(one6G)

WG2 ACTIVITIES

HIGH FREQUENCIES
NEXT GENERATION MIMO
INTEGRATED SENSING AND COMMUNICATIONS
6G RADIO ACCESS

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OUTLINE

High Frequencies: gaining access to unused spectrum

Next Generation MIMO: exploiting the spatial diversity

Integrated Sensing and Communications: gaining context awareness

6G Radio Access: sharing the resources among heterogeneous services and users

Exploiting the 160 GHz available for THz communications

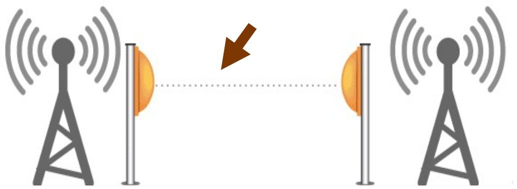
Already allocated spectrum between 252 and 275 GHz

Word Radio communication Conference (WRC) 19: Additional spectrum between 275 GHz and 450 GHz

Scenarios:

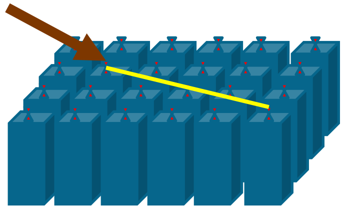
Ultra-high data rates for point-to-point communication IEEE Std. 802.15.3d-2017, sensing, and imaging

10..100 Gbit/s



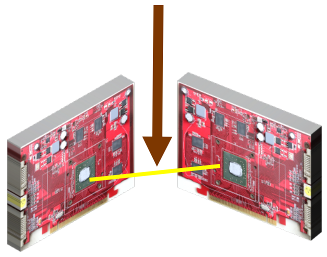
Backhaul/Fronthaul links

10...100 Gbit/s



Wireless Links in Data Centers

10...100 Gbit/s

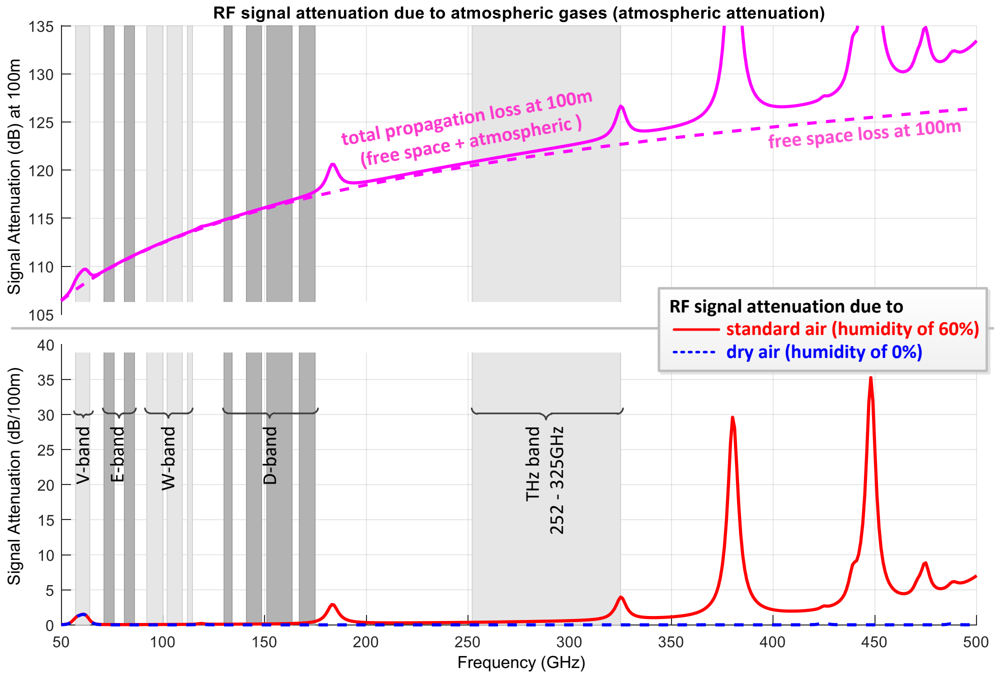


Intra-Device Communication

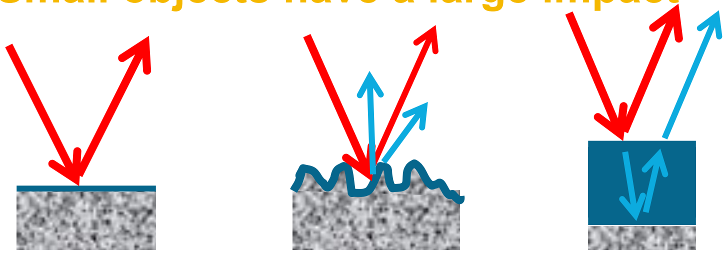
T. Kürner, A. Hirata, "On the Impact of the Results of WRC 2019 on THz Communications," in Proc. International Workshop on Mobile THz Systems, 2-3 July 2020.

