

## Key technical decisions when planning fiber-to-the-home networks

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## Centralized vs. distributed splitting

Service providers deploying FTTH network using point-to-multipoint topologies have a fundamental architectural choice to make regarding splitter placement in that network. This involves using centralized (single-stage) or cascaded (multi-stage) splitter configurations in the distribution portion of the network. Both are deployed for a number of reasons according to the desired outcome of the business plan – and both come with their own set of advantages and disadvantages.

### Centralized splitting topology

A centralized splitter approach generally uses a combined split ratio of 1:64 (with a 1:2 splitter in the central office, and a 1:32 in an outside plant [OSP] enclosure such as a cabinet). These single-stage splitters can be placed at several locations in the network or housed at a central location. The 1:64 splitter could even be placed within the central office to provide a point-to-point (P2P) outside plant network that still shares bandwidth across multiple customers, for instance a group of subscribers a short distance from the central office. But most often, the splitters are placed in the outside plant to reduce the amount of overall fiber required.

The optical line terminal (OLT) active port in the central office (CO) will be connected/spliced to a fiber leaving the CO. This fiber passes through different closures to reach the input port of the splitter, normally placed in a cabinet. Typically this splitter is a 1:64 ratio with both input and outputs connectorized. The output ports of this splitter goes to the distribution network, reaching the homes of potential customers through different closures and indoor/outdoor terminal boxes.

### Cascaded / distributed topology

In most cases, a cascaded or distributed splitter approach has no splitters in the central office. The OLT port is connected/spliced directly to an outside plant fiber. A first level of splitting (1:4 or 1:8) is installed in a closure, not far from the central office. The input of this first level splitter is connected with the OLT fiber coming from the central office.

A second level of splitters (1:16 or 1:8) resides in terminal boxes, very close to the customer premises (each splitter covering 8 to 16 homes). The inputs of these splitters are the fibers coming from the outputs of the first level splitters described above.

