Radio Access Networking Challenges Towards 2030

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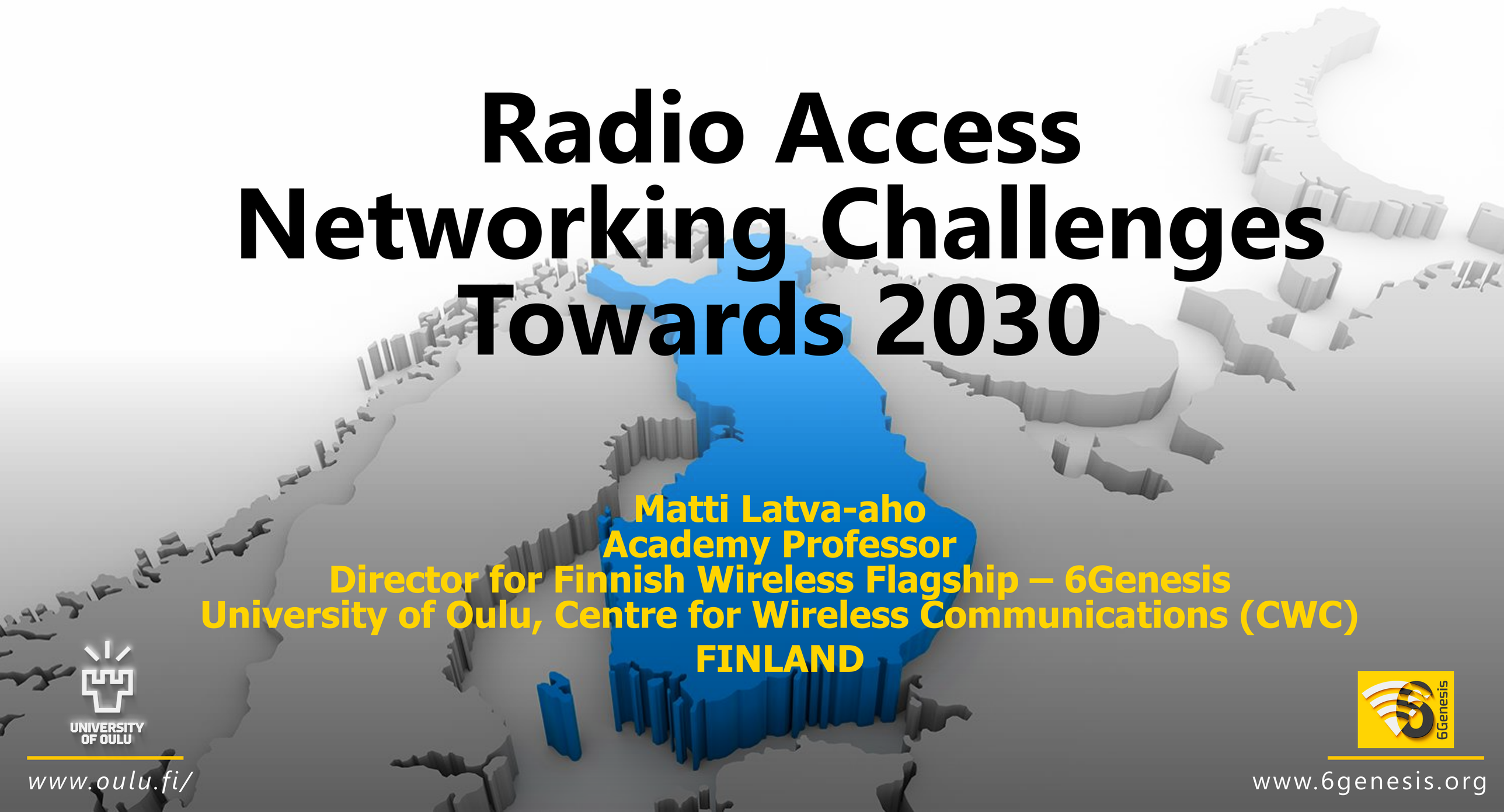

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Challenge #1: Verticals Driving Development

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Wireless Connectivity Offers Unlimited Opportunities

