ZENTRUM FÜR TELEMATIK E.V.

Mission Operations Navigation Services

Why MO Navigation services?

- Internal SM&C survey and preliminary IOAG-MOSSG service priorities identify Navigation as one of the top priorities

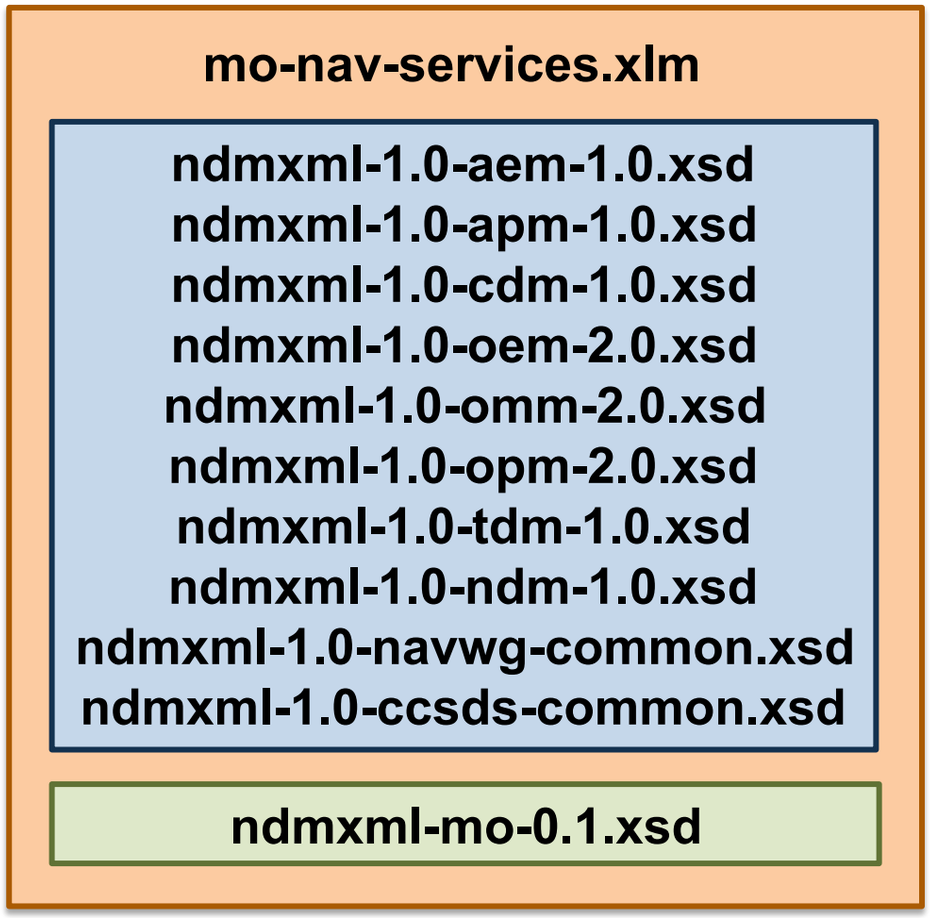
- Existing Navigation books are quite mature and its use widespread

- Navigation books are limited to the definition of the exchanged data types and messages. The transmission method is left unspecified

MO Navigation services

Objectives and scope

Define set of services for configuration and exchange of spacecraft navigation data using the MO framework



- Use as is the Navigation data types and messages defined by the NAV WG
- Wrap/Extend the existing Navigation specifications with a set o operations for configuration and control of the data exchange

