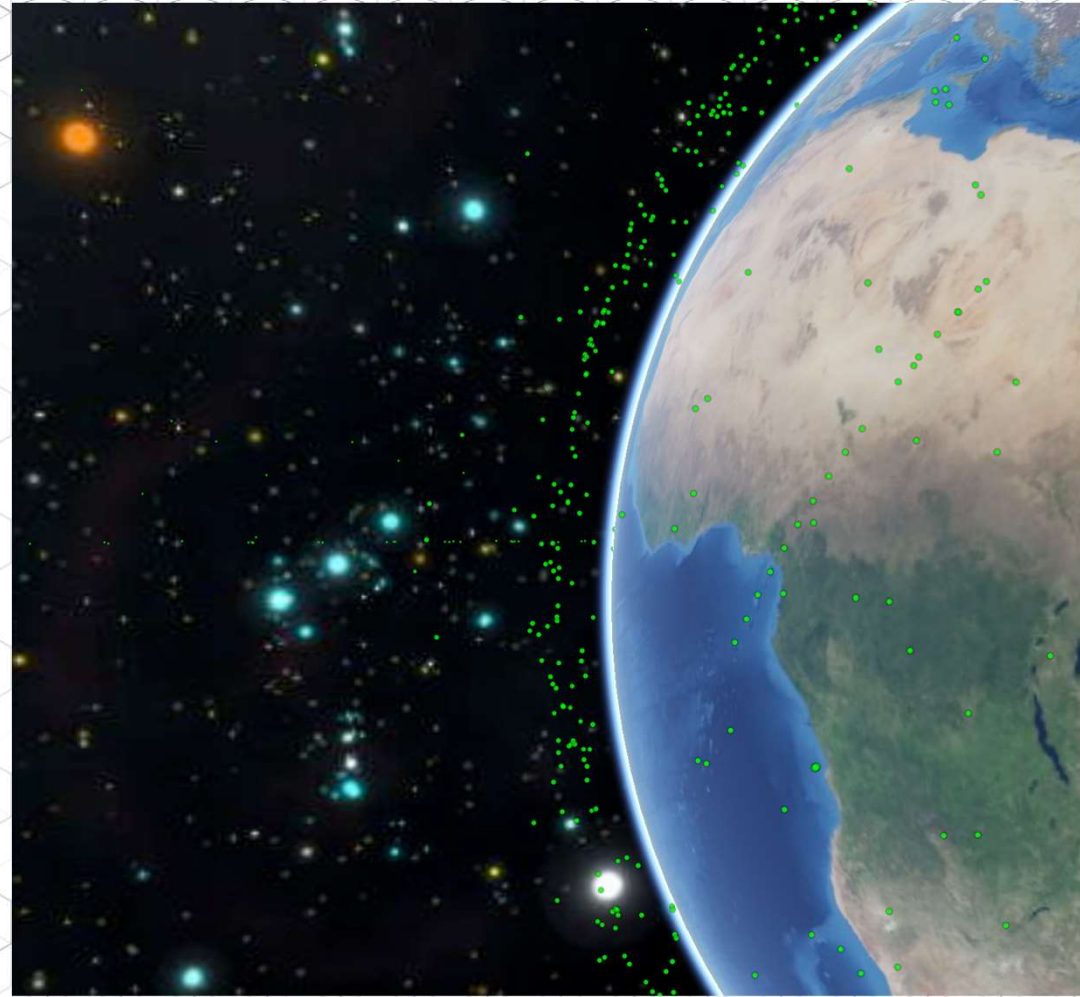


SDC Update

Robert Hall

SDC Operations Manager



SDC Improvements

- SDC Powered by COMSPOC

Background

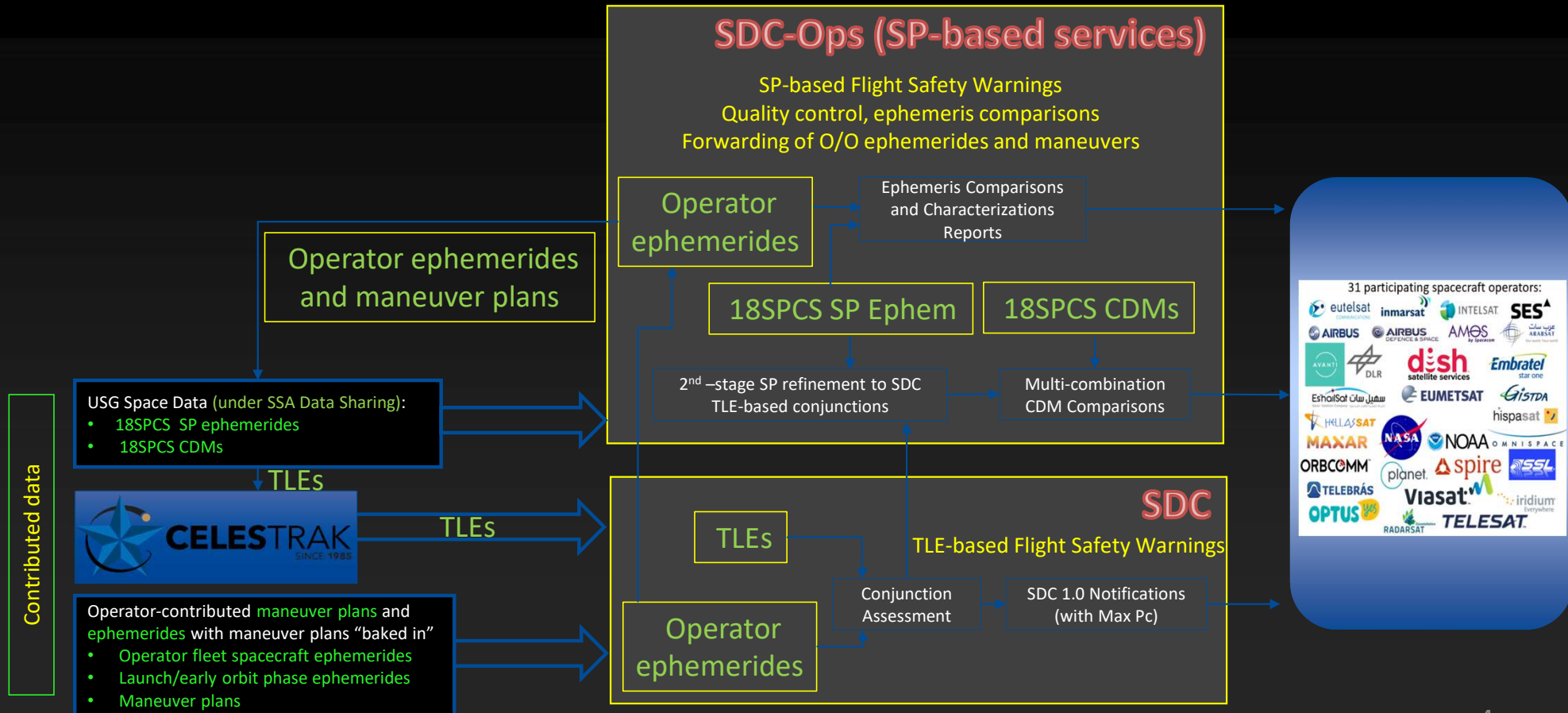
- Goals

- Improve quality of safety of flight services
 - Data processing
 - Conjunction assessment
 - Eliminate two-stage screening
- Update and modernize underlying system architecture
 - Improved scalability, esp. to handle large constellations
 - Harmonize legacy SDC and “SDC Ops
- Improve UI usability
- Simplify operations and support

- Phasing

- Project split into three phases, all based on Apr 2022 start date

Current SDC Functional Flow



Challenges

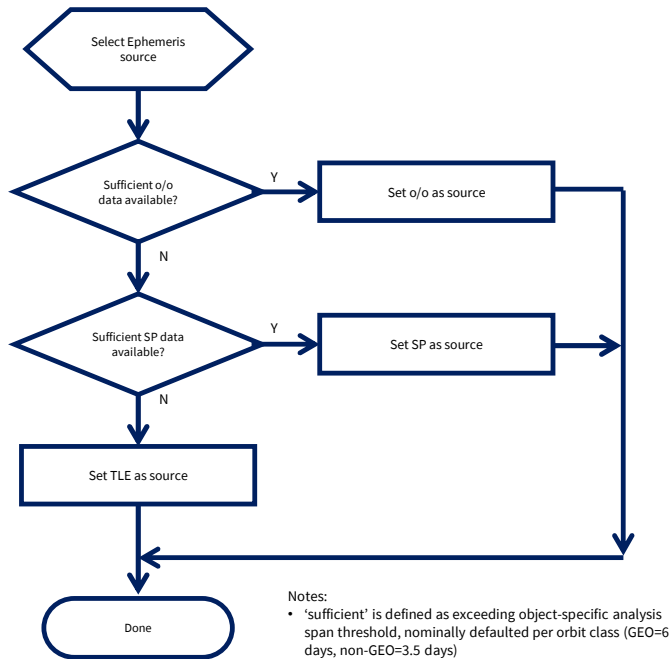
SDC 1.0 Challenge	Updated SDC Solution
Doesn't scale well <ul style="list-style-type: none">• important for more members/satellites, esp. large constellations	Integrate SDC CA w/existing COMSPOC SSA architecture <ul style="list-style-type: none">• Natively scales• Handles large constellations• Provides CDMs• Eliminates need to compare inferior (legacy) CDMs
Screens using TLEs <ul style="list-style-type: none">• SP screening is a dependent, secondary stage• Potential conflicting & confusing results	Screen once using best available source per object <ul style="list-style-type: none">• Owner data ->SP->TLE• May change dynamically based on data availability
Web pages slow/inefficient <ul style="list-style-type: none">• Prohibitive for scanning large data sets (conjunctions, satellites, etc)	Modernize web page design
Unable to compute collision probability Most of the available ephemerides lack covariance	Implement "synthetic" covariance Compute P_C Leverage available databases with RSO size

