6G Test Network Finland (6GTNF) workshop

on 26.09.2024

GOALS:

- **To share information about the latest 6GTNF ecosystem B5G and 6G R&D activity results and**

- **Discuss about 6GTNF ecosystem and test network utilization possibilities.**

Program

09.00 – 09.20: Opening and 6GTNF intro (Kyösti Rautiola, VTT)

6G challenges and potential solutions for 6G Test Network Finland

09.20 – 09.40: Radio access (Ari Pouttu, Oulu University)

09.40 – 10.00: Radio and core network (Jose Costa and Riku Jäntti, Aalto University)

10.00 – 10.20: coffee & tea

10.20 – 10.40: Beyond 5G network security (Valtteri Niemi, University of Helsinki)

10.40 – 11.00: 5G/6G sensing and positioning (Ossi Kaltiokallio, Tampere University)

… Program

VTT

6G R&D state of art:

11.00 – 11.20: 6GBridge program status (Pekka Rantala, Business Finland)

11.20 – 11.40: 6G eXperimental Research infrastructure to enable next-generation XR services
(Jarno Pinola/VTT, NN/OU, 6G-XR project)

11.40 – 12.00: Non-cellular mesh-based radio access technology (Juho Pirskanen/Wirepas, Celtic
USWA project)

12.00 – 12.50: lunch break

12.50 – 13.10: Introduction to SoC HUB Tampere (Timo Hämäläinen, Tampere University)

13.10 – 13.30: Co-operation with Japan B5G Consortium (Ari Pouttu, Oulu University)

13.30 – 13.35: Nokia technologies user group workshop (Olli Liinamaa, Nokia)

13.35 – 17.00: Demos and posters session; B5G and 6G technologies and solutions for verticals

6GTNF mission

- 6G Test Network Finland (6GTNF, www.6gtnf.fi) is open and evolving innovation ecosystem

- Supports:

  - Beyond 5G and 6G technology research and validation

  - vertical industry product development

  - Pioneer company experiments

Long term test network development targets:

- Enables rapid assessment of 5G Advanced and 6G service concepts, technologies, system solutions at a level that minimizes risks related to introduction of commercial services and products.

- Reusability and evolvability of the test environments over the lifetime of the national and European programs and 5G Advanced/6G standardization

- Accessibility, and openness, friendliness to disruptions and support to E2E demonstrations.

- Support validation of core technologies and architectures in the context of specific vertical use-case implementations and relevant deployment scenarios.

