



United States Space Force (SMC / ECX / EGS)

Space Enterprise User Experience Design System (UXDS)

Design Guidance And Specifications For Flight Dynamics
Service (FDS)

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Basic Tool Framework

Overview

Overview

The Flight Dynamics Service (FDS) Application is designed to support orbital analysis, spacecraft maneuvers, and reporting. There are three tiers of capability or tools upon which the Flight Dynamics Service application is built upon:

Orbit Determination (OD)

Allows the user to perform orbit determinations, generate ephemerides and two-line element sets (TLEs), as well as generate reports.

Maneuvering*

Allows the user to perform various types of maneuvers to include station keeping, attitude control, conjunction assessment, collision avoidance (COLAs), and thrusts-and-burns.

Reporting*

Allows the user to generate, compare, and manage orbital analysis reports and other products.

**While the Maneuvering and Reporting tools have not been researched, tested, and designed to the same depth as the Orbit Determination Tool, they have been considered throughout the research and design process from the broader perspective of the application.*

Overview - Users & Use Case

A common use case and user roles were identified in order to understand and organize FDS requirements, as well as to ensure that users can effectively and efficiently accomplish task requirements within their respective roles.

Users

The intended users of the Flight Dynamics Service application are orbital analysts, engineers, flight directors and/or any users performing orbital analysis and spacecraft maneuvers. User roles can range from entry-level to more advanced engineer-level roles.

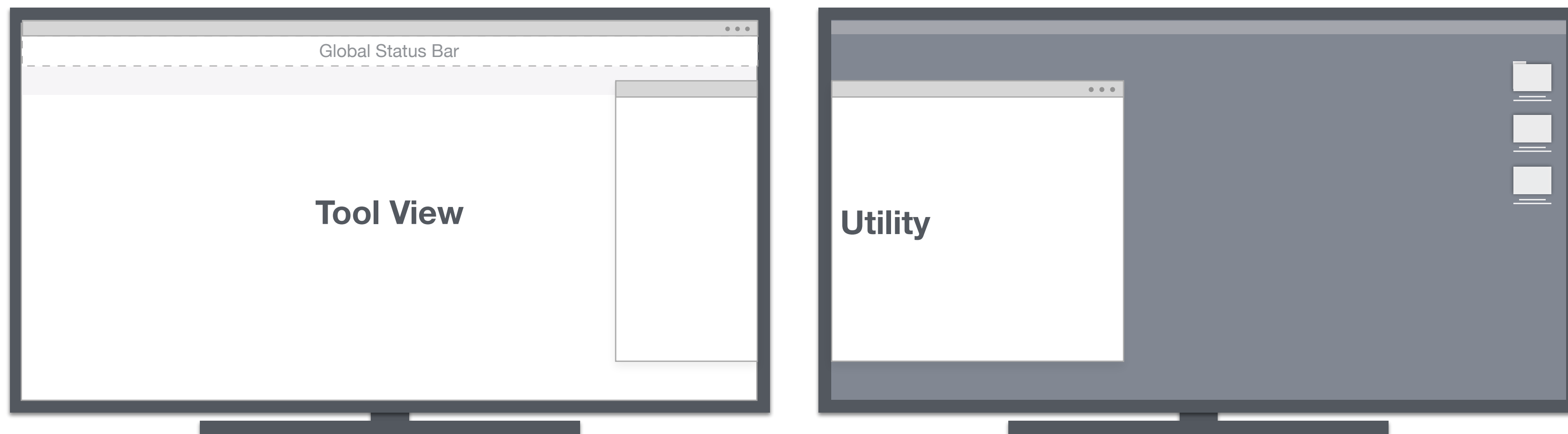
Use Case

The use case that helped to identify system requirements for orbit determination was centered around the task of performing an OD and generating an ephemeris.

Overview - Application Paradigm

The FDS application paradigm consists of a main application view that displays one tool at a time, which are accessed via tabs. Each tool features utilities that are contextual to its related task flows.

Utilities allow users to access secondary actions and tools when they need them, and dismiss them when they don't. Utilities launch in draggable, scalable modal windows. Users can work interchangeably between the tool and utility windows.

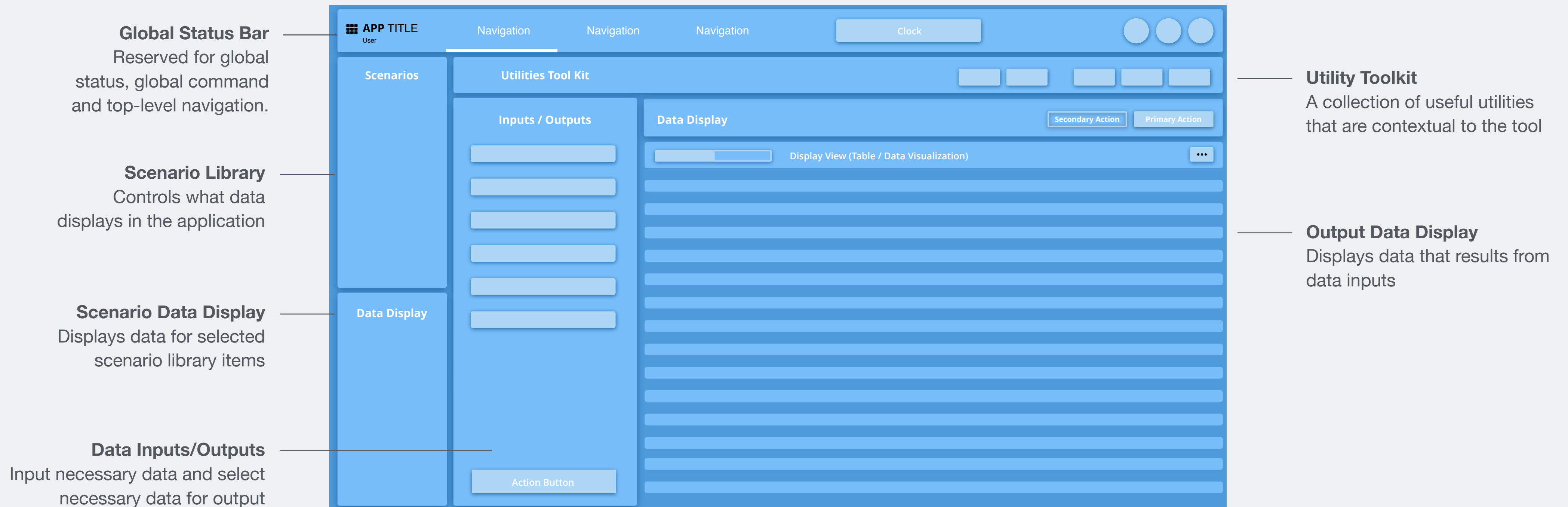


Dual-Monitor Setup

Overview - Tool Framework

Based on system requirements and user research, functionality has been categorized and organized into frameworks for developers to build from, including sections for a global status bar, a scenario library, data input/outputs, data display, and a utility toolkit. It's important to note that the labels, icons, and specific data included in the wireframes are for demonstrative purposes and are agnostic to the various flight dynamics missions.

Basic Tool Framework

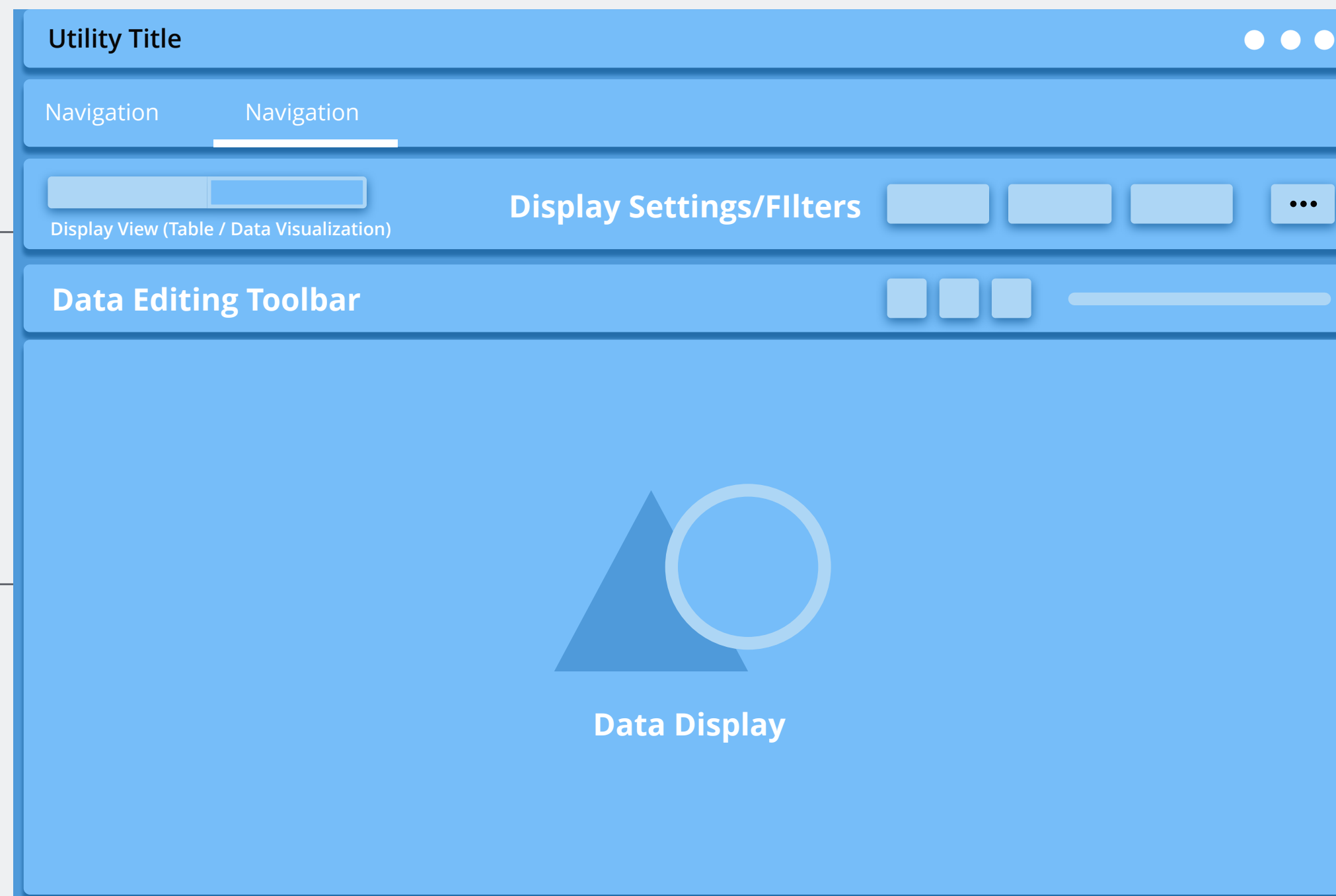


Overview - Utility Toolkit Framework

Basic Utility Toolkit Framework

Display Settings/Filters
Controls contents and view of the utility

Data Display
Displays data that results from data inputs



Navigation
Allows user to navigate between tabs

Data Editing Toolbar
A grouping of contextual editing controls used for real time data feedback and analysis

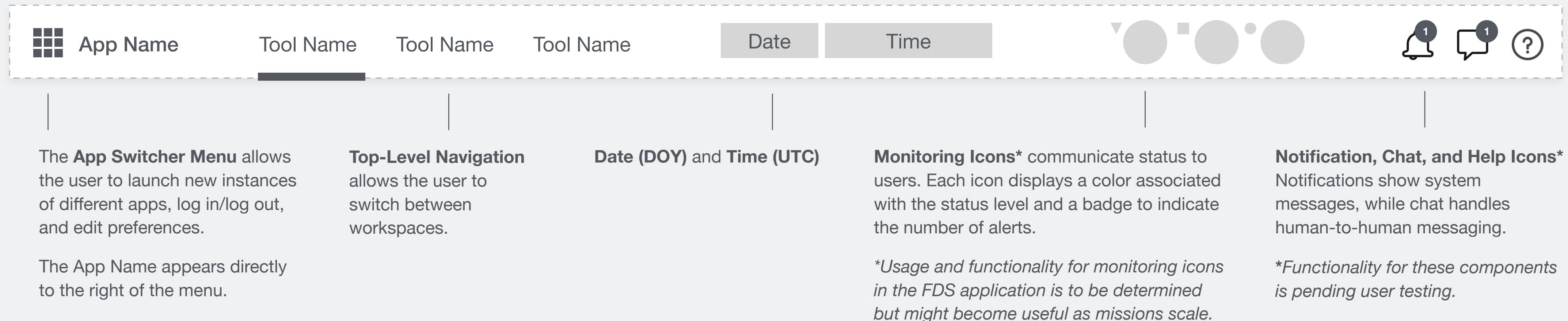
Global Components

Global Components - Global Status Bar

The Global Status Bar is a full width component that spans the top of all EGS Services applications; it is reserved for an app switcher menu, top-level navigation, date and time, monitoring icons and ancillary functionality like notifications, chat, and user profiles.

