Technical Specification 4DWxCube

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Abstract

The 4DWxCube Domain System is being developed as the focal point between Airspace and ATM users, on one side, and consistent, common & harmonized, integrated & interoperable MET Information providers, on the other side.
This document describes the technical specification of the Functional Blocks referred to in the Technical Architecture Description P11.02.01-D33 as part of the 4DWxCube Domain System. It is derived from requirements and operational scenarios expressed in documents P11.02.01-D26 (DOD), D23 (OSED), D24 (SPR) and D25 (INTEROP).
It addresses the requirements on capabilities of the 4DWxCube Functional Blocks: Management, and MET-GATE. The requirements of the Functional Blocks Consolidation and Translation are specified in separated documents (11.02.02-D38, D39, D40). Requirements on interfaces between the 4DWxCube and other Domain Systems are described in document P11.02.02-D42.
This document is the final version and includes the verification status of the requirements developed in SESAR 1 Programme.

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Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground and EUMETNET Consortium background. The NWP models and meteorological information used to support the described 11.02 prototypes and validation/demonstration exercises belong to the respective National Meteorological Service.

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Executive summary

The 4DWxCube is a Domain System, and is being developed as the focal point between Airspace and ATM users on one side, and consistent, common and harmonized, integrated and interoperable MET Information providers on the other.

This final document describes the technical specification requirements on capabilities of the 4DWxCube Functional Blocks: Management, and MET-GATE. The requirements of the Functional Blocks Consolidation and Translation are specified in separated documents for each operational user environment (local, sub-regional, network). Requirements on interfaces between the 4DWxCube and other Domain Systems are described in a separated document which will be published together with this document.

The following overarching principles explain the context in which decisions have been made within the document.

- The 4DWxCube is considered to be a single system, though in practice the implementation is likely to involve multiple physical locations.
- The 4DWxCube is isolated from all other systems. The 4DWxCube shall accept information from registered MET Service Providers only through defined interfaces. The 4DWxCube shall deliver information to ATM Users only through defined MET Services. It should not be possible for an ATM User request to access a MET Service or MET Product outside of the 4DWxCube.
- The 4DWxCube shall communicate with external entities primarily through machine-to-machine interfaces. Only the 4DWxCube Administrator shall interact with the 4DWxCube through user interfaces.
- The majority of ATM Users require the provision of regulatory product to support aviation needs within the scope of their operational role: local, regional, network, long term, medium term, short term, very short term and execution stages. To support this, the 4DWxCube shall provide access to MET Products through very simple services with minimum tailoring capabilities.
- A minority of ATM Users and other users (e.g. defence) will require provision of complex, non-regulatory products to support innovation in environments such as long term planning. To support this, the 4DWxCube shall provide access to tailored MET Products through sophisticated services that provide flexibility in how they deliver the information to the end user.
- The preferred mechanism for delivery of MET Information to consumers shall be through the OGC Web Services family. These provide well defined standardized interfaces to support interoperability between systems.
- The 4DWxCube shall advertise its Services through the SWIM Registry. The ATM User shall query the SWIM Registry to obtain a description of the MET Service, how to access the MET Service and what types of MET Products the MET Service can provide. For detailed information on the MET Service the user should access the Service directly (e.g. calling GetCapabilities on a WCS).
- ATM Users should only be able to access MET Products through the MET-GATE Services advertised through the SWIM Registry.

1 Introduction

1.1 Purpose of the document

The purpose of this document is to describe the technical specifications (section 2) and requirements (section 3) of the Functional Blocks of the "4DWxCube" Domain System as identified by the MET TAD (reference [11]) which are: Management, Consolidation, Translation and MET-GATE. The document defines the functions provided by the 4DWxCube and how these interact with each other. It also provides a comprehensive list of the criteria that the 4DWxCube should fulfil in terms of capabilities, adaptability, performance, safety, security, maintainability, reliability, interoperability, scalability and resilience. The requirements of the Functional Blocks Consolidation and Translation are described in detail in separated documents [12] [13] [14].
It summarizes the final status of the requirements within the SESAR 1 Programme.

Figure 1 presents the position of the Technical Specification (TS) document within the hierarchy of the SESAR concept documents, together with the SESAR Projects responsible for their production and maintenance. Requirements contained in this document can be traced to SPR, INTEROP and partly OSED requirements. General requirements are summarized in the MET TAD and DOD. The MET SPR and INTEROP requirements are compiled in documents P11.02.01-D24 and D25 (references [9], [10]). Interfaces are described in a separate document WP11.02.02-D42, Interface Requirements Specifications (IRS) [15].

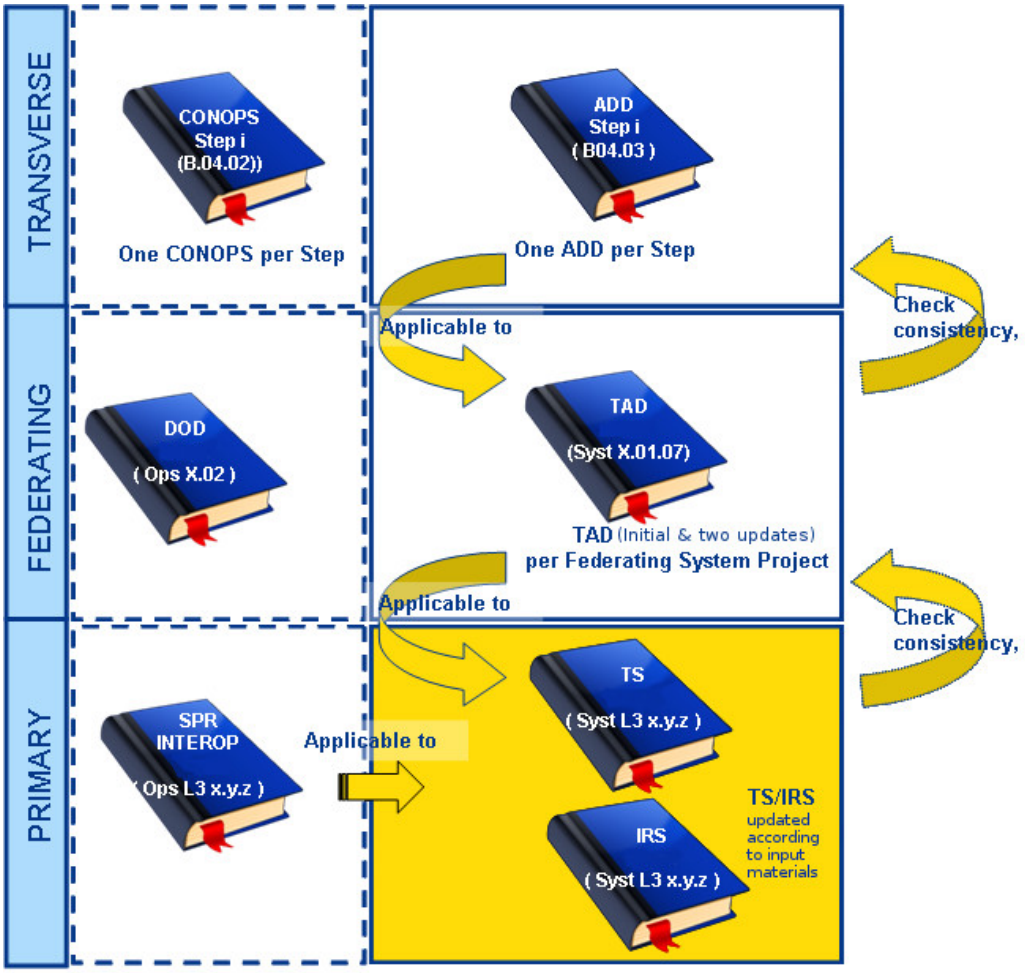

Figure 1: TS document with regards to the other SESAR deliverables

1.2 Intended readership

The intended audience of this document is initially WP11.2.2 project. The former versions of this document have been used to provide the necessary requirements inputs for the 4DWxCube development work.
Furthermore, WP B4.3, federating (X.1.7 & 11.1) projects, and relevant ATM System projects shall use this document to ensure consistency on MET Information usage across the ATM system domains (including Airspace Users).
Projects SWP08.01 and SWP08.03 whose domains include the modelling of MET Information and the development of MET–related Information Services shall use MET data exchange information when building information services. From the technical side, the WP14 project should be interested in enabling the seamless data exchange of MET data via the 4DWxCube MET-GATE to the ATM stakeholders.
This final version might be of interest for all stakeholders of MET information.

1.3 Inputs from other projects

The inputs for the 4DWxCube technical specifications are documents P 11.02.01- D26 (DOD), D23 (OSED), D24 (SPR), D25 (INTEROP) and D33 (TAD) (references [7] to [11]).

1.4 Structure of the document

The document is structured as follows:

- Part 1 introduces the document
- Part 2 describes the functional blocks Management, Consolidation, Translation and MET-GATE part of the 4DWxCube and associated functionalities and operational scenarios
- Part 3 structures the requirements associated to the 4DWxCube which are traced to INTEROP and SPR requirements of the Operational Projects and OFA.
- The other requirements associated to the 4DWxCube are listed in Part 4.

Note: the various UML diagrams used in the document are non-normative and are provided for guidance rather than formal definition.

1.5 Requirements Definitions – General Guidance

Requirements described in Part 3 are developed according to the Requirements and V&V Guidelines [2].

1.6 Functional blocks Purpose

The primary focus of the “4DWxCube” Domain System is to deliver ATM focused MET Information to ATM Consumers through MET Services. The 4DWxCube shall enable ATM consumers to subscribe to MET-ATM SWIM compliant services, offering access to tailored, high-level, user-oriented operational information, such as:

- “Gathering all relevant MET-ATM information along a 4D trajectory needed to plan a flight from the Airport of Departure (ADEP) to the Airport of Destination (ADES) scheduled at a given time/date ”;
- “Gathering all relevant MET-ATM information needed to update a flight briefing on the terminal approach”;
- “Gathering all relevant MET-ATM information needed to plan airport operations over the next 48 hours”;
- “Gathering all relevant MET-ATM information needed to plan the MET impact on traffic flow over a Flight Information Region (FIR) during the next 12 hours”;

To support this primary focus the 4DWxCube is also required to:-

- manage the delivery of meteorological information (observations and forecasts) from a variety of approved suppliers.
- consolidate the meteorological data to ensure that it is harmonized (e.g. resolution, units) on a regional domain.
- translate the consolidated meteorological information into ATM specific MET Products.
- deliver the ATM specific MET Products in a tailored form according to ATM role needs (sub-setting, reformatting, etc.).

The "4DWxCube" DS shown in Figure 2 collects

- generic MET Information from the "General MET Infrastructure" [Port 1].
- local MET Observations from the "ATM-dedicated Aerodrome MET Infrastructure" [Port 2].
- and Aircraft Information from Port 4, to supplement generic MET Information.

The developed MET Services are distributed to aviation end users via Port 5 for alerts and through the SWIM-compliant Port 3.

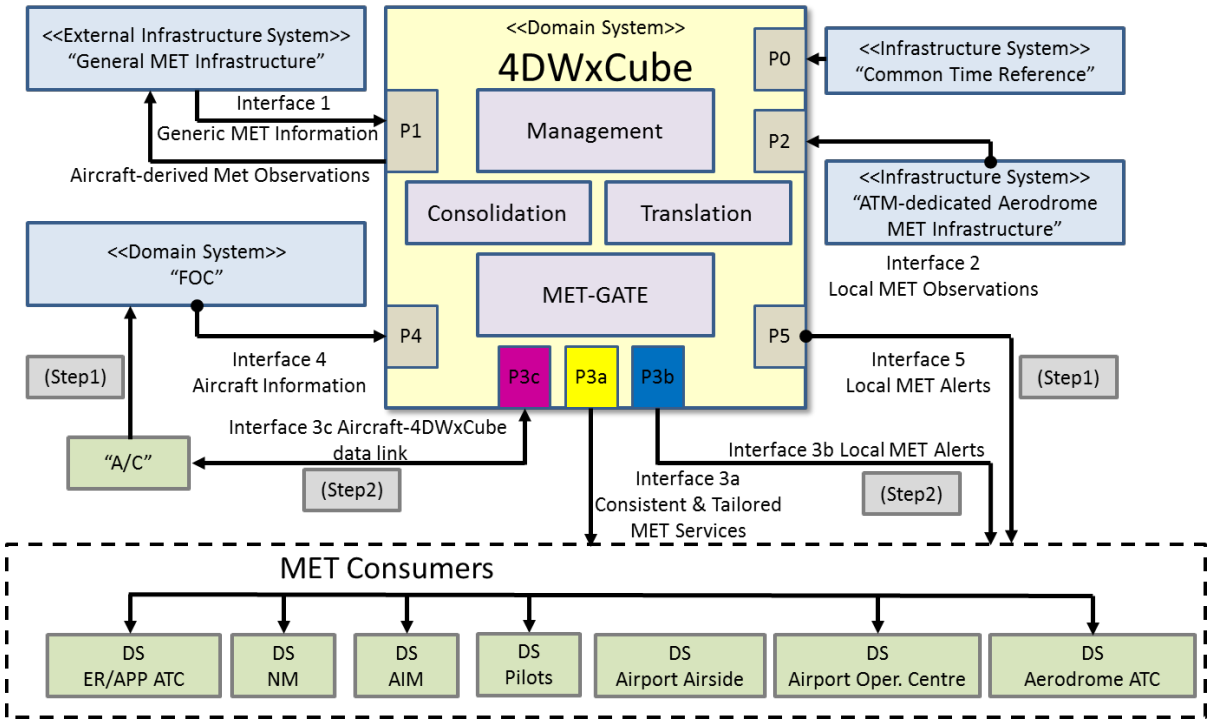

Figure 2: Overview of the "4DWxCube" DS

The essential benefits of the 4DWxCube are:

- To provide a **single consistent access point** to MET Information through the registry, instead of dozens or hundreds of geographically specialized SWIM services, addressing dozens of individual MET providers – which would be the case otherwise.
- To hide the **complexity of MET** to ATM systems by consolidating and translating generic meteorological information into ATM specific MET Products that shall be provided in a consistent form.
- To hide the **complexity of ATM** to MET systems enabling METSPs to deliver meteorological data independently of ATM specific needs.

- **Simpler ICAO compliance** by addressing ATM specific needs in a consistent manner by the managed consolidation and translation functional blocks.

The resulting reduction of complexity has multiple positive effects:

- On the cost and efficiency of multiple **ATM consumers systems** through the use of one limited set of «generic» MET-related SWIM services, identical to all ATM consumers.
- On the cost and efficiency of **communications between MET and ATM** through provision of data through a single interface in standard MET formats.
- On the cost and efficiency of multiple **MET providers systems** through removing the need for them to comply individually with SWIM compliant formats and protocols imposed by ATM.

This document focuses on the "4DWxCube" Functional Blocks, 4DWxCube Management and MET-GATE. The other Functional Blocks presented in Figure 2, namely Consolidation and Translation are addressed in the supporting documents

- 11.02.02–D38 Final Technical Specification, MET prototypes - Local (reference [12])
- 11.02.02–D39 Final Technical Specification MET prototypes – Sub-regional (reference [13])
- 11.02.02–D40 Final Technical Specification, MET prototypes - Network (reference [14])

This Technical Specification document is compliant with the high level architecture principles applied in SESAR and described in the MET TAD (reference [11]).

1.7 Functional blocks Overview

Prior to this document, an earlier activity of raising awareness on MET capabilities and the 4DWxCube concept has been done by the WP11.2.1. Results of this activity clarified the needs of ATM users regarding the supply of weather information including the functional blocks capabilities. Several deliverables have been produced about MET capabilities and the expectations of ATM users:

- 11.02.01-D05 – Technical Specification Convective Weather
- 11.02.01-D06 - Technical Specification Probability Forecasting
- 11.02.01-D07 - Technical Specification Wx Monitoring and ATM Impact
- 11.02.01-D22 - MET-DOD
- 11.02.01-D23 - MET-OSED parts A-B-C
- 11.02.01-D24 - MET-SPR parts A-B-C
- 11.02.01-D31 - MET TAD

The capabilities provided by the four 4DWxCube Functional Blocks (Management, Consolidation, Translation and MET-GATE) can be split into a number of categories:

- The 4DWxCube provides mechanisms for ingest and management of MET Products and observations delivered by MET Service Providers, Aircraft and Local MET Providers. It also provides administration functions to manage supporting information, deliver audit reports and publish new services.

- MET Products are enriched and completed by a second set of functions, specific to the MET-ATM domain, which allow preparing the MET-ATM data necessary to deliver the SWIM MET-related services (e.g. consolidating the requested MET Information, translating consolidated MET Information into information specific to aviation end users requirements).

- The MET-GATE provides functions directly related to the provision of SWIM compliant MET-ATM services, and making use of the SWIM Technical Infrastructure – based on the "Yellow

profile". (e.g., managing consumers' profiles, managing access rights, handling consumers' subscriptions and others). In a later stage, exposition of services according to the "Blue" or "Purple" profiles shall be also considered.

Those capabilities are further described in the Major Functional block Capabilities.

1.8 Glossary of terms

Note: the source column references the source of any formal terms. Where the source column is blank, this indicates that the terms have been agreed informally amongst the 4DWxCube design sub-group.

Term	Definition	Source
Catalogue	Set of all the MET Product Descriptions accessible for ATM consumers	
Data item	Statement of observed and/or forecast meteorological conditions related to a specific time (or period) and location.	
Discovery	Action to search into the catalogue to find out what MET Product is available and what are characteristics of each MET Product	
Metadata	Information which describes a data item. Some metadata are mandatory for all products, e.g unique identifier, common name; others are natural to a product, e.g geographical region for a forecast map.	
MET-GATE	A functional component of the 4DWxCube serving tailored MET Information and services to ATM systems through SWIM compliant webservices.	
MET services	Those facilities and services that furnish aviation with meteorological forecasts, briefings and observations as well as SIGMET Information, VOLMET broadcasting material and any other meteorological data provided by States for aeronautical use *Note: in order to have a definition in line with SESAR terminology, the following new definition is suggested by P11.02.01: MET Service = Operational, application or information service in relation to the provision or use of MET Information*	ICAO Doc 9713 *New*
Meteorological information	Meteorological report, analysis, forecast, and any other statement relating to existing or	ICAO Annex 3 ICAO Doc 9713

Term	Definition	Source
	expected meteorological conditions. *Note: It is suggested by P11.02.01 to add 'data' in this definition*	WMO N°182
MET Product	MET Information provided to the 4DWxCube which is specified by its metadata; therefore it contains metadata and data items.	
Consolidated MET Product	MET Information (from one or more sources) that has undergone consolidation to produce a consistent, common harmonized and seamless meteorological view at the European scale.	
Translated MET Product	MET Information (from one or more sources) that has undergone translation to produce an ATM specific view of meteorological phenomena.	
Tailored MET Product	MET Information (from one or more sources) that has undergone consolidated, translated and subsequently tailored to the need of ATM Users by the 4DWxCube. Tailored MET Products are specified by their metadata, therefore contain metadata and data items.	
MET Product Specification	Description of a specific MET Product properties to inform users of what the product delivers, its requirements and constraints. Within the 4DWxCube it should also describe the key elements of the data and metadata that must be provided.	
MET Product Definition	Static metadata associated with a specific MET Product that MET Service Providers deliver to the 4DWxCube. This acts as a template for the generated Product Description.	
MET Product Description	List of attributed product properties associated to a MET Product that ATM consumers shall use to access the MET Products. Each product property shall be attributed with values reflecting the content of the particular product item.	
Nowcast	A description of current weather and a short-period (0-2hours) forecast	WMO N°182
Polling	Operation to regularly check the status of another system. If the context of this document, the term polling applies to ATM consumers who check periodically if new data is available in the 4DWxCube.	

Table 1: Glossary of terms

1.9 Acronyms and Terminology

Term	Definition
4DWxCube	Four Dimensional Weather Cube
ADES	Airport of Destination
ADEP	Airport of Departure
AIRM	ATM Information Reference Model
AIRMET	AIRman's METeorological Information
ANSP	Air Navigation Service Provider
AOC	Airline Operation Control
AOP	Airport Operation Plan
APP	Air Traffic Control Approach
ATC	Air Traffic Control
ATM	Air Traffic Management
BUFR	Binary Universal Form for the Representation of meteorological data
CAT	Clear Air Turbulence
DOD	Detailed Operational Description
DS	Domain System
EFB	Electronic Flight Bag
EPSG	European Petroleum Survey Group (organization that manages coordinate reference systems)
ER	En Route
FB	Functional Block
FIR	Flight Information Region
FMS	Flight Management System
FOC	Flight Operation Centre
FTPS	File Transfer Protocol Secure

Term	Definition
GUI	Graphical User Interface
HCC	Hub Control Centre
HMI	Human Machine Interface
HTTP/HTTPS	Hypertext Transfer Protocol/ Hypertext Transfer Protocol Secure
ICAO	International Civil Aviation Organisation
INTEROP	Interoperability Requirements
IRS	Interface Requirements Specification
ISO	International Standards Organisation
ISRM	Information Service Reference Model
LDAP	Lightweight Directory Access Protocol
LFTM	Local Traffic Flow Management
LNM	Local Network Manager/Management
METAR	METeorological Aerodrome Report
METSP	MET Service Provider
MT	Medium term
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
N/A	Not applicable
NM	Network Manager/Management
NOP	Network Operation Plan
NWP	Numerical Weather Prediction
OCC	Operational Control Centre
OGC	Open Geospatial Consortium
OSED	Operational Service and Environment Definition
OUE	Operational User Environment

Term	Definition
PIREP	Pilot Report
QC/QA	Quality Control / Quality Assessment
QFE	Atmospheric pressure at field elevation
QNH	Atmospheric pressure at nautical height
QoS	Quality of service
RNM	Regional Network Manager/Management
RVR	Runway Visual Range
SESAR	Single European Sky ATM Research
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
SIGMET	Significant Meteorological information
SIGWX	Significant Weather Chart
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SLA	Service Level Agreement
SOA	Service Oriented Architecture
SPECI	Special unscheduled report of significant change in weather conditions.
SPR	Safety and Performance Requirements
ST	Short term
SWIM	System Wide Information Management
TAD	Technical Architecture Description
TAF	Terminal Aerodrome Forecast
TCA	Tropical Cyclone Advisory
TIN	Triangulated Irregular Network
TMA	Terminal Manoeuvering Area
TREND	Forecast valid for next 2 hours, appended to the end of a METAR
TS	Technical Specification

Term	Definition
TWR	Air Traffic Control Tower
UC	Use Case
URL	Uniform Resource Locator
VAA	Volcanic Ashes Advisory
VST	Very Short Term
WCS	Web Coverage Service
WFS	Web Feature Service
WGS	World Geodetic System
WMO	World Meteorological Organization
WMS	Web Map Service
WPS	Web Processing Service
Wx	Weather
XML	eXtensible Markup Language

Table 2: Acronyms and terminology

2 General Functional block Description

2.1 Context

The 4DWxCube is a domain system made of four functional blocks serving MET Information to ATM systems through the SWIM compliant webservices. These functional blocks are 4DWxCube Management, Consolidation, Translation and MET-GATE, as depicted in Figure 3 (this repeats Figure 2 above for ease of reference).

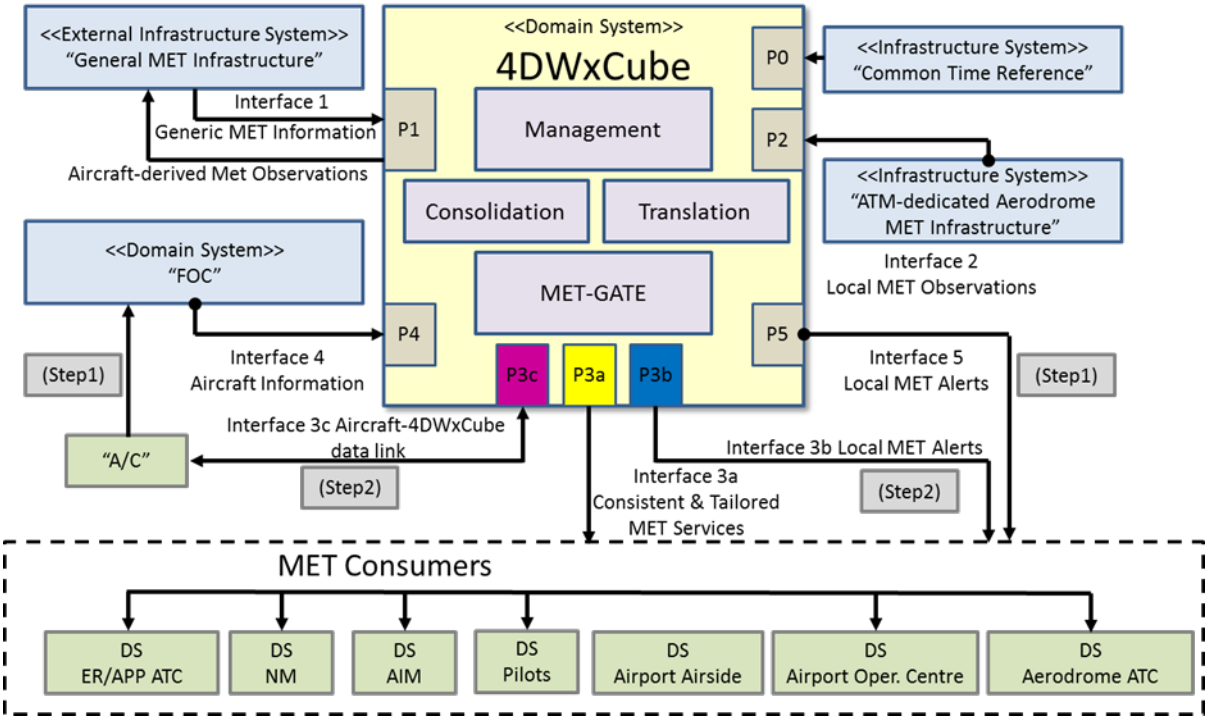

Figure 3: Overview of the "4DWxCube" DS

The Management FB manages the configuration of 4DWxCube itself and the input of meteorological information (observations and forecasts) from a variety of approved suppliers into the 4DWxCube.

The Consolidation FB consolidates the meteorological data to ensure that it is harmonized (e.g. resolution, units) on a regional domain.

The Translation FB translates the consolidated and raw meteorological information into ATM specific MET Products.

The MET-GATE FB deliver the ATM specific MET Products in a tailored form according to ATM role needs (sub-setting, reformatting, etc.). The MET-GATE FB is primarily concerned with the output of Met Information to ATM users.

2.2 Functional blocks Modes and States

The 4DWxCube operates in a continuous mode. It transfers information from the "Consolidation" and "Translation" functional blocks performing the relevant data selection, sub-setting, sub-gridding and finally sends via the MET-GATE MET Products to subscribed ATM systems.

State transitions may be triggered by subscriptions events. The 4DWxCube handles subscriptions on a scheduled basis managing periodic requests from ATM systems.

2.3 Major Functional Blocks Capabilities

The technical requirements are organized in two major categories according to their main functions, which are: functional requirements (Administration, Monitoring & control, Data providing, Subscription management, Storage and indexation), and non-functional requirements (Adaptability, Performance Characteristics, Safety and Security, Maintainability, Reliability).

2.3.1 Functional requirements

The first category includes functional requirements that define specific behaviours of the 4DWxCube. This category is further broken down according to the following functional objectives: administration, data management, consolidation, translation and data provision.

- Administration

  This capability refers to activities performed by the 4DWxCube administrator, such as managing access rights, registering MET Services, and managing new MET Product Descriptions in the 4DWxCube. It also supports the monitoring and control of the system to ensure that the data and services are operating at acceptable levels.

- Data management

  The 4DWxCube provides the capability to manage the various persistent data artefacts that support the provision of MET information to end users. The 4DWxCube shall also be able to accept and store MET Products from registered MET Service Providers to support the Consolidation and Translation processes.

- Consolidation

  The purpose of the Consolidation functional block is to create consistent, common harmonized and seamless MET Information at the European scale from the collection of MET Products delivered by the METSPs.

- Translation

  The purpose of the Translation functional block is create MET Products that meet specific aviation end user needs from the consolidated MET Information generated by the Consolidation functional block.

- Data provision

  One of the main functions of the 4DWxCube is to serve MET Products to ATM systems via the MET-GATE. In this section are described the functionalities needed to serve the ATM consumers the required data set. Subscription management is a key component of the data provision and refers to 4DWxCube capabilities to manage both types of subscriptions: subscriptions triggered as soon as new MET Product is available in the 4DWxCube or scheduled subscriptions.

2.3.2 Non-functional requirements

The remaining non-functional requirements are used to qualify the operation of the 4DWxCube.

- Adaptability

  Adaptability contains requirements related to the 4DWxCube adaptability. This section is organized according to the adaptability non-functional requirements characteristics documented in ISO 25010.

- Performance

Performance encompasses time behaviour, resource utilization and capacity of the 4DWxCube. This section is organized according to the performance non-functional requirements characteristics documented in ISO 25010.

- Safety & Security

  Safety and Security specify the security and safety requirements of the 4DWxCube, including access limitation, data protection and recovery methods. This section is organized according to the security non-functional requirements characteristics documented in ISO 25010.

- Maintainability

  Maintainability specifies modularity, reusability, analysability, modifiability and testability of the 4DWxCube. This section is organized according to the maintainability non-functional requirements characteristics documented in ISO 25010.

- Reliability

  Reliability specifies the 4DWxCube robustness to abnormal operating conditions including maturity, availability, fault tolerance and recoverability. This section is organized according to the reliability non-functional requirements characteristics documented in ISO 25010.

2.4 User Characteristics

This section identifies the type of users of each functional block and the way in which they will use the functional block.

There are several types of 4DWxCube users, but four main categories can be distinguished, these are: governance contributors, administrators of the system, providers of MET Information and services and ATM system consumers. There are groups are discussed below.

2.4.1 Governance contributors

2.4.1.1 4DWxCube Governance Board

The 4DWxCube Governance Board is the team of people who approve the addition or removal of new products, services and METSPs to the 4DWxCube. They have no direct interaction with the system but can instruct the Administrator to carry out specific tasks. The detailed governance guidelines under which the 4DWxCube Governance Board operates is outside the scope of this document.

2.4.1.2 Service Coordination Group

The Service Coordination Group (SCG) is a team of people that coordinates the activities required to develop and approve new SWIM Services.

2.4.2 4DWxCube Administrators

The 4DWxCube administrator is a human operator in charge of the 4DWxCube administration. This user is allowed to manage the list of access rights of ATM consumers and the list of available Product Definitions in the 4DWxCube though a dedicated Human Machine Interface (HMI) called “Administration portal”. The Administrator is responsible for registering MET Product Definitions and service providers ensuring that the 4DWxCube contains approved and consistent information relating to the primary artefacts in the system. The Administrator is also responsible for publishing metadata for specific MET Services to the SWIM Registry.

