

Wireless Networking: Issues and Trends



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These slides are available on-line at:

<http://www.cse.wustl.edu/~jain/cse574-08/>



- ❑ Top 10 Recent Networking Developments
- ❑ Hype Cycles of Technologies
- ❑ Wireless Equipment/Revenue Trends
 - Home Networking Equipment Trends
 - Global Broadband Wireless Equipment
 - Broadband Market by Regions
 - Fixed vs. Mobile
 - Voice vs. Data

Top 10 Recent Networking Developments

1. Large investments in Security: Message Aware Networking
⇒ All messages scanned by security gateways
2. Wireless (WiFi) is ubiquitous (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
5. Wiring more expensive than equipment
⇒ Wireless Access

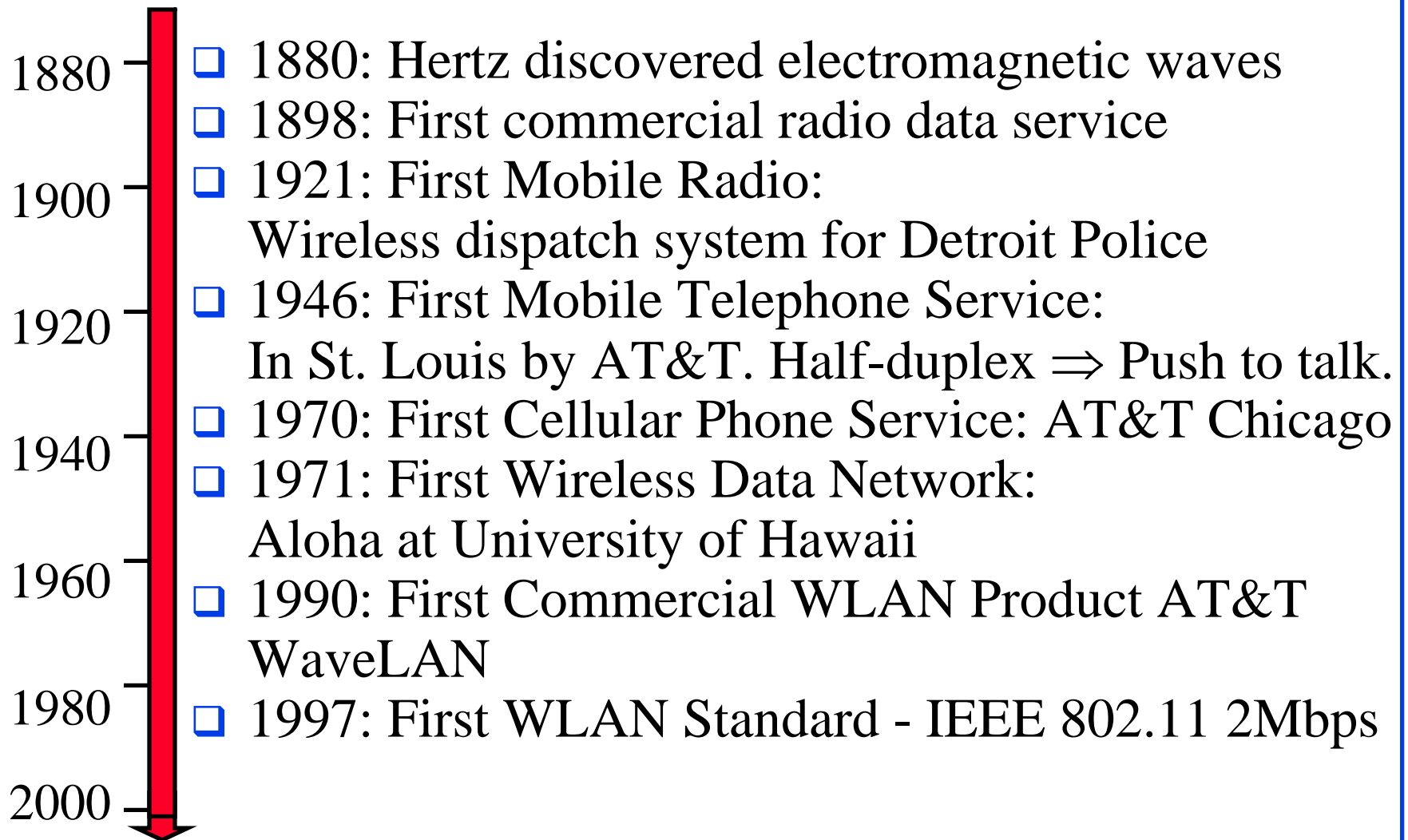
Top 10 Networking Developments (Cont)

6. Voice over Internet Protocol (VOIP) is in the Mainstream
VOIP over Broadband/Wi-Fi/Cellular
7. Multi-service IP: Voice, Video, and Data
8. Terabyte/Petabyte storage (Not VoD)
⇒ High-Speed Networking
9. Gaming: Internet and wireless based
10. 100-Mbps wireless LAN is here.
⇒ 100 Mbps in MAN and Gbps in design.