See the [Astro UXDS guidelines](#) to learn more about the Global Status Bar.

FDS Global Status Bar Features



Global Components - App Switcher Menu

Functionality

The App Switcher Menu allows the user to launch new instances of different applications, sign in/sign out of the application, and edit preferences.

Features & Interactions

1. Launching Apps

Clicking an application in the App Switcher Menu launches an instance of the application in a new browser window.

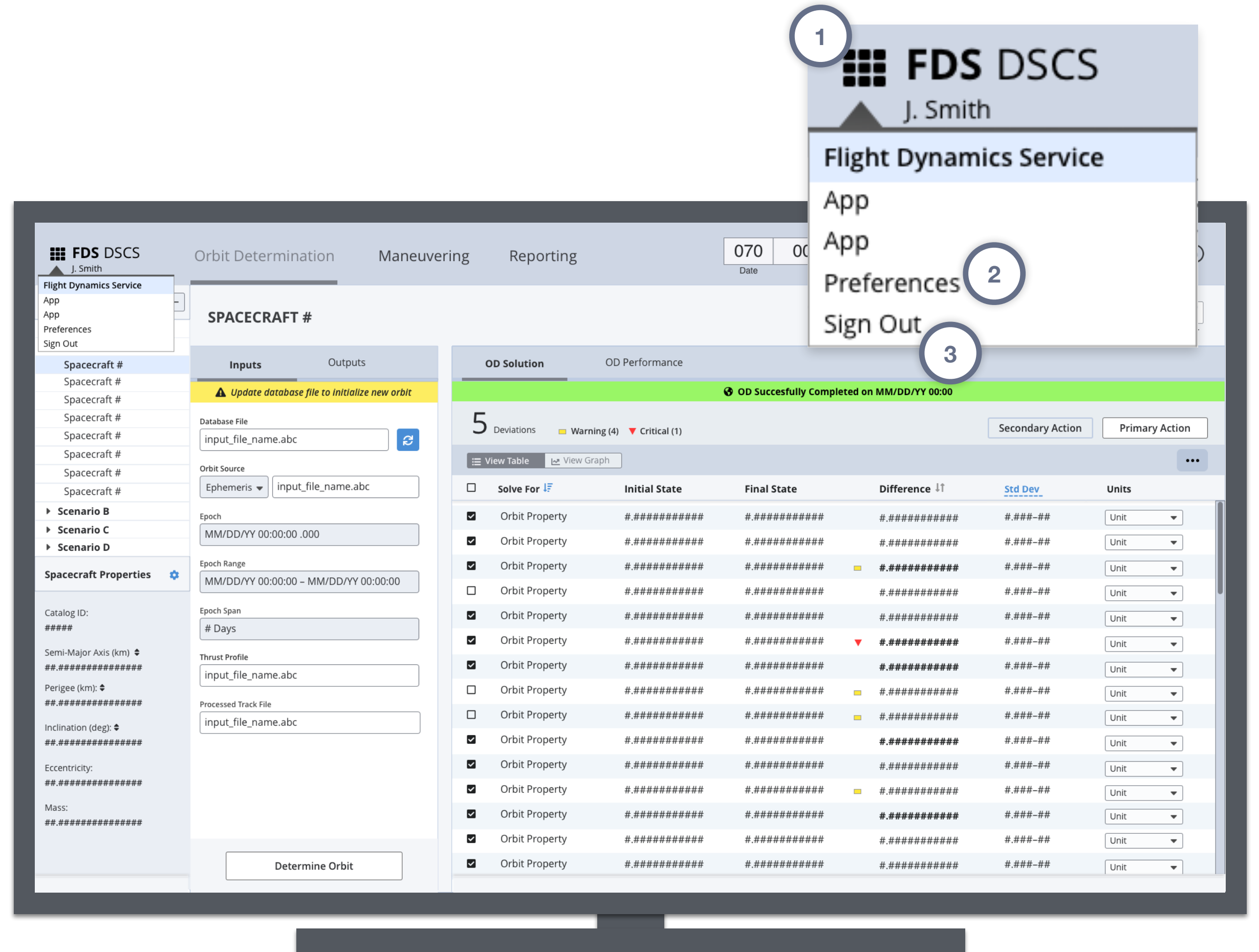
**Some FD missions may require the inclusion or integration of additional applications (i.e. a scheduling app). Those additional apps would be housed in the app switcher menu.*

2. Preferences

Preferences are used to configure and customize the appearance and behavior of the FDS app.

3. Sign In/Out

Users can sign in or out of the application through the App Switcher Menu.



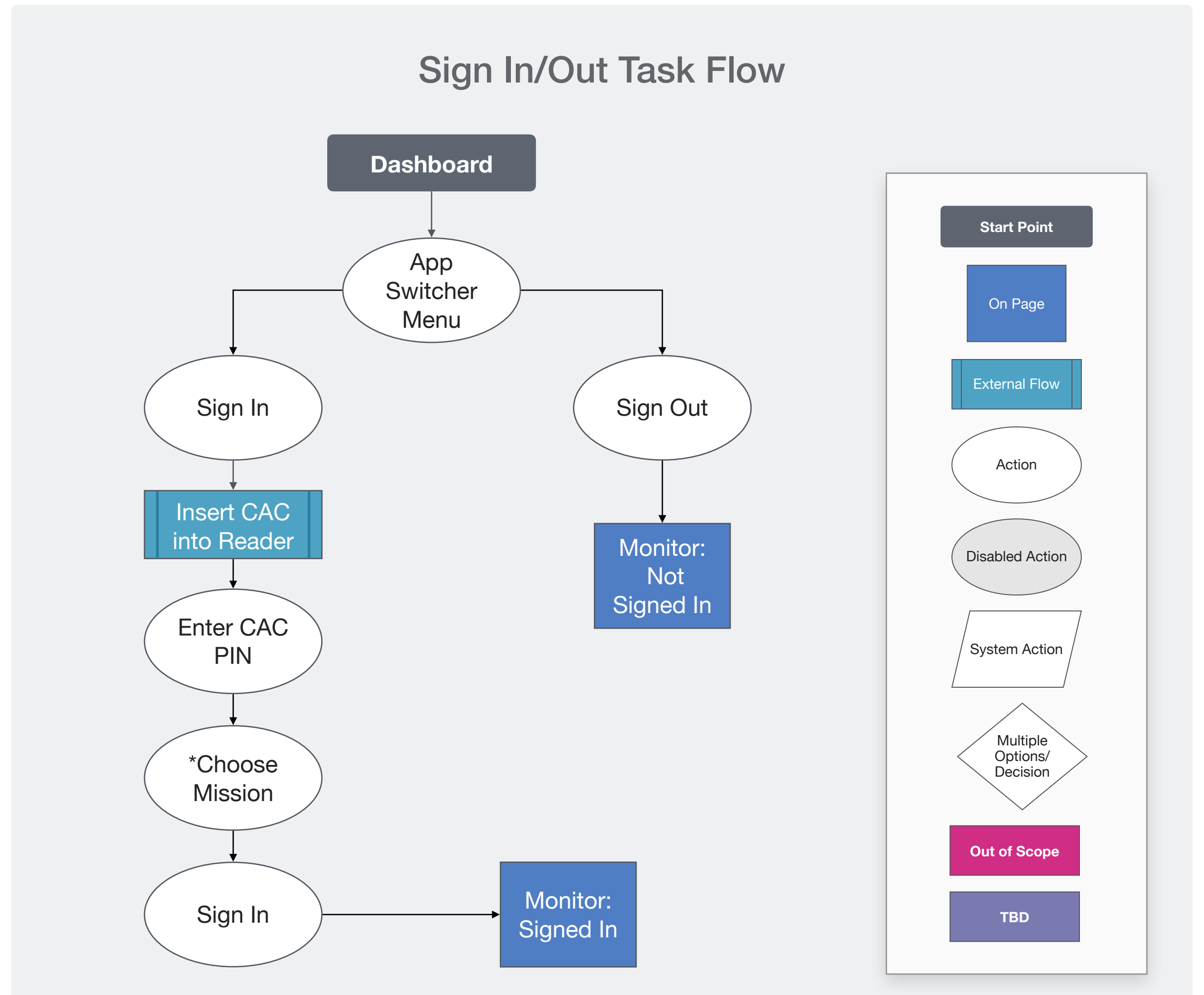
The screenshot displays the FDS DSCS application interface. At the top left, the user is logged in as J. Smith. The main navigation bar includes 'Orbit Determination', 'Maneuvering', and 'Reporting'. A date field shows '070 00'. The 'App Switcher Menu' is open, showing options: 'Flight Dynamics Service', 'App', 'App Preferences', and 'Sign Out'. The main dashboard is titled 'SPACECRAFT #' and features an 'Inputs' section with fields for 'Database File' (input_file_name.abc), 'Orbit Source' (Ephemeris), 'Epoch' (MM/DD/YY 00:00:00 .000), 'Epoch Range' (MM/DD/YY 00:00:00 - MM/DD/YY 00:00:00), 'Epoch Span' (# Days), 'Thrust Profile' (input_file_name.abc), and 'Processed Track File' (input_file_name.abc). A 'Determine Orbit' button is at the bottom of the inputs section. The 'Outputs' section shows a warning: 'Update database file to initialize new orbit'. The 'OD Solution' section displays '5 Deviations' (Warning (4), Critical (1)) and a status bar indicating 'OD Successfully Completed on MM/DD/YY 00:00'. Below this is a table with columns: 'Solve For', 'Initial State', 'Final State', 'Difference', 'Std Dev', and 'Units'. The table contains multiple rows of 'Orbit Property' data.

Global Components - Sign In/Out Flow

This user flow shows the actions involved in signing in or out of the FDS Application.

If the user works on multiple missions, mission is either pre-selected by system or user selects desired mission.

Sign In/Sign Out Flow may vary mission-to-mission.