2.4.3 MET Information and Service Providers

A generic MET Service Provider (METSP) provides meteorological information and services to the 4DWxCube. All MET Information and service providers shall be approved by the governance board (i.e. an authority who gives permission about what data an identified provider can supply).

National Meteorological Services are specialist METSPs that offer a wide range of authoritative MET Products. Other METSPs that could have access to the 4DWxCube domain system include: Local MET observations provided by ATM-dedicated Aerodrome infrastructure, Aircraft en-route MET Information, Commercial MET Product and/or service providers, and potentially crowd-sourced MET Information where this is deemed appropriate.

METSPs are assumed to provide the listed MET products at the expected following transaction levels. Table 3 provides a list of expected products and transaction levels. This list is not exhaustive.

MET Product	**Expected Transaction Levels**
METAR	Every 30 minutes, for each aerodrome
TREND (modifier to TAF/METAR)	Ad-hoc (addition to TAF/ METAR)
SPECI	Ad-hoc (update of METAR)
TAF	4 times per day, for each aerodrome
SIGMET	Ad-hoc (valid for 4 hours) for a specific region of airspace
SIGWX	4 times per day, 13 PNG charts in total and in BUFR format
Radar (observations)	Update rate of 5-15minutes
Satellite (observations)	Update rate of 5min to 1h
Turbulence / CAT	1h update rate for nowcast
Convection	5 min update for nowcast for 0-3h nowcast
Icing	1h update rate for nowcast
Wind	1h update rate for nowcast
VAA	Ad-hoc
TCA	Ad-hoc
AIRMET	Issued 4 times daily
Aerodrome Observations	15 seconds – 10 minutes depending on MET parameter (instrument)
Aircraft Observations (PIREP)	Ad-hoc

Table 3: MET Products with expected transaction levels

2.4.4 ATM System Consumers

Exchanges between the 4DWxCube and its ATM system consumers are always done through SWIM compliant services. Consumers access MET product information only through the services advertised by the SWIM Registry. Consumers must be known to the system and must have permission to access the advertised services.

The 4DWxCube does not present an HMI to its consumers as it cannot directly interact with a human user. Instead, it provides consumers with machine-to-machine services. An ATM system uses data supplied by the 4DWxCube (business-to-business operating) and advertised by the SWIM Registry. ATM systems are developed by ATM consumers and are specific to their type of activities.

The list below presents some assumptions about the type and number of user systems which would be using the 4DWxCube in a final stage of deployment:

- Applications for Airlines:
  - User Systems :
    - FOC/AOC: Flight Operation Centre - Airline Operation Control systems
    - FOC-HCC: Flight Operation Centre - Hub Control Centre systems
    - Aircraft FMS: Flight Management systems
  - Expected transaction volume: support to 30000 flights /day

- Applications for Air navigation service providers ANSPs (En-Route, Approach)
  - User Systems :
    - ATC-ER : En-route Air Traffic Control systems
    - ATC-LFTM : Local Traffic Flow Management systems
  - ATC-APP : Approach Air Traffic Control systems (arrivals and departures)
  - Expected transaction volume : support to 670 sectors in total (approach or en route)

- Applications for Airports (Tower, airport)
  - User Systems :
    - ATC-TWR : Tower Air Traffic Control systems
    - AOP: Airport Operations Plan systems
  - Expected transaction volume : support to 430 Aerodromes

- Applications for Network
  - User Systems :
    - NM : European Network Management systems
  - Expected transaction volume : support to 1 subscriber

2.5 Operational Scenarios

This section presents examples on how the 4DWxCube shall be used. These operational scenarios primarily describe functionality required to support the ATM focused scenarios described in the INTEROP ref. P11.02.01-D21 [10] document and are not necessarily related to any one ATM scenario. It is not meant to be an exhaustive list of operational scenarios for the 4DWxCube.

Operational scenarios are sorted according to:

- Administration activities – to support the integrity of the 4DWxCube
- MET Information Provider activities – to enable information to be provided to the 4DWxCube
- ATM Consumer activities – to support consumption of information from the 4DWxCube
- General activities – to support the general activities of the 4DWxCube

2.5.1 Administrator Activities

This section presents operational scenarios related to the administration activities. In this context, the 4DWxCube has no direct interaction with any other domain system. Administrator activities shall impact on the capability of other functional blocks to deliver information to ATM Users.

The Administrator shall interact with the 4DWxCube through a HMI that shall support the following operational scenarios.

METSPs may also have limited interaction with the 4DWxCube to support the Administrator in the registration of MET Products and for the retrieval of relevant reports.

2.5.1.1 TS-UC-MET-AD01: Define/Modify/Remove a MET Product Definition

Actors

- METSP
- Administrator of the "4DWxCube" DS
- 4DWxCube Governance Board

Objectives
To define, modify or remove a MET Product Definition in the 4DWxCube.

Description
Information on products that are to be managed by the 4DWxCube must be registered in the system.

A Product Definition may relate to a specific MET Product from an individual METSP or relate to a regulated product type, e.g. TAF or METAR. Product Definitions are also required to define Consolidated and Translated MET Products created within the 4DWxCube.

The Administrator shall receive Product Definition details from a METSP or the 4DWxCube Governance Board and register this within the 4DWxCube. The Product Definition will be associated with an existing MET Product Specification

The Administrator may also remove a product definition at the request of the 4DWxCube Governance Board or the METSP that made the original request.

Post-conditions
The 4DWXCube has a coherent collection of MET Product Definitions that are supported by the 4DWxCube.

Reference to INTEROP
This underpins all use cases in these INTEROP-UC groups.
INTEROP-UC-MET-MT
INTEROP-UC-MET-ST
INTEROP-UC-MET-EX

2.5.1.2 TS-UC-MET-AD03: Register/Unregister a MET Service Provider

Actors

- METSP
- Administrator of the “4DWxCube” DS
- 4DWxCube Governance Board

Objectives
To define or remove a METSP from the 4DWxCube. *(Related to access control)*

Description
Only approved METSPs can deliver MET Products to the 4DWxCube. The Administrator shall receive registration information from a METSP wishing to publish MET information through the MET-GATE.
All requests must be approved by the 4DWxCube Governance Board.

On receipt of the information the Administrator shall enter the information in the correct format into the system. The system shall verify the information to ensure that it adheres to the rules of the system.

On successful verification, the system shall store the METSP Metadata for future use and send confirmation of success back to the administrator.

Verification failure shall stop the process and return a failure message, with the reason for failure, back to the Administrator.

To unregister a METSP, the METSP itself or the 4DWxCube Governance Board shall issue a request for the removal of the METSP from the 4DWxCube. On receipt of the information the Administrator shall provide the identifier of the METSP to be removed. The system shall verify the information to ensure that it is an existing METSP.

The METSP information shall be marked as deprecated (as they may still have data in the system). The system shall reject any further MET Information delivered from this supplier.

Post-conditions
The 4DWXCube has a coherent collection of information on METSPs that can provide information to the 4DWxCube.

Reference to INTEROP
This underpins all use cases in these INTEROP-UC groups.
INTEROP-UC-MET-MT
INTEROP-UC-MET-ST
INTEROP-UC-MET-EX

2.5.1.3 TS-UC-MET-AD02: Register/Modify/Unregister an ATM system

Actors

- ATM SWIM Node Administrator
- Administrator of the “4DWxCube” DS

Objectives
To create, modify or delete access rights to the 4DWxCube services for SWIM consumers.

Description
In order to allow an ATM system to access the 4DWxCube services, an ATM SWIM-Node administrator shall create a ticket to register a new ATM system in the 4DWxCube. A 4DWxCube administrator shall manage the ticket to grant permissions to access to the 4DWxCube services.

The same process shall be used to modify and unregister an ATM system in the 4DWxCube.
A 4DWxCube administrator can also register, modify and unregister an ATM system in the 4DWxCube without a ticket.

Post-conditions
The 4DWXCube has a coherent collection of information on ATM Users (systems) that can make requests and subscriptions of MET-GATE services.

Reference to INTEROP
This underpins all use cases in these INTEROP-UC groups.
INTEROP-UC-MET-MT
INTEROP-UC-MET-ST
INTEROP-UC-MET-EX

2.5.1.4 TS-UC-MET-AD04: Register MET Service

Actors

- ATM User
- Service Coordination Group
- Administrator of the “4DWxCube” DS
- 4DWxCube Governance Board

Objectives
To support the creation of a specialist service to support a capability requested by an ATM user. This shall support the Test, Reference and Innovation requirement of the system.

Description
Within the MET-GATE all MET Information is accessed through services. Services can either deliver the MET Information directly, if designed to do so, or deliver a tailored version of the MET Information as directed by the ATM User.

Once a new service have been approved by the SCG and modelled by a service architect, it is implemented in the MET-GATE. The 4DWxCube Governance Board validates the new service when it is ready to use and Administrator registers the service metadata provided, including information related to the Product Definitions that the service accesses and the Product Specifications for the MET Products the Service delivers.

A registered Service is not automatically published to the SWIM Registry for external consumption. This is to support Test and Reference requirements of the registered service prior to making it available for external consumption.

Post-conditions
The 4DWXCube has a coherent collection of information on services available through the 4DWxCube.

Reference to INTEROP
This underpins all use cases in these INTEROP-UC groups.
INTEROP-UC-MET-MT
INTEROP-UC-MET-ST
INTEROP-UC-MET-EX

2.5.1.5 TS-UC-MET-AD05: Publish MET Service to the SWIM Compliant Registry

Actors

- METSP – Service Creator/Provider
- Administrator of the "4DWxCube" DS
- 4DWxCube Governance Board

Objectives
Having developed a new service either by request from an ATM User or through innovation that service needs to be provided to the SWIM Registry so that it can be accessed by ATM Users. (Related to access control)

Description
On approval by the governance board, the Administrator shall be instructed to publish the Service Description for the new validated service to the SWIM Registry to make it available to the wider ATM community.

The Administrator passes the service identifier to be published to the system. The system shall check the service identifier and extract the Service Description. This shall then be published to the SWIM Registry.

Once published, the Service Description can be discovered and accessed by external consumers through the SWIM Registry

Post-conditions

The 4DWXCube has a coherent collection of information on Services available to ATM Users through the MET_GATE.

Reference to INTEROP
This underpins all use cases in these INTEROP-UC groups.
INTEROP-UC-MET-MT
INTEROP-UC-MET-ST
INTEROP-UC-MET-EX

2.5.1.6 TS-UC-MET-AD06: Review MET Audit Trail

Actors

- Administrator of the "4DWxCube" DS
- 4DWxCube Governance Board

Objectives

On request from the 4DWxCube Governance Board the Administrator shall review data updates and publications for MET Products.

Description
On approval by the governance board, the Administrator shall be instructed to review details of what data was delivered by METSPs and published to consumers for a specific time period, a specific geographic area and a specific set of MET Products.

The Administrator shall review the audit trail data and report on all data delivered by providers and published to a consumer.

Post-conditions

A report is available detailing the recorded events related to information that has been received by the 4DWxCube or published to a consumer.

Reference to INTEROP
This underpins all use cases in these INTEROP-UC groups.
INTEROP-UC-MET-MT
INTEROP-UC-MET-ST
INTEROP-UC-MET-EX

2.5.2 MET Information Provider Activities

This section presents a number of operational scenarios where METSPs and other information providers interact with the 4DWxCube. These provide examples of typical activity patterns that shall be used to deliver information. The type of information delivered shall vary and is discussed in more detail in the various OUE Technical Specifications (MET TS Local, Deliverable P11.02.02-D13 [12], MET TS Sub-regional, Deliverable P11.02.02-D14 [13] and MET TS Network, Deliverable P11.02.02-D15 [14]).

Note that the METSP is involved in the Administrator activities to support the registration of METSP Information, registration of MET Product Definition and the registration of MET Service Information.

2.5.2.1 TS-UC-MET-SP01: Deliver METAR Information

Actors

- METSP
- 4DWxCube

Objectives
To deliver METAR Information to an ATM Consumer.

Description
This use case represents an example where defined/structured products are delivered to an ATM Consumer.

The METSP uploads the METAR Product (which includes the METAR data item and associated data item metadata) to the 4DWxCube through Port 1 (see Figure 3). METAR products may include METAR, METAR/TREND and SPECI variants.

The 4DWxCube sends a notification to the METSP to acknowledge receipt of the information. Acknowledgement of receipt does not mean that the information is valid. (Note: the upload process may be lengthy so the notification response may be asynchronous).

The 4DWxCube validates the information and then sends notification of the validation result to the METSP.

The 4DWxCube then processes the uploaded METAR Product through the Consolidation and Translation Functional blocks to produce a harmonized and consistent Translated METAR Product. The Translated METAR is made available to Consumers as soon as possible through subscriptions or on request. Note that the Consolidation and Translation functional block may only make minor modifications to the supplied METAR Product.

The upload stage and the result of the validation and process steps are recorded by the 4DWxCube in an audit log for future reference.

Post-conditions
The 4DWxCube stores a Consolidation and Translated MET Product and associated MET Product Description generated from the information delivered by METSPs.

A Tailored METAR Product, generated from the Translated MET Product, is delivered to an ATM Consumer that has previously subscribed for the METAR Product.

Reference to INTEROP
This underpins all use cases in these INTEROP-UC groups.

INTEROP-UC-MET-MT-Lx
INTEROP-UC-MET-ST-Lx
INTEROP-UC-MET-EX-Lx

2.5.2.2 TS-UC-MET-SP02: Deliver Turbulence Information

Actors

- METSP
- 4DWxCube

Objectives
To deliver MET Products to the 4DWxCube

Description
This use case represents an example of where collections of observations and forecasts are combined to produce a harmonized and consistent product to be delivered to the ATM Consumer.

The METSP delivers MET Product information in the form of observations or forecasts for a limited geographical extent to the 4DWxCube.

The 4DWxCube sends a notification to the METSP to acknowledge receipt of the information. Acknowledgement of receipt does not mean that the information is valid. (Note: the upload process may be lengthy so the notification response may be asynchronous).

The 4DWxCube validates the information and then sends notification of the validation result to the METSP.

The 4DWxCube then waits for a configurable period to allow time for METSPs to deliver information for additional geographical extents or additional products.

The 4DWxCube then processes the collected MET Products through the Consolidation and Translation Functional block to produce a harmonized and consistent Translated MET Product. The Translated MET Product is made available to Consumers as soon as possible through subscriptions or on request.

Post-conditions

The 4DWxCube stores a Consolidation and Translated MET Product and associated MET Product Description generated from the information delivered by METSPs.

A Tailored Turbulence Product, generated from the Translated MET Product, is delivered to an ATM Consumer that has previously subscribed for the Turbulence Product.

Reference to INTEROP
This underpins all global and regional use cases e.g. REQ-11.02.01-INTEROP-MG01.0004
INTEROP-UC-MET-MT-Gx
INTEROP-UC-MET-ST-Rx

2.5.2.3 TS-UC-MET-SP03: Deliver Aircraft Observations

Actors

- Aircraft/FOC
- 4DWxCube

Objectives
To deliver MET Observations collected by Aircraft en-route and within the TMA to enhance the MET Information provided through the 4DWxcube.

Description

This use case is designed to represent a case where MET information recorded by an aircraft is relayed back to the 4DWxCube.

Observations may be combined with observations from other sources to generate a Consolidated MET Product. Observations and/or Consolidated data is then made available by the METSP to be used in analysis and for initialising NWP which will feed back into the forecasts.

Post-conditions

The 4DWxCube has stored Observations and Consolidated Observation products available for consumption by METSPs.

Reference to INTEROP
This underpins all global and regional use cases.
INTEROP-UC-MET-MT-Gx
INTEROP-UC-MET-ST-Rx

2.5.2.4 TS-UC-MET-SP05: Deliver Local MET Information

Actors

- METSP
- 4DWxCube (provider)

Objectives
To deliver MET Observations collected at the aerodrome and by aircraft to enhance the MET Information provided through the 4DWxcube.

Description

This use case is designed to represent a case where MET information recorded by observation networks and and relayed back to the 4DWxCube. This data is then ingested by the METSP to be used in analysis and for initialising NWP which will feed back into the forecasts including nowcasts.

Reference to INTEROP
This underpins all local use cases.
INTEROP-UC-MET-MT-Lx
INTEROP-UC-MET-ST-Lx
INTEROP-UC-MET-EX-Lx

2.5.3 ATM Consumer Activities

This section presents the operational scenarios where the ATM systems interact with the 4DWxCube.

2.5.3.1 TS-UC-MET-AC02: MET Service Description Discovery

Actors

- ATM system (consumer)
- 4DWxCube (provider)

Objectives
To discover MET Services that have been made available through the MET-GATE

Description
This represents a generic use case where the ATM Consumer discovers information about a MET Service from the SWIM Registry. The Consumer makes a request of the MET-GATE for any Service Descriptions that meet the set of criteria that the Consumer is interested in. The Service Description shall include end points to the implemented Service interfaces and any parameters and constraints that are apply to those interfaces.

Post-conditions

The ATM Consumer has a collection of MET Service Descriptions that meet the request criteria.

Reference to INTEROP
This underpins all use cases in these INTEROP-UC groups.
INTEROP-UC-MET-MT-xx
INTEROP-UC-MET-ST-xx
INTEROP-UC-MET-EX-xx

2.5.3.2 TS-UC-MET-AC03: Add/modify/remove a subscription to a MET Service

Actors

- ATM system (consumers)
- 4DWxCube (provider)

Objectives
To manage an ATM system subscription.

Description
This is the general operational scenario for the subscription to a MET Service to deliver MET Products or tailored MET Products.

To subscribe the Consumer provides information, to the Subscription interface of a previously discovered Service to deliver a subset of information when a specific event occurs.

The Consumer shall provide information on

- Identification of the consumer
- service specific information
- return address for notifications
- event to trigger the notification (update, periodic , scheduled)
- termination time

On successful establishment of a subscription, the MET-GATE shall provide a unique identifier for the subscription that shall be returned to the consumer so that they can manage the subscriptions locally.

To modify a subscription the Consumer shall send the subscription identifier and changes to the original information provided.

To unsubscribe the Consumer shall request the MET-GATE to terminate an existing subscription by providing an unsubscribe request. The unsubscribe request shall contain the consumer identification and the subscription identifier provided when the subscription was established.

Post-conditions
The 4DWxCube has a collection of active subscriptions that will monitor and deliver MET Products to the ATM Consumer.

Reference to INTEROP
This underpins all use cases in these INTEROP-UC groups.
INTEROP-UC-MET-MT-xx
INTEROP-UC-MET-ST-xx
INTEROP-UC-MET-EX-xx

2.5.3.3 TS-UC-MET-AC04: Request a MET Service

Actors

- ATM system (consumers)
- 4DWxCube (provider)

Objectives
To retrieve a Tailored MET Product on request from an ATM Consumer.

Description
This is the general operational scenario where a request is sent from an ATM System to MET Service to deliver a Tailored MET Product (or collection of products) on demand.

Using information provided by the MET Service Description, discovered through the MET-GATE, the consumer shall construct a request and send this request in the correct form to the published service endpoint.

If the request and user are validated, the request shall be processed by the MET Service to retrieve the requested information from the MET-GATE system.

Post-conditions
The ATM Consumer receives a Tailored Met Product.

Reference to INTEROP
This underpins all use cases in these INTEROP-UC groups.
INTEROP-UC-MET-MT-xx
INTEROP-UC-MET-ST-xx
INTEROP-UC-MET-EX-xx

2.5.4 MET-GATE Publication Activities

This section provides examples of the main dynamic behaviour of the MET-GATE functional block of the 4DWxCube. The operational scenarios below assume that the ATM system consumer has created and configured a subscription to a MET Service (see 2.5.3.2). Once a subscription is established the automated service operations shall continue to deliver information for the lifetime of the associated subscriptions.

The following operational scenarios are sorted by ATM phase:

- Medium-term planning corresponds to needs between 6 months and the day before the flight.

- Short term planning corresponds to needs prior to the flight, from the day before the day of operations.
- Execution phase corresponds to needs during the flight.

2.5.4.1 TS-UC-MET-MT01: Medium-term forecast for En-Route

Actors

- ATM system (consumers) : FOC/OCC, NM
- 4DWxCube (provider)

Objectives

To provide updates on MET situation forecast to support Network and Airline AOC medium-term planning operations.

Spatial subset

Global or Regional area including trajectories.

Example of products

- SIGMET, AIRMET, VAA, TCA
- SIGWX
- Direct & Derived Aerodrome Routine Parameters (e.g.)
  - NWP gridded data
  - Wind/Temp/Pressure/… grids forecasts
  - Convection/Ceiling/Visibility… forecasts

Description

The user has previously subscribed to a service or set of services to provide a collection of MET Products. The subscription may include selection and sub-setting criteria to limit the return of information to that which is relevant to the planning operation. Sub-setting criteria may include a description of the planned trajectory to constraint the information delivered. The subscription is configured to deliver the information every 3 hours. *Note that the update period requested is flexible. The Service Description should indicate the acceptable range of periodicity.*

Post-conditions

Every 3 hours the subscribing ATM Consumer shall receive the latest versions of the requested Tailored MET Products.

Reference to INTEROP

INTEROP-UC-MET-MT-G01
INTEROP-UC-MET-MT-G02
INTEROP-UC-MET-MT-R01
INTEROP-UC-MET-MT-R02

2.5.4.2 TS-UC-MET-MT02: Medium-term forecast on detailed MET situation for one airport

Actors

- ATM system: AOP, FOC/HCC, NM
- 4DWxCube

Objectives

To provide updates on MET situation forecast to support Airport & Airline /Hub CC medium-term planning operations.

Spatial subset
Local area.

Example of products

- TAF, TREND,
- Direct & Derived Aerodrome Routine Parameters (e.g.)
  - Observations
  - Wind/Temp/Pressure/… forecasts
  - Convection/Visibility/Ceiling… forecasts
  - Site specific MT forecasts

Description
The user has previously subscribed to a service or set of services to provide a collection of MET Products. The subscription may include selection and sub-setting criteria to limit the return of information to that which is relevant to the planning operation. Selection criteria shall include the identifier of the Airport for which the information is required. The subscription is configured to deliver the information every 12 hours.

Every 12 hours the MET-GATE shall publish the latest versions of the requested MET Products for the selected Airport to the ATM system.

Post-conditions
Every 12 hours the subscribing ATM Consumer shall receive the latest versions of the requested Tailored MET Products for the selected Airport(s).

Reference to INTEROP
INTEROP-UC-MET-MT-L01

2.5.4.3 TS-UC-MET-ST01: Short Term Trajectory forecast for En-Route

Actors

- ATM system: FOC/OCC, NM, LNM, ATC-ER, ATC-APP
- 4DWxCube

Objectives
To provide updates on MET situation forecast to support Airline AOC Trajectory Prediction & Aircraft FMS Systems, NM Trajectory Prediction Systems and ATC-ER & ATC-APP Trajectory Prediction Systems.

Spatial subset
Global, Regional or Sub-Regional area including trajectories.

Example of products

- SIGMET, AIRMET, VAA, TCA
- Wind/Temp/Pressure/…grids (ST forecast)
- SIGWX
- METAR, TAF, TREND
- Trajectory analysis by flight path
- Direct & Derived Aerodrome Routine Parameters (e.g.

- Turbulence/Convection/Icing…(ST forecast)
- Turbulence/Convection/Icing…(Observations)

Description
The user has previously subscribed to a service or set of services to provide a collection of MET Products. The subscription may include selection and sub-setting criteria to limit the return of information to that which is relevant to the planning operation. Sub-setting criteria may include a description of the planned trajectory to constrain the information delivered. The planned trajectory information shall include a definition of the trajectory indicating the horizontal and vertical locations for the flight path, the anticipated time at which the flight shall arrive at a point along the trajectory and a volumetric buffer around flight path (e.g. 20Km). The subscription is configured to deliver the information every 1 hour.

Every hour the MET-GATE shall publish the latest versions of the requested Tailored MET Products to the ATM system. The Tailored MET product for a trajectory shall be constrained according to the defined trajectory and time range provided in the criteria for the subscription.

Post-conditions
Every 1 hour the subscribing ATM Consumer shall receive the latest versions of the requested Tailored MET Products for the requested trajectory.

Reference to INTEROP
INTEROP-UC-MET-ST-G01
INTEROP-UC-MET-ST-G02
INTEROP-UC-MET-ST-R01
INTEROP-UC-MET-ST-R02
INTEROP-UC-MET-ST-S01
INTEROP-UC-MET-ST-S02

2.5.4.4 TS-UC-MET-ST02: Short Term forecast on detailed MET situation for one airport

Actors

- ATM system: ATC-APP, ATC-TWR, AOP, FOC-HCC, NM
- 4DWxCube

Objectives
To provide updates on TMA MET situation forecast to support Approach, Tower, & Airport short-term planning operations.

Spatial subset
Local area (TMA + airport) including vertical profiles.

Example of products

- VAA, TCA
- METAR, TAF, TREND
- Direct & Derived Aerodrome Specific Parameters (e.g.)
  - Turbulence/Convection/Icing…(ST forecast)
  - Turbulence/Convection/Icing…(observations& nowcast)

Description
The user has previously subscribed to a service or set of services to provide a collection of MET Products. The subscription may include selection and sub-setting criteria to limit the return of

information to that which is relevant to the short-term planning operation. Selection criteria shall include the identifier of the Airport for which the information is required. The subscription is configured to deliver the information every 15 minutes.

Every 15 minutes the MET-GATE shall publish the latest versions of the requested MET Products for the selected Airport to the ATM system.

Post-conditions
Every 15 minutes the subscribing ATM Consumer shall receive the latest versions of the requested Tailored MET Products for the requested airport..

Reference to INTEROP
INTEROP-UC-MET-ST-L01

2.5.4.5 TS-UC-MET-EX01: Nowcast for En Route/TMA

Actors

- ATM system: FOC/OCC, NM, Aircraft, LNM, ATC-ER
- 4DWxCube

Objectives
To provide updates on MET parameters observation and forecast to support Airline Flight Briefing preparation, Airline Fleet Monitoring, Pilot Situation Awareness, Network real-time operations, ATC ER & ATC-APP & LTFM real-time operations, Airline AOC Trajectory Prediction & Aircraft FMS Systems.

Spatial subset
Global, Regional or Sub-Regional area including trajectories.

Example of products

- SIGMET, AIRMET, VAA, TCA
- METAR, TAF, TREND
- Direct & Derived Aerodrome Routine Parameters (obs & nowcast)
  - Wind/Temp/Pressure/… grids (obs & nowcast)
  - Turbulence/Convection/Icing…(obs & nowcast)
- Trajectory Analysis for flight path

Description
The user has previously subscribed to a service or set of services to provide a collection of MET Products. The subscription may include selection and sub-setting criteria to limit the return of information to that which is relevant to the operation. Sub-setting criteria may include a description of the planned trajectory to constraint the information delivered. The subscription is configured to deliver the information every 5 minutes.

Every 5 minutes the MET-GATE shall publish the latest versions of the requested MET Products .

Post-conditions
Every 5 minutes the subscribing ATM Consumer shall receive the latest versions of the requested Tailored MET Products for the requested area.

Reference to INTEROP

INTEROP-UC-MET-EX-G01
INTEROP-UC-MET-EX-G02
INTEROP-UC-MET-EX-G03
INTEROP-UC-MET-EX-G04
INTEROP-UC-MET-EX-R01
INTEROP-UC-MET-EX-R02
INTEROP-UC-MET-EX-S01
INTEROP-UC-MET-EX-S02

2.5.4.6 TS-UC-MET-EX02: Nowcast on detailed MET situation for one airport

Actors

- ATM system: ATC-APP, ATC-TWR, AOP, FOC-HCC, NM
- 4DWxCube

Objectives
To provide updates on TMA MET situation observation and forecast to support ATC-APP, ATC-TWR, FOC-HCC and AOP real-time operations and ATC-APP & ATC-TWR Trajectory Prediction Systems.

Spatial subset
Local area (TMA + airport) including vertical profiles.

Example of products

- METAR, TAF, TREND
- Direct & Derived Aerodrome Specific Parameters (e.g.)
  - Wind/Temp/Pressure
  - Turbulence/Convection/Icing…(obs & nowcast)
  - Wind/Temp/Pressure/… grids (obs & nowcast)

Description
The user has previously subscribed to a service or set of services to provide a collection of MET Products. The subscription may include selection and sub-setting criteria to limit the return of information to that which is relevant to the local area. Selection criteria shall include the identifier of the Airport for which the information is required. The subscription is configured to deliver the information every 5 minutes.

When an update event occurs the MET-GATE shall publish the latest versions of the requested MET Products for the selected Airport to the ATM system.

Post-conditions
The subscribing ATM Consumer shall receive the latest version of the requested Tailored MET Products as soon as that product becomes available.

Reference to INTEROP
INTEROP-UC-MET-EX-L01
INTEROP-UC-MET-EX-L02

2.5.4.7 TS-UC-MET-EX03: Alerts on airport / TMA

Actors

- ATM system: ATC-APP, ATC-TWR, AOP, FOC/HCC
- 4DWxCube

Objectives
To provide immediate MET alerts in support to ATC-APP & ATC-TWR real-time.

Spatial subset
Local area (TMA + airport) including vertical profiles.

Example of products

- Wind observation
- Turbulence & convection observation
- Windshear warning & alerts

Description
The user has previously subscribed to a service or set of services to provide a collection of MET Products. The subscription may include selection and sub-setting criteria to limit the return of information that is relevant to the local airport area. The subscription is configured to deliver the information whenever a significant change occurs.

Whenever a significant change occurs to any of the source MET Information the MET-GATE shall publish the latest versions of the requested MET Products.

Post-conditions
The subscribing ATM Consumer shall receive the latest version of the requested Tailored MET Products as soon as an alert is identified.

Reference to INTEROP
INTEROP-UC-MET-EX-L03

2.6 Functional

2.6.1 Functional decomposition

This section provides a functional view on how the functional blocks participate in realizing the operational needs.

The functions assigned to the 4DWxCube functional blocks are listed and described below. They are sorted according to the capabilities defined in the Major Functional blocks Capabilities. The functional blocks descriptions are based on a default scenario featuring no exceptional behaviour or error conditions. Under those circumstances the 4DWxCube execute all necessary functions satisfying users' needs.

The descriptions present an optimistic view in the sense that they do not describe the behaviour of the function when it is not possible to satisfy user needs.

Functions related to interfacing capabilities are not treated here, as they are laid out in a separate document [15].

The 4DWxCube Domain System decomposes into a number of major functional blocks and a number of sub components as illustrated in Figure 4.

Figure 4: "4DWxCube" DS and its functional blocks breakdown

The 4DWxCube Management Functional Block is concerned with the Management of the 4DWxCube itself and includes access control and user management, data management and administration functions.

The purpose of the Consolidation functional block is to create consistent, common harmonized and seamless MET Information at the European scale from the collection of MET Products delivered by the METSPs.

The purpose of the Translation functional block is create MET Products that meet specific aviation end user needs from the consolidated MET Information generated by the Consolidation functional block.