MO Navigation services

Objectives and scope

```
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        request an Orbit for a given user defined criteri (time-period, reference frame, other).">
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              <xsd:element name="dataType" type="ndm:EphemType"/>
              <xsd:element name="referenceFrame" type="ndm:ReferenceFrameType"/>
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              <xsd:element name="timeSystem" type="ndm:TimeSystemType"/>
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            <mal:response comment="">
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            </mal:response>
          </mal:messages>
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      </mal:capabilitySet>
```
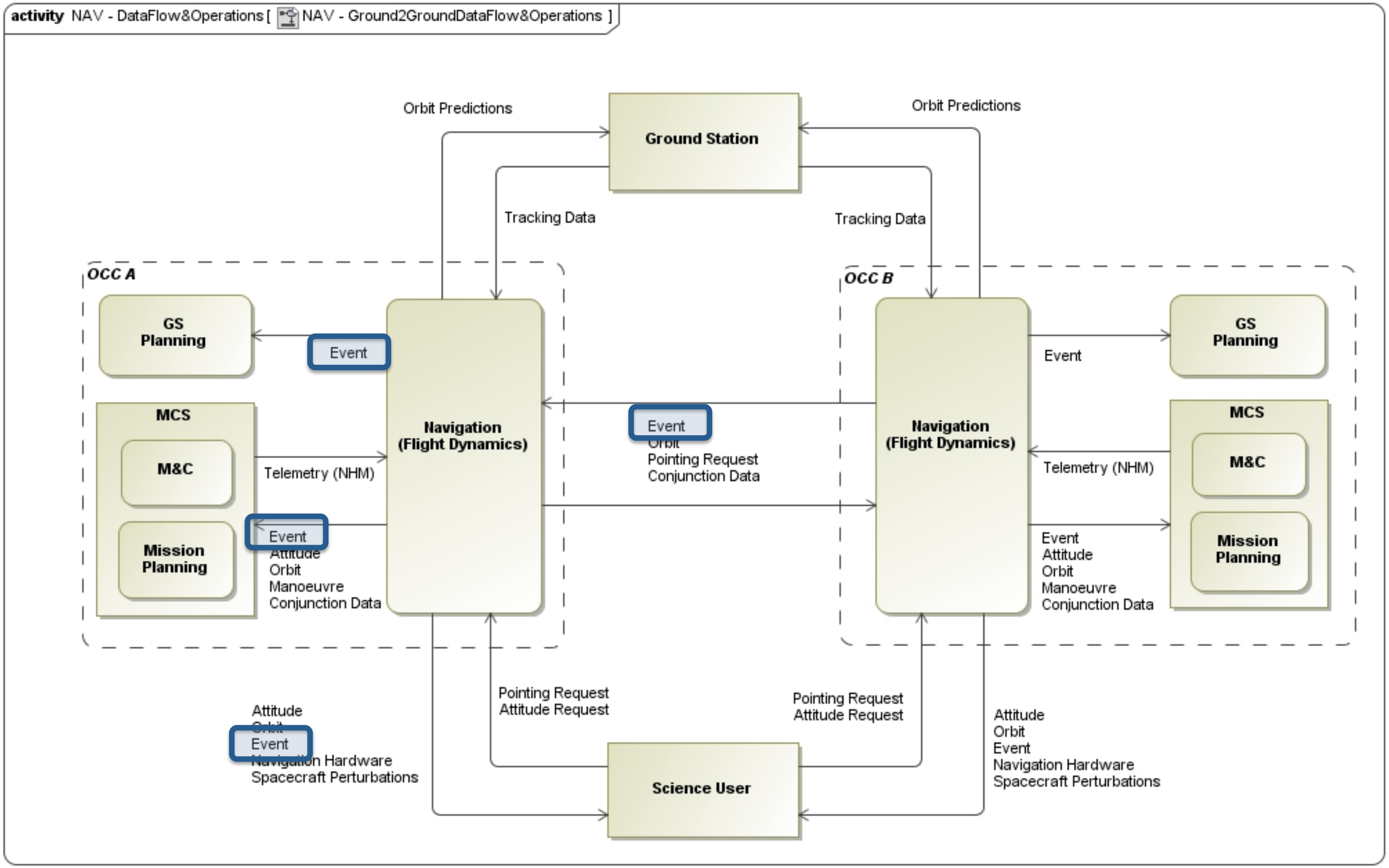