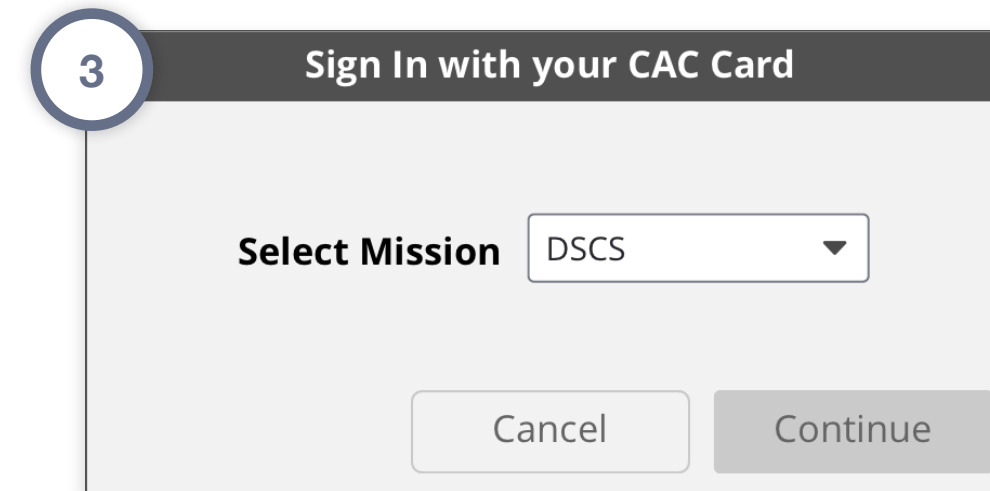
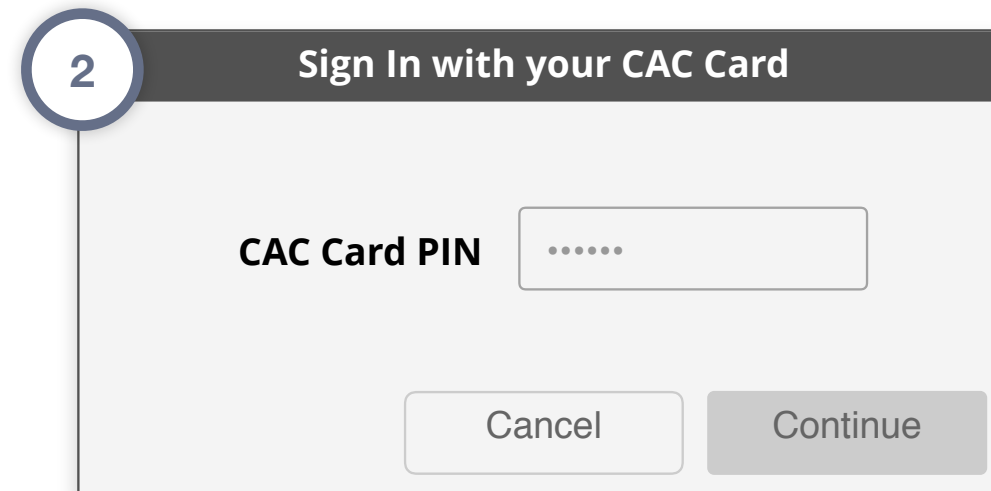
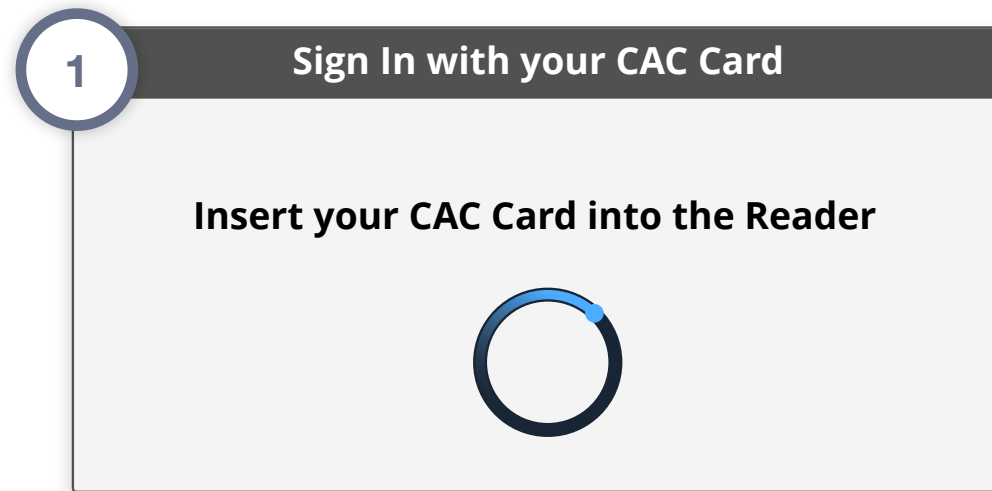


**Optional if user is only assigned to one mission*

Global Components - Sign In/Out Steps

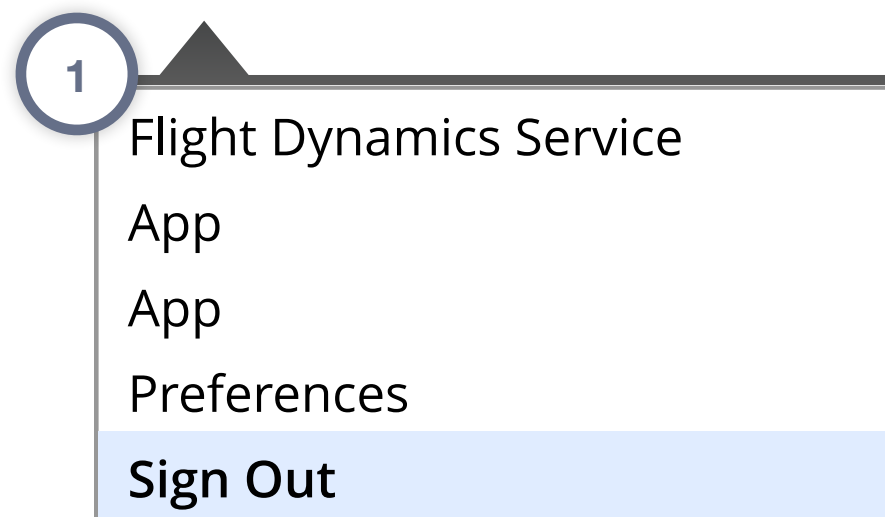
Sign In Steps

1. Insert Common Access Card (CAC) into the external reader.
2. Enter CAC PIN.
3. Select mission, then click “Sign In”.



Sign Out Steps

1. Click the App Switcher Menu icon, then click “Sign Out.”



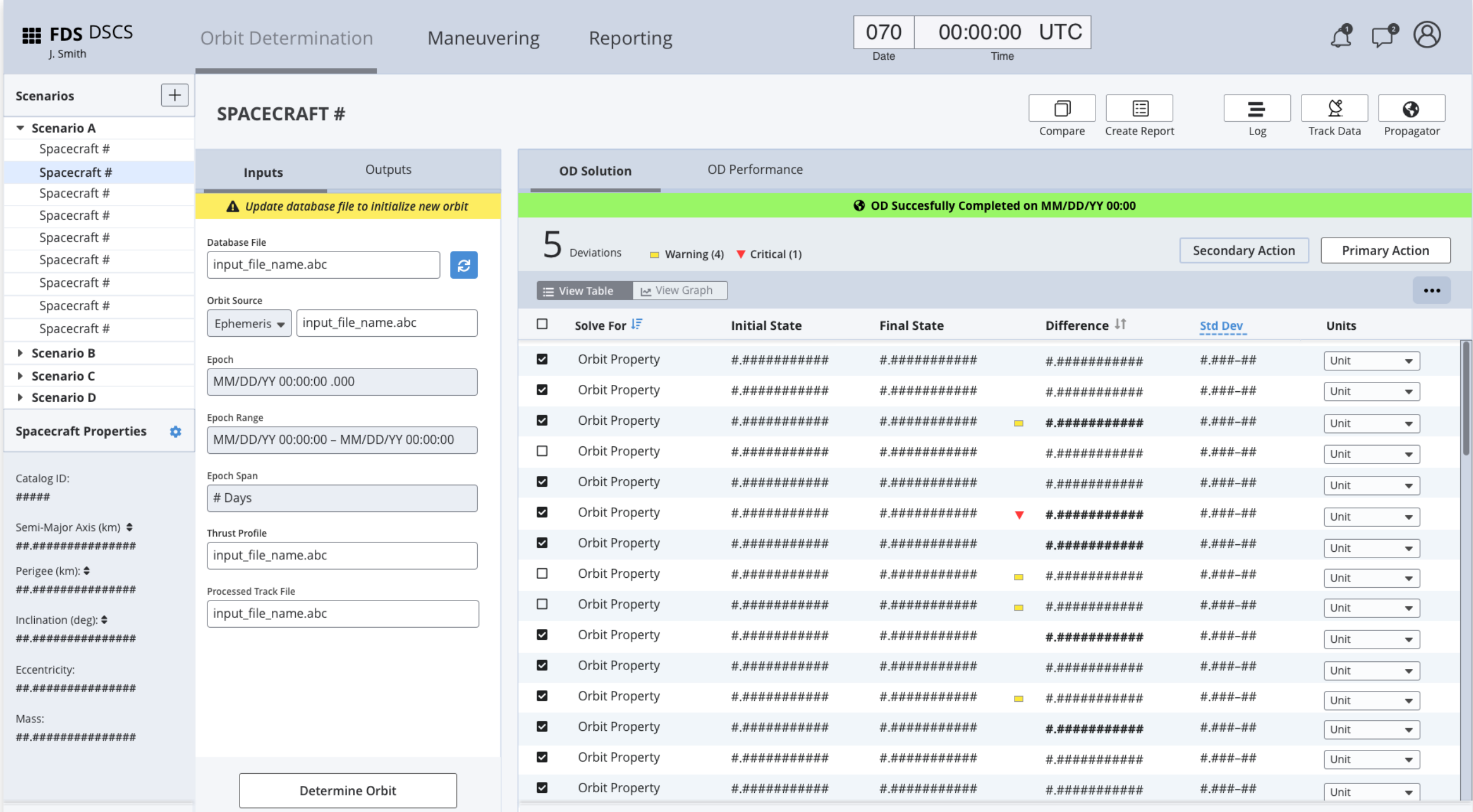
Orbit Determination Tool

Orbit Determination - Default View



The Orbit Determination (OD) Tool allows users to perform orbit determinations, generate ephemerides and two-line element sets (TLEs), as well as generate OD-related products and reports.

In its initial view, the OD Tool shows the last state for the most recently completed OD, for whichever spacecraft is selected in the Scenario Library.



The screenshot displays the Orbit Determination tool interface. At the top, it shows the user 'J. Smith' and navigation tabs for 'Orbit Determination', 'Maneuvering', and 'Reporting'. The current date and time are '070 00:00:00 UTC'. A status bar at the top right indicates 'OD Successfully Completed on MM/DD/YY 00:00'. Below this, a table lists 5 deviations, with 4 warnings and 1 critical. The main table displays orbit properties with columns for 'Solve For', 'Initial State', 'Final State', 'Difference', 'Std Dev', and 'Units'. The 'Initial State' and 'Final State' columns contain placeholder text '#####'. The 'Difference' column shows values like '#####' with small colored squares (yellow for warning, red for critical) next to them. The 'Units' column has a dropdown menu set to 'Unit'. On the left, there are input fields for 'Database File' (input_file_name.abc), 'Orbit Source' (Ephemeris), 'Epoch' (MM/DD/YY 00:00:00 .000), 'Epoch Range' (MM/DD/YY 00:00:00 - MM/DD/YY 00:00:00), 'Epoch Span' (# Days), 'Thrust Profile' (input_file_name.abc), and 'Processed Track File' (input_file_name.abc). A 'Determine Orbit' button is at the bottom of the input section. A 'Scenario Library' on the far left lists Scenario A, B, C, and D, with Scenario A selected.

