



Warning and Mitigation Technologies for Travelling Ionospheric Disturbances Effects

TechTIDE

D1.2

Warning system requirements report

Version 1.0

Grant agreement no: 776011

The TechTIDE has received funding from the European Commission Horizon 2020 research and innovation programme (2017 – 2020)



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Document Information

Deliverable number: D1.2
Deliverable title: Warning system Requirements report
Date of Delivery: 31.05.2018
Author(s): C. Borries, H. Barkmann, E. Borg, K.D. Missling
Work Package no.: 1
Work Package title: Requirements Analysis
Work Package leader: C. Borries
Dissemination level: Public
Nature: Report

Abstract

This document specifies the system requirements for a pre-operational system to demonstrate reliability of a set of TID (Travelling Ionospheric Disturbances) detection methodologies to issue warnings of the occurrence of TIDs.

It is based primarily on Grant Agreement number: 776011 [AD-1] and TechTIDE initial users' requirements report [REF-1].

It was prepared by the TechTIDE consortium.

Document history

Version	Date	Edited by	Reason for modification / Remarks
0.1	05.04.2018	C. Borries, E. Borg, H. Barkmann	Initial draft
0.2	30.04.2018	C. Borries, E. Borg, H. Barkmann	Revised draft
0.3	22.05.2018	C. Borries, E. Borg, H. Barkmann, K.D. Misling	Final draft
1.0	31.05.2018	C. Borries, E. Borg, H. Barkmann, K.D. Misling	First issue

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Executive Summary

TechTIDE, funded by the European Commission Horizon 2020 research and innovation program [AD-1], will establish a pre-operational system to demonstrate reliability of a set of TID (Travelling Ionospheric Disturbances) detection methodologies to issue warnings of the



occurrence of TIDs over the region extending from Europe to South Africa, to estimate the parameters that specify the TID characteristics and the inferred perturbation, and provide all additional geophysical information to the users to help them assess the risks and to develop mitigation techniques, tailored to their application. This document is TechTIDE D1.2 Warning system requirements report and it is an output of TechTIDE WP1 Task 1.2. The document presents a set of mandatory and desirable system requirements derived from TechTIDE D1.1 "Initial Users' Requirements Report".

In D1.2, system requirements are named, described and assigned an identification number and priority ("Mandatory" or "Desirable").

To derive the system requirements, use cases are discussed in Section 3, which show the relation between individual requirements.

Appendix 3 UR2SR Matrix shows the coverage of user requirements.

1 Introduction

1.1 Purpose and Scope of this document

The system requirements are driven by the users' initial requirements and by the community standards. This document describes requirements based on the participants experience from the operation of ionospheric specification and Space Weather prediction systems (NOA/DIAS, NOA/NetTIDE, DLR/SWACI), from the development of Space Weather services for the ESA SSA Programme and the coordination of the Ionospheric Expert Service Center (DLR) and from the development of large e-infrastructure projects (NOA as a scientific manager of the ESPAS).

The scope of the TechTIDE Warning system requirements report is as follows:

- Chapter 1 contains this introduction incl. Applied Method, General Description of requirements and Use Cases, Applicable and Reference Documents and Abbreviations.
- Chapter 2 contains the System Requirements.
- Chapter 3 assembles Use Cases.
- Chapter 4 compiles User requirements which have not been addressed.

The requirements compiled in this document are applicable to all subsystems of pre-operational warning system TechTIDE.

The requirements concern:

- Overall architecture of the TechTIDE warning system: it will be a distributed system, with the source codes of the TID identification algorithms residing in the nodes (DLR, BGD, NOA, UPC, OE, FU, IAP), the algorithms for the release of TID activity report, and the TechTIDE database and the test database to be developed for the impact assessment studies, and the user layer.
- Open Science policy for access and re-use
- Data and metadata management requirements
- Data and products standardization requirements
- Interfaces with external data providers (ESA SSA and NOAA) and APIs
- User Layer basic functionalities

The requirements will be specified with the design and analysis of some basic use cases:

- How to provide basic information to the standard user who needs to quickly identify the current TID activity levels
- How to provide detailed TID characteristics to the advanced user coming from different segments (EGNOS, N-RTK, HF comm and geolocation)
- How to provide the information in real-time

- How to provide the archived data with simple download and with targeted search filters
- How to keep track of the usage of the system, maintaining open access policy

1.2 Applied Method

- Analysis of user requirements (deliverable D1.1)
- Analysis of development capabilities (in interaction with WP2)
- Description and assessment of use cases

1.3 Description of requirements

Each of the requirements is represented by a table detailing the attributes associated with it. An Example is presented in Table 1-1.

Table 1-1 Example description of system requirements

Name	Example requirement				
ID	TeT_SReq_001_0	Priority:	Mandatory	Related User Req.	TeT-SRV-0010.1
Issue warnings of the occurrence of TIDs					
Notes:	[AD-1].				

Where:

- *Name* indicates full name of the requirement.
- *ID* is a unique identification code of the systems requirement.

TeT_SReq_Number_Version

Where:

- *TeT* is a fixed string meaning TechTIDE.
- *SReq* indicates that this is a system requirement.
- *Number* is a three-digit unique requirement identifier.
- *Version* is a one-digit requirement edition identifier.
- *Priority* marks the requirement as “Mandatory” or “Desirable”. We consider a requirement:
 - “Mandatory” when it is important to fulfill users’ primary needs.
 - “Desirable” when brings additional functionality to TechTIDE.
- *Description* provides the full description of the requirement.
- *Notes* provide additional notes or references to clarify the requirement.

1.4 Description of Use Cases

A Use Case Model describes the proposed functionality of a new system. A Use Case represents a discrete unit of interaction between a user (human or machine) and the system. This interaction is a single unit of meaningful work. Each Use Case describes the functionality to be built in the proposed system, which can include another Use Case's functionality or extend another Use Case with its own behavior.

A Use Case description will be described using the following common components:

- General comments and notes describing the use case.
- Requirements - The formal functional requirements of elements that a Use Case must provide to the end user. These correspond to the functional specifications found in structured methodologies, and form a contract that the Use Case performs some action or provides some value to the system.
- Constraints - The formal rules and limitations a Use Case operates under, defining what can and cannot be done. These include:
 - Pre-conditions that must have already occurred or be in place before the use case is run; for example, <create order¹> must precede <modify order>
 - Post-conditions that must be true once the Use Case is complete; for example, <order is modified and consistent>
 - Invariants that must always be true throughout the time the Use Case operates; for example, an order must always have a customer number.
- Additional attributes, such as implementation phase, version number, complexity rating, stereotype and status.

The Use Case Diagrams in Section 3 describe the external system behavior from the user's perspective. Diagrams show the actors, the use of the planned system (use cases) and the relationships between actors and use cases. They serve to derive the system requirements without making design decisions in advance.

Formal, sequential descriptions of the steps taken to carry out the use case, or the flow of events that occur during a Use Case instance will be given in the D4.1 design document as scenarios. These can include multiple scenarios, to cater for exceptional circumstances and alternative processing paths and are usually created in text and correspond to a textual representation of the Sequence Diagram, that depict the workflow; similar to Scenarios but graphically portrayed.

¹ subsequently used in a sense of ordering/subscription

1.5 Applicable Document

The following table contains the list of applicable documents.

Table 1-2 List of applicable documents

AD	Document title
[AD-1]	Grant Agreement number: 776011 — TechTIDE — H2020-COMPET-2017

1.6 Reference Documents

Table 1-3 List of reference documents

ID	Title	Reference
[REF-1]	TechTIDE initial users' requirements report	TechTIDE D1.1
[REF-2]	Report on the design and specifications of the TID algorithms and products	TechTIDE D2.1
[REF-3]	ESA SSA Team, "Space Situational Awareness – Space Weather Customer Requirements Document", Rev.5a, SSA-SWE-RS-CRD-1001, 2011-07-28	SSA-SWE-RS-CRD-1001
[REF-4]	TechTIDE Data Management Plan	TechTIDE D7.3

1.7 Abbreviations

Acronym	Definition
3D	3-Dimension
AATR	Along-arc TEC rate
BGD	Borealis Global Designs Ltd.
CDSS	Continuous Doppler Sounding System
CRUD	create, read, update, and delete
DLR	German Aerospace Center
DPS4D	Digisonde-Portable-Sounder-4D
EDD	electron density distribution
EGNOS	European Geostationary Navigation Overlay Service
FU	Frederick University
GNSS	Global Navigation Satellite System
HF	High Frequency



Acronym	Definition
HTI	Height-time-reflection intensity
IAP	Institute of Atmospheric Physics
IONEX	IONosphere map EXchange format
L-IAP	Leibniz-Institute of Atmospheric Physics e.V. at the Rostock University
MSTID	Medium Scale TID
MUF	Maximum Usable Frequency
NOA	National Observatory of Athens
N-RTK	Network Real Time Kinematic
OE	Fundació Observatori de l'Ebre
PFA	Probability of false alarm
POD	Probability Of Detection
SNR	Signal-to-Noise Ratio
SR	System Requirement
SSA SWE	Space Situational Awareness Space Weather
SSN	Sunspot Number
TBD	To Be Defined
TEC	Total Electron Content
TeT	TechTIDE
TID	Travelling Ionospheric Disturbance
UC	Use Case
UPC	Universitat Politècnica de Catalunya
UR	User Requirement
WP	Work-package

2 System Requirements

2.1 Functional Requirements

2.1.1 Provide alarms

Name	Dissemination of alarms				
ID	TeT_SReq_001_0	Priority:	Mandatory	Related User Req.	TeT-INT-3200.1 TeT-INT-3210.1 TeT-INT-3220.1 TeT-SRV-0020.1 TeT-INT-3230.1 TeT-INT-3240.1 TeT-INT-3260.1 TeT-INT-3270.1 TeT-INT-3280.1 TeT-INT-3290.1 TeT-INT-3300.1 TeT-INT-3310.1 TeT-INT-3320.1 TeT-INT-3330.1 TeT-INT-3340.1
The system shall be able to disseminate alarms via Email (at least html format) and TechTIDE twitter profile in near real time automatically.					
Notes:	[REF-1]				

Name	Revoke alarms				
ID	TeT_SReq_002_0	Priority:	Mandatory	Related User Req.	TeT-INT-3250.1
The system shall be able to send cancellation Emails or TechTIDE twitter profile to revoke alarms.					
Notes:	[REF-1]				

Name	Provide set of alarms				
ID	TeT_SReq_003_0	Priority:	Desirable/ Mandatory	Related User Req.	TeT-INT-3190.1 TeT-INT-3260.1
The system should provide a set of alarms, see Appendix 1 List of Email/ Twitter alarms.					
Notes:	[REF-1]				

Name	Alarms configuration				
ID	TeT_SReq_004_0	Priority:	Desirable	Related User Req.	TeT-INT-3260.1 TeT-INT-3280.1 TeT-INT-3290.1 TeT-INT-3300.1 TeT-INT-3320.1 TeT-INT-3330.1
The parameters of the alarm should be configurable: <ul style="list-style-type: none"> • The system has to be able to receive user inputs basing on a list (TBD) of products and their specific parameters and accompanying, pre-defined thresholds and to consider them during alarm generation. • The system has to be able to receive user inputs for an area of interest and to consider them during alarm generation. • The system has to be able to offer the user a set of selectable warnings and forecasts, to receive inputs referring to TIDs characteristics: period, phase velocity, direction of propagation, wavelength, amplitude and geographical location and to consider them during alarm generation. • The system has to be able to offer the user a set of selectable warnings, to receive inputs referring to the expected impact on the signal-to-noise ratio on HF links and to consider them during alarm generation. • The system has to be able to generate warnings if the path probability ratio on link sections between the DPS4D sounders deviates by more than 20% from the average standard value. • The system has to be able to offer the user a selection of positioning error thresholds caused by TEC gradients and to consider them during alarm generation. 					
Notes:	[REF-1]				

Name	Simple scale warning				
ID	TeT_SReq_005_0	Priority:	Mandatory	Related User Req.	TeT-INT-3070.1
The system shall show simple scale warnings (e.g. green, amber or red).					
Notes:	[AD-1].				