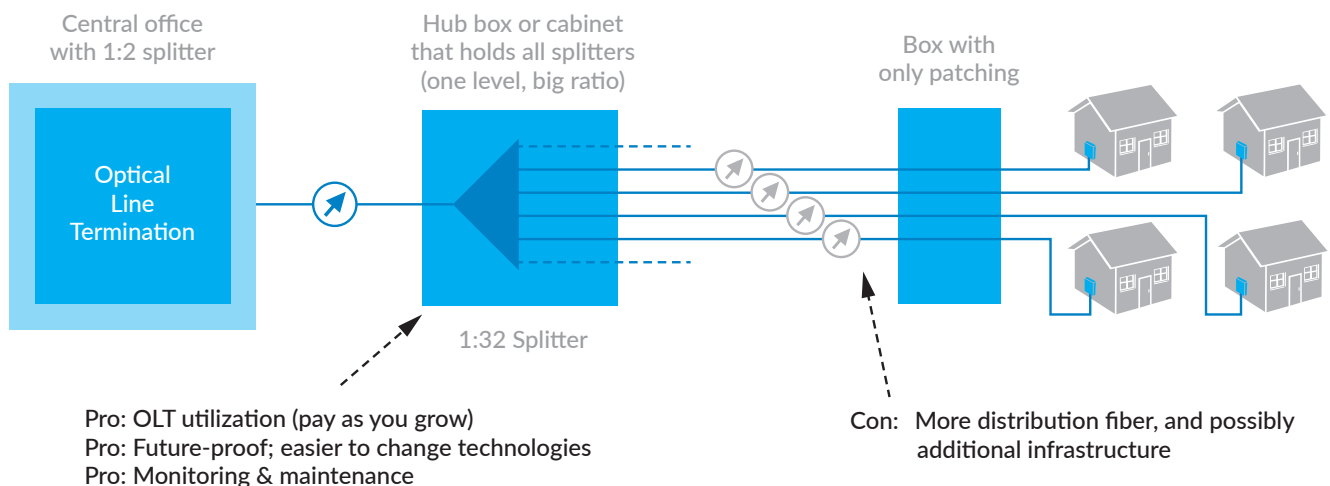


Figure 1: Centralized Splitting

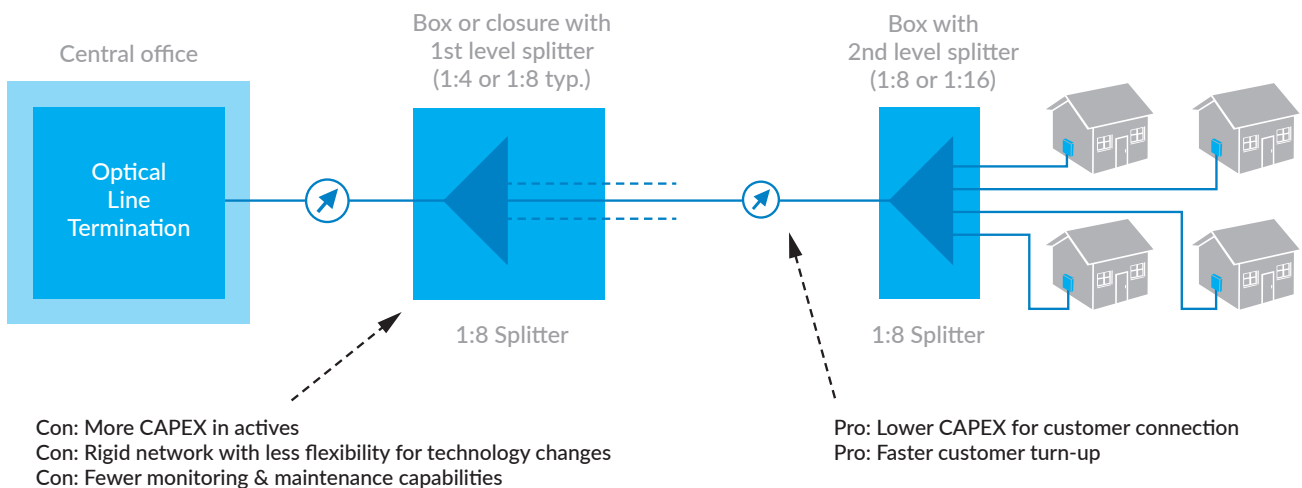
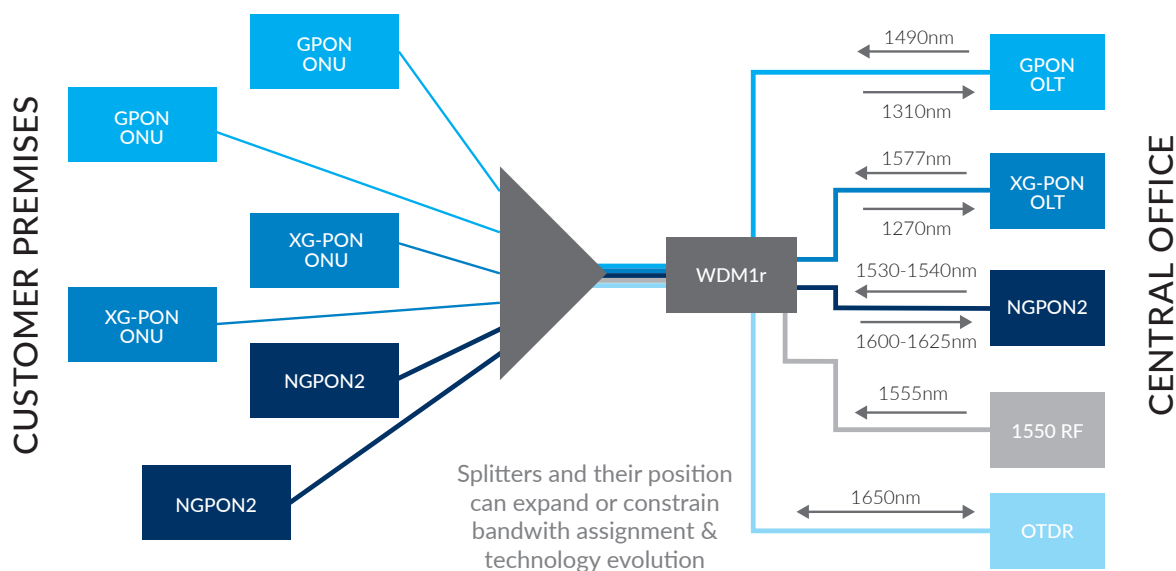
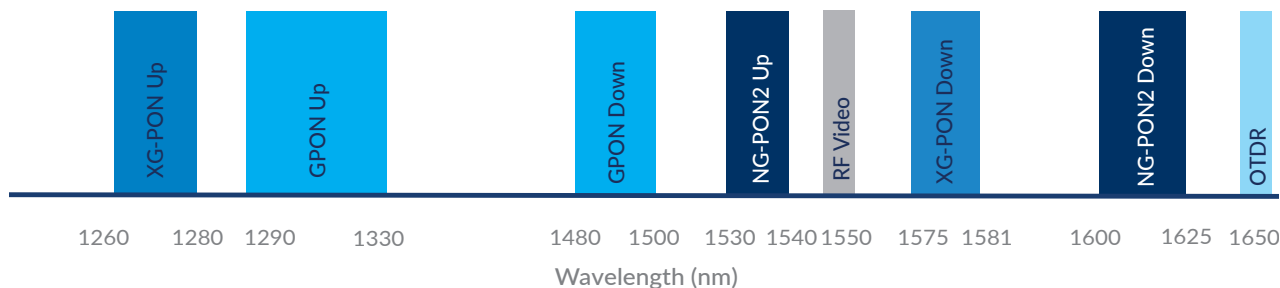