Project Phasing

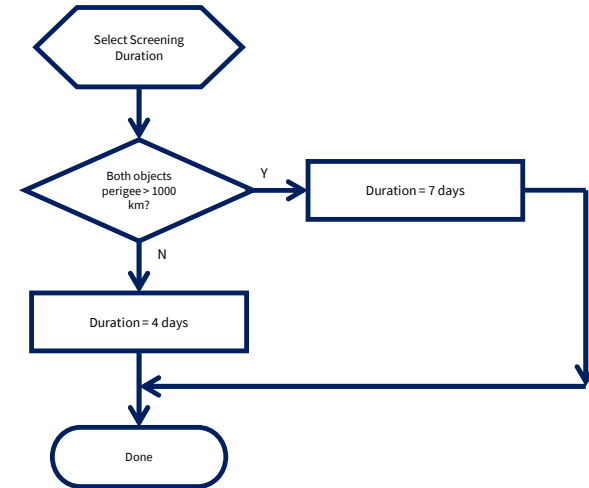
Phase	Updates
1	Single stage CA screening in COMSPOC using best ephemeris SDC Web site modernization for scaling and usability
2a	Synthetic covariance – TLE, SP & Owner ephemerides DISCOS db for object size True Probability (P_c) CDMs generated by COMSPOC
2b	P_c variability <ul style="list-style-type: none">• Scale factor ranges• Box-shaped objects OEM ingestion
3	COMSPOC SSA Services portal SDC 1.0 & SDC Ops interfaces retired Updated login security (MFA)

Ephemeris Hierarchy

“Best” ephemeris selection



Screening duration selection



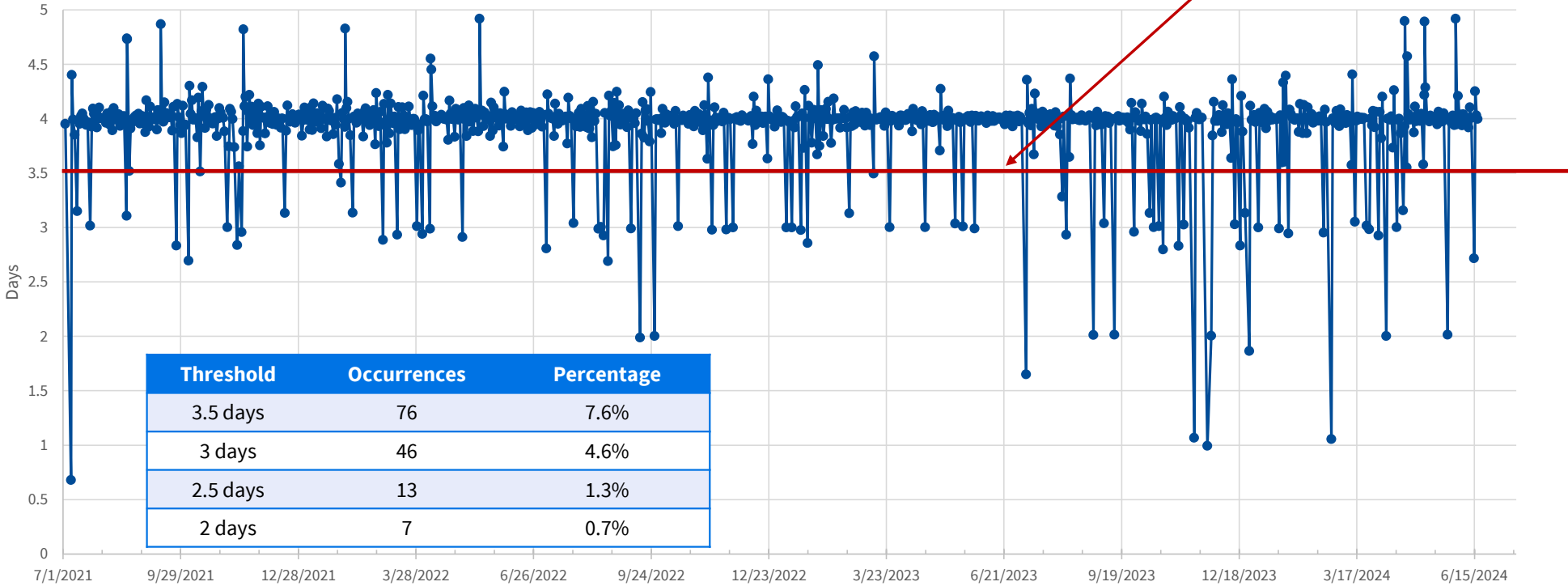
How much ephemeris is ‘sufficient’?

