Optical Access System for Next Generation Network

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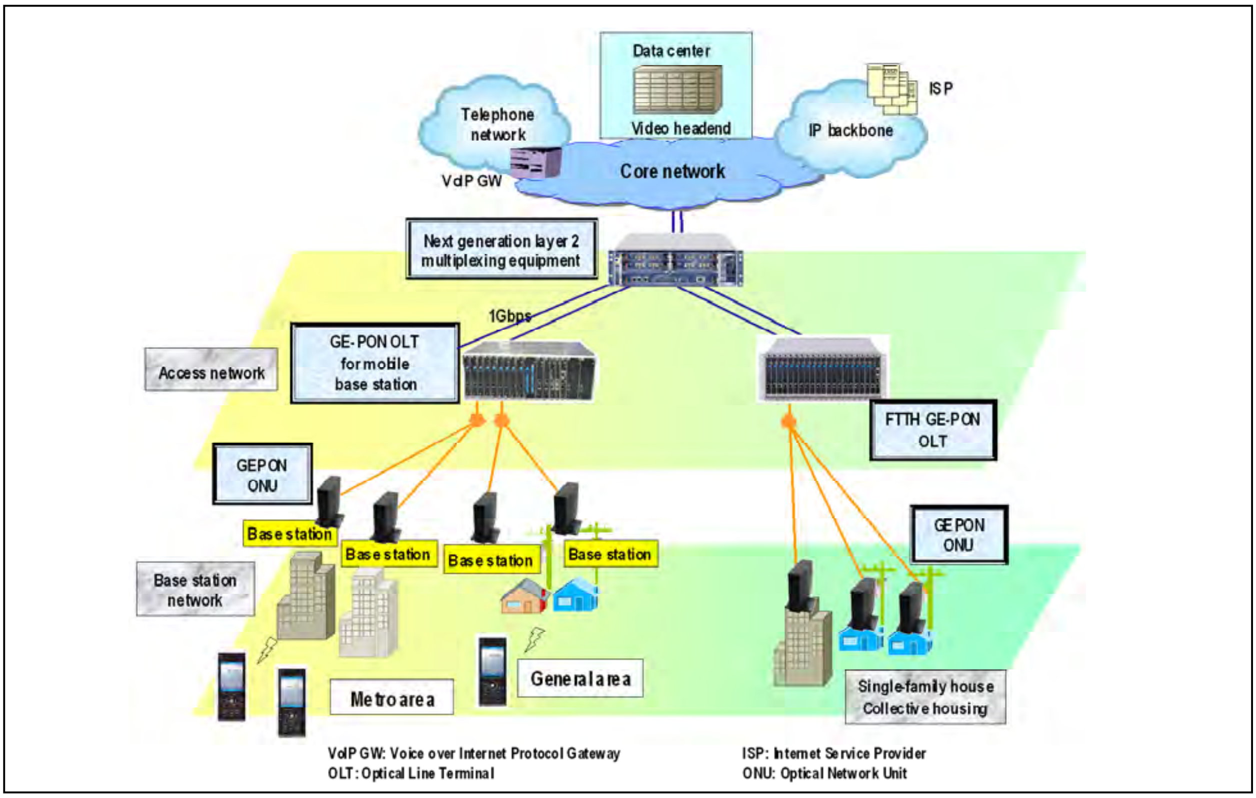
Abstract

Broadband services using optical access are steadily increasing in number. With optical access technologies advancing, the diversification of services, including fixed-mobile convergence (FMC) services, Internet Protocol (IP) retransmission of terrestrial digital broadcasting, and high definition visual contents transmission, as well as an increase in the traffic are expected.

Mitsubishi Electric has developed a gigabit Ethernet passive optical network (GE-PON) system for mobile communication base stations, which can be applied to the FMC services, as one of the efforts to support the next generation network scheme. This system aims at accommodating IP-based mobile base stations and features high reliability by employing a redundant access circuit and high efficiency by incorporating layer 2 switches.

In the next generation network, traffic with various types of communication quality demands becomes heavy in the access network as a result of an increase in traffic and diversified services. Mitsubishi Electric has developed the next generation layer 2 multiplexing equipment that will be positioned at an edge of the access network and can secure the communication quality and high throughput by means of the traffic control provided at high processing speeds.



Optical Access System

The GE-PON system for mobile base stations features high efficiency with the redundant access circuit and layer 2 switches within the system. The next generation layer 2 multiplexing equipment can secure the communication quality and high throughput even at a traffic flow of several tens of thousands.

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1. Optical Access System (GE-PON) for Mobile Base Stations

1.1 Development of OLT to accommodate mobile base stations

Mitsubishi Electric has developed the GE-PON system for mobile base stations that accommodate mobile phone and personal handyphone system (PHS) base stations on the basis of the GE-PON system for FTTH, which Mitsubishi Electric previously developed, with an eye to FMC services in the next generation network.

