

Emerging Challenges and New Research Directions: A Perspective from Network 2030

Session 2: IMT-2020/5G Systems - “Transport, slicing, FMC”

Richard Li, Ph.D.

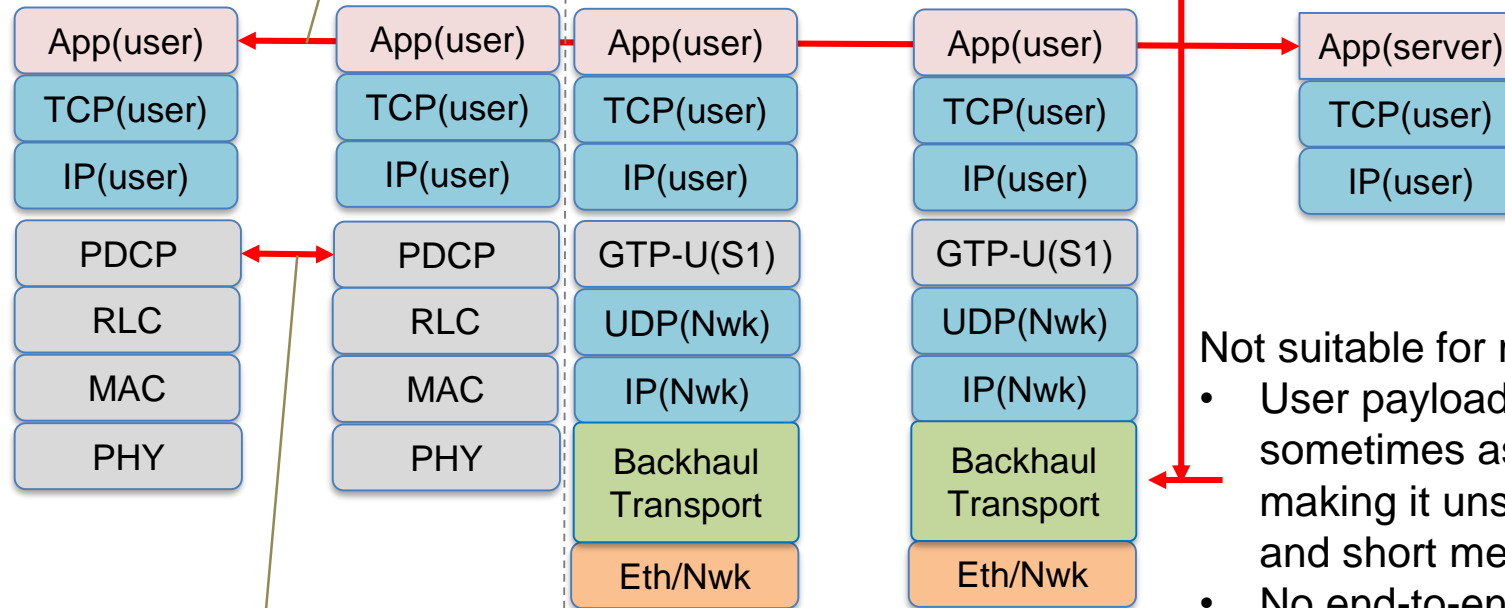
Chairman of the ITU-T Focus Group on Network 2030

Budapest, Sept 9-10, 2019

RAN has evolved, but wireline data communication networks have been left behind. There is no way to meet end-to-end requirements

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

Delay variations: Radio retransmissions are not synchronized with TCP flow control, causing TCP to wastefully retransmit packets



