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STATUS OF EUMETSAT CURRENT AND FUTURE SATELLITE PROGRAMMES - REPORT TO CGMS-42

This document summarises the status of EUMETSAT current and future LEO and GEO satellite systems. The reporting period for current satellite operations is 1 June 2013 to 31 March 2014. For future satellites, progress to date at the time of writing is included.

Current satellite programmes cover status of the spacecraft, ground segment, data transmission, projects and services, user statistics.

Future satellite programmes cover the mission objectives (spacecraft, payload, instruments, products) and programme status (space, system and ground segments).

CGMS is invited to take note.

Status of EUMETSAT current and future satellite programmes - report to CGMS-42

1 INTRODUCTION

This paper reports on the status of EUMETSAT current and future satellite systems. The reporting period for current satellite operations is 1 June 2013 to 31 March 2014. 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)	9.5°E	21/12/2005	Service Status Data access Level 1 data info	Rapid Scanning Service, Prime GERB Service
	Meteosat-10 (Op)	0°W	05/07/2012		12-channel SEVIRI imager, DCS, GERB not operational Data disseminated via EUMETCAST and LRIT
	Meteosat-8 (backup)	3.5°E	28/08/2002		Back-up of Meteosat-9 and Meteosat-10. GERB and DCS not operational
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 (B)	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 (Op)	21:30	837 km	17/09/2012	Data access L1 data info	AVHRR/3, HIRS/4, AMSU-A, MHS, IASI, GRAS, ASCAT, GOME-2 (HRPT fully functional). Dissemination via EUMETCast

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 10 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. Meteosat-10 satellite was launched in July 2012 and is currently providing the core service from 0deg while Meteosat-8 was relocated to 3.5 deg East to provide backup function to Meteosat-10 and Meteosat-9.

Meteosat Second Generation (MSG) consists of a series of four geostationary meteorological satellites, along with ground-based infrastructure, that will operate consecutively beyond 2020. The core mission of the MSG satellites is provided by the Spinning Enhanced Visible and InfraRed Imager (SEVIRI), which has the capacity to observe the Earth in 12 spectral channels and provide impressive high quality image data which is at the heart of the operational forecasting needs, and the Geostationary Earth Radiation Budget (GERB) instrument supporting long term climate studies.

Each Meteosat satellite is designed to remain in orbit, in an operable condition for at least seven years, but the actual performance of the satellites in orbit has exceeded this limit. The current policy is to keep two operable satellites in orbit and to launch a new satellite based upon a service availability analysis. In the case of MSG-4, the last satellite of the series, in view of the on-ground storage limitation being reached, an approach was selected to store the satellite in-obit, following launch and an initial commissioning phase, as long as the in orbit status will allow. Towards 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 June 2013 to 31 March 2014 the Meteosat Transition Programme and Meteosat Second Generation space segments have performed well.

The MSG system, following completion of the satellite relocations in early 2013, has been stable.

The following operations or events impacting the Meteosat service are worth noting:

- Meteosat-10 SEVIRI decontamination from 1 July 2013 until 9 July 2013;
- A ground segment outage of about 3 hours on 18 August 2013 affecting both 0° service and RSS (Incident #53);
- Meteosat-9 RSS monthly gap filled using the Meteosat-8 backup satellite until the collapse of the Antenna 20 in November 2013. No gap-filling in December, January and February;
- Meteosat-9 Safe Mode on 25 October 2013 (Incident #54);

- Antenna 20 mechanical collapse on 22 November 2013 (Incident #56);
- Meteosat-9 SEVIRI stand-by mode on 1 December 2013 (Incident #57);
- The autonomous switch over of the Meteosat-9 Remote Terminal Unit (RTU) on the Main Platform (MP) from the nominal side to the redundant side, on 29 January 2014, which seems to be due to a Single Event Upset and for which a recovery strategy is under discussion;
- Two interruptions of the Meteosat-9 RSS on 25 February 2014 caused by the slow execution of the satellite calibration procedures in the Mission Control facility which caused SEVIRI to go into stand-by mode.

Meteosat-8

Meteosat-8, launched on 28 August 2002, has been on station at 3.5°E since 11 February 2013. The satellite is available for use as a hot backup for the Meteosat-10 prime service and for the Meteosat-9 RSS service.

Meteosat-8 is nominally configured in Full Earth Scan (FES) imaging mode with the images being archived, not disseminated, GERB is in safe mode, Search and Rescue is switched-off and the Data Collection Platform (DCP) transponder is switched-off.

Meteosat-9

Meteosat-9, launched on 21 December 2005, is on station at 9.5°E since 5 February 2013 and supports the Rapid Scanning Service (RSS) since 9 April 2013.

The spacecraft is in RSS imaging mode, GERB is operated as prime GERB instrument since April 2013, (due to the GERB-3 anomaly on Meteosat-10), the Search and Rescue transponder switched-on (as requested by COSPAS-SARSAT) and the DCP transponder is switched-off.

Meteosat-9 was used at the beginning of the annual, one month RSS outage to provide the Full Earth Scan service during the decontamination of the SEVIRI instrument on Meteosat-10 (14-20 January 2014).

No permanent failures have occurred on-board although the satellite experienced the following anomalies:

- a “Safe Mode” on 25 October 2013 (Operational Incident #54);
- a “SEVIRI stand-by mode” on 1 December 2013 (Operational Incident #57);
- A Remote Terminal Unit Main Platform (RTU MP) switchover on 29 January 2014 still under investigation and for which a recovery approach under definition;
- Two SEVIRI stand-by modes on 25 February 2014 as a consequence of slow execution of the SEVIRI calibration procedure on ground.

Meteosat-9 Safe Mode on 25 October 2013 (Incident #54)

On Friday, 25 October 2013 at 03:20 UTC, a Processor Module (PM) B safe-mode was experienced on Meteosat-9 (MSG-2). The PMB safe-mode was triggered by a Single Event Upset (SEU) on the Latch Current Limiter No. 6 (LCL06) which supplies power to the nominal Attitude and Orbit Control Subsystem (AOCS). As a result, synchronisation on board was lost and the on-board protections automatically swapped the satellite to the redundant platform and switched off all payloads (including SEVIRI).

As Meteosat-8 (MSG-1) was available at that time as backup imaging spacecraft, the RSS mission was rapidly swapped to Meteosat-8, causing only about 3 hours of outage for images, (it should be noted that due to a significant complexity, in case of RSS satellite contingency swap, the meteorological products cannot be provided). After consultation with Thales Alenia Space, LCL06 was successfully tested before proceeding with the recovery which was then completed around 21:00 UTC on the same day when the S/C reached a nominal state performing rapid-scanning imaging. The RSS mission, however, was left on Meteosat-8 during the weekend and RSS was successfully swapped back to Meteosat-9 on Monday, 28 October 2013.

SEVIRI stand-by mode on 1 December 2013 (Incident #57)

On 1 December 2013 @ 18:10 UTC, the SEVIRI calibration unit (CALU) on board Meteosat-9 was switched OFF autonomously by the satellite Monitoring and Reconfiguration Function (MRF). This resulted in an approximately 5-hour interruption of the Rapid Scanning Service (RSS) due to the time required to assess and recover from the anomaly and to stabilise the ground Control Facility which was very slow in executing the satellite control procedures.

In this case, a swap of the RSS to Meteosat-8, which was available, was about to be performed, but was in the end cancelled as the recovery of Meteosat-9 was performed in a short and comparable time.

RTU MP switch-over on 29 January 2014

On 29 January 2014 the Meteosat-9 spacecraft autonomously reconfigured from the Nominal (or A side) Remote Terminal Unit (RTU) Main Platform (MP) to the Redundant (or B side) RTU MP. The RTUs are vital units on board the satellite as they receive telemetry and dispatch telecommands to/from the different satellite subsystems and the Central Data Management Unit (CDMU) allowing, in the end, monitoring and control of the satellite from ground. The RTU switch-over was nominal and had no impact on any satellite function.

Following investigation, both Thales Alenia Space (TAS) and EUMETSAT arrived independently at the conclusion that the satellite telemetry points to a Single Event Upset (SEU) anomaly (i.e. a non-permanent failure) in the nominal RTU MP. TAS also recommended switching back to the nominal RTU MP in order to re-gain full redundancy and as it is normal practice on MSG operations e.g. after a CDMU SEU transient.

