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5G as enabling technology for Smart Energy Systems

DI (FH) DI Peter Dorfinger

About Salzburg Research

Research and Technology Organisation (RTO)

Foundation: 1996

Employees: 70

Turnover: 5,5 Mio. EUR

Ownership Structure: „Land Salzburg“ (100 %)

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FORSCHUNG AUSTRIA

EARTO IMPACT DELIVERED

Fields of expertise

Data driven innovation

(Motion) data analytics

- Realtime localisation and motion capturing
- Spatio-temporal analysis of motion data

Digital **platforms**

- Platform-based business process and digital asset management

Intelligent **communication** technologies

- Software-defined networking & network function virtualisation
- Performance modeling, measurement and monitoring of complex communication systems

- Data-driven innovation & value creation
- Network-based digital business models

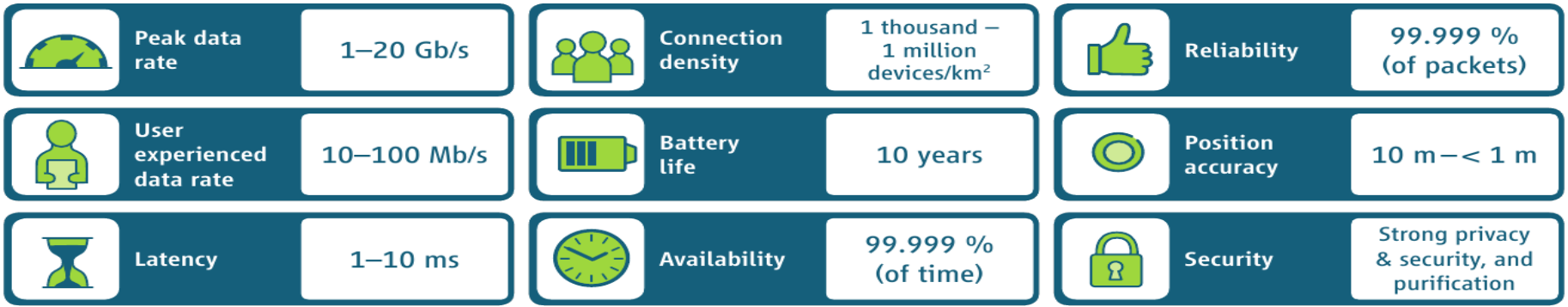
3G/4G

Current networks (e.g. LTE)

- Individual devices (1-2 per person)

5G

- Introduction beginning in year 2020
- Hundred(s) of sensors per person
- Real-time traffic
- High energy efficiency
- Stable at high speeds (500 km/h)
- Cost-effective hardware



Why is 5G more than a next step (3G->4G)?

- Fokus on 4 different categories
  - Enhanced mobile broadband (eMBB)
  - Fixed Wireless Access (FWA)
  - Ultra Reliable Low Latency Communication (URLLC)
  - Massive Machine Type Communication (mMTC)
- Reliability as a main target
- Lower frequencies

5G Smart Energy Systems

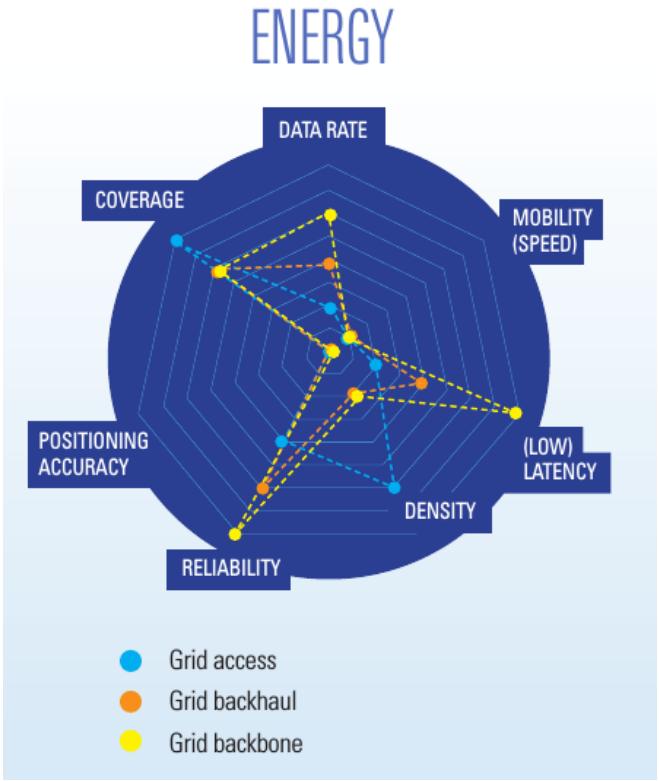


Image source: 5G-PPP, “5G Empowering Vertical Industries” 2016.

