



Mobilizing Everyone: The Rise of Mobile Broadband

Craig J. Mathias

Principal

Farpoint Group

craig@farpointgroup.com

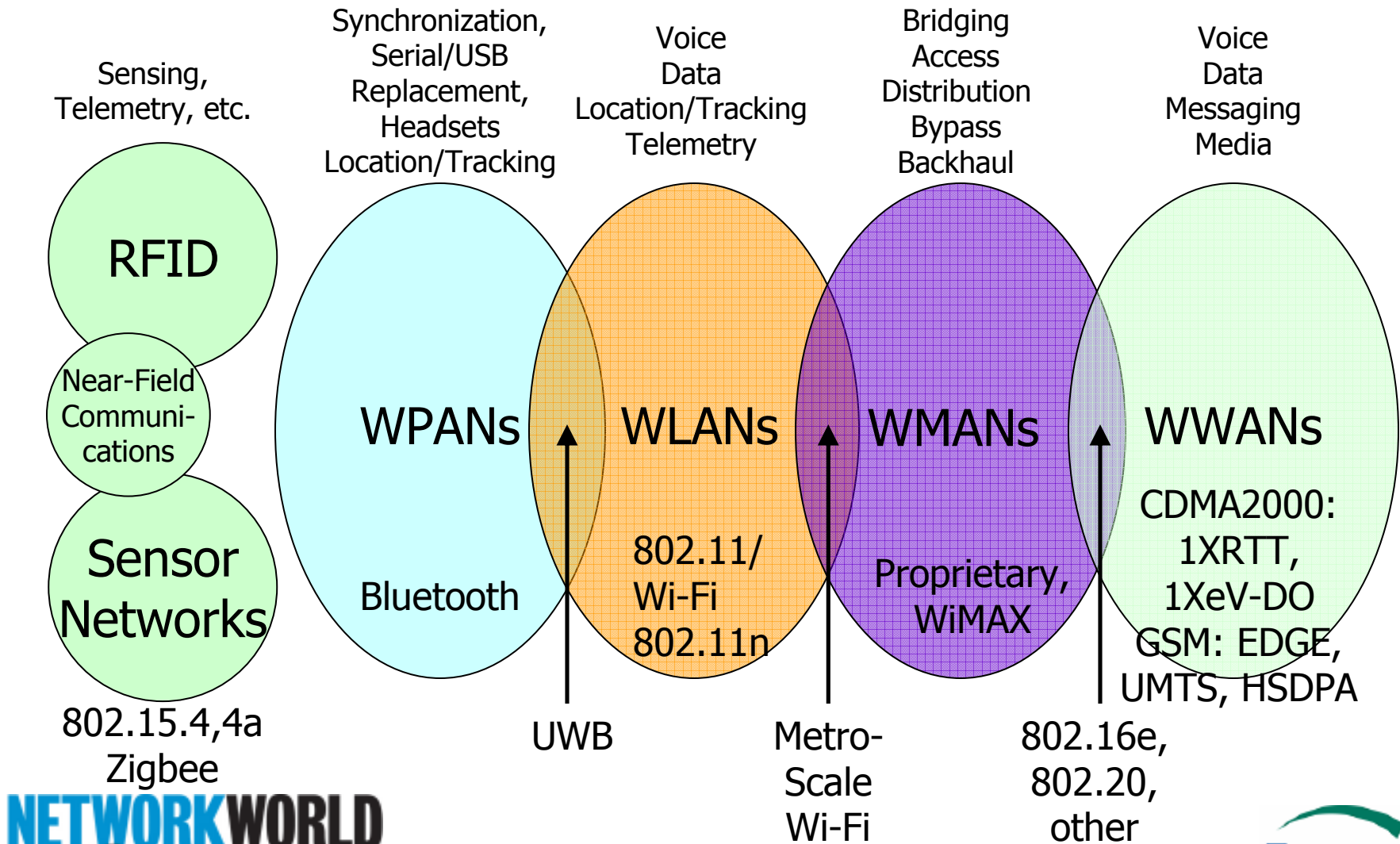
Our Agenda for Today...

- ◆ Mobile broadband takes over
- ◆ Wireless LANs – current challenges and next steps
- ◆ Redefining the wireless metropolitan-area network (WMAN)
 - Metro-scale Wi-Fi
 - What is the opportunity for WiMAX?
 - Cellular broadband – 3G is *really* here
- ◆ Wireless Web Services
- ◆ Fixed/Mobile and Mobile/Mobile Convergence (FMC/MMC)
- ◆ Looking ahead

Wireless Replaces Wire?

- ◆ Increasingly, yes!
- ◆ Broadband implies not just more *throughput*, but also support for *time-bounded traffic*
 - Throughput is a function of *bandwidth* (directly related to spectrum)
 - Time-boundedness is a function of *capacity*
 - Making wireless behave like wire
- ◆ Replacement?
 - Wireless LANs – absolutely
 - Wireless MANs and WANs – we're getting there
 - Improvements in mobile devices (subscriber units) and operating models
- ◆ Mobile enterprises have competitive and productivity advantages

