National Aeronautics and Space Administration

Space Communications & Navigation

International Spectrum Management: A NASA Perspective

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Greetings!

Melanie Brunner

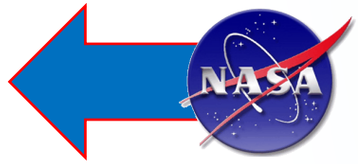
Glenn Feldhake

манекен в скафандре

Pop Quiz #1: A Little About NASA

In what year was NASA founded?

A. 1945
B. 1958
C. 1969

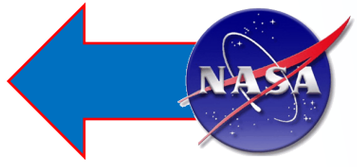


Who owns NASA?

A. The President of the United States
B. Elon Musk
C. The U.S. Taxpayers

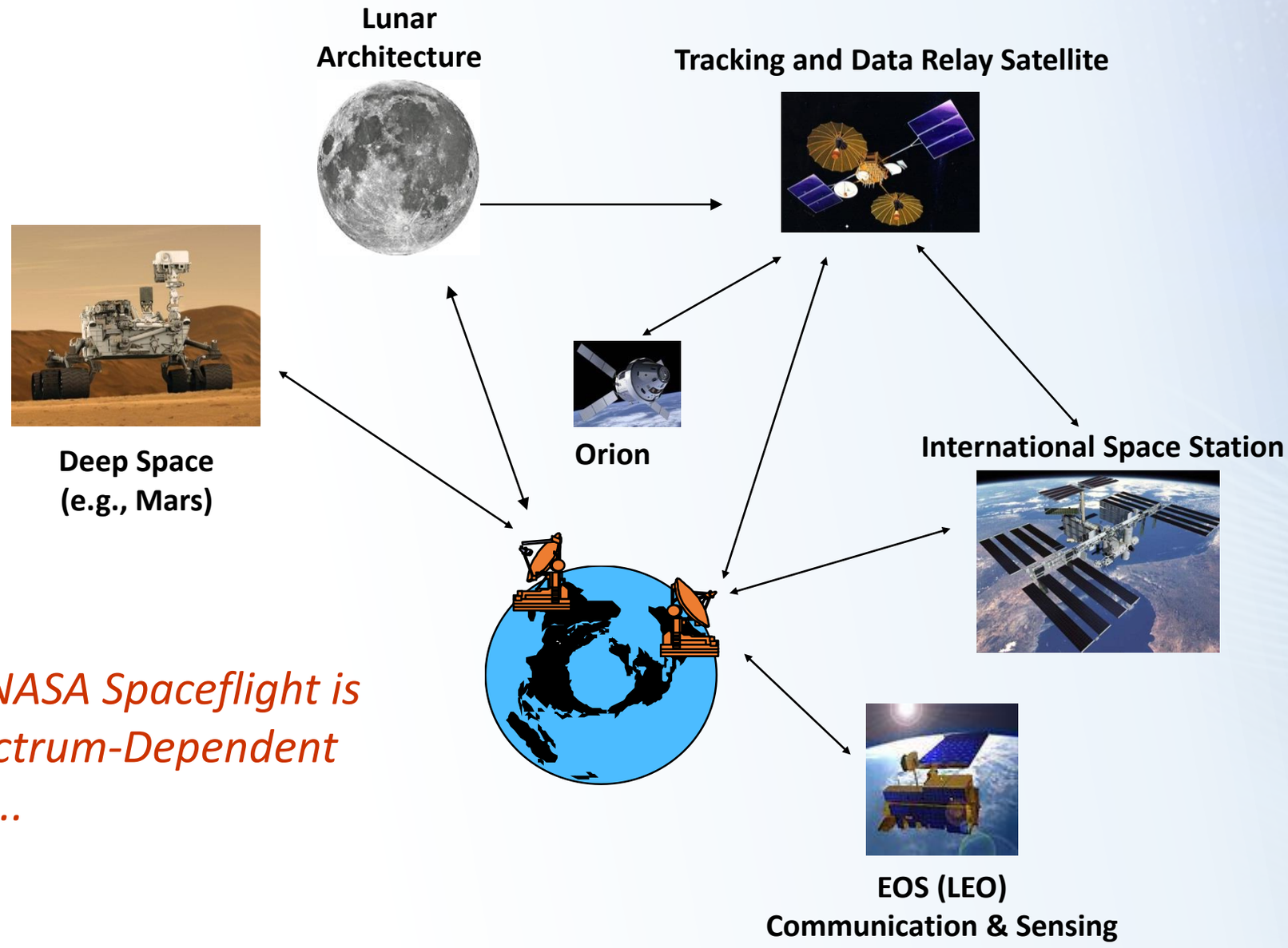
How many spacecraft (satellites + robots) is NASA currently operating?

