Argus

Interference analysis for ITU frequency coordination. Select networks, pull ITU data, run a physics-backed simulation, and export a coordination-ready report and administration letter.

VERSION	DATE	PREPARED BY	CLASSIFICATION
0.1.0	2026-07-07	The ODES Team	Public

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REVISION HISTORY

REV	DATE	DESCRIPTION	AUTHOR
0.1.0	2026-07-07	Initial release.	The ODES Team

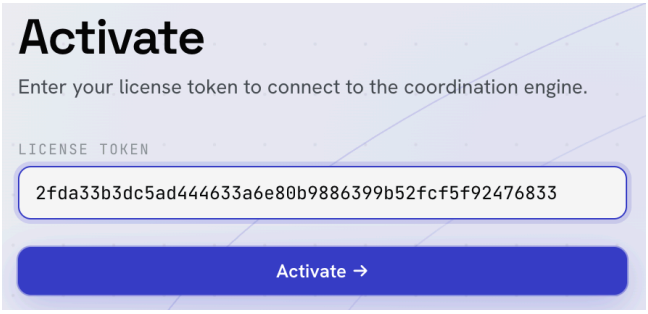
CHAPTER 01

Quick start

Here's a very brief rundown that gets you from logging in to the application all the way to generating an interference analysis report. This section can help you get a very basic feel for using the Argus software. For more information, read on to the next sections.

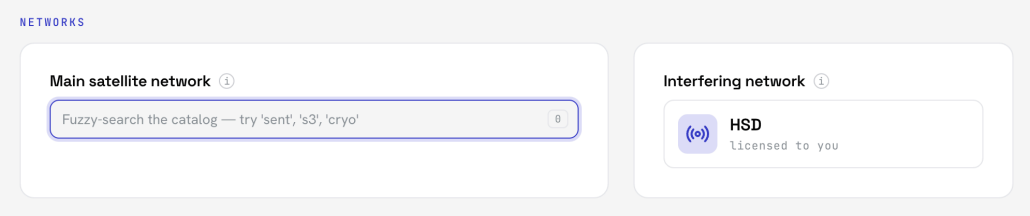
1.1 Grabbing some data

When you first open the Argus app, you will be greeted with the login screen. Enter your user token to authenticate:

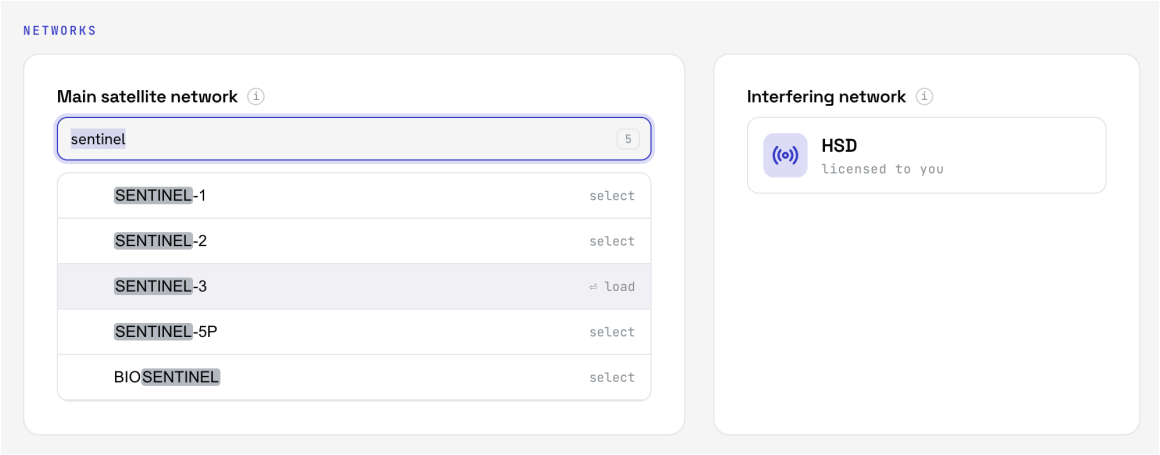


> **NOTE**
>
> New to Argus? Click the `Tour` button in the top bar. It walks you through the active view step by step.

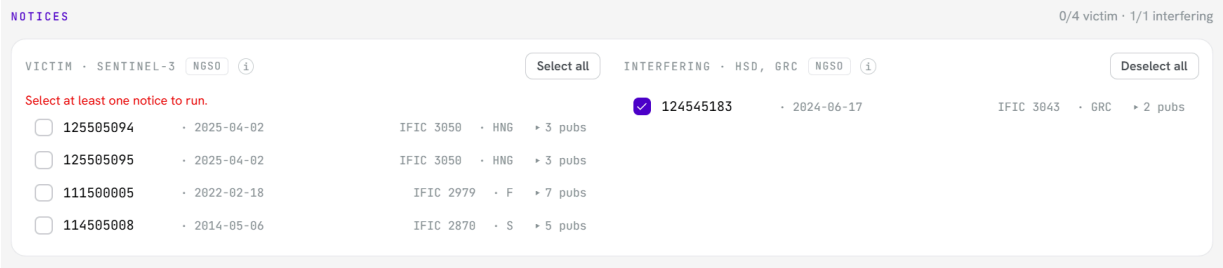
Next, search for the victim satellite network name you received the frequency coordination letter for:



Select the network to load the ITU data for:

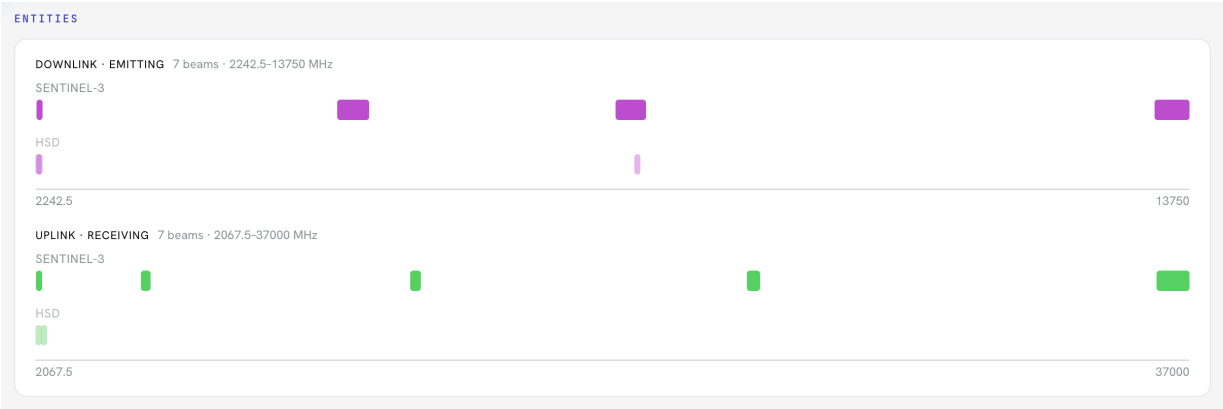


ITU data comes from notices. You may have to choose which notice (or notices) to pull the analysis data from:

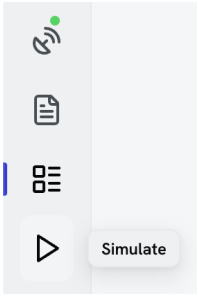


1.2 Running a simulation

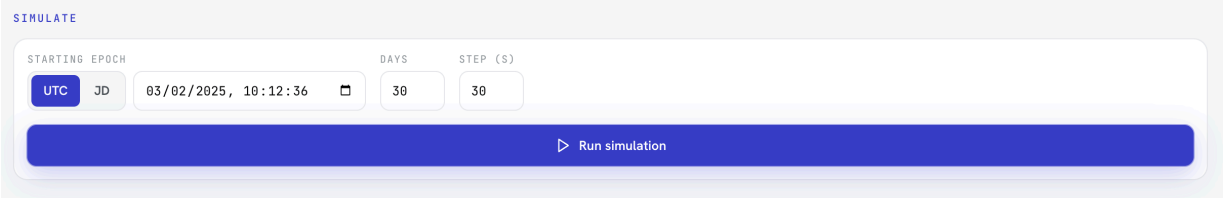
You can then inspect and modify the loaded data. First, take a look at this visualization that helps assess whether there's frequency overlap between the satellite network beams. If there's no overlap, there's no possible interference. Click a frequency block to see the exact frequency range.



Below the frequency visualization is where you can get more information on the loaded data. Let's skip that for now. Click the `Simulate` button at the sidebar to the left of the application window to go to the simulation section:

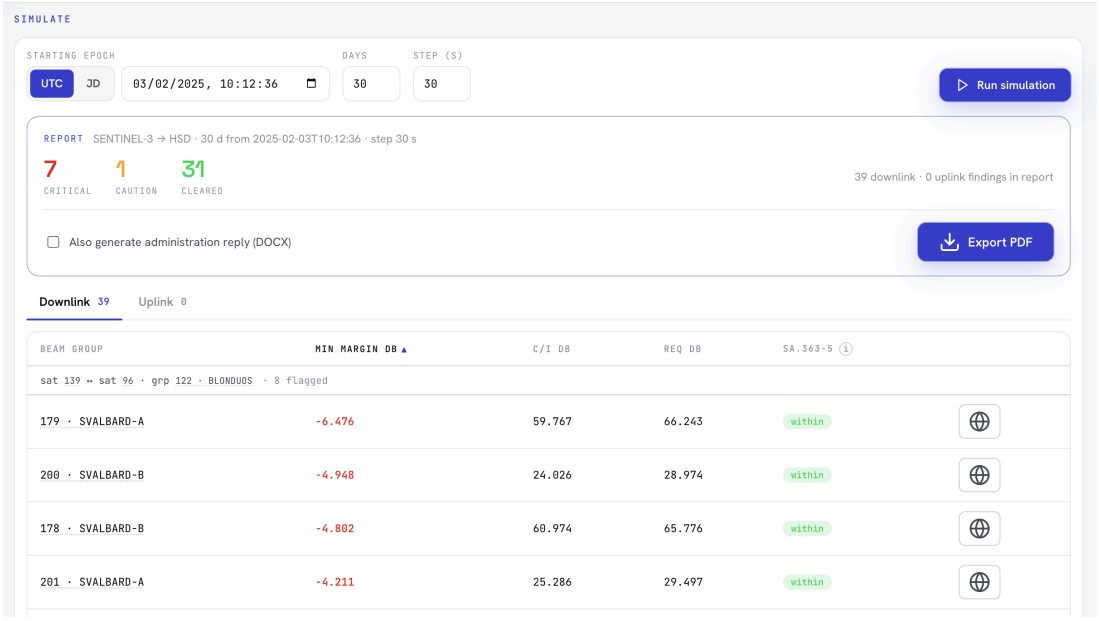


Here you can select the starting date of the simulation, as well as how many days the simulation will run for, and the step size (in seconds). Click the `Run simulation` button:

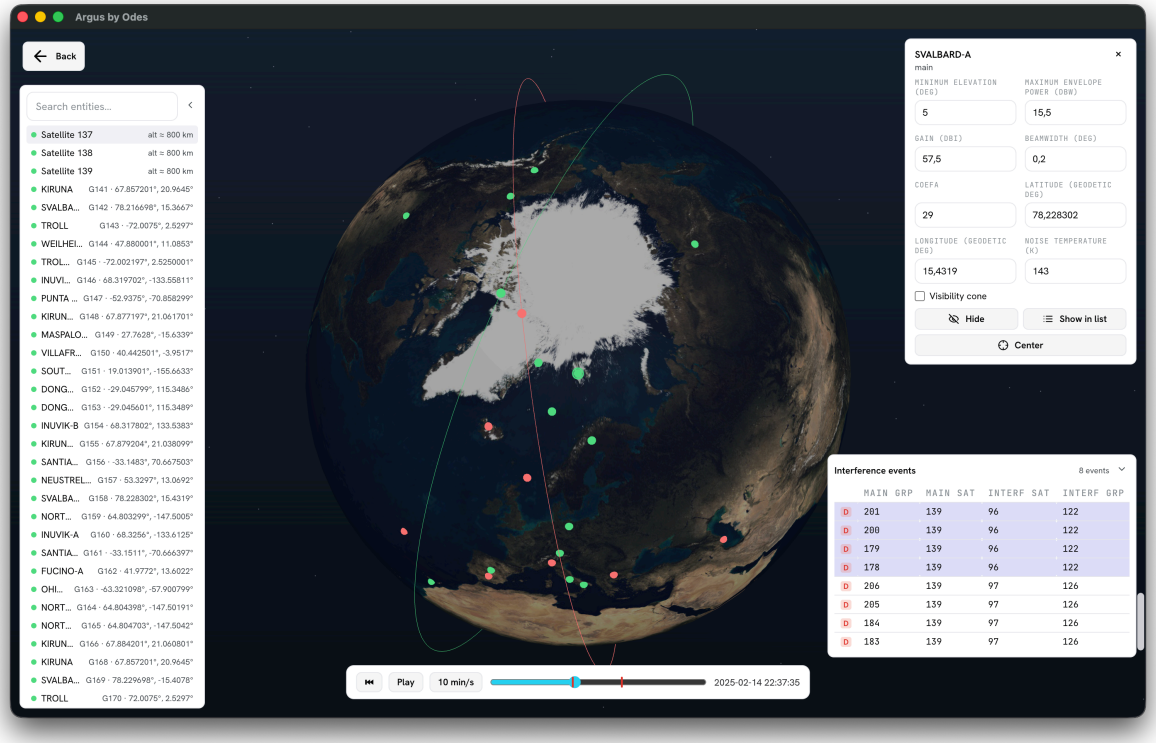


1.3 Looking at the results

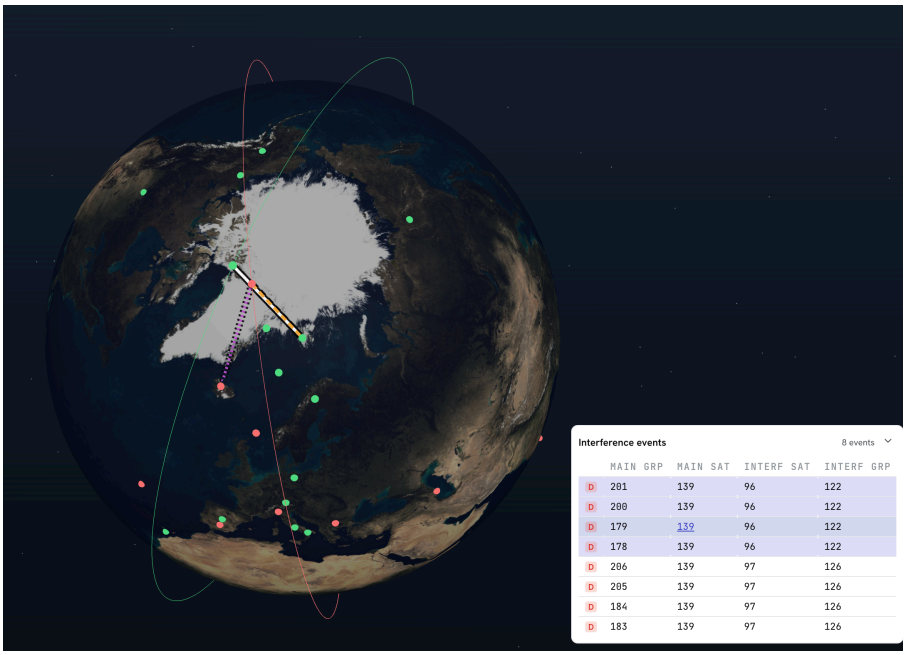
After the simulation has run, you'll see a table with the simulation results:



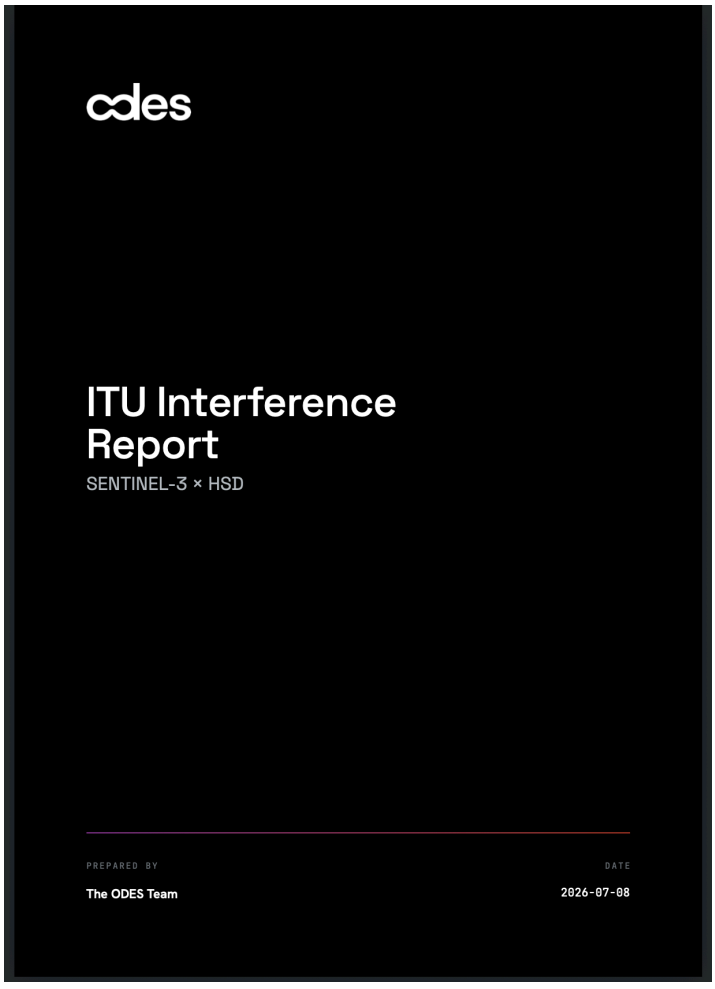
Click the globe button in a result row to go to the globe view:



Hover over an interference event row in the bottom-right table to draw lines between the satellites and ground stations. Click a number in the row to center the camera on that entity (satellite or ground station):



Press `Esc` to go back to the main view. In the simulation results section there's an `Export PDF` button. Click it to generate a PDF report with the analysis configuration and results. The report includes an autogenerated summary based on the simulation outcome:



That's all for now! The rest of the manual will cover the Argus software in more detail, section by section.

CHAPTER 02

Introduction

2.1 Who this manual is for

This manual is written for engineers familiar with answering frequency coordination letters. That includes being familiar with ITU terminology like the IFIC databases or C/I calculations. There's a brief overview of how the simulation works in Section 8 .

2.2 Argus description

Argus is the ODES interference analysis tool for ITU frequency coordination. Given a victim satellite network and an interfering satellite network, it loads entity data from the ITU: satellites, antenna beams, and frequency groups. Argus then propagates every satellite and, for each timestep, calculates all C/I metrics between the victim and interfering network satellite pair, taking all of their associated stations into account. Argus allows for inspecting the analysis results, as well as visualizing the entire simulation timeline on the 3D globe of the Earth. Finally, it can produce an analysis report PDF to be attached to your coordination correspondence, as well as automatically fill in text in a DOCX file to assist with programmatically generating administration letter replies.

2.3 Conventions used in this manual

On-screen elements are written as they appear in the app, as chips: `Run simulation` is a button you click, a section you scroll to, or a field you fill in. Keys are chips too: press `?`, or `Shift` + `P`. Monospaced text like `119500200` denotes values you type or read from the interface.

CHAPTER 03

Getting started

3.1 The Argus workflow

Every analysis follows the same five steps:

1. **Networks**: pick the victim and interfering satellite networks.
2. **Notices**: select which ITU notices to include.
3. **Entities**: review the satellites, beams, and frequency groups extracted from the notices.
4. **Simulate**: configure and run an analysis.
5. **Playback**: go over the results, replay events on the 3D globe, generate a PDF analysis report and a templated DOCX for the administration reply.

3.2 Navigation

The Argus workflow mostly involves working in the same view, scrolling to and from the `Networks`, `Notices`, `Entities`, `Simulate` sections. Since efficient navigation across the app is important, Argus offers several ways to move around quickly.

3.2.1 Navigation rail

A navigation rail runs along the left edge of the app, with one button per section. Clicking a button scrolls the workspace view to the corresponding section.

3.2.2 Keyboard shortcuts

There are various shortcuts you can use to navigate and interact with Argus while using the keyboard. Press `?` to bring up a list with all the available keyboard shortcuts. For example, use the `1` `2` `3` `4` keys to navigate across the sections. `j` scrolls down, `k` up, `gg` scrolls to the top and `Shift` + `G` to the bottom.

3.2.3 Command Palette

Press `Shift` + `P` to bring up the Command Palette. From here, quickly trigger an action, either by clicking or by pressing `Enter`. Cycle through actions with the arrow keys. Start typing to fuzzy-search actions. For example, to run a simulation, instead of scrolling to the `Simulate` section, bring the Command Palette up, type “run” to narrow the list to the `Run simulation` action, and press `Enter`.

3.2.4 Scrollbar

Finally, there’s a scrollbar to the right side of the workspace. This can be a faster alternative to scrolling with, e.g., the mousewheel.

