Utilising 5G testnetworks

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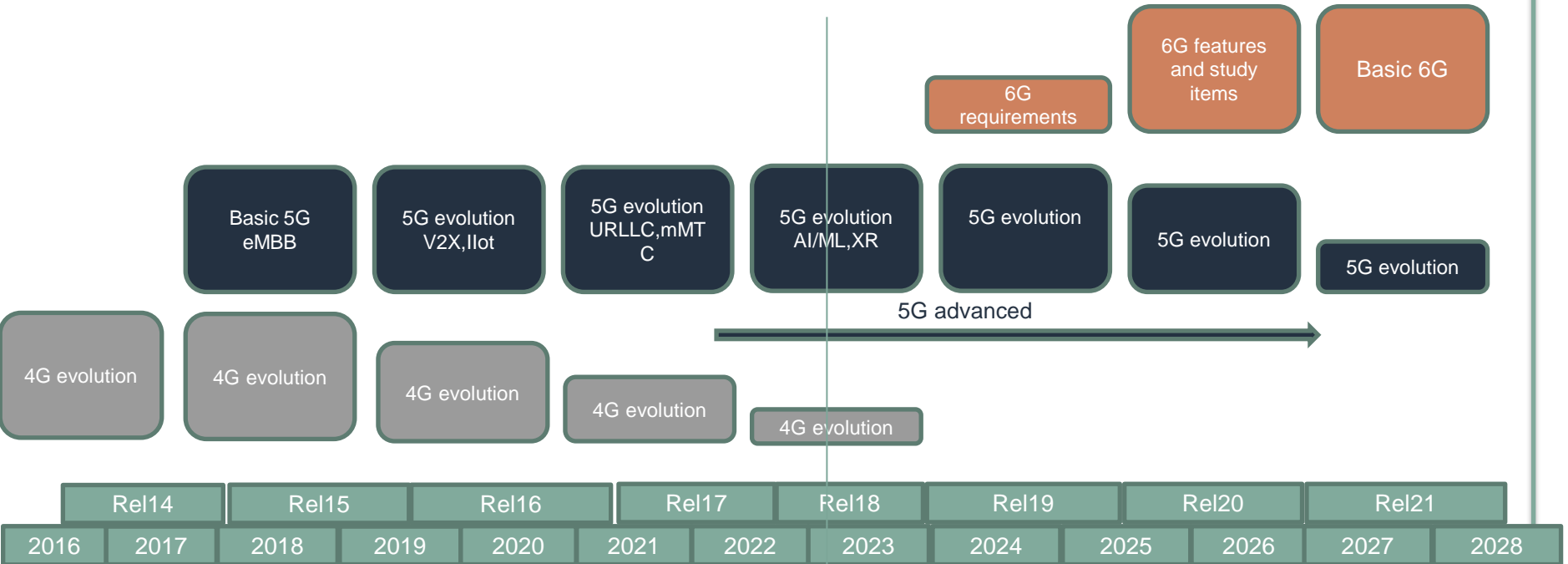**08/05/2023   VTT – beyond the obvious**

Outline

- Status of 5G
- Testnetworks in Finland
- VTT 5G & beyond testnetworks
- How to get started

