REVIEW ON PASSIVE OPTICAL NETWORK

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Abstract: With the recent increase of the number of Fiber-tothe-Home deployments worldwide, and the corresponding hugeinvestment in infrastructure, there is a need to devise a migrationpath that assures the full future usability and enhancedperformance of the installed fiber plant, possibly using emerging opto-electronic technologies. With this aim, within the IST ePhoton/One Network of Excellence, different technological solutions have been extensively analyzed and discussed. In this paper, a brief summary on access applications is presented.

***Key Terms*— Access networks, FTTH, Optical fiber Communications, Passive Optical Networks.**

I. INTRODUCTION

PASSIVE Optical fibre access to the user, the so-called Fibre-to-the-Home (FTTH), is becoming a mature concept and a reality in many regions of the globe. Firstly, they were established on point-to-point fibre links; lately, the more advanced point-to-multipoint Passive Optical Network (PON) are being deployed, in Asia and USA mainly. After more than 20 years of active research, passive opticalnetwork (PON)-based broadband optical access systems are finally seeing wide-scale deployments in Asia and North America. In Europe, carriers and service providers are also actively looking into PONs as the next-generation broadband access solutions.

In near future, further generations of PON will be available (in the same way as we have had multiple generations of DSL), and there will be drivers to deploy some of them aiming towards increased capacity, lowered cost, new services. The cable modem architecture has a lot of similarities to themost commonly seen power-splitting PONarchitecture, although they use completely differentmedia for transmission. Both cable modem system and power-splitting PON use a point-tomultipoint (P2MP) tree-and-branch distribution plant as shared transmissionmedium among all the end nodes. They both use TDM for MAC. In a cable modem access system, the CMTS and cable modem form a master–slave relationship for mediumcontrol. TheCMTS controls the bandwidth allocation to cablemodems. In a power-splitting PON, the optical line terminal (OLT) and optical network unit (ONU) form a master–slave relationship for medium control. The OLT controls bandwidth allocation to the ONUs. Dynamic bandwidth allocation (DBA) is required in both cable modem systems and power-splitting PONs. PON standardization work began in the 1990s when carriers anticipated fast growth in bandwidth demands. In 1995, the full service access network (FSAN) consortium was formed by seven global telecommunication operators including British Telecom, NTT, and Bell South to standardize common requirementsand services for a passive optical access network system. One of the goals of FSAN was to create the economy of scale and lower the cost of fiber-optic access systems by promoting common standards. Considering this, the main features that may define a highly scalable new-generation PON may be stated

• High splitting ratio (>64)

- High speed (> 1 Gbps)
- High BW per user (>100Mbps)
- Bidirectional, symmetrical, single fibre interface
- Long reach (> 20 Km)
- Passive
- Simple upgradeability
- Centralized management and monitoring
- Dynamic resource allocation
- Basic protection incorporated

II. CATEGORIES

This first generation of TDM-PONs (BPON, GPON, EPON) have been recently standardized, offering symmetrical Gigabit/s bandwidth shared among several tens of users.FSAN recommendations were later adopted by the International Telecommunication Union (ITU) as the ITU-T G.983 BPON (i.e. broadband PON) standards . G.983 specified 622 Mbps downstream and 155 Mbps or 22 Mbps aggregate upstream data rate. Each OLT is shared by up to 32 ONUs for a maximum separation of 20 km between the OLT and ONU.BPONs use TDM for multiple access and asynchronous transfer mode (ATM) cells for data framing. Therefore, a BPON is also called an ATM PON or APON for short. The G.983.3 standard specified wavelength division duplex on a single fiber with 1.3-mm wavelength for upstream transmission and 1.49-mm wavelength for downstream transmission. The 1.55-mm wavelength window was reserved for analog TV signal overlay. Early BPON standard defined the reference architecture model and the physical medium dependent (PMD) layer. But it also left many of the control and management message formats unspecified for a considerable while.BPONs only had limited trials and deployments. In the past few years,Ethernet emerged as the dominating framing technology for packetized IP data transmission. In March 2001, the IEEE 802.3 standard group started the 802.3ah Ethernet in the First Mile (EFM) project . One of the charters of the 802.3ah work group was to standardize the transport of Ethernet frames on P2MP PONs or EPON. The IEEE802.3ah Standard was ratified in June 2004. It specifies an upstream and downstream throughput of 1 Gbps and a transmission distance of 10 km or 20 km with 16 ONUs per OLT. EPON has gained tremendous popularity in East Asian countries, especially Japan and Korea. NTT has selected EPON as the standard for its large-scale FTTH rollout. Nevertheless, EPON did not achieve much commercial success in the United States. At the same time that EPON was developed by IEEE, the ITU-T Study Group 15 (SG15) was also working on the next-generation PON called Gigabit capable PON (G-PON). G-PON specifications are captured in the G.984 series recommendations. G-PON increased the transmission speed to 2.5 Gbps downstream and 1.25 Gbps or 2.5 Gbps upstream. Besides, it uses a new framing mechanism called G-PON encapsulation mode (GEM), which is based on the original idea of generic framing procedure (GFP). G-PON was selected as the standard by Verizon, SBC (now AT&T), and Bell South in January 2003 when the three incumbent telecommunication operators issued a joint request for proposal (RFP) for fiber-to-the-premise (FTTP). These companies will use G-PON to compete with MSOs in delivering the so-called triple-play (video, voice, and data) services.