Orbit Determination - Scenario Library

Functionality

The Scenario Library allows users to group their tasks by scenario for quick access and efficiency. Users can also create new scenarios. Clicking on a spacecraft displays its properties in the Spacecraft Properties pane below.

Features & Interactions

1. Expandable/Collapsible Scenario Groups

Expands to show items, such as spacecrafts, grouped in the respective scenario.

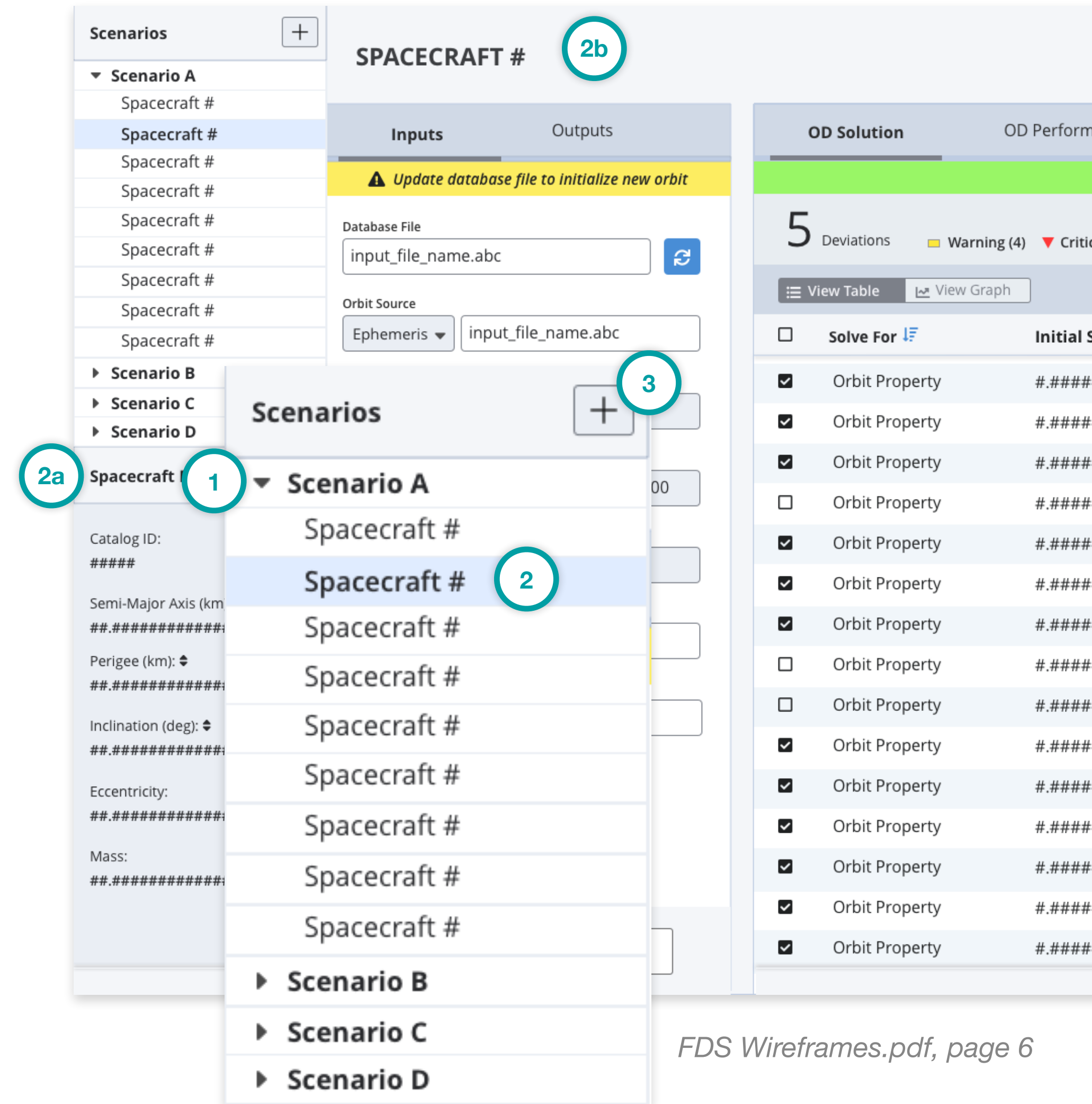
2. Select Group Item

Information for the selected group item displays in the main view (to the right of the library) which houses the input and output display areas (2b).

Properties for the selected group item display in the properties pane (2a) below the list of library items.

3. Create New Scenario

Allows users to create and name new scenarios.



The screenshot shows the 'Scenario Library' interface. On the left, a list of scenarios (Scenario A, B, C, D) is shown, with 'Scenario A' expanded to show a list of spacecraft. Callout 1 points to a spacecraft item in this list. To the right of the list is a 'Spacecraft Properties' pane (callout 2a) showing fields for Catalog ID, Semi-Major Axis, Perigee, Inclination, Eccentricity, and Mass. To the right of the properties pane is the main 'SPACECRAFT #' view (callout 2b), which has 'Inputs' and 'Outputs' tabs. The 'Inputs' tab is active, showing a 'Database File' field with 'input_file_name.abc' and an 'Orbit Source' dropdown set to 'Ephemeris'. A yellow warning banner at the top of the inputs section says 'Update database file to initialize new orbit'. On the far right, a 'OD Solution' pane shows a table of orbit properties with checkboxes and numerical values. Callout 3 points to a '+' button in the top right of the scenario list, used for creating new scenarios.

Orbit Determination - Properties Pane

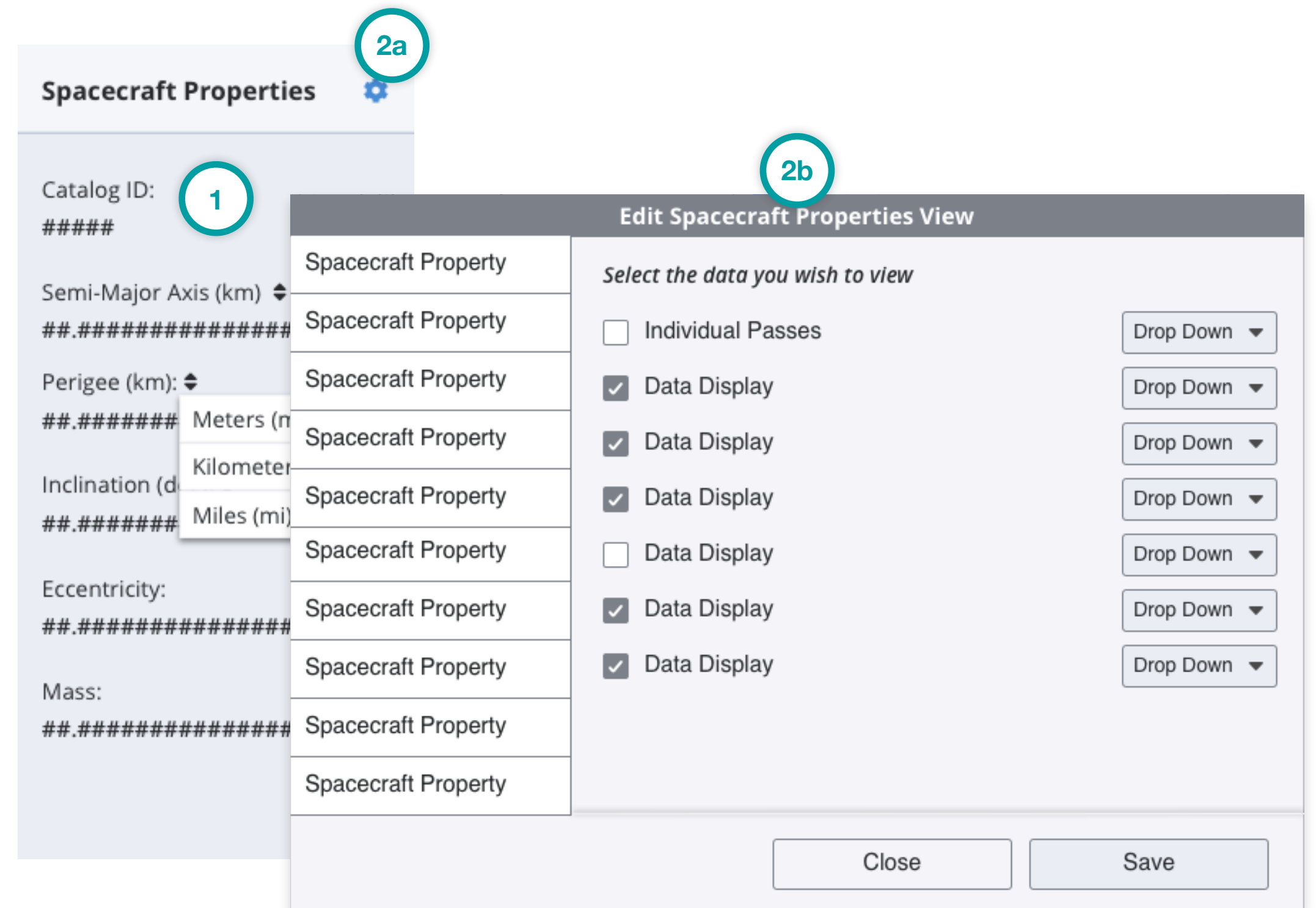


Functionality

The Spacecraft Properties pane displays various attributes an operator may view for the selected spacecraft.

Features & Interactions

1. **Properties**
Displays various object properties.
2. **Properties Settings**
Users can edit what properties are displayed in the properties pane using the property settings feature.



Orbit Determination - Inputs/Outputs Pane (Inputs Tab)



Functionality

The Inputs Tab houses the initial inputs needed in order to run an orbit determination.