What is 5G

- 5G is the 5th generation mobile network
- Defined and standardised by 3GPP
- New global standard after 1G, 2G, 3G, 4G and before 6G
- Target to provide:
  - Higher multi-Gbps data speeds
  - Ultra low latency
  - More reliability
  - More network capacity
  - More and new user experiences
  - Improved energy efficiency
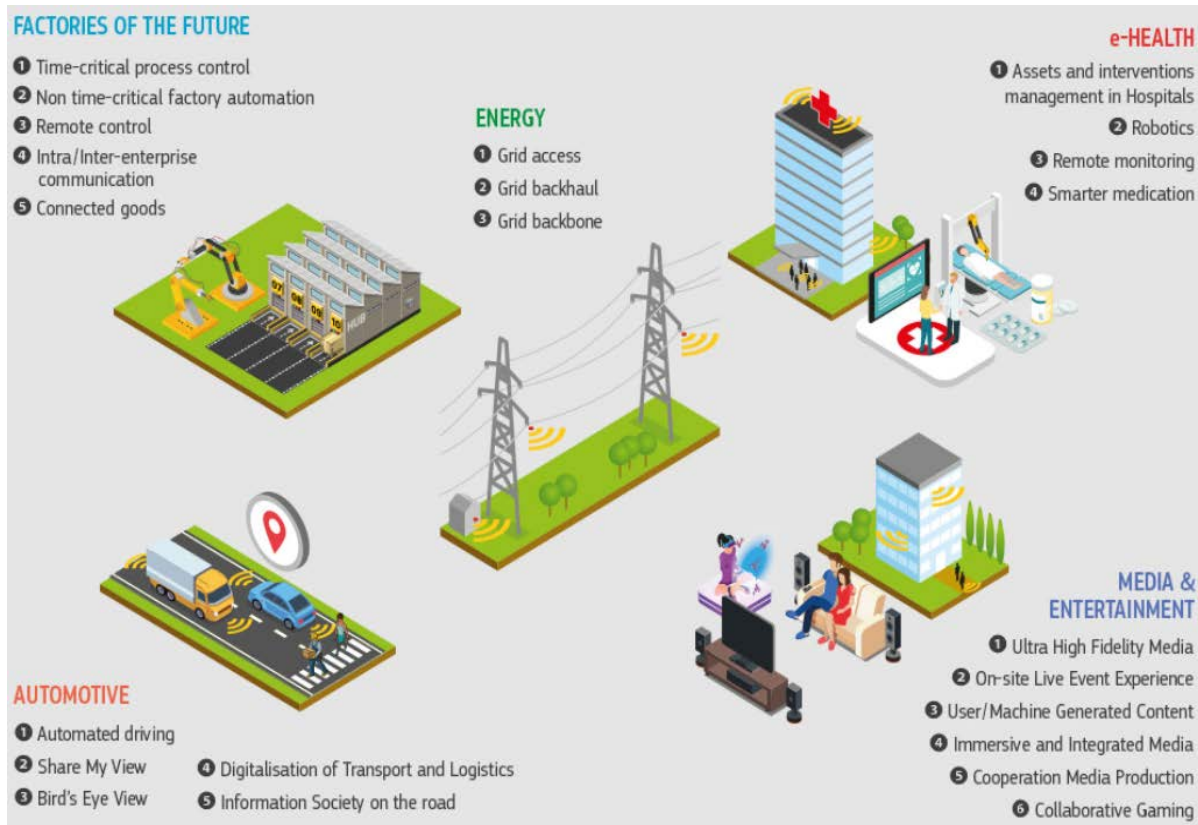 - *More everything (compared to 4th generation)*

Timeline of 5G, 5G advanced and 6G (3GPP standard)

Commercial availability of technology is business driven !!

Focus on verticals

FACTORIES OF THE FUTURE
1. Time-critical process control
2. Non time-critical factory automation
3. Remote control
4. Intra/Inter-enterprise communication
5. Connected goods

ENERGY
1. Grid access
2. Grid backhaul
3. Grid backbone

e-HEALTH
1. Assets and interventions management in Hospitals
2. Robotics
3. Remote monitoring
4. Smarter medication

AUTOMOTIVE
1. Automated driving
2. Share My View
3. Bird's Eye View
4. Digitalisation of Transport and Logistics
5. Information Society on the road

MEDIA & ENTERTAINMENT
1. Ultra High Fidelity Media
2. On-site Live Event Experience
3. User/Machine Generated Content
4. Immersive and Integrated Media
5. Cooperation Media Production
6. Collaborative Gaming

- Setting the requirements as a input to standardisation and commercial implementations

- Boosting the commercial deployments of 5G

- Piloting activities in order to study the feasibility and need of 5G in various cases.

