

Wireless Networking: Issues and Trends



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These slides are available on-line at:

<http://www.cse.wustl.edu/~jain/cse574-06/>



1. Top 10 Recent Networking Developments
2. Wireless: History
3. Life Cycles of Technologies
4. Wireless Industry Trends
5. Wireless Research Trends

Billion Dollar Question

Joan
Quigley



White
House
Astrologer

All I want you to tell me is what will be the
hot networking technology in the year 2007

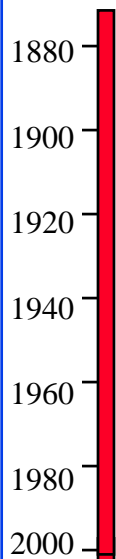
Top 10 Recent Networking Developments

1. Large investments in Security: Message Aware Networking
⇒ All messages scanned by security gateways
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
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
VOIP over Broadband/Wi-Fi/Cellular
8. Multi-service IP: Voice, Video, and Data
9. Terabyte/Petabyte storage (Not VoD)
⇒ High-Speed Networking
10. Gaming: Internet and wireless based

2002-2005: 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

- 
- ❑ 1880: Hertz discovered electromagnetic waves
 - ❑ 1898: First commercial radio data service
 - ❑ 1921: First Mobile Radio:
Wireless dispatch system for Detroit Police
 - ❑ 1946: First Mobile Telephone Service:
In St. Louis by AT&T. Half-duplex ⇒ Push to talk.
 - ❑ 1970: First Cellular Phone Service:
In Chicago by AT&T w cell, handoff, and roaming
 - ❑ 1971: First Wireless Data Network:
Aloha at University of Hawaii
 - ❑ 1990: First Commercial Wireless LAN Product
AT&T WaveLAN
 - ❑ 1997: First Wireless LAN Standard - IEEE 802.11
2Mbps

Cavemen of 2020



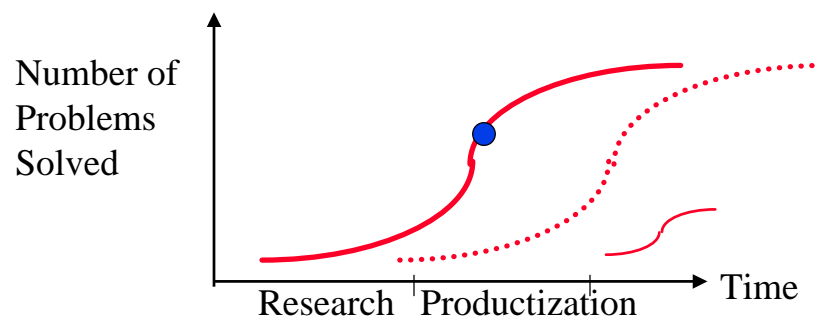
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Life Cycles of Technologies



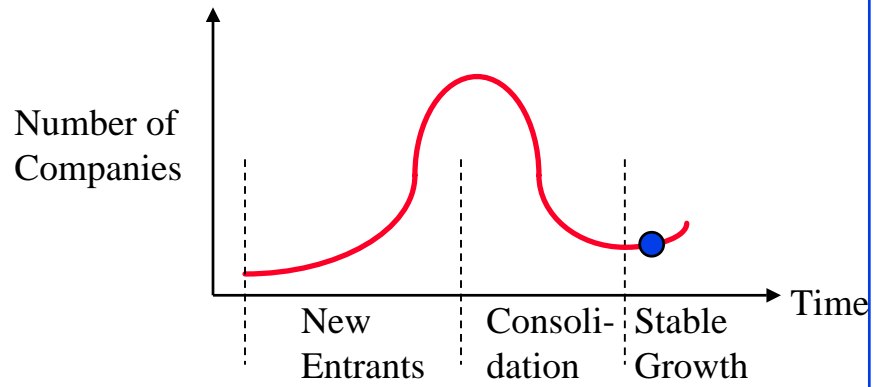
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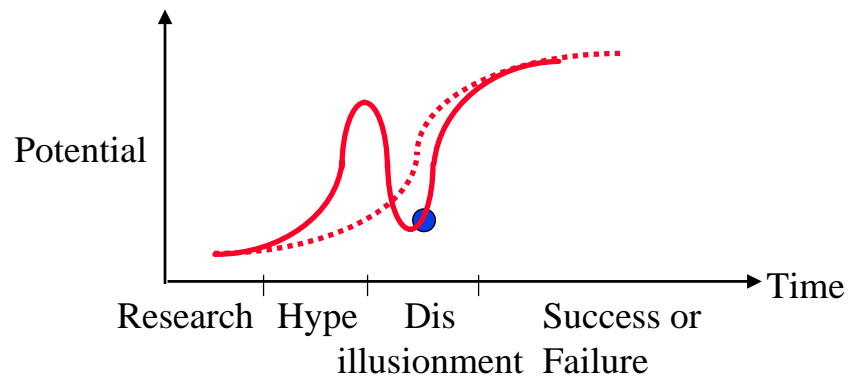
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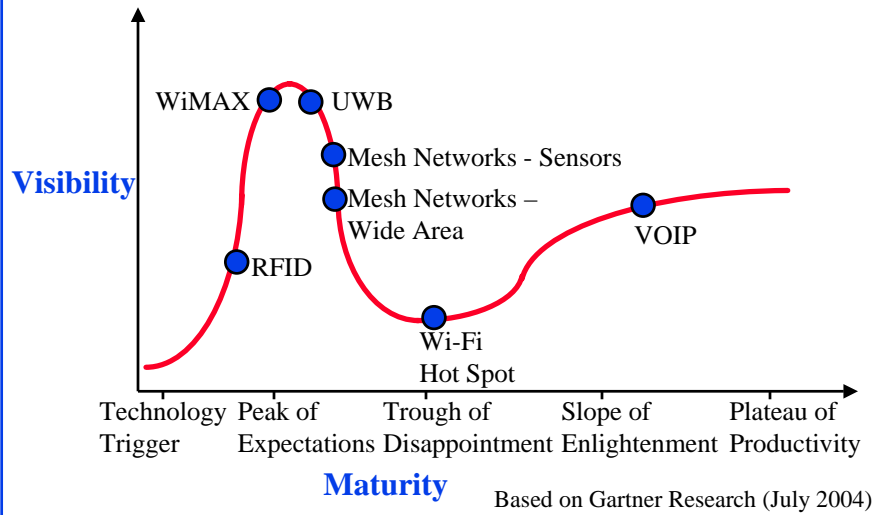
Industry Growth



