

Broadband Access: Issues and Trends

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Optical Transmission Systems and Equipment for WDM Networking IV
Conference 6012, Optics East 2005, Boston, October 24-26, 2005

These Slides are available at

<http://www.cse.wustl.edu/~jain/talks/oe05.htm>



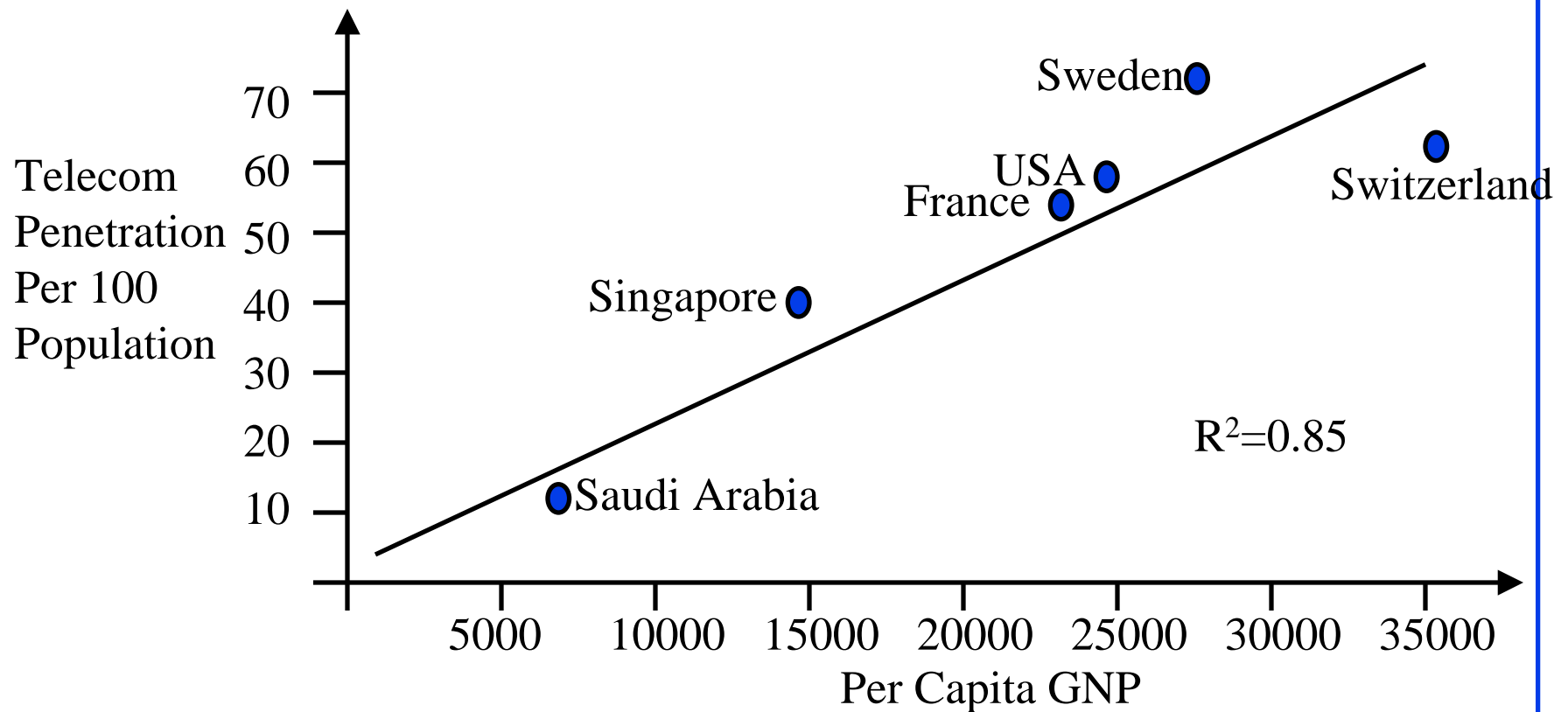


1. Top 10 Networking Developments of 2004-05
2. Access Networks
3. GPON vs EPON
4. Access Related Technologies
5. Mobility and Wireless Access

