



**INTERNATIONAL
ASTRONAUTICAL
FEDERATION**

Space Traffic Management

The IAF initiative

Status of Working Group #2.4

Improving the Knowledge

Improvement of orbital data precision and accuracy

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Special Session

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Dream Team



Connecting @ll Space People

Motivation

Space Traffic Management (STM) is highly reliant on Space Surveillance Awareness (SSA).

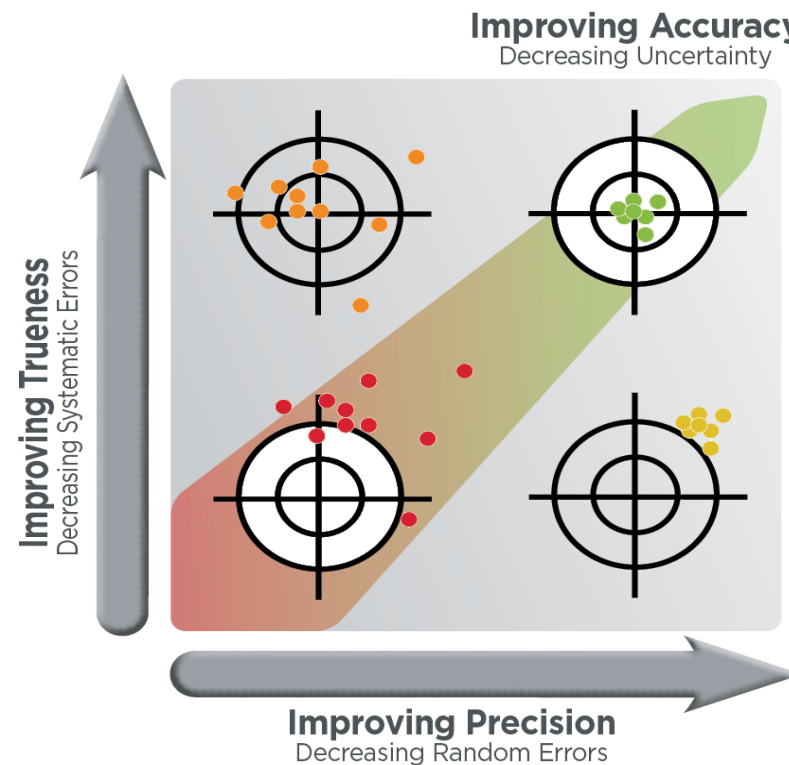
SSA core missions, highly depends on our ability to

- Properly characterize **aleatory uncertainty**,
- Reduce **epistemic uncertainty**,
- Properly take into account uncertainty on the state vector estimation and propagation

The **UN Long-Term Sustainability** (LTS) guidelines explicitly mention the relevance of the **collection and accuracy of orbital data** (B.2) together with the importance of promoting and supporting research and novel approaches to ensure **sustainable operations** in space (D.1, D.2).

Concepts and Sources of Uncertainty

Accuracy
 Uncertainty
 Randomness
 Lack of Knowledge



Propagation models
 Data Reduction
 Reference Frames
 Roto-Translational Dynamics

Uncertainty Estimation

Focus on:

- Estimation of state vector uncertainty after the **data reduction** process,

Existing Algorithms:

- Spans from simple probabilistic distribution functions (e.g. Gaussian distribution) to Crude Monte Carlo

- **Current Efforts:**

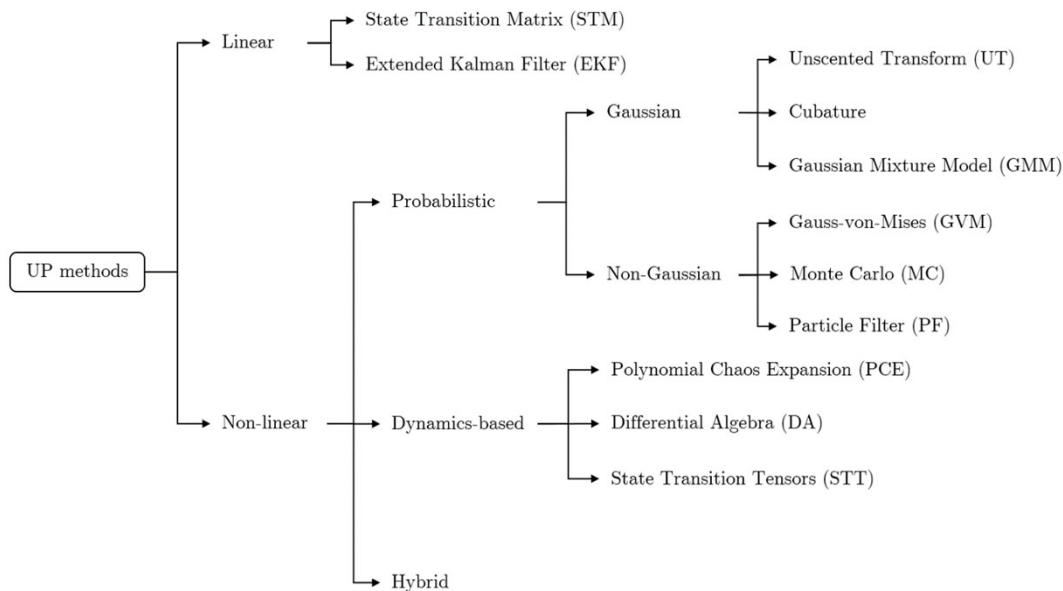
- Focus on assessing and understanding the non Gaussianity of observables and estimates

Uncertainty Propagation

Focus on:

- Identifying and describing key considerations when propagating state vector uncertainty,

Existing Models and Algorithms



Current Efforts

- Linear methods are widely used
- Application of non linear methods are mostly applied by academia

Uncertainty Realism

Focus on:

- Identifying and describing approaches used to guarantee Uncertainty Realism.

Existing Algorithms:

- Algorithms trying to integrate **lack of knowledge** on the form of apriori information
- Algorithms based on the application of **scaling factors** or **uncertainty correction matrices**

• Current Efforts:

- A great effort is / has been done past on increase the aleatory uncertainty realism
- Significant work is done on the **reference frames** maintaining the nature of the uncertainty

Recommendations

UNCERTAINTY ESTIMATION

- Use of Statistical Tests
- Improve Uncertainty linked with Orbit Propagation
- Favor Probabilistic Approaches with no apriori information

UNCERTAINTY PROPAGATION

- Characterize initial PDFs
- Define Metrics to evaluate performance of Uncertainty Propagation
- Define canonical test as common basis for evaluation

UNCERTAINTY REALISM

- Use apriori uncertainty to account for lack of knowledge
- Better consider epistemic uncertainty
- Critically assess the nature of uncertainty over time
- Use scaling factors or uncertainty correction matrices