



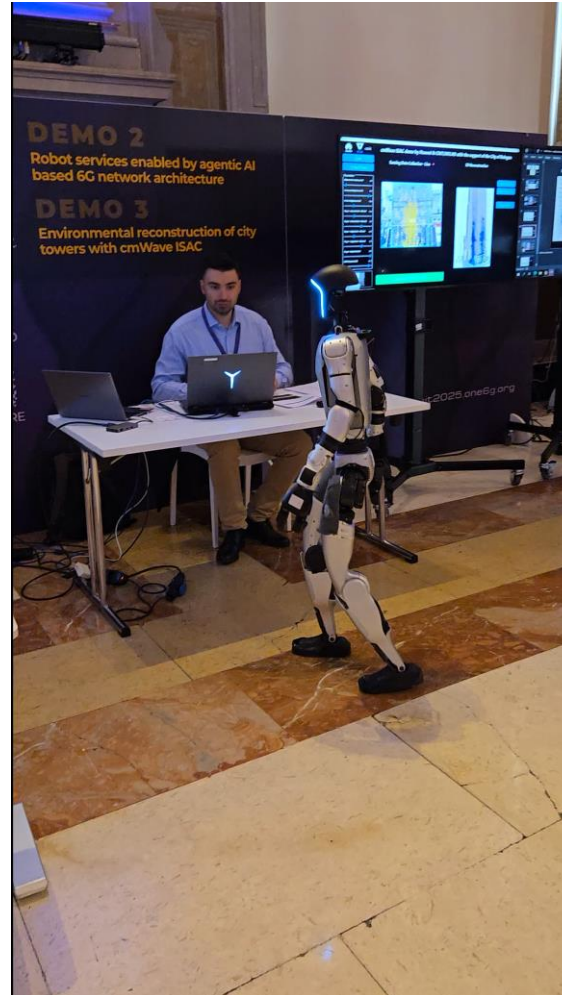
ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
Εθνικόν και Καποδιστριακόν
Πανεπιστήμιον Αθηνών
——— ΙΔΡΥΘΕΝ ΤΟ 1837 ———

Δίκτυα Νέας Γενιάς και Εφαρμογές

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Robotic Networks – the trend



New Generation Networks

- 5G/6G
- Advanced use cases
- Next Generation IoT
- Drones – swarm networking
- Robots – robotic networks- Agentic AI network architecture
- Digital Twins



Enablers



A⁴ - Access to data:

- ☐ Anytime
- ☐ Anywhere
- ☐ Any Volume
- ☐ Any Thing (M2M/IoT)

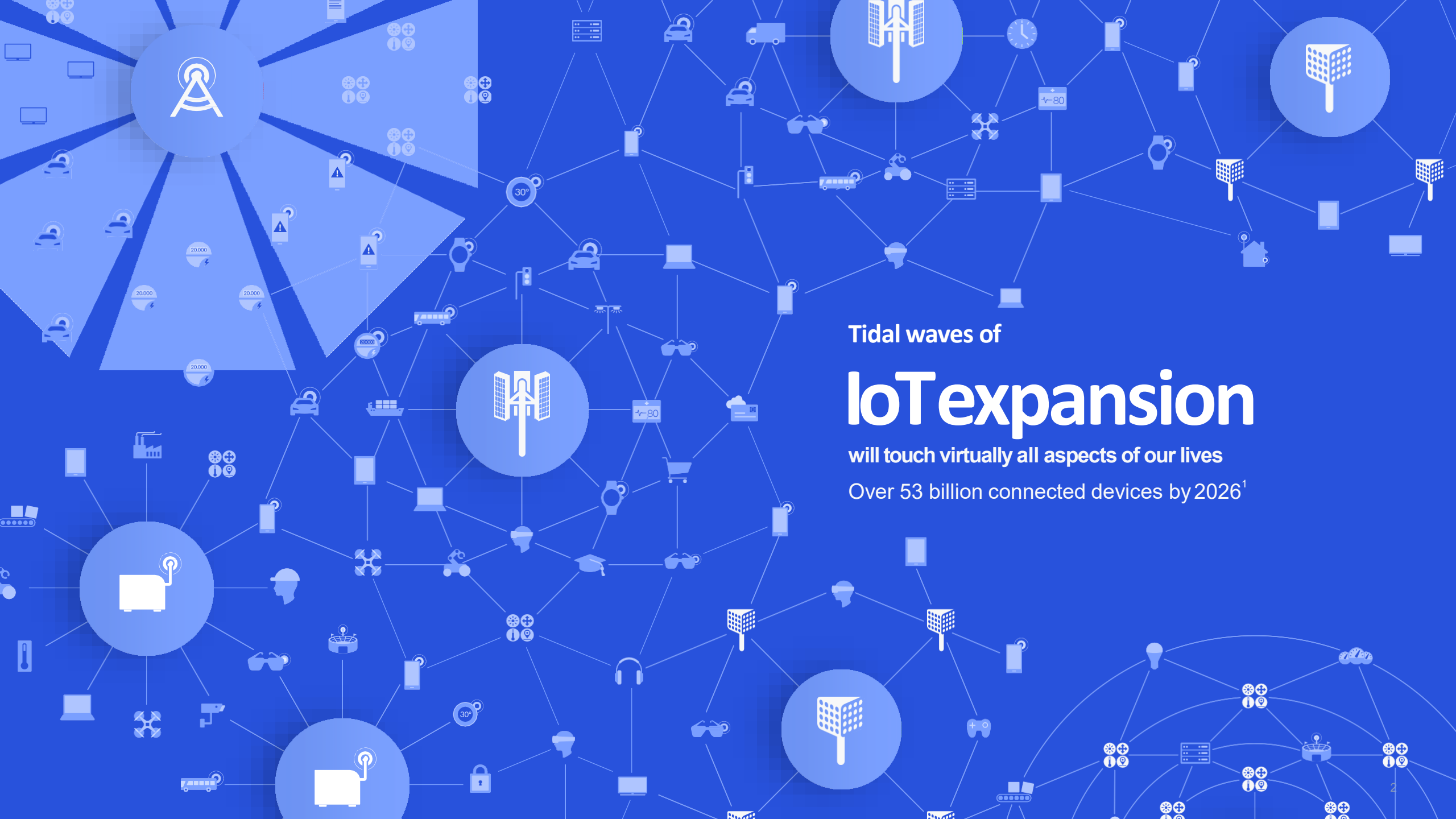
Connectivity

- ✓ Ubiquitous
- ✓ Resilient
- ✓ Secure

Cloud native services,
big data, AI

Service categories, use cases, ...

