Radio site reduction effects on flight services ground-to-air radio frequency coverage

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Objective

- **The objective of this analysis is to investigate the effect of reducing remote communication outlets (RCOs) and Very High Frequency (VHF) Omni-Directional Radio (VOR) on Flight Services Airspace Radio Frequency (RF) Coverage**

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Approach: RF Coverage Analysis Steps

STEP 1

Show current RF coverage from all RCO and FAA-owned VORs that support Flight Service Voice communications

DOD & Emergency Frequencies not considered

STEP 2

Establish a coverage baseline. Eliminate VORs that are planned to be decommissioned by the VOR MON Program from analysis

Remove RCOs with duplicate frequencies/radios at the same location

STEP 3

Continue removing RCO sites while preserving the RF Coverage

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Methodology

- **Exclude Emergency and military radios from all simulations**
- **Start with all existing VORs that support Flight Service voice communications as well as all current RCOs (step 1)**
- **Exclude from the analysis VORs that are proposed to be decommissioned by the VOR MON program to establish baseline coverage (step 2)**
- **Perform incremental reduction of RCO sites (step 3) and generate RF coverage at five altitudes for each step**
  - 5,000, 4,000, 3,000, 2,000, and 1,000 feet Above Ground Level (AGL)
- **Apply the following general rules in the RF coverage analysis**
  - Exclude radios with multiple frequencies at the same location during the reduction process
  - Keep radios with higher transmitter power (that provide larger RF coverage footprint)
  - Eliminate RCOs that provide En-Route Flight Advisory, Airport Advisory and other flight related services while not degrading the RF coverage below 90% of the baseline (current) coverage at 5,000 feet AGL

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Analysis Results

- **The results are presented in the following charts**
  - **Provide CONUS-wide views of the RF coverage results at different altitudes**
  - **Illustrate coverage for each individual Flight Services Area of Responsibilities (AORs)**
  - **Estimate percent Coverage for each AOR**

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Step 1: Current RF Coverage for ALL RCOs and ALL VORs Used for FSS

(Removed Emergency and DoD frequencies)

Includes: 1223 RCOs and 398 VORs

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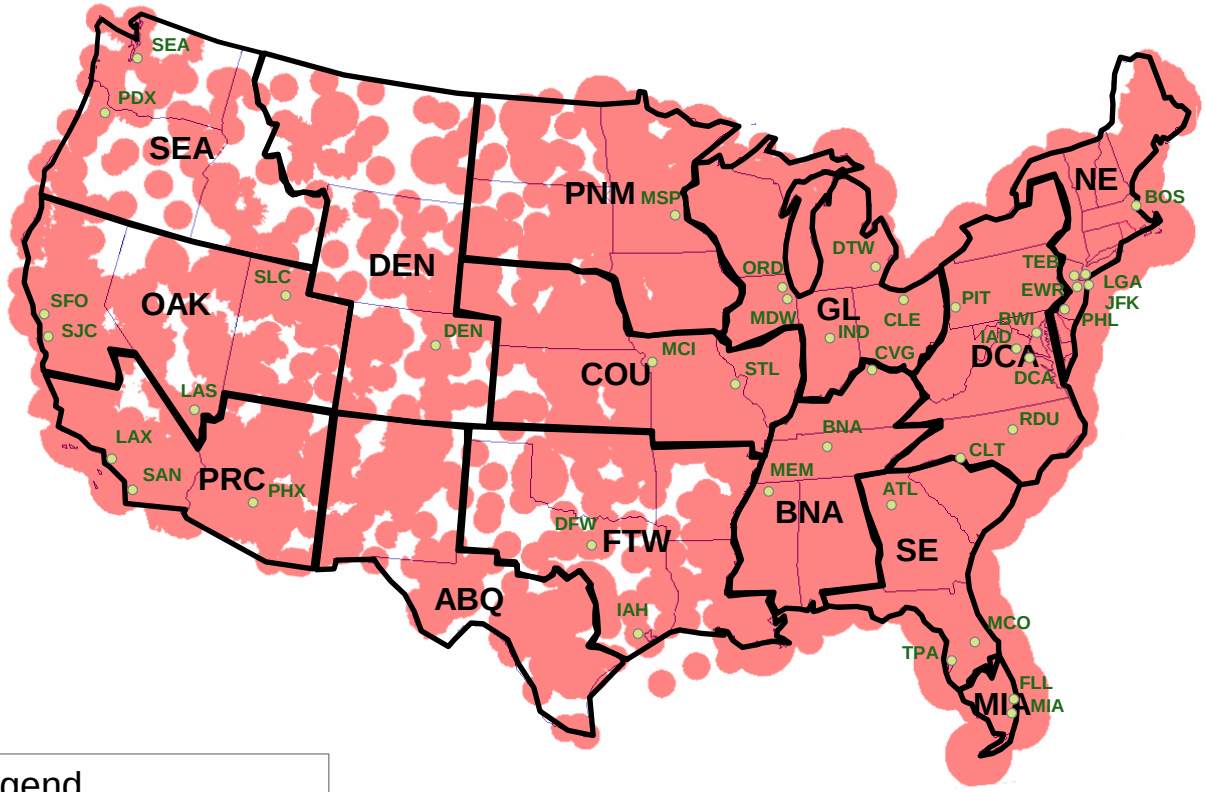
Current RF Coverage at 5,000 ft. AGL



Legend

Current RF Coverage for all RCOs and VORs

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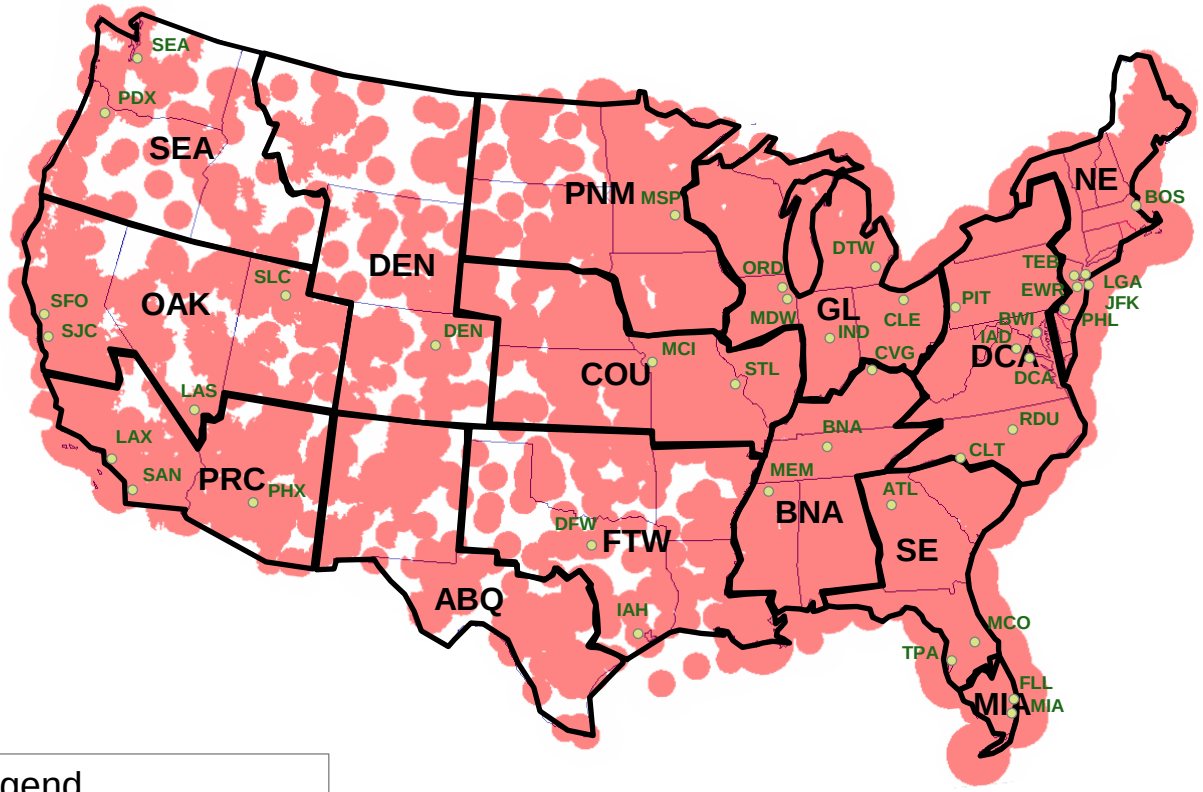
Current RF Coverage at 4,000 ft. AGL



