
# Spectrum Update
# GOES DCS TWG

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# Topics

GOES 13,14 & 15 versus GOES 16-series Downlink Services

“Was/Now” DCPR and DCPC Frequencies

Spectrum “Neighbors”:

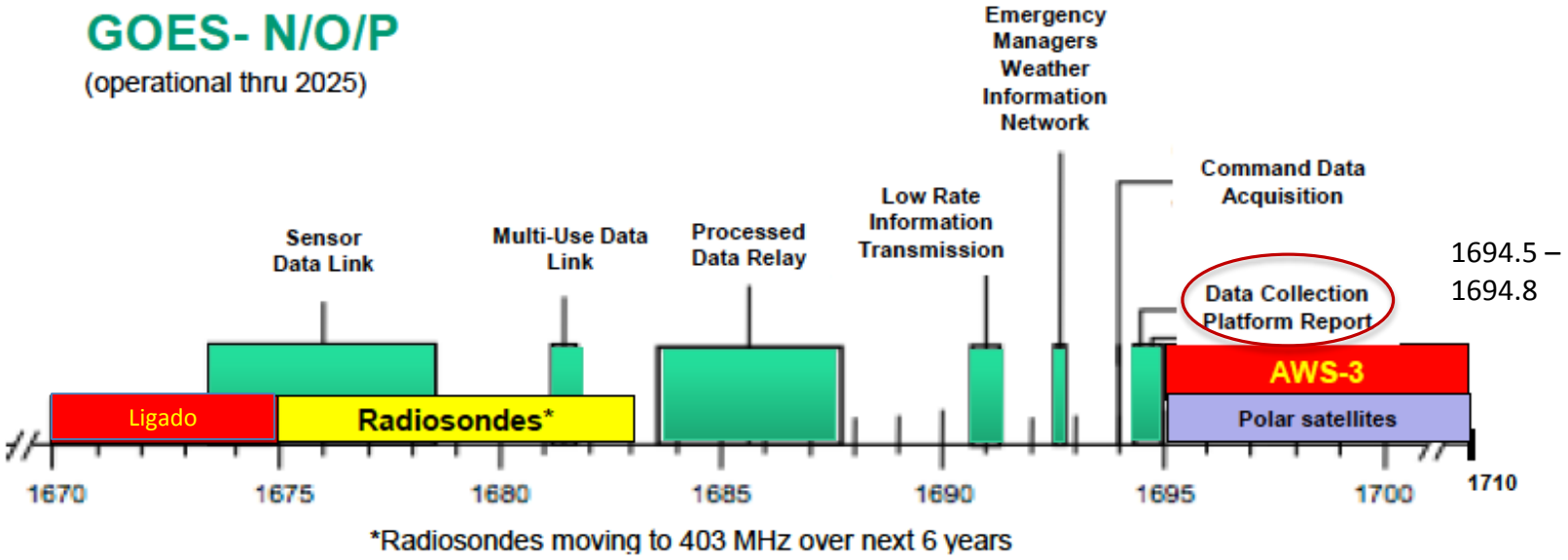
- Advanced Wireless Services-3 (AWS-3) in 1695-1710 MHz
- FCC Band Sharing Proposals at 1675 – 1680 MHz

