The 6GTandem Project and its Use Cases

Presented during the 6G-IA and 5G MAG WS

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The 6GTandem Consortium

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6GTandem System and Use Case Selection Procedure

Overview of the Considered Use Cases

Preliminary Learnings Regarding the Use Cases

A Foreword on the 6GTandem System

- Dense sub-THz deployment
  - Leverage large bandwidth for high data rates
  - Mitigate path loss by bringing the infrastructure close to the user
- Sparse sub-15 GHz deployment
  - Offer a resilient wireless link for critical data
  - Fallback in case of outage or constrained devices
- Central baseband processing
  - Infrastructure coordination is part of the design
  - Could mitigate material and energy footprint

Identifying Use Cases

External Drivers

Emerging applications with new requirements

The Project as an Enabler

Enabling technology that offers enhanced performance

- Based on the expertise of the consortium partners
  - Extended reality (XR): Gaming, training; professional and pervasive usage
  - Industry 4.0: Cooperative robots, flexible manufacturing; positioning and asset tracking
  - AI/ML: Federated learning for public safety and sensing applications
- Emphasis on XR UCs
  - Potential future pervasive UC with a novel set of requirements (e.g., versus handheld)
  - Benefit from joint high & low frequency operation (bandwidth & resilience)
  - Knowledge and data availability within the consortium (tracking, requirements, emulation)

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Overview of the Identified Use Cases

Preliminary Learnings Regarding the Use Cases

Identified Use Cases

	Listed use case suggestions
Immersive multimedia (AR/VR/XR)	UC1: Mixed Reality (MR) in industrial environments
	UC2: Professional Virtual Reality (VR) training
	UC3: Remote surgery, enabled by VR telepresence
	UC4: MR surgery
	UC5: Social XR interaction/interactive classroom
	UC6: AR-enriched events
	UC7: XR in a metro/train station
URLLC	UC8: Cooperative mobile robots & flexible manufacturing
	UC9: Digital Twin (DT) in Industrial Environments
	UC10: Position tracking of roots and UVs
Positioning /tracking	UC11: Tracking of goods and real-time inventory
	UC12: Contact tracing and people tracking in large venues
	UC13: Location-based information transfer
	UC14: Crowd scenarios in public transportation
	UC15: Federated learning-based intelligent video surveillance for public safety in large venues
	UC16: Sub-THz radio stripe as fronthaul solution

Use case Classification

Classified the use cases based on their specific **common characteristics** or **similar technical challenges** that they pose on the system

Table 2 Matrix presentation of the use case families

		Application			
		Positioning/ tracking	AR/VR/XR	URLLC	High throughput
Environ-ment	Large venues, sport events, entertainment	UC12, UC13	UC6		UC15, UC16
	Industrial: manufacturing sites, factory, warehouses	UC10, UC11	UC1, UC2, UC13, UC8	UC8, UC9, UC10	UC16
	Public transportation stations	UC13	UC7		UC14
	Care/hospitals/ surgery rooms	UC13, UC10	UC3, UC4		UC16
	Education, classrooms, seminars		UC5		UC16

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Preliminary Learnings

- The over-the-air link budget demonstrates that **antenna gains** are required at both sides of the link.
- This should be achieved with some options to **steer or switch beams** in antenna arrays.
- The dense distribution of infrastructure antennas is an opportunity for **spatial multiplexing**.
- Challenging requirements reach beyond the capabilities of current wireless networks and conventional deployment of infrastructure
- A very high-capacity network will hence need to be pursued based on the combination of the utilization of a (very) **wide bandwidth** and a **dense deployment** of infrastructure antennas.

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If you need further information, please contact the coordinator:

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Bonus slides

Q&A Template

How 6GTandem Targets Extended Reality (XR) UCs

XR UC Requirement and Key Performance Indicator (KPI) Summary

Q&A Template

Which Multimedia use cases can be addressed with (B)5G technology according to your estimation, and for which, is it necessary to wait for 6G?