- Sufficient o/o data
 - minimum 7 days by default; can be modified on a per-satellite basis
 - Most sats in SDC use the default
- Sufficient SP data
 - Typically, we receive ~5 days of propagated SP ephem each day
 - However, we don't always receive it every day or at the same time of day
 - When problems arise (i.e., gaps in SP delivery) we need to balance desire for sufficient lead time of conjunction notice against desire to use most trust-worthy source (SP v. TLE)

SP Delivery History

SP Data
Ephemeris remaining upon next receipt
July 2021-present

Initial proposed cutoff
(configuration setting)



Project Status

- User experience (UI) has been modernized
 - Leveraging COMSPOC SSA services
 - Configurable grids
 - Queries
 - Filters

Main Conjunction page with Grid Layout

The screenshot displays the 'Main Conjunction page with Grid Layout' in a web browser. The page features a navigation bar with the 'space data center' logo and 'COMSPOC' branding. Below the navigation bar, there are several tabs: 'Conjunctions Grid' (highlighted in orange), 'Orbits Data', 'Maneuver Reporting', 'Conjunction Reports', and 'RFI Events'. The main content area shows a table of 'Latest Conjunction Jobs' with a 'Total Rows: 114' indicator. The table has the following columns: Job ID, Scheduled Date UTC, Source, Analysis Start Date UTC, Analysis Stop Date UTC, Job Status, Run Time, # of Satellites, and Actions. The table contains 11 rows of data, each representing a conjunction job. The 'Query Filters' section on the left includes options for 'Last 10 days', 'Last 20 days', 'Last 30 days', and 'Date Range'. The 'Grid Filters' section includes a search box and a 'Reset' button. The 'Source' and 'Job Status' sections include dropdown menus.

Job ID	Scheduled Date UTC	Source	Analysis Start Date UTC	Analysis Stop Date UTC	Job Status	Run Time	# of Satellites	Actions
91517	2023-01-27 06:00:00	Scheduled Run	2023-01-27 06:00:00	2023-02-03 06:00:00	Waiting	Scheduled	0	
91516	2023-01-27 00:00:00	Scheduled Run	2023-01-27 00:00:00	2023-02-01 00:00:00	Completed	30 min 9 sec	25,485	
91515	2023-01-26 18:00:00	Scheduled Run	2023-01-26 18:00:00	2023-02-02 18:00:00	Completed	30 min 20 sec	25,485	
91514	2023-01-26 12:00:00	Scheduled Run	2023-01-26 12:00:00	2023-02-02 12:00:00	Completed	32 min 51 sec	25,485	
91513	2023-01-26 06:00:00	Scheduled Run	2023-01-26 06:00:00	2023-02-02 06:00:00	Completed	33 min 11 sec	25,485	
91512	2023-01-26 00:00:00	Scheduled Run	2023-01-26 00:00:00	2023-02-02 00:00:00	Completed	29 min 51 sec	25,485	
91511	2023-01-25 18:00:00	Scheduled Run	2023-01-25 18:00:00	2023-02-01 18:00:00	Completed	18 min 50 sec	25,485	
91510	2023-01-25 12:00:00	Scheduled Run	2023-01-25 12:00:00	2023-02-01 12:00:00	Completed	32 min 40 sec	25,485	
91509	2023-01-25 06:00:00	Scheduled Run	2023-01-25 06:00:00	2023-02-01 06:00:00	Completed	32 min 53 sec	25,485	
91508	2023-01-25 00:00:00	Scheduled Run	2023-01-25 00:00:00	2023-02-01 00:00:00	Completed	32 min 39 sec	25,485	
91507	2023-01-24 18:00:00	Scheduled Run	2023-01-24 18:00:00	2023-01-31 18:00:00	Completed	23 min 37 sec	25,485	
91506	2023-01-24 12:00:00	Scheduled Run	2023-01-24 12:00:00	2023-01-31 12:00:00	Completed	37 min 5 sec	25,485	

New UI – Ephemeris Page

Main Ephemeris Page with Grid Layout

The screenshot shows the 'Ephemeris Grid' on the 'space data center' website. The grid contains columns for 'Uploaded ID', 'Submission Date UTC', 'Satellite', 'SSC', 'International Designator', 'Processing Status', and 'Ephemeris Type'. Callouts highlight the 'Filter Panel' on the left, the 'Row Count' (140) at the top right, and the 'Grid Scrollbar' at the bottom right.

Uploaded ID	Submission Date UTC	Satellite	SSC	International Designator	Processing Status	Ephemeris Type
4895277	2023-01-26 21:29:32	FLOCK 2P-8	41813	2016-0400	Completed	Training
4895276	2023-01-26 21:33:04	FLOCK 2P-8	41813	2016-0400	Completed	Training
4895275	2023-01-26 21:19:09	FLOCK 2K-10	41905	2016-1114F	Completed	Training
4895274	2023-01-26 21:10:01	FLOCK 2K-4	43883	2016-1117	Completed	Training
4895273	2023-01-26 21:08:20	FLOCK 2K-9	41899	2016-1112	Completed	Training
4895272	2023-01-26 21:05:39	FLOCK 2K-9	43906	2016-1114G	Completed	Training
4895271	2023-01-26 21:02:21	FLOCK 2P-8	41813	2016-0400	Completed	Training
4895270	2023-01-26 21:01:15	FLOCK 2K-9	41899	2016-1112	Completed	Training
4895269	2023-01-26 20:42:55	FLOCK 2P-8	41813	2016-0400	Completed	Training
4895268	2023-01-26 19:28:24	FLOCK 2M-4	42997	2017-066L	Completed	Training
4895267	2023-01-26 19:27:44	FLOCK 2P-9	41818	2016-040V	Completed	Training
4895266	2023-01-26 19:26:18	FLOCK 2P-3	41818	2016-040V	Completed	Training

