



Unleashing the Power of 6G: Opportunities, Challenges, and Impacts



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6G: Driving Applications



Man, machine, object, genie -semantic?

6G: Driving Applications

Multisensory XR Applications



Connected robotics and Autonomous Systems



Wireless Brain-Computer Interactions



Blockchain and Distributed Ledger Technologies



Digital Agriculture and industrial



Smart hydro power vehicles



Digital Replica



Av/VR multisensory applications



Bio-Nano Internet of things Molecular Communication



Tangible internet



Holographic communication

Immersion education



Telecommuting



Metaverse applications



Smart cities



Product testing



Production optimization

6G: Driving Applications

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XR
Applications

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and
Autonomous

Wireless Brain-
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Interactions

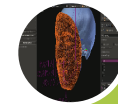
Blockchain and
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Smart hydro power
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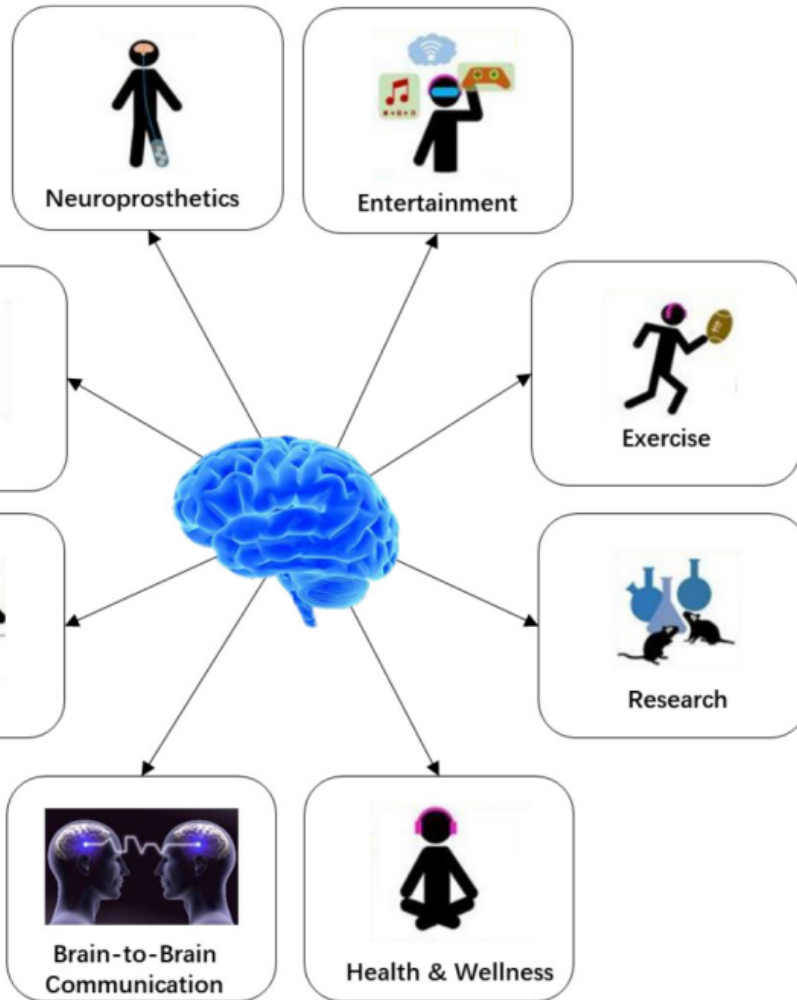
Bio-Nano Internet of
things Molecular
Communication



Tangible
internet



Holographic
communication



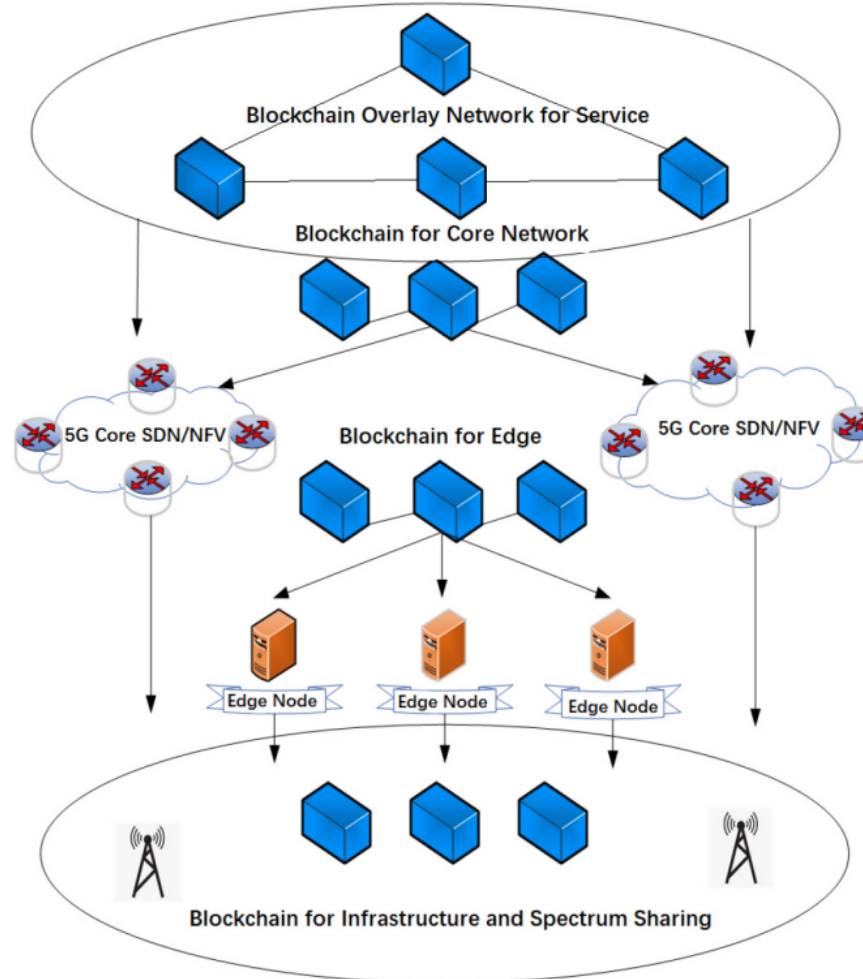
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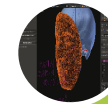
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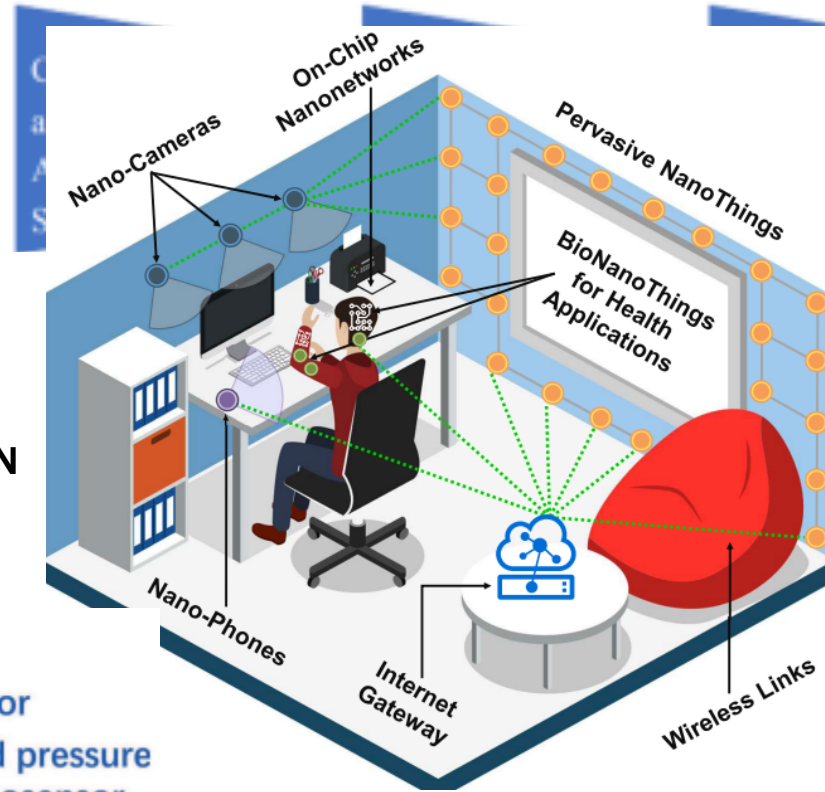
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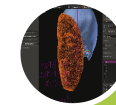
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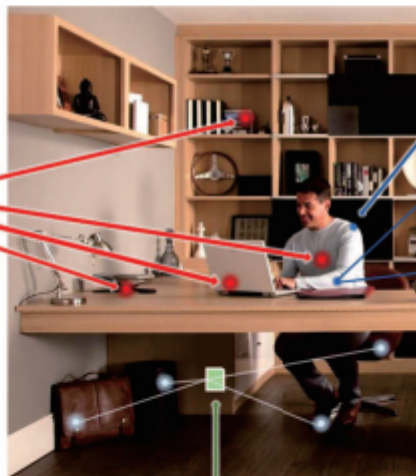


