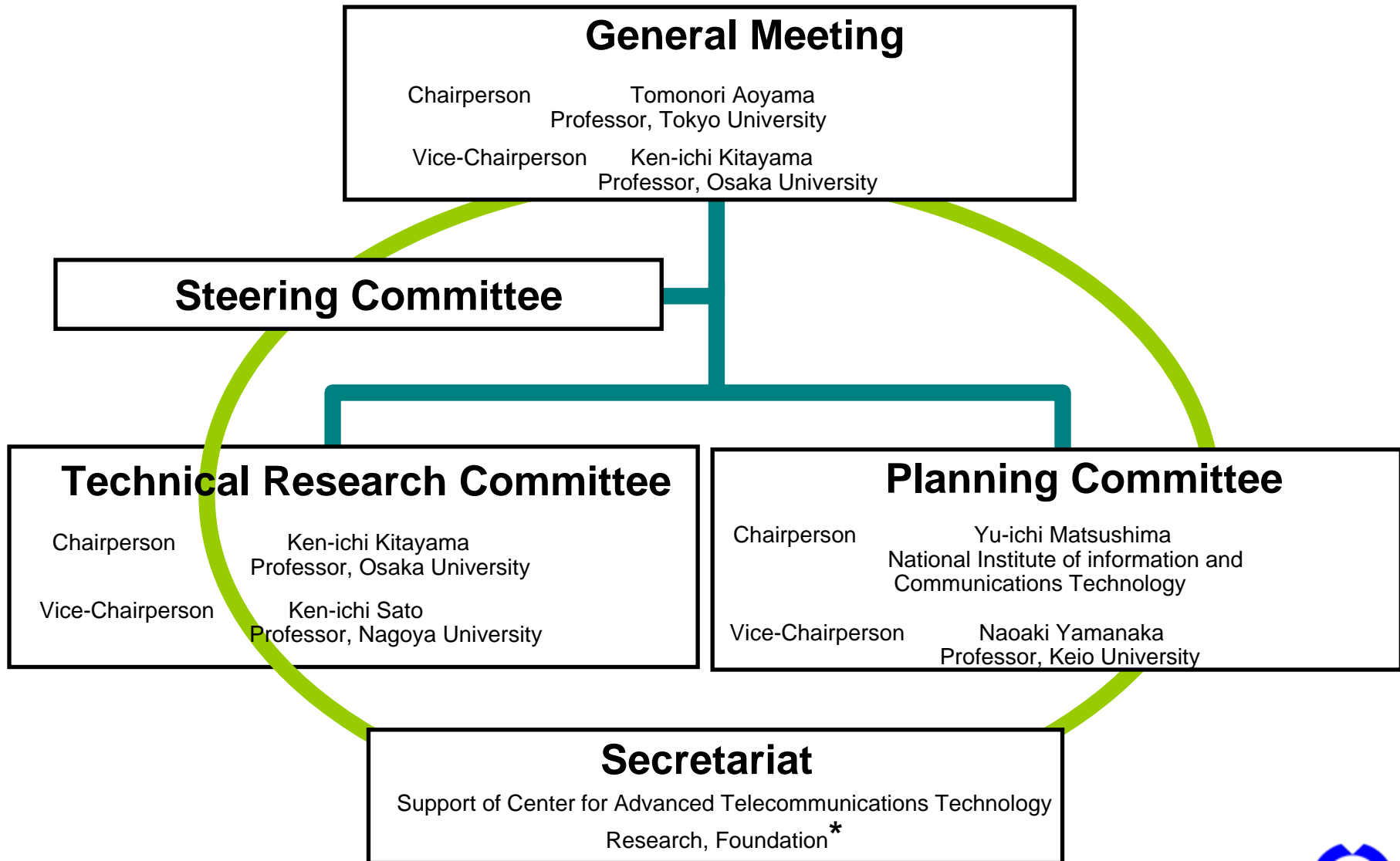

Photonic networking R&D activities and plans in Japan

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Photonic Internet Forum (PIF)



* Ministry of Internal Affairs & Communications (MIC)