Hype Cycles of Technologies



Hype Cycle 2004



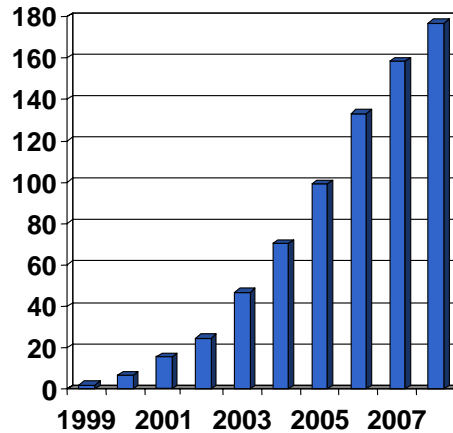
Telecom Revenue

	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)

Wireless Data Connections

North American Wireless Data Connections (Millions)



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

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Wireless Industry Trends

- ❑ Wireless industry is stronger than wireline.
Particularly strong growth in developing countries.
- ❑ 48% of global telco revenues coming from wireless
- ❑ 26% of wireless revenues coming from data (vs voice)
- ❑ Past: Voice, email, SMS, Ring tones
- ❑ Present: Push, Gaming, Pictures, Instant Messaging
- ❑ Future: Music, Video, Location, Remote monitoring, m-commerce
- ❑ Long Term: Video telephony, remote enterprise applications, remote management, Multiparty collaboration

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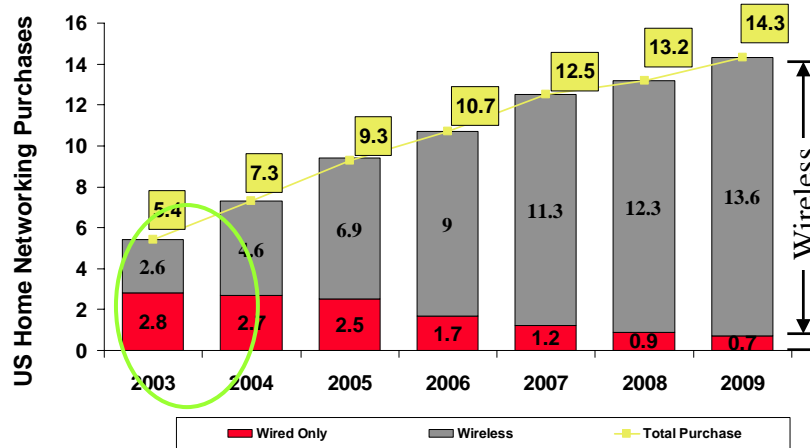
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Home Networking Equipment Trends

(in millions)



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

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

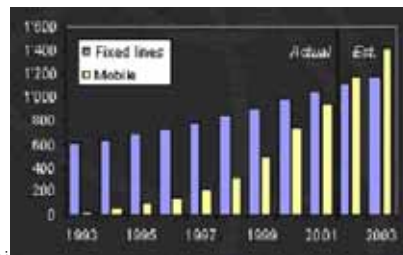
Cantenna



- 13,000 Free WiFi access nodes and growing
- 12db to 12db can-to-can shot can carry an 11Mbps link well over ten miles
- Ref: <http://www.netcum.com/~clapp/wireless.html>