Cellular network

Fixed, IP based wireline network

Inefficient use of protocols

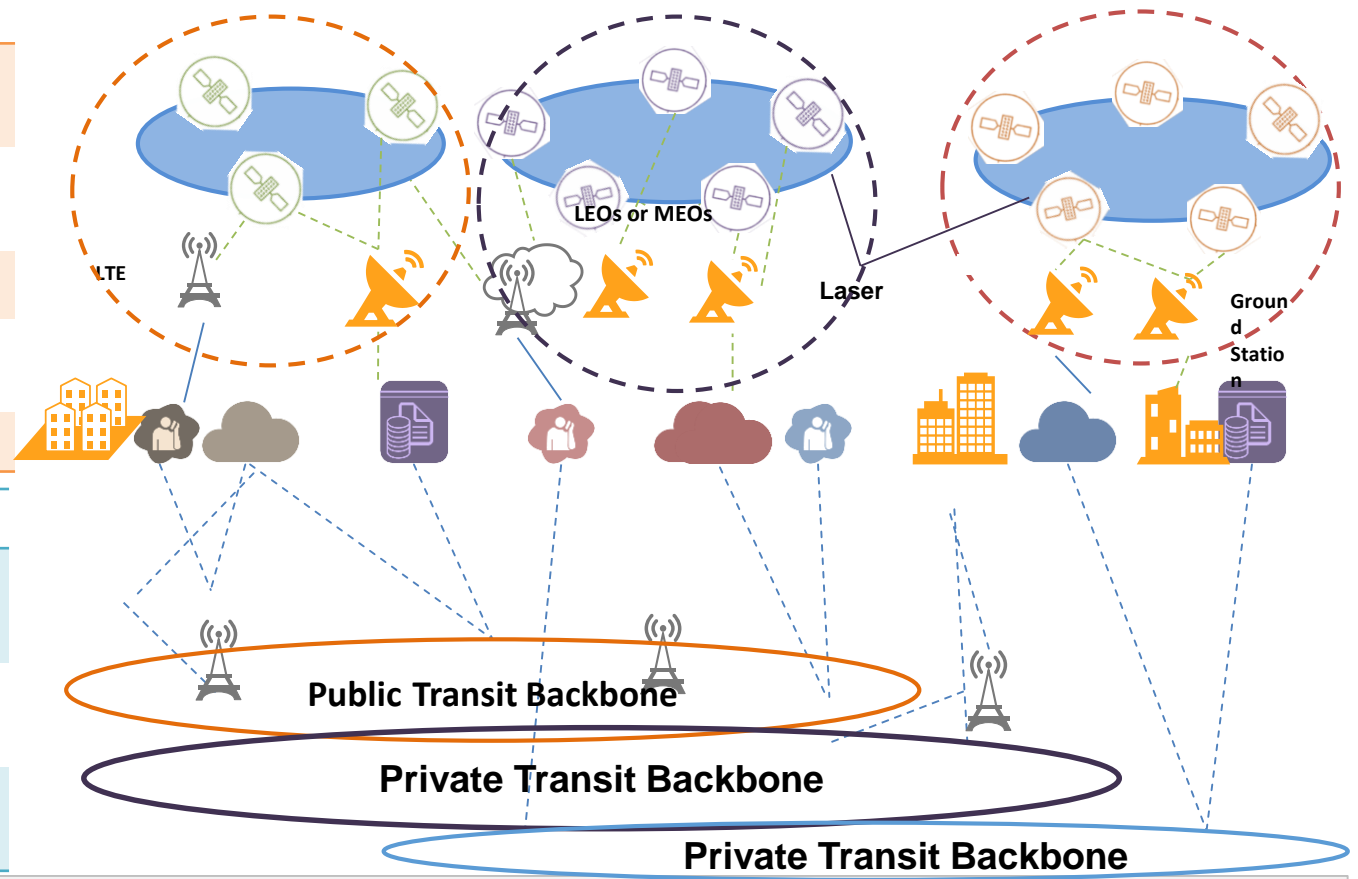
- Tunnels over tunnels
- Some header fields repeat each other

Not suitable for mMTC and uRLLC

- User payload efficiency is low, sometimes as low as 30%, making it unsuitable for mMTC and short messages
- No end-to-end QoS, making it unsuitable for uRLLC

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)

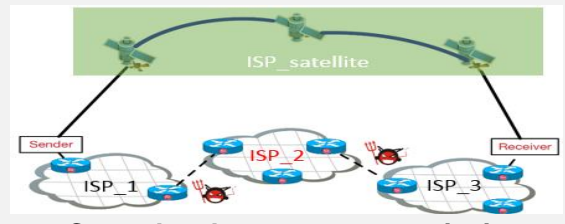
Distances	Bandwidth	delay
(LEO) 900-1200 KM	1—200 Gbps	35ms
(MEO) ~2000 KM	1-200 Gbps	~60ms
Space to space	~100 KM – ~Tbps ~1000 KM ~10 Gbps	



Emergency relief



High-speed aviation and navigation broadband



Cross-border secure transmission

Emerging Applications and New Requirements

High precision in services

- Industrial Control
- Autonomous Driving
- Tactile Internet



- ✓ Extremely Low Latency
- ✓ High-Precision Latency
- ✓ Lossless

Holographic media

- Real-time high-throughput streaming
- Coordination of different streaming



- ✓ Very high throughput
- ✓ Blended with five senses

ManyNets Infrastructure

- Space Internets
- Private Internets
- Unresolved Regulatory barriers



- ✓ Multi-type addressing
- ✓ Convergence
- ✓ Federation and Collaboration

Moving beyond best effort

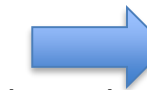
- Business-Class Services
- Privacy and Trust
- Lossless Networking