Challenges for THz communications

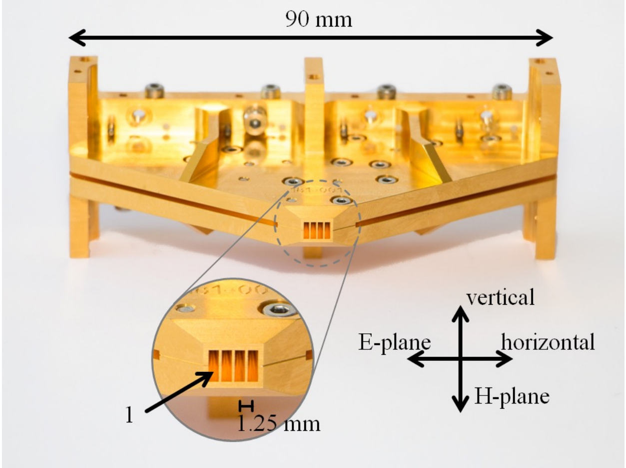
1. High free-space path loss and atmospheric attenuation



2. Small objects have a large impact



3. Antenna design



T. Kürner, A. Hirata, B. K. Jung, E. Sasaki, P. Jurcik, and T. Kawanishi, “Towards Propagation and Channel Models for the Simulation and Planning of 300 GHz Backhaul/Fronthaul Links,” in Proc. URSI GASS, 2020.