3.3 Getting help

There are pop-up helper tooltips available when you hover over most UI elements. The `Tour` button in the top left of the application can serve as a refresher for some of the essential workflow steps. For additional help, do not hesitate to contact us (see Section 9).

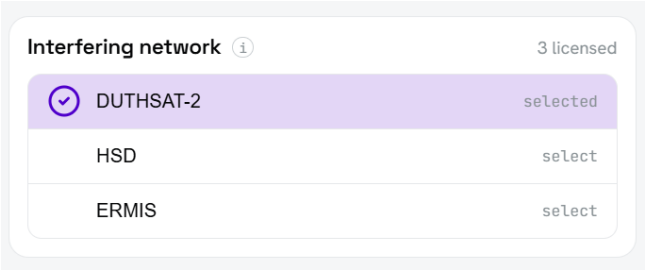
CHAPTER 04

Main workspace

The main workspace is a single GUI view, with four distinct sections. This is the home to every single Argus feature, except for the 3D globe playback, which is located in a different view.

4.1 Networks section

The `Networks` section allows for selecting the victim and interfering satellite network to load ITU data for. Select any active satellite network across the entire ITU database corpus as the victim network. Conversely, each interfering network is licensed to your account. If more than one interfering network is available for your account, select one to run the analysis for:

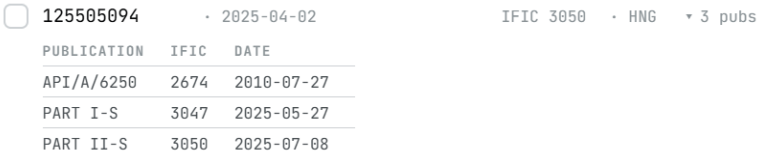


Selecting a network pulls in all associated notices for that network. If there's only one available notice, the data from that notice is automatically loaded for you. Otherwise, you'll have to select which notice to pull data from yourself, which is where the `Notices` section comes in.

> **NOTE**
> Changing a loaded network will reload all loaded data, for both selected networks.

4.2 Notices section

There is some metadata listed here for each notice, to streamline selecting the one you need. The numbers next to the checkboxes represent the notice ID. Next to the ID is the date the ITU received the notice. Next to that is the latest IFIC ITU database containing data from that notice. Next to that are the notifying administrations. Finally, Argus includes a dropdown you can use to track the history of the notice as it moves across publications:

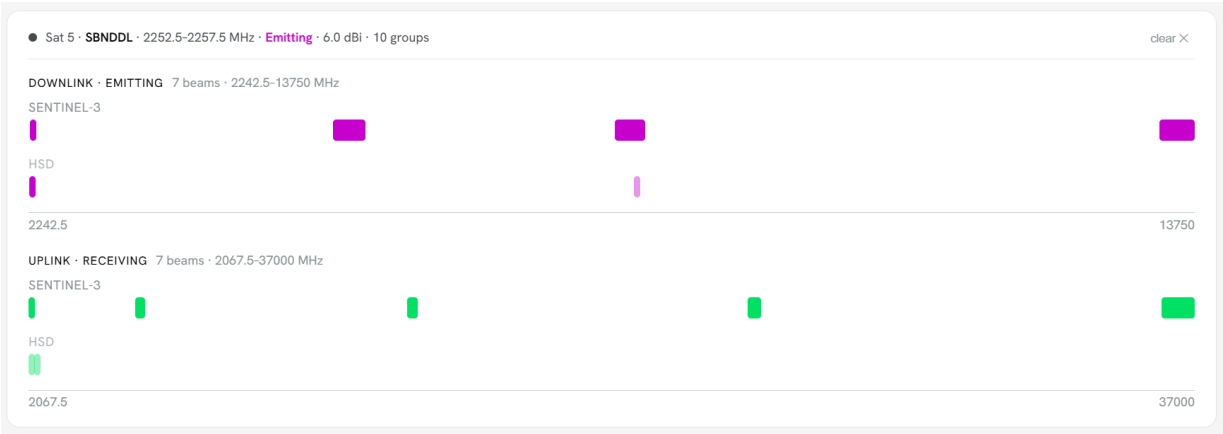


Hover the mouse cursor over a notice and click the little copy icon next to its ID to copy it to your clipboard. At the top of the card, next to the loaded network name, is also an indicator of the orbit: `GSO` / `NGSO`. Selecting a specific notice loads all associated network data from that notice. Most of the time, you will only want to select a single notice. Loading notice data populates the `Entities` section. Either go to that section to further inspect and modify

the loaded data, or go to the `Simulate` section to configure and run an analysis. When notice data is loaded, a rundown of the count of loaded entities also appears in the victim satellite network card in the `Networks` section.

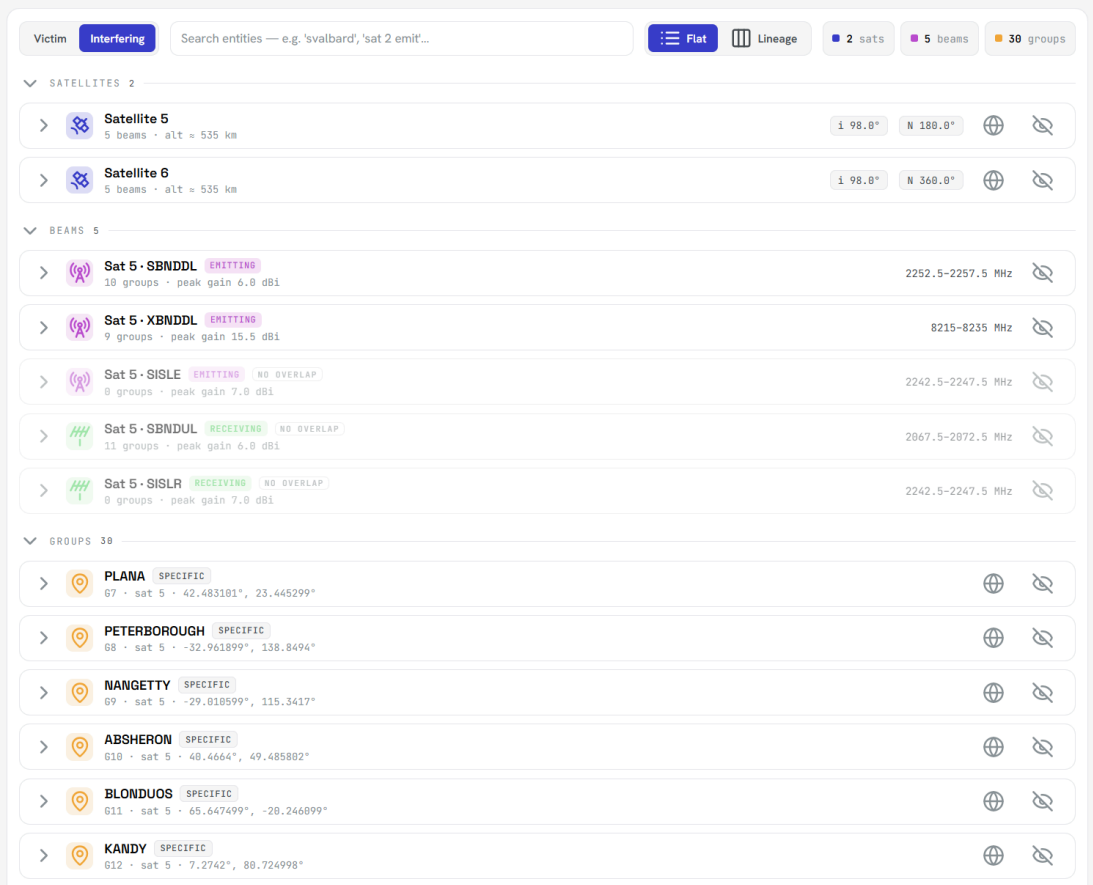
4.3 Entities section

The first card in this section gives you a quick way to visualize the frequency ranges of the loaded antenna beams for both satellite networks. This can assist in pinpointing if there's any overlap between the frequency ranges of the two network beams. If there's no overlap, Argus does not calculate C/I metrics for that beam pair. Hover over a segment, or click it, to get more information regarding that particular beam at a glance. The receiving beams are listed separately from the emitting beams.

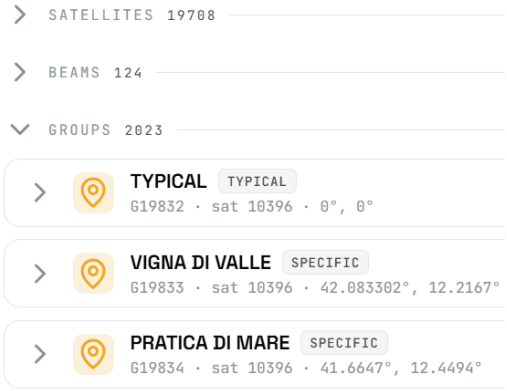


The second card is where the bulk of information on the loaded data lies. First, take a look at the top row. There, left to right, you have: a toggle to display data for the victim or interfering network, a search box to go to specific entities, the entity view toggle, and an overview of the loaded entity count for the highlighted network.

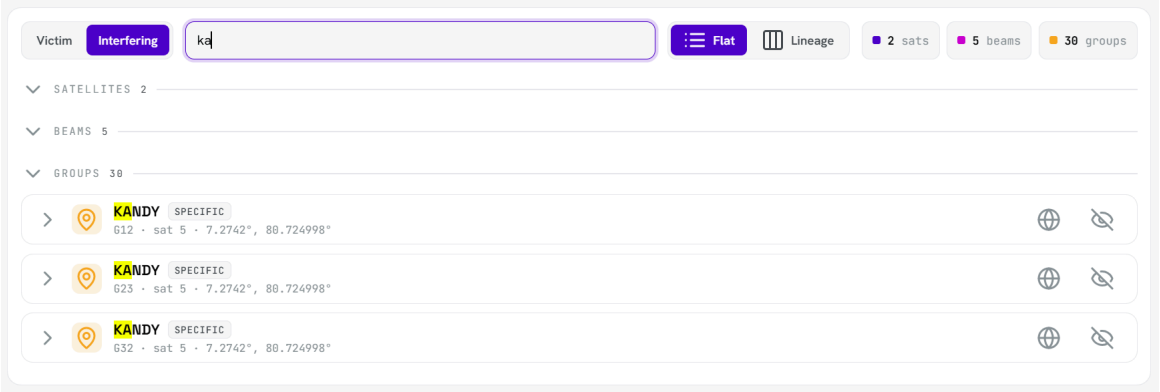
The `Flat` view lists all the loaded entities as they are: satellites, beams, and frequency groups.



