

# 6GTandem KPI/KVI

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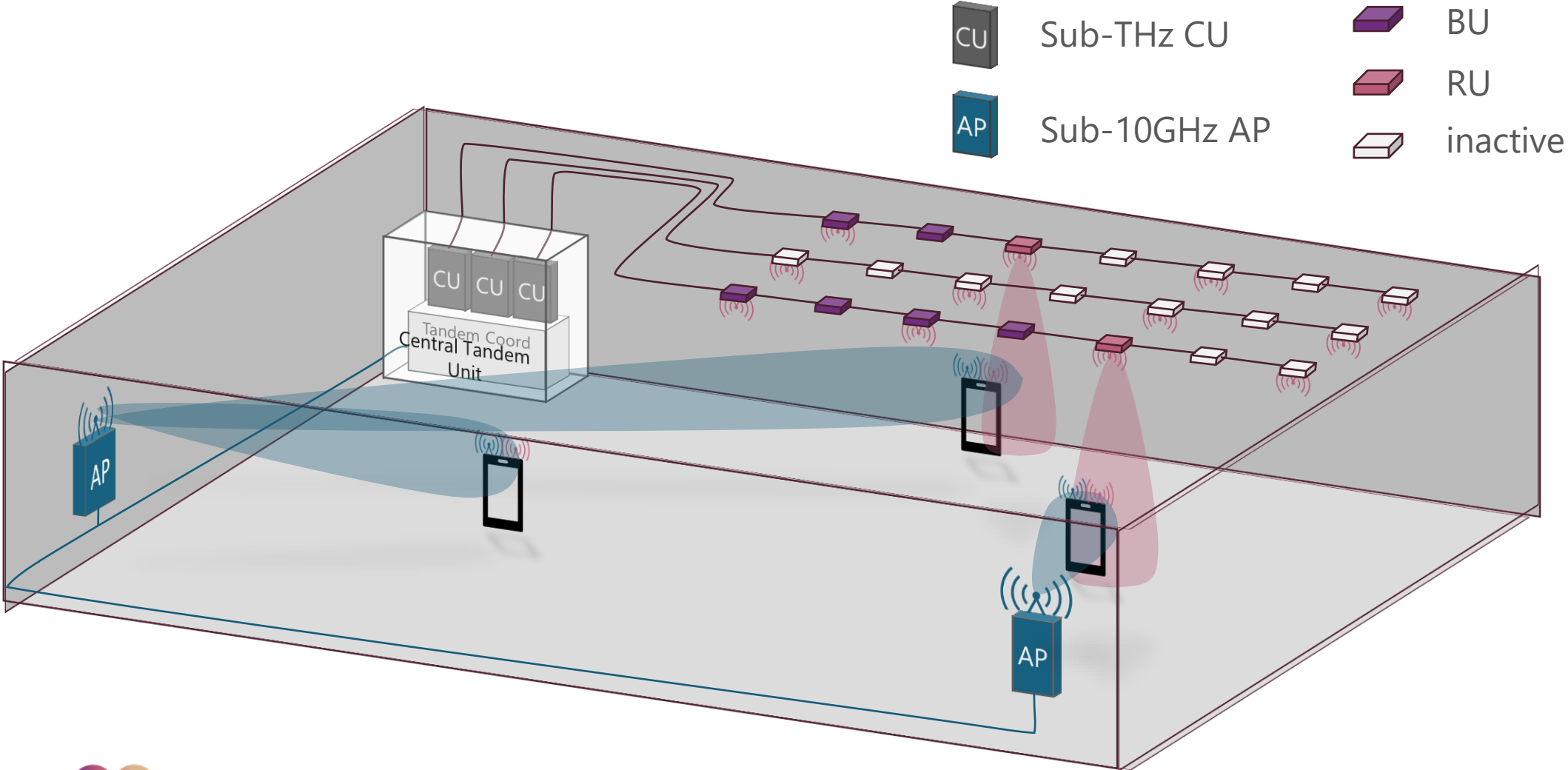


**6G**Tandem

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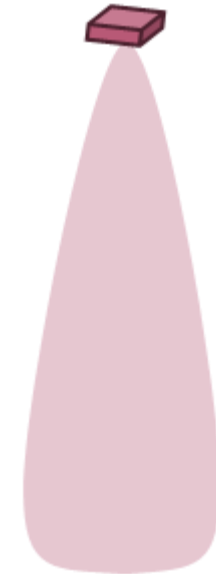


