Network 2030 and the Future of IP

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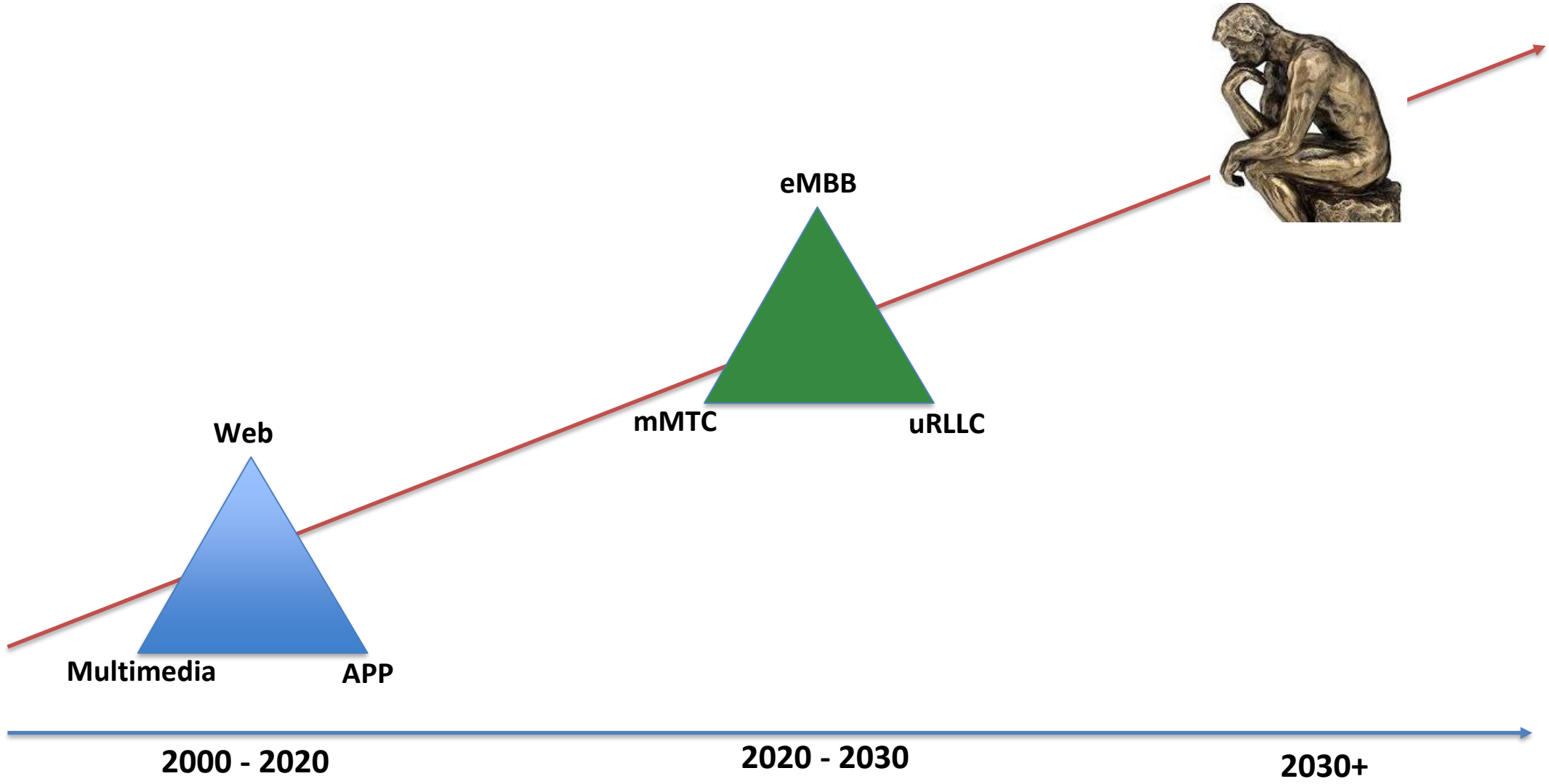
Agenda

- **Network 2030**
  - **ITU-T Initiative**
  - **Use Cases and Driving Forces**
- **A Research Proposal**

What will be the market drivers in the year 2030 and beyond?



