JPL Spectrum Management Process

CORF Meeting
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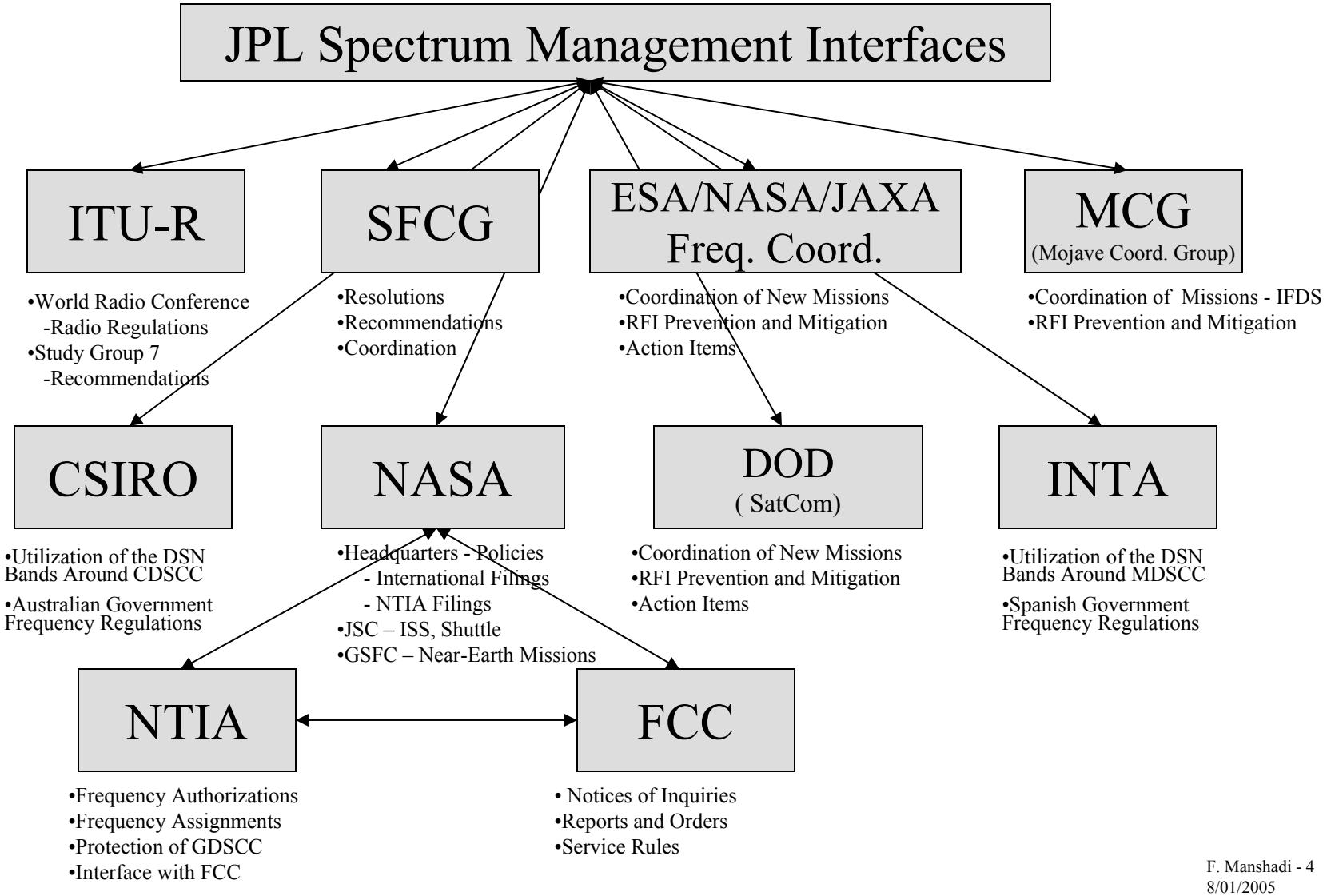
JPL SPECTRUM MANAGEMENT ROLES AND RESPONSIBILITIES

- Plan and coordinate frequency allocations, assignments, and use in order to meet NASA requirements for JPL institutional and Deep Space Mission Services commitments
  - Obtain frequencies for deep space and JPL-managed near-Earth missions
  - Conduct sharing studies or studies needed to establish protection Criteria
  - Support NASA participation in ITU and Space Frequency Coordination Group in deep space and active sensing areas
- Minimize risk of losing mission data due to interference through coordination with domestic and foreign agencies
  - Analysis, filing, and assessment of missions frequency plan
  - Participation in NASA/DoD and NASA/ESA/JAXA Frequency coordination activities
  - Participation in the Space Frequency Coordination Group (SFCG)
  - Develop tools for RFI analysis

