# Naval Strike and Air Warfare Center
# Fallon Range Training Complex

# Spectrum

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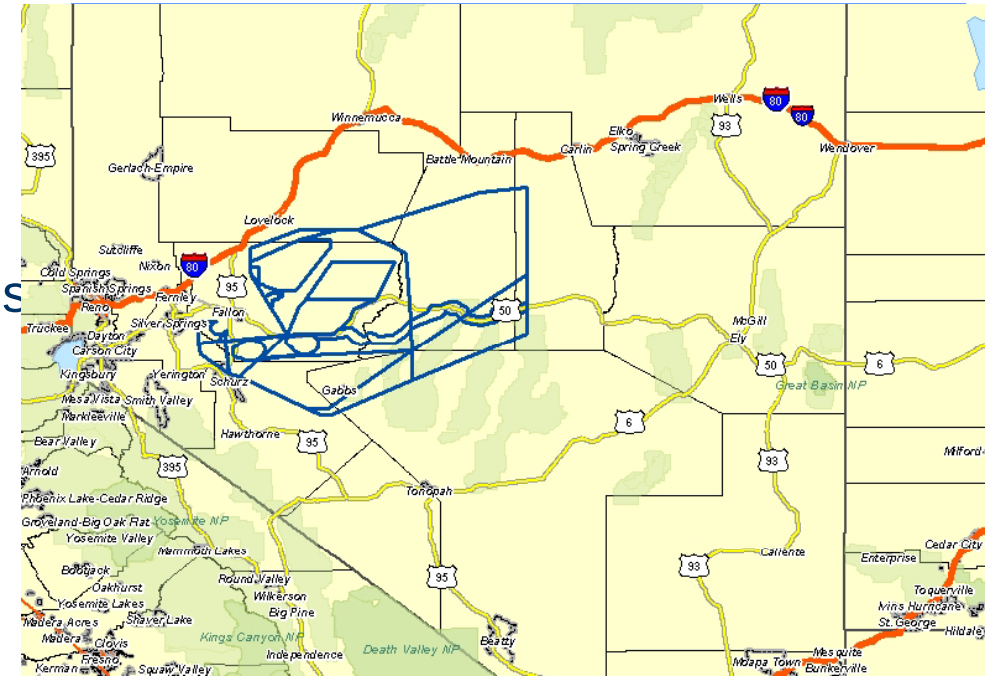
# Outline

- The Naval Strike and Air Warfare Center (NSAWC) and The Fallon Range Training Complex
- Electronic Warfare and Spectrum
- Interesting Facts about Nevada
- Spectrum Auction
- Spectrum Preserve

# Naval Strike and Air Warfare Center
# Fallon Range Training Complex

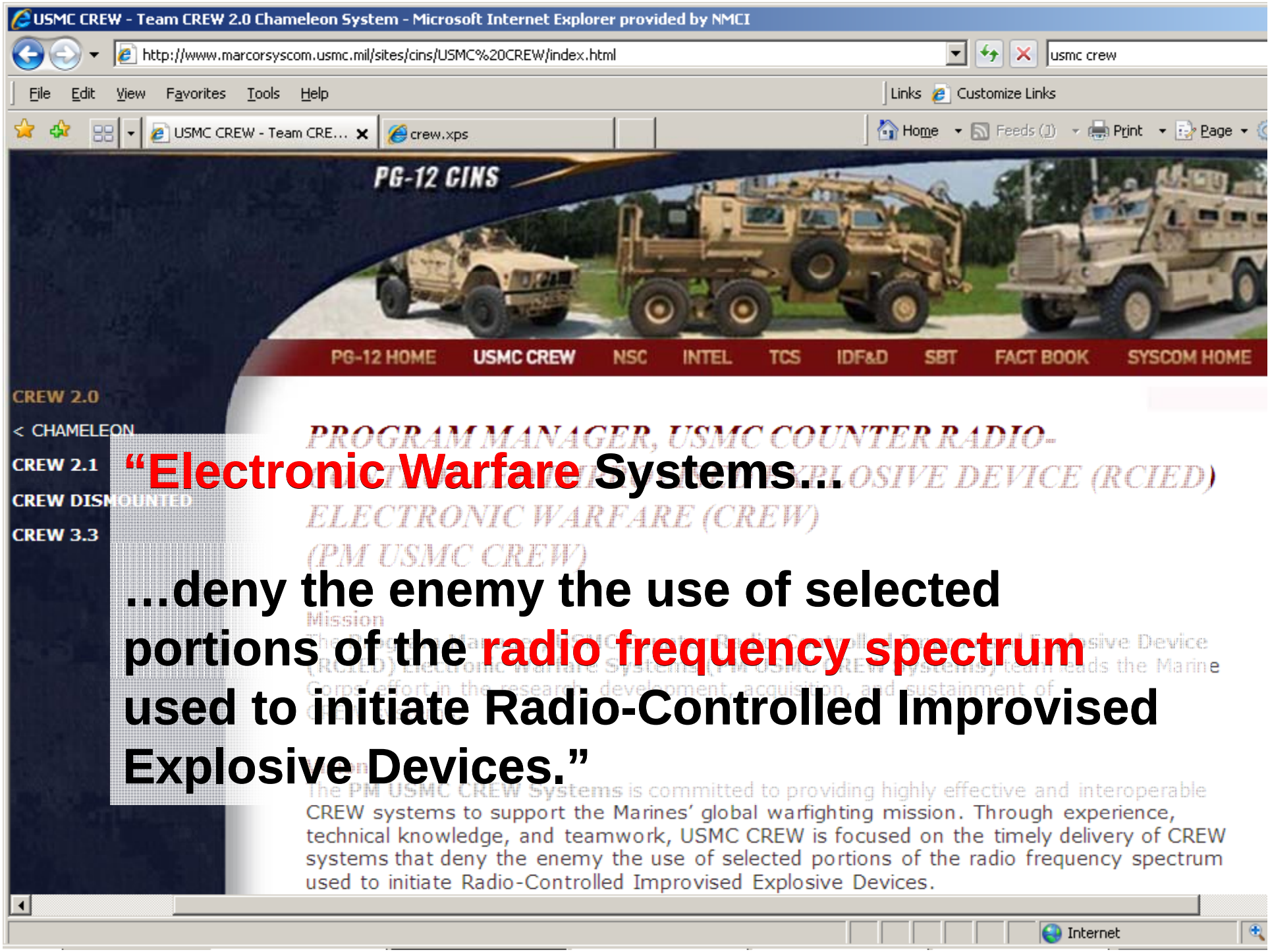
- **Fallon Range Training Complex**
  - Airspace and targets NSAWC uses to conduct its training mission

- **Naval Strike and Air Warfare Center, Fallon NV "NSAWC"**
  - Mission: Train Naval Air Forces on advanced tactics
  - Originally established in 1969 as the Navy Fighter Weapons School ("TOPGUN")



# Electronic Warfare and Spectrum

## Derived From a Presentation Given in April 2012 to the Nevada Broadband Task Force

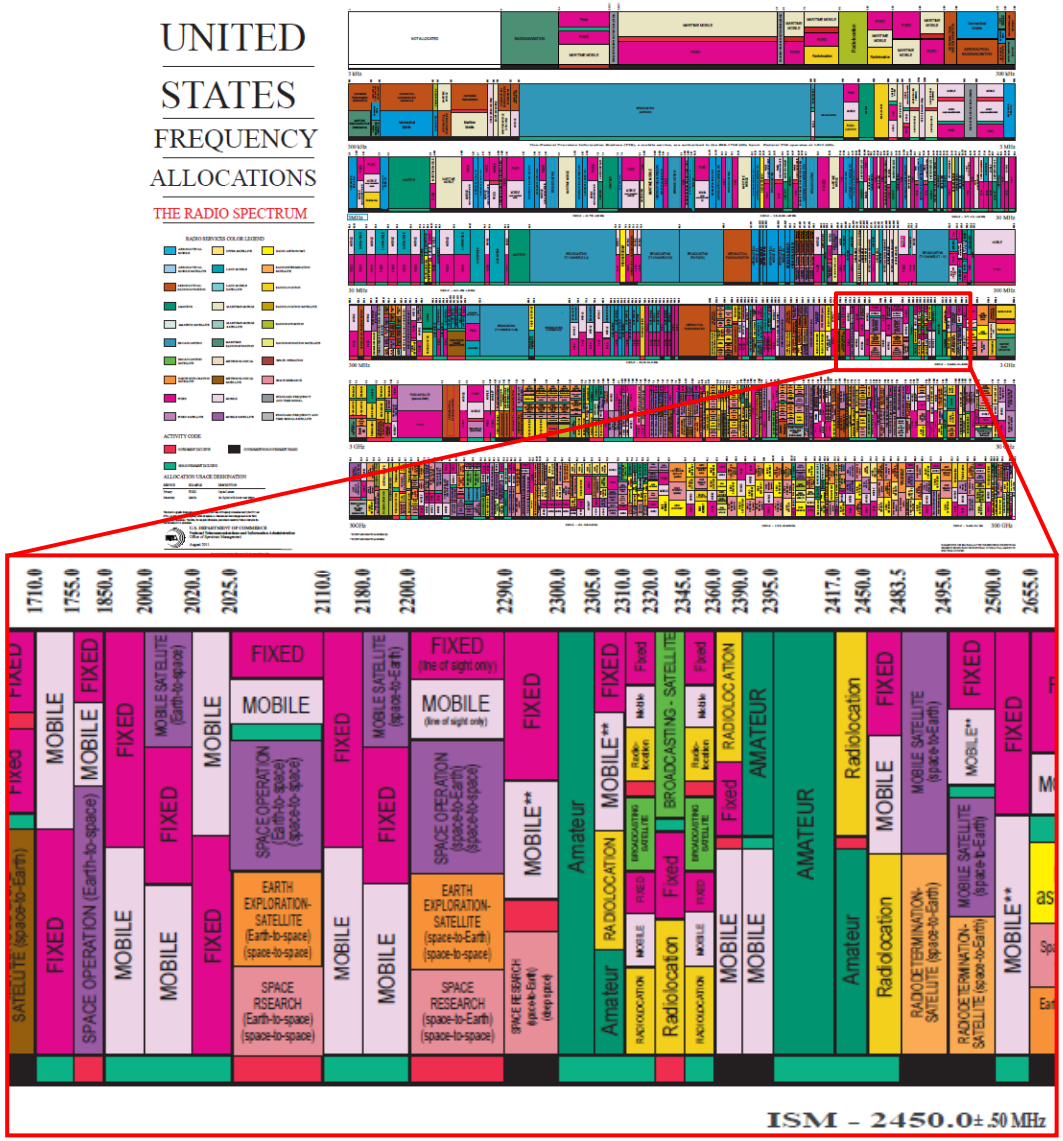



**"Electronic Warfare Systems…**

**…deny the enemy the use of selected portions of the radio frequency spectrum used to initiate Radio-Controlled Improvised Explosive Devices."**