... Background - 6G development roadmap

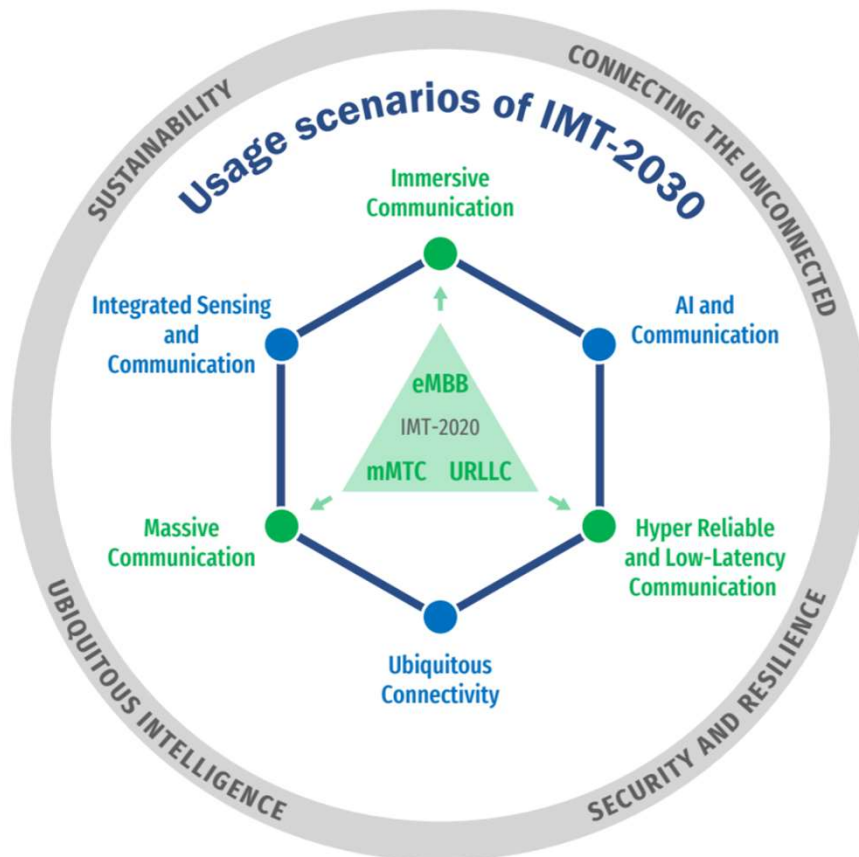Finnish Strategic Research and Innovation Agenda
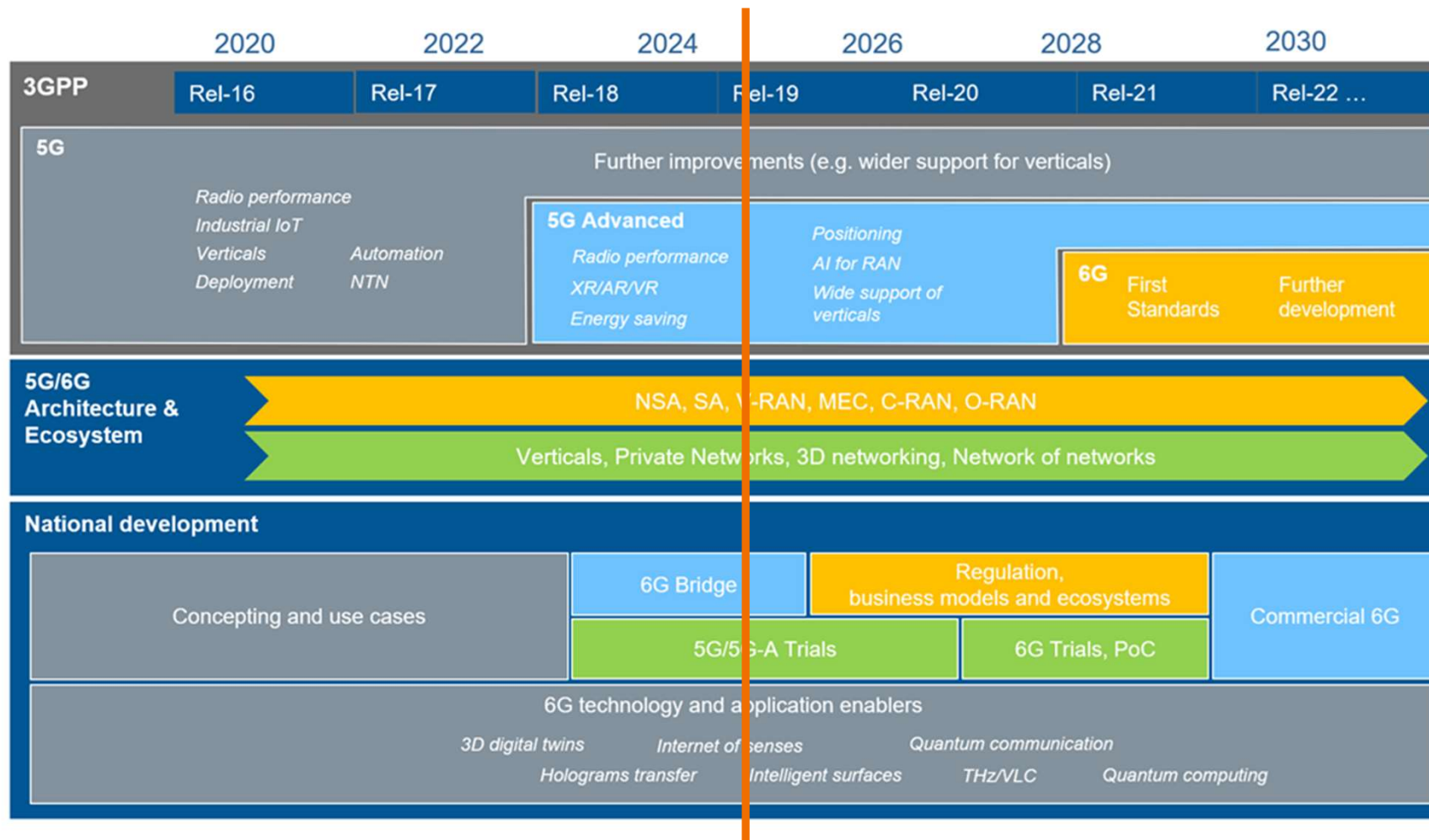
6GTNF is part of Business Finland 6G Bridge program

