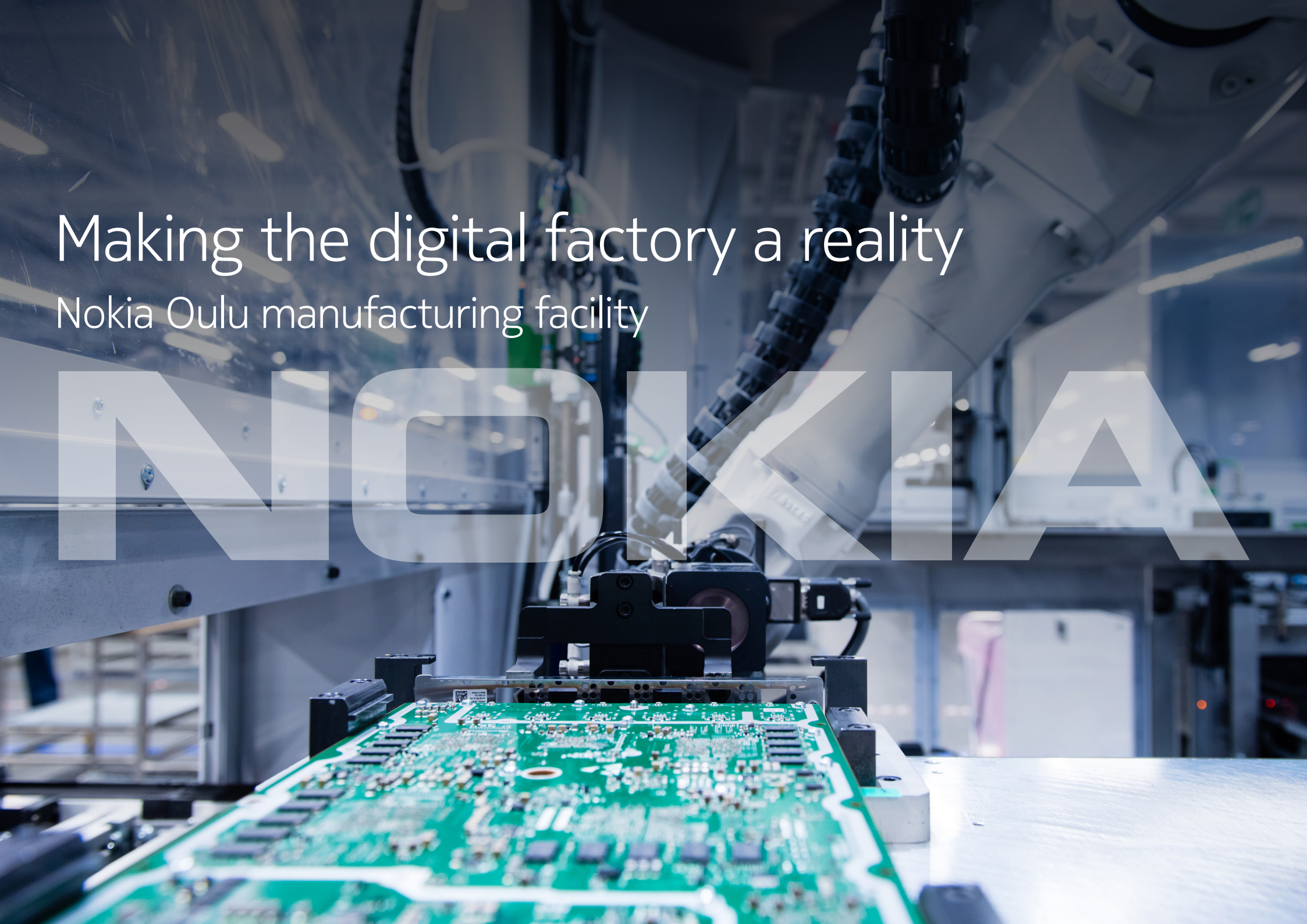

Making the digital factory a reality
Nokia Oulu manufacturing facility
NOKIA

Digital transformation project leaders and plant managers know there are many challenges in digitalizing existing factories that have lots of physical assets and manual production processes. But, where to start? And what to prioritize?

The Nokia Oulu factory in Finland is a new product introduction (NPI) factory that produces 4G and 5G radio base stations. It faced similar challenges and questions with its own manufacturing lines and processes. To address the challenges, Nokia embarked on a factory automation and digitalization project, together with strategic partners, to increase productivity, reduce lead times and time-to-market, and improve quality. This case study discusses four key initiatives.