Tangible internet



Holographic communication
Health etc

MOLECULAR COMMUNICATION



ECG nanosensor
Blood pressure nanosensor
Pulse oximetry nanosensor

Nano-micro interface


The Internet of Nano-Things

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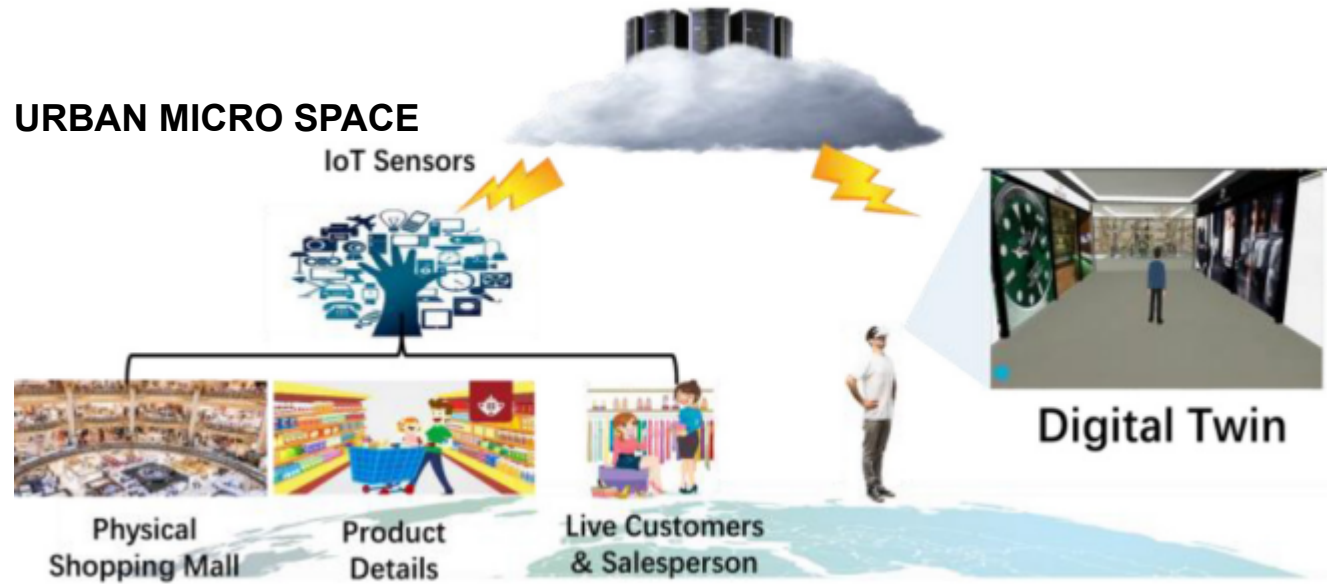
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Holographic communication

URBAN MICRO SPACE



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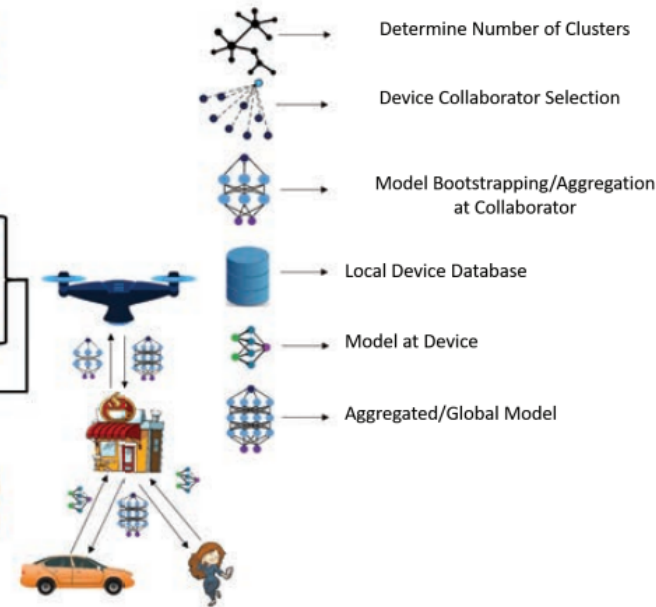
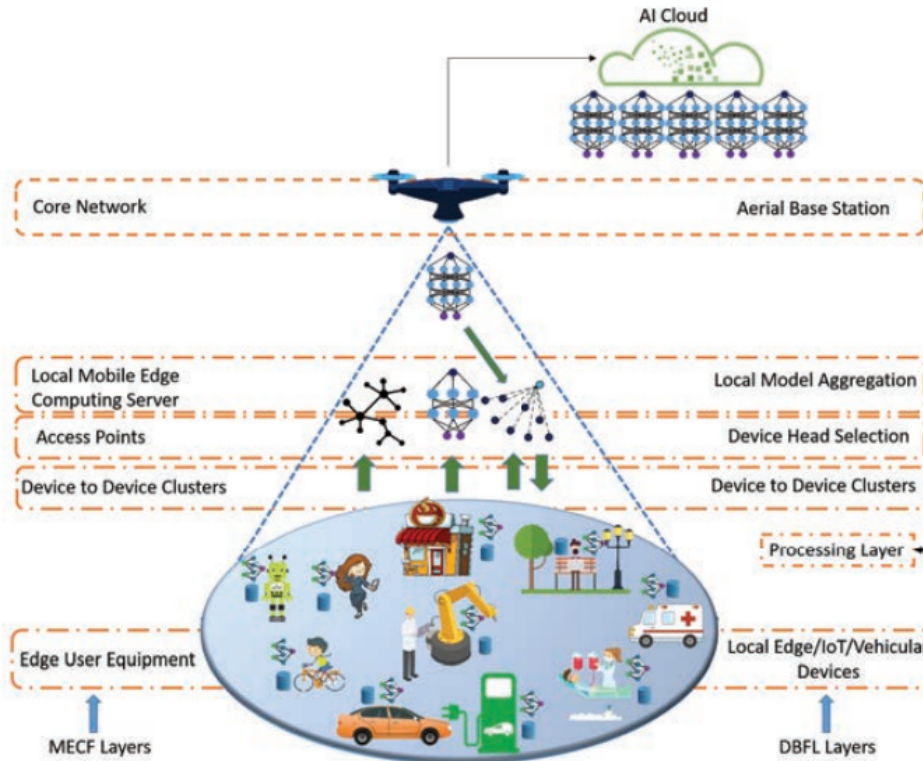
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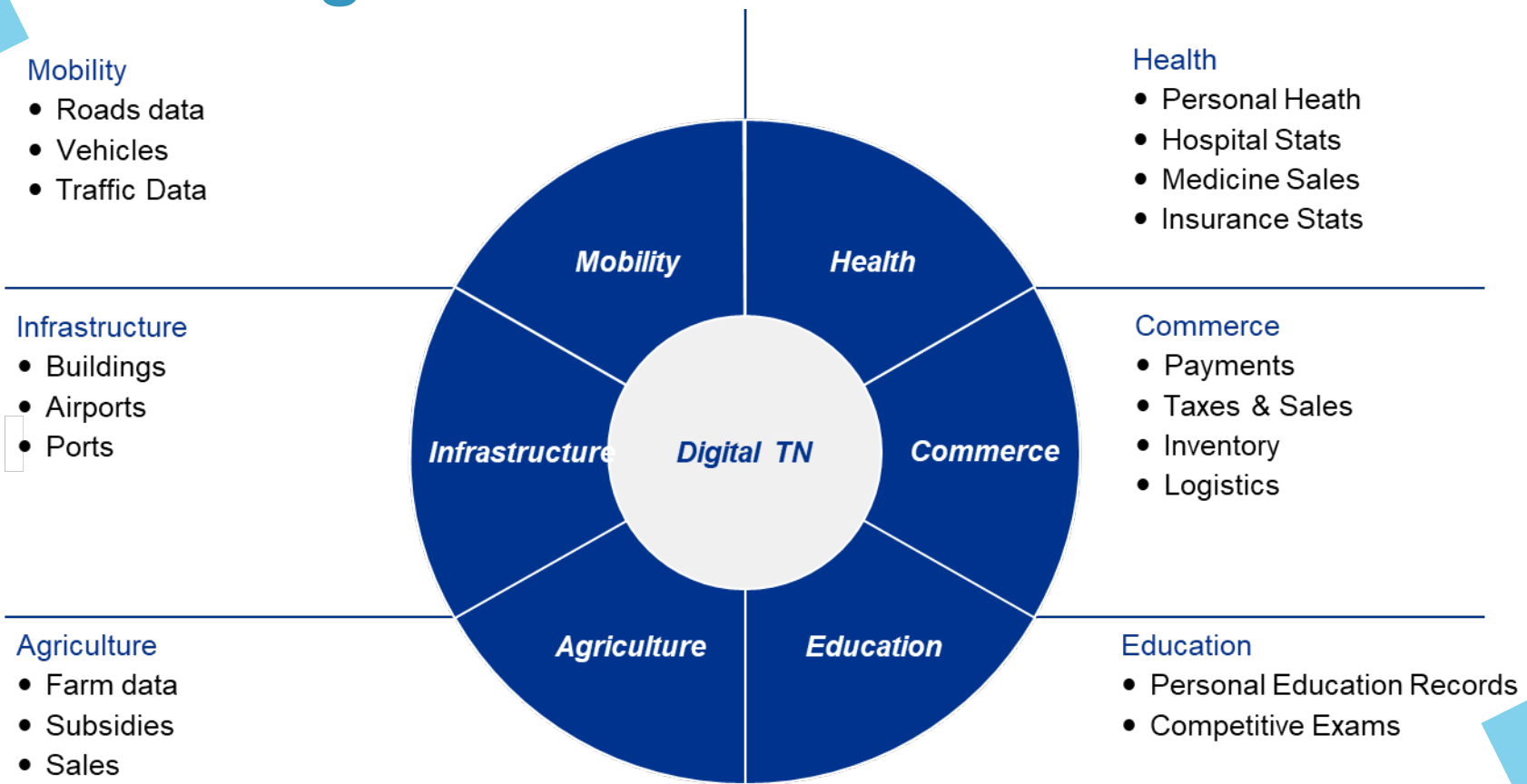
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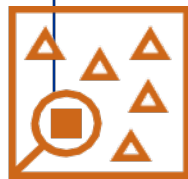
FEDERATED LEARNING



