WIRELESS FUTURE

IC² Institute, The University of Texas at Austin

Austin Wireless Alliance

Austin Technology Council

Sponsored by Andrews Kurth LLP

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Austin Technology Council

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Need for Wireless Future

- The Austin Wireless scene was fragmented
- Local wireless as a whole had low visibility
- Austin's relevance was unclear

Wireless Future

Purpose of the Wireless Future Project

- Understand wireless in Austin
- Elevate profile of Austin's wireless industry
- Educate regional/national stakeholders
- Lay groundwork for vision of Austin's success in wireless

Wireless Future

Methods

- Stakeholder meetings
- Interviews
- Survey
- Future Scenarios

Why Wireless?

- The value of wireless is in networks
- The value of wireless is in mobility
- The value of wireless is in pervasive access
- “Everything, everywhere – in the palm of your hand.”

Current wireless technologies are evolving rapidly

- The FCC is opening more unlicensed spectrum
- Barriers to entry are low in the unlicensed realm
- Explosive growth in the number of wireless devices and services is feeding innovation and economic growth

Vision: Wireless will mean ubiquitous mobile communication

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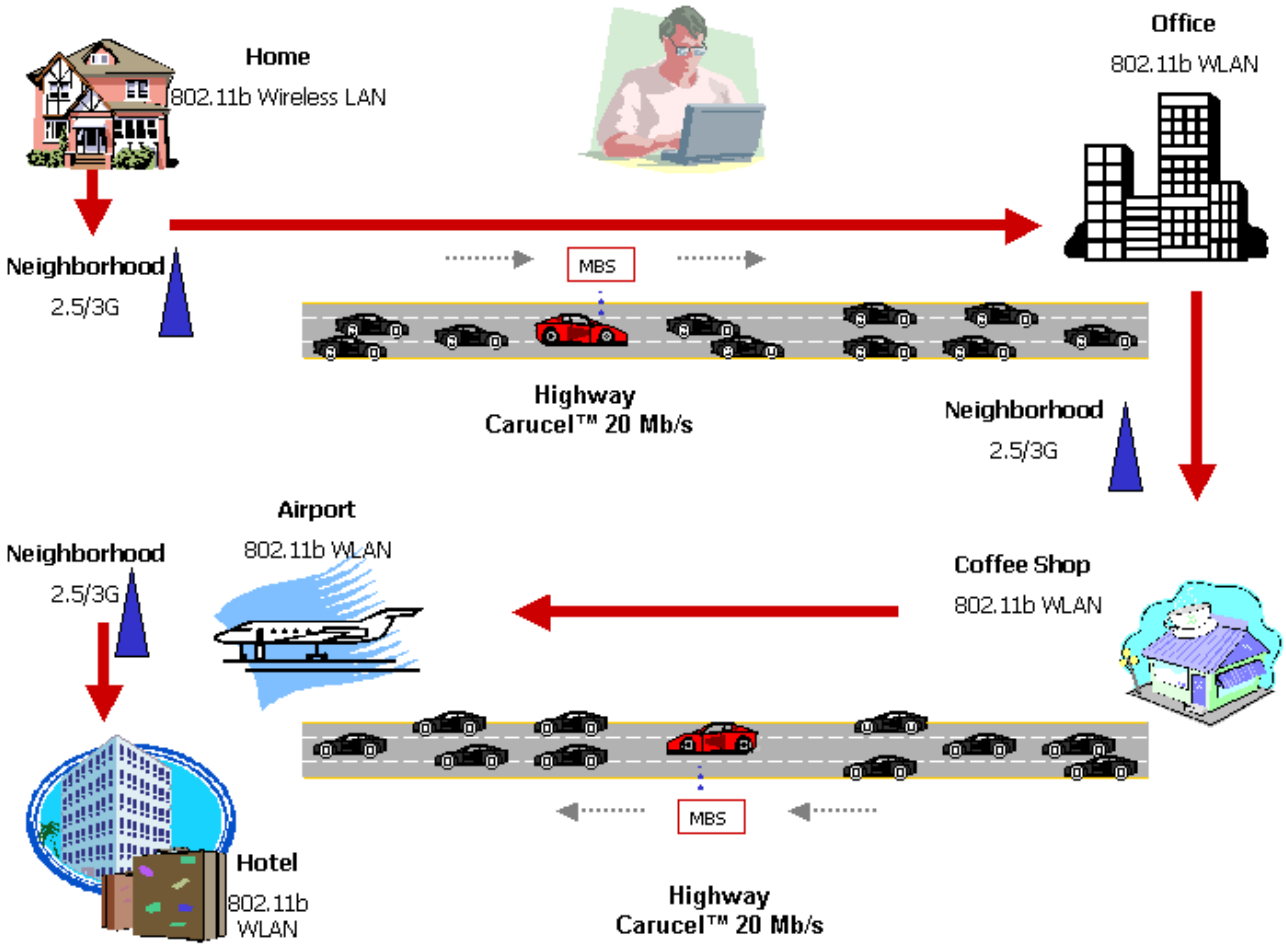
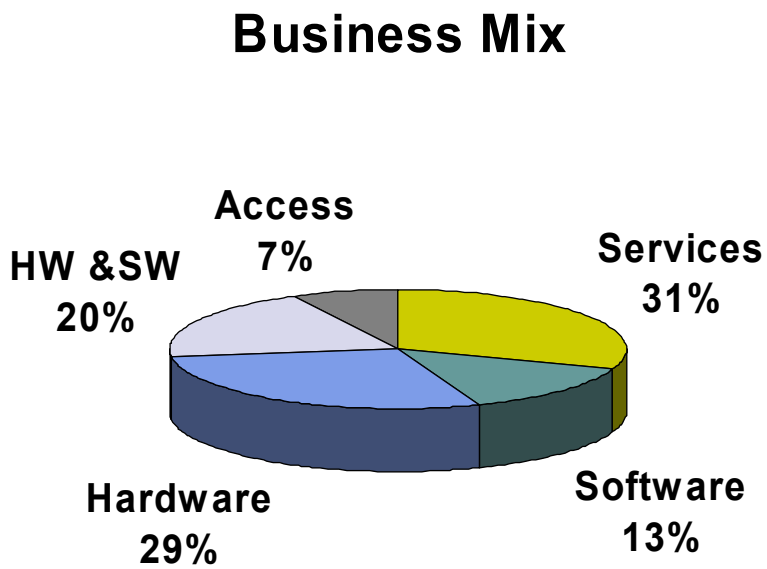


Austin's Wireless Future Report

- Wireless technology and trends
- Vision for ubiquitous mobile communication
- Analysis of Austin's wireless companies
- Analysis of support infrastructure
- Conclusions

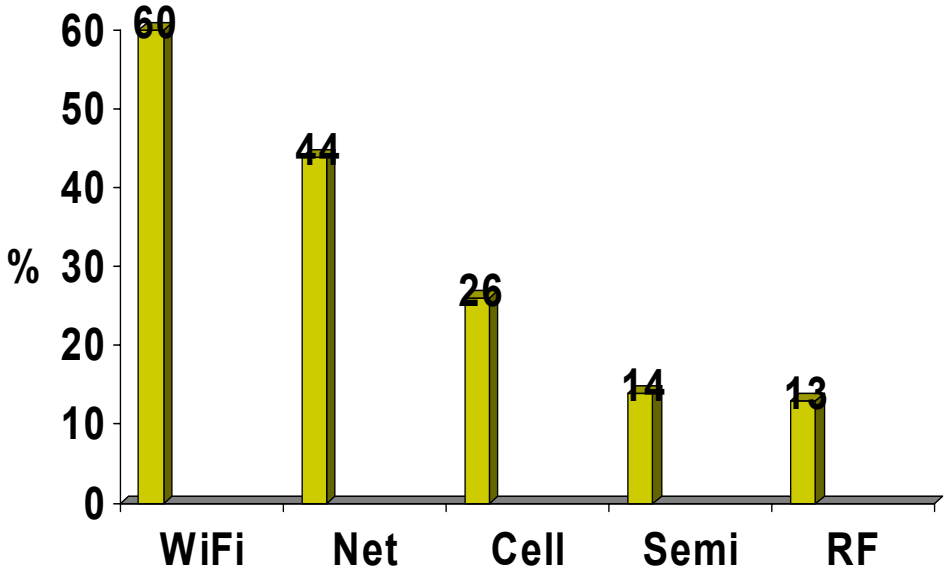
Austin's Wireless Companies

- 91 wireless companies



Austin's Wireless Companies

- Technology focus
  - WiFI/802.11
  - Networking
  - Cellular
  - Semiconductors
  - RF



Employment

- 80% have fewer than 50 employees
- 55% have fewer than 10 employees
- Approximately 3000-3400 currently employed in Austin wireless companies with fewer than 100 employees
- $125 million payroll
- Optimistic regarding employment growth

Finance

- 70% have revenue less than $1 million
- Half financed through personal savings/debt
- Access to capital remains one of Austin's wireless sector's biggest challenges.
  - 37% will seek seed/venture/expansion funding in next 12 months
- No company reported receiving government funds.

What do Austin wireless companies want?

- Tax incentives for relocation/recruitment
- Networking
- Facilities incentives
- Technology incubation
- Workforce needs met

Wireless Sector Ecology

- Investment Capital
- Human Capital
- Intellectual Capital
- Social Capital/Civic Infrastructure

Next Steps

- Improve Visibility
- Maintain and grow Austin's best competitive advantage—people
- Build a better network
- Support entrepreneurs and growth businesses
- Capitalize on existing strengths

Wireless Future Conference

- From local to global
- Forward-looking
- Focus on entrepreneurs, developers, and creatives
- Combination of local and national talent

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Rocksteady

Futures Lab

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The Austin Technology Incubator

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Austin Technology Council

"Going Global On Day One - A Key to Success in the Wireless Industry"

Erin Defosse
Director
Austin Technology Incubator

Wireless is a Global Industry

- GSM subscribers account for over 70% of mobile phone users world wide*
- North America accounts for only 2.5% of global GSM subscribers*
- North America accounts for only 9.1% of operational GSM networks-on-air*

Companies must think and act globally to be successful…but acting globally is difficult and costly

*as of May 2003, Source: GSM Association

Acting Globally Requires Specific Assets and Capabilities

- Staff on the ground in-country
- Understanding of local business culture
- Local language capabilities
- Relationships

By definition, most startups do not have these capabilities yet need to develop them early in order to meet the demands of the global market

ATI is developing the infrastructure to deliver these assets and capabilities

- Network of fellows cultivated over 25 years, starting with the work done by George Kozmetsky
- Network of incubators currently being developed by ATI
- Teams on the ground
  - Trained by ATI
  - Relationships with business and government entities in-country
  - Mission to facilitate relationships with US firms trying to access their markets and vice-versa

ATI recently completed the launch of 2 incubators in Europe under contract from Lockheed Martin. Work is in progress to launch similar ones in South America and Asia.

ATI will deliver these global capabilities in addition to its existing suite of offerings

- Relationships with wireless industry partners and access to potential reference customers
- Access to seed stage capital
- Access to management know-how
- Access to technical know-how and resources
  - Corporate partners
  - Wireless Networking and Communications Group (WNCG) at The University of Texas

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The Business of Wireless

Agenda

- Introduction to Wireless
  - The basics
- Wireless Future – A discussion
  - Panel discussion on the next three years
- The Austin Wireless Landscape
  - A brief look at the Austin wireless market
  - A overview of select Austin Wireless companies

Wireless 201
A Primer on Wireless Technology

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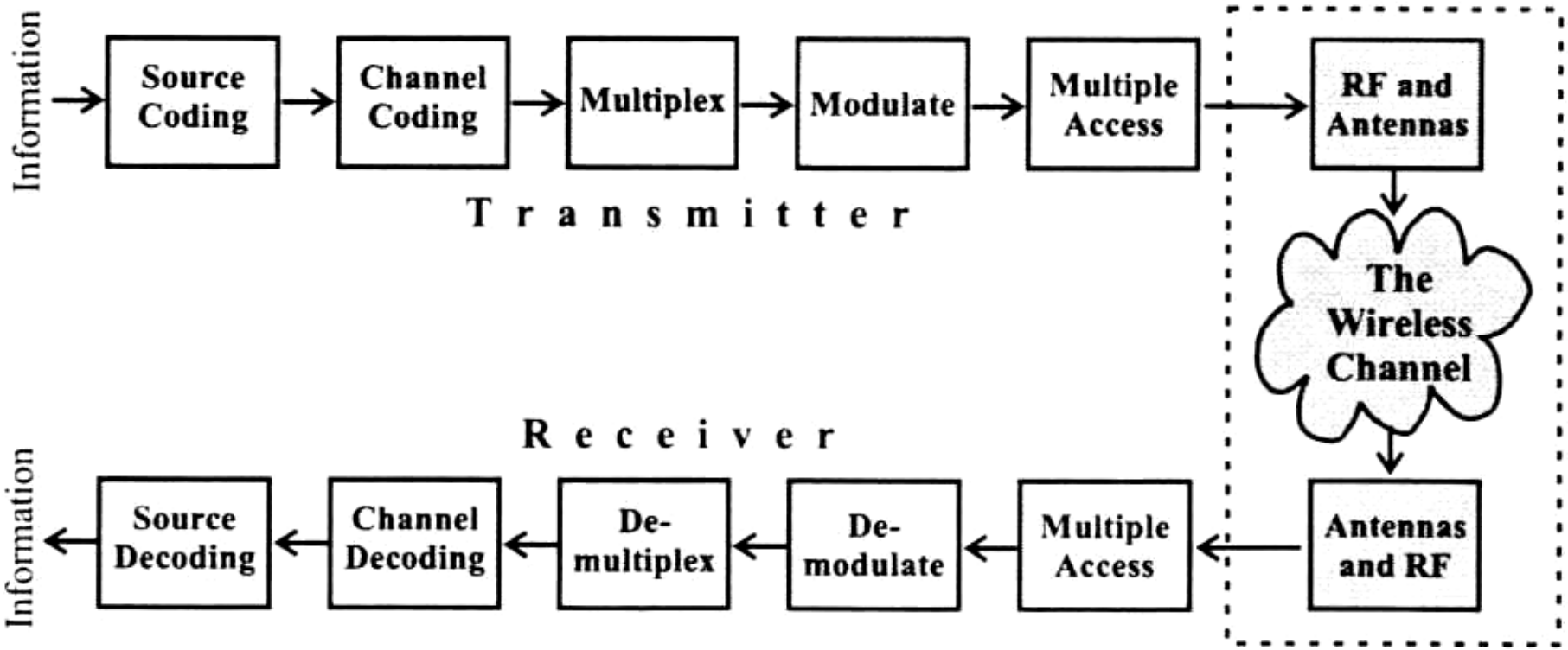
♦

Presented to Austin Wireless Alliance
Launch of IC² Report
Austin, TX
January 13, 2004

Overview

- Wireless Fundamentals
- Cellular / PCS
- Wireless LAN and Home Wireless
- Broadband Fixed Wireless
- The Future of Wireless

Wireless Fundamentals



Wireless Fundamentals

- Radio waves travel at speed of light
- Antennas are required to send and receive
- Wavelength and frequency are related to speed of light
- $c=\lambda f$

Frequency vs. Wavelength

	Service	Carrier Freq	λ	$\lambda/4$ Length
Ionosphere Skip	AM Radio	1 MHz	300m	75m
Line of Site	FM Radio	100 MHz	3m	3/4m
Propagation “Magic”PCS	Cellular	900 MHz	1/3m	1/12m
		1800 MHz	1/6m	1/24m
	WiFi 802.11b	2.4 GHz	1/9m	1/36m
	WiFi 802.11a	5.8 GHz	1/20m	1/80m
	UWB 802.15	2-10 GHz		
Weather affects	WiMax 802.16	28-38 GHz	1/90m	1/360m

GHz=10^9 Hz MHz=10^6 Hz KHz=10^3 Hz

Spectrum Chart

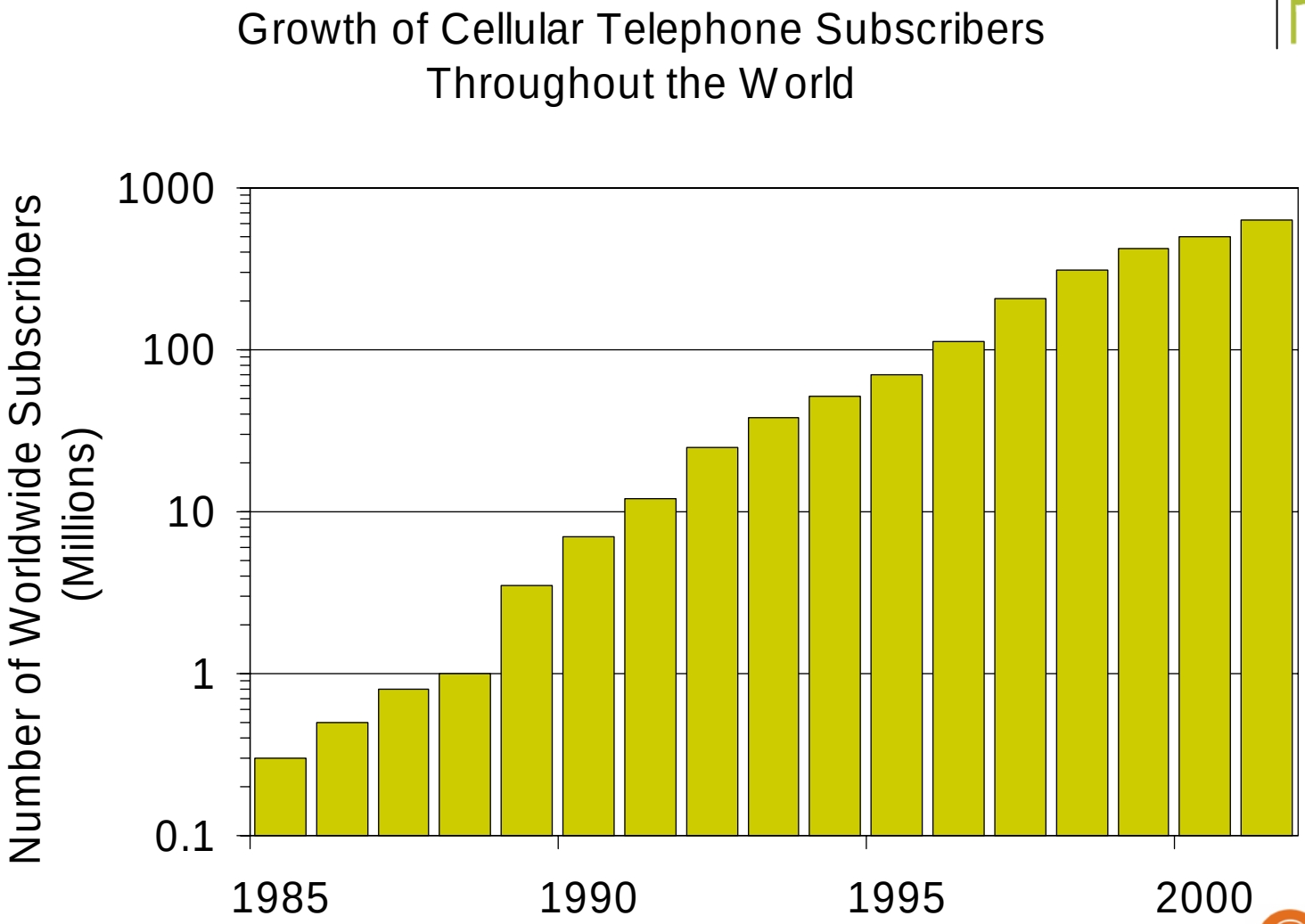
Bandwidth Description	Frequency
Extremely Low Frequency (ELF)	0 to 3KHz
Very Low Frequency (VLF)	3KHz to 30KHz
Radio Navigation & maritime/aeronautical mobile	**9KHz to 540KHz**
Low Frequency (LF)	30KHz to 300KHz
Medium Frequency (MF)	300KHz to 3000KHz
AM Radio Broadcast	**540KHz to 1630KHz**
Travellers Information Service	**1610KHz**
High Frequency (HF)	3MHz to 30MHz
Shortwave Broadcast Radio	**5.95MHz to 26.1MHz**
Very High Frequency (VHF)	30MHz to 300MHz
Low Band: TV Band 1 - Channels 2-6	**54MHz to 88MHz**
Mid Band: FM Radio Broadcast	**88MHz to 174MHz**
High Band: TV Band 2 - Channels 7-13	**174MHz to 216MHz**
Super Band (mobile/fixed radio & TV)	216MHz to 600MHz
Ultra-High Frequency (UHF)	300MHz to 3000MHz
Channels 14-70 TV	**470MHz to 806MHz**
L-band:	**500MHz to 1500MHz**
Personal Communications Services (PCS)	1850MHz to 1990MHz
Unlicensed PCS Devices	**1910MHz to 1930MHz**
Superhigh Frequencies (SHF) (Microwave)	3GHz to 30.0GHz
C-band	**3600MHz to 7025MHz**
X-band:	**7.25GHz to 8.4GHz**
Ku-band	**10.7GHz to 14.5GHz**
Ka-band	**17.3GHz to 31.0GHz**
Extremely High Frequencies (EHF) (Millimeter Wave Signals)	30.0GHz to 300GHz
Additional Fixed Satellite	**38.6GHz to 275GHz**
Infrared Radiation	300GHz to 430THz
Visible Light	430THz to 750THz
Ultraviolet Radiation	1.62PHz to 30PHz
X-Rays	30PHz to 30EHz
Gamma Rays	30EHz to 3000EHz

http://www.adec.edu/tag/spectrum.html

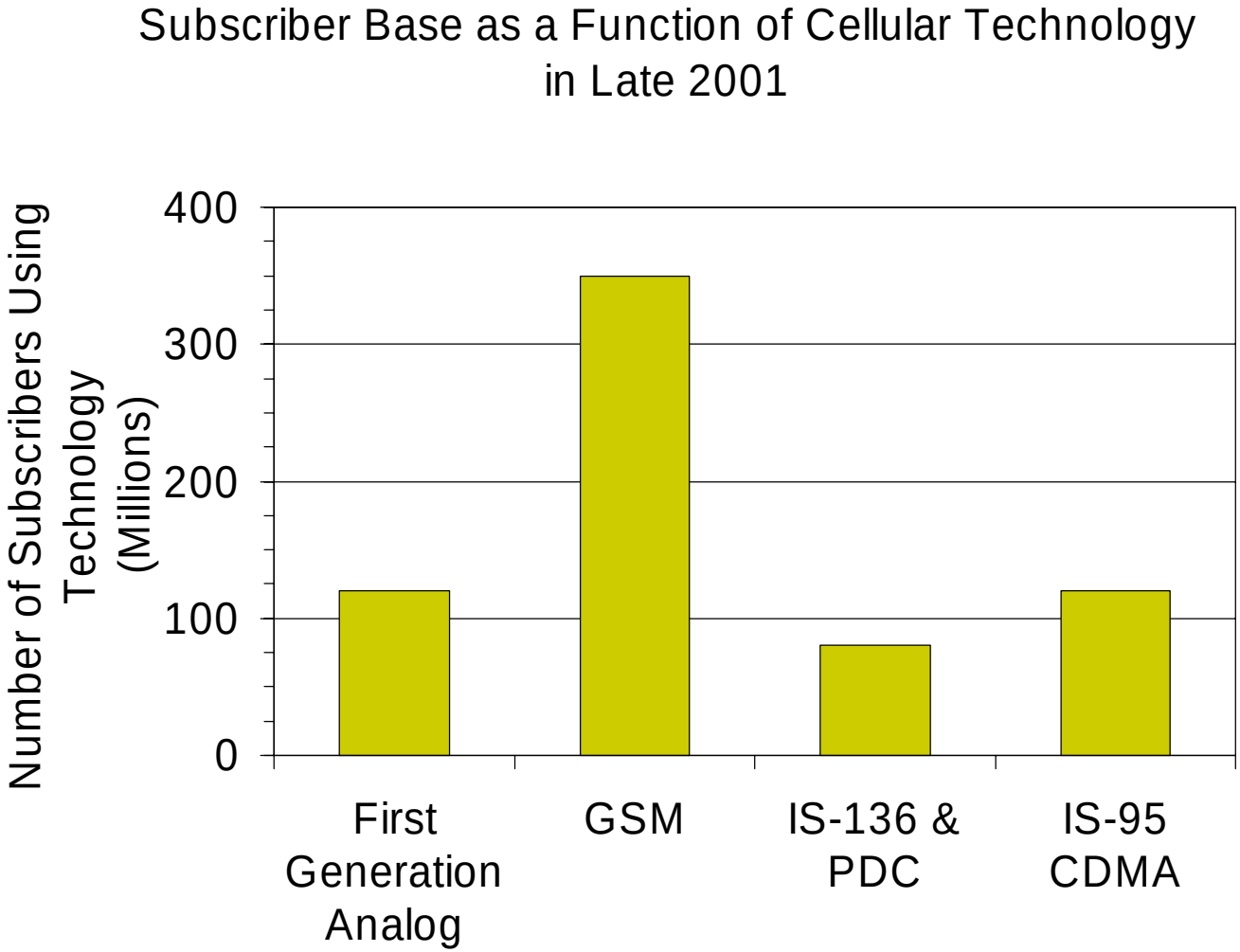
Cellular / PCS

- Established in 1970's – 1980's
- Uses licensed spectrum in ~45MHz blocks
- Mobile voice origin
- 900 MHz – 1800 MHz carrier frequency
- Analog FM in 1980's
- GSM, CDMA in 1990's – 2000's

