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Strategies for Deploying Gigabit Broadband to the Home

The need for Gigabit broadband to the home is increasing as more people work from home, access the cloud and use video conferencing services. Outside of work, people are using video streaming services, playing multi-player games and taking part in distance learning. This is causing an unprecedented demand for bandwidth that must be addressed by service providers.

While the need for Gigabit broadband is clear, the strategies to solve the problem are, at best, confusing. What is the best technology to bring Gigabit broadband to the home? Is there a way to deploy such a technology in a cost-effective manner? Will this technology soon be obsolete or can it be used as part of a migration to future technology advancements? Service providers are asking themselves similar questions as they decide on the best way to proceed. Several providers have decided to do what their competitors are doing, but this might not be the best strategy for their customers or their network.

Let’s take a look at the three top technologies to bring Gigabit broadband to the home: Fiber-to-the-Home (FTTH), DOCSIS 3.1 that sometimes includes Distributed Access Architectures, and G.fast for Digital Subscriber Line (DSL). We’ll look at each one and discuss its benefits, the best environment for deployment, and some potential challenges that must be overcome. We’ll also look at potential migration strategies to future-proof a network and the best ways to overcome challenges with testing.

Fiber-to-the-Home

FTTH is an obvious choice for greenfield deployments where a new housing development is being built or a high-rise building is under construction. In this example, it’s cost effective to bring fiber to the home using Passive Optical Network (PON) since there is no legacy network in place and few physical or regulatory obstacles. For high-rises, the main fiber to the node or building can be installed before major building or road improvements are made to the area, making it easy to install.

Although FTTH is an obvious choice for greenfield environments, there are still migration paths to consider as bandwidth demand increases. One of the popular current standards for FTTH is Gigabit-PON (G-PON), which provides speeds of 2.4G downstream and 1.2G upstream. As demand increases, service providers need to have a plan in place to up the bandwidth by either upgrading to XGS-PON with symmetrical rates of 10G for both upstream and downstream, or upgrading directly to NG-PON2, which provides speeds of 40G downstream and 10G upstream – with 40G upstream as an option.

Some providers may decide to use XGS-PON as a stepping stone to NG-PON2 while they wait for the cost of NG-PON2 Customer Premise Equipment (CPE) to decrease to a suitable level that makes their business case work. This creates a cost-effective way to keep up with bandwidth demand as it increases over time. XGS-PON and NG-PON2 can be deployed and co-exist on the same fiber plant as G-PON services, so operators can also choose to run the higher bit rate standards in parallel and migrate customers as demand requires.

Service providers could use any one of these strategies – or all of them at the same time depending on demand requirements at specific locations in their network. For instance, if bandwidth demand is increasing significantly in one area, migrating directly to NG-PON2 could be the best choice since it bypasses the time and cost of using XGS-PON as a stepping stone. In another area of the network, demand might be increasing at a slower pace, making a migration to XGS-PON – or sticking with G-PON – more economical since the central office or Hub transmission equipment is less expensive and there is a lower cost for CPE with this strategy.

FTTH does have its challenges as bandwidth continues to increase. The newer, more advanced standards use longer wavelengths to transport data making macro-bends in the fiber a problem, especially with the final fiber drop into a premise. The newer network standards are also just as susceptible to common network issues such as cross connections, dirty connectors and faulty splitters. This makes testing during deployment a critical piece of the equation. It also means that home installations should be done by a professional technician versus a home owner to ensure the job is done correctly the first time. Although this will cost a service provider more money upfront, it could save significant money and time over the life of the customer relationship.

DOCSIS 3.1 with Distributed Access Architectures

DOCSIS 3.1 has provided a leap in bandwidth for service providers with an existing Hybrid Fiber Cable (HFC) plant. This newest version of DOCSIS allows stretching of frequency ranges and provides more bits per Hz of spectrum through higher Quadrature Amplitude Modulations (QAMs). New Low-Density Parity-Check (LDPC) forward error correction can help increase network performance by allowing 1024QAM to work with relative ease in plant sections that were previously only able to support 256QAM. Some parts of the plant can achieve 4096QAM if the plant is clean and all systems are working to allow DOCSIS 3.1 to maximize its modulation structure.

DOCSIS 3.1 is a good fit for service providers that have already invested in an HFC plant and are planning to increase bandwidth to existing structures or green field areas. Backward compatibility allows operators to ramp up DOCSIS 3.1 in specific parts of the network as demand requires, making it a cost-effective strategy.

But sometimes the increased bits per Hz enabled by DOCSIS 3.1 are not enough to meet the bandwidth demand by itself. In this case, fiber needs to be pushed deeper into the HFC plant to reduce service group sizes. The traditional node splits used to accomplish this are no longer feasible due to cost, as well as hub power and space constraints.

