URL: http://flip1.engr.oregonstate.edu:9666/

Project Title: NASA RDMS - Robotic Device Management System
Team Name: PK Thunder
Team members: Richie Stuver, Jack Gallivan

Executive Summary

The overall design of the NASA RDMS remained relatively consistent over the course of each iteration. The first major improvement based on peer feedback was to implement filter functionality across each column on each table to easily allow users to customize their view of the data that is presented. After reviewing other team's work in progress we also made the decision to implement an "in place" update feature, where users edit and update individual rows of data directly in the table in which they are displayed, rather than requiring a user to fill out a separate form.

Following this, we received feedback that our minimal implementation of foreign key columns across tables was actually very difficult for users to manage, since IDs needed to be looked up on separate pages and then entered manually in the required form field. To remedy this, we first tried implementing view-only tables so that the user could use it to reference foreign keys, but realized that it was still clumsy for the user. We ended up removing the view-only tables and modifying both our front and back-end to support selecting descriptive values corresponding to foreign keys (mostly "name"-style attributes from their respective tables) within dropdowns on each add and edit form. While the UI in particular required a few iterations where reviewers provided feedback on various bugs encountered (for instance, duplicate values appearing in dropdowns or ability to enter an empty string in a text field) we eventually were able to nail down our interface with the assistance of those reviewing.

While we did receive consistent positive feedback about our minimalist interface throughout each iteration, one reviewer did recommend that we introduce an alert to inform users when a particular action does not succeed. Previously, while the expected behavior for particular errors such as 500 server responses did occur, these errors "failed silently" without the user being aware of them. We took this reviewer's recommendation and introduced alerts for most major error conditions with brief explanatory text to notify the user of the issue.

Lastly, after receiving feedback from a grader regarding being unable to update a NULLable foreign key to NULL, which we fixed in our final step, we also noticed that supposed NULL values were neither consistently displayed on our website, nor updated as NULL in the database. Our solution was to always display NULL values as empty strings in our website's tables, and vice-versa; interpret empty strings from all inputs on the website as NULL values in our database queries.

Project Overview

The engineering department at NASA is ramping up their production of robotic systems to send out into the solar system. The management of these devices has become problematic and quickly getting out of hand as the quantity of devices launched into space is now 100+ per year on over 80 missions across over 20 locations in space and is growing at an exponential rate.

To solve this problem, we created a robot management system capable of managing thousands of robotic devices to allow NASA engineers to track and manage all devices launched on missions to outer space. The system allows engineers to track: robotic devices, functionality, operators, missions, and locations. This allows NASA to be more efficient by conserving resources using existing robots already out there to work on new missions.

Database Outline

Entities

- Devices: records the robotic devices launched on missions.
    - deviceID: int, auto_increment, not NULL, PK
    - deviceName: varchar, UNIQUE, not NULL
    - dateLaunched: date, not NULL
    - manufacturer: varchar, not NULL
    - locationID: int, FK, not NULL
    - missionID: int, FK, default NULL
- Locations: records locations in space where there may or may not be robotic devices.
    - locationID: int, auto_increment, not NULL, PK
    - locationName: varchar, UNIQUE, not NULL
    - localSystem: varchar, not NULL
    - localBody: varchar, not NULL
- Functions: records the functionality assigned to each device.
    - functionID: int, auto_increment, not NULL, PK
    - functionName: varchar, UNIQUE, not NULL
    - description: varchar
- Missions: records NASA missions to locations in space.
    - missionID: int, auto_increment, not NULL, PK
    - missionName: varchar, UNIQUE, not NULL
    - objective: varchar, not NULL
    - locationID: int, FK, not NULL
- Operators: records operators that execute day-to-day operations for devices.
    - operatorID: int, auto_increment, not NULL, PK
    - operatorName: varchar, UNIQUE not NULL
    - deviceID: int, FK, default NULL

