

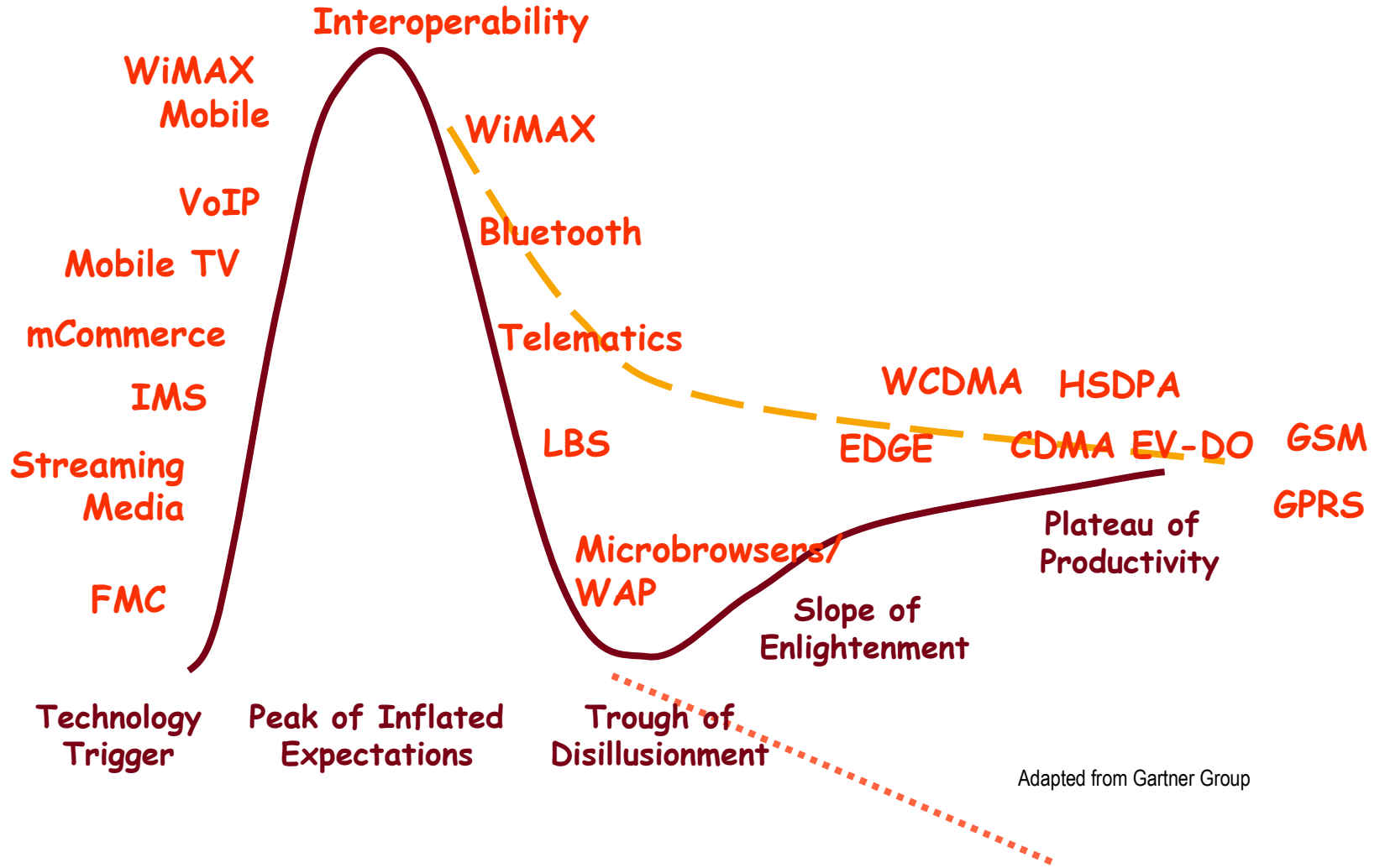
WiMAX, Cellular And Wi-Fi



Andrew Seybold Group, LLC

Andrew Seybold
andy@4mobility.com

Wireless Hype Cycle





My Statement Still Remains Unchallenged!

“No single terrestrial provider of wireless Internet data-only services has ever made money.”



Wide-Area Technologies

Full Mobility on Two-Way Networks



Wide-Area Fully-Mobile Two-Way Technologies

EDGE

WCDMA

HSDPA

HSUPA

MBMS

WCDMA Rel 7

CDMA2000 1xEV-DO

EV-DO Rev A

EV-DO Rev B

EV-DO Gold

EV-DO Platinum

WiMAX Mobile

WiBRO

IP Wireless

Flarion

IEEE 802.20



WCDMA

- Initial standards April 1999 (Rel 99, 5-MHz carrier)
- Rel 4 (2001), Rel 5 (2002), Rel 6 (2005)
- Rel 5 (HSDPA, IMS, IP UTRAN)
- Rel 6 (HSUPA, MBMS)
- Rel 5 currently being deployed, Rel 6 late 2007
- Rel 7 (fine tuning, MIMO, UTRAN performance 2008/9)
- Rel 8 & longer-term evolution 2010/12 (LTE) includes support for all-IP, lower latency, faster data
- 2012 and beyond (ITU-R working party 8f, G4G)
- Conclusion: Quickly closing the gap with EV-DO



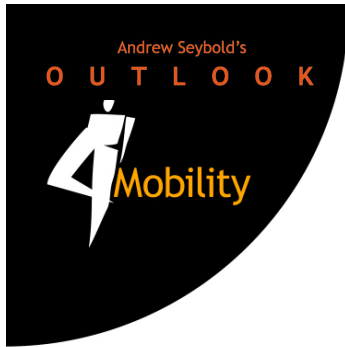
WCDMA HSDPA

- Evolution to shared high-speed forward link channel
- Reverse link channel will ultimately determine coverage
- Requires new terminal but compatible with Rel 99
- Rake receiver limited, diversity fix in Rel 6
- Impacted by location of customers in cell
- Chip supply looks good (plenty beyond Qualcomm)
- Cards, handsets and integrated laptops available from many suppliers (we quickly identified 14 vendors)
- Intel is NOT listed on Qualcomm lists of companies that have licensed its technologies (www.qualcomm.com/qtl/)



WCDMA HSUPA

- Enhanced uplink (E-DCHA key Rel 6 feature) to go beyond Rel 99 384-Kbps uplink (Enhanced Dedicated Channel)
- Study concluded Mar 2004, spec published Dec 2004, finalized during 2005
- Cingular conducting field trials (1.25-2 Mbps claimed)
- Leverages many features from HSDPA (TTI between 2 and 10 msec)
- LTE targets 2-3 Mbps in 2008/9 timeframe



WCDMA MBMS (Multimedia Broadcast Multicast Service)

- Another integrated key feature of Rel 6
- Best effort point-to-multipoint service
- Two modes of operation (broadcast/multicast)
- Multicast most likely subscription-based group call
- Can consume between 7% and 30% of a cell's capacity and will probably be drawback to MBMS services
- Technical info
 - WCDMA 5-MHz carrier can support 16 channels at 64 Kbps and 6 channels at 128 Kbps
 - 128 Kbps at 15 FPS+12.2 Kbps for voice (sports application)
 - Can support 10-20 channels at 128 Kbps and 20-40 at 64 Kbps



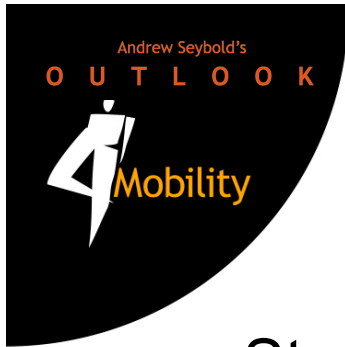
Analysis Of WCDMA

- Spectral efficiency is a good benchmark for any system's relative cost/benefit and Rel 6 much improved over Rel 99
- Great progress catching up to EV-DO
- No free lunch
 - Antenna diversity (MIMO) = more antenna site rental cost
- Capacity demands will probably drive deployments
 - Advantages to 1900-MHz deployment = added capacity and better in-building coverage because cell sites are more dense than at 850 MHz
- Speed vs. coverage decisions
 - 2 Mbps mobile = 1 mile radius cells @1900 MHz
 - Building penetration is another cost driver
- AMR 5.9 voice quality drives cost
- Requires higher S to N as modulation complexity increases
- Wide selection of chip/device vendors due to GSM global dominance



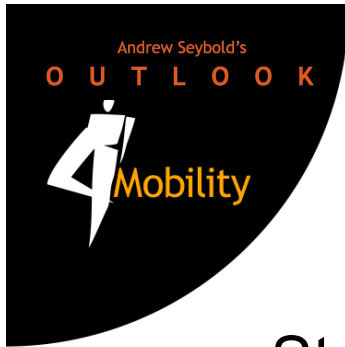
CDMA2000 1xEV-DO Rev 0

- Standard approval
 - Approved by ITU April 2002
- Network infrastructure available for installation
 - Q3 2002
- Mobile chipset available to device manufacturers
 - Q2 2002
- Mobile device available
 - Q4 2002
- Commercial network available
 - Q4 2002
- Key technology platform characteristics
 - Data-only
 - 500-700 Kbps forward link (avg. throughput)
 - 60-80 Kbps reverse link (avg. throughput)



CDMA2000 1xEV-DO Rev A

- Standard approval March 2004
- Network infrastructure available for installation
 - Q1 2007
- Mobile chipset available to device manufacturers
 - Q1 2006 (engineering samples of 6800 Q1 2005)
- Mobile device available
 - Sierra Wireless card beta today, ship Q3 2006
- Commercial network available
 - Late 2006 (few test markets) full deployment 2007 and early 2008
- Key technology platform characteristics
 - 3.1 Mbps forward link, 1.8 Mbps reverse link
 - 1.5 Mbps multicasting
 - QoS embedded in this release
 - Capability to support VoIP