MO Navigation services

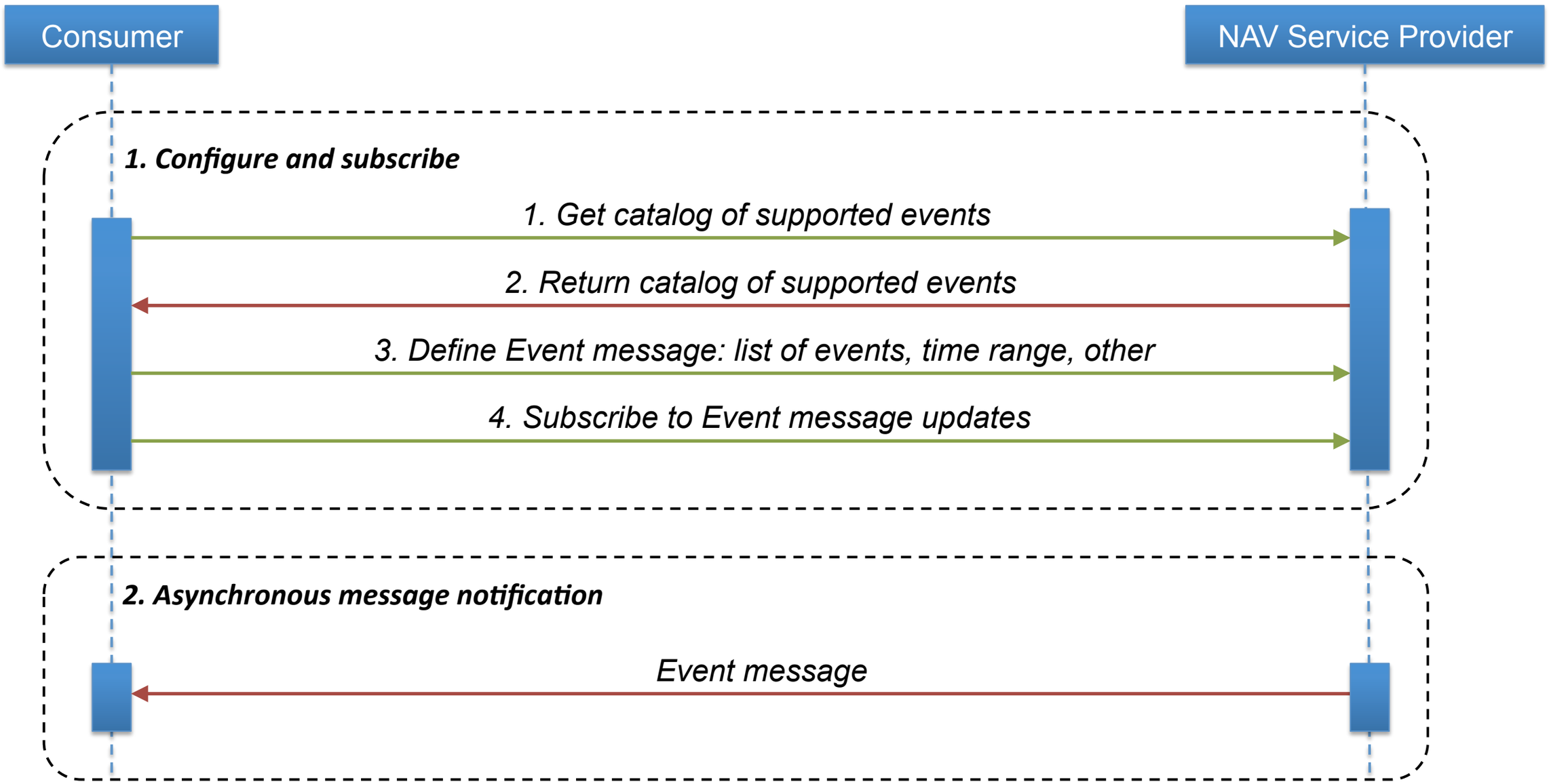
Implementation approach

Navigation WG Specifications		MO Navigation Services
Attitude Data Message		Attitude Data Service
Orbit Data Message		Orbit Data Service
Event Message		Event Service
Navigation Hardware Message	→	Navigation Hardware Service
Pointing Request Message		Pointing Request Service
Tracking Data Message		Tracking Data Service
Spacecraft Manoeuvre Message		Spacecraft Manoeuvre Service
Spacecraft Perturbations Message		Spacecraft Perturbations Service
Conjunction Data Message		Conjunction Assessment Service


