

Appendix 2 to Tender Specifications

Software Requirement Specification



S-AIS DPC Block2

ESA contract n°: 4000103276/11/NL/US

SAT-AIS DPC Block2 - Software Requirements Specification [D2-D3 / DSA]

Reference: CLS-DT-NT-11-592

Nomenclature: SAI-CLS-RS-3014

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Figure 60 - Use Cases diagram for DPC Framework 203

List of items to be confirmed or to be defined

Lists of TBC:

Lists of TBD:

Applicable documents

- AD 1** Demonstrator of a Data Processing Centre for Satellite Based AIS Services -
Statement of Work
SAI-EST-SOW-3001
- AD 2** Technical Requirements for the “Demonstrator of a Data Processing Centre for
Satellite Based AIS Services”
SAI-EST-RS-3001
- AD 3** Space Engineering - Software
ECSS-E-ST-40C
- AD 4** SAT-AIS DPC Block2 - Software System Specification [D1/DSA]
SAI-CLS-RS-3008
- AD 5** CLS proposal for a Data Processing Centre (DPC) for Satellite-based AIS Services
CLS-DCL-PR-11-032
- AD 6** CLS answers to ESA request for clarifications
CLS-DCL-PR-11-270
- AD 7** DPC Block2 Software Product Assurance Plan
SAI-CLS-PL-3005
- AD 8** DPC Block2 Software Development Plan
SAI-CLS-DVP-3006

Reference documents

- RD 1** Preliminary High-Level Architecture of the ESA SAT-AIS Data Processing Centre
SAI-EST-TN-3001 1rev0
- RD 2** S-AIS DPC Block 2 - Interface Control Document
SAI-CLS-ICD-3015 1rev0
- RD 3** Maritime navigation and radio-communication equipment and systems - Digital
interfaces - Part 1: Single talker and multiple listeners
IEC 61162-1 Ed.3
- RD 4** Maritime navigation and radio-communication equipment and systems -
Automatic Identification System (AIS) - Part 1: AIS Base Stations - Minimum



operational and performance requirements, methods of testing and required test results

IEC 62320-1 Ed.1

RD 5 Technical characteristics for an automatic identification system using time-division multiple access in the VHF maritime mobile band

ITU-R M.1371-4

RD 6 Common Alerting Protocol (CAP 2.0)

ITU-T Recommendation X.1303



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1. Introduction

The software requirements specification is a major constituent of the technical specification (TS). It describes the functional and non functional requirements applicable to the SAT-AIS DPC Block2.

It is based on the requirements expressed in the SAT-AIS DPC Block2 Software System Specification (AD 4) which have been consolidated, completed and allocated to the software sub-systems.

2. Applicable and reference documents

Refer to document preliminary pages.

3. Terms and definitions

The following table summarizes the definition or abbreviated terms used in this document.

Ancillary data	Additional data associated to individual AIS messages, which are received directly from the SAT-AIS ground stations. Ancillary data may include : Doppler shift measurements, timestamp, power level etc.
Auxiliary data	Data related to ground stations or satellite constellations (orbits, planned events files), provided by the SAT-AIS ground control centres.
Block2 raw data products	Data products as acquired from data providers
Block2 level 1 data products	Data products transformed in human readable format (e.g. AIS messages translated in MMSI, latitude/longitude, SOG, COG, etc.)
Doppler effect	A phenomenon, observed for electromagnetic radiation, characterized by a change in the apparent frequency of a wave as a result of relative motion between the receiver and the transmitter.
Dynamic data	Dynamic data corresponds to time-varying data (e.g. vessel position)
Kalman Filter	The Kalman filter uses a system's dynamics model (i.e., physical laws of motion), known control inputs to that system, and measurements (such as from sensors) to form an estimate of the system's varying quantities (its state) that is better than the estimate obtained by using any one measurement alone. (Wikipedia)
Static data	Static Data corresponds to constant data (e.g vessel characteristics)
Time update interval	Time interval between two consecutive AIS messages from a same vessel, available in the data archive of the DPC. The time update interval is a measure of the temporal distance between two messages transmitted by the same vessel, which can be retrieved from the archive.
Timeliness	Time interval between detection of an AIS message (N) by a satellite of the space segment and the availability of the AIS data retrieved from the message (N) in the data archive of the DPC. It comprises the time required



	for processing the AIS message on board the satellite, the time for transmitting the data to the closest ground station, and the time to transfer the data to the DPC. The timeliness is a measure of “how old” the available data stored in the archive is.
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The acronyms definition is given in Appendix A -.

4. Software overview

4.1. Function and purpose

The main objectives of the SAT-AIS DPC System are to receive, correlate, store and distribute enhanced SAT-AIS data to the maritime community.

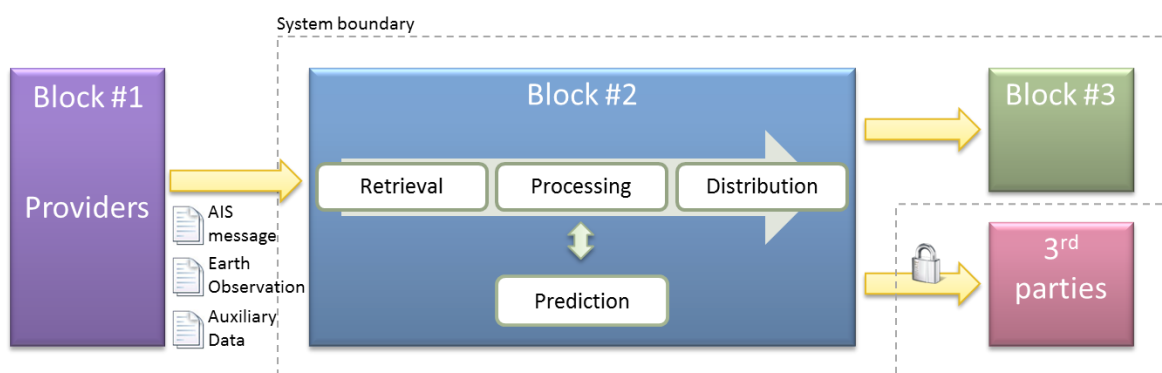


Figure 1 - Data Processing Centre overview

As shown in the diagram above, the Data Processing Centre System is made of two systems: Block2 and Block3.

Block2, the system being described, is in charge of collecting and processing SAT-AIS data in order to deliver enhanced SAT-AIS information to Block3.

From a functional point of view, the Block2 is the composition of four modules: the Retrieval Module, the Processing Module, the Prediction Module and the Distribution Module.

The function of the Retrieval Module is to collect SAT-AIS data from providers, including Auxiliary Data from SAT-AIS Control Centres and Earth Observation Data for EO data providers, if available.

At the next stage, the Processing Module performs processing of all data previously acquired. This module is in charge of:

- Validating AIS messages. It checks the CRC (if provided), the message consistency as well as position.
- Detecting missing AIS messages. It provides indication of the times during which AIS messages were lost as well as times where the contacts were expected.
- Enhancing AIS messages. It provides AIS messages that have been validated or recovered using ancillary data, and also provides AIS messages with EO correlation.

To carry out the high-level processing, like the AIS messages recovery for instance, the Processing Module relies on simulated data supplied by a dedicated Prediction Module. This module is able to produce synthesized AIS messages from simulated satellites constellations, and provide the estimated positions of ships.

As a result, the system delivers enhanced SAT-AIS data to the EMSA Block3 and other users, in accordance with the defined security policy through the Distribution Module.



The Block2 system is designed to be scalable in order to be capable of handling the load when new SAT-AIS space segments and data providers become available.

Block3, is part of the EMSA Integrated Maritime Data Environment (IMDatE) that already receives data from terrestrial AIS or LRIT, and will interface to Block2 in order to collect SAT-AIS data and merge them with other sources.

4.2. Relation to other systems

4.2.1. Boundary of the system

We consider in this chapter the S-AIS DPC Block2 as a black box. Boundary systems are introduced here with the UML notation and point of view. An actor is a participant, i.e. an agent external to the S-AIS DPC Block2 system that exchange information with it.

An actor:

- can act on the system in, which case it uses the services offered by the system,
- can be used by the system, in which case the system uses the services provided by the actor.

The following context diagram details the identified actors that are in direct relation with the S-AIS DPC Block2 system.

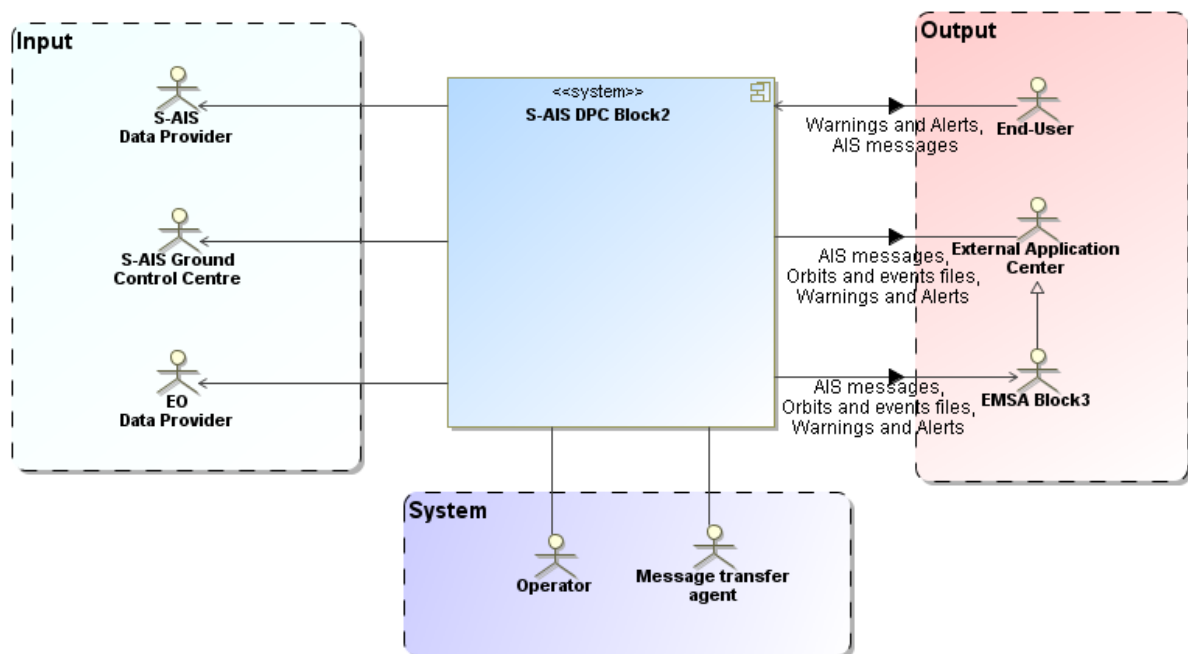


Figure 2 - DPC Block2 in its context

Three kinds of actors are identified for the S-AIS DPC Block2:

- The actors that act as an input for the S-AIS DPC Block2 by producing data ("input" block in the diagram).
- The actors that act as a receiver from the S-AIS DPC ("output" block in the diagram). Those are mainly the Block3 (called EMSA Block3 in the diagram), but also other users through dedicated machine-to-human (Web interface) or machine-to-machine (Web Services) interfaces. The EMSA Block3 actors can act as an External Application Center and as such, can access to all the data provided by the Web Services interface.
- Other actors that are needed by the S-AIS DPC system to operate.



4.2.2. Actors

The following diagram lists all the identified actors of the S-AIS DPC Block2 with relationships between actors.

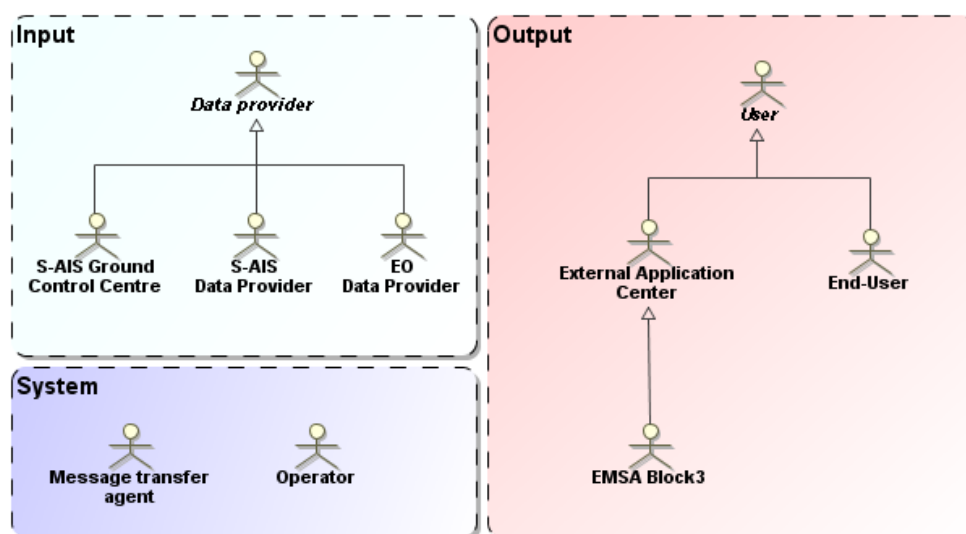


Figure 3 - Boundary actors of the DPC Block2 System

The notation \triangle in the diagram models the actor generalization and refers to the special relationship which can exist between two actors. The generalization relationship implies that one actor (descendant) inherits the role and behaviour of another actor (ancestor).

An abstract actor, drawn with a label in italics in the diagram, is a shorthand way to reference any concrete actor who fulfils the role. It also reflects the common nature that exists between actors at a high level of abstraction.

4.2.2.1. Input

The following chapter introduces the hierarchy of “input” actors identified for the DPC Block2, depending on the quality, function and responsibility that they assume.

All actors of this category are actors publishing an interface that allows the DPC Block2 to be fed with data.

4.2.2.1.1. Data provider Actor

The Data Provider Actor represents an abstraction of all the input data sources that are considered for the DPC Block2. A data provider is an agent that is able to deliver a content used by the system, like an AIS Message for instance.

4.2.2.1.2. S-AIS Data Provider Actor

The S-AIS Data Provider Actor supplies DPC Block2 with AIS messages received by a SAT-AIS satellites constellation together with ancillary data such as the satellite reception timestamp or a Doppler shift measurement. No assumption is made here on the format of the data carried or on the protocol.



4.2.2.1.3. S-AIS Ground Control Centre Actor

The S-AIS Ground Control Centre Actor supplies DPC Block2 with SAT-AIS orbits and events files – called Auxiliary Data.

These data enables the DPC Block2 to calculate if/when a satellite will be visible by a ground station, and know about the availability of satellite or a ground station.

4.2.2.1.4. EO Data Provider Actor

The EO Data Provider Actor, that processes EO data that overlaps with SAT-AIS orbits, supplies DPC Block2 with Vessel Detection Reports (VDRs) that can be correlated with SAT-AIS position reports. The EO provider may also deliver the Level 1 images used as input of their vessel detection algorithms.

4.2.2.2. Output

The following diagram introduces the hierarchy of “output” actors identified for the DPC Block2, depending on the quality, function and responsibility that they assume.

4.2.2.2.1. User actor

The User Actor represents an abstraction of all the clients (data consumers) that are considered for the DPC Block2.

4.2.2.2.2. End-User actor

The End-User represents a human client needing to have access (visualization and extraction) to the information provided by DPC Block2 via a dedicated Web User Interface.

4.2.2.2.3. External Application Center Actor

The External Application Center Actor represents all clients needing to have access to SAT-AIS data through the Web Services supplied by the DPC Block3. The provided interface is exclusively via dedicated Web Services.

Since EMSA Block3 Actor is a descendent of this actor, it also uses these Web Services to access to information stored in Block2.

4.2.2.2.4. EMSA Block3 Actor

The EMSA Block3 Actor represents the DPC Block3 that ingests AIS data received from terrestrial and satellite sources. It is a recipient system for raw or post-processed SAT-AIS messages and EO data, warnings and SAT-AIS information. As the inheritor of the Actor “External Application Center”, it also uses the provided DPC Block2 Web Services to fetch data.

4.2.2.3. System

4.2.2.3.1. Operator actor

The operator represents the human client that has the role to check and monitor any kind of resources, notably the measurements of the activity (performance, resources usage, statistics) provided by DPC Block2 via a dedicated monitoring interface.



4.2.2.3.2. Message transfer agent actor

The message transfer agent represents software that transfers electronic mail messages to recipients.

4.2.3. External Interfaces

The following diagram shows all the interfaces involved in the boundary of the system, i.e. actors that are in interaction with the DPC through one of several interfaces.

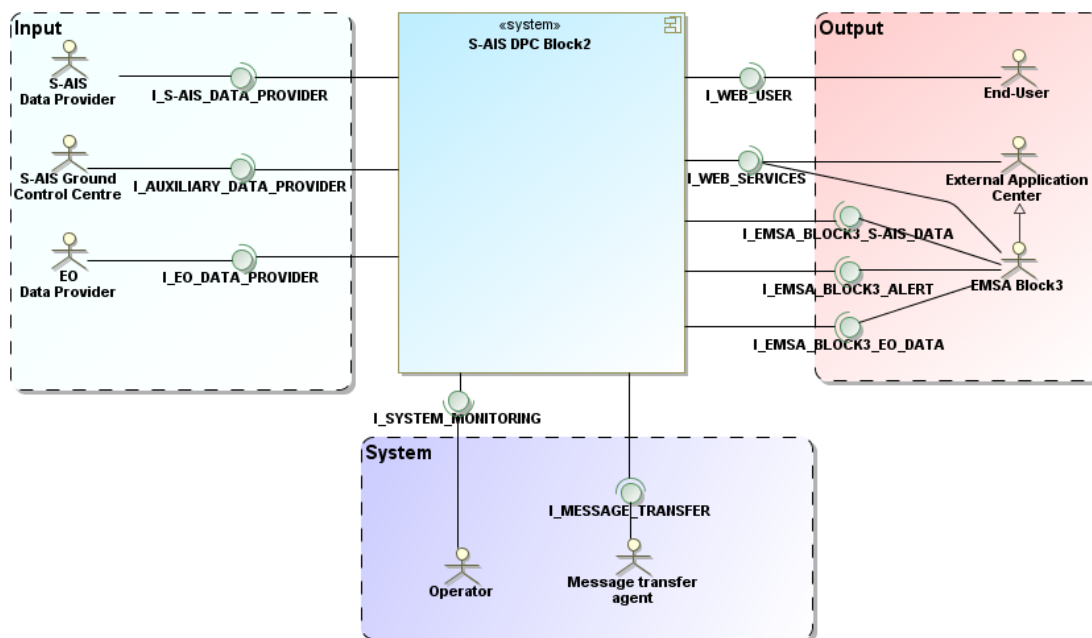


Figure 4 - The S-AIS DPC Block2 in its surrounding context

An interface is the mean through which services are accessed. At this stage, the interfaces are not detailed nor formally described (protocols, data format), but just inventoried. The interfaces requirements are presented in the Software System Specification (AD 4) and will be detailed in the Interface Control Document (RD 2).

The following table enumerates all the published interfaces, both those that are implemented by actors and the DPC Block2.

System or Actor	Published Interface	Used by	Information exchanged
S-AIS Data Provider	I_S-AIS_DATA_PROVIDER	S-AIS DPC Block2	SAT-AIS messages, Ancillary data
<p>The S-AIS Data Provider Actor publishes an interface that delivers different AIS messages with ancillary data, i.e. additional data associated to the AIS messages including Doppler shift measurement, reception timestamp, signal power level...</p> <p>Although the interface is identified as unique, it is specialized by suppliers, both by the protocol (FTP, SFTP, TCP, JMS) and the message format (NMEA v4, CDF).</p> <p>This interface shall handle both the existing SAT-AIS data providers and the future ones.</p>			



S-AIS Ground Control Center	I_AUXILIARY_DATA_PROVIDER	S-AIS DPC Block2	Auxiliary data
	<p>The S-AIS Ground Control Center Actor publishes an interface that delivers Auxiliary Data, i.e. satellite orbits, ground station characteristics but also events description and plans. The events may include ground station maintenance, satellite maneuvers...</p> <p>This interface shall handle both the existing SAT-AIS data providers and the future ones.</p>		
EO Data Provider	I_EO_DATA_PROVIDER	S-AIS DPC Block2	EO data
	<p>The EO Data Provider Actor publishes an interface that delivers Vessel Detection Reports (VDR) and Level 1 Images.</p>		
S-AIS DPC Block2	I_WEB_SERVICES	External Application Center	AIS messages (simple and enhanced), AIS messages correlated with EO data and SAT-AIS orbits, event messages
	<p>The S-AIS DPC Block2 System publishes an interface through which an external application can query and retrieve simple AIS Messages (real time or historic), as well as enhanced and predicted messages. This interface is subject to a restricted permission check.</p>		
S-AIS DPC Block2	I_WEB_USER	End-User	data graphical representation, extractions
	<p>The S-AIS DPC Block2 System publishes a graphical user interface that provides display capabilities on the SAT-AIS data processed, products generated, warning and message logs. This interface also allows for the management of the users (authentication) and the security policy in force (authorization).</p>		
EMSA Block3	I_EMSA_BLOCK3_S-AIS_DATA	S-AIS DPC Block2	AIS messages
	<p>The EMSA Block3 Actor publishes an interface for the distribution of SAT-AIS messages.</p>		
EMSA Block3	I_EMSA_BLOCK3_EO_DATA	S-AIS DPC Block2	EO data
	<p>The EMSA Block3 Actor publishes an interface through which Vessel Detection Reports can be dropped off.</p>		
EMSA Block3	I_EMSA_BLOCK3_ALERT	S-AIS DPC Block2	Alert, info, area, ship MMSI
	<p>The EMSA Block3 Actor publishes an interface through which warnings can be pushed when AIS messages have not been received from a given ship (while messages were expected) or if contact with the ship was lost.</p>		
S-AIS DPC Block2	I_SYSTEM_MONITORING	S-AIS DPC Block2	System health information (status, notifications, logs) and synopsis
	<p>The S-AIS DPC Block2 System publishes a monitoring interface providing all</p>		



information related to the state and health of the DPC Block2 system.			
Message Transfer Agent	I_MESSAGE_TRANSFER	S-AIS DPC Block2	email
The Message Transfer Agent Actor publishes an interface for electronic mail (e-mail) transmission across Internet Protocol (IP) networks. This interface is used by the Monitor, Command And Control subsystem to send warnings and alerts to the technical staff.			

Table 1 - External Interfaces of the DPC Block2 System

4.3. Main handled entities (data and concepts)

As part of this document, an entity must be understood as a piece of information that has a distinct existence and is meaningful in the system.

This chapter introduces the entities that are handled by the DPC Block2 system and that are necessary to specify.

4.3.1. Core entities

4.3.1.1. Raw SAT-AIS Message

A Raw SAT-AIS Message is an AIS Message in its original data format, exactly as received by the SAT-AIS data providers. It can be level-0 AIS messages encoded in NMEA 6-bit ascii format, or a more evolved form (potentially decoded) like EMSA CDF.

4.3.1.2. Decoded SAT-AIS Message

An AIS message, whose CRC has been checked (if provided), whose size is valid, and whose fields have been decoded and converted according to the AIS message type (e.g. MMSI, latitude, longitude, etc.).

4.3.1.3. Enhanced SAT-AIS Message

An Enhanced SAT-AIS Message is an AIS Message for which some information has been completed, corrected or added.

4.3.1.4. Ancillary Data

Ancillary Data are additional data associated to individual AIS messages, which are received directly from the SAT-AIS ground stations.

Ancillary data may include: Doppler shift measurements, timestamp, power level etc.

4.3.1.5. Auxiliary Data

Auxiliary Data are data related to ground stations or satellite constellations (orbits, planned events files), provided by the SAT-AIS ground control centers.



4.3.2. Traceability entities

The purpose of the traceability entities is to capture the history of the processing applied to data, at large, and then confer a tri-dimensional view (who, when, what) to the system. The traceability within the DPC Block2 system provides:

- Identification of the data passing through the system (mainly AIS messages)
- Information of when and where they are moved or transformed
- A system linking these data

The following class diagram explains the way data are subject to traceability.

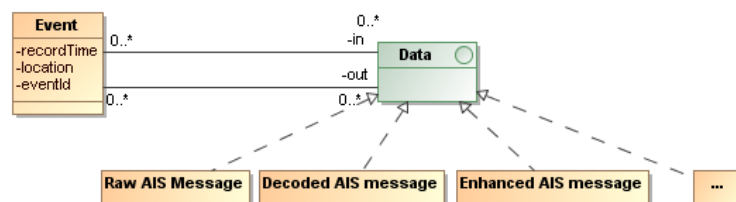


Figure 5 - Traceability classes

Traceability is a set of events recording all changes that apply successively to a dataset. Traceability keeps the path of a particular data (AIS message for instance) through all the intermediate steps which process and combine the data into new one.

For instance, the path taken by an AIS Message goes through the following steps: Message retrieval, Message validation and Message enhancement. The traceability of these events is described as follows.

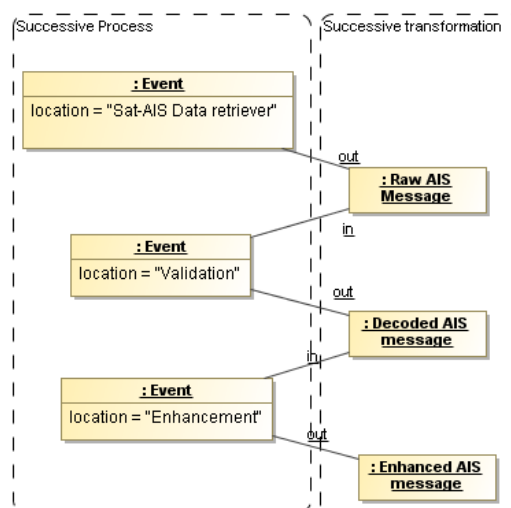
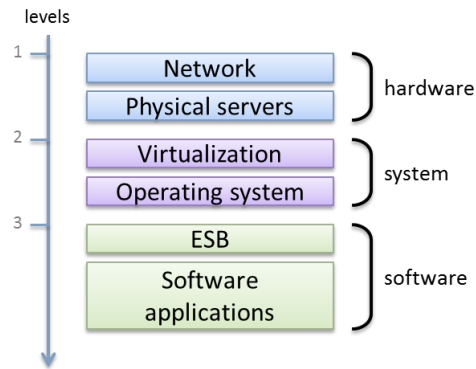


Figure 6 - Illustration of a traceability chain

5. High level architecture

This chapter introduces the high level architecture of the DPC Block2. The methodological approach used here is to detail the stacking of the system, from the hardware (network devices and servers) to the software (ESB, applications), with a strong focus on that last stage.



For each level (hardware, system, software), the scalability and rationale of the proposed architecture are discussed, in order to demonstrate the system could be extended to the full operational DPC without major changes to the architecture.

5.1. Hardware Level

5.1.1. Hardware architecture for the DPC Block2 Demonstrator

5.1.1.1. Overview

Expectations

The technical requirements for the DPC Block2 listed in AD 4 include several “performance” requirements which impact the definition of the hardware architecture.

- SR-DPC-SAF-1840 and SR-DPC-SAF-1860 require a redundant system consisting of a primary and a backup system, which are exact replicas.
- The “environmental” requirements SR-DPC-HW-1650 and SR-DPC-HW-1710 impose a lifetime of minimum 5 years and a data and processing capacity of 4 TBytes per year.

Solution

The proposed hardware architecture is presented in Figure 7.

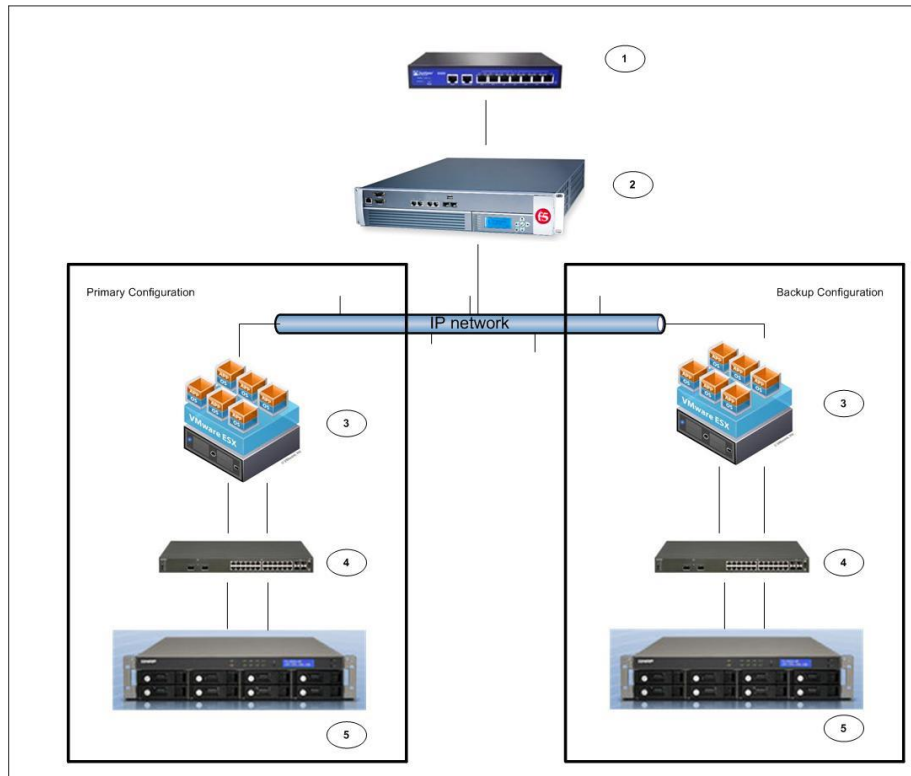


Figure 7: Hardware architecture for DPC

The architecture consists of the following hardware elements:

Firewall (1)

Proxy device (2)

F5 Big IP. This device supports in a double configuration load balancing. It provides shared IP address (1 address from outside, 2 addresses inside) for load balancing.

In the DPC Block2 context, it will allow to switch from the Primary configuration to the Backup configuration.

The Primary and backup systems consist of the following components:

Physical server (3)

PowerEdge R610. This server has two Ethernet cards which provide additional redundancy and double throughput towards the storage device.

A Network Switch (4)

Gigabit Ethernet NORTEL 4524GT.

A Storage equipment (5)

NAS QNP-TS859U-RP+. This NAS has two Ethernet cards which provide additional redundancy and double¹ throughput. The physical servers include iSCSI interfaces towards the storage equipment. The NAS is configured with RAID-5. The NAS devices are optimized for growth and expansion, i.e. the physical volumes are grouped into logical volumes.

¹ You can enable "Balance-alb" bonding mode or 802.3ad aggregation mode (an 802.3ad s compliant witch required) to allow inbound and outbound traffic link aggregation (up to 2 Gb/s).



In the frame of the demonstration, the NAS will be configured with 3 disks RAIDS * 2 Tbytes for effective storage of 4 Tbytes. This storage volume is more than enough for the duration of the demonstration (8 months), given the following assumptions:

- S-AIS Messages: 100,000 messages per day, with an estimated and average storage size of
 - 1400 bytes for an AIS message stored in the database, including the different process (raw, L1, L2, L3) and miscellaneous database overheads.
 - 100 bytes for a raw AIS messages (as received from the SAT-AIS data providers) stored in files on the file system.
- EO data: 110 images over the 8 months period, with an average size of:
 - 200 kBytes for the VDRs stored in the database
 - 200 Mbytes for the EO product (including VDRs and Level 1 image) received from the EO data provider and stored in the file system.

Which leads to a data volume less than 66 GBytes for the duration of the demo.

To allow switching from the primary to the backup environment, the database and file systems will be synchronized in real-time on both servers. The NAS devices are optimized for growth and expansion, i.e. the physical volumes are grouped into logical volumes, for example using Linux-LVM.

5.1.1.2. Hardware scalability

The proposed hardware architecture is fully scalable. The following scenarios are supported to scale the hardware:

- One or more additional physical servers (3) can be added to the switch (4) providing additional CPU resources for processing. Note that according to the “exact replicas” requirement, adding resources on the primary configuration will require the addition of the same resources on the backup configuration.
- The NAS (5) will be provided with sufficient capacity (disks) to cover the demonstration period. To cover a five year lifetime, additional disks can be added in the storage equipment (up to 8).
- Additional NAS (5) can be added to further increase the storage capacity to 8x2 TBytes. In the near future, this model is expected to support 8x3 TBytes or 24 TBytes providing a net storage capacity of about 19 TBytes.

5.1.1.3. Storage of DPC historical data

The Data Management and Archiving requirements SR-DMA-FUN-0680, SR-DMA-FUN-0690 and SR-DMA-FUN-0700 from AD 4 ask for a 3-year long-term storage of all input data and of all data products generated by the DPC Block2. These requirements have an impact on the hardware architecture (for storage capacity) and database design (for data access).

The policy for the storage of the historical DPC Block2 data is the following:

- All input data “acquired” from real or simulated SAT-AIS data providers (raw AIS messages with ancillary data, auxiliary data) are stored for a duration of 3 years in the Block2 file-system, in their raw format (i.e. as received).
- All EO products received from EO data providers are stored for a duration of 3 years in the Block2 file-system in their raw format. This includes the VDRs and EO Level1 images and meta data, when available.



- The Data Management and Archiving subsystem provides archiving and restoring functions, that are started manually by the DPC Block2 administrator. These functions allow to generate archive files of all data older than a given threshold (e.g. 3 years), that can be moved on an external support such as tapes (out of the scope of the DPC Demonstrator). An inverse mechanism allows to restore the data from an external archive file.

As far as the DPC Block2 database is concerned, considering the very large number of AIS messages that would be collected by a future high performance SAT-AIS constellation (> 10 millions messages per day), it cannot be envisaged to have all AIS messages available on-line for a 3-year period.

- In order to improve the performance of queries related to large DB tables (e.g. historical AIS positions of ships), a partitioning mechanism of these tables shall be put in place. Partitioning allows to “cut” large tables into smaller parts, which can be accessed directly in order to accelerate DB queries. Partitioning is done according to a partition key, typically the date in the case of the DPC Block2 (e.g. one partition per day).

In the frame of the DPC Block2 Demonstrator, considering the much smaller volume of data that will be processed, the partitioning of the database is not envisaged. However, partitioning would have no technical impact and would not bring any new risk to the DPC Block2 system.

- Even with partitioning, the database performance - and the one of the whole DPC Block2 system - will dramatically decrease if billions of AIS messages are kept and accessible on-line. A shorter on-line duration (typically a few months) shall be defined in agreement with the users.
 - Beyond this duration, data shall be archived externally to the DB (in the file-system or on external support), using the archiving and restoring functions of the Data Management and Archiving subsystem described above. Once archived, data will be deleted from the database.
 - Upon user request, the archives corresponding to a given range of dates can be restored in the database, using an inverse mechanism.

Assessment of the storage requirements for a fully operational DPC with high performance SAT-AIS constellation will be performed in the DPC design phase.

5.1.2. Hardware architecture for the CCN1

5.1.2.1. Overview

The hardware used for the CCN1 is the one provided by EMSA in a single instance deployment. Network devices, as well as storage equipment (NAS) are also part of the infrastructure.

5.1.2.2. Storage of DPC historical data

Regarding data stored in the database, the same mechanism than in the demonstrator is implemented at EMS. Thus, a partitioning mechanism of the big tables is put in place.

For archiving, we consider, provided the specifics of DB schema (like spatial extensions) don't prevent it, the creation of jobs/schedule tasks responsible of:

- initializing the partitions for the next years;
- moving partition to transportable tablespaces;
- detaching transportable tablespaces older than 12 months (configurable) for archiving;
- manually restoring dumpfile and reattaching the archived partition to online DB.



5.2. System Level

5.2.1. For the DPC Block2 Demonstrator

The primary and backup environments logically consist of one or more application servers/machines hosting the various DPC subsystems and one or several database servers/machines.

We propose having these servers/machines as virtual machines using VMWARE ESX. Using virtualisation, n virtual machines may run on m physical machines, with n typically (strictly) greater than m . The number of machines can be easily increased as explained in § 5.1.1.2 detailing the hardware scalability, if the average load on the physical servers is considered too high. For the Demonstrator, m will be 1 as only one physical machine has been quoted per environment (1 for primary and 1 for backup).

For the demonstration of scalability, we also propose to use multi database nodes approach (DB spread on several machines) instead of a single DB server approach.

5.2.1.1. Database scalability using multiple DB nodes

The DPC services are accessible to other applications (machine to machine) which may heavily query the database. In parallel, the DPC Block2 shall continue to perform AIS data acquisition, processing and distribution with unaffected performance, so that the timeliness requirements are respected. Thus, it is important that the Block2 database is designed so that it does not become the bottleneck of the system.

The proposed approach is to have scalability through DB replication. The concept is to limit the contention between DB queries on a single DB server (mainly due to data locking, number of connections and CPU allocation) by distributing the queries on a given number of copies of the DB. This requires:

- Replication mechanisms that are efficient, reliable and with controlled lag
- Query distribution mechanisms: to be able to distribute the queries on the master and replicated DB, ideally with load-balancing features

This will be achieved using PostgreSQL mechanisms, combined with external tools, to set-up an asymmetric and asynchronous replication: writing queries are made only a “master” DB; the replication of data is propagated to one or several “slave” DBs, which can only access read-only queries.

The replication of DB updates on the Master DB is performed at a differed time to the Slave DB(s). The advantage is that the write queries on Master DB are well isolated from the Slave DB; hence performance of slaves and replication channel have no direct impact on master performance. The drawback is that there is a lag in the replication, leading to transient differences between Master and Slave DB(s); however, this can be mitigated by using streaming replication (see below).

The following techniques / tools of PostgreSQL will be used for replication and scalability of the database:

- Hot-Standby: the “Slave” DB’s are accessible at any time for read-only queries. Hot-Standby is useful for scalability since it allows distributing read-only queries on a pool of DBs.
- Streaming replication: allows for sending WAL (Write Ahead Log) records instead of whole files. The standby server connects to the primary, which streams WAL records to the standby as they’re generated, without waiting for the WAL file to be filled. The replication remains asynchronous but the replication lag becomes very short and can be as little as a single transaction.
- Load-balancing: the scalability requirement entails that the distribution of queries on available DBs (Master and Hot-Standby slaves) shall ideally be made through a load-



balancing mechanisms. This will be achieved through a DB connection pooler (pgpool-II) with load-balancing as an added-value function, amongst others.

5.2.1.2. Possible enhancements to virtualization for system scalability

The proposed configuration for the DPC Block2 Demonstrator can be enhanced by using VMWare DRS and VMotion. The extension with VMWare DRS and VMotion will not be delivered as part of the demonstrator but is described to illustrate the scalability of the proposed architecture for coping with future growth.

When a virtual machine experiences an increased load, VMware Distributed Resource Scheduler (DRS) would automatically allocate additional resources by redistributing virtual machines among the physical servers in the resource pool. DRS thus takes care of the load balancing.

The resource allocation changes can be automatically executed by performing live migration of virtual machines through VMware VMotion. Alternatively, in manual mode, VMware DRS provides execution recommendations for system administrators.

DRS has the following advantages worth mentioning as well:

- Prioritize resources to the highest value applications in order to align resources with business goals.
- Optimize hardware utilization automatically and continuously to respond to changing conditions.
- Provide dedicated resources to business units while still profiting from higher hardware utilization through resource pooling.
- Conduct zero-downtime server maintenance.

The addition of VMware DRS and VMotion would have no technical impact to the proposed system architecture, and would not bring any new risk to the DPC Block2 system.

5.2.2. For the CCN1

As we do for the demonstrator and since the EMSA infrastructure allows it, we propose to use virtual machines using VMWARE ESX, hosting all the S-AIS DPC sub-systems. The system topography will be refined during design phase in order to keep performance and liveliness of the processing.

Known elements of EMSA infrastructure involved in the DPC Block2 architecture are:

- Oracle RAC (Oracle 11g Release 2 Enterprise Edition - at time of writing) with Locator extension enabled.
- JMS servers, configured in clusters, which support failover of broker and/or load balancing of messages.

5.3. Software Level

5.3.1. Introduction

Expectations

From a functional point of view, DPC Block2 will provide a complex layer for processing SAT-AIS data, enhancing its quality, archiving and distributing (enhanced or not) SAT-AIS data products. SAT-AIS data enhancement will be based on the integration of SAT-AIS data (as received from the ground stations) with SAT-AIS ancillary data information and auxiliary information.

According to AD 1, the scope of functionalities covered by the system results in the following services:

- Service 1 (S1) "AIS messages provision"



- Service 2 (S2) “Missing AIS Messages detection service”
- Service 3 (S3) “Enhanced AIS messages service”
- Service 4 (S4) “Predicted AIS messages service”
- Service 5 (S5) “AIS messages with EO data service”
- Service 6 (S6) “SAT-AIS information”

Solution

The component diagram of Figure 8 shows the coarse breakdown of DPC Block2 System into architectural elements and relationships among them..

System is composed of 8 subsystems:

- Data Retrieval: subsystem in charge of acquiring all data (SAT-AIS messages with ancillary data, EO data, auxiliary data) from several providers and making them available in the system.
- Data Processing: subsystem in charge of processing, validating and enhancing SAT-AIS messages.
- Data Prediction: subsystem providing services to simulate a complete SAT-AIS system as well as to predict the position of a given ship (future and past).
- Data Management and Archive: subsystem that provides the system with the storage and the retrieval of all DPC Block2 data from a database or files system.
- Monitoring, Command And Control: subsystem in charge of monitoring and controlling the execution of the whole system.
- Data Distribution: subsystem dedicated to the external interfaces provided to the DPC end-users.
- SAT-AIS System Performance Monitoring: subsystem dedicated to the measurement of the performances of the SAT-AIS systems.
- Enterprise Service Bus: subsystem forming the backbone of the DPC Block2 system enabling SOA architecture.

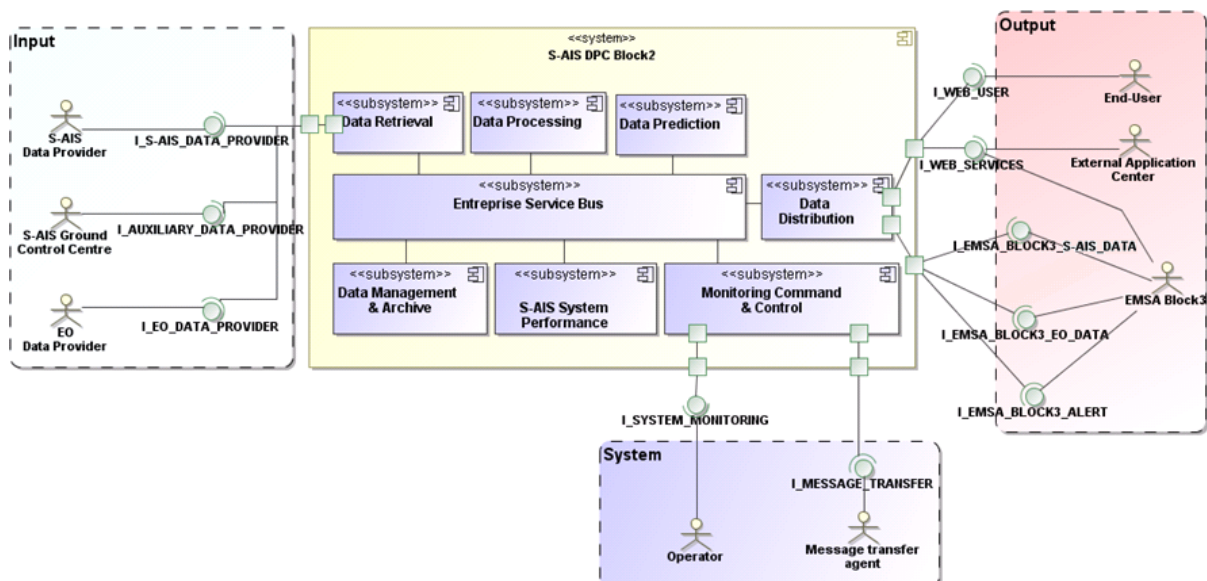


Figure 8 - DPC Block2 High Level Architecture



One or several of these subsystems perform a high-level service, as shown by the following matrix.

Service/ Subsystem	S1 AIS messages provision	S2 Missing AIS Messages detection service	S3 Enhanced AIS messages service	S4 Predicted AIS messages service	S5 AIS messages with EO data service	S6 SAT-AIS information
Data Retrieval	✓					
Data Processing	✓	✓	✓		✓	
Data Prediction		✓	✓	✓		
Data Management and Archive	✓	✓	✓	✓	✓	✓
S-AIS System Performance						✓
Monitoring, Command and Control		✓	✓	✓	✓	✓

Table 2 - Services to Subsystems matrix

Rationale

The DPC Block2 architecture is the result of analysis taking into account:

- the critical analysis of the requirements from AD 4,
- the preliminary high level architecture provided in RD 1,
- the separation of roles into functional or technical independent components providing one or several services.

This architecture is the assembly of elements that are:

- interoperable: ESB subsystem is responsible for ensuring that subsystems can exchange information and use the information
- well-defined: Sub-systems has been cut down respects the Separation of Concerns (SOC) principle.
- independent: Subsystems does not depends to other subsystems in the respect of the Inversion of Control (IoC) software paradigm. This allows the sub-systems to be easily composed and involved in complex scenarios to produce higher functionalities.
- loosely coupled: The services provided by the subsystems emphasize the "contract" rather than the underlying implementation details, and rely on standard network-oriented protocols like HTTP.

This makes the architecture of the DPC fully SOA.

5.3.2. Enterprise Serial Bus (ESB) Subsystem

The following chapter focuses on the ESB, the backbone of the DPC Block2 System.

5.3.2.1. ESB for SOA

Expectations

According to SR-DPC-DES-1940 and SR-DPC-DES-1950, the development, upgrading, testing and operations of the modules shall be based on the principles of SOA, which should enable the integration of the existing applications as well as newly developed services.



Solution

In the context of the DPC Block2, the ESB is a bus into which every service (subsystem or component) is plugged. The following diagram illustrates the contribution of the ESB in the DPC Block2 system architecture.

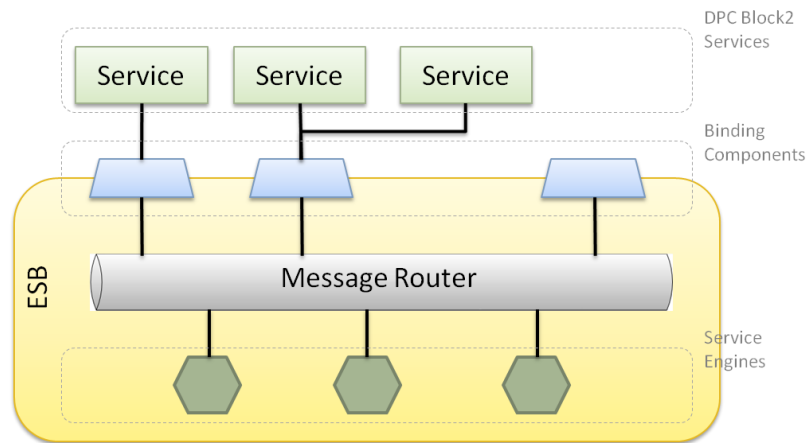


Figure 9 - SOA architecture of the system with the usage of an ESB

The services are integrated in the ESB through a specific “Binding Component” that converts the service request/response to internal message formats compatible with the message router. Given that some services of the DPC Block2 are in fact legacy applications, the use of specific binding components is necessary as long as they do not provide standardized interfaces (WS-*, FTP, JMS, etc.). For the ones that provide standardized interfaces, the ESB can easily integrate them, without any further integration layer.

At the heart of the ESB, the message router is in charge of routing messages (with eventual transformations) from one service to another.

ESB provides a set of Service Engines that can be used in the DPC Block2. This is the case of the BPMN, a graphical notation that can be run by a BPMN Service Engine. Thus the business logic of orchestration is totally managed and can be easily monitored.

Rationale

Enterprise Service Bus (ESB) is an integration tool/middleware that enables the use of SOA architecture while preserving existing software developments. It is an architectural solution to guarantee the flexibility, reliability and scalability of a system (or a set of systems).

The main benefits that are drawn are following:

- The ESB provides out-of-the-box functionality such as file polling, scheduling, scripting, notification service (e.g. WS-Notification), BPEL engine, security enforcement, mediators, etc.
- The ESB increases flexibility and is resilient to changes.
- The ESB provides a central point (bus) where monitoring, logging, and auditing can be performed on all client applications/services interactions and usually provides a console to access this information.
- Due to its (distributed) bus architecture, the ESB leads to solutions that are highly scalable.
- The ESB is highly configurable and typically stores this configuration into a Registry that can easily be replicated for redundancy reasons.



5.3.2.2. ESB for Performance

Expectations

DPC Block2 System processing shall be optimized so that it does not add significant delays to the distribution of data to EMSA Block3. The DPC Block2 data processing should allow complying with an overall timeliness requirement of 1 hour and a time update interval of 3 hours in all regions once the future high performance SAT-AIS constellations are available.

Solution

In the DPC Block2 system, every subsystem identified in § 5.3.1 is published as a proxy on the ESB. In that perspective, every subsystem can be instantiated and declared more than once.

The following diagram illustrates the deployment of several components onto the ESB in the DPC Block2 system architecture.

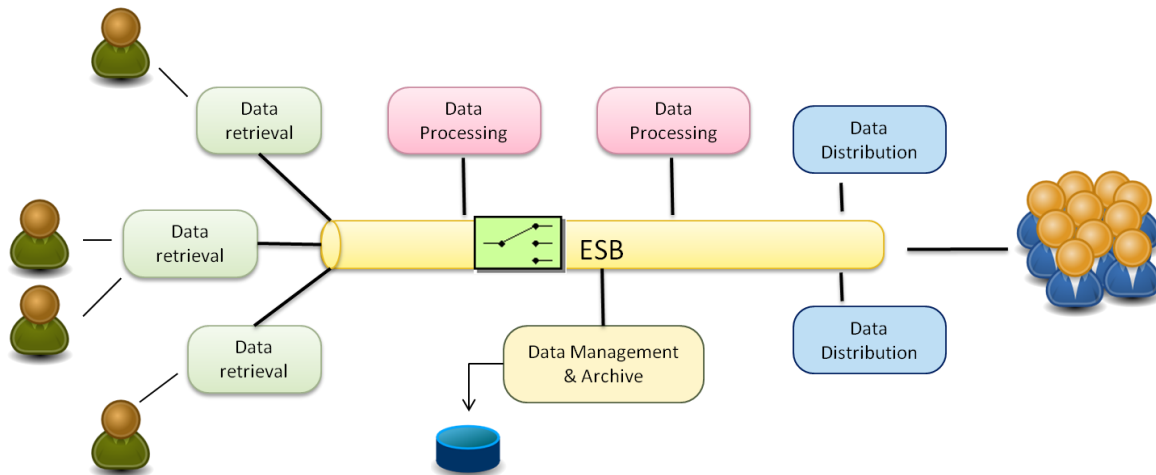


Figure 10 - Distribution of components onto ESB

The given architecture allows distributing the load between the available service instances with the help of the ESB.

Since the ESB is the centre where all the messages transit, it becomes the bottleneck of the system. So the load balancing can be pushed a little further by load balancing the ESB itself. ESBs being clusterables, they share the same configuration. In that context, an additional hardware device, a load balancer box, is necessary to balance the requests between the different ESBs.

The following diagram illustrates the deployment of several components onto several ESB instances in the DPC Block2 system architecture.

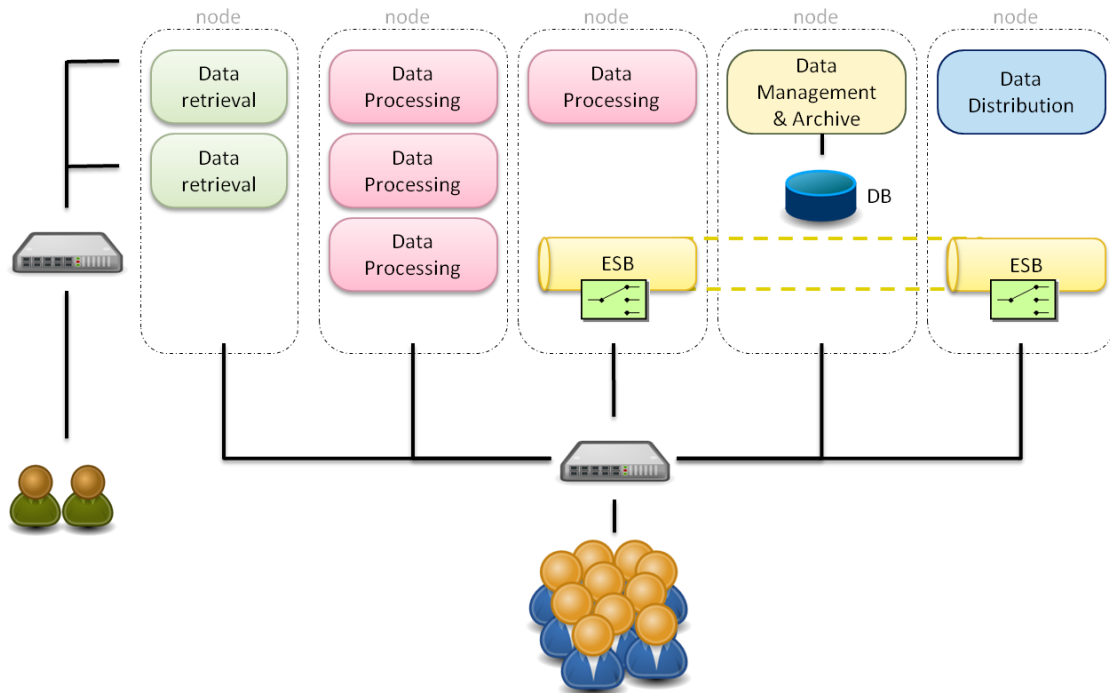


Figure 11 - Distribution of components onto a cluster of ESBs

The given architecture allows distributing the load between all subsystems without any bottleneck.

Rationale

Since every service invocation pass through the ESB, it can distribute the messages to multiple services. The incoming requests are redirected to the recipient in a round robin manner.

This load-balancing method increases the overall message throughput, since incoming messages are now processed by multiple instances of a service, typically running on different machines (or being processed by separate threads on a single machine).

If the number of requests coming through the ESB increases, according to requirement SR-DPC-DES-1950, the limit can be reached. In that case the ESB is distributed on several servers which means to group ESB instances in a cluster. The ESB instances must then be configured to share the same repository.

5.3.3. Service design

5.3.3.1. Patterns for information exchange

Expectations

According to SR-DPC-PER-0210, the DPC Block2 System shall be optimized so that it does not add significant delays to the distribution of data to EMSA Block3. The network resources used to establish a communication channel shall be moderated.

The system shall then adopt the most appropriate pattern for information exchange within the system that complies with the performance requirement.

Solution

In the DPC Block2 system, the subsystem and components will mostly adopt the callback pattern to exchange information through the ESB, especially for the “business” services. The following components are identified to provide a callback-oriented service (not exhaustive):



- **Data Distribution:** The Data Distribution feeds the system with new incoming data without being asked to deliver them. This is a callback call without initialization, also called “push” pattern.
- **Data Processing:** The Data Processing takes data as inputs from a provider (Data Distribution), process them for a while, and return results to several consumers (other Processing stages, Data Distribution, Data Management and Archive) via a callback/push mechanism.
- **Data Management and Archive:** The Data Management and Archive delivers the data in response of a query through a callback mechanism.
- **Data Distribution:** The Data Distribution disseminates data to external users through a callback mechanism.

Rationale

From a functional point of view, the main DPC Block2 scenario consists in a chain of processing that takes incoming data, performs a processing, and disseminates data.

- Synchronous request/response pattern

This is the most widely common pattern used to interface a service with a consumer. The following diagram illustrates this pattern.

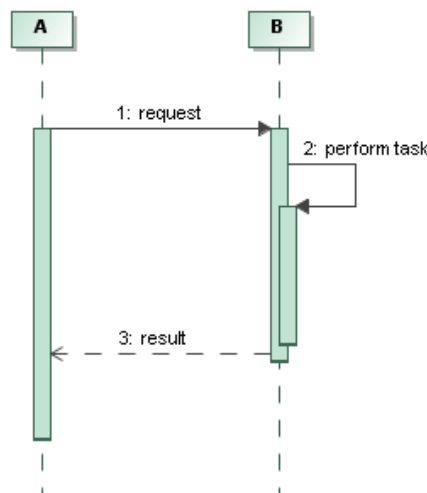


Figure 12 - Synchronous request/response Pattern

For example, the Data Retriever subsystem publishes an interface to retrieve new available data. In a blocking synchronous request, the consumer waits until the Data Retriever subsystem can feed it with data.

This approach leads to several problems of resource efficiency, especially network resources and the availability of the server. That's why this choice is removed.

- Polling pattern

This is an asynchronous pattern where the consumer asks regularly if new data are available, and if so, it fetches them. The following diagram illustrates this pattern.

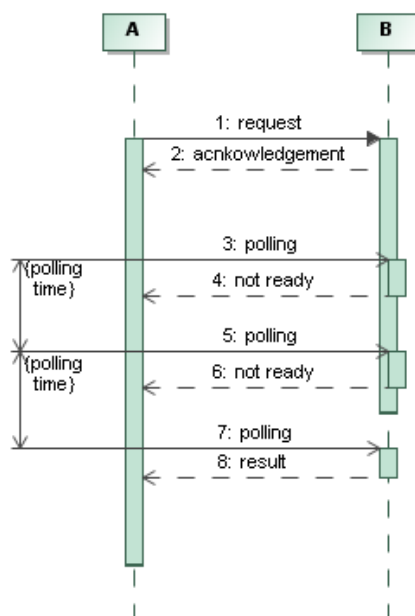


Figure 13 - Polling Pattern

This approach avoids maintaining the network link but requires multiple calls to the server at a certain frequency (polling time in the diagram).

The pitfall here is that, if the adjusted frequency is high, the system is very reactive but wastes a lot of network resources. In contrast, if the adjusted frequency is low, consumption of network resources can become acceptable but not responsiveness. That's why this choice is removed.

This pattern is compatible with many protocols including WS-*.

- Callback pattern

This is an asynchronous pattern where a request is made to the provider and a response is send back to the requester when it is ready. The following diagram illustrates this pattern.

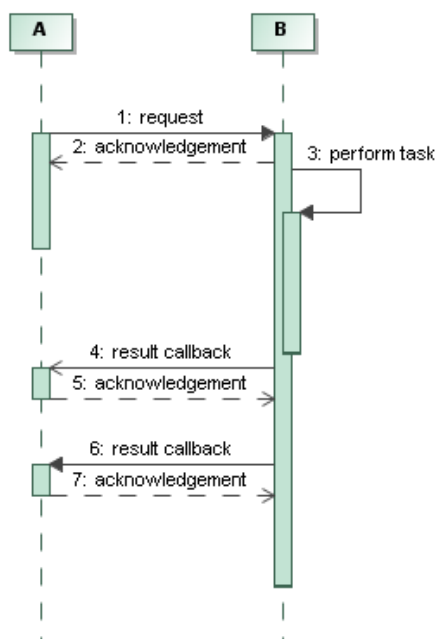


Figure 14 - Callback Pattern



The advantage is that, once the request is made, it proceeds with its own execution. When the response is completed, the provider sends it to the requester.

This pattern expects to return several responses for a single request (response fragmentation) that increases the reactivity of the system.

A variant of the pattern is when the recipient is not the initiator of the request. In that case the Callback Pattern is much like a “push” pattern as the following diagram shows.

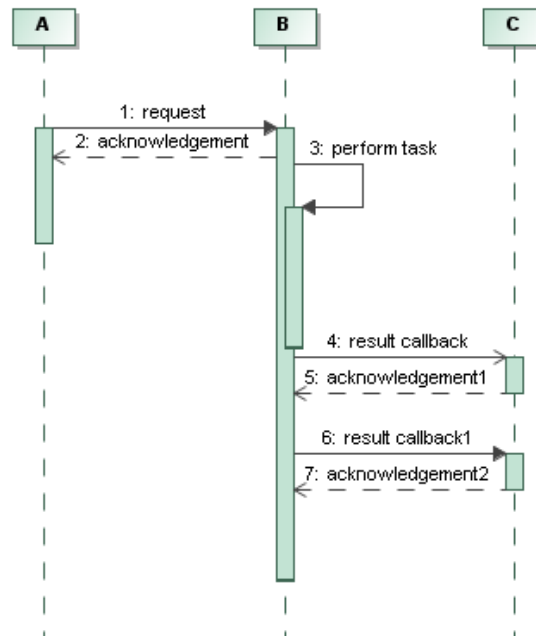


Figure 15 - Callback/Push Pattern

This pattern is compatible with several protocols including WS-*.

5.3.3.2. Communication channels

Expectations

The DPC Block2 System shall be designed to be capable of handling the load when new S-AIS space segments and data providers become available.

Solution

Within the DPC Block2 System, we distinguish the data flows and the control flows:

- The control flow is implemented via WS-* invocation and contains the minimal and necessary information. In particular, the control flow contains a reference to the data.
- The data flow contains the payload message. Data are transmitted via files shared on the network file system.

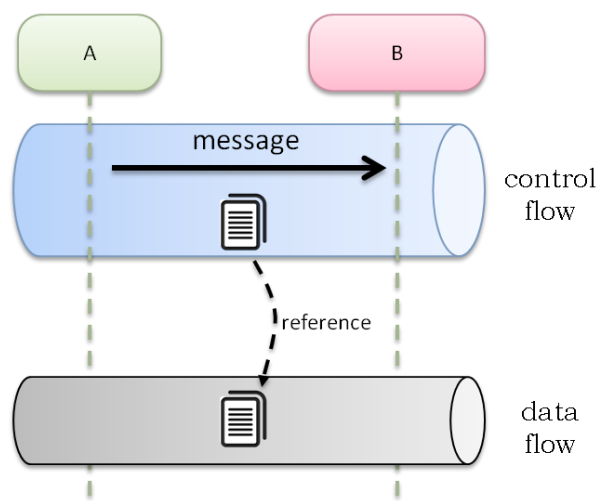


Figure 16 - Two channels communication

Rationale

In the chapter §5.3.2.2, the ESB element has been introduced as a solution for the increase of the message throughput in the DPC Block2 system, and the chapter §5.3.3.1 has defined the pattern for the information exchange that increases the reactivity of the DPC Block2 system.

But another aspect is important is the message payload. If the message is big it consumes time and resources to be routed through the several layers of the infrastructure.

To contravene this problem, the flow of exchange is divided into two, one for the control using the regular WS-* protocol, and one for the data using a shared file system.

In this architecture, large data does not transit through all the layers of the infrastructure, until it becomes really useful, in which case it is accessed.

5.4. Main scenarios for the provision of Block2 services

As seen in the chapter introducing ESB §0, ESB provides services for coordination and orchestration of the processing. This service is an engine that can run business workflows described using a notation (eventually graphical).

In that chapter, the BPMN notation is used as it is a well known graphical flow-chart notation for defining Business Processes.

The given chapter develops the main scenarios that relate the business activities being processed. Five scenarios are considered. The following matrix traces the coverage of each scenario with the services from AD 1 (“p” symbol stands for partial coverage, “✓” total coverage).

Service/ Scenario	S1 AIS messages provision	S2 Missing AIS Messages detection service	S3 Enhanced AIS messages service	S4 Predicted AIS messages service	S5 AIS messages with data service	S6 SAT-AIS information
Scenario 1	p	p	p	p	p	p
Scenario 2	✓		✓			
Scenario 3					✓	
Scenario 4		✓				



Scenario 5



Table 3 - Scenario to Services matrix

5.4.1. Scenario 1 - Data Provision

The scenario presents the business process that consists in provisioning the SAT-AIS DPC Block2 with all the incoming data. The scenario is a prerequisite for the realization of S1 to S6 services.

The BPMN diagram below shows the main dataflow and the components involved in this scenario.

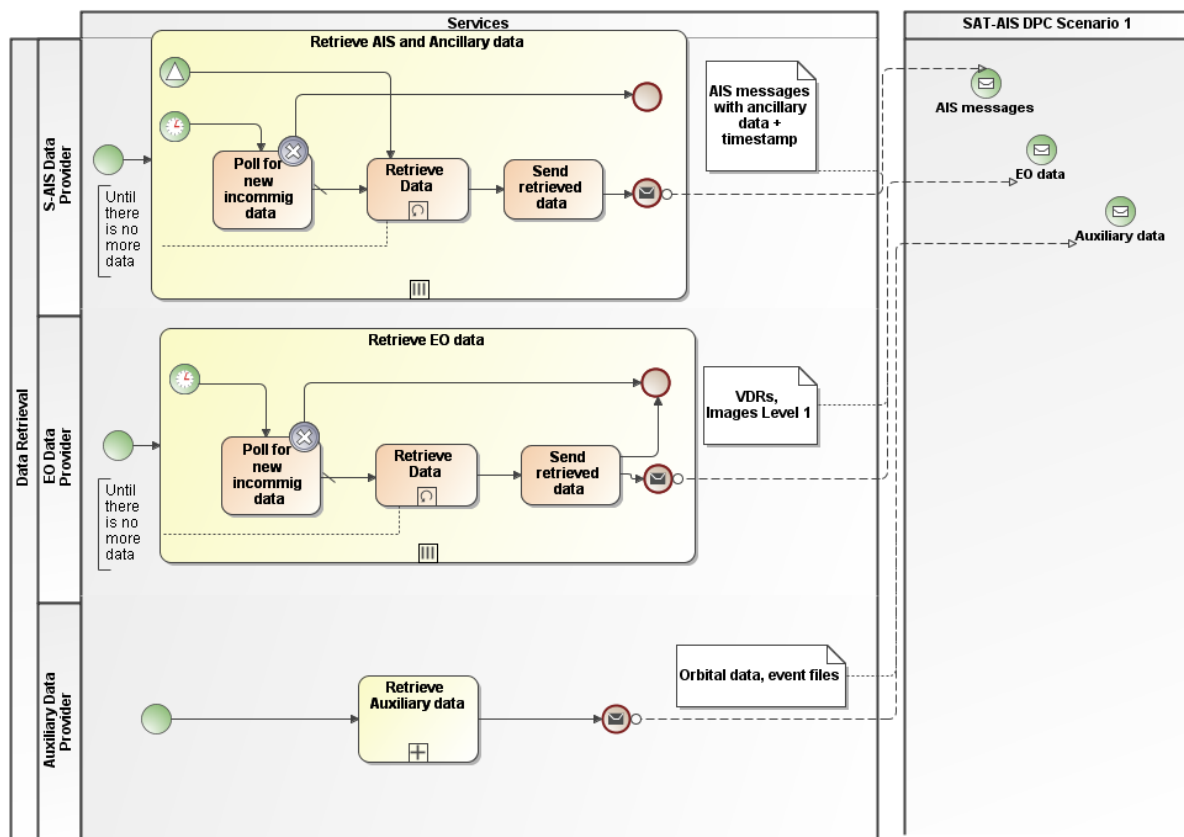


Figure 17 - DPC Block2 Scenario 1

The diagram splits into two:

- On the right the business process in-itself, containing the orchestration directives and responsible for chaining services in order to provide the business functionality.
- On the left the available services implemented by the components in the ESB. The components are represented in horizontal “lanes” for each subsystem.

The DPC Block2 runs the available providers component in an autonomously and independently way. For the sake of clarity, the main tasks are detailed in the BPMN sub-process but may be subject to minor changes during the design phase.

For the Sat-AIS Data Provider Component, the activities are following:

- For “passive” providers like those publishing FTP/SFTP interfaces, the retrieval component regularly polls for new available data. For the ones that publishes data through TCP protocol, newly data are considered as an external event.
- If newly data actually exist, the component takes in charge the retrieval task.



- Once done, the component “fires” an event about the availability of new incoming (raw) SAT-AIS messages.

For the EO Data Provider component, the activities are following:

- The retrieval component regularly polls for new available data.
- If newly data actually exist, the component takes in charge retrieval task.
- Once done, the component “fires” an event about the availability of new incoming EO data.

