Wireless for Verticals (WIVE) 2017-2018
WP1 Business aspects and regulation: use cases, scenarios and future markets

D1.4 Input for other 5G TNNF projects

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Executive summary

The document summarizes input from the WIVE project to 5G Test Network Finland (5GTNF). 5G Test Network Finland (5GTNF) coordinates and combines the research and technology development activities from the 5G infrastructures built under Business Finland’s 5thGear programme (businessfinland.fi/5thGear).

The input covers posters presented at the 5GTNF Demo seminar on November 15th, 2018, on the following topics

- Market making and shaping in 5G (Nyström & Barner-Rasmussen)
- WIVE scenarios for 5G (Nyström, Lindström & Barner-Rasmussen)
- Business and spectrum opportunities enabled by 5G in different verticals: Regulatory view (Vuojala & Hoyhtyä)

The posters are based on data collected within the WIVE consortium, aimed at contributing with analysis of different aspects of 5G development from a business and regulatory view. The business aspects cover market learning, market shaping and market creation as well as scenarios for 5G identified by WIVE participants. The regulatory view covers different spectrum opportunities in 5G, from the viewpoint of the WIVE project. In addition, WIVE contributed with input from the WIVE project through the following presentations:

- Verticals as drivers of 5G, presentation by Miia Mustonen 26th October 2017 at the COCOM Working group 5G meeting
INTRODUCTION

We conducted 9 interviews with 18 people during April 3-May 14, 2018. The interviews formed a part of WIVE WP1 “Business aspects and regulation: use cases, scenarios and future markets”. We explore the process of market-making and market-shaping around 5G as a fundament of future 5G-enabled business opportunities in different verticals.

The interviews focused on:

- the forms that 5G-related markets are taking
- factors at different levels of analysis that contribute to shaping them, and
- the process through which this occurs.

Markets – a theory flash

Markets are ecosystems which do not simply pre-exist. They are created and recreated as a result of co-evolving value propositions, negotiations between multiple actors, and new solutions that emerge and become institutionalized (Vargo et al., 2015).

Markets are socially constructed (Granovetter, 1992), and hence emergent in the sense of being both shapeable and shaped by numerous, continuous change efforts (Storbacka & Nenonen, 2015, 73, building on Kjellberg et al., 2012).

Markets are “non-linear, non-sequential, iterative, and continuous” processes (Storbacka & Nenonen, 2015, 74; Colarelli O’Connor & Rice, 2013) that market actors may engage in to shape markets by changing their configuration and/or behavior individually or collectively.

In the WIVE project we use the term market shaping (according to Storbacka & Nenonen, 2015)

CONCLUSIONS: 5G – A MARKET THAT ISN’T YET

- Technical development far ahead of market development.
- Informants mostly perceive 5G as a “technology”, a “standard”, an “enabler” - not so much a “market”.
- Therefore, external hype and high expectations lead to frustration.
- Emerging actor network perceived very differently by different actors.
- Need for cooperation acknowledged but many actors are yet “in their own silos”.
- Many actors call for someone else to take the lead - unclear who should do this.
- Individuals struggle to find time for out-of-the-box thinking at a strategic level; “Is it my job to reinvent the market?”
- Technical experts not comfortable with initiatives that can have big strategic implications - meanwhile top managers contribute to the hype. The balance of power/expectations/expertise is hard to strike.

The market learning cycle (Granovetter, 1992, 3-11; Storbacka & Nenonen, 2015, 82) involves several market actors involved in “reciprocal processes of higher-level learning […] where the learning outcomes are changes in market-level properties”, such as:

- Market network structures
- Market practices
- Market agendas (mental models)

(Storbacka & Nenonen, 2015, 76)
BACKGROUND & METHODOLOGY

During the WIVE project, participants have discussed scenarios at workshops (Autumn 2017), divided into three main topics defined as relevant for the WIVE project:

- **Ultra-reliable low latency communication (URLLC)**
- **National broadcast delivery**
- **Massive NB-IoT/sensor networking**

For each topic, key issues and factors were identified. Then, a dream state scenario and a threatening scenario were mapped based on a number of change factors, namely a) political, b) economic, c) social, d) technological, and e) environmental. Some weak signals and megatrends were also identified. Initial actor networks were drawn during the workshops, and complemented with data from interviews during Spring 2018.