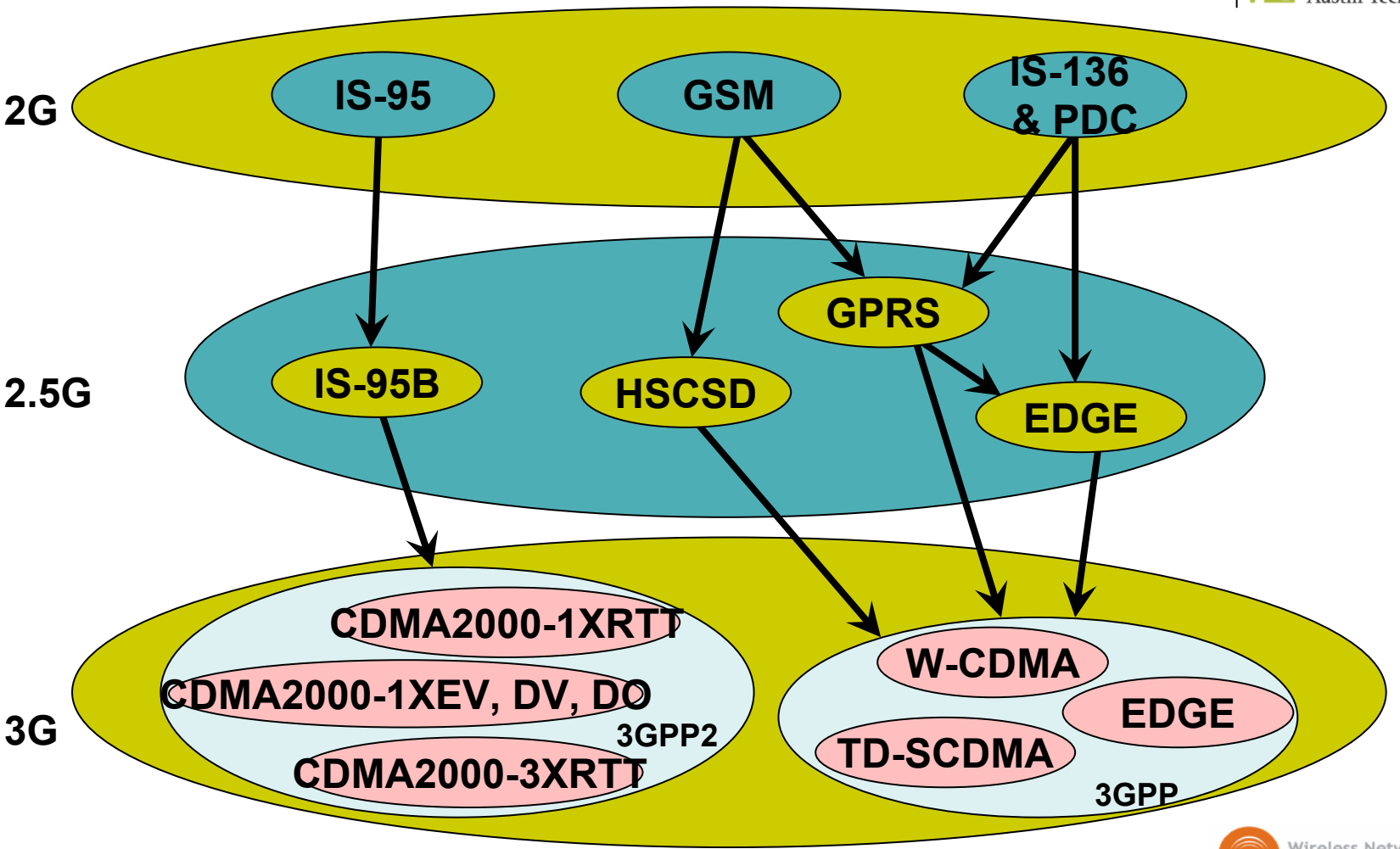
The Wireless Revolution



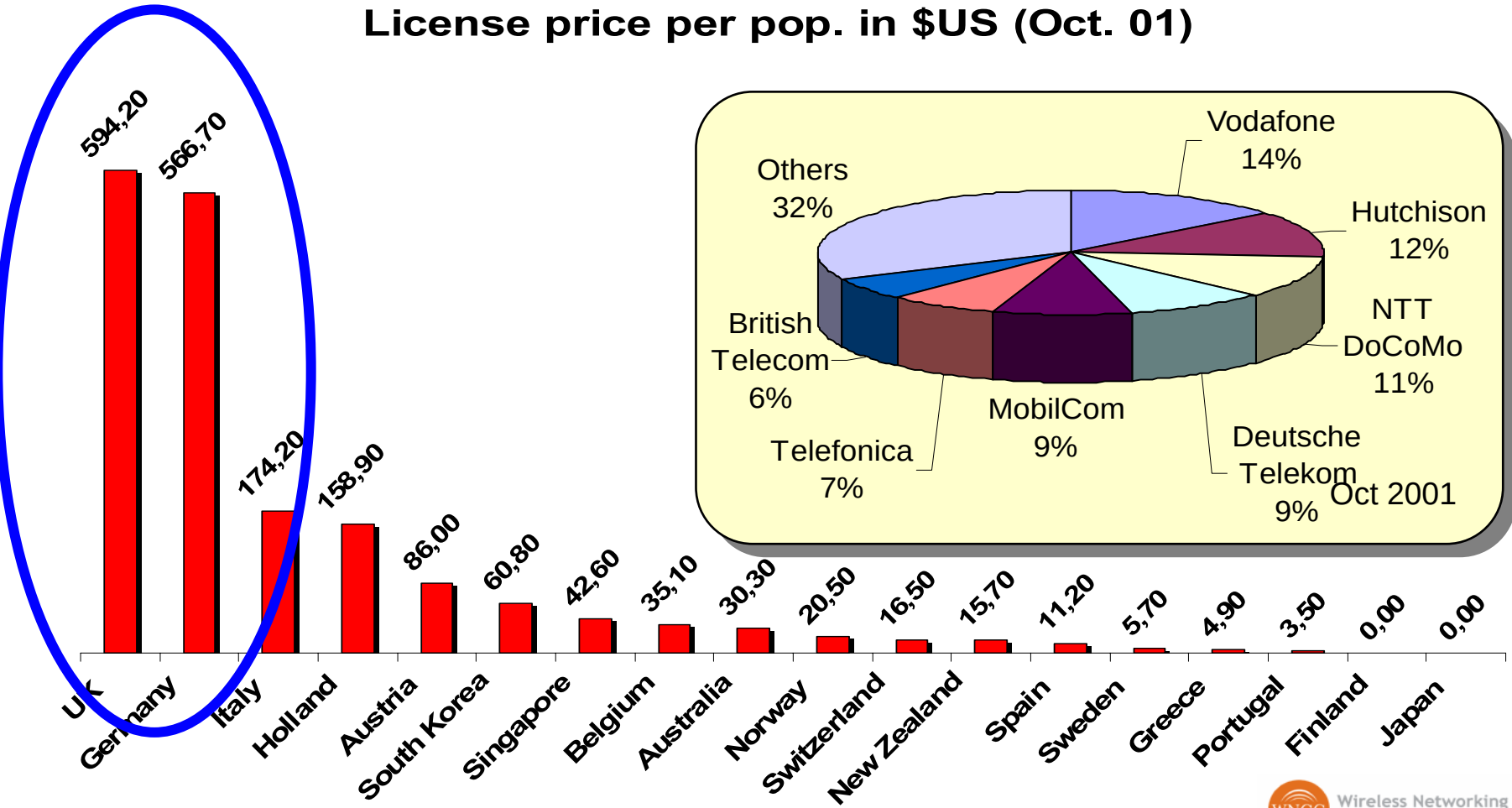
Today's Subscriber Base



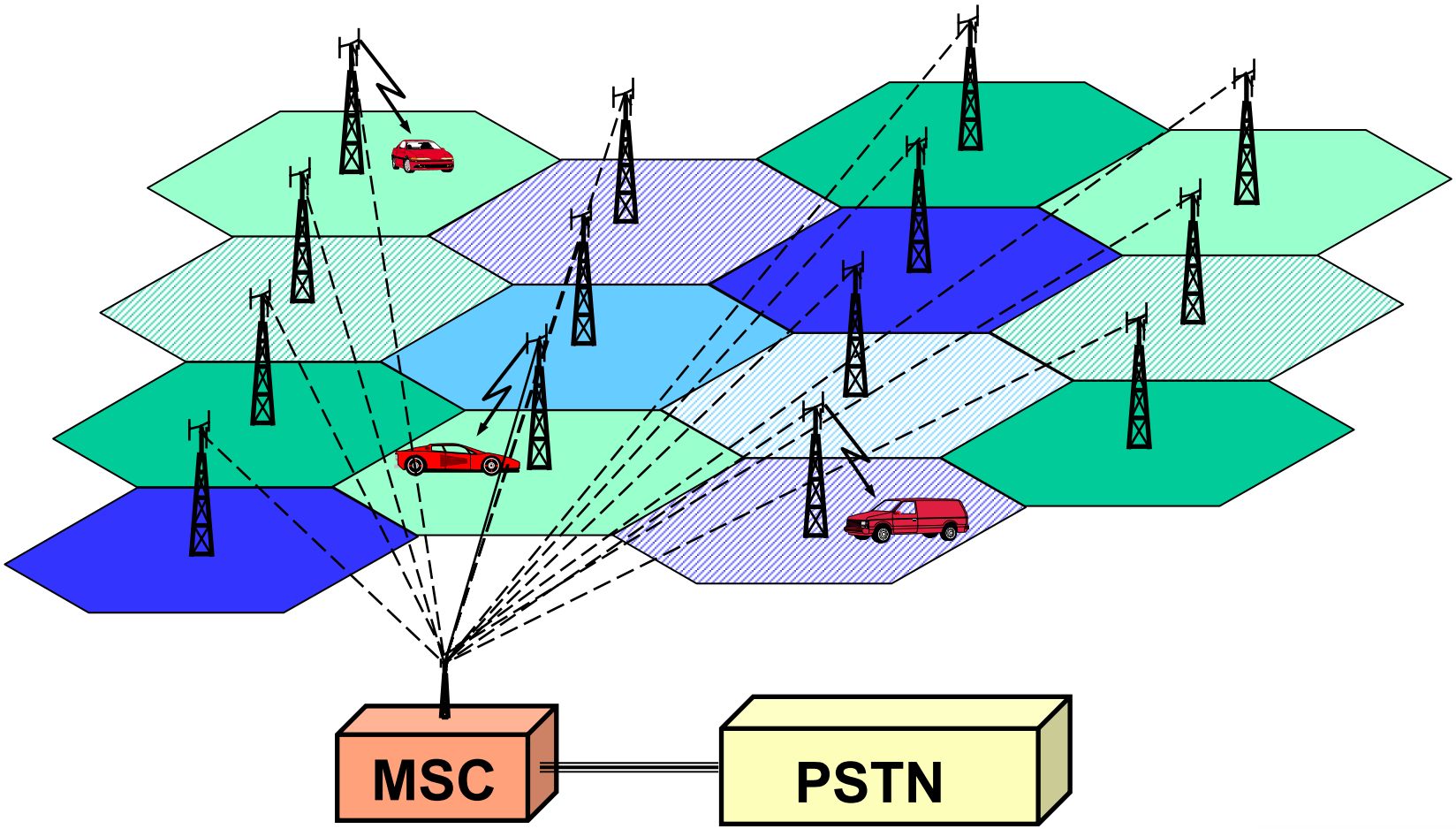
From 2G to 3G



Investor´s Perspective

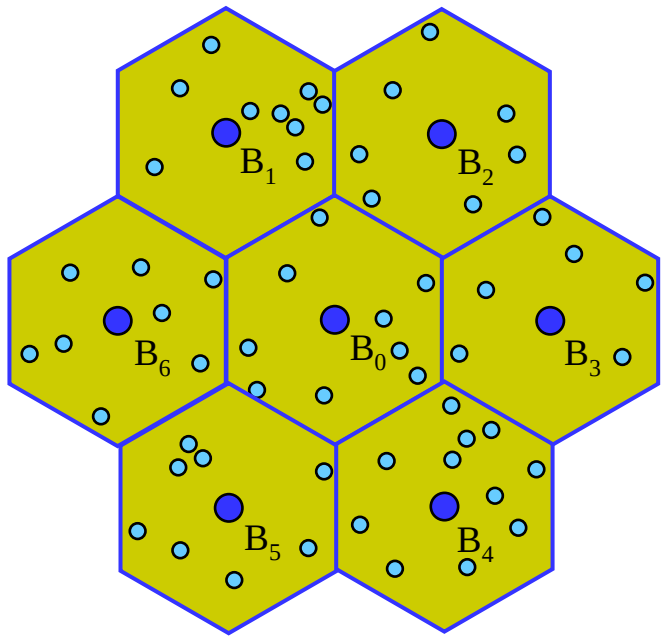


Cellular System Design Fundamentals



T. S. Rappaport, Wireless Communications: Principles and Practice, Second Edition, Prentice Hall, 2002.ISBN 0-13-042232-0.

Cellular System Design Fundamentals



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Cellular System Design Fundamentals

Base Station: **A fixed station in a mobile radio system used for radio communication with mobile stations. Base stations are located at the center or on the edge of a coverage region and consists of radio channels and transmitting and receiving antennas mounted on a tower.**

Control Channel: **Radio channels used for transmission of call setup, call request, and other control purposes.**

Forward Channel: **Radio channel used for transmission of information from the base station to the mobile.**

Full Duplex Systems: **Communications systems which allow simultaneous two-way communication. Transmission and reception is typically on two different channels (FDD) although new cordless/PCS systems are using TDD.**

Half Duplex Systems: **Communication systems which allow two-way communication by using the same radio channel for both transmission and reception. At any given time, the user can only either transmit or receive information.**

Handoff: **The process of transferring a mobile station from one channel or base station to another.**

T. S. Rappaport, Wireless Communications: Principles and Practice, Second Edition, Prentice Hall, 2002.ISBN 0-13-042232-0.

Cellular System Design Fundamentals

Mobile Station: **A station in the cellular radio service intended to be used while in motion or during halts at unspecified locations. They could either be hand-held personal units (portable) or installed in vehicles (mobiles).**

Mobile Switching Center: **Switching center which coordinates the routing of calls in a service area. In a cellular radio system connects the cellular base station and mobiles to the PSTN.**

Page: **A brief message which is broadcast over the entire service area.**

Reverse Channel: **Radio channel used for transmission of information from the mobile to the base station.**

Roamer: **A mobile station which operates in a service area other than that from which the service has been subscribed.**

Simplex Systems: **Communication systems which provide only one-way communication.**

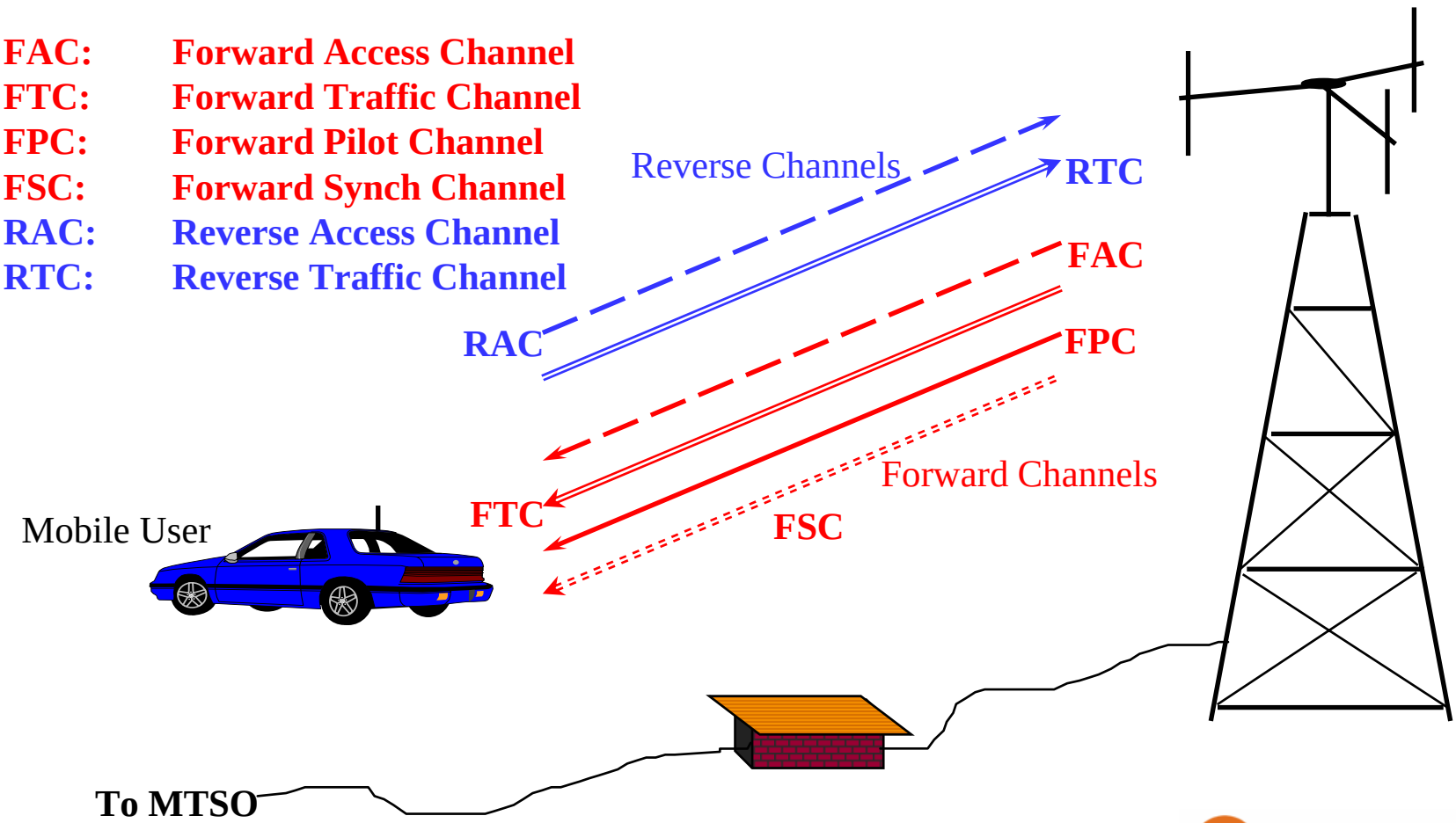
Subscriber: **A user who pays subscription charges for using mobile communications systems.**

Transceiver: **A device capable of simultaneously transmitting and receiving radio signals.**

T. S. Rappaport, Wireless Communications: Principles and Practice, Second Edition, Prentice Hall, 2002.ISBN 0-13-042232-0.

Cellular System Design Fundamentals

FAC: Forward Access Channel
FTC: Forward Traffic Channel
FPC: Forward Pilot Channel
FSC: Forward Synch Channel
RAC: Reverse Access Channel
RTC: Reverse Traffic Channel



J. C. Liberti, T. S. Rappaport, Smart Antennas for Wireless Communications: IS-95 and Third Generation CDMA Applications, Prentice Hall, 1999. ISBN 0-13-719287-8

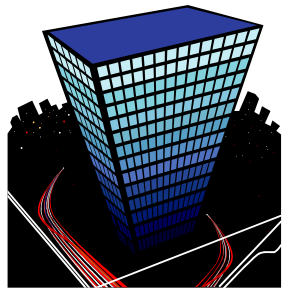
Wireless LAN and Home Wireless

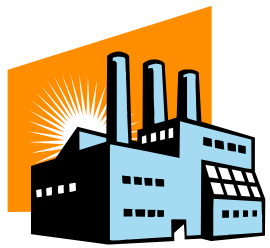
- **Pioneered in US with ISM spectrum allocation in 1984**
- **Unlicensed Operation**
- **Wireless LAN (WLAN): implemented as extension to or alternative for wired LAN within buildings or campus**
- **Data connectivity and user mobility combined**
- **Public Access: wireless strategy for cable, wireline carriers**

"Introduction to Wireless LANs," The Wireless LAN Alliance, http://www.wlana.com.

Wireless LANs in the Market Place

- Small Businesses
- Corporations
- Education
- Finance
- Healthcare
- Hospitality and Retail
- Manufacturing
- Warehousing





Wireless LAN Marketplace: Future Growth Expectations

- Revenue[1]:
- 1999: just over $400 million
- 2000: $550 million
- 2001: $700 million
- 2002: $830 million
- 2003: $1.1 billion

- Shipments[1]:
- 1999: just under 1.5 million
- 2000: 2.2 million
- 2001: 3.4 million
- 2002: 4.75 million
- 2003: 6.2 billion

- Users[2]:
- 1.7 million today
- 25 million by 2003

[1]Source: Frost & Sullivan, "Clear Signals For Wireless LANs", Information Week Online, October 11, 1999

[2]Source: Cahner's In-Stat Group (Scottsdale, AZ), "Wireless Data Users to Reach 25 Million by 2003," Wireless Design Online, November 3, 1999.

Wireless LAN Marketplace (1999)

Baystack 600 Series Wireless LAN Products[1]

- Access Point $1,499[3]
- PC Card $499[3]

Aironet PC4800 Turbo DS Series[2]

- Access Point $1,695[3]
- PC Card Adapter $595[3]

[1] http://business.baynetworks.com/

[2] http://www.aironet.com/products/index.html

[3] http://www.gcn.com/vol18_no28/guide/514-2.html

Wireless LAN Marketplace (2004)

Dell TrueMobile[1]

- Broadband Router $89.00[1]
- PC Card $49.00[1]
- Can be built-in for $29.00

Cisco Linksys Wireless-G[2]

- Access Point $99.99[3]
- Notebook Adapter $79.99[3]

[1] http://www1.us.dell.com/content/topics/segtopic.aspx/wireless?c=us&cs=19&l=en&s=dhs&~tab=4

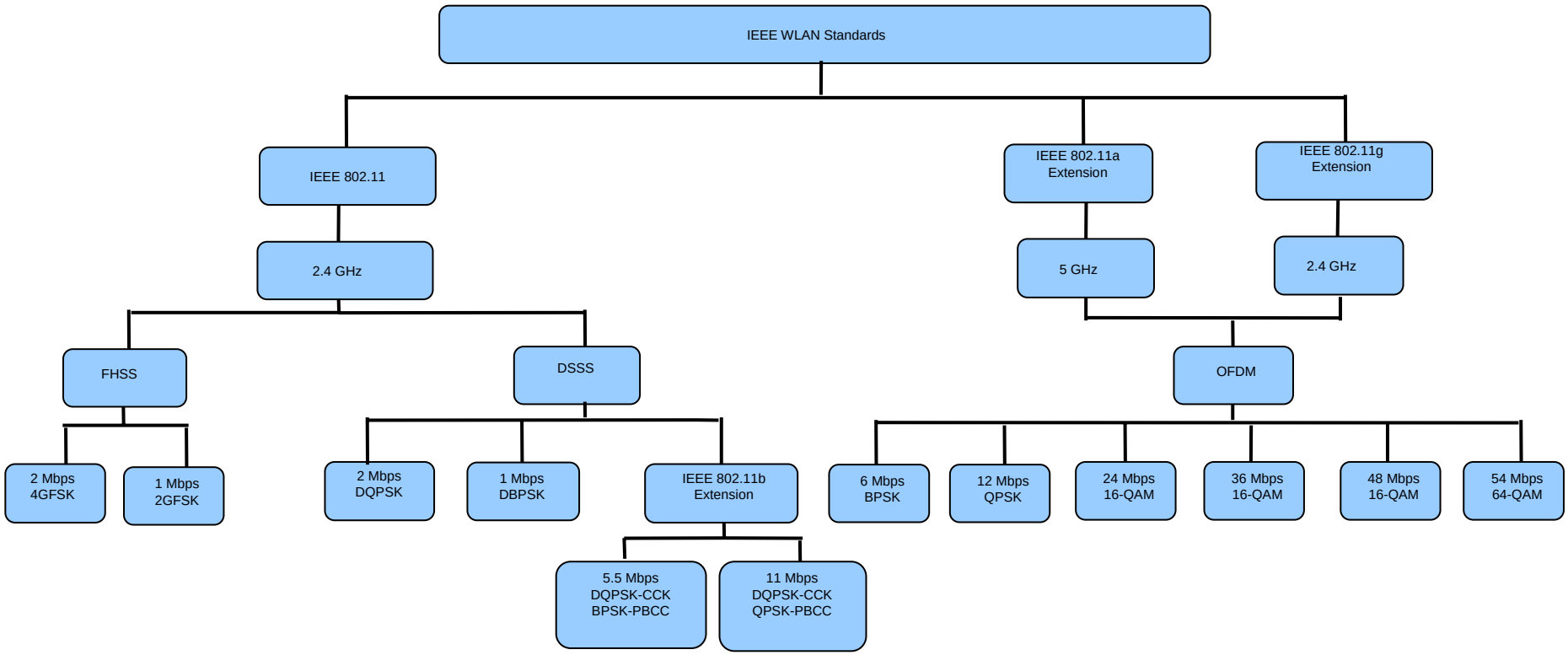
[2] http://www.linksys.com/splash/cmt.asp

[3] http://www.amazon.com/exec/obidos/tg/browse/-/3343901/2/ref=br_lpsp_pg/102-5065952-1365728?

