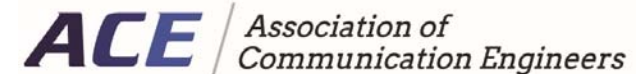


Wireless Access Network Update

2016 ACE/RUS
School and Symposium

Presented by:

Engineering Associates, LLC.



Wireless Access Network Update

- Spectrum and Bandwidth
- LTE in 5 MHz + 5 MHz block
- Cost Structure
- Hosted Solutions

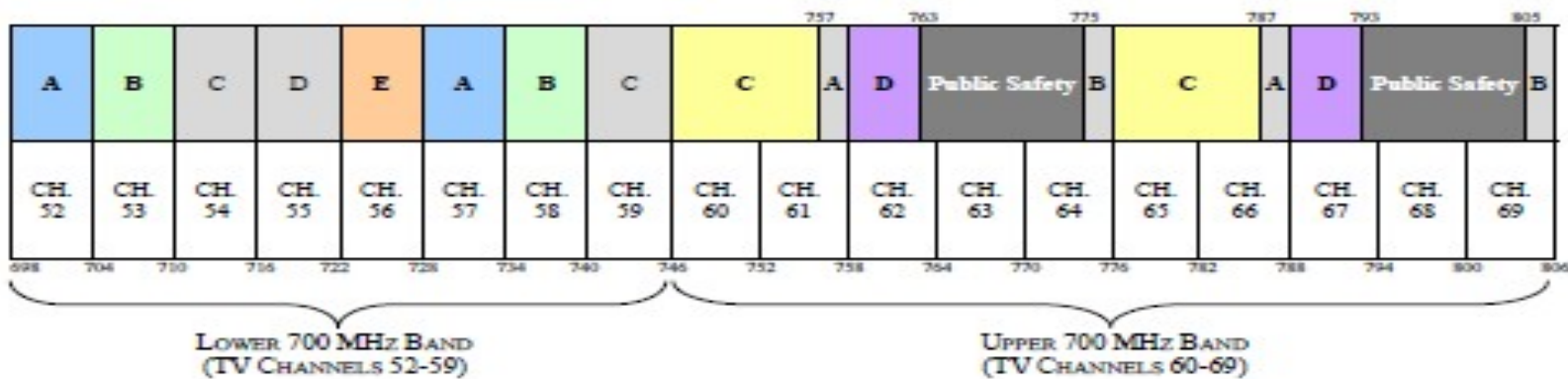
Wireless Network Design Criteria

- Which Spectrum is Available?
- What is Population Density?
- Applications - Fixed Solution vs. Mobility?
- CPE – USB Desktop, Dongle, or Handsets
- What Backhaul Options are Available?
- Product Availability and Number of Vendor Options?
- Ensure Design Reflects Goals for Geographic Coverage and Broadband Speed?

700 MHz Band Plan

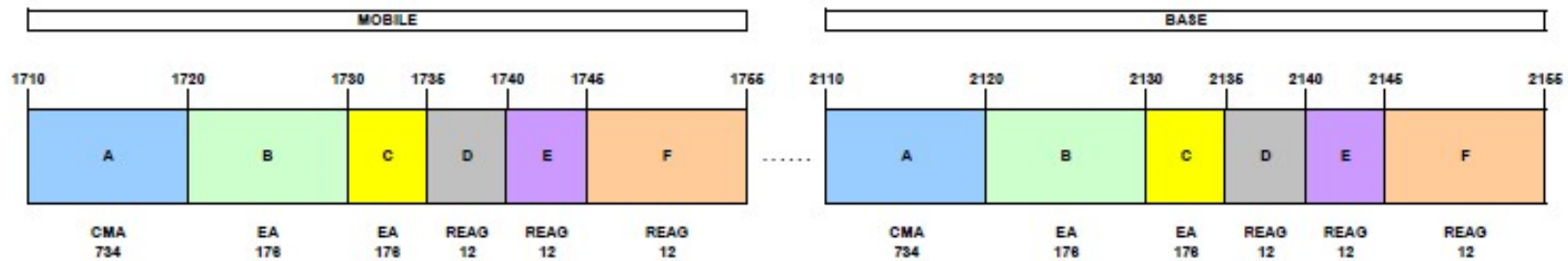
700 MHz – Lower Band 48 MHz; Upper Band 60 MHz