- A **service category** is a **set of services that share some common characteristics in terms of connectivity**
 - Three categories defined by ITU: **eMBB (enhanced Mobile Broadband)**, **mMTC** (massive Machine type Communications) and **URLLC (Ultra Reliable Low Latency Communications)**
 - Services within each category may not have the same KPIs, but at least they share some basic parameters
- A **use case** is a **real-life application** that can cover **one or more service categories (eMBB, mMTC, URLLC)**
 - A given use case can support different services, belonging to one or more service categories
- A **service** can be provided **within a use case and scenario**, with particular characteristics in terms of KPIs (Key performance indicators)
 - E.g. UR/VR applications, UHD video, factory control, etc.
 - Each service should have clearly identified KPIs



Tidal waves of

IoT expansion

will touch virtually all aspects of our lives

Over 53 billion connected devices by 2026¹

Efficiently expanding the IoT requires a new distributed intelligence paradigm

Current

Cloud-centric intelligence

IoT services depends on the central cloud to extract value



Latency could be over 100s ms today

Future

Distributed intelligence

Based on economic and performance tradeoffs for IoT use cases



Distribute functions to meet diverse system requirements, e.g., latency, privacy

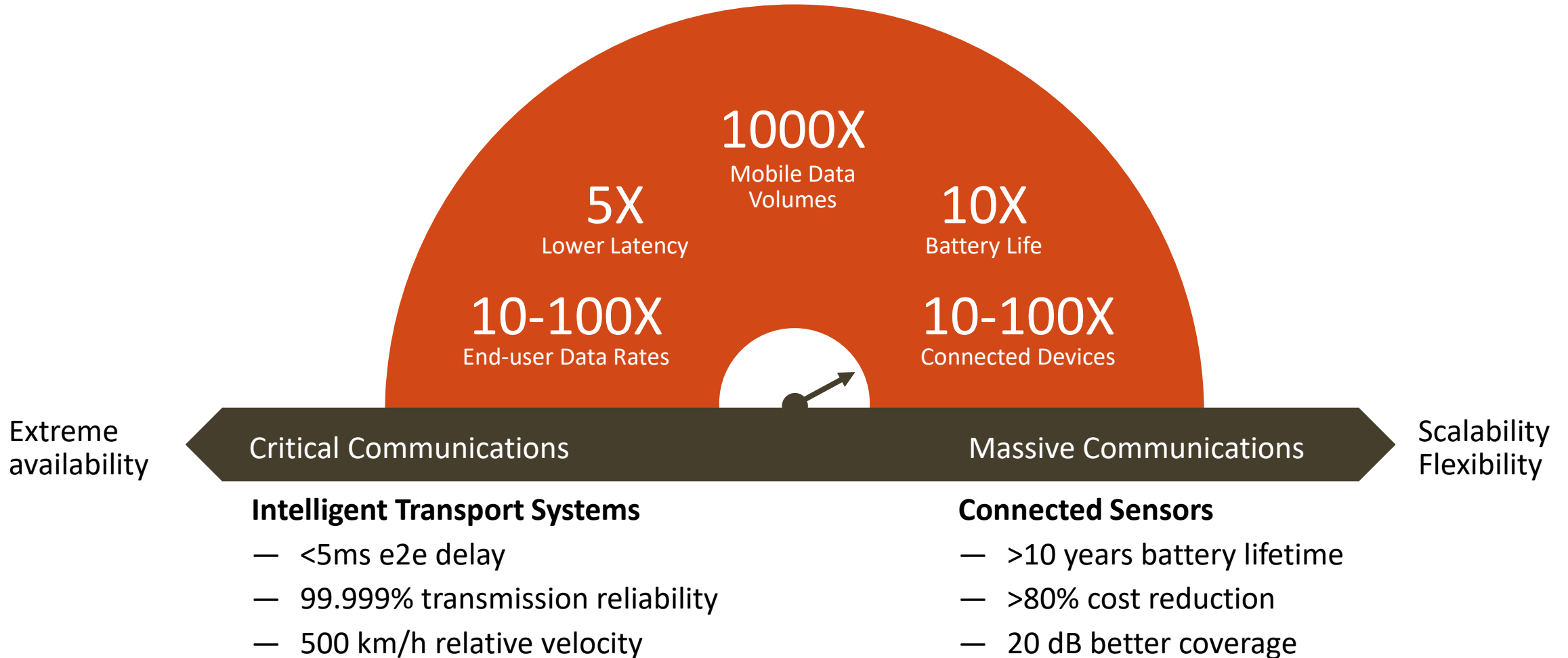
5G



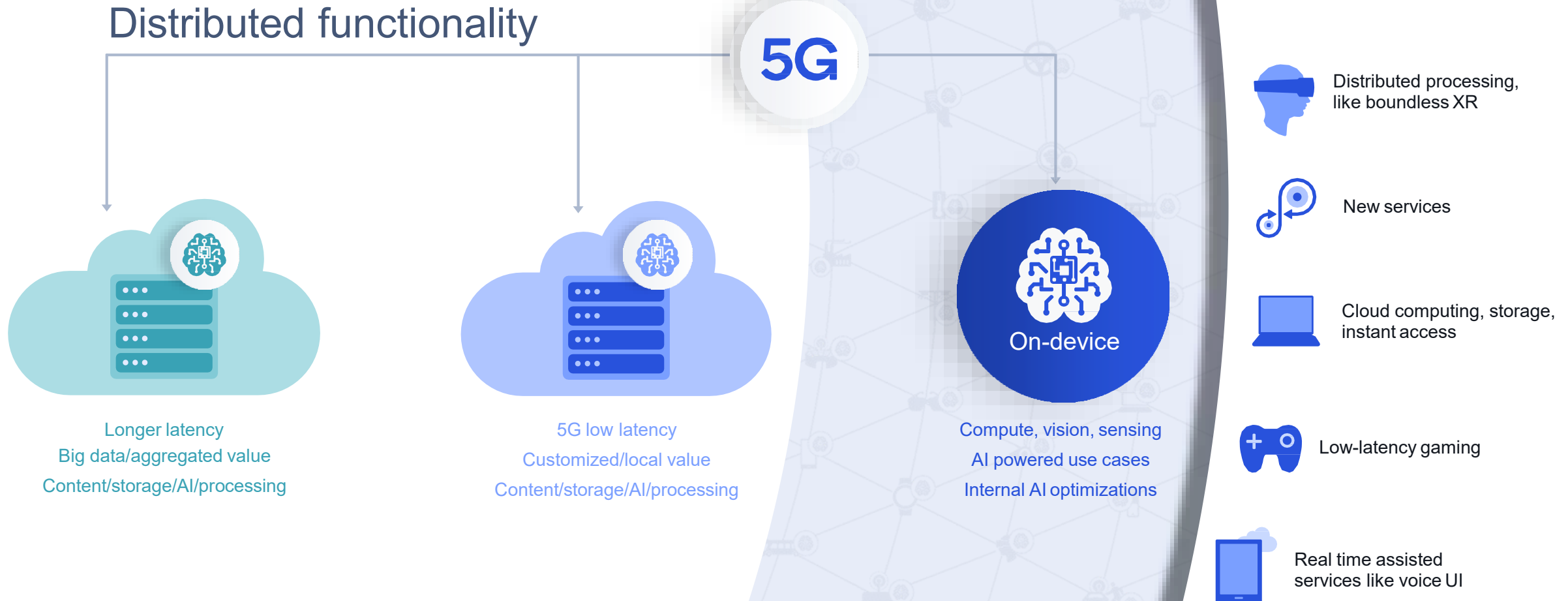
Latency as low as 1 ms



5G : specifications



New services



Delivering on the 5G/6G vision

Where virtually everyone and everything is intelligently connected





5G: Wireless networks economy

Powering the digital economy

\$13.2 Trillion

in global economic value by 2035*



Precision agriculture

\$389B



Construction and mining

\$1,061B



Digitized education

\$258B



Connected healthcare

\$1,056B



Richer mobile experiences

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Smart manufacturing

\$4,687B



Intelligent retail

\$1,198B



Smart city

\$2,242B



* The 5G Economy, an independent study from IHS Markit, Penn Schoen Berland and Berkeley Research Group, commissioned by Qualcomm

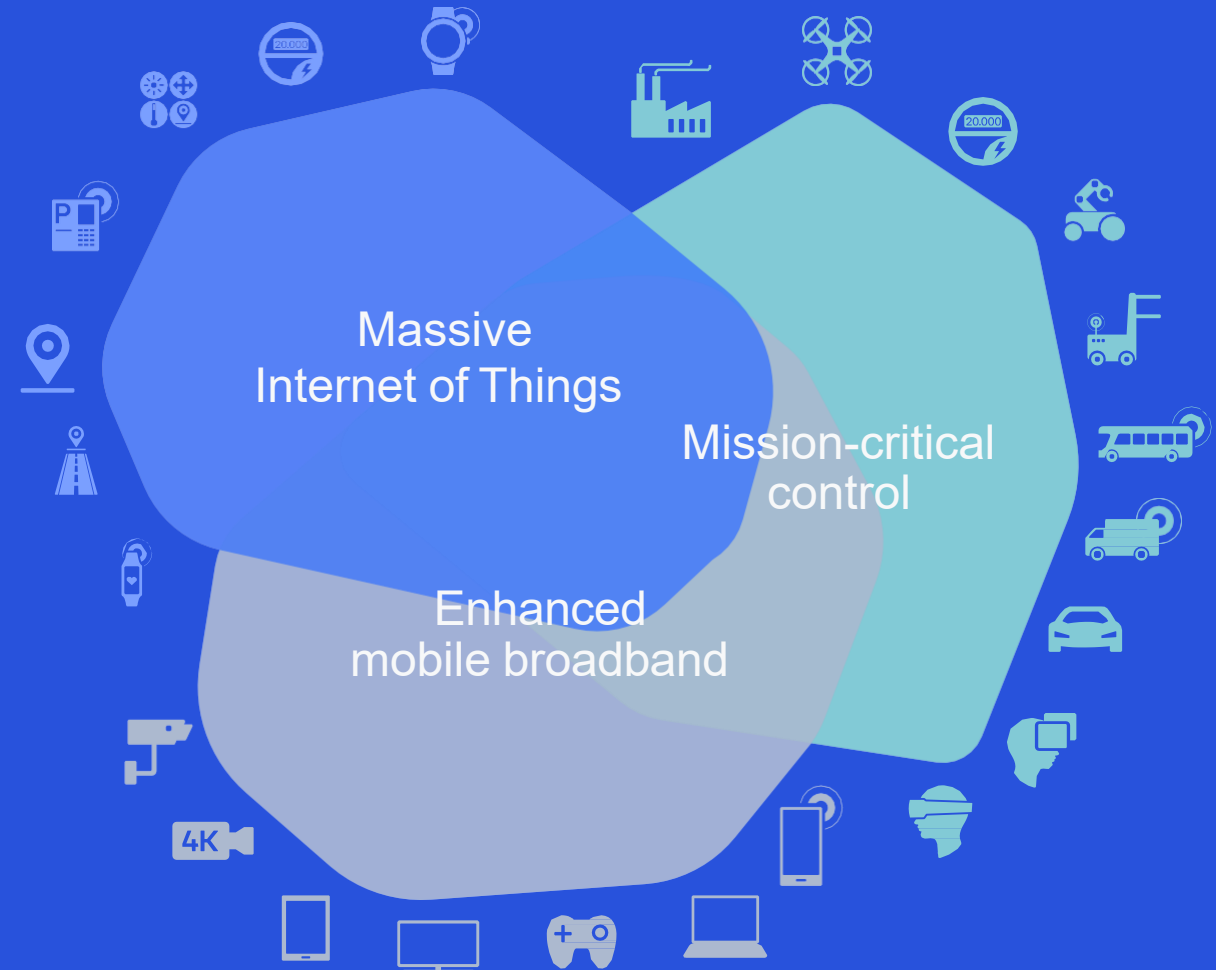
5G: A unified innovation platform for this decade and beyond



5G is the common connectivity platform

for the IoT

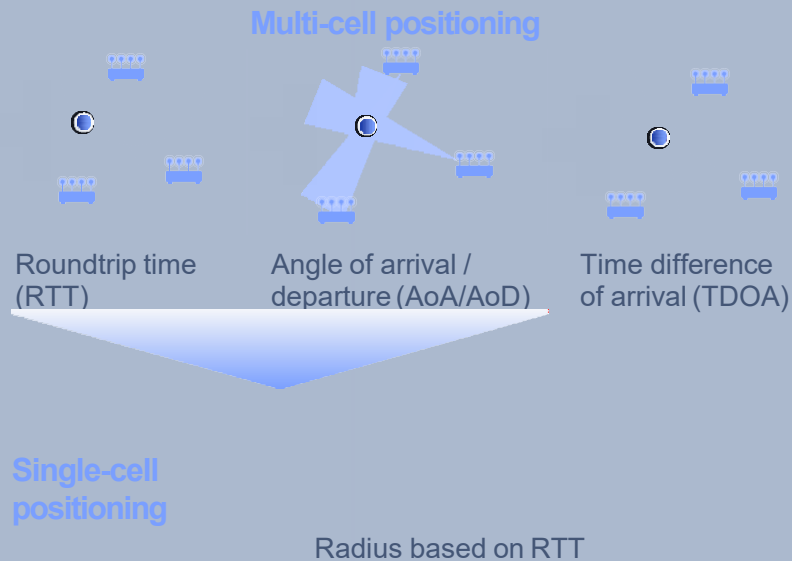
Broad set of devices and services
For all spectrum bands¹ and types²
Public and private networks