The next steps are currently under discussion at EUMETSAT with the support of TAS.

Two transitions to stand-by mode of SEVIRI on 25 February 2014
These events caused two outages of the RSS for approximately 50 minutes and 3 hours respectively. They were due to the same root cause of the "SEVIRI stand-by mode on 1 December 2013" (see above anomaly) i.e. the slow execution of the automated calibration procedure in the Mission Control Facility.

A solution to this recurrent and intermittent problem in the Mission Control Facility is being actively sought. The robustness of the automated calibration procedure was increased and the number of calibrations reduced to the strict minimum compatible with the radiometric quality of the SEVIRI data. In parallel a software patch for the Mission Control Facility is under preparation.

Meteosat-10

Meteosat-10, launched on 5 July 2012, following January 2013 relocations, has been the prime Meteosat satellite for the 0° service since 21 January 2013.

The spacecraft is currently in imaging mode, fully configured including DCP and Search and Rescue transponders.

The GERB instrument experienced an Auto-Safe mode on 27 April 2013. The anomaly affects the GERB de-spin mirror (DSM) which is vital unit for GERB data acquisition and all attempts to resume MSG-3 GERB imaging operations have been unsuccessful so far. An Incident Review Board (IRB) with participation of ESA-ESTEC, Rutherford Appleton Laboratory, Imperial College London (ICL) and Thales Alenia Space is still active to support the investigation and define the in-orbit recovery actions. At this stage the recovery of GERB-3 is very unlikely as even complex attempts to move the DSM by heating up the instrument were unsuccessful. During the investigation of the GERB-3 in-orbit anomaly, a similar anomaly was also discovered during the ground tests of the GERB model integrated on the MSG-4 satellite. Extensive analysis has led to the conclusion that the design of the GERB-3/4 DSM electronics, which was modified to improve the pointing performance with respect to GERB-1/2, is affected by design weaknesses which have reduced the DSM torque margin and rendered the mechanism vulnerable to debris in the DSM ball bearings. While this is currently under correction for GERB-4, very little hope is left to recover GERB-3.

MSG-4

The plans to prepare MSG-4 for launch were revisited as result of a Non Conformance of the SEVIRI Calibration Unit (CALU), associated with delamination of the coating of the motor magnets: discovered in early summer 2013, its resolution leads to the readiness for launch of MSG-4 in early July 2015. In parallel Arianespace was approached for redefining the launch period of the MSG-4, at the end of November the agreement was eventually reached between Arianespace and

EUMETSAT for the new MSG-4 launch period, from August to October 2015, with the satellite targeting an earlier readiness in July 2015, should a launch opportunity arise.

Activities are currently progressing in accordance with the new plan. In early February 2014 SEVIRI was back in Cannes at the Prime Contractor's premises. Originated by the major open issue at the time of the satellite entry into storage in 2007, the tasks associated with the new SEVIRI Drive Unit were finally completed with the delivery of the scan mechanisms with a new DU in June 2013. The new tasks associated with refurbishing the CALU were also done by mid December 2013 and the involved processes in this exchange completed their qualification in early January 2014.

During execution of activities at satellite level, a test on the de-spin mirror of GERB-4 showed no effect of the command to move the mirror, as result of it the decision was taken to dismount GERB-4 from the satellite and ship it to RAL for investigations and refurbishment. Modifications have been identified at the level of on-board software and electronics that would increase the resilience to the de-spin mirror blocking encountered in orbit on GERB-3. The refurbishment of the GERB-4 instrument to implement these changes is planned for completion by end July/early August.

Concerning the preparation for MSG-4 operations, work is progressing with ESOC on the Launch and early Operations Phase (LEOP) service, with the mission analyses taking into account the In-Orbit Storage which should last 1.5 years or longer. The preparation of the EUMETSAT ground segment to support the operations of MSG-4 is also progressing in line with the schedule needs. The plan of the MSG-4 Commissioning remains similar to the one of MSG-3, i.e., inclusive of the imaging and meteorological product extraction beyond the satellite performance aspects, and of early dissemination to expert users for feedback on products. Similarly to MSG-3, it is planned to start external dissemination to NMS and ECMWF as soon as the MSG-4 satellite tests and the imaging, cal/val and meteorological product extraction activities will give enough confidence, for about 2.5 months.

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.)
25 Oct 2013	Geo (9.5 deg East)	Geo	No eclipse			Galactic Cosmic Rays	High	Satellite Safe Mode	Meteosat-9	
29 Jan 2014	Geo (9.5 deg East)	Geo	No eclipse			Galactic Cosmic Rays	To be confirmed	Unit switch-over	Meteosat-9	

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.

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

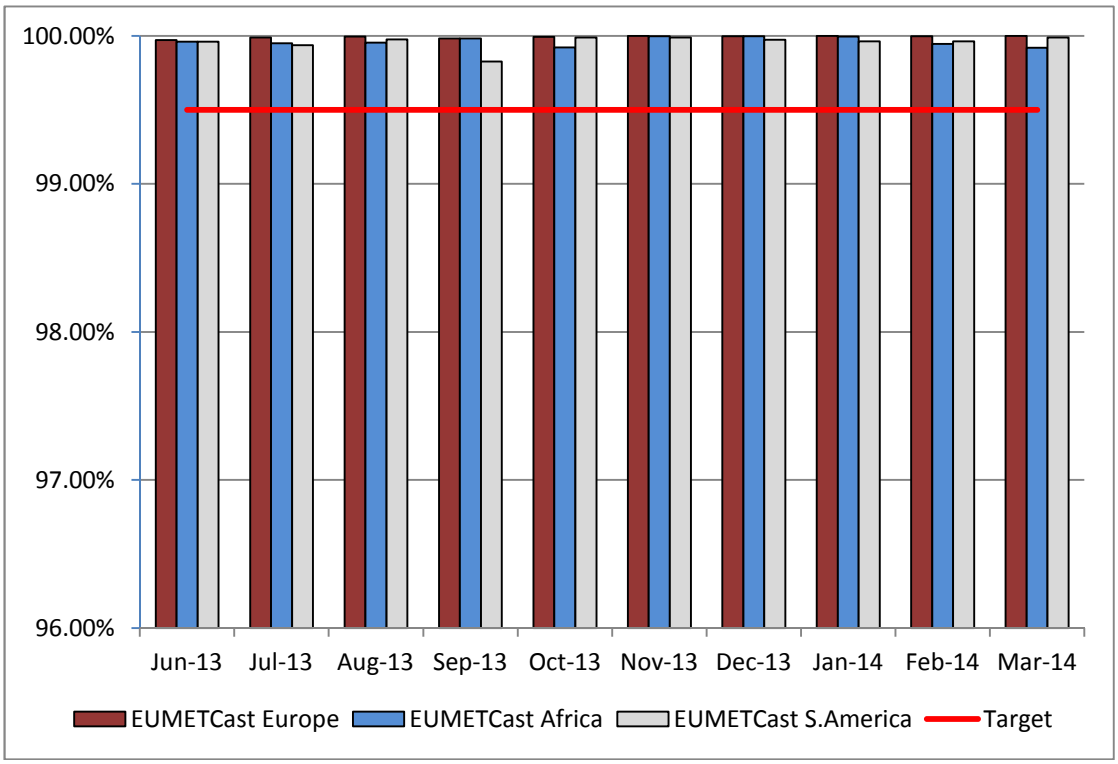

Figure 1: EUMETCast Availability

As can be seen in **Error! Reference source not found.Error! Reference source not found.**, all services provided very good availability over the reporting period with no exceptions.

2.1.6 Projects, services

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

FY-2D&E Data Dissemination Service
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 dissemination to EUMETCast Americas has been stopped due to lack of users in that area.

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

BMD and MDD service
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.

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

In addition to new products, the Agricab and GIO-GL projects provide continuity of the EAMNET and former Geoland2 projects in Africa and Americas.

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 implementation of users to the EUMETSAT subnet (the EUMETSAT datastream) on CMACast is complete. In July, the Australian Weather Bureau (ABoM) became the first trial user of this service.

The implementation of registration to data on CMACast from the EO Portal is in progress.