Figure 2: Cascaded Splitting



## Comparing cascaded/centralized topologies

PON architecture decisions are based on the approach that lines up best with the requirements of the specific business case scenario. Each approach has its own series of pros and cons to be considered during the planning phase of any network.

## Centralized splitter architecture advantages

### OLT utilization (pay as you grow)

A centralized splitter architecture allows the operator to concentrate active customers on a few OLT ports. For example, 200 houses (representing 200 potential customers) are concentrated or brought together at a centralized splitter point. At this centralized point, a 1:32 splitter will serve the first 32 active customers in this cluster of 200 houses. As we'll see, focus in decentralized splitter architecture is different. There are trade-offs in both architectures between take-rate and utilization rate. To read more on this topic, please refer to our white paper, "Optimizing PON Architectures Maximizes Electronics Efficiencies."

### Future proof and easy to change technology

The nature of single-stage, connectorized splitting allows providers to easily adapt to changing subscription patterns, split ratios, speeds and new technologies like WDM PONs.

### Monitoring and maintenance

This topology can reduce operational expense (OPEX) through convenient and easy technician access for maintenance and reconfigurations in a single location. Fewer truck rolls are required in this topology. Record keeping is simpler, as are upgrades to technology and additions of new customers.

## Centralized splitter architecture disadvantages

### More distribution fiber

A centralized approach generally requires deployment of more fiber in the outside plant, particularly in the distribution network. This can result, without even taking into account costs for civil works, an incremental increase in capital expense (CAPEX) of over 38-percent (primarily in cable and accessories) compared to a cascaded topology.

### Larger network elements in the OSP

Optical splitters with high split ratios require more fiber, and must be terminated to customer either through individual splices or connectors. The splitters and termination fields are generally housed in street cabinets, which are more expensive than closures and occupy more real estate. They are also subject to more stringent regulations from local (government) planning bodies. All this can add time and cost to the deployment.

## Cascaded splitter architecture advantages

### Lower CAPEX

Differences in CAPEX between cascaded and centralized topologies greatly depends on the demography and density of the area. In a cascaded topology, the amount of fiber required is much lower in the network's distribution portion, the area of the network with the greatest impact on the overall cost of the infrastructure. If civil works are necessary in the distribution area, the greater amount of cable in a centralized topology means more ducts, and obviously more expensive digging. CAPEX differences also depend on the individual operator's business case and expectation of successful initial take rate. The costs for all contingencies must be weighed during the planning phase. A thorough costing-exercise of possible expenses is requisite.