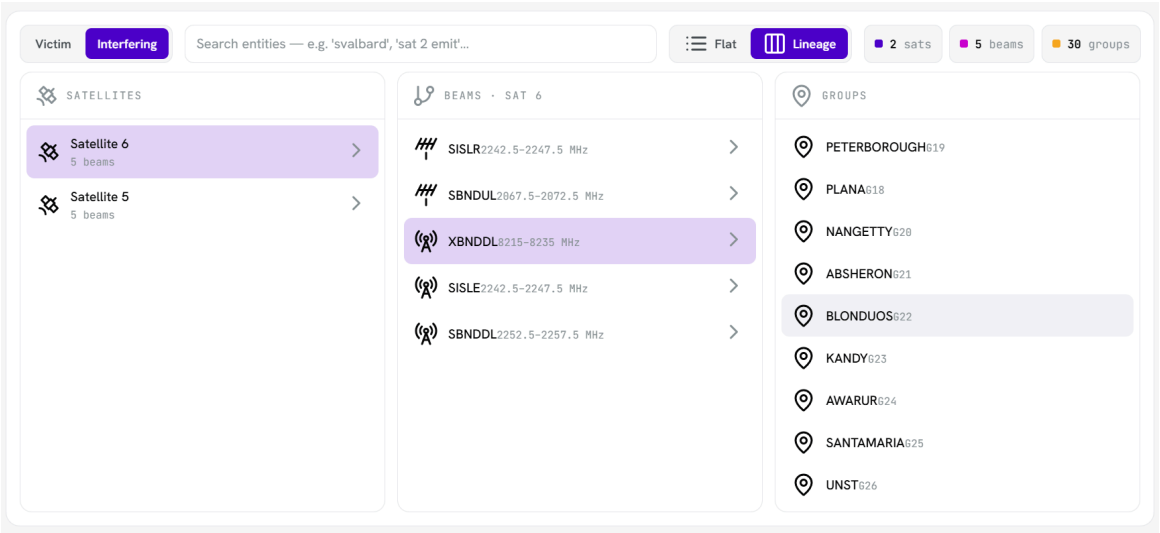
> **NOTE**
>
> Click the header dropdown to collapse the entities.



Use the entity search box to fuzzy search and bring up a specific entity with a matching name.

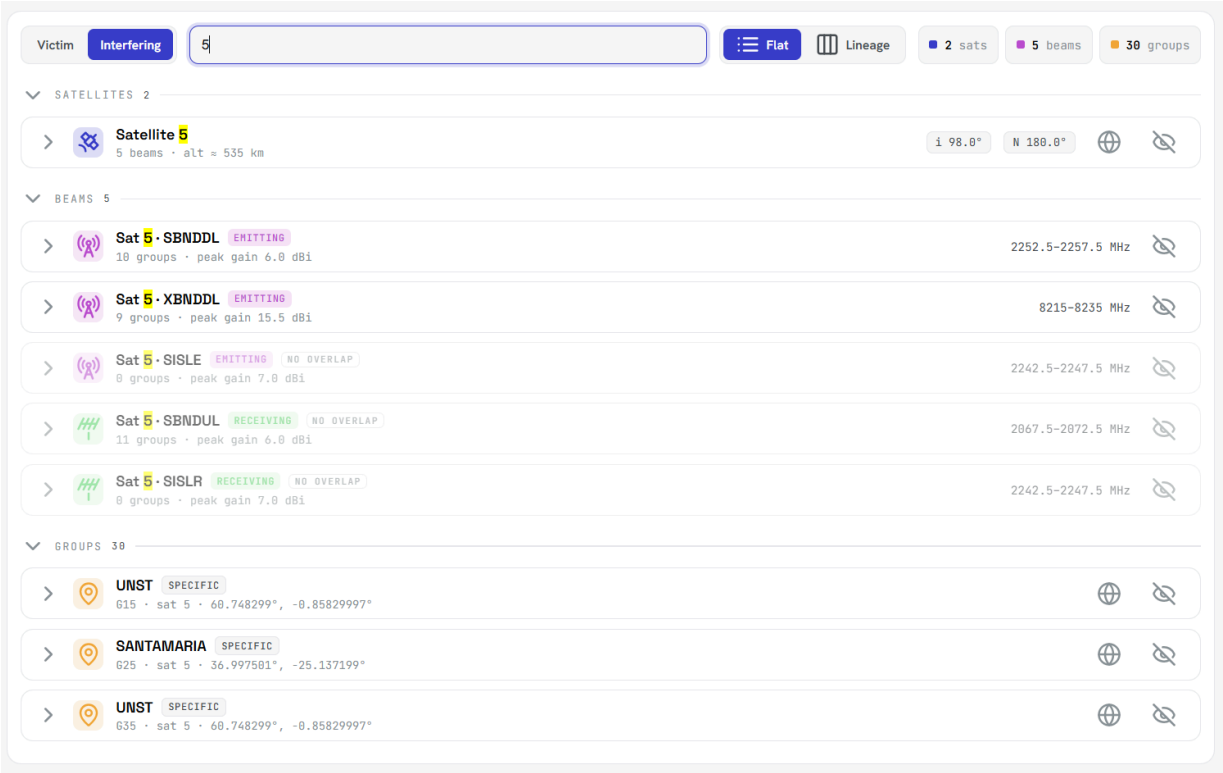


The `Lineage` view allows you to see how the loaded entities are related: satellites have associated beams, and beams have associated frequency groups, which have associated stations.

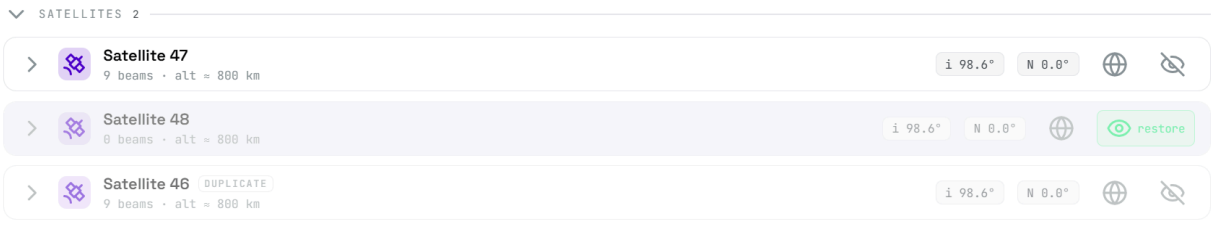


Let’s now take a closer look at the loaded entity cards, top to bottom, beginning with the satellites. Satellites in ITU data don’t carry any names you can identify them with, unlike the other entities. Argus assigns a unique ID to each entity, and you can see the ID of each satellite used as its name.

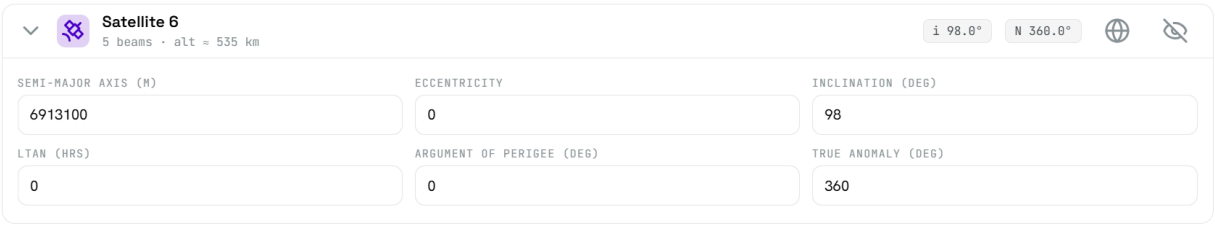
> **NOTE**
>
> Use the satellite ID to search for it in the search box. E.g., search for “5” to bring up Satellite 5, as well as its associated beams and frequency groups.



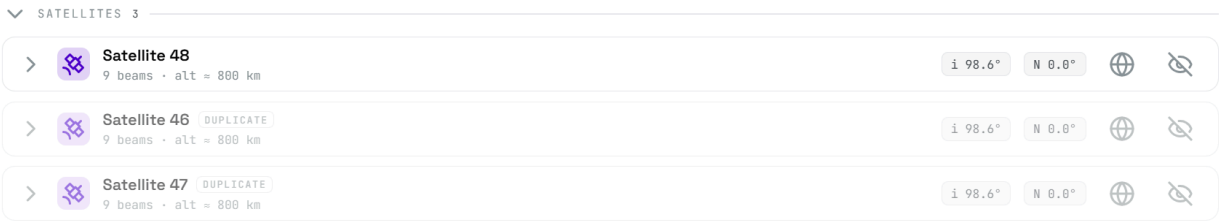
At a glance, you can also see what the altitude of the satellite is, the count of its associated antenna beams, as well as its inclination `i` and its true anomaly `N`. On the right side of the card there are two icons. Clicking the first will take you to the globe workspace, where it highlights this satellite and centers the camera on it. For more information on the globe workspace, refer to Section 5 . Clicking the rightmost icon disables this entity. Disabling an entity keeps its data out of the simulation. This is an easy way to exclude an entity from an analysis. To re-include the entity data for future simulation runs, click the `Restore` button.



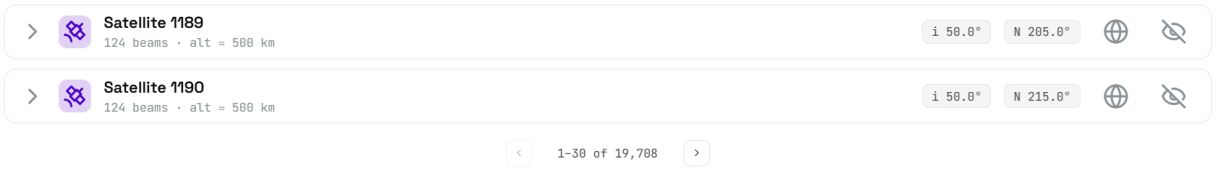
Clicking the satellite entity card will expand it. Use the expanded view to inspect additional entity data. You can also modify most entity data. Next to the field name you can also find the unit of the field, when applicable.



There's a variety of optimizations implemented in Argus to enable high-performance simulations. These can range from clever algorithms and algebra manipulation to more simple, user-facing optimizations. Argus automatically detects satellites with identical orbital elements and only includes one from that set in the simulation. The excluded satellites are grayed out and marked as duplicates in the `Flat` view.



Some satellite networks have a lot of associated entities. To simplify navigation, Argus splits entities into pages, each page containing 30 entities.