CDMA2000 1xEV-DO Rev B

- Standard approval
 - Q1 2006
- Network infrastructure available for installation
 - Q4 2007
- Mobile chipset available to device manufacturers
 - Q1 2007
- Mobile device available
 - Q1 2008
- Commercial network available
 - Q1 2008 and fully backward compatible
- Key technology platform characteristics include dynamically scalable bandwidth up to 20 MHz
 - Up to 73.5 Mbps forward link (15 carriers possible/not practical)
 - Up to 27 Mbps reverse link (15 carriers possible/not practical)



CDMA2000 1xEV-DO Gold (Multicast)

- Standard approval
 - No change in standard—Runs on REV 0
- Network infrastructure available for installation
 - 2006
- Mobile chipset available to device manufacturers
 - 2006
- Mobile device available
 - 2006
- Commercial network available
 - 2006 key technology platform characteristics
 - Multicast capabilities
- Not requested by any network operator we are aware of



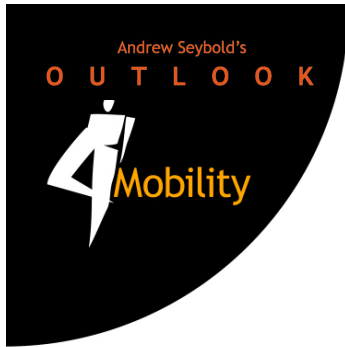
CDMA2000 1xEV-DO Platinum

- Standard approval
 - No new standard, enhancements only—Runs on REV A
- Network infrastructure available for installation
 - Q3 2006
- Mobile chipset available to device manufacturers
 - Q3 2006
- Mobile device available
 - Q1 2007
- Commercial network available
 - Q1 2007 Key technology platform characteristics
 - Additional multicast capabilities
- Not requested by any network operator we are aware of



Analysis Of CDMA2000 1xEV-DO

- No compelling reason for existing CDMA operators to change to WiMAX or UMTS technology
- WCDMA argument that EV-DO cannot dynamically allocate between voice and data mitigated by Rev A
 - Erlang capacity compatible to circuit switched
- Rev B in 2008 introduces dynamically scalable bandwidth
 - Claims of 1-10 combined carriers, practical limit is 7 (10 MHz)
- Exact features of Rev C still in development
 - Advanced smart antenna technology and combining carriers to create larger channel bandwidth
 - May also see aggressive use of OFDM



Developing Wide-Area Mobile Technologies

WiMAX Mobile (802.16e)

WiBRO

Flarion

IEEE 802.20



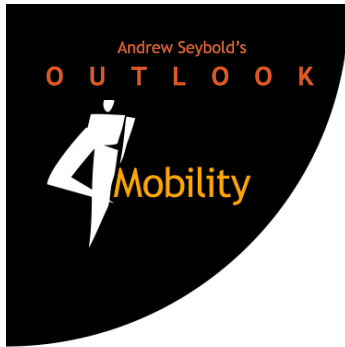
WiMAX Mobile (802.16e)

- Standard approval
 - 12/2005
- Network infrastructure available for installation
 - Mid 2006
- Mobile chipset available to device manufacturers
 - Mid 2006
- Mobile device available
 - Q4 2006
- Commercial network available
 - Q3 2007
- WiMAX portable may be bypassed in favor of mobile
 - There are implications for Clearwire's upgrade path
- Key technology platform characteristics (see speed charts)



WiMAX—The Politics

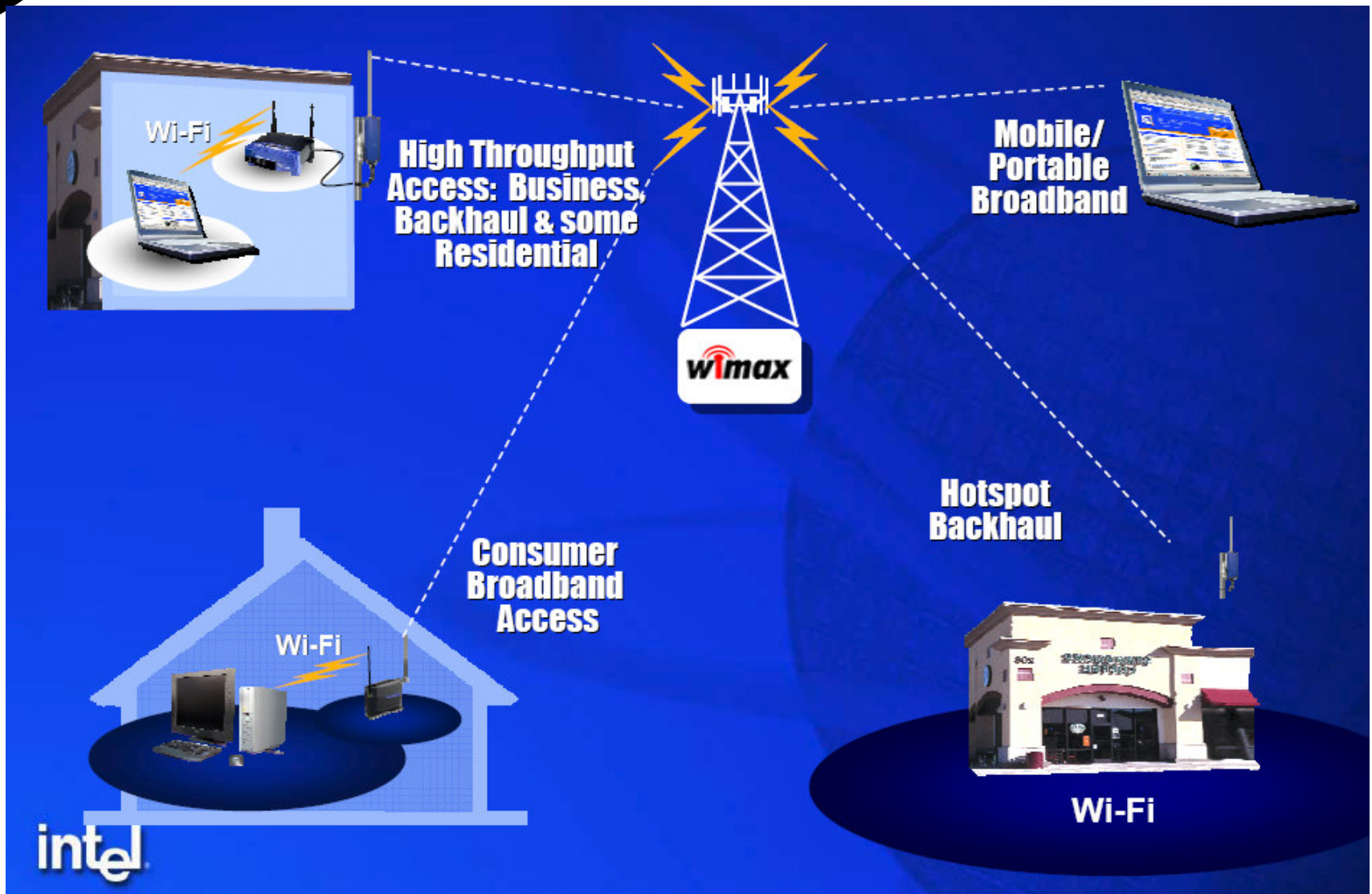
- WiMAX coming to wireless industry from computer industry
- Aggressively pushed by Intel (\$600 million investment in Clearwire)
- Today on licensed spectrum (2.3, 2.5 and 3.5 GHz) and unlicensed spectrum (5.9 GHz)
 - In U.S. Intel is aggressively pushing for 700-MHz licensed and TV shared (unlicensed) spectrum for WiMAX
- Some network operators not interested in WiMAX mobile because it could compete with their 3G mobility play
- Gaining momentum but business case issues remain
 - What happens if Intel drops the price of WiMAX chips to build market acceptance?
 - Intel's chipsets are designed for notebooks not handhelds



WiMAX: Financial Implications

- Can a WiMAX mobile system built out at 2.5 GHz compete with existing technologies that are:
 - Already in the ground
 - Huge Capex issues
 - Have millions of voice and data customers
 - Offer thousands of devices for customers to chose from?
- In the United States at least, the 2.5 GHz spectrum is already licensed
 - Only WiMAX hardware vendors can make money
 - Will Clearwire ever make money?
- Will a bidder that wants to deploy WiMAX show up at the AWS auctions in August? (Intel?)
 - Create one-off system, high capex, high cost of handsets

Intel WiMAX: Still Fixated On Fixed Use?