Most Blocks are 6 MHz, Allowing 5 MHz LTE Carrier

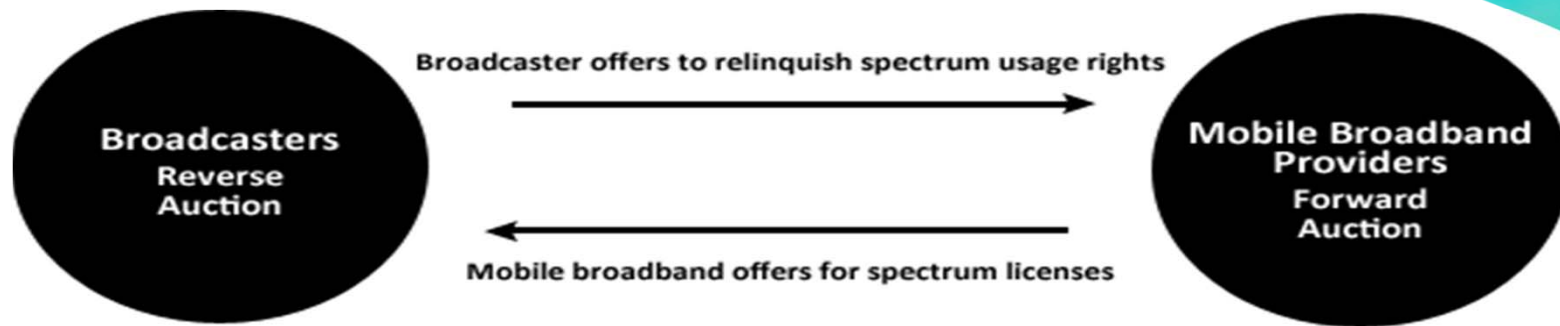


AWS Band Plan

AWS – Advanced Wireless Service; 1.7 GHz; 2.1 GHz
Blocks are 6 or 10 MHz, Allowing 5 or 10 MHz LTE Carrier



600 MHz Incentive Auction



“a reverse auction, which will determine the price at which broadcasters will voluntarily relinquish their spectrum usage rights”

“a forward auction, which will determine the price companies are willing to pay for flexible use wireless licenses.”

Information Courtesy of WWW.FCC.GOV

600 MHz Incentive Auction

“The 600 MHz band plan adopted by the Commission maximizes the value of spectrum to potential bidders and provides both larger and smaller bidders a fair opportunity to acquire spectrum.”

“Specifically the band plan consists of paired uplink and downlink bands (which enables two-way communications), offered in **5+5 megahertz blocks** across 416 market areas called Partial Economic Areas ("PEA").”