Legend

Current RF Coverage for all RCOs and VORs

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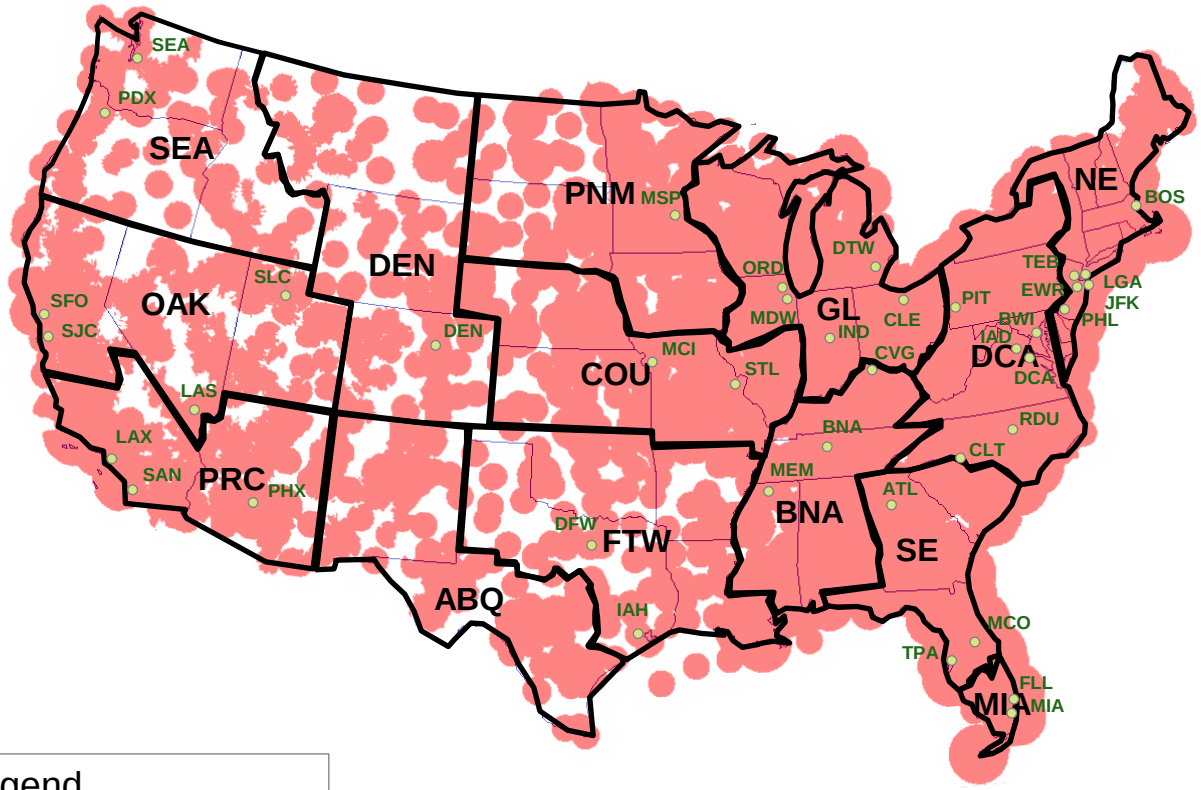
Current RF Coverage at 3,000 ft. AGL



Legend

Current RF Coverage for all RCOs and VORs

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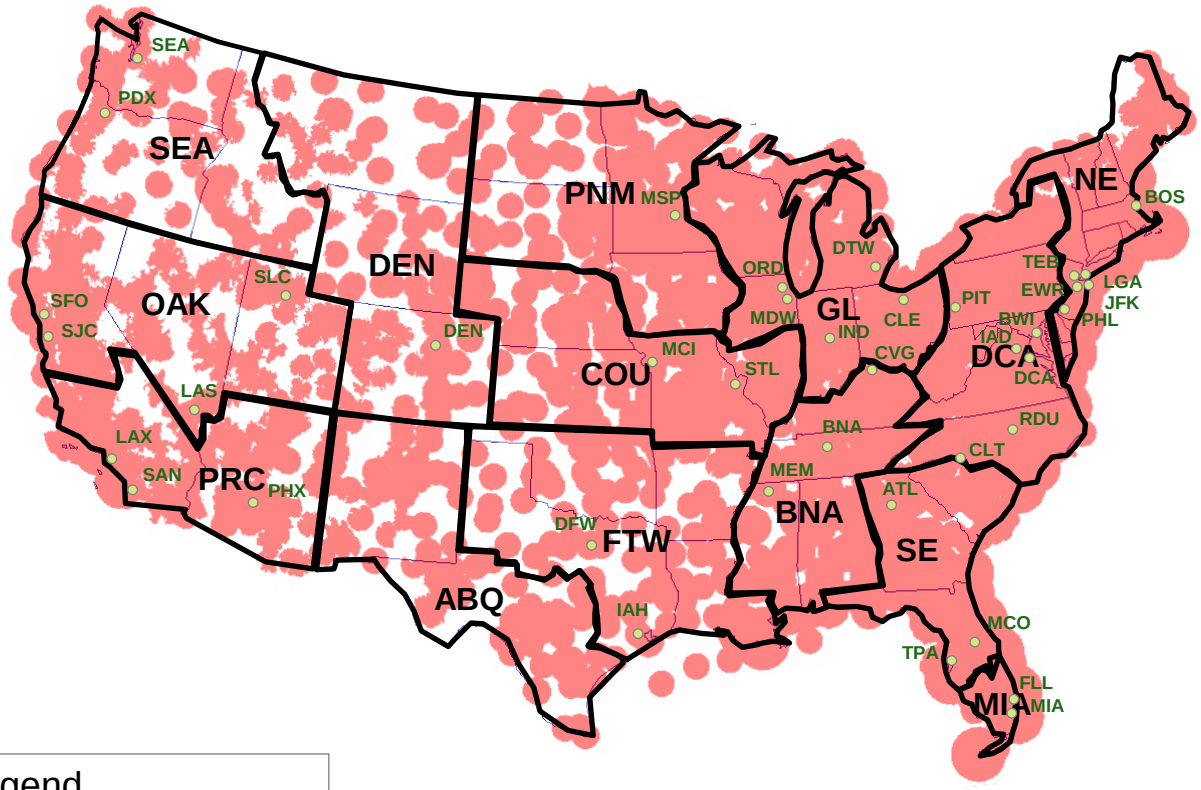
Current RF Coverage at 2,000 ft. AGL