5G could cater to local XR SU or undemanding (low requirements) MU deployments. However, dense MU deployments, roaming deployments (load-based service migration), and camera-less XR may require larger bandwidth availability and AI network orchestration.

Do you expect stakeholders in the multimedia sector to be engaged in the short, medium or long term with new B5G/6G technologies?

Yes. VR (pass-through MR) HMDs are being used on the streets, indicating the inclination of users towards pervasive XR. Scaling these HMDs down to ergonomic devices, akin to prescription glasses, is likely to require occasional remote processing, hence, wireless links.

What B5G/6G enabled multimedia services/applications do you foresee becoming popular in the short and medium term?

Subscription-based XR gaming that does not require on-device or on-premise processing.

Which Network Functions and features are your use cases requesting access to?

Low-latency rendering, RF-based positioning and gesture detection, and general processing, for example, digital twinning in industrial settings and healthcare.

Which 5G System components is your project making use of?

Not explicitly using, yet envisioned: MEC for rendering/processing, eMBB for high-throughput XR video downlink with non-extreme latency and reliability constraints (e.g., 10 ms and 97%), and URLLC for critical uplink data (e.g., HMD pose updates).

What is the readiness of those, which platforms are you using to develop, is there any open-source toolbox as outcome of the project?

Publicly-accessible tracking data for XR training and XR gaming; 28 GHz channel measurements for XR-like applications.

https://zenodo.org/records/10836884 https://zenodo.org/records/10822725

Bonus slides

Q&A Template

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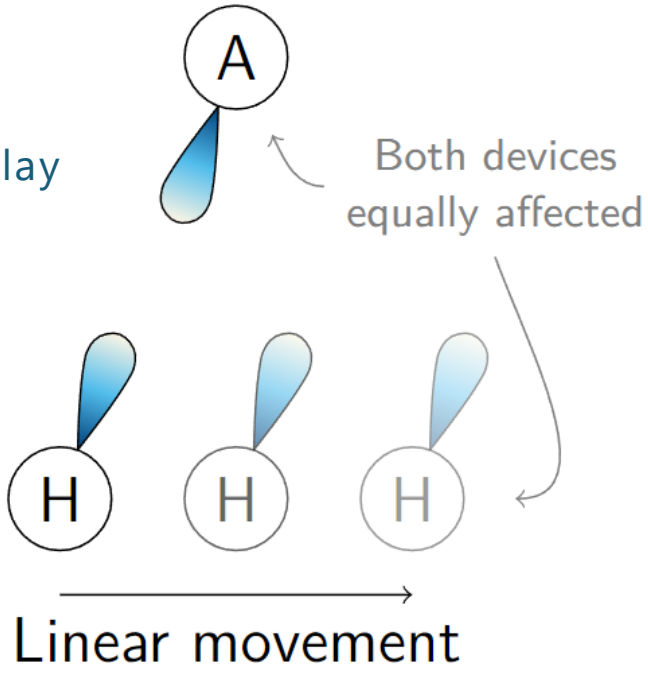
XR UC Requirement and Key Performance Indicator (KPI) Summary