At the end of February, a feasibility test was performed sending encrypted 15 min MSG HRIT SEVIRI data to NOAA for dissemination on GEONETCast Americas. NOAA and INPE participated as test users and were able to receive and decrypt 100% of the data on the test stations. The data latency was acceptable with occasional queuing up to several minutes.

Other Projects

Within the context of the AMESD programme a number of existing products on EUMETCast are 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).

In the GEONETCast context the dissemination of products from NOAA NESDIS, US-EPA, SERVIR and RANET is ongoing with nominal status.

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 31 December 2012 is provided in Figure 2. Note that Total number of registered Users on 31 March 2014 was 3288 (users may have more than one station).

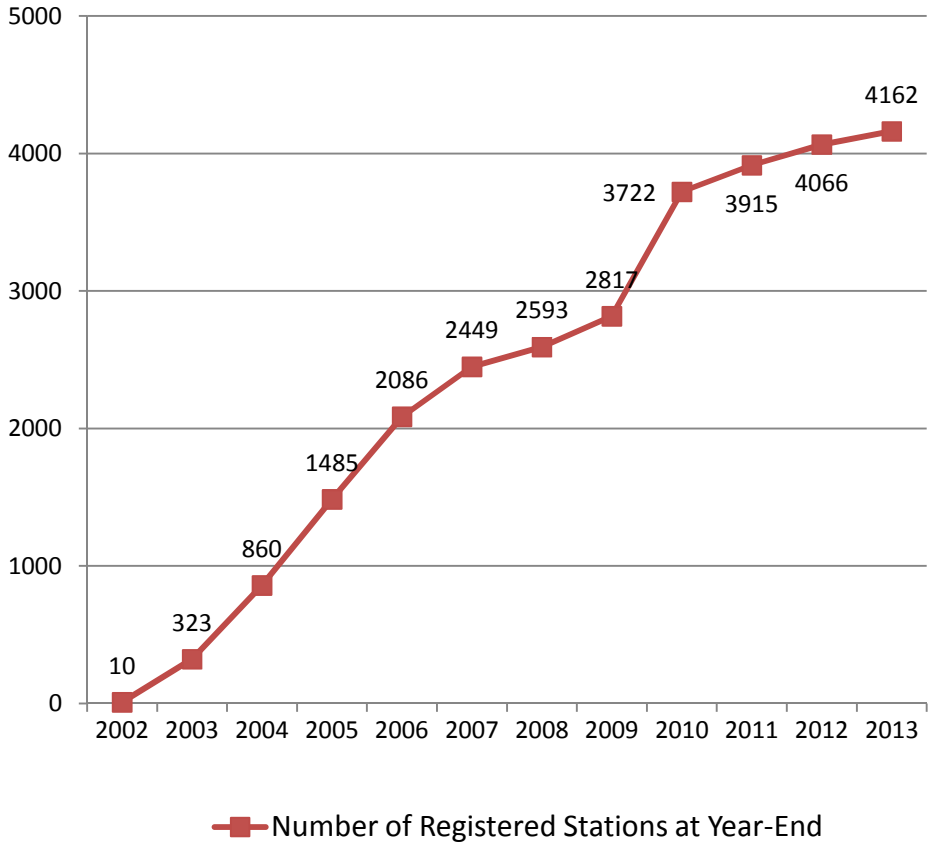

Figure 2: EUMETCast Registrations

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 development of orders and deliveries is provided in **Error! Reference source not found.Error! Reference source not found.** below. The chart here shows volumes of data retrieved from the Archive in response to user ordering on a monthly basis, from Jan 2012 up to and including March 2014. Also presented is the resulting delivery to the users on a volume basis as well as on a number of items basis. It can be seen that ordering from the Data Centre remains at a high level.

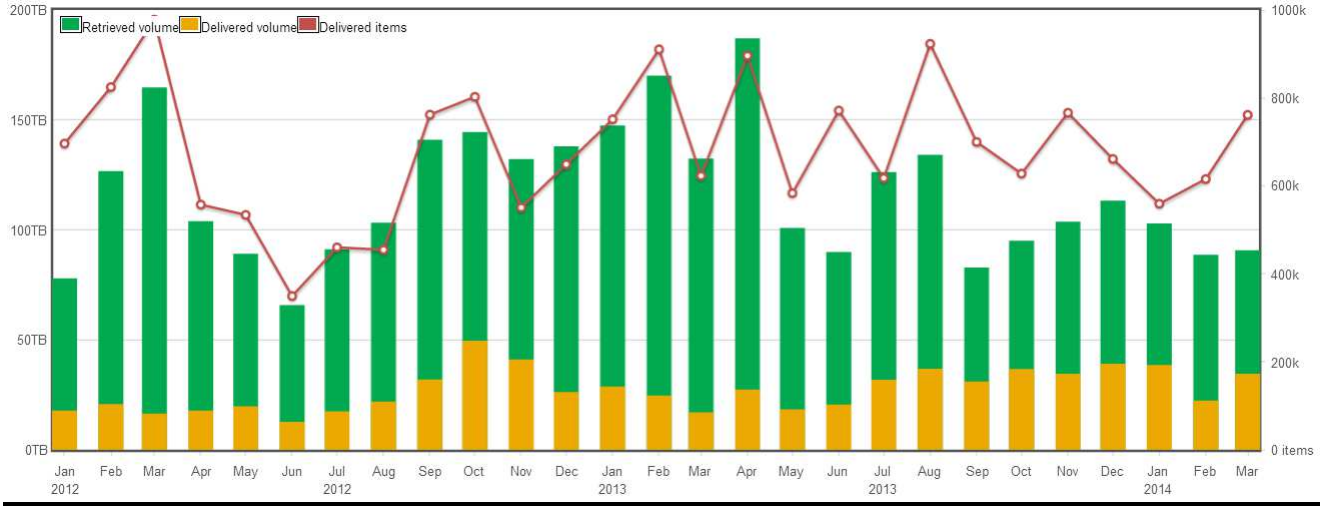

Figure 3: Data Centre Retrieval and Delivery of User Ordering

To improve user access, a lightweight, more intuitive online ordering client has been developed, which is expected to replace the current Java-based client in mid 2014. The most popular EPS user products are now also available in netCDF format from the Data Centre, a development which is extended to include the Meteosat MSG1.5 and MTP1.5 data in the next months.

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 baseline consists of a series of three polar orbiting Metop satellites, to be flown successively for more than 14 years, from 2006, supported by the relevant ground facilities. However, with the continuing good health of Metop-A and following the successful entry into operations of Metop-B, it has been decided to continue a dual-Metop operational service as long as this provides added user value and is compatible with the Metop-A end-of-life constraints due to the space debris mitigation guidelines.

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 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, a reduced-swath GOME-2 tandem product has been introduced in July 2014 in order to improve resolution. This configuration uses a half swath/ double resolution on Metop-A, but a nominal swath on Metop-B, in order to combine the benefits of better resolution with global swath coverage.

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 providing Metop-B data from most orbits.

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 Metop-B satellite has completed commissioning of all Level-1 data products and took over from Metop-A as the primary operational Metop satellite on 24 April 2013.

Metop-A continues full service provision in parallel, as the secondary Metop satellite. Note that the final Level-2 product commissioning activities on Metop-B were completed in July 2013.

