Towards a New Internet for the Year 2030 and Beyond

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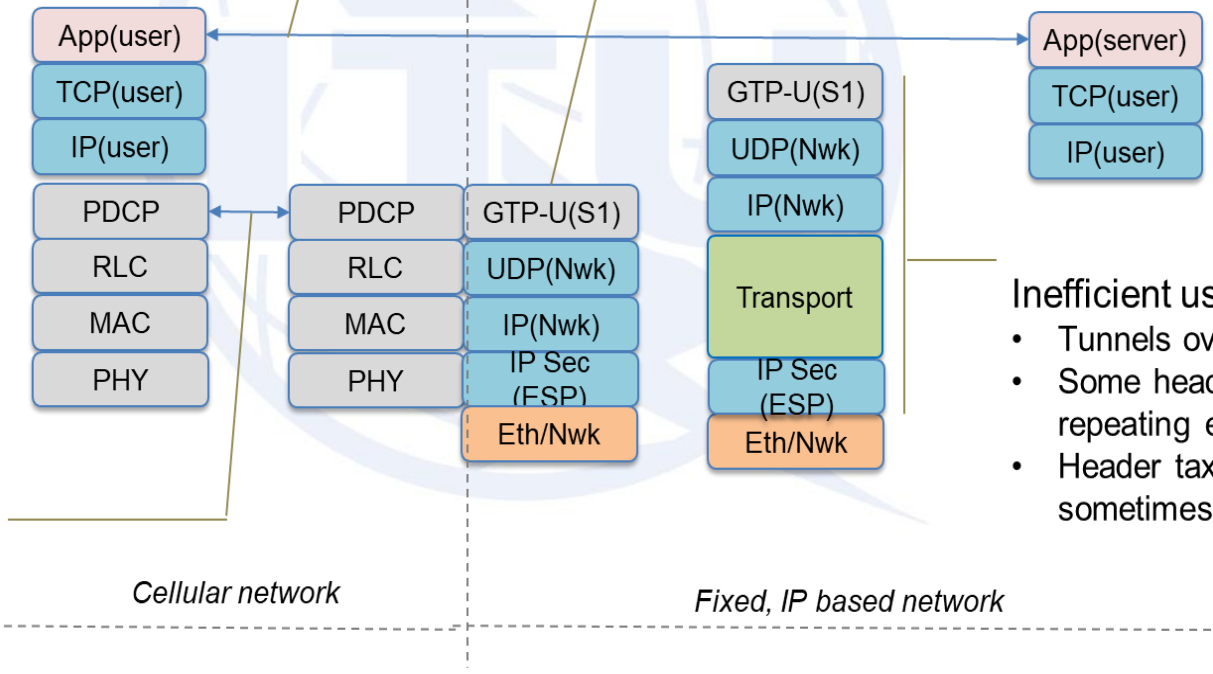
Mobile Internet

≈ 3GPP Architectures + IP Protocols, But…

Throughput and latency are not guaranteed by the current TCP/IP

GTP Complexity: Tunnel setup/teardown processing, tunnel header overheads, extra C-P signalling

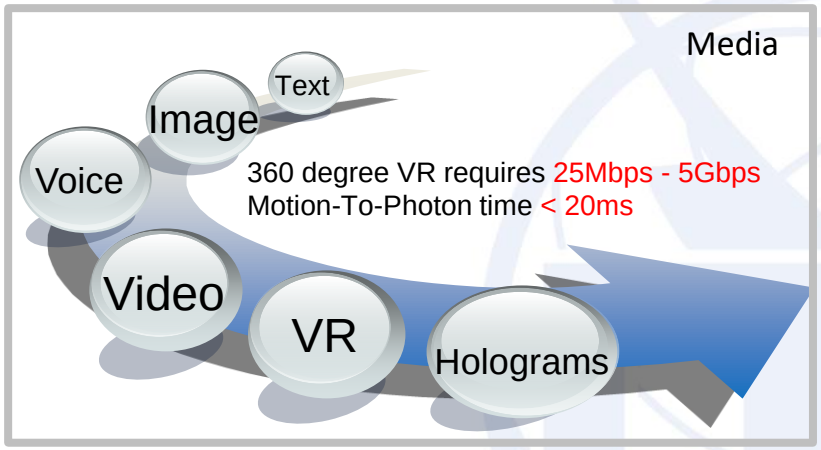


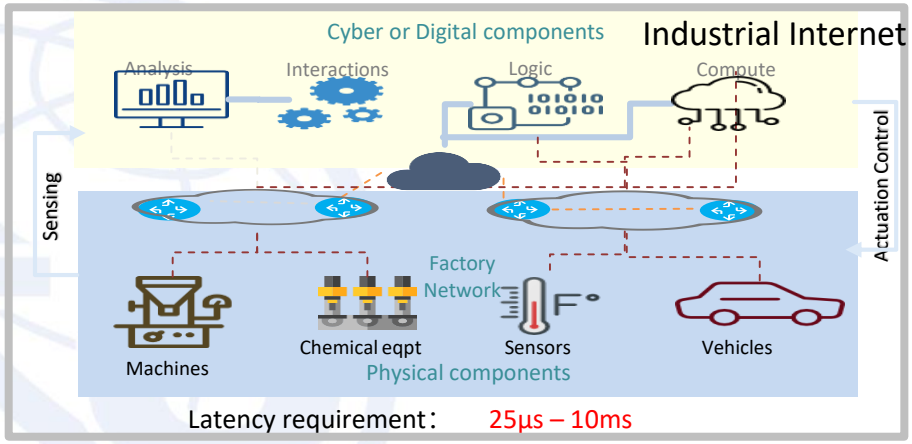
Delay variations: Radio retransmissions are not synchronized with TCP flow control, making TCP wastefully retransmitting packets

