WHITE PAPER

Migration to GPON –

Practical Considerations from the Central Office to the Outside Plant

ADC KRONE

KRONE

Migration to GPON –

Practical Considerations

from the Central Office to the Outside Plant

Gazing into the future may be possible for the few clairvoyants living among us, but building a telecommunication network based on psychic prediction would be like basing critical business decisions on a coin flip. Still, today's telecommunication buzzword for any fibre-to-the-premise (FTTP) network is "future-proofing." Without a crystal ball to examine future bandwidth needs and determine winning technologies, service providers face some major challenges in getting it right the first time.

With that in mind, however, there are plenty of considerations to examine closely when selecting an FTTP that will enable the flexibility of easy migration to next generation demand. This is particularly true of the passive optical network (PON) portion of the network. Practical considerations, based on informed decision-making, when designing flexible next-generation networks provide the foundation for a cost-effective transition between legacy and future access technologies.

For FTTP networks, the advent of Gigabit passive optical network (GPON) will confirm the need for network flexibility. Service providers need not to look too far in the past to find examples of networks built without consideration for future technologies. While our telecommunication forefathers may not have predicted today's broadband revolution as they designed the copper telephone network, this legacy infrastructure still enabled a rough deployment of xDSL technologies.

The unpredictable performance of xDSL over load coils, splices, varying gauges and conditions of the legacy copper network produced costly lessons in the importance of network flexibility. FTTP provides the opportunity for service providers to deploy new subscribers with a "clean slate." Together, they promise a new network built to provide today's services while adding the flexibility to handle future access technologies.

As predicted, GPON promises to dominate the access market by offering a bandwidth boost and enabling higher split ratios. GPON's entry as the "latest and greatest" PON flavour is also coinciding with challenges service providers face in delivering high speed, high bandwidth, packaged services to business and residential customers. The pressure is on for providers to make their networks GPON-ready from the central office (CO) to the outside plant (OSP).

The importance of future-proofing networks will pay huge dividends to service providers faced with a migration to GPON. Those who made informed choices in building a flexible, interoperable, reconfigurable network will reap substantial benefits in the move to GPON. In any case, the motivation to make the early move to GPON is compelling, and ensuring your network is ready – from CO to OSP – is critical.

Where's the Motivation?

There is already considerable motivation for service providers to migrate their networks to GPON. First and foremost is the ability to offer their customers a much larger variety of services – not just today, but well into the future. Technology, particularly in video, is making huge strides in home entertainment, including high-definition television, gaming, teleconferencing, and other high-bandwidth applications. Today's (and tomorrow's) enhanced services, interoperability requirements, use of enhancement bands, and the promise of higher split ratios and increased capacity are all pointing providers to GPON as the best upgrade path.

The International Telecommunication Union (ITU) has already raised several issues that provide further motivation for service providers to move toward GPON in the access network. Demand for dedicated GigE and 10GigE services to business – and in some cases, even residential – users is on the rise. With that in mind, new techniques are necessary to increase performance and reduce the costs of getting bundled services to the customer. How can I best integrate all services onto a single backhaul fibre network? – has become the question for network operators. A migration to GPON architecture is the answer.

GPON – The Standard

By its ratification of a GPON standard, the ITU has provided the industry with its first "coming together" of electronics vendors and enabled everyone to get behind one standard. Previously, much of the BPONs were built around proprietary standards, based loosely on a basic PON standard. But with a single GPON standard, service providers can now offer better services, greater interoperability, enhancement of bandwidth, and even the higher split ratios that have become a serious motivator for considering GPON technology.

There are compelling advantages to a common GPON standard. One of the major costs of a fibre-to-the-home (FTTH) infrastructure, for example, is the electronics at the home, or the optical network terminals (ONTs). A common standard promises to, over time, bring those costs down considerably.

In fact, the ITU points out several key issues that should convince any service provider to consider GPONs for tomorrow's access network:

- Optical access systems will be required to operate at higher and higher bit rates.
- Access systems will need to evolve to higher split ratios physically and logically.
- Providers must ensure interoperability.
- Legacy services must be supported on any new access system, as well as the latest voice, data and video offerings.
- Physical interconnect conformance and performance cannot be overstated.

While GPON is beginning to stimulate the collective appetites of FTTP providers clamoring to be first to roll out these latest and greatest services to customers, its value to the industry doesn't stop there. The future also holds a promise of unification through a new standard – one that will not be overshadowed by its inability to provide adequate bandwidth for the next generation of applications and services.