# Radio Frequency Spectrum

- Simultaneous users of the same radio frequency spectrum can interfere with each other
- So the US Government assigns – *allocates* - portions of the radio spectrum to different users so they do not interfere with each other



# Radio Spectrum and Broadband

## An implication of *broadband*

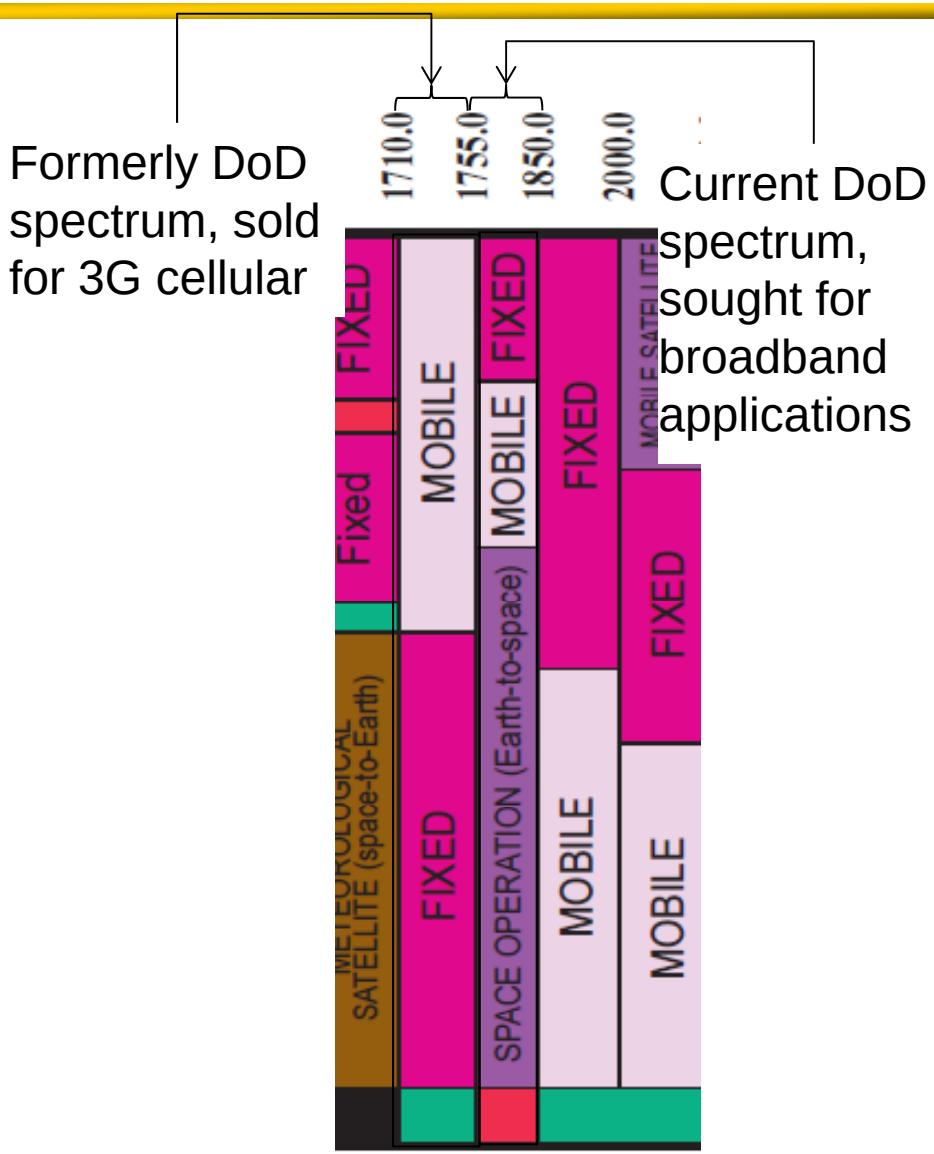
- A *law of physics**: the more bits per second of computer information you send on a radio wave, the more radio spectrum you will need
- If you want to send *mega* bits per second *by radio* you must have a…

## *Broad band* of radio spectrum…

*The Shannon Limit

# Radio Spectrum and Broadband

- **Within the US, all useful radio frequency spectrum is <u>already allocated</u>**
- **To increase broadband services by radio (wireless), allocated spectrum will have to be taken from existing users**
- **Since the 1990s, the government has taken spectrum allocated to the DoD and sold it via auctions to commercial wireless vendors**
- **DoD spectrum generally is taken across the entire US and auctioned off across the entire US**



# Radio Spectrum and EW

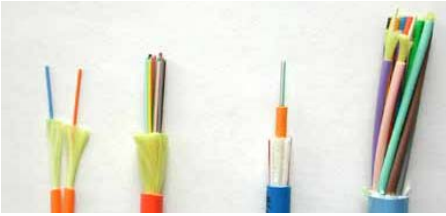
- **When DoD radio spectrum is taken away, the DoD attempts to move its equipment to other radio bands, but it cannot move *electronic warfare* equipment**
- ***Electronic Warfare* (EW) involves jamming or otherwise disrupting enemy use of the radio spectrum**
- ***The part of the radio spectrum EW requires is determined by the enemy***

# Radio Spectrum and EW

- **NSAWC conducts EW training and testing on the Fallon Range**
- **Currently, the requirement for EW training and testing is *increasing***
- **The requirement for spectrum to support this training and testing is *significantly increasing***

# Spectrum: EW and Broadband

- **If greater broadband is pursued in Nevada wirelessly by traditional spectrum auction, EW training and testing will be negatively impacted**
- **Greater broadband can be achieved without this impact, with potentially greater performance and permanence**
  - *Up front costs* (and time) are the difference



- **Additional Considerations:**
  - Locally coordinate spectrum use across Nevada between DoD and civil/commercial users to maximize access <u>for all</u>
  - Approach spectrum allocation differently in the lightly populated regions of Nevada – spectrum sharing vice auction – *"Spectrum Preserve"*

# Local Coordination

- With Churchill County Communications
- With COMNET Nevada and other Cell Tower Installers
- With the FAA
- With the Nevada Department of Public Safety

# Local Coordination

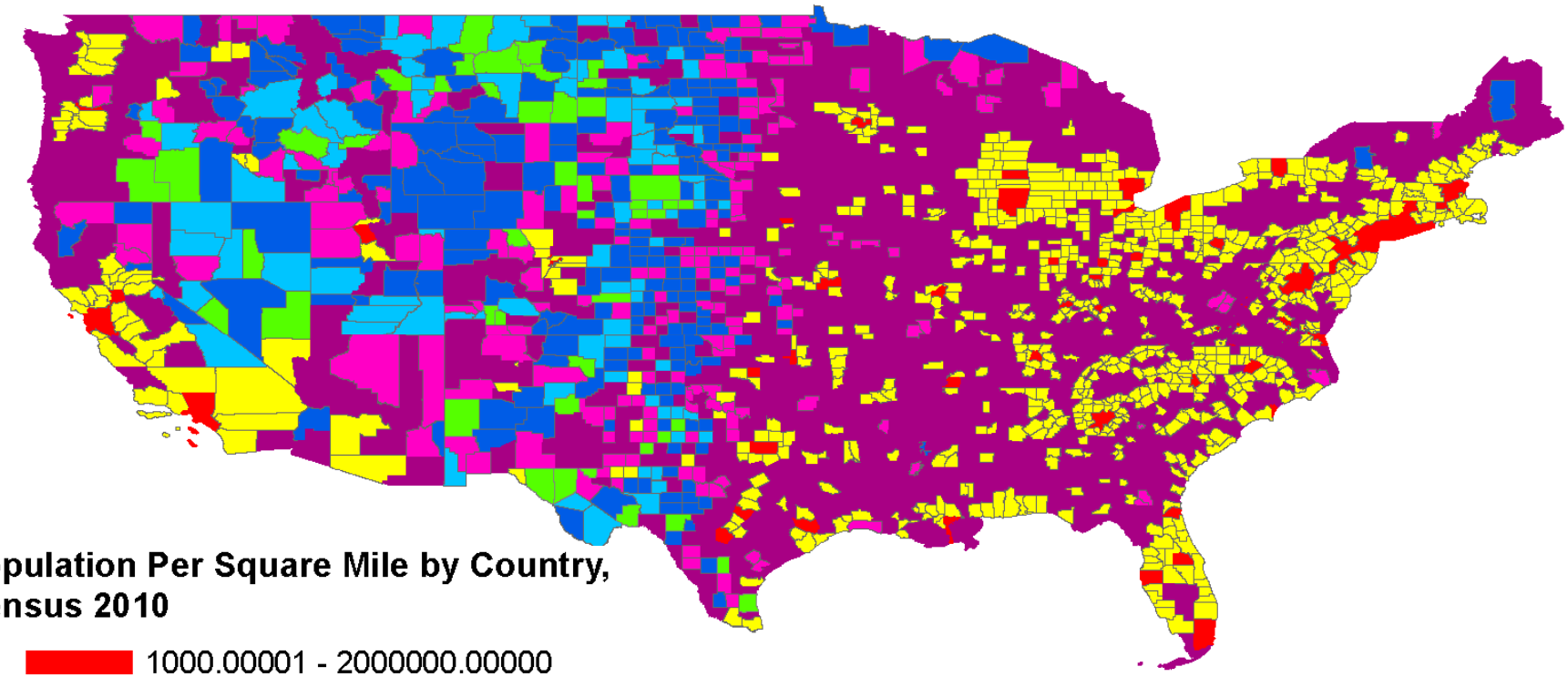
- ***Guidelines* given to cellular providers for towers near the Fallon Range Training Complex**
  - Dual-band towers (e.g., 850/1900)
  - Backhaul by (in order of preference):
    - **Fiber (!!!)**
    - Millimeter wave
    - Dual-band microwave, seek max separation
    - Get above 10 GHz, ideally 17 GHz
  - Rubidium time source backup (standard design for existing towers)
  - Provide realtime data to NSAWC on 911 activity and location
  - Over time: increased tower density

