1st EUSST Webinar

SST Cooperation

27 November 2019

Agenda

- 10:30-10:40 Welcome to the 1st EUSST Webinar
- 10:40-11:00 EU SST Support Framework
- 11:00-12:00 SST Services and EUSST Portal
- 12:00-12:20 Questions and Answers
- 12:20-12:30 Conclusions and Closure

Speakers

Mrs Amélie Gravier
EUSST Consortium

Mr Paulo Nunes
EUSST Front Desk

Ms Cristina Pérez
Spanish SST Operational Centre
Expert on CA service

Dr Elena Vellutini
Expert on RE and FG services

Mr Florian Delmas
French SST Operational Centre
Expert on CA service

2nd Lt Moreno Peroni
Italian SST Operations Centre
Expert on RE and FG services

EU SST Support Framework

The foundation

Decision 541/2014/EU for an SST Support Framework

Decision of the European Parliament and of the Council of 16 April 2014 establishing a Framework for Space Surveillance and Tracking Support

« Ensuring the long-term availability of European and national space infrastructure, facilities and services which are essential for the safety and security of the economies, societies and citizens in Europe » (article 3)

With the aim to (article 4):

« Establish a SST capability at European level and with an **appropriate level of autonomy** » :

(a) The establishment and operation of a **sensor function** consisting of a network of Member State ground-based and/or space-based sensors, including national sensors developed through ESA, to survey and track space objects and to produce a database thereof;

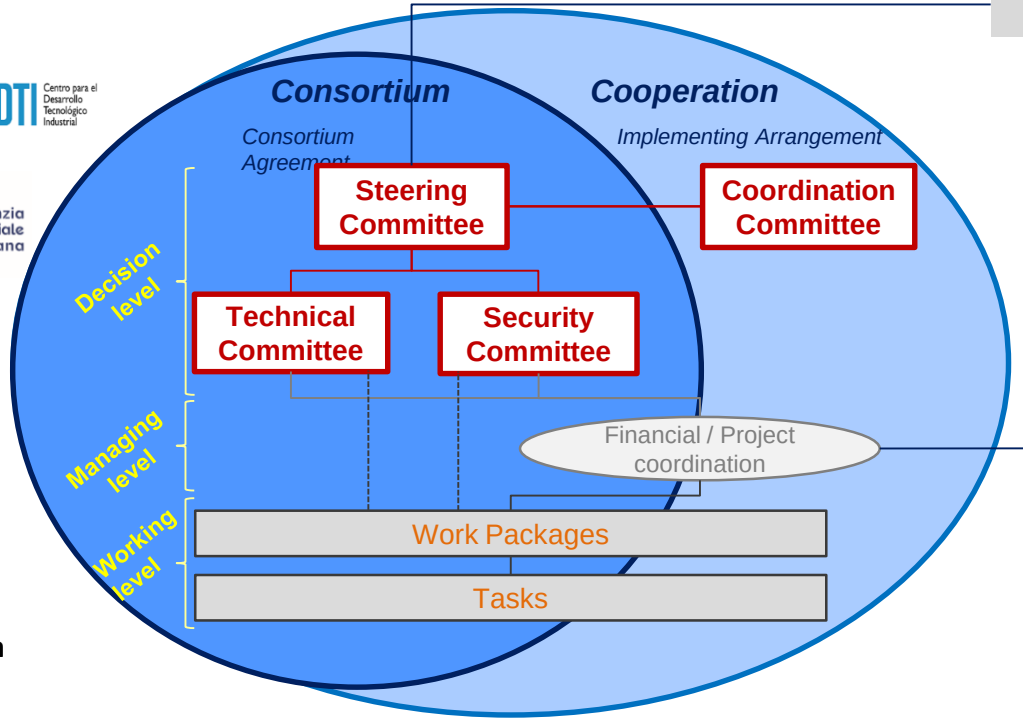
(b) The establishment and operation of a **processing function** to process and analyse the SST data at national level to produce SST information and services for transmission to the SST service provision function;

(c) The setting up of a function to provide **SST services** as defined in Article 5(1) to the entities referred to in Article 5(2).

Governance of the Consortium

State of play

- National Designated Entities from 8 MS are composing the **EU SST Consortium**



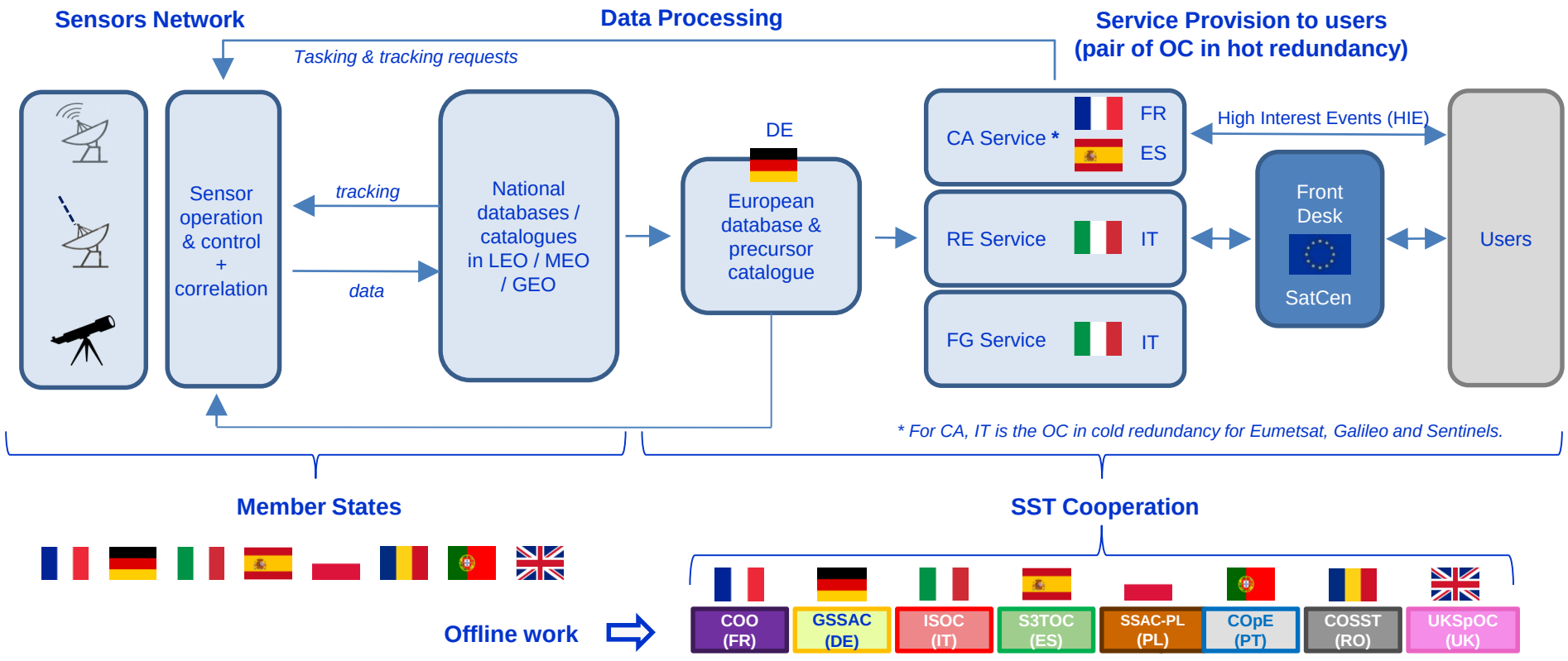
European Commission
DG GROW

28 Member States
SST Committee
SST Expert Group
SST User Forum

COM REA

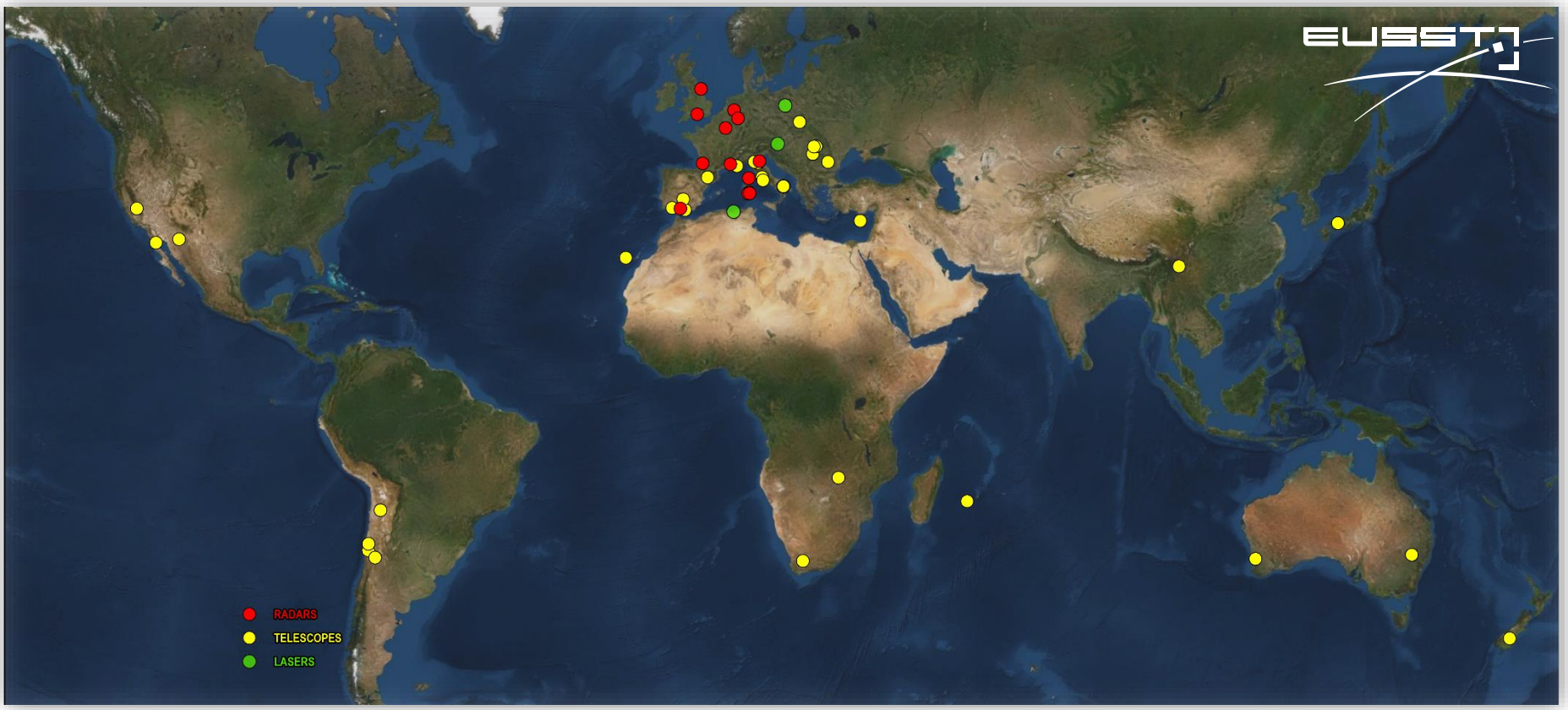
- EU SST Consortium + EU SatCen are composing the **SST Cooperation**

Service Provision Model



Sensor Network

Network of sensors composed of 35 telescopes, 12 radars and 4 lasers

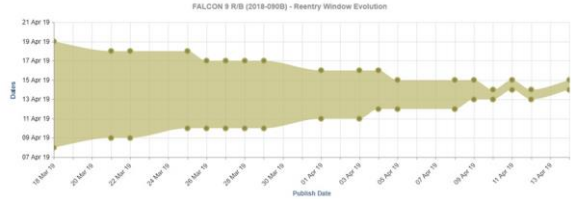


(In operation as of 1st April 2019)

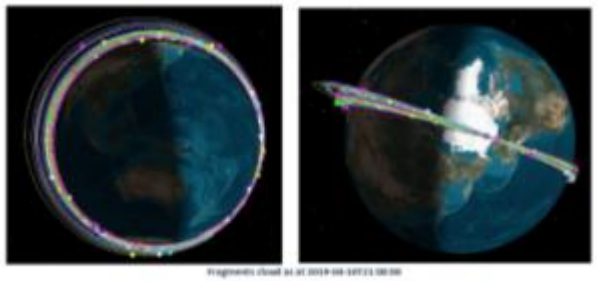
Service Provision to Users
SST Services

- **Collision Avoidance**. It provides the **risk assessment of collision** between spacecraft or between spacecraft and space debris and the generation of collision avoidance products.

- **Re-entry Analysis.** It provides the **risk assessment of the uncontrolled re-entry of man-made space objects** and space debris into the Earth's atmosphere and the generation of related information.



- Fragmentation Analysis. It provides the **detection and characterization of in-orbit fragmentations**, break-ups or collisions;



SST Services are described in the Service Portfolio available on the EUSST Portal

Service Provision to Users
EUSST Front Desk

SST Consortium

Responsible for generating the SST services and their information

SST Front Desk

Interface for the delivery of the SST services in accordance with the Data and Information Policy

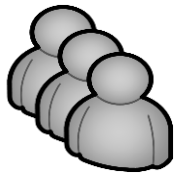
SatCen

User Coordination
User approval and uptake

EUSST Service Provision Portal for the delivery of the SST information and services and a **EUSST Helpdesk** to support users

https://sst.satcen.europa.eu

SST Users



SST services to be provided to:

- All Member States
- the Council
- the Commission
- the EEAS
- public and private spacecraft owners and operators
- public authorities concerned with civil protection.

106 user accounts
(60 organizations)
129 Satellites registered for CA

SST Users
Organisations

Non-exhaustive list of organisations
As of end of September-2019

SST Users

Users vs Organisations

106 USERS | **60** ORGS

18 EU MS

Collision Avoidance

45 USERS | **22** ORGS

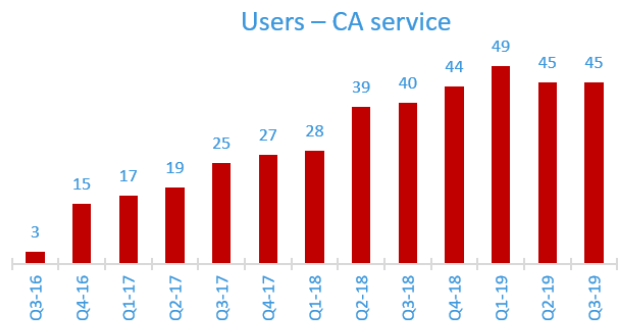
129 satellites

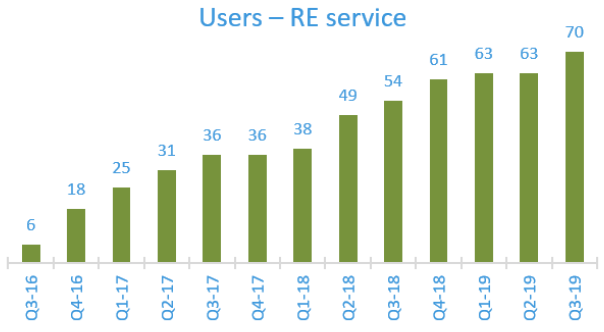
Re-entry Analysis

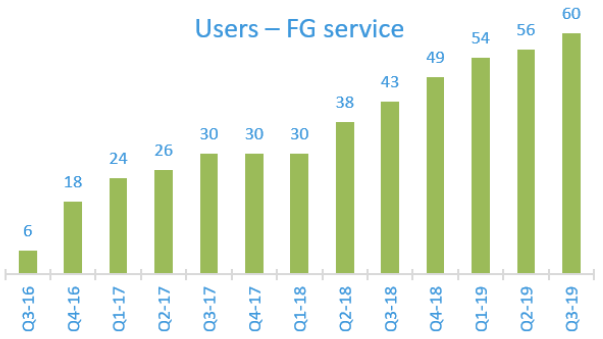
70 USERS | **46** ORGS

Fragmentation Analysis

60 USERS | **39** ORGS



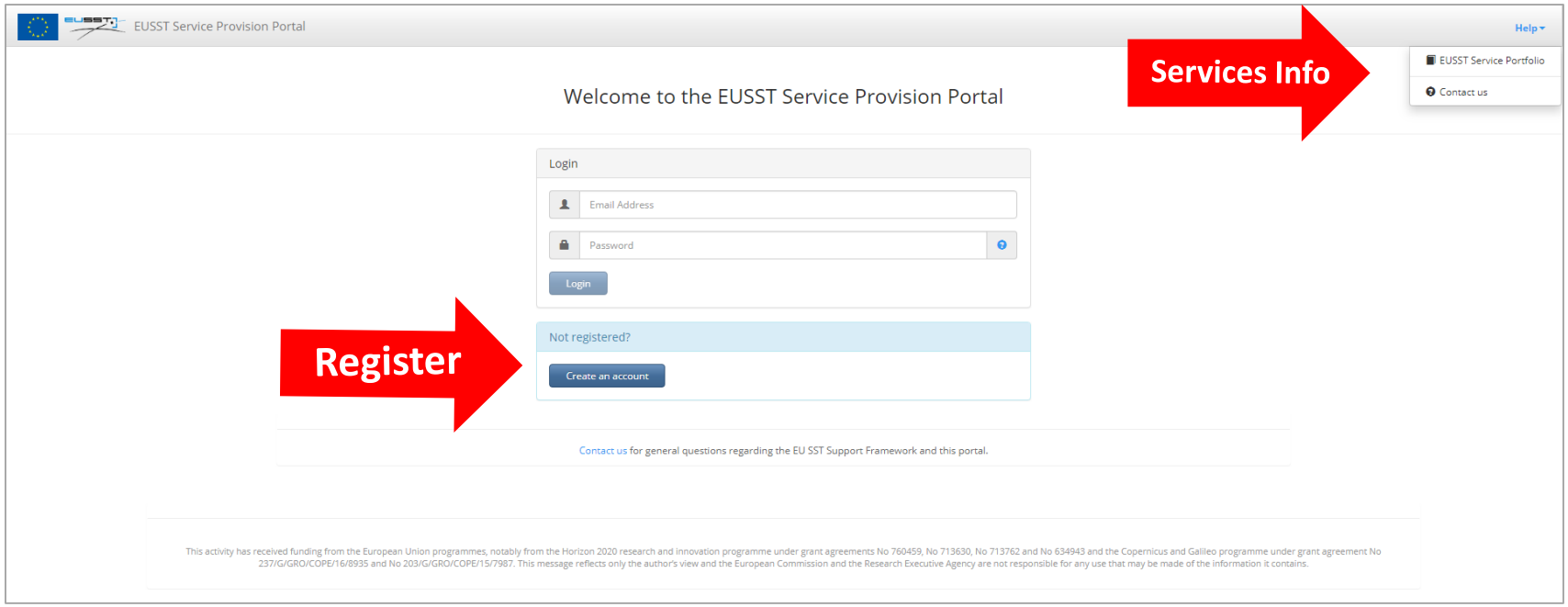




*Metrics as of end of September-2019. In Q2, Q3-19 the decrease of users is due to one organization requesting to merge several associated user accounts (10 accounts have been transformed into 2).