# 6GTandem system, topology and terminology



# Tandem operation for E2E services opens new possibilities

Sub-THz user plane:  
Offers high performance services



Sub-10GHz: control plane:  
Enables smooth/reliable operation

# Enabling technologies in 6GTandem

- We target (very) high bandwidth (over Sub-THz link) to provide throughput and enable high accuracy positioning
- Dense multi-user capacity: schedule users - fibers
- Dual frequency operation



- KVIs
  - Lowering Capex and Opex
    - Radio stripe is **flexible** and is a **light** and **low-cost** deployment
    - Radio stripe could be installed on the **walls** and **ceilings**, bringing the **RUs closer to the users**, adding more **degrees of freedom** for the installation
  - Socio-economics:
    - Needs of **society** and the **industries**, when it comes to **health**, **entertainment** and improved **industrial processes**.

Literature review: we have mainly scouted the use cases from the relevant previous/ongoing EU projects (such as **Hexa-X**, **Reindeer**) as well as the latest **3GPP** documents

# Deployment Scenarios



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3 selected environments: Industrial sites, sport event arenas, and public transportation hubs

**Link budget calculations** helped us with identifying the **requirements** (e.g. the ceiling height ranging from **3-13m**) and sketching deployment scenarios

6G wireless connectivity need for: **Flexible, autonomously controlled** and **adaptable** to new production scenarios