The Metop-A satellite continued to perform well over the reporting period, except for a significant recent outage of MHS. The following points are noteworthy:

- AMSU-A1 is exhibiting an exponential increase in NEDT on channels 3 and 8, the specification thresholds having been exceeded in July and September 2013 respectively. Data is regarded as usable for the time-being and is being monitored for quality;
- On 25 June 2013, GRAS was upgraded to give the same functional improvements as introduced onto Metop-B during its commissioning activities;
- On 15 July 2013, GOME was configured to a half-swath configuration in order to commence a GOME tandem operations scenario (Metop-B GOME remaining full swath);
- On 6 October 2013, IASI suffered a Single Event Upset leading to a Heater Refuse Mode. Since this anomaly had been seen before, a recovery could be initiated immediately, minimising the outage to less than three hours;
- On 12 November 2013, a suspected space radiation effect caused a Solid Status Recorder “Wait State” anomaly, leading to the loss of about 5 hours of sensing data. Although less than 2 weeks following a similar anomaly on Metop-B, no linkage could be identified;
- On 21 January 2014, GOME-2 suffered an outage of over 40 hours due a radiation induced Single Event Upset causing an over-current detection on-board;
- On 18 February 2014, on request from CNES and SSST, an on-board test of IASI was attempted to investigate whether it (and the satellite as a whole) could satisfactorily operate without the use of the Compensation Device (CD) used to reduce torques from the Scan Mechanism. This is in connection with the magnet delamination anomaly mitigation planning and the investigation as to whether Metop-C CD magnets require replacement or not. The planned test did foresee several days of unavailability of the instrument. Due to problems with the supplied configuration parameter loading on-board, it was not possible to achieve the state required for the testing and the test had to be abandoned before the desired results could be obtained. An outage of around 3 days was nevertheless incurred due to this attempt. The feasibility and necessity to re-attempt this test is under discussion;
- On 11 March 2014, the SARP Search and Rescue Processor had to be restarted on request of CNES due to a suspected latch-up. Transmissions were unavailable for around 3 hours due to this anomaly;
- On 26 March 2014, MHS went into a “Fault Mode” whilst being commanded to Standby during the preparations for the scheduled satellite out-of-plane manoeuvre. MHS data has been unavailable since this anomaly and the investigation is continuing with the support of the manufacturer. On-board diagnostic testing, coupled with failure analysis by experts is on-going, allowing a better insight into the characteristics of the failure. The failure is believed to be most likely due to a short-circuit of two independent heater switches. It is

possible that this hardware failure may be overcome through a procedural workaround and/or software changes to the instrument. However, it is expected that the solution will not be in place before end-May 2014 at the earliest.

Metop-B was launched on 17 September 2012. In-orbit performances of the satellite and its payload are generally very good, but with the following exceptions:

- Observed degradation of HIRS channel performances, (impacting mainly channels 1-12), has been under investigation during the reporting period. The observed trends appear to be cycling and linked to a possible hardware problem on the instrument. Data quality has remained acceptable throughout the reporting period however.
- On 12 July 2013, on GOME-2, a flow of dark signal, leakage current commenced, affecting Channel 4 and had been gradually increasing. On 14 August, the leakage suddenly stopped. Nevertheless, the problem resumed, albeit at a lower level on 28 October and again stopped on 2 February 2014. Product quality has not been impacted due to this leakage and based on the investigation performed involving industry and partners, it is hypothesised that the problem is unlikely to get worse;
- On 17 September 2013, the Solid State Recorder (SSR) suffered a word group loss, which although not leading to a loss of on-board recorded data, interrupted ADA dumps for a period of around 19 hours. An equivalent anomaly occurred on a second word group on 19 September, with similar consequences. Despite the occurrence of two such events so close together, two separate radiation induced Single Event Upsets are suspected as the cause. Both word groups were successfully recovered on 30 September, but with the loss of 10 minutes of global data;
- On 29 October 2013, a suspected space radiation effect caused a Solid Status Recorder “Wait State” anomaly, leading to the loss of over 4 hours of sensing data. No connection with the previous SSR anomalies on Metop-B or the subsequent SSR anomaly reported on Metop-A has been identified (Incident 55);
- On 24 December 2013, AMSU-A1 Channel 9 exhibited a sudden rise in noise, well above the specified threshold, lasting for just under three days before returning to nominal values. The instrument is under observation and the anomaly under investigation;
- On 5 March 2014, an MHS Spin State anomaly occurred due to suspected Single Event Upset. Data was unavailable for approximately one orbit as a result;
- On 10 March 2014, IASI initiated decontamination operations, with the associated data unavailability planned until 15 March. However, whilst the instrument was being cooled to reach its nominal thermal conditions, it suffered a suspected radiation induced Single Event Upset which required recovery from ground and delayed the restoration of the data service another 2 days (until 17 March).

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 S/C coordinates	6. Velocity vector of spacecraft in spacecraft coordinate	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.)
17 Sep. 2013 12:49:22 (+/-16s)	SSR Word Group	Time: 2013-09-17 12:49:22.00 Satellite: M01 a[km] = 7188.94279 e[-] = 0.00225 i[deg] = 98.651 RAAN[deg] = 319.374 PSO[deg] = 291.196 PSO[rad] = 5.08233	Penumbra		VY [km/s] = -7.42724 VZ [km/s] = -0.18466	2.1.1	High	Overcurrent in memory partition	Metop-B	EUM/EPS/AR/15034 South polar rad belt
19 Sep. 2013 13:41:37 (+/-16s)	SSR Word Group (different)	Time: 2013-09-19 13:41:37.00 Satellite: M01 a[km] = 7186.72467 e[-] = 0.00256 i[deg] = 98.652 RAAN[deg] = 321.375 PSO[deg] = 265.809 PSO[rad] = 4.63925	Penumbra		VY [km/s] = -7.42825 VZ [km/s] = 0.03733	2.1.1	High	Overcurrent in memory partition	Metop-B	EUM/EPS/AR/15046 South polar rad belt
6 Oct. 2013	IASI	Time: 2013-10-06 21:03:36.00	Umbra/Penumbra		VY [km/s] =	2.1.1	High	SEU in CCM	Metop-A	EUM/EPS/AR/15083

21:03:36 (+/-1s)		Satellite: M02 a[km] = 7192.58053 e[-] = 0.00117 i[deg] = 98.677 RAAN[deg] = 337.872 PSO[deg] = 414.978 PSO[rad] = 7.24273	border		-7.43855 VZ [km/s] = -0.29356	or 2.2.1		subsys (Instrument outage)		North polar rad belt
29 Oct. 2013 07:19:15 (+/-8s)	SSR Controller	Time: 2013-10-29 07:19:15.00 Satellite: M01 a[km] = 7186.60292 e[-] = 0.00046 i[deg] = 98.696 RAAN[deg] = 0.491 PSO[deg] = 448.080 PSO[rad] = 7.82047	penumbra		VY [km/s] = -7.44448 VZ [km/s] = -0.01715	2.1.1 or 2.2.1	High	Loss of communication with SSR	Metop-B	EUM/EPS/AR/15129 North polar rad belt
12 Nov. 2013 12:12:08 (+/-8s)	SSR Controller	Time: 2013-11-12 12:12:08.00 Satellite: M02 a[km] = 7201.60441 e[-] = 0.00087 i[deg] = 98.715 RAAN[deg] = 13.966 PSO[deg] = 203.647 PSO[rad] = 3.55431	none		VY [km/s] = -7.42170 VZ [km/s] = 0.46751	2.1.2	High	Loss of communication with SSR	Metop-A	EUM/EPS/AR/15158 SAA
24 Dec. 2013 10:16:42 (+/-4s)	AMSU-A1 Ch.9	Time: 2013-12-24 10:16:42.00 Satellite: M01 a[km] = 7200.83749 e[-] = 0.00082 i[deg] = 98.776 RAAN[deg] = 55.873 PSO[deg] = 207.104 PSO[rad] = 3.61465	none		VY [km/s] = -7.42139 VZ [km/s] = 0.45429	2.1.2	Low	Instability of IF amplifier	Metop-B	Significant instrument noise increase in radiometric data (one channel) EUM/EPS/AR/15230 Anomalous spikes in previous orbits may or may not be related
21 Jan. 2014	GOME-2	Time: 2014-01-21 23:32:15.00	none		VY [km/s] =	2.2.1	High	Latch-up in	Metop-A	EUM/EPS/AR/15267

23:32:15 (+/-1s)		Satellite: M02 a[km] = 7186.75205 e[-] = 0.00276 i[deg] = 98.770 RAAN[deg] = 83.356 PSO[deg] = 274.525 PSO[rad] = 4.79137			-7.42677 VZ [km/s] = -0.04030			electronics board		South Pole
5 March 2014 07:00:16 (+/-2s)	MHS	Time: 2014-03-05 07:00:16.00 Satellite: M01 a[km] = 7190.56684 e[-] = 0.00083 i[deg] = 98.763 RAAN[deg] = 125.777 PSO[deg] = 117.910 PSO[rad] = 2.05791	none		VY [km/s] = -7.44174 VZ [km/s] = 0.23953	2.2.1	High	Motor spin state	Metop-B	EUM/EPS/AR/15356 North Polar rad belt
10 March 2014 02:01:00 (+/-16s)	SARP	Time: 2014-03-10 02:01:00.00 Satellite: M02 a[km] = 7203.30462 e[-] = 0.00096 i[deg] = 98.730 RAAN[deg] = 129.687 PSO[deg] = 344.771 PSO[rad] = 6.01739	full		VY [km/s] = -7.42249 VZ [km/s] = -0.49249	2.1.2	High	Loss off communication with instrument	Metop-A	EUM/EPS/AR/15363 SAA
14 March 2014 14:24:52	IASI	Time: 2014-03-14 14:24:52.00	none		VY [km/s] = -7.42230 VZ	2.1.2	High	Over-voltage	Metop-B	EUM/EPS/AR/15372 Coincident with proton flux peak from SAA

(+/-1s)		Satellite: M01 a[km] = 7200.85980 e[-] = 0.00103 i[deg] = 98.747 RAAN[deg] = 134.941 PSO[deg] = 207.269 PSO[rad] = 3.61753			[km/s] = 0.45368					

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

No conjunctions requiring avoidance manoeuvres on Metop satellites occurred during the reporting period.

