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5G-MLab: Wireless Reliability Measurement

ITG Fachgruppe 5.2.4

Reliable wireless communication

- New/extended use cases:
  - **Automotive**
  - **Production**
  - **Energy**
  - **Health**
  - **Media & Entertainment**

➔ Dependence on communication will increase

➔ **Communication must be reliable**

Research question:

How to measure reliability of 5G at a reasonable cost?

Why reliability?

- High technical complexity

  ➔ currently not core focus in
  5G development
- Great potential for automotive and factories

What will 5G provide?

- Current networks (e.g. LTE)
  - Individual devices (1-2 per person)
- 5G
  - Introduction beginning in year 2020
  - Hundred(s) of devices per person (sensors)
  - Real-time traffic
  - High energy efficiency
  - Stable at high speeds (500 km/h)
  - Cost-effective hardware

Details of reliability measurement

Determining 99.999 % (1 out of 100 000) reliability

- 300,000 (independent) measurements
- 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

- Methods to be developed can be evaluated with existing technologies
- For 5G networks same methods with new parameters
- Objective: As realistic as possible measurements
  - Few assumptions / abstractions
  - Interactions of layers
  - Hardware features

Types of measurements

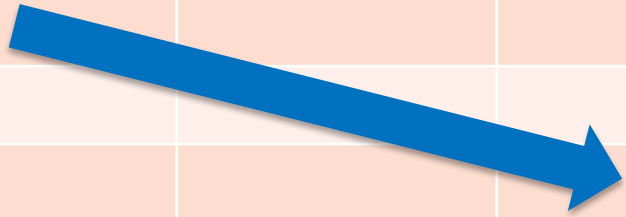
Example of possible applications:

- Phase 1: measure **before** productive use of wireless technology
  - Operating factory (working other communication system)
  - Road with traffic
  - Active generation of network traffic
- Phase 2: measure **during** productive use
  - Warn for deviations from normal values
  - Check whether guarantees are respected
  - Active or passive

Project plan

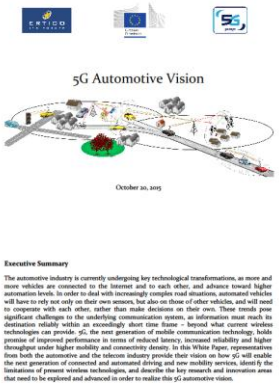
- Reference scenarios
  - Automotive
  - Industrial
- Simulation, lab, and real setups
- Stationary, mobile, and hybrid measurements

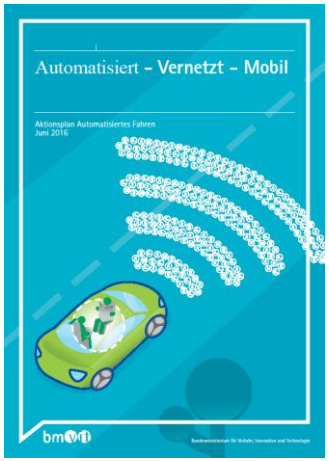
	Simulation	Lab	Real
Stationary			
Mobile			
Hybrid			



