## 5G connected industries Transforming industry with 5G

### The future of industry

Technology is advancing. Machines are getting smarter. And consumers are becoming more demanding. As such, industry is facing a number of challenges, from rising costs to changing production trends, and the need to cater for the greater customization of products.

Many organizations are looking to closely couple their physical assets with the digital world – increasing automation and using data to create a more agile business.

## Preparing the world for Industry 4.0

The factory of the future will see people and machines working safely together to increase productivity and improve efficiency.

As the fourth industrial revolution dawns, these organizations are already becoming more reliant on the use of cyber-physical systems – computer-controlled robots and machinery – to streamline and transform their processes. The use of analytics is also an essential tool, as organizations rely on the analysis of data to ensure accuracy, make informed decisions and even ensure safety for workers.

These changes are being felt in all areas of industry, including:

- Manufacturing
- Construction
- Logistics
- Power generation
- Distribution and transportation.

This ebook looks at the challenges faced by industry and the different ways in which 5G is essential for the successful adoption of Industry 4.0. It also highlights our industry use case and how Nokia is already demonstrating the impact 5G will have.



# What are the key challenges for industry?

Manufacturers around the world are facing a number of challenges:

- Increasing energy costs
- The need to securely connect systems on a common infrastructure
- Increasing consumer demand for customized and personalized products
- More complex operating and business models
- Demand for products which are more complex to build and deliver.

On the whole, organizations have made good efforts to combat these challenges. However, progress is still hampered by a number of connectivity issues. In the first instance, businesses have to deal with multiple cabling standards and communications protocols. IT teams also face the challenge of connecting older machinery which has never previously been connected to a network. Then they need to ensure it can co-exist and operate effectively on the same network as new machinery.

A lack of integration between front-end machinery and back-office systems adds another layer of complexity. It can lead to reduced visibility into operations, which makes it harder to effectively plan and make informed decisions. Introducing robotic systems into industrial processes also creates a new series of challenges around ensuring the safety of human operators.

## How can 5G help?

5G is the only solution that enables industrial organizations to meet the challenges they face and fully embrace the benefits of Industry 4.0. It offers unique benefits in four key areas:

- Flexibility
- Efficiency
- Productivity
- Safety.

#### **Be more flexible**

Wireless communications, like those available with 5G, enable organizations to be more flexible. Machines can be located across wider areas without the need for physical cabling, and they can be more easily moved without the need to alter the infrastructure of the building. This can create huge cost savings in large scale operations, like water treatment plants. Machines can be installed quickly and with minimal fuss. And they can be easily moved into different configurations, according to production demands.

#### Efficiency in everything

With 5G, companies can vastly increase the number of sensors in their operation, and the frequency of the data being recorded. The data can then be analyzed by an edge cloud to ensure machines are operating at optimal levels. This can help to reduce the number of equipment failures or planned outages due to unnecessary maintenance. And it means machines are working more efficiently.

#### A more productive way

In order to improve productivity, industrial firms need to be able to operate at faster speeds, without compromising quality. The ability to move raw materials, pre-finished and final assembly products seamlessly is key to this. With 5G, this could all be done by transporting products via guided vehicles, which communicate with an edge cloud to ensure there are no interruptions in the process.

#### Safe and sound

Worker safety is of paramount importance to any organization. Especially for industries where people operate machinery, robotic equipment, or come into contact with hazardous materials. The ability to automate processes, or carry them out using remote-controlled machines, can help to protect workers. With wireless 5G, companies can implement wireless safety control systems that cover multiple machines, which helps to reduce the risk of incidents.



## So, why does industry need 5G?

As technology advances, and industrial equipment and processes become more complex, keeping everything connected and working seamlessly also becomes more difficult. In addition to this, the various standards for both wired and wireless communications make creating a cohesive IT strategy even more complicated.

While some industries have already implemented wireless technologies, these have typically been based on their own proprietary standards, so they have more control over how wireless can be used to interact with them. Similarly, others have used wireless on limited, less critical parts of their business.