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Outline

- Introduction

- What's happening in broadband services in Japan

- Current government-funded R&D programs for photonic networks in Japan

- Next-generation photonic networks R&D programs toward 2010

Outline

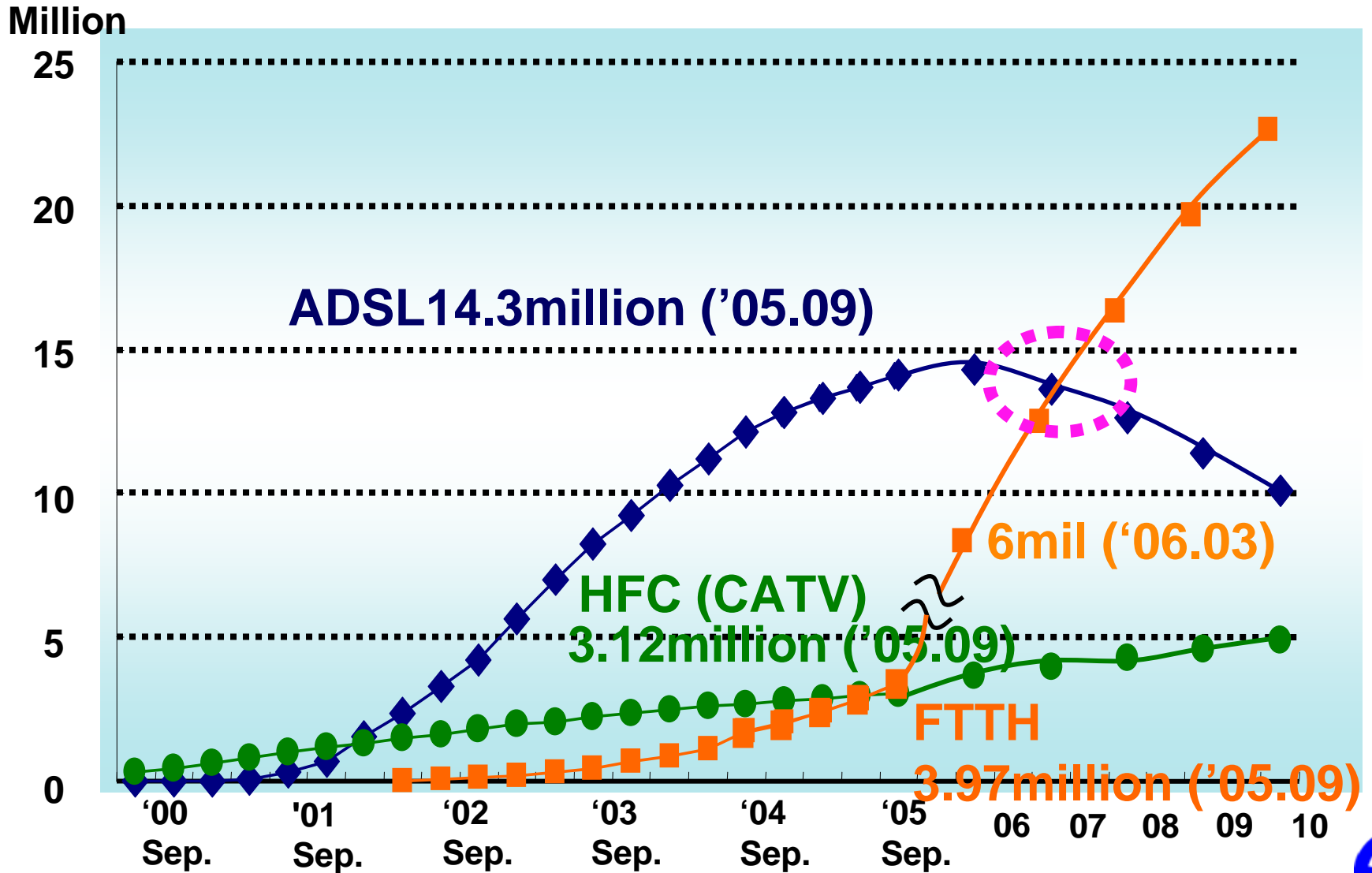
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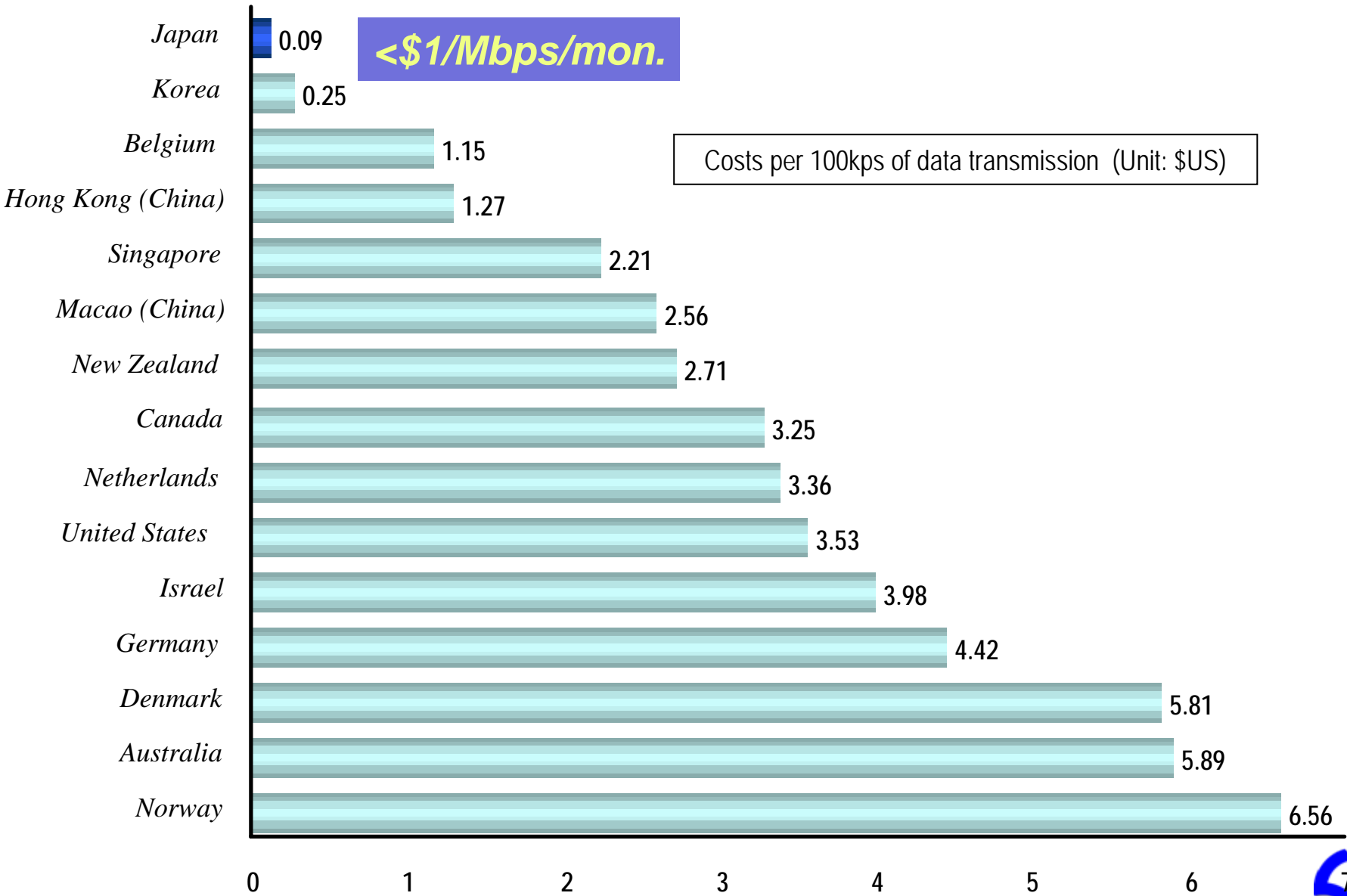
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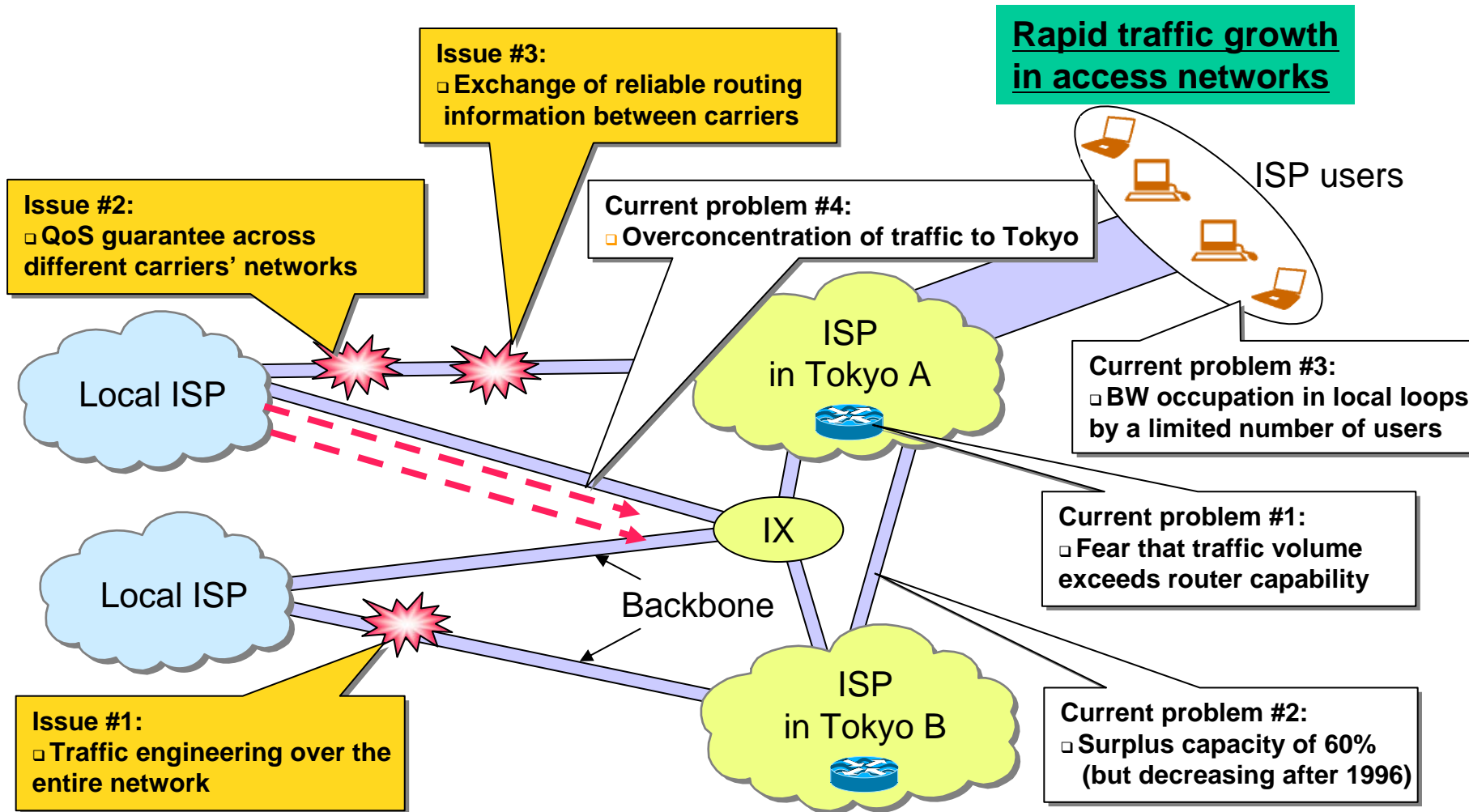
Broadband services in Japan