Legend

Current RF Coverage for all RCOs and VORs

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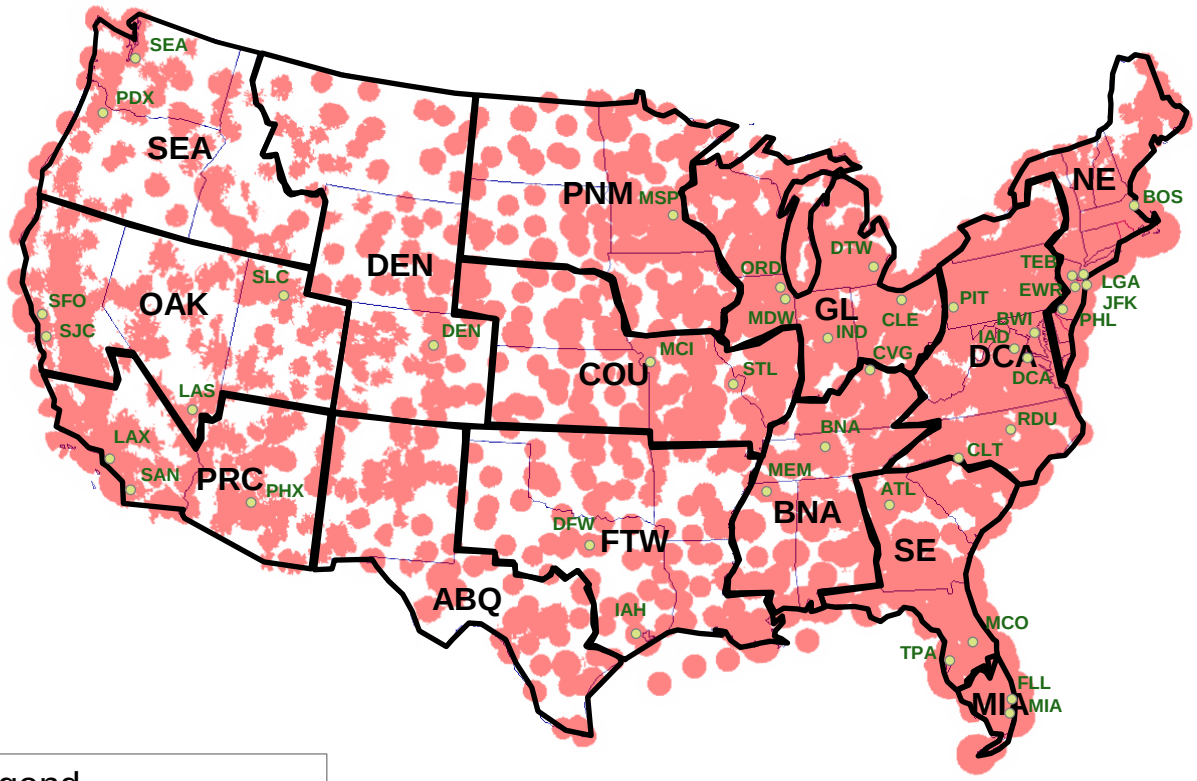
Current RF Coverage at 1,000 ft. AGL



Legend

Current RF Coverage for all RCOs and VORs

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Step 2: RF Coverage for RCOs

and

VORs proposed to be retained by VOR MON Program

(Removed 291 duplicate RCO frequencies (multiple frequencies at the same ground location) and 222 VORs)

Includes: 932 RCOs and 176 Retained VORs

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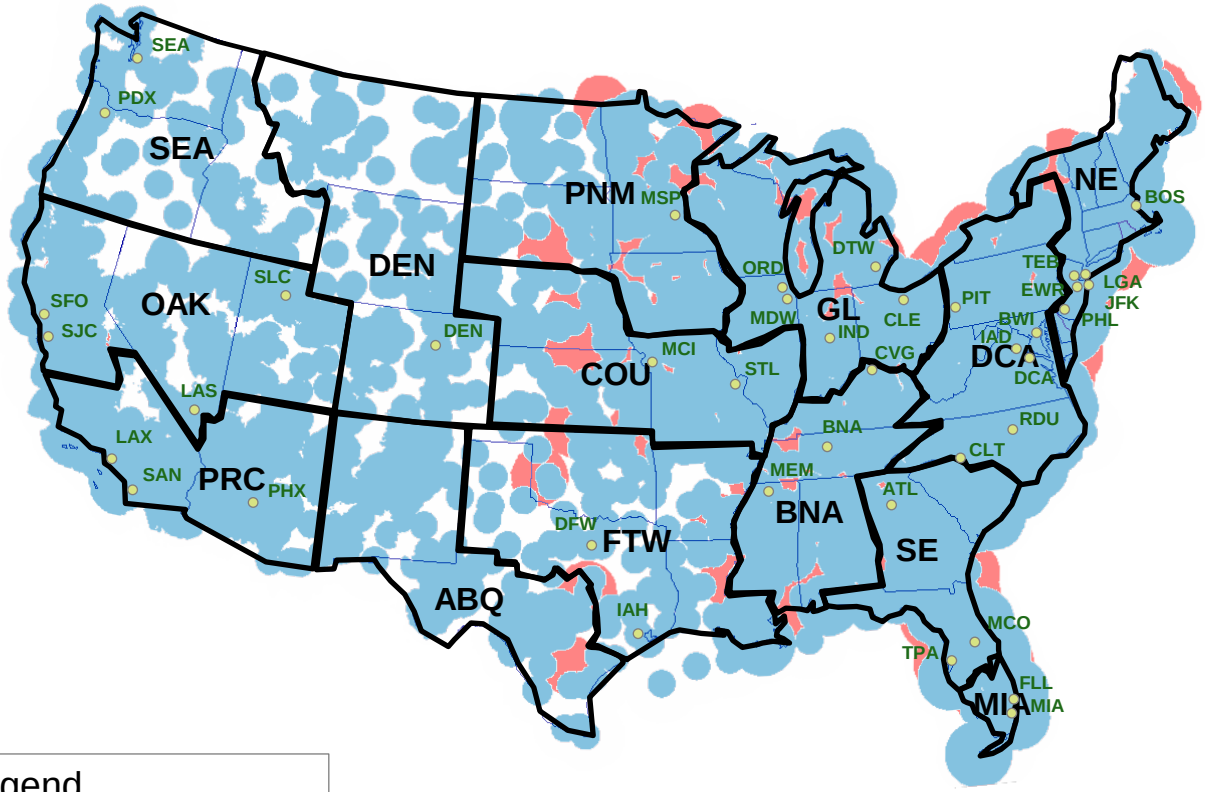
Current RCOs and VOR MON Retention vs. Current RF Coverage at 5,000 ft. AGL



Legend

- Current RF Coverage (all RCOs and all VORs - Step 1)
- RF Coverage for all RCOs and VOR MON Retention (Step 2)

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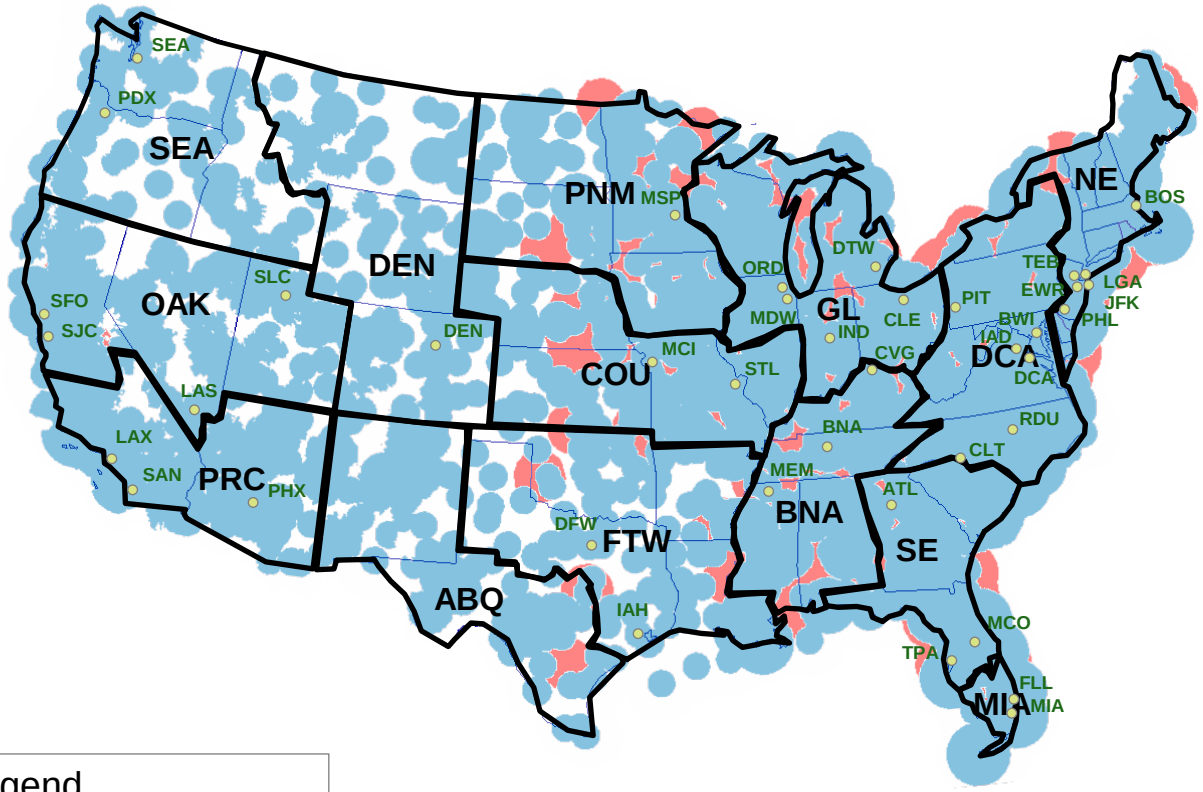
Current RCOs and VOR MON Retention vs. Current RF Coverage at 4,000 ft. AGL



