Terveyden 5G/6G sovellukset – pohjoisesta puhaltaa

6G Flagship research – Use case public safety (and other critical verticals)

5G/6G Teknologia tulevaisuuden yhteiskunnan kriittinen infrastruktuuri

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PPDR comms in Finland – Current Status

- PPDR communications system currently used in Finland since 2002 is TETRA based VIRVE system (Services comparable to GSM system)
- Initially provided by Nokia, now maintained by Airbus Finland
- Main users of VIRVE system include
  - Public safety players (fire brigades, police, ambulance services), department of corrections, Finnish Defence Forces, Welfare and health administration, Emergency Dispatch Service, Border Control, Customs, some municipality services.
- Some VIRVE numbers
  - 380-400 MHz
  - More than 44 000 subscriptions, more than 100 000 users
  - 1400 base stations providing nationwide coverage
  - 74 M messages and 2 M group calls per week
- Operated by state owned MNO Erillisverkot LTD.

PPDR comms in Finland – Next Phase

- Erillisverkot is developing broadband VIRVE 2.0 service utilizing 4G/5G mobile cellular systems enabling services such as
  - Real-time video
  - File transfer
  - XR applications
  - AI/ML services
  - IoT data transfer
- Erillisverkot will have its' own core (MVNO) provided by Ericsson and buying connectivity services from commercial MNO Elisa (and in the future most likely with a dedicated high priority network slice).
- Deployment will begin 2022 with nationwide coverage target
- TETRA based VIRVE will serve as support system until the end of deployment phase of VIRVE 2.0 (at least 2025)