For the Auxiliary Data Provider component, the activities are the same than the EO Data Provider component. The component “fires” an event about the availability of new incoming Auxiliary Data.

5.4.2. Scenario 2 - Processing of SAT-AIS data

The scenario presents the business process that consists in processing incoming SAT-AIS messages. The scenario 2 covers the S1 and S3 services.

The BPMN diagram below shows the main dataflow and the components involved in this scenario.

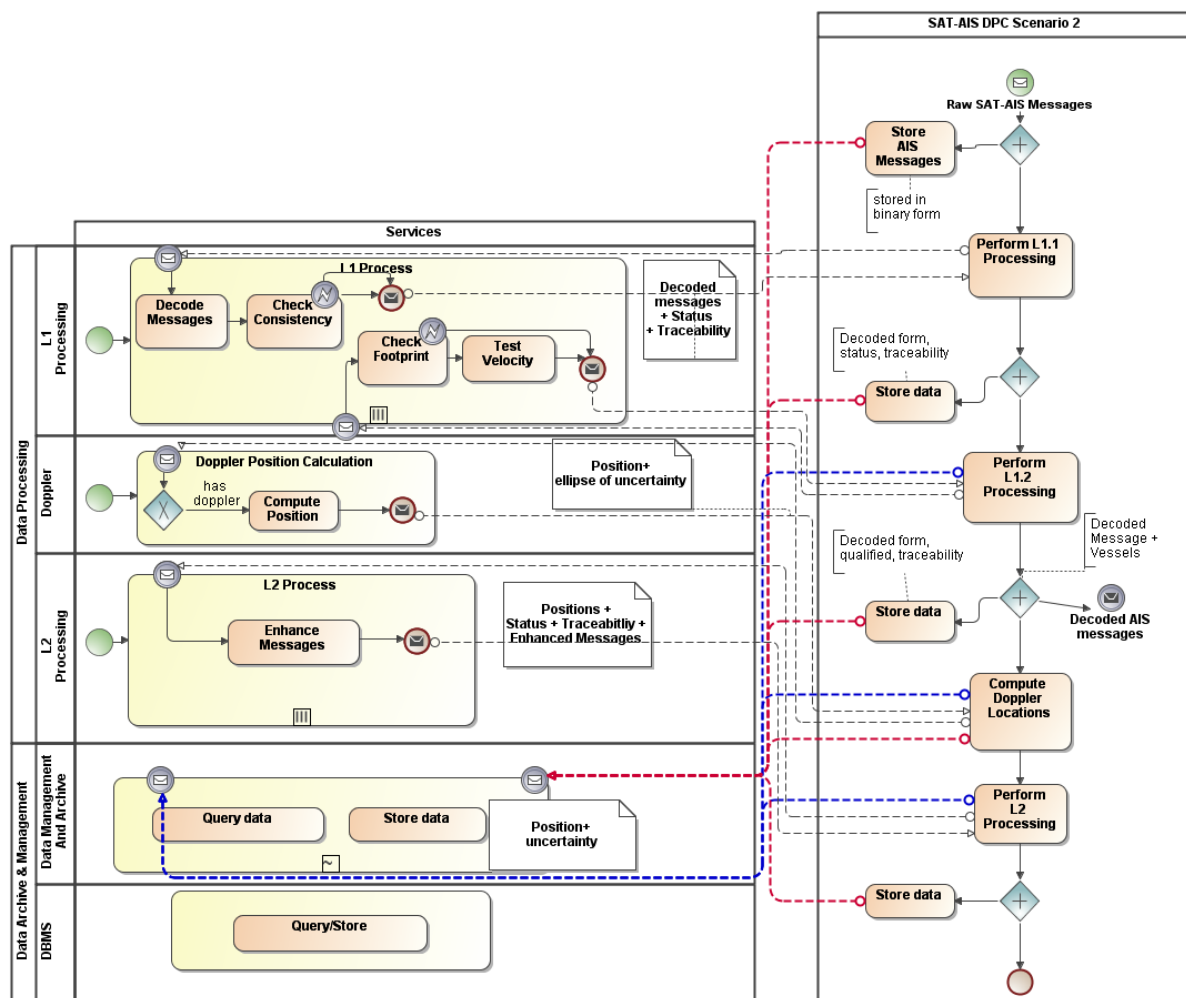


Figure 18 - DPC Block2 Scenario 2

The diagram splits into two:



- On the right the business process in-itself, containing the orchestration directives and responsible for chaining services in order to provide the business functionality.
- On the left the available services implemented by the components in the ESB. The components are represented in horizontal “lanes” for each subsystem.

The scenario starts when a new Raw SAT-AIS message has been notified. It is worth pointing out that raw SAT-AIS messages can come with an already decoded format (like EMSA CDF) which may contain or not the NMEA v4 sentence.

At start, the scenario asynchronously runs a task to store the incoming data in the database. For that, the task relies on the services of the Data Management & Archive component.

The scenario then continues with the different processing layers (L1 and L2).

The first steps concern the L1 process. Its purpose is to check whether the incoming SAT-AIS messages are valid or not, and provide at the end, a decoded form of the messages. For that, two sub-processes are necessary:

- L1.1: this sub-process is in charge of testing both the syntactic level and decoding the AIS messages into a textual representation. In cases where the AIS message format includes both NMEA v4 sentence and a decoded representation (EMSA CDF), it is assumed that the NMEA v4 is used to perform the processing, otherwise the decoded information is used instead.
- Control of the CRC, if CRC is provided. If not, it is assumed the CRC check was performed by the SAT-AIS data provider, and that the message CRC is correct.
- Decoding of the message (conversion of binary message to structured fields and values, according to the AIS message type).
- Message consistency checks: message length, fields with respect to bounding values, consistency of static information vs ships database.
- L1.2: this sub-process performs semantic checks of the previously decoded AIS messages:
 - For AIS position reports, check that the reported position is inside the satellite footprint.
 - For AIS position reports, test on the average velocity between consecutive positions (taking into account the uncertainty of the GPS positions).

The L1 process relies on the services of the Data Management & Archive component if contextual information is needed by the activity. This is the case for the L1.2 sub-process which needs the last positions of the vessels – for the velocity check – and the ephemerides of the satellite – for the satellite footprint check –.

At the end of the L1 process, a valid/invalid status is attributed to the message depending on the results of the different tests.

The scenario asynchronously runs a task to store the processed data in the database. For that, the task relies on the services of the Data Management & Archive component.

The scenario orchestrates the calculation of data necessary for the next step, which is the L2 process. It should be noted that once AIS messages have been decoded, scenario 2 also starts the scenario 3 which performs the correlation with EO data (L3 process).

The L2 process is applied:

- to the AIS messages with ancillary data that include Doppler shift measurements, with the objective of calculating a Doppler location and then compare it to the AIS positions.
- to the AIS position reports that have been considered as invalid according to the L1 process, with the objective of recovering the messages.

As far as Doppler calculation is concerned, the activity prepares a set of data (Doppler shift measurements - timestamp - satellite position at the same date/time, sorted by vessels) and transmits it to the Doppler component. The Doppler component computes positions (if enough measurements are available), characterized by an ellipse of uncertainty. The result of the Doppler calculation is returned and finally stored in the database.

The next step is the L2 process task itself.



- On the left the available services implemented by the components in the ESB. The components are represented in horizontal “lanes” for each subsystem.

The scenario starts either when acquisition of new EO data has been notified, or when new decoded AIS messages have been processed by the scenario 2:

- Upon acquisition of new EO data, the scenario asynchronously runs a task to store the incoming data in the database. For that, the task relies on the services of the Data Management & Archive component. Note that depending on the nature and size of the incoming data, the persistence may consist only in storing data in file system, and simply reference it in the database.
- Upon acquisition of new Decoded AIS Messages produced by the scenario 2, the scenario starts a sub-process dedicated to the selection of EO data that are candidates for an EO correlation. The criteria for selection are not described here and are detailed in the specification part of the L3 Process.

The scenario then continues with the L3 processing stage.

Based on the received VDRs, the scenario selects from the database the decoded AIS positions that could be correlated by the EO correlation: all AIS positions within the same timeframe and same geographical area are returned, in order to define a list of candidate ships. For that, the task relies on the services of the Data Management & Archive component.

The set of AIS position messages returned by the sub-process can be larger than the one received from the L2 Process, in case where the scenario would have been triggered by the arrival of new AIS Position Messages. This is important for the effectiveness of the processing, especially for the predicted position calculus.

At last, the scenario performs the EO data correlation which tries to relate VDRs with the reported positions. If correlation is successful, then the AIS messages of the “best” candidate ships are enhanced by adding a flag indicating the match between the VDR and the AIS position. Traceability is updated accordingly to reflect any changes.

The scenario asynchronously runs a task to store the processed data in the database. For that, the task relies on the services of the Data Management & Archive component.

The scenario ends.

5.4.4. Scenario 4 - Missing AIS Messages detection

The scenario presents the business process that consists in detecting missing AIS messages. The scenario 4 covers the S2 service.

The BPMN diagram below shows the main dataflow and the components involved in this scenario.

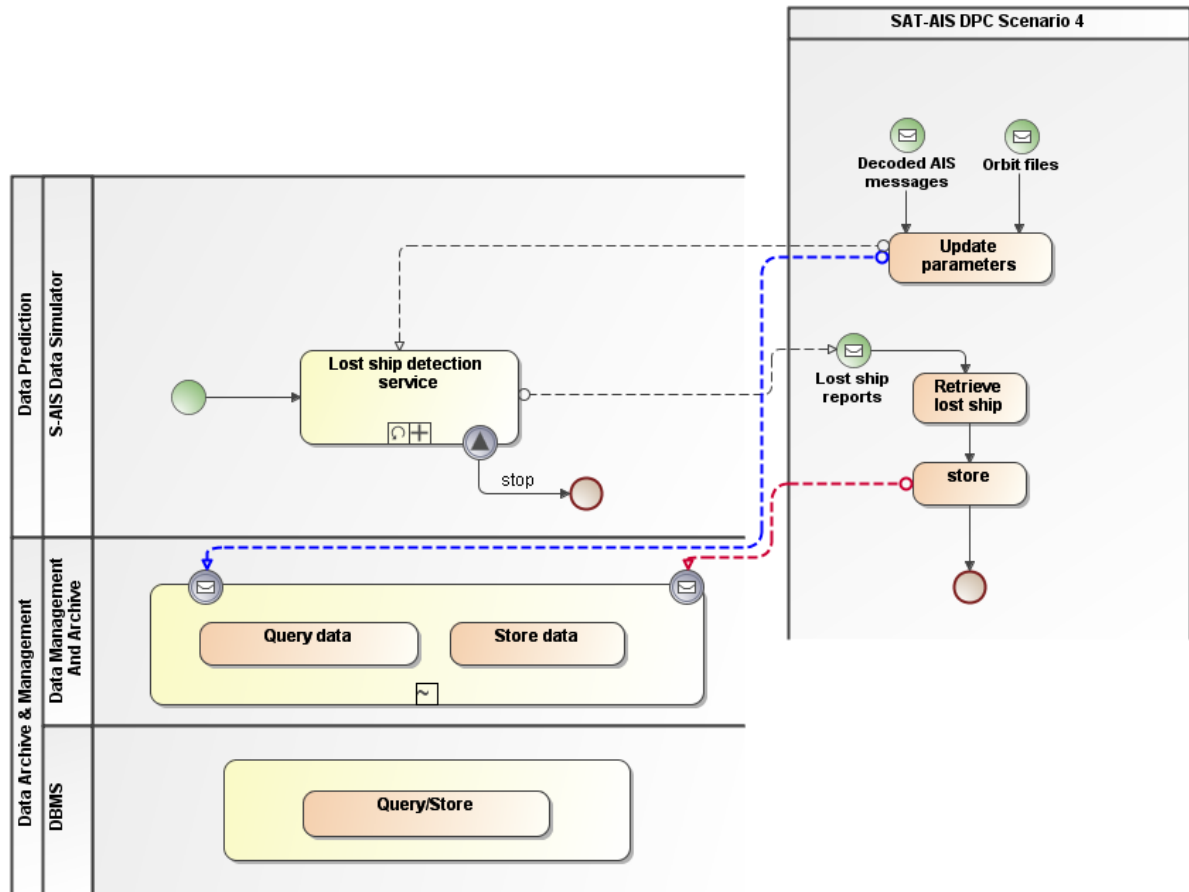


Figure 20 - DPC Block2 Scenario 4

The diagram splits into two:

- On the right the business process in-itself, containing the orchestration directives and responsible for chaining services in order to provide the business functionality.
- On the left the available services implemented by the components in the ESB. The components are represented in horizontal “lanes” for each subsystem.

The DPC Block2 continuously runs independent instances of the SAT-AIS simulator, each instance being configured to simulate a given SAT-AIS data provider (space assets, ground station, and geographic coverage area). The simulator calculates the cumulated detection probability of vessels, and is configured to compare this probability to the AIS message flows provided by the SAT-AIS providers. If vessels have not been detected while their detection probability is above a configurable threshold, “lost ship” reports are generated.

The scenario has two independent activities:

- The first activity is started when new Decoded AIS messages or new orbit/events files (including updated orbital elements) have been received. In that case, the scenario runs a task to update the simulator with the new incoming data:
 - Reset of the detection probability of ships that have been detected
 - Update of orbital elements for satellites orbit calculation
- The second activity starts after a “lost ship” report as been generated by the simulator. In that case, the scenario consists in storing the content of the report into the database thanks to the Data Management and Archive component.

The scenario ends.



5.4.5. Scenario 5 - Predicted messages

The scenario presents the business process that consists in providing predicted AIS messages, based on previous positions from the same ship. Scenario 5 covers the S4 service.

The BPMN diagram below shows the main dataflow and the components involved in this scenario, especially the Ship Prediction component and the S-AIS Data Simulator component.

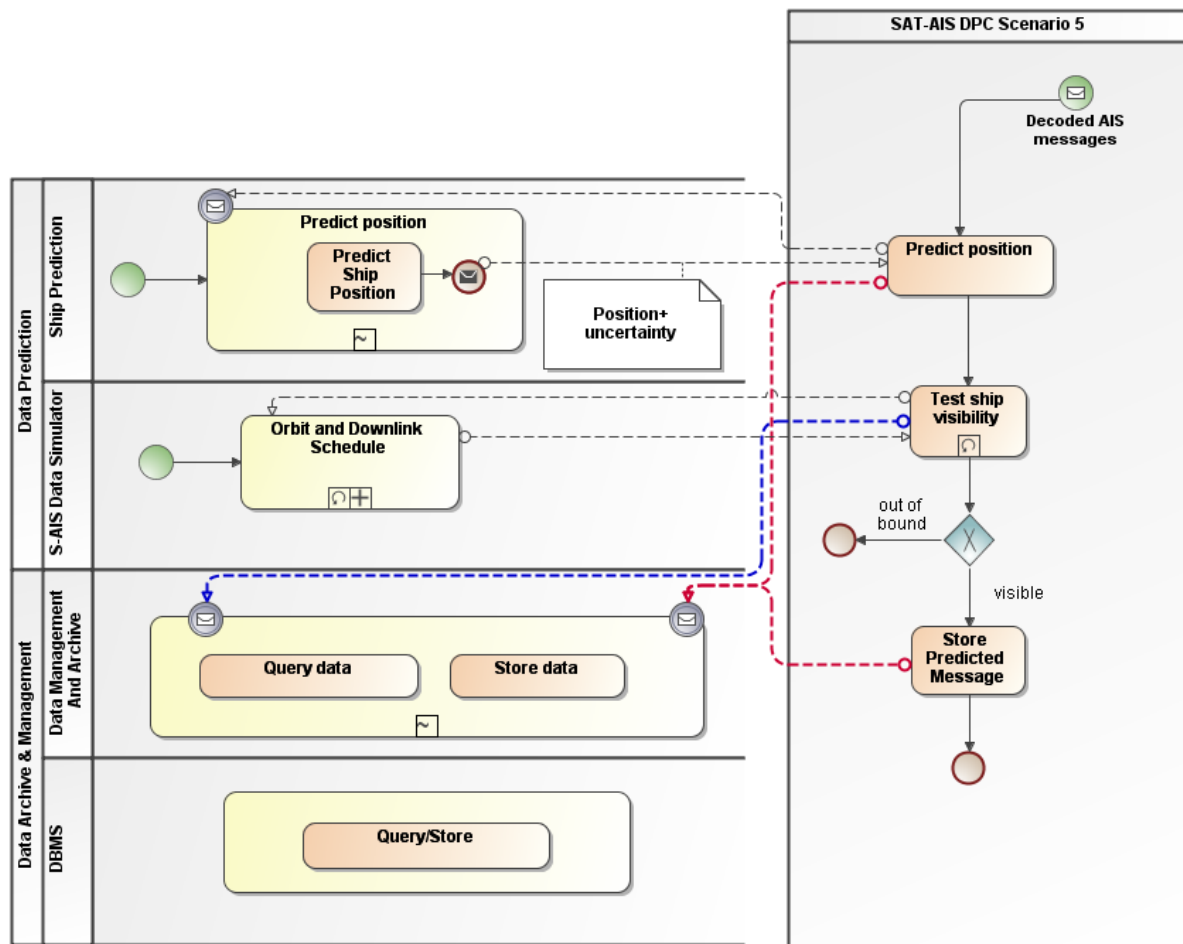


Table 4 - DPC Block2 Scenario 5

Like the others BPMN scenario, the diagram splits into two:

- On the right the business process in-itself, containing the orchestration directives and responsible for chaining services in order to provide the business functionality.
- On the left the available services implemented by the components in the ESB. The components are represented in horizontal “lanes” for each subsystem.

The scenario starts when new decoded AIS messages are available in the system.

DPC Block2 continuously maintains the predicted positions of ships that have been recently detected, so that predicted positions are available in advance and not calculated upon request. This is because the ship prediction algorithm can be time consuming especially when a large number of vessels is considered. The predicted positions are calculated using the Ship Prediction component. Upon reception of new decoded AIS messages, the first task of the scenario is then to recalculate and update the predicted positions for the vessels that have been detected. The predicted positions are stored in the database thanks to the Data Management and Archive component.



The second task of the scenario is, using the predicted positions, to test the visibility of ships using the SAT-AIS simulator. When the simulator calculates that a ship is detected, the corresponding AIS messages is synthesized and stored in the database thanks to the Data Management and Archive component.

The detailed algorithm of this process shall be detailed during the system design phase.

The scenario ends.

5.5. DPC Block2 subsystems breakdown

The following sections describe the role, components, and interfaces of the subsystems that constitute the DPC Block2.

5.5.1. Data Retrieval

5.5.1.1. Overview

The subsystem is aiming at acquiring all data from the identified providers (SAT-AIS Data Provider, EO Data Provider and S-AIS Ground Control Centre) and make them available to the other subsystems without any further processing other than adding necessary elements of traceability (source, date). The nature of the data is mainly SAT-AIS messages with ancillary data, earth observation data (VDRs and level 1 images), orbit data files, ground station status, satellite and payload status.

For that purpose it is composed of three components, one for each provider. The following component diagram shows the subsystem in its ecosystem.

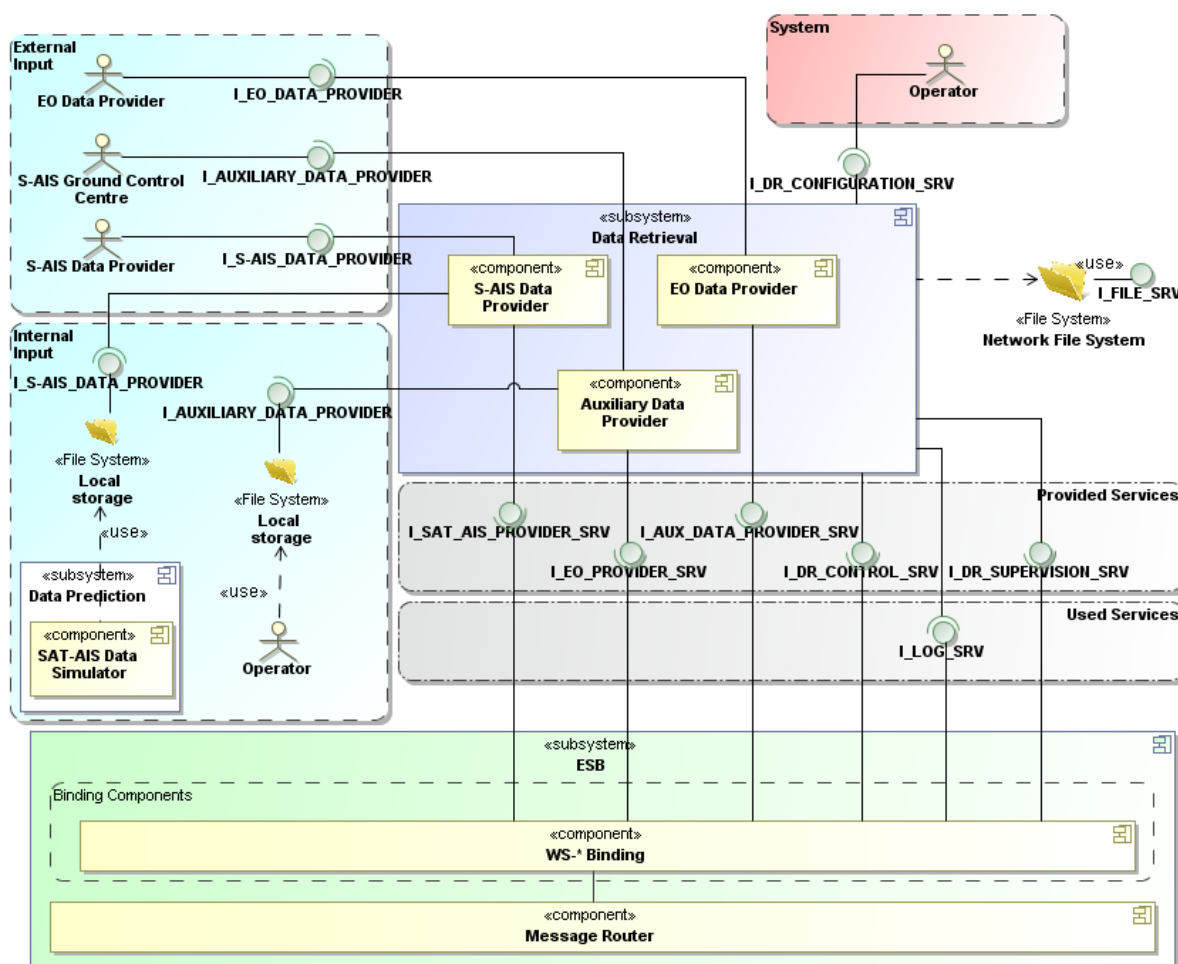


Figure 21 - Data Retrieval Subsystem Overview

The Data Retrieval subsystem, at the center of the diagram, is composed of three components:

- The S-AIS Data Provider Component able to acquire SAT-AIS messages,
- The Auxiliary Data Provider Component able to acquire Auxiliary Data,
- The EO Data Provider Component able to acquire EO data.

These components can be instantiated several times and are independent from each other in line with the SOA philosophy. Thus, parallel execution is allowed.

On the left of the diagram are represented the input of the Data Retrieval subsystem. Two kinds of inputs are available:

- The external inputs are the “Input Actors” identified at §4.2.2.1 that feed the system with AIS messages and ancillary data for the S-AIS Data Provider, SAT-AIS orbit files and SAT-AIS events file for S-AIS Ground Control Provider and EO data for EO Data Provider. Each of these providers is requested by one of the Data Retrieval components: the S-AIS Data Provider, the Auxiliary Data Provider and at last the EO Data Provider, using their respective published interface.
- The internal inputs are additional inputs that come from the DPC Block2 itself or come from an operator during the configuration phase. These inputs are:
 - The simulated (predicted) AIS messages produced by the SAT-AIS Data Simulator of the Data Prediction subsystem. These items that go out the DPC Block2 itself, serve as input for the DPC Block2 in the same way as the outside inputs: the involved interface is the same. However, inside of the DPC, thanks to the traceability, it is



always possible to make the distinction between the simulated items and the ones obtained from real providers.

- The orbit files from an Operator. The DPC Block2 accepts as input an orbit file that will be ingested in the system as if coming from the S-AIS Ground Control Provider. In that case, the involved interface is the same and the distinction between the simulated items and the originals ones is made possible thanks to traceability.

On the bottom of the diagram, the ESB subsystem is detailed. A single binding component is used to interface with the Data Retrieval Subsystem: The WS-* Binding component. This component first allows the ESB to enable the connectivity with the Data Retrieval Subsystem, and let every subsystem linked to the ESB to consume the provided services. At second, it allows the Data Retrieval subsystem to consume the services available in the ESB, especially the logging facility.

5.5.1.2. S-AIS Data Provider Component

5.5.1.2.1. Overview

The S-AIS Data Provider Component supplies the DPC system with Raw SAT-AIS Messages. In the DPC context, the component can connect to several endpoints as long as provided data are conforming to what is expected concerning protocols (local file, TCP, FTP, SFTP, JMS) and data format (NMEA v4, EMSA CDF).

This component does not really interpret (decode) incoming data but some features may require to analyze information content. A good Example of this is the gathering of messages according to the satellite. In such case, the satellite name information needs to be retrieved.

The component is designed to be functionally scalable in the sense the proposed architecture is not affected if new formats or protocols have to be managed. This is achieved in two ways:

- At the implementation level by using Virtual File System API for accessing various file systems (local and network) in a unique way. "Pluggability" of this API allows to easily and seamlessly introduce new protocols.
- At the component level by integrating another component that inherits and specializes the original component. Thanks to the ESB, this addition to the system can be done easily and seamlessly.

From the ESB point of view, the S-AIS Data Provider component is a service provider.

5.5.1.2.2. Behavior

Retrieval activity

The behavior of this activity depends on the network capacity of the S-AIS Data Provider on which the component is connected.

- For file systems, FTP and SFTP protocols, the component acts against the provider as a polling consumer. In that case, the remote server is regularly polled for new available data, and when there are new ones, the data retrieval starts.
- For JMS or TCP protocols, the component is waiting for incoming data: the stream of bytes is retrieved synchronously and in real time. In that case, the data retrieval activity is permanent (nevertheless it can be started and stopped by the operator).

Storage activity

During the data retrieval activity, fetched data (i.e. AIS messages) are stored in the local file storage in their original form, with full preservation of their content. A metadata is also stored apart to keep some information about the retrieval activity, whatever considered as valuable for traceability: retrieval date, size of the retrieved data, information about the provider (URL, name), etc.



This behavior makes the component independent from the bus health: if the ESB fails for one reason or another, the component can still continue to consume incoming messages without loss.

The following diagram shows the logical chaining of the activities in the S-AIS Data Provider component.

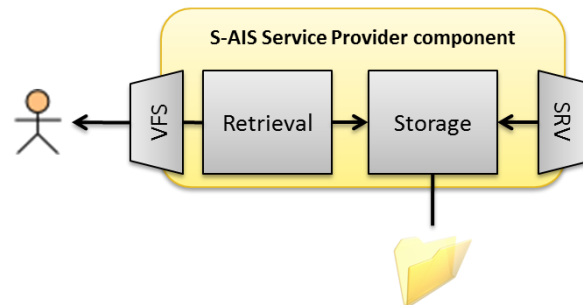


Figure 22 - High level functional blocks of the S-AIS Data Provider component

Services

Once some AIS messages have been stored, they become available through a dedicated interface.

The service provided through this interface allows getting the collected AIS messages. In order to lighten the processing load of the ESB framework, the service does not deliver the binary content of AIS messages, but a “handle” containing a reference (URI/URL) to the messages. This handle contains also the necessary metadata information that is required by the DPC to work (i.e. traceability).

The following figure illustrates the notion of handles. A set of handles is a container for several handles. Each handle references a retrieved binary file which, in turn, is composed of several AIS messages. Inside the ESB, only the handles, or set of handles, are passed.

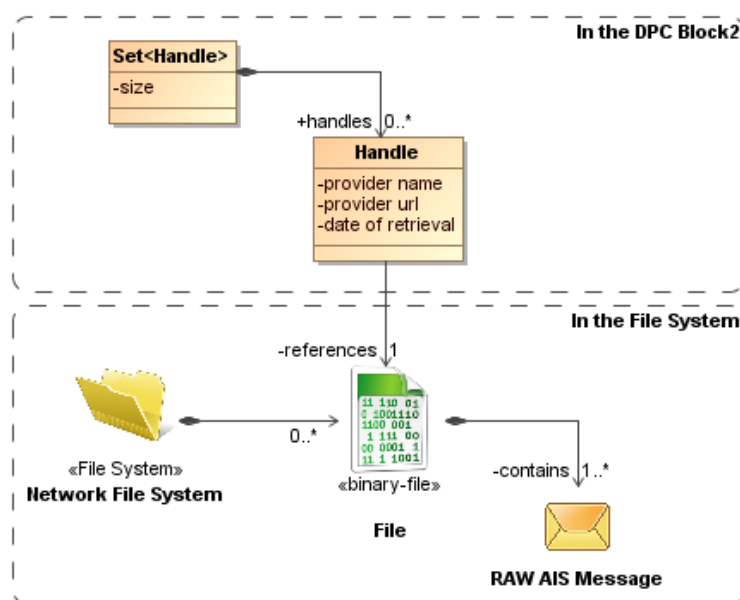


Figure 23 - Handles in the Data Retrieval subsystem

As one can see in Figure 23, since several raw AIS messages can be referenced by a unique handle, it is the responsibility of the other components to manage the multiplicity of messages.



5.5.1.2.3. Interfaces

The interfaces published by the component are inventoried in the following table.

Component	Published Interface	Visibility
S-AIS Data Provider	I_DR_CONFIGURATION_SRV	<i>Internal</i>
	The S-AIS Data Provider component publishes an interface that allows configuring and tuning the parameters of the component.	
	<i>Information exchanged:</i> Configuration items such as the polling frequency, the size of the messages bulk to deliver, the number of reconnect attempts, or some more specific protocol parameters (passive mode, socket timeout), encryption algorithm if used.	
	<i>Used By:</i> Operator actor	
S-AIS Data Provider	I_DR_CONTROL_SRV	<i>Internal + ESB</i>
	The S-AIS Data Provider component publishes an interface that allows controlling the component life-cycle such as starting and stopping the activity of the component.	
	<i>Information exchanged:</i> None	
	<i>Used By:</i> Operator actor	
S-AIS Data Provider	I_DR_SUPERVISION_SRV	<i>Internal + ESB</i>
	The S-AIS Data Provider component publishes an interface from which various metrics and statistics can be consulted.	
	<i>Information exchanged:</i> The number of processed messages, the volume of data retrieved, etc...	
	<i>Used By:</i> Operator actor	
S-AIS Data Provider	I_SAT_AIS_PROVIDER_SRV	<i>Internal + ESB</i>
	The S-AIS Data Provider Component publishes onto the ESB an interface from which the collected AIS messages can be retrieved.	
	The provided service allows to get the handles of new (or newer than a specific date-time) data available. The service can provide extra control on the content response by:	
	<ul style="list-style-type: none"> • Query for the number of handles available. • Get a fixed size-set of handles. 	
	<i>Information exchanged:</i> Handles (or a set of handles) on AIS messages with associated traceability	
	<i>Used By:</i> ESB	

Table 5 - Interfaces published by the S-AIS Data Provider component

5.5.1.2.4. Dependencies

The component only depends on the logging service provided by the ESB. Through this service, the component can report significant events that occur during its activity.



5.5.1.3. EO Data Provider Component

5.5.1.3.1. Overview

The EO Data Provider Component supplies the DPC Block2 system with Earth Observation data, i.e. Vessel Data Reports (VDRs) used as input of the AIS/EO correlation algorithms, as well as Level 1 images.

As for the S-AIS Data Provider Component described in § 5.5.1.2, this component is designed to be functionally scalable using similar design solutions. Thus, the retrieval functionality can be easily and seamlessly improved to support others protocols.

5.5.1.3.2. Behavior

Retrieval activity

This component behaves almost like the S-AIS Data Provider Component described in § 5.5.1.2. The difference is that only file-delivery protocols are supported (File system, FTP, SFTP). So the retrieval activity acts against the provider as a polling consumer only: the remote server is regularly polled for new data, and when there are new ones, the data retrieval starts. The data retrieval activity is permanent (nevertheless it can be started and stopped by the operator).

Storage activity

During the data retrieval activity, fetched data (i.e. EO data) are stored in the local file storage in their binary form, with full preservation of their content. A metadata is also stored apart to keep some information about the retrieval activity, whatever considered as valuable for traceability: retrieval date, size of the retrieved data, information about the provider (URL, name), etc.

This behavior makes the component independent from the bus health: if the ESB fails for one reason or another, the component can still continue to consume incoming messages without loss.

Services

Once some data (Level 1 images, VDRs) have been stored, they become available through a dedicated interface.

The service provided through this interface allows getting the fetched data. In order to lighten the processing load of the framework, especially for images that can be huge, the service never delivers the binary content, but a “handle” containing a resolvable reference (URI/URL) to the data. This handle contains also the necessary metadata information that is required by the DPC to work (i.e. traceability).

Note that unlike the S-AIS Data Provider Component, a handle references a unique VDR or image.

5.5.1.3.3. Interfaces

The interfaces published by the component are inventoried in the following table.

Component	Published Interface	Visibility
EO Data Provider	I_DR_CONFIGURATION_SRV	<i>Internal</i>
	The EO Data Provider Component publishes an interface that allows configuring and tuning the parameters of the component.	
	<i>Information exchanged:</i> Configuration items such as the polling frequency, the number of reconnect attempts or some more specific protocol parameters (passive mode, socket timeout)...	
	<i>Used By:</i> Operator actor	



EO Data Provider	I_DR_CONTROL_SRV	<i>Internal + ESB</i>
	The EO Data Provider Component publishes an interface that allows controlling the component life-cycle such as starting and stopping the activity of the component.	
	<i>Information exchanged:</i> None	
	<i>Used By:</i> ESB	
EO Data Provider	I_DR_SUPERVISION_SRV	<i>Internal + ESB</i>
	The EO Data Provider Component publishes an interface from which various metrics and statistics can be consulted.	
	<i>Information exchanged:</i> The number of processed data, the volume of data retrieved, etc...	
	<i>Used By:</i> ESB	
EO Data Provider	I_EO_PROVIDER_SRV	<i>Internal + ESB</i>
	The EO Data Provider Component publishes onto the ESB an interface from which the collected EO data can be retrieved.	
	The provided service allows to get the handles of new (or newer than a specific date-time) data available. The service can provide extra control on the content response by:	
	<ul style="list-style-type: none"> • Query for the number of handles available. • Get a fixed size-set of handles. 	
	<i>Information exchanged:</i> Handles (or a set of handles) on EO data (Level 1 image, VDRs) with associated traceability.	
	<i>Used By:</i> ESB	

Table 6 - Interfaces published by the EO Data Provider Component

5.5.1.3.4. Dependencies

The component only depends on the logging service provided by the ESB. Through this service, the component can report significant events that occur during its activity.

5.5.1.4. Auxiliary Data Provider Component

5.5.1.4.1. Overview

The Auxiliary Data Provider Component supplies the DPC Block2 system with auxiliary data such as orbit files and events files.

In the same way as the S-AIS Data Provider Component described in § 5.5.1.2, this component is designed to be functionally scalable using similar design solutions. Thus, the retrieval functionality can be easily and seamlessly improved to support others protocols.

5.5.1.4.2. Behavior

Retrieval activity

This component behaves almost like the S-AIS Data Provider Component described in § 5.5.1.2. The difference is that only file-delivery protocols are supported: File system, FTP, SFTP, WS-*, and the protocol for the ground stations of the future S-AIS data providers. So the retrieval activity acts



against the provider as a polling consumer only: the remote server is regularly polled for new data, and when there are new ones, the data retrieval starts. The data retrieval activity is permanent (nevertheless it can be started and stopped by the operator).

Storage activity

During the data retrieval activity, fetched data (i.e. auxiliary data) are stored in the local file storage in their binary form, with full preservation of their content. A metadata is also stored apart to keep some information about the retrieval activity, whatever considered as valuable for traceability: retrieval date, size of the retrieved data, information about the provider (URL, name), etc.

This behavior makes the component independent from the bus health: if the ESB fails for one reason or another, the component can still continue to consume incoming messages without loss.

Services

Once some data (orbit files, event files) have been stored, they become available through a dedicated interface.

The service through provided this interface allows getting the fetched data. In order to lighten the processing load of the framework, even if data are not particularly large, the service never delivers the binary content, but a “handle” containing a resolvable reference (URI/URL) to the data. Thus, the way the information travels in the system is always the same.

Like for the other components of the Data Retrieval subsystem, every handle contains also the necessary metadata information that is required by the DPC Block2 to work (i.e. traceability).

5.5.1.4.3. Interfaces

The interfaces published by the component are inventoried in the following table.

Component	Published Interface	Visibility
Auxiliary Data Provider	I_DR_CONFIGURATION_SRV	<i>Internal</i>
	The Auxiliary Data Provider Component publishes an interface that allows configuring and tuning the parameters of the component.	
	<i>Information exchanged:</i> Configuration items such as the polling frequency, the number of reconnect attempts, or some more specific protocol parameters (passive mode, socket timeout)...	
	<i>Used By:</i> Operator actor	
Auxiliary Data Provider	I_DR_CONTROL_SRV	<i>Internal + ESB</i>
	The Auxiliary Data Provider Component publishes an interface that allows controlling the component life-cycle such as starting and stopping the activity of the component.	
	<i>Information exchanged:</i> None	
	<i>Used By:</i> ESB	
Auxiliary Data Provider	I_DR_SUPERVISION_SRV	<i>Internal + ESB</i>
	The Auxiliary Data Provider Component publishes an interface from which various metrics and statistics can be consulted.	
	<i>Information exchanged:</i> The number of processed data, the volume of data retrieved, etc...	
	<i>Used By:</i> ESB	



Component	Published Interface	Visibility
Auxiliary Data Provider	I_AUX_DATA_PROVIDER_SRV	<i>Internal + ESB</i>
	The Auxiliary Data Provider Component publishes onto the ESB an interface from which the collected auxiliary data can be retrieved.	
	The provided service allows to get the handles of new (or newer than a specific date-time) data available. The service can provide extra control on the content response by:	
	<ul style="list-style-type: none"> • Query for the number of handles available. • Get a fixed size-set of handles. 	
	<i>Information exchanged:</i> Handles (or a set of handles) on auxiliary data (orbit file, events file) with associated traceability.	
	<i>Used By:</i> ESB	

Table 7 - Interfaces published by the Auxiliary Data Provider Component

5.5.1.4.4. Dependencies

The component only depends on the logging service provided by the ESB. Through this service, the component can report significant events that occur during its activity.

5.5.2. Data Processing

5.5.2.1. Overview

This subsystem is dedicated to the processing of the SAT-AIS data that pass through the ESB where a message processing consists in applying several levels of treatment. For traceability considerations, each treatment applied to a message is kept and bound to it.

The following component diagram shows the three levels of processing available in the DPC Block2 ecosystem.

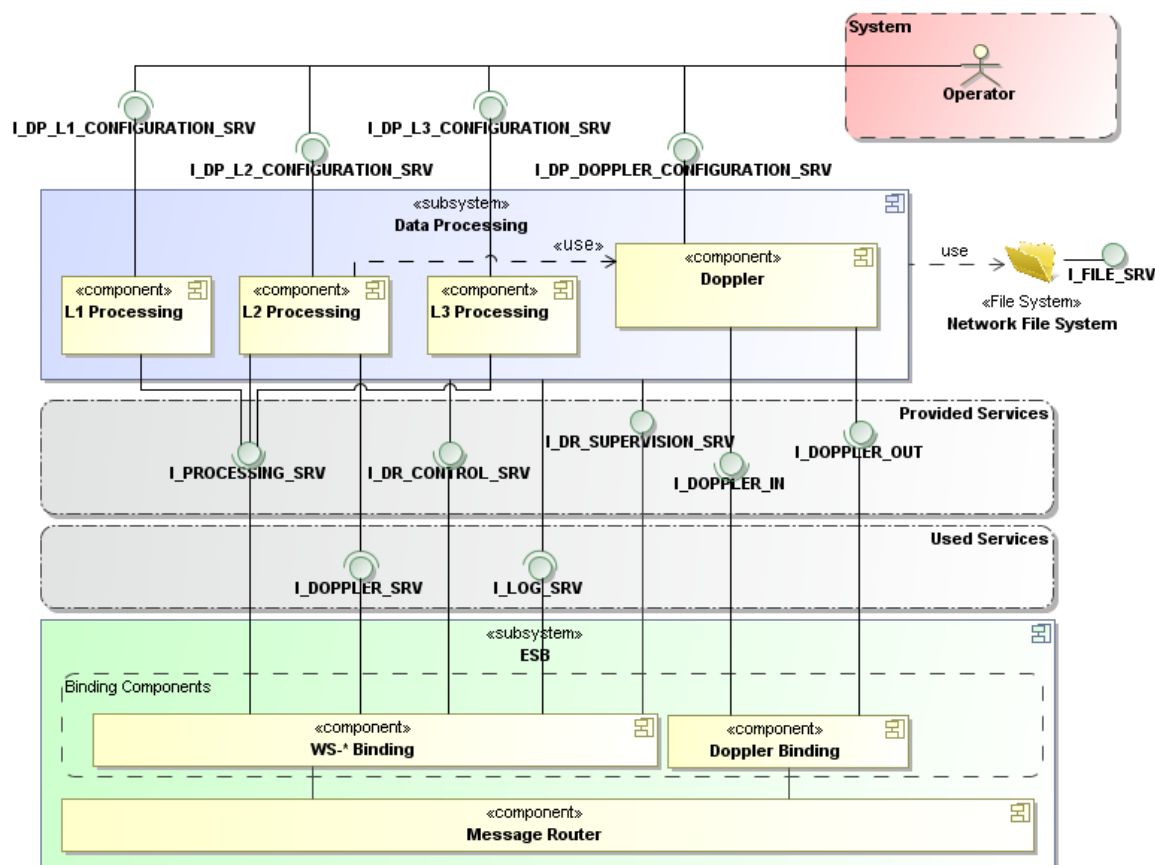


Figure 24 - Data Processing Subsystem Overview

The Data Processing subsystem, at the center of the diagram, is composed of four components: three components for the L1, L2 and L3 processing, and one for the Doppler processing.

This breakdown is consistent with AD 5 and takes into account the facts that AIS messages are organized by packets associated to a satellite visibility over a ground station.

The functional decomposition allows more control and flexibility on how the processing is performed.

Each component has a dedicated interface to manage configuration aspects. It allows the Operator actor to parameter the components.

At the bottom of the diagram, the ESB subsystem is detailed. Three binding components are used to interface with the Data Processing subsystem:

- The WS-* Binding component. This component first allows the ESB to enable the connectivity with the Data Processing Subsystem, and let every subsystem linked to the ESB to consume the provided services. At second, it allows the Data Processing Subsystem to consume the services available in the ESB, especially the logging facility.
- The Doppler Binding component. This component allows the ESB to enable the connectivity with the Doppler component and let every subsystem linked to the ESB consume the provided services.



5.5.2.2. L1 Data Processing Component

5.5.2.2.1. Overview

The L1 Data Processing Component supplies the DPC Block system with Decoded AIS Messages without any further enhancement processing.

5.5.2.2.2. Behavior

At first, the component controls the CRC, if provided, in order to verify the message integrity. If CRC is not provided, it is assumed the CRC check was performed by the SAT-AIS data provider, and that the message CRC is correct.

Then, the component decodes the message, i.e. convert the binary message into structured fields and values, according to the AIS message type. This allows revealing the fields contained in the message (MMSI, name, latitude, longitude, etc.). Decoding process depends on the data format of the S-AIS message:

- If message is observing the NMEA v4 format or contains such a sentence (EMSA CDF case), this information is used for decoding;
- If message is already a decoded form and the original NMEA v4 is not available then decoded values are re-used.

The component then performs a set of verifications:

- If relevant, the size (number of bits) of each received message is compared with its predefined length. The length may be a function of the message type (e.g. for NMEA v4 message with type 1, 2 or 3 has a fixed size of 168 bits). Others messages have length which is bounded by a given interval.
- Content (decoded fields) of each AIS message is controlled. Some field values are bounded by a given interval (e.g. latitude values shall be comprised between -90 and +90° or equal to 91 if not available).
- IMO number or vessel name contained in the AIS message is checked with respect to the information stored in the database.
- Messages are compared with the satellite footprint at the same date and time for AIS position reports (AIS messages with type 1, 2, 3, 18 or 27). The vessel shall be located inside the visibility circle of the satellite. A tolerance margin shall be added in order to take into account atmospheric effects that can extend the visibility of SAT-AIS beyond the horizon.
- A velocity test is performed for AIS position reports, in order to detect unrealistic positions not detected by the previous tests such as the CRC check, due to messages collisions or GPS failure onboard the vessel.

5.5.2.2.3. Interfaces

The interfaces published by the component are inventoried in the following table.

Component	Published Interface	Visibility
L1 Processing	I_DP_L1_CONFIGURATION_SRV	<i>Internal</i>
	The L1 Processing Component publishes an interface that allows configuring and tuning the parameters of the component.	
	<i>Information exchanged:</i> Configuration items (constants for AIS message structure, tolerance margin, etc.)	



Component	Published Interface	Visibility
	<i>Used By:</i> Operator actor	
L1 Processing	I_DR_CONTROL_SRV	Internal + ESB
	The L1 Processing Component publishes an interface that allows controlling the component life-cycle such as starting and stopping the activity of the component.	
	<i>Information exchanged:</i> None	
	<i>Used By:</i> ESB	
L1 Processing	I_DR_SUPERVISION_SRV	Internal + ESB
	The L1 Processing Component publishes an interface from which various metrics and statistics can be consulted.	
	<i>Information exchanged:</i> The number of processed data, the volume of data handled, component uptime, etc...	
	<i>Used By:</i> ESB	
L1 Processing	I_PROCESSING_SRV	Internal + ESB
	The L1 Processing Component publishes onto the ESB an interface for invoking L1 processing on incoming Raw AIS Messages.	
	<i>Information exchanged:</i> Handles (or a set of handles) on Raw AIS Messages as input, Decoded messages, status and traceability as output.	
	<i>Used By:</i> ESB	

Table 8 - Interfaces published by the L1 Processing Component

5.5.2.2.4. Dependencies

The component can rely on the services provided by the Data Management and Archive subsystem when needed. Through this interface, the component is able to fetch the missing contextual information it needs.

5.5.2.3. L2 Data Processing Component

5.5.2.3.1. Overview

The L2 Data Processing Component provides the DPC Block2 with:

- the capability to compares the Doppler positions (that were previously computed) and the positions from AIS messages;
- the capability to recover AIS positions reports that have been considered as invalid according to L1 process.

5.5.2.3.2. Behavior

The component performs two processing depending on the incoming messages:

- For AIS messages with ancillary data that include Doppler shift measurements, a comparison of the Doppler positions (previously computed) and the positions from AIS messages within the same timeframe is performed. A status is then attributed to the AIS messages that either confirms the AIS position (if Doppler and AIS positions are close to each other), or on



the contrary indicates an inconsistency between the AIS and Doppler positions (if Doppler and AIS positions diverge).

- For invalid AIS position reports, and given a reliable prediction, the component performs a replacement of the invalid AIS position by the predicted one. A status is then attributed to the AIS messages to indicate that they have been recovered using prediction.

At the end of the processing, traceability is updated accordingly to reflect any changes.

5.5.2.3.3. Interfaces

The interfaces published by the component are inventoried in the following table.

Component	Published Interface	Visibility
L2 Processing	I_DP_L2_CONFIGURATION_SRV	<i>Internal</i>
	The L2 Processing Component publishes an interface that allows configuring and tuning the parameters of the component.	
	<i>Information exchanged:</i> Configuration items (default values, reliability threshold, etc.)	
	<i>Used By:</i> Operator actor	
L2 Processing	I_DR_CONTROL_SRV	<i>Internal + ESB</i>
	The L2 Processing Component publishes an interface that allows controlling the component life-cycle such as starting and stopping the activity of the component.	
	<i>Information exchanged:</i> None	
	<i>Used By:</i> ESB	
L2 Processing	I_DR_SUPERVISION_SRV	<i>Internal + ESB</i>
	The L2 Processing Component publishes an interface from which various metrics and statistics can be consulted.	
	<i>Information exchanged:</i> The number of processed data, the volume of data handled, component uptime, etc...	
	<i>Used By:</i> ESB	
L2 Processing	I_PROCESSING_SRV	<i>Internal + ESB</i>
	The L2 Processing Component publishes onto the ESB an interface for invoking L2 processing on incoming Decoded AIS Messages.	
	<i>Information exchanged:</i> Handles (or a set of handles) on Decoded AIS Messages, Doppler positions, Predicted Positions as input, Positions, status and traceability and Enhanced Messages as output.	
	<i>Used By:</i> ESB	

Table 9 - Interfaces published by the L2 Processing Component

5.5.2.3.4. Dependencies

The component can rely on the services provided by the Data Management and Archive subsystem when needed. Through this interface, the component is able to fetch the missing contextual information it needs.



5.5.2.4. L3 Data Processing Component

5.5.2.4.1. Overview

The L3 Data Processing Component provides the DPC Block2 with the correlation with EO capability.

5.5.2.4.2. Behavior

The component tries to relate VDRs with the reported positions. If correlation is successful, then the AIS messages of the “best” candidate ships are enhanced by adding a flag indicating the match between the VDR and the AIS position.

Traceability is updated accordingly to reflect any changes.

5.5.2.4.3. Interfaces

The interfaces published by the component are inventoried in the following table.

Component	Published Interface	Visibility
L3 Processing	I_DP_L3_CONFIGURATION_SRV	<i>Internal</i>
	The L2 Processing Component publishes an interface that allows configuring and tuning the parameters of the component.	
	<i>Information exchanged:</i> Configuration items.	
	<i>Used By:</i> Operator actor	
L3 Processing	I_DR_CONTROL_SRV	<i>Internal + ESB</i>
	The L3 Processing Component publishes an interface that allows controlling the component life-cycle such as starting and stopping the activity of the component.	
	<i>Information exchanged:</i> None	
	<i>Used By:</i> ESB	
L3 Processing	I_DR_SUPERVISION_SRV	<i>Internal + ESB</i>
	The L3 Processing Component publishes an interface from which various metrics and statistics can be consulted.	
	<i>Information exchanged:</i> The number of processed data, the volume of data handled, component uptime, etc...	
	<i>Used By:</i> ESB	
L3 Processing	I_PROCESSING_SRV	<i>Internal + ESB</i>
	The L3 Processing Component publishes onto the ESB an interface for invoking L3 processing (EO correlation) on incoming Decoded Messages.	
	<i>Information exchanged:</i> Handles (or a set of handles) on Decoded AIS Messages, Predicted Positions, VDRs as input, Positions, status and traceability and Correlated Messages as output.	
	<i>Used By:</i> ESB	

Table 10 - Interfaces published by the L3 Processing Component



5.5.2.4.4. Dependencies

The component can rely on the services provided by the Data Management and Archive subsystem when needed. Through this interface, the component is able to fetch the missing contextual information it needs.

5.5.2.5. Doppler component

5.5.2.5.1. Overview

The Doppler Component provides the DPC Block2 a position calculation service using as inputs the Doppler shifts measured by the satellite at the reception of AIS messages and distributed as ancillary data by the SAT-AIS providers.

5.5.2.5.2. Behavior

The component provides a computed position from several position messages of a given ship. Doppler measurements are combined in order to compute a more accurate Doppler location. As a consequence, the time stamp attributed to the Doppler location might be different from SAT-AIS message time stamp.

Traceability is updated to keep the link between the computed positions and the messages that were used for the processing.

5.5.2.5.3. Interfaces

The interfaces published by the component are inventoried in the following table.

Component	Published Interface	Visibility
Doppler	I_DP_DOPPLER_CONFIGURATION_SRV	<i>Internal</i>
	The Doppler Component publishes an interface that allows configuring and tuning the parameters of the component.	
	<i>Information exchanged:</i> Configuration items.	
	<i>Used By:</i> Operator actor	
Doppler	I_DR_CONTROL_SRV	<i>Internal + ESB</i>
	The Doppler Component publishes an interface that allows controlling the component life-cycle such as starting and stopping the activity of the component.	
	<i>Information exchanged:</i> None	
	<i>Used By:</i> ESB	
Doppler	I_DR_SUPERVISION_SRV	<i>Internal + ESB</i>
	The Doppler Component publishes an interface from which various metrics and statistics can be consulted.	
	<i>Information exchanged:</i> The number of processed data, the volume of data handled, component uptime, etc...	
	<i>Used By:</i> ESB	
Doppler	I_DOPPLER_IN	<i>Internal + ESB</i>



Component	Published Interface	Visibility
	The Doppler Component publishes onto the ESB an interface for	
	<i>Information exchanged:</i>	
	<i>Used By:</i> ESB	
Doppler	I_DOPPLER_OUT	<i>Internal + ESB</i>
	The Doppler Component publishes onto the ESB an interface for	
	<i>Information exchanged:</i>	
	<i>Used By:</i> ESB	

Table 11 - Interfaces published the Doppler Component

5.5.2.5.4. Dependencies

The component is totally independent from the DPC Block2 system: it does not depend on any internal interface of the ESB.

5.5.3. Data Distribution subsystem

5.5.3.1. Overview

This subsystem serves several purposes to several actors:

- It supplies the EMSA Block3 Actor with SAT-AIS messages, EO derived data (VDRs), and alerts (missing messages).
- It supplies the End-User Actor, External Application Center Actor and also the EMSA Block3 Actor with every SAT-AIS related messages passing through the ESB: simple and enhanced AIS messages, warning messages for missing AIS messages, predicted AIS messages, AIS messages correlated with EO data and SAT-AIS orbits and events messages...
- It defines and enforces a security policy that sets the rules of data access for each user.
- It offers to the Operator actor a mean to manage and administrate policies.



The following component diagram shows the subsystem in its ecosystem.

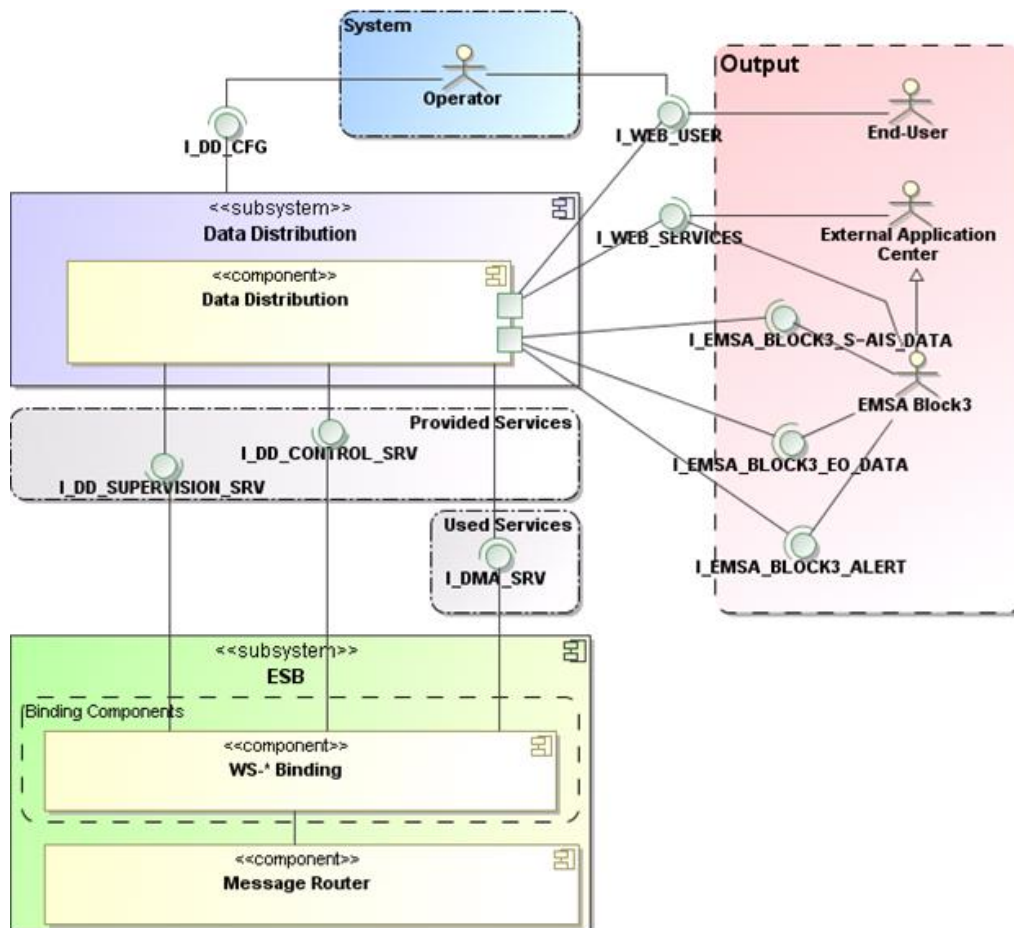


Figure 25 - Data Distribution Subsystem Overview

At the centre of the diagram, the Data Distribution Subsystem is described. It is composed of a unique component: the Data Distribution Component in charge of performing all the identified tasks.

At the bottom of the diagram, the ESB subsystem is detailed. Only one binding component is involved: The WS-* Binding component. This component first allows the ESB to enable the connectivity with the Data Distribution Subsystem, and let every subsystem linked to the ESB to consume the provided services, especially the supervision interface for monitoring purposes, and the control interface. In addition, it allows the Data Distribution component to consume the services available in the ESB, especially the Data Management and Archive subsystem from which all the disseminated data are fetched.

5.5.3.2. Data Distribution Component

5.5.3.2.1. Overview

The Data Distribution Component is an indivisible unit for the ESB. However, the subsystem is internally designed as an assembly of components according to the Separation of Concerns (SoC) principle.



The following diagram shows the major modules used to build the Data Distribution component.

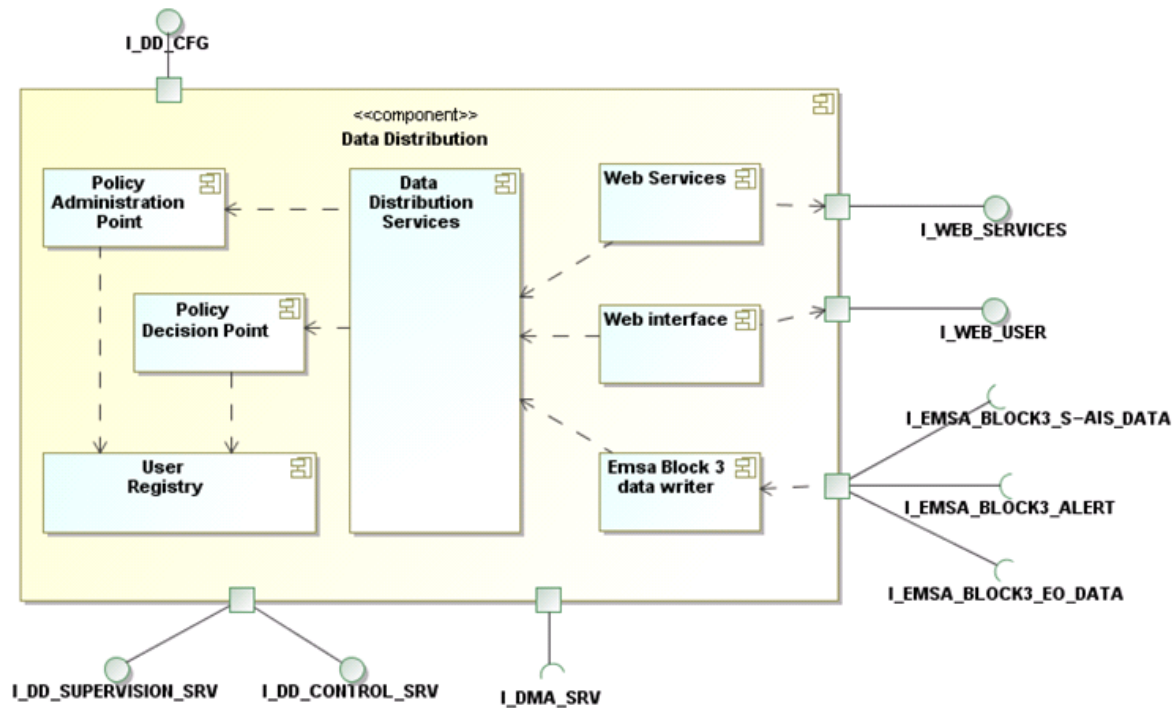


Figure 26 - Data Distribution Component internal overview

EMSA Block3 Data Writer

The subcomponent is a client of the Block3 services. It interconnects with the Block3 interfaces in order to push several data like AIS messages, alerts and EO data.

Web Interface

The Web Interface subcomponent provides display capabilities of the SAT-AIS data processed, products generated, warning and message logs. In that context, the published interface is a frontend interface.

The subcomponent has also the responsibility to provide a graphical mean to manage the users, their profiles and their right access to the information. In that context, the published interface is a backend interface, rather reserved for the Operator.

In any case, the confidentiality of information is guaranteed: the user must be authenticated and have sufficient rights (according its profile) to be authorized to access information.

Web Services

The Web Services subcomponent deploys an interoperable mean to access almost all the data held by the DPB Block2 system.

In any case, the confidentiality of information is guaranteed: the user must be authenticated and have sufficient rights (according its profile) to be authorized to access information.

Data Distribution Services

The Data Distribution Services subcomponent is the core of the Data Distribution Subsystem. It performs the mediation between the needed information to provide services and the information available in the system.

Policy Administration Point

The Policy Administration Point subcomponent manages the user rights and profiles.



Policy Decision Point

The Policy Decision Point subcomponent evaluates and issues authorization decisions according to the security policy in force.

User Registry

The User Registry subcomponent contains all the users and their corresponding profiles, with authorizations, digital certificates...

5.5.3.2.2. Behavior

The main activity of the component is to dispatch new data to the EMSA Block3 through its dedicated interfaces. Receivables messages are AIS messages (simple), Alerts (warning for missing AIS messages) as well as EO data. Other information are available to the EMSA Block3, on his own initiative, through the published Web Services interface.

The component also responds to incoming requests. In such case, the component applies the policy security in force for each requested and delivered information according to the nature of the information, its content and the identity (role or rights) of the requester.

Once the user has been fully authorized, the component translates the request into one or several requests to the Data Management & Archive subsystem. Of course, for performance reasons, the information can be cached in memory in order to be accessed quickly.

5.5.3.2.3. Interfaces

Component	Published Interface	Visibility
Data Distribution Component	I_DD_SUPERVISION	<i>Internal + ESB</i>
	The Data Distribution Component publishes an interface from which activity information are accessible.	
	<i>Information exchanged:</i> Events	
	<i>Used By:</i> ESB	
Data Distribution Component	I_DD_CONTROL_SRV	<i>Internal + ESB</i>
	The Data Distribution Component publishes an interface that allows controlling the component life-cycle such as starting and stopping the activity of the component.	
	<i>Information exchanged:</i> None	
	<i>Used By:</i> ESB	
Data Distribution Component	I_DD_CFG	<i>Internal</i>
	The Data Distribution Component publishes an interface that allows configuring and tuning the parameters of the component.	
	<i>Information exchanged:</i> Configuration items.	
	<i>Used By:</i> Operator	

Table 12 - Interfaces published by the Data Distribution Component



5.5.3.2.4. Dependencies

The component relies on the services provided by the Data Management and Archive subsystem when needed. Through this interface, the component is able to fetch the missing contextual information it needs.

5.5.4. Data Management and Archive subsystem

5.5.4.1. Overview

This subsystem supplies the DCP with the capability to store and query all the business entities handled by the system. To achieve its mission, the subsystem is divided into two components:

- The data management and Archive Component that includes all the logic of data management, and publishes a service for storing and retrieving information ;
- The RDBMS Component which is actually a database system, and the file system for the storage of large volume data.

The following component diagram shows the subsystem in its ecosystem.

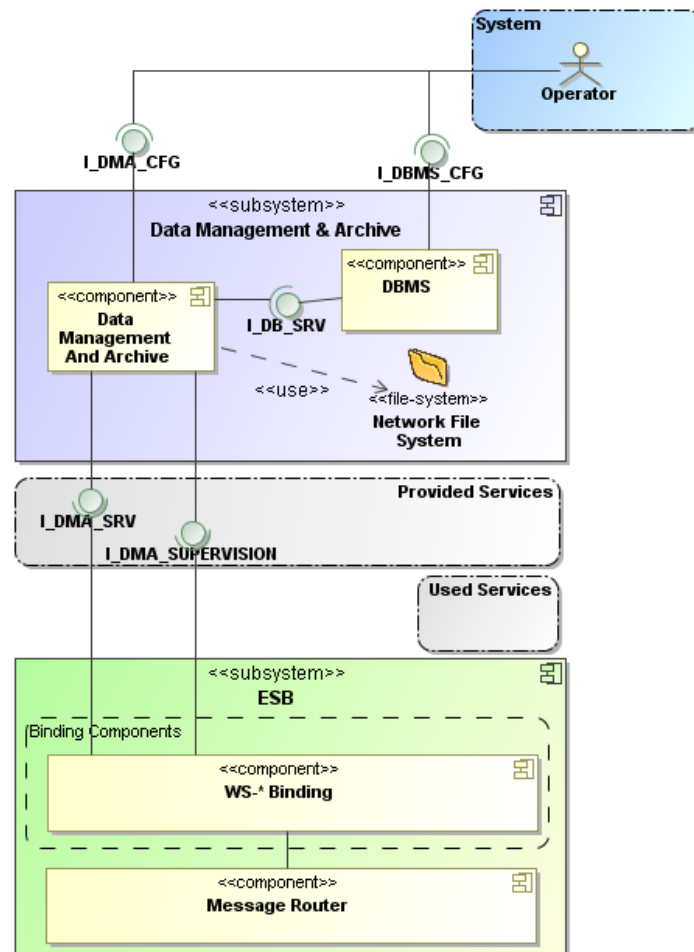


Figure 27 - Data Management & Archive Subsystem Overview

At the bottom of the diagram, the ESB subsystem is detailed. Only one binding component is involved: The WS-* Binding component. This component allows every subsystem linked to the ESB to



consume the provided services, especially the Data Distribution Subsystem and the Processing Subsystem.

5.5.4.2. Data Management and Archive component

5.5.4.2.1. Overview

The Data Management and Archive component is responsible for storing and retrieving every entity of the system.

It provides DPC Block2 System with high level services to create, request, update and delete data. Data can be almost any information that is managed by the system:

- Input information:
 - AIS Messages (original form)
 - Ancillary data,
 - Satellite Orbit data files,
 - AIS Satellite event files,
 - EO Data (VDRs, Level 1 images)
- Processed information:
 - L1, L2, L3 products (decoded messages, traceability, validation degree)
 - Vessels (static information)
 - Events and error log files

This component offers its services through the ESB.

5.5.4.2.2. Behavior

The component pilots the DMBS component to provide data management services including the four basic functions of persistent storage: Create, Read, Update and Delete. And this, for every kind of data managed in the system.

Depending on the nature and size of data, the data can be completely stored in the database or dropped off in a file system, in which case, the external file is referenced within the database by its URI. The threshold that determines the storage location will be decided during the design phase of the system.

The component is in close interaction with the DBMS component from which it uses all the available features. For instance, if the DBMS is “spatially enabled”, the component can use geographic requests to enhance the performance.

In addition, the component may rely on several cache levels to store information in memory and optimize the response time. In that case, the component is instanced a single time, except if the cache is distributed.

At last, replication mechanisms are implemented for both the file system and the database.

5.5.4.2.3. Interfaces

The interfaces published by the component are inventoried in the following table.