Legend

- Current RF Coverage (all RCOs and all VORs - Step 1)
- RF Coverage for all RCOs and VOR MON Retention (Step 2)

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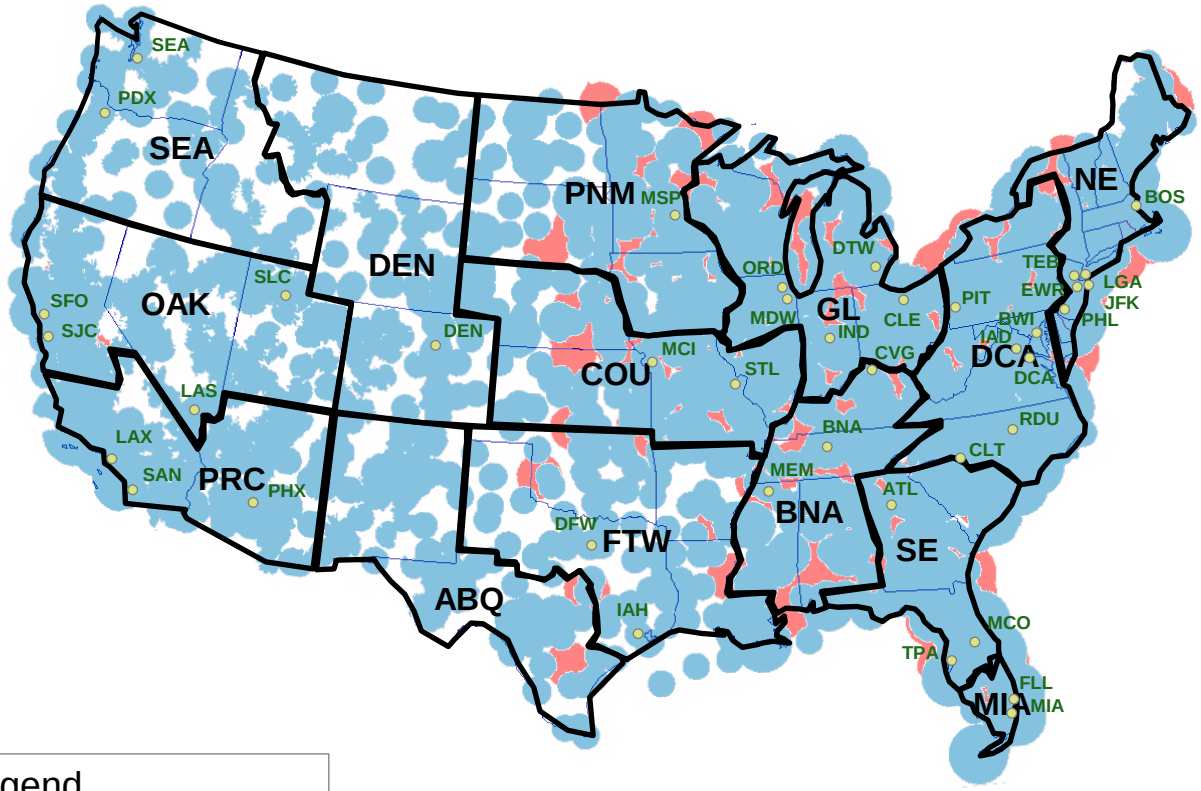
Current RCOs and VOR MON Retention vs. Current RF Coverage at 3,000 ft. AGL



Legend

- Current RF Coverage (all RCOs and all VORs - Step 1)
- RF Coverage for all RCOs and VOR MON Retention (Step 2)

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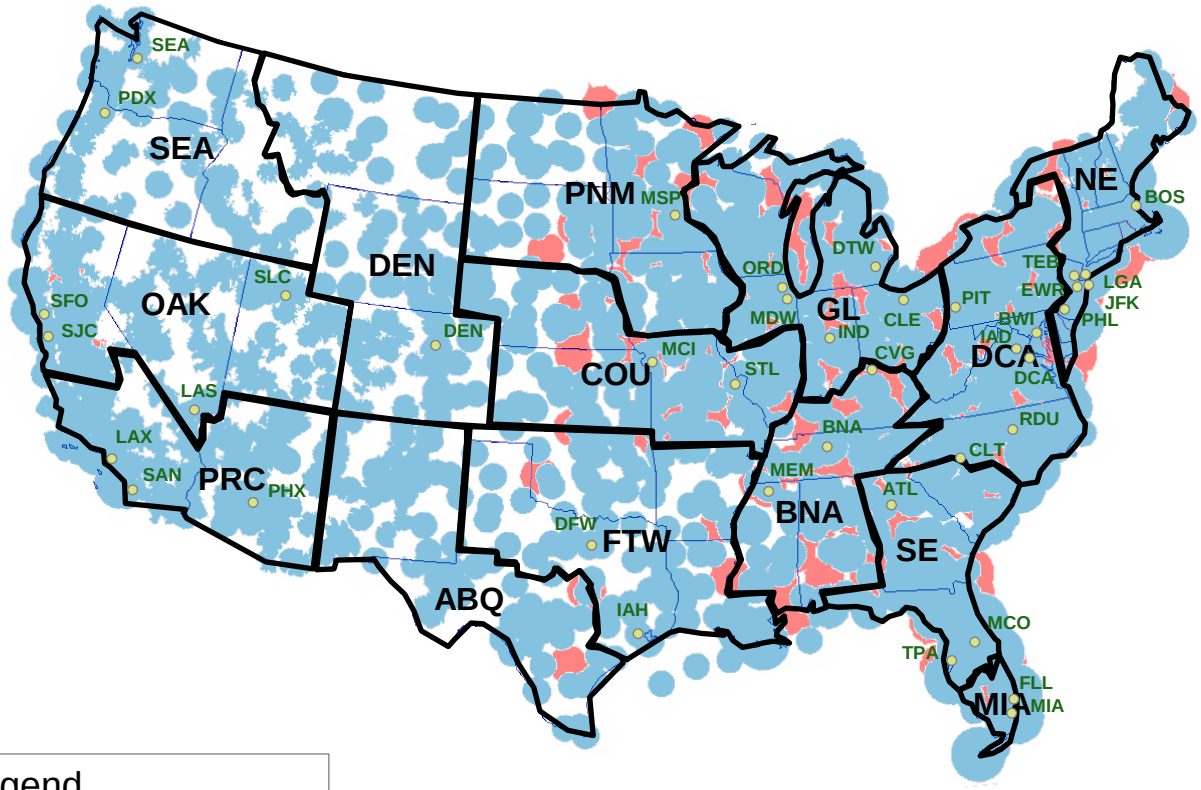
Current RCOs and VOR MON Retention vs. Current RF Coverage at 2,000 ft. AGL