Name	Simple scale warning				
ID	TeT_SReq_011_0	Priority:	Desirable	Related User Req.	TeT-INT-3350.1
The system should show simple scale warnings (e.g. green, amber or red) via TechTIDE twitter/email.					
Notes:	[AD-1].				

2.1.2 Provide products

Name	Include products				
ID	TeT_SReq_006_0	Priority:	Mandatory	Related User Req.	TeT-SRV-0090.1 TeT-SRV-0100.1 TeT-SRV-0110.1 TeT-SRV-0120.1 TeT-SRV-0130.1 TeT-SRV-0140.1 TeT-PRD-1010.1 TeT-PRD-1020.1 TeT-PRD-1030.1 TeT-PRD-1040.1 TeT-PRD-1070.1 TeT-PRD-1080.1 TeT-PRD-1090.1 TeT-PRD-1100.1 TeT-PRD-1110.1

					TeT-PRD-1140.1 TeT-PRD-1150.1 TeT-PRD-1180.1 TeT-PRD-1190.1 TeT-PRD-1200.1 TeT-PRD-1050.1 TeT-PRD-1060.1 TeT-PRD-1120.1 TeT-PRD-1130.1 TeT-PRD-1160.1 TeT-PRD-1170.1 TeT-PRD-1210.1 TeT-PRD-1220.1 TeT-PRD-1230.1 TeT-PRF-2430.1
The system shall include products from provider (Appendix 2 Product Specification).					
Notes:	[REF-1]				

Name	Provide products				
ID	TeT_SReq_007_0	Priority:	Mandatory	Related User Req.	TeT-SRV-0090.1 TeT-SRV-0100.1 TeT-SRV-0110.1 TeT-SRV-0120.1 TeT-SRV-0130.1 TeT-SRV-0140.1 TeT-PRD-1010.1 TeT-PRD-1020.1 TeT-PRD-1030.1 TeT-PRD-1040.1 TeT-PRD-1070.1 TeT-PRD-1080.1

					TeT-PRD-1090.1 TeT-PRD-1100.1 TeT-PRD-1110.1 TeT-PRD-1140.1 TeT-PRD-1150.1 TeT-PRD-1180.1 TeT-PRD-1190.1 TeT-PRD-1200.1 TeT-PRD-1050.1 TeT-PRD-1060.1 TeT-PRD-1120.1 TeT-PRD-1130.1 TeT-PRD-1160.1 TeT-PRD-1170.1 TeT-PRD-1210.1 TeT-PRD-1220.1 TeT-PRD-1230.1 TeT-PRF-2430.1
The system shall deliver defined products to the user (Appendix 2 Product Specification).					
Notes:	[REF-1]				

Name	Expandable system				
ID	TeT_SReq_008_0	Priority:	Desirable	Related User Req.	TBD
The system should be expandable to include new products. Standards for meta data and data format shall be used whenever appropriate.					
Notes:					

Name						Product meta data					
ID	TeT_SReq_009_0	Priority:	Mandatory	Related User Req.	TeT-INT-3400.1 TeT-INT-3410.1 TeT-INT-3420.1 TeT-INT-3430.1 TeT-INT-3440.1 TeT-INT-3450.1 TeT-INT-3460.1 TeT-INT-3470.1 TeT-INT-3480.1 TeT-INT-3490.1 TeT-INT-3500.1 TeT-INT-3520.1						
The system shall retrieve, handle and provide product meta data.											
Notes:	[REF-1]										

Name						Automatic product access					
ID	TeT_SReq_0010_0	Priority:	Desirable	Related User Req.	TeT-SRV-0090.1 TeT-SRV-0100.1 TeT-SRV-0110.1 TeT-SRV-0120.1 TeT-SRV-0130.1 TeT-SRV-0140.1 TeT-PRD-1010.1 TeT-PRD-1020.1 TeT-PRD-1030.1 TeT-PRD-1040.1 TeT-PRD-1070.1 TeT-PRD-1080.1 TeT-PRD-1090.1						

					TeT-PRD-1100.1 TeT-PRD-1110.1 TeT-PRD-1140.1 TeT-PRD-1150.1 TeT-PRD-1180.1 TeT-PRD-1190.1 TeT-PRD-1200.1 TeT-PRD-1050.1 TeT-PRD-1060.1 TeT-PRD-1120.1 TeT-PRD-1130.1 TeT-PRD-1160.1 TeT-PRD-1170.1 TeT-PRD-1210.1 TeT-PRD-1220.1 TeT-PRD-1230.1
The system should provide functionality for an automatic access to the products (Appendix 2 Product Specification).					
Notes:	[REF-1]				

2.1.3 Provide archived data

Name	Dissemination means: Archive				
ID	TeT_SReq_0025_0	Priority:	Mandatory	Related User Req.	TeT-INT-3390.1
The system shall provide a dedicated archive containing all products listed in Appendix 2 Product Specification to the users.					
Notes:	[REF-3]				

Name	Archive: data files				
ID	TeT_SReq_0026_0	Priority:	Mandatory	Related User Req.	TeT-INT-3420.1

All products shall be stored in human-readable files.

Notes: [REF-3]

Name	Archive				
ID	TeT_SReq_0027_0	Priority:	Mandatory	Related User Req.	TeT-INT-3420.1
The Archive shall provide sufficient storage space to archive at least all listed products considering the specified time period and other given specifications (Appendix 2 Product Specification).					
Notes:	[REF-3]				

2.1.4 Manage Database

Name	TeT Data Management System (DMS)-1: maintain database				
ID	TeT_SReq_0028_0	Priority:	Mandatory	Related User Req.	TeT-INT-3400.1 TeT-INT-3410.1 TeT-INT-3420.1 TeT-INT-3430.1 TeT-INT-3440.1 TeT-INT-3450.1 TeT-INT-3460.1 TeT-INT-3470.1 TeT-INT-3480.1 TeT-INT-3490.1 TeT-INT-3500.1 TeT-INT-3520.1
The system shall maintain a system database.					
Notes:					

Name	TeT Data Management System (DMS)-2: make data findable				
ID	TeT_SReq_0029_0	Priority:	Mandatory	Related	TeT-INT-3400.1

				User Req.	TeT-INT-3410.1 TeT-INT-3420.1 TeT-INT-3430.1 TeT-INT-3440.1 TeT-INT-3450.1 TeT-INT-3460.1 TeT-INT-3470.1 TeT-INT-3480.1 TeT-INT-3490.1 TeT-INT-3500.1 TeT-INT-3520.1
The system shall implement a filename convention, metadata convention and File Search.					
Notes:	Requirement from the FAIR principle described in the Data Management Plan [REF-4].				

Name	TeT Data Management System (DMS)-3				
ID	TeT_SReq_0030_0	Priority:	Mandatory	Related User Req.	TeT-INT-3400.1 TeT-INT-3410.1 TeT-INT-3420.1 TeT-INT-3430.1 TeT-INT-3440.1 TeT-INT-3450.1 TeT-INT-3460.1 TeT-INT-3470.1 TeT-INT-3480.1 TeT-INT-3490.1 TeT-INT-3500.1 TeT-INT-3520.1
The system shall provide a possibility for add, remove and correct data and Metadata.					
Notes:					

2.1.5 Data exchange functionalities

Name	Data exchange functionalities: Fetch products from providers				
ID	TeT_SReq_0031_0	Priority:	Mandatory	Related User Req.	TBD
The system shall provide a functionality to fetch products from providers.					
Notes:					

Name	Data exchange functionalities: Provide data upload facility for providers				
ID	TeT_SReq_0032_0	Priority:	Mandatory	Related User Req.	TBD
The system shall be able to handle by the provider uploaded data to the TeT system.					
Notes:					

2.1.6 Provide system reports

Name	Service report: Usage statistics				
ID	TeT_SReq_0033_0	Priority:	Desirable	Related User Req.	TeT-PRF-2010.1
The system should provide a statistic report to the availability of the system and the usage of the system.					
Notes:					

Name	Service report: Unavailability information				
ID	TeT_SReq_0034_0	Priority:	Desirable	Related User Req.	TeT-PRF-2040.1
The system should provide an unavailability information report to the users of any limitations of service that may occur due to unexpected unavailability with a minimum delay and within a maximum of 1 hour from the start of the unavailability.					
Notes:					

Name	Service report: Recovery information				
ID	TeT_SReq_0079_0	Priority:	Desirable	Related User Req.	TeT-PRF-2050.1
The system should provide information to the users when it is functioning normally following an unavailability period with a minimum delay and within a maximum of 1 hour from the end of the unavailability.					
Notes:					

Name	Service report: scheduled maintenance information				
ID	TeT_SReq_0080_0	Priority:	Desirable	Related User Req.	TeT-PRF-2060.1
The system should provide information about scheduled maintenance and limitations of service that may occur due to planned unavailability periods 30 days in advance.					
Notes:					

Name	Service report: Service operational availability				
ID	TeT_SReq_0035_0	Priority:	Desirable	Related User Req.	TeT-PRF-2010.1
The system should be able to provide a product availability report documenting the service operational availability in an appropriate way.					
Notes:					

Name	Service reports: data timeliness report				
ID	TeT_SReq_0036_0	Priority:	Mandatory	Related User Req.	TeT-PRF-2070.1
The system shall be able to report the timeliness of the provided data to document the near real time capability.					
Notes:	Timeliness is considered to be the delta time between end of measurements and product provision to the user.				

Name	Service reports: archive data report				
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ID	TeT_SReq_0037_0	Priority:	Mandatory	Related User Req.	TeT-PRF-2080.1
The system shall provide a report on the timeliness of the data provision in the TeT online archive.					
Notes:					

2.1.7 Provide website

Name	Provide Website				
ID	TeT_SReq_0038_0	Priority:	Mandatory	Related User Req.	TeT-INT-3010.1 TeT-INT-3100.1
The system shall provide TechTIDE information and warnings by means of dedicated website.					
Standardized website information shall be available to non-registered users.					
Notes:	[REF-3]				

Name	Provide sections for different user communities				
ID	TeT_SReq_0039_0	Priority:	Mandatory	Related User Req.	TeT-INT-3180.1
The website shall differentiate products targeting different user communities like HF, EGNOS and N-RTK. The website can include for common information a general section.					
Notes:	[REF-3]				

Name	Browser and system compatibility				
ID	TeT_SReq_0040_0	Priority:	Desirable	Related User Req.	TeT-INT-3140.1
The system should provide the interface for displaying the results to a remote user using a PC/Mac/Smartphone and different browsers.					
Notes:	[REF-3]				

Name	Graphical indication of each product				
ID	TeT_SReq_0041_0	Priority:	Mandatory	Related	TeT-INT-3020.1

				User Req.	
The website shall provide graphical presentation of each product (Appendix 2 Product Specification).					
Notes:	[REF-3]				

Name	User registration				
ID	TeT_SReq_0043_0	Priority:	Mandatory	Related User Req.	TeT-INT-3090.1
The website shall provide a user registration.					
Notes:	[REF-3]				

Name	Provide product and contact information				
ID	TeT_SReq_0044_0	Priority:	Mandatory	Related User Req.	TeT-INT-3110.1 TeT-INT-3120.1 TeT-INT-3160.1 TeT-INT-3170.1
The website shall provide User guide describing the generation, interpretation, usage and formats of the output products and shall provide a clear path to contact TechTIDE team by email.					
The website shall provide information and links on where to find all measurements used as system inputs.					
The website shall inform when the data on the website was last updated.					
Notes:	[REF-3]				

Name	Enable users' feedback				
ID	TeT_SReq_0045_0	Priority:	Mandatory	Related User Req.	TeT-INT-3130.1
The website shall provide the means to collect users' feedback.					
Notes:	[REF-3]				

