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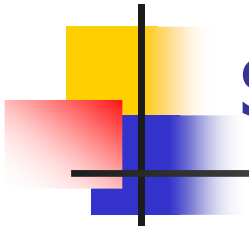
Wireless

The fastest way to roll out a network

How will it meet the data rate demands?

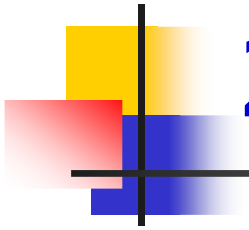
Why is DATA communication so HOT?



- Voice and video, converted to data, flow via network protocols

  vs. dedicated switching. Cheaper
- Data is easier to correct for noisy conditions. Better (DSPs)
- Data can have clocking embedded within the stream, further simplifying network design. Faster

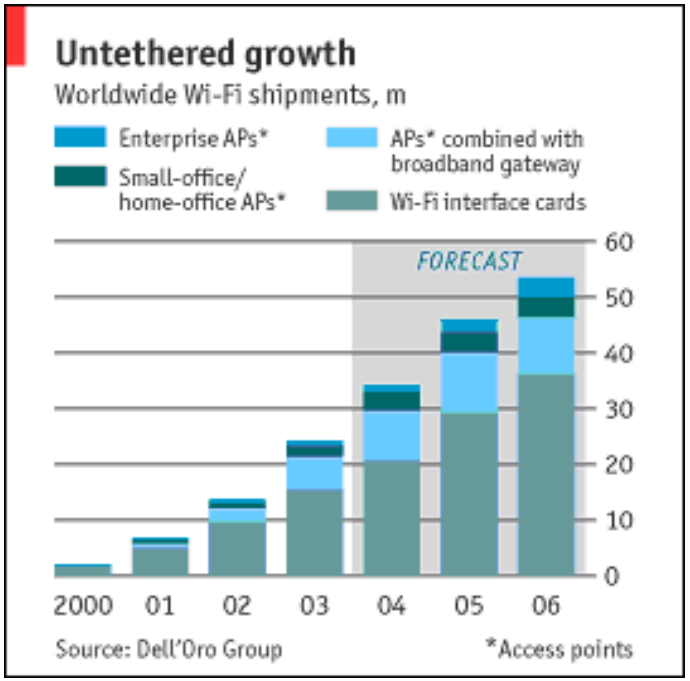
Telephonic Communications Lines 2005



- Number of wireless lines and wired lines is converging.
- About 1300 M wireline subscribers, 800 M wireless subscribers, per Phillips forecast, 1995. Connection types at parity by 2010 at 1400 M each (Estimate proved low and long).
- Current 2005 cell phone shipments are about 700M handsets annually, with about 30% as replacements. (Roughly 3 year life on mobile phones.

Wireless Access Points

South Korea's telecommunications provider KT doubled the number of its hotspots to 18,000 by the end of 2004. This gave the company the world's largest commercial Wi-Fi network. KT will have more commercial hotspots than all of North America and slightly less than Europe. With entire city blocks as hotspots, South Korea may be the most advanced wireless market on the planet.



General Thoughts

- **Communications Deregulation begets Technology which begets New Services which begets New Products (devices)**
- **For communications capacity**

  Fiber trumps copper which trumps wireless

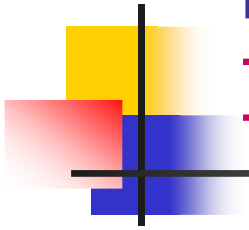
  (see BER and lossy transmission rules)
- **Interconnects are the technologically exciting places for engineers; Merged media excites business and education and government applications designers. Entertainment, Security and Search are fundamental needs. IT technologists will still be challenged by transitions, integration, and security.**
- **Standards make some integration possible. They provide a possible applications path forward which still requires creativity and cash.**
- **Public policy issues abound – Pole, right-of-way and spectrum rights, must carry rules. Funding public safety transition to digital shareable modes is a contemporary challenge.**

The Triple Play

Service/Provider	Cellular	Cable/Wireless Cable	Wireline Common Carrier
Voice	1 ☐	2	1 ☒
Video	3	1	2
Data	3	2	1
Bid for all 3 with customers			

" Opportunities for U.S. Firms "
in the growth of wireless network businesses in Asia

- Deliver the elements and expertise to grow, manage and integrate networked solutions.
- Concentrate on Korea for new solutions: Supply chain, entertainment, security monitoring. Learn metro networking applications that are seamless, cellular vs. WiFi. There are keys to success. Learn these.
- Explore and lead in new use billing models: DoCoMo revenue sharing led the world.



Opportunities:
Move from Personal to Integrated Applications

- Personal Pictures, Ringtones, music, 2-way chatting and messaging
- Business purchases, mobile exec supply chain coordination, medical id/telemetry, telematics
- Keys: Jumping Beans™, Java with DB, Sharp, CRM 3.0, Tiny OS...