… Background - ITU 6G vision

(3GPP stage 1 workshop on IMT-2030 use cases, 8-10.05.2024)

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Usage scenarios of IMT-2030

6 Usage scenarios

- Extension from IMT 2020 (5G)
  - eMBB -> Immersive Communication
  - mMTC -> Massive Communication
  - URLLC ->HRLLC (Hyper Reliable & Low Latency Communication)

- New
  - Ubiquitous Connectivity
  - AI and Communication
  - Integrated Sensing and Communication

4 Overarching aspects

- act as design principles commonly applicable to all usage scenarios

  - Sustainability
  - Connecting the unconnected
  - Ubiquitous intelligence
  - Security / resilience

… Background - ITU 6G vision

(3GPP stage 1 workshop on IMT-20230 use cases, 8-10.05.2024)

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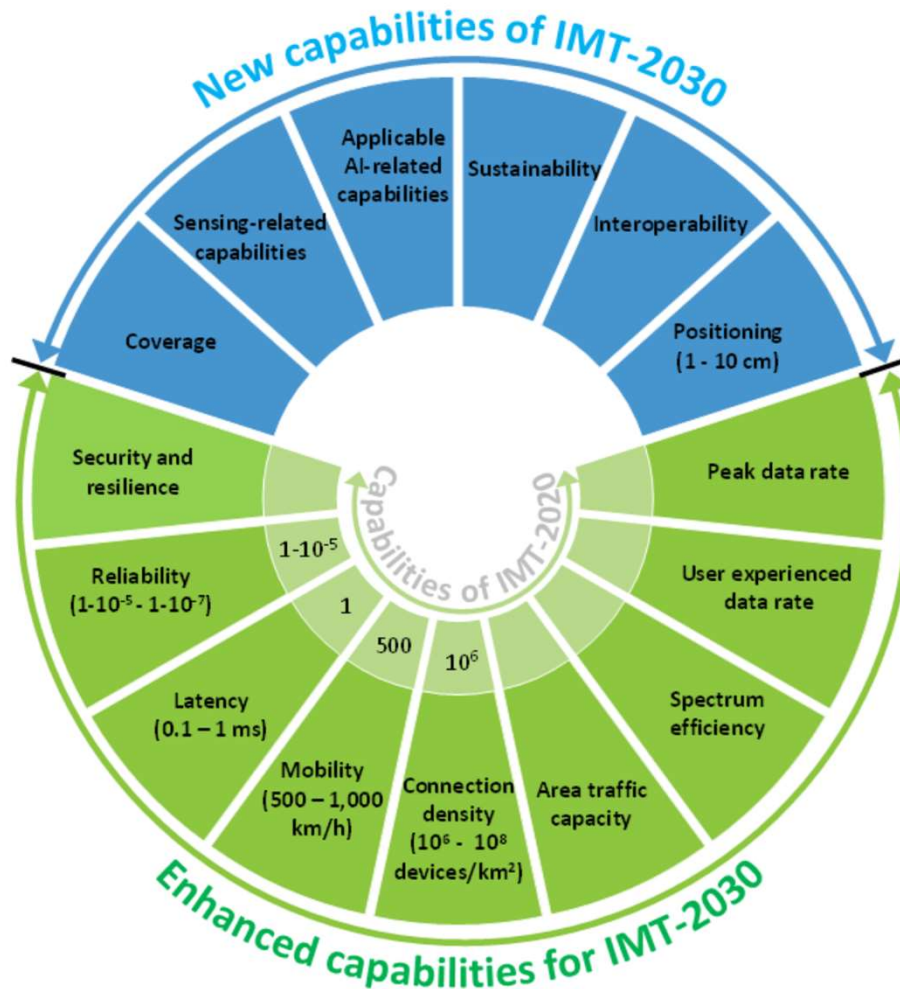
IMT 2030 Framework Recommendation identifies 15 capabilities for 6G technology

• Nine of those capabilities are derived from existing 5G systems
The range of values given for capabilities are estimated targets for research and investigation of IMT 2030

