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FRAUNHOFER INSTITUTE FOR
INTEGRATED CIRCUITS IIS

VIRTUAL ELECTROMAGNETIC ENVIRONMENT
AT FORTE

FACILITY FOR OVER THE AIR RESEARCH AND TESTING

IN COOPERATION WITH

th
TECHNISCHE UNIVERSITÄT
ILMENAU

OVER-THE-AIR TESTING IN A VIRTUAL ELECTROMAGNETIC ENVIRONMENT (OTA*in*VEE)

Virtual Electromagnetic Environments reproduce:

– Realistic multipath propagation environments including spatiotemporal characteristics of the electromagnetic field
– Mobile scenarios (incl. high-speed)
– Arbitrary radio environments and application scenarios
– Coexistence and interference scenarios

With advantages:

– Reproducibility compared to field tests
– Cost-efficient
– Available at any time and weather independent
– No interference to licenced users (shielded chamber)
– Virtually any location/scenario/prognostic testing in still unavailable bands or uncommissioned systems, incl. "what-if" scenarios
– Non-destructive assessment of integrated multi-antenna system performance
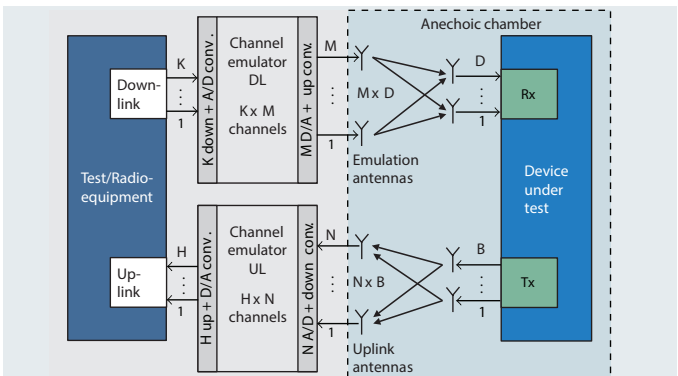
OTA/in VEE

For testing of:

– Mobile communication systems (LTE, LTE-A, UMTS, 5G)
– Global navigation systems
– Industrial communication systems
– Cognitive radio systems
– C2I (car to infrastructure), C2C (car to car) systems

Especially suited for:

– Multi-antenna systems
– MIMO (Multiple Input Multiple Output) equipment
– Direction finders
– Communictation systems with integrated antennas
– Beam forming antennas
– Controlled-reception-pattern antennas (CRPA)

OTAinVEE Concept
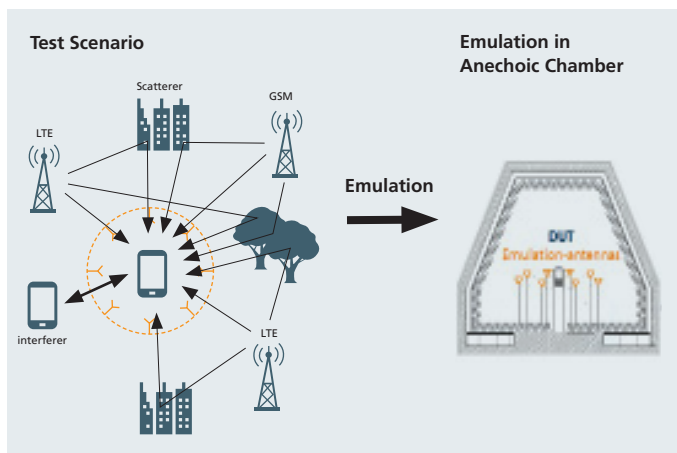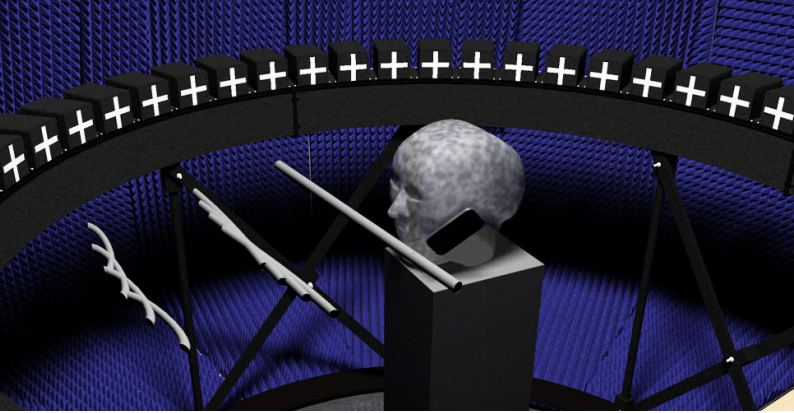
OTA*in*VEE TESTBED FEATURES

Technical information:
- Frequency range: 350 MHz - 3 GHz (6 GHz)
- Signal bandwidth: 80 MHz
- Maximum RF output power: +10 dBm
- Connectivity: 12 input x 32 output = 384 physical channels
- Two modes of operation:
    - Frequency domain: unlimited number of delay taps
    - Time domain: 32 delay taps per physical channel
- Doppler scenarios with up to 100 kHz Doppler frequency
- Real-time channel convolution with arbitrary multiple radio signals (not just playback)

