What does 6G Need from Network Protocols?

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Panel: Way Forward to 5G/6G: What is Missing in Network Protocols and Technologies?

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6G is not yet defined, but …

❖ Its visions are being set up, and use cases are being identified

  • ITU-T Focus Group on Network 2030

  • Next-G Alliance, USA

  • 6G Flagship, Finland,

  • 5G/6G Innovation Center, University of Surrey, UK

  • Europe Hexa-X

  • China IMT-2030 Promotion Group

  • Many, many others
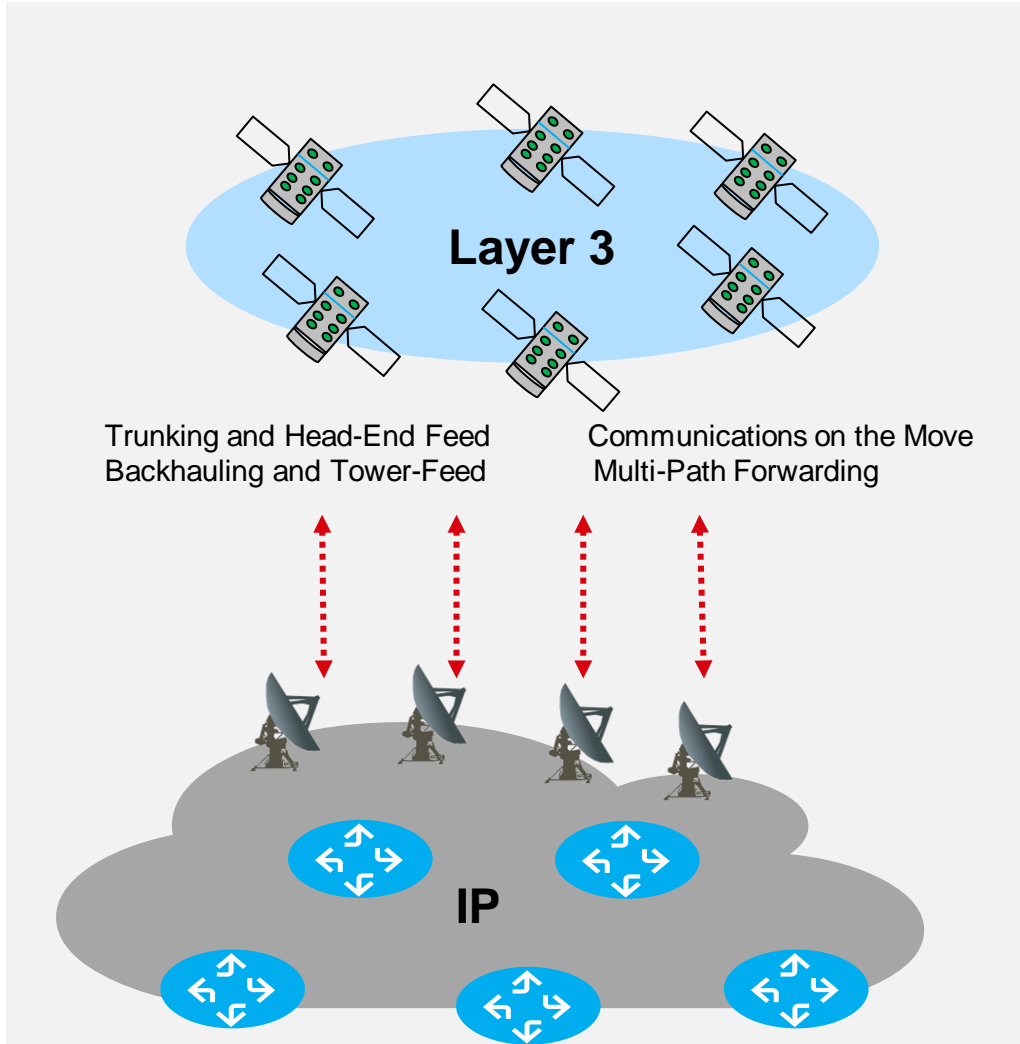
❖ Its enabling technologies are under way