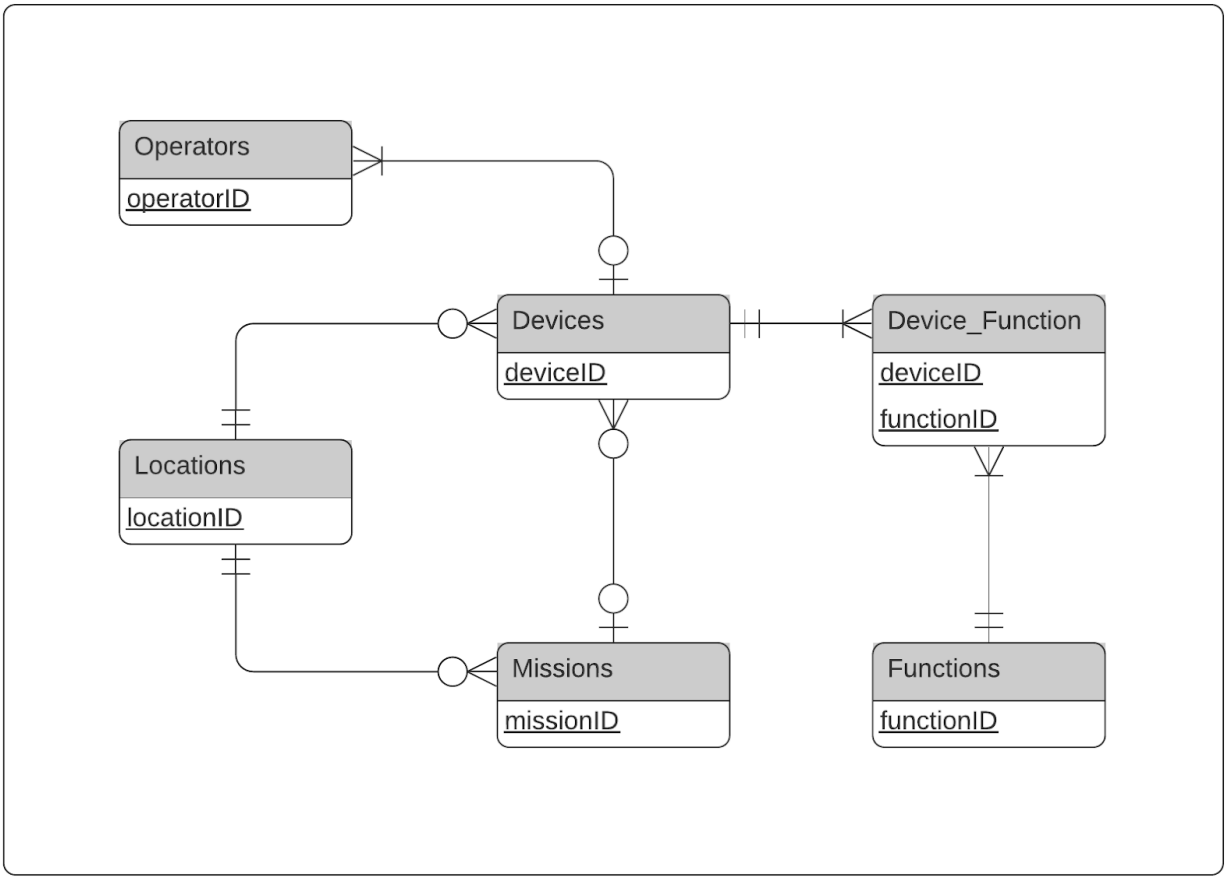
Relationship Tables

- Device_Function: records the many-to-many relationship between Devices and Functions.
    - deviceID: int, FK, not NULL
    - functionID: int, FK, not NULL

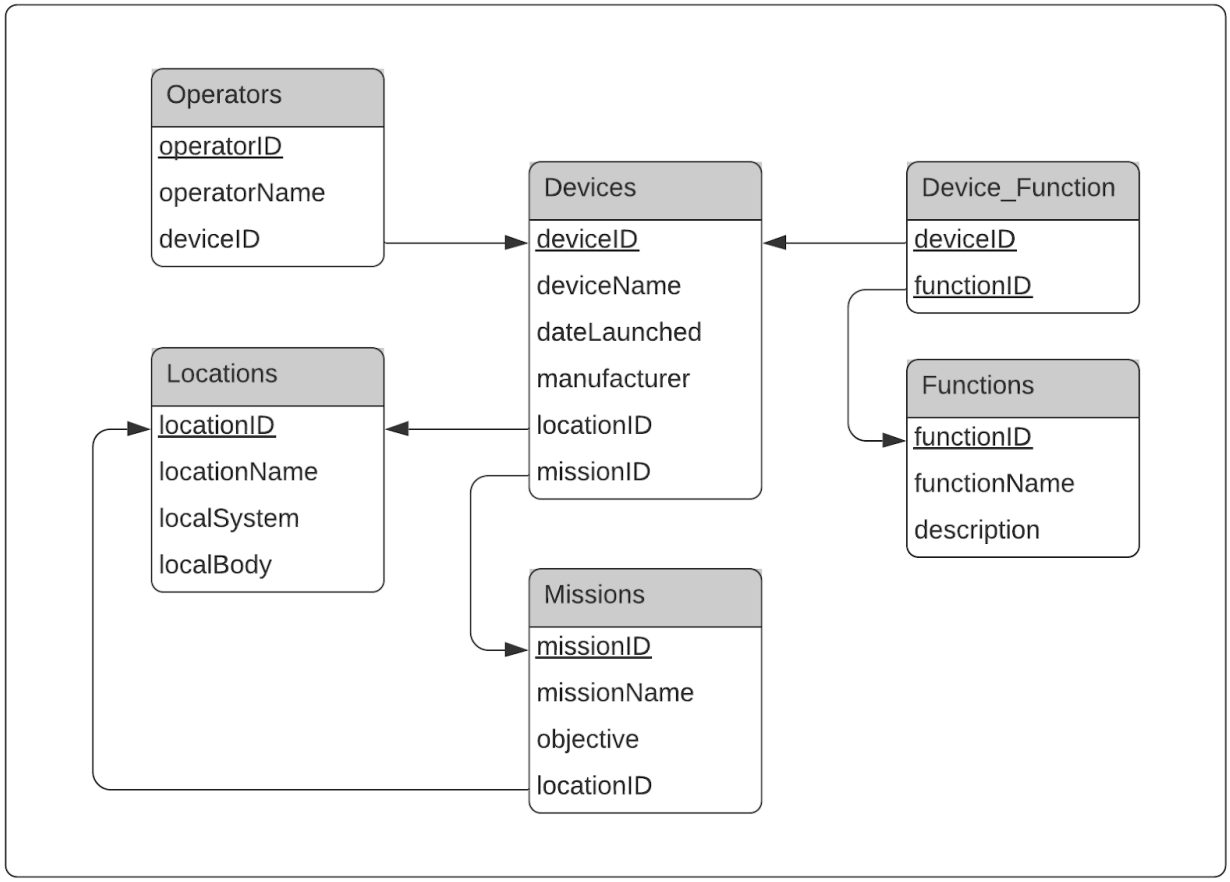
Relationships

- Devices : Missions
    - M:1. 0 or 1 missions per device, 0 or more devices per mission.
- Devices : Locations
    - M:1. Exactly 1 location per device, 0 or more devices per location.
- Missions : Locations
    - M:1. Exactly 1 location per mission, 0 or more missions per location.
- Operators : Devices
    - M:1. 0 or 1 devices per operator, 1 or more operators per device.
- Devices : Functions
    - M:M. 1 or more functions per device, 1 or more device per function.

