

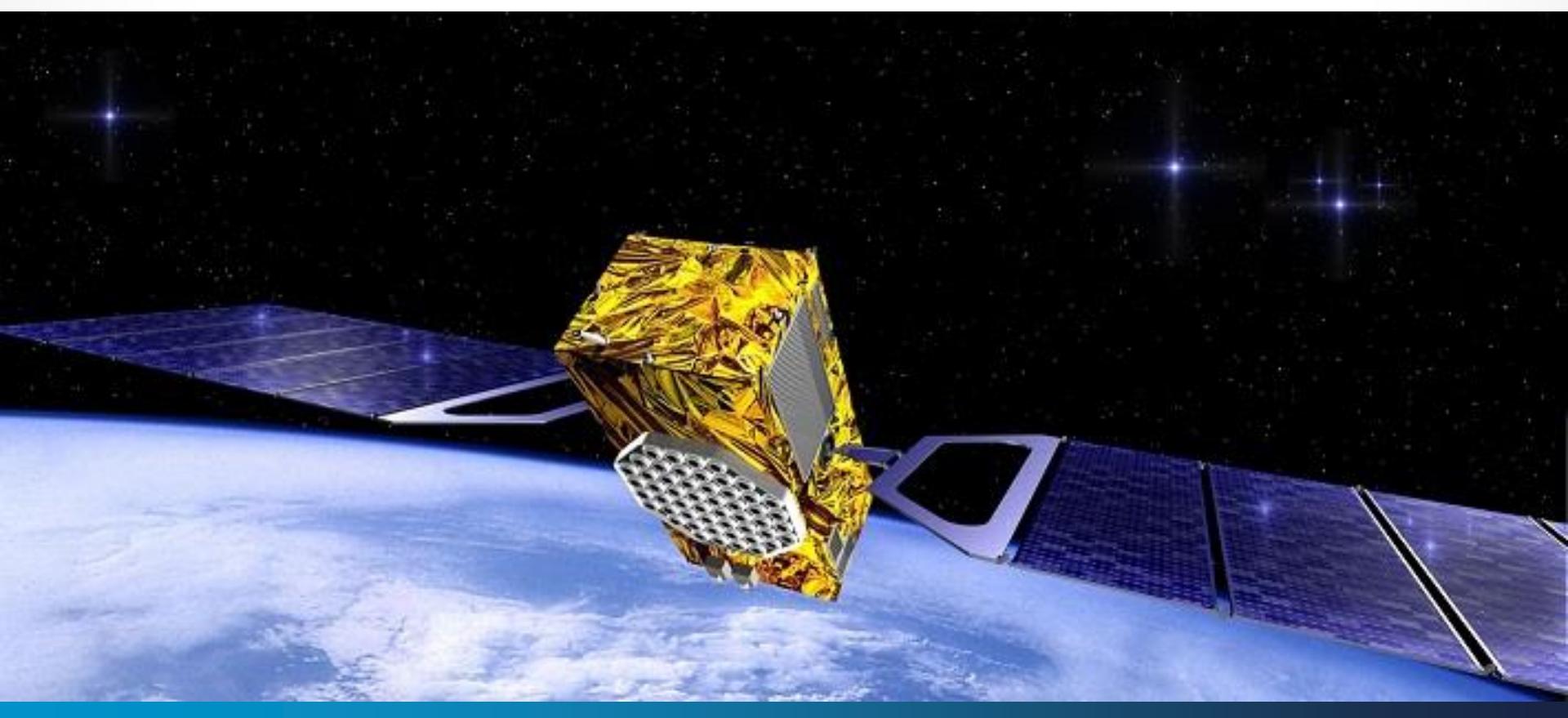


Kartverket

Galileo orbit performance monitoring with Where

M. Dähnn, G. A. Hjelle, A.-S. Kirkvik, I. Fausk, M. Ouassou, A. M. Solberg

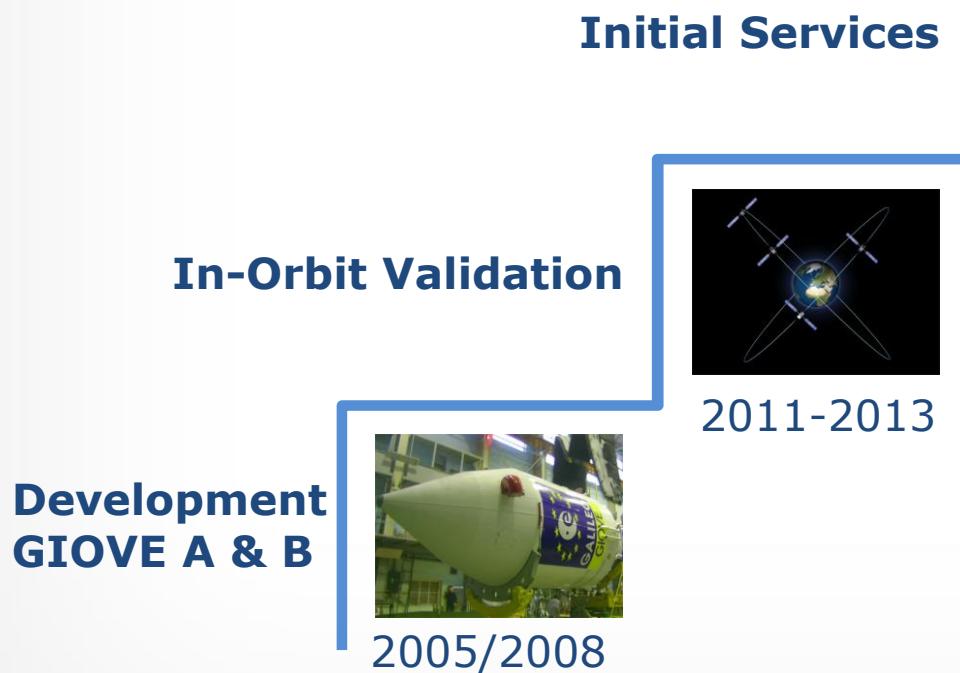
NKG General Assembly, Helsinki, 6. September 2018



Part I

Background

Galileo deployment



Galileo deployment



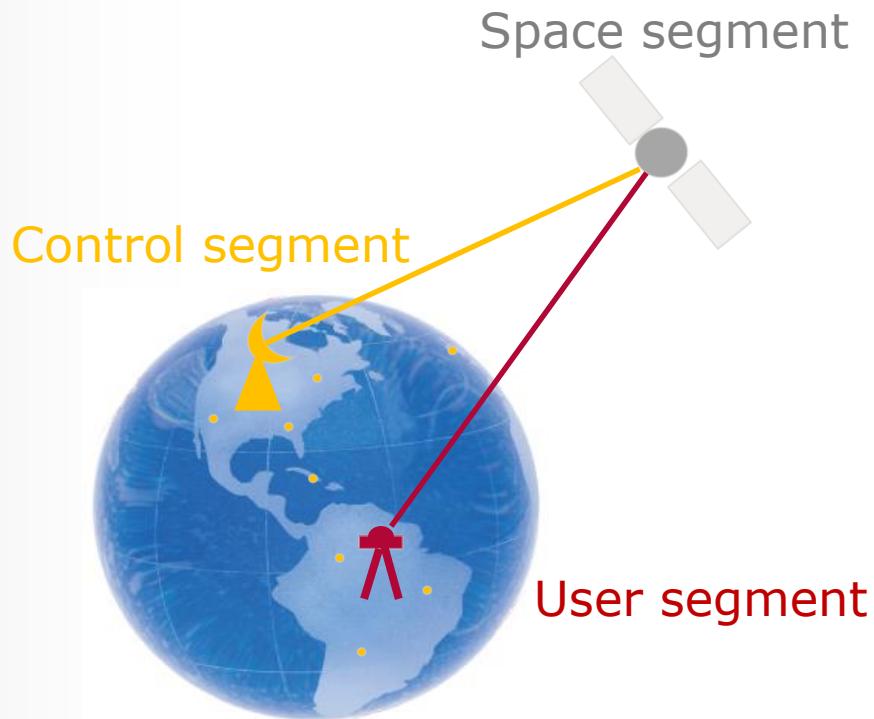
Galileo deployment



Galileo deployment



Motivation – Galileo performance monitoring



- testing and verifying the initial services
- detecting anomalies (satellite faults)
- ensure the provision of high quality satellite data to users
- signal-in-space range error is a key performance indicator used from all GNSS

Part II

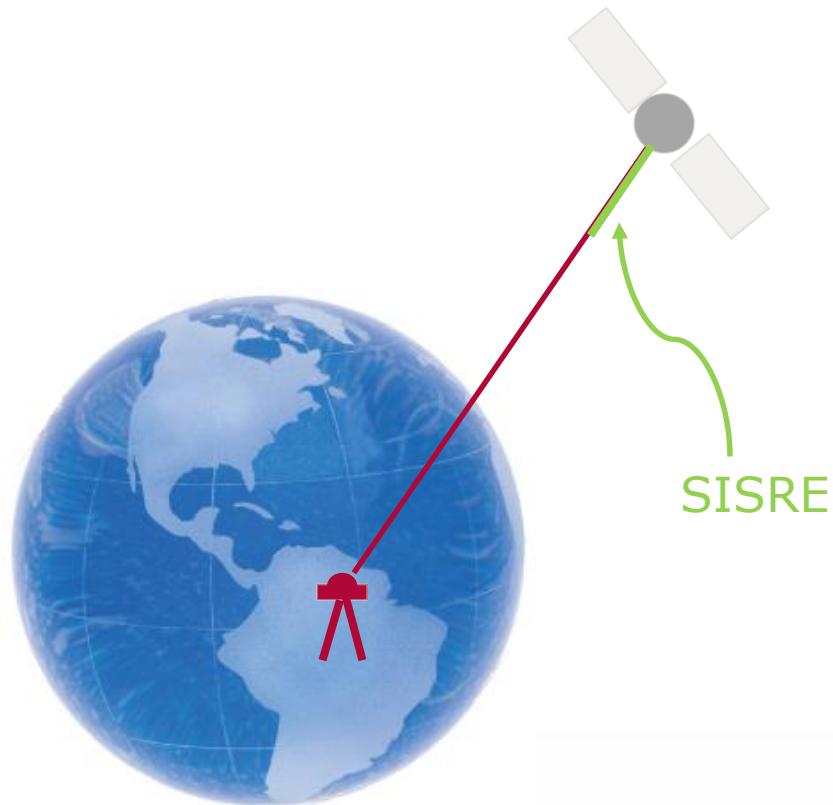
What is signal-in-space range error
(SISRE)?