  • Basic Technology: Physics, Material, Biology, Chemistry, Semi-Conductor

  • Radio Technology: TeraHtz, RIS, OAM, IHR

  • Networking Technology: New Architecture, New Communication Methods , New Protocols

    – Omni-Convergence and Reconvergence

    – High Precision Communications

    – Qualitative Communications and/or Semantic Communications

    – Heterogenous Networks: Heterogenous Access, Heterogenous Control, Heterogenous Networking Resources and Power

❖ All that 5G promised but not delivered are expected to be supported by 6G
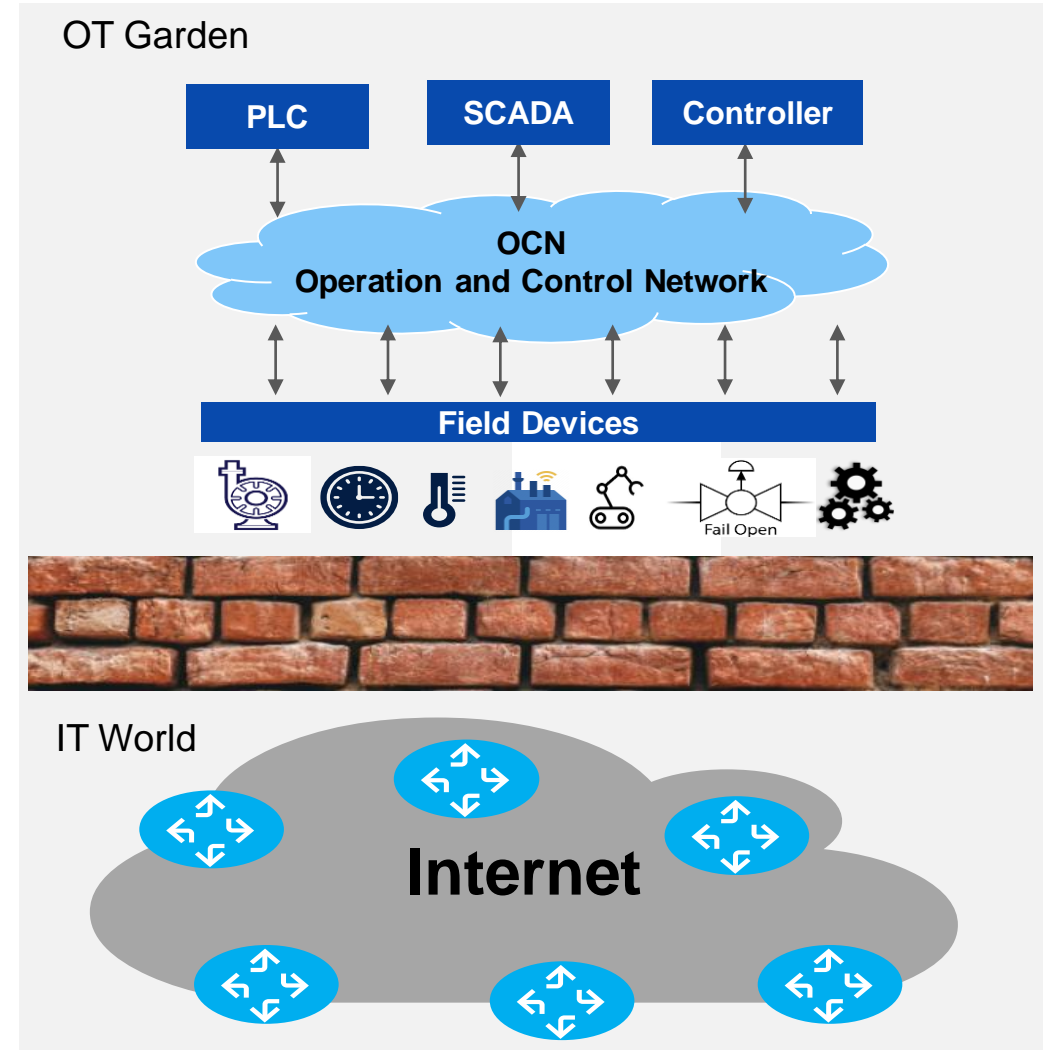
❖ 6G will ultimately rely on enabling technologies: neither over-promised nor under engineered

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Some use cases require convergence of heterogenous networks

Convergence of Spatial and Terrestrial Networks

Convergence of OT and IT

OT Garden

PLC SCADA Controller

OCN
Operation and Control Network

Field Devices

IT World

Internet

Layer 3

Trunking and Head-End Feed
Backhauling and Tower-Feed

Communications on the Move
Multi-Path Forwarding

IP

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Some use cases require more than connectivity; KPI guarantee is a must!!!