Digital TN



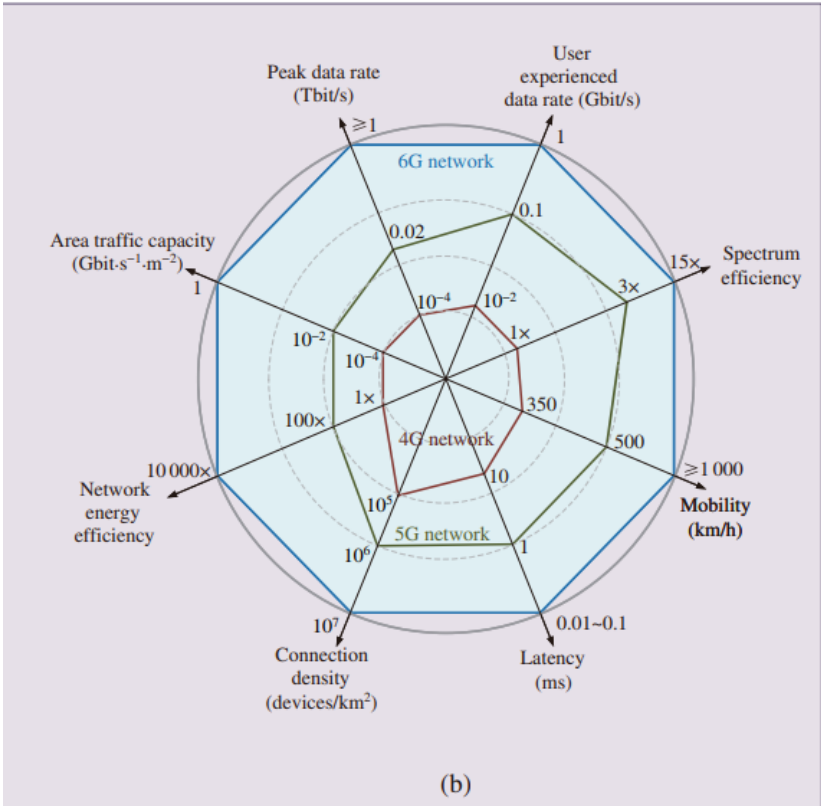
Place sensors around the city



Build a simulation model



Provide a disaster risk map and disaster alert service; Weather pattern; Crime Analysis etc