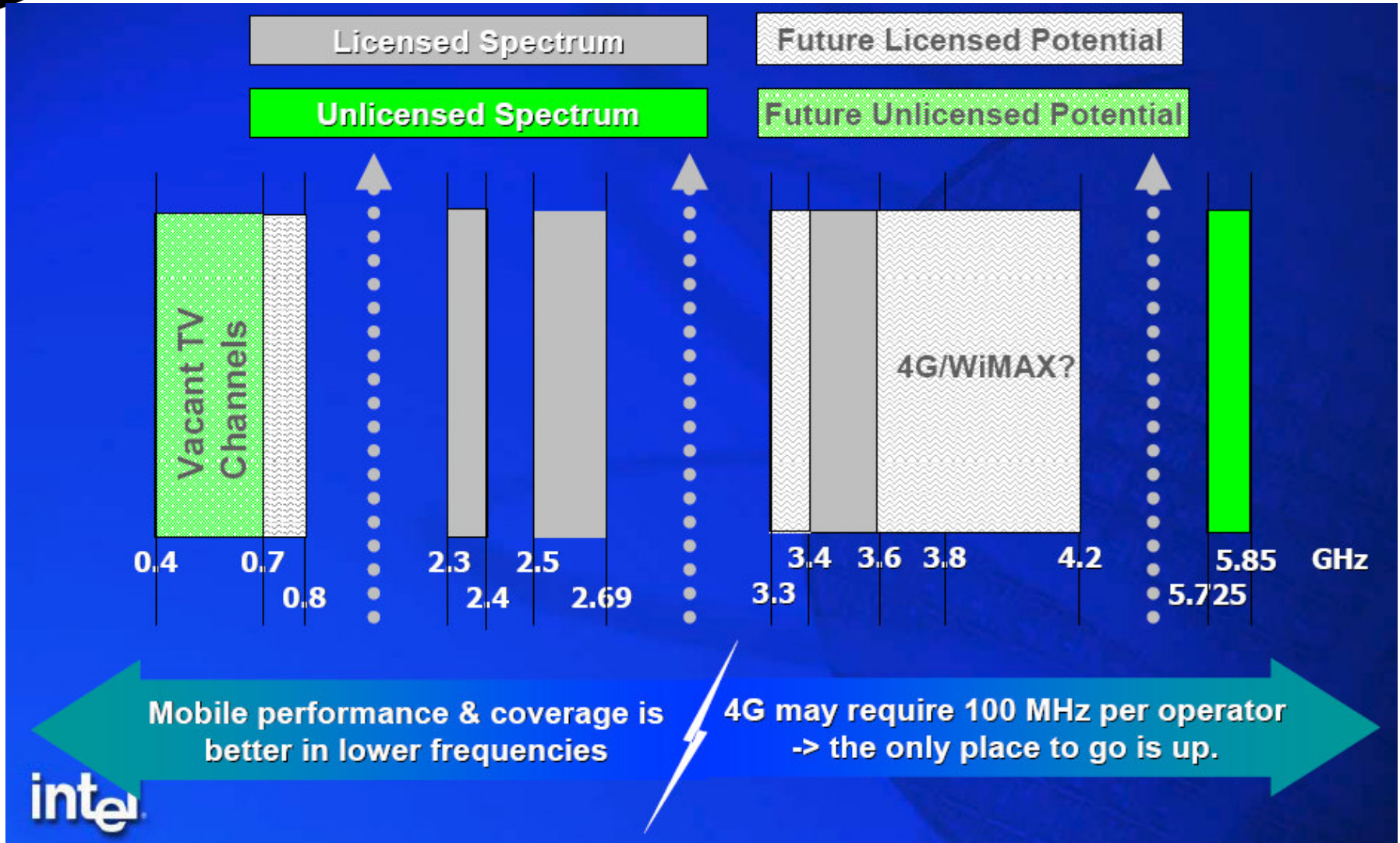




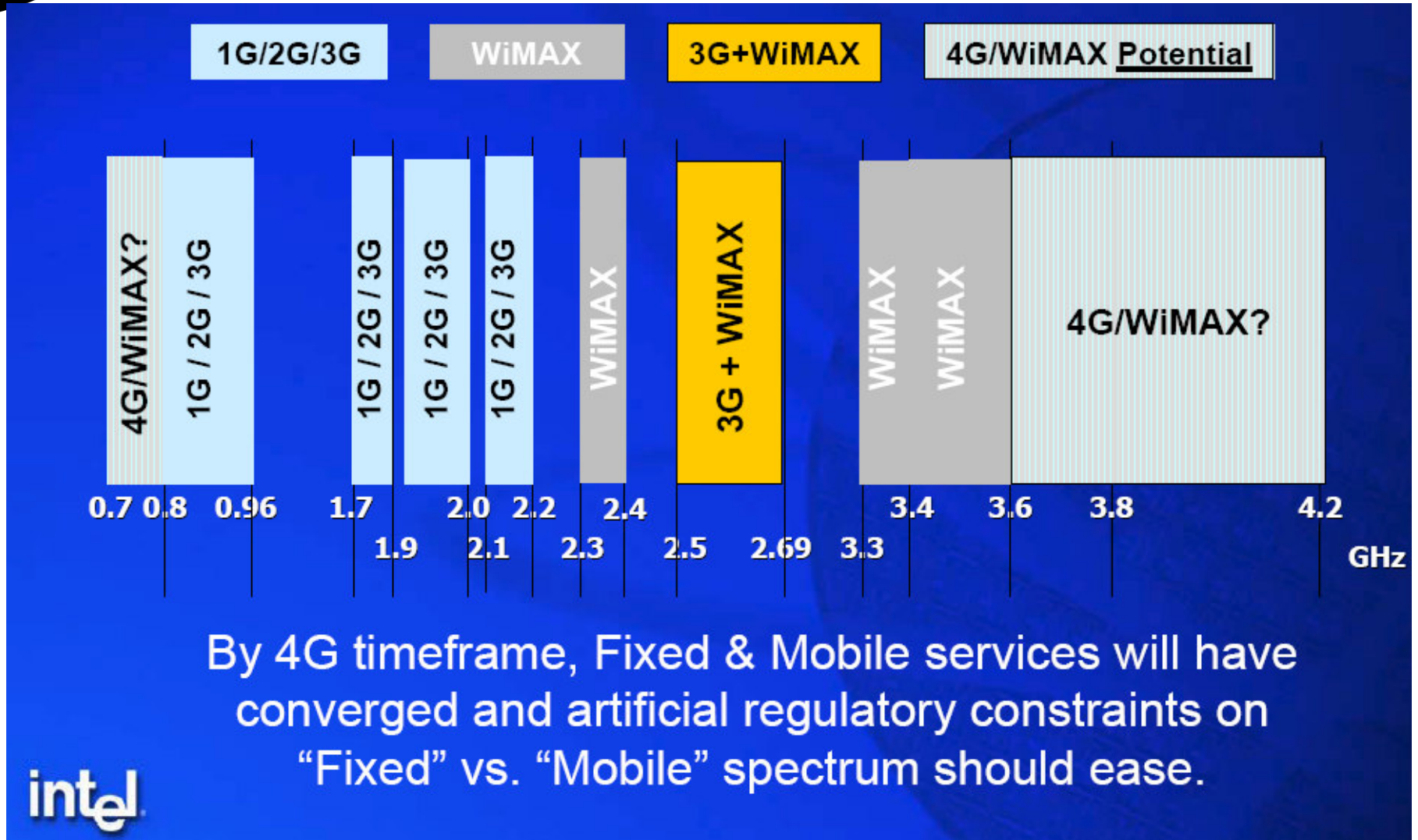
WiMAX And The Spectrum

WiMAX supporters are asking for a LOT of spectrum worldwide for an unproven and virtually untested technology!

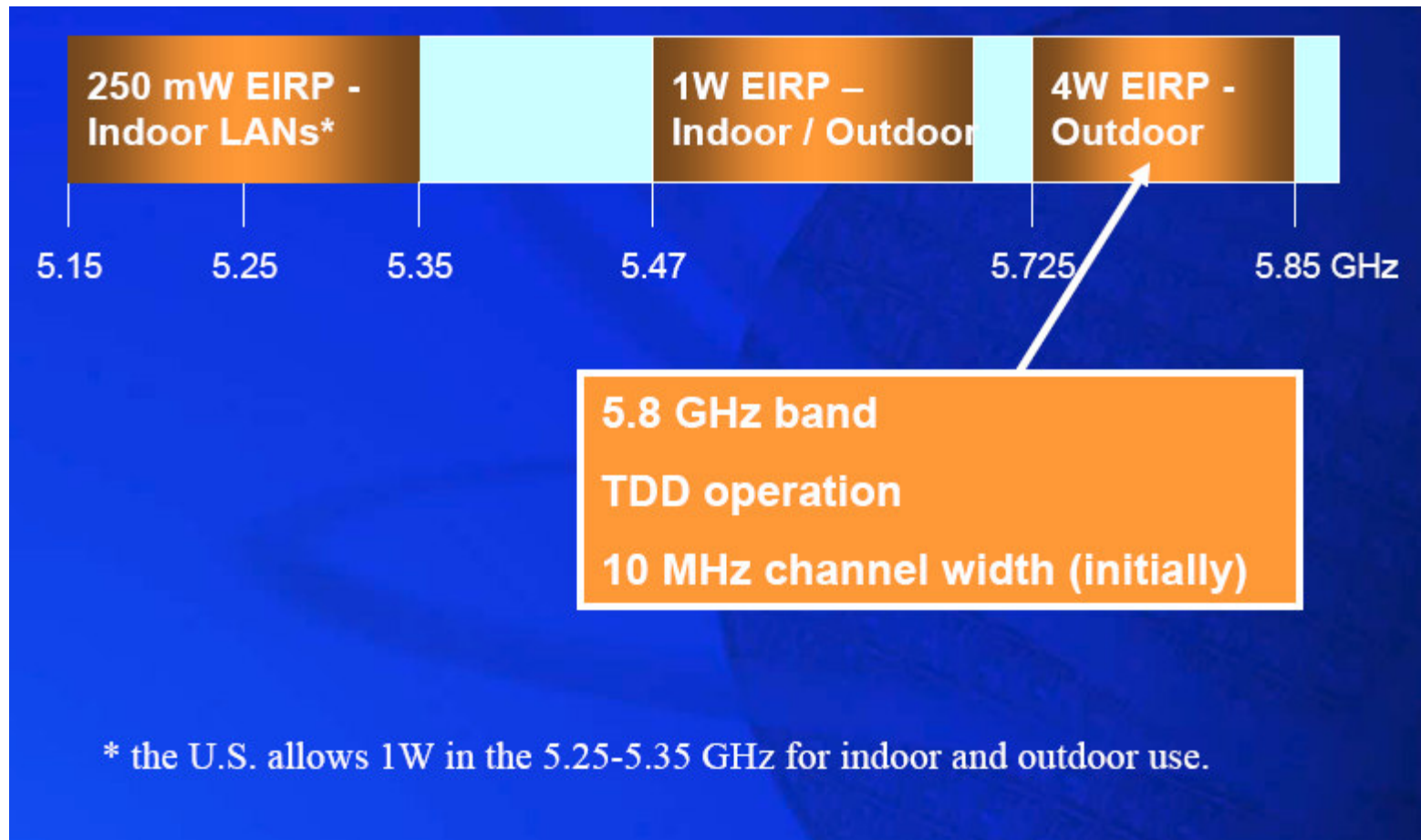
WiMAX Licensed And Unlicensed Target Spectrum