Features & Interactions

1. Notification Banner

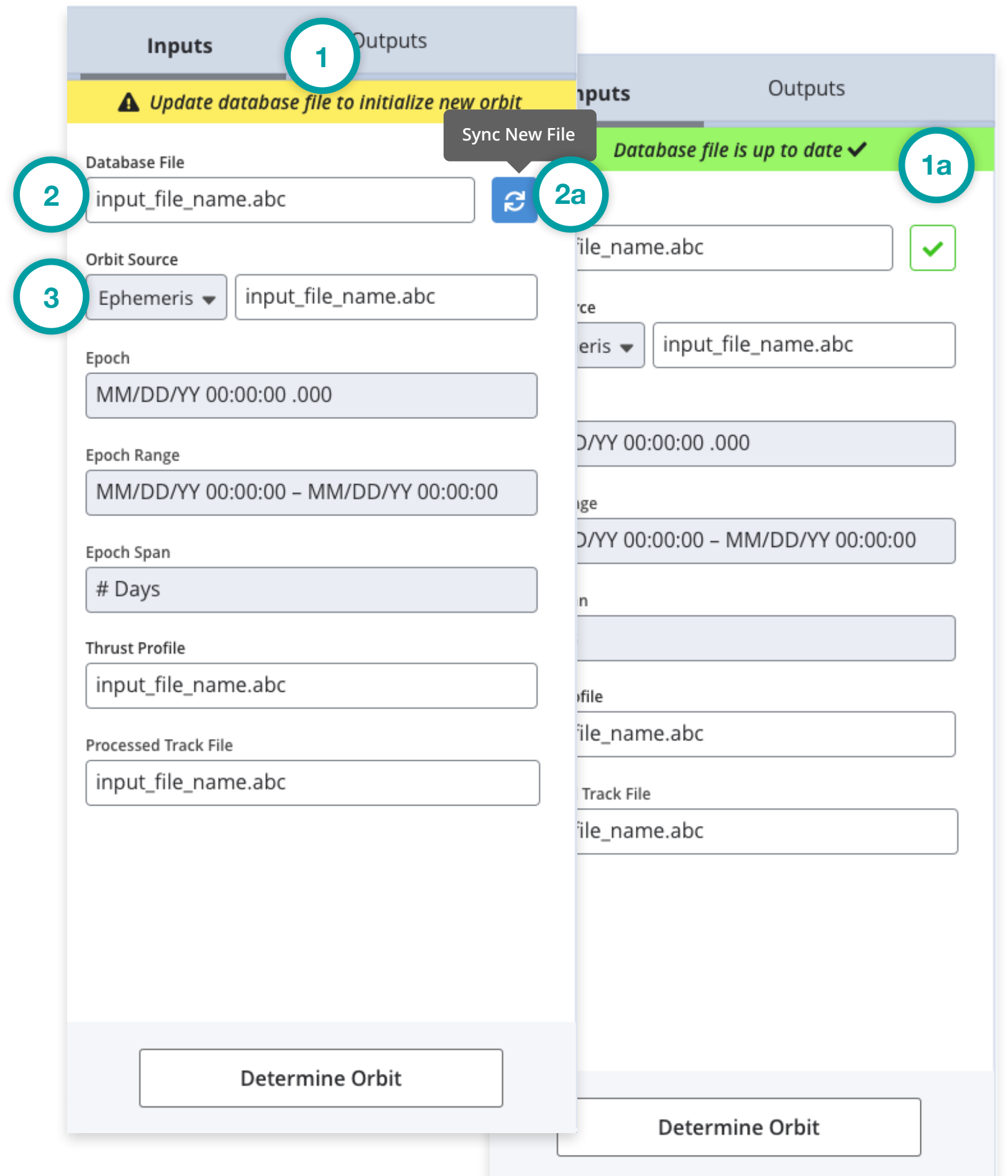
Indicates whether the latest database file has been synced. Once the latest file has been synced the notification banner indicates that the file is up-to-date and the blue sync button changes to a green check to indicate its in sync (1a).

2. Database File

Shows the database file that will be used to determine orbit. The most recent database file can be loaded/synced using the blue sync button (2a). It's recommended that any primary input that has other dependent inputs are placed at the top.

3. Orbit Source

Shows what source is being used to determine orbit. Source type can be selected from the dropdown while the actual source file can be selected by clicking into the interactive input field.



The wireframe shows two overlapping views of the 'Inputs' tab. The top view (left) shows a yellow notification banner with a warning icon and the text 'Update database file to initialize new orbit'. Below it is a 'Database File' input field containing 'input_file_name.abc' and a blue 'Sync New File' button. The 'Orbit Source' section has a dropdown menu set to 'Ephemeris' and an input field containing 'input_file_name.abc'. Other fields include 'Epoch' (MM/DD/YY 00:00:00 .000), 'Epoch Range' (MM/DD/YY 00:00:00 - MM/DD/YY 00:00:00), 'Epoch Span' (# Days), 'Thrust Profile' (input_file_name.abc), and 'Processed Track File' (input_file_name.abc). A 'Determine Orbit' button is at the bottom. The bottom view (right) shows the same interface but with a green notification banner indicating 'Database file is up to date' and a green checkmark next to the 'Sync New File' button, which now contains a checkmark icon. The 'Database File' input field also contains a checkmark icon.

Orbit Determination - Inputs/Outputs Pane (Inputs Tab Continued)



Functionality

The Inputs Tab houses the initial inputs needed in order to run an orbit determination.

Features & Interactions

4. **Epoch**
Set desired epoch time for OD by date and time.
5. **Epoch Range**
Set desired epoch time for OD by date and time range.
6. **Epoch Span**
Set desired epoch time for OD by number of days.
7. **Thrust Profile**
Shows the database file that will be used to determine orbit.
8. **Processed Track File**
Shows the processed track file that will be used to determine orbit.
For input fields like this, either click (8a) or type (8b) into the field to reveal a dropdown of available files.

FDS Wireframes.pdf, page 14 & 15

FDS Wireframes.pdf, page 6

Orbit Determination - Inputs/Outputs Pane (Inputs Tab, Continued)



Functionality

The Inputs Tab houses the initial inputs needed in order to run an orbit determination.

Features & Interactions

5. **Determine Orbit Button**
Initiates orbit determination.

Inputs
Outputs

⚠ Update database file to initialize new orbit

Database File

 ↻

Orbit Source

Ephemeris ▾

Epoch

Epoch Range

Epoch Span

Thrust Profile

Processed Track File

9

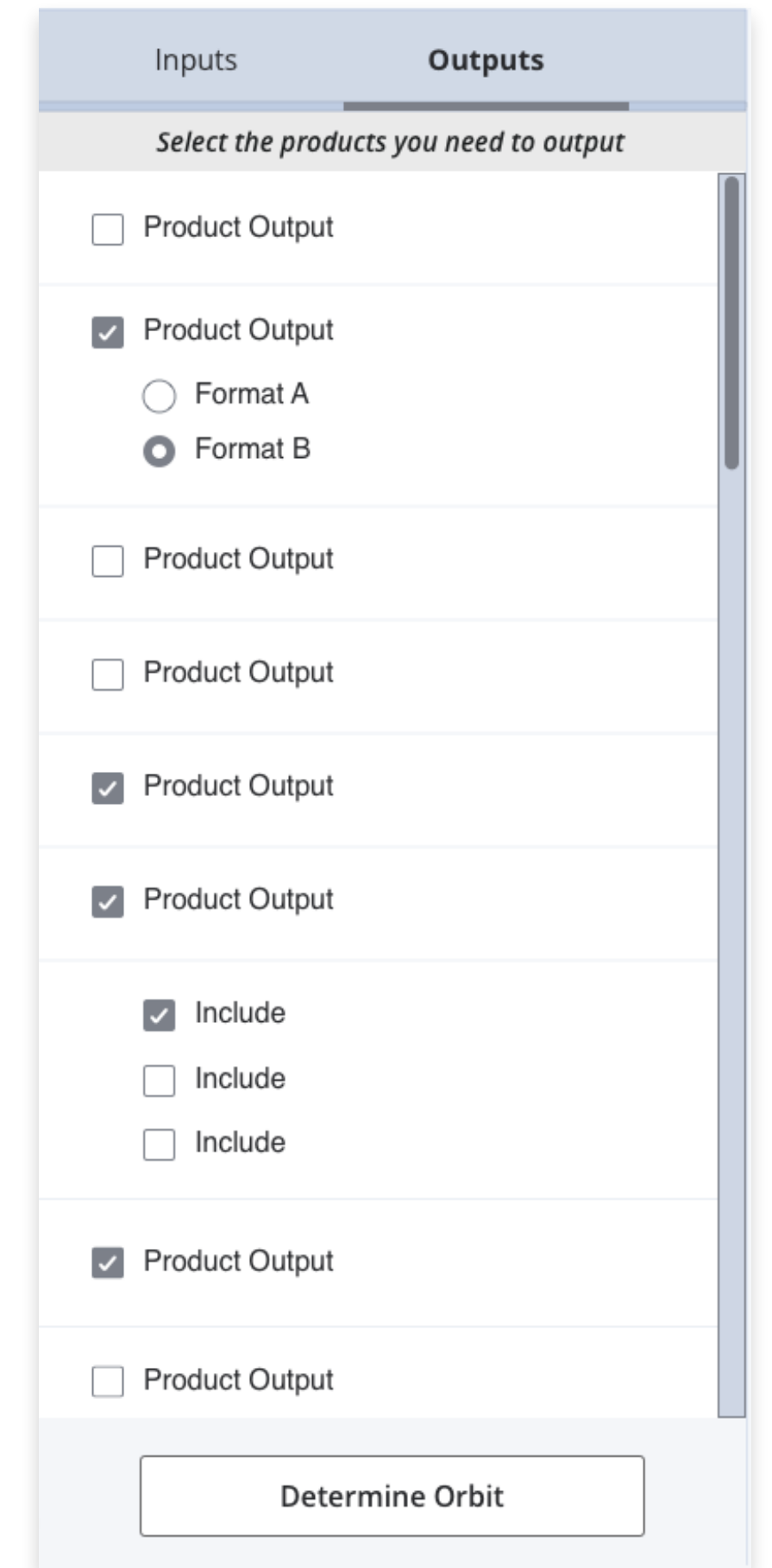
Determine Orbit

Orbit Determination - Inputs/Outputs Pane (Outputs Tab)



Functionality

The Outputs Tab allows the user to select the products they wish to output as a result of an orbit determination.



The screenshot shows a web interface with two tabs: 'Inputs' and 'Outputs'. The 'Outputs' tab is active. Below the tabs is a header that says 'Select the products you need to output'. The main area contains a list of items, each with a checkbox and a label. The items are:

- Product Output
- Product Output
 - Format A
 - Format B
- Product Output
- Product Output
- Product Output
- Product Output
- Include
 - Include
 - Include
- Product Output
- Product Output

At the bottom of the pane is a button labeled 'Determine Orbit'.

Orbit Determination - Data Display

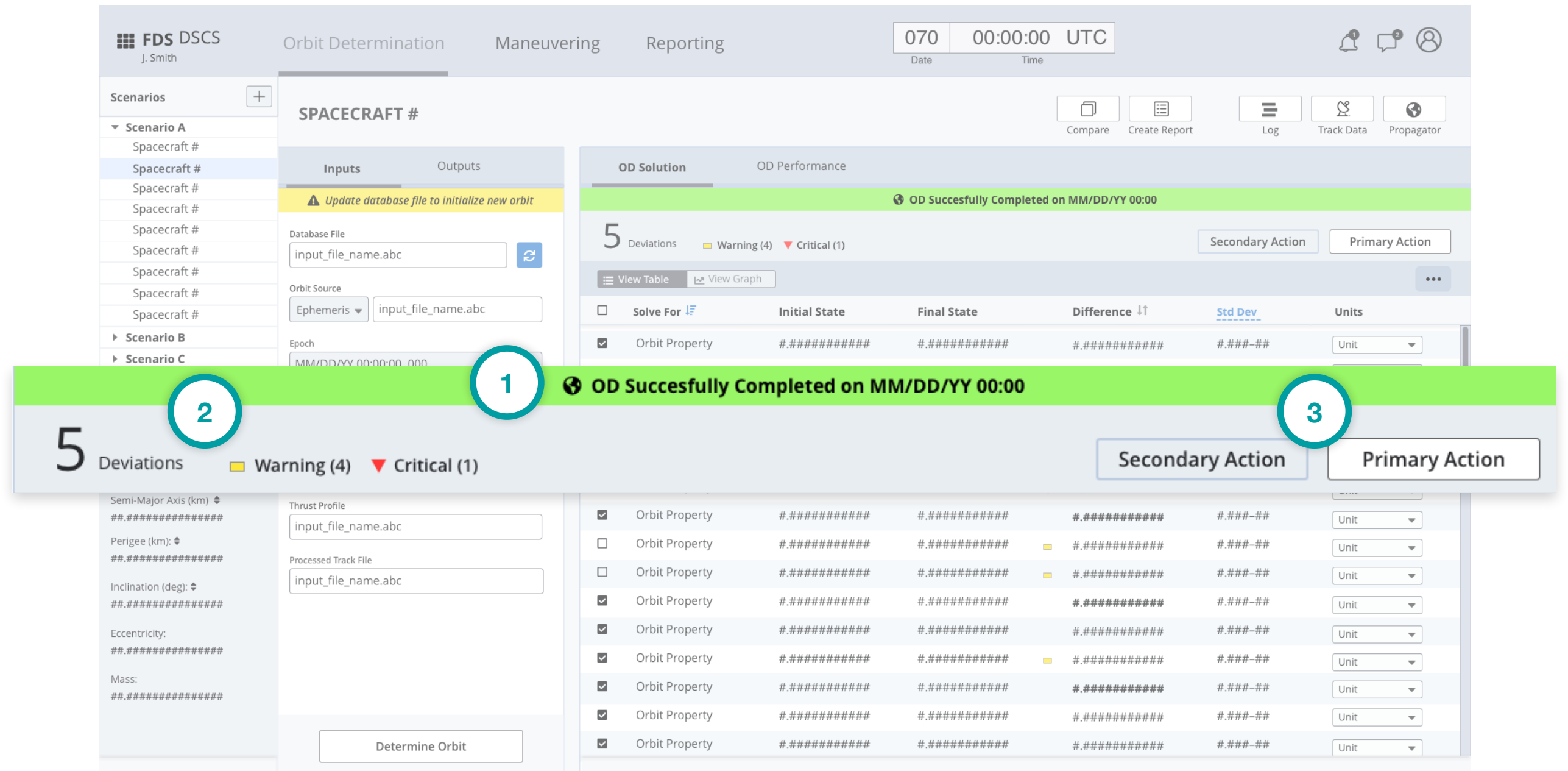


Functionality

The Data Display shows OD solutions and performance results.

