5G VIIMA

5G FOR INDUSTRY

LESSONS LEARNED IN 5G-VIIMA RESEARCH PROJECT

FIIF Event – Private 5G Networks, 18 February 2021
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Centre for Wireless Communications (CWC), University of Oulu

OUTLINE

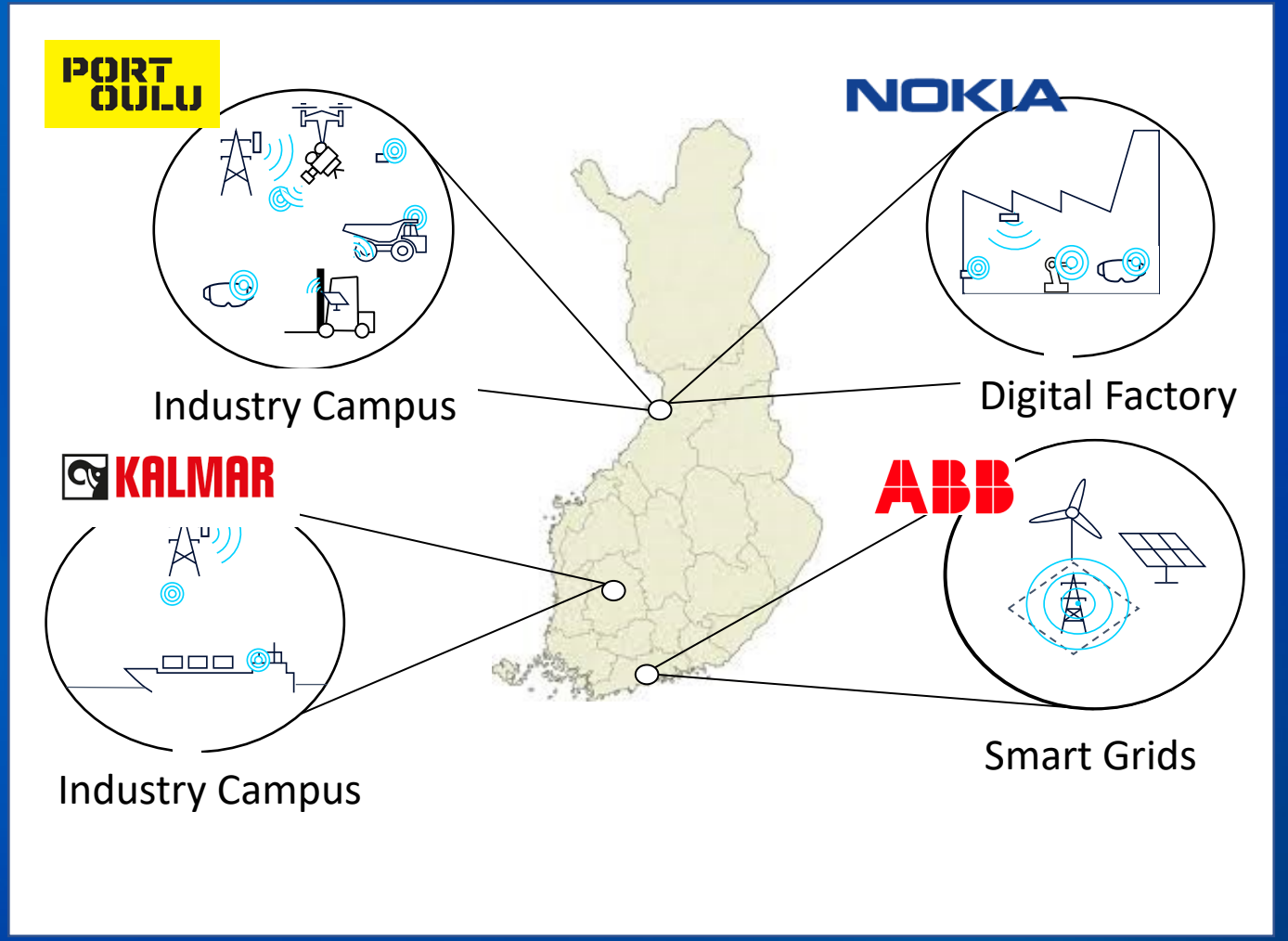
- 5G-VIIMA approach
- Local (private) 5G networks
- Results higlights