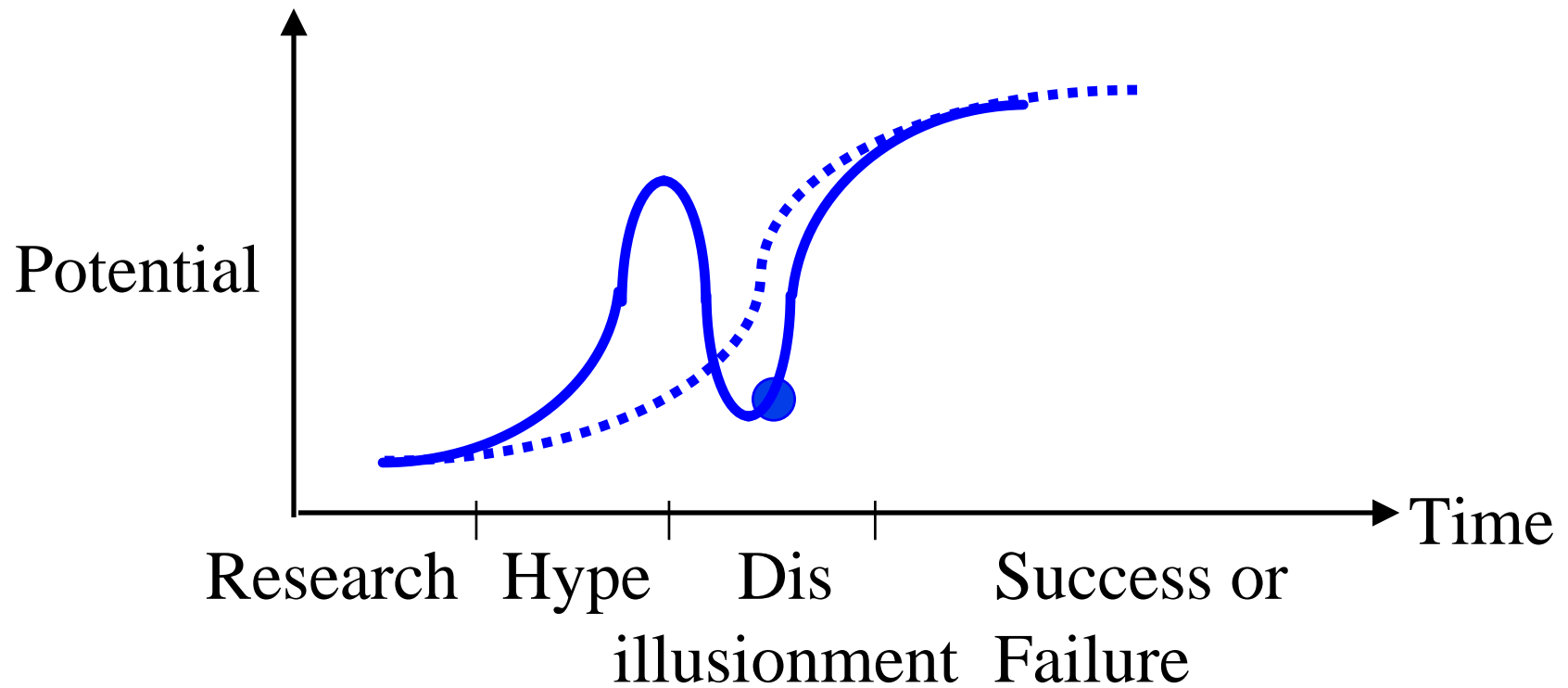
2002-2007: Mega-to-Giga Transition

- ❑ Memory in Laptops: Megabytes to Gigabytes
- ❑ Cordless Phones: 900 Mega Hertz to 2.4/5.8 GHz
- ❑ Processors: MIPS (Mega Instructions per second) to GFIPS (Giga Flops)
- ❑ Digital Cameras: 100-500 Mega Pixels to Giga Pixels
- ❑ Office Networks: 10/100 Mega bps to 1-10 Giga bps
- ❑ Worldwide Wireless Network Users:
Millions to Billions

