CGMS

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REPORT ON THE STATUS OF EUMETSAT CURRENT AND FUTURE SATELLITE SYSTEMS

This document summarises the status of EUMETSAT current and future LEO and GEO satellite systems. The reporting period for current satellite operations is 1 July 2011 to 30 June 2012. For future satellites, progress to date at the time of writing is included.

CGMS is invited to take note.

Report on the status of EUMETSAT current and future satellite systems

1 INTRODUCTION

This paper reports on the status of EUMETSAT current and future satellite systems. The reporting period for current satellite operations is1 July 2011 to 30 June 2012. For future satellites, progress to date at the time of writing is included.

2 CURRENT SATELLITE SYSTEMS

EUMETSAT Current GEO satellites

Sector	Satellites in orbit P=pre-operational Op=operational B=back-up L=limited availability	Location	Launch date	Details on near real time access to L0/L1 data (links)	Environmental payload and status
East Atlantic (36°W-36°E)	Meteosat-9 (Op)	0°	21/12/2005	Service Status Data access Level 1 data info	12-channel SEVIRI imager, GERB, DCS Data disseminated via EUMETCAST and LRIT
	Meteosat-10 (Commissioning)	3.4°W	05/07/2012		12-channel SEVIRI imager, GERB, DCS Data disseminated via EUMETCAST and LRIT
	Meteosat-8 (Op)	9.5°E	28/08/2002		Rapid Scanning Service and back-up of Meteosat-9. No Direct broadcast. Dissemination by EUMETCast.
Indian Ocean (36°E-108°E)	Meteosat-7 (Op)	57.5°E	02/09/1997		3-channel imager. Dissemination via EUMETCast Indian Ocean Data Coverage (IODC), currently approved until end of 2013

EUMETSAT Current LEO satellites

Orbit type ECT=Equator Crossing Time (for sun-synchronous orbits)	Satellites in orbit P=pre-operational Op=operational B=back-up, secondary L=limited availability	Equator Crossing Time (ECT) Ascending Node	Mean Altitude	Launch date	Details on near real time access to L0/L1 data (links)	Instrument payload and status
Sun-synchronous "Morning" orbit ECT between 19:00-24:00 and between 07:00-12:00	Metop-A (Op)	21:30	837 km	19/10/2006	Data access L1 data info	AVHRR/3, HIRS/4, AMSU-A, MHS, IASI, GRAS, ASCAT, GOME-2, SEM (HRPT partly functional) Dissemination via EUMETCast
Sun-synchronous "Morning" orbit ECT between 19:00-24:00 and between 07:00-12:00	Metop-B (Metop-1) (Commissioning)	21:30	837 km	17/09/2012		AVHRR, HIRS, MHS,AMSU-A, IASI, ASCAT,GRAS GOME.

2.1 Status of current GEO satellite systems

2.1.1 Mission objectives, payload/instruments, products

The Meteosat system is designed to support nowcasting, short-range forecasting, numerical weather forecasting and climate applications. The system currently comprises two operational satellites of the Meteosat Second Generation (MSG) (Meteosat 8 and 9) providing the core services over Europe and Africa and one satellite of the first generation (Meteosat 7) which is providing Indian Ocean Data Collection services. A third MSG satellite was launched in July 2012 and is currently undergoing commissioning.

Meteosat Second Generation (MSG) consists of a series of four geostationary meteorological satellites, along with ground-based infrastructure, that will operate consecutively until 2020. The MSG satellites carry an impressive pair of instruments — the Spinning Enhanced Visible and InfraRed Imager (SEVIRI), which has the capacity to observe the Earth in 12 spectral channels and provide image data which is core to operational forecasting needs, and the Geostationary Earth Radiation Budget (GERB) instrument supporting climate studies.

Each Meteosat satellite is expected to remain in orbit, in an operable condition for at least seven years. The current policy is to keep two operable satellites in orbit and to launch a new satellite based upon a service availability analysis. After the end of the MSG lifetime there will be a follow-on series in geostationary orbit — Meteosat Third Generation.

2.1.2 Status of spacecraft

During the period from 1 July 2011 to 30 June 2012 the Meteosat -7 (first generation) system performed well.

The Meteosat Second Generation (MSG) system also performed well in the reporting period, but there have been several significant issues of note, including one event after this period reported due to its significance:

2.1.2.1 Meteosat-8

A satellite safe mode occurred on 21 August 2011 (caused by a Single Event Upset)

Degraded service performance was also seen during two months in 2011 due to seasonal fuel migration effects.

In April 2012 a loss of the Sun Sensor Pulses from the on board Attitude and Orbit Control Subsystem was experienced. On board synchronisation was switched to the earth sensors. Changes to the Image Processing Facility algorithms to perform proper image processing using Earth Sensor pulses (as opposed to Sun Sensor pulses which is the nominal method) allowed a reduction of the outage of the image quality of the Rapid Scanning Service (RSS) to a minimum duration (i.e. several hours). The investigation board concluded that a thermal frame had become displaced from the satellite periphery and is obstructing the sun sensor view on a seasonal basis. The RSS is currently provided with performance within specification using Earth Sensor data.

2.1.2.2 Meteosat-9

An improvement to the SEVIRI WV channels dynamic range was successfully deployed in operations for the Meteosat-9 0° Services on 8 November 2011.
On 12 August 2012, Meteosat-9 also suffered a detachment of a thermal frame from the satellite periphery, with similar symptoms as reported for Meteosat-8 above. To date, the satellite functionality and, in particular its thermal control, do not seem to be significantly impaired. However, a few in-orbit tests need to be performed and a few more eclipses passed before gaining full confidence on the status of the satellite.

2.1.2.3 MSG-3

2.1.2.3.1 MSG Launch, LEOP and commissioning

The launch of MSG-3 took place successfully on 5 July 2012 . The subsequent LEOP phase was nominal, following which satellite control was handed over to EUMETSAT on 16 July 2012. MSG-3 reached its final commissioning longitude at 3.4 W on 24 July, since then MSG-3 commissioning is ongoing and progressing well.

The first SEVIRI image was successfully acquired on 7 August 2012. The first GERB image was then acquired on 10 August 2012. Dissemination of MSG-3 data (images and meteorological products) as part of commissioning activities started in late September 2012. The satellite is undergoing in orbit testing and calibration activities as part of the satellite and system commissioning. The plan is to complete all the satellite and system commissioning activities by end of the year with the Satellite Commissioning Results Review and the System Commissioning Results Review, following which the readiness for routine operations of MSG-3 will be declared. MSG-3 will then be re-named as Meteosat-10.

2.1.2.3.2 In orbit satellites relocation plan

The plan of satellite relocation foresees:

- Meteosat-10 will replace all Meteosat-9 services: current position 3.4°W; final position 0 Degree longitude
- Meteosat-9 will replace Meteosat-8 services, current position 0 Degree longitude, final position 9.5°E

Meteosat-8 , current position at 9.5°E, will be: relocated at 3.5°East, remaining in full disc imaging but not disseminating, to provide a “hot stand-by” backup for Meteosat-10 and Meteosat-9

Satellites will be relocated in the timeframe January - April 2013.

2.1.2.4 MSG-4

Based on the satellite in orbit status, the MSG-4 launch date has been re-planned targeting a launch by early 2015 (Jan/Feb 2015), to be followed by a period of satellite in orbit storage of about two years. The MSG-4 satellite is currently stored in a clean-room. The major item which remains open for MSG-4 is the replacement of the Drive Unit (DU) of SEVIRI which was the root cause of an anomaly discovered during MSG-4 integration. Manufacturing the new DU was finally completed in early March 2012 and reassembly of the drive unit (DU) has now been done. The measurement of the DU performance before environmental tests evidences that the DU is within specification. The environmental test of the DU will be done this year, in October/November timeframe.

In view of the limited amount of spares for MSG-4, the highest schedule risk for MSG-4 is the failure of a flight unit during the preparation for launch. For this, dedicated mitigation actions have been considered to minimize the time to repair flight units should the need occur, oriented to ensure the readiness for repair.

The GERB-4 instrument has been in long term storage since December 2009. Recalibration is scheduled to start towards the end of 2012.

2.1.3 Impact on spacecraft due to space weather

Space weather related spacecraft anomalies (Items in bold are required)

Source: Recommendations for Contents of Anomaly Database for Correlation with Space Weather Phenomena, P. O'Brien, J.E. Mazur, T. Guild, November 2011, AEROSPACE Report No.TOR-2011(3903)-5.

