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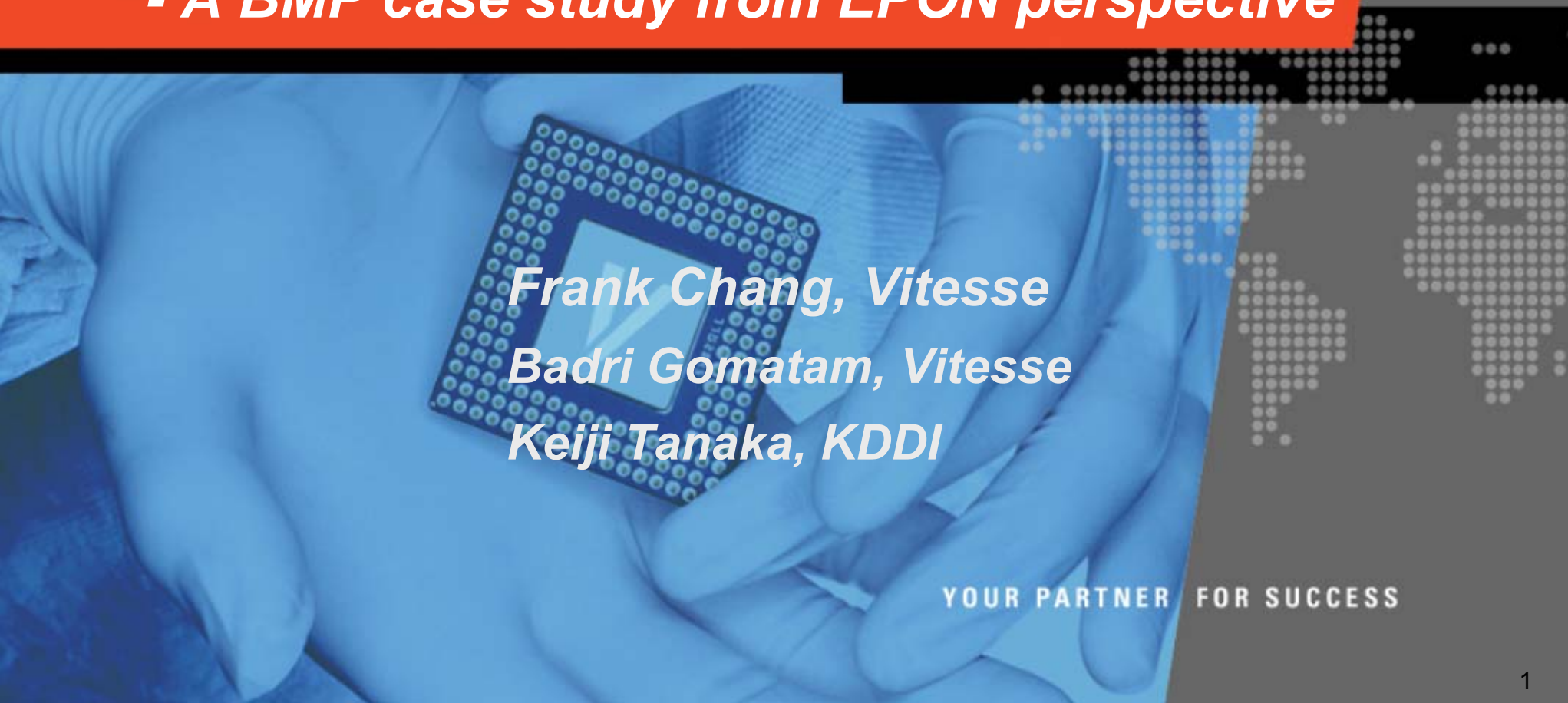
Bandwidth Drivers in Broadband Access
- A BMP case study from EPON perspective