2.2.5 Ground segment matters

The EPS Ground Segment has generally performed very well, supporting both EPS (dual-Metop) and NOAA operations. However an EPS Dissemination Outage occurred late in the reporting period, described further below.

In June 2013, a data throughput speed increase on the Svalbard to Darmstadt communications link for Metop instruments data from 3.9 Mbps to 8 Mbps was successfully implemented for both Metop data streams, as well as for the NOAA data stream, which was increased from 300 kbps to 1 Mbps. This new operational baseline constitutes a significant improvement in the delivery timeliness of data and products to end users; e.g. for ADA supported passes, typical of Metop-B, the average data timeliness for ascending half-orbits has been reduced from 59 min to 47 min and for Metop-A, the whole orbit average data delivery timeliness has been reduced from 101 min to 82 min.

EPS Dissemination System Outage:
On 26 March 2014, at 12.15 UTC an anomaly on EPS dissemination system resulted in data delays and accumulated losses of approximately 1.5 hours of data from Metop-A, Metop-B and NOAA-19, between sensing time 11:14 UTC and 14:15 UTC, dissemination was resumed at 13:03, stopped again at 13:30, and finally resumed at 15:41. The operational DIFF server crashed which caused a corruption of the files on the shared disk. Dissemination was swapped to the backup server and dissemination started again but due to the corrupted files and the system not responding as expected the DIFF server had to be stopped and started again. Most of Metop-A dissemination had in any case been switched-off as a manoeuvre was being performed at the same time.

The communications equipment in NOAA has been upgraded due to obsolescence in December 2013. Further obsolescence upgrades are planned at the SVL station in Q2 2014. All changes are planned to avoid any impact on on-going operations.

EUMETSAT is providing global data from Suomi NPP to its user community via EUMETCast and the GTS/RMDCN for routine operational use since 31 July 2012.

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. All the services (EARS-ATOVS, EARS-AVHRR, EARS-ASCAT and EARS-IASI) performed well over the reporting period. For these services, the Metop-B data were added on 20 August 2013.

In addition, the implementation of the EARS-NWC service started the dissemination via EUMETCast to all users on 24 April 2013 for Metop-A data. The EARS-NWC service subsequently switched to Metop-B data on 20 August 2013.

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

Since the A-HRPT on Metop-B was re-engineered as a result of the lessons learned from the Metop-A A-HRPT failure, users around the globe are receiving operational instrument raw data, without restriction.

2.2.7 Projects, Services

Suomi NPP Global and Regional Service Projects

The Suomi NPP (S-NPP) satellite was successfully launched on 28 October 2011 and has been undergoing commissioning under NASA and more recently under NOAA responsibility. It is the first of the next generation of polar spacecraft to be operated by NOAA and will ensure continuity of Afternoon Orbit operational data services within the IJPS, once S-NPP takes the role as the primary operational satellite in this orbit. The satellite has performed well during the reporting period.

Global Data

EUMETSAT is providing global data from Suomi NPP to its user community via EUMETCast and the GTS/RMDCN for routine operational use since 31 July 2012.

EUMETSAT's Suomi NPP related activities 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.

EUMETSAT has continued to work with NOAA in order to coordinate the acquisition, tailoring and redistribution of additional NPP datasets as these have become available from NOAA. This includes also the support for GMES/Copernicus Marine and Atmosphere Services by acquiring user requirements for the EUMETCast dissemination of selected SNPP SST, Ocean Colour and Atmospheric Composition products.

The S-NPP NDE was declared operational in Sep 2013, and was relocated to the Operations Centre at NOAA in Q3.

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.

All core EARS stations now have the new X/L-band reception systems operational and are receiving Suomi NPP data on a routine basis. The last station to become ready was Kangerlussuaq, in September 2013, because severe flooding impacted Greenland in July 2012 and postponed the station upgrade.
The product processing for the ATMS, CrIS and VIIRS instrument data is based on the CSPP processing package provided by University of Wisconsin-Madison.

The EARS-ATMS and EARS-CrIS services were declared operational on 15 May 2013 from the first core stations to be ready (Svalbard, Lannion, Maspalomas and Athens). Data acquired in Kangerlussuaq was added in January 2014.

The EARS-VIIRS service is expected to commence in the first half of 2014. A first version with data acquired at Lannion only is available to trial users via EUMETCast since November 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 operated in cooperation between EUMETSAT, NOAA, CNES and NASA in the frame of the Ocean Surface Topography Mission (OSTM). EUMETSAT and NOAA process the data from the Jason-2 satellite in near real-time and archive and disseminate the products.

The Jason-2 Service for Near Real Time (NRT) products became operational on 15 December 2008. Overall, for the reporting period, the Jason-2 System provided a satisfactory operational service with availability around 97%, and 88% of data meeting the 3 hours timeliness target. As in the previous reporting period, these figures are slightly lower than normal due to another Safe Hold Mode which happened in September 2013, (the third such occurrence in 2013) and this resulted in a mission outage of about 7.5 days during the reporting period.
In addition to the Safe Hold Mode outages, from 1 June 2013 to 31 March 2014, different problems impacted the data latency: several ground stations anomalies (Usingen, Fairbanks and Wallops), connectivity problems between NOAA and EUMETSAT, and several ground facilities anomalies at NOAA.

On 19 November, ECMWF upgraded their operational meteorological models: cycle 40r1 has been implemented. This upgrade has had an impact on the production of Jason-2 OGDRs with significant improvements in the model wet and dry tropospheric correction fields up to about ±5 cm.

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.

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).

Agreed MODIS products are disseminated unchanged on EUMETCast. Level 1 Calibrated Radiances products (MOD02) are processed before dissemination, comprising a spatially thinned sub-set of channels. MODIS precipitable water products (MOD05 and MYD05) are processed by EUMETSAT in order to retain only near infrared measurements over land during daytime. The worst-case dissemination delay generally stays below 30 min.

FY-3A&B Data Dissemination Service

Global Microwave Temperature Sounder (MWTS) and Microwave Humidity Sounder (MWHS) Level 1 products from FY-3A and FY-3B are provided by CMA, and are made available to EUMETSAT Member States via EUMETCast. MWRI from FY-3B are also redistributed via EUMETCast.

SSMIS Data Dissemination Service

ENV, IMA, LAS and UAS products are disseminated on EUMETCast in BUFR format.

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 SARAL Launch was successful on 25 February 2013. An early dissemination of NRT altimetry products started on EUMETCast on 23 July 2013, and the products were declared operational on 16 September 2013. The start of operational distribution to users via the GTS was on 10 October 2013.

Oceansat-2 Data Dissemination Service

This service has been 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.

The service was declared operational on 25th October 2012, its availability and timeliness usually reached the requirements of 85% of data within 180 minutes.

Unfortunately, ISRO announced on 2 April 2014 that the service will be discontinued, due to an instrument failure.

Megha-Tropiques Data Dissemination Service

Based on the requirements for Level 1A2 data from the SAPHIR, MADRAS, ScaRaB and ROSA instruments and the tripartite cooperation agreement between ISRO, EUMETSAT, and CNES, a data transfer mechanism was agreed which uses a procured data line directly from ISRO to EUMETSAT. The implementation and testing of the data line is still on-going, with good progress so far. The initial service will only comprise data from the SAPHIR instrument. The availability of ROSA data remains to be clarified, and the MADRAS instrument has failed and so no products from MADRAS will be available for forwarding. A corresponding BUFR reformatting software has been developed at EUMETSAT. It is anticipated that the data will be available within 180 minutes of sensing. The start of a trial dissemination is foreseen to start in the second quarter of 2014.

