Market- versus Technology-Driven R&D in Optical Communications Industry

Winston I. Way, ***April 23, 2008***

OUTLINE

- Bandwidth drivers and market trend
- Telecom R&D environment change since ATT divestiture in 1984
- R&D in optical fiber communications industry
- R&D for niche versus volume products
- Implications to Taiwan’s optical fiber R&D

Bandwidth Explosion and Market Trend

Why more bandwidth?

Fundamental bottlenecks are happening everywhere

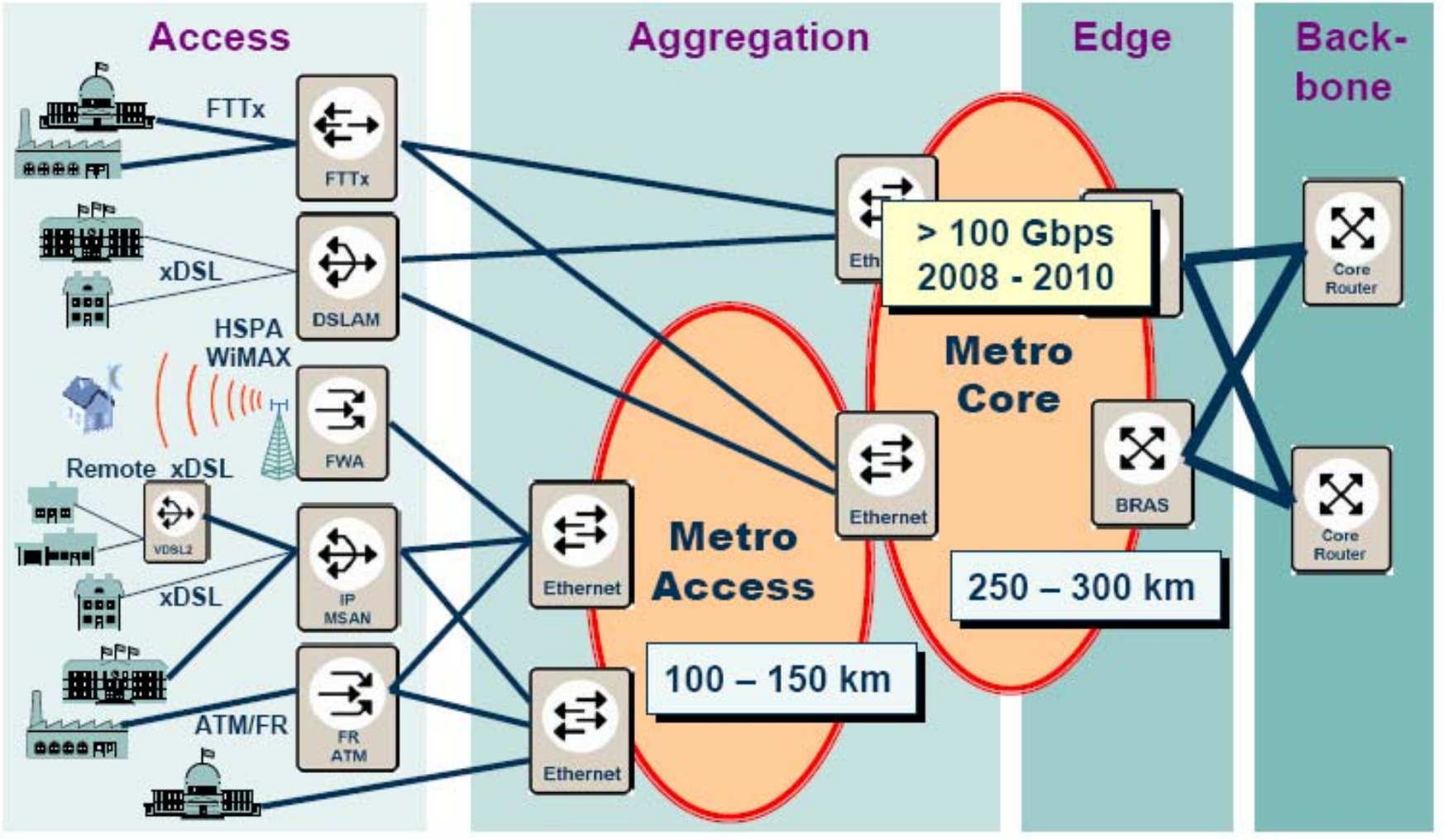
Increased # of users	+	Increased access rates and methods	+	Increased services	=	Bandwidth explosion everywhere
As demonstrated by the number of ISPs: Comcast, AOL, YahooBB, NTT, Cox, EasyNet, Rogers, BT, ...		EFM, xDSL, WiMax, xPON, Cable, WiFi, 3G/4G...		YouTube, BitTorrent, VOD, Facebook, Kazaa, Netflix, iTunes, 2nd life, Gaming...		