NEXT GENERATION MIMO

User-centric and cell-free heterogeneous architectures

Self-configuration and optimization to fully exploit the spatial resources

Flexible and scalable AI/ML-enabled RAN

Plug-and-play of radio units and IRS

Energy/cost-efficiency

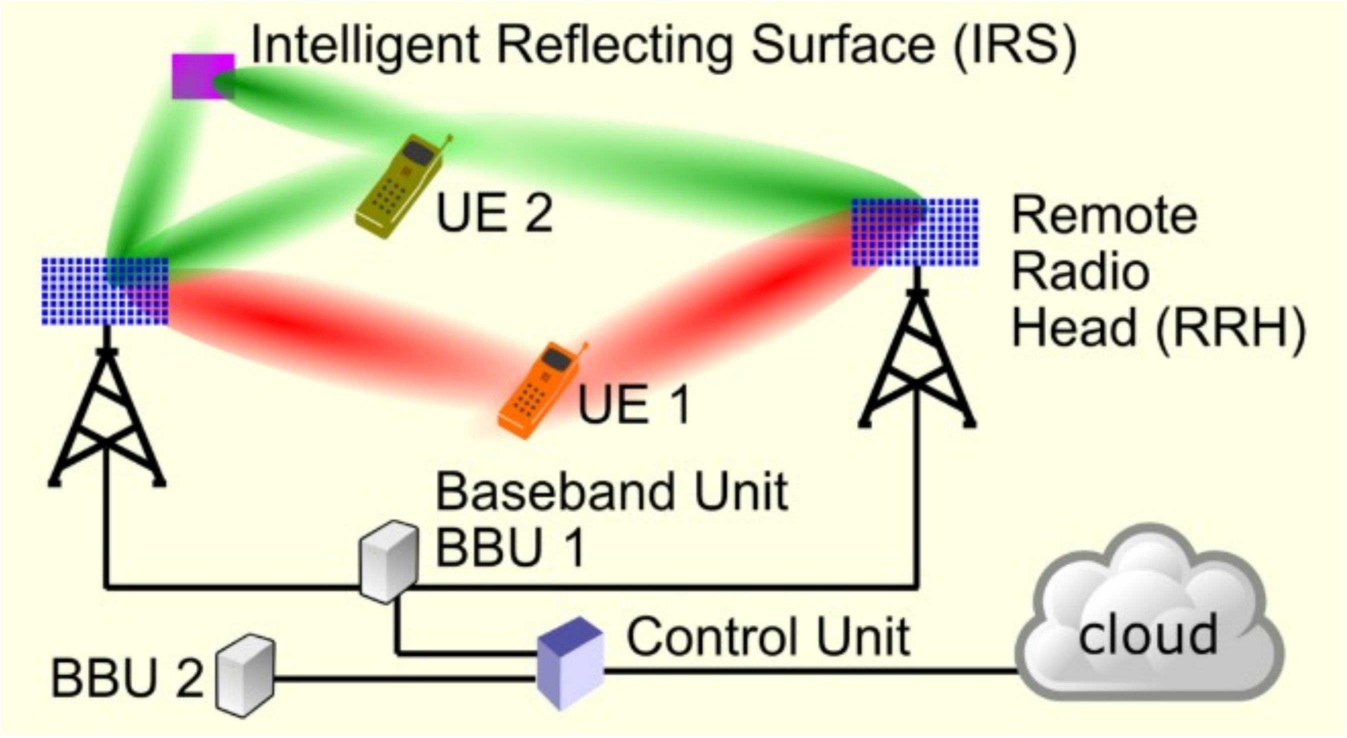
Lower carbon footprint: dynamic on/off

Reliability and resilience

Multi-connectivity, micro-/macro-diversity

Network as a sensor

From component- to system-level



User-centric and cell-free heterogeneous architectures

Mobile devices navigating seamlessly through a "sea of access points" associated dynamically

Stable QoS across the coverage area

Challenges:

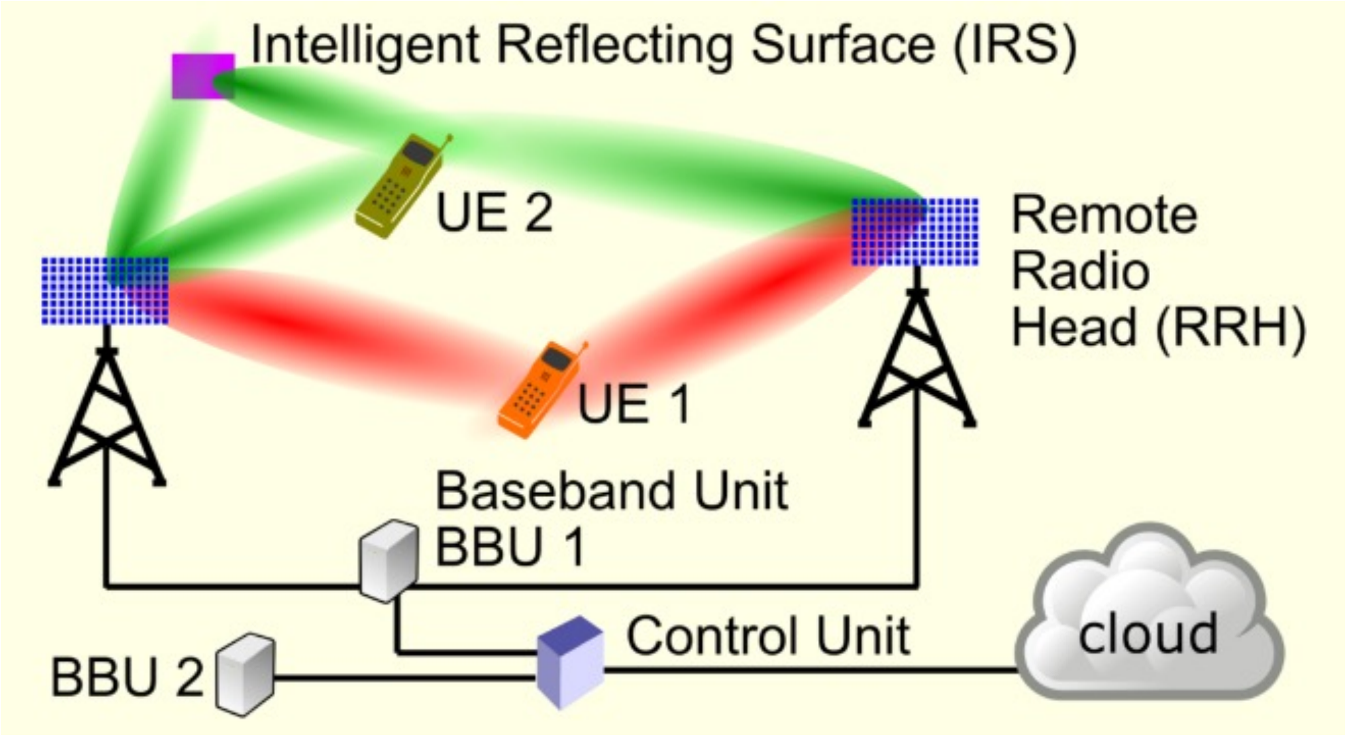
Backhaul/fronthaul

Central vs. distributed controller

Scheduling

Reference signal design

Distributed precoding



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From coexistence to JOINT sensing and communications

