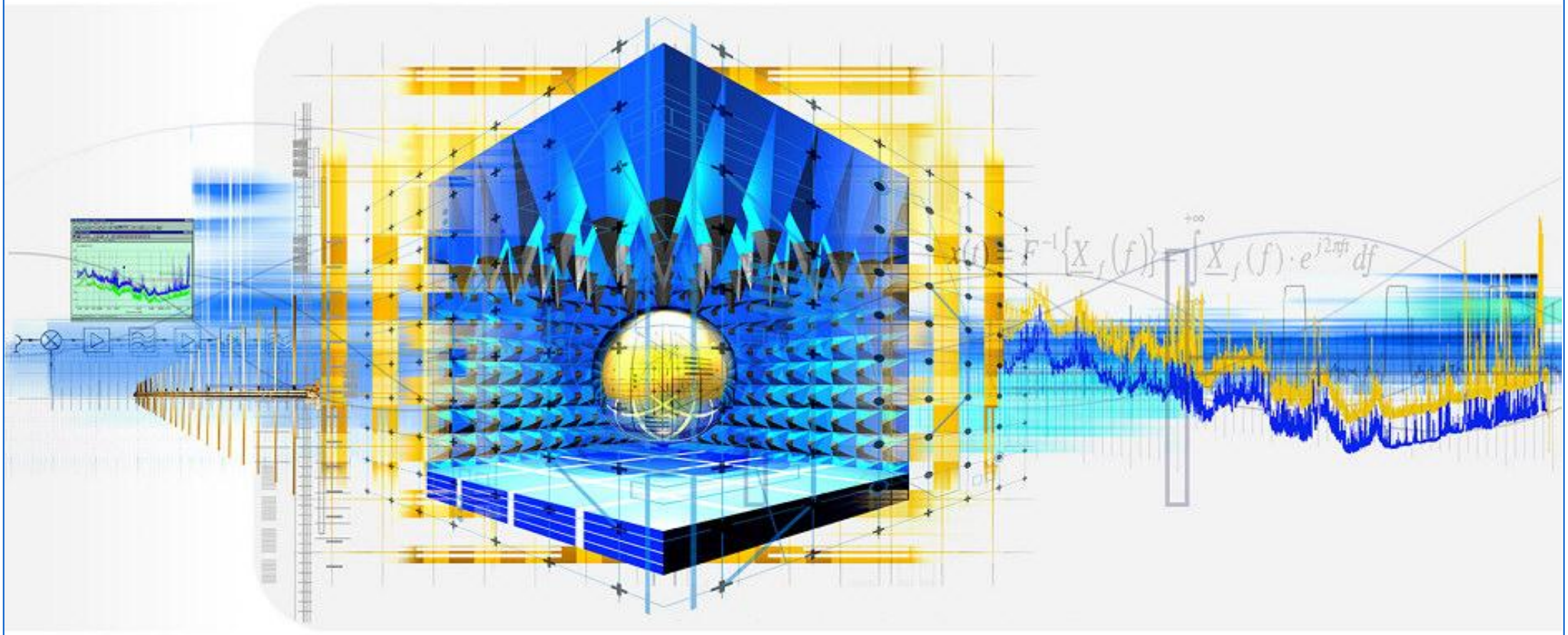
Wireless Communication in Vehicles



Agenda

- *Introduction*
- *Status*
  - *Measurements on wireless devices*
  - *Measurements on vehicles*
- *Scenarios*
  - *Direct coupling of one device*
  - *Characterization of many devices*
  - *Field generation possibilities*
- *Summary*