Fiber is much broader band and generally more permanent than wireless

# Interesting Facts About Nevada

# From Census 2010

# Counties, Contiguous US



**Population Per Square Mile by Country, Census 2010**

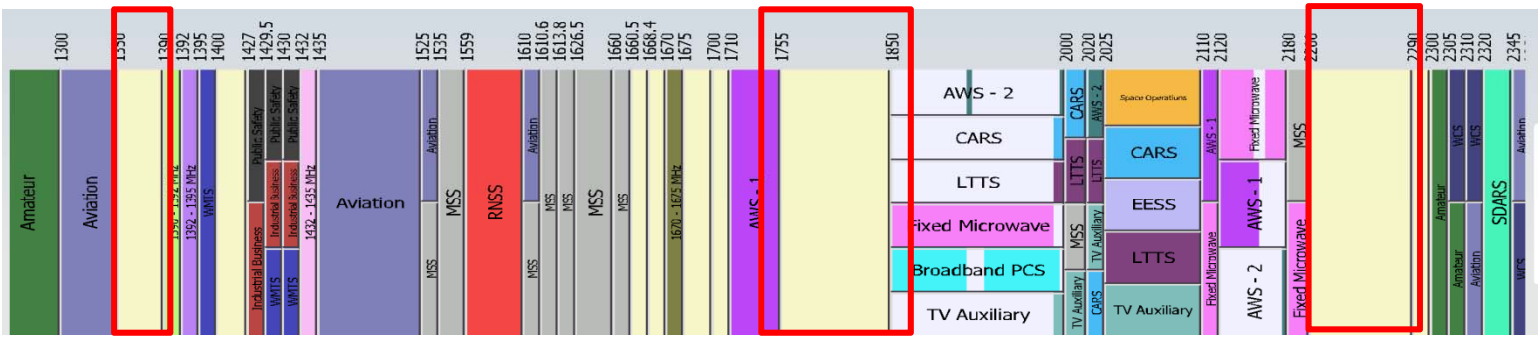
- 1000.00001 - 2000000.00000
- 100.00001 - 1000.00000
- 10.00001 - 100.00000
- 5.00001 - 10.00000
- 2.00001 - 5.00000
- 0.99001 - 2.00000
- 0.00001 - 0.99000
- 0.00000

# Spectrum Auction

## Derived From a Presentation Made to the FCC Office of Engineering and Technology

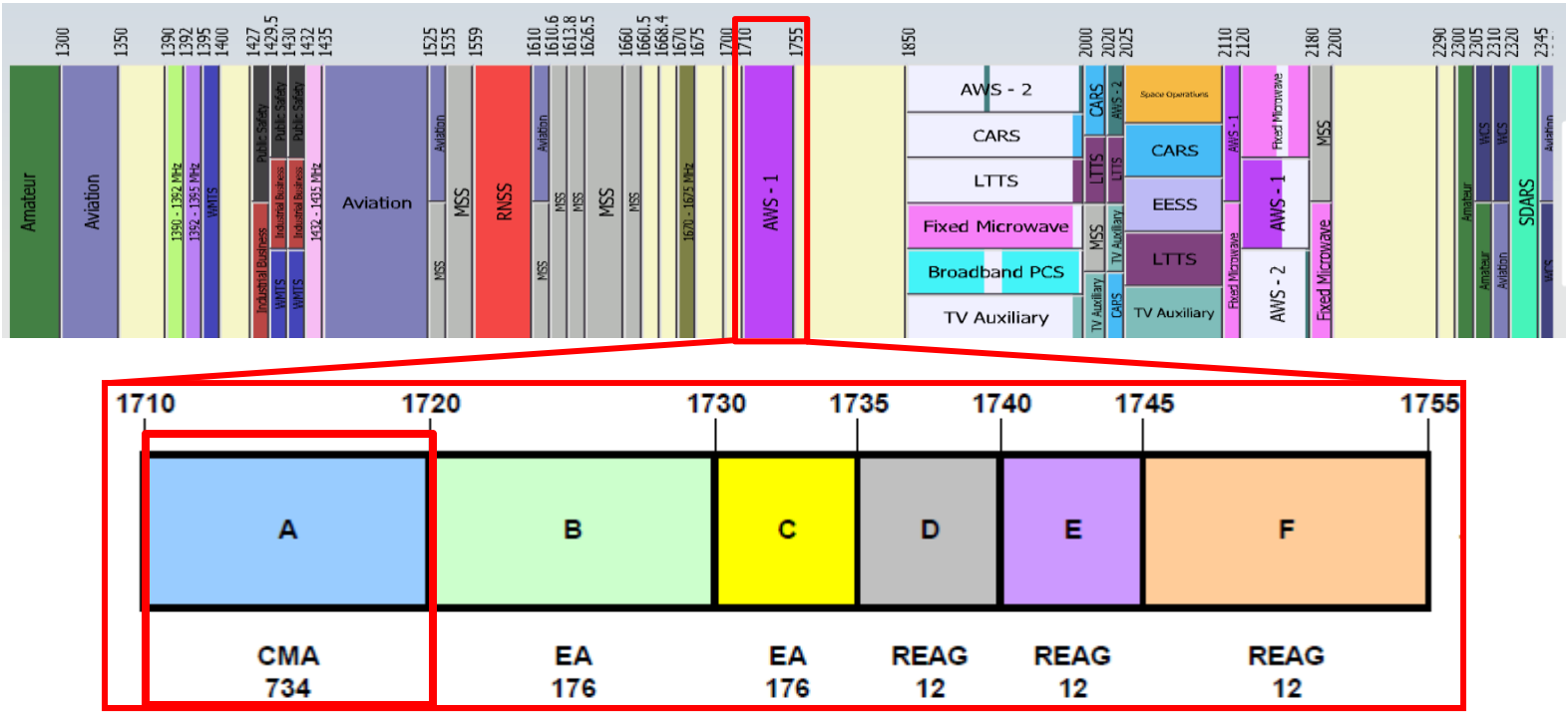
# Spectrum Auction

- **Further auction of DoD RF spectrum is under consideration**
- **Impetus:**
  - National Broadband Plan
  - Revenue
- **What is the revenue impact of auctioning spectrum in lightly populated regions?**



# Spectrum Auction

- **Example case: Auction 66, *Advanced Wireless Service-1* (AWS-1), DoD's former 1710-1755 MHz band auctioned off for commercial 3G cellular service in 2006**
- **Part of 1710-1755 MHz ("Block A", 1710-1720 MHz) was auctioned across the FCC's *Cellular Market Areas* (CMA)**

