8 Conclusions

The telecommunications and cable network operators have deployed 1G-EPON on a large scale and the 10G-EPON deployments are ramping up around the world. Several distinct markets and applications currently rely on EPON:

- Residential subscriber access providing voice, video and data services,
- Commercial (business) subscriber access providing primarily voice and high-grade/high-reliability data services,
- Mobile (cellular) backhaul.

The observed ~50% annual growth in volume of Internet traffic in residential applications is driving the migration from legacy to fiber-based access technologies. For the residential subscribers served by EPON, the speed of residential wired or wireless LANs becomes the primary gating factor for the bandwidth demand. While being predominantly in the range between 100 Mb/s and 1 Gb/s today, the interface speeds of the customer equipment (PCs, laptops, set-top boxes, TVs, security cameras, personal storage farms, etc.) are expected to increase to 2.5 Gb/s – 5.0 Gb/s within the target timeframe for the NG-EPON technology. The stochastic nature and the temporal profiles of the residential traffic make statistical multiplexing techniques especially beneficial to the performance of the residential access networks, while at the same time relaxing the aggregated capacity targets, compared to the business access environment.

The bandwidth demand in the business access market is being driven by two major factors:

- An increase in the average bandwidth demand per business subscriber.
- An increase in the number and density of business subscribers which provides strong incentives for the network operators to migrate customers currently served with point-to-point solutions to a PON-based solution.

The simultaneous increase in bandwidth demand per business subscriber and aggregation of multiple subscribers on a single PON lead to much higher bandwidth requirements for NG-EPON in business access markets, compared to the residential markets. Higher-grade service level agreements and an abundance of time-sensitive circuit-like flows in the business access environment give higher priorities to user isolation and hard performance guarantees per business customer. This drives providers to provision less capacity sharing for business subscribers then is typically used for residential subscribers.

A very similar transformation is taking place in the mobile backhaul market. To serve an increasing number of mobile devices, wireless operators are increasing the density of antenna deployments with the corresponding reduction is cell size. At the same time the traffic volume per individual cell is increasing steadily. A typical cell tower has moved from being served with 100 Mb/s circuit at the end of 2013 to ~350 Mb/s circuit at the end of 2014, and it is expected to increase to ~500 Mb/s by the end of 2015. With the evolution towards bonding multiple LTE bands, it is likely that in 2016 the industry would see backhaul capacity grow in excess of 1 Gb/s per cell tower.

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The growing number of subscribers, ever-increasing bandwidth consumption, and the continued demand for new, higher-speed services in both residential and business environments create an impetus for the industry to initiate the development of the standard for the next generation of EPON systems.

While unified in the common trend to support more subscribers with a higher data rates, the residential access, business access, and mobile backhaul markets have different bandwidth targets and technical performance requirements. Not only are the technical requirements different in all these markets, but also the cost-to-performance objectives are different. To address these diverse requirements the following solutions merit further consideration:

- A multi-wavelength (per-direction) EPON PHY (i.e., hybrid PON) with an aggregate downstream capacity of at least 40 Gbps (40G-EPON), with an evolutionary path to 100 Gbps (100G-EPON);
- A single wavelength (per direction) EPON PHY (i.e., TDM-PON) that supports symmetric downstream and upstream line rates of at least 25 Gbps (25G-EPON) or 25 Gbps downstream / 10 Gbps upstream line rate (25/10G-EPON).

The new PHYs need to consider the coexistence with the deployed EPON technologies and reuse functions and components of 10G-EPON to the extent possible.

The findings of this report substantiate a recommendation that a Study Group be formed within the IEEE 802.3 Working Group to develop a Project Authorization Request, Criteria for Standards Development and objectives for a new standard for the next generation of EPON PHYs.

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