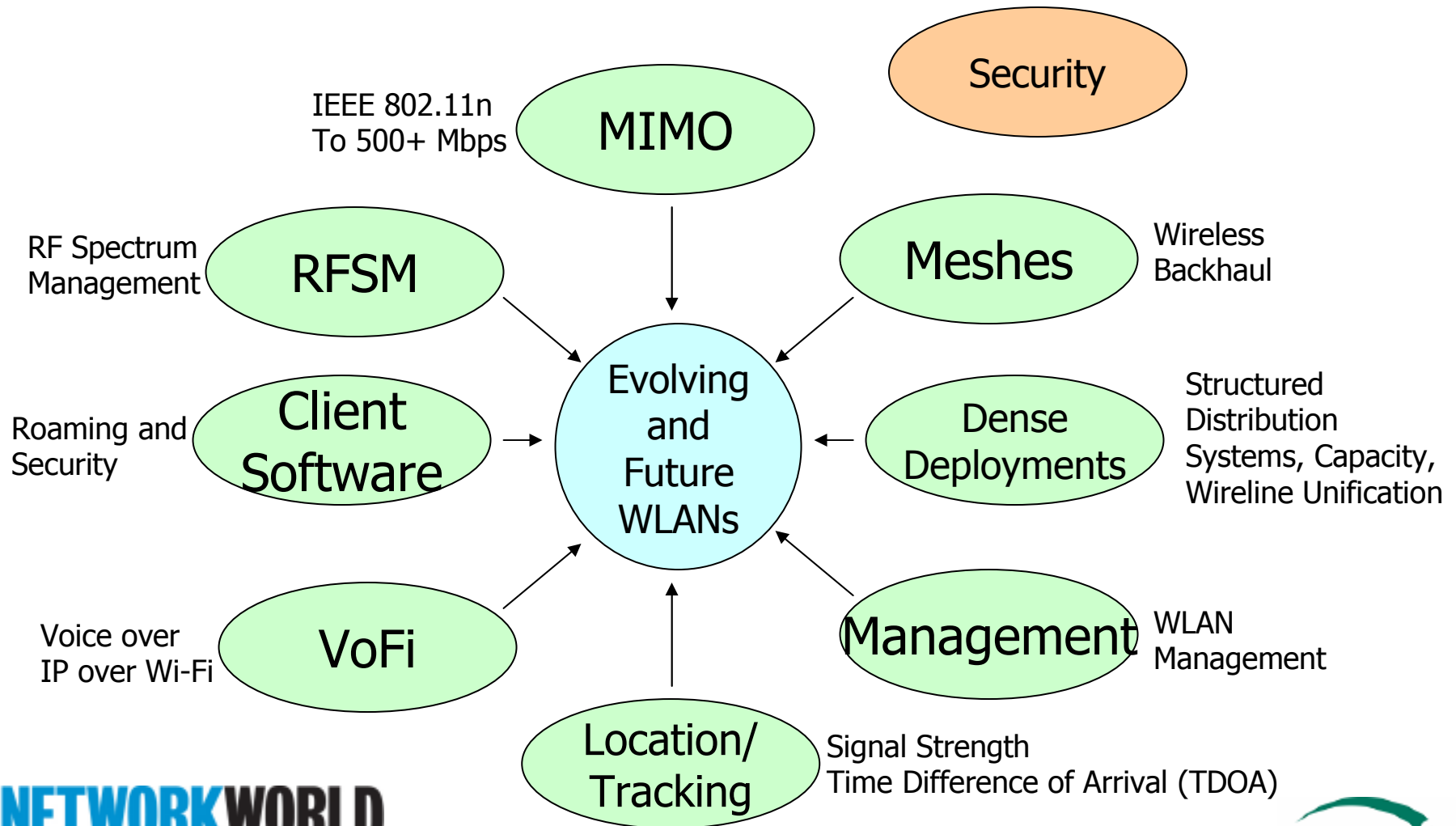
The Big Picture...



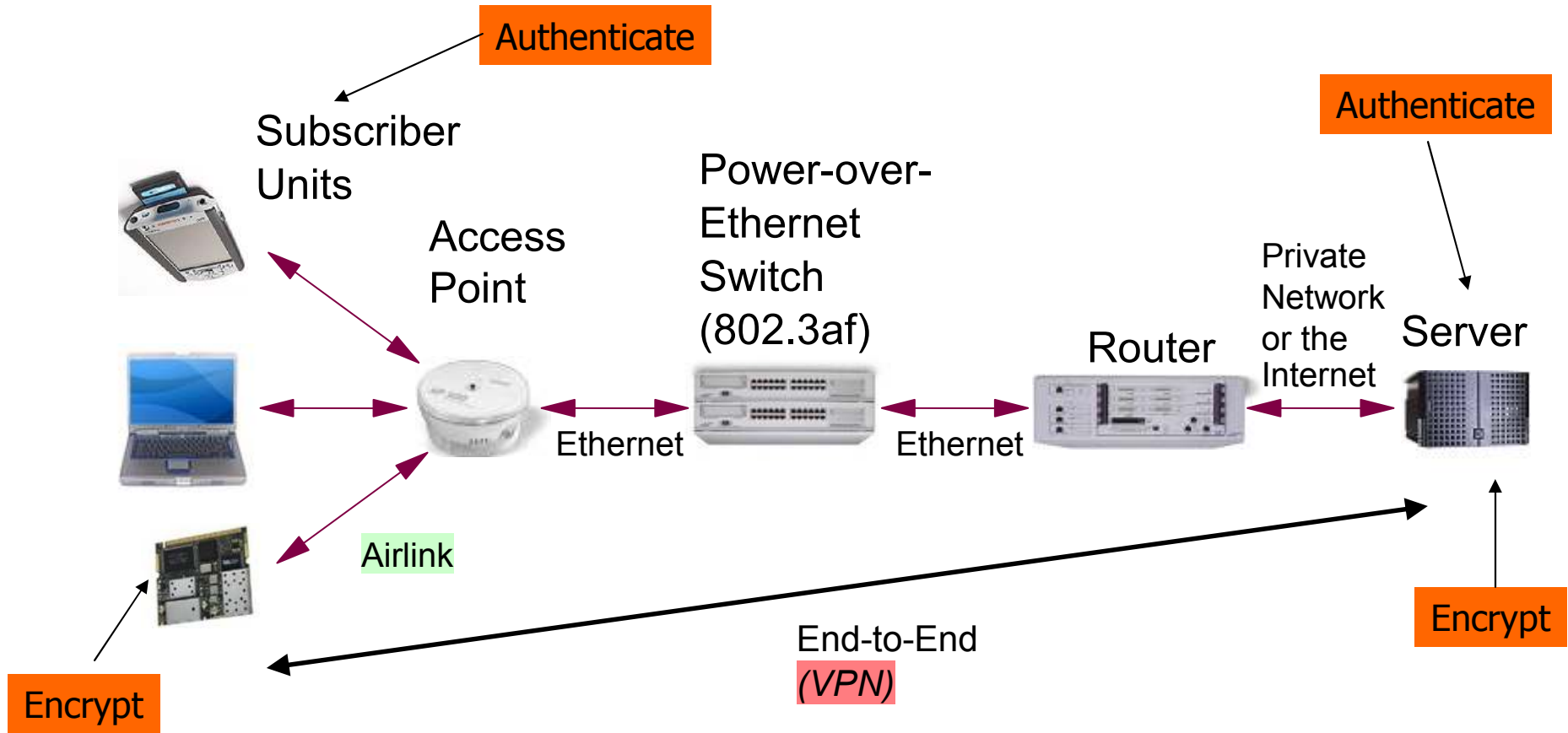
Improving Radio Performance

- ◆ **Rule #1: More bandwidth (limited by regulation)**
 - Channel bonding
- ◆ **Transmit power (limited by regulation)**
 - And/or limiting range - microcells
- ◆ **Minimize interference**
- ◆ **Antenna type, position, and orientation**
 - Antenna diversity; diversity combining, polarization
 - Geometric relationship of transmitter and receiver
- ◆ **Improving modulation efficiency**
- ◆ **Spatial multiplexing (MIMO)**
- ◆ **Improved channel coding (e.g., Turbo Codes)**
- ◆ **Improve signal-to-noise ratio (chips/design)**
- ◆ **Protocols and other higher-level techniques**
 - Compression, packet size, frame bursting, packet scheduling
- ◆ **Also: lower power consumption**