A. About 150
B. About 70
C. About 50



NASA Facilities

Spectrum Dependent Equities – Part I

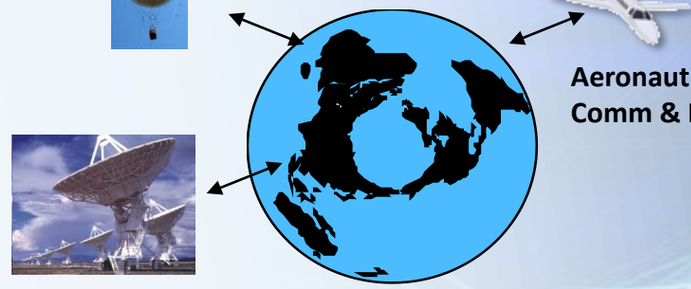


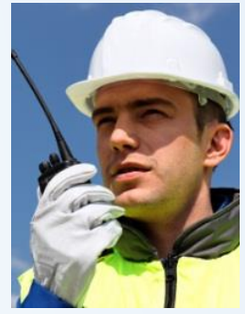
All NASA Spaceflight is Spectrum-Dependent but...

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
  - 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
  - Public address systems/wireless microphones

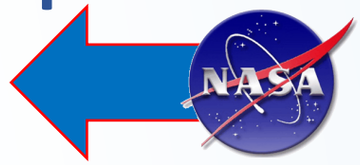




Pop Quiz #2: NASA's many missions

What does NASA do in space?

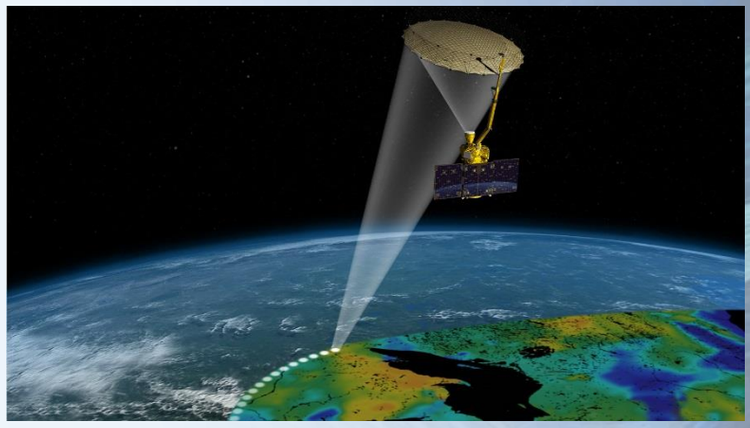
A. Scientific Research
B. Telecommunication
C. Climate Monitoring
D. Human/Robotic Exploration
E. All of the Above



Types of NASA Space Missions

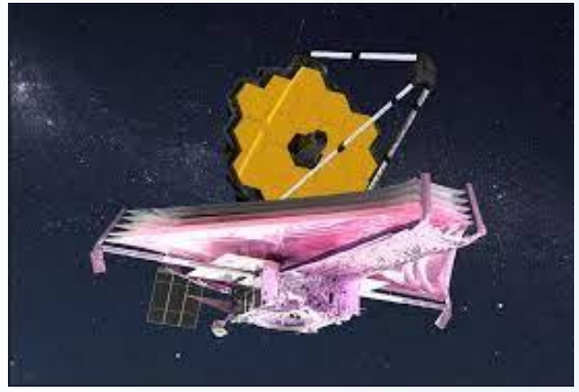
- Telecommunication (*e.g.*, TDRSS)
- Deep Space (*e.g.*, Voyager, Curiosity)
- Space Research (*e.g.*, Hubble Telescope, International Space Station)
  - Science
  - Exploration
- Earth Exploration (*e.g.*, AQUA, EOS-AM, SMAP)
  - Active Sensors
  - Passive Sensors