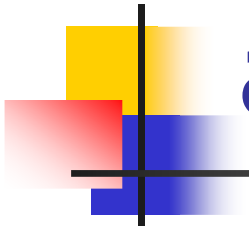
Opportunities:

- Skip the internal minutes accounting and run a real network – WiFi, Wi MAX, via cellular or cable or telephone/fiber network
- Electronic stored and recharged minutes, money and access privileges
- Key: Instant-grant wireless PVCs to build zero click VPN...

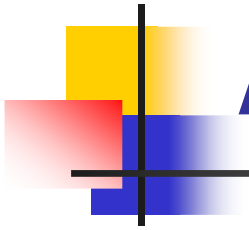
Technical reality - wireless

- Mutual tradeoffs for bit rate, distance, power, and no of users within a 'cell'
- Range of 30 miles may be achieved in special / rare situations
  - Typical ranges will be MUCH smaller
- To serve a large population of users with high reliability the density of base stations needs to be significantly higher than predicted by the range calculated (fractions of mile)
  - Effective throughput is much smaller than indicated by maximum data rates
- Performance is dominated by low data rate users

Sensible bit rates for applications



- Cellular EVDO is a sufficient rate for reasonable web applications.
- Ping time, or latency, is a driving factor with most enterprise protocols.
- WiFi rates are good, but beware mesh network multiple hop delays.



Appendix

- Cellular Data Rates
- Wireless LAN Data Rates
- Capacity per User-Kbps: Cell Sites Size
- Challenges for 802.11

Cellular Data Rates

Data Communications and Connectivity				
GS/GPRS	N-WWAN	36-50Kbps	100K	GSM
EDGE	N-WWAN	105Kbps	170-384K	GSM
WCDMA/HSDPA	BWN	600-900Kbps	2M	GSM
WCDMA/HSDPA	BWN	4-8Mbps	10-14M	GSM
CDMA/1x RTT	N-WWAN	60-90Kbps	144-307K	CDMA
CDMA/1xEV-DO	BWN	300-500Kbps	2.4-4.8M	CDMA

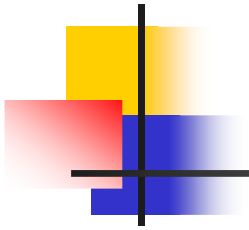
Wireless LAN data rates

WiFi 802.11b	WLAN	5Mbps	11M
Wi-Fi 802.11 a/g	WLAN		54M
WiFi 802.11n	WLAN	100Mbps	500M
WiMAX 802.16a/Rev D	BWN	70Mbps	286M
WiMAX 802.16e	BWN	>1Mbps	10M
809.2	BWN		>1Mbps
FLASH-OFDM	BWN	500Kbps	1.5M
UWB	PAN		500M

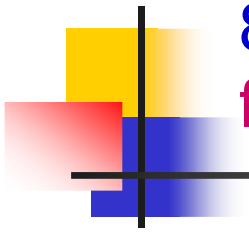
Capacity per User: Cell Size

	Cell Size (Miles)	Power (Watts)	Capacity per user (Kbps)
Big Power (TV/Radio)	>10	~1,000,000	0
Cellular (telephony)	> 1	~10	~10s to 100s
Dense-Cellular (Wi-Fi)	< 1	~1	>>1000s

New Challenges for 802.11



- Today 802.11 is rapidly proliferating all over the planet. technological challenges: **Range**.
  - The farthest a device can currently stray and still receive an adequate signal from an 802.11 access point is about 300 feet — and that's if there are no major walls or other substantial physical obstructions. performance drops off rapidly as you move farther from the access point.
- Other major challenges
  - improve data throughput speeds
  - enhance security, and
  - improve quality of service.



802.11, began in 1985 with a release of 'junk spectrum,' first devices 1990...

- It is a common misconception that 802.11a and g operate in an unlicensed portion of the radio frequency spectrum.
- Unlicensed (legal) operation of 802.11 a & g is covered under Part 15 of the FCC Rules and Regulations.
- Frequencies used by channels one (1) through six (6) (802.11b) fall within the range of the 2.4 gigahertz Amateur Radio band. Licensed amateur radio operators may operate 802.11b devices under Part 97 of the FCC Rules and Regulations.