5G positioning supports a wide range of IoT use cases

Release 16

Meeting initial accuracy requirements of 3m (indoor) to 10m (outdoors) for 80% of time



Release 17

Enhancing capability and performance for a wide range of use cases



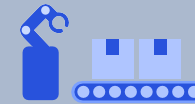
New evaluation scenarios

Supporting new channel models for industrial IoT environment



Centimeter level accuracy

Meeting absolute accuracy requirements¹ of down to 0.2m



Lower latency

Reducing positioning latency to as low as 10ms



Higher capacity

Scaling to millions of simultaneous devices (e.g., IoT, automotive)

¹ 5G positioning requirements defined in TS 22.261; ² Such as GNSS, beacons, sensors, Wi-Fi/Bluetooth

For indoor and outdoor applications

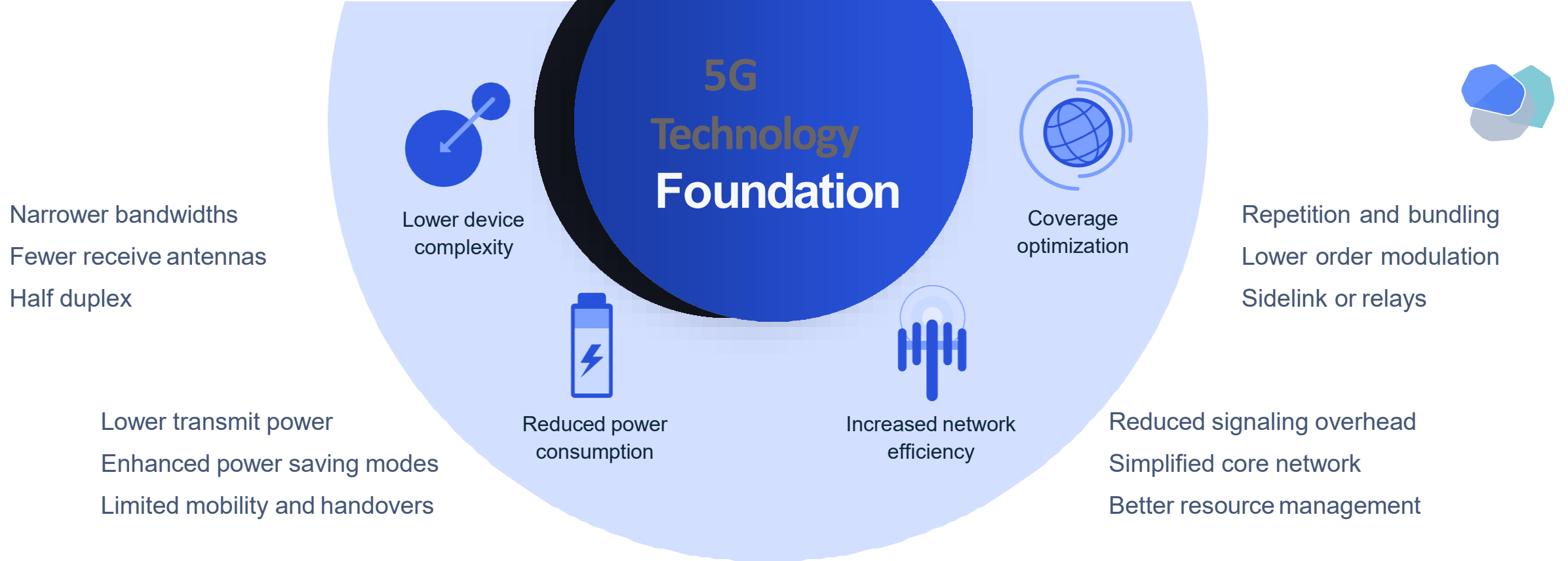
Targets various accuracy and latency requirements

