Featured Topic: Efforts toward Building Higher-Speed Broadband Optical Networks

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With the collapse of the conventional telecommunication carrier business model based on distance-based time duration billing system, Internet Protocol (IP) services with monthly flat-rate pricing are rapidly growing. Owing to the accelerating progress in the performance of digital processors and memory, expansion of communication line bandwidth with the use of optical fiber cables, and great advances in mobile terminals as a result of progress in mobile radio telecommunication technologies, business models of communication carriers are dramatically changing to service provider models that can cover sharp drops in unit price per bit using profits from cloud services as well as content and applications. At the same time, this has presented a huge challenge to the global business models of infocommunication system vendors and parts device vendors, which has led to significant changes in technological development and product strategies as described below.

1. Challenges Faced in Product Technology Development in the Infocommunication Area

1-1 Challenges faced with communication traffic volume

In 2007, the world's urban population exceeded rural population, and mega-cities with populations over 10 million are seen forming around the world with the growth of emerging economies. It is predicted that by 2030, more than 60% of people on earth will be concentrated in cities, and urban problems caused by the excessive concentration of population, energy, and commodities in these cities will become an even greater global challenge than today.

As of 2012, there were 26 mega-city metropolitan areas with populations exceeding 10 million people around the world. The world's largest mega-city is metropolitan Tokyo (37 million). The growth rate of mobile network traffic (monthly) in the five years from 2012 to 2017 in the Tokyo-Nagoya-Osaka zone, which is only 550 km long zone but houses Japan's three largest mega-cities, is predicted to be 18-fold, greater than the growth rate of the world's mobile IP traffic of 12.4 times (Cisco Visual Networking Index Mobile Data Traffic Forecast and Methodology, 2012–2017). With carriers reporting that the traffic of the mobile IP backbone in the Tokyo metropolitan area is doubling every year, the increased usage of 4G smartphones and mobile tablets and rapid increase in user-generated payroads with video multimedia like YouTube and social media have led to a concentration of traffic in cloud data centers, such that ICT industries worldwide are now faced with a massive volume challenge.

1-2 Challenge of dealing with the transition from mobile to an M2M, connected world

The change in our lifestyles from one where people used to talk to others when they had to (= communication link (Call)) to one where we always want to be connected to someone (= always-connected (Wi-Fi IP)) has resulted in the need to overcome time differences and regional differences brought about by the change from human-to-human communication to human-to-machine communication, as well as the simultaneity of the formation and awareness of global communities due to the spread of personal media like Twitter and Facebook. Furthermore, advances in sensor technology and the great strides made in processor, memory, network technologies that enable real-time accumulation and processing of massive amounts of data have led to the rapid increase in machine-to-machine (M2M) communication needs. This has expanded to smart cities including smart cars (connected cars), smart homes (connected homes), Intelligent Transport System (ITS; interconnected cars, traffic lights, and road infrastructures), and health monitoring of bridges and infrastructures, in efforts to respond to the needs of resolving social issues such as energy savings, CO_2 reduction, and efficient investment in the conservation of aging infrastructures. This trend of accelerated expansion of the scope has led to a dramatic increase in the telecommunication network scale that had until now been restricted by the number of households, as well as in the number of network terminals that need to be managed by IP addresses and the scale (number, volume, time) of data centers that integrate and manage generated traffic data [massive data processing in cloud data centers], thereby posing a huge challenge to the information communication infrastructures supporting them.

1-3 Security challenges

While convenience has dramatically improved with many users using similar basic software accompanying the increased use of the Internet on PCs, the risks of hacking where people with malicious intent invade our systems are also increasing, so that ensuring information security is now

a huge challenge. Since diverse social infrastructure systems are globally linked by IP networks, and the use of IP services based on mobile networks is increasing, security threats that are hard to detect are on the rise around the world. Various efforts are thus being made to tackle this security problem in each layer of networks and applications from the electro-physical layer of high-speed broadband IP networks.

2. Sumitomo Electric's R&D Strategies in the Infocommunication Area and Intention of the Featured Topic

To deal with the three challenges given above by meeting the needs for even faster broadband in optical networks that support the increased usage of various broadband data, such as video distribution by general households, companies, and governments, and the use of cloud and massive data volumes, Sumitomo Electric is conducting extensive R&D work and commercialization of innovative products.

