Wireless 101

Understanding the Basics from A-Z

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CHAPTER 1

Wireless 101: Putting the Pieces Together

Handset

Spectrum

Network

Tower

Handset

Image Sources: CTIA; HTC, Motorola.
Wireless 101: *Handsets, Devices & More*…

- **History of Innovation**
  - “Brick” to Broadband…Innovation
  - Who’s Who?
  - What’s Inside?

- **Convergence**
  - Healthcare
  - Education
  - Mobile Usage Snapshot
  - Minorities Lead the Way

*Def: Convergence,* the concept of convergence originates where the hard-wired broadband network meets the mobile phone. It is one device that can provide you mobility, internet, television, location-based services, music, camera and a host of other functions besides being your phone. (See Glossary Pg. 13)
Handsets: *What’s Inside?*

- Antenna and Signal Amplifiers
- Battery
- Circuit Board with Microprocessors (“Chips”):
  - Digital Signal Processor
  - Flash (Internal) or SIM (External) Memory
  - GPS (Location)
- Display
- Key Board / Touch Screen
- Microphone / Speaker
**Def: OEM**, Original Equipment Manufacturer produces the hardware of the device (see Glossary pg 15)

**Def: Operating System**, As of August 2010, there are 10 wireless operating system platforms (See Glossary pg 17)

**Def: Open Internet**, The ability of end users to access and content producers to distribute information over specific applications, devices, services and networks (See Glossary pg 25)
Handsets: “Brick” to Broadband...Innovation

✓ Voice Only;
✓ Text Only (E-Mail, Pagers); or
✓ Early Internet

✓ Voice + Text + Camera; or
✓ Wireless Internet Only

Image Source: BlackBerry®; CTIA.
Handsets: *Convergence*
Handsets Factoid:

• At least 33 companies manufacture more than 630 unique devices for the U.S. market – more devices than in any other country in the world.

• At the end of 2009, 83% of devices operating on wireless networks were capable of web-browsing; including 49 Million Smartphones and wireless-enabled PDAs and 11 Million Wireless-enabled Laptops and Wireless modems.

Source: CTIA (July 2010).
Handsets: Healthcare

Source: Qualcomm; Rob Atkinson. ITIF
Handsets: **Education**

- Accessibility
- Books / Reading Comprehension
- Distance Learning
- Math / Science
- Information / Reference
- Quiz / Testing
Handsets Data Usage Factoid: *Minorities Lead The Way*

Percentage Accessing Data via Mobile Browsers

Source: ComScore (March 2010)
CHAPTER 2

Wireless 101: Spectrum

• What is Spectrum?
  – The Fuel of Innovation
  – Spectrum Map

• Licensing & Auctions
  – The Spectrum Squeeze
  – The National Broadband Plan

• The Many Users

**Def:** Spectrum, a range of radio waves used for communications. (See Glossary Pg. 21)
Spectrum: Making the Connection

Image Sources: CTIA; HTC.
Spectrum: *Wireless Network’s Oxygen*
Spectrum Factoid: The Fuel of Innovation

Virtuous Cycle

Consumers continue to consume & want more

Spectrum is available

So app/content developers are creating new apps/content

Since networks can handle more

Device manufacturers offer new capabilities
Spectrum: Licensing & Auctions

- Licensing prevents everyone using same frequencies at the same time (“Interference”)
- How are Licenses Obtained?
  - Broadcast (TV/Radio) were FREE
  - Wireless (CMRS) are auctioned by FCC
    - Revenue of Last 2 Commercial Wireless Auctions = $33 B

**Def:** Auctions, FCC method to distribute commercial wireless licenses. (See Glossary pg 23)
**Spectrum: The Many Users**

**Facilities-Based Providers**
Wireless Carriers (National, Regional, Local)
- Sprint
- AT&T
- U.S. Cellular
- Cricket
- T-Mobile

**Non-Facilities-Based Providers**
Mobile Virtual Network Operators (MVNOs)
- Virgin Mobile
- Boost Mobile
- TRACFONE
- Jitterbug
- Kajeet

**Unlicensed Users**
Hot Spots (Home, Retail, Commercial)
- Bluetooth
- WiFi

**Other Spectrum Users**
Broadcasters, Satellite, Defense, Public Safety
- INAB
- SIA
- Department of Defense
The U.S. Government uses a majority of the available radio spectrum between 174 MHz and 4.2 GHz.