Features & Interactions

- 1. Notification Banner**
 Shows the status for the latest orbit determination.
- 2. Deviation Count**
 Shows total number of deviations (*violations of the standard deviation*) found in the OD results.
- 3. Primary/Secondary Action Buttons**
 Can be set to display desired primary and/or secondary actions. Recommended for quick actions related to OD results (i.e. Create TLE).



The screenshot shows the FDS DSCS Orbit Determination interface. The top navigation bar includes 'Orbit Determination', 'Maneuvering', and 'Reporting'. The main content area is divided into 'Inputs' and 'Outputs' sections. A notification banner at the top right displays 'OD Successfully Completed on MM/DD/YY 00:00' with a green background and a circular callout '1'. Below this, a summary bar shows '5 Deviations' (with a circular callout '2'), 'Warning (4)', and 'Critical (1)', along with 'Secondary Action' and 'Primary Action' buttons (with a circular callout '3'). The main table displays a list of orbit properties with columns for 'Solve For', 'Initial State', 'Final State', 'Difference', 'Std Dev', and 'Units'. The 'Determine Orbit' button is visible at the bottom of the interface.

FDS Wireframes.pdf, page 6

Orbit Determination - Data Display (Continued)

Functionality

The Data Display shows OD solutions and performance results.

Features & Interactions

1. Table View Switch

Switches between a tabular view and visual/graph view (1a) of the OD results.

2. Action Menu

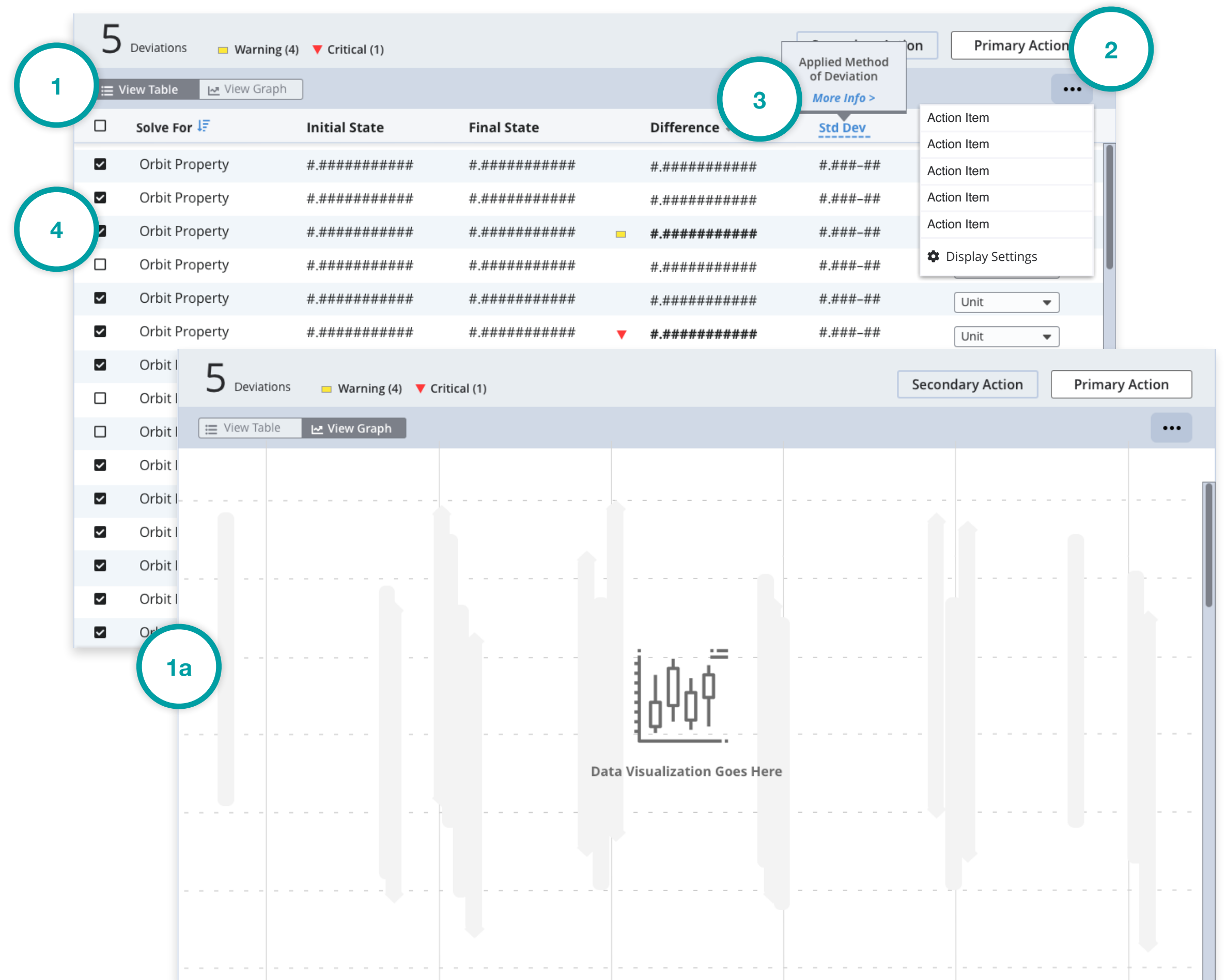
Displays table action items and display settings, export, save, print, etc.

3. Interactive Click State

Blue text with a dotted underline indicates a click state that can be drilled into for more information. Recommended for click states that may feature additional information with an action item.

4. Selectable Table Rows

Table rows can be selected/unselected in order to be included or not included in an orbit determination solution.



Orbit Determination - OD Solution Table (Continued)



Functionality

The OD Solution Table shows orbit determination results.

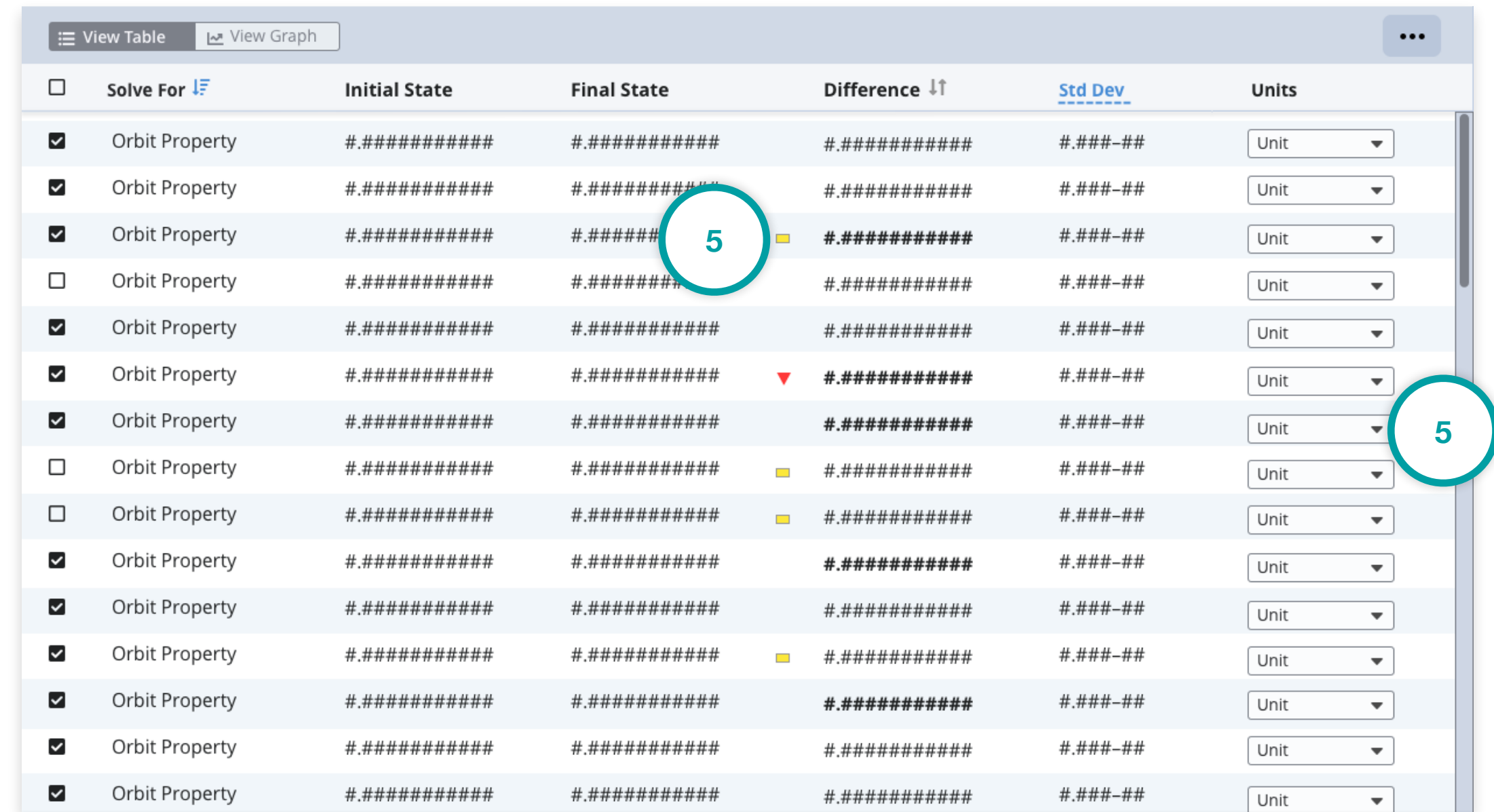
Features & Interactions

5. Status Icons

Status icons indicate the status of a feature. In the example to the right, status icons indicate violations of the acceptable deviation limits in the data returned in the OD results.

6. Editable Table Data (Dropdown Menu)

Allows user to view table data in different units of measurement.



