



CENTER FOR ADVANCED AVIATION SYSTEM DEVELOPMENT (CAASD)

Clearing a Frequency Subband for Enhanced Aeronautical Communications

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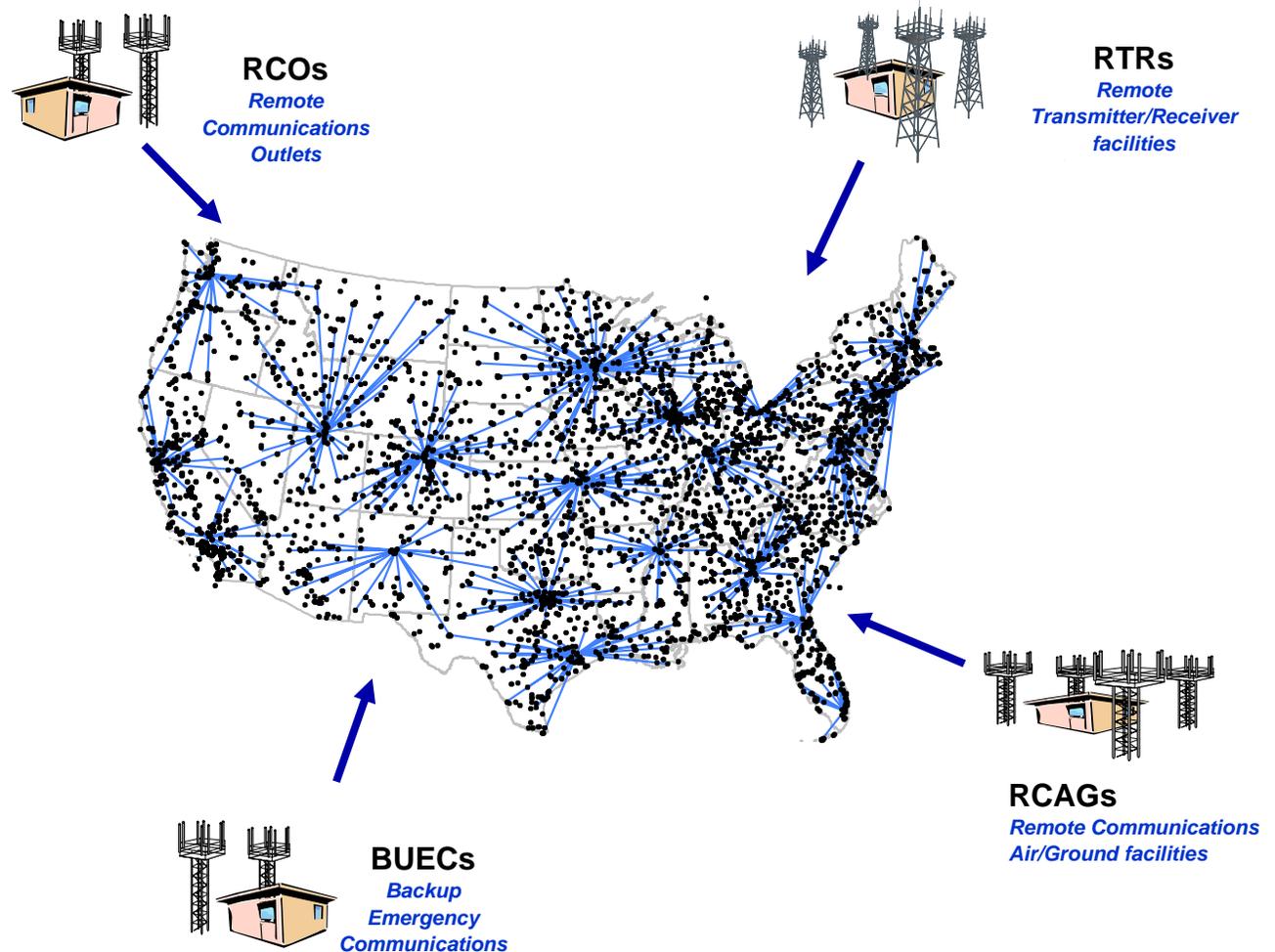
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VHF Air/Ground Radio System for ATS

Today's System:

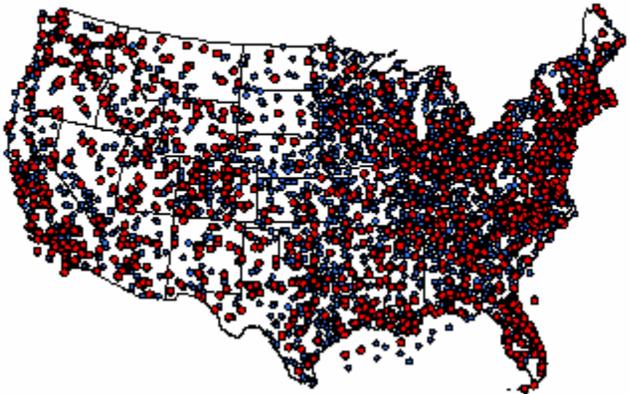
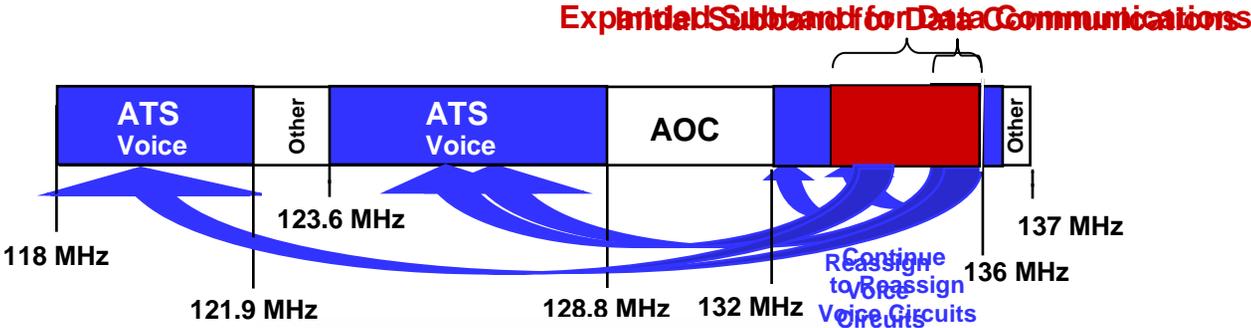
- Carries ATC and uplink broadcast (ULB) messages
- **25AM** architecture (AM analog voice in 25-kHz channels)
- **7,162** frequency-protected circuits
- Uses **516** of 760 channels in 117.975–137 MHz band





Clearing a VHF Subband for an Aeronautical Data Network

Clearing a subband for an aeronautical data network



- ATS voice radios that must migrate out of the cleared subband
 - Retuning costs incurred

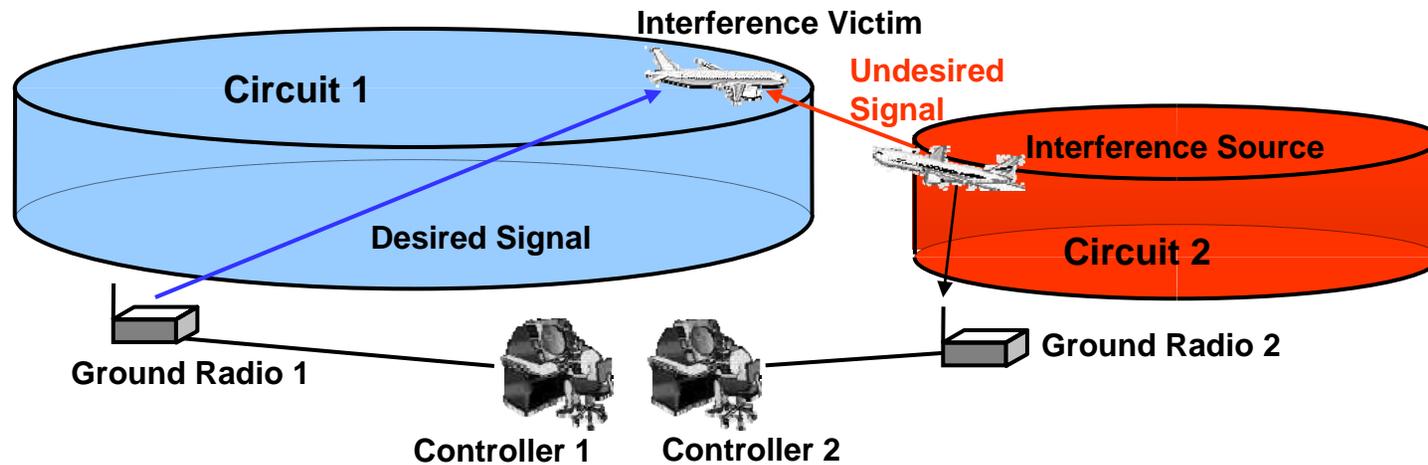


Subband-Clearing Analysis

- **Objective:** Assess the feasibility of creating a contiguous data-communications subband out of the portion of the 117.975 – 137 MHz band currently used by voice ATS circuits
- **Architectural alternatives considered**
 - The voice ATS system remains all 25AM, or
 - The en route voice circuits convert to 8.33-kHz channels but rest of system remains 25AM