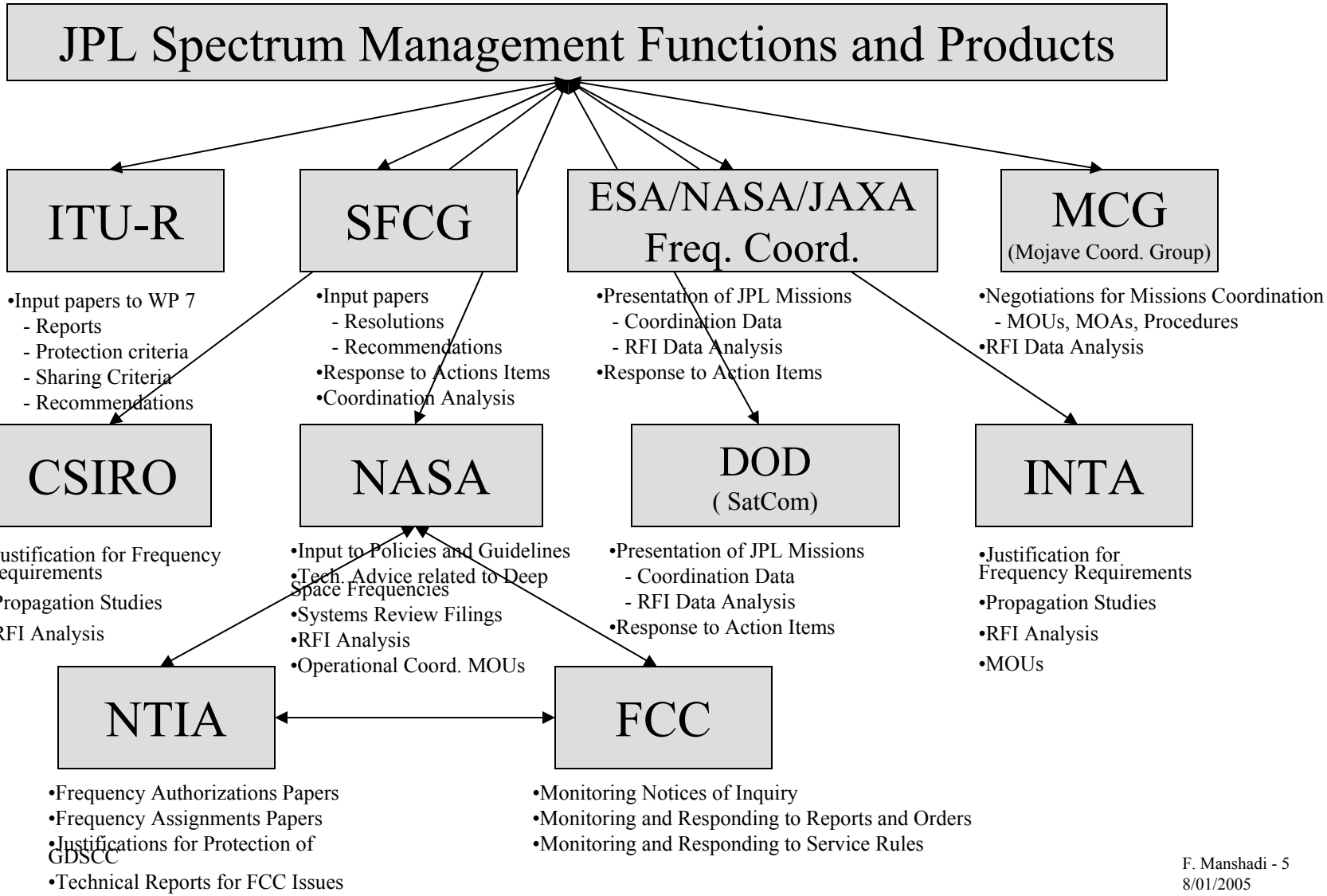
JPL SPECTRUM MANAGEMENT ROLES (Continued)

- **Protect NASA investment by ensuring that allocated frequency bands remain accessible and interference-free**
  - **ITU frequency allocations, footnotes, and protection criteria**
  - **Negotiation with the National Training Center at Fort Irwin to ensure the new plans for extensive desert training, involving thousand of military troops, do not adversely affect Goldstone operations**
  - **Negotiation with Spanish Government and FCC protecting the right to transmit at S-Band after IMT2000 mobile phone implementation**
  - **Dialogue with NASA and non NASA agencies to protect the deep space X-band from out of band emissions of the near-Earth satellites**