# Deployment Scenarios- Public Transportation Hubs

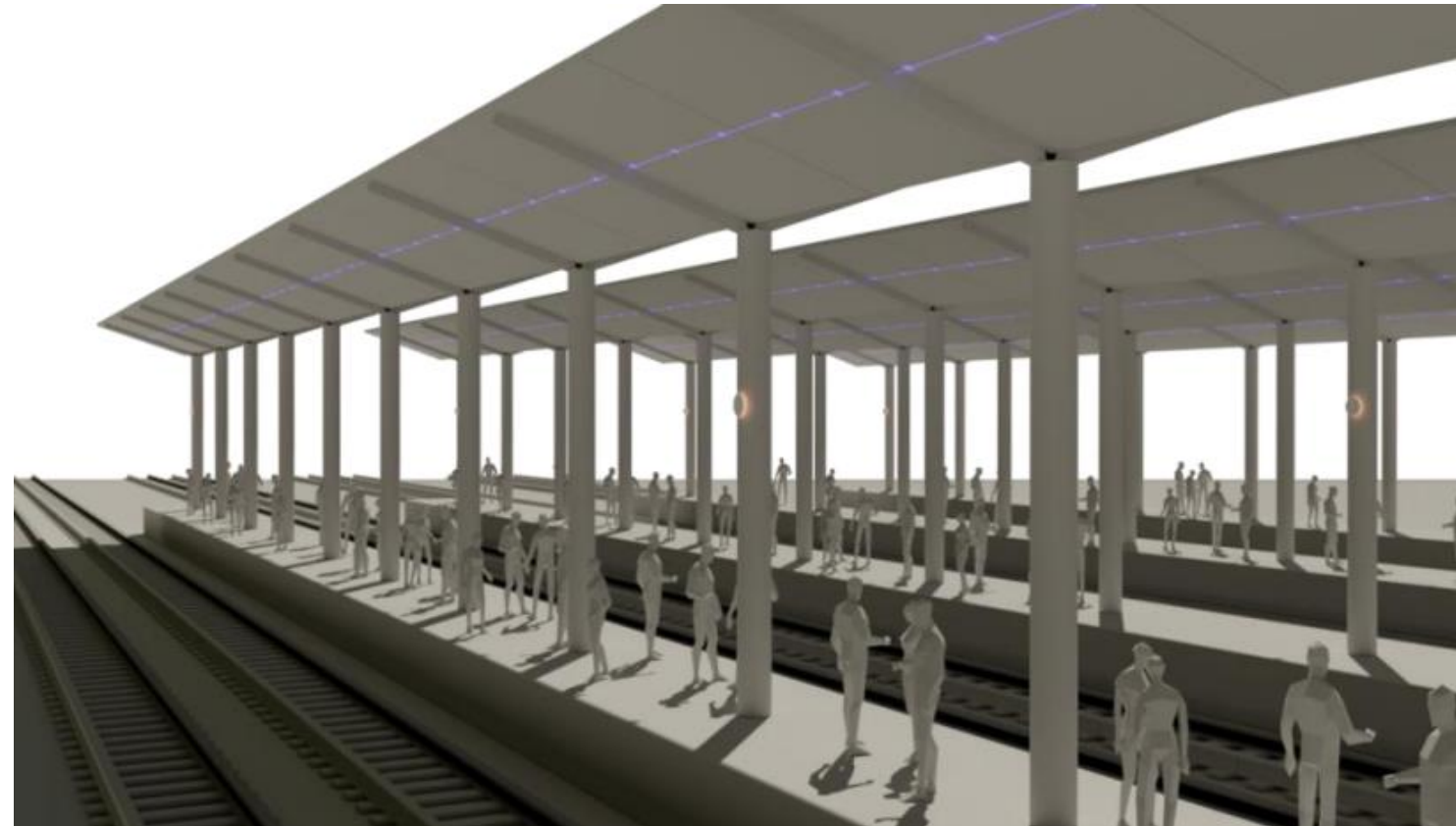


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**Impact on society:** Affecting the way people commute, offering the future of smart, efficient, and sustainable urban transportation system

**Characteristic: Dense concentrations** of passengers can place a significant strain on the communication infrastructure, congesting the wireless networks

**Passenger's experience** is paramount yet achieving and maintaining **reliable communication** systems is also a **public safety concern**