Top 10 Networking Developments of 2004-05

1. Security is most important: All packets go through deep inspections
⇒ Throughput limited by packet inspection, Firewalls, Spam filters
2. Wireless (WiFi) is spreading (Intel Centrino)
3. More Cell phones than POTS.
Smart Cell phones w PDA, email, video, images ⇒ Mobility
4. Broadband Access is growing faster than cell phones
Fiber is creeping towards home
5. Ethernet extending from Enterprise to Access to Metro ...
6. Wiring more expensive than equipment ⇒ Wireless Access
7. Voice over Internet Protocol (VOIP) is in the Mainstream
8. Multi-service IP: Voice, Video, and Data
9. Terabyte/Petabyte storage (Not VoD) ⇒ High-Speed Networking
10. Internet is less about communication and more for information retrieval

Telecom and Economic Development



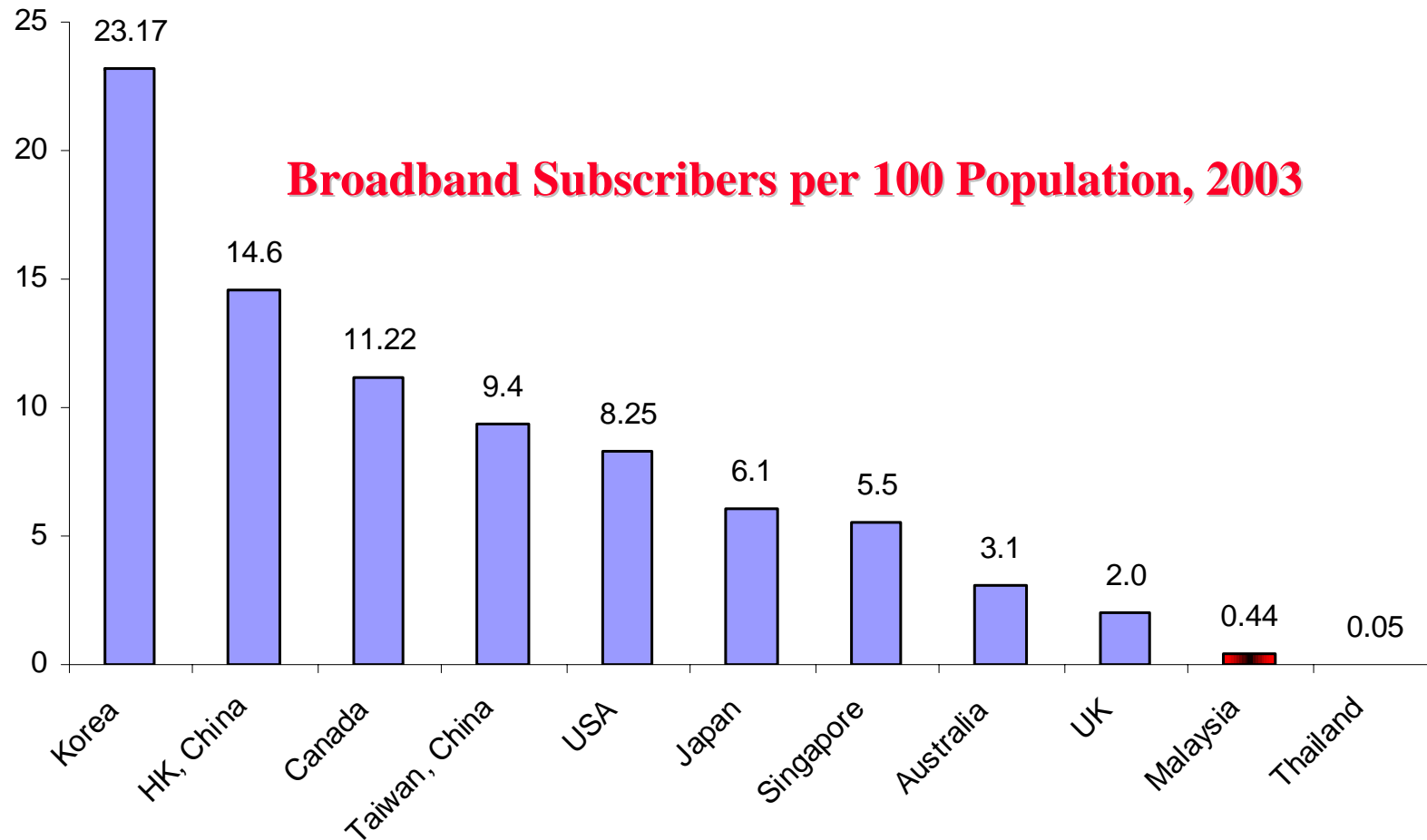
- Fundamental correlation between GDP growth and teledensity

