Radio for THz Communication – what are we up against?

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Towards a local connect and compute paradigm

**2022**

- AR Glasses
- Tablet
- Watch
- Device
- Phone

**2030**

- AR Glasses
- VR Goggles
- Device
- Device
- Device
- Phone
- Watch

**3GPP**

**MBB**

**FBB**

Phone software ecosystem

Evolved software ecosystem

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Wide area – local area

Strategic venues
Factory floors
Offices
Classrooms
Hospitals
Retail
Home

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Deployment challenges

Laws of nature difficult to combat

- Free space
- Diffraction
- Penetration
- Pencil beams

![Diagram showing signal power loss](image)

\[ FSPL = 20 \log_{10} \left( \frac{4\pi d}{\lambda} \right) \]

28GHz to 140GHz = +14dB loss

28GHz to 140GHz = +7dB loss

Huge variation depending on scenario

Link budget → antenna gain → narrow beams
Propagation measurements

- Similar reflection losses for 28 and 140GHz
- Noticeably higher penetration loss for 140GHz
- Similar excess loss in an open office for 28 and 140GHz, but difficult to get coverage in closed meeting rooms @ 140GHz

Open office coverage

B-E. Olsson et al, "Radio Propagation in an Office Environment at 140GHz and 28GHz", European Conference on Antennas and Propagation (EuCAP), 2021
Open area with conference rooms
Coverage

- Open area very similar for all 3 frequencies
- Higher loss in conference rooms for 58 and 143 than 28GHz
- Very similar excess loss in the conference rooms @ 58 and 143GHz
Hardware challenges

“Not a question whether something is possible or not - more when things become business viable”

- Transmit power
- Sensitivity
- Phase noise
- Data converters
- Building practice
How do we handle thousands of antennas?

Example
- Distance: 200m
- Bandwidth: 10GHz
- SNR: 30dB (includes margin)
- Antenna element gain: 3dB
- TX power: 5dBm @ 100GHz, and ~ $f^{-3}$
- NF: 9dB @ 100GHz, with excess noise factor ~ $f$
- # Base station antennas = 10x # device antennas

To cover all directions several panels must be used
So, what do we need to be successful?
Understand the development cycle

How many technology changes can one afford until the market window is jeopardized?
Understand the development cycle

Making use of qualitative pilot lines

- Robust design environment
- Explorative research
- External collaboration
- Standardization
- Trials
- Ecosystem engagements
- Concept development
- Product development
- Products in volume

Effort:
- -8 years
- -5 years
- -3 years
- -1 year
- Product introduction
- +1 year

Mature technology
High production yield

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Understand the development cycle

...and not forget about heterogenous integration, package, antennas, cooling etc.