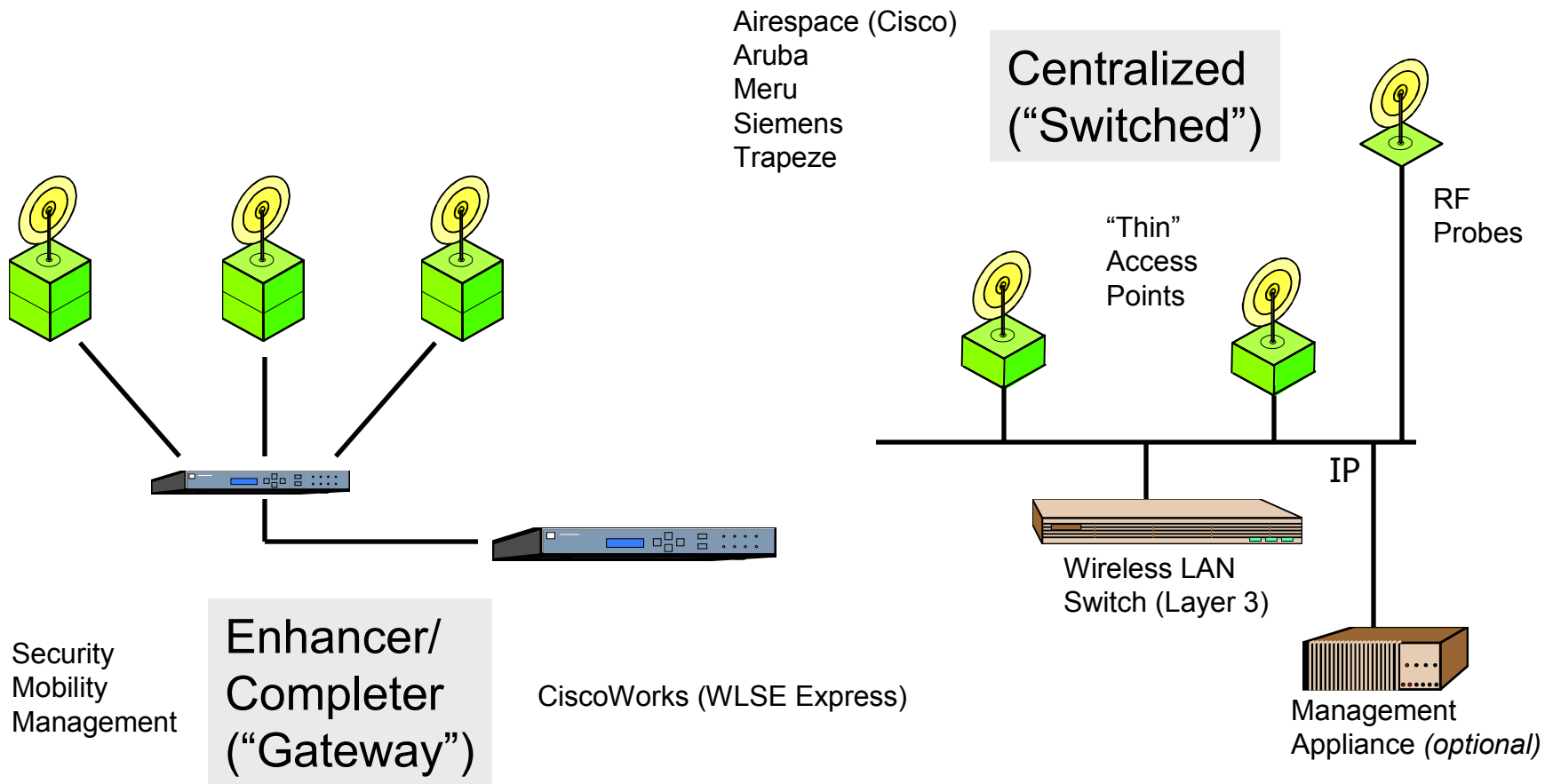
WLANs – Key Trends and Opportunities



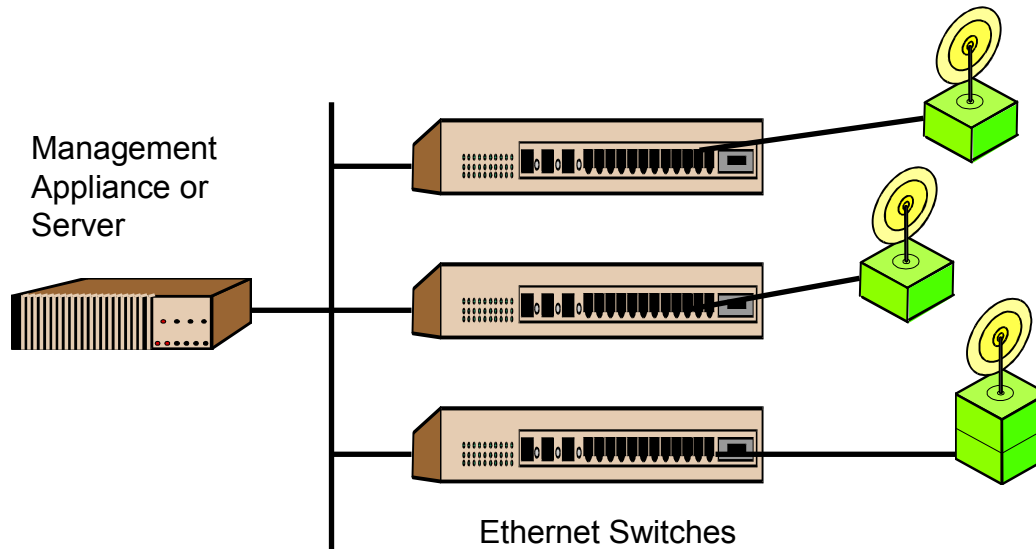
The WLAN Security Value Chain



Unified (W)LANs - Background



Unified LANs – Wired and Wireless Infrastructure Merge



- Traditional APs
- Thin APs
- Standardized APs
- Multi-radio APs/Arrays
- Dynamic probes (APs/Probes)

Distributed/
Switched
(control of traditional
wired switches)