Wireless: History

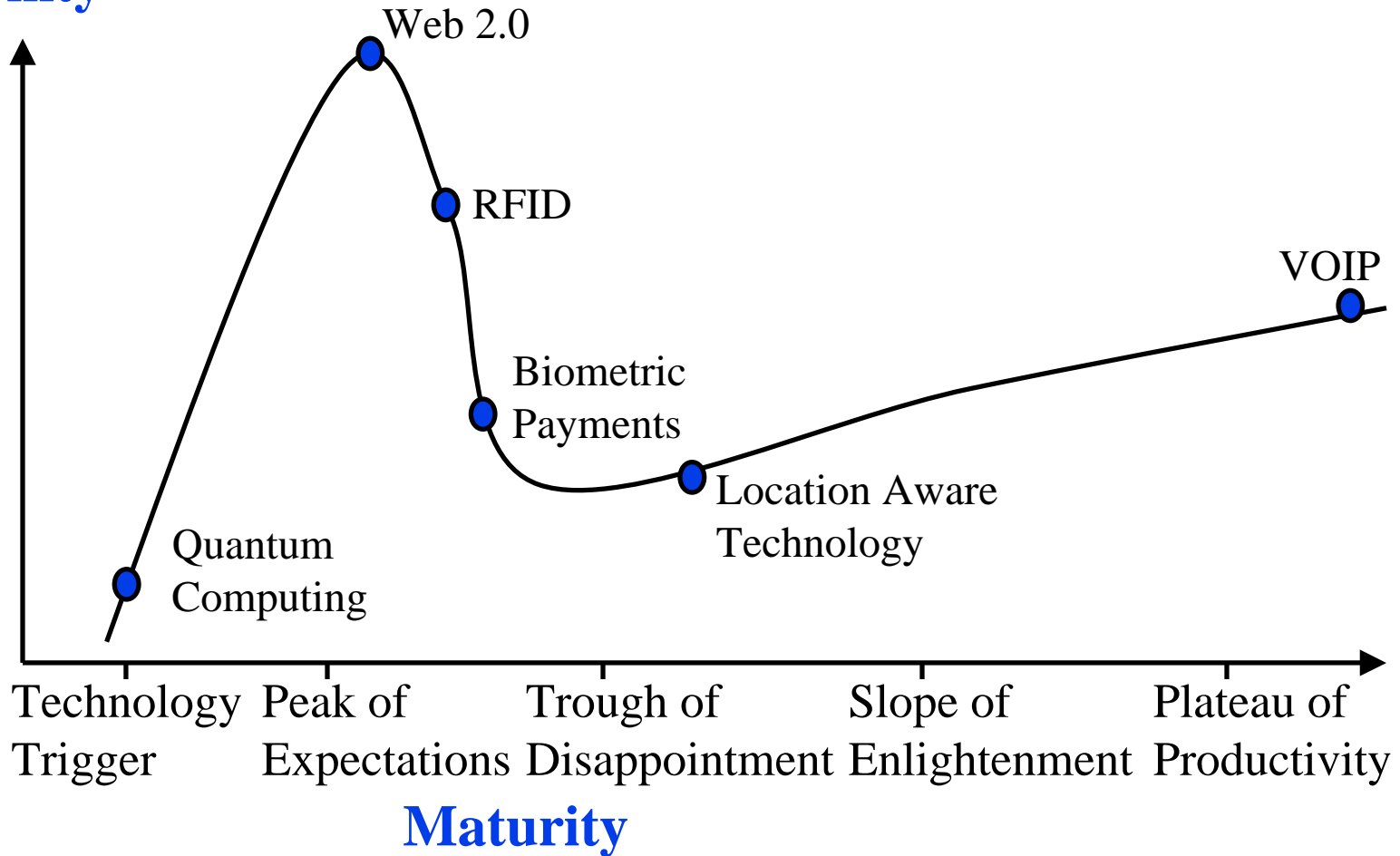


Hype Cycles of Technologies



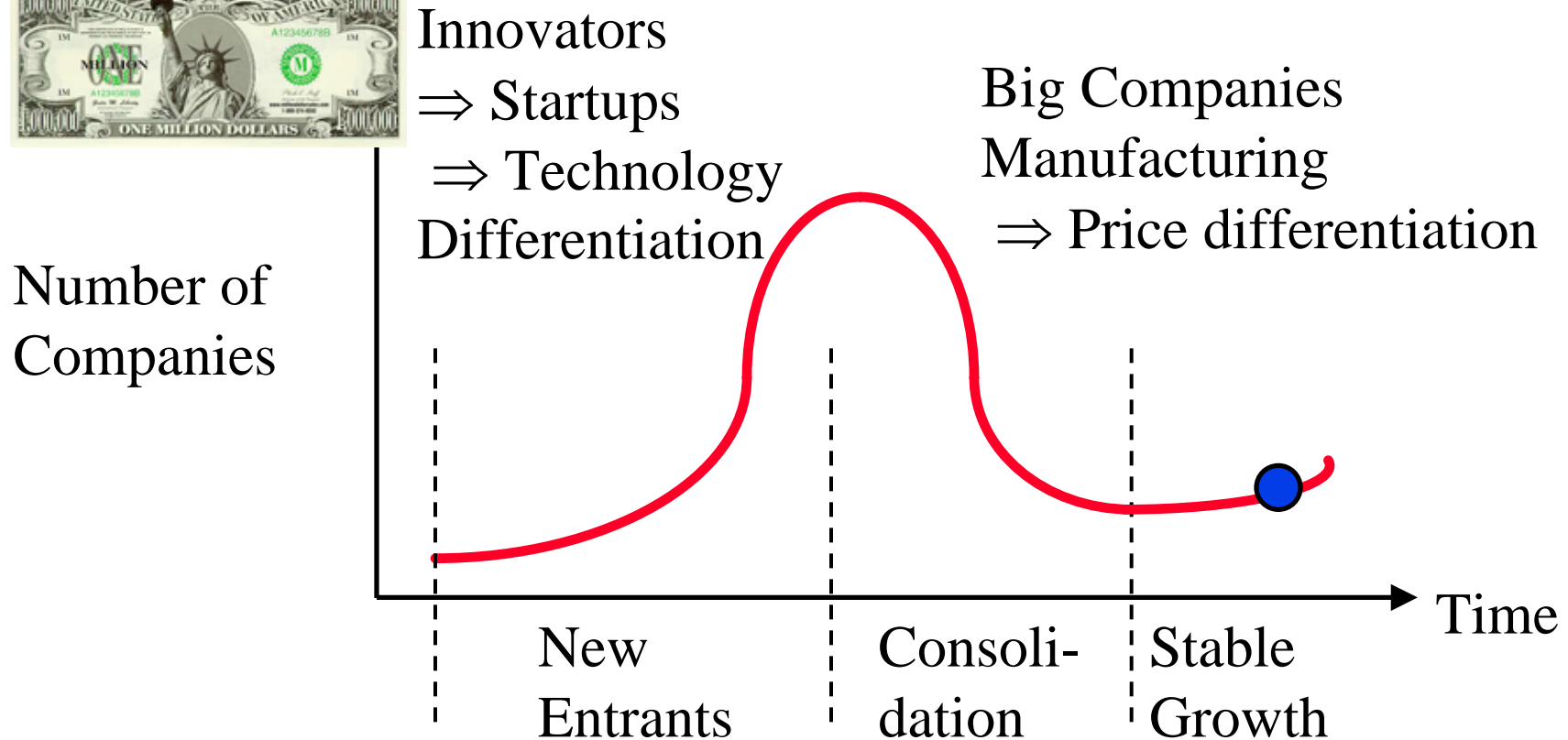
Networking Hype Cycle 2006

Visibility



Based on Gartner Research (July 2006)