5GTN – Use Case Public safety

Priority project

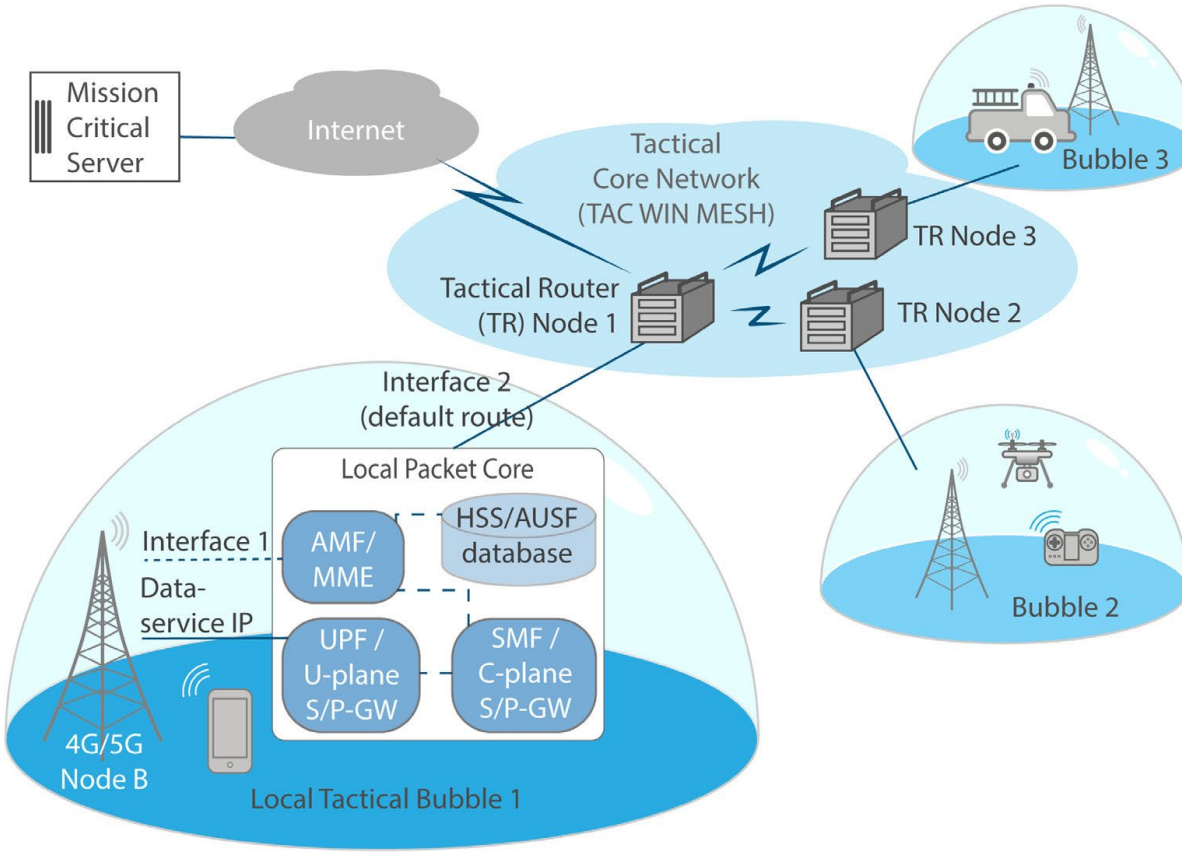
Extending the capabilities of VIRVE 2.0

- In large scale disasters, the commercial cellular networks may become non-operational
- 4G/5G cellular networks may not always provide full nationwide coverage (however, in Finland 4G coverage 99 % of population)
- Remote areas and areas deep inside buildings must be handled differently
- Solution: Rabidly deployable networks
- **Priority** project: **Critical Communications for Digital Trusted Society**
  - 7 M€ project, partners University of Oulu, Centria University of Applied Sciences, Turku University of Applied Sciences, Jyväskylä University of Applied Science and VTT Technical Research Centre of Finland, Airbus, Bittium, Digita, Exfo, Keysight, Finnish Transport and Communications Authority Traficom, Finnish Defence Forces, Rescue services in Finland, Elisa, Erillisverkot, Fairspectrum, Verkotan, Acgo, Goodmill Systems and Central Union of Agricultural Producers and Forest Owners of Finland.

Extending the capabilities of VIRVE 2.0

- The project targets include
  - Broadband service in extremely remote locations
  - Quality of Service differentiation and provisioning for diverse needs (e.g. slicing)
  - Communication security
  - Interworking of dedicated and commercial networks
  - Field tests on these rapidly deployable networks with use cases
    - Search and capture
    - Smart rural business
    - Emergency response

Extending the capabilities of VIRVE 2.0
Tactical bubbles and requirements



Essential requirements for tactical bubbles

Communication type	Requirement category	Identified requirements
Generic	Availability	99% to 99.999%
	Start-up time	0 to few minutes
	Configuration efforts	Zero-configuration
Combined user traffic (avg.)	Downlink/user	50 Mbps
	Uplink/user	25 Mbps
Push to talk	Packet delay	75 ms
Group video	Packet delay	100 ms
Virtual reality (4K CG video)	Data rate	50 to 200 Mbps
	Latency	<16 ms
Sensor data	Sensor amount/cell	0 to massive
Machine remote control (UAV)	Latency	40 ms to 1 s

Heikkilä M, Koskela P, Suomalainen J, Pouttu A. et al. Field trial with tactical bubbles for mission critical communications. Wiley *Trans Emerging Tel Tech*. 2021;e4385. doi: 10.1002/ett.4385

Extending the capabilities of VIRVE 2.0 – Some results of Tactical Bubble System Demos

Summary of performance measurements

Setup/performance	Bubble1	Bubble2	Bubble3
Bubble type	Commercial LTE TDD Microcell	Commercial LTE FDD Microcell	Experimental 5G SA Picocell
Coverage area size at ground level	600 m	600 to 1100[a] m	100 m
Throughput uplink	<11 Mbps	<9 Mbps	<14 Mbps
Throughput downlink	<70 Mbps	<33 Mbps	<49 Mbps
RTT	30 to 60 ms	30 to 60 ms	<26 ms

Vision Video

Why and what is 6G?