1. Date and Universal Time of the anomaly	**2. Fully specified location of the anomaly** (spacecraft location)	**3. Velocity or orbital elements at time of the anomaly**	4. Eclipse state of the vehicle (full, penumbra, partial, none)	5. Vector to Sun in spacecraft coordinates	6. Velocity vector of spacecraft in spacecraft coordinates	7. Initial guess at type of anomaly (See taxonomy below)	8. Estimated confidence of that guess	9. Anomaly category (e.g., affected system or kind of disruption)	10. Vehicle identity	11. Notes (e.g. unusual operational states or recent changes to operations (recent commands, attitude scheme, etc.)
21 August 2011	Geo (9.5deg East)		No eclipse			Galactic Cosmic Rays	High	Satellite Safe Mode	Meteosat-8	
13 Oct 2011	Geo (9.5deg East)		No eclipse			Galactic Cosmic Rays	High	Communication Transponder interface switched ON uncommanded	Meteosat-8	
7 Dec 2011	GEO (0 deg)		No Eclipse			Single event	High	GERB memory corrupted	Meteosat-9	Non-Permanent (reset by switch-off)

30 Jan 2012	GEO (0 deg)		No Eclipse			Single event	High	GERB memory corrupted	Meteosat-9	Non-Permanent (reset by switch-off)
23-March-2012	GEO (0 deg		No Eclipse			Galactic Cosmic Rays	High	Battery Charging ended early	Meteosat-9	No operational impact
24 Apr 2012	GEO (0 deg)		No Eclipse			Single event	High	GERB memory corrupted	Meteosat-9	Non-Permanent (reset by switch-off)
6 Jun 2012	GEO (0 deg)		No Eclipse			Single event	High	GERB memory corrupted	Meteosat-9	Non-Permanent (reset by switch-off)

Taxonomy of Satellite Anomalies Caused by In Situ Charged Particle Environment (to be used for column 7):

1. Electrostatic discharge (charging)
    - 1.1 Surface charging
        - 1.1.1 Plasma sheet (subauroral)
        - 1.1.2 Auroral
    - 1.2 Internal charging
        - 1.2.1 Subsurface charging (e.g., beneath blanket)
        - 1.2.2 Deep charging (e.g., inside a box)
2. Single-Event Effects
    - 2.1 Protons
        - 2.1.1 Solar proton event
        - 2.1.2 Geomagnetically trapped protons
    - 2.2 Heavy ions
        - 2.2.1 Galactic Cosmic Rays
        - 2.2.2 Solar energetic particles
        - 2.2.3 Geomagnetically trapped heavy ions
3. Total Dose
    - 3.1 Long-term dose accumulation (multiple causes combined)
    - 3.2 Short-term (days or less) dose accumulation
        - 3.2.1 Solar protons
        - 3.2.2 Geomagnetically trapped protons
        - 3.2.3 Geomagnetically trapped electrons

2.1.4 Ground segment matters

The availability of the Meteosat (first and second generation) ground segments was nominal in the reporting period.

A third imaging chain (including an additional antenna) has been added and validated to avoid RSS interruptions during the MSG-3 commissioning.

2.1.5 Data transmission

GEO satellite product dissemination is made via EUMETCast.

EUMETCast is EUMETSAT's primary dissemination mechanism for the near real-time delivery of satellite data and products generated by the EUMETSAT Application Ground Segment. Third party data and products from partner organisations are also delivered by the system, which is based on Digital Video Broadcast (DVB) technology. EUMETCast comprises three services:

Ku-band Europe service
C-band Africa service
C-band Americas service

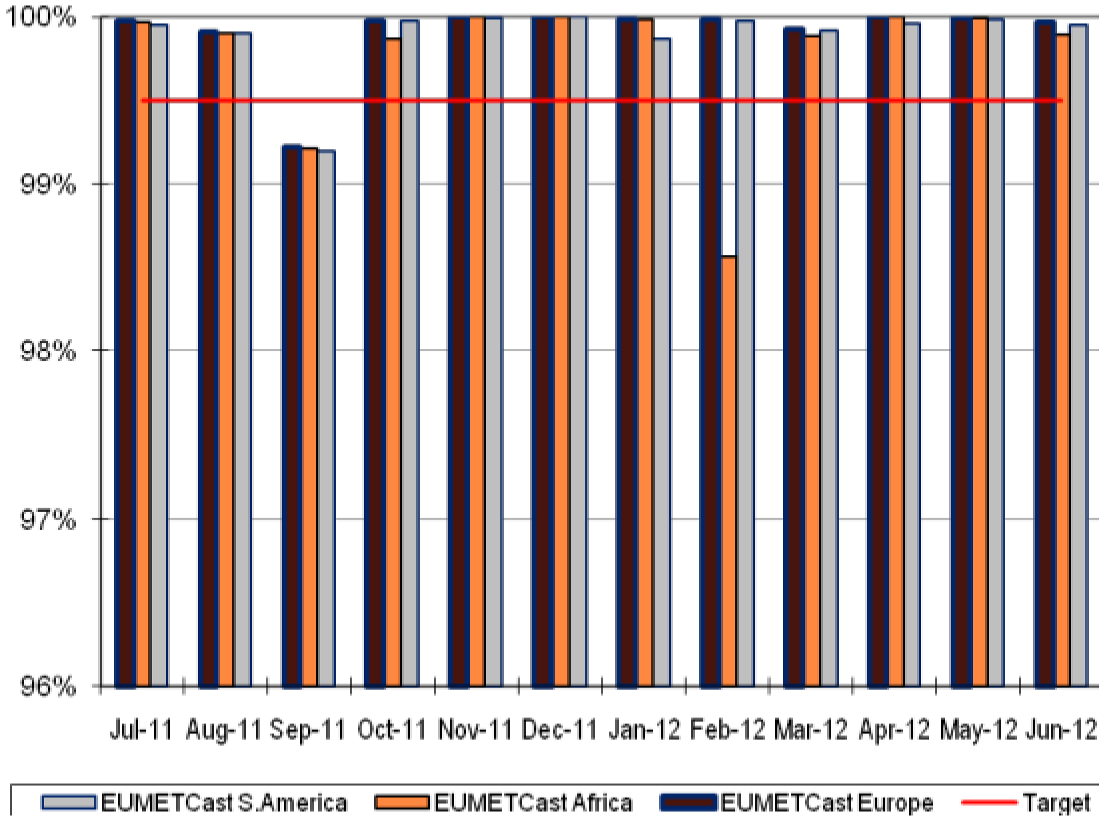

Figure 1: EUMETCast Availability

As can be seen in Figure 1, all services provided very good availability over the reporting period with the following exceptions:

- 5 hours of severe degradation was experienced in the night of 4/5 September 2011 caused by a malfunction at the service provider site. All services were affected.
- On 3-4 February 2012, extreme weather at C Band Africa uplink led to a 20 hour degradation of the C-Band turnaround service for Africa.
- An interruption of 30 min on EUMETCast Europe occurred on 29 March 2012, caused by hardware degradation in the uplink chain.

2.1.6 Projects, services

<u>GOES and MTSAT Data Dissemination Service</u>

EUMETSAT receives image data from Météo-France (Lannion) hourly for retransmission via EUMETCast to end users. Image data is received from NOAA (GOES-11, GOES-15 and GOES-13) and from JMA (MTSAT-2).

<u>FY-2D&E Data Dissemination Service</u>

EUMETSAT receives image data and meteorological products from FY-2D (86.5° E) and FY-2E (105° E) for retransmission via EUMETCast to end users. The implementation of the full data stream from FY-2D started in November 2011. A stable data flow from FY-2D was established in January 2012.

The monthly end-to-end availability of FY-2E and FY-2D images and products (complete and timely hourly cycles) was close to 99% excluding planned outages during the eclipse period. Occasionally the data delivery from CMA to EUMETSAT was partially interrupted and resumed after intervention by the operations teams.

<u>DWDSAT and RETIM</u>

The DWDSAT and RETIM services on EUMETCast were nominal throughout the period.

<u>BMD and MDD service</u>

The Basic Meteorological Data (BMD) and Meteorological Data Dissemination (MDD) services on EUMETCast were nominal throughout the period.

MDD is currently part of the MSG Direct Dissemination Service and available on EUMETCast and BMD is implemented as a GTS-like data stream on a dedicated EUMETCast channel.

The BMD/MDD harmonisation activity started in July 2011. It has the goal of implementing GTS-like data streams for both services using WMO file naming on dedicated EUMETCast channels. This will also allow better data discovery using the EO-Portal and Product Navigator.

In July 2012 new ATDNet Lightning Detection products for Africa were introduced on the “WMO-RA-I” channel on EUMETCast.

EC FP7 Projects

The dissemination performance of the Seventh Framework Programme (FP7) data streams reflects the general EUMETCast performance.

The product flow from the EAMNET, Agricab and Geoland2 projects are ramping up. New channels have been created for dedicated dissemination of FP-7 products to the various footprints. All these projects provide environmental products for developing countries in South America and Africa.

Other EU FP-7 Projects have not yet reached the dissemination operations phase.

GEONETCast Data Exchange

The data exchange between NOAA, CMA and EUMETSAT is continuing with exchanged data being disseminated on GEONETCast Americas, CMACast and EUMETCast.

The interface between the Chinese Meteorological Administration (CMA) and EUMETSAT in the GEONETCast context has now reached a state that presents a fully integrated GEONETCast data exchange and dissemination system. Both CMA and EUMETSAT have implemented dedicated channels (subnets) for broadcasting products on each other's dissemination system.

The implementation of users to the EUMETSAT subnet on CMACast is pending the deployment of CMACast stations within the wider Asia-Pacific region.

Other Projects

Within the context of the AMESD programme a number of existing products on EUMETCast are now available to the AMESD users via EUMETCast-Africa. In addition, data providers are producing dedicated products for the AMESD community, such as Ocean Sea Ice Satellite Application Facility (OSI SAF), Collecte Localisation Satellite (CLS), and University of Cape Town (UCT). The implementation status of these data flows are in various stages from planning to operational dissemination.

Furthermore, as part of the AMESD programme, Regional Implementation Centres (RICs) will create dedicated regional products for the dissemination on EUMETCast. Out of these RICs, the National Meteorological Service of Botswana for the Southern African region (SADC) went into the production phase, and the related products are being transmitted on EUMETCast.

Following the failure of ESA's Envisat satellite the related NRT products for the AMESD community on EUMETCast were suspended.

In the GEONETCast context the dissemination of products from NOAA NESDIS, US-EPA, SERVIR and RANET is ongoing with nominal status. The dissemination trial of weather products from the South African Weather Service (SAWS) will be reassessed in 2013.

The distribution of OSFAC (Observatoire Satellital des Forêts d'Afrique Centrale) Land Application Products on EUMETCast consisting of Landsat scenes for Central Africa started on 12 July 2012.

Vegetation data for Africa, provided by VITO, and Rainfall Estimates, provided by Tamsat / University of Reading, were nominal throughout the reporting period.

