Trends in Telecommunication Technology

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Thank you Mr. Chairman for your kind introduction.

Good morning ladies and gentlemen.

Today, I would like to talk about “Trends in Telecommunication Technology”.

Outline

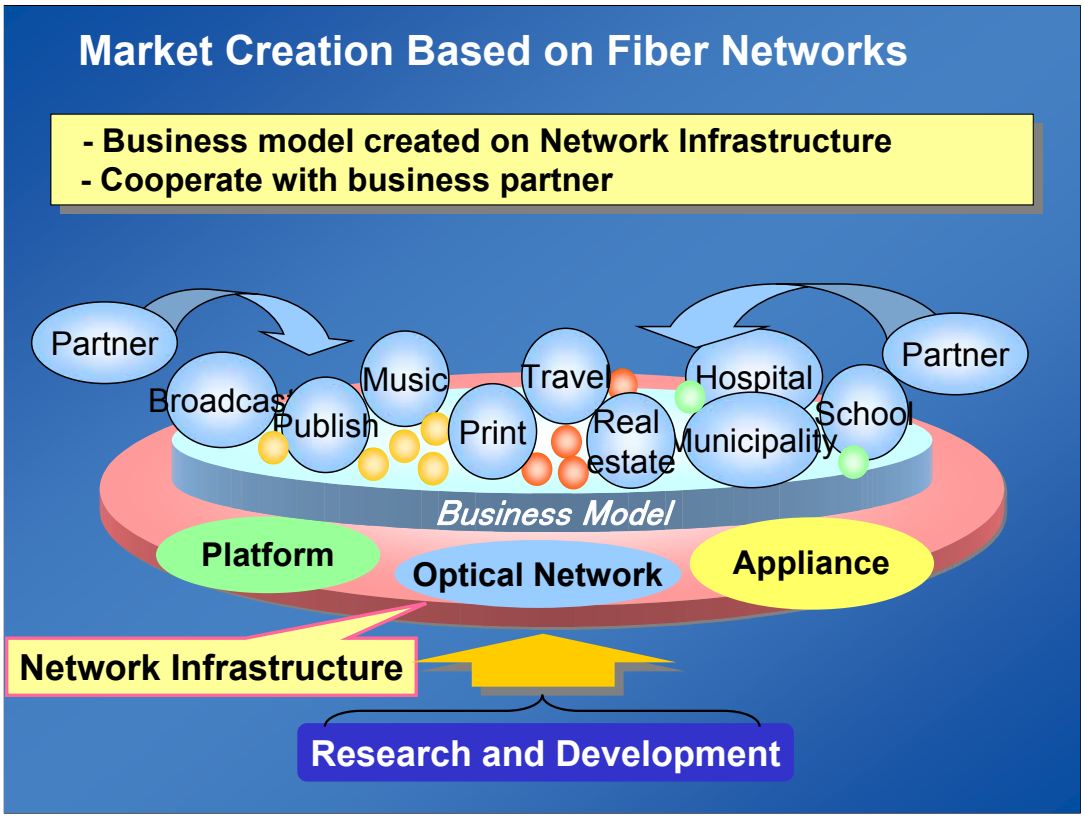
1. Broadband Access Network Service Market
   - A View of Network
   - Japan
   - Asia-Pacific
   - FTTH Council promote its market

2. Service trend ? What happening in Networks?
   - Access Network and Core Network, migration to IP Network
   - NGN (Next generation network)

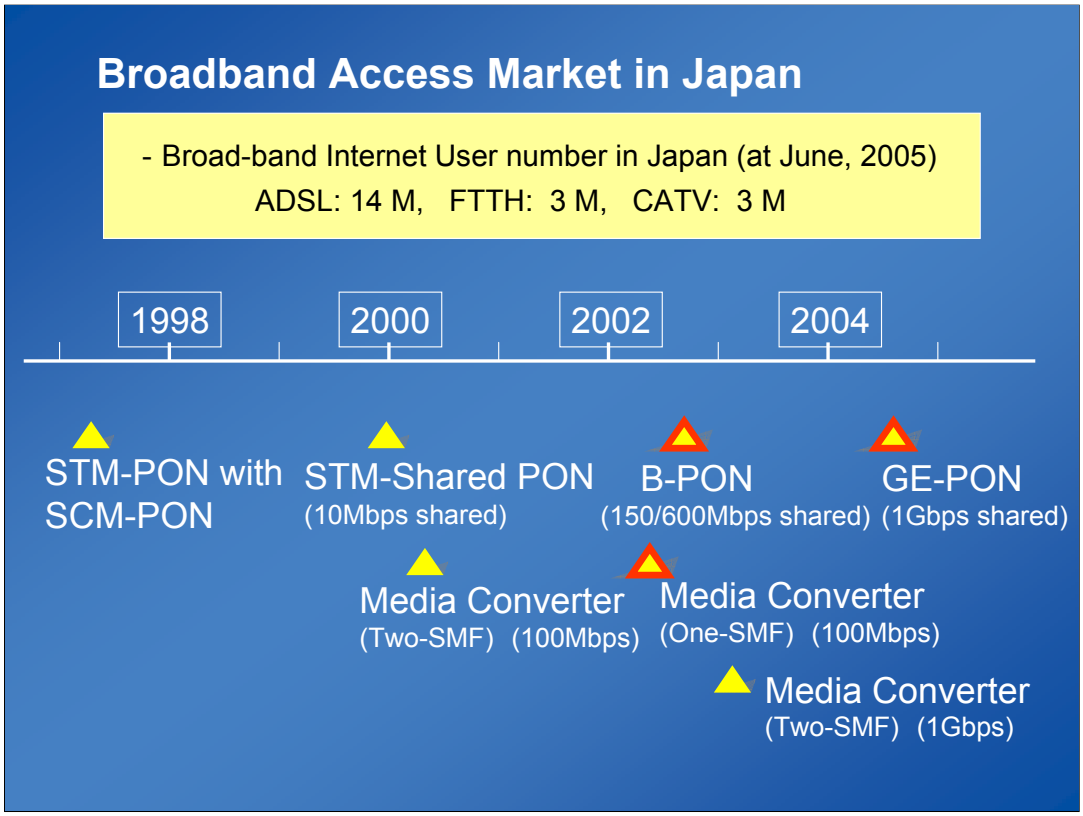
3. Typical R&D Issue for Future Network
   - Problems to be solved in future network
   - Technology trend
   - Typical R&D Issues

This is an outline of my talk.

First of all, I would like to summarize the broadband service market trend up to date, especially in Japan and the Asia-Pacific region. Next, I will talk about what is happening in the access and core network. I will focus on transmission traffic increase, and problems caused in the network will be clarified. The third is about typical R&D issues to be solved in the future network. And I would like to inform you about some technologies to overcome these problems.



This figure shows the market creation model on fiber networks. We cable manufactures are mainly working on developing network components such as fiber, cable and optical components. However nowadays, it is very important to create business models on network infrastructure. Many kinds of businesses have already developed in the publishing, music, travel areas. To activate these network services further, cooperation between network service providers and various business partners is required.



In Japan, the user number for broadband service was 20 million in June of this year. As to the FTTH, the user number is 3 million, which is a larger number than CATV internet users. And it increases by more than one-hundred thousand users every month. In the lower bottom of the slide, the FTTH service trend is described. It started with STM-PON service in 1997 by NTT, B-PON service in 2002 and GE-PON service started first of this year.

Why FTTH Market Developed in Japan?

Supply-side Factors

1) Installation of optical fiber for B-ISDN
2) Development of high-speed ADSL
   (1.5/2M ⇒ 8M ⇒ 12M ⇒ 24M ⇒ 40M etc.)
3) Regulatory reform to ensure competition in FTTH service.