Component	Published Interface	Visibility
Data	I_DMA_CFG	Internal



Component	Published Interface	Visibility
Management And Archive	The Data Management and Archive component publishes an interface that allows configuring and tuning the parameters of the component.	
	<i>Information exchanged:</i> Configuration items such as: Database URI, Database user and password, connection pool configuration...	
	<i>Used By:</i> Operator actor	
Data Management And Archive	I_DMA_SRV	<i>Internal + ESB</i>
	The Data Management and Archive component publishes an interface that allows storing and retrieving entities in business oriented way. The information exchanged are as close as possible to the ones managed by the system.	
	<i>Information exchanged:</i> AIS messages, Vessels, Doppler Locations, VDR, Alerts...	
Data Management And Archive	I_DMA_SUPERVISION	<i>Internal + ESB</i>
	The Data Management and Archive component publishes an interface from which statistics and metrics about the storage activity can be retrieved: max, min and average time for queries, hits on cache, misses on cache, etc. This information can be used to monitor the activity, but also to optimize the performance of the Data Management and Archive subsystem.	
	<i>Information exchanged:</i> Significant events with criticality...	
	<i>Used By:</i> ESB	

Table 13 - Interfaces published by the Data Management And Archive Component

5.5.4.2.4. Dependencies

The component relies on the (internal) services provided by the RDBMS component. Through this interface, the component is able to fetch and store the information.

It also relies on the file system for storing large data files.

5.5.4.3. DBMS component

5.5.4.3.1. Overview

The DBMS component is the database system used by the DPC Block2 to store all the information. The DBMS is a Relational Database Management System with potentially geographic enablement.

5.5.4.3.2. Behavior

The behavior is the same as any DBMS.

5.5.4.3.3. Interfaces

Component	Published Interface	Visibility
DBMS	I_DBMS_CFG	<i>Internal</i>
	The DBMS component publishes an interface that allows configuring and tuning the	



Component	Published Interface	Visibility
	parameters of the component.	
	<i>Information exchanged:</i> Database schema, declared users and privileges, tablespaces...	
	<i>Used By:</i> Operator actor	
DBMS	I_DBMS_SRV	<i>Internal</i>
	The DBMS component publishes an interface that allows storing and retrieving data, according to the relational schema in use.	
	<i>Information exchanged:</i> data	
	<i>Used By:</i> Data Management And Archive Component	

Table 14 - Interfaces published by the DBMS Component

5.5.4.3.4. Dependencies

The component is totally independent from the DPC Block2 system: it does not depend on any internal interface of the ESB.

5.5.5. Monitoring and Control

5.5.5.1. Overview

This subsystem is in charge of performing several activities related to the supervision and control of the system. The main functionalities, for which it has responsibility, are the following:

- Provide a system cartography for the software and hardware components, with their status, and the ability to raise an alert;
- Allow an Operator actor to acknowledge an alert;
- Manage the components life-cycle : start and stop;
- Provide a mean to record an event in a logbook;
- Provide a real-time consultation view of the logbook for the Operator actor;
- Provide a management for tasks, i.e. scheduling execution of scripts.

The following component diagram shows the subsystem in its ecosystem.

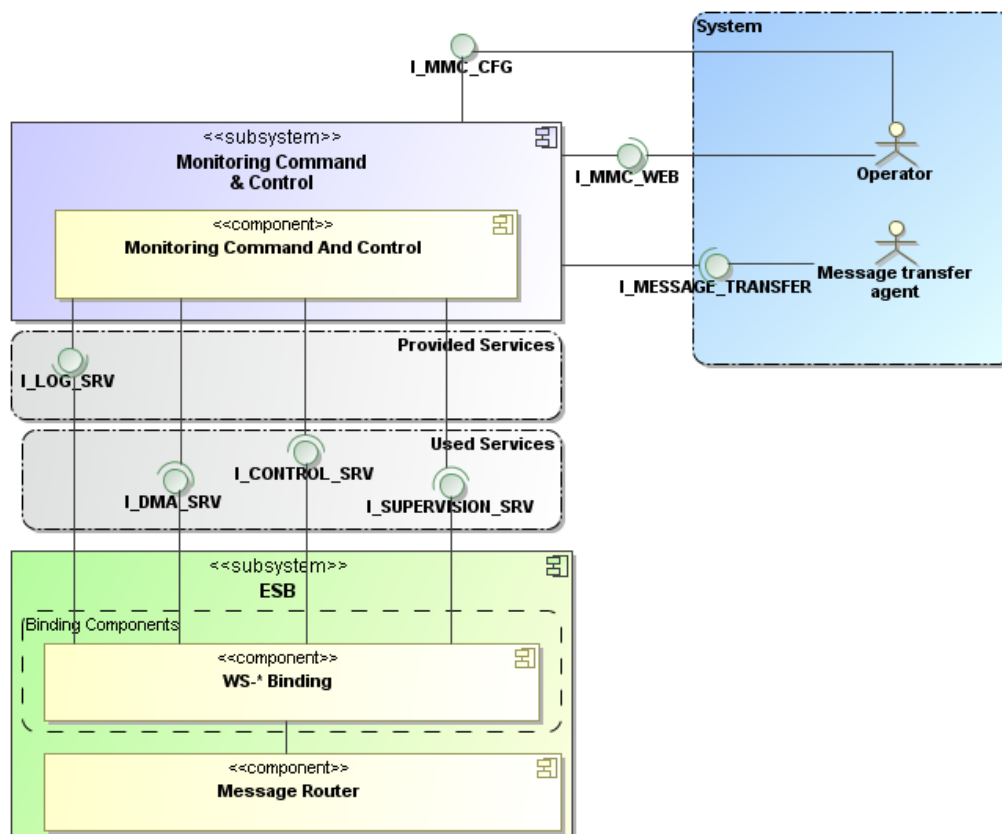


Figure 28 - Monitoring Command And Control Subsystem Overview

The Monitoring Command And Control subsystem, at the center of the diagram, is composed of a unique component: the Monitoring Command And Control component.

This component is intended to be instantiated a single time.

At the system boundary, on the right of the diagram, the subsystem interfaces with the operator to provide monitoring and control services through a Web interface. It interfaces also with a Message Transfer Agent Actor to perform the function of sending warnings and alerts to the technical staff by e-mail.

On the bottom of the diagram, the ESB subsystem is detailed. A single binding component is used to interface with the Monitoring Command And Control Component: The WS-* Binding component. This component first allows the ESB to enable the connectivity with the Data Retrieval Subsystem, and let every subsystem linked to the ESB to consume the provided logging facility service. At second, it allows the Monitoring Command And Control Component subsystem to consume the services available in the ESB, especially the supervision and control interfaces. The supervision interface is the mean through which the component retrieve all monitoring and supervision information.

5.5.5.2. Monitoring Command And Control Component

5.5.5.2.1. Overview

See 5.5.5.1.

5.5.5.2.2. Interfaces

The interfaces published by the component are inventoried in the following table.



Component	Published Interface	Visibility
Monitoring Command And Control	I_MMC_CFG	<i>Internal</i>
	The Monitoring Command And Control Component publishes an interface that allows configuring and tuning the parameters of the component.	
	<i>Information exchanged:</i> Configuration items.	
	<i>Used By:</i> Operator actor	
Monitoring Command And Control	I_LOG_SRV	<i>Internal + ESB</i>
	The Monitoring Command And Control Component publishes an interface that allows others components to log events in a logbook.	
	<i>Information exchanged:</i> Events (with date, time, level and description)	
	<i>Used By:</i> ESB	
Monitoring Command And Control	I_MMC_WEB	<i>Internal + ESB</i>
	The Monitoring Command And Control Component publishes a Web Interface from which the DPC Block2 System can be supervised and monitored.	
	<i>Information exchanged:</i> Synoptics representative of the Block2 architecture (software and hardware), start & stop orders, logbook...	
	<i>Used By:</i> Operator actor	

Table 15 - Interfaces published by the Monitoring Command And Control Component

5.5.5.2.3. Dependencies

The component relies on the supervision and control services provided by the different components available through the WS-* Binding component. Thus, the component is able to monitor and control the activity of the components.

5.5.6. Data Prediction

5.5.6.1. Overview

This subsystem provides the system with the following simulation components:

- The SAT-AIS Data simulator in charge of simulating a complete SAT-AIS system, taking into account a given fleet of ships, a given satellites constellation and a given set of ground stations.
- The Ship prediction module in charge of predicting the position of ships (future and past).

For that purpose it is composed of two components. The following component diagram shows the subsystem in its ecosystem.

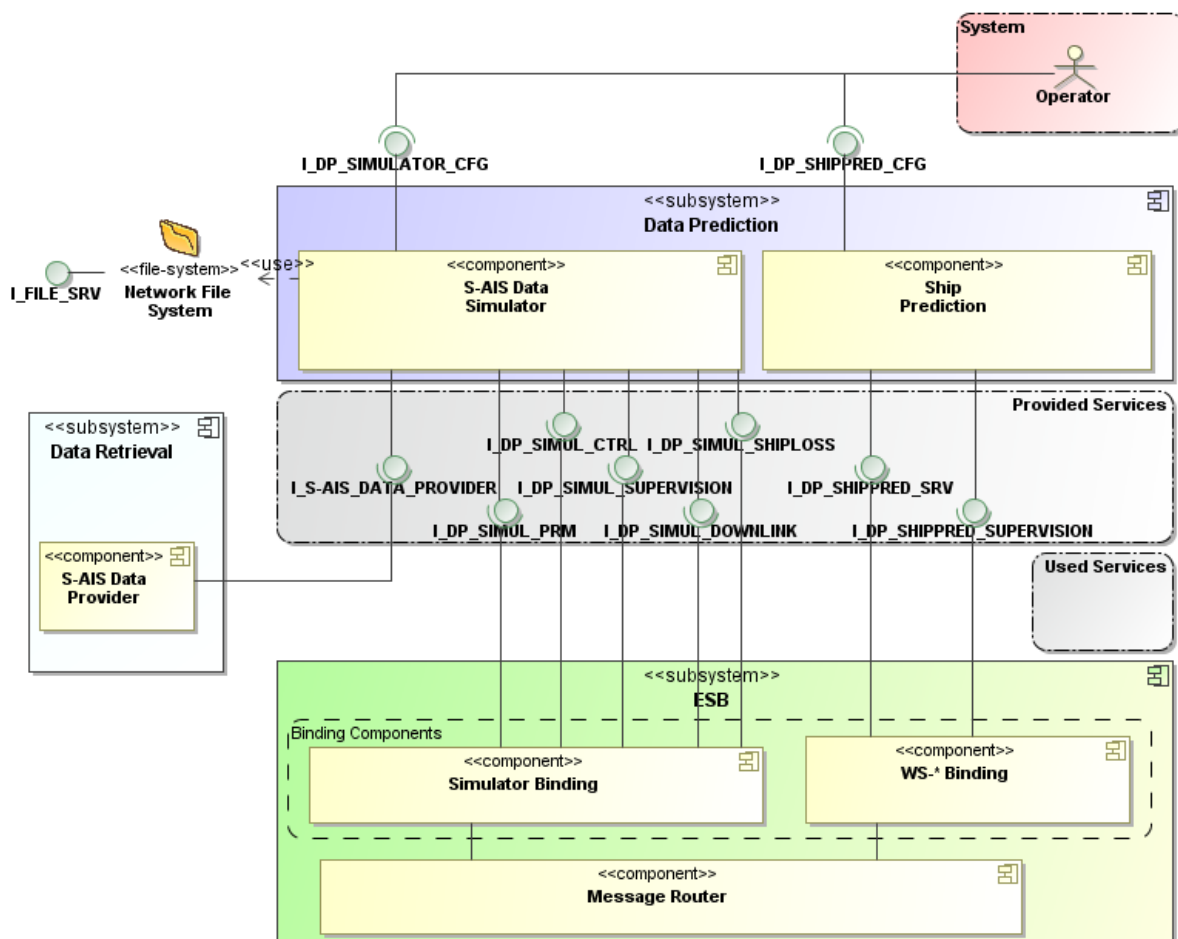


Figure 29 - Data Prediction Subsystem Overview

5.5.6.2. Ship Prediction Component

5.5.6.2.1. Overview

The Ship Prediction component is in charge of predicting the position of ships (future and past). The prediction is based on ship previous positions and navigation parameters like the port of call, maritime traffic routes and continental contour.

5.5.6.2.2. Behavior

To be able to perform the prediction, the component relies on a model of main maritime traffic routes in order to relate a ship to a navigational route when possible. The prediction also takes into account the continental shores and the navigation area (open ocean, close to shore, close to port).

The validity of the prediction may range from a few hours to a couple of days, depending on the traffic area. In any cases, the predicted ship position comes with an accuracy indicator.

5.5.6.2.3. Interfaces

The interfaces published by the component are inventoried in the following table.



Component	Published Interface	Visibility
Ship Prediction component	I_DP_SHIPPRED_CFG	<i>Internal</i>
	The Ship Prediction component publishes an interface that allows configuring the static parameters of the prediction.	
	<i>Information exchanged:</i> Configuration items such as: <ul style="list-style-type: none"> ○ Model of maritime traffic routes ○ Continental shores ○ Navigation area ○ Ports 	
	<i>Used By:</i> Operator actor	
Ship Prediction component	I_DP_SHIPPRED_SRV	<i>Internal + ESB</i>
	The Ship Prediction component publishes an interface that allows querying predicted ship positions.	
	<i>Information exchanged:</i> <ul style="list-style-type: none"> • in: Previous ship locations • in: Prediction date • out: Predicted ship position • out: Uncertainty on the predicted position 	
	<i>Used By:</i> ESB	
Ship Prediction component	I_DP_SHIPPRED_SUPERVISION	<i>Internal + ESB</i>
	The Ship Prediction component publishes an interface from which prediction activity can be monitored.	
	<i>Information exchanged:</i> logs, prediction progress.	
	<i>Used By:</i> ESB	

Table 16 - Interfaces published by the Ship Prediction Component

5.5.6.2.4. Dependencies

The component is totally independent from the DPC Block2 system: it does not depend on any internal interface of the ESB.

5.5.6.3. S-AIS Data Simulator component

5.5.6.3.1. SAT-AIS Simulator heritage and ESA simulation environment

The SAT-AIS Simulator to be developed and provided for the Satellite-AIS Data Processing Centre inherits from a prototype simulator, AIS-SMAR, developed by TAS-F for the CNES.

This prototype simulator implemented most of the functions needed for the new simulator:

- XML parameter interface file
- Control Interface
- SOTDMA model
- Link elaboration model



- Signal processing model

As the prototype simulator was intended for performance evaluation, its outputs were not messages but detection probabilities. The main new functions to be added are then:

- Downlink definition
- Message elaboration

Even if the heritage is significant, the Simulator for the DPC is however considered as newly developed for several reasons:

- As a performance evaluator, the prototype simulator has evolved in parallel of the knowledge in Satellite-AIS, and has then kept a lot of options and incremental improvement of the calculations, that are not necessary for a final Simulator
- As a prototype, the first Simulator was developed in accordance with TAS standards, knowing that in addition it has been delivered to the CNES. It is then fully described and documented, but the process has not followed all the constraints of a ECSS DAL-D development.
- For a better flexibility and for still be compliant with the processing delays, the prototype had been developed in C++, while the DPC Simulator, as the rest of the DPC, shall be developed in Java.

This heritage is not a “re-use”, according to ECSS standard, but may be seen as an anteriority in “know-how”. This “know-how” is used for:

- Specification of the processing functions
- Re-use of the documentation of these functions
- Validation of processing durations

Another option for building the DPC Simulator would have been to consider the SIMULUS library as proposed by ESA. This option has not been kept for the following reasons:

- The Satellite-AIS simulation in real-time or faster requires a very optimized management of memory, with in particular a “slot-by-slot” approach and the use of classical functions, such as link budget and visibility evaluation, in a very specific manner.
- The SIMULUS environment does not provide all required functions, in particular the highly specific functions, such as the beamforming model, that is as far as we know only included for now in AIS-SMAR prototype.
- The functions of SIMULUS that could have been re-used for the DPC Simulator are already included and validated in the AIS-SMAR prototype, so that there is no risk for the definition or the performance (calculation duration) of these functions as an already optimized function exists as reference.

5.5.6.3.2. Overview

The S-AIS Data Simulator component supplies the DPC system with simulation services that are:

- Orbits propagation and downlink schedule delivery.
- Simulated SAT-AIS messages provider.
- Ship lost detection service.

The component is totally independent from the DPC Block2 system: it does not depend on any internal interface of the ESB. So it could be freely used in another context.



Since it is context free, it must be supplied with all the data it needs to perform a simulation. Classically, two kinds of configuration are necessary: a static configuration, and a dynamic configuration.

The static configuration of the simulation consists in setting the parameters that are constants for each simulation. This task is usually performed by the Operator. The (non exhaustive) following static parameters are:

- the simulation parameters of the ground segment (geometry of the ground stations and ground processing),
- an initial global virtual fleet (updated by the simulation process),
- the transmission model,
- the SAT-AIS provider processing model,
- the simulator mode (real, accelerated or full speed),

For more details see RD 2. Moreover, the parameters to be defined depend on the simulation service to be run. For instance, the SAT-AIS provider processing model is only required for Satellite-AIS Data Provider simulation.

The dynamic configuration of the simulation consists in setting up the parameters that characterize a simulation. It is the responsibility of the DPC Block2 to gather all the necessary data before running a simulation.

Once properly configured (statically and dynamically), the simulation can be started. A published interface allows to start and stop the simulation and another one allows to monitor the simulation (logs & progress).

From the ESB point of view, the S-AIS Data Simulator component is considered as an additional AIS data provider so that the retrieval mechanisms, provided by the Data Retrieval subsystem, are fully reused.

Several simulation instances can be dynamically started (if they have been previously configured) and processed in parallel. Of course, a matching Data Retrieval instance must be started to allow the ingestion of the simulation results in the system.

5.5.6.3.3. Behavior

The following diagram details the major activities of the S-AIS Data Simulator component.

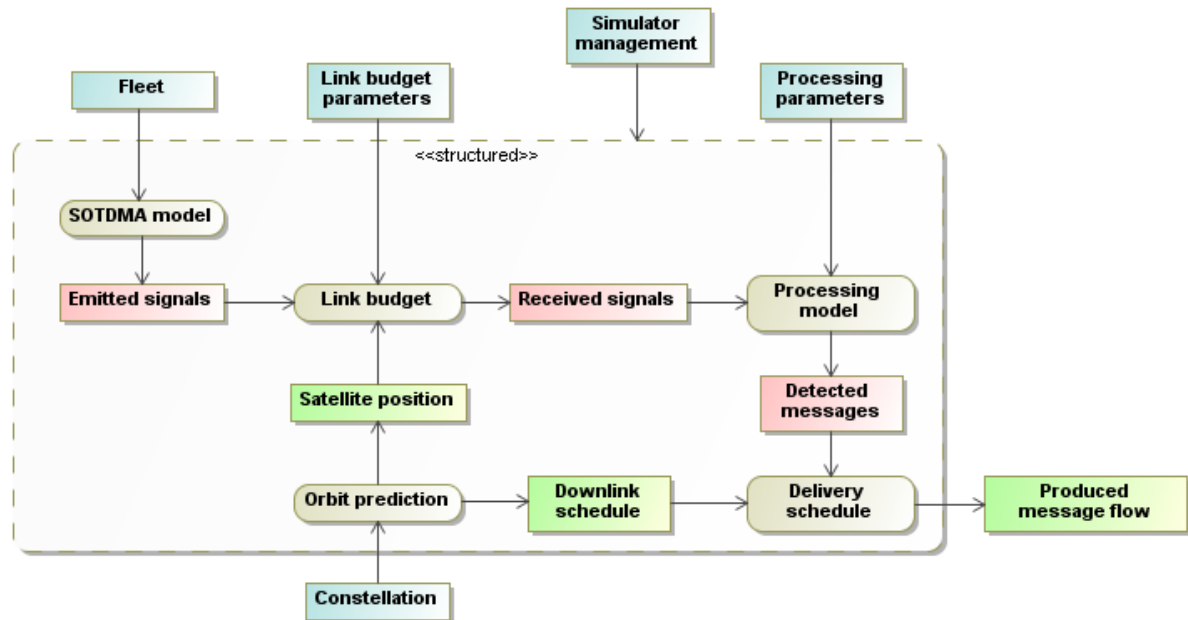


Figure 30 - Activities of the S-AIS Data Simulator component

SOTDMA model

The “SOTDMA model” consists in a random assessment of all emitting ships at a given date, depending in particular of the nominal transmission period of the ship and of the previous transmission date. It is recalculated for each time step. It also includes the management of jamming emissions.

Orbit prediction

The “orbit prediction” calculates the position of the satellites at each date. It also evaluates the date at which the satellites will be visible by a ground station (downlink schedule).

Link budget

The “link budget” models the ship antenna pattern, the free space and atmospheric losses, including polarization effects, and the satellite antenna pattern. The link budget can be modelled for several satellites and several antennas per satellite, and for first AIS frequencies (AIS 1 & 2) and/or new ones (AIS 3 & 4).

Processing model

The “processing model” provides the detection probability of all received messages. It allows to implement different features: phased array processing, including adaptative beamforming, demodulation performance (tables), Signal Interference Cancellor (SIC) or other multi-user detection algorithms.

After this processing stage, a bit error rate is assigned to each signal received, and the value of each bit is randomly taken accordingly. In addition, the Doppler (including noise effect) and other ancillary data are evaluated. The AIS message is then constructed, taking into account the ID of the emitting ship, its position, its speed and course, etc., and completed with ancillary data and reception date.

Delivery schedule

The “delivery schedule” processes the downlink schedule to evaluate the date at which the message will be delivered to the processing centre, including:

- the time to next ground station visibility (downlink schedule);
- the duration of processing by the ground station;



- the delivery time by the ground network to the processing centre.

A message is then characterized by 3 dates :

- The transmission date (from ship): date used for performance evaluation.
- The reception date (by satellite): date used for the message quality assessment.
- The delivery date (to the processing centre).

The data flow is created at entry of the processing centre at the delivery date.

5.5.6.3.4. Interfaces

The interfaces published by the component are inventoried in the following table.

Component	Published Interface	Visibility
S-AIS Data Simulator	I_DP_SIMULATOR_CFG	<i>Internal</i>
	<p>The S-AIS Data Simulator component publishes an interface that allows configuring the static parameters of a simulation.</p> <hr/> <p><i>Information exchanged:</i> Configuration items (depending on the service to use) such as:</p> <ul style="list-style-type: none"> • Ground segment: Simulation parameter <ul style="list-style-type: none"> ○ Geometry of the ground stations : position, masking ○ Ground processing : FTP/SLE approach, processing delays • Virtual fleet: Simulation parameter <ul style="list-style-type: none"> ○ Global fleet (based on a global traffic model), from which virtual ships will eventually be replaced by real ships • Transmission model: Simulation parameter <ul style="list-style-type: none"> ○ Repartition of messages transmission periods in relation with the speed of ship • Satellite-AIS provider processing model : Simulation parameter <ul style="list-style-type: none"> ○ Performance parameters to evaluate the processing capacity ○ Demodulation capacity wrt signal to noise ratio, ... (list TBC during detailed design) ○ Definition of the geographic area for which the data are provided (in case of regional coverage instead of global coverage) • Outputs definition: Simulation parameter <ul style="list-style-type: none"> ○ Address of delivery of output data to data retrieval ○ Specific ID to identify the messages from this Simulated Satellite-AIS provider • Warning thresholds: Simulation parameter <ul style="list-style-type: none"> ○ Non-detection threshold for the provider (several levels: unusual, warning, alert) ○ Address of the multi-instances common non-detection file • Simulator mode: <ul style="list-style-type: none"> ○ Real, accelerated or free run mode ○ Parameter for visualization data delivery <hr/> <p><i>Used By:</i> Operator actor</p>	
S-AIS Data Simulator	I_DP_SIMUL_PRM	<i>Internal + ESB</i>
	<p>The S-AIS Data Simulator component publishes an interface that allows configuring the dynamic parameters of a simulation.</p>	



Component	Published Interface	Visibility
	<i>Information exchanged:</i> Configuration items such as: <ul style="list-style-type: none"> • TLE: necessary for orbit propagation • IERS : pole parameters (for conversion to J2000) • Real fleet: currently observed fleet • Current date (Use of real hardware current date by default) 	
	<i>Used By:</i> ESB	
S-AIS Data Simulator	I_DP_SIMUL_CTRL	<i>Internal + ESB</i>
	The S-AIS Data Simulator component publishes an interface that allows controlling the component life-cycle such as starting and stopping the simulation.	
	<i>Information exchanged:</i> None	
	<i>Used By:</i> ESB	
S-AIS Data Simulator	I_DP_SIMUL_SUPERVISION	<i>Internal + ESB</i>
	The S-AIS Data Simulator component publishes an interface from which simulation activity can be monitored.	
	<i>Information exchanged:</i> logs, simulation progress.	
	<i>Used By:</i> ESB	
S-AIS Data Simulator	I_S-AIS_DATA_PROVIDER	<i>Internal</i>
	The S-AIS Data Simulator component publishes an interface that allows retrieving the simulated AIS messages, in the same way as the S-AIS Data Provider Actor. See SI_S-AIS_DATA_PROVIDER .	
	<i>Information exchanged:</i> Message flow: <ul style="list-style-type: none"> • Messages are put in the required address at the time corresponding to the simulated downlink • Message format identical to other providers: Header + Ancillary data + Message (ASCII with specific conversion from binary to ASCII for the binary message) • Use of required specific provider ID. 	
	<i>Used By:</i> ESB	
S-AIS Data Simulator	I_DP_SIMUL_DOWNLINK	<i>Internal + ESB</i>
	The S-AIS Data Simulator component publishes an interface that allows retrieving the orbit and downlink schedules.	
	<i>Information exchanged:</i> The information retrieved by the interface is the list of ship visibilities and downlinks. One table of ship geometric visibilities per satellite with the following information: ship ID, next visibility of the ship by the satellite, following downlink.	
	<i>Used By:</i> ESB	
S-AIS Data Simulator	I_DP_SIMUL_SHIPLOST	<i>Internal + ESB</i>
	The S-AIS Data Simulator component publishes an interface that allows retrieving the results of a lost ship detection.	
	<i>Information exchanged:</i> The information retrieved by the interface are following: <ul style="list-style-type: none"> • Lost Ship reports: Messages providing lost ship detection reports: 	



Component	Published Interface	Visibility
	<ul style="list-style-type: none"> ○ for the different levels (unusual, warning, alert): ○ per satellite constellation, and globally for all satellites (cumulating the space assets of all providers) ● Satellite failure reports : Message providing satellite failure reports: <ul style="list-style-type: none"> ○ Loss of a major part of ships that should have been seen by a satellite ○ Beginning and end dates and failure ID 	
	<i>Used By: ESB</i>	

Table 17 - Interfaces published by the S-AIS Data Simulator Component

5.5.6.3.5. Dependencies

The component is totally independent from the DPC Block2 system: it does not depend on any internal interface of the ESB.

6. Requirements

6.1. Methodology

6.1.1. Functional views

The method used to describe the functionalities of the DPC Block2 system is based on Unified Modelling Language (UML) Use Cases Diagrams.

These diagrams are a widely used to capture functional requirements of a system. Use cases work by describing the typical interactions between the users of a system and the system itself. A Use Case is made up of a set of scenarios. Each scenario is a sequence of steps that encompass an interaction between a user and a system. The use case brings scenarios together that accomplish a specific goal of the user. A Use Case diagram allows a designer to graphically show these use cases and the actors that use them, in particular.

The following items will provide some information on the Use Case diagram representation components, with a short explanation and a graphic example of each:

- **Use Case** - A use case describes a sequence of actions that provide something of measurable value to an actor and is drawn as a horizontal ellipse.

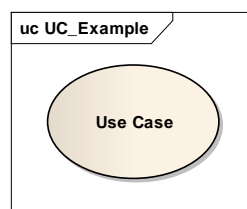


Figure 31: Use Case Example

- **Actor** - An actor is a person, organization, or external system that plays a role in one or more interactions with the system. Actors are drawn as stick figures.

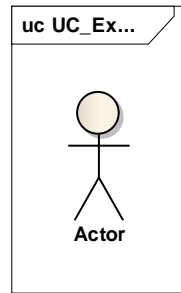


Figure 32: Actor Example

- Association** - Associations between actors and use cases are indicated in use case diagrams by solid lines. An association exists whenever an actor is involved with an interaction described by a use case. Associations are modelled as lines connecting use cases and actors to one another, with an optional arrowhead on one end of the line. The arrowhead is often used to indicating the direction of the initial invocation of the relationship or to indicate the primary actor within the use case. The arrowheads are typically confused with data flow and as a result they should be avoided.

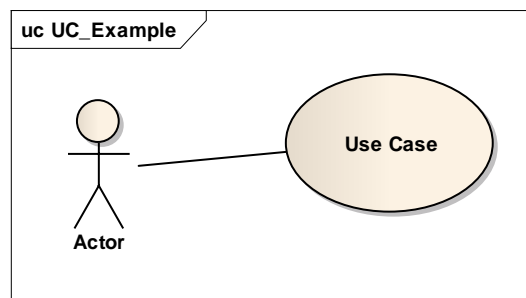


Figure 33: Association Example

- System Boundary Box** - You can draw a rectangle around the use cases, called the system boundary box, to indicate the scope of your system. Anything within the box represents functionality that is in scope and anything outside the box is not.

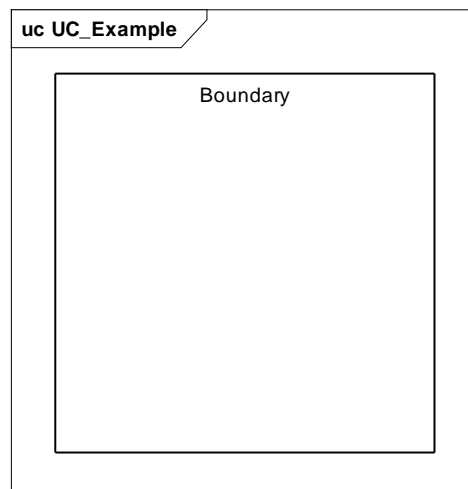


Figure 34: Boundary Example



6.1.2. Requirements and Specification Nomenclature

The nomenclature rules applied in the requirement specification are given hereafter. Each requirement follows the nomenclature:

Level-MOD-TYPE-n°/V

Where:

Level: **SR** for requirements (input document AD1 and consolidation, SSS and IRD)
TS for technical specifications (SRS and ICD documents)
PD Preliminary Design

MOD: module, concerned element

DPC Global
 DRT Data Retrieval
 PL1 Processing Level 1
 PL2 Processing Level 2
 PL3 Processing Level 3
 DLP Doppler Location Processing
 PRO Processing in general
 DIS Distribution
 MCC DPC MCC
 SSP S-AIS System Performance
 DMA Data Management & Archive
 DSS S-AIS Data Simulation Service
 DPS Data Prediction S-AIS Simulator
 DPP Data Prediction Ship Prediction
 DCF DC Framework

TYPE: requirement type

FUN Functional aspects
 IFR Input and Output Interfaces
 PER Performance
 SEC Security aspects
 DES Design constraints
 REL Reliability and Availability
 SAF Safety
 OPE Operational
 SW Software
 HW Hardware
 DAT Data procurement
 DDD Data Definition and Database requirements
 VVI Verification Validation Integration
 SWQ Software Quality aspects

n°: from 10 to n (from 10 to 10)

/V: requirement verification method: (T = Test, A = Analysis or I = Inspection)

Test: a test of validation makes it possible to check the requirement

For the requirements which cannot be checked by a test:



Inspection: activity of control per examination, observation or audit (example: the data access path is customizable)

Analysis: activity which requires a study to validate the respect of the requirement, for example calculation of performance.

In case of multiple verification methods, use a combination of T, A and I (/TA, /TAI ...)

6.1.3. Actors

The boundary actors of the S-AIS DPC Block2 has been described in the chapter §4.2.2, and are fully involved in the following stage of engineering. As a reminder, the boundary actors are summarized in the following diagram.

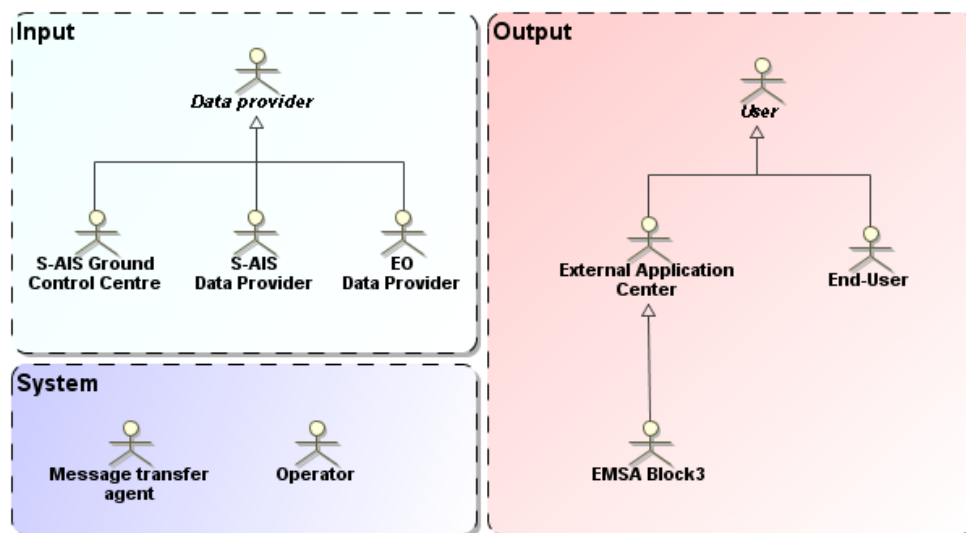


Figure 35 - Boundary actors of the DPC Block2 System

The chapter §5.3 has unveiled the software elements that compose the S-AIS Block2 system in terms of subsystem and components. In the following chapters the focus is put on use cases for which the interaction between an actor and a subsystem or component is detailed.

Since every subsystem or components can play the role of an actor, they are promoted as such, as described in the following actor diagram.

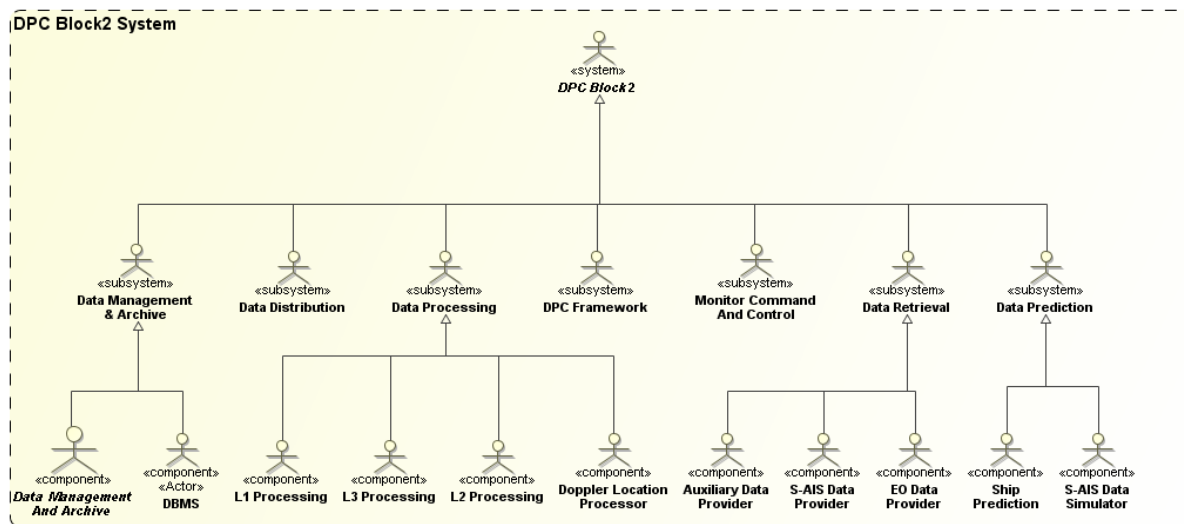


Figure 36 - Internal actors of the DPC Block2 System

6.2. Data Retrieval

The Data Retrieval is the sub-system in charge of the acquisition of all input data for the DPC Block2 System.

6.2.1. Functional requirements

The following diagram details the use cases assumed by the subsystem.

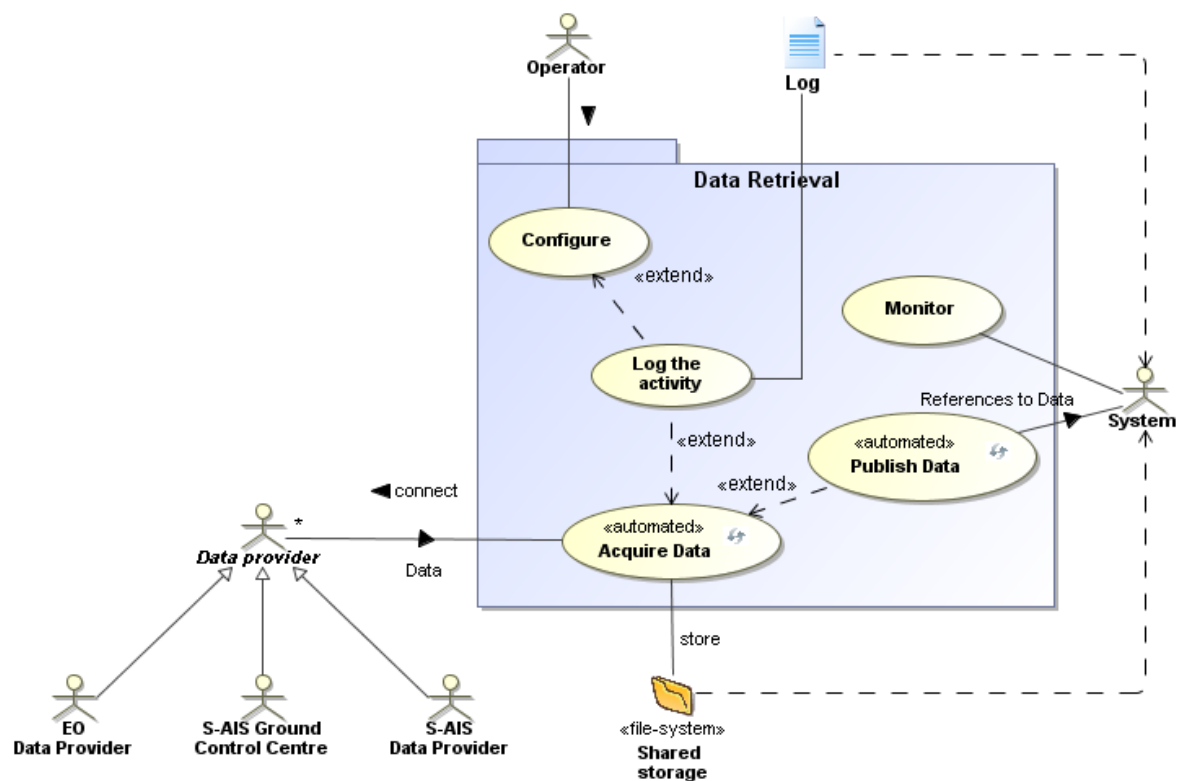


Figure 37 - Use Cases diagram for Data Retrieval subsystem



6.2.1.1. “Acquire Data” UC

The use case supplies the Data Retrieval Sub-system with the capability of retrieving (acquiring) external content made available by Data Providers.

6.2.1.1.1. Context

This UC is independent.

6.2.1.1.2. Interactions

The UC requests AIS messages and associated ancillary data from S-AIS Data Provider actors.

The UC requests auxiliary data from the S-AIS Ground Control Centre actors.

The UC requests VDRs and Level 1 images from the EO Data Provider actors.

The UC uses the Shared storage system to store incoming data.

TS-DRT-FUN-0005/I

Data Retrieval shall support the communication protocols commonly used by SAT-AIS and EO data providers (FTP/SFTP, Socket (TCP/UDP), Web Services, JMS).

Trace from:

SR-DRT-FUN-0360

6.2.1.1.3. Pre-conditions

A data provider must be configured for the retrieval process.

6.2.1.1.4. Description

6.2.1.1.4.1. Overview

The UC is a generic and versatile function to transfer any kind of content from one location to another. It makes very few assumption on the nature of the information retrieved and on the admissible protocols.

Within the DPC Block2 frame, it is in charge of retrieving all the information made available by the Data Providers, such as AIS messages along with ancillary data, Auxiliary data, VDRs and Level 1 images.

TS-DRT-FUN-0010/T

The Data Retrieval shall retrieve remote content with no assumption on the nature of the information retrieved.

IFR-0010

SR-DPC-IFR-0020

SR-DPC-IFR-0030

SR-DPC-IFR-0040

SR-DPC-FUN-0080

SR-DPC-PER-0270

SR-DRT-FUN-0340

SR-DRT-IFR-0170Trace from:

SR-DPC-FUN-0040



SR-DPC-FUN-0050
 SR-DPC-IFR-0090
 SR-DPC-IFR-0100
 SR-DRT-IFR-0110
 SR-DRT-IFR-0120
 SR-DRT-IFR-0170
 SR-DRT-FUN-0290
 SR-DRT-FUN-0300
 SR-DRT-FUN-0310
 SR-DRT-FUN-0320
 SR-DPC-

The UC is described by a life-cycle composed of four states, as the following activity diagram shows.

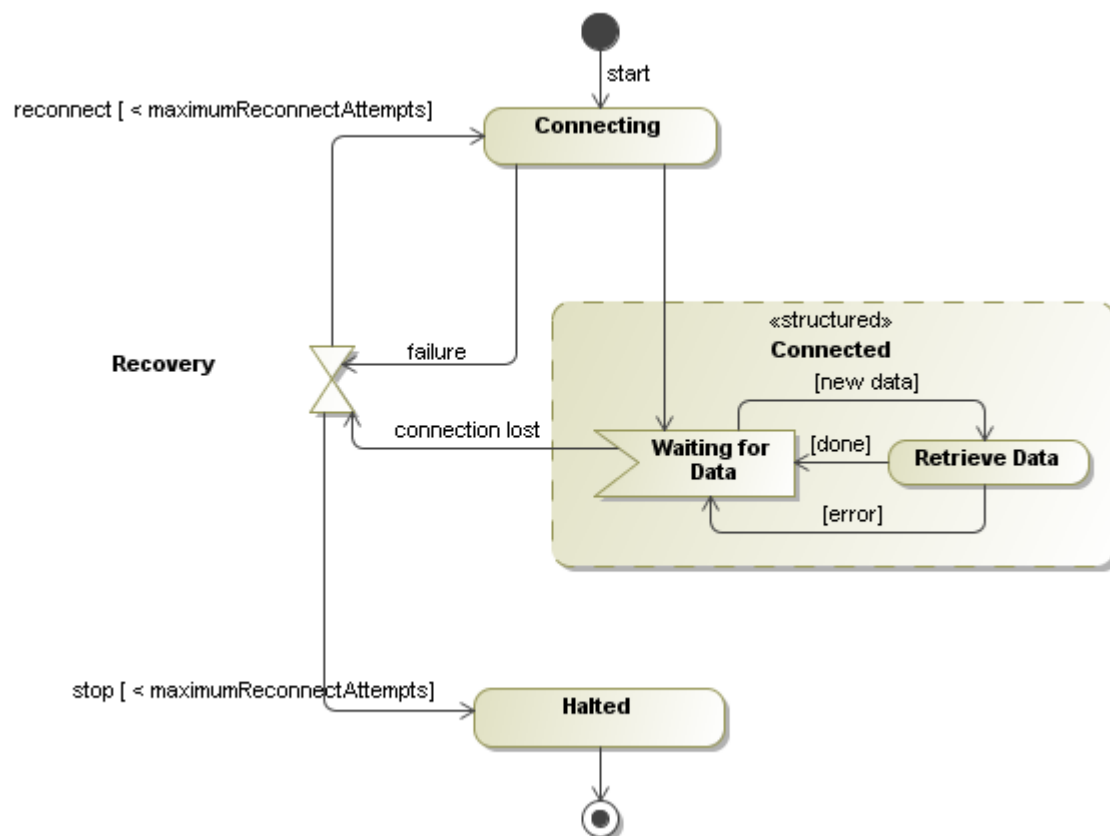


Figure 38 - Activity Diagram of the Data Retrieval Connection

The reachable states are following:

6.2.1.1.4.2. Connecting state:

The UC is in the process to connect to the configured protocol. This connection may require an appropriate authentication depending on the protocol specificities (login/password pair or trusted certificate).

TS-DRT-FUN-0020/T

The Data Retrieval shall be able to authenticate to the remote system with a configured username/password pair.



Trace from:

TS-DRT-FUN-0030/T

The Data Retrieval shall be able to authenticate to the remote system with a client certificate.

Trace from:

If a fail occurs, the Recovery state is reached.

6.2.1.1.4.3. *Connected state:*

The UC is in the process to retrieve data from the remote system if there are new. Two sub-activities are to be considered here:

Wait for new data available

The wait can be passive if the protocol pushes new data through the established link. In that case, the process is awake to the rhythm of the incoming data. This is especially the case for JMS and TCP/Socket protocols.

The wait can be active if the Data Retrieval must ensure that newly data are ready to be retrieved. In that case, the process is awakened by a timer and goes back to sleep if nothing is available. This is the case for directory-browsable protocols like FTP and SFTP protocols.

In this second case, the frequency of the polling activity can be expressed in fixed delay or fixed rate. A fixed delay defines a periodic poll that becomes enabled after the given initial delay, and subsequently with the given delay between the termination of one poll and the commencement of the next. A fixed rate defines a period poll that occurs at fixed interval times regardless of their duration.

TS-DRT-FUN-0040/T

The Data Retrieval shall poll for new available data in a configured fixed delay or fixed rate.

Trace from:

SR-DRT-IFR-0190

In the DPC, each Data Provider is configured according to the period of reactivity needed for the type of data retrieved. For the S-AIS auxiliary data, if a near-real-time reactivity is needed the delay is chosen as short as possible.

The strategy used to establish the set of data to retrieve is based on two regular expression patterns whose combination defines the set of directories and files to take into account. The grammar used to express the patterns is left to the design phase, but can be a POSIX Basic/Extended Regular Expression or an Ant Regexp.

TS-DRT-FUN-0050/T

The Data Retrieval shall include the remote available files matching a configured regular expression.

Trace from:

TS-DRT-FUN-0060/T

The Data Retrieval shall exclude remote available files matching a configured regular expression.

Trace from:

The Data Retrieval can be configured to look recursively into directories.

**TS-DRT-FUN-0070/T**

The Data Retrieval shall be able to look for files recursively in all the sub-directories, if it is configured as such.

Trace from:

In this state, if an error occurs, the « Recovery State » is reached.

Retrieve data

The retrieve data activity consists in copying the data identified as new into the Shared storage system.

TS-DRT-FUN-0080/T

The Data Retrieval shall store retrieved data in a configured local directory.

Trace from:

For streaming protocols (TCP, JMS) and concerning only SAT AIS messages, a special feature is implemented that allows splitting the incoming data according to SAT-AIS satellite it was acquired. For that, the content is not in itself decoded (since it's the responsibility of the L1 processing), but an "analyzer" is used instead which is able to tell what satellite the content belongs to. This particular aspect should be treated during the design phase keeping in mind that event if the content analyzed is not consistent (corrupted, incomplete), robustness of the processing must be maintained.

TS-DRT-FUN-0085/T

The Data retrieval shall produce data files containing AIS messages coming from a unique satellite.

Trace from:

A naming scheme is used to name the file created in the file system. This naming scheme can address the original file name, extension, date, as well as the current timestamp.

TS-DRT-FUN-0090/T

The Data Retrieval shall use a configured naming scheme, including original file name, extension, data and timestamp, to name stored files.

Trace from:

SR-PRO-FUN-0390/T

Once a data has been successfully stored in the local file system, the Data Retrieval can perform an action on the remote server side:

- delete the retrieved file, if it is both supported and authorized;
- move the retrieved file according a naming scheme, it is both supported and authorized;
- nothing, for read-only servers (FTP), stream oriented protocols (TCP/Socket), consumer oriented protocols (JMS).

TS-DRT-FUN-0100/T

The Data Retrieval shall be able to delete the retrieved files on the remote system.

Trace from:

**TS-DRT-FUN-0110/T**

The Data Retrieval shall be able to move the retrieved files on the remote system according a configured naming scheme.

Trace from:

In this state, if an error occurs, the activity is stopped, no file is written in the file system and the “Waiting for Data” state is reached.

6.2.1.1.4.4. Recovery State

The UC is in the process to recover the connection to a Data Provider. The UC increments the number of failure by one and if the maximum reconnect attempts has not been reached, the UC waits for a configured amount of time before going back to the Connecting State.

TS-DRT-FUN-0120/T

The Data Retrieval shall wait for a configured amount of time before automatically perform a reconnection to a Data Provider.

Trace from:

If the maximum reconnect attempts is reached, the Data Retrieval stops its activity.

TS-DRT-FUN-0130/T

The Data Retrieval shall stop the retrieval activity for a Data Provider if the number of reconnect attempts has crossed a configured ceil.

Trace from:

6.2.1.1.4.5. Halted state

The retrieval activity is stopped.

6.2.1.1.5. Post-conditions

None.

6.2.1.2. “Publish Data” UC

The use case supplies the system with the capability of publishing retrieved data through a notification mechanism.

6.2.1.2.1. Context

The UC is independent.

The UC is started when new successfully retrieved data are available (and not already successfully sent).

6.2.1.2.2. Interactions

The UC sends notification of data to the System Actor.



6.2.1.2.3. Pre-conditions

New available data must have been successfully retrieved.

6.2.1.2.4. Description

The UC specifies the activity of publishing (sending notifications) data to the System Actor (which is the ESB in the DPC frame).

TS-DRT-FUN-0140/T

The Data Retrieval shall send the notification of a successfully retrieved data.

Trace from:

The notification does not contain the data itself, but the information (metadata) about the retrieved data. The following elements are expected to be given:

- a unique identifier,
- a URL expressing a link to the concrete resource,
- the name of the data provider from which the data comes from,
- the creation date of the original file, if it is known,
- the creation date of the stored file,
- the media-type of the retrieved data (ais-message, auxiliary data...)
- the size of the retrieved data.

TS-DRT-FUN-0150/T

The Data Retrieval shall send a notification about a successfully retrieved data with the following information: unique identifier, URL to the data file, name of the Data Provider, original creation date, stored creation date, data media-type, data size.

Trace from:

SR-PRO-FUN-0390

SR-DRT-FUN-0350

If the publication fails, the notification is delayed for a while before being sent again.

TS-DRT-FUN-0160/T

The Data Retrieval shall delay failed notifications for a configured amount of time.

Trace from:

In that case, and if the problem persists, the pending notifications grow together with the publication time. That's why, if age of the notification is older than a configured delay, the notification is removed from the pending notifications.

TS-DRT-FUN-0170/T

The Data Retrieval shall delete unsent notifications that are older than a configured delay.

Trace from:

6.2.1.2.5. Post-conditions

Notifications have been sent to the recipient.



6.2.1.3. “Configure” UC

The use case allows configuring the Data Retrieval sub-system.

6.2.1.3.1. Context

The UC is independent.

6.2.1.3.2. Interactions

The UC is initiated by the Operator in order to manage the configuration items of the Data Retrieval sub-system.

6.2.1.3.3. Pre-conditions

None.

6.2.1.3.4. Description

The UC provides the configuration capability of a set of parameters like the declaration of the Data Providers, the behaviour of the sub-system, the declaration of the recipient of the published data.

Through this UC, the operator can manage the Data Providers for which the sub-system is consumer. The management activity covers the functionalities of declaration, modification and deletion of Data Providers.

TS-DRT-FUN-0180/T

The Data Retrieval shall allow the management (declaration, modification, deletion) of an unbounded set of Data Providers.

Trace from:
SR-DPC-DES-1930/T

Through this UC, the operator can set-up the recipient of the published data.

TS-DRT-FUN-0190/T

The Data Retrieval shall allow the modification of the system recipient of the published data.

Trace from:

6.2.1.3.5. Post-conditions

The configuration is changed.

The modification of the configuration is not expected to be dynamically taken into account. A restart of the sub-system might be necessary.

6.2.1.4. “Log the activity” UC

The UC provides the subsystem with the capability to store the activity in a log.



6.2.1.4.1. Context

The UC is independent and can be invoked at any time.

This UC is initiated by any other UCs who needs to keep track of their activities.

6.2.1.4.2. Interactions

The UC uses the Log actor as persistence means.

6.2.1.4.3. Pre-conditions

A significant event has occurred.

6.2.1.4.4. Description

The UC provides the means to carry in a single log all the activity of the subsystem. Each entry of that log is an event or a notable fact that is written in the log along with several attributes that characterizes it:

- Timestamp: the date and time on which the event has occurred;
- Severity: a value from the severity scale which expresses the significance of the event, including but not limited to the following: Error, Warning, Information;
- Context: a free text value referring to a context;
- Circumstance: Explicit and detailed description of the event.

TS-DRT-FUN-0200/T

The Data Retrieval shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.

Trace from:

6.2.1.4.5. Post-conditions

The log is appended with one or several entries.

6.2.1.5. “Monitor” UC

The UC provides the subsystem with the capability to publish the measurements of the activity (performance, resources usage, statistics).



6.2.1.5.1. Context

6.2.1.5.2. Interactions

6.2.1.5.3. Description

6.2.1.5.4. Pre-conditions

6.2.1.5.5. Post-conditions

6.2.2. Performance requirements

In order to keep the global timeliness in the bound required by the end users, it is necessary to retrieve data flows in a reasonable delay.

TS-DRT-PER-0205/T

The Data retrieval shall retrieve and publish a new data flow of AIS messages in less than 30 seconds for a volume of 10000 AIS messages.

Trace from:
SR-DPC-PER-0210

The Data Retrieval can retrieve Level 1 images that can be very huge. In that case, the Data Retrieval must take care of resources consumed especially the memory: memory consumption must remain the same whether the file is large or small. Several implementations exist and the choice is left for the design phase.

TS-DRT-PER-0210/T

The Data Retrieval shall keep the memory consumption constant, i.e. contained in a range of 10MB width, regardless of the size of the retrieved file.

Trace from:
SR-DPC-DES-1930/T

When retrieving data, the Data Retrieval can optimize the bandwidth available by allowing the download of several data simultaneously, if agreed by the remote server.

TS-DRT-PER-0220/T

The Data Retrieval shall accept a number of configured simultaneous retrieval by provider.

Trace from:
SR-DPC-DES-1930

The publication of retrieved data can be done each time a new data is available. If several data are available at about the same time, the publication rate can be very high, too high for the receiver. That's why the Data Retrieval shall be "nice" proposing to space messages with a minimum time.

TS-DRT-PER-0230/T

The Data Retrieval shall not send two consecutive data notifications in a time shorter than a configured period.

Trace from:



6.2.3. Interface requirements

Interface requirements are detailed in the ICD (RD 2).

6.2.4. Operational requirements

To maintain a high level of control, the Data Retrieval stores in a log file a set of significant events that may be used by an operator to learn and understand the past activity.

TS-DRT-OPE-0240/T

The Data Retrieval shall log the event of a successful connection to a Data Provider with the information of: Data Provider name, Data Provider URL, duration time.

Trace from:

TS-DRT-OPE-0250/T

The Data Retrieval shall log the event of a successful retrieval activity with the information of: Data Provider name, Data Provider URL, remote file location, local file location, file size, duration time.

Trace from:

TS-DRT-OPE-0260/T

The Data Retrieval shall log the event of a successful publication activity with the information of: Recipient URL, list of file names.

Trace from:

TS-DRT-OPE-0270/T

The Data Retrieval shall log all fail events: network error, authentication error, file retrieval error, publication failure, with the appropriate severity and the most detailed information.

Trace from:

TS-DRT-OPE-0280/T

The Data Retrieval shall log all the notifications that have been removed because of age.

Trace from:

To maintain a high level of operability, the Data Retrieval offers to the operator a view of the activity in the form of statistics.

TS-DRT-OPE-0290/T

The Data Retrieval shall provide the cumulative number of successful and failed data retrieved for each provider.

Trace from:

TS-DRT-OPE-0300/T

The Data Retrieval shall provide the date and time of the last successful retrieved data and last failed retrieved data for each provider.

Trace from:

**TS-DRT-OPE-0310/T**

The Data Retrieval shall provide the min, max and mean time of data retrieval for each provider.

Trace from:

TS-DRT-OPE-0320/T

The Data Retrieval shall provide the number of successful and failed published data.

Trace from:

TS-DRT-OPE-0330/T

The Data Retrieval shall provide the date and time of the last successful published data and last failed published data.

Trace from:

TS-DRT-OPE-0340/T

The Data Retrieval shall provide the min, max and mean time taken to publish data.

Trace from:

TS-DRT-OPE-0350/T

The Data Retrieval shall provide the current memory used.

Trace from:

6.2.5. Resources requirements

Not applicable.

6.2.6. Design requirements and implementation constraints

The Data Retrieval is designed to allow new custom strategies that determine availability of data during the poll activity.

TS-DRT-DES-0360/T

The Data Retrieval shall provide a pluggable infrastructure accepting new “poll” strategies.

Trace from:

SR-DPC-DES-1920

SR-DPC-SW-0020

The Data Retrieval is designed to allow new custom strategies for naming stored files.

TS-DRT-DES-0370/T

The Data Retrieval shall provide a pluggable infrastructure accepting new naming strategies for stored files.

Trace from:

SR-DPC-DES-1920

SR-DPC-SW-0020

The Data Retrieval is designed to allow the plug of new retrieval protocols.

**TS-DRT-DES-0380/T**

The Data Retrieval shall provide a pluggable infrastructure accepting new retrieval protocols.

Trace from:

SR-DPC-DES-1920

SR-DPC-SW-0020

TS-DRT-DES-0390/I

The Data Retrieval shall be implemented using the Java Platform, Enterprise Edition 7 or higher.

Trace from:

SR-DPC-DES-2070

6.2.7. Security and privacy requirements

Not applicable.

6.2.8. Portability requirements

Not applicable.

6.2.9. Software quality requirements

Software quality requirements are detailed in the Software Product Assurance Plan (AD 7).

6.2.10. Software reliability requirements

Once started, the Data Retrieval connects to the configured Data Providers and polls for new data available. If for some reason, the connection is lost, the Data Retrieval automatically reconnects.

TS-DRT-DES-0400/T

The Data Retrieval shall automatically reconnect to providers if the link is lost.

Trace from:

SR-DPC-REL-1890

SR-DPC-PER-0100

SR-DPC-PER-0270

If the Data Retrieval is stopped abruptly, it should not lose information. For instance, if a data has been successfully retrieved (which means it has been potentially renamed or removed from the Data Provider), and not already notified to the system, the data should not be lost and should be notified once the Data Retrieval is started again.

TS-DRT-DES-0410/T

The Data Retrieval shall persist the information of a successfully retrieved data that is ready to be published.

Trace from:

6.2.11. Software maintainability requirements

Software maintainability requirements are detailed in the Software Product Assurance Plan (AD 7).



6.2.12. Software safety requirements

Not applicable.

6.2.13. Software configuration and delivery requirements

TS-DRT-CFG-0420/T

The Data Retrieval shall define the configuration of a Data Provider by the name (unique), the URL (including the protocol) and the mime-type of the data delivered by the Data Provider.

Trace from:

TS-DRT-CFG-0430/T

The Data Retrieval shall define the configuration of the System recipient of the published data by the URL.

Trace from:

TS-DRT-CFG-0440/T

The Data Retrieval shall define the configuration of the log with the flowing items: level of severity, location (directory and naming scheme) of the log file.

Trace from:

6.2.14. Data definition and database requirements

Not applicable.

6.2.15. Human factors related requirements

Not applicable.

6.2.16. Adaptation and installation requirements

Not applicable.

6.3. Data Processing - L1 Processing

The Data Processing - L1 Processing is the subsystem in charge of decoding AIS Messages with syntax and semantic control, without any further enhancement processing.

6.3.1. Functional requirements

The following diagram details the use cases assumed by the subsystem.

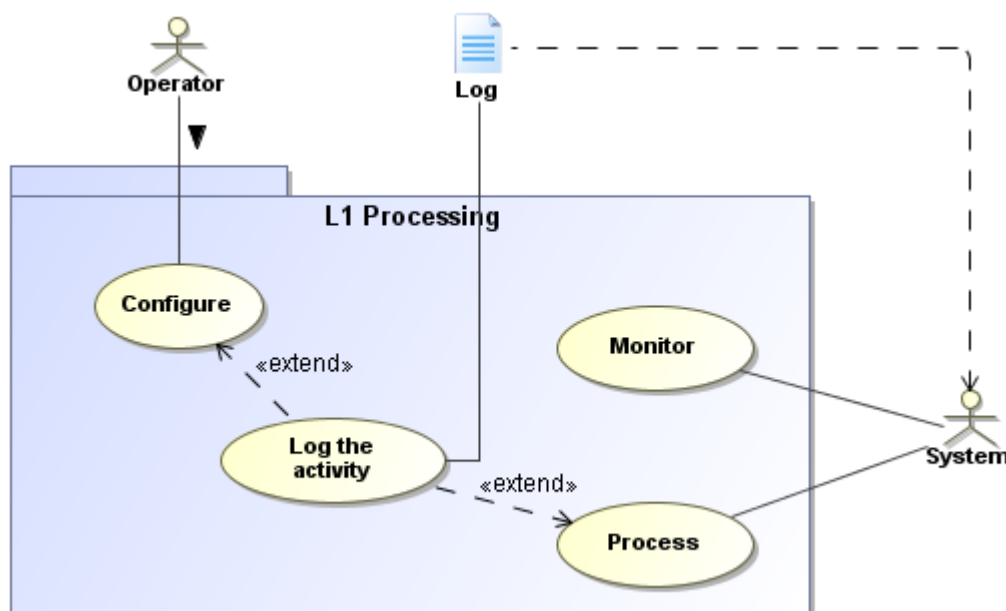


Figure 39 - Use Cases diagram for L1 Processing subsystem

6.3.1.1. “Process” UC

The use case supplies the subsystem with the capability to decode and control the validity of raw S-AIS messages.

6.3.1.1.1. Context

This UC is independent.

6.3.1.1.2. Interactions

The UC is initiated by the System to perform the decoding of S-AIS messages.

6.3.1.1.3. Pre-conditions

None.

6.3.1.1.4. Description

6.3.1.1.4.1. Overview

The UC captures the data processing applied to raw AIS Messages, i.e. S-AIS messages coming from data providers. This processing is divided in two independent scenarios:

- the first scenario consists in decoding the AIS-Message while performing a consistency (and intrinsic) check;
- the second scenario consists in performing advanced coherency check that needs a context, like the check for footprint or the test for velocity.



6.3.1.1.4.2. First scenario

In this scenario, the system asks for decoding raw AIS Messages (coming from S-AIS data provider) to level 1 AIS Messages, XML representation of AIS Messages with each field value turned into a readable alphanumeric value (§ Interface requirements - RD 2).

All AIS messages can be handled by the L1 processing without any restriction on the message type, or their integrity. This includes level-0 S-AIS messages (NMEA v4 sentences) or EMSA CDF format.

TS-PL1-FUN-0450/T

The L1 Processing shall process raw S-AIS Messages, along with ancillary data, to generate decoded XML L1 AIS Messages.

Trace from:

SR-PRO-FUN-0450
SR-DPC-DES-2050
SR-DPC-DES-2040
SR-DRT-IFR-0090
SR-DRT-IFR-0100
SR-DRT-IFR-0120
SR-DPC-FUN-0080
SR-PRO-FUN-0390
SR-PRO-FUN-0460
SR-DPC-FUN-0120

During the process, a set of intrinsic verifications, i.e. which relates only to the message under verification without the need for addition information, is performed.

The verifications are performed in sequence for each raw S-AIS message.

CRC Check

If the CRC is provided (i.e. in the NMEA sentence but not only), a checksum control is performed. If not, it is assumed the CRC check was performed by the S-AIS Data Provider and the message is assumed to be correct.

TS-PL1-FUN-0460/T

The L1 Processing shall control the CRC of raw AIS-Messages and the checksum of all retrieved ancillary data, if relevant.

Trace from:

SR-PRO-FUN-0470
SR-DRT-IFR-0100
SR-PRO-FUN-0480

Length check

The length (number of unit information, bits or bytes) of the S-AIS message is compared with its predefined length according to its type. This case is relevant for “binary” encoded S-AIS messages like NMEA v4 sentences, where messages type 1, 2 or 3 has a fixed size of 168 bits.

TS-PL1-FUN-0470/T

The L1 Processing shall check the length of raw AIS-Messages according to its (decoded) type.

Trace from:

SR-PRO-FUN-0490

Consistency check

Once the message is decoded, each field value is controlled against the admissible values. For instance, latitude values shall be comprised between -90° and +90°, or equal to 91 if not available.

**TS-PL1-FUN-0480/T**

The L1 Processing shall check the consistency of raw AIS-Messages according to the admissible values of each field.

Trace from:
SR-PRO-FUN-0490

6.3.1.1.4.3. Second scenario

In this scenario, the system asks for “advanced” coherency checks of decoded L1 AIS Messages. This processing needs an additional context that has to be provided by the invoker.

The verifications are performed in sequence for each level 1 S-AIS message.

Satellite footprint check

For S-AIS Position reports, verification is made to ensure the reported position is inside the satellite footprint. To complete, this verification needs to know the satellite position at the time of the message.

TS-PL1-FUN-0490/T

The L1 Processing shall check a reported position of L1 position messages (type 1, 2 and 3) are inside the satellite footprint.

Trace from:
SR-PRO-FUN-0500

A configurable tolerance is added in order to take into account atmospheric effects that can extend the visibility of S-AIS beyond the horizon.

TS-PL1-FUN-0500/T

The L1 Processing shall admit a configured tolerance for the Satellite footprint check that extends the satellite visibility.

Trace from:
SR-PRO-FUN-0500

Ship Velocity check

For S-AIS Position reports, verification is made to ensure the reported position is realistic against to the computed velocity from the previous position.

TS-PL1-FUN-0510/T

The L1 Processing shall check the reported position of L1 position messages (type 1, 2 and 3) leads to a computed average speed from the previous reported position (of the same ship) lower than a configured threshold.

Trace from:
SR-PRO-FUN-0510

6.3.1.1.5. Post-conditions**6.3.1.2. “Configure” UC**

The use case supplies the Operator with the capability of configuring the L1 Processing sub-system.



6.3.1.2.1. Context

This UC is independent.

This UC is invoked by an Operator.

6.3.1.2.2. Interactions

The UC is initiated by the Operator in order to manage the configuration items of the L1 Processing sub-system.

6.3.1.2.3. Pre-conditions

None.

6.3.1.2.4. Description

The UC provides the configuration capability of a set of parameters that affect the behaviour of the L1 Processing.

Through this UC, the operator can enable or disable the advanced checks that are performed by the processing on the decoded L1 AIS Messages. The CRC Check, Length Check and Consistency Check cannot be disabled since they are fundamental for the system in order to handle properly the incoming raw AIS-Messages.

TS-PL1-FUN-0520/T

The L1 Processing shall allow the enabling or disabling of the following advanced AIS-Message verifications: Satellite footprint check, Ship velocity check.

Trace from:

The UC allows the operator to configure the behaviour of each check, like the tolerance used for the Satellite footprint check for instance (see § 6.3.13 – Software configuration and delivery requirements).

TS-PL1-FUN-0530/T

The L1 Processing shall allow the configuration of the AIS-message checks.

Trace from:

6.3.1.2.5. Post-conditions

6.3.1.3. “Log the activity” UC

The use case supplies the subsystem with the capability to store the activity in a log.

6.3.1.3.1. Context

The UC is independent and can be invoked at any time.

This UC is initiated by any other UCs who needs to keep track of their activities.



6.3.1.3.2. Interactions

The UC uses the Log actor as persistence means.

6.3.1.3.3. Pre-conditions

A significant event has occurred.

6.3.1.3.4. Description

The UC provides the means to carry in a single log all the activity of the subsystem. Each entry of that log is an event or a notable fact that is written in the log along with several attributes that characterizes it:

- Timestamp: the date and time on which the event has occurred;
- Severity: a value from the severity scale which expresses the significance of the event, including but not limited to the following: Error, Warning, Information;
- Context: a free text value referring to a context;
- Circumstance: Explicit and detailed description of the event.

