4.3 Bandwidth Consumption Forecast – Residential Access

4.3.1 FTTH

The bandwidth requirement for a TDM-PON is a function of the aggregated bandwidth demand of all the subscribers on that PON. A statistical model, described in [15] and [17], forecasts aggregate residential downstream bandwidth demands. The model attempts to bound the forecast with a "moderate" set of inputs and a "heavy" set of inputs. The heavy inputs, in relation to the moderate inputs, assume a larger number of concurrent video streams per home, relatively higher penetration of HD and UHD displays and higher availability of HD and UHD content, lower video compression ratio for improved video quality, and faster growth in bursty traffic. In both examined scenarios, NG-EPON needs to be able to support the worst-case bandwidth consumption, where all video traffic, including all linear TV (i.e., traditional scheduled non-time-shifted television service), is transmitted as unicast to individual subscribers. The forecasts for aggregate bandwidth demand at peak-hours for both the moderate and heavy demand scenarios are presented in Figure 10 and Figure 11, respectively.

Figure 10: Forecasted Downstream Demand – Moderate Demand Scenario, FTTH

Figure 11: Forecasted Downstream Demand – Heavy Demand Scenario, FTTH

The aggregated downstream bandwidth demand shown in Figure 10 and Figure 11 includes peak-hour sustained downstream bandwidth demand and peak-hour average burst downstream bandwidth demand. By far, most of the demand results from managed plus OTT video traffic.

To complete the demand picture, it is necessary to add the maximum individual peak burst demand, which requires additional bandwidth for headroom, the size of which needs to accommodate a least one successful speed test run by a subscriber already receiving the maximum offered service level. This extra bandwidth is necessary because subscribers expect to be able to successfully complete a speed test even during peak hour traffic. The probability of multiple subscribers executing simultaneous speed tests is negligible. For example, in 2024, it is expected that under the heavy demand scenario, ~~and with~~ 32 subscribers~~,~~ on a PON will consume approximately 1 Gb/s of downstream peak hour traffic. If 1 Gb/s service is offered over this PON, then 1 Gb/s of bandwidth headroom is required to support peak bursts of 1 Gb/s, resulting in the total aggregate downstream bandwidth demand of 2 Gb/s during peak hours.

Using the model described above, it can be concluded that 10G-EPON can support bandwidth demand in residential access up to the year 2024[1] for up to 1 Gb/s service.

The maximum service levels supported by different FTTH technologies (both existing and emerging) by the year 2024 are shown in Figure 12 for the heavy scenario. These are determined by simply subtracting the forecasted aggregate demand in Figure 11 from the TDM-PON MAC downstream bandwidth capacity (less overheads).

Figure 12: Peak-hour downstream bandwidth headroom, FTTH

Comment [e1]: It is more clear to consider the FTTH and FTTB cases separately rather than mix them together.

Comment [e2]: Leave original figure in.

Comment [e3]: Leave original figure in.

Comment [e4]: In Atlanta, this sentence was agreed to be retained.

Comment [e5]: Retain footnote

Comment [e6]: I think the explanation needs to be re-inserted. There was some confusion on how this was calculated during the presentation in San Antonio.

Figure 12 indicates, from a residential downstream bandwidth point of view, that to significantly differentiate itself from existing 10G-EPON, an NG-EPON system will need to support more than 10 Gb/s service. In other words, a TDM-PON MAC must support an aggregate bit rate or a WDM-PON must support a per-wavelength bit rate of more than 10 Gb/s. Failing that, NG-EPON would not support significantly superior bandwidth service than can already be provided by 10G-EPON.

4.3.2 FTTB

For FTTB, the same methodology applies. The difference is that multiple subscribers are served by a single ONU, and therefore there will typically be a larger number of subscribers per PON compared to FTTH (where the number of subscribers is limited by optical splitting). Subscriber aggregates of 128 to 512 are considered. The forecasts for aggregate bandwidth demand at peak-hours for both the moderate and heavy demand scenarios, for FTTB, are presented in Figure 13 and Figure 14, respectively.

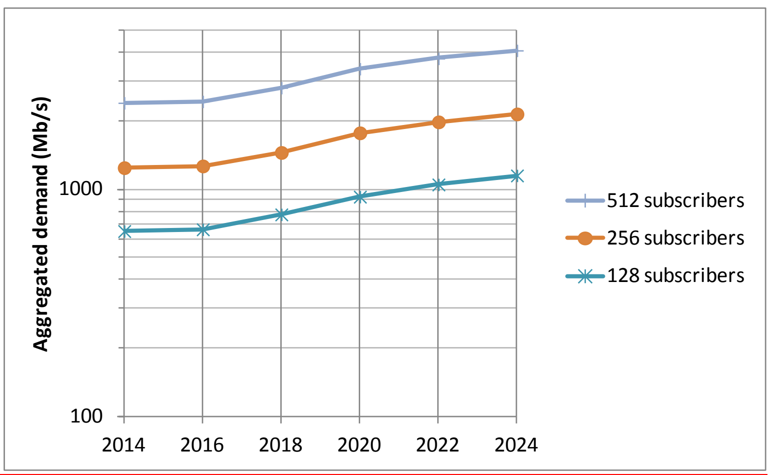

Figure 10: Forecasted Downstream Demand – Moderate Demand Scenario, FTTB

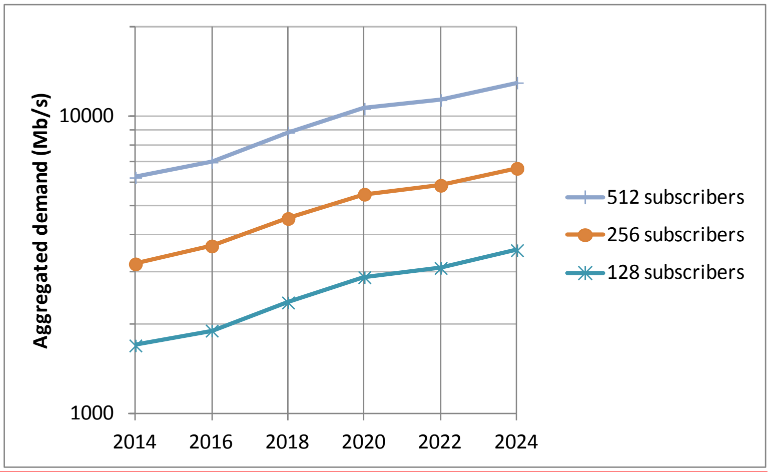

Figure 11: Forecasted Downstream Demand – Heavy Demand Scenario, FTTB

From these results it can be concluded that 10G-EPON can support bandwidth demand in residential access up to the year 2024 in the moderate scenario, with sizable headroom. However for the heavy demand scenario, 512 subscribers will exhaust 10G-EPON bandwidth before 2018 (assuming 1 Gb/s headroom is required). This can be solved by either (1) limiting the number of subscribers per 10G-EPON via split ratio reduction, or (2) NG-EPON. Examples of NG-EPON implementations that could address this are: a higher speed TDM-PON (e.g. 25 Gb/s downstream); two 10 Gb/s wavelengths of hybrid PON; or logical PTP connections of more than 1 Gb/s (depending on the number of subscribers per ONU), either PTP fiber or a WDM-PON.