VoiceCon
ORLANDO 2008
The Forum for Business IP Telephony

Wireless Technology Update

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Program Description

The range of mobility options is exploding with the introduction of new wireless services and technologies. However, as the collapse of the Muni Wi-Fi business has demonstrated, success is difficult to achieve in deploying radio-based networks, and the wireless business has seen more losers than winners. This session is designed to being you up-to-date on some of the major developments in the wireless arena, where they fit, as well as when and how they will be a factor in enterprise networks.

KEY QUESTIONS:

- Is 802.11n a game-changer in wireless LANs, and how will it impact network planning?
- Is WiMAX service finally a reality, and how will it stack up against 3G cellular services in the near term?
- Have the cellular carriers finally abandoned their "walled garden" strategy and what will that mean for developments like femtocells, fixed-mobile convergence, and Google's Android platform?
- Now that the 700 MHz auctions are complete, who are the winners and losers, and what will this mean in terms of enterprise wireless service options?

Other Wireless Sessions at VoiceCon

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Fixed Mobile Convergence: What's Real for the Enterprise

Tuesday, 2:30 -3:45 PM

Integrating Location-based Services with IP Telephony

Wednesday, 8:00 -8:45 AM

Design Issues in Voice over WLANs

Thursday, 8:00 -8:45 AM

Mobile Security

Thursday, 11:30 -12:30 PM

Program Outline

Section 1: What's up With Wi-Fi

Section 2: WiMAX Arrives!

Section 3: New Cellular Options

Section 4: 700 MHz Plans

My background…

- Independent consultant, writer, and industry analyst
- Over 30-years experience in wired and wireless telecommunications
- Management and engineering positions at ITT, AT&T, and MDS
- Presented over 2000 training programs in the US, Europe, Asia, Africa, and Latin America
- Published over 200 columns and articles in *Business Communications Review*, *Computerworld*, *ACUTA Journal,* …
- Now write on Wireless and Mobility for CMP's *NoJitter* Web Site
- Spoken at numerous industry conferences including InterOp, VoiceCon, Mobile Business Expo, ComNet, Wall Street Tech Assn.
- Just completed my first book: *Voice over Wireless LANs: The Complete Guide* (Elsevier, December 2007)
- MBA in Marketing and MIS from Northwestern University and a member of the IEEE

1. What's Up with Wi-Fi?

Major Wi-Fi Developments

- The 802.11n Radio Link
- Voice over Wireless LANs
  - Improved Security
  - 802.11e/WMM Quality of Service
  - WLAN Switch infrastructure for manageability and handoffs
  - Improved Battery Life
  - Network Management Requirements

802.11n Radio Link Highlights

- Major increase in WLAN data rates, range, and reliability (The Three-R's)
- Technical Highlights:
  - Orthogonal Frequency Division Multiplexing (OFDM) based
  - Multiple Input-Multiple Output (MIMO) Antenna Systems (up to 4 Transmit Chains)
  - Can operate in either 20 MHz or 40 MHz channels
  - Operates in either the 2.4 GHz or 5 GHz band
  - Backwards compatible with 802.11a, b, or g, but with significant performance penalties
  - Includes MAC Layer enhancements to improve efficiency

Comparison of 802.11 Radio Links

Standard	Channel Bandwidth	Maximum Transmission Rate	Signal Encoding
802.11 (1997)	22 MHz	2 Mbps	Direct Sequence Spread Spectrum
802.11b (1999)	22 MHz	11 Mbps (5.5x)	Complementary Coded Keying
802.11a/g (2000/03)	20 MHz	54 Mbps (4.9x)	OFDM
802.11n (2007)	20 MHz	289 Mbps (5.3x)	OFDM with 4-Chain MIMO

IEEE 802.11n Data Rates (20 MHz Channel)

