Air Force Cost Analysis Agency

Army Cost & Economics

I Need Your Cost Estimate for a 10 Year Project…

by Next Week

A Case Study in Broad System Analysis:

DoD Spectrum Reallocation

Feasibility Study, 1755-1850 MHz

Presented at the 2012 SCEA/ISPA Joint Annual Conference and Training Workshop - www.iceaaonline.com

Momentum From Industry & Response from Government

The wireless industry is putting pressure on the federal government to make more spectrum available. An example of the advertising campaign by the CTIA (Cellular Telecommunications Industrial Association) follows:

http://www.ctia.org/media/index.cfm/AID/12071
(view video segment)

Presidential Memo June 2010 directed Dept of Commerce (NTIA) to Collaborate with the FCC to

- meet 500 MHz requirement
- develop a specific Plan and Timetable

Public Release of Results

- All the quantitative information for this report comes from either:
  - Department of Commerce (DoC) report: An Assessment of the Viability of Accommodating Wireless Broadband in the 1755-1850 MHz Band, dated 27 Mar 2012, which is available to the public at the following website: www.ntia.doc.gov
  - Other publicly available information (as cited)

- Data contained in the Department of Defense (DoD) reports that formed the basis for the DoC report are currently not approved for public release, and as such are not included in this presentation

Past Wireless Spectrum Auctions

- Auction revenue is driven by:
  - Demographics: Size and makeup of the consumer population in the geographic area affected
  - Amount of contiguous spectrum
  - Propagation characteristics of the band

Auction	Frequency Band (MHz)	Total MHz	Year	Revenue In Billions
PCS	1900	90	1995	$17
PCS	1900	30	1996	$2
AWS1	1700	90	2006	$14
700	700	52	2008	$19

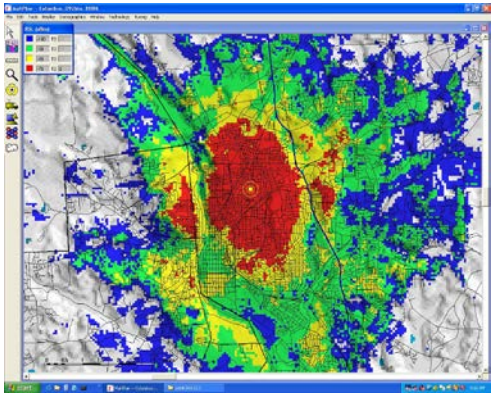
Anticipate approx. $30 B potential revenue from 1755-1850 band based on historical data above

Signal Propagation Characteristics

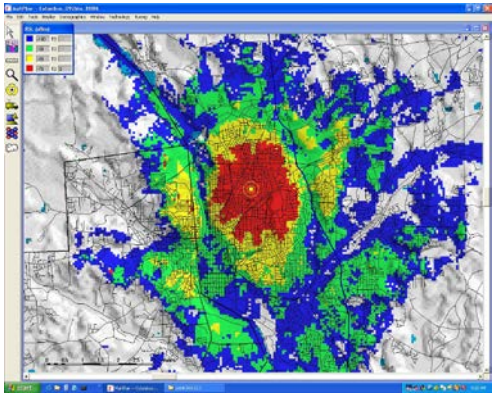
- Signal propagation distance decreases with increasing radio frequency (MHz)
- Signal power density is decreases with distance by the inverse square law: $1/r^2$ (doubling the distance reduces signal power density to 1/4)
- Possible mitigation steps:
  - Directional (Gimbaled) antenna vs. Omni directional antenna
  - Increase antenna height
  - Increase transmission power (Size & Weight impact)

Signal Propagation Example

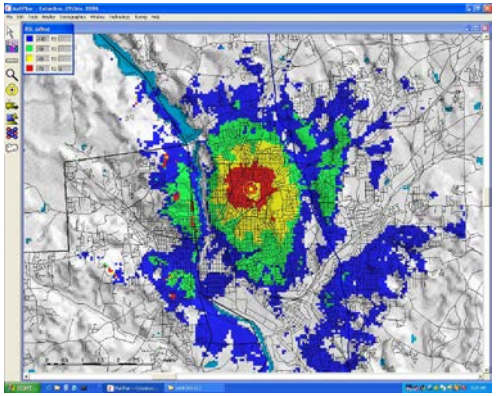
Cell Phone Tower in Columbus Georgia
Constants: 120' tower, 100 W transmission power