ER Diagram

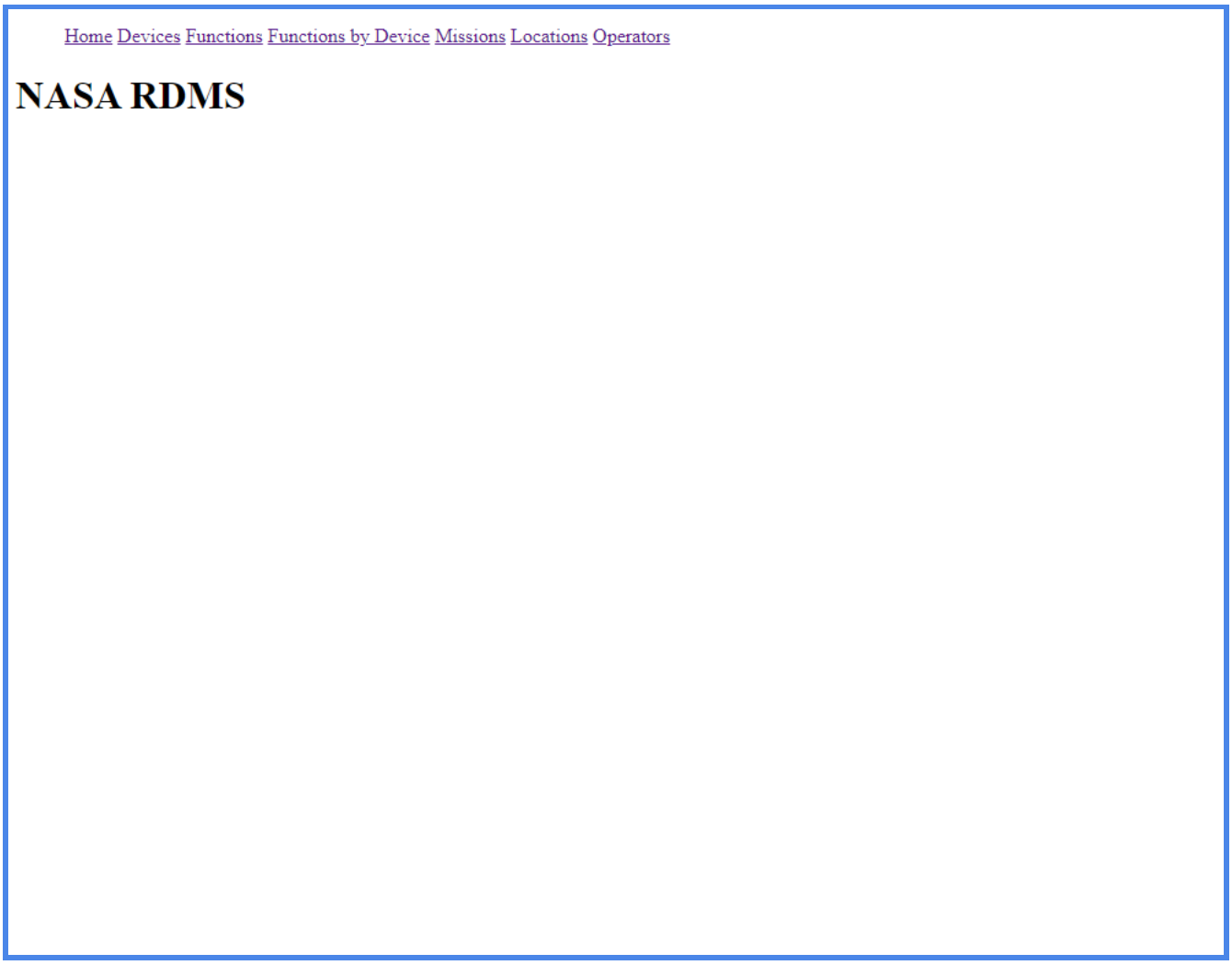

Operators
operatorID
Devices
deviceID
Device_Function
deviceID
functionID
Locations
locationID
Missions
missionID
Functions
functionID