TS-PL1-FUN-0540/T

The L1 Processing shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.

Trace from:

6.3.1.3.5. Post-conditions

The log is appended with one or several entries.

6.3.1.4. “Monitor” UC

The UC provides the subsystem with the capability to publish the measurements of the activity (performance, resources usage, statistics).

6.3.1.4.1. Context

This UC is independent.

6.3.1.4.2. Interactions

The UC is initiated by the System to supervise the component.

6.3.1.4.3. Pre-conditions

None.



6.3.1.4.4. Description

6.3.1.4.5. Post-conditions

6.3.2. Performance requirements

In order to keep the global timeliness in the bound required by the end users, it is necessary to process data flows in a reasonable delay.

TS-PL1-PER-0545/T

The L1 Processing shall process and publish the results of a single data flow in less than 3 minutes for a volume of 10000 AIS messages.

Trace from:
SR-DPC-PER-0210

S-AIS messages corresponding to a SAT-AIS pass can be large, especially at the end of the L1 processing, mainly because XML is somewhat verbose. The L1 Processing must take care of resources consumed, especially the memory: memory consumption must remain the same whether the file is large or small.

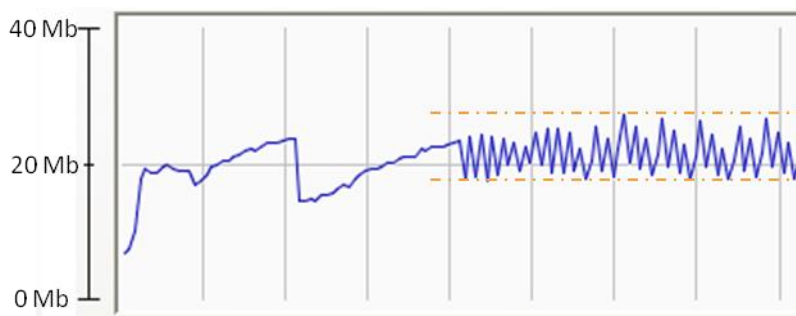


Figure 40 - Memory consumption control

TS-PL1-PER-0550/T

The L1 Processing shall keep the memory consumption constant, i.e. contained in a range of 10MB width, regardless of the size of the processed file.

Trace from:
SR-DPC-DES-1930

6.3.3. Interface requirements

Interface requirements are detailed in the ICD (RD 2).

6.3.4. Operational requirements

To maintain a high level of control, the L1 Processing stores in a log file a set of significant events that may be used by an operator to learn and understand the past activity.

**TS-PL1-OPE-0560/T**

The L1 Processing shall log the event of the start of the activity with the information of: path of the raw messages file, size of the file.

Trace from:

TS-PL1-OPE-0570/T

The L1 Processing shall log the event of the end of the activity with the information of: path of the raw messages file, processing duration time, number of messages processed, number of valid messages, number of failed messages.

Trace from:

TS-PL1-OPE-0580/T

The L1 Processing shall provide the cumulative number of valid and invalid raw messages processed.

Trace from:

TS-PL1-OPE-0590/T

The L1 Processing shall provide the cumulative number of valid raw messages for each type of AIS message.

Trace from:

TS-PL1-OPE-0600/T

The L1 Processing shall provide the date and time of the last L1 processing.

Trace from:

TS-PL1-OPE-0610/T

The L1 Processing shall provide the min, max and mean time taken to process a file of raw messages.

Trace from:

TS-PL1-OPE-0620/T

The L1 Processing shall provide the current memory used.

Trace from:

6.3.5. Resources requirements

Not Applicable.

6.3.6. Design requirements and implementation constraints

The L1 Processing is designed to allow the addition of new S-AIS Messages verifications.

TS-PL1-DES-0630/T

The L1 Processing shall provide a modular infrastructure accepting new S-AIS Messages verifications.



Trace from:
SR-DPC-DES-1920

The L1 Processing is designed to be extensible so that it accepts new (future) S-AIS Messages types.

TS-PL1-DES-0640/T

The L1 Processing shall provide a modular infrastructure accepting new S-AIS Messages types.

Trace from:
SR-DPC-DES-1920

TS-PL1-DES-0650/I

The L1 Processing shall be implemented using the Java Platform, Enterprise Edition 7 or higher.

Trace from:
SR-DPC-DES-2070

6.3.7. Security and privacy requirements

Not Applicable.

6.3.8. Portability requirements

Not Applicable.

6.3.9. Software quality requirements

Software quality requirements are detailed in the Software Product Assurance Plan (AD 7).

6.3.10. Software reliability requirements

Not Applicable.

6.3.11. Software maintainability requirements

Software maintainability requirements are detailed in the Software Product Assurance Plan (AD 7).

6.3.12. Software safety requirements

Not Applicable.

6.3.13. Software configuration and delivery requirements**TS-PL1-CFG-0660/I**

The L1 Processing shall consider the size boundary of the AIS messages for all the message types as configurable parameters.

Trace from:
SR-PRO-FUN-0490

**TS-PL1-CFG-0670/I**

The L1 Processing shall consider the configurable parameter “tolerance” that extends the satellite visibility during the Satellite footprint check.

Trace from:
SR-PRO-FUN-0500

TS-PL1-CFG-0680/I

The L1 Processing shall consider the configurable parameter “maximum velocity” that defines the speed threshold above which the Ship Velocity check fails.

Trace from:
SR-PRO-FUN-0510

6.3.14. Data definition and database requirements

Not Applicable.

6.3.15. Human factors related requirements

Not Applicable.

6.3.16. Adaptation and installation requirements

Not Applicable.

6.4. Data Processing - L2 Processing

The Data Processing - L2 Processing is the subsystem in charge of:

- Qualifying (enhancement) level 1 AIS messages that match the computed Doppler location with the reported position;
- Recovering position of invalid level 1 AIS messages.



6.4.1. Functional requirements

The following diagram details the use cases assumed by the subsystem.

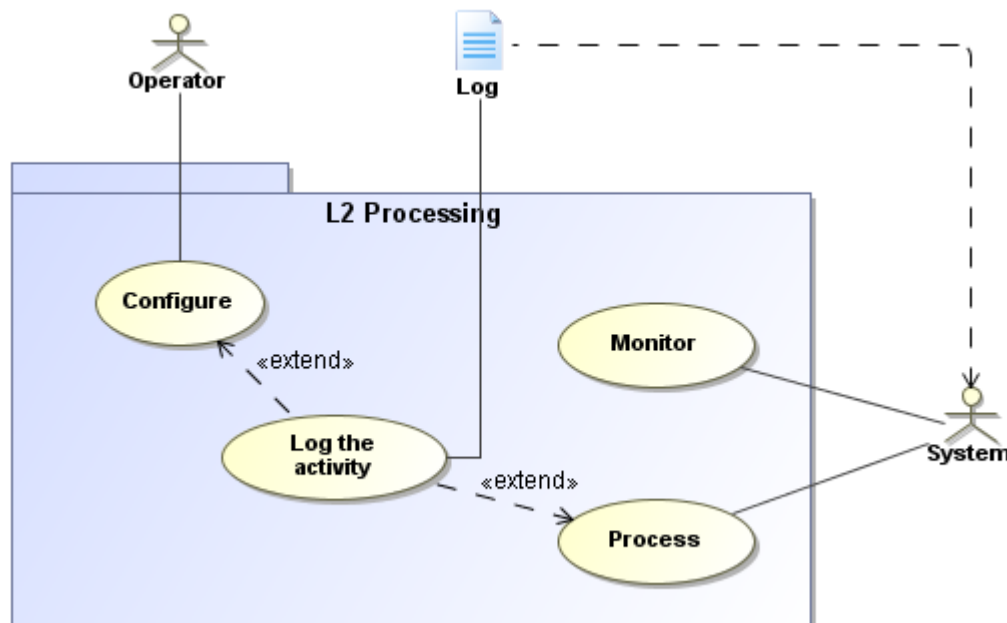


Figure 41 - Use Cases diagram for L2 Processing subsystem

6.4.1.1. “Process” UC

The use case supplies the subsystem with the capability to qualify level 1 AIS messages after Doppler location matching, and to recover positions of invalid level 1 AIS messages.

6.4.1.1.1. Context

This UC is independent.

6.4.1.1.2. Interactions

The UC is initiated by the System to perform the enhancement of L1 AIS Messages.

6.4.1.1.3. Pre-conditions

None.

6.4.1.1.4. Description

6.4.1.1.4.1. Overview

The UC captures the data processing applied to decoded (level 1) AIS Messages whether they are valid or invalid (which means they have passed through the decoding stage). This processing is divided in two independent scenarios:



- the first scenario consists in comparing the Doppler positions (that were previously computed) and the reported positions from AIS messages;
- the second scenario consists in performing the recovery of AIS positions reports that have been considered as invalid according to L1 process.

6.4.1.1.4.2. First scenario

In this scenario, the system asks for a correlation activity between positions reported in AIS messages and the Doppler location that have been calculated with a sufficient reliability.

The processing is possible only for AIS messages with ancillary data that include Doppler shift measurements.

TS-PL2-FUN-0690/T

The L2 Processing shall perform the correlation of reported positions in the AIS Position Reports that consists in comparing the computed position and the reported one.

Trace from:

SR-PRO-FUN-0560
SR-DPC-FUN-0080
SR-DPC-FUN-0130

TS-PL2-FUN-0700/T

The L2 Processing shall take into account the uncertainty on the Doppler location when performing the Doppler correlation.

Trace from:

SR-PRO-FUN-0560

TS-PL2-FUN-0705/T

The L2 Processing shall produce L2 AIS Position Reports for those whose Doppler location is calculated with a sufficient configured quality.

Trace from:

The result of the correlation is recorded in the AIS message position as a metadata information.

TS-PL2-FUN-0710/T

The L2 Processing shall store the result of the Doppler correlation in the L2 AIS Position Report with a value denoting that the reported position is consistent.

Trace from:

SR-PRO-FUN-0390

The scenario considers a configurable threshold that determines if a computed Doppler location is reliable or not.

TS-PL2-FUN-0715/T

The L2 Processing shall admit a configured threshold for defining if a Doppler location is reliable or not.

Trace from:



6.4.1.1.4.3. Second scenario

In this scenario, the system asks for the recovery of corrupted level 1 AIS position reports by another one from another data source.

Recovered Positions are an additional context of this scenario and as such, have to be provided by the invoker. The method used to compute the recovered position is then left to the invoker. In the frame of the DPC Block2 project, the recovered position is the Doppler Location (provided that the message contains a Doppler measure).

Besides this, the L2 Processing performs a basic extrapolation of the last known location knowing its speed and heading or an interpolation of two consecutive locations. The results are also considered as Recovered Positions.

TS-PL2-FUN-0718/T

The L2 Processing shall perform, for invalid AIS positions, the prediction of the position by extrapolation of the last known location knowing its speed and heading or by interpolation of two consecutive locations.

Trace from:
SR-DPC-FUN-0130

The scenario applies to invalid level 1 AIS position reports from the L1 processing that have one or more recovered positions. The following image shows an invalid position that have two recovered positions:

- a Doppler location which is provided by an external agent as an input of this UC,
- a projected AIS position computed by this scenario which is the result of an interpolation between two consecutive positions.

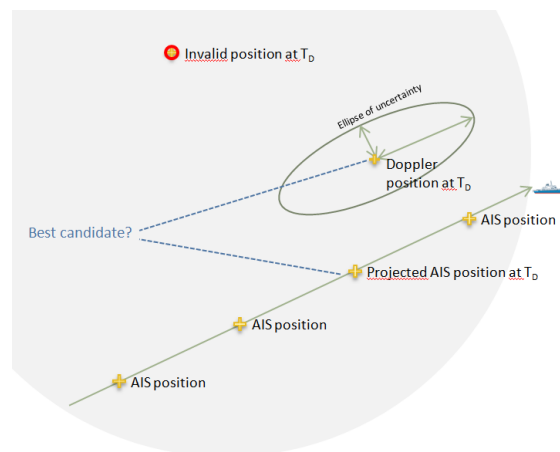


Figure 42 - Reconstruction of an invalid AIS positions

The best recovered position is selected based on the ellipse of error of the Doppler location and the estimated quality of the interpolated or extrapolated of the projected position.

TS-PL2-FUN-0720/T

The L2 Processing shall produce L2 AIS Position Reports which is the replacement of the invalid reported position in the AIS Message by the best recovered one (i.e. the best quality), if it has a sufficient configured quality.

Trace from:
SR-PRO-FUN-0580

The result of the position recovery is recorded in the AIS message position as a metadata information containing the necessary elements to understand the processing that has been applied.



This metadata contains the reconstruction method used (Doppler location or Prediction) and the uncertainty.

TS-PL2-FUN-0730/T

The L2 Processing shall store for invalid L1 AIS messages together with a reliable predicted position, the success of the recovery with the method used for the recovery and the uncertainty.

Trace from:

SR-PRO-FUN-0600

SR-PRO-FUN-0390

SR-PRO-FUN-0590

The scenario considers a configurable threshold that determines if a predicted position is reliable or not.

TS-PL2-FUN-0760/T

The L2 Processing shall admit a configured threshold for defining if a Predicted Position is reliable or not.

Trace from:

6.4.1.1.5. Post-conditions

6.4.1.2. “Configure” UC

The use case supplies the Operator with the capability of configuring the L2 Processing sub-system.

6.4.1.2.1. Context

This UC is independent.

This UC is invoked by an Operator.

6.4.1.2.2. Interactions

The UC is initiated by the Operator in order to manage the configuration items of the L2 Processing sub-system.

6.4.1.2.3. Pre-conditions

None.

6.4.1.2.4. Description

The UC provides the configuration capability of a set of parameters that affect the behaviour of the L2 Processing.

6.4.1.2.5. Post-conditions

6.4.1.3. “Log the activity” UC

The use case supplies the subsystem with the capability to store the activity in a log.



6.4.1.3.1. Context

The UC is independent and can be invoked at any time.

This UC is initiated by any other UCs who needs to keep track of their activities.

6.4.1.3.2. Interactions

The UC uses the Log actor as persistence means.

6.4.1.3.3. Pre-conditions

A significant event has occurred.

6.4.1.3.4. Description

The UC provides the means to carry in a single log all the activity of the subsystem. Each entry of that log is an event or a notable fact that is written in the log along with several attributes that characterizes it:

- Timestamp: the date and time on which the event has occurred;
- Severity: a value from the severity scale which expresses the significance of the event, including but not limited to the following: Error, Warning, Information;
- Context: a free text value referring to a context;
- Circumstance: Explicit and detailed description of the event.

TS-PL2-FUN-0770/T

The L2 Processing shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.

Trace from:

6.4.1.3.5. Post-conditions

The log is appended with one or several entries.

6.4.1.4. “Monitor” UC

The UC provides the subsystem with the capability to publish the measurements of the activity (performance, resources usage, statistics).

6.4.1.4.1. Context

This UC is independent.

6.4.1.4.2. Interactions

The UC is initiated by the System to monitor the component.

6.4.1.4.3. Pre-conditions

None.



6.4.1.4.4. Description

6.4.1.4.5. Post-conditions

6.4.2. Performance requirements

Not Applicable.

6.4.3. Interface requirements

Interface requirements are detailed in the ICD (RD 2).

6.4.4. Operational requirements

To maintain a high level of control, the L2 Processing stores in a log file a set of significant events that may be used by an operator to learn and understand the past activity.

TS-PL2-OPE-0780/T

The L2 Processing shall log the event of the start of the activity.

Trace from:

TS-PL2-OPE-0790/T

The L2 Processing shall log the event of the end of the activity with the information of: processing duration time, number of processed messages, number of correlated messages, number of recovered messages.

Trace from:

TS-PL2-OPE-0800/T

The L2 Processing shall provide the cumulative number of correlated AIS messages positions processed.

Trace from:

TS-PL2-OPE-0810/T

The L2 Processing shall provide the cumulative number of recovered AIS messages positions processed.

Trace from:

TS-PL2-OPE-0820/T

The L2 Processing shall provide the date and time of the last L2 processing.

Trace from:

TS-PL2-OPE-0830/T

The L2 Processing shall provide the min, max and mean time taken to process a set of L1 messages.

Trace from:

**TS-PL2-OPE-0840/T**

The L2 Processing shall provide the current memory used.

Trace from:

6.4.5. Resources requirements

Not Applicable.

6.4.6. Design requirements and implementation constraints**TS-PL2-DES-0850/I**

The L2 Processing shall be implemented using the Java Platform, Enterprise Edition 7 or higher.

Trace from:

SR-DPC-DES-2070

6.4.7. Security and privacy requirements

Not Applicable.

6.4.8. Portability requirements

Not Applicable.

6.4.9. Software quality requirements

Software quality requirements are detailed in the Software Product Assurance Plan (AD 7).

6.4.10. Software reliability requirements

Not Applicable.

6.4.11. Software maintainability requirements

Software maintainability requirements are detailed in the Software Product Assurance Plan (AD 7).

6.4.12. Software safety requirements

Not Applicable.

6.4.13. Software configuration and delivery requirements**TS-PL2-CFG-0860/I**

The L2 Processing shall consider the configurable parameter “predicted reliability threshold” with which a predicted position can be estimated good or not.



Trace from:
SR-PRO-FUN-0500

6.4.14. Data definition and database requirements

Not Applicable.

6.4.15. Human factors related requirements

Not Applicable.

6.4.16. Adaptation and installation requirements

Not Applicable.

6.5. Data Processing - L3 Processing

The Data Processing - L3 Processing is the subsystem in charge of validating positions of Ship by Vessels detection derived from EO images.

6.5.1. Functional requirements

The following diagram details the use cases assumed by the subsystem.

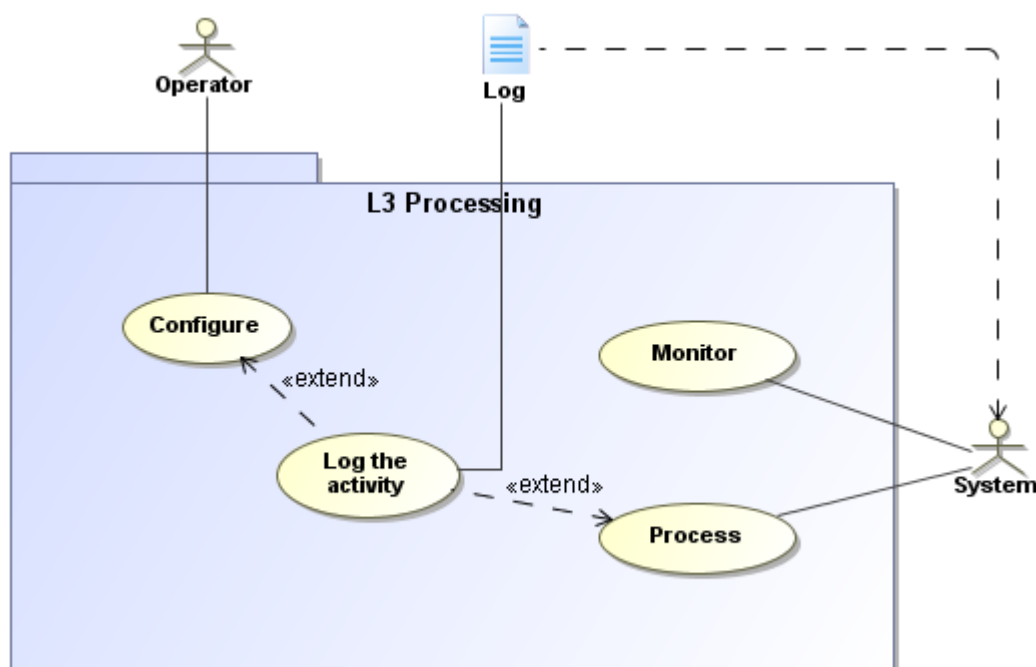


Figure 43 - Use Cases diagram for L3 Processing subsystem

6.5.1.1. "Process" UC

The use case supplies the subsystem with the capability to correlate received S-AIS position reports with VDRs.



6.5.1.1.1. Context

This UC is independent.

6.5.1.1.2. Interactions

The UC is initiated by the System to perform the correlation of (previously decoded) S-AIS messages.

6.5.1.1.3. Pre-conditions

None.

6.5.1.1.4. Description

The UC captures the correlation processing applied to decoded reported positions. In this scenario, the system asks for a EO correlation activity between positions reported in AIS messages and the VDRs that have been provided.

TS-PL3-FUN-0870/I

The L3 Processing shall perform the correlation of S-AIS reported positions with VDRs derived from EO images.

Trace from:

SR-PRO-FUN-0610

SR-DPC-FUN-0060

SR-DPC-FUN-0080

The result of the correlation is recorded in the AIS message position as a metadata information containing the necessary elements to understand the processing that has been applied.

The following table describes the information recorded in the AIS message.

Information recorded	Description
VDRs	The link on the VDRs that has been involved in the correlation processing.
EO correlation status	Value denoting that the position has been confirmed by an EO.
Reliability indicator	The reliability indicator

TS-PL3-FUN-0880/I

The L3 Processing shall maintain the relationship between the AIS message correlated and the VDRs.

Trace from:

SR-PRO-FUN-0620

SR-DPC-FUN-0060

**TS-PL3-FUN-0890/T**

The L3 Processing shall store the result of the EO correlation in the AIS messages with a value denoting that the reported position has been confirmed.

Trace from:

SR-PRO-FUN-0610

SR-DPC-FUN-0060

SR-PRO-FUN-0390

TS-PL3-FUN-0900/T

The L3 Processing shall store reliability indicator of the correlation result in the AIS messages.

Trace from:

SR-PRO-FUN-0610

SR-DPC-FUN-0060

The scenario considers a configurable threshold that determines if a correlation matches or not.

TS-PL3-FUN-0910/T

The L3 Processing shall admit a configured threshold for defining if an EO correlation matches or not.

Trace from:

SR-DPC-FUN-0060/A

6.5.1.2. “Configure” UC

The use case supplies the Operator with the capability of configuring the L3 Processing sub-system.

6.5.1.2.1. Context

This UC is independent.

This UC is invoked by an Operator.

6.5.1.2.2. Interactions

The UC is initiated by the Operator in order to manage the configuration items of the L3 Processing sub-system.

6.5.1.2.3. Pre-conditions

None.

6.5.1.2.4. Description

The UC provides the configuration capability of a set of parameters that affect the behaviour of the L3 Processing.



6.5.1.2.5. Post-conditions

6.5.1.3. “Log the activity” UC

The use case supplies the subsystem with the capability to store the activity in a log.

6.5.1.3.1. Context

The UC is independent and can be invoked at any time.

This UC is initiated by any other UCs who needs to keep track of their activities.

6.5.1.3.2. Interactions

The UC uses the Log actor as persistence means.

6.5.1.3.3. Pre-conditions

A significant event has occurred.

6.5.1.3.4. Description

The UC provides the means to carry in a single log all the activity of the subsystem. Each entry of that log is an event or a notable fact that is written in the log along with several attributes that characterizes it:

- Timestamp: the date and time on which the event has occurred;
- Severity: a value from the severity scale which expresses the significance of the event, including but not limited to the following: Error, Warning, Information;
- Context: a free text value referring to a context;
- Circumstance: Explicit and detailed description of the event.

TS-PL3-FUN-0920/T

The L3 Processing shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.

Trace from:

6.5.1.3.5. Post-conditions

The log is appended with one or several entries.

6.5.1.4. “Monitor” UC

The UC provides the subsystem with the capability to publish the measurements of the activity (performance, resources usage, statistics).

6.5.1.4.1. Context

This UC is independent.



6.5.1.4.2. Interactions

The UC is initiated by the System to supervise the component.

6.5.1.4.3. Pre-conditions

None.

6.5.1.4.4. Description

6.5.1.4.5. Post-conditions

6.5.2. Performance requirements

Not Applicable.

6.5.3. Interface requirements

Interface requirements are detailed in the ICD (RD 2).

6.5.4. Operational requirements

To maintain a high level of control, the L3 Processing stores in a log file a set of significant events that may be used by an operator to learn and understand the past activity.

TS-PL3-OPE-0930/T

The L3 Processing shall log the event of the start of the activity.

Trace from:

TS-PL3-OPE-0940/T

The L3 Processing shall log the event of the end of the activity with the information of: processing duration time, number of messages processed, number of correlated messages, number of inconsistent correlated messages.

TS-PL3-OPE-0950/T

The L3 Processing shall provide the cumulative number of correlated AIS messages positions processed.

Trace from:

TS-PL3-OPE-0960/T

The L3 Processing shall provide the cumulative number of inconsistent correlated AIS messages positions processed.

Trace from:

TS-PL3-OPE-0970/T

The L3 Processing shall provide the date and time of the last L3 processing.

**TS-PL3-OPE-0980/T**

The L3 Processing shall provide the min, max and mean time taken to process a set of messages.

Trace from:

TS-PL3-OPE-0990/T

The L3 Processing shall provide the current memory used.

Trace from:

6.5.5. Resources requirements

Not Applicable.

6.5.6. Design requirements and implementation constraints**TS-PL3-DES-1000/I**

The L3 Processing shall be implemented using the Java Platform, Enterprise Edition 7 or higher.

Trace from:

SR-DPC-DES-2070

6.5.7. Security and privacy requirements

Not Applicable.

6.5.8. Portability requirements

Not Applicable.

6.5.9. Software quality requirements

Software quality requirements are detailed in the Software Product Assurance Plan (AD 7).

6.5.10. Software reliability requirements

Not Applicable.

6.5.11. Software maintainability requirements

Software maintainability requirements are detailed in the Software Product Assurance Plan (AD 7).

6.5.12. Software safety requirements

Not Applicable.



6.5.13. Software configuration and delivery requirements

Not Applicable.

6.5.14. Data definition and database requirements

Not Applicable.

6.5.15. Human factors related requirements

Not Applicable.

6.5.16. Adaptation and installation requirements

Not Applicable.

6.6. Data Processing - Doppler Location Processor

The Doppler Location Processor subsystem is in charge of computing the ships locations based on Doppler shift measured by SAT-AIS satellites, and to provide an associated error estimate.

6.6.1. Functional requirements

The following diagram details the use cases assumed by the subsystem.

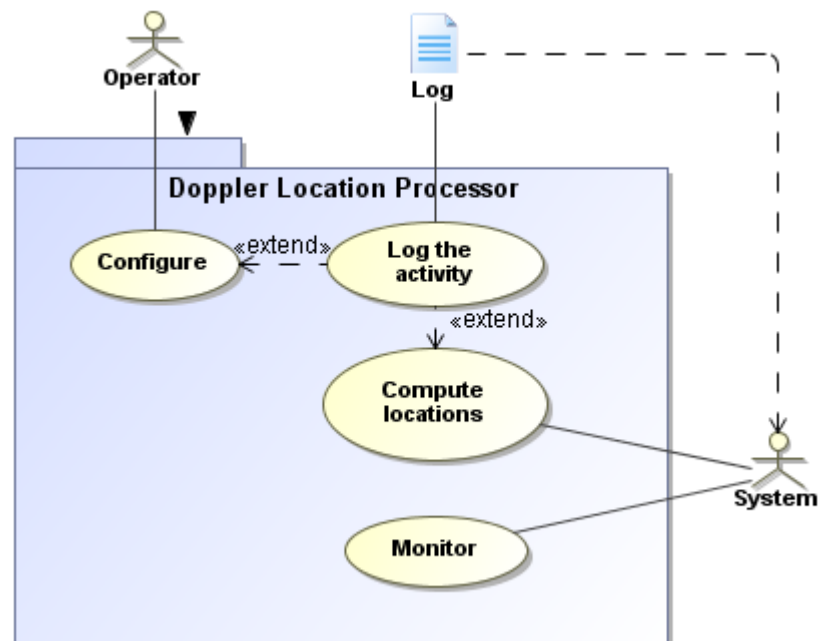


Figure 44 - Use Cases diagram for Doppler subsystem



6.6.1.1. “Compute locations” UC

The use case supplies the Doppler Location Processor subsystem with the position calculation service, using as inputs the Doppler shifts measured by the satellite at the reception of AIS messages and distributed as ancillary data by the SAT-AIS Data Providers.

6.6.1.1.1. Context

This UC is independent.

6.6.1.1.2. Interactions

The UC is initiated by the System to perform the calculation of the Doppler location.

6.6.1.1.3. Pre-conditions

None.

6.6.1.1.4. Description

6.6.1.1.4.1. Overview

The UC is the calculation of the Doppler Location given a set Doppler shifts measured by SAT-AIS satellite during a pass over ships equipped with AIS. These Doppler shifts are distributed by the SAT-AIS Data Providers together with the AIS messages.

The purpose of the Doppler Location is to provide the position of the ship which requires the estimation of the transmission frequencies of the AIS onboard the ship.

TS-DLP-FUN-1010/I

The Doppler Location Processor shall perform the calculation of the Doppler Location of ships using Doppler shift measurements detected by SAT-AIS satellites during a pass.

Trace from: SR-PRO-FUN-0520 & SR-PRO-FUN-0530

TS-DLP-FUN-1012/T

For each Doppler position calculated, the Doppler Location Processor shall provide an estimate of the latitude/longitude and transmission frequencies of the AIS transceiver onboard the ship.

Trace from: -

The UC is described by three steps as shown in the following activity diagram.

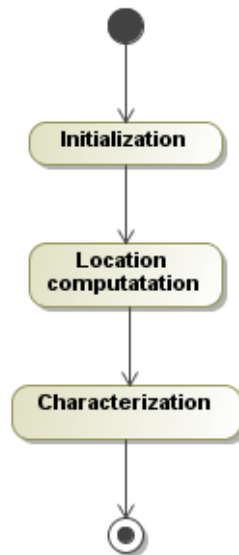


Figure 45 - Activity Diagram of the Doppler Location computation

6.6.1.1.4.2. Initialization

The calculation of the Doppler location for a given ship is an iterative process, which is initialized using the results of the previous Doppler calculation for that same ship. The information needed for initialization is the ship Doppler “history”, that is the previous Doppler position calculated for the ship, the estimated frequencies for each AIS channels, and some probability results from the previous calculation.

If no previous Doppler information is available for the ship, or if the information is too old, the calculation shall be initialized using the average GPS position of the ship obtained from the AIS position messages.

TS-DLP-FUN-1020/T

The Doppler Location Processor shall be initialized using the Doppler “history” of ships, that is for each ship the previous Doppler position calculated and the estimated frequencies for each AIS channels.

Trace from: -

TS-DLP-FUN-1022/T

In case the age of the previous Doppler history calculated for a ship shall is greater than a predefined value, or if no previous Doppler history is available in the system, then the Doppler Processor shall be initialized using the average GPS position of the ship obtained from the AIS position messages.

Trace from: -

TS-DLP-FUN-1025/T

In order to be usable, the date of the last Doppler history for a ship shall be strictly anterior to the date of new Doppler shift measurements. If not, the Doppler Processor shall be re-initialized and no Doppler location is computed.

Trace from: -

**TS-DLP-FUN-1030/T**

The initialization shall sort the Doppler shift measurements by ship and by chronological order to facilitate the Doppler position calculation. In case of duplicate measurements for the same ship, the initialization shall select the most reliable one.

Trace from: SR-PRO-FUN-0540

6.6.1.1.4.3. Location computation

The Doppler Location Processor uses Kalman filtering technique. In a general manner, Kalman filter uses a system's dynamics model (i.e., physical laws of motion), known control inputs to that system, and measurements (from sensors) to estimate the system's varying quantities, called "state", that is better than the estimate which would be obtained by using any one measurement alone.

Applied to Doppler location, Kalman filter is used to provide the estimate of the ships position and transmission frequencies.

TS-DLP-FUN-1035/T

The Doppler Location Processor shall use Kalman filtering.

Trace from: -

TS-DLP-FUN-1040/T

The Doppler Location Processor shall provide two dynamics models: a fixed position model and a random walk model.

Trace from: -

TS-DLP-FUN-1050/T

The Doppler Location Processor shall use a multiple-model filter based on a bank of Unscented Kalman filters.

Trace from: -

TS-DLP-FUN-1060/T

The Doppler Location Processor shall combine several Doppler shift measurements for the same ship and the same satellite pass over the ship, in order to provide the best estimate of the ship position.

Trace from: SR-PRO-FUN-0540

TS-DLP-FUN-1070/T

The Doppler Location Processor shall perform a location computation only if the number of measurements for a vessel and for a satellite pass is greater than a predefined minimum message number.

Trace from: -

TS-DLP-FUN-1080/T

The Doppler Location Processor shall state to the caller that the processing has ended successfully, has failed with no locations computed or has been partially completed.

Trace from: -



6.6.1.1.4.4. Characterization

TS-DLP-FUN-1090/T

The Doppler Location Processor shall consider as valid a location computed by the multiple-model filter if the following two assertions are true: the distance between the previous computed location and the current computed location is smaller than the ship maximum speed multiplied by the time elapsed since the last computed location, and the difference between the previous computed transmission frequency and the current transmission frequency is smaller than a predefined maximum difference.

Trace from:

TS-DLP-FUN-1100/T

The Doppler Location Processor shall only provide the computed locations that are characterized as valid.

Trace from: SR-PRO-FUN-0520

TS-DLP-FUN-1105/T

The valid Doppler location and estimated frequencies shall be used to update the Doppler history of the ships, so that it can be used for the Doppler processing of the next set of measurements received from SAT-AIS data providers.

Trace from: -

TS-DLP-FUN-1110/T

The Doppler Location Processor shall provide an indicator of the Doppler location reliability as an ellipse of error.

Trace from: SR-PRO-FUN-0550

TS-DLP-FUN-1120/T

The Doppler ellipse of error associated to each calculated Doppler location shall be representative of the quality of the input data: accuracy and number Doppler measurements, stability of the AIS oscillator, time stamp of measurement and accuracy of satellite orbit modelization.

Trace from: SR-DPC-PER-0280

6.6.1.1.5. Post-conditions

If the Doppler calculation is successful, the Doppler history is updated with the new calculated position and estimated frequencies.

6.6.1.2. “Configure” UC

The use case allows configuring the Doppler Location Processor sub-system.

6.6.1.2.1. Context

The UC is independent.

The UC is invoked by an Operator.



6.6.1.2.2. Interactions

The UC is initiated by the Operator in order to manage the configuration parameters of the Doppler Location Processor sub-system.

6.6.1.2.3. Pre-conditions

None.

6.6.1.2.4. Description

The UC provides the configuration capability of a set of parameters that affect the Doppler location processing.

TS-DLP-FUN-1125/T

The Doppler Location Processor shall allow for the configuration of the Doppler location processing.

Trace from:

6.6.1.2.5. Post-conditions

The configuration is changed.

The modification of the configuration is not expected to be dynamically taken into account. A restart of the sub-system might be necessary.

6.6.1.3. “Log the activity” UC

The UC provides the subsystem with the capability to store in a log the activity.

6.6.1.3.1. Context

The UC is independent and can be invoked at any time.

This UC is initiated by any other UCs who needs to keep track of their activities.

6.6.1.3.2. Interactions

The UC uses the Log actor as persistence means.

6.6.1.3.3. Pre-conditions

A significant event has occurred.

6.6.1.3.4. Description

The UC provides the means to carry in a single log all the activity of the subsystem. Each entry of that log is an event or a notable fact that is written in the log along with several attributes that characterizes it:

- Timestamp: the date and time on which the event has occurred;



- Severity: a value from the severity scale which expresses the significance of the event, including but not limited to the following: Error, Warning, Information;
- Context: a free text value referring to a context;
- Circumstance: Explicit and detailed description of the event.

TS-DLP-FUN-1130/T

The Data Location Processor shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.

Trace from:

6.6.1.3.5. Post-conditions

The log is appended with one or several entries.

6.6.2. Performance requirements

TS-DLP-PER-1140/T

The Doppler Location Processor shall compute Doppler Locations within 10 minutes after submission of a data set to the Doppler calculation module. A data set corresponds to all data received by a ground station for a satellite downlink (partial or entire orbit).

Trace from: -

6.6.3. Interface requirements

Interface requirements are detailed in the ICD (RD 2).

6.6.4. Operational requirements

To maintain a high level of control, the Doppler Location Processor subsystem stores in a log file a set of significant events that may be used by an operator to learn and understand the past activity.

TS-DLP-OPE-1160/T

The Doppler Location Processor shall log that an invalid input (incorrect format, invalid values) has been submitted, accompanied by the most accurate and detailed information about the nature of the error.

Trace from:

In case of anomaly, the Doppler Location Processor keeps available, in a specific location, the processing context that allows the operator to diagnose the cause of the error.

TS-DLP-OPE-1170/T

The Doppler Location Processor shall copy the full context of a Doppler processing that failed, in a configured location in the file system.

Trace from:

6.6.5. Resources requirements

Not applicable.



6.6.6. Design requirements and implementation constraints

TS-DLP-DES-1180/I

The Doppler Location Processor shall be implemented using the Java Platform, Enterprise Edition 7 or higher.

Trace from: SR-DPC-DES-2070

6.6.7. Security and privacy requirements

Not applicable.

6.6.8. Portability requirements

Not applicable.

6.6.9. Software quality requirements

Software quality requirements are detailed in the Software Product Assurance Plan (AD 7).

6.6.10. Software reliability requirements

Not applicable.

6.6.11. Software maintainability requirements

Software maintainability requirements are detailed in the Software Product Assurance Plan (AD 7).

6.6.12. Software safety requirements

Not applicable.

6.6.13. Software configuration and delivery requirements

TS-DLP-CFG-1190/T

The Doppler Location Processor shall define the configuration of the Doppler processing with the following items: Maximum difference between the previous computed transmission frequency and the current transmission frequency, the maximum elapsed location time, the minimum message number

Trace from:

TS-DLP-CFG-1200/T

The Data Location Processor shall define the configuration of the log with the flowing items: level of severity, location (directory and naming scheme) of the log file.

Trace from:



6.6.14. Data definition and database requirements

Not applicable.

6.6.15. Human factors related requirements

Not applicable.

6.6.16. Adaptation and installation requirements

Not applicable.

6.7. Data Distribution

The Data Distribution is the system in charge of transferring data products from the SAT-AIS DPC to EMSA Block 3 and external users. The system provides also the capabilities:

- for the authorized users, to check the real time data, access to historic data or to manage the access permissions, among other functionalities that it may be agreed with the client.
- to access to the archive through the means of external services request or through the Web Interface. In any case, the access to that information is always subject to a restricted permission check.

6.7.1. Functional requirements

The following diagram details the use cases assumed by the system.

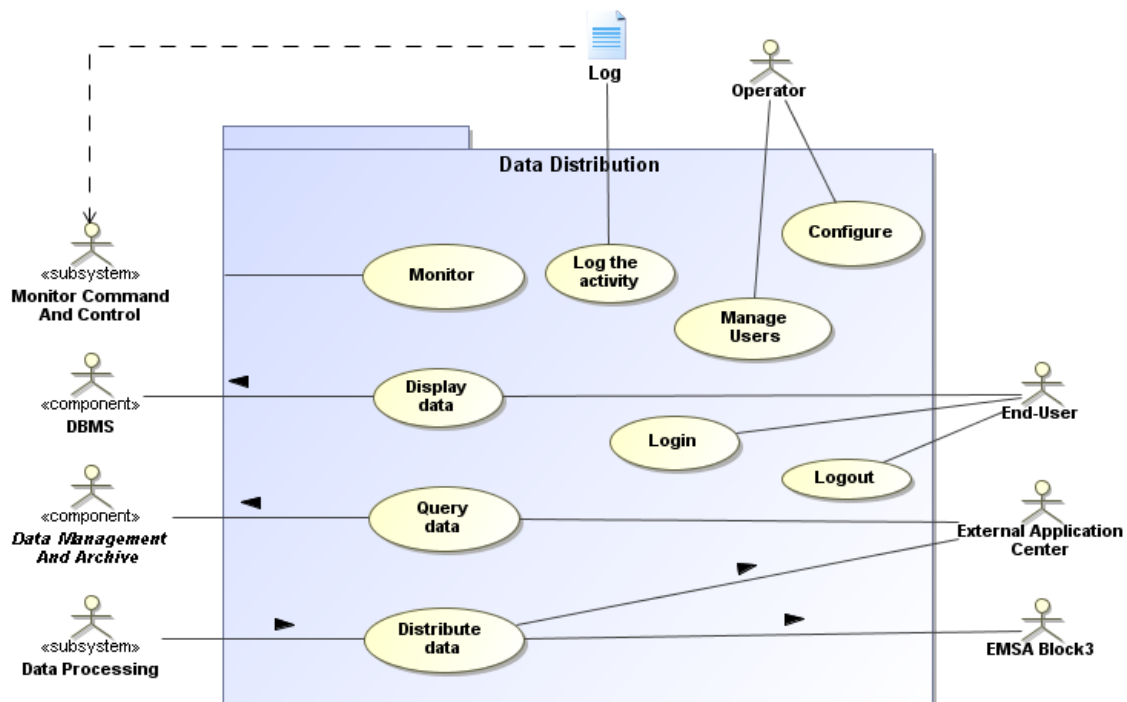


Figure 46 - Use Cases diagram for Data Distribution subsystem



6.7.1.1. “Login” UC

This use case supplies the subsystem with the capability to open an authenticated session to the Data Distribution Web Display.

6.7.1.1.1. Context

This UC is independent.

6.7.1.1.2. Interactions

The UC is invoked by an End-User.

6.7.1.1.3. Pre-conditions

This use case is unreachable for authenticated users who have opened a session already.

6.7.1.1.4. Description

The UC captures the log in phase initiated by an “anonymous” user when he wants to open a session to the Data Distribution Web display.

The following diagram describes the different steps of the log in process.

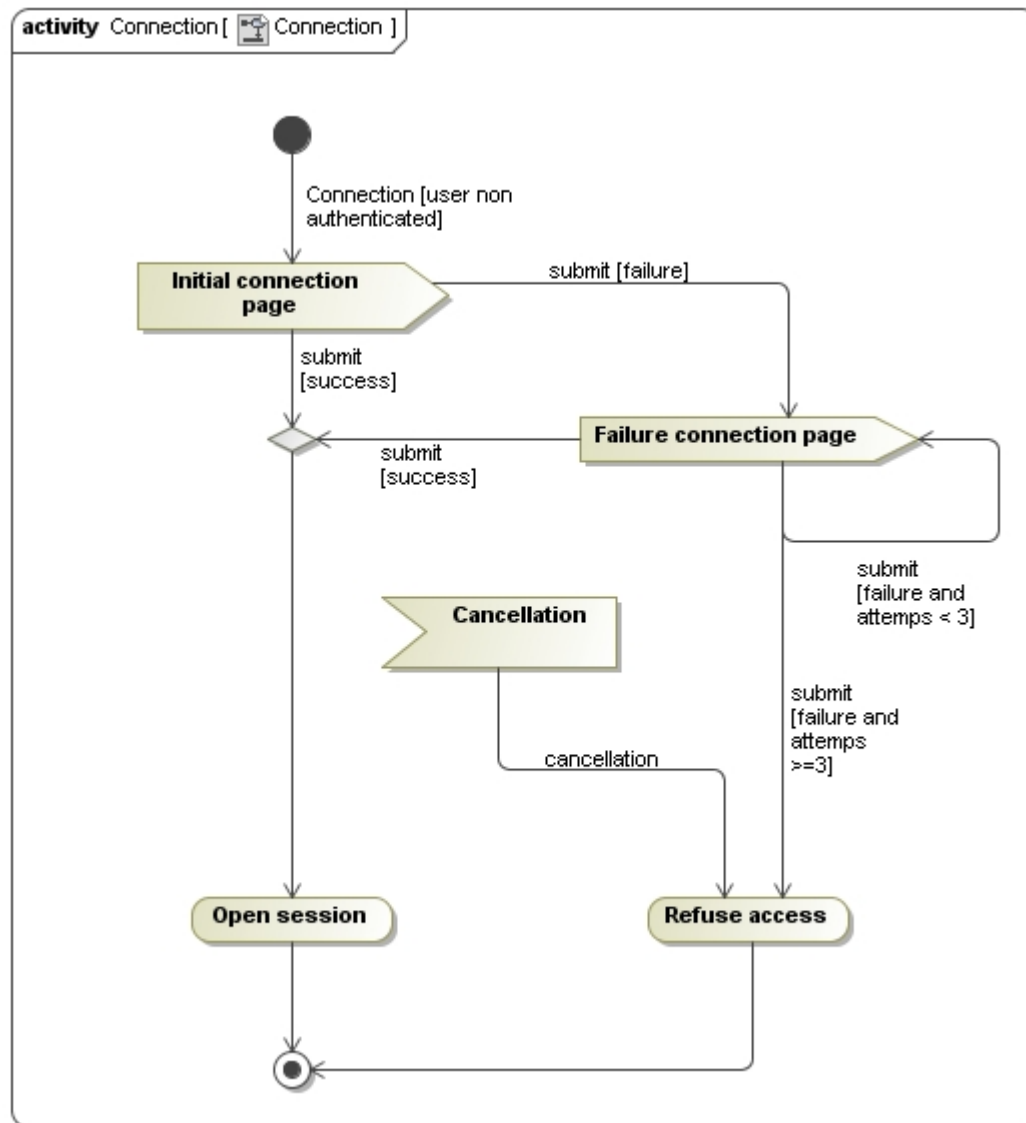


Figure 47 - Log in activity diagram

Initial connection page:

The connection process answers the request of an anonymous user by displaying a connection page.

TS-DIS-FUN-1210/T

The Data Distribution shall display a connection page to anonymous users.

Trace from:

SR-DIS-FUN-1780

SR-DIS-FUN-1740

Failure connection page:**TS-DIS-FUN-1220/T**

The Data Distribution shall display to the anonymous user the causes of the log in failure.

Trace from:

SR-DIS-FUN-1780

SR-DIS-FUN-1740

**TS-DIS-FUN-1230/T**

The Data Distribution shall limit the number of log in attempts to a configurable value.

Trace from:

SR-DIS-FUN-1780

SR-DIS-FUN-1740

Cancellation:

TS-DIS-FUN-1240/T

The Data Distribution shall provide to the user a mean to cancel the log in procedure.

Trace from:

SR-DIS-FUN-1780

SR-DIS-FUN-1740

Open session:

TS-DIS-FUN-1250/T

The Data Distribution shall recognize a user as authenticated if the login/password pair is confirmed.

Trace from:

SR-DIS-FUN-1780

SR-DIS-FUN-1740

Refuse access:

6.7.1.1.5. Post-conditions

The user is authenticated and a session is opened.

6.7.1.2. “Logout” UC

This use case supplies the subsystem with the capability to close a previously opened session to the Data Distribution Web Display.

6.7.1.2.1. Context

This UC is independent.

6.7.1.2.2. Interactions

The UC is invoked by an End-User.

6.7.1.2.3. Pre-conditions

The End-user must be authenticated and must have an active session.

6.7.1.2.4. Description

The UC captures the log out phase initiated by an authenticated user when he wants to close his session from the Data Distribution Web display.

**TS-DIS-FUN-1260/T**

The Data Distribution shall provide to the authenticated user a mean to log out from the Web Display.

Trace from:

SR-DIS-FUN-1780

SR-DIS-FUN-1740

If the end-user that has previously opened a session on the Data Distribution web Display is inactive for a duration longer than a configured duration, the Data Distribution automatically close the session. It will then have to log in again to use the functions requiring authentication.

TS-DIS-FUN-1270/T

The Data Distribution shall close a user session if the user inactivity is longer than a configured duration.

Trace from:

SR-DIS-FUN-1780

SR-DIS-FUN-1740

6.7.1.2.5. Post-conditions

The End-user is stripped of his authenticated status.

6.7.1.3. “Display Data” UC

The use case supplies the Data Distribution sub-system with the capability of providing display capabilities on the S-AIS data processed, product generated, warning and message logs.

6.7.1.3.1. Context

This UC is independent.

6.7.1.3.2. Interactions

The UC is initiated by the End-User actor.

The UC relies on the DBMS component services to fetch the information to be displayed.

6.7.1.3.3. Pre-conditions

The user must be authenticated.

TS-DIS-FUN-1280/T

The Data Distribution shall restrict the access to the Data Distribution display to authenticated and authorized users only.

Trace from:

SR-DIS-FUN-1780



6.7.1.3.4. Description

TS-DIS-FUN-1290/T

The Data Distribution shall provide a Web based application accessible from outside Block-2 infrastructure.

Trace from:
SR-DIS-FUN-0840
SR-DIS-IFR-0400
SR-DPC-IFR-0070

6.7.1.3.4.1. Tabular view

TS-DIS-FUN-1300/T

The Data Distribution shall display the content of all AIS messages into a tabular format so that it is readable by a human user.

Trace from:
SR-DIS-FUN-0890
SR-DIS-IFR-0400
SR-DIS-IFR-0390

The Data Distribution displays the list of ships in a tabular format, with some properties for each of them. The following image shows how the information might be represented on the user screen.

Object	Name	Speed (kn)	Ship Position	Description
45	Vessel 1	12.5	N 48 36.667, E 11 27.524	Liberia Cargo Ship - crew 54
48	Vessel 2	8	N 49 36.667, E 12 23.524	South Africa Tanker - crew 12
52	Vessel 3	0	N 38 36.667, E 11 26.324	Portuguese Submarine
53	Vessel 4	1	N 39 33.367, E 11 27.124	USA Aircraft Carrier
54	Vessel 5	32	N 48 36.667, E 11 29.524	Spanish Fishing Boat
78	Vessel 6	3	N 38 36.667, E 11 26.324	Spanish Yacht
79	Vessel 7	1.6	N 49 36.667, E 12 23.524	Passenger Express
80	Vessel 8	2.8	N 38 36.667, E 11 26.324	Champion Trader (Liberia)

Figure 48 - Tabular view of ships

TS-DIS-FUN-1301/T

The Data Distribution shall allow the user to perform searches on the AIS messages displayed and stored. The search results will be limited to a configurable number.

Trace from:
SR-DIS-IFR-0390

TS-DIS-FUN-1310/T

The Data Distribution shall display the ships positions (including the corresponding accuracy) in a tabular format

Trace from:
SR-DIS-FUN-0900
SR-DIS-IFR-0390

TS-DIS-FUN-1320/T

The Data Distribution shall display the historical and predicted visibility of a SAT-AIS Satellite by a ground station.



Trace from:
SR-DIS-FUN-0950
SR-DIS-IFR-0390

6.7.1.3.4.2. Map view

TS-DIS-FUN-1330/T

The Data Distribution shall display on the world map the satellite positions at a given time.

Trace from:
SR-DIS-FUN-0930
SR-DIS-IFR-0390

TS-DIS-FUN-1340/T

The Data Distribution shall display on the world map the satellite ground track at a given time.

Trace from:
SR-DIS-FUN-0930
SR-DIS-IFR-0390

TS-DIS-FUN-1350/T

The Data Distribution shall display on the world map the satellite coverage area (footprint) at a given time (past or in the near future).

Trace from:
SR-DIS-FUN-0920
SR-DIS-FUN-0930
SR-DIS-FUN-0960
SR-DIS-IFR-0390

TS-DIS-FUN-1360/T

The Data Distribution shall display on the world map the ground station position and visibility area.

Trace from:
SR-DIS-FUN-0940
SR-DIS-IFR-0390

The Data Distribution displays on a world map the latest known position for ships, with the predicted route and the historic route. The following image shows how the information might be represented on the user screen.



Figure 49 - Data Distribution Map view

TS-DIS-FUN-1370/T

The Data Distribution shall display multiple vessels in the world map based on their latest known position.

Trace from:

SR-DIS-FUN-0780

SR-DIS-FUN-0880

SR-DIS-IFR-0390

TS-DIS-FUN-1380/T

The Data Distribution shall display the historic and predicted route of the vessels in the world map. The historic AIS messages shall also be displayed using different symbols according to the message type.

Trace from:

SR-DIS-FUN-0780

SR-DIS-IFR-0390

TS-DIS-FUN-1381/T

The Data Distribution shall allow the user to search for a vessel based on input criteria such as Origin, Destination, IMO, MMSI, Name or Date. When selecting any results for the query result the vessel shall be highlighted on the map.

Trace from:

SR-DIS-IFR-0390

TS-DIS-FUN-1400/T

The Data Distribution shall display the Earth Coverage of a S-AIS Satellite (footprint).



Trace from:
SR-DIS-FUN-0960
SR-DIS-IFR-0390

TS-DIS-FUN-1420/T

The Data Distribution shall present the vessel information when the user clicks on the selected ship in the world map.

Trace from:
SR-DIS-FUN-0880
SR-DIS-IFR-0390

TS-DIS-FUN-1430/T

The Data Distribution shall display data timeliness, time update interval and Doppler positions maps based on ships selected by the user on the world map.

Trace from:
SR-DIS-FUN-0980
SR-DIS-IFR-0390

TS-DIS-FUN-1450/T

The Data Distribution Service shall display warnings and alerts generated by Block-2 Processing for the following cases: Unexpected interruption of AIS messages, reconstruction of an AIS message, invalid AIS message.

Trace from:
SR-DIS-FUN-0910
SR-DIS-IFR-0390

TS-DIS-FUN-1460/T

The Data Distribution shall display the status of a ground station when receiving signal from a satellite.

Trace from:
SR-DIS-FUN-0970
SR-DIS-IFR-0300
SR-DIS-IFR-0390

TS-DIS-FUN-1471/T

The Data Distribution shall allow the user to search for the different types of AIS messages on the tabular display using input criteria such as date, ship id, geographic area, message type. The search results will be limited to a configurable number.

Trace from:
SR-DIS-IFR-0390

TS-DIS-FUN-1472/T

The Data Distribution shall provide a sort mechanism on all tabular data displays.

Trace from:
SR-DIS-IFR-0390

6.7.1.3.5. Post-conditions

None.



6.7.1.4. “Distribute Data” UC

The use case supplies the Data Distribution sub-system with the capability of providing to external entities, such as EMSA Block3, several outputs:

- AIS messages (original ones as well validated, reconstructed and correlated ones) with ancillary information;
- Auxiliary data;
- Messages warnings;
- EO derived data.

6.7.1.4.1. Context

This UC is independent.

6.7.1.4.2. Interactions

The UC is invoked by the Data Processing subsystem.

The UC invokes the provided services of the External Application Centre actor.

TS-DIS-FUN-1476/T

Data Distribution shall interface with EMSA Block3 for the distribution of SAT-AIS messages through EMSA JMS interfaces.

Trace from:
SR-DIS -IFR-0370

6.7.1.4.3. Pre-conditions

None.

6.7.1.4.4. Description

The UC captures the data provision activity to external entities which are:

- The External Application Centre
- EMSA Block3

The UC is invoked by the Data Processing subsystem when a new data “appears” in the system and needs to be distributed to the external entities. As such, the UC is mainly a distributor which ensures that:

- data are correctly delivered (quality of service);
- data are conforms to what expected by the recipients (protocols, format);
- the distribution does not infringe the confidentiality that surround data.

Distributed data:

The Data Distribution is able to deliver the following data:

- L1 AIS Messages (S1)
- Alerts (S2)
- Enhanced AIS Messages (S3)
- EO Correlated AIS Messages (S5)
- VDRs (S5)

**TS-DIS-FUN-1480/T**

The Data Distribution shall distribute the outputs of the Block2 processing.

Trace from:

SR-DIS-FUN-0750/T

SR-DPC-FUN-0070/T

SR-DPC-FUN-0080/A

TS-DIS-FUN-1490/T

The Data Distribution shall distribute the L1 AIS messages data.

Trace from:

SR-DPC-FUN-0040

SR-DPC-FUN-0140

SR-DIS-FUN-0730

SR-DIS-FUN-0750/T

TS-DIS-FUN-1500/T

The Data Distribution shall distribute AIS messages using the following standard formats: IEC standard 61162-1 (NMEA 0183), ITU-R M 1371-1, IEC 62320-1, NMEA 0183 v4.0 (tag block), EMSA CDF.

Trace from:

SR-DIS-FUN-0740

SR-DIS-IFR-0290

TS-DIS-FUN-1510/T

The Data Distribution shall distribute Alerts related to missing AIS messages (no AIS messages are received from a ship over one or several expected contact periods).

Trace from:

SR-DPC-FUN-0150

SR-DIS-FUN-0790

SR-DIS-FUN-0750/T

TS-DIS-FUN-1520/T

The Data Distribution shall distribute enhanced AIS messages.

Trace from:

SR-DPC-FUN-0040

SR-DIS-FUN-0750

SR-DPC-FUN-0160

TS-DIS-FUN-1530/T

The Data Distribution shall distribute AIS messages correlated with EO data.

Trace from:

SR-DPC-FUN-0190

SR-DPC-FUN-0040

SR-DIS-FUN-0750

TS-DIS-FUN-1540/T

The Data Distribution shall distribute EO derived data (VDR).

Trace from:

SR-DPC-FUN-0040

SR-DIS-IFR-0300



SR-DIS-FUN-0750
SR-DIS-FUN-0760

TS-DIS-FUN-1550/T

The Data Distribution shall distribute orbital data and satellites/ground stations events information.

Trace from:
SR-DPC-FUN-0200
SR-DIS-FUN-0750
SR-PRO-FUN-0670

TS-DIS-FUN-1560/T

The Data Distribution shall provide Warnings when the satellite fails to receive or forward AIS data to the ground stations.

Trace from:
SR-DIS-FUN-0750

~~**TS-DIS-FUN-1561/T**~~

~~The Data Distribution shall be able to distribute the raw SAT-AIS data immediately after being received by Block2. This data will be delivered to the users that subscribed the service.~~

~~Trace from:
SR-DIS-FUN-0750/T
SR-DPC-FUN-0135/T~~

Protocol:

The Data Distribution acknowledges two users:

- The EMSA Block3 that interfaces with the S-AIS Block2 using:
 - the EMSA JMS for AIS messages (decoded, enhanced, correlated or reconstructed);
 - the CSN SFTP interface for EO Data.
- The External Application Centre that interfaces with the S-AIS Block2 using a WS-* protocol.

TS-DIS-FUN-1570/T

The Data Distribution Service shall use of the EMSA JMS to distribute AIS messages (decoded, enhanced, correlated or reconstructed) to EMSA Block3.

Trace from:
SR-DPC-IFR-0050
SR-DIS -IFR-0370

TS-DIS-FUN-1580/T

The Data Distribution Service shall use of the CSN SFTP interface to distribute EO Data to EMSA Block3.

Trace from:
SR-DIS-IFR-0320
SR-DPC-IFR-0080

TS-DIS-FUN-1590/T

The Data Distribution Service shall use a WS-* SOAP messaging protocol v1.1 or v1.2 to distribute data to the External Application Centre.

Trace from:
SR-DPC-DES-2040
SR-DPC-IFR-0060



SR-DPC-IFR-0080
SR-DIS-IFR-0310
SR-DIS-FUN-0750

TS-DIS-FUN-1600/T

The Data Distribution Service shall use an asynchronous protocol to distribute data to the External Application Centre.

Trace from:

Quality of service:

If the delivery fails (external client is not reachable, or refuse the distribution), the distribution is delayed for a while before being sent again.

TS-DIS-FUN-1610/T

The Data Distribution shall delay failed deliveries for a configured amount of time.

Trace from:

Whether the distribution fails or not, the Data Distribution takes care of the age of the delivered data. If the data is too old, it's not delivered. This principle is used to ensure the maximum desired timeliness when delivering AIS messages to EMSA Block-3.

TS-DIS-FUN-1620/T

The Data Distribution shall prevent the distribution of data older than a configured delay.

Trace from:
SR-DIS-FUN-0810

6.7.1.4.5. Post-conditions

None.

6.7.1.5. "Query Data" UC

The use case supplies the Data Distribution sub-system with the capability of requesting data available in the DPC Block2 system.

6.7.1.5.1. Context

This UC is independent.

6.7.1.5.2. Interactions

The UC is invoked by the External Application Centre.

The UC uses the services provided by the Data Management and Archive subsystem.

6.7.1.5.3. Pre-conditions

None.



6.7.1.5.4. Description

The UC is invoked by the External Application Centre actor to express a query on data available on the DPC Block2 system. As a result, the data are returned to the caller such as:

- data are conforms to the criteria expressed in the query;
- data are conforms to the format expected by the caller;
- the delivery does not infringe the confidentiality that surround data.

TS-DIS-FUN-1630/T

The Data Distribution shall allow the External Application Centre to query for AIS messages (normal, reconstructed, correlated) and associated ancillary data.

Trace from:

SR-DIS-FUN-0750/T
SR-DPC-FUN-0050
SR-DIS-FUN-0770
SR-DIS-IFR-0340
SR-DPC-FUN-0070/T

TS-DIS-FUN-1640/T

The Data Distribution shall allow the External Application Centre to query for SAT-AIS satellites data.

Trace from:

SR-DIS-FUN-0750/T
SR-DPC-FUN-0050
SR-DIS-FUN-0770
SR-DIS-IFR-0340

TS-DIS-FUN-1650/T

The Data Distribution shall allow the External Application Centre to query for EO VDRs.

Trace from:

SR-DIS-FUN-0750/T
SR-DPC-FUN-0050
SR-DIS-FUN-0770
SR-DIS-IFR-0340

TS-DIS-FUN-1660/T

The Data Distribution shall allow the External Application Centre to query for Level 1 images.

Trace from:

SR-DIS-FUN-0750/T
SR-DPC-FUN-0050
SR-DIS-FUN-0770
SR-DIS-IFR-0340

TS-DIS-FUN-1670/T

The Data Distribution shall allow the External Application Centre to query for warnings and alerts.

Trace from:

SR-DPC-FUN-0050
SR-DIS-FUN-0750/T
SR-DIS-FUN-0770
SR-DIS-IFR-0340
SR-DIS-IFR-0330

**TS-DIS-FUN-1680/T**

The Data Distribution shall allow the External Application Centre to query for predicted AIS messages.

Trace from:

SR-DPC-FUN-0050

SR-DPC-FUN-0170

SR-DIS-IFR-0340

SR-DIS-FUN-0750/T

TS-DIS-FUN-1690/T

The Data Distribution shall allow the External Application Centre to query for the latest information for a ship including, if available: identifier, MMSI, IMO number, call sign, country, vessel name, dimension to bow, dimension to stern, dimension to starboard, type, ETA at destination, draught, destination, DTE and last known position (dated).

Trace from:

SR-DIS-FUN-0780

SR-DIS-IFR-0340

TS-DIS-FUN-1700/T

The Data Distribution shall accept requests for data with the following selection criteria: Time interval, given Fleet or Vessel, specific AIS Message Type, specific Level of Data enhancement.

Trace from:

SR-DIS-IFR-0350

6.7.1.5.5. Post-conditions

None.

6.7.1.6. “Manage Users” UC

The use case supplies the Data Distribution sub-system with the capability of conducting the management activities of users, at the administrator level.

6.7.1.6.1. Context

This UC is independent.

6.7.1.6.2. Interactions

The UC is invoked by the Operator.

6.7.1.6.3. Pre-conditions

The UC invocation is restricted to the Operator recognized as such by the system.

TS-DIS-FUN-1710/T

The Data Distribution shall restrict the access on the user management interface to authenticated users with appropriate rights.



Trace from:
SR-DIS-FUN-0830

6.7.1.6.4. Description

The UC captures the activity of managing and administrating the users. The user here is one of the following actors:

- The EMSA Block3
- The External Application Centre
- The End-User

The use case includes the following scenario:

- declare, edit, consult, remove, and browse the users
- declare, edit, consult, remove and browse the users privileges, i.e. the rights granted to the user to access a “resource”.

User management:

TS-DIS-FUN-1720/T

The Data Distribution shall provide for the operator the capability to perform through a Web Display the user management and administration of the users.

Trace from:
SR-DIS-FUN-0820/T
SR-DIS-FUN-0850/T

TS-DIS-FUN-1730/T

The Data Distribution shall allow the Operator to create a user account given a user name, an e-mail address.

Trace from:
SR-DIS-FUN-1740

TS-DIS-FUN-1740/T

The Data Distribution shall allow the Operator to edit (and update) an existing user account.

Trace from:
SR-DIS-FUN-0850

TS-DIS-FUN-1741/T

The Data Distribution shall allow any Operator to recover the password of his account.

Trace

from:

TS-DIS-FUN-1750/T

The Data Distribution Service shall acknowledge user identities with a user password or a digital certificate issued by EMSA Block3.

Trace from:
SR-DIS-FUN-1740

**TS-DIS-FUN-1760/T**

The Data Distribution shall allow the Operator to remove an already declared user account.

Trace from:
SR-DIS-FUN-0850

TS-DIS-FUN-1770/T

The Data Distribution shall warn the Operator about the deletion of a user and prompt him to confirm his intention.

Trace from:
SR-DIS-FUN-0850

TS-DIS-FUN-1780/T

The Data Distribution shall send an e-mail to the e-mail address associated to the user account for each account change with the updated account information.

Trace from:
SR-DIS-FUN-0850

User rights:**TS-DIS-FUN-1790/T**

The Data Distribution shall provide for the Operator the capability to manage the rights granted to users in the data access.

Trace from:
SR-DIS-FUN-1760
SR-DIS-FUN-0800
SR-DIS-FUN-0820/T

The user rights activity consists in defining a distribution policy, i.e. express what kind of data can be delivered to users. The policy enforcement use a deny-by-default principle: every rule not explicitly expressed is considered as inapplicable.

A right expresses the authorization, for the user who can exercise it, to access a data. A set of rights defines for the user the set of data it can access or the set of data that can be distributed to him. The principle also applies to the EMSA Block3 for which the configured security policy defines also the distribution policy: what are the data that are distributed to it.

TS-DIS-FUN-1800/T

The Data Distribution shall provide for the Operator the capability to grant an access right to a user.

Trace from:
SR-DIS-FUN-1760
SR-DIS-FUN-0820/T

TS-DIS-FUN-1810/T

The Data Distribution shall provide for the Operator the capability to revoke an access right from a user.

Trace from:
SR-DIS-FUN-1760
SR-DIS-FUN-0820/T

Regarding security policy, a right is a rule for which it can be decided if it is respected or violated.



At first instance, a right concerns a kind of data. For instance, a right can grant a user to access to AIS messages, and no other data type like Auxiliary data.

TS-DIS-FUN-1820/T

The Data Distribution shall provide for the Operator the capability to grant the access to the following kind of data: AIS Messages (and associated ancillary data), Auxiliary data, Alerts, VDRs, Images, Ship properties.

Trace from:

SR-DIS-FUN-1760

SR-DIS-FUN-0820/T

The right can also be expressed such that it concerns a property of the data depending on its type. For instance, for AIS messages, the right can express the authorized message types like position reports. It can also express the geographic zone.

TS-DIS-FUN-1830/T

The Data Distribution shall provide for the Operator the capability to edit a granted right

Trace from:

SR-DIS-FUN-1760

SR-DIS-FUN-0820/T

TS-DIS-FUN-1840/T

The Data Distribution shall provide for the Operator the capability to grant the access to an AIS Message depending on the message type, the level of processing, the ship identifier, the geographic zone for position reports, the time window.

Trace from:

SR-DIS-FUN-1760

SR-DIS-FUN-0810

SR-DIS-FUN-0820/T

SR-DIS-FUN-0860/T

TS-DIS-FUN-1850/T

The Data Distribution shall provide for the Operator the capability to grant the access to an Alert message depending on the alert severity and alert domain.

Trace from:

SR-DIS-FUN-1760

SR-DIS-FUN-0810

SR-DIS-FUN-0820/T

SR-DIS-FUN-0860/T

TS-DIS-FUN-1861/T

The Data Distribution shall allow authorized users to configure the Block2 specific Web Display parameters.

Trace from:

6.7.1.6.5. Post-conditions

None.



6.7.1.7. “Configure” UC

The use case supplies the Data Distribution sub-system with the capability of

6.7.1.7.1. Context

This UC is independent.

6.7.1.7.2. Interactions

6.7.1.7.3. Pre-conditions

None.

6.7.1.7.4. Description

TS-DIS-FUN-1860/T

The Data Distribution shall allow authorized users to configure through a Web Display the Block-3 data distribution parameters.