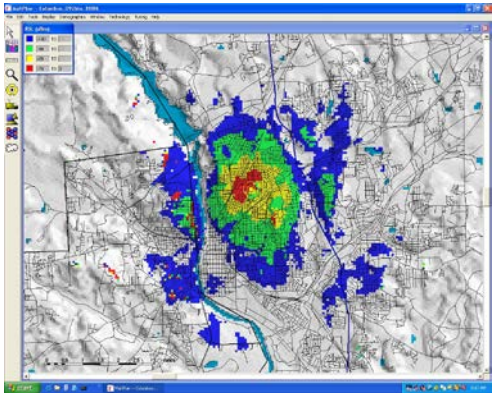
500 MHz



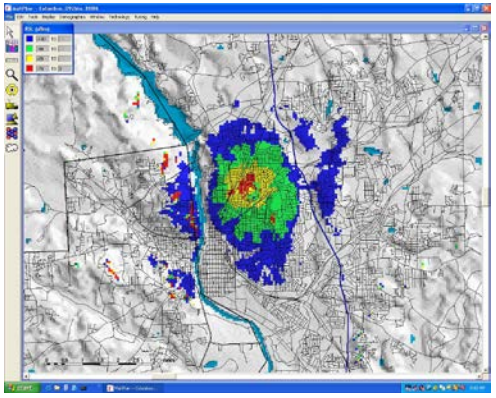
1000 MHz



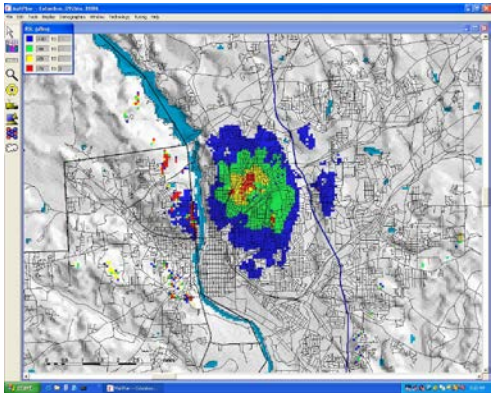
2000 MHz



3000 MHz



4000 MHz



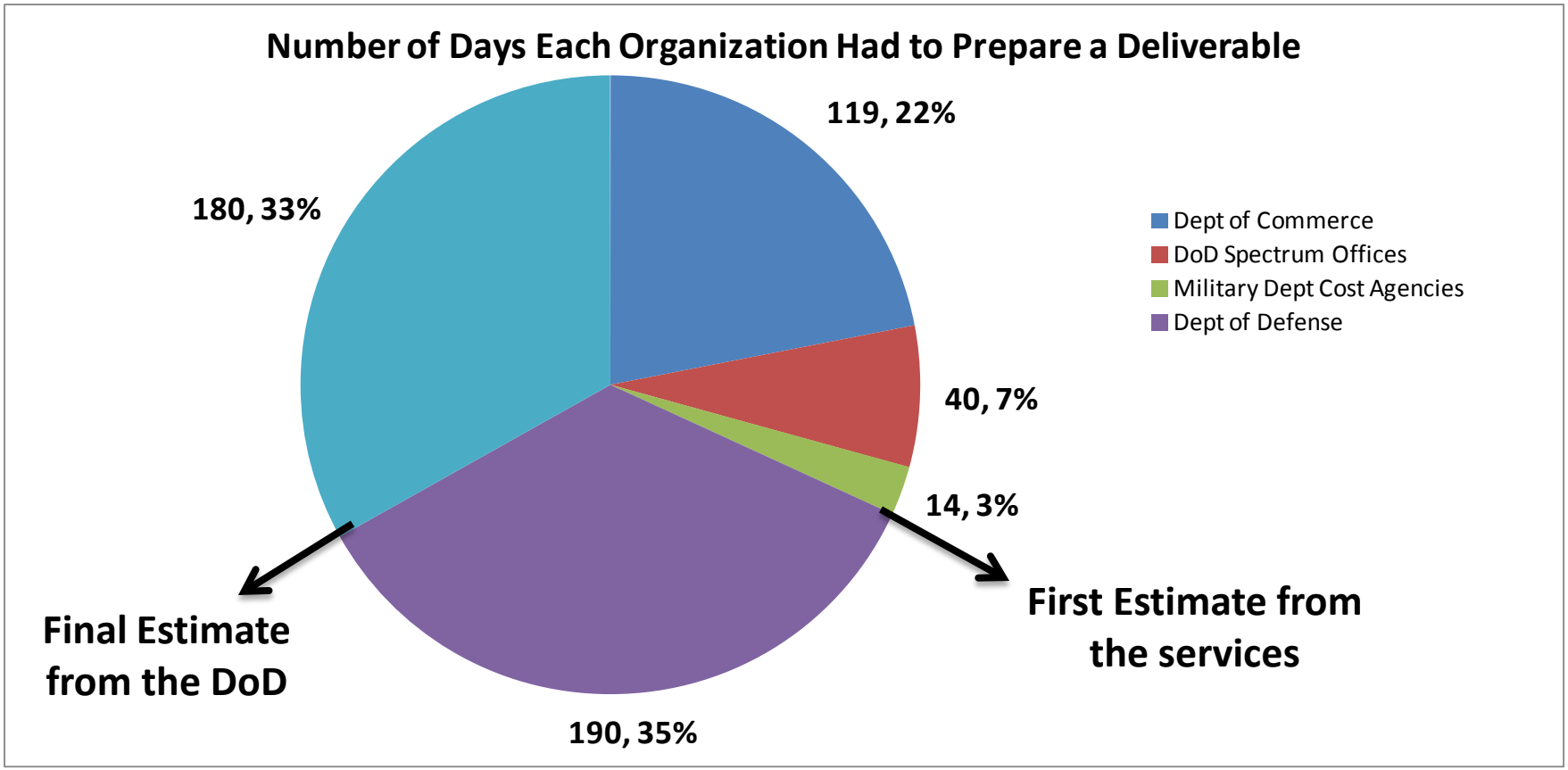
5000 MHz

Estimated Cost to Relocate Federal Operations from 1755-1850 MHz

Operation	Estimated Cost ($M)
Fixed Point-to-Point Microwave	186
Military Tactical Radio Relay	160
Air Combat Training System	4,500
Precision Guided Munitions	518
Tracking, Telemetry, and Commanding	2,350
Aeronautical Mobile Telemetry	3,140
Video Surveillance	5,097
Unmanned Aerial Systems	1,511
Other DOD Systems	364
Total ($M) [See Note]	17,826