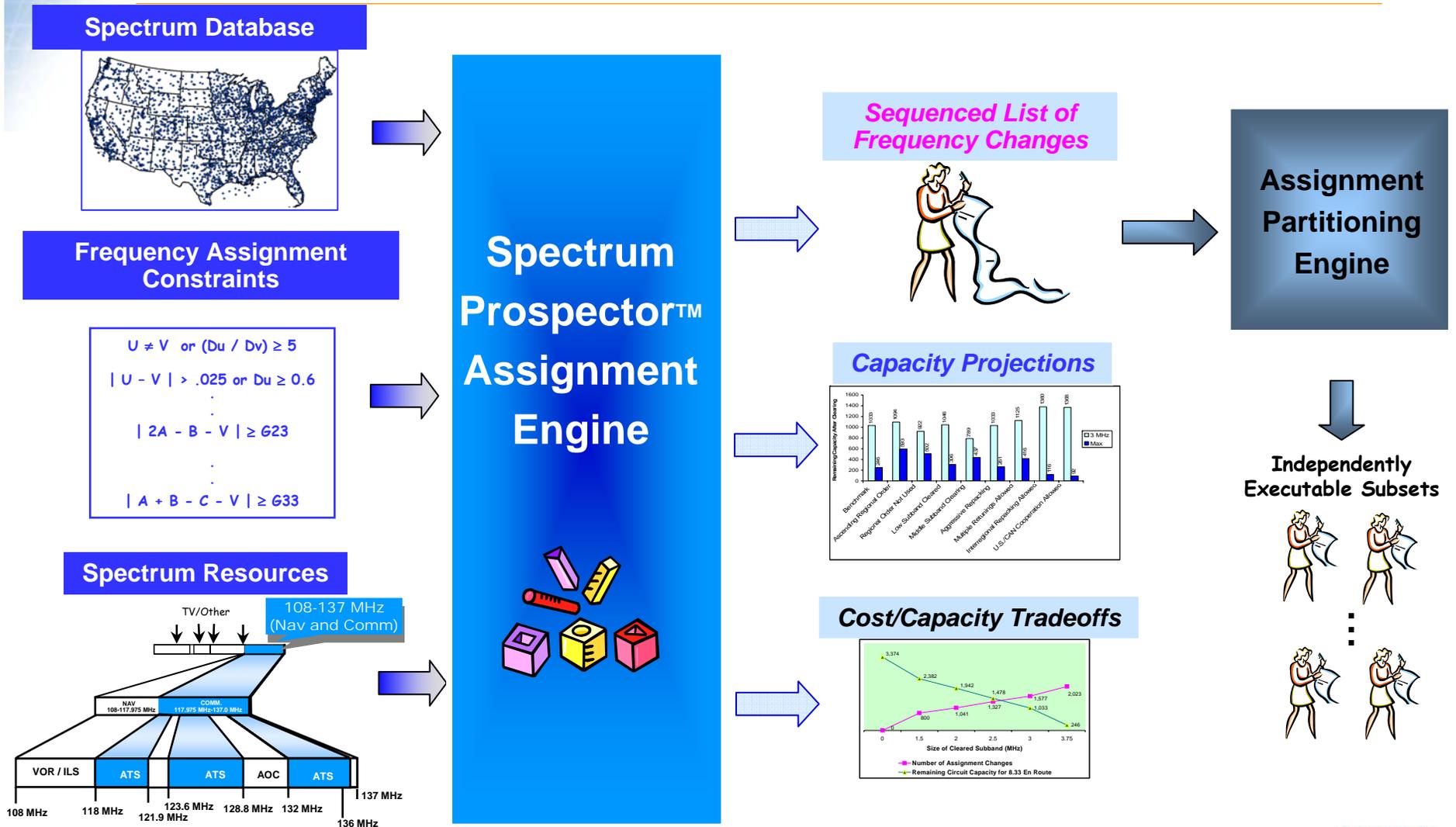
Interference-Prevention Rules



- Mutually visible circuits must use separate channels unless undesired signal travels at least 5 times as far as desired signal
- “Nearby” circuits must stay at least 2 channels apart