3G And WiMAX Licensed Spectrum



Frequency Bands—License-Exempt Targeted By Initial Profiles

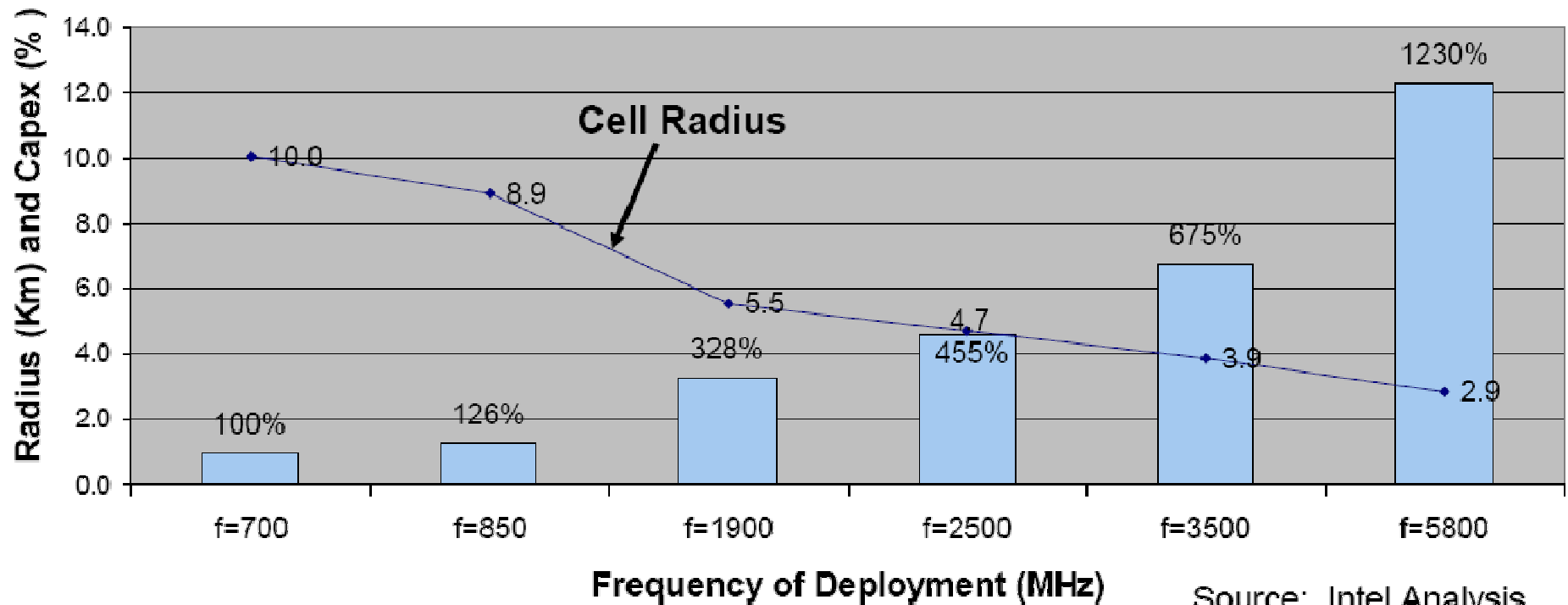


Sites Required By Frequency

Capex Comparisons as a Function of Deployment Spectrum

Propagation analysis baseline:

Suburban, Max Available PL=145dB, f=700 MHz, Ht=50m, Hr=1.5m



- At 1900 MHz, 3 times more cell sites are required than at 850 MHz

RF Propagation Is Only Part Science!

RF Propagation Calculator

File Recalculate! Params Options Help

Nominal range [m] 100 Building loss [dB] 0

Tx to obstruction distance [m] 50 Obstruction to Rx distance [m] 50

Propagation Law 2

Tx antenna gain [dBi] 0 Rx antenna gain [dBi] 6

Obstruction radius [m] 0.05

Tx antenna height [m] 2 Rx ant. height [m] 2

Obstruction height [m] 0

Heights baseline

-10 Tx power [dBW] Rx noise figure [dB] 6

2.45e+009 Carrier frequency [Hz] Signal bandwidth [Hz] 1e+006

20 Fading margin [dB] Rx detector S/N [dB] 16

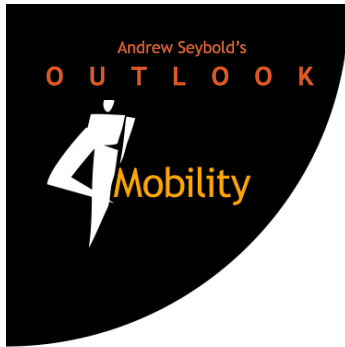
Temperature [K] 290

Input Intercept [dBm] 5

Max. range (exc. diffr. loss) = 771.467 m No diffraction

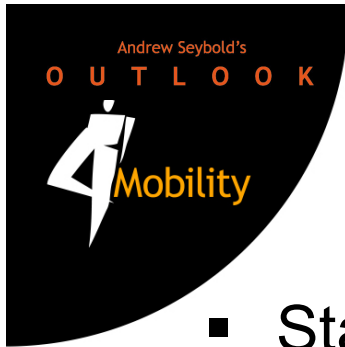
Margin at nom. range (exc. diffr. loss) = 17.7463 dB Hill Type Diff. Tog

The diagram shows a cross-section of the ground with a central hill. A transmitter antenna is on the left and a receiver antenna is on the right. The hill is represented by a green mound with a red circle at its peak. The ground is a green line. The sky is a light blue gradient. Arrows indicate various distances and heights: Tx to obstruction, obstruction to Rx, Tx antenna height, Rx antenna height, and obstruction height. The obstruction radius is shown as a red circle on the hill's peak.



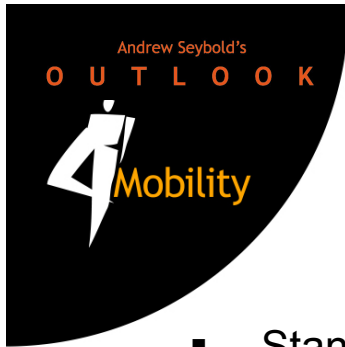
WiMAX WiBRO

- Standard approval
 - Non-standard pre-WiMAX
- Network infrastructure available for installation
 - Today
- Mobile chipset available to device manufacturers
 - Today
- Mobile device available
 - Today
- Commercial network available
 - Today
- Key technology platform characteristics
 - System up and running in Korea
 - Testing scheduled for 2006 with Sprint
 - Field results in Korea show 1.84 Mbps forward link speed (8.75 MHz)
 - Edge-of-cell speeds reported as low as 512 Kbps



Flarion (Qualcomm)

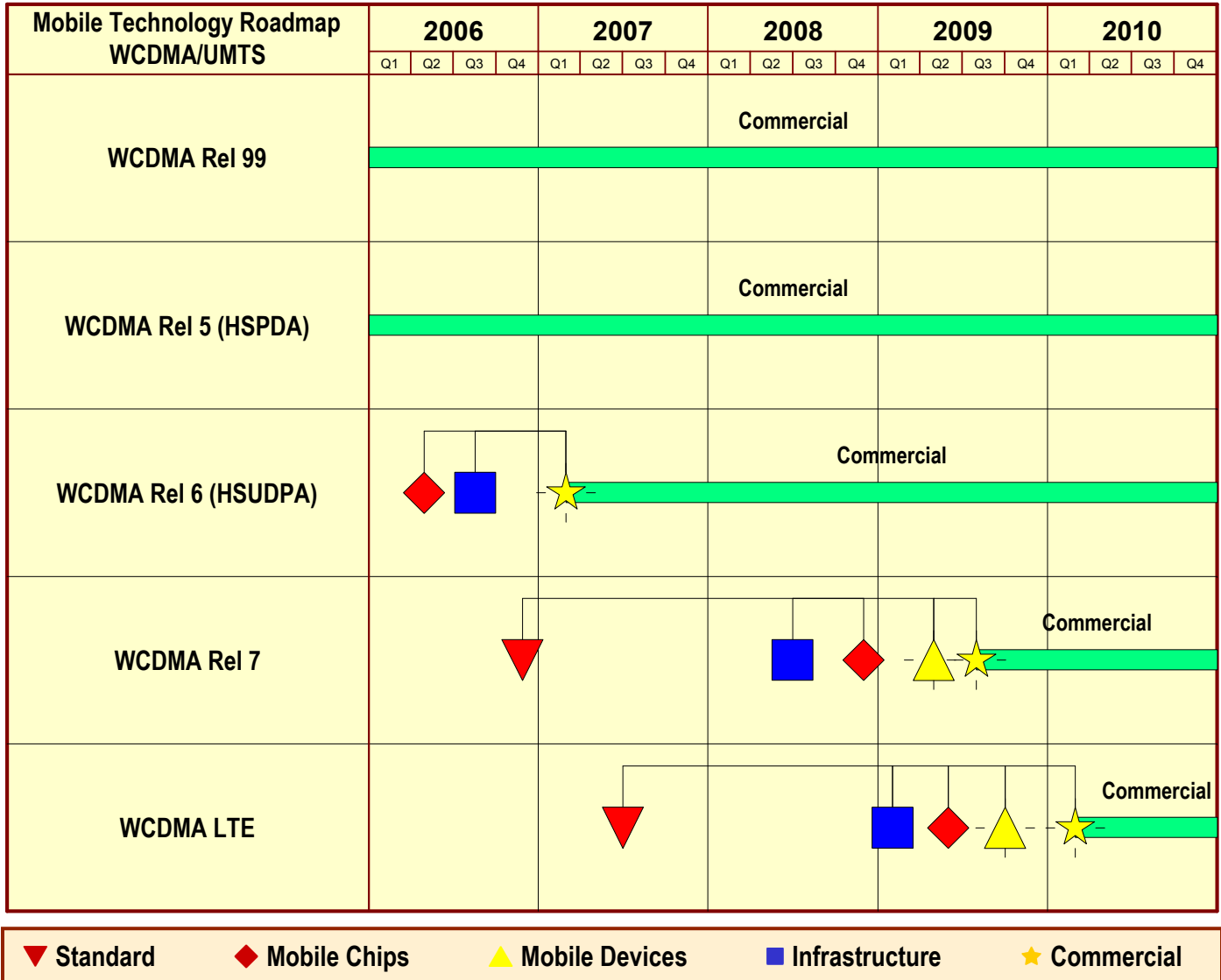
- Standard approval
 - Non-standard OFDM
- Network infrastructure available for installation
 - Today
- Mobile chipset available to device manufacturers
 - Today
- Mobile device available
 - Today
- Commercial network available
 - Today
- Key technology platform characteristics
 - Data speeds equal to EV-DO Rev A
 - Uses 1.25-MHz carriers
 - Does not need guard band between carriers
 - Therefore one more carrier available in 10 MHz of spectrum