Users Registration

Potential users entitled to receive SST services can request access through the EUSST Portal at sst.satcen.europa.eu



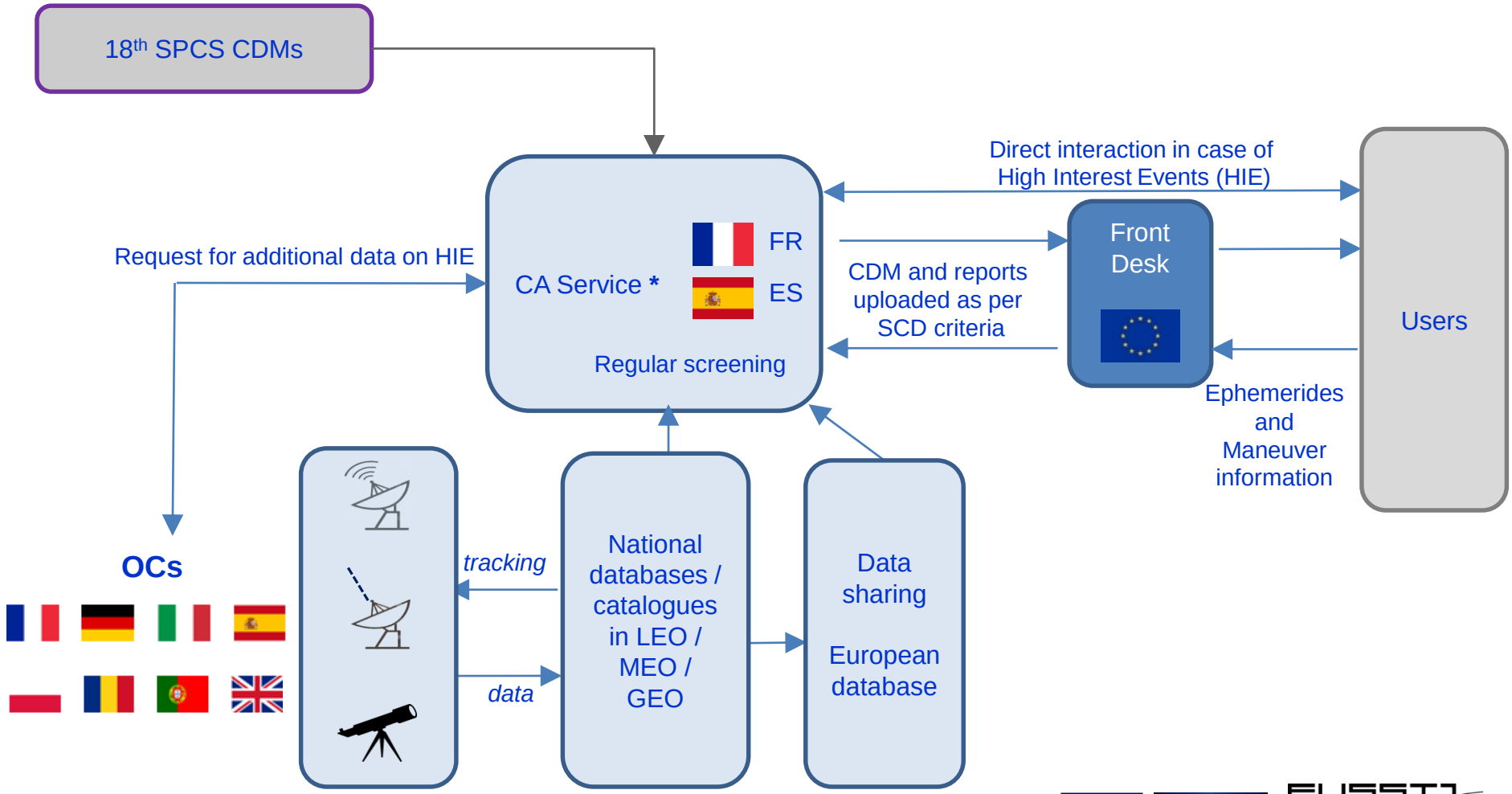
Collision Avoidance Service

Collision Avoidance
Service Description

The Collision Avoidance Service:

- provides the **risk assessment of collision** between spacecraft or between spacecraft and space debris and the generation of collision avoidance products.
- consists on processing all available information, concluding with the provision of products derived from the detection and analysis of:
  - **High Interest Event (HIE),** close approach that require a further analysis and which might request a mitigation manoeuvre due to its high level of risk (severity ALERT).
  - **Interest Event (IE),** close approach that require a further analysis due to its level of risk (severity WARNING).
  - **Info Event (INFO),** close approach with a low level of risk (severity INFO).
- Events are categorised according the criteria defined with users and reflected in the **Service Configuration Document (SCD)**.

CA Service Provision Mechanism (I)



CA Service
Provision Mechanism (II)

- Provision mechanism based on hot redundancy concept:
  - provided by a pair of Operational Centres (OCs) with nominal (single point of contact for users) and hot redundant roles;
  - service provided through the EUSST Service Provision Portal.
- Exceptionally, a cold redundant OC can be part of the provision mechanism allowing it visibility through the entire CA process.
- All OCs cooperate, in particular for HIE with data from sensors contributing to the EUSST.

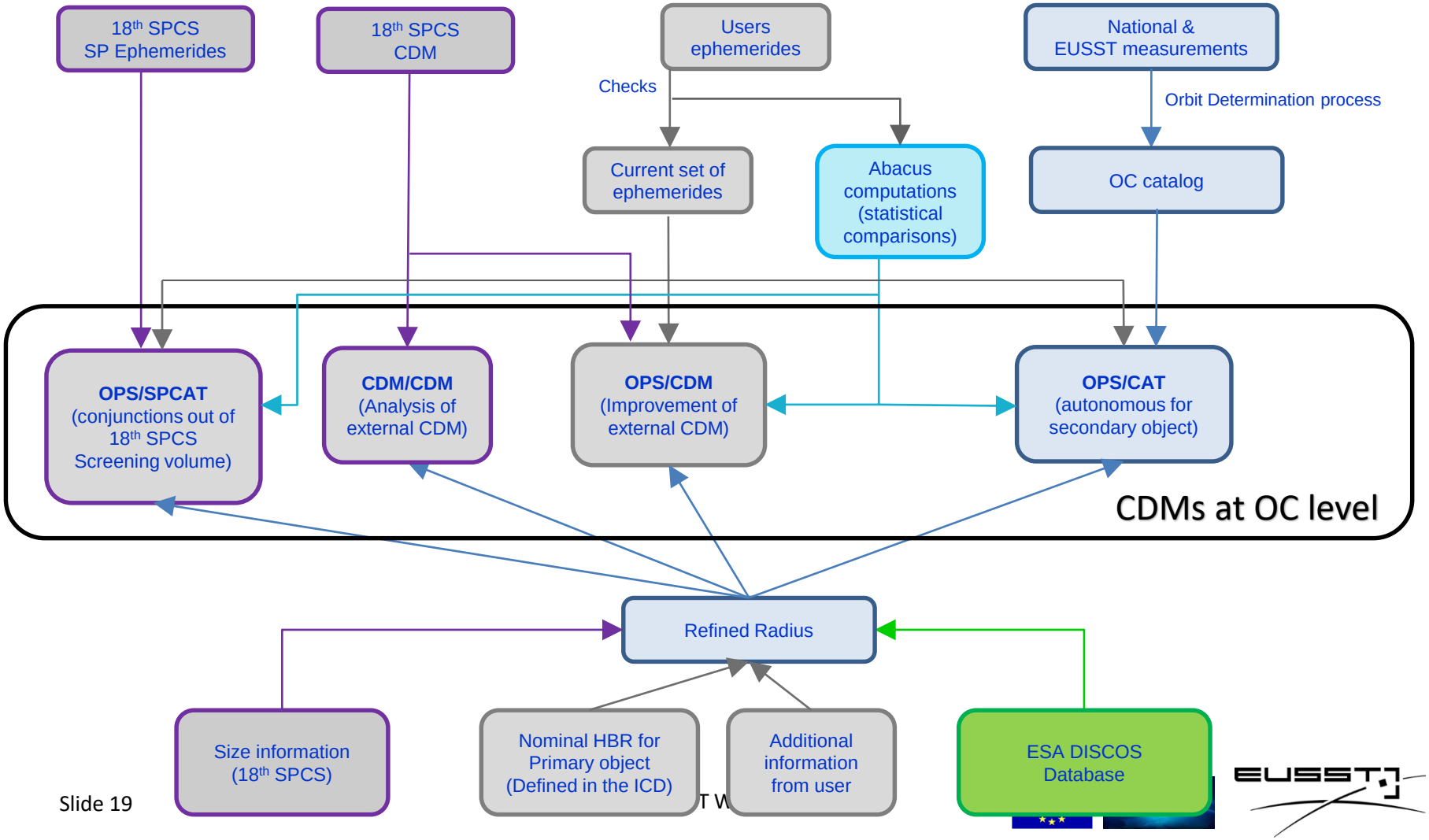
Collision Avoidance
Service provision pre-requisites

- To start the provision of CA service, the following steps are required:
  - Service Configuration Document definition and agreement (bilateral meeting between EUSST and users);
  - Ephemerides upload to EUSST Portal by users;
  - OCs access to 18th SPCS CDMs granted by users;

	MISS DISTANCE (m)		RADIAL DISTANCE (m)		Scaled POC		Time to TCA (days)	
CONSTELLATION	**WARNING**	**ALERT**	**WARNING**	**ALERT**	**WARNING**	**ALERT**	**WARNING**	**ALERT**
SAMPLESAT LEO	2000	200	200	50	1.00E-05	2.20E-05	7	5
SAMPLESAT GEO	5000	1000	1000	500	1.00E-06	-	7	7
SAMPLESAT MEO	10000	4000	-	-	1.00E-09	1.00E-08	14	14

Example of SCD

Collision Avoidance
Data Sources

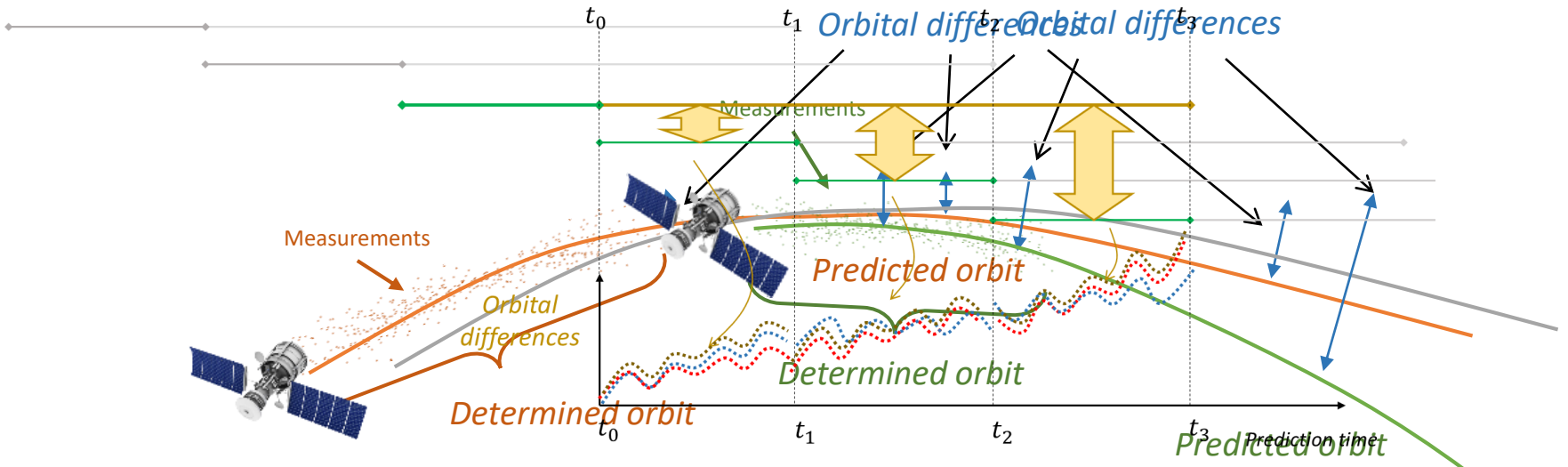


Collision Avoidance
EUSST Products

- The content of the EUSST products includes:
  - Event and product identification, including severity level (e.g. ALERT)
  - Product creation date;
  - Time of Closest Approach (TCA) of the event;
  - Source of information used for the products;
  - Event characterization:
    - Miss distance;
    - Probability of Collision (PoC) including method;
    - Evolution of the conjunction geometry and of the Probability of Collision (B-plane plots and time evolution plots);
    - Probability of Collision sensitivity analysis.
  - Mitigation manoeuvres support.
- Content is provided to the users in the following formats:
  - CDM (standard to exchange CA information)
  - CA Report (associated to each CDM file).

