



# OKAPI ORBITS

Making NewSpace Safer  
Space Traffic Management



Reverse Calibration of SST Networks  
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## Activity Objective

### SSN Calibration

- Offer users the ability to select from a list of pre-defined and pre-calibrated sensor networks to evaluate the trackability of their satellite mission.
- For this, a list of sensors needs to be defined and calibrated to achieve tracking performance as close as possible to the real network.
- Get a reasonable answer that might not be precise.
- Reverse calibration as an experimental approach to investigate how well OD accuracy can be simulated:
  - Given general sensor performance characteristics.
  - Respecting non-disclosure constraints of the network by using only publicly available information.



# SSN Calibration Experimental Analysis

Initial network calibration was performed for the US SSN radar network.

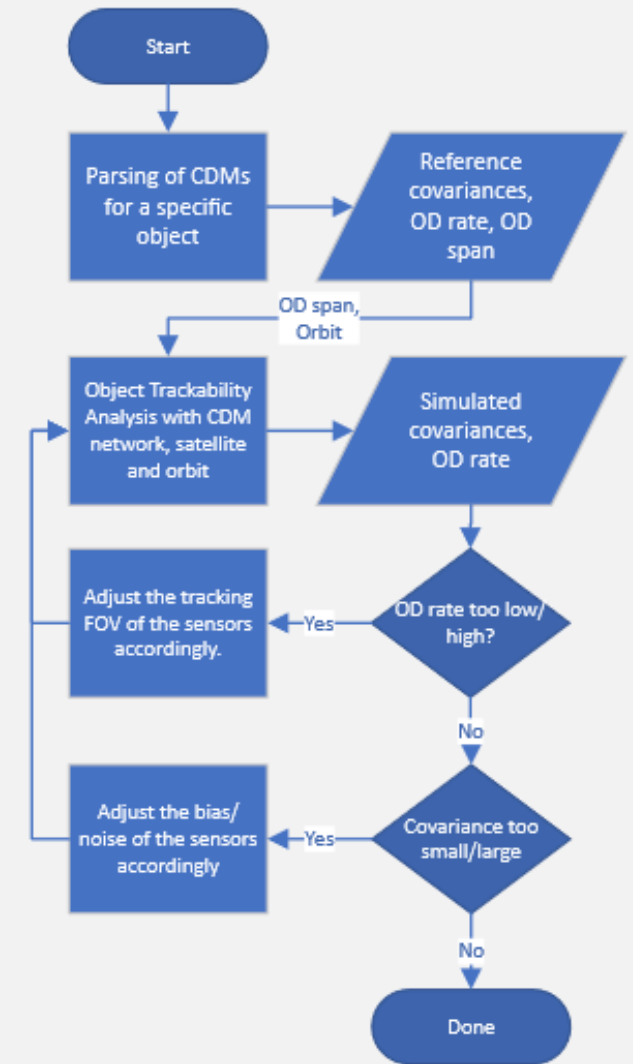
The goal is to calibrate for the covariance at TCA, or as close as possible to reduce the impact of covariance propagation.

Using publicly available information to assume multiple radar locations and sensor performance specifications.

CDMs were analyzed to determine a reference covariance.

Without the number of tracks in the CDMs, it is difficult to determine whether the number of crossings is correct.

Tuning of the sensor noise terms to calibrate the network.



Network calibration workflow.