Broadband service rates



Problems of current IP networks in Japan



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Current government-funded R&D programs

All-optical transport
(1996~2005)

Photonic node enabling broadband access
(2000~2005)

Optical burst switching network
(2001~2005)

Control plane for terabit-class network
(2001~2005)

Devices for photonic network
(2002~2006)

Femtosecond technology
(1995~2004)

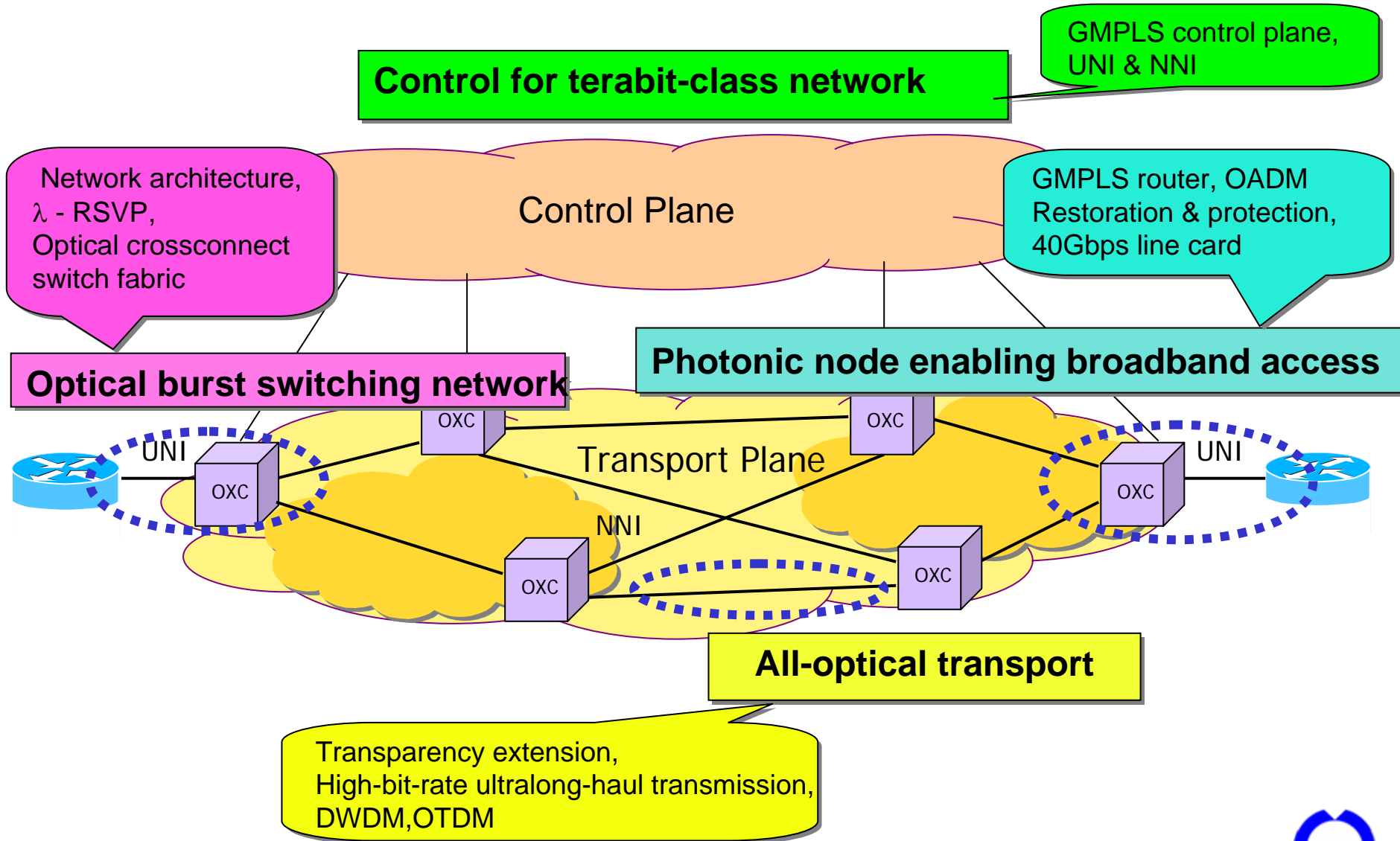
Ministry of Internal affairs
& Communs. (MIC)

NTT, Fujitsu, NEC, Hitachi, OKI,
Sumitomo, Univ. Tokyo, Osaka Univ.,
Univ. Electro-Communs.