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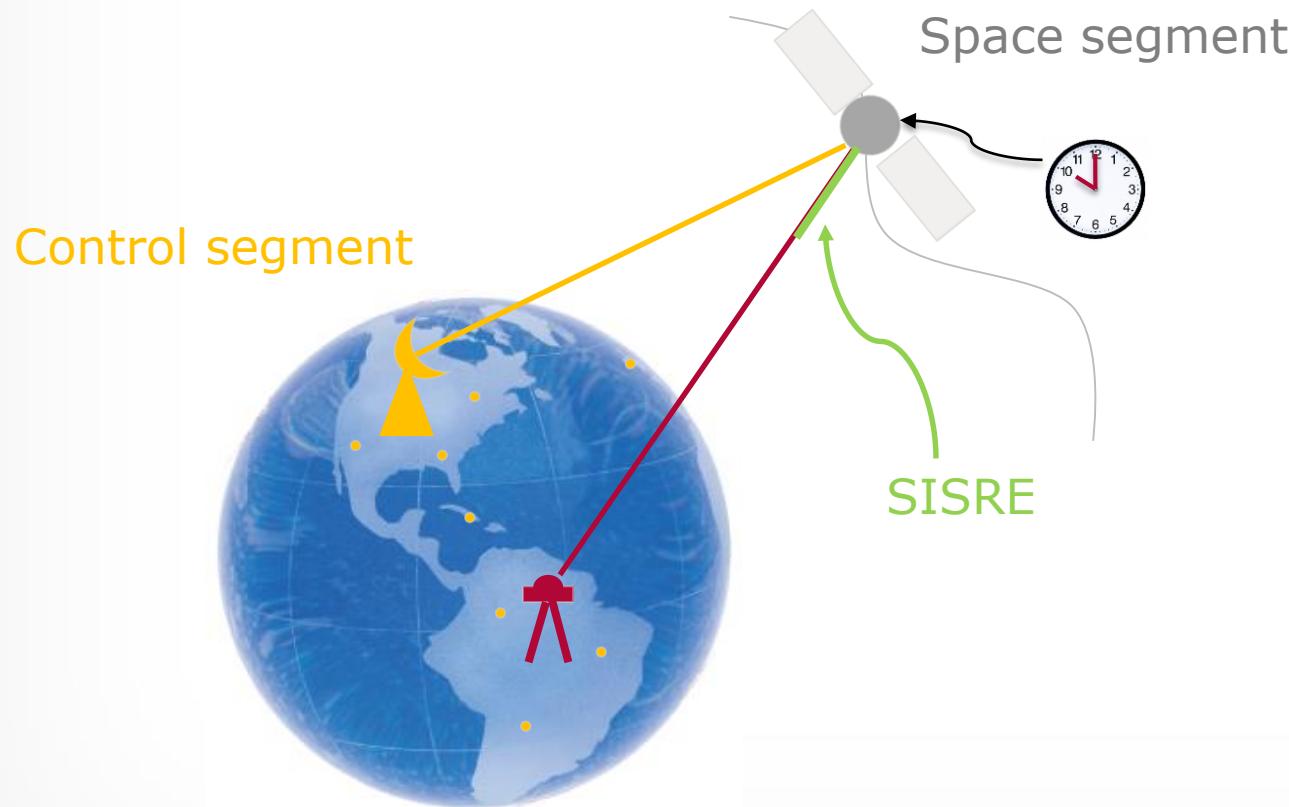
What is signal-in-space range error (SISRE)?

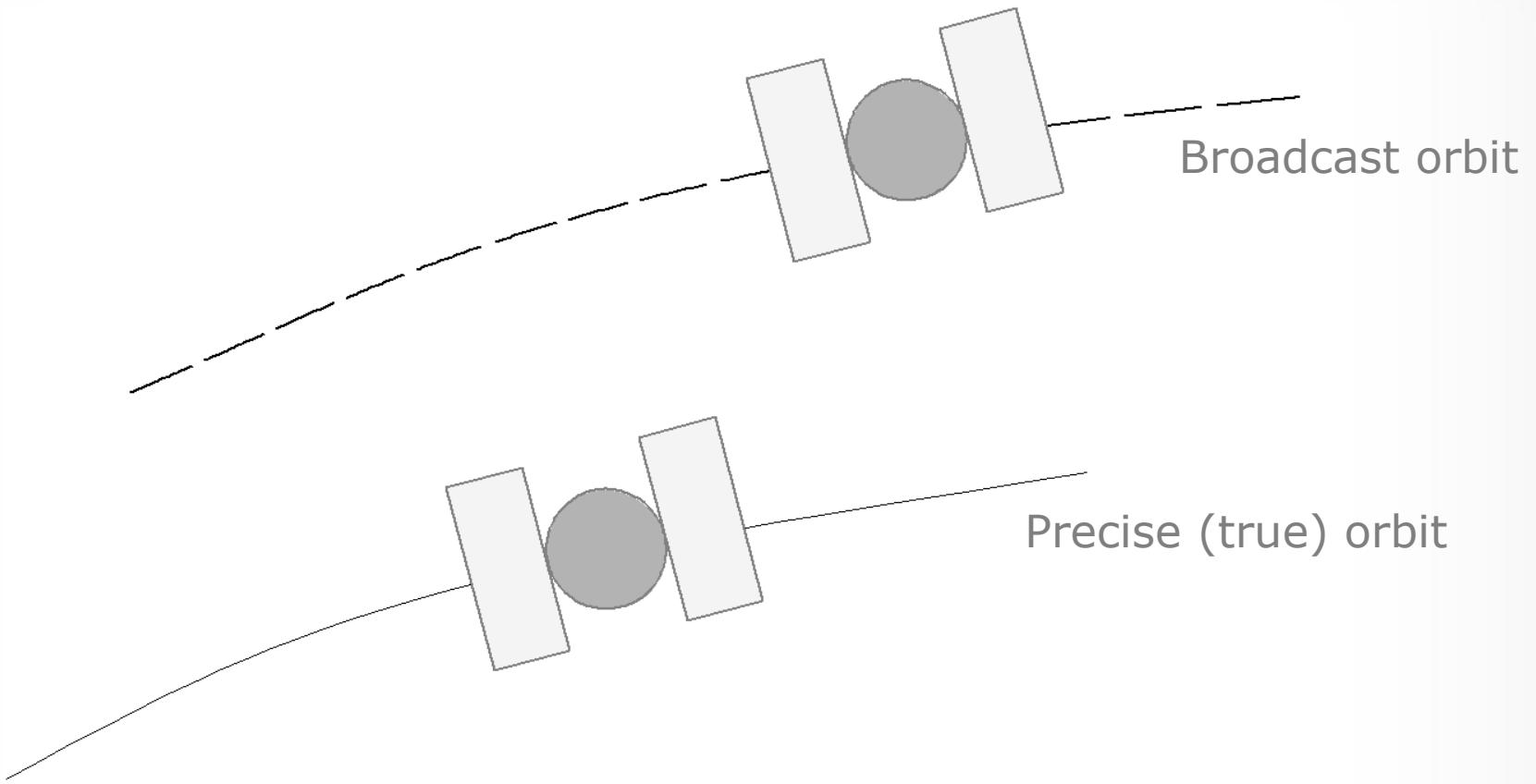
SISRE: Statistical uncertainty of the modeled pseudorange related to errors in the broadcast orbit and clock information.