5G-VIIMA

- 2-year project until 04/2021, Business Finland funded.
- 7 academic, 17 industry parties, 3 public sector organizations
- Key Focus:
  - Industry 4.0 relevant 5G technologies
  - Wireless industry services
  - Practical experiments
  - Business environment analysis

New Assets and Practical Experiments

- Investigating and exploring 5G technologies bringing value to Industry sector
- Enabling wireless connectivity to existing Industrial products
- Exploring new ways of using data
- Running Practical experiments in a factory, a controlled semi-open outdoor/indoor industry campus and smart energy grids



Involved Partners

Industry (21)

KALMAR
ABB
UROS
FINWE
MEDIATEK
NOKIA
FinCloud.tv
Attracs
VALOSSA
tieto
OY HERMAN Andersson OULU SINCE 1902
FIN-TERPUU
Valmet
SOLITA
augumenta
KAITOTEK
STRONG WOOD POLKKY
Telia
REALMAX
Efora
PORT OULU

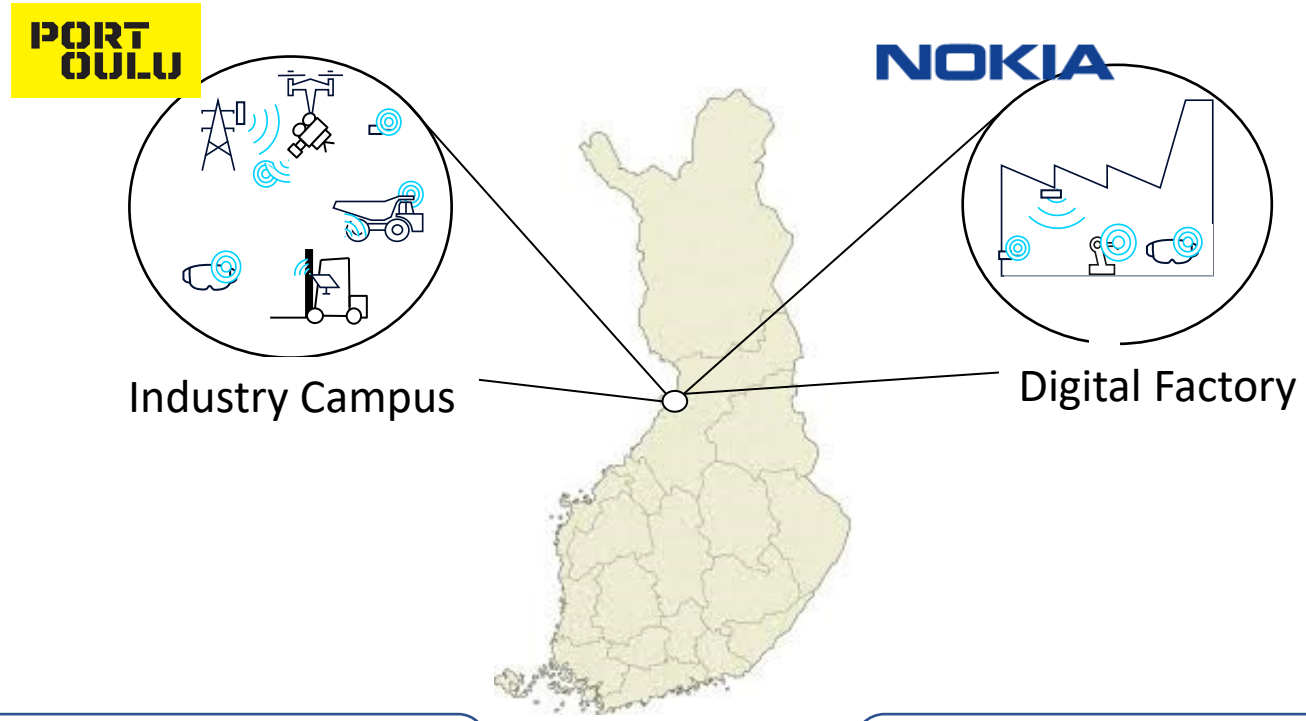
Academic (7)