Information Courtesy of WWW.FCC.GOV

Technology Considerations

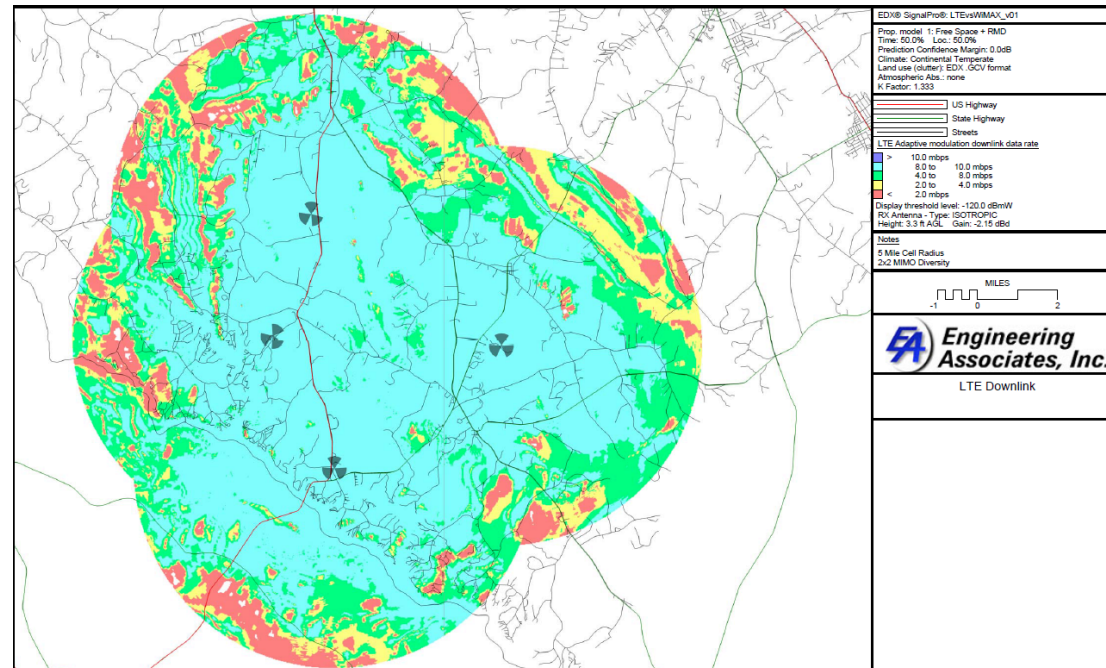
Historically:

- 700 MHz is Fundamental Design Based Upon Coverage; However, Bandwidth is Limited
- Reserve 700 MHz for Rural Areas that Require More Reach but Serves Fewer Subscribers
- Use AWS, BRS, or PCS for Capacity in Populated Areas with Shorter Reach

600 MHz Incentive Auction:

- Coverage should be similar to 700 MHz and capacity will depend on Spectrum Bandwidth available.