• All values in the range have equal priority in research and Investigation

… Background – 5G vs. 6G KPI's

	KPI	5G	6G	Enhancement
Data rate & delay	Peak data rate	20 Gbps	1 Tbps	50
	User experienced data rate	100 Mbps	10 Gbs	100
	Latency	1 ms	0,1 ms	10
	Delay jitter	1 ms	1 us	1000
Capacity & coverage	Area traffic capacity	10 Mbps/m^2	10 Gbps/m^2	1000
	Connection density	10^6 devices/km^2	10^8 devices/km^2	100
	Coverage	10%	99%	10
Service efficiency	Spectrum efficiency	30 bps/Hz	≥ 90 bps/Hz	≥ 3
	Network energy efficiency	10^7 bit/J	10^9 bit/J	100
	Cost efficiency	10 Gb/$	500 Gb/$	50
Diversified service evaluation	Mobility	500 km/h	1000 km/h	2
	Battery life	10 years	20 years	2
	Reliability	99,999%	99,99999%	≥ 100
	Positioning (indoor & outdoor)	1 & 10 m	10 cm & 1 m	10
	Sensing/Imaging resolution	1 m	1 mm	1000
	Security capacity	Low	High	
	Intelligence level	Low	High	

6GTNF scope 2023-2024
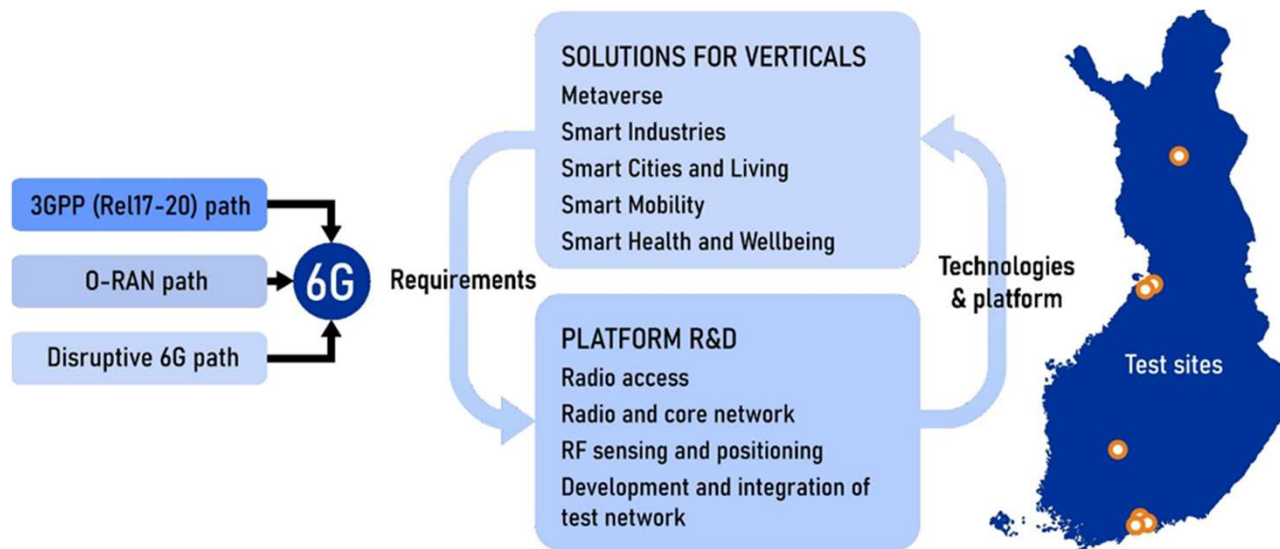
R&D target:

- concepts and technologies for complementary 6G deployment paths (3GPP, O-RAN, distributive 6G)
- Update of existing 5G Test Network Finland infrastructure and ecosystem towards 6G.
- R&D focus on radio access, radio and core network, sensing and positioning, testing tools and related test network and ecosystem.

- **3GPP path:** providing coverage, medium data rate and jitter, zero carbon footprint solutions and RedCap devices.

- **O-RAN path:** providing low capex with moderate performance, high opex, goals: improve security, energy consumption, jitter/latency performance and stability.

- **Disruptive 6G:** providing 1 Tbps, joint communication and sensing, sub-cm positioning, reflective surfaces, and sub-THz transceivers.