HDTV

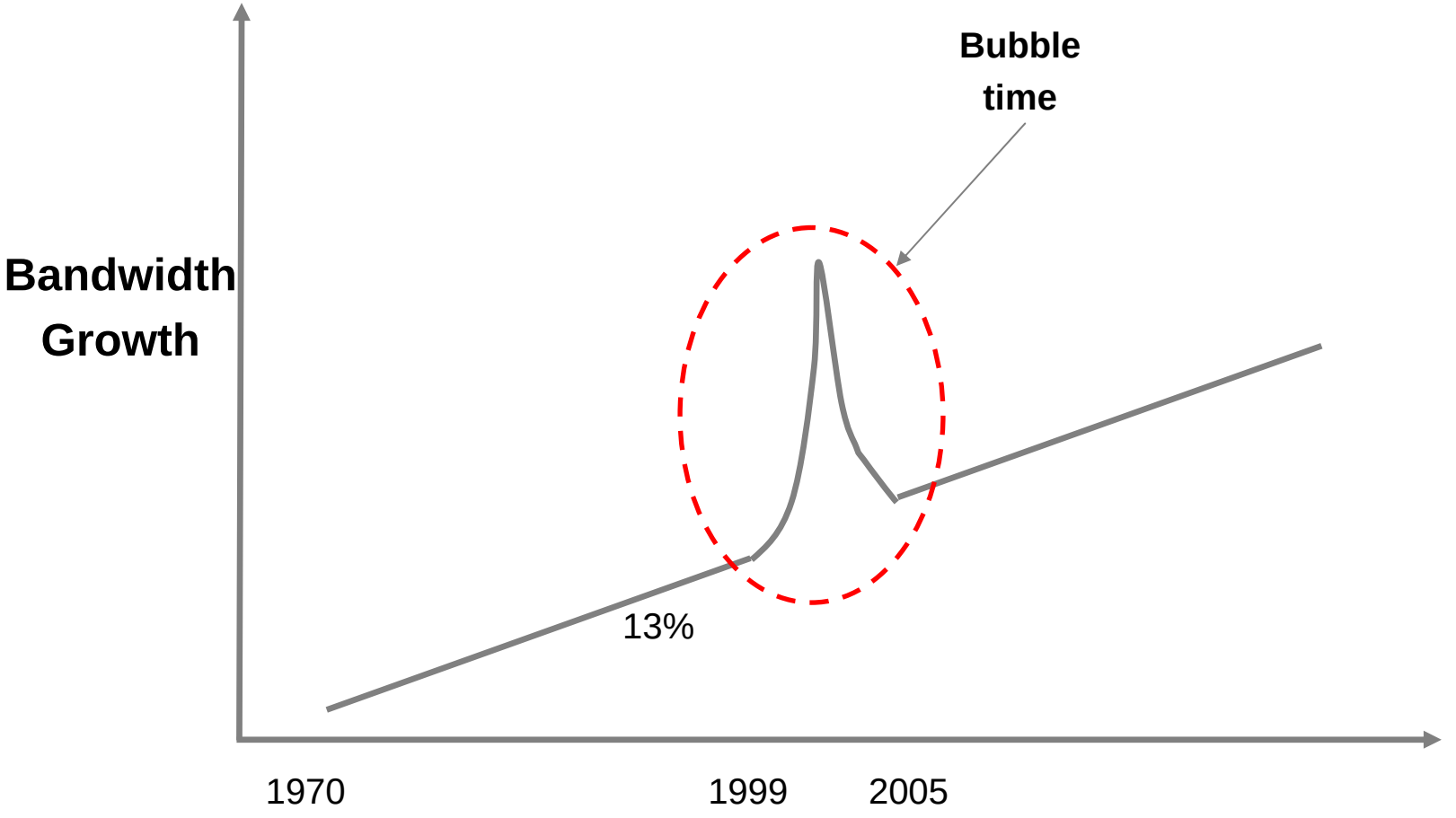
IPTV

(IEEE802.3ba)

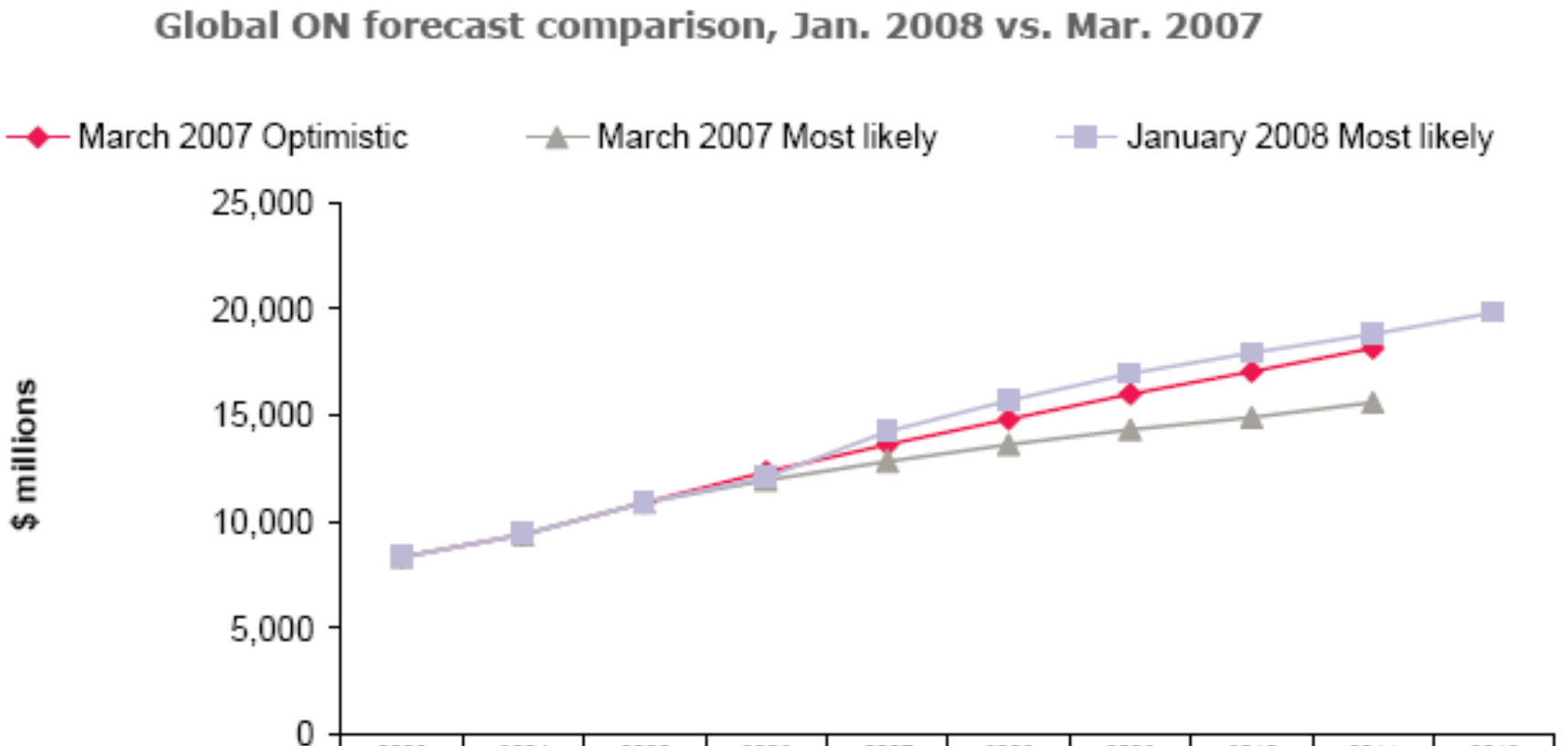
Broadband Networks: Reference Architecture



Steady Bandwidth Growth



Global Optical Network Forecast



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
March 2007 Optimistic	$8,355	$9,429	$10,881	$12,375	$13,623	$14,848	$16,018	$17,014	$18,093	
March 2007 Most likely	$8,355	$9,429	$10,881	$11,949	$12,808	$13,624	$14,349	$14,933	$15,559	
January 2008 Most likely	$8,355	$9,429	$10,842	$12,033	$14,217	$15,716	$16,923	$17,901	$18,841	$19,762