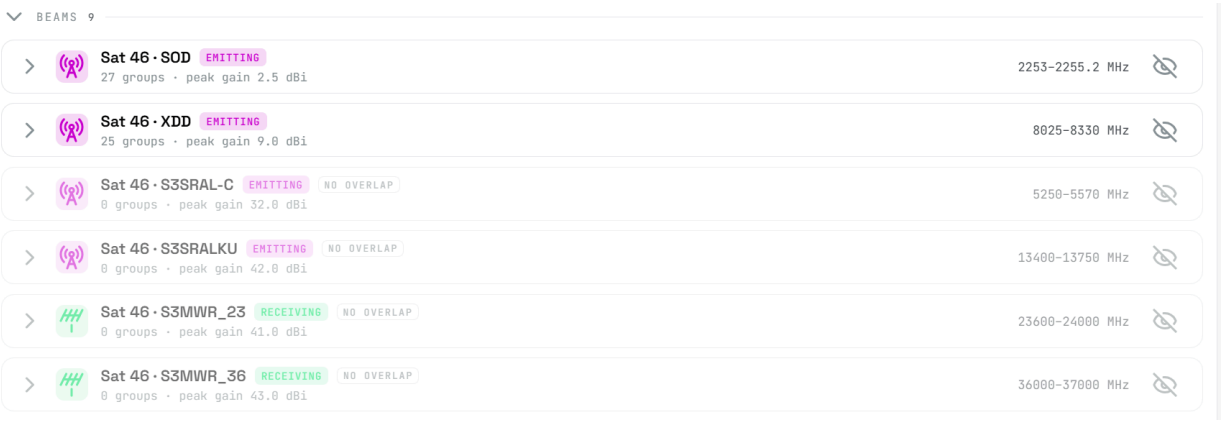


> **NOTE**
>
> When displaying satellites across multiple pages, Argus shows you all the non-duplicate satellites first, and displays the duplicate satellites second.

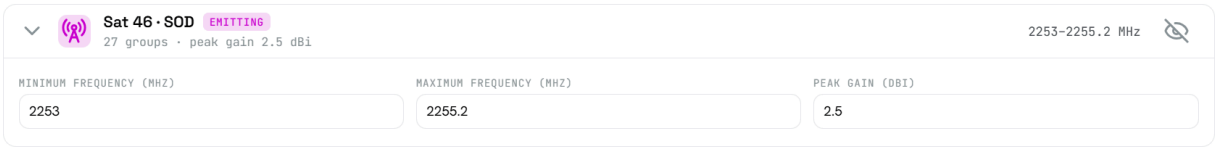
Below the satellites lie the antenna beam entities. In each beam card you can see one of its associated satellites. Next to that is the beam name. You can also see whether it's listed as emitting or receiving, its peak gain, its frequency range, and the count of its associated frequency groups.

> **NOTE**
>
> If a satellite is marked as duplicate, the beams might still list it as their associated one. The Lineage view is a better way to visualize the relationship between satellite, antenna beam, and frequency group entities.

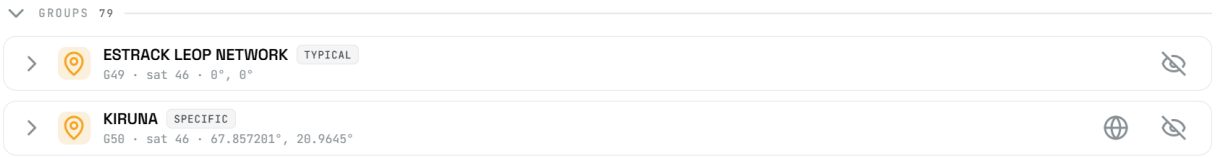
Similar to how Argus can detect satellites with duplicate orbital elements and exclude them from the simulations, it can also detect whether there's no possible frequency overlap between a specific beam and all the same-kind beams of the other network, and exclude it. These beams are grayed out and marked as "no overlap". Argus will first display all the beams with potential frequency overlap, and it will leave the no overlap beams at the end. Click the icon at the far right to exclude the entity from the simulation, and click the restore button to restore it.



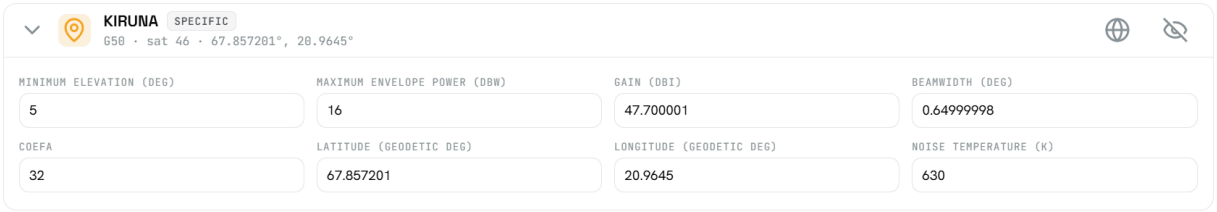
Expand a beam card to modify its corresponding data.



After the antenna beam entities are the frequency groups. Frequency group cards contain the name of the associated earth station of the group, and are marked as typical or specific, depending on whether the corresponding earth station is typical or specific. Groups linked to specific earth stations also list the station's latitude and longitude. The cards of these groups also include the globe button, which will take you to the globe workspace, where it highlights this earth station and centers the camera on it. For more information on the globe workspace, refer to Section 5 . Typical earth stations don't have an associated position on the globe, so you can't visualize them that way. Click the eye button to exclude the entity from the simulation, or include it again. Additionally, you can see the group ID prefixed with `G` and one of the group's associated satellites. The `Lineage` view is a better way to determine links between entities.

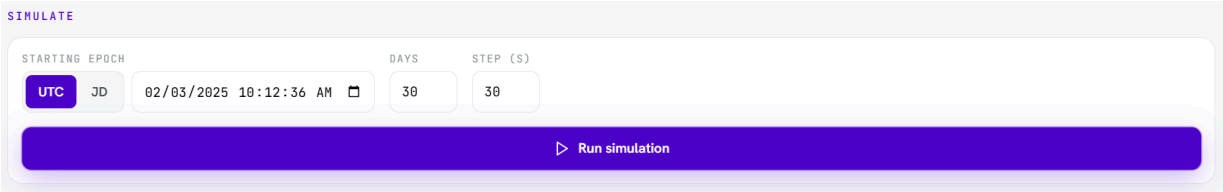


Expand a frequency group card to modify most of its corresponding data. `COEFA` is a parameter of the antenna pattern of the earth station beam that is linked to this frequency group.

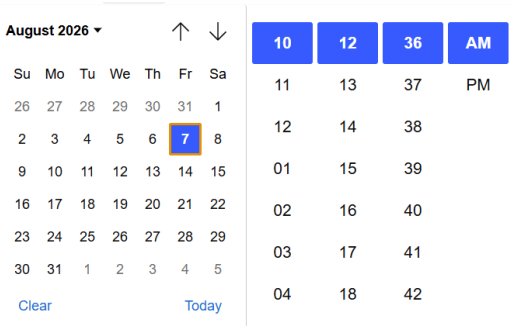


4.4 Simulate section

The top portion of the simulate section allows you to configure and run a frequency interference analysis. Set the starting epoch used to propagate satellite state in UTC time or Julian Day. Additionally, you can select the number of days for which the simulation will run, as well as the step size in seconds.

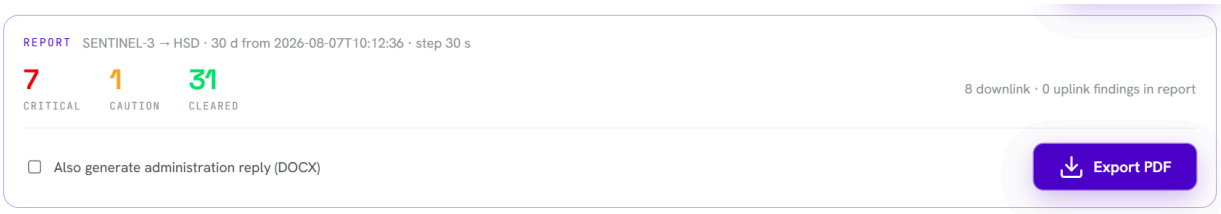


Bring up a date picker by selecting the calendar button next to the starting epoch time.



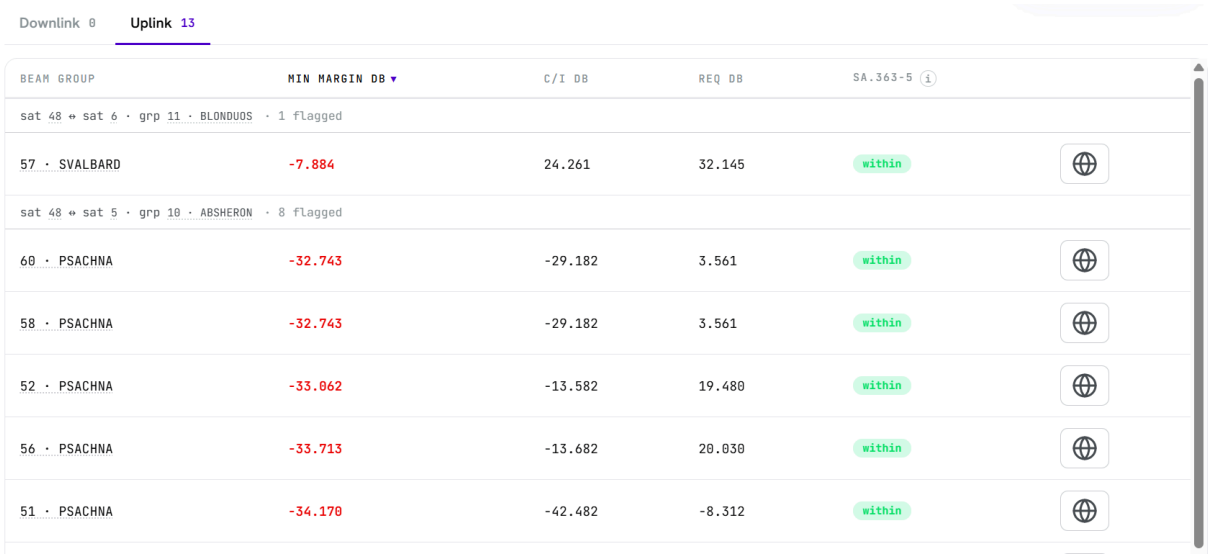
Click the `Run simulation` button to run the interference analysis. After the simulation is complete, you'll be presented with a report summary, a detailed results table, and export options. Furthermore, the globe workspace will now be populated with the simulation playback and events timeline. For more information on the globe workspace, refer to Section 5 . For more information on exporting the results refer to Section 6 and Section 7 .