Demand-side Factors

1) Demand for contents, such as Rental Video on Cassette tapes.
2) Public Awareness of the merit of High-speed Internet Service through acceleration of ADSL speed and Optical Service.
3) Experience in Cellular Phone, such as with Music Distribution, Game Downloads and Video Communication.

(by S. Suzuki, FTTH Council Asia-Pacific General Meeting)

It is often questioned by other countries “Why did the FTTH market develop in Japan?”. Actually, there are some reasons for this question. This slide summarizes them. From a supply-side view point, ISDN service started in 1988 in Japan, and to upgrade it to broadband-ISDN much amount of fiber has been installed in Japan since the 1980s. Core networks and major access trunk lines have already finished deploying optical fibers. We were in fiber rich circumstances in the early 2000s. Also, spreading (popularizing) ADSL service and its upgrade competition, and the unbundling regulation enhanced FTTH service development.

From a view point of user-side, actual demands for high speed internet service existed in video and music down-load services.

Broadband Access Market in Asia-Pacific

Japan
- NTT Plan to 30 M homes served by 2010

Korea
- Extremely high broadband penetration and FTTB
- IEEE802.3ah E-PON deployment plan

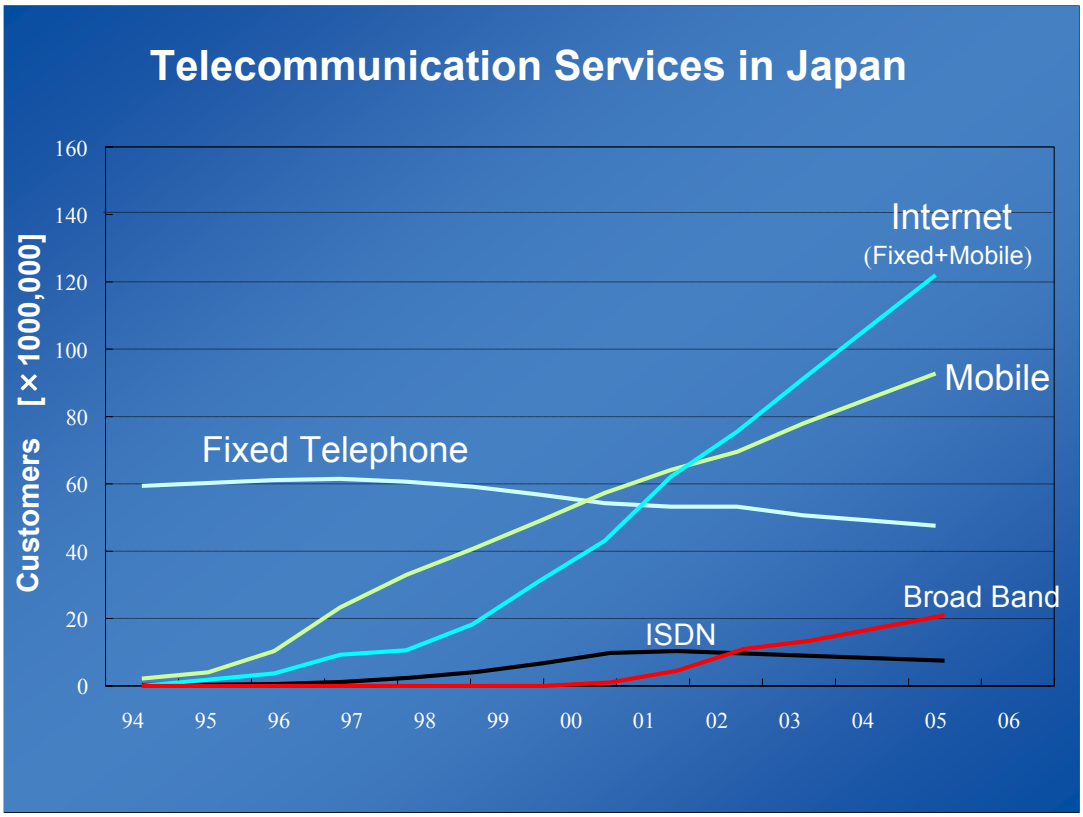
Taiwan
- E-Taiwan project will drive FTTH

China
- FTTH pilots in several regions
- Hong-Kong more Broadband than Dialup Internet

Australia/NZ
- Pilots by incumbents in Greenfield areas

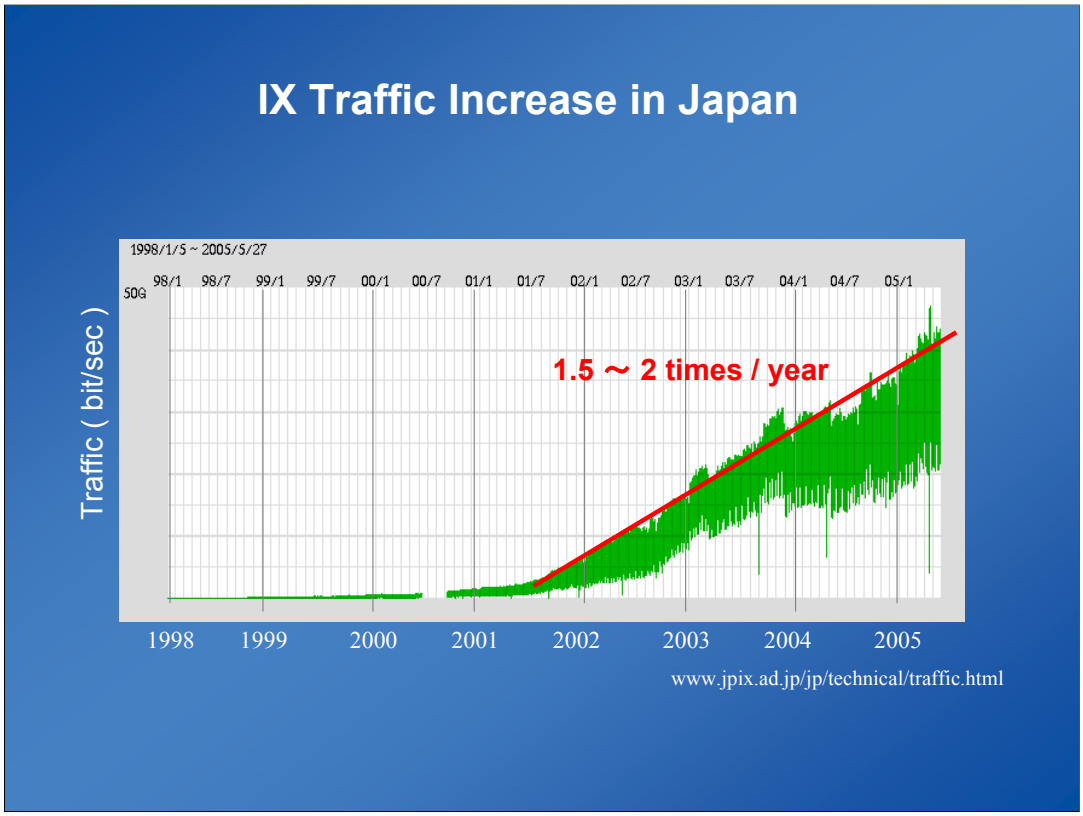
Next, I would like to talk about the broadband market situation of FTTH in Asia-Pacific countries. In Japan, NTT announced that they are planning for 30 million homes to be connected with FTTH by 2010. In Korea, there is extremely high penetration with VDSL and FTTB. Also, they are planning GE-PON deployment. In China, FTTH pilot projects have started in many regions and so in Australia.