Schema

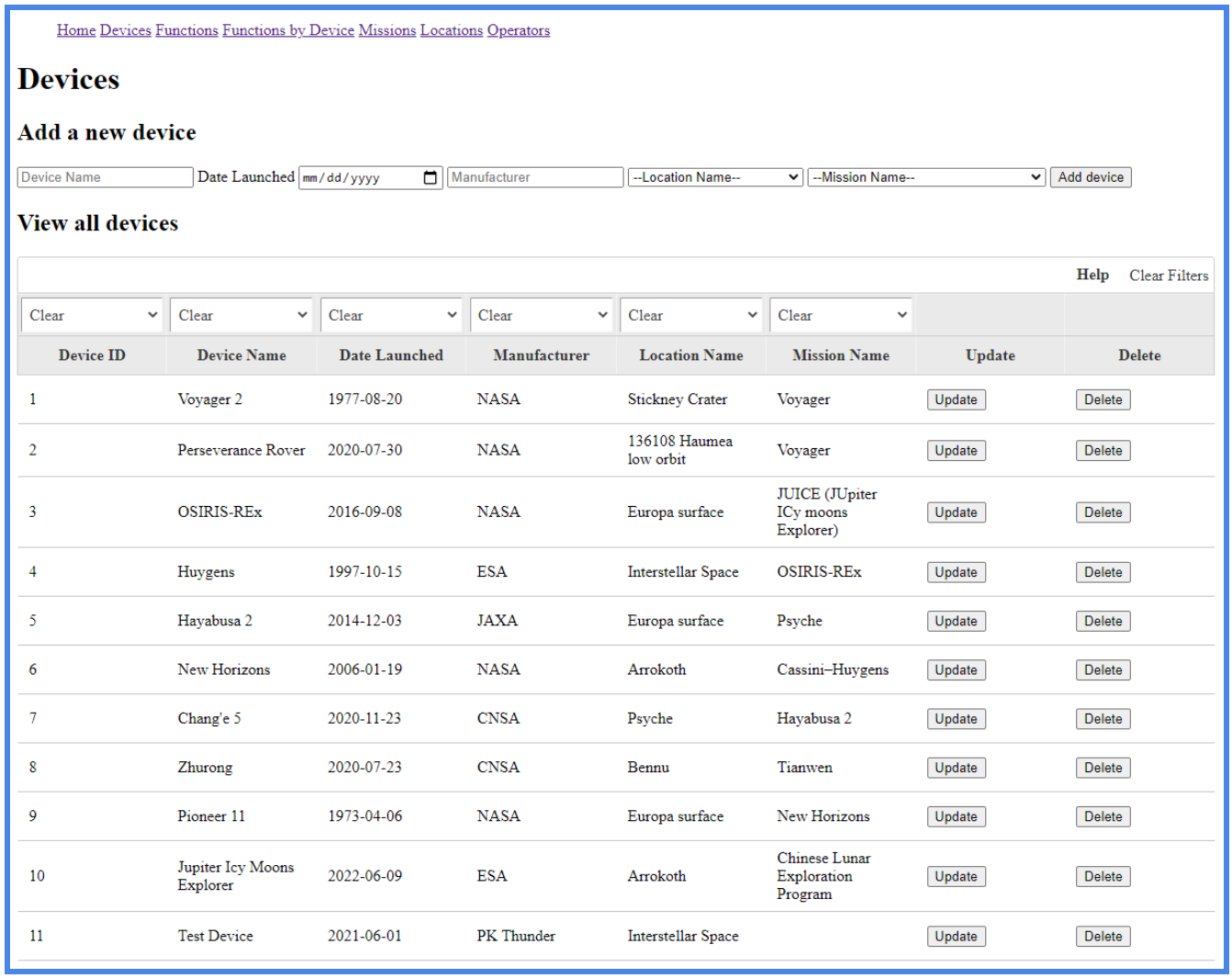

Operators
operatorID
operatorName
deviceID
Devices
deviceID
deviceName
dateLaunched
manufacturer
locationID
missionID
Device_Function
deviceID
functionID
Functions
functionID
functionName
description
Locations
locationID
locationName
localSystem
localBody
Missions
missionID
missionName
objective
locationID