Complements existing positioning technologies²

Optimizing 5G NR for Boundless XR experiences

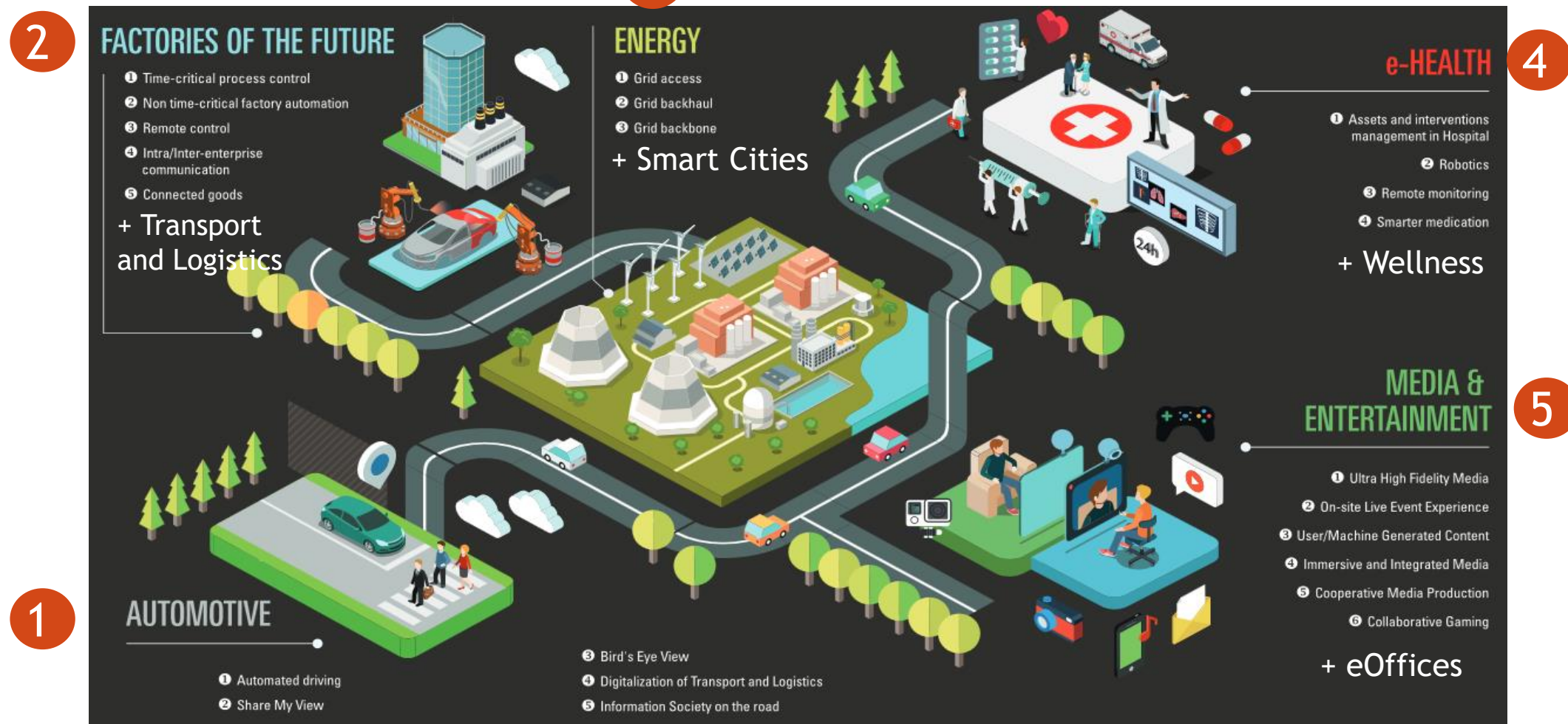


¹ For example, using File Error Rate (FER) and File Delay Budget (FDB) that are used by the app function vs. Packet Error Rate (PER) and Packet Delay Budget (PDB)



Scaling down 5G for lower complexity IoT devices

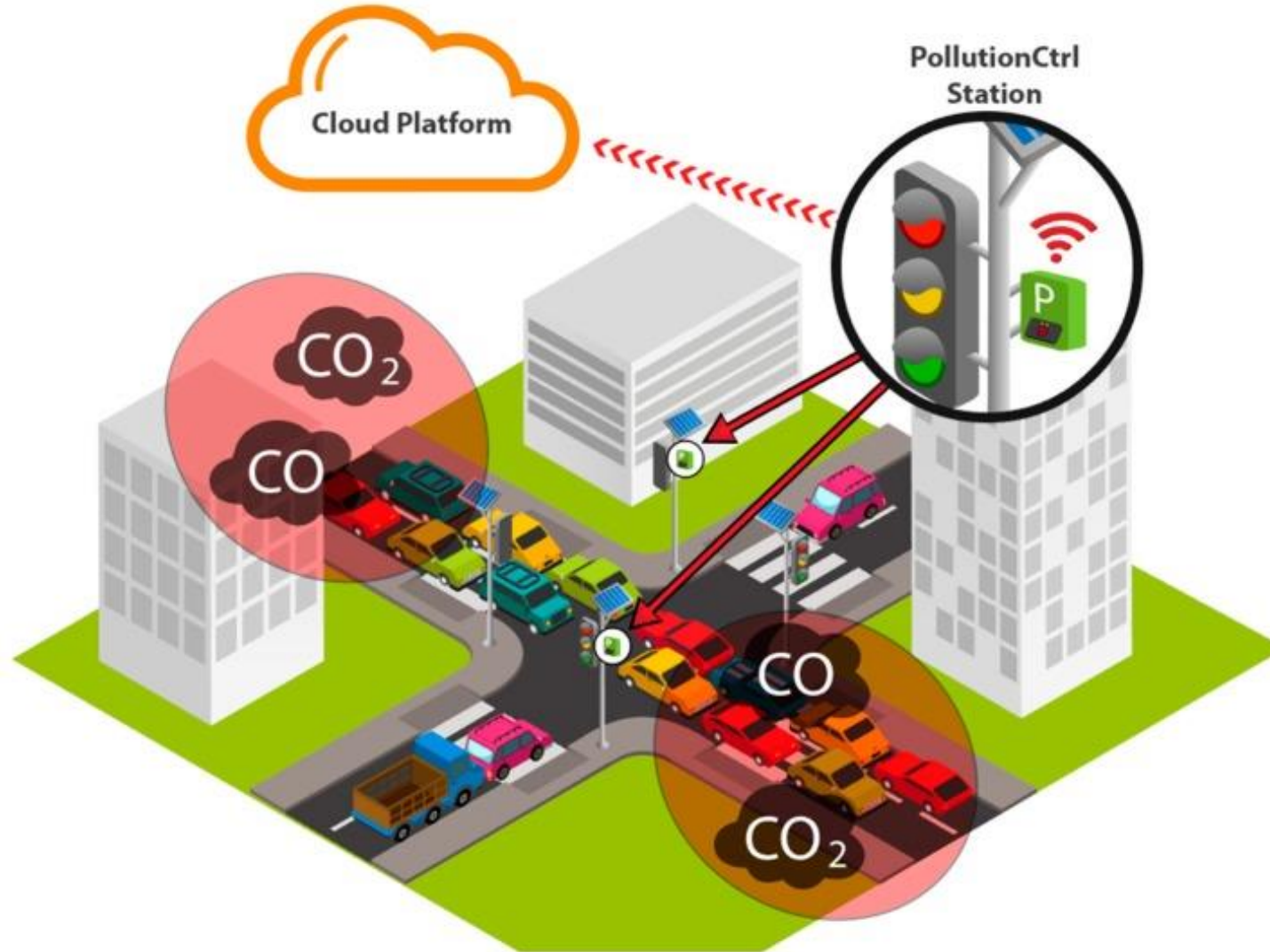
Vertical Industries supported by new generation networks