Status: EMC on Wireless Devices

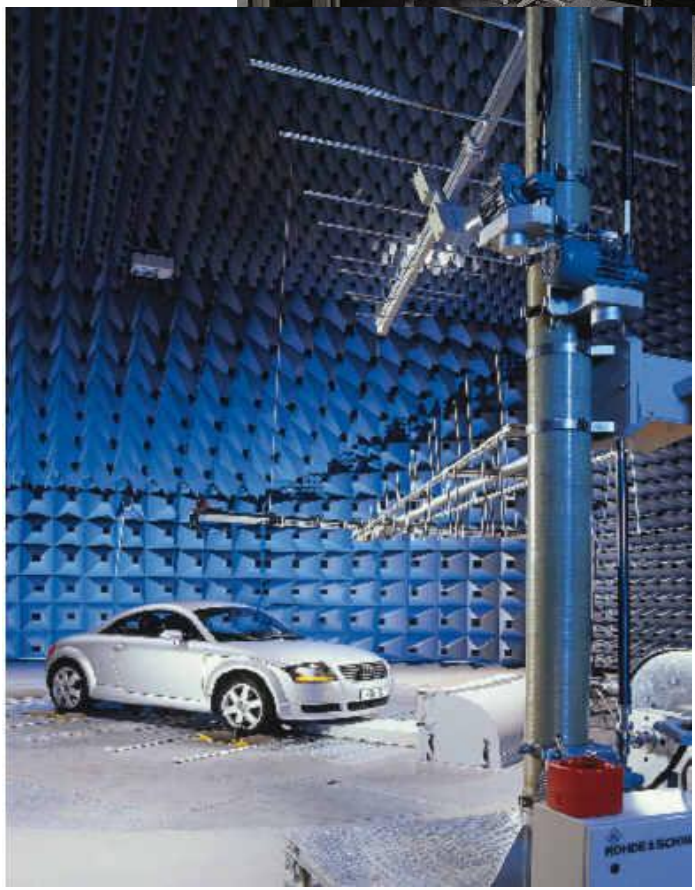
EMC and related measurements

- ***Emission (up to 1 GHz, Commercial)***
- ***Spurious emissions***
- ***Radiated power (EIRP)***
  typ. 100 mW to 2 W
- ***OTA (Over The Air radiation performance)***
- ***SAR (Specific Absorption Rate)***
- ***Susceptibility (3 V/m)***
- ***Standards:***
  ETSI EN 301 489
  CTIA 2.0

Status: EMC in Automotive

EMC and related measurements

- ***Susceptibility up to 200 V/m CW***
  Field generation outside
  Test distance 1 to 2,5 m
  Full vehicle and components
- ***Emission***
  Test distance 1 to 3 m
- ***On board transmitters***
  (e.g. ISO11451-3):
  EMC of fixed installed transmitters
  Constant coupling conditions
- ***Distributed electronic devices***
- ***Critical safety functions involved***
  (Drive assist systems)



Scenario: Single Wireless Device

2 Watt wireless device (Example GSM phone)

Placed near electronic devices

- ***Theory: 100 V/m in 10 cm distance***
- ***Field variation by***
  - ***Radiation pattern***
  - ***Surrounding materials (d < λ/4)***
  - ***Reflections***
  - ***Actual output power (Worst case to be assumed)***

  Safety factor must be considered
- ***High field in direct vicinity***
- ***Several transmitters in one unit***

Single Wireless Device

No correlation with field distribution from outside due to

- ***Influence of metallic enclosure and windows coating***
- ***Frequencies 800 MHz to 3 GHz***

Testing possibilities:

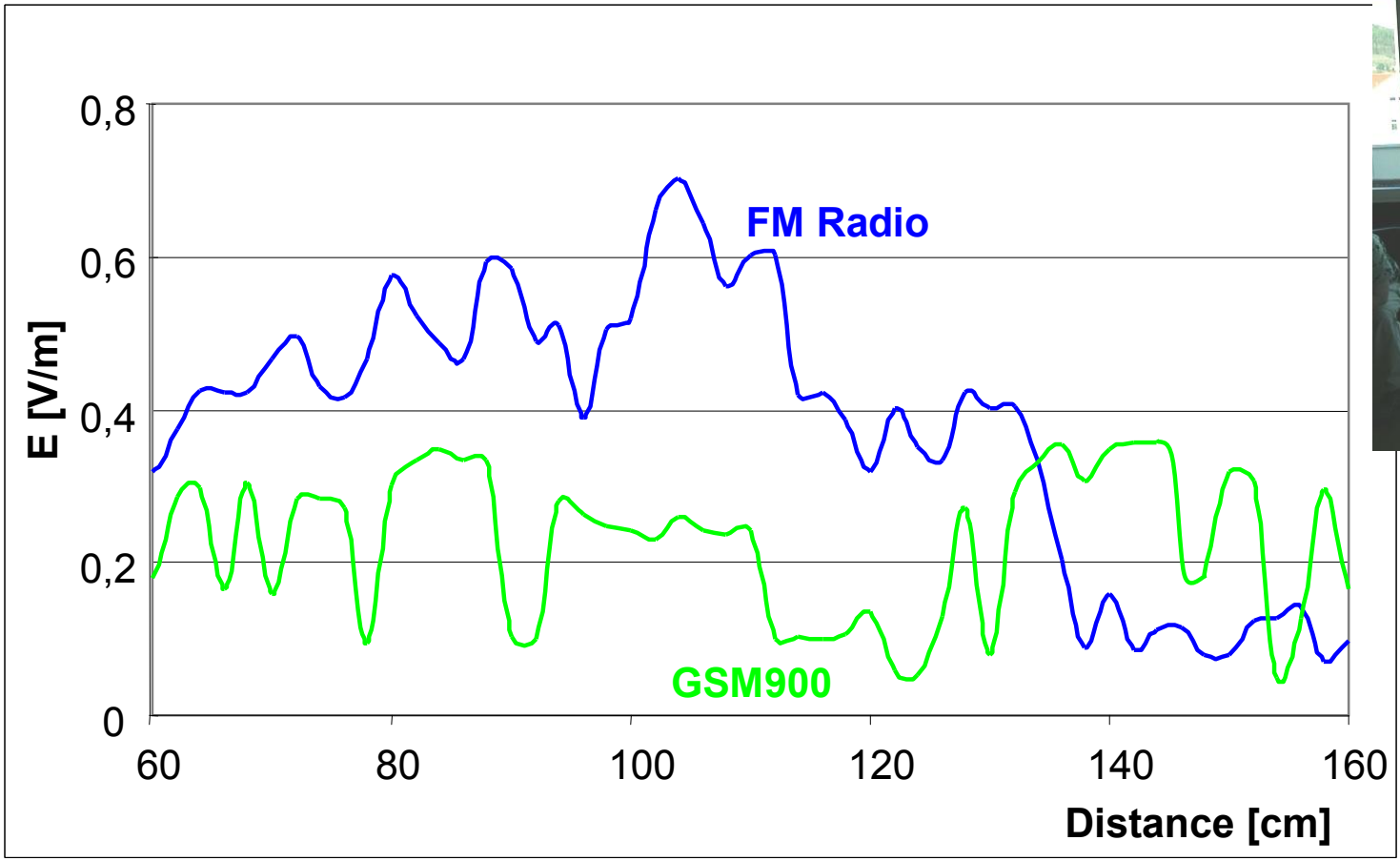
- ***Component testing (200 V/m CW up to 600 V/m pulse)***
- ***Local field generation by dummy transmitter***
  Advantage: Similar coupling mechanism
  Disadvantage: Testing at single, typical points; Reproduceability;
  Many points may be necessary
- ***Field generation by directional antenna inside the vehicle***
  Advantage: Testing of an area
  Disadvantage: Space limitation in vehicle
  (Antenna size typ. 0,3 m)

Multiple Wireless Devices (Public Transport)

- ***Many users at the same time***
- ***Field distribution unknown***
- ***Reflections and modes***
- ***Influence of people on field distribution (Absorbing effects)***
- ***Influence of environment (e.g. wet windows, external transmitters)***
- ***Medium level fieldstrength due to seperation between the devices***
- ***Coupling with electronic devices and other communication systems***
- ***Worst case scenario to be considered (All devices at full power)***

Field Distribution in Reflective Environment

- ***High field variations due to reflections***
- ***Example: Measurement within a building Þ Variation up to 10 dB***