Ministry of Economy,
Trade, and Industry (METI)



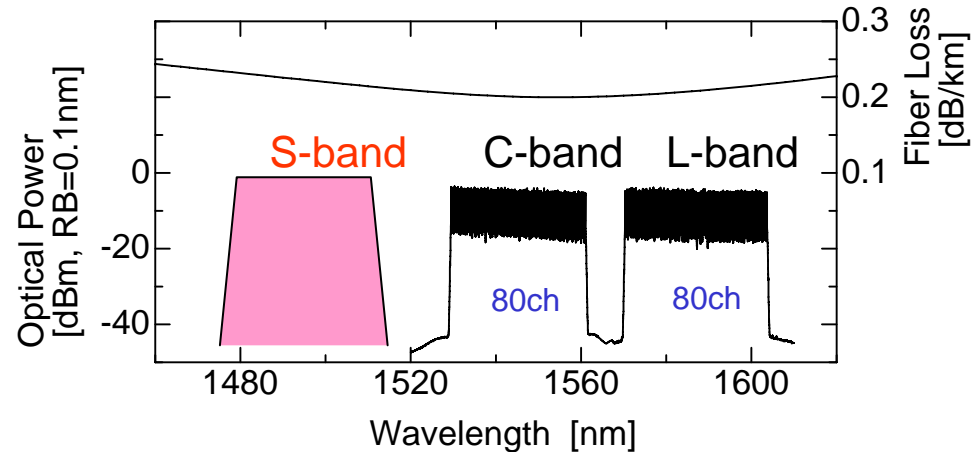
Targets and goals of current R&D programs



10.9Tb/s (40Gb/s x 273λs) WDM

(1) S-band(1.49μm) optical amplifier

- S-band GS-TDFA + C-band EDFA(1.55μm) + L-band GS-EDFA(1.58μm)
- Available bandwidth 64nm → 110nm (x 1.7)

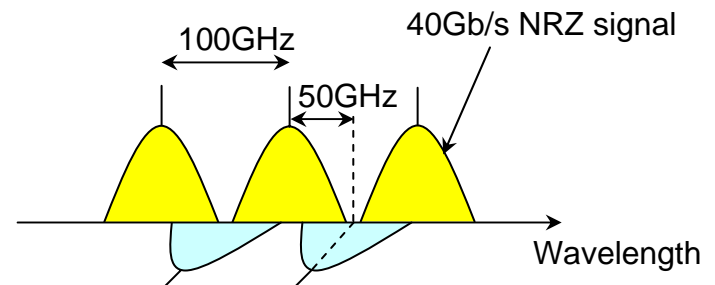


(2) 3-band WDM transmission

- NL suppression by large-core PSCF
- Dispersion compensation by RDF
- Distributed Raman amplification

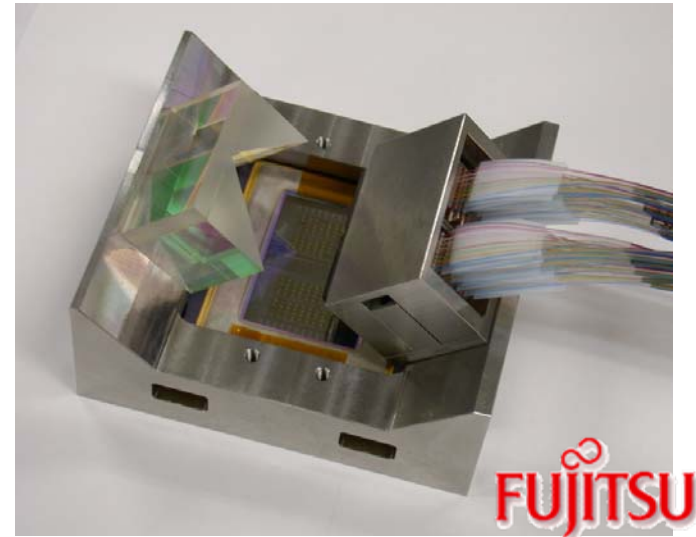
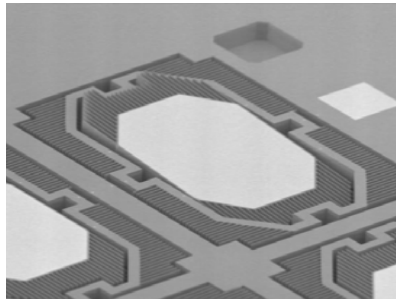
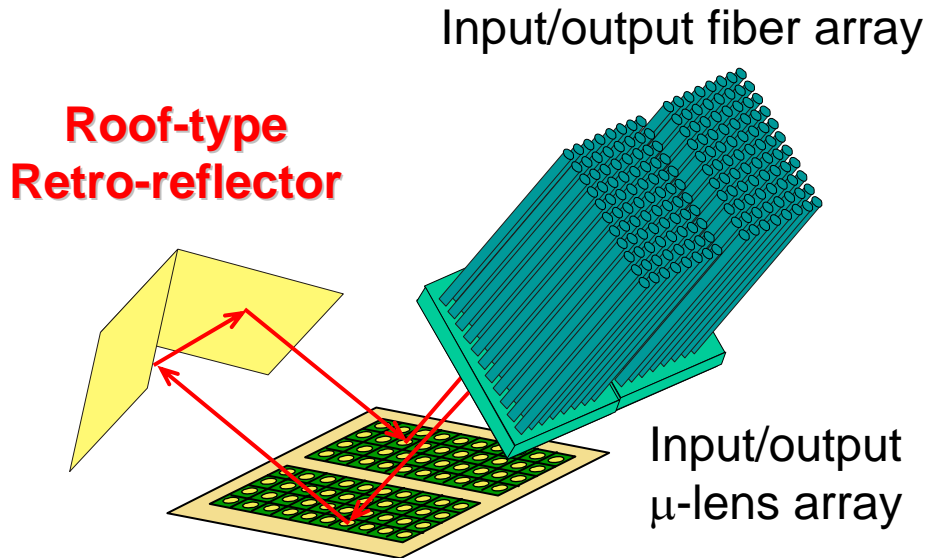
(3) 0.8 bit/s/Hz by polarization MUX/DEMUX