Frank Chang, Vitesse

Badri Gomatam, Vitesse

Keiji Tanaka, KDDI

YOUR PARTNER FOR SUCCESS

PON Based FTTH/x Deployment

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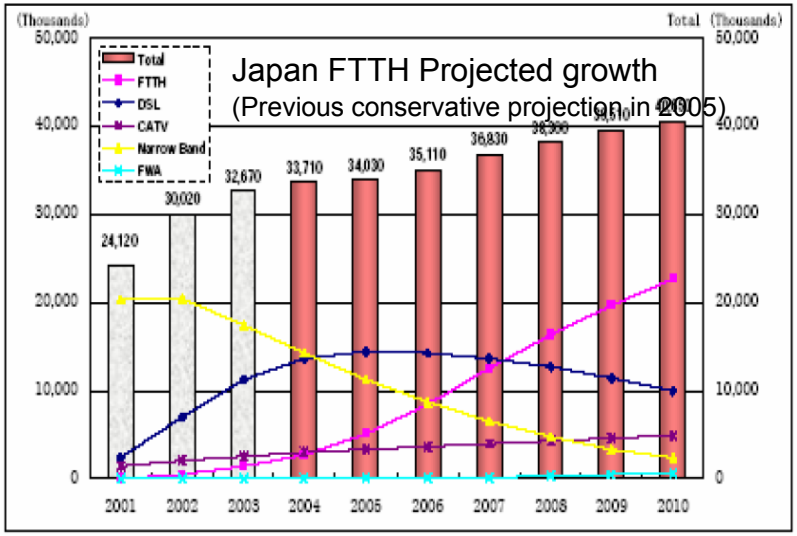
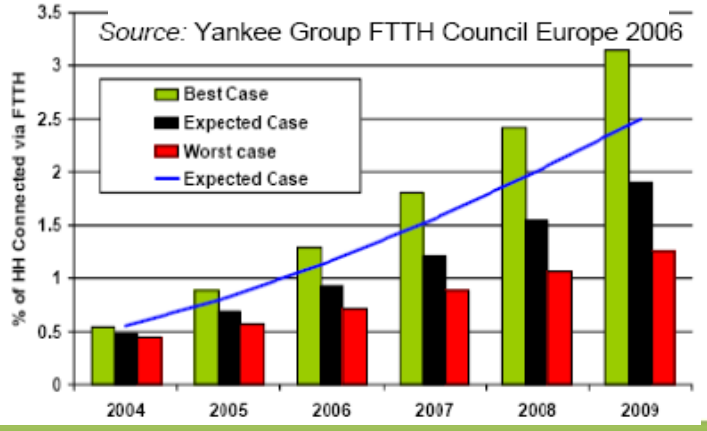
- **1G EPON has emerged as highly successful technology**
  - Standardized in June 2004 (EFM 802.3ah), Japan MIC already announced 7.2M lines deployed in 3 years by Q3'06.
    - Compared with 2.7M for Q3'05, 1.1M for Q3'04.
    - 7.2M = 29% of its total 25M broadband users
  - NTT alone expect over 30 million users in 2009/10.
    - Represent half of its total access market
    - Others key players: KDDI, Softbank BB, USEN
  - Asia-pacific still continue to lead in the near term
    - By 2010, KT plan 10M in Korea, China 20M, ChungHwa 4M.

(Estimated by Yano Research Institute Ltd: As of March 15, 2005)



- **NA operators rolling current BPON to G-PON**
  - Verizon: 7M FiOS internet users and 4M FIOS TV customer by 2010.
  - Greenfield deployment defaulting to FTTH/N.

EU FTTx Forecast



- **The next gen. EPON bringing 10Gb/s to access**
  - The scope of 10G EPON 802.3av task force.