Trace from:
SR-DIS-FUN-0830

6.7.1.7.5. Post-conditions

None.

6.7.1.8. “Log the Activity” UC

The UC provides the subsystem with the capability to store in a log the activity.

6.7.1.8.1. Context

The UC is independent and can be invoked at any time.

This UC is initiated by any other UCs who needs to keep track of their activities.

6.7.1.8.2. Interactions

The UC uses the Log actor as persistence means.

6.7.1.8.3. Pre-conditions

A significant event has occurred.

6.7.1.8.4. Description

The UC provides the means to carry in a single log all the activity of the subsystem. Each entry of that log is an event or a notable fact that is written in the log along with several attributes that characterizes it:



- Timestamp: the date and time on which the event has occurred;
- Severity: a value from the severity scale which expresses the significance of the event, including but not limited to the following: Error, Warning, Information;
- Context: a free text value referring to a context;
- Circumstance: Explicit and detailed description of the event.

TS-DIS-FUN-1870/T

The Data Distribution shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.

Trace from:

6.7.1.8.5. Post-conditions

The log is appended with one or several entries.

6.7.1.9. “Monitor” UC

The use case supplies the Data Distribution sub-system with the capability of

6.7.1.9.1. Context

This UC is independent.

6.7.1.9.2. Interactions

6.7.1.9.3. Pre-conditions

None.

6.7.1.9.4. Description

6.7.1.9.5. Post-conditions

None.

6.7.2. Performance requirements

In order to keep the global timeliness in the bound required by the end users, it is necessary to distribute data flows in a reasonable delay.

TS-DIS-PER-1875/T

The Data Distribution shall start the distribution of incoming L1 process data flows to EMSA Block3 in less than 1 minute for a volume of 10000 AIS messages.

Trace from:

SR-DPC-PER-0210



Incoming data can be large, mainly because XML is somewhat verbose. The Data Distribution must take care of resources consumed, especially the memory: memory consumption must remain the same whether the file is large or small.

TS-DIS-PER-1880/T

The Data Distribution shall keep the memory consumption constant, i.e. contained in a range of 10MB width, regardless of the size of the distributed data.

Trace from:

When distributing data, the Data Distribution can optimize the bandwidth available by allowing the dissemination of several data simultaneously, if agreed by the remote recipient.

TS-DIS-PER-1890/T

The Data Retrieval shall accept a number of configured simultaneous distributions by external client.

Trace from:

~~The distribution of data can be done each time a new data is available. If several data are available at about the same time, the dissemination rate can be very high, too high for the receiver. This is the case for the EMSA SSN NPR Proxy.~~

~~That's why the Data Distribution shall be "nice" proposing to space data with a minimum time.~~

TS-DIS-PER-1900/T

~~The Data Distribution shall not send two consecutive data distribution in a time shorter than a configured period.~~

~~Trace from:~~

~~SR-DIS-FUN-0380/T~~

6.7.3. Interface requirements

Interface requirements are detailed in the ICD (RD 2)

6.7.4. Operational requirements

TS-DIS-OPE-1910/T

The Data Distribution, documentation and test products shall be considered Operational Software (ESA IPR).

Trace from:

To maintain a high level of control, the Data Distribution stores in a log file a set of significant events that may be used by an operator to learn and understand the past activity.

TS-DIS-OPE-1920/T

The Data Distribution shall log the event of a successful delivery to recipient with the information of: Recipient name, recipient URL and duration time.

Trace from:

**TS-DIS-OPE-1930/T**

The Data Distribution shall log all fail events: network error, authentication error, data distribution error, with the appropriate severity and the most detailed information.

Trace from:

TS-DIS-OPE-1940/T

The Data Retrieval shall log all the distributions that have been undelivered because of age.

Trace from:

6.7.5. Resources requirements

Not Applicable.

6.7.6. Design requirements and implementation constraints

The Data Distribution provides a Web interface that must be compatible with the major web browsers. The following diagram shows the trends in browser usage from February 2011 to February 2012.

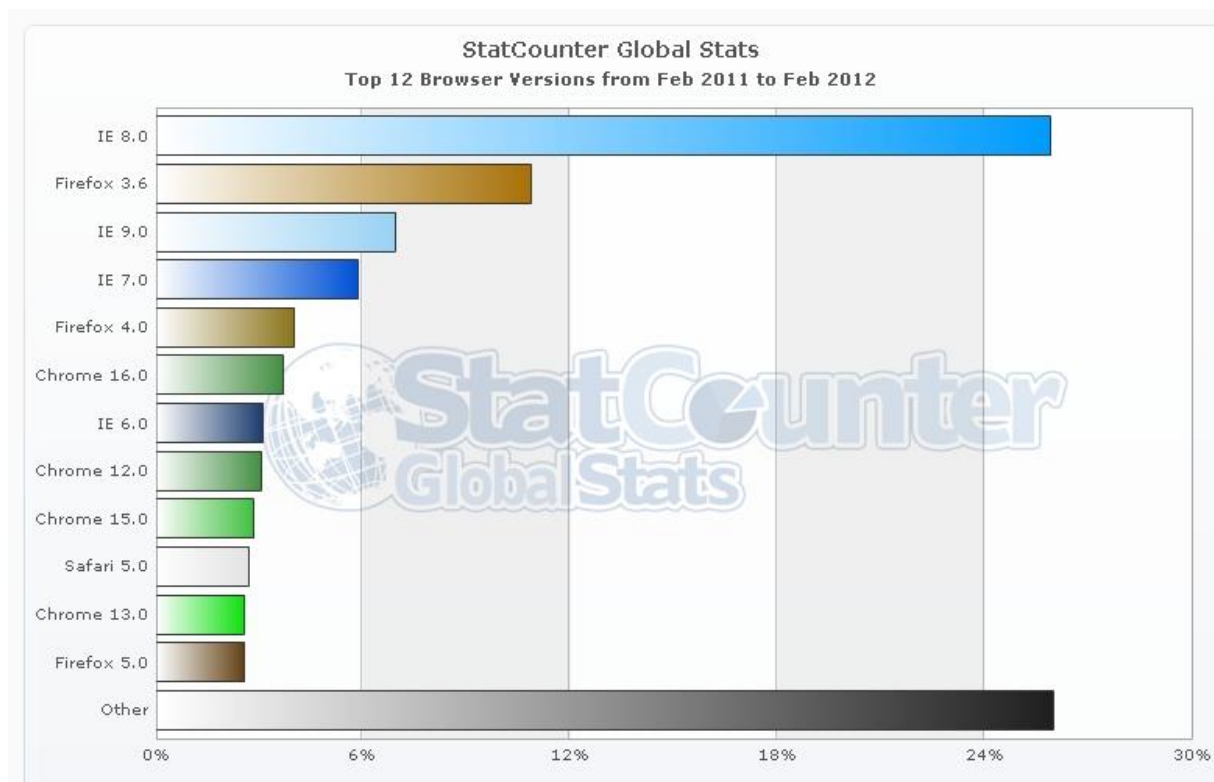


Figure 50 - Web Browser usage statistics

TS-DIS-DES-1950/T

The Data Distribution shall ensure the compatibility with the following web browsers: Microsoft Internet Explorer 7 and higher, Mozilla Firefox 4 and higher, Apple Safari 5 and higher, Google Chrome 4 and higher.

Trace from:



The Data Distribution is designed to allow new external entities to be recipient of data with custom protocols.

TS-DIS-DES-1960/T

The Data Distribution shall provide a pluggable infrastructure accepting new distribution protocols.

Trace from: SR-DPC-SW-0020

TS-DIS-DES-1970/I

The Data Distribution shall distribute Alerts to the External Application Centre and EMSA Block3 using the OASIS Common Alerting Protocol (CAP) 2.0 format.

Trace from:

SR-DPC-DES-2060

SR-DPC-DES-2050

SR-DPC-DES-2040

TS-DIS-DES-1980/I

The Data Distribution shall distribute textual data to the External Application Centre and EMSA Block3 using an XML dialect conforms to a W3C XML Schema Definition (XSD) v1.0.

Trace from:

SR-DPC-DES-2050

SR-DPC-DES-2040

TS-DIS-DES-1990/I

The Data Distribution shall accompany XML data to the External Application Centre and EMSA Block3 with a reference on an Extensible Stylesheet Transformation (XSLT) v1.0 that transforms the data into a human readable web page.

Trace from:

SR-DPC-DES-2040

SR-DPC-DES-2050

TS-DIS-DES-2000/I

The Data Distribution shall publish web pages conform to the W3C HTML 4.01 Transitional and CSS level 2 standards.

Trace from:

SR-DPC-DES-2040

TS-DIS-DES-2010/I

The Data Distribution shall use an Open Source Web-based mapping tool with GIS capabilities compliant with OGC.

Trace from:

SR-DIS-FUN-0870

TS-DIS-DES-2020/I

The Data Distribution shall be implemented using the Java Platform, Enterprise Edition 7 or higher.

Trace from:

SR-DPC-DES-2070



6.7.7. Security and privacy requirements

TS-DIS-SEC-2030/T

The Data Distribution shall provide the Web Display through the Hypertext Transfer Protocol Secure (HTTPS).

Trace from:
SR-DIS-FUN-1780

TS-DIS-SEC-2040/T

The Data Distribution shall restrict data distribution to authorized users, i.e. users with necessary security credentials.

Trace from:
SR-DIS-FUN-1740
SR-DIS-FUN-1750

TS-DIS-SEC-2050/T

The Data Distribution shall establish a channel with external Block-2 systems based on TCP/IP 2-way SSL protocols using client and server digital certificates for mutual authentication.

Trace from:
SR-DIS-FUN-1740
SR-DIS-FUN-1770
SR-DIS-FUN-1790
SR-DIS-IFR-0360
SR-DIS-IFR-0410
SR-DIS-FUN-1800/I

TS-DIS-SEC-2060/T

The Data Distribution shall support secure cypher suites of at least 128 bit.

Trace from:
SR-DIS-FUN-1820
SR-DIS-FUN-1800/I

6.7.8. Portability requirements

Not Applicable.

6.7.9. Software quality requirements

Software quality requirements are detailed in the Software Product Assurance Plan (AD 7).

6.7.10. Software reliability requirements

Not Applicable.

6.7.11. Software maintainability requirements

Software maintainability requirements are detailed in the Software Product Assurance Plan (AD 7).



6.7.12. Software safety requirements

Not Applicable.

6.7.13. Software configuration and delivery requirements

Not Applicable.

6.7.14. Data definition and database requirements

TS-DIS-DDD-2070/T

The Data Distribution shall store the managed users and rights into an Open Source LDAP server.

Trace from:

6.7.15. Human factors related requirements

Not Applicable.

6.7.16. Adaptation and installation requirements

Not Applicable.

6.8. Data Management And Archive - DMA

The Data Management And Archive - DMA is the subsystem in charge of providing the long term archive of all DPC Block2 system data.

It supplies the DPC Block2 system all the necessary advanced services to store, retrieve, delete and query for data.



6.8.1. Functional requirements

The following diagram details the use cases assumed by the subsystem.

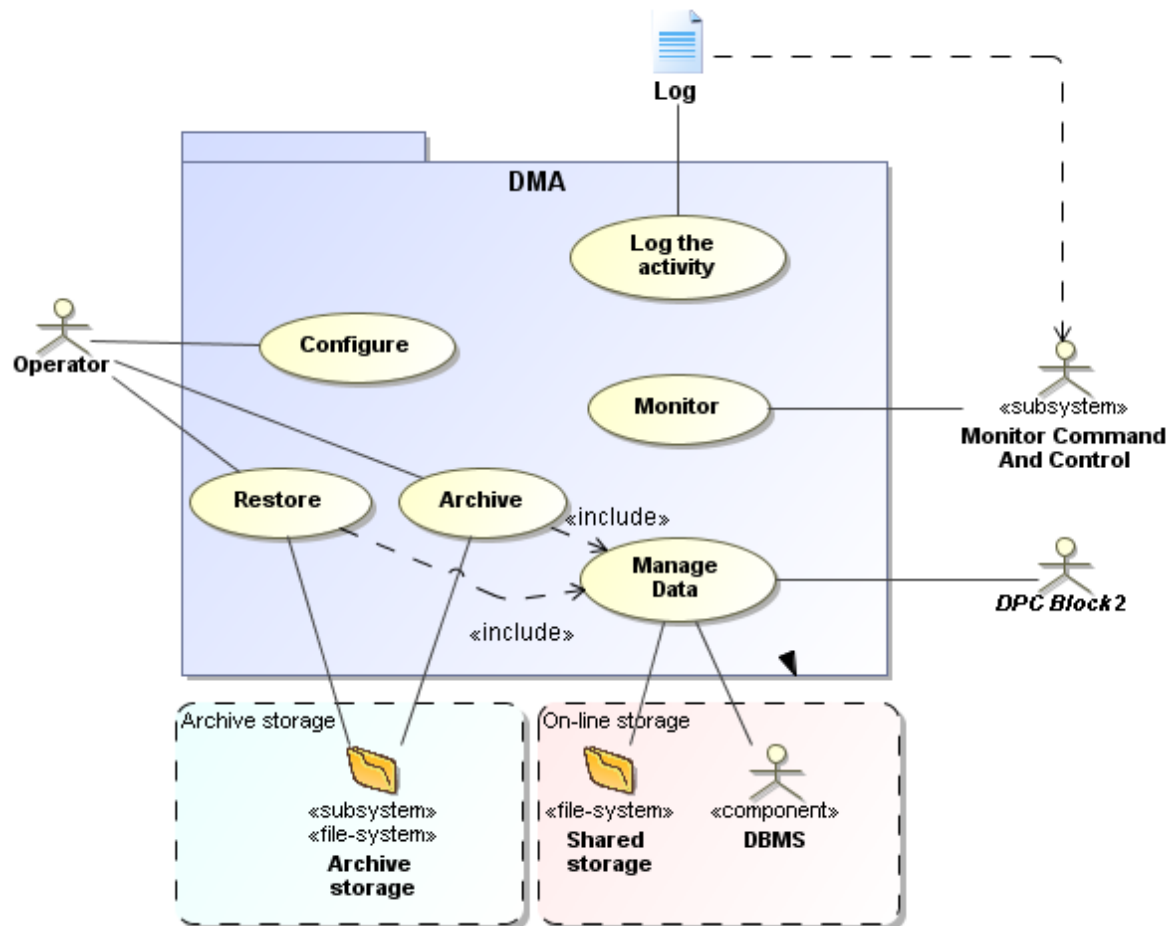


Figure 51 - Use Cases diagram for DMA

6.8.1.1. “Manage Data” UC

The use case supplies the subsystem with the capability to deal with data persistence. This includes the four basic functions of persistent storage:

- Store and retrieve data,
- Delete data,
- Query for data.

These data are expected to be aged lower than 3 years. The data managed by this UC are called “on-line” data.

6.8.1.1.1. Context

The UC is independent.

6.8.1.1.2. Interactions

The UC is initiated by the DPC Block2 system.



The UC uses the services provided by the DBMS subsystem.

The UC uses the services provided by the File System.

The UC is included in the “Restore” UC.

The UC is included in the “Archive” UC.

6.8.1.1.3. Pre-conditions

None.

6.8.1.1.4. Description

The UC captures the persistence activity required by the DPC Block2 system to achieve the goal of a on-line archiving.

The data managed by the UC are almost any information handled by DPC Block2 system:

- Incoming information:
 - AIS Messages (original raw form);
 - Ancillary data;
 - Satellite event files;
 - AIS Satellite event files;
 - VDRs;
 - EO Level 1 images.
- Processed information:
 - L1, L2 and L3 AIS Messages (decoded with traceability and metadata about processing);
 - Vessels (static information);
 - Satellite position schedules;
 - Alerts;

Data

TS-DMA-FUN-2080/T

The DMA shall allow to store, delete and query Raw AIS Messages, Level 1 AIS Messages, Level 2 and Level 3 Positions Reports as well as Predicted Position Reports.

Trace from:

SR-DMA-FUN-0690

SR-DMA-FUN-0700

SR-DPC-FUN-0080

SR-PRO-FUN-0390

SR-PRO-FUN-0400

TS-DMA-FUN-2090/T

The DMA shall allow to store, delete and query Auxiliary data.

Trace from:

SR-DMA-FUN-0690

TS-DMA-FUN-2100/T

The DMA shall allow to store, delete and query VDRs.



Trace from:
SR-DMA-FUN-0690

TS-DMA-FUN-2110/T

The DMA shall allow to store, delete and query EO Level 1 images.

Trace from:
SR-DMA-FUN-0690

TS-DMA-FUN-2120/T

The DMA shall allow to store, delete and query Alerts.

Trace from:
SR-DMA-FUN-0690
SR-PRO-FUN-0430

TS-DMA-FUN-2125/T

The DMA shall allow to persist the traceability elements along with the AIS messages.

Trace from:
SR-PRO-FUN-0370
SR-PRO-FUN-0380
SR-PRO-FUN-0390
SR-PRO-FUN-0440

Strategy

Depending on the nature and size of data, the data can be completely stored in the DBMS or dropped off in the Shared Storage File System, in which case, the external file is referenced within the DBMS by its URI. The classification of the data, determining whether data should be stored in the Shared Storage File System or in the DBMS, will be consolidated in the Design Phase.

TS-DMA-FUN-2130/I

The DMA shall rely on the services provided by a Database Management System (DBMS) for data considered as small.

Trace from:
SR-DMA-FUN-0680

TS-DMA-FUN-2140/I

The DMA shall rely on the services provided by a file system for data considered as huge.

Trace from:

6.8.1.1.5. Post-conditions

None.

6.8.1.2. “Archive” UC

The use case supplies the subsystem with the capability to transfer into an archive the on-line data.



6.8.1.2.1. Context

The UC is independent.

6.8.1.2.2. Interactions

The UC is initiated by the Operator.

The UC uses the services provided by the Shared storage system.

TS-DMA-FUN-2150/T

The DMA shall rely on the services provided by a File System.

Trace from:

SR-DMA-FUN-0680

The UC includes the “Manage Data” UC.

6.8.1.2.3. Pre-conditions

Data are in the on-line storage.

6.8.1.2.4. Description

The UC captures the intention of the Operator to transfer data from the on-line storage to the archive storage.

TS-DMA-FUN-2160/T

The DMA shall provide the capability for the operator to archive data.

Trace from:

SR-DMA-FUN-0710

The UC is covered by the following sequence of actions:

- A query is made to the DBMS component to retrieve all records having time-related data with date older than a configurable threshold date.
- The retrieved data is stored in the file system in a temporary directory, using an appropriate text-oriented serialization mechanism like CSV or XML. Note that external files that are referenced in the database are simply copied in the archive.
- The archive is packaged and compressed, and the resulting file is named to contain the date of archiving and the used archive threshold date.
- The records that have been archived are removed (deleted) from the DBMS component.

Once this sequence of actions has been performed, the archive file can be freely moved on an external support.

6.8.1.2.5. Post-conditions

Data are transferred in the archive storage.



6.8.1.3. “Restore” UC

The use case supplies the subsystem with the capability to restore archived data into the on-line storage.

6.8.1.3.1. Context

The UC is independent.

6.8.1.3.2. Interactions

The UC is initiated by the Operator.

The UC uses the services provided by the Shared storage system.

The UC includes the “Manage Data” UC.

6.8.1.3.3. Pre-conditions

Data are stored in the archive storage.

6.8.1.3.4. Description

The UC captures the intention of the Operator to transfer data from the on-line storage to the archive storage.

TS-DMA-FUN-2170/T

The DMA shall provide the capability for the operator to restore archived data into the on-line storage.

Trace from:
SR-DMA-FUN-0720

The UC is covered by the following sequence of actions:

- The archive is uncompressed in a dedicated temporary directory.
- The serialized tables are read and inserted into the DBMS.
- The temporary directory is deleted.

6.8.1.3.5. Post-conditions

Data are re-integrated into the on-line storage..

6.8.1.4. “Configure” UC

The use case supplies the subsystem with the capability to configure the DMA subsystem.

6.8.1.4.1. Context

The UC is independent.



6.8.1.4.2. Interactions

The UC is initiated by the Operator in order to manage the configuration items of the DMA sub-system.

6.8.1.4.3. Pre-conditions

None.

6.8.1.4.4. Description

The UC provides the configuration capability of a set of parameters like the database connection information.

TS-DMA-FUN-2180/T

The DMA shall allow the configuration of the underlying DBMS.

Trace from:

6.8.1.4.5. Post-conditions

None.

6.8.1.5. “Log the activity” UC

The UC provides the subsystem with the capability to store the activity in a log.

6.8.1.5.1. Context

The UC is independent and can be invoked at any time.

This UC is initiated by any other UCs who needs to keep track of their activities.

6.8.1.5.2. Interactions

The UC uses the Log actor as persistence means.

6.8.1.5.3. Pre-conditions

A significant event has occurred.

6.8.1.5.4. Description

The UC provides the means to carry in a single log all the activity of the subsystem. Each entry of that log is an event or a notable fact that is written in the log along with several attributes that characterizes it:

- Timestamp: the date and time on which the event has occurred;
- Severity: a value from the severity scale which expresses the significance of the event, including but not limited to the following: Error, Warning, Information;
- Context: a free text value referring to a context;
- Circumstance: Explicit and detailed description of the event.

**TS-DMA-FUN-2190/T**

The DMA shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.

Trace from:

6.8.1.5.5. Post-conditions

The log is appended with one or several entries.

6.8.1.6. “Monitor” UC

The UC provides the subsystem with the capability to publish the measurements of the activity (performance, resources usage, statistics).

6.8.1.6.1. Context**6.8.1.6.2. Interactions****6.8.1.6.3. Description****6.8.1.6.4. Pre-conditions**

Post-conditions

6.8.2. Performance requirements

Database connections are expensive and can take a long time to be opened. It is very inefficient for an application to create and close a database connection whenever it needs to access the database.

So, the DMA has to use a connection pooling technique designed to alleviate this problem.

TS-DMA-PER-2200/I

The DMA shall implement a connection pooling technique.

Trace from:

SR-DPC-DES-1930/T

6.8.3. Interface requirements

Interface requirements are detailed in the ICD (RD 2).

6.8.4. Operational requirements

To maintain a high level of control, the DMA stores in a log file a set of significant events that may be used by an operator to learn and understand the past activity.

TS-DMA-OPE-2210/T

The DMA shall log the event of a failed connection to the underlying DBMS with the information of: DBMS connection URL, error message returned.



Trace from:

6.8.5. Resources requirements

Not Applicable.

6.8.6. Design requirements and implementation constraints

The database schema should follow a normal form (NF), a particular structure that prevents the data model from vulnerability to logical inconsistencies and anomalies. However, in the particular context of the project, the performance prevails.

Thus, to ensure performance, the database schema can be normal-form free.

6.8.7. Security and privacy requirements

Not Applicable.

6.8.8. Portability requirements

Not Applicable.

6.8.9. Software quality requirements

Software quality requirements are detailed in the Software Product Assurance Plan (AD 7).

6.8.10. Software reliability requirements

TS-DMA-DES-2300/T

The DMA shall be robust when a DBMS connection is lost.

Trace from:

6.8.11. Software maintainability requirements

Software maintainability requirements are detailed in the Software Product Assurance Plan (AD 7).

6.8.12. Software safety requirements

TS-DMA-SAF-2310/I

The DMA shall be deployed identically (software and configuration) between primary and secondary system.

Trace from:

SR-DPC-SAF-1840

SR-DPC-SAF-1860

TS-DMA-SAF-2320/T

The DMA-FS on DPC Block 2 primary system shall be automatically replicated on the secondary system.



Trace from:
SR-DPC-SAF-1870

Depending on the required trade-off on writing latency and risk of data loss (TBD), the replication shall be synchronous, semi-synchronous or asynchronous.

TS-DMA-SAF-2330/I

The DMA shall be automatically replicated from the primary system to the secondary system.

Trace from:
SR-DPC-SAF-1870

Depending on the required trade-off on writing latency and risk of data loss (TBD), the replication shall be synchronous or asynchronous.

TS-DMA-SAF-2340/T

The DMA shall come with failover procedures for switching DPC Block 2 primary/secondary systems, including the primary/secondary role switching, the management of degenerate state (i.e. secondary system missing), and the reconciliation of data of DMA-FS and DMA-DB after restart.

Trace from:
SR-DPC-SAF-1850

Such failover procedures could be triggered at any time by the administrator, in order to allow maintenance of primary or secondary system.

6.8.13. Software configuration and delivery requirements

TS-DMA-CFG-2350/T

The DMA shall define the configuration of a DBMS by the URL database connection, database name, database user name, database user password.

Trace from:

TS-DMA-CFG-2360/T

The DMA shall define the configuration of the connection pool by the initial size of the pool, the maximum allowed of active connections, the maximum number of connections that can remain idle in the pool, the minimum number of connections that can remain idle in the pool, the maximum number of milliseconds that the pool will wait for a connection to be returned.

Trace from:

6.8.14. Data definition and database requirements

TS-DMA-DDD-2370/A

The DMA shall maintain an on-line holding capacity of three years.

Trace from:
SR-DMA-FUN-0690
SR-DMA-FUN-0700

TS-DMA-DDD-2380/A

The DMA shall maintain an unbounded off-line holding capacity for duration greater than three years.



Trace from:
SR-DMA-FUN-0710

6.8.15. Human factors related requirements

Not Applicable.

6.8.16. Adaptation and installation requirements

Not Applicable.

6.9. Data Management And Archive - DBMS

The Data Management And Archive - DBMS is the component in charge of managing (creation, storage, deletion and query) data into a database system.

6.9.1. Functional requirements

The Use cases are the ones provided by every existing DBMS:

- Modeling structure of data;
- Managing data (store, update, delete and search);
- Protecting the data.

TS-DMA-FUN-2410/I

The DBMS shall implement a Relational meta-model.

Trace from:

TS-DMA-FUN-2420/I

The DBMS shall provide a spatial extension that encompasses Simple Feature Access of ISO 19125 standard.

Trace from:

6.9.2. Performance requirements

Not Applicable.

6.9.3. Interface requirements

Interface requirements are detailed in the ICD (RD 2)

6.9.4. Operational requirements

To maintain a high level of operability, the DMA offers to the operator a view of the activity in the form of statistics.

TS-DMA-OPE-2220/T

The DMA shall provide the cumulative number of connection requests.



Trace from:

TS-DMA-OPE-2230/T

The DMA shall provide the cumulative number of completed transactions (failed and successful).

Trace from:

TS-DMA-OPE-2240/T

The DMA shall provide the cumulative number of transactions completed without failure.

Trace from:

TS-DMA-OPE-2250/T

The DMA shall provide the number of queries executed.

Trace from:

TS-DMA-OPE-2260/T

The DMA shall provide the time of the slowest query executed.

Trace from:

TS-DMA-OPE-2270/T

The DMA shall provide the slowest query executed.

Trace from:

TS-DMA-OPE-2280/T

The DMA shall provide the average time of query execution.

Trace from:

6.9.5. Resources requirements

Not Applicable.

6.9.6. Design requirements and implementation constraints

TS-DMA-DES-2430/I

The DBMS shall be an existing, widely adopted, database system.

Trace from:

The DBMS can be:

- PostgreSQL v9.x or higher with the PostGIS cartridge.
- Oracle 11g Enterprise Edition or higher, with Locator features.

6.9.7. Security and privacy requirements

Not Applicable.



6.9.8. Portability requirements

Not Applicable.

6.9.9. Software quality requirements

Software quality requirements are detailed in the Software Product Assurance Plan (AD 7).

6.9.10. Software reliability requirements

Not Applicable.

6.9.11. Software maintainability requirements

Software maintainability requirements are detailed in the Software Product Assurance Plan (AD 7).

6.9.12. Software safety requirements

Not Applicable.

6.9.13. Software configuration and delivery requirements

Not Applicable.

6.9.14. Data definition and database requirements

Not Applicable.

6.9.15. Human factors related requirements

Not Applicable.

6.9.16. Adaptation and installation requirements

Not Applicable.

6.10. Data Prediction - Ship Prediction

The Ship Prediction subsystem is in charge of computing (predicting) the route (a list of positions in the time) of a ship, in the future or in the past.

6.10.1. Functional requirements

The following diagram details the use cases assumed by the subsystem.

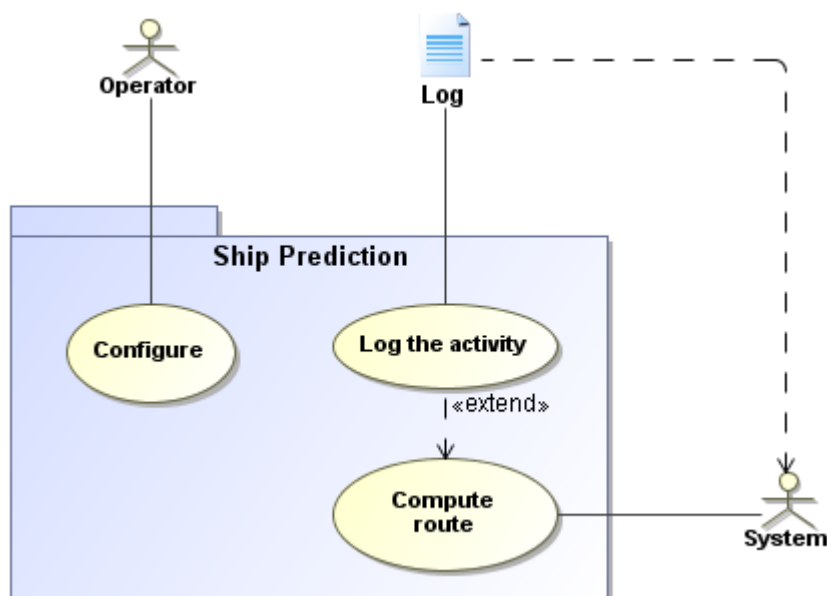


Figure 52 - Use Cases diagram for Ship Prediction subsystem

6.10.1.1. “Compute route” UC

The use case supplies the Ship Prediction subsystem with the computation of predicted routes of a given ship in the future.

6.10.1.1.1. Context

The UC is independent.

6.10.1.1.2. Interactions

The UC is initiated by the System to perform the computation of the route for a ship.

6.10.1.1.3. Pre-conditions

None.

6.10.1.1.4. Description

The UC captures the processing activity of the predicted route for a ship (or a set of ships).

The following image describes the principle of a ship route in case of the destination of the ship is known by the system:

- a route is a set of points such that they form a continuous sequence of segments;
- a point in a route is characterized at least by its geographic position (latitude, longitude) and its date.
- the route starts from the observed position of the ship to a target point, generally the destination port;
- the route can be limited to a time window.
- the route is qualified with an accuracy indicator.

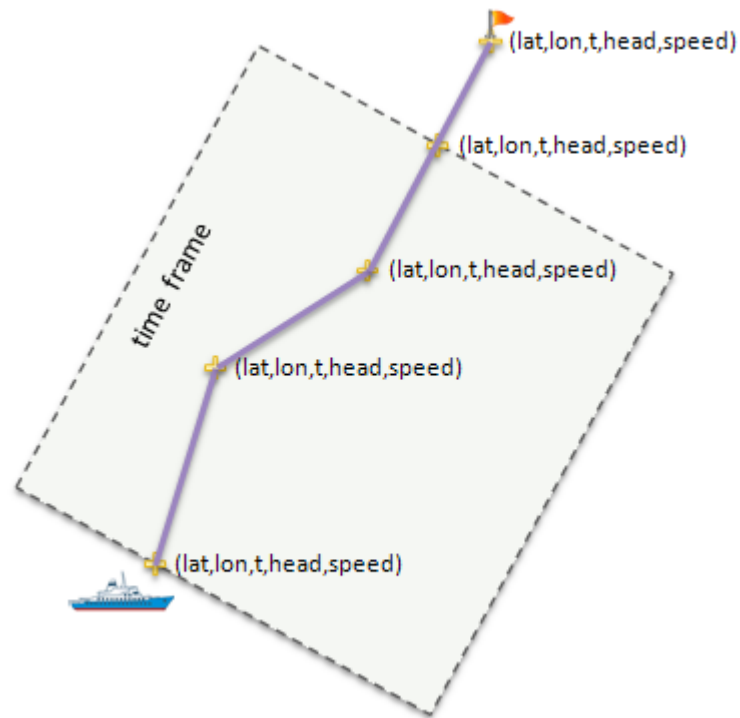


Figure 53 - Principle of a ship route with a known destination

When the destination is unknown the Ship Prediction algorithm provides the predicted positions along an extrapolated path given by the speed and course over ground of the ship:

- a route is then characterized by a unique segment traced at constant course over ground
- a route is limited by the specified time frame
- the route starts from the observed position of the ship and ends to the position where the route crosses the coast line or at the end of the time window
- the route is characterized by an accuracy indicator

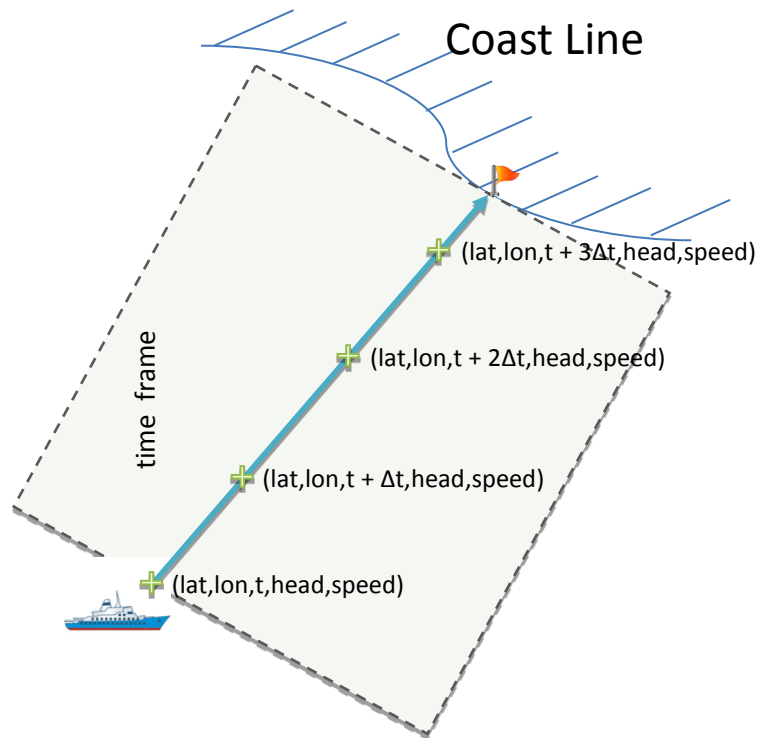


Figure 54: - Principle of a ship route without known destination

TS-DPP-FUN-2450/T

The Ship Prediction shall predict the route of a given ship in a future time frame.

Trace from:

SR-DPP-FUN-1580

SR-DPC-FUN-0080

SR-PRO-FUN-0570

The prediction algorithm takes the latest position of ship.

TS-DPP-FUN-2460/T

The Ship Prediction shall take into account the latest ship position (longitude, latitude and date time).

Trace from: SR-DPP-FUN-1580

The prediction algorithm takes, if available, the port of call to determine the mobile route.

TS-DPP-FUN-2470/T

The Ship Prediction shall take into account the port of call (name of destination) of the ship, if available.

Trace from: SR-DPP-FUN-1580

Only valid port of call and ETA provided in the last received AIS Voyage message (message #5) shall be taken in consideration in the route computation: the port of call is referenced into a list of worldwide ports along with its position, the ETA provided shall be compatible with the maximum speed of the vessel at first approximation.

**TS-DPP-FUN-2475/T**

The Ship Prediction shall perform a preliminary validation of the last voyage information (port of call, ETA) received by the system to avoid computation of unrealistic routes.

Trace from: SR-DPP-FUN-1580

TS-DPP-FUN-2480/T

The Ship Prediction shall take into account the last known course over ground of the ship.

Trace from: SR-DPP-FUN-1580

TS-DPP-FUN-2490/T

The Ship Prediction shall take into account the last known speed over ground of the ship.

Trace from: SR-DPP-FUN-1580

TS-DPP-FUN-2500/T

The Ship Prediction shall use a network of the main navigational route nodes in order to relate the ship to a navigational route when the port of call is known and valid.

Trace from: SR-DPP-FUN-1590

In case the port of call is unknown or invalid, the estimation of the route is based on an extrapolation of the last known location considering the ship's speed and course over ground.

TS-DPP-FUN-2505/T

The ship prediction shall use the last known location, speed and course over ground of the ship to provide the estimated route when the port of call is unknown. The estimated route shall be stopped when it crosses coastlines.

Trace from: SR-DPP-FUN-1590

The Ship Prediction takes into account the ship navigation area: in open ocean, close to shore, close to port.

TS-DPP-FUN-2510/T

The Ship Prediction shall take into account the following ship navigation area: in open ocean, close to shore, close to port.

Trace from: SR-DPP-FUN-1610

TS-DPP-FUN-2520/T

The Ship Prediction shall ensure the computed route is all included in sea.

Trace from: SR-DPP-FUN-1600

**TS-DPP-FUN-2530/T**

The Ship Prediction shall characterize the reliability of the predicted positions of the ship with an accuracy indicator, related to the prediction duration (how far in the future is the prediction) and the navigation area.

Trace from: SR-DPP-FUN-1620

6.10.1.1.5. Post-conditions

The predicted route is computed.

6.10.1.2. “Log the activity” UC

The UC provides the subsystem with the capability to store the activity in a log.

6.10.1.2.1. Context

The UC is independent and can be invoked at any time.

The UC is initiated by any other UCs who needs to keep track of their activities.

6.10.1.2.2. Interactions

The UC uses the Log actor as persistence means.

6.10.1.2.3. Pre-conditions

A significant event has occurred.

6.10.1.2.4. Description

The UC provides the means to carry in a single log all the activity of the subsystem. Each entry of that log is an event or a notable fact that is written in the log along with several attributes that characterizes it:

- Timestamp: the date and time on which the event has occurred;
- Severity: a value from the severity scale which expresses the significance of the event, including but not limited to the following: Error, Warning, Information;
- Context: a free text value referring to a context;
- Circumstance: Explicit and detailed description of the event.

TS-DPP-FUN-2540/T

The Ship Prediction shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.

Trace from:

6.10.1.2.5. Post-conditions

The log is appended with one or several entries.



6.10.1.3. “Configure” UC

The use case allows configuring the Ship Prediction subsystem.

6.10.1.3.1. Context

The UC is independent.

The UC is invoked by an Operator.

6.10.1.3.2. Interactions

The UC is initiated by the Operator in order to manage the configuration items of the Data Retrieval sub-system.

6.10.1.3.3. Pre-conditions

None.

6.10.1.3.4. Description

The UC provides the configuration capability of a set of parameters like the network of nodes of the maritime traffic routes.

Through this UC, the operator can set:network

- the network that models the topology of maritime traffic routes;
- the list of port of call, with the name of the port and its location

The following image shows the track of vessels near Brittany (region in the north-west of France) from which we can deduce a network of nodes.

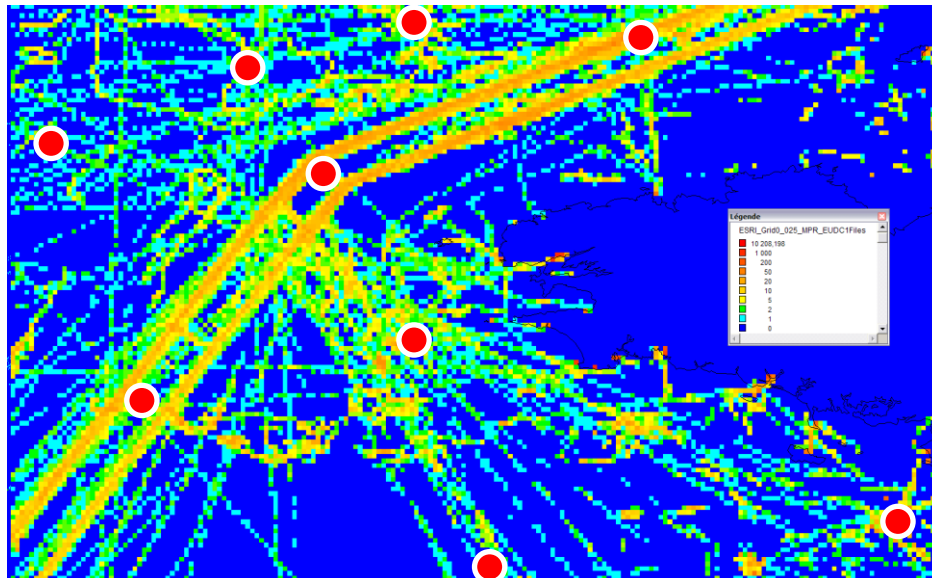


Figure 55 - Pre-identified network of nodes

TS-DPP-FUN-2550/T

The Ship Prediction shall allow the management of (declaration, modification, and deletion) of a graph topology of maritime traffic routes.



Trace from:
SR-DPP-FUN-1590

6.10.1.3.5. Post-conditions

The configuration is changed.

The modification of the configuration is not expected to be dynamically taken into account. A restart of the sub-system might be necessary.

6.10.2. Performance requirements

TS-DPP-PER-2560/I

The Ship Prediction shall use a cache mechanism such that it returns a route previously computed if the computation conditions are the same.

Trace from:

6.10.3. Interface requirements

Interface requirements are detailed in the ICD (RD 2)

6.10.4. Operational requirements

Not Applicable.

6.10.5. Resources requirements

Not Applicable.

6.10.6. Design requirements and implementation constraints

The Ship Prediction is designed to allow new position prediction algorithm such as the Kalman related algorithms.

TS-DPP-DES-2570/T

The Ship Prediction shall provide a pluggable infrastructure accepting new position prediction algorithms.

Trace from:
SR-DPC-DES-1920
SR-DPC-SW-0020

TS-DPP-DES-2580/I

The Ship Prediction shall be implemented using the Java Platform, Enterprise Edition 7 or higher.

Trace from:
SR-DPC-DES-2070



6.10.7. Security and privacy requirements

Not Applicable.

6.10.8. Portability requirements

Not Applicable.

6.10.9. Software quality requirements

Software quality requirements are detailed in the Software Product Assurance Plan (AD 7).

6.10.10. Software reliability requirements

Not Applicable.

6.10.11. Software maintainability requirements

Software maintainability requirements are detailed in the Software Product Assurance Plan (AD 7).

6.10.12. Software safety requirements

Not Applicable.

6.10.13. Software configuration and delivery requirements

TS-DPP-CFG-2590/I

The Ship Prediction shall store maritime traffic routes in XML.

Trace from:
SR-DPP-FUN-1590

TS-DPP-CFG-2710/I

The Ship Prediction shall store the list of port of call (name, position) in XML.

Trace from:
SR-DPP-FUN-1590

6.10.14. Data definition and database requirements

Not Applicable.

6.10.15. Human factors related requirements

Not Applicable.



6.10.16. Adaptation and installation requirements

Not Applicable.

6.11. Data Prediction - S-AIS Data Simulation Service

The S-AIS Data Simulation Service is the sub-system in charge of providing several simulation services within the DPC Block2 System. Those are:

- **Real-time data production:** The S-AIS Data Simulation Service produces data as if it was an AIS Provider.
- **Real-provider surveillance:** The S-AIS Data Simulation Service mainly produces detection probability (“next detection probability”), warnings and alerts for the ships whose detection probability are higher than thresholds – meaning that it is probably abnormal that no detection has been achieved on this ship since the previous one.
- **Long-term message prediction:** S-AIS Data Simulation Service produces messages that could be achieved by a provider(real or virtual).

6.11.1. Functional requirements

The following diagram details the use cases assumed by the subsystem.

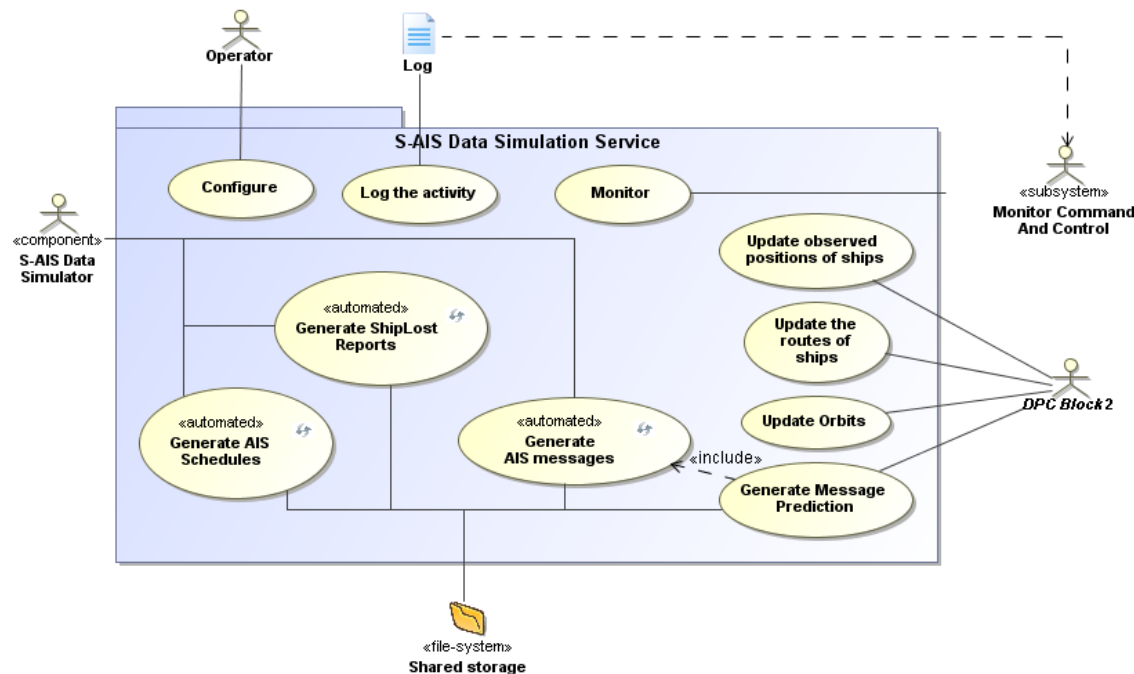


Figure 56 - Use Cases diagram for the S-AIS Data Simulator

6.11.1.1. “Configure” UC

This use case allows configuring the S-AIS Data Simulation Service sub-system.

6.11.1.1.1. Context

This UC is independent.



The UC is invoked by an Operator.

6.11.1.1.2. Interactions

The UC is initiated by the Operator in order to manage the configuration items of the S-AIS Data Simulation Service sub-system.

6.11.1.1.3. Pre-conditions

None.

6.11.1.1.4. Description

The UC provides the configuration capability of a set of static parameters that characterises the simulations behaviours.

Through this UC, the operator can manage the Simulations that are running.

6.11.1.1.5. Post-conditions

The configuration is changed.

The modification of the configuration is not expected to be dynamically taken into account. A restart of the sub-system might be necessary.

6.11.1.2. “Log the activity” UC

The use case supplies the subsystem with the capability to store the activity in a log.

6.11.1.2.1. Context

This UC is independent and can be invoked at any time.

The UC is initiated by the “Generate AIS messages” UC and “Generate ShipLost Reports” UC to keep track of the activity.

6.11.1.2.2. Interactions

The UC uses the Log actor as a persistence means.

6.11.1.2.3. Pre-conditions

A significant event has occurred.

6.11.1.2.4. Description

The UC provides the means to carry in a single log all the activity of the subsystem. Each entry of that log is an event or a notable fact that is written in the log along with several attributes that characterizes it:

- Timestamp: the date and time on which the event has occurred;
- Severity: a value from the severity scale which expresses the significance of the event, including but not limited to the following: Error, Warning, Information;



- Context: a free text value referring to a context;
- Circumstance: Explicit and detailed description of the event.

TS-DSS-FUN-2830/T

The S-AIS Data Simulation Service shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.

Trace from:

6.11.1.2.5. Post-conditions

The log is appended with one or several entries.

6.11.1.3. “Monitor” UC

The UC provides the subsystem with the capability:

- to publish the measurements of the activity (performance, resources usage, statistics).
- to monitor the simulation instances (number of running instances, progress of each simulation).
- to control the simulation instances (start and stop).

6.11.1.3.1. Context

This UC is independent.

6.11.1.3.2. Interactions

The UC is initiated by the System.

6.11.1.3.3. Pre-conditions

None.

6.11.1.3.4. Description

The UC provides the capability to monitor the S-AIS Simulation Service subsystem. With this UC, the operator can, through the Monitor Command and Control subsystem get access to the characteristics of the configured simulations.

The following table summarizes the information that is available for each configured simulation instances.

Category	Information	Description
General	Simulation identifier	A unique identifier for the declared simulation.
	Simulation type	A Short sentence describing the nature of the simulation. Three kind of simulations are identified:
		<ul style="list-style-type: none"> • The simulation in charge of generating AIS Messages • The simulation in charge of generating Schedules



		<ul style="list-style-type: none"> The simulation in charge of Generating Ship Lost Reports
Status	Status	The status of the simulation: <ul style="list-style-type: none"> Running: the simulation is actually running Stopped: the simulation is halted, no process is running.
	Started date time	The date and time the simulation was launched, if the simulation is actually running.
	Alert report file	The location of the alert report file in the shared file system. This file contains the warning/alert report.
System	Configuration file	The location of the configuration file in the local file system.
	Progress report file	The location of progress report file in the local file system. This file contains the progression messages of the running simulation.
	Process Identifier	The system identifier of the launched process (PID).

TS-DSS-FUN-2840/T

The S-AIS Simulation Service shall provide a list of the configured simulation instances characterized with the following general information: simulation identifier, simulation type (AIS messages, AIS Schedules, Ship Lost Reports).

Trace from:

TS-DSS-FUN-2850/T

The S-AIS Simulation Service shall provide a list of the configured simulation instances characterized with the following status information: status (started/stopped), started date and time, location of the shared alert report file.

Trace from:

SR-DPS-FUN-1570

TS-DSS-FUN-2860/T

The S-AIS Simulation Service shall provide a list of the configured simulation instances characterized with the following system information: location of the local configuration file, location of the local progress report file, the launched process identifier (PID).

Trace from:

SR-DPS-FUN-1570

The UC provides also the capability to control the S-AIS Simulation Service subsystem. With this UC, the operator can, through the Monitor Command and Control subsystem, start and stop the configured simulation instances.

TS-DSS-FUN-2870/T

The S-AIS Simulation Service shall provide the capability to start a stopped configured simulation.



Trace from:
SR-DPS-FUN-1570

TS-DSS-FUN-2880/T

The S-AIS Simulation Service shall provide the capability to stop a started configured simulation.

Trace from:
SR-DPS-FUN-1570

6.11.1.3.5. Post-conditions

None.

6.11.1.4. “Generate AIS messages” UC

This use case supplies the S-AIS Simulation Service with the capability of acting as a supplementary AIS data provider.

6.11.1.4.1. Context

This UC is independent.

6.11.1.4.2. Interactions

The UC uses the S-AIS Simulation Service component.

The UC uses the Shared storage system to store the generated AIS messages.

6.11.1.4.3. Pre-conditions

None.

6.11.1.4.4. Description

The UC provides the subsystem with the capability to generate AIS messages as if it was an AIS provider:

- the UC covers the production of AIS messages data as if it was a real AIS provider. This UC corresponds to a continuous real-time service that produces AIS messages on successive fixed periods.
- the UC covers the production of future AIS messages that will be produced by a provider for a ship . This UC corresponds to an on-demand accelerated service that produces AIS messages on successive fixed periods. This service takes benefit of the simplified processing modes to speed-up the simulation.

The realization of the UC is almost performed by the S-AIS Data Simulator component. All requirements of this use case are then assumed by this component.

6.11.1.4.5. Post-conditions

None.



6.11.1.5. “Generate ShipLost Reports” UC

This use case supplies the S-AIS Simulation Service with the capability of providing indication of the period of time during which AIS messages were lost as well as times where the contacts were expected.

6.11.1.5.1. Context

This UC is independent.

6.11.1.5.2. Interactions

The UC uses the S-AIS Simulation Service component.

The UC uses the Shared storage system to store the generated Ship Lost Reports.

6.11.1.5.3. Pre-conditions

None

6.11.1.5.4. Description

This UC deals with messages that were supposed to be received by the satellites but were not. The principle is to calculate the detection probability for any given ship. At each simulation step, the detection probability is cumulated in order to calculate the detection expectancy of all ships.

The realization of the UC is almost performed by the S-AIS Data Simulator component. All requirements of this use case are then assumed by this component.

6.11.1.5.5. Post-conditions

None

6.11.1.6. “Generate Message Prediction” UC

This use case supplies the S-AIS Simulation Service with the capability of providing AIS messages prediction.

6.11.1.6.1. Context

This UC is independent.

6.11.1.6.2. Interactions

The UC uses the S-AIS Simulation Service component.

The UC includes the “Generate AIS messages UC” used to produce predicted AIS messages.

The UC uses the Shared storage system to store the generated predicted AIS messages.



6.11.1.6.3. Pre-conditions

None.

6.11.1.6.4. Description

The UC provides AIS messages prediction, based on previous SAT-AIS messages from the same ship. Once invoked by the System actor, the UC provides both the predicted positions of a given ship, and the SAT-AIS messages that would be received for a given satellite constellation and ground stations.

The UC needs to succeed to have:

- the last position message received from a ship,
- the predicted route (from the S-AIS Data Prediction sub-system).

TS-DSS-FUN-3020/T

The S-AIS Simulation Service shall produce predicted AIS messages of a ship given the last position message received and the predicted route.

Trace from:

The realization of the UC is almost performed by the S-AIS Data Simulator component. All requirements of this use case are then assumed by this component.

6.11.1.6.5. Post-conditions

A set of predicted AIS messages over a window of 24 hours.

6.11.1.7. “Generate AIS Schedules” UC

6.11.1.7.1. Context

This UC is independent.

6.11.1.7.2. Interactions

The UC uses the S-AIS Simulation Service component.

The UC uses the Shared storage system to store the generated AIS schedules.

6.11.1.7.3. Pre-conditions

None

6.11.1.7.4. Description

The realization of the UC is almost performed by the S-AIS Data Simulator component. All requirements of this use case are then assumed by this component.

6.11.1.7.5. Post-conditions

None



6.11.1.8. “Update the Observed Positions of Ships” UC

The use case supplies the S-AIS Simulation Service with the capability to modify the observed positions of ships.

6.11.1.8.1. Context

This UC is independent.

6.11.1.8.2. Interactions

The UC is invoked by the System actor when it needs to update the ship positions.

6.11.1.8.3. Pre-conditions

None.

6.11.1.8.4. Description

The UC allows the System actor to update a fleet map. The new fleet is then taken into account by the simulation instances in a 3 minutes delay.

TS-DSS-FUN-3150/T

The S-AIS Simulation Service shall offer a way to update the observed positions of ship.

Trace from:

If observed positions of ships are not received at the scheduled date of reception from the SAT-AIS provider while data reception was expected, the S-AIS Simulation Service warns the operation through the MCC.

TS-DSS-FUN-3152/T

In case of no reception of AIS messages while it was expected from a S-AIS Provider, the S-AIS Simulation Service shall alert the operator through the MCC. The expected date shall take into account delays of reception from the provider.

Trace from:
SR-PRO-FUN-0650

6.11.1.8.5. Post-conditions

None.

6.11.1.9. “Update the routes of ships” UC

The use case supplies the S-AIS Simulation Service with the capability to modify the predicted routes of ships.



6.11.1.9.1. Context

This UC is independent.

6.11.1.9.2. Interactions

The UC is invoked by the System actor when it needs to update the ship routes.

6.11.1.9.3. Pre-conditions

None.

6.11.1.9.4. Description

The UC allows the System actor to update the fleet routes. The new route is then taken into account by the simulation instances in a 3 minutes delay.

TS-DSS-FUN-3155/T

The S-AIS Simulation Service shall offer a way to update the predicted routes of ships.

Trace from:

6.11.1.9.5. Post-conditions

None.

6.11.1.10. "Update Orbits" UC

The use case supplies the S-AIS Simulation Service with the capability to update the orbits elements.

6.11.1.10.1. Context

This UC is independent.

6.11.1.10.2. Interactions

The UC is invoked by the System actor when it needs to update the orbits.

6.11.1.10.3. Pre-conditions

None.

6.11.1.10.4. Description

The UC allows the System actor to update the orbits. The new orbits are then taken into account by the simulation instances in a 3 minutes delay.

TS-DSS-FUN-3160/T

The S-AIS Simulation Service shall offer a way to update the orbits.



Trace from:

6.11.1.10.5. Post-conditions

None.

6.11.2. Performance requirements

Not applicable.

6.11.3. Interface requirements

Interface requirements are detailed in the ICD (RD 2).

6.11.4. Operational requirements

To maintain a high level of control, the S-AIS Simulation Service stores in a log file a set of significant events that may be used by an operator to learn and understand the past activity.

TS-DSS-OPE-3190/T

The S-AIS Simulation Service shall log the event of the start and stop of the simulation instances.

Trace from:

TS-DSS-OPE-3200/T

The S-AIS Simulation Service shall log the event of an AIS message flow generation with the information of: local file location, file size.

Trace from:

TS-DSS-OPE-3210/T

The S-AIS Simulation Service shall log the event of a Ship Lost report generation with the information of: local file location, file size.

Trace from:

6.11.5. Resources requirements

Not Applicable.

6.11.6. Design requirements and implementation constraints

TS-DSS-DES-3250/T

The S-AIS Simulation Service shall be implemented using the Java Platform, Enterprise Edition 7 or higher.

Trace from:



6.11.7. Security and privacy requirements

Not Applicable.

6.11.8. Portability requirements

Not Applicable.

6.11.9. Software quality requirements

Software quality requirements are detailed in the Software Product Assurance Plan (AD 7).

6.11.10. Software reliability requirements

Not Applicable.

6.11.11. Software maintainability requirements

Software maintainability requirements are detailed in the Software Product Assurance Plan (AD 7).

6.11.12. Software safety requirements

Not applicable.

6.11.13. Software configuration and delivery requirements

Not Applicable.

6.11.14. Data definition and database requirements

TS-DSS-DDD-3430/T

The S-AIS Simulation Service shall emit warnings and alarms that comply with the OASIS Common Alerting Protocol (CAP) 2.0 format.

Trace from:
SR-DPC-DES-2060

6.11.15. Human factors related requirements

Not applicable.

6.11.16. Adaptation and installation requirements

Not applicable.



6.12. S-AIS Data Simulator

The S-AIS Data Simulator component provides within the DPC Block2 the services described hereafter.

Service A : Real-Time data production

For this service, the Simulator shall produce data as if it was an AIS provider.

This service is a “permanent” service.

The processing speed is real-time.

The parameters (satellites, processing solution, ground network, ...) depends on the characteristics of this virtual provider. For instance, the beamforming option shall be activated for processing to provide high-performance results.

The real fleet may be used so that the position of ships used at input be the most possible close to the reality. The 3 minutes fixed period may allow in parallel the Ship prediction module to elaborate the new fleet every 3 minutes.

The useful outputs are the message flow (both for real and virtual fleet) and the ETRF schedules with a 24h window for visualisation. As the data are not real, they shall not be transferred to EMSA, and are then only intended for comparison and pre-validation purposes.

Service B : Real-provider surveillance

For this service, the Simulator shall mainly produce detection statistics, and eventually orbits and schedules that have not been delivered by the real provider.

This service is a “permanent” service.

The processing speed is real-time.

The parameters (satellites, processing solution, ground network, ...) shall as much as possible be the same than the ones of this real provider. In particular, the real TLE and auxiliary files are directly used. The high-volume of options in the different parameters shall allow to get rather close of the real provider capacity, so that alerts and warnings will become even more relevant.

The real fleet shall be used. The 3 minutes fixed period may allow in parallel the Ship prediction module to elaborate the new fleet every 3 minutes. Every time a ship is seen by the real provider, the detection date is given in the real fleet file, and the Simulator reset the “Next detection probability” to zero for the ship.

The outputs are the detection probability (“Next detection probability”) and warnings and alerts (for the ships whose detection probability are higher than thresholds - meaning that it is probably abnormal that no detection has been achieved on this ship since the previous one). In addition, if it is not deliver by the real provider, the orbits and schedules over the next 24 hours may be required for visualisation purposes.

Service C : Long-term message prediction

For this service, the Simulator shall produce messages, orbits and schedules that could be achieved by a provider (real or virtual) over a window of 24 hours.

This service is a “on-request” service.

The processing speed is full-speed.

There are two options for the parameters: either use the real parameters of a provider (as in service A or B), or use the detection map model. The first solution will be closer from the reality in terms of detection, but the detection map model will significantly reduce the processing duration and then reduce the waiting delays for the user. To increase the speed, it is also recommended to



apply this function to a subset of ships, in the order of magnitude of 10, both in real and virtual fleets.

The real fleet is used at the beginning of the simulation. Thanks to the capability to take into account a trajectory, it is possible to provide messages over a long period according to the Ship prediction module outputs.

The useful outputs are the message flow for the real fleet (the geographic filtering may be useful to reduce the volume of data provided), and the ETRF associated schedules (ship, station, satellite) for visualisation purposes.

Remark : With a detection map filled with 100% in all points, it is possible to produce all the messages that will be sent by the whole ships with a satellite in visibility. The message volume will however be very high.

Service D : Long-term detection prediction

For this service, the Simulator shall produce detection statistics, orbits and schedules (in particular ship downlink schedules) that could be achieved by a real provider over a window of 24 hours.

This service is a “on-request” service.

The processing speed is full-speed.

This service is very similar to the Service C, except that the output is detection statistics instead of messages. The use of real parameters of the provider is recommended for a better idea of the performances.

As the real fleet will not be updated during the simulation, the detection probability will continuously increase, so that by comparing the results on several dates, it will be possible to produce maps with the next detection probability of each ship over time. To avoid too numerous alarms, the corresponding threshold shall be set to 1.0 in the parameters.

6.12.1. Functional requirements

6.12.1.1. Main functions

TS-DPS-FUN-0010/T

The simulator shall simulate a satellite-AIS system, taking into account a given fleet of transmitting ships, a given set of satellites with a defined payload performance and a given ground segment.

Trace from: SR-DPS-FUN-1360

SR-DPC-FUN-0080/A

TS-DPS-FUN-0020/T

The simulator shall be able to provide at output a list of schedules, including next visibilities of the ships, and next downlink of the satellites.

Trace from: SR-DPS-FUN-1520, SR-DPC-FUN-0180

TS-DPS-FUN-0030/T

The simulator shall be able to provide at output a list of messages, including ancillary data, as if they had been received, processed and downlinked by a real satellite system.

Trace from: SR-DPS-FUN-1390

**TS-DPS-FUN-0040/T**

The simulator shall be able to provide at output a list of detection statistics per ship, to allow further comparison processing between a real flow and a simulated one. The comparison itself is not part of the simulator.

Trace from: SR-DPS-FUN-1520

TS-DPS-FUN-0050/T

The Simulator shall be able to produce data as if they were produced by a non-nominal model, for ship, satellite and/or ground network.

Trace from: SR-DPS-FUN-1450, SR-DPS-FUN-1460 and SR-DPS-FUN-1470

TS-DPS-DES-0051/T

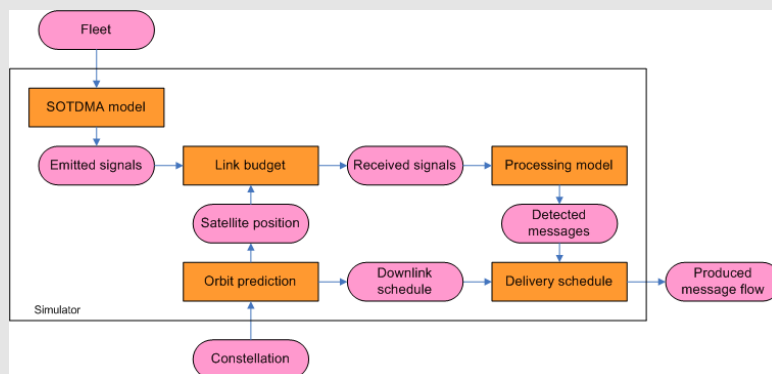
The Simulator shall be able to produce data as if they were produced by a non-nominal model thanks to a high flexibility in the simulation parameters.

Trace from: -

6.12.1.2. Processing functions

TS-DPS-FUN-0100/I

The simulator shall integrate the main functions presented in the following figure (orange boxes):



Trace from: -

TS-DPS-FUN-0110/T

The SOTDMA model module shall identify at each slot and for each frequency the transmitting ships.

Trace from: -

TS-DPS-FUN-0111/T

The SOTDMA model module shall be so that each ship transmits alternatively on the 2 used AIS channels.

Trace from: -

**TS-DPS-FUN-0112/T**

The SOTDMA model module shall be so that ships transmits with an average period corresponding to their characteristic transmission period.

Trace from: -

TS-DPS-FUN-0113/T

The SOTDMA model module shall be so that ships transmits with a jitter of +/- 10% around their average period.

Trace from: -

TS-DPS-FUN-0114/T

The SOTDMA model module shall be so that ships transmits on the same slots for 3 consecutive minutes.

Trace from: -

TS-DPS-FUN-0115/T

The SOTDMA model module shall be so that on AIS 3&4 channels only class A ships transmit messages, and that on AIS 3&4 channels all ships transmits with a 3 minute period instead of their nominal transmission period.

Trace from: -

TS-DPS-FUN-0120/T

The orbit prediction module shall calculate the position of the satellite at each date. It also evaluates the date at which the satellite will be visible by a ship or by a ground station for the downlink schedule.

Trace from: SR-DPS-FUN-1370, SR-DPC-FUN-0180

TS-DPS-FUN-0121/T

The orbit prediction shall be performed based on TLE received at input ant using Celestrak's SGP4 algorithm.

Trace from: SR-DPS-FUN-1430

TS-DPS-FUN-0122/T

The orbit prediction module shall evaluate the date at which the satellite will be visible by a ship or by a ground station. If a satellite is seen by a ground station for a duration longer than a parameter threshold, the downlink is considered feasible.

Trace from: SR-DPS-FUN-1380, SR-DPC-FUN-0180

TS-DPS-FUN-0123/T

The orbit prediction module shall be able to consider an external Downlink Schedule file for a satellite instead of producing it.

Trace from:

**TS-DPS-FUN-0130/T**

The link budget module shall evaluate the signal reception conditions, in terms of power, direction, time and frequency of arrival.

Trace from: SR-DPS-FUN-1480 and SR-DPS-FUN-1490

TS-DPS-FUN-0131/T

The link budget module shall take into account the ship antenna pattern, the free space and atmospheric losses, including polarization effects, and the satellite antenna pattern. In addition, it shall consider randomness to take into account the multi-path and attitude effects.

Trace from: SR-DPS-FUN-1480

TS-DPS-FUN-0132/T

The link budget module shall evaluate the received frequency according to the nominal emission frequency, and to the ship oscillator error.

Trace from: SR-DPS-FUN-1480 and SR-DPS-FUN-1490

TS-DPS-FUN-0133/T

The Simulator shall allow the processing of different link budgets per satellite considering several different antennas per satellite, and different reception conditions for first AIS frequencies (AIS 1 & 2) and/or new ones (AIS 3 & 4).

Trace from: -

TS-DPS-FUN-0140/T

The processing model shall provide the detection probability, the CRC correctness probability and the bit error rate of all received messages. In nominal mode, this processing model shall use a table providing the BER and PER in relation with the signal to noise ratio.

Trace from: SR-PRO-FUN-0630

TS-DPS-FUN-0141/T

The processing model shall construct the nominal message and the value of each bit shall be taken accordingly to the bit error rate.

Trace from: -

TS-DPS-FUN-0142/T

The processing model shall evaluate the received power, the reception date, the measured frequency, the frequency measure date and the number of simultaneously received signals and combine them in a block of "ancillary data".

Trace from: -

TS-DPS-FUN-0143/T

The processing model shall evaluate the measured frequency, taking into account the received frequency and the signal to noise ratio.