Source: CTIA
Spectrum: The U.S. Spectrum Squeeze

Source: CTIA Research, Merrill Lynch Global Wireless Matrix, 2Q 2009
Data Factoid: Mobile Traffic ....The “X” Factor

AT&T
50x Mobile Data Traffic Increase in Past 3 Years

AT&T Mobile Data Traffic Growth, CQ2:06 – CQ2:09

Source: Rob Atkinson, ITIF.
Data: **Apps**

**Skyrocketing Apps:**
- Available: 300,000 (Only 130,000 in 2009)
- Downloads: 6 Billion

**Apps for Everything**
- Books
- Business & Productivity
- Education
- Entertainment
- Finance
- Games
- Gov 2.0
- Healthcare & Fitness
- Music
- Navigation
- News
- Social Networking
- Sports

**Def:** *Applications (Apps)*, Any third-party software that can run on wireless devices. (See Glossary pg 13)
Def: Air Interface, The operating system of a wireless network e.g. CDMA, GSM (See Glossary pg 16)
Analog systems transmit a replica of the original sound waves.

Digital systems convert sound to binary code for transmission.
Understanding Air Interfaces?

Advanced Mobile Phone Service (AMPS): Original Cell Phone Licensees

Global Systems for Mobile Communications (GSM): AT&T, GCI Wireless, T-Mobile

Code Division Multiple Access (CDMA): Cellular South, MetroPCS, Sprint, US Cellular, Verizon Wireless

Orthogonal Frequency-Division Multiplexing (OFDM): Sprint / ClearWire
Air Interface: What does that mean...really?

Sources: Rob Atkinson, ITIF
Faster Speeds allows for more Convergence

Mobile Banking

Communication

Mobile Learning

Mobile Health
Air Interface: Another Way to Think About It…The Evolution of Network Capabilities

1G
- VOICE
- SHORT MESSAGE SERVICE (SMS)
- E-MAIL
- GPS-BASED SERVICES

2G
- TAKE AND SEND PICTURES
- WEB-BROWSING
- MOBILE GAMES

2.5G
- STREAMING VIDEO / RADIO
- MOBILE APP STORES
- ADVANCED GAMING
- TELEMEDICINE (IMAGING AND MONITORING)

3G
- *SIGNIFICANTLY ADVANCED SPEEDS FOR ALL MOBILE APPLICATIONS*

4G
Handsets: “Brick” to Broadband...Innovation

- Voice Only;
- Text Only (E-Mail, Pagers); or
- Early Internet
- Voice + Text;
- Text + Voice; or
- Wired Internet or Wi-Fi
- Voice + Text + Camera; or
- Wireless Internet Only
- Internet, SocNets Apps;
- Music, Games, Video; and
- Wireless Broadband services: Gov 2.0, public safety, mLearning. Etc.

Image Source: BlackBerry®; CTIA; HTC; Modem Image taken by Douglas Whitaker posted to Wikipedia.org; Motorola; Samsung.
High-Speed Wireless Coverage Factoid:

According to the FCC, as of November 2008:

- **98.1%** of the U.S. population (>279.7 million) lived in census blocks with **one or more** mobile broadband providers.

- **89.5%** of the U.S. population (>255.1 million) lived in census blocks with **two or more** mobile broadband providers.

- **76.1%** of the U.S. population (>217.0 million) lived in census blocks with **three or more** mobile broadband providers.

- **58%** of the U.S. population (>165.3 million) lived in census blocks with **four or more** mobile broadband providers.
WiMax Attributes

- Comparable to Wi-Fi®, but instead of for last 100 ft, for last mile
- Coverage – up to 31 sq. miles
- Speed – up to 75 Mb/s (real world ~9 Mb/s)
- Available Today

Def: WiMax, a wireless technology providing wide area connectivity for fixed wireless access at broadband speeds (See Glossary pg 3)

LTE Attributes

- Similar to WiMax
- Faster download, upload and lower latency under most conditions
- Worldwide roaming
- Expected Deployment 2011

Def: LTE, Designated standard for 3G services designed for increased speeds and capacity (See Glossary pg 3)
Air Interface: WiMax Coverage Map (Clearwire)

Source: Rob Atkinson, ITIF
Air Interface: LTE Coverage Map

Carriers Announcing LTE Commitments:

• AT&T
• Cox Communications
• T-Mobile
• U.S. Cellular
• Verizon Wireless
**Def:** Cloud Computing, An Internet-based or intranet-based computing environment where resources are distributed across the network (i.e., the “cloud). (See Glossary pg 4)
CHAPTER 4
Wireless 101: Towers & Network

• Cell Site
  – Tower Placement (Radio Propagation)
  – Another Way to Look at It…Original Wireless Networks
  – Another Way to Look at It…Today’s Cell Networks

• Handoff

• Mobile Switching Center: Backhaul
  – Case Study: Smart Grid
  – Case Study: Mobile Banking (Western Union)

• Continuous Investment
When you physically move from one point to another, the **signal strength** of transmissions back to the **cell site’s tower** begins to decline.