In March of this year, FTTH Council Asia-Pacific was launched as an international organization. 32 companies joined from manufacturers, construction and engineering companies, network service providers, content providers, academia. The mission of this council is to educate, promote and accelerate FTTH and to pursue the enhancement of the quality of life. Its activity will promote the market development in FTTH.

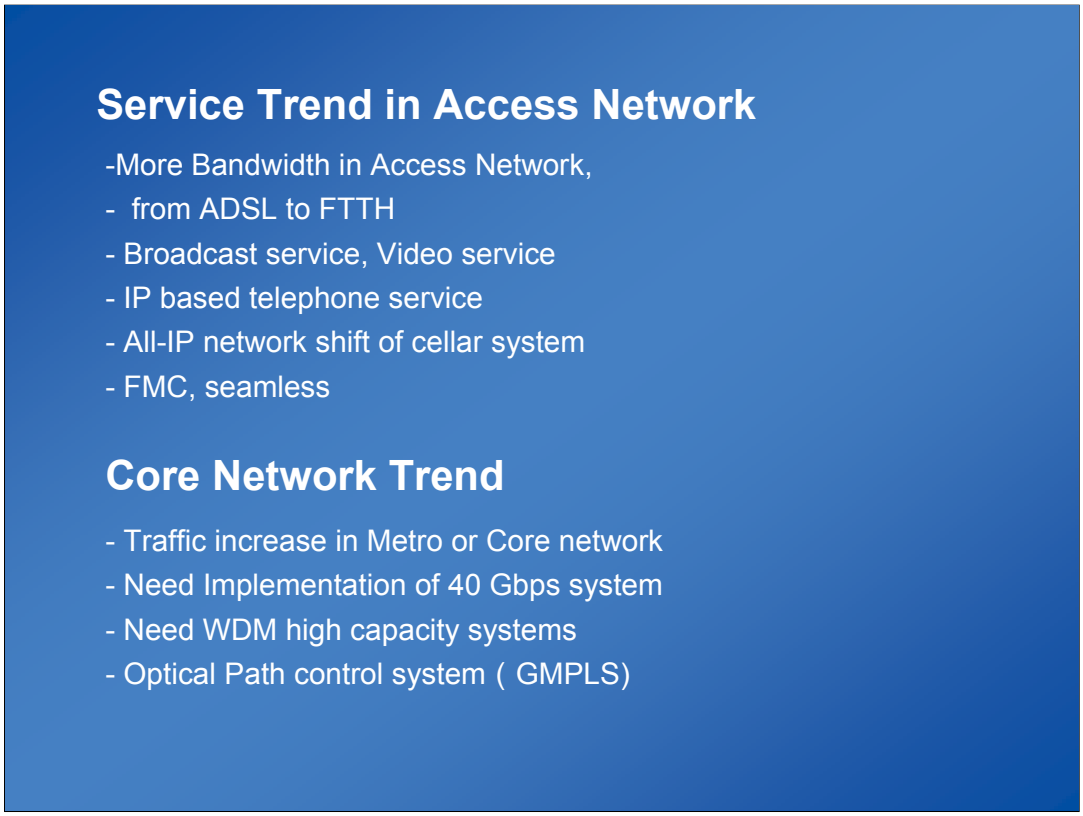


Next, I would like to talk about network trends.

First of all, I would like to introduce the subscriber number change in these ten years in various network services. I think this figure is very popular nowadays. However, let me highlight the user number of broadband services. It rapidly increased from 2001. As I said before 14 million of ADSL, 3 million of FTTH, 3 million of CATV Internet, and we have in total 20 million broadband users.



This is an internet traffic increase at IX (Internet Exchange) in Japan. Traffic is increasing 1.5 to 2 times every year. This is because of the widespread use of high speed FTTH services, and it effects the metro and core networks, it causes traffic increase in the trunk network area.



To summarize the network trend, this viewgraph shows typical issues. In the access network, network service is moving from ADSL to FTTH, and an increase of the user numbers in FTTH service is expected. The service will shift to video service. We can expect a demand for more bandwidth in the access network. Also, fixed mobile convergence will proceed, and the cellular phone will be supported with the IP network.

In the core network, with the traffic increase in the access network, the metro and core networks need an upgrade in transmission speed. A 40 Gbit/s transmission system, WDM high capacity system and optical path control system such as GMPLS will hopefully be launched into commercial use.

Why Broadband Networks will migrate to Optical Fiber Access Networks?

- Internet users increasing,
- Information communication traffic increasing,
- New services such as video and music etc,
- xDSL to FTTH
  (ADSL: bit rate strongly depending on distance)

Vendors are taking efforts to develop practical next generation network

- Scalable network
- Flexible for transmission capacity
- Flexible for services multiplexing
- WDM based ?
- with Acceptable cost

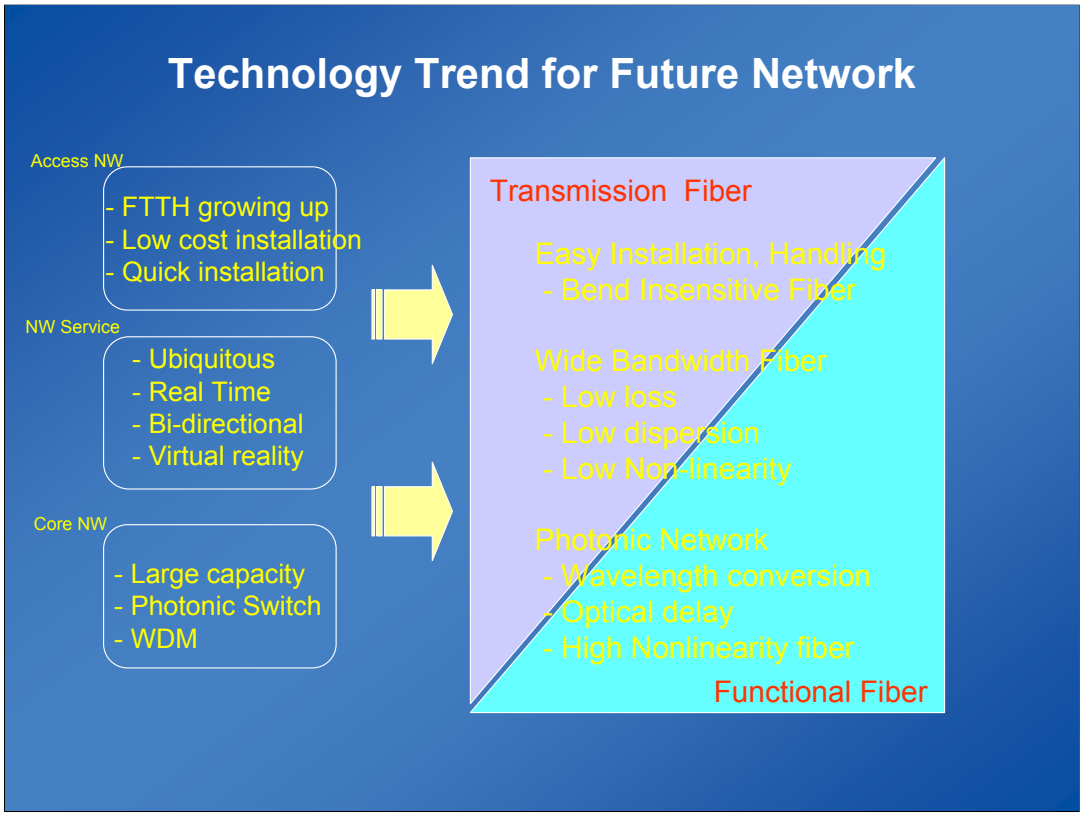
From the discussion mentioned so far, the broadband network will migrate to optical fiber. In order to support scalable, flexible services with multiplexed features, WDM will take an important role.