Overview of Next-gen 10G EPON

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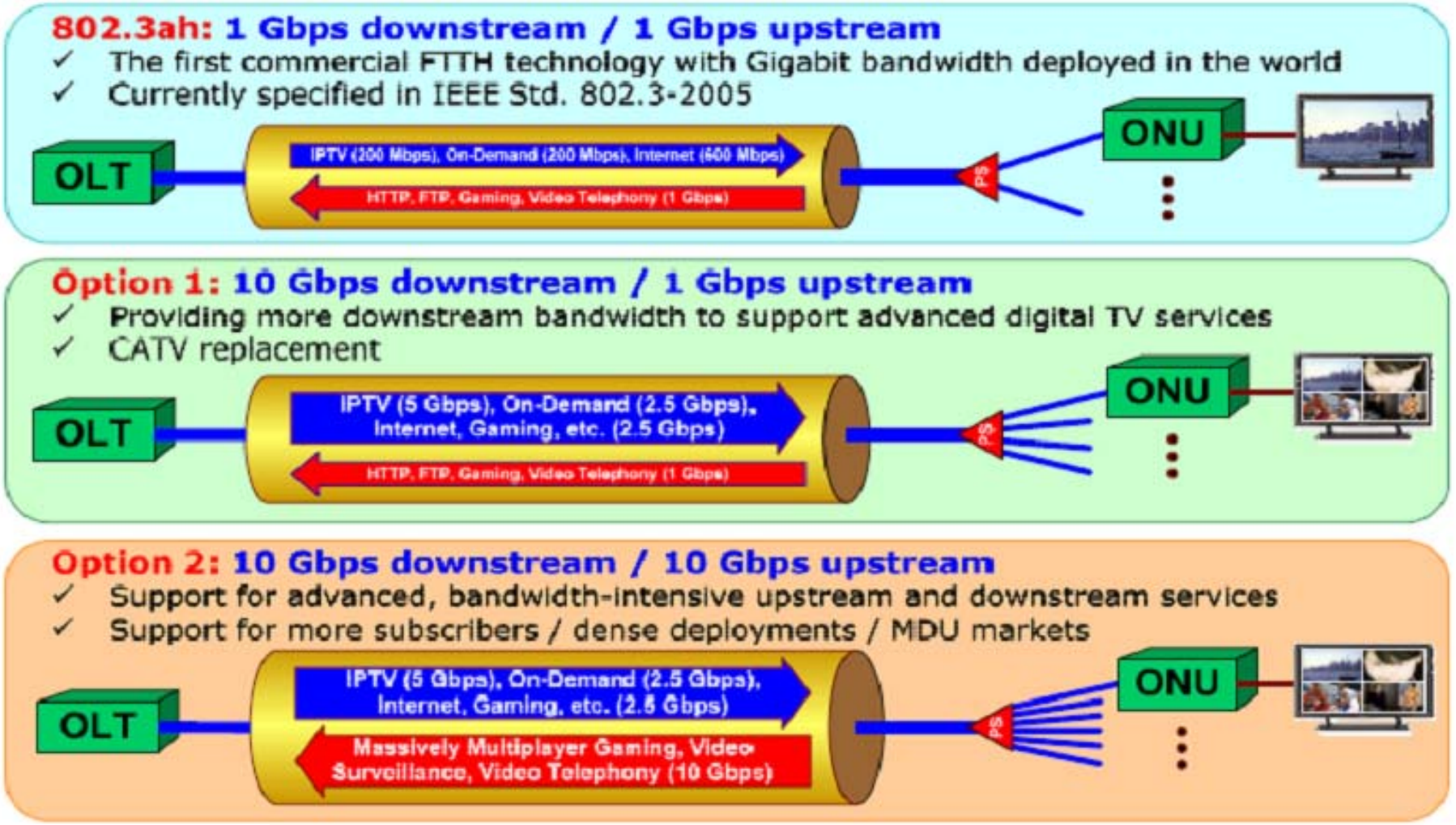

- Video overlay options at third lamda (1550nm).
- Interactive video service could drive BW for US.