Migration-Ready PONs

There are several additional considerations when designing a PON for ease of migration to GPON. These include the fibre optic cable characteristics, optics classes, and split ratio implications. When increasing split ratios from 1x32 to 1x64 or even higher, for example, spectral attenuation will become an important factor to consider.

Optical link budgets are determined by the individual vendor's active components – PON chips within the electronics, lasers, and receivers. The loss range for each class is as follows:

Class A – Min. 5 dB to max. 20 dB
Class B – Min. 10 dB to max. 25 dB
Class B+ – Min. 10 dB to max. 28 dB
Class C – Min. 15 dB to max. 30 dB

Traditional BPON equipment has typically used Class B optics, but it was determined that some of the PON network of 20km were actually stretching the budget to the limits, forcing active equipment manufacturers to increase budgets to 26.5 dB. These increased budgets, coupled with a possible requirement to increase the split ratios of GPON, resulted in an increase in the Class B receiver photo detectors to allow for a 28 dB loss budget – thus, establishing the Class B+ optics category.

Connectorization plays a huge role in a migration-ready FTTP network. With the addition of next-generation video requirements, GPON systems will likely require higher power, creating a requirement for the superior performance of angled physical contact (APC) connectors – particularly in the PON portion. The APC connector is the best choice for high-bandwidth applications and long-haul links since it offers the lowest return loss characteristics of connectors currently on the market.
In an APC connector, the end-face of a termination is polished precisely at an 8-degree angle to the fibre cladding to reflect most of the return loss into the cladding where it cannot interfere with the transmitted signal or damage the laser source. As a result, APC connectors offer a superior RL performance of -65 dB. For nearly every application, APC connectors offer the optical return loss performance that broadcasters require to maintain optimum signal integrity.

Systems should also ensure built-in laser safety features for use in networks with Class B and C lasers. Laser safety must be considered with high-power lasers typically used in the analog video OLT. Since infrared lasers are not visible to the human eye, it's important to take precautions when exposure is possible. Fibre distribution frames need to have built-in laser eye safety features – features that ensure connectors don't point directly at technicians. Designs that have connector ports contained within a tray or other enclosure and pointing side to side, rather than straight out of the panel, help protect technicians, regardless of their level of training or awareness.

Advantage of Centralised Splitters

The ease of migration from earlier PON architectures to GPON will also be dependent on the design of the fibre distribution portion of the network – the link between customers and the central office. This refers mainly to the splitter configuration and how efficiently each optical line terminal (OLT) card is used.

The two common splitter approaches are centralised and distributed or cascaded configurations. The centralised splitter approach uses 1x32 splitters in OSP enclosures, such as fibre distribution terminals. Each splitter is connected to an OLT in the central office with 32 split fibres routed from the optical splitter through distribution panels, splice points, and/or access point connectors to the optical network terminals (ONTs) at 32 homes.

The distributed, or cascaded, splitter approach is typically configured with a 1x4 splitter residing in the OSP enclosure and connected directly to an OLT in the central office. Each of the four fibres leaving the 1x4 splitter is routed to an access terminal housing another splitter, either a 1x4 or 1x8. Optimally, there would eventually be 32 fibres reaching the ONTs of 32 homes.

A centralised approach offers several advantages in terms of flexibility. First, it maximises the efficiency of expensive OLT cards. A cascaded architecture will strand unused ports in areas of low take rates or where customer premises are not grouped tightly together. Other advantages in a centralised splitter architecture include easier access for testing and troubleshooting (it's very difficult for an OTDR to "see" down individual fibre lengths through a series of splitters) and less splitter signal loss by eliminating extra splices and/or connectors in the distribution network.

More importantly, however, a centralised splitter configuration provides the best means to future-proof the network by providing the smoothest and most flexible capability to migrate to next-generation PON technologies, such as GPON, particularly with the likelihood of increasing split ratios from 32 to 64 or higher.

Implications of Split Ratios

Since much of the GPON standard already revolves around centralised 1x32 splitter architectures in the OSP, GPON's promise of enabling the capability for 1x64 splits is a huge benefit – servicing twice the homes from a single splitter. Upgrading a cascaded architecture to a 1x64 centralised architecture will involve significant investment and deployment of additional fibre to take advantage of the full capabilities of GPON.