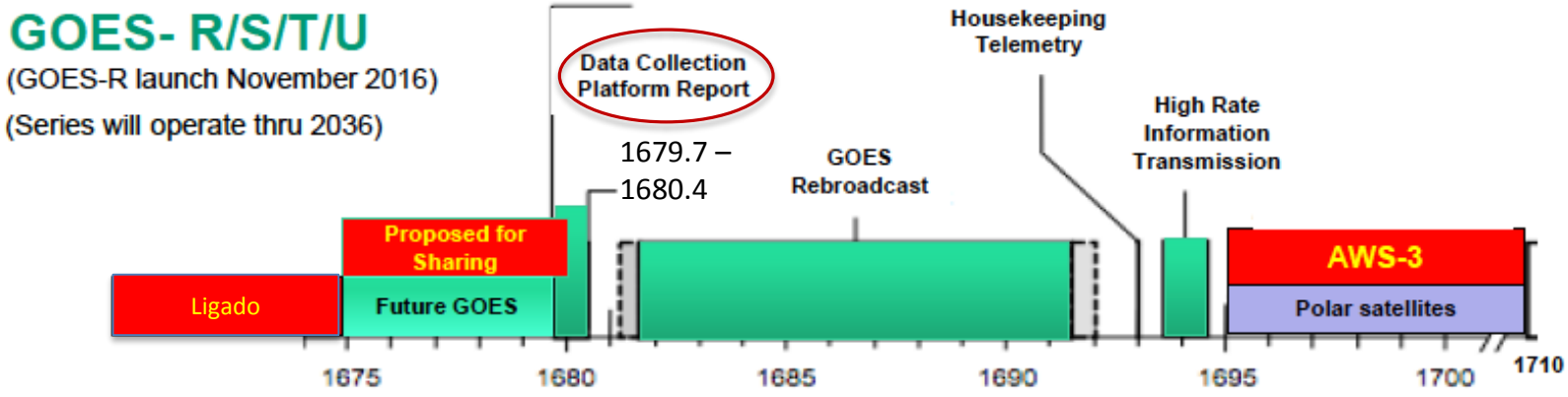
Growth of Small Satellites

- SmallSat Spectrum Options
- Space Operations Service
- International Amateur Radio Union (IARU) and 400 MHz

Nomigraphs and DCS

# GOES/GOES-R Services & Spectrum



# Center Frequencies Associated with DCS

- GOES-13/14/15 vs GOES-16 series Frequencies Associated with DCS

| Service | Satellite Family | Frequency (MHz) |
|---|---|---|
| DCPR (downlink) | GOES 13,14,15 | 1694.5 - 1694.8 |
| DCPR (downlink) | GOES-16 series | 1679.7 – 1680.4 |
| DCPI (return DL) | GOES 13,14,15 | 468.825 |
| DCPC (return DL) | GOES-16 series | 468.775-468.825 |
| DCPR (uplink) | All Satellites | 401.7 – 402.4 |
| | | |

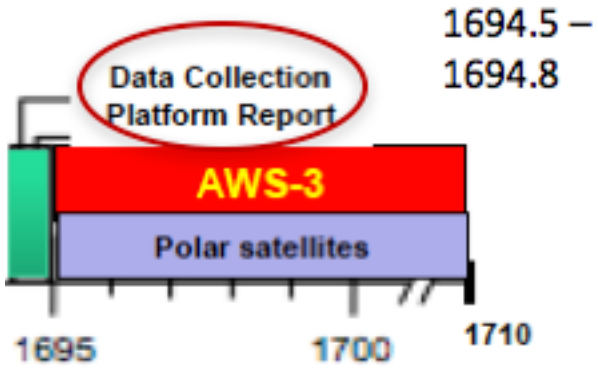
- Why did these downlink frequencies change between satellite series?
  - GOES-R satellites have considerably more data in other services broadcast in this band, requiring more bandwidth in other services
  - EMWIN/HRIT and DCS frequencies in GOES-16 series revised to have GOES-ReBroadcast (GRB) between them (see prior slide)

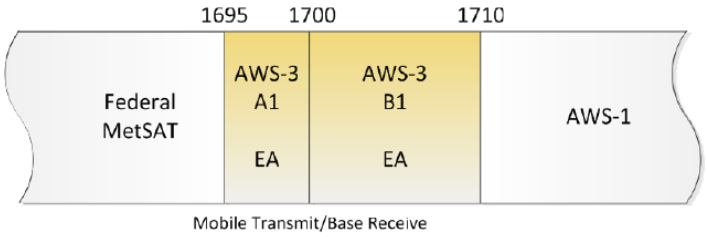
Status: DCPR Adjacent Band Services GOES 13, 14 & 15

1695 – 1710 MHz (AWS-3)

# Adjacent Band Spectrum Neighbors Advanced Wireless Services

- Growth is occurring in spectrum use, by nearly all users
- Federal regulators study Federal spectrum use and opt to share some bands with commercial users