### ULTRA-RELIABLE LOW LATENCY COMMUNICATION (URLLC)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Dream state scenario</th>
<th>Threatening scenario</th>
<th>Weak signals and megatrends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical</td>
<td>Reduced latency, enhanced reliability</td>
<td>Increased latency, reduced reliability</td>
<td>New technologies for ultra-reliable communication</td>
</tr>
<tr>
<td>Economic</td>
<td>Reduced costs, increased efficiency</td>
<td>Increased costs, decreased efficiency</td>
<td>Increase in demand for ultra-reliable communication</td>
</tr>
<tr>
<td>Social</td>
<td>Increased trust, reduced errors</td>
<td>Decreased trust, increased errors</td>
<td>Changes in social norms and values</td>
</tr>
<tr>
<td>Technological</td>
<td>Advancements in technology, increased capacity</td>
<td>Decrease in technology, reduced capacity</td>
<td>Increase in research and development</td>
</tr>
<tr>
<td>Environmental</td>
<td>Improved sustainability, reduced impact</td>
<td>Decreased sustainability, increased impact</td>
<td>Changes in environmental conditions</td>
</tr>
</tbody>
</table>

### NATIONAL BROADCAST DELIVERY

Aspirants or new types of players to existing ecosystems and networks are identified as, for instance, application developers, spectrum brokers, electricity brokers, and micro-operators.
Introduction / background
Current mobile networks will significantly change during the next decade, transforming industries and business models. Therefore it is essential to explore future, innovative service concepts in the 5G context, with a special focus on machine type communications (MTC). The WIVE project has covered two aspects enabling 5G, namely 1) business opportunities in the future 5G context, including use case scenarios for different verticals, and 2) regulatory aspects.

Business and regulation aspects affect possible use cases and requirements for 5G. The work has translated and validated research results into, e.g., innovative business models and scenarios to be used as input in the project’s technical trials and other activities. This poster presents mainly the regulatory work from spectrum sharing models point of view. Involved companies have impacted the model definition work in the joint workshops via their feedback.

![Figure 1. Unlicensed use in ISM bands](image1)
In unlicensed scenarios national regulatory authority (NRA) allocates spectrum for unlicensed usage. In CBRS and TV white space bands incumbent user defines terms of usage such as operation area and time. For vertical service provider there is no licensing requirements which enables easy and fast access to spectrum. License-exempt users have to be able to tolerate some interference, latency issues, congestion, and possible availability limitations caused by higher priority users.

![Figure 2. Unlicensed use in CBRS (GAA users) and TV white space bands](image2)

Regulatory activities and publications
VTT has lead regulatory activities regarding MTC by both developing and promoting MTC related spectrum management schemes, spectrum policies and results from interference considerations in relevant regulatory forums. The presented results will also be reported as international publications, some papers have been submitted already.

![Figure 3. Secondary licensing](image3)
- More certain spectrum availability
- Higher data rate, for users willing to pay for license
- Have to tolerate some delays, need for e.g. MNO network backup

![Figure 4. Spectrum trading or leasing](image4)
- NRA grants an exclusive license to an MNO with rights to lease the spectrum or parts of the licensed spectrum to one or more vertical service providers
- Reliable service, higher license costs

![Figure 5. Virtual network provided by MNO](image5)
- NRA grants exclusive license to the MNO. The MNO offers full service package to the vertical service provider needs, and they negotiate commercial agreements including e.g. fee for the service and expiry date

Conclusions
On a high level, spectrum options for vertical service providers can be divided into four different categories: unlicensed, secondary licensing, spectrum trading or leasing, and dedicated virtual network provided by Mobile Network Operator (MNO). The applicability of these scenarios depends on the characteristics and requirements of the vertical use case.

VTT – beyond the obvious
www.vttresearch.com
Verticals as drivers of 5G

COCOM Working Group 5G meeting
26th October 2017

Miia Mustonen
VTT Technical Research Centre of Finland Ltd

Outline

- WIVE project
  - Goal
  - Consortium
  - 5G use cases
- Spectrum considerations
- Business studies
- Ultra Reliable Low Latency Communications
- Massive Machine Type Communications
- Broadcast delivery
- Summary
Wireless for verticals (WIVE) project

- WIVE-project aims to speed up the roll out of new vertical services in 5G by testing and experimenting new vertical services in 4G/5G in realistic environments.

- Funded by the Finnish Funding Agency for Innovation, supported by additional funding and supporting projects from Finnish industry stakeholders.

- Total research volume is 110 person years during 2017-2018. Project coordinators: Nokia Bell Labs Finland (Industrial) and Turku University of Applied Sciences (Academic).