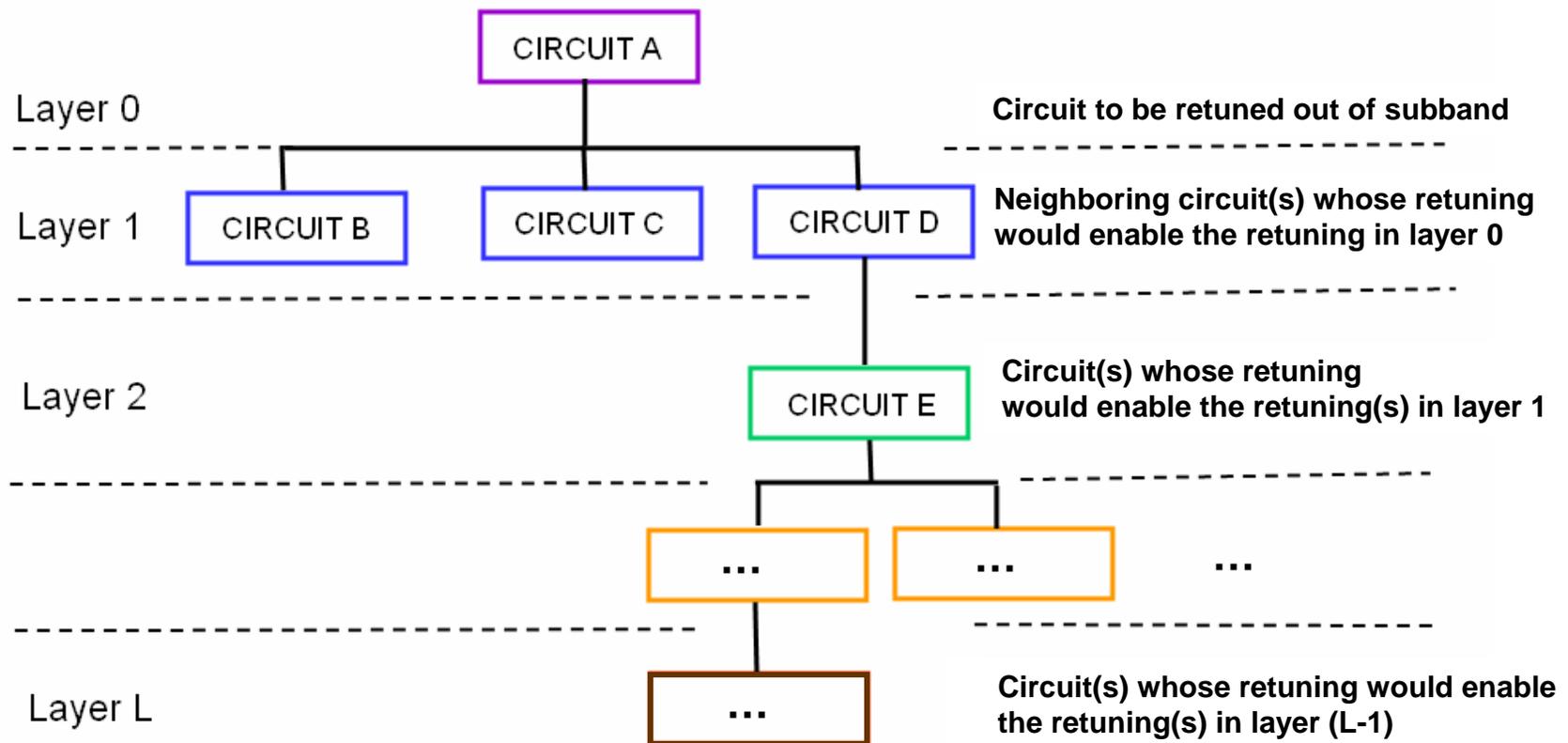


Simulation Methodology





Neighbor-Repacking



Moderate repacking: Up to 2 layers, with up to 6 neighbors retuned

Aggressive repacking: Up to 9 layers, with up to 20 neighbors retuned

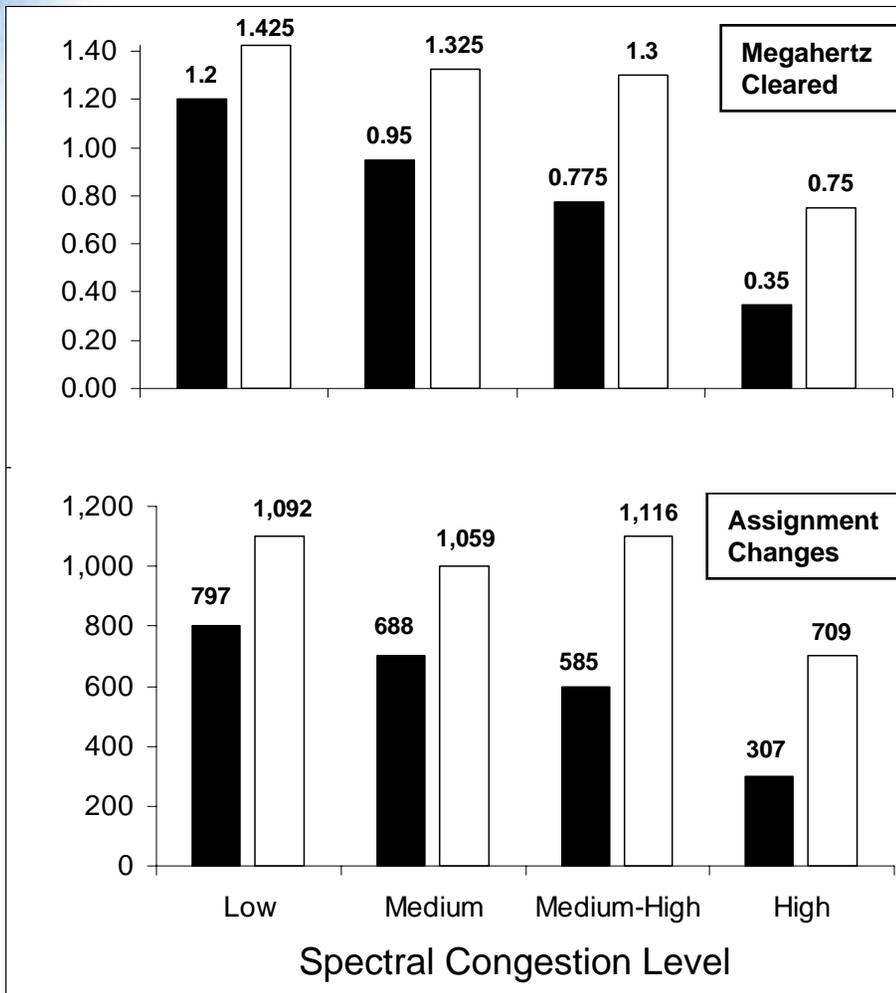


Subband-Clearing in a 25AM System

- **Assumption: ATC circuit population grows as predicted by the FAA Future Demand Study (FDS) for 2005-2015**
- **Approach**
 - **Simulations performed for four different levels of spectral congestion, dependent on**
 - **Geographical distribution of the new FDS en route circuits**
 - **Uniform, or**
 - **Chicago-to-New York Corridor (CNYC) concentration**
 - **ULB (ATIS/AWOS/ASOS) growth**