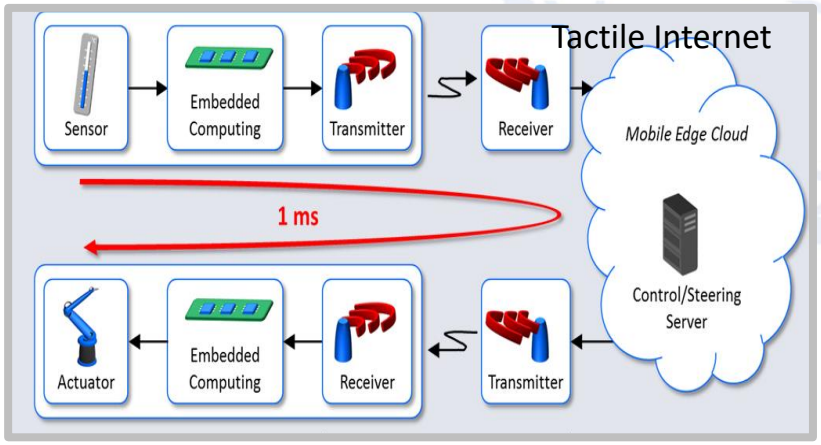
Inefficient use of protocols

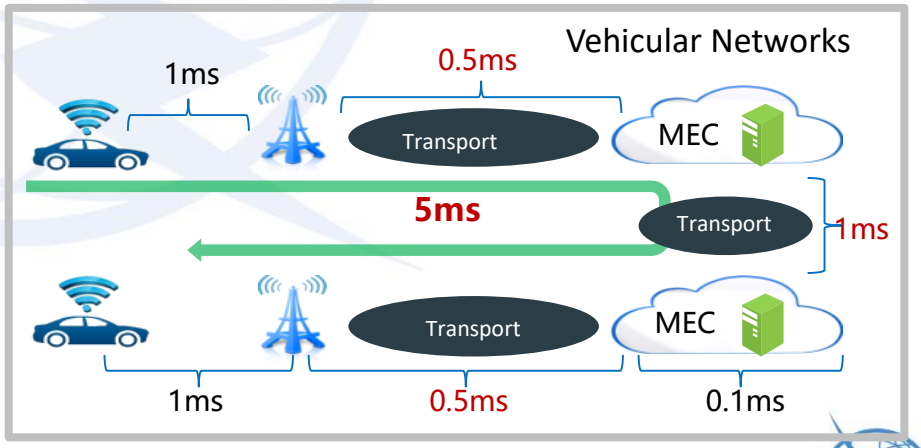
- Tunnels over tunnels
- Some header fields are repeating each other
- Header taxes are high, sometimes as high as 90%

Current Internet cannot guarantee new application delivery constraints





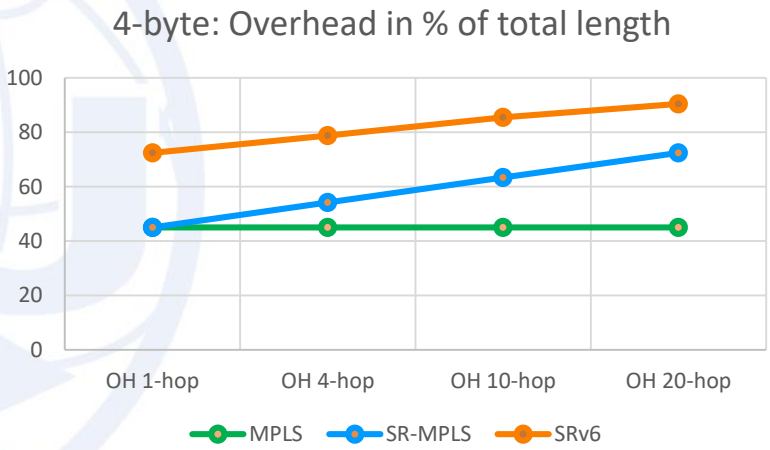




Transport Network Header Tax Often Reaches 90%

Many real-time Short Messaging Apps, IoT, and mMTC packets are small-sized

Extra Header	44-52		44-160		100-564
MPLS	bytes	**MPLS-SR**	bytes	**SRV6**	bytes
				IPv6 Encap	40
				SRH header	8
Transport Labels	4 to 12	Transport Labels	4 x SID count (upto 30)	transport SID	16 x SID count (upto 30)
Service Label	4	Service Label	4		
Outer IPv4 (for GTP)	20	Outer IPv4 (for GTP)	20	Service SID	16
UDP Hdr	4	UDP Hdr	4	UDP Hdr	8
GTP	12	GTP	12	GTP	12
Inner User IP	20	Inner User IP	20	Inner User IP	20
User Transport	4	User Transport	4	User Transport	4
User Payload	4 to 1200	User Payload	4 to 1200	User Payload	4 to 1200