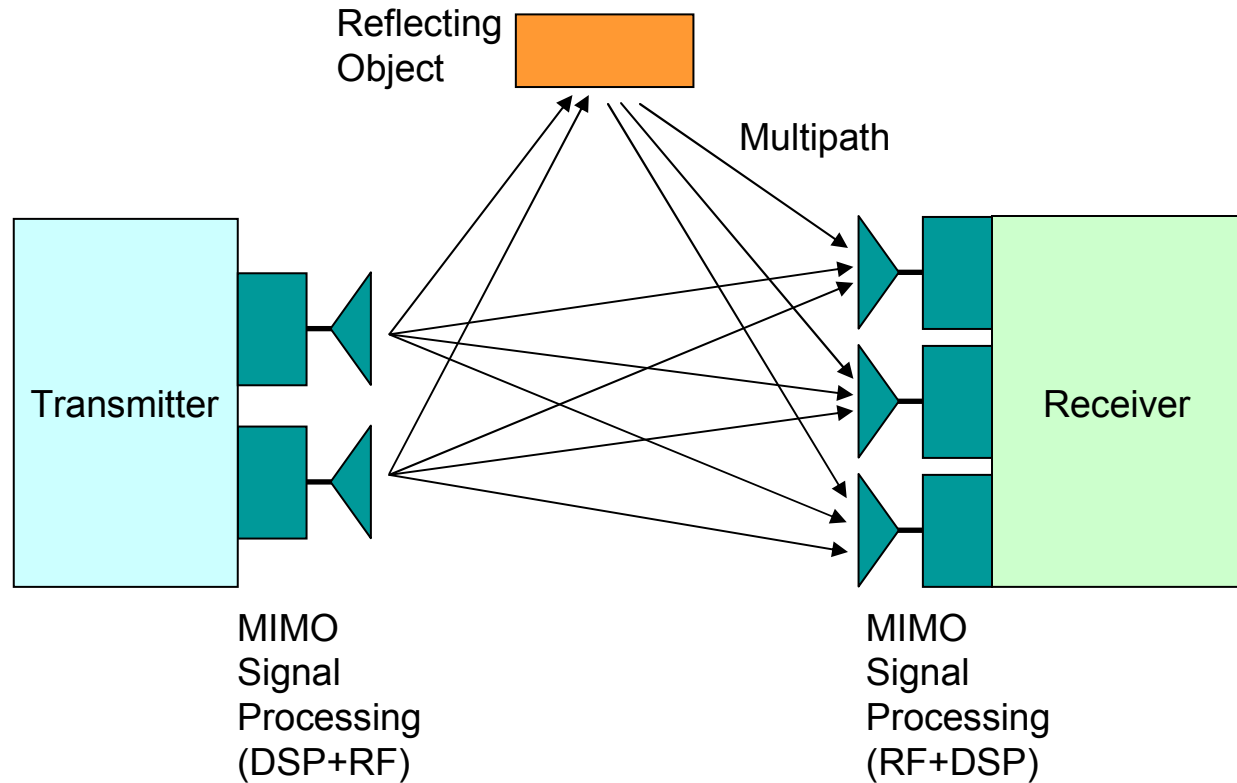
Unified
(new programmable
wired/wireless switches)

Broadcom
Marvell
SiNett
Nexthop
ipinfusion
Colubris

802.11n

- ◆ **The next generation WLAN PHY**
- ◆ **100 to 600+ Mbps**
- ◆ **Will be based on MIMO/OFDM**
- ◆ **Backwards compatible to .11a/g**
- ◆ **Draft standard approved, Final in late 2006**
 - **Some “pre-n” products available now**
 - Very controversial
 - But different from the “pre-g” mess
 - Excellent performance – throughput and range
 - **“Real” products late 2006 at the earliest; don’t assume upgradeability**
- ◆ **Will likely be the PHY of choice for some time to come**
 - **Gradual phase-out of 2.4 GHz. (b/g) products in enterprises**
 - Use “triple-mode” (a/b/g) clients in the interim
- ◆ **Video alternative: Amimon**

MIMO Example – 2T, 3R



The Future of WLANs

- ◆ **Established technology, products, and markets – here to stay**
 - The LAN itself isn't going anywhere...
 - No real challenge from WPANs, WMANs, or WWANs
- ◆ **Much higher throughput – to perhaps 600+ Mbps**
 - And eventually 1-6 (!) Gbps
- ◆ **Major role for voice**
- ◆ **Position/location tracking as standard feature**
- ◆ **Great integration into both wired infrastructure and enterprise management**
- ◆ **Becomes, for many if not most, the default network connection – essentially everywhere!**