Collision Avoidance
Covariance Abacus

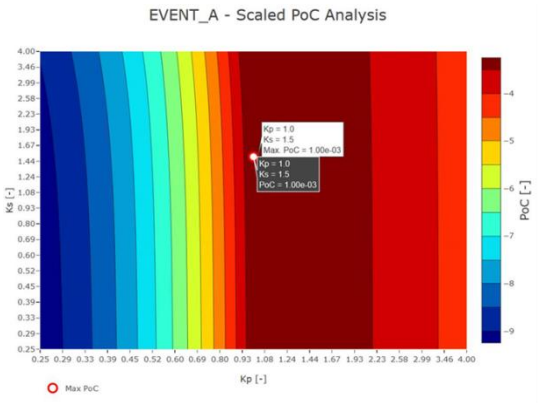
- Covariance Abacus generation
  - Statistical comparison between predicted and determined (observed) orbit
  - Reference covariance for probability computation
  - Outliers detection

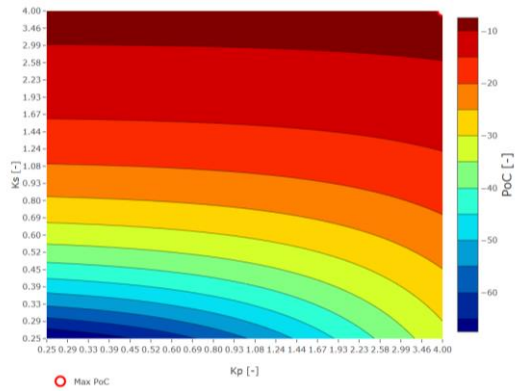


Collision Avoidance
PoC sensitivity analysis

Probability of Collision (PoC) sensitivity analysis:

- Use of covariance abacus for PoC calculations
- Use of configurable Hard Body Radius (HBR) for PoC calculations
- PoC sensitivity analysis: Use of Scaled PoC
- Scaled PoC used as baseline PoC to trigger threshold-based alerts

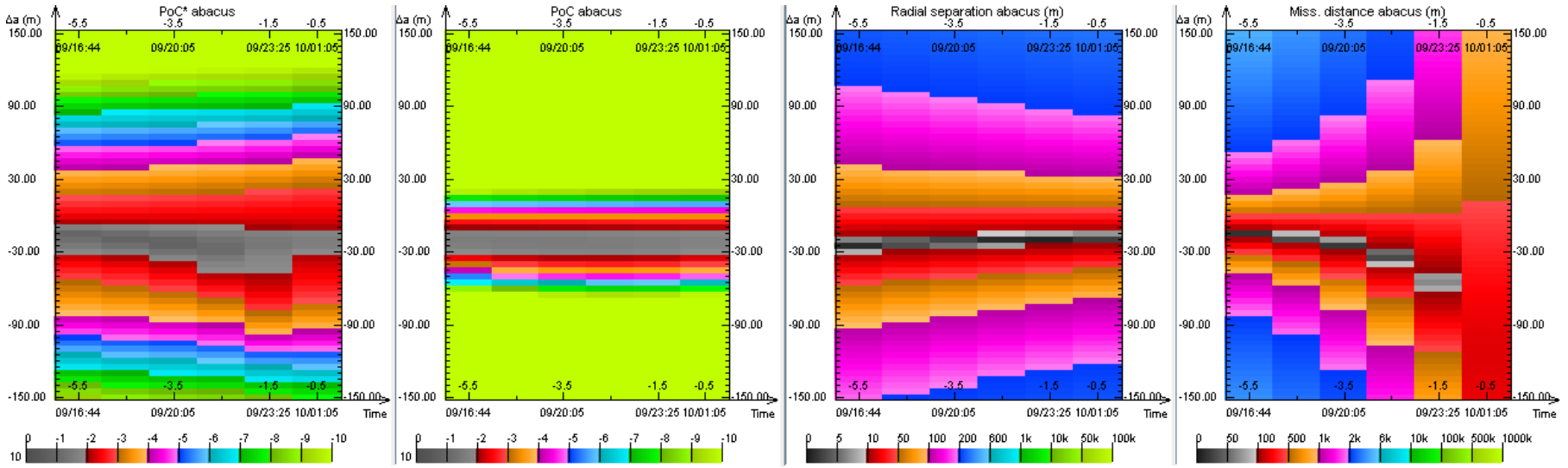




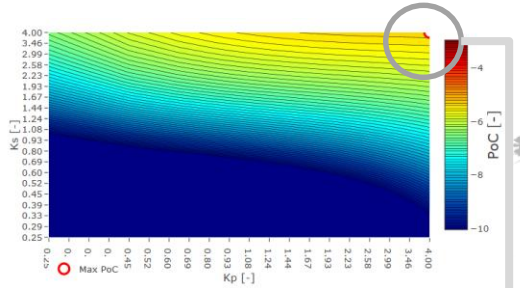
Collision Avoidance

Mitigation recommendation and manoeuvre support

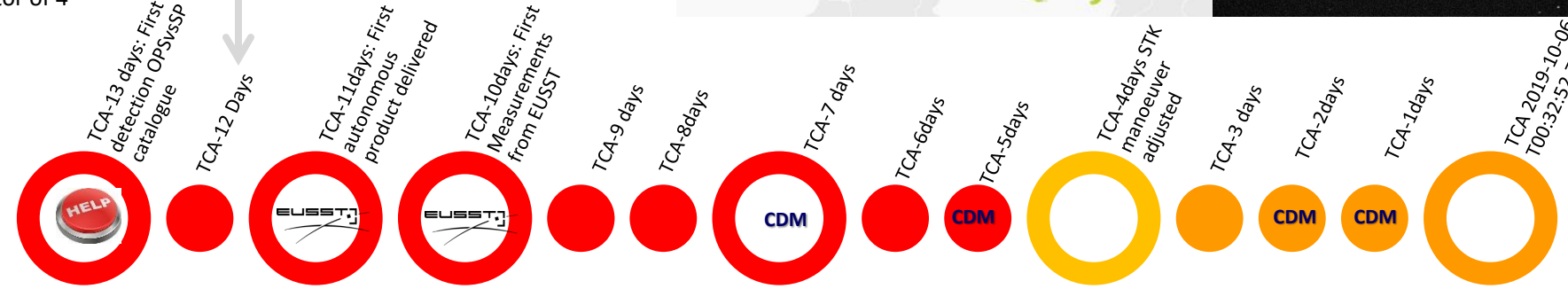
- **Mitigation recommendation** and **manoeuvre support**
  - Triggered by HIE detection or at O/O request

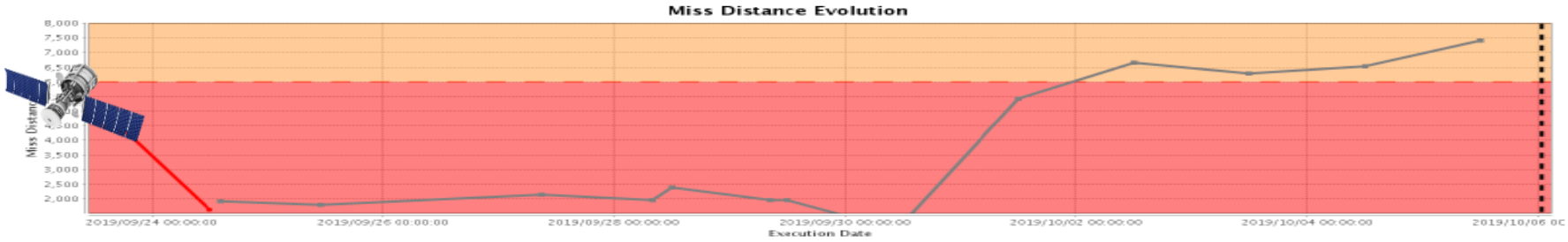


Collision Avoidance
HYLAS 4 (2018-033B) vs Gorizon 16 (1988-071A)



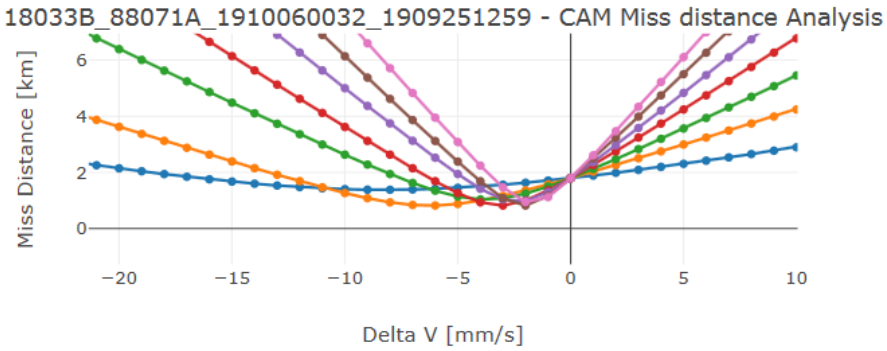
The conjunction was alert based on geometry, the worse PoC (10(-6)) was obtained with Kp and Ks of a factor of 4

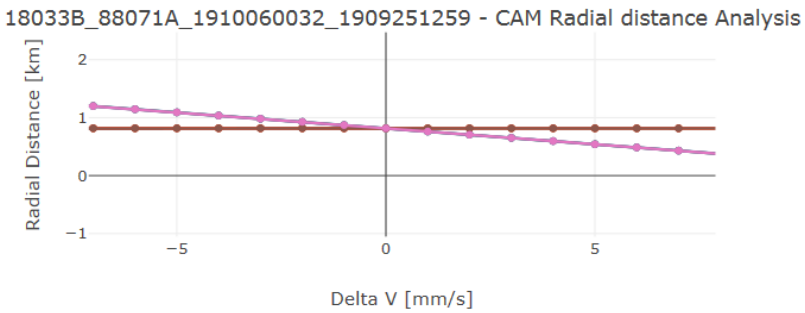




Collision Avoidance
HYLAS 4 (2018-033B) vs Gorizon 16 (1988-071A)

- Nominal OC worked together with the Operator to:
  - Assess a potential manoeuver
  - Screen the new Operator's ephemeris after the potential manoeuver
  - Finally the Operator decided to adjust the station keeping manoeuver and @TCA minus 4 days the risk decreased to WARNING





Collision Avoidance
EUSST Service Provision Portal

CA Info

Dashboard | Conjunctions | Fragmentations | Re-Entries | API | Events | SCD | Help

Dashboard

19/11/19 11:59 UTC – 28/11/19 21:27 UTC Conjunctions

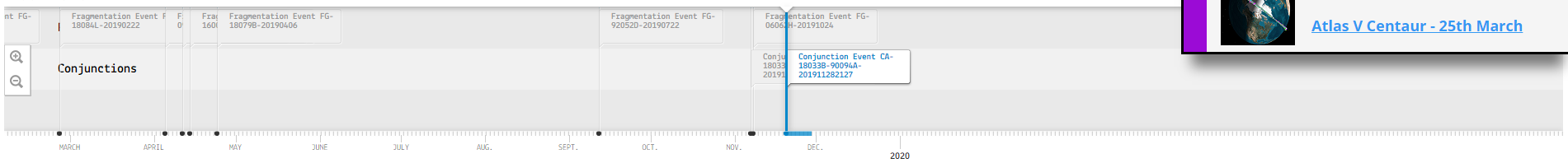
Conjunction Event CA-18033B-90094A-201911282127

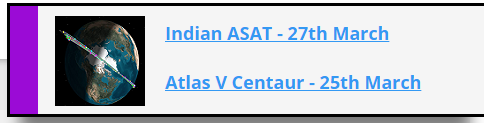
CA Info

Asset Object: HYLAS 4 --- Conjuncting Object: GORIZONT 21

Product ID: 2CA-18033B-90094A-201911282127-004-ALERT-REPORT -- Creation Date: 19/11/2019 11:59:08 UTC

Conjunction TCA: 28/11/2019 21:27:58 UTC





Conjunction Events - 10 Upcoming

Identifier	Severity	Actio...	Objects	TCA (UTC)
CA-18033B-90094A-...	ALERT	report	HYLAS 4 GORIZONT 21	28/11/2019 21:27:58.374

Fragmentation Events

Identifier	Actions	Parents	Event Epoch (UTC)
FG-06062H-20191024	report	SL-12 R/B(AUX MOTOR)	24/10/2019 09:23:00.0(
FG-92052D-20190722	report	ARIANE 42P R/B	22/07/2019 09:17:00.0(
FG-18079B-20190406	report	ATLAS 5 CENTAUR R/B	06/04/2019 00:00:00.0(
FG-16004A-20190408	report	INTELSAT 29E	08/04/2019 00:00:00.0(
FG-19006A-20190327	report	Microsat-R	27/03/2019 05:39:00.0(
FG-09047B-20190325	report	ATLAS 5 CENTAUR R/B	25/03/2019 00:00:00.0(
FG-18084L-20190222	report	H-2A R/B	22/02/2019 21:52:00.0(
FG-98046E-20181222	report	ORBCOMM FM 16	22/12/2018 07:12:00.0(

Reentry Events - 10 Upcoming

No upcoming events

CA Info

Collision Avoidance
EUSST Service Provision Portal

Collision Avoidance Events

Dashboard / Conjunctions

Identifier	Severity	Messages	Status	Actions	Time to TCA	TCA (UTC)	PoC	Miss Distance (m)	Primary			Secondary			Radial Miss Dist. (m)	Min. Miss
									Name	Int. Designator	NORAD ID	Name	Int. Designator	NORAD ID		
CA-18033B-90094A-201911282127	ALERT	8	Not Downloaded	report	8d, 11h, 41m, 9s	28/11/2019 21:27:58.374	2.466e-81	3,533.54	HYLAS 4	2018-033B	43272	GORIZONT 21	1990-094A	20923	2,690.14	3,533.54
CA-18033B-67094A-201911070638		1	Not Downloaded	cdm	Past	07/11/2019 06:39:21.066		17,324.00	HYLAS 4	2018-033B	43272	INTELSAT 2-F4	1967-094A	2969	-17,2	

1 20 items per page 1 - 2 ms

Dashboard / Conjunctions / CA-18033B-90094A-20

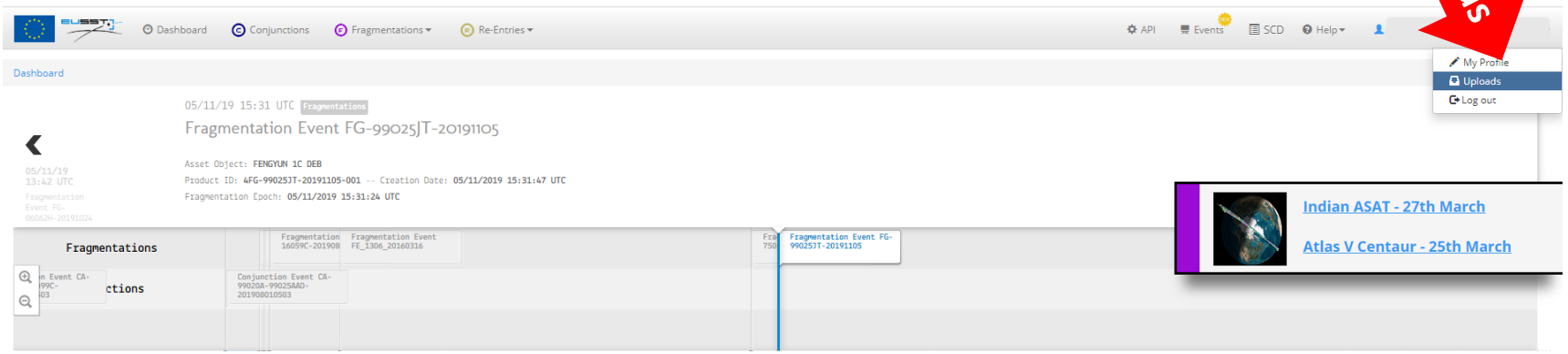
Time to TCA: 8d, 11h, 26m, 47s

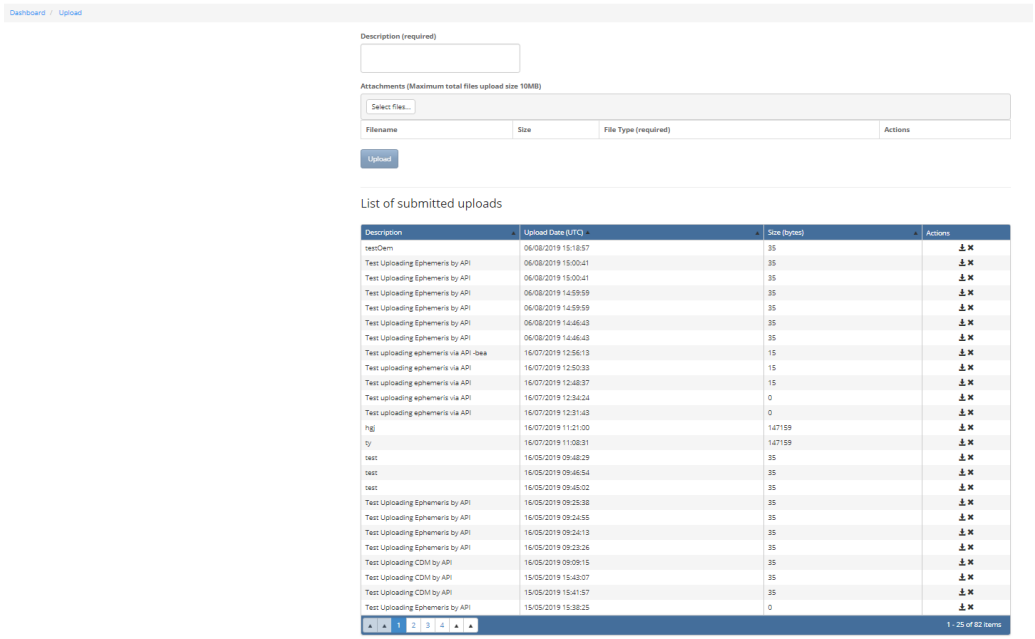
Index	Severity	Status	Actions	Creation Date (UTC)	TCA (UTC)	Primary			Secondary			Autonomous	PoC	Miss Distance (m)	Radial Miss Dist. (m)	PoC Method
						Name	Int. Designator	NORAD ID	Name	Int. Designator	NORAD ID					
8	ALERT	Not Downloaded	report	19/11/2019 11:59:08	28/11/2019 21:27:58.374	HYLAS 4	2018-033B	43272	GORIZONT 21	1990-094A	20923	Yes	2.466e-81	3,533.54	2,690.14	Scaled PoC
7	ALERT	Not Downloaded	cdm	19/11/2019 11:59:08	28/11/2019 21:27:58.374	HYLAS 4	2018-033B	43272	GORIZONT 21	1990-094A	20923	Yes	2.466e-81	3,533.54	2,690.14	Scaled PoC
6	ALERT	Not Downloaded	report	18/11/2019 11:59:07	28/11/2019 21:27:58.122	HYLAS 4	2018-033B	43272	GORIZONT 21	1990-094A	20923	Yes	1.023e-74	5,600.58	2,662.19	Scaled PoC
5	ALERT	Not Downloaded	cdm	18/11/2019 11:59:07	28/11/2019 21:27:58.122	HYLAS 4	2018-033B	43272	GORIZONT 21	1990-094A	20923	Yes	1.023e-74	5,600.58	2,662.19	Scaled PoC
4	ALERT	Not Downloaded	report	17/11/2019 11:59:07	28/11/2019 21:27:58.116	HYLAS 4	2018-033B	43272	GORIZONT 21	1990-094A	20923	Yes	1.025e-67	5,511.23	2,649.37	Scaled PoC
3	ALERT	Not Downloaded	cdm	17/11/2019 11:59:07	28/11/2019 21:27:58.116	HYLAS 4	2018-033B	43272	GORIZONT 21	1990-094A	20923	Yes	1.025e-67	5,511.23	2,649.37	Scaled PoC
2	ALERT	Not Downloaded	report	15/11/2019 11:59:07	28/11/2019 21:27:58.086	HYLAS 4	2018-033B	43272	GORIZONT 21	1990-094A	20923	Yes	9.855e-21	5,152.18	2,515.71	Scaled PoC
1	ALERT	Not Downloaded	cdm	15/11/2019 11:59:07	28/11/2019 21:27:58.086	HYLAS 4	2018-033B	43272	GORIZONT 21	1990-094A	20923	Yes	9.855e-21	5,152.18	2,515.71	Scaled PoC