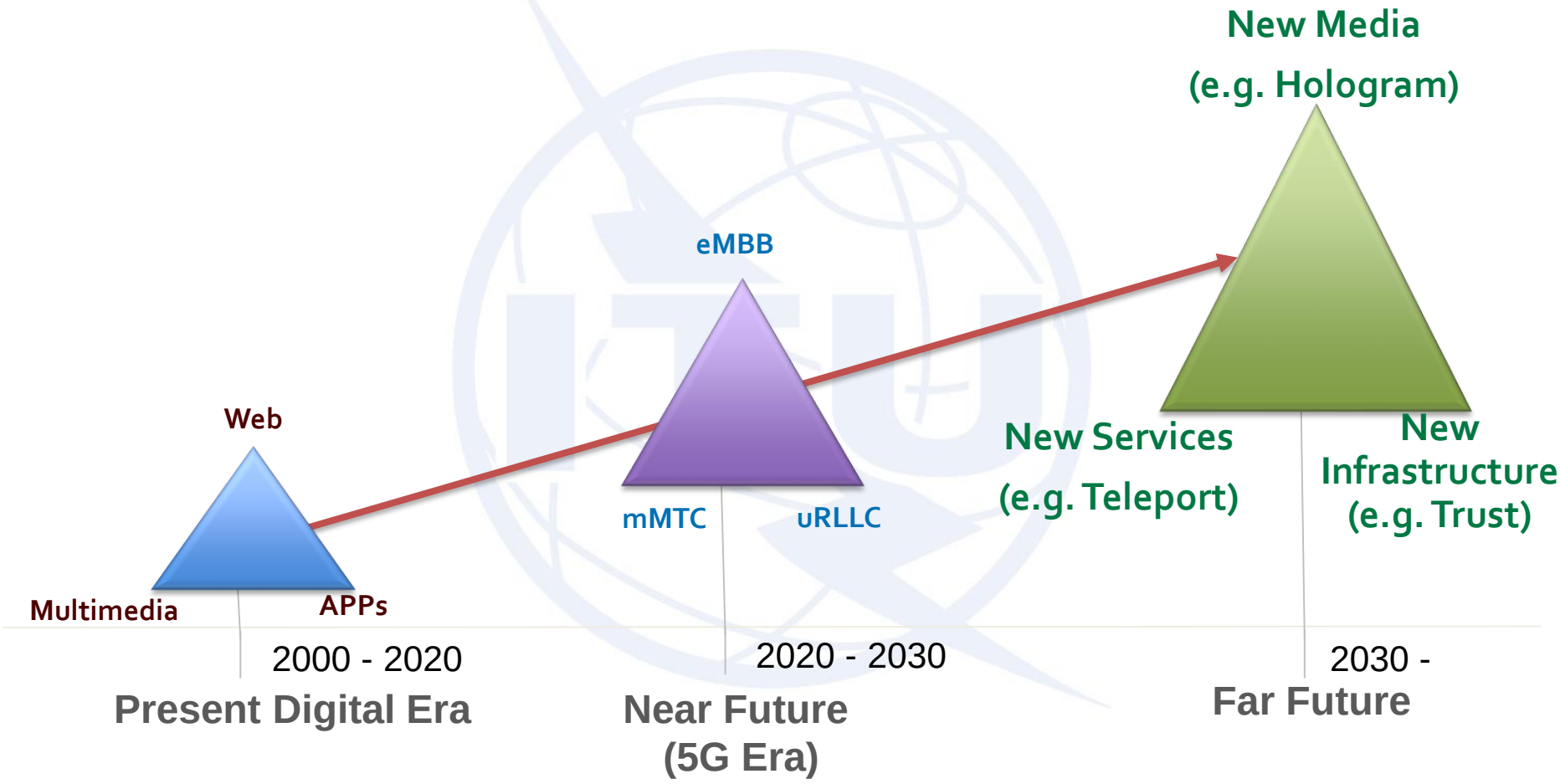


$$transport\ OH\ \% = \frac{(Path_{oh})}{(Std_{hdr} + Path_{oh} + Pl)}$$

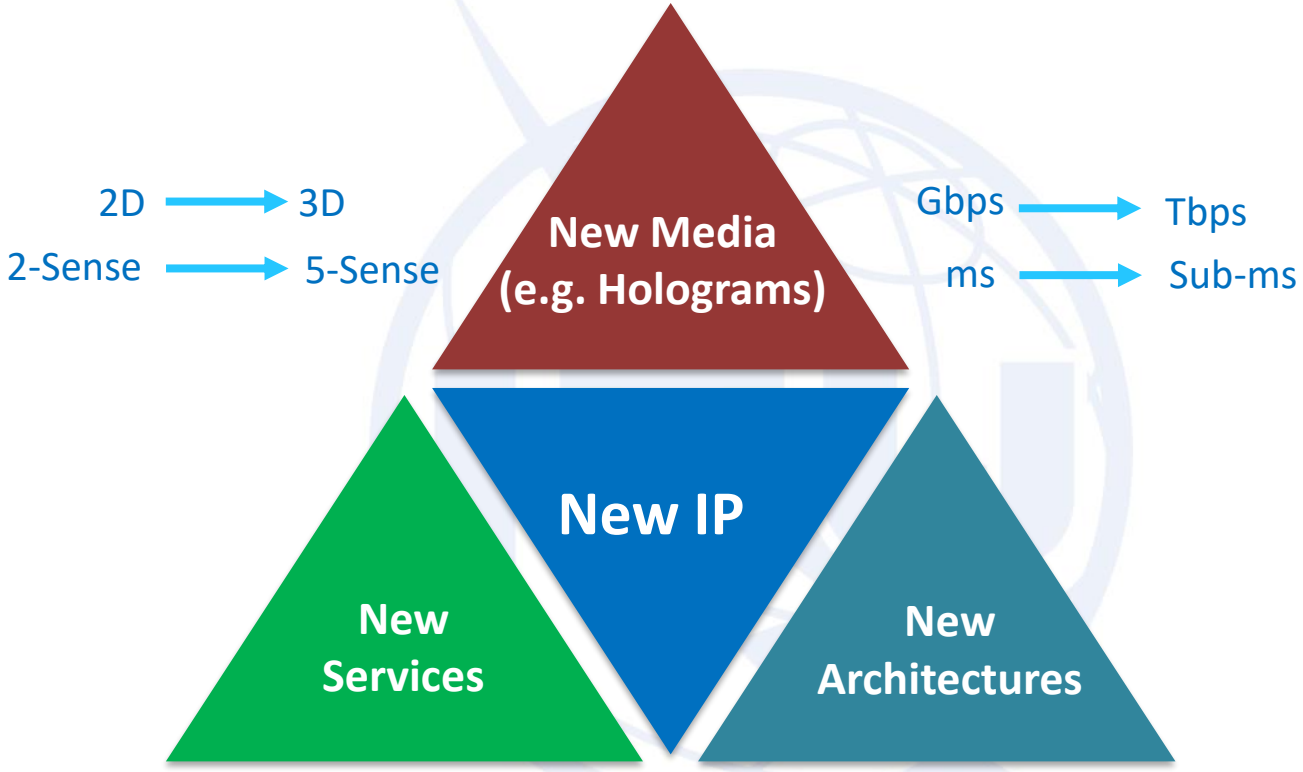
- MPLS-SR and SRv6 overheads go up with the number of hops
- Protocol efficiency with regards to small packets is very low, and can be as low as below 10%

If we design a network to support 5G, we had better design it for a lifespan going over 5G

Internet: Past, Present, Future



A New Horizon beyond 5G Era



Holographic Teleport
High-Precision Service
Deterministic Service
Best-Guaranteed Services

Integrated Terrestrial and Space
Federated Networks
Decentralized Infrastructure
Trustable Infrastructure