- Mobile communications have driven major societal changes in 20-year cycles

1G - 2G

1980s – 2000s
Millions of voice users

3G - 4G

– 2020s Billions of Mobile Broadband users

5G – 6G

– 2040s Trillions of connected objects & intelligence

- **Massive automation of society** needs more than 5G can offer**.**
- 6G will **merge physical, digital and biological worlds** fulfilling UN SDGs of digital societies.
- 6G requires more radical transformations:
  - capabilities of **wireless transmission must be pushed to the limits**
  - **massive utilization of artificial intelligence** in networks and applications
  - radical **innovations needed for future wireless business ecosystems**

How 6G Flagship Tackles the Vision !

Strategic Research Areas (SRAs)

- Wireless connectivity solutions
- Device and circuit technologies
- Distributed intelligent wireless computing
- Sustainable human-centric services and applications

Flagship Goals

1. 6G technology enablers
2. 6GTN development
3. 6G vertical applications
4. 6G opinion leadership

Impact Actions

A 6G-enabled Sustainable Society

B Strategic Vertical Areas (SVAs)
- Health
- Industry
- Vehicular
- Energy

C Global 6G Collaboration

D Research infra-structures – 6G Test Network (6GTN)

5G 6G LTE

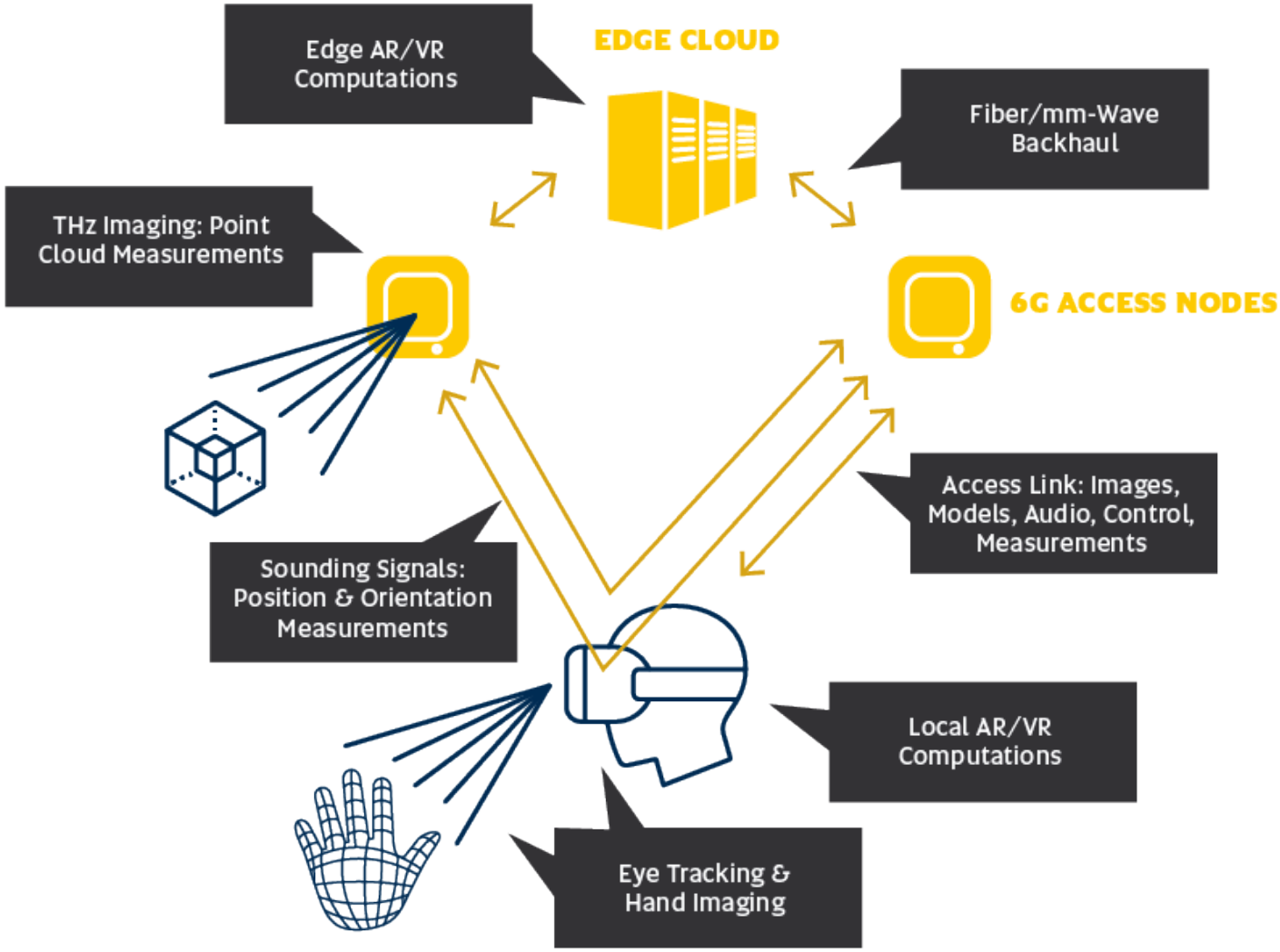
Beyond 6G Flagship

- 6GTN as the core of 6G Radio Park
- Training 6G experts for industry
- Influence on 6G standard
- Expertise building beyond 6G

2027 2028 2029 2030

6G Merges Communications with New Applications – What's in it for PPDR players

Integration of sensing, imaging and highly accurate positioning capabilities with mobility opens a myriad of new applications in 6G.



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

KPIs Approach to Use Cases – High End Use cases

100 µs **1 Tbps**

- **Hysteresis free remote control with haptics**
- **Active protection circuitry**
- **2000 Hz control loops**

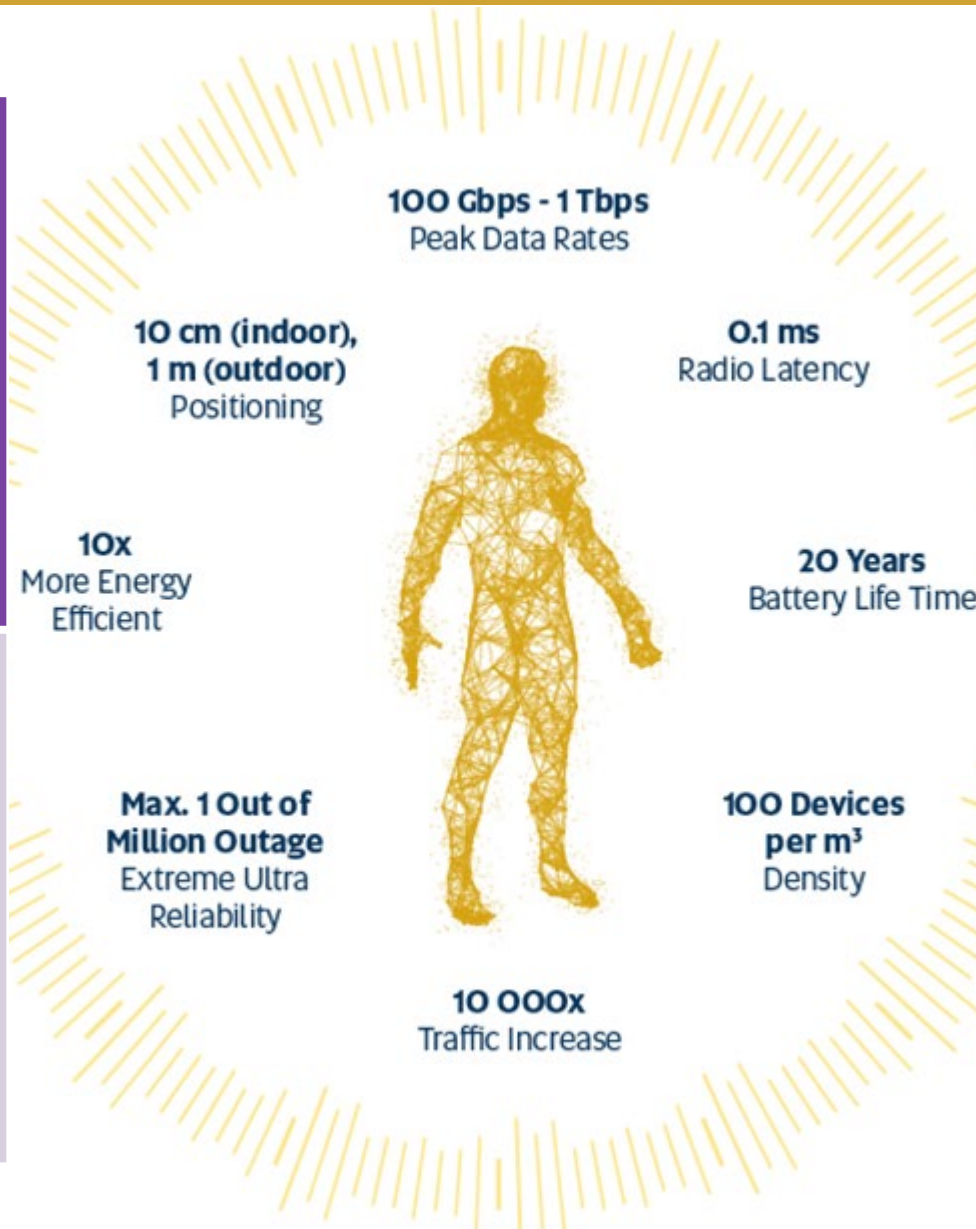
- **Holography**
- **16K/240 Hz eXR**
- **InChip Radio**
- **InDevice Radio**
- **Data center connectivity**
- **Data kiosks**
- **Huge datasets (DNA, Astronomy)**