Modulation Scheme	FEC	Data Rates (Mbps)							
		1 Stream		2 Streams		3 Streams		4 Streams	
		Guard Interval		Guard Interval		Guard Interval		Guard Interval	
		800ns	400ns	800ns	400ns	800ns	400ns	800ns	400ns
BPSK	1/2	6.5	7.2	13.0	14.44	19.5	21.7	26.0	28.9
QPSK	1/2	13.0	14.4	26.0	28.89	39.0	43.3	52.0	57.8
QPSK	3/4	19.5	21.7	39.0	43.33	58.5	65.0	78.0	86.7
16-QAM	1/2	26.0	28.9	52.0	57.78	78.0	86.7	104.0	115.6
16-QAM	3/4	39.0	43.3	78.0	86.67	117.0	130.0	156.0	173.3
64-QAM	2/3	52.0	57.8	104.0	115.56	156.0	173.3	208.0	231.1
64-QAM	3/4	58.5	65.0	117.0	130.00	175.5	195.0	234.0	260.0
64-QAM	5/6	65.0	72.2	130.0	144.44	195.0	216.7	260.0	288.9

Issues to Address with 802.11n

- Will require new access points and WLAN NICs
- Different coverage pattern than 802.11a, b, g, so new site survey tools will be required for network design
- Wireless intrusion detection/prevention systems (WIDS/WIPS) will have to be upgraded to detect 802.11n-networks
- Backwards compatible with 802.11a/b/g, but with a major penalty in performance (*Greenfield Mode* or *All-n* network preferred)
- Should we run 802.11n in the 2.4GHz or 5 GHz band?
- A 5 GHz implementation would avoid existing b/g networks, but many organizations were looking at 5 GHz for WLAN voice networks.
- 802.11n access points will require 1 Gbps Ethernet connections to the wired LAN
- 802.11n access points may not work with standard 802.11af Power over Ethernet so infrastructure upgrades might be required

Voice over Wireless LANs (VoWLAN, Vo-Fi, WVoIP)

- WLAN voice is still in its infancy, but holds significant promise
  - Current implementations limited to a few vertical markets
  - Primarily: Health care, materials handling, and retail
  - Next Step: Moving up to management
- Acceptable voice quality requires a sound network design that insures dense, pervasive coverage, sufficient network capacity and handoff capability
- Large scale installations require centrally-controlled WLAN switches
- Key WLAN features for voice support:
  - Support for 802.11a/b/g radio links (802.11n eventually)
  - 802.11e/WMM Quality of Service
  - Automatic Power Save Delivery (APSD) and other battery features
  - Call Admission Control/Load Balancing
  - Capacity planning and troubleshooting tools

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Design Issues in Voice over WLANs- Thursday, 8:00 -8:45 AM

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2. WiMAX Arrives

Options for Metro-Area/Wide Area Wireless

- Cellular Carriers
  - Voice
  - 2.5G/3G Data Service (up to 700 Kbps Downstream)
  - Mobile Video (Coming)
- WiMAX
  - Multi-megabit data service (up to 2 M or 4 Mbps)
  - Potentially voice (VoIP or Real-time Polling Service)
- Municipal Wi-Fi
  - Does not appear to be a viable business model for carriers

The Two WiMAX's- Fixed and Mobile

- Fixed/Nomadic: IEEE 802.16- 2004 (Originally 802.16d)
  - With the fixed-location version, a user could access the network from a stationary position anywhere in the coverage area (*Nomadic* service).
  - US carriers have made few commitments to deploy fixed-location WiMAX, though many smaller regional operators do sell broadband wireless Internet access using pre-WiMAX technologies.
- Mobile WiMAX: IEEE 802.16-2005 (Originally 802.16e)
  - The Mobile WiMAX technology uses a different radio interface and includes a hand-off capability so a user could stay connected while they move through the service area.
  - A carrier deploying mobile WiMAX could support fixed, nomadic, or mobile broadband wireless access. As a result, mobile WiMAX could serve as an alternative to ADSL, cable modem, Wi-Fi Hot Spots, or 3G cellular data services.
  - Sprint/Nextel and Clearwire Communications are deploying networks, but nationwide availability could still be years away.

What Talks to WiMAX?