Source: Ovum RHK

Global Annual Carrier Capex: Wireline vs Wireless

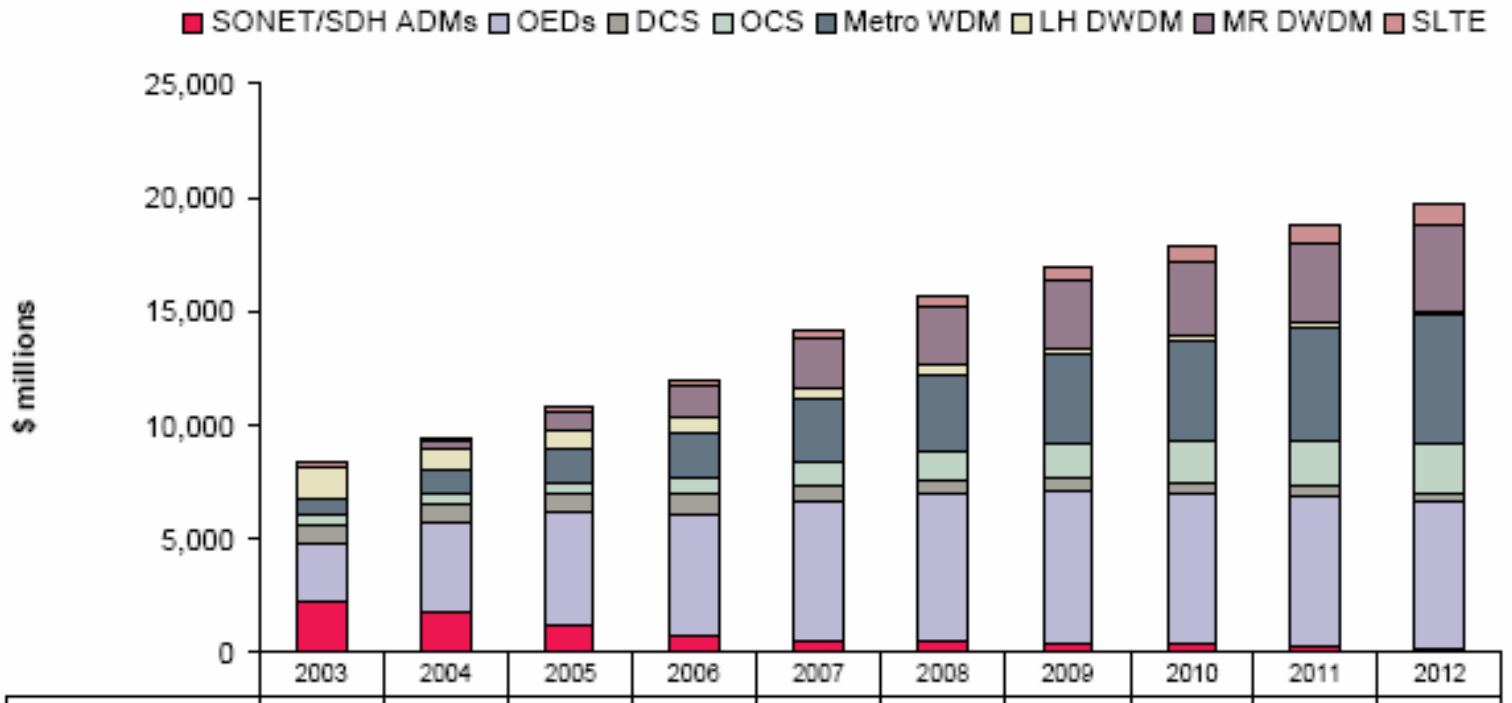
$USD Millions

	2004	2005	2006	2007	2008E
Global Wireline Capex	56,836	62,933	73,523	90,369	91,833
Y/Y Growth	13.1%	10.7%	16.9%	22.9%	1.6%
Global Wireless Capex	55,554	67,399	79,916	91,529	95,871
Y/Y Growth	26.4%	21.3%	18.4%	14.7%	4.7%

(Source: Credit Suisse)

Global ON Forecast by Product Group

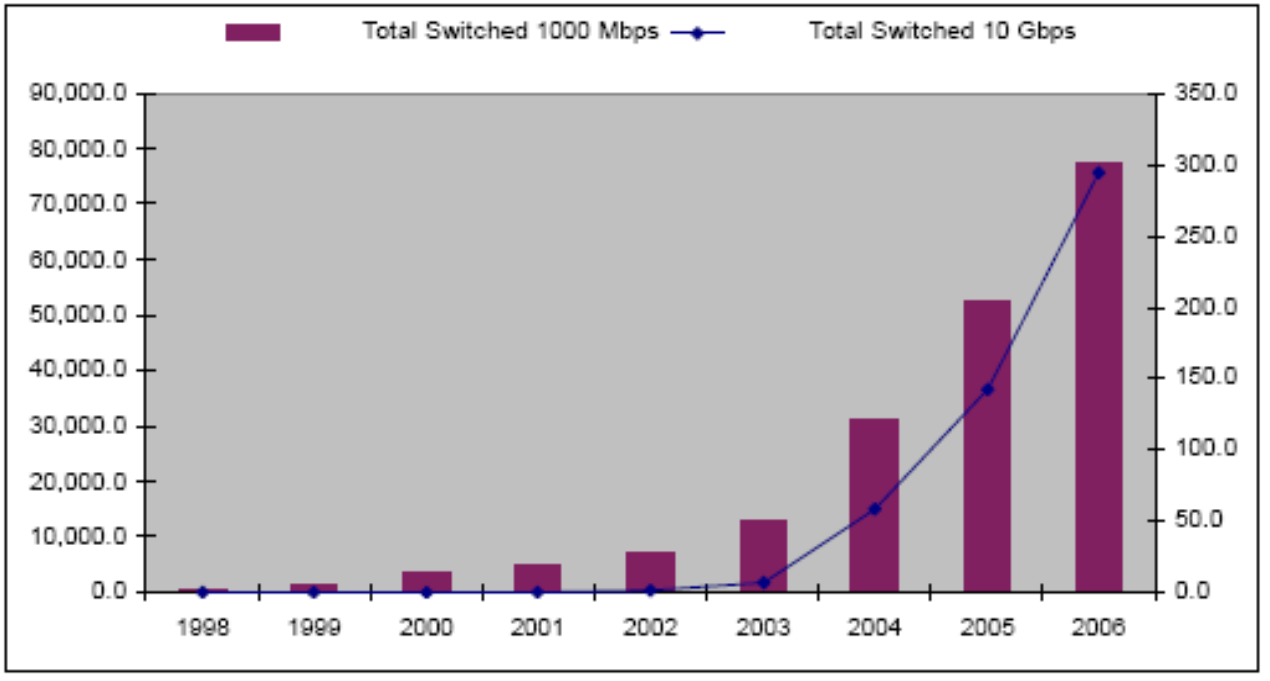
Figure 4 **Global ON forecast by product group, 2003–12**



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
SLTE	$236	$154	$322	$255	$398	$517	$621	$745	$875	$1,007
MR DWDM	$44	$340	$787	$1,510	$2,136	$2,540	$2,877	$3,179	$3,484	$3,812
LH DWDM	$1,263	$918	$818	$615	$574	$465	$377	$254	$179	$100
Metro WDM	$738	$1,065	$1,424	$1,973	$2,798	$3,361	$3,919	$4,512	$5,066	$5,709
OCS	$430	$451	$573	$710	$1,029	$1,239	$1,462	$1,689	$1,896	$2,095
DCS	$786	$800	$777	$931	$663	$607	$579	$527	$488	$452
OEDs	$2,692	$3,899	$4,907	$5,307	$6,090	$6,465	$6,662	$6,648	$6,593	$6,419
SONET/SDH ADMs	$2,165	$1,803	$1,234	$732	$529	$521	$426	$347	$260	$167