III. **PON ARCHITECTURE**:

The general structure of a modern telecommunication network consists of three main portions: backbone (or core) network, metro/regional network, and access network (Fig.) On a very high level, core backbone networks are used for long-distance transport and metro/regional networks are responsible for traffic grooming and multiplexing functions. Structures of backbone and metro networks are usually more uniform than access networks and their costs are shared among large numbers of users. These networks are built with state-of-the-art fiber optics and wavelength division multiplexing (WDM) technologies to provide high-capacity connections.Access networks provide end-user connectivity. They are placed in close proximity to end users and deployed in large volumes. As can be seen from Fig. 2.1,access networks exist in many different forms for various practical reasons. In an environment where legacy systems already exist, carriers tend to minimize their capital investment by retrofitting existing infrastructure with incremental changes, whereas in a green-field environment, it often makes more sense to deploy future proof new technologies which might be revolutionary and disruptive.Compared to traditional copper-based access loops, optical fiber has virtually unlimited bandwidth (in the range of tera-hertz or THz of usable bandwidth). Deploying fiber all the way to the home therefore serves the purpose of futureproofing capital investment. A passive optical network (PON) is a form of fiberoptic access network. Most people nowadays use PON as a synonym of FTTx, despite the fact that the latter carries a much broader sense. shows the alternatives of FTTx . As seen from the figure, in the simplest case, individual optical fibers can be run directly from the central office (CO) to end users in a single star architecture. Alternatively, an active or passive remote terminal1 (RT) with multiplexing functions may be placed in the field to reduce the total fiber mileage in the field. A PON network is characterized by a passive RT. In an optical access network, the final drop to customers can be fiber (FTTH), coaxial cable (as in an HFC system), twisted pairs or radio (FTTC). In fact, a PON system can be used for FTTH or FTTC/FTTP depending on whether the optical fiber termination (or the ONU location) is at the user, or in a neighborhood and extended through copper or radio links to the user. In this book, we do not make a distinction between FTTH and FTTC/FTTP.

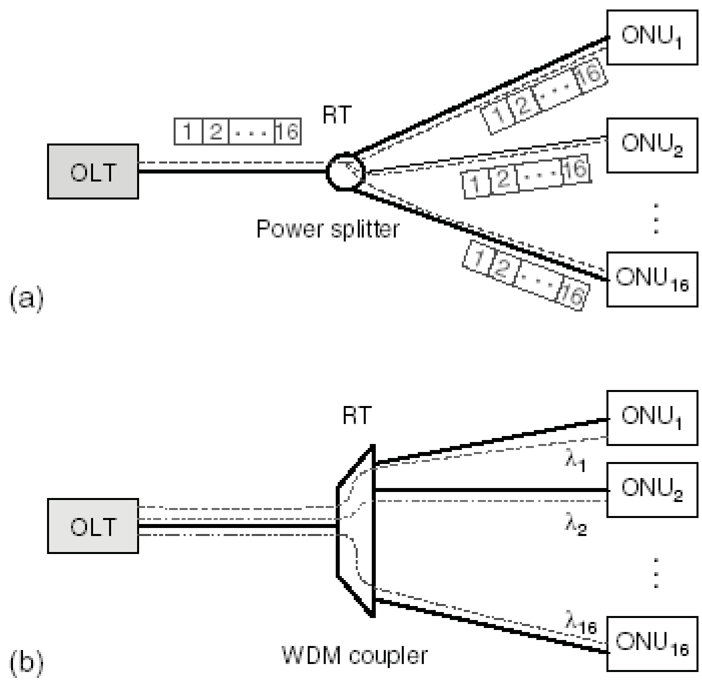

Figure 2.3 Architecture of (a) TDM-PON and (b) WDM-PON.

IV. CONCLUSION

Long reach passive optical networks as exemplified by the proposed PON system may radically change the way in which future networks are designed, leading to significant reductions in the cost of delivery of future broadband services. Long reach passive optical networks as exemplified by the proposed PIEMAN system may radically change the way in which future networks are designed, leading to significantreductions in the cost of delivery of future broadband services.

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