Information about the object:

- Position
- Trajectory

Information about the environment:

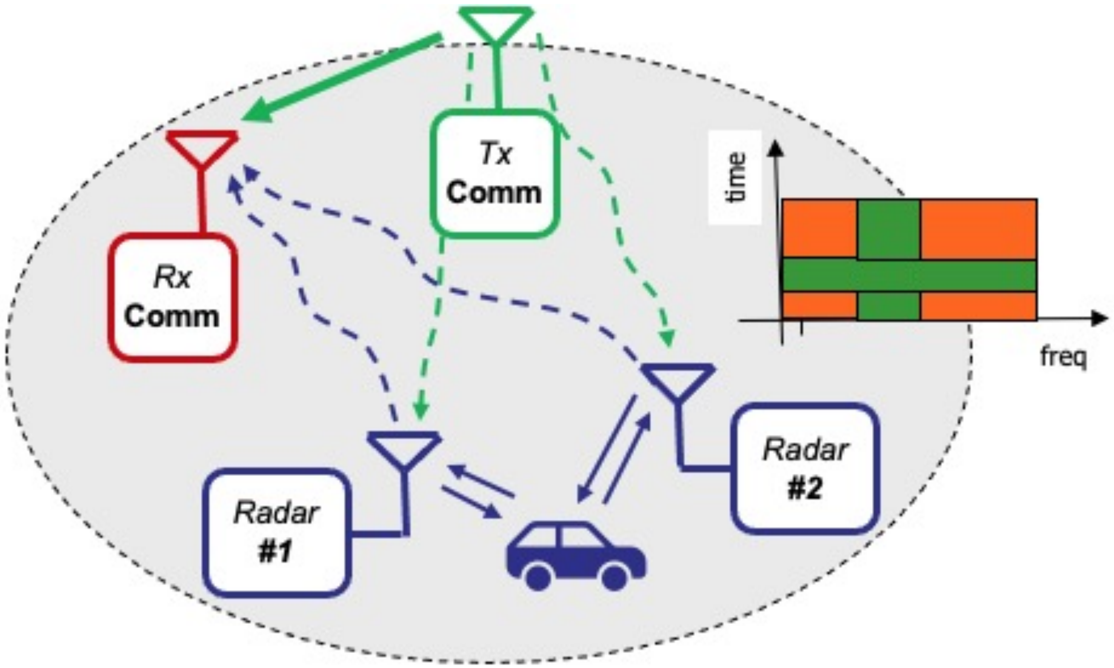
- Imaging
- Mapping

From presence detection to micro-Doppler features

Humans: Gestures and gait

Non-humans: Rotating parts

Coexistence



INTEGRATED SENSING AND COMMUNICATIONS

How to achieve joint sensing and communications?

Integrating sensing in a communications waveform

Orthogonal frequency division multiple access (OFDMA)

Integrating communications in a sensing waveform

Frequency-modulated continuous-wave (FMCW)