Source: Ovum RHK

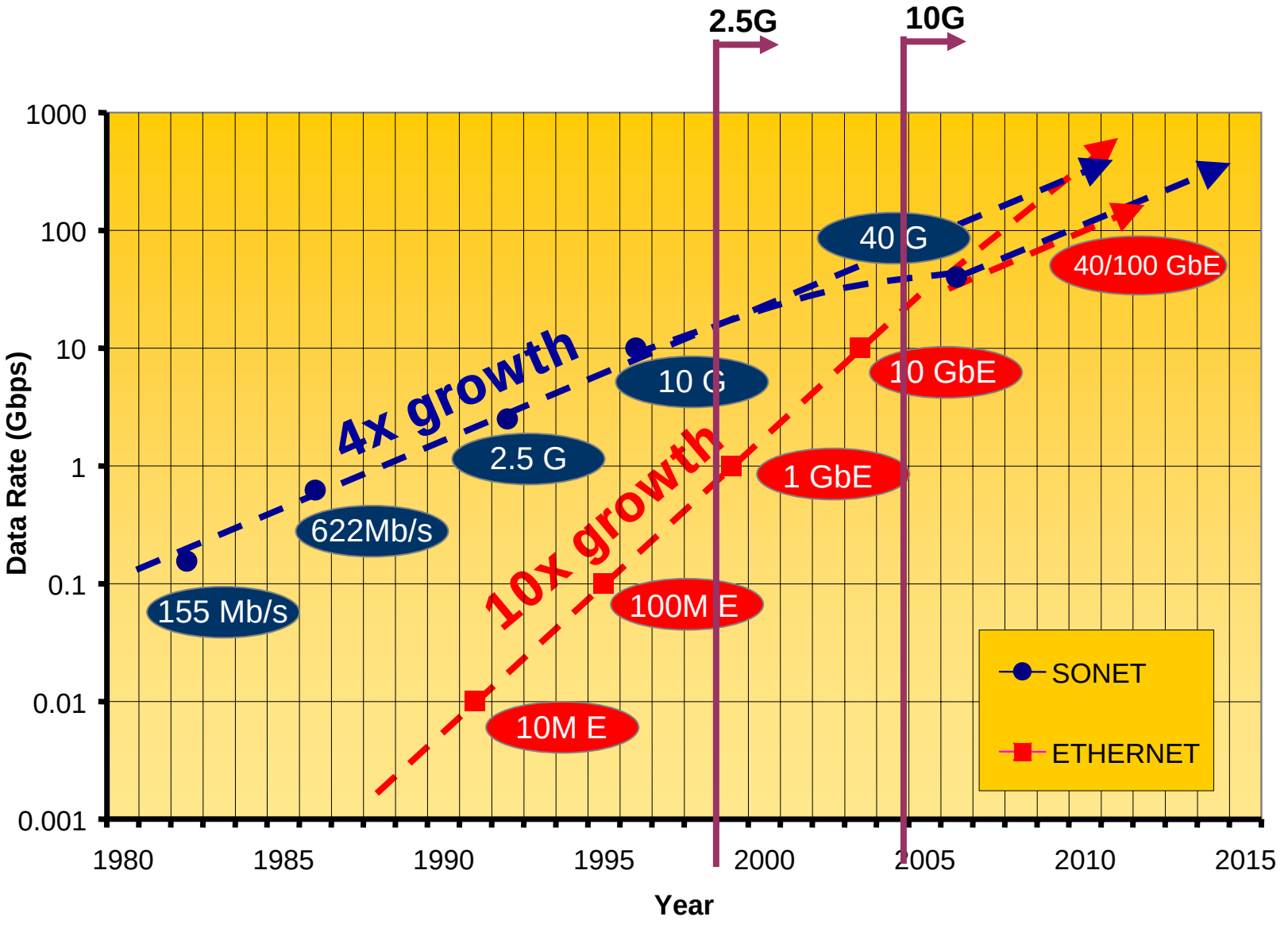
10GbE and 1GbE Ports Growth



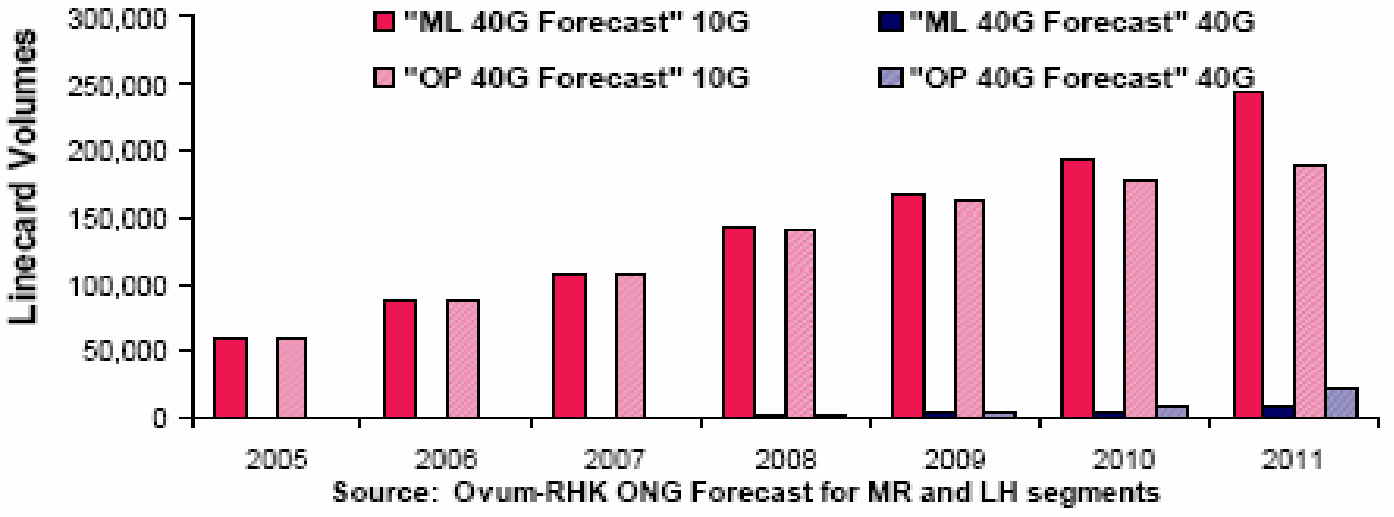
Source: Cisco (barbieri_01_0107.pdf)

- **Between 2003 and 2006, GbE growth and 10GE growth were correlated. Symbiotic relationship.**
- **2007: 10GE growth being constrained by lack of higher speed interface (Sources: Sprint, Yahoo, EDS, Amazon, AMS-IX, Cox, NTT, Equinox)**