UI Screenshots

1 - Home Page



2 - (CREATE / READ / UPDATE / DELETE) Devices



Home Devices Functions Functions by Device Missions Locations Operators

Devices

Add a new device

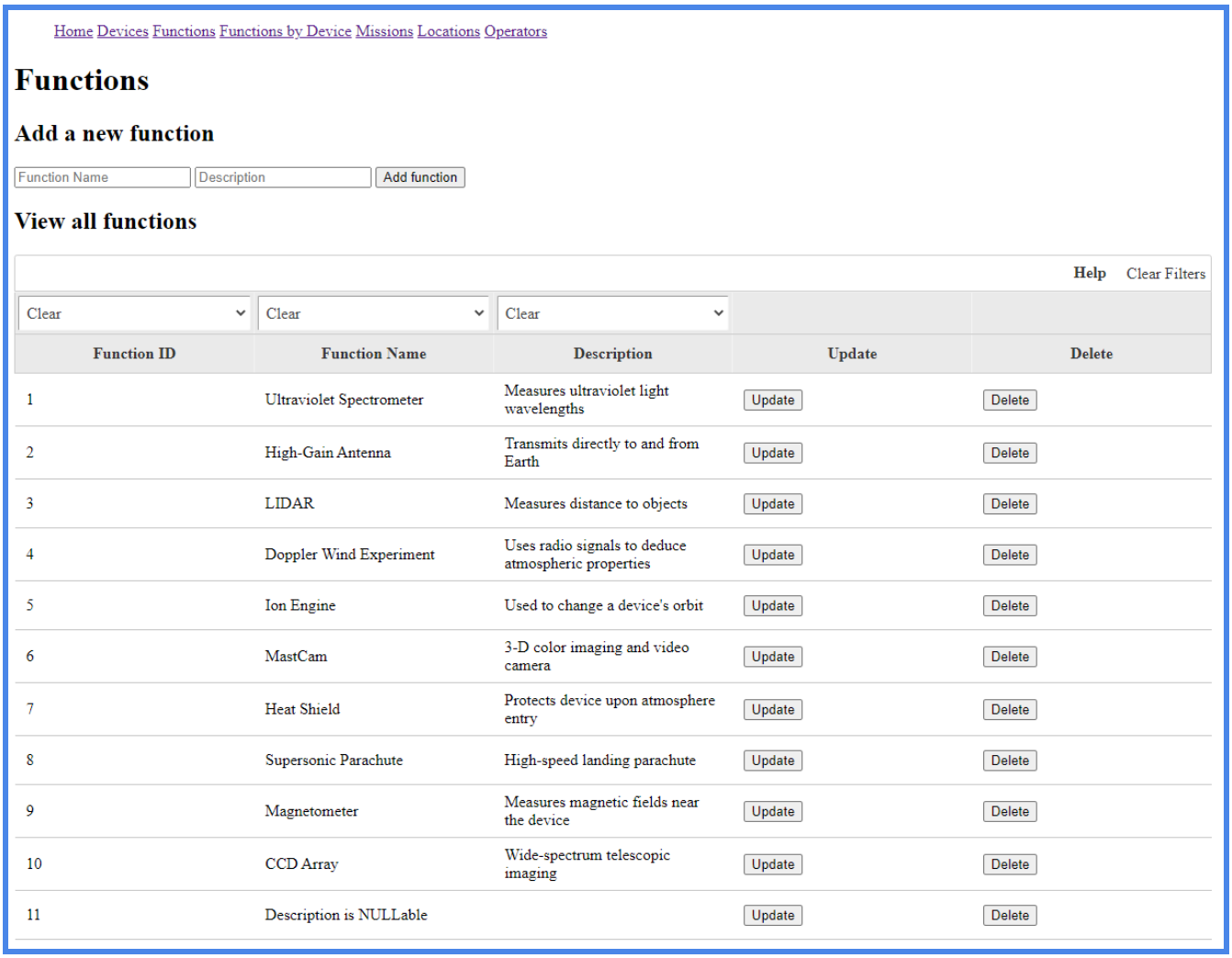
Device Name | Date Launched mm/dd/yyyy | Manufacturer | --Location Name-- | --Mission Name-- | Add device

View all devices

Help Clear Filters

Clear	Clear	Clear	Clear	Clear	Clear		
Device ID	**Device Name**	**Date Launched**	**Manufacturer**	**Location Name**	**Mission Name**	**Update**	**Delete**
1	Voyager 2	1977-08-20	NASA	Stickney Crater	Voyager	Update	Delete
2	Perseverance Rover	2020-07-30	NASA	136108 Haumea low orbit	Voyager	Update	Delete
3	OSIRIS-REx	2016-09-08	NASA	Europa surface	JUICE (JUpiter ICy moons Explorer)	Update	Delete
4	Huygens	1997-10-15	ESA	Interstellar Space	OSIRIS-REx	Update	Delete
5	Hayabusa 2	2014-12-03	JAXA	Europa surface	Psyche	Update	Delete
6	New Horizons	2006-01-19	NASA	Arrokoth	Cassini–Huygens	Update	Delete
7	Chang'e 5	2020-11-23	CNSA	Psyche	Hayabusa 2	Update	Delete
8	Zhurong	2020-07-23	CNSA	Bennu	Tianwen	Update	Delete
9	Pioneer 11	1973-04-06	NASA	Europa surface	New Horizons	Update	Delete
10	Jupiter Icy Moons Explorer	2022-06-09	ESA	Arrokoth	Chinese Lunar Exploration Program	Update	Delete
11	Test Device	2021-06-01	PK Thunder	Interstellar Space		Update	Delete