5G Grid access

- Communication network which connects the customer premises or e.g. low-voltage sensors to a specific Secondary Substation.
- For example citizens energy community or renewable energy community
- Better coverage inside buildings
  - Lower frequencies are lesser attenuated
  - Communication optimized for lower data rates with weaker signals
- Low latency for machine to machine communication
- Reliability is important

5G Grid backhaul

- Communication network which connects the Secondary Substation LANs with each other and with a control center. This network domain might also connect to the respective Primary Substation LAN.
- Low latency for machine to machine communication
- 5G Slicing
- Reliability is key

5G Grid backbone

- Communication network which connects the Primary Substation LANs amongst each other and with regional control centers (often co-located) and central control centers.
- Low latency for machine to machine communication
- 5G Slicing
- Private 5G networks
- Reliability is really critical

5G Reliability

- Spectrum used for reliability not for high throughput
- Private 5G networks with exclusive usage of frequencies
- 5G Slicing with SLA guarantees
- 5G coordinated multipoint
  - More than one frequency, base station, … used in parallel

Your core business –
Would you trust network operators / Internet service providers?

or would you like to control them to ensure the network is reliable?

Reliability is key

- **Reliability**: rate (or ratio or probability) of packets received
  - correctly and
  - in time

- Reasons for reduced reliability?
  - Wireless channel conditions
    - Objects in line-of-sight (machines, cars, vegetation)
    - Reflections
    - Interference (from same or other frequency bands)
  - Antenna (direction, capacity changes due to close-by objects)
  - Mechanical (temperature, vibration, metal dust)
  - Weather (rain in air, water on surface)
  - Software stack
    - Medium access, scheduling, control/cross traffic
    - Retransmission protocol, rate control
  - Hardware, manufacturing, counterfeit chips, single event upsets
  - Security features, attacks, jammers
  - **Not all are known ➔ End-to-end tests necessary**

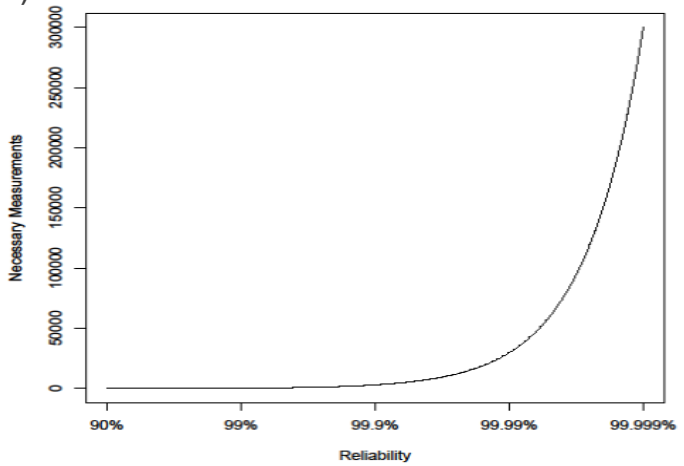
Reliability measurement

Determining 99.999 % (1 out of 100 000) reliability

- ~300,000 (independent) measurements needed
  - Lower bound of 95% Confidence Interval > 99.999%
  - P(Unreliability detected | Unreliability exists) > 95%
    - For 99.999%: ~1 100 000 measurement needed
- Per 100 cm^2 (10 cm coherence distance ➔100 points per 1 m^2)
- Per 500 kHz bandwidth (coherence bandwidth)

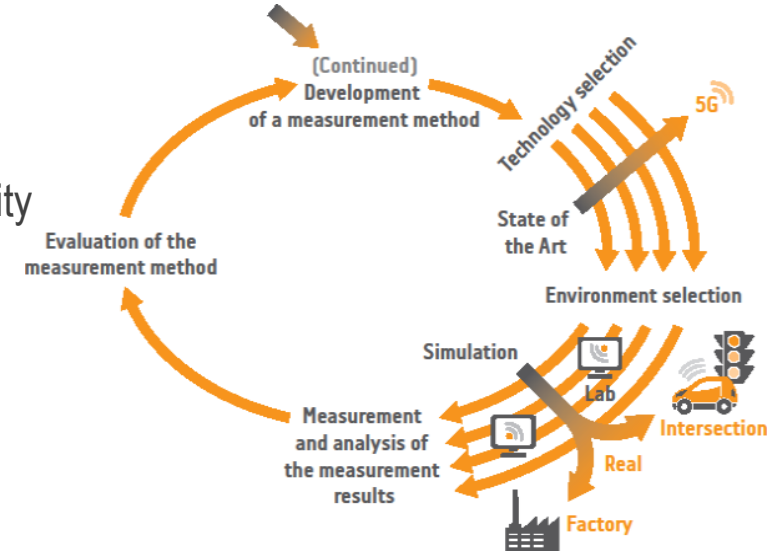
➔ **Explosion in the number of measurements**

➔ **Exploitation of correlation in space / time / frequency** needed



Reliability measurements

- We develop methods to measure the reliability of wireless networks
- Measure/Monitor the surrounding on potential changes in the influence on the communication
- No dedicated costly hardware should be used
- Based on measurements we try to predict the future reliability
- **Independent entity**



Conclusions

- 5G is much more than 4G+
- 4 different categories (FWA, eMBB, URLLC, mMTC)
- 5G as a good candidate as a one for all soution for networked Smart Energy Systems
- Reliability as a core aspect
- Reliability has to be controlled/monitored

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5G is an enabler

Thank you!

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