1 All items per page 1 - 8 of 8 items

CA Event Products

Collision Avoidance
EUSST Service Provision Portal

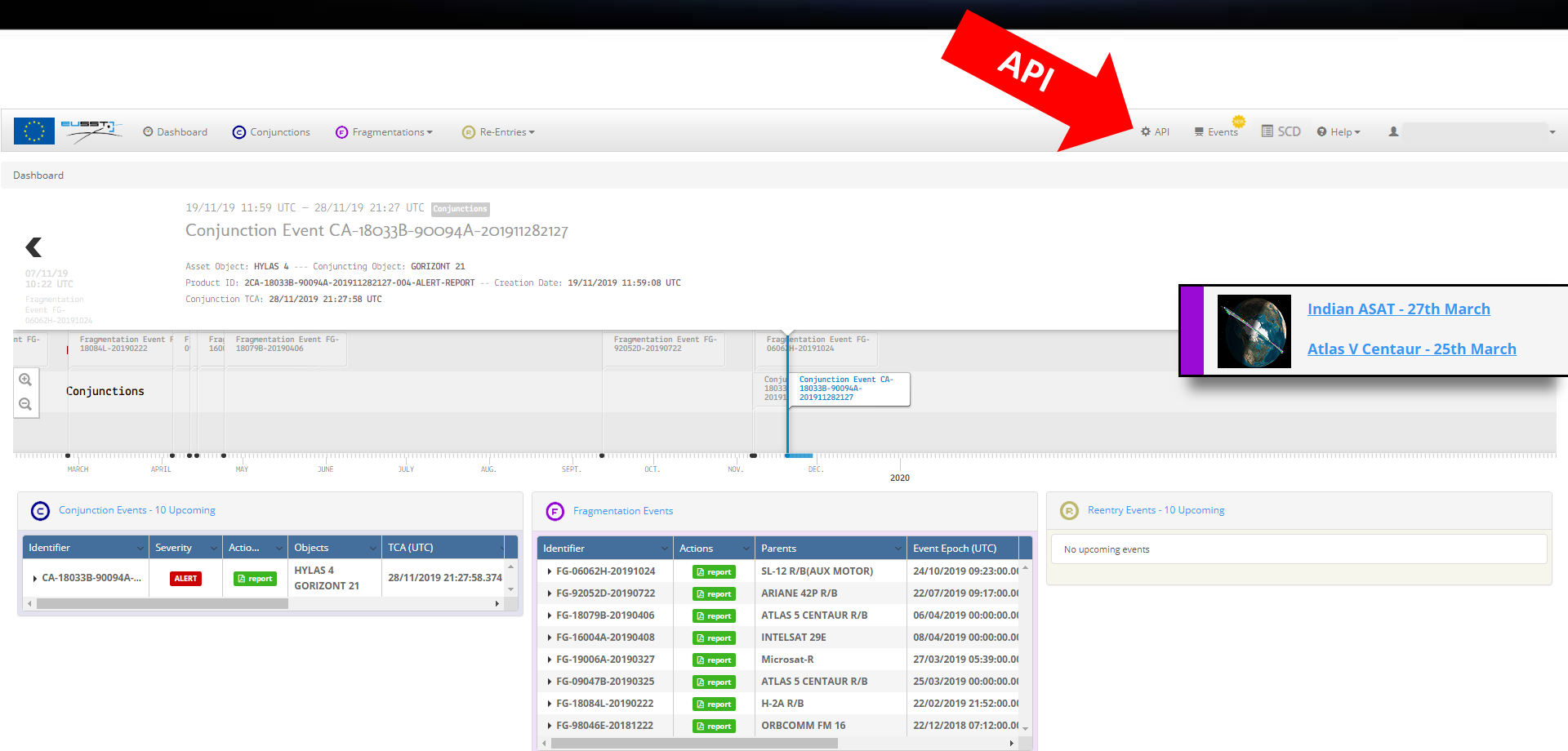




CA User Data uploads:

Any kind of file can be uploaded. Allocated OCs are automatically notified.

Collision Avoidance
EUSST Service Provision Portal



Collision Avoidance
EUSST Service Provision Portal

EU SST Service Provision REST API

This document describes the EU SST Service Provision Rest API, which is meant to be used by back-end servers or trusted parties. The API provides most of the functionality available in the portal.

Collision Avoidance Service

Show/Hide | List Operations | Expand Operations

GET	/api/ca/cdm	Retrieve the list of CDMs for the user.
GET	/api/ca/cdm/{cdmId}	Returns the Conjunction cdm for a certain id
GET	/api/ca/report	Retrieve the list of Conjunction Reports for the user.
GET	/api/ca/report/{reportId}	Returns the Conjunction report for a certain report id

Fragmentation Analysis Service

Show/Hide | List Operations | Expand Operations

Re-entry Analysis Service

Show/Hide | List Operations | Expand Operations

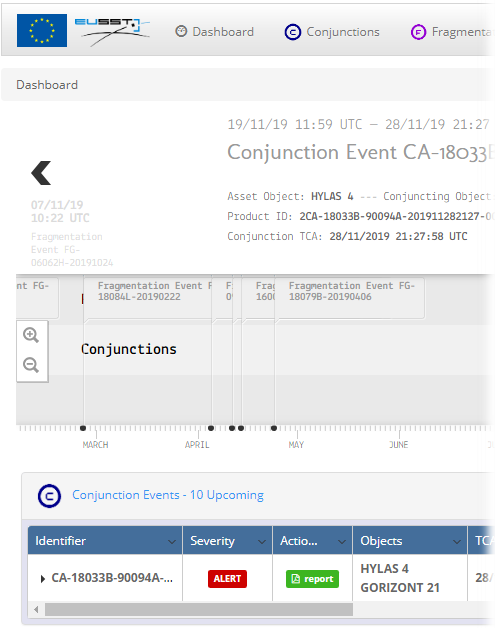
User Data Upload Service

Show/Hide | List Operations | Expand Operations

GET	/api/file	Get all uploaded files for the user.
GET	/api/file/{dataUploadId}	Returns the file information for a certain file id
POST	/api/file/delete/{dataUploadId}	Delete a file upload.
POST	/api/file/upload	Upload a file.

Collision Avoidance

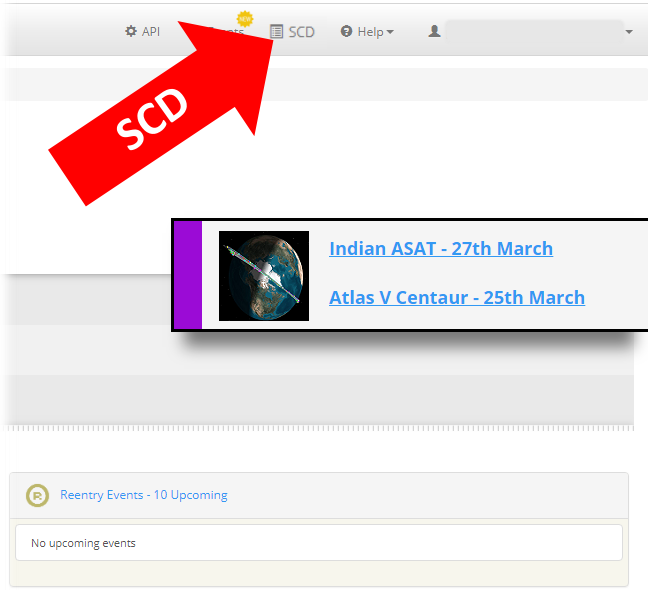
EUSS n Portal



Unclassified / LIMITE (EU SST Cooperation and User)

EUSST Service Configuration Document with XXX

Approved by STC on 2017-06-02



Collision Avoidance
Conclusions

- Provision mechanism in hot redundancy.
- Direct dialogue for HIE.
- User-oriented service (SCD).
- Autonomous products based on data provided by EUSST contributing sensors.
- Standard information (CDM) complemented by expert analysis (CA report).
- Collision Avoidance manoeuvre support.
- Service provision through User and API interfaces.

Re-entry Analysis Service

Re-entry Analysis
Service Description

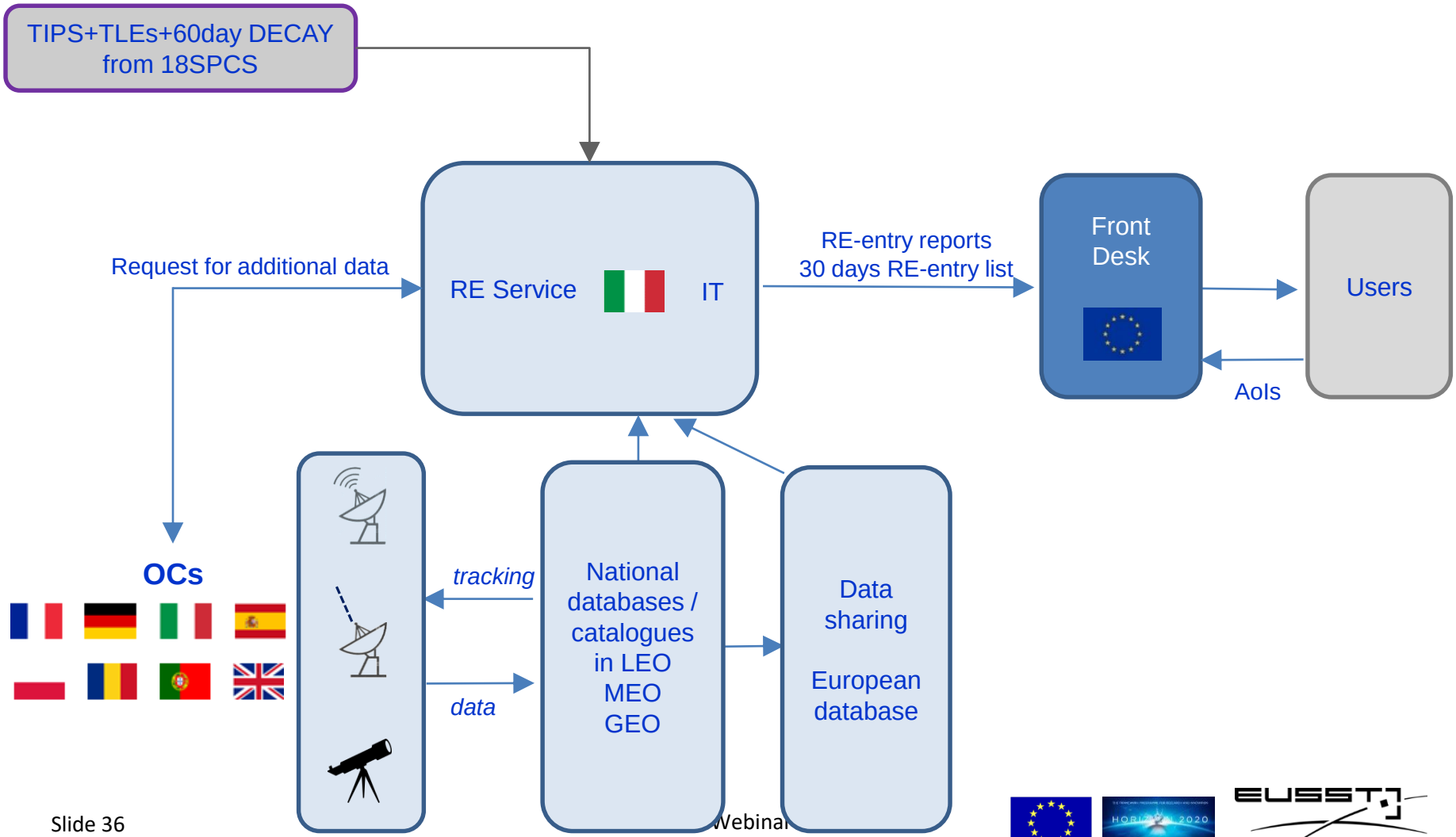
The Re-entry Analysis (RE) Service:

- provides the risk assessment of the uncontrolled re-entry of man-made space objects and space debris into the Earth's atmosphere and the generation of related information.
- consists on analysing all available information regarding the uncontrolled re-entries within 30 days.

Re-entry Analysis
Service Characteristics

- The criteria applied for the objects to be reported is:
  - Radar Cross Section (RCS) larger than $1m^2$;
  - *or* mass greater than 2.000 kg;
  - *and* all rocket bodies.
- All relevant sensors operated under EUSST are contributing to the service provision;
- Re-entry information provided in accordance to users' personalised geographical Areas of Interest (AoIs).