UNIVERSITY OF OULU
Aalto-yliopisto Teknillinen korkeakoulu
VTT
Tampere University
OAMK OULUN AMMATTIKORKEAKOULU
TURKU AMK
Centria AMMATTIKORKEAKOULU

Public Sector (3)

BUSINESS OULU
BUSINESS FINLAND
TRAFICOM Liikenne- ja viestintävirasto

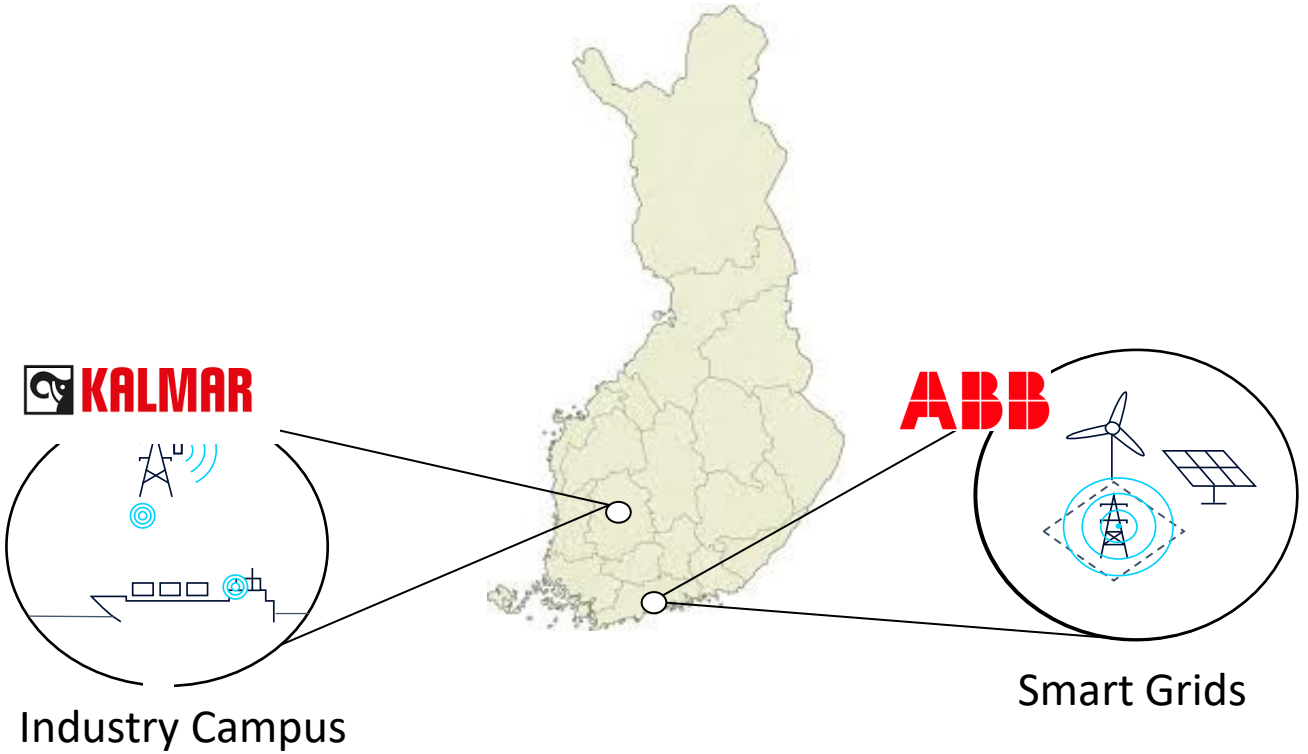
Experiment Networks in real Industrial use