The majority of organizations, however, still use wired networks. This is due to the limitations posed by the majority of wireless technologies:

- Bluetooth is short-range low power and limited to small numbers of devices
- Zigbee can support large numbers of devices but has very short range (typically 20m)
- Wi-Fi supports a larger coverage area (160m for industrial use) but performance is more variable and it has an increased security risk for critical applications, due to the usage of unlicensed spectrum and the possibility of co-channel interference
- **3G** can support data transfer and cover wide areas, but is limited in bandwidth and the ability to pass larger amounts of data
- **4G** has increased data transfer capabilities and reduced network delay than 3G, but is not the most efficient in supporting the massive numbers of simultaneous connections in a factory or warehouse.

This is where 5G comes into its own. It's designed to support ultra-reliable, low-latency and massive machine-type communications. There are three main aspects to this:

#### • Radio

By changing the physical layer of radio frequencies, it's possible to transmit short packets of information, such as those used in machine-type communications. This creates a very low delay, which enables real-time control of machinery and supports critical safety functions. And with reduced signaling for short packets, it's possible to increase the number of concurrent user-connections. With joint or co-operative multipoint, it's possible to achieve 99.999% reliability of transmissions. This is critical for safety control systems and alarms that monitor hazardous environments.

#### • Multi-access edge computing

With multi-access edge computing, it's possible to process data at the edge of the network, using virtualized platforms that can be hosted either on or close to a company's premises. This helps to reduce delay and makes it possible to control and access data without third-party involvement. This is especially important for analytics, where data needs to be processed quickly. And with machines and systems all connected to an edge-based aggregator, it's possible to get insights much faster.

#### • Network slicing

Network slicing is a means whereby communications paths can be allocated for sole use by different types of applications. The network is literally 'sliced' into a number of multiple virtual networks, all existing on a single infrastructure. These virtual networks are then configured to operate with specific characteristics. Each 'slice' is used for a different application, meaning less cross-over, more efficient use of resources and improved security.

So, for example, a treatment processing plant with 5G could record data from thousands of sensors throughout a specific area. The data recorded by the sensors could then be analyzed in near-real time to ensure that water treatment machines are operating optimally. Similarly, in manufacturing, the ability to interconnect collaborative robots within a manufacturing cell, or across multiple cells, while working alongside human operators, can improve co-ordination and overall process flow.



## What are the key benefits of 5G for industry?

The key benefits of 5G are flexibility, efficiency, productivity, and safety and security. But how exactly do these key aspects benefit industries?

## Flexibility

There are two main areas of manufacturing:

- **Discrete** the creation of individual or separate unit products
- **Process** mass production of products, such as food, biotech, chemical and pharmaceuticals.

Both forms of manufacturing can greatly benefit from the capabilities of 5G. It will enable manufacturers to easily monitor and reconfigure their control systems. It will also make it easier to relocate machinery to cope with changing demands.

#### **Discrete** methods

In discrete manufacturing, products are generally highly complex to produce and made in low volumes. As such, these manufacturers require an extremely flexible system that enables them to improve quality and speed to market, while also cutting costs. When producing high-complexity products, machines require very fine motion control in order to produce the varying parts. As such, these machines need ultra-low latency of one millisecond, with a low jitter rate of a few microseconds and reliability of 99.999%.

#### **Process driven**

Process manufacturers deal with high volumes of low-complexity products. So, their key concerns are controlling inventory, improving lead times and reducing or limiting the costs and waste of materials.

In high-volume/ low-complexity manufacturing, inventory needs to be tightly managed to ensure that production processes run at optimum levels. This means that everything, from raw materials to production and packaging, needs to be closely monitored in real time. This enables manufacturers to easily adjust production according the volume of demand. This can be done in a number of ways, including:

- Tracking delivery of raw materials from suppliers using hybrid indoor/ outdoor micro-location systems
- Using production and packaging 'cells' that are networked across wireless and wired systems to ensure optimal process flow

• Tracking all inventory from receiving to put-away, picking and shipping, which provides insight into optimizing routes, rack slots, zones and throughputs.

Currently, many operations are set up to run production with wired connections. However, this adds a further layer of complexity, as there are many multiple types of Ethernet standards, each with their own types of physical connectors, cabling and shielding. By switching to wireless, organizations can remove the need for cabling, which offers:

- Simpler infrastructure design in buildings
- Faster installations
- The ability to introduce new machines without having to reconfigure or shutdown the existing network.