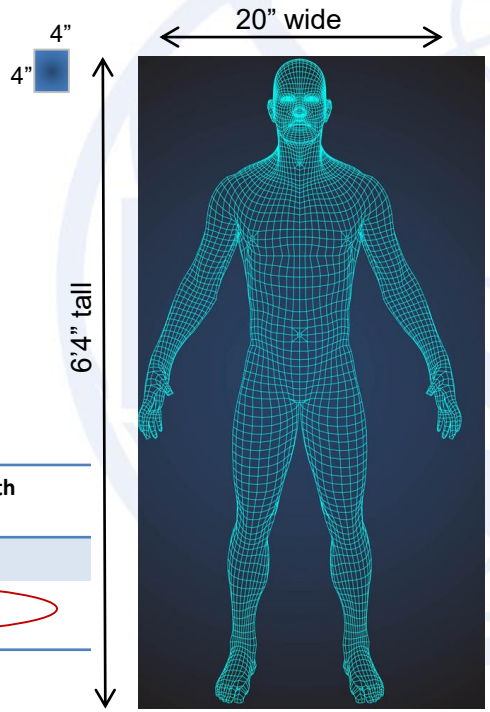
New Media: Hologram

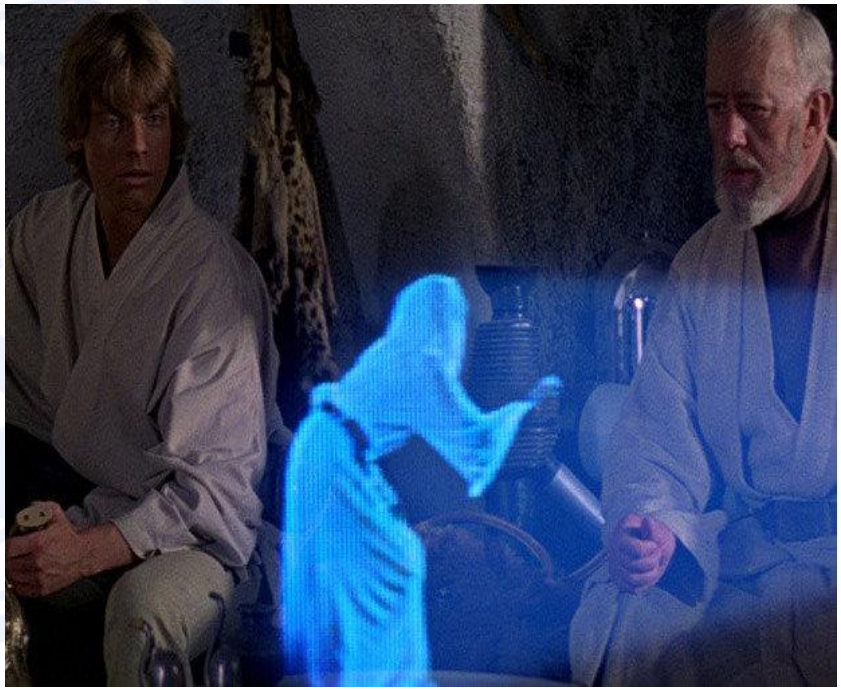
Bandwidth requirement will grow up to terabits for holographic telepresence applications

Effective Pixel Count	Approx. Bandwidth Requirement
31.5 M	1 Gbps
157 M	10 Gbps
755 M	~75 Gbps
1.19G	~90 Gbps
5.10 G	300 Gbps
19.1G	1Tbps

	Dimensions	Bandwidth
Tile	4 x 4 inches	30 Gbps
Human	77 x 20 inch	4.62 Tbps

color, FP (full parallax), 30 fps
(reference: N. Peyghambarian, University of Arizona)





Source: 20th Century Fox

New Digitization: from Quantitative to Qualitative

Quantitative

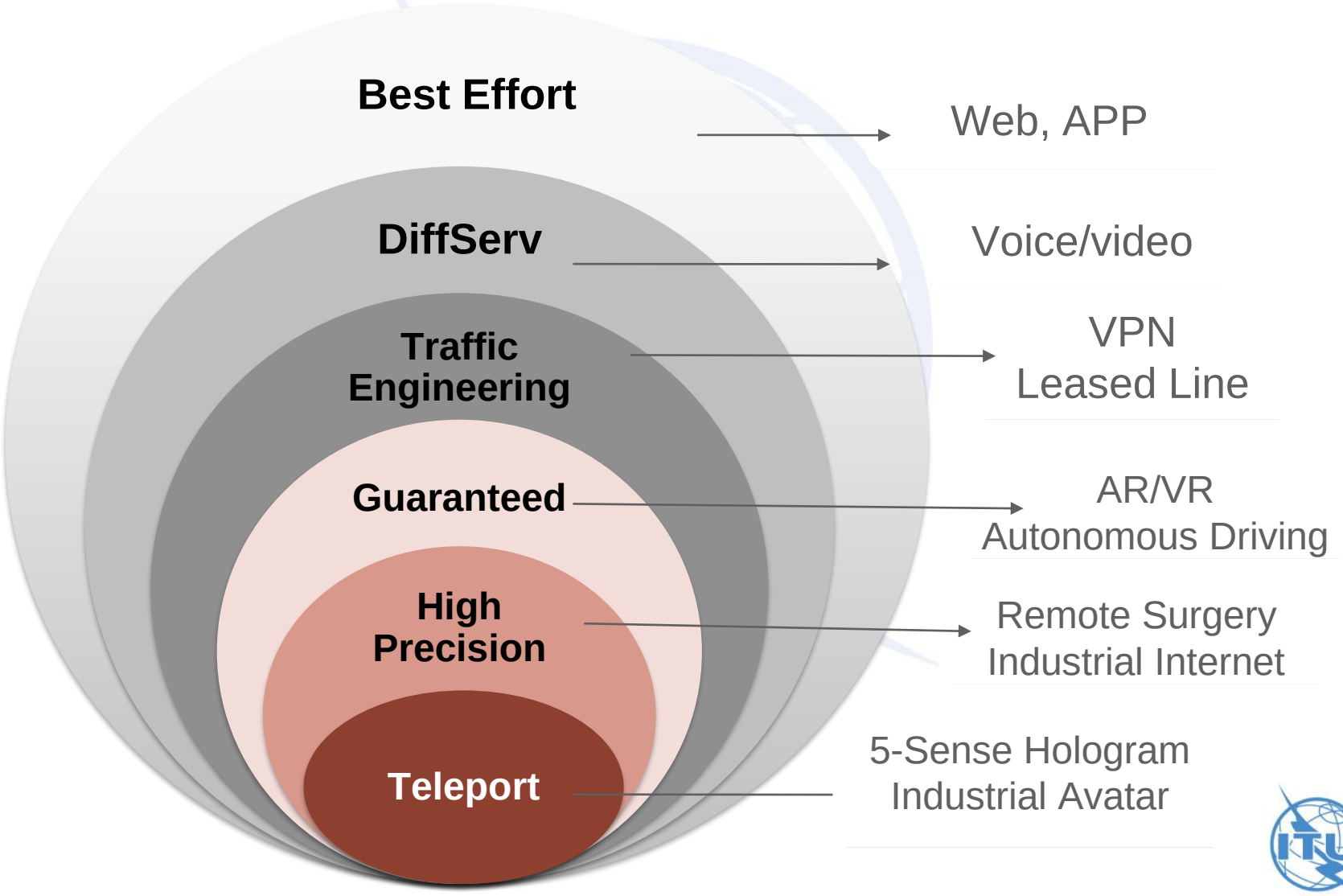
Goldman Sachs have been busy playing with their AI system, which has predicted victory for Brazil in the FIFA World Cup 2018 final. The AI system reportedly ran simulations of 1 million possibilities and variations, before reaching its conclusion.

- Each and every byte has the same significance
- the whole packet is retransmitted if a byte is lost
- Reliability is often a concern
- Example:
  - Texts, voices
- Traditional applications

Qualitative

- Each byte has different significance than other
- No retransmission is required if the lost byte is not significant
- Latency is often a concern
- Example
  - Images, voices, videos, holograms
- High-throughput holographic applications

New Services:
Best-Effort to Guaranteed to High-Precision



Why Latency Matters?