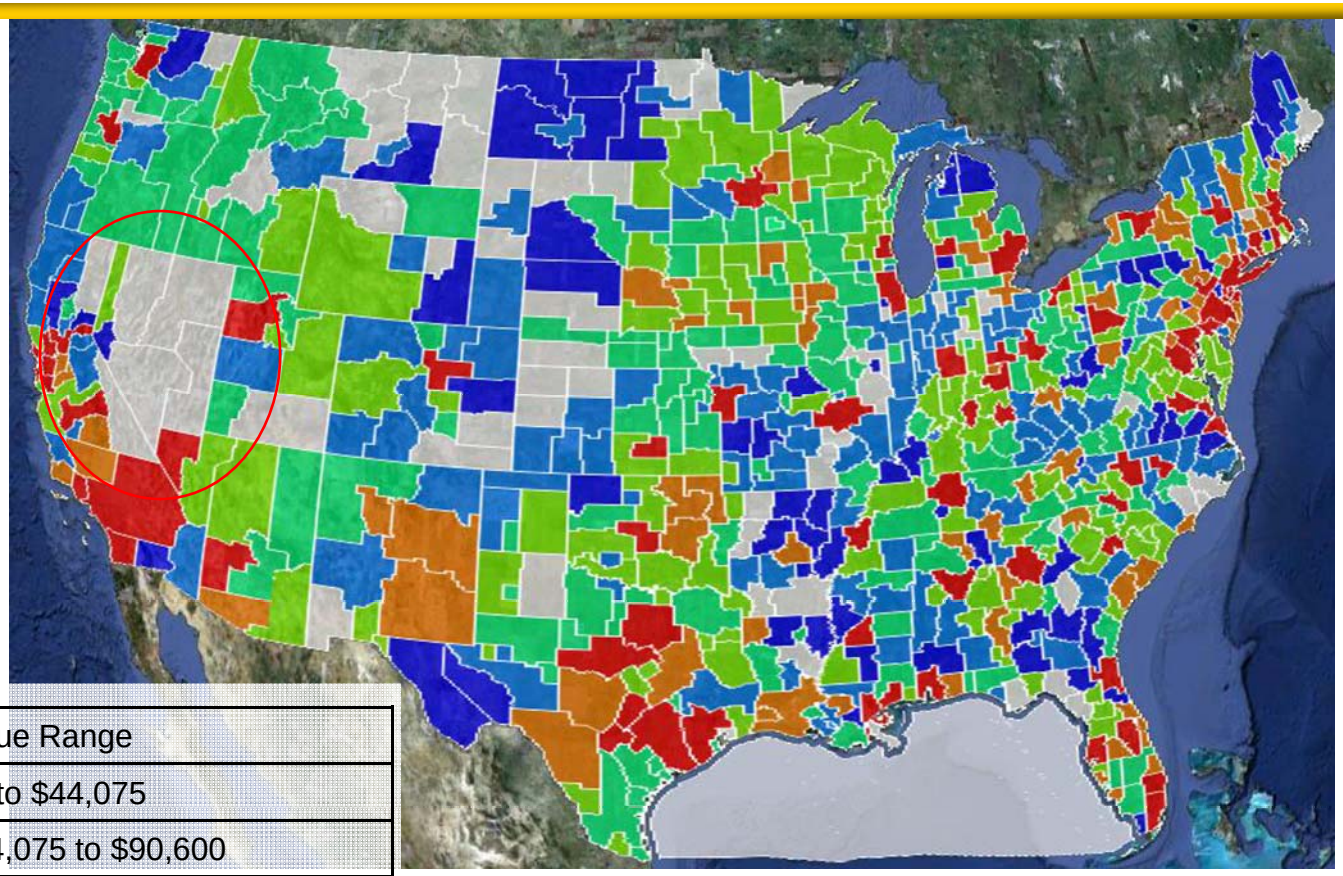


# Spectrum Auction

- **CMAs - The smallest geographic unit the FCC uses for spectrum auctions**

# Auction 66 Block A Results

- **Hid Bid: $396,232,000 (New York-Newark)**
- **Low Bid: $0 (Many including Mineral NV CMA)**
- **Average Bid: $3,061,332**
- **Total Cellular Market Areas: 734**
- **Total Revenue Collected: $2,247,017,800**



| Color | Percentile Range | Value Range |
|---|---|---|
| | 0 to 10 | $0 to $44,075 |
| | 10 to 20 | $44,075 to $90,600 |
| | 20 to 40 | $90,600 to $188,200 |
| | 40 to 60 | $188,200 to $450,800 |
| | 60 to 80 | $450,800 to $1,160,200 |
| | 80 to 90 | $1,160,200 to $2,759,100 |
| | 90 to 100 | $2,759,100 to $396,232,000 |

- **<u>CMAs with large populations gain the most revenue</u>**

# Auction 66 Block A Results

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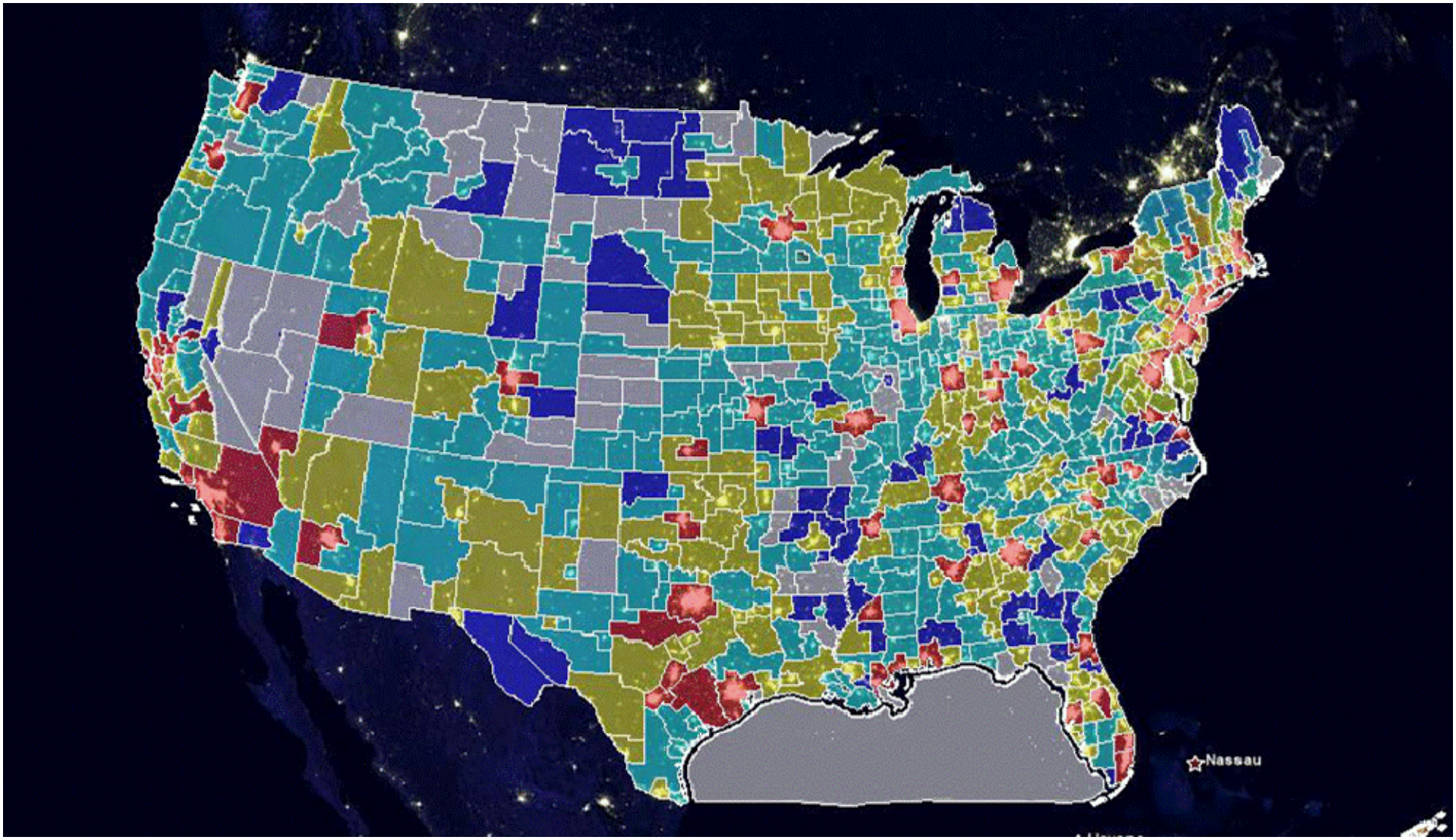
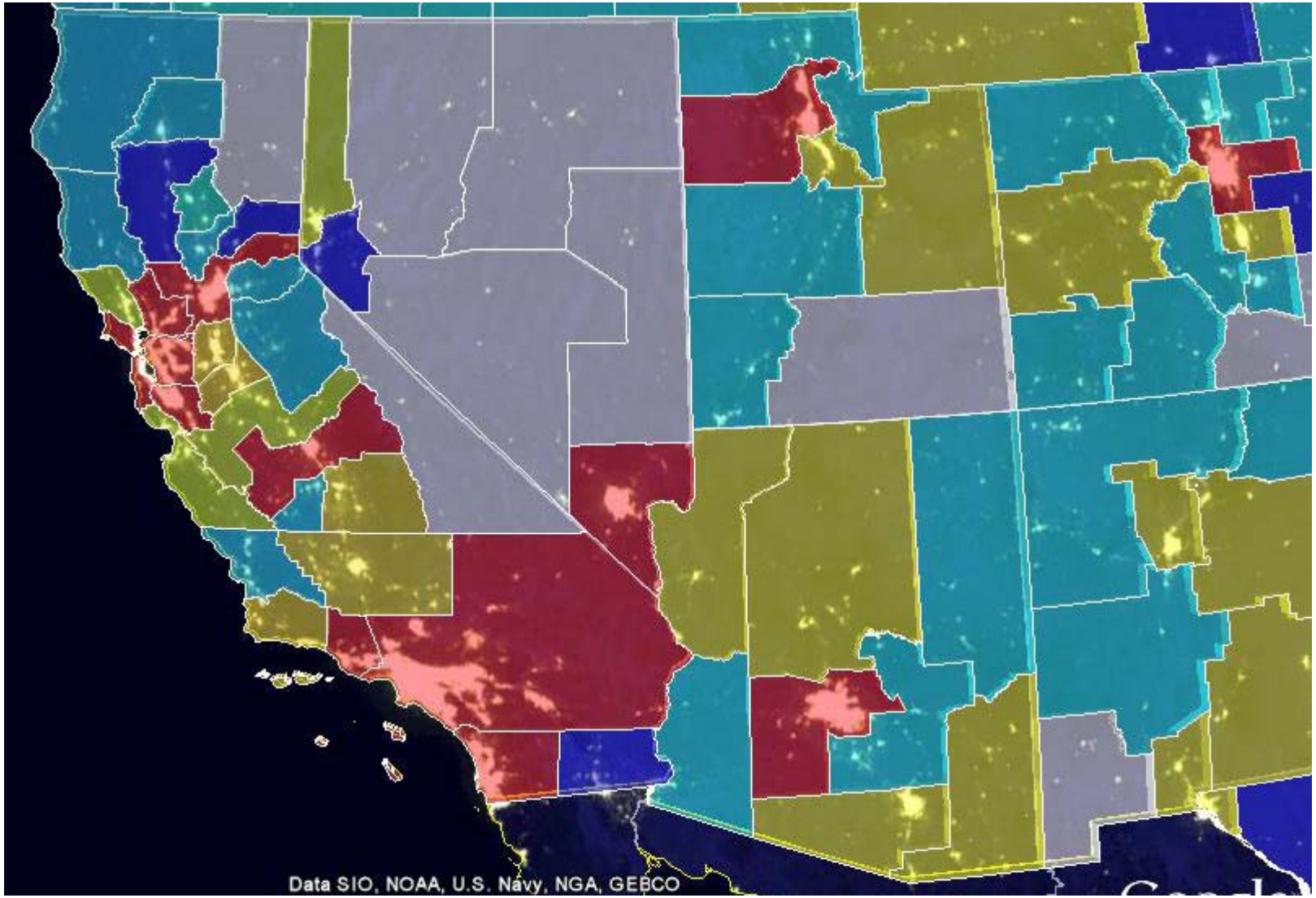
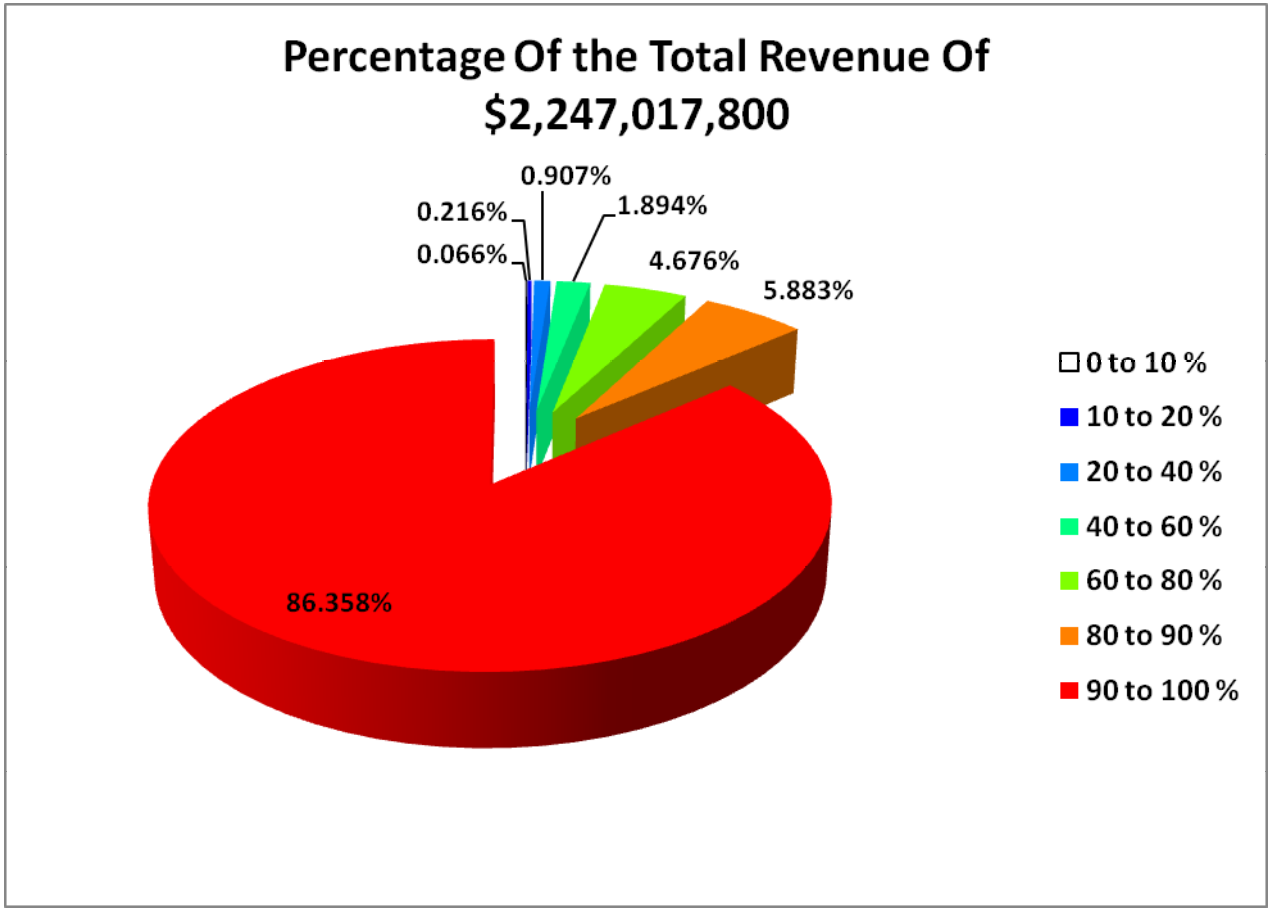