Industry Growth: Formula for Success



- **10-20-70 Formula:** 10% of R&D on distant future, 20% on near future, 70% on today's products

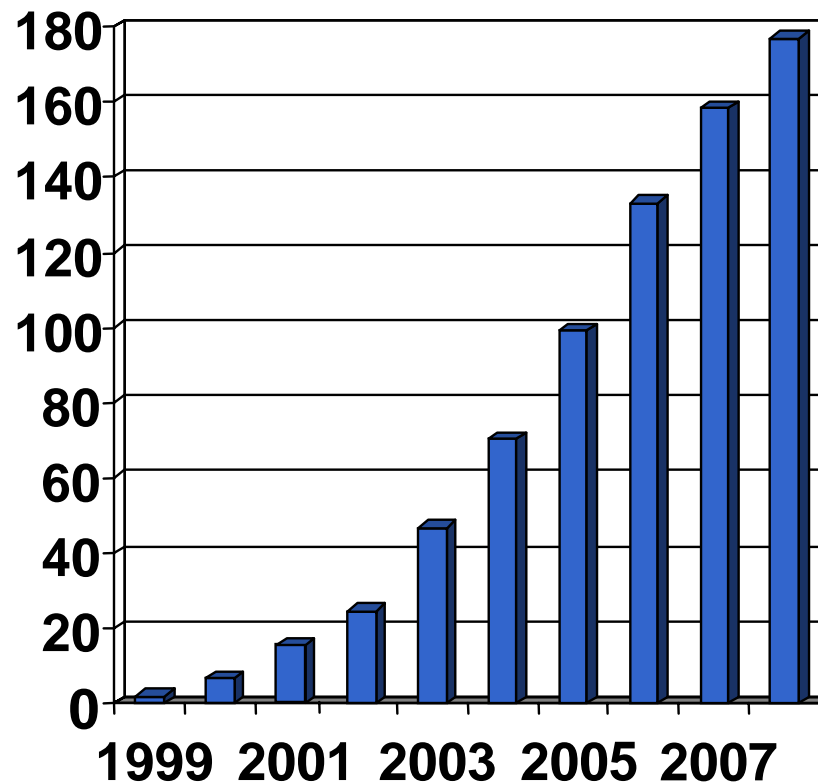
Telecom Revenue

	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%

- ❑ 48% revenues are from wireless.
- ❑ 26% of revenue from data (vs. voice)
- ❑ Source: Instat/MDR (Business Week, Feb 28, 2005)