- Own private LTE network
- Commercial 5G by Telia

- Own private LTE network
- 5G indoor solution

Experiment Networks in real Industrial use



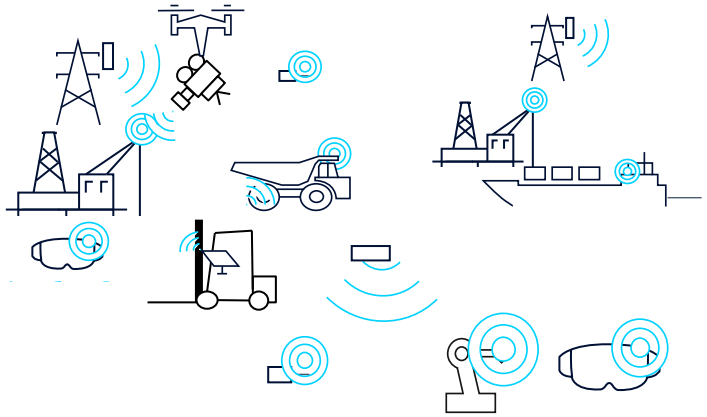
…and more tests in each consortium partner.

- Own private LTE network
- 5G prototypes with URLLC connectivity

- 5GTNF / Smart Otaniemi
- Multiple 4G test networks
- 5GNR outdoor

Business Environment Analysis

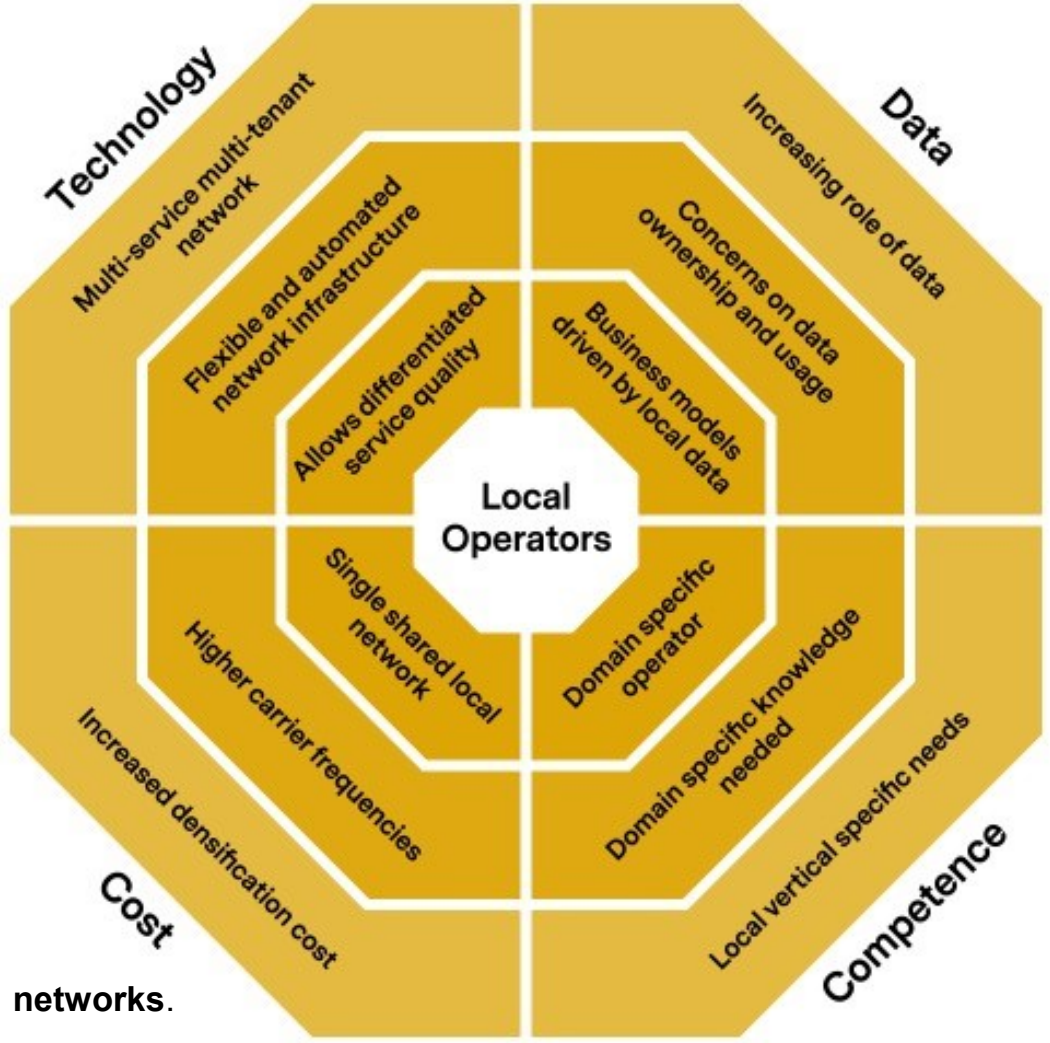
- Deep-dives into selected trial environment
  - Use case analysis for involved stakeholders
  - Modelling for techno-economics
  - Impacting to legislation, regulation and policies