Name	Manual search of archive				
ID	TeT_SReq_0046_0	Priority:	Desirable	Related	TeT-INT-3150.1

				User Req.	
The website should provide a functionality to display archived graphical outputs by selecting the start and end date and time.					
Notes:	[REF-3]				

Name	Subscription of warnings and forecasts				
ID	TeT_SReq_0047_0	Priority:	Mandatory	Related User Req.	TeT-INT-3190.1
The website shall provide functionality for registered users to select a subset of warnings and forecasts (see Appendix 1 List of Email/ Twitter alarms), which they want to receive automatically.					
Notes:	[REF-3]				

2.1.8 Manage Users

Name	User Management: registration				
ID	TeT_SReq_0048_0	Priority:	Mandatory	Related User Req.	TeT-INT-3090.1
The system should provide a possibility to add and remove user.					
Notes:	[REF-3]				

Name	User Management: authorization				
ID	TeT_SReq_0049_0	Priority:	Mandatory	Related User Req.	TeT-INT-3090.1
The system should provide user authorization functionality.					
Notes:	[REF-3]				

Name	User Management: authentication				
ID	TeT_SReq_0050_0	Priority:	Mandatory	Related User Req.	TeT-INT-3090.1
The system should provide user authentication functionality.					
Notes:	[REF-3]				



Name	User Management: alert configuration				
ID	TeT_SReq_0051_0	Priority:	Mandatory	Related User Req.	TeT-INT-3090.1
The system should allow the user to configure the alerts he wants to receive.					
Notes:	[REF-3]				

Name	User Management: self-management				
ID	TeT_SReq_0052_0	Priority:	Desirable	Related User Req.	TeT-INT-3090.1
The system should allow the user to edit and modify their contact data and other user information.					
Notes:	[REF-3]				

2.2 Non-Functional Requirements

2.2.1 Legal and Regulatory

Name	Legal and Regulatory: Open access				
ID	TeT_SReq_0054_0	Priority:	Mandatory	Related User Req.	Regulation (EU) No 1291/2013 of the European Parliament and of the council of 11 December 2013 - establishing Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020) and repealing Decision No 1982/2006/EC
All data and final products shall be delivered by open access.					
Notes:	<p>“(§ 28) To increase the circulation and exploitation of knowledge, open access to scientific publications should be ensured. Furthermore, open access to research data resulting from publicly funded research under Horizon 2020 should be promoted, taking into account constraints pertaining to privacy, national security and intellectual property rights.” https://ec.europa.eu/research/participants/data/ref/h2020/legal_basis/fp/h2020-eu-establact_en.pdf)</p> <p>[AD-1]</p>				

Name	Legal and Regulatory: Open Science policy for access and re-use				
ID	TeT_SReq_0055_0	Priority:	Mandatory	Related User Req.	Open Access: article 29.2 and article 29.3 of Grant Agreements
All data, final products, and publications shall be fulfill the rules of open science policy for access and re-use.					
Notes	<p>The paragraphs 29.2 "Open access to scientific publications" and 29.3 "Open access to research data" of the H2020 Program, AGA – Annotated Model Grant Agreement (Version 4.1, 26 October 2017) regulate the open access handling of results, data, and publications. All data and final products shall be delivered by open access</p>				

	http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/amga/h2020-amga_en.pdf). [AD-1]
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2.2.2 Performance

Name	Performance: Operational Availability				
ID	TeT_SReq_0056_0	Priority:	Mandatory	Related User Req.	TeT-PRF-2010.1
The operational availability of the system should be better than 99% per year.					
Notes:	SWE-SRD-9168 [REF-3]				

Name	Performance: Operational Availability - Aviation				
ID	TeT_SReq_0057_0	Priority:	Desirable	Related User Req.	TeT-PRF-2020.1
For aviation, the operational availability of the system shall be better than 99.9% per year.					
Notes:	SWE-SRD-9168 [REF-3]				

Name	Performance: Service maximum contiguous downtime				
ID	TeT_SReq_0058_0	Priority:	Desirable	Related User Req.	TeT-PRF-2030.1
The maximum contiguous downtime of the service should be less than 5 minutes with the exception of scheduled maintenance					
Notes:	SWE-SRD-9167, SWE-CRD-TIO-164 [REF-3]				

Name	Performance: Service unavailability information delay				
ID	TeT_SReq_0059_0	Priority:	Desirable	Related User Req.	TeT-PRF-2040.1
The service unavailability information delay should be in a minimum delay and within a maximum of 1 hour from the start of the unavailability.					
Notes:	SWE-SRD-10861 [REF-3]				

Name	Performance: Service recovery information delay				
ID	TeT_SReq_0060_0	Priority:	Desirable	Related User Req.	TeT-PRF-2050.1
The service recovery information delay should have a minimum delay and within a maximum of 1 hour from the end of the unavailability.					
Notes:	SWE-SRD-10860 [REF-3]				

Name	Archive: time range				
ID	TeT_SReq_0061_0	Priority:	mandatory	Related User Req.	TeT-INT-3470.1 TeT-INT-3480.1 TeT-INT-3490.1 TeT-INT-3500.1 TeT-INT-3520.1
All products (Appendix 2 Product Specification) shall be provided for at least the past 6 month.					
Notes:	[REF-3]				

Name	Archive: full time range				
ID	TeT_SReq_0062_0	Priority:	Desirable	Related User Req.	TeT-INT-3460.1
The time range of archived data should be from the oldest date of data to most recent.					
Notes:	[REF-3]				

Name	Timeliness: near real-time data				
ID	TeT_SReq_0063_0	Priority:	Mandatory	Related User Req.	TeT-PRF-2070.1 TeT-PRF-2110.1 TeT-PRF-2120.1 TeT-PRF-2160.1 TeT-PRF-2190.1 TeT-PRF-2200.1 TeT-PRF-2210.1 TeT-PRF-2140.1

					TeT-PRF-2150.1 TeT-PRF-2130.1 TeT-PRF-2100.1
The system should provide near real-time data less than 5 minutes after completion of measurements.					
Notes: ESA PSD IT-011-N [REF-3]					

Name	Timeliness: archive data				
ID	TeT_SReq_0064_0	Priority:	Desirable	Related User Req.	TeT-PRF-2080.1
The time between completion of measurements and product archive should be less than 2 days.					
Notes: ESA PSD IT-011-P [REF-3]					

Name	Timeliness: forecast				
ID	TeT_SReq_0065_0	Priority:	Desirable	Related User Req.	TeT-PRF-2090.1
The time between forecasted time and product provision should be at least 15 minutes up to 3 days.					
Notes:					

Name	Spatial Resolution				
ID	TeT_SReq_0024_0	Priority:	Mandatory	Related User Req.	TeT-PRF-2250.1 TeT-PRF-2270.1 TeT-PRF-2300.1
<p>The system shall be able to provide the products with the spatial resolution like defined in Appendix 2 Product Specification.</p> <ul style="list-style-type: none"> • localization of MSTIDs: 1 degree or better in latitude and longitude • TEC gradients: 1 degree or better in latitude and longitude • ionosphere perturbation index: not more than 1 degree in latitude and longitude • TEC maps: at least 5 degrees or better 					
Notes:					

Name	Spatial Resolution				
ID	TeT_SReq_0082_0	Priority:	Desirable	Related User Req.	TeT-PRF-2220.1 TeT-PRF-2230.1 TeT-PRF-2240.1 TeT-PRF-2260.1 TeT-PRF-2280.1
<p>The system should be able to provide the products with the spatial resolution like defined in Appendix 2 Product Specification.</p> <ul style="list-style-type: none"> • near real-time data, archive data, forecast data: 100 km • TID amplitudes: 30km x 30km • TEC gradients: with 30km x 30 km 					
Notes:					

Name		Data Format			
ID	TeT_SReq_0083_0	Priority:	Mandatory	Related User Req.	TeT-INT-3440.1 TeT-INT-3450.1 TeT-INT-3380.1 TeT-INT-3430.1 TeT-INT-3030.1 TeT-INT-3050.1 TeT-INT-3060.1
<p>The system should be able to provide the products in the data format like defined in Appendix 2 Product Specification.</p>					
Notes:					

Name		Geographical scope			
ID	TeT_SReq_0084_0	Priority:	Mandatory	Related User Req.	TeT-SRV-0010.1 TeT-SRV-0090.1 TeT-SRV-0100.1 TeT-SRV-0110.1 TeT-SRV-0120.1 TeT-SRV-0130.1 TeT-SRV-0140.1 TeT-SRV-0150.1 TeT-SRV-0160.1
<p>The system shall provide products over the region extending from Europe to South Africa with the geographical scope like defined in Appendix 2 Product Specification.</p>					
Notes:					

Name	Temporal resolution				
ID	TeT_SReq_0085_0	Priority:	Mandatory	Related User Req.	TeT-PRF-2310.1 TeT-PRF-2320.1 TeT-PRF-2330.1 TeT-PRF-2340.1 TeT-PRF-2350.1 TeT-PRF-2360.1 TeT-PRF-2390.1
The system shall provide products with the temporal resolution less than 5 or 15 minutes like defined in Appendix 2 Product Specification.					
Notes:					

2.2.3 Reliability

Name	Reliability: POD - TEC gradient warnings				
ID	TeT_SReq_0071_0	Priority:	Desirable	Related User Req.	TeT-PRF-2450.1 TeT-PRF-2440.1
The system should provide warnings for TEC gradients exceeding a certain threshold at least 50 % probability of detection.					
Notes:					

Name	Reliability: PFA - TEC gradient warnings				
ID	TeT_SReq_0074_0	Priority:	Desirable	Related User Req.	TeT-PRF-2480.1 TeT-PRF-2470.1
The system should provide warnings for TEC gradients exceeding a certain threshold with a maximum of 5 % probability of false alarm.					
Notes:					

2.2.4 Security

Name	Security: Manipulations of data, information, and websites by third parties				
ID	TeT_SReq_0077_0	Priority:	Mandatory	Related User Req.	Regulation (EU) 2016/679 of the European Parliament and of the council of 27 April 2016 Directive (EU) 2016/1148 European Parliament and of the council
<p>The protection of data and information should comply with good scientific practice in accordance with recognized recommendations for action. According to the European law the protection of the website against manipulation by third parties is important for data and information security.</p>					
Notes:					

Name	Security: User credentials				
ID	TeT_SReq_0078_0	Priority:	Mandatory	Related User Req.	Regulation (EU) 2016/679 of the European Parliament and of the council of 27 April 2016
<p>The protection of data and information should comply with good scientific practice in accordance with recognized recommendations for action. In accordance with applicable European law, users' data must be protected against manipulation by third parties. This also includes the right to oblivion. For this purpose, write, read and delete procedures must be developed in such a way that they can only be used confidentially by the user.</p> <p>The system should secure personal and other user data against hacking in accordance with federal and EU laws.</p>					
Notes:					

3 Use Cases

3.1 Introduction to Use Cases

3.1.1 Actors

The system considers user, which can be registered users, unregistered users, administrators and data providers as its actors (c.f. Figure 1).

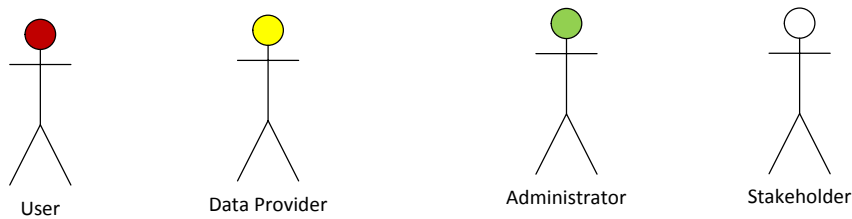


Figure 1 TechTIDE actors

User

Any human being getting in touch with the TechTIDE system is principally considered as user.