Re-entry Analysis
Provision Mechanism



Re-entry Analysis
EUSST Products

- The content of the EUSST products includes:
  - Object identification and characterization;
  - Object orbital information;
  - Re-entry prediction information.
- Content is provided to users as:
  - 30 Days Re-entry List;
  - Re-entry Report;

In addition, dedicated event pages are created for specific events (e.g. Tiangong-1)

Re-entry Analysis
EUSST Products – 30 Days Re-entry List

30 Days Re-Entry List

Product ID: **4-RE30DRL-11112019**
Creation Date (UTC): **11/11/2019 12:45:00**
Publish Date (UTC): **11/11/2019 12:49:43**

Object Name	Int. Designator	Object Type	Max. Latitude (deg.)	Mass (Kg.)	Size	Window Start	Window End
PSLV DEB	**2010-035G**	Debris	98.04		Large	17/11/2019	21/11/2019
CZ-3B DEB	**2012-018C**	Debris	54.7		Large	16/11/2019	18/11/2019
ATLAS 5 CENTAUR R/B	**2017-004B**	RocketBody	22.5		Large	15/11/2019	18/11/2019

1 20 items per page 1 - 3 of 3 items

Re-entry Analysis
EUSST Products – Re-entry Report

Re-entry Analysis Report

4RE-97067A-003

EXAMPLESAT
NORAD ID: 12345
Int.Designator: 2016-099C

Creation Date (UTC): 2019-09-03T09:28:15

Overview
This report presents the results of the EXAMPLESAT re-entry analysis in accordance with the latest available information:

Epoch of the re-entry:	2019-08-30T04:25:03 UTC
Uncertainty of epoch:	±0h15m
Nominal re-entry point:	Lat. 48.94°N Lon. 5.3°E
Direction:	Ascending

Table 1: Re-entry information

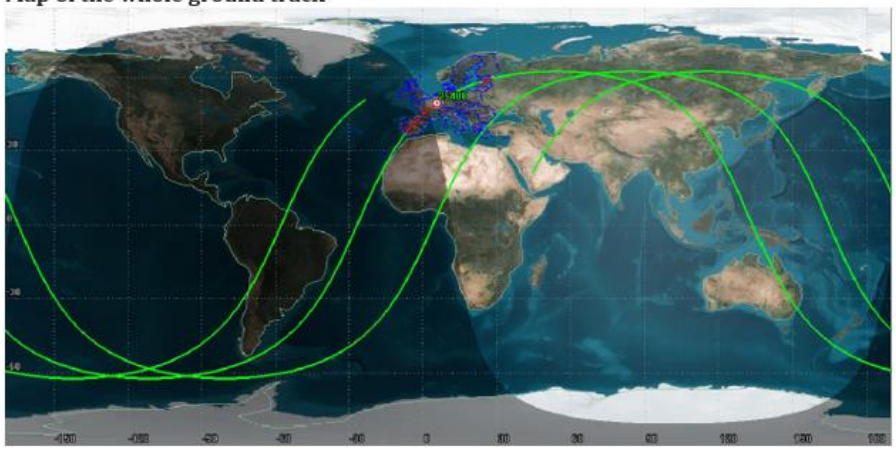
Apogee:	31989 km
Perigee:	185 km
Inclination:	62°

Table 2: Object information at report creation date

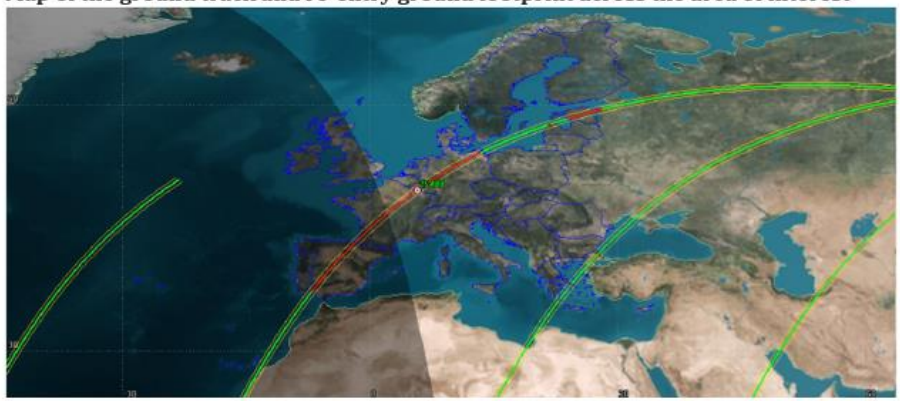
AOI	Entry Epoch	Entry Lat	Entry Lon	Exit Epoch	Exit Lat	Exit Lon
Greece	2019-08-30 03:02:45	36.152	23.066	2019-08-30 03:02:49	36.272	22.976
Greece	2019-08-30 03:03:40	37.989	24.520	2019-08-30 03:03:44	38.142	24.398
Bulgaria	2019-08-30 03:05:45	42.003	27.957	2019-08-30 03:05:47	42.085	27.879
Spain	2019-08-30 05:06:15	37.210	-1.685	2019-08-30 05:09:26	43.306	-7.046
France	2019-08-30 05:09:26	43.309	5.716	2019-08-30 05:13:08	49.542	-1.682
Luxembourg	2019-08-30 05:13:13	49.668	6.230	2019-08-30 05:13:22	49.900	5.896
Germany	2019-08-30 05:13:22	49.900	13.436	2019-08-30 05:16:20	54.116	6.231
Latvia	2019-08-30 05:19:11	57.491	21.943	2019-08-30 05:19:17	57.592	21.641
Estonia	2019-08-30 05:19:57	58.264	28.180	2019-08-30 05:21:12	59.386	24.063

Table 3: Area of interest information

Map of the whole ground track



Map of the ground track and re-entry ground footprint across the area of interest

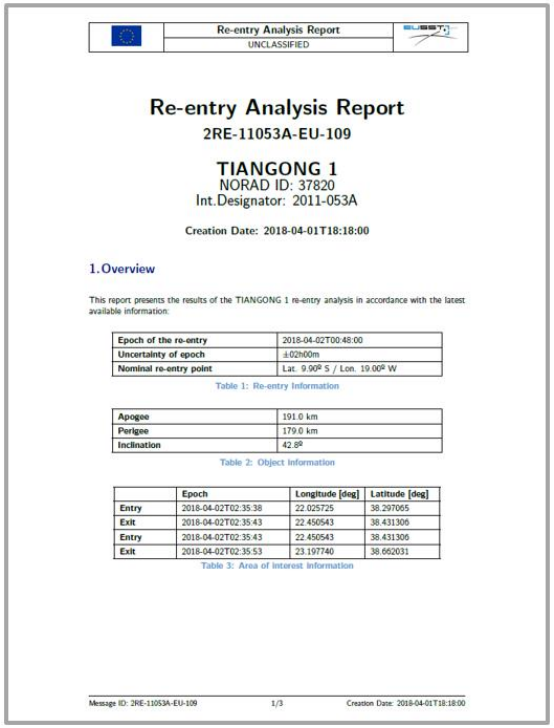


Re-entry Analysis
Real case

Tiangong-1

13 Reports

6 Autonomous Reports based on data from 6 EUSST contributing sensors



Re-entry Analysis Report
UNCLASSIFIED

Re-entry Analysis Report
2RE-11053A-EU-109

TIANGONG 1
NORAD ID: 37820
Int.Designator: 2011-053A

Creation Date: 2018-04-01T18:18:00

1. Overview

This report presents the results of the TIANGONG 1 re-entry analysis in accordance with the latest available information:

Epoch of the re-entry	2018-04-02T00:48:00
Uncertainty of epoch	±02h00m
Nominal re-entry point	Lat. 9.90º S / Lon. 19.00º W

Table 1: Re-entry Information

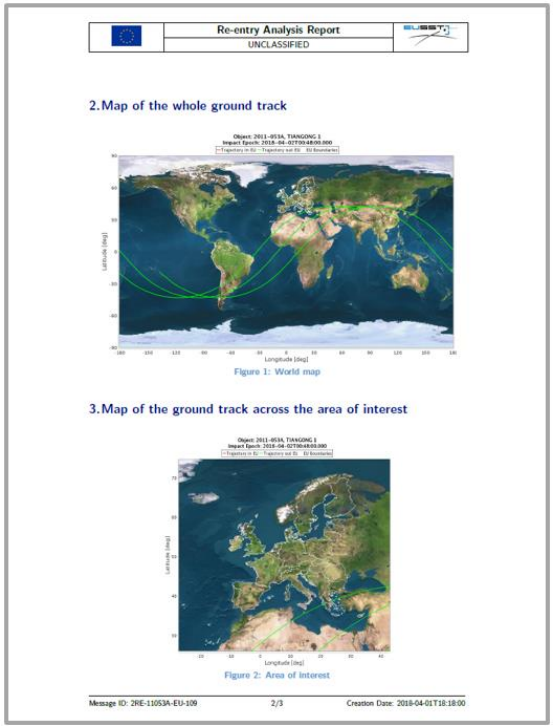
Apogee	191.0 km
Perigee	179.0 km
Inclination	42.8º

Table 2: Object information

	Epoch	Longitude [deg]	Latitude [deg]
Entry	2018-04-02T02:35:38	22.025725	38.297065
Exit	2018-04-02T02:35:43	22.450543	38.431306
Entry	2018-04-02T02:35:43	22.450543	38.431306
Exit	2018-04-02T02:35:53	23.197740	38.662031

Table 3: Area of Interest Information

Message ID: 2RE-11053A-EU-109 1/3 Creation Date: 2018-04-01T18:18:00



Re-entry Analysis Report
UNCLASSIFIED

2. Map of the whole ground track

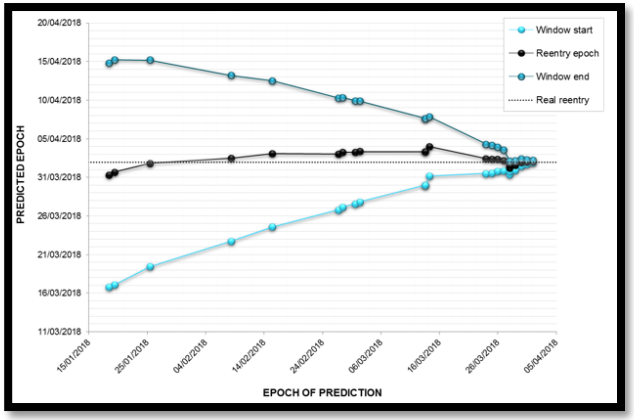
Figure 1: World map

3. Map of the ground track across the area of interest

Figure 2: Area of Interest

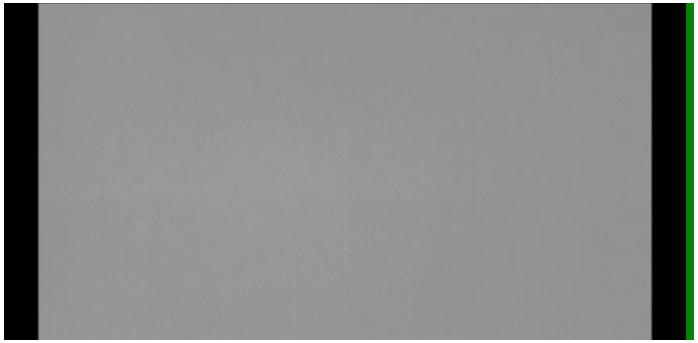
Message ID: 2RE-11053A-EU-109 2/3 Creation Date: 2018-04-01T18:18:00