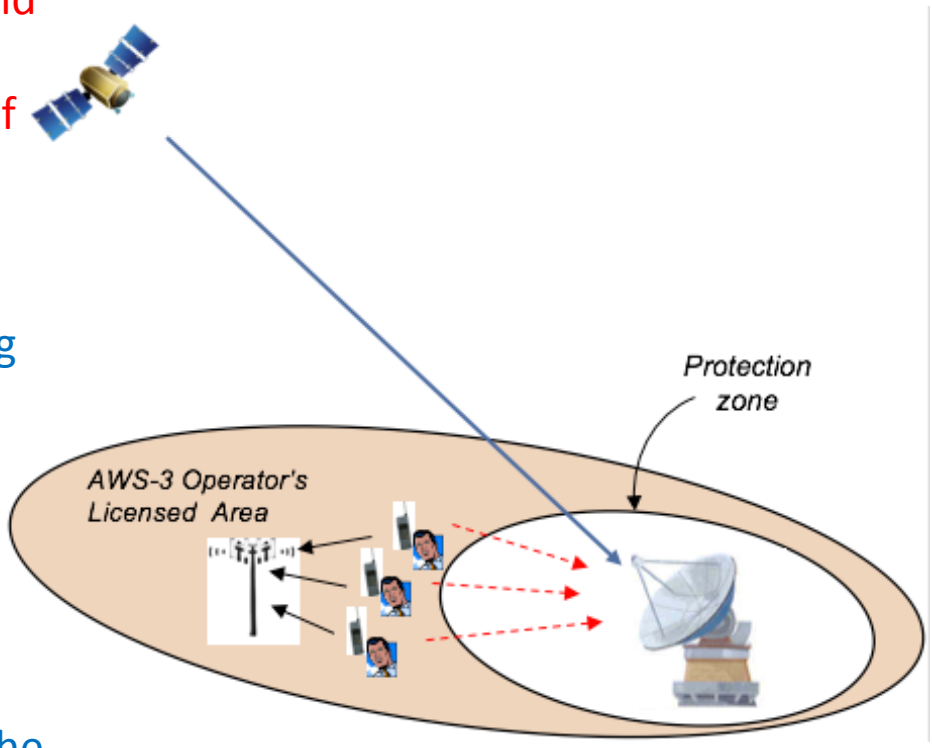


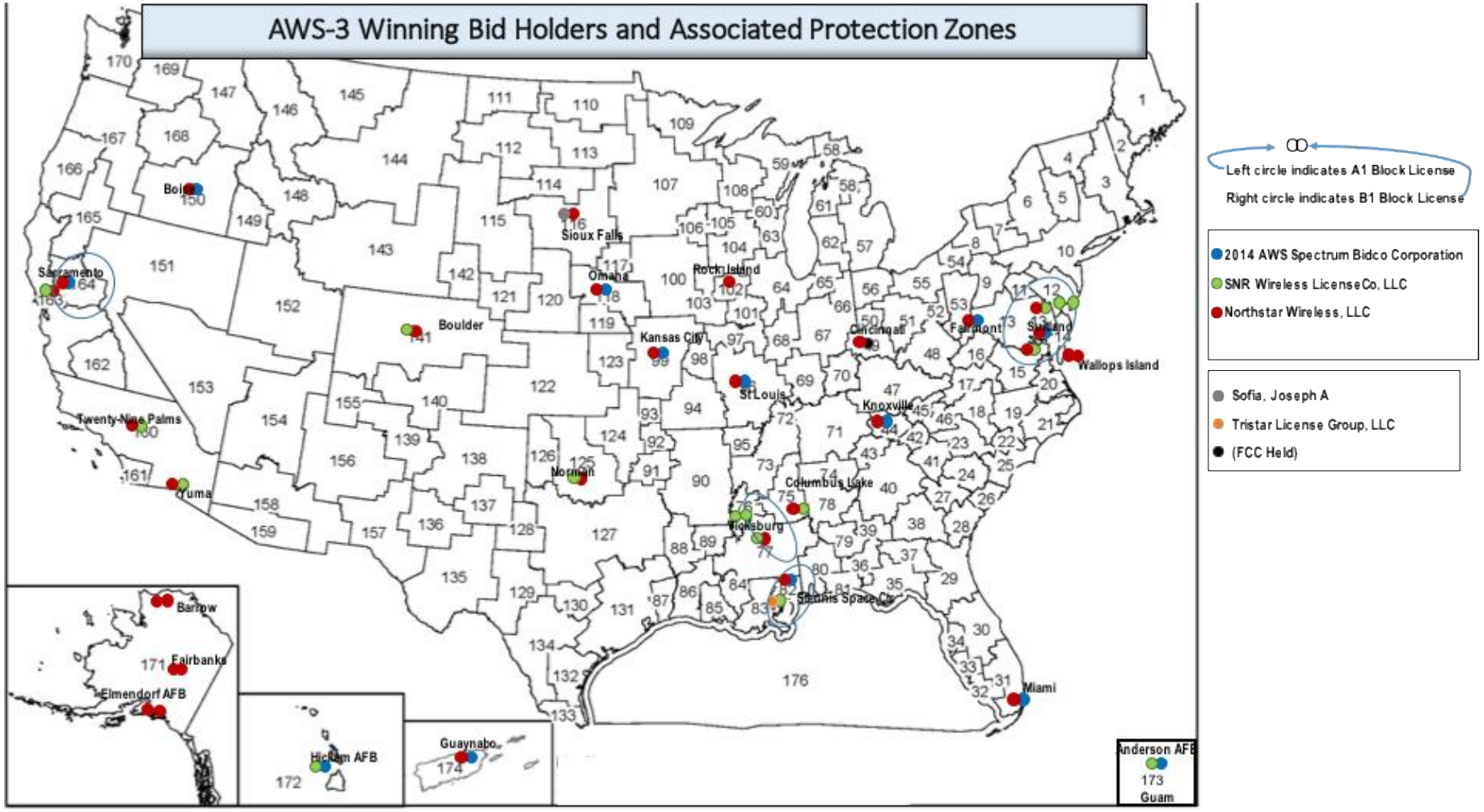

- In 2015, the band adjacent to legacy GOES DCPR was sold at auction for use in handset-to-tower commercial broadband.
- Provisions were made for select Federal stations to have Protection Zones where towers would prevent handsets from being used in this band.
- This 1695 – 1710 MHz was divided into two blocks (A1 & B1) and sold “unpaired” which means it did not come with the tower-to-handset frequencies

# Why should DCS users care about the adjacent band operation?

- Signals transmitted by handsets (individually or in aggregate) could interfere with DCP reception, if those signals were in proximity of Earth stations.
- Selected Federal sites, received Protection Zones, in the rules of the auction and resulting winning bidder licenses from the FCC
- Any stations other than the ones associated with the 27 zones, does not have any regulatory method to keep handsets away from the Earth station.
- Interference is likely to prevent the reception of DCP data at a given location.



# Stations Near Protected Sites




Note: Only Zones in Proximity to Listed Federal Sites Shown. Nearly All Blocks Sold.

# Protection Zones Near DCS Sites

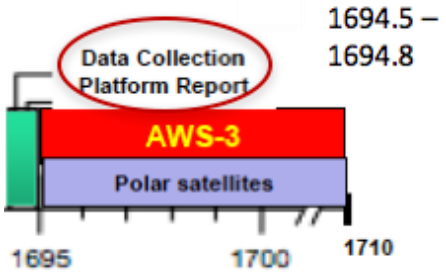
- Table Describes Zones Near Relevant Sites, zone size and winning bidders of the two spectrum blocks.

| Federal Earth Station Protection Zones (subset) | | | | Holder of Winning Bid from Auctic | Holder of Winning Bid from Auction |
|---|---|---|---|---|---|
| Location | State | Radius (km) | Market (BEA)Market (BEA) | A1 Block: 1695-1700 | B1 Block: 1700-1710 |
| Fairbanks | AK | 20 | Anchorage AK | Northstar Wireless LLC | Northstar Wireless LLC |
| Suitland | MD | 98 | Harrisburg-Lebanon-Carlisle PA | Northstar Wireless LLC | SNR Wireless LicenseCo LLC |