Access Networks

- ❑ 63.84 M DSL subscribers worldwide. 2003 growth rate of 77.8% is more than the peak growth rate of cellular phones.
- ❑ By Q3'04, 19M Cable Modems, 12M DSL in USA [Leichtman Research]
- ❑ All countries are racing to a leadership position in broadband
- ❑ Digital-Divide \Rightarrow 30M subs@10Mbps, 10M@100Mbps in Japan by 2005
- ❑ Telecom epicenter has moved from NA+Europe to Asia Pacific

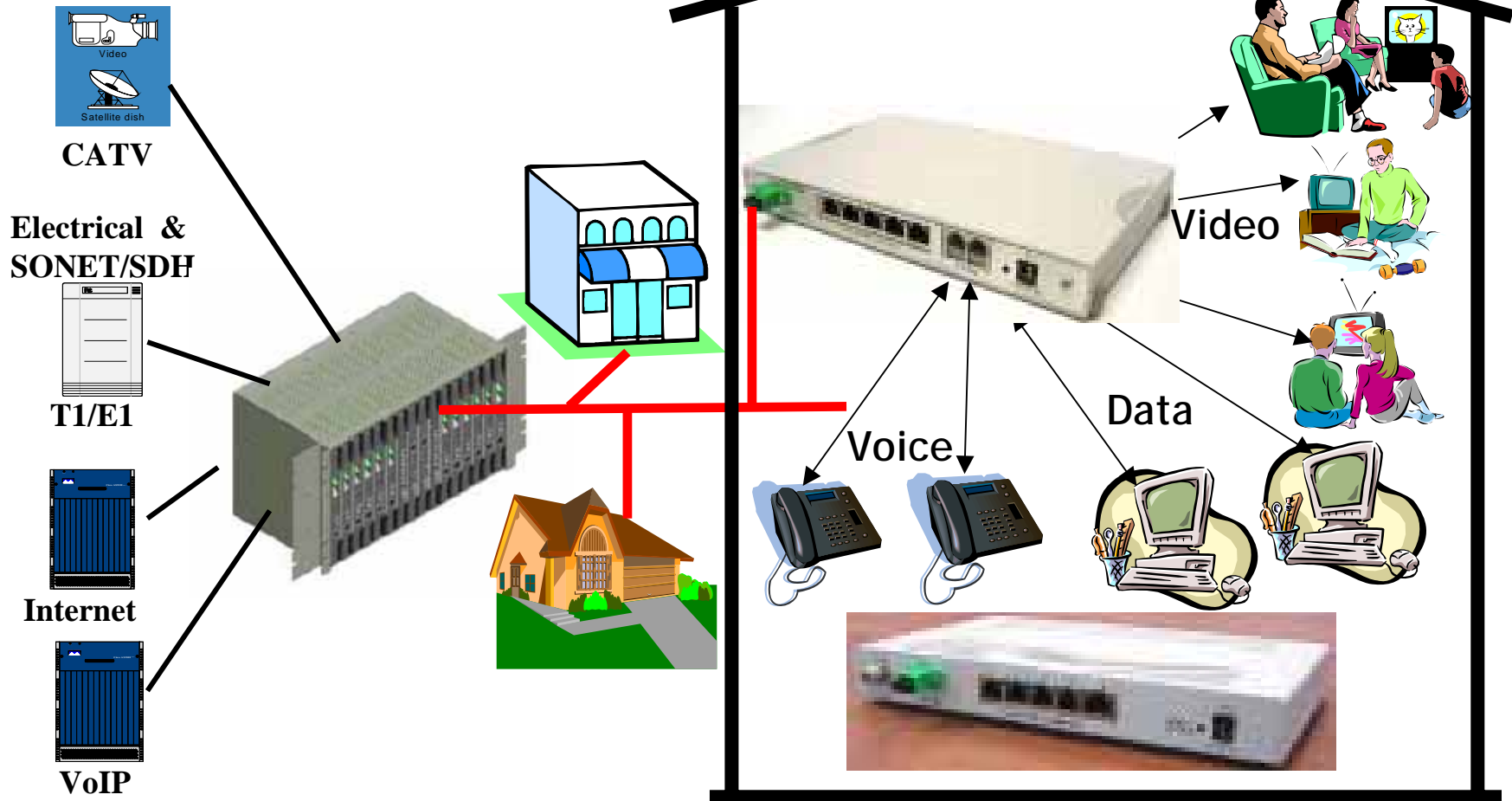
Rank	Country	DSL per 100 Phones	Rank	Country	DSL per 100 Phones
1	South Korea	28.3	6	Israel	14.5
2	Taiwan	19.8	7	Denmark	14.2
3	Belgium	16.7	8	Finland	13.6
4	Hong Kong	16.1	9	Singapore	13.4
5	Japan	15.7	10	France	12.1
			32	USA	5.6