2.1.7 User statistics

EUMETCast

The status of EUMETCast registrations up to 30 June 2012 is provided in Figure 2. Note that Total number of registered Users was 3217 (users may have more than one station).

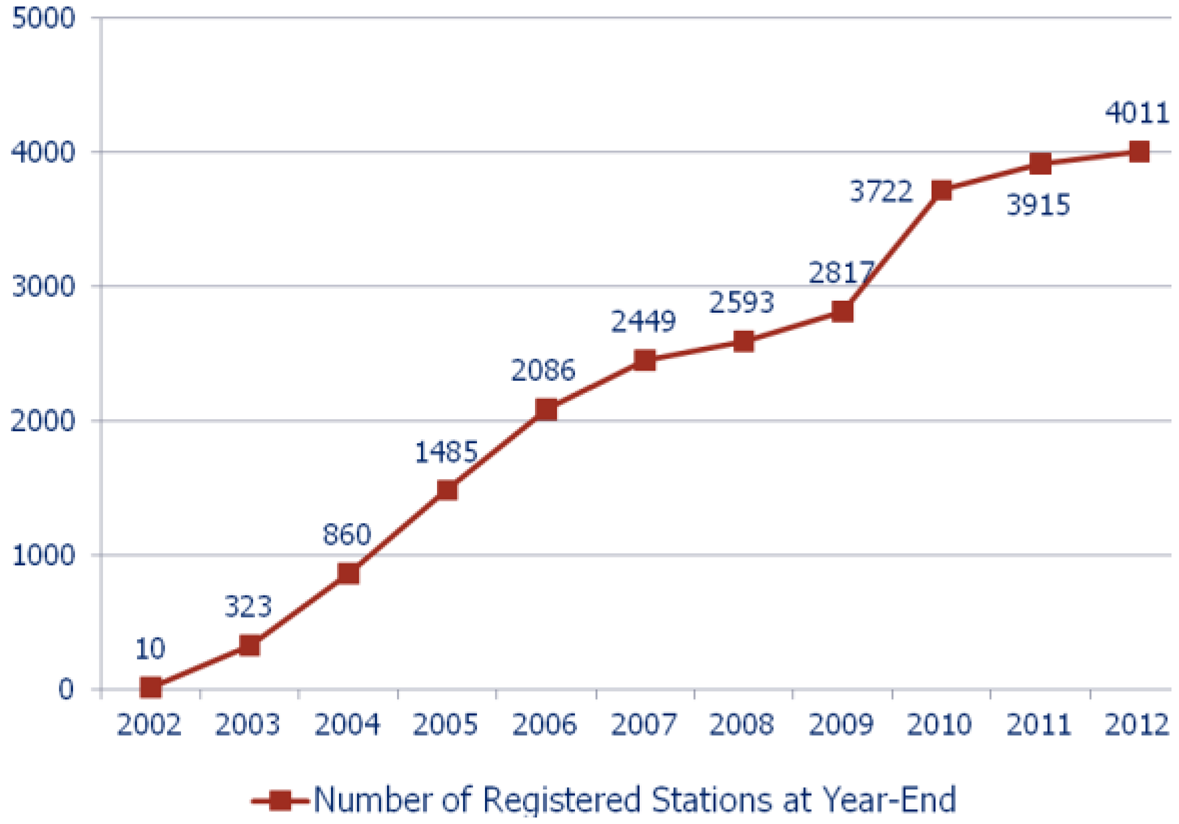

Figure 2: EUMETCast Registrations

The availability of the EUMETCast dissemination system has already been provided in Section 2.1.5.

The EUMETSAT Data Centre

EUMETSAT's Data Centre archives all payload data acquired from EUMETSAT's operational satellites and most of the products derived from that data. The Data Centre allows registered users to request data and products from the archive by use of its online 'self-service' ordering mechanism and supplies the requested items via physical media and the Internet. It also allows 'bulk orders' for long time-periods of data and 'standing orders' for repeated delivery of data / products over specified time periods to be requested for special needs.

The trend of orders and deliveries is provided in Figure 3 below. The chart here shows the orders processed on a monthly basis by the Data Centre and the resulting volumes of data delivered to the users in the 2 years up to and including June 2012.

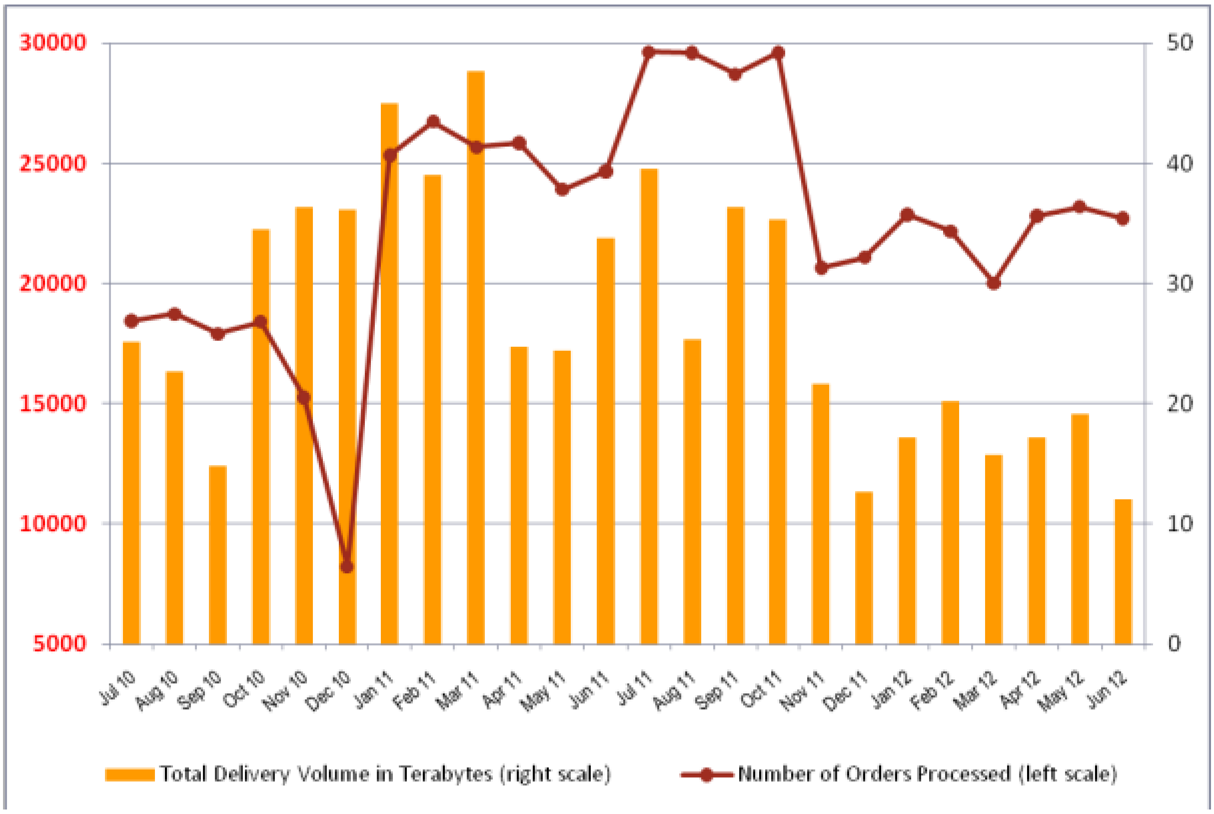

Figure 3: Data Centre Orders Processed and Delivered

All types of orders (regular, bulk and standing) are included in the statistics. There can be significant variation in the amount of data delivered per order, which thus gives rise to only a loose correlation between the numbers of orders processed in a month and the total volume of data delivered. Since the start of 2012, some consolidation of standing orders has been made and consequently numbers of orders and delivery volumes have decreased in general, as can be seen from the chart.

2.2 Status of current LEO satellite systems

2.2.1 Mission objectives, payload/instruments, products

The prime objective of the EUMETSAT Polar System (EPS) Metop mission series is to provide continuous, long-term datasets, in support of operational meteorological and environmental forecasting and global climate monitoring.

The EPS programme consists of a series of three polar orbiting Metop satellites, to be flown successively for more than 14 years, from 2006, together with the relevant ground facilities.

Metop-A was launched on 19 October 2006 and Metop-B was launched on 17 September 2012.

Metop carries a set of 'heritage' instruments provided by the United States and a new generation of European instruments that offer improved remote sensing capabilities to both meteorologists and climatologists. The new instruments will augment the accuracy of temperature humidity measurements, readings of wind speed and direction, and atmospheric ozone profiles.

Taking advantage of the presence of Metop-B and the continuation in-orbit of Metop-A, it is planned to develop a reduced-swath GOME tandem product in order to improve resolution. This shall be commenced once the correct calibration and validation of the standard operational GOME mode on Metop-B has been completed.

Under the Initial Joint Polar System (IJPS) and Joint Transition Activities (JTA) agreement, EUMETSAT and NOAA have agreed to provide instruments for each other's satellites; exchange all data in real time, and assist each other with backup services. NOAA, with the support of NASA and the US National Science Foundation also provide an Antarctica Data Acquisition (ADA) service providing global data acquisition and real-time transmission to the EUMETSAT processing facilities in order to reduce data dissemination latency. This service is currently in its demonstration phase (until Q1 of 2014) in which not all passes may be acquired.

Full details of the satellite, its instruments and access to the related data and products can be found on www.eumetsat.int .

2.2.2 Status of spacecraft

The recently launched Metop-B is currently undergoing commissioning.