Prediction Evolution

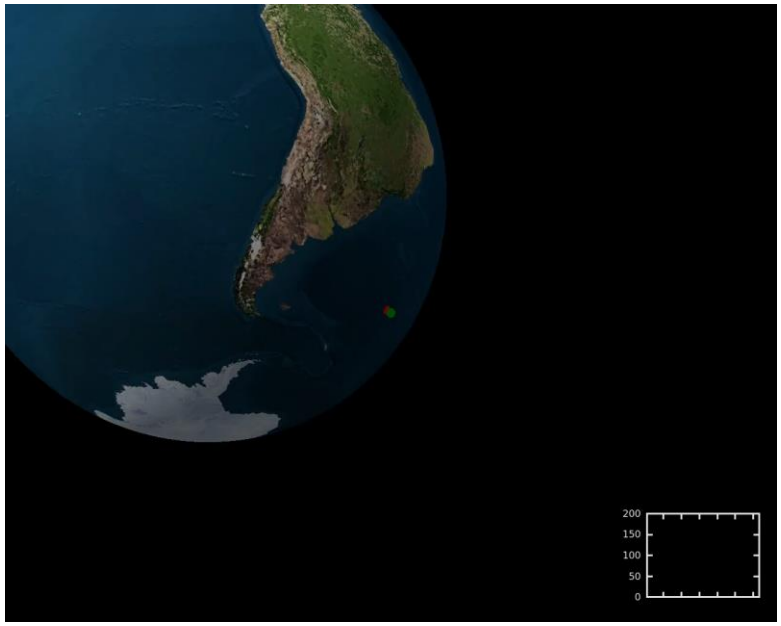


RE Event Page

Re-entry Analysis
Real case



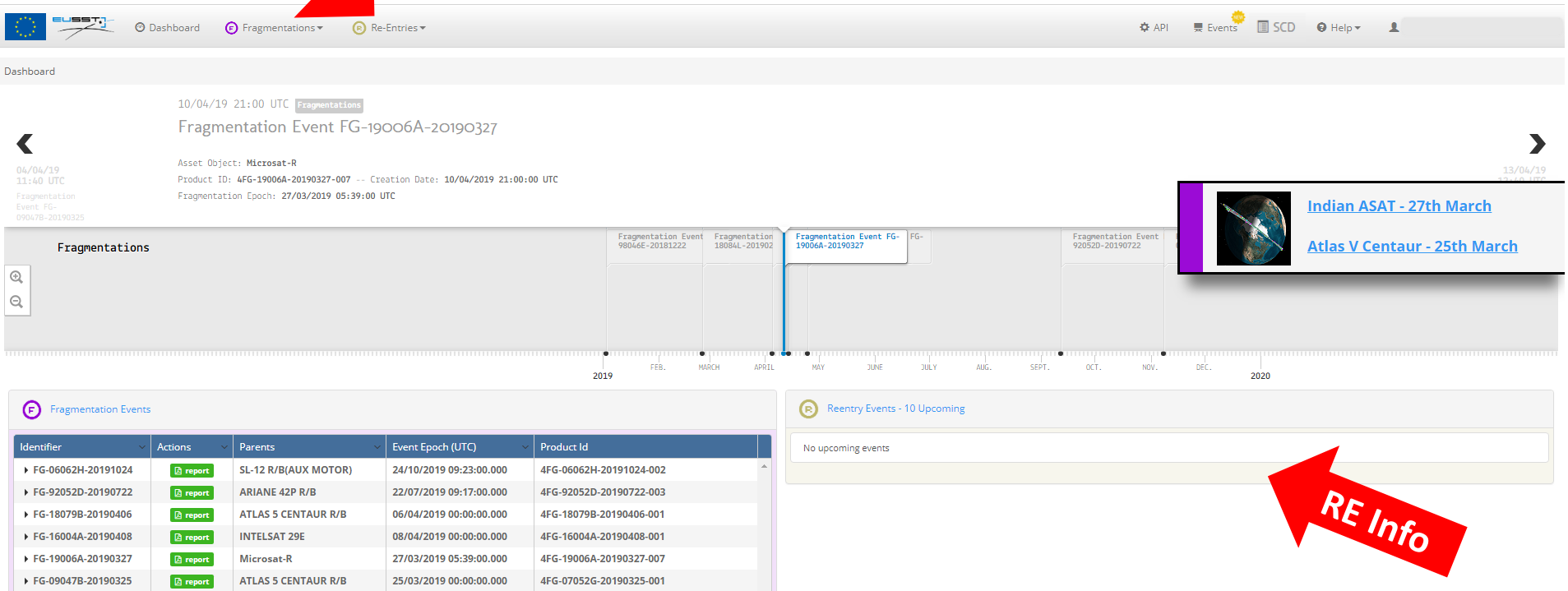
Tiangong-1



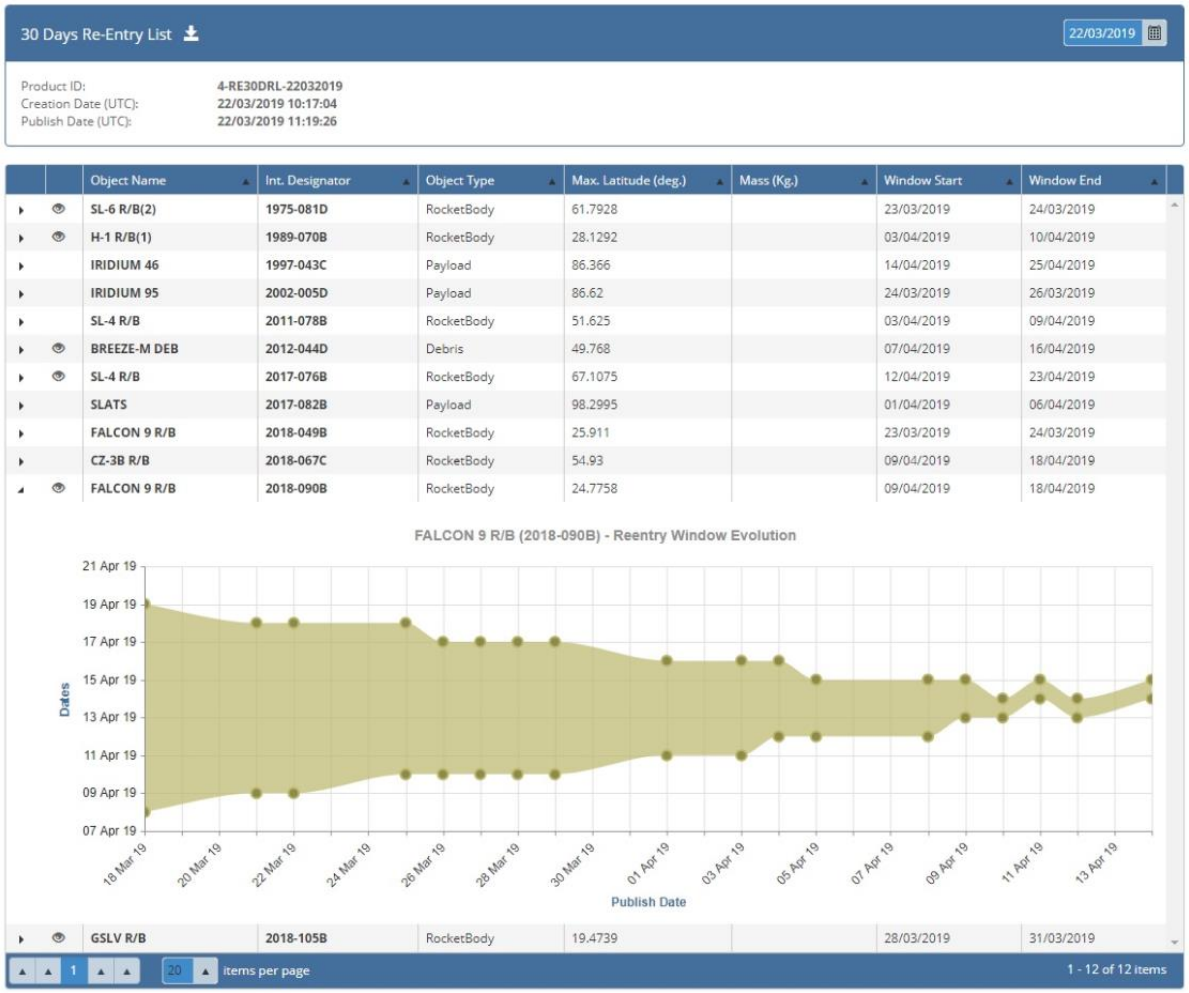
Re-entry Analysis

EUSST Service Provision Portal

RE Info



Re-entry Analysis
EUSST Service Provision Portal



30 Days Re-Entry List

Re-entry Analysis
EUSST Service Provision Portal

Re-Entry Events

Dashboard / Re-Entries

Identifier	Messages	Status	Actions	Time to Window	Creation Date (UTC)	Window Start (UTC)	Window End (UTC)	Re-entry Epoch (UTC)	Decay Report	Object		Publish Date (UTC)	Product Id
										Name	Int. Designator		
RE-75063A	3	Downloaded	report	Past	11/09/2018 23:31:02	12/09/2018 06:41:00.000	12/09/2018 08:41:00.000	12/09/2018 08:41:00.000	No	Molinya 2-13	1975-063A	11/09/2018 22:33:45	5RE-75063A-EU-3
RE-16020B	3	Not Downloaded	report	Past	05/09/2018 23:55:50	06/09/2018 08:53:00.000	06/09/2018 12:53:00.000	06/09/2018 10:53:00.000	No	SL-4 R/B	2016-020B	05/09/2018 22:58:11	5RE-16020B-EU-3
RE-17034E	3	Not Downloaded	report	Past	25/08/2018 01:28:57	25/08/2018 09:06:00.000	25/08/2018 13:06:00.000	25/08/2018 11:06:00.000	No	CZ-4B R/B	2017-034E	25/08/2018 00:34:01	5RE-17034E-EU-3
RE-17036AH	3	Not Downloaded	report	Past	24/07/2018 11:20:54	24/07/2018 20:12:00.000	25/07/2018 00:12:00.000	24/07/2018 22:12:00.000	No	PSLV R/B	2017-036AH	24/07/2018 10:30:22	5RE-17036A-EU-3
RE-18007C	3	Not Downloaded	report	Past	17/07/2018 01:45:57	17/07/2018 10:18:00.000	17/07/2018 14:18:00.000	17/07/2018 12:18:00.000	No	EPSILON Deb	2018-007C	17/07/2018 00:48:47	5RE-18007C-EU-3
RE-18058B	3	Downloaded	report	Past	12/07/2018 21:05:18	13/07/2018 00:31:00.000	13/07/2018 04:31:00.000	13/07/2018 02:31:00.000	No	SL-4 R/B	2018-058B	12/07/2018 20:06:43	5RE-18058B-EU-3
RE-99032B	2	Downloaded	report	Past	24/05/2018 11:15:00	24/05/2018 12:14:00.000	24/05/2018 13:26:00.000	24/05/2018 12:50:00.000	No	IRIDIUM 21	1999-032B	24/05/2018 11:32:33	4RE-99032B-EU-002
RE-98032B	1	Not Downloaded	report	Past	13/05/2018 21:30:55	14/05/2018 00:52:00.000	14/05/2018 02:34:00.000	14/05/2018 01:43:53.085	No	IRIDIUM 72	1998-032B	13/05/2018 22:46:27	4RE-98032B-EU-001
RE-18040F	2	Not Downloaded	report	Past	29/04/2018 19:30:31	29/04/2018 20:58:00.000	29/04/2018 22:20:00.000	29/04/2018 21:39:00.000	No	CZ-11 R/B	2018-040F	07/05/2018 13:31:50	3RE-18040F-EU-1-r1
RE-02059D	1	Not Downloaded	report	Past	04/05/2018 22:14:45	05/05/2018 01:58:00.000	05/05/2018 03:48:00.000	05/05/2018 02:53:30.000	No	SL-6 R/B(2)	2002-059D	04/05/2018 23:23:54	4RE-02059D-EU-001
RE-02005C	1	Not Downloaded	report	Past	18/04/2018 03:46:35	18/04/2018 05:10:00.000	18/04/2018 06:50:00.000	18/04/2018 06:00:00.000	No	IRIDIUM 94	2002-005C	18/04/2018 03:46:44	3RE-02005C-EU-1
RE-18032B	2	Downloaded	report	Past	07/04/2018 18:31:47	07/04/2018 11:55:00.000	07/04/2018 15:55:00.000	07/04/2018 13:55:00.000	No	DRAGON CRS-14 DEB	2018-032B	07/04/2018 18:31:52	3RE-18032B-EU-2
RE-97056A	2	Not Downloaded	report	Past	07/04/2018 10:35:25	07/04/2018 07:50:00.000	07/04/2018 08:54:00.000	07/04/2018 08:22:00.000	No	IRIDIUM 19	1997-056A	07/04/2018 10:35:30	3RE-97056A-EU-2
RE-11053A	13	Not Downloaded	report	Past	02/04/2018 00:59:00	02/04/2018 00:15:00.000	02/04/2018 00:17:00.000	02/04/2018 00:16:00.000	No	TIANGONG 1	2011-053A	04/04/2018 15:34:02	2RE-11053A-EU-111
RE-12017B	1	Downloaded	report	Past	03/04/2018 12:00:41	03/04/2018 13:32:00.000	03/04/2018 14:56:00.000	03/04/2018 14:14:00.000	No	PSLV R/B	2012-017B	03/04/2018 12:00:49	3RE-12017B-EU-1
RE-18026B	4	Not Downloaded	report	Past	25/03/2018 04:07:00	25/03/2018 01:24:00.000	25/03/2018 01:26:00.000	25/03/2018 01:25:00.000	No	SL-4 R/B	2018-026B	25/03/2018 12:30:08	2RE-18026B-EU-007
RE-97082E	3	Not Downloaded	report	Past	13/02/2018 10:04:00	13/02/2018 11:25:00.000	13/02/2018 12:23:00.000	13/02/2018 11:54:00.000	No	IRIDIUM 49	1997-082E	13/02/2018 14:10:01	2RE-97082E-EU-008
RE-17081B	1	Not Downloaded	report	Past	20/12/2017 11:00:00	20/12/2017 14:55:00.000	20/12/2017 17:15:00.000	20/12/2017 16:05:00.000	No	SL-4 R/B	2017-081B	20/12/2017 12:36:59	4RE-17081B-EU-001
RE-98067JB	1	Not Downloaded	report	Past	30/11/2017 16:11:14	30/11/2017 17:36:00.000	30/11/2017 18:22:00.000	30/11/2017 17:59:00.000	No	FLOCK 2EP 2	1998-067JB	30/11/2017 16:14:51	3RE-98067JB-EU-1
RE_53_20171124	1	Not Downloaded	report	Past	24/11/2017 10:46:00	24/11/2017 11:51:00.000	24/11/2017 13:51:00.000	24/11/2017 12:51:00.000	No	IRIDIUM 8	1997-020A	24/11/2017 10:49:25	3RE-97020A-EU-1

1 2 3 4 5 20 items per page 61 - 80 of 87 items

Re-entry Analysis
EUSST Service Provision Portal

Tiangong-1 RE Reports

Dashboard / Re-Entries / RE-11053A

Index	Status	Actions	Time to Window	Creation Date (UTC)	Window Start (UTC)	Window End (UTC)	Re-entry Epoch (UTC)	Decay Report	Object		Product Id
									Name	Int. Designator	
13	Not Downloaded	report	Past	02/04/2018 00:59:00	02/04/2018 00:15:00.000	02/04/2018 00:17:00.000	02/04/2018 00:16:00.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-111
12	Not Downloaded	report	Past	01/04/2018 22:53:00	01/04/2018 22:49:00.000	02/04/2018 02:49:00.000	02/04/2018 00:49:00.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-110
11	Not Downloaded	report	Past	01/04/2018 18:18:00	01/04/2018 22:48:00.000	02/04/2018 02:48:00.000	02/04/2018 00:48:00.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-109
10	Not Downloaded	report	Past	01/04/2018 14:49:57	01/04/2018 22:06:30.000	02/04/2018 05:18:30.000	02/04/2018 01:42:30.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-108
9	Not Downloaded	report	Past	31/03/2018 12:49:09	01/04/2018 16:54:32.000	02/04/2018 07:21:48.000	02/04/2018 00:08:10.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-107
8	Not Downloaded	report	Past	30/03/2018 15:33:15	01/04/2018 10:46:46.000	02/04/2018 10:10:08.000	01/04/2018 22:28:27.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-106
7	Not Downloaded	report	Past	29/03/2018 15:05:31	31/03/2018 22:42:27.000	02/04/2018 04:03:41.000	01/04/2018 13:23:04.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-105
6	Not Downloaded	report	Past	28/03/2018 16:12:48	31/03/2018 18:13:10.000	02/04/2018 03:19:46.000	01/04/2018 10:46:28.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-104
5	Not Downloaded	report	Past	28/03/2018 07:57:31	31/03/2018 09:40:33.000	02/04/2018 02:28:33.000	01/04/2018 06:04:33.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-103
4	Not Downloaded	report	Past	27/03/2018 09:30:17	31/03/2018 20:35:13.000	03/04/2018 13:43:53.000	02/04/2018 05:09:33.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-102
3	Not Downloaded	report	Past	26/03/2018 09:30:17	31/03/2018 18:39:58.000	03/04/2018 22:39:44.000	02/04/2018 08:39:51.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-101
2	Not Downloaded	report	Past	25/03/2018 09:30:17	31/03/2018 13:41:08.000	04/04/2018 03:45:08.000	02/04/2018 08:43:08.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-100
1	Not Downloaded	report	Past	24/03/2018 09:30:17	31/03/2018 12:03:10.000	04/04/2018 07:57:28.000	02/04/2018 10:00:19.000	No	TIANGONG 1	2011-053A	2RE-11053A-EU-099

1 | All items per page 1 - 13 of 13 items

Re-entry Analysis
EUSST Service Provision Portal

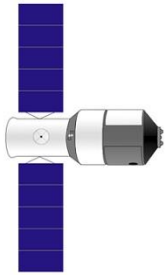
Configure RE AoIs

Re-entry Analysis
EUSST Service Provision Portal

Tiangong-1 RE Event Page

Dashboard / Tiangong-1

Tiangong-1



Credit: By Tiangong_1_drawing.png: Craigboy derivative work: 70.49.127.65 [CC BY-SA 3.0 or GFDL], via Wikimedia Commons

In early 2018 a large object of special interest will re-enter into the Earth's atmosphere: the former Chinese space station Tiangong-1 (NORAD ID: 37820 / COSPAR ID: 2011-053A). The object was launched in September 2011 by a "Long March 2" launch vehicle from Jiuquan LA-4/SLS-1 into a Low Earth Orbit (LEO) with an inclination of approximately 43°. During its operational life time the station has hosted two manned Missions with six astronauts in total. On 21.03.2016 Chinese "Manned Space Engineering Office" announced that they disabled data service to their space station. Analysis of the objects' orbit has shown that no significant manoeuvres have been made since December 2015. Since that moment in time, the height of the object has permanently dropped mainly due to the atmospherical drag. The objects' altitude decreased from its' original position of 400km to 270km by the end of January 2018. The lower the orbit the faster the decrease in altitude will be due to the increase of the atmospheres' density. Due to the mass of approximately 7600kg and its size of about 11m x Ø3.5m (without solar arrays) the object is of special interest.

Most recent analysis show that the object will re-enter in late March / early April plus/minus the uncertainty (typically 20% of the remaining orbital lifetime) that comes along with the re-entry prediction due to the unknown long-term behaviour of the Earth's atmosphere (influenced by the solar activity), which is mainly responsible for the decrease in orbit altitude. It can be expected that some larger pieces will survive the re-entry and reach the Earth's surface. A rough estimation is to assume the equivalent of approximately 40% of the object dry mass, which leads to a total mass of surviving fragments of approximately 3 tons. Especially massive components such as the engines, tanks or massive part of the primary structure are most likely to partially survive. In any case, these pieces will not accumulate at a certain re-entry point but instead be spread over a large area along the final trajectory, which will be approximately 1000km long and a few hundred kilometres wide. Due to the inclination of the object, the re-entry will happen between ±43° geographical latitude. Thus all locations north and south of this latitude-band can be discarded from being affected. Consequently, mid and northern European countries such as Germany, Austria, Switzerland, Hungary or Romania, as well as most parts of France (except a small region close to the border of Spain and Corsica) are not within the re-entry region.

Within the region of ±43° geographical latitude most part of the Earth surface is covered by ocean so the statistical probability of an impact on soil is low. However, due to the orbital mechanics, the probability of a re-entry at the northern or southern boundary (±43°) of this region is a bit higher than at the equator simply because the residence time at certain latitude is lowest near the equa-tor. Thus, European countries such as Portugal, Spain, France, Italy, Malta, Greece, Bulgaria and Rep. of Cyprus are exposed to a slightly higher risk.

Besides other organisations, this object is also being monitored by EUSST. Sensors capable of tracking the object are used to permanently collect orbit-tracking data towards the end of the orbital life time of the object. Together with data of other sources (e.g. space weather data, etc.) analysis are performed to produce the best possible estimation for the expected re-entry location and time. However, due to the large uncertainties within re-entry predictions in general (approximately ±20% of the remaining lifetime) a precise estimation will be possible only a few hours before the re-entry actually occurs. Even one day in advance the uncertainty in the remaining lifetime of the object will be in the order of around ±5 hours and, considering the velocity of the object, this implies a very wide portion of Earth's surface. How-ever, based on the regions without overflights during the remaining lifetime some regions can al-ready be excluded at an early stage.

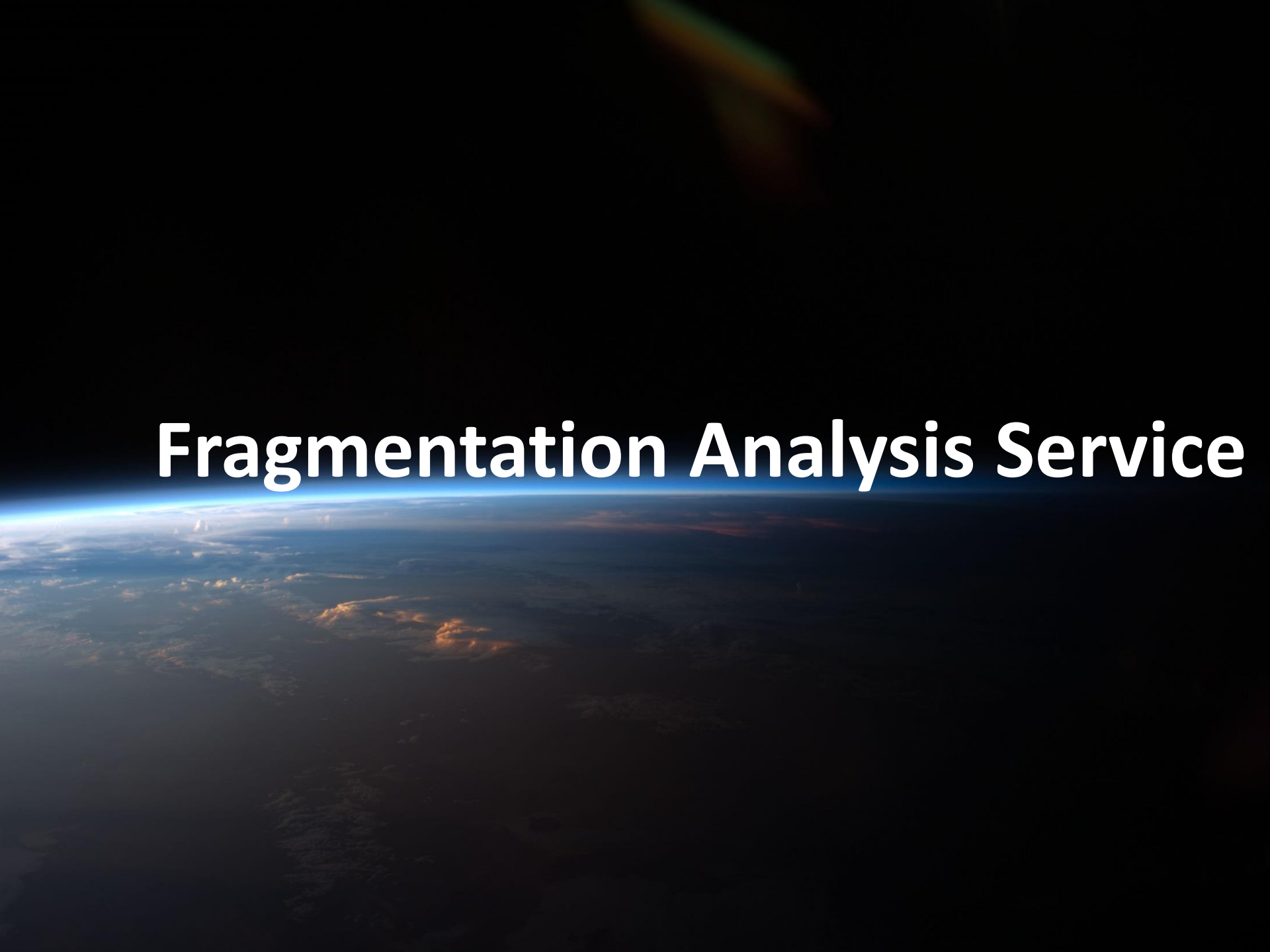
Index	Status	Actio...	Time to Window	Creation Date (UTC)	Window Start (UTC)	Window End (UTC)	Re-entry Epo
1	Not Downloaded	report	Past	23/09/2017 18:22:57	03/12/2017 12:57:00.000	01/12/2016 12:57:00.000	02/12/2017 0

19/03/2018 10:38:07 UTC

© 2018 - EU SatCen | v0.3.0.0

Re-entry analysis
Conclusions

- Autonomous products based on data provided by EUSST contributing sensors.
- Object overflight passes provided for the re-entry predicted window.
- Users' personalised geographical areas of interest.
- Ad-hoc information for mediatic events.