IEEE 802.11a/b/g WLAN's

- 11 Mbps incumbent
- 54 Mbps now
- Roaming 802.11g

IEEE 802.11 Evolution

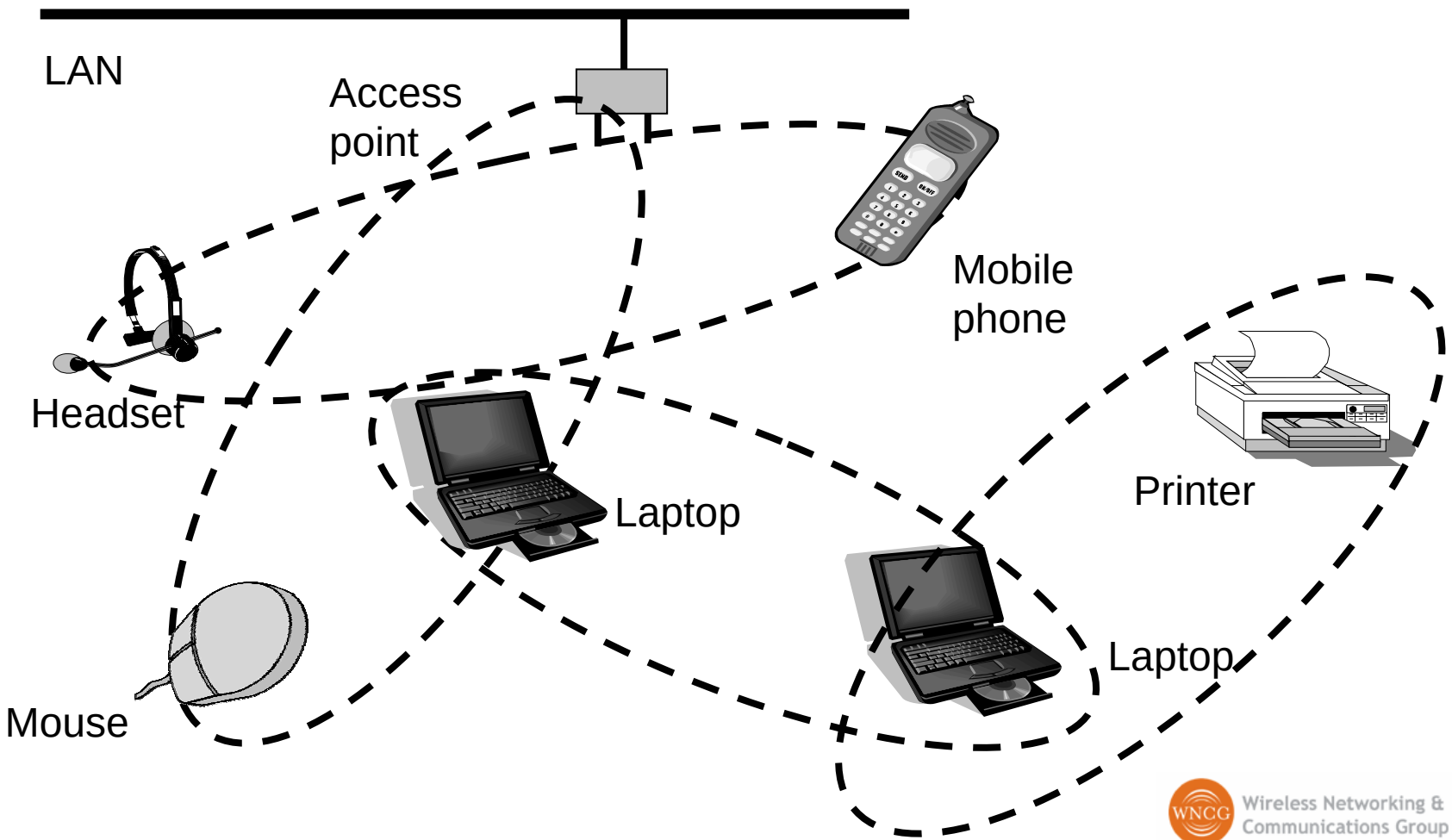


From: B. Li, N. Kanat, H. Lee, D. Menchaca, and T. S. Rappaport, “Overview of Wireless Networks and Security Issues for WiFi Networks”, *Radio Club of America,* Fall 2003, pp. 14-28.

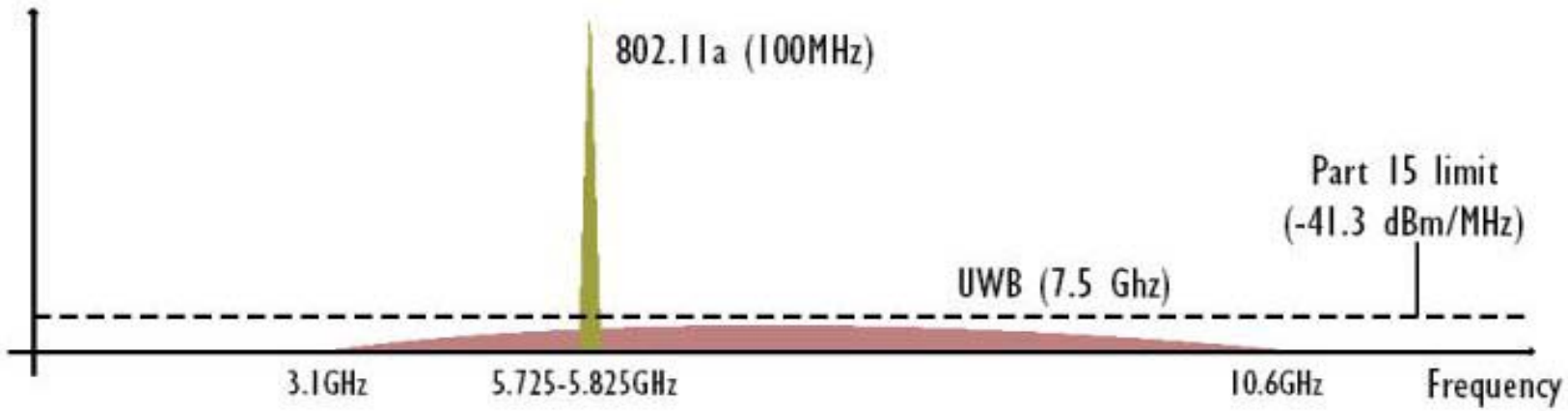
2.4 GHz Channelization for WLAN's

Country	Regulatory Agency	Frequency Range Available	DSSS Channels Available	FHSS Channels Available
United States	FCC	2.4 to 2.4835 GHz	1 through 11	2 through 80
Canada	IC	2.4 to 2.4835 GHz	1 through 11	2 through 80
Japan	MKK	2.4 to 2.497 GHz	1 through 14	2 through 95
France		2.4465 to 2.4835 GHz	10 through 13	48 through 82
Spain		2.445 to 2.475 GHz	10 and 11	47 through 73
Remainder of Europe	ETSI	2.4 to 2.4835 GHz	1 through 13	2 through 80

Personal Area Networks – Bluetooth / UWB



UWB – Broadband in the Home by 2005



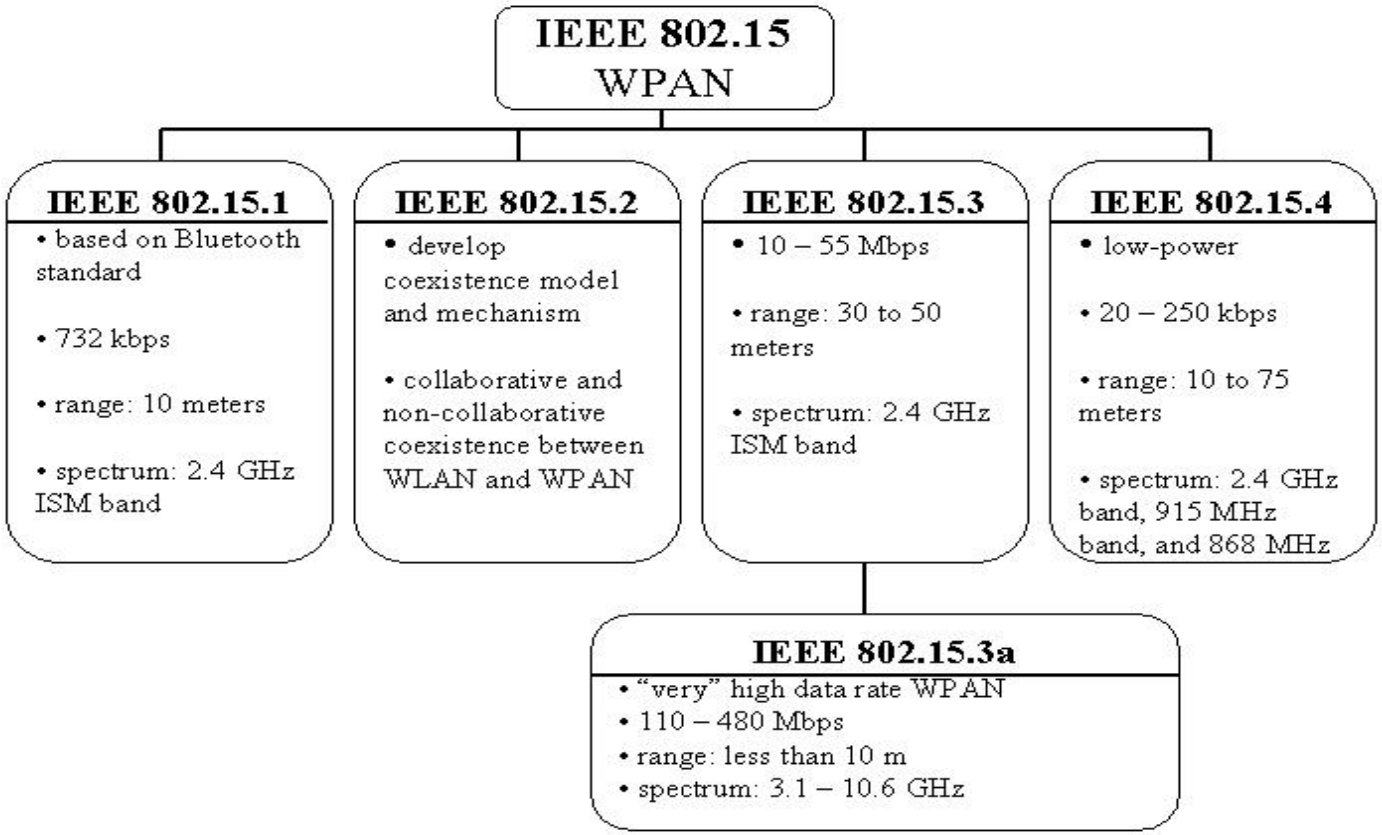
From: K. Mandke, H. Nam, L. Yerramneni, C. Zuniga, and T. S. Rappaport, "The Evolution of Ultra Wide Band Radio for Wireless Personal Area Networks", *High Frequency Electronics*, September 2003, pp. 22-32

UWB Regulations - FCC

Operating frequency range	3.1 GHz to 10.6 GHz
Average radiated emissions limit	
Frequency range (MHz)	mean EIRP in dBm/MHz (indoor/hand held)
960-1610	-75.3 / -75.3
1610-1900	-53.3 / -63.3
1900-3100	-51.3 / -61.3
3100-10600	**-41.3 / -41.3**
Above 10600	-51.3 / -61.3
Peak emission level in band	60 dB above average emission level
Max unacknowledged transmission period	10 seconds

From: K. Mandke, H. Nam, L. Yerramneni, C. Zuniga, and T. S. Rappaport, "The Evolution of Ultra Wide Band Radio for Wireless Personal Area Networks", *High Frequency Electronics*, September 2003, pp. 22-32

Personal Area Networks IEEE 802.15



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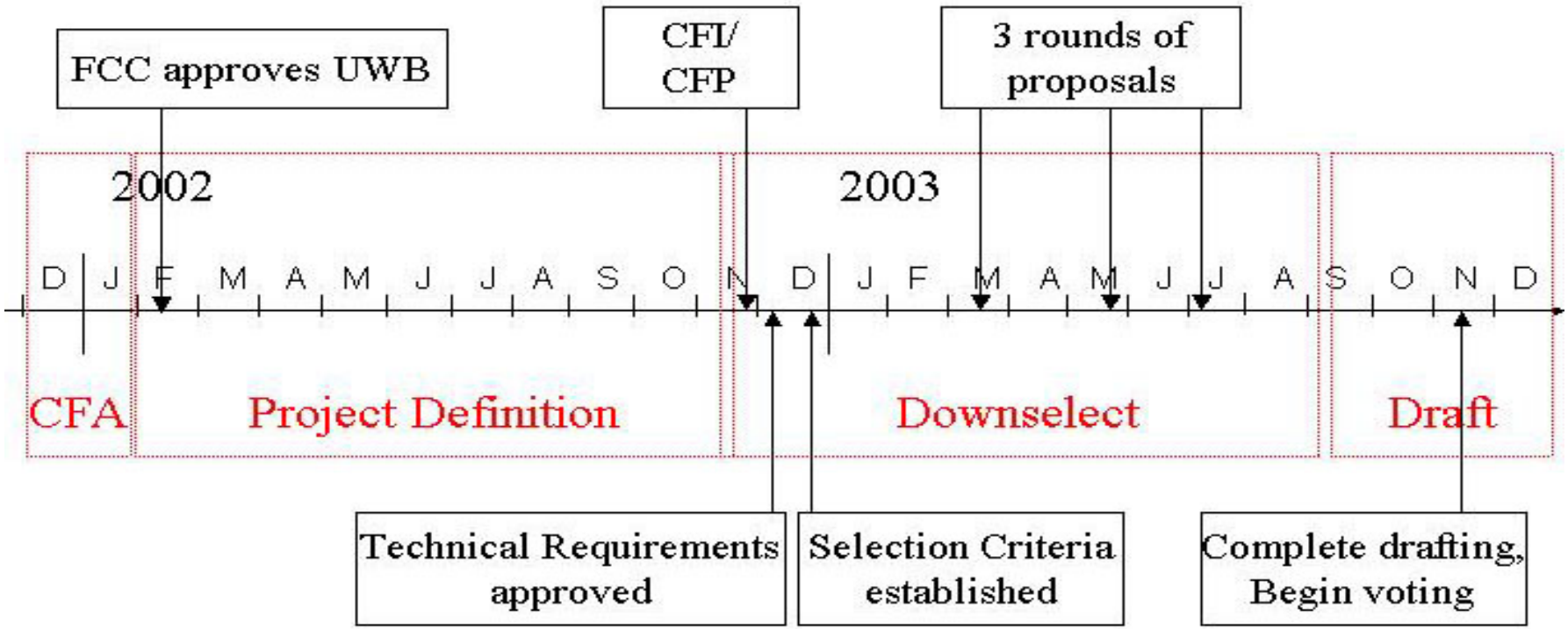
IEEE 802.15.3 UWB

Parameter	Value
Data Rates (measured at PHY-SAP)	110, 200 and (optional) 480 Mbps
Range	10 m, 4 m, and below
Power Consumption	100 mW and 250 mW
Power management modes	Capabilities such as power save, wake up etc
Co-located piconets	4
Interference susceptibility	Robust to IEEE systems, PER < 8% for a 1024 byte packet length
Co-existence capability	Reduced interference to IEEE systems, interfering average power at least 6dB below the minimum sensitivity level of non-802.15.3a device
Cost	Similar to Bluetooth
Location awareness	Location information to be propagated to a suitable management entity
Scalability	Backwards compatibility with 802.15, adaptable to various regulatory regions (such as the US, European countries, or Japan).
Signal Acquisition	<20μs for acquisition from the beginning of the preamble to the beginning of the header
Antenna practicality	Size and from factor consistent with original device

From: K. Mandke, H. Nam, L. Yerramneni, C. Zuniga, and T. S. Rappaport, "The Evolution of Ultra Wide Band Radio for Wireless Personal Area Networks", *High Frequency Electronics*, September 2003, pp. 22-32

UWB will Revolutionize Consumer Electronics



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One UWB Standard Proposal

Company	Multiband-OFDM Coalition (presented by TI)
Spectrum Allocation:	
# of bands	3 (1st generation bands), 10 optional bands
Bandwidths	528 MHz
Frequency ranges	Group A: 3.168 – 4.752 GHz, Group B: 4.752 – 6.072 GHz, Group C: 6.072 – 8.184 GHz, Group D: 8.184 – 10.296 GHz
Modulation Scheme	TFI-OFDM (with 128-point FFT), QPSK
Coexistence method	null band for WLAN (~5 GHz)
Multiple access method	Time frequency interleaving (TFI)
# of simultaneous piconets	4
Error correction codes	Convolutional code
Code rates	11/32 @ 110 Mbps, 5/8 @ 200 Mbps, ¾ @ 480 Mbps
Link margin	5.3 dB @ 10 m @ 110 Mbps, 10.0 dB @ 4 m @ 200 Mbps, 11.5 dB @ 2 m @ 480 Mbps
Symbol period	312.5 ns OFDM symbol
Multipath mitigation method	1-tap (robust to 60.6 ns delay spread)

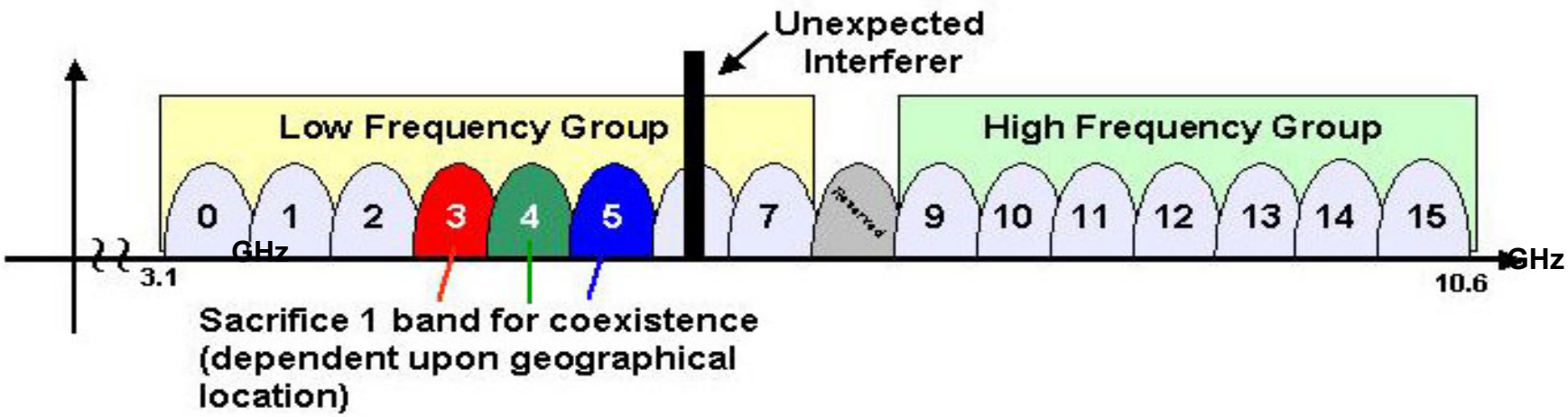
From: K. Mandke, H. Nam, L. Yerramneni, C. Zuniga, and T. S. Rappaport, "The Evolution of Ultra Wide Band Radio for Wireless Personal Area Networks", *High Frequency Electronics*, September 2003, pp. 22-32

Another UWB Standard Proposal

Company	XtremeSpectrum
Spectrum Allocation:	
# of bands	2
Bandwidths	1.368 GHz, 2.736 GHz
Frequency ranges	3.1 GHz – 5.15 GHz, 5.825 GHz – 10.6 GHz
Modulation Scheme	BPSK, QPSK, DS-SS
Coexistence method	null band for WLAN (~5 GHz)
Multiple access method	Ternary CDMA
# of simultaneous piconets	8
Error correction codes	Convolutional code, Reed-Soloman code
Code rates	½ @ 110 Mbps, RS(255,223) @ 200 Mbps, RS(255,223) @ 480 Mbps
Link margin	6.7 dB @ 10 m @ 114 Mbps, 11.9 dB @ 4 m @ 200 Mbps, 1.7 dB @ 4 m @ 600 Mbps
Chip time	731 ps (Low band), 365.5 ps (High band)
Multipath mitigation method	Decision feedback equalizer and RAKE

From: K. Mandke, H. Nam, L. Yerramneni, C. Zuniga, and T. S. Rappaport, "The Evolution of Ultra Wide Band Radio for Wireless Personal Area Networks", *High Frequency Electronics*, September 2003, pp. 22-32

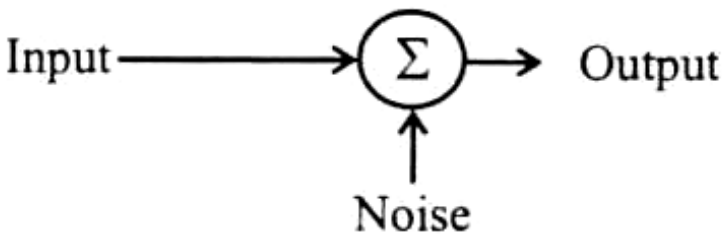
How the 2 UWB Standards Operate



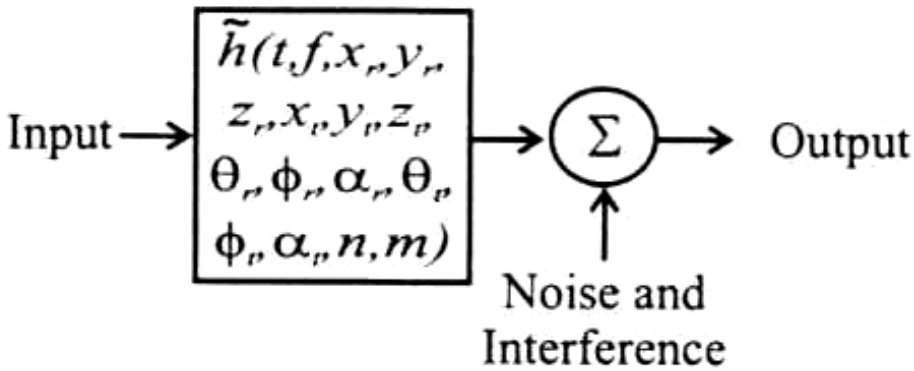
From: K. Mandke, H. Nam, L. Yerramneni, C. Zuniga, and T. S. Rappaport, "The Evolution of Ultra Wide Band Radio for Wireless Personal Area Networks", *High Frequency Electronics*, September 2003, pp. 22-32

Making Wireless Work

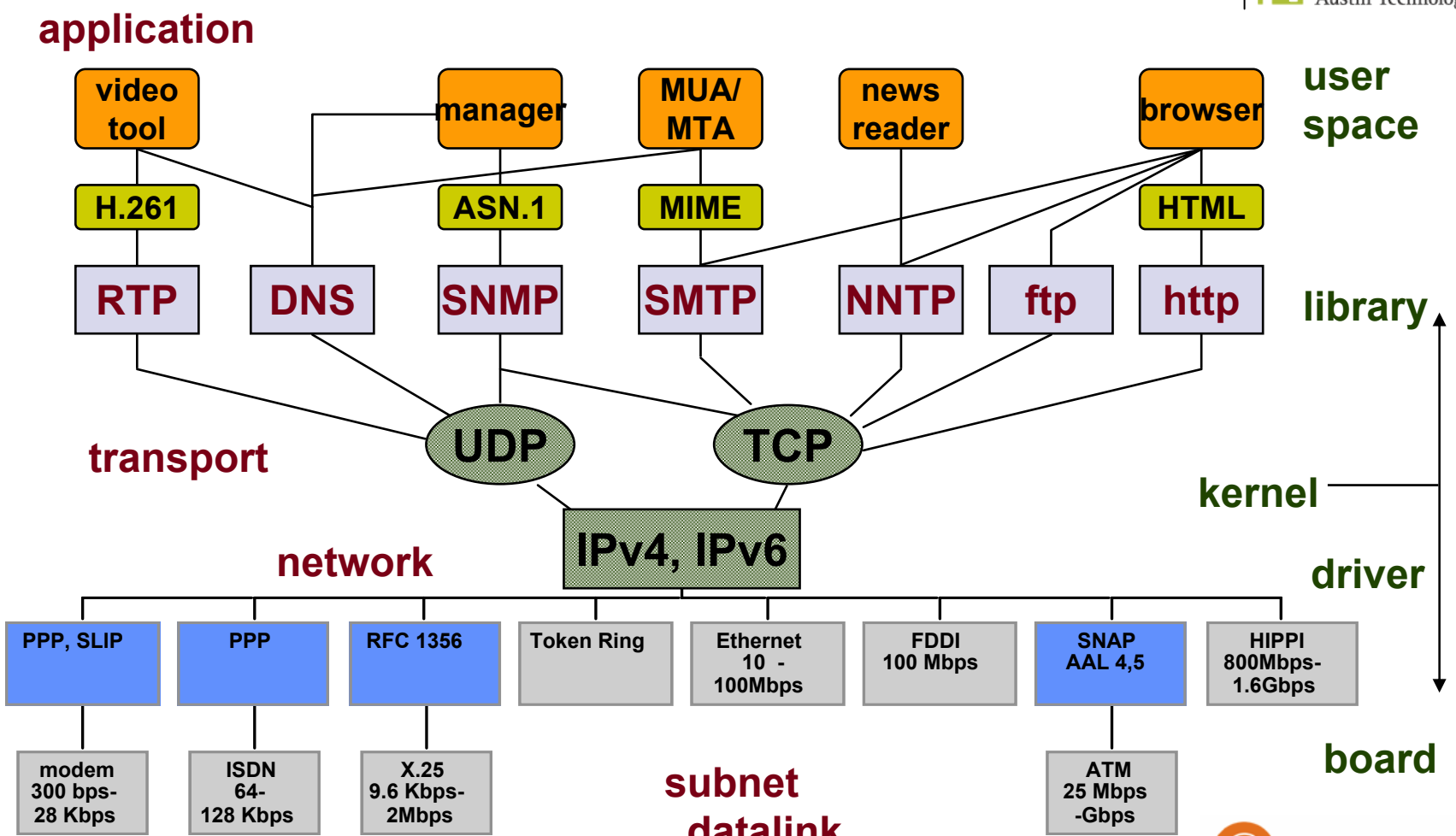
The Idealized AWGN Channel...