- 50GHz-interval
- Spectral eff.=0.8 [bit/s/Hz]



Pol MUX WDM signal

High-speed, 128x128 3D-MEMS OXC switch



Features

- Control interface: GSMP
- Large scale: **128 x 128 channels**
- High speed switching: **1ms**
- Low power consumption: 22W
- Small size: 430 x 131 x 400mm

■ Folded configuration with roof-type retro-reflector by a factor of 1/2 of flat-reflector (Lucent)

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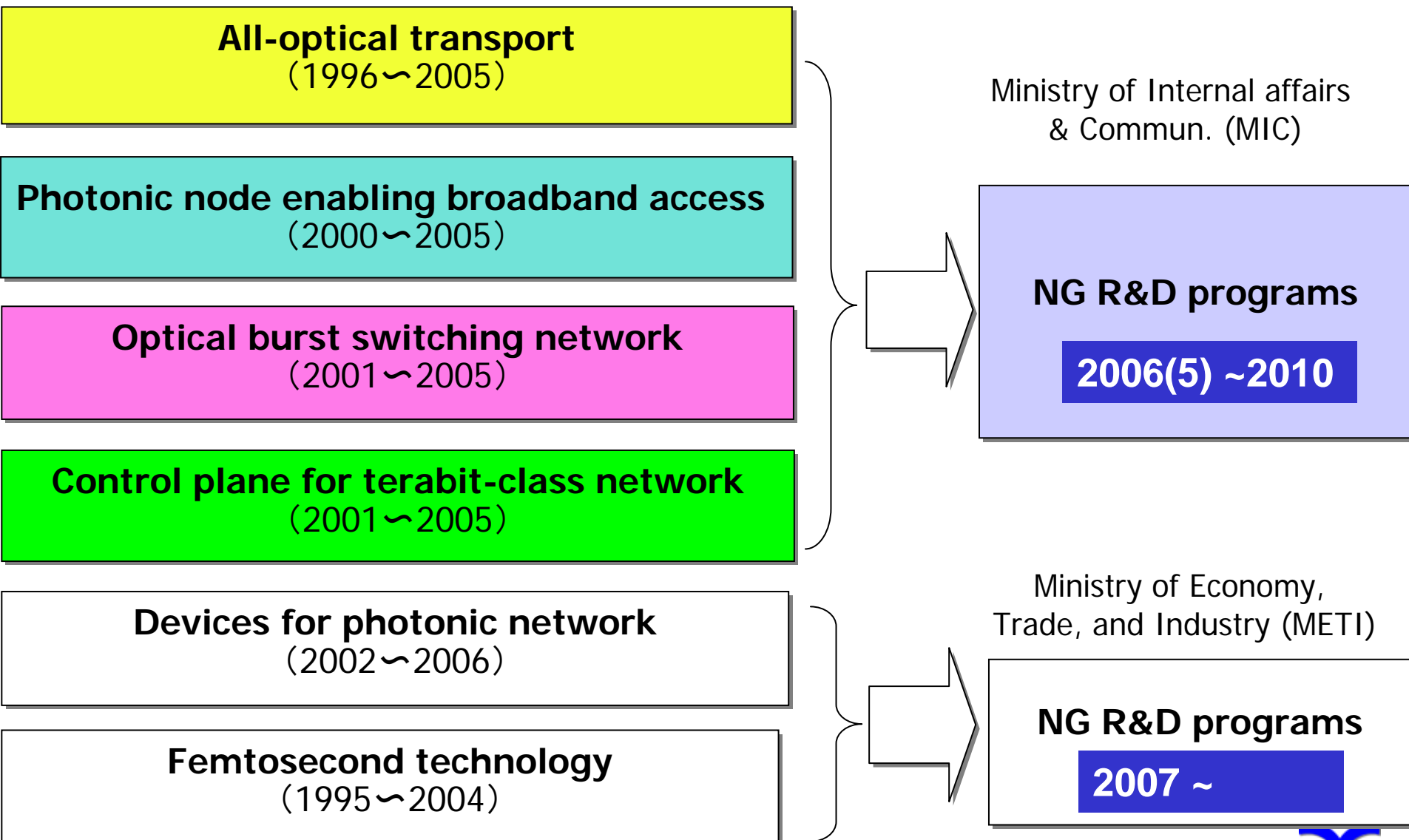
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Report from the Research Promotion Council for 21st-Century Network Technologies,
Ministry of Internal Affairs and Communications (MIC)
(http://www.soumu.go.jp/s-news/2005/050728_8.html)