802.3av task force

Broadband Drivers

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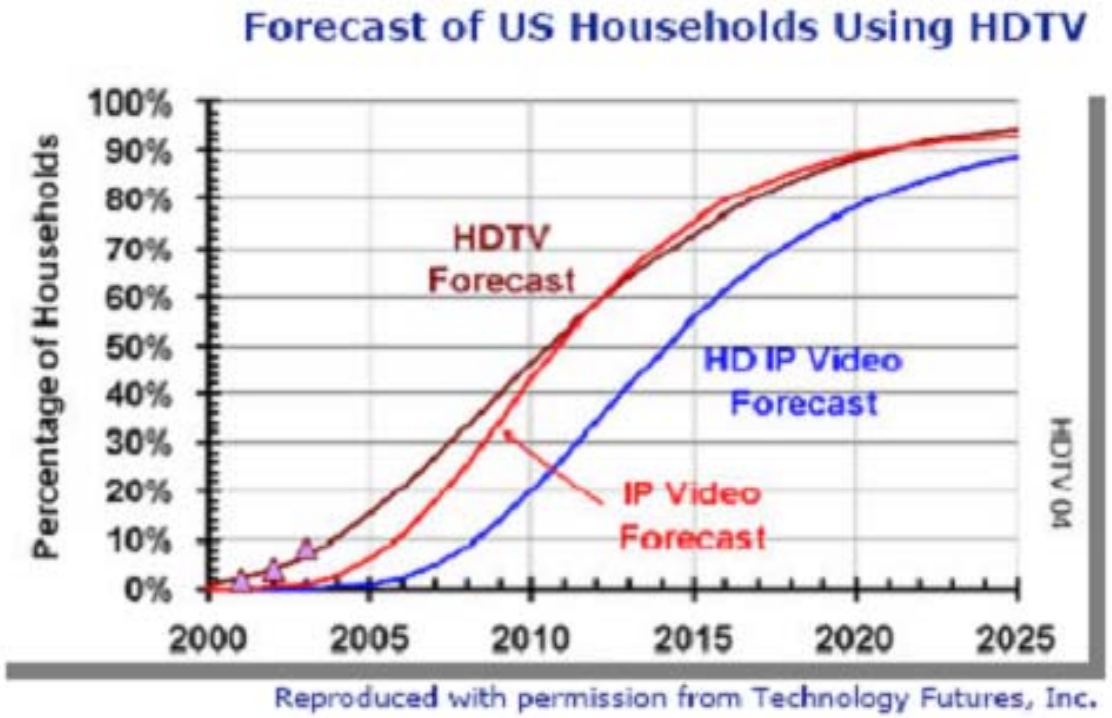
- Main Drivers
  - IP video services
  - Digital delivery of HD/IP TV
- Plus Other Drivers:
  - Gigabit-capable home networks
    - Digital TV
    - Digital home
  - MDU market
    - Resembles FTTC
    - Leverage cable access
  - 4th gen. mobile communication
    - Increased BW in access point



- 45%(90%) US homes using HDTV in 2010(2020)
- Support HDTV and other advanced video services
- Next generation wireless backhaul.

BW reqs in access will be reflected by traffic growth in backbone networks.

Advanced Video Services

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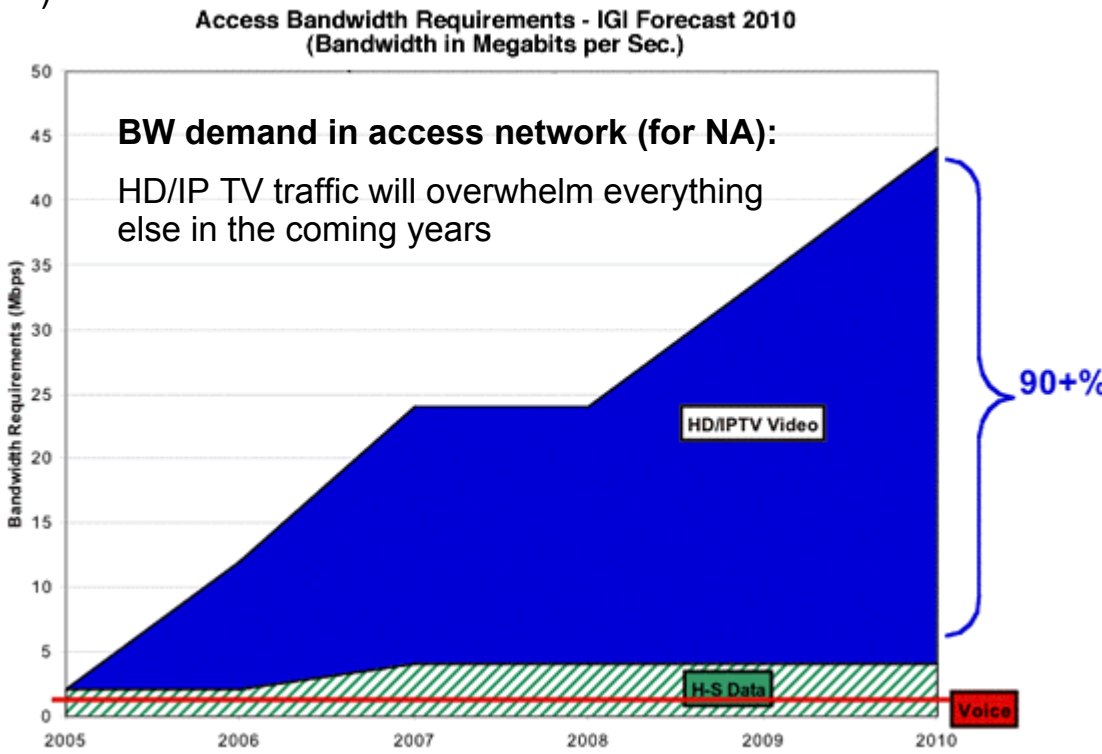
EPON driving up new BW-intensive services:

- **DVD-quality video (VoD)**
- **Peer-to-peer video sharing (interactive)**
- **IP broadcasting**
- Digital video surveillance
- Competitive real-time broadcast TV (100's channels)
  - MTV, ESPN etc.
- Video conferencing/telephony
- Distribute DVD content to in-home recorder via FTTH systems
- Online real-time gaming
- Remote data backup/restore
- Digital cinema/camera distribution
- **Sevices integrated through mobile phone**
  - VoD reservation, Stock/Sports, TV guides etc
- **Video+wireless phone (future?)**

- **Example: KDDI *"Hikari one"* FTTH services**
  - DVD-grade multicasting TV (~40ch., 50ch soon)
  - Video-on-demand (VoD) (~5000 programs)
  - High-grade IP telephony
  - Karaoke-on-demand service (~4500)
  - High-speed internet



Digital Home Television

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Service Offerings

Current Situation

- ✓ Broadcast
- ✓ Video-on-Demand

Near Future (2010)

- ✓ Time-shifted / narrowcast
- ✓ All-channel network-based personal video recorder
- ✓ Picture-in-picture / split screen
- ✓ Digital cinema distribution
- ✓ Personal multimedia publishing
- ✓ Residential and business digital video surveillance

Bandwidth Per Channel

×5~80

Current Situation

- ✓ **Standard Definition TV (SDTV)** 2 Mbps per channel

Near Future (2010)

- ✓ **High Definition TV (HDTV)** 10+ Mbps per channel
- ✓ **Large-Screen Digital Imagery (LSDI)** [standardized by ITU-T J.601] 40 or 160 Mbps per channel

Number of Channels

×10

Current Situation

- ✓ 30 ~ 100 channels

Near Future (2010)

- ✓ 1,000 or more channels

For now, AT&T will offer 200 channels though it expects to offer 1,000 or more channels when it expands the service to other markets in about six months. Its channel lineup already includes major networks as well as ESPN, HBO, the Discovery Channel, the Disney Channel, MTV, the History Channel, USA, CNN, National Geographic and others.