Legend

- Current RF Coverage (all RCOs and all VORs - Step 1)
- RF Coverage for all RCOs and VOR MON Retention (Step 2)

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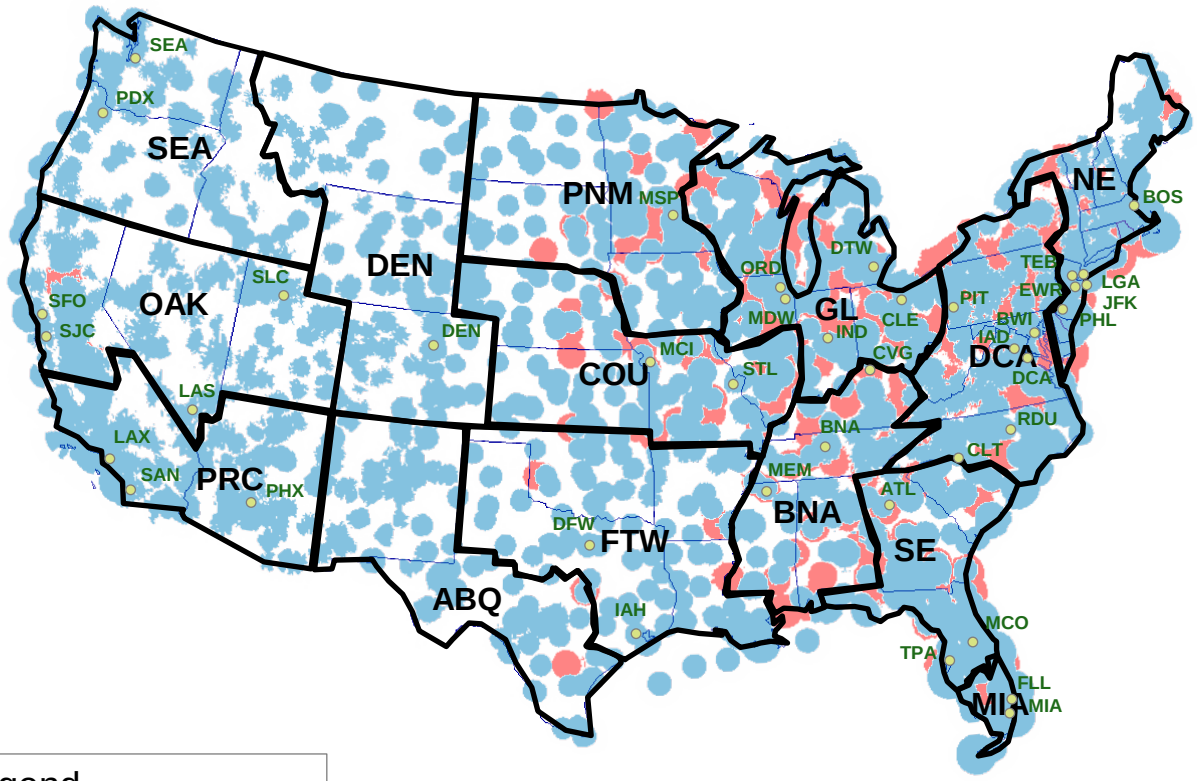
Current RCOs and VOR MON Retention vs. Current RF Coverage at 1,000 ft. AGL



Legend

- Current RF Coverage (all RCOs and all VORs - Step 1)
- RF Coverage for all RCOs and VOR MON Retention (Step 2)

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Step 3: RF Coverage for reduced set of RCOs and retained VOR MON

(same as Step 2 plus removed 153 more RCOs)

Includes: 779 RCOs and 176 Retained VORs

Total RCO reduction = 444

Total VOR Reduction = 222

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Number of RCO Radios Removed by AOR

AOR	ABQ	BNA	COU	DCA	DEN	FTW	GL	MIA	NE	OAK	PNM	PRC	SE	SEA
RCOs Removed	19	40	24	54	22	39	56	8	43	22	30	25	38	24

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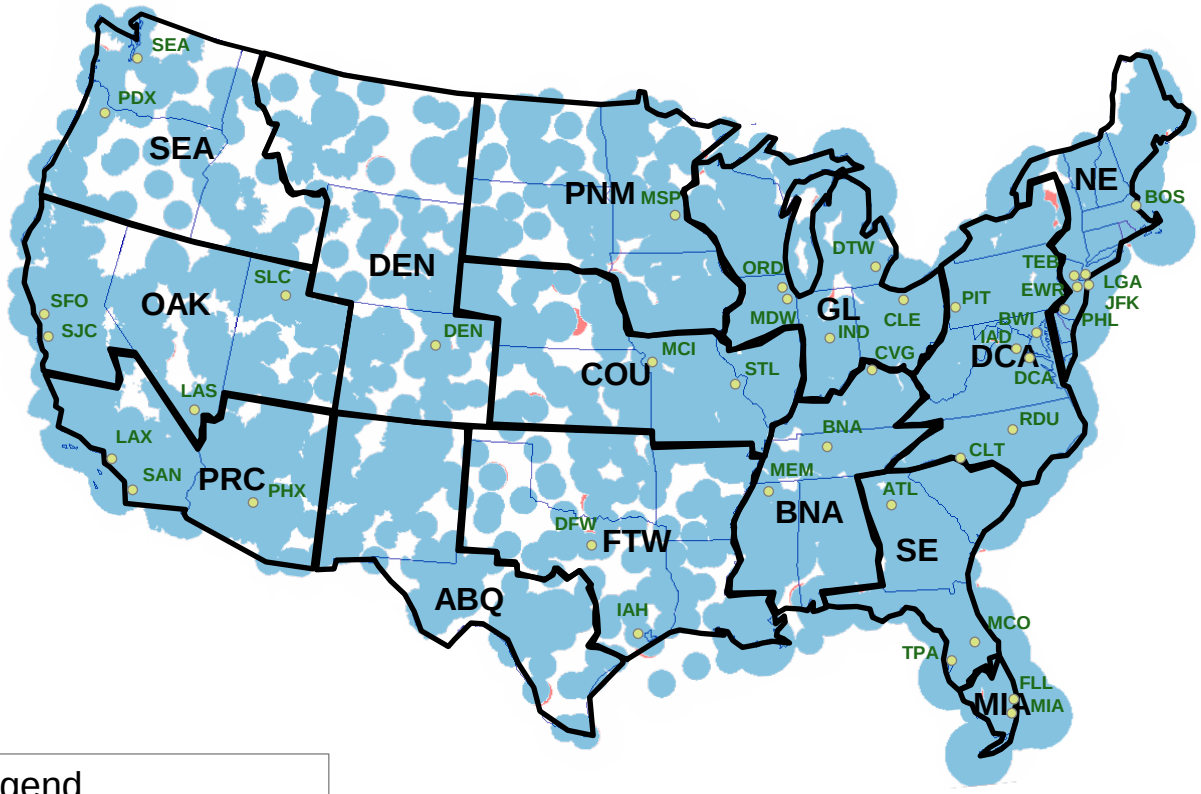
Reduced RCOs and VOR Retention vs. Current RCOs and VOR Retention Coverage at 5,000 ft. AGL



Legend

- Current RF Coverage for all RCOs and VOR MON Retention (Step 2)
- RF Coverage for reduced RCOs and VOR MON Retention (Step 3)