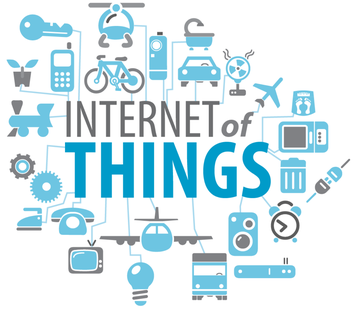
- Wireless connectivity is driving major societal changes:

1G - 2G

1980s – 2000s
Millions of voice users

3G - 4G

– 2020s Billions of Mobile Broadband users



5G and beyond

– 2040s Trillions of connected objects

- Application range explodes and new value chains emerge:

Logistics

Shopping

Agriculture

Industry 4.0

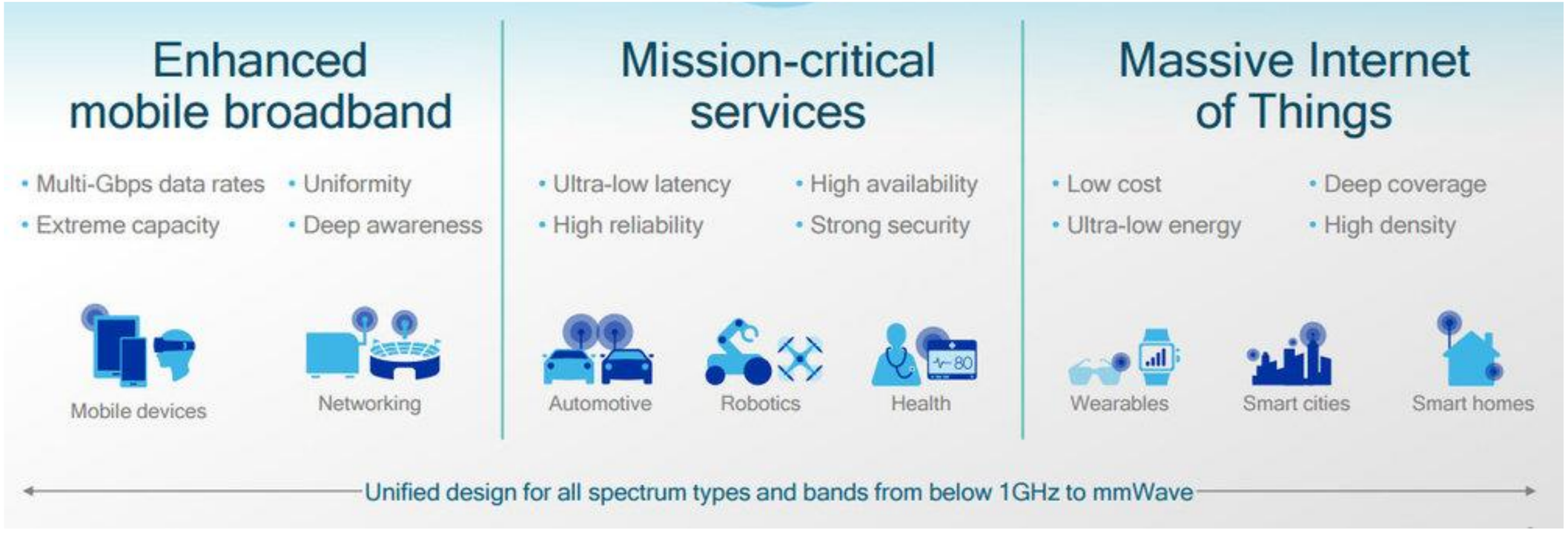
Health

Sustainable energy

Automotive & transportation

EC estimates of 5G in Europe by 2025: **€113.1B revenue per year and 2.3M new jobs**.

5G Use Cases



Network infrastructure is spreading massively to other locations besides operator base station sites.

Requirements for security and reliability become much more stringent.