Problem to be solved in Future Network

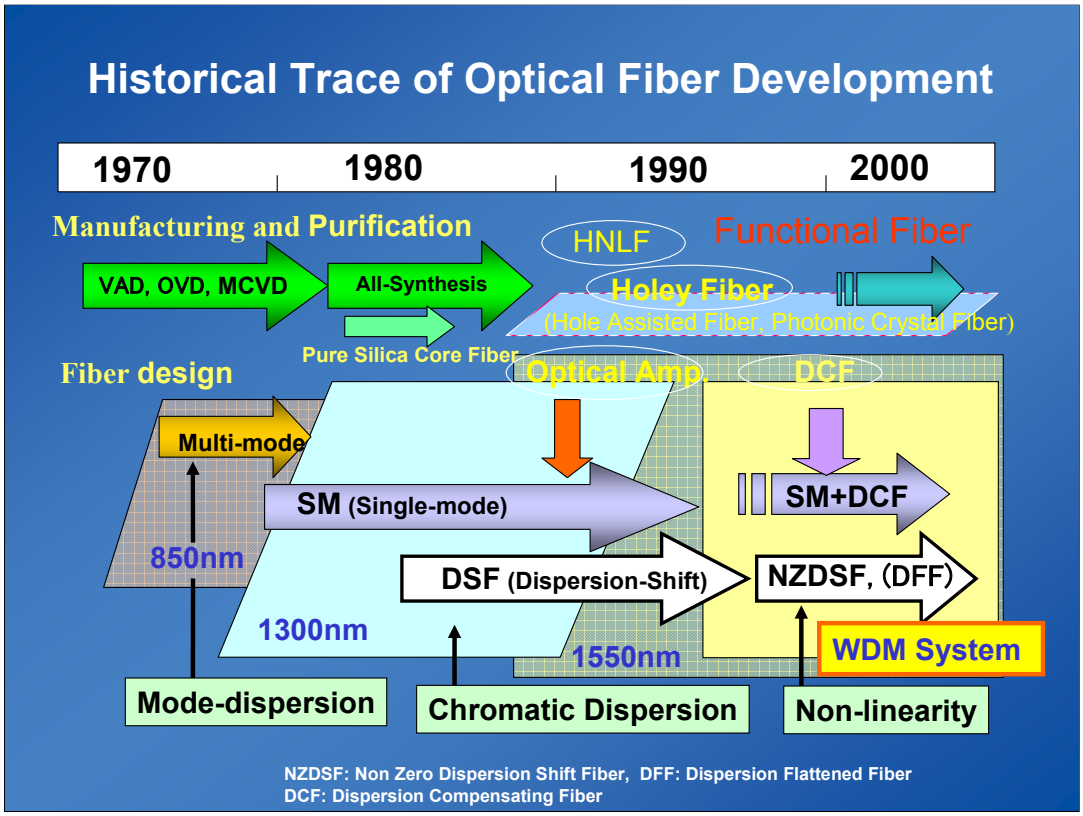
(1) From Triple play to Quadruple Play
(2) FMC（Fix Mobile Convergence)、Seamless
(3) Necessity for Large capacity Metro and Core Network
(caused by increasing GE-PON users)
(4) Network Security
- Protection from NW Attacker
- Network Architecture Recovery from nature disaster
(5) Protocol for Scalable Network
(6) High Capacity Router
(7) Optical Burst Switch, Optical Packet Switch
(8) B-PON → GE-PON (or G-PON) → WDM-PON
(9) LAN/WAN: GE → 10GE → 100GE

The third issue of my talk is about typical R&D.

When thinking about a future network, there are some technical trends and some problems to be solved. Triple play will move to quadruple play which means including cellular phones in the IP network, and everything will be served in the IP network. Necessity for large capacity metro and core networks, network security, optical burst and packet switches are highlighted.

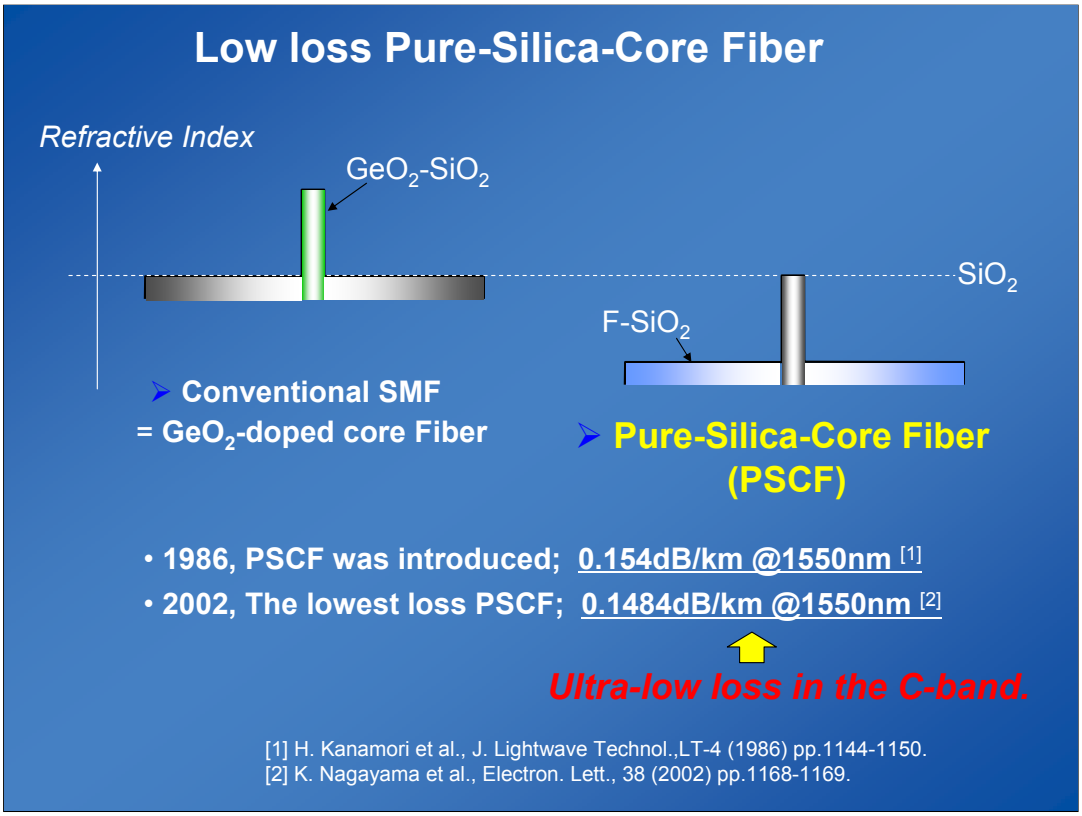


As a result of the backgrounds summarized here, the fiber development trend to support future networks can be summarized as seen in this viewgraph. In the access network, easy installation is important, and fibers or cables are required, which are easier to handle and have improved insensitivity to bending. From a viewpoint of the transmission media, low loss, low dispersion, low nonlinearity and wide wavelength band is preferable. These are requirements for transmission fibers. In the near future, functional fibers seem to be important for the use of optical signal controlling such as photonic switching. In the following, I would like to address some R&D issues in the fiber development.



This viewgraph shows historical development activities of optical fibers.