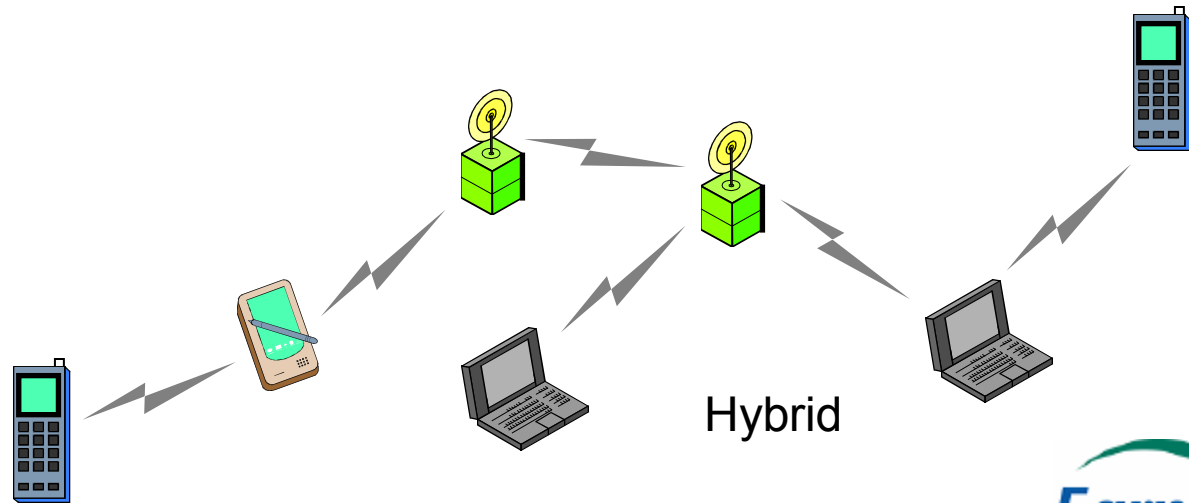
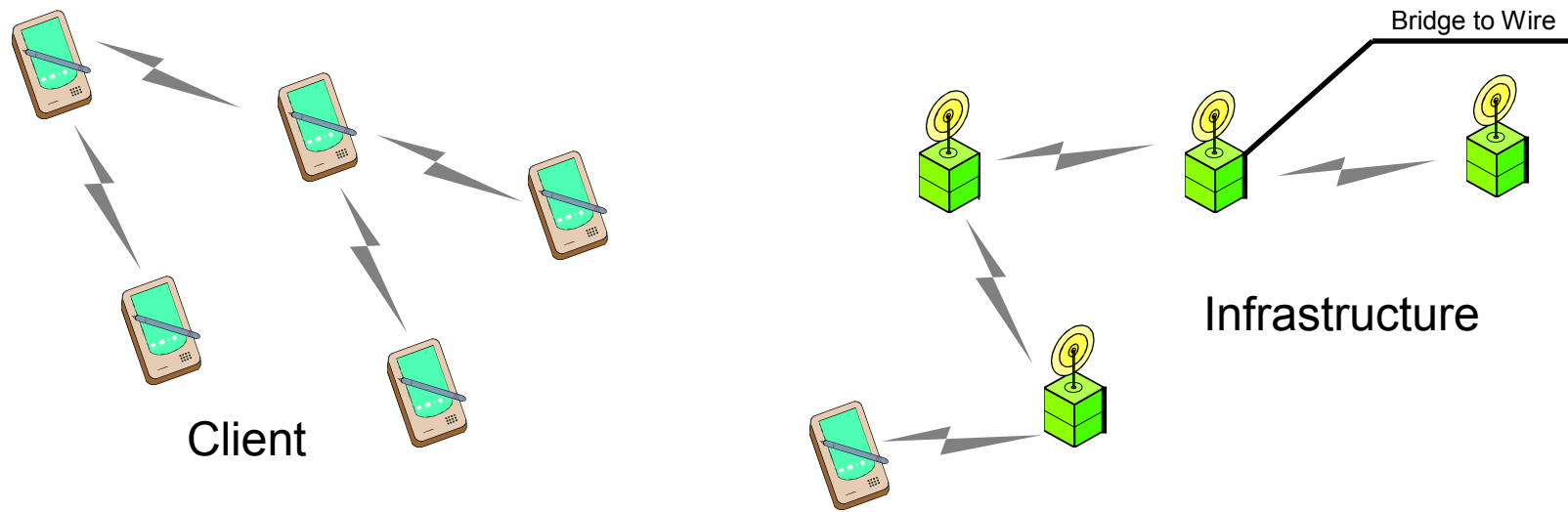
60 GHz.

- ◆ 57-64 GHz., unlicensed, Part 15 rules
- ◆ GaAs to this point, SiGe this year (IBM), CMOS next year
 - No core technical issues remain
 - Antennas are critical
- ◆ Oxygen-absorption band; very directional – issues with range (although better than UWB) and coverage
- ◆ Some residential media/LAN products now in development – expect production in 2007
 - 6+ Gbps possible
- ◆ 802.15.3c Millimeter-Wave Working Group

Meshes

- ◆ **Meshes are the most important *architectural* innovation in wireless networks today**
 - **Reduced requirement for backhaul**
 - But more backhaul is always desirable
 - **Reduced installation expense**
 - Cover even an entire city in minimal time
 - **Simple incremental growth – more nodes, more radios per node**
- ◆ **Primarily outdoor, but some indoor systems and applications**
 - **Macro, metro, WLAN, micro (sensor meshes)**
- ◆ **Static/deterministic vs. self-organizing (dynamic routing)**
- ◆ **Infrastructure, client, or hybrid**
- ◆ **Core issues**
 - **Nodal complexity (it's a router...)**
 - **Time-bounded performance (latency)**
 - **User/backhaul competition – multiple radios per node are the future**
 - **Single-radio implementations may involve store and forward**
 - **Security (not really...)**
 - **Power consumption (micromeshes)**

Mesh Architectures



Metro-Scale Wi-Fi

- ◆ Or even wide-area deployments?
- ◆ The idea – use Wi-Fi meshes to rapidly deploy outdoor services over a large geographic area
- ◆ Origins: Metricom's *Ricochet* (mid-1990s)
- ◆ Economics now allow for residential services in suburbia
 - But most emphasis remains on high-density areas and government services
- ◆ The Wi-Fi mesh phenomenon may spill over into in-building deployments
 - “Instant” Wi-Fi deployments
 - Little or no infrastructure in the traditional sense
- ◆ WiMAX as backhaul (and eventually access?) in some implementations

WiMAX

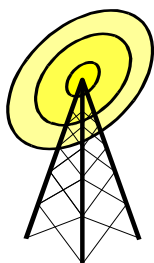
- ◆ **Worldwide Interoperability for Microwave Access**
- ◆ **Clearing up the confusion**
 - WiMAX is an interoperability specification for 802.16-2004 – fixed point-to-multipoint (P2M or P-to-MP)
 - Mobility extensions defined in 802.16e-2005
- ◆ **NB: Today's WiMAX products are for *fixed* applications only!**
- ◆ **WiMAX is based on a subset of 802.16-2004 (formerly 802.16a Rev d)**
 - 256 QAM/OFDM
 - 2.5 and 3.5 GHz. licensed bands; 5 GHz. unlicensed
 - Goals are \$250 "set top" box; \$100 PC Card
 - Truck rolls remain an issue
 - To 70 Mbps and 50-60 miles (not)
 - More likely: xDSL/T1 speeds over a few kilometers
 - 40+ Mbps possible in some fixed applications
- ◆ **Big investment in VLSI by Intel and others**

Mobile WiMAX

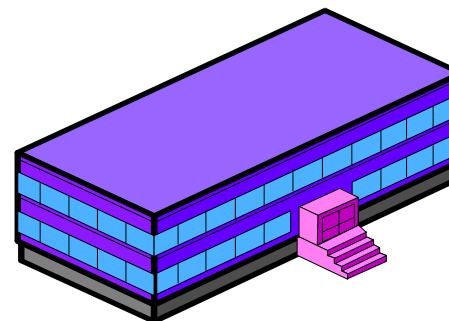
- ◆ **Mobility is *the* killer app for wireless**
- ◆ **Mobile voice is well-established**
 - And is beginning to replace land lines...
- ◆ **Mobile data is becoming more important**
 - Critical to cellular growth as voice market saturates
 - The Web will become as important as telephony
 - Mobility could replace many fixed installations (access)
- ◆ **But competition is significantly more brutal here...**
 - Metro-scale WLANs
 - 3G Cellular
 - 4G Cellular

The WiMAX Question – Which Access?