5G boosting the wireless communication

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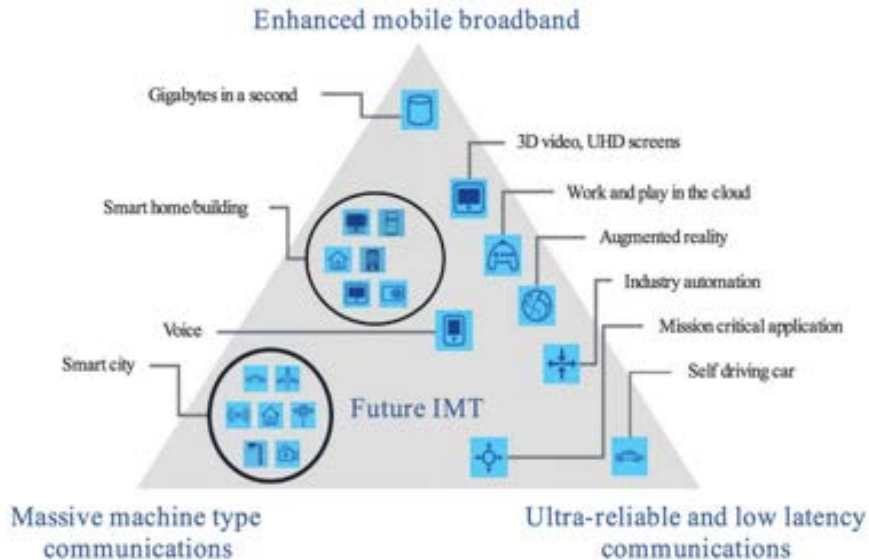
Vision usage scenarios

Main 5G Key Performace Indicators:

Enhanced moblie broadband eMBB:
- Peak Data Rate: Downlink 20Gbps, Uplink: 10Gbps
- Data rate experienced by user: Downlink: 100Mbs, Uplink: 50Mbs

Ultra Reliable Low Latency communication URLLC:
Latency: <1ms (0,5ms)
Reliability: 99.9999% success within 1ms delay

Massive Machine Type of Communication mMTC:
Device battery life >10 years
Connection density: 1×10^6 devices/Km^2

Key technologies of 5G

- New 5G Radio technology
  - Enabling better performace on wireless links
  - New frequency ranges for increasing better capacity
- Slicing
  - Enhancing service level Quality of Service provisioning
  - Provide a flexible way to "slice" the radio network resources
- Edge processing
  - Enabling low latencies by providing local data processing
  - Key enabler also for private networks
- Private/non-public networks
  - New business opportunities for local operators
  - Enables small scale and isolated network environment

- ***Softwarization together with technology enhancements !!***

Status of 5G

Enhanced mobile broadband (eMBB)

- Standard ready
- Ready for deployment
- Used in public networks
- Latencies ~5-10 ms
- Peak datarates DL > 1Gbps, Uplink ~90-100Mbps
- mmWave frequencies still in piloting phase in Finland

Ultra Reliable Low Latency Communication (URLLC)

- Standard ready
- Not used in public networks
- Still in pilot/prototyping phase
- Expected Latencies <1ms

Massive Machine Type of communication (mMTC)

- Standard ready
- Ready for deployment
- Used already in public networks
- Utilises NB-IoT/LTE-M

Implementation of standard features are business driven !!!