<input type="checkbox"/>	Solve For	Initial State	Final State	Difference	Std Dev	Units
<input checked="" type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input checked="" type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input checked="" type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input checked="" type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input checked="" type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input checked="" type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input checked="" type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input checked="" type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input checked="" type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input checked="" type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input checked="" type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit
<input checked="" type="checkbox"/>	Orbit Property	#####	#####	#####	###-##	Unit

Orbit Determination - Utility Toolkit



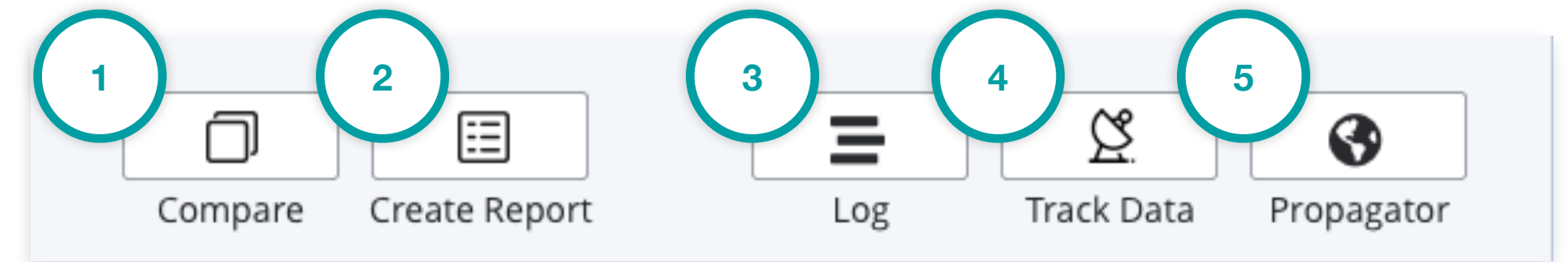
Functionality

The Utility Toolkit is a collection of contextual utilities that house secondary actions and tools.

Note: Labels and icons are mission-agnostic and should be named according to mission needs.

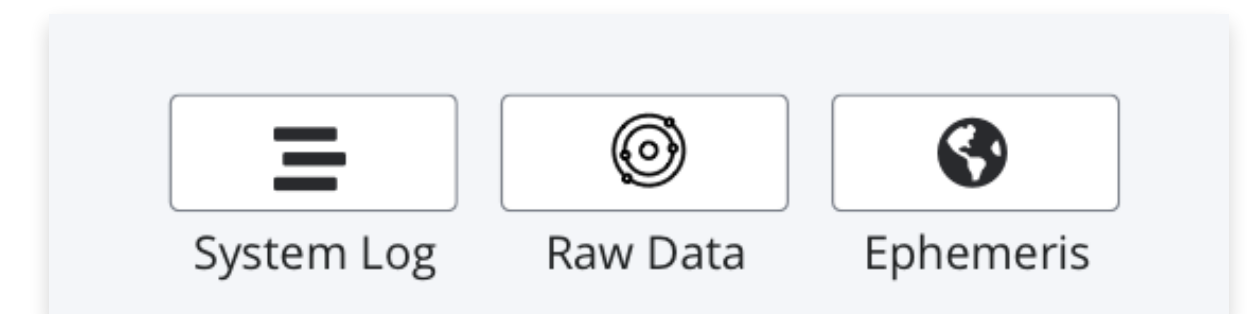
Features & Interactions

5. **Compare**
Allows user to compare reports or products.
6. **Create Report**
Allows user to create reports contextual to the current orbit determination.
7. **Log**
Shows a log of application and system messages, including errors, information messages, and warnings.
8. **Track Data**
Allows user to filter and edit raw track data.
9. **Propagator**
Allows user to generate ephemerides and TLE's.



Sample Utility Toolkit

Labels and icons are mission-agnostic



Utility buttons with different icons and labels

Labels and icons will differ mission to mission

FDS Wireframes.pdf, page 17

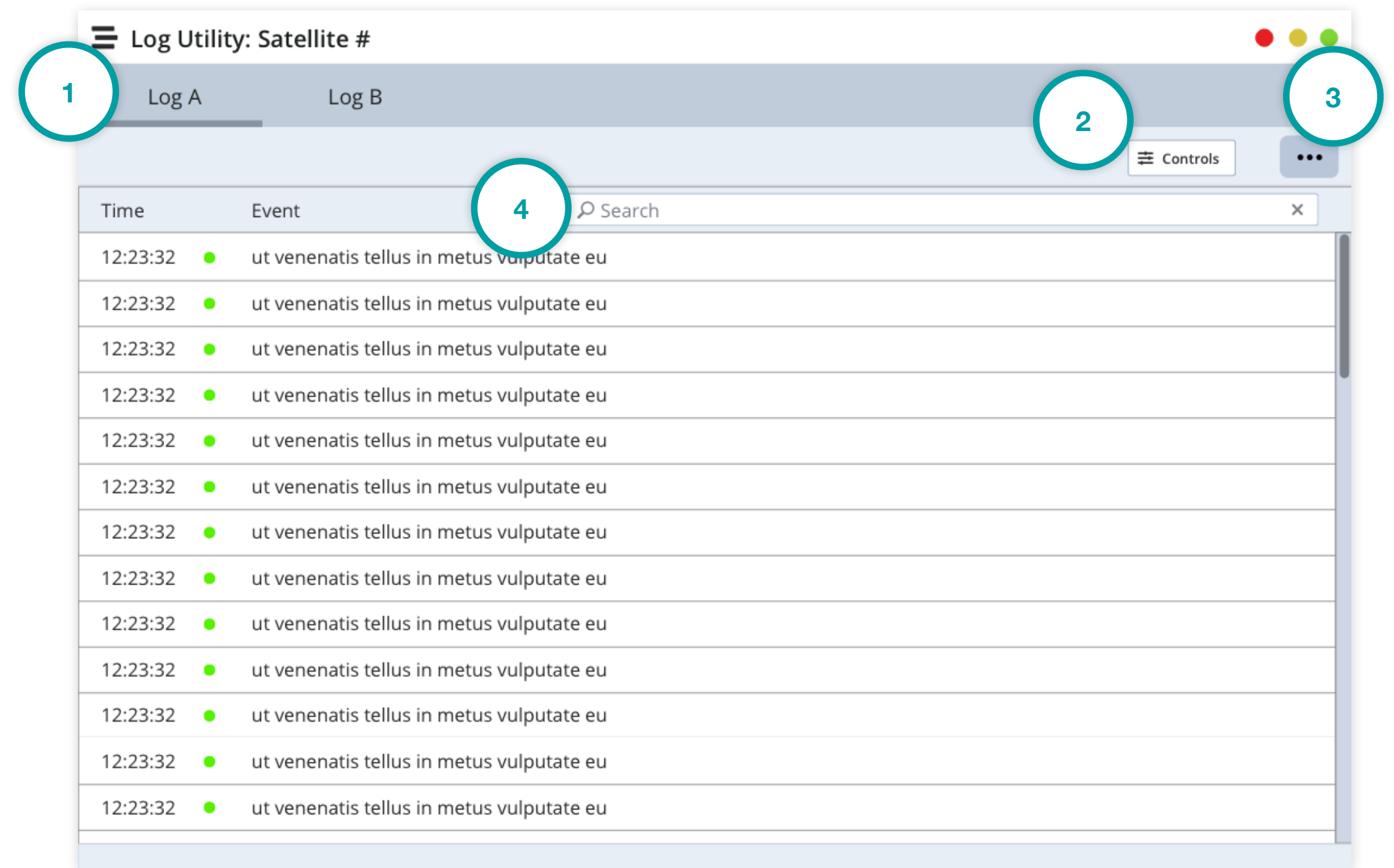
Orbit Determination - Log Utility

Functionality

The Log Utility shows a log of application and system messages. Usage and functionality for this utility is mission-agnostic.

Features & Interactions

1. **Tabs**
Allows for more than one view/category of log messages.
2. **Controls Buttons**
Triggers a sliding pane that houses controls for the event log.
3. **Action Menu**
Displays action items and display settings.
4. **Search Bar**
Allows user to query log messages.



FDS Wireframes.pdf, page 41

Orbit Determination - Track Data Utility (Select Files)

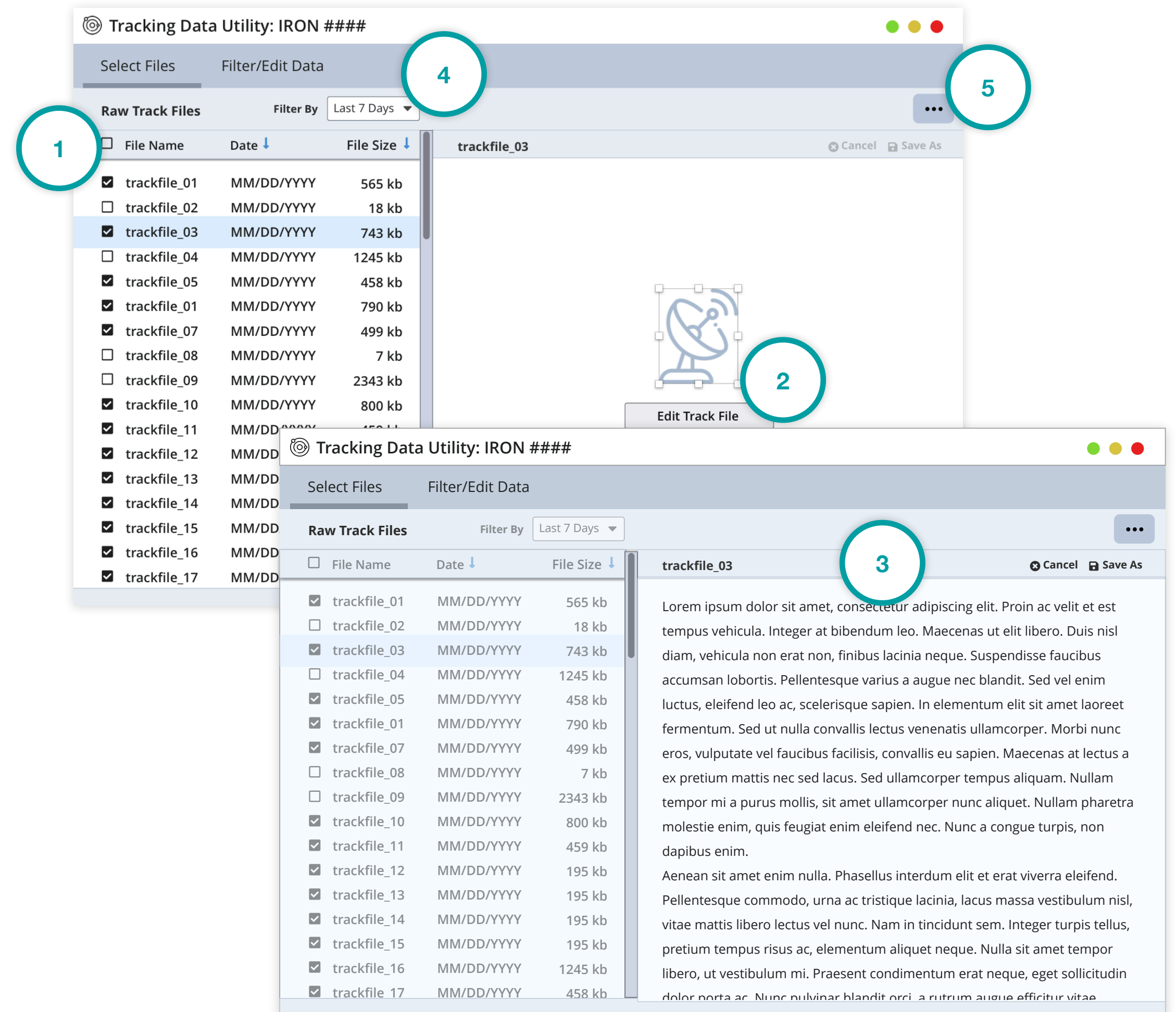


Functionality

Select Files allows users select and edit track files.