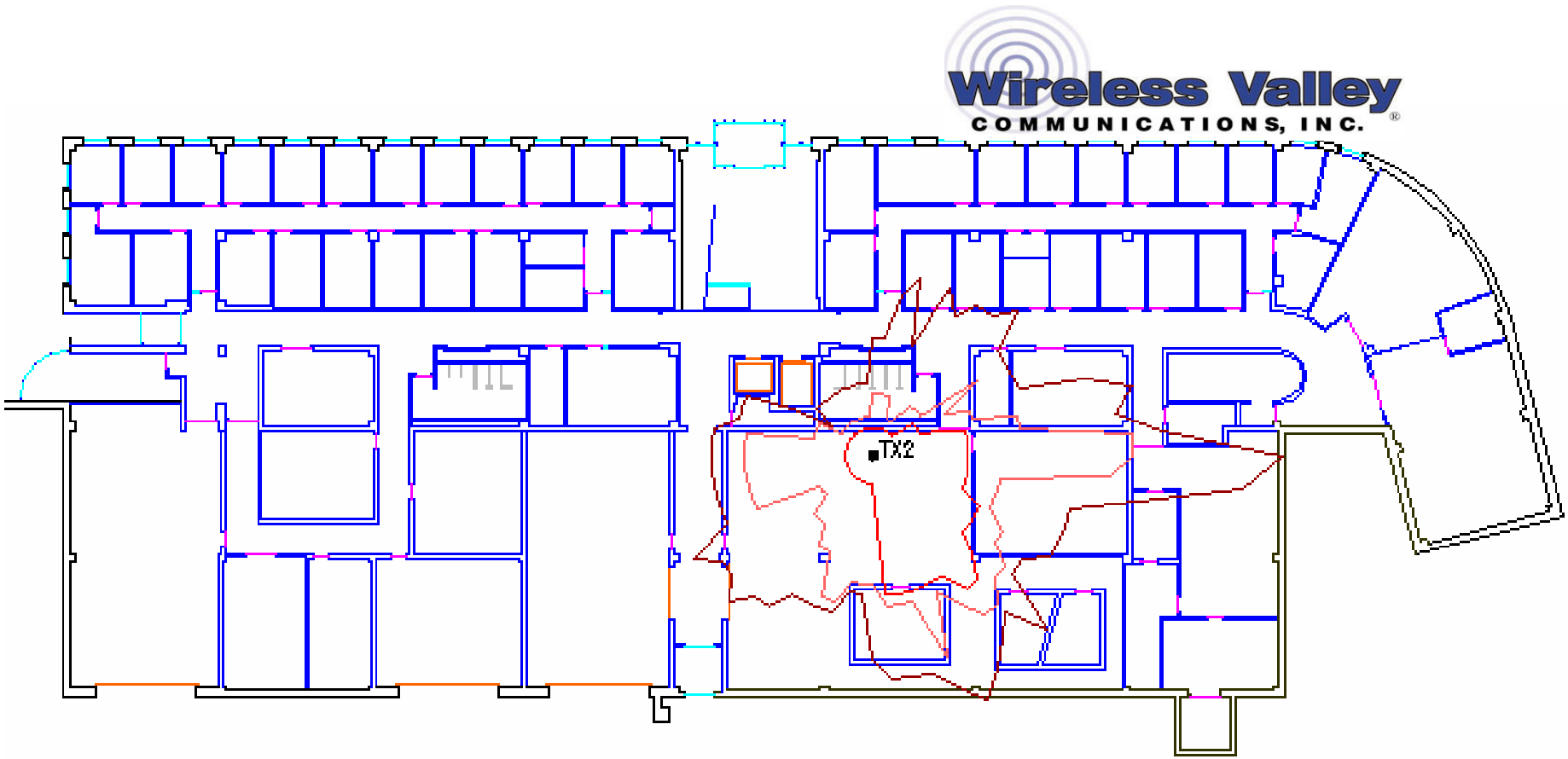
The Ugly Reality...



Internet Protocol Zoo



How to Place and Measure Access Points?

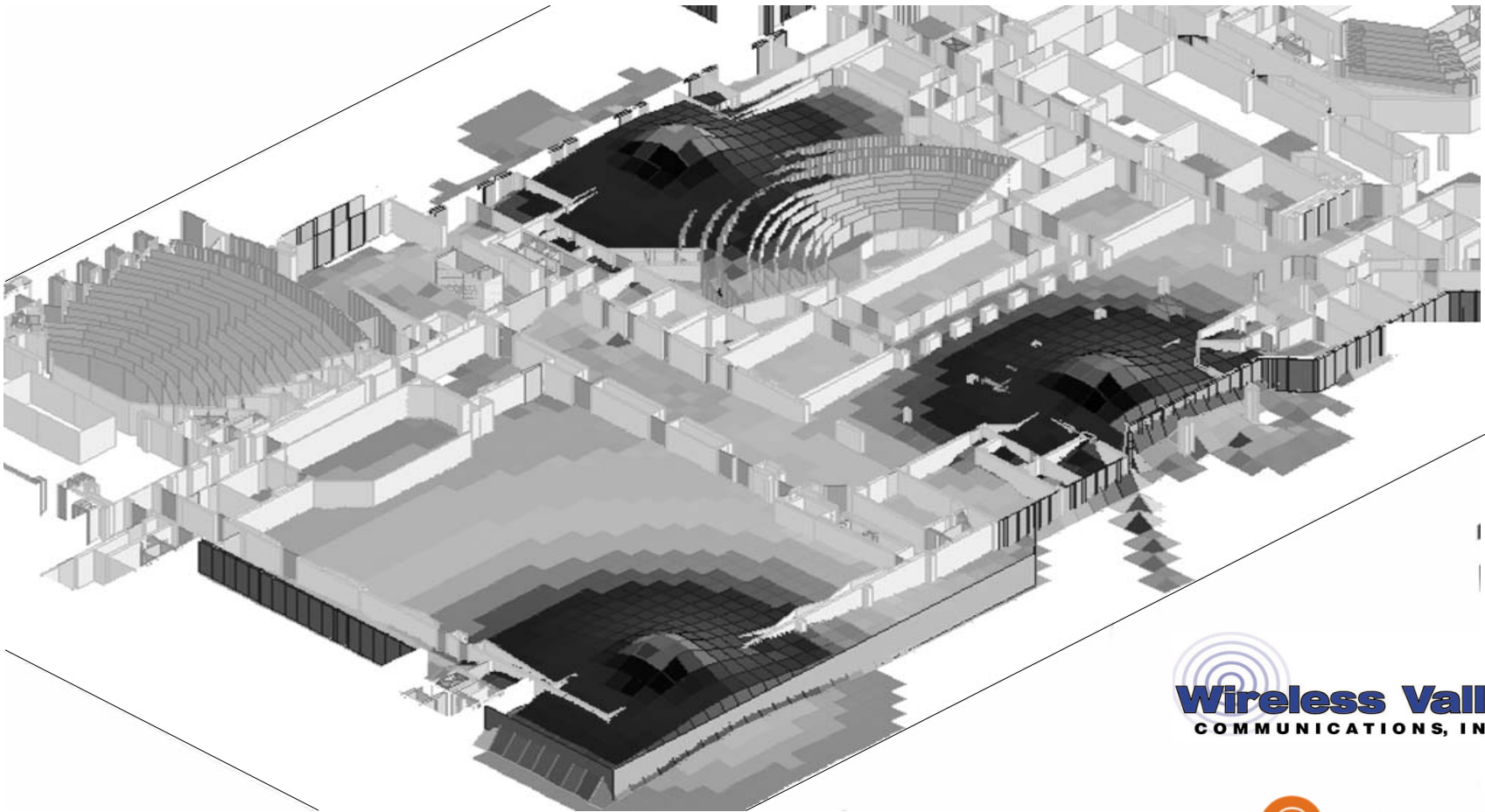


Knowledge leads to management tools

IC2 INSTITUTE
The University of Texas at Austin

austin wireless alliance

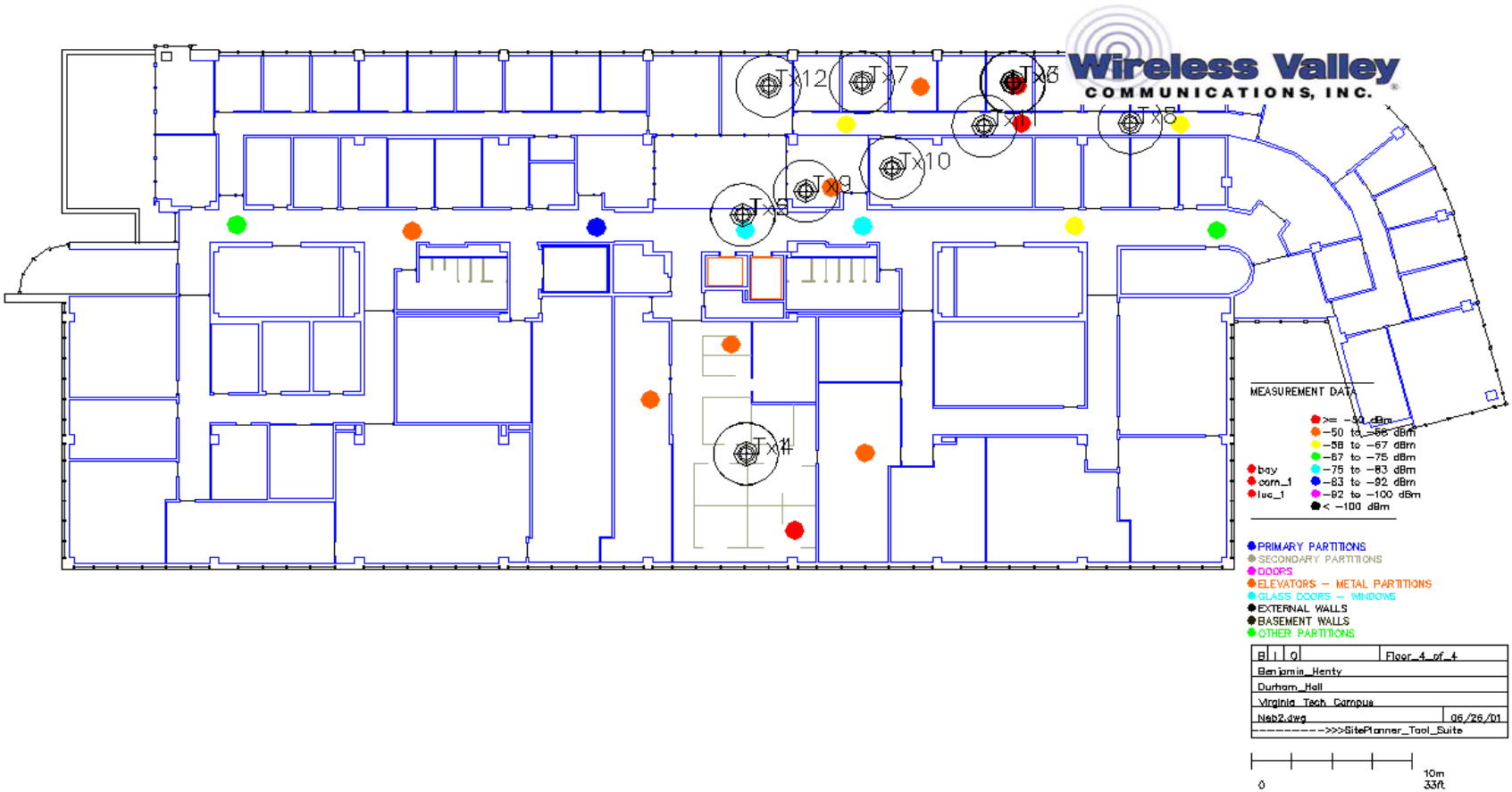
Austin Technology Council

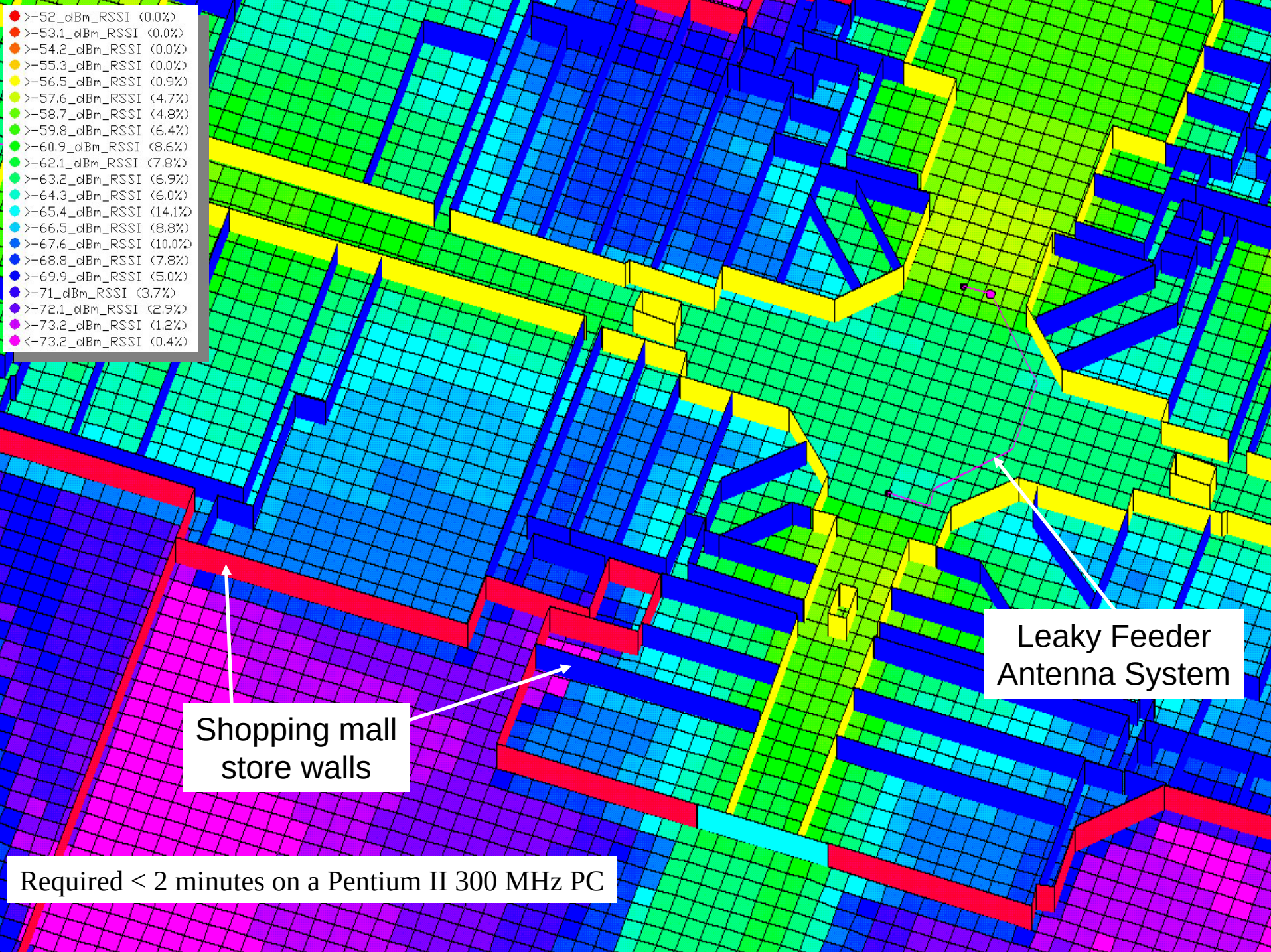


Wireless Valley
COMMUNICATIONS, INC.®

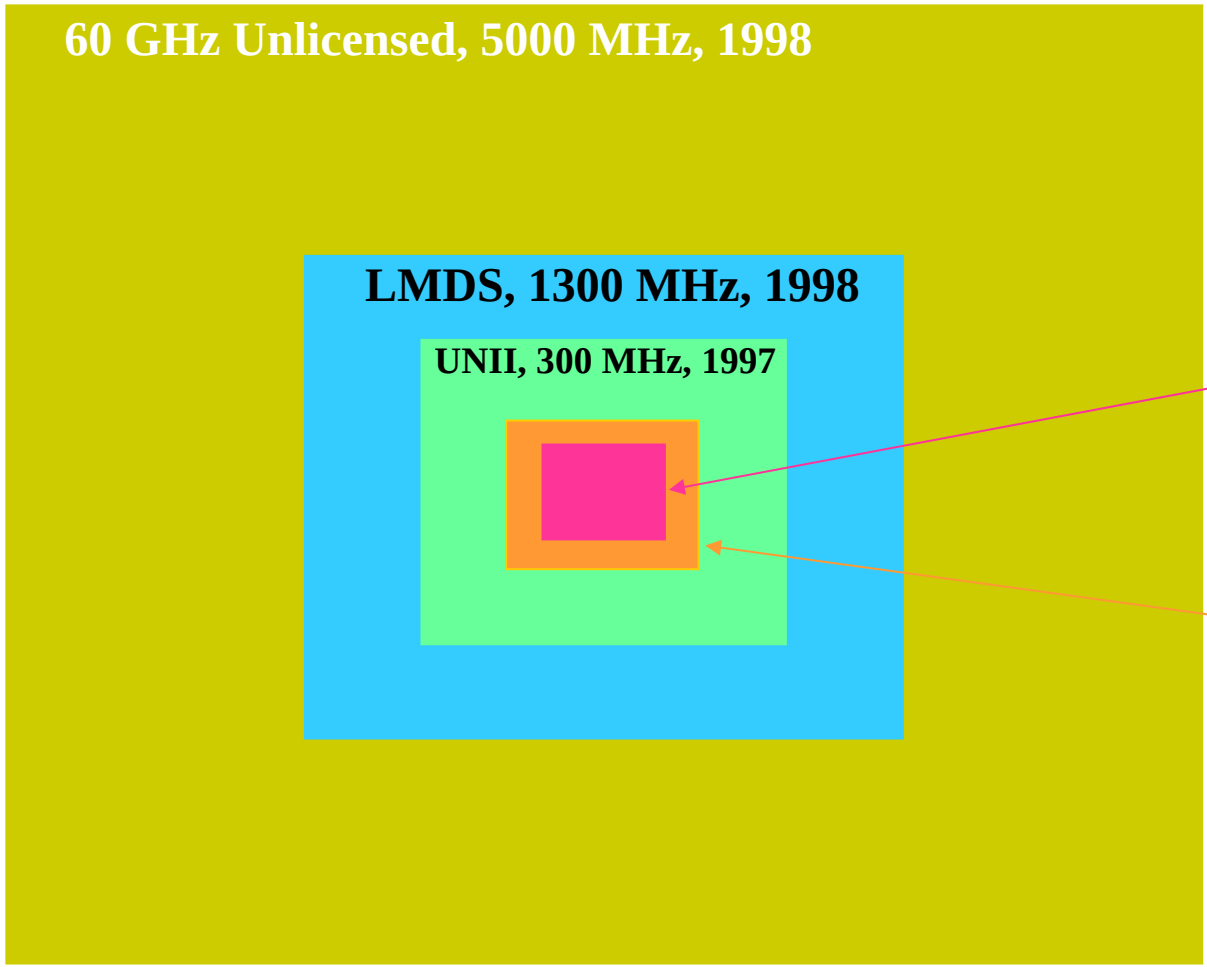
WNCG Wireless Networking & Communications Group

SitePlanner® with Real Time Channel Measurements and Throughput Control




>-52_dBm_RSSI (0.0%)
>-53.1_dBm_RSSI (0.0%)
>-54.2_dBm_RSSI (0.0%)
>-55.3_dBm_RSSI (0.0%)
>-56.5_dBm_RSSI (0.9%)
>-57.6_dBm_RSSI (4.7%)
>-58.7_dBm_RSSI (4.8%)
>-59.8_dBm_RSSI (6.4%)
>-60.9_dBm_RSSI (8.6%)
>-62.1_dBm_RSSI (7.8%)
>-63.2_dBm_RSSI (6.9%)
>-64.3_dBm_RSSI (6.0%)
>-65.4_dBm_RSSI (14.1%)
>-66.5_dBm_RSSI (8.8%)
>-67.6_dBm_RSSI (10.0%)
>-68.8_dBm_RSSI (7.8%)
>-69.9_dBm_RSSI (5.0%)
>-71_dBm_RSSI (3.7%)
>-72.1_dBm_RSSI (2.9%)
>-73.2_dBm_RSSI (1.2%)
<-73.2_dBm_RSSI (0.4%)
Leaky Feeder Antenna System
Shopping mall store walls
Required < 2 minutes on a Pentium II 300 MHz PC

Recent U.S. Spectrum Allocations



- A voice channel occupies ~ 10 kHz of spectrum.
- A TV channel occupies ~ 5 MHz of spectrum.

Problems

- Broadband fiber offers enormous capacity
- to feed “last” mile

- Telco’s must compete with Cable triple play
  - Phone Service
  - Internet
  - On-Demand Video

- Carriers need an immediate infrastructure for broadband video delivery / cable-like world

- Wireless offers rapid deployment with extreme bandwidths and little plant

Solution

- Broadband wireless supported by:
  - Integrated Antennas
  - MIMO Technology
  - Novel and flexible architecture
- Carriers can deploy in neighborhoods with just one truck-roll per large neighborhood
- Delivers last-mile huge bandwidths that will be “pulled’ by new consumer electronics, UWB home networks

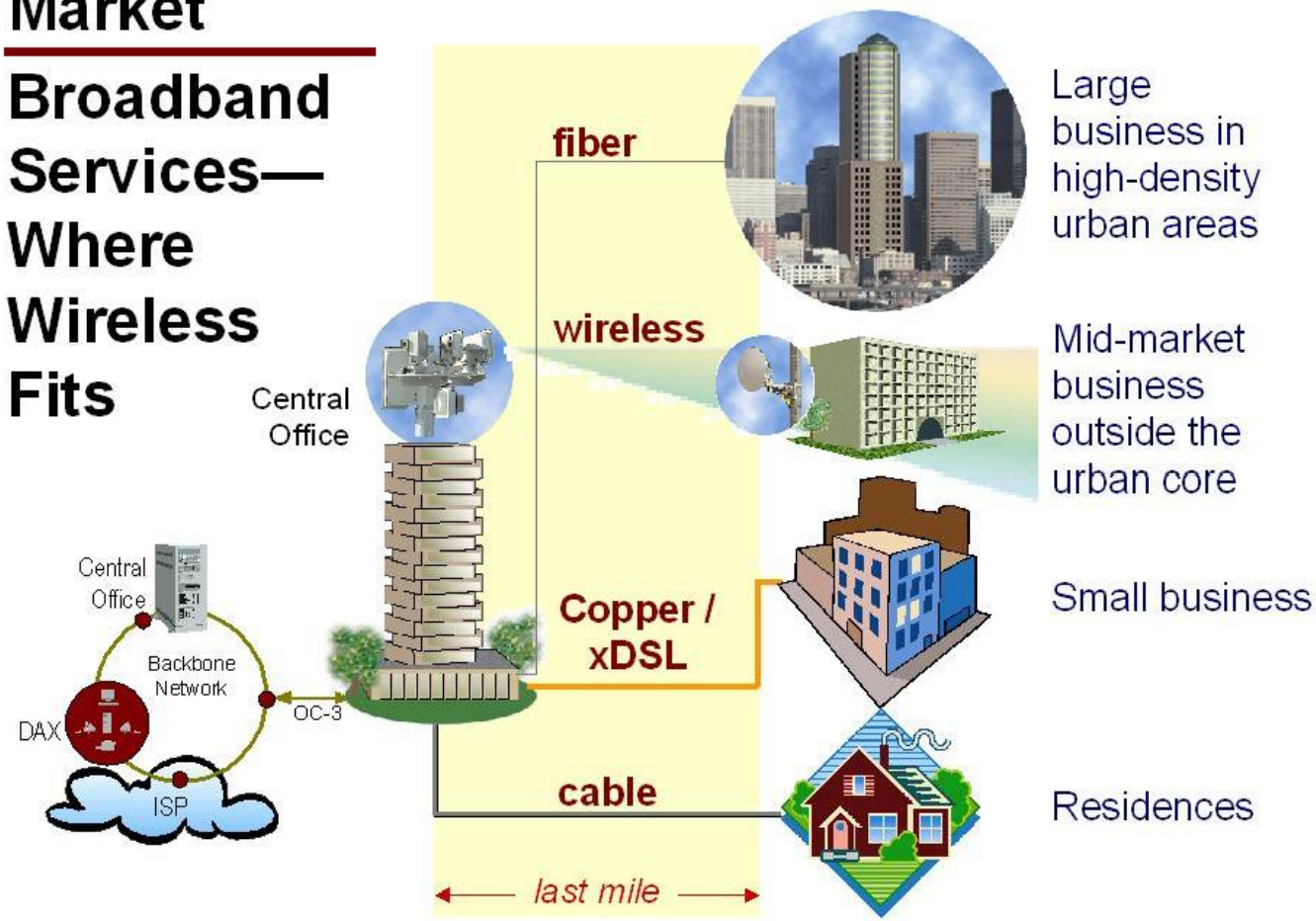
Why Hasn't Last Mile Broadband Wireless Happened?