Trace from: SR-DPS-FUN-1480

**TS-DPS-FUN-0144/T**

The processing model shall include simple modes to get quickly a raw estimations of the performance for free running or highly accelerated simulations.

Trace from: -

TS-DPS-FUN-0145/T

The processing model shall update the detection expectancy of each couple (ship, satellite) by each instantaneous detection probability.

Trace from: -

TS-DPS-FUN-0146/T

The processing model shall be able to evaluate the detection expectancy and then the message production probability based on a static detection probability map instead of the complete processing model.

Trace from: -

TS-DPS-FUN-0150/T

The delivery schedule module shall evaluate for each satellite at which date and by which station it will become visible from ground. The date, the station and the associated delivery date to the processing centre is the “next downlink” of the satellite.

Trace from: SR-DPS-FUN-1390

TS-DPS-FUN-0151/T

The delivery schedule module shall take into account the position of the satellite, the position of the ground network and its characteristics (masking angles, transfer mode and duration).

Trace from: SR-DPS-FUN-1390

TS-DPS-FUN-0152/T

If the satellite is simultaneously visible by two or more ground stations, the Simulator shall identify which unique ground station will be used and then considered in the “next downlink” schedule according to the date and duration of the visibilities.

Trace from: -

Remark: The rule to consider may be to select the station which has at least the minimum visibility duration and which ends the first.

Remark: If an external Downlink Schedule is available, the Simulator shall apply it without verifying the conditions of visibilities of ground stations.

TS-DPS-FUN-0153/T

The delivery date shall be evaluated by the date of the end of the downlink plus the transfer delay.

Trace from: -

TS-DPS-FUN-0154/T

The delivery schedule module shall reset the detection probability per ship/satellite if the ship has really been detected by the real satellite in the fixed period or in a shortly previous (parameter) fixed period as stated in the real fleet file.



Trace from: -

TS-DPS-FUN-0155/T

The delivery schedule shall update the detection statistics from the accumulated expectancy only if the delivery date corresponding to the satellite is within the current fixed period.

Trace from: -

6.12.1.3. Processing versus time

TS-DPS-FUN-0200/I

The simulator shall maintain the time by storing at the beginning of the simulation the current local date of the hardware, and accessing again to this local date when necessary.

Trace from:

TS-DPS-FUN-0211/T

The simulator shall be able to work in full speed mode. All processing is done without particular real-time or synchronization constraints.

Trace from: SR-DPS-FUN-1550

TS-DPS-FUN-0212/T

The simulator shall be able to work in real-time mode : the processing is performed in full speed, but once the processing is ended and the data are ready, the simulator waits that the time passed since the beginning of the simulation become equal to the fixed processing period before beginning a new fixed period.

Trace from: SR-DPS-FUN-1530

TS-DPS-FUN-0213/T

The simulator shall be able to work in accelerated-time mode : the processing is performed in full speed, but once the processing is ended and the data are ready, the simulator waits that the time passed since the beginning of the simulation becomes equal to the fixed processing period divided by a factor before beginning a new fixed period.

Trace from: SR-DPS-FUN-1540

TS-DPS-FUN-0220/T

When the simulator is late in real-time or accelerated-time modes, it shall raise an alert to the user with a visible message.

Trace from: SR-DPS-FUN-1560

TS-DPS-FUN-0221/T

When the simulator is late in real-time or accelerated-time modes, and if the parameter “break when late” in the parameters is on, the Simulator shall immediately break its processing.

Trace from: SR-DPS-FUN-1560



6.12.1.4. Processing schedules

TS-DPS-DES-0310/T

The Simulator shall work with a processing fixed period of 3 minutes in simulated time.

Trace from: -

TS-DPS-FUN-0320/T

The Simulator shall read the required inputs at the beginning of each fixed period, including the Main parameter file.

Trace from: -

TS-DPS-FUN-0321/T

The Simulator shall verify that the header field of the Main parameter file has not been modified since the first fixed period. If it has been modified, the simulator shall break with an appropriate error message.

Trace from: -

TS-DPS-FUN-0330/T

The Simulator shall write and make available the required outputs at the end of each fixed period.

Trace from: -

TS-DPS-DES-0340/T

The evaluation of the satellite position and downlink schedules shall cover the 24 hours (simulated time) after the beginning of the simulation.

Trace from: -

TS-DPS-DES-0341/T

The evaluation of the satellite position and satellite downlink schedules during the long-term propagation shall be made with a 30s (simulated time) period.

Trace from: -

TS-DPS-DES-0342/T

The evaluation of the satellite position and ship visibility calculations during the fixed-period propagation shall be made with a 5s (simulated time) period.

Trace from: -

6.12.2. Performance requirements

TS-DPS-PER-0410/T

Based on the use of one dedicated processor core for the Simulator instance, the Simulator shall be able to run in real-time a simulation with 150000 ships worldwide, with a constellation of 6 satellites with 4-antennas beamforming on each, and a ground network with 6 stations.

Trace from: -

**TS-DPS-PER-0420/T**

The Simulator shall be able to run with at maximum 200000 ships worldwide, a constellation of at maximum 24 satellites, an antenna array of at maximum 20 antennas, and a ground network with at maximum 60 stations.

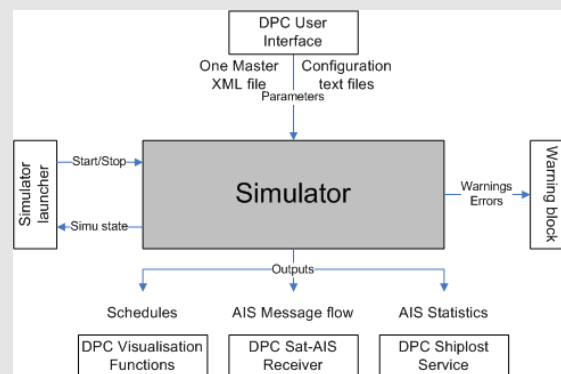
Trace from: -

6.12.3. Interface requirements

This section provides the external interface requirements. The formats are described in the ICD [AD3].

6.12.3.1. Interfaces overview**TS-DPS-IFR-0500/T**

The simulator shall implement the interfaces presented in the figure below:



Trace from:

TS-DPS-IFR-0510/T

The Simulator shall verify that the input files are accessible when it needs them. If they are not, it shall quit with an appropriate error indicator.

Trace from: -

TS-DPS-IFR-0511/T

The Simulator shall verify that the input files have the correct format. If they have not, it shall quit with an appropriate error indicator.

Trace from: -

TS-DPS-FUN-0520/T

The Simulator shall verify that it is able to create the outputs files (memory space, memory protections, ...). If it is not, it shall quit with an appropriate error indicator.

Trace from: -

**TS-DPS-FUN-0521/T**

The Simulator shall verify that the created outputs files are accessible when it needs them. If they are not, it shall quit with an appropriate error indicator.

Trace from: -

TS-DPS-FUN-0522/T

The Simulator shall remove to its output directories all outputs strictly older than 24 hours in simulated time.

Trace from: -

6.12.3.2. External program launcher

TS-DPS-IFR-0530/T

The simulator shall be managed by an external program launcher.

Trace from: -

Remark : This external management program shall mainly follow the requirement SR-DPS-FUN-1570.

TS-DPS-IFR-0531/T

The Simulator shall be able to receive the Start command from the External program launcher.

Trace from: -

TS-DPS-IFR-0532/T

The Simulator shall be able to receive the Stop command from the External program launcher.

Trace from: -

TS-DPS-IFR-0540/T

During the simulation, the Simulator shall provide access to the progression of the simulation through progress messages displayed or stored at the choice of the external management process.

Trace from:

TS-DPS-IFR-0541/T

In case of a warning or error, the Simulator shall simultaneously provide a warning/alert report at the address given in parameter and display on the external manager window a message with the type of error.

Trace from: -

6.12.3.3. External warning manager

TS-DPS-IFR-0550/T

The Simulator shall provide its warnings and error logs to an external warning manager.

Trace from: -

**TS-DPS-SW-0551/T**

The Simulator shall use the log4j format for providing warnings and alarms on the simulator software.

Trace from: -

6.12.3.4. Input : Parameters**TS-DPS-IFR-0600/T**

The Simulator shall simulate a Satellite-AIS environment easily modifiable by several parameters files centralized in one Main parameter file.

Trace from: SR-DPS-FUN-1440

TS-DPS-IFR-0601/T

The Simulator Parameter file shall be structured according to the following high-level sections :

- Header : name, date of the simulation, author, reference
- Simulation management parameters
- I/O files addresses
- Constellation parameters
- Ground-network parameters
- Link budget parameters
- Processing parameters
- Address of the virtual fleet map
- Address of the real fleet

Trace from: SR-DPS-FUN-1440/T

TS-DPS-IFR-0610/T

The Simulator shall use parameters included in the simulation management section shall drive the configuration of the Simulator instance, in particular Monitoring & Control.

Trace from: SR-DPS-FUN-1440/T

TS-DPS-IFR-0620/T

The Simulator shall use the parameters included in the I/O files addresses section to define the addresses of input and output files.

Trace from:

TS-DPS-IFR-0630/T

The Simulator shall use the parameters included in the constellation section to define the configuration of the constellation, including in particular the links to dynamic files (TLE, IERS and Auxiliary bulletin) and the Ground stations used by each satellite.

Trace from: SR-DPS-FUN-1410

SR-DPS-FUN-1440/T

**TS-DPS-IFR-0631/T**

The Simulator shall use the TLE file to get the orbital parameters of the satellite necessary for its position prediction.

Trace from: SR-DPS-FUN-1410

TS-DPS-IFR-0632/T

The Simulator shall use the IERS Bulletin A file to get the Earth rotation parameters necessary for conversion to J2000.

Trace from: SR-DPS-FUN-1410

TS-DPS-IFR-0633/T

The Simulator shall use the Auxiliary file to get the unavailability events of the satellites and ground stations of a provider.

Trace from: SR-DPS-FUN-1410, SR-DPS-FUN-1440/T

TS-DPS-IFR-0640/T

The Simulator shall use the parameters included in the ground-network sections to define the ground-network in terms of number of stations and characteristics of each of them.

Trace from: SR-DPS-FUN-1420, SR-DPS-FUN-1470, SR-DPS-FUN-1440/T

TS-DPS-IFR-0650/T

The Simulator shall use the parameters included in the link budget parameters to elaborate the link-budgets, in particular for what concerns the atmospheric parameters, the noise reception conditions and the considered antennas.

Trace from: SR-DPS-FUN-1410, SR-DPS-FUN-1440/T

TS-DPS-IFR-0655/T

The Simulator shall take into account the geographic filters set in the satellite parameters by providing no data (detection statistics, messages, schedules) for the ships that are outside the given geographic filter.

Trace from: -

TS-DPS-IFR-0660/T

The Simulator shall use the parameters included in the processing parameters to define the AIS signal processing capacity of the simulated constellation.

Trace from: SR-DPS-FUN-1410, SR-DPS-FUN-1440/T

TS-DPS-IFR-0670/T

The Simulator shall use the virtual fleet map to construct the reference AIS-equipped-ships fleet according to the provided worldwide ship density. The Simulator shall use the virtual fleet to complete the real fleet every fixed period, so that the number of ships in the simulation is always equal to the number of ships in the virtual fleet.

Trace from: SR-DPS-FUN-1410, SR-DPS-FUN-1440/T

**TS-DPS-IFR-0680/T**

The Simulator shall use the fleet input to read the list of all detected ships, with their known characteristics (MMSI, status health, position (position, speed, heading), transmission frequency, transmission period, class (class and transmission power)), use of AIS 3&4, and their previous detection date per real satellite and their predicted trajectory.

Trace from: SR-DPS-FUN-1400, SR-DPS-FUN-1450, SR-DPS-FUN-1490, SR-DPS-FUN-1440/T

TS-DPS-IFR-0681/T

The Simulator shall use the trajectory (list of latitude, longitude, speed, heading, date of turn) given in the real fleet file to propagate the ship position from one fixed period to the next one (but not during a fixed period where the ship is considered as fixed).

Trace from: -

6.12.3.5. Outputs

TS-DPS-IFR-0710/T

The Simulator shall be able to produce the following schedule files:

- Satellite position in terrestrial reference frame
- Satellite position in J2000 reference frame
- Satellite downlink schedule
- Ground station downlink schedule
- Ship downlink schedule

Trace from: SR-DPS-FUN-1500

TS-DPS-IFR-0711/T

The Simulator shall be able to produce the Satellite position in terrestrial reference frame as the list of satellite positions (x, y, z) every 30s on the next 24 hours after the beginning date of the simulation.

Trace from:

TS-DPS-IFR-0712/T

The Simulator shall be able to produce the Satellite position in J2000 reference frame as the list of satellite positions (x, y, z) every 30s on the next 24 hours after the beginning date of the simulation.

Trace from: SR-DPS-FUN-1510/T

TS-DPS-IFR-0713/T

The Simulator shall be able to produce the Satellite downlink schedule as the list of satellite-ground stations visibilities, each visibility being characterized by the ground station ID, the beginning date of the visibility and the visibility duration.

Trace from:

**TS-DPS-IFR-0714/T**

The Simulator shall be able to produce the Ground station downlink schedule as the list of satellite-ground stations visibilities, each visibility being characterized by the satellite ID, the beginning date of the visibility and the visibility duration.

Trace from:

TS-DPS-IFR-0715/T

The Simulator shall be able to produce the Ship downlink schedule as the list for all ships of satellite visibilities within the current fixed period, each visibility being characterized by the satellite ID, the visibility beginning date, the next ground-station ID seen by the satellite and the associated DPC delivery date.

Trace from:

TS-DPS-IFR-0720/T

The Simulator shall be able to produce an AIS message flow which follows the following formats:

ITU-R M.1371 for the message content ([RD1])

IEC 61162-1 for the information coding ([RD2])

IEC 62320-1 for the header definition ([RD3])

Trace from: SR-DPC-DAT-0250

TS-DPS-IFR-0721/T

The Simulator shall be able to produce the message types 1 (dynamic message for moving class A ships), 3 (dynamic message for static class A ships), 5 (static message for class A ships), 18 (dynamic message for class B ships) and 27 (long-range message used on AIS 3&4).

Trace from: SR-DPC-DAT-0250

TS-DPS-IFR-0722/T

The Simulator shall complete the messages with the known elements (MMSI, position, speed, heading) and with default values when elements are unknown.

Trace from:

TS-DPS-IFR-0723/T

The Simulator shall define for Virtual ships as MMSI the value 200XXXXXX with XXXXXX the ship ID.

Trace from: -

TS-DPS-IFR-0724/T

The Simulator shall include in the comment section of the message block the ancillary data: satellite ID, detection date, delivery date, ground-station ID, Time Of Arrival, Frequency Of Arrival, Frequency Of Arrival Date, Power Of Arrival, quality index, number of simultaneously received messages.

Trace from:

TS-DPS-IFR-0725/T

The Simulator shall set the first bit of the quality index to '0' if it is a real vessel and to '1' if it is a virtual vessel.



Trace from: -

TS-DPS-IFR-0726/T

The Simulator shall produce one AIS message flow file per satellite downlink.

Trace from: -

TS-DPS-IFR-0727/T

The Simulator update the current AIS message flow files (one per satellite) at the end of each fixed period.

Trace from: -

Remark: As only one “next downlink” per satellite is considered (see TS-DPS-FUN-0152), only one file per satellite may be updated per fixed period.

TS-DPS-IFR-0730/T

The Simulator shall be able to produce the list of AIS detection statistics per ship and per satellite, and per ship combined on all satellites of the simulation.

Trace from: SR-DPS-FUN-1390, SR-SSP-FUN-1010

TS-DPS-IFR-0731/T

The Simulator shall be able to identify among the detection statistics per ship the ones that may be considered as suspicious for the ship lost DPC task.

Trace from: SR-DPS-FUN-1390

TS-DPS-IFR-0732/T

The Simulator shall produce one AIS detection statistics file every fixed period.

Trace from: -

TS-DPS-IFR-0733/I

The Simulator shall use the OASIS Common Alerting Protocol (CAP) [RD4] for providing warnings and alarms on missing ships.

Trace from: SR-DPC-DES-2060, SR-PRO-FUN-0640

6.12.4. Operational requirements

TS-DPS-OPE-0810/T

The Simulator shall be able to produce AIS message data as if it was a real AIS provider. In this service, it shall be used in “real-time” speed mode, as a permanent service on successive fixed periods, reading the inputs and writing the outputs every fixed period, without interruption.

Trace from: -

TS-DPS-OPE-0820/T

The Simulator shall be able to produce detection statistics, orbits and schedules, necessary to visualize and monitor a real AIS provider. In this service, it shall be used in “real-time” speed mode, as a permanent service on successive fixed periods, reading the inputs and writing the outputs every fixed period, without interruption.



Trace from: -

Remark: For this service, the real fleet updates shall be performed or simulated in parallel to avoid a too significant volume of ship lost alerts.

TS-DPS-OPE-0830/T

The Simulator shall be able to produce messages, orbits and schedules that could be achieved by a provider (real or simulated) over a window of 24 hours. This service is a “on-request” service to be performed in accelerated mode. This service will take benefit of the simplified processing modes to speed-up the simulation.

Trace from: -

TS-DPS-OPE-0840/T

The Simulator shall be able to produce detection statistics, orbits and schedules (including in particular ship detection schedules) that could be achieved by a real provider over a window of 24 hours. This service is a “on-request” service to be performed in full-speed mode.

Trace from: -

TS-DPS-OPE-0851/T

The Simulator shall be able to simulate failures in the constellation (removal of a satellite or modification of its characteristics in the Main parameter file or use of the Auxiliary file).

Trace from: SR-DPS-FUN-1460

TS-DPS-OPE-0852/T

The Simulator shall be able to simulate failures in the ground segment (removal of a ground station or modification of its characteristics in the Main parameter file or use of the Auxiliary file).

Trace from: SR-DPS-FUN-1470

TS-DPS-OPE-0853/T

The Simulator shall be able to simulate failures in the ship segment (removal of a ship or modification of its characteristics (including status-health) in the fleet file). It shall also be able to consider a fake position for a ship.

Trace from: SR-DPS-FUN-1450

6.12.5. Resources requirements

6.12.5.1. Software requirements

TS-DPS-SW-1010/I

The Simulator software shall preferably be written in Java language.

Trace from: SR-DPC-DES-2070

TS-DPS-SW-1011/I

The Simulator software may be written in C++ language if it appears that it is more suitable to comply with the performance requirements.

Trace from: -



Remark: The Real-Time constraint is rather significant, and a particular attention to it and then eventually to all aspects that may contribute to slow the processing shall be identified and avoided as possible (virtualization, high number of memory allocations, ...). For instance, the management of ship to satellites link requires around 500000 values to calculate, store and delete, per second.

TS-DPS-SW-1020/T

The Simulator shall run on Linux RedHat 6/6.1.

Trace from: SR-DPC-HW-1720

TS-DPS-SW-1021/I

The impacts for a deployment of the Simulator on Windows shall be identified and minimized.

Trace from: -

TS-DPS-SW-1030/I

The Simulator shall use only non contaminant software.

Trace from: -

TS-DPS-SW-1040/I

The Simulator interfaces with the DPC shall be based on a file-based Interface.

Trace from: -

Remark: No SOA framework is used to expose Simulator services to host framework.

TS-DPS-SW-1050/I

The Simulator shall use the XML standard for exchange files as default format.

Trace from: SR-DPC-DES-2050

Remark: XML may not be used if different standards already exists (AIS messages, TLE, IERS bulletin, ...) or if the data may be seen as a simple but large table (fleet, detection statistics, schedules, ...)

6.12.5.2. Hardware requirements

TS-DPS-HW-1100/T

The Simulator shall run on the following hardware:

PowerEdge R610

2 x Intel Xeon L5640, 6C, 2.26Ghz, 12M Cache (4 core)

16GB Memory for 2 CPUs, DDR3, 1333MHz

16X DVD+/-RW ROM Drive SATA

PERC H700, Integrated RAID Controller, 512MB NV Cache

600GB, SAS 6Gbps, 2.5-in, 10K RPM Hard Drive (Hot Plug)

Trace from: -

**TS-DPS-HW-1110/T**

The Simulator shall be able to run in several instances in parallel, using possibly different parameters.

Trace from: -

TS-DPS-HW-1111/T

Each instance of the Simulator shall be independent. In particular, it shall use its own memory resources.

Trace from: -

6.12.6. Design requirements and implementation constraints

No complementary requirement to the ECSS compliance (see section Software Quality)

6.12.7. Security and privacy requirements

Not applicable.

6.12.8. Portability requirements

Not applicable.

6.12.9. Software quality requirements**TS-DPS-SWQ-1400/I**

The Simulator shall be classified in category D and developed in compliance with the standard software product assurance requirements ref 100141944N-EN issue 4.

Trace from: SR-DPC-SW-0010

TS-DPS-SWQ-1401/I

The required quality characteristics shall be: functionality, reliability and maintainability.

Trace from: SR-DPC-SWQ-1900

TS-DPS-SWQ-1402/I

The targets value shall be 50 lines of code per method and 25% of comment frequency.

Trace from: -

TS-DPS-VVI-1410/I

The software shall be verified according to the Validation plan to cover all requirements of this document.

Trace from: SR-DPC-VVI-2180

TS-DPS-VVI-1420/I

Interfaces shall be tested through specific test cases



Trace from: SR-DPC-VVI-2150/T

TS-DPS-VVI-1430/I

The software shall be tested with a minimum coverage of 70%.

Trace from: SR-DPC-VVI-2200

TS-DPS-VVI-1440/I

The Simulator shall initialize the random seed at zero at the beginning of each simulation.

Remark: This requirement will allow to reproduce exactly the same results for a given input configuration, which will facilitate in particular the non-regression tests.

Trace from: -

6.12.10. Software reliability requirements

Not Applicable.

6.12.11. Software maintainability requirements

TS-DPS-DES-1600/T

The Simulator shall provide Traces of the processing for debugging and maintenance purposes.

Trace from: -

TS-DPS-DES-1610/I

All configuration and input files of the Simulator shall be modifiable with a basic Text editor.

Trace from: -

6.12.12. Software safety requirements

Not Applicable.

6.12.13. Software configuration and delivery requirements

TS-DPS-OPE-1700/I

The Simulator configuration shall be managed through ClearCase.

Trace from: -

6.12.14. Data definition and database requirements

See ICD [AD3]



6.12.15. Human factors related requirements

TS-DPS-OPE-1800/I

The Simulator shall be delivered with a Parameters User Manual describing the purpose, the format, the minimum and maximum values and examples of each parameter of the Simulator.

Trace from: -

6.12.16. Adaptation and installation requirements

TS-DPS-OPE-1900/I

The Simulator shall be delivered with the appropriate installation tools.

Trace from: -

6.13. Monitoring Command and Control

The Monitoring Command and Control system is the system in charge of several activities related to the supervision and control of the DPC Block2 system.

6.13.1. Functional requirements

TS-MCC-FUN-3440/I

The Monitoring Command and Control shall be able to monitor applications in real-time, with 24/7 availability.

Trace from:

SR-MCC-FUN-1050

SR-DPC-FUN-0080/A

SR-DPC-OPE-2080/I

TS-MCC-FUN-3450/I

The Monitoring Command and Control graphical interface shall give a representation of the Block2 H/W and S/W architecture, giving a synthetic view of the Block2 components.

Trace from:

SR-MCC-FUN-1060

TS-MCC-FUN-3460/T

The MCC graphical interface shall be interactive.

Trace from:

SR-MCC-FUN-1070

TS-MCC-FUN-3470/T

The MCC graphical interface shall allow to start a Block2 component.

Trace from:

SR-MCC-FUN-1070

SR-DPC-FUN-0110

**TS-MCC-FUN-3480/T**

The MCC graphical interface shall allow to stop a Block2 component.

Trace from:
SR-MCC-FUN-1070
SR-DPC-FUN-0110

TS-MCC-FUN-3490/T

The MCC graphical interface shall provide map, a graphical representation of Block2 components, or group of components, giving the actual status.

Trace from:
SR-MCC-FUN-1080

TS-MCC-FUN-3500/I

The MCC graphical interface shall allow to draw links between Block2 components on the map.

Trace from:
SR-MCC-FUN-1090

TS-MCC-FUN-3510/T

The Monitoring Command and Control interface shall allow to add, delete, modify and suspend a monitoring task.

Trace from:
SR-MCC-FUN-1100

TS-MCC-FUN-3520/T

The Monitoring Command and Control interface shall allow to create/delete monitoring item/template, create/monitoring user monitoring item, add/delete monitored hosts and upgrade of the MCC tools.

Trace from:
SR-MCC-FUN-1100

TS-MCC-FUN-3530/T

The MCC graphical interface shall allow adding a new Block2 component to the display.

Trace from:
SR-MCC-FUN-1110

TS-MCC-FUN-3540/T

The Monitoring Command and Control shall allow to define warnings and alerts to raise; display notification on the graphical interface; send notification by e-mail.

Trace from:
SR-MCC-FUN-1120

TS-MCC-FUN-3550/T

The Monitoring Command and Control shall allow to define alerts to raise, regarding the inactivity of a component (alert based on a threshold period without activity, scalable for each component).

Trace from:
SR-MCC-FUN-1130

**TS-MCC-FUN-3560/T**

The Monitoring Command and Control shall allow to acknowledge an alert, with a text field for a comment.

Trace from:
SR-MCC-FUN-1140

TS-MCC-FUN-3570/T

The Monitoring Command and Control should provide a real-time journal of application generated events (provided in log files), with configurable filtering parameters: time interval, severity status of events (Error, Warning, Info, Debug and Activity), components.

Trace from:
SR-MCC-FUN-1150

TS-MCC-FUN-3580/T

The MCC graphical interface should be able to display the event journal in a separated window.

Trace from:
SR-MCC-FUN-1160

TS-MCC-FUN-3590/T

The Monitoring Command and Control shall allow to execute a given task.

Trace from:
SR-MCC-FUN-1170

TS-MCC-FUN-3600/T

The Monitoring Command and Control shall allow to configure the scheduling of the task execution.

Trace from:
SR-MCC-FUN-1180

TS-MCC-FUN-3610/T

The Monitoring Command and Control shall acknowledge as a task executable scripts regarding the operating system on which it runs (i.e. bash script or script with SQL requests).

Trace from:
SR-MCC-FUN-1190

TS-MCC-FUN-3620/T

The Monitoring Command and Control shall consider the content returned by a processed task as a number that can be used as metric, giving the execution status.

Trace from:
SR-MCC-FUN-1200

TS-MCC-FUN-3630/T

The Monitoring Command and Control shall display the execution history of each scheduled task (with its returned status) via a graph.

Trace from:
SR-MCC-FUN-1240
SR-MCC-FUN-1220/T

Remark: No execution history will be available for manual tasks.

**TS-MCC-FUN-3640/T**

The Monitoring Command and Control shall display returned status of each scheduled task as a graphic over a configurable period of time (day, week, month, year).

Trace from:

SR-MCC-FUN-1250

SR-MCC-FUN-1220/T

TS-MCC-FUN-3650/T

The Monitoring Command and Control shall allow to raise alerts depending on task execution status.

Trace from:

SR-MCC-FUN-1210

TS-MCC-FUN-3660/T

The Monitor Command And Control shall provide a mean to configure a task (name, script, frequency, parameters).

Trace from:

SR-MCC-FUN-1260

TS-MCC-FUN-3670/T

The Monitoring Command and Control shall be a multi-user system, reachable simultaneously by several remote connections.

Trace from:

SR-MCC-FUN-1270

TS-MCC-FUN-3680/T

The Monitoring Command and Control shall be configurable to monitor any internal Block2 infrastructure component availability and performance outage (network, hardware, database).

Trace from:

SR-MCC-FUN-1280

TS-MCC-FUN-3690/T

The Monitoring Command and Control shall provide statistics (average, min, max) from monitored item.

Trace from:

SR-MCC-FUN-1290

TS-MCC-FUN-3700/T

The Monitoring Command and Control shall be able to monitor external link.

Trace from:

SR-MCC-FUN-1300

TS-MCC-FUN-3710/T

The Monitoring Command and Control shall allow to define a warning to raise, in case on communication network issues with external entities (e.g. using ping command).

Trace from:

SR-MCC-FUN-1310

**TS-MCC-FUN-3720/T**

The MCC subsystem shall be able to monitor the status of the reception of AIS data by the ground stations following.

Trace from:
SR-MCC-FUN-1320

TS-MCC-FUN-3730/T

The MCC subsystem shall be able to send notifications when a satellite fails to receive or forward AIS data to the ground stations.

Trace from:
SR-MCC-FUN-1330

TS-MCC-FUN-3740/T

The Monitoring Command and Control shall allow to stop the monitoring of a given DPC BLOCK2 during his maintenance.

Trace from:
SR-MCC-FUN-1340

TS-MCC-FUN-3750/T

The Monitoring Command and Control shall provide historical report of alerts, notifications, outages, and alert responses.

Trace from:
SR-MCC-FUN-1350

6.13.2. Performance requirements

Not Applicable.

6.13.3. Interface requirements

Interface requirements are detailed in the ICD (RD 2).

6.13.4. Operational requirements

Not Applicable.

6.13.5. Resources requirements

Not Applicable.

6.13.6. Design requirements and implementation constraints

Not Applicable.

6.13.7. Security and privacy requirements

Not Applicable.



6.13.8. Portability requirements

Not Applicable.

6.13.9. Software quality requirements

Software quality requirements are detailed in the Software Product Assurance Plan (AD 7).

6.13.10. Software reliability requirements

Not Applicable.

6.13.11. Software maintainability requirements

Not Applicable.

6.13.12. Software safety requirements

Not Applicable.

6.13.13. Software configuration and delivery requirements

Not Applicable.

6.13.14. Data definition and database requirements

Not Applicable.

6.13.15. Human factors related requirements

Not Applicable.

6.13.16. Adaptation and installation requirements

Not Applicable.

6.14. S-AIS System Performance

The SAIS System Performance subsystem calculates statistics on the general performance of the S-AIS System based on all AIS messages received by the DPC Block2 (including Class B messages if any are received) and the corresponding flags archived in the SAT-AIS Database. These flags are generated during the different levels of processing of the AIS messages L1, L2 and L3.



6.14.1. Functional requirements

The following diagram details the use cases assumed by the subsystem.

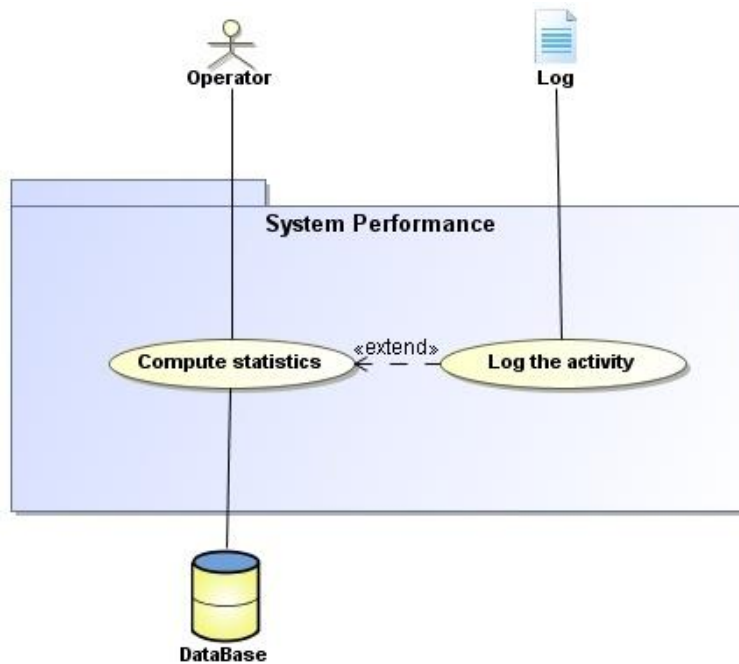


Figure 57 - Use Cases diagram for Sat-AIS System Performance subsystem

6.14.1.1. “Compute statistics” UC

The use case supplies the subsystem with the capability to compute Key Performance Indicators (KPI) from raw information available in the DPC Block2 System and turn them into diagrams (plots, charts and maps) and dashboards.

6.14.1.1.1. Context

This UC is independent.

6.14.1.1.2. Interactions

The UC is initiated by the Operator to generate KPI on available AIS messages.

6.14.1.1.3. Pre-conditions

None.

6.14.1.1.4. Description

6.14.1.1.4.1. Overview

During this UC, the SAT-AIS System Performance subsystem performs the adequate requests needed to extract data from the DBMS subsystem, and then, performs the calculation and visualization of the results (plots, charts, gridded map...).



6.14.1.1.4.2. Exploited flags

The following table describes the different AIS message flags used by the System Performance subsystem.

Flag	Application	Message type	Definition	Processing level	Service
L1_CRC	Message	All	Invalid CRC (only available with the simulator) "CRC flag"	PL1	S1
L1_LENGTH	Message	All	Inconsistent message length	PL1	S1
L1_THRESHOLDS	Message	All	Inconsistent message parameters (out of thresholds) Applied to lon, lat, SoG, CoG (AC)	PL1	S1
L1_FOOTPRINT	Message	AIS Position reports	Location out of satellite footprint "footprint flag"	PL1	S1
L1_VELOCITY	Message	AIS Position reports	Inconsistent velocity (distance / time) "velocity flag"	PL1	S1
S2_MISSING	Vessel	NA	Missing vessel	-	S2
L2_PREDICT_RECOVERY	Message	AIS Position reports	Vessel position recovered with prediction "recovery with prediction position flag"	PL2	S3
L2_DOPPLER_RECOVERY	Vessel	AIS Position reports	Vessel position recovered with Doppler position "recovery with Doppler position flag"	PL2	S3
L2_DOPPLER_INTEGRITY	Vessel	-	Vessel position confirmed or invalidated with Doppler "Doppler position integrity flag" (AC)	PL2	S3
L3_EO_CORRELATION	Vessel	NA	Vessel position confirmed with EO data "EO confirmed position flag"	PL3	S5

Table 18 - Flags used by the System Performance subsystem

6.14.1.1.4.3. Scenario

In base scenario, the Operator asks for computing some statistics on level 1 AIS Messages.

For each statistic request, the representation shall be performed according to different selection criteria: by time period, AIS message type, by satellite, by data provider, by vessel type (if the information is available), by vessel identifiers (MMSI or group of MMSI) and shall distinguish the messages with valid or invalid CRC (L1_CRC flag).

TS-SSP-FUN-3760/T

The System Performance shall filter selected data by time period, AIS message type, satellite, data provider, vessel type, vessel identifier.

Trace from:

SR-SSP-FUN-0990

SR-SSP-FUN-1020



SR-SSP-FUN-1030
SR-DPC-FUN-0080
SR-SSP-FUN-1040

TS-SSP-FUN-3770/T

The System Performance shall distinguish AIS messages by the CRC-16 value.

Trace from:
SR-SSP-FUN-0990
SR-SSP-FUN-1020
SR-SSP-FUN-1030

The available possibilities are described below:

- 1- The SAT-AIS System Performance module shall plot on a world map all the AIS messages positions received, globally or limited to a specific geographic area, over a period of time. The data may be exported in KML format to be viewed using GoogleEarth.

TS-SSP-FUN-3780/T

The System Performance shall plot filtered AIS data on map.

Trace from:
SR-SSP-FUN-0990
SR-SSP-FUN-1020
SR-SSP-FUN-1030

TS-SSP-FUN-3790/T

The System Performance shall export plot data to external KML 2.2 format.

Trace from:

- 2- The SAT-AIS System Performance module shall plot on a world map the latest vessels position, globally or limited to a specific geographic area, on a certain period. Only the last positions of the vessels on this period will be plot. It shall allow selecting and distinguishing the origin and type of the position (well received AIS message position, recovered AIS position, Doppler position, AIS position correlated with VDR).

TS-SSP-FUN-3800/T

The System Performance shall plot latest vessel position on map with different colours depending on AIS position origin.

Trace from:
SR-SSP-FUN-0990
SR-SSP-FUN-1030

- 3- The SAT-AIS System Performance module shall calculate the number of AIS messages received globally or limited to a specific geographic area, according to a longitude/latitude grid with user defined step and for a period of time, and plot this gridded distribution on a world map.

TS-SSP-FUN-3810/T

The System Performance shall plot the number of AIS message on user defined grid.

Trace from:
SR-SSP-FUN-0990
SR-SSP-FUN-1000



SR-SSP-FUN-1020

SR-SSP-FUN-1030

- 4- The SAT-AIS System Performance module shall calculate the percentage of Inconsistency flags raised globally or limited to a specific geographic area, according to a longitude/latitude grid with user defined step, and plot this gridded distribution on a world map. This representation shall allow making the distinction between the different inconsistency flags (L1_LENGTH, L1_THRESHOLDS, L1_FOOTPRINT, L1_VELOCITY). This percentage shall be obtained by dividing the number of inconsistent messages (i.e. marked with an inconsistency flag) by the number of messages processed (message with CRC correct).

Note: regarding the L1_THRESHOLDS flag, the number of messages processed to be considered must contain at least one of the parameters whose thresholds are controlled.

TS-SSP-FUN-3820/T

The System Performance shall plot the percentage of AIS inconsistent message on user defined grid.

Trace from:

SR-SSP-FUN-0990

SR-SSP-FUN-1000

SR-SSP-FUN-1020

SR-SSP-FUN-1030

- 5- The SAT-AIS System Performance module shall calculate the number of missing vessels warnings raised globally or on a specific area, according to a longitude/latitude grid with user defined step and for a period of time, and plot this gridded distribution on a world map.

TS-SSP-FUN-3830/T

The System Performance shall plot the percentage of AIS missing vessels warnings messages on user defined grid.

Trace from:

SR-SSP-FUN-0990

SR-SSP-FUN-1000

SR-SSP-FUN-1010

SR-SSP-FUN-1020

SR-SSP-FUN-1030

- 6- The SAT-AIS System Performance module shall calculate the timeliness distribution of the AIS messages received and processed by the DPC Block2, globally or limited to a specific geographic area and for a period of time. Different graphical outputs shall be available:
- Plot of the cumulative distribution function (timeliness wrt the percentage of number of messages);
 - Plot of bar charts (timeliness wrt the percentage of number of messages);
 - Representation of the timeliness as a gridded distribution on a world map, according to a longitude/latitude grid with user defined step. The plot shall display the average of the timeliness calculated for the messages in each cell of the grid.

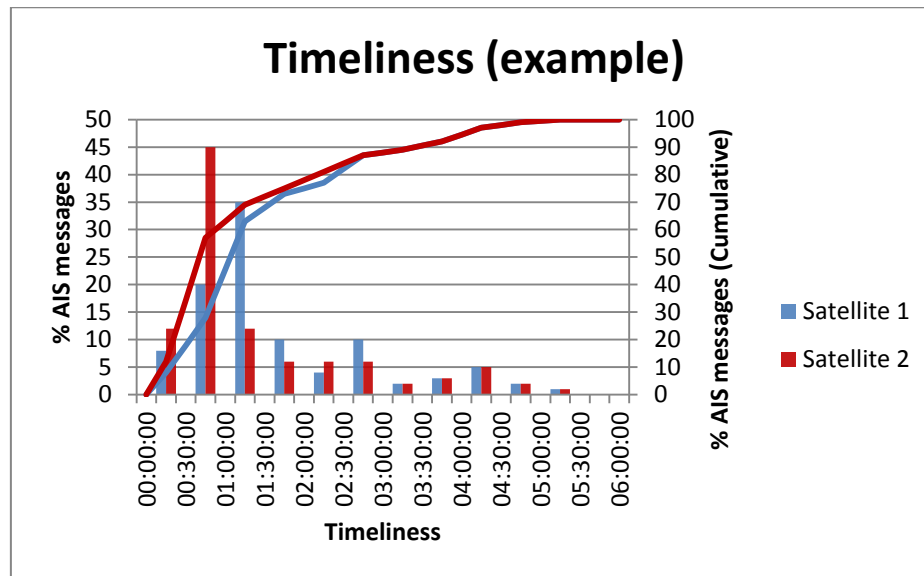


Figure 58 - Timeliness 2D plot example

TS-SSP-FUN-3840/T

The System Performance shall plot the timeliness distribution of the AIS messages on 2D plots and on user defined grid.

Trace from:

SR-SSP-FUN-0990

SR-SSP-FUN-1000

SR-SSP-FUN-1020

SR-SSP-FUN-1030

- 7- The SAT-AIS System Performance module shall calculate the time update interval distribution of the vessels, globally or limited to a specific geographic area and for a period of time. Different graphical outputs shall be displayed:
 - Plot of the cumulative distribution function (TUI wrt the percentage of number of vessels);
 - Plot of bar charts (TUI intervals wrt the percentage of number of vessels);
 - Plot of a spatio-temporal distribution on a gridded map: according to a predefined longitude/latitude sampling and for a period of time, the SAT-AIS System Performance module shall perform the average of the TUI calculated for the vessels in each cell of the gridded map.

TS-SSP-FUN-3850/T

The System Performance shall plot the time update interval distribution of the vessels on 2D plots and on user defined grid.

Trace from:

SR-SSP-FUN-0990

SR-SSP-FUN-1000

SR-SSP-FUN-1020

SR-SSP-FUN-1030

- 8- The SAT-AIS System Performance module shall calculate the percentage of AIS messages that were recovered during L2 processing, globally or limited to a specific geographic area, according to a longitude/latitude grid with user defined step, and plot this gridded distribution on a world map. This distribution shall allow distinguishing the type of recovery (L2_PREDICT_RECOVERY, L2_DOPPLER_RECOVERY). The percentage shall be obtained by



dividing the number of recovered L2 enhanced messages by the number of L1 invalid messages.

TS-SSP-FUN-3860/T

The System Performance shall plot the percentage of AIS messages recovered by prediction or Doppler on user defined grid.

Trace from:

SR-SSP-FUN-0990

SR-SSP-FUN-1000

SR-SSP-FUN-1020

SR-SSP-FUN-1030

- 9- The SAT-AIS System Performance module shall calculate the percentage of successful Doppler Position Calculations. This percentage shall be obtained by dividing the number of vessels successfully localized by Doppler by the number of vessels with Doppler data available in ancillary data.

TS-SSP-FUN-3870/T

The System Performance shall calculate and display the percentage of vessels localized by Doppler calculation.

Trace from:

SR-SSP-FUN-0990

SR-SSP-FUN-1000

SR-SSP-FUN-1020

SR-SSP-FUN-1030

- 10- The SAT-AIS System Performance module shall calculate the percentage of AIS messages confirmed by Doppler positions (integrity of the AIS position confirmed or invalidated thanks to Doppler positioning). This percentage shall be obtained by dividing the number of Doppler Position Integrity flags (OK or NOK) by the number of AIS Positions with Doppler calculation considered as successful.

TS-SSP-FUN-3880/T

The System Performance shall calculate and display the percentage of AIS message confirmed by Doppler calculation.

Trace from:

SR-SSP-FUN-0990

SR-SSP-FUN-1000

SR-SSP-FUN-1020

SR-SSP-FUN-1030

For the map representation, the user is allowed to adjust the scale as shown in the following image.

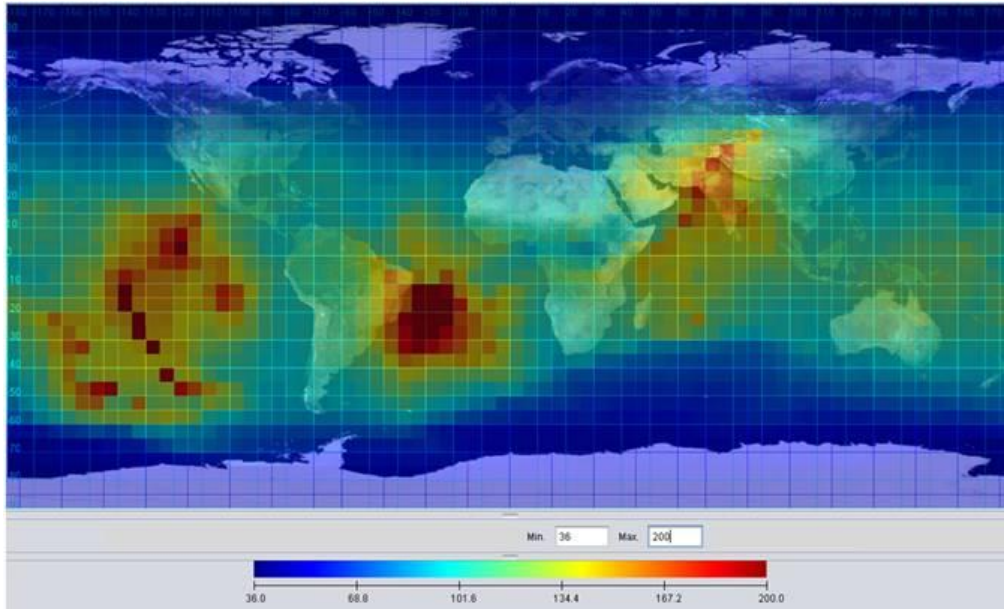


Figure 59 - AIS message density, with modifiable colour scale

TS-SSP-FUN-3890/T

The System Performance shall allow the user to change the minimum and maximum values of the scale.

Trace from:

6.14.1.2. “Log the activity” UC

The use case supplies the subsystem with the capability to store the activity in a log.

6.14.1.2.1. Context

The UC is independent and can be invoked at any time.

This UC is initiated by any other UCs who needs to keep track of their activities.

6.14.1.2.2. Interactions

The UC uses the Log actor as persistence means.

6.14.1.2.3. Pre-conditions

A significant event has occurred.

6.14.1.2.4. Description

The UC provides the means to carry in a single log all the activity of the subsystem. Each entry of that log is an event or a notable fact that is written in the log along with several attributes that characterizes it:

- Timestamp: the date and time on which the event has occurred;



- Severity: a value from the severity scale which expresses the significance of the event, including but not limited to the following: Error, Warning, Information;
- Context: a free text value referring to a context;
- Circumstance: Explicit and detailed description of the event.

TS-SSP-FUN-3900/T

The System Performance shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.

Trace from:

6.14.1.2.5. Post-conditions

The log is appended with one or several entries.

6.14.2. Performance requirements

S-AIS messages corresponding to a SAT-AIS database request can be large, especially for global statistics. The SAT-AIS System Performance must take care of resources consumed, especially the memory: memory consumption must remain the same whether the file is large or small.

TS-SSP-PER-3910/T

The System Performance shall keep the memory consumption constant, i.e. contained in a range of 10MB width, regardless of the size of the database request result.

Trace from:

6.14.3. Interface requirements

Not Applicable.

6.14.4. Operational requirements

To maintain a high level of control, the SAT-AIS System Performance stores in a log file a set of significant events that may be used by an operator to learn and understand the past activity.

TS-SSP-OPE-3920/T

The System Performance shall log the event of statistics processing completed with the information of: kind of plot, parameters.

Trace from:

6.14.5. Resources requirements

Not Applicable.

6.14.6. Design requirements and implementation constraints

The SAT-AIS System Performance is designed to allow the addition of new statistics computing and plotting.

**TS-SSP-DES-3930/T**

The System Performance shall provide a modular infrastructure accepting new statistics possibilities.

Trace from:
SR-DPC-DES-1920

The SAT-AIS System Performance is designed to be reusable so that it offers the possibility to store and replay statistics with parameters.

TS-SSP-DES-3940/T

The System Performance shall provide a serializable infrastructure saving parameters of calculation.

Trace from:
SR-DPC-DES-1920

TS-SSP-DES-3950/I

The System Performance shall be implemented using the Java Platform, Enterprise Edition 6 or higher.

Trace from:
SR-DPC-DES-2070

6.14.7. Security and privacy requirements

Not Applicable.

6.14.8. Portability requirements

Not Applicable.

6.14.9. Software quality requirements

Not Applicable.

6.14.10. Software reliability requirements

Not Applicable.

6.14.11. Software maintainability requirements

Not Applicable.

6.14.12. Software safety requirements

Not Applicable.

6.14.13. Software configuration and delivery requirements

Not Applicable.



6.14.14. Data definition and database requirements

Not Applicable.

6.14.15. Human factors related requirements

Not Applicable.

6.14.16. Adaptation and installation requirements

Not Applicable.

6.15. DPC Framework

The DPC Framework subsystem provides a set of services enabling the interaction and communication between mutually interacting software applications in Service Oriented Architecture (SOA).

In the DPC Block2 System frame, the DPC Framework is the backbone of the software architecture and allows the cooperation of all the subsystems and components.



6.15.1. Functional requirements

The following diagram details the use cases assumed by the subsystem.

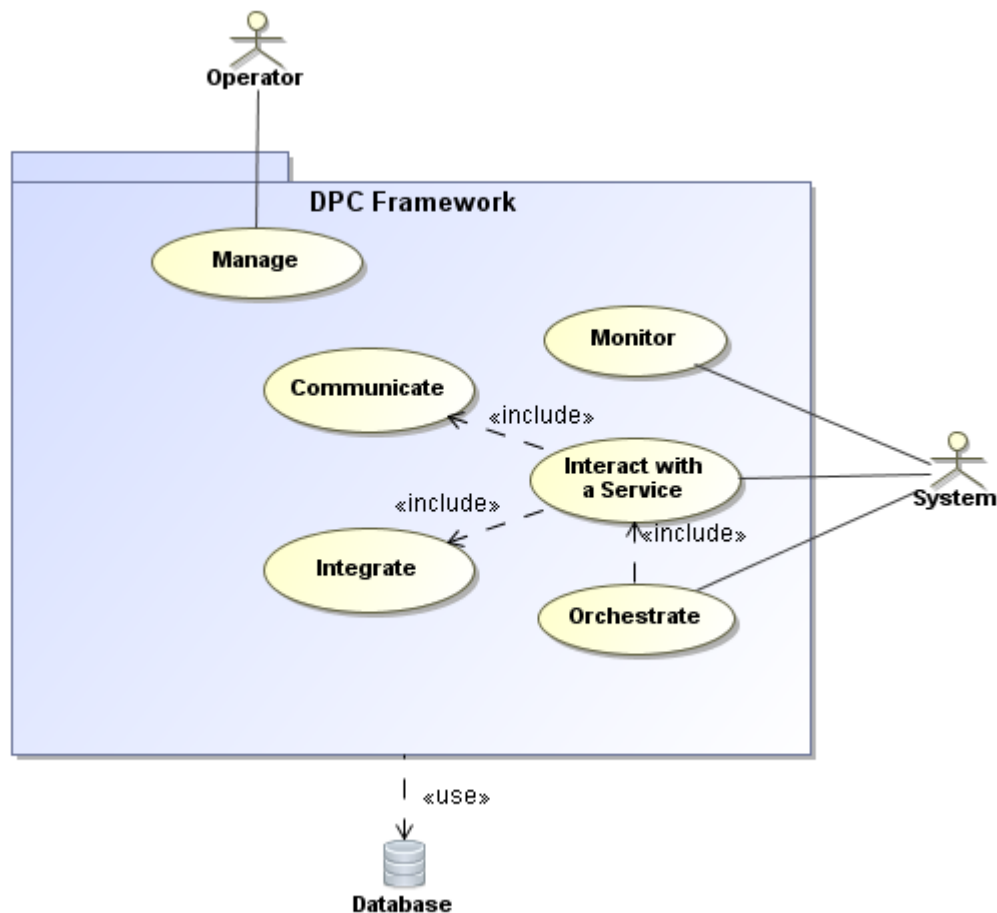


Figure 60 - Use Cases diagram for DPC Framework

This view unveils the minimal but required capabilities without going into details, inasmuch as the DPC Framework will be a Commercially Available Off-The-Shelf (COTS) ESB component.

TS-DCF-FUN-3960/I

The DPC Framework shall implement an Enterprise Service Bus (ESB) architecture.

Trace from:

SR-DPC-DES-1940

SR-DPC-DES-1910

SR-DPC-DES-1950

6.15.1.1. “Communicate” UC

The UC provides the subsystem with a communication layer through which service interactions is possible. This layer support communication through a variety of protocols and offers a set of functionalities like the message routing.



6.15.1.1.1. Context

The UC is independent and can be invoked at any time.

6.15.1.1.2. Interactions

The UC is initiated by the “Interact with a Service” UC.

6.15.1.1.3. Pre-conditions

Not Applicable.

6.15.1.1.4. Description

TS-DCF-FUN-3970/I

The DPC Framework shall provide the routing capability based on content message.

Trace from:

SR-PRO-FUN-0660

SR-PRO-FUN-0670

SR-DPC-DES-1910

TS-DCF-FUN-3980/I

The DPC Framework shall provide the synchronous and asynchronous messaging.

Trace from:

6.15.1.1.5. Post-conditions

Not applicable.

6.15.1.2. “Integrate” UC

The UC provides the subsystem with the capability of linking to a variety of systems that do not directly support service-style interactions, or for which a content transformation is necessary.

6.15.1.2.1. Context

The UC is independent and can be invoked at any time.

6.15.1.2.2. Interactions

The UC is initiated by the “Interact with a Service” UC.

6.15.1.2.3. Pre-conditions

Not Applicable.



6.15.1.2.4. Description

TS-DCF-FUN-3990/I

The DPC Framework shall provide the following XML processing (query and transformation) defined and recommended by the W3C: XPath 2.0, XSLT 1.0 & 2.0, XQuery 1.0.

Trace from:

SR-DPC-DES-2050
SR-DPC-DES-2040
SR-DPC-DES-2030
SR-PRO-FUN-0660
SR-PRO-FUN-0670

TS-DCF-FUN-4000/I

The DPC Framework shall provide message mediation based on sequences allowing message splitting and message aggregation.

Trace from:

SR-DPC-DES-1930

6.15.1.2.5. Post-conditions

Not Applicable.

6.15.1.3. “Interact with a Service” UC

The UC provides the subsystem with the capability to interact with a service via a proxy defined at the ESB level providing flexible reconfiguration, load balancing and fault tolerance.

6.15.1.3.1. Context

The UC is independent and can be invoked at any time.

6.15.1.3.2. Interactions

The UC is initiated by the System and eventually by any other UC of the subsystem.

6.15.1.3.3. Pre-conditions

Not Applicable.

6.15.1.3.4. Description

TS-DCF-FUN-4010/I

The DPC Framework shall provide the capability to interact with a service via a proxy service defined in the ESB.

Trace from:

TS-DCF-DES-4020/I

The DPC Framework shall support the following major Web Services standards: SOAP 1.1/SOAP 1.2, WSDL 1.1/WSDL 2.0, WS-Addressing 2005.



Trace from:
SR-DPC-DES-1970
SR-DPC-DES-2040
SR-DPC-DES-1950/I

6.15.1.3.5. Post-conditions

Not Applicable.

6.15.1.4. “Orchestrate” UC

The UC provides the subsystem with the capability of describing and processing the coordination and collaboration of Web Services.

It is used in the DPC Block2 to define a data processing chain, driven by event triggering, scheduling or a predefined sequence.

6.15.1.4.1. Context

The UC is independent and can be invoked at any time.

6.15.1.4.2. Interactions

6.15.1.4.3. Pre-conditions

6.15.1.4.4. Description

TS-DCF-FUN-4030/T

The DPC Framework shall provide the capability to execute business processes, a sequence of activities, triggered by events or by scheduling.

Trace from:
SR-DPC-FUN-0090
SR-DPC-DES-1910

6.15.1.4.5. Post-conditions

6.15.1.5. “Monitor” UC

6.15.1.5.1. Context

6.15.1.5.2. Interactions

6.15.1.5.3. Pre-conditions

6.15.1.5.4. Description

TS-DCF-FUN-4040/I

The DPC Framework shall provide a web based user interface console to monitor the activity.

Trace from:



6.15.1.5.5. Post-conditions

6.15.1.6. “Manage” UC

6.15.1.6.1. Context

6.15.1.6.2. Interactions

6.15.1.6.3. Pre-conditions

6.15.1.6.4. Description

TS-DCF-FUN-4050/I

The DPC Framework shall provide a web based user interface console to manage workflow processes and workflow instances.

Trace from:

TS-DCF-FUN-4060/T

The DPC Framework shall provide the capability to validate a WSDL file.

Trace from:

SR-DPC-DES-2030/I

6.15.1.6.5. Post-conditions

None

6.15.2. Performance requirements

Not applicable.

6.15.3. Interface requirements

Interface requirements are detailed in the ICD (RD 2)

6.15.4. Operational requirements

Not applicable.

6.15.5. Resources requirements

Not applicable.

6.15.6. Design requirements and implementation constraints

TS-DCF-FUN-4080/T

The DPC Framework shall provide the capability to execute WS-BPEL 2.0 business processes.



Trace from:
SR-DPC-DES-1910
SR-DPC-DES-2010
SR-DPC-REL-1880

6.15.7. Security and privacy requirements

TS-DCF-SEC-4090/T

The DPC Framework shall limit the access to the management console to authorized users.

Trace from:

6.15.8. Portability requirements

Not Applicable.

6.15.9. Software quality requirements

Software quality requirements are detailed in the Software Product Assurance Plan (AD 7)

6.15.10. Software reliability requirements

Not Applicable.

6.15.11. Software maintainability requirements

Software maintainability requirements are detailed in the Software Product Assurance Plan (AD 7).

6.15.12. Software safety requirements

Not Applicable.

6.15.13. Software configuration and delivery requirements

Not Applicable.

6.15.14. Data definition and database requirements

To ensure its own functioning, the DPC Framework needs to persist its data in a relational database.

TS-DCF-DAT-4100/I

The DPC Framework shall support PostgreSQL v9.1.x (or higher) and Oracle 11g Release 2 (or higher) database.

Trace from:



6.15.15. Human factors related requirements

Not applicable.

6.15.16. Adaptation and installation requirements

Not applicable.

6.16. Assumptions and considerations on existing and future SAT-AIS data

The DPC Block2 architecture and the system and subsystem requirements developed in the present SRS document are, as much as possible, independent of existing SAT-AIS data providers. The objective is to ensure the Block2 Demonstrator is scalable to the full operational DPC, that is to a system capable of handling large volumes of AIS data detected by future high performance SAT-AIS constellations.

Some assumptions have however been made, applying to existing and/or future SAT-AIS data.

1. Format of future SAT-AIS data: all existing SAT-AIS data providers deliver AIS data in a standardized "comment block + NMEA VDM sentence" format. This standardized format is described in reference documents RD 3 - RD 4 - RD 5, and further detailed for identified data providers in RD 2. Prior to their delivery by the SAT-AIS providers, data are processed and pre-validated at the ground station level, then formatted to the "comment block + NMEA VDM sentence" format when made available to the DPC Block2.

In the case of future SAT-AIS data, the assumption as been made that the same logic would apply, that is data would be pre-processed and de-collided at the ground station level, and "ready to process" AIS messages be delivered to Block2. RD 2 proposes an extension of the existing comment block tags that could be adopted by future SAT-AIS providers.

Another option could have been to consider that raw binary signals (as recorded onboard and received by the ground stations) would be acquired directly by the DPC Block2, and that sophisticated processing would be performed by Block2 to de-collide the signals. If such an option was to consider, then the Block2 architecture would need to be revised by adding an intermediate "L0 Processing" component, taking as input the raw binary signals acquired by the Data Retrieval, and providing as output AIS messages similar to the ones described above.

The impact on the Block2 architecture and design would then be limited. However the processing and storage capabilities would need to be re-assessed.

2. New AIS channels: one of the functional differences in future AIS system is that more channels will be used. Some of these will be dedicated to long-range AIS (SAT-AIS). The use of different frequencies and also different message transmission schemes will give different probabilities of detection depending on the channel used. This mostly impacts the SAT-AIS Simulator component of the Block2. The extension to new AIS channels is considered in the Simulator requirements of the present document.

A consequence is for the ancillary data (contained in the comment block section of the message) to include which AIS channel an AIS message has been received from.

For Doppler location processing, the Doppler shift information should also be coupled with the channel used as there could potentially be a difference in a vessels transmission frequency offset from the nominal frequencies. In a future system with more than one receiver/spacecraft delivering Doppler shift measurements, it is important also to keep track of the source as there is a potential for different frequency offset biases on the SAT-AIS receiver equipment.



The extension to new AIS channels is also considered in the Doppler Location Processing requirements of the present document.

3. Filtering of messages by SAT-AIS providers: if for some reason a filtering of AIS messages is performed before being delivered to the DPC Block2, i.e. due to limited downlink capacity from the space segment, the information should be included as auxiliary information as this may affect both the Block2 ability to do Doppler positioning and how the system handles missing messages.
4. Accuracy of time stamps: the detection time of the message (reception by the satellite) is provided as ancillary information to each SAT-AIS message. The accuracy of timestamp is most important for Doppler location calculation, as an uncertainty of 1 second may result in several kilometres of error on the Doppler position. An error may also lead to message rejection during L1 processing, because of validity checks that would not pass due to a time stamp error (e.g. velocity or satellite footprint control).

Hence, it is important that the accuracy of time stamp is clearly indicated in the ICD between the DPC Block2 and a SAT-AIS provider (existing or future).

6.17. Considerations for the selection of EO data

This section discusses briefly some possible functional and performance considerations for the selection of relevant EO data in support of the level 3 processing of SAT-AIS data, that need to be considered by the DPC Block2.

1. For a given area of interest (AOI), the DPC Block2 shall select EO datasets that are within a fixed time period of available SAT-AIS data. Depending on the ship traffic situation in the AOI the following restrictions should apply:
 - In high density ship traffic areas (shipping lanes, approaches to ports, fishing areas, etc.) the EO data acquisition should be within 15 minutes of a SAT-AIS acquisition covering the area of the EO data. I.e. if a SAT-AIS acquisition takes place from T1 to T2 the EO data acquisition should not be earlier than T1-15 minutes but not later than T2+15 minutes.
 - In open ocean areas the EO data acquisition should be within 30 minutes of a SAT-AIS acquisition covering the area of the EO data. I.e. if a SAT-AIS acquisition takes place from T1 to T2 the EO data acquisition should not be earlier than T1-30 minutes but not later than T2+30 minutes.
2. Block2 should select EO data that has been acquired with an imaging mode suitable to detect ships carrying AIS, i.e. the resolution and/or polarisation of the EO data should be adequate to detect ships in the AOI. It is important that the EO data provides VDR records with a low rate of false alarms, as it should be avoided that a correlation match is done with a false target (noise).
3. In addition to being quite expensive, the coverage of EO data is typically much less than that of the footprint of a SAT-AIS sensor. Hence, care should be taken when planning EO data acquisitions. These should be carefully planned for areas where the expected value is the highest, i.e. areas where the need to validate AIS targets are the highest (e.g. where AIS-spoofing is known to be happening). This also applies to the update frequency of the EO data.

Also, in general, tasking EO data within 72 hours of the actual acquisition is quite expensive as this normally induces hefty extra tasking fees. Hence this should be avoided as much as possible.



4. For the DPC Block2 to be an operational system the EO data and VDRs should be available in Near Real-Time (NRT), i.e. within 30-60 minutes after the EO data has been acquired by the satellite, so that timeliness of EO data is comparable to the timeliness of SATAIS data. Any on-board storage of the data before downlink, processing and analysis will add to this delay.

Thus, the selection EO data and providers shall concentrate on EO providers having distribution agreements EO satellite operators and ground station receiving/processing equipment allowing for NRT EO data delivery.

7. Validation requirements

The validation approach of the requirements defined in the present SRS will be detailed in each subsystem SVP and SVS documents.

8. Traceability

See traceability matrices in Appendix C and D.



Appendix A - List of acronyms

AD	Applicable Document
AIS	Automatic Identification System
AOI	Area of Interest
BPEL	Business Process Execution Language
BPMN	Business Process Model and Notation, a graphical representation for specifying business workflows.
CRC	Cyclic Redundancy Check
COTS	Commercially Available Off-The-Shelf
DB	Database
DLP	Doppler Location Processing
DPC	Data Processing Centre
EO	Earth Observation (radar or optical images)
ESB	Enterprise Serial Bus
ETA	Estimated Time of Arrival
FTP	File Transfer Protocol
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
ITDMA	Incremental Time Division Multiple Access
JMX	Java Management Extensions, a Java technology that supplies tools for managing and monitoring applications.
KML	Keyhole Markup Language
KPI	Key Performance Indicator
MMSI	Maritime Mobile Service Identity
NAS	Network Attached Storage
NRT	Near Real Time
OGC	Open Geospatial Consortium
RD	Reference Document
SOTDMA	Self Organizing Time Division Multiple Access
S-AIS	Satellite AIS (data collection of AIS messages by satellites)
TBC	To be confirmed
TBD	To be defined



TLE	Two-Line Elements
TLS	Transport Layer Security
UC	Use Case
UML	Unified Modeling Language, a standardized general-purpose modeling language in the field of object-oriented software engineering.
XML	eXtensible Markup Language
XSLT	Extensible Stylesheet Language Transformations
WS-*	Web Services (W3C)



Appendix B - Requirements table

Identifier	Description
TS-DRT-FUN-0005/I	Data Retrieval shall support the communication protocols commonly used by SAT-AIS and EO data providers (FTP/SFTP, Socket (TCP/UDP), Web Services, JMS).
TS-DRT-FUN-0010/T	The Data Retrieval shall retrieve remote content with no assumption on the nature of the information retrieved.
TS-DRT-FUN-0020/T	The Data Retrieval shall be able to authenticate to the remote system with a configured username/password pair.
TS-DRT-FUN-0030/T	The Data Retrieval shall be able to authenticate to the remote system with a client certificate.
TS-DRT-FUN-0040/T	The Data Retrieval shall poll for new available data in a configured fixed delay or fixed rate.
TS-DRT-FUN-0050/T	The Data Retrieval shall include the remote available files matching a configured regular expression.
TS-DRT-FUN-0060/T	The Data Retrieval shall exclude remote available files matching a configured regular expression.
TS-DRT-FUN-0070/T	The Data Retrieval shall be able to look for files recursively in all the sub-directories, if it is configured as such.
TS-DRT-FUN-0080/T	The Data Retrieval shall store retrieved data in a configured local directory.
TS-DRT-FUN-0085/T	The Data retrieval shall produce data files containing AIS messages coming from a unique satellite.
TS-DRT-FUN-0090/T	The Data Retrieval shall use a configured naming scheme, including original file name, extension, data and timestamp, to name stored files.
TS-DRT-FUN-0100/T	The Data Retrieval shall be able to delete the retrieved files on the remote system.
TS-DRT-FUN-0110/T	The Data Retrieval shall be able to move the retrieved files on the remote system according a configured naming scheme.
TS-DRT-FUN-0120/T	The Data Retrieval shall wait for a configured amount of time before automatically perform a reconnection to a Data Provider.
TS-DRT-FUN-0130/T	The Data Retrieval shall stop the retrieval activity for a Data Provider if the number of reconnect attempts has crossed a configured ceil.
TS-DRT-FUN-0140/T	The Data Retrieval shall send the notification of a successfully retrieved data.
TS-DRT-FUN-0150/T	The Data Retrieval shall send a notification about a successfully retrieved data with the following information: unique identifier, URL to the data file, name of the Data Provider, original creation date, stored creation date, data media-type, data size.
TS-DRT-FUN-0160/T	The Data Retrieval shall delay failed notifications for a configured amount of time.
TS-DRT-FUN-0170/T	The Data Retrieval shall delete unsent notifications that are older than a configured delay.
TS-DRT-FUN-0180/T	The Data Retrieval shall allow the management (declaration, modification, deletion) of an unbounded set of Data Providers.
TS-DRT-FUN-0190/T	The Data Retrieval shall allow the modification of the system recipient of the



Identifier	Description
	published data.
TS-DRT-FUN-0200/T	The Data Retrieval shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.
TS-DRT-PER-0205/T	The Data retrieval shall retrieve and publish a new data flow of AIS messages in less than 30 seconds for a volume of 10000 AIS messages.
TS-DRT-PER-0210/T	The Data Retrieval shall keep the memory consumption constant, i.e. contained in a range of 10MB width, regardless of the size of the retrieved file.
TS-DRT-PER-0220/T	The Data Retrieval shall accept a number of configured simultaneous retrieval by provider.
TS-DRT-PER-0230/T	The Data Retrieval shall not send two consecutive data notifications in a time shorter than a configured period.
TS-DRT-OPE-0240/T	The Data Retrieval shall log the event of a successful connection to a Data Provider with the information of: Data Provider name, Data Provider URL, duration time.
TS-DRT-OPE-0250/T	The Data Retrieval shall log the event of a successful retrieval activity with the information of: Data Provider name, Data Provider URL, remote file location, local file location, file size, duration time.
TS-DRT-OPE-0260/T	The Data Retrieval shall log the event of a successful publication activity with the information of: Recipient URL, list of file names.
TS-DRT-OPE-0270/T	The Data Retrieval shall log all fail events: network error, authentication error, file retrieval error, publication failure, with the appropriate severity and the most detailed information.
TS-DRT-OPE-0280/T	The Data Retrieval shall log all the notifications that have been removed because of age.
TS-DRT-OPE-0290/T	The Data Retrieval shall provide the cumulative number of successful and failed data retrieved for each provider.
TS-DRT-OPE-0300/T	The Data Retrieval shall provide the date and time of the last successful retrieved data and last failed retrieved data for each provider.
TS-DRT-OPE-0310/T	The Data Retrieval shall provide the min, max and mean time of data retrieval for each provider.
TS-DRT-OPE-0320/T	The Data Retrieval shall provide the number of successful and failed published data.
TS-DRT-OPE-0330/T	The Data Retrieval shall provide the date and time of the last successful published data and last failed published data.
TS-DRT-OPE-0340/T	The Data Retrieval shall provide the min, max and mean time taken to publish data.
TS-DRT-OPE-0350/T	The Data Retrieval shall provide the current memory used.
TS-DRT-DES-0360/T	The Data Retrieval shall provide a pluggable infrastructure accepting new "poll" strategies.
TS-DRT-DES-0370/T	The Data Retrieval shall provide a pluggable infrastructure accepting new naming strategies for stored files.
TS-DRT-DES-0380/T	The Data Retrieval shall provide a pluggable infrastructure accepting new retrieval protocols.
TS-DRT-DES-0390/I	The Data Retrieval shall be implemented using the Java Platform, Enterprise Edition 7 or higher.