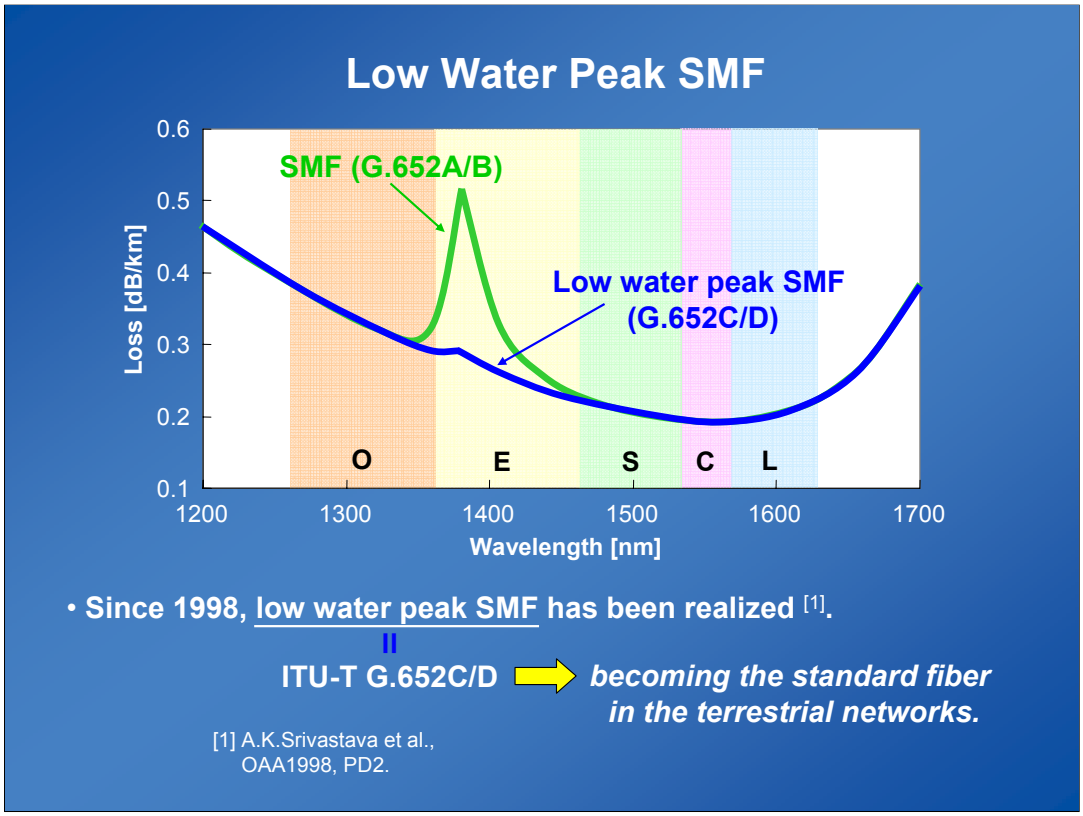
In 1970, fiber development started with multi-mode fiber operating at 850 nm. Then, single-mode fiber operating at 1300 nm followed. After that, dispersion-shifted fiber and non-zero dispersion fibers were developed. In these development processes, technologies of new manufacturing process and novel glass synthesis and purification progressed. In the 1990s, newly categorized functional fibers were developed. These included optical fiber amplifiers, dispersion compensating fibers and high nonlinearity fibers. And in the late 1990s, holey fibers or photonic crystal fibers were reported. As explained later, the functional fibers can be used in various kinds of optical signal controls. As to the limitation factor in the transmission characteristics, the non-linearity phenomenon is a major factor in densely WDM transmission system.



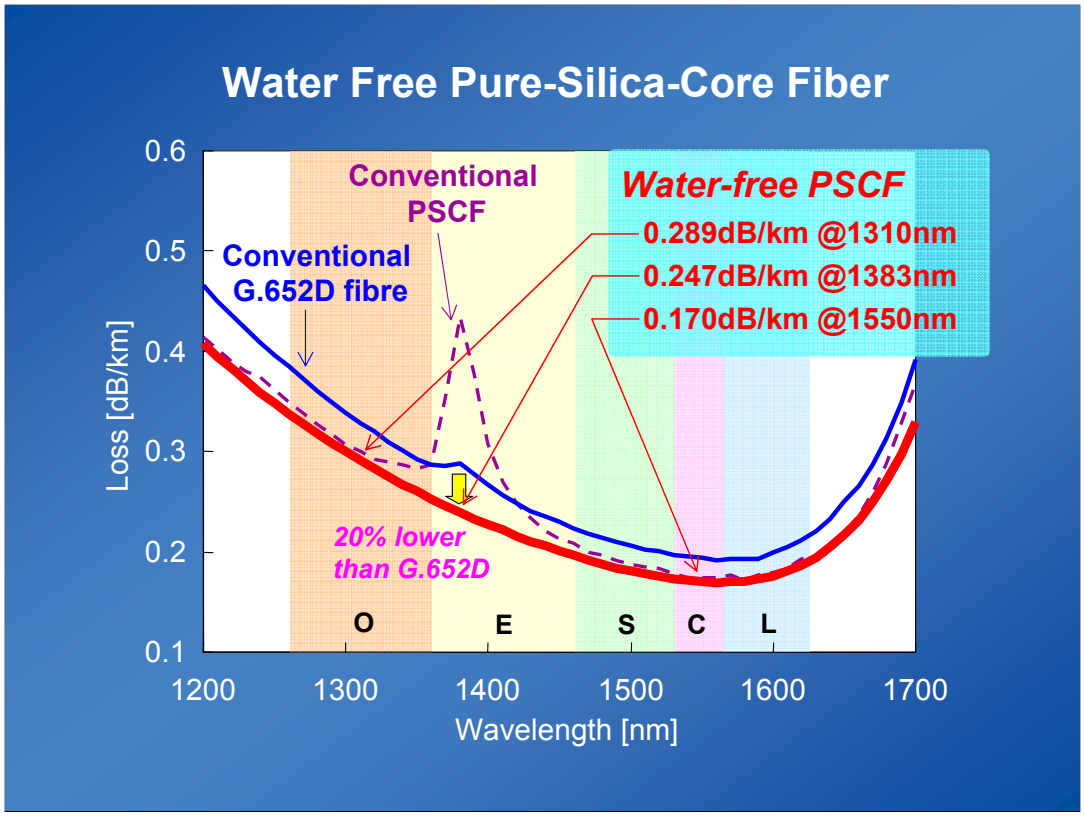
In the following, I would like to present some typical R&D issues.

This shows the structure of an optical fiber. In a standard fiber, Ge is used for doping, to create a high refractive core. In the right hand figure, the fiber core is kept to be pure silica, whereas the clad region is doped. This brought two merits.