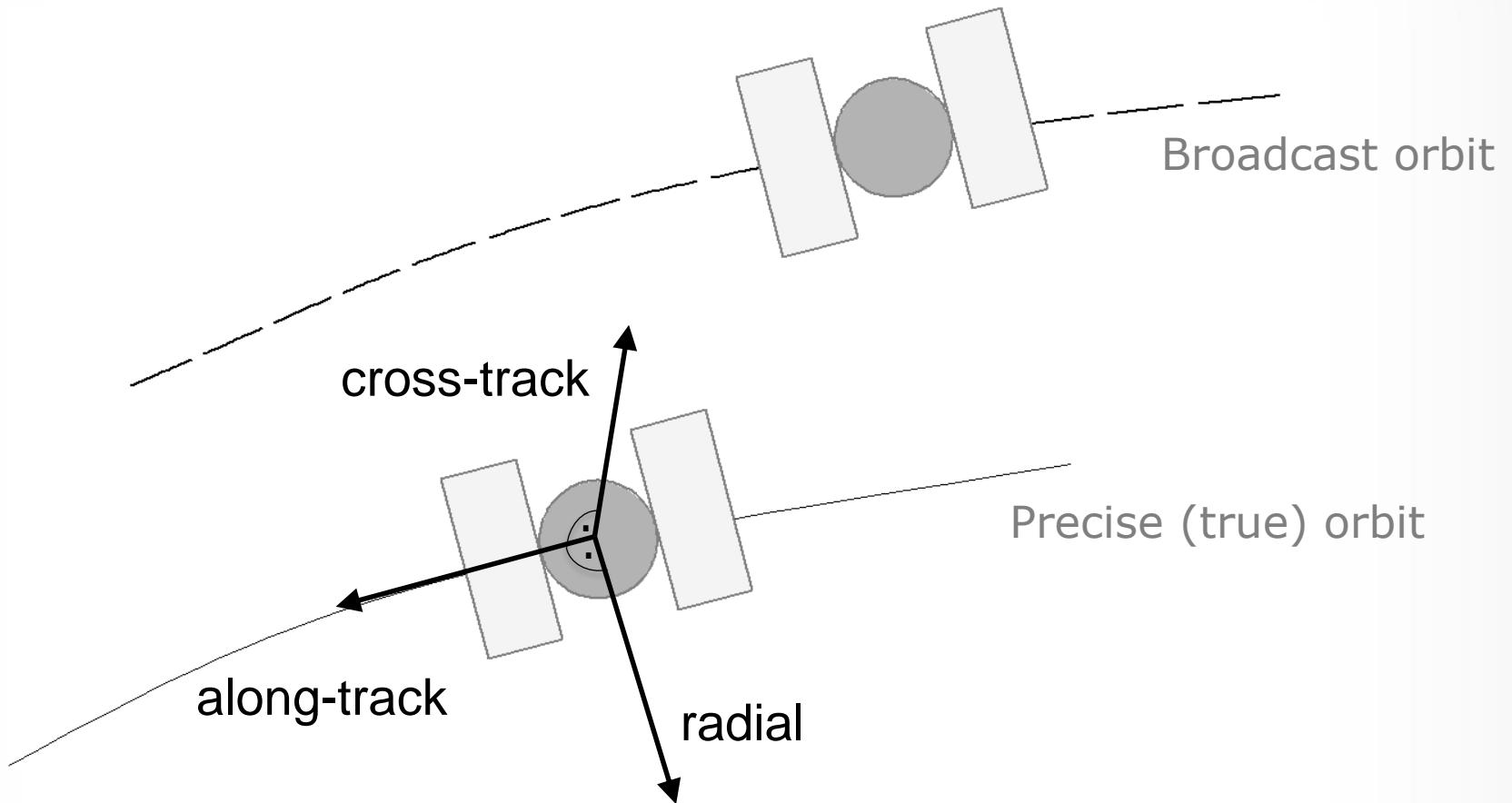


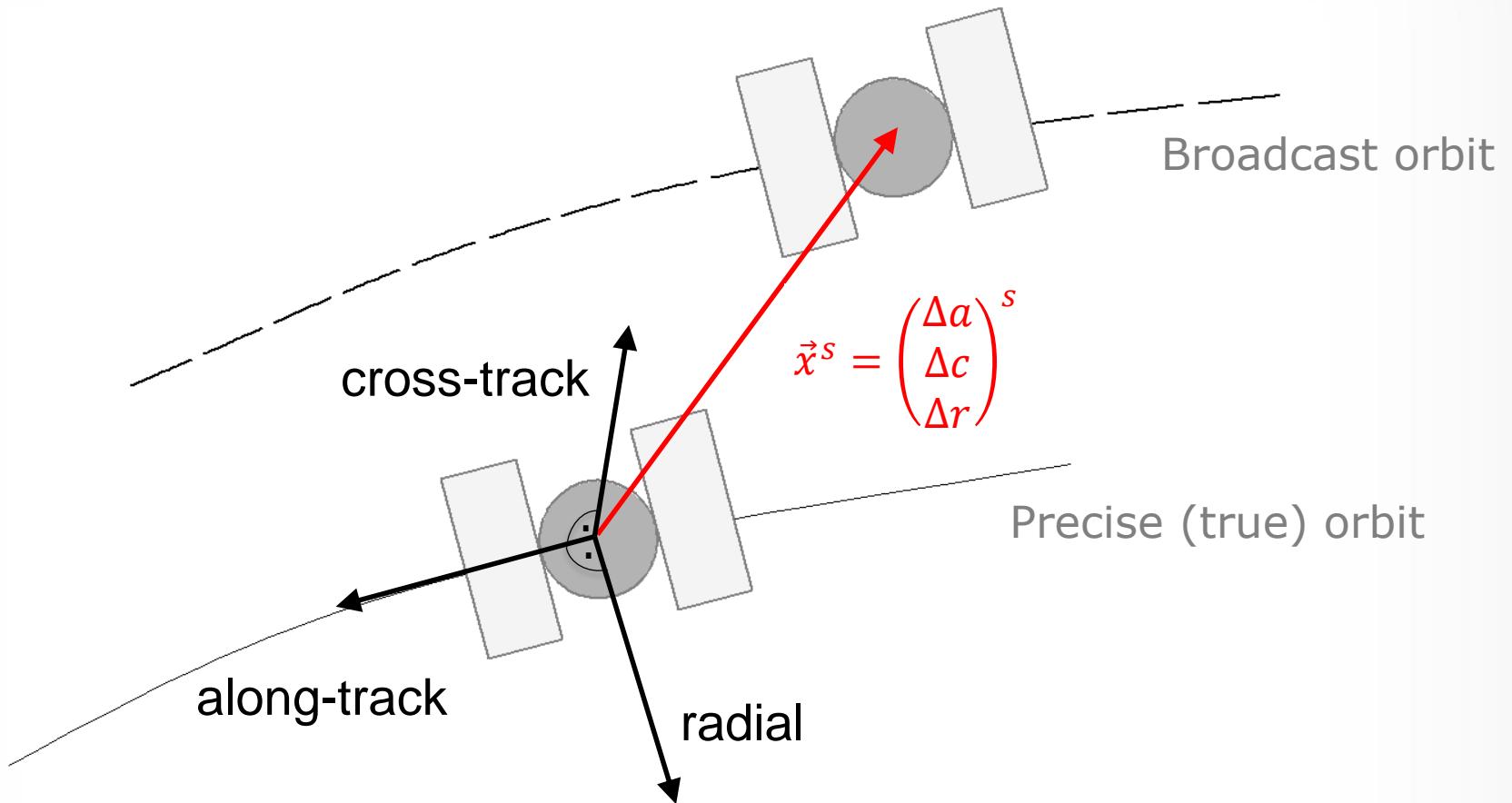
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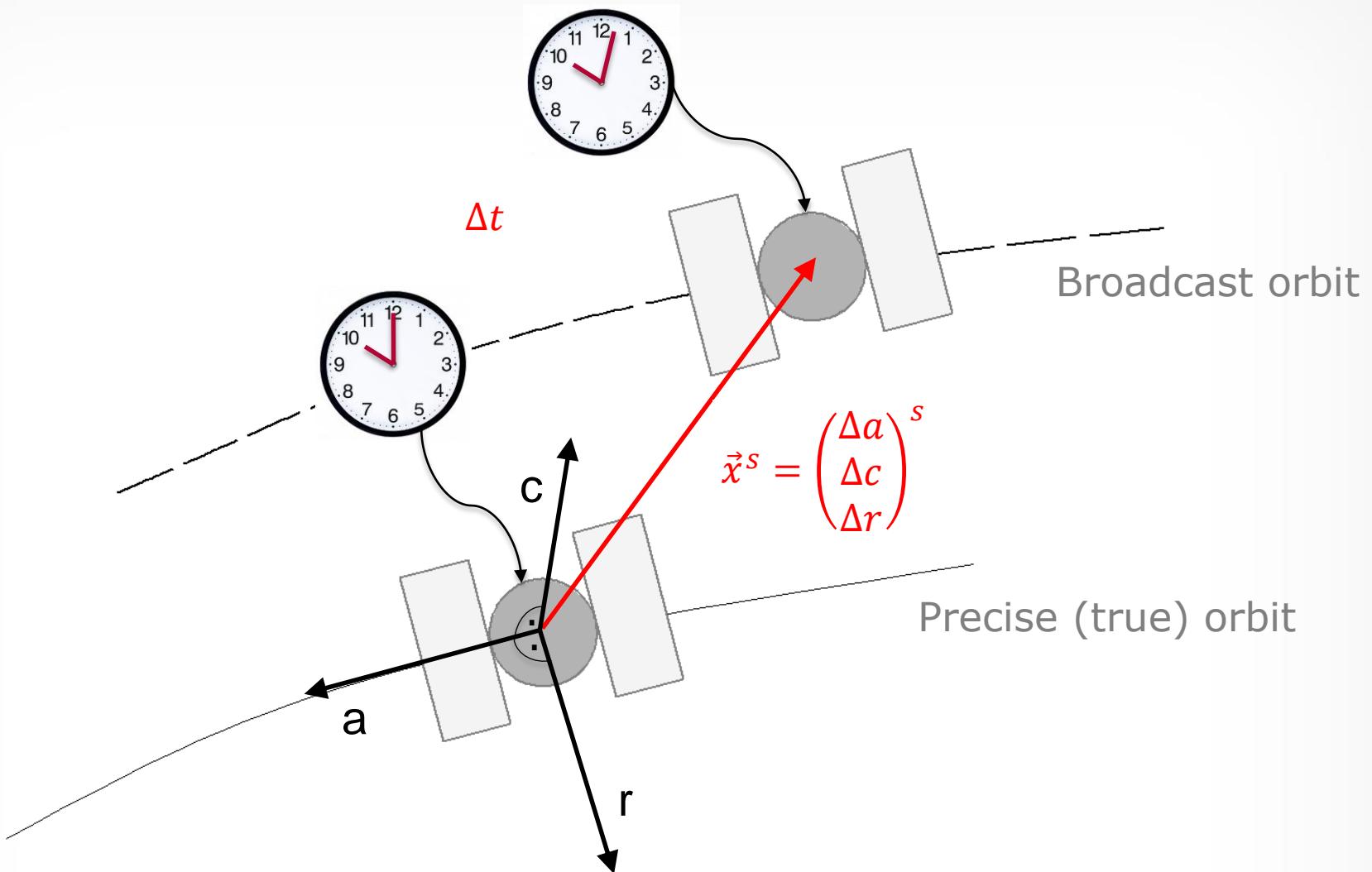
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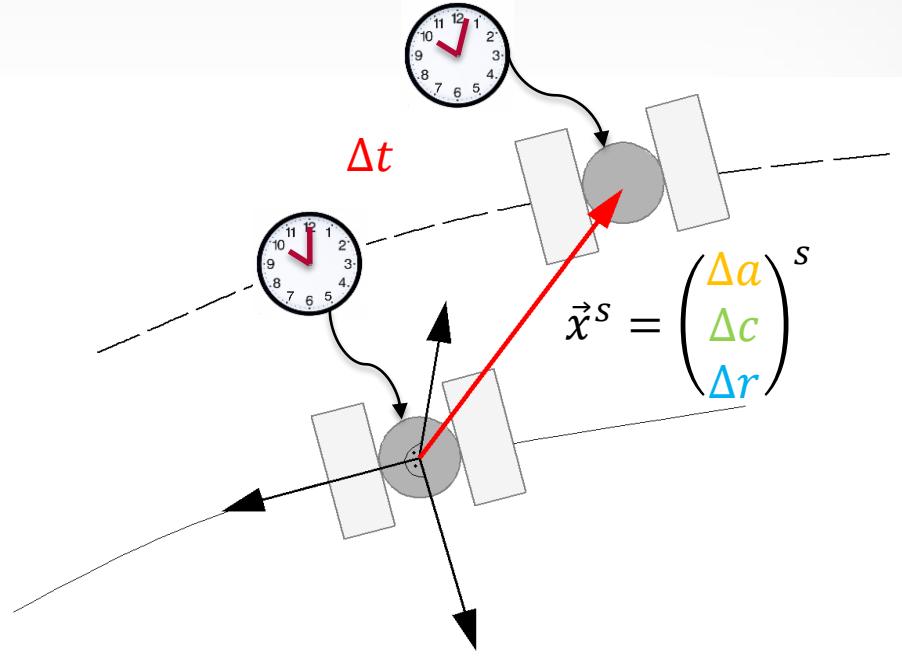