SMOS Data Dissemination Service

A BUFR version of the SMOS Level 1c near real time light product received from ESA via the Met Office (UK), is being distributed by EUMETSAT since February 2013.

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°	H2/2015		12-channel SEVIRI imager, GERB, DCS
	MTG I1[1]	9.5°E	12/2018-01/2019		Meteosat Third Generation/ Imaging (FCI, LI)
	MTG S1	0°	Mid 2021		Meteosat Third Generation/ Sounding (IRS, UVN)
	MTG I2	9.5°E	Mid 2023		Meteosat Third Generation/ Imaging (FCI, LI)
	MTG I3	9.5°E	End 2026		Meteosat Third Generation/ Imaging (FCI, LI)
	MTG S2	0°	Mid 2029		Meteosat Third Generation/ Sounding (IRS, UVN)
	MTG I4	9.5°E	Mid 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	2018		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 Copernicus (formerly 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 space segment development schedule has remained stable for the MTG-I Flight acceptance Review in July 2018, compatible therefore with a MTG-I launch by end of 2018/early 2019, but intermediate milestones have been subjected to some delay; the instrument Qualification Reviews (QRs), the platform Critical Design Review (CDR) and QR have slipped by a few months. PDR of the LI is on-going, with closure expected mid-April, to be followed by the mission level PDR in early summer, addressing the level 1b data processing. The MTG-S satellite milestones were subject to delays during last year; the MTG-S FAR is now in January 2021, implying a launch mid-2021, but industry is still attempting a recovery. After the closure of the MTG-S PDR in Autumn 2013, the S-4 PDR was also closed in November 2013.

Significant pressure remains on both MTG-I and MTG-S schedules; the critical path for MTG-I and MTG-S is through the FCI & IRS instrument development, with Lightning Imager following the FCI on MTG-I. Critical platform issues are being addressed on the attitude control system, thermal control of the reaction wheels, and onboard software development which have the potential to propagate delays to the satellite level. A detailed re-assessment of both the MTG model philosophy and test plans is ongoing to identify potential schedule and effort optimisations.

Close scrutiny is maintained on system performance issues and launcher compatibility, particularly with respect to satellite mass. For both MTG-I and MTG-S, a mass reduction plan is being implemented with important actions to conclude by spring this year. Current indication is that the launch mass for MTG-I and MTG-S should remain within the 3600kg and 3800kg limits. Conclusions of this work are a prerequisite for EUMETSAT to finalise the preparation of the Request for Quotation

(RFQ) for the launch service procurement to Arianespace. Work continues in parallel with SpaceX for ensuring the compatibility of the satellites with Falcon 9.

The EUMETSAT system activities have focussed on the close out of the Delta System Preliminary Design Review which was held in spring/early summer 2013. All the main areas are considered to have been properly addressed, in particular the consolidation of the Integration Verification and Validation plans at system and ground segment levels, the definition of associated test data and the plans for their timely production, as well as the Sentinel- 4 requirements with ESA. A dedicated Review has been set up towards the end of 2015, in the form of a System Implementation Review, which will focus on reviewing the implementation status of MTG-I, and plans for MTG-S, the adequate finalisation of all PDR's below system level, the System-level design performances to be demonstrated at CDR and the potential impacts on the EURD. It implies an incremental approach for arriving to the system CDR in early 2017, which could be very relevant for anticipating possible issues. As result of the conclusion of the Delta system PDR, work is now in full C/D mode at EUMETSAT.

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) for MTG-I and for MTG-S
- Mission Operations Facility (MOF)
- Mission Data Acquisition (MDA) Ground Stations
- Telemetry, Tracking and Control (TTC) Ground Stations
- Level-2 Processing Facility (L2PF) and GS Network.

Both the Mission Operations Facility (MOF) contract and the MTG-I Instrument Data Processing Facility (IDPF-I) contract had their kickoffs in the second half of the year and development work has commenced. For the MOF, the requirements analysis and the detailed design have been the main focus of work, with the Facility PDR on track for July 2014 as per schedule. Concerning the IDPF-I, nominal progress is ongoing, the algorithm panels are being prepared and the Facility PDR is on track for Nov 2014. The IDPF-S procurement approach is being defined, for release of ITT in 2015. Work for the ITT preparation of the L2PF has progressed with planned release of the ITT in spring 2014. The industrial offers for the Telemetry Tracking and Control (TT&C) and Mission Data Acquisition (MDA) Ground Station Facilities have been evaluated and Contract Proposals for both facilities are now submitted to the spring round of EUMETSAT Delegate Body meetings in spring 2014.

For the science activities important effort was related to the Algorithm Theoretical Baseline Documents which were updated following the Delta system PDR. First simulated proxy data for FCI have been produced and studies on the volcanic ash product have started to compare the current product with optimal estimation methods. Terms of reference of the LIST and MIST (Science Teams for the LI and

MTG-IRS) were modified to better address the forthcoming phases of MTG, in fact the ongoing scientific support for MTG will progressively shift its focus to cover also aspects related to L1 processing, Cal/Val and user readiness.

3.2 Status of future LEO satellite systems

This section covers EPS-SG; Jason 3 and CS; and Sentinel 3.

3.2.1 EPS-SG

This section presents the status of the EPS Second Generation (EPS-SG) Preparatory Programme activities, which started in October 2012.

The EPS-SG Space Segment scope and Payload Complement relying on a two satellite configuration (Metop-SG A and B) were agreed by EUMETSAT Council in 2012 and constituted the baseline for the ESA Metop-SG Development Programme which was approved at the ESA Ministerial Council end of 2012 (ESA C-MIN-12).

The space segment Invitation to Tender (ITT) for phases B2/C/D/E1 to industry was released by ESA in September 2013. Following the evaluation of the proposals, ESA announced at its Industrial Policy Committee (IPC) in April 2014 Airbus Defence and Space (France) as the prime contractor for the Metop-SG A satellite and Airbus Defence and Space (Germany) as the prime contractor for the Metop-SG B satellite.

Following the selection of the prime contractors for the space segment and having established at EUMETSAT the EPS-SG system and ground segment architectures, design and development plans for the overall programme the EPS-SG Programme Proposal and associated draft Programme Resolution was submitted to EUMETSAT Delegations in April 2014. The approval of the EPS-SG Programme is targeted for end of 2014.

Schedule

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

Phase B	Preliminary Definition	Q4 2012 –mid 2015
Phase C,D	Detailed Definition, Production	2015 – 2021
Phase E	Utilisation	from 2021

The EPS-SG Preparatory Programme works on the assumption of a series of three spacecraft of each type (Metop-SG A and B), with a 7.5-year design lifetime of each satellite and thus is planned to cover at least 21 years of operations for each series of satellites.

The foreseen EPS-SG satellite deployment scenario is as follows:

- Nominal launch of Metop-SG A1: 2021
- Nominal launch of Metop-SG B1: 2022
- Nominal launch of Metop-SG A2: 2028
- Nominal launch of Metop-SG B2: 2030
- Nominal launch of Metop-SG A3: 2035
- Nominal launch of Metop-SG B3: 2036

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 23.4 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 in 11 channels (2 of which being dual-polarisation)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 0.05 to 1 nm in the wavelength range from 0.27 to 2.385 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 in 12 spectral channels 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:

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

The mapping between the EPS-SG missions and the corresponding instruments to be carried on the Metop-SG satellites is given below:

Metop-SG A Missions	Instrument (and Provider)	Predecessor on Metop
Infrared Atmospheric Sounding (IAS)	IASI-NG (CNES)	IASI (CNES)
Visible-Infrared Imaging (VII)	METimage (DLR)	AVHRR (NOAA)
Microwave Sounding (MWS)	MWS (ESA)	AMSU-A (NOAA) MHS (EUM)
Radio Occultation (RO)	RO (ESA)	GRAS (ESA)
Multi-viewing, -channel, -polarisation Imaging (3MI)	3MI (ESA)	-/-
UV/VIS/NIR/SWIR Sounding (UVNS)	Sentinel-5 (Copernicus/ ESA)	GOME-2 (ESA)

Table 1: EPS-SG missions and corresponding instruments on Metop-SG A

Metop-SG B Missions	Instrument (and Provider)	Predecessor on Metop
Scatterometry (SCA)	SCA (ESA)	ASCAT (ESA)
Microwave Imaging for Precipitation (MWI)	MWI (ESA)	-/-
Ice Cloud Imaging (ICI)	ICI (ESA)	-/-
Radio Occultation (RO)	RO (ESA)	GRAS (ESA)
Advanced Data Collection (ADCS)	A-DCS4 (CNES)	A-DCS3 (CNES)

Table 2: EPS-SG missions and corresponding instruments on Metop-SG B

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.

