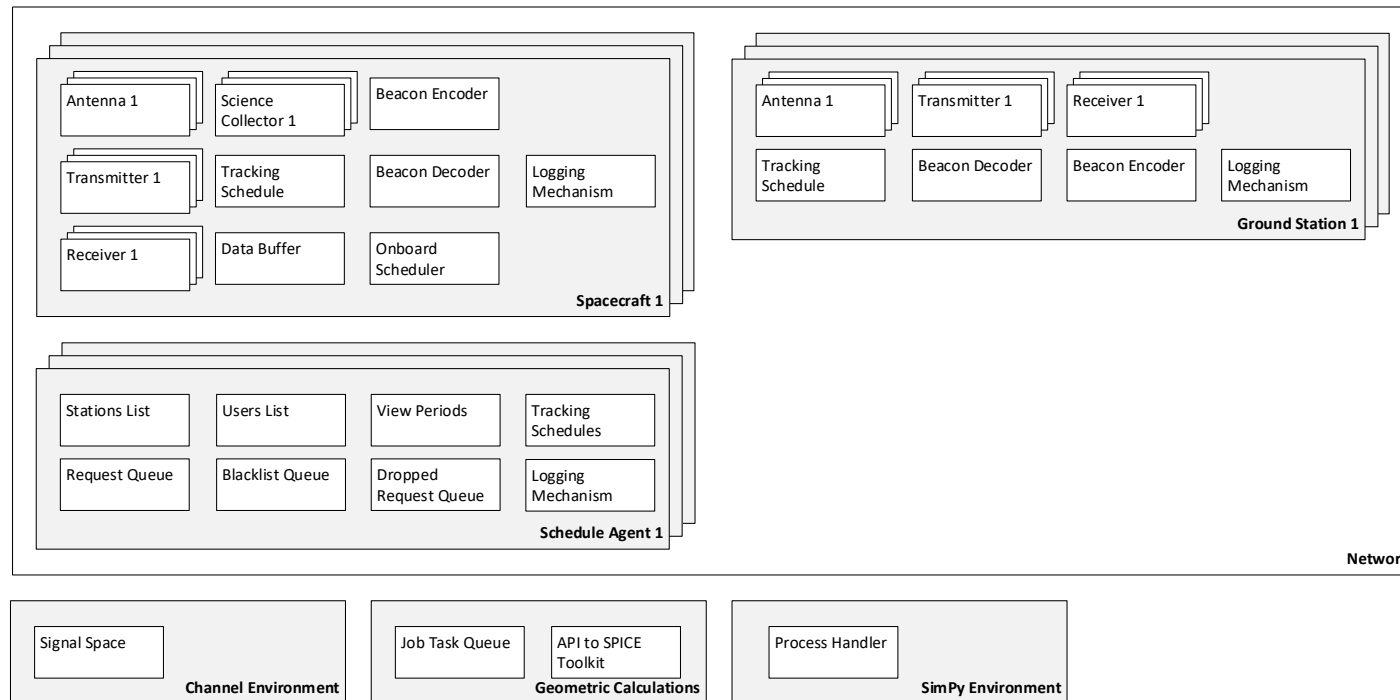


# Development of a Deep Space Network Simulator

25 June 2019



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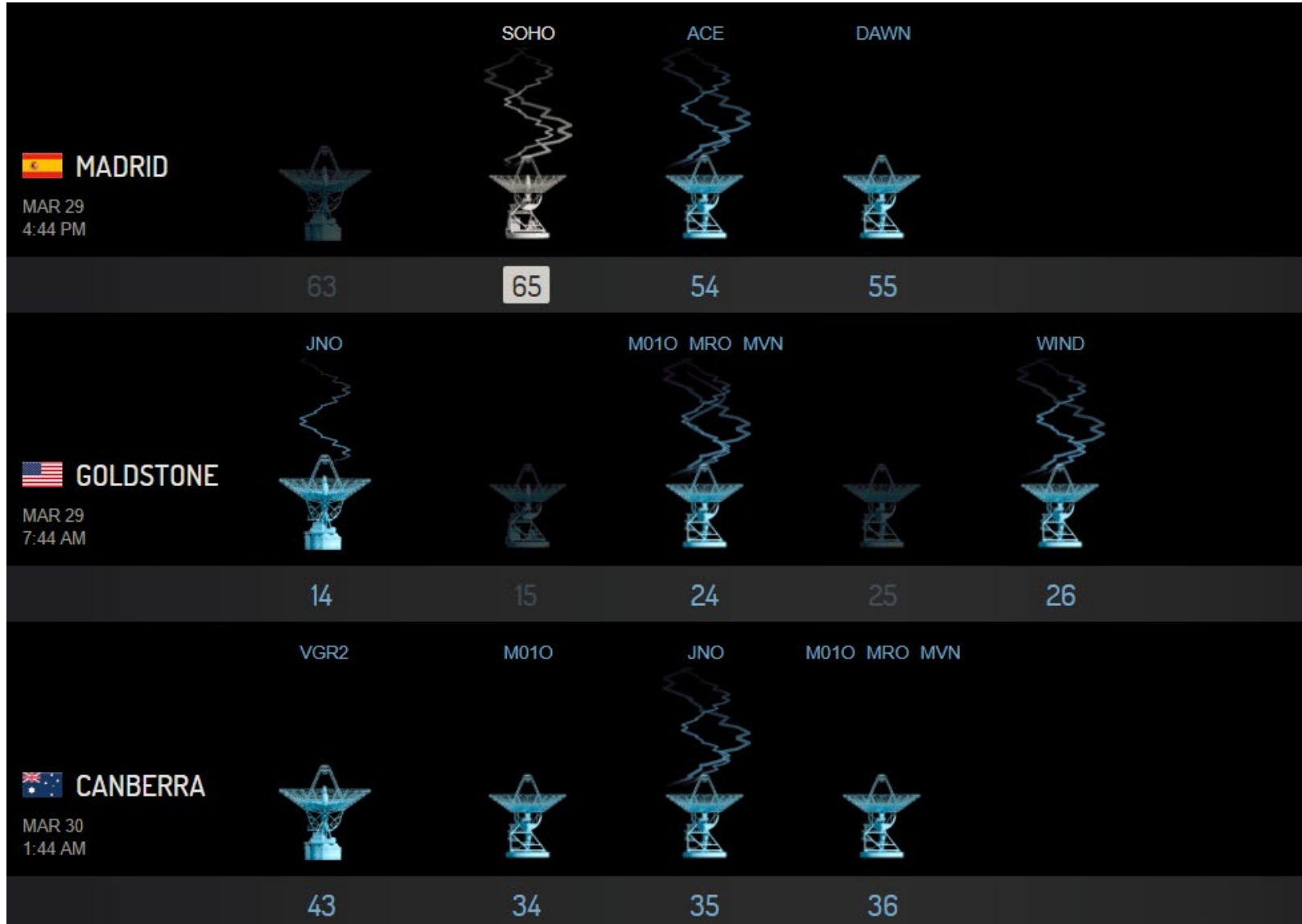
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*This research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration. This work was also supported by a NASA Space Technology Research Fellowship (grant number NNX15AQ41H).*