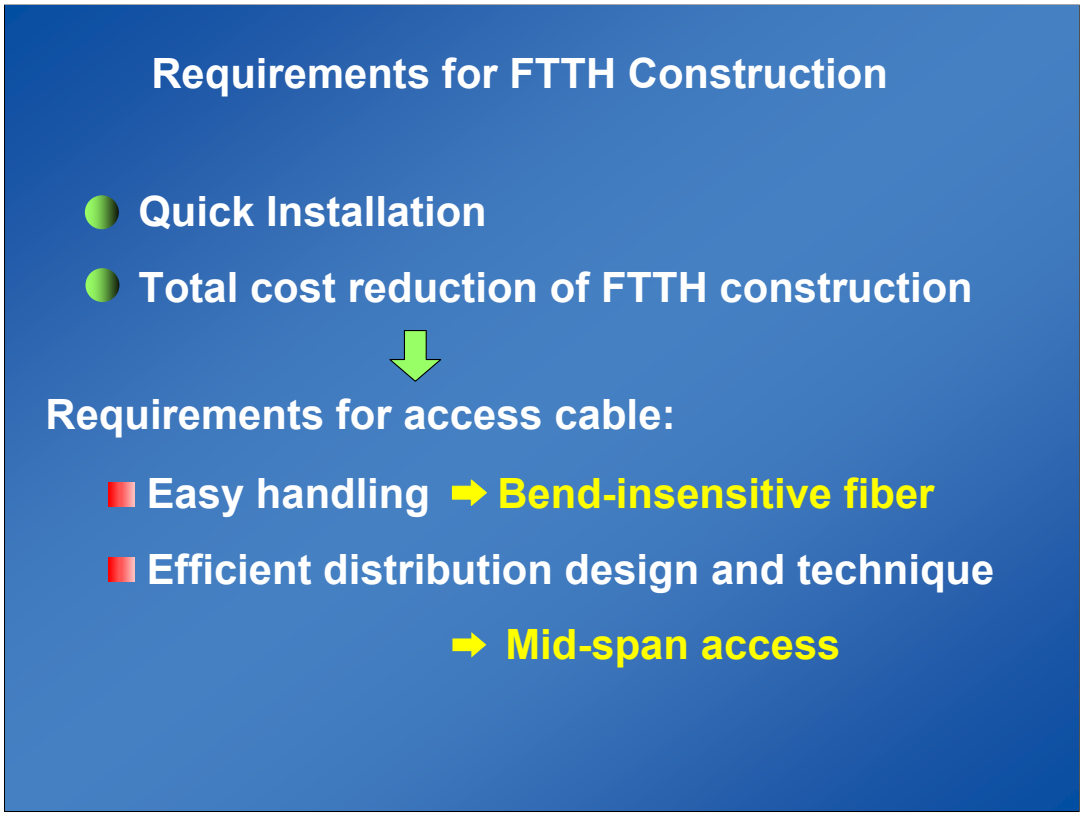
First one is that a purely silicate core assures low attenuation, second is long term reliability for materials. This means it is free from loss increase and stability for radio isotopic radiation. The lowest attenuation attained so far is 0.148 dB/km.



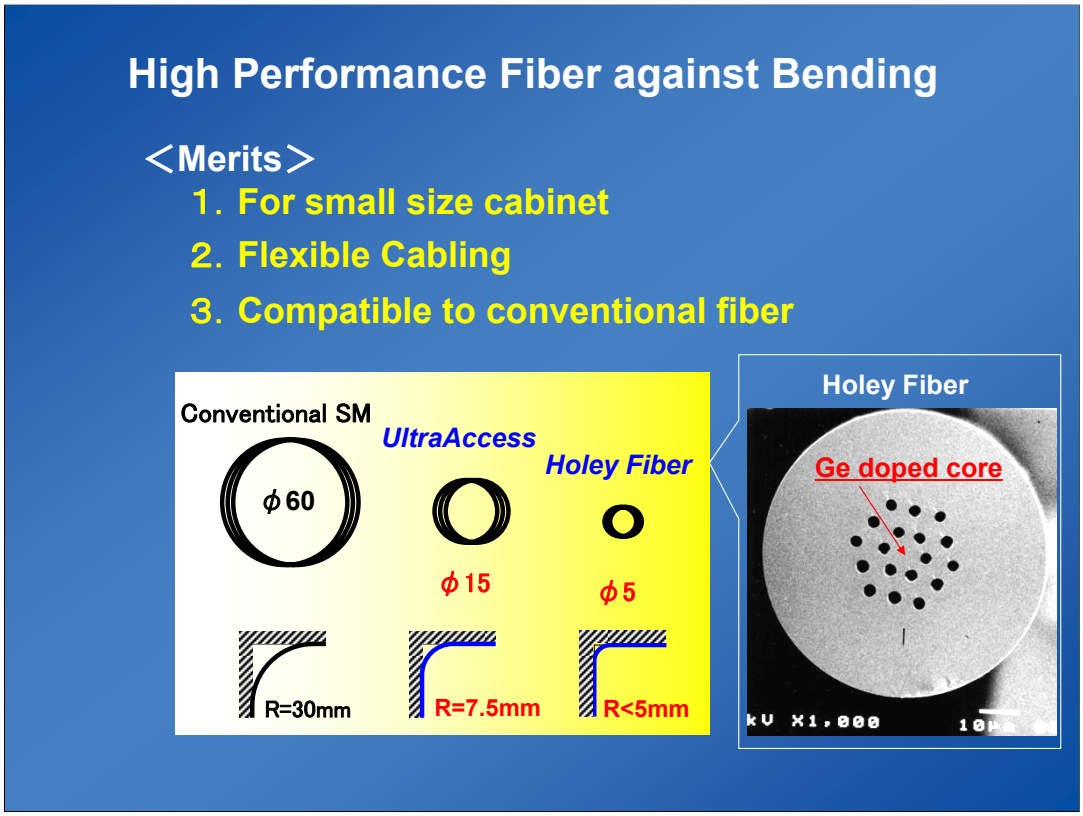
This is a typical loss spectrum for a standard fiber. The green line is the conventional case. In the telecommunication area, 1300 and 1550 nm windows are popular wavelength ranges. The wavelength range over 1700 nm is a limited area because of infrared absorption in the silica glass material. The peak around 1400 nm is caused by water contamination in the glass material. This peak can be reduced by removing the water. The result is shown with the blue line in the figure. This fiber is promising for the use as transmission fiber because of its wide wavelength range. It was accepted as ITU-T standard.



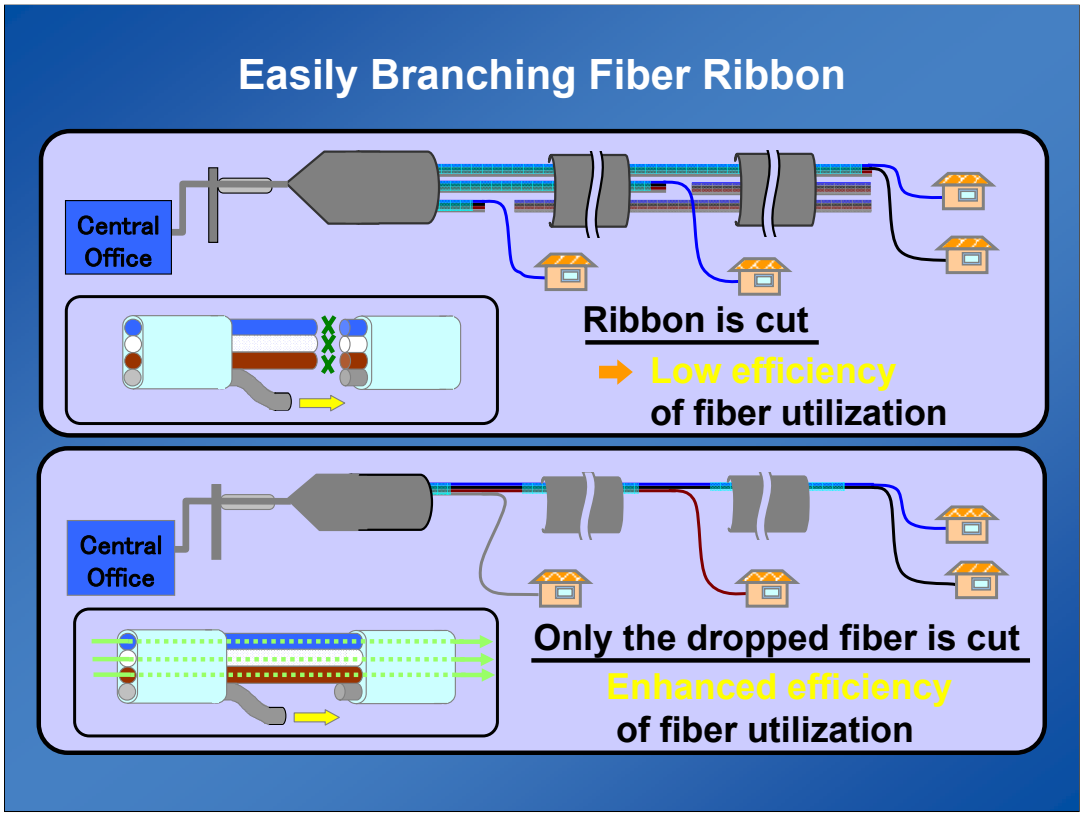
This figure is the same as the previous one, however, the fiber type is a pure silica core fiber. In this case, attenuation is almost 20 % lower than that of the standard fiber. It is promising as a transmission fiber from a viewpoint of low loss and long term reliability.



