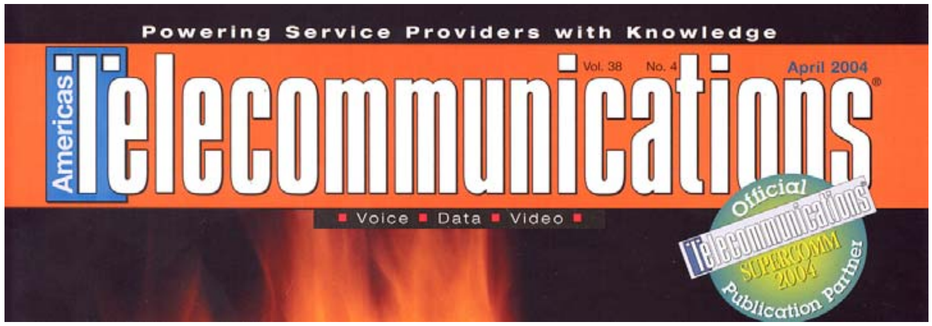
RACEPOINT



Active Ethernet vs. PON

Active or passive in the first mile?

Barry Kantner

As the telecom markets begin to recover, many network operators are focusing on broadband access technologies. For those that are evaluating optical access technologies, the selection will likely come down to PON (passive optical networks) or active Ethernet. Although PON has garnered a lot of attention, there are several tradeoffs that potential buyers should fully understand.

When PON was first introduced in the 1990s, fiber optic cable and optical transceivers were very expensive. Sharing these expensive resources was the only practical way to deploy optical services cost-effectively. All PON technologies enable a single port on a central distribution unit known as an OLT (Optical Line Terminal) to be connected to multiple subscriber terminals, known as ONUs (Optical Network Units). Passive (non-powered, and hence the name) optical splitters provide connectivity between the multiple ONUs and the single OLT port over a single optical cable.

Today, the cost of fiber optic cable and optical transceivers are a fraction of what they were in the 1990s. These cost reductions, combined with the reach, scalability and revenue-generating potential of an active Ethernet switched, point-to-point optical solution, make selecting a shared PON deployment difficult.

Table 1 describes the three main varieties of PON. None of them interoperate with any of the others. Each has its own drawbacks and limitations. PON problems fall into three main areas:

- Geography and reach.
- Consistency and predictability.
- Bandwidth limitations.

The Flavors of PON			
Name	ATM PON	Ethernet PON	Gigabit PON
Standard	ITU-T G.983	Ad hoc extensions to IEEE 802.3	ITU-T G.984.1, G.984.2, and G.984.3

Speeds	155 Mbps or 622 Mbps	1 Gbps	2 Gbps or 1 Gbps
Bandwidth to Subscriber	4.8 Mbps (155 Mbps systems) or 19.4 Mbps (622 Mbps systems)	31.25 Mbps	31.25 Mpbs (2 Gpbs operating speeds) or 15.625 Mpbs (1 Gpbs operating speeds)
ONUs/OLT Port	32	32	64
Limitations	Increasing the speed of a subscriber terminal from 155 Mbps to 622 Mbps requires deployment of an entirely new OLT, passive splitters and ONU.	Connection between the OLT and ONU are not compatible with equipment compliant with the IEEE 802.3 Ethernet standard.	Few vendors offer products supporting GPON.

Table 1 The flavors of PON.

Geography and Reach

PON deployments define a maximum distance, typically 20 km, between the OLT and the ONU. This maximum range helps prevent multiple ONUs sharing an OLT port from sending traffic at the same time, which would cause collisions and render the applications inoperable. It also ensures that there will be sufficient optical power available after taking into account the increased losses associated with the passive splitters. All ONUs must be within this maximum range.

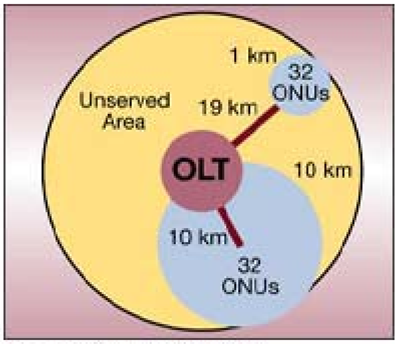


FIG. 1 PON'S BOUNDARIES.

Figure 1 illustrates the criticality of the location of the passive splitters for a PON deployment. The yellow circle represents the maximum distance an ONU can be located from the OLT, 20 km in this example. The centers of the green circles represent the location of the passive splitters. The diameter of the green circle represents the maximum distance the ONU can be located from the passive splitter and is directly related to the distance between the OLT and the passive splitter. In all cases, the maximum distance between the OLT and the ONU cannot be more than the system specification. Two examples are provided in the diagram: One locates splitters 19 km from the OLT, resulting in a serving-area radius of one km. The other locates splitters 10 km from the OLT, resulting in a serving-area radius of 10 km. The OLT port connected to each serving area can support up to the maximum number of ONUs defined by that technology, typically thirty-two. Serving subscribers outside the green serving areas requires another OLT port and passive splitters.