Fortunately, Distributed Access Architectures (DAA) have emerged to address these concerns. Remote PHY, Remote MAC/PHY and Remote Converged Cable Access Platform (CCAP) all migrate much of the hub-based functionality out to the fiber node, overcoming traditional constraints. But these newer technologies create plant maintenance challenges. By moving Radio Frequency (RF) functions from the hub into the field, many existing plant maintenance and troubleshooting processes are disrupted. Hub-based gear, which relied on RF feeds, must be virtualized and leverage the DAA units as monitoring probes.

Further compounding the challenges is the proliferation of new vendors entering the DAA space, and the expected 10 plus year overall DAA migration. The result for technicians will be an extended period where they must maintain a highly heterogeneous plant consisting of a wide range of different plant architectures from many different vendors – quite a challenge for maintaining standard processes.

G.fast for DSL

G.fast has turned existing copper networks from a dying technology into one of the fastest and most cost-effective ways to bring 1G to the home. G.fast can take existing copper lines and use wider frequency profiles, from 2MHz up to 106MHz, to achieve 1G speeds for both the upstream and downstream. Future versions of G.fast will use frequency profiles up to 212MHz to achieve speeds of 10G.

The distance of the copper segment determines the G.fast rate reach. Distances under 250 meters from the distribution point to the home are best for obtaining 1G, with shorter distances performing better than their longer counterparts. This makes dense urban deployments the best target for G.fast where urban infill is taking place. Multi-dwelling buildings have become the first target for G.fast since most of these buildings already have copper to each apartment and rewiring a building is expensive. In dense urban environments, it's economical to bring fiber to the building.

G.fast uses a small Distribution Point Unit (DPU) approximately the size of a shoe box that can be placed on an existing pole, underground or in a building – making it easy to deploy. G.fast is also one of the most economical technologies to deploy and allows for a phased evolution of the network.

For example, service providers can add fiber over time in a mixed use building where businesses may need high speed business-rated FTTx service while residences can benefit from Gigabit G.fast services. This creates a good business proposition for service providers as it allows them and the building owner to target services at a price point and bandwidth customers are willing to pay.

The largest challenges for G.fast are twofold. Distance of the copper line as discussed earlier, and crosstalk. Far end cross talk becomes a problem as the signal gets amplified, but vectoring can be used to eliminate noise and interference that impede this high frequency service.

Testing

With these new network advancements comes complexity, particularly during deployment, test, and turn up. Technicians must learn a new architecture, devices, and test procedures. New, faster network modulation schemes are susceptible to faults, and pinpointing problems can take time with hybrid network architectures. Technicians are often tasked with using multiple testers depending on where they are in a network – the core, access or home. Technicians must also test over several different segments – such as the WiFi, DSL, fiber and coaxial cable network sections and the problems can be compounding.

Knowing what to test and where to test within a network are the most difficult issues of pinpointing a fault in these new network configurations.

Service providers need a testing strategy as much as they need a deployment strategy for the technologies themselves. Trying to find a testing solution that works now and as the network progresses/evolves with time will be paramount to creating an efficient and cost-effective testing solution strategy. Let's look at the three main areas of consideration when creating a testing strategy.

1. Modularity – Most service providers have fewer technicians in the field. Those technicians no longer know what they will be testing each day since pinpointing a fault might require testing several different technologies. Because of this fact, testing solutions should conduct more tests with fewer units. This means less units for the technicians to carry into the field. The units should be modular in that they can easily work with each other so the technician doesn't have to repeatedly conduct similar tests with different units. This also helps future-proof a testing solution since new testing modules can be easily added to the mix as new technologies are deployed.
2. Simple to Use – The complexity of maintaining Gigabit-capable networks is rapidly increasing, but the incoming knowledge level of new technicians is not keeping up. Technicians also need to be as efficient as possible while in the field. Testing solutions should be able to auto-detect network configurations and channels currently in use to save technicians time. The best solutions now provide much faster sweep testing to reduce costs and find faults quicker, as well as automated testing to improve workflow. The technician no longer needs to be an expert since testing solutions can provide pass/fail results and easy-to-read graphical interfaces.

3. Centrally Tracked Results – More and more service providers are using contractor-based technicians. By using a testing solution that enables centralized definitions of test configurations and centrally tracks and stores test results, providers have a way to make sure the contractor did the work and that the tests were done correctly. Centrally stored results can also save time and money by giving a history of what has been done in a certain area, showing the problems and the tests results that solved a problem in the past. This can keep providers from starting from scratch when a new problem arises.

Conclusion

Service providers are asking themselves, "What is the best strategy to deploy Gigabit broadband to the home?" But as we have discussed, this may not be the right question for successful deployments over time. A better approach is to focus on high-bandwidth service offerings that are practical, economical and future-ready for each specific neighborhood or region.

For testing, investing in a suite of solutions that can serve current needs and easily incorporate features for future technologies will be important. Testing solutions must make the job of the technician easier, which also saves time and truck rolls for the service provider and contractors. Centrally storing test results will go a long way in helping service providers know what has been done in the past, which can provide a clearer picture of what needs to be done as networks continue to change in the future.

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