Status of 5G

Private networks
- Ready for deployment
- Edge solutions for local data break-out available
- Has been used already for 4G

Network Slicing
- Standard ready
- In piloting phase
- Commercially available

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Other important radio technologies

Other technologies to be considered: Wi-Fi

- Can be integrated as part of 5G network
- Can be deployed also as a standalone version as well
- Complementing tech to 5G

- Provide cost efficient way to connectivity
- Provides already a good indoor uplink capacity
- Provides low latency ~ 2ms -> cannot be quaranteed well in congested situation (Wi-Fi 6)

The evolution of a wireless revolution

Wi-Fi 4
IEEE 802.11n
Bands:
2.4 GHz, 5 GHz
Channel Bandwidths
20, 40 MHz
64 QAM

KEY ADVANCES:
• WPA2 Security
• 4x4 MIMO
• LDPC Error Correction

Wi-Fi 5
IEEE 802.11ac
Bands:
5 GHz
Channel Bandwidths
20, 40, 80, 160 MHz
256 QAM

KEY ADVANCES:
• Up to 8x8 MIMO
• DL MU-MIMO
• Beamforming

Wi-Fi 6 / 6E
IEEE 802.11ax
Bands:
2.4 GHz, 5 GHz
Channel Bandwidths
20, 40, 80, 160 MHz
1024 QAM

KEY ADVANCES:
• Best-in-class WPA3
  security
• UL and DL MU-MIMO,
  OFDMA
• Target wait time (TWT)

Wi-Fi 7
IEEE 802.11be
Bands:
2.4 GHz, 5 GHz, 6 GHz
Channel Bandwidths
20, 40, 80, 160, 320 MHz
4096 QAM

KEY ADVANCES:
• Multi-link operation
  (MLO)
• Multi-RU and
  puncturing
• Managed QoS &
  Restricted Service
  Periods

~300 Mbps
~600 Mbps
2007

~1.7 Gbps
~7 Gbps
2013

~2.4 Gbps
~9.6 Gbps
2019 Wi-Fi 6E, 6 GHz BAND ADDED (JAN 2021)

~5.8 Gbps**
~36 Gbps[1*]
2024

Max. PC data rates   Max. Access Point data rates

5G Test Networks in Finland

5G Test Network Finland

Open innovation ecosystem for communication network and service research, testing and piloting

Over 40 industry and academic ecosystem partner organizations

VTT is coordinating the ecosystem and hosting one of test network platforms

- For 5G large scale trials and pre-commercial deployments
- To test 5G and beyond solutions enabling new products and services
- State-of-the-art technologies from leading vendors
- Flexible service configurations using standardized and open interfaces

5G Test Network Finland

Sodankylä

Oulu

Ylivieska

Kuopio

Vaasa

Tampere

Turku

Helsinki/Espoo

Test sites

- Main test sites hosted by academic institutions

- Lot of experience of different use cases and field trials

- Established 2015 and will continue towards 6G

- Well-knit research collaboration between academic partners and industry partners for 5G piloting and testing and future 6G research

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VTT Test Network Platform

VTT 5G & Beyond Test network

- Managed and operated by VTT
- Main location Oulu, Espoo, Sodankylä arctic test area
- Possibility to create local setups
- Connected with VTT other R&D infra
  - Industrial Robots, Autonomous Car, Drones etc.
  - GPU clusters for AI
  - Cyber security testing and validation
- Setups will be tailored based on the use case requirements
- Connected to 5GTNF test networks
- Cost of usage will be tailored based on the type of usage and project