6G: Driving Trends

More Bits, Spectrum, Reliability

From Areal to Volumetric Spectral and Energy Efficiency

bps/Hz/
Joules/m³

Emergence of Smart Surfaces and Environments

Massive Availability of Small Data

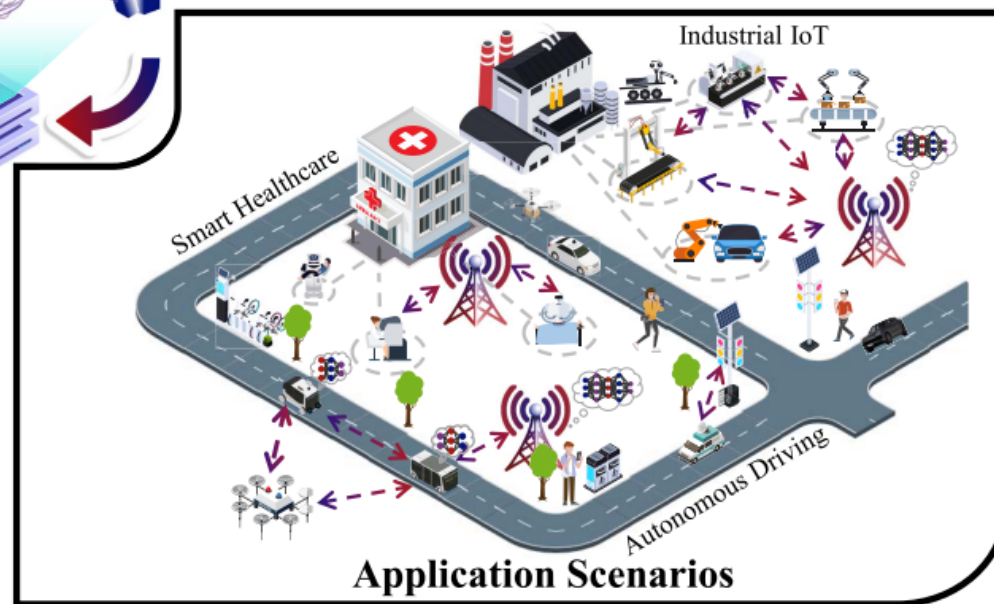
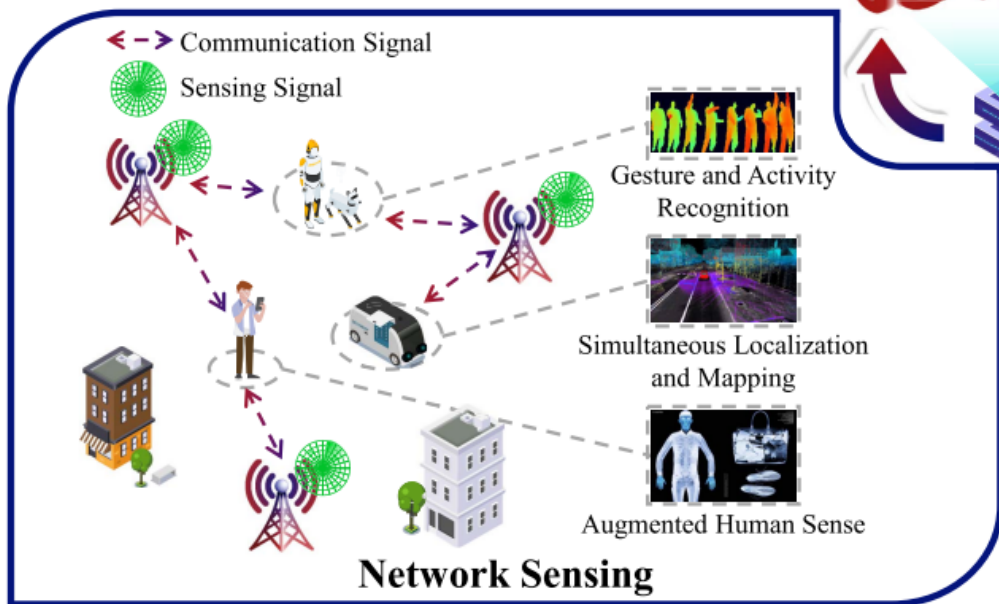
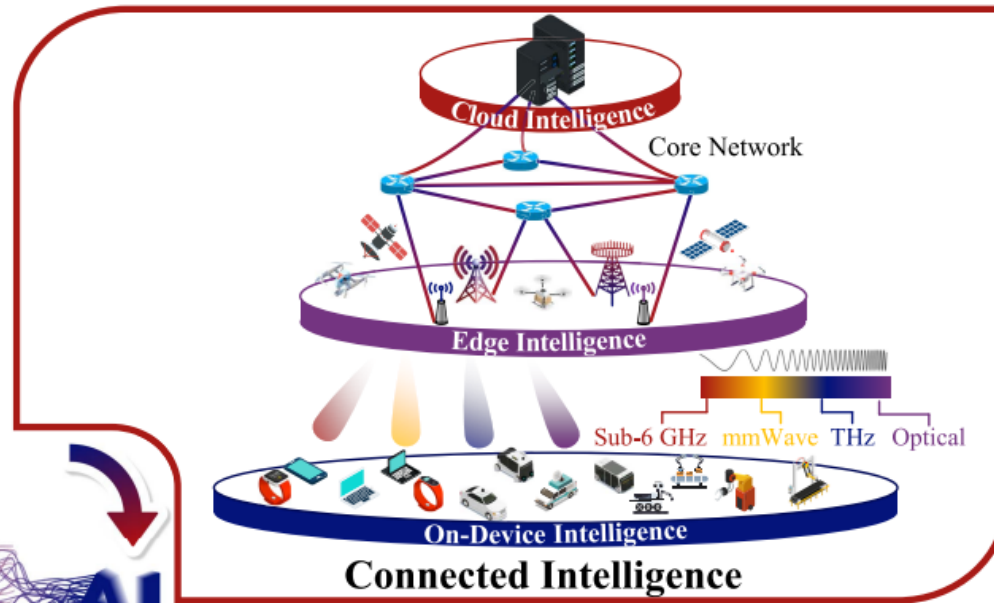
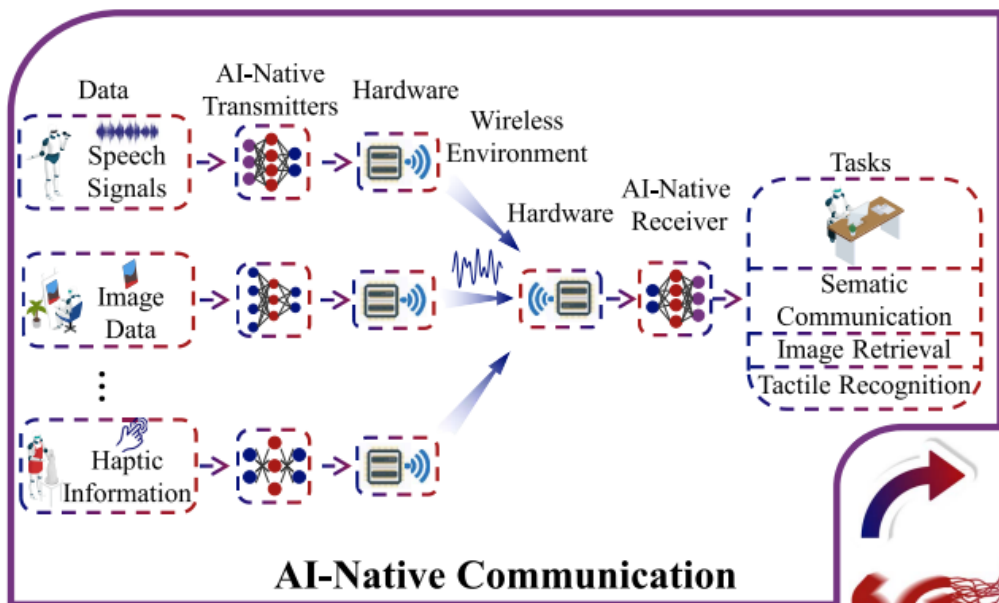
From SON to Self-Sustaining Networks