The cell site equipment notifies a computer called the **Mobile Switching Center (MSC)** that the signal is getting weaker.

The MSC then orchestrates the passing of the call from one cell site to another.

**Def:** Handoff

**Def:** Mobile Switching Center, a regional “hub” of network infrastructure where servers connect elements of the network. (See Glossary, pg 12)
Def: *Backhaul*, the transmission of network traffic from a cell site to the mobile switching center. (See Glossary pg 9)
Handset -> Spectrum -> Network -> Tower

Image Sources: CTIA; HTC, Motorola.
Cell Sites

- **Grid**: Area of Wireless Coverage
- **Cells**: Divide grid among a few city blocks or up to 250 square miles
- **Site**: Location of cell which includes a tower.
"Dead spots" can be caused by trees, tall buildings or other obstructions that block your wireless signal from reaching a nearby antenna.

Propagation improves and reduces "dead spots by adding cell sties or placing cell sites at the highest point.

**Def:** Propagation, The ability of radio signal travels across space and through objects. (See Glossary pg 12)
Original Design for Wireless Networks

- Tall Towers
  - √ Over 200 Feet
- High Power Emissions
- Inadequate Coverage
  - √ 30 Mile Radius
- Few Radio Channels
  - √ Interference
- Poor Service
  - √ Unhappy Customers

Radius = 30 miles
Today’s *Cell* Networks

- **Short Towers**
  - √ Under 200 Feet

- **Low Power Emissions**

- **Adequate Coverage**
  - √ 10 Mile Radius

- **Many Radio Channels**
  - √ Simultaneous Use

- **Improved Service**
  - √ Happier Customers
Towers & Infrastructure: Continuous Investment

Thousands

$0

$50,000,000

$100,000,000

$150,000,000

$200,000,000

$250,000,000

$300,000,000

Dec-85 $911,167
Dec-86 $1,436,753
Dec-87 $2,234,635
Dec-88 $3,548,105
Dec-89 $4,480,142
Dec-90 $6,281,596
Dec-91 $8,671,544
Dec-92 $11,262,070
Dec-93 $13,956,366
Dec-94 $18,938,678
Dec-95 $24,080,467
Dec-96 $32,573,522
Dec-97 $46,057,910
Dec-98 $60,542,774
Dec-99 $71,264,865
Dec-00 $89,624,387
Dec-01 $105,530,101
Dec-02 $126,922,347
Dec-03 $145,663,507
Dec-04 $172,789,507
Dec-05 $223,449,194
Dec-06 $244,591,206
Dec-07 $264,760,517
Dec-08 $285,121,591

Source: CTIA Semi-Annual Wireless Survey
National Broadband Plan: **Infrastructure Factoid**

- **Infrastructure**
  - “Shot Clock”
  - More uniform access to poles
  - “Dig Once”
  - Access to Government Property

- **Inter-carrier Compensation**

- **Universel Service Reform**
**Mobile Switching Center**

**TWO CASE STUDIES**

*Def: Mobile Switching Center,* a regional “hub” of network infrastructure where servers connect elements of the network. (See Glossary, pg 12)
Mobile Switching Center: Case Study Smart Grid

- **Smart Grid**: The integration of information and communication applications with the electric power grid.
- **Consumers** can monitor/adjust usage of appliances, and electricity via wireless device.
- **Utilities** can detect outages and establish real-time demand response solutions through wireless platforms.
- **Commercial wireless networks** can transfer all Smart Grid information.
- **$3.4 Billion** in U.S. stimulus funds announced for 100 smart grid projects in October 2009.
Mobile Switching Center: Case Study – Mobile Banking

The Western Union® mobile money transfer program allows consumers with an additional option to send and receive funds how, where and when they want.

Cash to Mobile: Send cash by identifying the recipients mobile number.

Mobile to Cash: Send cash using mobile-enable account; the recipient is notified of funds arrival by text message.

Mobile to Mobile: Send funds between mobile-enabled accounts. Funds may be added to recipients account balance.

All this information requires working with the network operator to transfer through MSC.
CHAPTER 5
Wireless 101: Consumer Services

• Voice Calls
  – E-9-1-1
  – Network Management

• Text Messaging
  – The Network Difference
  – mCommerce (UPS)
  – mGiving (Haiti)

• Data
  – Expanding Array of Devices & Services
  – Traffic Explosion
    • Why does traffic matter?
  – New Business Models
  – Apps

• Measuring Consumer Value
Established connection between two or more users.

Requires continuous transmission to maintain connection.

Ancillary Services:
• Voice Mail
• Caller ID
• Ringtones
Voice Calls: E-9-1-1

• All Calls to 9-1-1 from a cell phone are routed to the appropriate Public Safety Answering Point (PSAP).