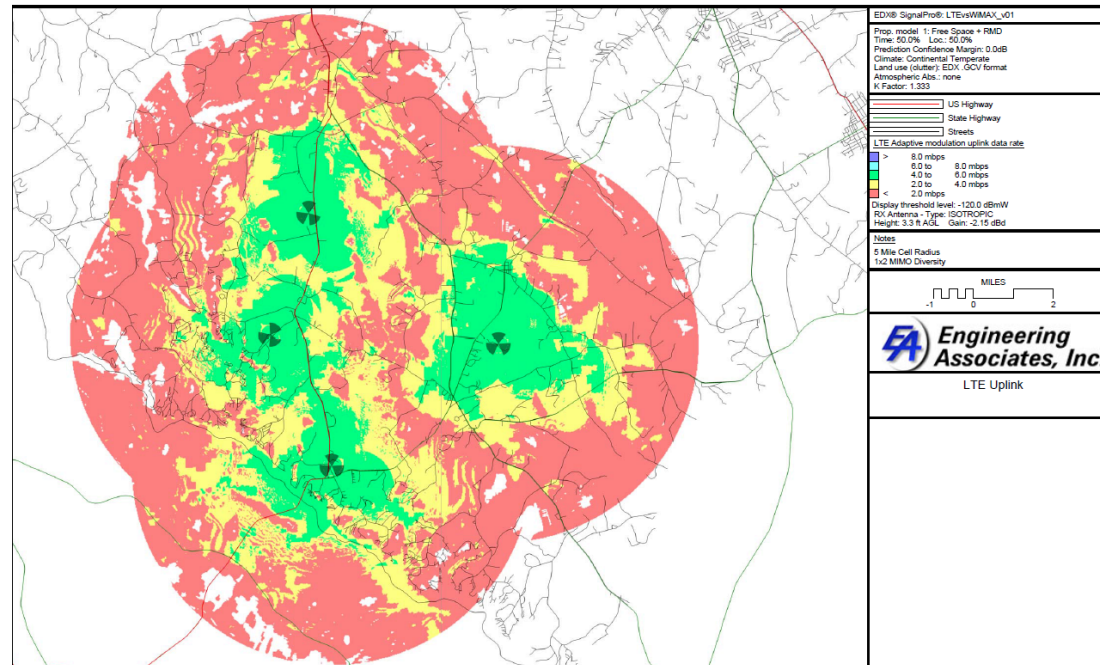
LTE Coverage Maps



LTE Downlink (USB Dongle) 2Mbps to 8Mbps

Four Towers with Five Mile Radius; Roughly 16 Miles x 16 Miles

LTE Coverage Maps



LTE Uplink (USB Dongle) 2Mbps to 6Mbps

Four Towers with Five Mile Radius; Roughly 16 Miles x 16 Miles

Bandwidth Efficiency

700 MHz	LTE
Available Licensed Bandwidth (MHz)	6 + 6
Usable Bandwidth (MHz)	5 + 5
Spectral efficiency, downlink (bps/Hz)	1.67
Spectral efficiency, uplink (bps/Hz)	0.89
Average Throughput per 3-sector site, downlink (Mbps)	25.05
Average Throughput per 3-sector site, uplink (Mbps)	13.35
Loading Factor, downlink	70%
Loading Factor, uplink	60%

** Performance data is averaged from various vendors' claims as of 2011.*

Subscriber Traffic Model

700 MHz	LTE
Traffic per Subscriber per Month (GB)	30
Downlink Traffic (%)	70%
Uplink Traffic (%)	30%
Hours in the Busy Period per Day	4
Percent of Daily Traffic Carried in Busy Period	25%
Downlink Busy Hour Traffic per Subscriber	97 kbps
Uplink Busy Hour Traffic per Subscriber	42 kbps
Subscribers Supported per Sector	60
Subscribers Supported per Base Station (3 sectors)	180

** Performance data is averaged from various vendors' claims as of 2011.*

Estimate of Investment

700 MHz	LTE
Access Network	
3-Sector Single-5MHz-Carrier Macro Cell	\$55,000
Investment per Subscriber	\$306
Core Network	
Broadband Data-Only Core Network	\$3,000,000
Incremental for VoIP Core Network	\$1,400,000
CPE Terminals	
Desktop/Fixed CPE	\$395
USB Dongle	\$200

** Performance data is averaged from various vendors' claims as of 2011.*

Pricing- Example Network #1

700 MHz	LTE
Base Stations	50
Subscribers Supported	9000
Total Investment	\$9,827,500
Investment per Subscriber	\$1,092

** Performance data is averaged from various vendors' claims as of 2011.*

Pricing- Example Network #2

700 MHz	LTE
Base Stations	100
Subscribers Supported	18,000
Total Investment	\$15,255,000
Investment per Subscriber	\$848

** Performance data is averaged from various vendors' claims as of 2011.*

Pricing-

Example Network #3

700 MHz	LTE
Base Stations	200
Subscribers Supported	36,000
Total Investment	\$26,110,000
Investment per Subscriber	\$725

** Performance data is averaged from various vendors' claims as of 2011.*

Core Design

- Design Core Network Based Upon Projected Number of Subscribers and Bandwidth Requirements
- Is VoIP Required or Data Only?
- Ancillary/OEM Solutions Needed
 - Billing
 - Network Management,
 - Subscriber Provisioning
 - Regulatory (E911, CALEA)
- Identify Existing Equipment Required to Interface
- Evaluate Building Feasibility Related to Redundant Backhaul Facilities, Security, and Back-up Power

Hosted Solution

When evaluating a Hosted Solution consider the following:

- Operations – Business Philosophy, Day-to-Day Management, Marketing, Billing and other services provided
- Governance – Contracts, Board makeup, Voting Rights
- Technology - LTE solutions, Backhaul, Software and Hardware requirements
- Financials – Capital Costs, Operational Costs, Cost to change

Hosted Solution Experience

Virginia Telephone Co-op

South Carolina Telephone Co-op

Thank You

Engineering Associates, LLC

1220 Old Alpharetta Road, Suite 380
Alpharetta, Georgia 30005
(678) 455-7266
www.engineeringassociates.com