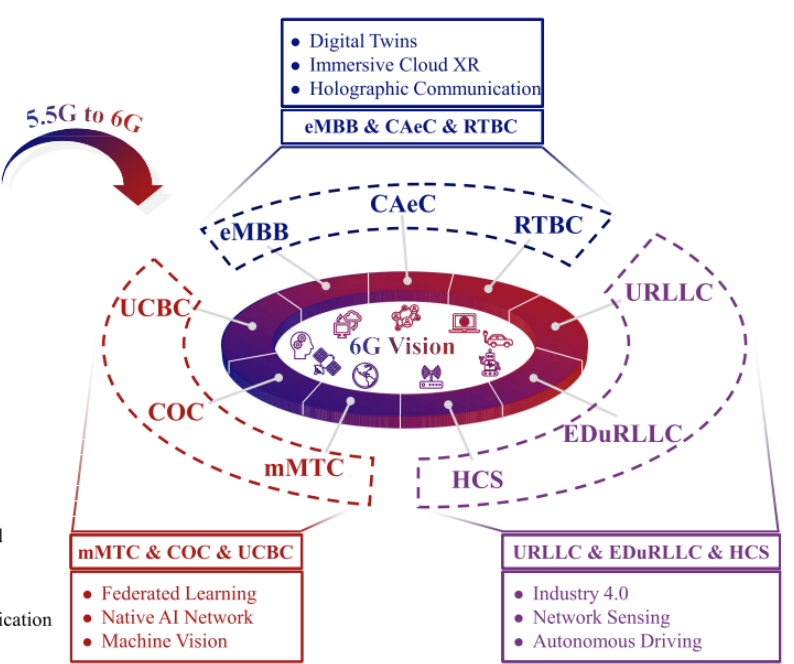
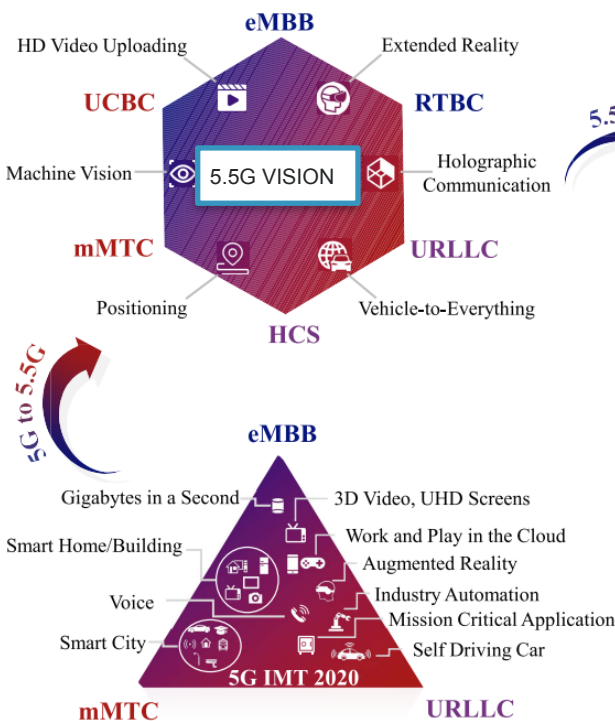
Convergence of Communication, Sensing, Control, Localization, and Computing

End of the Smartphone Era

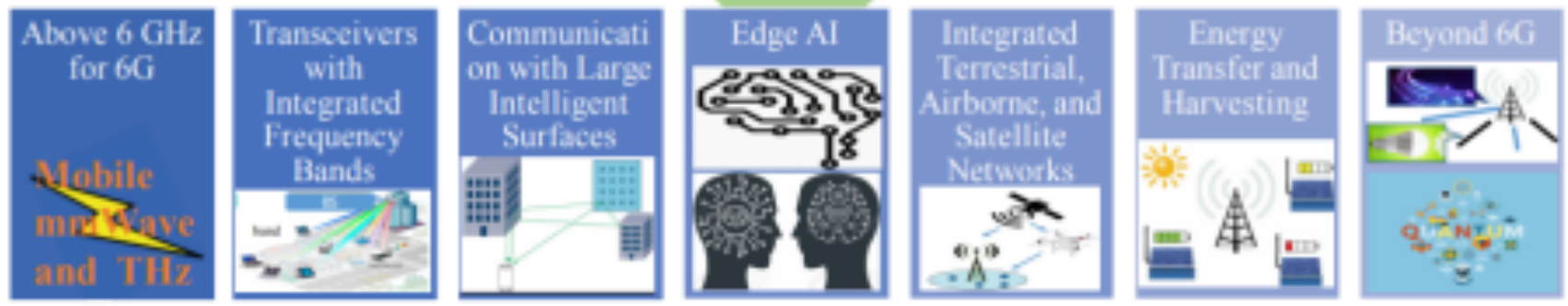


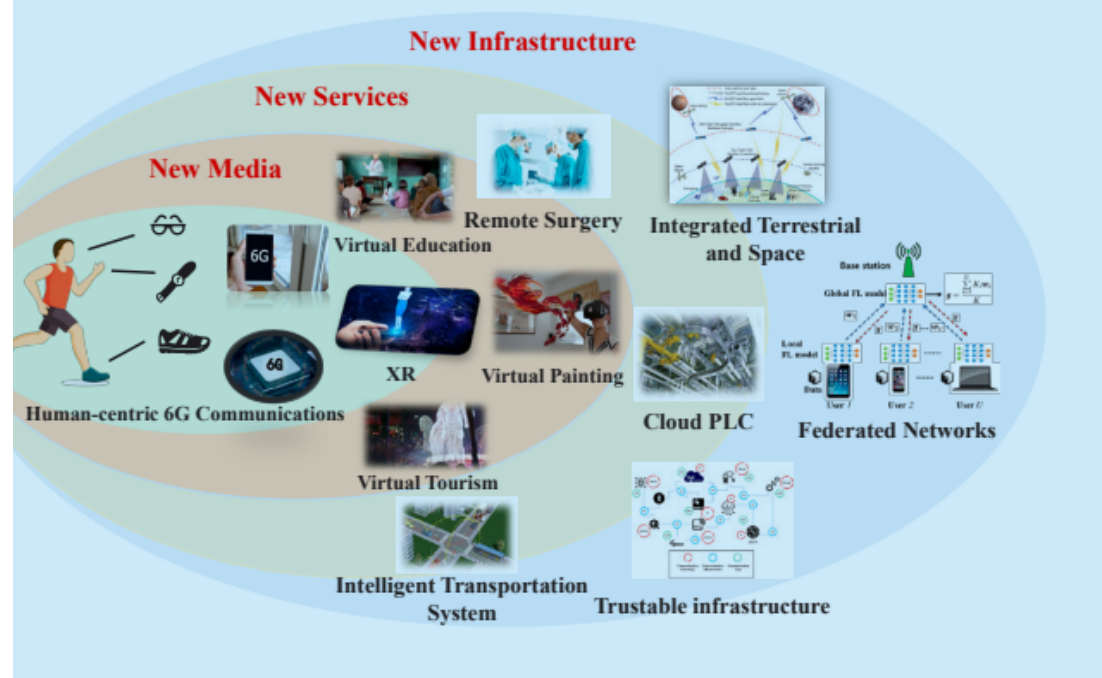
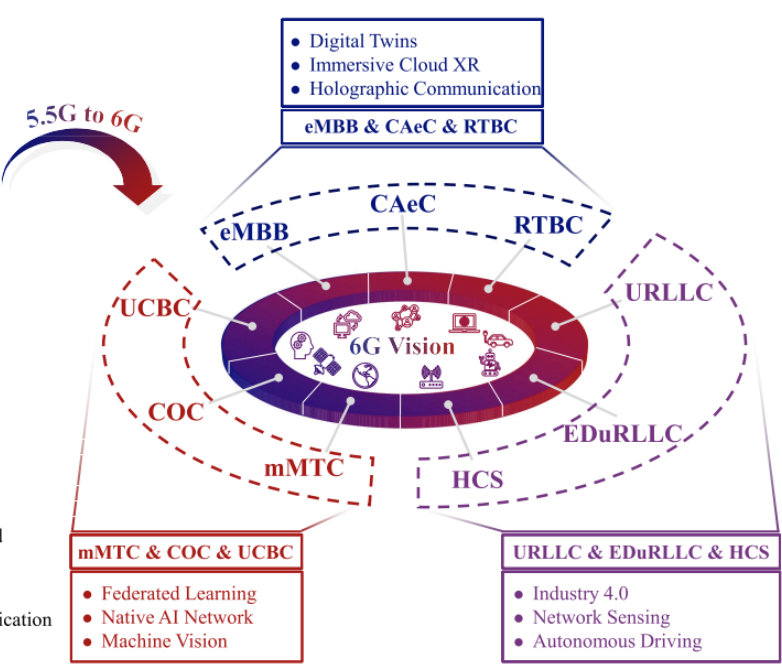
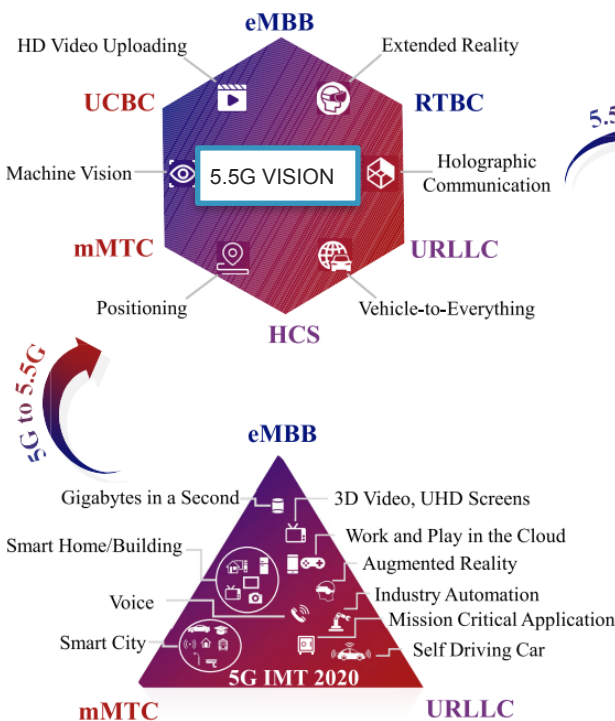
Edge AI empowered 6G networks