The Wall Street Journal
January 5, 2006

Access network bandwidth grow beyond 1 Gbps

MDU Market

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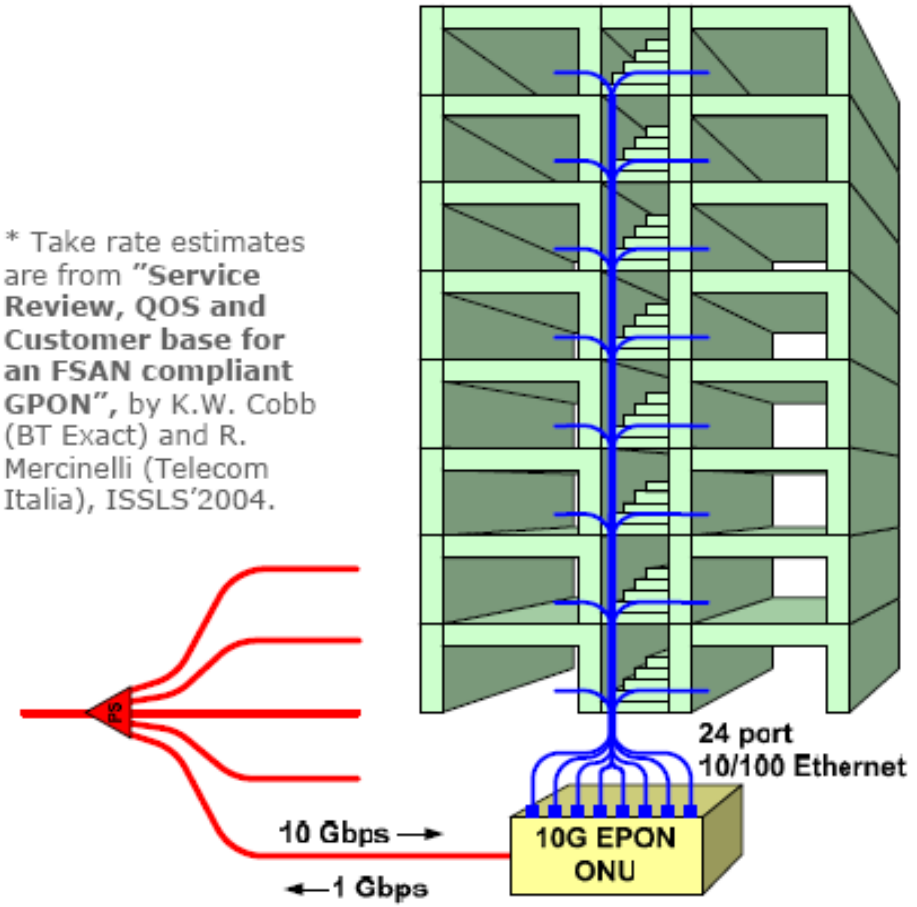
- A large fraction of Asian broadband users lives in Multiple Dwelling Units (MDUs)
- Each of 16 MDU ONUs can provide service to 24–48 subscribers, a total of 384-768 subscribers per EPON

Broadcast Video	100 channels x 10 Mbps/channel =	**1.0 Gbps**
Video on Demand	10 Mbps/channel x 2 channels/user x 24 users/ONU x 16 ONUs/PON x 30% active users*=	**2.304 Gbps**
Video Conferencing	10 Mbps/user x 24 users/ONU x 16 ONUs/PON x 30% active users =	**1.152 Gbps**
Internet	5 Mbps/user x 24 users/ONU x 16 ONUs/PON x 50% active users =	**1.92 Gbps**
Gaming	10 Mbps/user x 24 users/ONU x 16 ONUs/PON x 10% active users =	**0.384 Gbps**
	Required PON bandwidth =	**6.76 Gbps**

* Take rate estimates are from **"Service Review, QOS and Customer base for an FSAN compliant GPON"**, by K.W. Cobb (BT Exact) and R. Mercinelli (Telecom Italia), ISSLS'2004.