ITU-T Focus Group on Network 2030

ITU | General Secretariat | Radiocommunication | Standardization | Development | ITU Telecom | Members' Zone | Join ITU

About ITU-T | Study Groups | Events | All Groups | Join ITU-T | Standards | Resources | Regional Presence | BSG

Focus Group on Technologies for Network 2030

Identify future use cases and new requirements

Study capabilities of networks for the year 2030 and beyond

Explore new concepts, principles, mechanisms, and architectures

Establish

July 16 – 27, 2018
Geneva

1st Meeting

October 2 – 4, 2018
New York

2nd Meeting

December 18 – 21, 2018
Hong Kong

3rd Meeting

18th Week, February 2019
London

4th Meeting

20th Week, May 2019
St. Petersburg

5th Meeting

October 2019
Geneva

https://www.itu.int/en/ITU-T/focusgroups/net2030/Pages/default.aspx

Output and Deliverables

A. *Network 2030 – A Blueprint of Technology, Applications, and Market Drivers towards the Year 2030 and Beyond*, a White Paper on Network 2030, ITU-T, May 2019 (Download)

B. *New Services and Capabilities for Network 2030: Description, Technical Gap and Performance Target Analysis*, ITU-T FG Network 2030, Oct 2019 (Download)

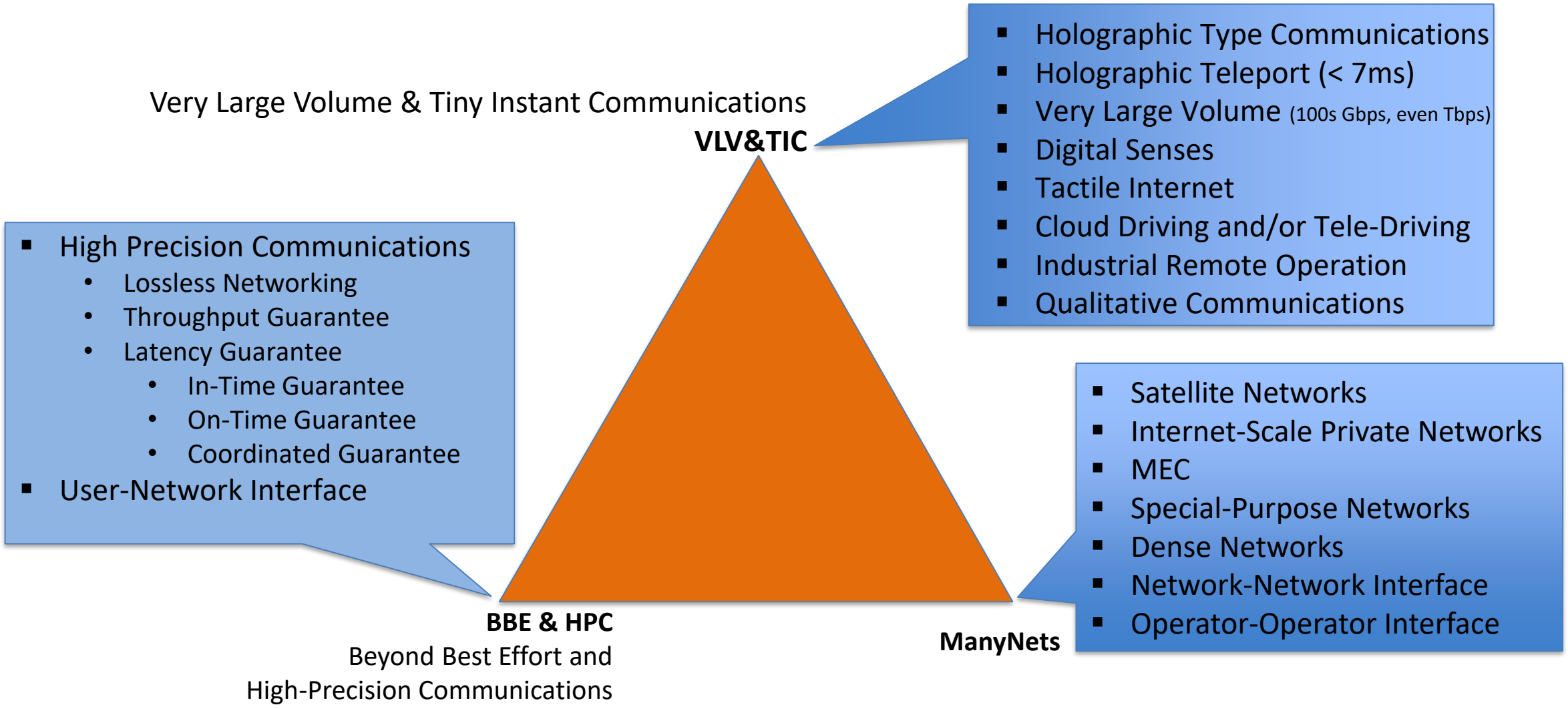
C. Use Cases and Requirements for Network 2030 (In Progress)