 - **No new ULB circuits, or**
 - **ULB circuit population continues growing at 1998-2005 rate through 2015**



Results of Subband-Clearing for All-25AM System



Spectral Congestion Level		
	FDS En Route Sectors CNYC-Concentrated	ULB Growth
<i>Low</i>	<i>No</i>	<i>No</i>
<i>Medium</i>	<i>No</i>	<i>Yes</i>
<i>Medium-High</i>	<i>Yes</i>	<i>No</i>
<i>High</i>	<i>Yes</i>	<i>Yes</i>

Geographical concentration of the future en route circuits will heavily influence size of clearable subband below 136 MHz

Aggressive repacking significantly increases subband size

- 9 ■ Moderate Repacking
- Aggressive Repacking



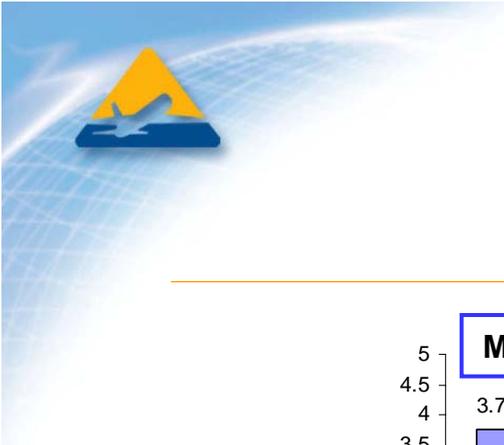
Subband-Clearing in an En Route 8.33 System