Wireless Back-haul

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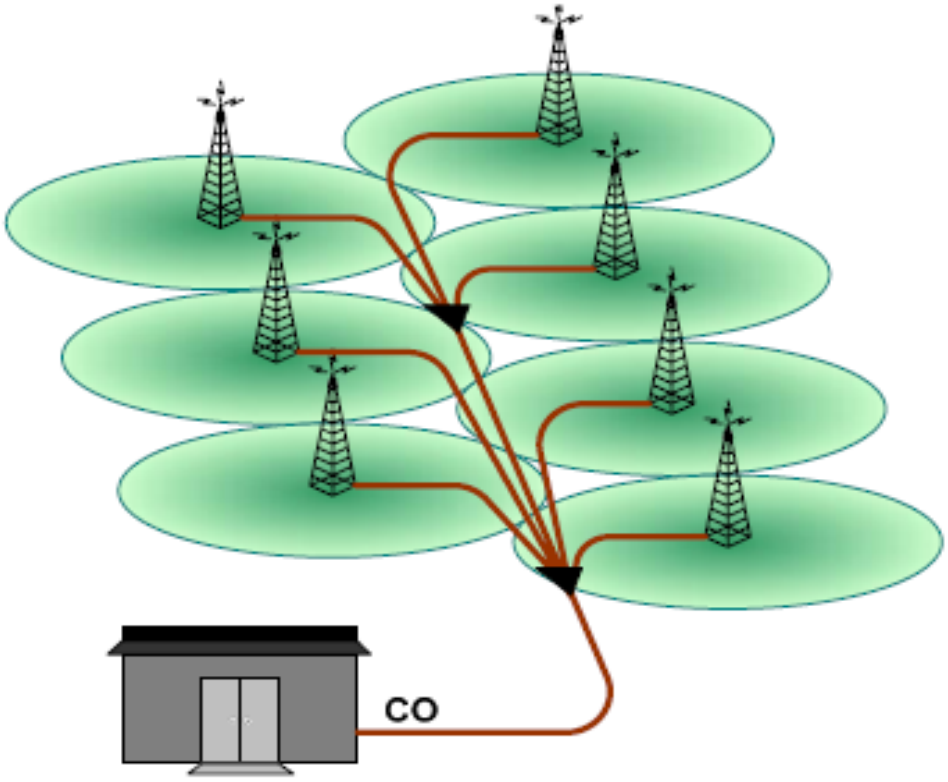
- 4th Gen mobile communication will be ubiquitous
  - Bandwidth: ~30Mbps/user, 100M~1Gbps/access point
  - Access point coverage will decrease
  - Number of access points will increase
  - EPON is a natural back-haul solution for the 4th Gen access points
- Next generation wireless back-haul
  - 802.11n: up to 100 Mbps per device
  - 802.16e: up to 70 Mbps per access point
- **Access bandwidth grow beyond 1 Gbps**



Fiber Access Drives Core Transport

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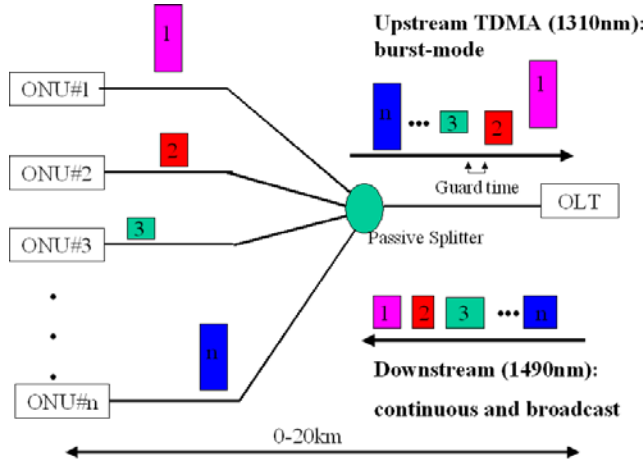
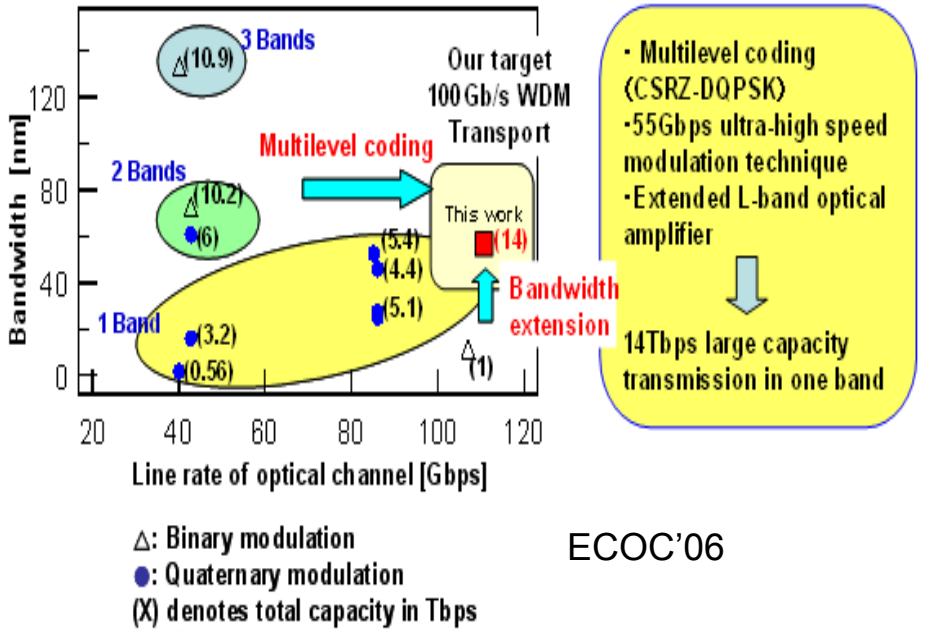
- PON reduces OPEX and CAPEX
  - Broad mfg base, equipment/optics costs decrease dramatically.
  - Accommodates large number of users (ONU) efficiently
  - Reduce footprint, fiber base, power dissipation and repairs
- Data traffic doubling every year due to rapid spread of fiber access, - driving core transport.
  - BW glut finally ends in core/carrier transport
  - Fiber access placed NTT current 1Tb/s backbone under strain to 10Tb/s, planned "hero" 14Tb/s exp:
    - 160km 140x111Gb/s (CSRZ-DQPSK) WDM transport.
  - AT&T announced to upgrade backbone by 2010
    - 1-yr-old 80x40G DWDM already 25% full.





