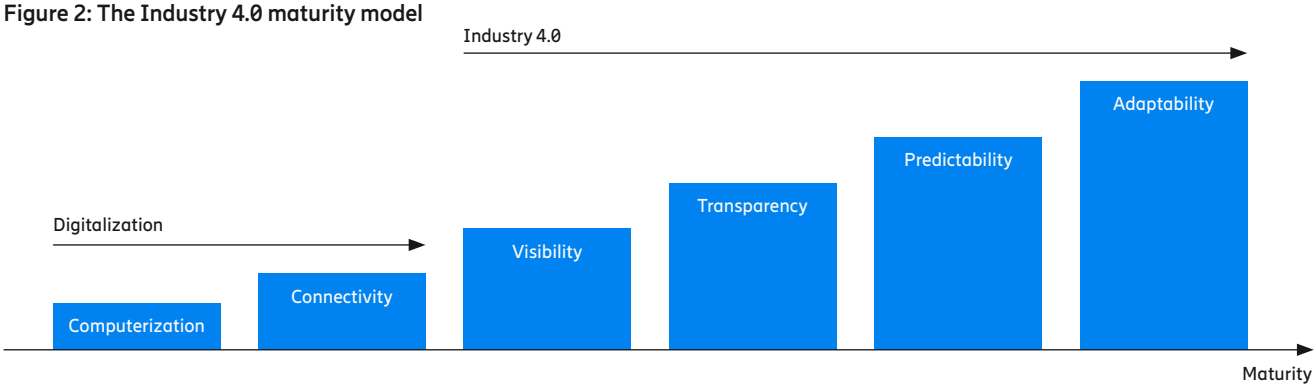
The next generation will see the geometry of BLISKs continue to evolve; thinner blades with increased aspect ratios make them more flexible and therefore prone to vibration, which will further increase the production challenge.[4]

25%

A main challenge is the 25 percent rework in the BLISK production process.

[2] The best-known example is the Pensacola aircraft crash in 1996, when minute quality deficiency in the BLISK prevented cooling fluid from proper effect
[3] Chatter is a specific type of vibration that is "self-induced" or "self-excited", i.e. a consequence of the interaction of the tool with the workpiece in conditions where the damping behavior is significantly smaller than the excitation
[4] Increased aspect ratios are increases in the ratio between the absolute blade length (from the root to the tip) and the chord length (length in air flow direction, length of the tip from front to back)

Figure 2: The Industry 4.0 maturity model



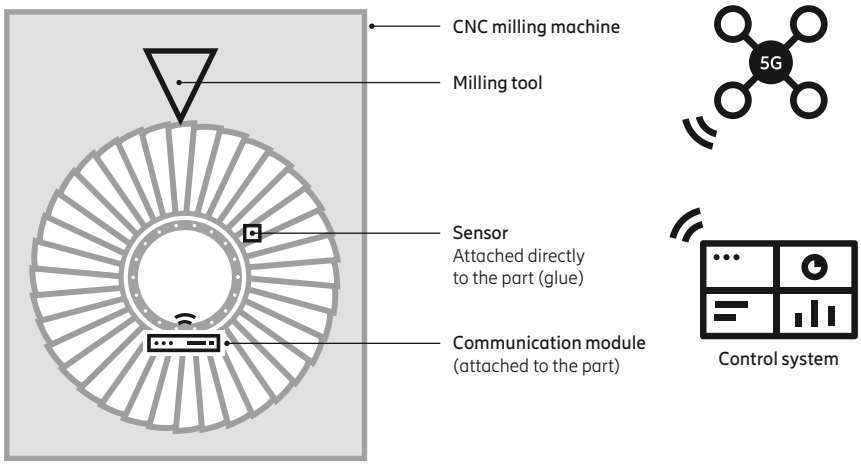
The solution

The Fraunhofer IPT project tested automated production, monitoring and real-time control of the BLISK production process to identify issues and areas where improvements could be made by introducing intelligence to the system. A maturity model that demonstrates the solution (see Figure 2) has been devised, which can be summarized in four steps:

1. Enable monitoring and data collection – to optimize future milling
2. Enable real-time monitoring – to stop defective parts from further processing, or localize and describe defects to initiate rework
3. Enable real-time control – to adjust the process in motion, for example by altering the milling tool spinning speed
4. Enable a fully automated factory – the total number of connected devices can be combined and managed as one ecosystem

These solutions can be achieved through added and/or improved components (see Figure 3).

Figure 3: Illustration of the solution components



5G holds the key

As current technology is not capable of supporting this solution, 5G is key.

The main benefit of 5G in this use case is that it can provide very low, stable and predictable latency. For real-time control, the sensor's information needs to be processed and acted on within 1 millisecond. 5G technology can enable the control loop by providing this low latency capability, enabling its application in BLISK production.

Miniaturized sensors and 5G communication modules are also critical to wireless data collection and the communication capability for cases like this one.