# Auction 66 Block A Results



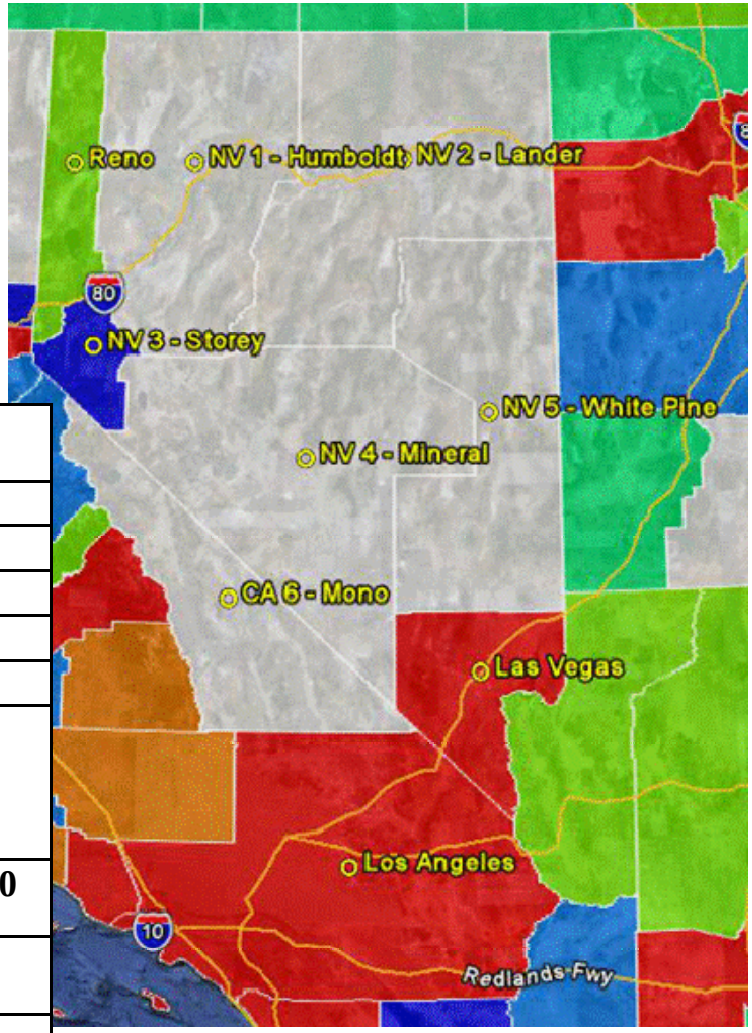
# Auction 66 Block A Results

- **The top ten percentile is responsible for 86% of the total revenue**



# Auction 66 Block A Results

- **A closer look at some below 10 percentile CMAs**
- **<u>CMAs with small populations gain the least revenue</u>**




| CMA Name | High Bid |
|---|---|
| Mono | $13,500 |
| Humboldt | $28,000 |
| Lander | $32,000 |
| Mineral | $0* |
| White Pine | $6,000** |
| **Total of high bids from CMAs listed (population impacted more than one per cent by the Spectrum Preserve)** | **$79,500** |
| **Sum of high bids from all CMAs offered in the auction** | **$2,247,017,800** |
| **Percentage of the sum of all high bids from listed CMAs** | **0.004** |
| **Average high bid from all CMAs sold in the auction** | **$3,061,332** |

# Spectrum Auction

- **These results are typical of spectrum auctions**
  - Metropolitan areas are responsible for most of the revenue
  - Unpopulated areas do not sell, or sell for miniscule prices
- ***Insignificant revenue would be lost if spectrum were not auctioned in the lightly populated regions of Nevada***

# Spectrum Preserve

# Spectrum Preserve

- Generally adheres to county boundaries, similar to FCC auction regions
- Some simple exceptions to avoid populated areas

