Sub-THz Testbed for 5G and beyond

1 Wilhelm Keusgen, 2 Mathis Schmieder, Alper Schultze, Michael Peter, and 3 Thomas Merkle

1 TU Berlin, 2 Fraunhofer HHI, 3 Fraunhofer IAF
Outline

• What 6G could be and what the challenges are
• Sub-THz Testbed and its applications
The Advent of 6G

• What is 6G?
• What are the socio-economical drivers?
  – Need for higher level of industrial automation
  – Telepresence
  – Autonomous vehicles
  – Wearable devices, new man machine interfaces, and context aware networks, which predict our needs
• What are the expected KPIs?
  – Known 5G KPIs: data rate, latency, massive number of devices
  – Security by design
Paradigm Shift in Transition from 5G to 6G

Inspired by: Communications in the 6G Era, White paper by Nokia Bell Labs
Technology Transformation in 6G

- Utilization of higher frequencies up to Sub-THz
- Convergence of sensing and communication; network as a sensor
- Computation in network beyond edge cloud
- Network enabled by AI and network intelligence e.g. self-optimizing transceivers
- Non terrestical networks
Spectrum Options für 6G

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Sub-THz Spectrum

WRC-19 bands for 5G study
Aggregate BW: 33.25 GHz

60 GHz unlicensed
BW: 6–9 GHz

D-band
Overall BW: 60 GHz

WLAN
(2.4, 5.2 GHz)
BW: 0.54 GHz

LTE
(700, 800, 1800, 2100, 2300, 2600, 3500, 3700 MHz)
Aggregate BW: 1.3 GHz

Aggregate spectrum allocated for mobile use: 35.0 GHz (30.2 GHz within D-band)

WRC-19 Agenda Item for THz: 175 GHz for land mobile communication between 275 and 450 GHz
Open RAN and Open Ecosystem

Open RAN

open interfaces and APIs with interoperable RAN components

Traditional RAN

closed BBU with proprietary hardware and design

6G as a solution platform
Technological Challenges

- Semiconductor Technology for sub-THz systems (CMOS, SiGe, III / V)
- Massive beamforming antennas
- Intelligent reflective surfaces
- Energy consumption of RF-components
- Impairments (e.g. phase noise)
- Heterointegration of different technologies

- Computing resources
- Transport network
Test and Measurement Challenges

• Carrier frequency, including harmonics
• Large bandwidth
• Accessible Interface Planes
  – Over the air
  – IP
• Network testing
• Testing of new network components like intelligent reflective surfaces
Diagram shows a tethered configuration (untethered operation with 2 synchronomat units)
300 GHz Frontend

- Transceiver developed at Fraunhofer
- InGaAs mHEMT technology
- Direct conversion, used as SSB in this setup
- LO frequency 7.5 – 8.9 GHz, internal multiplier
- RX and TX I/Q baseband signal with >20 GHz bandwidth
- RF frequency 270 – 320 GHz
- Tx Power: + 3 dBm
- NF: 8 dB
Setup
Example: Channel Sounding

Angle Resolved Outdoor Measurements
Measurement Results

2GHz BW, Minimum measurable path loss: 130 dB, dynamic range > 60 dB
Example: Transmission Experiments
Measurement Results

- 5G NR FR2
- 100 MHz BW
- 120 kHz sub-carrier spacing
- Downlink
- LOS scenario
- 20 dBi antennas

- 5G compliant results
Thank you for your Attention

Contact:

Prof. Dr. Wilhelm Keusgen
wilhelm.keusgen@tu-berlin.de