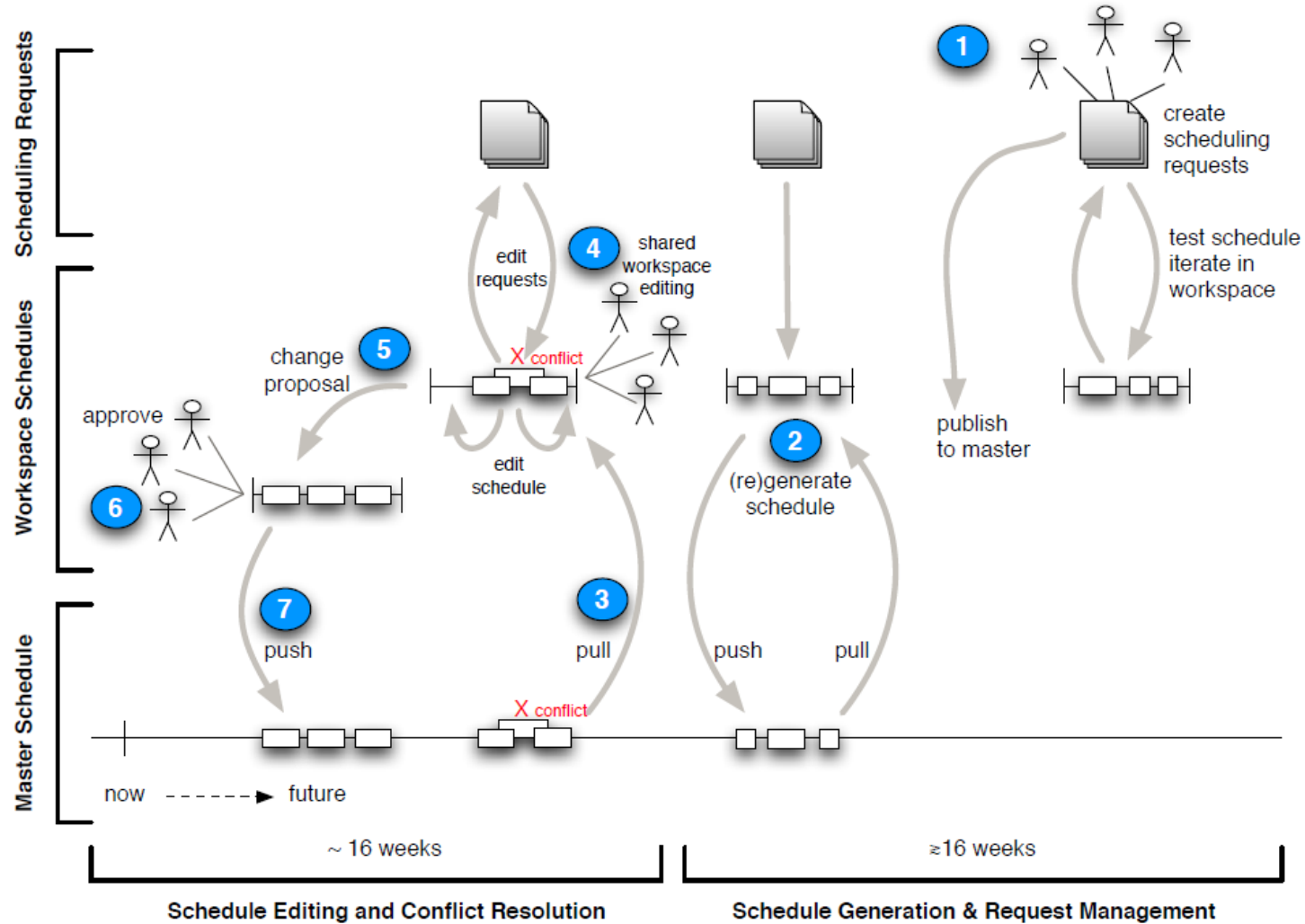


# NASA's Deep Space Network

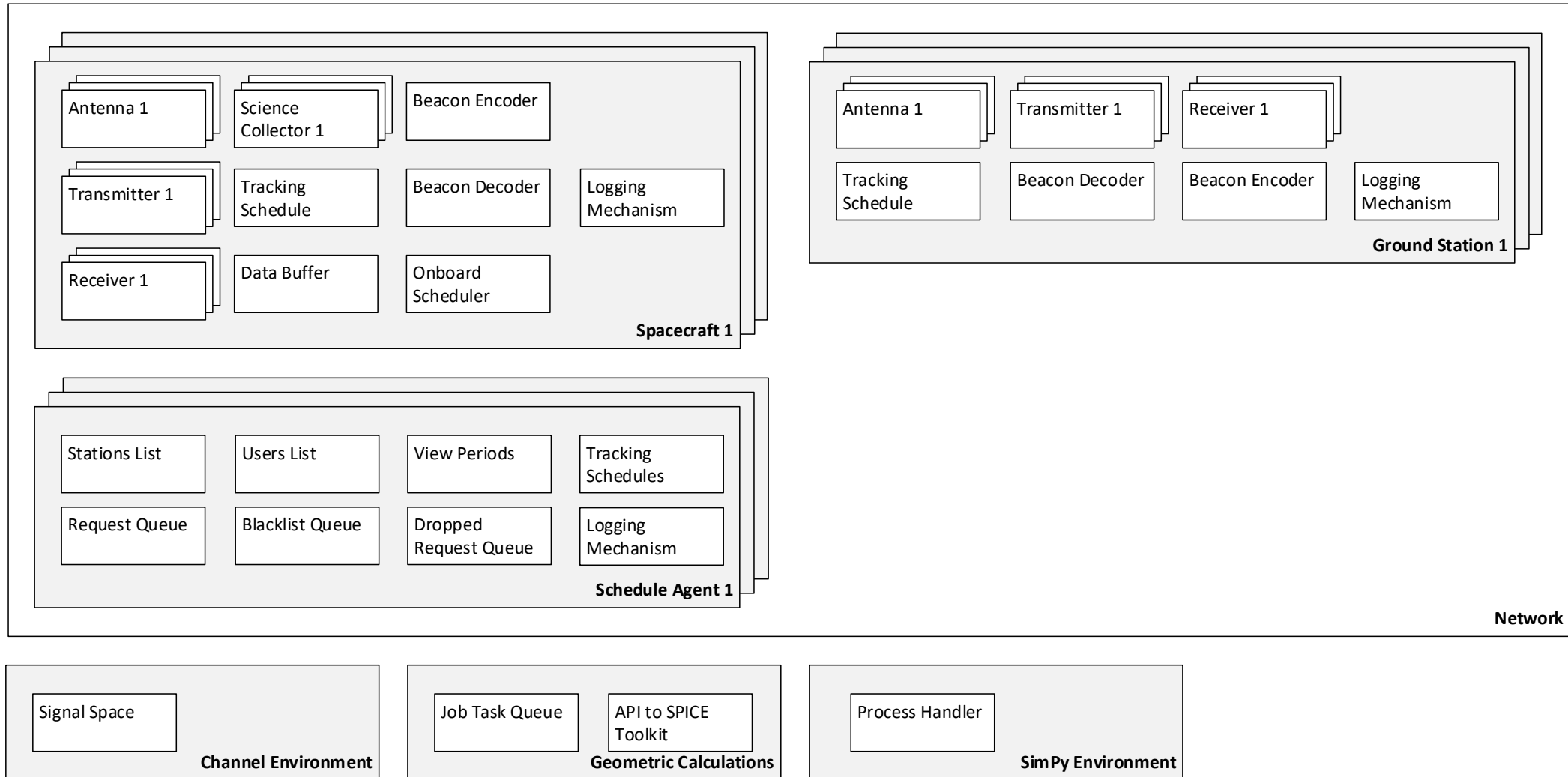


JPL/NASA

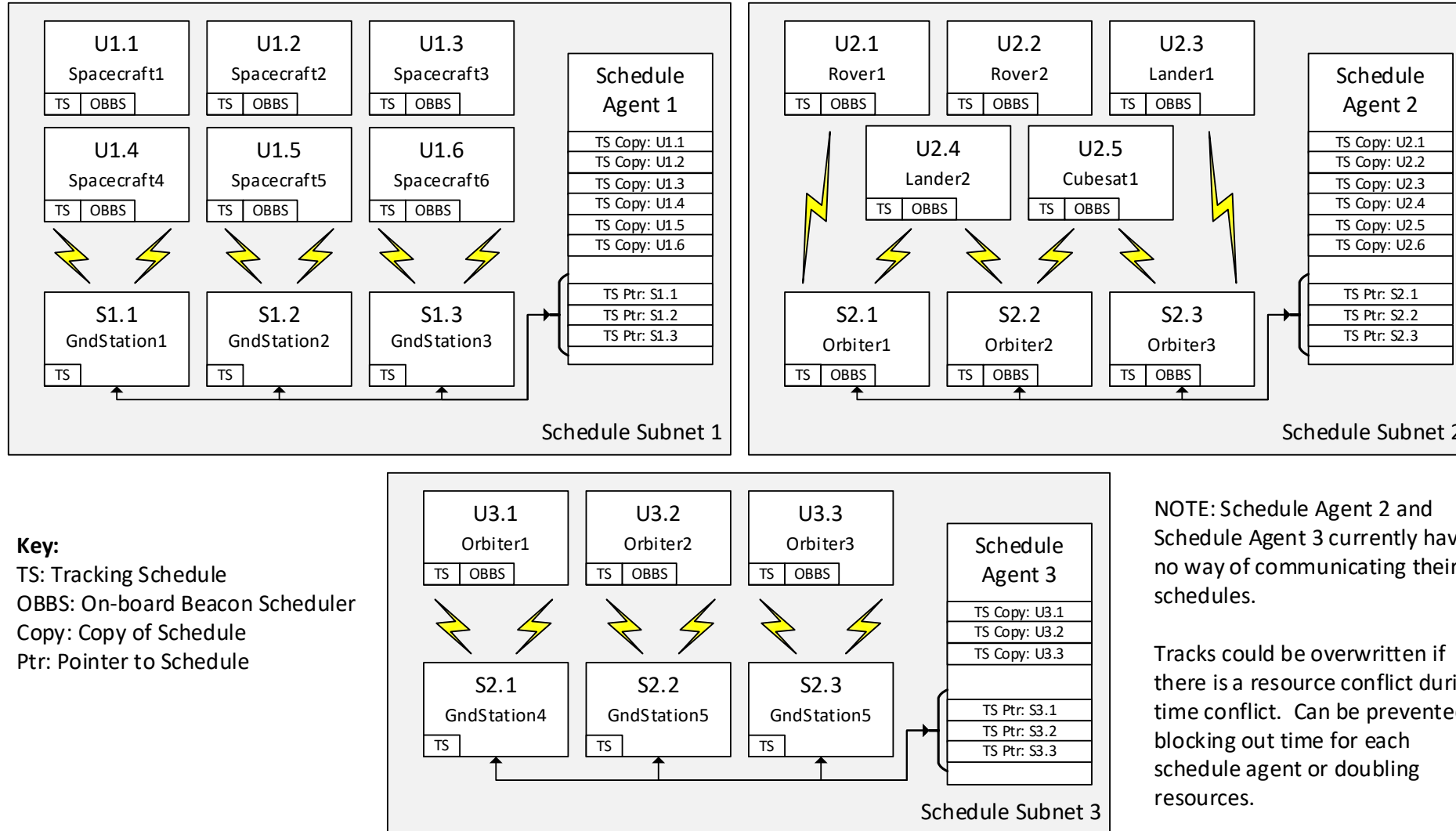
# The DSN Scheduling Process



# Network Simulator Architecture



# Subnet Architectures



## Network Element (Spacecraft)

### Network Element (Spacecraft)

Name

#### Antennas

##### Antenna A

##### Antenna 1

- Name
- Diameter
- Gain/Beamwidth Properties

#### Transmitters

##### Transmitter T

##### Transmitter 1

- Name
- Freq Band/Carrier Freq Pairs
- Data Rates
- Transmit Power

#### Receivers

##### Receiver R

##### Receiver 1

- Name
- Freq Band
- Data Rates/Min RX Pwr Pairs
- Max System Temperature
- SNR/Integration Time Pairs