Data provider

The TechTIDE system uses data from external providers, who either belong to the TechTIDE consortium or are public entities.

Administrator

Administrator is the administrator and or technician of the TechTIDE system.

Stakeholder

e.g. ESA SSA

3.1.2 TechTIDE Primary Use Cases

There is a number of ways how users can interact with the TechTIDE system. An overview is provided in Figure 2. Each use case will be described in the following sections in more detail.

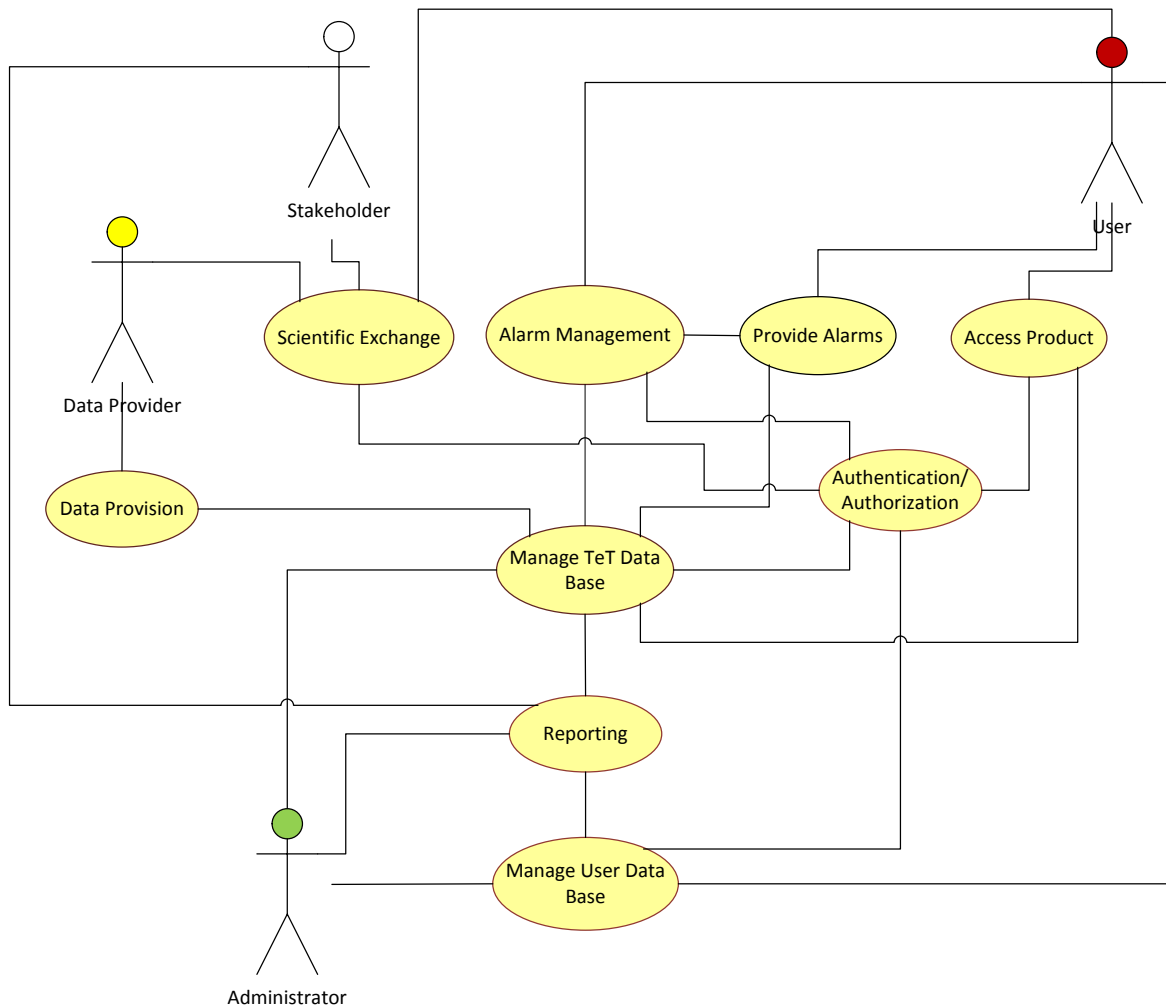
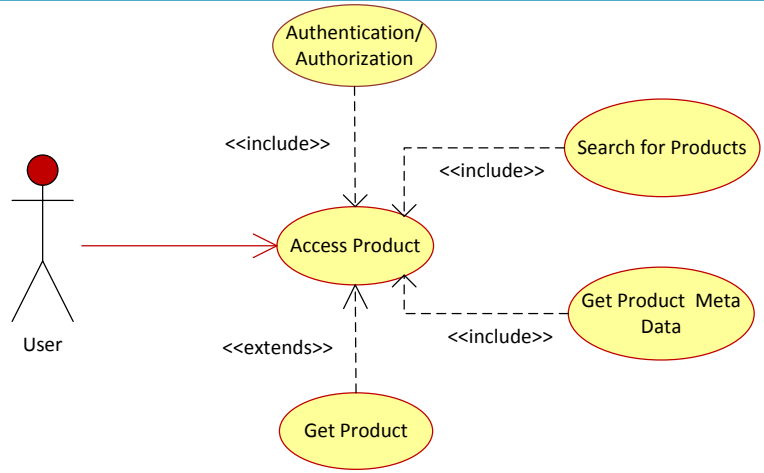


Figure 2 TechTIDE primary use cases

3.2 Access Product

Use Case	Access Product		Use Case Id	TeT-SR-UC-1
Status:	Proposed	Version 1.0	Phase	1.0
Author:	C. Borries	Created 04.04.2018	Modified	
Use Case Diagram				
 <pre> graph TD User((User)) --> AP((Access Product)) AA((Authentication/Authorization)) -.-> <<include>> AP SP((Search for Products)) -.-> <<include>> AP GPM((Get Product Meta Data)) -.-> <<include>> AP GP((Get Product)) -.-> <<extends>> AP </pre>				
Description:	The system allows the user to search for and download data. The system provides product metadata for this purpose. Open Access can also be configured via the authentication and authorization process.			
Related to:	<i>Source</i>	<i>Connector</i>	<i>Target</i>	
	User	UseCaseLink	Access Product	
	Access Product	Realization	TeT_SReq_007_0, (provide product Sec 2.1.1), TeT_SReq_009_0, TeT_SReq_0010_0, TeT_SReq_0038_0, TeT_SReq_0039_0, TeT_SReq_0040_0, TeT_SReq_0041_0, TeT_SReq_0044_0, TeT_SReq_0045_0, TeT_SReq_0046_0, TeT_SReq_0054_0, TeT_SReq_0055_0, TeT_SReq_0056_0, TeT_SReq_0057_0, TeT_SReq_0058_0, TeT_SReq_0059_0	

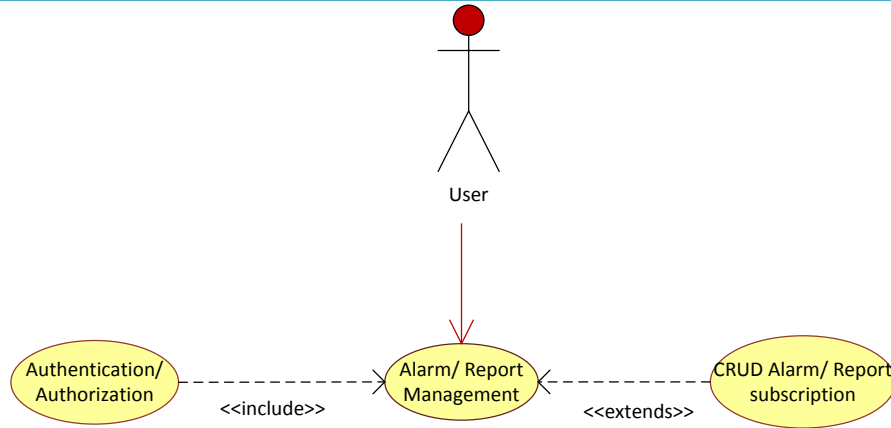
<i>Use Case</i>	<i>Access Product</i>	<i>Use Case Id</i>	<i>TeT-SR-UC-1</i>
	Access Product	Dependency	Authentication/ Authorization
	Access Product	Dependency	Manage TeT Data Base
Preconditions:	<i>Name</i>	<i>Description</i>	
	TeT Database availability	Database is accessible and readable	
	Product availability	Product is available	
	Access Authorization	User has access rights	
Postconditions:	<i>Name</i>	<i>Description</i>	
	Product is provided	Product is stored on a pickup point/ pushed to user	
Sub Use Cases:			
Authentication/ Authorization	<i>Authentication ensures that the user is who he claims to be, During authorization, the system checks whether the user is authorized to use the Access Product service.</i>		
Search for Products	<i>User formulates a query.</i>		
Get Product Meta Data	<i>The system provides meta data of the appropriate products.</i>		
Get Product	<i>The system provides the selected products.</i>		

3.2.1 Search for Products

3.2.2 Get Product Meta Data

3.2.3 Get Product

3.3 Alarm/ Report Management

Use Case	Alarm Management		Use Case Id	TeT-SR-UC-1
Status:	Proposed	Version 1.0	Phase	1.0
Author:	C. Borries	Created 04.04.2018	Modified	
Use Case Diagram				
				
Description:	The system allows the user to select an alarm from a predefined list and configure it. The system allows the user to configure (Create, Read, Update, Delete – CRUD) the alerts he wants to receive.			
Related to:	<i>Source</i>	<i>Connector</i>	<i>Target</i>	
	User	UseCaseLink	Alarm Management	
	CRUD Alarm/ Report subscription	Dependency	Authentication/ Authorization	
	CRUD Alarm/ Report subscription	Realization	TeT_SReq_004_0, TeT_SReq_0024_0, TeT_SReq_0038_0, TeT_SReq_0047_0, TeT_SReq_0051_0	
Preconditions:	<i>Name</i>	<i>Description</i>		
	Alarm/ Report management Availability	Database is accessible and readable		
	Alarm/ Report Management Authorization	User has rights to CRUD alarm subscription		
Postconditions:	<i>Name</i>	<i>Description</i>		

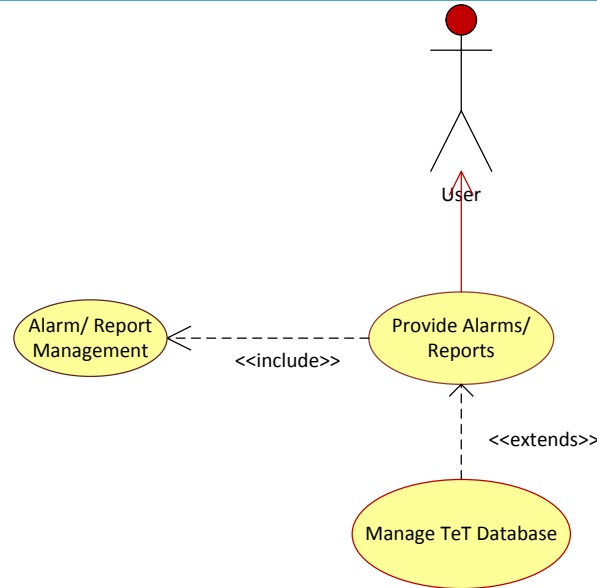
<i>Use Case</i>	<i>Alarm Management</i>	<i>Use Case Id</i>	<i>TeT-SR-UC-1</i>
	Alarm/ Report is configured		Alarm Management is updated
Sub Use Cases:			
Authentication/ Authorization	<i>Authentication ensures that the user is who he claims to be, During authorization, the system checks whether the user is authorized to subscribe an alarm.</i>		
CRUD alarm/report subscription	<i>Create, read, update, and delete an alarm/report subscription</i>		

3.3.1 CRUD alarm/report subscription

3.4 Alarm/ Report Provision

Use Case	Alarm Provision		Use Case Id	TeT-SR-UC-1
Status:	Proposed	Version 1.0	Phase	1.0
Author:	C. Borries	Created 04.04.2018	Modified	

Use Case Diagram



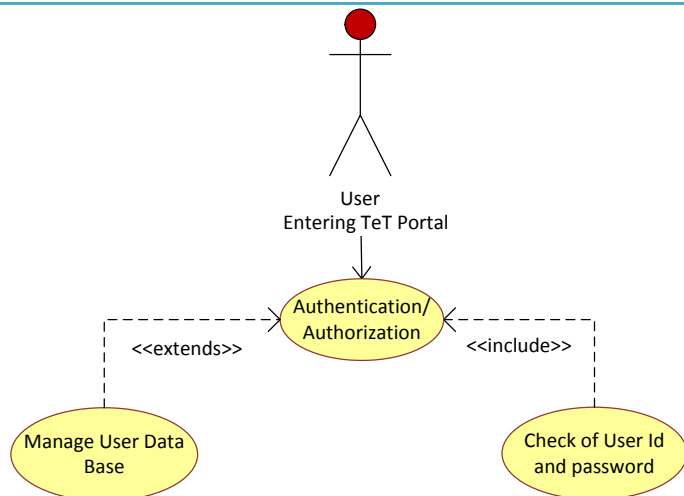
Description: The system generates an alarm for the user in accordance with the corresponding configured subscription if the alarm conditions are fulfilled.