Status: Reference scenarios

- Documents



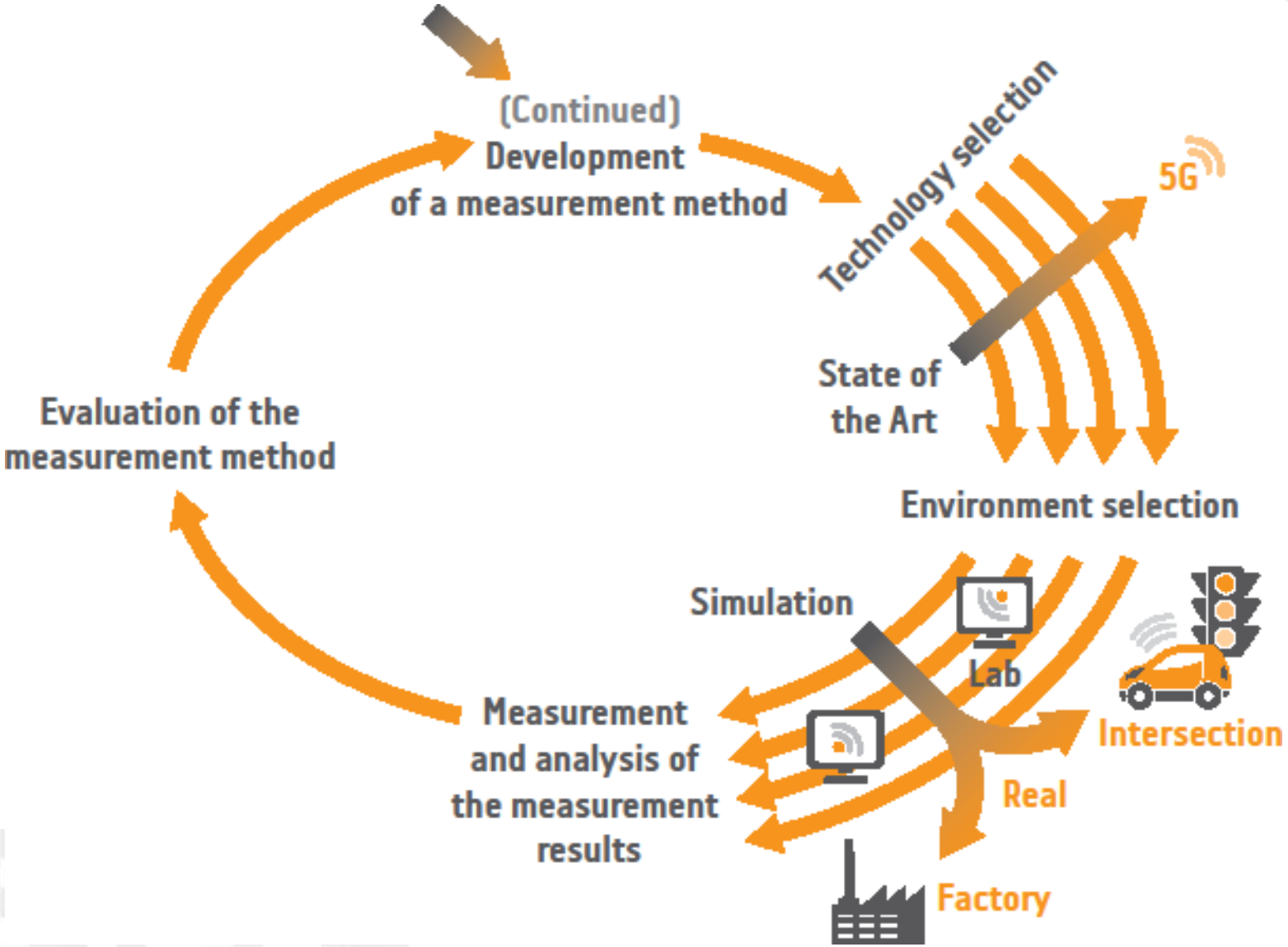


ITG VDE

- Two profiles of contacts
  - Information about how / where wireless will be used
  - Possibility to measure in such an environment

- In contact with partners from automotive and industry

Iterative development of measurement methods



Status: Simulation (Tools)

- OMNeT++
  - Discrete Event Simulator
- INET Framework
  - Models for the Internet stack (TCP, UDP, IPv4, IPv6, OSPF, BGP)
  - Wired and wireless link layer protocols (Ethernet, PPP, IEEE 802.11)
  - Support for mobility
- SimuLTE
  - System level performance-evaluation of LTE and LTE Advanced (3GPP Release 8 and beyond)
- Vagrant to set up the environment

Status: Simulation (Example)

- Single LTE cell + Single UE
- Distance: 141m
- One-way data (up)
  - 300 Byte every 10 ms
  - Time limit 10 ms
- Simulated time ~3h
- Results
  - 1 000 000 packets sent
  - 999 288 Packets received
  - ➔ 95% Confidence Interval (Clopper-Pearson): [0.9992337, 0.9993393]

➔ Methods, not numbers!

Next step: Use SINR for estimation

Status: Lab

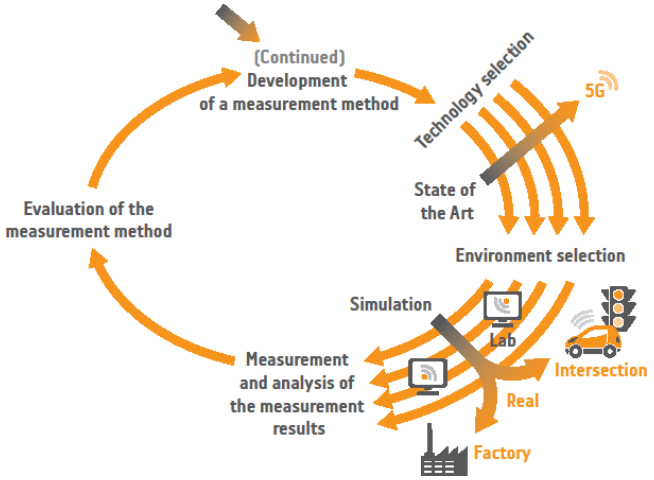
- 5G Hardware not yet available
- 5G will use mmWaves
- IEEE 802.11ad as test environment (WLAN with 60 GHz mmWaves)
  - Router available
  - Very little client hardware available
    - Intel
    - Qualcomm
    - Wilocity (acquired by Qualcomm)
    - Dell
  - Open questions
    - Drivers (Windows/Linux)?
    - Antennas?
    - Compatibility with other Hardware?

➔ Continue to watch 802.11ad, use 802.11ac

https://wikidevi.com/wiki/List_of_802.11ad_Hardware

Summary

- Reliable wireless communication important
- Define scenarios (automotive and industrial)
- Develop measurement methods
  - Simulation
  - Lab
  - Real



➔ Don‘t trust reliability, **measure** it!

Thank you for your attention!

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