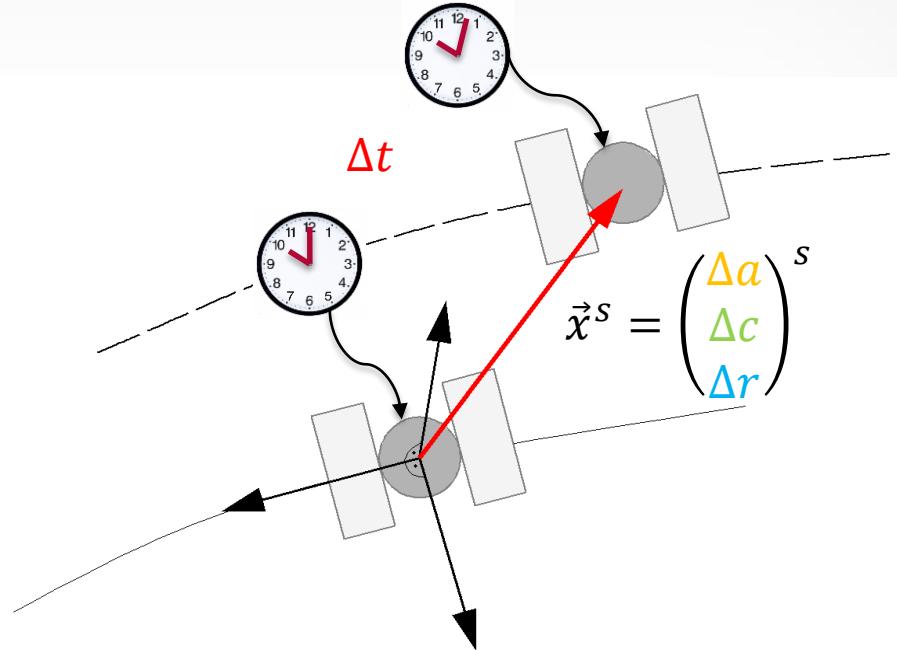




SISRE computation

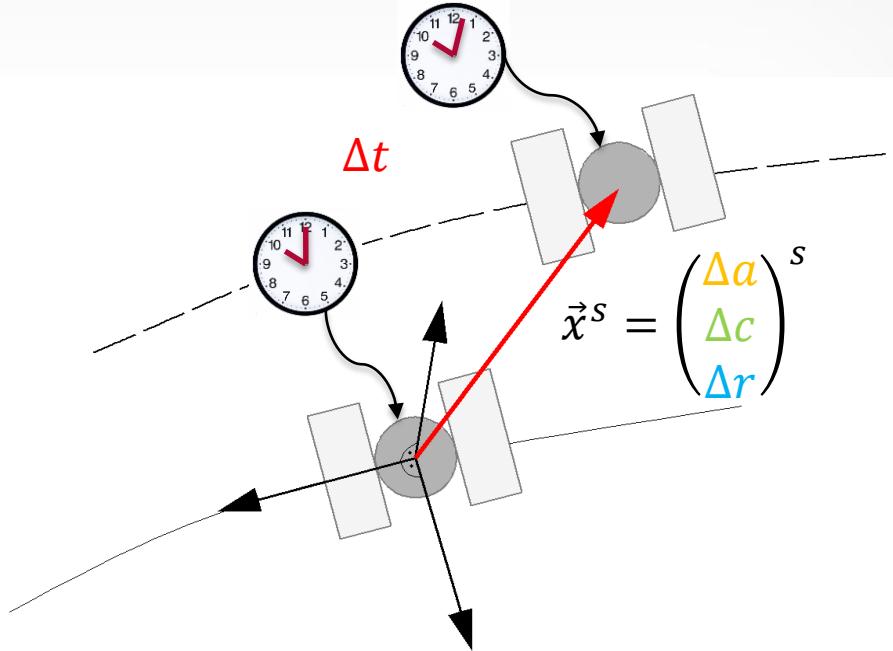


SISRE computation



$$SISRE = \sqrt{(w_r \cdot \Delta r - \Delta t)^2 + w_{a,c}^2 \cdot (\Delta a^2 + \Delta c^2)}$$

SISRE computation



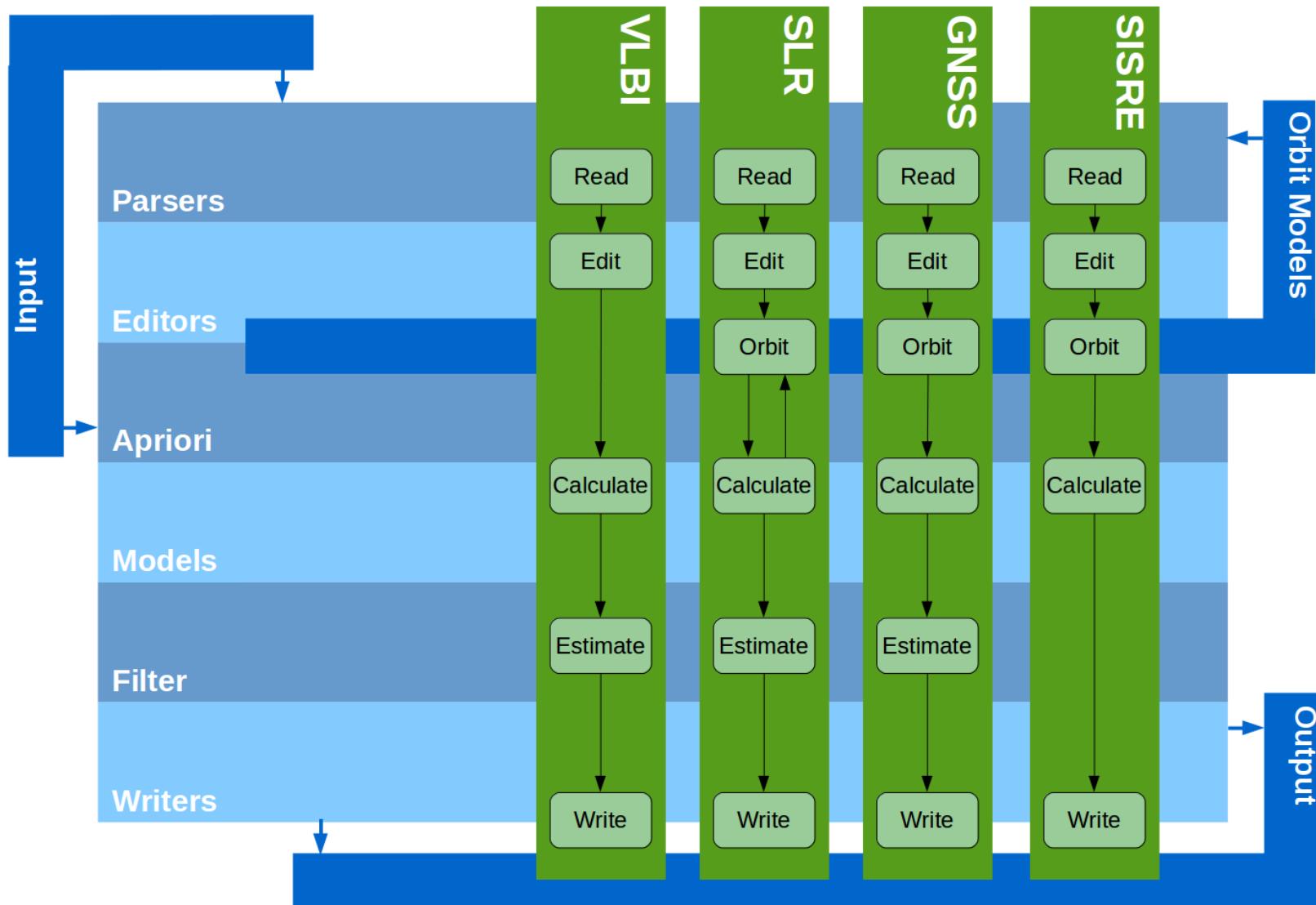
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weight factors