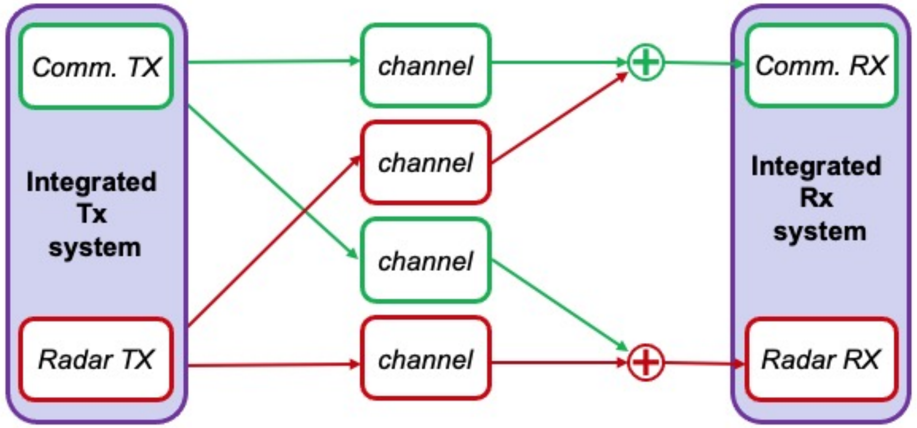
New waveform to support both functions

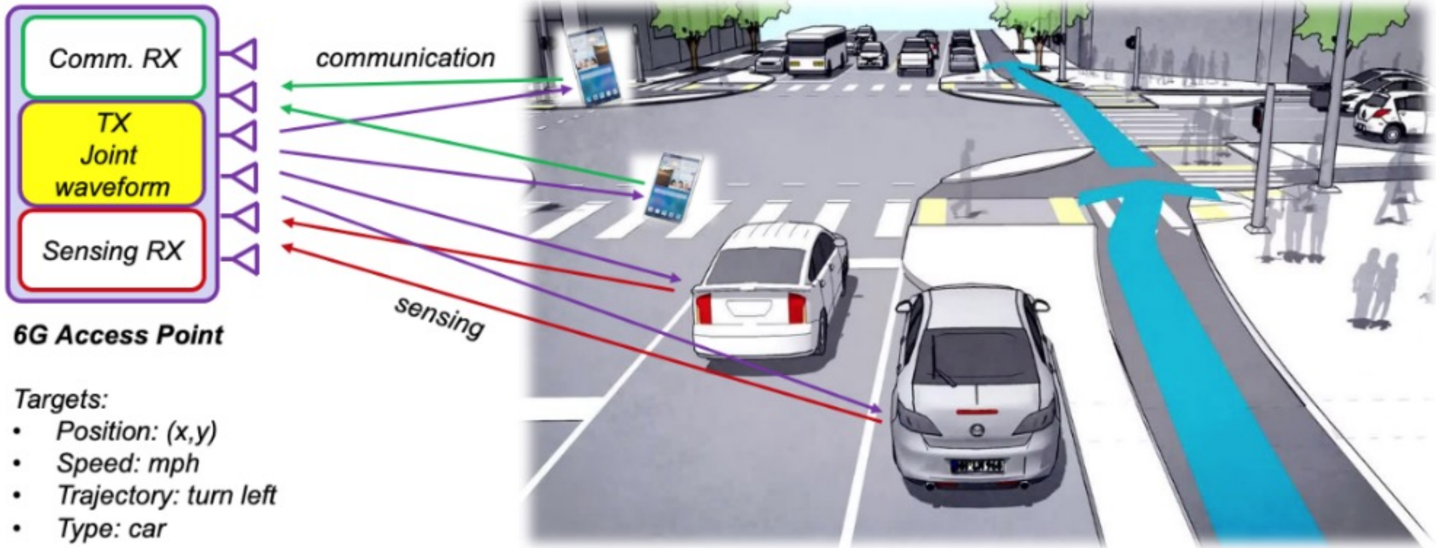
Orthogonal time-frequency-space (OTFS)

Novel schemes to use sensor information

To assist :