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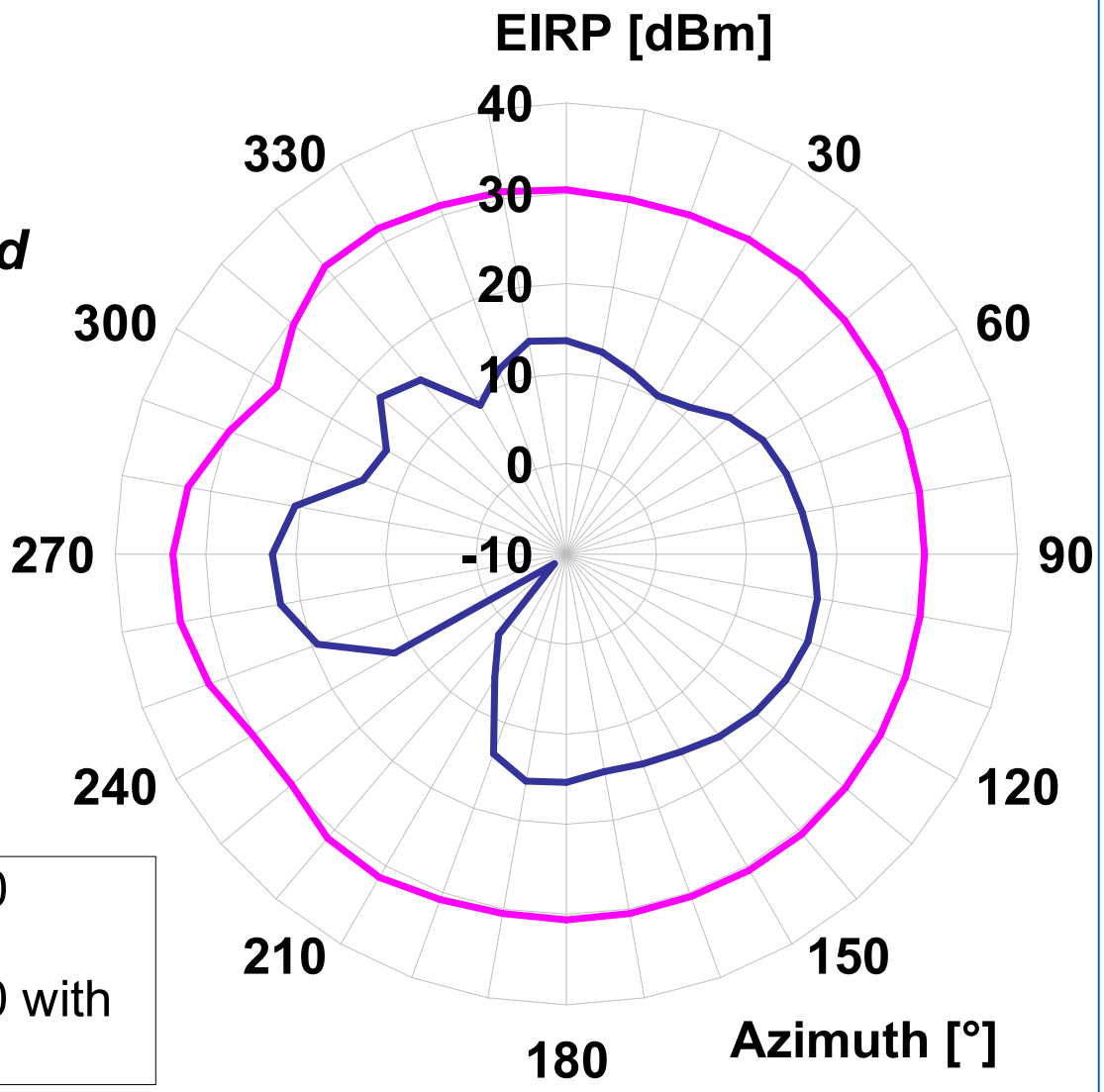
Influence of Person on Radiated Power

- ***Example for radiation pattern of GSM900 mobile phone without and with phantom head***

