Destination 5G

Explosion of possibilities in the programmable world present huge opportunities

5G:n uudet disruptiiviset liiketoimintamahdollisuudet -seminaari
5.9.2016 – Oulun yliopisto
seppo.yrjola@nokia.com
Explosion of possibilities

**AUGMENTED**
- Augmented gaming
- Augmented shopping
- Augmented dashboard

**INTERCONNECTED**
- Personal robot
- Real time work in cloud
- Smart clothes
- VR gaming
- Mobile living
- Smart watch
- Real time cloud access

**REDEDIATED**
- Work & game while traveling
- Assisted driving
- Maintenance optimization
- Tracking / inventory systems
- Logistics
- Toll collection
- Traffic steering & management

**AUTONOMOUS**
- Self driving
- Automotive
- Factory automation
- Real-time remote control
- Industry 4.0

**VIRTUAL**
- Communication
- 8k Video beamer
- 4k Video
- HD Cams NW
- Reliable emergency communications

**TACTILE**
- Health
- Advanced monitoring
- Connected home
- Safety & Security
- Touch & steer

**SUPEREFFICIENT**
- Real-time work in cloud
- Advanced monitoring
- Remote Diagnosis
- HD Cams NW
- Reliable emergency communications
- Remote diagnosis
- Real-time remote control
- Traffic steering & management
- Traffic Mgmt.
- Utility & Energy
- Industry 4.0

**REVOLUTIONIZED**
- Personal robot
- Real time work in cloud
- Smart clothes
- VR gaming
- Mobile living
- Smart watch
- Real time cloud access

**4th industrial revolution**
- High performance infrastructure
- Touch & steer
- People & Things

**Real world mobility**
- Driverless cars
- Real-time remote control

**Virtual mobility**
- HD Cams NW
- Reliable emergency communications

**Connected home**
- Safety & Security
- Reliable emergency communications

**Health**
- Advanced monitoring
- Remote Diagnosis

**Time shift**
- Self driving
- Desktop
- 4G/LTE

**People & Things**
- Connected home
- Reliable emergency communications
- Driverless cars

**High performance infrastructure**
- Real-time remote control
- Traffic steering & management
- Transportation

**TACTILE**
- HD Cams NW
- Reliable emergency communications

**SUPEREFFICIENT**
- Remote diagnosis
- Real-time remote control
- Traffic steering & management
- Transportation

**VIRTUAL**
- Communication
- 8k Video beamer
- 4k Video
- HD Cams NW
- Reliable emergency communications

**AUGMENTED**
- Augmented gaming
- Augmented shopping
- Augmented dashboard

**INTERCONNECTED**
- Personal robot
- Real time work in cloud
- Smart clothes
- VR gaming
- Mobile living
- Smart watch
- Real time cloud access

**REDEDIATED**
- Work & game while traveling
- Assisted driving
- Maintenance optimization
- Tracking / inventory systems
- Logistics
- Toll collection
- Traffic steering & management

**AUTONOMOUS**
- Self driving
- Automotive
- Factory automation
- Real-time remote control
- Industry 4.0

**VIRTUAL**
- Communication
- 8k Video beamer
- 4k Video
- HD Cams NW
- Reliable emergency communications

**TACTILE**
- Health
- Advanced monitoring
- Connected home
- Safety & Security
- Touch & steer

**SUPEREFFICIENT**
- Remote diagnosis
- Real-time remote control
- Traffic steering & management
- Transportation

**AUGMENTED**
- Augmented gaming
- Augmented shopping
- Augmented dashboard

**INTERCONNECTED**
- Personal robot
- Real time work in cloud
- Smart clothes
- VR gaming
- Mobile living
- Smart watch
- Real time cloud access

**REDEDIATED**
- Work & game while traveling
- Assisted driving
- Maintenance optimization
- Tracking / inventory systems
- Logistics
- Toll collection
- Traffic steering & management

**AUTONOMOUS**
- Self driving
- Automotive
- Factory automation
- Real-time remote control
- Industry 4.0

**VIRTUAL**
- Communication
- 8k Video beamer
- 4k Video
- HD Cams NW
- Reliable emergency communications

**TACTILE**
- Health
- Advanced monitoring
- Connected home
- Safety & Security
- Touch & steer

**SUPEREFFICIENT**
- Remote diagnosis
- Real-time remote control
- Traffic steering & management
- Transportation
With transforming Internet business models

**Tradition**
- Value in access
- Own and control e2e infrastructure
- Value capture from own value chain
- Leverage legacy assets

**Transformation**
- Value in existing (shared) infra
- Value capture from content, context and commerce
- Embrace sharing economy and build ecosystem
- Early adoption of innovations
In diversified business environment

New customers and spaces
Tailored E2E solutions for
• Media
• Enterprises
• Governments, cities and societies
• Industry 4.0
• Verticals

New use cases
• Extremely fast and secure, e.g., real-time medical imaging
• Low latency, critical availability e.g., healthcare, autonomous driving
• Machine communications with millions of sensors, e.g., factories, smart cities

New business models
• Connectivity+
• Content
• Context
• Commerce
• X as-a-Service
Calls for a different approach than 3G -> 4G