- E-Commerce
  - If an e-commerce site makes $100,000 per day, a 1 second page delay could potentially cost $M2.5 in lost sales every year. 1 second improvement in page speed brings $7000 daily
  - Amazon: A page load slowdown of 1 second could cost Amazon $B1.6 in sales each year
- Stock trading
  - A millisecond delay = $M100/year (Information Week 2017)
  - To process an order: 400 microseconds
- User-Experience
  - Networked AR/VR: more than 20 ms will make you feel dizzy
- Industrial Internet
  - 20us – 10ms is required for machine to machine communications

Guaranteed and High-Precision Services

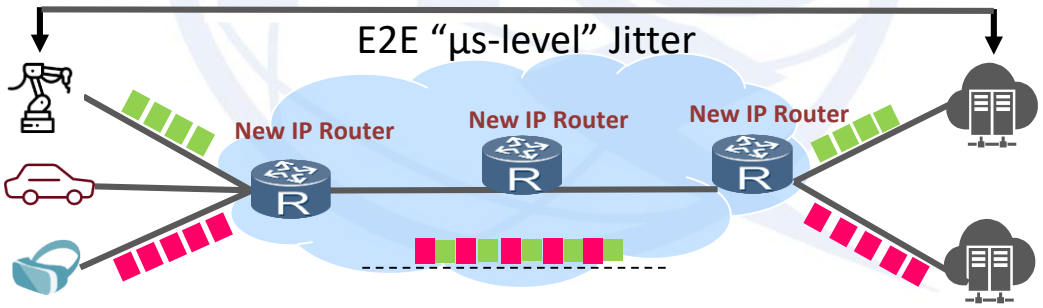
Remote Surgery

Cloud PLC

Intelligent
Transportation System

Applications Require Absolute Delivery Times

New behavior: packet transmission from "in-time" to "on-time".

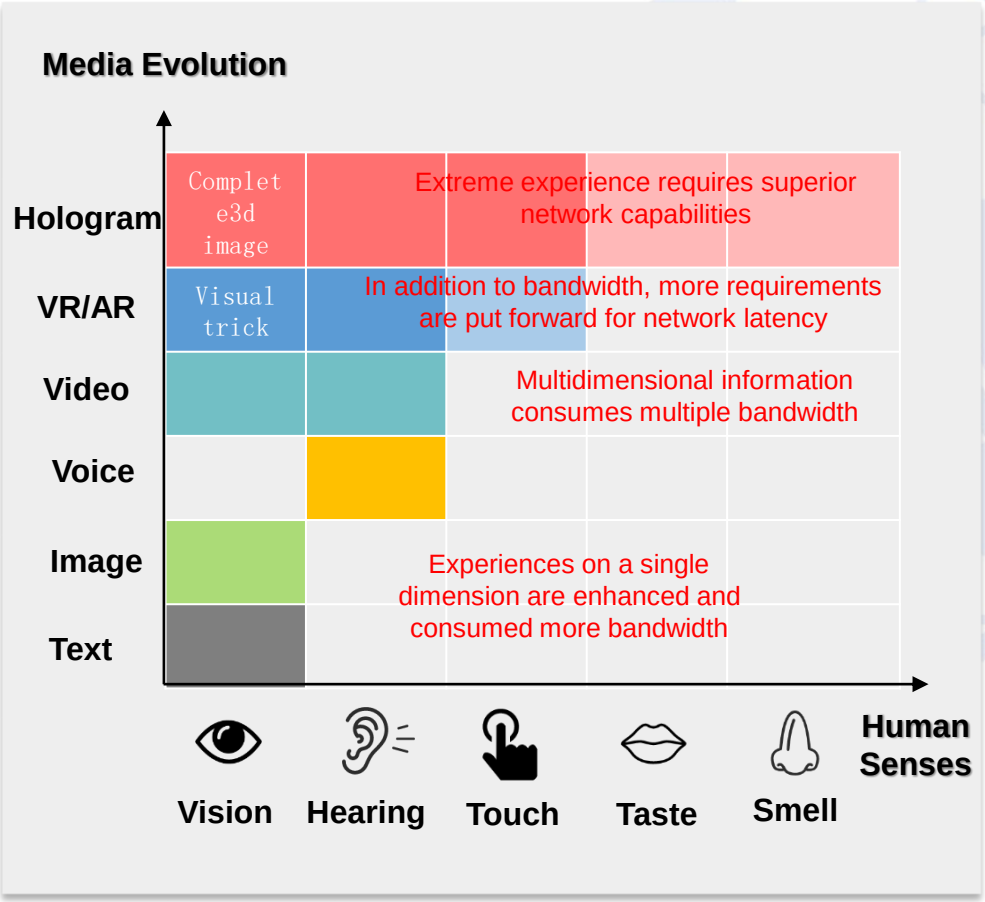


Statistical Multiplexing is not adequate for these applications

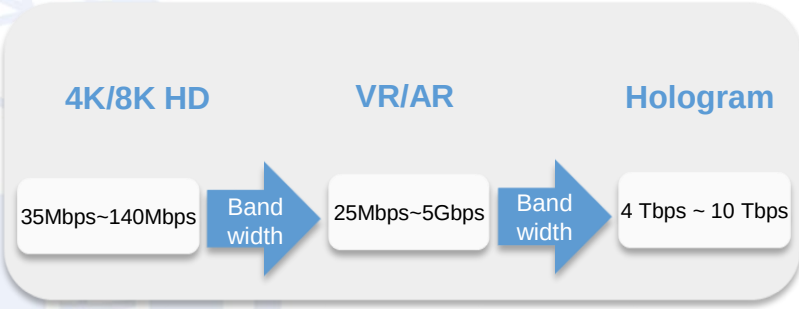
New Functional Components: (1) User-Network Interface (UNI), (2) Reservation Signaling, (3) New Forwarding Paradigm, (4) Intrinsic, Self-Monitoring OAM

New User Experience: Senses, Throughput and Latency

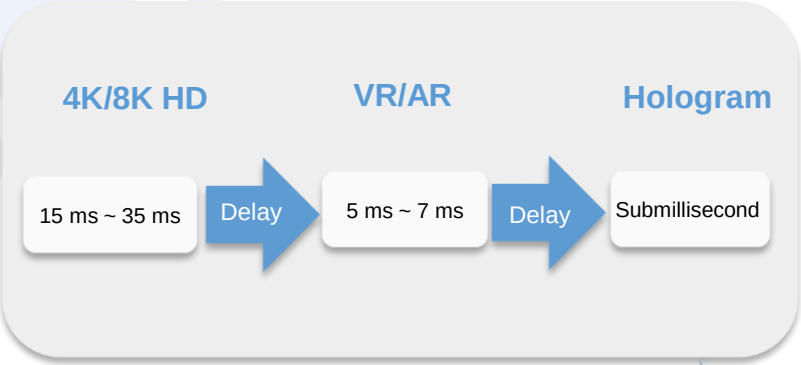
User experience goes from single sense to five senses