D. Architecture and Framework for Network 2030 (In Progress)

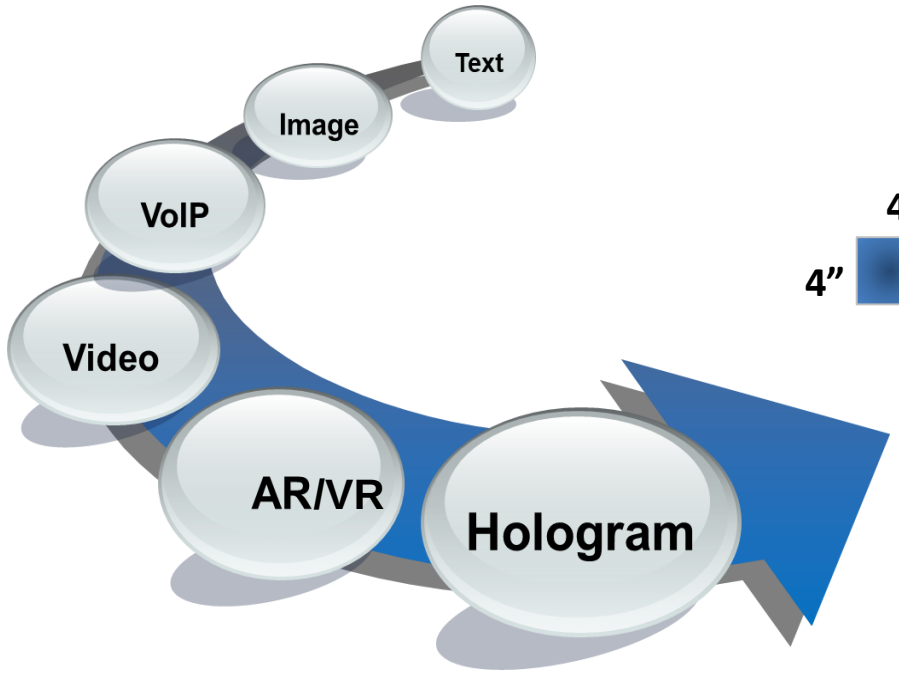
Use Cases being discussed

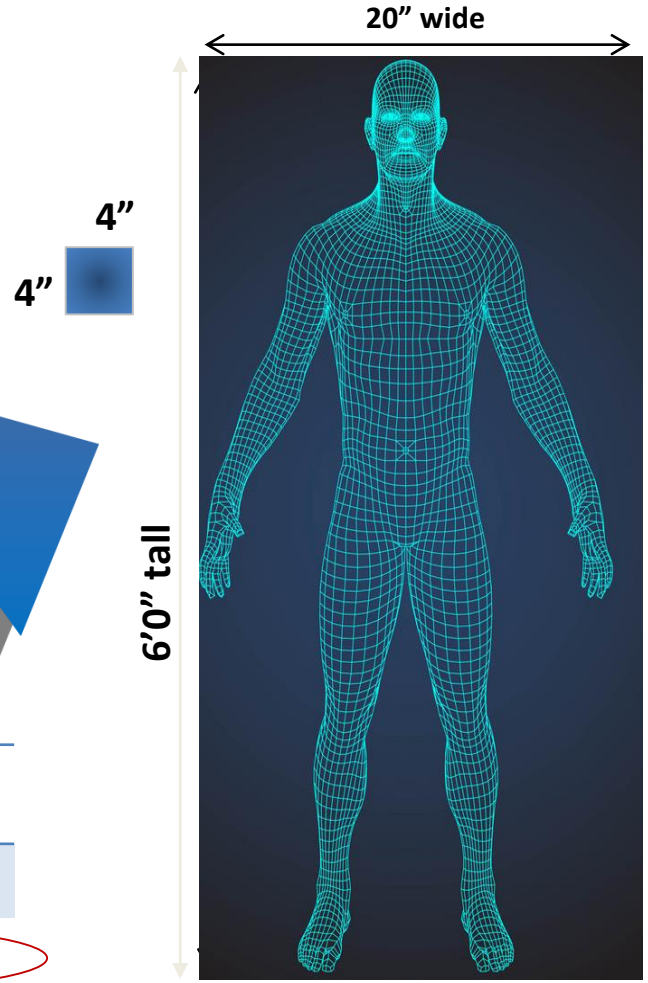
- Holographic type communications (HTC)
- Tele-driving, cloud driving and integrated driving
- Space-terrestrial integrated network (STIN)
- Industrial IoT (IIoT) with fully cloudified PLC
- Intelligent operation network (ION)
- Light-field 3D communications (LF3D)
- Tactile internet (TAC)
- Network computing convergence (NCC)
- Digital Twin and Holographic Twin (DT/HT)