IEEE 802.20

- Standard approval
 - Letter ballot passed Q1 2006
 - IEEE held up process due to complaints filed by Intel and others
 - Earliest committee will reconvene is October 2006
 - Could impact dates shown in this report
 - At this point it is unclear how this will be resolved
- Network infrastructure available for installation
 - Q1 2008
- Mobile chipset available to device manufacturers
 - Q2 2008 single mode (802.20 only)
 - Q2 2009 multimode (EV-DO and UMTS)
- Mobile device available
 - 9-12 months after chipset availability
- Commercial network available
 - Q4 2009 to Q1 2010
- Key technology platform characteristics
 - Claims: 50% greater throughput than WiMAX
 - Three times more efficient per user than WiMAX
 - Operates with carriers from 5 to 40 MHz wide
- NOTE: It is too early in technology design cycle to predict final capabilities—lab tests later this year will help

Mobile Technologies Roadmap



Mobile Technologies Roadmap

Mobile Technology Roadmap CDMA2000	2006				2007				2008				2009				2010			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1xEV-DO	Commercial																			
1xEV-DO Rev A	Commercial																			
					Sprint Nationwide Availability															
1xEV-DO Rev B	Commercial																			
1xEV-DO Rev C	Commercial																			

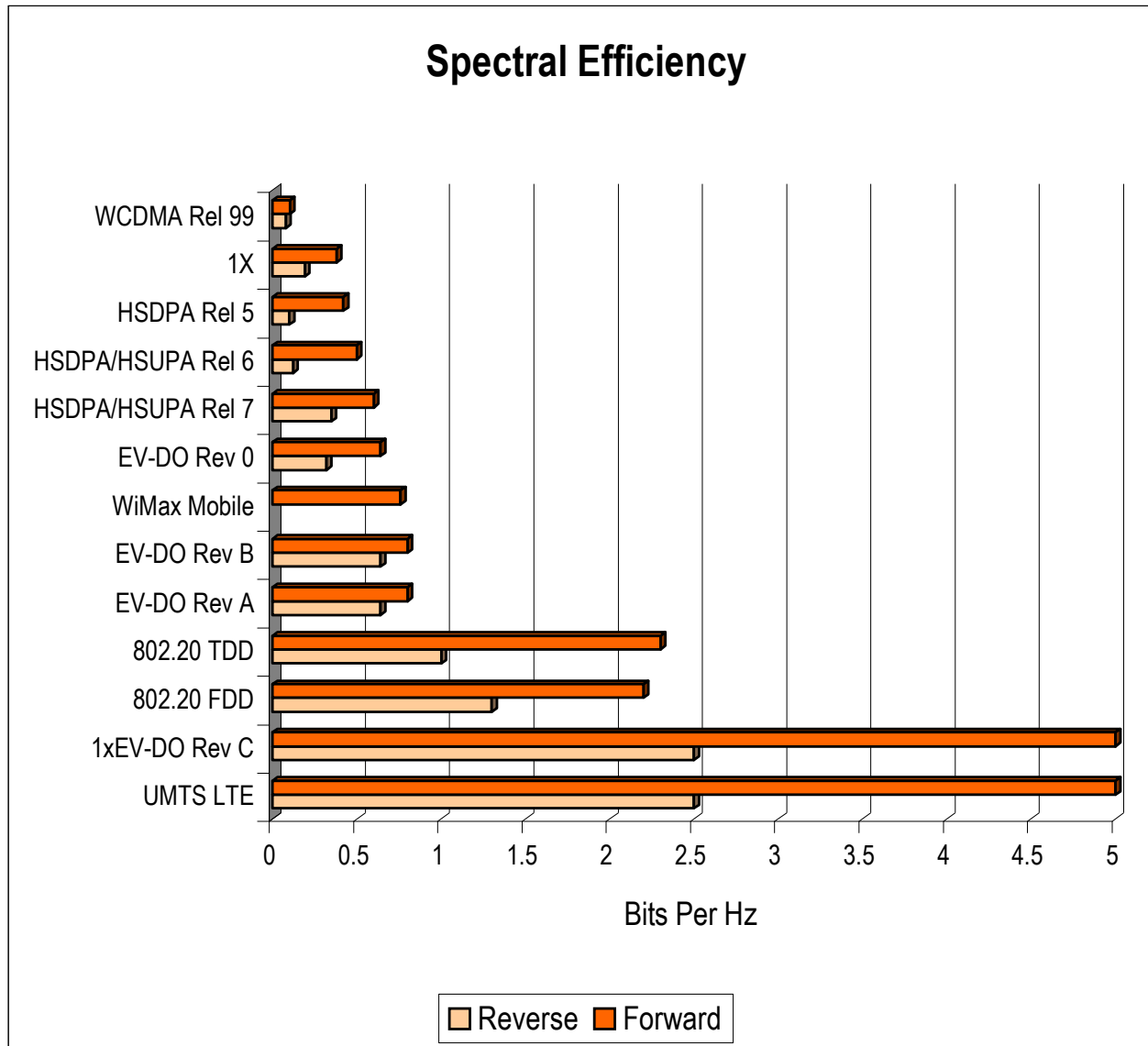
▼ Standard	◆ Mobile Chips	▲ Mobile Devices	■ Infrastructure	★ Commercial
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Mobile Technologies Roadmap

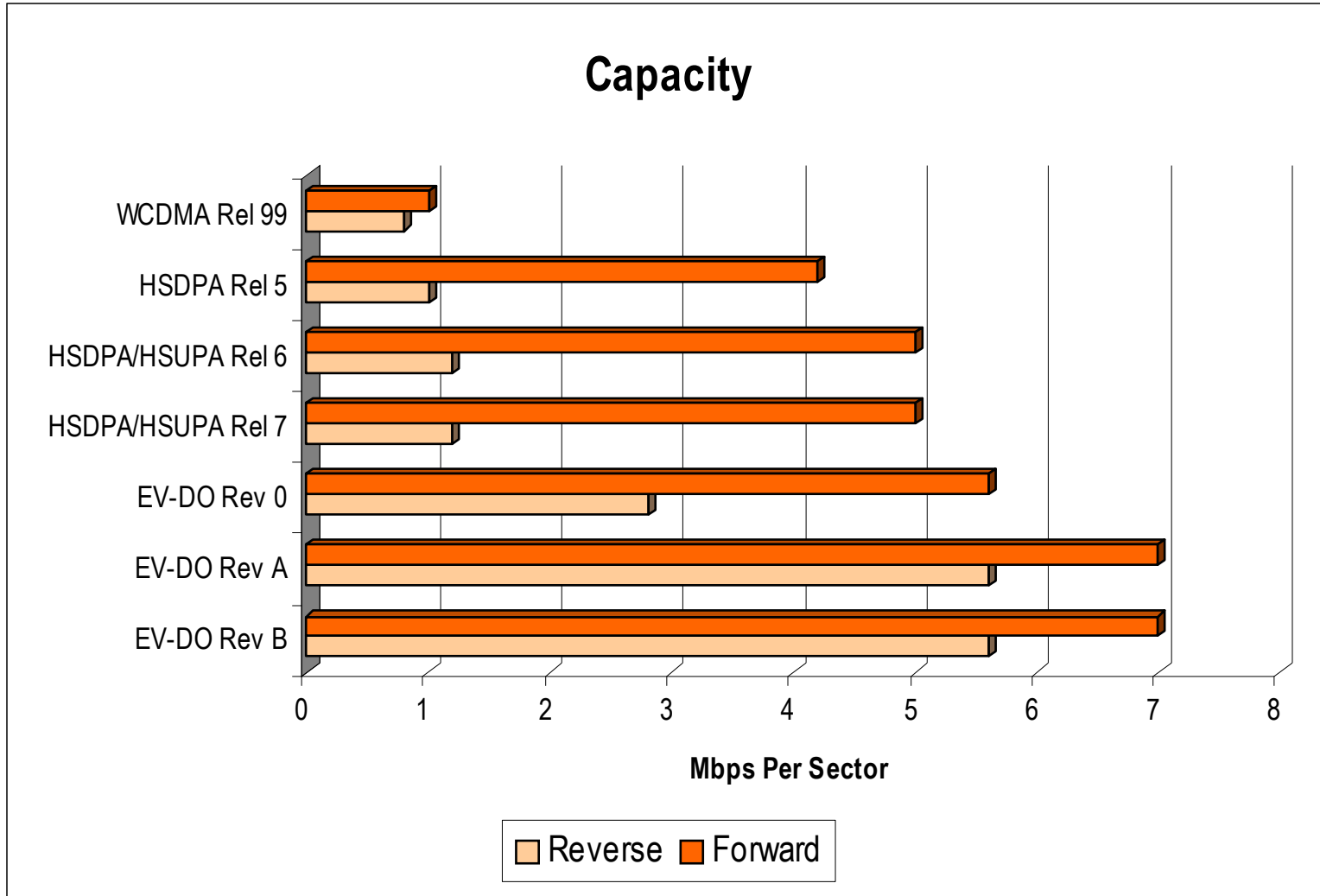
Mobile Technology Roadmap	2006				2007				2008				2009				2010			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
IPWireless									Commercial											
Flarion Wireless									Commercial											
WiBRO																				
WiMAX Mobile/802.16e													Commercial							
IEEE 802.20 FDD																				