- WiMAX: Open or Closed?
  - "Open"
    - A user could buy a WiMAX modem at any retail store, connect it to their laptop or PC, and get on the network--like Wi-Fi. The user would need an a account with a WiMAX provider.
    - The other advantage of an open standard is that the consumer could buy a device with a WiMAX modem built-in, and use it on any WiMAX network.
  - "Closed"
    - In the cellular model, the consumer must buy their data card (or their handset) from their specific cellular carrier, and that card can only be used on that carrier's network.
- WiMAX will debut as an open network
  - External modems will still be used for fixed applications
  - WiMAX modem integrated in laptops
  - WiMAX voice handsets planned
  - Wi-Fi Router with WiMAX backhaul
  - Mobile WiMAX interface for consumer electronics

Municipal Wi-Fi Movement

- Original Idea: Socialist Networking
  - The city would build and operate a Wi-Fi Mesh network itself.
  - Besides supporting city workers, the city would act as a carrier and provide broadband Internet service to individuals and businesses.
  - The justification was based on the idea of making the city a better place to visit or to do business and provide Internet access to underserved poor neighborhoods ("Bridging the digital divide").
  - Carriers went ballistic at the idea of competing with the government!
- “Philadelphia Plan”: Privately-owned, City-sponsored
  - The Philadelphia city government formed a semi-private corporation called Wireless Philadelphia who was charged with requesting/evaluating bids and developing a business plan.
  - Wireless Philadelphia selected a supplier (i.e. EarthLink), and guaranteed them access to lamp posts to install the access points for which EarthLink pays a fee.
  - The city government also signed up as the first customer ("Anchor Tenant"), and is given special discounted rates.
  - EarthLink will also provide discounted access for low-income customers, free Hot Spot services in about 20 locations, and offer services to the public at city-approved rates (around $20 per month).

Collapse of the Muni Wi-Fi Business

- Major Problems:
  - Expensive: Required 40 mesh access points per square mile
  - Subscription price was unrealistically low: Grossly underestimated the ongoing operations costs of the service.
  - Poor Indoor Service: Indoor service required a repeater that the customer would place by a window.
  - Interference: Interferes with all other home- and office-based Wi-Fi networks
  - Poor Business Sense: In the end it appears that the parties involved lacked any sense for what was involved in building and running a network, and political posturing didn't pay the bills.
- EarthLink Bows Out
  - Mid-2007 EarthLink, the largest operator of these networks, announced they would no longer pursue bids unless the city government agreed to become the "anchor tenant".
- Private Networks Continue- 4.9 GHz
  - There is still a market for private networks that are owned and used by the city government itself.
- Shouldn’t This Be a WiMAX Network?

Potential WiMAX Providers

- Sprint's Xohm Service
  - Major announcement in 2006 with plans to invest $5 billion to deploy Mobile WiMAX service to reach 1/3 of the US population by YE '08
  - Significant holdings in the licensed 2.5 GHz band (Nextel)
  - Service currently in limited trials in Chicago and Baltimore/Washington
  - Ongoing Business Problems:
    - In October 2007, Gary Forsee, Sprint's CEO, was forced to step down and was replaced by Dan Hesse.
    - Sprint lost about 300,000 post-paid subscribers in 2007, posted significant losses, has ongoing problems integrating Nextel, laid off 4K in January '08, and fired several C-level executives.
    - In 2007, Sprint announced and then suspended a joint marketing agreement with Clearwire
    - In January 2008, announced the Clearwire agreement might be resurrected, and Google and Intel might be interested in investing.
    - It remains to be seen if Sprint/Nextel's ongoing problems will allow them to fulfill the WiMAX promise
    - Official service introduction is planned for April '08, but limited coverage will likely require a plan that includes EV-DO as well.

Potential WiMAX Providers

- Independent BWA Carriers
  - Clearwire Communications (Craig McCaw)
    - Pre-WiMAX Fixed Service in dozens of small markets--394K subscribers
    - Significant 2.5 GHz frequency holdings
    - In 2006, received $900 MM investment from Intel and Motorola, but still need more capital to expand nationwide
    - In January 2008, Clearwire announced they were scaling back their deployment plans for mobile WiMAX. The plan is now to provide service for 6 million potential customers rather than the 30.5 million they had originally targeted.
  - Lots of smaller regional operators and some enterprise providers like TowerStream and NextPhase.
    - Most of those are using pre-WiMAX equipment, which puts them outside the “WiMAX ecosystem”.
    - No roaming, no integrated modems, no chip-level components…