The Consolidation and Translation functional blocks are dealt with in detail in a collection of separate documents (references [12][13][14]).

The MET-GATE functional block is concerned with the delivery of information to the ATM Users who consume the information delivered by METSPs and further refined by the Consolidation and Translation.

The following sections elaborate the four FBs of Figure 4 in further technical detail (whereas the previous section 2.5 provides typical operational scenarios to exemplify typical user activities).

2.6.1.1 4DWxCube Management Functional Block

The management capabilities are broken down into a number of components: access control, data management and administration functions.

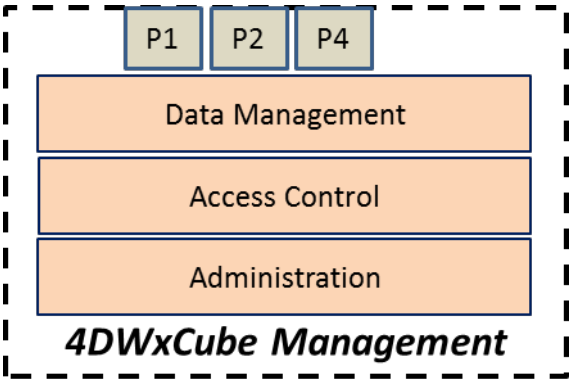

Figure 5: 4DWxCube Management Functional Block

2.6.1.1.1 Access Control and Authentication

All users requiring access to the 4DWxCube shall be authenticated against a central store of known users. Users are defined as any system or individual that is characterized in section i.e. 4DWxCube Governance Board, 4DWxCube Administrators, METSPs and ATM System Consumers. Once authenticated, access to capabilities provided by the 4DWxCube shall be controlled according to the privileges assigned by the 4DWxCube administrator. Privileges may be assigned to an individual user or a group of users.

In terms of access control there are three categories of user

- Administrator – individuals who interact with the 4DWxCube system functions.
- Provider – those systems/individuals that provide information to the 4DWxCube.
- Consumer – those systems/individuals that consume information from the 4DWxCube

The types of privileges assigned to each of these categories shall vary. Administrator privileges should be restricted to system level functions. Provider's privileges should be restricted to provision of identified MET Information. Consumers' access shall be restricted to access to service interfaces.

The following list identifies functionality required to underpin the overarching authentication and access control requirements of the 4DWxCube. The first set of items on the list support the management of the access control whilst the "authenticate user" and "control access" items relate to the execution of the access control functionality when an external party attempts to access the 4DWxCube.

- Add User – Administrator function
    - Create user with username and password, contact information etc.
    - Add to user to specific groups (as a minimum a user shall be assigned to the Administrator, METSP or ATM Consumer group).
- Modify User – Administrator function
    - Change user password
    - Add/remove user to/from group
- Allow user to change their own password.- User function
    - Change password
    - Change contact information
    - Request password reminder
- Remove User – Administrator function
    - Remove user from system. (Note better to lock out user to support audit trails)
- Add Privilege – Administrator function
    - The 4DWxCube offers the capability for an administrator to edit and update the list of access rights according to previous agreements between an ATM consumers and the 4DWxCube. Such access rights shall identify which MET Services that the Consumer user can access.
    - The 4DWxCube offers the capability for an administrator to edit and update the list of access rights according to previous agreements between an METSP Provider user and the 4DWxCube. Such access rights shall identify which upload services the Provider user can access and which MET Products the Provider user can provide.
    - The 4DWxCube offers the capability for an administrator to allow another known user to access to the administration functions.
- Remove Privilege - Administration
    - Remove rights to access a function from a user or group.
- Authenticate User – system function
    - Confirm that the user is known to the system and has provided the correct credentials
- Control Access – system function
    - The 4DWxCube consults the access rights for a Provider User when an upload request is sent to the 4DWxCube. The 4DWxCube shall identify the type of MET Information (MET Product Definition) to confirm that the Provider is allowed to deliver that type of information. Any requests which upload unapproved product types shall raise an exception response.

- The 4DWxCube consults the access rights for a Consumer User when a request or subscription is made to a service interface. Any requests to service interfaces for which the user has no access right shall raise an exception response.

2.6.1.1.2 Administration Functions

2.6.1.1.2.1 Add a MET Service Provider Definition.

The 4DWxCube offers the capability to add information about a METSP on approval by the 4DWxCube Governance Board. Access rights shall be assigned to the METSP to allow them to deliver MET Products to the 4DWxCube.

2.6.1.1.2.2 Add a new MET Product Definition

The 4DWxCube offers the capability to add a MET Product Description to the registry/catalogue of the 4DWxCube. The content of this MET Product Definition is agreed between 4DWxCube Governance board and the METSP(s). Access rights for Provider Users shall be assigned to the appropriate METSPs.

2.6.1.1.2.3 Add a new MET Service Description

The 4DWxCube offers the capability to add a MET Service Description. New MET Services may be implemented in response to a request by Consumer users or through innovation by the METSPs or 4DWxCube Technical support. The content of this MET Service description is agreed between 4DWxCube Governance board, the Provider(s) and the Consumer(s).

2.6.1.1.2.4 Publish a new MET Service Description

The 4DWxCube shall allow an Administrator user to make a MET Service Description that has been verified and validated, available through the SWIM Registry. Access rights shall be granted to individual Consumer Users or groups.

2.6.1.1.2.5 Purge deprecated data and services

The 4DWxCube shall allow an Administrator user to issue a request to purge old data (including older Consolidated and Translated MET Products) and deprecated services from the system to reduce the resource requirements for the system. Purging data and services shall remove them from the registry. *Note: where data and services are hosted on distributed sites it shall be the responsibility of the remote site Administrator to make sure data and services are removed.*

2.6.1.1.2.6 Monitor System Behaviour

The 4DWxCube shall allow an Administrator or automated process to review the behaviour of the system over a period of time. The 4DWxCube shall produce a variety of outputs

2.6.1.1.2.6.1 Provider Alerts

The 4DWxCube shall monitor the upload profile for METSP and raise an alert if the METSP fails to deliver MET Information at the expected update rate.

2.6.1.1.2.6.2 Quality of Service Monitoring

The 4DWxCube shall measure metrics on its internal processing to guarantee the adequate quality of service by measuring a number of key parameters

- Up time for each published MET Service.
- Number and size of data uploads to the system (categorized by product definition)

- Time to process uploaded data through consolidation and translation (categorized by product type).
- Number of subscriptions to each MET Service
- Number of requests to Each MET Service.
- Time to process requests
- Number of failed requests.

2.6.1.1.2.6.3 QoS Alert:

The 4DWxCube shall automatically raise an alert to the Administrator or other selected users if any of the measured metrics are outside of a configured range, e.g. if the time between data upload and processing through Consolidation and Translation exceeds 5 minutes for TAF products.

2.6.1.1.2.6.4 Detailed audit analysis

The 4DWxCube shall allow an Administrator to produce a detailed report on which products have been uploaded and downloaded by a selection of Provider or Consumer users over a period of time. *Note: this information could be used for billing purposes.*

2.6.1.1.3 Data Management

2.6.1.1.3.1 Upload MET Product

The 4DWxCube shall provide an interface that shall allow METSPs to deliver MET Products to the 4DWxCube. Only METSPs that are authenticated and have access rights to the interface shall be permitted to upload MET Product information.

MET Products shall contain both the MET data itself and the metadata associated with the data item (Figure 6). The data item and the metadata may be provided in a single entity or may be provided as separate entities.

The metadata provided may contain only a subset of the full product metadata. Additional metadata shall be provided from the MET Product Definition and the METSP information.

All upload requests shall be audited.

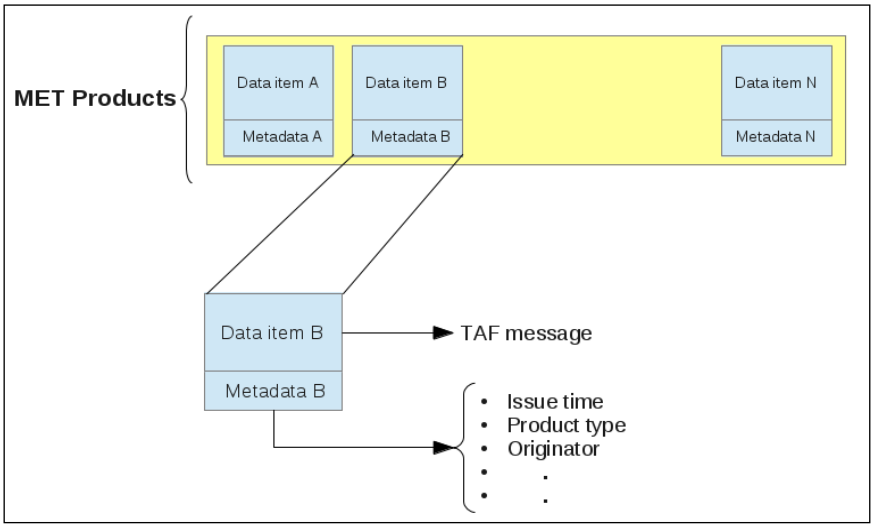

Figure 6: Received MET Products

2.6.1.1.3.2 Check validity of MET Products

On receipt of the MET Product, the 4DWxcube shall ensure that the format and metadata is consistent with the contract between the 4DWxCube and the Provider. This validity check shall confirm that:

1) The METSP Metadata complies with the associated Product Definition and Product Specification stored in the 4DWxCube Registry.
2) The data item is in an acceptable format
3) The data provided matches that described by the associated MET Product Definition
4) The metadata provided is sufficient to complete the MET Product Description.

All validity requests shall be audited.

2.6.1.1.3.3 Process and Store MET Products

The MET Product Data Item shall be processed and stored in the 4DWxCube. The processing of the MET Product Data Item as delivered by the METSP will be dependent on the type of MET Product Data Item delivered. In some cases the MET Product Data Item will be stored as delivered by the METSP, in other cases the MET Product Data Item may be modified before storage e.g. conversion of units. Any processing at this stage shall be constrained to the data item delivered by the METSP and shall not depend on other data items. If the MET Product Data Item is modified before storage the associated metadata shall be updated to reflect any additional processing steps.

The associated MET Product Metadata, the MET Product Definition and the METSP Definition shall be combined to produce a MET Product Description that fully describes the instance of the MET Product that has been uploaded and processed. The MET Product Description shall provide a reference to the location of the stored data item. The MET Product Description shall be published to the Registry where it can be accessed by other processes in the 4DWxCube.

Once the MET Product Data Item has been stored and the MET Product Description registered the 4DWxCube shall send a message other processes in the 4DWxCube that new information is available.

The Consolidation and Translation functional blocks shall be informed that new data is available in order to carry out their functions. Subscription monitoring shall also be informed when new data is available in order to respond to user subscriptions.

All registry update events shall be audited.

2.6.1.2 Consolidation Functional Block

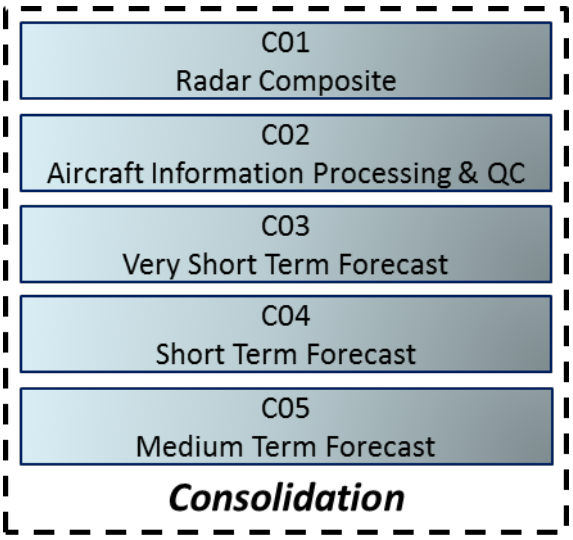

Figure 7: Consolidation Functional Block

The meteorological specific details for the Consolidation functional block are discussed in detail in the following documents.

- Final Technical Specification, MET prototypes - Local P11.02.02-D (reference [12])
- Final Technical Specification, MET prototypes – Sub-regional P11.02.02-D (reference [13])
- Final Technical Specification, MET prototypes - Network P11.02.02-D (reference [14])

To support the integration of the Consolidation functional blocks a number of additional capabilities need to be provided.

2.6.1.2.1 Monitoring of new MET Product Information

The system is required to create Consolidated MET Products in a timely manner to ensure efficient delivery of information to the ATM User. To support this the consolidation processes must be made aware when new MET Products are available.

A monitoring process shall be created to listen for broadcasts of new MET Product. The monitoring process shall examine the associated product type information and determine if the product is relevant to any of the consolidation processes. If it is, the information shall be passed to the identified consolidated process(es).

2.6.1.2.2 Synchronization for processing of MET Product

The various consolidation processes shall combine MET Products from a number of sources. For example production of the pan-European Radar Reflectivity Product requires information from the UK Met Office, DWD, Meteo France and other National MET Service Providers. The MET Products shall be uploaded to the 4DWxCube at different points in time. The Consolidation synchronization process shall therefore identify when sufficient information is available execute the given consolidation process.

2.6.1.2.3 Metadata Creation for Consolidated MET Products

The consolidation processes shall generate new Consolidated MET Products from incoming MET Products. The resultant products shall need metadata and Product Descriptions to accurately describe the Consolidated Met Product.

2.6.1.2.4 Broadcast of newly created Consolidated MET Product information.

Once a Consolidated MET Product has been created other functional blocks, specifically the Translation functional block and the MET-GATE, shall be informed that the new product is available.

The consolidation functional block shall broadcast the product type, identified by the Product Specification, and the unique identifier of the associated metadata record. This shall enable other monitoring processes to react to the newly created product.

2.6.1.2.5 Audit support

The creation of each Consolidated MET Product shall be audited. This shall provide a unique identifier for the created product and the unique metadata identifiers for the source products that contributed to the Consolidated MET Product. This audit entry, combined with other audit entries should enable a complete trace from source to final product.

2.6.1.3 Translation Functional Block:

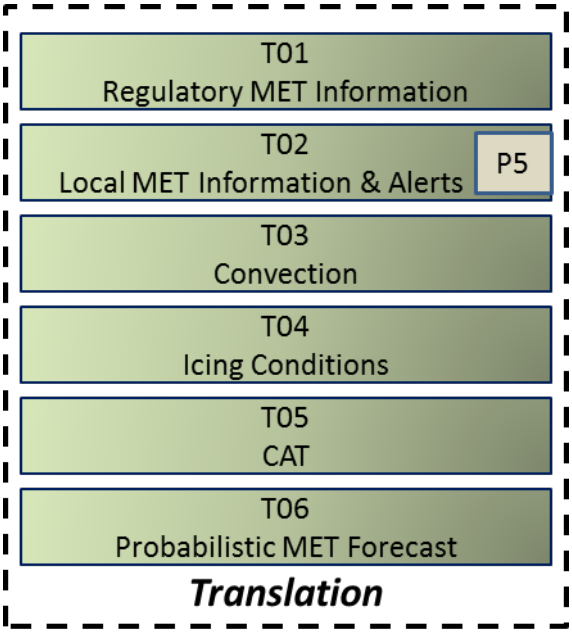

Figure 8: Translation Functional Block

The meteorological specific details for the Translation functional block are discussed in detail in the following documents.

- Final Technical Specification, MET prototypes - Local P11.02.02-D8 (reference [12])
- Final Technical Specification, MET prototypes – Sub-regional P11.02.02-D (reference [13])
- Final Technical Specification, MET prototypes - Network P11.02.02-D (reference [14])

To support the integration of the Translation functional blocks a number of additional capabilities need to be provided.

2.6.1.3.1 Monitoring of new MET Product Information

The system shall create Translated MET Products in a timely manner to ensure efficient delivery of information to the ATM User. To support this, the translation processes shall be made aware when new MET Products and Consolidated MET Products are available.

A monitoring process shall be created to listen for broadcasts of new MET Products and Consolidated MET Products. The monitoring process shall examine the associated product type information and determine if the product is relevant to any of the consolidation processes. If it is, the information shall be passed to the identified consolidated process(es).

2.6.1.3.2 Synchronization for processing of MET Product

The various consolidation processes shall combine a number of Consolidated MET Products. For example the production of the Convection Product requires Consolidated Radar Reflectivity, Aircraft Derived MET Observations, Consolidated VST Forecasts, Consolidated ST Forecast, and Consolidated MT Forecasts. The Consolidated MET Products shall be available to the 4DWxCube at different points in time. The Translation synchronization process shall therefore identify when sufficient information is available execute the given translation process.

2.6.1.3.3 Metadata Creation for Translated MET Products

The translation processes shall generate new Translated MET Products from incoming generic and Consolidated MET Products. The resultant products shall need metadata and Product Descriptions to accurately describe the Translated MET Product.

2.6.1.3.4 Broadcast of newly created Translated MET Product information.

Once a Translated MET Product has been created, other functional blocks, specifically the MET-GATE, shall be informed that the new product is available.

The translation functional block shall broadcast the product type, identified by the Product Specification, and the unique identifier of the associated metadata record. This shall enable other monitoring processes to react to the newly created product.

2.6.1.3.5 Audit support

The creation of each Translated MET Product shall be audited. This shall provide a unique identifier for the created product and the unique metadata identifiers for the source products that contributed to the Translated MET Product. This audit entry, combined with other audit entries shall enable a complete trace from source to final product.

2.6.1.4 MET-GATE Functional Block

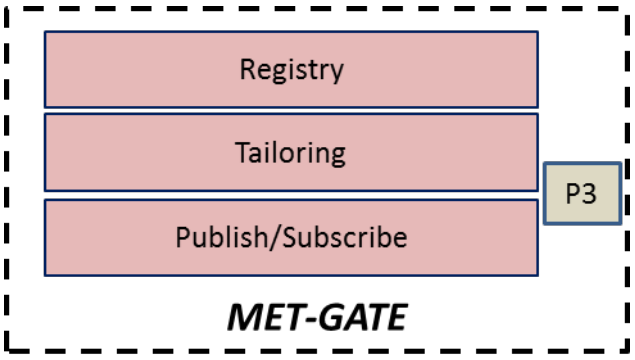

Figure 9: MET-GATE Functional Block

2.6.1.4.1 Tailoring

All MET Information delivered by the MET-GATE shall be delivered through services rather than accessing MET Products directly. The tailoring function refers to the ability of the MET-GATE Services to deliver MET Information to the ATM Consumer, in a modified or constrained form, according to the consumer's criteria and needs. For the purposes of the 4DWxCube the term *modified* relates to changes in the data from the natively stored MET Product form e.g. interpolation or re-projection; constrained relates to a reduction in the amount of data returned e.g. reduction in returned area/volume or reduction in the number of parameters returned.

2.6.1.4.1.1 Web Map Service (WMS)

Provide Web Map Services (WMS) to deliver representations of MET Information as images

WMS can typically tailor its output according to location, portrayal/styles, coordinate systems and output image format. WMS can also support the retrieval of information for a visualization of a parameter/feature at a specific location.

WMS can also portray a number of different layers simultaneously in the order requested by the ATM Consumer.

2.6.1.4.1.1.1 Geographic Area

The WMS shall allow the retrieval of MET Information for a specified geographic area. The extent of the MET Information delivered by the WMS shall be published as part of the WMS Capabilities document.

2.6.1.4.1.1.2 Data Portrayal/Styles

The WMS can portray the same MET Product type in a number of predefined styles. The available styles shall be published as part of the WMS Capabilities document. If a number of styles are made available through a WMS it shall also provide a suitable legend.

2.6.1.4.1.1.3 Re-projection

The WMS can portray the same MET Product type in a number of pre-defined coordinate systems. The available styles shall be published as part of the WMS Capabilities document.

2.6.1.4.1.1.4 Overlaying

The WMS can portray a number of MET Products simultaneously in the order specified by the ATM Consumer. The available MET Products (as visualization layers) shall be published as part of the WMS Capabilities document.

2.6.1.4.1.1.5 Get Feature Information

The WMS can provide information for a visualized feature on a particular image at a specified location.

2.6.1.4.1.2 Web Feature Service (WFS)

WFS provide information on geometrically described features (point, line or polygon). WFS can allow features to be queried, created, updated and deleted by a consumer. However, for the MET-GATE the WFS shall only permit features to be queried. The output from the WFS may be tailored by sophisticated filtering capabilities.

2.6.1.4.1.2.1 Filtering

Select only those features that match selection criteria based on feature attribution and/or geographic area.

2.6.1.4.1.2.2 Re-projection

The WFS can deliver the same MET Product type in a number of pre-defined coordinate systems. The available styles shall be published as part of the WFS Capabilities document.

2.6.1.4.1.3 Web Coverage Services (WCS)

WCS typically provide information in multi-dimensional gridded data sets covering a geographic area (coverages) and holding multiple parameters.

Coverages can be a set of data points; a regular grid of points (or pixels); a set of segmented curves (e.g. road paths); a set of Thiessen polygons; or a triangulated irregular network (TIN) (eg. terrain models).

Output from the WCS may be tailored by sophisticated sub-setting, interpolation and trajectory analysis capabilities.

2.6.1.4.1.3.1 Sub-setting

The MET Service shall support the extraction of a subset of information from a MET Product based on geographical criteria. The geographical area of interest is defined by the ATM consumer. It can be a point (latitude, longitude), a circle about a point, a horizontal cross section, a vertical cross section, a trajectory, a corridor or a sector.

The MET Service shall support the extraction of a subset of information from a MET Product based on a time-related criterion. The timestamp of interest is defined by the ATM consumer.

The MET Service shall support the extraction of a subset of information from a MET Product based on a list of meteorological parameters. The list of parameters of interest is selected by the ATM consumer in the MET Product Description and the WCS capabilities document.

2.6.1.4.1.3.2 Interpolation

Interpolation involves constructing new data points by analysis the surrounding information. This would be required if the requested resolution or co-ordinate system does not match the native resolution of the source MET Product.

2.6.1.4.1.3.3 Re-projection

The re-project function shall support a number of different algorithms for re-projection (re-sampling, interpolation, etc.) and different types of data (images and more generally n-dimensional data).

2.6.1.4.1.4 Web Processing Services (WPS)

Web Processing Services offer a standard interface “envelope” for web based methods of implementing calculations, models or processes on spatially referenced data. The actual process itself can be any algorithm, calculation or access to a bespoke process.

Example of such services could be:

- Conversion of OPMET from TAC to IWXXM.
- Map MET Products into the AIRM model.
- Contouring Service

WPS should be used to implement the services are described the series of European ATM Service Description documents in the WP_08 section of the SJU extranet https://extranet.sesarju.eu/WP_08/Project_08.03.10 .

2.6.1.4.2 MET Product Retrieval

The MET-GATE shall allow an ATM Consumer to request a subscription on a particular service such that the tailored information requested by the consumer shall be delivered when a specified event occurs. That event may be periodic, scheduled or when an update occurs.

Note: Periodic events and update events could be implemented in a generic manner that could be applied to any/most of the services. If threshold breach events are to be included these would need to be implemented very specifically for each individual service type.

2.6.1.4.2.1 Request/Response

ATM consumers shall be able to request MET Information from the MET-GATE via Web Services. The consumer shall construct a request in the correct format that is refined by a number of parameters. The format and acceptable parameters for the request shall be identified in the Service Description. The format and parameters shall vary from service to service and for various endpoints within a service.

2.6.1.4.2.2 Create Subscription

The ATM Consumer can issue a subscription request to a specified service to deliver tailored MET Information when a specified event occurs. The ATM Consumer shall provide

- user identifier
- return URL to which to return the information to. The URL must be accessible from the 4DWxCube
- details on the event on which to return the information (e.g. periodic 30 minutes, on update)
- publishing criteria (always, source changed, updates only)
- start time for the subscription (optional)
- termination time for the subscription (optional)
- service specific request

The structure/schema of the subscription request (with the exception of the service specific request) shall be the same for all subscription services.

2.6.1.4.2.3 Modify Subscription

The ATM Consumer can issue an update subscription request to a specified service to modify the behaviour of a pre-existing subscription.

2.6.1.4.2.4 Unsubscribe

The ATM Consumer can issue an unsubscribe request to a specified service to terminate a pre-existing subscription.

2.6.1.4.2.5 Manage Subscriptions

The MET-GATE system shall manage all active subscriptions for the Web Services.

2.6.1.4.2.6 Publish Subscription Response

When a trigger event for a subscription is identified the MET-GATE shall determine if the requested tailored information from MET Product should be published according to the publishing criteria.

2.6.1.4.2.7 Auditing

The MET-GATE shall audit all MET Information responses send to an ATM Consumer. This shall record the consumer identifier, the service identifier, the MET Product type, the associated geographic area and the size of the response.

2.6.1.4.3 Registry

The registry is a central facility where metadata related to MET Products and Service are stored and maintained. The registry can also store support information that is relevant to the 4DWxCube including: MET Product Definitions, METSP Definitions, MET Product Specifications, schema definitions, service agreements, etc.

2.6.1.4.3.1 Create MET Product Description Entry

The 4DWxCube shall create a new entry in the registry that describes a MET Product. A MET Product can cover any of the types of MET Information that can be managed by the 4DWxCube. This includes uploaded MET Products, Consolidated MET Products and Translated MET Products.

The MET Product Metadata entry shall provide a summary of the MET Product Description to support fast Discovery of products and a full representation of the Product Description containing all metadata data. Metadata should comply with the WMO Core Metadata profile.

Registry entries for a MET Product shall be used to support internal processes such as consolidation, translation, and administration functions as well as supporting service delivery through the MET-GATE.

A new registry entry for a MET Product shall only be created the first time an instance of a MET Product is actually created in the 4DWxCube. After the initial creation, if a new version of the MET Product is created by upload, consolidation or translation this shall result in an update to the registry entry rather than a new registry entry.

Note: this is required to ensure that associations between services and MET Products are correctly maintained.

2.6.1.4.3.2 Create MET Service Entry

The 4DWxCube shall create a new entry in the registry that describes a MET Service that can deliver tailored MET Information to an ATM Consumer.

The MET Service Metadata entry shall provide a summary of the MET Service Description to support fast Discovery of products and a full representation of the Service Description containing all metadata. Metadata information shall comply with the ISO 19119 standard.

The entry shall also provide associations between the MET Service and the MET Products that are operated on by the MET Service.

2.6.1.4.3.3 Update MET Product Entry

The 4DWxCube system shall update an entry in the registry that describes a MET Product. This shall typically be as a result of a MET Product being uploaded by a METSP, a MET Product being updated by the Consolidation functional block or a MET Product being updated by the Translation functional block. An update shall result in a new version of MET Product Entry.

Note: versioning is required to allow for access to older versions of MET Products. This is expected to occur frequently.

2.6.1.4.3.4 Update MET Service Entry

The 4DWxCube system shall update an entry in the registry that describes a MET Service. An update shall result in a new version for the Service Entry.

Note: this is expected to occur infrequently.

2.6.1.4.3.5 Remove MET Product Entry

The 4DWxCube Administrator shall mark an entry in the registry as being deprecated, all versions of the entry shall also be deprecated. A deprecated entry shall remain in the registry until it is purged by the administrator. If a MET Product entry is removed the all associations between a MET Service and the deprecated MET Product shall also be removed.

Note: deprecated entries are only accessible by the 4DWxCube Administrator.

2.6.1.4.3.6 Remove MET Service Entry

The 4DWxCube Administrator shall mark an entry in the registry as being deprecated, all versions of the entry shall also be deprecated. A deprecated entry shall remain in the registry until it is purged by the administrator.

Note: deprecated entries are only accessible by the 4DWxCube Administrator.

2.6.1.4.3.7 Discover MET Product

The ATM Consumer can request the registry to provide information on the latest MET Product Descriptions that meet selected criteria provided by the consumer. As a minimum the selection criteria shall include

- Product type
- Geographic area
- Keywords
- Publication Date
- Time horizon
- Level

The consumer shall also be able to define the level of detail that is returned. This should allow either summary or full Product Descriptions to be returned. If full Product Descriptions are requested this should also include identifiers for the Services that can deliver the MET Product.

2.6.1.4.3.8 Discover MET Service

The ATM Consumer can request the registry to provide information on the available MET Service Descriptions that meet selected criteria provided by the consumer. As a minimum the selection criteria shall include

- Service type
- Keywords

- MET Product Types

The consumer shall also be able to define the level of detail that is returned. This should allow either summary or full Service Descriptions to be returned. If full Service Descriptions are requested this should also include identifiers for the MET Products that it can deliver.

Only those Services that the ATM Consumer has rights to access shall be returned.

2.6.2 Functional analysis

This section shows a more detailed view of the functions introduced section 2.6.1, their dynamic behaviour and how they interact with each other.

2.6.2.1 Functional analysis overview

Figure 9(below) presents an overview of how the various functions are expected to interact within the system. The rectangles represent the external entities that shall interact with the system, providing or requesting data. The circles represent processes within the system that consume, modify or deliver data. The parallel lines represent persistent data stores for the data entities. The arrows represent the flow of data between the entities.

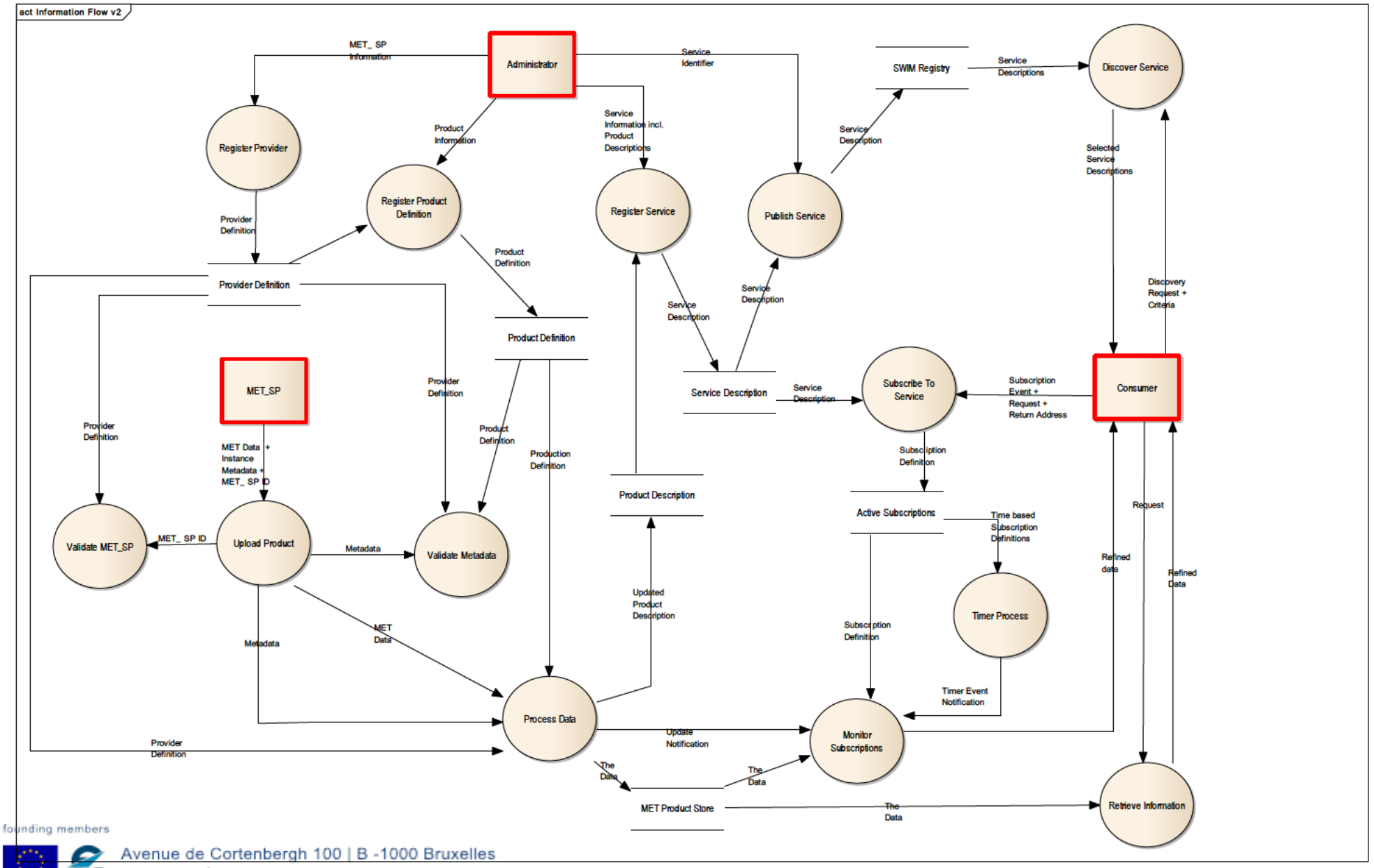

Figure 10: Information Flow Diagram

Active Subscriptions

Type: DataStore

Collection of Active Subscriptions that are managed by the MET GATE/Service.