Latency (ms)

better

- Tactile Internet
- High Voltage Electricity Distribution
- Holographic Teleport
- Industrial Automation
- Robots
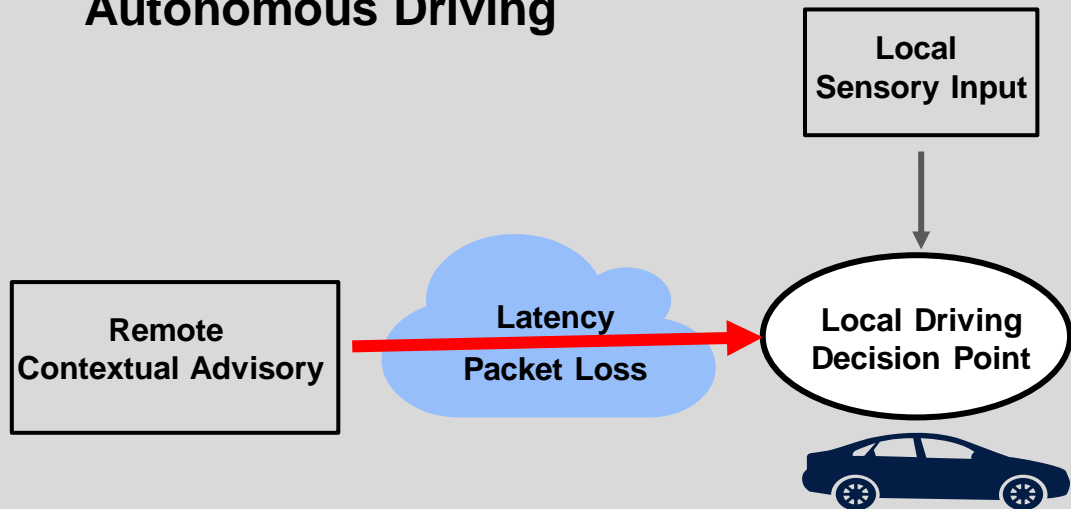- Intelligent Transport
- Electricity Distribution
- Remote Control
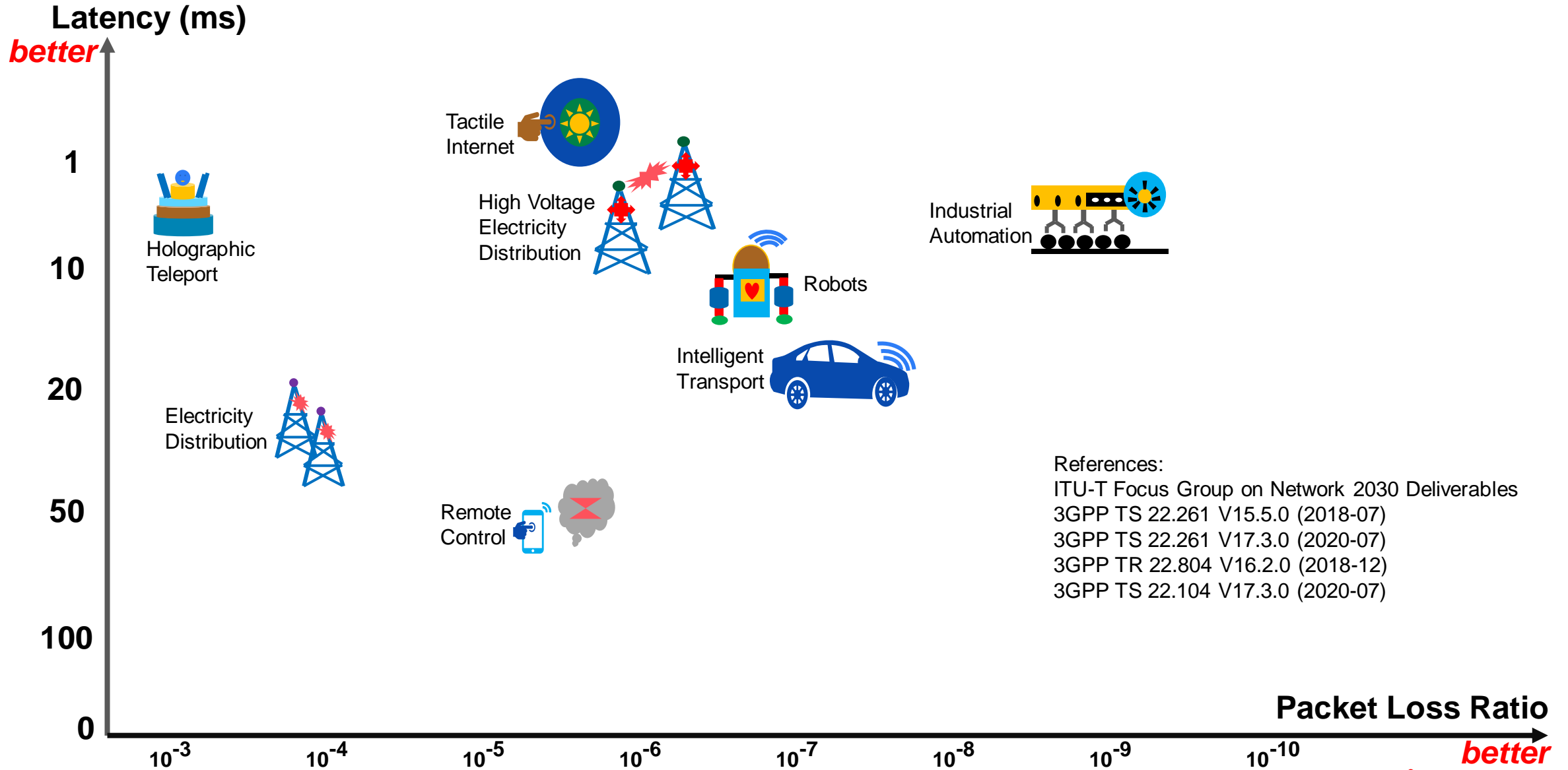
References:
ITU-T Focus Group on Network 2030 Deliverables
3GPP TS 22.261 V15.5.0 (2018-07)
3GPP TS 22.261 V17.3.0 (2020-07)
3GPP TR 22.804 V16.2.0 (2018-12)
3GPP TS 22.104 V17.3.0 (2020-07)