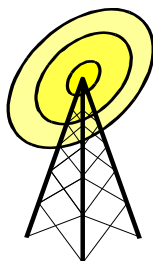
WiMAX
Base Station



WiMAX as *Access*



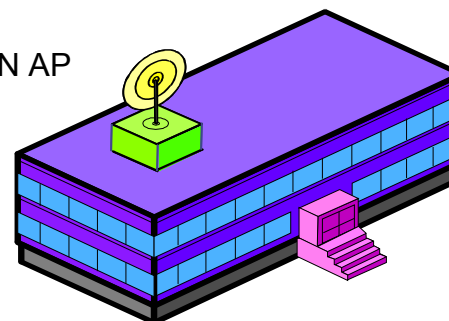
Or...



WLAN AP



WiMAX as *Distribution*



What is 3G?

- ◆ Technically – data throughput of >144 Kbps, to 2 Mbps (“3.5G” above that)
- ◆ Two flavors – narrowband (1.25-MHz. CDMA) and broadband (5 MHz. - UMTS)
- ◆ Improved voice services, management, OSS, spectral efficiency
 - Includes all 2G voice functions
- ◆ Higher-speed data
 - 144 Kbps vehicular, 384 Kbps slow movement, 2 Mbps peak
- ◆ Progress has been slow
 - Technical issues
 - The recession
 - The need for a cellular industry consolidation
 - The fundamental conflict between voice and data
- ◆ But 3G services are available from all nationwide carriers now (except T-Mobile)

Universal Mobile Telecommunications System (UMTS)

- ◆ The natural evolutionary path to 3G for GSM
- ◆ Frequency division (FDD, up/down channels) and time division (TDD) versions
- ◆ Based on W-CDMA
- ◆ Available in spots in much of the world today
- ◆ Chief competitor is CDMA2000
- ◆ Standards are in the hands of the Third Generation Partnership Project (3GPP)
 - Next: UTRAN LTE (Long-Term Evolution)
 - To 100 Mbps downlink, 50 Mbps uplink
- ◆ Issues with “warm” handsets...
- ◆ Available from Cingular (limited cities)

1XRTT

- ◆ **CDMA-2000 – The “American” 3G**
- ◆ **153 – 307 Kbps peak**
 - 60 – 80 Kbps typical
- ◆ **Verizon Wireless and Sprint PCS offer unlimited packages**
 - “NationalAccess” and “PCS Vision”
 - “Mobile Office” kit, VZAccess software
 - Data Card for PC

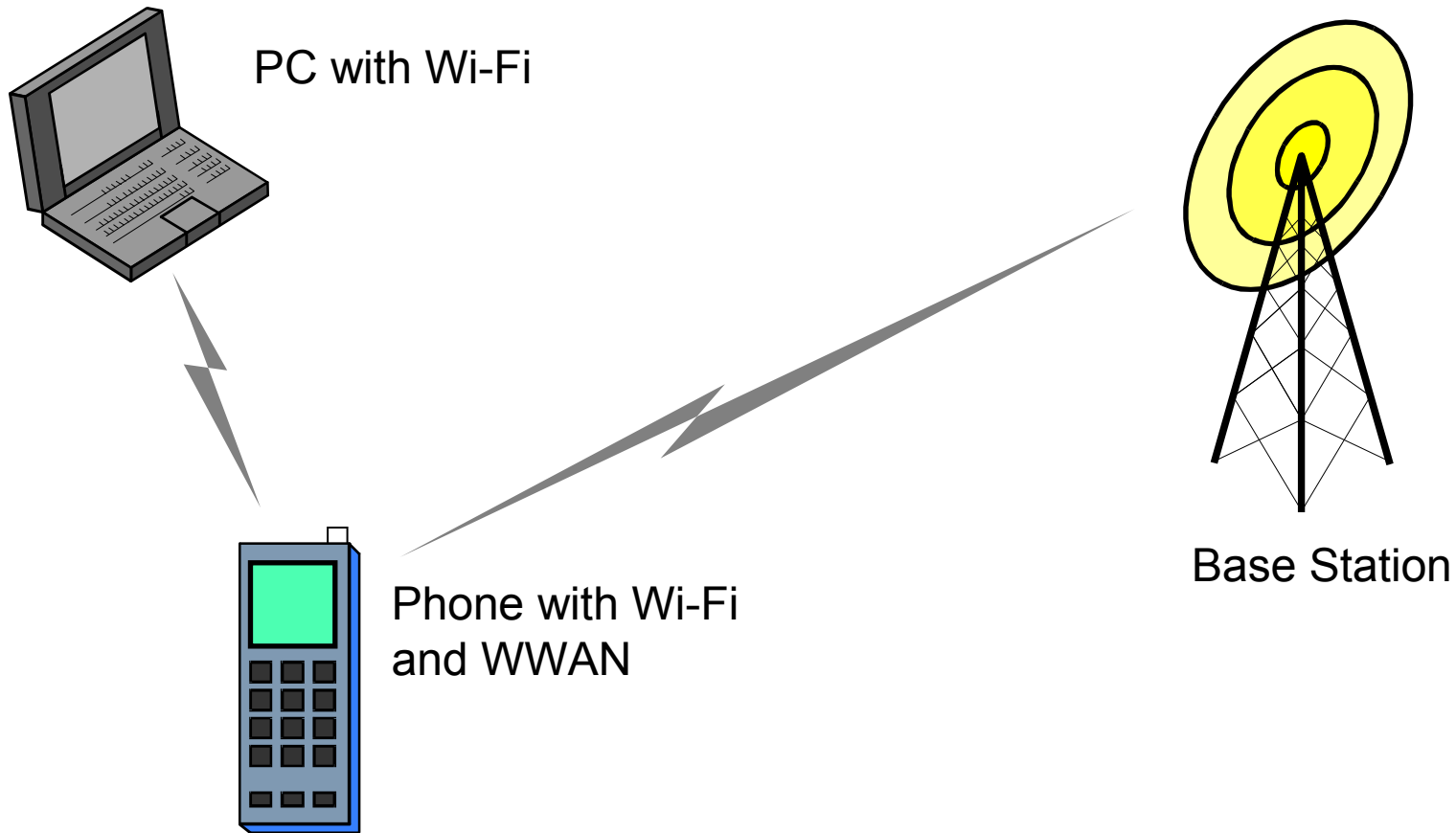


Audiovox
PC 5220

1xEV-DO

- ◆ “Data Optimized” or “Data Only” in a single 1.25-MHz. CDMA channel
- ◆ To 2.4 Mbps (Rev A: 3.09 Mbps) on downlink
 - Actual throughput to 300-500-700 Kbps
 - Remember: *availability (coverage) and latency*
- ◆ Standards work continues under the direction of the 3GPP2
- ◆ Available from Verizon Wireless (*BroadbandAccess*) and Sprint
 - Limited cities
- ◆ “nxEV-DO” – higher speeds

The Relay-Point Model



Why Ultra-Wideband (UWB)?