Administrator

Type: External

The Administrator is responsible for registering providers, products and services within the 4DWxCube. The Administrator ensures that the 4DWxCube contains approved and consistent information of the primary artefacts in the system.

Consumer

Type: External

The Generic consumer accesses meteorological product information ONLY though the services advertised by the SWIM compliant MET GATE Registry. A generic consumer must be known to the system and have permission to access the advertised service.

MET Product Store

Type: DataStore

Collection of Meteorological Data Items stored in the 4DWxCube. This includes Met Products delivered.

METSP

Type: External

A Meteorological Service Provider (METSP) is any approved Data provider that can provide selected product information to the 4DWxCube.

Product Definition

Type: DataStore

Static metadata associated with a specific MET product that METSPs deliver to the 4DWxCube. This acts as a template for the generated Product Description.

Product Description

Type: DataStore

A list of properties that describe a deliverable MET Product. ATM clients use these properties to assess the available data items. The Product Description is constructed from the source MET Product Definition, METSP information, Data Item Metadata and any process metadata used to create the final product.

Provider Definition

Type: DataStore

Metadata related to the approved Meteorological Service Providers.

SWIM Registry

Type: DataStore

The centralised SWIM Registry that maintains information of all services available to consumers.

Service Description

Type: DataStore

Metadata for all services are available through the 4DWxCube/MET-GATE. This metadata is used by the consumers (human or machine) to assess the relevance of the service to their role.

Discover Service

Type: Process

Process whereby consumers discover a collection of Service Descriptions that describe services that meet the criteria requested by the consumer.

Monitor Subscriptions

Type: Process

Internal process that monitors the state of all currently active subscriptions to determine if an event should trigger delivery of information to the subscriber.

Process Data

Type: Process

Generic 4DWxCube process that processes the incoming MET Data Item to produce a harmonised/consolidated view of the meteorological information. Consolidation and translation are examples of such processes.

Publish Service

Type: Process

In this process the Administrator publishes metadata about a previously registered service so that it can be discovered and used by external consumers through the SWIM Registry.

Register Product Definition

Type: Process

In this process the Administrator registers Product Definition information that defines the static information related to MET Product that has been provided by a METSP or created by the Consolidation/Translation process. All products (types) shall be suitably defined so that they provide metadata; including:

- identifier for the product
- description of the product
- extent of the product
- the format of the product
- usage constraints
- the update regime
- associated MET Product Specification
- etc.

Registered product definitions shall be verified to ensure that they adhere to rules of the system and the associated MET Product Specification.

Register Provider

Type: Process

In this process the Administrator registers METSP information that provides information on the METSP that will be used to identify the provider and define which product they can provide. Only approved METSPs can deliver MET Products to the 4DWxCube. The registration shall provide

- Organisation Information
- Product types they are permitted to deliver

Registered METSP metadata shall be verified to ensure that they adhere to rules of the system e.g. the registered products shall align with recorded product definitions.

Register Service

Type: Process

In this process the Administrator registers service metadata, including information related to the products definitions that the service accesses, in the system. A registered Service is not automatically published for external consumption. The service metadata shall include:

- organisation information (author, publisher)
- details on the products that it operates on
- collection of service operation information
- binding information
- output formats

Note that the organisation information relates to the service NOT the products that the service operates on.

Retrieve Information

Type: Process

This processes a standard request, in the form described by the Service Definition, sent by a consumer to a service to retrieve a subset of information. Each service may have a different request form e.g. WMS, WFS, WCS and specifically WPS.

Subscribe To Service

Type: Process

In this process the Consumer provides information to the subscription interface of a previously discovered Service to deliver a subset of information when a specific event occurs. This event may be periodic, scheduled or event-driven.

Timer Process

Type: Process

An internal process that manages timer events that "may" initiate a subscription response.

Upload Product

Type: Process

In this process the METSP delivers MET Products to the 4DWxCube for management.

Validate METSP

Type: Process

This process confirms that the METSP uploading any MET Product is known to the 4DWxCube and that they are delivering an agreed MET Products.

Validate Metadata

Type: Process

This process validates that the metadata provided adheres to agreed standards and is relevant for the stated MET Product Definition and MET Product Specification.

2.6.2.2 Key Entity Types

Figure 11 shows the key entity types that are managed by the 4DWxCube. Each of these entity types need to be managed by the Administrator or by automatic processes within the system.

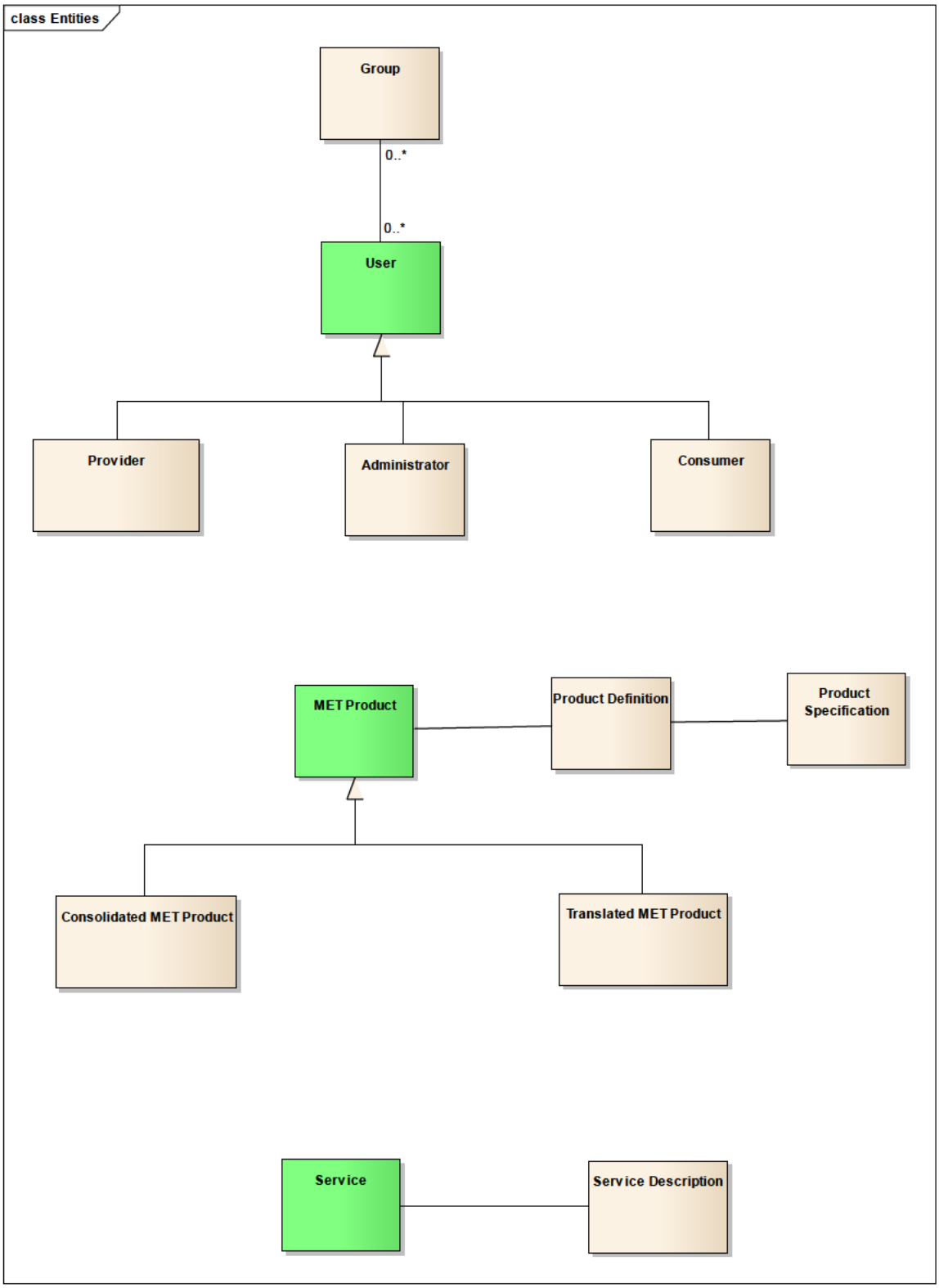

Figure 11: Key Entity Types

There are other supporting entities that also need to be managed such as Service Level Agreements, Copyright support etc.

In all cases the entities have a defined lifecycle. The following sections describe the lifecycle for the main entity types.

2.6.2.2.1 User Lifecycle

The system shall manage the following lifecycle for a user:

1. Created – the user is created in the system and information is provided to uniquely identify the user and what that user is permitted to do.
2. Modified – information associated with the user can be changed but the unique identification for the user shall remain unchanged. Previous versions of the user information shall be maintained for a configurable period of time.
3. Deprecated – a user is no longer able to utilize the system. Users shall not deleted immediately but shall be retained for a period of time to maintain the integrity of audit reviews.
4. Deleted – once a user has been deprecated it can be removed from the system after a configurable period of time.

2.6.2.2.2 Product Lifecycle

The system shall manage the following lifecycle for a product:

1. Created – a Product is created when a new Product Definition has been entered into the system. The MET Product Definition, with its associated MET Product Specification, can describe MET Product information that is delivered by a METSP or Consolidated or Translated Products that are generated by the 4DWxCube itself. At creation time a uniquely identified Product Description shall be created but no concrete data shall be associated with it.
2. Modified – Consolidated and Translated Products shall be generated from MET Product information delivered by the METSP. These shall be considered as new versions of the original products with a new version of the Product Description generated to reflect the new instance information.
3. Deprecated – When a new version of a Product is created the previous version shall be deprecated to indicate that it should no longer be used. Deprecated versions of Products shall not be deleted immediately but shall be retained for a period of time to maintain the integrity of audit reviews.
4. Deleted – Older versions of MET Product Descriptions and their associated data shall be deleted from the system after a configurable period of time.

2.6.2.2.3 Service Lifecycle

The system shall manage the following lifecycle for a service

1. Created – a Service is created when a new Service Description is has been entered into the system on approval by the 4DWXCube Governance Board. The Service Description shall reference one or more working instances a capability that can respond to consumer requests or subscriptions.
2. Modified – a Service may be configured to use one or more Product Descriptions or to edit supporting information. A new version of the Service Description shall be create to reflect configuration changes.
3. Deprecated – When a new version of a Service Description is created the previous version shall be deprecated to indicate that it should no longer be used. Deprecated versions of

Services shall not be deleted immediately but shall be retained for a period of time to maintain the integrity of audit reviews.

4. Deleted – Older versions of Service Descriptions shall be deleted from the system after a configurable period of time.

2.6.2.3 Administration

The Administration Functions underpin the operation of the 4DWxCube by configuring the system, monitoring the overall behaviour of the system and maintaining the system.

2.6.2.3.1 Register Product Definition.

Information on MET Product types that are to be managed by the 4DWxCube shall be registered in the system.

The Administrator shall receive MET Product Definition information from a METSP. This Product Definition may relate to a specific product from an individual METSP or relate to a regulated product type, e.g. TAF or METAR that can be delivered by multiple METSPs. Note that the 4DWxCube itself is considered as a special type of METSP as it is responsible for the generation of Consolidated and Translated Products which also require a MET Product Definition.

All products (types) shall be suitably defined so that they provide information on the following metadata categories

- identification of the product
- extent of the product
- format of the product
- usage constraints
- observed/forecast parameters

The metadata is not necessarily complete as it only provides a sub-set of the final metadata required for an actual instance.

On receipt of the registration information, the Administrator shall enter the information in the correct format into the system. The system shall then verify the information to ensure that it adheres to the governance rules of the system.

On successful verification the system shall store the MET Product Definition in the 4DWxCube Registry for future use and send confirmation of success back to the Administrator.

An initial Product Description is also created and stored to provide a unique identifier for future Products.

Verification failure shall stop the process and return a failure message, with the reason for failure, back to the Administrator.

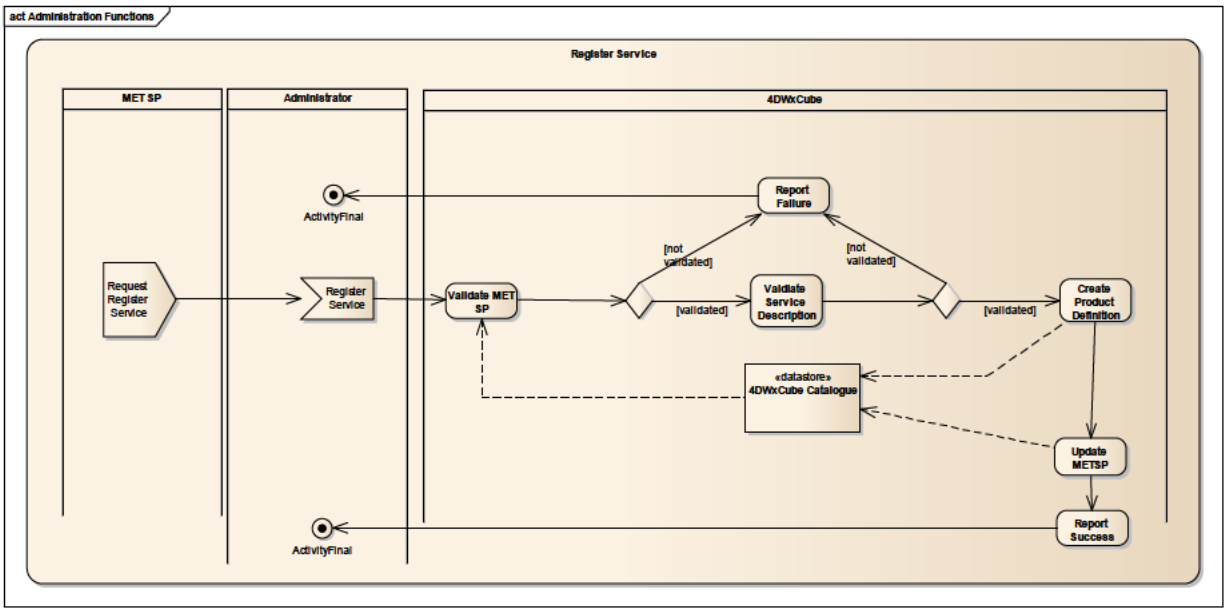

Figure 12: Register Product Definition

2.6.2.3.2 Register Service Description.

Services can either deliver Consolidated and Translated Products directly or send a tailored version of the Products if designed to do so.

The Administrator shall receive a Service Description from a METSP for a service that that is already implemented and has been accepted by the 4DWxCube Governance Body. The Service Description shall include

- organisation information (author, publisher of the service)
- details on the MET Product Definitions that it operates on
- details of the MET Product Specifications that it delivers
- collection of service operation information
    - endpoint address (The end point must be accessible from the 4DWxCube)
    - binding information
        - input parameters
        - input constraints
    - output formats

The Administrator shall enter the Service Description information into the 4DWxCube either by providing a correctly formatted XML document (ISO 19119 definition of a Service) or by entering the information through a form based interface.

The 4DWxCube shall verify the METSP providing the information is authorized to do so and shall then validate Service Description itself to ensure that it provides all the required information to fully define the Service.

Optionally the 4DWxCube shall attempt to access the service to confirm that it is reachable. (Each Service should be able to provide some form of capabilities document to describe its parameters.)

The 4DWxCube shall register the Service Description in the 4DWxCube Registry and report success to the Administrator.

If the information provided is invalid the 4DWxCube shall report an exception giving details for the failure.

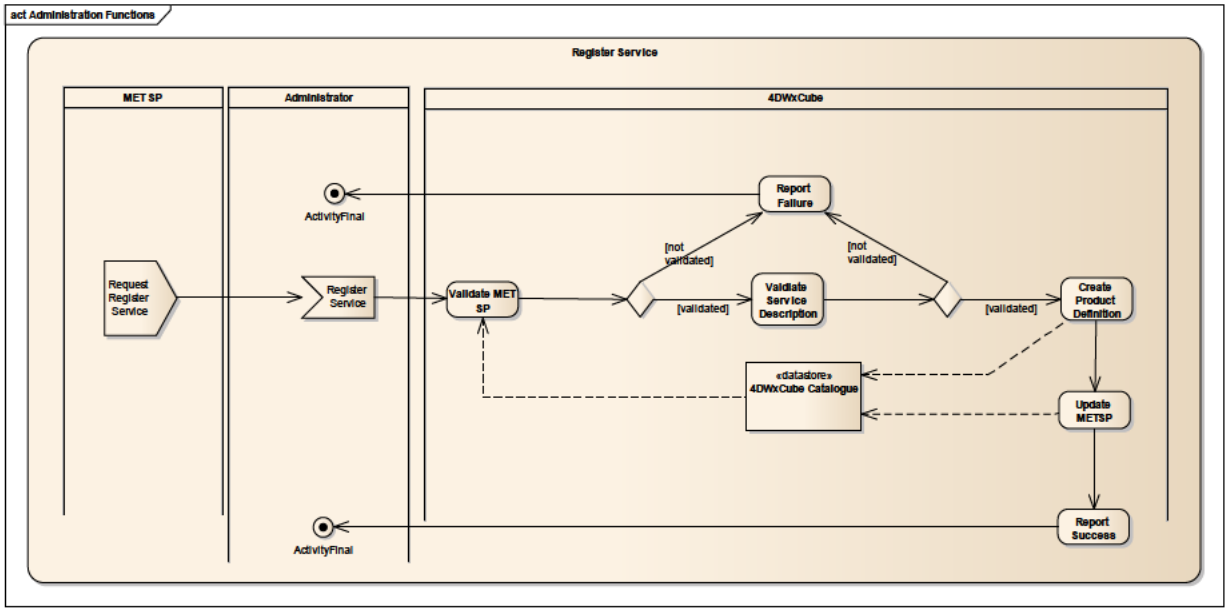

Figure 13: Register Service Description

2.6.2.3.3 Publish Service

Services that are registered within the 4DWxCube are not necessarily discoverable by ATM Consumers, this may be the case when new services are being tested or where services are only available to processes internal to the 4DWxCube.

To make services available to ATM Consumers the Service Descriptions shall be published to the SWIM Registry. This shall provide a duplicate of the Service Description held in the 4DWxCube Registry.

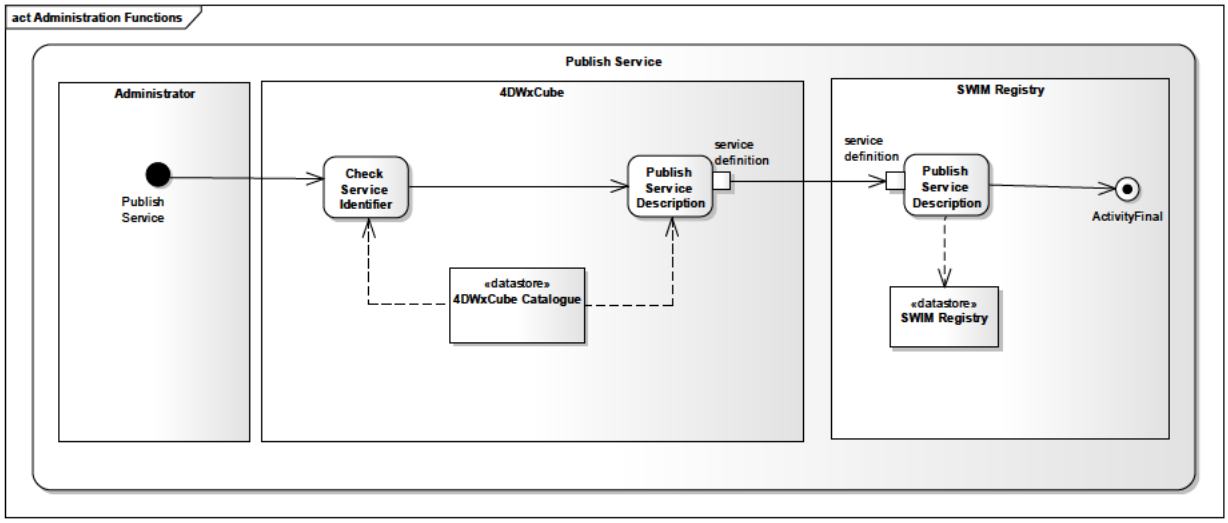

Figure 14: Publish Service to SWIM Registry

2.6.2.3.4 Purge Data

As MET Information is added to the 4DWxCube new versions of MET Products and Product Descriptions are generated. There is a need to maintain older versions to support audit reviews. However, over time, older versions shall require excessive resources to store them and shall need to be deleted. *Note: METSPs are expected to archive their original MET Products for longer periods. This will support reproduction of Consolidated and Translated Products if necessary.*

Each MET Product Definition relating to a MET Product shall have associated with it a lifespan indicating how long product versions of that type are to be retained by the 4DWxCube. At regular intervals the system shall check the age of all Product Description versions and delete the artefacts, i.e. any files and data, associated with that version.

2.6.2.3.5 Monitor System Behaviour

The 4DWxCube is required to ensure that the system behaves as expected. Monitoring of system behaviour shall be an automatic process. The Administrator shall be able to review the behaviour of the system on a Performance Dashboard display which shall display information relating to provider alerts and quality of service.

2.6.2.3.5.1 Provider Alerts

A provider registers with the 4DWxCube and commits to provide MET information described by one or more MET Product Definitions. This commitment includes an update rate for delivery of the MET information.

The system shall monitor that each METSP delivers the required MET information at the agreed rate. If MET Information is not delivered as expected, within an agreed timeframe, the system shall send an email notification to the Administrator and a Provider Representative. Any breaches in the delivery agreement shall also be presented in a Performance Dashboard.

Note that the 4DWxCube itself is a provider of Consolidated and Translated MET Products that shall be produced at an agreed update rate. Because of the dependency of the Consolidated and Translated MET Products on externally delivered information the notification should indicate if the failure or reduced quality of the generated products is as a result of source data problems.

Where a failure occurs more than a configurable number of times no more emails will be sent. The follow up resolution process for multiple errors will need to be addressed as part of the governance procedures.

2.6.2.3.5.2 Quality of Service

Consumers shall access MET Products through the use of MET Services. These need to be monitored to ensure that the meet performance criteria. The system shall monitor each of the active registered services to determine:

- Availability: to ensure the MET Service is available for use.
- Accessibility: to ensure that the service is capable of serving a valid request.
- Integrity: to ensure that the response to the request is as expected.
- Performance: to measure of how many requests were made and the time taken to respond to the request.
- Reliability: to measure the number of failures in a given period.

In the event of any measure going outside of a configured range e.g. not available for > 1 minute, average response time > 10 seconds, a notification shall be sent to the Administrator. Any breaches shall also be reported in the Dashboard.

Where a failure occurs more than a configurable number of times no more emails will be sent. The follow up resolution process for multiple errors will need to be addressed as part of the governance procedures.

2.6.2.3.5.3 Audit Report

All significant events in the 4DWxCube shall be audited. This includes delivery of MET Information by a Provider, generation of Consolidated and Translated Products, requests sent by a consumer, and publications in response to a subscription.

Each auditable event shall record the time the event occurred, the source of the event and the type and identifiers of associated parent objects e.g. the provider of delivered MET information, the MET Products used to generate a Consolidated MET product, the Translated Products used to generate a Tailored MET Product response. Maintaining the immediate parent hierarchy provides flexibility in tracing the source of information in the event of any failures or quality issues.

The 4DWxCube shall provide a set of tools to enable the Administrator to report on the sequence of events leading up to an identified auditable event and resulting from an identified auditable event.

2.6.2.4 Access Control

Authentication and Access control shall follow the requirements outlined in the SWIM-TI. See the Security Functional Block Section 1.9 of the 14.01.04.D44-004-SWIM-TI Yellow Profile Technical Specification Ref.[17]

There are three main user types of associated with the 4DWxCube; Administrator, Providers and Consumers. The Administrators access the 4DWxCube through a series of specialist GUIs and interfaces, Providers access the 4DWxCube through a number of provider interfaces on Ports 1, 2 and 4, Consumers access the 4DWxCube through published SWIM compliant interfaces (Port 3).

The Administrator is an internal role to the 4DWxCube and shall be managed independently from the other roles in such a way that access to GUIs and interfaces are restricted according to configured rights.

The majority of interactions with the 4DWxCube shall be by ATM Consumers requesting MET Information through published services. Access control granularity shall be defined at a service level, i.e. if an ATM Consumer is granted access to a service then that ATM Consumer shall have access to all MET Information delivered by that service. An additional level of granularity could be applied based on MET Product Definitions i.e. the 4DWxCube shall only deliver any MET Information for products that the ATM Consumer has access rights. The 4DWxCube does not need to manage information about consumer users; it only needs to be aware of the attributes associated with the consumer users to determine if they can access an individual SWIM service. Each consumer role shall have a number of attributes associated with them to enable the system to review their right to access 4DWxCube services and data. This shall be managed by SWIM-TI.

METSPs, those users that provide MET information to the system, require additional access control information to determine if they are permitted to deliver particular product types. The 4DWxCube also needs to know detailed information about the METSP as this information shall be used by the 4DWxCube to complete lineage and publisher information for the complete MET Product Description. No MET Information shall be accepted from a METSP if the METSP does not have an appropriate associated Product Definition.

2.6.2.4.1 Register MET Service Provider

The Administrator shall receive registration information from a METSP wishing to publish Met information through the MET-GATE and approved by the 4DWxCube Governance Board. The registration shall provide:

- Organisation Information
- Product types they wish to deliver (optional)
- Usage constraints for the products that they may provide.

On receipt of the information the Administrator shall enter the information through a graphical user interface (GUI). The GUI shall present a form with fields for the expected data. Required fields shall be marked as such. The Administrator shall enter the information and select save.

The system shall verify the information to ensure that it adheres to rules of the system, e.g.

- METSP is not duplicated
- contact information has been provided
- registered products must align with a recorded MET Product Specification.

On successful verification, the system shall store the METSP information for future use and send confirmation of success back to the administrator.

Verification failure shall stop the process and return a failure message, with the reason for failure, back to the Administrator.

An audit record shall be generated indicating the success of failure of the addition of METSP information.

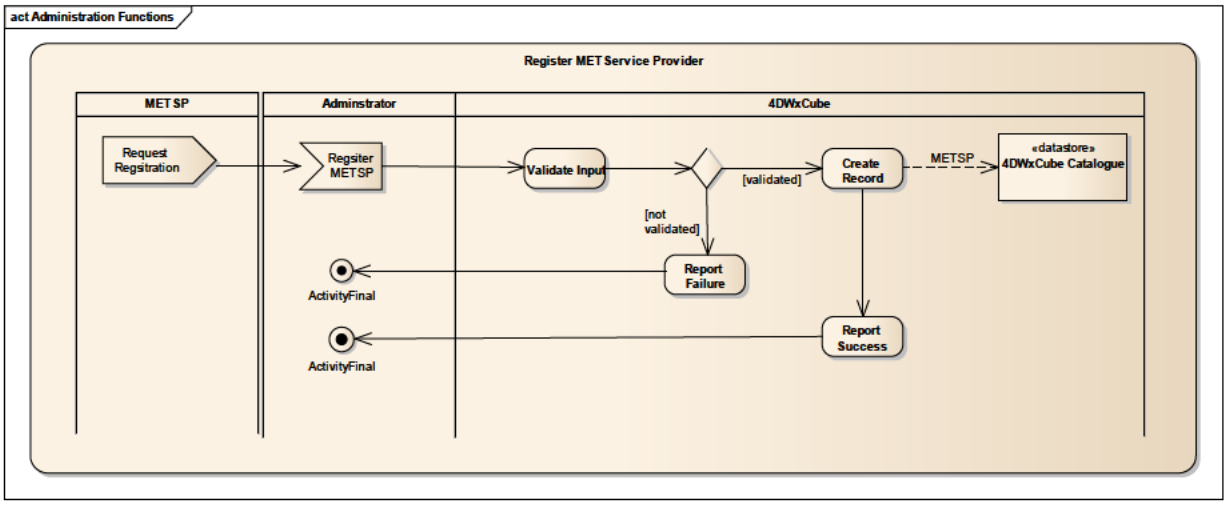

Figure 15: Register MET Service Provider Activity Diagram

2.6.2.4.2 Modify MET Service Provider

Using a GUI application the Administrator shall select the METSP to be modified from the list of available METSPS and select the edit option. The GUI shall present a form with the existing information on the METSP displayed. The Administrator may edit those fields that are not displayed as read only.

On completion of editing, the information shall be saved in the 4DWxCube Registry. An audit record shall be generated indicating what changes were made to the METSP information.

Note: up versioning of METSP information was considered as an alternative approach. This was discarded in favour a simpler audit trail as up-versioning has the potential for cascading new versions of related information.

2.6.2.4.3 Remove MET Service Provider

Using a GUI application the Administrator shall select the METSP to be deleted from the list of available METSPs and select the delete option. The GUI shall present a form with the existing information on the METSP displayed and ask for confirmation of the deletion.

On confirmation of delete the latest version of the METSP information in the 4DWxCube Registry shall be marked as “deprecated”. All relationships which involve the METSP shall also be marked as deprecated. An audit record shall be generated indicating the deletion of the METSP information.

METSPs which have been marked as deprecated shall no longer be able to provide information to the 4DWxCube.