The Metop-A satellite continued to perform well over the reporting period. The following points are noteworthy:

An IASI Single Event Upset (SEU) requiring ground recovery took place on 25 July 2011;

An IASI outage due to a commanding conflict occurred on 18 August 2011;

A payload switch-off (PLSOL) due to a suspected SEU was triggered by the satellite platform on 22 October 2011 leading to outages on all instruments;

Problems with a new version of GRAS on-board software led to GRAS data losses on 26/27 October 2011;

The MHS channels 3,4 degradation led to the need to swap the local oscillator on 6 December 2012, which restored nominal performances. However, it was subsequently observed that degradation is occurring more rapidly than at the start of the mission and we could expect to reach previously experienced peaks of Noise Equivalent Delta Temperature by mid-2013;

On 2 March 2012, it was necessary to perform a collision avoidance manoeuvre due to a high-risk conjunction with a piece of the Iridium-33 debris (from its 2009 collision with COSMOS 2251). This was soon followed on 14 April 2012 by another manoeuvre to avoid a high-risk conjunction with a piece of Fengyun-1C debris (the result of the Chinese anti-satellite missile test on 11 January 2007). These represent the second and third collision avoidance manoeuvres performed on Metop-A (the first was on 1 May 2011).

A double-burn out-of-plane (OOP) manoeuvre was successfully executed on 28 September 2011, followed by an in-plane manoeuvre in December 2011. It is now anticipated that the next OOP will not be necessary until March 2013. The above mentioned collision avoidance manoeuvres also allowed the ground track to be maintained to avoid further need for in-plane manoeuvres during the reporting period.

2.2.3 Impact on spacecraft due to space weather

Space weather related spacecraft anomalies (Items in bold are required)

Source: Recommendations for Contents of Anomaly Database for Correlation with Space Weather Phenomena, P. O'Brien, J.E. Mazur, T. Guild, November 2011, AEROSPACE Report No.TOR-2011(3903)-5.

1. Date and Universal Time of the anomaly	**2. Fully specified location of the anomaly** (spacecraft location)	**3. Velocity or orbital elements at time of the anomaly**	4. Eclipse state of the vehicle (full, penumbra, partial, none)	5. Vector to Sun in spacecraft coordinates	6. Velocity vector of spacecraft in spacecraft coordinates	7. Initial guess at type of anomaly (See taxonomy below)	8. Estimated confidence of that guess	9. Anomaly category (e.g., affected system or kind of disruption)	10. Vehicle identity	11. Notes (e.g. unusual operational states or recent changes to operations (recent commands, attitude scheme, etc.)
25 July 2011 09:16:31	Latitude : 55.9° S Longitude: 164.0° W	Speed: 7431 m/s Height: 827 Km Perigee: 813 Km Apogee: 828 Km Inclination : 98.7°	Eclipse: Shadow (Full)			Single-Event Effects (2)		IASI Instrument	Metop-A	Ground recovery necessary (not in on-board auto-recovery list)
22 October 2011 22:38:48	Latitude : 60.3° N Longitude: 33..2° W	Speed: 7445 m/s Height: 813 Km Perigee: 813 Km Apogee: 827 Km	Eclipse: Shadow (Full)			Single-Event Effects (2)		Suspected SEU on opto-coupler of payload distribution unit	Metop-A	Entire Payload Switch-down Significant outage to all instruments.

		Inclination : 98.7°								
27 Nov. 2011 10:38:19	Latitude : 2.8° S Longitude: 17..8° W	Speed: 7441 m/s Height: 823 Km Perigee: 814 Km Apogee: 827 Km Inclination : 98.7°	Eclipse: None			Single-Event Effects (2)		IASI Instrument	Metop-A	Auto-recovery took place (negligible impact on data)
28 Nov. 2011 12:26:36	Latitude : 75.4° S Longitude: 171..8° E	Speed: 7428 m/s Height: 827 Km Perigee: 813 Km Apogee: 827 Km Inclination : 98.7°	Eclipse: None			Single-Event Effects (2)		IASI Instrument	Metop-A	Auto-recovery took place (negligible impact on data)

Taxonomy of Satellite Anomalies Caused by In Situ Charged Particle Environment (to be used for column 7):

1. Electrostatic discharge (charging)
   - 1.1 Surface charging
     - 1.1.1 Plasma sheet (subauroral)
     - 1.1.2 Auroral
   - 1.2 Internal charging
     - 1.2.1 Subsurface charging (e.g., beneath blanket)
     - 1.2.2 Deep charging (e.g., inside a box)
2. Single-Event Effects
   - 2.1 Protons
     - 2.1.1 Solar proton event
     - 2.1.2 Geomagnetically trapped protons
   - 2.2 Heavy ions
     - 2.2.1 Galactic Cosmic Rays
     - 2.2.2 Solar energetic particles
     - 2.2.3 Geomagnetically trapped heavy ions
3. Total Dose
   - 3.1 Long-term dose accumulation (multiple causes combined)
   - 3.2 Short-term (days or less) dose accumulation
     - 3.2.1 Solar protons
     - 3.2.2 Geomagnetically trapped protons
     - 3.2.3 Geomagnetically trapped electrons

2.2.4 Impact of Space Debris

Space debris related spacecraft events

1. Date and Time of the event	2. Location of the event (spacecraft position)	3. Orbital velocity at time of the event	4. Identity and size of offending object	5. Miss distance at closest conjunction	6. Angle and velocity of conjunction in S/C frame	7. Predicted collision probability	8. Executed Manoeuvre (size, time)	9. Mission Impact	10. Space asset identity	11. Notes
1 May 2011 06:00 UTC	On-orbit: 113.7 deg long: 64.9 deg lat: 1.2 deg	7.4 km/h	Cosmos 2251 debris #34451 < 0.1m^2	Total: 55.1 m Radial: -8.4 m	170.3 deg 14.7 km/h	1/320	In-plane: -0.015 m/s; 1.5 orbits before TCA	Earlier dead band exit; marginal fuel loss	Metop-A	Frontal conjunction: debris velocity opposite to asset one. 60 grams of fuel penalty observed
2 March 2012 23:58 UTC	On-orbit: 91.1 deg long:-2.1 deg lat: 81.2 deg	7.4 km/h	Iridium 33 debris #33874 < 0.1 m^2	Total: 207.6 m Radial: 27.1 m	-143.8 deg 12 km/h	1/2600	In-plane -0.015 m/s; 6.5 orbits before TCA	None	Metop-A	Side conjunction: debris velocity normal to asset one. Manoeuvre used to avoid exit from the ground-track
14 April 2012 06:53 UTC	On-orbit: 79.9 deg long: 2.8 deg lat: 84.8 deg	7.4 km/h	Fengyun-1C debris #30451 < 0.1 m^2	Total: 239.9m Radial: 0.8 m	94.2 deg 0.3 km/h	1/1300	In-plane 0.015 m/s; 7.5 orbits before TCA	None	Metop-A	Parallel conjunction: debris velocity parallel to asset one. Manoeuvre used to initiate ground-track control cycle
19 September 2012 20:35 UTC	On-orbit: 17.5 deg long 10.7 deg lat 17.4 deg	7.4 km/h	Fengyun-1C debris #31291 < 0.1 m^2	Total: 454.6 Radial: -3.4	-151.5 deg 13 km/h	1/7900	In-plane 0.539 m/s; 19/09/2012 06:53 UTC	None	Metop-B	Maneuver performed by ESA/ESOC during LEOP. Manoeuvre used to calibrate the thrusters

2.2.5 Ground segment matters

The EPS Ground Segment has performed very well since Metop-A launch supporting both EPS and NOAA operations. The entire ground segment was successfully validated to support dual-Metop operations in readiness for the launch of Metop-B.

Another upgrade of note was the implementation and entry into operations of the GEANT link between Svalbard and EUMETSAT as a back-up to the primary fibre link. A reduced-capacity satellite link is maintained only as a backup for TTC traffic.

Due to some problems experienced in the reception of data from NOAA to EUMETSAT, a new redundant link is being established which is expected to improve availability of the IJPS data flows.

The ADA Service provided on average 10.8 passes per day from McMurdo over the reporting period. On 12 June 2012, McMurdo suffered electrical damage to MG1 following a power failure during extreme weather conditions. Despite the extent of the damage and continuing bad weather, NSF and NASA teams were able to restore the service on 14 June, after a total loss of 53 passes.

The EUMETSAT Advanced Retransmission Service (EARS) acquires regional data at a network of European ground stations and retransmits the data for processing and dissemination from the EUMETSAT Central Site, thereby providing regional data timeliness in the order of 30 minutes from sensing.

In early 2012, the EARS-IASI service joined the already established EARS-ATOVS, EARS-AVHRR, EARS-ASCAT services, which showed a high availability.

With respect to Metop-B, the ground segment has been upgraded to handle the parallel operations of Metop-A and –B, and these upgrades have been rolled out to the operational ground segment GS-1.

Changes to the operational ground segment have been reduced to a minimum since the system Launch and Operations Readiness Review in January 2012. The ground segment GS-1configuration was frozen from a month before the Metop-B launch, with changes once more allowed from the end-October 2012. This is normal practice to ensure a stable system during launch and satellite in-orbit verification activities.

2.2.6 Data transmission

LEO satellite product dissemination is made via EUMETCast. This applies to the global data and the regional data acquired by EARS stations. Please refer to Section 2.1.5 for a report on EUMETCast availability.

Metop satellites also provide a direct broadcast service through the Advanced High Resolution Picture Transmission (A-HRPT) subsystem. Following the failure of the prime A-HRPT on Metop-A in 2007 due to heavy-ion impact, the redundant A-HRPT unit operation is providing a restricted, zone-based operations service, avoiding regions of high cosmic ray and proton activity such as the polar regions and the South Atlantic Anomaly. The extent of the operational zones can be found on:

http://www.eumetsat.int/Home/Main/DataAccess/DirectDissemination/index.htm?l=en

Data from Metop-B is becoming incrementally available to users through the direct broadcast High Resolution Picture Transmission (A-HRPT) service. Since the A-HRPT on Metop-B was reengineered as a result of the lessons learned from the Metop-A A-HRPT failure (see Section 2.2.6), users around the globe are already able to receive instrument commissioning raw data, without restriction.