The “conscious” factory of the future

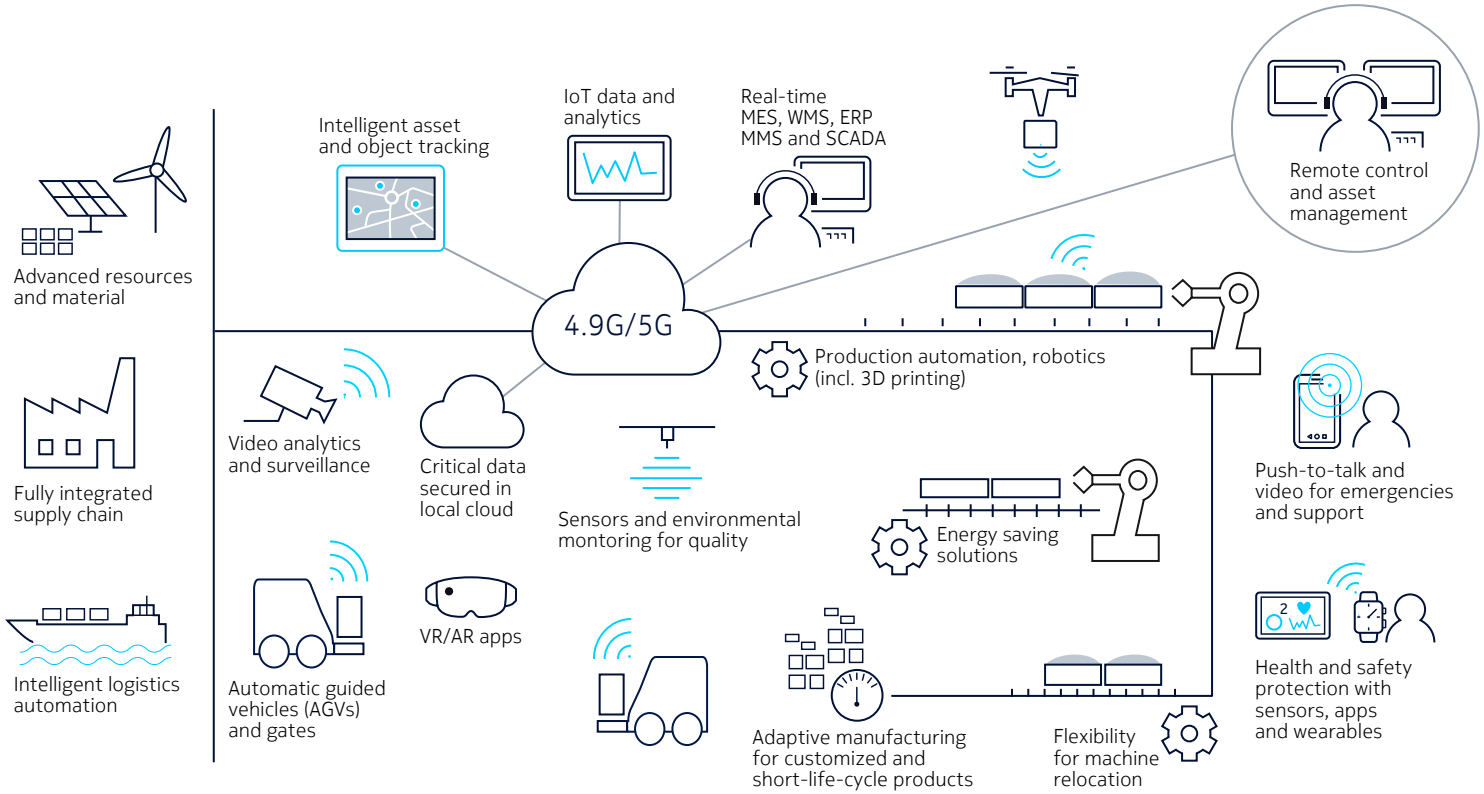
To remain competitive, factories need to be flexible, versatile and productive—and smart. The factory of the future leverages digital technologies that integrate the supply chain, automate logistics and connect everything—people, machines and processes (see Figure 1).

How do you accomplish all of this? The Nokia manufacturing factory in Oulu, Finland did it through four key initiatives:

- Private 4.9G wireless network
- Cloud-based digital data control
- Virtualization of NPI production processes
- Zero-touch logistics/material handling

The results speak for themselves. Thirty percent productivity gains. A significant reduction in product time-to-market. Annual cost savings of millions of euros.

Figure 1. The factory of the future



Private 4.9G wireless network

In Nokia's Oulu factory, the need to continuously change the production lines to meet weekly NPI requirements and quickly ramp up capacity for new models required a more flexible manufacturing floor.

The integration of a private wireless 4.9G network provided connectivity for 100 percent of the production area. 4.9G delivers the bandwidth, scalability and performance that's needed to support the smart factory Industrial IoT (IIoT) applications.

The new network easily connects stationary and mobile production machines in a plug-and-play mode—and also allows for quick floor layout changes without the need to reconfigure and rewire the cabled LAN network.

The private 4.9G wireless network is more reliable than Wi-Fi, overcoming connectivity and service continuity issues with handovers. It's more flexible than wireless LAN or wired alternatives but still provides the security and bandwidth needed for business-critical operations. The network is also fully integrated with production IT systems, delivering secure and robust access to all operational services.