The system generates a report for a certain predefined period of time containing specified information about the occurrence of TIDs and ionospheric perturbations.

Related to:	Source	Connector	Target
	TeT Database	UseCaseLink	Alarm Provision
Provide Report	Alarm/	Dependency	Alarm Management
Provide Report	Alarm/	Dependency	Manage TeT Database
Provide Report	Alarm/	Realization	TeT_SReq_001_0, TeT_SReq_002_0, TeT_SReq_003_0, TeT_SReq_005_0, TeT_SReq_0024_0, TeT_SReq_0056_0, TeT_SReq_0057_0,

<i>Use Case</i>	<i>Alarm Provision</i>	<i>Use Case Id</i>	<i>TeT-SR-UC-1</i>								
		TeT_SReq_0058_0, TeT_SReq_0059_0, TeT_SReq_0060_0, TeT_SReq_0063_0, TeT_SReq_0065_0, TeT_SReq_0066_0, TeT_SReq_0071_0, TeT_SReq_0074_0, TeT_SReq_0076_0									
Preconditions:	<table border="1"> <thead> <tr> <th><i>Name</i></th> <th><i>Description</i></th> </tr> </thead> <tbody> <tr> <td>Database is available</td> <td>Database is accessible and readable</td> </tr> <tr> <td>Alarm/ Report is subscribed</td> <td>Subscription in Alarm Management</td> </tr> <tr> <td>Alarm/ Report condition occurs</td> <td>New Product fulfills alarm condition</td> </tr> </tbody> </table>			<i>Name</i>	<i>Description</i>	Database is available	Database is accessible and readable	Alarm/ Report is subscribed	Subscription in Alarm Management	Alarm/ Report condition occurs	New Product fulfills alarm condition
<i>Name</i>	<i>Description</i>										
Database is available	Database is accessible and readable										
Alarm/ Report is subscribed	Subscription in Alarm Management										
Alarm/ Report condition occurs	New Product fulfills alarm condition										
Postconditions:	<table border="1"> <thead> <tr> <th><i>Name</i></th> <th><i>Description</i></th> </tr> </thead> <tbody> <tr> <td>Alarm/ Report is provided</td> <td>Alarm is successfully executed on time and in terms of content.</td> </tr> </tbody> </table>			<i>Name</i>	<i>Description</i>	Alarm/ Report is provided	Alarm is successfully executed on time and in terms of content.				
<i>Name</i>	<i>Description</i>										
Alarm/ Report is provided	Alarm is successfully executed on time and in terms of content.										
Sub Use Cases:											
	Provide Alarm										
	Provide Report										

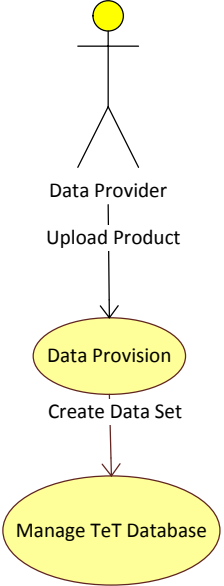
3.5 Authentication/ Authorization

Use Case	Authentication/ Authorization	Use Case Id	TeT-SR-UC-1
Status:	<i>Proposed</i>	Version	1.0
Author:	K.D. Misling	Created	04.05.2018
		Modified	
Use Case Diagram			
			
Description:	<p>In a first step (authentication) the system provides a way of identifying a user (e.g. by valid user name and password).</p> <p>In the second step (authorization) the system determines whether the user has the authority to issue certain types of system interaction.</p>		
Related to:	<i>Source</i>	<i>Connector</i>	<i>Target</i>
	User	UseCaseLink	Authentication/ Authorization
	Authentication/ Authorization	Dependency	Manage User Data Base
	Authentication/ Authorization	Realization	TeT_SReq_0049_0, TeT_SReq_0050_0
Preconditions:	<i>Name</i>	<i>Description</i>	
	User Data Base is available	Database is accessible and readable	
Postconditions:	<i>Name</i>	<i>Description</i>	
	authentication	session ID and access rights assigned	



<i>Use Case</i>	<i>Authentication/ Authorization</i>	<i>Use Case Id</i>	<i>TeT-SR-UC-1</i>
	passes		
	authentication fails,	display error message, return user to login page; decrement remaining attempts; if preset attempts exceed limit, notify user and lock out the account	
Sub Use Cases:			
Check of User Id and password			
Assignment of session Id, user role and access rights			

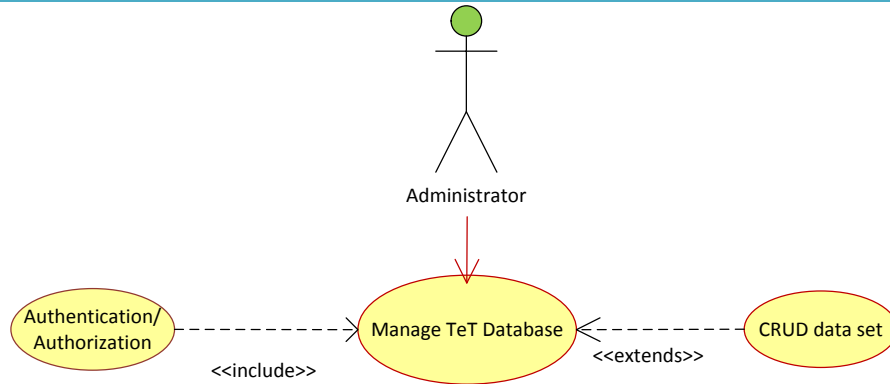
3.6 Data Provision

Use Case	Data Provision	Use Case Id	TeT-SR-UC-1												
Status:	<i>Proposed</i>	Version 1.0	Phase 1.0												
Author:	K.D. Missling	Created 04.05.2018	Modified												
Use Case Diagram	 <pre> graph TD Actor((Data Provider)) -- Upload Product --> UC1((Data Provision)) UC1 -- Create Data Set --> UC2((Manage TeT Database)) </pre>														
Description:	The system fetches products from data provider, creates a new Data Set in TeT Data Base.														
Related to:	<table border="1"> <thead> <tr> <th>Source</th> <th>Connector</th> <th>Target</th> </tr> </thead> <tbody> <tr> <td>New Product at data provision place</td> <td>UseCaseLink</td> <td>Data Provisison</td> </tr> <tr> <td>Data Provision</td> <td>Dependency</td> <td>Manage TeT Data Base</td> </tr> <tr> <td>Data Provision</td> <td>Realization</td> <td>TeT_SReq_006_0, TeT_SReq_0031_0, TeT_SReq_0032_0, TeT_SReq_0056_0, TeT_SReq_0058_0, TeT_SReq_0059_0, TeT_SReq_0060_0, TeT_SReq_0063_0, TeT_SReq_0064_0, TeT_SReq_0065_0, TeT_SReq_0066_0, TeT_SReq_0071_0, TeT_SReq_0074_0,</td> </tr> </tbody> </table>	Source	Connector	Target	New Product at data provision place	UseCaseLink	Data Provisison	Data Provision	Dependency	Manage TeT Data Base	Data Provision	Realization	TeT_SReq_006_0, TeT_SReq_0031_0, TeT_SReq_0032_0, TeT_SReq_0056_0, TeT_SReq_0058_0, TeT_SReq_0059_0, TeT_SReq_0060_0, TeT_SReq_0063_0, TeT_SReq_0064_0, TeT_SReq_0065_0, TeT_SReq_0066_0, TeT_SReq_0071_0, TeT_SReq_0074_0,		
Source	Connector	Target													
New Product at data provision place	UseCaseLink	Data Provisison													
Data Provision	Dependency	Manage TeT Data Base													
Data Provision	Realization	TeT_SReq_006_0, TeT_SReq_0031_0, TeT_SReq_0032_0, TeT_SReq_0056_0, TeT_SReq_0058_0, TeT_SReq_0059_0, TeT_SReq_0060_0, TeT_SReq_0063_0, TeT_SReq_0064_0, TeT_SReq_0065_0, TeT_SReq_0066_0, TeT_SReq_0071_0, TeT_SReq_0074_0,													



<i>Use Case</i>	<i>Data Provision</i>	<i>Use Case Id</i>	<i>TeT-SR-UC-1</i>
		TeT_SReq_0076_0	
Preconditions:	<i>Name</i>	<i>Description</i>	
	Product is available	Product at right place is accessible and readable	
Postconditions:	<i>Name</i>	<i>Description</i>	
	Product is ingested	Product is stored TeT Data Base	
Sub Use Cases:			

3.7 Manage TeT Data Base

Use Case	Manage TeT Data Base	Use Case Id	TeT-SR-UC-1
Status:	<i>Proposed</i>	Version 1.0	Phase 1.0
Author:	<i>K.D. Missling</i>	Created 04.05.2018	Modified
Use Case Diagram			
 <pre> graph TD Admin((Administrator)) --> ManageTeT((Manage TeT Database)) AuthAuth(Authentication/Authorization) -.-> <<include>> ManageTeT CRUDData(CRUD data set) -.-> <<extends>> ManageTeT </pre>			
Description:	The system allows the Administrator to set access right, maintain all TeT data sets and the Data base itself (e.g. backup etc.)		
Related to:	<i>Source</i>	<i>Connector</i>	<i>Target</i>
	Administrator	UseCaseLink	Manage Database
	Manage TeT Data Base	Dependency	Authentication/ Authorization
	CRUD data set	Realization	
	Maintaine TeT Data Base	Realization	TeT_SReq_008_0, TeT_SReq_0025_0, TeT_SReq_0026_0, TeT_SReq_0027_0, TeT_SReq_0028_0, TeT_SReq_0029_0, TeT_SReq_0030_0, TeT_SReq_0061_0, TeT_SReq_0062_0, TeT_SReq_0077_0, TeT_SReq_0078_0
Preconditions:	<i>Name</i>	<i>Description</i>	
	Database Availability	Database is accessible and readable	
	Access Authorization	Administrator has access rights	