Identifier	Description
TS-DRT-DES-0400/T	The Data Retrieval shall automatically reconnect to providers if the link is lost.
TS-DRT-DES-0410/T	The Data Retrieval shall persist the information of a successfully retrieved data that is ready to be published.
TS-DRT-CFG-0420/T	The Data Retrieval shall define the configuration of a Data Provider by the name (unique), the URL (including the protocol) and the mime-type of the data delivered by the Data Provider.
TS-DRT-CFG-0430/T	The Data Retrieval shall define the configuration of the System recipient of the published data by the URL.
TS-DRT-CFG-0440/T	The Data Retrieval shall define the configuration of the log with the flowing items: level of severity, location (directory and naming scheme) of the log file.
TS-PL1-FUN-0450/T	The L1 Processing shall process raw S-AIS Messages, along with ancillary data, to generate decoded XML L1 AIS Messages.
TS-PL1-FUN-0460/T	The L1 Processing shall control the CRC of raw AIS-Messages and the checksum of all retrieved ancillary data, if relevant.
TS-PL1-FUN-0470/T	The L1 Processing shall check the length of raw AIS-Messages according to its (decoded) type.
TS-PL1-FUN-0480/T	The L1 Processing shall check the consistency of raw AIS-Messages according to the admissible values of each field.
TS-PL1-FUN-0490/T	The L1 Processing shall check a reported position of L1 position messages (type 1, 2 and 3) are inside the satellite footprint.
TS-PL1-FUN-0500/T	The L1 Processing shall admit a configured tolerance for the Satellite footprint check that extends the satellite visibility.
TS-PL1-FUN-0510/T	The L1 Processing shall check the reported position of L1 position messages (type 1, 2 and 3) leads to a computed average speed from the previous reported position (of the same ship) lower than a configured threshold.
TS-PL1-FUN-0520/T	The L1 Processing shall allow the enabling or disabling of the following advanced AIS-Message verifications: Satellite footprint check, Ship velocity check.
TS-PL1-FUN-0530/T	The L1 Processing shall allow the configuration of the AIS-message checks.
TS-PL1-FUN-0540/T	The L1 Processing shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.
TS-PL1-PER-0545/T	The L1 Processing shall process and publish the results of a single data flow in less than 3 minutes for a volume of 10000 AIS messages.
TS-PL1-PER-0550/T	The L1 Processing shall keep the memory consumption constant, i.e. contained in a range of 10MB width, regardless of the size of the processed file.
TS-PL1-OPE-0560/T	The L1 Processing shall log the event of the start of the activity with the information of: path of the raw messages file, size of the file.
TS-PL1-OPE-0570/T	The L1 Processing shall log the event of the end of the activity with the information of: path of the raw messages file, processing duration time, number of messages processed, number of valid messages, number of failed messages.
TS-PL1-OPE-0580/T	The L1 Processing shall provide the cumulative number of valid and invalid raw messages processed.



Identifier	Description
TS-PL1-OPE-0590/T	The L1 Processing shall provide the cumulative number of valid raw messages for each type of AIS message.
TS-PL1-OPE-0600/T	The L1 Processing shall provide the date and time of the last L1 processing.
TS-PL1-OPE-0610/T	The L1 Processing shall provide the min, max and mean time taken to process a file of raw messages.
TS-PL1-OPE-0620/T	The L1 Processing shall provide the current memory used.
TS-PL1-DES-0630/T	The L1 Processing shall provide a modular infrastructure accepting new S-AIS Messages verifications.
TS-PL1-DES-0640/T	The L1 Processing shall provide a modular infrastructure accepting new S-AIS Messages types.
TS-PL1-DES-0650/I	The L1 Processing shall be implemented using the Java Platform, Enterprise Edition 7 or higher.
TS-PL1-CFG-0660/I	The L1 Processing shall consider the size boundary of the AIS messages for all the message types as configurable parameters.
TS-PL1-CFG-0670/I	The L1 Processing shall consider the configurable parameter “tolerance” that extends the satellite visibility during the Satellite footprint check.
TS-PL1-CFG-0680/I	The L1 Processing shall consider the configurable parameter “maximum velocity” that defines the speed threshold above which the Ship Velocity check fails.
TS-PL2-FUN-0690/T	The L2 Processing shall perform the correlation of reported positions in the AIS Position Reports that consists in comparing the computed position and the reported one.
TS-PL2-FUN-0700/T	The L2 Processing shall take into account the uncertainty on the Doppler location when performing the Doppler correlation.
TS-PL2-FUN-0705/T	The L2 Processing shall produce L2 AIS Position Reports for those whose Doppler location is calculated with a sufficient configured quality.
TS-PL2-FUN-0710/T	The L2 Processing shall store the result of the Doppler correlation in the L2 AIS Position Report with a value denoting that the reported position is consistent.
TS-PL2-FUN-0715/T	The L2 Processing shall admit a configured threshold for defining if a Doppler location is reliable or not.
TS-PL2-FUN-0718/T	The L2 Processing shall perform, for invalid AIS positions, the prediction of the position by extrapolation of the last known location knowing its speed and heading or by interpolation of two consecutive locations.
TS-PL2-FUN-0720/T	The L2 Processing shall produce L2 AIS Position Reports which is the replacement of the invalid reported position in the AIS Message by the best recovered one (i.e. the best quality), if it has a sufficient configured quality.
TS-PL2-FUN-0730/T	The L2 Processing shall store for invalid L1 AIS messages together with a reliable predicted position, the success of the recovery with the method used for the recovery and the uncertainty.
TS-PL2-FUN-0760/T	The L2 Processing shall admit a configured threshold for defining if a Predicted Position is reliable or not.
TS-PL2-FUN-0770/T	The L2 Processing shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.
TS-PL2-OPE-0780/T	The L2 Processing shall log the event of the start of the activity.



Identifier	Description
TS-PL2-OPE-0790/T	The L2 Processing shall log the event of the end of the activity with the information of: processing duration time, number of processed messages, number of correlated messages, number of recovered messages.
TS-PL2-OPE-0800/T	The L2 Processing shall provide the cumulative number of correlated AIS messages positions processed.
TS-PL2-OPE-0810/T	The L2 Processing shall provide the cumulative number of recovered AIS messages positions processed.
TS-PL2-OPE-0820/T	The L2 Processing shall provide the date and time of the last L2 processing.
TS-PL2-OPE-0830/T	The L2 Processing shall provide the min, max and mean time taken to process a set of L1 messages.
TS-PL2-OPE-0840/T	The L2 Processing shall provide the current memory used.
TS-PL2-DES-0850/I	The L2 Processing shall be implemented using the Java Platform, Enterprise Edition 7 or higher.
TS-PL2-CFG-0860/I	The L2 Processing shall consider the configurable parameter “predicted reliability threshold” with which a predicted position can be estimated good or not.
TS-PL3-FUN-0870/I	The L3 Processing shall perform the correlation of S-AIS reported positions with VDRs derived from EO images.
TS-PL3-FUN-0880/I	The L3 Processing shall maintain the relationship between the AIS message correlated and the VDRs.
TS-PL3-FUN-0890/T	The L3 Processing shall store the result of the EO correlation in the AIS messages with a value denoting that the reported position has been confirmed.
TS-PL3-FUN-0900/T	The L3 Processing shall store reliability indicator of the correlation result in the AIS messages.
TS-PL3-FUN-0910/T	The L3 Processing shall admit a configured threshold for defining if an EO correlation matches or not.
TS-PL3-FUN-0920/T	The L3 Processing shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.
TS-PL3-OPE-0930/T	The L3 Processing shall log the event of the start of the activity.
TS-PL3-OPE-0940/T	The L3 Processing shall log the event of the end of the activity with the information of: processing duration time, number of messages processed, number of correlated messages, number of inconsistent correlated messages.
TS-PL3-OPE-0950/T	The L3 Processing shall provide the cumulative number of correlated AIS messages positions processed.
TS-PL3-OPE-0960/T	The L3 Processing shall provide the cumulative number of inconsistent correlated AIS messages positions processed.
TS-PL3-OPE-0970/T	The L3 Processing shall provide the date and time of the last L3 processing.
TS-PL3-OPE-0980/T	The L3 Processing shall provide the min, max and mean time taken to process a set of messages.
TS-PL3-OPE-0990/T	The L3 Processing shall provide the current memory used.
TS-PL3-DES-1000/I	The L3 Processing shall be implemented using the Java Platform, Enterprise Edition 7 or higher.
TS-DLP-FUN-1010/I	The Doppler Location Processor shall perform the calculation of the Doppler Location of ships using Doppler shift measurements detected by SAT-AIS satellites during a pass.



Identifier	Description
TS-DLP-FUN-1012/T	For each Doppler position calculated, the Doppler Location Processor shall provide an estimate of the latitude/longitude and transmission frequencies of the AIS transceiver onboard the ship.
TS-DLP-FUN-1020/T	The Doppler Location Processor shall be initialized using the Doppler “history” of ships, that is for each ship the previous Doppler position calculated and the estimated frequencies for each AIS channels.
TS-DLP-FUN-1022/T	In case the age of the previous Doppler history calculated for a ship shall is greater than a predefined value, or if no previous Doppler history is available in the system, then the Doppler Processor shall be initialized using the average GPS position of the ship obtained from the AIS position messages.
TS-DLP-FUN-1025/T	In order to be usable, the date of the last Doppler history for a ship shall be strictly anterior to the date of new Doppler shift measurements. If not, the Doppler Processor shall be re-initialized and no Doppler location is computed.
TS-DLP-FUN-1030/T	The initialization shall sort the Doppler shift measurements by ship and by chronological order to facilitate the Doppler position calculation. In case of duplicate measurements for the same ship, the initialization shall select the most reliable one.
TS-DLP-FUN-1035/T	The Doppler Location Processor shall use Kalman filtering.
TS-DLP-FUN-1040/T	The Doppler Location Processor shall provide two dynamics models: a fixed position model and a random walk model.
TS-DLP-FUN-1050/T	The Doppler Location Processor shall use a multiple-model filter based on a bank of Unscented Kalman filters.
TS-DLP-FUN-1060/T	The Doppler Location Processor shall combine several Doppler shift measurements for the same ship and the same satellite pass over the ship, in order to provide the best estimate of the ship position.
TS-DLP-FUN-1070/T	The Doppler Location Processor shall perform a location computation only if the number of measurements for a vessel and for a satellite pass is greater than a predefined minimum message number.
TS-DLP-FUN-1080/T	The Doppler Location Processor shall state to the caller that the processing has ended successfully, has failed with no locations computed or has been partially completed.
TS-DLP-FUN-1090/T	The Doppler Location Processor shall consider as valid a location computed by the multiple-model filter if the following two assertions are true: the distance between the previous computed location and the current computed location is smaller than the ship maximum speed multiplied by the time elapsed since the last computed location, and the difference between the previous computed transmission frequency and the current transmission frequency is smaller than a predefined maximum difference.
TS-DLP-FUN-1100/T	The Doppler Location Processor shall only provide the computed locations that are characterized as valid.
TS-DLP-FUN-1105/T	The valid Doppler location and estimated frequencies shall be used to update the Doppler history of the ships, so that it can be used for the Doppler processing of the next set of measurements received from SAT-AIS data providers.
TS-DLP-FUN-1110/T	The Doppler Location Processor shall provide an indicator of the Doppler location reliability as an ellipse of error.



Identifier	Description
TS-DLP-FUN-1120/T	The Doppler ellipse of error associated to each calculated Doppler location shall be representative of the quality of the input data: accuracy and number Doppler measurements, stability of the AIS oscillator, time stamp of measurement and accuracy of satellite orbit modelization.
TS-DLP-FUN-1125/T	The Doppler Location Processor shall allow for the configuration of the Doppler location processing.
TS-DLP-FUN-1130/T	The Data Location Processor shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.
TS-DLP-PER-1140/T	The Doppler Location Processor shall compute Doppler Locations within 10 minutes after submission of a data set to the Doppler calculation module. A data set corresponds to all data received by a ground station for a satellite downlink (partial or entire orbit).
TS-DLP-OPE-1160/T	The Doppler Location Processor shall log that an invalid input (incorrect format, invalid values) has been submitted, accompanied by the most accurate and detailed information about the nature of the error.
TS-DLP-OPE-1170/T	The Doppler Location Processor shall copy the full context of a Doppler processing that failed, in a configured location in the file system.
TS-DLP-DES-1180/I	The Doppler Location Processor shall be implemented using the Java Platform, Enterprise Edition 7 or higher.
TS-DLP-CFG-1190/T	The Doppler Location Processor shall define the configuration of the Doppler processing with the following items: Maximum difference between the previous computed transmission frequency and the current transmission frequency, the maximum elapsed location time, the minimum message number
TS-DLP-CFG-1200/T	The Data Location Processor shall define the configuration of the log with the following items: level of severity, location (directory and naming scheme) of the log file.
TS-DIS-FUN-1210/T	The Data Distribution shall display a connection page to anonymous users.
TS-DIS-FUN-1220/T	The Data Distribution shall display to the anonymous user the causes of the log in failure.
TS-DIS-FUN-1230/T	The Data Distribution shall limit the number of log in attempts to a configurable value.
TS-DIS-FUN-1240/T	The Data Distribution shall provide to the user a mean to cancel the log in procedure.
TS-DIS-FUN-1250/T	The Data Distribution shall recognize a user as authenticated if the login/password pair is confirmed.
TS-DIS-FUN-1260/T	The Data Distribution shall provide to the authenticated user a mean to log out from the Web Display.
TS-DIS-FUN-1270/T	The Data Distribution shall close a user session if the user inactivity is longer than a configured duration.
TS-DIS-FUN-1280/T	The Data Distribution shall restrict the access to the Data Distribution display to authenticated and authorized users only.
TS-DIS-FUN-1290/T	The Data Distribution shall provide a Web based application accessible from outside Block-2 infrastructure.
TS-DIS-FUN-1300/T	The Data Distribution shall display the content of all AIS messages into a tabular format so that it is readable by a human user.



Identifier	Description
TS-DIS-FUN-1301/T	The Data Distribution shall allow the user to perform searches on the AIS messages displayed and stored. The search results will be limited to a configurable number.
TS-DIS-FUN-1310/T	The Data Distribution shall display the ships positions (including the corresponding accuracy) in a tabular format
TS-DIS-FUN-1320/T	The Data Distribution shall display the historical and predicted visibility of a SAT-AIS Satellite by a ground station.
TS-DIS-FUN-1330/T	The Data Distribution shall display on the world map the satellite positions at a given time.
TS-DIS-FUN-1340/T	The Data Distribution shall display on the world map the satellite ground track at a given time.
TS-DIS-FUN-1350/T	The Data Distribution shall display on the world map the satellite coverage area (footprint) at a given time (past or in the near future).
TS-DIS-FUN-1360/T	The Data Distribution shall display on the world map the ground station position and visibility area.
TS-DIS-FUN-1370/T	The Data Distribution shall display multiple vessels in the world map based on their latest known position.
TS-DIS-FUN-1380/T	The Data Distribution shall display the historic and predicted route of the vessels in the world map. The historic AIS messages shall also be displayed using different symbols according to the message type.
TS-DIS-FUN-1381/T	The Data Distribution shall allow the user to search for a vessel based on input criteria such as Origin, Destination, IMO, MMSI, Name or Date. When selecting any results for the query result the vessel shall be highlighted on the map.
TS-DIS-FUN-1400/T	The Data Distribution shall display the Earth Coverage of a S-AIS Satellite (footprint).
TS-DIS-FUN-1420/T	The Data Distribution shall present the vessel information when the user clicks on the selected ship in the world map.
TS-DIS-FUN-1430/T	The Data Distribution shall display data timeliness, time update interval and Doppler positions maps based on ships selected by the user on the world map.
TS-DIS-FUN-1450/T	The Data Distribution Service shall display warnings and alerts generated by Block-2 Processing for the following cases: Unexpected interruption of AIS messages, reconstruction of an AIS message, invalid AIS message.
TS-DIS-FUN-1460/T	The Data Distribution shall display the status of a ground station when receiving signal from a satellite.
TS-DIS-FUN-1471/T	The Data Distribution shall allow the user to search for the different types of AIS messages on the tabular display using input criteria such as date, ship id, geographic area, message type. The search results will be limited to a configurable number.
TS-DIS-FUN-1472/T	The Data Distribution shall provide a sort mechanism on all tabular data displays.
TS-DIS-FUN-1476/T	Data Distribution shall interface with EMSA Block3 for the distribution of SAT-AIS messages through EMSA JMS interfaces.
TS-DIS-FUN-1480/T	The Data Distribution shall distribute the outputs of the Block2 processing.
TS-DIS-FUN-1490/T	The Data Distribution shall distribute the L1 AIS messages data.



Identifier	Description
TS-DIS-FUN-1500/T	The Data Distribution shall distribute AIS messages using the following standard formats: IEC standard 61162-1 (NMEA 0183), ITU-R M 1371-1, IEC 62320-1 or NMEA 0183 v4.0 (tag block), EMSA CDF.
TS-DIS-FUN-1510/T	The Data Distribution shall distribute Alerts related to missing AIS messages (no AIS messages are received from a ship over one or several expected contact periods).
TS-DIS-FUN-1520/T	The Data Distribution shall distribute enhanced AIS messages.
TS-DIS-FUN-1530/T	The Data Distribution shall distribute AIS messages correlated with EO data.
TS-DIS-FUN-1540/T	The Data Distribution shall distribute EO derived data (VDR).
TS-DIS-FUN-1550/T	The Data Distribution shall distribute orbital data and satellites/ground stations events information.
TS-DIS-FUN-1560/T	The Data Distribution shall provide Warnings when the satellite fails to receive or forward AIS data to the ground stations.
TS-DIS-FUN-1561/T	The Data Distribution shall be able to distribute the raw SAT-AIS data immediately after being received by Block2. This data will be delivered to the users that subscribed the service.
TS-DIS-FUN-1570/T	The Data Distribution Service shall use of the EMSA JMS to distribute AIS messages (decoded, enhanced, correlated or reconstructed) to EMSA Block3.
TS-DIS-FUN-1580/T	The Data Distribution Service shall use of the CSN SFTP interface to distribute EO Data to EMSA Block3.
TS-DIS-FUN-1590/T	The Data Distribution Service shall use a WS-* SOAP messaging protocol v1.1 or v1.2 to distribute data to the External Application Centre.
TS-DIS-FUN-1600/T	The Data Distribution Service shall use an asynchronous protocol to distribute data to the External Application Centre.
TS-DIS-FUN-1610/T	The Data Distribution shall delay failed deliveries for a configured amount of time.
TS-DIS-FUN-1620/T	The Data Distribution shall prevent the distribution of data older than a configured delay.
TS-DIS-FUN-1630/T	The Data Distribution shall allow the External Application Centre to query for AIS messages (normal, reconstructed, correlated) and associated ancillary data.
TS-DIS-FUN-1640/T	The Data Distribution shall allow the External Application Centre to query for SAT-AIS satellites data.
TS-DIS-FUN-1650/T	The Data Distribution shall allow the External Application Centre to query for EO VDRs.
TS-DIS-FUN-1660/T	The Data Distribution shall allow the External Application Centre to query for Level 1 images.
TS-DIS-FUN-1670/T	The Data Distribution shall allow the External Application Centre to query for warnings and alerts.
TS-DIS-FUN-1680/T	The Data Distribution shall allow the External Application Centre to query for predicted AIS messages.
TS-DIS-FUN-1690/T	The Data Distribution shall allow the External Application Centre to query for the latest information for a ship including, if available: identifier, MMSI, IMO number, call sign, country, vessel name, dimension to bow, dimension to stern, dimension to starboard, type, ETA at destination, draught, destination, DTE and last known position (dated).



Identifier	Description
TS-DIS-FUN-1700/T	The Data Distribution shall accept requests for data with the following selection criteria: Time interval, given Fleet or Vessel, specific AIS Message Type, specific Level of Data enhancement.
TS-DIS-FUN-1710/T	The Data Distribution shall restrict the access on the user management interface to authenticated users with appropriate rights.
TS-DIS-FUN-1720/T	The Data Distribution shall provide for the operator the capability to perform through a Web Display the user management and administration of the users.
TS-DIS-FUN-1730/T	The Data Distribution shall allow the Operator to create a user account given a user name, an e-mail address.
TS-DIS-FUN-1740/T	The Data Distribution shall allow the Operator to edit (and update) an existing user account.
TS-DIS-FUN-1741/T	The Data Distribution shall allow any Operator to recover the password of his account.
TS-DIS-FUN-1750/T	The Data Distribution Service shall acknowledge user identities with a user password or a digital certificate issued by EMSA Block3.
TS-DIS-FUN-1760/T	The Data Distribution shall allow the Operator to remove an already declared user account.
TS-DIS-FUN-1770/T	The Data Distribution shall warn the Operator about the deletion of a user and prompt him to confirm his intention.
TS-DIS-FUN-1780/T	The Data Distribution shall send an e-mail to the e-mail address associated to the user account for each account change with the updated account information.
TS-DIS-FUN-1790/T	The Data Distribution shall provide for the Operator the capability to manage the rights granted to users in the data access.
TS-DIS-FUN-1800/T	The Data Distribution shall provide for the Operator the capability to grant an access right to a user.
TS-DIS-FUN-1810/T	The Data Distribution shall provide for the Operator the capability to revoke an access right from a user.
TS-DIS-FUN-1820/T	The Data Distribution shall provide for the Operator the capability to grant the access to the following kind of data: AIS Messages (and associated ancillary data), Auxiliary data, Alerts, VDRs, Images, Ship properties.
TS-DIS-FUN-1830/T	The Data Distribution shall provide for the Operator the capability to edit a granted right
TS-DIS-FUN-1840/T	The Data Distribution shall provide for the Operator the capability to grant the access to an AIS Message depending on the message type, the level of processing, the ship identifier, the geographic zone for position reports, the time window.
TS-DIS-FUN-1850/T	The Data Distribution shall provide for the Operator the capability to grant the access to an Alert message depending on the alert severity and alert domain.
TS-DIS-FUN-1861/T	The Data Distribution shall allow authorized users to configure the Block2 specific Web Display parameters.
TS-DIS-FUN-1860/T	The Data Distribution shall allow authorized users to configure through a Web Display the Block-3 data distribution parameters.
TS-DIS-FUN-1870/T	The Data Distribution shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.



Identifier	Description
TS-DIS-PER-1875/T	The Data Distribution shall start the distribution of incoming L1 process data flows to EMSA Block3 in less than 1 minute for a volume of 10000 AIS messages.
TS-DIS-PER-1880/T	The Data Distribution shall keep the memory consumption constant, i.e. contained in a range of 10MB width, regardless of the size of the distributed data.
TS-DIS-PER-1890/T	The Data Retrieval shall accept a number of configured simultaneous distributions by external client.
TS-DIS-PER-1900/T	The Data Distribution shall not send two consecutive data distribution in a time shorter than a configured period.
TS-DIS-OPE-1910/T	The Data Distribution, documentation and test products shall be considered Operational Software (ESA IPR).
TS-DIS-OPE-1920/T	The Data Distribution shall log the event of a successful delivery to recipient with the information of: Recipient name, recipient URL and duration time.
TS-DIS-OPE-1930/T	The Data Distribution shall log all fail events: network error, authentication error, data distribution error, with the appropriate severity and the most detailed information.
TS-DIS-OPE-1940/T	The Data Retrieval shall log all the distributions that have been undelivered because of age.
TS-DIS-DES-1950/T	The Data Distribution shall ensure the compatibility with the following web browsers: Microsoft Internet Explorer 7 and higher, Mozilla Firefox 4 and higher, Apple Safari 5 and higher, Google Chrome 4 and higher.
TS-DIS-DES-1960/T	The Data Distribution shall provide a pluggable infrastructure accepting new distribution protocols.
TS-DIS-DES-1970/I	The Data Distribution shall distribute Alerts to the External Application Centre and EMSA Block3 using the OASIS Common Alerting Protocol (CAP) 2.0 format.
TS-DIS-DES-1980/I	The Data Distribution shall distribute textual data to the External Application Centre and EMSA Block3 using an XML dialect conforms to a W3C XML Schema Definition (XSD) v1.0.
TS-DIS-DES-1990/I	The Data Distribution shall accompany XML data to the External Application Centre and EMSA Block3 with a reference on an Extensible Stylesheet Transformation (XSLT) v1.0 that transforms the data into a human readable web page.
TS-DIS-DES-2000/I	The Data Distribution shall publish web pages conform to the W3C HTML 4.01 Transitional and CSS level 2 standards.
TS-DIS-DES-2010/I	The Data Distribution shall use an Open Source Web-based mapping tool with GIS capabilities compliant with OGC.
TS-DIS-DES-2020/I	The Data Distribution shall be implemented using the Java Platform, Enterprise Edition 7 or higher.
TS-DIS-SEC-2030/T	The Data Distribution shall provide the Web Display through the Hypertext Transfer Protocol Secure (HTTPS).
TS-DIS-SEC-2040/T	The Data Distribution shall restrict data distribution to authorized users, i.e. users with necessary security credentials.
TS-DIS-SEC-2050/T	The Data Distribution shall establish a channel with external Block-2 systems based on TCP/IP 2-way SSL protocols using client and server digital certificates for mutual authentication.



Identifier	Description
TS-DIS-SEC-2060/T	The Data Distribution shall support secure cypher suites of at least 128 bit.
TS-DIS-DDD-2070/T	The Data Distribution shall store the managed users and rights into an Open Source LDAP server.
TS-DMA-FUN-2080/T	The DMA shall allow to store, delete and query Raw AIS Messages, Level 1 AIS Messages, Level 2 and Level 3 Positions Reports as well as Predicted Position Reports.
TS-DMA-FUN-2090/T	The DMA shall allow to store, delete and query Auxiliary data.
TS-DMA-FUN-2100/T	The DMA shall allow to store, delete and query VDRs.
TS-DMA-FUN-2110/T	The DMA shall allow to store, delete and query EO Level 1 images.
TS-DMA-FUN-2120/T	The DMA shall allow to store, delete and query Alerts.
TS-DMA-FUN-2125/T	The DMA shall allow to persist the traceability elements along with the AIS messages.
TS-DMA-FUN-2130/I	The DMA shall rely on the services provided by a Database Management System (DBMS) for data considered as small.
TS-DMA-FUN-2140/I	The DMA shall rely on the services provided by a file system for data considered as huge.
TS-DMA-FUN-2150/T	The DMA shall rely on the services provided by a File System.
TS-DMA-FUN-2160/T	The DMA shall provide the capability for the operator to archive data.
TS-DMA-FUN-2170/T	The DMA shall provide the capability for the operator to restore archived data into the on-line storage.
TS-DMA-FUN-2180/T	The DMA shall allow the configuration of the underlying DBMS.
TS-DMA-FUN-2190/T	The DMA shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.
TS-DMA-PER-2200/I	The DMA shall implement a connection pooling technique.
TS-DMA-OPE-2210/T	The DMA shall log the event of a failed connection to the underlying DBMS with the information of: DBMS connection URL, error message returned.
TS-DMA-DES-2300/T	The DMA shall be robust when a DBMS connection is lost.
TS-DMA-SAF-2310/I	The DMA shall be deployed identically (software and configuration) between primary and secondary system.
TS-DMA-SAF-2320/T	The DMA-FS on DPC Block 2 primary system shall be automatically replicated on the secondary system.
TS-DMA-SAF-2330/I	The DMA shall be automatically replicated from the primary system to the secondary system.
TS-DMA-SAF-2340/T	The DMA shall come with failover procedures for switching DPC Block 2 primary/secondary systems, including the primary/secondary role switching, the management of degenerate state (i.e. secondary system missing), and the reconciliation of data of DMA-FS and DMA-DB after restart.
TS-DMA-CFG-2350/T	The DMA shall define the configuration of a DBMS by the URL database connection, database name, database user name, database user password.
TS-DMA-CFG-2360/T	The DMA shall define the configuration of the connection pool by the initial size of the pool, the maximum allowed of active connections, the maximum number of connections that can remain idle in the pool, the minimum number of connections that can remain idle in the pool, the maximum number of milliseconds that the pool will wait for a connection to be returned.
TS-DMA-DDD-2370/A	The DMA shall maintain an on-line holding capacity of three years.



Identifier	Description
TS-DMA-DDD-2380/A	The DMA shall maintain an unbounded off-line holding capacity for duration greater than three years.
TS-DMA-FUN-2410/I	The DBMS shall implement a Relational meta-model.
TS-DMA-FUN-2420/I	The DBMS shall provide a spatial extension that encompasses Simple Feature Access of ISO 19125 standard.
TS-DMA-OPE-2220/T	The DMA shall provide the cumulative number of connection requests.
TS-DMA-OPE-2230/T	The DMA shall provide the cumulative number of completed transactions (failed and successful).
TS-DMA-OPE-2240/T	The DMA shall provide the cumulative number of transactions completed without failure.
TS-DMA-OPE-2250/T	The DMA shall provide the number of queries executed.
TS-DMA-OPE-2260/T	The DMA shall provide the time of the slowest query executed.
TS-DMA-OPE-2270/T	The DMA shall provide the slowest query executed.
TS-DMA-OPE-2280/T	The DMA shall provide the average time of query execution.
TS-DMA-DES-2430/I	The DBMS shall be an existing, widely adopted, database system.
TS-DPP-FUN-2450/T	The Ship Prediction shall predict the route of a given ship in a future time frame.
TS-DPP-FUN-2460/T	The Ship Prediction shall take into account the latest ship position (longitude, latitude and date time).
TS-DPP-FUN-2470/T	The Ship Prediction shall take into account the port of call (name of destination) of the ship, if available.
TS-DPP-FUN-2475/T	The Ship Prediction shall perform a preliminary validation of the last voyage information (port of call, ETA) received by the system to avoid computation of unrealistic routes.
TS-DPP-FUN-2480/T	The Ship Prediction shall take into account the last known course over ground of the ship.
TS-DPP-FUN-2490/T	The Ship Prediction shall take into account the last known speed over ground of the ship.
TS-DPP-FUN-2500/T	The Ship Prediction shall use a network of the main navigational route nodes in order to relate the ship to a navigational route when the port of call is known and valid.
TS-DPP-FUN-2505/T	The ship prediction shall use the last known location, speed and course over ground of the ship to provide the estimated route when the port of call is unknown. The estimated route shall be stopped when it crosses coastlines.
TS-DPP-FUN-2510/T	The Ship Prediction shall take into account the following ship navigation area: in open ocean, close to shore, close to port.
TS-DPP-FUN-2520/T	The Ship Prediction shall ensure the computed route is all included in sea.
TS-DPP-FUN-2530/T	The Ship Prediction shall characterize the reliability of the predicted positions of the ship with an accuracy indicator, related to the prediction duration (how far in the future is the prediction) and the navigation area.
TS-DPP-FUN-2540/T	The Ship Prediction shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.
TS-DPP-FUN-2550/T	The Ship Prediction shall allow the management of (declaration, modification, and deletion) of a graph topology of maritime traffic routes.
TS-DPP-PER-2560/I	The Ship Prediction shall use a cache mechanism such that it returns a route previously computed if the computation conditions are the same.



Identifier	Description
TS-DPP-DES-2570/T	The Ship Prediction shall provide a pluggable infrastructure accepting new position prediction algorithms.
TS-DPP-DES-2580/I	The Ship Prediction shall be implemented using the Java Platform, Enterprise Edition 7 or higher.
TS-DPP-CFG-2590/I	The Ship Prediction shall store maritime traffic routes in XML.
TS-DPP-CFG-2710/I	The Ship Prediction shall store the list of port of call (name, position) in XML.
TS-DSS-FUN-2830/T	The S-AIS Data Simulation Service shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.
TS-DSS-FUN-2840/T	The S-AIS Simulation Service shall provide a list of the configured simulation instances characterized with the following general information: simulation identifier, simulation type (AIS messages, AIS Schedules, Ship Lost Reports).
TS-DSS-FUN-2850/T	The S-AIS Simulation Service shall provide a list of the configured simulation instances characterized with the following status information: status (started/stopped), started date and time, location of the shared alert report file.
TS-DSS-FUN-2860/T	The S-AIS Simulation Service shall provide a list of the configured simulation instances characterized with the following system information: location of the local configuration file, location of the local progress report file, the launched process identifier (PID).
TS-DSS-FUN-2870/T	The S-AIS Simulation Service shall provide the capability to start a stopped configured simulation.
TS-DSS-FUN-2880/T	The S-AIS Simulation Service shall provide the capability to stop a started configured simulation.
TS-DSS-FUN-3020/T	The S-AIS Simulation Service shall produce predicted AIS messages of a ship given the last position message received and the predicted route.
TS-DSS-FUN-3150/T	The S-AIS Simulation Service shall offer a way to update the observed positions of ship.
TS-DSS-FUN-3152/T	In case of no reception of AIS messages while it was expected from a S-AIS Provider, the S-AIS Simulation Service shall alert the operator through the MCC. The expected date shall take into account delays of reception from the provider.
TS-DSS-FUN-3155/T	The S-AIS Simulation Service shall offer a way to update the predicted routes of ships.
TS-DSS-FUN-3160/T	The S-AIS Simulation Service shall offer a way to update the orbits.
TS-DSS-OPE-3190/T	The S-AIS Simulation Service shall log the event of the start and stop of the simulation instances.
TS-DSS-OPE-3200/T	The S-AIS Simulation Service shall log the event of an AIS message flow generation with the information of: local file location, file size.
TS-DSS-OPE-3210/T	The S-AIS Simulation Service shall log the event of a Ship Lost report generation with the information of: local file location, file size.
TS-DSS-DES-3250/T	The S-AIS Simulation Service shall be implemented using the Java Platform, Enterprise Edition 7 or higher.
TS-DSS-DDD-3430/T	The S-AIS Simulation Service shall emit warnings and alarms that comply with the OASIS Common Alerting Protocol (CAP) 2.0 format.



Identifier	Description
TS-DPS-FUN-0010/T	The simulator shall simulate a satellite-AIS system, taking into account a given fleet of transmitting ships, a given set of satellites with a defined payload performance and a given ground segment.
TS-DPS-FUN-0020/T	The simulator shall be able to provide at output a list of schedules, including next visibilities of the ships, and next downlink of the satellites.
TS-DPS-FUN-0030/T	The simulator shall be able to provide at output a list of messages, including ancillary data, as if they had been received, processed and downlinked by a real satellite system.
TS-DPS-FUN-0040/T	The simulator shall be able to provide at output a list of detection statistics per ship, to allow further comparison processing between a real flow and a simulated one. The comparison itself is not part of the simulator.
TS-DPS-FUN-0050/T	The Simulator shall be able to produce data as if they were produced by a non-nominal model, for ship, satellite and/or ground network.
TS-DPS-DES-0051/T	The Simulator shall be able to produce data as if they were produced by a non-nominal model thanks to a high flexibility in the simulation parameters.
TS-DPS-FUN-0100/I	The simulator shall integrate the main functions presented in the following figure (orange boxes):
TS-DPS-FUN-0110/T	The SOTDMA model module shall identify at each slot and for each frequency the transmitting ships.
TS-DPS-FUN-0111/T	The SOTDMA model module shall be so that each ship transmits alternatively on the 2 used AIS channels.
TS-DPS-FUN-0112/T	The SOTDMA model module shall be so that ships transmits with an average period corresponding to their characteristic transmission period.
TS-DPS-FUN-0113/T	The SOTDMA model module shall be so that ships transmits with a jitter of +/- 10% around their average period.
TS-DPS-FUN-0114/T	The SOTDMA model module shall be so that ships transmits on the same slots for 3 consecutive minutes.
TS-DPS-FUN-0115/T	The SOTDMA model module shall be so that on AIS 3&4 channels only class A ships transmit messages, and that on AIS 3&4 channels all ships transmits with a 3 minute period instead of their nominal transmission period.
TS-DPS-FUN-0120/T	The orbit prediction module shall calculate the position of the satellite at each date. It also evaluates the date at which the satellite will be visible by a ship or by a ground station for the downlink schedule.
TS-DPS-FUN-0121/T	The orbit prediction shall be performed based on TLE received at input and using Celestrak's SGP4 algorithm.
TS-DPS-FUN-0122/T	The orbit prediction module shall evaluate the date at which the satellite will be visible by a ship or by a ground station. If a satellite is seen by a ground station for a duration longer than a parameter threshold, the downlink is considered feasible
TS-DPS-FUN-0123/T	The orbit prediction module shall be able to consider an external Downlink Schedule file for a satellite instead of producing it.
TS-DPS-FUN-0130/T	The link budget module shall evaluate the signal reception conditions, in terms of power, direction, time and frequency of arrival.
TS-DPS-FUN-0131/T	The link budget module shall take into account the ship antenna pattern, the free space and atmospheric losses, including polarization effects, and the satellite antenna pattern. In addition, it shall consider randomness to take



Identifier	Description
	into account the multi-path and attitude effects.
TS-DPS-FUN-0132/T	The link budget module shall evaluate the received frequency according to the nominal emission frequency, and to the ship oscillator error.
TS-DPS-FUN-0133/T	The Simulator shall allow the processing of different link budgets per satellite considering several different antennas per satellite, and different reception conditions for first AIS frequencies (AIS 1 & 2) and/or new ones (AIS 3 & 4).
TS-DPS-FUN-0140/T	The processing model shall provide the detection probability, the CRC correctness probability and the bit error rate of all received messages. In nominal mode, this processing model shall use a table providing the BER and PER in relation with the signal to noise ratio.
TS-DPS-FUN-0141/T	The processing model shall construct the nominal message and the value of each bit shall be taken accordingly to the bit error rate.
TS-DPS-FUN-0142/T	The processing model shall evaluate the received power, the reception date, the measured frequency, the frequency measure date and the number of simultaneously received signals and combine them in a block of "ancillary data".
TS-DPS-FUN-0143/T	The processing model shall evaluate the measured frequency, taking into account the received frequency and the signal to noise ratio.
TS-DPS-FUN-0144/T	The processing model shall include simple modes to get quickly a raw estimations of the performance for free running or highly accelerated simulations.
TS-DPS-FUN-0145/T	The processing model shall update the detection expectancy of each couple (ship, satellite) by each instantaneous detection probability.
TS-DPS-FUN-0146/T	The processing model shall be able to evaluate the detection expectancy and then the message production probability based on a static detection probability map instead of the complete processing model.
TS-DPS-FUN-0150/T	The delivery schedule module shall evaluate for each satellite at which date and by which station it will become visible from ground. The date, the station and the associated delivery date to the processing centre is the "next downlink" of the satellite.
TS-DPS-FUN-0151/T	The delivery schedule module shall take into account the position of the satellite, the position of the ground network and its characteristics (masking angles, transfer mode and duration).
TS-DPS-FUN-0152/T	If the satellite is simultaneously visible by two or more ground stations, the Simulator shall identify which unique ground station will be used and then considered in the "next downlink" schedule according to the date and duration of the visibilities.
TS-DPS-FUN-0153/T	The delivery date shall be evaluated by the date of the end of the downlink plus the transfer delay.
TS-DPS-FUN-0154/T	The delivery schedule module shall reset the detection probability per ship/satellite if the ship has really been detected by the real satellite in the fixed period or in a shortly previous (parameter) fixed period as stated in the real fleet file.
TS-DPS-FUN-0155/T	The delivery schedule shall update the detection statistics from the accumulated expectancy only if the delivery date corresponding to the satellite is within the current fixed period.



Identifier	Description
TS-DPS-FUN-0200/I	The simulator shall maintain the time by storing at the beginning of the simulation the current local date of the hardware, and accessing again to this local date when necessary.
TS-DPS-FUN-0211/T	The simulator shall be able to work in full speed mode. All processing is done without particular real-time or synchronization constraints.
TS-DPS-FUN-0212/T	The simulator shall be able to work in real-time mode : the processing is performed in full speed, but once the processing is ended and the data are ready, the simulator waits that the time passed since the beginning of the simulation become equal to the fixed processing period before beginning a new fixed period.
TS-DPS-FUN-0213/T	The simulator shall be able to work in accelerated-time mode : the processing is performed in full speed, but once the processing is ended and the data are ready, the simulator waits that the time passed since the beginning of the simulation becomes equal to the fixed processing period divided by a factor before beginning a new fixed period.
TS-DPS-FUN-0220/T	When the simulator is late in real-time or accelerated-time modes, it shall raise an alert to the user with a visible message.
TS-DPS-FUN-0221/T	When the simulator is late in real-time or accelerated-time modes, and if the parameter "break when late" in the parameters is on, the Simulator shall immediately break its processing.
TS-DPS-DES-0310/T	The Simulator shall work with a processing fixed period of 3 minutes in simulated time.
TS-DPS-FUN-0320/T	The Simulator shall read the required inputs at the beginning of each fixed period, including the Main parameter file.
TS-DPS-FUN-0321/T	The Simulator shall verify that the header field of the Main parameter file has not been modified since the first fixed period. If it has been modified, the simulator shall break with an appropriate error message.
TS-DPS-FUN-0330/T	The Simulator shall write and make available the required outputs at the end of each fixed period.
TS-DPS-DES-0340/T	The evaluation of the satellite position and downlink schedules shall cover the 24 hours (simulated time) after the beginning of the simulation.
TS-DPS-DES-0341/T	The evaluation of the satellite position and satellite downlink schedules during the long-term propagation shall be made with a 30s (simulated time) period.
TS-DPS-DES-0342/T	The evaluation of the satellite position and ship visibility calculations during the fixed-period propagation shall be made with a 5s (simulated time) period.
TS-DPS-PER-0410/T	Based on the use of one dedicated processor core for the Simulator instance, the Simulator shall be able to run in real-time a simulation with 150000 ships worldwide, with a constellation of 6 satellites with 4-antennas beamforming on each, and a ground network with 6 stations.
TS-DPS-PER-0420/T	The Simulator shall be able to run with at maximum 200000 ships worldwide, a constellation of at maximum 24 satellites, an antenna array of at maximum 20 antennas, and a ground network with at maximum 60 stations..
TS-DPS-IFR-0500/T	The simulator shall implement the interfaces presented in the figure below:
TS-DPS-IFR-0510/T	The Simulator shall verify that the input files are accessible when it needs them. If they are not, it shall quit with an appropriate error indicator.



Identifier	Description
TS-DPS-IFR-0511/T	The Simulator shall verify that the input files have the correct format. If they have not, it shall quit with an appropriate error indicator.
TS-DPS-FUN-0520/T	The Simulator shall verify that it is able to create the outputs files (memory space, memory protections, ...). If it is not, it shall quit with an appropriate error indicator.
TS-DPS-FUN-0521/T	The Simulator shall verify that the created outputs files are accessible when it needs them. If they are not, it shall quit with an appropriate error indicator.
TS-DPS-FUN-0522/T	The Simulator shall remove to its output directories all outputs strictly older than 24 hours in simulated time.
TS-DPS-IFR-0530/T	The simulator shall be managed by an external program launcher.
TS-DPS-IFR-0531/T	The Simulator shall be able to receive the Start command from the External program launcher.
TS-DPS-IFR-0532/T	The Simulator shall be able to receive the Stop command from the External program launcher.
TS-DPS-IFR-0540/T	During the simulation, the Simulator shall provide access to the progression of the simulation through progress messages displayed or stored at the choice of the external management process.
TS-DPS-IFR-0541/T	In case of a warning or error, the Simulator shall simultaneously provide a warning/alert report at the address given in parameter and display on the external manager window a message with the type of error.
TS-DPS-IFR-0550/T	The Simulator shall provide its warnings and error logs to an external warning manager.
TS-DPS-SW-0551/T	The Simulator shall use the log4j format for providing warnings and alarms on the simulator software.
TS-DPS-IFR-0600/T	The Simulator shall simulate a Satellite-AIS environment easily modifiable by several parameters files centralized in one Main parameter file.
TS-DPS-IFR-0601/T	The Simulator Parameter file shall be structured according to the following high-level sections :
TS-DPS-IFR-0610/T	The Simulator shall use parameters included in the simulation management section shall drive the configuration of the Simulator instance, in particular Monitoring & Control.
TS-DPS-IFR-0620/T	The Simulator shall use the parameters included in the I/O files addresses section to define the addresses of input and output files.
TS-DPS-IFR-0630/T	The Simulator shall use the parameters included in the constellation section to define the configuration of the constellation, including in particular the links to dynamic files (TLE, IERS and Auxiliary bulletin) and the Ground stations used by each satellite.
TS-DPS-IFR-0631/T	The Simulator shall use the TLE file to get the orbital parameters of the satellite necessary for its position prediction.
TS-DPS-IFR-0632/T	The Simulator shall use the IERS Bulletin A file to get the Earth rotation parameters necessary for conversion to J2000.
TS-DPS-IFR-0633/T	The Simulator shall use the Auxiliary file to get the unavailability events of the satellites and ground stations of a provider.
TS-DPS-IFR-0640/T	The Simulator shall use the parameters included in the ground-network sections to define the ground-network in terms of number of stations and characteristics of each of them.



Identifier	Description
TS-DPS-IFR-0650/T	The Simulator shall use the parameters included in the link budget parameters to elaborate the link-budgets, in particular for what concerns the atmospheric parameters, the noise reception conditions and the considered antennas.
TS-DPS-IFR-0655/T	The Simulator shall take into account the geographic filters set in the satellite parameters by providing no data (detection statistics, messages, schedules) for the ships that are outside the given geographic filter.
TS-DPS-IFR-0660/T	The Simulator shall use the parameters included in the processing parameters to define the AIS signal processing capacity of the simulated constellation.
TS-DPS-IFR-0670/T	The Simulator shall use the virtual fleet map to construct the reference AIS-equipped-ships fleet according to the provided worldwide ship density. The Simulator shall use the virtual fleet to complete the real fleet every fixed period, so that the number of ships in the simulation is always equal to the number of ships in the virtual fleet.
TS-DPS-IFR-0680/T	The Simulator shall use the fleet input to read the list of all detected ships, with their known characteristics (MMSI, status health, position (position, speed, heading), transmission frequency, transmission period, class (class and transmission power)), use of AIS 3&4, and their previous detection date per real satellite and their predicted trajectory.
TS-DPS-IFR-0681/T	The Simulator shall use the trajectory (list of latitude, longitude, speed, heading, date of turn) given in the real fleet file to propagate the ship position from one fixed period to the next one (but not during a fixed period where the ship is considered as fixed).
TS-DPS-IFR-0710/T	The Simulator shall be able to produce the following schedule files:
TS-DPS-IFR-0711/T	The Simulator shall be able to produce the Satellite position in terrestrial reference frame as the list of satellite positions (x, y, z) every 30s on the next 24 hours after the beginning date of the simulation.
TS-DPS-IFR-0712/T	The Simulator shall be able to produce the Satellite position in J2000 reference frame as the list of satellite positions (x, y, z) every 30s on the next 24 hours after the beginning date of the simulation.
TS-DPS-IFR-0713/T	The Simulator shall be able to produce the Satellite downlink schedule as the list of satellite-ground stations visibilities, each visibility being characterized by the ground station ID, the beginning date of the visibility and the visibility duration.
TS-DPS-IFR-0714/T	The Simulator shall be able to produce the Ground station downlink schedule as the list of satellite-ground stations visibilities, each visibility being characterized by the satellite ID, the beginning date of the visibility and the visibility duration.
TS-DPS-IFR-0715/T	The Simulator shall be able to produce the Ship downlink schedule as the list for all ships of satellite visibilities within the current fixed period, each visibility being characterized by the satellite ID, the visibility beginning date, the next ground-station ID seen by the satellite and the associated DPC delivery date.
TS-DPS-IFR-0720/T	The Simulator shall be able to produce an AIS message flow which follows the following formats:
TS-DPS-IFR-0721/T	The Simulator shall be able to produce the message types 1 (dynamic message for moving class A ships), 3 (dynamic message for static class A ships), 5 (static message for class A ships), 18 (dynamic message for class B



Identifier	Description
	ships) and 27 (long-range message used on AIS 3&4).
TS-DPS-IFR-0722/T	The Simulator shall complete the messages with the known elements (MMSI, position, speed, heading) and with default values when elements are unknown.
TS-DPS-IFR-0723/T	The Simulator shall define for Virtual ships as MMSI the value 200XXXXXX with XXXXXX the ship ID.
TS-DPS-IFR-0724/T	The Simulator shall include in the comment section of the message block the ancillary data: satellite ID, detection date, delivery date, ground-station ID, Time Of Arrival, Frequency Of Arrival, Frequency Of Arrival Date, Power Of Arrival, quality index, number of simultaneously received messages.
TS-DPS-IFR-0725/T	The Simulator shall set the first bit of the quality index to '0' if it is a real vessel and to '1' if it is a virtual vessel.
TS-DPS-IFR-0726/T	The Simulator shall produce one AIS message flow file per satellite downlink.
TS-DPS-IFR-0727/T	The Simulator update the current AIS message flow files (one per satellite) at the end of each fixed period.
TS-DPS-IFR-0730/T	The Simulator shall be able to produce the list of AIS detection statistics per ship and per satellite, and per ship combined on all satellites of the simulation.
TS-DPS-IFR-0731/T	The Simulator shall be able to identify among the detection statistics per ship the ones that may be considered as suspicious for the ship lost DPC task.
TS-DPS-IFR-0732/T	The Simulator shall produce one AIS detection statistics file every fixed period.
TS-DPS-IFR-0733/I	The Simulator shall use the OASIS Common Alerting Protocol (CAP) [RD4] for providing warnings and alarms on missing ships.
TS-DPS-OPE-0810/T	The Simulator shall be able to produce AIS message data as if it was a real AIS provider. In this service, it shall be used in "real-time" speed mode, as a permanent service on successive fixed periods, reading the inputs and writing the outputs every fixed period, without interruption.
TS-DPS-OPE-0820/T	The Simulator shall be able to produce detection statistics, orbits and schedules, necessary to visualize and monitor a real AIS provider. In this service, it shall be used in "real-time" speed mode, as a permanent service on successive fixed periods, reading the inputs and writing the outputs every fixed period, without interruption.
TS-DPS-OPE-0830/T	The Simulator shall be able to produce messages, orbits and schedules that could be achieved by a provider (real or simulated) over a window of 24 hours. This service is a "on-request" service to be performed in accelerated mode. This service will take benefit of the simplified processing modes to speed-up the simulation.
TS-DPS-OPE-0840/T	The Simulator shall be able to produce detection statistics, orbits and schedules (including in particular ship detection schedules) that could be achieved by a real provider over a window of 24 hours. This service is a "on-request" service to be performed in full-speed mode.
TS-DPS-OPE-0851/T	The Simulator shall be able to simulate failures in the constellation (removal of a satellite or modification of its characteristics in the Main parameter file or use of the Auxiliary file).



Identifier	Description
TS-DPS-OPE-0852/T	The Simulator shall be able to simulate failures in the ground segment (removal of a ground station or modification of its characteristics in the Main parameter file or use of the Auxiliary file).
TS-DPS-OPE-0853/T	The Simulator shall be able to simulate failures in the ship segment (removal of a ship or modification of its characteristics (including status-health) in the fleet file). It shall also be able to consider a fake position for a ship
TS-DPS-SW-1010/I	The Simulator software shall preferably be written in Java language.
TS-DPS-SW-1011/I	The Simulator software may be written in C++ language if it appears that it is more suitable to comply with the performance requirements.
TS-DPS-SW-1020/T	The Simulator shall run on Linux RedHat 6/6.1.
TS-DPS-SW-1021/I	The impacts for a deployment of the Simulator on Windows shall be identified and minimized.
TS-DPS-SW-1030/I	The Simulator shall use only non contaminant software.
TS-DPS-SW-1040/I	The Simulator interfaces with the DPC shall be based on a file-based Interface.
TS-DPS-SW-1050/I	The Simulator shall use the XML standard for exchange files as default format.
TS-DPS-HW-1100/T	The Simulator shall run on the following hardware:
TS-DPS-HW-1110/T	The Simulator shall be able to run in several instances in parallel, using possibly different parameters.
TS-DPS-HW-1111/T	Each instance of the Simulator shall be independent. In particular, it shall use its own memory resources.
TS-DPS-SWQ-1400/I	The Simulator shall be classified in category D and developed in compliance with the standard software product assurance requirements ref 100141944N-EN issue 4.
TS-DPS-SWQ-1401/I	The required quality characteristics shall be: functionality, reliability and maintainability.
TS-DPS-SWQ-1402/I	The targets value shall be 50 lines of code per method and 25% of comment frequency.
TS-DPS-VVI-1410/I	The software shall be verified according to the Validation plan to cover all requirements of this document.
TS-DPS-VVI-1420/I	Interfaces shall be tested through specific test cases
TS-DPS-VVI-1430/I	The software shall be tested with a minimum coverage of 70%.
TS-DPS-VVI-1440/I	The Simulator shall initialize the random seed at zero at the beginning of each simulation.
TS-DPS-DES-1600/T	The Simulator shall provide Traces of the processing for debugging and maintenance purposes.
TS-DPS-DES-1610/I	All configuration and input files of the Simulator shall be modifiable with a basic Text editor.
TS-DPS-OPE-1700/I	The Simulator configuration shall be managed through ClearCase.
TS-DPS-OPE-1800/I	The Simulator shall be delivered with a Parameters User Manual describing the purpose, the format, the minimum and maximum values and examples of each parameter of the Simulator.
TS-DPS-OPE-1900/I	The Simulator shall be delivered with the appropriate installation tools.
TS-MCC-FUN-3440/I	The Monitoring Command and Control shall be able to monitor applications in real-time, with 24/7 availability.
TS-MCC-FUN-3450/I	The Monitoring Command and Control graphical interface shall give a representation of the Block2 H/W and S/W architecture, giving a synthetic



Identifier	Description
	view of the Block2 components.
TS-MCC-FUN-3460/T	The MCC graphical interface shall be interactive.
TS-MCC-FUN-3470/T	The MCC graphical interface shall allow to start a Block2 component.
TS-MCC-FUN-3480/T	The MCC graphical interface shall allow to stop a Block2 component.
TS-MCC-FUN-3490/T	The MCC graphical interface shall provide map, a graphical representation of Block2 components, or group of components, giving the actual status.
TS-MCC-FUN-3500/I	The MCC graphical interface shall allow to draw links between Block2 components on the map.
TS-MCC-FUN-3510/T	The Monitoring Command and Control interface shall allow to add, delete, modify and suspend a monitoring task.
TS-MCC-FUN-3520/T	The Monitoring Command and Control interface shall allow to create/delete monitoring item/template, create/monitoring user monitoring item, add/delete monitored hosts and upgrade of the MCC tools.
TS-MCC-FUN-3530/T	The MCC graphical interface shall allow adding a new Block2 component to the display.
TS-MCC-FUN-3540/T	The Monitoring Command and Control shall allow to define warnings and alerts to raise; display notification on the graphical interface; send notification by e-mail.
TS-MCC-FUN-3550/T	The Monitoring Command and Control shall allow to define alerts to raise, regarding the inactivity of a component (alert based on a threshold period without activity, scalable for each component).
TS-MCC-FUN-3560/T	The Monitoring Command and Control shall allow to acknowledge an alert, with a text field for a comment.
TS-MCC-FUN-3570/T	The Monitoring Command and Control should provide a real-time journal of application generated events (provided in log files), with configurable filtering parameters: time interval, severity status of events (Error, Warning, Info, Debug and Activity), components.
TS-MCC-FUN-3580/T	The MCC graphical interface should be able to display the event journal in a separated window.
TS-MCC-FUN-3590/T	The Monitoring Command and Control shall allow to execute a given task.
TS-MCC-FUN-3600/T	The Monitoring Command and Control shall allow to configure the scheduling of the task execution.
TS-MCC-FUN-3610/T	The Monitoring Command and Control shall acknowledge as a task executable scripts regarding the operating system on which it runs (i.e. bash script or script with SQL requests).
TS-MCC-FUN-3620/T	The Monitoring Command and Control shall consider the content returned by a processed task as a number that can be used as metric, giving the execution status.
TS-MCC-FUN-3630/T	The Monitoring Command and Control shall display the execution history of each scheduled task (with its returned status) via a graph.
TS-MCC-FUN-3640/T	The Monitoring Command and Control shall display returned status of each scheduled task as a graphic over a configurable period of time (day, week, month, year).
TS-MCC-FUN-3650/T	The Monitoring Command and Control shall allow to raise alerts depending on task execution status.



Identifier	Description
TS-MCC-FUN-3660/T	The Monitor Command And Control shall provide a mean to configure a task (name, script, frequency, parameters).
TS-MCC-FUN-3670/T	The Monitoring Command and Control shall be a multi-user system, reachable simultaneously by several remote connections.
TS-MCC-FUN-3680/T	The Monitoring Command and Control shall be configurable to monitor any internal Block2 infrastructure component availability and performance outage (network, hardware, database).
TS-MCC-FUN-3690/T	The Monitoring Command and Control shall provide statistics (average, min, max) from monitored item.
TS-MCC-FUN-3700/T	The Monitoring Command and Control shall be able to monitor external link.
TS-MCC-FUN-3710/T	The Monitoring Command and Control shall allow to define a warning to raise, in case on communication network issues with external entities (e.g. using ping command).
TS-MCC-FUN-3720/T	The MCC subsystem shall be able to monitor the status of the reception of AIS data by the ground stations following.
TS-MCC-FUN-3730/T	The MCC subsystem shall be able to send notifications when a satellite fails to receive or forward AIS data to the ground stations.
TS-MCC-FUN-3740/T	The Monitoring Command and Control shall allow to stop the monitoring of a given DPC BLOCK2 during his maintenance.
TS-MCC-FUN-3750/T	The Monitoring Command and Control shall provide historical report of alerts, notifications, outages, and alert responses.
TS-SSP-FUN-3760/T	The System Performance shall filter selected data by time period, AIS message type, satellite, data provider, vessel type, vessel identifier.
TS-SSP-FUN-3770/T	The System Performance shall distinguish AIS messages by the CRC-16 value.
TS-SSP-FUN-3780/T	The System Performance shall plot filtered AIS data on map.
TS-SSP-FUN-3790/T	The System Performance shall export plot data to external KML 2.2 format.
TS-SSP-FUN-3800/T	The System Performance shall plot latest vessel position on map with different colours depending on AIS position origin.
TS-SSP-FUN-3810/T	The System Performance shall plot the number of AIS message on user defined grid.
TS-SSP-FUN-3820/T	The System Performance shall plot the percentage of AIS inconsistent message on user defined grid.
TS-SSP-FUN-3830/T	The System Performance shall plot the percentage of AIS missing vessels warnings messages on user defined grid.
TS-SSP-FUN-3840/T	The System Performance shall plot the timeliness distribution of the AIS messages on 2D plots and on user defined grid.
TS-SSP-FUN-3850/T	The System Performance shall plot the time update interval distribution of the vessels on 2D plots and on user defined grid.
TS-SSP-FUN-3860/T	The System Performance shall plot the percentage of AIS messages recovered by prediction or Doppler on user defined grid.
TS-SSP-FUN-3870/T	The System Performance shall calculate and display the percentage of vessels localized by Doppler calculation.
TS-SSP-FUN-3880/T	The System Performance shall calculate and display the percentage of AIS message confirmed by Doppler calculation.



Identifier	Description
TS-SSP-FUN-3890/T	The System Performance shall allow the user to change the minimum and maximum values of the scale.
TS-SSP-FUN-3900/T	The System Performance shall keep in a log file every significant event along with the timestamp, the severity, the context and the circumstance.
TS-SSP-PER-3910/T	The System Performance shall keep the memory consumption constant, i.e. contained in a range of 10MB width, regardless of the size of the database request result.
TS-SSP-OPE-3920/T	The System Performance shall log the event of statistics processing completed with the information of: kind of plot, parameters.
TS-SSP-DES-3930/T	The System Performance shall provide a modular infrastructure accepting new statistics possibilities.
TS-SSP-DES-3940/T	The System Performance shall provide a serializable infrastructure saving parameters of calculation.
TS-SSP-DES-3950/I	The System Performance shall be implemented using the Java Platform, Enterprise Edition 6 or higher.
TS-DCF-FUN-3960/I	The DPC Framework shall implement an Enterprise Service Bus (ESB) architecture.
TS-DCF-FUN-3970/I	The DPC Framework shall provide the routing capability based on content message.
TS-DCF-FUN-3980/I	The DPC Framework shall provide the synchronous and asynchronous messaging.
TS-DCF-FUN-3990/I	The DPC Framework shall provide the following XML processing (query and transformation) defined and recommended by the W3C: XPath 2.0, XSLT 1.0 & 2.0, XQuery 1.0.
TS-DCF-FUN-4000/I	The DPC Framework shall provide message mediation based on sequences allowing message splitting and message aggregation.
TS-DCF-FUN-4010/I	The DPC Framework shall provide the capability to interact with a service via a proxy service defined in the ESB.
TS-DCF-DES-4020/I	The DPC Framework shall support the following major Web Services standards: SOAP 1.1/SOAP 1.2, WSDL 1.1/WSDL 2.0, WS-Addressing 2005.
TS-DCF-FUN-4030/T	The DPC Framework shall provide the capability to execute business processes, a sequence of activities, triggered by events or by scheduling.
TS-DCF-FUN-4040/I	The DPC Framework shall provide a web based user interface console to monitor the activity.
TS-DCF-FUN-4050/I	The DPC Framework shall provide a web based user interface console to manage workflow processes and workflow instances.
TS-DCF-FUN-4060/T	The DPC Framework shall provide the capability to validate a WSDL file.
TS-DCF-FUN-4080/T	The DPC Framework shall provide the capability to execute WS-BPEL 2.0 business processes.
TS-DCF-SEC-4090/T	The DPC Framework shall limit the access to the management console to authorized users.
TS-DCF-DAT-4100/I	The DPC Framework shall support PostgreSQL v9.1.x (or higher) and Oracle 11g Release 2 (or higher) database.