# Deployment Scenarios- Sport Event Arenas

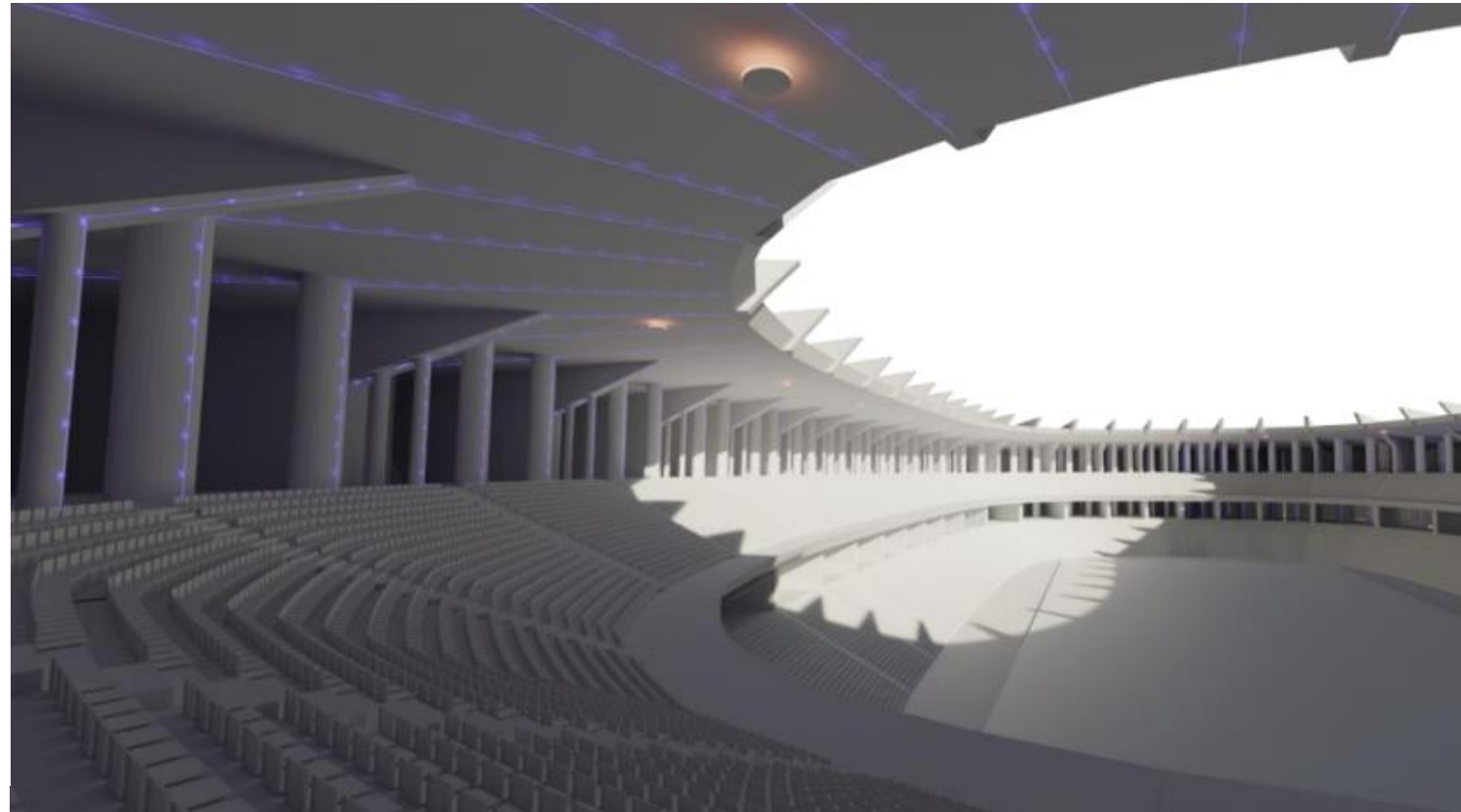


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**Impact on society:** Smart and connected stadium market

**Characteristics:** **Dense concentration** of spectators

The inclusion of **IoT** in smart stadiums and spectators need to share/interact/**stream high data rate video content** from AR/VR/XR HMDs exerts ever increasing demand on mobile coverage





# KPIs

KPI	
Capacity	Peak Data Rate
	User Experienced Data Rate
	Network Capacity
	Service Bandwidth
	Area Traffic Capacity
	Connection Density
Latency	User Plane Latency
	Control Plane Latency
	E2E Service Latency
	New Latency contribution components
	E2E Application Latency – for Video processing services
	Mission critical QoS of services – latency related
	Runtime Delay
	Service Setup Delay
	Slice Setup Delay

Packet Loss	Packet Error Rate
	Layer2/3 packet transmission success rate
	Packet Loss Rate
	Frame Loss
Compute	Signal Packet Loss
	Edge computational resource usage
	Operation expenditure @edge
	Delta in network management decision
	Availability
	Resource utilization
	Computing resource utilization
Energy	Network Energy efficiency
	Device Energy Efficiency
	Reduced energy consumption
	VNF Energy consumption reduction

Security	Anomaly detection precision
	Security conformance
	Tenant data privacy
Localization	Localization accuracy
	Direction and orientation accuracy
	Localization related delays
	Localization (error) integrity
Service	Service availability
	Service reliability
	Service safety, integrity, maintainability
	CAPEX & OPEX reduction

# Identified Use Cases



Listed use case suggestions	
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 UAVs
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 cases-Key Performance Indicators



## Assumptions:

- Real-time video compression with a ratio of 1:300 (h.265) is considered. Note: **traffic volume density** and **latency** is affected by this
- Use the sub-10GHz radio for providing **reliable coverage** and the sub-THz for coping with the stringent requirements **on data rates as well as latency**.

## Key take aways:

Highest **traffic volume density DL**:

768Mbps/m<sup>2</sup>

User experience data rate: few Mbps-400 Mbps

**Reliability:** >5-nines in automation in industry 4.0

Table 13 Summary of KPIs for all the presented use-cases

	Use case														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Traffic volume density DL (Mbps/m <sup>2</sup> )	104	193	768	204	76	24	12	12	20	40	100	2	100	100/25	259 000
Traffic volume density UL (Mbps/m <sup>2</sup> )	50	5	20	10	12	32	2	14	10	50	100	2	100	50/50	129 500
User density (1/m <sup>2</sup> )	1	1	2	2	2	4	2	2	0.2	5	100	2	10	1-2	
E2E latency (ms)	6+6	6+6	6+6	6+6	9+9	8+8	8+8	<25	<10 0	10	100	100 0	100 0	2-4	600 00
Reliability (%)	99	97	99	99	97	97	97	99.9 99	99.9 99 %	99.9 999	99.9 %	99.9 %	99 %	99.9 9	99
Positioning & mapping Accuracy (cm,degree)	<5 <5°	<5 <5°	<5 <5°	<5 <5°	<5 <5°	100 <5°	100 <5°	1-5 <1°	1 <10 °	1 <10 °	1	100	50	30	
Mobility(m/s)	<6	<6	<6	<2	<6	<6	<6	<10	<10	<10	<10	<2	<2	2	