- Telco's and Cableco's invested in wiring
- MMDS Wireless
  - Too narrowband
  - No clear spectrum policy or owner (however, Nextel bought Worldcom footprint)
  - Nationwide broadband wireless last-mile emerging as a strategy (Nextel, Sprint, ??)
- LMDS Wireless
  - 28 / 38 GHz too expensive to date but technology is maturing
  - 5.8 to 12 GHz is the next frequency revolution (WiFi, Northpoint Wireless Cable)

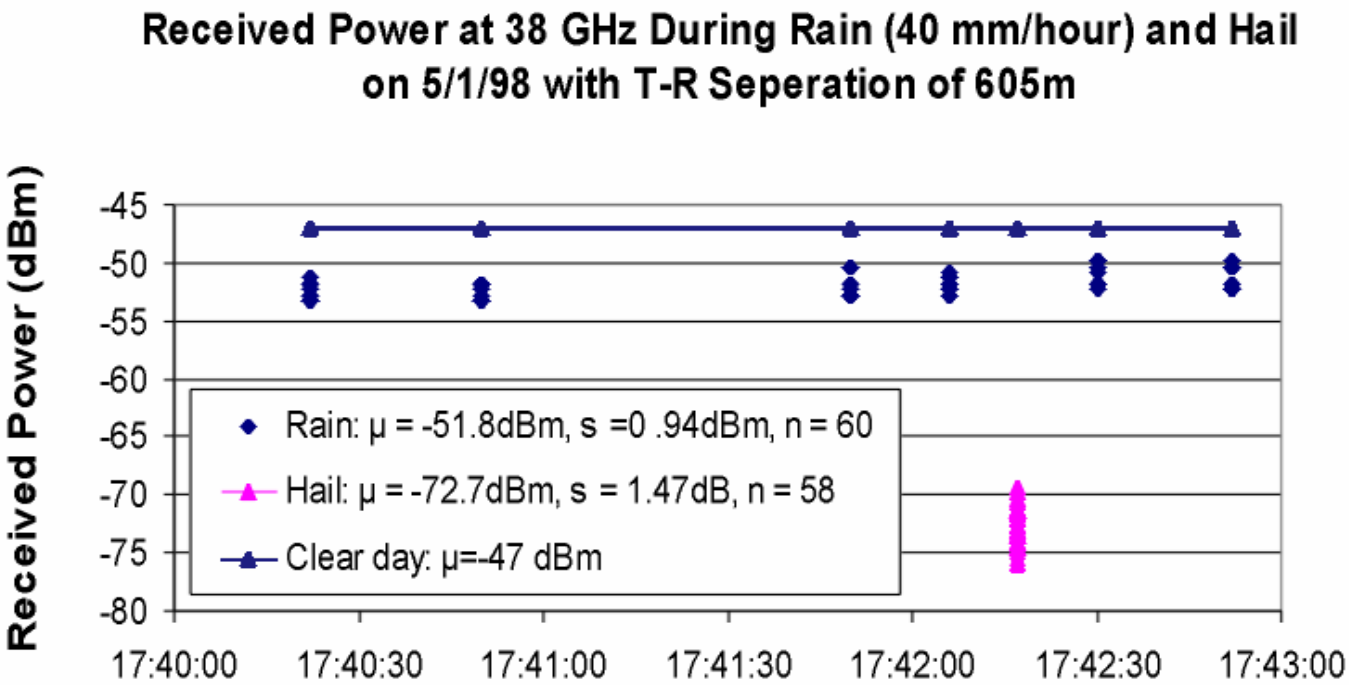
Today's Local Loop

Market

Broadband Services—Where Wireless Fits



Weather Effects at Millimeter Wave



Attenuation due to hail: 25.7 dB.
Hail size: 0.5-1.5 cm in diameter.

From: H. Xu, T. S. Rappaport, R. J. Boyle, and J. H. Schaffner, "Measurements and Models for 38-GHz Point-to-Multipoint Radiowave Propagation", *IEEE Journal on Sel. Areas in Communications*, March 2000, Vol. 18, No. 3, pp. 310-321

Last-Mile Wireless Will Happen!

- Reduce truck rolls – high data rate last-mile ports sold in Walmart (or Dell) for home installation
- Communications / Computing / Entertainment will pull bandwidth into every home and office on “portable” flexible devices.
  - “On-the-pole” provisioning supports neighborhood growth
- Already cable companies eyeing “Wireless Roadrunner”, Hot spots are harbingers
- Why do I need to put my TV and stereo near a cable jack?
- Why does the cable guy have to come into my house?

Current Status / Future Directions

	Cost per Subscriber	Date Rate per User	Streaming Video
POTS	$40 / month	56 kbps	Poor
Cellular / PCS	$50 / month	10 – 64 kbps	Poor
DSL	$50 / month	1 Mbps	Fair
Cable	$80 / month	1.2 – 5 Mbps	Good / Excellent
Fiber to the Home	Expensive – Dig up street	>10 Mbps	Excellent
MIMO Last Mile	Inexpensive – Climb a pole	>10 Mbps	Excellent

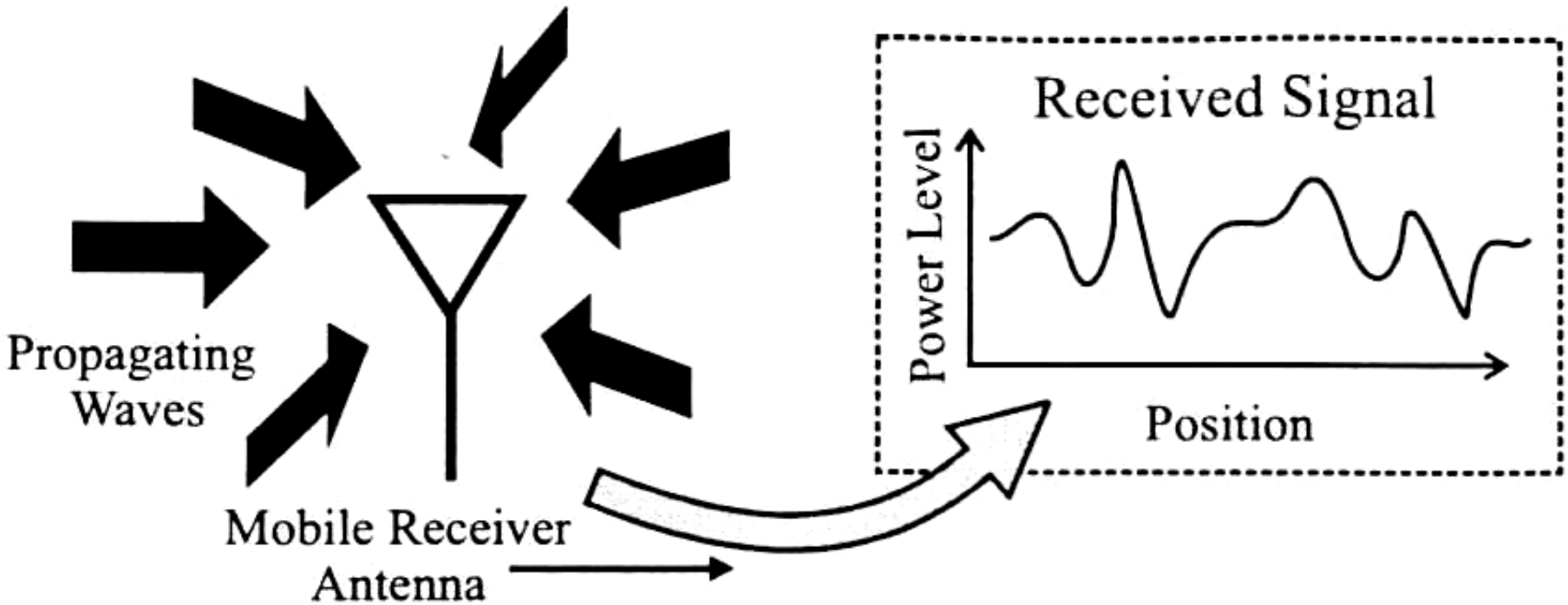
The Market and How Austin Can Play

- Broadband Trends
  - December 1999: 2.8M US Broadband subs
  - June 2002: 16.2M US Broadband subs
  - 80% annual growth rate yet only 15% of homes have broadband today
  - “Broadband in the States 2003” c.2003 AeA
- Intellectual property
  - WNCG faculty have promising technology solutions
  - Integrated antennas and MIMO are working in lab
  - Industrial Affiliate Sponsors get first look at all technology
- Next steps
  - Strategic partnerships for commercialization of patents can come from UT, surrounding chip companies

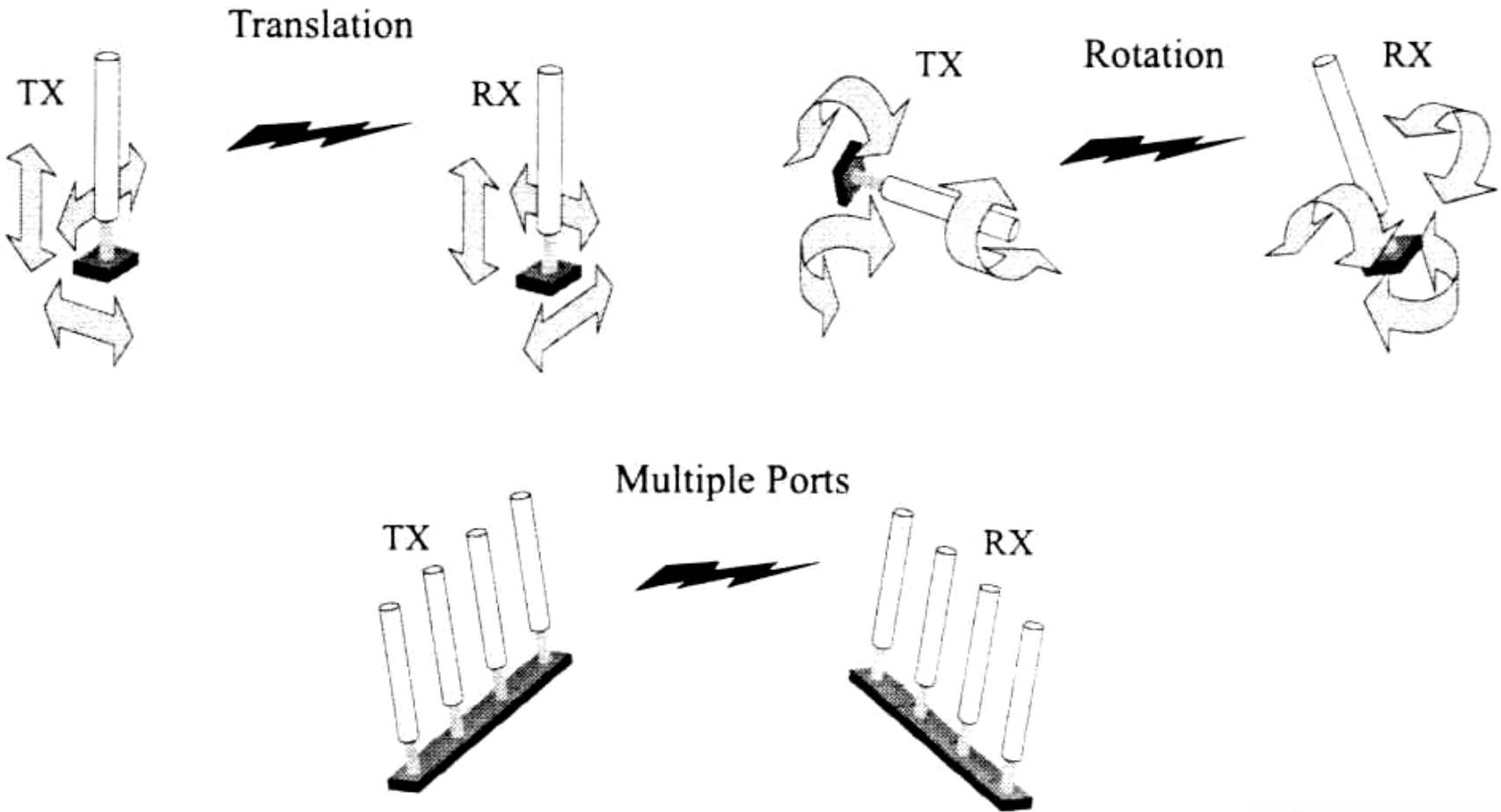
The Future of Wireless

- Cellular, PCS, WAP
- Wireless Office Service
- Wireless LAN (IEEE 802.11)
- Wireless PDAs (Compaq IPAQ, Handspring)
- Wireless VoIP
- Wireless Video
- Home Servers
- Wireless Post-its

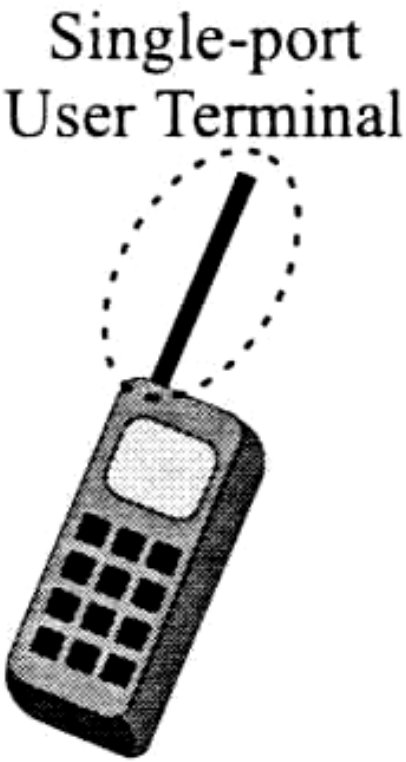
Space – The Final Frontier

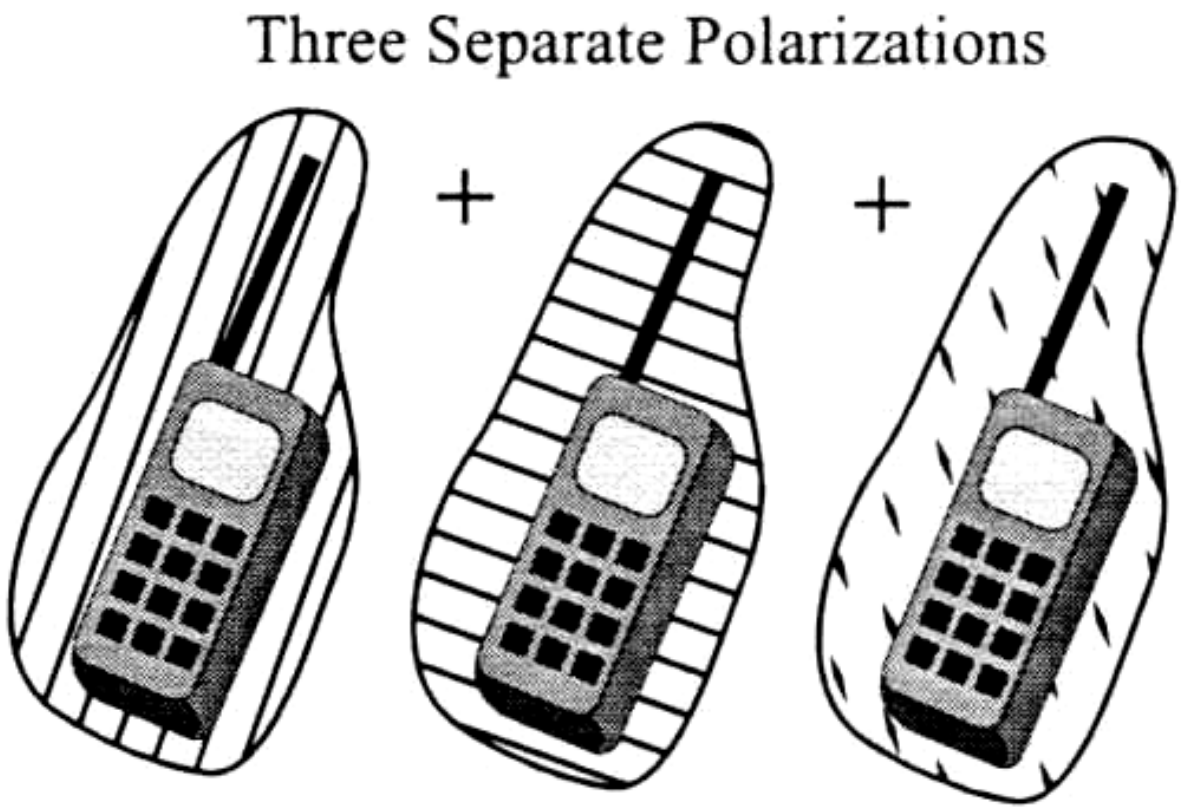


Diversity gives Capacity – MIMO!

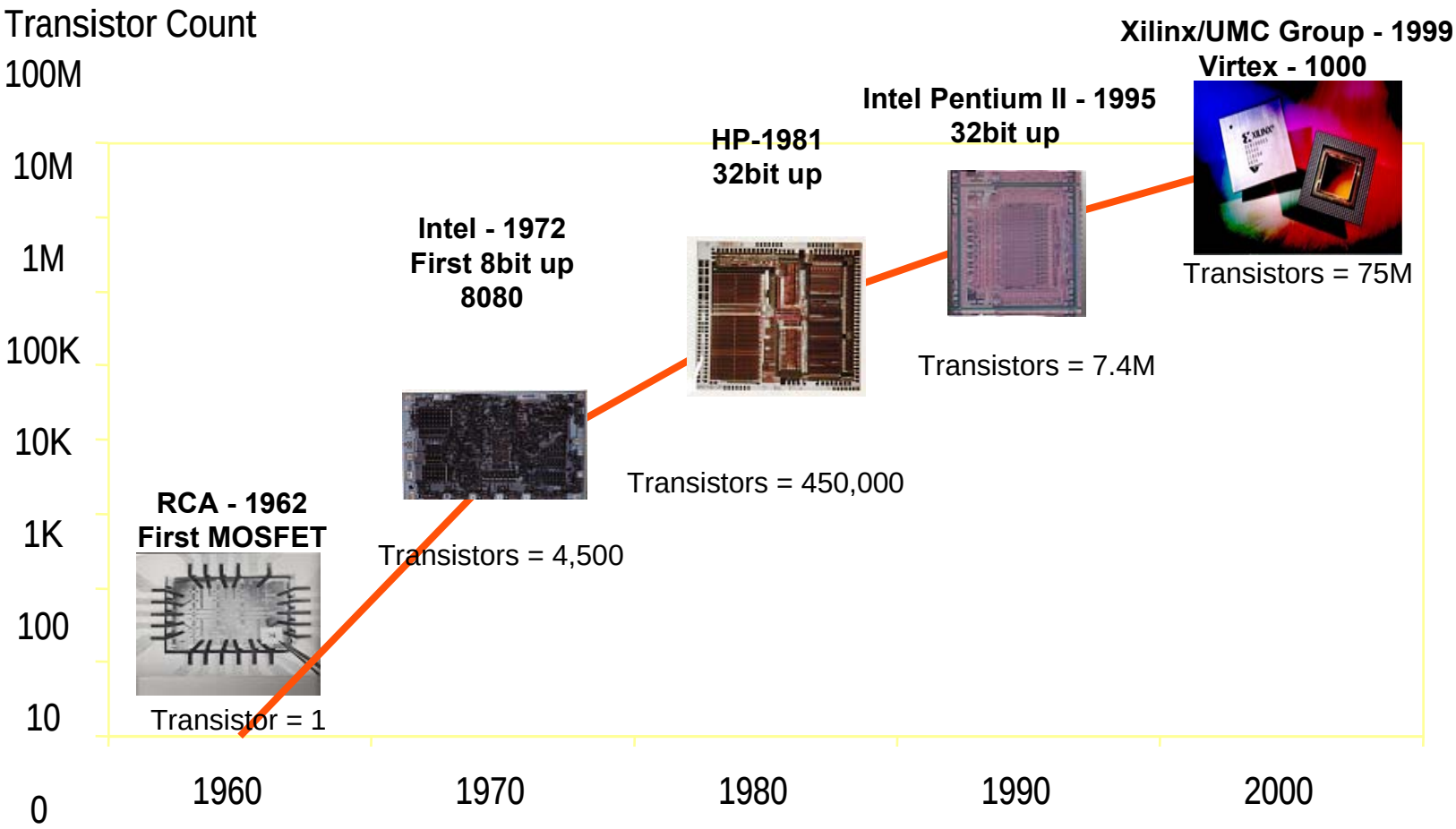


HUGE Capacity Increases are coming!





Moore's Law



Final Remarks

- The Web, the PC, and Wireless will merge
- Today 1 Billion, but 2 Billion users by 2008
- We only use high data rates when we sit or stand, hence a commercial battle will occur inside buildings
- Space-Time technology will yield huge capacity increases
- DSP, Networking, and Communications are fundamental to future systems
- Austin and Texas can and will be a world leader in creating the wireless future

The Future of Wireless
The next three years

IC2 INSTITUTE
The University of Texas at Austin

austin wireless alliance

Austin Technology Council

Kevin McKeand

TexLink communications

Jim Keeler
VP Engineering
Wayport

WAYPORT

Jeff Mucci
Former VP Sales and Marketing
Clearwire Technologies

CLEARWIRE

Austin's Wireless Landscape

Ed Acosta
Consultant &
Former CEO, BroadCloud Communications, Inc.

Defining the Landscape

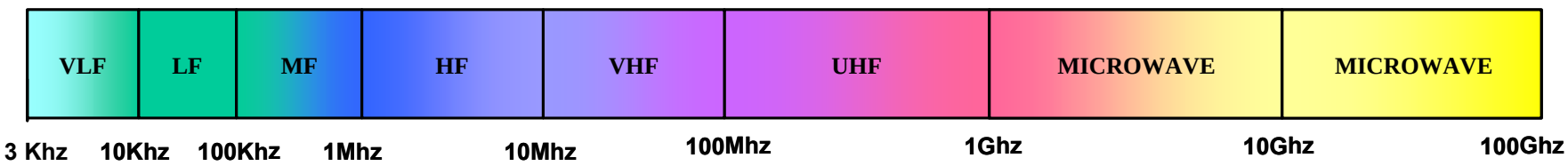
- Objective: Develop a framework to easily visualize the landscape of Austin wireless companies
- Benefits:
  - Easily communicate the breadth and depth of Austin wireless companies
  - Form a common reference that allows companies to quickly and easily communicate what they do
- The work is on going and we hope for its continued development and use in the future

The Classification Framework

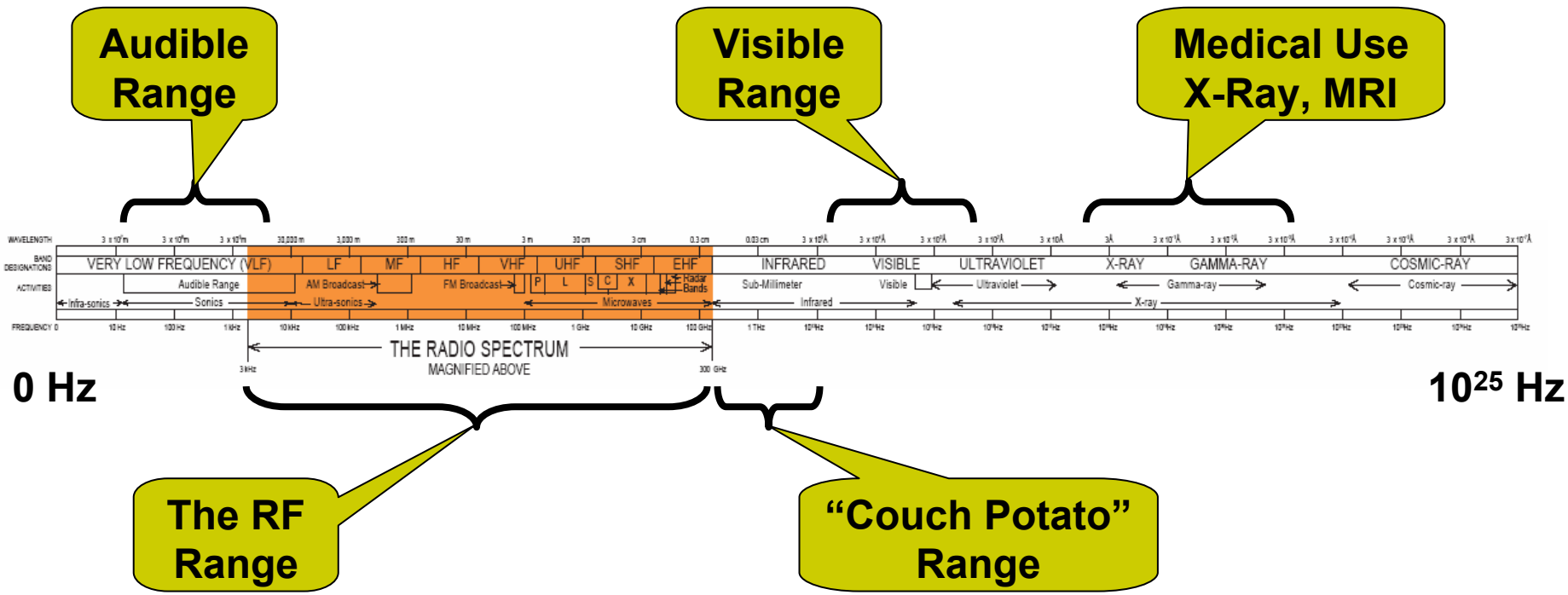
- We will classify companies within a two dimensional framework:
  - **#1**, by segment of the ***Radio Frequency spectrum*** that their products are used within, and
  - **#2**, by portion of the ***wireless value chain*** the products fall within
- Company names will then be plotted and color coded within this two dimensional picture

The RF Spectrum Generally

- Communication of information through the air by use of the Radio Frequency (“RF”) Spectrum
- Facilitated by the controlled insertion and extraction of energy into the atmosphere at various frequencies
- The RF Spectrum as commonly defined