Ephemeris Notes Tooltip

This screenshot shows a tooltip for the 'Notes' column of the Ephemeris grid. The tooltip displays the full text of the notes for a specific row, which was truncated in the grid view. The notes include: 'Training Notes 123 - Line 1', 'Training Notes 123 - Line 2', and 'Training Notes 123 - Line 3'.

Ephemeris File Upload Modal

The screenshot shows the 'Upload Ephemeris File' modal dialog. It includes fields for 'Satellite', 'Ephemeris File*', and 'Ephemeris Type*'. A 'NOTE' section provides instructions: '1. Covariance data must be provided for each timestep and must accompany a position and velocity.', '2. SSC does not accept covariance data with times other than those defined for the position and velocity.', and '3. SSC does not accept a single covariance data record for static covariance. The user must replicate the static covariance for each time step defined for the position and velocity.' There are 'Upload' and 'Cancel' buttons at the bottom.

New UI – Query & Filter

Query by Date Range

← → ↻ ⚠ Not secure | cs-devvm05/ephemeris

space data center
Serving the satellite operator community

Welcome Apollo Nath | Sign Out

Ephemeris Data | Maneuver Report

Latest Ephemeris Files Uploaded

Query Filters: Refresh Upload Ephemeris File ...

- Last 10 days
- Last 20 days
- Last 30 days
- Date Range

From Submission Date: 11/01/2022 00:00:00 **Query by Date Range**

To Submission Date: mm/dd/yyyy HH:mm:ss

Apply

Uploaded ID	Submission Date UTC	Satellite
4695277	2023-01-26 21:29:32	FLOCK
4695276	2023-01-26 21:28:04	FLOCK
4695271	2023-01-26 21:03:21	FLOCK
4695269	2023-01-26 20:42:55	FLOCK
4695260	2023-01-25 22:04:44	FLOCK
4695256	2023-01-25 18:59:41	FLOCK

Filter Dropdown on Processing Status

← → ↻ ⚠ Not secure | cs-devvm05/ephemeris

space data center
Serving the satellite operator community

Welcome Apollo Nath | Sign Out

Ephemeris Data | Maneuver Report

Latest Ephemeris Files Uploaded

Query Filters: Refresh Upload Ephemeris File ...

- Last 10 days
- Last 20 days
- Last 30 days
- Date Range

Grid Filters: Reset

Search: Enter Satellite, SSC, Notes, etc

Processing Status: All, Completed (118), Failed (22) **Filter by Processing Status**

Uploaded ID	Submission Date UTC	Satellite
4695277	2023-01-26 21:29:32	FLOCK 2P-8
4695276	2023-01-26 21:28:04	FLOCK 2P-8
4695271	2023-01-26 21:03:21	FLOCK 2P-8
4695269	2023-01-26 20:42:55	FLOCK 2P-8
4695260	2023-01-25 22:04:44	FLOCK 2P-8
4695256	2023-01-25 18:59:41	FLOCK 2P-8
4695254	2023-01-25 18:23:57	FLOCK 2P-8
4695254	2023-01-25 18:11:54	FLOCK 2P-8

Filter Dropdown on Ephemeris Type

← → ↻ ⚠ Not secure | cs-devvm05/ephemeris

space data center
Serving the satellite operator community

Welcome Apollo Nath | Sign Out

Ephemeris Data | Maneuver Report

Latest Ephemeris Files Uploaded

Query Filters: Refresh Upload Ephemeris File ...

- Last 10 days
- Last 20 days
- Last 30 days
- Date Range

Grid Filters: Reset

Search: Enter Satellite, SSC, Notes, etc

Processing Status: All

Ephemeris Type: All, Operational (1), Training (139) **Filter by Ephemeris Type**

Uploaded ID	Submission Date UTC	Satellite
4695277	2023-01-26 21:29:32	FLOCK 2P-8
4695276	2023-01-26 21:28:04	FLOCK 2P-8
4695271	2023-01-26 21:03:21	FLOCK 2P-8
4695269	2023-01-26 20:42:55	FLOCK 2P-8
4695260	2023-01-25 22:04:44	FLOCK 2P-8
4695256	2023-01-25 18:59:41	FLOCK 2P-8
4695254	2023-01-25 18:23:57	FLOCK 2P-8
4695254	2023-01-25 18:11:54	FLOCK 2P-8
4695254	2023-01-25 16:57:17	FLOCK 2P-8
4695254	2023-01-25 16:45:56	FLOCK 2P-8

Filter Panel with Search capability in Grid

← → ↻ ⚠ Not secure | cs-devvm05/ephemeris

space data center
Serving the satellite operator community

Welcome Apollo Nath | Sign Out

Ephemeris Data | Maneuver Reporting | Conjunction Reports | RFI Events

Latest Ephemeris Files Uploaded

Query Filters: Refresh Upload Ephemeris File ...