⇒ **Radiated power changed by more than 10 dB**

⇒ **Radiation pattern can change significant**

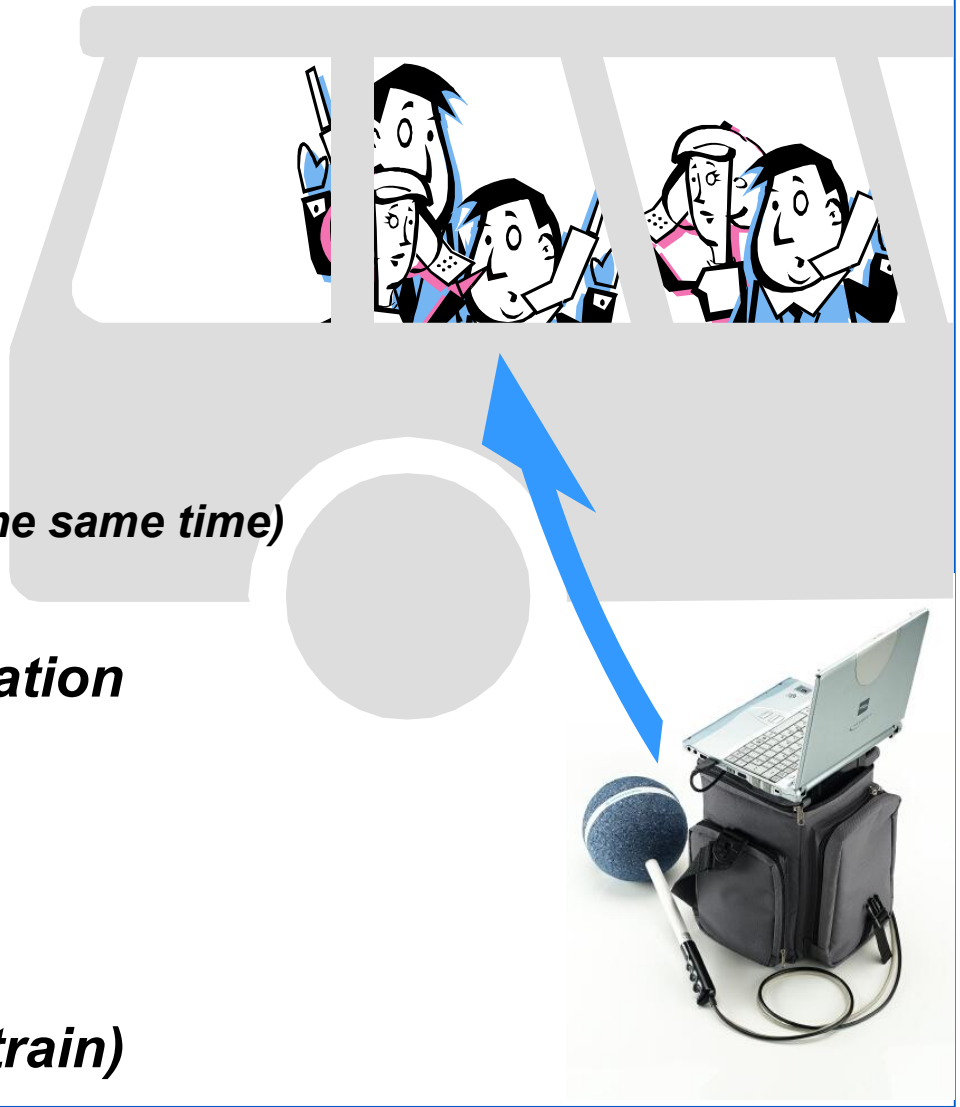
⇒ **Influence of user must be considered**



Multiple Wireless Devices (Public Transport)

Field characterisation:

- ***Typical transmitter setup (partial)***
- ***Measurement of field strength***
  - ***All directions***
  - ***All polarisations***
  - ***Multi-band***
    (Measurement of different services at the same time)
- ***Result:***
  Typical values and data for extrapolation



Additional:

- ***Monitoring of real scenarios***
  (e.g. longterm monitoring in bus or train)

Multiple Wireless Devices (Public Transport)

Alternatives for field characterisation:

- ***Simulation***
  - ***Large EUT***
    - Þ ***Complex models, long computation time***
  - ***Limited accuracy in modelling and wiring***
    - Þ **Limited *accuracy of fields and coupling***
  - ***Influence of persons***
    - Þ ***Dielectric properties must be included***
  - ***Different scenarios to be calculated***
- ***Reverberation***
  - ***Multiple fixed transmitters or one transmitter***
  - ***Paddles have to be installed inside***
  - ***High attenuation due to absorbing effects***
    - Þ ***Modes are damped***

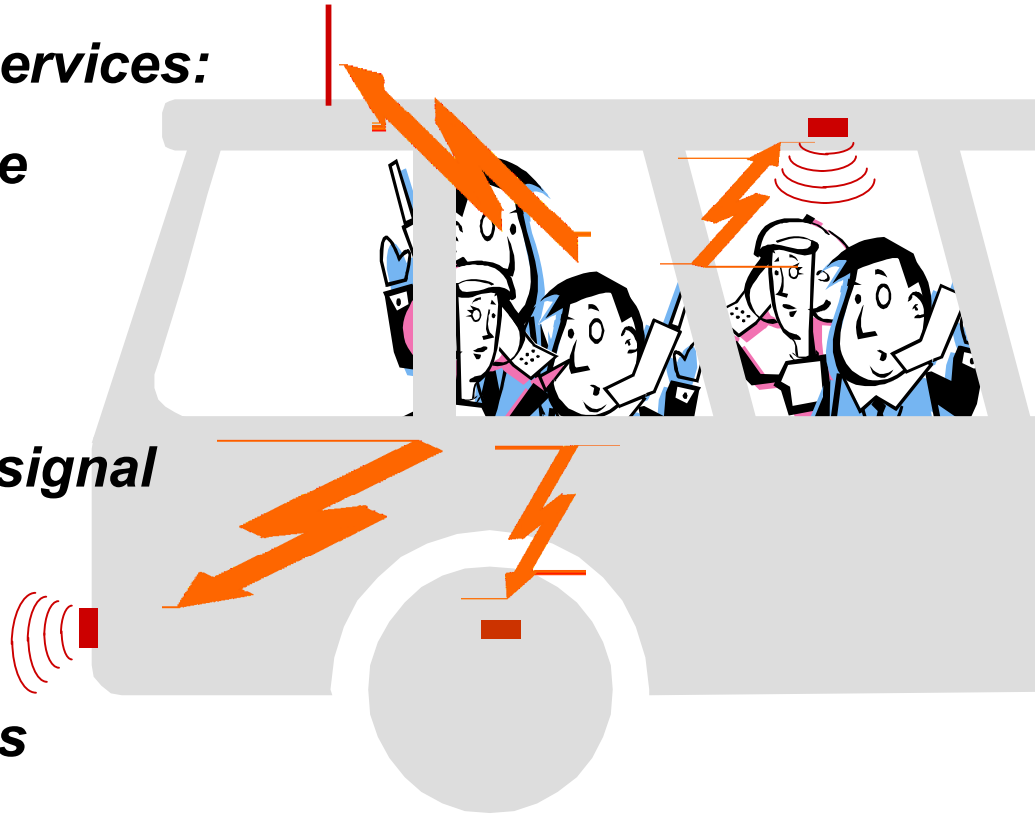
High effort for reliable results

Worst case without people (Overestimation)
Paddle installation necessary

Multiple Wireless Devices (Public Transport)

Influence on other communication services:

- ***Limits depend on frequency range***
- ***Low limits due to high sensitivity***
- ***Harmonics and intermodulation***
- ***Interference depends on type of signal (Modulation, time structure)***
- ***Broadband frontends***
- ***Demodulation in analogue circuits***



⇒ ***These parameters must be included in scenario analysis***

⇒ ***Measurements with communication system adopted parameters***

⇒ ***EMC setups and regulations should be based on this scenarios***

Summary

- High field strength in direct vicinity of a wireless device
  - ⇒ Field generation by antenna inside the vehicle
- Scenarios for mobile devices are very complex
- Presence of people has to be taken into account
- Definition of field distributions based on real and typical measurements
- Measurement equipment for field characterization:
  - Isotropic
  - Frequency selective
  - High sensitivity and dynamic range