Challenge #2: Network Architectures Change

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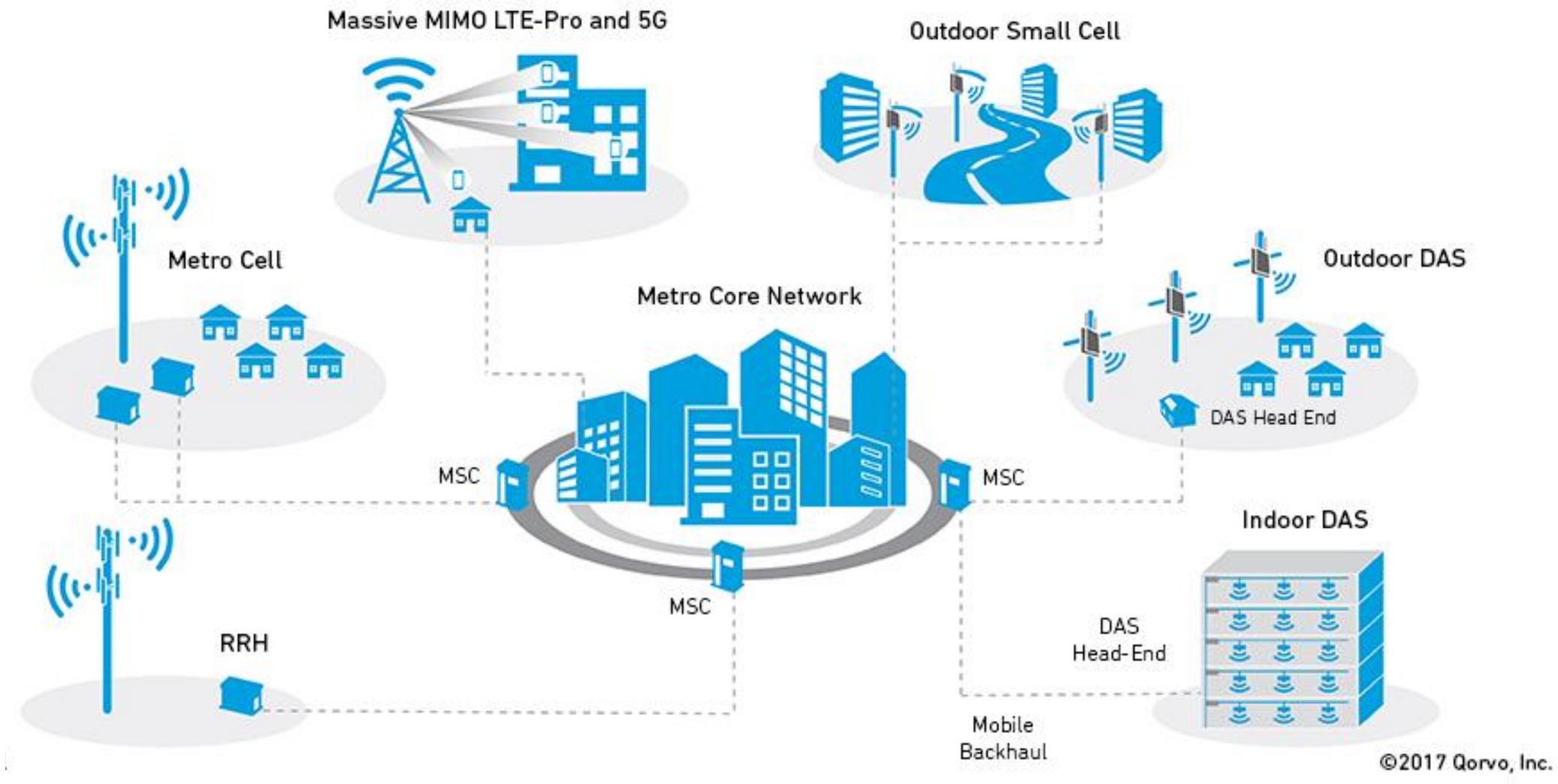
Short Range Connectivity Becomes Vital

1) Higher frequencies needed => the physics of radio signals propagation mean shorter link ranges
⇒More basestations needed => **the role of short range connectivity** is drastically increasing.

