NG-EPON for Low Latency Services

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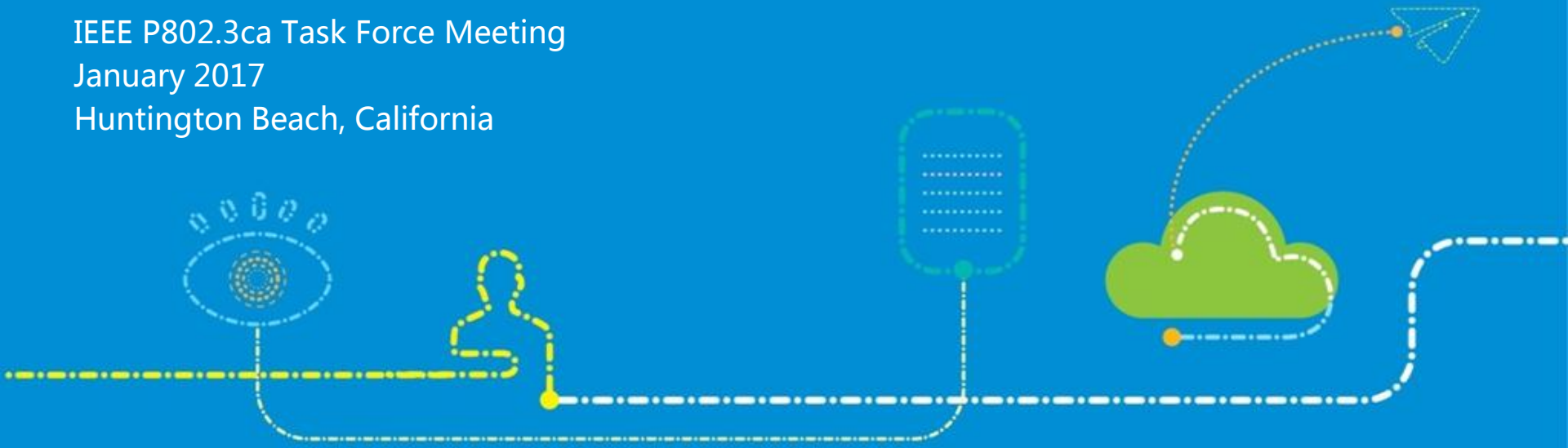
IEEE P802.3ca Task Force Meeting
January 2017
Huntington Beach, California



Motivation

- Discussions on NG-EPON have been focusing on high bandwidth services
- Future services requiring low latency, such as 5G mobile backhaul/fronthaul and virtual reality/augmented reality videos, need to be considered for NG-EPON

  "*Support for cellular fronthaul is highly desirable*" - NG-EPON Report
- Now is the time to examine how low latency requirements for these future services would impact NG-EPON standards

5G system latency requirements according to NGMN

A 5G system needs to provide E2E latency ranging from 10 ms (typ.) to < 1 ms (ultra-low)

Use case category	User Experienced Data Rate	E2E Latency	Mobility
Broadband access in dense areas	DL: 300 Mbps UL: 50 Mbps	10 ms	On demand, 0-100 km/h
Indoor ultra-high broadband access	DL: 1 Gbps, UL: 500 Mbps	10 ms	Pedestrian
Broadband access in a crowd	DL: 25 Mbps UL: 50 Mbps	10 ms	Pedestrian
50+ Mbps everywhere	DL: 50 Mbps UL: 25 Mbps	10 ms	0-120 km/h
Ultra-low cost broadband access for low ARPU areas	DL: 10 Mbps UL: 10 Mbps	50 ms	on demand: 0-50 km/h
Mobile broadband in vehicles (cars, trains)	DL: 50 Mbps UL: 25 Mbps	10 ms	On demand, up to 500 km/h
Airplanes connectivity	DL: 15 Mbps per user UL: 7.5 Mbps per user	10 ms	Up to 1000 km/h
Massive low-cost/long-range/low-power MTC	Low (typically 1-100 kbps)	Seconds to hours	on demand: 0-500 km/h
Broadband MTC	See the requirements for the Broadband access in dense areas and 50+Mbps everywhere categories		
Ultra-low latency	DL: 50 Mbps UL: 25 Mbps	<1 ms	Pedestrian
Resilience and traffic surge	DL: 0.1-1 Mbps UL: 0.1-1 Mbps	Regular communication: not critical	0-120 km/h
Ultra-high reliability & Ultra-low latency	DL: From 50 kbps to 10 Mbps; UL: From a few bps to 10 Mbps	1 ms	on demand: 0-500 km/h
Ultra-high availability & reliability	DL: 10 Mbps UL: 10 Mbps	10 ms	On demand, 0-500 km/h
Broadcast like services	DL: Up to 200 Mbps UL: Modest (e.g. 500 kbps)	<100 ms	on demand: 0-500 km/h

Source:
NGMN 5G whitepaper

Big video Virtual Reality check

NG-EPON Report in May 2015 considered UHD-2 8K video (50Mb/s each) in the worst case bandwidth estimate. However, industry trends show that advanced video applications such as virtual reality and augmented reality are on the rise.

Are our networks ready for VR?

What is the latency requirement to support (interactive) VR/AR?

Video Format	Bandwidth (Mb/s)	Roundtrip Delay (ms)
4K	> 45	< 20
8K	> 180	< 16
VR	> 300	< 12

Impact of low latency requirements on NG-EPON standards

Low latency requirements could impact several NG-EPON features.

We need to carefully consider how NG-EPON standards should be specified to meet those requirements.

- Further latency reduction in the case of channel bonding
- Optimize downstream traffic scheduling to reduce latency
- Optimize DBA to minimize latency
  - Grants always ready for upstream traffic
  - Grant to one ONU could be limited to microsecond level
- Other requirements?

Proposal

We propose to start the conversation on the following questions:

- What are the low latency services important to IEEE 802.3 operators?
- What are the requirements of these low latency services?
- How can/should NG-EPON address these requirements?

Thank You 谢谢！

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