National Aeronautics and Space Administration





# **Space Communications & Navigation**

**International Spectrum Management: A NASA Perspective** 

> Glenn Feldhake

> NASA International Spectrum Program Manager

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# **A Little About NASA**

- Established 29 July 1958; began operations 1 October 1958
- Started with three research labs; now have 10
- This year's budget is 0.49% of the national budget
- 17,200 employees plus contractors
- ~65 operational spacecraft (including robots)
- ~40 planned in the next 4-5 years (many small satellites)
- Currently has ~2,300 frequency assignments domestically authorized (Spacecraft & terrestrial operations)
- Design, build, and launch U.S. weather satellites



#### **NASA Facilities**



#### **Spectrum Dependent Equities – Part I**



EOS (LEO) Communication & Sensing

#### **Spectrum Dependent Equities – Part II**

#### ...70% of NASA frequency assignments are not operating in space

- Research
  - **High-altitude balloons**
  - Weather radars
  - **Technology demonstrations**
  - **Radio astronomy**
  - Aircraft: Communication, radiolocation, and radionavigation lacksquare
  - **RF** signals to test and calibrate equipment
- **Day-to-day operation of Centers** 
  - Handheld radios for maintenance crews
  - **Building-to-building communications**
  - Security at front gate/emergency response lacksquare
  - Public address systems/wireless microphones







# **Types of NASA Space Missions**

- Telecommunication (e.g., TDRSS)
- Deep Space (e.g., Voyager, Curiosity)
- Space Research (e.g., Hubble Telescope, International Space Station)
  - Science
  - Exploration
- Earth Exploration (e.g., AQUA, EOS-AM, SMAP)
  - Active Sensors
  - Passive Sensors



Tracking and Data Relay Satellite System (TDRSS)



Hubble Space Telescope



Voyager



Soil Moisture Active/Passive (SMAP)

#### **Earth Exploration: Examples of Data Products and Uses**

#### **Disaster Management**

- **Extreme Weather**
- Floods
- **Coastal Hazards/Tsunamis**
- Volcanoes
- **Earthquakes**
- Landslides/Subsidence
- **Droughts**
- **Dust Storms**
- Wildfires

**Long-Term Management** 

- **Climate Change** •
- **Pollution Monitoring**
- **Plant Health**
- Land Usage
- **Population Density**
- **Deforestation**
- Desertification

Data products are made available to other Administrations via: SERVIR (www.servir.net) and UN SPIDER (www.un-spider.org)

# Earth Exploration Allocations for Active Sensing Emissions<sup>1</sup>

Fraguanay Rand Radia Sanviaa		Fraguancy Rand	Padio Sonvico	
Frequency band	Raulo Selvice	Frequency Band	Raulo Selvice	
401-403 MHz	EESS (E-s)	432-438 MHz	eess (active)	
460-470 MHz	[eess (s-E)]	1215-1300 MHz	EESS (active)	
1525-1535 MHz	eess	3100-3300 MHz	eess (active)	
1690-1710 MHz	[eess (s-E)]	5250-5570 MHz	EESS (active)	
2025-2110 MHz	EESS (E-s) (s-s)	8550-8650 MHz	EESS (active)	
2200-2290 MHz	EESS (s-E) (s-s)	9200-9800 MHz	EESS (active)	
7190-7250 MHz	EESS (E-s)	9800-9900 MHz	eess (active)	
8025-8400 MHz	EESS (s-E)	9900-10400 MHz	EESS (active)	
13.75-14 GHz	eess	13.25-13.75 GHz	EESS (active)	
25.5-27 GHz	EESS (s-E)	17.2-17.3 GHz	EESS (active)	
28.5-30 GHz	eess (E-s)	24.05-24.25 GHz	eess (active)	
29.95-30 GHz	eess (E-s)(s-s)	35.5-36 GHz	EESS (active)	
37.5-40 GHz	eess (s-E)	78-79 GHz	[EESS (active)]	
40-40.5 GHz	EESS (E-s) / eess (s-E)	94-94.1 GHz	EESS (active)	
65-66 GHz	EESS	130-134 GHz	EESS (active)	

<sup>1</sup> CAPITAL LETTERS: Primary Allocation lower case letters: Secondary Allocation [Square Brackets]: Allocation by footnote

#### **Allocations for Passive Sensing<sup>2</sup>**

Frequency Band	Radio Service	Frequency Band Radio Service
1370-1400 MHz	[eess (passive)]	36-37 GHz EESS (passive)
1400-1427 MHz	EESS (passive)	50.2-50.4 GHz EESS (passive)
2640-2655 MHz	[eess (passive)]	52.6-59.3 GHz EESS (passive)
2665-2690 MHz	eess (passive)	86-92 GHz EESS (passive)
2690-2700 MHz	EESS (passive)	100-102 GHz EESS (passive)
4200-4400 MHz	[eess (passive)]	109.5-122.25 GHz EESS (passive)
4950-4990 MHz	[eess (passive)]	148.5-151.5 GHz EESS (passive)
6425-7250 MHz	[eess (passive)]	155.5-158.5 GHz EESS (passive)
10.6-10.7 GHz	EESS (passive)	164-167 GHz EESS (passive)
14.8-15.35 GHz	[eess (passive)]	174.8-191.8 GHz EESS (passive)
15.35-15.4 GHz	EESS (passive)	200-209 GHz EESS (passive)
18.6-18.8 GHz	EESS (passive)	226-231.5 GHz EESS (passive)
21.2-21.4 GHz	EESS (passive)	235-238 GHz EESS (passive) / [EESS (active)]
22.21-22.5 GHz	EESS (passive)	250-252 GHz EESS (passive)
23.6-24 GHz	EESS (passive)	275-1000 GHz [eess (passive)]*
31.3-31.8 GHz	EESS (passive)	