… 6GTNF - specific objectives 2023-2024

Specific objective	Expected R&D results
Testbed development	• Requirements of emerging 5G Advanced and 6G vertical applications • Testbed architecture with refined investment roadmap • Support to test environment integration and validation
Radio Access solutions	Concepts and methods for • Ultra-reliable and low latency communication • Uplink waveforms • Low complexity radio access solutions
Radio and core network concepts	Concepts and methods for • Disaggregated RAN architecture development • Service based network slicing • Edge orchestration • Ultra secure B5G network design
RF Sensing, Positioning and Device technologies	• Concepts, algorithms, and reference signals for cellular positioning and SLAM (Simultaneous Localization and Mapping) • Concepts, algorithms, waveform, and reference signals for ISAC (Integrated Sensing and Communication) and mobile/terminal radar
Ecosystem management	• Information exchange between vertical and telecom industry and co-operating projects about vertical requirements and 5G/6G solutions • Support to vertical trials • Service provisioning ecosystem development • Identification of testbed services consumption vertical ecosystems

Core partners 1/2023 - 3/2025

VTT

Research organizations:

- ***VTT*** (coordinator)
  - Leader of WP1 (Specification) and WP5 (Ecosystem management)
  - R&D focus: disaggregated RAN, security monitoring, test network and ecosystem
- ***Aalto university***
  - Leader of WP3 (Radio and core network)
  - R&D focus: disaggregated RAN, low complexity radio access solutions, service-based network slicing, Non-Public Networks with 5GLAN and TSN integration, core integration with SCION, test network and ecosystem
- ***Helsinki university***
  - Leader of secure B5G network R&D
  - R&D focus: extended use of AI and cybersecurity for the network platform, edge computing orchestration, ultra secure B5G network design, test network and ecosystem
- ***Oulu university***
  - Leader of WP2 (Radio access)
  - R&D focus: ultra-reliable and low latency communication, uplink waveforms, low complexity radio access implementation, ORAN , service migration in multi-access edge computing, test network and ecosystem
- ***Tampere university***
  - Leader of WP4 (RF Sensing, Positioning and Device technologies)
  - R&D focus: cellular positioning and SLAM, ISAC and mobile radar, 6G waveform, physical layer and radio protocols; emphasis on URLLC and uplink-oriented use cases, test network and ecosystem

Companies:

- ***Nokia***

- ***HERE***

- ***Elisa***

- ***MediaTek***

- ***Murata***

- ***Wirepas***

- ***YL-verkot***

Co-operation

- co-operation and knowledge exchange with co-operating technology and vertical projects and partners

National activities
- FUWIRI (Future Wireless Communication Networks)
- EMETA (Enabling Metaverse, www.emeta.fi)
- REEVA (6G features and services to support energy vertical applications)
- 6G Bridge Local 6G
- Smart Otaniemi
- FUAVE/drones
- SoC HUB Tampere
- Defence and Security ecosystem

International activities
- HEXA-X II (European level 6G Flagship project)
- 6G-XR (6G eXperimental Research infrastructure to enable next-generation XR services)
- 6G Research Hub (Germany); coverage and mobility support, particularly at high-frequencies
- CELTIC ENTRY 100 GHz
- PREVAIL (Partnership for Realization and Validation of AI hardware Leadership)
- CELTIC USWA (non-cellular mesh-based radio access technology)
- ETRI (uRLLC solutions for industry automation)
- Japan B5G promotion Consortium (private networking solutions, high-altitude platforms, test platforms)
- NaCQI (National Quantum Communication Infrastructure)

Test Network sites
## https://www.6gtnf.fi/sites/

- 6GTNF system level architecture; main sites and locations are VTT Oulu and Espoo, Aalto univ., Helsinki univ., Oulu univ., Tampere univ. and Sodankylä

- Sodankylä site infra is owned by Finnish Meteorological Institute FMI and operated by VTT. RAN is located at Sodankylä airfield.