Level 1 product data is already being disseminated to commissioning partners (e.g. ECMWF, UK Met Office, Meteo-France, Deutscher Wetter Dienst) as the data calibration and validation (Cal/Val) continue. Once Cal/Val activities on a given instrument chain are complete, pre-operational dissemination to all users is intended, prior to the end of the Commissioning Phase.

Level 1 Commissioning is expected to be completed by end-April 2013, at which point, assuming performances are as good as or better than Metop-A, Metop-B will become the prime operational satellite. The Antarctic Data Acquisition Service is planned to switch from serving Metop-A to acquiring the dumps from Metop-B at this point, to ensure maximum service performance of the prime satellite.

The actual progress of the Metop-B commissioning can be found via the link:
http://www.eumetsat.int/metop-b/

2.2.7 Projects, Services

EARS Extension Project

The project objective is to extend the EARS service to include IASI. The new EARS-IASI service is intended to provide L1C products including 366 selected IASI channels as well as a set of Principal Component scores covering the full IASI spectra. As reported above, the service is now operationally disseminated over EUMETCast. The remaining activity is to begin distribution of these data via the RMDCN/GTS, which is expected to be completed during Q4 2012.

Suomi NPP Global and Regional Service Projects

The Suomi NPP satellite was successfully launched on 28 October 2011 and is currently undergoing commissioning under NASA responsibility. It will be the first of the next generation of polar spacecraft to be operated by NOAA, and will be followed by JPSS-1. The baseline Suomi NPP/JPSS-1 services are defined to be equivalent to the current and approved operational services for data from the US satellites in the Afternoon Orbit. They will ensure continuity, once Suomi NPP takes the role as the primary operational satellite in this orbit, within the IJPS.

Global Data

EUMETSAT is providing global data from Suomi NPP to its user community via EUMETCast and the GTS/RMDCN. These data will allow them to fulfil any Cal/Val commitments and to access the data for routine operational use.

EUMETSAT's Suomi NPP related activities will encompass:

- The acquisition of global data from the CrIS, ATMS and VIIRS instruments from NOAA;
- The tailoring of these data according to the requirements of the user community;
- The dissemination of the tailored products to the user community.

On 12 January 2012, NOAA and EUMETSAT successfully completed the first round of formal interface testing between the two ground segments. The routine dissemination of ATMS and CrIS SDR data via EUMETCast to Member State NMHSs, as well as to ECMWF and to manufacturers of satellite data reception systems began on 11 July 2012. The EUMETCast distribution was enabled for all users on 31 July 2012.

The distribution of the tailored data from ATMS and CrIS via EUMETSAT and RTH/GISC Offenbach to the global GTS community was also activated on 31 July 2012.

In the coming months EUMETSAT will continue to work with NOAA in order to coordinate the acquisition, tailoring and redistribution of additional NPP datasets as these become available from NOAA.

Regional Data

The core European EARS stations are being upgraded to support Suomi NPP and to establish operational regional services for ATMS, CrIS and VIIRS instrument data.

The expected Suomi NPP Operational Readiness of the stations is Q3 2012 Athens and Q4 2012 for Lannion, Svalbard and Maspalomas. As a consequence of the severe flooding which impacted Greenland in July, the installation of the Kangerlussuaq station has been postponed to summer 2013.

Work is also progressing to establish the product processing for the ATMS, CrIS and VIIRS instrument data based on the CSPP processing package.

The start of early access services will depend on the progress of commissioning activities, availability of the calibration tables and the availability of CSPP for processing to Level-1. The expected early access start to the EARS services are: EARS-ATMS and EARS-CrIS in Q4 2012 and EARS-VIIRS in 2013.

Jason-2 Data Processing and Dissemination Service

This service delivers the 'Operation Geophysical Data Record' products, derived from the altimetry data acquired from the Jason-2 satellite. Jason-2 is the second satellite of the space segment of the Ocean Surface Topography Mission (OSTM), a cooperation between EUMETSAT, NOAA, CNES and NASA. EUMETSAT and NOAA process the data from the Jason-2 satellite in near real-time and archive and disseminate the products.

Overall, for the year ending June 30 2012, the Jason-2 System provided a good operational service with availability around 98% and in the region of 90% of data meeting the 3 – hour timeliness target.

Note that since data can be redumped, many ground segment problems may affect only the data latency 3-hour timeliness target, but not the 5-hour availability target, hence the difference between the reported figures.

For the year-ending 30 June 2012, different problems impacted the data latency: several ground stations anomalies (Usingen, Fairbanks and Wallops), connectivity problems between NOAA and EUMETSAT, a ground processor problem and a few EUMETCast outages. In March 2012, problems at NOAA also lead to a loss of data of about 66 minutes in total.

Note also that from July until September 2011 NOAA performed building and antenna moves at Fairbanks. This resulted in less passes available at that station impacting the overall timeliness of the Jason-2 products, but the performance still remained within requirements.

Special calibrations of the POSEIDON-3 instrument were carried out on 25 August 2011 and on 10 February 2012, resulting in a planned data gap of around 34 minutes in each case.

An upgrade of the ECMWF model (to c37r3 model on 15 November 2011) was also made with minor impacts on the Jason-2 mission data availability.

The Jason-2 products have been enhanced to the GDR-D standard on 31 July 2012; the BUFR encoding software was also upgraded accordingly.

MODIS Data Dissemination Service

EUMETSAT receives the following MODIS data from NASA for redistribution via EUMETCast:

- Level 1 calibrated radiances (MOD02, MYD02);
- Fire product (MOD14, MYD14);
- MODIS chlorophyll Alpha.

The distribution of geo-location data (MOD03 and MYD03) was stopped in early 2012 as these are no longer required.

EUMETSAT also receives MODIS direct broadcast polar winds from the Cooperative Institute for Meteorological Satellite Studies (CIMSS) for redistribution via EUMETCast.

The level 1 calibrated radiances and geo-location data are processed at EUMETSAT in order to retain only those data over the geographical region north of 25° North between 60° West and 45° East, and north of 65° North elsewhere. Furthermore, the level 1 radiance data are further reduced by retaining only measurements from 18 spectral channels (1, 2, 5, 6, 8, 9, 10, 12, 15, 20, 23, 26, 27, 28, 29, 31, 32 and 33).

The dissemination performance of MODIS data on EUMETCast reflects the general EUMETCast performance. The worst-case dissemination delay generally stays below 30 min.

In response to evolving requirements from the user community, EUMETSAT has added MODIS precipitable water products from NASA (MOD05 and MYD05). Prior to redistribution via EUMETCast, these data are processed by EUMETSAT in order to retain only near infrared measurements over land during daytime.

FY-3A&B Data Dissemination Service
Dissemination of FY-3A products on EUMETCast started in December 2010. Global FY-3A MWTS and MWHS level 1 products have been available for all orbits with a timeliness of between 4 – 6 hours. The monthly end to end availability varied between 97% and 100%.

Global FY-3B MWTS and MWHS products have been available on the EUMETSAT-CMA data exchange link for a short time early July 2011 and continuously since December 2011. After an initial assessment of the reliability of the flow, the products were made available to Member States on EUMETCast in January 2012.

SSMIS Data Dissemination Service
The reformatting of the products in BUFR format and subsequent dissemination on EUMETCast became operational on 31 January 2012.

SARAL Data Processing and Dissemination Service
SARAL (Satellite with ARgos and ALtika) is a joint CNES/ISRO programme. The role of EUMETSAT is analogous to the support provided for Jason-2:

- NRT processing of AltiKa payload instrument data;
- Encoding the SARAL products in BUFR;
- NRT dissemination of the SARAL products via EUMETCast and GTS/RMDCN;
- Archiving of the SARAL products in the Data Centre; and
- Coordination with CNES for the set-up, validation and operations of the SARAL ground segment at EUMETSAT.

The implementation, integration and testing of the Ground Segment at EUMETSAT is well advanced, and the last set of tests before launch are currently being carried out with CNES, ISRO and other partners (SSC for the X-band ground stations, CLS for Argos mission). The launch of SARAL is planned for December 2012.

Oceansat-2 Data Dissemination Service

This service is being established to deliver data from the OSCAT instrument onboard of the ISRO satellite Oceansat-2 in near-real time to EUMETCast users and to NOAA. There are two delivery modes, which are transparent for the users, but require a significantly different set-up of the data streams.

In the (nominal) routing mode the OSCAT products are produced by ISRO and delivered to Svalbard. From there, they are transferred to EUMETSAT, where they are segmented and then forwarded to EUMETCast dissemination. In an alternative (backup) mode EUMETSAT receives raw data directly from Svalbard and produces the OSCAT products using an ISRO software package.

The data routing of OSCAT products is in the trial phase. Data are routinely distributed to EUMETCast trial users and provided to NOAA via a dedicated FTP-service. The data availability, completeness and timeliness are monitored by EUMETSAT; the data quality is monitored by OSI-SAF/KNMI.

Some problems with data gaps at the end of ascending paths over the North Atlantic are being experienced and under investigation.. The service availability and timeliness usually reaches the requirements of 85% of data within 180 minutes. In July and August, some larger problems led to a temporary drop of the performance.

It is expected that the service becomes operational by end of October 2012.

Megha-Tropiques Data Dissemination Service

The requirements for level 1A2 data from the SAPHIR, MADRAS, ScaRaB and ROSA instruments have been confirmed. The level 1A2 SAPHIR and MADRAS data will be delivered directly from India to EUMETSAT, in a dump-by-dump manner. The availability of ScaRaB and ROSA data remains to be clarified. In order to provide the data in BUFR as requested, it will need to be reformatted at EUMETSAT prior to redistribution via EUMETCast. It is anticipated that the data will be available within 180 minutes of sensing.