Packet Loss Ratio

10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7} 10^{-8} 10^{-9} 10^{-10}

better

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Some use cases are mission-critical, and even life-critical

Packet loss is a serious issue!
If a packet is lost, its retransmission will triple the latency
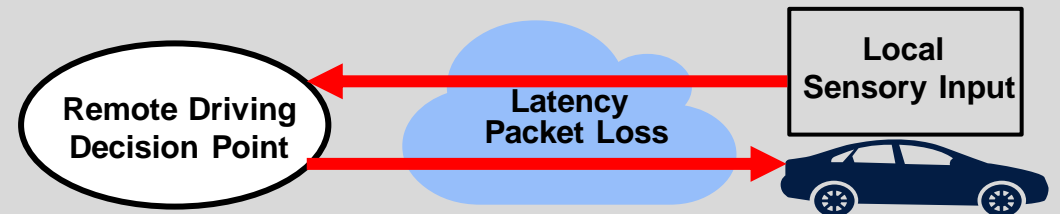
Collision-Avoidance Distance

Maximal End-to-End Latency = 30 ms (3GPP TS 22.261 version 15.5.0 Release 15)

Autonomous Driving

Local Sensory Input

Remote Contextual Advisory

Latency Packet Loss

Local Driving Decision Point

Cloud Driving

Local Sensory Input

Remote Driving Decision Point

Latency Packet Loss

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Some use cases are subject to motion-to-photon time

