Wireless Networking: Issues and Trends

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These slides are available on-line at:
http://www.cse.wustl.edu/~jain/cse574-08/
Overview

- 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

- 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: AT&T Chicago
- 1971: First Wireless Data Network:
  Aloha at University of Hawaii
- 1990: First Commercial WLAN Product AT&T WaveLAN
- 1997: First WLAN Standard - IEEE 802.11 2Mbps
Hype Cycles of Technologies

Potential

Research  Hype  Dis  Success or Failure

Time
Networking Hype Cycle 2006

Visibility

Web 2.0
RFID
Biometric Payments
Location Aware Technology
VOIP
Quantum Computing

Technology
Peak of Expectations
Trough of Disappointment
Slope of Enlightenment
Plateau of Productivity

Maturity

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

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<th>Revenue in Billions</th>
<th>Annual Growth</th>
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<td>2003</td>
<td>2004</td>
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<tr>
<td>Video</td>
<td>0.2</td>
<td>0.3</td>
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<tr>
<td>Consumer Broadband</td>
<td>2.8</td>
<td>3.5</td>
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<tr>
<td>Consumer long distance</td>
<td>20.7</td>
<td>18.2</td>
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<td>Business local</td>
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<td>Business data</td>
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<tr>
<td>Consumer local</td>
<td>46.9</td>
<td>42.2</td>
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<tr>
<td>Wireless</td>
<td>91.5</td>
<td>108.7</td>
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<tr>
<td>Total</td>
<td>260.7</td>
<td>271.5</td>
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- 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

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

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

Source: Skylight Research
Voice and Data Revenues (Korea)

- **Fixed Voice:**
  - 2004: 6.23%
  - 2008: 5.50%
  - CAGR = -6.23%

- **Fixed Data:**
  - 2004: 4.77%
  - 2008: 5.67%
  - CAGR = 4.77%

- **Mobile Voice:**
  - 2004: 12.00%
  - 2008: 16.80%
  - CAGR = -3.08%

- **Mobile Data:**
  - 2004: 12.00%
  - 2008: 15.20%
  - CAGR = 20.2%

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

3. A simple transmit diversity technique for wireless communications, JSAC, Aug 1998
7. Capacity limits of MIMO channels, JSAC, May 2003
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 ⇒ 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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HTML Intro (2)

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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/