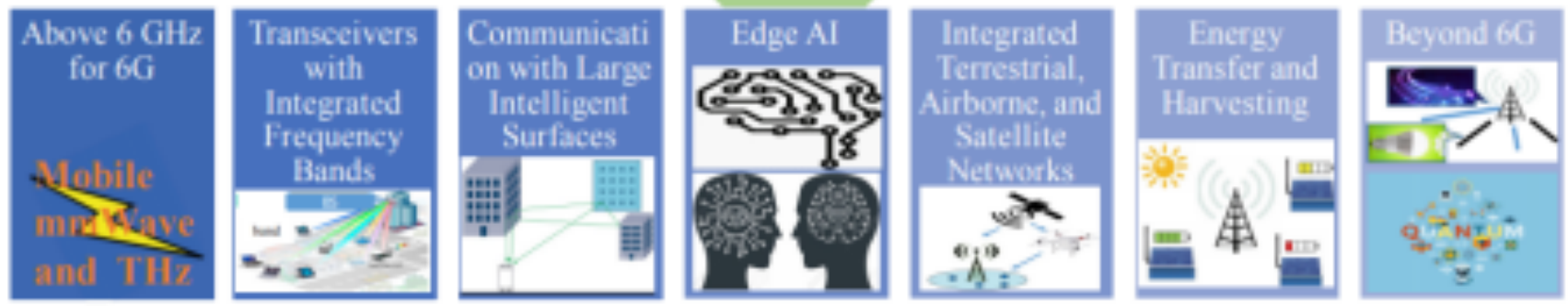


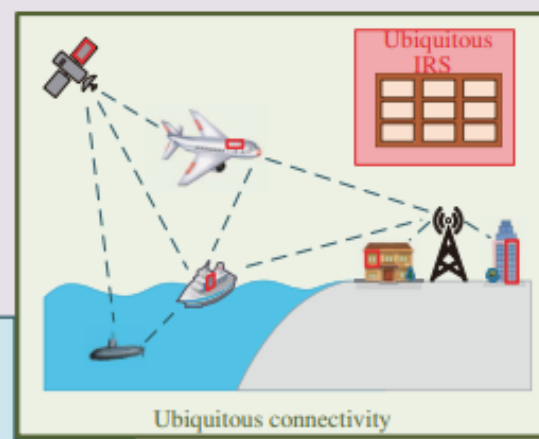
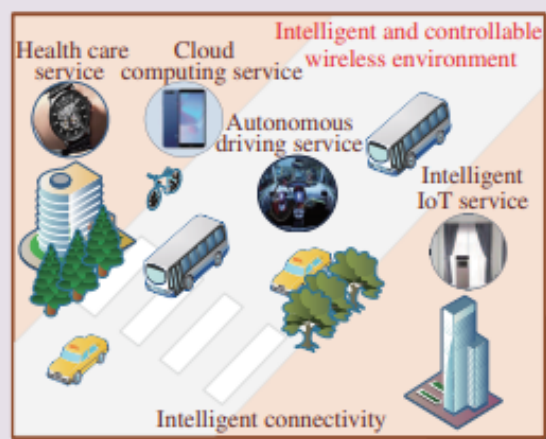
6G: Enabling Technologies





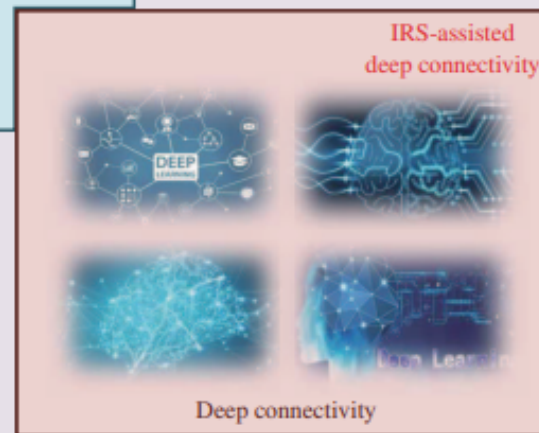
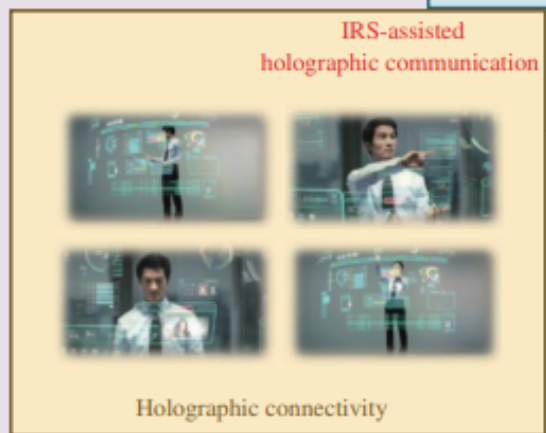
6G: Enabling Technologies





6G Vision

SAGIN



Above 6 GHz for 6G

Mobile mmWave and THz

Transceivers with Integrated Frequency Bands

Communication with Large Intelligent Surfaces

Edge AI

Integrated Terrestrial, Airborne, and Satellite Networks

Energy Transfer and Harvesting

Beyond 6G

QUANTUM

concepts of everything-connected-to-the-network and everything-as-a-service

Semantic communications

ARTIFICIAL NEURAL NETWORKS FOR COMMUNICATIONS

quantum teleportation

Augumentation of Human Intelligence

GENETIC PROGRAMMING

Back scatter communication

HC2WA framework

QUANTUM AND QC-ASSISTED COMMUNICATIONS

DEEP LEARNING FOR COMMUNICATIONS

Model Acoustic Meta Learning

Federated Learning

Spectrum Sensing - Blind detection/Eigen Value detection/ cyclco-stationary

QUANTUM TECHNOLOGY AND QML-ASSISTED COMMUNICATIONS

Quantum-assisted SatCom systems

Time Convergence

QUANTUM SVMs AND ANNS

Six Sense Communication Network

Hybrid front-end for all spectrum sensing end to end THz com system

Multi-hop transmission system

A complete AI solution for intelligent cognitive and self-sustaining networks

Endogenous security technology

Visible Light Communications

Over The Air - Computation

Edge AI for Metaverse

New infra; info-structure; fusion-infrastructure ; innovation infra – integrates ground; UAV, satellite for global coverage