JPL Spectrum Management Considerations



JPL Spectrum Management Considerations



JPL SPECTRUM MANAGEMENT PROGRAM ELEMENTS

- **DSMS Spectrum Manager**
  - The JPL Spectrum Manager performs duties of a NASA Center Spectrum Manager as described in NASA Radio Frequency Spectrum Management Guidelines NPG 2570.1
  - Represents JPL/DSMS in national and international spectrum management arena
  - Ensures JPL/DSMS spectrum program achieves its objectives on schedule
  - Manages the JPL/DSMS Spectrum Program budget

- **ITU Deep Space Representative**
  - Support NASA efforts to ensure that ITU Radio Regulations allocate sufficient spectrum to support future NASA deep space missions, allowing RFI-free reception and unrestricted transmission
  - Conduct frequency sharing studies
  - Propose new recommendations
  - Characterize communication parameters of new deep space systems for the ITU
  - Contribute to the SFCG studies on issues related to the ITU-R

JPL SPECTRUM MANAGEMENT PROGRAM ELEMENTS - Continued

- **ITU Remote Sensing Representative**
  - Represent NASA/JPL at the ITU-R study groups on remote sensing and attend the Space Frequency Coordination Group for the same purpose
  - Ensures the availability and protection of spectrum for NASA/JPL remote sensing, especially in the areas of active sensors such as synthetic aperture radars (SARs), radar altimeters, scatterometers, precipitation radars, and cloud profile radars

- **RFI Analysis**
  - Conduct frequency assignment analysis and select frequencies for use by deep space missions
  - Predict and mitigate potential RFI from deep-space missions, Earth orbiters and terrestrial systems
  - Perform studies/analyses and tool development needed to solve DSN-related RFI problems

JPL SPECTRUM MANAGEMENT PROGRAM ELEMENTS - Continued

- ITU/SFCG Technical Support
  - Conduct studies to support protection and advancement of NASA/JPL's interests in spectrum allocation and regulations at the SFCG and ITU arenas
  - Evaluate impacts of relevant new and proposed ITU, SFCG, and CCSDS recommendations/policies on NASA-JPL
  - Assess and mitigate potential adverse impacts of new systems on future deep-space spectrum usage
  - Provide technical basis for NASA/JPL spectrum-related positions and proposals
  - Select frequency channels for foreign deep-space missions
    - Recommend frequency channels for space-earth links
    - Coordinate Mars in-situ remote sensing frequency
  - Participate and support other relevant activities for the SFCG, ITU-R, USWP7B, and ESA/NASA/JAXA Frequency Coordination

JPL SPECTRUM MANAGEMENT PROGRAM ELEMENTS - Continued

- **Frequency Coordination**
  - Prepare and submit system reviews to NTIA to obtain official frequency authorization for deep space missions, including licensing of earth stations for support of non-NASA missions
  - Coordinate frequency assignments with other users and agencies and conduct necessary analysis to ensure compatibility with all DSN-supported missions
  - Implement and carry out operational coordination agreements with other projects and agencies to protect the DSN from harmful interference
- **Radiation Measurements**
  - Provide resources, as needed, to measure RFI in and around the Laboratory, especially those involving measurements at JPL facilities such as Table Mountain Facility and Goldstone:
    - Commercial RFI measurement equipment
    - Commercial software for RFI analysis and investigations
    - Customized commercial tools for satellite RFI simulation (SOAP)

JPL SPECTRUM MANAGEMENT PROGRAM ELEMENTS - Continued

- **Institutional Spectrum Management (JPL Technical Infrastructure Program)**
  - **Develop, maintain, and manage institutional JPL spectrum policies**
  - **Plan and coordinate frequency spectrum for Caltech and JPL near-Earth missions**
  - **Ensure RFI free environment at JPL and associated facilities such as Table Mountain Facility (TMF)**
  - **Maintain spectrum standards and regulatory and frequency assignment databases**
  - **Review all radio frequency assignments under control of JPL**
  - **Submit System Reviews to obtain official NTIA Frequency Authorizations for non-deep-space JPL missions**
  - **Participate and contribute to the Mojave Coordination Group**

Major Space Research Frequency Allocations

- **S-band**
  - 2025-2110 MHz uplink, near-Earth
  - 2110-2120 MHz uplink, deep space
  - 2200-2290 MHz downlink, near-Earth
  - 2290-2300 MHz downlink, deep space
- **X-band**
  - 7145-7190 MHz uplink, deep space
  - 7190-7235 MHz uplink, near-Earth
  - 8400-8450 MHz downlink, deep space
  - 8450-8500 MHz downlink, near-Earth
- **Ka-band**
  - 25.5-27.0 GHz downlink, near-Earth and deep space*
  - 34.2-34.7 GHz uplink, deep space
  - 31.8-32.3 GHz downlink, deep space
  - 40.0-40.5 GHz uplink, near-Earth and deep space
  - 37.0-38.0 GHz downlink, near-Earth and deep space