New IP Frontier – Market and Business Drivers



Media Evolution: Holograms and Holographic Type Communications





	Dimensions	Bandwidth
Tile	4 x 4 inches	30 Gbps
Human	72 x 20 inch	4.32 Tbps

- Raw data; no optimization or compression.
- color, FP (full parallax), 30 fps

(reference: 3D Holographic Display and Its Data Transmission Requirement, 10.1109/IPOC.2011.6122872), derived from for ‘Holographic three-dimensional telepresence’; N. Peyghambarian, University of Arizona)

Throughput goes up

4K/8K HD		VR/AR		Hologram
35Mbps~140Mbps	band width	25Mbps~5Gbps	band width	2 Tbps~10 Tbps

Holographic Twin: Latency falls down

4K/8K HD		VR/AR		Hologram
15 ms~35 ms	delay	5 ms~7 ms	delay	Sub ms~7ms

Synchronization of parallel streams

4K/8K HD		VR/AR		Hologram
Audio/Video(2)	streams	Multiple tiles (12)	streams	~thousands (view-angles)

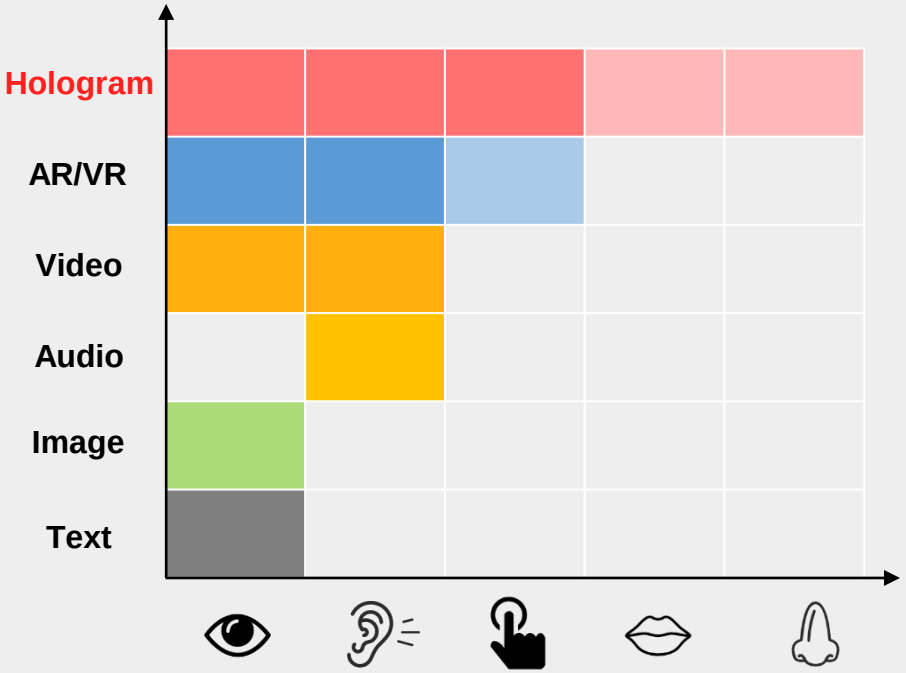
Attaching Digital Senses to Holographic Type Communications