3 - (CREATE / READ / UPDATE / DELETE) Functions



Home Devices Functions Functions by Device Missions Locations Operators

Functions

Add a new function

Function Name | Description | Add function

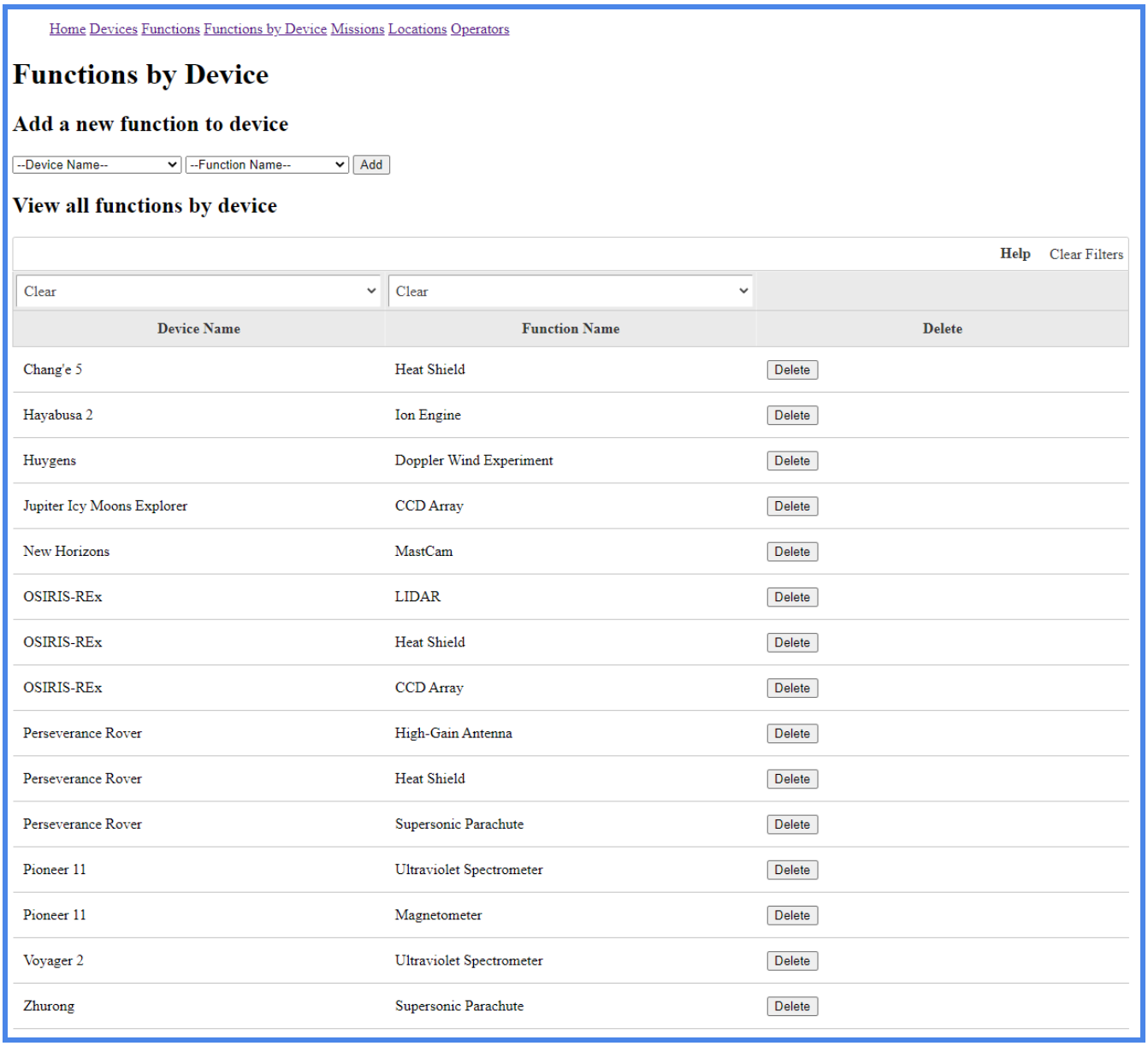
View all functions

Help Clear Filters

Clear | Clear | Clear

Function ID	Function Name	Description	Update	Delete
1	Ultraviolet Spectrometer	Measures ultraviolet light wavelengths	Update	Delete
2	High-Gain Antenna	Transmits directly to and from Earth	Update	Delete
3	LIDAR	Measures distance to objects	Update	Delete
4	Doppler Wind Experiment	Uses radio signals to deduce atmospheric properties	Update	Delete
5	Ion Engine	Used to change a device's orbit	Update	Delete
6	MastCam	3-D color imaging and video camera	Update	Delete
7	Heat Shield	Protects device upon atmosphere entry	Update	Delete
8	Supersonic Parachute	High-speed landing parachute	Update	Delete
9	Magnetometer	Measures magnetic fields near the device	Update	Delete
10	CCD Array	Wide-spectrum telescopic imaging	Update	Delete
11	Description is NULLable		Update	Delete

4 - (CREATE / READ / DELETE) Functions by Device



Home Devices Functions Functions by Device Missions Locations Operators

Functions by Device

Add a new function to device

--Device Name-- --Function Name-- Add

View all functions by device

Help Clear Filters

Clear Clear

Device Name	Function Name	Delete
Chang'e 5	Heat Shield	Delete
Hayabusa 2	Ion Engine	Delete
Huygens	Doppler Wind Experiment	Delete
Jupiter Icy Moons Explorer	CCD Array	Delete
New Horizons	MastCam	Delete
OSIRIS-REx	LIDAR	Delete
OSIRIS-REx	Heat Shield	Delete
OSIRIS-REx	CCD Array	Delete
Perseverance Rover	High-Gain Antenna	Delete
Perseverance Rover	Heat Shield	Delete
Perseverance Rover	Supersonic Parachute	Delete
Pioneer 11	Ultraviolet Spectrometer	Delete
Pioneer 11	Magnetometer	Delete
Voyager 2	Ultraviolet Spectrometer	Delete
Zhurong	Supersonic Parachute	Delete