QoL. /. Generative Adversarial Netorks

HOLISTIC SECURITY SOLUTION

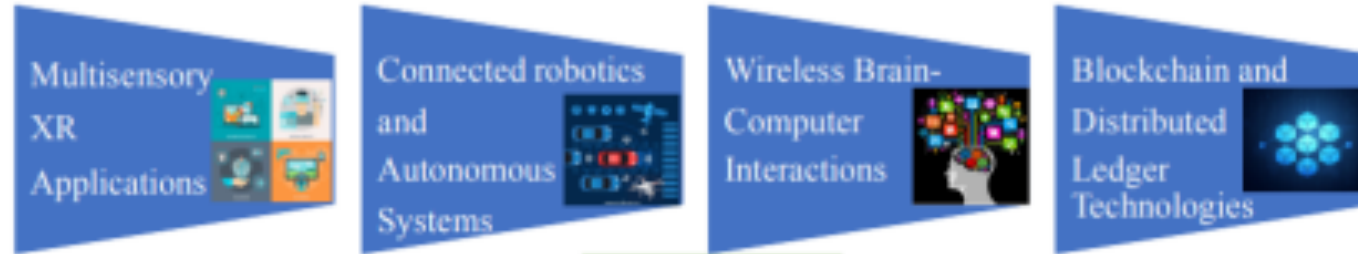
end-to-end auto-encoding, *learning at user-side, multiple access for massive connectivity,*

Liquid Ionization System, and fluid-antennas

Nano scale applications

Cell free Macro MIMO

6G: Driving Applications



6G: Driving Trends



6G: Enabling Technologies

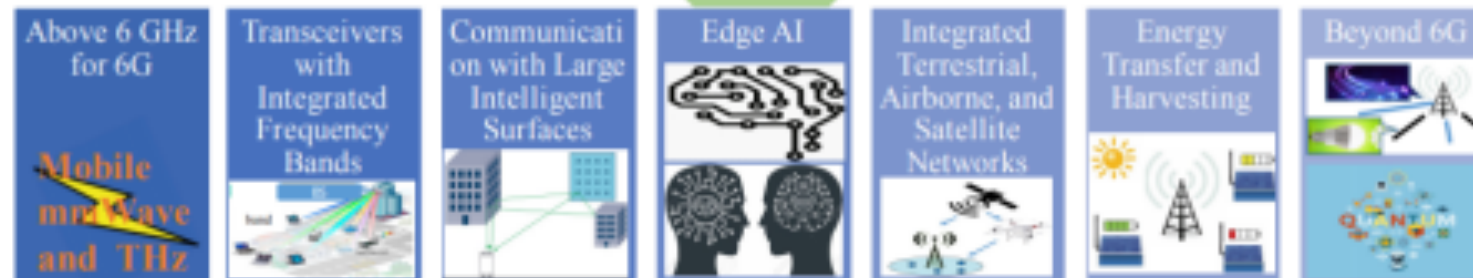
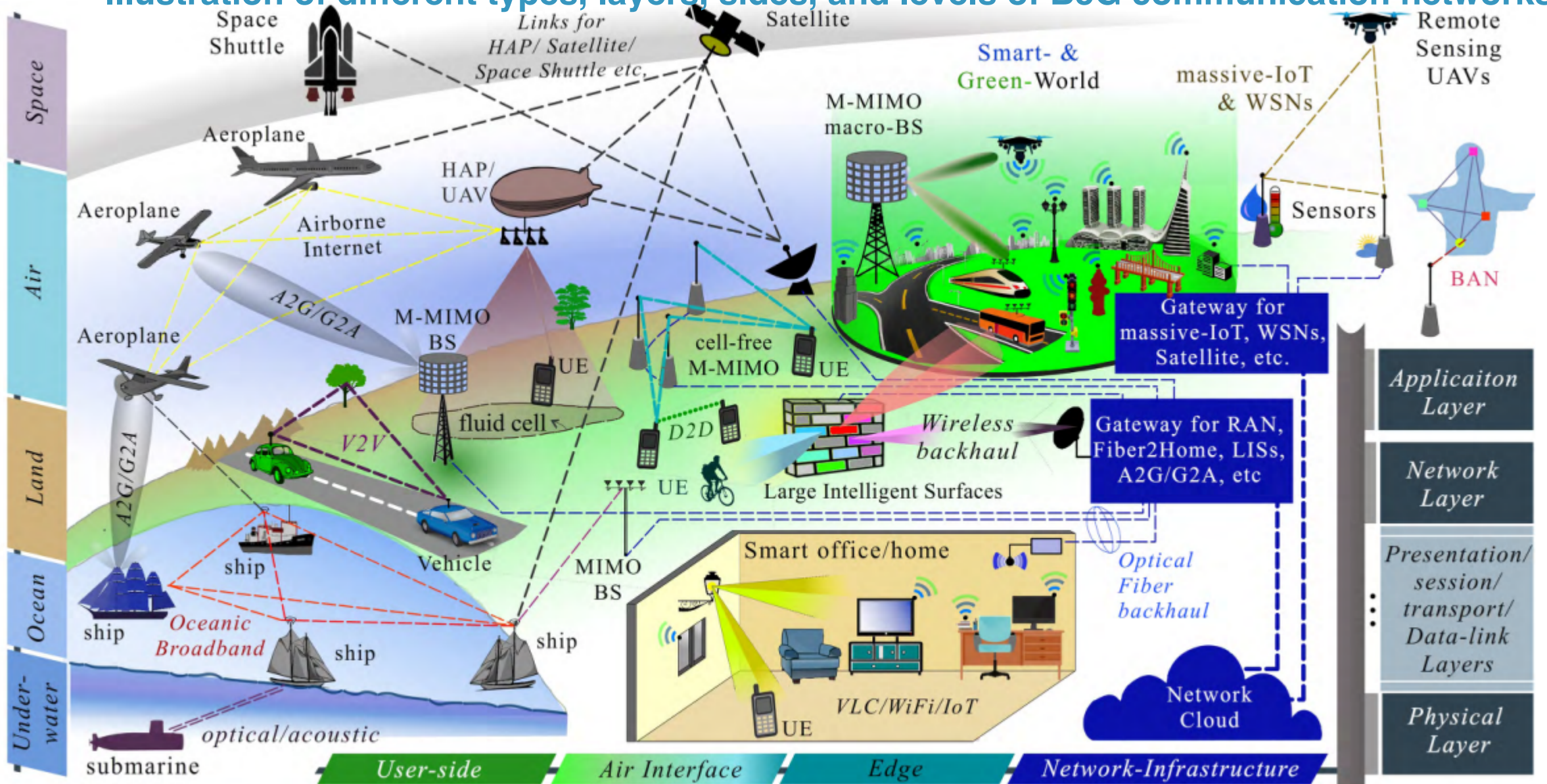
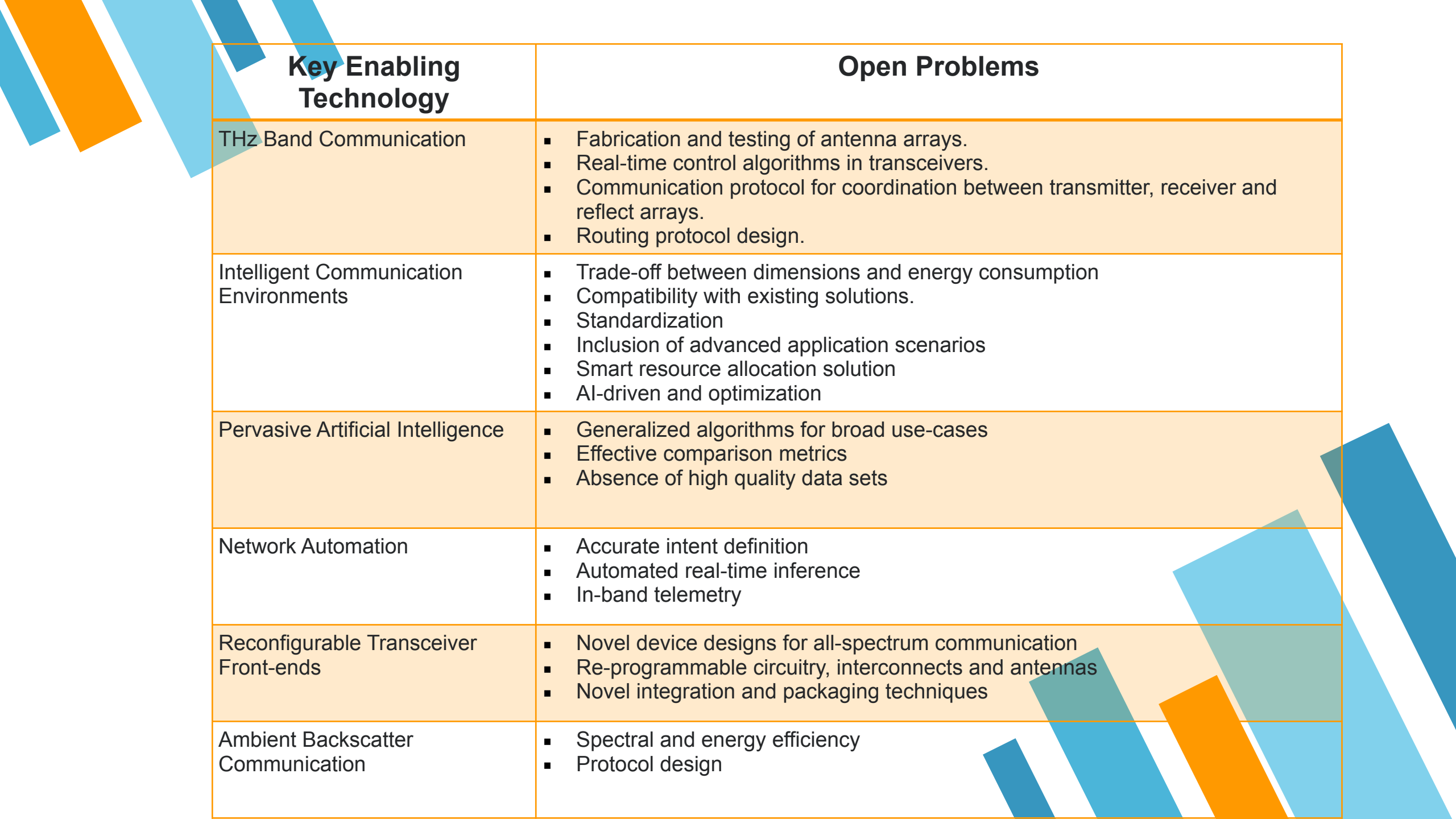