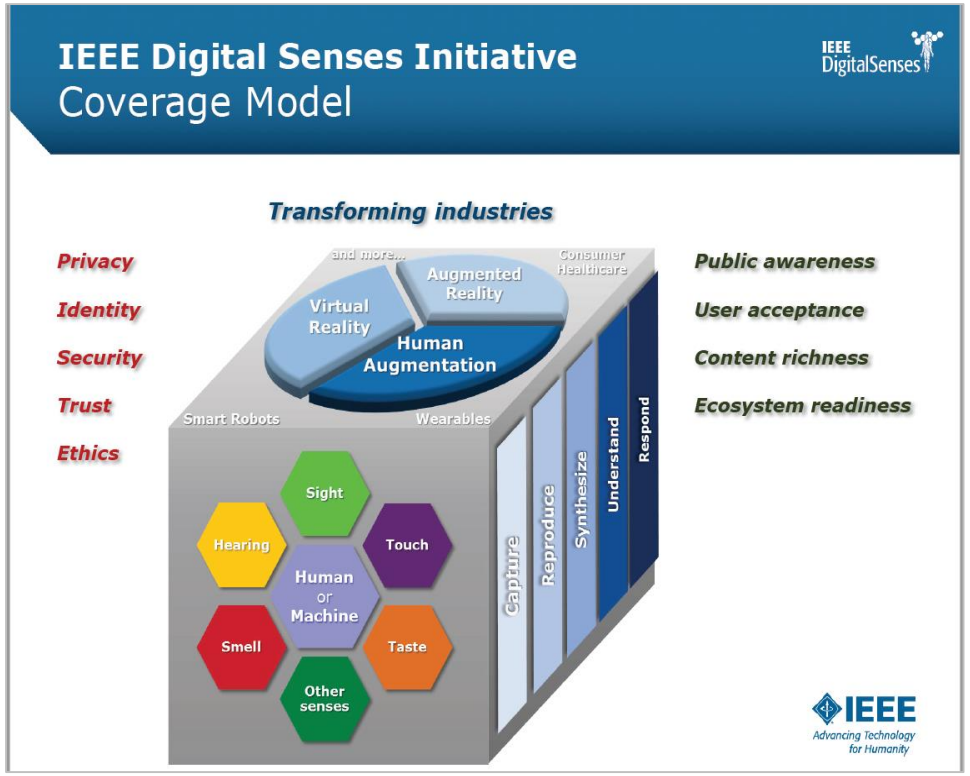
1T/s — 1ms

1G/s — 17ms

100M/s — 33ms

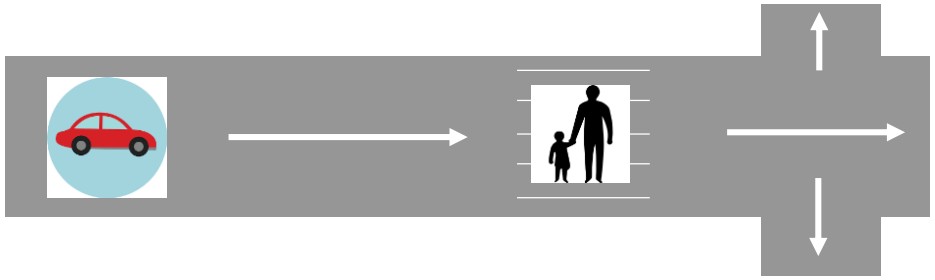
64k/s — 50ms





Packet loss and latency are safety of life KPIs

UC, Berkeley
Pizza Delivery



Sensory Image Capture: 40ms
Framing + Encoding: 120 ms
Decoding + Display: 100ms
RTT between Colombia to San Francisco: 200 – 400ms

Total: 460 – 660 ms

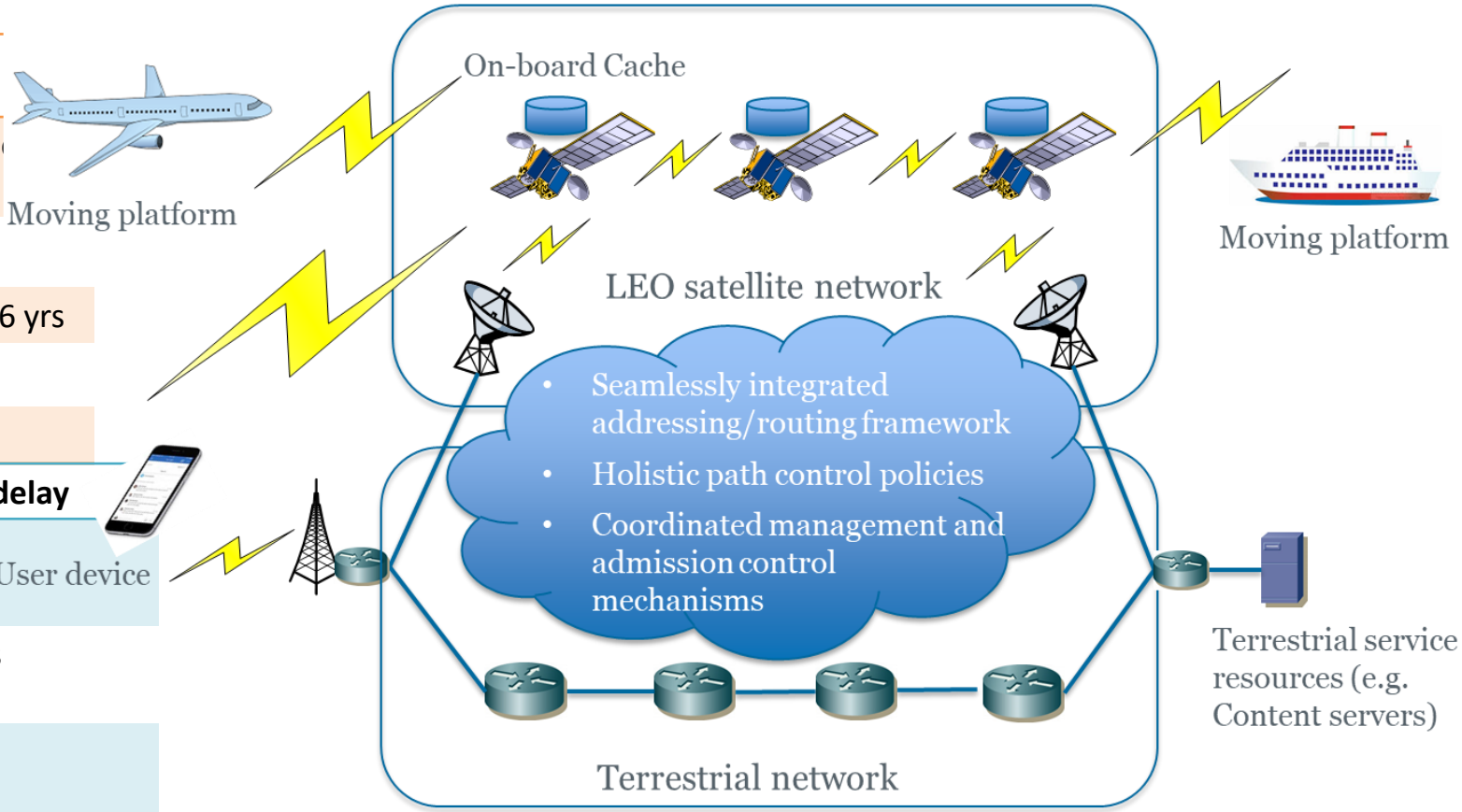
Extrapolation:

1) 5 km/hour = 1.4m/sec. Crash-Avoidance distance = 1.4m/sec x 660ms = 0.92m
2) 30 km/hour = 8.4m/sec. Crash-Avoidance distance = 8.4m/sec x 660ms = 5.54m
3) 60 km/hour = 16.8m/sec. Crash-Avoidance distance = 16.8m/sec x 660ms = 11.08m

Convergence of Satellite Networks and Terrestrial Networks

Co.	Support (Data are from the Internet, not yet verified)	Scale
Starlink	SpaceX (Elon Musk)	4K by 2019, th 12K
Oneweb	Softbank	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	



Use Cases

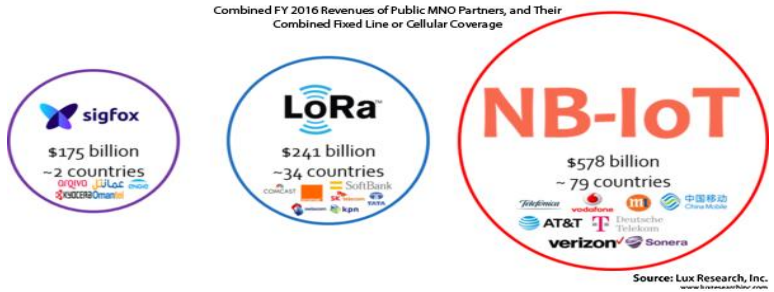
- Satellite as access, and terrestrial networks as backhaul
- Satellite as transport
- Hybrid and Integrated

Requirements

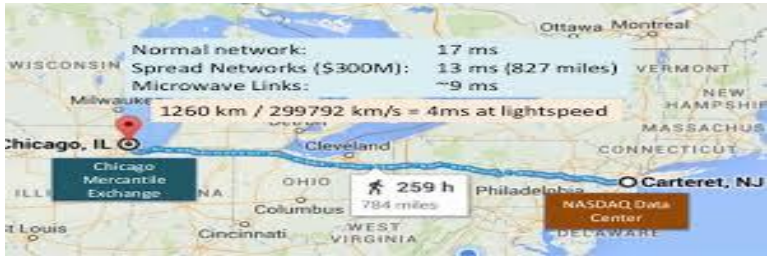
- Uniform Addressing and Converged Routing
- Bandwidth capacity at the satellite side
- Admission control by satellites
- Edge storage and computing

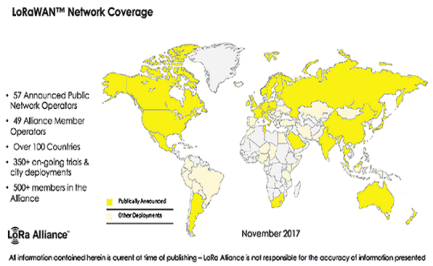
Many Nets: Diversity, Variety, and Economy

Non-IP Networks
(Growing market segment)