- At system level RAN sharing will be taken use between VTT Oulu, VTT Espoo and Aalto University.
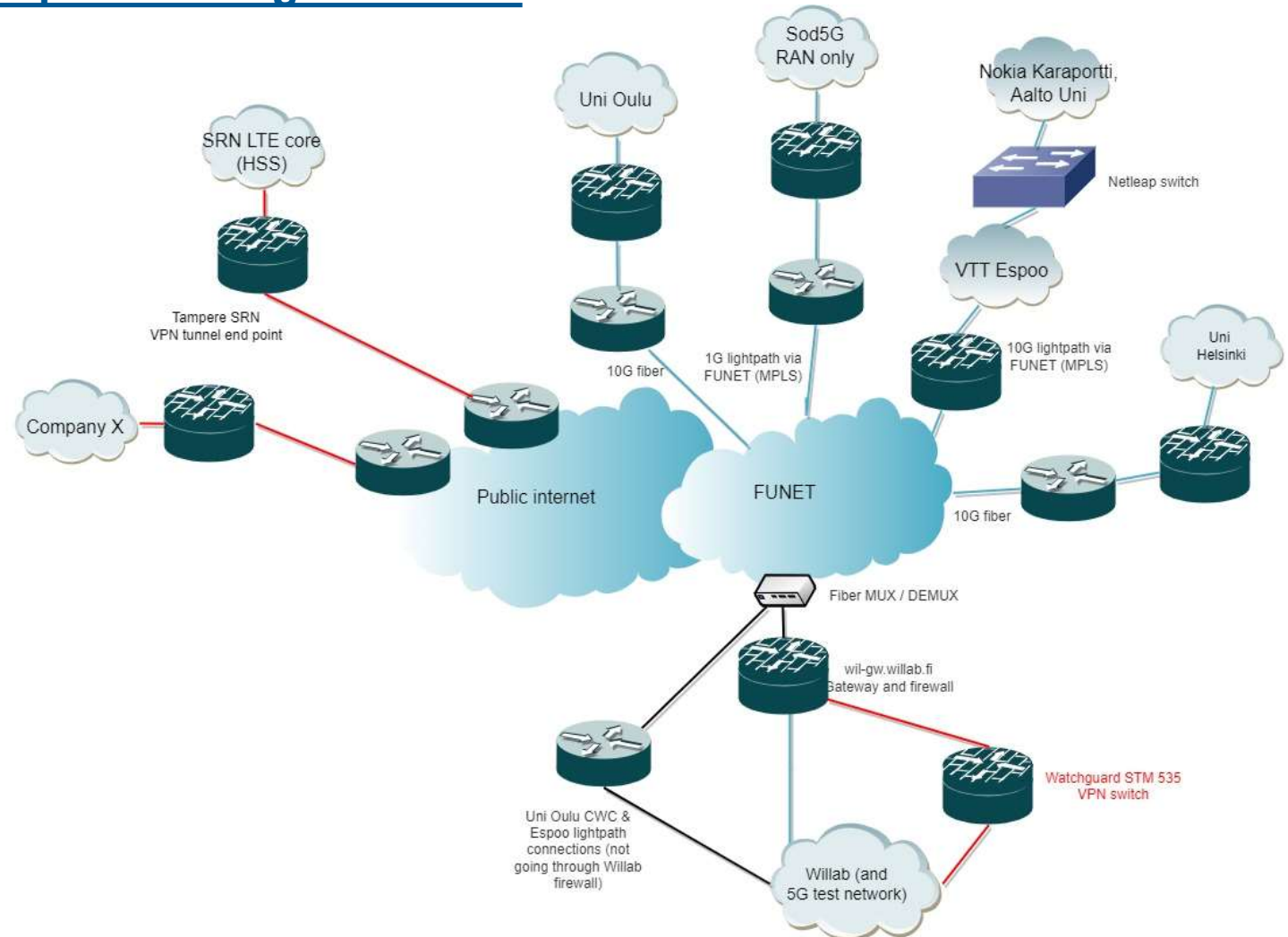