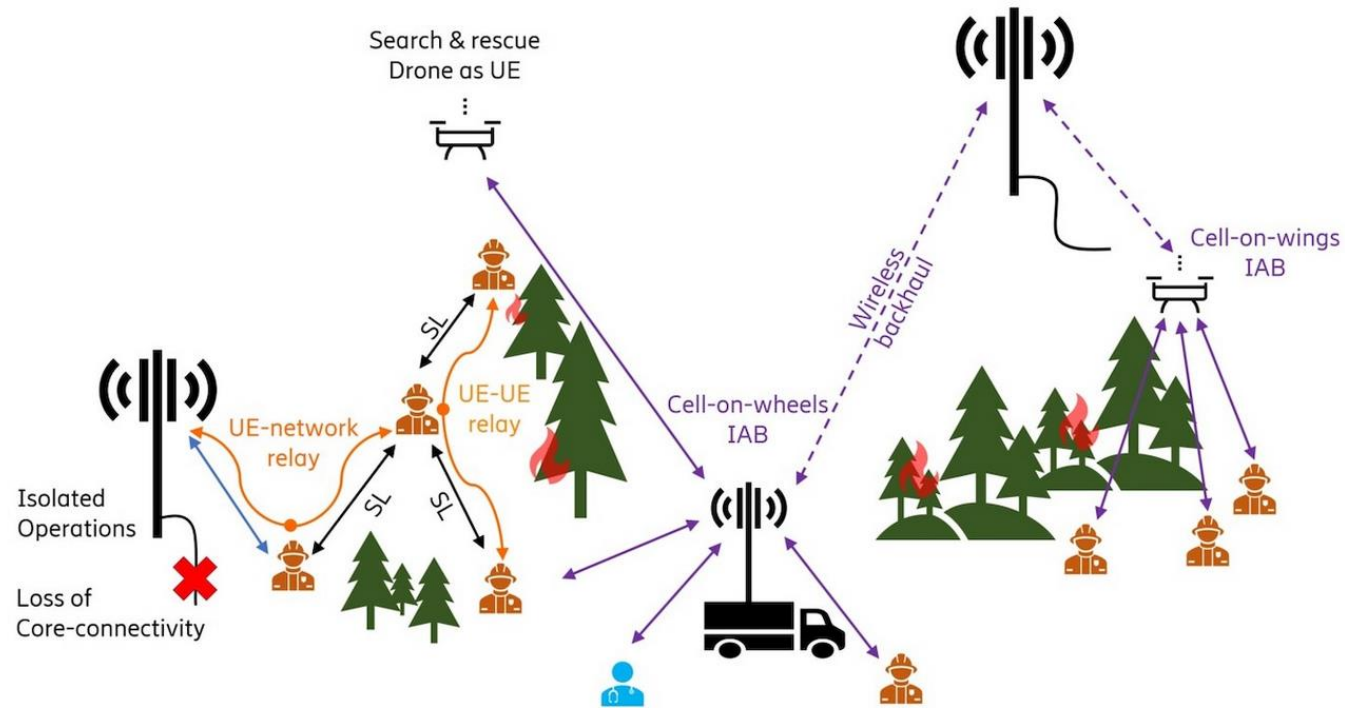
IoT PLATFORM for Monitoring Smart Cities' Pollution

- The Internet of Things platform for monitoring smart cities' pollution contains the following components:
 - Wired and wireless sensors for various metrics measurements;
 - IoT gateway(s)/node(s) for data collection
 - IoT communication middleware with security features for sending data to IoT clouds.
 - IoT cloud solution for mathematical, statistics, and artificial intelligence (AI) models for data analytics and data science techniques