2.6.2.4.4 Assign MET Product Definition to MET Service Provider

A MET Product that has been defined shall be provided by one or more approved METSPs.

Using a GUI application the Administrator shall select one or more MET Product Definitions from the list of registered definitions to be assigned. They shall then select one or more METSP from the list of registered providers and create a relationship between the MET Product Definitions and the METSPs. For each relationship the Administrator shall qualify the relationship by providing information on

- when delivery of defined MET Products shall start
- when delivery of defined MET Products shall finished (optional)
- update rate for the publication
- usage constraints

The relationship shall be used later to verify if a METSP can provide a particular MET product.

The qualified relationship between the METSP and the MET Product Definitions that they can provide shall be stored in the 4DWxCube Registry.

Figure 16: Assign Product Definitions

2.6.2.4.5 Modify MET Product Definition/MET Service Provider relationship

Using a GUI application, the Administrator shall select the METSP. The GUI shall display a list of existing MET Product Definition relationships. The Administrator shall then select a MET Product Definition relationship and select the edit option. The GUI shall present a form with the existing information on the relationship displayed. The Administrator may edit those fields that are not displayed as read only. Example of editable fields are:

- start date for delivery of defined MET Products
- end date for delivery of defined MET Products
- update rate for the publication
- usage constraints

On completion of editing, the information shall be saved in the 4DWxCube Registry. An audit record shall be generated indicating what changes were made to the METSP information.

2.6.2.4.6 Remove MET Product Definition/MET Service Provider relationship

Using a GUI application, the Administrator shall select the METSP. The GUI shall display a list of existing MET Product Definition relationships. The Administrator shall then select one or more MET Product Definition relationships and select delete. The GUI shall request confirmation of the deletion.

On confirmation of delete, the MET Product Definition relationship in the 4DWxCube Registry shall be marked as "deprecated".

2.6.2.5 Data Management

The Data Management Functional Block is responsible for the management of all delivered and created data within the system. Figure 17 provides a summary of the managed data types.

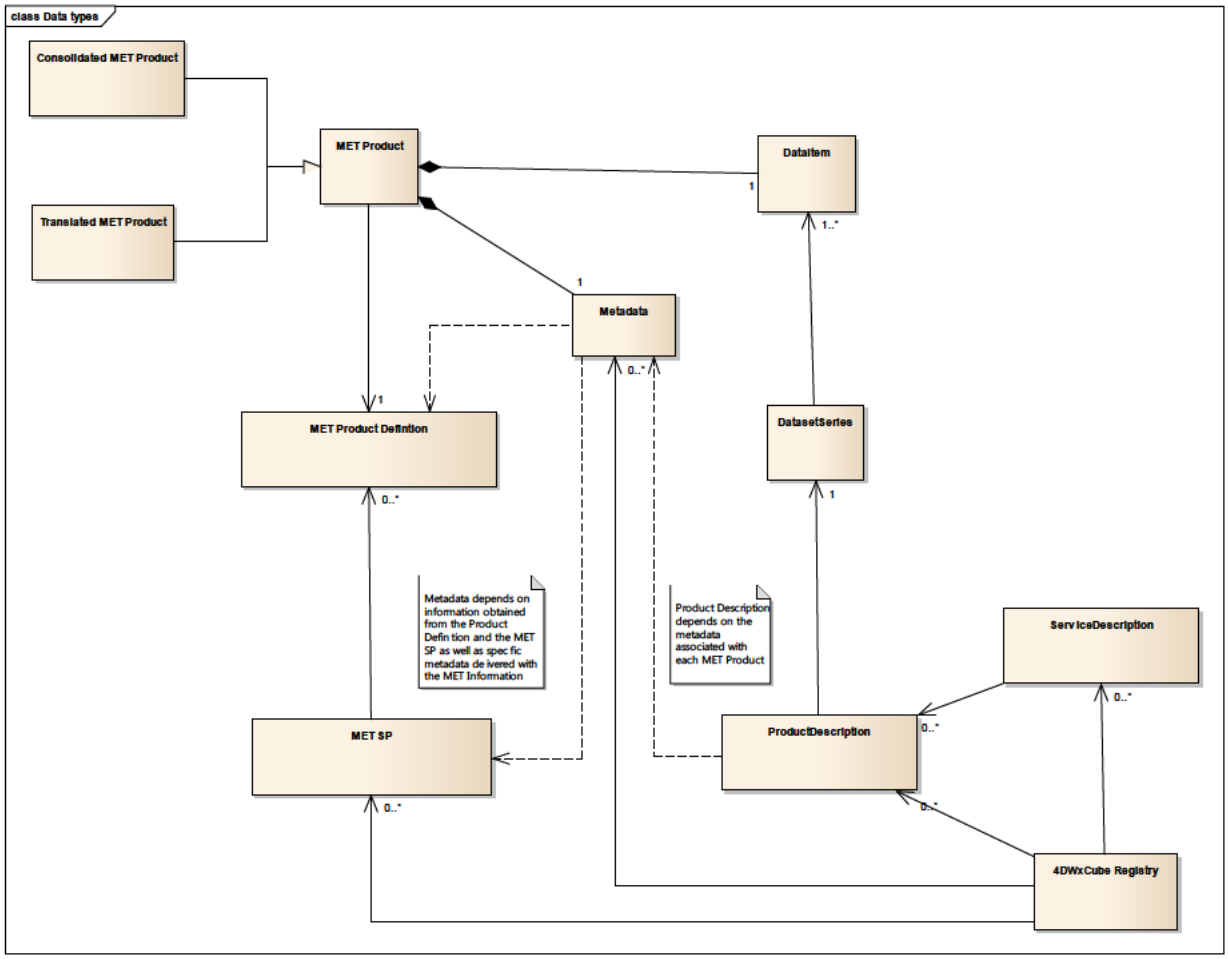

Figure 17: Summary of 4DWxCube Managed Data Types

MET Product	MET Information provided to the 4DWxCube which is specified by its metadata; therefore it contains metadata and data item
Data item	Coherent collection of meteorological information.
Metadata	Information that describes the data item.

Consolidated MET Product	MET Information (from one or more sources) that has undergone consolidation to produce a consistent, common harmonized and seamless meteorological view at the European scale.
Translated MET Product	MET Information (from one or more sources) that has undergone translation to produce an ATM specific view of meteorological phenomena.
MET Product Definition	Static metadata associated with a specific MET Product that METSPs deliver to the 4DWxCube. This acts as a template for the generated Product Description.
METSP	Information on the METSP that defines static details about the Provider and identifying which Product Definitions they are authorised to deliver.
MET Product Description	List of properties associated to a MET Product that ATM consumers shall use to access to the MET Products.
Dataset Series	"A collection of resource related by a common heritage adhering to a common specification." A dataset series may be a collection of data items that provide the same information for different time frames (a chronological series) or it may be a series of data items that provide the same information for different geographical areas (a mosaic). Within the 4DWxCube the Dataset Series acts as a proxy to frequently changing datasets so that the Service Description does not need to be constantly updated.
Service Description	Metadata for a service available through the 4DWxCube.This metadata is used by the consumers (human or machine) to assess the relevance of the service to their role and provides information on how to access the service.
4DWxCube Registry	The 4DWxCube Registry manages the various metadata used to describe the providers, products and services.

Figure 18 below describes a typical information flow through the 4DWxCube highlighting the key information artefacts (*in red italics*), the key processes and the persistent stores (**in bold**). This specific information flow diagram describes how radar information is managed within the 4DWxCube to support the publication of a tailored convection product for an ATM consumer.

1. The provider uploads the *radar information* with minimum *metadata* related to the specific instance of the *radar information.*
2. The *radar information* is validated to make sure that it is in the expected format etc.
3. The *metadata* is validated to make sure that it provides the minimum metadata information required.
4. The *radar information* and the *metadata* are processed. The metadata is extended to include *provider information* and *product definition* information obtained from the **4DWxCube Registry**. The *raw radar information* is stored in the **MET Product Store**. The *extended metadata* is stored in the **4DWxCube Registry**, the *extended metadata* shall contain information about the location of the *raw radar information* in the **MET Product Store**.

5. The *Metadata ID* and the *Product Definition ID* are passed to the broadcast process which broadcasts the information to any processes that may be interested in the fact that new data is available.
6. A consolidation monitoring process shall monitor for any new information (based on product definition ID) that is relevant to one or more of the consolidation processes. The *Metadata ID* is then transferred to the appropriate process(es).
7. The selected consolidation process (CO2 Radar Composite) is informed of new information and retrieves the *radar extended metadata* from the **4DWxCube Registry**. The process itself may need to wait until *radar information* is available from other providers. Using the information contained in the metadata the process shall retrieve all relevant *radar information* from the **MET Product Store** and then produce a *Consolidated Radar Reflectivity* product and store this in the **Consolidated MET Product Store,** *Consolidated Radar Reflectivity Metadata* associated with the consolidated product shall be stored in the **4DWxCube Registry**.
8. The *Metadata ID* and the *Product Definition ID* are passed to the broadcast process which broadcasts the information to any processes that may be interested in the fact that new data is available.
9. A translation monitoring process shall monitor for any new information (based on product definition ID) that is relevant to one or more of the consolidation processes. The *Metadata ID* is then transferred to the appropriate process(es)
10. The selected translation process (TO3 Convection) is informed of new information and retrieves the *Consolidated Radar Reflectivity Metadata* from the **4DWxCube Registry**. The process itself shall also need to may need to wait until new *Forecast and Observation metadata* is available. Using the information contained in the metadata the process shall retrieve the *Consolidated Radar Reflectivity* and *Forecast and Observation Products* from the **Consolidated MET Product Store** and then produce the *Convection Product* and store this in the **Translated MET Product Store,** *Convection Product Metadata* associated with the consolidated product shall be stored in the **4DWxCube Registry**.
11. The *Metadata ID* and the *Product Definition ID* are passed to the broadcast process which broadcasts the information to any processes that may be interested in the fact that new data is available.
12. A subscription monitoring process shall monitor for any new information (based on product definition ID) that is relevant to any of the active subscriptions. The *Convection Product Metadata* is retrieved from the **4DWxCube Registry** and passed to the specific tailoring service associated with the subscription.
13. Using the *Convection Product Metadata* the service retrieves the *Convection Product* from the **Translated MET Product Store** and creates a *tailored ATM Product* that is published to the consumer.

Central to the data management of the system are the MET Product Stores (Raw, Consolidated and Translated) which store the meteorological information and the 4DWxCube Registry which stores the metadata associated with the MET Products and the providers.

The Data Management functional block spans all the internal processes of the 4DWxCube. Upload and management of providers, product definitions and service descriptions are dealt with in the Administration functional block described in section 2.6.2.3. Consolidated MET Products and Translated MET Products are managed in the same way as Raw MET Products.

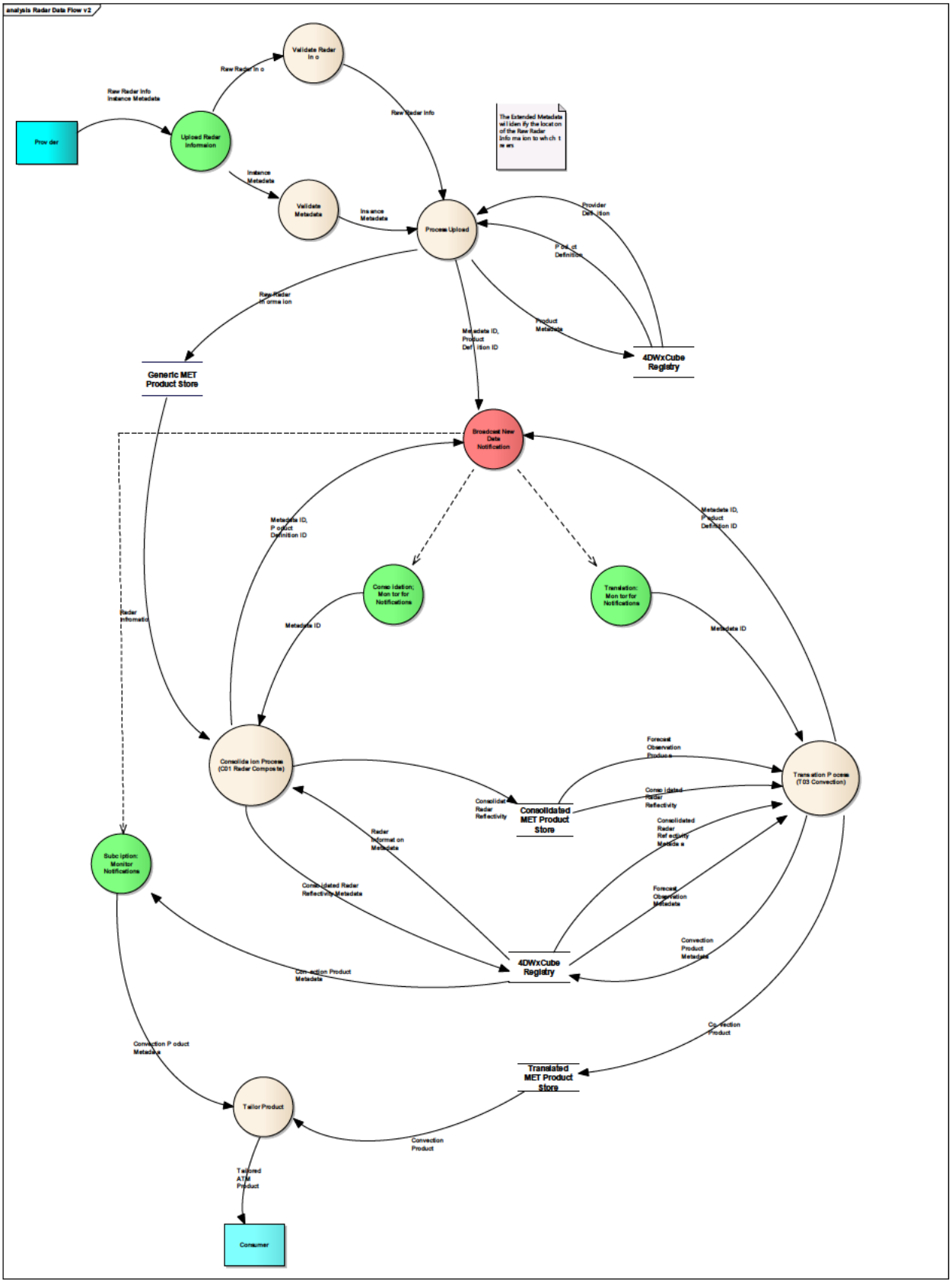

Figure 18: Information Flow for the Radar Information

2.6.2.5.1 Upload MET Information

The 4DWxCube shall provide an interface that shall allow METSPs to deliver MET Information to the 4DWxCube. Only METSPs that are authenticated shall be permitted to upload MET Product information.

METSPs shall provide the MET data item itself and the metadata associated with the data item. The data item and the metadata may be provided in a single entity or may be provided as separate entities. The metadata provided may contain only a subset of the full product metadata, additional metadata shall be provided from the MET Product Definition and the METSP information

The following information shall also be provided

- a unique identifier for the METSP
- an identifier for the MET Product Definition that the data item conforms to

A summary of the upload process is shown in Figure 19 below. This pattern is considered to be a generic pattern for the delivery of most MET Information; forecasts, observations, ICAO products, text based products etc.

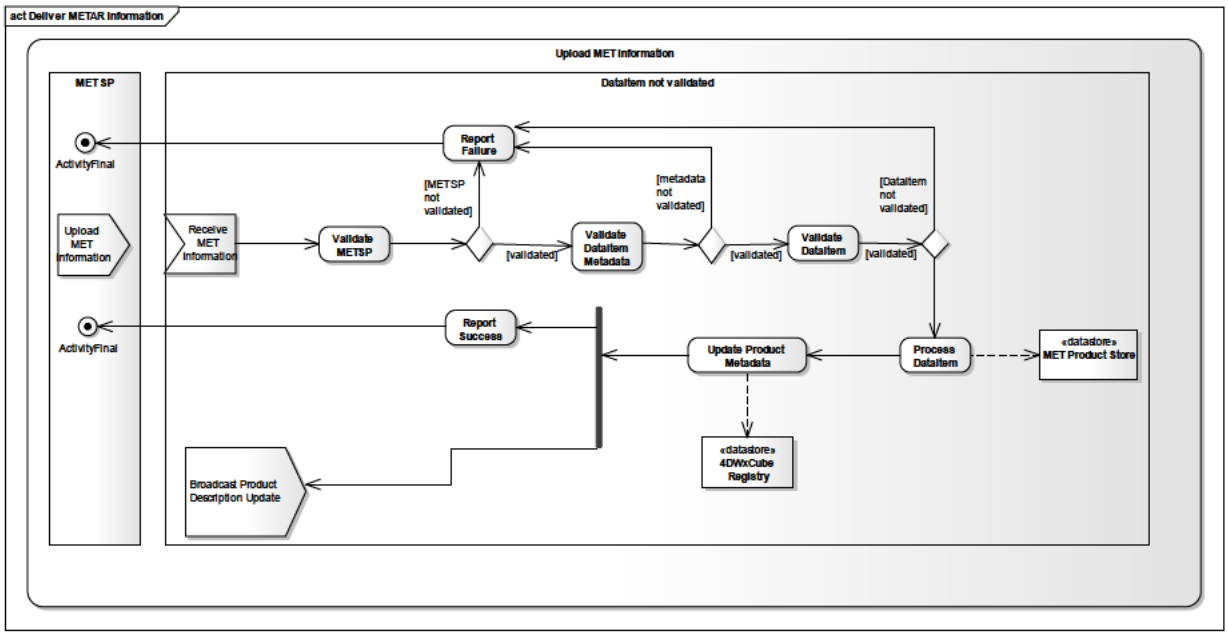

Figure 19: Upload MET Information

All upload requests shall create an audit record containing (as a minimum):

- Time of request
- METSP identifier
- MET Product Definition identifier
- Unique identifier for the generated Product Metadata stored in the 4DWxCube.
- Status of the upload request
- Reason for failure (if any)

2.6.2.5.2 Check validity of MET Information

On receipt of the MET Product the 4DWxCube shall ensure that the format and metadata is consistent with the contract between the 4DWxCube and the Provider. This validity check shall confirm that:

1. The METSP providing the MET information is known to the 4DWxCube

2. The METSP providing the MET information is permitted to deliver the identified MET Product Definition.
3. The data item metadata provided is sufficient to complete the MET Product metadata.
4. The data item provided matches that described by the associated MET Product Specification.

Due to the large variety of MET Product Specifications and data item formats, the validation process for the data item metadata and the data item itself shall be bespoke to a particular MET Product Specification. For example, the validation process for a METAR shall be different from the validation process for Radar Information due to the difference in format and content.

2.6.2.5.3 Process and Store MET Products

Successfully validated MET information shall be processed and stored in the 4DWxCube as a Raw MET Product.

As with the validation process, the processing of the MET information as delivered by the METSP is dependent on the type of MET Product Data Item delivered. In some cases the MET Product Data Item is stored as delivered by the METSP, in other cases the MET Product Data Item may be modified before storage, e.g. conversion of units. Any processing at this stage shall be constrained to the data item delivered by the METSP and shall not depend on other data items. If the data item is modified before storage the associated metadata shall be updated to reflect any additional processing steps.

The processed MET Product Data Item shall be stored in the MET Product store. *(Note: the form of the MET Product store is not considered in this TS).*

The data item metadata, the MET Product Definition and the METSP Definition shall be combined to produce a MET Product Metadata record that fully describes the instance of the MET Product that has been uploaded and processed. The MET Product Metadata shall provide a reference to the location of the stored data item. The MET Product Metadata shall be published to the Registry where it can be accessed by other processes in the 4DWxCube.

The 4DWxCube shall broadcast a message to other processes in the 4DWxCube indicating that new information is available. The broadcast message shall contain sufficient information to identify the metadata and product type to enable processes to decide if the new information is relevant or not.

The Consolidation and Translation functional blocks shall need to be informed that new data is available in order to carry out their functions. Subscription monitoring shall also need to be informed when new data is available in order to respond to user subscriptions.

2.6.2.6 Consolidation/Translation

The following section relates to the non-meteorological aspects of the Consolidation and Translation Functional Blocks. They both have the same requirements in relation to their integration/interaction with the rest of the 4DWxCube. The actual details of the various processes are dealt with in the following documents

- Final Technical Specification, MET prototypes - Local P11.02.02-D (reference [12])
- Final Technical Specification, MET prototypes – Sub-regional P11.02.02-D (reference [13])
- Final Technical Specification, MET prototypes - Network P11.02.02-D (reference [14])

2.6.2.6.1 Process Configuration

To manage the Consolidation/Translation Functional Block the following configuration information is required for each separate process:

- Product Specification for the Consolidated/Translated MET Product that is produced by the process.

- Product Definition for the Consolidated/Translated MET Product to provide the static information related to the final product e.g. processing information, parameters produced.
- Product Specifications for generic/Consolidated MET Products that are relevant to the process to enable the monitoring process to determine when to trigger a specific consolidation process.
- METSP information for each contributing product to determine what the lineage of the final product is.
- Where a process requires input from more than one Product Specification a limiting time period is required to determine how long the process should wait from receipt of the first product before triggering the execution of the process.

2.6.2.6.2 Monitoring of new MET Product Information

A monitoring process shall be available to listen for broadcasts of new MET Products. The monitoring process shall examine the associated product type information and determine if the product is relevant to any of the consolidation processes. If it is, the information shall be passed to the identified consolidated process(es).

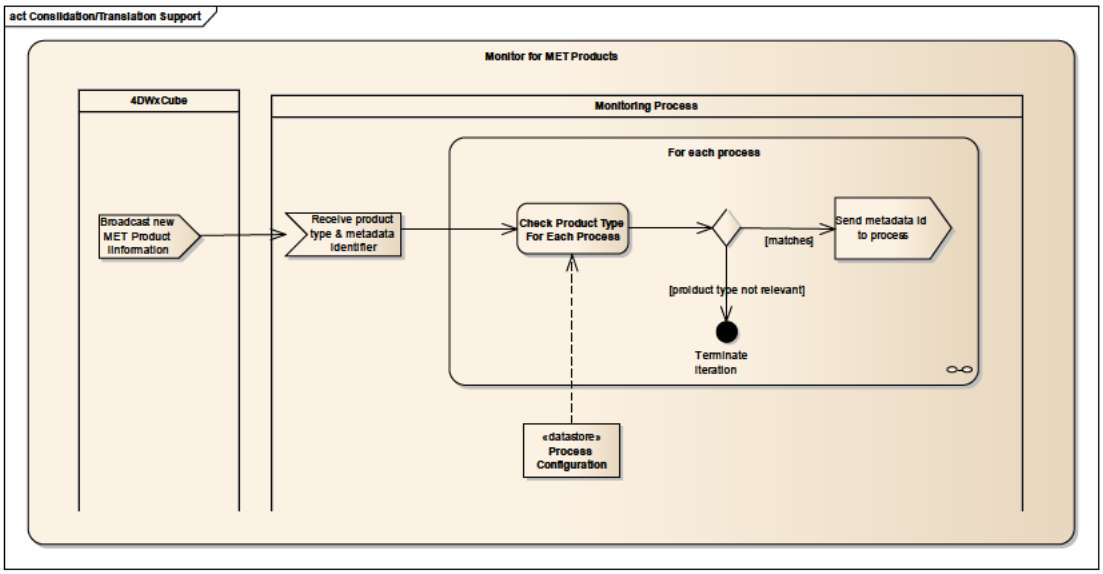

Figure 20: Monitor for MET Products

Figure 20 shows how the monitoring process shall operate. On creation of a new MET product the 4DWxCube shall broadcast minimal product type information and metadata ID. The monitoring process shall listen for such broadcasts. On receipt of a broadcast the monitor shall loop over all configured consolidation processes and determine if the product type is of interest to the process. If it is, it shall send the metadata ID to the consolidation process.

2.6.2.6.3 Synchronization for processing of MET Product

The various consolidation processes combines a number of MET Products. For example, the production of the Convection Product requires Consolidated Radar Reflectivity, Aircraft Derived Met Observations, Consolidated VST Forecasts, Consolidated ST Forecast, and Consolidated MT Forecasts. The Consolidated MET Products shall be available to the 4DWxCube at different points in time. The synchronization process shall therefore identify when sufficient relevant information is available to execute a given process.

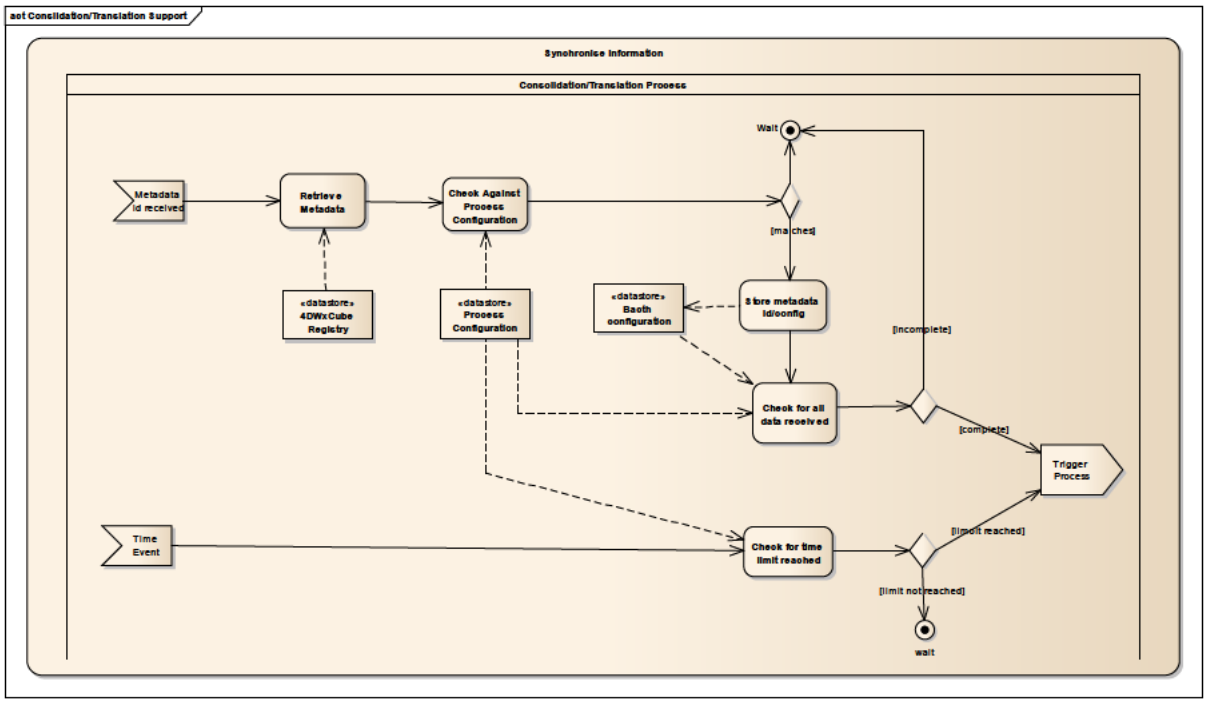

Figure 21 Synchronization process

Figure 21 shows the general synchronization process behaviour. Each separate process may have a variant of this if required. When the monitoring process identifies a product type of interest for a process the metadata ID for the MET Product shall be sent to the process specific synchronization process.

The synchronization process shall retrieve the metadata from the 4DWxCube Registry. This shall provide detailed information about the new MET Product including product specification and lineage information. The process shall check the detailed information against the process configuration to determine if the MET Product should be included in the process. The decision as to what should be included and what should be ignored is process specific. If MET Product is valid the metadata and associated configuration information shall be stored for inclusion in the next execution of the process.

The process shall then check if all required information is available. If it is, then the process shall execute. Alternatively, the process can check against time criteria to determine if the process should execute after a given time even if not all information is available. This decision is process specific.

2.6.2.6.4 Metadata Creation for Consolidated/Translated MET Products

The translation processes shall generate new Consolidated and Translated MET Products from incoming generic and Consolidated MET Products. The resultant products shall need detailed metadata to accurately describe the new products. This shall provide the following information:

- unique identification information for the product
- the lineage of the product including the METSPs that provided the MET products
- geographic information for the product
- relevant keywords
- usage constraints
- the parameters that the MET Product provides (Temperature, Humidity etc.)
- temporal and spatial resolution
- validity period for the newly created product

- description of the process that was used to produce the product. This may reference an external document.

Generated metadata shall comply with the WMO Core Metadata Profile Ref. [18][19]

2.6.2.6.5 Broadcast of newly created Consolidated/Translated MET Product information.

Once a new MET Product has been created, other functional blocks within the 4DWxCube, specifically the Translation Functional Block and the MET-GATE, shall be informed that the new product is available.

The process shall broadcast the product type, identified by the Product Specification, and the unique identifier of the associated metadata record. This shall enable other monitoring processes to react to the newly created product.

2.6.2.7 4DWxCube Registry

The 4DWxCube Registry is a central store that holds descriptions of all the resources that the 4DWxCube manages. Figure 22 shows the key registry artefacts that the 4DWxCube Registry shall support. These fall into two main types, registry objects and relationships.

Registry objects provide core information on a resource that they are describing. It is important to identify that registry objects are not the same as the resource they are describing even if that resource is a metadata record. A registry object shall contain:

- unique identifier — to uniquely identify the registry object within the 4DWxCube Registry.
- object type — to determine the type of registry object. Typically this shall be equivalent to the type of resource it is describing. Object types shall be constrained to only those types allowed by the 4DWxCube.
- version information — to determine the version of the registry object.
- status — to determine if the described resource is submitted, approved or deprecated.
- name — (optional) human readable name for the resource
- description — (optional) human readable description for the resource
- keywords — (optional) relevant keywords for the resource being described, e.g. forecast, climatology , gridded data, WCS. Keywords shall be constrained only to those allowed by the 4DWxCube.
- other attributes — (optional) additional information specific to the resource being described. Such attributes should only be included in the registry object if they are relevant to discovery of the specific resource. For example, it may be relevant for the registry object describing a forecast to hold a time range attribute to enable a consumer to search for forecasts that overlap a specific time period.

As well as describing a resource, the object may also contain the actual resource that it is describing. This shall be the case for the metadata objects, service descriptions, organization information and (smaller) supporting artefacts such as product specifications or schemas. Large resources, such as MET Products, shall not be contained but they shall contain information to allow the system to access the actual resource.

Relationships are a special type of registry object which provides information on relationship between resources. The object type of the object identifies the type of relationship. Relationship objects identify the source and target objects of the relationship. For example, the CMP-CMPMD relationship in Figure 22 identifies a specific relationship type between a Consolidated MET Product resource and a Consolidated MET Product Metadata resource. Relationships allow the 4DWxCube to understand how the resources are connected. For example, it should be possible to determine which METSPs delivered the original MET Products used in the generation of a Consolidated MET Product.

The 4DWxCube Registry may hold other object types, for example relating a Product Definition and Product Description to a Product Specification. These are not described in detail here.