Text

Image

VoIP

Video

AR /VR
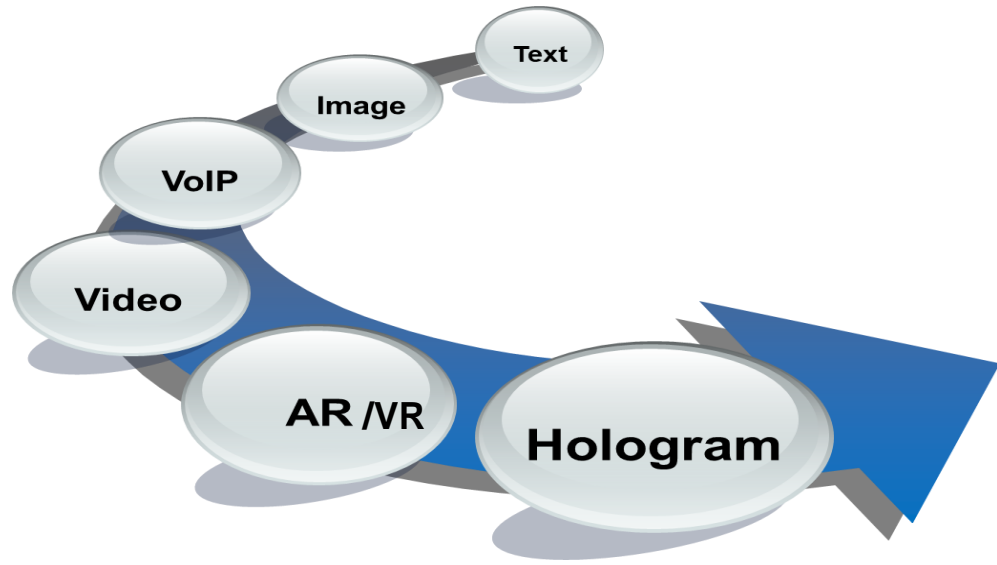
Hologram

Motion-to-Photon Time: Total 20 ms

Framing	Encoding	Streaming

5-7 ms

Display	Decoding	Network Transport

Source: Samsung

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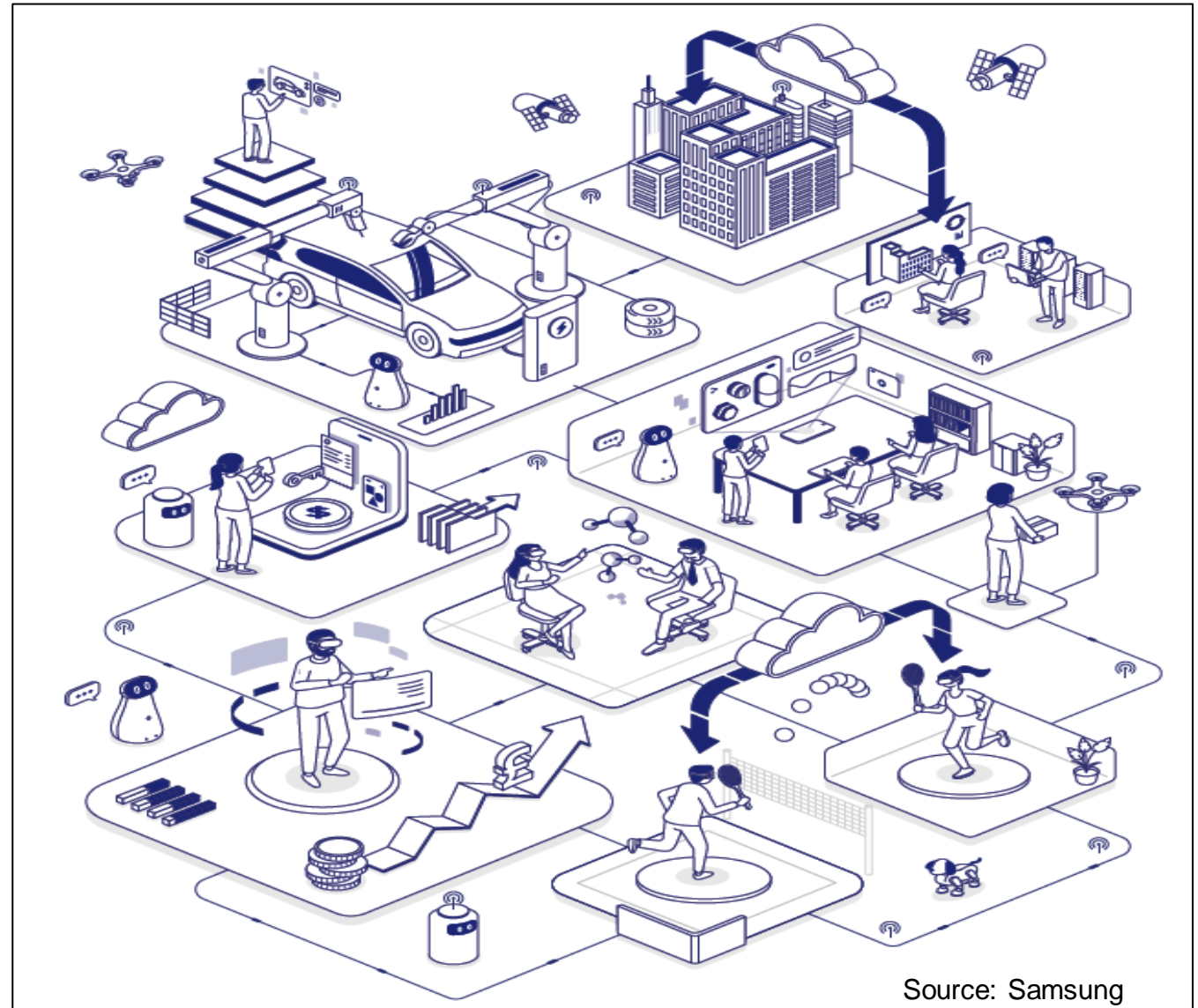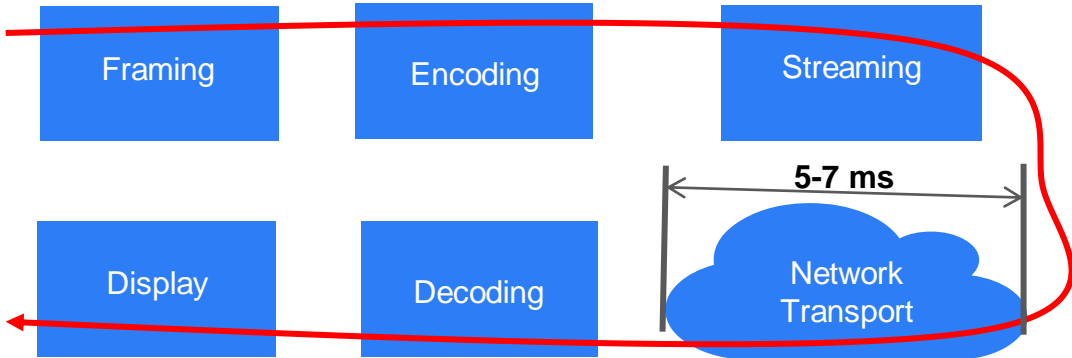
6G needs network protocols for:
Omni-Convergence, KPI Guarantee, and Holographic Transport

Omni-Convergence

Convergence of Spatial (Non-Terrestrial) and Terrestrial Networks
Convergence of ICT Networks and OT Networks
Convergence of Physical and Digital Universes
Convergence of Computing and Communications
Convergence of Sensing and Communications
Convergence of Intelligence and Communications

Holographic Type Communications
Live AR/VR Streaming
Volumetric Multi-Camera Video Streaming

In-Time Guarantee
On-Time Guarantee
Lossless Networking

**KPI Guarantee
(High-Precision Communications)**

Qualitative and Semantic Communications

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Towards Network Protocols for 6G

Layer	Protocols	Era
Omni-Convergence		
Qualitative and Semantic Communications		
High-Precision Communications	Needed by 6G Apps and Services	
Programmable Networks	SRv6/IPv6+ SDN, P4	2015-Now
Security	TLS, QUIC	2000-2020
Traffic Engineering (deliver a packet from S to D along a specific path)	MPLS, SR	2000-2020
Connectivity (deliver a packet from S to D)	IPv4/v6	1980-2000

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Thank you!