Specifically, we are carrying out research and development of: user home equipment product technologies such as smart home service gateways and video set-top boxes; optical fiber cables and access network devices; optical devices for backbone networks; optical transmission devices for cloud data centers; M2M communication technology; various sensor technologies; ITS technology as a social infrastructure system supporting smart mobility; security application package products for companies; on-vehicle radars; satellite communication composite semiconductor wireless devices; etc.

Of this broad range of R&D efforts being carried out, the Featured Topic focuses on next-generation optical technologies for supporting high-speed broadband in IP networks for which efforts are being made to deal with the rapid increase in communication traffic.

As described below, we undertook the development of 11 technologies spanning four areas, namely: optical fiber cable product technology aimed at reducing the cost of access networks and transmission of greater information volumes, access network system product technology aimed at optical CATV and the construction of 10 Gbit/s high-speed broadband access networks, digital coherent method mid- and long-distance communication device product technology to deal with the increasing transmission capacity of backbone networks, and short-distance high-speed broadband optical transmission device product technology around cloud data centers (see **Fig. 1**, items ① to ⑪ in the figure correspond to items ① to ⑪ below).

First, with optical fiber cable product technology, we introduce: ① optical Thunderbolt cable for PCs and peripheral devices requiring high-speed broadband networking for video distribution and other services; ② ultra-large capacity multi-core fiber enabling transmission of rapidly increasing backbone IP traffic; ③ connector-type optical branching parts for connecting multi-core fiber to optical transmission units and conventional single mode fiber; and ④ thin high-density optical fiber cable for efficient and low-cost Fiber to the Home (FTTH) construction work. With access network system product technology, the following are introduced: ⑤ FTTH system for vendors of optical CATV networks; and ⑥ improvement of operations by vendors of Passive Optical Network (PON) systems for subscribers of optical networks to realize 10 Gbit/s high-speed IP communication. Then with mid- and long-distance communication device product technology supporting digital coherency, the following are discussed: ⑦ IC technology for controlling 100 Gbit/s coherent communication tunable laser oscillation wavelengths; ⑧ 200 kHz linewidth tunable laser realizing high-speed communication by 100 Gbit/s phase modulation; and ⑨ device for receiving and converting 100 Gbit/s coherent light to electrical signals for mid- and long-distance trunk communication systems. Finally, with short-distance high-speed broadband optical transmission device product technology, the following are discussed: ⑩ low-power-consumption compact light transceiver for single-mode fiber connecting data centers internally or with other data centers at short distance; and ⑪ vertical cavity surface emitting laser (VCSEL) for ultra-high-speed multi-mode fiber communication at data centers, and a reception photodiode.

There are many other technologies related to high-speed broadband such as important optical technologies like low-loss optical fibers that could not be taken up in this issue due to the timing of disclosing their details. We hope to report on these technologies including the many technologies and products introduced above in future issue.

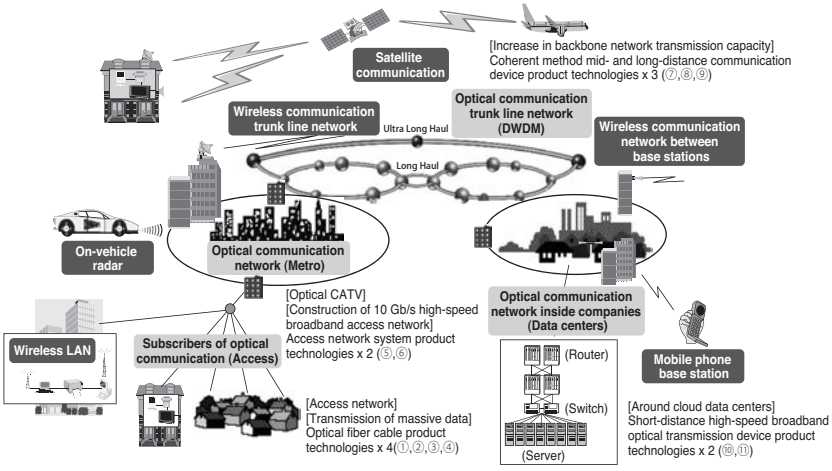

Fig. 1. Sumitomo Electric's IP network related products and papers featured in this issue