A network built with the minimum number of connections, including splitter ports, will minimise optical loss while maintaining the flexibility necessary to ensure equipment and customer churn can be quickly and cost-effectively accomplished. Splitter loss depends mainly on the number of output ports. Each splitter configuration is assigned a particular maximum split ratio loss, including connectors, defined by the ITU G.671 standard and Telcordia GR-1209.

Since the GPON standards have not yet defined the current split ratio maximum for 1x64 splitters, network designers must use a single 1x2 splitter interfacing two 1x32 splitters to make up the 1x64 configuration. Although this is allowable with today's packaging, using Class B optics only leaves 5.35 dB of "head room." Therefore, even with the best fibre manufactured, where the spectral attenuation is 0.31 dB per kilometre, only a 17.25 km PON network is achievable without including any of the connectors within the CO or the splices in the OSP.

Still, the design engineer does have some options. In designing the network, premium splitters and low loss connectors can be deployed, and fusion splices must be kept well below 0.05 dB of loss per splice. These and other techniques will be used until the standards line up with the technology for 1x64 and higher split ratios. But in any case, it is easy to see that moving to a 1x64 split ratio from an existing centralised configuration will offer the best flexibility, easier test access, and the greatest overall cost efficiencies in most FTTP applications.

GPON-Ready – From CO to OSP

Within the CO, flexibility is the key. A network should never be built for a single application. Rather, it should be built as a flexible long-term network that can adapt to changes in equipment and technology. A crossconnect network offers excellent flexibility for configuration points. The output connector side is an important consideration and should include high quality connectors that can accommodate higher power. Again, as optical output levels increase, angle-polish connectors will offer both flexibility and adaptability in a migration to GPON technology.

Cable management is critical in the CO, particularly bend radius protection. Serving more and more subscribers requires careful consideration of loss budgets and physical fibre management methods that protect the optical signal from any degradation. The CO considerations for GPON are easily boiled down into three words – flexibility, quality, and protection.

The same architectural principles for the CO can be applied to the OSP portion of the network in ensuring smooth migration to GPON. The emphasis in the OSP is on centralised splitting. As mentioned earlier, it's much easier to upgrade to a higher split ratio from a centralised approach as opposed to a cascaded configuration. There is some serious doubt as to whether cascaded systems can even be converted to GPON without significant expense and overhaul.

The selection of connectors in the OSP is one more important element to GPON upgrades. Some vendors may tell customers that APCs are too expensive and unnecessary for GPON. That may have been true at the onset, but the economies of scale in recent years have resulted in SC/APC becoming a cost effective solution. Network architects owe it to themselves to look ahead when planning any upgrade. Not knowing what the next technology may be, taking additional steps to ensure a future proof network is always good business sense.

The trend toward pushing fibre all the way to the customer premise has established a need to consider high-performance hardened APCs that can withstand the rigors associated with OSP implementation. Connectors must perform in austere environments and varying temperature extremes. Today, cost effective APCs are available and specifically designed to meet the highest OSP performance standards -- minimising loss budgets and mitigating reliability issues such as endface geometry and temperature variation.

Conclusion

While service providers strive to meet the challenges of upgrading their FTTP networks to GPON, solution vendors should seek to make any migration as painless as possible. Flexibility is always the key to achieving upgrades as easily, quickly, and painlessly as possible – and will likely be the differentiator between service providers of the future. Although seeing into the future may not be an exact science, making informed decisions based on the most flexible and reliable designs available cannot be overemphasised for today's FTTP buildouts.

The inevitable need to migrate to GPON technology is today's reality – with NGPON (next-generation GPON) already being envisioned for the near future. With a little thoughtful planning, service providers will ensure their network has the flexibility to make a smooth, cost-effective migration to GPON, NGPON and whatever access technologies tomorrow may bring.

WHITE PAPER

www.adckrone.com/au
AUSTRALIA 2 Hereford Street, Berkeley Vale NSW 2261
Mailing Address: PO Box 335, Wyong NSW 2259, Australia
TECH SUPPORT 1800 801 298 helpdesk.au@adckrone.com

www.adckrone.com/nz
NEW ZEALAND 2 Nevis Street, Petone, Wellington
Mailing Address: PO Box 38-177, Wellington Mail Centre 6008, New Zealand

ADC Telecommunications, Inc., P.O. Box 1101, Minneapolis, Minnesota USA 55440-1101