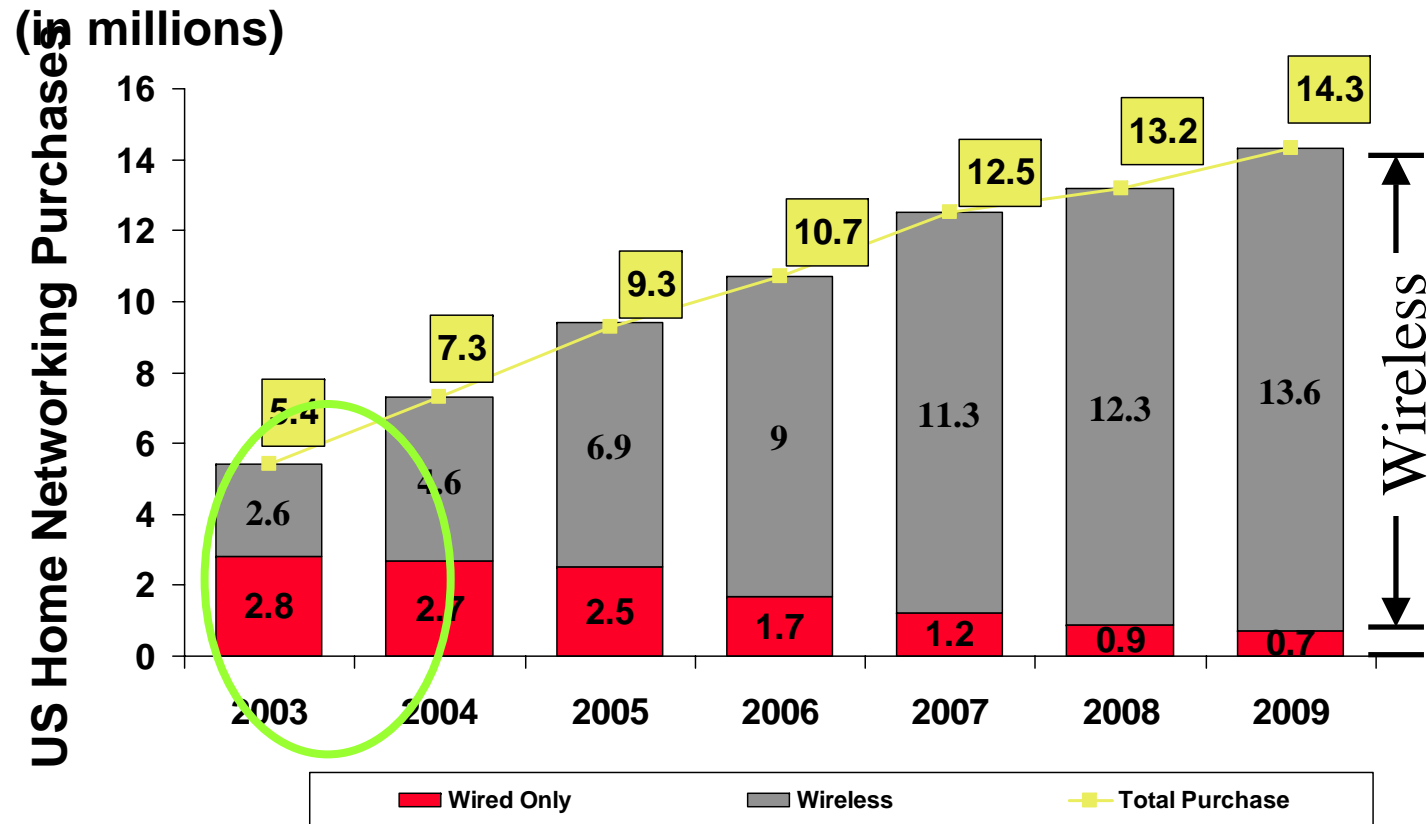
Wireless Data Connections

North American Wireless Data Connections (Millions)



Source: Gartner, "U.S. Wireless Data Market Update, 2004"

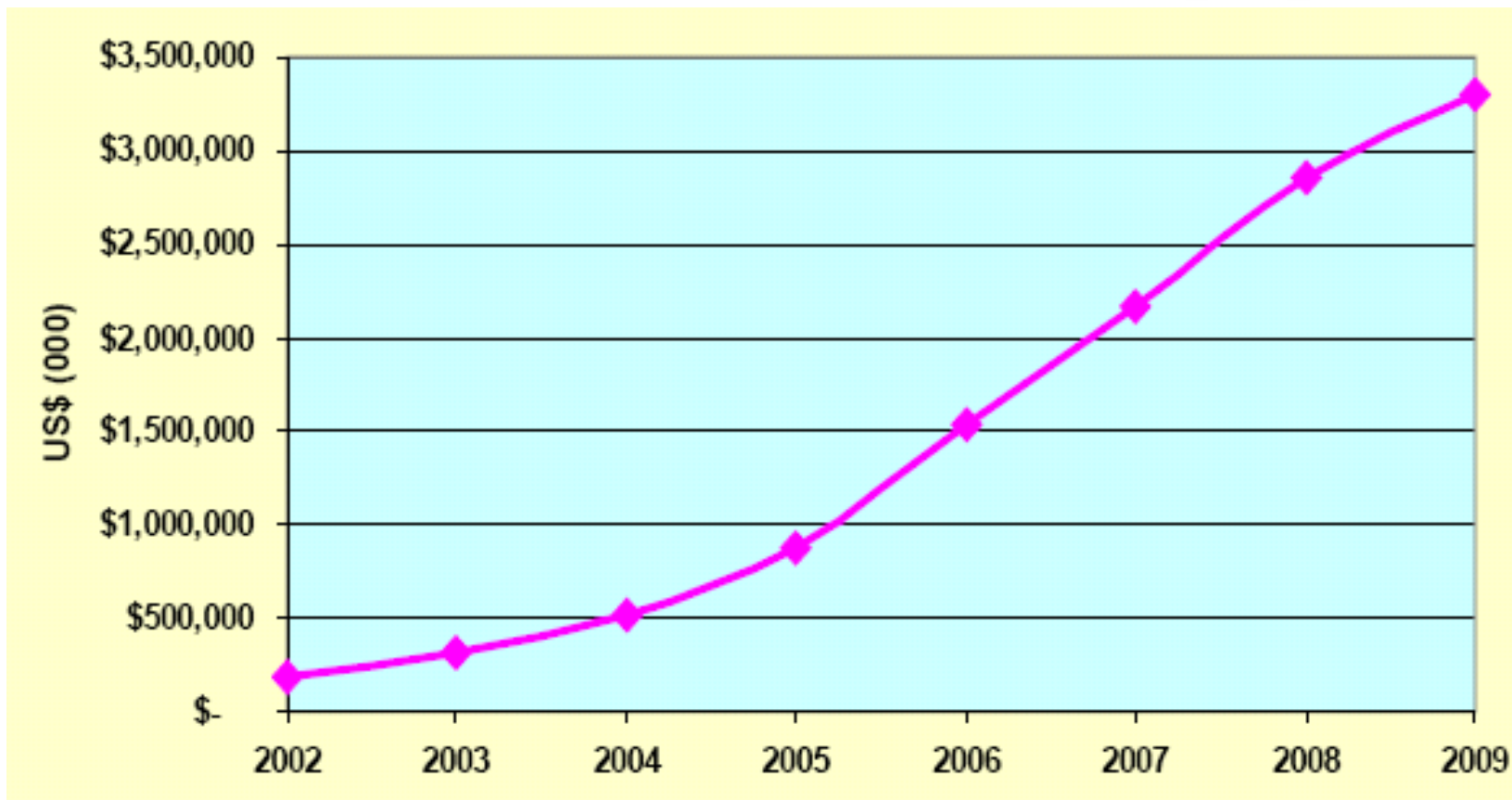
Home Networking Equipment Trends



Source: JupiterResearch Home Networking Model, 8/04 (US Only)