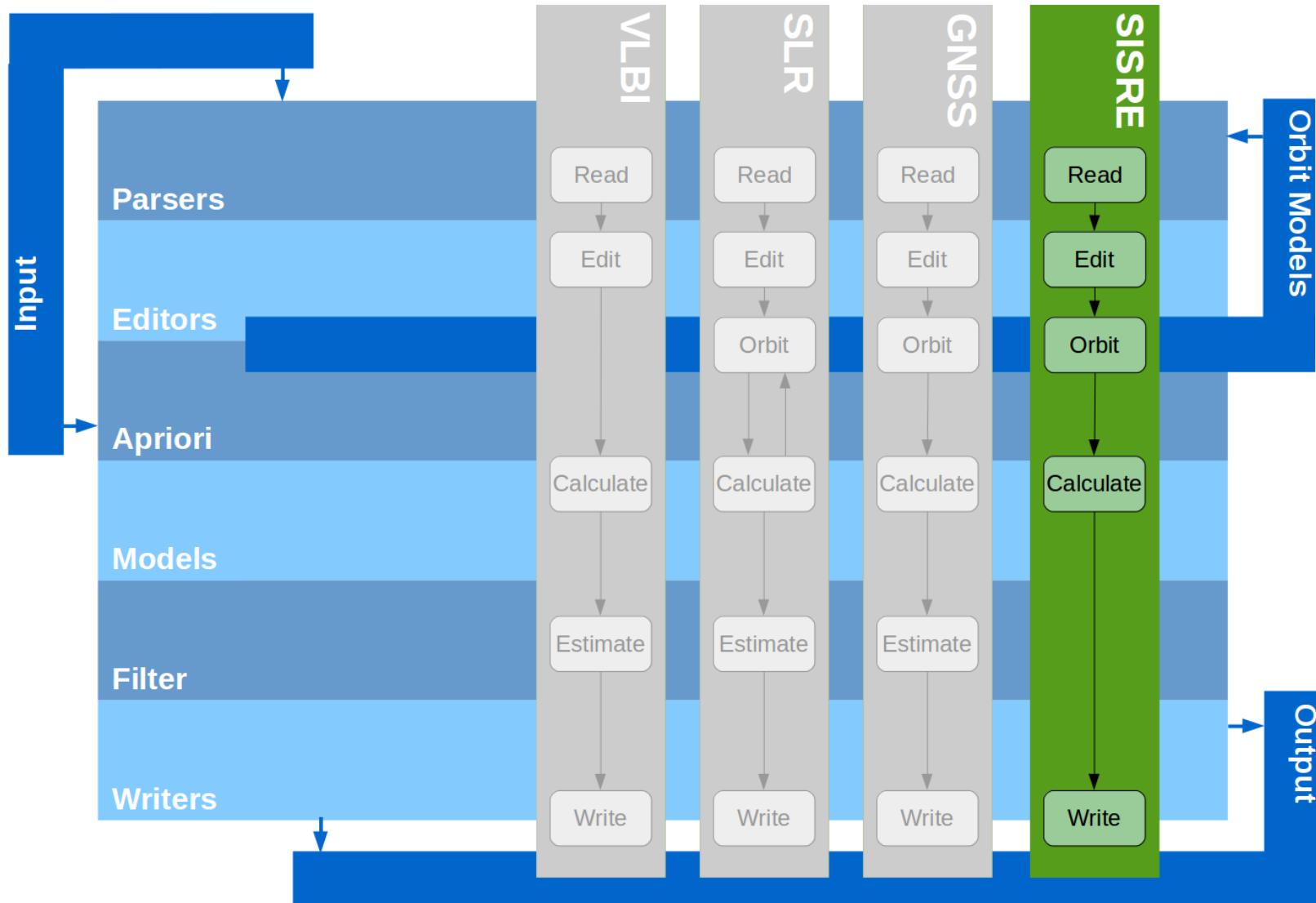
Part III

SISRE implementation in Where

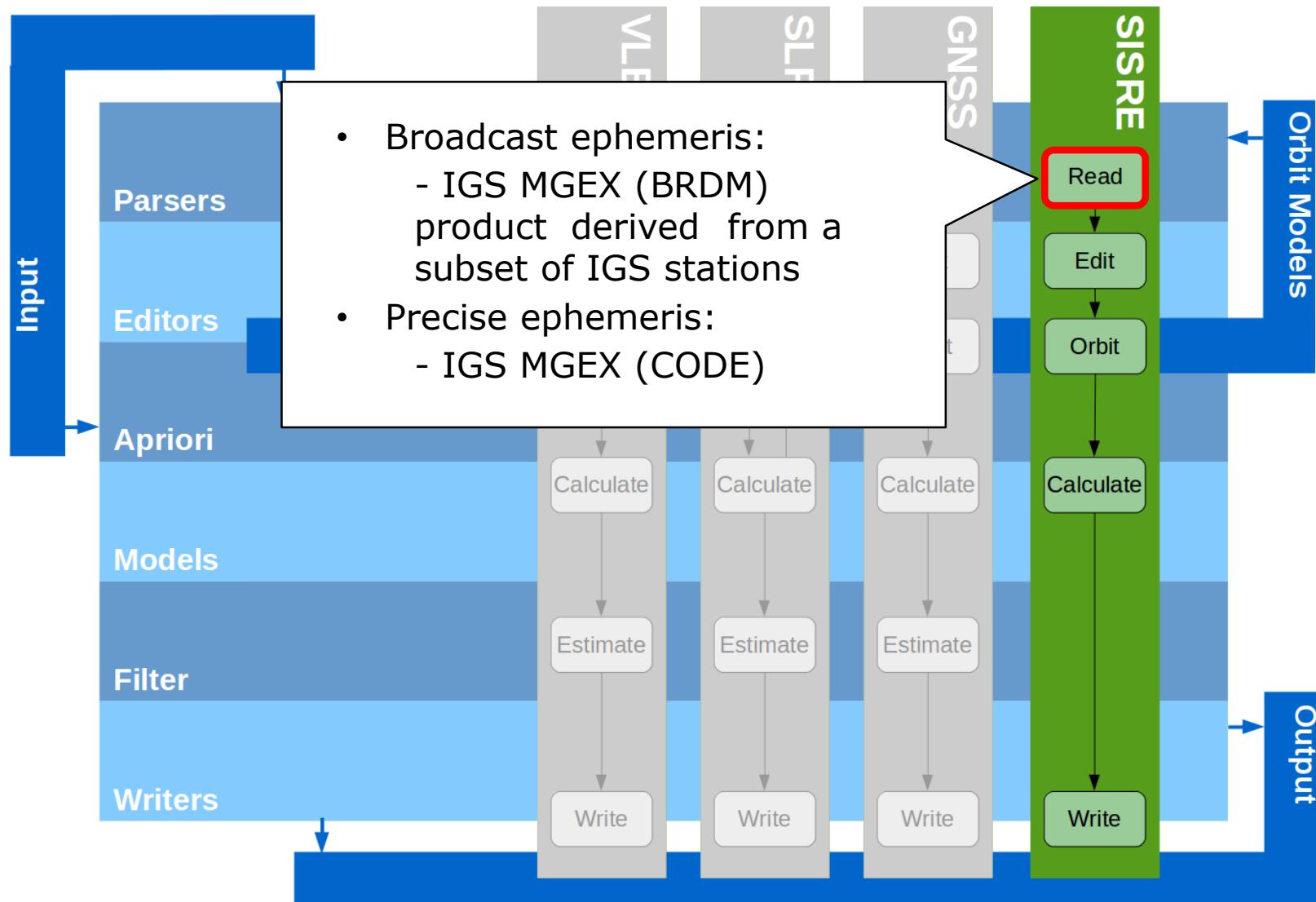
SISRE implementation in Where



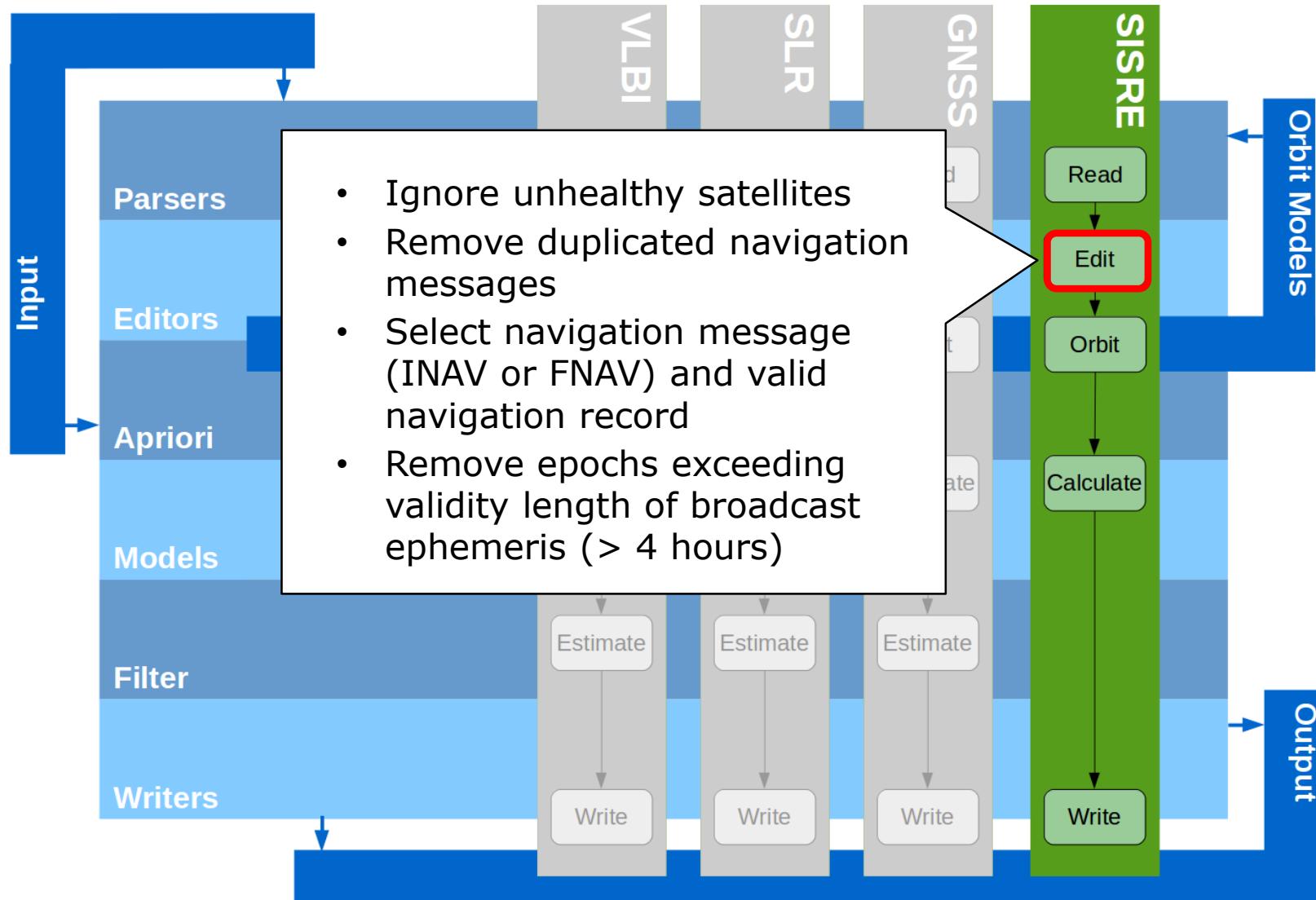
SISRE implementation in Where



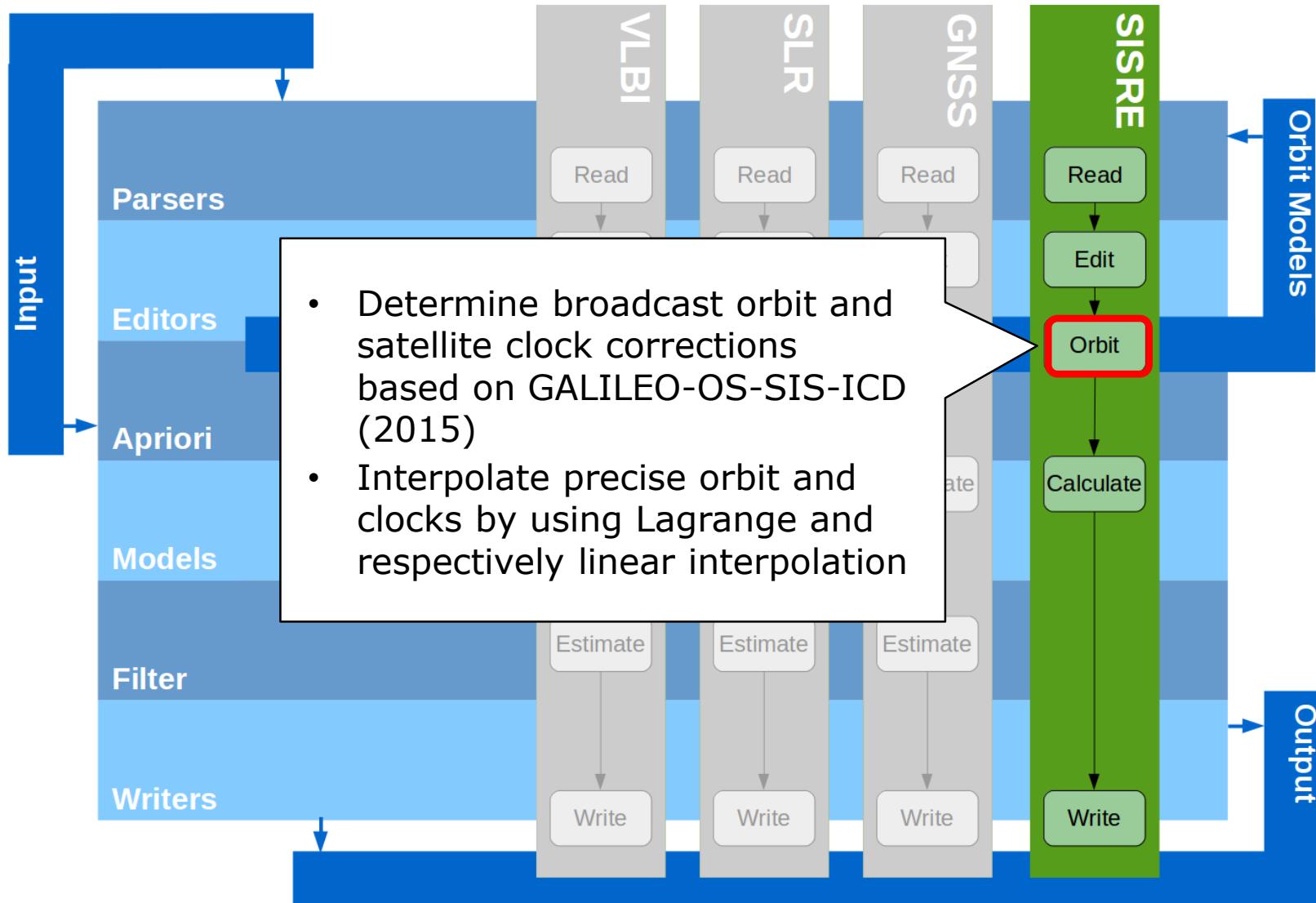