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)



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Wireless Technologies to Watch 2006

- ❑ 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

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Wireless Research Trends

- ❑ NSF funded \$40M for networking research over the past three years
- ❑ Three areas:
 - Software programmable networks
 - Sensor Networks
 - All other type of networking
 - **Two Thirds** of networking funding on wireless
- ❑ Defense Networks are mostly wireless

Top 10 Downloads from Computer Communications

1. Christos Xenakis and Lazaros Merakos
Security in third Generation Mobile Networks
Computer Communications, 27 (2004) 638-650
2. Marko Hannikainen, Timo D. Hamalainen, Markku Niemi and Jukka Saarinen
Trends in personal wireless data communications
Computer Communications, 25 (2002) 84-99
3. David Remondo and Ignas G. Niemegeers,
Ad hoc networking in future wireless communications
Computer Communications, 26 (2003) 36-40
4. S. DasBit and S. Mitra,
Challenges of computing in mobile cellular environment--a survey,
Computer Communications, 26 (2003) 2090-2105
5. Theuns Verwoerd and Ray Hunt
Intrusion detection techniques and approaches
Computer Communications, 25 (2002) 1356-1365
6. S. A. M. Makki, Niki Pissinou and Philippe Daroux
Mobile and wireless Internet access
Computer Communications, 26 (2003) 734-746
7. Costas Lambrinouidakis, Stefanos Gritzalis, Fredj Dridi and Gunther Pernul
Security requirements for e-government services: a methodological approach for developing a common PKI-based security policy
Computer Communications, 26 (2003) 1873-1883
8. Kwok-Yan Lam, Siu-Leung Chung, Ming Gu and Jia-Guang Sun
Lightweight security for mobile commerce transactions
Computer Communications, 26 (2003) 2052-2060
9. Antonio Grilo, Mario M. Macedo and Mario S. Nunes
IP QoS support in IEEE 802.11b WLANs
Computer Communications, 26 (2003) 1918-1930
10. Walter Hirt
Ultra-wideband radio technology: overview and future research
Computer Communications, 26 (2003) 46-52

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 ⇒ 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

Research Areas

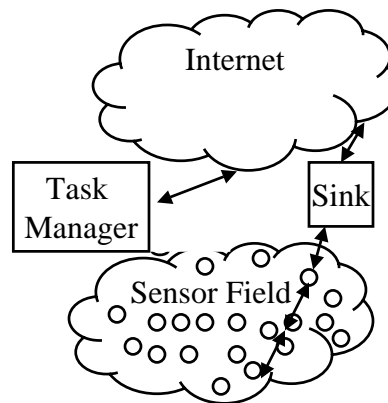
- 1. Disruption Tolerant Networking:**
Frequent Disconnection due to mobility, power outage, DTN nodes have limited storage
- 2. Overlay Networking:** Virtual Networks, P2P, Application level optimization
- 3. Sensor Networks:** Large scale, Energy efficient
- 4. Distributed Computing Networks (Grids):** Grid Storage
- 5. Security**

Disruption Tolerant Networking

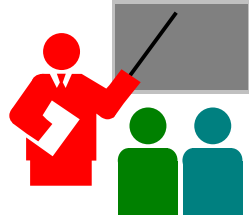
- ❑ Frequent Disconnection due to mobility, power outage (Military Ad hoc networks)
- ❑ Regular or unpredictable disconnections (LEO satellites)
- ❑ Very high delay networks (Inter-planetary networks)
- ❑ Aka Delay Tolerant/Difficult/challenged/disconnected/Intermittent networks
- ❑ DTN routers need storage but not unlimited
- ❑ End-to-end retransmissions not desirable
- ❑ Congestion management in DTNs
- ❑ Path selection and scheduling in DTNs
- ❑ Ref: DTN IRTF

Sensor Networks

- ❑ A large number of **low-cost**, **low-power**, **multifunctional**, and small sensor nodes consisting of sensing, data processing, and communicating components
- ❑ Key Issues:
 1. Scalability
 2. Power consumption
 3. Fault tolerance
 4. Network topology
 5. Transmission media
 6. Cost
 7. Operating environment
 8. Hardware constraints



Summary



1. Wireless is the major source of carrier revenue
⇒ Significant growth in Wireless networking
2. Internet has flattened the world
⇒ More mobility and need to be connected
3. NSF, DARPA, and other research agencies see more research opportunities in wireless than in other areas of networking
4. Internet is 40 years old, mobile networking is just beginning
⇒ Great job and research opportunities.

HTML – An Intro

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<HEAD>  
...  
</HEAD>  
<BODY>  
...  
</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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<H3>1.1 Local Area Networks</H3>
<UL>
<LI>Item 1</LI>
</UL>
<A HREF="http://www.google.com">Google</A>
<A HREF="#section2">Section 2</A>
<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 CSE574@cec.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/>