Mars Curiosity Rover



Soil Moisture Active/Passive (SMAP)

Tracking and Data Relay Satellite System (TDRSS)



James Webb Space Telescope

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[1]

Frequency Band	Radio Service
401-403 MHz	EESS (E-s)
460-470 MHz	[eess (s-E)]
1525-1535 MHz	eess
1690-1710 MHz	[eess (s-E)]
2025-2110 MHz	EESS (E-s) (s-s)
2200-2290 MHz	EESS (s-E) (s-s)
7190-7250 MHz	EESS (E-s)
8025-8400 MHz	EESS (s-E)
13.75-14 GHz	eess
25.5-27 GHz	EESS (s-E)
28.5-30 GHz	eess (E-s)
29.95-30 GHz	eess (E-s)(s-s)
37.5-40 GHz	eess (s-E)
40-40.5 GHz	EESS (E-s) / eess (s-E)
65-66 GHz	EESS

Frequency Band	Radio Service
432-438 MHz	eess (active)
1215-1300 MHz	EESS (active)
3100-3300 MHz	eess (active)
5250-5570 MHz	EESS (active)
8550-8650 MHz	EESS (active)
9200-9800 MHz	EESS (active)
9800-9900 MHz	eess (active)
9900-10400 MHz	EESS (active)
13.25-13.75 GHz	EESS (active)
17.2-17.3 GHz	EESS (active)
24.05-24.25 GHz	eess (active)
35.5-36 GHz	EESS (active)
78-79 GHz	[EESS (active)]
94-94.1 GHz	EESS (active)
130-134 GHz	EESS (active)

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

Allocations for Passive Sensing[2]

Frequency Band	Radio Service
1370-1400 MHz	[eess (passive)]
1400-1427 MHz	EESS (passive)
2640-2655 MHz	[eess (passive)]
2665-2690 MHz	eess (passive)
2690-2700 MHz	EESS (passive)
4200-4400 MHz	[eess (passive)]
4950-4990 MHz	[eess (passive)]
6425-7250 MHz	*[eess (passive)]*
10.6-10.7 GHz	EESS (passive)
14.8-15.35 GHz	[eess (passive)]
15.35-15.4 GHz	EESS (passive)
18.6-18.8 GHz	EESS (passive)
21.2-21.4 GHz	EESS (passive)
22.21-22.5 GHz	EESS (passive)
23.6-24 GHz	EESS (passive)
31.3-31.8 GHz	EESS (passive)

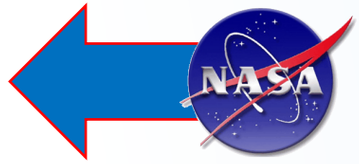
Frequency Band	Radio Service
36-37 GHz	EESS (passive)
50.2-50.4 GHz	EESS (passive)
52.6-59.3 GHz	EESS (passive)
86-92 GHz	EESS (passive)
100-102 GHz	EESS (passive)
109.5-122.25 GHz	EESS (passive)
148.5-151.5 GHz	EESS (passive)
155.5-158.5 GHz	EESS (passive)
164-167 GHz	EESS (passive)
174.8-191.8 GHz	EESS (passive)
200-209 GHz	EESS (passive)
226-231.5 GHz	EESS (passive)
235-238 GHz	EESS (passive) / [EESS (active)]
250-252 GHz	EESS (passive)
275-1000 GHz	*[eess (passive)]**

[2] *[Italics/square brackets]* : Not allocated but in use.