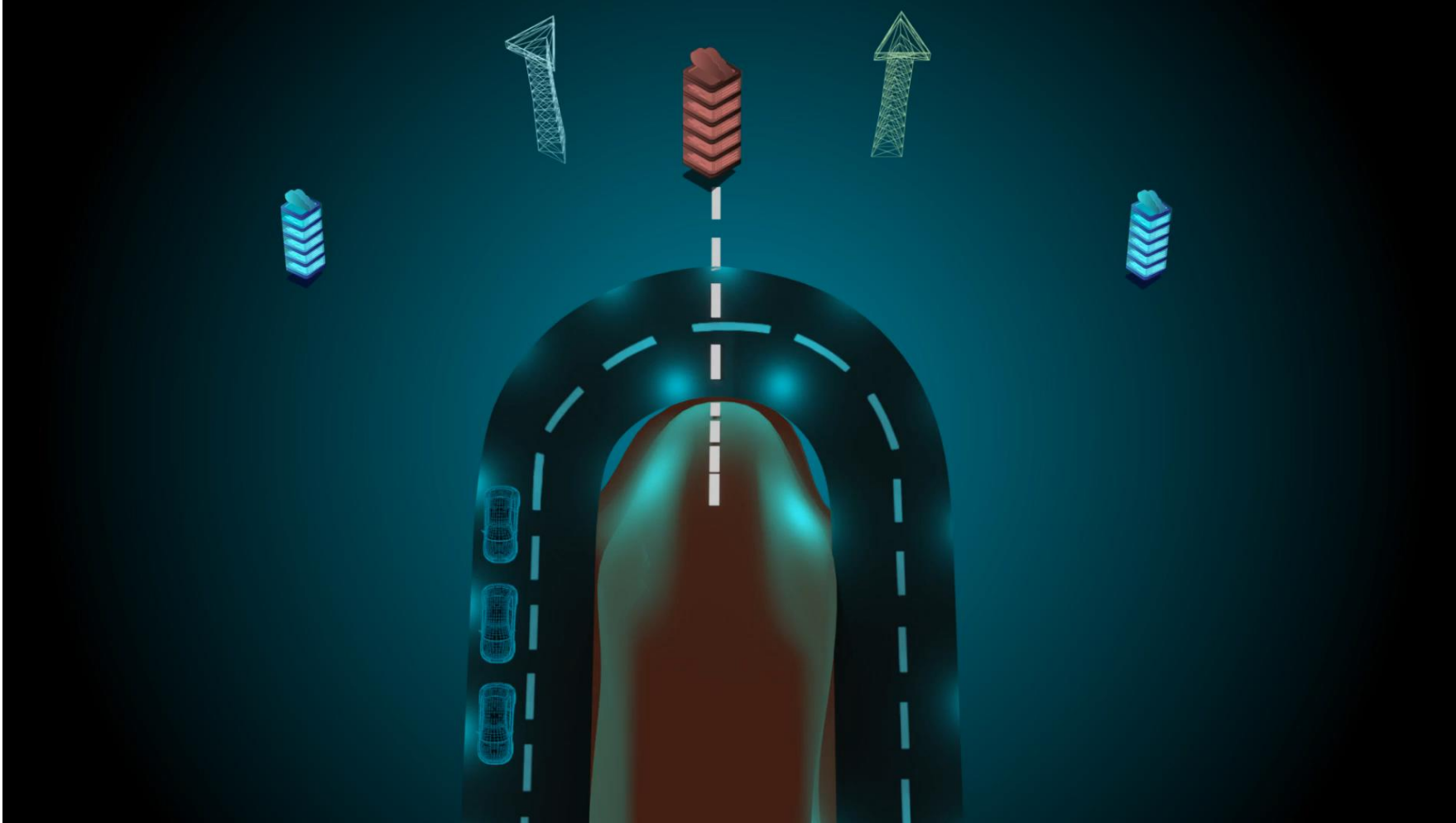
Environmental Monitoring



Smart Nets for Crisis Management



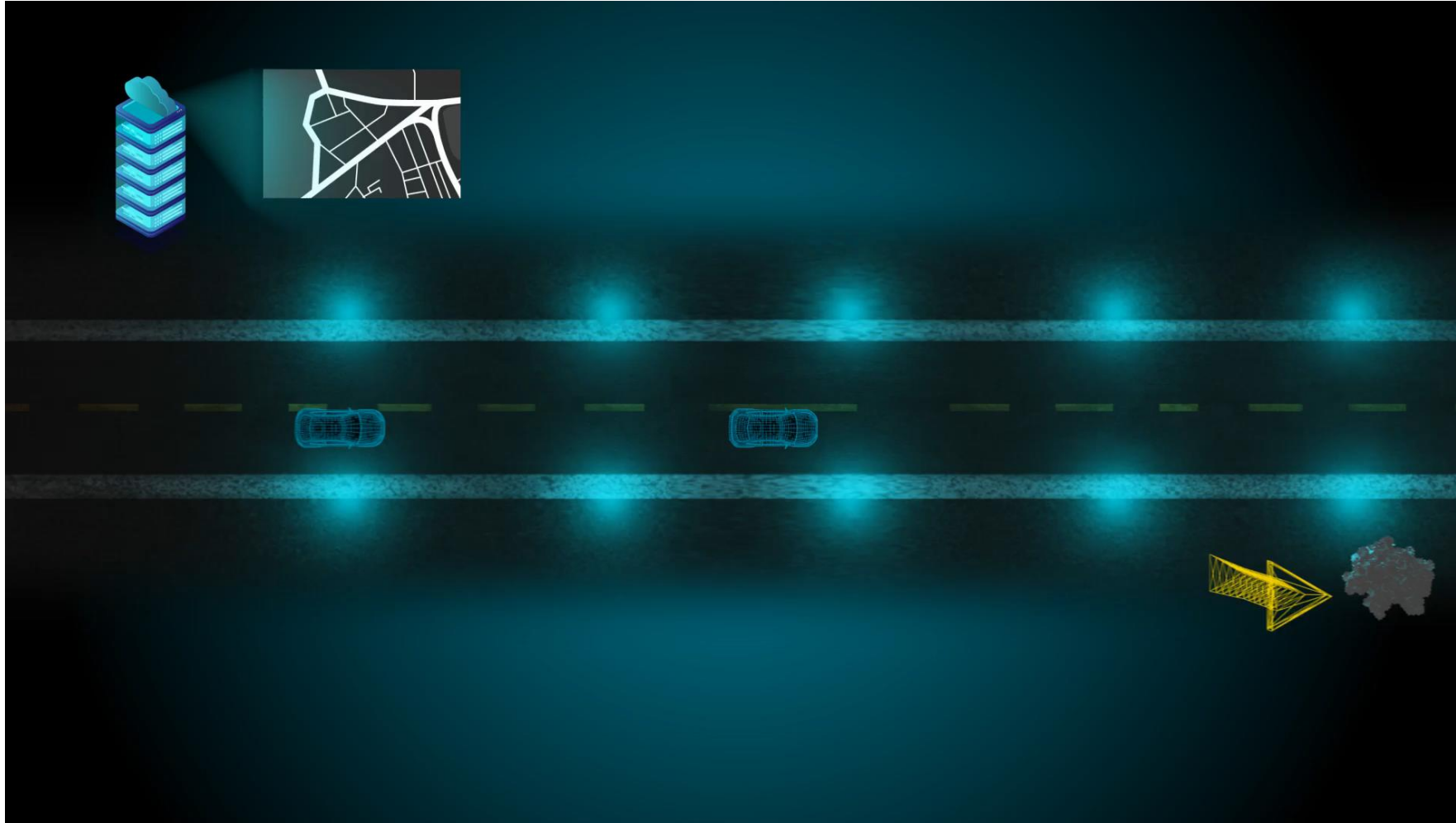
Autonomous driving – Cooperative hazardous situation detection for cross border traffic jam



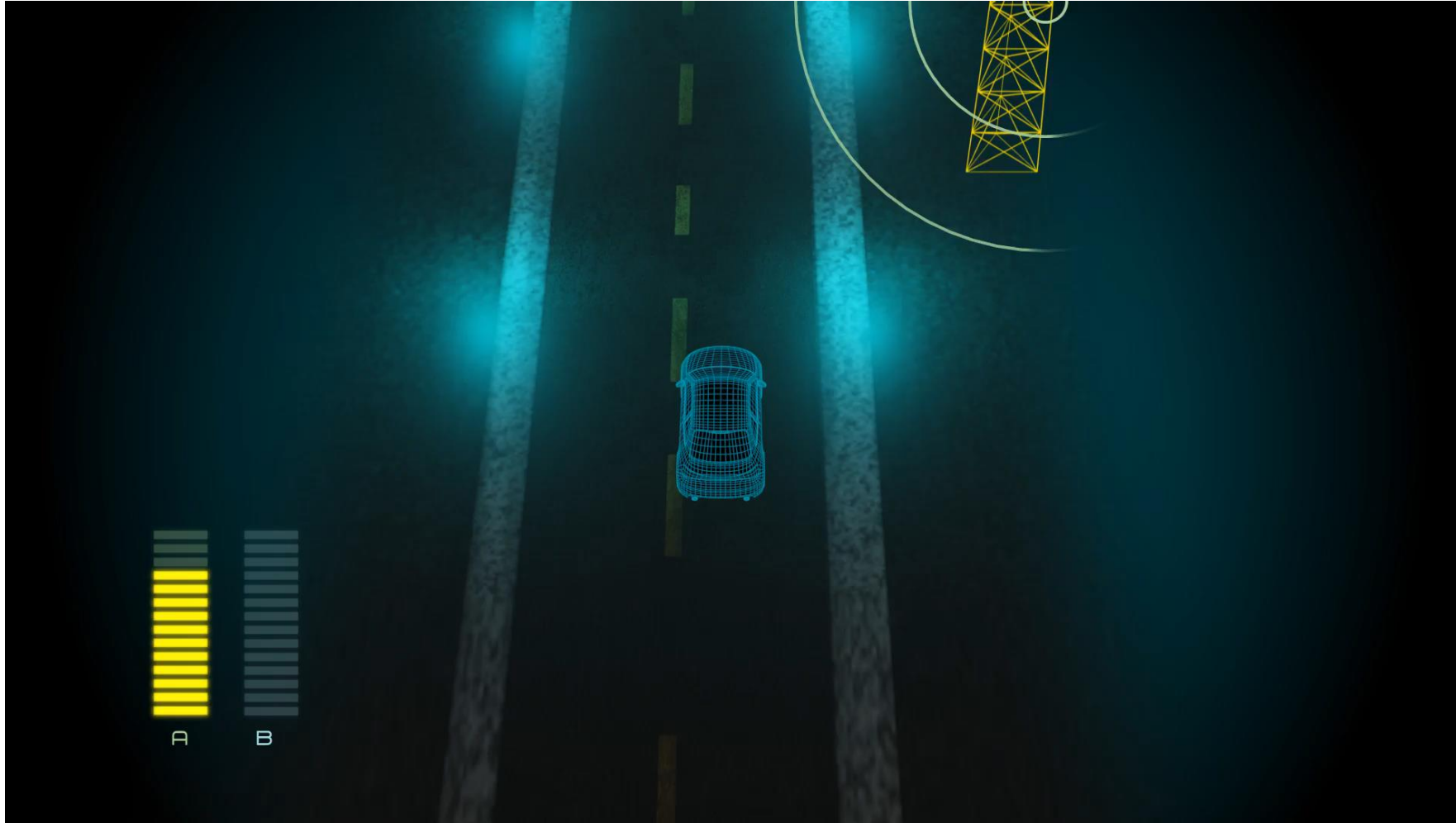
Autonomous driving – Context awareness from RI