Broadband Subscribers

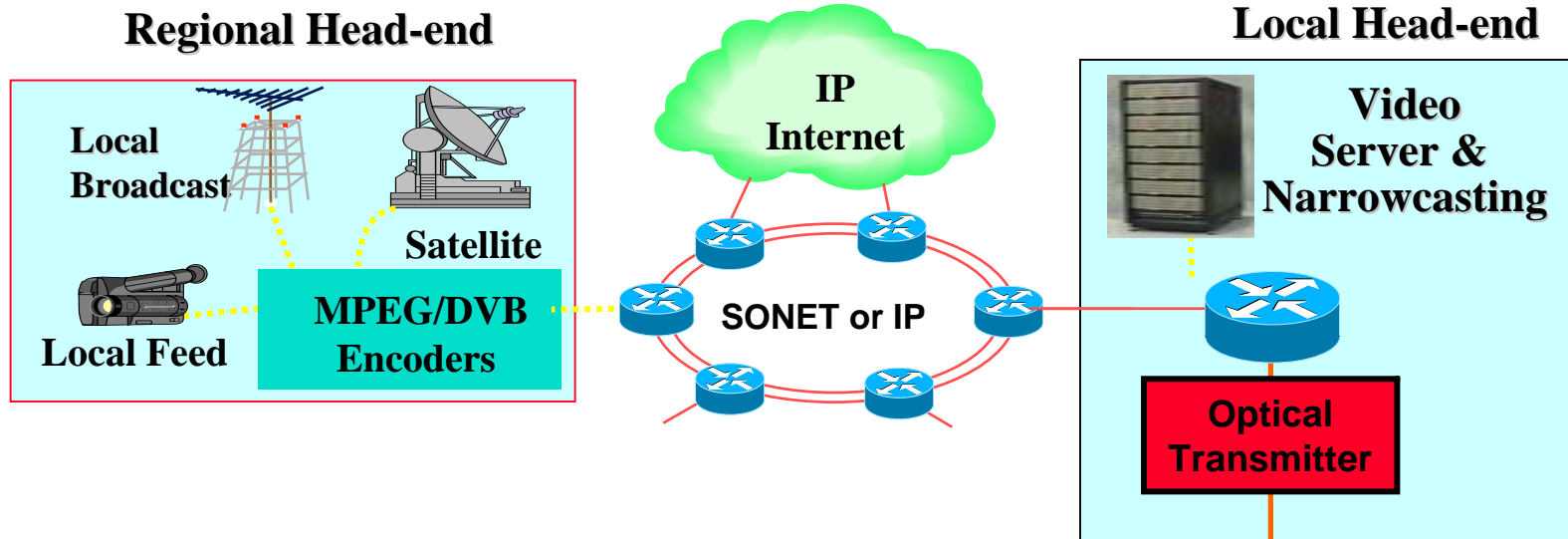


Source : ITU 2003 / Analysis

Ethernet to the First Mile (EFM)