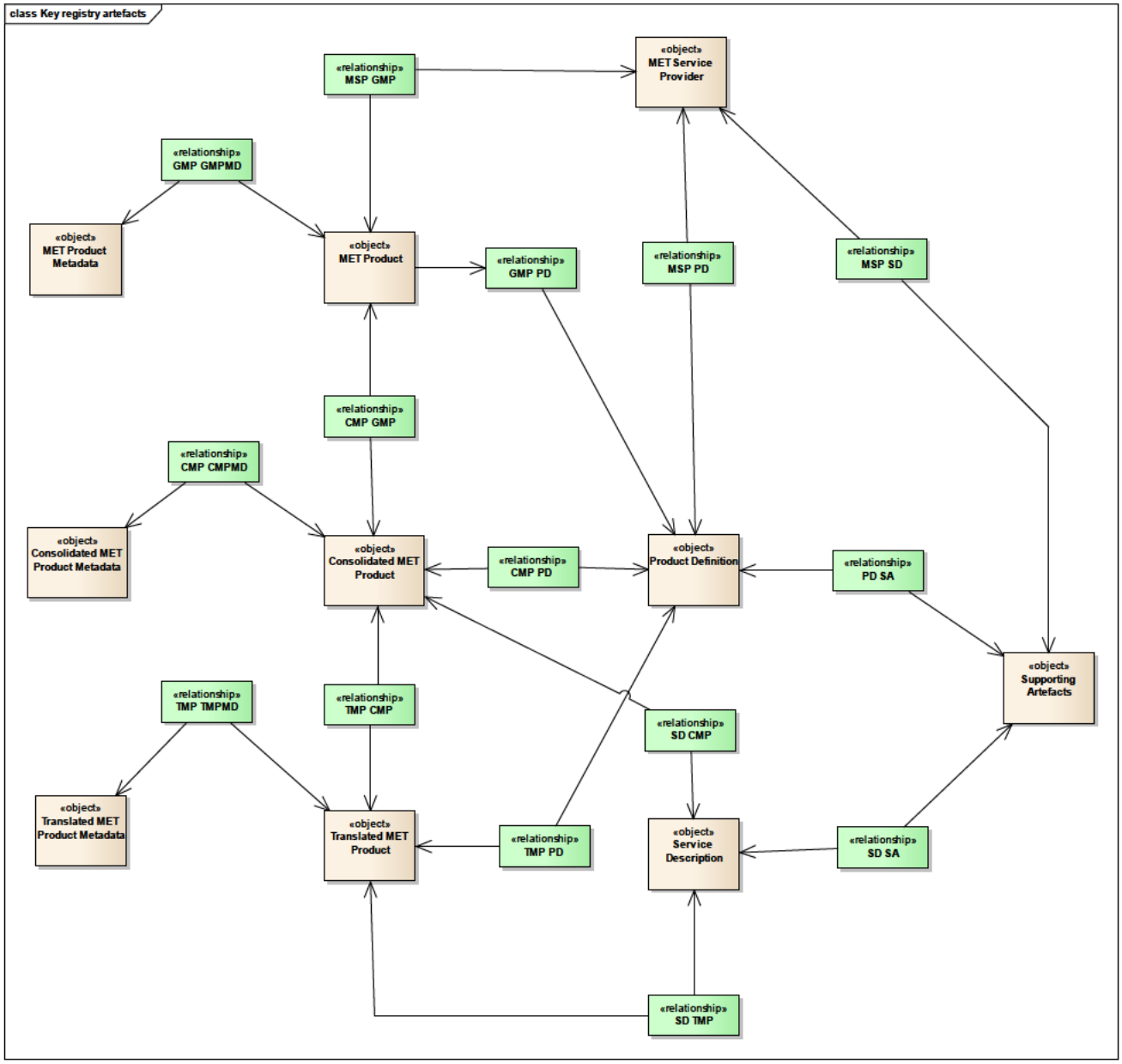

Figure 22: Key Registry Artefacts

The 4DWxCube Registry shall provide one or more interfaces to support the functionality defined in the following sections.

2.6.2.7.1 Extend object types

As new meteorological and supporting object types are identified in the evolution of the 4DWxCube, new object types shall need to be created. For example, a Product Exchange Schema may be identified as a new object type that is relevant to the 4DWxCube.

2.6.2.7.2 Extend relationship types

As new meteorological and supporting object types are created, new relationship types may need to be created to support new relationship types. For example, it may be necessary to create a new relationship type to relate a Product Specification with a Product Exchange Schema.

2.6.2.7.3 Extend keyword types

To support the discovery and assessment of new object types, new keywords may need to be created to identify unique characteristics of the new object type. For example, a particular instance Product Exchange Schema could be characterized by the keyword “BUFR”.

2.6.2.7.4 Create a Registry Object/Relationship Object

As new resources are added to the 4DWxCube, it shall be possible to create new Registry Objects to describe them. Each Registry Object shall be uniquely identified within the registry.

The 4DWxCube system shall create new Registry Objects as information is uploaded, processed and created by system.

New Registry Objects shall be also be created through the Administrator functions to manage METSPs, MET Product Definitions and Service Descriptions. Creation of a Registry Object shall also allow the upload of the resource it describes, if the resource is to be stored with the object.

2.6.2.7.5 Update a Registry Object/Relationship Object

Attributes associated with Registry Objects may be updated to reflect changes in the Registry Object or the contents of the resource that it describes.

Registry Objects shall be updated through the Administrator functions to manage METSPs, MET Product Definitions and Service Descriptions.

Note that a “soft delete” of a Registry Object is actually a change of status to deprecated. The Registry Object shall remain in the registry until it undergoes a “hard delete”.

2.6.2.7.6 Delete a Registry Object/Relationship Object

A “hard delete” of a Registry Object shall remove it from the registry. If an object is to be deleted any Relationship Object that contains a reference to the deleted Registry Object should also be deleted.

2.6.2.7.7 Discovery of Registry Objects

The 4DWxCube Registry shall allow a request to discover information about Registry Objects that meet a set of provided criteria. The selected criteria can include any attribute associated with a collection of Registry Objects. As a minimum the allowed criteria shall be:

- Object type
- Name contains a partial string
- Description contains a partial string
- One or more keywords

Meteorological types shall also allow criteria for:

- Geographical Area of the object overlaps the area provided
- Time Horizon overlaps the time provided
- Product Type

- Level

Other criteria can include object type specific attributes.

It shall be possible to return differing levels of information so that the returned information contains:

1) Identifier and object type only
2) Identifier, object type, name , description , status, version
3) All attributes for the object type.

Controlling the type of information returned shall control message sizes and support business logic information.

2.6.2.7.8 Retrieve Information for Registry Objects

The 4DWxCube Registry shall allow a request to return detailed information about Registry Objects identified by their unique global identifier.

It shall be possible to return differing levels of information so that the returned information contains:

1) Identifier and object type only
2) Identifier, object type, name , description , status, version
3) All attributes for the object type.

2.6.2.7.9 Retrieve the Registry Object Resource

The 4DWxCube Registry shall allow a request to return the resource identified by a Registry Object identified by their unique global identifier.

If the resource is stored with the Registry Object, this shall be returned directly. The resource may be in any format: XML, text, document, binary etc.

If the resource is not stored with the Registry Object, a reference to the resource shall be returned allowing access to the resource by other means.

2.6.2.8 Publish/Subscribe

The Publish/Subscribe functional block is responsible for managing the delivery of information based on requests received from a consumer. Such requests may be a onetime request where the MET-GATE responds immediately to the request from a consumer. Alternatively the consumer can issue a subscription request which the MET-GATE shall use to deliver information when an event occurs, such events may be scheduled, periodic or as a result of new data being made available.

2.6.2.8.1 Event types

The Publish Subscribe functional block can be configured to respond to a number of event types. Identified event types are:

- Scheduled. A scheduled event occurs when a specified date and time has been reached. Such scheduled events are 9:00 am on Monday or at 20:00 on 20/08/2015
- Periodic. A periodic event occurs at a regular interval after a specified start time. Such events are every 30 minutes after 20:00 on 20/08/2015
- On Update. An “on update” event occurs whenever any of the products used by a service are updated.

Note: the concept of a threshold breach event has been discussed. This can be considered as a later extension to the system if suitable use cases are identified.

2.6.2.8.2 Discovering Services

Before any service can be used it shall first be “discovered” to retrieve one or more Service Descriptions to assess if a service can support the requirements of the ATM Consumer and to provide information on how the service can be accessed. Discovery can be done through document or electronic means. The SWIM Registry shall provide the link to a web service based discovery service to enable relevant Service Descriptions to be retrieved. This service will be implemented in the MET-GATE. The expected behaviour for the SWIM Discovery service is shown Figure 23. Note that ATM Consumer shall only be able to discover services for which they have access rights.

Discovery of a Service can be constrained by the following criteria:

- Name contains a partial string
- Description contains a partial string
- One or more keywords
- Geographical Area of the object overlaps the area provided
- Time Horizon overlaps the time provided
- Product Type
- Level

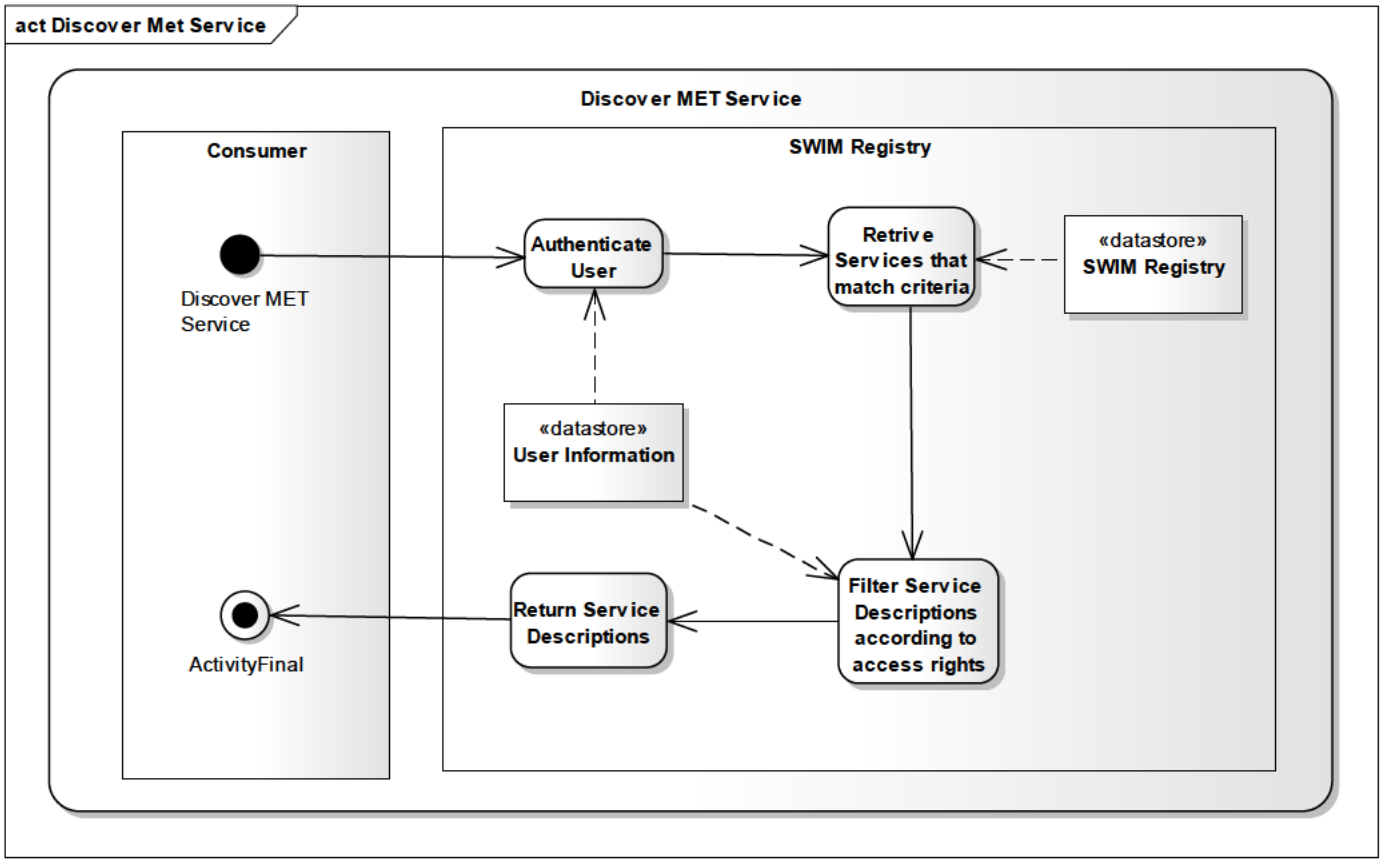

Figure 23: SWIM Registry Discovery Service

2.6.2.8.3 Request/Response

The Request/Response paradigm is one of the basic methods that systems use to communicate with Web Services. The consumer system issues a request to the Web Service which then responds with the requested information. This capability underpins the Publish/Subscribe capability of the system since the subscription ultimately issues a request in some form to obtain the necessary information.

Figure 24 represents the standard behaviour of a service to deliver a Tailored MET Product based on a user request. There may be other service specific Request/Response operations that relate to supporting information. These are not dealt with in this TS.

Prior to making a request, the ATM Consumer should discover information about the service of interest through the SWIM Registry. This shall allow the ATM User to assess the relevance of the service to their role and to understand the capabilities of the service and the structure of any requests made.

ATM Consumers can request Tailored MET Products from the MET-GATE via the selected service. The consumer constructs a request in the correct format. The request may include a set of criteria to refine aspects of the returned information such as geographical area, time relation information and specific meteorological parameter. The format and acceptable parameters for the request shall be identified in the Service Description. The actual format and parameters shall vary from service to service and for various endpoints within a service.

Note: To comply with the SWIM profile, it is expected that requests shall be sent using HTTP/HTTPS request using POST or GET. POST requests shall be constructed using XML and that XML should comply with a defined schema.

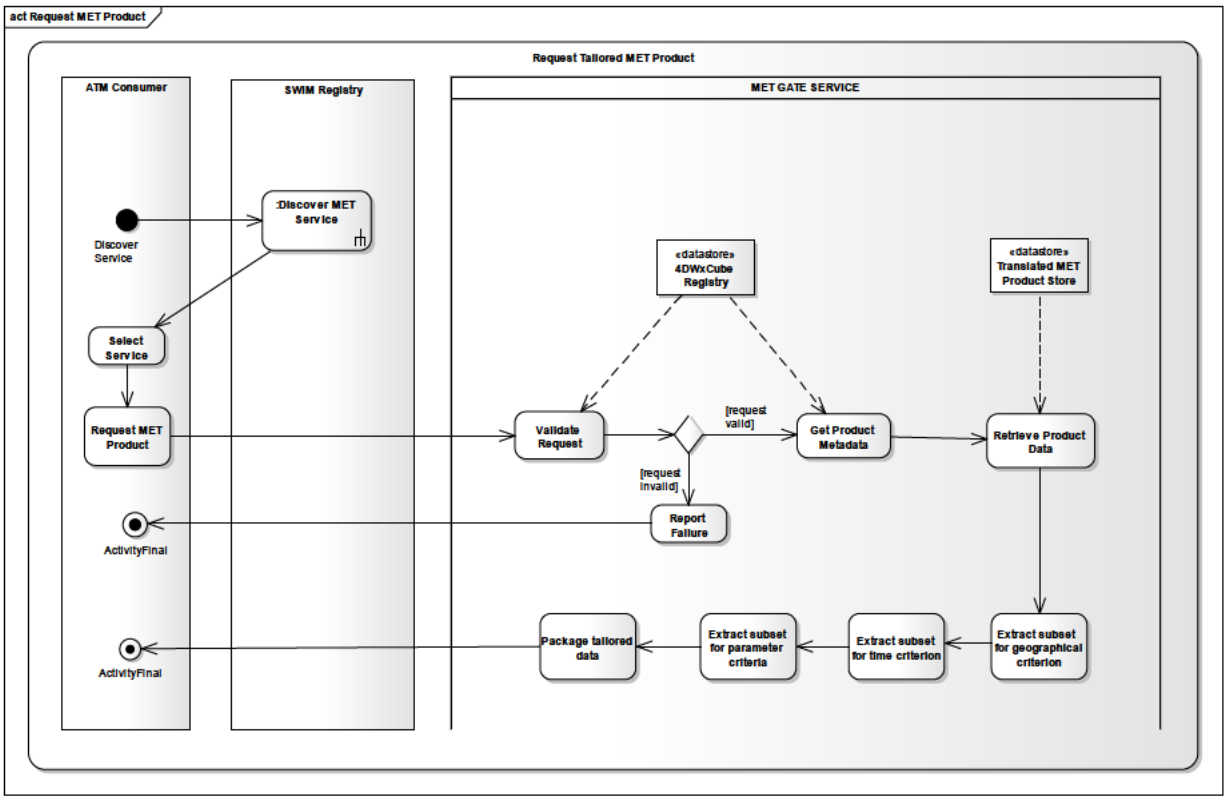

Figure 24: Request MET Product

On receipt of the request the service shall verify that the request is valid by comparing against the Service Description (and schemas) obtained from the 4DWxCube Registry. If the request is valid the system shall extract the latest product metadata from the 4DWxCubeRegistry to identify that MET Product(s) that are identified in the Service Description. The process of checking the validity of the request shall be dependent on the specific service. If the request is not valid the MET-GATE shall return an exception message detailing why the request failed.

Using the metadata information the system shall extract the correct MET Product information from the Translated MET Product Store.

The Translated MET Product information is tailored according to the parameters sent with the request. The type of tailoring allowed (area, time and parameter sub-setting) are dependent on the

specific service. It may be possible that a Tailored MET Product shall have zero content e.g. because there is no data in the requested area, this is still a valid response. Once the Tailored MET Product is constructed it shall be returned to the ATM Consumer.

All requests to a MET-GATE service shall be audited for success or failure.

2.6.2.8.4 Create Subscription

The ATM Consumer can issue a subscription request to a specified service to deliver tailored MET Information when a specified event occurs. The request shall include

- user identifier
- return URL to which to return the information to. The URL must be accessible from the 4DWxCube
- details of the event on which to return the information (e.g. periodic 30 minutes, on update)
- publishing criteria (always, source changed, updates only)
- start time for the subscription (optional)
- termination time for the subscription (optional)
- service specific request information.

The structure/schema of the subscription request (with the exception of the service specific request) shall be the same for all subscription services.

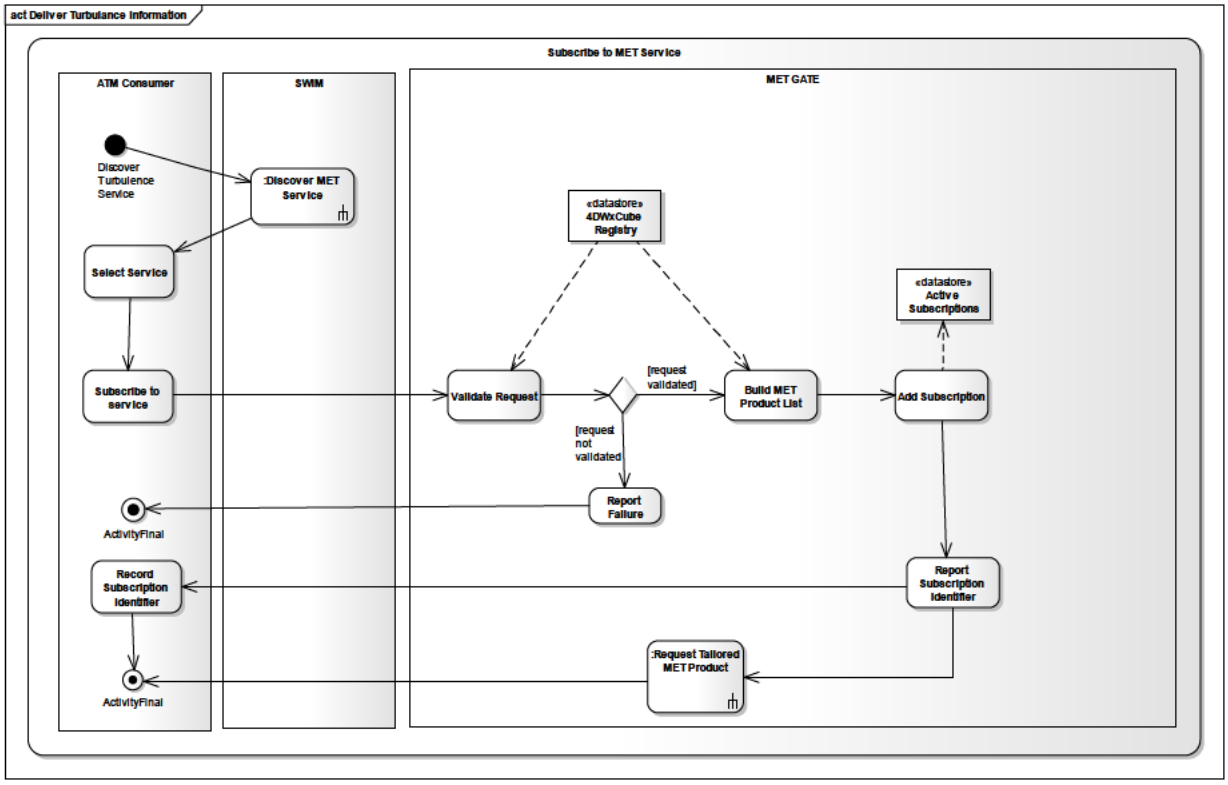

Figure 25: MET Service Subscription

Figure 25 represents a standard subscription request.

The ATM Consumer should be able discover a relevant service from the SWIM Registry. Any selected service shall support a subscription interface. The Service Description shall describe the capabilities of the service and the structure of the request.

The ATM Consumer shall construct a request and send the request to the service.

The MET-GATE shall validate the subscription request. The validation process shall check the general structure of the subscription request. The system shall also check that the specified return URL for the results is accessible from the service. The process for validating the service specific parts of the request shall depend on the specific service. If the request is invalid the system shall return an exception explaining the reason for failure.

Using the service specific parts of the request, the system shall build a list of references to the Product Descriptions to be used in handling the request. This information, along with generic subscription information (user identifier, return URL, event information etc.), shall be stored as an active subscription. The resultant unique identifier for the subscription shall be returned to the user.

If the start time of the subscription is not set, or is in the past, the subscription shall trigger immediately and return the Tailored MET Product to the specified return URL.

All subscription requests shall be audited.

2.6.2.8.5 Modify Subscription

The ATM Consumer can issue an update subscription request to a specified service to modify the behaviour of a pre-existing subscription. The ATM Consumer shall provide:

- user identifier
- unique identifier for the subscription to be updated.
- return URL to which to return the information to. The URL must be accessible from the 4DWxCube (optional)
- details on the event on which to return the information (e.g. periodic 30 minutes, on update) (optional)
- publishing criteria (always, source changed, updates only)
- start time for the subscription (optional)
- termination time for the subscription (optional)

Note that the service specific information does not form part of the update subscription request. If a different set of tailored information is required a new subscription request shall be issued.

The MET-GATE shall validate the update subscription request. Only the user identifier and the identifier for the original subscription are required though if no other parameter is provided the request shall be rejected. If the update subscription is not valid the current subscription shall be unaffected.

If the request is acceptable the active subscription shall be updated and the original subscription identifier shall be returned to the ATM Consumer.

All modification requests shall be audited.

2.6.2.8.6 Unsubscribe

The ATM Consumer can issue an unsubscribe request to a specified service to terminate a pre-existing subscription. The ATM Consumer shall provide:

- user identifier
- unique identifier for the subscription to be updated.

The MET-GATE shall validate the unsubscribe request and if acceptable delete the subscription in the MET-GATE and return a success response to the ATM Consumer.

The active subscription and any supporting state information shall be deleted from the system.

All unsubscribe requests shall be audited.

2.6.2.8.7 Manage Subscriptions

The MET-GATE system shall manage all active subscriptions.

On receipt of a new subscription request the system shall store the generic and service specific information related to the subscription. It shall immediately start monitoring for trigger events for that subscription.

On receipt of a modify subscription request the system shall modify the generic information related to the subscription. It shall immediately start monitoring for modified trigger events for that subscription.

On receipt of an unsubscribe request the system shall remove the subscription from the list of active subscriptions and any future trigger events shall be ignored.

The MET-GATE shall monitor events that occur in the 4DWxCube. Figure 26 describes the subscription monitoring behaviour.

The MET-GATE shall also monitor the subscriptions to determine if a subscription exceeds its termination time. If it does, the system shall remove the subscription from the list of active subscriptions and any future trigger events shall be ignored. When a subscription has been terminated the MET-GATE shall send a message to the return URL indicating that the subscription has been terminated.

The MET-GATE shall monitor for all newly created Consolidated and Translated MET Products. The MET-GATE shall also monitor for time based events.

It shall identify all subscriptions that are impacted by the update or time event and decide if the event is relevant to the subscriptions.

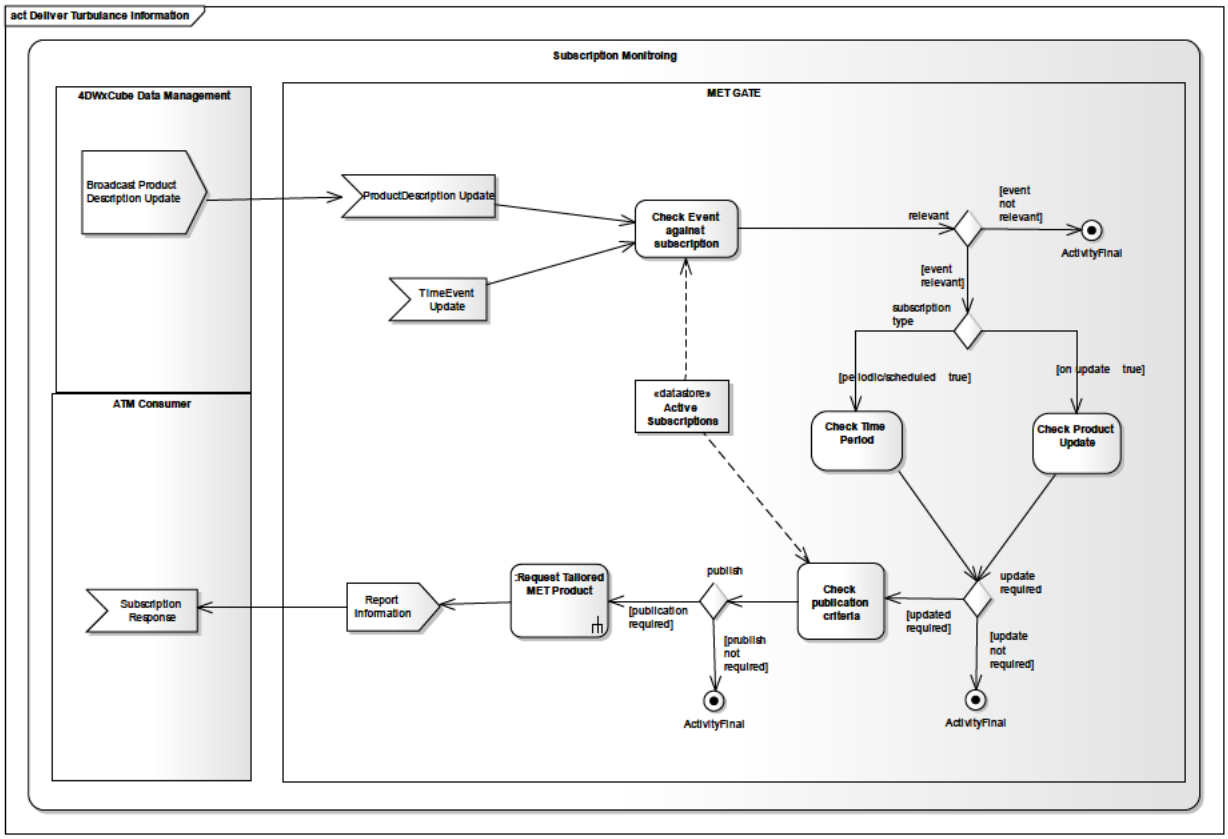

Figure 26: Subscription Monitoring

When a trigger event is identified the MET-GATE shall determine if the requested tailored information from the MET Product should be published according to the publishing criteria.

If the publishing criterion is set to “always” the tailored MET Information shall be published whenever a trigger event occurs irrespective of whether the source MET Product has changed or not. *Note: This places the work load on the consuming client to determine if anything significant has changed though it may have a performance impact on the MET-GATE if the client requests a high frequency subscription response for a MET Product that updates at a low frequency. A subscription service should possibly set a minimum and maximum value for a periodic trigger.*

If the publishing criterion is set to “source update” the tailored MET Information shall be published if the source MET Product has updated. If the source MET Product has not updated the MET-GATE shall send a response to the return URL indicating the date of the last valid update (“no new data response”). *Note: This improves performance for the MET-GATE in that it does not need to do any work unless an update has occurred, even for a periodic trigger. The consuming client shall be aware of the possibility of a “no new data” response.*

If the publishing criterion is set to “updates only” the tailored MET Information shall be published if the contents of the return response is different from the last response sent for this subscription. If the source MET Information has not changed the MET-GATE shall send a response to the return URL indicating the date of the last valid update (“no new data response”). *Note: This impacts on the performance for the MET-GATE as it shall execute the tailored MET Information request every time a trigger event occurs and then compare this to the previous response to identify if any changes have occurred. The consuming client shall be aware of the possibility of a “no new data” response.*

2.6.2.9 Tailoring

The Tailoring capabilities of the MET-GATE Functional Block are specific to the capabilities of the services. As identified in section 2.6.1.4.1 the services available to the MET-GATE fall into a number of broad categories:

- Web Map Services (OGC)
- Web Feature Services (OGC)
- Web Coverage Services (OGC)
- Web Processing Services (OGC)

2.6.2.9.1 Compatibility requirements

All services that deliver Tailored MET Products shall support a common set of units and map projections to ensure that information retrieved from the various services are compatible with each other.

The “ICAO Annex 5 Units of Measurements to be used in Air and Ground Operations” (reference [22]) shall be used as the guide for the preferred units to be supported by the services.

ICAO Annex 3 (reference [21]) indicates that as a minimum the Mercator Projection and Polar Stereographic Projection shall be available where appropriate. EPSG:4326- WGS 84 projections should also be available from the services.

Note, the ICAO Working Paper (IAVWOPSG/8-WP/25) from the International Airways Volcano Watch Operations Group raises the awareness of using map projections other than that which the forecast was originally prepared in.

2.6.2.9.2 OGC Services

The OGC services are fully defined by their accompanying OGC specifications. These specifications determine the type of tailoring that can be applied to a request. WPS Services are the exception to this. Note that the OGC Services can be configured to utilize the same source product.

Web Map Service

The OpenGIS® Web Map Service Interface Standard (WMS) provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. A WMS request defines the geographic layer(s) and area of interest to be processed. The response to the request is one or more geo-registered map images (returned as JPEG, PNG, etc) that can be displayed in a browser application. The interface also supports the ability to specify whether the returned images should be transparent so that layers from multiple servers can be combined or not.