LOCAL 5G NETWORKS

Towards Local Operator Paradigm

- **Stakeholder roles are changing. Different stakeholders can have their own local 5G networks[1], independent of mobile network operators, through local spectrum licenses[2].**
- **Progress is slow and divergence in spectrum decisions between countries is high[3], leading to market fragmentation.**
- **MNOs offer local private 4G/5G networks.**

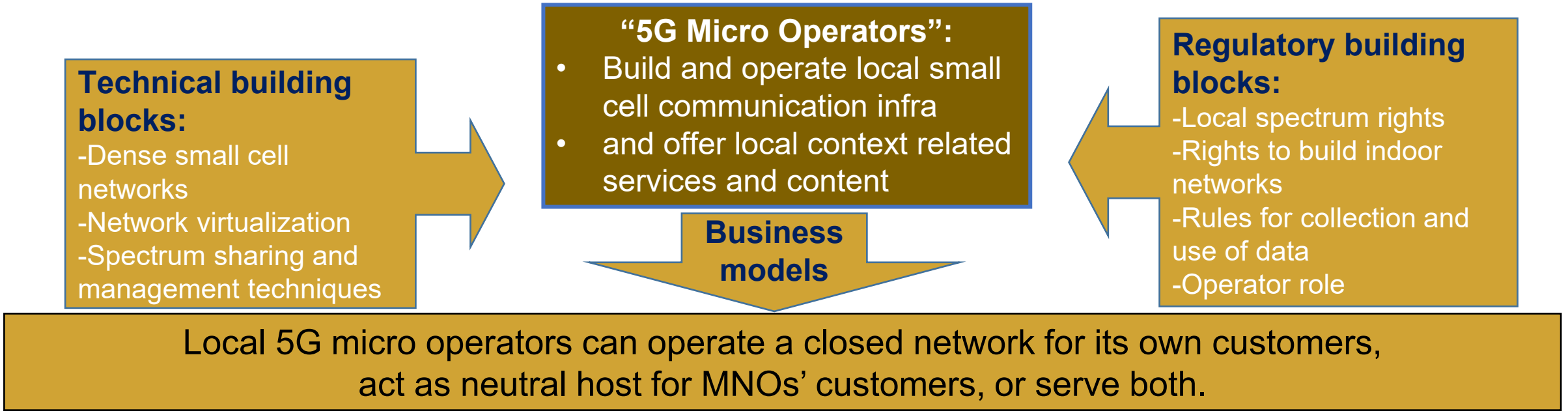


[1]M. Matinmikko, et al. (2017) **Micro operators to boost local service delivery in 5G**. Wireless Personal Communications, 95(1), 69-82.
[2]M. Matinmikko, et al. (2018) **On regulations for 5G: Micro licensing for locally operated networks**. Telecommunications Policy, 42(8), 622-635.
[3]M. Matinmikko-Blue, et al. (2019) **Analysis of Spectrum Valuation Elements for Local 5G Networks: Case Study of 3.5-GHz Band**. IEEE Transactions on Cognitive Communications and Networking, 5(3), 741-753.

http://6gflagship.com/6gwhitepaper/

Emergence of local 5G networks

- Finnish uO5G project (2016-2018) developed a local 5G micro operator concept to allow different stakeholders to deploy their own local 5G networks.
- At that time, the majority of 5G research and development considered MNO deployments.
- Since then, growing interest towards local 5G networks has led to new deployment models, depending on spectrum availability.