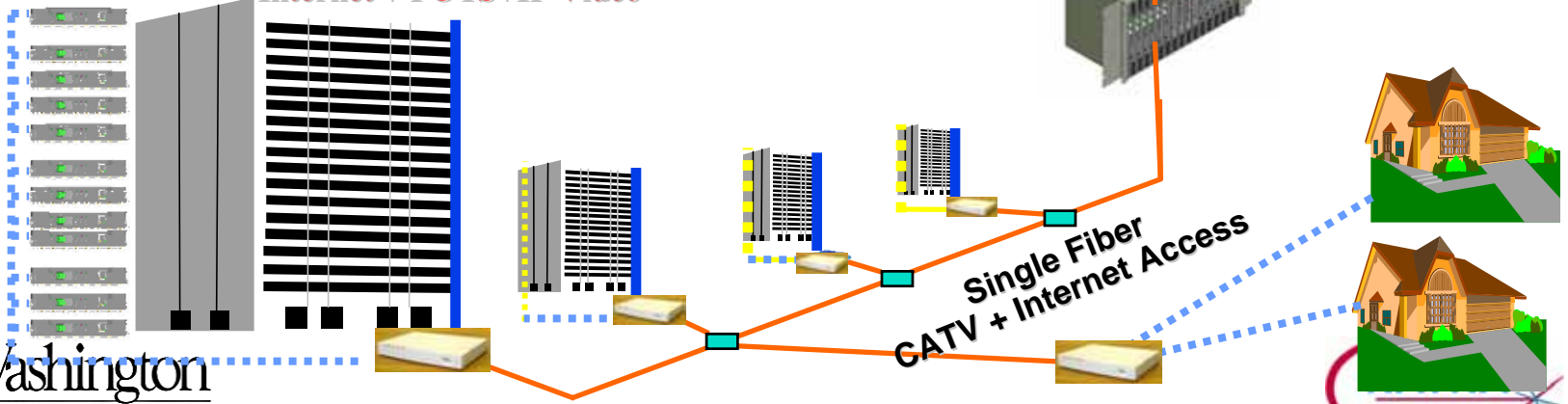


CATV with EFM



CATV
STB

Internet + POTS+IP Video



Optics East 2005

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GPON vs EPON

GPON	EPON
ATM-based	Ethernet Based
10% Cell Tax \Rightarrow 1 Gbps payload	No segmentation overhead
Legacy	New trend
US RBOCs	US Munis + Asia + Europe
US 10 th in Broadband penetration	Asia and Europe are broadband leaders
RBOCs already selected suppliers	Large potential market
ATM Switches Expensive	Ethernet Switches Cheap
Components relatively expensive.	Other components also high volume.
ITU design \Rightarrow Expensive Optics	IEEE Design \Rightarrow Cheap Optics
Re-conversion when connecting to IP backbone	Native mode IP connection
Can connect to SONET backbone	Can connect to SONET backbone
ATM non-existent in Enterprise Networks	Compatible with Enterprise Networks
T1/T3 supported	T1/T3 supported
ATM DSLAM easier to connect	Most DSLAM also have Ethernet or T1/T3 uplinks
ATM personnel difficult to find	Easier to maintain


Japanese Fiber to Premises

PennWell

LIGHTWAVE

Japanese subscribers are adopting FTTH at a rate of 80,000-90,000 subscribers per month.

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Japanese fiber to premises deployments worth watching

Meghan Fuller

Japan represents the largest-and to date most successful-wide-scale fiber to the home (FTTH) deployment in the world. According to Hiroshi Ishikawa, president and CEO of NTT Advanced Technology, the R&D arm of NTT East and West, 50% of Japanese households have fiber service directly to the home. Thanks to a competitive marketplace and supportive government policies, broadband service in Japan is the cheapest in the world, at 18¢ per 100 kbits/sec (compared to \$2.86 in the United States and \$7.18 in the United Kingdom). Japanese subscribers are adopting FTTH at a rate of 80,000-90,000 subscribers per month. So what's next for Japan? And what can U.S. providers learn from Japan's aggressive FTTH deployment plans?