Throughput goes up higher and higher



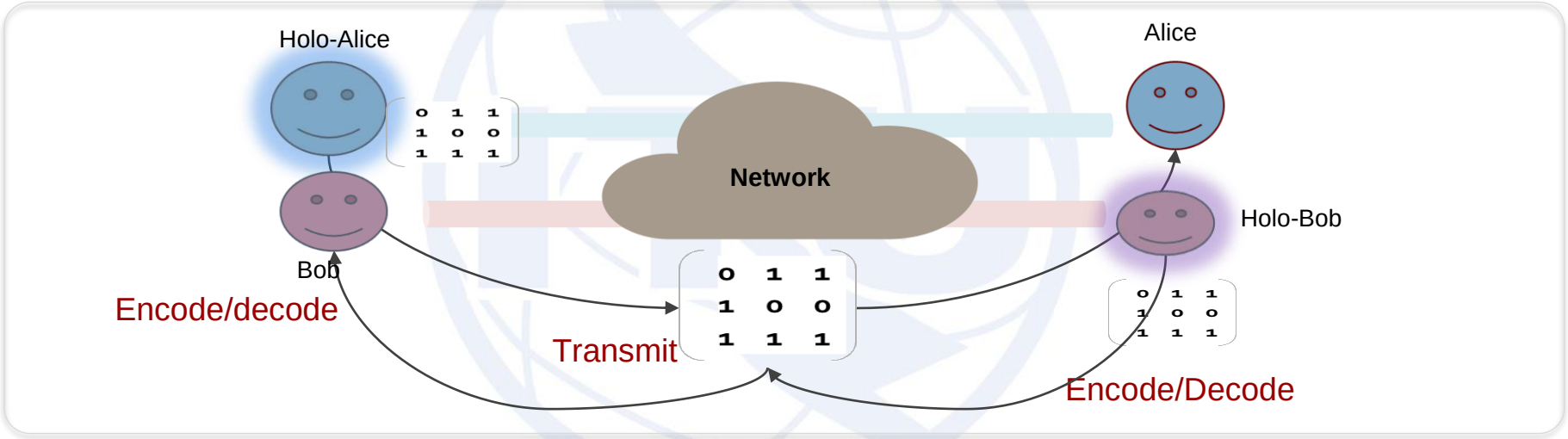
Latency falls down lower and lower



Multi-Sense in Holographic Type Communications

New Holographic Applications

1. Near-Real Personal Communication with Digital/Holographic Presence
2. Immersive Live Models (combination of environment with multiple digital avatars from different sources, for autonomic response to emergency situations).

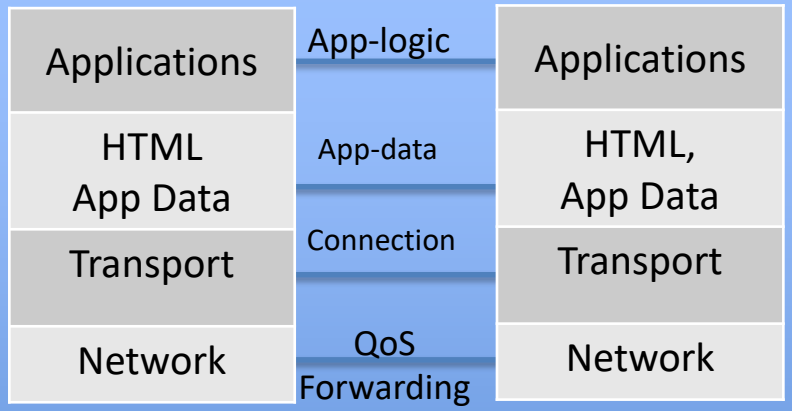


Holo-Object: A Near-real capture of an Object/Actor

Attributes	Light intensity, 3D-Audio, Sensitivity (touch, smell, texture, etc.). user-defined
Multi-Faceted Information	Views from different angles, movement
Scene Isolation	Digital environment composition from avatars for model augmentations

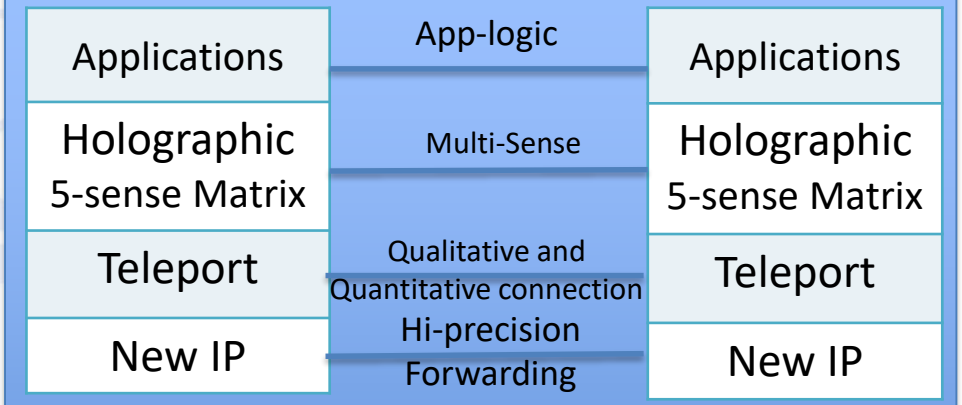
New Concepts for Future Communications

Today's Communications



Datagram	A self-contained routable entity with destination address in packet switched networks
Transport	A one-dimensional information carrier over network. Behavior captured E2E.