EUMETSAT and CNES have signed the tripartite cooperation agreement with ISRO, and ISRO's agreement is expected in October 2012.

SMOS Data Dissemination Service

ESA has asked EUMETSAT to collaborate on the establishment of a EUMETCast distribution service for the Soil Moisture and Ocean Salinity (SMOS). A BUFR version of the SMOS level 1c near real time light product is going to be received by EUMETSAT from ESA via the Met Office, UK. The implementation of this service has started with the test dissemination phase which commenced in August 2012.

2.2.8 User statistics

Overall user statistics are provided in Section 2.1.7.

3 FUTURE SATELLITE SYSTEMS

EUMETSAT Future GEO Satellites

Sector	Satellites in orbit P=pre-operational Op=operational B=back-up L=limited availability	Location	Launch date	Details on near real time access to L0/L1 data (Links)	Environmental payload and status
East Atlantic (36°W -36°E)	Meteosat-11 (MSG-4)	0°	01/2015		12-channel SEVIRI imager, GERB, DCS
	MTG I1[1]	9.5°E	12/2018		Meteosat Third Generation/ Imaging (FCI, LI)
	MTG S1	0°	2020		Meteosat Third Generation/ Sounding (IRS, UVN)
	MTG I2	9.5°E	2022		Meteosat Third Generation/ Imaging (FCI, LI)
	MTG I3	9.5°E	2026		Meteosat Third Generation/ Imaging (FCI, LI)
	MTG S2	0°	2028		Meteosat Third Generation/ Sounding (IRS, UVN)
	MTG I4	9.5°E	2031		Meteosat Third Generation/ Imaging (FCI, LI)

[1] Operational Scenario for the MTG Imaging Mission will be provided by one satellite at 0 deg and one satellite at 9,5 deg East, providing the Full Disc (FD) imaging service and the Rapid Scan Service (RSS)

EUMETSAT Future LEO Satellites

Orbit type ECT=Equator Crossing Time (for sun-synchronous orbits)	Satellites in orbit P=pre-operational Op=operational B=back-up, secondary L=limited availability	Equator Crossing Time (ECT) Ascending Node	Mean Altitude	Launch date	Details on near real time access to L0/L1 data (links)	Instrument payload and status
Sun-synchronous "Morning" orbit ECT between 19:00-24:00 and between 07:00-12:00	Metop-C (Metop-3)	21:30	837 km	End 2016		AVHRR, MHS,AMSU-A, IASI, ASCAT,GRAS GOME

3.1 Status of future GEO satellite systems

3.1.1 MTG

3.1.1.1 Mission objectives, spacecraft, payload/instruments, products

The MTG mission encompasses the following observation missions:

Flexible Combined Imager (FCI) mission, allows scanning of either the full disc in 16 channels every 10 minutes with a spatial sampling distance in the range 1-2km (Full Disc High Spectral resolution Imagery (FDHSI) in support of the Full Disc Scanning Service (FCI-FDSS)) or a quarter of the earth in 4 channels every 2.5 minutes with a improvement in resolution by a factor of two High spatial Resolution Fast Imagery (HRFI) in support of the Rapid Scanning Service (FCI-RSS)).

InfraRed Sounding (IRS) mission, covering the full disc in 60 minutes, providing hyperspectral sounding information in two bands, a Long Wave InfraRed (LWIR: 700 - 1210 cm-1) and Mid Wave InfraRed (MWIR: 1600 - 2175 cm-1) band with a spatial sampling distance around 4km.

Lightning Imagery (LI) mission, detecting continuously over almost the full disc, the lightning discharges taking place in clouds or between cloud and ground with a spatial sampling distance around 10km.

Ultraviolet, Visible & Near-infrared (UVN) sounding mission, covering Europe every hour taking measurements in three spectral bands (UV: 290 - 400 nm; VIS: 400 - 500 nm, NIR: 755 - 775 nm) with a spatial sampling distance better than 10km. This mission will be implemented with the GMES Sentinel-4 instrument which will be accommodated on two of the MTG Satellites, the so called MTG -S satellites.

Complementary to the direct observation missions summarised above and essential to satisfy key user needs, the following mission objectives also need to be fulfilled by MTG:

Level 2 product extraction;

Data Collection System (DCS), for collecting and transmitting observations and data from surface, buoy, ship, balloon or airborne Data Collection Platforms (DCP);

Search And Rescue (SAR) relay service. Similarly to MSG, the MTG System will accommodate a Geostationary Search and Rescue (GEOSAR) transponder, enabling the operations of the mission under the aegis of the COSPAS-SARSAT System.

Near Real Time Data Dissemination & Relay services to users, including Foreign Satellite Data (FSD) collection and distribution (data from other EUMETSAT and Third Party satellite systems for calibration and global applications):

EUMETCast & High Rate dissemination services (including relay of FSD);

Regional Meteorological Data Communication Network (RMDCN) dissemination service. (RMDCN provides a computer network infrastructure for the meteorological community in World Meteorological Organization (WMO) Region VI (Europe) and has expanded to sites in WMO Region II (Asia)). It is integrated with the Global Telecommunication System (GTS) established by the WMO.

Internet dissemination services;

Data stewardship and reprocessing support;

Off-line data delivery; on-line services to the Users; Data exploitation support, reach-out, training and help desk.

Archived dataset retrieval services will continue to be provided as part of the multi-mission EUMETSAT Data Centre services, and User support services will be enhanced to address the additional needs with MTG.

3.1.1.2 Programme status

3.1.1.2.1 Overall status, system and space segment

The approval steps of MTG have been completed both at EUMETSAT level with entry into force of Council Resolution on the MTG Programme in February 2011, and at ESA level with the programme approval at the ESA Ministerial Council in November 2008. An update of the Declaration on the Meteosat Third Generation was agreed at ESA's Programme Board for Earth Observation (PB-EO) level in March 2011 which followed the selection of the industrial prime and core team for the satellites development/production and the completion of the MTG approval process at EUMETSAT.

At overall system level, the engineering work is progressing towards consolidation of requirements and interfaces and detailed analyses are produced to assess the instrument and system performance, however the schedule consolidation at space segment and overall programme level requires substantial work to address all the internal and external constraints. Specific work has been started to consolidate the satellite schedule between ESA and Industry, focussing in parallel between EUMETSAT and ESA to the space to ground interface requirements, with a target to establish coherent planning at space segment level by early 2013. The scenario of a MTG-I1 launch around mid 2018 appears to be the most realistic scenario at the present time.

At space segment level after the Preliminary Design Reviews (PDRs) for the satellite (covering both the MTG-I and MTG-S) and for the Flexible Combined Imager held from March to July 2012, the Platform PDR was started in August and the Infrared Sounder PDR will start in October. As Part of the GMES programme, the Sentinel 4 PDR has also started in August.

3.1.1.2.2 Ground segment and scientific studies

The Ground Segment system design is done by EUMETSAT,.

The major foreseen Ground Segment Procurements are:

- Instrument Data Processing Facility (IDPF)
- Mission Operations Facility (MOF)
- Mission Data Acquisition (MDA) Ground Stations
- Telemetry, Tracking and Commanding (TTC) Ground Stations
- Level-2 Processing Facility (L2PF) and GS Network.

Significant effort is ongoing for the scientific studies. As a general principle, the scientific development of the MTG Level-2 product generation chains is based on theoretical considerations, exchange of scientific ideas with scientists working in the field, followed by software prototyping activities, using real and proxy data, but mostly confined to selected case studies. This scientific process pursued by scientists in EUMETSAT is supported by external studies, visiting scientists, guidance by NMS and dedicated MTG-IRS (MIST) and MTG-LI (LIST) Science Teams. Studies on SEVIRI future products are done in view of the future MTG FCI applications.

3.2 Status of future LEO satellite systems

This section covers:

- EPS-SG
- Jason 3 and CS
- Sentinel 3

3.2.1 EPS-SG

This section presents the status of the Programme Preparation of the EPS Second Generation (EPS-SG), which is now entering its Phase B.

The EPS-SG Space Segment scope and Payload Complement were agreed by EUMETSAT Council in 2012 and constitutes the baseline for the ESA Metop-SG Development Programme to be approved at the ESA Ministerial Council end of 2012 (ESA C-MIN-12).

Draft cooperation agreements with CNES and DLR respectively on the IR sounding (IASI NG) and Imaging (METImage) were approved by EUMETSAT Council.