 **Washington**
WASHINGTON UNIVERSITY IN ST. LOUIS

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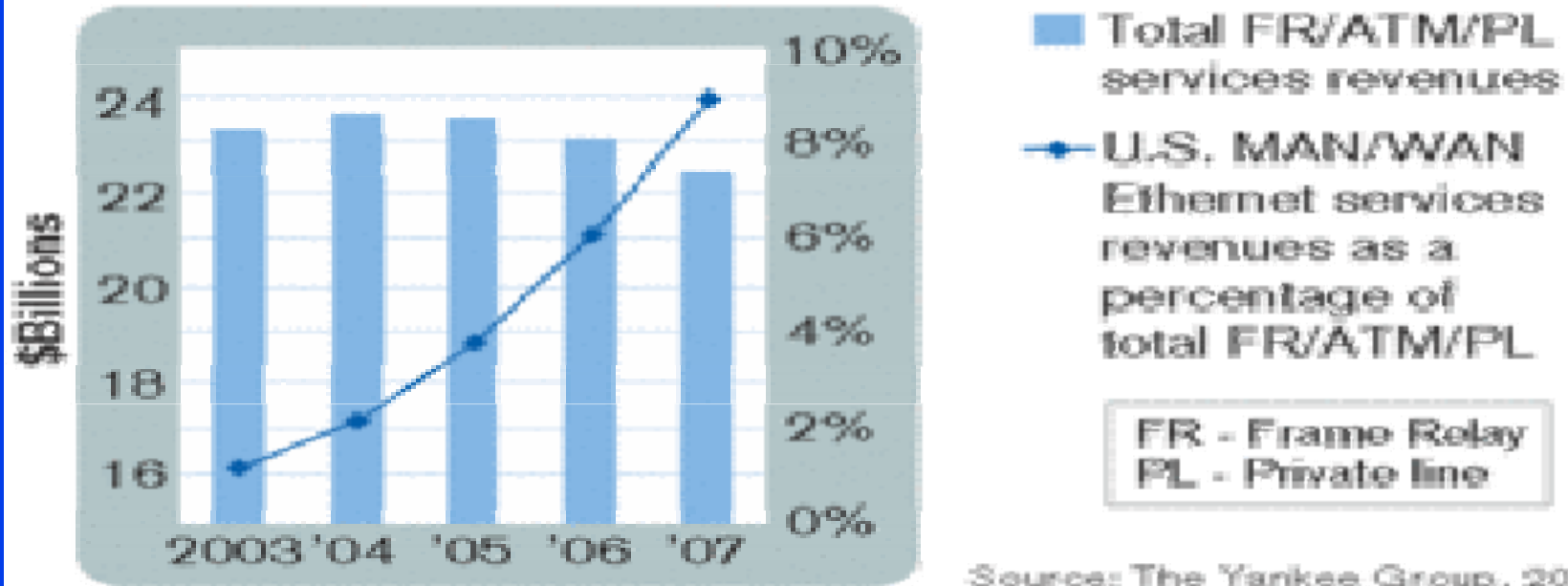
 **NAYNA**
Networks

PON Deployments

- ❑ Lead by Japan, Korea, Taiwan, ...
- ❑ Apartment complexes
- ❑ Municipal Projects: Traffic monitoring, railroad communications
- ❑ Carriers: Yahoo BB, NTT, KDDI, CHT,
- ❑ Community Networks: 800 communities
- ❑ FTTN by SBC and Verizon

Ethernet in the Access

U.S. MAN/WAN Ethernet services revenue



- ❑ Ethernet service revenues are cutting into Frame Relay, ATM, and private line revenues
- ❑ Ethernet revenues are \$580M in 2004 and will reach 8.9% of the FR/ATM/PL revenues