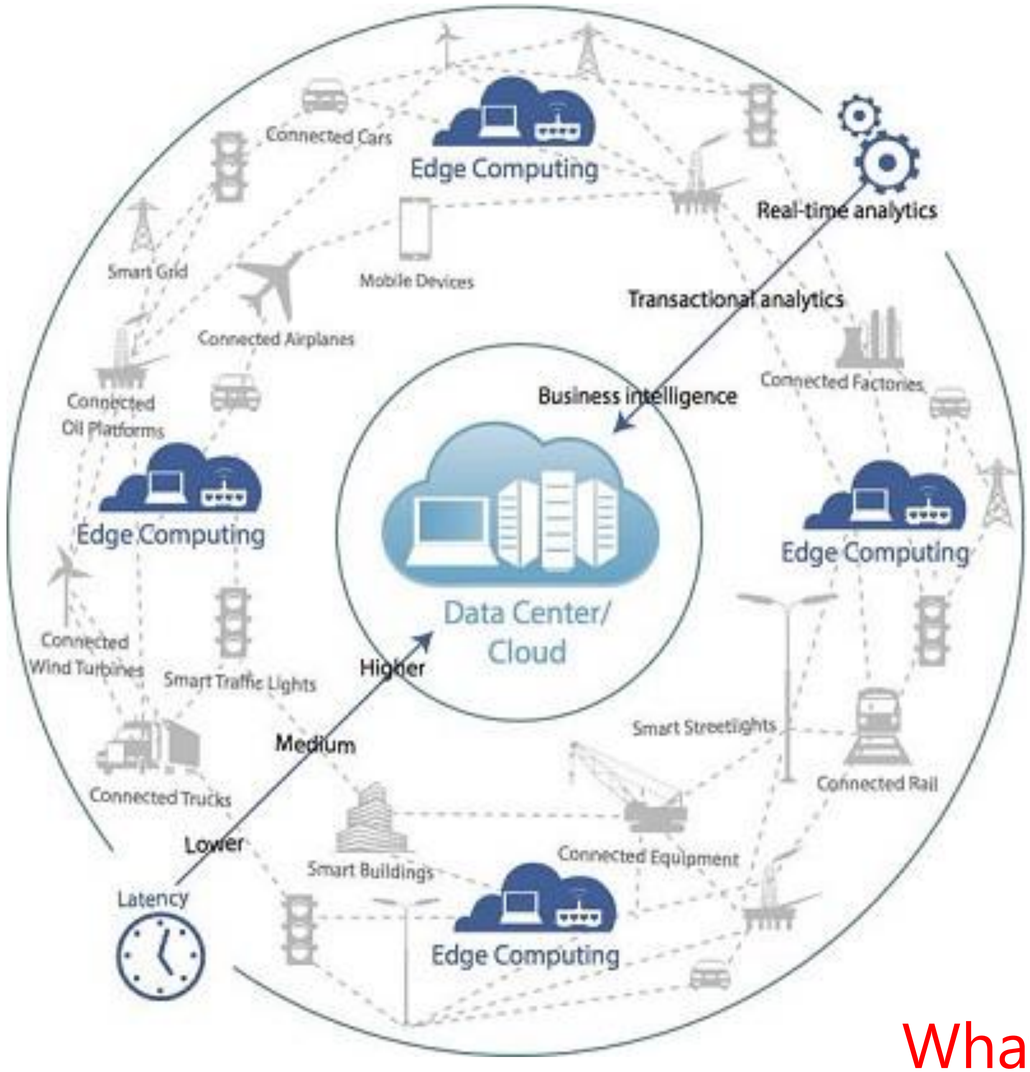
2) Higher frequencies do not propagate through walls => **base stations must be installed indoors**
⇒who does that and pays the bill?? => new value chains / business models needed.

3) Spectrum regulation has to enable **local frequency licencing** for the benefit of different verticals
=> Radio Spectrum Policy Group (RSPG) in European Commission is pushing this.

More Variety in Networks Deployment



Cloud Distribution Accross Network…



- Smart society calls for distributed AI.
- AI solutions are driven by different verticals.
- Whole system architecture is changing: basestation densification, mobile edge computing, fog computing at devices…

What AI/ML brings to wireless systems and what wireless connectivity offers to AI/ML based apps.