OpenGIS Web Map Service (WMS) Implementation Specification

Web Map Services - Application Profile for EO Products (0.3.3)

DGIWG WMS 1.3 Profile and systems requirements for interoperability for use within a military environment (0.9.0)

OGC Best Practice for using Web Map Services (WMS) with Time-Dependent or Elevation-Dependent Data (1.0)

WMS 1.3 Best Practice for Ensemble Data

Web Feature Service

The WFS specification defines interfaces for describing data manipulation operations of geographic features. Data manipulation operations include the ability to:

- get or query features based on spatial and non-spatial constraints
- create a new feature instance
- delete a feature instance
- update a feature instance

The basic Web Feature Service allows querying and retrieval of features. A transactional Web Feature Service (WFS-T) allows creation, deletion, and updating of features. *Note:The MET-GATE is expected to only support basic Web Feature Services.*

OpenGIS Web Feature Service 2.0 Interface Standard (also ISO 19142)

OpenGIS Web Feature Service (WFS) Implementation Specification

Web Coverage Service

A Web Coverage Service (WCS) offers multi-dimensional coverage data for access over the Internet. The interface standard document specifies a core set of requirements that a WCS implementation shall fulfill. WCS extension standards add further functionality to this core; some of these are required in addition to the core to obtain a complete implementation. This document indicates which extensions, at a minimum, need to be considered in addition to this core to allow for a complete WCS implementation. This core does not prescribe support for any particular coverage encoding format. This also holds for GML as a coverage delivery format: while GML constitutes the canonical format for the definition of WCS, it is not required by this core that a concrete instance of a WCS service implements the GML coverage format. WCS extensions specifying use of data encoding formats in the context of WCS are designed in a way that the GML coverage information contents specified in this core is consistent with the contents of an encoded coverage.

OGC® WCS 2.0 Interface Standard - Core, version 2.0.1

OGC® WCS Interface Standard - Range Subsetting Extension, version 1.0.0

OGC® WCS Interface Standard - Scaling Extension, version 1.0.0

OGC® WCS Interface Standard – CRS Extension, version 1.0.0

OGC® WCS Interface Standard - Interpolation Extension, version 1.0.0

OGC® WCS Interface Standard - Processing Extension, version 2.0.0

OGC® WCS - Transaction operation extension, version 1.1.4

Note: that a new profile is being developed to address the specific access requirements for 4D weather data.

A MetOcean Metadata Profile for WCS 2.0
OGC(R) Web Coverage Service Interface Standard – Coverage Collection Extension.

Web Processing Service

The OpenGIS® Web Processing Service (WPS) Interface Standard provides rules for standardizing how inputs and outputs (requests and responses) for geospatial processing services, such as polygon overlay. The standard also defines how a client can request the execution of a process, and how the output from the process is handled. It defines an interface that facilitates the publishing of geospatial processes and clients' discovery of and binding to those processes. The data required by the WPS can be delivered across a network or they can be available at the server.

Because a Web Processing Service supports bespoke processing of geospatial information each WPS instance may have differing tailoring functionality. These shall be described in the Service Description documents to allow the consumers to correctly utilise the tailoring parameters.

OGC® WPS 2.0 Interface Standard

2.6.2.10 Non-Nominal cases

This section identifies the potential non-nominal behaviour of the 4DWxCube. It presents cases where invalid situations lead to an error or an exception.

2.6.2.10.1 Authorization error

Only users who are correctly authorized are permitted access a service or interface. If a known user attempts to access a service or interface on the 4DWxCube for which they are not authorized the 4DWxCube shall report an exception back to the user. All unauthorized access attempts shall be logged.

2.6.2.10.2 Malformed request

If a user is authorized to access a service or interface but sends a malformed request the service or interface shall report an exception back to the use indicating the reason for a failure. A malformed request shall not affect the state or contents of the 4DWxCube. All invalid requests shall be logged.

2.6.2.10.3 Service unavailable

This case may occur each time a consumer makes a request of a service that has been discovered but is not available to at the time a request is made. In this case where the service is unavailable an exception shall be sent back to the consumer. If a service is unavailable a notification shall be sent to the Administrator no more than once in a configurable period.

2.7 Service View

This section describes the externally accessible 4DWxCube services that are required to enable the MET Information Providers and ATM Consumers to interact with the 4DWxCube, subject to the appropriate access control rights for a given user. Each service identifies the operational scenarios

(described in section 2.5) to which it relates. Note that administration functions are considered internal to the 4DWxCube and are not described here.

2.7.1 METSP Product Management Service

The METSP Product Management Services provides a METSP with the ability to register, manage and unregister product definitions with the 4DWxCube once the MET Product Definition has been approved by the 4DWxCube Governance Board. It also allows the METSP to review the usage of the products that it supplies. The METSP Product Management Service augments the 4DWxCube Administrator role by allowing METSPs to access some administration functions.

This service is provided to support for the operational scenarios

- TS-UC-MET-AD01: Define/Modify/Remove a MET Product Definition
- TS-UC-MET-AD06: Review MET Audit Trail

2.7.1.1 Register MET Product

A METSP adds a new MET Product Definition to the catalogue/registry. The proposed MET Product Definition must be approved with the 4DWxCube Governance Board. The METSP shall also provide details of the frequency of update of the associated MET Product.

2.7.1.2 Recall MET Product / Send alert

A METSP sends a message to identify MET products that were previously uploaded by them but should not be provided to ATM consumers because of e.g. defective data items. The METSP recalls an individual the MET product by marking them as invalid. The recall status can be deleted and the data items delivered to the end users without uploading them again to the 4DWxCube.

2.7.1.3 De-register MET Product

The MET Product Management Service provides the opportunity to delete a MET Product Definition e.g. when it cannot be produced anymore or it is not necessary anymore because of a replacement of a higher quality product.

2.7.1.4 Request Met Product Usage Log

A METSP queries subscriptions and requests for MET Products that it supplies. This can include the current subscriptions for statistical and development purposes (number of subscribers, of applicable area and time of interest, resolution, update rate) or a log of MET Products delivered through the MET service exchange interfaces.

2.7.1.5 METSP Observation Retrieval Service

The Observation Retrieval Service provides a mechanism for a METSP to retrieve MET Observation information from the 4DWxCube. METSPs accessing the upload service shall be authenticated and authorized to do so. Each request shall provide

- The unique Identifier for the METSP. This is the identifier provided by the 4DWxCube Administrator when the METSP is registered with the system.
- The unique identifier for the MET Product Definition that describes the MET information to be retrieved.
- Geographical extent information

The Observation Retrieval Service does not have to be SWIM compliant.

This service is provided to support the operational scenario

- TS-UC-MET-SP04: Deliver Local MET Observations

2.7.2 Upload service

The upload service enables METSPs to deliver MET Information and associated metadata to the 4DWxCube. METSPs accessing the upload service shall be authenticated and authorized to do so. Each upload transaction shall need to provide

- The unique Identifier for the METSP. This is the identifier provided by the 4DWxCube Administrator when the METSP is registered with the system.
- The unique identifier for the MET Product Definition that describes the raw MET information. This is the identifier provided by the Administrator when the METSP contacts to provide a set of MET information to the 4DWxCube.
- A unique identifier for the MET information being delivered. This is the METSP identifier for the met information being provided. This shall be used in any audit records to enable the METSP to trace back to any issues.
- Raw MET information
- Partial metadata for the MET Information. Metadata is only required as a separate item if it is not embedded in the MET information itself as may be the case for particular data formats.

This service is provided to support the operational scenarios

- TS-UC-MET-SP01: Deliver METAR Information
- TS-UC-MET-SP02: Deliver Turbulence Information
- TS-UC-MET-SP03: Deliver Aircraft Observations
- TS-UC-MET-SP04: Deliver Local MET Observations

2.7.3 Discovery service

This service supports of the discovery of MET Products and MET Services that are available through the MET-GATE. It can return information on Product Descriptions and associated Services that can deliver them or Service Description and the associated Products that they can deliver.

Service Descriptions provide details on how to access the service and what parameters can be provided when requesting Tailored MET Products. It is only possible to access Tailored MET Products through their associated services.

The Discovery Service shall respond to a user request providing one or more criteria for filtering the information returned. The filtering criteria can include

- object type – product type or service type
- one or more keywords
- partial strings which may be contained in the name or description of the object
- a geographical area by name or by explicit lat/lon coordinates.
- a time horizon

This sub-service is used by the following operational scenario:

- TS-UC-MET-AC01: MET Product Description discovery
- TS-UC-MET-AC01: MET Service Description discovery

2.7.4 MET Products Request/Reply service

This service type fulfils the ATM consumers' need of performing an ad-hoc request. There may be a number of services that satisfy this requirement.

This service consists of the supply of “Tailored MET-ATM” products, selected according to a set of parameters - which in general shall have been defined according to the outcomes of an interrogation of the discovery service.

This service is used by the following operational scenario:

- TS-UC-MET-AC04: Send Request to MET Service

2.7.5 MET Subscription service

This service consists of the configuration of a subscription to MET Service on the MET-GATE. The parameters needed by the ATM consumer to use this service shall in general have been defined according to the outcomes of an interrogation of the discovery service. There may be a number of services that satisfy this requirement.

This service combines several sub-services which are described below. This service subset is used by the following operation scenario

- TS-UC-MET-AC03: Add/modify/remove subscription.

2.7.5.1 Subscription creation

This sub-service allows the ATM consumer to create and configure its subscription. The ATM Consumer shall provide:

- user identifier
- return URL to which to return the information to. The URL must be accessible from the 4DWxCube
- details of the event on which to return the information (e.g. periodic 30 minutes, on update)
- publishing criteria (always, source changed, updates only)
- start time for the subscription (optional)
- termination time for the subscription (optional)
- service specific parameters

The service specific parameters shall have been described in the associated Service Description.

2.7.5.2 Modify Subscription

The ATM Consumer can issue and modify subscription request to a specified service to modify the behaviour of a pre-existing subscription. The ATM Consumer shall provide

- user identifier
- unique identifier for the subscription to be updated.
- return URL to which to return the information to. The URL must be accessible from the 4DWxCube (optional)
- details on the event on which to return the information (e.g. periodic 30 minutes, on update) (optional)
- publishing criteria (always, source changed, updates only)
- start time for the subscription (optional)
- termination time for the subscription (optional)

Note that the service specific information does not form part of the update subscription request. If a different set of tailored information is required a new subscription request shall be issued.

2.7.5.3 Remove subscription

The ATM Consumer can issue an unsubscribe request to a specified service to terminate a pre-existing subscription. The ATM Consumer shall provide:

- user identifier
- unique identifier for the subscription to be updated.

2.7.6 MET Publication service

This service provides automatic supply of Tailored MET Products following the creation of a subscription. Two types of publication are distinguished.

2.7.6.1 Periodic update

This case consists of a periodic publication of Tailored MET Products. The user defines the update rate.

Periodically, the MET-GATE subscription service shall create a Tailored MET Product as defined by the original description and delivers this to the URL configured in the subscription.

This case is used by the following operational scenarios:

- TS-UC-MET-MT01: Medium-term forecast for En Route
- TS-UC-MET-MT02: Medium-term forecast on detailed MET situation for one airport
- TS-UC-MET-ST01: Short Term forecast for En Route
- TS-UC-MET-ST02: Short Term forecast on detailed MET situation for one airport

2.7.6.2 On event update

This case consists of the publication of a Tailored MET Product as soon as it is available. The subscription service shall deliver the Tailored MET Product, as defined by the original subscription, if any of the associated Consolidated or Translated MET Products have been updated.

This service is used by the following operational scenario:

- TS-UC-MET-EX01: Nowcast for En Route/TMA
- TS-UC-MET-EX02: Nowcast on detailed MET situation for one airport
- TS-UC-MET-EX03: Alerts on airport / TMA

2.7.7 European ATM MET Services

WP 08 has defined as number of specific MET Services that are to be provided by the 4DWxCube. These services are described in the series of European ATM Service Description documents in the WP_08 section of the SJU extranet (reference [25]).

The following sections provide a brief description of each of the services. More detail can be found in the associated references.

2.7.7.1 European ATM Service Description for AirportMETForecast Service

The service covers the dissemination of customized airport meteorological forecasts over SWIM. Service design has been performed in the context of Service Activity SVA003 entailing Airport Meteorological and Surface Contamination services. (Reference [26])

2.7.7.2 European ATM Service Description for the AirportMETInducedCapacityReduction Service

The Airport MET Induced Capacity Reduction Service provides an indication of the maximum airport capacity achievable considering only the current and near term weather conditions, and thus providing useful input to the overall capacity computation made by DCB at the airport. This service is consumed by the airport operations centre. The supplier of the service is the Airport MET Provider. (Reference [27])

2.7.7.3 European ATM Service Description for AirportMETNowcast Service

The AirportMETNowcast Service provides a Meteorological prediction of the weather at the airport concerned, at a small interval in the future. This service is consumed by a number of different actors with the airport. The supplier of the service is currently the IWIS (Improved Weather Information System). (Reference [28])

2.7.7.4 European ATM Service Description for the AirportMETObservation Service

The AirportMETObservation Service covers the dissemination of customized airport meteorological observations over SWIM. Service design has been performed in the context of Service Activity SVA003 entailing Airport Meteorological and Surface Contamination services. (Reference [29])

2.7.7.5 European ATM Service Description for METAR Service

The METAR service covers the dissemination of standard ICAO METAR bulletins over SWIM. Service design has been performed in the context of Service Activity SVA003 entailing Airport Meteorological and Surface Contamination services. (Reference [30])

2.7.7.6 European ATM Service Description for the SNOWTAM Service

The SNOWTAM service covers the dissemination of standard ICAO SNOWTAM over SWIM. Service design has been performed in the context of Service Activity SVA003 entailing Airport Meteorological and Surface Contamination services. (Reference [31])

2.7.7.7 European ATM Service Description for the TAF Service

The TAF service covers the dissemination of standard ICAO TAF bulletins over SWIM. Service design has been performed in the context of Service Activity SVA003 entailing Airport Meteorological and Surface Contamination services. (Reference [32])

2.7.7.8 European ATM Service Description for the METHazardEnrouteForecast Service

The METHazardEnrouteForecast service defines an information service for exchanging Forecasts and Nowcasts of significant weather phenomena. The service is realised in the publish/subscribe message exchange pattern and to this end defines subscribe, unsubscribe and publish operations. The subscription mechanism additionally allows for fine-grained filtering. (Reference [33])

2.7.7.9 European ATM Service Description for the METHazardEnrouteObservation Service

The METHazardEnrouteObservation service defines an information service for information exchanges for Observations of significant weather phenomena. The service is realised in the publish/subscribe

message exchange pattern and to this end defines subscribe, unsubscribe and publish operations. The subscription mechanism additionally allows for fine-grained filtering. (Reference [34])

2.7.7.10 European ATM Service Description for the METGriddedForecast Service

The METGriddedForecast service defines an information service for information exchanges for Forecasts of meteorological parameters (such as wind, temperature or relative humidity). Output of this service is a 4D grid. The service is realised in the publish/subscribe message exchange pattern and to this end defines subscribe, unsubscribe and publish operations. The subscription mechanism additionally allows for fine-grained filtering. (Reference [35])

3 Functional and non-Functional Requirements

This chapter provides the functional and non-functional requirements according to the SESAR TS Template. Each item identifies a testable requirement that supports the functional blocks described in section 2. Each item also traces back to the originating requirements expressed in documents P11.02.01-D26 (DOD), D23 (OSED), D24 (SPR) and D25 (INTEROP) (references [7]to[10]]).

The requirements are categorised into groups according to the functional block capabilities identified in section 2.3.

Requirements numbering reflects the document phase in which requirements were identified. Requirements numbers in the range 0001 to 0199 are requirements that were identified in the fore-runner document 11.02.02-D23 Technical Specification. Requirements numbers in the 1000 to 1199 are requirements that were identified in the development of the 11.02.02-D27 Technical Specification. Requirements have been re-ordered to assign the requirements into the correct functional grouping.

At the end of the SESAR 1 Programme the requirement status is selected to be either 'validated', 'deleted' or 'in progress'. System requirements have not been validated as operational requirements have been. Nevertheless, the status is named 'validated' if the system requirements have been verified successfully. The status of a requirement has been set on deleted for any requirement that has not been verified successfully due to the unavailability of input or contribution from the outside. Requirements that have been partially verified successfully are marked as 'in progress' because some effort (e.g. implementation of functionalities in the prototypes) is needed to complete the verification process. Details of the verification results are reported in [16].
'Deleted' does not include 'not valid anymore', all requirements are evaluated as necessary and important.

3.1 Capabilities

3.1.1 Administration Requirements

This capability refers to activities performed by the 4DWxCube administrator, such as manage access rights, accept a request for registration for an ATM system, and create a new MET Product Definition in the 4DWxCube.

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0007
Requirement	The 4DWxCube shall monitor the status of the MET Information required for a MET Information service
Title	MET information status monitoring.
Status	<In Progress>
Rationale	The 4DWxCube Administrators need to know the status of MET information required for MET services in order to identify and fix service failures.
Category	<Functional>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.06.02-SPR-0001.0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-5.6.4-REQS-0028.1210	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.1005
Requirement	The 4DWxCube shall prepare and make available statistical information and case analysis on stakeholder's requests.

Title	Provision of statistical information and case analysis to stakeholders.
Status	<In Progress>
Rationale	Provision of statistical information and case analysis to ATM clients.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0029	<Partial>
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3.1.2 Data provision Requirements

One of the main functions of the 4DWxCube is to serve MET Products to ATM systems. This section describes the functionality needed to serve the ATM consumer the required datasets.

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.1001
Requirement	The 4DWxCube shall support the provision, by authorized METSP, of MET products generated from Regulatory MET, Nominal MET or Significant MET services.
Title	Provision of MET information.
Status	<Validated>
Rationale	Provision of MET information to ATM consumers.
Category	<Functional>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

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[REQ]

Identifier	REQ-11.02.02-TS-4DWC.1012
Requirement	The 4DWxCube shall support the provision, by authorized METSP, of the probability that certain MET elements are above or below one or more defined thresholds.
Title	Provision of thresholds exceedance probability.
Status	<In Progress>
Rationale	Provision of the probability that certain MET elements are above or below one or more defined thresholds.
Category	<Functional>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.05.03-OSED-DCBH.0131	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.03-OSED-DCBS.0120	<Partial>
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[REQ]

Identifier	REQ-11.02.02-TS-4DWC.1002
Requirement	The 4DWxCube shall support and make available warnings when the observed MET information provided by the authorized METSP is above or below one or more pre-defined thresholds.
Title	Provision of MET warnings.
Status	<Validated>
Rationale	Provision of warnings when certain MET elements are above or below one or more pre-defined thresholds.
Category	<Functional>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-05.07.04-OSED-Ac01.0023	<Partial>
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<SATISFIES>	<ATMS Requirement>	REQ-06.05.04-INTEROP-ALRT.0125	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0001	<Partial>
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<SATISFIES>	<ATMS Requirement>	REQ-06.09.02-OSED-WEA.0001	<Partial>
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[REQ]

Identifier	REQ-11.02.02-TS-4DWC.1013
Requirement	The 4DWxCube shall provide forecast verification results as input to the post-operations process upon request.
Title	Post-operation MET forecast verification results.
Status	<In Progress>
Rationale	Provision of MET forecast verification results for post-operation.
Category	<Functional>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-11.02.01-OSED-LOC1.5007	<Partial>
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3.1.3 Subscription/publication Requirements

Subscription/publication refers to the 4DWxCube capability to manage subscriptions and publish information when triggered by new MET Product availability or at scheduled times

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0001
Requirement	The 4DWxCube shall allow configuration of each subscription individually (parameters, area of interest, time horizon and threshold level e.g. severe , moderate)
Title	Configuration of subscriptions.
Status	<Validated>
Rationale	Each ATM consumers has different needs of MET Information.

Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0021	<Partial>
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3.1.4 Storage and indexation Requirements

Storage and indexation relates to the 4DWxCube capabilities to store data, metadata and supporting information within the system.

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0002
Requirement	The 4DWxCube shall remove MET product according to a determined time window.
Title	MET information purge function.
Status	<Validated>
Rationale	Unnecessary to hold information that is not required by the ATM clients. After a time period, MET products are not required by ATM clients. Moreover old products can be retrieved using request to the Tailored MET-ATM Information domain system.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0031	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0003
Requirement	The 4DWxCube shall provide MET products based on the most accurate ground based or airborne observations available.
Title	MET information source.
Status	<Validated>
Rationale	Due to the importance of the weather services for aeronautical purpose.

Category	<Functional>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-04.07.02-OSED-0001.3029	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.1003
Requirement	The 4DWxCube shall archive all MET information for a defined period of time in support of post-operations analysis.
Title	MET information record.
Status	<In Progress>
Rationale	Archived MET information must be available for post-operation analysis.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0025	<Partial>
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<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-WOCM.1030	<Partial>
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[REQ]

Identifier	REQ-11.02.02-TS-4DWC.1006
Requirement	The 4DWxCube shall archive audit information for a defined period of time in support of post operational analysis.
Title	Audit information record.
Status	<In Progress>
Rationale	Archived audit information must be available for post-operation analysis.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0027	<Partial>
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<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0023	<Partial>
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<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0025	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-WOCM.1032	<Partial>

3.2 Adaptability

3.2.1 Adaptability Requirements

As none of the requirements are currently traceable, they are included in section 4 of this document (Assumptions).

3.3 Performance Characteristics

3.3.1 Performance Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0013
Requirement	The 4DWxCube shall make available MET observations to ATM users immediately after detection.
Title	MET observation availability.
Status	<Validated>
Rationale	Due to the importance of the weather services for aeronautical purpose.
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0009	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-5.6.4-REQS-0028.1210	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.03-OSED-DCBS.0120	<Partial>
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<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0089	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.1008
Requirement	The 4DWxCube shall support the provision of Regulatory MET products in accordance to issue time / update rate of ICAO Annex 3 (reference [21]) and ICAO Doc 7754 (reference [23]).
Title	Issue time/Update rate/Accuracy of Regulatory MET products
Status	<Validated>
Rationale	The issue time / update rate of the Local MET has to follow ICAO Annex 3 and ICAO Doc 7754.
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0001	<Partial>
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<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0058	<Partial>
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<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0082	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0011	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0017	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.1004
Requirement	If not otherwise specified, the accuracy of the MET information provided by the 4DWxCube shall be at least the accuracy required by ICAO Annex 3 (reference [21]).
Title	Accuracy of MET information.

Status	<Validated>
Rationale	The accuracy of MET information has to satisfy the accuracy required by ICAO Annex 3.
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-0600.0001 (old)	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-0600.0002 (old)	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-0600.0004 (old)	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-0600.0006 (old)	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-0600.0007 (old)	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-0600.0008 (old)	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-0600.0010 (old)	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-0600.0011 (old)	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0030 (old)	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0032 (old)	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0043	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0047	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0051	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.08.07-OSED-CAD/0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.08.07-OSED-CHD/0001	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1009
Requirement	The 4DWxCube shall be capable to deliver MET products at pre-defined spatial resolutions (airport, runway, etc.).
Title	MET products spatial resolution.
Status	<In Progress>
Rationale	ATM consumers have a need for MET products at different spatial resolutions.
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.05.03-OSED-DCBS.0120	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.03-OSED-STPF.0090	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-DCBS.0120	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-DCBS.0130	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-DCBS.0140	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-DCBS.0150	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0012	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0021	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0010	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0016	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0017	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0018	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0019	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0020	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0021	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0022	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0023	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0024	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0025	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0026	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0026	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0027	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0037	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0038	<Partial>

<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0048	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0049	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.08.01-OSED-FUNC.0005	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.08.01-OSED-FUNC.0008	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.08.01-OSED-FUNC.0106	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.09.02-OSED-WEA.0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-07.06.01-1MET1.0041	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1010
Requirement	The 4DWxCube shall be capable to deliver MET products at pre-defined temporal resolutions (forecast at 1 hour, 3 hours, 6 hours, etc.).
Title	MET products temporal resolution.
Status	<Validated>
Rationale	ATM consumers have a need for MET products at different temporal resolutions.
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-DCBS.01xx	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-DCBS.02xx	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0010	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0021	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0022	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET2.0090	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0011	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0012	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0014	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0017	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0019	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0020	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.08.01-OSED-FUNC.0106	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.08.01-OSED-FUNC.0107	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-07.06.01-MET1.0010till00.40	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-07.06.01-MET1.0041	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-07.06.01-WX01.0010	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.1014
Requirement	The 4DWxCube shall enable METSP to update MET information at a rate depending on the updating cycle of Numerical Weather Prediction models or observation frequencies.
Title	MET information update rate.
Status	<Validated>
Rationale	Different MET products are updated at different times requiring agreed update rate.
Category	<Performance>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.05.03-OSED-STPF.0090	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0011	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0012	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0013	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0019	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0030	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET1.0031	<Partial>

<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-OSED-MET3.0006	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0015	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-07.06.01-WX01.0010	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-WOCM.1003	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-11.01.02-OSED-WOCM.1012	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1019
Requirement	The horizontal and vertical resolutions of the MET information shall be higher than the horizontal and vertical resolutions in ICAO Annex 3 (reference [21]).
Title	MET information horizontal and vertical resolutions.
Status	<Validated>
Rationale	The horizontal and vertical resolutions of MET information have to satisfy ICAO Annex 3.
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-07.06.01-MET1.0070	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-07.06.01-MET1.0090	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-07.06.01-WX01.0010	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1020
Requirement	The temporal resolution of the forecast MET information in the TMA & En-route Significant Weather Information service shall be higher than the temporal resolution in ICAO Annex 3 (reference [21]).
Title	MET information temporal resolution.
Status	<Validated>
Rationale	The temporal resolutions of MET information have to satisfy ICAO Annex 3.
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-07.06.01-MET1.0010till00.41	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-04.07.07-OSED-DCM1.0014	<Partial>

3.4 Safety & Security

3.4.1 Safety and Security Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.1021
Requirement	The probability of a Meteorological service providing wrong pressure to ATS shall be no more than 1.0 E-06 per final approach.
Title	Pressure probability safety.
Status	<In Progress>
Rationale	Due to the importance of MET services providing pressure to ATS the probability of delivering a wrong value needs to be extremely low.
Category	<Safety>
Validation Method	

Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-05.06.03-SPR-ATSI.0001)	<Partial>

3.5 Maintainability

3.5.1 Maintainability Requirements

As none of the requirements are currently traceable, they are included in section 4 of this document (Assumptions).

3.6 Reliability

3.6.1 Reliability Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1016
Requirement	The 4DWxCube shall provide only reliable (not corrupted) MET products.
Title	Reliable MET information.
Status	<Validated>
Rationale	Due to the importance of the weather services for aeronautical purpose.
Category	<Reliability>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-11.02.01-SPR-NET1.1211	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-11.02.01-SPR-TER1.1211	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0004
Requirement	The 4DWxCube services shall meet availability of 99.9%
Title	4DWxCube availability.
Status	<In Progress>
Rationale	Due to the importance of the weather services for aeronautical purpose.
Category	<Reliability>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.06.02-SPR-0001.0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-5.6.4-REQS-0028.1210	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0005
Requirement	The 4DWxCube services shall meet Mean Time To Repair (MTTR) - 30 min.
Title	4DWxCube Mean Time To Repair.
Status	<In Progress>
Rationale	Due to the importance of the weather services for aeronautical purpose.
Category	<Reliability>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.06.02-SPR-0001.0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-5.6.4-REQS-0028.1210	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0006
Requirement	The 4DWxCube services shall meet Mean Time Between Failures (MTBF) - 5000 hours.
Title	4DWxCube Mean Time Between Failures.
Status	<In Progress>
Rationale	Due to the importance of the weather services for aeronautical purpose.
Category	<Reliability>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.06.02-SPR-0001.0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-5.6.4-REQS-0028.1210	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.08.01-SPR-SIR1.0003	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0008
Requirement	The 4DWxCube shall issue an alert to indicate that part or all of the MET Information of a MET Information service is not available, out of date or cannot be generated
Title	MET information alerts.
Status	<In Progress>
Rationale	Due to the importance of the weather services for aeronautical purpose.
Category	<Reliability>
Validation Method	
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.06.02-SPR-0001.0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-5.6.4-REQS-0028.1210	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0016	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-06.05.05-SPR-MET1.0026	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0009
Requirement	The 4DWxCube services shall meet Loss of service no more than 1 per week
Title	4DWxCube loss of service.
Status	<In Progress>
Rationale	Due to the importance of the weather services for aeronautical purpose.
Category	<Reliability>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.06.02-SPR-0001.0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-5.6.4-REQS-0028.1210	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0010
Requirement	The 4DWxCube shall support a deployment set-up time of no more than 2 hours to support expansion / adjusting to demand.
Title	4DWxCube deployment set-up time.
Status	<In Progress>
Rationale	Due to the importance of the weather services for aeronautical purpose.
Category	<Reliability>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.06.02-SPR-0001.0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-5.6.4-REQS-0028.1210	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0011
Requirement	The 4DWxCube shall support the functionality to resume information about operations and configurations
Title	4DWxCube information resume.
Status	<In Progress>
Rationale	Due to the importance of the weather services for aeronautical purpose.
Category	<Reliability>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.06.02-SPR-0001.0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-5.6.4-REQS-0028.1210	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0012
Requirement	MET Information shall be consistent for all users (both ground and airborne).
Title	MET information consistency.
Status	<Validated>
Rationale	Due to the importance of the weather services for aeronautical purpose.
Category	<Reliability>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.06.02-SPR-0001.0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-5.6.4-REQS-0028.1210	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0028
Requirement	The 4DWxCube shall not accept more than a pre-defined number of registered users.
Title	4DWxCube number of users.
Status	<Validated>
Rationale	To avoid system overloading
Category	<Reliability>
Validation Method	

Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.06.02-SPR-0001.0001	<Partial>
<SATISFIES>	<ATMS Requirement>	REQ-5.6.4-REQS-0028.1210	<Partial>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1017
Requirement	The frequency of a MET system failure to provide MET Information shall be very low.
Title	4DWxCube system failure.
Status	<In Progress>
Rationale	Due to the importance of the weather services for aeronautical purpose, system failure needs to be very low.
Category	<Reliability>
Validation Method	
Verification Method	<Analysis>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<ATMS Requirement>	REQ-06.08.01-SPR-SIR1.0004	<Partial>

3.7 Functional block Internal Data Requirements

Requirements concerning this category have not been identified yet.

3.8 Design and Construction Constraints

Requirements concerning this category have not been identified yet.

3.9 Functional block Interface Requirements

This part is treated in a separate deliverable, P11.02.02-D42 [15].

4 Assumptions

The assumptions section identifies those 4DWxCube requirements that do not directly address requirements identified in the SPR and OSED documents. There are a significant number of requirements. This is due to the fact that the SPR and OSED documents focus on the delivery and consumption of MET data by ATM users and provide only limited requirements for the data provision from METSP and internal requirements of the system. This section, therefore, is primarily concerned with functionality that is internal to the 4DWxCube.