# Spectrum Preserve

## ➢ Populations stats for the depicted region

| County | Population within the Preserve, Census 2010 | Total County Population, Census 2010 | Population within the Preserve, Percent of Total County Population | Area of County Encompassed by the Preserve, Sq Mi, Land and Water | Total Area of County, Sq Mi, Land and Water | Percent of Total |
|---|---|---|---|---|---|---|
| San Bernardino | 11237 | 2035210 | 0.55 | 3989.9 | 20104.8 | 19.85 |
| Inyo | 1008 | 18546 | 5.44 | 7855.3 | 10226.9 | 76.81 |
| Mono | 186 | 14202 | 1.31 | 355.0 | 3131.9 | 11.34 |
| Eureka | 1369 | 1987 | 68.90 | 2897.0 | 4180.0 | 69.31 |
| Lander | 536 | 5775 | 9.28 | 3909.5 | 5519.5 | 70.83 |
| Esmeralda | 783 | 783 | 100.00 | 3589.0 | 3589.0 | 100.00 |
| Mineral | 4772 | 4772 | 100.00 | 3813.0 | 3813.0 | 100.00 |
| Lincoln | 5345 | 5345 | 100.00 | 10637.0 | 10637.0 | 100.00 |
| White Pine | 10030 | 10030 | 100.00 | 8896.8 | 8896.8 | 100.00 |
| Churchill | 844 | 24877 | 3.39 | 3534.7 | 5024.1 | 70.36 |
| Nye | 6101 | 43946 | 13.88 | 17258.4 | 18198.6 | 94.83 |
| **Total Population Within the Preserve** | **42211** | | **Total Preserve Area, Sq Mi** | **66735.6** | | |
| **Persons Per Sq Mile Within the Preserve** | | **0.63** | | | | |

# For Consideration

- **Don't auction spectrum in the depicted region**
- ***Share* spectrum**
  - DoD retains control of its spectrum but shares with commercial/civil
  - Use auction revenue and/or Universal Service Funds to adapt commercial/civil applications to DoD spectrum use

# Summary

- EW Training, Testing, and Tactics development remains a necessity
- It requires <u>spectrum</u> – so do civil/commercial applications
- Local coordination is a key
- And there may be alternatives to current spectrum auction practices in some geographic regions

# Questions?

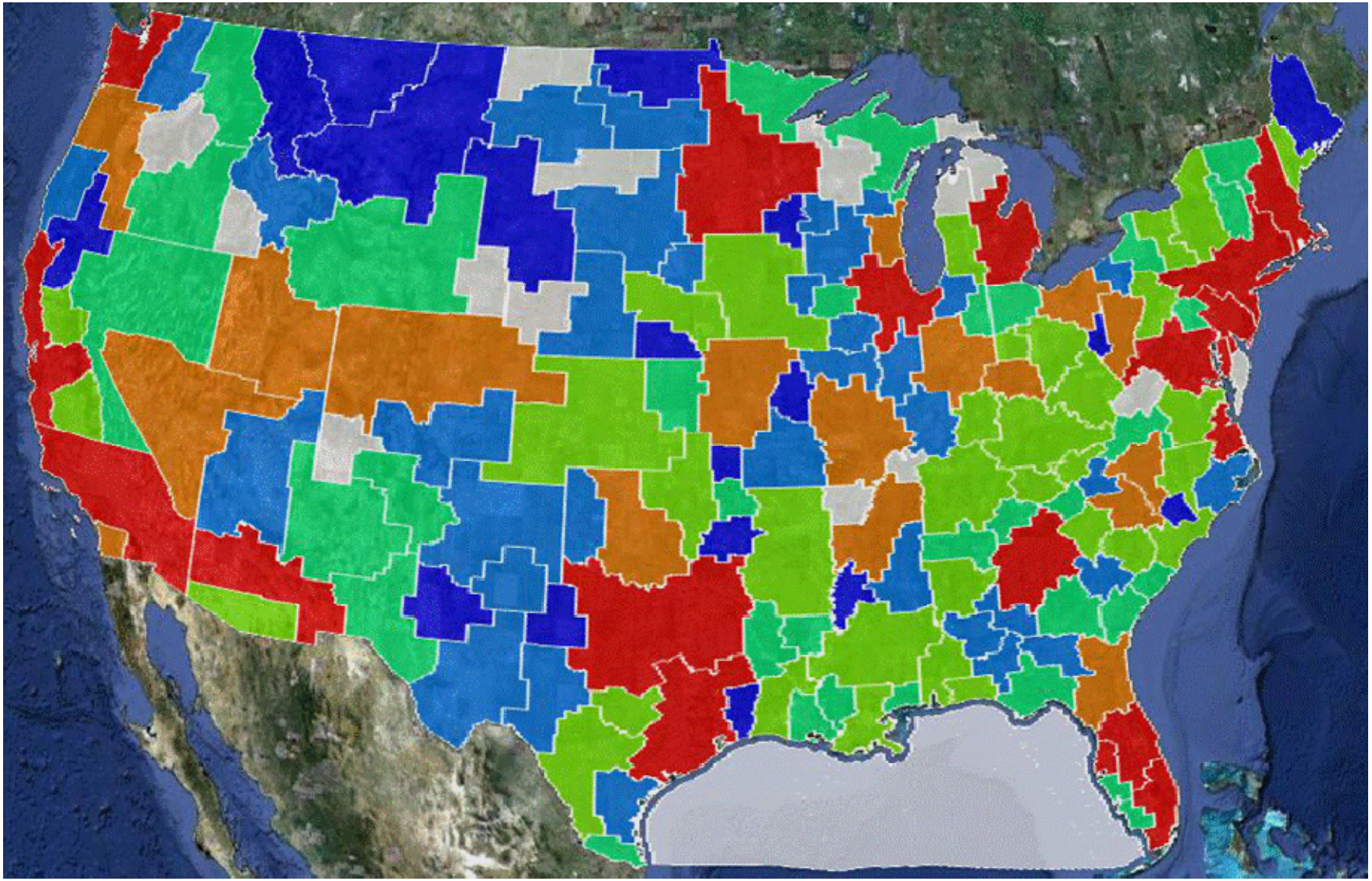
# Auction 66 Block B BEAs

**Auction 66 Advanced Wireless Service -1 Block B Market BEA**

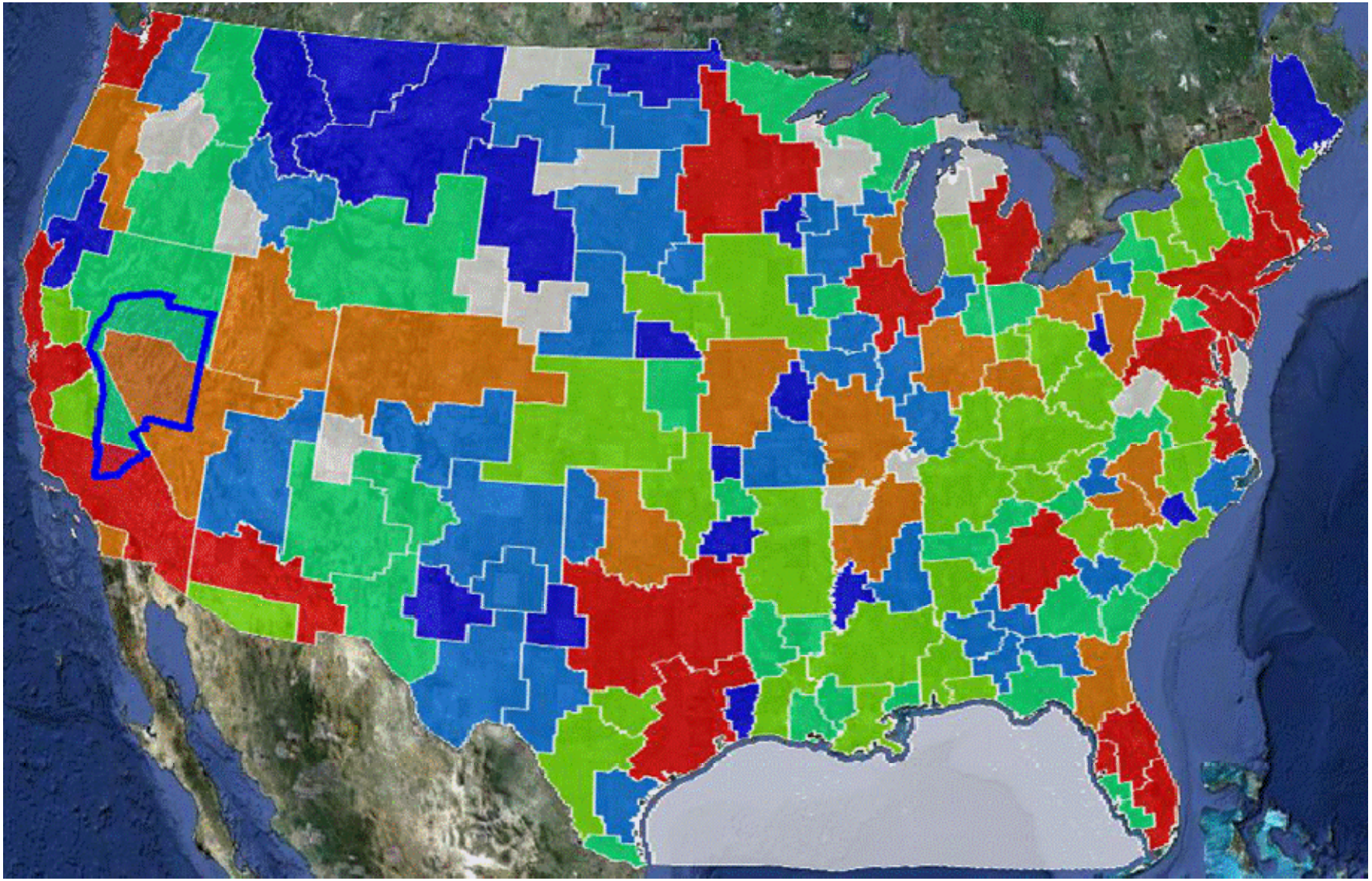
**Hid Bid: $468,178,000**
**Low Bid: $0**
**Average Bid: $13,847,345**
**Total Market Areas: 176**
**Total Revenue Collected: $2,437,132,750**

| Color | Percentile Range | Value Range |
|---|---|---|
| | 0 to 10 | $0 to $287,875 |
| | 10 to 20 | $287,875 to $496,000 |
| | 20 to 40 | $496,000 to $1,140,000 |
| | 40 to 60 | $1,140,000 to $3,366,000 |
| | 60 to 80 | $3,366,000 to $12,431,000 |
| | 80 to 90 | $12,431,000 to $25,627,000 |
| | 90 to 100 | $25,627,000 to $468,178,000 |