Benchmark Assumptions

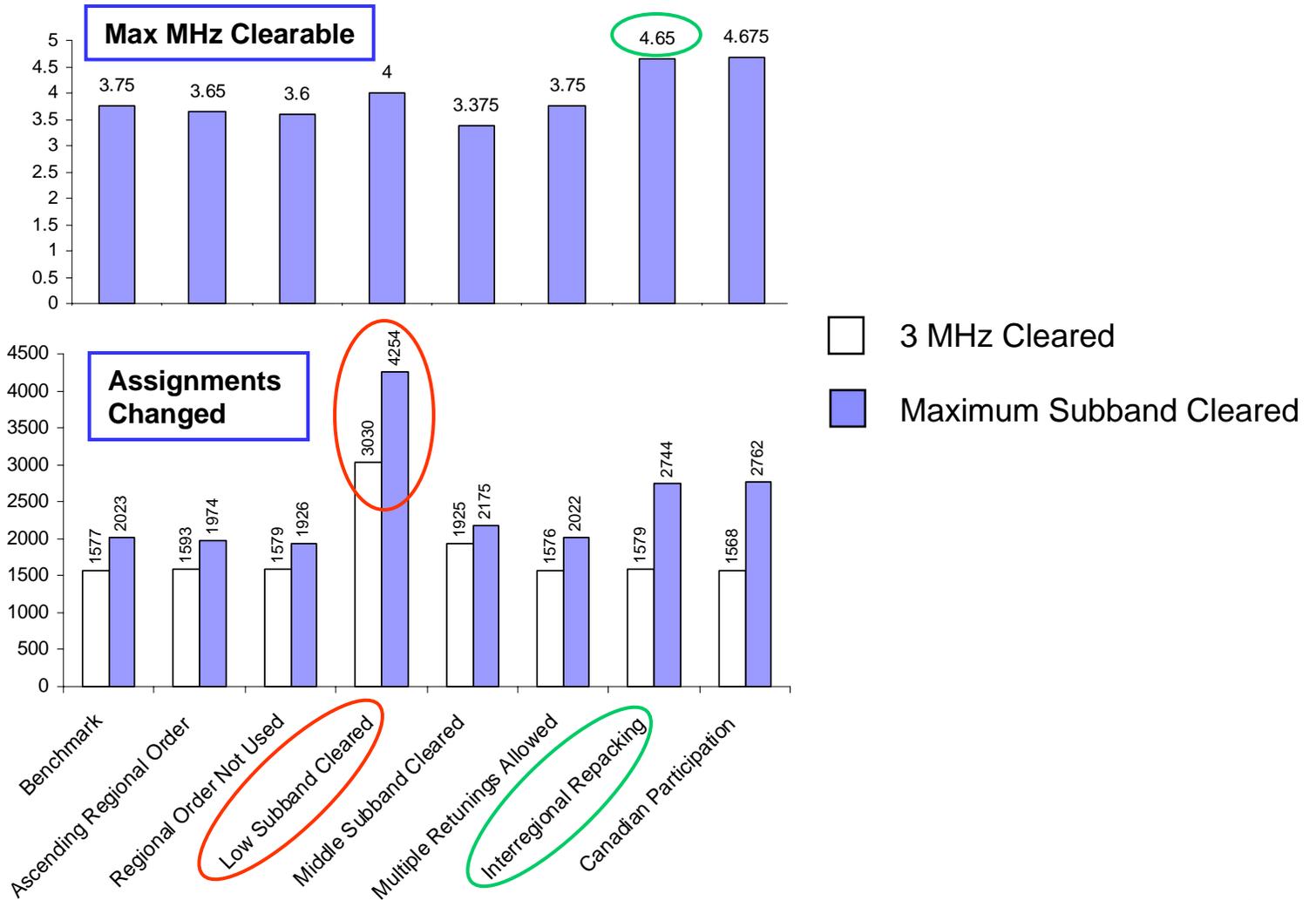
- Most-congested FAA regions cleared first
- Clearing done at high end of 118-135.975 MHz range
- “Moderate” neighbor-repacking
- No ground radio retuned more than once
- No interregional or international neighbor-repacking cooperation
- Clearing in U.S. only (except Alaska)

Variations

- Regions processed in different orders
- Clearing at low end or middle
- “Aggressive” repacking
- Multiple retunings permitted
- Interregional and/or U.S./Canadian cooperation allowed
- Same subband cleared in Canada