Next-generation R&D programs



Paradigm shift of R&D programs

- From technology-driven to application-driven -

Current R&D programs

- 1000ch. DWDM per fiber & 10,000km non-repeater transmission
- 10Tbps photonic router
- Terabit-class wavelength routing network

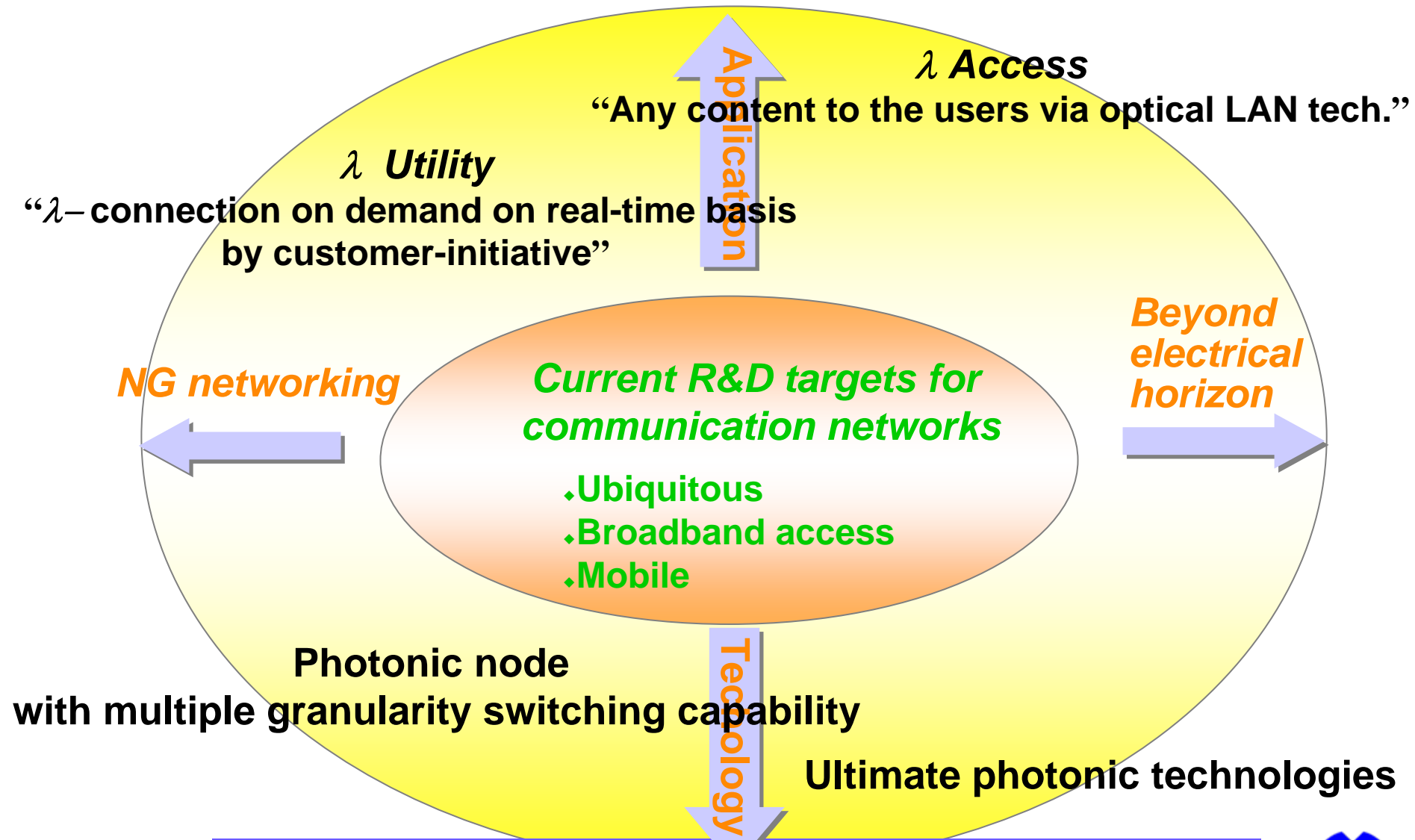
Key drivers: *Bandwidth-rich networked applications*

- Grid computing
- Real-time streaming: digital cinema, medical, education
- e-Commerce: Network storage