Ethernet & SONET/SDH Line-Rate Growth



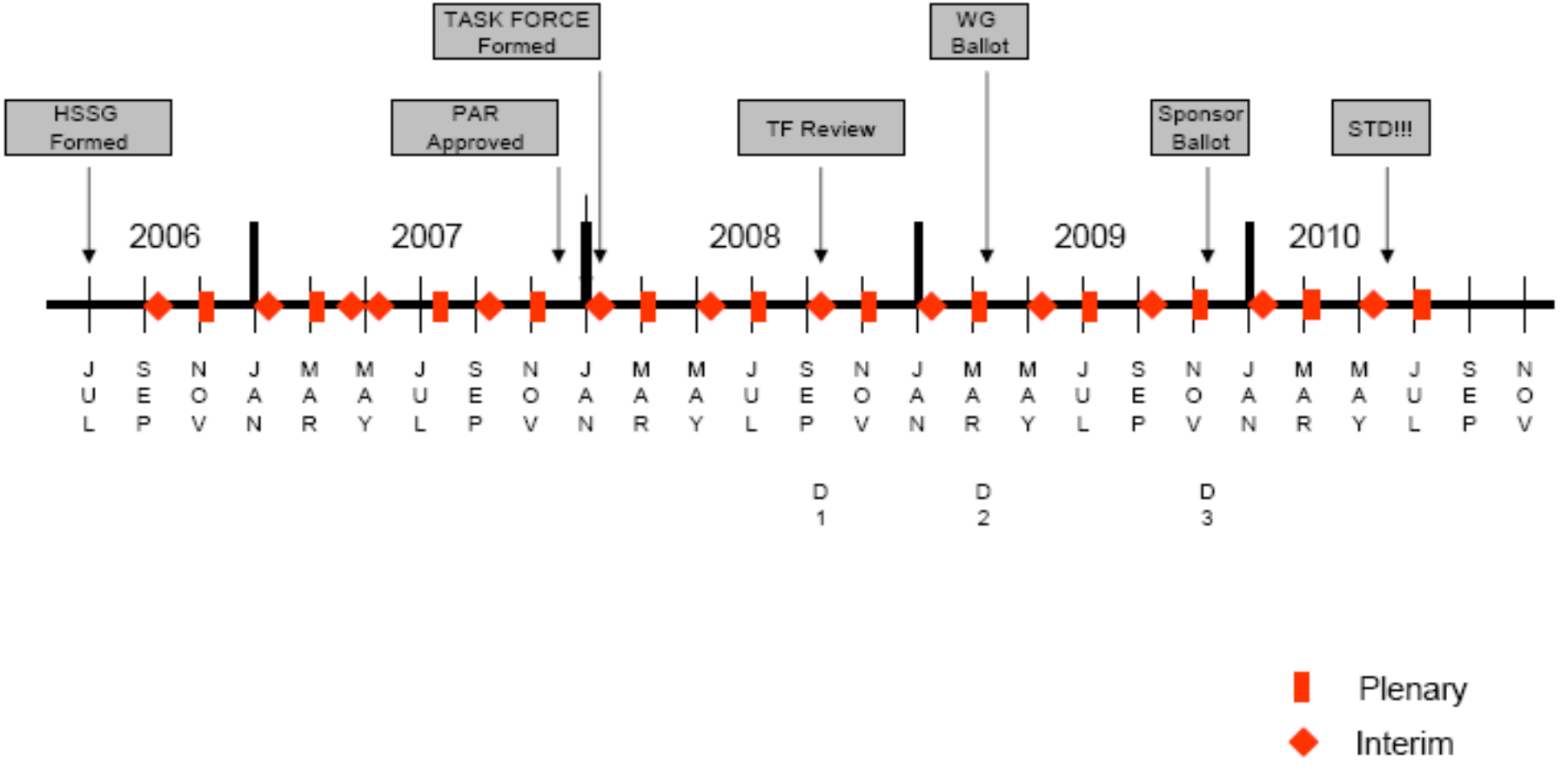
10G and 40G Linecard forecasts



Source: Ovum-RHK ONG Forecast for MR and LH segments

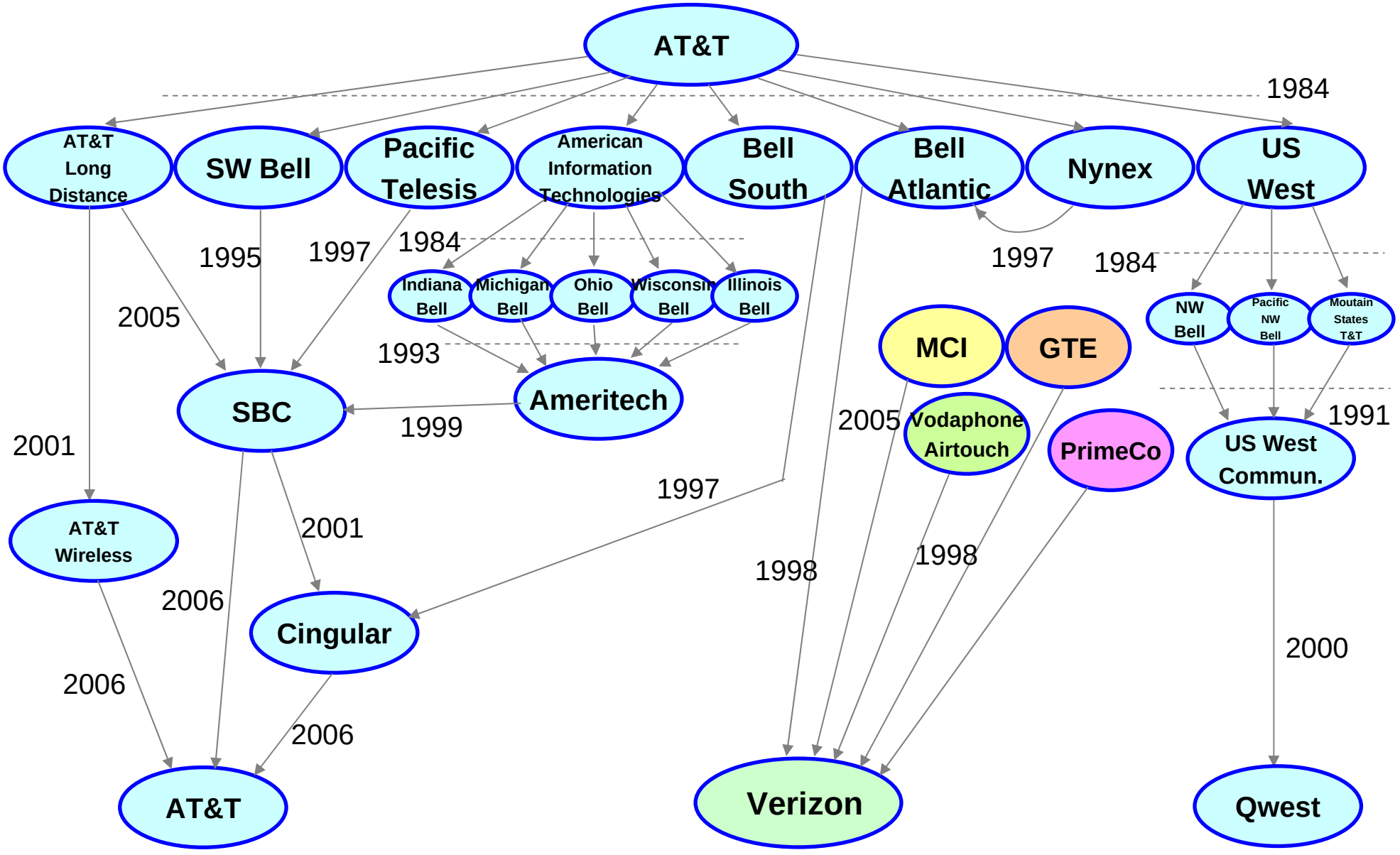
- Most likely: 40G does not achieve 2.5x price benchmark 10G across the full ULH range of distances and fiber types by end of forecast period
- Optimistic: Technology barriers including PMD are resolved, starts 40G on the path to overtake 10G