Enterprise vs Carrier Ethernet

Enterprise

- ❑ Distance: up to 2km
- ❑ Scale:
 - ❑ Few K MAC addresses
 - ❑ 4096 VLANs
- ❑ Protection: Spanning tree
- ❑ Path determined by spanning tree
- ❑ Simple service
- ❑ Priority \Rightarrow Aggregate QoS
- ❑ No performance/Error monitoring (OAM)

No 100 Mbps Ethernet switches with Q-in-Q, Rate control, Priority



Carrier

- ❑ Up to 100 km
- ❑ Millions of MAC Addresses
- ❑ Millions of VLANs
 - Q-in-Q
- ❑ Rapid spanning tree (Gives 1s, need 50ms)
- ❑ Traffic engineered path
- ❑ SLA. Rate Control.
- ❑ Need per-flow QoS
- ❑ Need performance/BER



Access Related Technologies

Broadband Access

Wireless
xDSL/Cable
FTTX

Residential Gateways



Home Networking Technologies

Wireless

Cat-5e/6

Powerline

Home Appliances



TV

Audio



Computer

Security

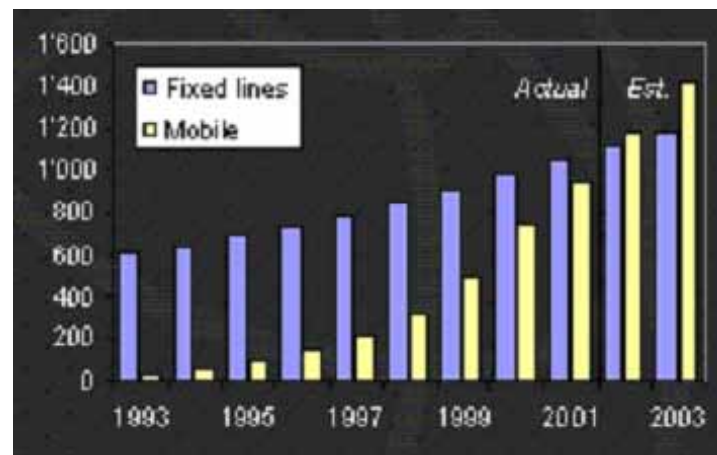


Remote Control

- Home networks are reaching Gbps but over Cat-5/6
Video interconnection via wireless USB or UWB
- Need multi-service (multi-LAN, Multy-WAN) residential gateways
- More money in applications than transport

Mobility

- ❑ 1.35 Billion mobile subscribers vs 1.2 Billion Fixed line subscribers at the end of 2003 [ITU]
- ❑ Number of wired phones in USA is declining for the first time since the Great Depression.
- ❑ 20% of world population is mobile. Need internet access.
70% of internet users in Japan have mobile access
- ❑ Vehicular mobility up to 250 Km/h (IEEE 802.20)