### Drop made at once, in a single place

In a cascaded topology, when connecting a new customer, the drop is installed from a terminal box close to the premises (usually at a distance of tens of meters). Then, all work to complete service turn-up is done inside the premises. In a centralized topology, in addition to this step, the technician must also go to the cabinet containing the splitter and make the appropriate connection there. This extra step can be easy if good records for the cabinet are kept and appropriate cabinets are used. Unfortunately, this is not always the case and inaccurate or incomplete circuit identification, as well as improper handling of the cabling or confusion during splicing, can create delays – and cost money.

## Cascaded splitter architecture disadvantages

### More actives and more splitters

Unlike the centralized topology, in the cascaded topology, the operator focuses on assuring that the last splitter in the cascade serves the largest number of houses/customers. If, as is usually the case, initial take-rates are low, overall utilization rate of the central office will also be low, and there is a risk of stranding OLT port capacity.

For additional information on this topic, please see our white paper "Optimizing PON Architectures Maximizes Electronics Efficiencies."

### Less flexible network

Two splitter steps are most common in cascaded topologies, especially in new builds; at times, three steps are required. This results in a rigid network. In as short a period of time as four to six years, new technologies, new services and ever higher speeds drive network upgrades. Introducing change in a rigid cascaded network can be difficult, time-consuming and costly. In the distribution network, splitters with new split ratios may be required – and if this is done within central offices, thousands of patch cords must move to remove existing splitters or to install new ones.

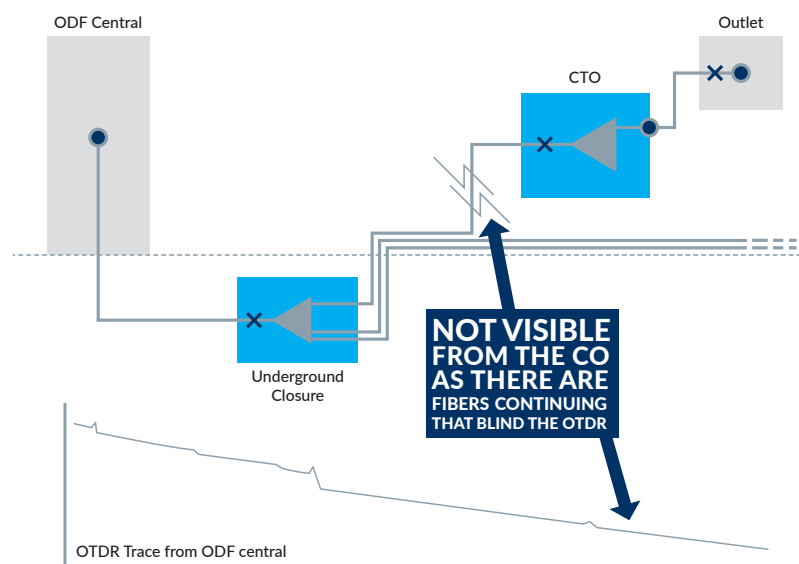
### Monitoring and maintenance

Splitters in a cascaded topology are often spliced rather than connectorized. Test equipment such as ODTRs are blind after large split count splitters; unless reflectors and sophisticated monitoring systems with a high dynamic range are used, they often do not recognize failures after splitters. In a cascaded topology, monitoring always occurs upwards, from customer to central office. Typically, in a centralized topology all monitoring can be done from the cabinet where the splitters are located, both downwards to the customer premises, and upwards to the central office.

## Final considerations

Finally, it's worth noting that there are sometimes advantages to mixing both architectures, creating a hybrid that leverages the advantages of each.

Deploying an FTTH network requires critical architectural decisions, always considering every unique aspect of the business case. The best architecture is the one that meets the requirements and expectations of the provider by reducing CAPEX, optimizing long-term OPEX, and making a future-proof network that can cope with new technologies without dramatic changes.



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