An active Ethernet solution uses concentration points instead of passive components. Concentration points can be located up to 80 km from the distribution point, and subscriber access points can be located up to 80 km from concentration points. Concentration points provide cost-effective scalability from a few subscribers to many thousands of subscribers and can service subscribers anywhere within a 160-km radius of the distribution point (see *Figure 2*).

Consistency and Predictability

PON presents difficulties in planning and deploying networks in all but the smallest geographic deployments.

Because they are designed to send an optical signal up to 20 km with enough power to light 32 ONUs, OLTs are expensive pieces of equipment. The cost of an OLT does not become economical until a large portion of the total number of potential ONUs the OLT could support is reached. This causes the CPS (cost per subscriber) to vary widely depending on the ratio of the number of ONUs served by the number of OLTs deployed. The geographic and distance limitations associated with PON make it very difficult to pre-plan the optimum location of the splitters in relation to the potential subscribers to realize the most efficient deployment.

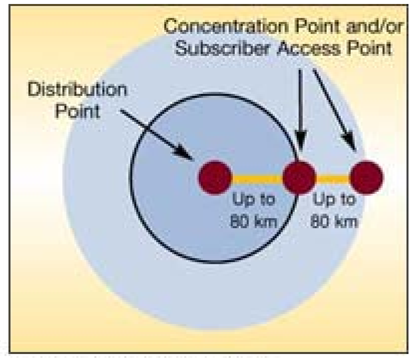


FIG. 2: ACTIVE ETHERNET SERVICE AREA.

PON deployments require constant evaluation of a complex set of tradeoffs and compromises:

- If less than 32 subscribers are located within an ONU serving radius, the CPS is high.
- If more than 32 subscribers are located within an ONU serving radius, a second OLT port must be deployed to support the 33rd subscriber, resulting in a high CPS.
- If one customer requires service outside an existing ONU serving radius, a new OLT port must be deployed.
- If customers outside the 20-km OLT serving area require service, a new OLT must be deployed, resulting in higher CPS.

PON also has problems maintaining level CPS (cost-per-subscriber) rates. Because OLTs are expensive, the initial CPS is inflated. This number falls rapidly as the number of ONUs increases. However, once the maximum number of ONUs is reached, the provider must purchase a new OLT, spiking the CPS dramatically.

The location of the splitters in relation to the OLT also figures heavily in calculating the CPS. The further away, the smaller the serving radius becomes. To achieve the number of customers necessary to make the deployment economical, the ONU serving area needs a high density of potential customers. Where potential customer density is lower, a larger ONU serving radius can address more potential customers. However, this results in inefficient utilization.

The geographic limitations of PON also make it difficult for the provider to deploy the necessary number of ONUs to make the OLT economically viable. Pre-planning the exact location of the splitters in relation to the OLT is challenging enough.

Because of these constraints, PON deployments result in unpredictable customer acquisition costs. Significant amounts of capital can be stranded waiting for ONU serving areas to reach the optimum number of subscribers.

In contrast, active Ethernet solutions require capital only as subscribers are added and exhibit very linear costs per subscriber from small to large deployments. This eliminates the risk of stranded capital investments.

Bandwidth per-subscriber

Because PONs share the OLT among the subscriber terminals, the available bandwidth is also shared. The total amount and range of bandwidth available depends on the specific type of PON technology and the split ratio deployed. In contrast, active Ethernet supports a consistent 100 Mbps or 1000 Mbps to each subscriber regardless of the distance.

Deploying PON with lower split ratios results in more available bandwidth, but increases the cost-basis of the solution as the OLT port is shared among fewer ONUs.

More available bandwidth translates into being able to support the delivery of more simultaneous applications as well as advanced applications that require significant amounts of bandwidth, both of which enable more revenue potential.

Why active Ethernet?

Unlike PON's cost structure, capital expenses for active Ethernet are coincident with subscriber acquisition. This means deployed capital immediately works to generate revenue. Because subscribers can be added without geographic restrictions, active Ethernet solutions provide a stable cost of customer acquisition from the first few subscribers to many thousands of subscribers, without the need for expensive and painful pre-planning.

PON network proponents claim reduced operational expense and increased reliability because of powered components located in the field. In reality, the actual number of powered sites in an active network is only about one percent greater than a passive network deployment. This is primarily because the OLT and the ONUs of a passive deployment are powered devices, not passive. The increased bandwidth per subscriber and revenue potential of an active Ethernet solution far outweigh the slight increase in the number of active sites.

Passive deployments have only one path between the OLT and the ONU. If an OLT fails or the fiber feeder between the OLT and the passive splitter is cut, all the ONUs will be out of service. Ethernet solutions have mean-time-between-failure ratings measured in years, and can be deployed in any topology, including rings to provide redundant paths to protect against fiber path or electronic equipment failures.

Active Ethernet promises to reshape the access market. Now that fiber-optic prices have eliminated the desire for passive components, more providers have the opportunity to turn to a fully standardized option — Ethernet technology — to provide connectivity in the first mile.

Barry Kantner is vice president of marketing and product development for World Wide Packets (barry.kantner@wwp.com).