| Suitland | MD | 98 | Phil.-Atl. City PA NJ DE MD | SNR Wireless LicenseCo LLC | SNR Wireless LicenseCo LLC |
| Suitland | MD | 98 | Wash. Balt. DC MD VA WB PA | Northstar Wireless LLC | 2014 AWS Spectrum Bidco Corp |
| Suitland | MD | 98 | Richmond-Peterburg VA | Northstar Wireless LLC | SNR Wireless LicenseCo LLC |
| Stennis Space Center | MS | 57 | Biloxi-Gulfport-Pascagoula MS | Northstar Wireless LLC | 2014 AWS Spectrum Bidco Corp |
| Stennis Space Center | MS | 57 | New Orleans LA MS | Tristar License Group LLC | SNR Wireless LicenseCo LLC |
| Sioux Falls | SD | 42 | Sioux Falls SD-IA-MN-NE | Sofio, Joseph A | Northstar Wireless LLC |
| Wallops Island | VA | 30 | Salisbury MD DE VA | Northstar Wireless LLC | Northstar Wireless LLC |
| Sacramento | CA | 55 | San Fran.-Oakland-San Jose CA | SNR Wireless LicenseCo LLC | Northstar Wireless LLC |
| Sacramento | CA | 55 | Sacramento-Yolo CA | Northstar Wireless LLC | 2014 AWS Spectrum Bidco Corp |
| Boise | ID | 39 | Boise City ID OR | Northstar Wireless LLC | 2014 AWS Spectrum Bidco Corp |
| Rock Island | IL | 19 | Davenport-Moline IA IL | Northstar Wireless LLC | Northstar Wireless LLC |
| St. Louis | MO | 34 | St. Louis MO IL | Northstar Wireless LLC | 2014 AWS Spectrum Bidco Corp |
| Columbus Lake | MS | 3 | Tupelo MS AL TN | Northstar Wireless LLC | SNR Wireless LicenseCo LLC |
| Vicksburg | MS | 16 | Greenville MS | SNR Wireless LicenseCo LLC | SNR Wireless LicenseCo LLC |
| Vicksburg | MS | 16 | Jackson MS AL LA | SNR Wireless LicenseCo LLC | Northstar Wireless LLC |
| Cincinnati | OH | 32 | Cincinnati-Hamilton OH KY IN | Northstar Wireless LLC | (No Bidder During Auction) |
| Knoxville | TN | 50 | Knowville TN | Northstar Wireless LLC | 2014 AWS Spectrum Bidco Corp |
| Fairmont | WV | 4 | Pittsburgh PA WV | Northstar Wireless LLC | 2014 AWS Spectrum Bidco Corp |