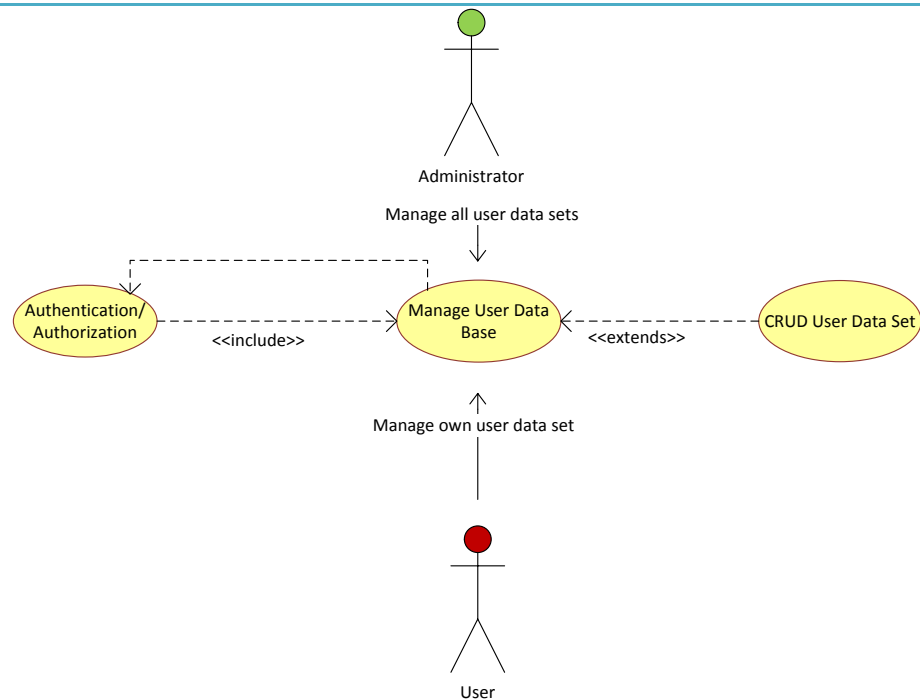


<i>Use Case</i>	<i>Manage TeT Data Base</i>	<i>Use Case Id</i>	<i>TeT-SR-UC-1</i>
Postconditions:	<i>Name</i>	<i>Description</i>	
	TeT Data Base	TeT Data base is maintained and well system up-to-date configured	
Sub Use Cases:			
CRUD data set		<i>Create, read, update, and delete data sets</i>	
Maintain TeT Data Base		<i>Carry out all measures to ensure that the TeT Data Base is fully operational</i>	

3.8 Manage User Data Base

Use Case	Manage User Data Base	Use Case Id	TeT-SR-UC-1
Status:	<i>Proposed</i>	Version 1.0	Phase 1.0
Author:	<i>K.D. Missling</i>	Created 04.05.2018	Modified

Use Case Diagram



Description: The system allows the user to create, read, update, and delete its own user data record.

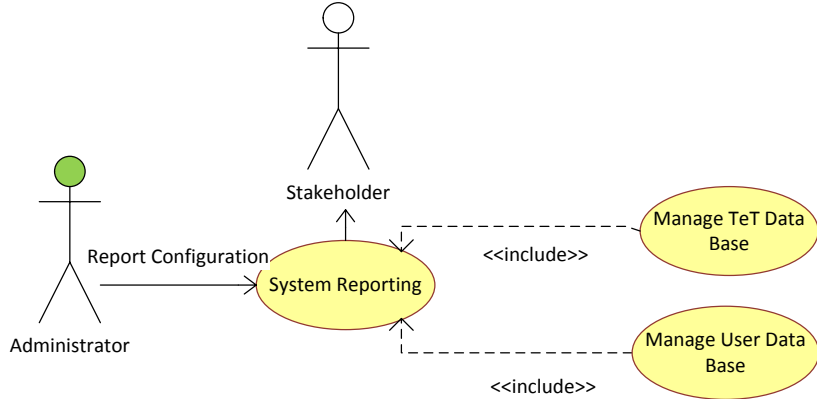
The system allows the administrator to update and delete user data records and to maintain the user data base (e.g. backup etc.).

Related to:	Source	Connector	Target
	Administrator	UseCaseLink	Manage Database
	User	UseCaseLink	Manage Database
	CRUD User Data Set	Dependency	Authentication/Authorization
	Maintain User data base	Realization	TeT_SReq_0043_0, TeT_SReq_0048_0, TeT_SReq_0052_0, TeT_SReq_0077_0, TeT_SReq_0078_0



<i>Use Case</i>	<i>Manage User Data Base</i>	<i>Use Case Id</i>	<i>TeT-SR-UC-1</i>
Preconditions:	<i>Name</i>	<i>Description</i>	
	User Database availability	Database is accessible and readable	
	User data Set availability	User data Set is accessible and readable	
	Access Authorization	Actor has access rights	
Postconditions:	<i>Name</i>	<i>Description</i>	
	User Data Base is up-to-date	User Data base is maintained and well configured	
Sub Use Cases:			
CRUD User Data Set			
Maintain User data base			

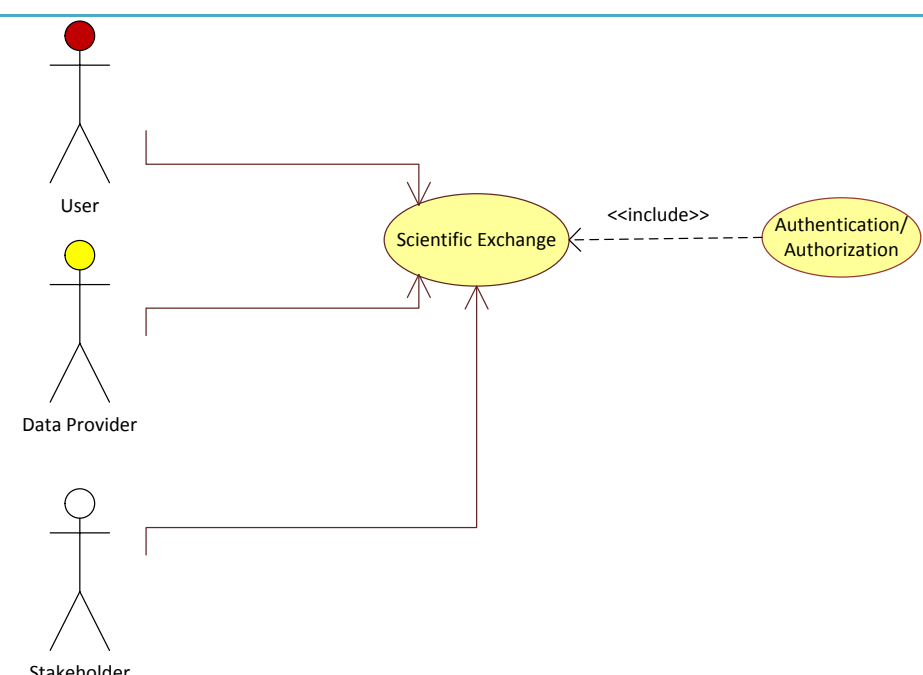
3.9 System Reporting

Use Case	Reporting	Use Case Id	TeT-SR-UC-1
Status:	<i>Proposed</i>	Version 1.0	Phase 1.0
Author:	<i>K.D. Missling</i>	Created 04.05.2018	Modified
Use Case Diagram			
			
Description:	The system allows the administrator to configure the system to generate system reports for stakeholder. The reports are generated when the triggering conditions occur (e.g. date, unavailability).		
Related to:	<i>Source</i>	<i>Connector</i>	<i>Target</i>
	Administrator	UseCaseLink	Reporting
	System Reporting	Dependency	Manage TeT Data Base
	System Reporting	Dependency	Manage User Data Base
	System Reporting	Realization	TeT_SReq_0033_0, TeT_SReq_0034_0, TeT_SReq_0035_0, TeT_SReq_0036_0, TeT_SReq_0037_0, TeT_SReq_0056_0, TeT_SReq_0058_0, TeT_SReq_0059_0, TeT_SReq_0060_0
Preconditions:	<i>Name</i>	<i>Description</i>	
	Databases are available	Databases are accessible and readable	
	Report Conditions	Conditions for Report Generation are met (e.g. date, unavailability)	



<i>Use Case</i>	<i>Reporting</i>	<i>Use Case Id</i>	<i>TeT-SR-UC-1</i>
	Access Authorization	Stakeholder has access rights	
Postconditions:	<i>Name</i>	<i>Description</i>	
	Report is provided	Report is stored on a pickup point/ pushed to Stakeholder	
Sub Use Cases:			
Configuration of Reporting			
Process Flow of a Report			

3.10 Scientific Exchange

Use Case	Scientific Exchange		Use Case Id	TeT-SR-UC-1
Status:	<i>Proposed</i>	Version 1.0	Phase	1.0
Author:	K.D. Missling	Created 04.05.2018	Modified	
Use Case Diagram				
Description:	The system allows the User, Data Provider and Stakeholder to discuss in an open platform (e.g. a forum)			
Related to:	<i>Source</i>	<i>Connector</i>	<i>Target</i>	
	Actors	UseCaseLink	Scientific Exchange	
	Discuss in Forum	Dependency	Authentication/ Authorization	
	Discuss in Forum	Realization	TBD	
Preconditions:	<i>Name</i>	<i>Description</i>		
	Access Authorization	Actor has access rights		
Postconditions:	<i>Name</i>	<i>Description</i>		
	n/a			
Sub Use Cases:				



<i>Use Case</i>	<i>Scientific Exchange</i>	<i>Use Case Id</i>	<i>TeT-SR-UC-1</i>
Authentication/ Authorization			

4 User requirements which have not been addressed

There are a number of user requirements, which have not been addressed by the system requirements. These requirements are listed below along with the reason, why they are not addressed.

ID	Name	Reason
TeT-PRD-1240.1	Ionosphere perturbation index	This product is not available in the TechTIDE consortium
TeT-PRF-2180.1	Timeliness: ionosphere perturbation index warnings	This product is not available in the TechTIDE consortium
TeT-SRV-0040.1	Geospace warning: TEC	This product is not available in the TechTIDE consortium
TeT-SRV-0050.1	Geospace warning: HF	This product is not available in the TechTIDE consortium
TeT-INT-3360.1	Dissemination means: smartphone app	The development is not feasible in TeT project.
TeT-INT-3370.1	Dissemination means: MF/HF/VHF communication	The development is not feasible in TeT project.
TeT-PRF-2170.1	Timeliness: ionosphere perturbation index	This product is not available in the TechTIDE consortium
TeT-PRF-2290.1	Spatial resolution: Ionosphere perturbation index	This product is not available in the TechTIDE consortium
TeT-PRF-2370.1	Temporal resolution: Ionosphere perturbation index	This product is not available in the TechTIDE consortium
TeT-PRF-2420.1	Minimum advance: Ionosphere perturbation index	This product is not available in the TechTIDE consortium
TeT-INT-3040.1	Website: graphical ionosphere perturbation index	This product is not available in the TechTIDE consortium
TeT-INT-3540.1	Archive: time range of ionosphere perturbation index images	This product is not available in the TechTIDE consortium
TeT-PRF-2460.1	POD: ionosphere perturbation index warnings	This product is not available in the TechTIDE consortium



TeT-PRF-2490.1	PFA: Ionosphere perturbation index warnings	This product is not available in the TechTIDE consortium
TeT-INT-3530.1	Archive: time range of Ionosphere perturbation index warnings	This product is not available in the TechTIDE consortium
TeT-PRF-2410.1	Minimum advance: TEC gradient forecast	This product is not available in the TechTIDE consortium
TeT-INT-3510.1	Archive: time range of TEC gradient forecast	This product is not available in the TechTIDE consortium
TeT-PRF-2380.1	Temporal resolution: ionosphere perturbation index forecast	This product is not available in the TechTIDE consortium
TeT-INT-3550.1	Archive: time range of Ionosphere perturbation index forecasts	This product is not available in the TechTIDE consortium
TeT-INT-3080.1	Website: geomagnetic activity	TBD
TeT-PRF-2400.1	Minimum advance: MSTID forecast	TBD
TeT-SRV-0030.1	Scope: TID warning	TBD
TeT-SRV-0060.1	Ionospheric conditions: background	TBD
TeT-SRV-0070.1	Ionospheric conditions: forecast	TBD
TeT-SRV-0080.1	Interhemispheric circulation	TBD

Appendix 1 List of Email/ Twitter alarms/ User Reports

Users' Requirements [REF-1]	Description	Comment	Priority
TeT-INT-3230.1	TID warning	final implementation phase	TBD
TeT-INT-3240.1	TID forecast	final implementation phase	TBD
TeT-INT-3260.1	product threshold warnings	final implementation phase	TBD
TeT-INT-3270.1	TEC gradient warning threshold	final implementation phase	TBD
TeT-INT-3280.1	TEC gradient warning area	final implementation phase	TBD
TeT-INT-3290.1	TID characteristics warnings	final implementation phase	TBD
TeT-INT-3300.1	impact on SNR HF warning	final implementation phase	TBD
TeT-INT-3310.1	SNR on HF warning	final implementation phase	TBD
TeT-INT-3320.1	path probability ratio on links warning	final implementation phase	TBD
TeT-INT-3330.1	positioning error warning	final implementation phase	TBD
TeT-INT-3340.1	operational effects warnings	final implementation phase	TBD

Appendix 2 Product Specification

This list currently only includes the intermediate products and is completed to **TBD**.