In the report overview, you can find the number of interference events. Results are calculated for each frequency group of the victim satellite network. The results are based on C/I calculations. For each frequency group, Argus reports the worst-case event. Frequency groups for which there was no potential interference whatsoever are omitted from the overview counts. The `CRITICAL` events are those for which the C/I margin was below –2 dB. The simulation includes the standard 12.2 dB margin as indicated by the ITU. `CAUTION` events are those for which the C/I margin was between –2 and 0 dB. These typically constitute significant interference events according to a strict interpretation of the ITU guidelines. In practice, however, administrations believe the 12.2 dB required margin to be too strict. `CAUTION` events would not be considered significant for a required margin of approximately 10 dB. `CLEARED` events are those where, while potential interference was detected, the C/I margin was above 0 dB. Beyond the event counts, you can also see how many of the `CRITICAL` and `CAUTION` events correspond to downlink and how many correspond to uplink. Additionally, you can find a summary of the simulation configuration parameters on the top left of the card.

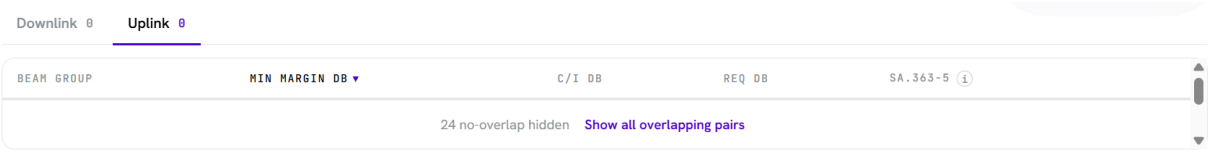


Each interference event involves four entities: a victim satellite and the earth station of one of its frequency groups, plus an interfering satellite and its associated earth station. The results are listed in two tabs: one for the `Downlink` and one for the `Uplink` results. Each row in the results table corresponds to a frequency group of the victim satellite network. The frequency group ID is displayed in the leftmost part of the row, followed by the name of the associated earth station. The columns next to that list the C/I margin, the C/I, and the required margin, in dB. Additional results are available in the exported PDF report (see Section 6). Next to the required margin column is the SA 363-5 column. Here you can see whether the longest total amount of significant interference events found in a given day is below

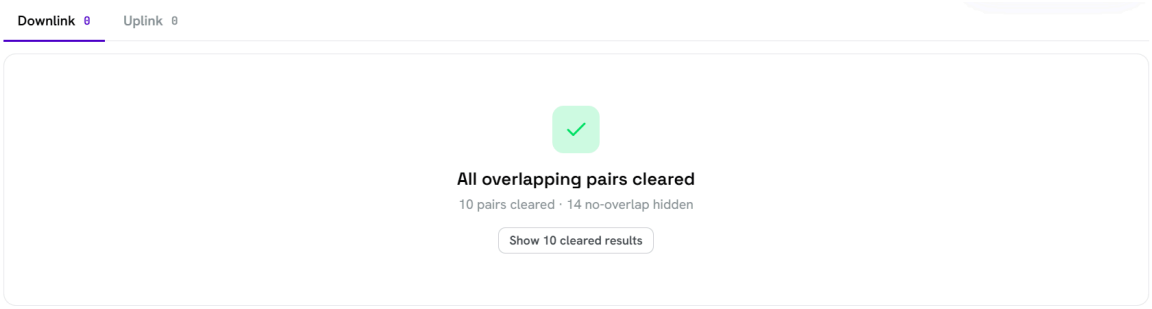
(within), or exceeds the 1% of the total day time (86400 seconds). The result rows are grouped by the rest of the entities involved, i.e., victim satellite network satellite, interfering satellite network satellite, and its corresponding associated frequency group. Each entity listed is underlined with a dotted line. Clicking the link will scroll the view up to the entities section, highlighting the selected entity (see Section 4.3). Click a column name to sort in ascending or descending order, while retaining the row grouping. Finally, each row has a globe icon on the right side. Clicking the icon will bring up the globe workspace, highlight the earth station associated with the victim satellite network frequency group of the event, center the camera at its location, and seek the simulation playback timeline to the moment the event was registered (see Section 5).



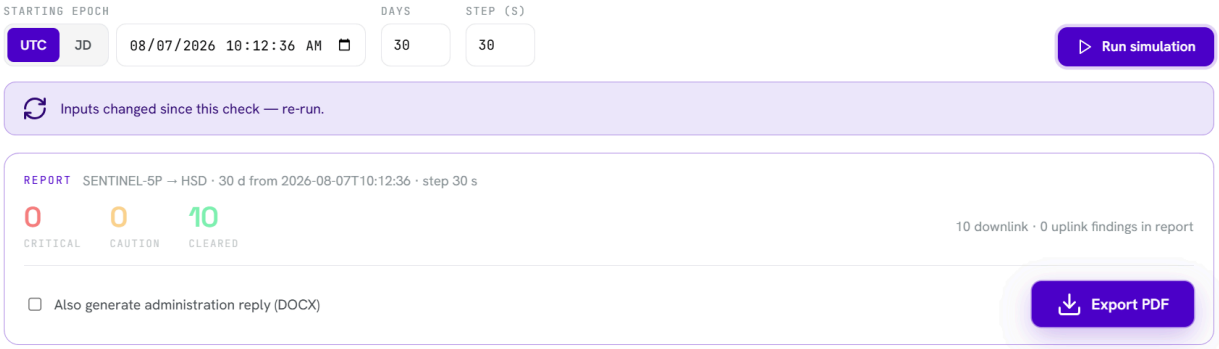
By default, only the `CRITICAL` and `CAUTION` interference events are shown in the results table. Inspect `CLEARED` events by scrolling to the bottom of the results table and clicking the `Show all overlapping pairs` button.



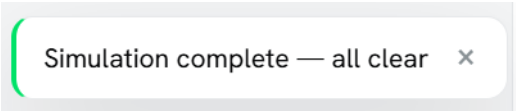
Overlapping pairs are pairs of frequency groups with overlapping frequency ranges and same-kind associated antenna beams. If all overlapping pair events are `CLEARED`, Argus will let you know on the screen.



If you modify the loaded data after a simulation run (or load different data), Argus will let you know with a banner above the results overview card.

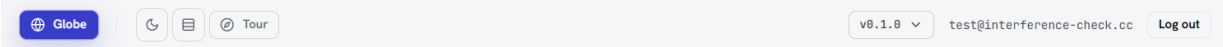


If a simulation run is completed while you have navigated away from the simulate section, Argus will notify you with a small notification toast in the top right side of the application window.



4.5 Ribbon

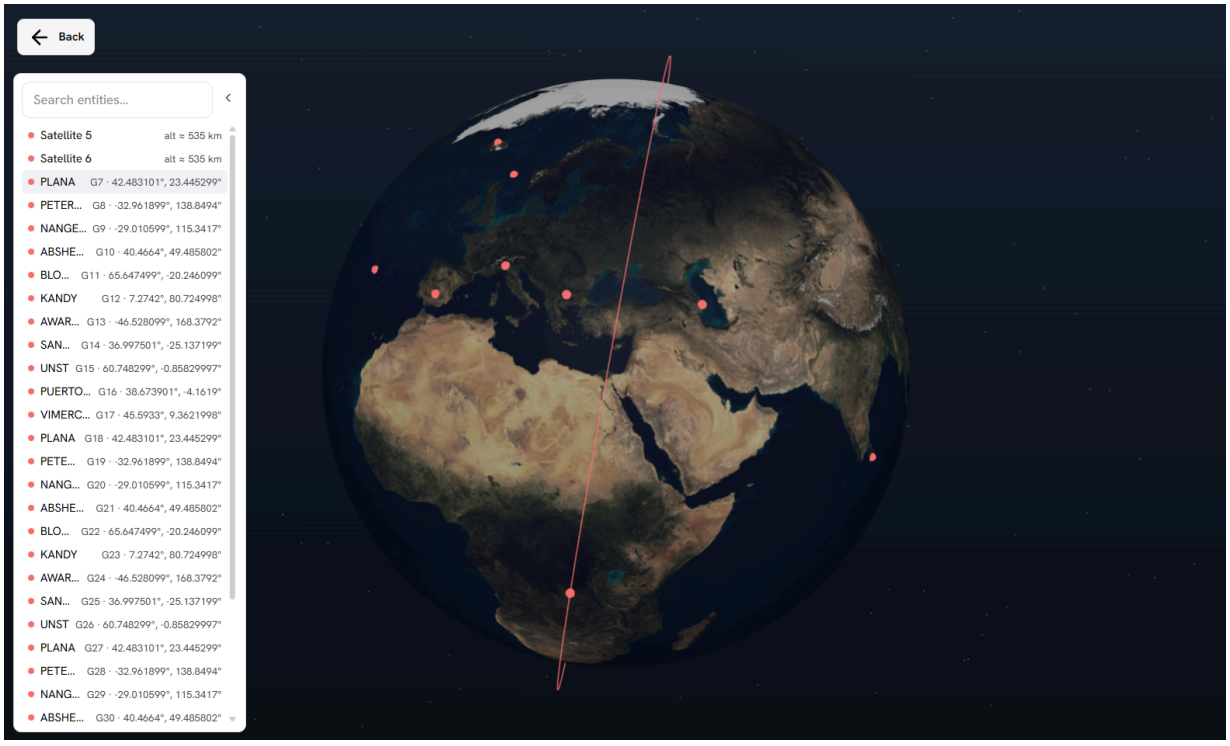
At the top of the main workspace, from left to right there's the globe button, which takes you to Section 5 , a button to toggle between light and dark theme, a button to choose the density of the layout, and next to that a `Tour` button. Use the tour button to familiarize yourself with the main workspace. Next to the tour button, towards the right side, there's a version picker dropdown for Argus, your username and a `Log out` button that brings you back to the login screen.