Note: Entities listed in red have partial ownership by Dish Network or Dish affiliates

# Current Status AWS-3 1695-1710

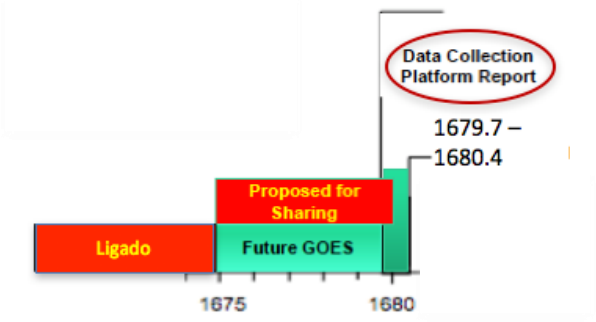
- No bidder is currently operating in the 1695-1710 MHz band
- Bidders affiliated with Dish, combined this band with other spectrum owned by Dish Network – and received approval for a new cellular band -- Band 70 in the 3GPP standard for LTE
- Dish Network has build out requirements for the paired tower spectrum in Band 70 of March 2020
  - It is unclear when the final installations or operations will occur in this band and when Band 70 will become widely included in smartphones
  - All licensees must coordinate with DOC, and no coordination requests are expected within the next few months -
- Note: GOES-13, 14, and 15 DCPR channels are 200 kHz below the 1695-1700 MHz AWS-3 channel block