Pop Quiz #3: Satellite Orbits

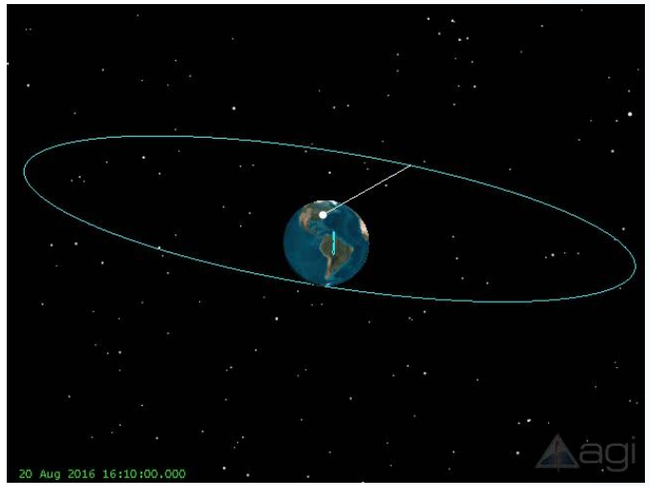
Which of these is not a type of satellite orbit?

a) Geostationary
b) Sun-synchronous
c) Highly-Elliptical
d) Backyard
e) Molniya
f) Halo
g) Geosynchronous
h) Graveyard

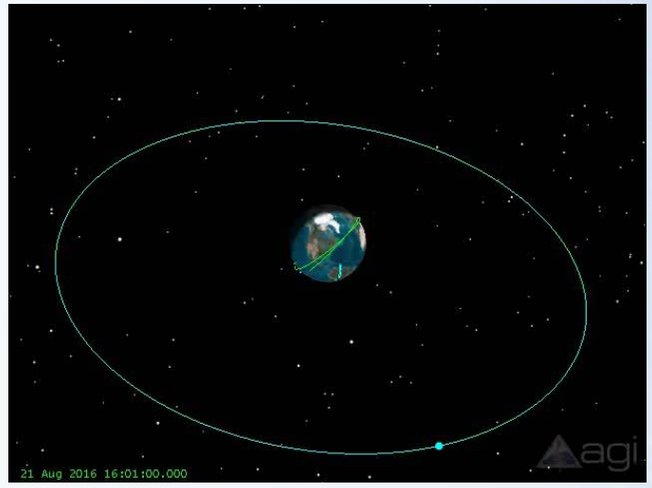


Types of Orbits

Geostationary Orbit (GSO)



Low Earth Orbit (NGSO)



Highly Elliptical Orbits (HEO)

Deep Space

Near Earth Network

Space (TDRSS) Network

Deep Space Network

Pop Quiz #4: International Space Station

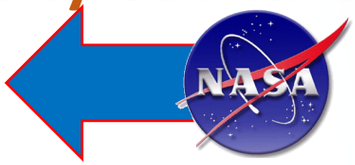
How Many Countries Participate in the International Space Station?