The introduction of 5G will also bring more tightly controlled monitoring capabilities, meaning that the performance of a critical sensor, such as the BLISK vibration sensor, can be monitored at all times.

1 millisecond

1 millisecond is the ultra-low latency needed for real-time control of the BLISK manufacturing process and can be provided through 5G technology capabilities.

Unveiling the value

The value of the connected solution for BLISK production has been analyzed from both an economic and a sustainability perspective.[5]

The economic value

The potential for improving production economics for the BLISK is very high and is a revealing illustration of how incredible value can be realized when introducing high performance connectivity to the factory floor.

The rework rate of BLISKs today is approximately 25 percent, meaning that 1 in every 4 BLISKs needs to be reworked. Given their high cost, any decrease in the rework rate is of significant value.

If the rework rate through automation can be decreased from 25 to 15 percent, the machine time will in turn be reduced, which can be translated into a machine cost reduction of EUR 3,600 per BLISK.[6]

The market for BLISKs is seeing strong growth. A typical BLISK factory produces 40 per day, including rework. For one factory, the annual saving through real-time monitoring and control enabled by 5G would amount to EUR 27 million. Assuming 100,000 BLISKs are produced annually gives an idea of the order of magnitude.[7] Globally, this means value potential of around EUR 360 million annually for current BLISK production alone; a significant metal processing operation, but still only a fraction of total global metal processing.[8]

The sustainability value

As mentioned earlier, introducing 5G into the BLISK case could lead to a significant reduction in production time. This will give rise to decreased electricity consumption, which in turn means the potential to decrease annual CO_2-equivalent emissions by 360 metric tons if applied to the overall global BLISK production.[9]

Higher-quality BLISK production also creates opportunities to reduce fuel consumption and thereby greenhouse gas emissions when operating jet engines. Increased production quality means BLISKs operate more efficiently, reducing fuel consumption and, in turn, lowering CO_2 emissions. Assuming an average 2 percent higher efficiency is achieved, global CO_2 emissions could be reduced by 16 million metric tons annually. These savings equal the total annual consumption-based CO_2-equivalent annual emissions of approximately 1.4 million people in Sweden, a greater number than the population of the capital, Stockholm.[10]

Another way to view these savings is to compare them with flying; 16 million metric tons of CO_2 emissions is the same amount that 4.4 million people flying from London to Bangkok would emit.

EUR 360 million

An annual saving of EUR 360 million can be made on BLISK production through 5G-enabled real-time monitoring and control.

16 million metric tons

16 million metric tons in global CO_2 emissions can be reduced annually, assuming 2% more efficient jet engines resulting from higher-quality BLISKs.

[5] In addition, increased value will be released by having one network serve all operations instead of several different networks. Increased flexibility in manufacturing to better serve customers is another value realized through Industry 4.0. However, these values have not been studied in this report

[6] Machining is assumed to account for 50 percent of the total average BLISK production cost

[7] There are approximately 13 global factories, together producing the 100,000 BLISKs per working year (250 days per year). It is not unreasonable to assume that adding military and small BLISK production could double that amount

[8] Going forward, the number of manufactured BLISKs will continue to grow. The engine market roughly doubles every 20 years, and the compressor parts of these engines all have BLISK design

[9] Calculations and assumptions are described in more detail in Ericsson's sustainability appendix (document number 1/GFTB-18:001245 Uen)

[10] www.naturvardsverket.se/Sa-mar-miljon/Statistik-A-O/Klimat-vaxthusgasutslapp-fran-svensk-konsumtion-per-person

An operator opportunity there for the taking

The industrial market offers a major growth opportunity for the telecommunications industry. Mobile operators can now create a new business model based on Service Level Agreements (SLAs) rather than subscriptions. However, to do so will require adapting their go-to-market and delivery strategies.

It is important to understand that industrial sites constitute a new market, where new product packages are required and the customer values need to be understood; it is not merely an extension of the consumer service.

To address this market and unlock its value, operators must look at three areas:

1. Solutions: Work together with major factory ecosystem suppliers to help Industry 4.0 take off by establishing one unified form of communication technology. Based around high-value use cases, this would make it easy for a customer to choose a private enterprise cellular connectivity solution. Being early in offering a unified solution could build momentum in an expanding market, and would also accelerate mobile communications' progress into the selection of available options.

2. Delivery: Build trust in operating core processes with high performance requirements, ensure processes are in place to deliver at that level and be resilient in restoring and proactively preventing disturbances.

3. Sales and marketing: Build awareness and demonstrate a credible understanding of customer needs through, for example, demonstrating capability to actively engage with partners and drive the market.

In order to address the large business opportunity operators need to:

– Package an easy-to-buy, off-the-shelf commercial solution

– Build a delivery organization that responds to very strict SLAs

– Gain market awareness of the deployment challenges and ecosystem properties affecting customers

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.

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