Other Potential WiMAX Providers

- Incumbent LECs
  - Could use WiMAX to increase their broadband coverage in areas where it is not economical to deploy ADSL
  - Independent telco TDS introduced service in Madison, WI in 2008.
  - Lots of trials--few service announcements (AT&T currently testing a WiMAX service in Alaska)
- WiMAX in Developing Countries
  - Possibly the biggest market for fixed-location WiMAX will be in developing countries.
    - Countries like China and India have little in the way of cable plant connecting residential customers.
    - Voice service is provided by cellular telephone and their video service comes via satellite.
    - With no copper wire there is no potential for ADSL and with no coaxial cable, cable modem service is out of the picture.
  - WiMAX could be the third wireless link to deliver broadband Internet service.

WiMAX Conclusion

- WiMAX looks great on paper and has major support from Intel, Motorola, Samsung, Nokia, Nortel, and others
- The standards are carrier-scale and cover virtually every conceivable option:
  - Fixed and Mobile
  - Integrated Encryption
  - QoS Capability for Voice or Data
  - Licensed or Unlicensed Spectrum- 2 G to 66 GHz
  - Can incorporate next-gen MIMO and beam-forming technologies
- However, the biggest proponents, Sprint and Clearwire, are facing significant business challenges.
- For the moment, the technology is essentially untested and its competitive posture to other wireless technologies is unknown:
  - Cost/performance
  - User device availability- laptop cards, handsets, etc.
  - Ability to share cellular infrastructure (e.g. indoor antenna systems)
  - Scalability and expansion
  - Indoor operation
  - Support requirements
- This might be the worst product introduction since ISDN!

