Open networks for the 4th industrial revolution

Lauri Oksanen
VP Research and Technology
The next growth cycle is driven by an industrial revolution

Traditional CSP service revenues in mature markets* are flat

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2019</th>
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</thead>
<tbody>
<tr>
<td>Data</td>
<td>479</td>
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<tr>
<td>Voice</td>
<td>322</td>
<td>234</td>
</tr>
<tr>
<td>TV</td>
<td>200</td>
<td>207</td>
</tr>
</tbody>
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* Western Europe, Canada, USA, Japan, South Korea, Singapore, Australia, and NZ
Source: Gartner

Value creation lies in novel services where network service performance is critical
The future of digital service delivery from Digital Service Providers (DSPs)

**Future DSP**

- Digital experience: broad array of new services that combine cloud services and network resources
- Tailor virtual networks for each use case: latency, bandwidth, security, choice of functions
- Agile network: services are rapidly trialed, deployed & scaled
- Open platform: ecosystem of cloud and network players

**Implications to standards**

- Standards need to cover the end-to-end chain of network, cloud, and services
- Network slicing standards are needed for configuration and assurance
- Standards need to enable automation of decisions and deployment
- Standards must define open interfaces and APIs at the right places in the end-to-end architecture

Source: Analysys Mason

Anatomy of the DSP of 2025

Source: Analysys Mason
Future X architecture – built on openness

Openness and standardization in collaboration

Acumos
ETSI ZSM
Open APIs
ONAP
ETSI NF
3GPP
IEE
IETF
CPR
O-RAN
TIP
ETSI MEC
Kubernetes
OB-BAA
OCP
Akraino
OPNFV
OpenStack

Dynamic Data Security
- New trust framework
- Ecosystem sharing
- Mass edge monitoring

Dynamic network optimization
- Modular, decomposed network functions
- Common data layer

Analytics
Machine learning

Dynamic customer services

Access agnostic converged core

Management, Orchestration
SDN
NFV

Multi-operator federation

Web, Enterprise & Vertical apps

Openness and standardization in collaboration

External data sources

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External data sources
5G is the first network designed to connect everything, in an open and agile way.

3GPP is uniquely positioned to deliver the standards as it covers the network E2E.

5G serves all use cases:
- Capacity: >10 Gbps peak data rates
- Connectivity: 1,000,000 devices per km²
- Latency: <1 ms radio latency
- Reliability: 10 years on battery
- Multi-radio
- Distributed
- Network slicing
- Centralized

3GPP
3GPP for industrial grade networks in next releases

Enhancements for latency and reliability in Radio and E2E
- Higher reliability with multi-connectivity etc.
- Deterministic QoS

Industrial IoT in 5GS and NR
- Support for Wireless Industrial Ethernet and deterministic communications
- High performance, wide area

5G Private Networks in licensed and unlicensed bands
- Enable easy and cost effective deployment of industrial private networks
- High frequency

Positioning for 5G and IoT
- Positioning with scalable bandwidth and beamforming

Cellular IoT evolution
- New NR IoT UE categories for uses cases beyond NB-IoT/eMTC
- Multi access
In addition to 3GPP standards we need to define the domains of cloud, transport, control, and automation.
The network edge is going through a major architectural change

Capacity

- 5G serves all use cases
- >10 Gbps peak data rates
- 100 Mbps whenever needed
- <1 ms radio latency

Connectivity

- 1,000,000 devices per km
- 10 years on battery

Latency

- >10 Gbps peak data rates
- 100 Mbps whenever needed
- <1 ms radio latency

Reliability

- 1,000,000 devices per km

5G serves all use cases
Industry Landscape around the edge – from cloud infrastructure to applications
Orchestration and management are critical for E2E control and agility

- **Capacity**: 5G serves all use cases
  - >10 Gbps peak data rates
  - 100 Mbps whenever needed

- **Connectivity**: 1,000,000 devices per km
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- **Latency**: <1 ms radio latency

- **Reliability**: 5G serves all use cases

- **5G** serves all use cases

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**3GPP**

- Acumos
- ETSI ZSM
- ONAF
- SDN
- NFV
- Dynamic customer services
- Dynamic network optimization
- Multi-operator federation
Orchestration, control, and automation are going through a major transformation

ONAP and ZSM are key initiatives for E2E automation
We need more than network standards to enable new IoT use cases
A vertical view, what is needed to enable IoT applications

- Deep, vertical-specific insights
- Interoperability and open interfaces
- Cooperation cross industries
- Industrial implementation: open source

**Vertical APPs**
IoT Ecosystem for E2E vertical applications & services: smart cities, smart home...

**Platforms**
Common Components
Connectivity, Security, Management, APIs...

**Connectivity**
Multiple communication technologies for different scenarios
Always open

Delivering on 5G promises

Open community
Standards and Open Source

Open interfaces
open APIs for 3rd party plug-ins and data exposure

Nokia openness

Open analytics
data-powered everything for cognitive control
We create the technology to connect the world