Industrial IoT Networks: 5G transforming industry verticals

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Ulrich Barth, Nokia Bell Labs
Nokia between 1865 and 2000
The technology to connect everything, everywhere brings incredible opportunity
Automation of everything – the next technological revolution

1. Pervasive digital-physical systems drive life and business automation
2. Transforms economy and society and creates time
3. Fundamental digital needs demand radically new network architecture
## Industrial IoT requirements

Challenging for traditional telco architectures and business models

<table>
<thead>
<tr>
<th>Autonomy</th>
<th>Security</th>
<th>Business model</th>
<th>Liability</th>
<th>Longevity</th>
</tr>
</thead>
</table>
| • Keep data local  
• Require a resilient architecture | • Full control of infrastructure, people, and information  
• IT/Webscale level of ext. attacks not acceptable | • Avoid vendor & MNO lock-in  
• Fair and quick access to spectrum | • MNOs have only partial control of the solution | • Need much longer equipment lifetimes  
• Need much longer support lifetimes |
Technology enablers for the factory of the future
Industry IoT technologies transforming factory operations

5G wireless, converged automation protocols
Eliminate wires; support time synchronous ops

Private edge cloud
Scalable, secure local computing

Deep slicing for industrial IoT networks
Multiple stakeholders on one infrastructure

ML-enabled automated operations
“Expertless” monitoring, prediction, optimization

Factory floor flexibility
Rapid reconfiguration & product customization

Resilient, secure operations
Critical factory data stays local

Shared infrastructure costs
Custom networks for on-site ecosystem

Resilient, efficient production
Optimized prod. lines, minimized downtime

5G technologies will trigger an IoT revolution in future factories
Realize opportunities of IoT with 5G
IoT connectivity technologies
Coverage and mobility requirements

Static/portable
- Limited area mobility
- Long-range, low-rate, low-power, low-cost managed service

Localized
- Widespread
- Medium-range, low-rate, low-power, enterprise-deployed, established ecosystem
- Long-range, rechargeable battery, highly secure, managed service

Wi-Fi, Zigbee/IEEE 802.15.4
- Smart metering
- Parking meter
- Building automation
- Hospital asset tracking
- Warehouse logistics
- Home automation
- Industrial automation

LPWA, mobile cellular
- Long-range, low-rate, low-power, low-cost managed service

Mobile cellular, satellite
- Connected car
- Remote health monitoring
- Fleet management

5G NR: ideally positioned to support diverse geographic requirements
IoT connectivity technologies
Reliability, latency, and throughput requirements

5G NR: the only radio technology to simultaneously provide high reliability & low latency
5G’s universal adaptive core and edge cloud
Meeting requirements of resilient, scalable, private networking and computing

Programmable Network OS

Massively scalable WAN IoT core
Compact LAN IoT core

Private resilient edge computing

Emerging Devices & Sensors
Massive Scale Access
Converged Edge Cloud

Smart Network Fabric

Cognition Systems

Dynamic customer services
SDN
NFV
Multi-operator federation

Open APIs

Analytics
Management & Orchestration
Dynamic network optimization

Machine learning

Universal Adaptive Core

Autonomously optimized coverage & capacity

Deep and dynamic network slicing

A single 5G core infrastructure supports diverse industrial IoT applications & stakeholders
Evolution of 3GPP for IoT: Research and standardization topics
Industrial IoT research in the evolution of 3GPP standards

<table>
<thead>
<tr>
<th>Release</th>
<th>Radio use case</th>
<th>Networking + core</th>
<th>OT integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>R13</td>
<td>NB-IoT + LTE-M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R15</td>
<td>+ NR eMBB</td>
<td>Non-standalone</td>
<td></td>
</tr>
<tr>
<td>R16, R17</td>
<td>+ NRURLLC</td>
<td>+ standalone</td>
<td>Industry slicing</td>
</tr>
<tr>
<td>&gt;R17</td>
<td>+ NR mMTC</td>
<td>+ D2D, mesh</td>
<td>Multilayer security</td>
</tr>
</tbody>
</table>

Realizing the full promise of 5G and the Future X network for OT-managed industries

3GPP research & standardization sequentially unlocking value in industrial IoT
Industrial IoT and private networks topics in Rel-16

Enhancements for latency and reliability in Radio and E2E
- Rel-16: new use cases with higher requirements
- Higher reliability with multi-connectivity, 0ms HO, L1 enhancements
- Better efficiency with enhancements to data duplication and eMBB-URLLC mux

Industrial IoT in 5GS and NR
- Support for Wireless Industrial Ethernet and deterministic communications
- Enhancements for global time synchronization, deterministic QoS, time-sensitive flows

5G Private Networks in licensed and unlicensed bands
- Enable easy and cost effective deployment of industrial private networks
- Enhancements to support Non-Public and Closed Access Group (CAG) Networks

Positioning for 5G and IoT
- Positioning enabling Lower bandwidth, lower complexity and lower cost at UE
- Positioning with scalable bandwidth and beamforming
- NR based positioning reference symbols

Cellular IoT evolution
- Enabling connecting eMTC/NB-IoT to 5G Core
- New NR IoT UE categories for uses cases beyond NB-IoT/eMTC, such as surveillance cameras

3GPP Rel 16 Schedule

<table>
<thead>
<tr>
<th>4Q18</th>
<th>1Q19</th>
<th>2Q19</th>
<th>3Q19</th>
<th>4Q19</th>
<th>1Q20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
<td>Architecture and concepts</td>
<td>Detailed specification completed</td>
<td>ASN.1 code</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5G and industrial IoT networks, research vision for R17 and beyond

5G NR as the optimal radio for industrial IoT

Unified access infrastructure for multiple use cases in the one physical space

5G as full lifecycle solution optimized for industrial IoT: deployment, configuration, & management

Deep automation to minimize total cost of system ownership, maximize flexibility

5G multi-layer security for both data and networks

Bridging the privacy, security, resiliency gap for critical, cannot-fail industrial operations

Realizing the full promise of 5G for OT-managed industries
Go Allwhere.

Networking solutions for the new age of industry.

nokia.com/networks/go-allwhere