### 4.2.2 Forecasting Bandwidth consumption – residential access

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 [eh1] and [eh3], forecasts aggregate residential downstream bandwidth demands. Since it is not possible to predict the future with certainty, 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 more concurrent video streams per home, relatively higher penetration of HD and UHD displays and higher availability of HD and UHD content, lighter video compression for improved video quality, and larger and faster growing burst traffic. In both scenarios, it is most appropriate for NG-EPON to be able to support the "worst case" where all video traffic, including all linear TV (i.e., traditional scheduled non-time-shifted television service), is unicasted in band. Peak-hour forecasts for both the moderate and heavy demand scenarios are presented in Figure 1. By far, most of the demand results from managed plus OTT video traffic.

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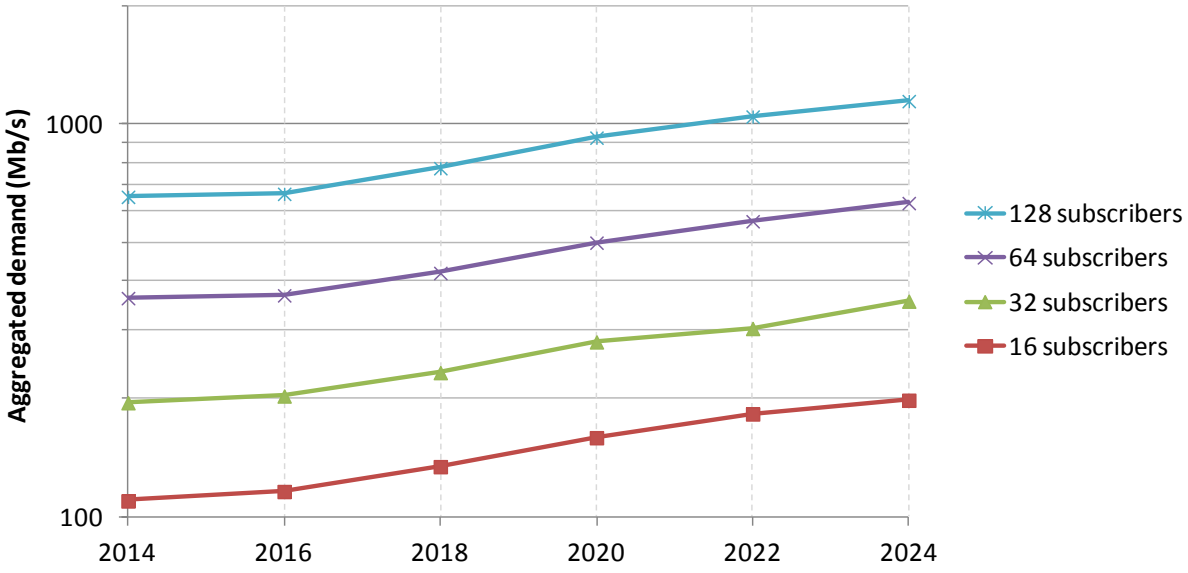
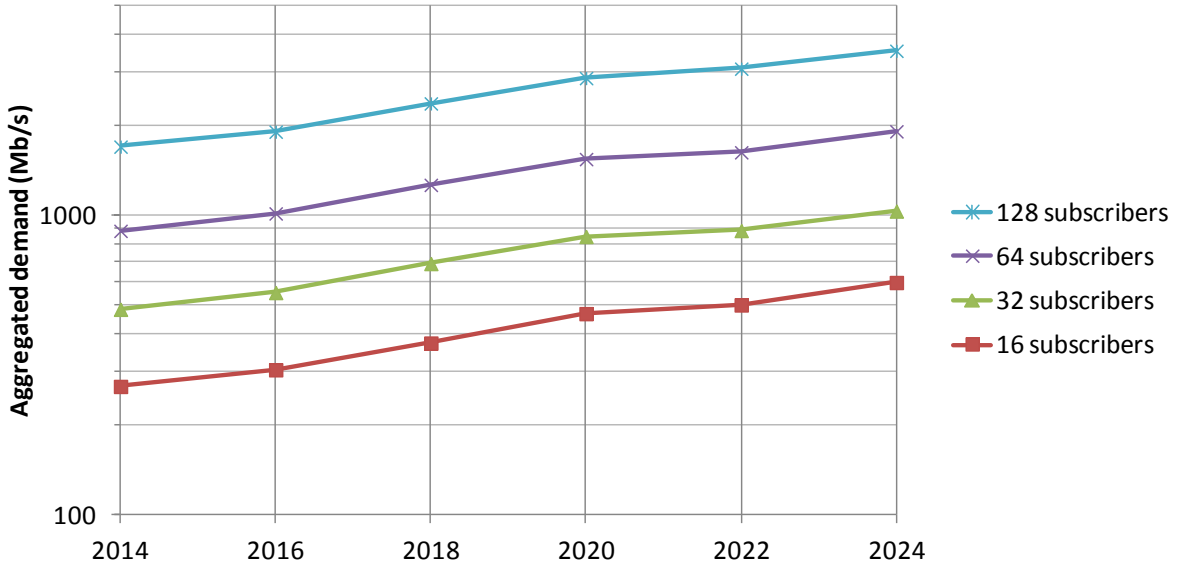



(a) Moderate demand scenario




(b) Heavy demand scenario

**Figure 1: Forecasted DS demand vs. the number of aggregated subscribers, peak hour**

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The aggregated downstream demands in Figure 1 include peak-hour sustained bandwidth demand and peak-hour average burst bandwidth demand. To complete the demand picture, it is necessary to add the maximum individual peak burst demand, which requires additional bandwidth for headroom. The magnitude of this headroom must at least accommodate a successful speed test run by a subscriber receiving the maximum service level offered. This is required because subscribers will expect to pass a speed test even during peak hour traffic (the

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case where multiple subscribers run a speed test simultaneously is neglected). For example, in the heavy demand scenario, for 32 subscribers on a TDM-PON, there will be approximately 1 Gb/s of downstream peak hour traffic in the year 2024. If 1 Gb/s service is to be offered over this PON, then 1 Gb/s of bandwidth headroom is required to support peak bursts of 1 Gb/s, for a total aggregate downstream bandwidth demand of 2 Gb/s during peak hour.