Status of EPS-SG Preparatory Programme Activities

Following its approval by EUMETSAT Council in June 2013, the End User Requirements Document (EURD), including the list of products to be developed in the EPS-SG framework, is being used as the programme baseline.

ESA pre-selected the prime contractors for the MWS, ICI, MWI, 3MI and RO instruments in March 2013 and released an Invitation to Tender (ITT) for the full development and procurement of the Metop-SG satellites (phases B2/C/D/E1) in September 2013. Following the evaluation of the proposals, Airbus Defence and Space (France) in Toulouse was announced as the prime contractor for the Metop-SG A satellite and Airbus Defence and Space (Germany) in Friedrichshafen as the prime contractor for the Metop-SG B satellite by the ESA Industrial Policy Committee (IPC) in April 2014.

The System Requirements Review (SRR) has been successfully completed in April 2014 and confirmed the complete system requirements baseline for system design and development.

EUMETSAT has had significant interactions with ESA, CNES, DLR and NOAA regarding the draft Cooperation Agreements for Phase C/D/E with the objective to have these agreements ready to be signed after the entry into force of the EPS-SG Programme.

In November 2013, CNES selected Airbus Defence and Space (France) as the IASI-NG instrument prime contractor. Meanwhile, Phase B2 activities have been kicked-off. Some instrument advanced Phase C activities (breadboarding) on critical subsystems started early December 2013 for schedule optimization.

The METimage instrument activities are on-going under a DLR Phase B2 contract. The instrument design has been revised as showstoppers were identified in the original design of the instrument during a key point process which has started in spring 2013. In order to reduce development and schedule risks, the new design makes use of detectors similar to those of MTG. Consequently, a Delta System Requirements Review is planned in May 2014.

Interactions with NOAA are conducted in the framework of the Joint Working Group (JWG) focusing on the scope of the future Joint Polar System (JPS) Cooperation Agreement. Good progress has been achieved in this area. EUMETSAT and NOAA have agreed a model of sharing the ground infrastructure (Svalbard and Mc Murdo) to better serve Metop-SG and JPSS satellites.

On the Ground Segment side, the activities have focussed on preparing for the Overall Ground Segment Requirement Review (OGSRR), which is planned for June 2014.

3.3 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 March 2015 with a 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.

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

All US and European payload instruments were delivered to Thales Alenia Space (TAS), Cannes by mid 2013 and then the satellite Assembly, Integration and Test (AIT) started with a verification of initial performance. This campaign allows having a performance reference measurement for the instruments mounted onto the satellite before the environmental tests. These initial performances can be compared to the instrument stand alone performance in order to detect any modification linked to the satellite configuration. Further performance measurements measured after the environmental tests can then also be compared to this initial set.

All mechanical tests (vibration, shock, acoustic) have been completed without any problem. The preliminary results from these tests show a good compatibility of the spacecraft with respect to the Falcon 9 loads with a limited number of notching to be required. More detailed analysis is ongoing. The fit check and separation tests with the Falcon 9 flight interface have also been conducted and did not reveal any issues.

The first successful launch of the Falcon 9 new V1.1 version, on September 29th, 2013 was a critical milestone for the Jason-3 project as it was the first launch of this version of the launcher with a similar fairing to Jason-3 and from the new Vandenberg Air Force Base launch pad. Since then, two more successful Falcon 9 V1.1 launches took place, and on that basis, NOAA and NASA endorsed the Space X proposal to move the Jason-3 contract from the initial V1.0 version to the new V1.1. The launch site certification review has already taken place and the launch vehicle review, focused on the specific features of the Jason-3 launcher, will be

conducted in April 2014. One critical area remains the NASA process for certification of this version of the launcher, which is ongoing and needs to be closed between Launch -4 and Launch -6 months.

3.3.2 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 Technical Qualification phase (QT) of the 4-partners ground segment was successfully completed. The executed system tests covered different technical aspects such as the Jason-3 LEOP (Launch and Early Operations Phase), the routine generation of Jason-3 Near-Real-Time products (NRT) in parallel to the Jason-2 ones, the Jason-3 recovery from a potential SHM (Save Hold Mode) or the handover of the satellite commanding from CNES to NOAA after the launch.

Continuing with all Partners' efforts to merge the Jason-2 and Jason-3 processing on the same ground segment after the Jason-3 launch, EUMETSAT has now a consolidated detailed merge procedure which will be tested before the end of the year. The advantages of centralising the Jason-2 and Jason-3 processing on the same hardware platform are numerous, simplifying the maintenance and implying significant cost reductions for EUMETSAT in the long term.

All ground segment efforts are now focused on the preparations for the Jason-3 Operational Qualification phase (QO) which has been kicked off end of March. The QO tests will extend until November, leading to the Jason-3 Operational Readiness Review (ORR) at the end of the year.

3.3.3 Schedule and main milestones

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

- Thermal/Vacuum test from mid June to end of July 2014;
- EMC test, and acoustic satellite test to check proper workmanship in September 2014;
- Final performances in October 2014
- Flight Acceptance Review in November 2014.
- Preparation for and launch campaign from December 2014 to March 2015.

From a system stand point, the main milestone is the operational qualification from April 2014 to November 2014 with the Operational Readiness Review in November 2014.

3.4 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.

The phase B2 satellite activities kicked off by ESA in June 2013, are planned to be extended up until autumn 2014 and will conclude with a satellite PDR in the September/October timeframe.

The option on the satellite configuration, which remained open at the end of Phase B1 on possible addition to the payload of a High Resolution Microwave Radiometer (HRMR), was abandoned at the beginning of Phase B2 to reduce complexity, risk and cost.

At system level, the activity was mainly dedicated to the preparation of the System requirement documentation in preparation for the System Requirement Review.

In this context, the system activities concentrated on the following system requirements documentation required to support SRR-1:

- The Jason-CS End User Requirements Document (EURD),
- The Jason-CS Mission Requirements Document (MRD),
- The Jason-CS System Requirements Document (SRD);
- The Mission Operation Concept
- The system level interface requirements;
- Multi partner Management documentation;
- The Satellite System Requirements Document (SSRD) and US provided instruments performance requirements in line with the above system level requirements baseline.

The Review Board emphasised the need to focus on the activities needed to ensure that the spacecraft preliminary design activities are optimised with respect to both the needs of the user community and the programmatic/system-level constraints as well as the need to establish the roles, responsibilities, and contributions for phases C, D and E, in order to provide the required elements to the EUMETSAT Programme Proposal.

In 2014, the activities at EUMETSAT will focus on the consolidation of the system requirement and management documentation based on the outcome from SSR

Part1, the preparation of the draft agreements and the consolidation of the cost estimation of the ground segment development and of the operations.

The results of these activities should enable to provide a Jason-CS Programme Proposal, Draft Declaration and Enabling Resolution reflecting also discussions of Potential Participating States Meetings for end of 2014.

The SRR part 2 is planned in Q1 2015 and the system PDR to verify the preliminary design of the selected concept and technical solutions against the system requirements is planned in 2016.

On 3 December, the second meeting of Potential Participating States of the EUMETSAT Jason-CS optional programme reviewed the benefits expected from the mission in various application areas, as presented by the Secretariat and ECMWF, and, on that basis, endorsed the draft End User Requirement Document. The document on benefits was distributed to all Heads of Delegation to encourage those Member States who have not yet decided to be Potential Participating States to join.
The EUMETSAT Participating States also reviewed the programme baseline and alternative scenarios proposed by the Secretariat in response to affordability and other issues raised at the first PPM meeting, concluding that a two-satellite programme was indeed required to deliver the reference altimeter mission throughout the lifetime of the approved Copernicus Sentinel-3 satellites.