• Enhanced 9-1-1
  • Automatic Number Information (ANI)
  • Automatic Location Information (ALI)

• Location Accuracy
  • Radio Propagation Implications
  • Phase II PSAP Required

• E-9-1-1 calling requires careful network management to establish, route and provide additional information.
Voice Calls Factoid: Network Management

- The underlying network infrastructure, which is spectrum-dependent, and the inherently mobile nature of wireless makes these networks significantly different from wired networks.
  - The capacity of a wireless cell site is shared between all users in that cell.
  - The capacity of a cell is shared between all services running over the network.
- Spectrum-based services such as mobile require careful management of scare network resources.
Presidential Inauguration

Source: White House Flickr Stream
Natural Disaster

Aftermath of Hurricane Katrina

No Amount of Steel or Redundancy Can Guarantee Communications
COWS = Cells on Wheels
Text Communications: *The Network Difference*

Each of the different forms of communications interacts with a different portion of a wireless network.

- **Cell Phone:** Voice, E-Mail or SMS
- **Cell Site:** Base Station sorts the type of communications
- **Gateway Voice Server**
- **Gateway E-Mail Server**
- **Gateway SMS Server**
- **Other Carriers, Public Telephone Network, Internet, etc.**
# Text Communications

<table>
<thead>
<tr>
<th></th>
<th>Text Messaging</th>
<th>Multimedia Messaging</th>
<th>Instant Messaging</th>
<th>Social Networking</th>
<th>E-mail</th>
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<tbody>
<tr>
<td><strong>Service is Also Known As:</strong></td>
<td>“SMS”</td>
<td>“MMS”</td>
<td>“IM”</td>
<td>Facebook</td>
<td></td>
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<td></td>
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<td></td>
<td>Myspace</td>
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<td></td>
<td></td>
<td></td>
<td>Twitter</td>
<td></td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Send short, text-only messages quickly</td>
<td>Include pictures, video or music</td>
<td>Carry on an informal “conversation”</td>
<td>Post messages to one or all of my friends</td>
<td>Like writing a letter only electronic</td>
</tr>
<tr>
<td><strong>Character Limit (English)</strong></td>
<td>160 characters</td>
<td>Depends on formatting</td>
<td>Depends on formatting</td>
<td>Twitter: 140</td>
<td>none</td>
</tr>
</tbody>
</table>

**Note:** Texting services may be charged separately from voice or data services on wireless phone bills.
Text Communications: *Case Study mCommerce*

**UPS Mobile via SMS**

- Track delivery status
- Schedule Pick Up
- Quotes for Rates and Travel Time
- E-mail shipping label
- Find UPS Locations
Data: Expanding Array of Devices and Services

21st Century Wireless technology ....not just for talking and texting!!!!
Data: New Business Models

Source: Rob Atkinson, ITIF; http://www.usatoday.com/mobile/index.htm; AT&T Mobile 2D Bar Codes; http://static.businessinsider.com/image/4b9f133c7f8b9a2e0ed80600-400-300/zipcar-rental-car.jpg.
**Text Communications: Mobile Giving**

2005 (Hurricane Katrina) - The Wireless Foundation and the American Red Cross start **Text2Help** which raised $120,000 from the generosity of mobile consumers.

2008 (Hurricane Gustav) - **Text2Help** raised approximately $250,000.

2009 - Alicia Keys and the Keep a Child Alive campaign raised approximately $450,000.

2010 (Haiti Earthquake) - More than 2 million people raised more than **$32 million** via text for the American Red Cross’s relief efforts.
Def: **ARPU**, the average revenue generated per customer per month (See Glossary pg 6)

Def: **MOU**, minutes of use is a measure of customer talk time (See Glossary pg 7)
The Wireless Revolution is NOW…

Jobs  Competitive  Social Media  Smart Grids
Spectrum  Remote Monitoring  National Framework  Intelligent Transportation
Tax Reform  Text  Gov 2.0  Innovation  mHealth
Community Investment  Gov 2.0  Innovation  mHealth
Emergency Alerts  Towers  mCommerce  Netbooks
Gov 2.0  Innovation  mHealth  MyWireless
Mobile  Telecommuting  Gov 2.0  Innovation  mHealth
Music  Telecommuting  Gov 2.0  Innovation  mHealth
Energy Efficiency  Rural Adoption  Accessibility  MyWireless
Preventative Care  Rural Adoption  Accessibility  MyWireless
Campaign 2.0  Rural Adoption  Accessibility  MyWireless
600+ Unique Handsets  Rural Adoption  Accessibility  MyWireless
Camera  Rural Adoption  Accessibility  MyWireless
Carrier Partners  Rural Adoption  Accessibility  MyWireless
E9-1-1  Rural Adoption  Accessibility  MyWireless
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