Fragmentation Analysis Service

Fragmentation Analysis
Service Description

The Fragmentation Analysis (FG) Service:

- provides the detection and characterization of in-orbit fragmentations, break-ups or collisions.
- consists on analysing all available information regarding the object(s) involved in the event.

Fragmentation Analysis
EUSST Products

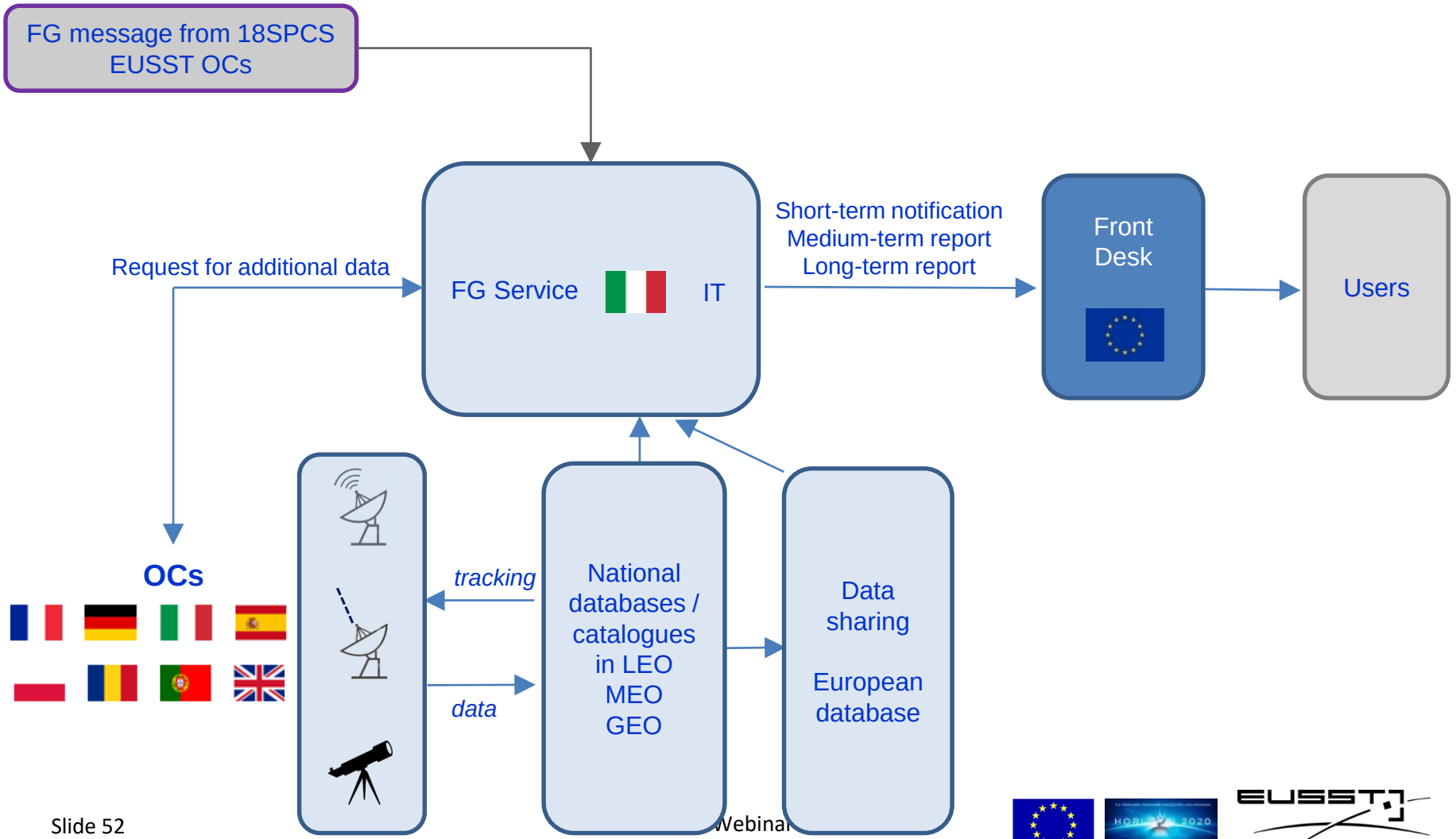
- The content of the FG Service is provided in 3 types of products:
  1. **Short-term notification;**
  2. **Medium-term report;**
  3. **Long-term report.**

as foreseen by the new Service Portfolio

Multiple reports based on available information

- Contribution of all relevant sensors operated under EUSST is requested for all fragmentation events.
- In addition, dedicated event pages are created for mediatic events (e.g. Microsat-R)

Fragmentation Analysis
Provision Mechanism

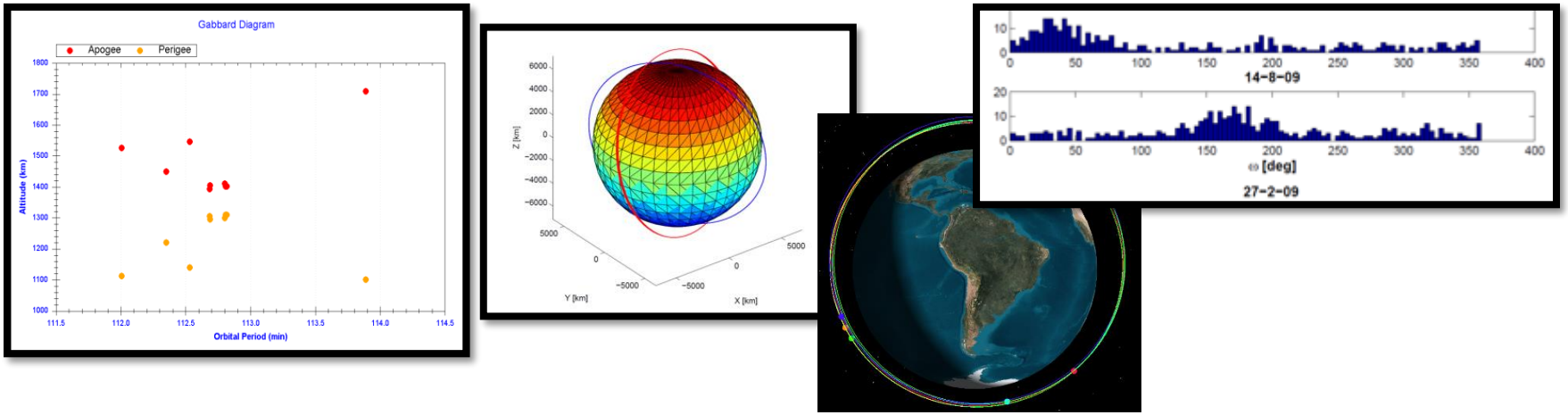


Fragmentation Analysis
Short-term Notification

- The Short-term product is provided as an email containing basic information regarding the FG event. It includes:
  - **type of fragmentation** (i.e. explosion/breakup, collision, release of fragments, ASAT, other, unknown)
  - **object type** (i.e. satellite/payload, rocket body)
  - **apogee/perigee** of parent object/s with their **orbital regime** (LEO, MEO, GEO, other)
  - **number of detected fragments** if this information is available to the OC.

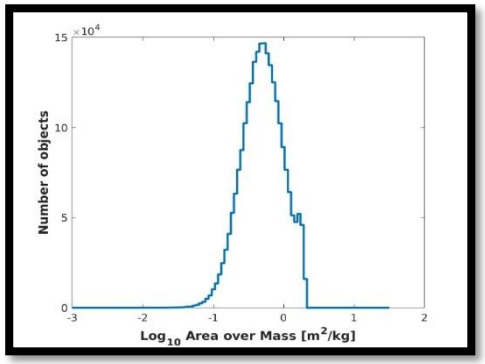
Fragmentation Analysis
Medium-term Report

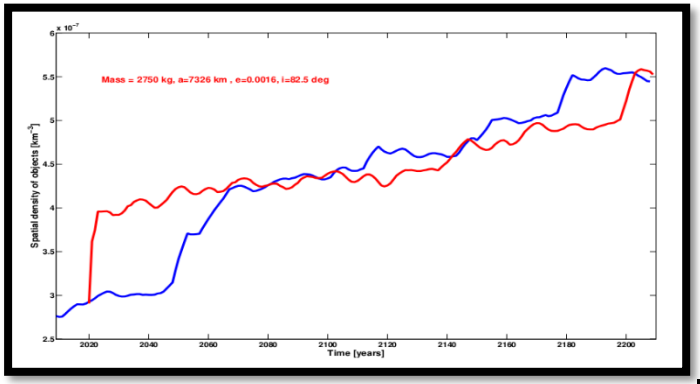
- The Medium-term report provides updates of the event with the following information:
  - Fragments distribution (e.g. Gabbard diagram)
  - 3D graph of the position of the object/s
  - 3D cloud evolution of the fragments
  - Dispersion of the orbital parameters of the fragments



Fragmentation Analysis
Long-term Report

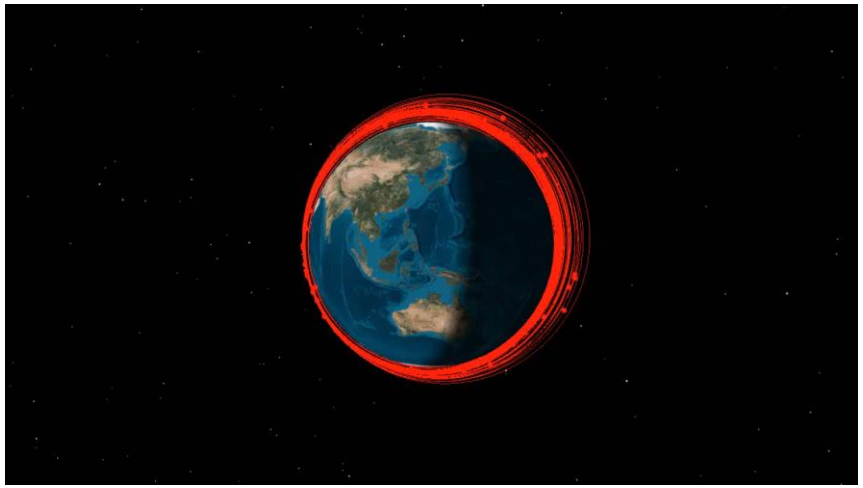
- Long-term report provides updates of the event with the following information:
  - Simulations of the event using an adequate breakup, collision model;
  - Area to Mass ratio distribution;
  - Delta Velocity distribution;
  - Objects' spatial density evolution;
  - Number of fragments expected greater than a given size.