- Maximize use of Pre-5G-technologies
- Ecosystem development beyond telcos
- Business models beyond connectivity
- Services transformation is a pre-requisite
- Fundamental Architecture Evolution is required
- Multiple Operator strategies possible. Defining a clear strategy matters

- Extreme Mobile Broadband
- Mass machine communication
- Critical machine communication
Utilizing novel technology enablers

Network

Performance

Connectivity +

Connected home Real time work in cloud 8k Video beamer UHD video Virtual presence Advanced monitoring

XXL broadband +“= content + tariffing / packaging

Virtual reality

Information brokering

Augmented gaming Augmented dashboard Self driving T. mgmt. Logistics Factory automation Waste mgmt. Smart grids

Traffic systems Advanced logistics & production Massive metering

Network as a Service

Safety & Security Mobile Living Utility & Energy Traffic Mgmt. Automotive Health Communication Logistics

Tailored XaaS solutions for spaces and vertical
Connectivity +
Differentiated and guaranteed quality

$ Access
$ Quality
$ Quality
$ Content

Vertical
End-user
Network operator
Content Delivery Network
Content aggregator
Content provider

$ UHD, FMC, + Quality
$ Content

"+" = content + tariffing / packaging

KEY ENABLERS
• Multi-connectivity
• Dynamic Experience Management
• Low latency

Revenue opportunities
Legacy revenues

Legacy revenues

Connected home
Real time work in cloud
8k Video beamer
4k Video
Virtual presence
Advanced monitoring

XXL broadband
UHD video
Virtual reality
**Information brokering**

Leverage assets for profitable partnerships

Retail customers

- End-user
- Retail

Network

Operator

Wholesale

- Content provider
- Retail shop
- Utility
- ... (indicated by "...")

**KEY ENABLERS**

- Big data analytics
- Lowest latency
  (as much info as possible is context specific)

- Augmented reality
- Traffic systems
- Advanced logistics & production
- Massive metering
Network slicing
Help different industries to transform

**KEY ENABLERS**

- Slicing
- Dynamic Experience Management
- Any-to-any connectivity
- Vertical specific augmented value adds to their core offering + CRM
- Low latency
- Slim radio for IoT

**Network as a Service**

- Tailored vertical XaaS solutions

**Network operator**

- Management
- Orchestrator
- Applications
- Platforms
- Infrastructure

**Security / Privacy**
Creativity is connecting things

<table>
<thead>
<tr>
<th>Connections*</th>
<th>ARPC**</th>
<th>Churn</th>
<th>Data pricing</th>
<th>Connectivity</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecting people</td>
<td>11 billion</td>
<td>$30 per month</td>
<td>~35% often more</td>
<td>Based on VOLUME of data</td>
<td>Best effort QoE mgmt.</td>
</tr>
<tr>
<td>Connecting things</td>
<td>Tens of billions</td>
<td>$3 per month</td>
<td>~10% or less</td>
<td>Based on VALUE of data</td>
<td>SLAs Criticality</td>
</tr>
</tbody>
</table>

*) 2020; **) 2015
To tap into huge IoT market opportunity

<table>
<thead>
<tr>
<th>2025 market projection in €</th>
<th>Mobility</th>
<th>Industries</th>
<th>Utilities</th>
<th>Digital Health</th>
<th>Smart Homes</th>
<th>Retail &amp; Services</th>
<th>Public Safety</th>
<th>Smart City</th>
<th>IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications, Analytics and End-User Services</td>
<td>203B</td>
<td>110B</td>
<td>31B</td>
<td>23B</td>
<td>19B</td>
<td>18B</td>
<td>18B</td>
<td>6B</td>
<td>6B</td>
</tr>
<tr>
<td>Application Enablement Platform</td>
<td>11B</td>
<td>3B</td>
<td>5B</td>
<td>2B</td>
<td>2B</td>
<td>0.6B</td>
<td>0.3B</td>
<td>3B</td>
<td>0.3B</td>
</tr>
<tr>
<td>Connectivity Management Platform</td>
<td>2B</td>
<td>0.4B</td>
<td>0.8B</td>
<td>0.3B</td>
<td>0.2B</td>
<td>0.1B</td>
<td>0.04B</td>
<td>0.04B</td>
<td>0.002B</td>
</tr>
<tr>
<td>Cellular Connectivity</td>
<td>6B</td>
<td>0.04B</td>
<td>0.02B</td>
<td>0.08B</td>
<td>0.01B</td>
<td>0.7B</td>
<td>0.7B</td>
<td>0.4B</td>
<td>0.01B</td>
</tr>
<tr>
<td>IoT modules</td>
<td>2B</td>
<td>2B</td>
<td>1B</td>
<td>0.6B</td>
<td>2B</td>
<td>3B</td>
<td>0.1B</td>
<td>0.3B</td>
<td>0.4B</td>
</tr>
</tbody>
</table>

Source: Machina Research and Nokia

- >€100B or >50% 2015-25 CAGR
- >€10B or >30% 2015-25 CAGR
Let’s work together to design and enable unique 5G

Thank you

www.networks.nokia.com/innovation/5G