#### Buffers

##### Buffer 1

- Initialization Level
- Capacity
- Trigger Level

#### Health State Monitors

##### Health State Monitor 1

- Model
- Model Parameters

#### Science Collectors

##### Science Collector S

##### Science Collector 1

- Name
- Type
- Model
- Model Parameters

#### Beacon Encoders

##### Beacon Encoder 1

- Name
- Lookup Table Name
- Symbol On Hold Duration
- Symbol Off Hold Duration
- Repeat Message  $n$  Times

#### Beacon Decoders

##### Beacon Decoder 1

- Name
- Lookup Table Name

## Network Element (Ground Station)

### Network Element (Ground Station)

Name

#### Antennas

##### Antenna A

##### Antenna 1

- Name
- Diameter
- Gain/Beamwidth Properties

#### Transmitters

##### Transmitter T

##### Transmitter 1

- Name
- Freq Band/Carrier Freq Pairs
- Data Rates
- Transmit Power

#### Beacon Encoders

##### Beacon Encoder 1

- Name
- Lookup Table Name
- Symbol On Hold Duration
- Symbol Off Hold Duration
- Repeat Message  $n$  Times

#### Beacon Decoders

##### Beacon Decoder 1

- Name
- Lookup Table Name

#### Beacon Encoders

##### Beacon Encoder 1

- Name
- Lookup Table Name
- Symbol On Hold Duration
- Symbol Off Hold Duration
- Repeat Message  $n$  Times

#### Receivers

##### Receiver R

##### Receiver 1

- Name
- Freq Band
- Data Rates/Min RX Pwr Pairs
- Max System Temperature
- SNR/Integration Time Pairs

#### Schedule Tracks

##### Track Y

##### Track 1

- Network Element
- Start Time {\_,TX,RX}
- Stop Time {\_,TX,RX}
- Element to Track
- Elements to TX/RX
- Antenna
- Receiver
- RX Band
- RX Data Rate
- Transmitter
- TX Band
- TX Data Rate
- TX Payload
- Schedule Agent Subnet
- Placeholder Track Flag
- Time Perspective

#### Schedule Agents

##### Schedule Agent N

##### Schedule Agents

- Name
- Station Names
- User Names
- Schedule Resolution Duration
- Request ACK Size
- Request ACK Priority
- On-Board Scheduler
- Schedule Request Engine Interval
- VP Generation Interval
- Initial Length of VP Generation
- Length of VP Generation Per Call
- Use Precomputed VP Flag
- Duration between Beacon Tracks (optional)
- Generate Downlink Track Parameters (optional)
  - Enable Downlink Track Generation
  - Number of Tracks per Block
  - Duration between Block Tracks
  - Block Track Duration
- Default Beacon Destination (Onboard Only)
- Default Beacon Start Time (Onboard Only)
- Default Beacon Stale Time (Onboard Only)

# Input File Architecture

## Beacon Lookup Tables

- **Lookup Table  $L$** 
  - **Lookup Table 1**
    - Sync Word
    - Message Length
    - Beacon Types
    - Word List Dictionary

## Shared Tracks View Periods

- **View Period  $V$** 
  - **View Period 1**
    - Users List
    - Station
    - Array of Start/Stop Intervals

## Pre-Computed View Periods Structure

- **View Period for User  $U$** 
  - **View Periods for User 1**
    - Array of Start/Stop Intervals for Each Station
- Next View Period Generation Time
- Maximum Light Time Across All User-Station View Periods
- Simulation Start Time
- Simulation End Time
- View Period Resolution

## Simulation Parameters

- Name
- Start Time
- Stop Time
- Step Duration
- Garbage Collection Duration
- SPICE Database
- SPICE Spacecraft SPK Load List (optional)