Future Communications

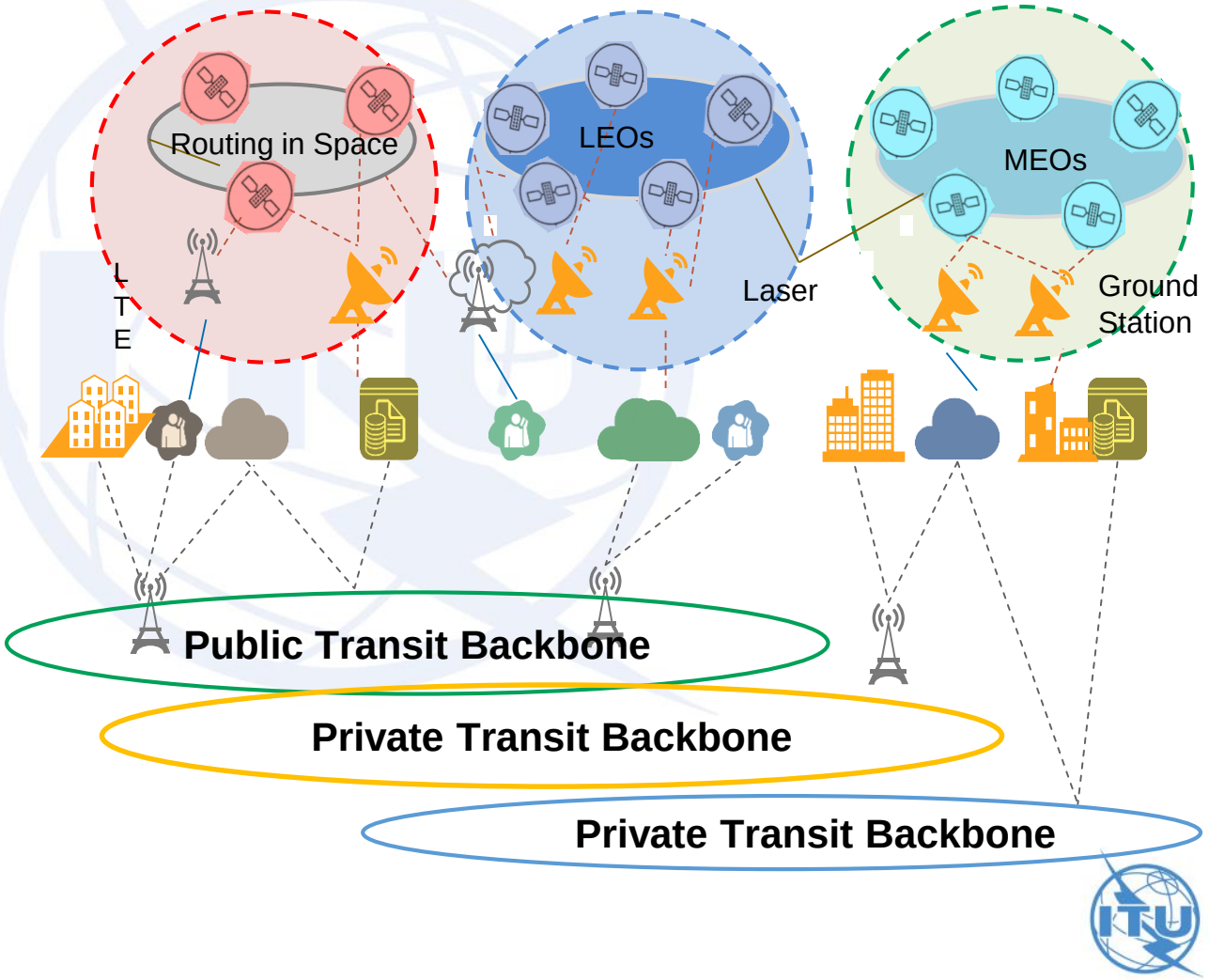


Hologram	New attributes for different senses
Teleport	Transmits at near-real-time (sub-ms) latency, b/w, metadata, behavior etc.),
New IP	Network enabler of high precision service attributes

New Infrastructure:
Convergence of Terrestrial and Space Networks

Co.	Support	Scale
Starlink	SpaceX, Google	4K by 2019, then 12K
Oneweb	Blue Origin (Bezos), Virgin Orbit	650 by 2019
Boeing	Apple (spec)	2956, 1350 in 6 yrs
O3Nb	Virgin group, SES	400
CASIC	China	300 (54 trial)

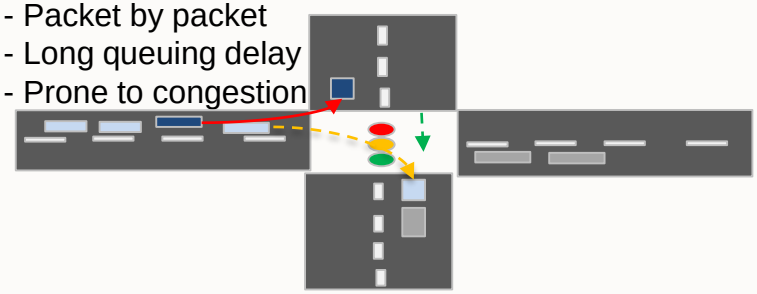
Distances	Bandwidth	delay
(LEO) 900-1200 KM	1—200 Gbps	35ms
(MEO) ~2000 KM	1-200 Gbps	~60ms
Space to space	~100 KM – ~Tbps ~1000 KM ~10 Gbps	



It Opens the Door to Explore New Technologies

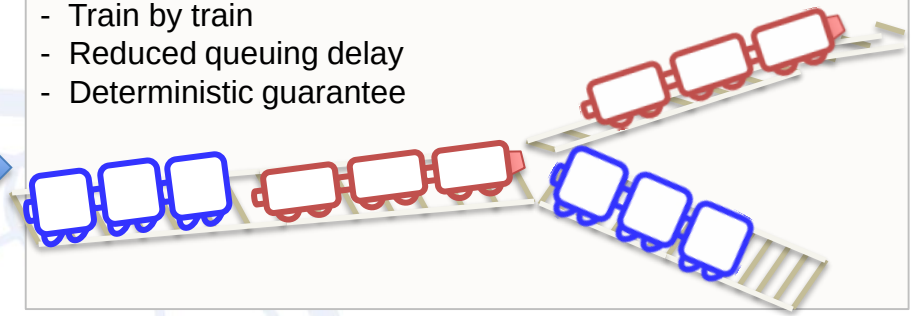
Packet Switched

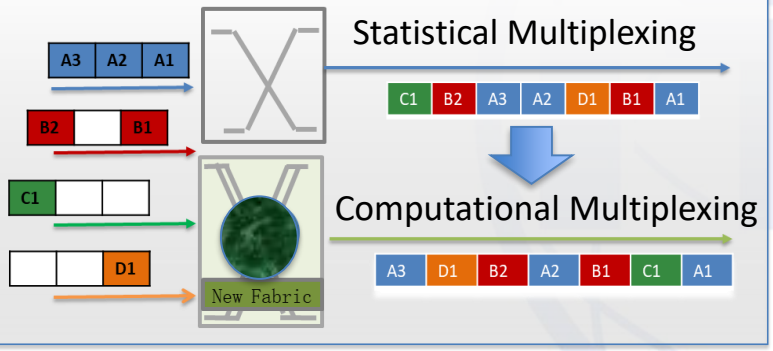
- Packet by packet
- Long queuing delay
- Prone to congestion