<sup>2</sup> [Italics/square brackets] : Not allocated but in use.

# **Types of Orbits**

#### Geostationary Orbit (GSO)



#### Low Earth Orbit (NGSO)



#### Highly Elliptical Orbits (HEO)



#### Deep Space



#### **Near Earth Network**



# Space (TDRSS) Network



![](_page_11_Picture_2.jpeg)

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![](_page_11_Picture_4.jpeg)

![](_page_11_Picture_5.jpeg)

#### **Deep Space Network**

![](_page_12_Picture_1.jpeg)

Goldstone Complex California

![](_page_12_Picture_3.jpeg)

![](_page_12_Picture_4.jpeg)

![](_page_12_Picture_6.jpeg)

#### **International Space Station**

- Construction Started in 1998
- Crew
  - Visited by 230 people from 18 countries
  - Continuously inhabited since 2 November 2000
  - Current crew: Six People
- Size
  - Height: 20 m (66 ft)
  - Width: 108.5 m (356 ft)
  - Length: 72.8 m (239 ft)
  - Mass: 419,455 kg (924,740 lb)
- 36 Different Radio Systems onboard
  - Communication
  - Docking
  - Spacesuits
  - Experiments
  - Wi-Fi routers & Bluetooth devices
  - Amateur radio

#### ...Just to provide some perspective

![](_page_14_Picture_1.jpeg)

### **Organization of NASA's Spectrum Management Office**

Headquarters Spectrum Policy: Five Civil Servants + Contractors

**Spectrum Management Office (Cleveland, OH):** 10 Civil Servants + Three contractors

10 NASA Centers: Two Civil Servants each

![](_page_15_Picture_4.jpeg)

#### **Four Phases of NASA Spectrum Management**

![](_page_16_Figure_1.jpeg)

# **ITU & CITEL Participation**

- Filing and Coordination of NASA Satellites
- ITU-R Study Groups:
  - Study Group 7 (Science Service)
    - Working Party 7B (Space Radiocommunication Applications)
    - Working Party 7C (Remote Sensing)
  - Study Group 3 (Radiowave Propagation)
    - Working Party 3J (Propagation Fundamentals)
    - Working Party 3K (Point-to-Area Propagation)
    - Working Party 3M (Point-to-Point and Earth-Space Propagation)
- World Radiocommunication Conferences
- Plenipotentiary Conference
  - Definition of "radio"
  - Uses of remote sensing data
- Development of Inter-American Proposals

![](_page_17_Picture_15.jpeg)

# **Space Frequency Coordination Group (SFCG)**

**Mission Statement:** SFCG is the pre-eminent radio-frequency collegiate of Space Agencies and related national and international organizations through which global space systems spectrum resources are judiciously husbanded for the benefit of humanity.

**30 Member Agencies representing:** Argentina, Australia, Austria, Azerbaijan, Brazil, Canada, China, European Union, France, Germany, India, Italy, Japan, Malaysia, Nigeria, Republic of Korea, Russian Federation, Spain, South Africa, Sweden, Taiwan, The Netherlands, Ukraine, United Arab Emirates, United Kingdom, United States

#### Meets once per year

#### **Four Working Groups:**

- > Preparations for WRCs
- > Communications Management
- > Remote sensing
- > Satellite coordination

http://www.sfcgonline.org

![](_page_18_Picture_10.jpeg)

# A Few Activities Outside the United States but still on the Earth

- Australia: Study icing conditions of aircraft
- Bermuda: Tracking radars
- Brazil: High altitude balloon studies of ozone
- Chile: Looking at conditions for planting vineyards
- Greenland: Robots studying ice sheets
- Norway: Ka-band propagation measurements
- Peru (& elsewhere): Searching for archeological sites
- Thailand: Mosquito tracking using remote sensors for disease research

![](_page_19_Picture_9.jpeg)

# **Spectrum Management Challenges**

- Increasing spectrum demand/New technologies
- Tracking regulatory paperwork
  - Being perceived as "red tape" by projects/programs
  - Spectrum Managers vs. "Spectrum Messengers"
- Small satellites/New operators in space
- New visitors and vehicles to the International Space Station
- Unknown projects/Programs within NASA
- Justifying the importance of NASA products to those of other communities

![](_page_20_Picture_9.jpeg)

![](_page_21_Picture_0.jpeg)

# Thank You!

![](_page_22_Picture_0.jpeg)