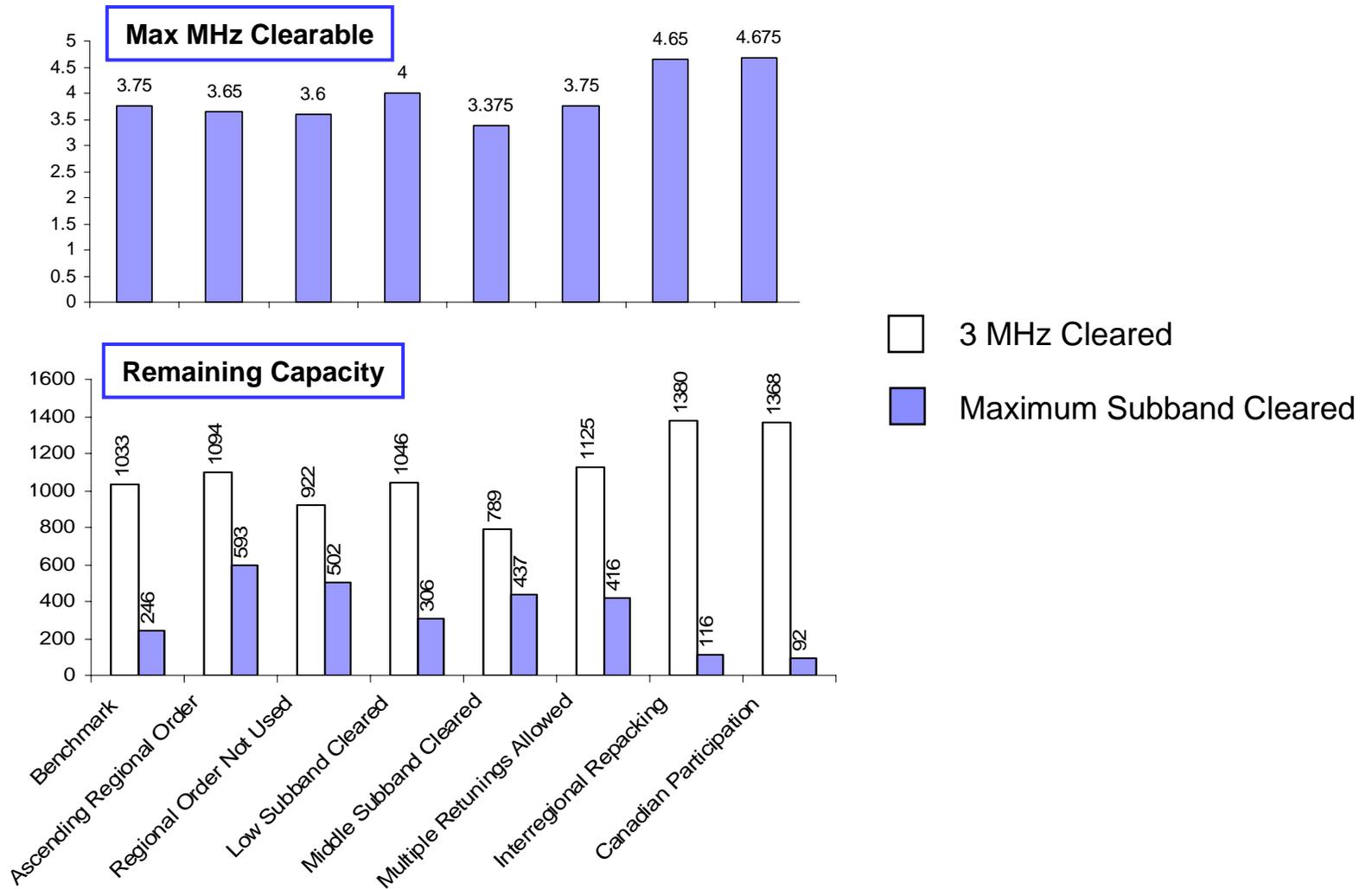


Subband Size vs. Effort for En Route 8.33 System



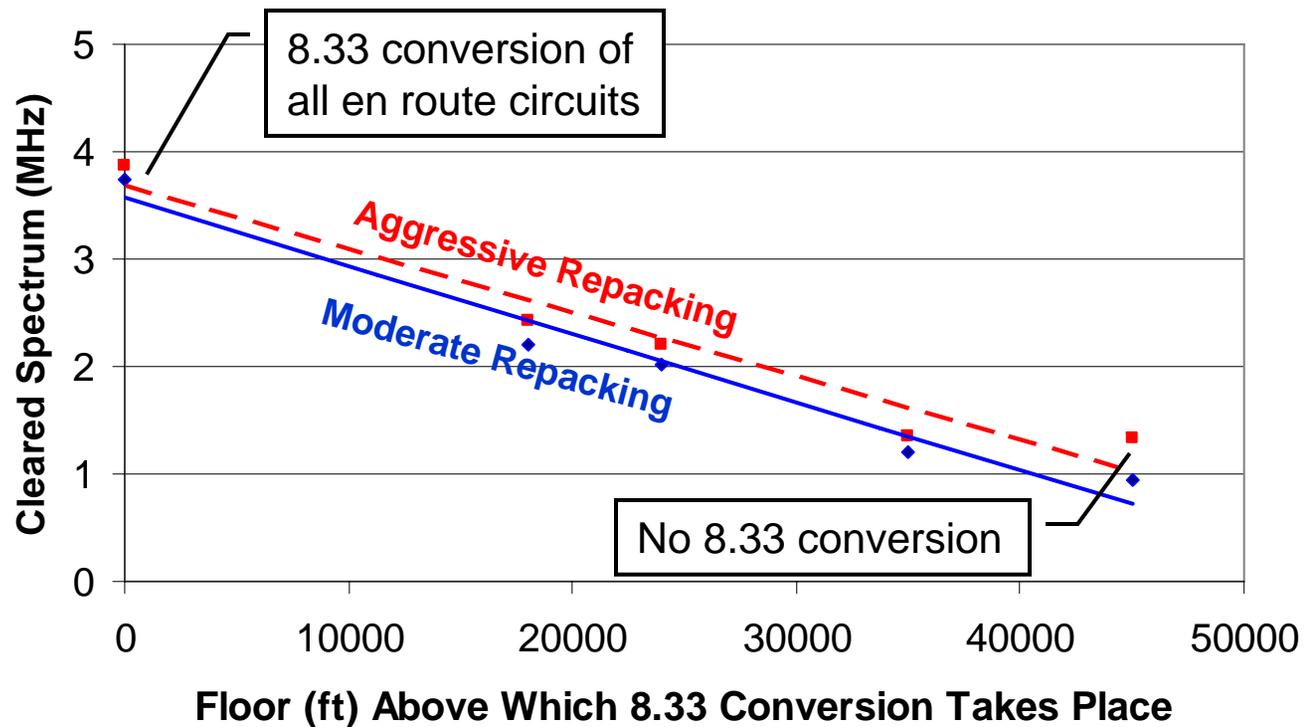


Subband Size vs. Remaining Capacity for En Route 8.33 System





Subband Size and Conversion Altitude





Partitioning a Subband-Clearing Plan

*Sequenced List of
Frequency Changes*



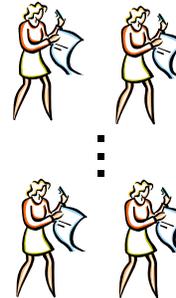
712 Circuits



**Assignment
Partitioning
Engine**

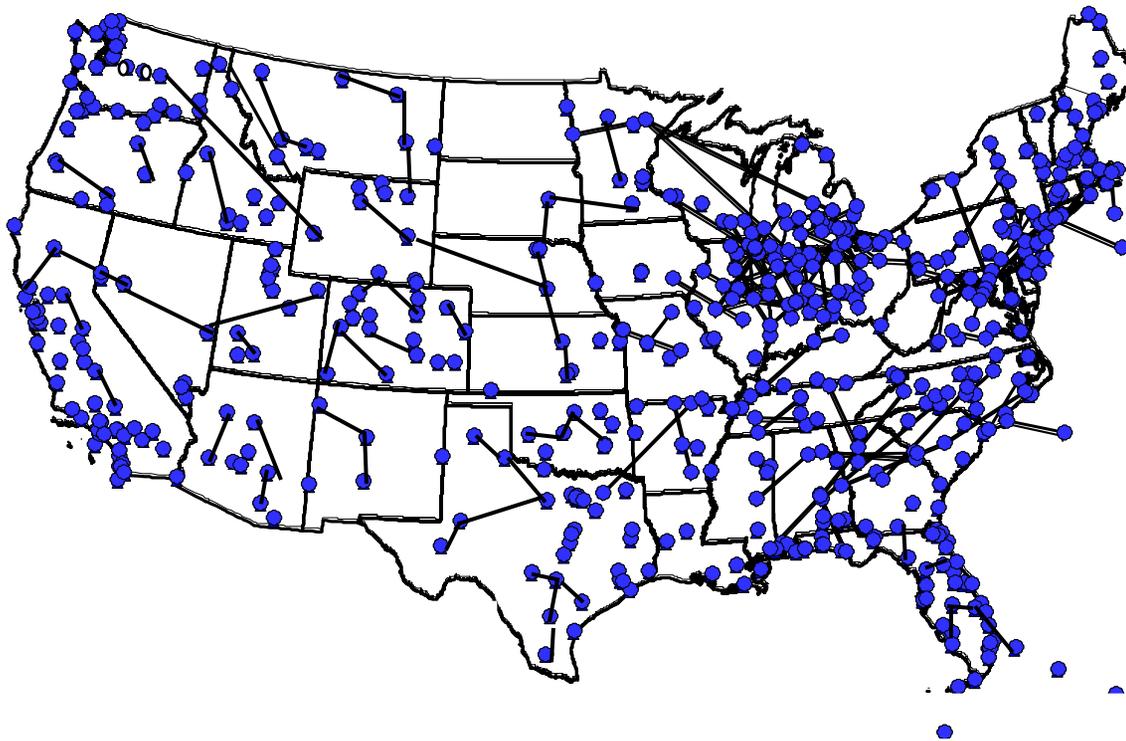


**Independently
Executable Subsets**



182 Circuits in
66 Sets with Between 2 and 7
Mutually Dependent Circuits

530 Singleton Sets





Summary and Conclusions

- If voice ATS requirements grow as projected by FDS, these amounts of spectrum may be clearable below 136 MHz:
 - 0.75 – 1.3 MHz in an all-25AM system
 - 3 – 4 MHz in an en route 8.33 system
- To realize these results, all necessary cosite and IM mitigation measures at affected ground sites must be implemented
- If maximum clearable subband is cleared in a 25AM system, then virtually no growth capacity will remain in voice ATS system without partial conversion to 8.33
- Master subband-clearing plan should be partitioned into the smallest possible independently executable subsets of circuits
 - Minimizes need for nationwide coordination/synchronization