
BP-4: When Will All-Optical Networks Be Deployed?

Hiroaki Harai (National Institute of Information and Communications Technology)

Foreword

This is a special report of seven panel discussions sponsored by Communications Society in 2008 IEICE General Conference held in Kitakyusyu-shi, Japan in this March.

Hot topics related to advanced communication technologies were extensively discussed by the experts together with the participants to explore not only the future of communications technologies but also the deployment of new systems and services.

1. Introduction

3-hour panel session BP-4 "When Will All-Optical Networks Be Deployed?" was held at March 18, 2008 in the IEICE General Conference. The author (organizer/session chair) reports this panel session.

2. Program Information

It has been told that all-optical networks will be deployed soon. WDM (wavelength division multiplex) links are deployed for transmission, ROADMs (reconfigurable optical add/drop multiplexers) compose a new type of ring networks, and FTTH (fiber to the home) subscribers are still increasing. However, deployment of "all-optical" technology is limited to such point-to-point transmissions, metro networks, and access areas. No optical connections over the fences/barriers are found.

The objectives of this panel session are as follows.

What optical network is ideal, all-optical or slight modification from networking using current all-optical technology?

What merits and effects do the carriers/networks provide and users have?

What technical solutions/innovations should be addressed?

We clarify issues addressed for deployment of the optical networks and discuss about optical network in 10-20 years.

The four distinguished experts were invited.

Dr. Atsushi Sugitatsu (OITDA/Mitsubishi Electric)

Dr. Shoichi Ozawa (Furukawa Electric)

Prof. Takamasa Imai (Kanagawa University)

Dr. Tomohiro Otani (KDDI R&D Labs.)

They were invited as panelists and made their presentation in sequence.

3. Presentation Overview

Dr. Sugitatsu and Dr. Ozawa kindly provided topics from device side. Prof. Imai and Dr. Otani kindly provided topics from network side. The valuable talks are reported as follows.

Dr. Sugitatsu talked about "wavelength conversion technology for optical node." WDM needs optical transceivers for each wavelength, which indicates increase in the power consumption. Power consumption of routers will reach 20 billion kWh/year in 2010 and 90 billion kWh/year in 2015, which is 9% of total power generation in Japan. Decreasing the power consumption is necessary and decreasing number of driver ICs and high-speed ICs leads to low energy consumption. All-optical wavelength conversion typically requires 5W while O/E/O wavelength conversion requires approx. 30W.

They develop SOA-MZI (semiconductor optical amplifier, mach-zehnder interferometer) type all-optical wavelength converter. This is bit-rate free up to 40Gbps and device size of this is 4.8 x 0.75 x 0.1 (mm). This can convert a wavelength to arbitral one and has polarization free property. For optimization, higher optical confinement coefficient, thinner depth, narrower waveguide width, higher input power: optimum length of SOA is 2400 μm .

He also introduced systems for OOK-BPSK (on-off keying; binary phase shift keying) format conversion and OOK-QPSK format conversion, which bypasses O/E/O in conversion.

Dr. Ozawa talked about "some basic approaches for all optical signal processing in an attempt to apply optical functional modules" He introduced several devices from diverse view of usage.

Ultra narrow pulse light-source toward ultra high-speed communication such as 100Gbps.

Athermal AWG (arrayed waveguide grating) for increasing number of wavelengths for bandwidth extension. For example, this will be useful for WDM-PON.

VOA (variable optical attenuator), optical amplifier and 1ch-optical amplifier are promising for optical power-level adjustment.

ROADM and WSS (wavelength selective switch) are emerging for switching optical signals in wavelength granularity.

40Gbps optical component, AWG, variable dispersion compensator, and PMD (polarization mode dispersion) compensator are available for transmission efficiency.

DPSK, DQPSK, and 8PSK for bandwidth efficiency (compression).

Raman amplifier for C and L band, TDFAs/SOA for S band.

He strengthened the importance of integration, low power consumption, and low cost implementation.

Prof. Imai talked about "prospect on optical access network." His talk began with a review that

optical access market is diffuse and still growing. Number of FTTH subscribers reached 10 million in Japan. Next step will be (distance) extension of the access and connection to metro area. Several tens of Gbps optical system may be needed in decade of 2010. 400km access may be possible by the use of high-power transmission, optical amplifier, dispersion compensation, and high-sensitive receiver. Decreasing delay at logical layer and adjusting to existing infrastructure are also important.

He suggested a possible scenario of combination of PON and WDM. Next progress will be found in 10Gbps-based TDMA but WDM and CDM are also expected when taking into account flexibility of channel additions.

His suggested open issues are as follows.

Miniaturization and economization of OLT

Wavelength-tunable transceivers

ROADM for OLT for seamless metro/access connection

Burst-tolerable optical amplifier for extension.

Fault identification and isolation

Improvement of allowable BER

He mentioned that progress of optical network brings following. For the carriers, cost reduction of optical components and related component, miniaturization, low power consumption, increasing capacity, and new services. Users can be given diverse services, high-quality services, and secure services.

Dr. Otani talked about “GMPLS control plane for all-optical networking.” He told that the key points of future deployment are high-speed transmission, cost reduction and high-reliability. He hopes that all-optical network, a new technology, will solve it. He reviewed historical overview of optical networks for past 20 years. From 2000, WDM and PXC (photonic cross connect) contributed for improvement of reliability and operation. However, network cost was not reduced due to any device cost reduction. From year 2005, ROADM and WSS are developed and deployed in part due to cost reduction.

- The open issues are as follows.
- Flexibility by using mesh-type topology
- High reliability/availability
- Control of wavelength switched optical networks
- Inter-operability among multi-vendor environment
- Accommodating colored interfaces at clients
- Standardization of optical signals
- Establishment of operation technique in real networks

He also introduced their IETF activity for wavelength label of GMPLS. Till now, labels have been defined for GMPLS but lambda or wavelength itself is not. In WSON (wavelength switched optical network), wavelength continuity should be taken into account. Such work is in progress at IETF CCAMP working group and a work-in-progress draft was introduced.

Finally, he addressed their developed PCE (path computation element) that is scalable to nation-wide

scale. The PCE takes into account OSNR and PMD factors of optical impairment as well as wavelength continuity.

4. Panel Session and Conclusion

- All-optical networks based on 10G to 40Gbps will be deployed in core, metro, and access. However, we need a big challenge to 40Gbps.
- Optical access link will be extended.
- We have to think about scenario for concurrence of existing services and new optical services for deployment of all-optical networks.
- We have to show operators merit of all-optical network system. Or, new all-optical systems should provide similar interface to operators.
- All-optical networks make equipment cost (e.g. transponders) and running cost (e.g. power consumption) low.
- For deployment, it is necessary to try to produce large quantity of components and to decrease price of them. To this end, current scale of the market is bothersome and markets should be expanded.
- It is important to give extendable and sustainable properties to the all-optical networks. Need to show good prospect.

5. Remarks

Panel on “When Will All-Optical Networks Be Deployed” was reported. Through the invited talks and the panel discussion, we can see the actual state of all-optical networks including control and devices. Furthermore, based on a perspective on the key technologies and functional requirements, this session provides a direction of the future all-optical networks.

Technical digest of invited panelists are available in part from proceedings of 2008 IEICE General Conference.

6. Acknowledgment

This panel session had a great success with over 80 participants. The program was planned and supported by IEICE Technical Committee on Photonic Networks (PN). I would like to appreciate them and panelists.

Organizer of the Panel



BP-4: Dr. Hiroaki HARAI

National Institute of Information and Communications Technology