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Demand for a next-generation internet protocol

Wireless Evolution

1980s	1990s	2000s	2010s	2020s	2030s
1G	2G	3G	4G	5G	6G

Internet Evolution

Packet Switching	TCP/IP	IPv4	IPv6	New IP
1961	1974	1981	1995	Now

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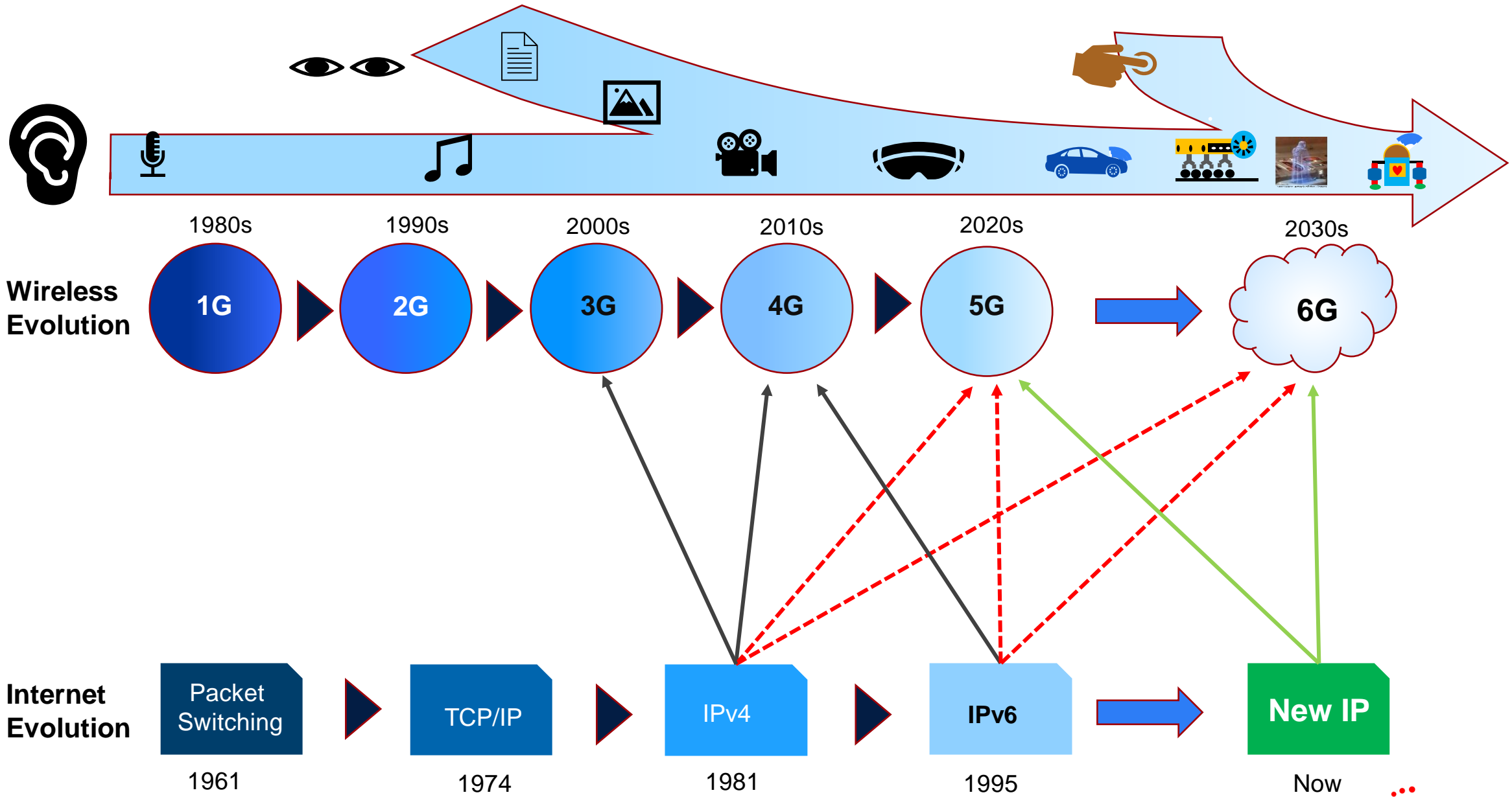
Deployment of New IP for 5G/B5G/6G