VTT test network sites in Espoo and Oulu
https://www.6gtnf.fi/vtt/
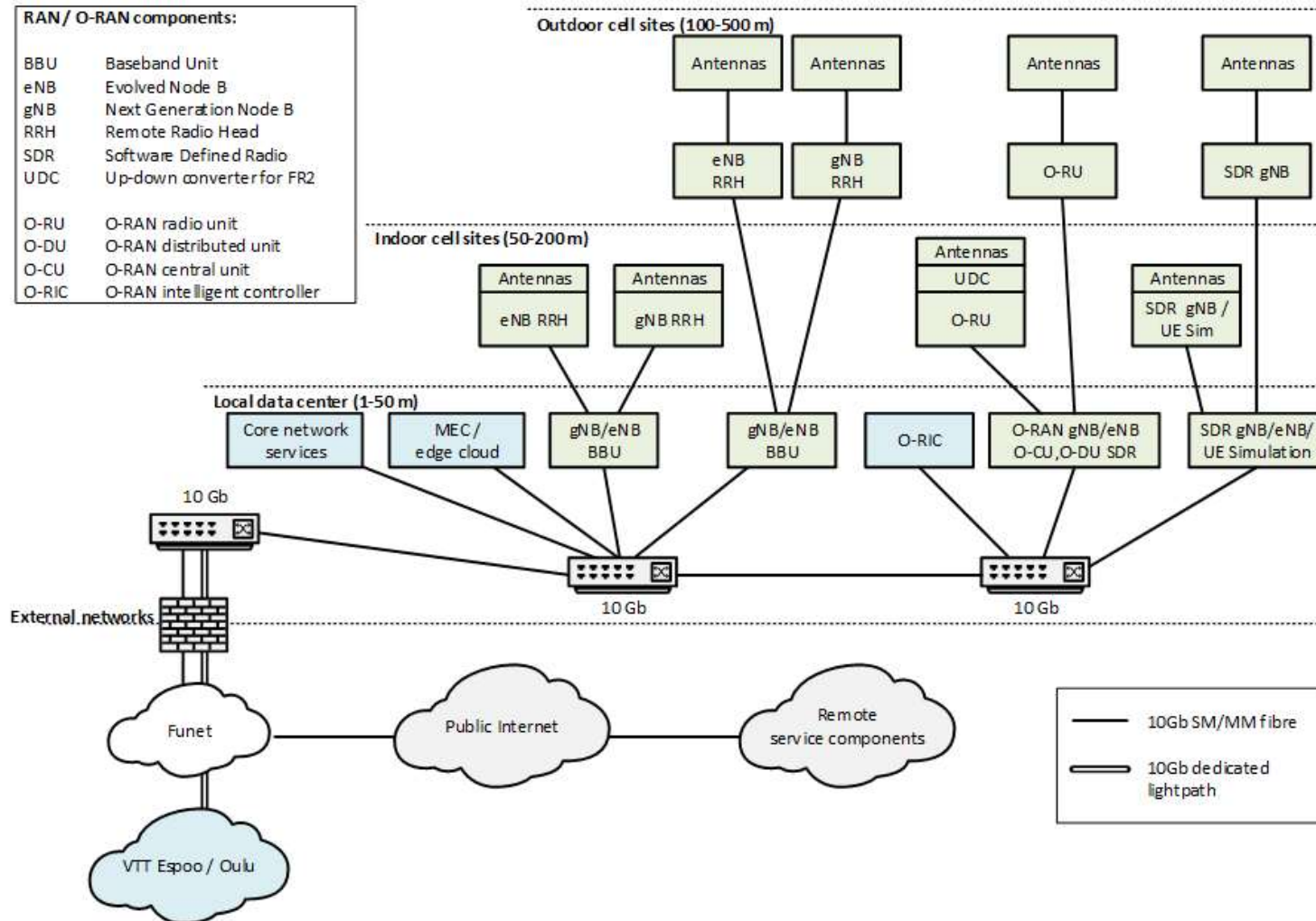
VTT site's basic features
https://www.6gtnf.fi/vtt/