3. Cellular Developments

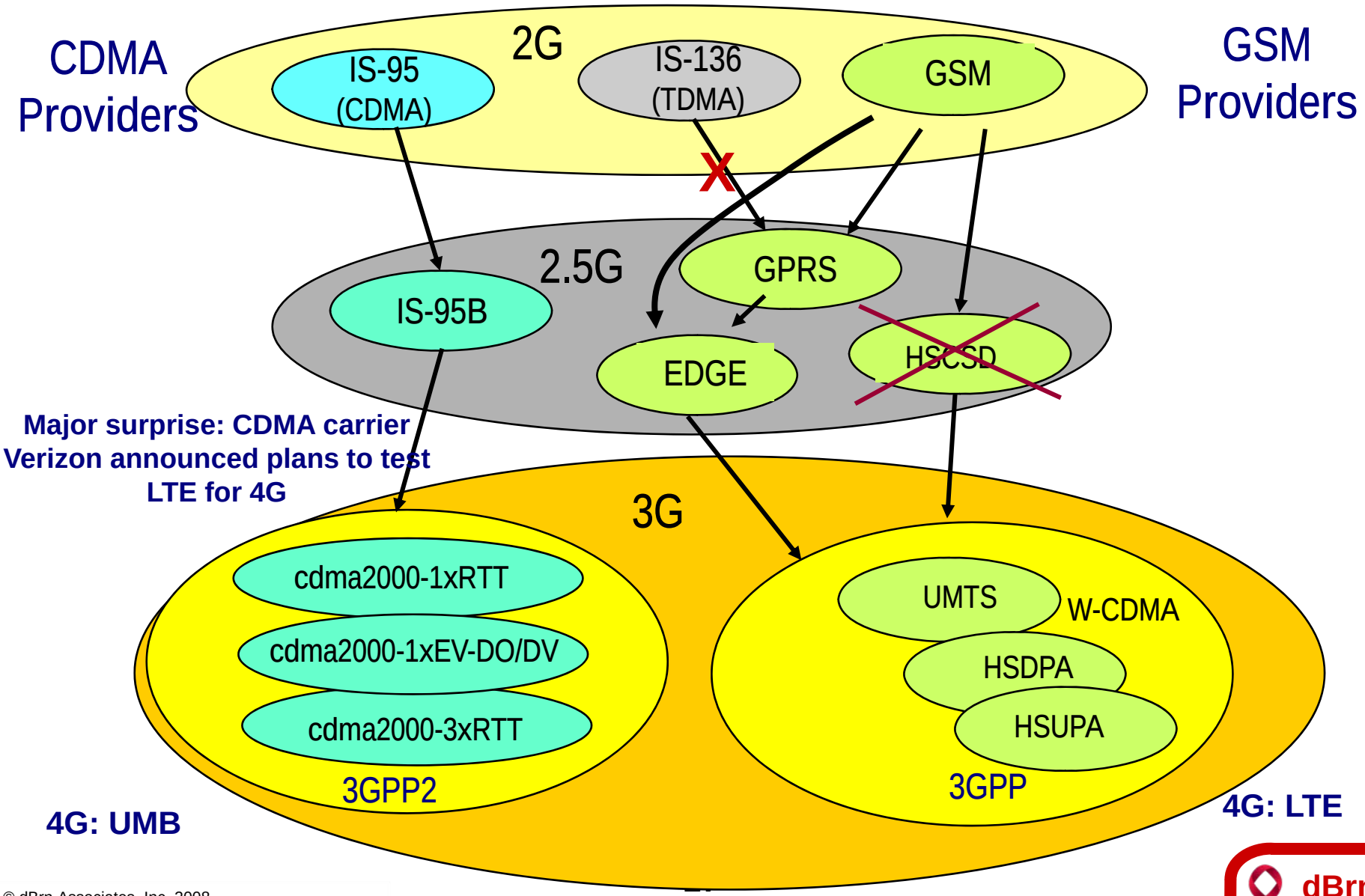
Cellular Developments

- Open Handset Initiatives
  - iPhone Factor
  - Google's Android
  - Verizon's "Any Apps, Any Device"
- Wireless Data Upgrades
- Mobile Video
- Fixed-Mobile Convergence

Open Handsets

- The Faustian Bargain
  - Carriers underwrite the cost of the handset, but lock it and require a long term contract
  - If it's lost, customer pays full price for a replacement.
  - Result: Limited number of mediocre options offered by the carriers, and the subsidy virtually eliminates any real consumer market for handsets.
- iPhone Changed the Game
  - Showed that people would spend big money for a hot handset
  - Apple's "bricking" plan demonstrated that they could be even more draconian than the cellular carriers
- Glimmers of Hope
  - Verizon is offering to certify any CDMA handset device- but how big a discount will we get on the service plan?
  - Qualcomm makes a chipset that supports both GSM and CDMA 3G offerings
  - Fixed-mobile convergence will bring increased pressure; carriers are not likely to subsidize handsets that work on other networks
  - Google and Yahoo are promoting development platforms that tie into their services
- In the end, the carriers are still holding all of the cards.

Migration Paths to 3G



Major surprise: CDMA carrier Verizon announced plans to test LTE for 4G

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Summary of 2.5G/3G Data Services

	GSM-Based Networks				CDMA-Based Networks		
	GPRS	EDGE	UMTS	HSDPA	1xRTT	1xEV-DO	1xEV-DO Rev A
Radio Access	TDMA	TDMA	CDMA	CDMA	CDMA	CDMA	CDMA
Theoretical Rate	170 K	473.6/384 K	2.4M/307K	14 Mbps	144 K	2.4M/153K	3.1M/1.8Ms
Actual Rate	20-40K	100-120 K	200- 250K	500-700 Kbps	50-70K	300- 500K	500- 700K

Challenges with Mobile Video

3G Cellular data services like are not designed to deliver multiple, high-capacity (e.g. >100 Kbps) video streams

- Relatively low-capacity networks
- Radio channels are shared within a cell or sector
- Capacity allocation and poor signal quality can cause the video to freeze
- Channel changing is slow
- Bi-directional protocols
  - Client devices send acknowledgements and transmit requests
  - Drains the mobile device's battery more quickly

New Mobile Video Technologies

- Two Alternative Technologies Proposed:
  - Digital Video Broadcast- Handheld (DVB-H)- ETSI Standard
  - MediaFLO ("Forward Link Only")- Qualcomm proprietary
- Both are designed for:
  - Light
  - Handheld
  - Battery-powered
  - Fixed, portable, or mobile (pedestrian and vehicular speed) terminals
  - Multiple channels: 20- to 24- small screen videos in a 6 MHz band
  - Fast channel changing
- At 700 MHz, only 4- to 6-transmitters required for a city!