- Wireless outsold wired home networking gear for the first time in 2004

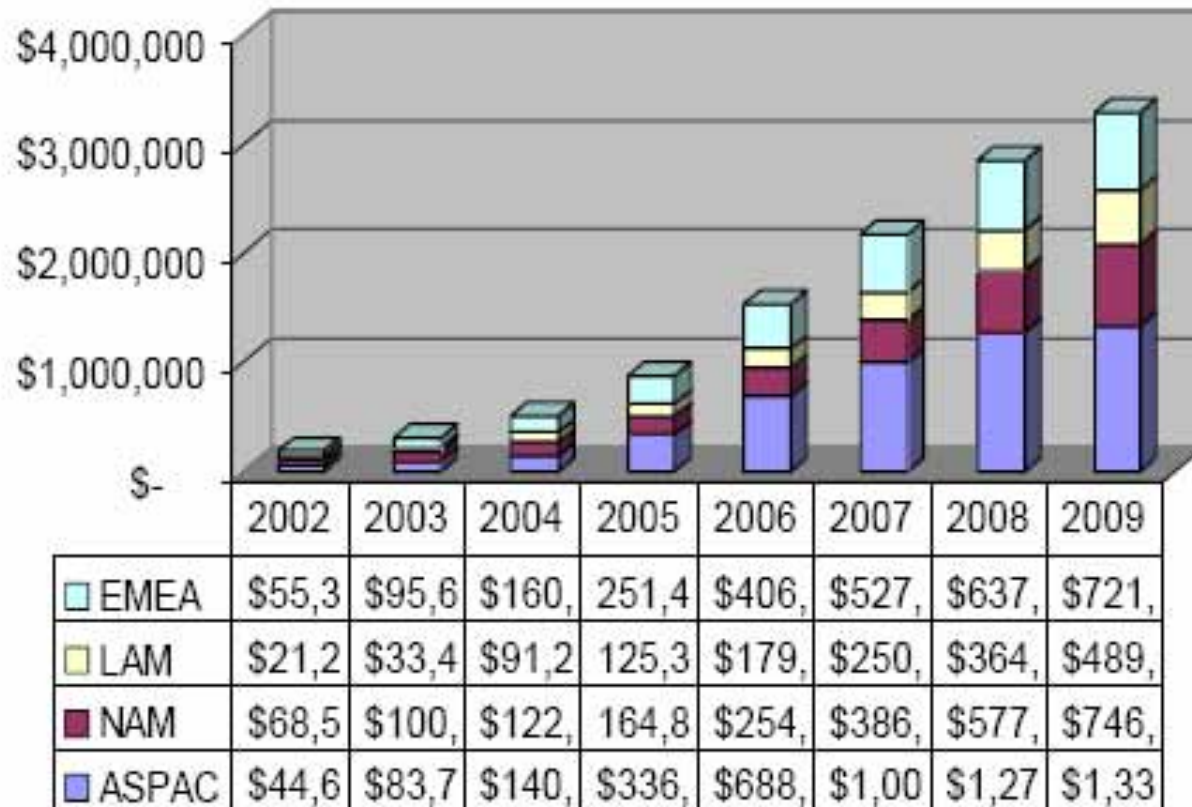
Global Broadband Wireless Equipment



□ 0-10 GHz, Base stations+Subscriber stations

Source: Skylight Research

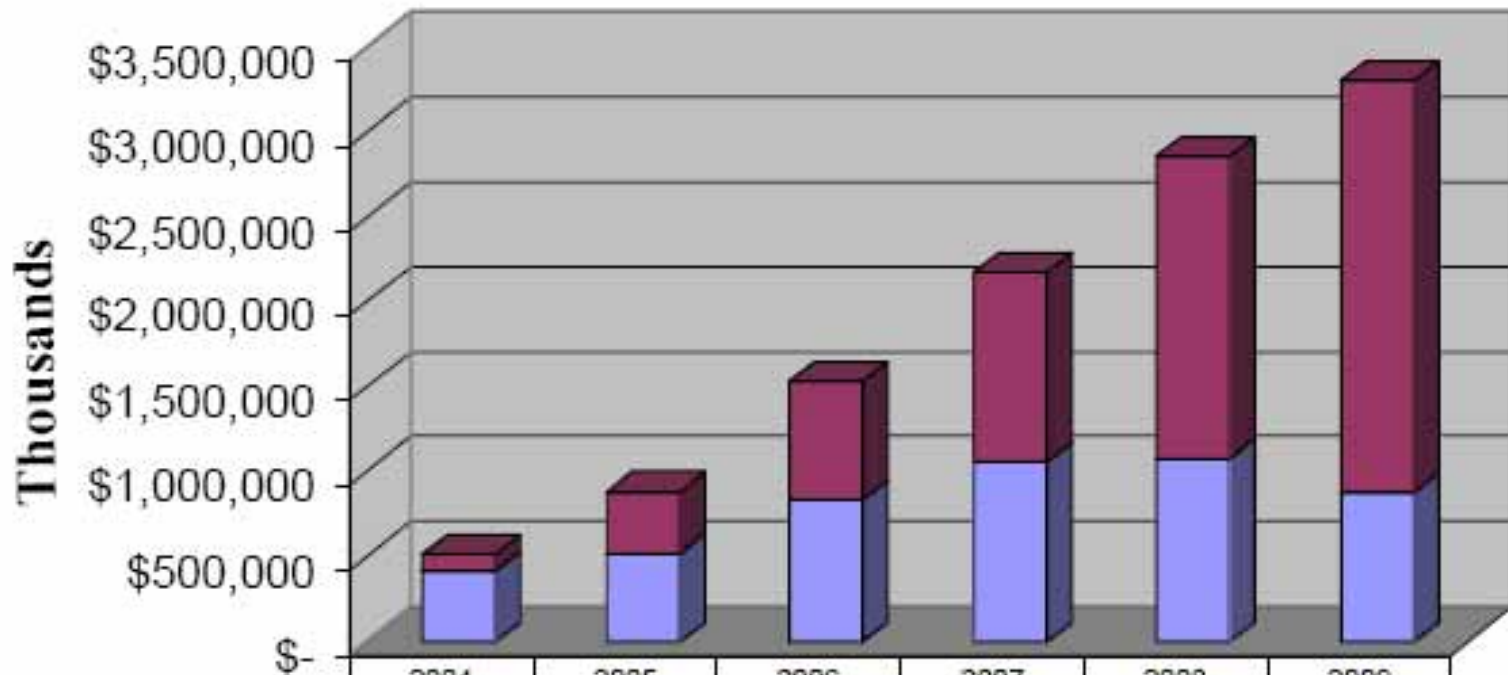
Broadband Market by Regions



- ASPAC and EMEA leading the growth