- Last 10 days
- Last 20 days
- Last 30 days
- Date Range

From Submission Date: 11/01/2022 00:00:00

To Submission Date: mm/dd/yyyy HH:mm:ss

Apply

Search: Enter Satellite, SSC, Notes, etc **Search in grid**

Processing Status: All

Ephemeris Type: All

Uploaded ID	Submission Date UTC	Satellite	SSC	Interpreted Flagship	Processing Status	Ephemeris Type	Notes	Actions
4695277	2023-01-26 21:29:32	FLOCK	2017-0616	Completed	Operational	Uploaded by ...	🔍 🗑️ 🔄	
4695276	2023-01-26 21:28:04	FLOCK	2017-0616	Completed	Operational	Uploaded by ...	🔍 🗑️ 🔄	
4695271	2023-01-26 21:03:21	FLOCK	2017-0616	Completed	Operational	Uploaded by ...	🔍 🗑️ 🔄	
4695269	2023-01-26 20:42:55	FLOCK	2017-0616	Completed	Operational	Uploaded by ...	🔍 🗑️ 🔄	
4695260	2023-01-25 22:04:44	FLOCK	2017-0616	Completed	Operational	Uploaded by ...	🔍 🗑️ 🔄	
4695256	2023-01-25 18:59:41	FLOCK	2017-0616	Completed	Operational	Uploaded by ...	🔍 🗑️ 🔄	
4695254	2023-01-25 18:23:57	FLOCK	2017-0616	Completed	Operational	Uploaded by ...	🔍 🗑️ 🔄	
4695254	2023-01-25 18:11:54	FLOCK	2017-0616	Completed	Operational	Uploaded by ...	🔍 🗑️ 🔄	
4695254	2023-01-25 16:57:17	FLOCK	2017-0616	Completed	Operational	Uploaded by ...	🔍 🗑️ 🔄	
4695254	2023-01-25 16:45:56	FLOCK	2017-0616	Completed	Operational	Uploaded by ...	🔍 🗑️ 🔄	

New UI- Grid column sort

Grid Column Sort

space data center
Serving the satellite operator community

Welcome Apollo Nath | Sign Out

Ephemeris Data | Maneuver Reporting | Co

Latest Ephemeris Files Uploaded

Query Filters: Refresh Upload Ephemeris File ...

- Last 10 days
- Last 20 days
- Last 30 days
- Date Range

From Submission Date*
11/01/2022 00:00:00

To Submission Date
mm/dd/yyyy HH:mm:ss

Apply

Uploaded ID	Submission Date UTC	Satellite	SSC
4684615	2022-11-01 05:39:27	FLOCK 3M-4	43
4684616	2022-11-01 05:39:30	FLOCK 3P-80	43
4684617	2022-11-01 05:39:33	FLOCK 3P-2	41
4684618	2022-11-01 05:39:35	FLOCK 3P-3	41
4684619	2022-11-01 05:39:38	FLOCK 3P-4	41
4684620	2022-11-01 05:39:40	FLOCK 3P-54	43

Click on column header to sort.

Grid Filter on specific column

space data center
Serving the satellite operator community

Welcome Apollo Nath | Sign Out

Ephemeris Data | Maneuver Reporting | Conjunction Reports

Latest Ephemeris Files Uploaded

Query Filters: Refresh Upload Ephemeris File ...

- Last 10 days
- Last 20 days
- Last 30 days
- Date Range

From Submission Date*
11/01/2022 00:00:00

To Submission Date
mm/dd/yyyy HH:mm:ss

Apply

Uploaded ID	Submission Date UTC	Satellite	SSC	Processing Status
4695277	2023-01-26 21:29:32	FLOCK 2P-8	41613	Completed
4695276	2023-01-26 21:28:04	FLOCK 2P-8	41613	Completed
4695271	2023-01-26 21:03:21	FLOCK 2P-8	41613	Completed
4695269	2023-01-26 20:42:55	FLOCK 2P-8	41613	Completed
4695260	2023-01-25 22:04:44	FLOCK 2P-8	41613	Completed
4695256	2023-01-25 18:59:41	FLOCK 2P-8	41613	Completed

Filter on specific column

Filter dropdown: Equals, 41613, AND, OR, Contains, Filter...

Grid Multi Column Sort

space data center
Serving the satellite operator community

Welcome Apollo Nath | Sign Out

Ephemeris Data | Maneuver Reporting | Conjunction Reports

Latest Ephemeris Files Uploaded

Query Filters: Refresh Upload Ephemeris File ...