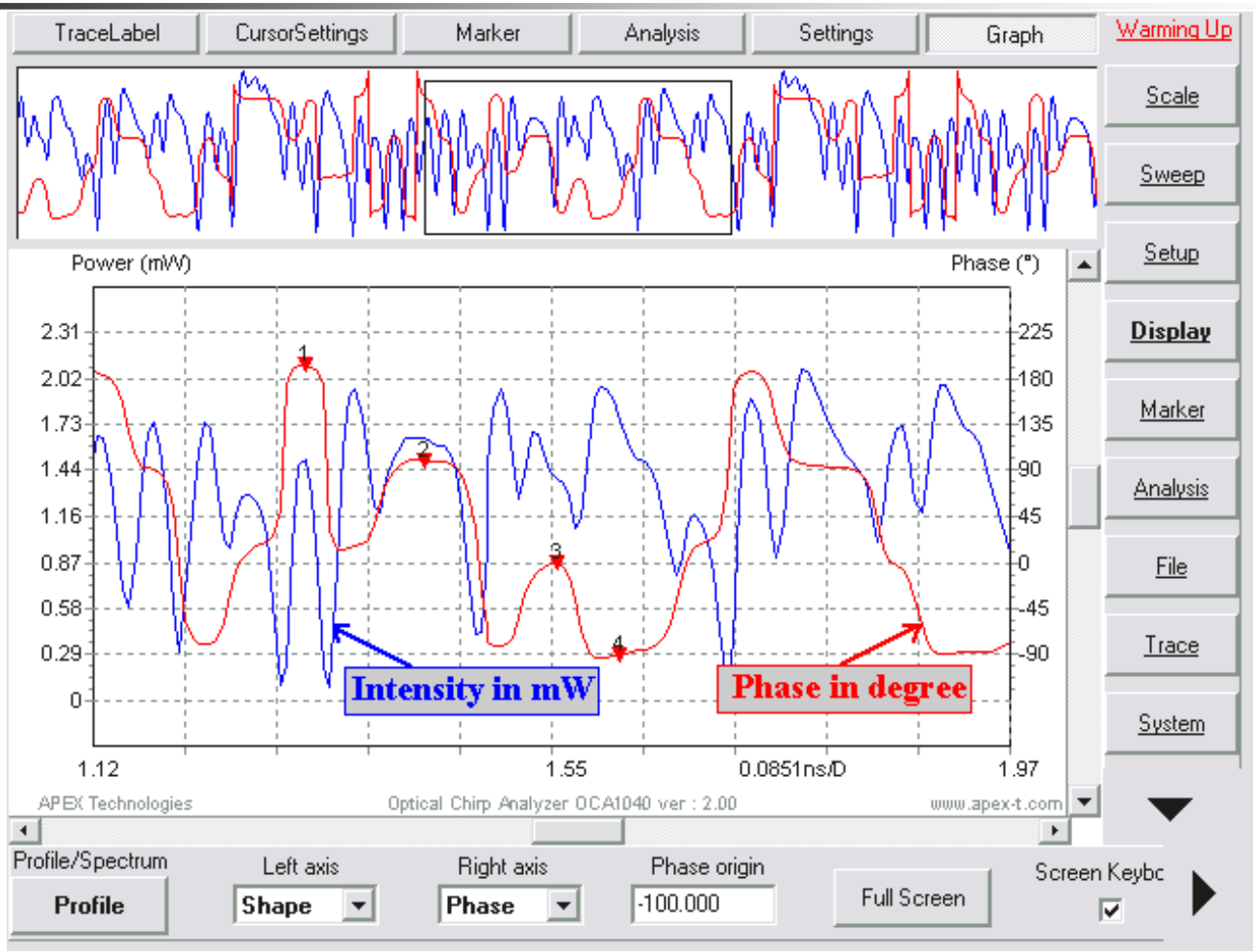
Wireless LAN Throughput by IEEE Standard

IEEE WLAN Standard	Over-the-Air (OTA) Estimates	Media Access Control Layer, Service Access Point (MAC SAP) Estimates
802.11b	11 Mbps	5 Mbps
802.11g	54 Mbps	25 Mbps (when .11b is not present)
802.11a	54 Mbps	25 Mbps
802.11n	200+ Mbps	100 Mbps

History, IEEE Wireless LANs

- IEEE 802.11 - The original 1 Mbit/s and 2 Mbit/s, 2.4 GHz RF and IR standard (1999)
- IEEE 802.11a - 54 Mbit/s, 5 GHz standard (1999, shipping products in 2001)
- IEEE 802.11b - Enhancements to 802.11 to support 5.5 and 11 Mbit/s (1999)
- IEEE 802.11c - Bridge operation procedures; included in the IEEE 802.1D standard (2001)
- IEEE 802.11d - International (country-to-country) roaming extensions (2001)
- IEEE 802.11e - Enhancements: QoS, including packet bursting (2005)
- IEEE 802.11F - Inter-Access Point Protocol (2003)
- IEEE 802.11g - 54 Mbit/s, 2.4 GHz standard (backwards compatible with b) (2003)
- IEEE 802.11h - Spectrum Managed 802.11a (5 GHz) for European compatibility (2004)
- IEEE 802.11i - Enhanced security (2004)
- IEEE 802.11j - Extensions for Japan (2004)
- IEEE 802.11k - Radio resource measurement enhancements
- IEEE 802.11m - Maintenance of the standard; odds and ends.
- IEEE 802.11n - Higher throughput improvements
- IEEE 802.11p - WAVE - Wireless Access for the Vehicular Environment (such as ambulances and passenger cars)
- IEEE 802.11r - Fast roaming
- IEEE 802.11s - ESS Mesh Networking
- IEEE 802.11T - Wireless Performance Prediction (WPP) - test methods and metrics
- IEEE 802.11u - Interworking with non-802 networks (e.g., cellular)
- IEEE 802.11v - Wireless network management
- IEEE 802.11w - Protected Management Frames

40Gb/s QPSK Modulation



New Display mode at high bit rate