The Potential Participating States considered the proposal of the EC to rename the Jason-CS mission as Sentinel 6 in the context of Copernicus to facilitate communication across the Copernicus stakeholders and supported the recommendation of the Director-General to refer to the “Sentinel-6 mission implemented by the Jason-CS satellites”, with the understanding that the renaming shall not impose legal constraints on the US partners and that EUMETSAT and the other implementation partners could continue to refer to Jason-CS for the purpose of the approval of their respective contributions to the programme, thus avoiding legal complication at national level.

ESA has now opened the phase 2 of the GSC-3 optional programme for subscription by its Member States (between 22 February and 21 May 2014) and called an additional Programme Board on 23-24 June to assess the outcome. A bridging phase is planned from late 2014 (after satellite PDR) to spring 2015 and the Phase C/D is expected to start by mid-2015.

NOAA has recently confirmed their plan to request funding for its contribution to Jason-CS as part of the FY2016 budget process, with the expectation that this would be included in the US President Budget proposal to be released in February 2015.

3.5 Sentinel-3

3.5.1 Background

Copernicus (formerly 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, near real time (sensing + 3h) and off-line products (sensing + 48h, sensing + 30 d).

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 COPERNICUS 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, 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 of EUMETSAT for 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.

Discussions with the European Commission (EC) regarding the setting-up of a Delegation Agreement to conduct Copernicus Space Segment operations relevant to EUMETSAT, including the S-3 operations have progressed well. It is expected that the Delegation Agreement be approved by EUMETSAT's Council this summer.

The EC GMES Committee requested ESA and EUMETSAT to analyse and to provide a technical, programmatic and financial proposal for the implementation of 100% SAR mode operations including the provision of Level 1 (L1) products to users. A joint proposal was elaborated by ESA and EUMETSAT, submitted to the EC for decision and recently approved by the EC. The implementation of the change will now proceed in the development baseline. Regarding the EC change for the Near Real-Time (NRT) production of Fire Radiative Power and Aerosol Optical Depth products, the technical analysis is in progress.

The procurement of the Mission Performance Centre (MPC) service is now closed proceeding with a single and full MPC service being procured by ESA to support the needs of ESA and EUMETSAT in the routine operations phase whilst allowing, through a contract option, for EUMETSAT to take-over part of the service in a EUMETSAT contract.

Regarding the consolidation of the Payload Data Ground Segment (PDGS) Commissioning and the Product Ramp-Up plans, the target is to rework these plans by the End-To-End Ground Segment Acceptance Review (GSAR), taking into consideration the need for consistency across all these plans and the need to provide operational products to users in a timely manner.

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

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

- The Flight Operations Segment (FOS) for routine operations 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 Marine PDGS Centre which is subset of the PDGS dealing with the marine data products generation, dissemination and archiving is located at EUMETSAT HQ.

The ESA development plan foresees the execution of a Ground Segment Verification (GSV) testing phase. This phase is led by ESA with the support of EUMETSAT and will complete with the End-To-End Ground Segment Acceptance Review. The GSV has been subdivided in three main phases named Compatibility, Integration and Verification phases:

- The Compatibility Test (GSV-CT) phase has the objective of ensuring the format compatibility of the data exchanged between the Flight Operation System (FOS) and PDGS and verifying all the File Format Specifications. This phase is currently being executed and will be completed in April 2014. The results of the tests carried out so far show successful results;

- The Integration Test (GSV-IT) phase has the objective to verify the connectivity between FOS and PDGS in terms of networking and data exchange protocols. This phase is currently scheduled to start in May 2014 and to complete in November 2014;

- The Ground Segment Verification - Test Phase (GSV-VT) has the objective of verifying the end-to-end functional and performance requirements of the Ground Segment. This phase will start in September 2014 and will complete in February 2015, time at which the GSV Acceptance Review will be held.

3.5.3 Sentinel-3 Ground Segment matters

3.5.3.1 Sentinel-3 Flight Operations Segment Status

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

- The development of the Flight Dynamics Facility has progressed well. The development of the D2 version of the software has been completed and the Factory Verification Readiness Review (FVRR) was undertaken. This review identified the need to close some residual open issues and make improvements to the Contractor's test procedures prior to the start of the factory testing. The open issues were subsequently closed with additional configurability of the external interface file formats introduced and the test procedures were improved by the FDF contractor. This allowed for the factory testing activities to be successfully undertaken at the end of February. The preparations for the on-site testing activities of the D2 version are now ongoing and scheduled for completion in April;

- The deployment of the Mission Control System (MCS) has also progressed well. An initial D3.0 version of the MCS software has been delivered to EUMETSAT in January and initially tested in the FOS development (DEV) environment before being rolled out into the FOS validation (VAL) and operational (OPE) environments to accommodate IV&V activities and Operation Preparation needs;

- The version D2.1 of the Spacecraft Simulator (SIM) was delivered in February. This delivery did not include the SLSTR and OLCI instrument models with further SIM versions expected in March incorporating the OLCI model and in April incorporating the SLSTR model. A formal on site test campaign on this SIM version with all instrument models incorporated will be performed by EUMETSAT in May.

3.5.3.2 Sentinel-3 Payload Data Ground Segment (PDGS) Status

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

- The PDGS CDR closeout is progressing with the closure of actions related to the Review Item Descriptions (RID) and the update of the relevant associated documents;

- The deployment and integration of the Core PDGS hardware in EUMETSAT HQ has now been completed with both the operational (new) and reference platforms now installed. The integration of the new operational platform with the EUMETSAT network and other infrastructure elements is ongoing;

- The V2 version of the Core PDGS software components are being integrated and tested on the Master Core Platform (the S-3 test and integration platform) at Telespazio in Rome with the formal factory testing expected in late May/early June 2014 and the On-site Acceptance Testing expected in August/September 2014;

- The development of the Mission Planning Facility (MPF) has progressed well in the reporting period. The development of the D2 version of the software has been completed and the Factory Verification Readiness Review (FVRR) was undertaken paving the wave to the factory testing activities to start end of March. The preparations for the on-site testing activities of the D2 version are also ongoing and scheduled for completion in April;

- Concerning the Sentinels Demodulator and Front End Processor (DFEP), the unit deployed in EUMETSAT is being tested prior to being used as a test tool to support the integration activities. The operational unit for S-3 in Svalbard is expected to undergo formal on-site testing in Q2 2014;

- The operational Instrument Processing Facilities development is progressing although some small delays have been encountered. The Factory Acceptance Tests (FAT) for the L0, Optical L1 and MWR/SRAL L1 processors have been successfully completed. For what concerns the SRAL L2 processor the FAT was partially successful as there are some differences with the prototype SW that are not explained yet, noting as well that the SAMOSA (SAR Ocean re-tracker) part is scheduled to be tested in June 2014. In addition, some updates to the SRAL L2 test documentation are also required to be completed before the FAT can be declared successful. The next FAT is expected in April 2014 and will contain updates to the L1 SLSTR processor to include gap and continuity handlings. Another FAT is due in June 2014 and will include the L2 optical processors, the completion of the SRAL L2 processor, and updates to all the remaining processors to ensure they are aligned with the latest processing baseline;

- The activities under the ESA service contract for the provision of S1/2/3 X Band data are progressing with the Site Readiness Review for S-3 in Q2 2014;

- The activities under the ESA service contract for the provision of the GMES Wide Area Network, to interconnect all operational centres are progressing well with a successful site survey held in EUMETSAT in February. For S-3 the operational services are expected to be in operation at both the Core Ground Station and the Marine Centre by Q2 2014 ready for the Core PDGS V2 testing;

- The development of the Precise Orbit Determination (POD) ESA service contract continues with the successful completion of the NRT POD Instrument Processing Facility Qualification Review and the delivery of the related processor for integration in the PDGS Core;

- The ITT for the Mission Performance Monitoring Facility was issued in late 2013 and the evaluation of the received proposals is ongoing with a contract kick-off envisaged in Q2 2014.

In parallel to the above activities, EUMETSAT is currently completing the verification testing of the EUMETSAT Multi Mission Elements (MME). These are the EUMETSAT operational facilities serving all operational missions, and are being 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.