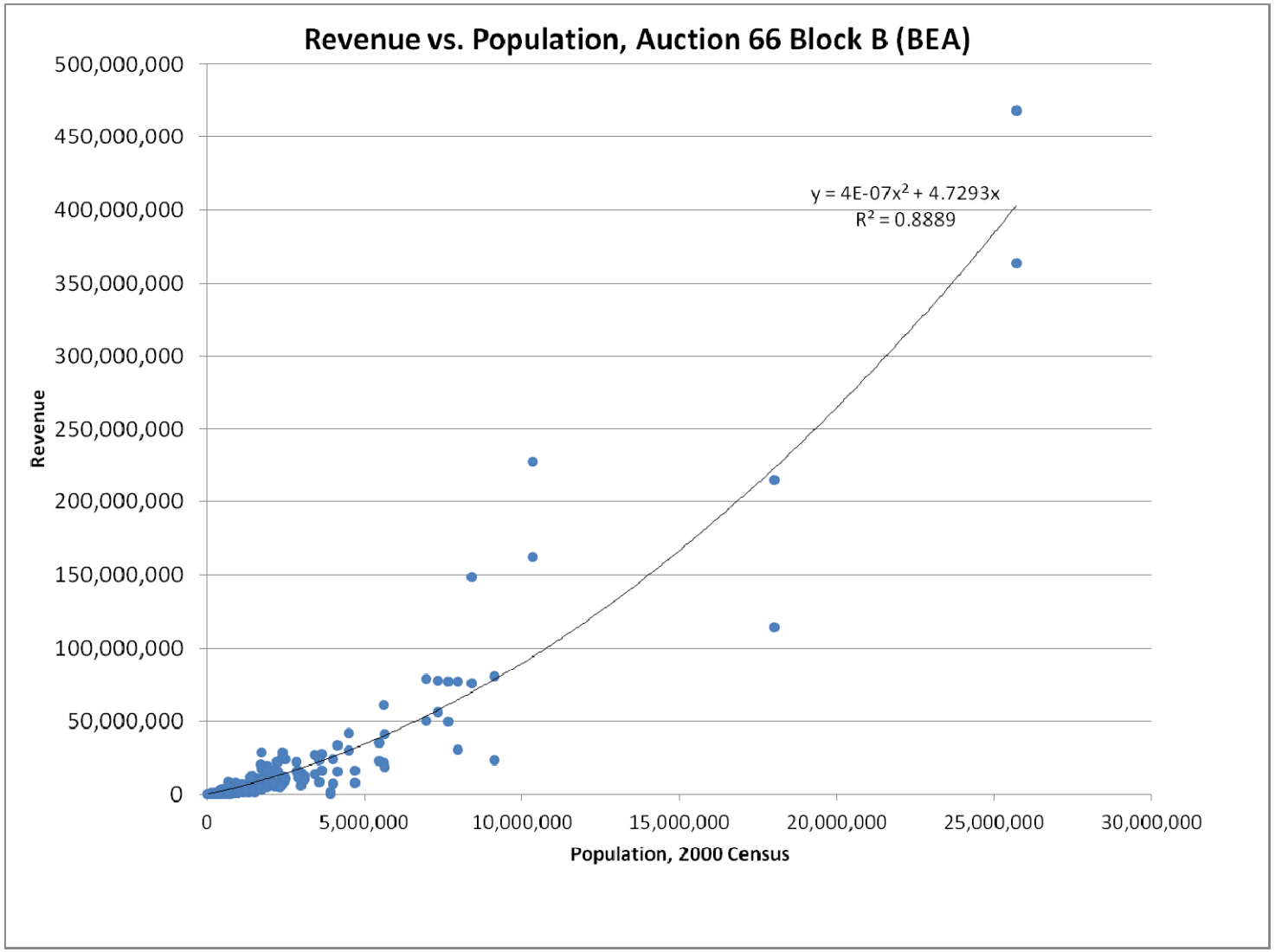
# Auction 66 Block B BEAs



# Auction 66 Block B BEAs



# BEA Population/Revenue Plot

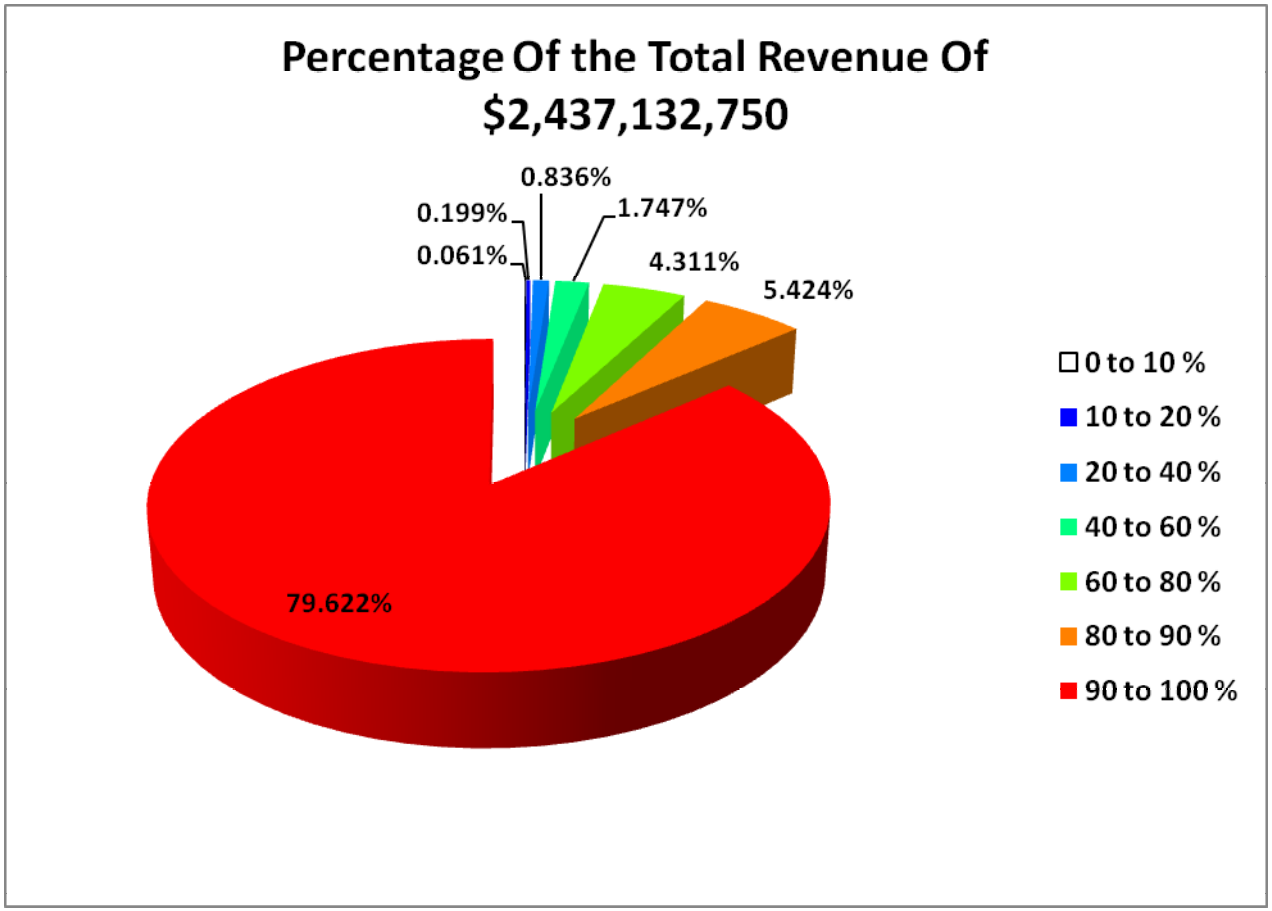


# BEA Impact

| EA/BEA Name | Total Population, Census 2010 | Population Lost to the Spectrum Preserve, Census 2010 | Percent of Population lost to the Spectrum Preserve | Area, $mi^2$ | Area Lost to the Spectrum Preserve, $mi^2$ | Percent of Area Lost to the Spectrum Preserve |
|---|---|---|---|---|---|---|
| Reno | 786501 | 17289 | 2.20 | 88149 | 20479* | 23.23* |
| Los Angeles | 19800937 | 14643 | 0.07 | 62541 | 4786 | 7.65 |
| Las Vegas | 2403936 | 18374 | 0.76 | 71595 | 35467 | 49.54 |