Source: Skylight Research

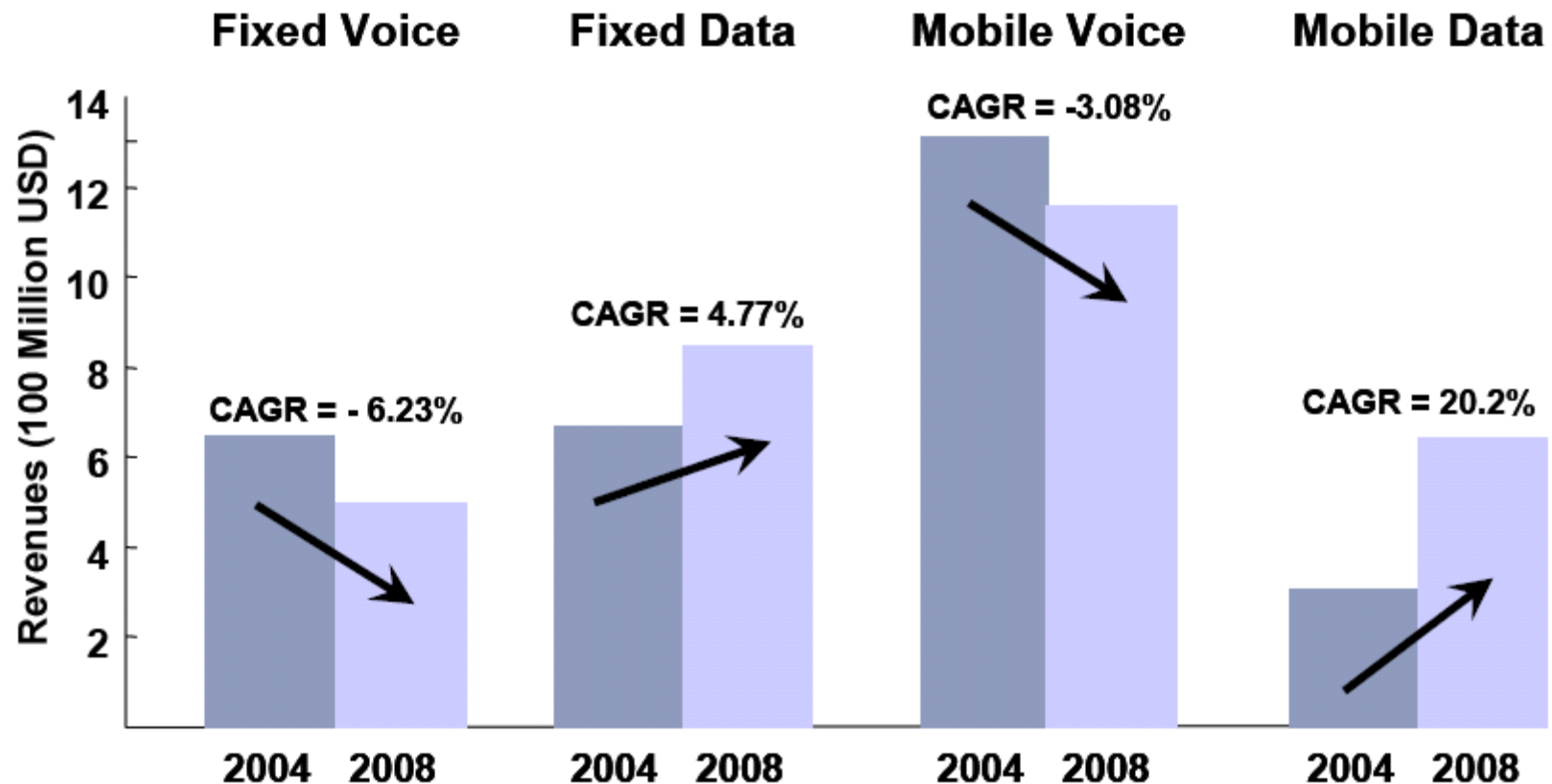
Personal Broadband: Fixed vs. Mobile



	2004	2005	2006	2007	2008	2009
■ Portable/Mobile wireless equipment	\$100,655	\$358,184	\$699,616	\$1,118,670	\$1,776,591	\$2,415,165
■ Fixed wireless equipment	\$414,125	\$519,620	\$829,612	\$1,051,557	\$1,072,812	\$878,090