…All the Way to Mobile Devices

Challenge #3: New Value Chains Appear

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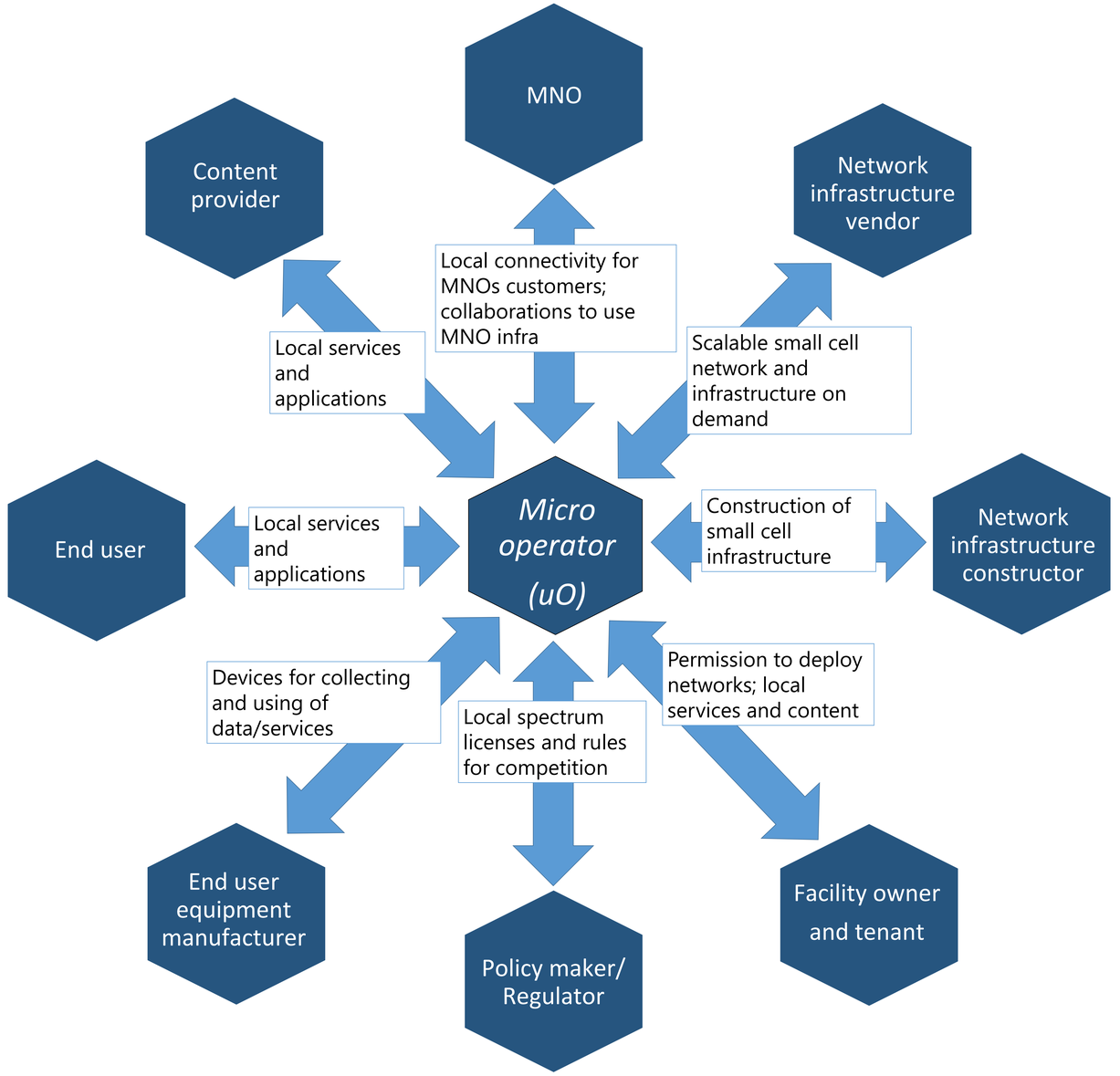
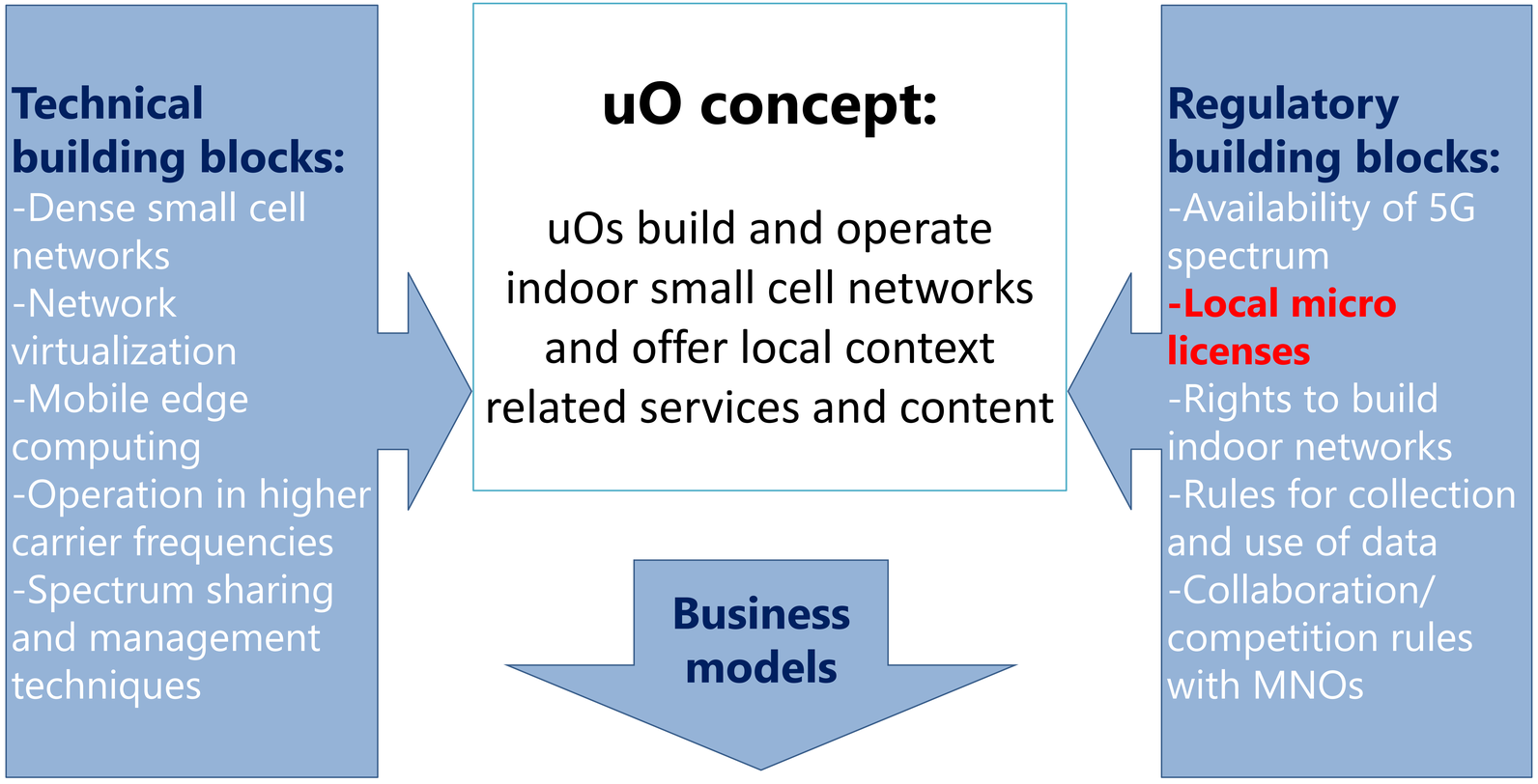
Content Depends on the Context