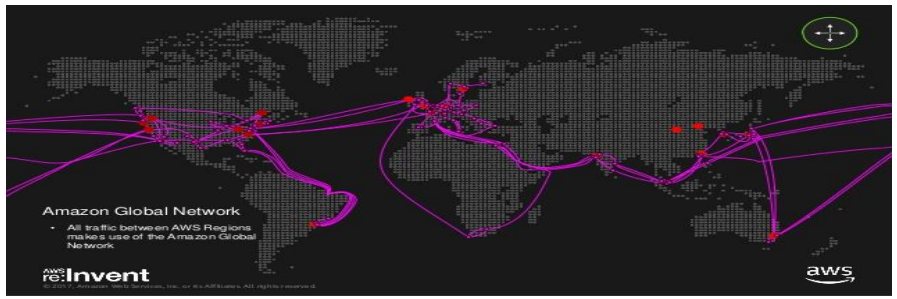
Spread Networks

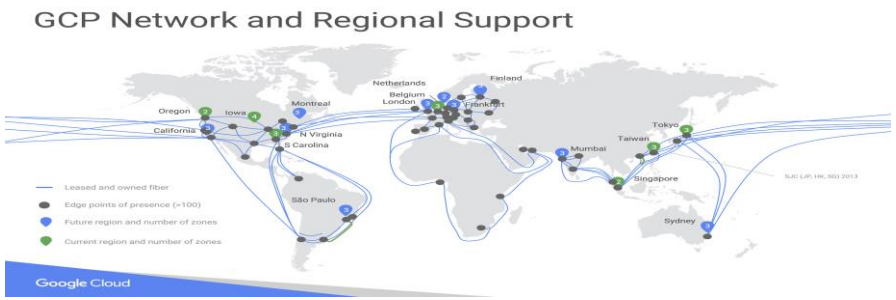


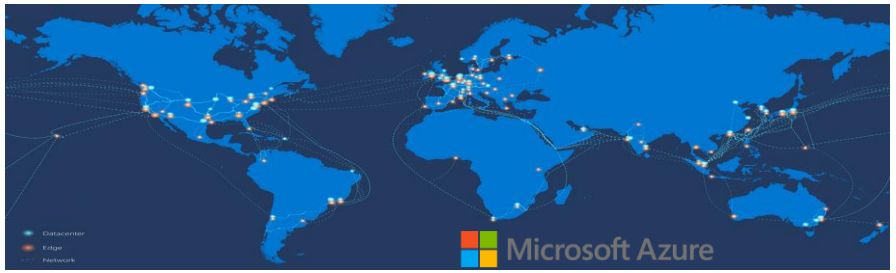


FirstNet®

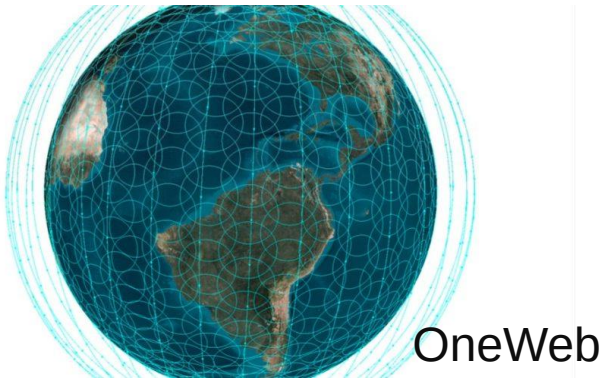
Private Global Backbones
(Death of Internet Transit)