* NASA intents to keep this band for use by near-Earth missions only (no deep space missions in this band)

Deep Space Protection Criteria

- Stringent protection criteria established by the ITUR and SFCG for the protection of deep-space SRS
  - Non-deep-space SRS allocations in general do not have the same stringent protection criteria
- Protection criteria for SRS (deep space) earth stations per ITU-R SA. 1157
  - -222 dB(W/Hz) for S-and
  - -220 dB(W/Hz) for X-band
  - -216 dB(W/Hz) for 32 GHz Ka-band
  - These protection criteria may be exceeded for no more than 0.001% of the time for non-line-of-sight interference
- Protection criteria for stations on spacecraft in the SRS (deep space) per ITU-R SA. 1157
  - -191 dB(W/20Hz) for S-and
  - -189 dB(W/20Hz) for X-band
  - -184 dB(W/20Hz) for 32 GHz Ka-band

Deep Space Protection Criteria - Continued

- **Protection criteria for SRS earth stations in the 37-38 GHz band per ITU-R SA. 1396:**
  - **-217 dB(W/Hz) at the input of the receiver in the 37-38 GHz band**
  - **Interference from non-line-of-sight sources may not exceed the above limit for more than 0.001% and 0.1% of the time for manned and unmanned missions respectively**

- **Protection criteria for stations on a SRS spacecraft per ITU-R SA. 1396:**
  - **-193 dB(W/20Hz) in the 40-40.5 GHz band**
  - **The above limit may not be exceeded for more than 0.1% of the time for both the manned and unmanned missions**

Deep Space Missions Frequency Selection process

- Missions contact the JPL spectrum manager as early as possible in their initial design phase
- Missions will provide the trajectory, telecom, and critical event periods to the spectrum manager or the Spectrum Engineering Group (SEG)
- SEG Conducts a channel selection study to select the appropriate frequency channel (or channels) compatible with existing channel assignments and applicable spectrum utilization policies/standards including SFCG recommendations
- Spectrum Manager/Alternate Spectrum Manager submits Frequency authorization applications to NTIA
  - Usually starts with Stage 3 System Review
  - Several iterations might be necessary before final approval from the NTIA
- Each NTIA System Review usually takes about 5 months
- Stage 4 approval will authorize space operation for the mission

Near-Earth Missions Frequency Selection Process

- Missions contact the JPL spectrum manager as early as possible in their initial design phase
- Missions will provide the trajectory, telecom, and critical event periods to the spectrum manager or the Spectrum Engineering Group (SEG)
- SEG analyzes mission data and will select one or several frequencies that potentially will be acceptable by other users of the band
- JPL Spectrum Manager contacts NASA GSFC for their approval
  - GSFC missions use this band very heavily
- If GSFC approves, JPL Spectrum Manager coordinates with DoD spectrum managers for their approval
    - Usually this step is difficult because we do not have access to the information for many DoD missions and therefore our selected frequencies might not be compatible with them
- If DoD approves JPL Spectrum manager presents the selection to ESA and JAXA for their approval
- Spectrum Manager/Alternate Spectrum Manager submits Frequency authorization applications to NTIA
  - Several iterations might be necessary before final approval from the NTIA
- Stage 4 approval will certify operational status for the mission

Information Needed for Frequency Selection

- Trajectory information that will sufficiently define the trajectory of the spacecraft for the entire mission
  - The software tools that we use to do the analysis require the trajectory files be in the SPK format
  - SPK is a standard trajectory file format used for most deep-space missions
- Telecom parameters that will define the transmitter and receiver parameters and the spectral characteristics of the uplink and downlink signals for all major telecom modes
  - See following forms that the project can use to provide project-specific telecom parameters
- Critical mission events
  - Since the available spectrum is limited, there is no guarantee that an interference-free channel can always be found
  - The Frequency selection study will allow identification of channels with minimum interference
  - With critical mission events specified, we can avoid selecting channels that would result in potential interference during these critical mission events.

NTIA System Reviews

- The system review is a procedure used by the SPS to develop recommendations on behalf of the IRAC for the Deputy Associate Administrator, Office of Spectrum Management of NTIA, regarding certification of spectrum support for telecommunication systems or subsystems. A system can be reviewed at four stages as it matures into an operational status
  - Stage 1, Conceptual: The initial planning effort has been completed, including proposed frequency bands and other available characteristics
  - Stage 2, Experimental: The preliminary design has been completed, and radiation, using such things as test equipment or preliminary models, may be required
  - Stage 3, Developmental: The major design has been completed, and radiation may be required during testing
  - Stage 4, Operational: Development has been essentially completed, and final operating constraints or restrictions required to assure compatibility need to be identified.