3.2.1.1 Schedule

Phasing of the EPS-SG Programme is planned as follows:

Phase 0	Mission Analysis	2005 – 2009
Phase A	Feasibility	2010 – Q3 2012,
Phase B	Preliminary Definition	Q4 2012 –mid 2015, started
Phase C,D	Detailed Definition, Production	2014 – 2020
Phase E	Utilisation	from 2020

3.2.1.2 EPS-SG Mission objectives, spacecraft, payload/instruments, products

The EPS-SG encompasses the following observation missions:

- The Infra-red Atmospheric Sounding mission (IAS), to provide temperature and humidity profiles, as well as observations of ozone and various trace gases, through a wide swath of hyper-spectral infra-red soundings in four bands from 3.62 to 15.5 µm, with radiometric and spectral resolutions improved by factor 2 vs. IASI and consistent spatial sampling of about 25 km.
- The Microwave Sounding mission (MWS), to provide all-weather atmospheric temperature and humidity profiles, as well as cloud liquid water columns, over a wide swath in the spectral region between 23 and 229 GHz, with footprints from 40 down to 17 km at the highest frequencies.
- The Scatterometry mission (SCA), to provide ocean surface wind vectors and land surface soil moisture by measurement of back-scattered signals at 5.3 GHz with spatial resolution of 25 km.
- The Visible/Infra-red Imaging mission (VII), for providing information on clouds, cloud cover, land surface properties, sea, ice and land surface temperatures, among other observations, by moderate-resolution optical imaging, in 20 spectral channels ranging from 0.443 to 13.345 µm, with a spatial sampling of 500 m (250 m in two channels).
- The Microwave Imaging mission (MWI), for precipitation and cloud imaging through measurements in the spectral range from 18.7 to 183 GHz with footprints from 10 to 50 km (for the highest to lowest frequency respectively).
- The Ice Cloud Imaging mission (ICI), to provide ice-cloud and water-vapour imaging by exploiting sub-millimetre-wave observations from 183 to 664 GHz with footprints of 15 km.
- The Radio Occultation mission (RO), for atmospheric all-weather soundings of temperature and humidity at high vertical resolution, and additionally ionospheric electron content in support of space weather, by tracking signals from global navigation satellites, GPS and Galileo at least.
- The Nadir-viewing Ultraviolet, Visible, Near-infra-red, Short-wave-infra-red Sounding mission (UVNS), to provide ozone profiles, monitor various trace gases, monitor air quality and support climate monitoring by means of hyper-spectral soundings with a spectral resolution from 0.06 to 1 nm in the wavelength range from 0.27 to 2.4 µm, at a spatial sampling of 7 km for channels above 0.3 µm.

The Multi-viewing, Multi-channel, Multi-polarisation Imaging mission (3MI), for aerosol observations by moderate resolution optical imaging from the ultra-violet (0.410 µm) to the short-wave infra-red (2.13 µm), at a spatial sampling of 4 km.

The IAS, MWS, SCA, VII, RO and UVNS missions provide continuity and improvements to missions currently provided with the Metop satellites. The MWI, ICI and 3MI are new missions with respect to Metop first generation, drawing from the experience with other experimental or operational missions.

In addition to the above observation missions, EPS-SG satellites will embark payload to provide the following service in the frame of a relevant cooperation and in continuity to EPS:

Data Collection Service (DCS), for the worldwide collection from in-situ platforms of oceanographic and meteorological data and their transmission to the user community.

For the delivery to the users of the mission data, services are defined which are similar and continue the services available with EPS, including:

Near Real Time (NRT) Data Dissemination, for the distribution of Level-1 data (instrument measurements after radiometric and spectral calibration, and geo-referencing) with timeliness between:

- 120 minutes (for 90% of the data, so called “Threshold” requirement); and
- 70 minutes (for 95% of the data, so called “Breakthrough” requirement) for global data; and down to
- 30 minutes at regional scale (data taken over Europe and the North Atlantic Ocean, for 95% of the data, “Breakthrough” requirement);

as well as Level-2 data (geophysical variables) with timeliness increased by the relevant processing time (estimated in up to 10 minutes); the distribution will occur by various means such as EUMETCast, the internet, the GTS/RMDCN networks.

Direct Data Broadcast, for the continuous and instantaneous transmission by the satellites of the instruments’ data being acquired;

Non-NRT Dissemination, for the distribution of data whose delivery is not time-critical;

Archiving and Retrieval, for the archiving of mission data in the multi-mission EUMETSAT Data Centre and their availability for off-line retrieval and reprocessing.

3.2.1.3 Status of Preparation of the EPS-SG Programme

EUMETSAT has produced and maintains with ESA a joint EPS-SG Roadmap taking into account the articulation between ESA and EUMETSAT activities and decision processes, and required agreements with other partners, in particular CNES, DLR and NOAA.

ESA is currently submitting to its ministerial conference CMIN -12 the proposal for the Metop-SG Development Programme.

Draft cooperation agreements with ESA, CNES, DLR, were approved by the EUMETSAT Council.

Phase A activities were completed and the following main achievements are reported:

- The Trade-off on the satellites configuration to be analysed in Phase A, and elaborated in 2009/2010 in cooperation with ESA, with a proposed two-satellite configuration was endorsed by the EUMETSAT Council in June 2010;
- the EPS-SG Space Segment scope and Payload Complement were approved in 2012
- The EUMETSAT Phase A activities at mission, system and ground segment level progressed as planned, with draft End-User Requirements being established and with preliminary System Requirements, Space to Ground Interface Requirements and Interface Requirements for the Instruments that will be provided by EUMETSAT via Cooperation with partners established;
- The EUMETSAT System level PRR were conducted in 2012 and allowed to establish the system level Phase A Baseline, as an input to Phase B work;

The ESA PRRs were also conducted in 2012 for the space segment activities.

The work also continues at CNES for the studies on the IASI New Generation Instrument and at DLR for the METimage Instrument.

EUMETSAT Phase B was started in October 2012. The EUMETSAT full EPS-SG Programme Proposal will be elaborated during the Phase B for submission to Council in 2013.

Work on the Joint Polar System (JPS) cooperation agreement with NOAA is progressing well, addressing the overall system definition and areas of cooperation based on the past successes and lessons learnt from the Initial Joint Polar System (IJPS).

3.2.2 Jason-3 and follow-on

The Jason-3 mission is a joint effort among four organizations: NOAA (National Oceanic and Atmospheric Administration), EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites), CNES (Centre National d'Etudes Spatiales), and NASA (National Aeronautic and Space Administration), to measure sea surface height by using a radar altimeter mounted on a low-earth orbiting satellite. The collection of precise measurements of sea surface height is essential for ocean climatology and ocean weather applications. Ocean climatology includes global sea-level rise, a key indicator of climate change, decadal variability in the ocean, seasonal/inter-annual variability, and coastal variability and its impact on ecosystems. Ocean weather involves operational oceanography, surface wave forecasting and evaluation, and hurricane intensity forecasting.

The Jason-3 mission will ensure the continuity of the 20 plus year data record started with TOPEX/Poseidon in 1992 and continued with Jason-1 and 2. The launch of Jason-3 is planned in Q4 2014 with an 6-month overlap with Jason-2. The overlap period will be used to conduct initial cross-calibration and validation activities, complete on-orbit check-out operations, and maintain consistent observations of sea surface height between the successive altimeter missions.

3.2.2.1 Jason-3 Mission objectives, spacecraft, payload/instruments, products

The PROTEUS platform is stored and periodically checked. No issues have been identified so far. The next platform check is planned for fall 2012. The development of the Payload Interface Module (PIM), element which hosts the payload instruments is on going with a delivery in October 2012.

The payload instruments development and test are ongoing and the delivery of all instruments (European and US) is planned between end of 2012 and early 2013 so that the payload module integration can start in March 2013. This will be followed by the satellite Assembly Integration and Test (AIT) sequence from June 2013 to end of January 2014. The flight acceptance review (FAR) is scheduled to take place in February/March 2014 and the satellite can then be stored until the start of the launch campaign. According to the current schedule, the launch campaign should start in October 2014 for a launch in December 2014.

Satellite activities have been mainly dedicated to the launcher compatibility analysis, with the objective again to minimize the impact of the launcher choice on the satellite and the instruments. The on board software validation has been performed and will be followed by the functional chain validation.

3.2.2.2 Jason-3 Ground segment matters

The Jason-3 ground segment architecture will look very similar to Jason-2, with the addition of two Earth Terminals (one in Usingen in Europe and one in Barrow in the US). The data communication network will also be increased to allow both Jason-2 and 3 data flows.

The development of the ground segment is in progress by each partner and the Ground Compatibility Testing (GQT) phase is ongoing. This is the first step of the ground segment validation and will be followed by the Technical and then Operational qualification phases. The objective of the GQT is to validate each individual interface between the partners, and check the overall compatibility before starting system level test.

The TM-NRT (Near Real Time processing) hardware and software will be delivered and installed at NOAA and EUMETSAT in December this year. In Usingen, robustness testing, consisting of shadowing a complete 10 day cycle of Jason-2 passes has been successfully made in July, with only a few minor anomalies detected. Periodic health check testing will now be performed to verify the good status of the earth terminal before it is used for the system test.

3.2.2.3 Schedule and main milestones

As a synthesis the main milestones of the Jason-3 satellite schedule are now the following:

- November 2012, satellite Critical Resign Review/AIT readiness review;
- From December 2012 to February 2013, delivery of European and US instruments;
- Payload AIT from March to June 2013;
- Satellite AIT from June 2013 to January 2014, with the FAR in February 2014;
- Satellite storage from January to September 2014;
- Preparation for and launch campaign from October to December 2014.

From a system stand point, the main milestones are:
- System Interface Review/System Test Readiness Review in February 2013;
- System technical qualification from March to October 2013;
- Operational qualification from January 2014 to August 2014 with the Operational Readiness Review in September 2014.

3.2.3 Jason CS

In order to ensure continuity of ocean altimetry measurements over the next 15 years, discussions have been initiated between potential Partners in Europe and in the US on a new programme named Jason CS (Continuity of Service). The programme will be based on at least two satellites, the first one being launched in 2018 covering the time span before a new technology can eventually become operational.

The Jason-CS satellite will be based on the Cryosat 2 satellite, the transition from Cryosat 2 to Jason-CS implies a number of modifications or adaptations which need to be analysed in detail before starting the development phase.

This is the objective of the industrial phase B1. Among the various activities to be performed, the accommodation of a new set of instruments is a key issue. A number of options including possible European and/or US procurement for the radiometer and the GPS receiver are considered. Various payload accommodation options have been presented and the compatibility with the fairing volume of the potential launchers will need to be now assessed in more detail.

