5G智慧城市
的展望

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Head of Technology
Nokia Taiwan

20 August 2019
5G is happening much faster than initial industry expectations.

... commercial 5G Networks and Devices launching now for eMBB services.
5G terminals and networks status
As of July 2019

5G terminals

13 Form factors
39 ue vendors
5 Chipset vendors
9 Smartphones

5G networks

35 operators in 20 countries offering 3GPP compliant commercial 5G services

Source: GSA
5G use case roadmap: eMBB → uRLLC → mMTC

Wave 1: eMBB
- 4G evolves naturally to 5G eMBB with lower bit cost
- Focus on 4K/8K videos, VR, AR, etc. applications
- Max DL: 1.5Gbps
- UL: 300Mbps
- DL: 10Gbps

Wave 2: uRLLC
- Machine remote control
- Autonomous car
- Cloud robotics & process automation
- Wave 1 with R15
- Wave 2 with R16

Wave 3: mMTC
- NB-IoT/LTE-M evolves to 5G mMTC
- Smart city, Smart agriculture, etc.
- Wave 3 with R17

4G: Mobile Broadband
- IoT & Sensors
- Machine communication
- Latency <10ms
- Reliability 3-5x 9’s
- LTE-M & NB-IoT
- Low data rate/long battery life

5G:
- Massively multi-access communication
- Critical machine communication
- Wave 1, Wave 2, Wave 3
5G 3GPP standardization evolving from eMBB (R15) to Industrial 5G (R16)

**Release 15 stability and completion**

<table>
<thead>
<tr>
<th>2017</th>
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- Rel-15 NSA is driving commercial launches across the globe (based on March/2019 version of specs)
- Rel-15 SA coming soon, first in China, driven by vertical IoT business
- Rel-15 late drop finalized specs for migration architectures

**Release 16 timeline**

<table>
<thead>
<tr>
<th>2018</th>
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- Rel-16 focus equally on functions for Verticals and overall System Improvements
Realizing the full promise of 5G with 3GPP and own Innovation

Nokia (+ Bell Labs) evolves 5G from a strong Rel-15 base

**Release 15**
- Flexible 5G New Radio
- 5G Cloud Native Core
- End-to-end Network Slicing
- mmW frequency territory

**Release 16**
- Industrial IoT foundation
- Wireless Wireline Convergence
- Non Public Networks (aka Private)
- 5G NR for Unlicensed Bands

**Release 17**
- NR-Lite foundation
- 3D-Expansion in Mobility & Altitude
- AI/ML powered 5G networks
- 5G NR for >52.6 GHz

Mobile Network Operators ➤ Converged Communication Service Provider ➤ Digital Service Provider

Connected Mobility ➤ Connected vehicles ➤ Connected & flying objects

Operational Technologies Other Industries

Railway, broadcast, satellite
On the road to 5G use cases

1. Video surveillance & analytics
2. Immersive experience
3. Smart Stadium
4. Fixed Wireless Access
5. Assisted & autonomous vehicles
6. Machine remote control
7. Cloud robotics & process automation
8. eHealth
Smart Cities in action

Use cases
- Smart Buildings
- Smart Lighting
- Smart Parking
- Fleet Management
- Smart Waste Bins
- Public Consultancy
- Efficient Energy Mgmt.
- Noise Monitoring
- Pollution Monitoring
- Time-of-day Tolling
- Connected Bus Shelter
- Smart Homes
- Car, Bike Sharing
- Water Monitoring
- Emergency Alerting

and many, many more ...

https://www.itu.int/en/ITU-T/ssc/Pages/default.aspx
IoT connectivity technologies
Reliability, latency, and throughput requirements

5G NR: the only radio technology to simultaneously provide high reliability & low latency
Connectivity on top of technologies needed to digitally transform industrial operations

**TOTAL**

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<tr>
<td>Cloud computing</td>
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**Aviation/Aerospace**

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**Manufacturing**

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**Power/Energy**

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**Transportation**

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**Utilities**

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*Note: Total unless otherwise stated.*
Network slicing enables guaranteed service performance

Use case-specific network slices

Flexibility to meet diverse requirements*
- Low cost
- Short range
- Best effort
- Low data rates
- Static
- Battery life critical
- High latency
- Not price critical
- Wide range
- High QoS
- Highest data rates
- Mobile
- Power not critical
- Low latency

Cloud scalability, efficiency and automation

Self service
- Public sector
- Railways
- Energy

Fully automated ad hoc slices for critical situations

*) Conceptual – to be defined by use case
URLLC and 5G IoT Use Cases market forecast (Worldwide)

- URLLC/MIoT devices take up from 2023 aligning with 3GPP schedule and design cycles of industrial application.
- Transport and Industrial use cases being main market driver.

Source: ABI research, Mobile Experts
Nokia Bell Labs Future X architecture for smart cities

Public spaces and venues, transport, businesses, city assets and infrastructures (roads, poles, town hall, ...)

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What does digital life mean to me now and the future?