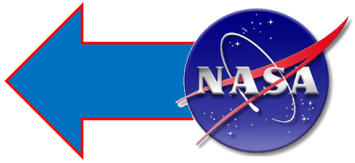
A. 4

B. 10

C. 15

D. 22

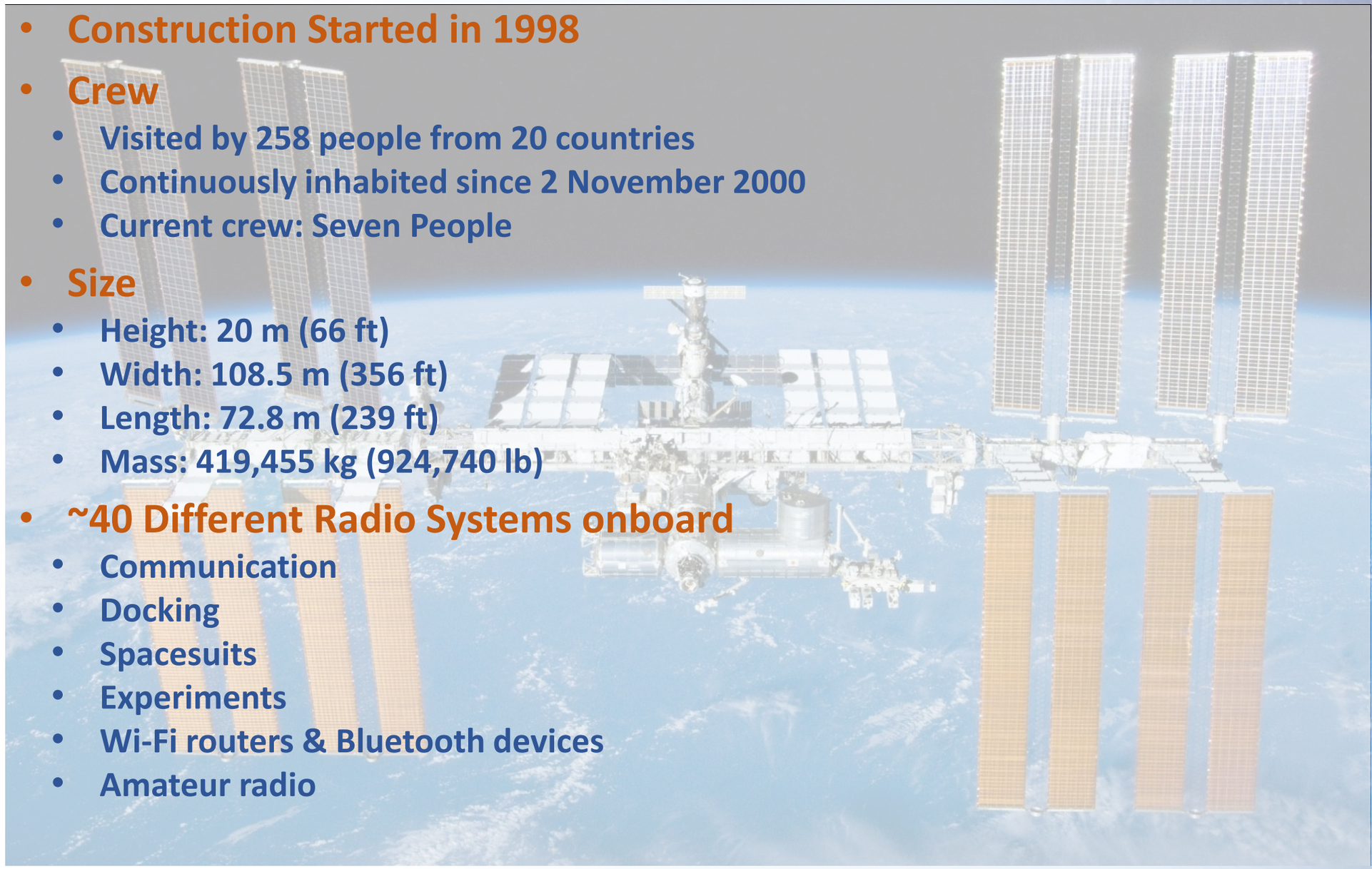




Trick Question!