Product-ID	Product	Official product short title	Responsibility
TeT-001	HF-TID		BGD
TeT-002	HF interferometry TID characteristics	HFI TID characteristics	OE
TeT-003	HF interferometry de-trended ionospheric characteristics	HFI residuals	OE
TeT-004	HF interferometry spectral energy contribution to data variability	HFI SEC	OE
TeT-005	Spatial and temporal GNSS analysis		
TeT-006	GNSS TEC gradients	NRT TEC gradient map, Europe	DLR
TeT-007	1D ED distribution	1D-ED	NOA
TeT-008	3D-EDD maps	TBD	NOA
TeT-009	3D-EDD maps bottom side	TBD	NOA
TeT-010	3D-EDD maps topside	TBD	NOA
TeT-011	HTI	HTI plot over each digisonde station	FU
TeT-012	CDSS	CDSS FRF, Europe, South Africa	IAP
TeT-013	AATR		
TeT-014	foF2 maps	DIAS foF2 nowcasting maps	NOA
TeT-015	Maximum Usable Frequency	DIAS MUF nowcasting maps	NOA
TeT-016	Sunspot Number	DIAS SSN plots	NOA
TeT-017	TID activity metrics report		
TeT-018	Signal-to-Noise ratio on links		
TeT-019	Path probability ratio on links		
TeT-021	MSTID warnings		
TeT-022	TEC gradient warnings		



TeT-024	SNR on links warnings		
TeT-025	Path probability ratio on links warnings		
TeT-028	HTI post processing		
TeT-029	TEC maps	NRT TEC map, Europe	DLR (not an official TechTIDE product. To be provided indirectly)
TeT-030	TEC maps	NRT TEC map, global	DLR (not an official TechTIDE product. To be provided indirectly)
TeT-031	Juliusruh geomagnetic variations	NRT Juliusruh geomag var	L-IAP (TechTIDE secondary product)
TeT-032	Juliusruh geomagnetic K and Ak indices	NRT Juliusruh K, Ak	L-IAP (TechTIDE secondary product)

Product title	Near real-time TID Specification by Doppler-and-angular pulsed high-frequency sounding
Product ID	TeT-001
Related Requirement ID	TeT-PRD-1010.1 TeT-PRD-1020.1 TeT-PRF-2130.1 TeT-INT-3030.1
Product short title	HF-TID



Description	Full specification of TID wave parameters (amplitude, period, wavelength, propagation azimuth, and phase velocity) by detection and evaluation of quasi-periodic oscillations that the high-frequency (HF) sensor signal exhibits as it propagates the trans-ionospheric channel modulated by TIDs
Scope (TID detection/ background condition)	TID detection and evaluation
Spatial coverage	Nowcast: 33..55°N, 0..33°E in Europe, 22..34°S, 19..31°E in South Africa. Forecast capability TBD.
Temporal resolution/ Update rate	2.5 or 5 minutes
Spatial resolution	N/A; only single-site detections at sensor sites and mid-points of D2D oblique links
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	Measurement end to product: 2 minutes Product to forecast: < 4 hrs, TBD
Forecast/ Nowcast/ A Posteriori	Nowcast and forecast
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII, PNG
Archive/Time coverage	Project duration

Product title	HF interferometry TID characteristics
Product ID	TeT-002
Related Requirement ID	TeT-PRD-1030.1 TeT-PRD-1040.1 TeT-PRF-2140.1 TeT-INT-3030.1
Product short title	HFI TID characteristics
Description	The product provides the dominant period, amplitude and 2D vector velocity of detected TIDs. TID characterization is obtained by applying spectral analysis methods, allowing to estimate dominant



	<p>oscillation activity period. Using interferometry methods to multi-site records, the 2D TID vector velocity is estimated.</p> <p>Due to the geographical distribution of Digisonde sites within Europe and South Africa network (distant by about 1000 km from to each other), only identification LSTID is feasible</p>
Scope (TID detection/ background condition)	LSTID / De-trending of the ionospheric characteristics removing the main daily harmonics.
Spatial coverage	At ionospheric stations in the regions (37°N to 55°N, 2°W to 25°E) and (22°S to 35°S, 19°E to 31°E)
Temporal resolution/ Update rate	5 minutes
Spatial resolution	At ionospheric stations in the regions (37°N to 55°N, 2°W to 25°E) and (22°S to 35°S, 19°E to 31°E)
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	5 minutes
Forecast/ Nowcast/ A Posteriori	Nowcast
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII
Archive/Time coverage	Past 6 month (not at providers site)
Product title	HF interferometry de-trended ionospheric characteristics
Product ID	TeT-003
Related Requirement ID	TeT-PRD-1030.1 TeT-PRD-1040.1 TeT-PRF-2140.1
Product short title	HFI Residuals
Description	This product provides the ionospheric characteristics disturbance potentially associated to TID in the last 6 hours after



	removing the main daily harmonics based on a Fourier model for a 24h time interval.
Scope (TID detection/ background condition)	LSTID / De-trending of the ionospheric characteristics removing the main daily harmonics.
Spatial coverage	At ionospheric stations in the regions (37°N to 55°N, 2°W to 25°E) and (22°S to 35°S, 19°E to 31°E)
Temporal resolution/ Update rate	5 minutes
Spatial resolution	At ionospheric stations in the regions (37°N to 55°N, 2°W to 25°E) and (22°S to 35°S, 19°E to 31°E)
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	5 minutes
Forecast/ Nowcast/ A Posteriori	Nowcast
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII
Archive/Time coverage	Past 6 month (not at providers site)

Product title	HF interferometry spectral energy contribution to data variability
Product ID	TeT-004
Related Requirement ID	TeT-PRD-1030.1 TeT-PRD-1040.1 TeT-PRF-2140.1
Product short title	HFI SEC
Description	This products provides the Spectral Energy Contribution (SEC) of the periodic range of the LTIDs to the total energy which is equivalent to the contribution of the LTIDs to the total variability of the given time series. It is obtained by applying the Parseval's relation.
Scope (TID detection/ background condition)	LSTID / De-trending of the ionospheric characteristics removing the main daily



	harmonics.
Spatial coverage	At ionospheric stations in the regions (37°N to 55°N, 2°W to 25°E) and (22°S to 35°S, 19°E to 31°E)
Temporal resolution/ Update rate	5 minutes
Spatial resolution	At ionospheric stations in the regions (37°N to 55°N, 2°W to 25°E) and (22°S to 35°S, 19°E to 31°E)
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	5 minutes
Forecast/ Nowcast/ A Posteriori	Nowcast
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII
Archive/Time coverage	Past 6 month (not at providers site)

Product title	Spatial and temporal GNSS analysis
Product ID	TeT-005
Related Requirement ID	TeT-PRD-1050.1 TeT-PRD-1060.1
Product short title	
Description	
Scope (TID detection/ background condition)	
Spatial coverage	
Temporal resolution/ Update rate	
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	
Forecast/ Nowcast/ A Posteriori	
Delivery format(s) (ASCII, JSON, PNG, etc.)	
Archive/Time coverage	



Product title	Near real-time TEC spatial gradient map for Europe
Product ID	TeT-006
Related Requirement ID	TeT-PRD-1070.1 TeT-PRD-1080.1 TeT-PRF-2110.1 TeT-PRF-2120.1 TeT-PRF-2270.1 TeT-PRF-2280.1 TeT-PRF-2360.1 TeT-INT-3050.1 TeT-INT-3500.1
Product short title	NRT TEC gradient map, Europe
Description	TEC gradients are derived from TEC maps. Latitudinal and longitudinal differences between the grid cells are the basis for the computation. The computed TEC gradient (TECU/degree) is converted into mm/km.
Scope (TID detection/ background condition)	Ionosphere background condition
Spatial coverage	30°W to 50°E and 30°N to 72°N
Temporal resolution/ Update rate	15 minutes
Spatial resolution	1 degree x 1 degree
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	5 minutes
Forecast/ Nowcast/ A Posteriori	Nowcast
Delivery format(s) (ASCII, JSON, PNG, etc.)	JSON, PNG, XML
Archive/Time coverage	past 6 month

Product title	1D ED distribution
Product ID	TeT-007
Related Requirement ID	
Product short title	1D-ED
Description	The electron density (ED) distribution is the reconstructed ED calculated with the TaD model over any Digisonde location. The input data to the model is the bottomside



	ionospheric characteristics and the TEC parameter calculated from a GNSS receiver co-located with the Digisonde or extracted from a TEC map. The output data is the electron density distribution from 90 to 20,000 km at 5 km step.
Scope (TID detection/ background condition)	This is the raw output from the TaD model and can be used as in input to scientific models requiring the ED at various heights for the evaluation of the ionospheric perturbations in the bottomside and topside ionosphere.
Spatial coverage	Global (can be applied in any Digisonde)
Temporal resolution/ Update rate	The temporal resolution follows the resolution of the Digisonde measurements.
Spatial resolution	The model can work at any Digisonde location.
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	5 min.
Forecast/ Nowcast/ A Posteriori	Nowcast and a posteriori.
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII
Archive/Time coverage	The results will be archived from September 2018 onwards.

Product title	3D-EDD maps
Product ID	TeT-008
Related Requirement ID	TeT-PRD-1090.1 TeT-PRF-2150.1
Product short title	3D-EDD maps
Description	
Scope (TID detection/ background condition)	
Spatial coverage	
Temporal resolution/ Update rate	
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	
Forecast/ Nowcast/ A Posteriori	
Delivery format(s) (ASCII, JSON, PNG, etc.)	