Autonomous driving – Speed and vehicle distance control



Autonomous driving – Predicting signal deterioration



Robotic Networks in Future 6G Communications

- Convergence of robotics, AI, sensing, and 6G
- Robots as network-native agents
- Ultra-reliable, low-latency, intelligent connectivity

6G Vision for Robotic Networks

- Extreme data rates
- Ultra-low latency
- Native AI-driven orchestration
- Integrated sensing & communication

Key Enablers

- AI/ML everywhere
- Edge-cloud continuum
- Network slicing
- High-precision localization

Robotic Swarms and Edge Intelligence - Networked Autonomy over 6G

- Swarms with autonomous coordination
- Collaborative task execution
- Real-time distributed sensing
- Full autonomy supported by the network
- Multi-robot coordination
- Predictive control loops

Joint Communication–Sensing–Computation

- Integrated sensing for situational awareness
- Joint optimization of compute and communication
- Unified waveform and protocol stack

6G Architecture for Robotic Networks

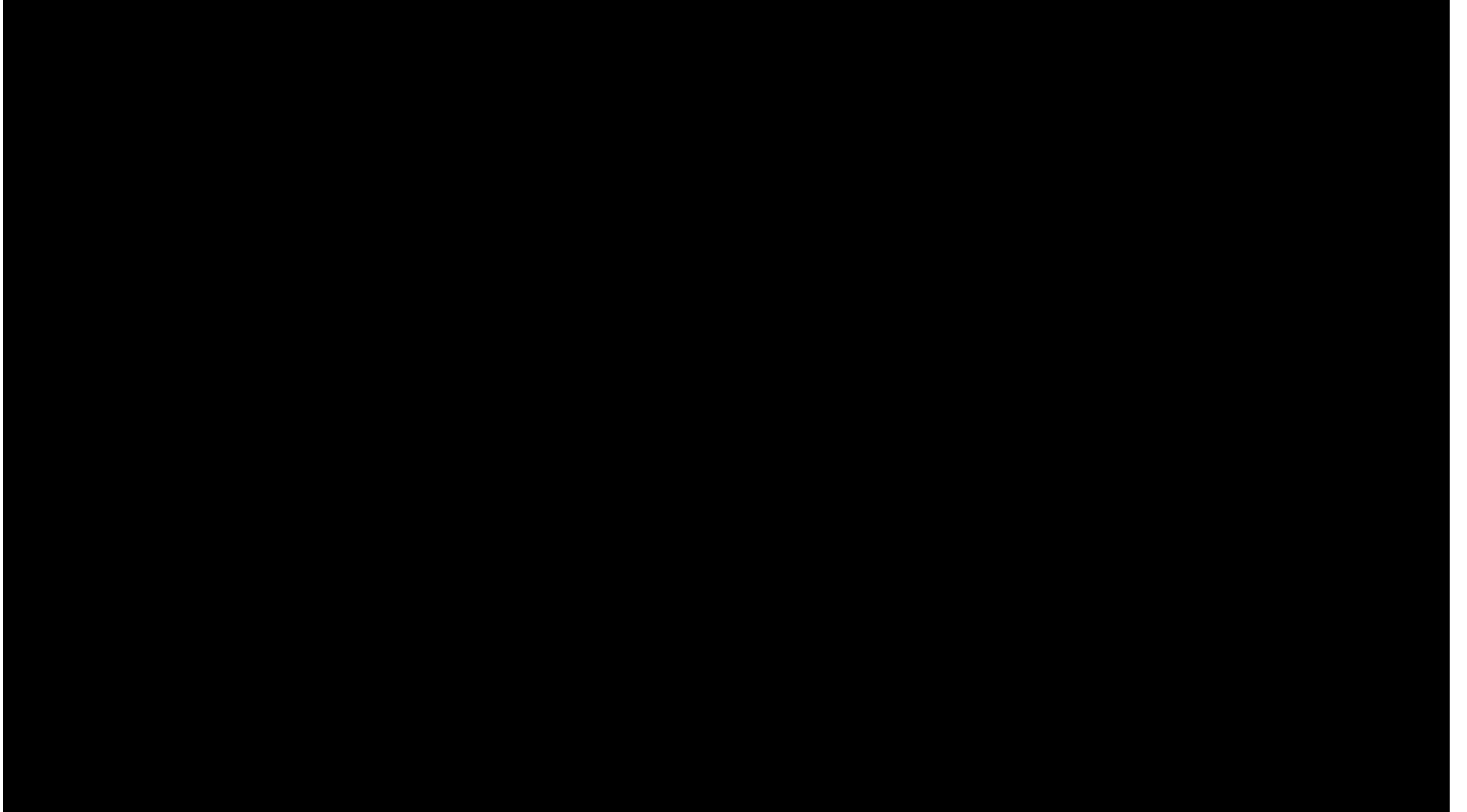
- Device-edge-cloud orchestration
- Programmable RAN and core
- Distributed compute fabric



Use Cases

- Industrial robotics
- Autonomous drones
- Smart mobility
- Search-and-rescue

Drone networks and digital twins for crisis management





Conclusion

- 6G will unlock fully autonomous robotic ecosystems