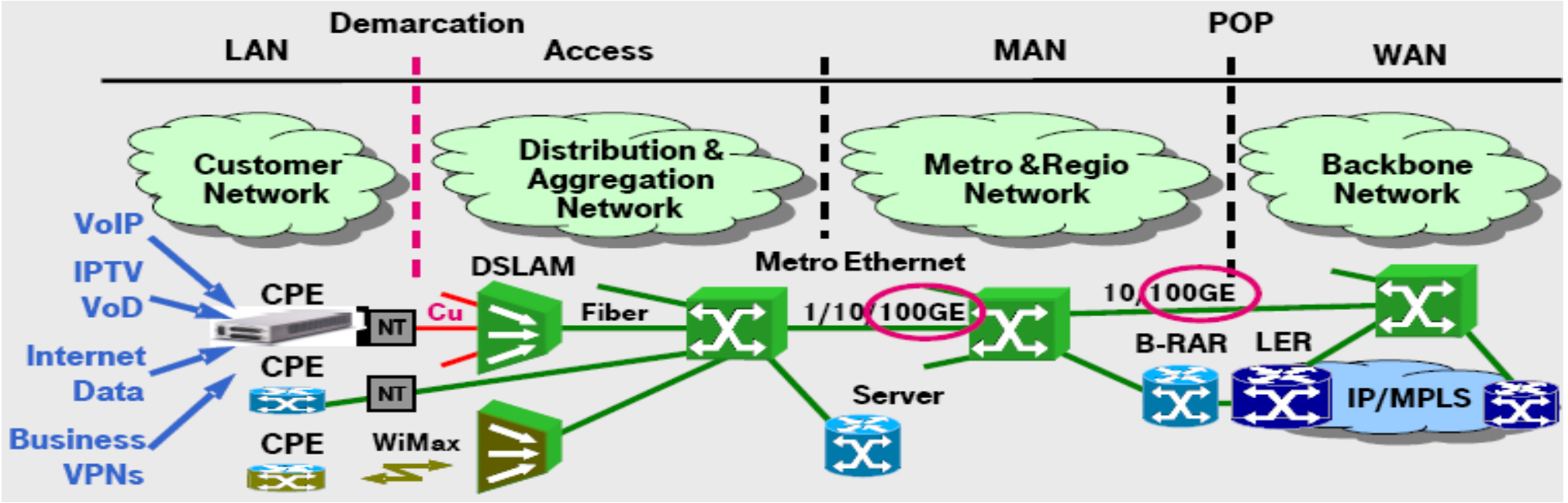
ECOC'06

http://www.ntt.co.jp/news/news06e/0609/060929a.html

Fiber Access Drives Core Transport

VITESSE

- Video and multimedia apps/services driving bandwidth demand
  - Advanced IP video services, HD/IP TV growth
  - Gigabit-capable home networks, 4th gen. wireless back haul, MDU market.
- Core Transports in MAN and WAN face huge bandwidth challenges across all networks – wireline, wireless, and cable.
  - 100GbE in Multi-domain Carrier Grade Ethernet Networking



http://www.ieee802.org/3/hssg/public/jan07/braun_01_0107.pdf