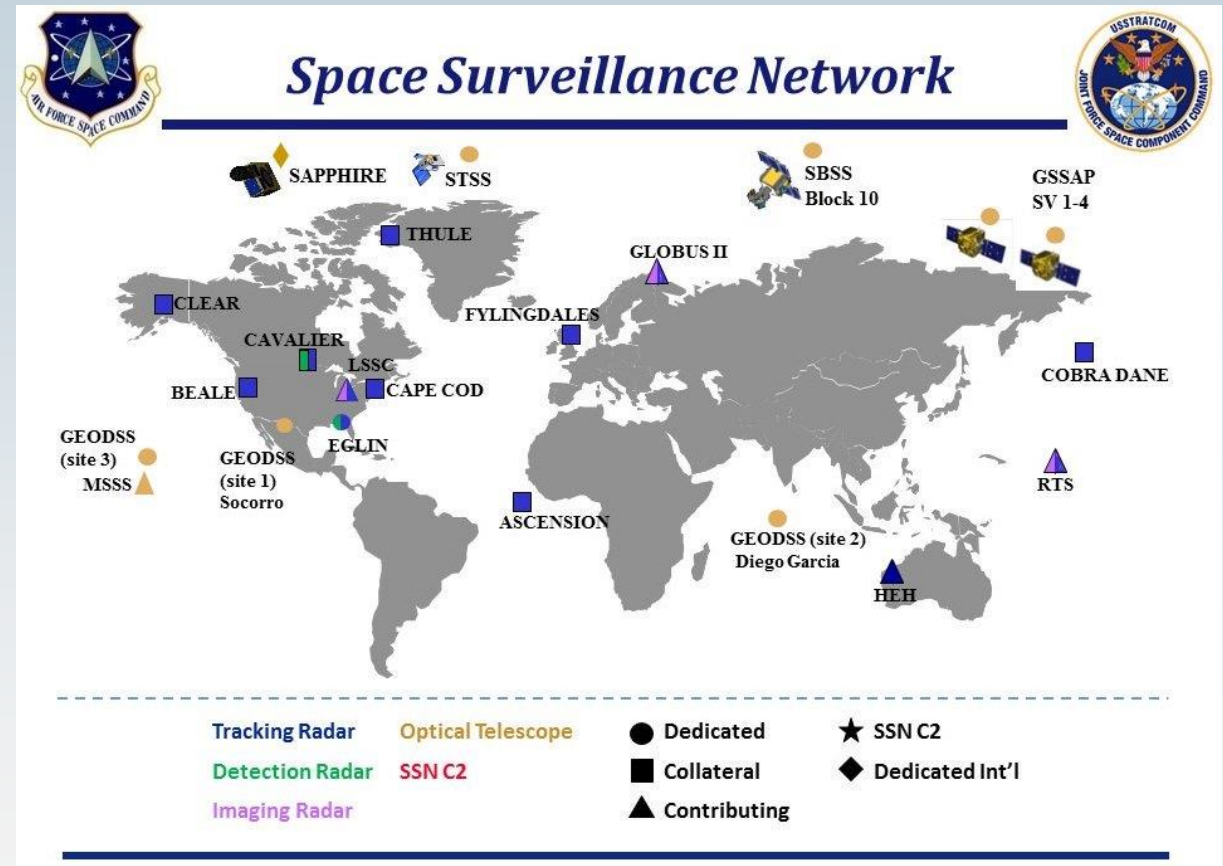
# SSN Calibration Experimental Analysis

Started calibration: using US-SSN radar network as a starting point.

Each radar station was set as an EGLIN phased array radar.

```
"userSensorNetwork": [  
  {  
    "name": "CAVALIER",  
    "id": "979a2b11-8171-4e88-926f-49c693fbc997",  
    "enableSwitch": true,  
    "designator": "EGLIN",  
    "spacebased": false,  
    "lightPollutionSwitch": false,  
    "sensorLocation": {  
      "geodeticLongitude": 38.0,  
      "geodeticLatitude": -97.0,  
      "geodeticAltitude": 0.0  
    }  
  },  
  {  
    "name": "CLEAR",  
    "id": "979a2b11-8171-4e88-926f-49c693fbc997",  
    "enableSwitch": true,  
    "designator": "EGLIN",  
    "spacebased": false,  
    "lightPollutionSwitch": false,  
    "sensorLocation": {  
      "geodeticLongitude": 38.0,  
      "geodeticLatitude": -97.0,  
      "geodeticAltitude": 0.0  
    }  
  }  
]
```

Network configuration in the input JSON.

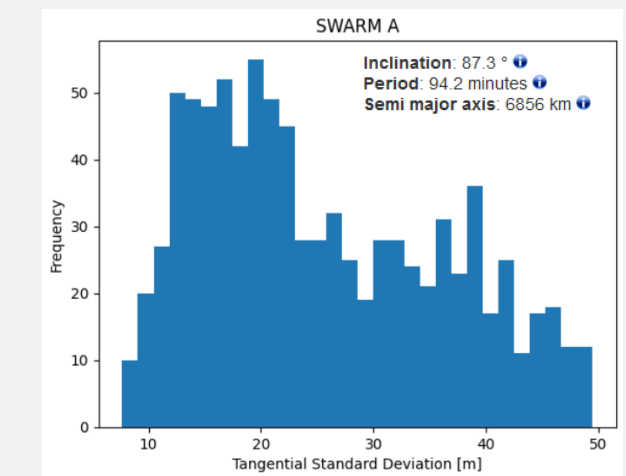
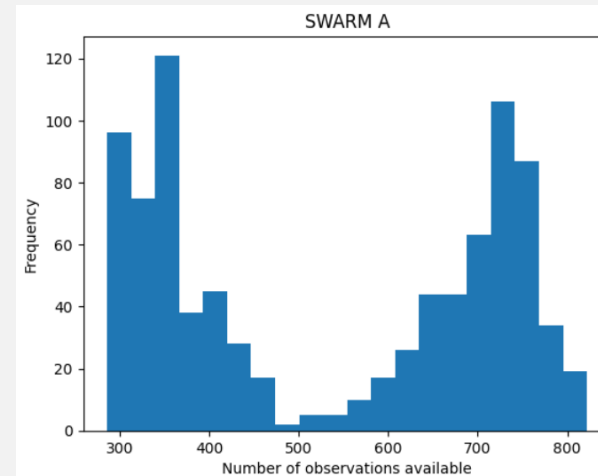
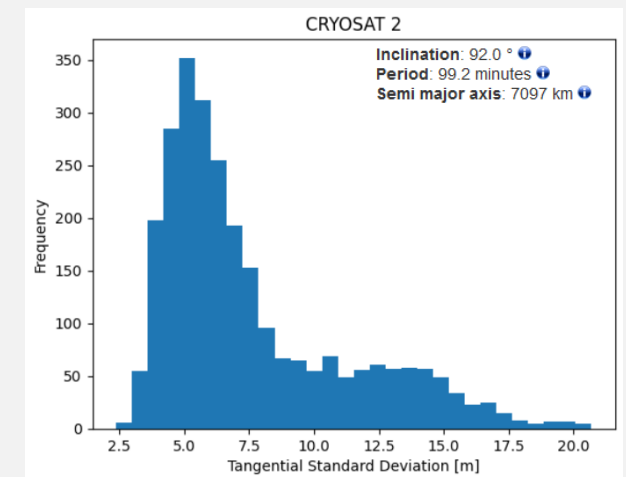
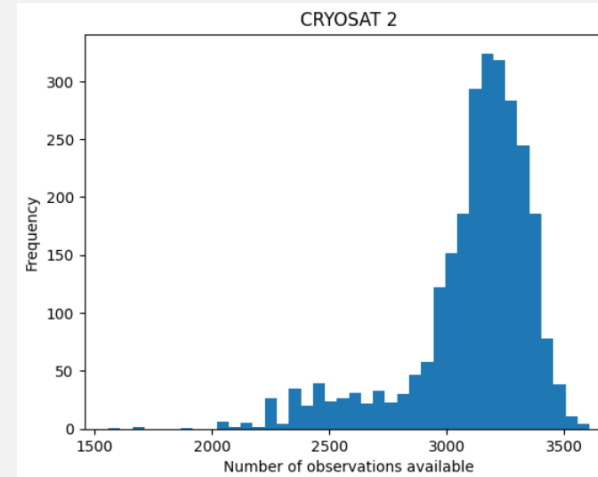