Telecom Revenue

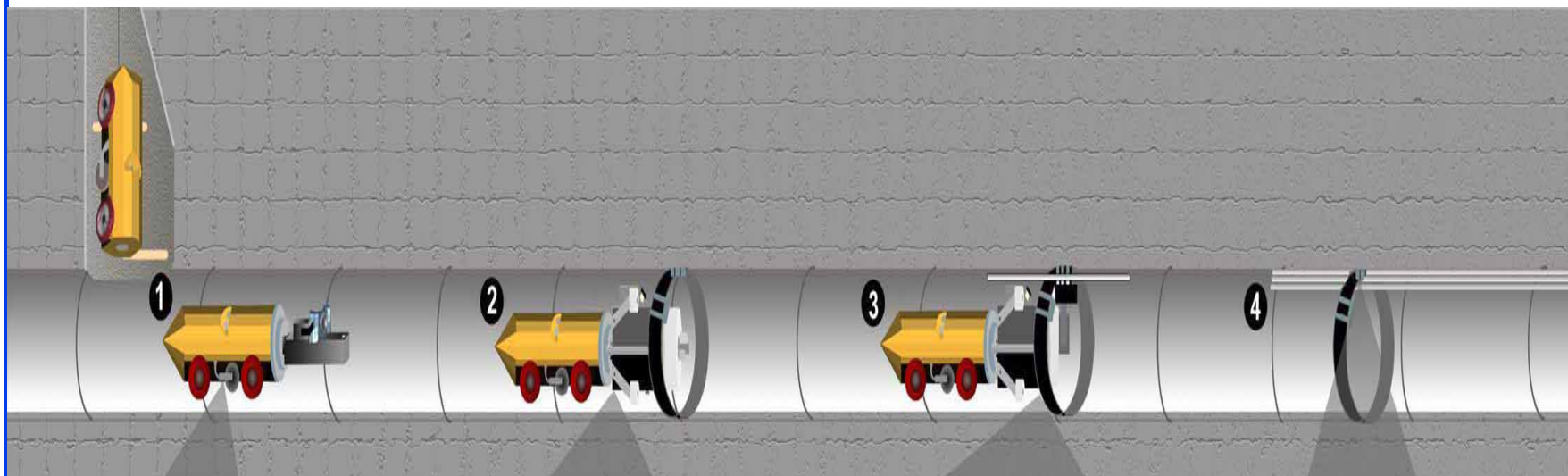
	Revenue in Billions						Annual Growth
	2003	2004	2005	2006	2007	2008	
Video	0.2	0.3	.05	1.0	1.6	2.5	65.7%
Consumer Broadband	2.8	3.5	4.0	4.2	4.6	4.8	11.4%
Consumer long distance	20.7	18.2	16.0	13.6	11.3	9.2	-15.0%
Business local	26.3	26.7	26.4	26.1	25.8	25.5	-0.6%
Business long distance	26.1	24.5	23.0	21.3	19.7	18.2	-7.0%
Business data	44.8	45.6	46.6	47.1	46.8	45.4	0.3%
Consumer local	46.9	42.2	39.0	36.2	34.0	32.3	-7.25%
Wireless	91.5	108.7	119.2	132.8	144.5	153.6	10.9%
Total	260.7	271.5	277.0	285.0	291.3	294.9	2.5%

- ❑ Long distance is disappearing.
- ❑ Most of the revenues are going to be from wireless.
- ❑ Source: Instat/MDR (Business Week, Feb 28, 2005)

Fiber Access Thru Sewer Tubes (FAST)

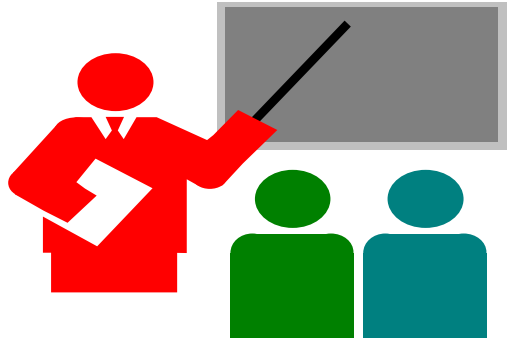
- ❑ Right of ways is difficult in dense urban areas
- ❑ Sewer Network: Completely connected system of pipes connecting every home and office
- ❑ Municipal Governments find it easier and more profitable to let you use sewer than dig street
- ❑ Installed in Zurich, Omaha, Albuquerque, Indianapolis, Vienna, Ft Worth, Scottsdale, ...
- ❑ Corrosion resistant inner ducts containing up to 216 fibers are mounted within sewer pipe using a robot called Sewer Access Module (SAM)
- ❑ Ref: <http://www.citynettelecom.com>, NFOEC 2001, pp. 331

FAST Installation



1. Robots map the pipe
2. Install rings
3. Install ducts
4. Thread fibers

Fast Restoration: Broken sewer pipes replaced with minimal disruption



Summary

1. Access is where the action is.
Core is cool. Metro is warm. Access is hot.
2. Telecom epicenter has moved from NA+Europe to Asia Pacific
3. FTTP is happening.
FTTH in Japan and Korea, FTTN in USA.
4. EPON is winning vs GPON
5. Most of the telecom revenue and growth is in wireless

Networking Trends: References

- ❑ References on Networking Trends,
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- ❑ References on Optical Networking,
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Thank You!