- Last 10 days
- Last 20 days
- Last 30 days
- Date Range

From Submission Date*
11/01/2022 00:00:00

To Submission Date
mm/dd/yyyy HH:mm:ss

Apply

Uploaded ID	Submission Date UTC	Processing Status	Satellite 2	SSC	Intern Design
4695129	2023-01-06 16:07:14	Failed	FLOCK 2P-3	41618	2016-
4695128	2023-01-06 16:06:56	Failed	FLOCK 2P-3	41618	2016-
4695127	2023-01-05 17:00:20	Failed	FLOCK 2P-3	41618	2016-
4695126	2023-01-04 22:32:41	Failed	FLOCK 2P-3	41618	2016-
4695125	2023-01-04 22:31:08	Failed	FLOCK 2P-3	41618	2016-
4695124	2023-01-04 21:32:34	Failed	FLOCK 2P-3	41618	2016-

Shift + Click on multiple column headers to sort.

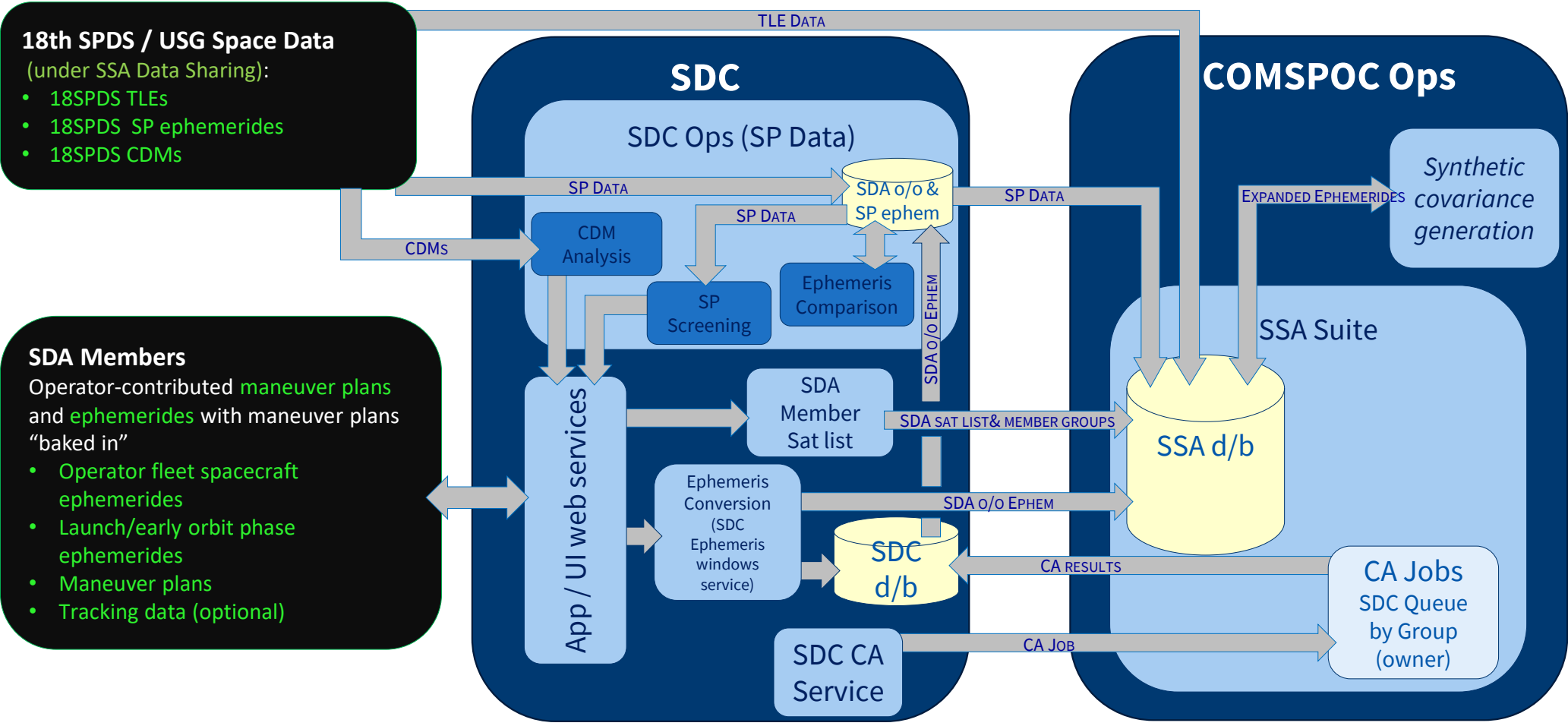
Project Status

- CA screening has been updated to support single-stage screening
 - Using hierarchy of best possible ephemeris
 - Replaces today's two-stage TLE->SP screening process
 - Updates to SDC software have been completed/installed
 - Updates to COMSPOC software have been completed/installed
- SDC conjunctions still using legacy SDC as primary with COMSPOC as secondary (not distributed)
- We are ready to go live with COMSPOC primary
 - Targeting the week of 8 July