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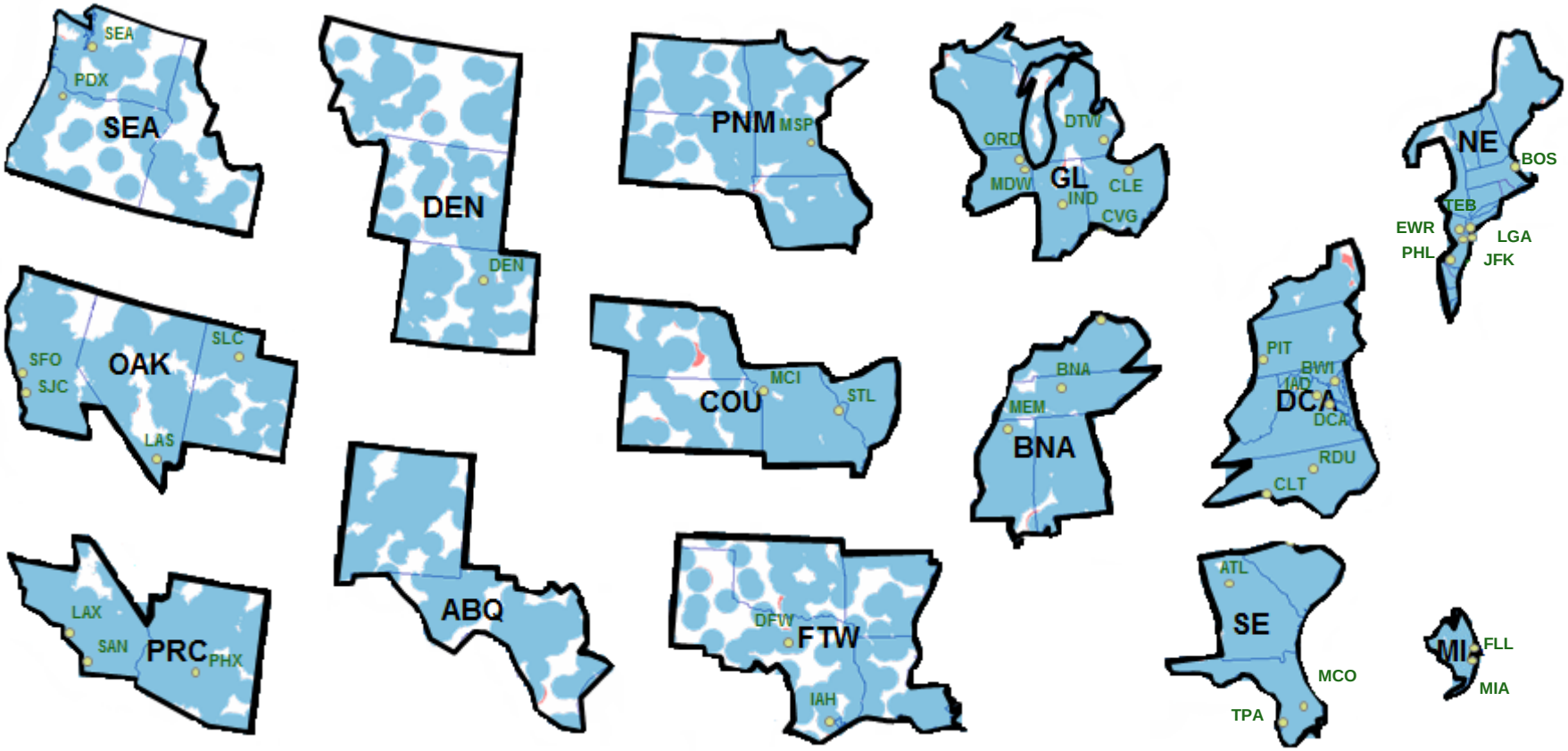
Reduced RCOs with VOR Retention vs. Current RCOs and VOR Retention Coverage at 5,000 ft. AGL by AOR



AOR	ABQ	BNA	COU	DCA	DEN	FTW	GL	MIA	NE	OAK	PNM	PRC	SE	SEA
RCOs Removed	19	40	24	54	22	39	56	8	43	22	30	25	38	24
% Coverage	99	99	99	99	100	99	100	99	100	100	100	100	100	100

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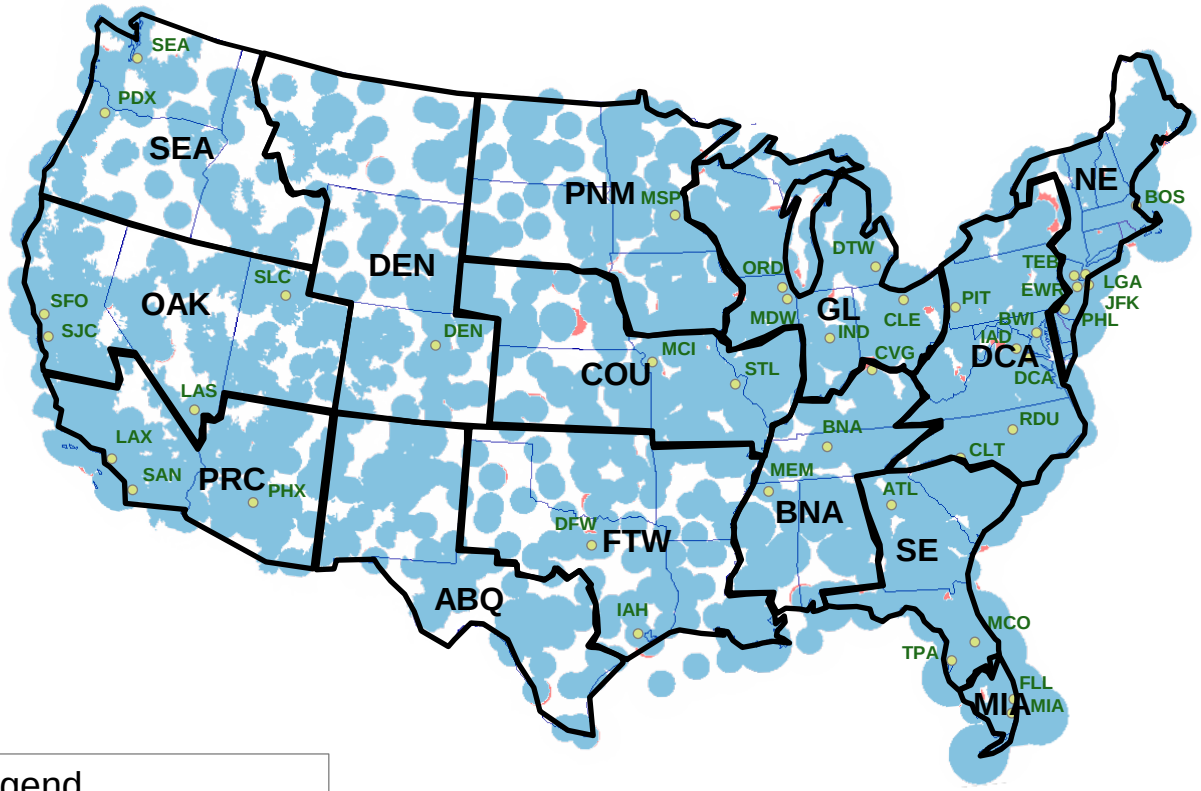
Reduced RCOs and VOR Retention vs. Current RCOs and VOR Retention Coverage at 3,000 ft. AGL



Legend

- Current RF Coverage for all RCOs and VOR MON Retention (Step 2)
- RF Coverage for reduced RCOs and VOR MON Retention (Step 3)