▼ Standard
 ◆ Mobile Chips
 ▲ Mobile Devices
 ■ Infrastructure
 ★ Commercial

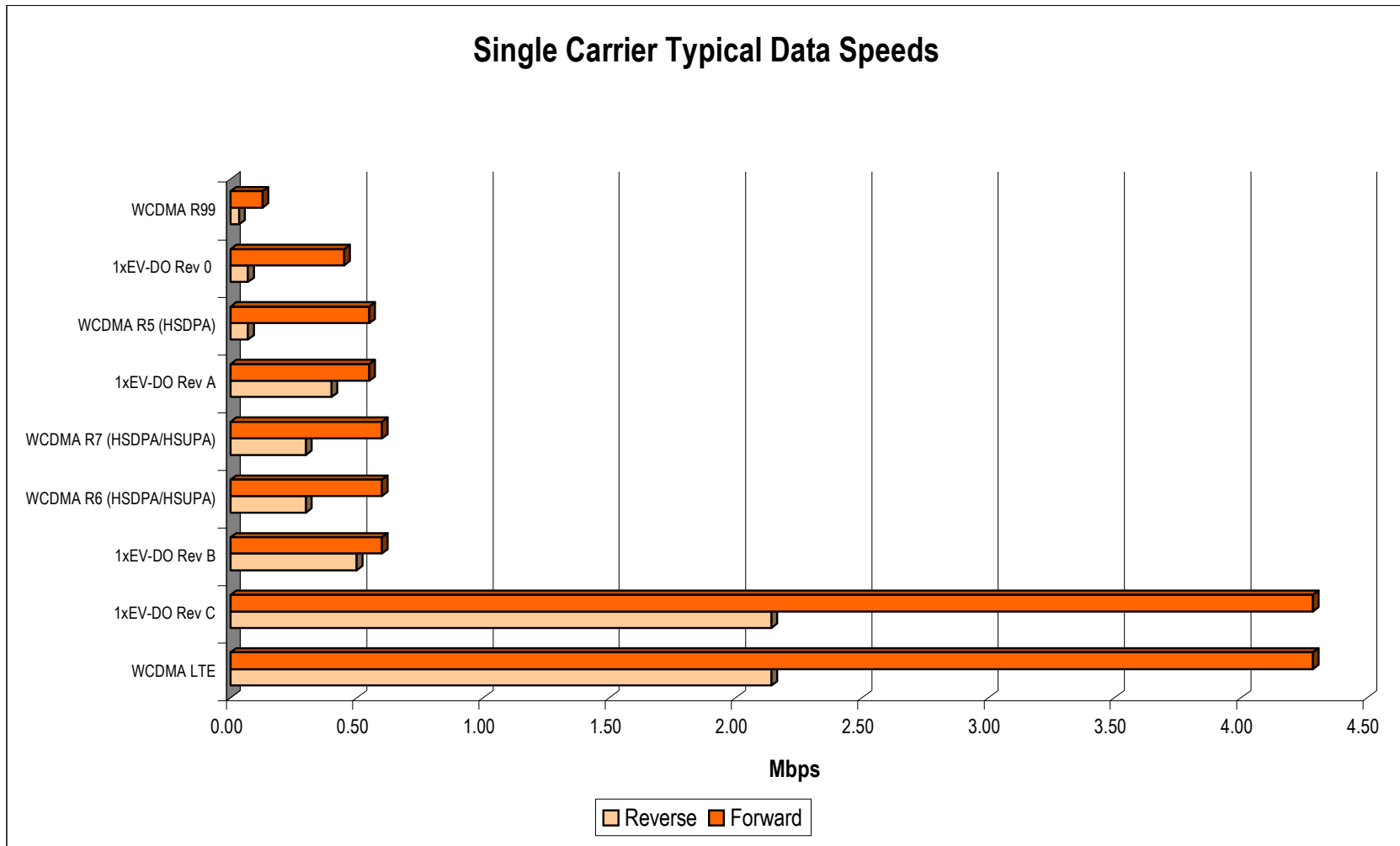
Spectral Efficiency Of Base Technology (No Smart Antenna Enhancements)



