Time Bias Service Latest Implementation and Status

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Introduction

- Prediction quality affects station performance: if satellites can only be acquired late or at all
- First time bias service in 11/17, allows to evaluate prediction quality
- Estimation of time bias values from recorded passes and prediction to current point in time, for various satellites, providers and predictions, this can be used
  - During acquisition (choose the best available prediction and get a real time a priori time bias value)
  - For analysis by comparison (for predictions from different providers for the same targets)
  - For monitoring of quality over time (modeling issues, unmodeled maneuvers, outages, etc.)
- Benefit is
  - Support for quicker or acquisition at all, thus more data or quicker target switching
  - Notification of providers AND stations upon issues (modeling, maneuvers or outages)
  - Support for effective as well as autonomous operation and avoiding unnecessary acquisition attempts
  - Support of mission initial phases
- JOG paper in Special Issue on SLR accepted and online
Latest implementation: Web

- First time bias service interface via website
- Targets: LEOs, Geodetic, Space Debris and GNSS
- Predictions: for different targets, providers & over time
- List of
  - Predicted time bias value at current point in time
  - Residuals of passes w.r.t. used fit
  - Number of passes used for prediction
- Modeling upgrades improved accuracy
  - Correction for atmospheric delay
  - Effect of solid tides on station position
  - Fit order adjusted to number of data points
  - Eccentricity vector if existent with a station

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- Improved graphical representation

Graphical representation of time bias values (blue: recorded passes, orange: predicted) as well as the applied fit (red) from the time bias service website.
Latest implementation: JSON

- Returns data in JSON format
  - Time bias values of recorded passes
  - Predicted time bias value
  - Applied fit
  - Link to graphical representation
- Allows for convenient integration into software
- Instead of crawling the website
- Example: SCOPE software integration

Example for JSON API implementation in SCOPE software. The data retrieved via the JSON API is displayed in the box highlighted in red.
Analysis by comparison

- **Lageos 1 predictions**
  - Good quality for all providers over first day (so totally fine!), afterwards trends visible
  - Gives an idea about the applied modeling – here trends and oscillations
  - In case of outage you know what you can expect from an older or a backup prediction

Lageos time bias values for passes recorded with predictions from different providers. Note the different ranges on the Y-Axis.
Monitoring over time

- Icesat2 predictions,
  - Quality analysis from monitoring over time
  - Large negative offsets and trends
  - Modeling issues?
  - No change for a long time
- But lately, improvement visible
- However, time bias service helps to track Icesat2 quite routinely

Icesat2 time bias values for passes recorded with predictions from different providers. Note the continuously existing negative trends and general offset towards negative values.
Time bias value prediction

- Icesat2
  - Relative prediction error is approx. 10% on average over full Icesat2 mission (up to now)
  - Predicted time bias values supports routine tracking even with large values

Time bias value of Icesat2 passes over a selected period of time with the respective color coded predictions.

Absolute prediction error (predicted – observed) over the selected timeframe with the respective color coded predictions.
Communication with providers & missions

- Technosat
  - Improvement of DLR predictions upon notification
- Analysis by comparison of predictions from different providers
- Monitoring over time
- Communication with provider
  - Notification end of 12/17
  - Improvement from mid 01/18 on

Technosat time bias values for passes recorded with predictions from different providers.
Communication with providers & missions

- **IRNSS**
  - Prediction outage without further notice or communication
  - No more SLR data required? Outage?

- **Case for other missions too**
  - Compass sometimes

- **But also more good examples**
  - Jason 2, notification upon all kinds of issues
  - Sentinel, notification upon maneuvers and others

Snapshot of the last available IRNSS predictions on the EDC website (requested on Oct 7th 2019).
What could stations want?

- ... with respect to predictions or „if you want your satellites actually to be tracked ...“
- Coverage and quality
  - Continuous and good predictions – good = sufficient for tracking, rather easy acquisition
- Communication
  - Modeling improvement upon notification if tracking is not feasible
  - Notifications for providers, stations and missions if something is wrong (modeling issues, maneuvers, outages or SLR data is not required for the mission anymore, etc.)
- Why or what would be the results?
  - Only try to acquire targets or missions that need SLR data
  - Save time on useless attempts (bad predictions and no information)
  - More effective operation, relevant with more targets and autonomous operation
- Continuing time bias service
  - Supporting the prediction quality evaluation, providing a basis for discussion and support during satellite tracking and for missions
Thanks