Features & Interactions

1. **File List**
Displays available raw tracking files.
2. **Edit Track File Button**
Clicking the Edit Track File button puts track file in an editable state.
3. **Text Editor**
Allows the user to edit and save the text in a track file.
4. **Filter Dropdown**
Allows the user to filter the track file list.
5. **Action Menu**
Displays action items and display settings.



Orbit Determination - Track Data Utility (Filter/Edit Data)

Functionality

Filter/Edit Data allows users filter and edit track data points.

Features & Interactions

1. **Data Graph**
Displays individual tracking data points. More details shows on hover.
2. **Remove Outliers**
Users can remove data points by selecting and deleting points, deleting points with a range selector or via system automation (auto-remove outliers button).
3. **Sites Button**
Displays tracking site settings.
4. **Filter Button**
Displays data filter settings.
5. **Settings Button**
Displays general settings.
6. **Action Menu**
Displays action items.



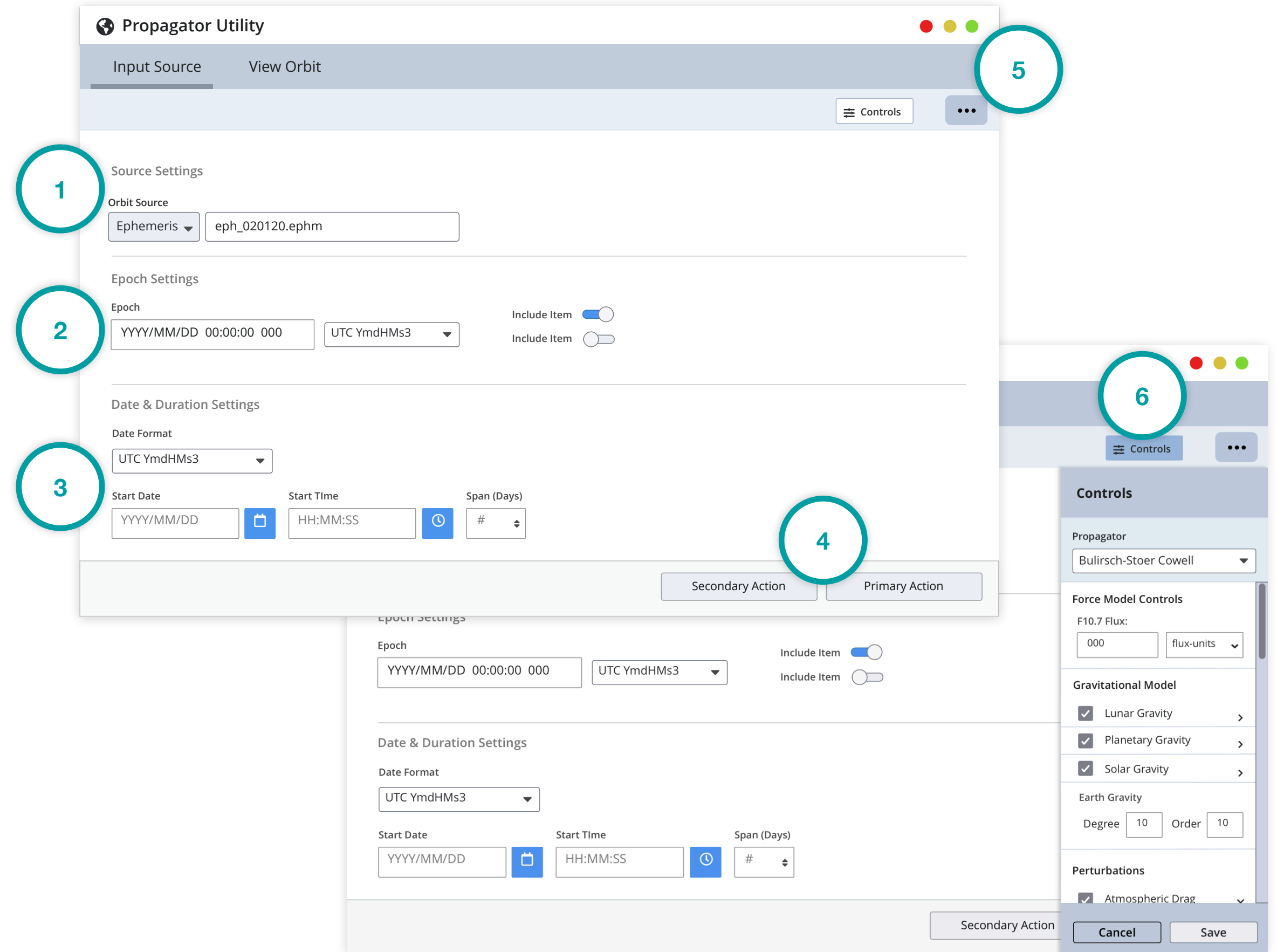
Orbit Determination - Propagator Utility (Input Source)



Functionality

Allows user to input source, epoch and date and time settings in order to generate an ephemeris.

1. **Source Settings**
Allows user to select an orbit source and input a source file.
2. **Epoch Settings**
Allows user to set epoch time.
3. **Date & Duration Settings**
Allows user to set date and duration.
4. **Action Buttons**
Allows user to apply actions to an ephemeris.
5. **Action Menu**
Displays action items.
6. **Controls Button**
Triggers a sliding pane that houses propagator controls.



The screenshot shows the 'Propagator Utility' application window with the following components highlighted by numbered callouts:

- 1. Source Settings:** A dropdown menu for 'Orbit Source' set to 'Ephemeris' and a text input field containing 'eph_020120.ephm'.
- 2. Epoch Settings:** An 'Epoch' input field with the value 'YYYY/MM/DD 00:00:00 000', a date format dropdown set to 'UTC YmdHMs3', and two 'Include Item' toggle switches.
- 3. Date & Duration Settings:** A 'Date Format' dropdown set to 'UTC YmdHMs3', and a 'Start Date' input field with a calendar icon, a 'Start Time' input field with a clock icon, and a 'Span (Days)' input field with a dropdown arrow.
- 4. Action Buttons:** Two buttons labeled 'Secondary Action' and 'Primary Action' at the bottom of the main form.
- 5. Action Menu:** A three-dot menu icon in the top right corner of the main form.
- 6. Controls Button:** A 'Controls' button in the top right corner of the application window, which triggers a sliding pane on the right side.

The sliding pane on the right, titled 'Controls', contains the following settings:

- Propagator:** A dropdown menu set to 'Bulirsch-Stoer Cowell'.
- Force Model Controls:** An 'F10.7 Flux' input field with the value '000' and a 'flux-units' dropdown.
- Gravitational Model:** Three checked checkboxes for 'Lunar Gravity', 'Planetary Gravity', and 'Solar Gravity', each with a right-pointing arrow.
- Earth Gravity:** Two input fields for 'Degree' (value 10) and 'Order' (value 10).
- Perturbations:** A checked checkbox for 'Atmospheric Drag' with a right-pointing arrow.
- Buttons:** 'Cancel' and 'Save' buttons at the bottom of the pane.

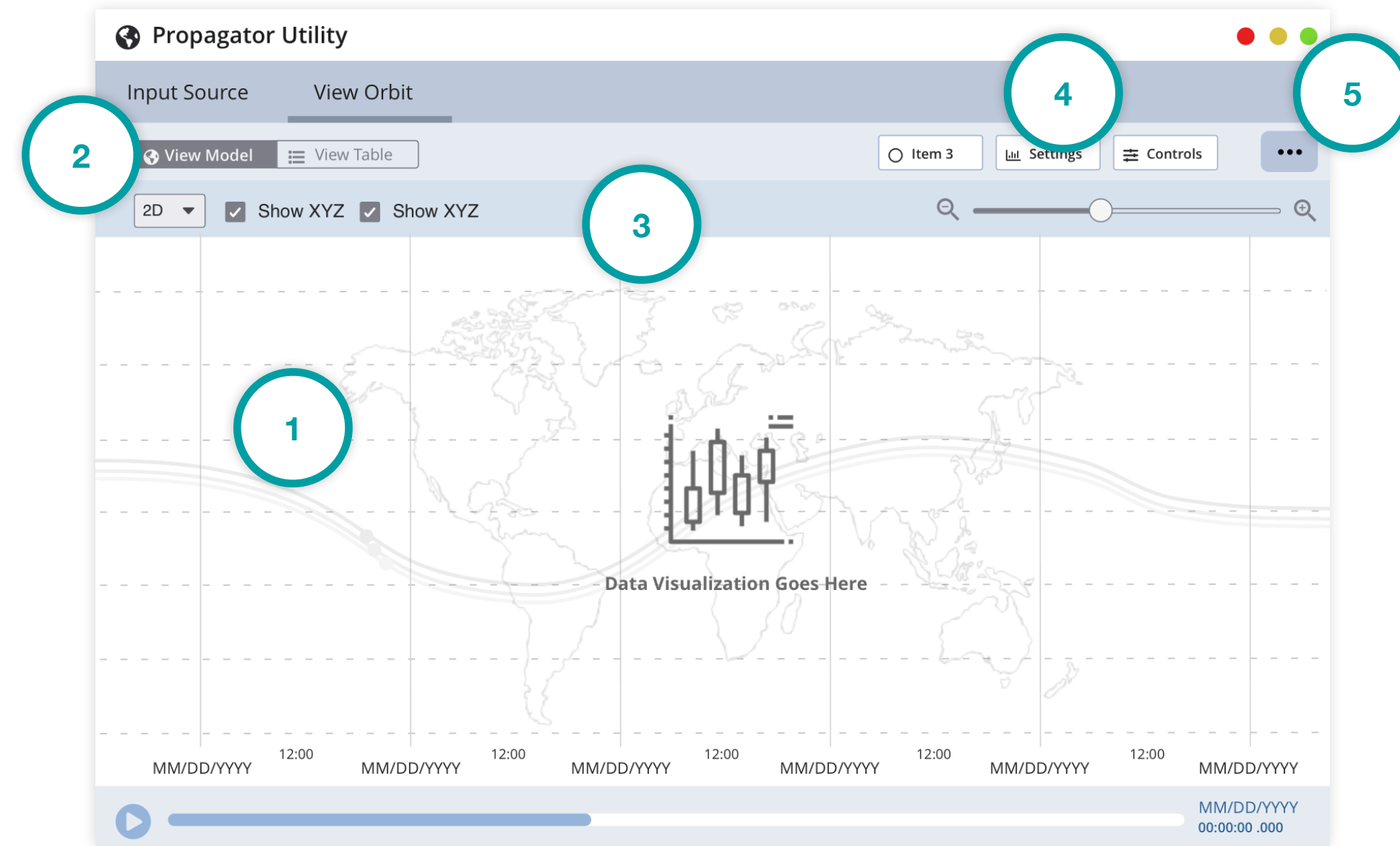
Orbit Determination - Propagator Utility (View Orbit)



Functionality

Allows user to view a visual representation of ephemeris data.

1. **Orbit Data Display**
Displays orbit data.
2. **Table View Switch**
Switches between a tabular view and visual/graph view of orbit data.
3. **View Settings**
Controls the data display view.
4. **Settings & Controls Button**
Displays general settings.
5. **Action Menu**
Displays action items.



FDS Wireframes.pdf, page 38

Maneuvering & Reporting Tools

Maneuvering - Basic Tool Framework

The framework for the Maneuvering and Reporting Tools and Utilities is similar to the frameworks from the OD Tool. These basic frameworks, along with the higher fidelity OD Tool wireframes and specifications, and the Astro Design System should provide developers a starting point from which to build additional tools. More research and user testing is required to finalize the design for these tools.

Basic Frameworks