## Efficiency

All industries aim to be as efficient as possible. 5G can help, by ensuring organizations can easily connect machines and increase their levels of digitized information. This data can then be processed using intelligent analytics to provide detailed and timely insights that help industries make more informed decisions.



#### More for your money

Installing physical communications cabling in a production facility can be very expensive. It also takes much longer to install than wireless systems. The cables also wear out and break, which can cause costly downtime that results in service outages or a halt in production. Additionally, each machine or sensor used in an industrial environment is designed differently. As such, they each have their own requirements for how they are connected to a physical network – which adds an extra layer of cost and complexity.

With a 5G wireless network, installation is quicker and easier, as there is no extensive cabling required and no ongoing cable maintenance costs. It is also much easier to connect machines and sensors too. Plus, it offers greater flexibility to move machines and reconfigure work stations.

#### More energy efficiency

In process manufacturing, the cost of energy can be a very big factor. As such, it's critical for manufacturers to ensure that their facility's power distribution systems are calibrated and performing at optimum levels. This means using sensors to constantly monitor systems and make regular adjustments to the operating machinery. With these tasks coordinated across a 5G wireless network, manufacturers can make significant savings in power consumption – with a relatively low upfront investment.

#### A full five-nines

Reliability is of paramount importance in industrial operations. If an organization uses a physical cabling system, the loss of just a single cable or switching point could result in costly outages. If the system is made up of multiple cables, this increases the risk, along with the cost and complexity of restoring the system.

With wireless, organizations can achieve 99.999% reliability, reducing the risk of downtime and ensuring operations run smoothly and effectively. This is because wireless communications can support multiple communications paths, using:

- Joint transmission and receiving, using COMP (co-operative multi-point)
- Multi-connectivity (combining different wireless and fixed technologies).

## Productivity

Productivity is a naturally key factor in the success of any industrial enterprise, so organizations need to ensure they are constantly evolving their production processes. This means ensuring that labor productivity (the output per hour of all persons) and all capital, energy, raw materials and business services are running at optimum levels. To achieve this, organizations need detailed and timely insights into every aspect of their operations.

#### Supercharged output

For optimum production, manufacturers need to ensure seamless coordination of raw materials. They also need to know what is happening at every point in their supply chain. Manufacturers can use automation to manage much of this work. A cloud-based system can gather data from sensors at different points in the supply chain, then automatically relay requirements to suppliers. This means parts and materials will be available quicker, with a much faster cycle of order to delivery..

#### Good state of repair

Manufacturers can only make products if their machinery is running effectively. Therefore, they need to carry out preventive maintenance, to ensure against any breakdown which could result in production downtime. Of course, this preventive work is based on the theoretical rate of machines failing – it doesn't take into account actual usage and specific wear and tear.

By using wireless sensors to constantly monitor equipment, manufacturers can get better insights into how machines are working. This helps them build a more effective maintenance schedule based on actual operational usage. They can spot issues quicker. And they are not simply checking at standard intervals, potentially risking damage or breakdown.

#### A quicker fix

Another key area in which 5G can help productivity is through augmented reality (AR). Industrial machinery is highly specialized and complex. It requires a great deal of expertise to maintain and repair. And with thousands of different types of machinery in use throughout different industries, it can be hard to ensure engineering staff with the right skills are available at the right time.

With 5G-powered AR, however, onsite technicians can access up-to-date information on a wide range of machinery, leading to potentially quicker fixes and reduced downtime. AR can also enable specialized engineers to diagnose problems remotely and relay instructions back to onsite staff, so issues can be fixed without needing to wait for experts to arrive.

## Safety and security

Whether it's ensuring staff are safe from harm, or guaranteeing all IT systems and operations are fully protected from threats, all firms need to be secure. 5G wireless networks offer a range of benefits over traditional fixed network infrastructure.