Status: Adjacent and In-Band to GOES-R DCPR

Petition to Share 1675 – 1680 MHz

# Petition to Share 1675 - 1680 MHz

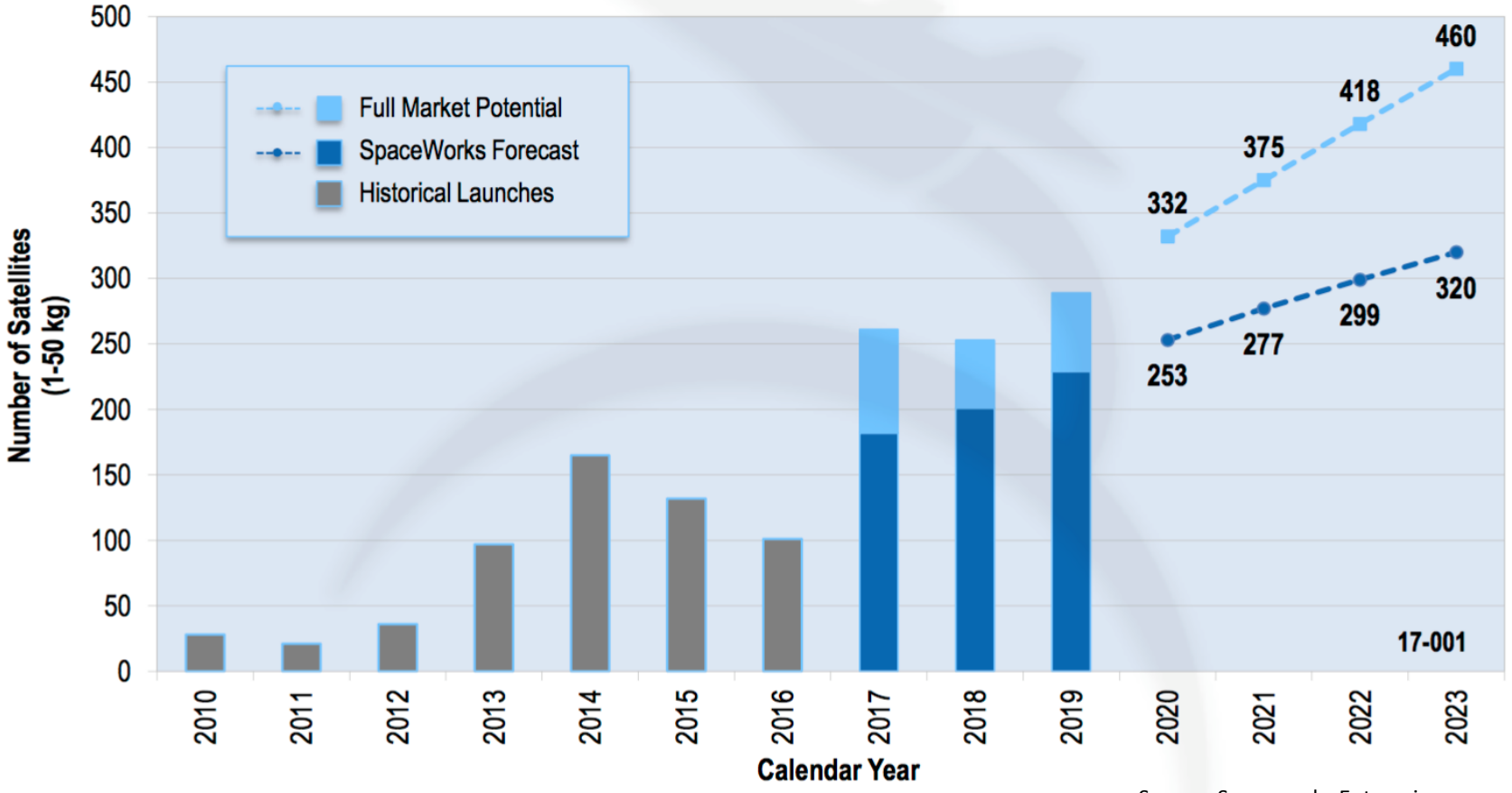



- A commercial provider has petitioned the FCC to share 1675-1680 MHz, because it is adjacent to nationally leased spectrum they have in 1670-1675 MHz
- Ligado Networks has been working to get some regulatory decision in this band for several years.
- This portion of spectrum, proposed for tower transmissions to users, is ¼ of what they require for full service. Three other blocks of spectrum, unrelated to hydrology frequencies, are also in discussion by regulators.
- The next step by the FCC would be to issue a Notice of Proposed Rulemaking, with another public comment period. There is no indication of when such FCC action would occur.

Small Satellites and VHF

# Growth of Small Satellites

- Nearly 2,400 satellites below 50 km size projected from 2017 through 2023

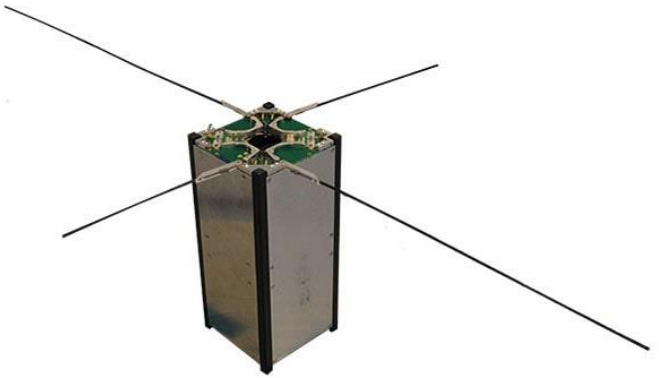



Source: Spaceworks Enterprises

There is no standard downlink allocation for smallsat operations in the 400 MHz band