Note: This total estimated cost to vacate the entire 1755-1850 MHz band includes the cost to relocate from the 1755-1780 MHz band; it does not include implementation and administration costs for DOD, which it estimates at $272M for vacating the 1755-1850 MHz band.

Challenging Timeline

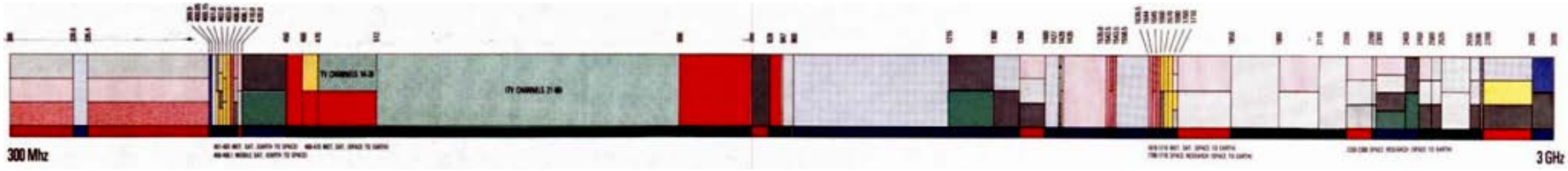


Date	Action	Lead Organization
1-Oct-10	Fast Track Evaluation of Spectrum bands	Dept of Commerce
28-Jan-11	DoC identified 1755-1850 as the first band for analysis	Dept of Commerce
9-Mar-11	Finalize band relocation choices for study	DoD Spectrum Offices
23-Mar-11	Intial estimates due from the military services to DoD	Military Dept Cost Agencies
29-Sep-11	Summary of DoD Relocation Estimates sent to DoC	Dept of Defense
27-Mar-12	DoC releases its report	Dept of Commerce