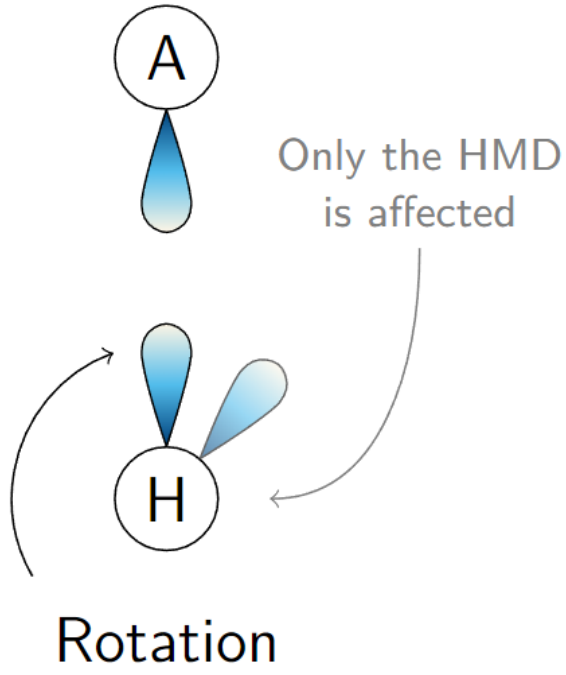
General XR Challenge 1: Rotation

A: Access point

H: Head-mounted display



The HMD moves along a tangent, intercepting the shortest distance mid-way through the movement