- WIVE-project is part of a large national effort, 5G Test Network Finland, which consists of four projects and tens of live testbed sites located in various parts of Finland.
5G use cases in WIVE

Media content delivery

- High data rates
- Low latency
- VR/AR authorities

5G use cases in WIVE

- Media content delivery
- High data rates
- Low latency
- VR/AR authorities

Massive MTC

- Predictive maintenance
- Low power consumption
- High device density
- Metering
-Low cost tracking roaming

URLLC

- High data rates
- High availability
- High reliability
- Ultra-low latency

Spectrum considerations for 5G

- New radio solutions that enable new higher frequency bands.
- Support different spectrum regulation and management regimes.
- Technical enablers to allow:
  - Utilization of licensed & unlicensed spectrum and possible other spectrum arrangements.
  - Standalone networks for local and/or specific purpose.
  - Solutions being integrated as part of cellular operators networks and existing spectrum
  - Improve co-existence with existing solutions and provide high reliability and lower latency.
- 3GPP Phase 2 standardization
- Studies in ITU-R for World Radio Conference 2019 (WRC-19) on new mobile bands (AI 1.13) and machine type communications (AI 9.1.8).
Business studies

- The future business opportunities of 5G hold more questions than answers
  - Recognizing and exploiting opportunities is a challenge
    - Does the company have the capabilities, resources and will to exploit an opportunity – or to create the opportunity?
  - Renewal of business models supporting new business opportunities
    - Which actors to team up with, and establish relations to?
    - Vertical actors need to establish new ecosystems
      - …in which ICT-actors are embedded
      - …which take into account changing consumer behavior and needs, e.g. in media, where consumers are shifting to co-creators of content, trends related to the sharing economy, green choices and convenience
  - The question of what kind of roles (and actors) there are in the future 5G business ecosystem for different actors is yet to be explored

Ultra Reliable Low Latency Communications

- URLLC enables real-time control and automation of dynamic processes e.g. remote control of moving machines, autonomous driving, robotics etc.
- Research questions
  - Overall system design e.g. reliability requirements.
  - Technical enablers and concept covering waveforms, radio resource management, grant-based/grant-free transmission, high accuracy positioning, mobility management reliable control and data channel design etc.
  - Time-critical connections in different radio conditions.
  - UE related complexity issues and power saving.
- Simulations have shown that continuous 10 Gbps data-rate can be achieved in high speed train scenario using 5G access on mm-waves.
Physical layer enablers for URLLC

Massive Machine Type Communications

- Internet of Things (IoT) will grow dramatically in the future, and wireless networks will have to support massive amounts of machine type connectivity (mMTC). These sensors will also have to be low cost and have low power consumption, as data sent per sensor is very low.

- Research questions
  - Discovering bottlenecks on radio access, mobile backhaul and core network.
  - Testing large amount of devices with respect to connection as well as management in the project test network.
  - Examining the constraints and scalability when handling large amount of connected devices.
  - Identify potential cost savings achieved by network virtualization, slicing or Mobile Edge Computing (MEC) with 4G/5G connections.

- The WIVE-project will study mMTC using different wireless communication standard with unlicensed spectrum (LoRa and WiFi) and licensed spectrum (3GPP standardized NB-IoT). The sensor data will be used for smart indoor environments and monitoring or maintenance of equipment.
mMTC: Devices/sensors discovery and management for smart buildings and industry sites

- Massive Machine Type Communications offer several advantages over manually operated sensors and devices, e.g.
  - Cost savings achieved by network virtualization, slicing or Mobile Edge Computing (MEC) with 4G/5G, LoRa, Wi-Fi connections,
  - Increased efficiency,
  - Improved maintenance industry site, smart building security and safety,

- Critical communication modes:
  - Remote control operations

Pilot Goal “Discover the bottlenecks on the radio access, mobile backhaul and core network managing large amount of devices. Examine connectivity and scalability constraints.”

Broadcast delivery

TV & Radio broadcasting

Pilot Goal “To study the viability of 4/5G multi/broadcasting mechanisms for nationwide delivery of TV and radio services towards future convergence of radio networks”

National authority broadcast delivery

Pilot Goal “To study the opportunities of localized delivery of authority broadcasts using 4G/5G with high reliability”
Broadcast delivery

Multimedia access in trains and buses

Virtual & Augmented reality

Pilot Goal: "to trial an end-to-end system for live streaming of media content in train environment for enhanced traveler experience"

Pilot Goal: "to study possibilities to use eMBMS for delivering VR and AR content to large areas and large audiences using portable terminals"

Summary

- 5G is foreseen to cover various use cases for numerous industry verticals that have quite diverse requirements for their services.
- In the WIVE-project, three main areas of 5G studied are ultra reliable low latency communications, massive machine type communications and broadcast delivery. Aspects considered include:
  - Business scenarios and models
  - Spectrum regulation
  - Standardization
  - Technical research
  - Pilots
- Several over-the-air pilots using different wireless technologies and spectrum bands are expected to shed light to many of the existing research questions and provide proof of concept for several use cases considered for 5G.
- Public trial events will be arranged to showcase the most promising results of the WIVE-project.