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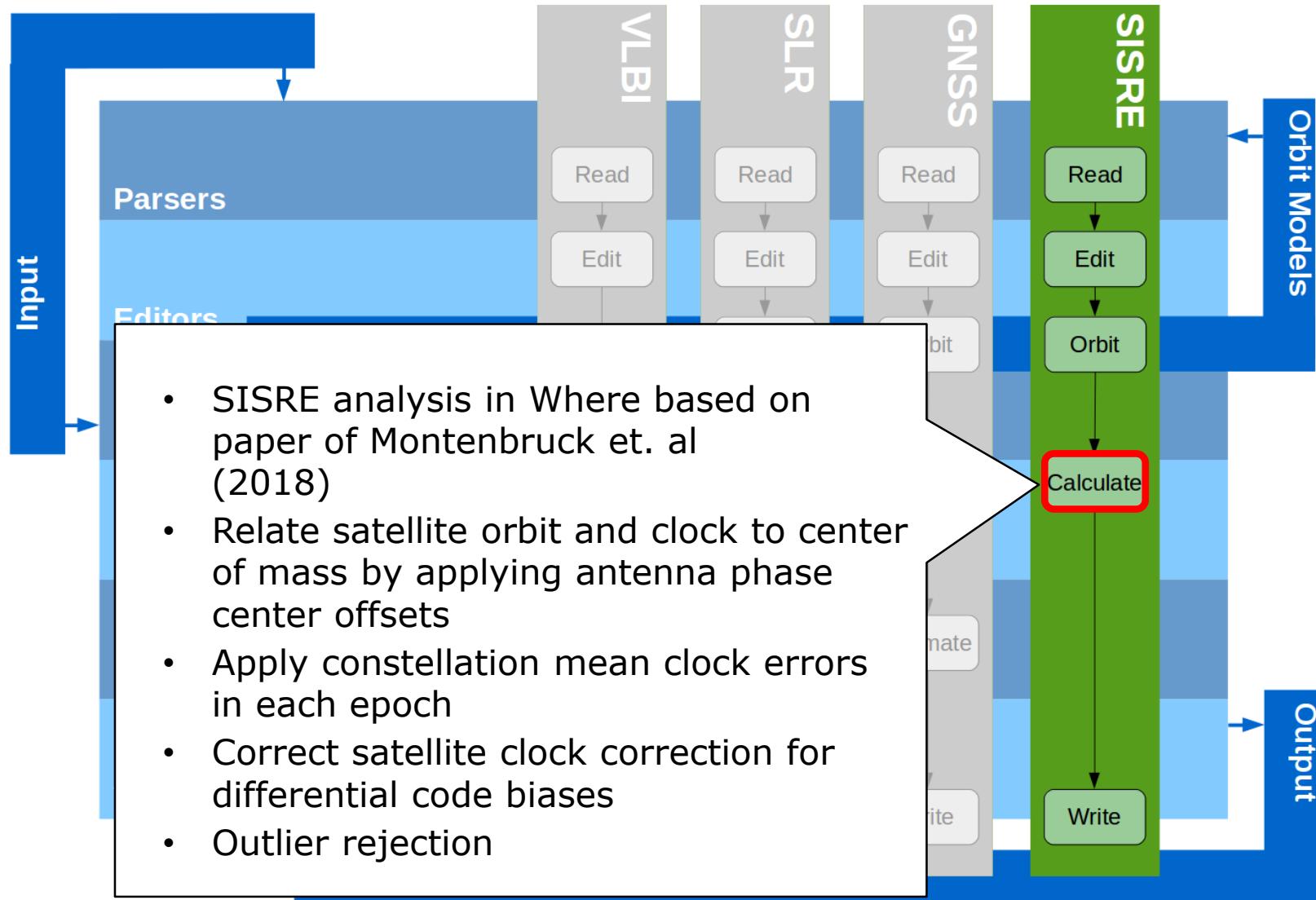
SISRE implementation in Where



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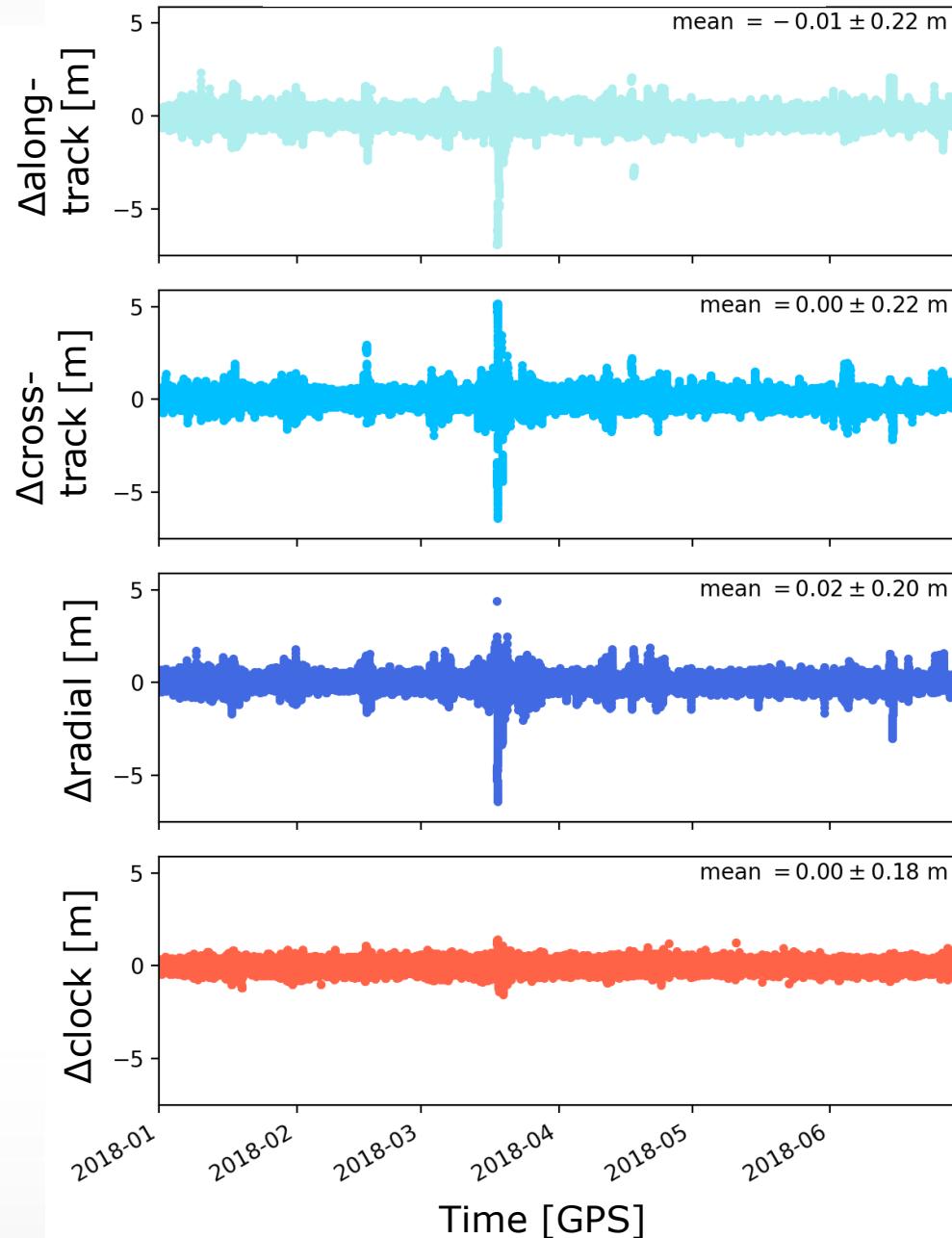
SISRE implementation in Where