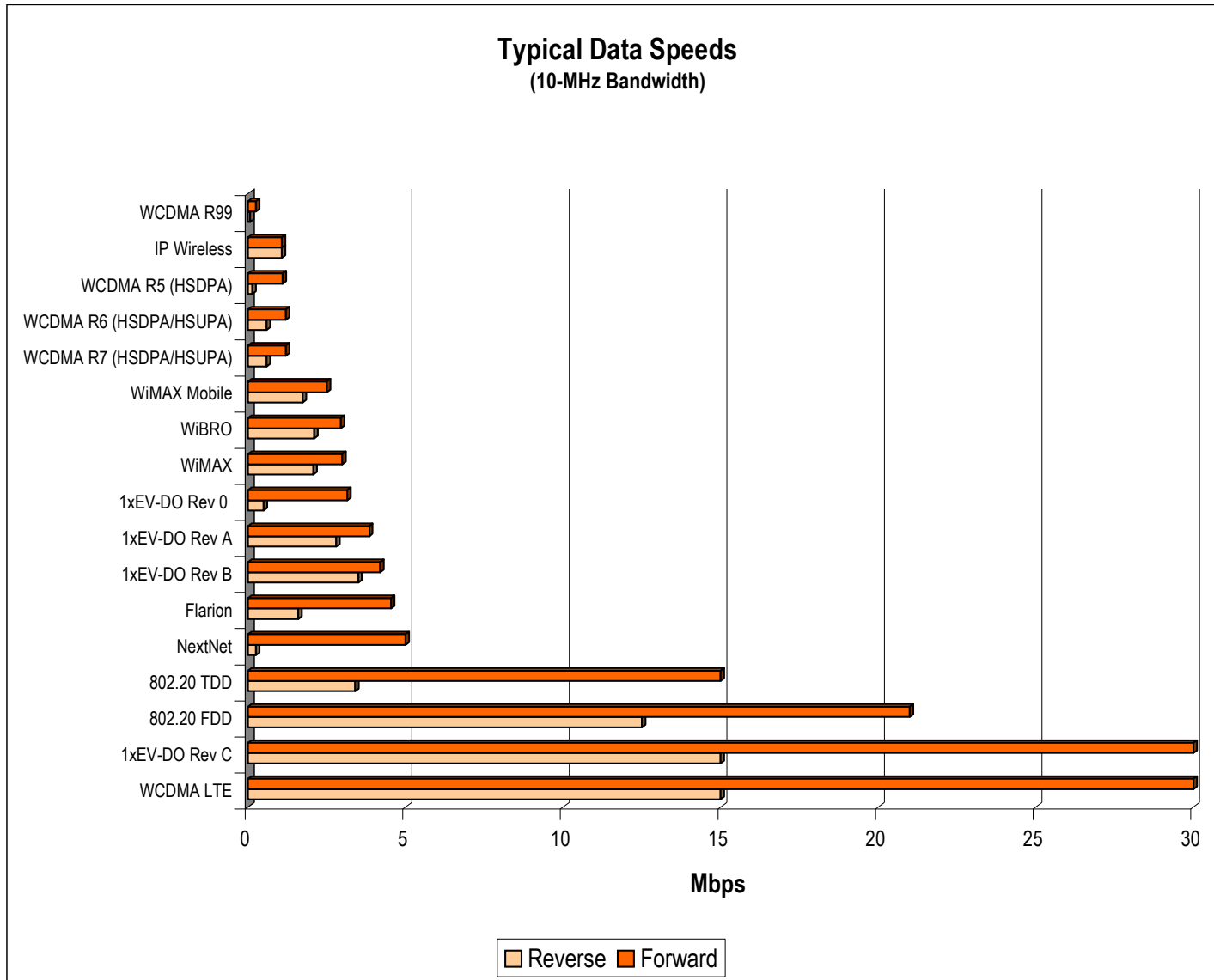
Capacity By Technology



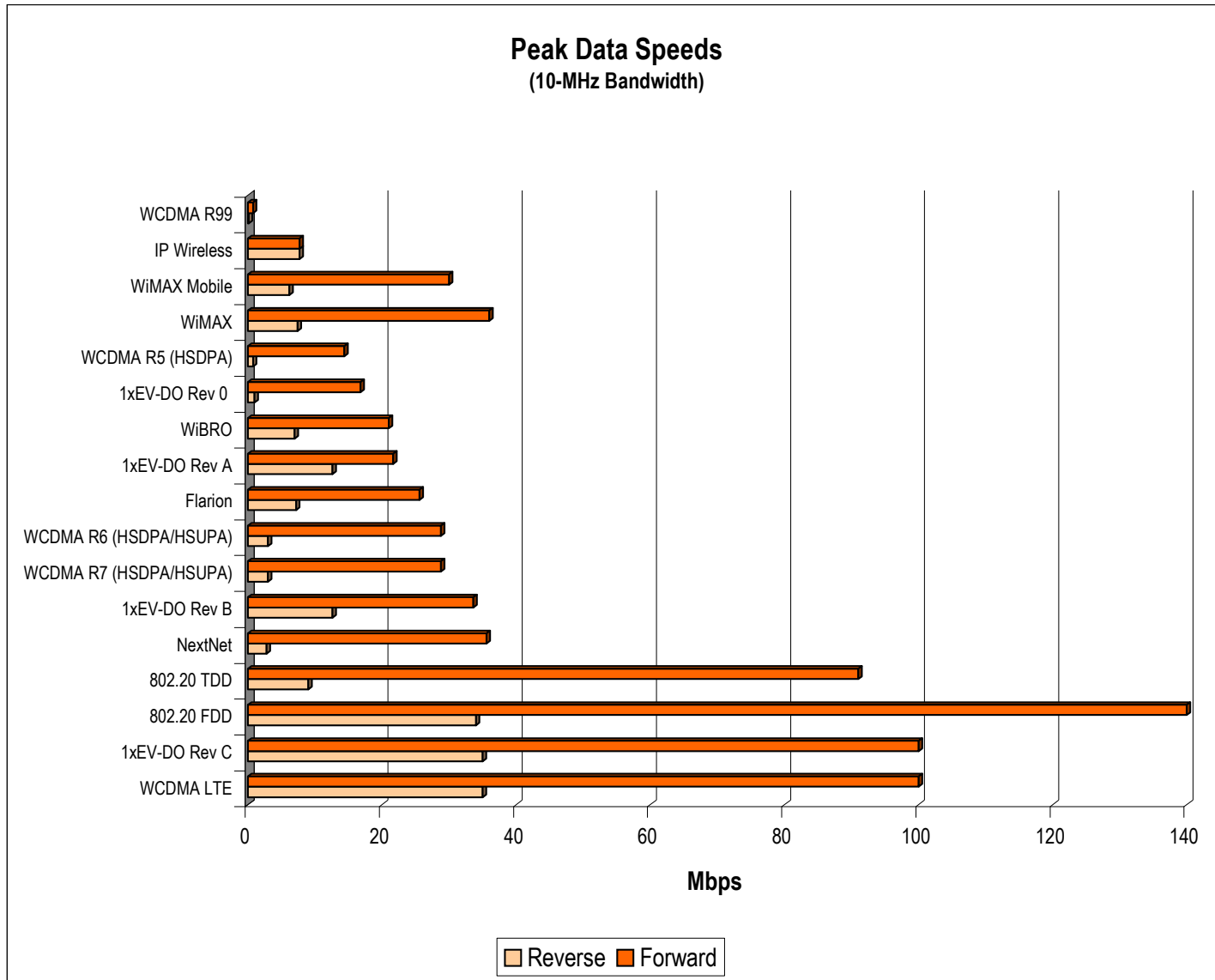
Typical Single Carrier Speeds



Normalized Typical Data Speeds



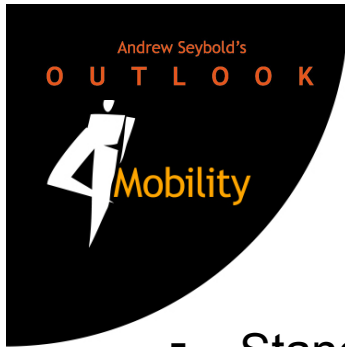
Peak Data Speeds





Wide-Area Portable Technologies

WiMAX 802.16
Clearwire



WiMAX Fixed (802.16)

- Standard approval
 - July 2004
- Network infrastructure available for installation
- Portable chipset available to device manufacturers
 - Wavestat December 2004, Intel April 2005
- Nomadic device available
 - Q1 2006
- Commercial network available
 - Pre-WiMAX standard today
 - Full WiMAX standard Q1 2007
- Developed as new standard for fixed wireless
- Analysis
 - Industry will bypass 802.16 fixed in favor of 802.16e mobile even for fixed systems
- Intel chipsets support 2.5, 3.5 and 5.8 GHz
 - Others will support 2.3 GHz and other bands
 - Intel has announced device chipset that supports both technologies
 - Use is planned for devices and picocells
 - No delivery date available at this time

Portable Technologies Roadmap

Portable Technology Roadmap	2006				2007				2008				2009				2010			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
NextNet/Clearwire	Commercial																			
WiMAX (802.16)	Commercial																			



▼ Standard
 ◆ Mobile Chips
 ▲ Mobile Devices
 ■ Infrastructure
 ★ Commercial



Local-Area Technologies

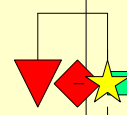
Muni-Wi-Fi can impact both WiMAX and 3G wide-area networks

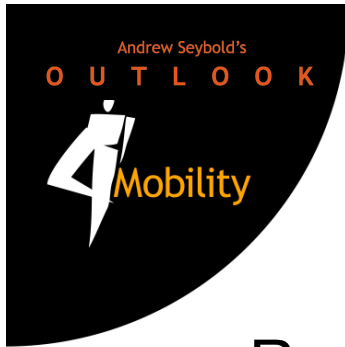
Local-Area Technologies Roadmap

Local-Area Technology Roadmap	2006				2007				2008				2009				2010			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
802.11 a/g																	Commercial			

802.11n																	Commercial			

▼ Standard
 ◆ Mobile Chips
 ▲ Mobile Devices
 ■ Infrastructure
 ★ Commercial





Latest Craze: Muni-Wi-Fi

- Recipe
 - Take a local-area wireless technology
 - Sprinkle in some mesh networking technology
 - Add many cups of back-end smarts
 - Stir up the politicians and convince them that broadband wireless is the new big thing and it will make their cities rich
- Preparation
 - Place access points on lamp posts all over town
 - Attach back-end wired/wireless capacity to every third or fourth
 - Test network for interference from existing systems
 - Advertise services to the community
- Result
 - An expensive, temperamental network prone to interference and on-going maintenance issues



Muni-Wi-Fi

- Many cities have announced
 - EarthLink launched Anaheim end of June
 - Philadelphia, San Francisco and more
 - Several smaller cities up and running
- Many cities sub-contracting to others
 - Philadelphia and Anaheim using EarthLink
 - Philadelphia no-charge-for-data has become \$20 per month
 - In San Francisco, EarthLink and Google have teamed up
- Little if any in-building coverage
- Great potential for interference
 - Cities have no more right to 2.4-GHz spectrum than you and I
- It's the latest craze. Will it be successful?
- Some cities are pushing for an advertising supported model for free Wi-Fi service
 - There is no free lunch!



Wi-Fi, WiMAX And 3G: Friends Or Foes?

- Wi-Fi driven by computer industry
- WiMAX driven by computer industry/Intel
- 3G driven by wireless industry
- Cellular operators working with Wi-Fi for in-building coverage
 - T-Mobile clearly the leader, its wide-area and local-area networks are fully integrated on the back-end
 - Wayport has deals with Sprint Nextel and others
- Can data-only networks make money?
 - No one has been successful yet
 - Perhaps Wi-Fi needs wide-area more than wide-area needs Wi-Fi
- Will VoIP give new life to Wi-Fi?
 - Is it an extension of wide-area networks or a standalone voice system designed to compete with wide-area networks?



WLAN's Impact On 3G Wireless

- **Some—mobile professionals**
 - Most only need access at office, home, airport, hotel
 - WLAN public networks provide convenience
 - Few will pay—enterprise unlikely to pay
 - Few will pay for 3G wide-area wireless
- **Some—sales professionals**
 - If client location access is needed, WAN is needed
 - Client enterprises not likely to support visitors
- **Some—consumers**
 - WLAN hotspot coverage primarily at business locations
 - Unlikely to pay
- **None—service, delivery, fleet management**
 - Large geographical coverage required
- **WLAN can be an added value for WAN operators**



Mobile TV Technologies

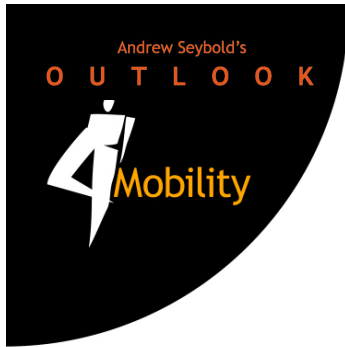
MediaFLO

DVB-H

ISDB-T

IP Wireless

Mobile TV



Two Ways To Deliver Mobile TV

- **On-Network**
 - Systems being used today
 - Deliver content over existing two-way wireless network to handsets
 - Most systems use high-speed data services (EV-DO, UMTS)
 - Content today usually short (2 min) video clips that are streamed to phone and played on phone
 - Some networks stream complete broadcasts
 - News, weather, etc.
- **Off-Network**
 - Several plans to provide more robust mobile TV are being developed and tested
 - Separate receiver chip in mobile phone
 - Standard phone network used to choose programs
 - Better resolution, faster frame speeds, more content choices