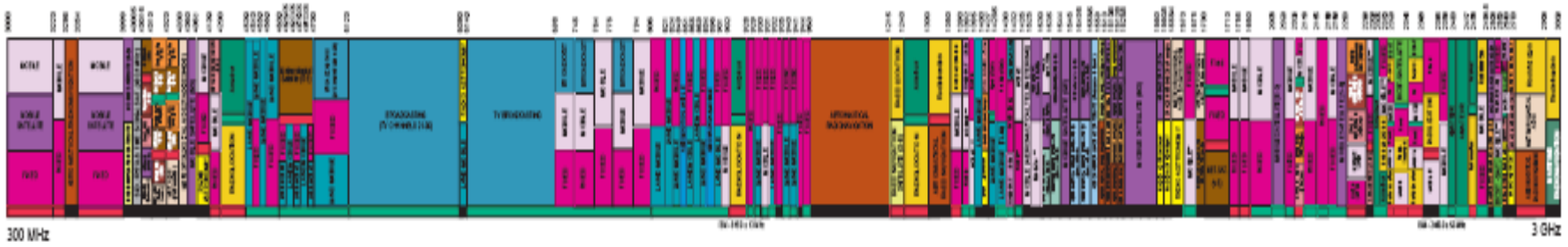
Why Spectrum Management is Becoming a Big Issue:

Increased Number of Devices Using the Spectrum

1975 Table of Frequency Allocations



2011 Table of Frequency Allocations



Increased Bandwidth Requirement of these devices…

Spectrum Requirements for Mobile Broadband

Technology	Year Introduced in the US	Generation	Typical Downlink Speed	Typical Channel Size
Advanced Mobile Phone System (AMPS)	1983	1G - Analog	Voice only. No data	.03 MHz
Ground System Mobile (GSM)	1993	2G - Digital	Voice + Text Messaging	.05 MHz
Enhanced Data rates for GSM Evolution (EDGE)	1999	Pre-3G	.07 -.14 Mbps	.2 MHz
Universal Mobile Telecommunications System (UMTS)	1999	3G	.2 to .3 Mbps	5 MHz
High Speed Packet Access (HSPA+)	2007 (T-Mobile)	4G*	1.9 -8.8 Mbps	5 MHz
Worldwide Interoperability for Microwave Access (WiMAX)	2008 (Clearwire / Sprint Nextel)	4G*	Up to 40 Mbps	20 MHz
Long Term Evolution (LTE)	2010 (Verizon) 2011 (AT&T)	4G*	5.9 - 21.5 Mbps	1.4 -20 MHz
LTE Advanced / WiMAX Update	Not yet introduced	4G	Theoretical up to 1500 Mbps	40 -100 MHz