Appendix C - Traceability matrix - SRS vs SSS

RequirementName (SSS)	TracedTo (SRS)
SR-DIS -IFR-0370/T	TS-DIS-FUN-1476/T
	TS-DIS-FUN-1570/T
SR-DIS-FUN-0380/T	TS-DIS-PER-1900/T
SR-DIS-FUN-0730/T	TS-DIS-FUN-1490/T
SR-DIS-FUN-0740/T	TS-DIS-FUN-1500/T
SR-DIS-FUN-0750/T	TS-DIS-FUN-1480/T
	TS-DIS-FUN-1490/T
	TS-DIS-FUN-1510/T
	TS-DIS-FUN-1520/T
	TS-DIS-FUN-1530/T
	TS-DIS-FUN-1540/T
	TS-DIS-FUN-1550/T
	TS-DIS-FUN-1560/T
	TS-DIS-FUN-1561/T
	TS-DIS-FUN-1590/T
	TS-DIS-FUN-1630/T
	TS-DIS-FUN-1640/T
	TS-DIS-FUN-1650/T
	TS-DIS-FUN-1660/T
	TS-DIS-FUN-1670/T
	TS-DIS-FUN-1680/T
SR-DIS-FUN-0760/T	TS-DIS-FUN-1540/T
SR-DIS-FUN-0770/T	TS-DIS-FUN-1630/T
	TS-DIS-FUN-1640/T
	TS-DIS-FUN-1650/T
	TS-DIS-FUN-1660/T
	TS-DIS-FUN-1670/T
SR-DIS-FUN-0780/T	TS-DIS-FUN-1370/T
	TS-DIS-FUN-1380/T
	TS-DIS-FUN-1690/T
SR-DIS-FUN-0790/T	TS-DIS-FUN-1510/T
SR-DIS-FUN-0800/T	TS-DIS-FUN-1790/T
SR-DIS-FUN-0810/T	TS-DIS-FUN-1620/T
	TS-DIS-FUN-1840/T
	TS-DIS-FUN-1850/T
SR-DIS-FUN-0820/T	TS-DIS-FUN-1720/T
	TS-DIS-FUN-1790/T
	TS-DIS-FUN-1800/T
	TS-DIS-FUN-1810/T
	TS-DIS-FUN-1820/T



RequirementName (SSS)	TracedTo (SRS)
	TS-DIS-FUN-1830/T
	TS-DIS-FUN-1840/T
	TS-DIS-FUN-1850/T
SR-DIS-FUN-0830/T	TS-DIS-FUN-1710/T
	TS-DIS-FUN-1860/T
SR-DIS-FUN-0840/T	TS-DIS-FUN-1290/T
SR-DIS-FUN-0850/T	TS-DIS-FUN-1720/T
	TS-DIS-FUN-1740/T
	TS-DIS-FUN-1760/T
	TS-DIS-FUN-1770/T
	TS-DIS-FUN-1780/T
SR-DIS-FUN-0860/T	TS-DIS-FUN-1840/T
	TS-DIS-FUN-1850/T
SR-DIS-FUN-0870/T	TS-DIS-DES-2010/I
SR-DIS-FUN-0880/T	TS-DIS-FUN-1370/T
	TS-DIS-FUN-1420/T
SR-DIS-FUN-0890/T	TS-DIS-FUN-1300/T
SR-DIS-FUN-0900/T	TS-DIS-FUN-1310/T
SR-DIS-FUN-0910/T	TS-DIS-FUN-1450/T
SR-DIS-FUN-0920/T	TS-DIS-FUN-1350/T
SR-DIS-FUN-0930/T	TS-DIS-FUN-1330/T
	TS-DIS-FUN-1340/T
	TS-DIS-FUN-1350/T
SR-DIS-FUN-0940/T	TS-DIS-FUN-1360/T
SR-DIS-FUN-0950/T	TS-DIS-FUN-1320/T
SR-DIS-FUN-0960/T	TS-DIS-FUN-1350/T
	TS-DIS-FUN-1400/T
SR-DIS-FUN-0970/T	TS-DIS-FUN-1460/T
SR-DIS-FUN-0980/T	TS-DIS-FUN-1430/T
SR-DIS-FUN-1740/T	TS-DIS-FUN-1210/T
	TS-DIS-FUN-1220/T
	TS-DIS-FUN-1230/T
	TS-DIS-FUN-1240/T
	TS-DIS-FUN-1250/T
	TS-DIS-FUN-1260/T
	TS-DIS-FUN-1730/T
	TS-DIS-FUN-1750/T
	TS-DIS-SEC-2040/T
	TS-DIS-SEC-2050/T
SR-DIS-FUN-1750/T	TS-DIS-SEC-2040/T
SR-DIS-FUN-1760/T	TS-DIS-FUN-1790/T
	TS-DIS-FUN-1800/T



RequirementName (SSS)	TracedTo (SRS)
	TS-DIS-FUN-1810/T
	TS-DIS-FUN-1820/T
	TS-DIS-FUN-1830/T
	TS-DIS-FUN-1840/T
	TS-DIS-FUN-1850/T
SR-DIS-FUN-1770/T	TS-DIS-SEC-2050/T
SR-DIS-FUN-1780/T	TS-DIS-FUN-1210/T
	TS-DIS-FUN-1220/T
	TS-DIS-FUN-1230/T
	TS-DIS-FUN-1240/T
	TS-DIS-FUN-1250/T
	TS-DIS-FUN-1260/T
	TS-DIS-FUN-1280/T
	TS-DIS-SEC-2030/T
SR-DIS-FUN-1790/I	TS-DIS-SEC-2050/T
SR-DIS-FUN-1800/I	ICD
	TS-DIS-SEC-2050/T
	TS-DIS-SEC-2060/T
SR-DIS-FUN-1810/I	ICD
SR-DIS-FUN-1820/I	TS-DIS-SEC-2060/T
SR-DIS-FUN-1830/I	ICD
SR-DIS-IFR-0290/T	TS-DIS-FUN-1500/T
SR-DIS-IFR-0300/T	TS-DIS-FUN-1460/T
	TS-DIS-FUN-1540/T
SR-DIS-IFR-0310/T	TS-DIS-FUN-1590/T
SR-DIS-IFR-0320/T	TS-DIS-FUN-1580/T
SR-DIS-IFR-0330/T	TS-DIS-FUN-1670/T
SR-DIS-IFR-0340/T	TS-DIS-FUN-1630/T
	TS-DIS-FUN-1640/T
	TS-DIS-FUN-1650/T
	TS-DIS-FUN-1660/T
	TS-DIS-FUN-1670/T
	TS-DIS-FUN-1680/T
	TS-DIS-FUN-1690/T
SR-DIS-IFR-0350/T	TS-DIS-FUN-1700/T
SR-DIS-IFR-0360/T	TS-DIS-SEC-2050/T
SR-DIS-IFR-0390/T	TS-DIS-FUN-1300/T
	TS-DIS-FUN-1301/T
	TS-DIS-FUN-1310/T
	TS-DIS-FUN-1320/T
	TS-DIS-FUN-1330/T
	TS-DIS-FUN-1340/T



RequirementName (SSS)	TracedTo (SRS)
	TS-DIS-FUN-1350/T
	TS-DIS-FUN-1360/T
	TS-DIS-FUN-1370/T
	TS-DIS-FUN-1380/T
	TS-DIS-FUN-1381/T
	TS-DIS-FUN-1400/T
	TS-DIS-FUN-1420/T
	TS-DIS-FUN-1430/T
	TS-DIS-FUN-1450/T
	TS-DIS-FUN-1460/T
	TS-DIS-FUN-1471/T
	TS-DIS-FUN-1472/T
SR-DIS-IFR-0400/T	TS-DIS-FUN-1290/T
	TS-DIS-FUN-1300/T
SR-DIS-IFR-0410/T	TS-DIS-SEC-2050/T
SR-DMA-FUN-0680/T	TS-DMA-FUN-2130/I
	TS-DMA-FUN-2150/T
SR-DMA-FUN-0690/T	TS-DMA-DDD-2370/A
	TS-DMA-FUN-2080/T
	TS-DMA-FUN-2090/T
	TS-DMA-FUN-2100/T
	TS-DMA-FUN-2110/T
	TS-DMA-FUN-2120/T
SR-DMA-FUN-0700/T	TS-DMA-DDD-2370/A
	TS-DMA-FUN-2080/T
SR-DMA-FUN-0710/T	TS-DMA-DDD-2380/A
	TS-DMA-FUN-2160/T
SR-DMA-FUN-0720/T	TS-DMA-FUN-2170/T
SR-DPC-DAT-0220/T	Data Procurement Plan
SR-DPC-DAT-0230/A	Data Procurement Plan
SR-DPC-DAT-0240/A	Data Procurement Plan
SR-DPC-DAT-0250/I	TS-DPS-IFR-0720/T
	TS-DPS-IFR-0721/T
SR-DPC-DAT-0260/A	Data Procurement Plan
SR-DPC-DES-1910/A	TS-DCF-FUN-3960/I
	TS-DCF-FUN-3970/I
	TS-DCF-FUN-4030/T
	TS-DCF-FUN-4080/T
SR-DPC-DES-1920/A	TS-DPP-DES-2570/T
	TS-DRT-DES-0360/T
	TS-DRT-DES-0370/T
	TS-DRT-DES-0380/T



RequirementName (SSS)	TracedTo (SRS)
	TS-PL1-DES-0630/T
	TS-PL1-DES-0640/T
	TS-SSP-DES-3930/T
	TS-SSP-DES-3940/T
SR-DPC-DES-1930/T	TS-DCF-FUN-4000/I
	TS-DMA-PER-2200/I
	TS-DRT-FUN-0180/T
	TS-DRT-PER-0210/T
	TS-DRT-PER-0220/T
	TS-PL1-PER-0550/T
SR-DPC-DES-1940/I	TS-DCF-FUN-3960/I
SR-DPC-DES-1950/I	TS-DCF-DES-4020/I
	TS-DCF-FUN-3960/I
SR-DPC-DES-1960/I	ICD
SR-DPC-DES-1970/I	ICD
	TS-DCF-DES-4020/I
SR-DPC-DES-1980/I	ICD
SR-DPC-DES-1990/I	ICD
SR-DPC-DES-2000/I	ICD
SR-DPC-DES-2010/I	TS-DCF-FUN-4080/T
SR-DPC-DES-2020/I	ICD
SR-DPC-DES-2030/I	ICD
	TS-DCF-FUN-3990/I
	TS-DCF-FUN-4060/T
SR-DPC-DES-2040/T	ICD
	TS-DCF-DES-4020/I
	TS-DCF-FUN-3990/I
	TS-DIS-DES-1970/I
	TS-DIS-DES-1980/I
	TS-DIS-DES-1990/I
	TS-DIS-DES-2000/I
	TS-DIS-FUN-1590/T
	TS-PL1-FUN-0450/T
SR-DPC-DES-2050/I	TS-DCF-FUN-3990/I
	TS-DIS-DES-1970/I
	TS-DIS-DES-1980/I
	TS-DIS-DES-1990/I
	TS-DPS-SW-1050/I
	TS-PL1-FUN-0450/T
SR-DPC-DES-2060/I	TS-DIS-DES-1970/I
	TS-DPS-IFR-0733/I
	TS-DSS-DDD-3430/T



RequirementName (SSS)	TracedTo (SRS)
SR-DPC-DES-2070/I	TS-DIS-DES-2020/I
	TS-DLP-DES-1180/I
	TS-DPP-DES-2580/I
	TS-DPS-SW-1010/I
	TS-DRT-DES-0390/I
	TS-PL1-DES-0650/I
	TS-PL2-DES-0850/I
	TS-PL3-DES-1000/I
	TS-SSP-DES-3950/I
SR-DPC-FUN-0040/A	TS-DIS-FUN-1490/T
	TS-DIS-FUN-1520/T
	TS-DIS-FUN-1530/T
	TS-DIS-FUN-1540/T
	TS-DRT-FUN-0010/T
SR-DPC-FUN-0050/A	TS-DIS-FUN-1630/T
	TS-DIS-FUN-1640/T
	TS-DIS-FUN-1650/T
	TS-DIS-FUN-1660/T
	TS-DIS-FUN-1670/T
	TS-DIS-FUN-1680/T
	TS-DRT-FUN-0010/T
SR-DPC-FUN-0060/A	TS-PL3-FUN-0870/I
	TS-PL3-FUN-0880/I
	TS-PL3-FUN-0890/T
	TS-PL3-FUN-0900/T
	TS-PL3-FUN-0910/T
SR-DPC-FUN-0070/T	TS-DIS-FUN-1480/T
	TS-DIS-FUN-1630/T
SR-DPC-FUN-0080/A	TS-DIS-FUN-1480/T
	TS-DMA-FUN-2080/T
	TS-DPP-FUN-2450/T
	TS-DRT-FUN-0010/T
	TS-MCC-FUN-3440/I
	TS-PL1-FUN-0450/T
	TS-PL2-FUN-0690/T
	TS-PL3-FUN-0870/I
	TS-SSP-FUN-3760/T
SR-DPC-FUN-0090/T	TS-DCF-FUN-4030/T
SR-DPC-FUN-0110/T	TS-MCC-FUN-3470/T
	TS-MCC-FUN-3480/T
SR-DPC-FUN-0120/T	TS-PL1-FUN-0450/T
SR-DPC-FUN-0130/T	TS-PL2-FUN-0690/T



RequirementName (SSS)	TracedTo (SRS)
	TS-PL2-FUN-0718/T
SR-DPC-FUN-0135/T	TS-DIS-FUN-1561/T
SR-DPC-FUN-0140/T	TS-DIS-FUN-1490/T
SR-DPC-FUN-0150/T	TS-DIS-FUN-1510/T
SR-DPC-FUN-0160/T	TS-DIS-FUN-1520/T
SR-DPC-FUN-0170/T	TS-DIS-FUN-1680/T
SR-DPC-FUN-0180/T	TS-DPS-FUN-0020/T
	TS-DPS-FUN-0120/T
	TS-DPS-FUN-0122/T
SR-DPC-FUN-0190/T	TS-DIS-FUN-1530/T
SR-DPC-FUN-0200/T	TS-DIS-FUN-1550/T
SR-DPC-HW-1630	See SRS § 4.4
SR-DPC-HW-1640	See SRS § 4.4
SR-DPC-HW-1650	See SRS § 4.4
SR-DPC-HW-1660	See SRS § 4.4
SR-DPC-HW-1670	See SRS § 4.4
SR-DPC-HW-1680/I	See SRS § 4.4
SR-DPC-HW-1690	See SRS § 4.4
SR-DPC-HW-1700	See SRS § 4.4
SR-DPC-HW-1710	See SRS § 4.4
SR-DPC-HW-1720	TS-DPS-SW-1020/T, See SRS § 4.4
SR-DPC-HW-1730	See SRS § 4.4
SR-DPC-IFR-0010/T	TS-DRT-FUN-0010/T
SR-DPC-IFR-0020/T	TS-DRT-FUN-0010/T
SR-DPC-IFR-0030/T	TS-DRT-FUN-0010/T
SR-DPC-IFR-0040/T	TS-DRT-FUN-0010/T
SR-DPC-IFR-0050/T	TS-DIS-FUN-1570/T
SR-DPC-IFR-0060/T	TS-DIS-FUN-1590/T
SR-DPC-IFR-0070/T	ICD
	TS-DIS-FUN-1290/T
SR-DPC-IFR-0080/T	ICD
	TS-DIS-FUN-1580/T
	TS-DIS-FUN-1590/T
SR-DPC-OPE-2080/I	TS-MCC-FUN-3440/I
SR-DPC-PER-0100/A	TS-DRT-DES-0400/T
SR-DPC-PER-0210/T	TS-DIS-PER-1875/T
	TS-DRT-PER-0205/T
	TS-PL1-PER-0545/T
SR-DPC-PER-0270/A	TS-DRT-DES-0400/T
	TS-DRT-FUN-0010/T
SR-DPC-PER-0280/T	TS-DLP-FUN-1120/T
SR-DPC-REL-1880/A	TS-DCF-FUN-4080/T



RequirementName (SSS)	TracedTo (SRS)
SR-DPC-REL-1890/A	TS-DRT-DES-0400/T
SR-DPC-SAF-1840/I	TS-DMA-SAF-2310/I
SR-DPC-SAF-1850/I	TS-DMA-SAF-2340/T
SR-DPC-SAF-1860/I	TS-DMA-SAF-2310/I
SR-DPC-SAF-1870/T	TS-DMA-SAF-2320/T
	TS-DMA-SAF-2330/I
SR-DPC-SW-0010/I	TS-DPS-SWQ-1400/I
SR-DPC-SW-0020	TS-DIS-DES-1960/T
	TS-DPP-DES-2570/T
	TS-DRT-DES-0360/T
	TS-DRT-DES-0370/T
	TS-DRT-DES-0380/T
SR-DPC-SW-0030	PAP
SR-DPC-SWQ-1900/AI	TS-DPS-SWQ-1401/I
SR-DPC-VVI-2090/I	SVD
SR-DPC-VVI-2100/TAI	SVD
SR-DPC-VVI-2110/TAI	SVD
SR-DPC-VVI-2120/I	SVD
SR-DPC-VVI-2130/I	SVD
SR-DPC-VVI-2140/T	SVD
SR-DPC-VVI-2150/T	TS-DPS-VVI-1420/I
SR-DPC-VVI-2160/I	SVD
SR-DPC-VVI-2170/I	SVD
SR-DPC-VVI-2180/A	TS-DPS-VVI-1410/I
SR-DPC-VVI-2190/I	SVD
SR-DPC-VVI-2200/A	TS-DPS-VVI-1430/I
SR-DPP-FUN-1580/T	TS-DPP-FUN-2450/T
	TS-DPP-FUN-2460/T
	TS-DPP-FUN-2470/T
	TS-DPP-FUN-2475/T
	TS-DPP-FUN-2480/T
	TS-DPP-FUN-2490/T
SR-DPP-FUN-1590/T	TS-DPP-CFG-2590/I
	TS-DPP-CFG-2710/I
	TS-DPP-FUN-2500/T
	TS-DPP-FUN-2505/T
	TS-DPP-FUN-2550/T
SR-DPP-FUN-1600/T	TS-DPP-FUN-2520/T
SR-DPP-FUN-1610/T	TS-DPP-FUN-2510/T
SR-DPP-FUN-1620/T	TS-DPP-FUN-2530/T
SR-DPS-FUN-1360/T	TS-DPS-FUN-0010/T
SR-DPS-FUN-1370/T	TS-DPS-FUN-0120/T



RequirementName (SSS)	TracedTo (SRS)
SR-DPS-FUN-1380/T	TS-DPS-FUN-0122/T
SR-DPS-FUN-1390/T	TS-DPS-FUN-0030/T
	TS-DPS-FUN-0150/T
	TS-DPS-FUN-0151/T
	TS-DPS-IFR-0730/T
	TS-DPS-IFR-0731/T
SR-DPS-FUN-1400/T	TS-DPS-IFR-0680/T
SR-DPS-FUN-1410/T	TS-DPS-IFR-0630/T
	TS-DPS-IFR-0631/T
	TS-DPS-IFR-0632/T
	TS-DPS-IFR-0633/T
	TS-DPS-IFR-0650/T
	TS-DPS-IFR-0660/T
	TS-DPS-IFR-0670/T
SR-DPS-FUN-1420/T	TS-DPS-IFR-0640/T
SR-DPS-FUN-1430/T	TS-DPS-FUN-0121/T
SR-DPS-FUN-1440/T	TS-DPS-IFR-0600/T
	TS-DPS-IFR-0601/T
	TS-DPS-IFR-0610/T
	TS-DPS-IFR-0630/T
	TS-DPS-IFR-0633/T
	TS-DPS-IFR-0640/T
	TS-DPS-IFR-0650/T
	TS-DPS-IFR-0655/T
	TS-DPS-IFR-0660/T
	TS-DPS-IFR-0670/T
	TS-DPS-IFR-0680/T
SR-DPS-FUN-1450/T	TS-DPS-FUN-0050/T
	TS-DPS-IFR-0680/T
	TS-DPS-OPE-0853/T
SR-DPS-FUN-1460/T	TS-DPS-FUN-0050/T
	TS-DPS-OPE-0851/T
SR-DPS-FUN-1470/T	TS-DPS-FUN-0050/T
	TS-DPS-IFR-0640/T
	TS-DPS-OPE-0852/T
SR-DPS-FUN-1480/T	TS-DPS-FUN-0130/T
	TS-DPS-FUN-0131/T
	TS-DPS-FUN-0132/T
	TS-DPS-FUN-0143/T
SR-DPS-FUN-1490/T	TS-DPS-FUN-0130/T
	TS-DPS-FUN-0132/T
	TS-DPS-IFR-0680/T



RequirementName (SSS)	TracedTo (SRS)
SR-DPS-FUN-1500/T	TS-DPS-IFR-0710/T
SR-DPS-FUN-1510/T	TS-DPS-IFR-0712/T
SR-DPS-FUN-1520/T	TS-DPS-FUN-0020/T
	TS-DPS-FUN-0040/T
SR-DPS-FUN-1530/T	TS-DPS-FUN-0212/T
SR-DPS-FUN-1540/T	TS-DPS-FUN-0213/T
SR-DPS-FUN-1550/T	TS-DPS-FUN-0211/T
SR-DPS-FUN-1560/T	TS-DPS-FUN-0220/T
	TS-DPS-FUN-0221/T
SR-DPS-FUN-1570/T	TS-DSS-FUN-2850/T
	TS-DSS-FUN-2860/T
	TS-DSS-FUN-2870/T
	TS-DSS-FUN-2880/T
SR-DRT-FUN-0290/T	TS-DRT-FUN-0010/T
SR-DRT-FUN-0300/T	TS-DRT-FUN-0010/T
SR-DRT-FUN-0310/T	TS-DRT-FUN-0010/T
SR-DRT-FUN-0320/T	TS-DRT-FUN-0010/T
SR-DRT-FUN-0330/T	ICD
SR-DRT-FUN-0340/T	TS-DRT-FUN-0010/T
SR-DRT-FUN-0350/T	TS-DRT-FUN-0150/T
SR-DRT-FUN-0360/T	TS-DRT-FUN-0005/I
SR-DRT-IFR-0090/T	ICD
	TS-DRT-FUN-0010/T
	TS-PL1-FUN-0450/T
SR-DRT-IFR-0100/T	ICD
	TS-DRT-FUN-0010/T
	TS-PL1-FUN-0450/T
	TS-PL1-FUN-0460/T
SR-DRT-IFR-0110/T	ICD
	TS-DRT-FUN-0010/T
SR-DRT-IFR-0120/T	ICD
	TS-DRT-FUN-0010/T
	TS-PL1-FUN-0450/T
SR-DRT-IFR-0130/T	ICD
SR-DRT-IFR-0140/T	ICD
SR-DRT-IFR-0150/T	ICD
SR-DRT-IFR-0160/T	ICD
SR-DRT-IFR-0170/T	TS-DRT-FUN-0010/T
SR-DRT-IFR-0180/T	ICD
SR-DRT-IFR-0190/T	ICD
	TS-DRT-FUN-0040/T
SR-DRT-IFR-0200/T	ICD



RequirementName (SSS)	TracedTo (SRS)
SR-DRT-IFR-0210/T	ICD
SR-DRT-IFR-0220/T	ICD
SR-DRT-IFR-0230/T	ICD
SR-DRT-IFR-0240/T	ICD
SR-DRT-IFR-0250/T	ICD
SR-DRT-IFR-0260/T	ICD
SR-DRT-IFR-0270/T	ICD
SR-DRT-IFR-0280/T	ICD
SR-MCC-FUN-1050/I	TS-MCC-FUN-3440/I
SR-MCC-FUN-1060/I	TS-MCC-FUN-3450/I
SR-MCC-FUN-1070/T	TS-MCC-FUN-3460/T
	TS-MCC-FUN-3470/T
	TS-MCC-FUN-3480/T
SR-MCC-FUN-1080/T	TS-MCC-FUN-3490/T
SR-MCC-FUN-1090/I	TS-MCC-FUN-3500/I
SR-MCC-FUN-1100/T	TS-MCC-FUN-3510/T
	TS-MCC-FUN-3520/T
SR-MCC-FUN-1110/T	TS-MCC-FUN-3530/T
SR-MCC-FUN-1120/T	TS-MCC-FUN-3540/T
SR-MCC-FUN-1130/T	TS-MCC-FUN-3550/T
SR-MCC-FUN-1140/T	TS-MCC-FUN-3560/T
SR-MCC-FUN-1150/T	TS-MCC-FUN-3570/T
SR-MCC-FUN-1160/T	TS-MCC-FUN-3580/T
SR-MCC-FUN-1170/T	TS-MCC-FUN-3590/T
SR-MCC-FUN-1180/T	TS-MCC-FUN-3600/T
SR-MCC-FUN-1190/T	TS-MCC-FUN-3610/T
SR-MCC-FUN-1200/T	TS-MCC-FUN-3620/T
SR-MCC-FUN-1210/T	TS-MCC-FUN-3650/T
SR-MCC-FUN-1220/T	TS-MCC-FUN-3630/T
	TS-MCC-FUN-3640/T
SR-MCC-FUN-1230/T	Not covered
SR-MCC-FUN-1240/T	TS-MCC-FUN-3630/T
SR-MCC-FUN-1250/T	TS-MCC-FUN-3640/T
SR-MCC-FUN-1260/T	TS-MCC-FUN-3660/T
SR-MCC-FUN-1270/T	TS-MCC-FUN-3670/T
SR-MCC-FUN-1280/T	TS-MCC-FUN-3680/T
SR-MCC-FUN-1290/T	TS-MCC-FUN-3690/T
SR-MCC-FUN-1300/T	TS-MCC-FUN-3700/T
SR-MCC-FUN-1310/T	TS-MCC-FUN-3710/T
SR-MCC-FUN-1320/T	TS-MCC-FUN-3720/T
SR-MCC-FUN-1330/T	TS-MCC-FUN-3730/T
SR-MCC-FUN-1340/T	TS-MCC-FUN-3740/T



RequirementName (SSS)	TracedTo (SRS)
SR-MCC-FUN-1350/T	TS-MCC-FUN-3750/T
SR-PRO-FUN-0370/T	TS-DMA-FUN-2125/T
SR-PRO-FUN-0380/T	TS-DMA-FUN-2125/T
SR-PRO-FUN-0390/T	TS-DMA-FUN-2080/T
	TS-DMA-FUN-2125/T
	TS-DRT-FUN-0090/T
	TS-DRT-FUN-0150/T
	TS-PL1-FUN-0450/T
	TS-PL2-FUN-0710/T
	TS-PL2-FUN-0730/T
	TS-PL3-FUN-0890/T
SR-PRO-FUN-0400/T	TS-DMA-FUN-2080/T
SR-PRO-FUN-0410/T	TBC at CDR
SR-PRO-FUN-0420/T	TBC at CDR
SR-PRO-FUN-0430/T	TS-DMA-FUN-2120/T
SR-PRO-FUN-0440/T	TS-DMA-FUN-2125/T
SR-PRO-FUN-0450/T	TS-PL1-FUN-0450/T
SR-PRO-FUN-0460/T	TS-PL1-FUN-0450/T
SR-PRO-FUN-0470/T	TS-PL1-FUN-0460/T
SR-PRO-FUN-0480/T	TS-PL1-FUN-0460/T
SR-PRO-FUN-0490/T	TS-PL1-CFG-0660/I
	TS-PL1-FUN-0470/T
	TS-PL1-FUN-0480/T
SR-PRO-FUN-0500/T	TS-PL1-CFG-0670/I
	TS-PL1-FUN-0490/T
	TS-PL1-FUN-0500/T
	TS-PL2-CFG-0860/I
SR-PRO-FUN-0510/T	TS-PL1-CFG-0680/I
	TS-PL1-FUN-0510/T
SR-PRO-FUN-0520/T	TS-DLP-FUN-1010/I
	TS-DLP-FUN-1100/T
SR-PRO-FUN-0530/T	TS-DLP-FUN-1010/I
SR-PRO-FUN-0540/T	TS-DLP-FUN-1030/T
	TS-DLP-FUN-1060/T
SR-PRO-FUN-0550/T	TS-DLP-FUN-1110/T
SR-PRO-FUN-0560/T	TS-PL2-FUN-0690/T
	TS-PL2-FUN-0700/T
SR-PRO-FUN-0570/T	TS-DPP-FUN-2450/T
SR-PRO-FUN-0580/T	TS-PL2-FUN-0720/T
SR-PRO-FUN-0590/T	TS-PL2-FUN-0730/T
SR-PRO-FUN-0600/T	TS-PL2-FUN-0730/T
SR-PRO-FUN-0610/T	TS-PL3-FUN-0870/I



RequirementName (SSS)	TracedTo (SRS)
	TS-PL3-FUN-0890/T
	TS-PL3-FUN-0900/T
SR-PRO-FUN-0620/T	TS-PL3-FUN-0880/I
SR-PRO-FUN-0630/T	TS-DPS-FUN-0140/T
SR-PRO-FUN-0640/T	TS-DPS-IFR-0733/I
SR-PRO-FUN-0650/T	TS-DSS-FUN-3152/T
SR-PRO-FUN-0660/T	TS-DCF-FUN-3970/I
	TS-DCF-FUN-3990/I
SR-PRO-FUN-0670/T	TS-DCF-FUN-3970/I
	TS-DCF-FUN-3990/I
	TS-DIS-FUN-1550/T
SR-SSP-FUN-0990/T	TS-SSP-FUN-3760/T
	TS-SSP-FUN-3770/T
	TS-SSP-FUN-3780/T
	TS-SSP-FUN-3800/T
	TS-SSP-FUN-3810/T
	TS-SSP-FUN-3820/T
	TS-SSP-FUN-3830/T
	TS-SSP-FUN-3840/T
	TS-SSP-FUN-3850/T
	TS-SSP-FUN-3860/T
	TS-SSP-FUN-3870/T
	TS-SSP-FUN-3880/T
SR-SSP-FUN-1000/T	TS-SSP-FUN-3810/T
	TS-SSP-FUN-3820/T
	TS-SSP-FUN-3830/T
	TS-SSP-FUN-3840/T
	TS-SSP-FUN-3850/T
	TS-SSP-FUN-3860/T
	TS-SSP-FUN-3870/T
	TS-SSP-FUN-3880/T
SR-SSP-FUN-1010/T	TS-DPS-IFR-0730/T
	TS-SSP-FUN-3830/T
SR-SSP-FUN-1020/T	TS-SSP-FUN-3760/T
	TS-SSP-FUN-3770/T
	TS-SSP-FUN-3780/T
	TS-SSP-FUN-3810/T
	TS-SSP-FUN-3820/T
	TS-SSP-FUN-3830/T
	TS-SSP-FUN-3840/T
	TS-SSP-FUN-3850/T
	TS-SSP-FUN-3860/T



RequirementName (SSS)	TracedTo (SRS)
	TS-SSP-FUN-3870/T
	TS-SSP-FUN-3880/T
SR-SSP-FUN-1030/T	TS-SSP-FUN-3760/T
	TS-SSP-FUN-3770/T
	TS-SSP-FUN-3780/T
	TS-SSP-FUN-3800/T
	TS-SSP-FUN-3810/T
	TS-SSP-FUN-3820/T
	TS-SSP-FUN-3830/T
	TS-SSP-FUN-3840/T
	TS-SSP-FUN-3850/T
	TS-SSP-FUN-3860/T
	TS-SSP-FUN-3870/T
	TS-SSP-FUN-3880/T
SR-SSP-FUN-1040/T	TS-SSP-FUN-3760/T



Appendix D - Traceability matrix - SSS vs SRS

RequirementName (SRS)	TracedFROM (SSS)
TS-DCF-DAT-4100/I	
TS-DCF-DES-4020/I	SR-DPC-DES-1950/I
	SR-DPC-DES-1970/I
	SR-DPC-DES-2040/T
TS-DCF-FUN-3960/I	SR-DPC-DES-1910/A
	SR-DPC-DES-1940/I
	SR-DPC-DES-1950/I
TS-DCF-FUN-3970/I	SR-DPC-DES-1910/A
	SR-PRO-FUN-0660/T
	SR-PRO-FUN-0670/T
TS-DCF-FUN-3980/I	
TS-DCF-FUN-3990/I	SR-DPC-DES-2030/I
	SR-DPC-DES-2040/T
	SR-DPC-DES-2050/I
	SR-PRO-FUN-0660/T
	SR-PRO-FUN-0670/T
TS-DCF-FUN-4000/I	SR-DPC-DES-1930/T
TS-DCF-FUN-4010/I	
TS-DCF-FUN-4030/T	SR-DPC-DES-1910/A
	SR-DPC-FUN-0090/T
TS-DCF-FUN-4040/I	
TS-DCF-FUN-4050/I	
TS-DCF-FUN-4060/T	SR-DPC-DES-2030/I
TS-DCF-FUN-4080/T	SR-DPC-DES-1910/A
	SR-DPC-DES-2010/I
	SR-DPC-REL-1880/A
TS-DCF-SEC-4090/T	
TS-DIS-DDD-2070/T	
TS-DIS-DES-1950/T	
TS-DIS-DES-1960/T	SR-DPC-SW-0020
TS-DIS-DES-1970/I	SR-DPC-DES-2040/T
	SR-DPC-DES-2050/I
	SR-DPC-DES-2060/I
TS-DIS-DES-1980/I	SR-DPC-DES-2040/T
	SR-DPC-DES-2050/I
TS-DIS-DES-1990/I	SR-DPC-DES-2040/T
	SR-DPC-DES-2050/I
TS-DIS-DES-2000/I	SR-DPC-DES-2040/T
TS-DIS-DES-2010/I	SR-DIS-FUN-0870/T
TS-DIS-DES-2020/I	SR-DPC-DES-2070/I



RequirementName (SRS)	TracedFROM (SSS)
TS-DIS-FUN-1210/T	SR-DIS-FUN-1740/T
	SR-DIS-FUN-1780/T
TS-DIS-FUN-1220/T	SR-DIS-FUN-1740/T
	SR-DIS-FUN-1780/T
TS-DIS-FUN-1230/T	SR-DIS-FUN-1740/T
	SR-DIS-FUN-1780/T
TS-DIS-FUN-1240/T	SR-DIS-FUN-1740/T
	SR-DIS-FUN-1780/T
TS-DIS-FUN-1250/T	SR-DIS-FUN-1740/T
	SR-DIS-FUN-1780/T
TS-DIS-FUN-1260/T	SR-DIS-FUN-1740/T
	SR-DIS-FUN-1780/T
TS-DIS-FUN-1270/T	
TS-DIS-FUN-1280/T	SR-DIS-FUN-1780/T
TS-DIS-FUN-1290/T	SR-DIS-FUN-0840/T
	SR-DIS-IFR-0400/T
	SR-DPC-IFR-0070/T
TS-DIS-FUN-1300/T	SR-DIS-FUN-0890/T
	SR-DIS-IFR-0390/T
	SR-DIS-IFR-0400/T
TS-DIS-FUN-1301/T	SR-DIS-IFR-0390/T
TS-DIS-FUN-1310/T	SR-DIS-FUN-0900/T
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1320/T	SR-DIS-FUN-0950/T
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1330/T	SR-DIS-FUN-0930/T
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1340/T	SR-DIS-FUN-0930/T
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1350/T	SR-DIS-FUN-0920/T
	SR-DIS-FUN-0930/T
	SR-DIS-FUN-0960/T
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1360/T	SR-DIS-FUN-0940/T
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1370/T	SR-DIS-FUN-0780/T
	SR-DIS-FUN-0880/T
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1380/T	SR-DIS-FUN-0780/T
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1381/T	SR-DIS-IFR-0390/T
TS-DIS-FUN-1400/T	SR-DIS-FUN-0960/T



RequirementName (SRS)	TracedFROM (SSS)
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1420/T	SR-DIS-FUN-0880/T
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1430/T	SR-DIS-FUN-0980/T
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1450/T	SR-DIS-FUN-0910/T
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1460/T	SR-DIS-FUN-0970/T
	SR-DIS-IFR-0300/T
	SR-DIS-IFR-0390/T
TS-DIS-FUN-1471/T	SR-DIS-IFR-0390/T
TS-DIS-FUN-1472/T	SR-DIS-IFR-0390/T
TS-DIS-FUN-1476/T	SR-DIS -IFR-0370/T
TS-DIS-FUN-1480/T	SR-DIS-FUN-0750/T
	SR-DPC-FUN-0070/T
	SR-DPC-FUN-0080/A
TS-DIS-FUN-1490/T	SR-DIS-FUN-0730/T
	SR-DIS-FUN-0750/T
	SR-DPC-FUN-0040/A
	SR-DPC-FUN-0140/T
TS-DIS-FUN-1500/T	SR-DIS-FUN-0740/T
	SR-DIS-IFR-0290/T
TS-DIS-FUN-1510/T	SR-DIS-FUN-0750/T
	SR-DIS-FUN-0790/T
	SR-DPC-FUN-0150/T
TS-DIS-FUN-1520/T	SR-DIS-FUN-0750/T
	SR-DPC-FUN-0040/A
	SR-DPC-FUN-0160/T
TS-DIS-FUN-1530/T	SR-DIS-FUN-0750/T
	SR-DPC-FUN-0040/A
	SR-DPC-FUN-0190/T
TS-DIS-FUN-1540/T	SR-DIS-FUN-0750/T
	SR-DIS-FUN-0760/T
	SR-DIS-IFR-0300/T
	SR-DPC-FUN-0040/A
TS-DIS-FUN-1550/T	SR-DIS-FUN-0750/T
	SR-DPC-FUN-0200/T
	SR-PRO-FUN-0670/T
TS-DIS-FUN-1560/T	SR-DIS-FUN-0750/T
TS-DIS-FUN-1561/T	SR-DIS-FUN-0750/T
-	SR-DPC-FUN-0135/T
TS-DIS-FUN-1570/T	SR-DIS -IFR-0370/T



RequirementName (SRS)	TracedFROM (SSS)
	SR-DPC-IFR-0050/T
TS-DIS-FUN-1580/T	SR-DIS-IFR-0320/T
	SR-DPC-IFR-0080/T
TS-DIS-FUN-1590/T	SR-DIS-FUN-0750/T
	SR-DIS-IFR-0310/T
	SR-DPC-DES-2040/T
	SR-DPC-IFR-0060/T
	SR-DPC-IFR-0080/T
TS-DIS-FUN-1600/T	
TS-DIS-FUN-1610/T	
TS-DIS-FUN-1620/T	SR-DIS-FUN-0810/T
TS-DIS-FUN-1630/T	SR-DIS-FUN-0750/T
	SR-DIS-FUN-0770/T
	SR-DIS-IFR-0340/T
	SR-DPC-FUN-0050/A
	SR-DPC-FUN-0070/T
TS-DIS-FUN-1640/T	SR-DIS-FUN-0750/T
	SR-DIS-FUN-0770/T
	SR-DIS-IFR-0340/T
	SR-DPC-FUN-0050/A
TS-DIS-FUN-1650/T	SR-DIS-FUN-0750/T
	SR-DIS-FUN-0770/T
	SR-DIS-IFR-0340/T
	SR-DPC-FUN-0050/A
TS-DIS-FUN-1660/T	SR-DIS-FUN-0750/T
	SR-DIS-FUN-0770/T
	SR-DIS-IFR-0340/T
	SR-DPC-FUN-0050/A
TS-DIS-FUN-1670/T	SR-DIS-FUN-0750/T
	SR-DIS-FUN-0770/T
	SR-DIS-IFR-0330/T
	SR-DIS-IFR-0340/T
	SR-DPC-FUN-0050/A
TS-DIS-FUN-1680/T	SR-DIS-FUN-0750/T
	SR-DIS-IFR-0340/T
	SR-DPC-FUN-0050/A
	SR-DPC-FUN-0170/T
TS-DIS-FUN-1690/T	SR-DIS-FUN-0780/T
	SR-DIS-IFR-0340/T
TS-DIS-FUN-1700/T	SR-DIS-IFR-0350/T
TS-DIS-FUN-1710/T	SR-DIS-FUN-0830/T
TS-DIS-FUN-1720/T	SR-DIS-FUN-0820/T



RequirementName (SRS)	TracedFROM (SSS)
	SR-DIS-FUN-0850/T
TS-DIS-FUN-1730/T	SR-DIS-FUN-1740/T
TS-DIS-FUN-1740/T	SR-DIS-FUN-0850/T
TS-DIS-FUN-1741/T	
TS-DIS-FUN-1750/T	SR-DIS-FUN-1740/T
TS-DIS-FUN-1760/T	SR-DIS-FUN-0850/T
TS-DIS-FUN-1770/T	SR-DIS-FUN-0850/T
TS-DIS-FUN-1780/T	SR-DIS-FUN-0850/T
TS-DIS-FUN-1790/T	SR-DIS-FUN-0800/T
	SR-DIS-FUN-0820/T
	SR-DIS-FUN-1760/T
TS-DIS-FUN-1800/T	SR-DIS-FUN-0820/T
	SR-DIS-FUN-1760/T
TS-DIS-FUN-1810/T	SR-DIS-FUN-0820/T
	SR-DIS-FUN-1760/T
TS-DIS-FUN-1820/T	SR-DIS-FUN-0820/T
	SR-DIS-FUN-1760/T
TS-DIS-FUN-1830/T	SR-DIS-FUN-0820/T
	SR-DIS-FUN-1760/T
TS-DIS-FUN-1840/T	SR-DIS-FUN-0810/T
	SR-DIS-FUN-0820/T
	SR-DIS-FUN-0860/T
	SR-DIS-FUN-1760/T
TS-DIS-FUN-1850/T	SR-DIS-FUN-0810/T
	SR-DIS-FUN-0820/T
	SR-DIS-FUN-0860/T
	SR-DIS-FUN-1760/T
TS-DIS-FUN-1860/T	SR-DIS-FUN-0830/T
TS-DIS-FUN-1861/T	
TS-DIS-FUN-1870/T	
TS-DIS-OPE-1910/T	
TS-DIS-OPE-1920/T	
TS-DIS-OPE-1930/T	
TS-DIS-OPE-1940/T	
TS-DIS-PER-1875/T	SR-DPC-PER-0210/T
TS-DIS-PER-1880/T	
TS-DIS-PER-1890/T	
TS-DIS-PER-1900/T	SR-DIS-FUN-0380/T
TS-DIS-SEC-2030/T	SR-DIS-FUN-1780/T
TS-DIS-SEC-2040/T	SR-DIS-FUN-1740/T
	SR-DIS-FUN-1750/T
TS-DIS-SEC-2050/T	SR-DIS-FUN-1740/T



RequirementName (SRS)	TracedFROM (SSS)
	SR-DIS-FUN-1770/T
	SR-DIS-FUN-1790/I
	SR-DIS-FUN-1800/I
	SR-DIS-IFR-0360/T
	SR-DIS-IFR-0410/T
TS-DIS-SEC-2060/T	SR-DIS-FUN-1800/I
	SR-DIS-FUN-1820/I
TS-DLP-CFG-1190/T	
TS-DLP-CFG-1200/T	
TS-DLP-DES-1180/I	SR-DPC-DES-2070/I
TS-DLP-FUN-1010/I	SR-PRO-FUN-0520/T
	SR-PRO-FUN-0530/T
TS-DLP-FUN-1012/T	
TS-DLP-FUN-1020/T	
TS-DLP-FUN-1022/T	
TS-DLP-FUN-1025/T	
TS-DLP-FUN-1030/T	SR-PRO-FUN-0540/T
TS-DLP-FUN-1035/T	
TS-DLP-FUN-1040/T	
TS-DLP-FUN-1050/T	
TS-DLP-FUN-1060/T	SR-PRO-FUN-0540/T
TS-DLP-FUN-1070/T	
TS-DLP-FUN-1080/T	
TS-DLP-FUN-1090/T	
TS-DLP-FUN-1100/T	SR-PRO-FUN-0520/T
TS-DLP-FUN-1105/T	
TS-DLP-FUN-1110/T	SR-PRO-FUN-0550/T
TS-DLP-FUN-1120/T	SR-DPC-PER-0280/T
TS-DLP-FUN-1125/T	
TS-DLP-FUN-1130/T	
TS-DLP-OPE-1160/T	
TS-DLP-OPE-1170/T	
TS-DLP-PER-1140/T	
TS-DMA-CFG-2350/T	
TS-DMA-CFG-2360/T	
TS-DMA-DDD-2370/A	SR-DMA-FUN-0690/T
	SR-DMA-FUN-0700/T
TS-DMA-DDD-2380/A	SR-DMA-FUN-0710/T
TS-DMA-DES-2300/T	
TS-DMA-DES-2430/I	
TS-DMA-FUN-2080/T	SR-DMA-FUN-0690/T
	SR-DMA-FUN-0700/T



RequirementName (SRS)	TracedFROM (SSS)
	SR-DPC-FUN-0080/A
	SR-PRO-FUN-0390/T
	SR-PRO-FUN-0400/T
TS-DMA-FUN-2090/T	SR-DMA-FUN-0690/T
TS-DMA-FUN-2100/T	SR-DMA-FUN-0690/T
TS-DMA-FUN-2110/T	SR-DMA-FUN-0690/T
TS-DMA-FUN-2120/T	SR-DMA-FUN-0690/T
	SR-PRO-FUN-0430/T
TS-DMA-FUN-2125/T	SR-PRO-FUN-0370/T
	SR-PRO-FUN-0380/T
	SR-PRO-FUN-0390/T
	SR-PRO-FUN-0440/T
TS-DMA-FUN-2130/I	SR-DMA-FUN-0680/T
TS-DMA-FUN-2140/I	
TS-DMA-FUN-2150/T	SR-DMA-FUN-0680/T
TS-DMA-FUN-2160/T	SR-DMA-FUN-0710/T
TS-DMA-FUN-2170/T	SR-DMA-FUN-0720/T
TS-DMA-FUN-2180/T	
TS-DMA-FUN-2190/T	
TS-DMA-FUN-2410/I	
TS-DMA-FUN-2420/I	
TS-DMA-OPE-2210/T	
TS-DMA-OPE-2220/T	
TS-DMA-OPE-2230/T	
TS-DMA-OPE-2240/T	
TS-DMA-OPE-2250/T	
TS-DMA-OPE-2260/T	
TS-DMA-OPE-2270/T	
TS-DMA-OPE-2280/T	
TS-DMA-PER-2200/I	SR-DPC-DES-1930/T
TS-DMA-SAF-2310/I	SR-DPC-SAF-1840/I
	SR-DPC-SAF-1860/I
TS-DMA-SAF-2320/T	SR-DPC-SAF-1870/T
TS-DMA-SAF-2330/I	SR-DPC-SAF-1870/T
TS-DMA-SAF-2340/T	SR-DPC-SAF-1850/I
TS-DPP-CFG-2590/I	SR-DPP-FUN-1590/T
TS-DPP-CFG-2710/I	SR-DPP-FUN-1590/T
TS-DPP-DES-2570/T	SR-DPC-DES-1920/A
	SR-DPC-SW-0020
TS-DPP-DES-2580/I	SR-DPC-DES-2070/I
TS-DPP-FUN-2450/T	SR-DPC-FUN-0080/A
	SR-DPP-FUN-1580/T



RequirementName (SRS)	TracedFROM (SSS)
	SR-PRO-FUN-0570/T
TS-DPP-FUN-2460/T	SR-DPP-FUN-1580/T
TS-DPP-FUN-2470/T	SR-DPP-FUN-1580/T
TS-DPP-FUN-2475/T	SR-DPP-FUN-1580/T
TS-DPP-FUN-2480/T	SR-DPP-FUN-1580/T
TS-DPP-FUN-2490/T	SR-DPP-FUN-1580/T
TS-DPP-FUN-2500/T	SR-DPP-FUN-1590/T
TS-DPP-FUN-2505/T	SR-DPP-FUN-1590/T
TS-DPP-FUN-2510/T	SR-DPP-FUN-1610/T
TS-DPP-FUN-2520/T	SR-DPP-FUN-1600/T
TS-DPP-FUN-2530/T	SR-DPP-FUN-1620/T
TS-DPP-FUN-2540/T	
TS-DPP-FUN-2550/T	SR-DPP-FUN-1590/T
TS-DPP-PER-2560/I	
TS-DPS-DES-0051/T	
TS-DPS-DES-0310/T	
TS-DPS-DES-0340/T	
TS-DPS-DES-0341/T	
TS-DPS-DES-0342/T	
TS-DPS-DES-1600/T	
TS-DPS-DES-1610/I	
TS-DPS-FUN-0010/T	SR-DPS-FUN-1360/T
TS-DPS-FUN-0020/T	SR-DPC-FUN-0180/T
	SR-DPS-FUN-1520/T
TS-DPS-FUN-0030/T	SR-DPS-FUN-1390/T
TS-DPS-FUN-0040/T	SR-DPS-FUN-1520/T
TS-DPS-FUN-0050/T	SR-DPS-FUN-1450/T
	SR-DPS-FUN-1460/T
	SR-DPS-FUN-1470/T
TS-DPS-FUN-0100/I	
TS-DPS-FUN-0110/T	
TS-DPS-FUN-0111/T	
TS-DPS-FUN-0112/T	
TS-DPS-FUN-0113/T	
TS-DPS-FUN-0114/T	
TS-DPS-FUN-0115/T	
TS-DPS-FUN-0120/T	SR-DPC-FUN-0180/T
	SR-DPS-FUN-1370/T
TS-DPS-FUN-0121/T	SR-DPS-FUN-1430/T
TS-DPS-FUN-0122/T	SR-DPC-FUN-0180/T
	SR-DPS-FUN-1380/T
TS-DPS-FUN-0123/T	xxx



RequirementName (SRS)	TracedFROM (SSS)
TS-DPS-FUN-0130/T	SR-DPS-FUN-1480/T
	SR-DPS-FUN-1490/T
TS-DPS-FUN-0131/T	SR-DPS-FUN-1480/T
TS-DPS-FUN-0132/T	SR-DPS-FUN-1480/T
	SR-DPS-FUN-1490/T
TS-DPS-FUN-0133/T	
TS-DPS-FUN-0140/T	SR-PRO-FUN-0630/T
TS-DPS-FUN-0141/T	
TS-DPS-FUN-0142/T	
TS-DPS-FUN-0143/T	SR-DPS-FUN-1480/T
TS-DPS-FUN-0144/T	
TS-DPS-FUN-0145/T	
TS-DPS-FUN-0146/T	
TS-DPS-FUN-0150/T	SR-DPS-FUN-1390/T
TS-DPS-FUN-0151/T	SR-DPS-FUN-1390/T
TS-DPS-FUN-0152/T	
TS-DPS-FUN-0153/T	
TS-DPS-FUN-0154/T	
TS-DPS-FUN-0155/T	
TS-DPS-FUN-0200/I	
TS-DPS-FUN-0211/T	SR-DPS-FUN-1550/T
TS-DPS-FUN-0212/T	SR-DPS-FUN-1530/T
TS-DPS-FUN-0213/T	SR-DPS-FUN-1540/T
TS-DPS-FUN-0220/T	SR-DPS-FUN-1560/T
TS-DPS-FUN-0221/T	SR-DPS-FUN-1560/T
TS-DPS-FUN-0320/T	
TS-DPS-FUN-0321/T	
TS-DPS-FUN-0330/T	
TS-DPS-FUN-0520/T	
TS-DPS-FUN-0521/T	
TS-DPS-FUN-0522/T	
TS-DPS-HW-1100/T	
TS-DPS-HW-1110/T	
TS-DPS-HW-1111/T	
TS-DPS-IFR-0500/T	
TS-DPS-IFR-0510/T	
TS-DPS-IFR-0511/T	
TS-DPS-IFR-0530/T	
TS-DPS-IFR-0531/T	
TS-DPS-IFR-0532/T	
TS-DPS-IFR-0540/T	
TS-DPS-IFR-0541/T	



RequirementName (SRS)	TracedFROM (SSS)
TS-DPS-IFR-0550/T	
TS-DPS-IFR-0600/T	SR-DPS-FUN-1440/T
TS-DPS-IFR-0601/T	SR-DPS-FUN-1440/T
TS-DPS-IFR-0610/T	SR-DPS-FUN-1440/T
TS-DPS-IFR-0620/T	
TS-DPS-IFR-0630/T	SR-DPS-FUN-1410/T
	SR-DPS-FUN-1440/T
TS-DPS-IFR-0631/T	SR-DPS-FUN-1410/T
TS-DPS-IFR-0632/T	SR-DPS-FUN-1410/T
TS-DPS-IFR-0633/T	SR-DPS-FUN-1410/T
	SR-DPS-FUN-1440/T
TS-DPS-IFR-0640/T	SR-DPS-FUN-1420/T
	SR-DPS-FUN-1440/T
	SR-DPS-FUN-1470/T
TS-DPS-IFR-0650/T	SR-DPS-FUN-1410/T
	SR-DPS-FUN-1440/T
TS-DPS-IFR-0655/T	SR-DPS-FUN-1440/T
TS-DPS-IFR-0660/T	SR-DPS-FUN-1410/T
	SR-DPS-FUN-1440/T
TS-DPS-IFR-0670/T	SR-DPS-FUN-1410/T
	SR-DPS-FUN-1440/T
TS-DPS-IFR-0680/T	SR-DPS-FUN-1400/T
	SR-DPS-FUN-1440/T
	SR-DPS-FUN-1450/T
	SR-DPS-FUN-1490/T
TS-DPS-IFR-0681/T	
TS-DPS-IFR-0710/T	SR-DPS-FUN-1500/T
TS-DPS-IFR-0711/T	
TS-DPS-IFR-0712/T	SR-DPS-FUN-1510/T
TS-DPS-IFR-0713/T	
TS-DPS-IFR-0714/T	
TS-DPS-IFR-0715/T	
TS-DPS-IFR-0720/T	SR-DPC-DAT-0250/I
TS-DPS-IFR-0721/T	SR-DPC-DAT-0250/I
TS-DPS-IFR-0722/T	
TS-DPS-IFR-0723/T	
TS-DPS-IFR-0724/T	
TS-DPS-IFR-0725/T	
TS-DPS-IFR-0726/T	
TS-DPS-IFR-0727/T	
TS-DPS-IFR-0730/T	SR-DPS-FUN-1390/T
	SR-SSP-FUN-1010/T



RequirementName (SRS)	TracedFROM (SSS)
TS-DPS-IFR-0731/T	SR-DPS-FUN-1390/T
TS-DPS-IFR-0732/T	
TS-DPS-IFR-0733/I	SR-DPC-DES-2060/I
	SR-PRO-FUN-0640/T
TS-DPS-OPE-0810/T	
TS-DPS-OPE-0820/T	
TS-DPS-OPE-0830/T	
TS-DPS-OPE-0840/T	
TS-DPS-OPE-0851/T	SR-DPS-FUN-1460/T
TS-DPS-OPE-0852/T	SR-DPS-FUN-1470/T
TS-DPS-OPE-0853/T	SR-DPS-FUN-1450/T
TS-DPS-OPE-1700/I	
TS-DPS-OPE-1800/I	
TS-DPS-OPE-1900/I	
TS-DPS-PER-0410/T	
TS-DPS-PER-0420/T	
TS-DPS-SW-0551/T	
TS-DPS-SW-1010/I	SR-DPC-DES-2070/I
TS-DPS-SW-1011/I	
TS-DPS-SW-1020/T	SR-DPC-HW-1720
TS-DPS-SW-1021/I	
TS-DPS-SW-1030/I	
TS-DPS-SW-1040/I	
TS-DPS-SW-1050/I	SR-DPC-DES-2050/I
TS-DPS-SWQ-1400/I	SR-DPC-SW-0010/I
TS-DPS-SWQ-1401/I	SR-DPC-SWQ-1900/AI
TS-DPS-SWQ-1402/I	
TS-DPS-VVI-1410/I	SR-DPC-VVI-2180/A
TS-DPS-VVI-1420/I	SR-DPC-VVI-2150/T
TS-DPS-VVI-1430/I	SR-DPC-VVI-2200/A
TS-DPS-VVI-1440/I	
TS-DRT-CFG-0420/T	
TS-DRT-CFG-0430/T	
TS-DRT-CFG-0440/T	
TS-DRT-DES-0360/T	SR-DPC-DES-1920/A
	SR-DPC-SW-0020
TS-DRT-DES-0370/T	SR-DPC-DES-1920/A
	SR-DPC-SW-0020
TS-DRT-DES-0380/T	SR-DPC-DES-1920/A
	SR-DPC-SW-0020
TS-DRT-DES-0390/I	SR-DPC-DES-2070/I
TS-DRT-DES-0400/T	SR-DPC-PER-0100/A



RequirementName (SRS)	TracedFROM (SSS)
	SR-DPC-PER-0270/A
	SR-DPC-REL-1890/A
TS-DRT-DES-0410/T	
TS-DRT-FUN-0005/I	SR-DRT-FUN-0360/T
TS-DRT-FUN-0010/T	SR-DPC-FUN-0040/A
	SR-DPC-FUN-0050/A
	SR-DPC-FUN-0080/A
	SR-DPC-IFR-0010/T
	SR-DPC-IFR-0020/T
	SR-DPC-IFR-0030/T
	SR-DPC-IFR-0040/T
	SR-DPC-PER-0270/A
	SR-DRT-FUN-0290/T
	SR-DRT-FUN-0300/T
	SR-DRT-FUN-0310/T
	SR-DRT-FUN-0320/T
	SR-DRT-FUN-0340/T
	SR-DRT-IFR-0090/T
	SR-DRT-IFR-0100/T
	SR-DRT-IFR-0110/T
	SR-DRT-IFR-0120/T
	SR-DRT-IFR-0170/T
TS-DRT-FUN-0020/T	
TS-DRT-FUN-0030/T	
TS-DRT-FUN-0040/T	SR-DRT-IFR-0190/T
TS-DRT-FUN-0050/T	
TS-DRT-FUN-0060/T	
TS-DRT-FUN-0070/T	
TS-DRT-FUN-0080/T	
TS-DRT-FUN-0085/T	
TS-DRT-FUN-0090/T	SR-PRO-FUN-0390/T
TS-DRT-FUN-0100/T	
TS-DRT-FUN-0110/T	
TS-DRT-FUN-0120/T	
TS-DRT-FUN-0130/T	
TS-DRT-FUN-0140/T	
TS-DRT-FUN-0150/T	SR-DRT-FUN-0350/T
	SR-PRO-FUN-0390/T
TS-DRT-FUN-0160/T	
TS-DRT-FUN-0170/T	
TS-DRT-FUN-0180/T	SR-DPC-DES-1930/T
TS-DRT-FUN-0190/T	



RequirementName (SRS)	TracedFROM (SSS)
TS-DRT-FUN-0200/T	
TS-DRT-OPE-0240/T	
TS-DRT-OPE-0250/T	
TS-DRT-OPE-0260/T	
TS-DRT-OPE-0270/T	
TS-DRT-OPE-0280/T	
TS-DRT-OPE-0290/T	
TS-DRT-OPE-0300/T	
TS-DRT-OPE-0310/T	
TS-DRT-OPE-0320/T	
TS-DRT-OPE-0330/T	
TS-DRT-OPE-0340/T	
TS-DRT-OPE-0350/T	
TS-DRT-PER-0205/T	SR-DPC-PER-0210/T
TS-DRT-PER-0210/T	SR-DPC-DES-1930/T
TS-DRT-PER-0220/T	SR-DPC-DES-1930/T
TS-DRT-PER-0230/T	
TS-DSS-DDD-3430/T	SR-DPC-DES-2060/I
TS-DSS-DES-3250/T	
TS-DSS-FUN-2830/T	
TS-DSS-FUN-2840/T	
TS-DSS-FUN-2850/T	SR-DPS-FUN-1570/T
TS-DSS-FUN-2860/T	SR-DPS-FUN-1570/T
TS-DSS-FUN-2870/T	SR-DPS-FUN-1570/T
TS-DSS-FUN-2880/T	SR-DPS-FUN-1570/T
TS-DSS-FUN-3020/T	
TS-DSS-FUN-3150/T	
TS-DSS-FUN-3152/T	SR-PRO-FUN-0650/T
TS-DSS-FUN-3155/T	
TS-DSS-FUN-3160/T	
TS-DSS-OPE-3190/T	
TS-DSS-OPE-3200/T	
TS-DSS-OPE-3210/T	
TS-MCC-FUN-3440/I	SR-DPC-FUN-0080/A
	SR-DPC-OPE-2080/I
	SR-MCC-FUN-1050/I
TS-MCC-FUN-3450/I	SR-MCC-FUN-1060/I
TS-MCC-FUN-3460/T	SR-MCC-FUN-1070/T
TS-MCC-FUN-3470/T	SR-MCC-FUN-1070/T
TS-MCC-FUN-3480/T	SR-MCC-FUN-1070/T
TS-MCC-FUN-3490/T	SR-MCC-FUN-1080/T
TS-MCC-FUN-3500/I	SR-MCC-FUN-1090/I



RequirementName (SRS)	TracedFROM (SSS)
TS-MCC-FUN-3510/T	SR-MCC-FUN-1100/T
TS-MCC-FUN-3520/T	SR-MCC-FUN-1100/T
TS-MCC-FUN-3530/T	SR-MCC-FUN-1110/T
TS-MCC-FUN-3540/T	SR-MCC-FUN-1120/T
TS-MCC-FUN-3550/T	SR-MCC-FUN-1130/T
TS-MCC-FUN-3560/T	SR-MCC-FUN-1140/T
TS-MCC-FUN-3570/T	SR-MCC-FUN-1150/T
TS-MCC-FUN-3580/T	SR-MCC-FUN-1160/T
TS-MCC-FUN-3590/T	SR-MCC-FUN-1170/T
TS-MCC-FUN-3600/T	SR-MCC-FUN-1180/T
TS-MCC-FUN-3610/T	SR-MCC-FUN-1190/T
TS-MCC-FUN-3620/T	SR-MCC-FUN-1200/T
TS-MCC-FUN-3630/T	SR-MCC-FUN-1220/T
	SR-MCC-FUN-1240/T
TS-MCC-FUN-3640/T	SR-MCC-FUN-1220/T
	SR-MCC-FUN-1250/T
TS-MCC-FUN-3650/T	SR-MCC-FUN-1210/T
TS-MCC-FUN-3660/T	SR-MCC-FUN-1260/T
TS-MCC-FUN-3670/T	SR-MCC-FUN-1270/T
TS-MCC-FUN-3680/T	SR-MCC-FUN-1280/T
TS-MCC-FUN-3690/T	SR-MCC-FUN-1290/T
TS-MCC-FUN-3700/T	SR-MCC-FUN-1300/T
TS-MCC-FUN-3710/T	SR-MCC-FUN-1310/T
TS-MCC-FUN-3720/T	SR-MCC-FUN-1320/T
TS-MCC-FUN-3730/T	SR-MCC-FUN-1330/T
TS-MCC-FUN-3740/T	SR-MCC-FUN-1340/T
TS-MCC-FUN-3750/T	SR-MCC-FUN-1350/T
TS-PL1-CFG-0660/I	SR-PRO-FUN-0490/T
TS-PL1-CFG-0670/I	SR-PRO-FUN-0500/T
TS-PL1-CFG-0680/I	SR-PRO-FUN-0510/T
TS-PL1-DES-0630/T	SR-DPC-DES-1920/A
TS-PL1-DES-0640/T	SR-DPC-DES-1920/A
TS-PL1-DES-0650/I	SR-DPC-DES-2070/I
TS-PL1-FUN-0450/T	SR-DPC-DES-2040/T
	SR-DPC-DES-2050/I
	SR-DPC-FUN-0080/A
	SR-DRT-IFR-0090/T
	SR-DRT-IFR-0100/T
	SR-DRT-IFR-0120/T
	SR-PRO-FUN-0390/T
	SR-PRO-FUN-0450/T
	SR-PRO-FUN-0460/T



RequirementName (SRS)	TracedFROM (SSS)
TS-PL1-FUN-0460/T	SR-DRT-IFR-0100/T
	SR-PRO-FUN-0470/T
	SR-PRO-FUN-0480/T
TS-PL1-FUN-0470/T	SR-PRO-FUN-0490/T
TS-PL1-FUN-0480/T	SR-PRO-FUN-0490/T
TS-PL1-FUN-0490/T	SR-PRO-FUN-0500/T
TS-PL1-FUN-0500/T	SR-PRO-FUN-0500/T
TS-PL1-FUN-0510/T	SR-PRO-FUN-0510/T
TS-PL1-FUN-0520/T	
TS-PL1-FUN-0530/T	
TS-PL1-FUN-0540/T	
TS-PL1-OPE-0560/T	
TS-PL1-OPE-0570/T	
TS-PL1-OPE-0580/T	
TS-PL1-OPE-0590/T	
TS-PL1-OPE-0600/T	
TS-PL1-OPE-0610/T	
TS-PL1-OPE-0620/T	
TS-PL1-PER-0545/T	SR-DPC-PER-0210/T
TS-PL1-PER-0550/T	SR-DPC-DES-1930/T
TS-PL2-CFG-0860/I	SR-PRO-FUN-0500/T
TS-PL2-DES-0850/I	SR-DPC-DES-2070/I
TS-PL2-FUN-0690/T	SR-DPC-FUN-0080/A
	SR-DPC-FUN-0130/T
	SR-PRO-FUN-0560/T
TS-PL2-FUN-0700/T	SR-PRO-FUN-0560/T
TS-PL2-FUN-0705/T	
TS-PL2-FUN-0710/T	SR-PRO-FUN-0390/T
TS-PL2-FUN-0715/T	
TS-PL2-FUN-0718/T	SR-DPC-FUN-0130/T
TS-PL2-FUN-0720/T	SR-PRO-FUN-0580/T
TS-PL2-FUN-0730/T	SR-PRO-FUN-0390/T
	SR-PRO-FUN-0590/T
	SR-PRO-FUN-0600/T
TS-PL2-FUN-0760/T	
TS-PL2-FUN-0770/T	
TS-PL2-OPE-0780/T	
TS-PL2-OPE-0790/T	
TS-PL2-OPE-0800/T	
TS-PL2-OPE-0810/T	
TS-PL2-OPE-0820/T	
TS-PL2-OPE-0830/T	



RequirementName (SRS)	TracedFROM (SSS)
TS-PL2-OPE-0840/T	
TS-PL3-DES-1000/I	SR-DPC-DES-2070/I
TS-PL3-FUN-0870/I	SR-DPC-FUN-0060/A
	SR-DPC-FUN-0080/A
	SR-PRO-FUN-0610/T
TS-PL3-FUN-0880/I	SR-DPC-FUN-0060/A
	SR-PRO-FUN-0620/T
TS-PL3-FUN-0890/T	SR-DPC-FUN-0060/A
	SR-PRO-FUN-0390/T
	SR-PRO-FUN-0610/T
TS-PL3-FUN-0900/T	SR-DPC-FUN-0060/A
	SR-PRO-FUN-0610/T
TS-PL3-FUN-0910/T	SR-DPC-FUN-0060/A
TS-PL3-FUN-0920/T	
TS-PL3-OPE-0930/T	
TS-PL3-OPE-0940/T	
TS-PL3-OPE-0950/T	
TS-PL3-OPE-0960/T	
TS-PL3-OPE-0970/T	
TS-PL3-OPE-0980/T	
TS-PL3-OPE-0990/T	
TS-SSP-DES-3930/T	SR-DPC-DES-1920/A
TS-SSP-DES-3940/T	SR-DPC-DES-1920/A
TS-SSP-DES-3950/I	SR-DPC-DES-2070/I
TS-SSP-FUN-3760/T	SR-DPC-FUN-0080/A
	SR-SSP-FUN-0990/T
	SR-SSP-FUN-1020/T
	SR-SSP-FUN-1030/T
	SR-SSP-FUN-1040/T
TS-SSP-FUN-3770/T	SR-SSP-FUN-0990/T
	SR-SSP-FUN-1020/T
	SR-SSP-FUN-1030/T
TS-SSP-FUN-3780/T	SR-SSP-FUN-0990/T
	SR-SSP-FUN-1020/T
	SR-SSP-FUN-1030/T
TS-SSP-FUN-3790/T	
TS-SSP-FUN-3800/T	SR-SSP-FUN-0990/T
	SR-SSP-FUN-1030/T
TS-SSP-FUN-3810/T	SR-SSP-FUN-0990/T
	SR-SSP-FUN-1000/T
	SR-SSP-FUN-1020/T
	SR-SSP-FUN-1030/T



RequirementName (SRS)	TracedFROM (SSS)
TS-SSP-FUN-3820/T	SR-SSP-FUN-0990/T
	SR-SSP-FUN-1000/T
	SR-SSP-FUN-1020/T
	SR-SSP-FUN-1030/T
TS-SSP-FUN-3830/T	SR-SSP-FUN-0990/T
	SR-SSP-FUN-1000/T
	SR-SSP-FUN-1010/T
	SR-SSP-FUN-1020/T
	SR-SSP-FUN-1030/T
TS-SSP-FUN-3840/T	SR-SSP-FUN-0990/T
	SR-SSP-FUN-1000/T
	SR-SSP-FUN-1020/T
	SR-SSP-FUN-1030/T
TS-SSP-FUN-3850/T	SR-SSP-FUN-0990/T
	SR-SSP-FUN-1000/T
	SR-SSP-FUN-1020/T
	SR-SSP-FUN-1030/T
TS-SSP-FUN-3860/T	SR-SSP-FUN-0990/T
	SR-SSP-FUN-1000/T
	SR-SSP-FUN-1020/T
	SR-SSP-FUN-1030/T
TS-SSP-FUN-3870/T	SR-SSP-FUN-0990/T
	SR-SSP-FUN-1000/T
	SR-SSP-FUN-1020/T
	SR-SSP-FUN-1030/T
TS-SSP-FUN-3880/T	SR-SSP-FUN-0990/T
	SR-SSP-FUN-1000/T
	SR-SSP-FUN-1020/T
	SR-SSP-FUN-1030/T
TS-SSP-FUN-3890/T	
TS-SSP-FUN-3900/T	
TS-SSP-OPE-3920/T	
TS-SSP-PER-3910/T	



Appendix E - Traceability matrix - CCN1 vs SRS

CCN1 technical requirements	RequirementName (SRS)
Section 2: Database Migration to Oracle RAC	TS-DCF-DAT-4100/I
Section 3: DATA ARCHIVING AND PURGING	TS-DMA-DES-2430/I
Section 5: Migration to Tomcat	TS-DIS-DES-2020/I
	TS-DLP-DES-1180/I
	TS-DPP-DES-2580/I
	TS-DRT-DES-0390/I
	TS-DSS-DES-3250/T
	TS-PL1-DES-0650/I
	TS-PL2-DES-0850/I
	TS-PL3-DES-1000/I
Section 7: Satellite AIS Input interface adaptation	TS-DRT-FUN-0005/I
	TS-PL1-FUN-0450/T
	TS-PL1-FUN-0460/T
	TS-PL1-FUN-0470/T
	TS-PL1-FUN-0480/T
	TS-PL1-OPE-0560/T
	TS-PL1-OPE-0570/T
	TS-PL1-OPE-0580/T
	TS-PL1-OPE-0590/T
	TS-PL1-OPE-0610/T
Section 8: B2/B3 interface adaptation	TS-DIS-FUN-1476/T
	TS-DIS-FUN-1500/T
	TS-DIS-FUN-1561/T
	TS-DIS-FUN-1570/T
	TS-DIS-PER-1900/T

Section 4 - Caching has not been selected in the CCN1:

The preliminary conclusion of implementing a caching mechanism of the integration test report has been modified in the delta DQR testing report. The conclusions that identified the database as being the major bottleneck of the system have been proved wrong during the last revision of the delta DQR integration test report. The complementary testing session showed that the partitioned database was solving this potential issue. Additionally, it was proven that no service degradation occurred between the start of a day (new partition) and the end of the day (end of the partition).

As specified in SAI-CLS-RS-3014, the architecture of S-AIS DPC is fully SOA. This is why: in particular, the main components of the system are stateless and independent: data and the context for its processing are provided at each call (in respect to Inversion of Control software paradigm). Since there is no information memorizing, none of those components can be improved by the usage of a caching mechanism.



Section 6 - ESB MIGRATION to ORACLE Service BUS has not been selected in the CCN1 because of the cost of the proposed solution with respect to the available budget.

Section 9-10-11-12 don't have any impact on the Software Requirement Specifications.