The number of FTTH subscribers is increasing rapidly, and it is over 3 million in Japan and increases with one hundred thousand users every month. Under this situation, a quick installation technology and total cost reduction for FTTH construction is strongly desired. From the viewpoint of the cable, easy handling is required to reduce installation time and cost. Efficient distribution design and technique are also in high demand. Mid-span access is the key to realize efficient distribution.



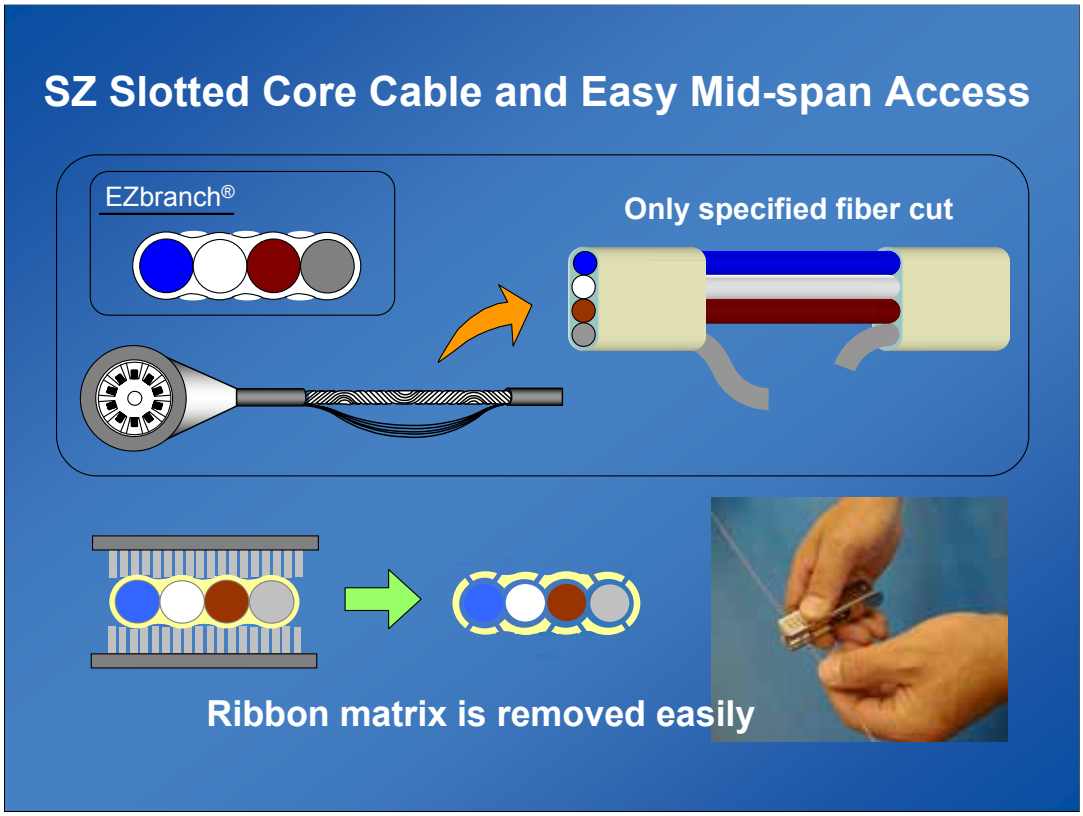
A high performance fiber against bending is preferable. This brings reduction of installation time because of its easy handling characteristics. In this diagram, three kinds of fibers are compared. The standard fiber is specified to handle 60 mm bending diameter. By designing a fiber, we can obtain a strong fiber against bending. Furthermore, by using this special fiber, called holey fiber or photonic crystal fiber, the fiber can endure bends of only 5 mm diameter. If optimized, even higher performance is available.



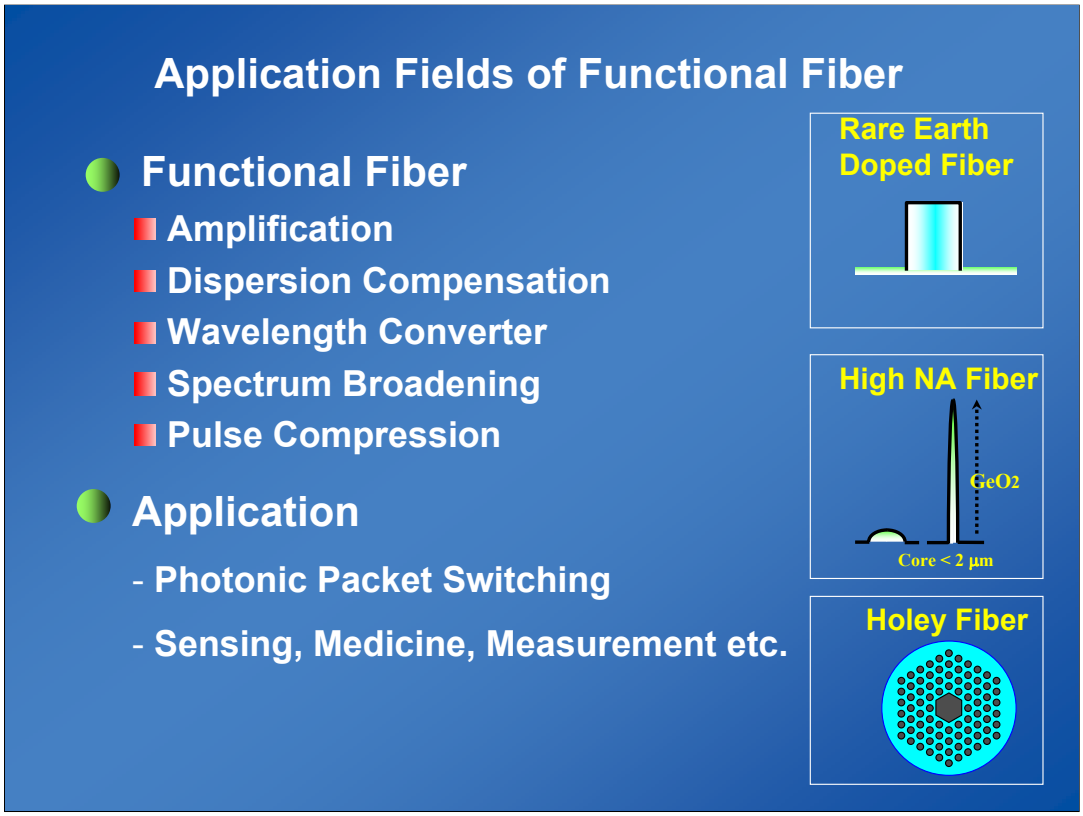
The second technology is a fiber ribbon, which is easily branched.

Usually a ribbon contains four fibers. So that for the case described in the upper figure, a ribbon unit is cut, and one fiber is dropped for service, however, others remain unused.

On the other hand, when only the dropped fiber is cut, all the fibers in the ribbon can be dropped at optional points, and the efficiency of the fiber utilization can be enhanced. For this reason, an easily branching ribbon is required.