## Input Files

- List of Structural Files
- List of Configuration Input Files

## Science Collector Time Series $X$

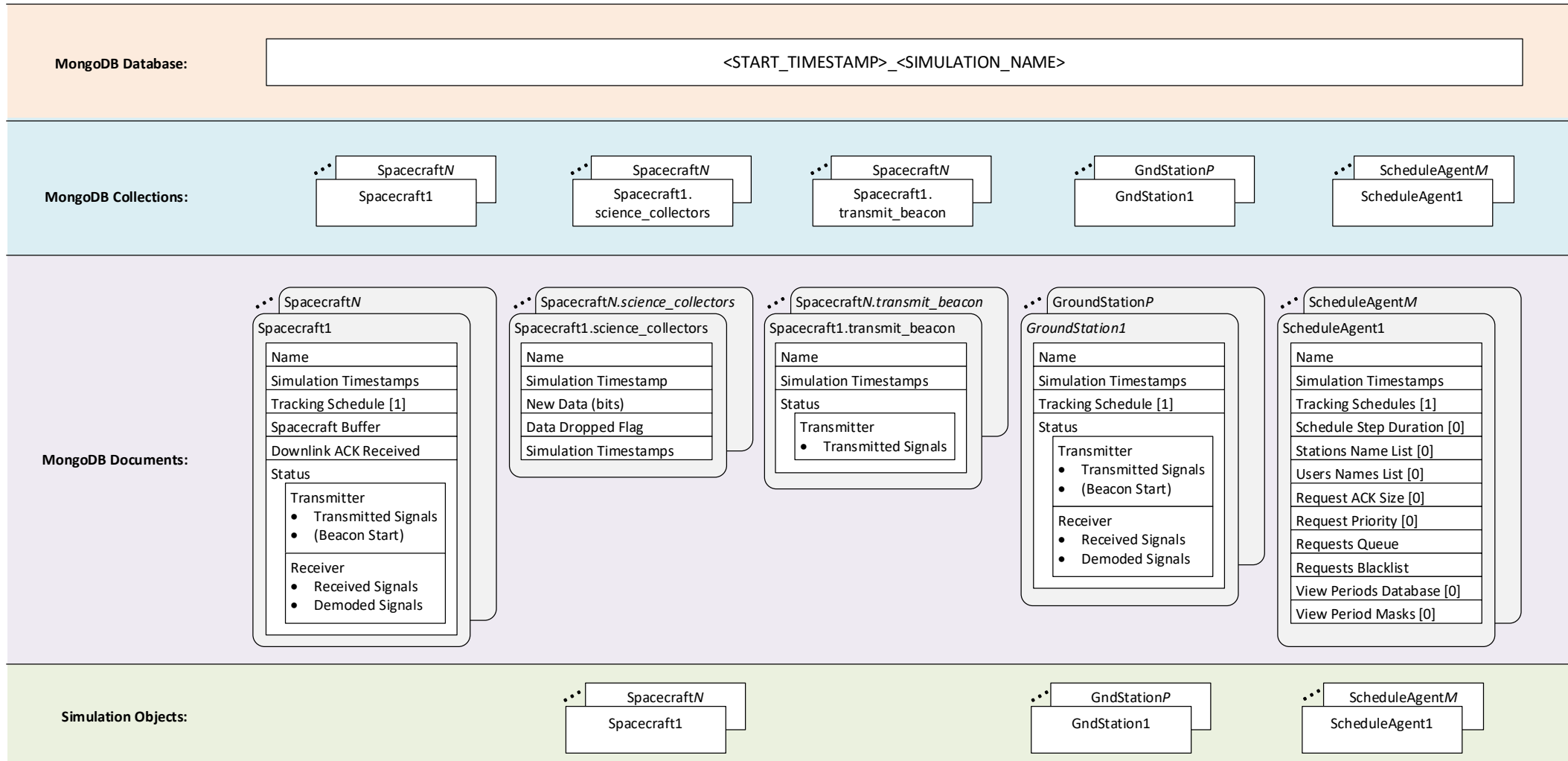
- **Science Collector Time Series 1**
  - Bits collected per simulation timestep