5 - (CREATE / READ / UPDATE / DELETE) Missions

Missions

Add a new mission

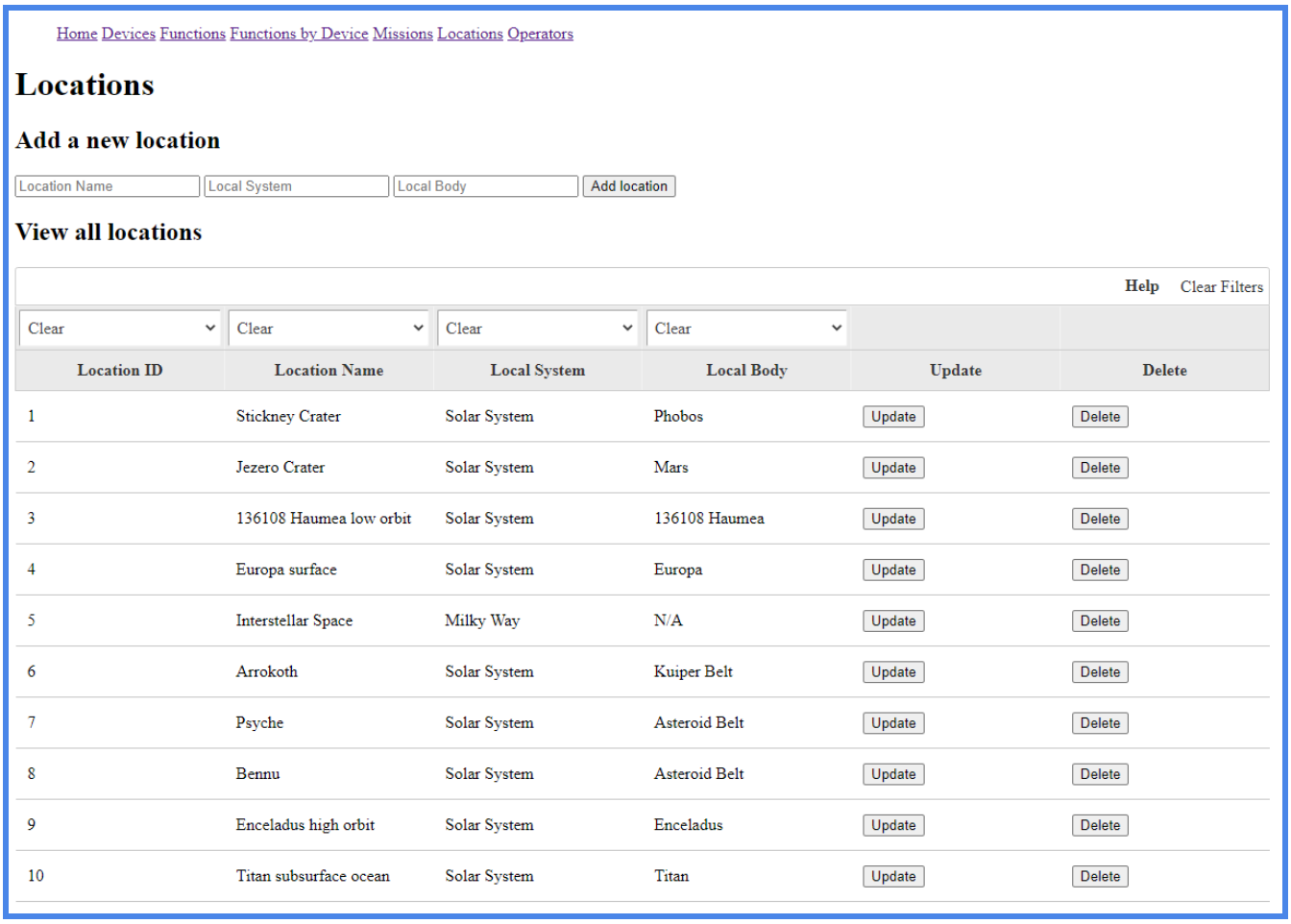
Mission Name | Objective | --Location Name-- | Add mission

View all missions

Help Clear Filters

Clear	Clear	Clear	Clear		
Mission ID	**Mission Name**	**Objective**	**Location Name**	**Update**	**Delete**
1	Chinese Lunar Exploration Program	ongoing series of robotic Moon missions by the China National Space Administration (Wikipedia)	Stickney Crater	Update	Delete
2	Voyager	Designed to take advantage of a rare planetary alignment to study the outer solar system up close. Voyager 2 targeted Jupiter, Saturn, Uranus and Neptune (NASA)	Interstellar Space	Update	Delete
3	Mars 2020	Seek signs of ancient life and collect samples of rock and regolith (broken rock and soil) for possible return to Earth (NASA)	Jezero Crater	Update	Delete
4	Hayabusa 2	six-year mission to study the asteroid Ryugu and to collect samples to bring to Earth for analysis (NASA)	136108 Haumea low orbit	Update	Delete
5	New Horizons	Pluto Flyby, Kuiper Belt Object Flyby (NASA)	Europa surface	Update	Delete
6	Psyche	will explore a metal-rich asteroid in the main asteroid belt between Mars and Jupiter (NASA)	Interstellar Space	Update	Delete
7	OSIRIS-REx	successfully collect a sample from an asteroid (NASA)	Arrokoth	Update	Delete
8	JUICE (JUpiter ICy moons Explorer)	will explore Jupiter and three of its icy moons in depth (NASA)	Psyche	Update	Delete
9	Cassini–Huygens	study the planet Saturn and its system, including its rings and natural satellites. (Wikipedia)	Bennu	Update	Delete
10	Tianwen	send a robotic spacecraft to Mars, consisting of an orbiter, deployable camera, lander and the Zhurong rover (Wikipedia)	Enceladus high orbit	Update	Delete