Higher Speed

Requires

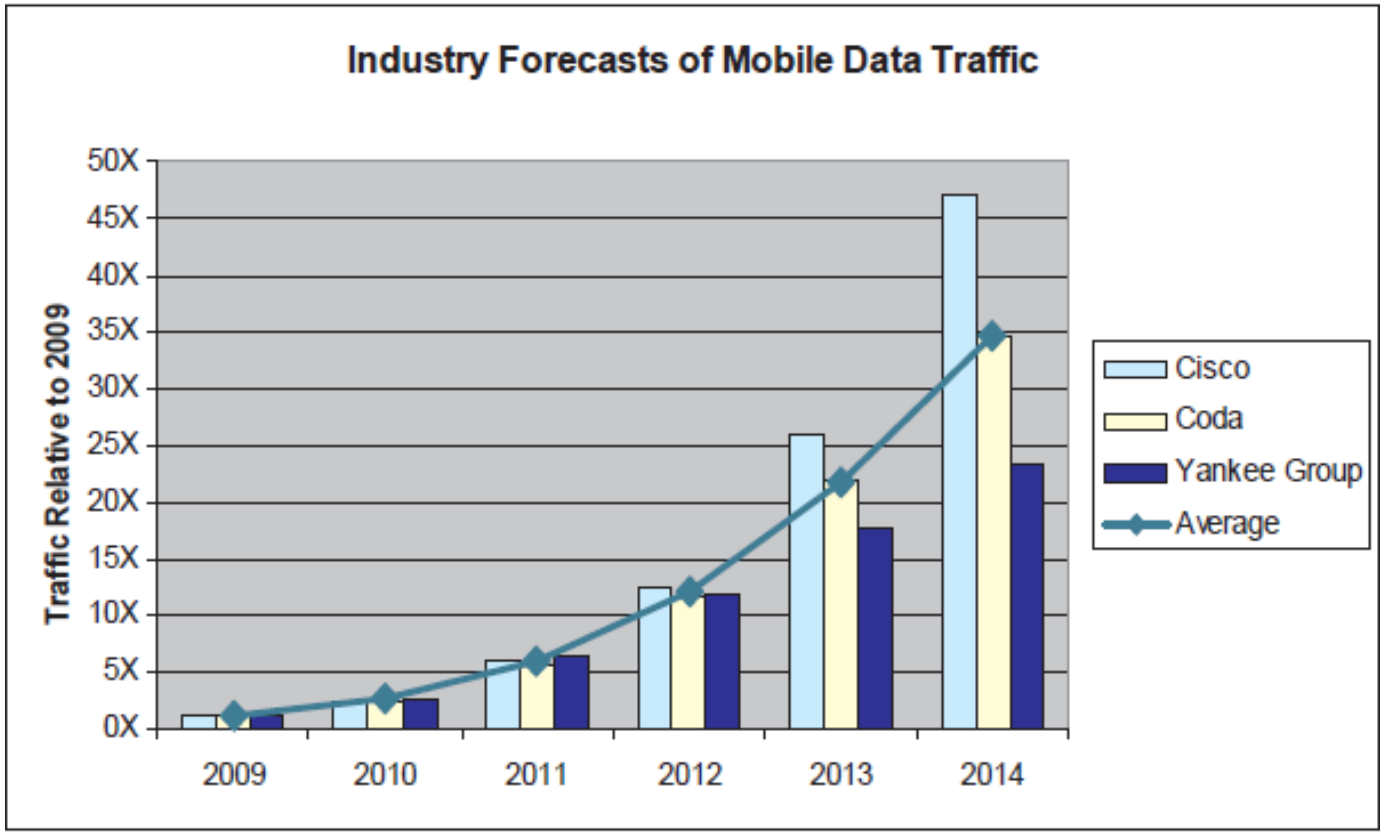
Bigger Channel Size

***Different companies are marketing their technologies as "4G," although they do not yet meet the 100 Mps requirement of the 4G standard for high mobility communications (i.e. – from moving vehicles such as cars)**

Source: 3G Americas, Transition to 4G

Projected Wireless Data Consumption

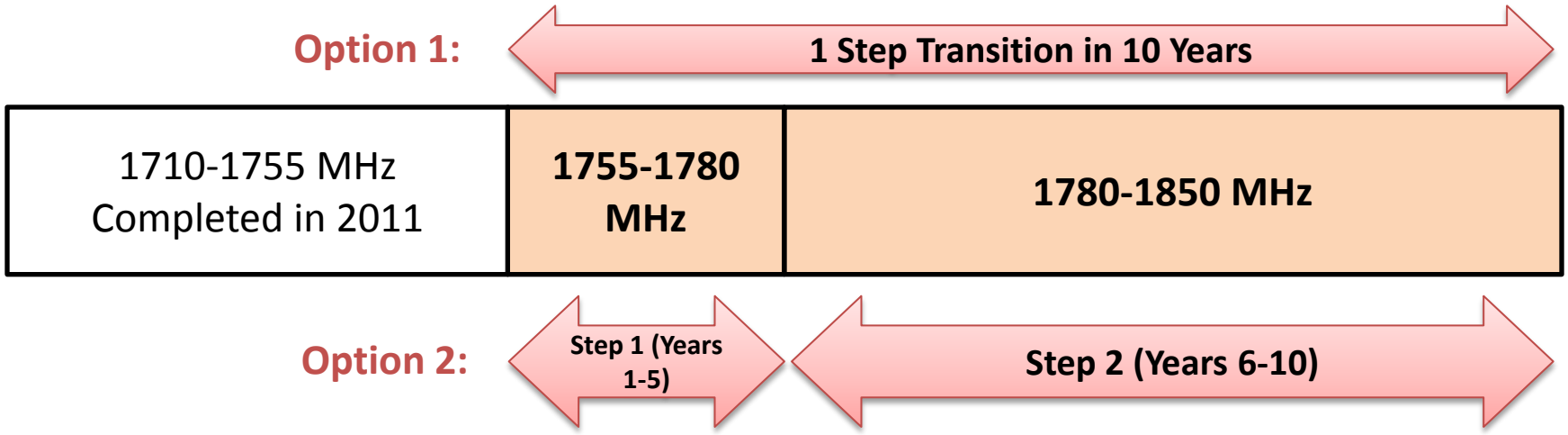
- **Average data consumption projections from three industry analysts show an increase of 35 times from the 2009 levels**



Source: FCC Technical Paper # 6

The Cost Estimating Task

1) Evaluate the feasibility and cost of relocating ***all DOD and Federal systems*** from 1755-1850 MHz in 10 years
2) Evaluate the feasibility and cost of vacating the bottom 25 MHz (1755-1780) in 5 years *as a initial step* towards vacating the entire band