100GbE and 40GbE standard (IEEE 802.3ba) will be completed by mid-2010



R&D Environment Change Since AT&T Divestiture

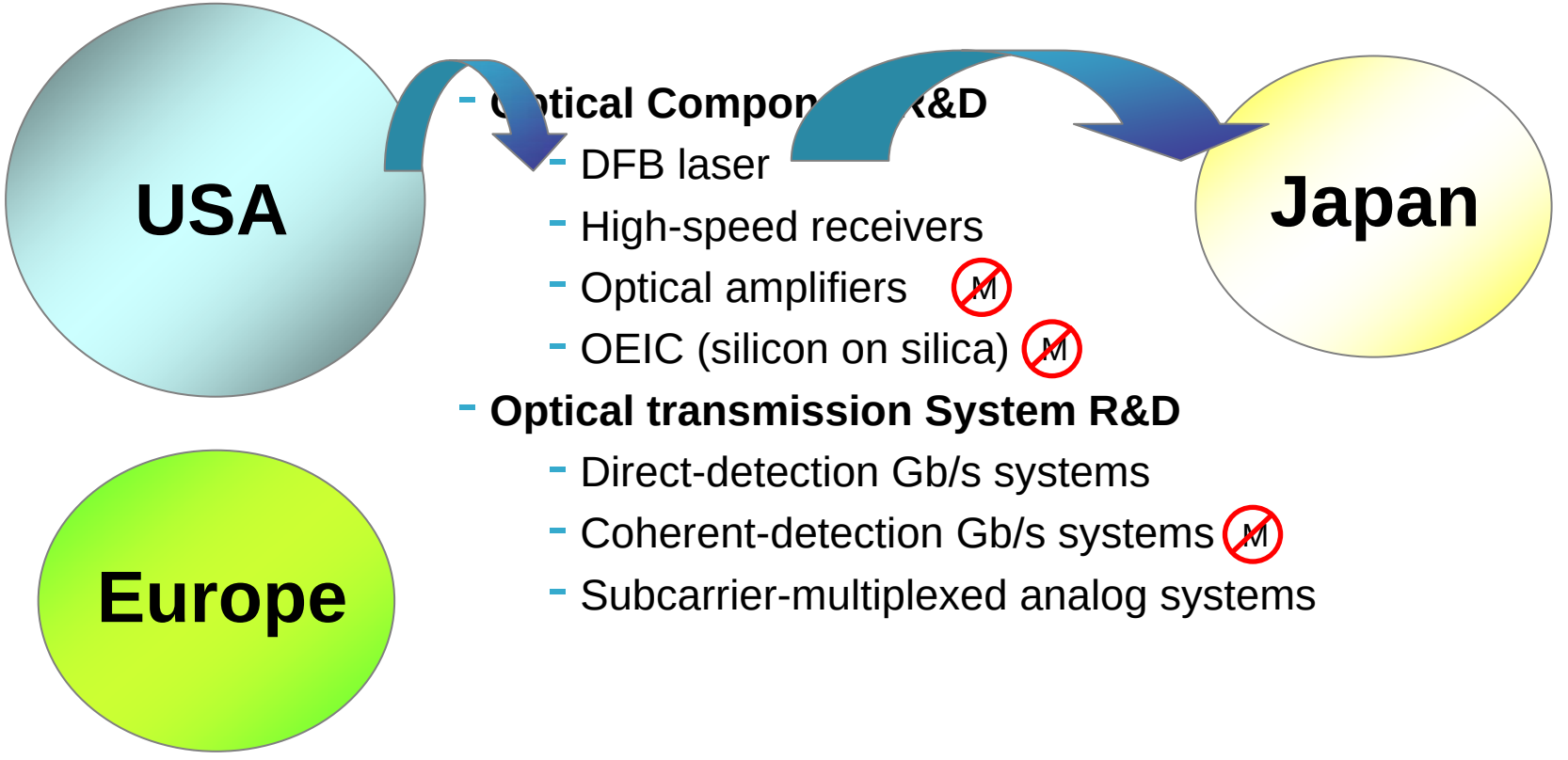
Telecom infrastructure change since Bell System divestiture in 1984



1984 ~ 1990

Technology-Driven R&D

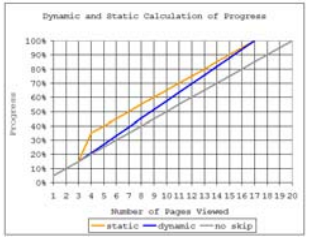
Engineering-Driven R&D



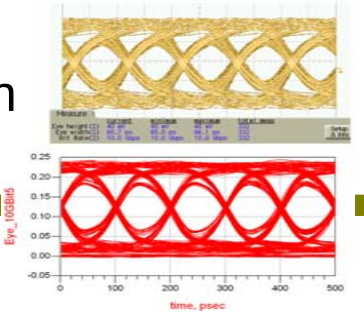
- **Optical Compon R&D**
  - DFB laser
  - High-speed receivers
  - Optical amplifiers M
  - OEIC (silicon on silica) M
- **Optical transmission System R&D**
  - Direct-detection Gb/s systems
  - Coherent-detection Gb/s systems M
  - Subcarrier-multiplexed analog systems

R&D Mindset (1984~1990)