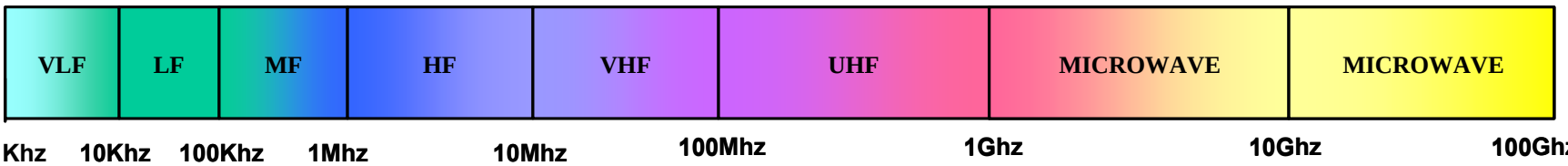


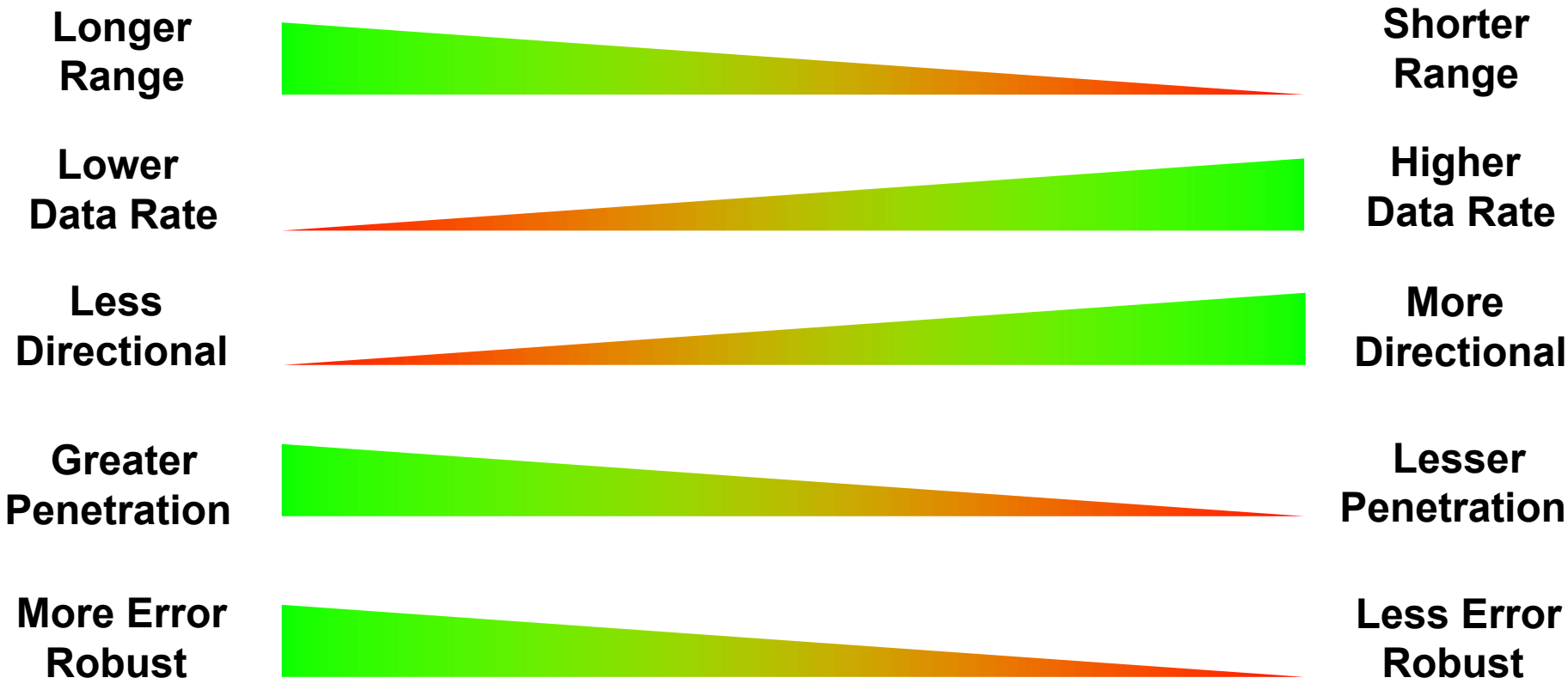
The Electro-Magnetic Spectrum



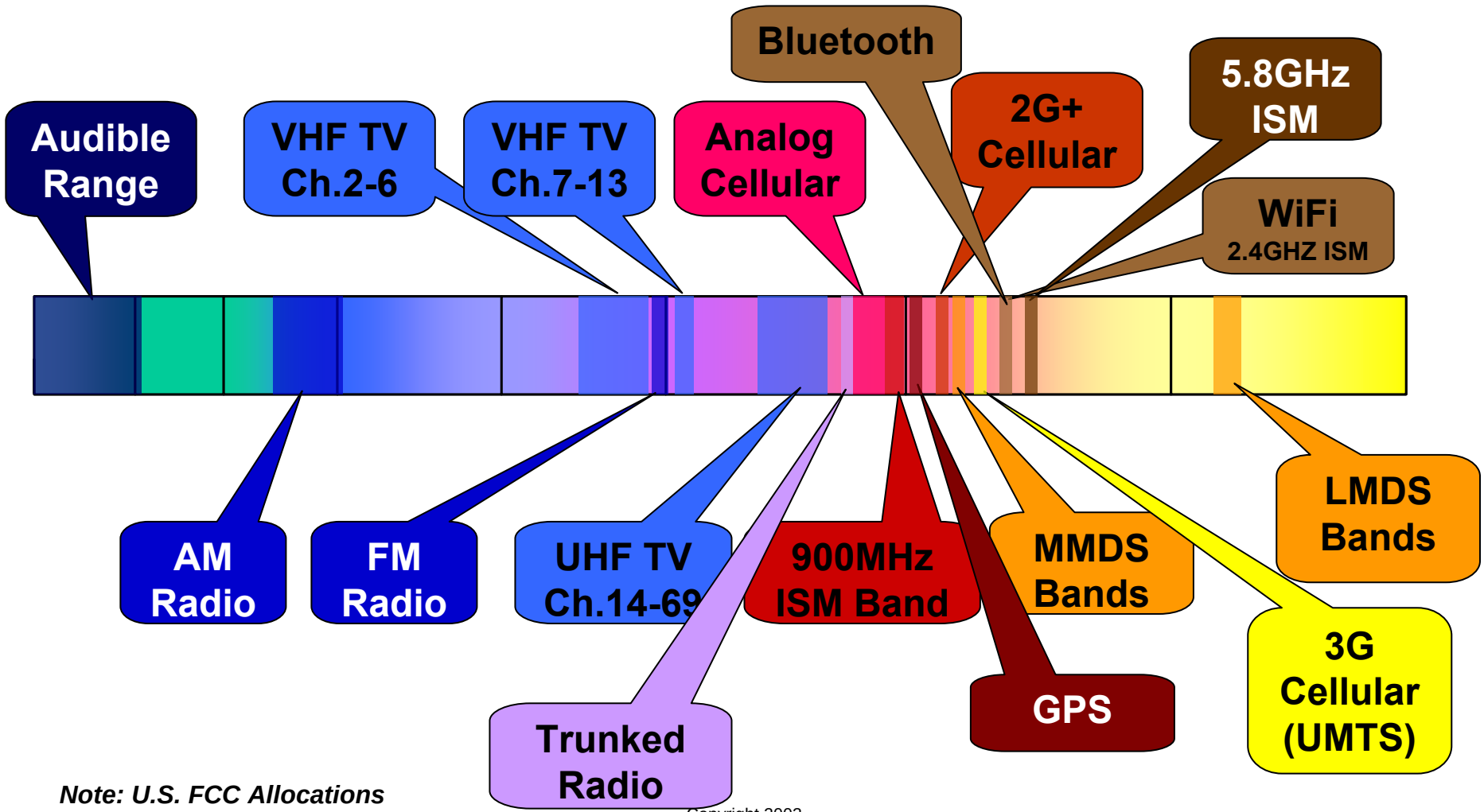
- The RF Spectrum is a component of the Larger EM Spectrum

RF Spectrum Properties



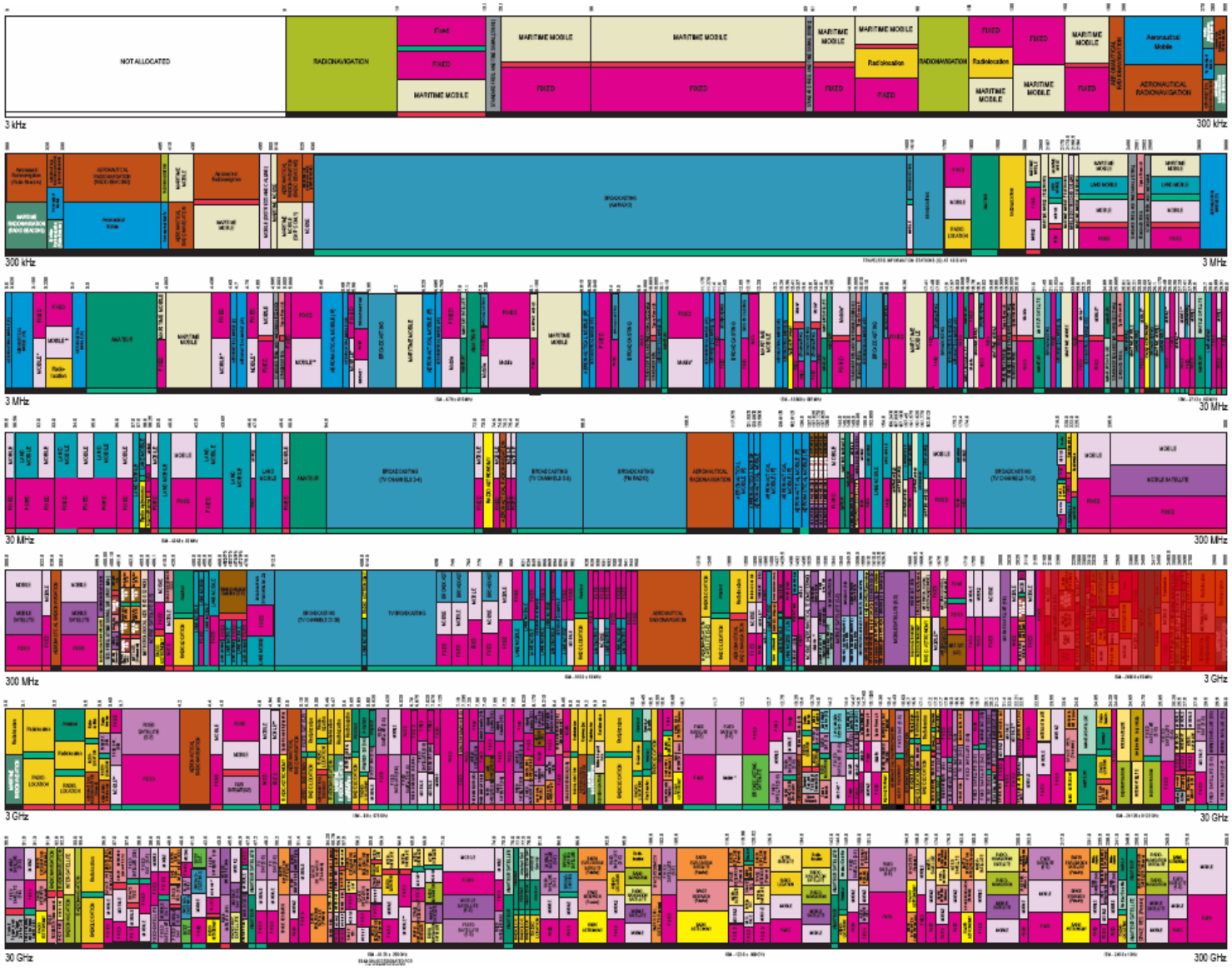


Spectrum Utilization Overview



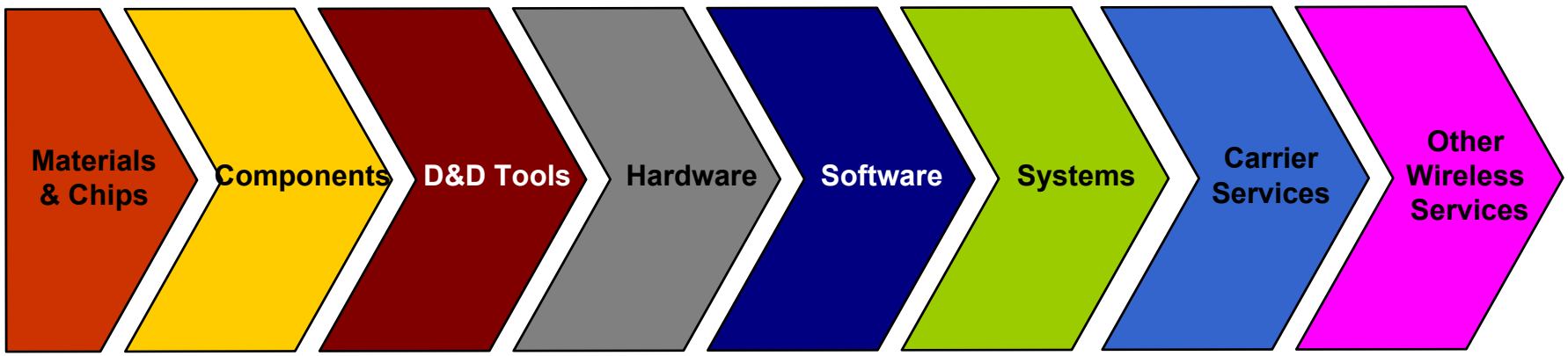
Note: U.S. FCC Allocations

FCC Spectrum Allocation



The Wireless Value Chain

- Each segment of the spectrum has its own eco-system and value chain
- The Value Chain Generally:

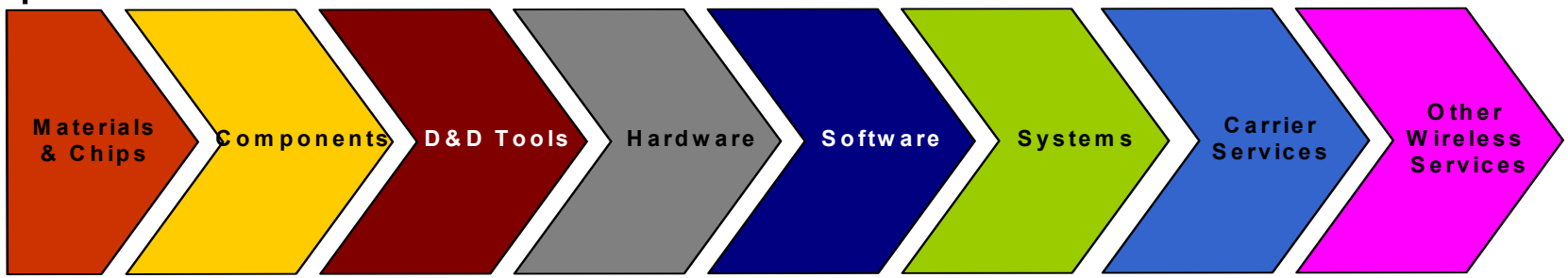


- Well Known 2G Cellular Examples:

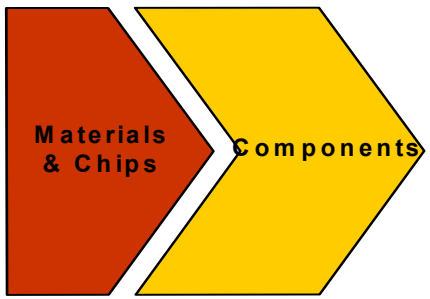
Motorola
LG Electronics
Cadence
Nokia
Openwave
Nortel
T-Mobile
American Tower

Value Chain Maturity

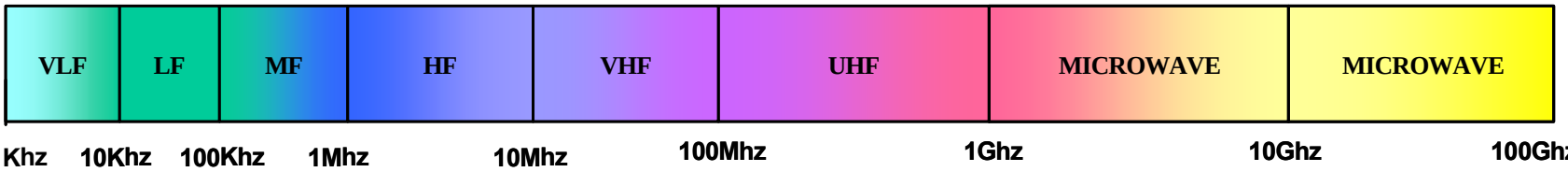
- The value chain is in different stages of maturity in different segments of the spectrum

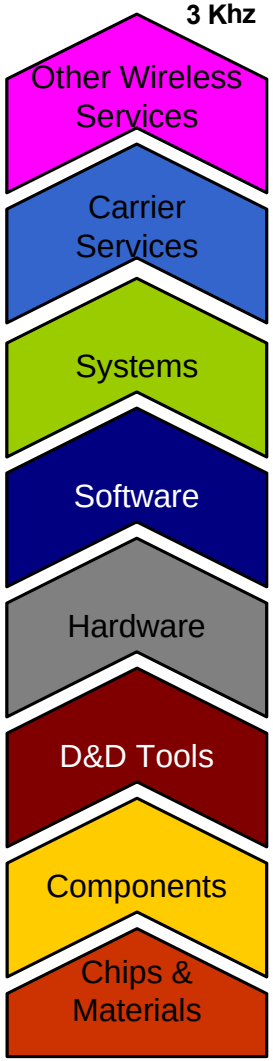


- Example: 60 GHz ISM, just getting going



Austin's Wireless Landscape

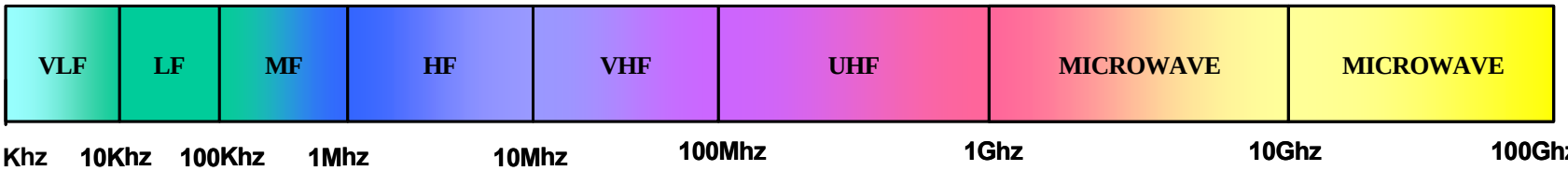




Three Views:

- Companies with Austin Headquarters
- National Companies with Austin Offices
- Other Organizations

Headquartered in Austin



- Other Wireless Services
- Carrier Services
- Systems
- Software
- Hardware
- D&D Tools
- Components
- Chips & Materials

Diarcy

Tuanis Technology

SBC Labs

Reunion Wireless

Reunion Wireless

Reunion Wireless

Rocksteady

TDK RF Solutions

Starlink

Reunion Wireless

National Instruments

TDK RF Solutions

Sierra Microwave

ETS Lindgren

Reunion Wireless

TDK RF Solutions

Intrinsity

Canyon Semiconductor

Headquartered in Austin

Other Wireless Services

Carrier Services

Systems

Software

Hardware

D&D Tools

Components

Chips & Materials

Traq Wireless
American Innovations
CFX Engineering
Isochron/CAC

Traq Wireless
IGillott Research
CFX Engineering
Artemis Wireless Werks

Triact
OTM Engineering
Artemis Wireless Werks
Tuanis Technology
AirChalk
CAZITech
VENewNet

Less Networks
Tstar
WiFiTexas
Wayport
Zeecon
Trillion
Tengo Internet
Wi-Speed
SBC Labs

SoloMio
Team Smarty Pants
UplinkGolf
Hillcast
NavComp
Knockabout Games
Survivorsoft
UplinkGolf
@ Hand
NavComp
Dell
Wireless Computing
SLB/Axalto
American Innovations