With the deployment of the private wireless network, the Oulu factory implemented wireless asset tracking and lean manufacturing concepts on the factory floor. This resulted in up to 90 percent reductions in lead times and factory floor layout changes. To learn more about Nokia industrial-grade private wireless networks, click here

Network connectivity:

100%

Lead times and factory floor layout changes:

Down

80%

Cloud-based digital data control

Digital twin technology has gained acceptance with progressive manufacturers. It uses real-time manufacturing data as inputs to build computer models of the factory's physical assets and processes. This enables changes to equipment or production lines to be simulated and tested to determine their impact and to optimize the changes before they are implemented.

In Nokia's Oulu factory, a digital twin system was designed as a platform to manage production data, develop applications and perform process analytics. The digital twin platform accesses real-time production data from multiple sources, including production machines, IT systems and middleware.

The digital twin system puts real demands on the data networking infrastructure both in the data processing capacity and responsiveness that's required. The use of both 4.9G private wireless and cloud technologies ensures scalability and modularity of the platform and provides a data processing/storage architecture that captures and processes real-time "hot" production data at the cloud-edge (inside the factory) and historical "cool" data that is stored offsite in the public cloud.

One example where the digital twin technology is used is in the surface-mount-technology (SMT) area. Intelligent SMT material handling was introduced with autonomous mobile robots (AMRs) delivering components and boards over the private 4.9G wireless network. This resulted in improved traceability, product quality and efficiencies yielding productivity gains of over 25 percent and a 50 percent improvement in product quality.

Virtualization of NPI production processes

One of many challenges that manufacturers face is introducing new products onto existing production lines and then quickly ramping up from initial pilot quantities to full volume. One way to speed up the transfer of the R&D product design to the new production process is through virtualized product prototyping and process simulation. New product hardware designs can be simulated in a virtual environment where testing and experimentation of assembly processes can be optimized before the new design goes into production.

After the process has been optimized, this virtualized product design model can be used to train assembly workers in conjunction with VR to accelerate learning and competence.

In Nokia's 4G/5G base station manufacturing, virtualized new product prototyping and NPI processes have been implemented along with VR training of assembly workers. Together, these changes have resulted in significantly reduced product time-to-market.

Prototype lead time:

Down

>50%

Assembly defects:

Down

30%

Zero-touch logistics/ material handling

With today's fast-changing business, a factory's logistics system is under increasing pressure to be more agile and flexible. Nokia's Oulu NPI factory addressed its material-handling challenges by adopting Mizusumashi lean manufacturing concepts in the material replenishment of its factory floor.

Wireless AMRs, which replaced automated guided vehicles (AGVs), use stored layout maps, sensors and SLAM (simultaneous location and mapping) software to autonomously navigate around obstacles. The AMRs are connected over the private 4.9G wireless network with its support for mobile services. (Wi-Fi was found to be unreliable, often losing connectivity in the production area.)

The AMRs are the "water spiders" that bring only the required quantity of material to the workstations on their route from the factory warehouse. As a result, productivity in the Oulu factory logistics increased by 100 percent with less manual handling, reducing both quality issues and scrap. Standardizing the material replenishment flow with Mizusumashi lean manufacturing concepts reduced WIP buffers and improved lead times. It also provided the flexibility to change the layouts, resulting in a 90 percent reduction in setup times compared to the previous AGVs and manual material-handling processes.

Logistics productivity:

Up

100%

Setup times:

Down

90%

Digitalizing an existing factory is do-able

Today's manufacturers know they need to automate and digitalize their production lines and facilities if they are to remain competitive. The initiatives shown here yielded tangible benefits to the Nokia 4G/5G base station manufacturing facility in Oulu. The factory, which produces 1,000 4G and 5G base stations per day, generated significant annual improvements, including 30 percent productivity gains, as well as significant reduction in product time-to-market—and annual cost savings of millions of euros.

As a result of these impressive results, Nokia's other 4G/5G base station factories are implementing the same initiatives. And the Oulu factory has been recognized by the World Economic Forum (WEF) as a global Lighthouse 4th Industrial Revolution manufacturing leader in 2019.[1]

By demonstrating industrial productivity gains for enterprises, Nokia paves the way for other enterprises to digitally transform for the Industry 4.0 era, adopting critical technologies at scale. The award-winning Oulu factory of the future illustrates how customer facilities can reap the benefits of increased productivity, agility and product quality as well as improved product lead time.

To learn more about Nokia solutions for industry, visit our Industries web page.

> "The bottom line is that the Oulu factory has leveraged connectivity to become one of the most flexible, versatile, and productive factories anywhere in the world."
> World Economic Forum

[1] Nokia's Digitalization of its 5G Oulu Factory recognized by WEF as advanced 4IR Lighthouse

Nokia OYJ
Karakaari 7
02610 Espoo
Finland

Document code: SR1912040216EN (December) CID207011

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Through our research teams, including the world-renowned Nokia Bell Labs, we are leading the world to adopt end-to-end 5G networks that are faster, more secure and capable of revolutionizing lives, economies and societies. Nokia adheres to the highest ethical business standards as we create technology with social purpose, quality and integrity.