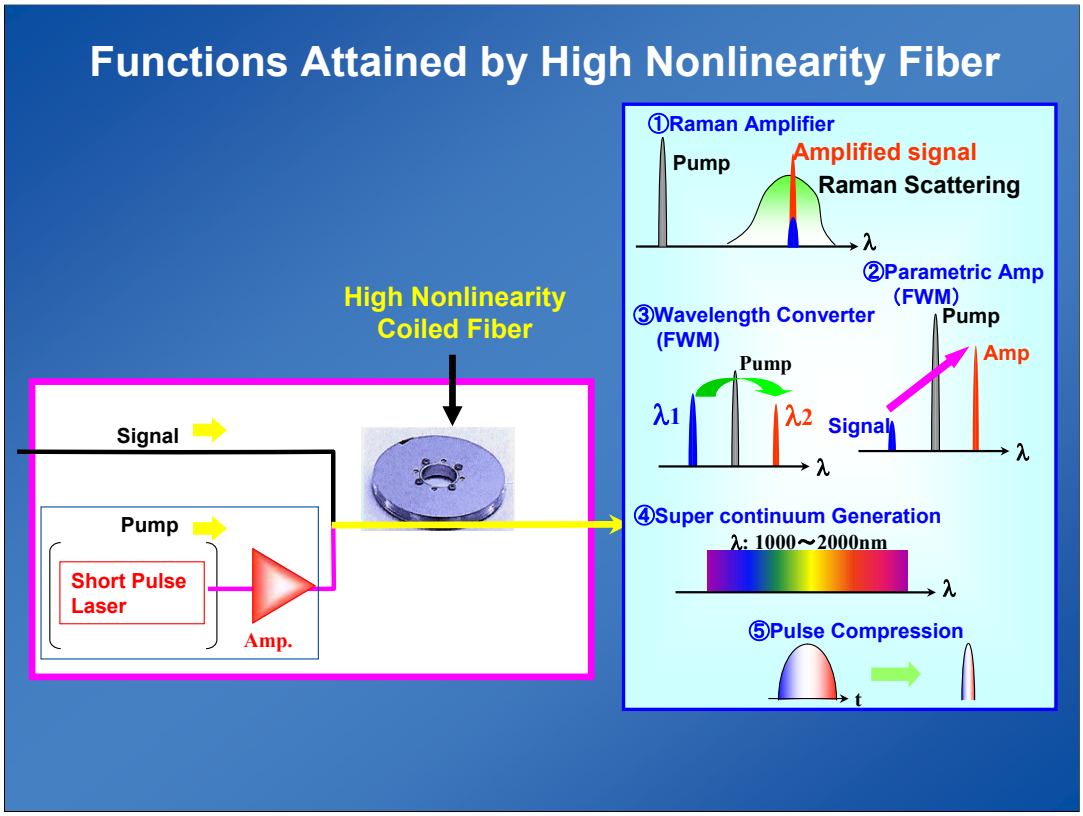


The key technology attaining it is the SZ slotted core cable. This is very popular in Japan. By removing the cable sheath, the fiber ribbon can be easily taken out. The other one is a special ribbon structure. In this structure, the ribbon matrix is easily removed.

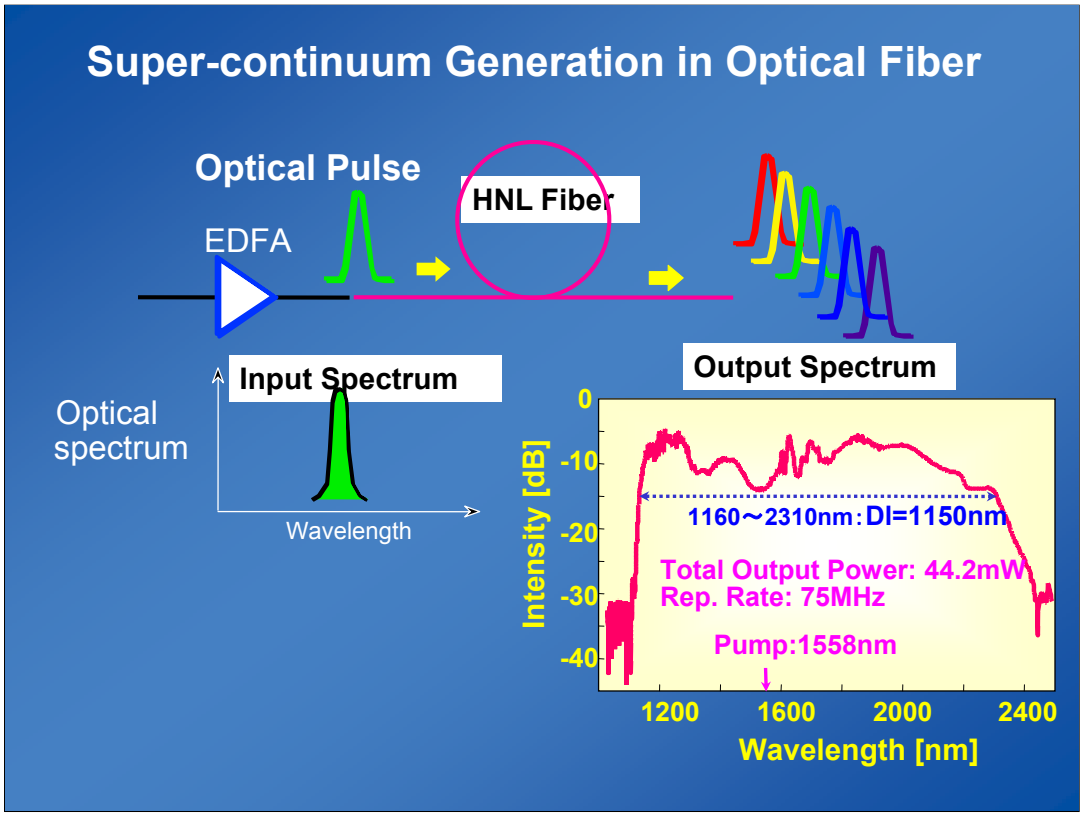


These are typical functional fibers. A doped fiber is a fiber including rare metal ions in its core region. This provides optical amplification. The next one is a high refractive fiber. The last one is a holey fiber. The holey fiber has 20 times stronger nonlinearity, and this enhances the functional features of the optical fiber.

In the following, I would like to show you some hot topics in functional fibers.



I would like to inform you about the nonlinearity in fibers. By using nonlinear fibers, we can obtain unique functions. The first is the Raman amplification, second is the parametric amplifier. These are so called optical amplifications. The third is the wavelength converter based on four wave mixing. The fourth is the spectral broadening based on the Kerr effect. The last is the optical pulse compression. As shown here, these functions are unique features compared with conventional phenomena. Nowadays, the matured fiber manufacturing technology and the progress in optoelectronics make it possible. Also, I would like to address the fiber length used here. It is only a few 10 m long.



The example of spectral broadening is described here. The operation is very simple, only by inputting an optical pulse to HNLF a very wide wavelength output can be obtained based on the Self Phase Modulation effect. This is a very promising technology for WDM systems.

These functional technologies are applicable for sensors, medicine, and in the measurement fields.

Conclusion

1. Broadband Service Market and Network Trend reviewed
   - Transmission traffic increase expected
     in Access and Core Networks

2. R&D Issues for Future Network expected
   - Easy Installation for Access Network
   - Necessity for Large capacity Metro and Core Network
   - Security: Protection from Network Attacker
   - Network Architecture Recovery from nature disaster
   - Protocol for Scalable Network
   - High Capacity Photonic Network
     (Optical Burst Switch, Optical Packet Switch)

Finally, I would like to summarize my presentation.

I have reviewed the broadband service market briefly. Then I have talked about R&D issues for the future network.

Thank you very much.