- ✓ High-Quality Networking
- ✓ Business Class vs. Economy Class

Advanced Access Technology

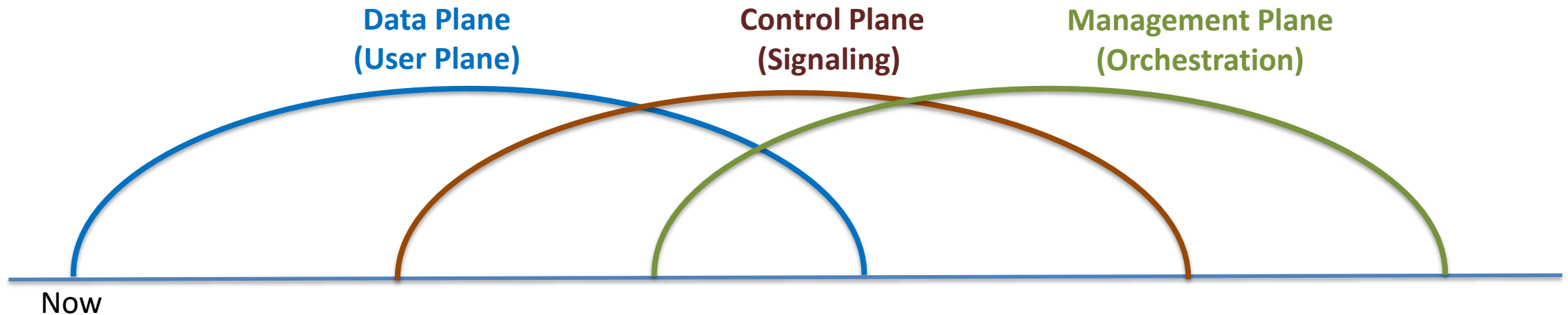
- Gbps/Tbps provided by 5G/B5G/6G
- Surface Wave
- The First/last mile is not the bottleneck any longer



- ✓ Innovation on fixed networks
- ✓ Re-imagination of the Internet

Strategic direction to be taken by ITU-T

Every major networking technology, big or small, often has three cycles, and always starts with data plane innovation
Examples: IPv4, IPv6, MPLS, L3VPN, L2VPN, etc



New applications are coming, requirements are clear, and gaps exist. Now it is exactly the time to start off a new wave of innovations with a new data plane/user plane for wireline data communication networks.

Start with **SG-13**, then have **SG-11** and perhaps others being involved step by step, blended with topic-specific focus groups.

Questions for SGLA discussion – 1

Question 1: Future user planes or data planes including its underlying technologies and solutions such as high-precision networking and time-engineered services to support and meet end-to-end requirements for emerging applications

- Throughput, Latency, Losslessness, High-precision communications
- User-Defined Networks, User-Network Interface, network Intelligence, In-Network Computing
- New transport technologies for 5G, B5G, and so on

Questions for SGLA discussion – 2

Question 2 : New, and better to be unified, architectures of ManyNets and Digital Twins, especially for convergence of terrestrial and satellite networks across the earth, sky and ocean, from the perspective of

- Addressing, Interworking technologies and solutions, Collaborative networks, Federated networks, Autonomous and self-governed networks
- Network Calculus, In-band telemetry, intent-based networking and verification
- Self-configuration, self-optimization, self-diagnostics, and self-healing
- Network models, analytics, planning, predictability and verification

Questions for SGLA discussion - 3

Question 3: Future Control Plane for Signaling and Control in Support of Future Data Planes

- User-Defined Networks, User-Network Interface and Network-Network Interface (UNI and NNI), In-Band Signaling, Routing and Control
- Service-Metric Routing, Multi-Dimensional Routing, Ultra-Fast Re-Convergence (uFRC), Ultra-Fast Re-Routing (uFRR)
- Preferred Path Routing for 5G/B5G
- Cross-Plane Signaling and Control, Cross-Routing for Terrestrial and Space Internets

Questions for SGLA discussion - 4

Question 4: Futuristic Media and Application-Aware Networking Technologies and Solutions

- Holographic Packetization, Entropy-based transmission vs digital transmission and communications
- Qualitative Communications and Holographic-Type Communications
- Packet wash, reparation, recovery, compensation, Computing in Networks