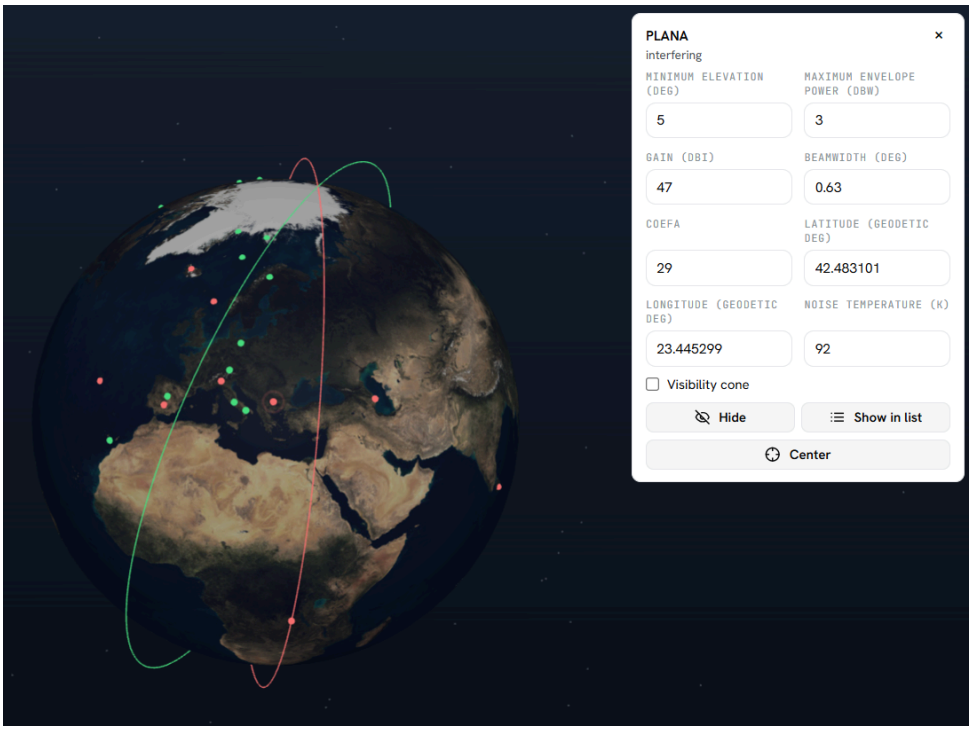
CHAPTER 05

Globe workspace

When you open Argus, the globe workspace is disabled. To enable it, load a victim satellite network. To visit the globe workspace, either click the `Globe` button in the ribbon at the top left, or press `V`. To go back to the main workspace, either click the `Back` button in the top left corner, or press `Esc`. In the center of the globe workspace there's a 3D representation of the Earth. The satellites of the loaded satellite networks are rendered as dots orbiting the planet, sitting on an orbit trace that helps visualize the satellite orbital elements. Similarly, the associated earth stations of the loaded frequency groups are rendered as dots on the surface of the globe. Loaded data from the interfering satellite network is represented in red, while loaded data from the victim network is represented in green. Use the left click to rotate the camera, the right click to pan the camera, and the scroll wheel to zoom in and out. On the left of the screen there's an entity catalog.

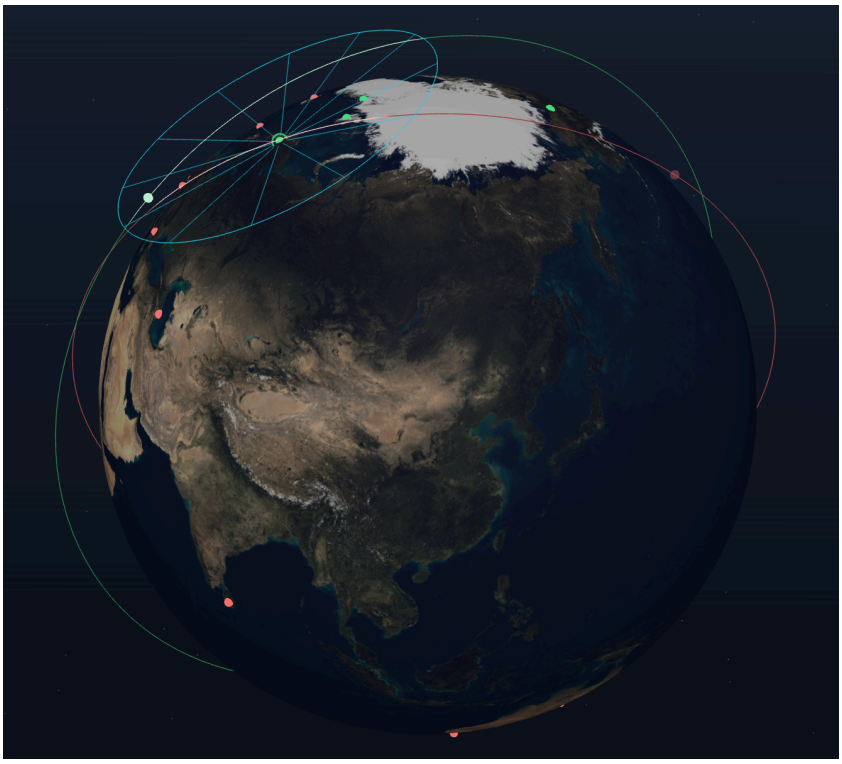


Clicking an entity highlights it, and brings up the entity card at the top-right corner. There, you can inspect and modify the entity data, similar to the entities section in the main workspace. The `Hide` / `Restore` button can be used to exclude an entity from the simulation. Clicking the show in list button will bring you to the main workspace, in the entities section, highlighting and expanding the corresponding entity entry. To go from an entity in the entities section to its representation in the globe workspace, click the globe inline button in the entity row. Use the center button to center the camera facing the selected entity. Instead of clicking a dot to bring up the entity card, you can use the fuzzy search in the entity catalog on the left and click the result.

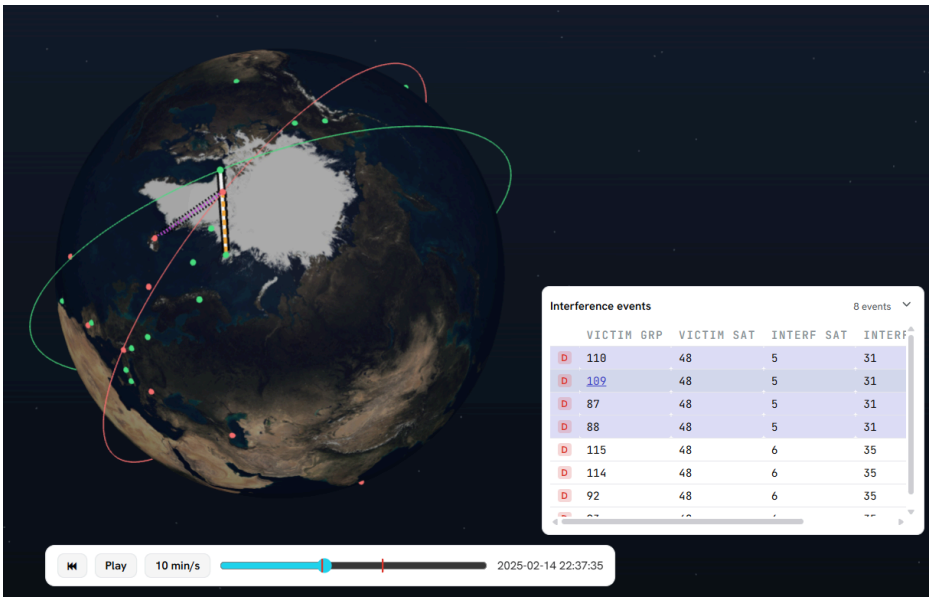


If you've run a simulation, the globe workspace has added features. At the bottom of the screen there's now a timeline you can use to see the satellites as their state is propagated across time.

There are two extra features that pair well with the timeline. The first is the visibility cone: highlight a ground station to bring up its card, then toggle the `Visibility cone` box above the `Hide` and `Show in list` buttons. You can now see the area inside which Argus will consider a satellite visible from that station. The cone also highlights satellite entities that are inside it, as well as the orbit trace segments that fall inside it. The second feature is the `Track` button in the satellite entity cards. Click it so that the camera stays centered on the satellite while you play through the timeline. You can have a visibility cone up while you track a satellite.



If Argus identified critical interference events during the simulation, the timeline will be marked with vertical bars that denote the time these events occurred. Click a vertical bar to automatically seek to that moment in time, with the camera also moving to show you where the interference took place. There's also a table at the bottom right of the view listing the interference events. Each row corresponds to an event, and the rows are grouped similar to how the rows in the results table in the simulate section are. The events are color-coded with red representing downlink events and orange representing uplink events. If you hover over a row, Argus will draw lines to help you see exactly which entities are involved. Clicking the ID of an entity in a row will highlight that entity on the globe, center the camera on its location and bring up its card.

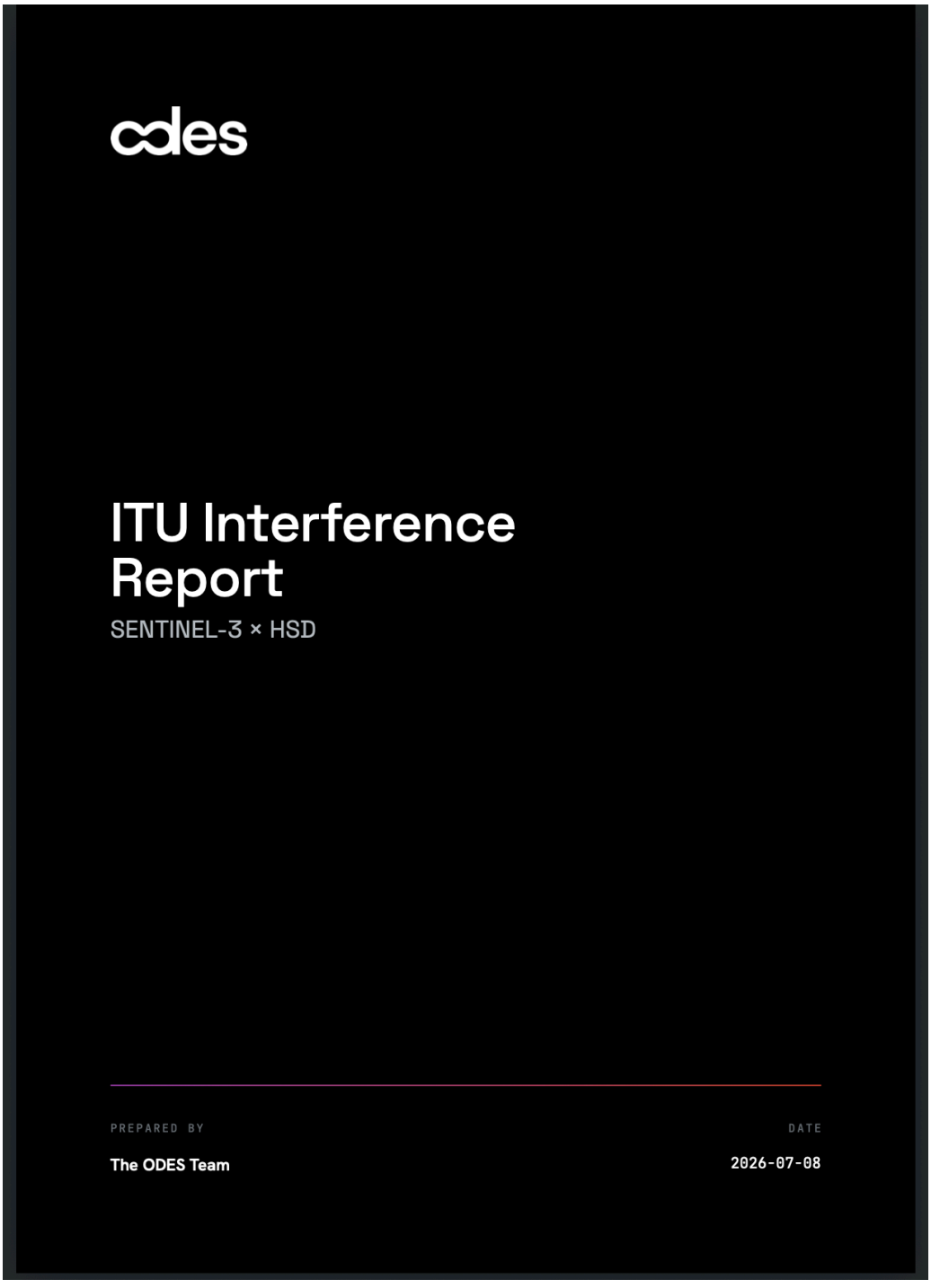


You can collapse both the events table and the entity catalog to reduce clutter in the workspace by clicking the dropdown arrows in the top-right corner of both widgets. You can close an entity card by clicking the `x` button in the top right of the card.