The requirements are categorised into groups according to the functional block capabilities identified in section 2.3.

4.1 Capabilities

4.1.1 Administration Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0014
Requirement	The 4DWxCube Management FB shall provide a human to machine interface, the Administration Portal" to allow the administrator to configure and monitor the system.
Title	Administration portal - HMI
Status	<In Progress>
Rationale	The 4DWxCube Administrator needs an UI to administrate and configure the system.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0015
Requirement	The Administration portal shall be accessible only to 4DWxCube Administrators to prevent unauthorized users from re-configuring the system.
Title	Administration portal - access
Status	<In Progress>
Rationale	Administration tasks must be performed only by administrators.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0016
Requirement	The Administration portal shall provide a MET Product Definition page that allows the administrator to list, create, edit and delete MET Product Definitions.
Title	Administration portal – MET product definition
Status	<In Progress>
Rationale	To support new MET Products
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0017
Requirement	The Administration portal shall provide a Data Management page that

	allows the administrator to list and delete MET Products and associated information.
Title	Administration portal – MET products
Status	<In Progress>
Rationale	In order to be able to administrate the content of 4DWxCube.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0022
Requirement	The Administration portal shall provide a Data Management page that allows the administrator to configure the time window for MET Product storage (minimum 24 hours).
Title	Administration portal – data storage
Status	<In Progress>
Rationale	In order to be able to configure time limit for storage of dynamic MET Product
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0018
Requirement	The Administration portal shall provide a User Registration page that allows the administrator to list, accept and discard requests for registration from ATM systems.
Title	Administration portal – user registration
Status	<In Progress>
Rationale	In order to be able to administrate the ATM registrations.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0019
Requirement	The Administration portal shall provide a Subscription Management page that allows the administrator to list, edit, suspend, resume and discard subscriptions.
Title	Administration portal - subscription
Status	<In Progress>
Rationale	In order to be able to administrate the ATM subscription.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0020
Requirement	The Administration portal shall provide a User Management page that allows the administrator to list, create, edit and delete access rights for each user.
Title	Administration portal – user management - access
Status	<In Progress>
Rationale	In order to be able to administrate access right in the MET-GATE.

Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0021
Requirement	The Administration portal shall provide a User Management page that allows the administrator to list, create, edit and delete user information
Title	Administration portal – user management
Status	<In Progress>
Rationale	In order to be able to administrate user information.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0023
Requirement	The Administration portal shall provide an Alarms page that allows the administrator to configure alarms to produce warning messages when thresholds are exceeded.
Title	Administration portal – alarm page
Status	<In Progress>
Rationale	In order to be able to configure the threshold of the alarms.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1121
Requirement	The Administration portal shall provide a METSP page that allows the administrator to list, create, edit and delete METSP Information and to configure which MET Products they can deliver.
Title	Administration portal – METSP info
Status	<In Progress>
Rationale	In order to configure the METSP information
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1122
Requirement	The Administration portal shall provide a Service Description page that allows the administrator to list, create, edit and delete Service Descriptions.
Title	Administration portal –service description
Status	<In Progress>
Rationale	In order to be able to administrate Service information
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1123
Requirement	The Administration portal shall provide Service Publication page to enable the publishing of a Service Description to the SWIM Registry.

Title	Administration portal – service publication
Status	<In Progress>
Rationale	In order to make MET services accessible to ATM users.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

4.1.2 Monitoring & Control Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0024
Requirement	The 4DWxCube Management FB shall provide a GUI, the Dashboard.to monitor the behaviour of distributed components, to be used by Administrators.
Title	Management - GUI
Status	<In Progress>
Rationale	The 4DWxCube Administrator needs an UI to oversee the operation of the system
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0025
Requirement	The Dashboard shall provide a Statistics page to allow the administrator to report on statistics about requests and subscriptions.
Title	Dashboard - statistics
Status	<In Progress>
Rationale	In order to monitor and make reports about the number of users that use the system
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0026
Requirement	The Dashboard shall provide a Log page to allow the administrator to list the log information.
Title	Dashboard – log page
Status	<In Progress>
Rationale	In order to oversee the operation of the system.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0027
Requirement	The Dashboard shall support different levels of severity of event, such as Information, Warning, and Critical to allow the Administrator to identify and filter important events.
Title	Dashboard – severity of events
Status	<Validated>
Rationale	In order to oversee the operation of the system.
Category	<Functional>
Validation Method	

Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1127
Requirement	The Dashboard shall support provide a configuration page to allow the administrator to configure the default behaviour when an event occurs, log, report (via email), raise alarm.
Title	Dashboard – configuration page
Status	<In Progress>
Rationale	In order to oversee the operation of the system.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1128
Requirement	The Dashboard shall provide configurable alarm functions which will produce warning messages when pre-defined thresholds are exceeded or defined events occur.
Title	Dashboard – alarm functions
Status	<In Progress>
Rationale	In order to monitor the system.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1129
Requirement	The 4DWxCube Management FB shall produce a warning message when the event "loss or corruption of data" occurs. The warning message is logged and optionally emailed to a predefined list of users.
Title	Warning message – corrupted data
Status	<In Progress>
Rationale	In order to monitor the system.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0030
Requirement	The 4DWxCube Management FB shall produce a warning message when the event "loss or corruption of metadata of the MET product (alarm raised when validation fails)" occurs. The warning message is logged and optionally emailed to a predefined list of users
Title	Warning message – corrupted metadata
Status	<In Progress>
Rationale	In order to monitor the system.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0031
Requirement	The 4DWxCube Management FB shall produce a warning message when the event “ingestion of product greater than <limit> GBytes in size" occurs. The <limit> value shall be configurable. The warning message is logged and

	optionally emailed to a predefined list of users
Title	Warning message – limit exceeded
Status	<Validated>
Rationale	In order to monitor the system.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0032
Requirement	The 4DWxCube Management FB shall produce a warning message when the event “ingestion of MET data for which no MET Product Definition exists" occurs. The warning message is logged and optionally emailed to a predefined list of users
Title	Warning message – data ingestion failure
Status	<Validated>
Rationale	In order to monitor the system.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0033
Requirement	The 4DWxCube Management FB shall produce a warning message when the event “administrator failed authentication" occurs. The warning message is logged and optionally emailed to a predefined list of users
Title	Warning message – authentication failed
Status	<Validated>
Rationale	In order to monitor the system.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0034
Requirement	The 4DWxCube Management FB shall produce a warning message when the event “unauthorised access to the system is attempted" occurs. The warning message is logged and optionally emailed to a predefined list of users
Title	Warning message – unauthorised access
Status	<Validated>
Rationale	In order to monitor the system.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0035
Requirement	The 4DWxCube Management FB shall produce a warning message when the event “number of registered authenticated users exceeds a defined threshold" occurs. The warning message is logged and optionally emailed to a predefined list of users
Title	Warning message – number of users exceeded
Status	<Validated>
Rationale	In order to monitor the system.

Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0036
Requirement	The 4DWxCube Management FB shall produce a warning message when the event “number of active authenticated users exceeds a defined threshold" occurs. The warning message is logged and optionally emailed to a predefined list of users
Title	Warning message – number of authenticated users
Status	<Validated>
Rationale	In order to monitor the system.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0038
Requirement	The 4DWxCube Management FB shall produce a warning message when the event “extraction fails" occurs. The warning message is logged and optionally emailed to a predefined list of users
Title	Warning message – extraction fails
Status	<Validated>
Rationale	In order to monitor the system.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0039
Requirement	The 4DWxCube Management FB shall produce a warning message when the event “volume of data in the cache exceeds a defined threshold" occurs. The warning message is logged and optionally emailed to a predefined list of users
Title	Warning message – volume of data exceeded
Status	<Validated>
Rationale	In order to monitor the system.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0040
Requirement	The 4DWXCube Management FB shall log all alarms in one or more predefined log file(s). The alarm log file will be in a defined common format.
Title	Alarm of log file
Status	<In Progress>
Rationale	In order to monitor the system.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0041

Requirement	The Dashboard shall present the alarms log events in a table to present alarm messages to the administrator.
Title	Dashboard – alarm logs
Status	<In Progress>
Rationale	In order to monitor and investigate issues in the system.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0042
Requirement	The 4DWxCube Management FB shall log details for each action that modifies the data or configuration of the system.
Title	Logging configurations
Status	<In Progress>
Rationale	In order to monitor and investigate issues in the system.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0043
Requirement	The 4DWxCube Management FB shall archive logs according to a configurable time window to limit the storage requirements for the system.
Title	Archiving logs
Status	<In Progress>
Rationale	The archives provide a way to trace the system but after a period of time (6 months), these are not needed anymore.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0044
Requirement	The 4DWxCube Management FB shall log information on every exchanges with an ATM system (what was requested, identity of the requestor, the time of the request, an indication if the request was fulfilled or not, the time that the request was fulfilled and the response) to allow for post operation analysis.
Title	Logging of any exchanges
Status	<Validated>
Rationale	In order to monitor and investigate issues in the system.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0045
Requirement	The 4DWxCube Management FB shall log information on errors (the 4DWxCube component that had the error, the type of error, the level of error (critical, non-critical, etc...), the time that the error occurred, any alerts that were generated as a result of the error, and any actions that were taken to isolate or correct the error.) to allow for post operation analysis.
Title	Logging – error information
Status	<Validated>
Rationale	In order to monitor and investigate issues in the system.

Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0046
Requirement	The 4DWxCube Management FB shall store the log messages a rolling fileset with the filename pattern using LogYYYYMMDD-<lognumber> to support easy retrieval of logfiles.
Title	Logging – rolling filesets
Status	<In Progress>
Rationale	In order to monitor and investigate issues in the system.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0047
Requirement	The 4DWxCube Management FB shall provide an integrated user interface, the Control Panel, to enable administrators to control the functions of the System.
Title	Control Panel
Status	<In Progress>
Rationale	The 4DWxCube Administrator needs an UI to take control the system.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0048
Requirement	The Control Panel shall provide a Service Management page to enable administrators to stop and start all the 4DWxCube services (collection of data, subscription, request/replay ...)
Title	Control panel – service management page
Status	<In Progress>
Rationale	In order to control the services in case of detected issues.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0049
Requirement	The Administration Portal shall produce reports on request based on the logs and events contained in available log files or database to support statistical and investigation reports. Reports will be integrated in the Administration Portal and can be exported, and filtered as a function of parameters specified by the Administrator. Report contents should be kept for five years
Title	Administration panel – reporting on requests
Status	<In Progress>
Rationale	In order to provide technical reports in case of issues.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0050
Requirement	The Administration Portal shall produce a report, on request, about the overall availability (daily percentage of availability) for a given period (day, week, month, year) to support statistical reporting.
Title	Administration portal – availability
Status	<In Progress>
Rationale	In order to provide statistics to analyse the behaviour of the system.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0051
Requirement	The Administrator Portal shall produce a report, on request, about the overall volume of collected and transferred data to support statistical reporting.
Title	Administration portal - volume
Status	<In Progress>
Rationale	In order to provide statistics about the rate of transfer data.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0052
Requirement	The Administrator Portal shall produce a report, on request, about the overall activity per day of request and subscriptions to support statistical reporting.
Title	Administrator portal – activity per day
Status	<In Progress>
Rationale	In order to provide statistics to analyse the behaviour of the system.
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

4.1.3 Data Provision Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0053
Requirement	The MET-GATE Services shall be able to process ad-hoc requests.to deliver MET Products to ATM users on demand.
Title	Services – ad hoc
Status	<Validated>
Rationale	ATM systems may request MET Product via ad-hoc requests.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0054
Requirement	The MET-GATE Services shall extract and provide MET Products based on request data parameters to deliver only the information required by the ATM User
Title	Services – parameter requests
Status	<Validated>
Rationale	ATM clients may request MET products according to some criteria.

Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0055
Requirement	The MET-GATE Services shall subset requested MET Products according to time related criteria to deliver only the information required by the ATM User
Title	Services – time criteria
Status	<Validated>
Rationale	ATM clients usually just need to get a portion of MET products according to time criteria.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0056
Requirement	The MET-GATE Services shall subset requested MET Products according to a geographical criterion. • By point location • By area around point • By horizontal cross-section • By vertical cross-section • By defined trajectory • By corridor • By ATM sector to deliver only the information for the geographical area of interest.
Title	Services – geographical criteria
Status	<Validated>
Rationale	ATM clients usually just need to get a portion of MET products according to geographical criteria.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0064
Requirement	The MET-GATE Services shall send an error message to the ATM client if the requested MET product is not found.
Title	Services – error message
Status	<Validated>
Rationale	ATM client must always receive a reply to a request even if this one it is an error.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0065
Requirement	The MET-GATE shall provide access to the MET Product Descriptions to allow ATM users to understand the information provided by the associated MET Product and to discover what services deliver that product.
Title	MET product description provision

Status	<In Progress>
Rationale	ATM clients need discovery to configure their requests
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0066
Requirement	The MET-GATE shall filter MET Product Descriptions according to a key-word to limit the information returned to the ATM user to that which is relevant.
Title	MET product description – key-word
Status	<In Progress>
Rationale	ATM clients need discovery to configure their requests
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0067
Requirement	The MET-GATE shall filter MET Product Descriptions according to a geographical criterion to limit the information returned to the ATM user to that which is relevant.
Title	MET product description – geographical description
Status	<In Progress>
Rationale	ATM clients need discovery to configure their requests
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0068
Requirement	The MET-GATE shall filter MET Product Descriptions according to a time-related criterion to limit the information returned to the ATM user to that which is relevant.
Title	MET product description – time criteria
Status	<In Progress>
Rationale	ATM clients need discovery to configure their requests
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1165
Requirement	The MET-GATE shall provide access to the MET Service Descriptions through the SWIM Registry to allow the ATM user to configure requests according to the capabilities of the MET-GATE
Title	MET Service Description via SWIM Registry
Status	<In Progress>
Rationale	ATM clients need service information to configure their requests
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1166
Requirement	The MET-GATE shall filter MET Service Descriptions according to one or more keywords to limit the information returned to the ATM user to that which is relevant. Keywords shall include the name of the MET Products that the service can supply.
Title	MET Service Description – keywords
Status	<In Progress>
Rationale	ATM clients need service information to configure their requests
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1167
Requirement	The MET-GATE shall filter Service Descriptions according to a geographical criterion • By point location • By area around point • By horizontal cross-section • By vertical cross-section • By defined trajectory • By corridor • By ATM sector to limit the information returned to the ATM user to that which is relevant
Title	MET Service description – geographical criteria
Status	<In Progress>
Rationale	ATM clients need service information to configure their requests
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1168
Requirement	The 4DWxCube Management FB shall broadcast product type and metadata identifiers to all processes within the 4DWxCube when a new MET Product is received or created.
Title	Product type – metadata identifiers
Status	<In Progress>
Rationale	To enable consolidation, translation and subscription processes to respond to the availability of new products in a timely manner.
Category	<Functional>
Validation Method	
Verification Method	<Test>

4.1.4 Subscription management Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0069
Requirement	The MET-GATE shall be able to process subscriptions requests periodically and on event to support delivery of information to ATM users at times that are relevant to the ATM user role.
Title	Subscription processing
Status	<Validated>
Rationale	ATM systems may request MET products via subscription.
Category	<Functional>
Validation Method	
Verification Method	<Test>

REQ]

Identifier	REQ-11.02.02-TS-4DWC-0071
Requirement	The MET-GATE shall notify subscribers when a MET Product is no longer available to enable the ATM users to modify their system behaviour e.g. use an alternative service.
Title	Subscriptions – notification of users
Status	<In Progress>
Rationale	ATM clients require to know when a MET Product they are subscribed to is no longer supplied by the 4DWxCube
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0072
Requirement	The MET-GATE Services shall provide an interface to allow ATM users to manage their own subscription details. ‘Manage’ means here: modify details, pause, resume, delete.
Title	Subscription – managing
Status	<In Progress>
Rationale	An ATM system is the owner of its subscription.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0073
Requirement	The MET-GATE shall detect when a new MET Product is supplied or created (i.e. Consolidated or Translated MET Products) process any subscriptions related to the new MET Product to ensure that ATM users are provided with the latest information.
Title	Subscription – product update
Status	<In Progress>
Rationale	In order to accomplish the subscription requirement on event.
Category	<Functional>
Validation Method	
Verification Method	<Test>

4.1.5 Storage and indexation Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0074
Requirement	The 4DWxCube Management FB shall index MET products to provide highest performance.
Title	Index MET products
Status	<Validated>
Rationale	Reduce the request time as much as possible.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0075
Requirement	The 4DWxCube Management FB shall delete MET Products, their associated Metadata and any relationships at the same time to maintain data integrity.
Title	Deletion - Data integrity
Status	<Validated>
Rationale	In order to keep the integrity of data.
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0076
Requirement	The 4DWxCube Management FB shall store MET Products for a determined time window (at least 24 hours) to limit resource usage and optimize performance.
Title	Storage of MET products
Status	<Validated>
Rationale	Caching is needed to optimize performance
Category	<Functional>
Validation Method	
Verification Method	<Test>

4.2 Adaptability

4.2.1 Adaptability Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0077
Requirement	The 4DWxCube Management FB shall be designed to accommodate increases in capacity or loading without major redesign.
Title	Capacity – loading – increase
Status	<In Progress>
Rationale	New functionalities can be required.
Category	<Design>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1177
Requirement	The MET-GATE FB shall be able to accommodate new Services without major redesign to support the integration of new services more easily.
Title	Integration of new services
Status	<In Progress>
Rationale	New capabilities will be required as the 4DWxCube evolves
Category	<Design>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0078
Requirement	The 4DWxCube Management FB shall be extensible to new MET Service Providers, new MET Products and new consumers to expand the capabilities of the system.
Title	Extent to new MET Service Providers
Status	<In Progress>
Rationale	New MET model and products may come up.
Category	<Design>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1179
Requirement	The 4DWxCube Management FB shall be able to extend the types of artefacts that can be stored in the central registry/catalogue to support extensibility of the system.
Title	Extent type of artefacts
Status	<In Progress>
Rationale	New artefact types and relationships shall need to be stored as the 4DWxCube evolves.
Category	<Design>
Validation Method	
Verification Method	<Inspection>

4.3 Performance Characteristics

4.3.1.1 Performance Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0092
Requirement	The 4DWxCube shall collect and store MET Products whose size ranges are between 10 bytes and 10 GB.
Title	MET product size
Status	<Validated>
Rationale	Caching is needed to optimize performance
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0093
Requirement	The 4DWxCube shall be able to collect and store up to 500GB per day.
Title	Data size per day
Status	<Validated>
Rationale	Caching is needed to optimize performance
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0094
Requirement	The 4DWxCube shall support a simple product insertion rate of 2000 Report type products per minute (e.g. TAF. METAR)
Title	Insertion rate
Status	<In Progress>
Rationale	Expected performance
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-1194
Requirement	The 4DWxCube shall support ingest of large Gridded MET Products within 5 minutes per upload request.
Title	Large gridded MET products
Status	<In Progress>
Rationale	Expected performance
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0095
Requirement	The 4DWxCube shall accept 200 requests per second.
Title	Number of requests per time
Status	<Validated>
Rationale	Expected performance
Category	<Performance>
Validation Method	

Verification Method	<Analysis>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0096
Requirement	The 4DWxCube shall support 10000 subscriptions simultaneously.
Title	Number of subscriptions
Status	<In Progress>
Rationale	Expected performance
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0098
Requirement	The 4DWxCube shall not exceed 10 seconds to process requests and subscriptions. This does not include transfer time to the return URL.
Title	Processing time – subscription
Status	<Validated>
Rationale	Expected performance
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0099
Requirement	The 4DWxCube shall not exceed 1 second for local authentication process.
Title	Authentication process – time
Status	<Validated>
Rationale	Expected performance
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0100
Requirement	The 4DWxCube shall not exceed 1 second per MB to collect and store MET Products whose size is less than 20 MB.
Title	MET products – upload time – small size
Status	<Validated>
Rationale	Caching is needed to optimize performance
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0101
Requirement	The 4DWxCube shall not exceed 5 seconds per MB to collect and store MET products whose size is between 20MB and the specified max value.
Title	MET products – upload time – large size
Status	<Validated>
Rationale	Caching is needed to optimize performance
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC.0102
Requirement	The 4DWxCube shall not exceed 10 seconds to process each simple subscription. The 4DWxCube shall not exceed 30 seconds to process each complex subscription. To process a subscription means to collect, build and make available the required data for the subscriber. A simple subscription is one that has only 1 filter criteria applied e.g. geographic or time.
Title	Subscription processing – time
Status	<Validated>
Rationale	Expected performance
Category	<Performance>
Validation Method	
Verification Method	<Analysis>

4.4 Safety & Security

4.4.1 Safety & Security Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0079
Requirement	The MET-GATE shall provide authentication, authorization and single sign-on mechanisms.
Title	Access mechanisms
Status	<In Progress>
Rationale	Only authorized ATM clients can use the MET-GATE.
Category	<Security>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0080
Requirement	The 4DWxCube Management FB shall assign a role and group to users during registration process to manage access rights to MET-GATE Services
Title	Access rights
Status	<In Progress>
Rationale	There are several users with different privileges.
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0081
Requirement	Private information of users shall reside inside the system and shall not be distributed.
Title	Private information
Status	<In Progress>
Rationale	Due to security reasons. This is to maintain user confidentiality
Category	<Security>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0082
Requirement	During a remote authentication, the system shall not log in log files any personal information related to the remote user, but only a technical ID known at the authenticating centre.
Title	Remote user
Status	<In Progress>
Rationale	Due to security reasons This is to maintain user confidentiality
Category	<Security>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0083
Requirement	The MET-GATE shall provide user/password based scheme for authentication.
Title	User – password – authentication
Status	<In Progress>

Rationale	MET-GATE users need to be register in the system to use its services.
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0084
Requirement	The MET-GATE shall support integration with an LDAP server for authentication to support a central repository for user information.
Title	LDAP server
Status	<In Progress>
Rationale	Another system authentication can be requested.
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0085
Requirement	The MET-GATE shall support a machine-to-machine authentication.
Title	Machine to machine
Status	<Deleted>
Rationale	Another system authentication can be requested.
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0086
Requirement	The 4DWxCube shall support local and remote authentication
Title	Authentication: local – remote
Status	<In Progress>
Rationale	Administrator do not need to be in the same network to access the MET-GATE
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0087
Requirement	The 4DWxCube remote authentication shall be done between trusted networks (SWIM nodes).
Title	Authentication: trusted networks
Status	<In Progress>
Rationale	Due to security reasons
Category	<Security>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0089
Requirement	The MET-GATE shall allow the configuration of SSL-based transport protocol (HTTPS and FTPS) for metadata and data transfer to maintain data security.
Title	Configuration of SSL-based transport
Status	<In Progress>

Rationale	Due to security reasons
Category	<Security>
Validation Method	
Verification Method	<Inspection>

4.5 Maintainability

4.5.1.1 Maintainability Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0090
Requirement	The 4DWxCube system shall be designed according to Service-oriented architecture (SOA) principles.
Title	SOA principles
Status	<In Progress>
Rationale	Loosely coupled services, increased competitions, and enhancement of business capabilities.
Category	<Maintainability>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-0091
Requirement	The 4DWxCube system shall be implemented as reusable components where possible to reduce the development effort for the system.
Title	Reusable components
Status	<In Progress>
Rationale	Similar projects may reused 4DWxCube components.
Category	<Maintainability>
Validation Method	
Verification Method	<Inspection>

4.6 Reliability

Reliability requirements have been identified in section 3.6.

4.7 Functional Block Internal Data Requirements

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2101
Requirement	The 4DWxCube Management FB shall store the following artefacts in a central registry/catalogue • METSP Information • Product Specifications • Product Definitions • MET Product Metadata • Consolidated MET Product Metadata • Translated MET Product Metadata • Service Descriptions and supporting relationships between the artefacts. To support management of the variety of information in the system.
Title	List of artefacts

Status	<In Progress>
Rationale	In order to manage data within the 4DWxCube and support discovery of information
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2102
Requirement	The 4DWxCube Management FB shall store configuration information on system administrators including • User name • Contact information • Email address • MET Product storage time limits To support the administration functions.
Title	Configuration: system administration
Status	<In Progress>
Rationale	To control the administration of the system.
Category	<Functional>
Validation Method	
Verification Method	<Inspection >

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2104
Requirement	The 4DWxCube Management FB shall store configuration information for logging behaviour including • filesize limits • storage location To support the logging capabilities of the system.
Title	Configuration information - for logging
Status	<In Progress>
Rationale	To support monitoring and control
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2105
Requirement	The 4DWxCube Management FB shall store the configuration for MET Product storage behaviour including • maximum ingest file size • maximum storage size • storage time limit to manage the storage requirements for the system
Title	Configuration information – for storage
Status	<In Progress>
Rationale	In order to manage data within the 4DWxCube
Category	<Functional>
Validation Method	
Verification Method	<Test>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2106
Requirement	The 4DWxCube Management shall store the configuration information for

	system event monitoring including • event types – list of event types that can be monitored • event response- how to respond to the an event • even level information, severe , critical to support monitoring of the system
Title	Configuration information – monitoring
Status	<In Progress>
Rationale	Support monitoring and control
Category	<Functional>
Validation Method	
Verification Method	<Test>

4.8 Design and Construction Constraints

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2110
Requirement	The 4DWxCube is considered to be a single system, though in practice the implementation is likely to involve multiple physical locations.
Title	Single system
Status	<In Progress>
Rationale	Design constraints
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2111
Requirement	The 4DWxCube is isolated from all other systems. The 4DWxCube shall accept information from registered MET Service Providers only through defined interfaces. The 4DWxCube shall deliver information to ATM Users only through defined MET Services.
Title	Isolated systems – defined interfaces
Status	<In Progress>
Rationale	Design constraints
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2112
Requirement	The 4DWxCube shall communicate with external entities primarily through machine-to-machine interfaces.
Title	Machine-to-machine interfaces
Status	<In Progress>
Rationale	Design constraints
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2113
Requirement	The majority of ATM Users require the provision of regulatory product to support aviation needs within the scope of their operational role: local, regional, network, long term, medium term, short term, very short term and execution stages. To support this, the 4DWxCube shall provide access to

	MET Products through simple services with minimum tailoring capabilities.
Title	Regulatory products – simple services
Status	<In Progress>
Rationale	Design constraints
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2114
Requirement	A minority of ATM Users and other users (e.g. defence) will require provision of complex, non-regulatory products to support innovation in environments such as long term planning. To support this, the 4DWxCube shall provide access to tailored MET Products through sophisticated services that provide flexibility in how they deliver the information to the end user.
Title	Non-regulatory products – complex services
Status	<In Progress>
Rationale	Design constraints
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2115
Requirement	The preferred mechanism for delivery of MET Information to consumers shall be through the OGC Web Services family. These provide standardized interfaces to support interoperability between systems.
Title	OGC Web Services - interfaces
Status	<In Progress>
Rationale	Design constraints
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2116
Requirement	The 4DWxCube shall advertise its Services through the SWIM Registry. The ATM User shall query the SWIM Registry to obtain a description of the MET Service, how to access the MET Service and what types of MET Products the MET Service can provide. For detailed information on the MET Service the user should access the Service directly. (e.g. calling GetCapabilities on a WCS).
Title	SWIM Registry – MET-GATE
Status	<In Progress>
Rationale	Design constraints
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

[REQ]

Identifier	REQ-11.02.02-TS-4DWC-2117
Requirement	ATM Users shall only be able to access MET Products through the Services advertised through the SWIM Registry.
Title	SWIM Registry – access MET products via Services
Status	<In Progress>

Rationale	Design constraints
Category	<Functional>
Validation Method	
Verification Method	<Inspection>

4.9 Functional block Interface Requirements

This information is dealt with in a separate deliverable, P11.02.02-D42 [15].

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[2] Requirements and V&V Guidelines 03.00.00
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[3] Templates and Toolbox User Manual 03.00.00
https://extranet.sesarju.eu/Programme%20Library/Templates%20and%20Toolbox%20User%20Manual.doc

[4] EUROCONTROL ATM Lexicon
https://extranet.eurocontrol.int/http://atmlexicon.eurocontrol.int/en/index.php/SESAR

[5] SESAR Definition Phase – Task 2.4.x Milestone 3 – System Architecture (DLT-0612-244-00-10), September 2007

[6] IEEE / MIL Standards

5.2 Reference Documents

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[8] MET OSEDs, Deliverable P11.02.01-D23, 30/04/2015

[9] MET SPRs, Deliverable P11.02.01-D24, 29/05/2015

[10] MET INTEROP, Deliverable P11.02.01-D25, 09/2015

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[12] Final Technical Specification, MET prototypes - Local P11.02.02-D38

[13] Final Technical Specification, MET prototypes – Sub-regional P11.02.02-D39

[14] Final Technical Specification, MET prototypes - Network P11.02.02-D40

[15] Final Interface Requirement Specification, 4DWxCube, P11.02.02-D42

[16] Final Verification Report 4DWxCube, P11.02.02-D30

[17] P14.01.04.D44-SWIM-TI Yellow Profile Technical Specification https://extranet.sesarju.eu/WP_14/Project_14.01.04/Project%20Plan/14.01.04.D44-004-SWIM-TI%20Yellow%20Profile%20Technical%20Specification.doc

[18] WMO Core Metadata Profile v1.3 (Part 1 – Conformance Requirements) , WMO , Feb 2013

[19] WMO Core Metadata Profile v1.3 (Part 2 – Abstract Test Suite, Data Dictionary and Code Lists), WMO, Jan 2014.

[20] WMO N°182 – International Meteorological Vocabulary

[21] ICAO Annex 3 – Meteorological Service for International Air Navigation

[22] ICAO Annex 5 - Units of Measurements to be used in Air and Ground Operations

[23] ICAO Doc 7754 – EUR Air Navigation

[24]ICAO Doc 9713 – International Civil Aviation Vocabulary

[25] SJU extranet, WP 8 section. the SJU extranet
https://extranet.sesarju.eu/WP_08/Project_08.03.10

[26] European ATM Service Description for the AirportMETForecast Service extranet.sesarju.eu/WP_08/Project_08.03.10/Project%20Plan/ISRM%202.0/DEL_08.03.10_D65_European_ATM_Service_Description_for_AirportMETForecast_Service.doc

[27] European ATM Service Description for the AirportMETInducedCapacityReduction Service https://extranet.sesarju.eu/WP_08/Project_08.03.10/Project%20Plan/ISRM%202.0/DEL_08.03.10_D65_European_ATM_Service_Description_for_AirportMETInducedCapacityReduction_Service.doc

[28] European ATM Service Description for the AirportMETNowcast Service https://extranet.sesarju.eu/WP_08/Project_08.03.10/Project%20Plan/ISRM%202.0/DEL_08.03.10_D65_European_ATM_Service_Description_for_AirportMETNowcast_Service.doc

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