- ◆ Takes advantage of inverse relationship between distance and throughput
- ◆ Huge bandwidth = very high throughput
 - FCC rules (15.517) - very low power (-41.3 dBm) from 3.1 GHz., to 10.6 GHz. (7.5 GHz.)
 - High throughput is *always* a requirement over time
- ◆ Low power consumption
- ◆ Convenience and flexibility
- ◆ Good “spectrum citizen”
- ◆ Approved in the United States; Japan and Europe in process
- ◆ Broad range of applications – wireless USB will be key
- ◆ Perfect for cable replacement, room-area networks, and video in the residence

Wireless WAN Evolution

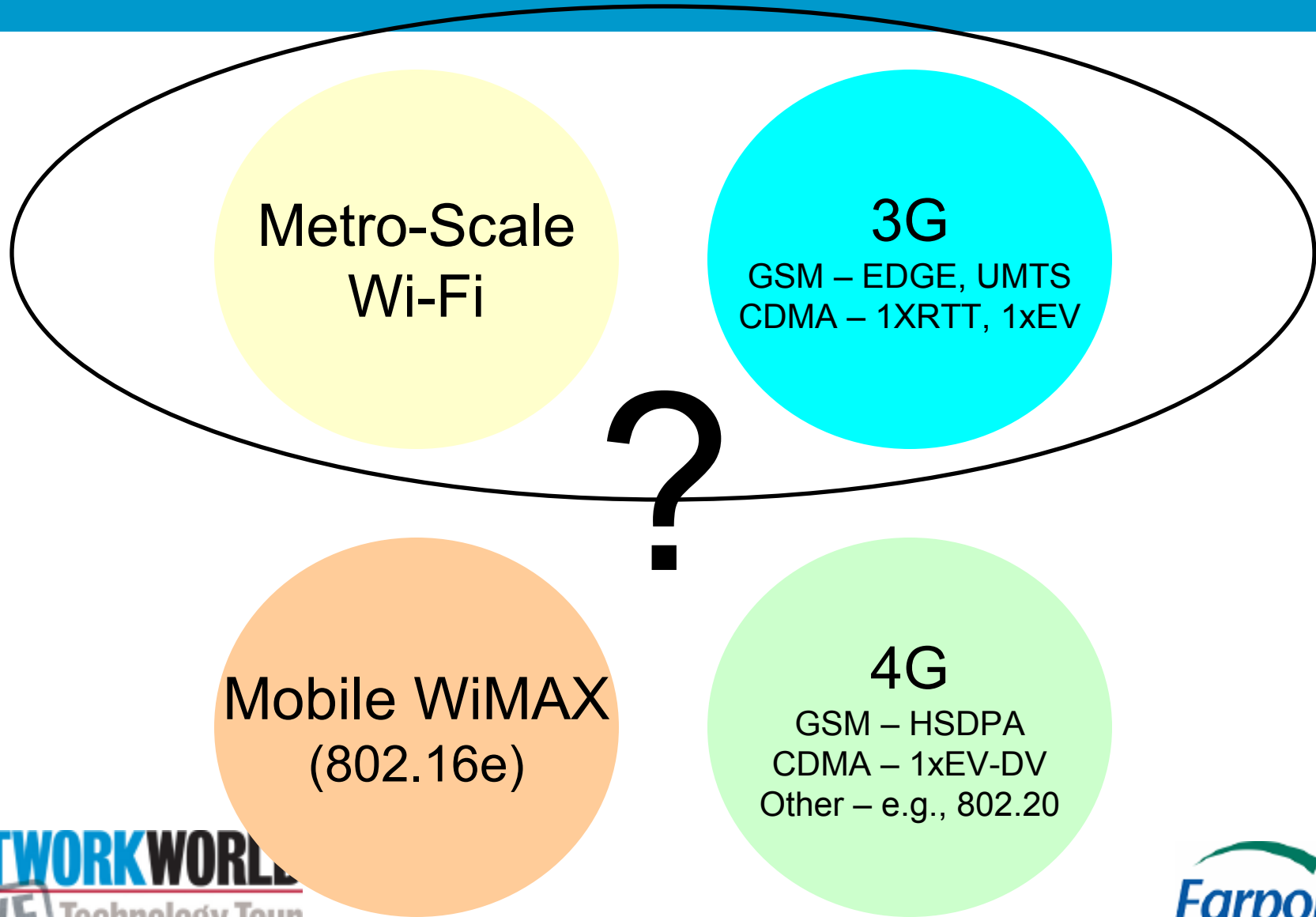
1G - Analog		2G – Digital, Narrowband, Circuit-Switched (2.5G Packet)		3G – Digital, Broadband		4G – Digital, All-IP	
System	Throughput	System	Throughput	System	Throughput	System	Throughput
AMPS	9.6 – 14.4 Kbps	GSM	9.6 – 14.4 Kbps	EDGE	60-80 kbps	HSDPA	<=14.4 Mbps
		CDMA	9.6 – 14.4 Kbps	1XRTT	40-60 Kbps	Flarion (Qualcomm)	3 Mbps
		GPRS (2.5G)	20-40 Kbps	UMTS	300-500 Kbps	1xEV-DO (Rev A)	3.1 Mbps
				1XeV-DO	300-500 Kbps	WiMAX	3 Mbps?
						Wi-Fi (802.11n)	50+ Mbps

Source: Farpoint Group

“4G” Wireless

- ◆ **Convergence...**
- ◆ **What is 4G wireless? Two schools of thought:**
 - **Ever higher throughput (e.g., 100 Mbps)**
 - NTT has demonstrated this in the wide area
 - But: the throughput/distance tradeoff
 - **“Inverted” (wireless) networks**
 - Full support for time-bounded IP-based communications – not separate voice/data
 - Essentially, what we'd like the Internet to be...
- ◆ **The key is support for native IP transport with mobility and megabit throughput**
 - **Fixed access may be doomed...**
- ◆ **WLANs could play a role here...**
 - **Distance/throughput inverse relationship (and power)**
 - **Cellular operators *must* get into WLAN in a big way...**

The Wide-Area Broadband Future



The Single-Device Paradox



Palm *Treo 650*

Phone in a PDA?

- ◆ Size
- ◆ Weight
- ◆ Battery Life
- ◆ Ruggedness
- ◆ Operating environment
- ◆ User Interface
- ◆ Platform/Software
- ◆ Cost
- ◆ Other functionality (cameras, MP3, ?)
- ◆ Etc.