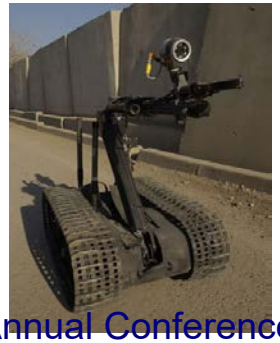


Critical Assumptions:

1) Comparable spectrum will be made available
2) System Relocation proceeds ***after*** receipt of funding

Affected Systems

- Precision Guided Munitions
- Point to Point Microwave Systems
- High Resolution Video
- Land Mobile Robotic Video
- Software Defined Radios
- Electronic Warfare
- Tactical Radio Relay
- Air Combat Training System
- Aeronautical Mobile Telemetry
- Satellite Operations
- Small Unmanned Aerial Systems



General Overview of Cost Approaches

- The cost agencies for each of the military services used a different approach to accomplish the study task
  - Employed the entire skill-set of estimating techniques and knowledge level
  - Initially assumed all capabilities would have to be relocated above 5 GHz as a first cut “worst case” scenario
  - Pros & Cons to each of the various approaches

Army Approach & Techniques

- Initially, due to time constraints, the estimate was based on ROMs from Subject Matter Experts (SMEs), and partially by analogy to data from the 1710-1750 MHZ relocation effort
- A large backlash from DoD occurred when the estimate was significantly higher than what they expected
- As the study progressed, the initial cost analysis was refined by including cost estimates prepared by program offices that used parametric and engineering techniques
- The refined cost estimates gained greater acceptance with assistance from the military operations and acquisition communities

Army Insights & Lessons Learned

- Insights
  - When an initial "rough order of magnitude" estimate is required, it's easier to assume worst case conditions and develop a cost estimate that may be on the high end than to do otherwise
- Lessons Learned
  - Direct input from the users of the systems being estimated (in our case, the warfighter) is essential when defending the estimate

Air Force Approach & Techniques

- Very hands-on, worked closely with affected groups, shared detailed information
  - Met early with operations, acquisition, spectrum, user groups and the cost agency to map-out the issue and determine SMEs
  - Continued to closely coordinate between the smaller SME groups
- Co-developed and/or reviewed estimates with program offices, user groups and acquisition organizations to ensure no gaps
  - Critical as not all AF systems have program offices or formal acquisition support

Air Force Insights & Lessons Learned

- Insights
  - Regular meetings between Service Cost Agencies ensured there was no double-counting or missing Joint service programs
- Lessons Learned
  - Support from Senior Leadership is essential; especially in a time-crunched environment
  - Subordinate commands cannot task their parent organization; task protocol must be observed

Path Forward for Analysis

We Analyzed this:

Small Unmanned Aerial Systems (All Services)

1755-1850 → 2025-2110

High Resolution Video (Army & AF)

1755-1850 → 2025-2110

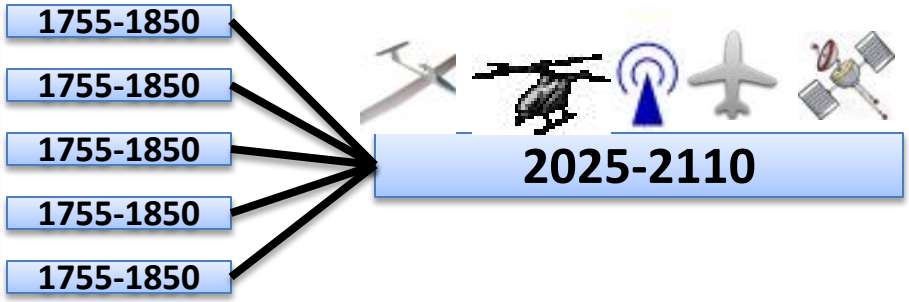
Tactical Radio Relay (Army & Navy)

1755-1850 → 2025-2110 or 2200-2290

Air Combat Training System (AF & Navy)

1755-1850 → 2025-2110

Now we must Analyze:



- **More in-depth analysis is required for the next phase:**
  - **Looking at all systems together**
  - **Re-looking exclusion zones**

- **Joint coordination between technical & program personnel done for each system**
- **Comprehensive analysis of all systems together still needs to be done**
- **OSD and the services will have to commit more resources to the analysis**