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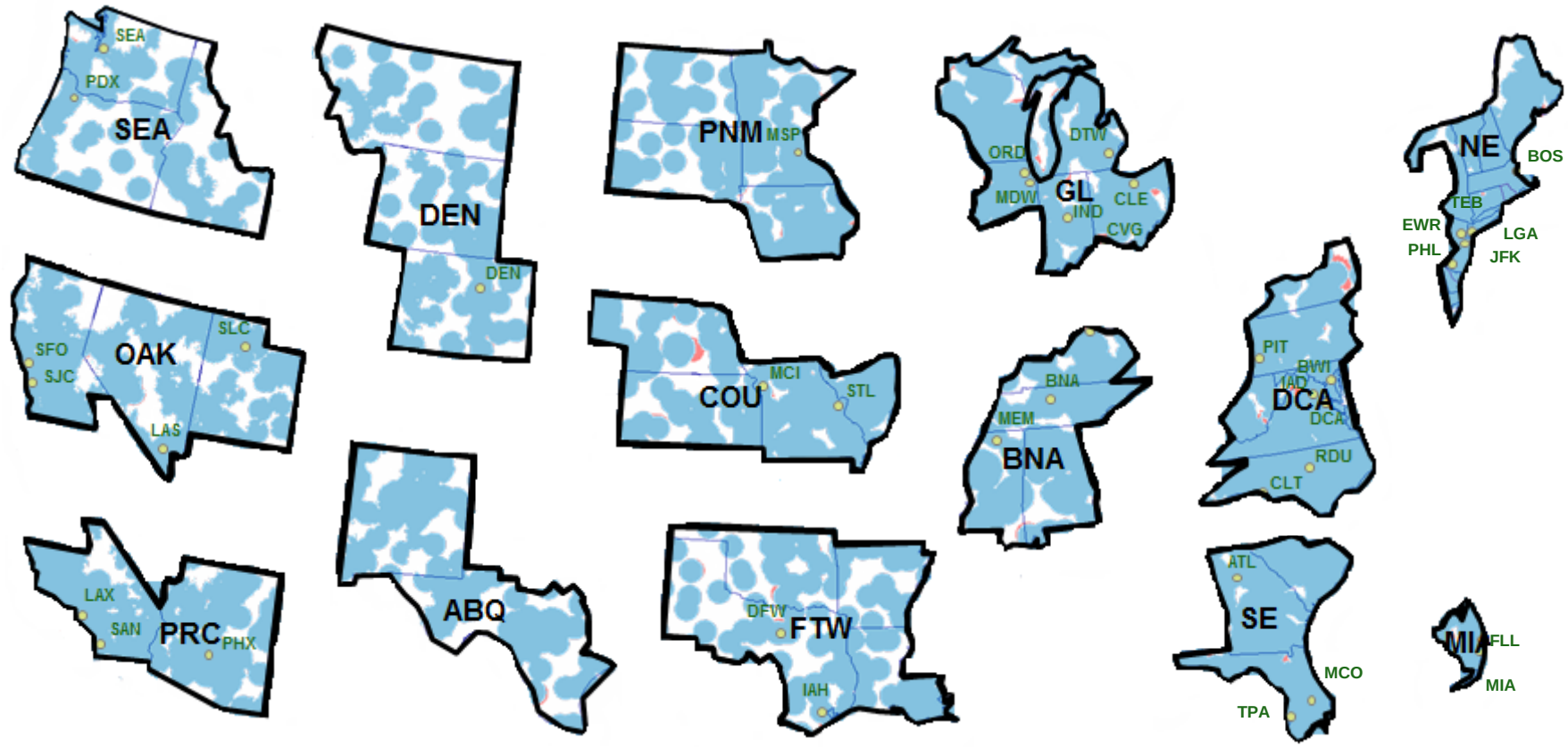
Reduced RCOs with VOR Retention vs. Current RCOs and VOR Retention Coverage at 3,000 ft. AGL by AOR



AOR	ABQ	BNA	COU	DCA	DEN	FTW	GL	MIA	NE	OAK	PNM	PRC	SE	SEA
RCOs Removed	19	40	24	54	22	39	56	8	43	22	30	25	38	24
% Coverage	99	99	98	98	100	99	99	98	100	100	100	100	100	100

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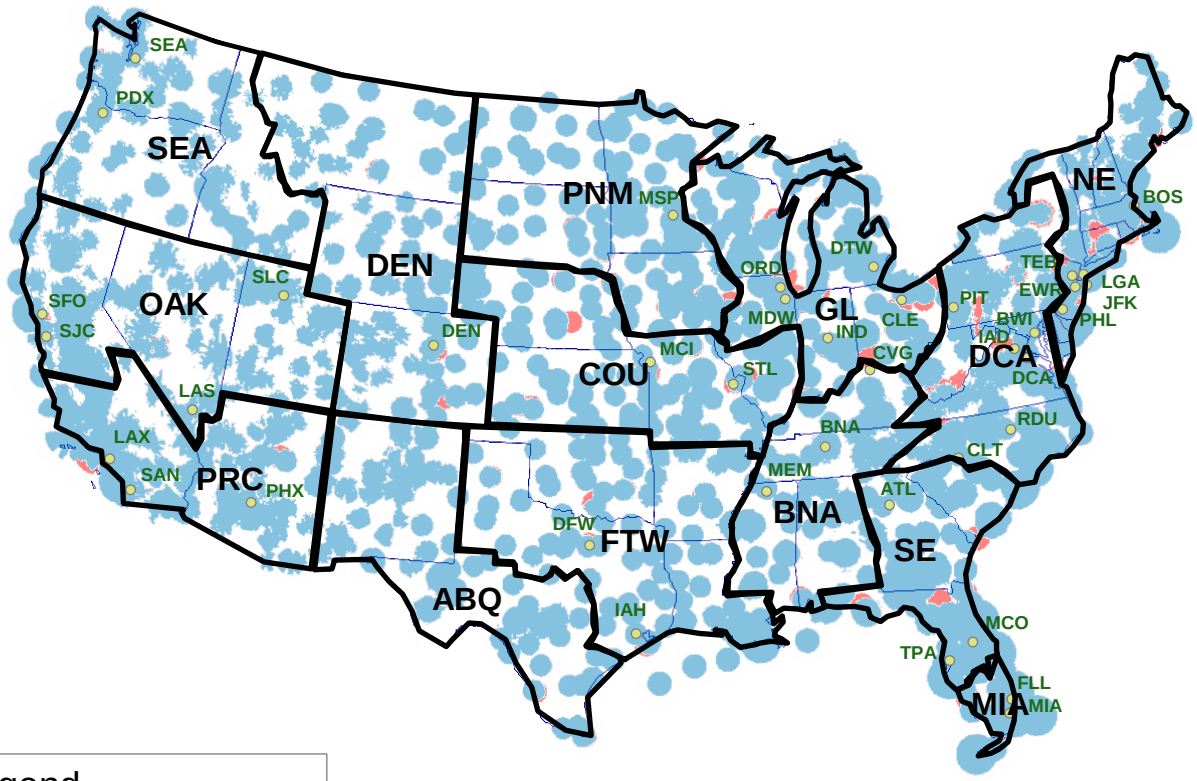
Reduced RCOs and VOR Retention vs. Current RCOs and VOR Retention Coverage at 1,000 ft. AGL



Legend

- Current RF Coverage for all RCOs and VOR MON Retention (Step 2)
- RF Coverage for reduced RCOs and VOR MON Retention (Step 3)