OTAinVEE emulation methods:
- Two-stage method: conducted test incorporating both the measured radiation pattern of the DUT and the propagation channel
- MIMO-OTA method: 2D/3D full-polarimetric wave field synthesis reproducing the angular characteristics of the channel and assessing DUT antenna performance over the air
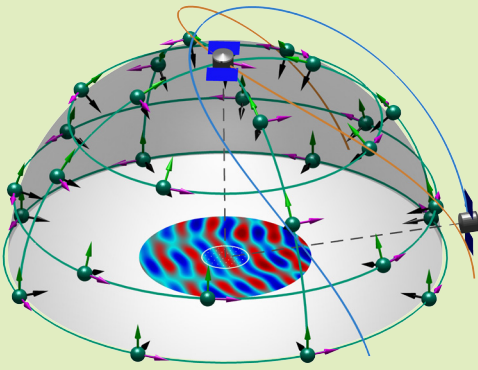
GLOBAL SATELLITE NAVIGATION SYSTEMS

– GPS/GALILEO/Compass/GLONASS navigation system testing
– Test of
    – Robustness against jammers and spoofers
    – Beam forming/CRPA antennas
    – Impact of multipath propagation
    – Receivers for not fully deployed satellite systems
    – Classified or confidential systems in a shielded environ-
      ment (e.g., GALILEO PRS)
    – High-speed mobile scenarios
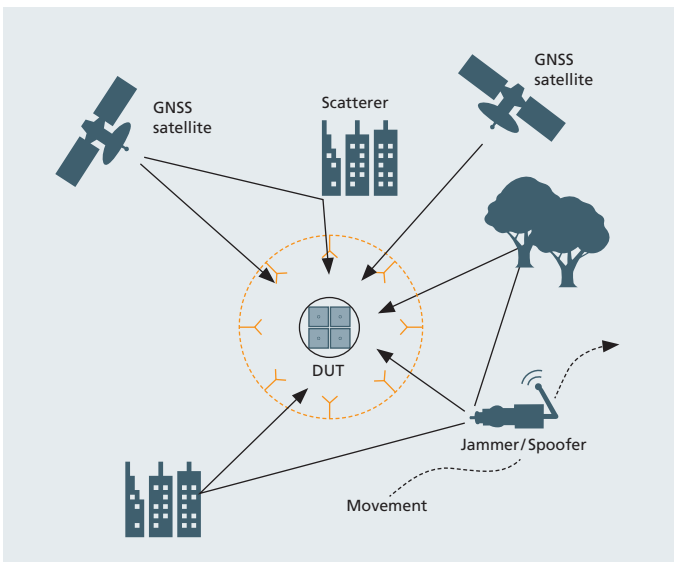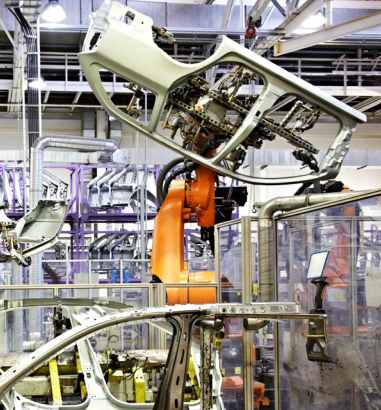
INDUSTRIAL AND MOBILE COMMUNICATIONS

Industrial Communications

Emulation of:

– Smart metering scenarios (e.g., automated meter reading, "walk-by" read out)
– Harsh Automation Environments
– Co-existence and interference between different standards
– M2M communication scenarios
– C2X communication

For testing of: Networks, SISO and MIMO systems, LTE, WIFI, Bluetooth

Mobile Communications

– Single UE and multiple eNB test
– Emulation of complete multi-base station LTE environments with moving multiple-antenna UE under multipath propagation
– Performance, conformance testing of UE (e.g., to industry standards)
– Handover, cooperative multi-point, interference, co-existence, beam forming etc. testing at eNB/UE
– Inter-RAT mobility testing of multi-mode devices
– Complete emulation of co-existing LTE/CMDA/UMTS/GSM, WiFi cells
– Interference management: e.g., between macro UE at cell edge and femto-AP
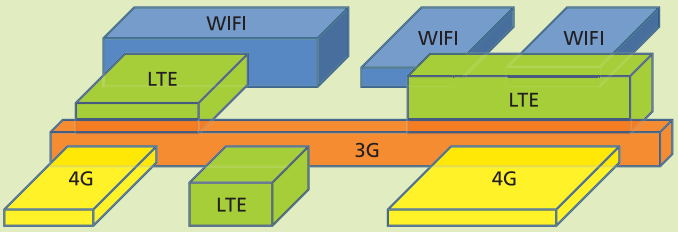
COGNITIVE RADIO

Emulation of:

– Authentic radio environments
– Various Primary User radio standards, e.g., GSM, LTE, WLAN
– Time, frequency, and spatial channel characteristics of multiple Primary Users
– Secondary User communication partner

For testing of:

– CR prototypes (frequency and spatial domain)
– Interference to primary users
– Network re-establishment and throughput (e.g., after a catastrophy)
– Cognitive cycle (Observe, Orient, Plan, Decide, Act)
– Cognitive Radio units with multiple/beam-forming antennas

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