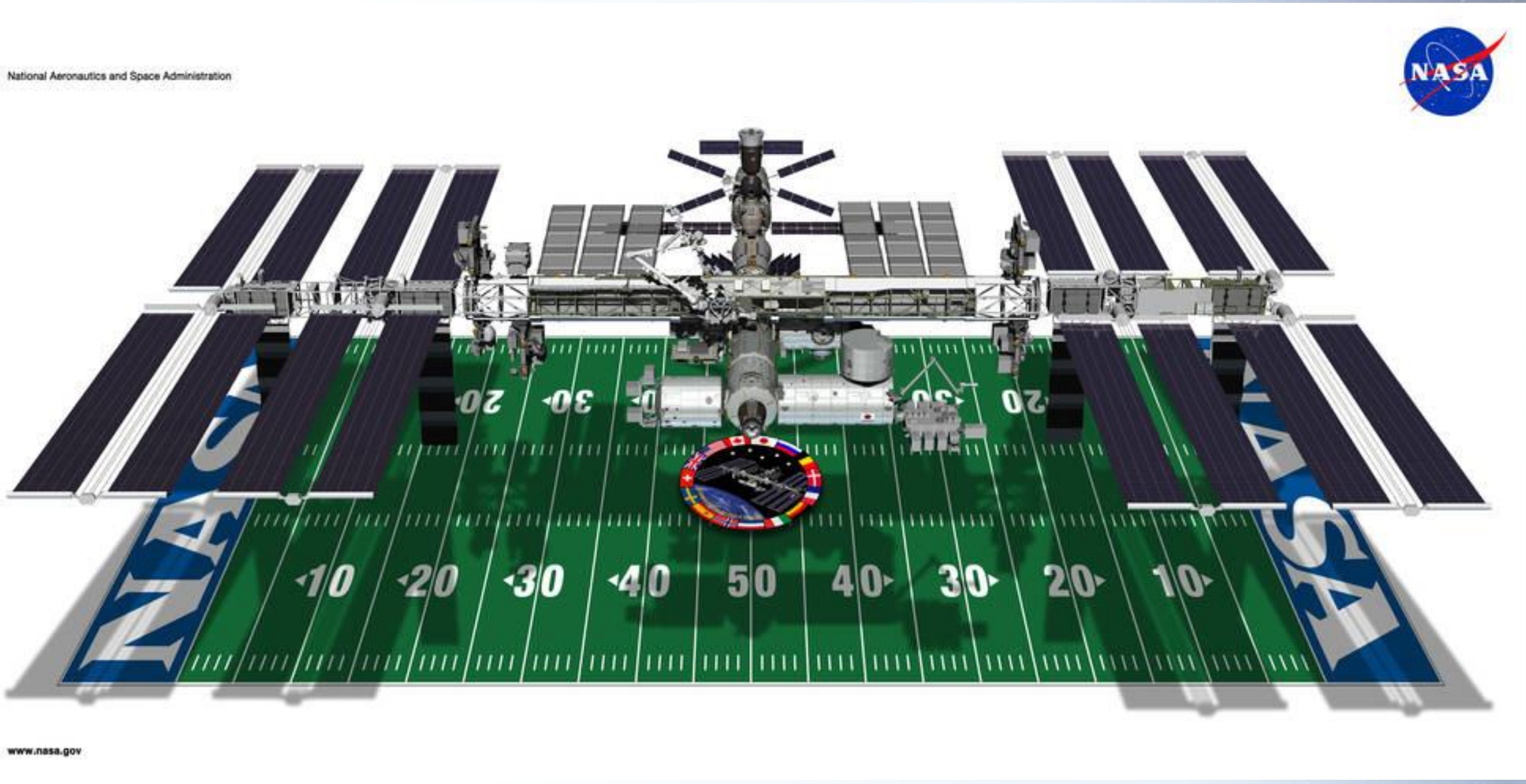
Canada, Japan, the Russian Federation, the United States, and eleven Member States of the European Space Agency (Belgium, Denmark, France, Germany, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom).

International Space Station



- Construction Started in 1998
- Crew
  - Visited by 258 people from 20 countries
  - Continuously inhabited since 2 November 2000
  - Current crew: Seven 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)
- ~40 Different Radio Systems onboard
  - Communication
  - Docking
  - Spacesuits
  - Experiments
  - Wi-Fi routers & Bluetooth devices
  - Amateur radio

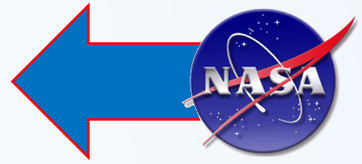
…Just to provide some perspective



Pop Quiz #5: NASA's Motto

What is NASA's official motto?

a) Failure is not an option
b) One giant leap for mankind
c) For the benefit of all
d) Faster, better, cheaper
e) Not flat; we checked
f) To boldly go where no one has gone before
g) Houston, we have a problem