The above forecast indicates that 10G-EPON can support downstream residential bandwidth demands plus a 1 Gb/s service offer up to the year 2024[1]. WDM-PON FTTH systems, with at least 1 Gb/s dedicated bandwidth per wavelength, could also support 1 Gb/s service. There is no differentiation on this point among these FTTH technologies.

Therefore, perhaps the most important bandwidth differentiation that can be offered by NG-EPON for residential services is the peak hour downstream bandwidth headroom, which determines the maximum burst demand that can be supported and therefore the maximum downstream service level that an operator can offer. For TDM-PON MAC domains, this can be determined by simply subtracting the forecasted aggregate downstream demand in Figure 1 from the TDM-PON MAC downstream bandwidth capacity (less overheads). For existing and NG-EPON candidate FTTH technologies, the maximum downstream service levels that can be offered in the year 2024 are indicated in Figure 2.

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[1] If, instead of a statistical view a "worst-case" view is preferred, a 10G-EPON could support 32 subscribers, each streaming four simultaneous streams of UHD-2 "8k" video at 50 Mb/s each, and still have enough headroom to support bursts, and therefore a service offer, of more than 2 Gb/s.

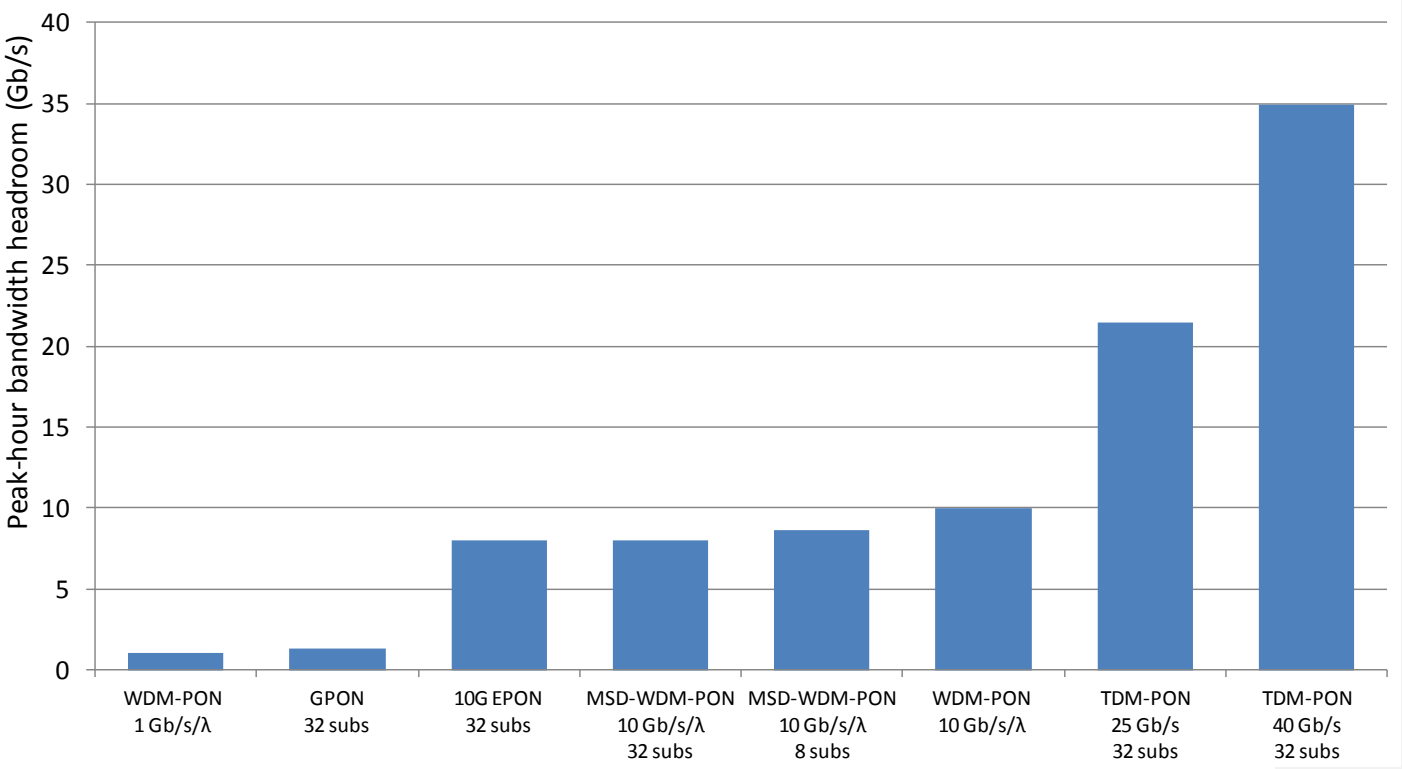


**Figure 2: Peak-hour bandwidth headroom = maximum service level that can be offered for existing and NG-EPON candidate access technologies in year 2024 (*32 subscribers per PON).**

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Figure 2 indicates, from a downstream residential 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.

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