Archive/Time coverage	
Product title	3D-EDD maps bottomside
Product ID	TeT-009
Related Requirement ID	TeT-PRD-1100.1
Product short title	3D-EDD maps bottomside
Description	
Scope (TID detection/ background condition)	
Spatial coverage	
Temporal resolution/ Update rate	
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	
Forecast/ Nowcast/ A Posteriori	
Delivery format(s) (ASCII, JSON, PNG, etc.)	
Archive/Time coverage	
Product title	
3D-EDD maps topside	
Product ID	TeT-010
Related Requirement ID	TeT-PRD-1110.1
Product short title	3D-EDD maps topside
Description	
Scope (TID detection/ background condition)	
Spatial coverage	
Temporal resolution/ Update rate	
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	
Forecast/ Nowcast/ A Posteriori	
Delivery format(s) (ASCII, JSON, PNG, etc.)	
Archive/Time coverage	
Product title	
HTI plot over each digisonde station	
Product ID	TeT-011



Related Requirement ID	TeT-PRD-1120.1 TeT-PRD-1130.1
Product short title	HTI plot
Description	HTI plots over each digisonde station will be derived by focusing on a specific frequency range on ionograms related to the F-region.
Scope (TID detection/ background condition)	TID detection
Spatial coverage	2°W to 55°E and 37°N to 55°N
Temporal resolution/ Update rate	15 minutes
Spatial resolution	Over each digisonde station
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	15 minutes (depends on ionogram delivery from individual stations).
Forecast/ Nowcast/ A Posteriori	A Posteriori
Delivery format(s) (ASCII, JSON, PNG, etc.)	PNG
Archive/Time coverage	past 6 month

Product title	CDSS spectrograms of fixed radio frequencies, Europe, South Africa
Product ID	TeT-012
Related Requirement ID	TeT-PRD-1140.1 TeT-PRD-1150.1 TeT-PRF-2160.1
Product short title	CDSS FRF Europe, South Africa
Description	Spectrograms, wave periods, amplitudes and phase velocities obtained from continuous Doppler shift measurements of the fixed radio frequencies in Central Europe and South Africa.
Scope (TID detection/ background condition)	Ionospheric background conditions



Spatial coverage	49°N to 50.38 N; 12.22°E to 14.34°E (Europe) 33.39°S to 34.38°S; 18.28°E to 20.13°E (South Africa)
Temporal resolution/ Update rate	1 minute
Spatial resolution	0.5 x 0.5 degree
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	10 minutes
Forecast/ Nowcast/ A Posteriori	Nowcast
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII, PNG, XML
Archive/Time coverage	past 6 month

Product title	AATR
Product ID	TeT-013
Related Requirement ID	TeT-PRD-1160.1 TeT-PRD-1170.1
Product short title	
Description	
Scope (TID detection/ background condition)	
Spatial coverage	
Temporal resolution/ Update rate	
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	
Forecast/ Nowcast/ A Posteriori	
Delivery format(s) (ASCII, JSON, PNG, etc.)	
Archive/Time coverage	

Product title	DIAS foF2 nowcasting maps
Product ID	TeT-014
Related Requirement ID	TeT-PRD-1180.1
Product short title	foF2 maps
Description	The foF2 maps are generated for the



	European region applying the SIRMUP model to the real-time foF2 characteristics measured by the European Digisondes participating in the DIAS network.
Scope (TID detection/ background condition)	The foF2 nowcasting maps allow the user to evaluate current ionospheric large-scale disturbances.
Spatial coverage	European region, Latitude from 34 to 60 deg N, longitude from -5 deg W to 40 deg E
Temporal resolution/ Update rate	15 min
Spatial resolution	1x1 degree
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	5 min.
Forecast/ Nowcast/ A Posteriori	Nowcast and a posteriori.
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII and PNG
Archive/Time coverage	Since 2007.

Product title	Maximum Usable Frequency nowcasting maps
Product ID	TeT-015
Related Requirement ID	TeT-PRD-1190.1
Product short title	DIAS MUF maps
Description	The MUF maps are generated based on the calculation of the ionospheric characteristics foF2 and M(3000)F2 applying the SIRMP and Lockwood formulas. The MUF is calculated for predefined transmission points.
Scope (TID detection/ background condition)	The foF2 nowcasting maps allow the user to evaluate current ionospheric large-scale disturbances.
Spatial coverage	European region, Latitude from 34 to 60 deg N, longitude from -5 deg W to 40 deg E
Temporal resolution/ Update rate	1 hr
Spatial resolution	1x1 deg.
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	10 min.
Forecast/ Nowcast/ A Posteriori	Nowcast
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII and PNG



Archive/Time coverage	No archive is currently available.
Product title	DIAS SSN plots
Product ID	TeT-016
Related Requirement ID	TeT-PRD-1200.1
Product short title	Solar sunspot number
Description	DIAS SSN plots provide the effective sunspot number together with the observed sunspot number. The plot corresponds to one day of calculations and is dynamically updated every 15 min. The DIAS SSN is a model-oriented index that corresponds to respective sunspot number for the given large-scale ionospheric disturbances. The current ionospheric conditions are estimated based on the foF2 parameter from all the Digisondes participating in DIAS network.
Scope (TID detection/ background condition)	The DIAS SSN plots allow the user to evaluate current ionospheric large-scale disturbances.
Spatial coverage	European region, Latitude from 34 to 60 deg N, longitude from -5 deg W to 40 deg E
Temporal resolution/ Update rate	15 min
Spatial resolution	N/A.
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	5 min.
Forecast/ Nowcast/ A Posteriori	Nowcast
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII and PNG
Archive/Time coverage	No archive is currently available
Product title	TID activity metrics report
Product ID	TeT-017
Related Requirement ID	TeT-PRD-1210.1 TeT-INT-3400.1 TeT-INT-3410.1
Product short title	TID activity metrics report
Description	Report about the TID activity in a certain period of time (initially 1 year)



Scope (TID detection/ background condition)	TeT products
Spatial coverage	global
Temporal resolution/ Update rate	1 year
Spatial resolution	n.a.
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	1 month
Forecast/ Nowcast/ A Posteriori	A posteriori
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII
Archive/Time coverage	From the first generated to the most recent.

Product title	Signal-to-Noise ratio on links
Product ID	TeT-018
Related Requirement ID	TeT-PRD-1220.1
Product short title	
Description	
Scope (TID detection/ background condition)	
Spatial coverage	
Temporal resolution/ Update rate	
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	
Forecast/ Nowcast/ A Posteriori	
Delivery format(s) (ASCII, JSON, PNG, etc.)	
Archive/Time coverage	

Product title	Path probability ratio on links
Product ID	TeT-019
Related Requirement ID	TeT-PRD-1230.1
Product short title	
Description	
Scope (TID detection/ background condition)	
Spatial coverage	
Temporal resolution/ Update rate	
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In	



case of forecasts: time between product delivery and forecasted time)

Forecast/ Nowcast/ A Posteriori

Delivery format(s) (ASCII, JSON, PNG, etc.)

Archive/Time coverage

Product title	MSTID warnings
Product ID	TeT-021
Related Requirement ID	TeT-PRF-2100.1 TeT-PRF-2440.1 TeT-PRF-2470.1 TeT-INT-3470.1

Product short title	
Description	
Scope (TID detection/ background condition)	
Spatial coverage	
Temporal resolution/ Update rate	
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	
Forecast/ Nowcast/ A Posteriori	
Delivery format(s) (ASCII, JSON, PNG, etc.)	
Archive/Time coverage	

Product title	TEC gradient warnings
Product ID	TeT-022
Related Requirement ID	TeT-PRF-2120.1 TeT-PRF-2450.1 TeT-PRF-2480.1 TeT-INT-3520.1 TeT-INT-3270.1 TeT-INT-3280.1
Product short title	TEC gradient warnings
Description	A warning will be issued in case TEC gradients exceed a certain threshold
Scope (TID detection/ background condition)	TEC spatial gradients
Spatial coverage	Europe
Temporal resolution/ Update rate	n.a.
Spatial resolution	n.a.



Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	5 minutes
Forecast/ Nowcast/ A Posteriori	alarm
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII
Archive/Time coverage	From the first to the most recent.

Product title	SNR on links warnings
Product ID	TeT-024
Related Requirement ID	TeT-PRF-2190.1
Product short title	
Description	
Scope (TID detection/ background condition)	
Spatial coverage	
Temporal resolution/ Update rate	
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	
Forecast/ Nowcast/ A Posteriori	
Delivery format(s) (ASCII, JSON, PNG, etc.)	
Archive/Time coverage	

Product title	Path probability ratio on links warnings
Product ID	TeT-025
Related Requirement ID	TeT-PRF-2200.1 TeT-INT-3320.1
Product short title	
Description	
Scope (TID detection/ background condition)	
Spatial coverage	
Temporal resolution/ Update rate	
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	
Forecast/ Nowcast/ A Posteriori	
Delivery format(s) (ASCII, JSON, PNG, etc.)	



Archive/Time coverage	
Product title	HTI post processing
Product ID	TeT-028
Related Requirement ID	TeT-PRF-2430.1
Product short title	
Description	
Scope (TID detection/ background condition)	
Spatial coverage	
Temporal resolution/ Update rate	
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	
Forecast/ Nowcast/ A Posteriori	
Delivery format(s) (ASCII, JSON, PNG, etc.)	
Archive/Time coverage	
Product title	Near real-time Total Electron Content map for Europe
Product ID	TeT-029
Related Requirement ID	TeT-INT-3430.1 TeT-SRV-0150.1 TeT-SRV-0160.1 TeT-PRF-2300.1 TeT-PRF-2390.1
Product short title	NRT TEC map, Europe
Description	Total Electron Content (TEC) is derived from dual frequency GNSS measurements provided by several GNSS reference networks like IGS, EUREF and ASI. The TEC data is assimilated into the Neustrelitz TEC Model (NTCM).
Scope (TID detection/ background condition)	Ionosphere background condition



Spatial coverage	30°W to 50°E and 30°N to 72°N
Temporal resolution/ Update rate	15 minutes
Spatial resolution	1 degree x 1 degree
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	5 minutes
Forecast/ Nowcast/ A Posteriori	Nowcast
Delivery format(s) (ASCII, JSON, PNG, etc.)	JSON, PNG, XML
Archive/Time coverage	past 6 month

Product title	Near real-time global Total Electron Content map
Product ID	TeT-030
Related Requirement ID	TeT-INT-3430.1 TeT-SRV-0150.1 TeT-SRV-0160.1 TeT-PRF-2300.1 TeT-PRF-2390.1
Product short title	NRT TEC map, global
Description	Total Electron Content (TEC) is derived from dual frequency GNSS measurements provided by several GNSS reference networks like IGS, EUREF and ASI. The TEC data is assimilated into the Neustrelitz TEC Model (NTCM).
Scope (TID detection/ background condition)	Ionosphere background condition
Spatial coverage	global
Temporal resolution/ Update rate	15 minutes
Spatial resolution	2.5 degree x 5 degree in latitude and longitudes
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product	5 minutes

delivery and forecasted time)	
Forecast/ Nowcast/ A Posteriori	Nowcast
Delivery format(s) (ASCII, JSON, PNG, etc.)	JSON, PNG, XML
Archive/Time coverage	past 6 month

Product title	Juliusruh geomagnetic variations
Product ID	TeT-031
Related Requirement ID	
Product short title	NRT Juliusruh geomag var
Description	Juliusruh 1-minute uncalibrated geomagnetic variations X, Y, Z
Scope (TID detection/ background condition)	Geomagnetic background condition
Spatial coverage	Juliusruh (54.629998N, 13.374455E) local
Temporal resolution/ Update rate	1 minute / 15 minutes
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	~2 minutes cadence after a quarter hour interval
Forecast/ Nowcast/ A Posteriori	Nowcast
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII/TXT
Archive/Time coverage	Most recent day data

Product title	Juliusruh geomagnetic K and Ak indices
Product ID	TeT-032
Related Requirement ID	TeT-INT-3080.1
Product short title	NRT Juliusruh K, Ak
Description	Juliusruh K, Ak-Indices from 1-minute uncalibrated geomagnetic variations (X, Y) Processed according to the official Finnish routine (Source: FMI-method for computer K index evaluation, C language version, Lasse Hakkinen, Finnish Meteorological Institute - Department of Geophysics, P.O.Box 503 FIN-00101 Helsinki/Finland) 3 hour K indices and daily Ak index Latest K is 3 hour running K



	Latest Ak is 24 hour running Ak
Scope (TID detection/ background condition)	Geomagnetic background condition
Spatial coverage	Juliusruh (54.629998N, 13.374455E) local
Temporal resolution/ Update rate	15 minute / 15 minutes
Spatial resolution	
Timeliness (Time between end of Measurements and product delivery. In case of forecasts: time between product delivery and forecasted time)	~2 minutes cadence after a quarter hour interval
Forecast/ Nowcast/ A Posteriori	Nowcast
Delivery format(s) (ASCII, JSON, PNG, etc.)	ASCII/TXT
Archive/Time coverage	Latest 28 days



Appendix 3 UR2SR Matrix

Attached to this document