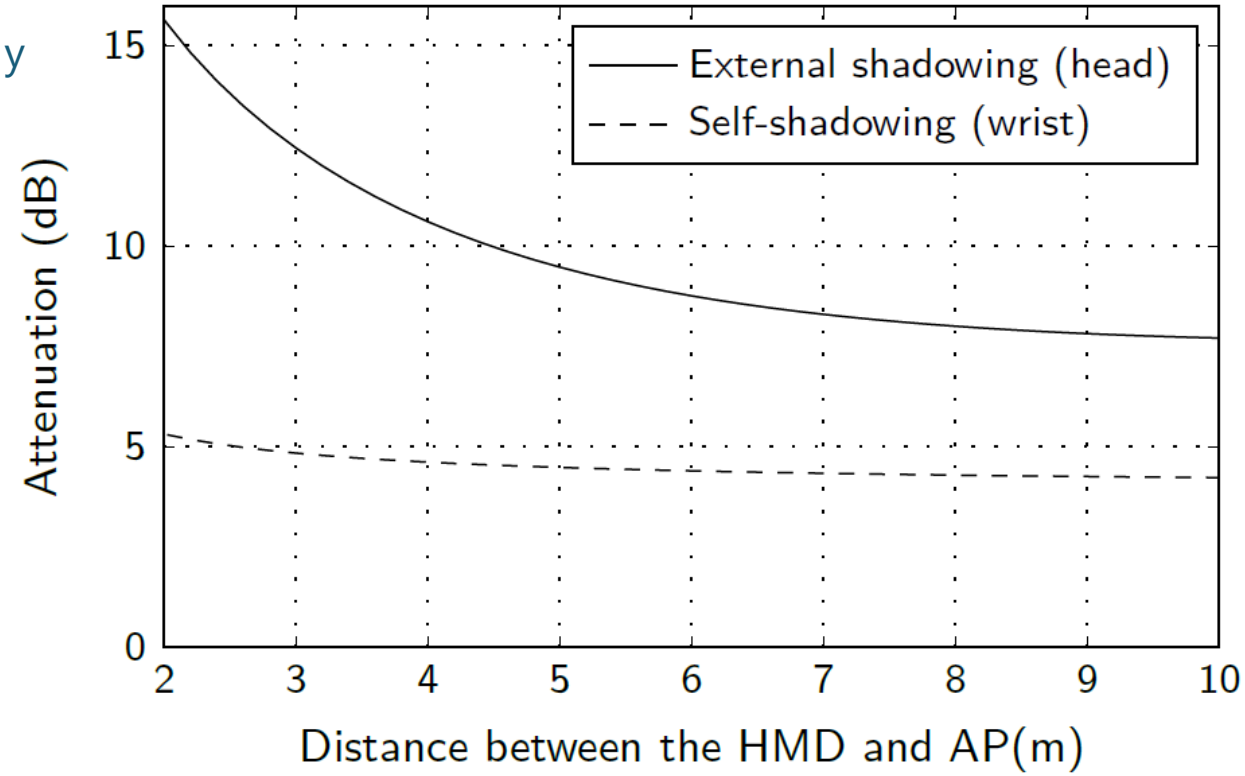


The axis of rotation is perpendicular to the AP–HMD axis

Sub-THz XR Challenge 2: Large-Scale Fading

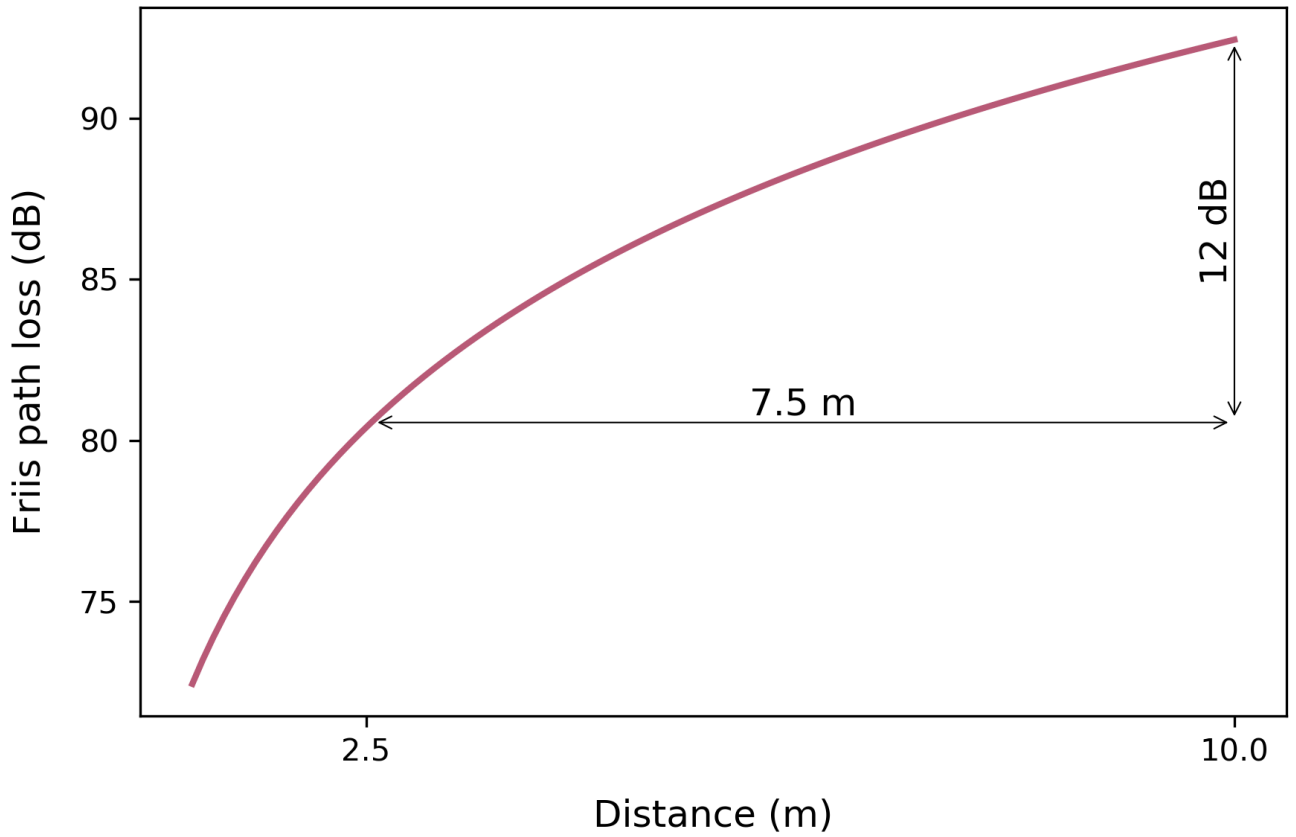
AP: Access point

HMD: Head-mounted display

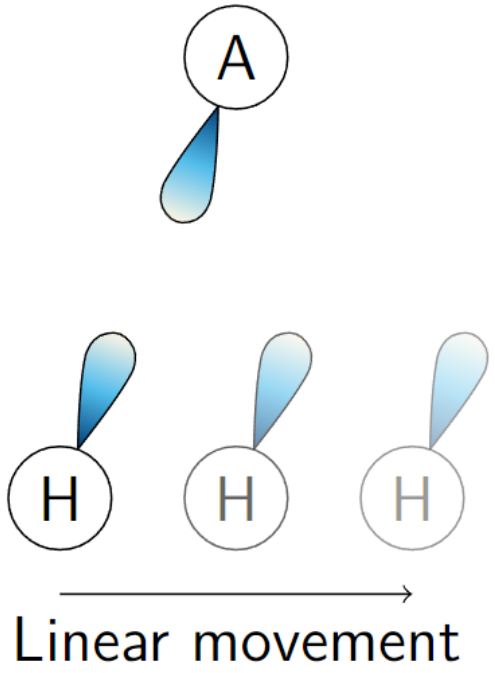


Unchanged Gain with Less Antennas

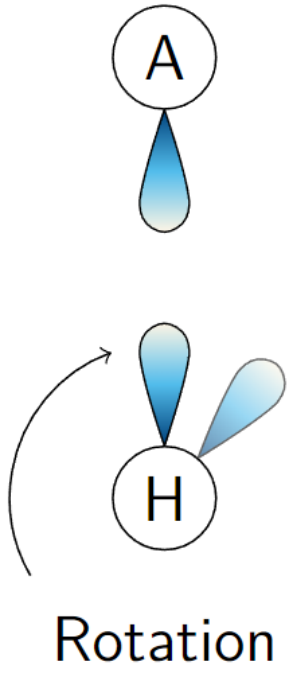
(wider beams, less beam management)



Real-Time, Resilient, High-Throughput XR



Solve using sub-15 GHz coarse estimation



Solve with dense sub-THz deployment

Bonus slides

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How 6GTandem Targets Extended Reality (XR) UCs

XR UC Requirement and Key Performance Indicator (KPI) Summary

The Considered XR UCs

Remote Surgery using Virtual Reality (VR) HMDs

Surgeons perform remote surgery using VR telepresence, employing high-resolution HMDs and haptic tools for precise and immersive operations.

Surgical Room Mixed Reality (MR)

Doctors and nurses use MR HMDs in surgical rooms to receive enhanced visual guidance, such as incision guides and vital stats.

Industry 4.0 MR

In an industrial setting, a machine operator utilizes an HMD with superimposed digital twin information and haptic gloves for detailed manual control.