Micro Operator (uO)

- **Virtual operator** does not have own infrastructure but has own customer base.
- **Micro operator** (uO) has own infrastructure but not necessarily own customer base.
- Revenue models for uOs are not based on monthly fees of bytes.
  - Part of property offering – inclusion to rent
  - Part of customer service model
  - Improving the efficiency of public service => savings for society
- Possible only via changes in regulation.



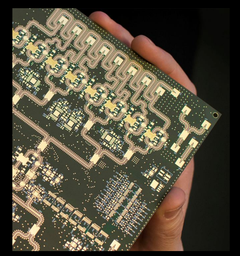
http://www.oulu.fi/uo5g/



HUGE ECONOMIC GROWTH VIA FAST DIGITALIZATION OF SOCIETY ENABLED BY AGILE NEW PLAYERS IN THE ECOSYSTEM

5G Test Network Driving uO Concept Trials

- Open test network for co-creation (https://5gtn.fi).
- Was used in EU-Korea demos at 2018 Winter Olympic Games (http://www.oulu.fi/cwc/node/50700).
- Operator grade live network with plugged in 5G prototype radios.
- Near future targets: become the first operational local micro-operator at University of Oulu Digital Campus.



800 MHz @26/28 GHz
10 Gbps
Hybrid beamformer

5G PoC

IoT sensors

LTE Macros
with NB IoT

LTE small cell
@3.5GHz

5GTN SIM

Challenge #4: Connecting The Last 4 Billion People

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Wireless Solutions Are Critical for Sustainable Development

Sustainability targets set by UN for 2030

Grand Challenges That Have Been Overlooked

- How to solve **backhauling** in remote areas?
- How remote area networks are **finaced**?
- How about emerging economies and **developing countries**?
- **Spectrum regulation** in remote areas should be handled differently.

ngmn
the engine of broadband wireless innovation

PRESS RELEASE

NGMN Alliance launches new projects to boost 5G success

Updates on first 5G deployment experiences, further technology development and new business models to be shared at the NGMN Industry Conference in Vancouver, November 6-8, 2018

Frankfurt, GERMANY, June 18, 2018 – Next Generation Mobile Networks (NGMN) has confirmed the launch of four new key projects to support the development and deployment of 5G networks.

The projects – **"Spectrum and deployment efficiencies", "Ultra Reliable Low Latency Communication (URLLC) requirements for vertical industries", "RAN convergence"** and **"Extreme long-range communications for deep rural coverage"** – have been highlighted as crucial development areas to further optimise and guide the telecoms industry towards the successful deployment of 5G beyond 2018.

Challenge #5: Major Technology Leap Required for 6G

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Finnish Flagship on Wireless Communications
6G Enabled Smart Society and Ecosystem
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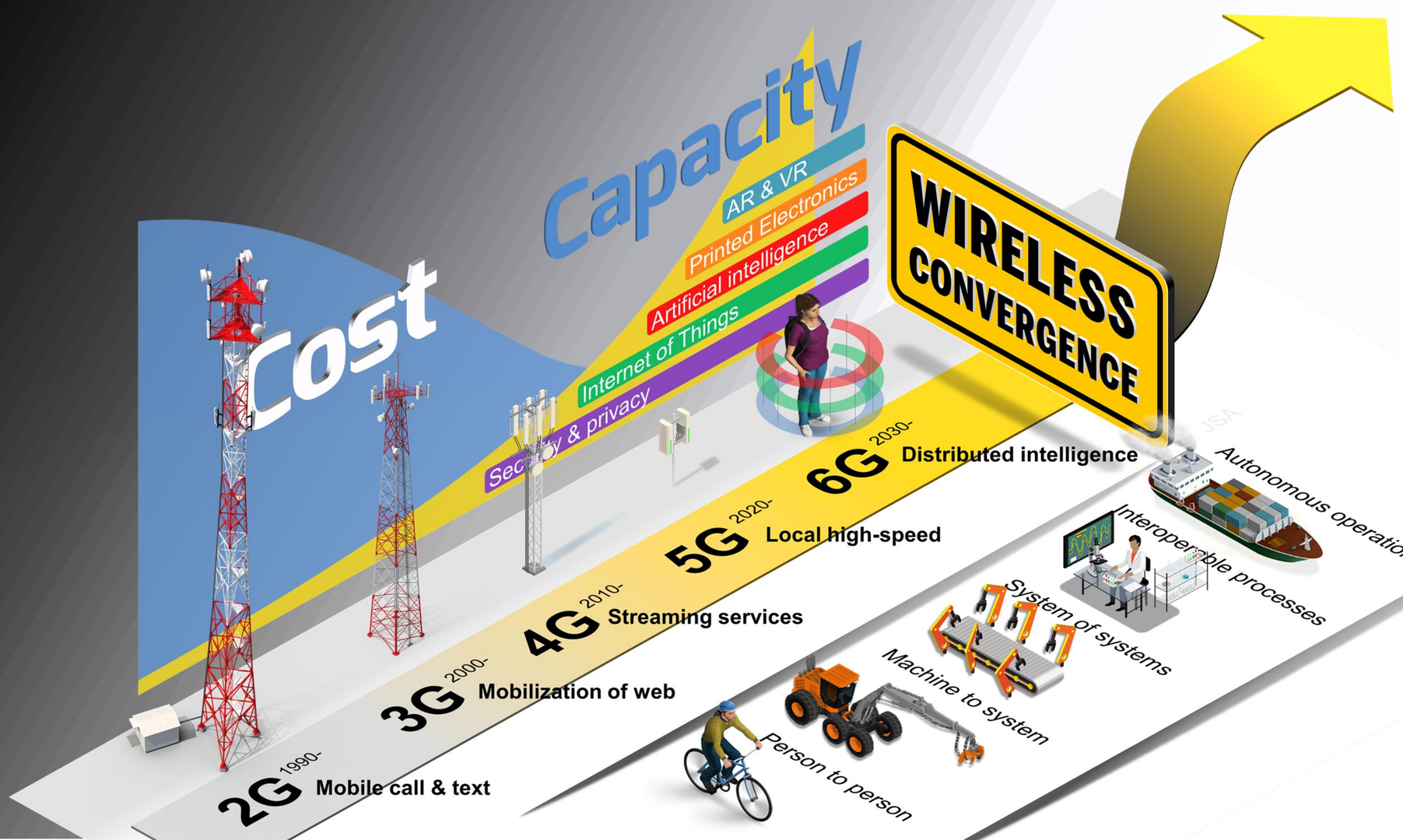
Vision for 2030