NG - R&D programs

- Build a **photonic platform** to provide abundant bandwidth on demand at anytime, anywhere for promoting bandwidth-rich networked applications

Guideline of NG R&D programs



Note: λ refers to a large-capacity and transparent information channel, identified by the wavelength value

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Quests for ultimate photonic technologies

Approach to Shannon's limit

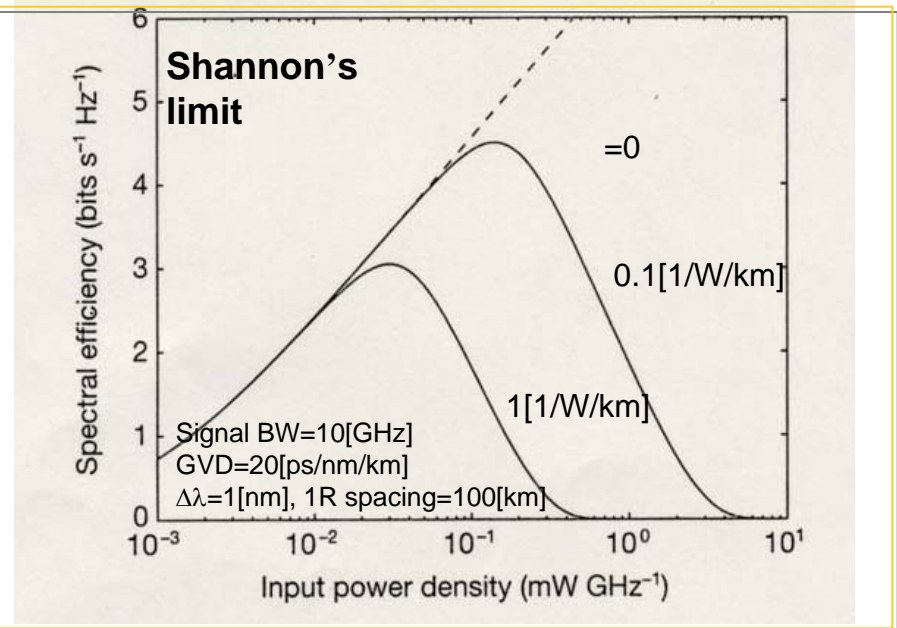
Ultimate spectral efficiency

$$\eta = \frac{C}{W} = \log_2\left(1 + \frac{S}{N}\right) [\text{bit} / \text{s} / \text{Hz}]$$

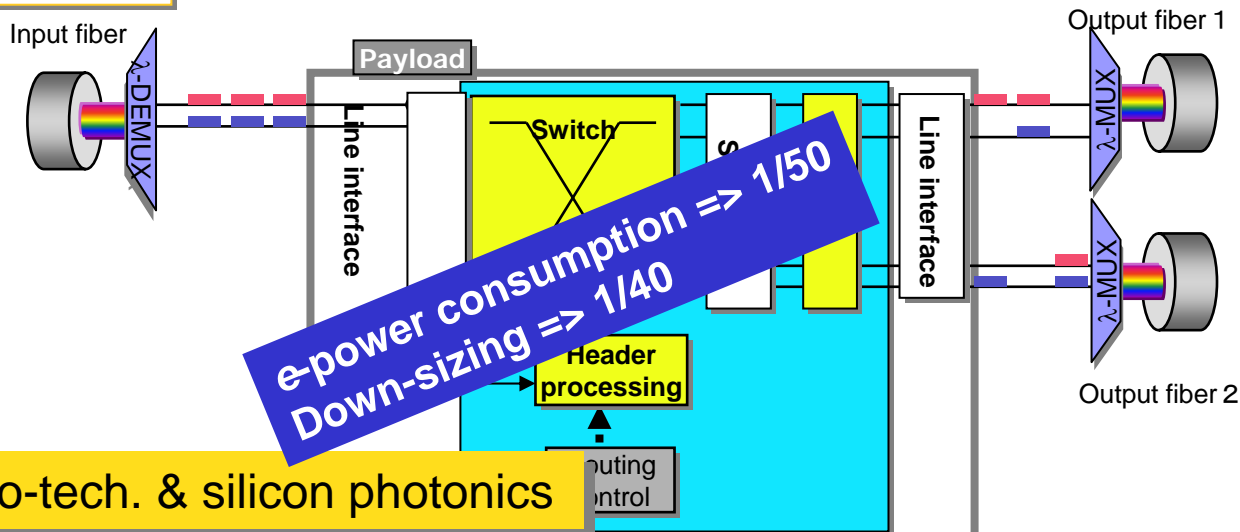
Signal bw : W [Hz], Channel capacity : C [bit/s]

*C.E.Shannon, *B.S.T.J.*,27,1948.

=> Multi-level modulation & FEC



Optical RAM



=> Nano-tech. & silicon photonics

Thank you!

K. Kitayama et al., “Photonic network R&D activities in Japan – Current activities and future perspectives – (Invited),” *IEEE/OSA J. Lightwave Technol.*, vol.23, No.10, pp.3404-3418, 2005.