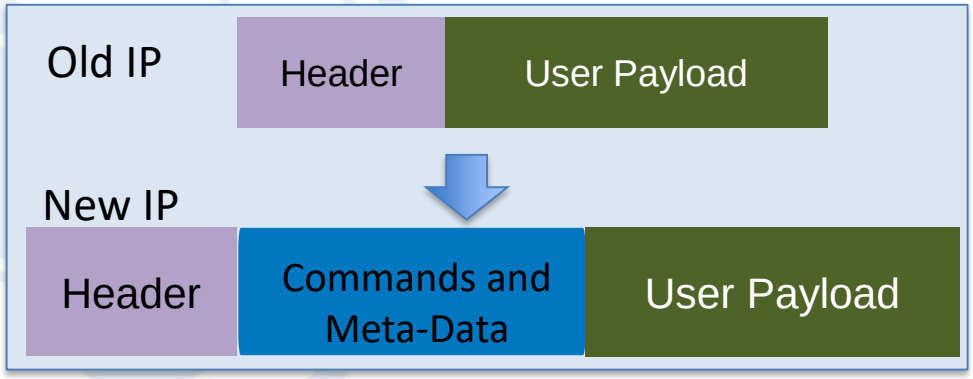


Rail Switched

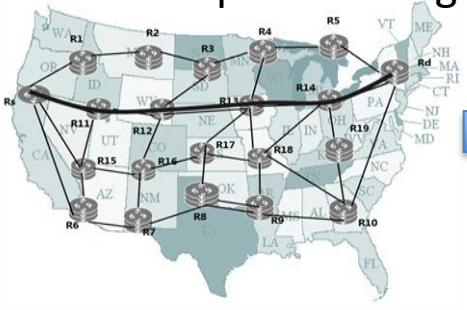
- Train by train
- Reduced queuing delay
- Deterministic guarantee





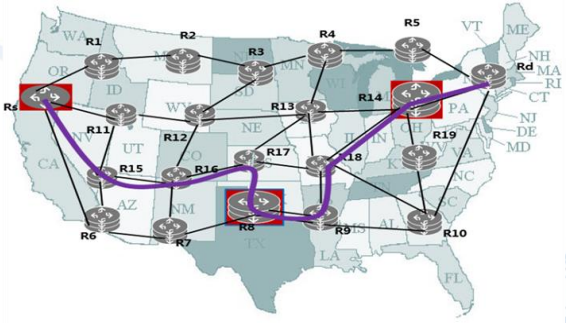


Shortest path routing

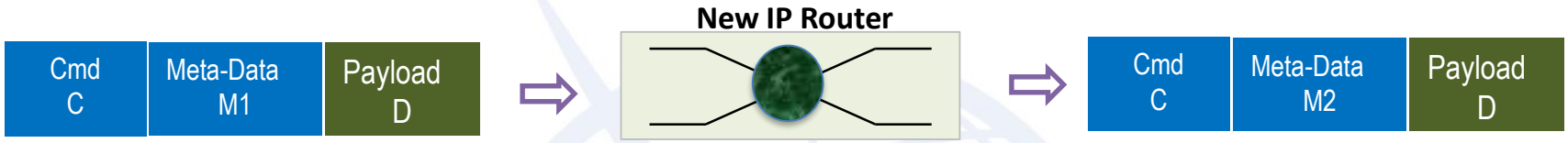


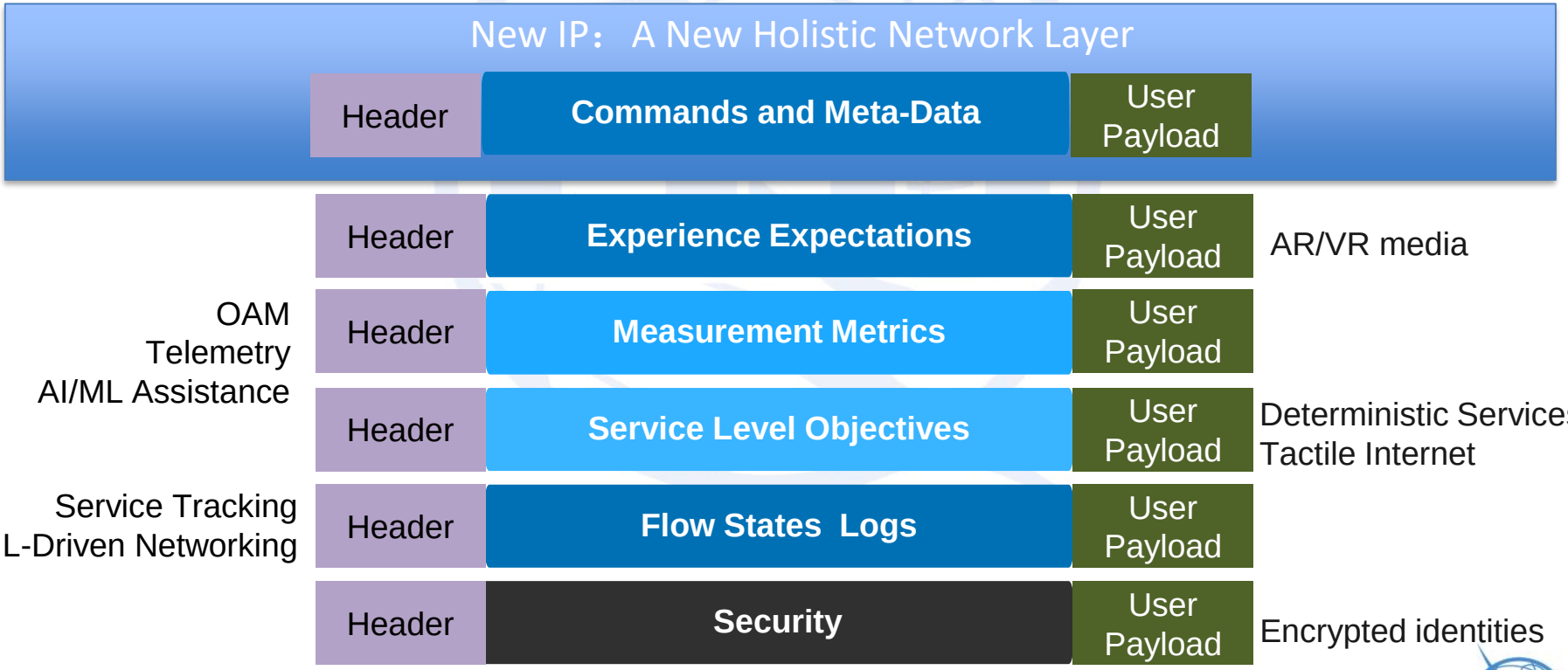
Segment Routing

Preferred Path Routing



New IP Unlocks New Opportunities





Summary:
From IMT 2020 to Network 2030

ITU-T IMT-2020	Network 2030
Enables an Era of Mobile Connected Society	Enables a New Internet
Low Latency (1 ms)	Super Ultra-Low Latency (<1ms)
	Guaranteed Latency (in-time)
	High-Precision Latency (on-time)
Data Rate (10 Gbps)	Data Rate (1 Tbps)
Network Technologies: Slicing, SDN, NFV, SON	New IP, Rail-Switching, Preferred Path Routing
Internet of Things	CPS and Digital/Physical Twins
Enhanced Privacy and Security	Trustable Network Infrastructure
2-Sense 3D Media	5-Sense 3D Holograms
	Holographic Teleport
	Holistic Protocol Efficiency

Join Us

We are proposing a new

Focus Group on Network 2030 in SG-13

We welcome and invite all of you to join us and help shape a New Internet!

Thank You


ITU