Connectione
Wireless Valley
Affinergy
Bandspeed
Dell
Raak
Buffalo
WISP Gear

Metrowerks

Teravicta

Teravicta

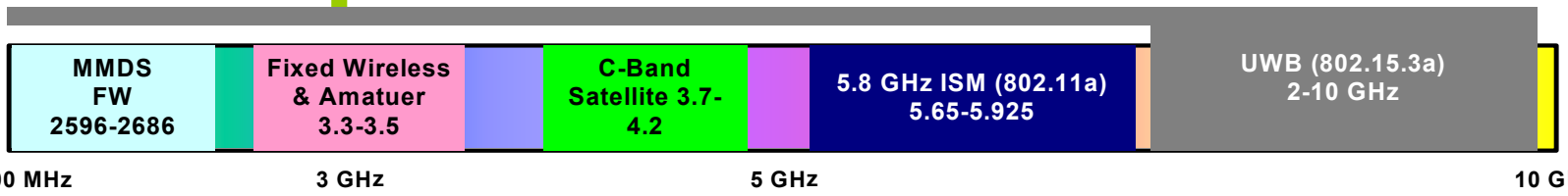
Teravicta

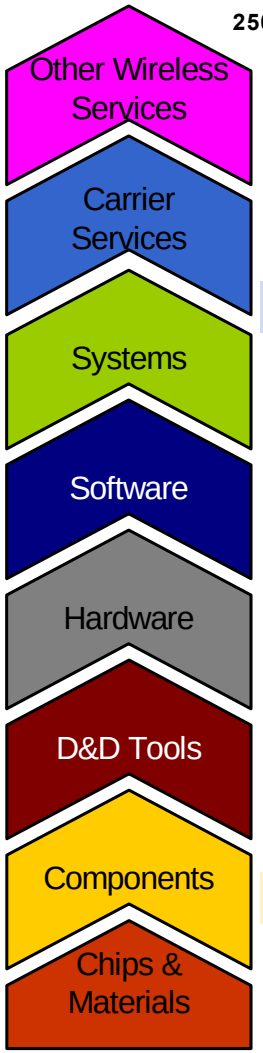
Wintegra

SiLabs
Wintegra

Teravicta
Cirrus Logic
SiLabs

Headquartered in Austin





OTM Engineering

Triact

Tuanis Technology

Grande

SBC Labs

SBC Labs

Wireless Valley

WISP Gear

Bandspeed

Dell

Raak

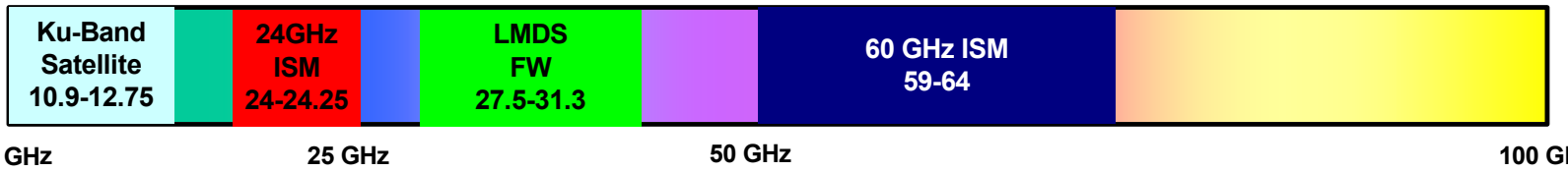
Buffalo

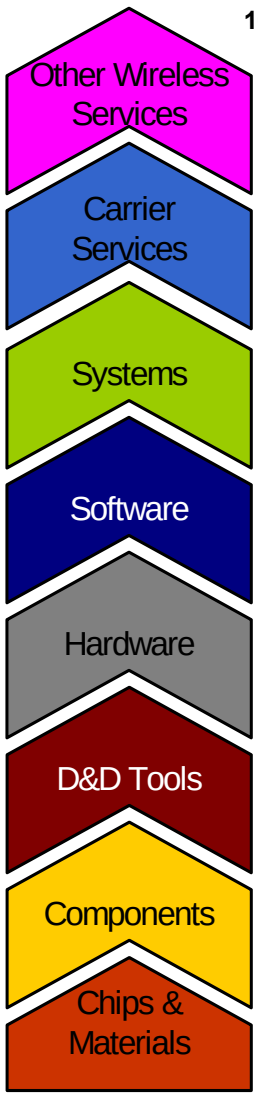
Teravicta

Cirrus Logic

Alereon

Headquartered in Austin





Tuanis Technology

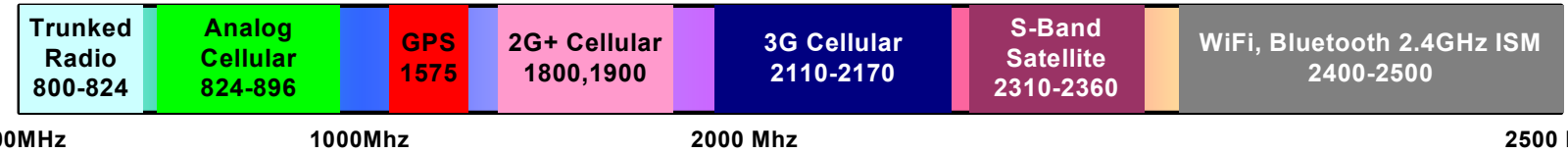
SBC Labs

Wireless Valley

Azar

Integral Signal

Austin Presence



Other Wireless Services

Carrier Services

Systems

Software

Hardware

D&D Tools

Components

Chips & Materials

Frog Design

Frog Design

Intag

SchlumbergerSema

Caci

Caci

Caci

Qwest

AT&T Wireless

AT&T Wireless

Trimble

Vytek

Vytek

Alcatel

Alcatel

Motorola

Telcordia

Trimble

Telcordia

Cisco

Vytek

Vytek

Sony OE

HP

SchlumbergerSema

IBM

Trimble

Cisco

Carcomm

Carcomm

IBM

SchlumbergerSema

Vytek

Vytek

HP

Rockwell Collins

Rockwell Collins

Trimble

Raven

Intel

Intel

Motorola

Motorola

Motorola

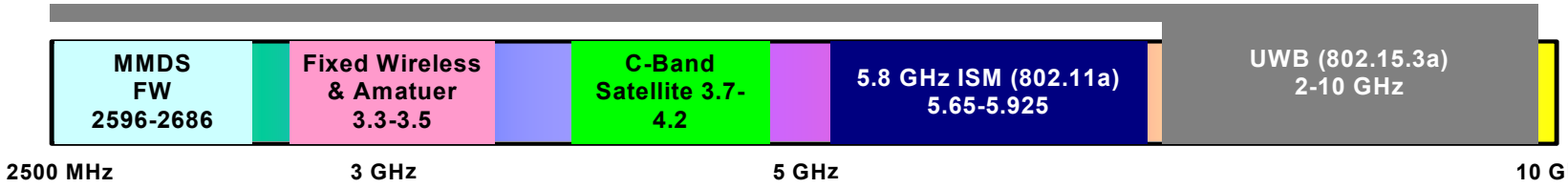
AMD

Trimble

Intel

Intel

Austin Presence



Other Wireless Services

Carrier Services

Systems

Software

Hardware

D&D Tools

Components

Chips & Materials

Intag

Caci

Vytek

Motorola

Alcatel

Motorola

Cisco

IBM

Vytek

HP

IBM

Cisco

Vytek

HP

Rockwell Collins

Rockwell Collins

Motorola

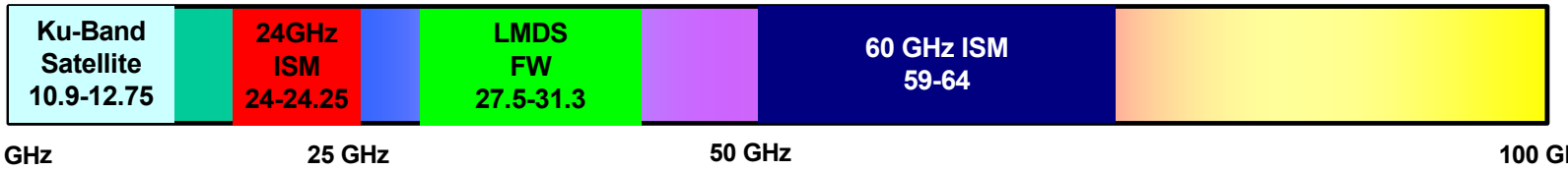
Intel

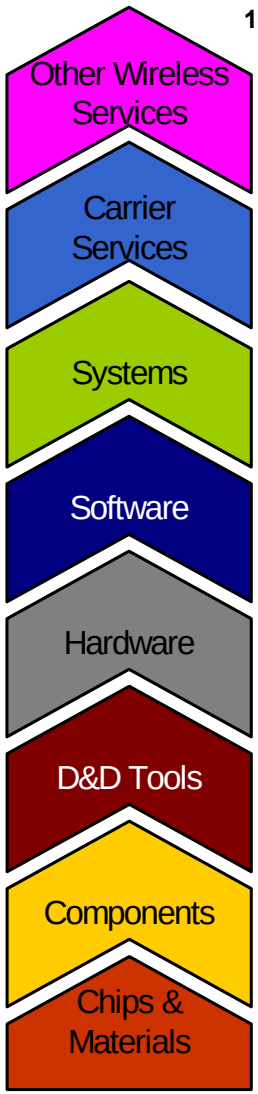
Motorola

AMD

Intel

Austin Presence





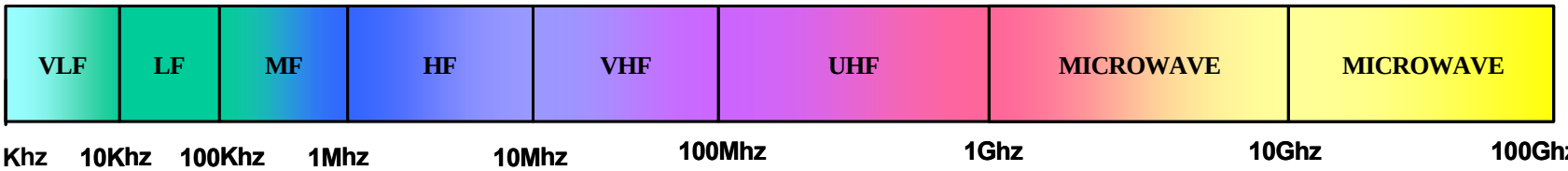
Caci

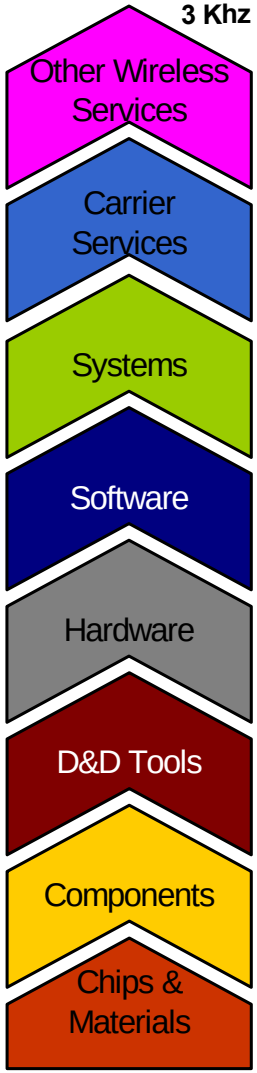
Alcatel

Rockwell Collins

Rockwell Collins

Austin Company Profile

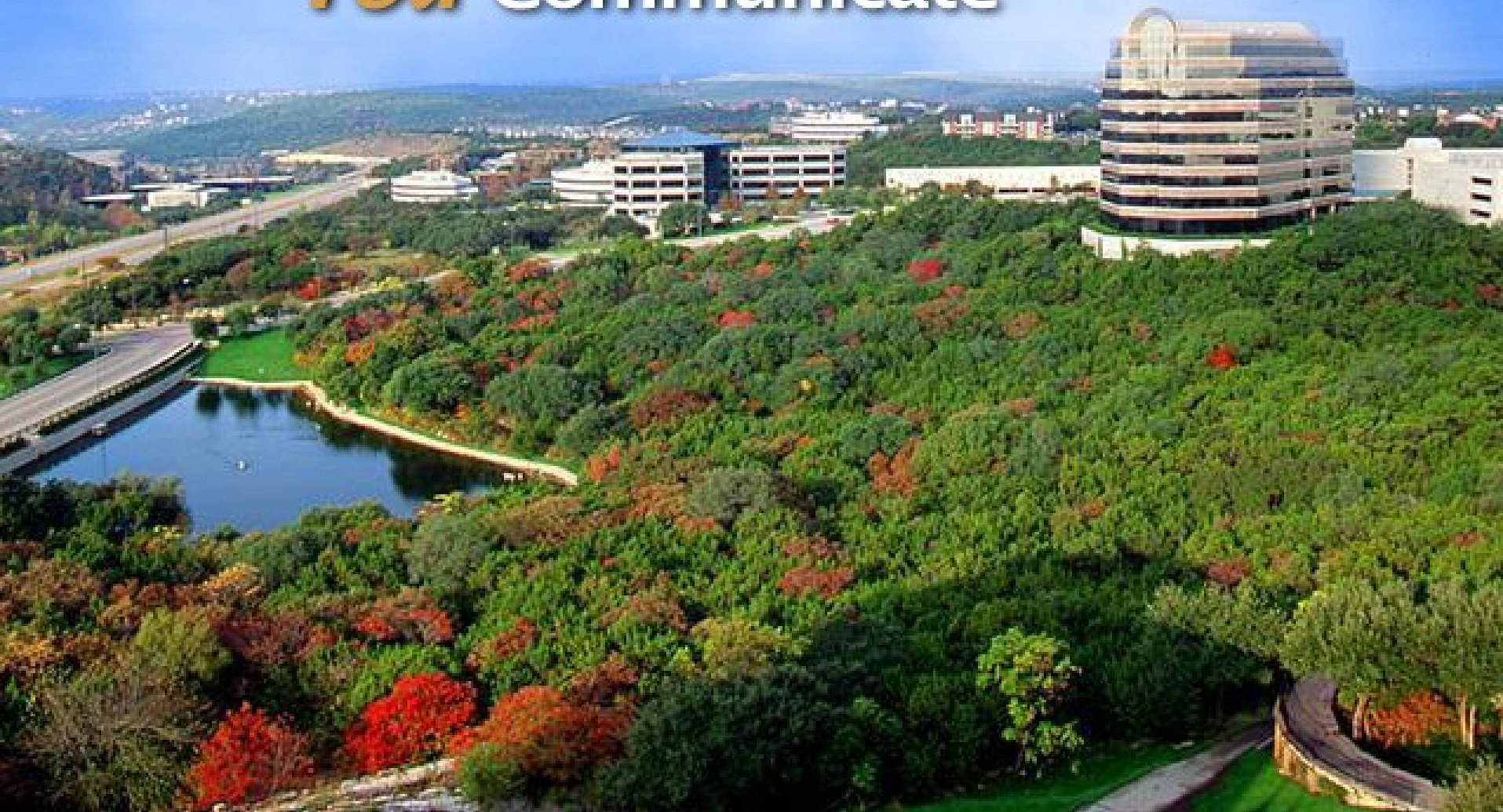




SBC Labs
David Deas

SBC Laboratories, Inc.

Changing the Way *You* Communicate



SBC Laboratories, Inc.

- **Formed in 1988**
- **Technical disciplines include:**
  - Electrical Engineering
  - Computer Science
  - Physics
  - Mathematics
  - Systems Engineering
  - Experimental Psychology
- **Parent Company – SBC**
  - 13 State Wireline/Internet Operation
  - 2002 Revenues of $43B
  - 55 million access lines
  - Majority owner: Cingular Wireless
  - 23 million wireless subscribers
  - 202 million covered POPs

Austin, TX

Pleasanton, CA

SBC Laboratories Clients

STERLING COMMERCE

Wireline Companies
Formerly: Southwestern Bell
Pacific Bell
Ameritech
SNET

E-Services

cingular WIRELESS

Messaging Services

Video Services**

Yellow Pages

International, Inc.

Telecom, Inc

Advanced Solutions, Inc.

Internet Services*

Communications Services (SBC LD)

*includes Yahoo Alliance
** includes Echo Star Alliance

SBC Laboratories Role

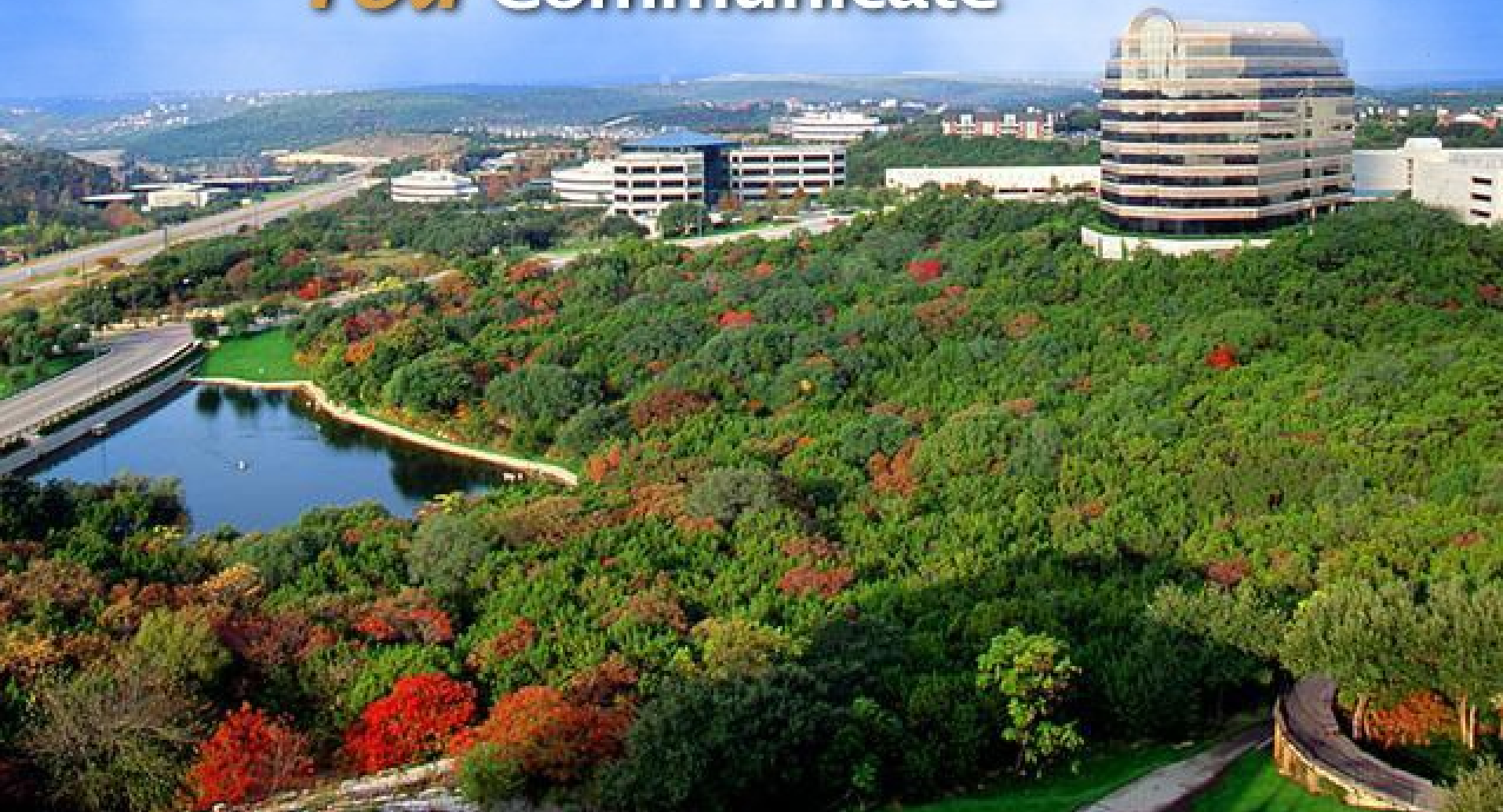
"Applied R&D using Technology Life Cycle Management for the SBC family of companies"

Technology Focus Areas

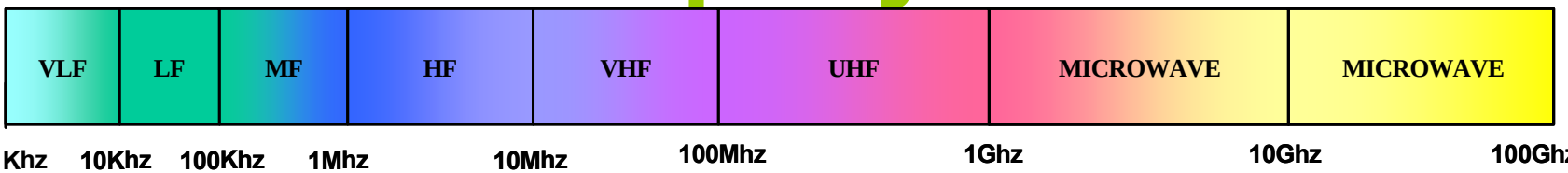
Broadband	*Communication Services*	*Internet*	*Wireless*	*Information Technology*
Austin, TX **Pleasanton, CA**	**Austin, TX**	**Austin, TX**	**Austin, TX**	**Austin, TX**
Fiber Optics **DSL** **ATM** **IP Core Networks** **Video Services**	**VoIP** **SS7** **Messaging** **Speech Recognition**	**IP Services** **IP Security**	**3G Networks** **Fixed Wireless Systems** **Unlicensed Band Radio** **Terminals**	**XML** **Web Architectures** **Management Systems**

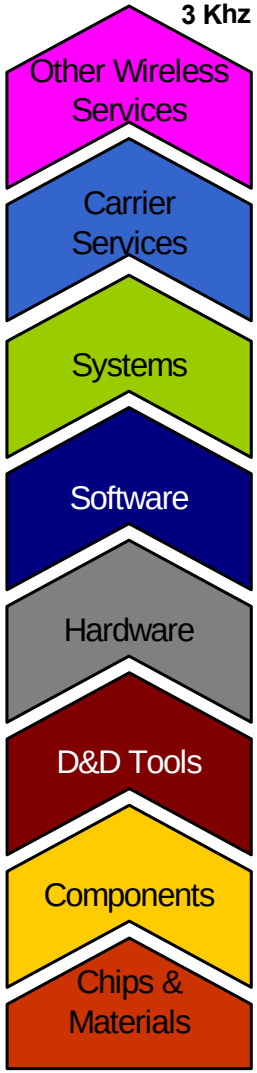
SBC Laboratories, Inc.

Changing the Way *You* Communicate



Austin Company Profile





CFX, LP

Carroll Faulkner

CFX ENGINEERING EXCELLENCE

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The University of Texas at Austin
austin wireless alliance
Austin Technology Council

- Overview
  - Civil Engineering Firm
  - Established 1996
  - Austin headquarters
  - 32 employees
  - 2003 ABJ lists CFX as 15th largest engineering firm in Austin

www.cfxamerica.com

CFX ENGINEERING EXCELLENCE

IC2 INSTITUTE
The University of Texas at Austin

austin wireless alliance

Austin Technology Council

- Areas of Practice
  - Land Development
  - Telecommunications
  - Municipal Infrastructure
  - Environmental
  - Surveying
  - Construction

CFX ENGINEERING EXCELLENCE

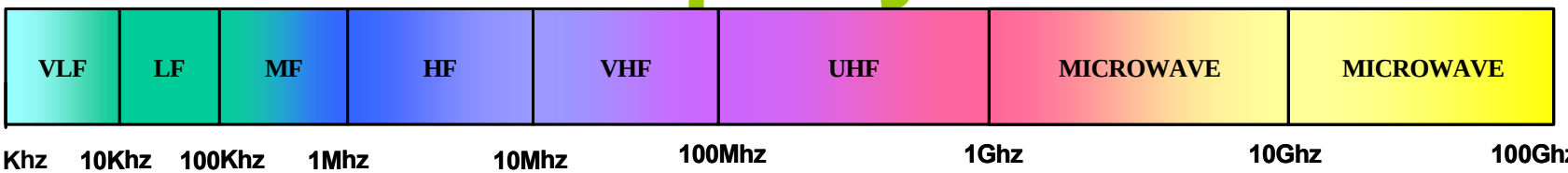
IC2 INSTITUTE
The University of Texas at Austin

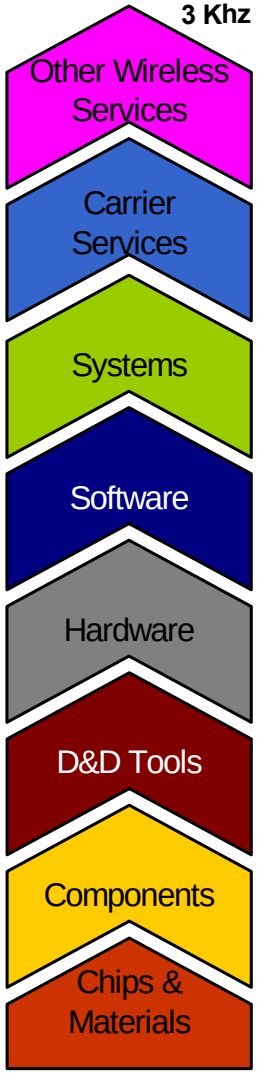
austin wireless alliance

Austin Technology Council

- Telecommunications Projects
  - Over 2000 sites for cellular/PCS carriers in Southwest and throughout U.S.
  - Clients include Cingular, Sprint, NexTel, NexTel Partners, Verizon, ALLTEL, Spectrasite, Crown Castle
  - Regional 9-1-1 System for Motorola

Austin Company Profile





metrowerks™

metrowerks™

Metrowerks
Chris Davis

metrowerks

Corporate Profile

IC2 INSTITUTE
The University of Texas at Austin

austin wireless alliance

Austin Technology Council

- **Employees:** 500+ Worldwide; 250+ are developers
- **Industries served:** Wireless, NetComm, Transportation, Consumer Electronics, Embedded Linux, and Desktop markets
- **Locations:** Headquartered in Austin, Texas with more than 15 offices in 13 nations worldwide. Regional Headquarters in Singapore, Munich and Tokyo..

- **History**
  - 1985: Founded in Montreal: soon recognized as Gold Standard for Mac/Desktop Development Tools
  - 1995: Company headquarters moved to Austin, Texas
  - 1996: Entered embedded development market
  - 1999: Acquired as an independent subsidiary of Motorola's Semiconductor Products Sector
  - 2002: Acquired Embedix (Lineo), established Linux Solutions Group
  - 2002: Acquired Applied Microsystems Corporation, expanded product offering to add board bring-up and code analysis capabilities
  - 2003: Recognized by industry as a worldwide leader in development solutions.

metrowerks

Metrowerks: Who We Are

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Austin Technology Council

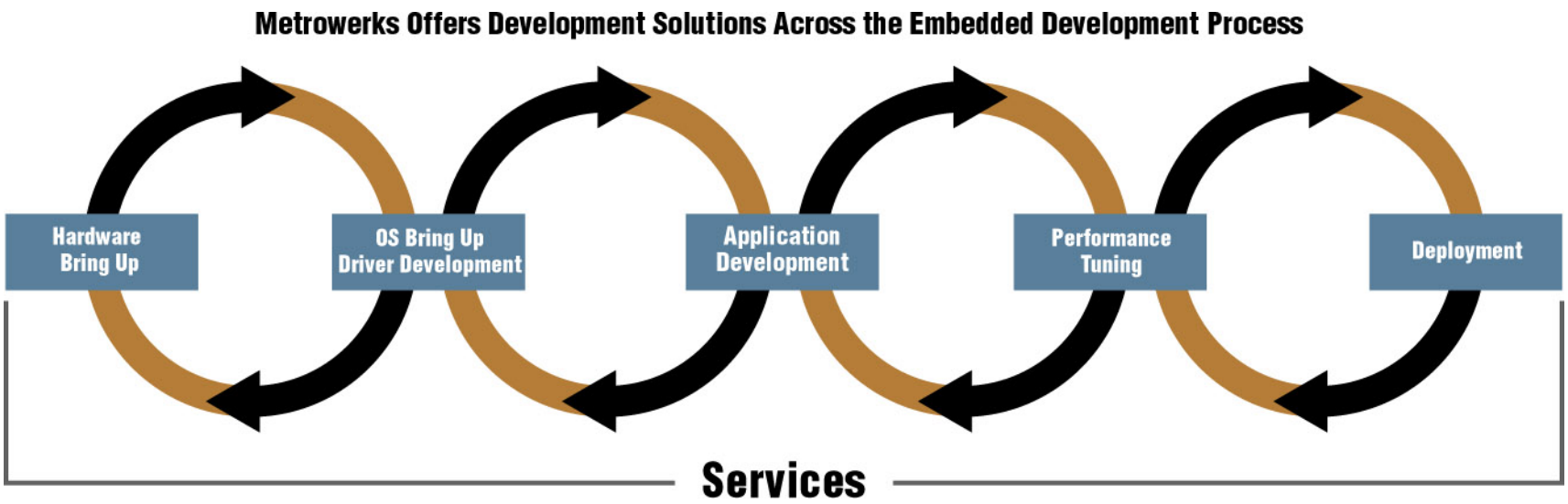
Metrowerks is a single source for embedded development solutions that enable the creation and deployment of successful products for a broad range of competitive, opportunity-rich markets.

We offer products and services across the development process, from board bring-up and platform development to application creation and code analysis as well as comprehensive developer services.

metrowerks

Across the Development Process

Value Proposition



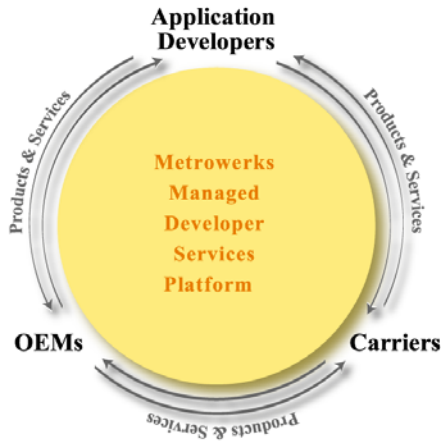
PowerTAP	Platform Creation Suite Kernel-Level Debugging	CodeWarrior Development Studio	CodeTEST Software Analysis Tools	Managed Developer Programs Application Stacks Custom S/W Development

metrowerks

About Metrowerks' Wireless Business

- **Development Tools:**
  - The Metrowerks CodeWarrior IDE supports a broad array of wireless platforms. It speeds and simplifies the creation of world class wireless applications and devices.

- **Linux-Based Platforms:**
  - The Metrowerks OpenPDA platform is a comprehensive development solution that offers professional grade tools, commercial software, integration services and training to facilitate the creation of Linux-based mobile computing devices.