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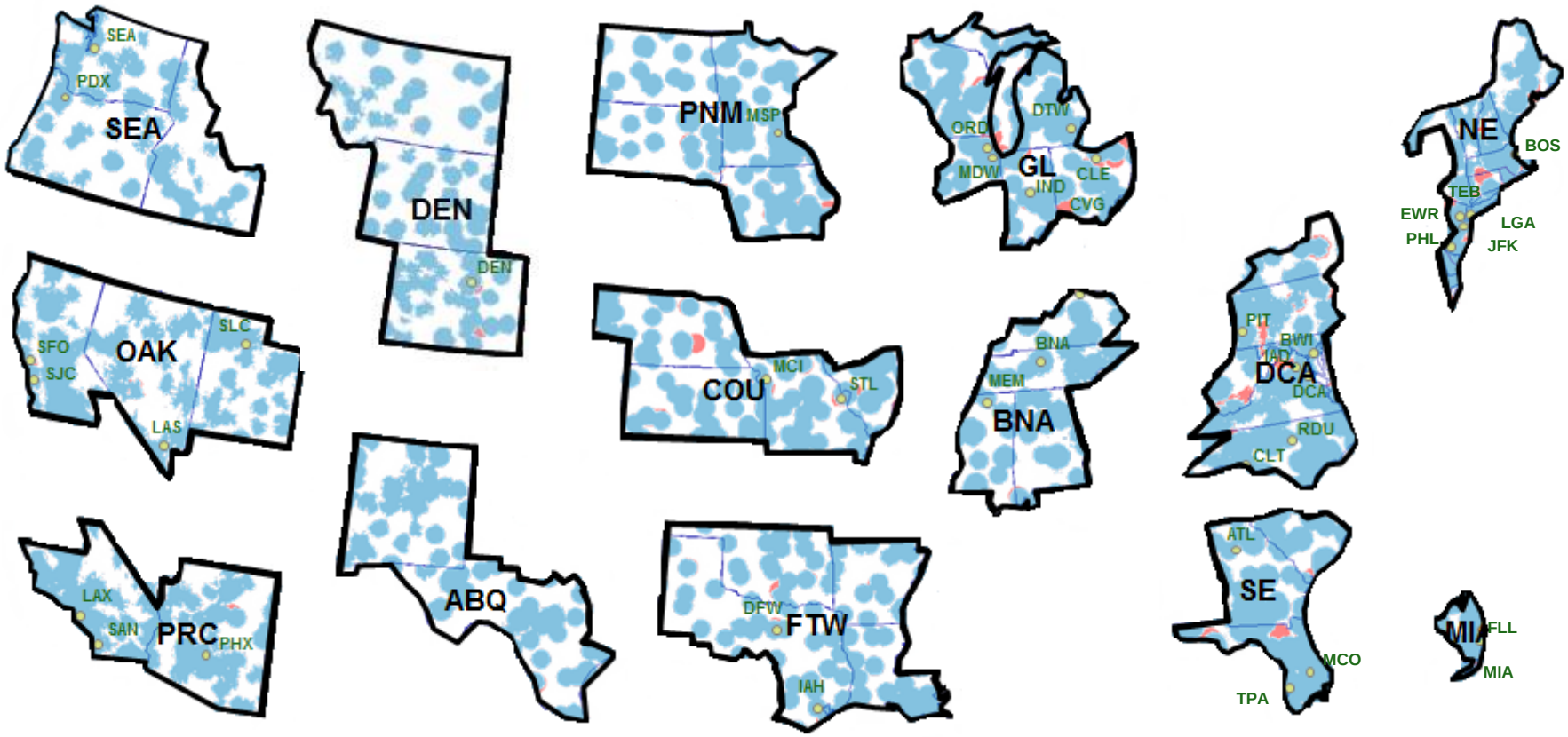
Reduced RCOs with VOR Retention vs. Current RCOs and VOR Retention Coverage at 1,000 ft. AGL by AOR



AOR	ABQ	BNA	COU	DCA	DEN	FTW	GL	MIA	NE	OAK	PNM	PRC	SE	SEA
RCOs Removed	19	40	24	54	22	39	56	8	43	22	30	25	38	24
% Coverage	99	99	94	95	94	96	93	94	96	100	98	99	96	100

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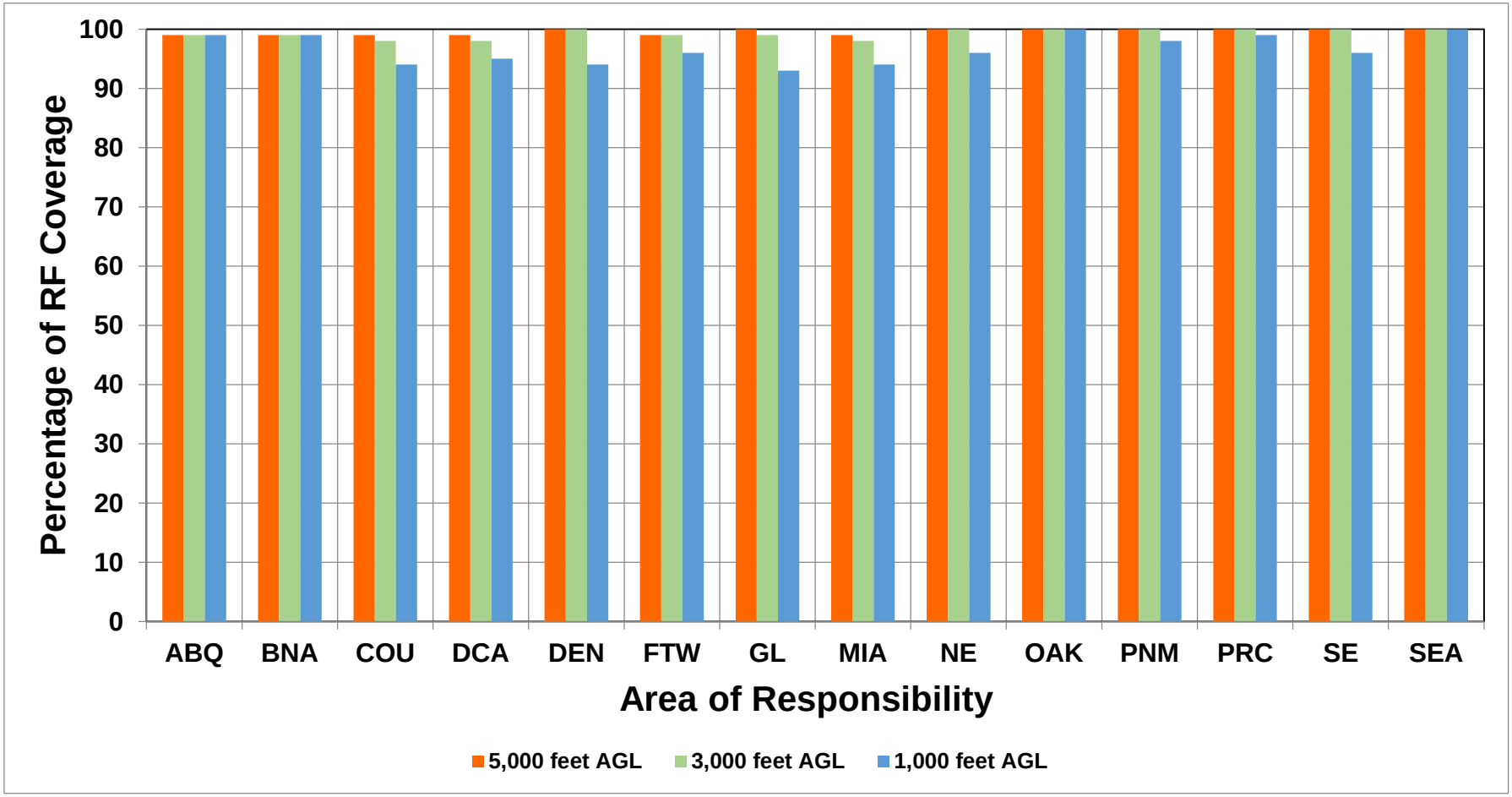
RF Coverage after RCO Reduction (step3) by AOR as a Percentage of Baseline (step2) at Three Altitudes



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Observations

- **VOR reduction being considered by FAA (VOR MON) could reduce Flight Service inflight coverage in some AORs, particularly at lower altitudes**
- **Further RCO reduction used in the analysis might translate into the following loss of coverage**
  - Not more than 1% additional lost coverage at 5,000 feet
  - Up to 7% of additional lost coverage at 1,000 feet (e.g., GL)
- **If resulting coverage doesn't meet the needs of any individual AOR, fewer radios could be removed**

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Input and Assumptions

- **Input radio sites data**
  - RCO sites data provided by the FAA (AJR-B)
  - VOR sites in alignment with the FAA's VOR Minimum Operating Network program
- **Used SignalPro RF propagation and design tool by EDX Wireless Inc.**
  - 30 second digitized terrain elevation database
  - Terrain Integrated Rough Earth Model (TIREM)
  - Ground Transmitter antenna gain: 2.2 dBi
  - Ground transmitter cable loss: 1.5 dB
  - 95% confidence of predicted ground to air coverage shown at -87 dBm or better at the aircraft receiver

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