activity NAV - DataFlow&Operations [NAV - Ground2GroundDataFlow&Operations]
Orbit Predictions
Ground Station
Orbit Predictions
Tracking Data
Tracking Data
OCC A
GS Planning
Event
MCS
M&C
Mission Planning
Telemetry (NHM)
Event
Attitude
Orbit
Manoeuvre
Conjunction Data
Navigation (Flight Dynamics)
Event
Orbit
Pointing Request
Conjunction Data
OCC B
Navigation (Flight Dynamics)
Event
GS Planning
MCS
M&C
Mission Planning
Telemetry (NHM)
Event
Attitude
Orbit
Manoeuvre
Conjunction Data
Pointing Request
Attitude Request
Pointing Request
Attitude Request
Attitude
Orbit
Event
Navigation Hardware
Spacecraft Perturbations
Science User
Attitude
Orbit
Event
Navigation Hardware
Spacecraft Perturbations

Use cases

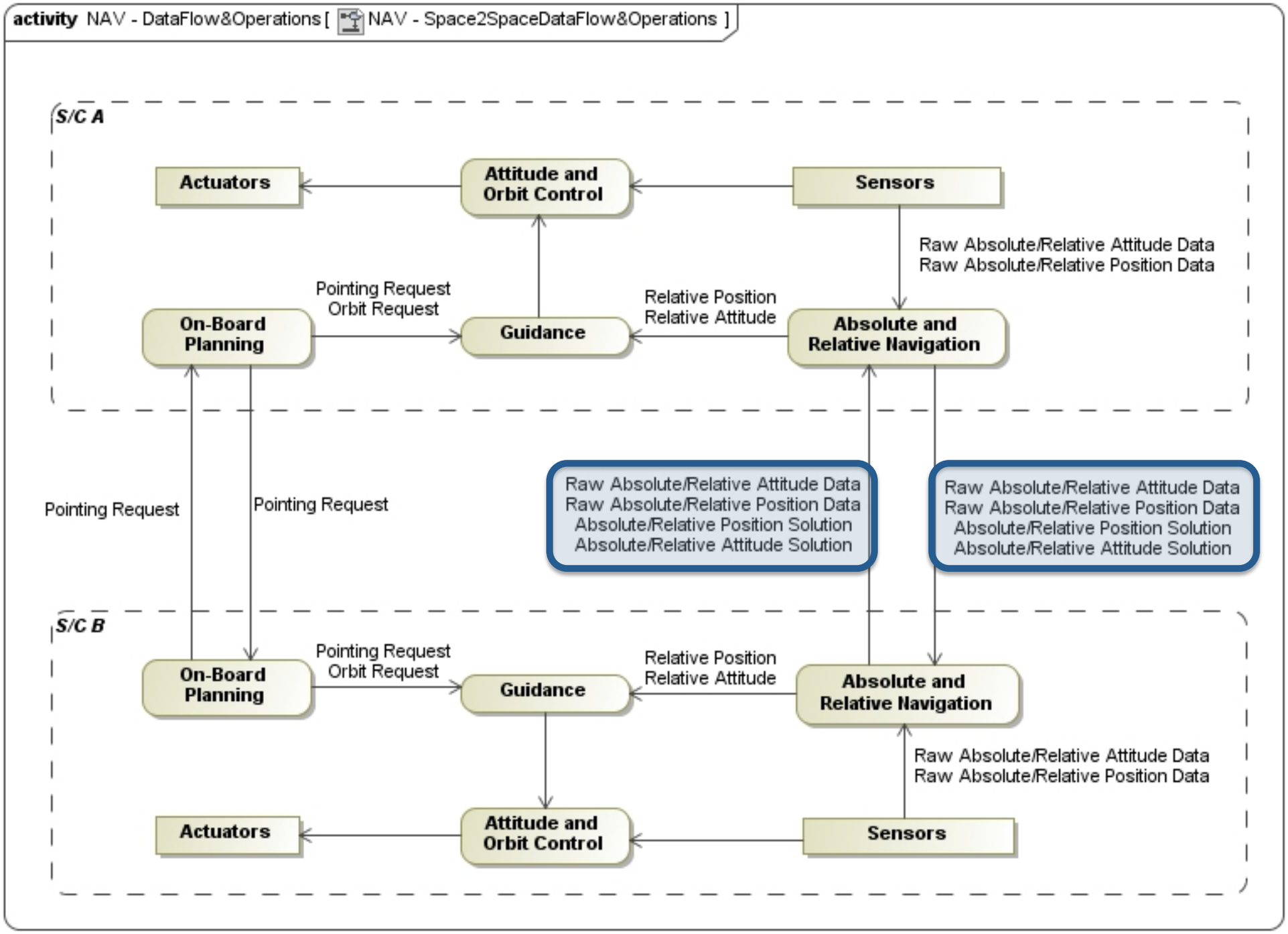
Event service



Use cases

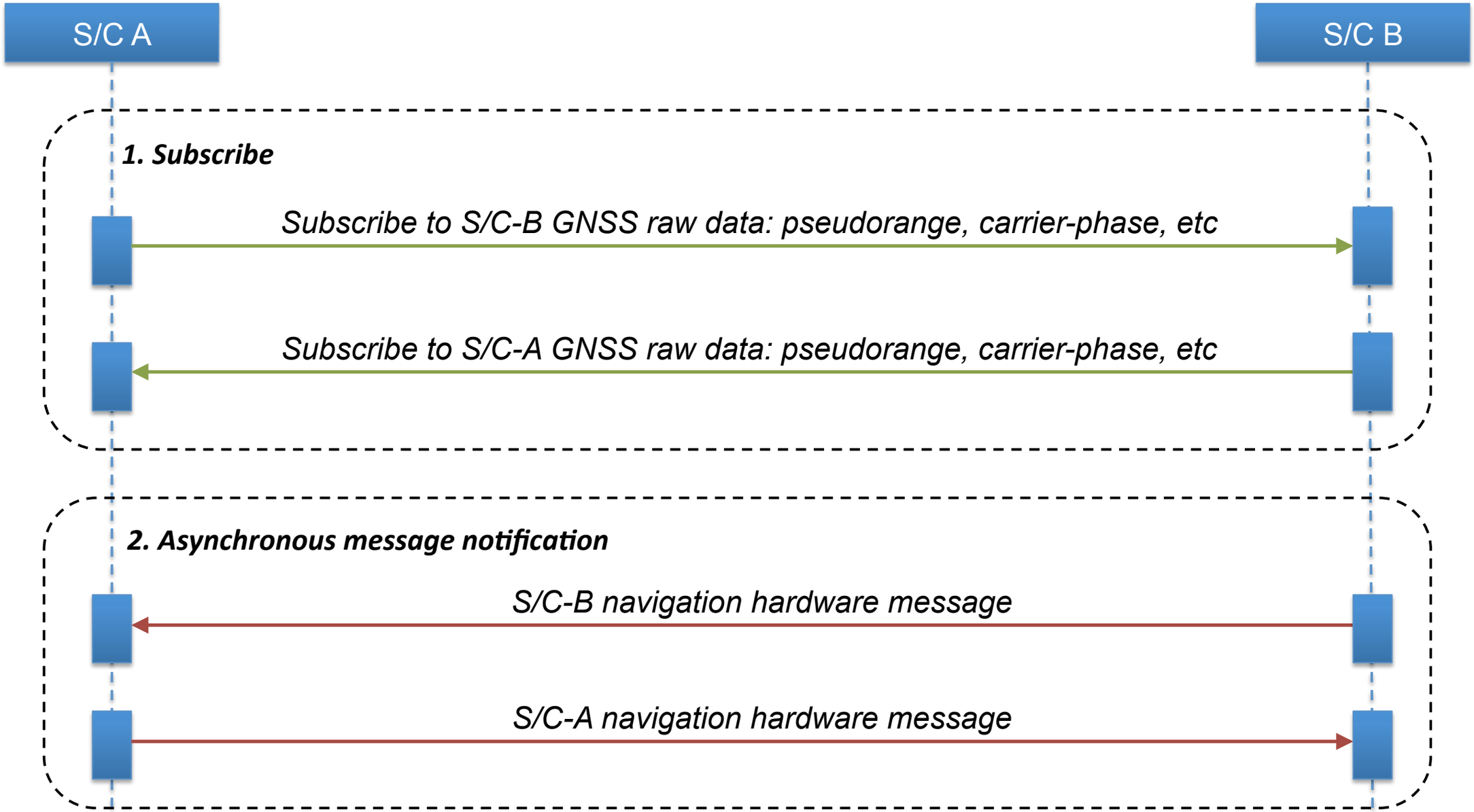
Event service: operations summary

Operation	Objectives
listSupportedEvents	Returns the list of events currently supported by the Navigation service provider
getEventMessage	Returns an event message for a consumer-defined time period and list of events
monitorEvents	Allows a consumer to subscribe to event message updates for a given predefined event message definition
listMessageDefinition	Returns the list of current event message definitions