- **Developer Services:**
  - Metrowerks lends its expertise to OEMs, platform owners, carriers, and ISVs to build developer loyalty and increase revenue through customized developer programs. Programs include out-sourced management, tech support, marketing, S/W development, etc.

metrowerks

Major Wireless Customers/Partners

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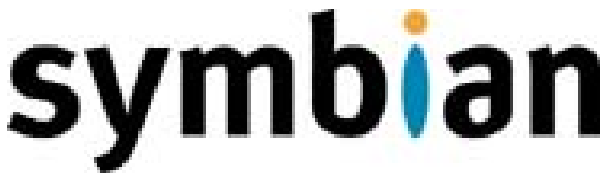
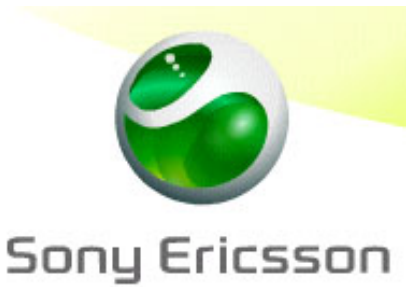
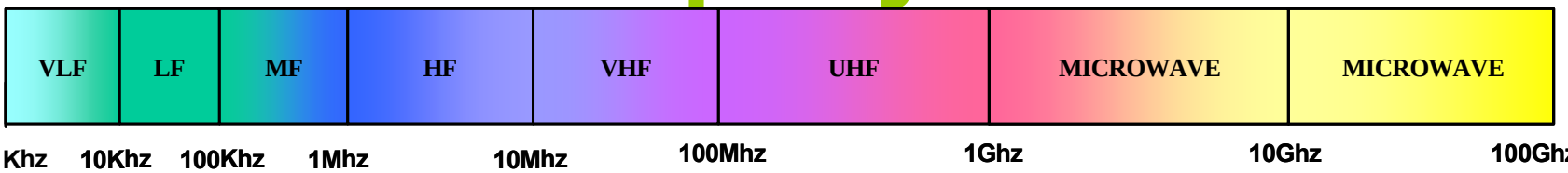
Austin Technology Council

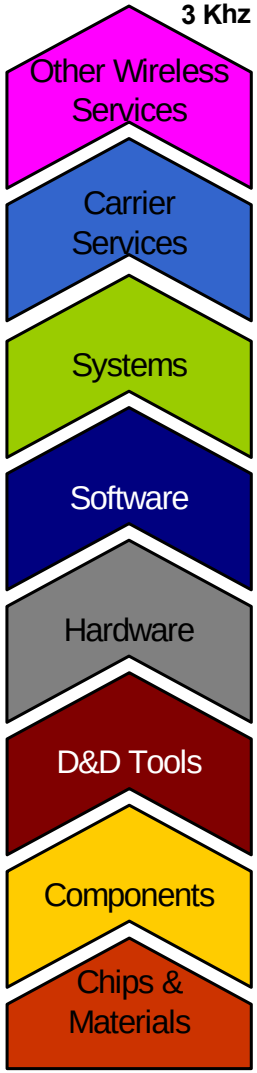




metrowerks

Austin Company Profile





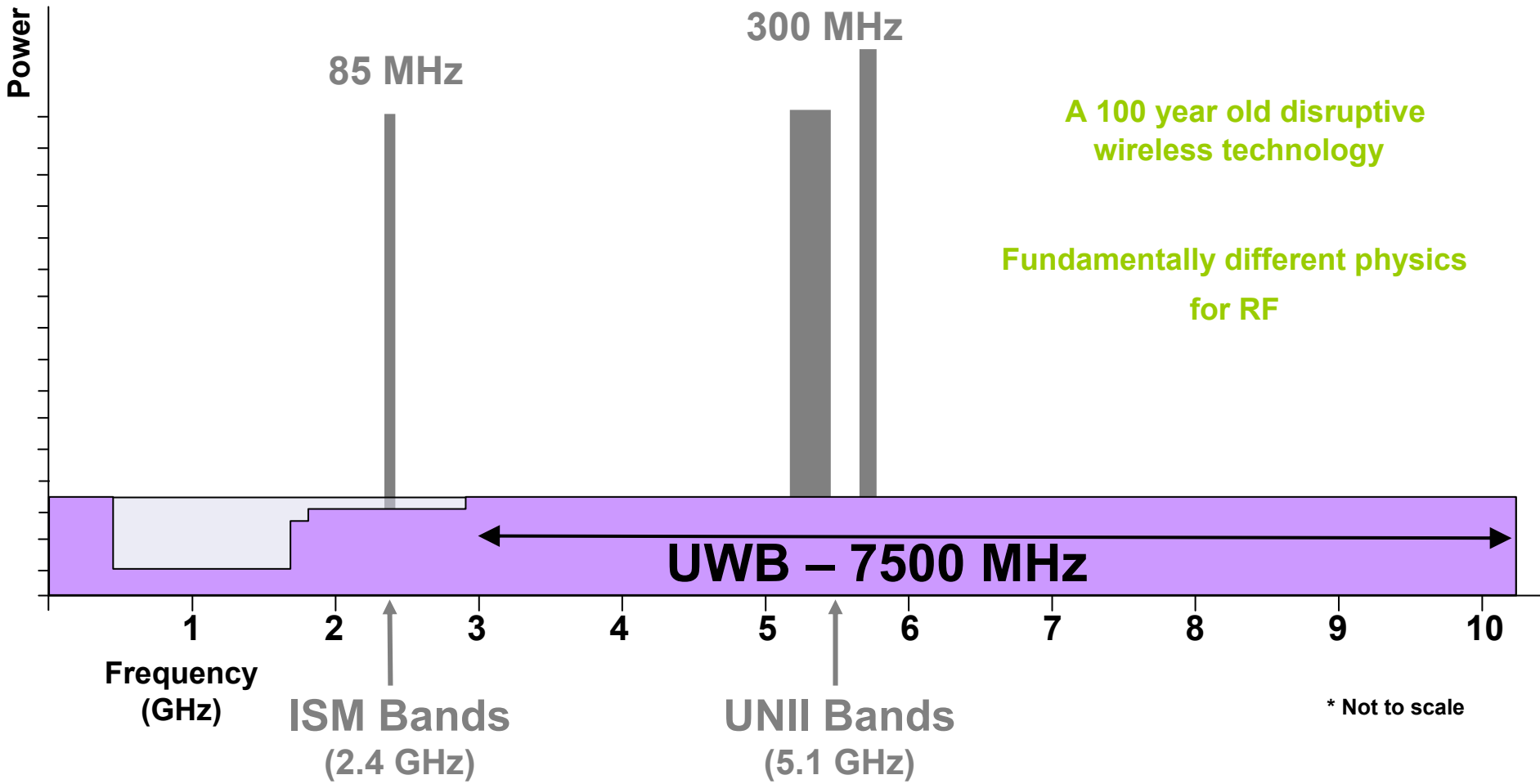
Eric Broockman
Alereon, Inc.

alereon alereon alereon alereon alereon alereon

Overview

- New UWB PAN Fabless semiconductor company – Austin, TX.
  - Very low power, 55 to 480 Mbps, 3.1 – 10.6 GHz
- Recent Series A Financing of $31.5M
  - Funding round led by Austin Ventures
  - Other VCs with Austin presence include Centennial and PTV Sciences
- Mission: Dominant supplier of UWB chipsets
- 40 Employees Total; 30 in Austin
- Product: Complete Solution UWB chipset: MAC to Antenna
  - Target : Wireless cable replacement for USB2.0, “S-Video” or 1394
  - First Customers: Portable PC peripherals, Photo Printers, Flat panel displays
- IP portfolio of more than 250 UWB patents and applications

What is UWB?



A 100 year old disruptive wireless technology

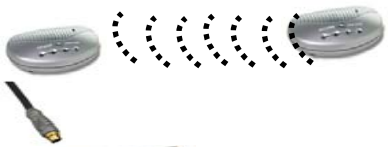
Fundamentally different physics for RF

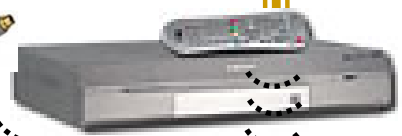
CE and PC Industry Vision for UWB

Wirelessly connect and print digital photographs.

802.X connection to rest of the house

Wirelessly connect to PDAs and MP3 players.

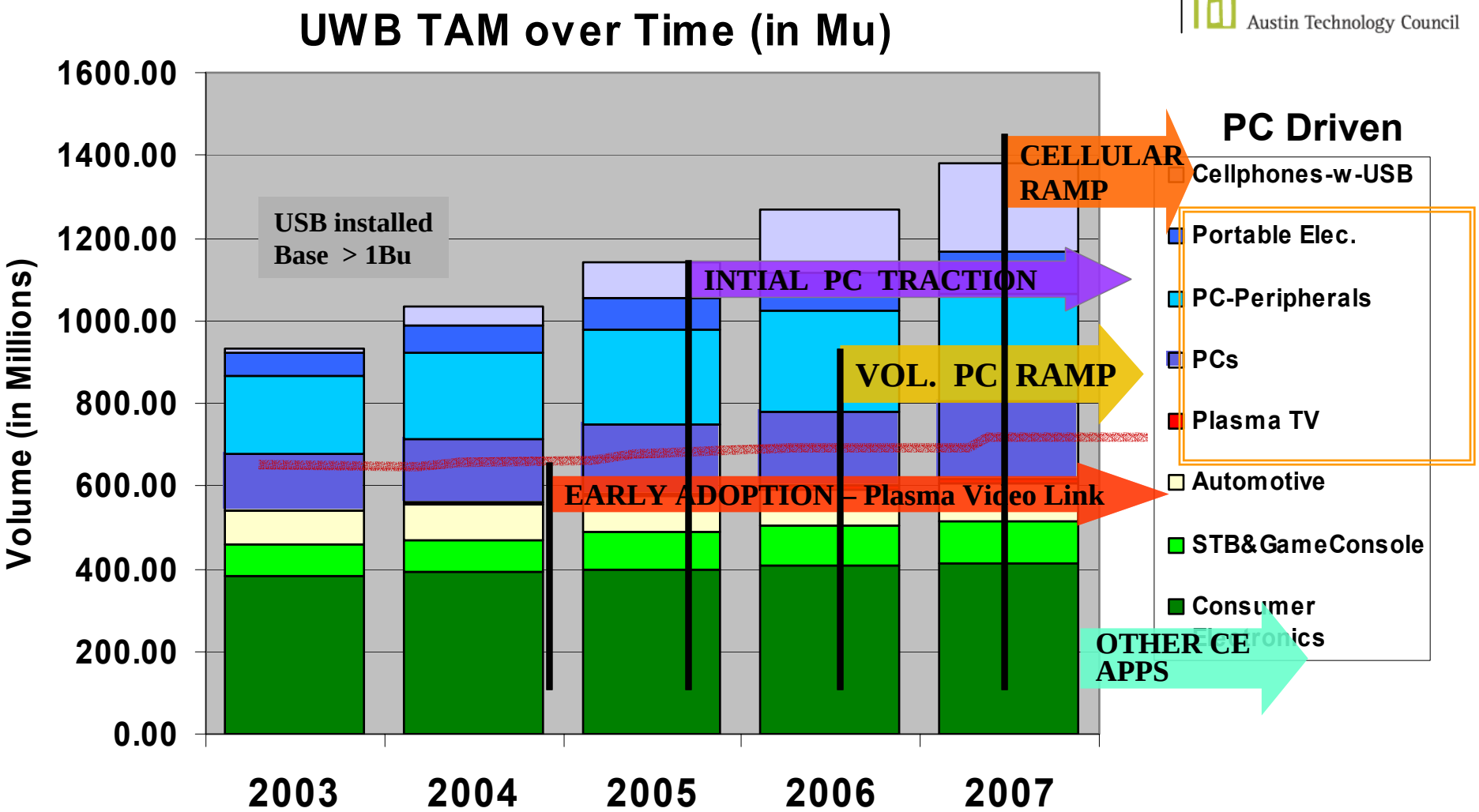




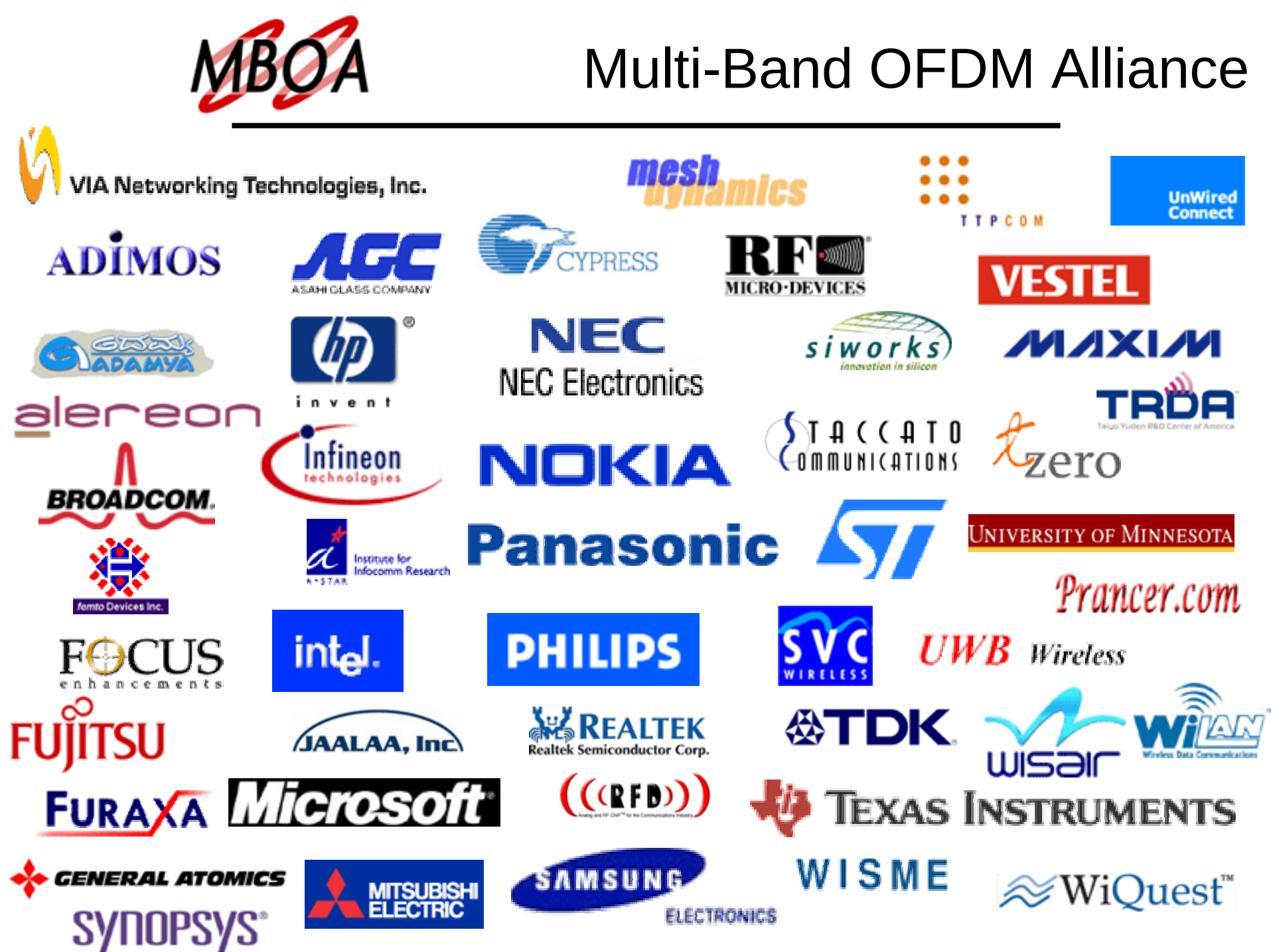
Watch digital video on TV, No Cables. Transfer to PC to Edit

Wirelessly connect to TV, flatscreen, DLP Projector

UWB TAM f/ CE 5 & Market Evolution



Multi-Band OFDM Alliance

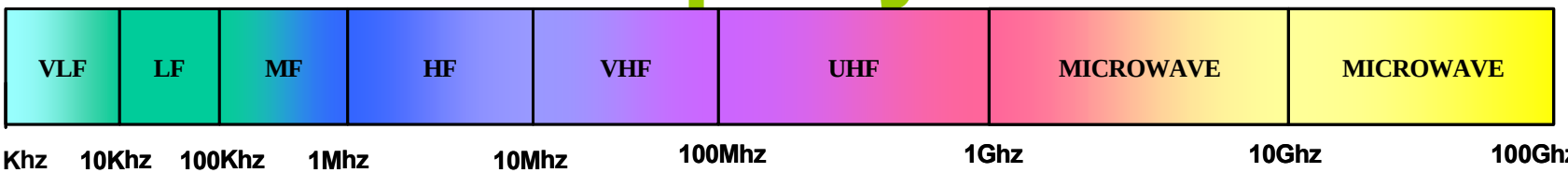


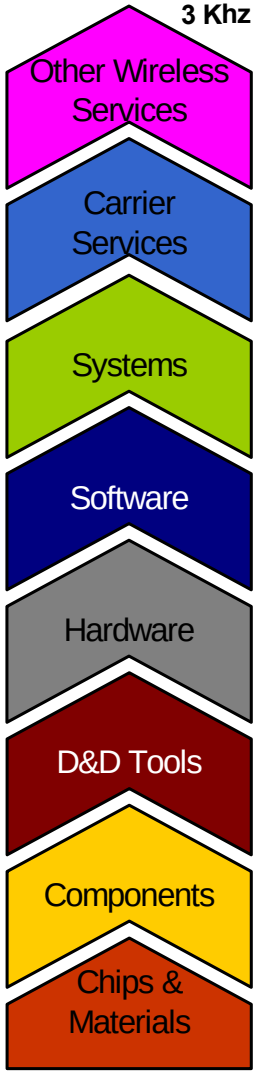
Summary

UWB is not just another wireless technology…

- Unique capabilities with differentiation
  - 10+ times the throughput of 802.11a/g
  - 25+ times reduction in power
- A solution to real problems - speed, battery life, no cables!
- Products will ship in volume in late 2004, early 2005
- $1B+ semiconductor market within 5 years
- Alereon has team, IP, funding, and development lead to be successful.

Austin Company Profile





bandspeed

Bandspeed, Inc.
Blaine Kohl

Overview

- Focused on bringing “sectorization” to 802.11 (2.4GHz and 5GHz)
- 802.11 (Wi-Fi) access point (AP) switch SOC player focused on
  - Throughput
  - Coverage
  - Simplicity
  - Significant cost savings
- Address co-channel interference problems experienced when using conventional APs
- Sell ICs, software and antennas to AP vendors
- First and only with SDMA products on the market
- OEMs and end users in beta trials

Market Segments

1. Public Access

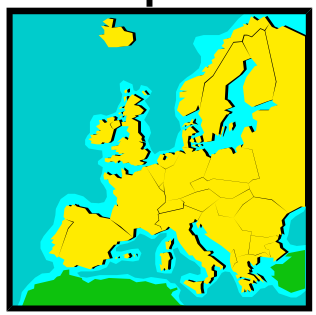
’07 Hotspots = 80.9K

2002 was a watershed deployment year in Asia

’07 Hotspots = 60.6K

Volume rollouts in 2003

’07 Hotspots = 32.6K



Volume roll-outs by the end of 2003

source: IDC, Gartner ‘03

2. Enterprise / Verticals

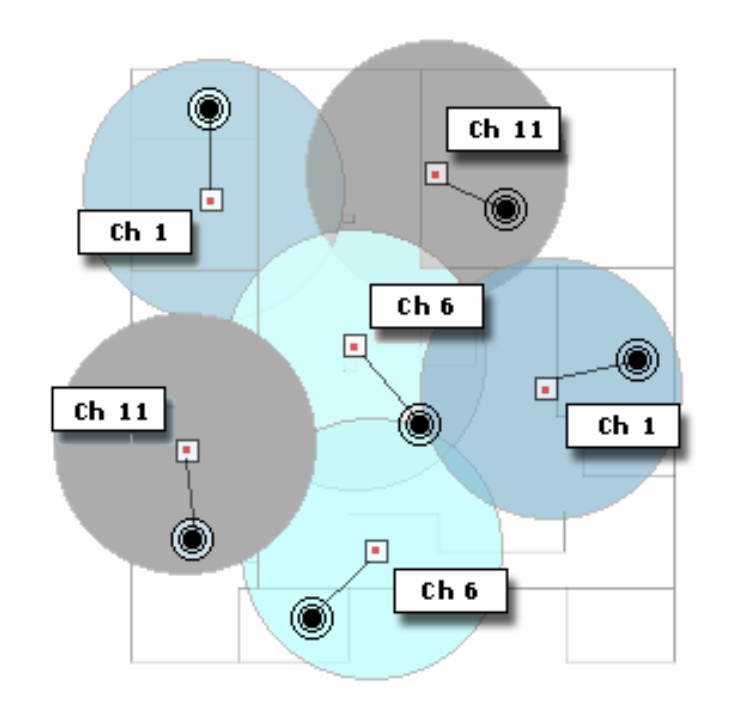
Collaborative work environments require employees be untethered

By ’05, 80% of laptops will have Wi-Fi embedded (Gartner, ‘03) + other portable devices = congestion

Enterprises with 10K+ employees or more will reduce long distance costs by 70%+ by using VoIP (Forrester ‘03)

source: TeleAnalytics, 2003

Today's WLANs are Obsolete



- **Difficult to deploy and manage**
- **Networks don't scale**
- **Future capacity needs can't be met**

Bandspeed: *AP Switch (SDMA)*

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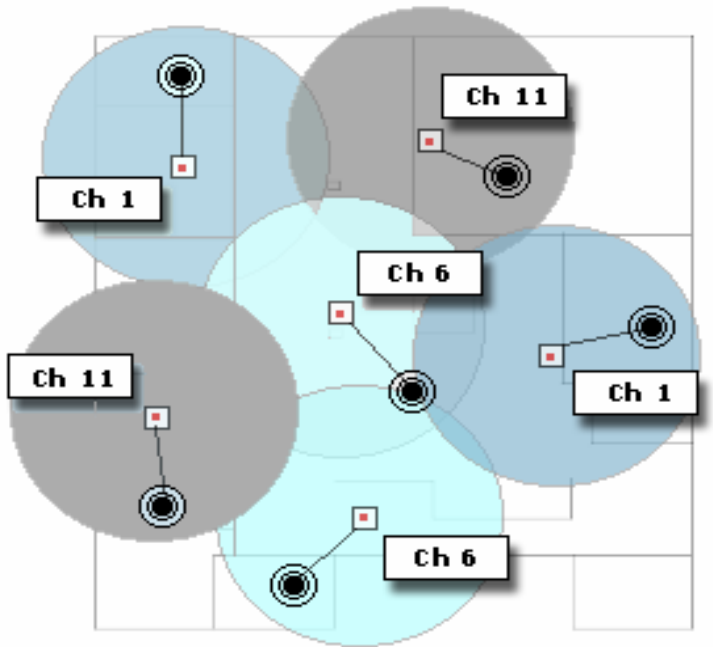
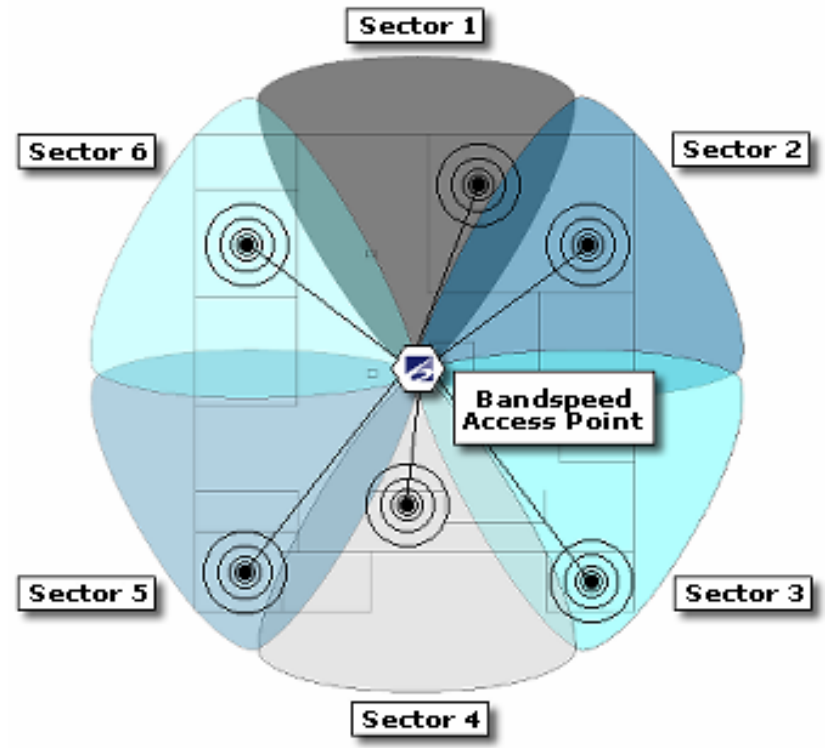
Sea of APs → **To SDMA APs**

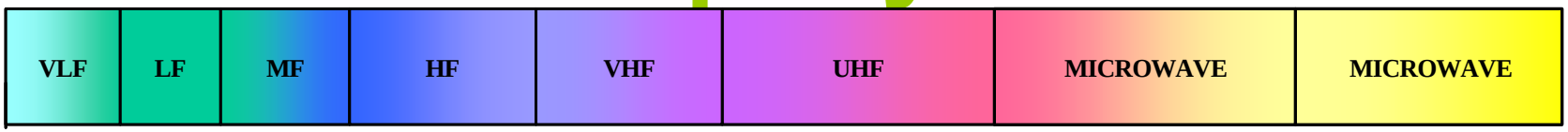


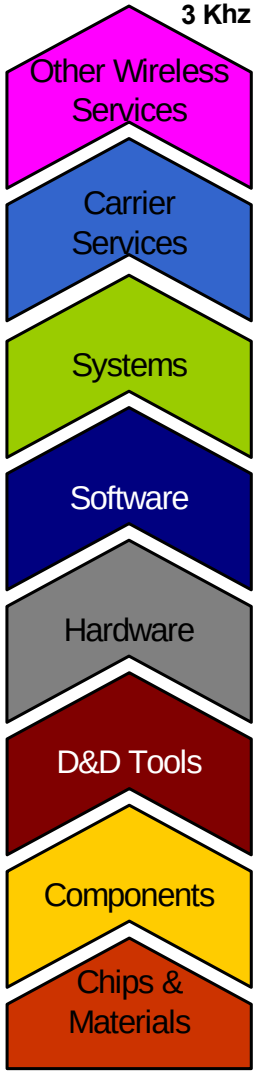


Summary

- Knowns:
  - Wi-Fi is in the very beginnings of a huge market
  - Work style changes demand employees be untethered
  - Solutions must offer performance and low cost
- Customers have simultaneous problems to solve… and current alternatives face obsolescence
- The “sea of APs” is the only real alternative
  - Interference
  - Manageability
- Bandspeed has the right solution – sophisticated answer to WLAN networks

Austin Company Profile





Manning NavComp INC

NavComp, Inc.
Jeff Manning

RASTRAC®

solutions for every tracking need

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Vehicle and asset tracking

The intersection of mass, energy and information

An industry entering the mainstream

RASTRAC is developed by Manning NavComp, Inc., 13706 Research Blvd, Austin, Texas. Call us at 512-918-0700 or visit www.navcomp.com

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solutions for every tracking need

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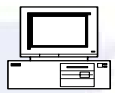
Austin Technology Council

- All-Tow Austin
- Pridemaster Dayton OH
- Denham Towing Austin
- BDD Dallas



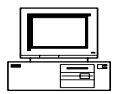
450 vehicles

RASTRAC Vehicle Tracking Service

(RASTRAC Net, Inc) www.rastrac.net

$15-45/month

- Disposal Mgmt Chicago
- Cross Ready Mix, NY
- Carribean Pools, Miami

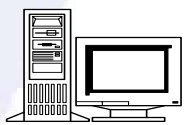


>2600 licenses sold since 1996

RASTRAC Small Business

$2500-$7000 private systems

- Key Energy Midland
- Western Geco
- Roto-Rooter of California
- City of San Diego
- Wackenhut Bogota



approx 40000 vehicles in 40 countries

RASTRAC Enterprise Back Office

$17000-$56000 + revenue share

A full suite of market-mature product solutions

512-918-0700

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