VR Training

Emergency service members train in VR using multisensory suits to simulate real-world disaster response scenarios.

Social VR/MR

A group uses standalone HMDs in various ad-hoc confined spaces for interactive XR experiences like gaming or prototype evaluations.

VR-Enriched Events (Future Pervasive XR)

Simple and ergonomic HMDs as HUDs, used to provide stats, animations, and navigation, with the potential for integration into everyday use.

Requirements and KPIs of the XR UCs

	Healthcare		Industry		Consumer	
	Remote VR	S. room MR	Ind. 4.0 MR	Training VR	Social VR/MR	Event MR
Resolution	4K	4K	4K	4K	2K	2K
Color depth (b)	10	8	8	10	8	8
Num. of colors	3	1	1	3	4	1
Frame rate (FPS)	240	240	240	120	90	60
Peak mobility (°/m)	180	180	180	360	180	180
Num. of users	4	4	4	1	12	50,000
User density (m^{-2})	2	2	1	1	2	4
Deployment	Local	Local	Roaming	Local	Roaming	Roaming
User DL (Mbps)	384	102	102	182	48	12.5
User UL (Mbps)	0.4	0.4	135	1.2	5	5
Sum DL (Mbps)	1,536	408	408	182	576	625,000
Sum UL (Mbps)	1.6	1.6	576	1.2	60	250,000
M2P latency (ms)	20	20	20	30	40	50
E2E latency (ms)	6+6	6+6	6+6	6+6	9+9	8+8
Video reliability (%)	99	99	99	97	97	97

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