Illustration of different types, layers, sides, and levels of B5G communication networks

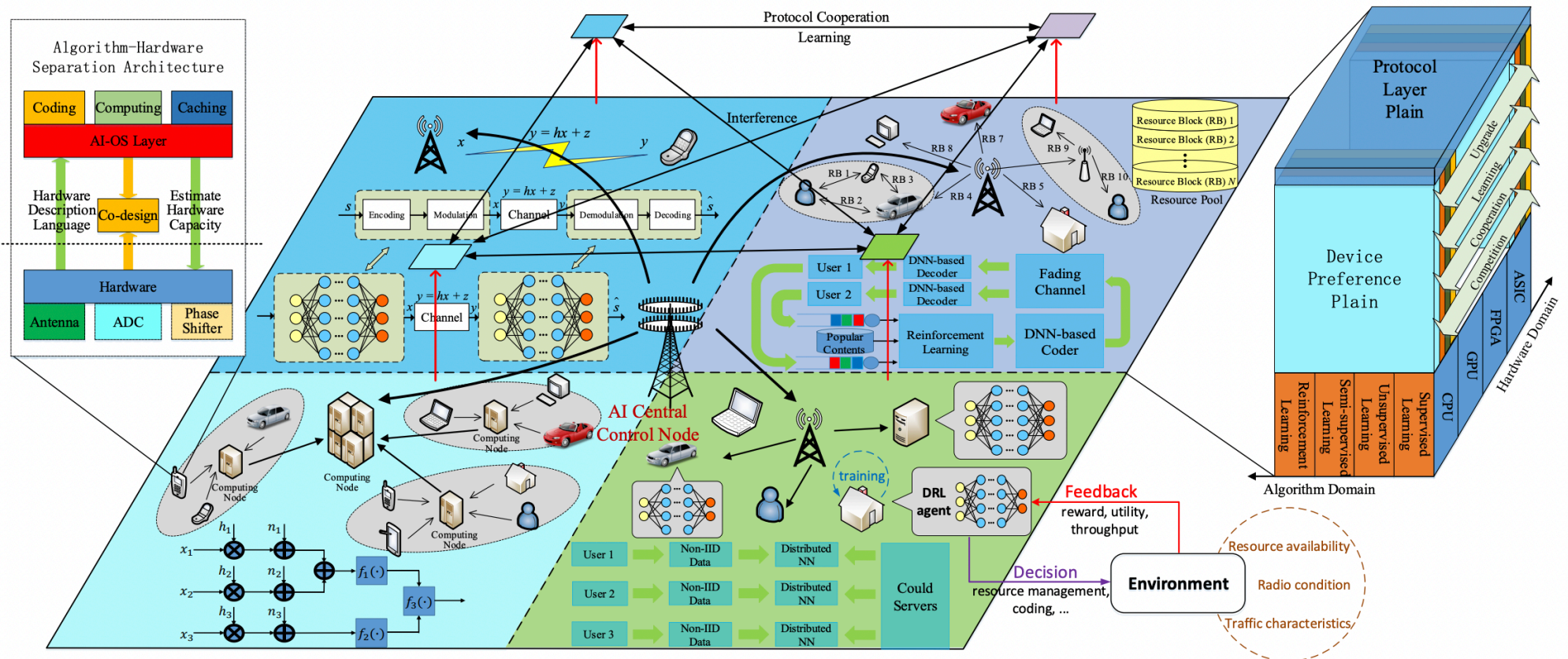


M-IoT, M-MIMO, tiny-cells, cell-free, fluid cells, mmWave, multiterahertz, VLC, SD fluid antennas, LISs, V2X, D2D, mMTC, MEC, NOMA, intelligent caching, energy harvesting, wireless backhaul, UAVs/satellites/airborne/underwater/oceanic, etc



Key Enabling Technology	Open Problems
THz Band Communication	<ul style="list-style-type: none">▪ Fabrication and testing of antenna arrays.▪ Real-time control algorithms in transceivers.▪ Communication protocol for coordination between transmitter, receiver and reflect arrays.▪ Routing protocol design.
Intelligent Communication Environments	<ul style="list-style-type: none">▪ Trade-off between dimensions and energy consumption▪ Compatibility with existing solutions.▪ Standardization▪ Inclusion of advanced application scenarios▪ Smart resource allocation solution▪ AI-driven and optimization
Pervasive Artificial Intelligence	<ul style="list-style-type: none">▪ Generalized algorithms for broad use-cases▪ Effective comparison metrics▪ Absence of high quality data sets
Network Automation	<ul style="list-style-type: none">▪ Accurate intent definition▪ Automated real-time inference▪ In-band telemetry
Reconfigurable Transceiver Front-ends	<ul style="list-style-type: none">▪ Novel device designs for all-spectrum communication▪ Re-programmable circuitry, interconnects and antennas▪ Novel integration and packaging techniques
Ambient Backscatter Communication	<ul style="list-style-type: none">▪ Spectral and energy efficiency▪ Protocol design

Key Enabling Technology	Open Problems
The Internet of Space Things	<ul style="list-style-type: none">▪ Multi-band transceiver design▪ Low-latency, low-overhead routing techniques▪ Optimized handover techniques with smart gateway diversity
Cell-free Massive MIMO	<ul style="list-style-type: none">▪ User Scheduling▪ Location optimization of APs
The Internet of Nano Things	<ul style="list-style-type: none">▪ Power efficiency optimization▪ Interference control▪ Network protocol design
The Internet of BioNano Things	<ul style="list-style-type: none">▪ Experiment validation▪ Data storage and validation
Quantum Communication	<ul style="list-style-type: none">▪ Quantum error correction▪ Entanglement distribution▪ At-scale deployments



Vision- 6G



THANKS!
Any questions?