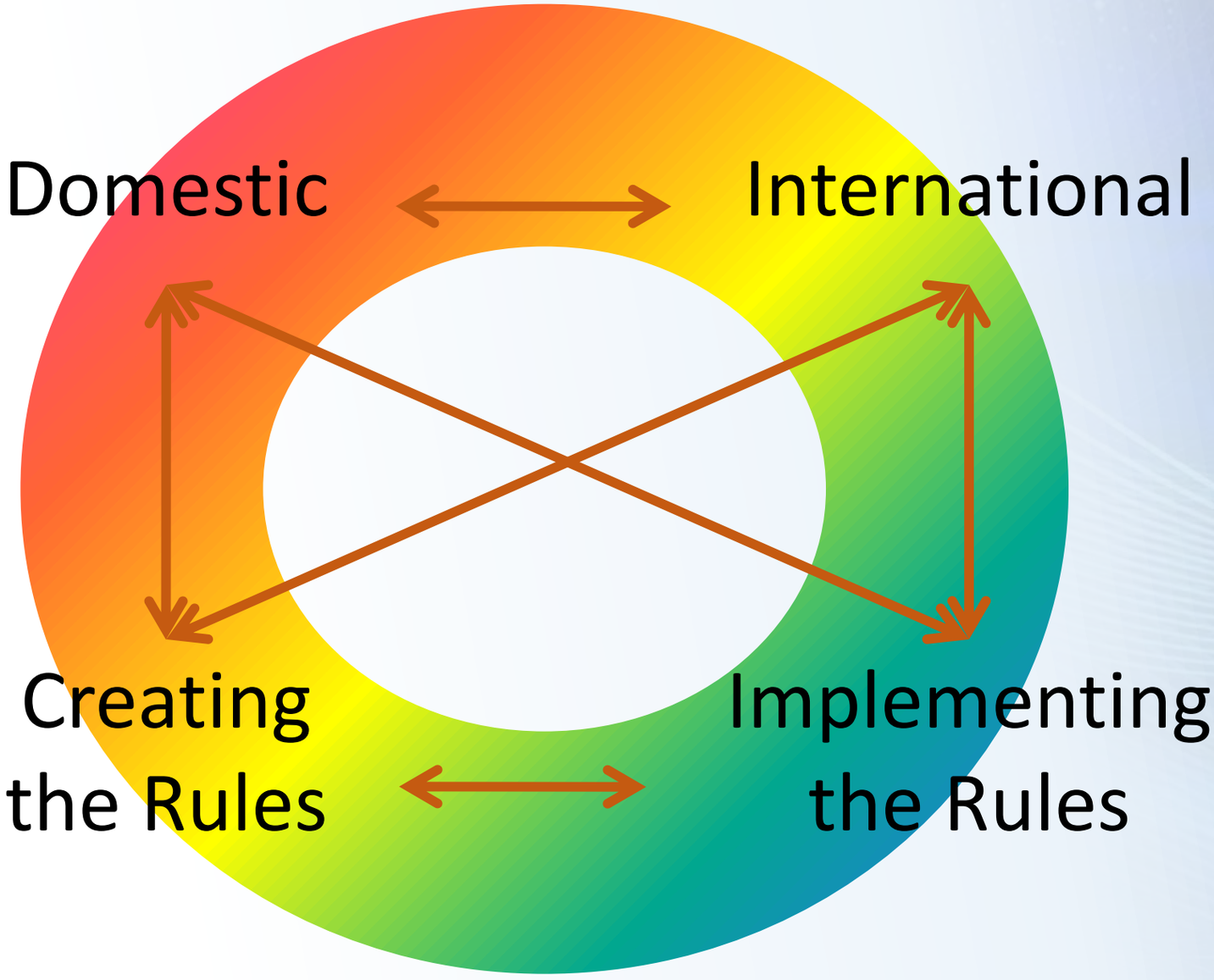
Organization of NASA's Spectrum Management Office

Headquarters Spectrum Policy: Four Civil Servants + Contractors

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

10 NASA Centers: Two Civil Servants each

Four Phases of NASA Spectrum Management



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**

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.

33 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

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

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

Questions?

Thank You!

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