Fixed Mobile Convergence (FMC)

Options for Implementing FMC

The ability to transparently handoff calls between cellular and private networks

1. Non-Integrated Solutions
   - Dual Mode Wi-Fi/Cellular Handsets, No handoffs
   - Indoor Cellular, No Wi-Fi (Microcells, Radio Repeaters, Distributed Antenna Systems [DAS])

2. PBX-Controlled Solutions: Basic Voice or Mobile Unified Communications
   - Manual Transfer
     - Simultaneous Ring/Extension to Cellular
     - User Initiated Hand-off
   - Automated Transfer: Agito, Avaya, DiVitas, Firsthand, Siemens

3. Carrier-Controlled Solutions
   - Manual Transfer
   - Automatic Transfer
     - WLAN Based (WLAN/Cellular Handset): UMA, IMS
     - Femtocells (Cellular Only)

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Fixed Mobile Convergence, Tuesday, 2:30 PM

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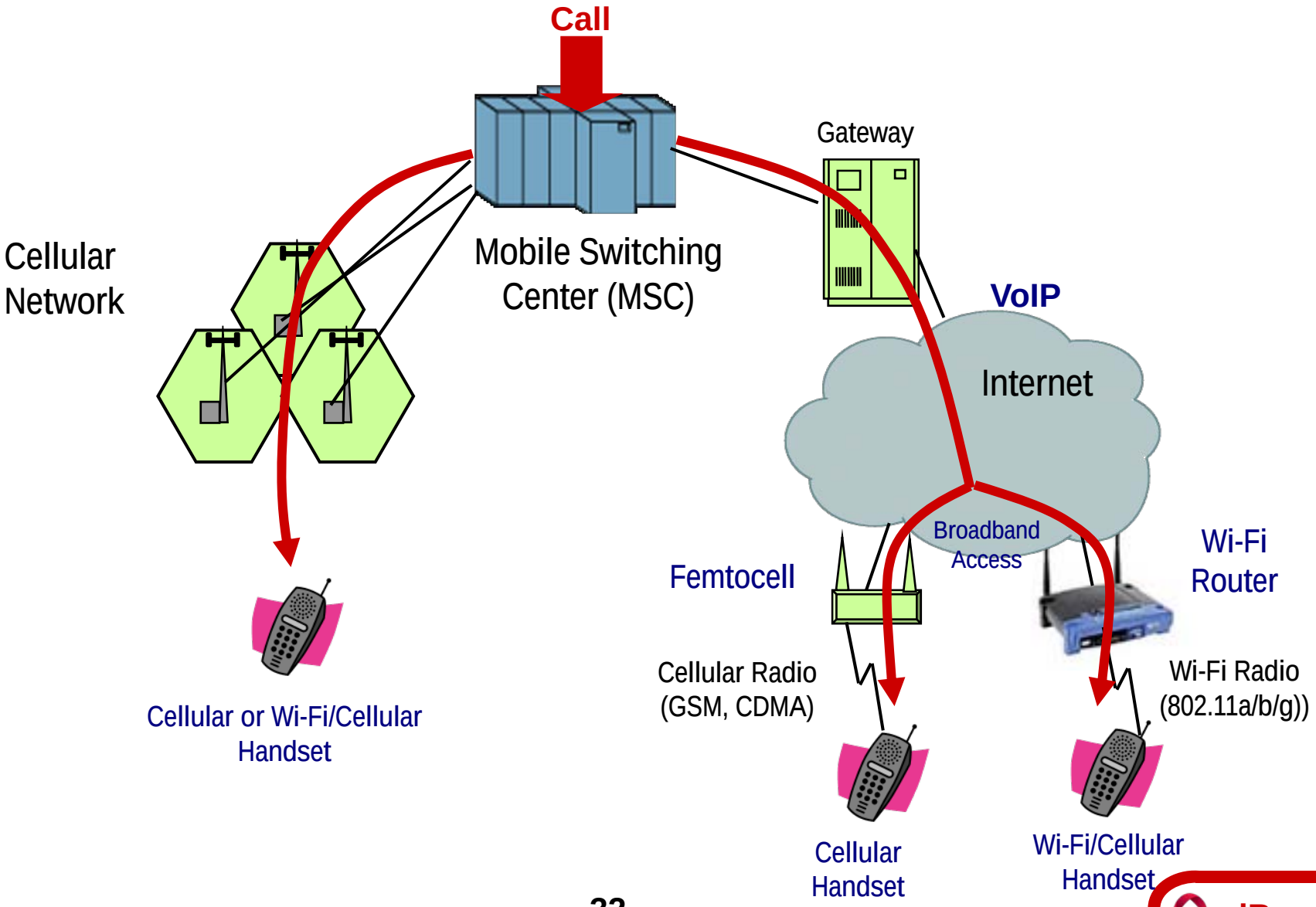
Overview of Carrier Controlled Options