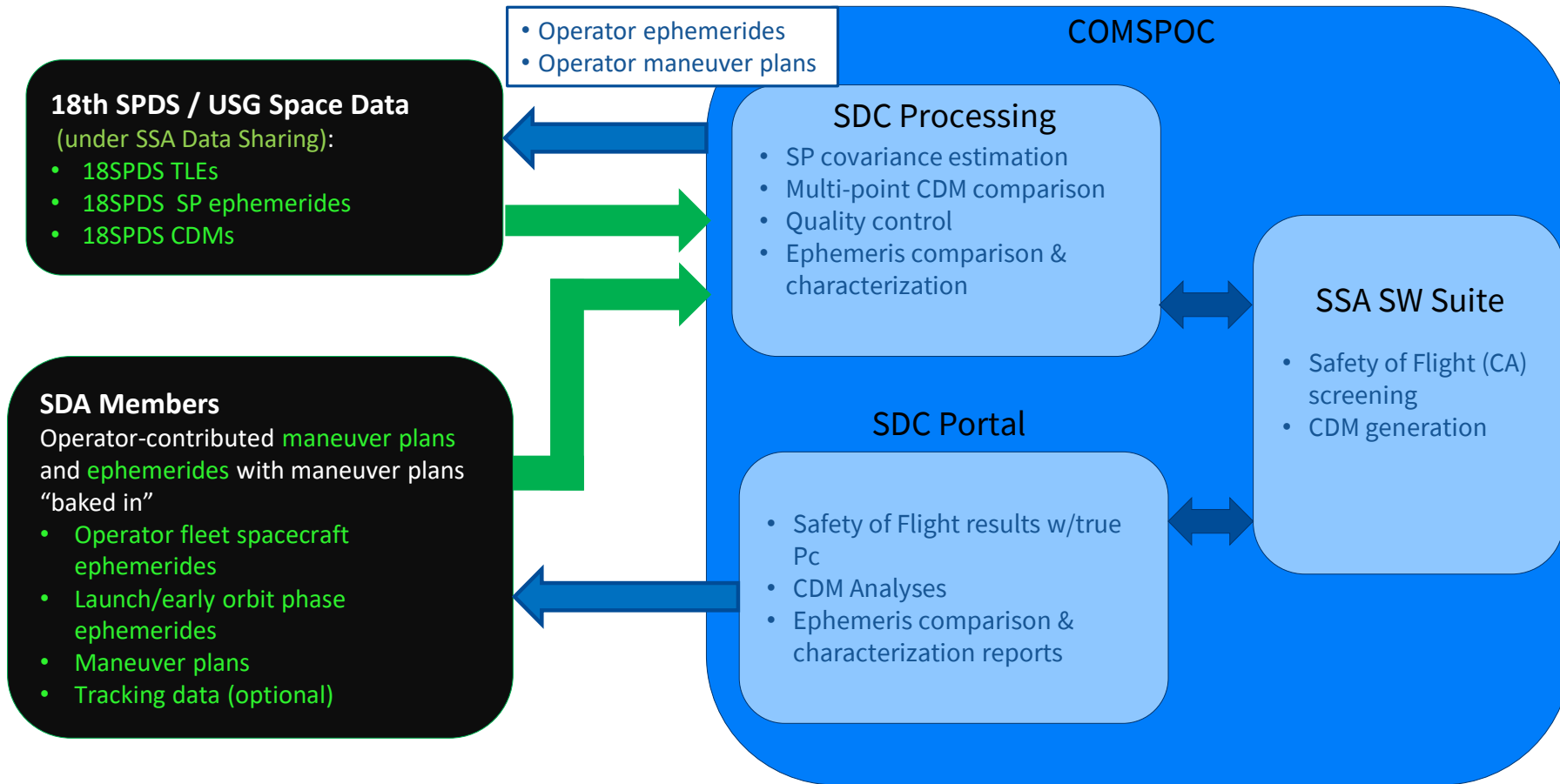
Project Status – Phase 2a

- SP data will be processed to derive overlap-based covariance
 - Will enable true probability computations
 - Synthetic covariance generation currently in testing
- True probability natively computed by COMSPOC
 - Need to expose on SDC website/API
- DISCOS database will be leveraged for object sizes
 - Improves probability assessment
 - DISCSO db already in use
 - Will implement automated periodic update (~weekly)
- CDMs will be natively generated by SDC
 - COMSPOC natively produces these
 - Need to expose them on SDC website/API

Updated SDC (phase 1 & 2) – Functional Flow



Phase 3 (Final) Functional Flow



Project Timeline

- Phase 1 - July 2024
 - Scalable CA computations (in COMSPOC)
 - Single-stage screening w/ best ephemeris
 - Existing SDC website improved for scalability
- Phase 2a - October 2024
 - Overlap-based SP covariance
 - DISCOS database for object sizes
 - CDM generation
- Phase 2b - December 2024
 - Scale factor and box-shaped objects supported
 - OEM ingestion
- Phase 3 - February 2025
 - Revised web site using COMSPOC SSA services portal
 - MFA login security