Visualization of the US-SSN.

# SSN Calibration

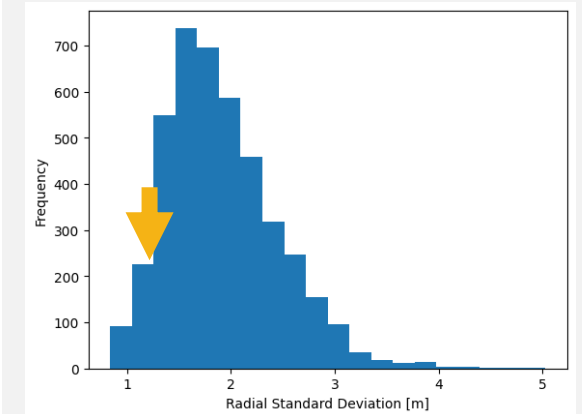
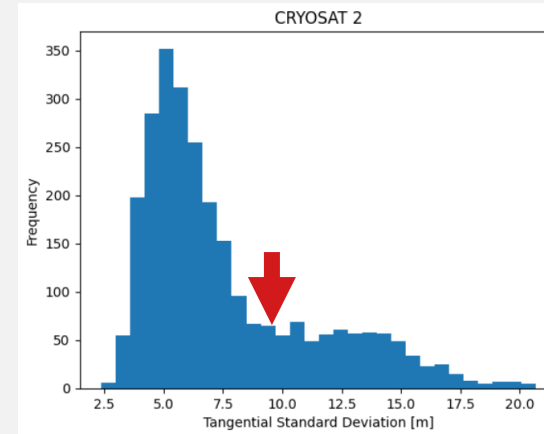
## Experimental Analysis

- Parsing of CDMs to generate “target covariances”.
- Provides insight into the number of observations and OD span.
- CDMs do not contain the number of tracks.
  - Calibrating the number of observations is challenging as a result.
- Despite “similar” orbits and OD spans:
  - Significantly different number of observations (tracks).
  - Large deviation in the tangential standard deviation.
  - In the workflow results in almost identical covariances.



# SSN Calibration Experimental Analysis

- The sensor network was calibrated using CRYOSAT 2 CDMs.
- The resulting trackability covariances are within the distribution found in the provided CDMs.
- The OD covariance was propagated for the same average time to TCA of the CDMs which was 0.15 days.
- No sensitivity analysis has been performed.



Covariance from the CDM analysis.

```
▼ results:  
  ► crossingResults: {}  
  ► detectionResults: {}  
  ► trackabilityResults: {}  
  ▼ covarianceResults:  
    radial_variance: 0.0000013712011858562087  
    tangential_variance: 0.00008924300497881285  
    normal_variance: 6.007468645453176e-7  
    radial_sd_meter: 1.1709829998152017  
    tangential_sd_meter: 9.446851590811239  
    normal_sd_meter: 0.7750786182996648  
    trackable: true  
  markups: []  
  logs: []  
  analysisModule: "assessment_workflow"  
                  "Finished"
```

Object Trackability Analysis test result JSON.

Thank you for your attention