Mobile phone and PHS base stations in the conventional arrangements were connected with the switching equipment via synchronous digital hierarchy (SDH) circuits or integrated services digital network (ISDN) circuits. Base stations, on the other hand, have been increasingly configured in accordance with the IP. Accommodating a number of IP-based base stations in the GE-PON system efficiently in a single optical fiber leads to an operation cost reduction.

Challenges we faced with the base station accommodation by the GE-PON system include the following:

(1) Clock information transmission between base stations and switching equipment
(2) Line concentration for the core side network
(3) Improved reliability

The respective solutions for the challenges above are described below.

1.1.1 Clock information transmission between base stations and switching equipment

As a solution, a digital clock supply (DCS) clock synchronized with the switching equipment clock frequency (master clock) from the core side network is given to optical line terminal (OLT), in which a clock receiver (CREC) board is installed to operate DCS synchronization. The CREC board distributes the clock to all of the PON interface boards, so that PON ports will be operated by the distributed clock. Furthermore, the optical network unit (ONU) extracts the clock from the PON port to distribute it to the base station, thus establishing clock synchronization between base stations and switching equipment.

1.1.2 Line concentration for the core side network

A PON interface board is equipped with one network node interface (NNI) port. With all NNI ports of PONs connected with the core side network, a lot of ports will be necessary on the core side equipment which will lead to an increase in hardware cost. To deal with the situation, the layer 2 switch (L2SW) is built in the OLT for line concentration. With eight PON ports concentrated to a single NNI port, the number of ports necessary in the core side equipment has been reduced by a factor of eight.

1.1.3 Improved reliability

Telephone services by mobile terminals are becoming a lifeline as mobile phones and PHS have prevailed in society. And the GE-PON system has been required to have high reliability.

(1) PON port redundancy

N+1 redundancy has been achieved with the PON port that accommodates base stations. A single PON interface board stands by as a backup system. In the event of failures with the PON interface board in operation, the PON port is switched to that on the backup PON interface board. With this method employed, the time required from the detection of failure to the switchover of the PON circuit is shorter than one second.

(2) L2SW board redundancy

The L2SW board accommodated in the OLT is duplexed. The live-or-dead status of the L2SW board is periodically monitored from the equipment control board of the OLT. In the event of failures with the L2SW board in operation, the remaining L2SW board will transmit traffic.

(3) CREC board redundancy

Clock information transmission between the base station and switching equipment is indispensable to maintain services; the CREC board that governs clock information transmission is duplexed. Under normal conditions, one of the clocks from the duplexed CREC boards is selected by the PON interface board. If disconnection of the selected clock is detected, the operation immediately takes in the remaining clock for hitless switchover

Table 1 shows the main specifications of the OLT that accommodates mobile base stations.

1.2 Development of ONU that accommodates mobile base stations

One base station is accommodated by the user network interface (UNI) port of 100 Mbps. As discussed in 1.1.1 above, the clock is extracted from the PON port and the clock is distributed to the base station by an installed clock port, for the clock information transmission between the base station and switching equipment.

Table 2 shows the main specifications of the ONU that accommodates mobile base stations.

Table 1 Main specification of OLT for mobile base station

Item		Specification
PON port		
	Number of ports	1 port/PON interface board Max. 8+1 (redundant) ports/OLT unit
	Number of ONU connected	32 ONUs/PON interface board
	Redundancy	N:1
	Encryption	AES128 CFB mode
NNI port		
	Number of ports	1 port/L2SW board Max. 2 ports/OLT unit
	Port type	100BASE-TX
	Redundancy	1+1
Clock port		
	Interface	64kHz+8kHz+0.4kHz AMI signal (DCS interface)
	Redundancy	1+1

Table 2 Main specification of ONU for mobile base station

Item		Specification
PON port		
	Number of ports	1 port
	Decryption	AES128 CFB mode
UNI port		
	Number of ports	3 ports
	Application	2 ports: for data (10/100BASE-TX) 1 port: for clock and control

2. Next Generation Layer 2 Multiplexing Equipment

The access circuits are provided with the systems discussed above. For effective relay of the traffic over these circuits, equipment must be provided at an edge of the access network for multiplexing and forwarding the traffic. Mitsubishi Electric is developing layer 2 multiplexing equipment that can be applied to the next generation network. This chapter discusses the elemental technologies such as high-reliability technology and traffic control technology.