CHAPTER 06

PDF report

The autogenerated PDF report begins with an overview of the simulation results. If significant interference events were identified, there's a table listing the calculated signals and margin. Below that, the report includes snapshots of the globe workspace (see Section 5), highlighting the corresponding entities of each interference event. Next, there's a dump of the loaded entities used in the simulation and the simulation configuration. Lastly, there's a section with additional details on how Argus works under the hood, as well as a primer on the C/I calculations.



CHAPTER 07

DOCX template

While the PDF report contents and style are set in stone, Argus can help you automatically populate a DOCX file of your choice with details about the simulation. Create a template file with your wording, contents and styling, and feed it to Argus to fill in the blanks. To do that, you can use several template specifiers in your DOCX file. These specifiers are normal text, enclosed in double curly braces: `{{templateSpecifierExample}}`. The available specifiers are:

NAME	DESCRIPTION	EXAMPLE
`{{victimNetworkName}}`	Victim satellite network name	`SENTINEL-3`
`{{interferingNetworkName}}`	Interfering satellite network name	`HSD`
`{{victimNetworkKind}}`	Victim network kind: NGSO or GSO	`NGSO`
`{{interferingNetworkKind}}`	Interfering network kind: NGSO or GSO	`NGSO`
`{{simDuration}}`	Duration of the simulation, number of days	`30 days`
`{{simEpoch}}`	Initial time used in the simulation, UTC	`2025-02-03 10:12:36 UTC`
`{{victimIFICNumber}}`	Number of the BR IFIC the victim network's selected notices were published in, without the `IFIC` prefix	`2979`
`{{interferingIFICNumber}}`	The same, for the interfering network	`3043`
`{{victimReceiptDate}}`	ITU date of receipt of the victim network's selected notices	`2022-02-18`
`{{interferingReceiptDate}}`	The same, for the interfering network	`2024-06-17`
`{{victimFiling}}`	IFIC number and date of receipt of the victim network's selected notices, kept paired per notice	`IFIC 2979, received 2022-02-18`
`{{interferingFiling}}`	The same, for the interfering network	`IFIC 3043, received 2024-06-17`
`{{victimAdministration}}`	Notifying administration(s) of the victim network's notices	`HNG, F, S`
`{{interferingAdministration}}`	Notifying administration(s) of the interfering network's notices	`GRC`
`{{victimSpecialSections}}`	BR IFIC publications of the victim network's selected notices, each followed by the IFIC it appeared in	`... PART I-S (2969), PART II-S (2973), PART II-S (2979)`
`{{interferingSpecialSections}}`	The same, for the interfering network	`API/A/13768 (3032), API/B/2960 (3043)`
`{{frequencyOverlap}}`	The beam pairs that share a frequency band, one per line	see below
`{{results}}`	The verdict of the analysis, in coordination-reply wording	see below

NAME	DESCRIPTION	EXAMPLE
`{{report}}`	Sentence pointing at the PDF report that accompanies the reply	`The accompanying detailed analysis is provided in the PDF report "F-SENTINEL-3-GRC-HSD.pdf".`
`{{pdfReport}}`	Filename of the exported PDF report, on its own	`F-SENTINEL-3-GRC-HSD.pdf`

`{{frequencyOverlap}}` example:

> The victim and interfering networks share overlapping frequency bands in the following beam pairs:
> - SOD (victim) and SBNDDL (interfering), downlink: 2253–2255.2 MHz
> - XDD (victim) and XBNDDL (interfering), downlink: 8215–8235 MHz

`{{results}}` example:

> The analysis found 7 events with a carrier-to-interference margin below –2 dB (worst –6.5 dB). However, all of these events remain within the ITU-R SA.363-5 recommendation, with interference present for less than 1% of any day. Therefore, the administration considers that no significant interference will occur between the SENTINEL-3 satellite network and the HSD satellite network, and that any difficulties between the networks can be considered as resolved.

NOTE

Every specifier resolves to something on every run. Where the ITU data carries no value, the notice-derived specifiers and the network kinds are filled in with `not available` rather than left blank, so a missing value is visible in the reply instead of silently reading as an omission.

To generate a DOCX file, toggle the `Also generate administration reply (DOCX)` option in the `Simulate` section.

CHAPTER 08

Methodology

8.1 Simulation procedure

The orbital elements of all the satellites that are part of the victim and the interfering satellite network are propagated across time, using J2 propagators. Typical ground stations of the interfering satellite network are co-located with the corresponding stations of the victim satellite network, and treated as always-transmitting. Typical associated ground stations of the victim satellite network are excluded from the analysis.

During each simulation timestep, all satellites are propagated using J2 propagators. Then, Argus identifies all victim satellite <–> victim ground station pairs where each satellite is visible from the corresponding ground station. For each pair, Argus identifies all of the interfering satellites that are visible from each ground station of each pair. Finally, for each group of three, Argus identifies all of the interfering ground stations from which the interfering satellites are visible. This process essentially identifies all 2-satellite, 2-ground station sets, consisting of a victim satellite and its linked ground station, and an interfering satellite and its linked ground station. The victim satellite is visible from the victim ground station. The interfering satellite is visible from the victim ground station, and also from the interfering ground station. This is based on two key assumptions. First, that each satellite is pointing to its linked ground station. Pointing accuracy is currently not taken into account — Argus assumes perfect pointing. Second, that if a satellite is not visible from any of its associated ground stations, it is not transmitting any data.

After computing all the different visible satellite-ground station groups across the total simulation duration, Argus investigates all of the associated antenna beams of the group. To assess whether there is potential interference in space-to-earth (downlink) and earth-to-space (uplink) links, Argus first checks for frequency overlap between the victim and interfering beams of matching types: either both emitting or both receiving, for downlink and uplink respectively. At this stage of the analysis Argus has identified cases of potential interference.

8.2 Carrier-to-interference ratio

To assess the significance of the potential interference, Argus calculates the C/I. Specifically, the analysis identifies potential interference cases when the calculated C/I margin is negative:

$$\text{margin} = \text{C/I}_{\text{adjusted}} - \text{C/I}_{\text{required}}$$

The required C/I can be derived from the C/N based on the carrier type. C/N is the ratio of carrier to total noise power, which includes all internal system noise and interference from other systems. To calculate the C/N in the uplink case, we derive:

$$C/N_{\text{up}} = P_{\text{Tx ES Max}} + G_{\text{Tx ES Max}} + G(\theta)_{\text{Rx Sat}} - FSPL_{(\uparrow \text{Freq})} - \left(k + T_{\text{Sat}} + B_{(\uparrow \text{Emiss})}\right)$$

Where

$$C/N_{\text{up}} = P_{\text{Tx ES Max}} + G_{\text{Tx ES Max}} + G(\theta)_{\text{Rx Sat}} - FSPL_{(\uparrow \text{Freq})}$$

stands for the carrier power C, and

$$-\left(k + T_{\text{Sat}} + B_{(\uparrow \text{Emiss})}\right)$$

stands for the noise power, N.

To calculate the C/N in the downlink case, we derive, similarly:

$$C/N_{\text{down}} = P_{\text{Sat Max}} + G(\theta)_{\text{Tx Sat}} + G_{\text{Rx ES Max}} - FSPL_{(\downarrow \text{Freq})} - \left(k + T_{\text{ES}} + B_{(\downarrow \text{Emiss})}\right)$$

The adjusted C/I can be derived from the basic calculated C/I, $C/I_b(\text{dB})$, by subtracting the interference adjustment factor:

$$C/I = C/I_b - I_a$$

To calculate the C/I, we define the following:

Carrier power:

$$C_L(\text{dBW}) = P_r + G_r + G_R - FSPL$$

Noise power:

$$N(\text{dB}) = T + BW + k$$

Interference power:

$$I(\text{dBW}) = P + G_R + G_r - FSPL$$

Then, to calculate the C/I in the uplink case:

$$\begin{aligned} C\uparrow &= P_{\text{Tx ES Max}} + G_{\text{Tx ES Max}} + G(\theta)_{\text{Rx Sat}} - FSPL_{(\uparrow \text{Freq})} \ (\text{dBW}) \\ I\uparrow &= P'_{\text{ES Max}} + G'(\varphi)_{\text{Tx ES}} + G(\theta')_{\text{Rx Sat}} - FSPL'_{(\uparrow \text{Freq})} \ (\text{dBW}) \\ C/I\uparrow &= C\uparrow - I\uparrow \ (\text{dB}) \end{aligned}$$

and, similarly, for the downlink:

$$\begin{aligned} C\downarrow &= P_{\text{Sat Max}} + G(\theta)_{\text{Tx Sat}} + G_{\text{Rx ES Max}} - FSPL_{(\downarrow \text{Freq})} \ (\text{dBW}) \\ I\downarrow &= P'_{\text{Sat Max}} + G'(\varphi)_{\text{Tx Sat}} + G(\theta')_{\text{Rx ES}} - FSPL'_{(\downarrow \text{Freq})} \ (\text{dBW}) \\ C/I\downarrow &= C\downarrow - I\downarrow \ (\text{dB}) \end{aligned}$$

Gain calculations involve the antenna pattern, which means there are three distinct cases:

1. Gain calculations using an ITU pattern ID
2. Gain calculations using a user-supplied antenna pattern
3. Gain calculations without antenna pattern information

CHAPTER 09

Support

For further inquiries and engineering support:

FULL NAME	TITLE	EMAIL ADDRESS
Orestis Ousoultzoglou	Co-Founder & CTO	orestis.ousoultzoglou@oodes.space

WHILE OTHERS CELEBRATE THE STARS, WE PRAISE THE GROUND
THAT MADE REACHING THEM POSSIBLE.