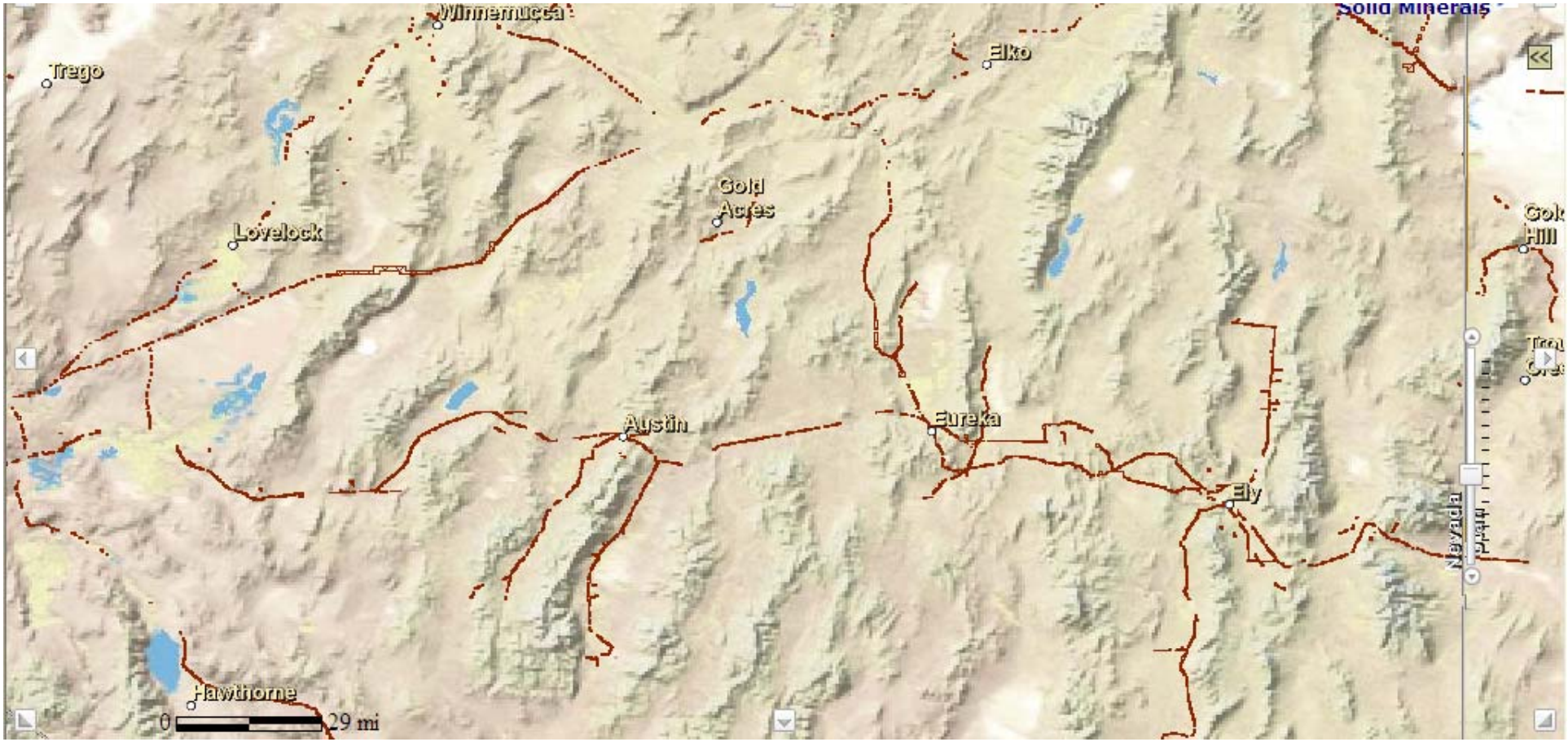
*Area based on a smaller exclusion zone that omits White Pine County. Population figures are accurate

# Auction 66 Block B BEAs



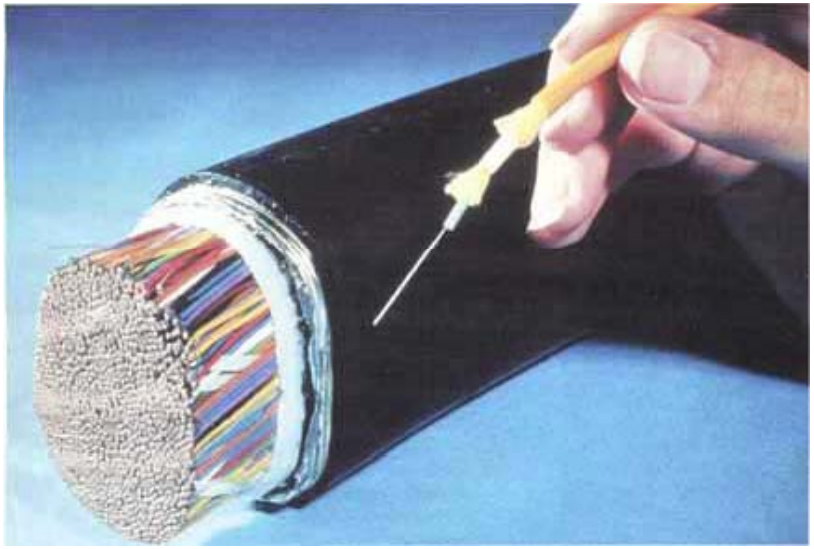
# Fiber in Central Nevada

- **Fiber rights of way on public land per BLM Geocommunicator**



# Fiber Optics

## ➢ From the Fiber Optic Association Website



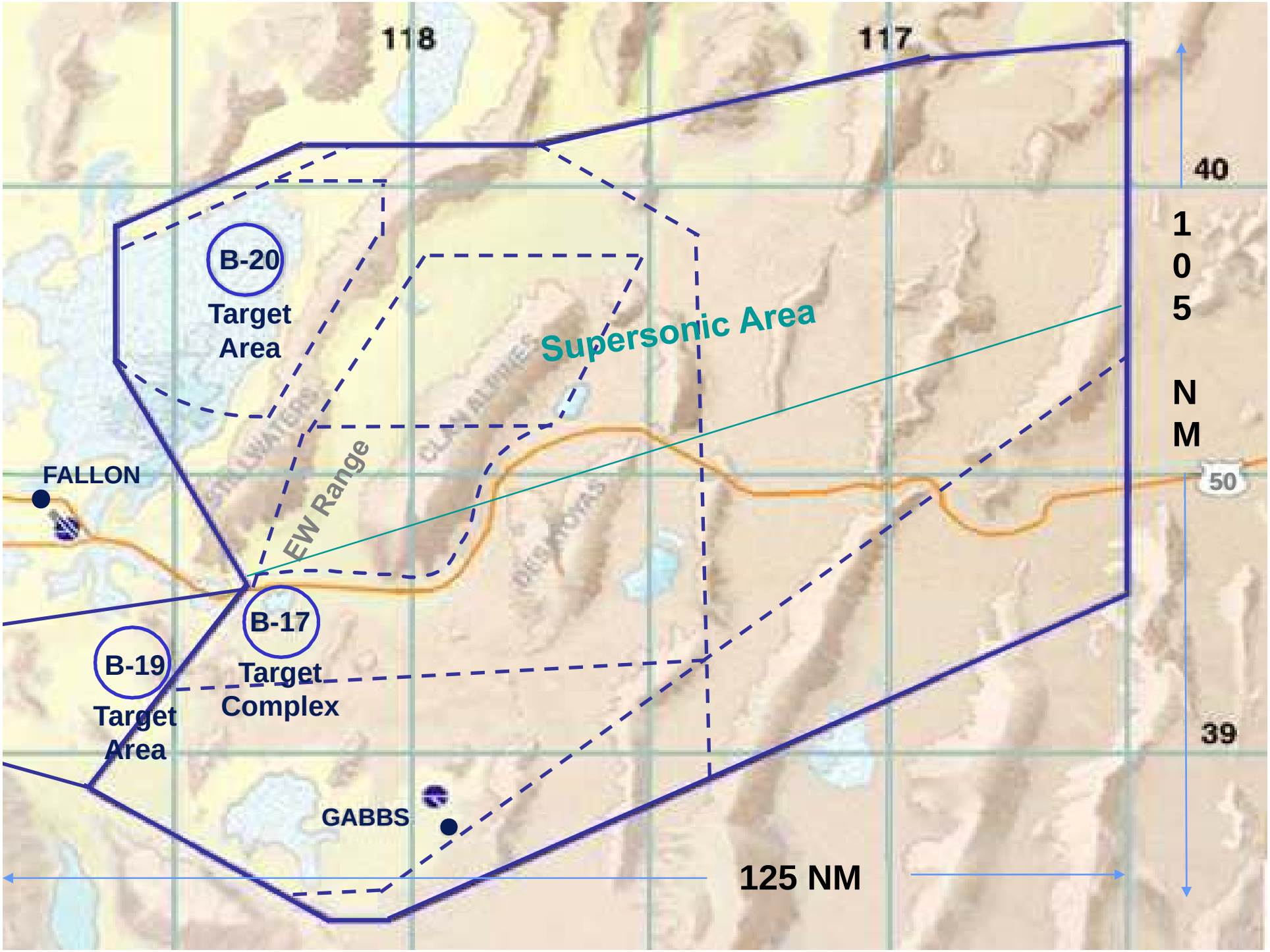
http://www.thefoa.org/tech/ref/basic/basics.html
(c) 1999-2008, The Fiber Optic Association, Inc.

**The biggest advantage of optical fiber is the fact it is the most cost effective means of transporting information.** Fiber can transport more information longer distances in less time than any other communications medium, as the photo on the left from the late 1970s illustrates so well.

The bandwidth and distance capability of fiber means that fewer cables are needed, fewer repeaters, less power and less maintenance. **In addition, fiber is unaffected by the interference of electromagnetic radiation** which makes it possible to transmit information and data with less noise and less error. Fiber is lighter than copper wires which makes it popular for aircraft and automotive applications.

Wireless was used as a long distance medium until fiber became available, but **wireless is limited by available transmission frequencies** so it was dropped as a long distance medium. While local wireless has grown exponentially, it uses fiber as a backbone and connection to the international phone system.

**These advantages makes the use of optical fiber the most logical choice in data transmission.**


118
117
40
105 NM
39
50
B-20
Target Area
Supersonic Area
EW Range
FALLON
B-17
Target Complex
B-19
Target Area
GABBS
125 NM