(1) High-reliability technology

For management of operation and maintenance of the next generation network, the OAM function used in the conventional synchronous optical network SONET/SDH and ATM circuits is necessary. Furthermore, for providing services even in the event of failure, a protection switching function to duplex the circuit and operate switch-over in the event of failure is necessary.

A prototype was prepared for implementation and verification of the Ethernet OAM function and protection function standardized by the ITU-T. Figure 1 shows the appearance of the experimental equipment. The prototype is equipped with the continuity check function and alarm transfer function conforming to the ITU-T Y.1731 and 1:1 bidirectional protection switching function conforming to ITU-T G.8031. Normal function of this equipment has been verified.

(2) Traffic control technology

To assure the end-to-end quality of service (QoS) required of the next generation network, it is necessary to control the traffic for each user application program. The volume of traffic to be controlled will be remarkably increased than in the past due to increased interface speed and a great number of application programs. Required under the circumstances is a control function that can maintain QoS control and multiplexing operation against high-speed and various types of traffic input patterns. With the conventional QoS control algorithms such as weighted fair queuing (WFQ) and the like that have been used commonly, it was not possible to operate QoS control at a high speed for large volumes of traffic and to multiplex the traffic, since the control logics increased with increasing multiplexed traffic volume thus requiring a longer processing time.

In order to solve this problem, Mitsubishi Electric has proposed a method called Simplified WFQ as a multiplexing technology that can hold the performance unchanged regardless of the volume of multiplexed traffic [(1)]. This method can reduce the processing volume by employing approximation in the WFQ algorithm and the volume of computation does not depend on the volume of multiplexed traffic, thus allowing much faster processing compared to the conventional methods.

In addition, in order to transfer the application traffic with which real-time mode is required for video, audio and the like with minimum delays, Mitsubishi Electric has also proposed the modified Simplified WFQ method [(2)]. Figure 2 shows the configuration.

Figure 2 shows a method that assures total band used for low-delay applications and standard applications for users who use both the real-time applications handling voice or the like and delay-tolerant applications handling e-mail or file transfer operation. This method can support a large-scale system since the method can be improved by modifying the calculation method of the Simplified WFQ method and can process at high speeds.

Fig. 1 Prototype for Ethernet OAM/protection functions

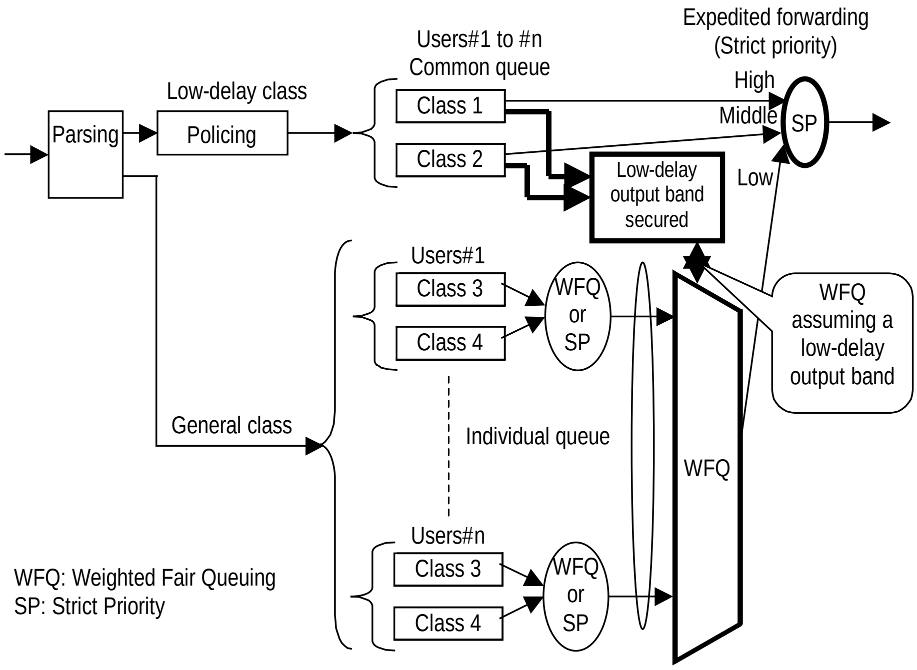

Fig. 2 QoS control mechanism for guaranteeing bandwidth per user

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(1) R. Kawate, K. Sato, K. Koguchi, T. Yokotani, "Proposal of Simplified Implementation of WFQ Mechanism," IEICE Transaction on Communications, Vol. J.90-B, pp. 213-216, 2007

(2) S. Taniguchi, R. Kawate, T. Yokotani, K. Motoshima, S. Yoshihara, "Proposal of Control Mechanism for Delay Sensitive Traffic in Simplified WFQ Scheduling," OECC/IOOC2007, Technical Digest, pp. 726-727, Jul. 2007