Calculation



Simulation

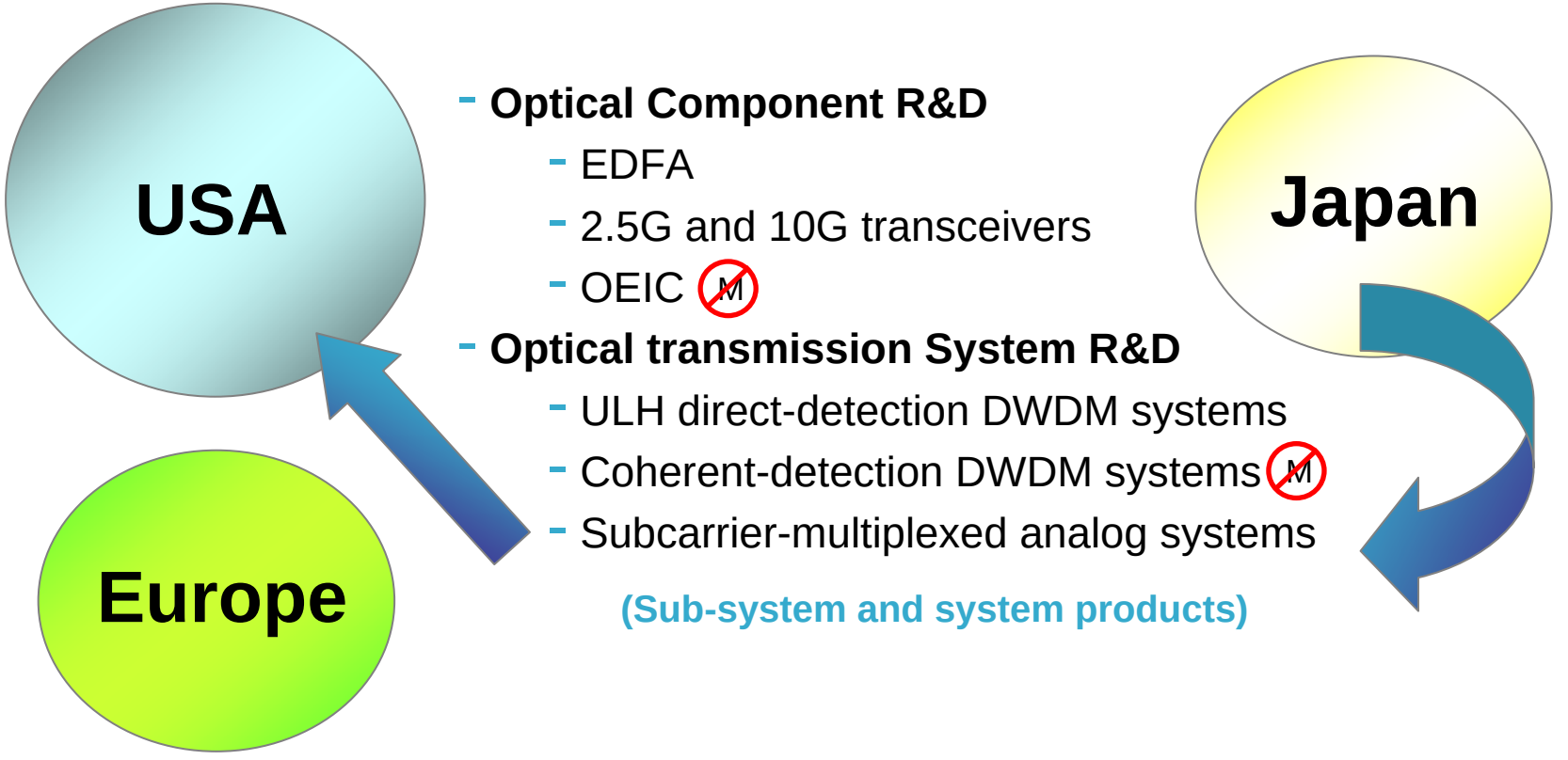


Experiment

1990 ~ 1999 (I)

Market-Driven R&D

Engineering-Driven R&D



- **Optical Component R&D**
  - EDFA
  - 2.5G and 10G transceivers
  - OEIC ~~M~~
- **Optical transmission System R&D**
  - ULH direct-detection DWDM systems
  - Coherent-detection DWDM systems ~~M~~
  - Subcarrier-multiplexed analog systems

(Sub-system and system products)

1990 ~ 1999 (II)

Market-Driven R&D

Engineering-Driven R&D

USA

Europe

Japan

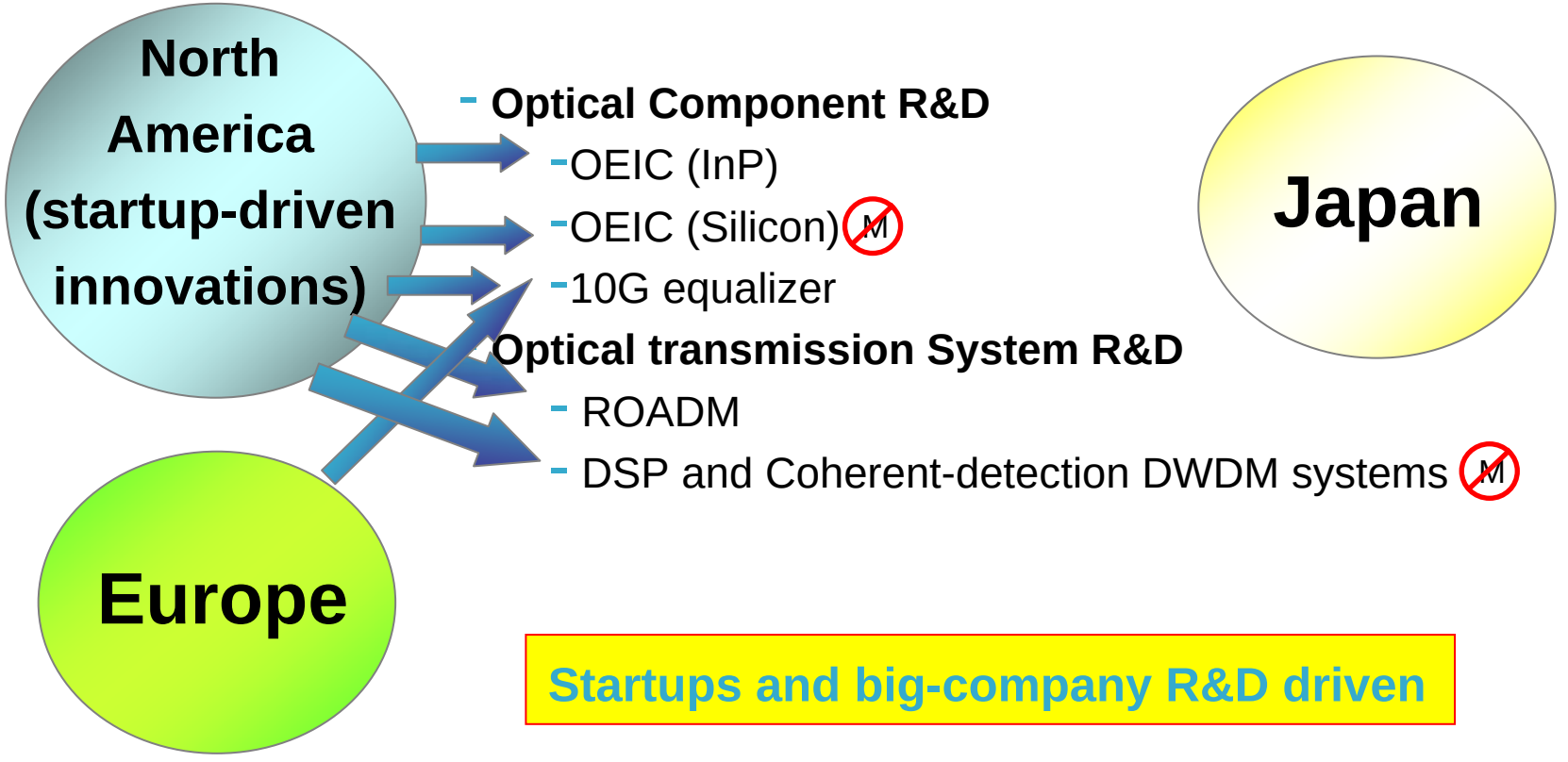
- **Optical Component R&D**
  - EDFA
  - 2.5G and 10G transceivers
  - OEIC (M)
- **Optical transmission System R&D**
  - ULH direct-detection DWDM systems
  - Coherent-detection DWDM systems (M)
  - Subcarrier-multiplexed analog systems