## Key:

**JSON File**

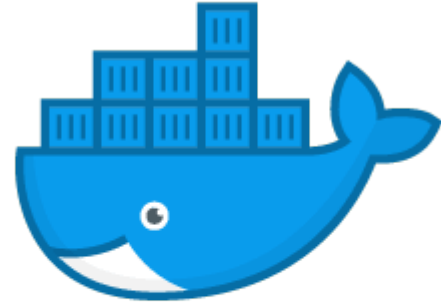
**$\backslash n'$  Delimited File**

# Output Logging Architecture





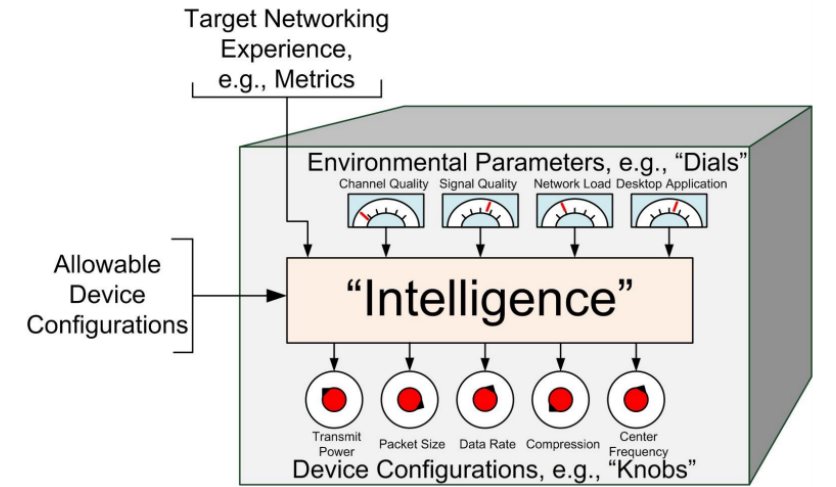
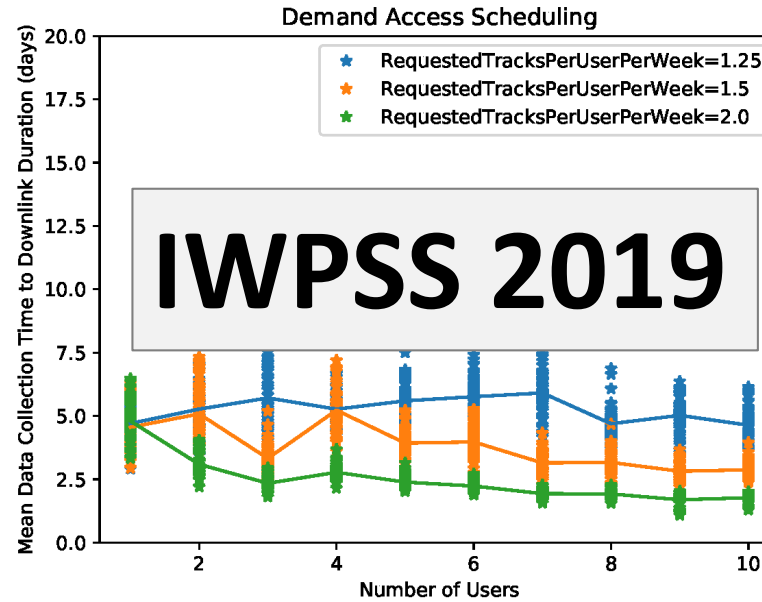
# Deployment Options



docker



# Next Steps



Collins, T. and Wyglinski, A. M. *MILCOM*, 2014

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