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Cellular Carrier Motivation

- Improved Indoor Coverage: WLANs can provide better indoor coverage than cellular networks
- Lower Cost Indoor Coverage: Eliminate the need to deploy radio repeaters, distributed antenna systems, and other indoor coverage solutions
- Load Shedding: Shifting calls to unlicensed WLAN channels would increase the call handling capacity of the cellular network
- Competition: Customers are clearly interested in this capability. If one carrier introduces the service, everyone else will have to follow suit to stay competitive.

Cellular Carrier Concerns

- Cellular carriers have been less than enthusiastic about FMC initiatives for several reasons:
  - Customer Control: Cellular carriers have enjoyed a unique franchise in mobile voice service that commands a premium price
  - Quality Control: Will the cellular carrier be held responsible for poor call quality or disconnects caused by WLAN screw-ups?
  - Revenue Impact: How will the cellular carrier be compensated?
  - Handset Subsidies: Will the cellular carrier be underwriting the cost of a handset that makes WLAN calls?
  - Security Control: Will WLAN security flaws open security vulnerabilities in the cellular network?

4. 700 MHz Plans

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New Spectrum Options

- Licensed 700 MHz
  - UHF Broadcast TV Channels 52 to 69 (108 MHz)
    - 24 MHz (Channels 63-64, 68-69) for Public Safety
    - 84 MHz (Channels 52-62, 65-67) auctioned
  - Available with the transition to digital broadcast TV (February 17, 2009)
- TV White Space Initiative
  - Plan to allow unlicensed operation in guard bands between adjacent TV channels
  - First test system failed in August 2007, but tests are ongoing
- Unlicensed 3.6 GHz Broadband Wireless Access
  - 50 MHz (3.65 to 3.70 GHz) allocated, first operating permissions granted in December '07
- Unlicensed: 5 GHz U-NII Band
  - Increased from 300 MHz to 555 MHz in 2003
  - 100 MHz indoor only, 100 MHz outdoor only, 355 MHz indoor/outdoor

700 MHz Highlights

- Digital Broadcast Video
  - Analog broadcast video in the US will cease February 17, 2009
  - Analog receivers will require a converter to receive digital broadcasts
  - Should not affect cable or satellite TV subscribers
  - All broadcast license holders have been assigned new transmission channels between channels 2 and 51
- Plan frees up UHF TV Channels 52 to 69 (108 MHz)
  - 24 MHz (Channels 63-64, 68-69) for Public Safety
  - 84 MHz (Channels 52-62, 65-67) auctioned
- Special Rules:
  - C Block: 22 MHz but winners must support “open” devices
  - D Block: Commercial licensees will form a Public Safety/Private Partnership to develop a shared, nationwide network for commercial and public safety users.

700 MHz Frequency Allocations

Lower 700 MHz Band (48 MHz)							
Name	Type	Licenses	TV Channel	Band (MHz)	TV Channel	Band (MHz)	Total B/W
A	EA	176	52	698-704	57	728-734	12 MHz
B	CMA	734	53	704-710	58	734-740	12 MHz
C	CMA	734	54	710-716	59	740-746	12 MHz
D	EAG	6	55	716-722			6 MHz
E	EA	176	56	722-728			6 MHz

Upper 700 MHz Band (36 MHz)							
Name	Type	Licenses	TV Channel	Band (MHz)	TV Channel	Band (MHz)	Total B/W
A	MEA	52	61*	757-758	66*	787-788	2 MHz
C	REAG	12	60/61*	746-757	65/66*	776-787	22 MHz
D	NAT'L	1	62*	758-763	67*	788-793	10 MHz
B	MEA	52	64*	775-776	69*	805-806	2 MHz
*Split Channels							