Motorola *MPx220*

PDA in a Phone?

PDA Phones/Mobile Communicators



Motorola Q



Motorola RAZR V3



Samsung SP-i600
(Windows Mobile)



Sprint PPC-6700



Nokia 7710



RIM BlackBerry 8700c
(Cingular)



Nokia E61



Palm Treo 700w

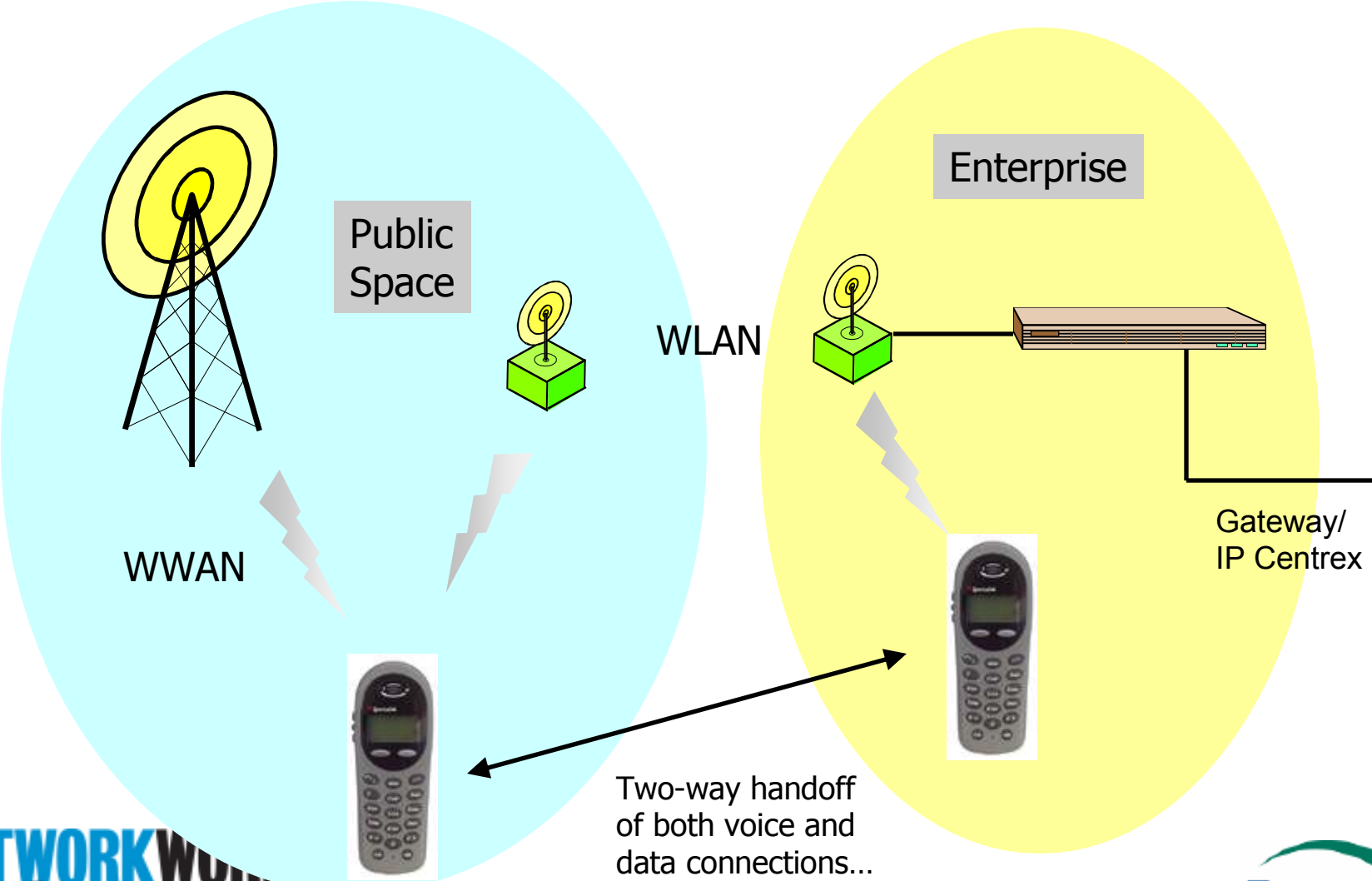
Fixed/Mobile Convergence

- ◆ **Really two issues**
 - **FMC – integrating wireline and wireless**
 - Likely to reduce landlines to just backhaul/ interconnect
 - PBX integration in the interim
 - **MMC (Mobile/Mobile) – Integrating cellular and Wi-Fi (and possibly others, like UWB)**
- ◆ **IP Multimedia Subsystem (IMS)**
 - 3GPP; becoming universal standard
- ◆ **Unlicensed Mobile Access (UMA)**
- ◆ **Possible scenarios:**
 - Wireline carriers take the lead – MVNOs
 - Wireless carriers see their destiny – core-network technology
 - The enterprise does it *a la* IP telephony

The Desktop of the Future...

- ◆ **Looks like the desktop of the 1920s!**
 - An AC outlet, and nothing else!
 - Lots of charging stands/batteries required...
- ◆ **Automatic handoff between wide-area voice (CDMA/GSM) and VoFi**
 - And data services as well
- ◆ **Fixed/Mobile and Mobile/Mobile convergence in action**
- ◆ **An opportunity for cellular operators to:**
 - Enhance their capacity in high-traffic areas without more expensive spectrum
 - Displace wireline carriers in the enterprise

VoFi – Everywhere, All the Time



The Mobile Web

- ◆ It's clear business users and consumers want the Web with them
- ◆ To date, most “microbrowser” efforts have been frustrating
 - WAP, cHTML
 - Some proprietary implementations
- ◆ The full “desktop” experience is required
 - Transcoding doesn't work
 - The Web gets more complex (from a technical perspective) all the time
- ◆ Modern wireless networks are simply “IP in the sky”
 - Minimal application integration
 - Are thin clients the answer?
 - Not yet... but they will be!



Nokia Series 60 Browser

Conclusions

- ◆ There are no fundamental roadblocks to mobile broadband becoming the *default* connectivity for businesses and consumers
 - Just as was the case with the cell phone...
 - Everything – triple play – everywhere, all the time
 - Fixed services will eventually be used for interconnect/backhaul only
- ◆ A combined big-cell (for coverage) / small-cell (for capacity) model works best
- ◆ The thin-client model will become dominant – eventually
 - Requires ubiquitous coverage and sufficient capacity
- ◆ Subscriber units are the biggest challenge
 - The single-device-paradox
 - Batteries!