CIENA **Corvis**

2000 ~ present

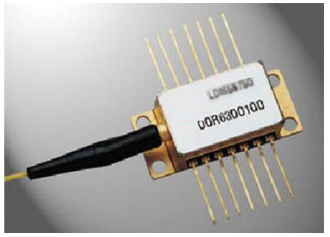
Market-Driven R&D

Engineering-Driven R&D



Startups and big-company R&D driven

Examples due to R&D attitude change



DFB laser

Tunable laser

3 US companies
1 European company
0 Japanese company

OADM

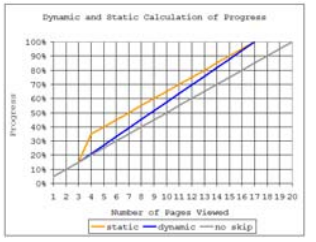
ROADM

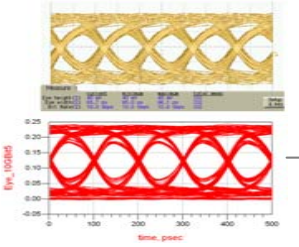
7 US companies
0 European company
1 Japanese company

ROI-Justifiable R&D: Innovation + Business Sense

18 months ~ 2 years

New to the World?	Entire new market
New product lines?	Allows a company to enter an established market
Additions to existing products	Supplement a company's established product line
Improvement/ Revision/ Cost-down	Improved performance. Greater perceived value. Cost reduction.
Re-positioning	Targeting new markets





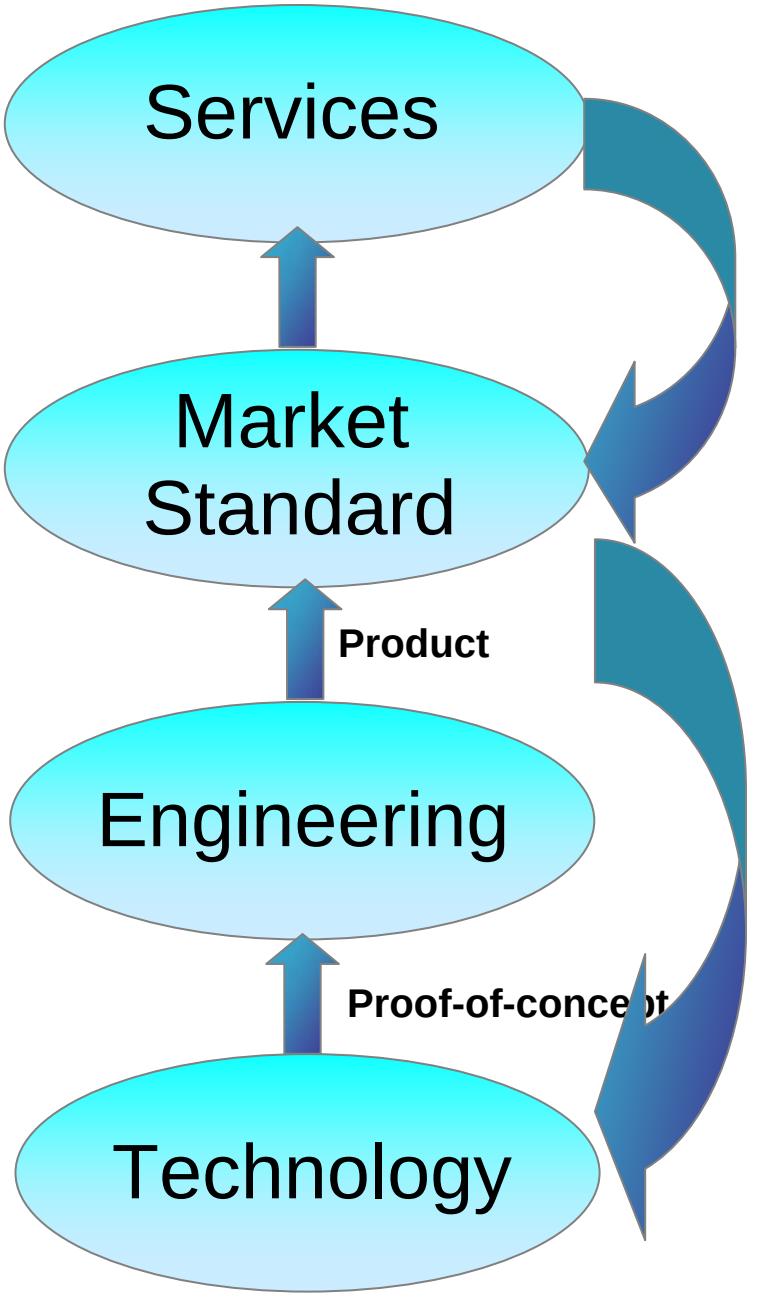
Product

A cycle from technology to services

YouTube, MySpace, SecondLife, eBay, Amazon, etc.

Metro, LH Broadband access

DWDM, Ethernet, ROADM, Switch/router, etc.



OPVISTA

Expertise and Talents Required

- **Market-driven telecom R&D**
  - Creativity in bandwidth-demanding services
  - Innovation in operational flexibility and efficiency (tunable laser, ROADM, etc.)
  - Innovation in user interface and user friendliness
  - Sensitivity to market trends
  - Flat organization (i.e., start-ups)
- **Engineering-driven telecom R&D**
  - Follow standards
  - Step-by-step qualification procedure
  - Engineering Discipline
- **Technology-driven telecom R&D**
  - Rigorous theoretical and experimental verification
  - Physical insights

Standard-Body Driven R&D

Volume Driven R&D

Example I: Optical transceiver modules

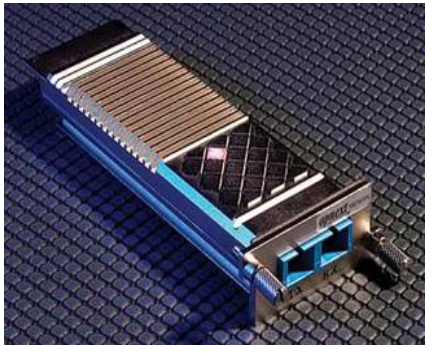
Price War…

SFP

XFP

SFP+

XFP-E



300pin SFF MSA

300pin MSA

300pin 40G

Example II: PON ONU and OLT modules

- **GPON/GEPON → 10G PON → WPON**
- **SONET/SDH → GbE/10GbE → 100GbE**

Implications to Taiwan's Optical Fiber R&D

- **Current status**
  - Mainly OEM manufacturing
- **Future**
  - Niche R&D innovation to create values
- **Standard-body driven R&D**
  - FTTH/FTTC
- **Front-end & academic R&D**
  - Teaming up with a common goal (sharing resources)
  - Take advantage of the strength of Taiwan→ IC → OEIC based on Silicon technology
  - DSP-based "soft" optical fiber systems
    - ADC, DAC, DSP

Thank You!