At satellite system level, an important trade off option is also the use of the high resolution along track (SAR) mode and on which areas (open ocean or coastal zone only) it would be used. This impacts the power needs and the data rate with possible need of on board processing and compression. One promising feature would be to have both the Low Resolution Mode (LRM) and SAR mode working simultaneously in a so-called interleaved mode which will allow benefit to be taken of the lower noise and higher resolution of the SAR mode for coastal and mesoscale applications while keeping through the traditional LRM mode a full back compatibility with previous missions.

The embarkment of a radio occultation secondary mission is also under consideration. Taking benefit of the fact that a GPS receiver is anyway needed for the POD as part of the primary mission, the main impact is the accommodation of additional antennas. The specific orbit of Jason-CS would make the occultations measured from Jason-CS complementary to those acquired from other sun synchronous LEO satellites such as Metop. Further analyses are on going before a formal recommendation based on cost/benefits.

Compatibility has to be ensured with various launchers, in particular the fairing volume

Several progress meetings have been held in 2012 with participation of the industrial consortium and all agencies (ESA, EUMETSAT, NOAA, NASA, and CNES). A design Concept Review has been held end of 2011/early 2012.

The phase B1 is planned to last up until early 2012 and as already indicated above, the partners NOAA/NASA and CNES are associated to this process. This Phase B1 will be concluded by a System Design Review with the objective to review the definition status, assess the various options considered at satellite and payload level so as to narrow down the number of options that will be further considered in a Phase B2 in 2103/14 pending decisions to be taken at the next ESA Ministerial meeting.

In parallel, EUMETSAT will move forward in the programme decision process in 2013 through dedicated Potential Participant Meeting where the programmatic and technical definition of the programme will be presented and discussed.

3.2.4 Sentinel-3

GMES will cover several areas of applications, among which EUMETSAT will play a key role as satellite data provider for the oceanography and atmosphere user communities. In response to the need for data in near real-time, together with guaranteed service levels, EUMETSAT will serve the Marine User community both with routine and off-line products.

Starting from the successful completion of the In-Orbit commissioning of the first Sentinel-3 spacecraft, the scope of EUMETSAT's operational role will be:

- Monitoring and control of spacecraft and flight operations segment;
- Payload data acquisition, consistent with the overall GMES ground segment design under ESA's responsibility;
- Product generation and dissemination of all Sentinel-3 products routinely required by the Marine User Community and the related downstream services;
- Serving the offline requests of the Marine User Community for Sentinel-3 products.

Complementing the Marine part of the mission, ESA will serve the Land Services Community including:

- Product generation and dissemination of all Sentinel-3 Land products routinely required by the Land community and the related downstream services;
- Serving the offline requests of the Land User Community for Sentinel-3 products.

To fulfil this operational role, EUMETSAT has undertaken, under a co-operation agreement with ESA, for the development of a ground segment to serve the needs of the Sentinel-3 mission as well as for the routine operations to be engineered, validated and rehearsed by a dedicated operations team.

The role for EUMETSAT in the provision of the Sentinel-3 Services over the mission lifetime takes benefit from, and builds upon, the significant infrastructure investments that have already been made, and will continue to be made, by EUMETSAT in the areas of:

Multi-mission operations within a unified Operational centre (MTP, MSG, EPS and Jason);

A common gateway to enable users to have straightforward access to all EUMETSAT's data and products (via the EUMETSAT unified archive and retrieval facility and its interface to the future ESA Heterogeneous Mission Accessibility (HMA);

Ground segment infrastructure, which allows the addition of further missions/services.

Beside the regular interactions between EUMETSAT and ESA to monitor and control the progress of the development, discussions have taken place with ESA on the organisational aspects of the Routine Operations Phase with a significant progress on the definition of the roles and responsibilities between ESA and EUMETSAT with respect to the mission operations and the mission performance monitoring aspects. A first version of the Operational Phase E Management Plan (PEMP), encompassing the agreed aspects of the overall mission management, is being elaborated. Iterations with ESA will continue in the months to come to complete the discussions on the roles and responsibilities and to begin iterating on topics such as the financial aspects, the approach to the procurement and the reporting. Updated versions of the PEMP will encapsulate the agreements reached in these areas as the discussions progress. The ultimate goal is to have a consolidated version of the PEMP by the end of the year.

ESA and EUMETSAT have significantly progressed in the elaboration of a joint calibration and validation (cal/val) plan covering both the commissioning and routine operations phases. This document sets out an overall Sentinel-3 strategy and plan for the calibration and validation of all satellite instruments and operational products. It uses a requirements based approach to ensure by traceability to the mission requirements that all parameters relevant for the instrument calibration and operational product validation have been adequately covered. A first version of the cal/val plan will soon be released for comments to the members of the Mission Advisory Group (MAG). The MAG meeting in October will review the comments with the goal to publish an updated and consolidated version of the cal/val plan by the end of 2012.

3.2.4.1 Sentinel-3 Mission objectives, spacecraft, payload/instruments, products

The EUMETSAT part of the Ground Segment is mainly composed of two distinct segments:

The EUMETSAT Flight Operations Segment (FOS) responsible for the satellite monitoring and control activities during the routine operations following the In-Orbit Commissioning Review (IOCR).

A Payload Data Ground Segment (PDGS) responsible for the instrument data acquisition and product generation, dissemination and archiving. The subset of the PDGS dealing with data products generation, dissemination and archiving will be located at EUMETSAT HQ.

The development of the Ground Segment (GS) is proceeding nominally with most of the GS facilities having completed their preliminary design and being close to complete their detailed design. Internal interfaces have reached a good level of maturity, even though a few issues are still being addressed. It is expected that these issues will be resolved early 2013, time at which the GS Critical Design Review (CDR) will start.

Discussions on the Ground Segment Integration, Verification and Validation activities have progressed well taking into consideration the Flight Operations Segment and Payload Data Ground Segment I,V&V plans to ensure completeness and coherence in the overall approach. This will be further assessed as part of the Ground Segment Critical Design Review.

3.2.4.1.1 Sentinel-3 Flight Operations Segment Status

The development of the FOS facilities has significantly progressed. The detailed facility level status is as follows:

- The EUMETSAT FOS Mission Control System (MCS) and SIMulator (SIM) hardware platforms procurement is under way with hardware deliveries targeted for November 2012;
- The development of the Flight Dynamics Facility (FDF) is on schedule. The Software Requirements Review (SWRR) was held over the June/July period. Next milestone is the D0 delivery in November 2012;
- The development of the FOS Mission Control System (MCS) has progressed with the completion of the Preliminary Design Review (PDR) of the D1 delivery. Current plan today foresees a full MCS D1 delivery by the end of November;
- The initial delivery (D0) of the spacecraft SIMulator (SIM) has been made available by mid August and its installation is in progress. The SIM D0 delivery was deployed this summer in the EUMETSAT Familiarisation Environment. The SIM D1 design phase is under way, with the PDR scheduled for mid October.

From the above, it can be seen that the deliveries of the FOS facilities to EUMETSAT in October/November will pave the way for the EUMETSAT FOS Integration, Verification and Validation phase to start. To this end, the procurement of the FOS I,V&V service was initiated in April 2012. The current schedule targets early December for the Kick-Off (KO) of the FOS I,V&V activities with the selected Contractor.

3.2.4.2 Sentinel-3 Ground segment matters

The development of the PDGS facilities has significantly progressed. The detailed facility level status is as follows:

The Core PDGS critical design has progressed during this period culminating in the Critical Design Review collocation which was held in June/July. The scope of this Core PDGS CDR was to review the system design definition file, including software architectural design, detailed design, code and user's manual for those components being part of the Master Core PDGS System. The CDR was considered successful with the majority of the review item discrepancies being successfully dispositioned and the associated actions agreed. The review outlined the need to perform some further consolidation in the following areas:

- Overall systems operations concept;
- Update to the data compression technical note;
- Finalization of some Interface Control Documents;
- Outstanding Reliability, Availability, Maintainability and Safety related issues to be resolved.

The PDGS Master Core Platform (MCP) to support the PDGS IV&V activities for the different core PDGS deliveries was deployed at the Telespazio premises in Rome with a successful Factory Acceptance Test completed in June.

The next tasks for the PDGS Core Consortium are the finalisation of the hardware procurement for the V1 deployment at the Marine Centre in EUMETSAT and the preparation of the documentation pack for the overall PDGS CDR to be held at the end of this year.

The Mission Planning Facility (MPF) continues to advance in its development with the Preliminary Design Review having been successfully held last summer. Work has concluded on defining the platform requirements for the MPF to ensure it meets the needs of EUMETSAT. Significant progress has been made on the MPF external interface definition and Instrument Parameter Handling aspects;

Concerning the development of the Sentinels Demodulator and Front End Processor (DFEP), the units to be deployed on the PDGS Master Core Platform and at EUMETSAT are now expected to be ready for a Factory Acceptance Testing (FAT) in October 2012;

The operational Instrument Processing Facilities development has progressed and the first design review (for all L0 processors) has been completed. The first versions of the L0 processors are expected to be delivered and tested during Q4 2012 in order to be integrated with the V1 version of the PDGS Core delivery in Q1 2013;

The negotiations with KSAT for the provision of GMES-wide X Band services have concluded and the Kick-Off meeting was held in July;

The ITT for the procurement of the GMES-wide Wide Area Network, to interconnect all operational centres, was released in early July;

ESA is now completing the ITT package for the procurement of the Precise Orbit Determination (POD) service, due for the end of 2012.

In parallel to the above activities, EUMETSAT is currently completing the design of the EUMETSAT Multi Mission Elements (MME). These are the EUMETSAT operational facilities serving all operational missions, and need to be upgraded to support the Sentinel-3 mission, such as the Dissemination, Data Centre, Earth Observation Portal and User Services.

4 CONCLUSIONS

This document summarises the status of EUMETSAT current and future satellite systems.

CGMS is invited to take note.