- **Communications link**
- **Resource allocation**





6G RADIO ACCESS

Flexible and resource-efficient support for extreme and heterogeneous services

Relaxing the orthogonality constraints

Exploit frequency, time, space, code, and/or power

More efficient and flexible access

Advanced and lightweight access

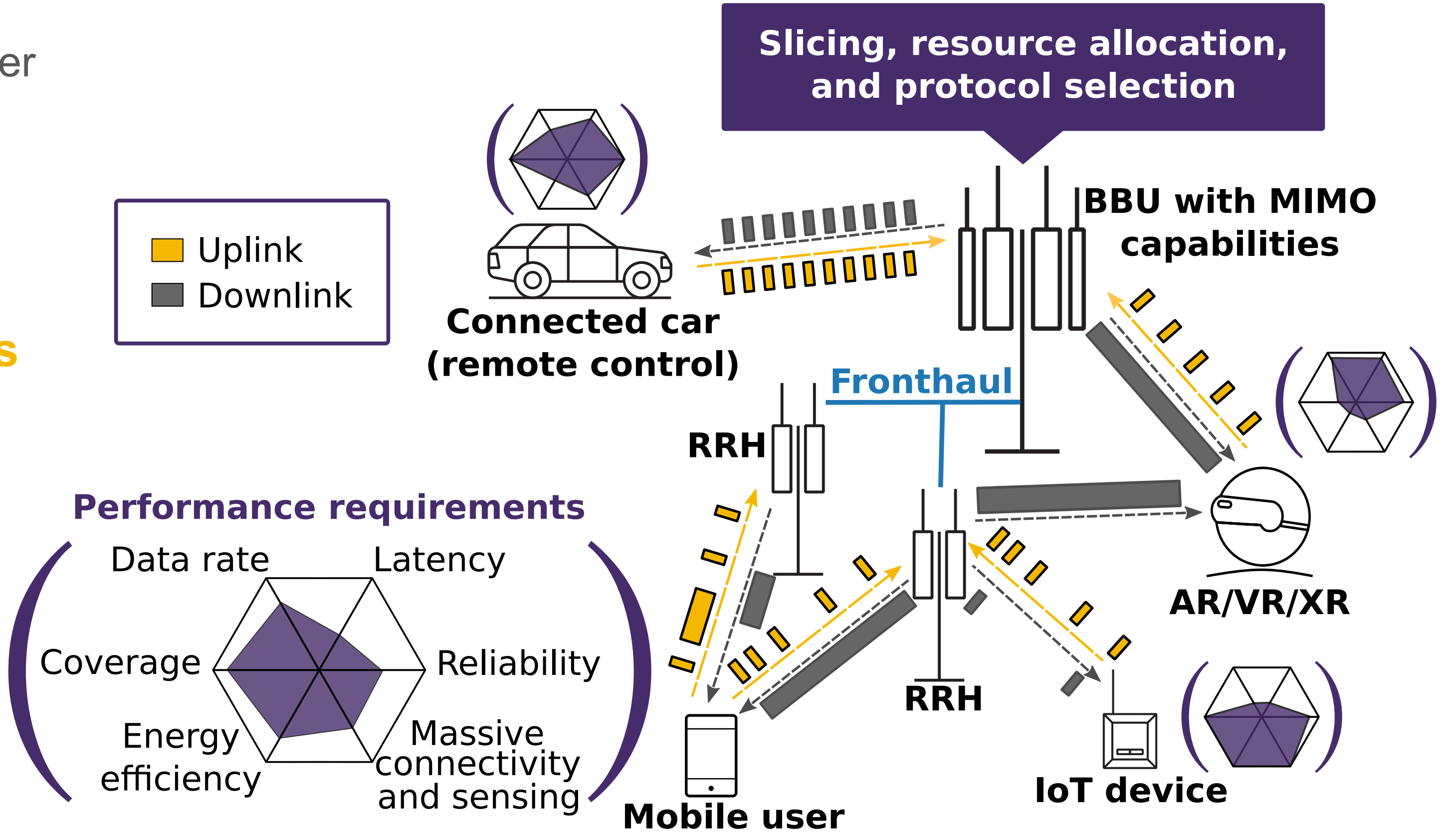
Protocols and decoding mechanisms

Multi-connectivity with diverse interfaces

Diversity trade-offs:

Efficiency, latency, reliability,...

Per-user vs. overall throughput and scalability



How to increase spectrum capacity and efficiency?

Coexistence of orthogonal and non-orthogonal multiple access (OMA and NOMA)

OMA: User separation across space, time, and frequency resources

- Uncertainty in the activity of users can lead to severe resource overprovisioning

NOMA: To increase the number of users that can be served per resource unit

- User grouping in exchange for increased decoding complexity

RAN slicing: Sharing of wireless resources among diverse services

Non-orthogonal: Allow users from different service types to share the spectrum

How do we measure capacity and efficiency with heterogenous services and requirements?

Traditional notion of maximizing spectral efficiency (b/s/Hz) is not applicable

Trade-offs between throughput, latency, and reliability

Flexibility in diverse access modes, uplink and downlink, in a cell-free MIMO architecture

WI STRUCTURE AND LEAD

WI204 High Frequencies

Lead: Thomas Kürner

WI205 6G Radio Access

Lead: Israel Leyva-Mayorga

WI209 Next Generation MIMO

Lead: Martin Schubert

WI210 Integrated Sensing and Communications

Lead: Andrea Giorgetti

THANK YOU FOR YOUR ATTENTION

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