Espoo

5G SA + NSA, LTE equipment from Nokia
•Primary core: Open5GS
•Nokia FXR Shared core with LBO
Different operating environments
•Outdoor including mmW, dense indoor office, underground tunnel, lab environment
Frequencies
•Indoor: B1 (10 MHz), B3 (5 MHz), B7 (10 MHz), n78 (60 MHz)
•Outdoor: B1 (4.8 MHz), n78 (60 MHz), n77 (100MHz), n258 (400 MHz, shared with Aalto)
Nokia BBU
•Nokia Airscale baseband
O-RAN solutions
•AccelleRAN CU/DU solution with indoor and outdoor cells on 5G SA band n77
•BubbleRAN O-RAN platform with Ettus SDR

Oulu

5G NR and 4G LTE RAN solutions from Nokia:
•Oulu Outdoor: 5G mMIMO (n78 / 60 MHz, n7 / 10 MHz, n77 / 2x100MHz), 4G (B3 / 5 MHz), 4G (CIoT, B28 / 3 MHz, B31 / 5 MHz), 4G MiniMacros, 5G mmWave (n258 / 800 MHz)
•Oulu Indoor: 4G small cells (B1 / 10 MHz, B3 / 5 MHz, B7 / 10 MHz), 5G small cells (n78 / 60 MHz)
•Nokia Airscale baseband
•cMG + cMM
O-RAN solutions:
•AccelleRAN technology with outdoor and indoor cells on 5G SA band n77
•srsRan open-source environment for indoor with SDR units
SDR solutions:
•Multiple Ettus USRP SDR devices
•Keysight SDR v.4 RF Unit 4 Layer 6 GHz 100 MHz BW, LTE RF Unit 1 Cell (2×2 MIMO), SDRv3
MEC AI/ML solutions:
•High performance Dell multiprocessor with Nvidia AI accelerators

Utilization of 6GTNF infrastructure with VTT

**1. Full service** – VTT is building and setting up the test environment, carrying out the testing, trials and/or measurements and providing analyzed results and reports.

2. Bring-Your-Own-Products – VTT provides the facilities and basic instruments for connectivity to carry out the testing, trialing/piloting and helps in building the test cases. VTT tailor system so that the Customer can carry out test with own personnel.

3. Remote Access – Remote access to specific part of test network for the Customer to carry out the testing, can be arranged. The best way to carry out the remote connection (e.g. using VPN) to Customer premises is agreed with Customer. This requires also specific tailoring of test network for Customer test cases.

4. Joint RDI project – We plan joint RDI project (EU, Business Finland) with other partners and apply funding for it. The project plan includes detailed description how VTT test sites will be utilized during the project implementation.

6GTNF future (2025 – 2026) goals

6G concepts and technologies:

- Fulfill 6G system KPI and KVI requirements
- Complementary deployment paths: 3GPP, ORAN and disruptive 6G
- More performance, flexibility and usability with **utilization of AI in radio access network, networking, security, sensing and positioning**
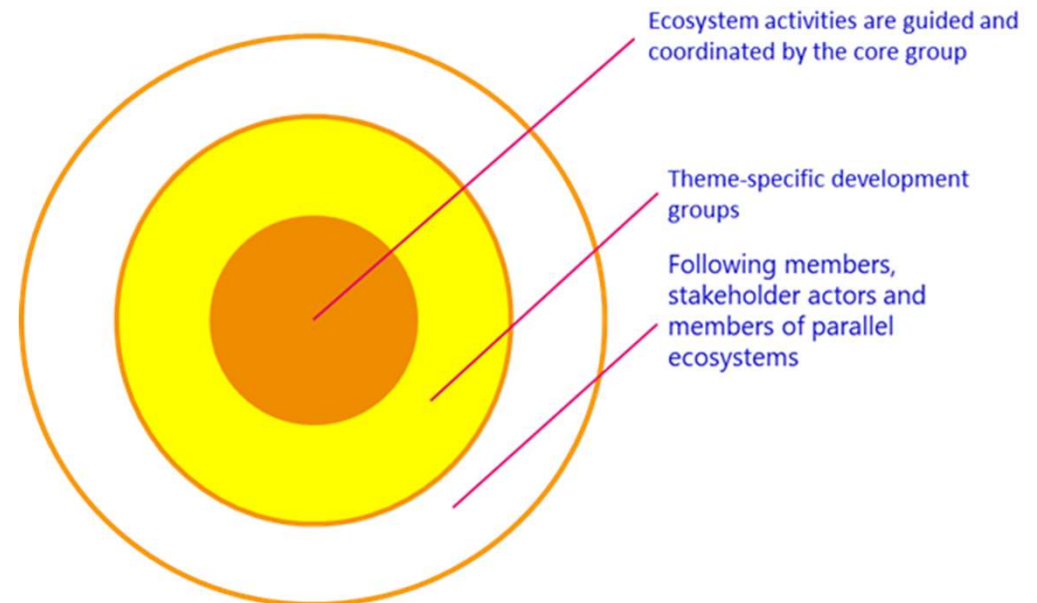
Ecosystem development

- RDI projects in theme specific development groups
  - Test bed B5G/6G enabling technologies
  - Testbed functionality, architecture, integration
  - Solutions for vertical industries

Ecosystem activities are guided and coordinated by the core group

Theme-specific development groups

Following members, stakeholder actors and members of parallel ecosystems

THANK YOU

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