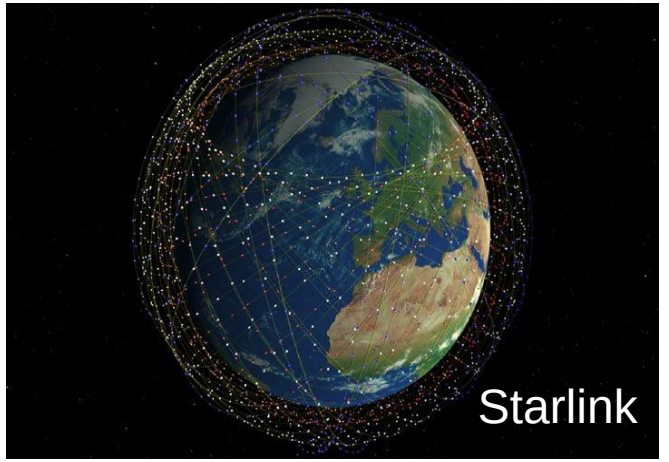






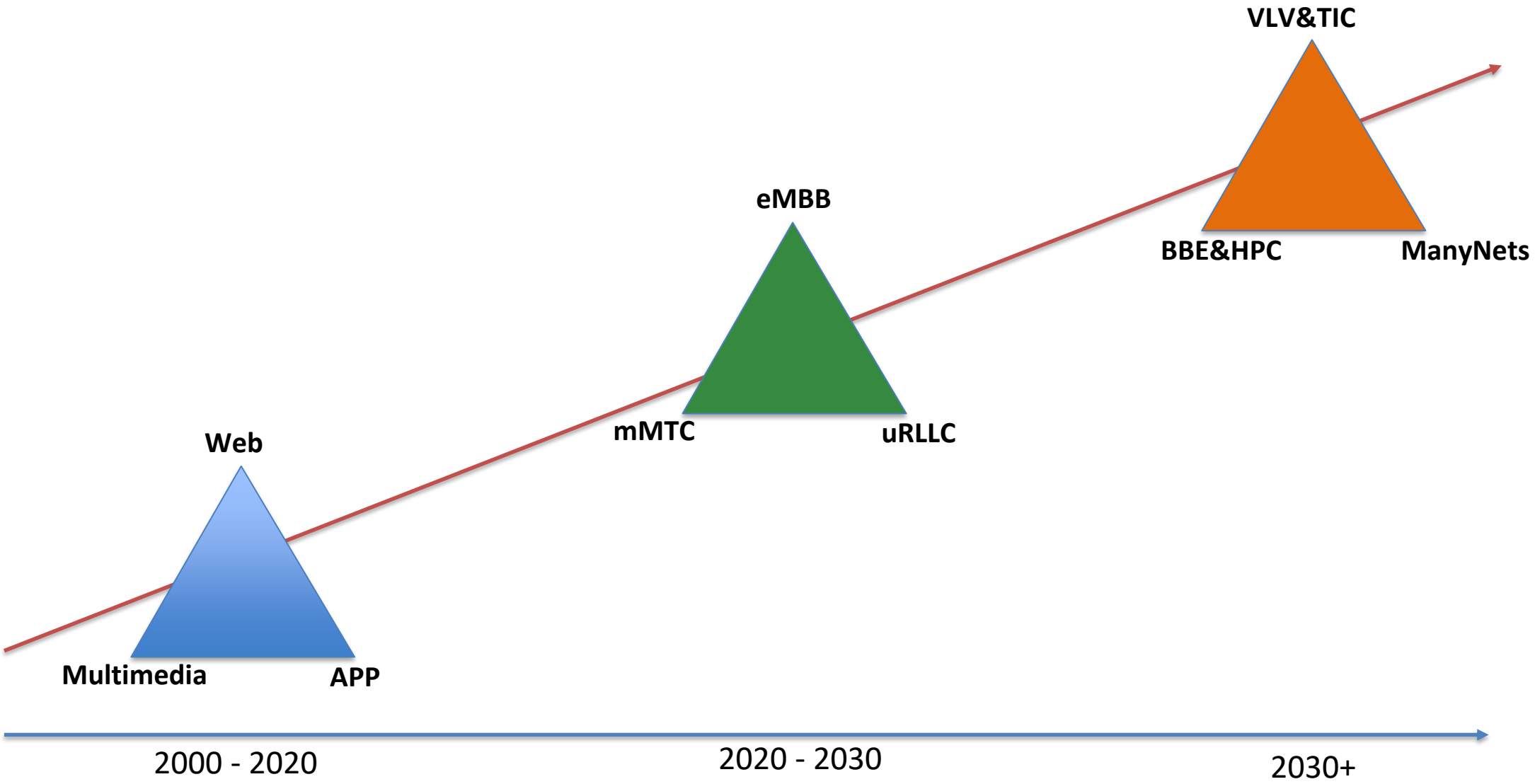
Emerging Satellite Constellations
(Global Broadband connectivity for 4 billion people who are not connected to any network today)





Ref: Geoff Huston and Mostafa Ammar's Talk at Network 2030

Past, Present and Future: Market Drivers



Proposal: Set up a new research group

- Provide a venue for the IETFers who are interested in the future of IP
- Make sure that its progress and changes keep the key attributes of the Internet that have allowed the Internet to thrive so far
- Collaborate with other organizations to synchronize the research
  - Workshop
  - Liaison

Jobs of the RG

1) Review output from the ITU-T Network 2030 and identify new services and applications which are of significant importance but which cannot be implemented on the current Internet as it is today.
2) Assess the capabilities of the current Internet as it has actually evolved to versus in regards to the needs of those upcoming applications.
3) Derive relevant requirements, if any, that have not been considered or adequately addressed in existing Internet designs
4) Explore the impact of applications-at-the-horizon to the Internet architecture and protocols
5) Investigate the implications of evolving infrastructures for the Internet architecture and protocols
6) Establish critical forwarding and operational characteristics of the data plane needed to support those new applications. (control plane and management plane initially not in focus.)

Discussions

1) Does it make any sense to have a RG? Shall we do it?
2) Assuming we set up such a RG,
    1) How do we call this RG? We need a name
    2) What is its scope? Does the job list look good?
    3) What would be the requirements of the future IP?
    4) Should it be transverse to Network/Transport layers? Or even more?
    5) What are the major technological bottlenecks today for future applications? Why?
3) If we set up a RG, would you like to make contributions?
4) Planning for IETF 107 at Vancouver

Thank you