6 - (CREATE / READ / UPDATE / DELETE) Locations



Home Devices Functions Functions by Device Missions Locations Operators

Locations

Add a new location

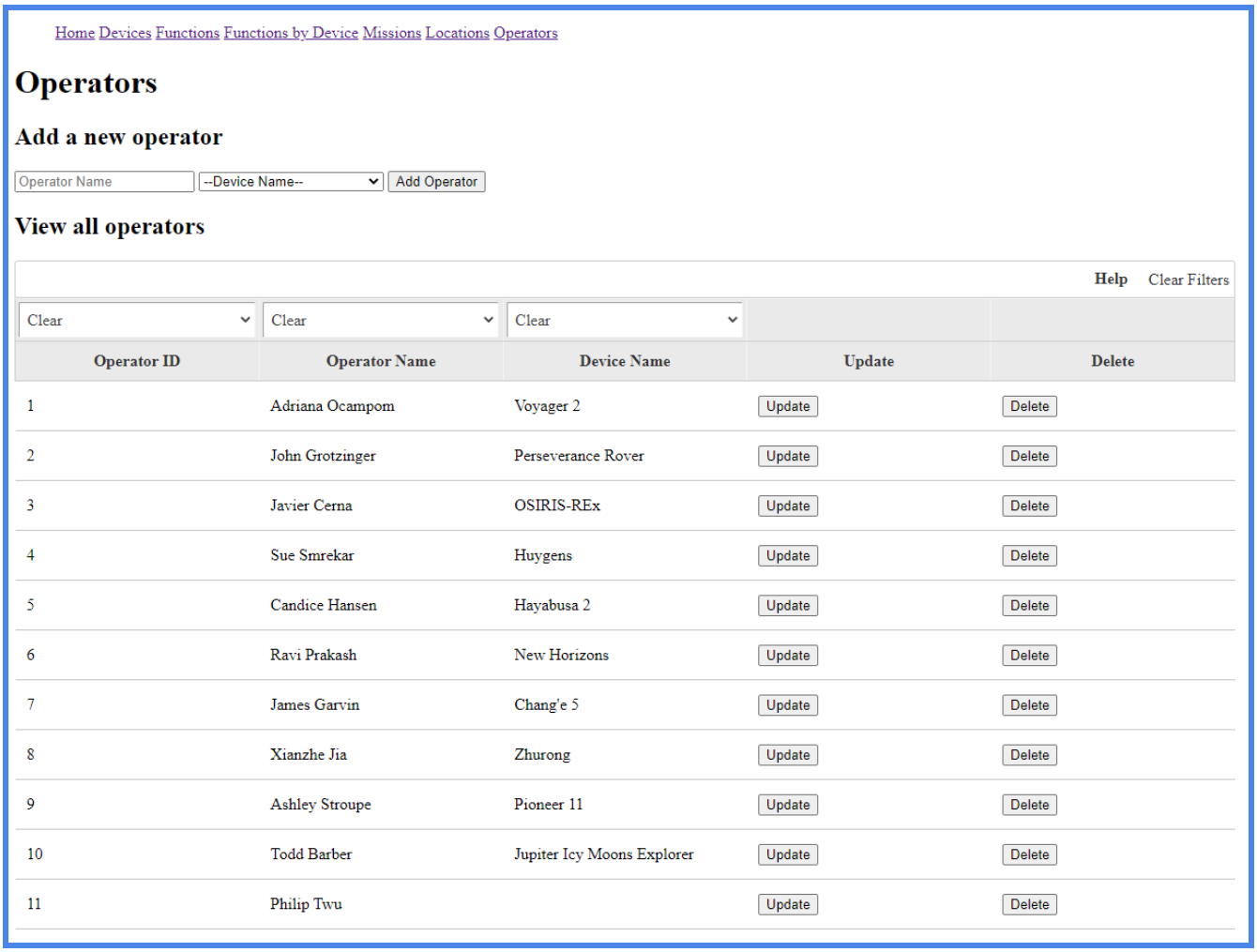
Location Name | Local System | Local Body | Add location

View all locations

Help Clear Filters

Location ID	Location Name	Local System	Local Body	Update	Delete
1	Stickney Crater	Solar System	Phobos	Update	Delete
2	Jezero Crater	Solar System	Mars	Update	Delete
3	136108 Haumea low orbit	Solar System	136108 Haumea	Update	Delete
4	Europa surface	Solar System	Europa	Update	Delete
5	Interstellar Space	Milky Way	N/A	Update	Delete
6	Arrokoth	Solar System	Kuiper Belt	Update	Delete
7	Psyche	Solar System	Asteroid Belt	Update	Delete
8	Bennu	Solar System	Asteroid Belt	Update	Delete
9	Enceladus high orbit	Solar System	Enceladus	Update	Delete
10	Titan subsurface ocean	Solar System	Titan	Update	Delete

7 - (CREATE / READ / UPDATE / DELETE) Operators



Home Devices Functions Functions by Device Missions Locations Operators

Operators

Add a new operator

Operator Name | --Device Name-- | Add Operator

View all operators

Help Clear Filters

Clear	Clear	Clear		
Operator ID	**Operator Name**	**Device Name**	**Update**	**Delete**
1	Adriana Ocampom	Voyager 2	Update	Delete
2	John Grotzinger	Perseverance Rover	Update	Delete
3	Javier Cerna	OSIRIS-REx	Update	Delete
4	Sue Smrekar	Huygens	Update	Delete
5	Candice Hansen	Hayabusa 2	Update	Delete
6	Ravi Prakash	New Horizons	Update	Delete
7	James Garvin	Chang'e 5	Update	Delete
8	Xianzhe Jia	Zhurong	Update	Delete
9	Ashley Stroupe	Pioneer 11	Update	Delete
10	Todd Barber	Jupiter Icy Moons Explorer	Update	Delete
11	Philip Twu		Update	Delete