M. Matinmikko, M. Latva-aho, P. Ahokangas, S. Yrjölä, and T. Koivumäki. Micro operators to boost local service delivery in 5G. Wireless Personal Communications, vol. 95, no. 1, pp. 69-82, May 2017.

Spectrum Management Approaches

Administrative allocation:	**Market-based mechanism:**	**Unlicensed commons approach:**
Regulator decides who can access spectrum. Aims at creating rules that minimize harmful interference and protect existing users. Spectrum sharing between systems is possible but not actively promoted.	Regulator defines spectrum property rights that are awarded using market mechanisms (e.g. auctions). Allows and promotes spectrum sharing through secondary markets.	Regulator allows spectrum access to many under defined rules and conditions. Entirely based on spectrum sharing through technical criteria for sharing.

M. Matinmikko-Blue, S. Yrjölä, V. Seppänen, P. Ahokangas, H. Hämmäinen and M. Latva-Aho. Analysis of Spectrum Valuation Elements for Local 5G Networks: Case Study of 3.5-GHz Band. IEEE Transactions on Cognitive Communications and Networking, vol. 5, no. 3, pp. 741-753, Sept. 2019.

Diverging 5G Spectrum Awards Mechanisms

Administrative allocation:

Local spectrum access rights are emerging in many countries.

Many auctions could have been conducted through administrative allocation due to the selected rules.

Market-based mechanism:

Auctions used in 5G spectrum awards extensively. Rules and obligations vary highly between countries.

Secondary markets typically allowed allowing MNOs to transfer rights.

Unlicensed commons approach:

5G variants operating in unlicensed bands are starting to be introduced.

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5G-VIIMA RESULTS HIGHLIGHTS

Remote Operations

- Reliable / low-latency connectivity for port automation and smart grid
- Remote robot control
- Telepresence & operations in XR
- Collaboration & support in XR
- Robot integration to XR

Collect Data and Show It

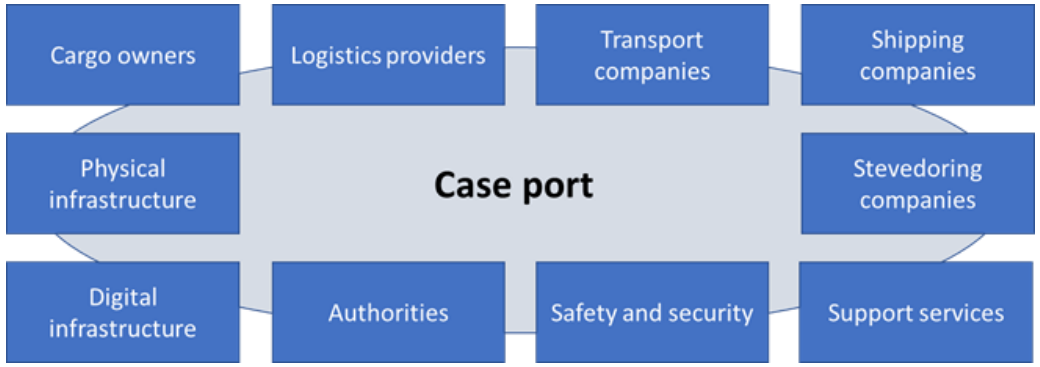
- Mobile network quality monitoring and visualization
- Environmental data collection
- Digital twin of port

Video Services

- Algorithms for object identification
- Analytics for material buffer analysis
- Analytics for process quality ensurance