Source: Skylight Research

Voice and Data Revenues (Korea)



Source: KISDI 2004

Wireless Technologies to Watch 2008

- ❑ Ultra-wide band has arrived
(Many companies showing products)
- ❑ MIMO: Pre-N routers
- ❑ Multimedia over Wireless: Media center extenders
- ❑ Video over Cell phones
- ❑ Wireless storage for home 4x250GB
- ❑ Wireless USB
- ❑ RFID

Top 10 Downloads from Computer Communications

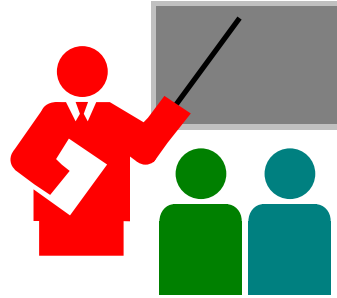
1. Policy-based IPsec management, Network, IEEE, Nov 2003
2. Wireless Broadband Access: WiMAX and Beyond – A Secure and Service-Oriented Network Control Framework for WiMAX Networks, Communications Magazine, IEEE, May 2007
3. A simple transmit diversity technique for wireless communications, JSAC, Aug 1998
4. A survey on sensor networks, Communications Magazine, IEEE, Aug 2002
5. Internet Protocol Television (IPTV): The Killer Application for the Next-Generation Internet, Communications Magazine, IEEE, Nov 2007
6. Broadband wireless access with WiMax/802.16: current performance benchmarks and future potential, Communications Magazine, IEEE, Feb 2005
7. Capacity limits of MIMO channels, JSAC, May 2003
8. Wireless Broadband Access: WiMAX and Beyond – Integration of WiMAX and WiFi: Optimal Pricing for Bandwidth Sharing, Communications Magazine, IEEE, May 2007
9. Cognitive radio: making software radios more personal, Personal Communications, IEEE, Jul 1999
10. A survey on wireless mesh networks, Communications Magazine, IEEE, Sep 2005

Observation: 8 out of 10 top downloads are on wireless. [November 2007]

Wireless Issues

- ❑ Security (IEEE 802.11i)
- ❑ Higher Data Rates:
 - Ultra-wide band (vs Bluetooth)
 - Wireless USB
 - Multiple In Multiple Out (MIMO) antennas: IEEE 802.11n
- ❑ Longer distance (WiMAX, >1Mbps to 50 km)
IEEE 802.22 Regional Area Networks
- ❑ Seamless Networking \Rightarrow Handoff (IEEE 802.21)
- ❑ Mobility (IEEE 802.20)
- ❑ Multimedia over Wireless: Media center extenders,
VOIP/Video over cell phones
- ❑ Channel congestion in license-exempt band

Summary: Wireless Trends



- ❑ Wireless is the major source of carrier revenue
⇒ Significant growth in Wireless networking
- ❑ Growth also in home and enterprise market
- ❑ Moving from fixed to mobile wireless
- ❑ Moving from voice to data

HTML – An Intro

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</BODY>

</HTML>

HTML Intro (2)

<HTML>

<HEAD>

<TITLE>CSE574S: Advanced Topics in Networking </TITLE>

<META NAME="AUTHOR" CONTENT="Raj Jain">

<META NAME="Classification" CONTENT="Technical">

<META NAME="Keywords" CONTENT="Quality of Service,
Voice over IP">

<META NAME="Description" CONTENT="Lectures and
reports on recent advances in networking ">

</HEAD>

<BODY>

<H1>CSE574S: Advanced Topics in Networking </H1>

<H2>Issue 1: High Speed</H2>

HTML Intro (3)

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</UL>
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<A HREF="http://www.google.com">Google</A>
```

```
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```

```
<A NAME="section2"><H2>Section 2</H2></A>
```

```
<IMG SRC="photos/ftp/jain5-s.jpg" ALT="[Raj Jain's Photo]"  
HEIGHT=150 WIDTH=102>
```

```
</Body>
```

```
</HTML>
```

Project Homework 2

- ❑ Prepare your personal web page. Must include your photograph
- ❑ Use meta-HTML commands in the header to indicate title, keywords, description, etc
- ❑ Must use at least all the commands listed in “HTML Intro” slides. Use others as appropriate.
- ❑ Use only a text editor
- ❑ Submit a link to the page via email to jain@cse.wustl.edu with a subject field of: CSE 574S Homework 2
- ❑ Validate your page on:
 - W3C Markup Validation Service, <http://validator.w3.org/>
 - HTML code check by Net Mechanic, <http://www.netmechanic.com/toolbox/html-code.htm>
 - CSE HTML Validator , <http://www.htmlvalidator.com/>