# SmallSat Downlinks Omnidirectional

- Many small satellites have dipole antennas for transmission in all directions – for intended space-to-earth links
- How many signals in the 400-406 MHz band can the GOES-R receiver tolerate?
- The answer may be upwards of 250 satellites simultaneously in view of GOES, with signal transmissions toward geostationary orbit. A precise number that could degrade reception is difficult to determine
- Even with so many satellites – having that many with simultaneous signals radiating toward GOES/GOES-R might not occur



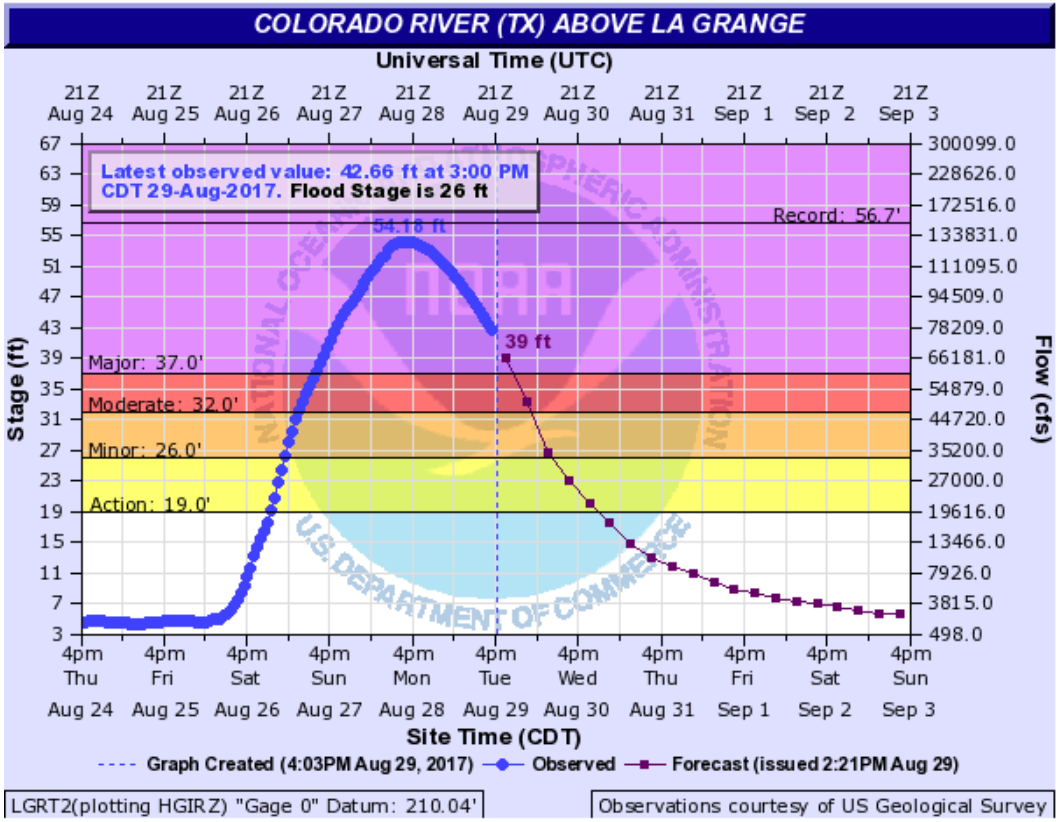
Source: Innovative Solutions in Space

# IARU Frequency Guidelines

- Many small satellites file with Amateur Radio frequency bands
- The International Amateur Radio Union (IARU) has come out in opposition to the widespread use – especially when the amateur connection is dubious.
- The International Telecommunications Union (ITU) noted that the use of 144-146 MHz and 435 – 438 MHz by non-amateur satellites is not in accordance with the radio regulations
- International recommendations were that “satellites with short duration missions” should use spectrum for space operations
  - 150.05 to 174 MHz (not used for satellites by FCC), and
  - **400.15 to 420 MHz** (in U.S. 400.15 – 401 MHz, 401 – 402 MHz are allocated for satellite downlinks for space operations)
- Will this drive more short duration satellites into the bands near the DCP uplink frequencies?
- ITU also has an Agenda Item 1.7, for 2019 conference, which may or may not help in alleviating pressure for other uses in the 400 MHz band.
  - Study of Telemetry & Command for non-Geostationary Short-Duration (Satellite) Missions, potentially to consider new frequency allocations.

# River Graphs & DCS Gages

- River Nomigraphs are not commonly identified with DCS
  - See Example LGRT2 Gage in Texas
- Perhaps the community should communicate the DCS contribution more widely




Source: NOAA AHPS