Potential 700 MHz Advantages/Applications

- Range Advantage
  - The 700 MHz band provides greater range and better wall penetration
    - Two times the range of 1.9 GHz (PCS digital cellular)
    - Four times the range of 2.5 GHz (Licensed WiMAX Band)
- MIMO Impact:
  - Minimum MIMO antenna spacing is 1/2 wavelength
  - At 700 MHz the wavelength is 42.85 cm so the antenna spacing is 21 cm (approx. 10 inches)
  - That will have an impact on the number of transmit chains and the size of the device
- Potential Applications
  - New wireless carriers (e.g. Google)
  - Licensed WiMAX (Requires a radio spec for 700 MHz operation)
  - Cellular Voice Competition
  - Mobile Video: MediaFLO, DVB-H
  - Enterprise special access alternatives

Conclusion

- Get started now!
  - Start small and expand
  - Develop wireless expertise
  - Track developments in the area
  - Talk to your users about how mobility can impact their business processes
- Cellular management is the next big frontier:
  - Need contract plans that cover wired and wireless
  - Dual line handsets for joint business/personal use
  - Why isn't 100% ubiquitous wireless data access commonplace today?
  - Fixed Mobile Convergence is only the first step
  - True unified communications mobile integration should be the real goal
- Pray for WiMAX
  - This is the best hope for competition in the wide area wireless space
  - May still take years to become a real nationwide offering
- The eventual mobility solution will likely involve a combination of these technologies to support the full range of applications and the best coverage

Some Cautions

- Unrealistic, unfounded speculation abounds in the wireless area
  - Capacity: Still limited when compared to wired service
  - Service Cost:
    - Assured availability and higher capacity cost more money
    - Wi-Fi Availability: You go to it
    - Cellular Availability: It comes to you, at a price. Availability of high-capacity service still limited (pay for HSDPA, get EDGE)
  - Reliability: Not up to wired networks but improving
  - Availability: Indoor/outdoor, major/minor markets, international
- Building a functional wide area mobile wireless service is difficult
  - Significant capital expenditures
  - Considerable technical expertise is required
  - Every new wireless technology has start-up problems

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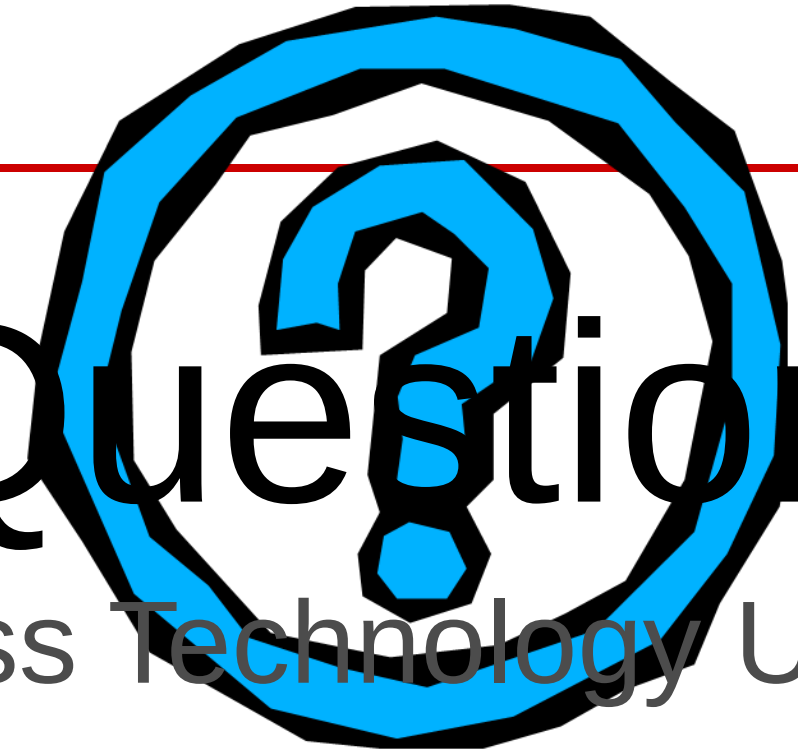

Questions

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