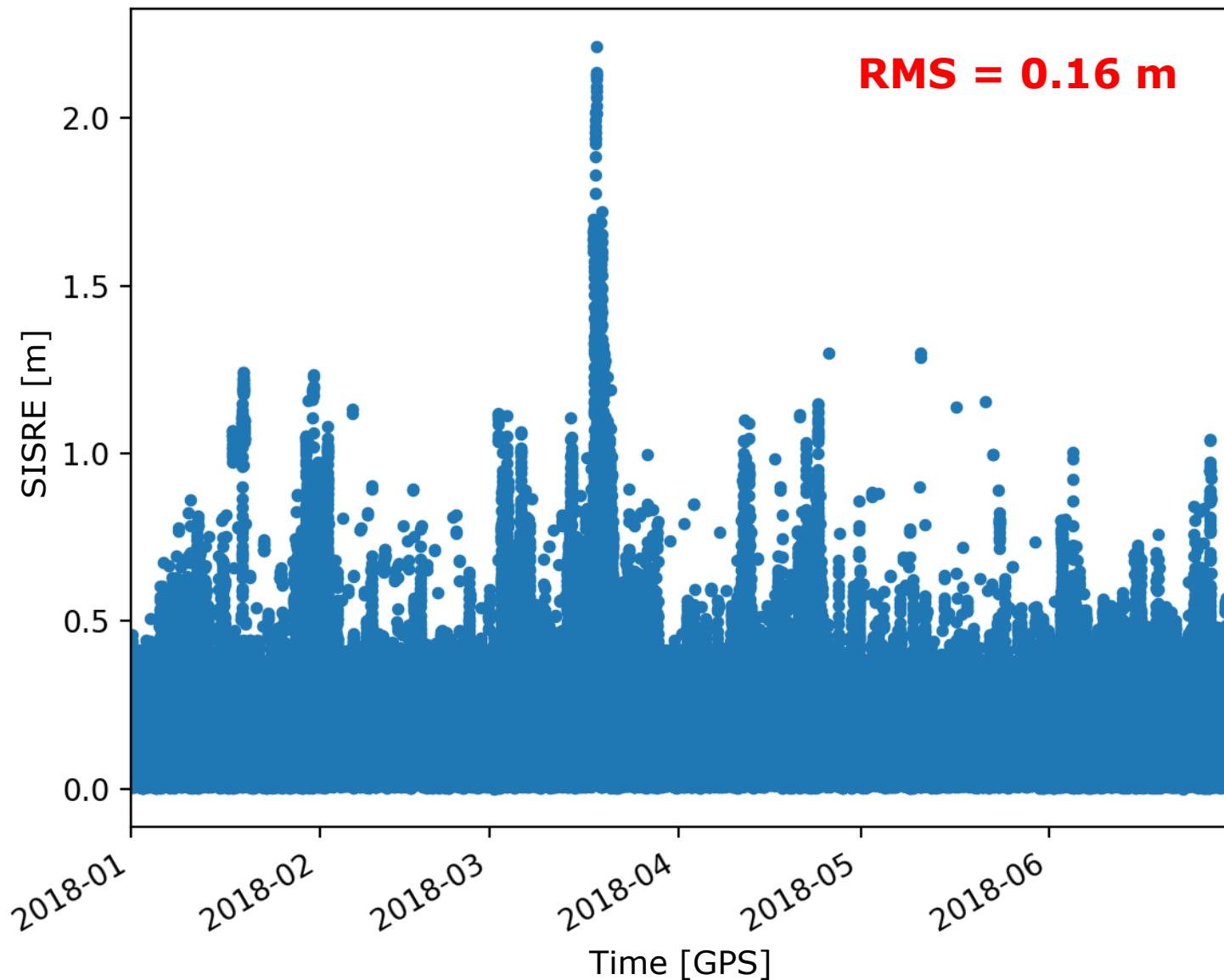
Part IV

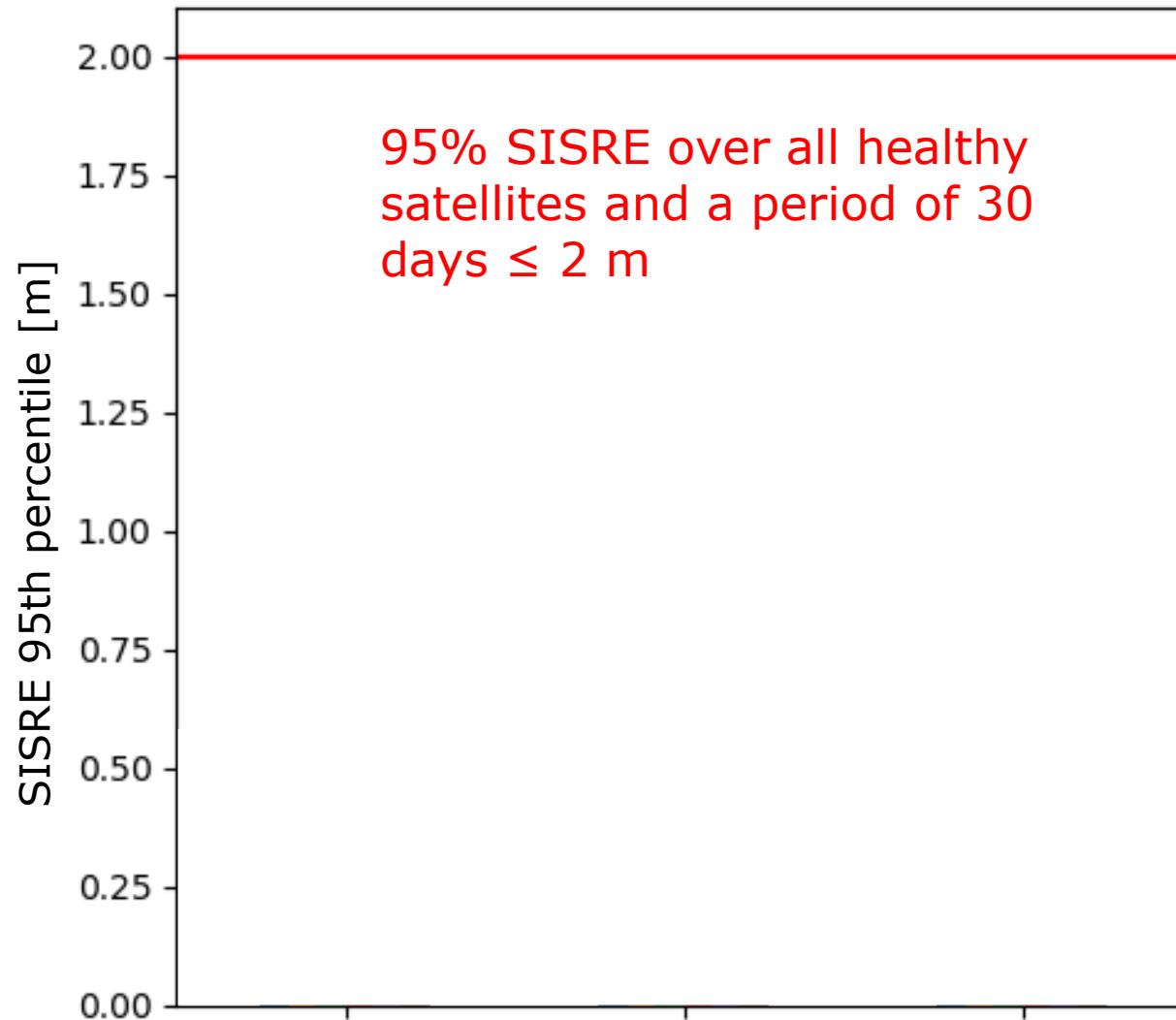
Results

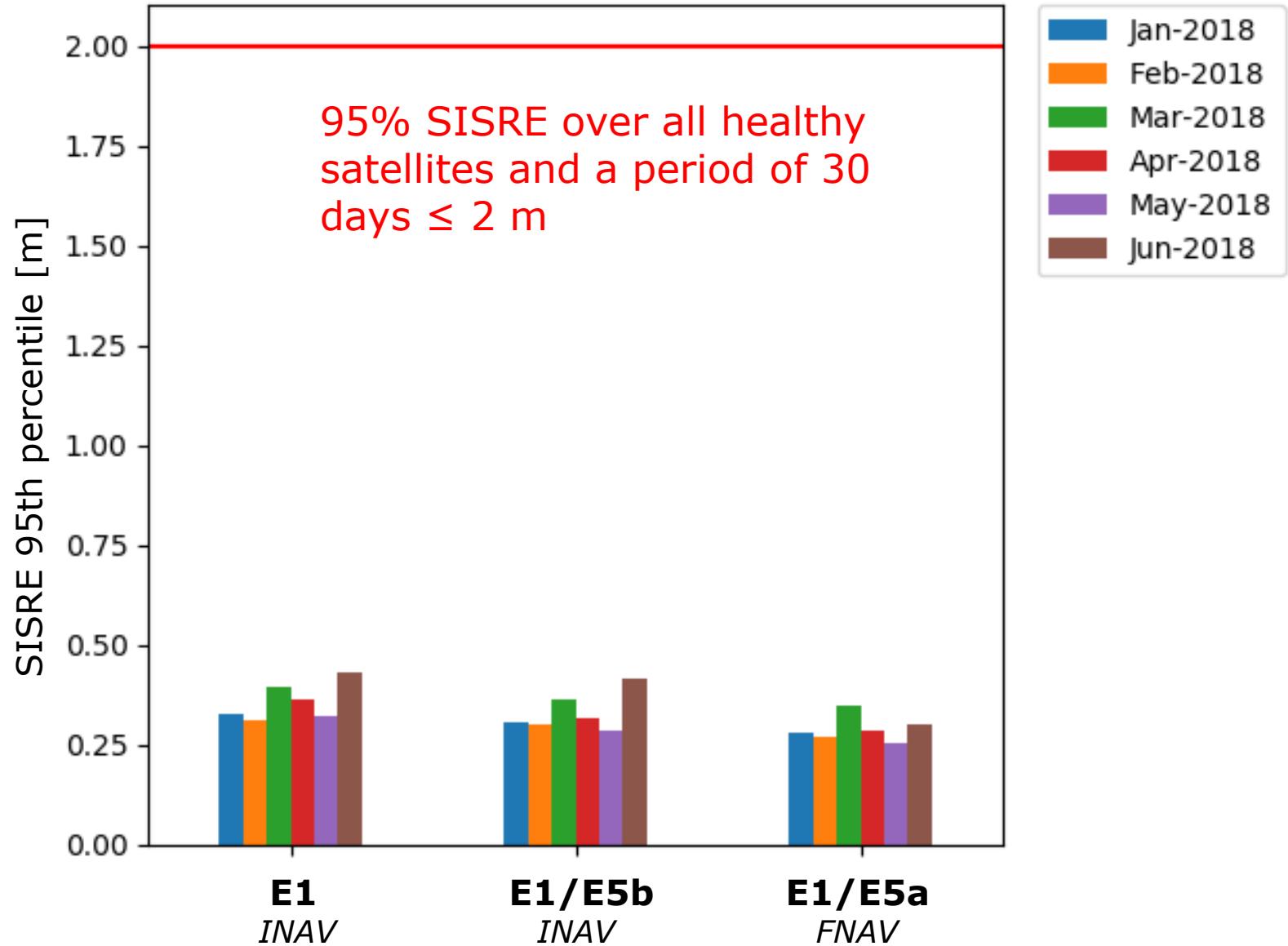
Galileo E1/E5a (FNAV)