addMessageDefinition	Allows a consumer to add a new event message definition
updateMessageDefinition	Allows a consumer to modify an existing event message definition
removeMessageDefinition	Allows a consumer to delete an existing event message definition
reportMessageDefinition	Allows a consumer to report the definition of an existing event message
defineNewEvent	Allows a consumer to define a new event using regular expressions combining existing events. Note: eventually we could also use data types from other services (e.g. Orbit, Attitude) to define more complex events, e.g: NewEvent = Attitude.AngularRate.X > 1deg/s
updateEventDefininton	Updates a previously defined event using the defineNewEvent operation
removeEventDefininton	Remove a previously defined event using the defineNewEvent operation


activity NAV - DataFlow&Operations [NAV - Space2SpaceDataFlow&Operations]
S/C A
Actuators
Attitude and Orbit Control
Sensors
Raw Absolute/Relative Attitude Data
Raw Absolute/Relative Position Data
Pointing Request
Orbit Request
Relative Position
Relative Attitude
On-Board Planning
Guidance
Absolute and Relative Navigation
Pointing Request
Pointing Request
Raw Absolute/Relative Attitude Data
Raw Absolute/Relative Position Data
Absolute/Relative Position Solution
Absolute/Relative Attitude Solution
Raw Absolute/Relative Attitude Data
Raw Absolute/Relative Position Data
Absolute/Relative Position Solution
Absolute/Relative Attitude Solution
S/C B
On-Board Planning
Pointing Request
Orbit Request
Guidance
Relative Position
Relative Attitude
Absolute and Relative Navigation
Raw Absolute/Relative Attitude Data
Raw Absolute/Relative Position Data
Actuators
Attitude and Orbit Control
Sensors

Use cases

Navigation Hardware service



MO Navigation services

Some potential benefits

- On demand (runtime) navigation data configuration and access
- Leverage on existing and future MO bindings for message transmission over ground and space links
- Seamless integration with future MO-based ground and on-board systems
- Possibility to expose navigation software as a service (SaaS) for inter- and intra-agency use
- Minimise need for out-of-band agreements
- Possibility to explore synergies with other MO services
  - e.g. retrieval of archived Telemetry from the MCS using M&C services

Way forward?

- Agree (or not) on the usefulness of MO Navigation services
- Jointly define service priorities
- Jointly define useful/required set of operations for each service