Dynamic Scheduling and Coordination Agreements

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Coordination Agreements

- Agreements negotiated with other spectrum users to protect radio astronomy observations from potentially conflicting transmissions
- Impacts shared bands or adjacent bands
- Often specified on the basis of one of the following:
  - Geography
  - Time
  - Both geography and time

Coordination Example (U.S.)

14.47-14.5 GHz
Radio Astronomy
(5.149 and US342)

FIXED-SATELLITE (Earth-to-space)

14 GHz   14.5 GHz

- 14-14.5 GHz is used in the U.S. for uplinks to GSO satellites for Internet service from planes, vehicles, and ships
- U.S. radio astronomers have executed coordination agreements to mitigate interference to radio astronomy in the 14.47-14.5 GHz band

14 GHz Coordination Agreements

- Aeronautical
  - Boeing/Connexion
  - Gogo
  - Panasonic
  - Row44
- Vehicular
  - L3
  - RaySat
- Ships
  - KVH

Observing Schedules

- All of the U.S. 14 GHz coordination agreements require radio astronomers to furnish a list of scheduled 14.5 GHz observations upon request

- In practice, radio astronomers distribute scheduled observing to respective satellite operators' points-of-contact on a monthly basis

Example Language

- ## NSF/Boeing agreement

  - NSF agrees to:
    - 3.7   Maintain an observation schedule for the band 14.47 - 14.5 GHz for the sites listed in Section 2.1 and provide this schedule via both e-mail and fax, to the designated CBB point-of-contact address listed in Section 5.2 at least one week prior to the scheduled observations.

- ## NSF/Gogo agreement

  - NSF agrees to:
    - 3.5   Maintain an observation schedule for the band 14.47 - 14.5 GHz for the sites listed in Section 2.1 and make this schedule available upon request to the designated Gogo point-of-contact listed in Section 5.2.

Dynamic Scheduling

- Radio astronomy community moving to increased use of dynamic scheduling of observations, based on weather and other considerations

- Dynamic scheduling complicates coordination agreements because advance notice of observations at specific frequencies is more problematic

Green Bank Telescope
Dynamic Scheduling System
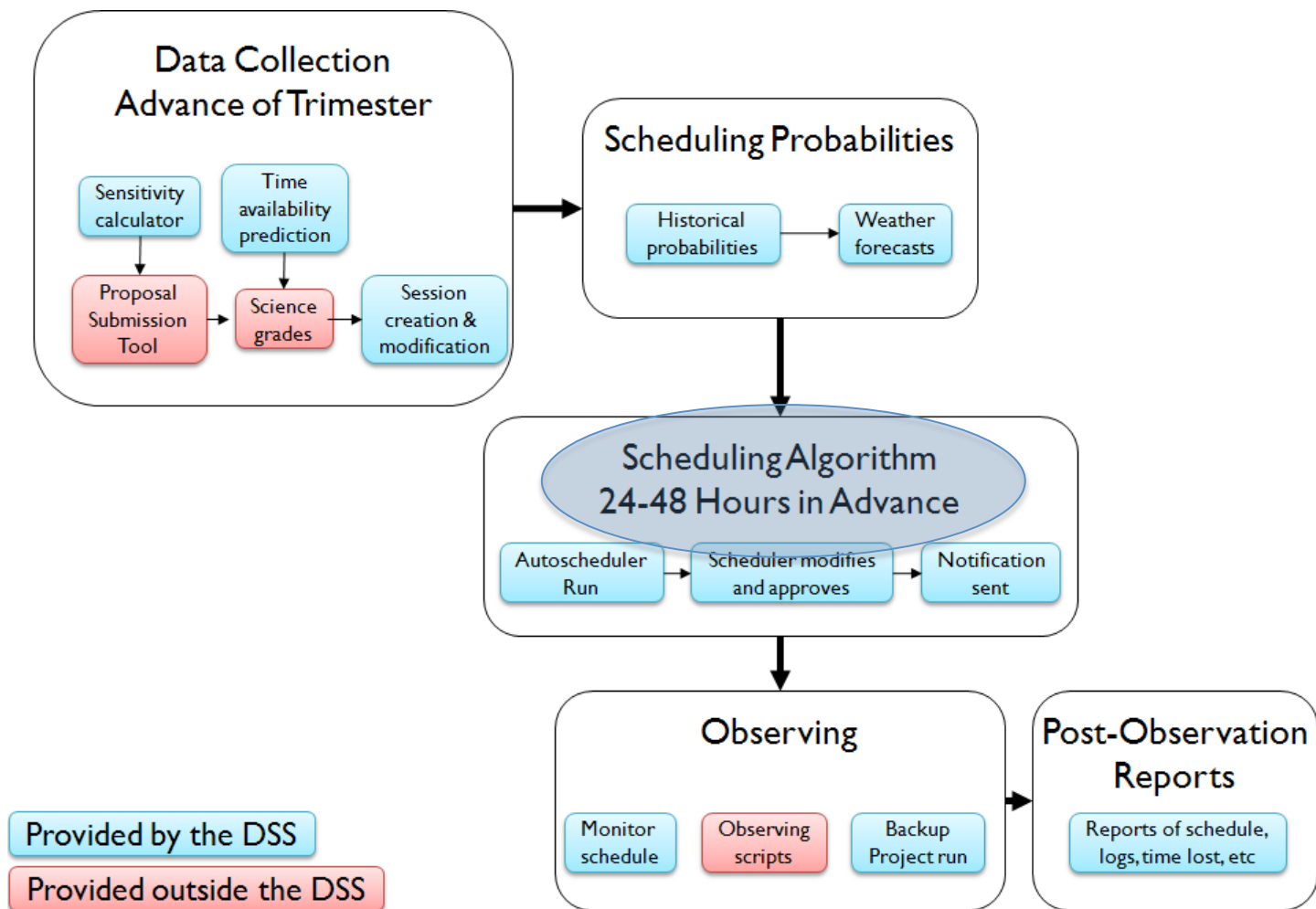
Challenges Going Forward

- Future spectrum sharing of radio astronomy bands (which is likely) will require increasing use of database-based approaches for notifying use of radio astronomy bands

- Minimum timescales of advance notification will be required to meet the requirements of dynamic spectrum access databases (such as the TVWS and SAS databases in the U.S.)

- Database timescales have typically been targeted at 24 hour updates, but could be shortened

- Real-time coordination is unlikely at least in the near- to mid-term

Opportunities Going Forward

- Will provide increasingly dynamic and complex coordination agreements allowing better protections in shared bands
- RA dynamic scheduling systems can be easily modified to provide automated integration with dynamic spectrum access databases
  - Efficient opportunities for spectrum sharing of RA bands with active users
  - May allow additional protection considerations for RA sites outside of RA bands
  - Will bring RA into the modern spectrum world

Near-term DSS/DSA Integration Opportunities

- Iridium
- TV White Spaces
- 14 GHz (including future air-to-ground)

Summary

- Dynamic scheduling systems, as isolated entities, make effective coordination agreements virtually impossible to implement

- Integrating dynamic scheduling systems into evolving dynamic spectrum access databases will be a powerful tool for improving spectrum access and utilization, and will provide for automated coordination agreements

Recommendations

- Radio astronomy facilities should think about the implications of setting a minimum dynamic scheduling time scale that's compatible with current developments in dynamic spectrum access databases
  - Two hours is probably the minimum
- The radio astronomy community should work with database providers to understand how dynamic scheduling software could be easily modified to facilitate M2M integration
  - TVWS database providers are active in the UK and US