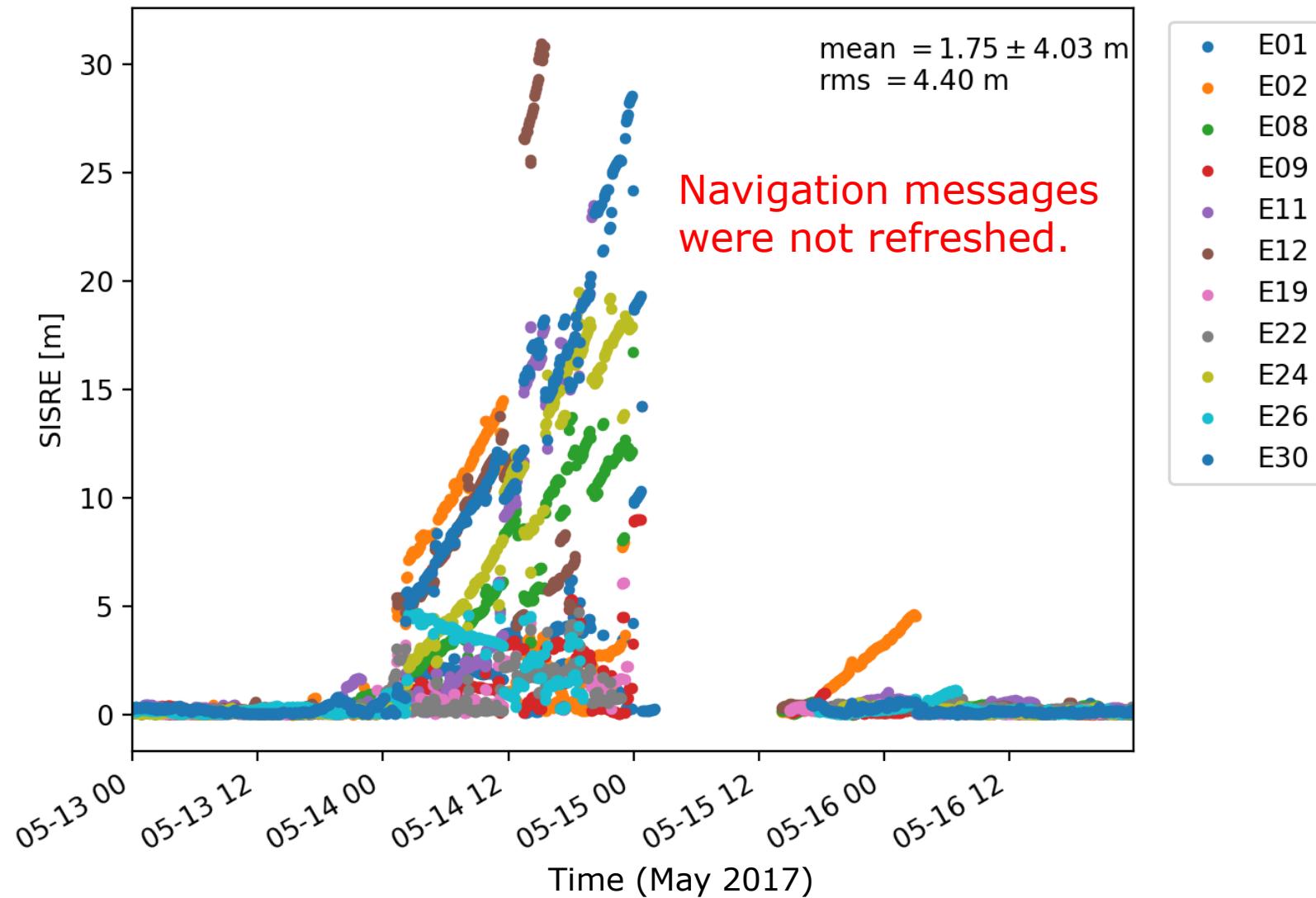
Galileo E1/E5a (FNAV)







Galileo E1/E5a (FNAV)



Part V

Conclusion and outlook

Conclusion and outlook

- Where SISRE solution shows comparable results to other studies (e.g. Montenbruck et. al (2018) or Galileo-IS-OS (2018)) with SISRE RMS of 16 cm and monthly 95th percentile of 30-50 cm
- Further validation of Where SISRE analysis needed
- Improvement of SISRE analysis by quality checking of input data and outlier rejection

Literature

Galileo-IS-OS (2018): *European GNSS (Galileo) initial services – Open service quarterly performance report*. January-March 2018.

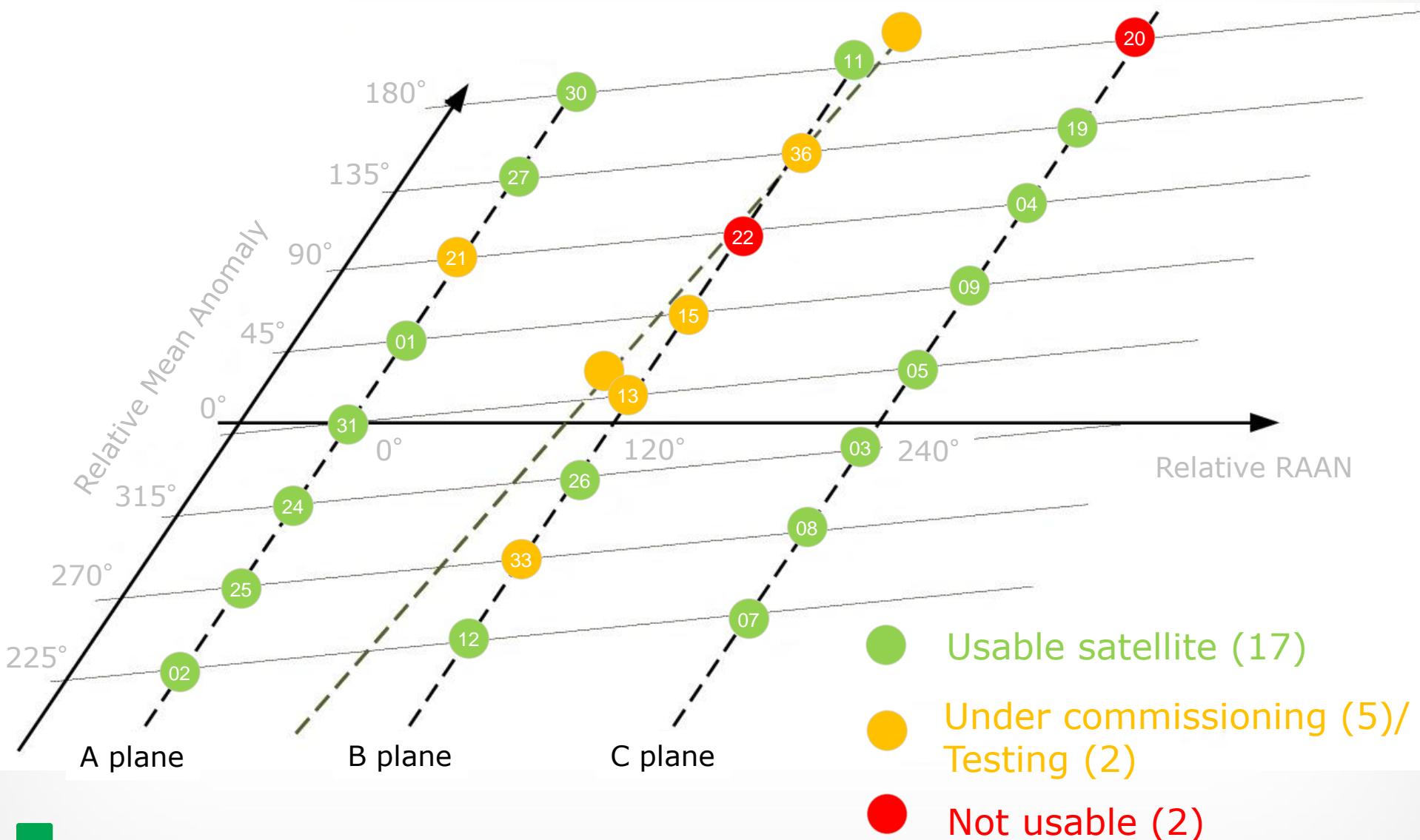
Galileo-OS-SDD (2016): *European GNSS (Galileo) initial services – Open service definition document*. Issue 1.0, December 2016.

Galileo-OS-SIS-ICD (2015): *European GNSS (Galileo) Open service – Signal in space interface control document*. Issue 1.2, November 2015.

Montenbruck, O., Steigenberger, P., and Hauschild, A. (2018): *Multi-GNSS signal-in-space range error assessment – methodology and results*. Advances in Space Research, 61(12):3020-3038. DOI 10.1016/j.asr.2018.03.041.

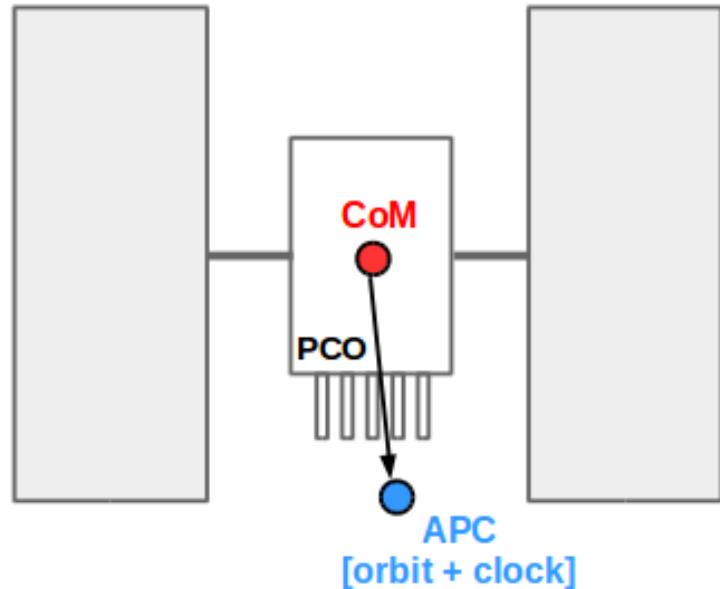
Thank you for your attention!

Galileo satellite constellation

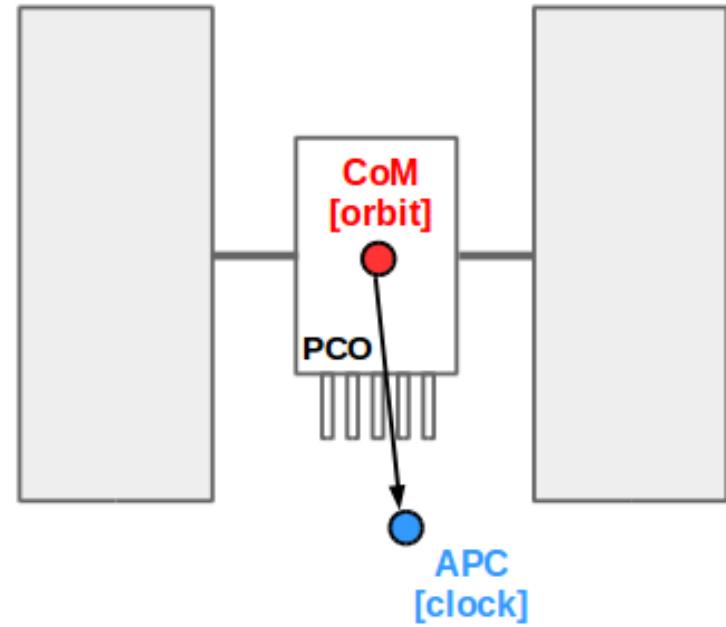


Satellite antenna relation

Broadcast orbit



Precise orbit



- Relate orbit and clock differences to center of mass by applying PCOs given by GSC and IGS (igs14.atx)