#### A safer workforce

Worker safety is never more of a concern than in industrial environments, where people operate heavy machinery or handle bio and chemical materials. One way to ensure staff are always safe is to enable them to operate machinery remotely wherever possible. With 5G connectivity and wireless sensors, workers can operate machines without needing to be in close physical proximity. They can monitor operations in greater detail, with increased data analysis. And they can shut down machinery instantly in the event of an emergency.

The ultra-low latency of 5G can provide haptic feedback for the most demanding operations where precise control is required, so operators are always aware of everything that is happening. 5G can also provide ultra-reliable communications to control systems, ensuring multiple machines in multiple locations are all working safely.

#### A more secure network

It's not only worker safety that 5G can benefit – it can also help to secure industrial IT networks. As more and more machines are connected using IP communications, organizations are open to increasing threats of hacking or other IT attacks. This could leave a company vulnerable, or result in service downtime due to loss of external connectivity.

With 5G, organizations can protect themselves from these potential outages. With network slicing, the critical control-based data for machines can be isolated on its own slice. It can then be processed via mobile edge cloud computing, with the control application located on the company's own network. This means it's essentially secured from external networks and hosted servers, so even in the event of a network failure or security breach, control systems and data are protected. Machines can keep operating and the risk of downtime is reduced.

## 5G: The future of industrial automation

Depending on their own plans for growth and investment, different industries will adopt new technologies at varying paces. For those organizations that are expanding, it's important to consider which technologies are being widely adopted. This can help them benefit from economies of scale. And it can also prevent them from being locked into proprietary systems which they could outgrow.

Not only does 5G enable far greater flexibility than wired communications, it can also be scaled easily to meet business needs. And it is being developed to comply with all the appropriate safety and security regulations.

#### Making 5G a commercial reality

At Nokia, we understand the immense challenge that lies ahead with 5G. We're at the forefront of research and development, and our 5G Acceleration Services are helping operators prepare for the introduction of 5G:

- Creating their own strategies and use cases to maximize the business potential of 5G
- Designing and implementing networks to realize the full technical benefits of 5G.

#### Creating strategies and developing use cases for 5G

We're working closely with our customers to explore the implications of 5G for technology and business strategy. And our 5G Acceleration Services are helping to explore the business opportunities that the technology will create.

The 5G Transformation Discovery Workshop, and our Network Modeling and Business Case Workshop help to build and validate strategy and use cases. As an outcome, it's possible to gain a clear understanding of how to evolve capabilities towards 5G step by step. This includes:

- The reasons for evolving to 5G and how to go about it
- The technology and commercial options for evolving to 5G
- Techno-economic modeling with sensitivity analysis that supports advanced decision making.



Our Technology Workshop and End-to-End Network Deployment Consultancy help customers gain a more in-depth view of 5G and its implications. We show how to prioritize the investments on the journey to 5G, with an end-to-end approach to network and anyhaul transport design to meet the performance requirements of use cases.

These will all help operators take the guesswork out of 5G business planning.

#### Cost savings: wireless vs wired

Based on insight from our own Nokia factories (<u>see how Nokia has successfully</u> <u>implemented Industry 4.0</u>), whenever a wired production line is reconfigured, it can lead to a production outage of up to one week. This clearly has huge cost implications for any organization. As more and more businesses begin to adopt Industry 4.0, many more factories will need to carry out reconfigurations. As such, there will be a real need for a wireless solution that helps to eliminate this downtime.

Nokia Services and Bell Labs techno-economic modeling (read our whitepaper: 'Techno-economic simulation results for solid 5G business and technology planning') shows that wireless connectivity has a two- to five-times lower total cost of ownership (TCO) than wired connectivity. This is because reconfigurations can be carried out in just minutes instead of days, and there are no wires that will eventually wear out and need to be replaced.

#### Designing and implementing 5G networks

Our Nokia 5G Acceleration Services help our customers to create and deploy their own 5G networks with detailed cost and business analysis for a range of Industrial and internet of things (IoT) type services, illustrating both the technical and economic benefits of 5G.

5G provides the performance, security and technological capabilities that industrial firms require. The global standardization efforts already underway, and the broad application to both consumer and enterprise markets, will ensure it will be widely adopted. It will have a significant impact for many different users, and will address the many needs of businesses that use industrial systems.