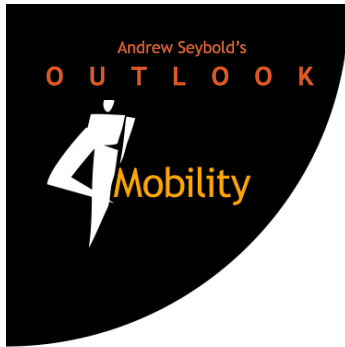
MediaFLO

- Qualcomm proprietary overlay network technology
- SK experience with streaming video on EV-DO (6/03)
- FLO Technology: New air interface (> 6 Mbps in 6 MHz)
- Lower cost per bit than cellular
- Fast channel-switching time (+/- 1.5 sec)
- Launched Q4/06
 - UHF channel 55, field trials started (Las Vegas is live)
 - Verizon signed up as first operator
- Also capable of delivering content off-peak and storing for later viewing
- Competition
 - Modeo, Hiwire (DVB-H), IP Wireless (TDtv)



MediaFLO USA-TV Channel 55

- The U.S. network can support between 15 and 20 live streaming video channels (total of 50 + channels)
 - Each transmitter covers approximately 50 Km
 - Quarter Video Graphics Array (QVGA)
 - 15-30 frames per second (15 design minimum)
 - 800 minutes of clip casting (short-format video)
 - 10 high-quality audio channels
 - Numerous data channels to 3G mobile phones
- Qualcomm just announced new chipset that will support multiple wireless TV technologies
 - UMB (Universal Broadcast Modem) will support MediaFLO, DVB-H and ISDB-T
 - Will support both CDMA and UMTS handsets
 - Sample chips will be available Q1 2007



DVB-H

- Extension of existing DVB-T standard in 36 countries
- Trial systems operating in Europe and U.S.
- Promoted as the open standard (Intel, TI, Nokia)
- Reliance on time slicing to reduce power but can impact viewing experience (great battery life if user accepted)
- Two radios, frequency above 706 MHz excluded
- Up to 55 mobile channels (video channels)
- Philips “TV on cellular chip”/ Modeo partnership
- Modeo & Hiwire (Crown Castle/Aloha Partners) will adopt
- Nokia introducing N93 Mobile TV Handset (2H06)
- Primary competition—MediaFLO



ISDB-T

- ISDB (Integrated Services Digital Broadcasting)
 - Being tested in Japan
 - First system on Tokyo Tower, nationwide tests to follow
 - From broadcast industry
 - OFDM technology
 - MPEG 2
 - 6, 7, 8 MHz of spectrum per system
 - Supports HDTV, SDTV and other formats
 - Supports TV “lite” for mobile handset applications
 - Appears to be a Japan-only technology at this point
 - However, Qualcomm’s multi-TV chipset will support this standard as well as MediaFLO and DVB-H



IP Wireless (TDtv)

- Sprint Nextel invested \$14M
- TD-CDMA technology (3GPP standard)
- Uses 5 MHz of unpaired spectrum for 50 channels or 15 high-quality channels
- IP wireless has driven systems in operation
 - Systems in commercial service are data-only, not TDtv
- No requirement to rely on overlay network
 - If TDD spectrum is available (mostly Europe and China)
- No integrated base station development yet
- Needs high-capacity backhaul
- Another use for TDD spectrum could be enhanced forward link for HSDPA network



Likely Approach To Mobile TV

- Operators create and brand a unique mobile TV offering
- Integrate on-network and off-network content into single offering
 - For MediaFLO, Roundbox provides menu and ability to segment TV delivery by cell sector and mesh with MediaFLO system
- Control electronic service guide on network
- Contract to use other providers' off-network services
- Contract with various content providers for on- and off-network content
- Operators will brand their mobile TV service as unique



Analysis Of Mobile TV

- 1.5% of wireless users streamed TV or video (2 of 3 users young men)
 - Telephia research for Q4/05
- At CES, Samsung, LG, Nokia displayed handsets, Sanyo offers mobile ESPN MVP EV-DO phone
- Revenue sharing with broadcasters/content owners
- Italian arm of 3 recently purchased TV station
- Mobile operators control handsets/unwilling to undermine prospects for subscription-based services with free on-air services
- Apple video iPod has stimulated the market
- Hiwire and MediaFLO do not have full geographic use of their 700-MHz channels until digital TV migration in 2009

Mobile TV Technologies Roadmap

Mobile TV Technology Roadmap	2006				2007				2008				2009				2010			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
MediaFLO Qualcomm					Qualcomm Universal				Commercial											
DVB-H ETSI Specification					Qualcomm Universal				Commercial											
ISDB-T Japanese Technology					Qualcomm Universal				Commercial											
TDtv IPWireless									Single Chip Dual Chips				Commercial							
On Network Technologies									Commercial											

Standard	Mobile Chips	Mobile Devices	Infrastructure	Commercial
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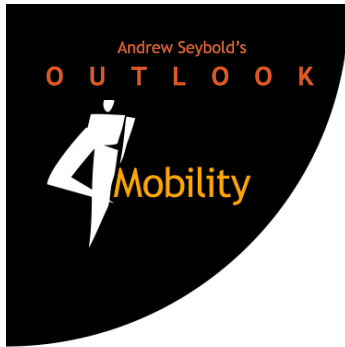
Impact Of FMC, UMA And OMA ②

- Industry believes convergence is next big thing
 - One device, multiple networks, broadband everywhere
 - Smart networks—least-cost routing, seamless transfer
 - Voice and data simultaneously
- IP/UMA/SIP/FMC/OMA all tied together
 - UMA first to be deployed (SIP connection standard within 24 months)
 - Implement UMA now and convert to SIP in the future
 - But IP moves into the core slower than anticipated
- Today's technology for hand-offs not ready for prime time
 - Much activity in this area, many advances
 - Network operators see it as a way to increase capacity and provide better in-building coverage



At The End Of The Day

Different technologies do not create a competitive advantage — applications will!



The Applications Disconnect

- Content providers still do not understand the limitations of wireless broadband capabilities
 - They do not understand capacity issues such as cell sector loading and bandwidth constraints
 - At CTIA, Sony and HBO expressed mystification regarding the ability of wireless networks to deliver their content
 - They seem to believe WiMAX is far more capable than UMTS/HSDPA and CDMA2000 1xEV-DO
- Network customers seem to think unlimited data means unlimited data
 - There will always be a huge difference between what can be delivered in a mobile environment and what can be delivered via wired DSL or cable
- If wireless operators continue to feed these misconceptions it will cost them dearly in the future!



In Summary

Who makes money at the end of the day?



Incumbent Wide-Area Wireless

- 3 or more wide-area wireless players already established with voice and data services
 - NOT for home or business fixed service delivery
 - Voice pays the bills and will continue to do so
 - Data services are getting faster
 - Notebooks, PDAs, and smartphones support and are available
 - Systems already in the ground and they know how to play the pricing game
- At least two one-way digital data delivery networks coming on line
 - DVB-H and MediaFLO
 - Can deliver 40-60 channels of high-quality video and data services
 - Will be adjacent to “on-network” audio and video services

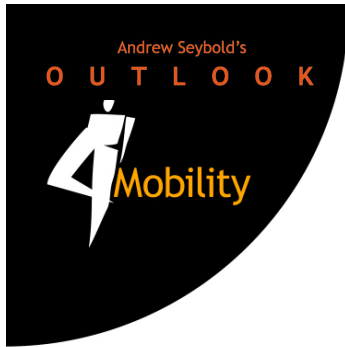


Incumbent Cable And DSL providers

- Competitors for home and office market, not mobility
- Plant already in the ground
- Data speeds getting faster
- Prices have dropped and will continue to drop
 - Bundle other services for incremental revenue
- Limited coverage beyond cities and suburbs
- Cable operators could be good partners for WiMAX networks
 - Sprint and major cable companies joint venture
 - Note: 95% of all wireless joint ventures have failed
- DSL operators (Bells) rapidly moving to fiber to the home
- Tough competitors where they offer service

Muni-Wi-Fi

- WiMAX can be used for backhaul for these systems
- WiMAX could replace Wi-Fi access points over time
 - This could add a mobility feature to network
- In the meantime, muni-Wi-Fi is both friend and foe
- The economics of muni-Wi-Fi are untested
 - Various business models
 - Pay for use
 - Advertising supported free service
 - Low-speed free, high-speed for pay
 - What are ongoing operating costs vs. income?
 - Will they be reliable enough for customers?
 - Many questions—no answers yet
 - The next two years will determine if they can stay in business



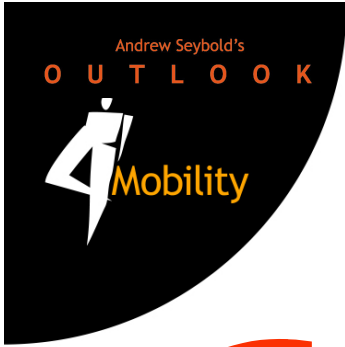
Future Technologies

- IMS back-end systems will take longer to come to market than anticipated
 - This will delay for several years the ability to provide access to multiple networks and multiple types of services
- Marriage of Wi-Fi in-building and wide-area networks is underway
 - Will WiMAX pay in this converged space, too?
- LTE and 802.20 are only 3-4 years away from being commercial
 - Can WiMAX network operators earn a return on investment in three or four years?



Final Comments

- Incumbents have the advantage where they already have plant and coverage
 - They already offer bundled services so business model is not dependant on a single service or technology
- Opportunities for WiMAX to level the playing field
 - AWS spectrum auctions
 - 700-MHz spectrum auctions
 - VoIP
 - If they can attract lots of devices, different form factors
- If WiMAX is deployed as a standalone network in areas where incumbents are already entrenched, they will fail
- WiMAX as an adjunct to existing technologies provided by incumbents makes sense
- What happens if WiMAX cannot attract a major network player?



Thank you!

**Questions,
Comments,
Information,**