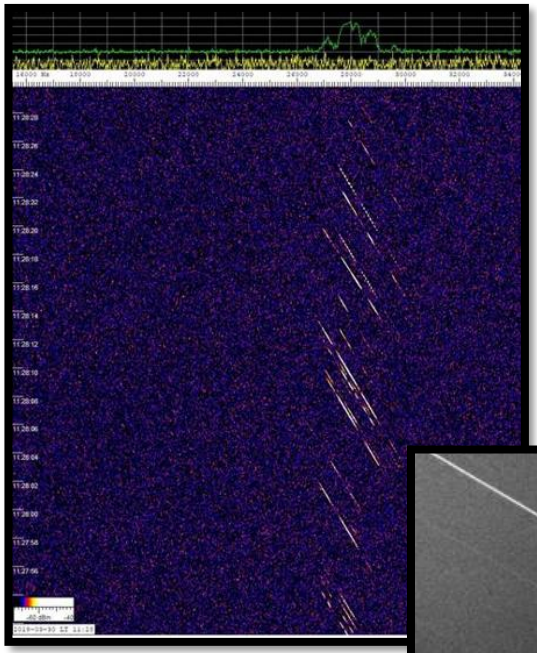


Fragmentation Analysis
Real Case

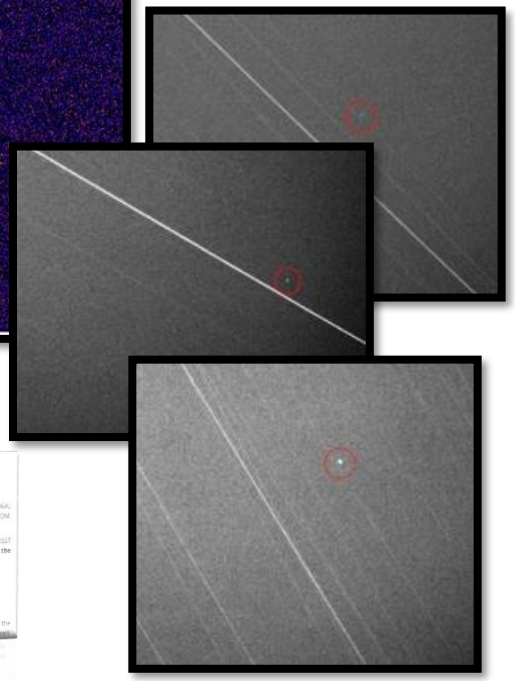
Microsat-R

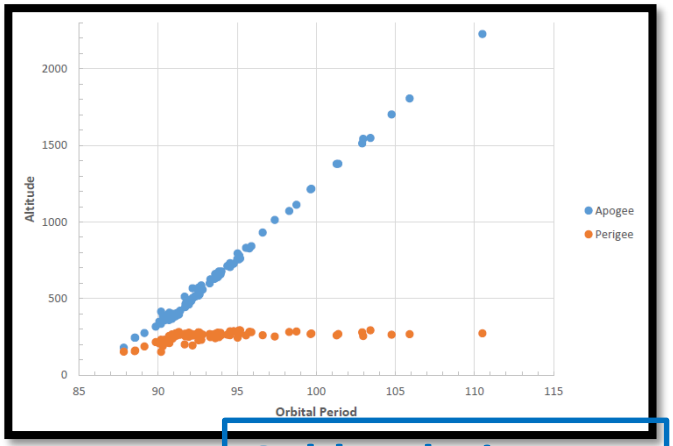


3D Cloud



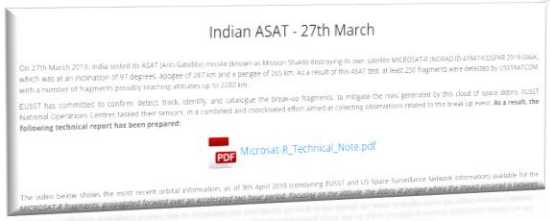
EUSST Contributing Sensors





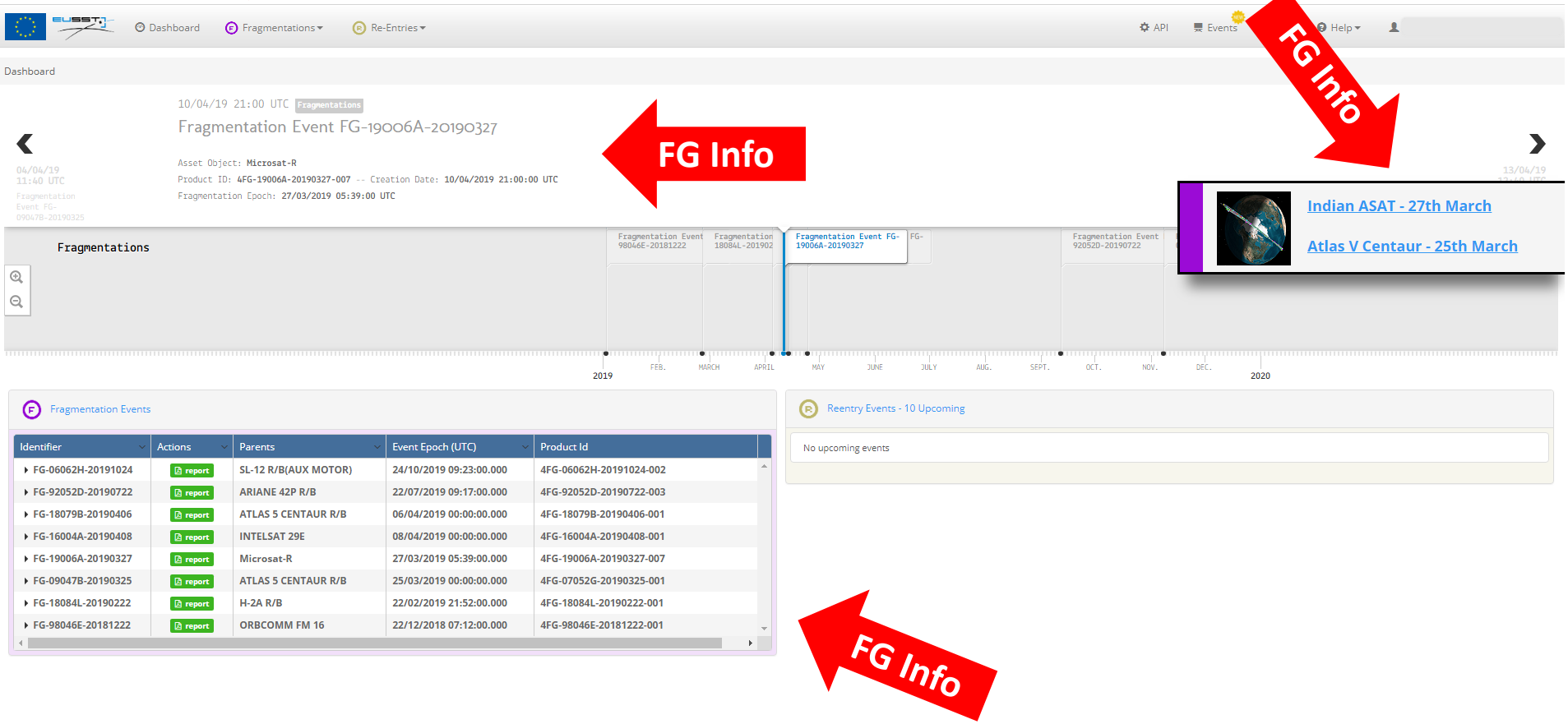
Gabbard Diagram

FG Event Page



Fragmentation Analysis
EUSST Service Provision Portal

FG Info



FG Info

FG Info

Fragmentation Analysis
EUSST Service Provision Portal

FG Events

Dashboard / Fragmentations

Identifier	Messages	Status	Actions	Creation Date (UTC)	Event Epoch (UTC)	Fragments Detected	Parent 1		Publish Date (UTC)	Product Id	Originator
							Name	Int. Designator			
FG-06062H-20191024	2	Downloaded	report	07/11/2019 10:22:44	24/10/2019 09:23:00.000	20	SL-12 R/B(AUX MOTOR)	2006-062H	07/11/2019 11:00:28	4FG-06062H-20191024-002	EUSST
FG-92052D-20190722	3	Not Downloaded	report	11/09/2019 13:14:43	22/07/2019 09:17:00.000	9	ARIANE 42P R/B	1992-052D	11/09/2019 13:50:56	4FG-92052D-20190722-003	EUSST
FG-16004A-20190408	1	Not Downloaded	report	13/04/2019 12:40:00	08/04/2019 00:00:00.000	2	INTELSAT 29E	2016-004A	13/04/2019 14:49:02	4FG-16004A-20190408-001	EUSST
FG-18079B-20190406	1	Not Downloaded	report	23/04/2019 18:50:00	06/04/2019 00:00:00.000	6	ATLAS 5 CENTAUR R/B	2018-079B	23/04/2019 19:07:08	4FG-18079B-20190406-001	EUSST
FG-19006A-20190327	7	Not Downloaded	report	10/04/2019 21:00:00	27/03/2019 05:39:00.000	250	Microsat-R	2019-006A	10/04/2019 21:25:58	4FG-19006A-20190327-007	EUSST
FG-09047B-20190325	1	Not Downloaded	report	04/04/2019 11:40:00	25/03/2019 00:00:00.000	20	ATLAS 5 CENTAUR R/B	2009-047B	04/04/2019 12:49:40	4FG-07052G-20190325-001	EUSST
FG-18084L-20190222	1	Not Downloaded	report	24/02/2019 13:02:00	22/02/2019 21:52:00.000	7	H-2A R/B	2018-084L	24/02/2019 14:01:05	4FG-18084L-20190222-001	EUSST
FG-98046E-20181222	1	Not Downloaded	report	02/01/2019 09:50:00	22/12/2018 07:12:00.000	34	ORBCOMM FM 16	1998-046E	02/01/2019 10:16:43	4FG-98046E-20181222-001	EUSST
FG-14055B-20180831	1	Not Downloaded	report	09/10/2018 07:38:00	31/08/2018 02:00:00.000	70	ATLAS 5 CENTAUR R/B	2014-055B	09/10/2018 09:40:49	4FG-14055B-20180831-001	EUSST
FG-05050F-20180824	1	Not Downloaded	report	02/10/2018 10:11:00	24/08/2018 21:59:00.000	19	SL-12 R/B (AUX MOTOR)	2005-050F	02/10/2018 12:50:17	4FG-05050F-20180824-001	EUSST

1 2 10 items per page

Indian ASAT FG Reports

Dashboard / Fragmentations / FG-19006A-20190327

Index	Status	Actions	Creation Date (UTC)	Event Epoch (UTC)	Fragments Detected	Parent 1		Publish Date (UTC)	Product Id	Originator
						Name	Int. Designator			
7	Downloaded	report	10/04/2019 21:00:00	27/03/2019 05:39:00.000	250	Microsat-R	2019-006A	10/04/2019 21:25:58	4FG-19006A-20190327-007	EUSST
6	Downloaded	report	08/04/2019 19:30:00	27/03/2019 05:39:00.000	250	Microsat-R	2019-006A	08/04/2019 20:42:02	4FG-19006A-20190327-006	EUSST
5	Downloaded	report	05/04/2019 20:00:00	27/03/2019 05:39:00.000	250	Microsat-R	2019-006A	05/04/2019 20:36:54	4FG-19006A-20190327-005	EUSST
4	Downloaded	report	03/04/2019 14:00:00	27/03/2019 05:39:00.000	250	Microsat-R	2019-006A	03/04/2019 14:48:27	4FG-19006A-20190327-004	EUSST
3	Downloaded	report	01/04/2019 14:00:00	27/03/2019 05:39:00.000	250	Microsat-R	2019-006A	01/04/2019 14:48:34	4FG-19006A-20190327-003	EUSST
2	Downloaded	report	29/03/2019 13:15:00	27/03/2019 06:00:00.000	90	Microsat-R	2019-006A	29/03/2019 14:08:41	4FG-19006A-20190327-002	EUSST
1	Downloaded	report	27/03/2019 12:12:00	27/03/2019 06:00:00.000	90	Microsat-R	2019-006A	27/03/2019 13:12:17	4FG-19006A-20190327-001	EUSST

1 All items per page 1 - 7 of 7 items

Fragmentation Analysis
EUSST Service Provision Portal

FG Event Pages

FG Event Pages

Dashboard | Fragmentations | Re-Entries | API | Events | Help

Dashboard

10/04/19 21:00 UTC Fragmentations

Fragmentation Event FG-19006A-20190327

Asset Object: Microsat-R
Product ID: 4FG-19006A-20190327-007 -- Creation Date: 10/04/2019 21:00:00 UTC
Fragmentation Epoch: 27/03/2019 05:39:00 UTC

Indian ASAT - 27th March

Atlas V Centaur - 25th March

Fragmentations

Fragmentation Event 98046E-20181222 | Fragmentation 18084L-201902 | Fragmentation Event FG-19006A-20190327 | Fragmentation Event 92052D-20190722

2019 FEB. MARCH APRIL MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC. 2020

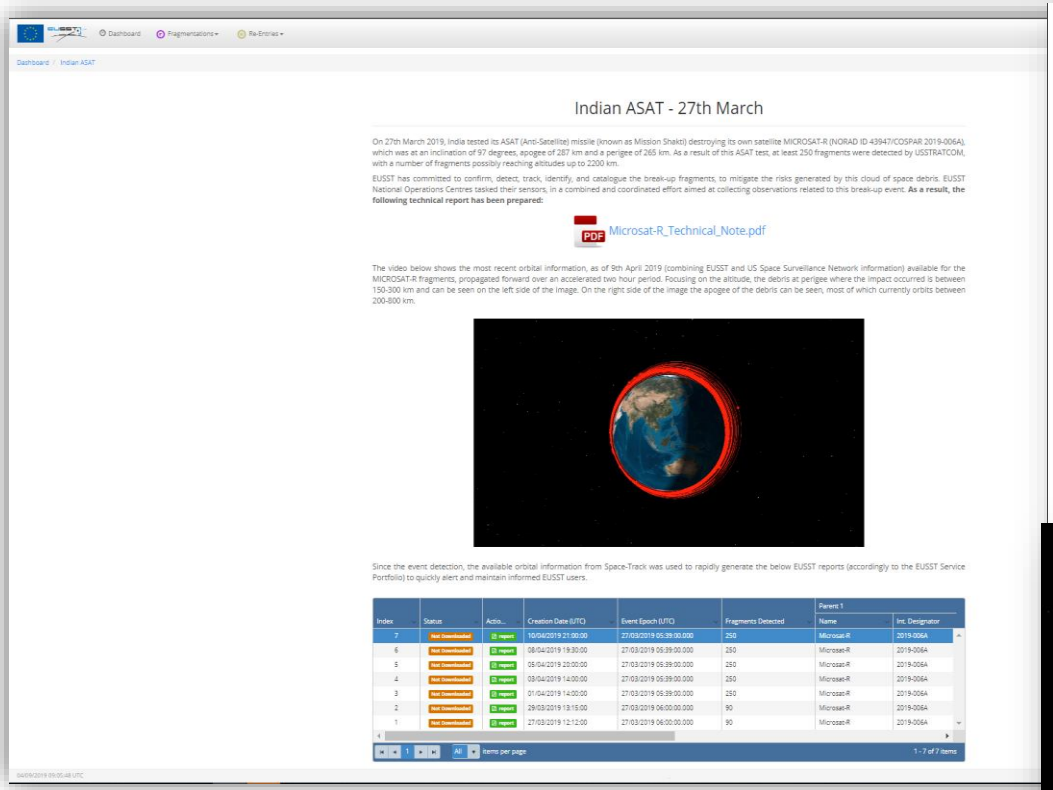
Fragmentation Events

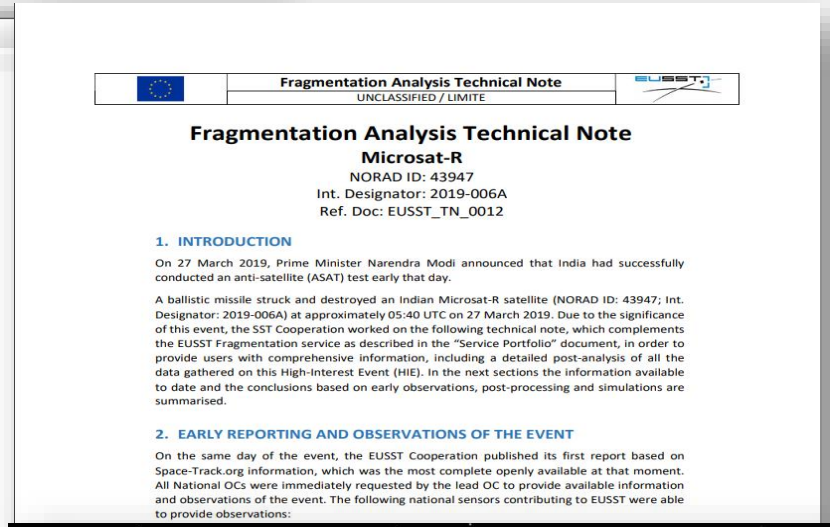
Identifier	Actions	Parents	Event Epoch (UTC)	Product Id
FG-06062H-20191024	report	SL-12 R/B(AUX MOTOR)	24/10/2019 09:23:00.000	4FG-06062H-20191024-002
FG-92052D-20190722	report	ARIANE 42P R/B	22/07/2019 09:17:00.000	4FG-92052D-20190722-003
FG-18079B-20190406	report	ATLAS 5 CENTAUR R/B	06/04/2019 00:00:00.000	4FG-18079B-20190406-001
FG-16004A-20190408	report	INTELSAT 29E	08/04/2019 00:00:00.000	4FG-16004A-20190408-001
FG-19006A-20190327	report	Microsat-R	27/03/2019 05:39:00.000	4FG-19006A-20190327-007
FG-09047B-20190325	report	ATLAS 5 CENTAUR R/B	25/03/2019 00:00:00.000	4FG-07052G-20190325-001
FG-18084L-20190222	report	H-2A R/B	22/02/2019 21:52:00.000	4FG-18084L-20190222-001
FG-98046E-20181222	report	ORBCOMM FM 16	22/12/2018 07:12:00.000	4FG-98046E-20181222-001

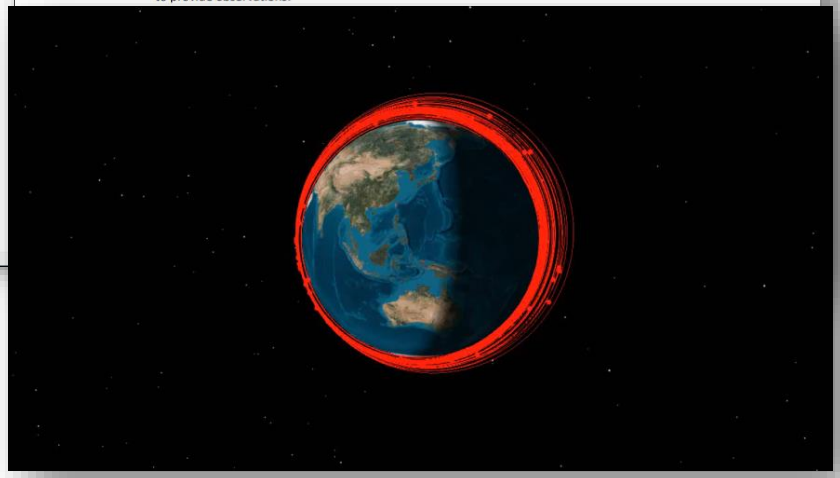
Reentry Events - 10 Upcoming

No upcoming events

Fragmentation Analysis
EUSST Service Provision Portal







Indian ASAT
FG Event Page

Fragmentation analysis
Conclusions

- Autonomous products based on data provided by EUSST contributing sensors.
- Advanced analysis performed within 3 months after the confirmation of the FG event.
- Ad-hoc information for mediatic events.

Questions and Answers

Conclusions

Conclusions

- The EU SST Support Framework was established in 2014 to ensure the long-term availability of European and national space infrastructure, facilities and services, which are essential for the economies, societies and citizens in Europe.
- Currently, 8 EU MS and the EU SatCen are cooperating in the provision of the SST services: Collision Avoidance, Re-entry analysis and Fragmentation Analysis.
- The EUSST Front Desk is the main interface towards the users for the provision of services and user support.
- This webinar is the first of a series of webinars planned under the EU SST Support Framework activities.
- Access to the SST services can be requested through the EUSST Portal at sst.satcen.europa.eu

User Registration & Service Request
https://sst.satcen.europa.eu

Helpdesk
sst.helpdesk@satcen.europa.eu

General Information
www.eusst.eu

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