Sodankylä

Oulu

Tampere

Espoo
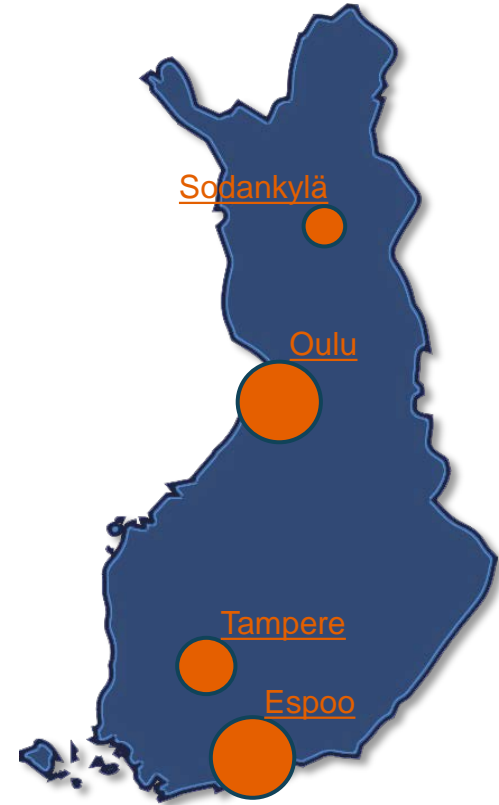
How does it look

VTT as a operator

UE devices & sensors

Wireless access LTE + 5G Indoor and outdoor

Edge cloud, 5G core network, application backend

UE emulators (100-1000 NB-IoT and 5G devices)

How does it look - special environments

Underground

Industrial

Application testing mobile network

- Standard mobile network environment for application front- and back-end testing

- Testing also the application functionality in the worst case
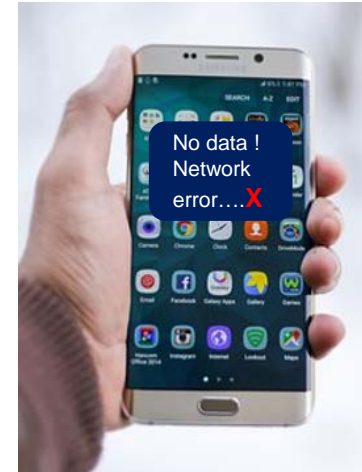
Nomadic test unit

Private 5G network and testbed "in a box"

- 5G functionalities, wireless access, CPU/GPU processing, tailored based on the requirements
- 3GPP standard 5G NR, LTE, WIFI 6 connectivity
- ETSI MEC compliant Edge and application cloud
- 5G operator core
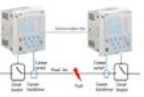
Main features

- 5G RAN
  - NSA, SA
  - Indoor and outdoor coverages
  - Sub6G, mmWave
- Cellular IoT (NB-IoT- LTE-M)
- Short range radios BLE,WIFI zigbee etc.
- WiFi 6
- Broadcast with LTE eMBMS
- QoS measurement and analysis tools
- UE emulators (1000 LTE/100 5G NR UEs)

- Several core network instances
  - Multioperator environment enabling for example private public network co-operation
- Edge processing
- Positioning
- Satellite connection
  - Possibility to create remote site management scenarios etc.
- SDN based fiber backbone (possible to create wireless backbones)

Focus on verticals

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Vertical	Description	Service type
Public Safety	• Rapid deployable 5G private network for mission critical communication. • Satellite backbone for 5G private network backbone	eMBB, uRRLC, mMTC
Manufacturing	• Applying 5G and Edge Processing in Smart Manufacturing • Remote controlled/operated vehicles. • Connected collaborative robots	uRLLC
Energy	• Control and protection of smart grids • Energy consumption in data networks	uRLLC
Health & Wellbeing	• Human tachography. • Low energy cellular IoT for wearable devices. • 5G for remote learning and remote attendance .	eMBB mMTC
Transport/ Automotive	• Autonomous connected cars and road safety. • Smart Globally-Connected IoT Devices.	eMBB, uRRLC, mMTC
Media & Entertainment	• Media broadcast via data networks • Live video streaming for low latency use cases • VR and XR use cases	eMBB

How to get started

How to get started (VTT model)

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Utilising the test infrastructure in the format of a project

Contract project

- Work tailored for customer need
  - Typical duration of the study 1 month -1 year
  - Commony used for small studies
- VTT test environmment and technology expertise

Jointly funded project

- Business Finland, EU funded project
- Task as a part of larger consortium
- Typical time for R&D project 2-3 years
- Typically a public project
- Subcontracting as part of projects

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