Optical Switching in Fiber-To-The-Home Networks

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Introduction

Large scale Fiber-To-The-Home (FTTH) deployments over the last few years in the US and Asia have highlighted the need to lower costs and automate many of the manual procedures employed during installation, service activation and maintenance. Service providers today are under tremendous pressure to improve services while competition from a variety of sources is reducing what can be charged for voice, video and data services. Addressing these issues is critical and can make the difference between the success and failure of carriers.

New applications of optical switching in FTTH can help address these issues and reduce costs. Optical switching technology has matured in recent years and costs have been lowering steadily. This, combined with proven performance and reliability in small telecom and defense network deployments, are causing carriers to take notice. The question moving forward is not if but, rather, when optical switching will be deployed in FTTH networks.

FTTH service providers are actively developing architectures using optical switches. Figure 1 shows a typical application of optical switching in a FTTH passive optical network. In the Central Office (CO) an Optical Line Terminal (OLT) provides services to many customers. A feeder fiber extends from the OLT out to a Fiber Distribution Hut (FDH) where an optical splitter fans out the signal to 32 customers. At the subscriber's home, an Optical Network Terminal (ONT) breaks out phone, video and internet access. Voice, video, and data travel over three wavelengths: a downstream 1550nm signal is devoted to carrying analog and digital televisions; a downstream 1490 nm signal delivers data and other services; and a 1310nm upstream signal sends customers' data back to the OLT. In this architecture, the optical switch is located in the CO between OLTs and the feeder fibers. Test equipment is connected to the switch to automate network measurments.

One big benefit of using optical switching comes from automating manual operations. During installation and service activation measurements are currently taken manually and the data is then manually entered into databases. This process is time consuming, expensive and fraught with errors. With optical switching, these tests can be performed automatically from the CO. Polatis has partnered with JDSU to work on seamlessly integrating the measurement functions into FTTH networks. The feeder fiber from the CO to the FDH can be measured directly and newly developed OTDR techniques allow measurements of loss and delay of the optical fibers after the FDH to be made through the splitter. This arrangement allows the network databases to be automatically populated and checked against the engineering designs in real time.

If customers lose service it is critical to locate the fault as quickly as possible. Manual trouble-shooting and fault location are time consuming and often require two or more technicians to be deployed at multiple locations. Optical switching can reduce the time to locate faults from hours to minutes. If an entire OLT fails, the switch can automatically perform a 1:N OLT protection switch and customers can potentially be back in service in minutes. Overall, optical switching dramatically reduces the Mean-Time-To-Repair and increases network availability. Faster repair of service disruptions is critical to ensure customer satisfaction and to keep customer churn to a minimum.

Optical Switch Requirements

During recent studies and technology trials, service providers have identified the key optical switch specifications. Loss is critically important and optimally should be under 1.0 dB to minimize impact on the transmission loss budgets. Return Loss is also important to preserve the integrity of the 1550nm video signal and should be better than 55dB. It is important for optical switches to be able to switch bi-directional signals since FTTH systems have both upstream and downstream optical signals. Also, dark fiber switching is required since many common types of test equipment use intermittent signals. These requirements may seem obvious but some switching technologies require a continuous optical signal on the fiber to make and maintain connections and are only able to switch signals traveling in one direction, since they use directional optical detectors as part of the switch control system. Switch speed is important for OLT protection switching. Preliminary work indicates that switch speeds under 20ms are suitable to minimize service disruptions. In the carrier lab trails, Polatis switches have met or exceeded all of these requirements.

Recent Developments

Service providers are working closely with Polatis and other equipment suppliers to validate the business case for deploying optical switching in FTTH networks. Most service providers have been studying optical switching for a while and are expanding their efforts. Recently there have been internal lab trials that demonstrate technical feasibility. If development continues at the present rate, we could see FTTH optical switching RFQs issued and initial deployments sometime in 2008.

Conclusion

Optical switching technologies have matured over the last few years and are poised for larger scale FTTH deployment. Polatis has been working closely with service providers to identify the key requirements and help build the business case. Optical switching delivers strong value in FTTH networks by reducing costs through the automation of manual procedures throughout the network life cycle. Recent work shows the viability of optical switching in FTTH and now it is only a matter or time before we see wide-scale deployment.

Figure 1 Caption: This figure shows a typical optical switch deployment in an FTTH passive optical network. The Polatis optical switch and JDSU test equipment are located in the Central Office (CO) to automate testing and protection switching.