Seeing the future:
Augmented human

- Holography (multi-stream synchronisation)
- Industrial ethernet

- Real-Time Digital Twins and virtual remote control
- Holography
- Extreme Swarms
- Material idenfication

10 ns **1-3 mm**



Why bother with experimental test networks?

Answer: Versatility of Vertical Requirements

Examples of KPIs for verticals

Vertical	Link DataRate	Latency	LinkBudget	Jitter	Density	Energy Efficiency	Reliability	Capacity	Mobility
Industry mMTC	< 1 Mbps	< 100ms	+ 10 dB	100 µs	100/m^3	High	1-10^{-6}	< 10 Gbps	240 km/h
Industry eURLLC	< 5 Mbps	< 100 µs	+ 20 dB	< 1 µs	10/m^3	Nominal	1-10^{-9}	< 100 Mbps	240 km/h
Mobility	<10 Gbps	< 100 µs	+ 20 dB	100 µs	100/m^3	Nominal	1-10^{-7}	1 Tbps	1200 km/h
eHealth	< 1 Gbps	< 1 ms	+ 10 dB	100 µs	1/m^3	High	1-10^{-9}	< 10 Gbps	240 km/h
Energy	<1 Mbps	< 500 µs	+ 40 dB	< 1 µs	10/m^3	Nominal	1-10^{-6}	< 100 Mbps	N/A
Finance	< 1 Gbps	< 10 ms	varies	N/A	1/m^3	High	1-10^{-9}	< 10 Gbps	Low
Public Safety	<1 Gbps	< 1 ms	+ 20 dB	100 µs	1/m^3	Nominal	1-10^{-7}	< 10 Gbps	240 km/h
Agri-business	100 Mbps	< 10 ms	+ 40 dB	100 µs	100/km^2	Nominal	1-10^{-7}	1 Gbps	240 km/h

Industry 4.0
Telecom
Emergency response
Energy
Auto motive
Media
Smart cities

How do we facilitate service pull and avoid technology push!

Thank you!

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