Business Environment Analysis

Stakeholder identification



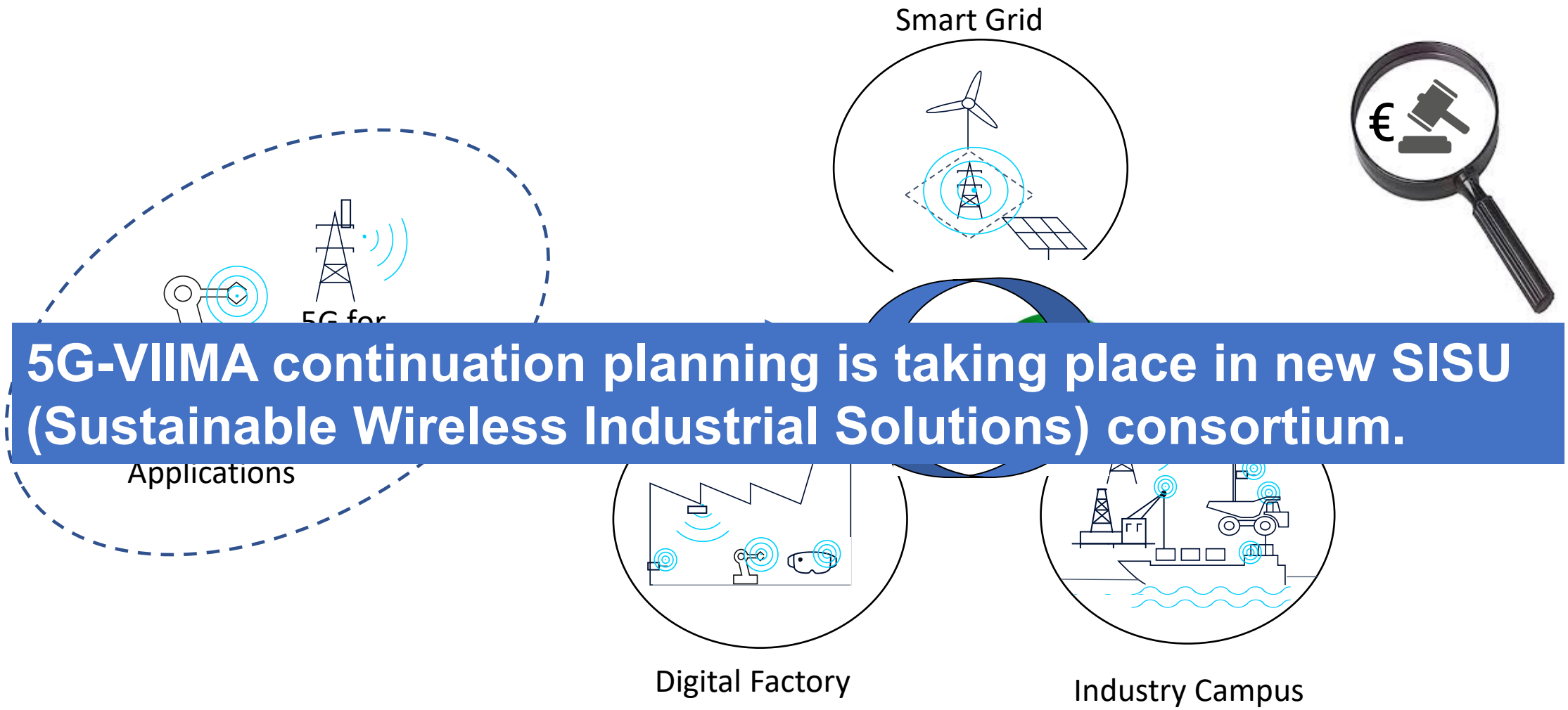
Business model creation

	Components	Interfaces	Data	Algorithms
Commerce	Digital twin Local computing services	Access to data	Marketplace for data	Data analytics services
Context	Situational awareness	Cyber security Physical gates	Control and monitoring data for robots	Video analytics
Content	Sensors Video cameras	Cloud and device interfaces	IoT sensor data Open data	3D map of area as digital twin
Connectivity Computing	Private mobile network Private computing platform	Network management Open interfaces	Local data warehousing "Digital Twin"	Operational awareness and optimization

Regulatory element identification

- Spectrum
- Operator role
- Competition
- Access to infrastructure
- Radio equipment authorization
- Security and privacy
- Vertical specific regulations

Summary



5G-VIIMA continuation planning is taking place in new SISU (Sustainable Wireless Industrial Solutions) consortium.

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Funded by BUSINESS FINLAND