Our society is data-driven, enabled by near-instant, unlimited wireless connectivity.

6G will emerge around 2030 to satisfy the expectations not met with 5G, as well as, the new ones fusing AI inspired applications in every field of society with ubiquitous wireless connectivity.

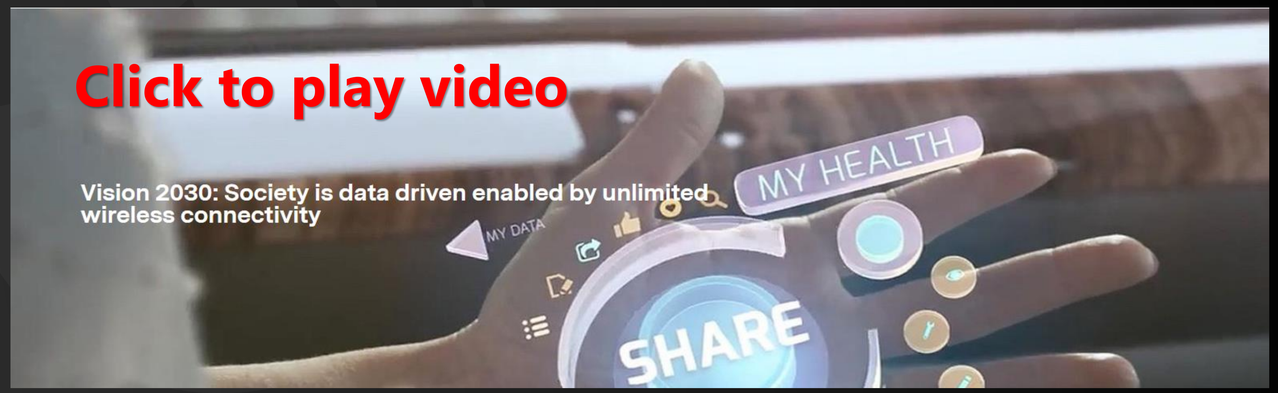
Trends in Mobile Technology Development



Fully automated society

National Flagship on Wireless Communications

- National Flagship for 2018-2026
- Volume 251M€
- Operated by University of Oulu
- Contact: matti.latva-aho@oulu.fi
- More info: www.6genesis.org



RESEARCH AREAS:

Wireless Connectivity

Ultra-reliable low-latency communications

Unmanned processes

Devices & Circuit Technology

THz communications materials & circuits

Unlimited connectivity

Distributed Computing

Mobile edge intelligence

Time critical & trusted applications

Services and Applications

Multidisciplinary research accross verticals

Disruptive value networks