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STATUS OF THE METEOSAT SYSTEM

This paper reports the status of the Meteosat System from 1 July 10 until 30 June 2011.

The operational status of the geostationary systems is stable with Meteosat-7 at 57.5º East (Indian Ocean Data Collection - IODC), Meteosat-8 at 9.5º East (Rapid Scan Service - RSS) and Meteosat-9 at 0º (0º Service).

No significant in-flight anomalies have occurred on board the Meteosat satellites during the reporting period with the exception of a safe mode transition which occurred on Metesosat-8 on 30-7-2010 and the failure of a telemetry transmitter on board Meteosat-7.

It should be noted that Meteosat-6 was successfully re-orbited in April 2011.

Status of the Meteosat System

1 INTRODUCTION

During the period from 1 July 2011 until 30 June 2011 the Meteosat Transition Programme (MTP) system performed well. The main operational events to report are the Met-6 re-orbiting which was completed successfully in April 11 and the failure of one transmitter of the Meteosat-7 Mission Support Transmission subsystem which was observed on 1-3-2011 (see section below).

Similarly, the Meteosat Second Generation (MSG) system performed well in the reporting period and there are no significant issues to report apart a 3.5 hours interruption of the 0° Service which occurred on 16-3-2011 and which was caused by an operational problem with the Met-9 imaging function (see below section 3.2.1).

2 SPACE SEGMENT

The MTP and MSG space segment have performed well in the period from 1 July 2010 until 31 December 2010. However the following three events occurred during the reporting period:

- Meteosat-8 safe mode transition on 30-7-10 (see section below)
- Met-9 imaging interruption of 3.5 hours on 16-3-2011 (see below Incident #45);
- Met-7 MST TX1 anomaly observed on 1-3-2011 (see below under Met-7)

2.1 Meteosat-9

The satellite was launched on 21 December 2005.

Meteosat-9 is on station at 0° and provides all 0° services.

At the end of June 2011 it was estimated to have 99.04 kg of fuel still available. At least 29 kg of fuel needs to be reserved for re-orbiting at the end of the satellite's life. Assuming that only one further longitude relocation is performed, the last orbit inclination manoeuvre is estimated to take place in 2014. The satellite will then finish its inclination controlled lifetime in 2015. If the other vital functions are still working as specified, it is estimated that the fuel currently available should allow nominal longitude and attitude control until beyond 2019.

It should be noted that the fuel availability is just one element affecting the satellite lifetime. In this respect EUMETSAT has undertaken to perform availability analyses to determine the planned launch dates of MSG-3/4, based on the mission availability targets agreed with delegates. Among other factors, this analysis will take into account the fuel budget lifetime, the failures experienced on-board and the satellite reliability models.

The spacecraft is in imaging mode, fully configured including DCP and Search And Rescue transponder and no changes to the on-board configuration or significant anomalies have occurred during the reporting period.

Met-9 SEVIRI scanning interruptions on 16-3-11 (Incident #45)

On 16 March 2011 at about 19:30 UTC, a short interruption to the Meteosat-9 spacecraft telemetry caused SEVIRI to attempt an on-board black-body calibration in the wrong instrument configuration. As a result, the on-board protections were triggered and, in turn, commanded SEVIRI to Stand-by with a part of the instrument electronics switched-off. After investigation recovery started and Meteosat-9 SEVIRI resumed imaging at 22:45 UTC.

As a side effect of the above anomaly and subsequent recovery, in the morning of 17 March 2011 at about 05:30 UTC Meteosat-9 SEVIRI was commanded to stand-by from ground following detection of an inconsistency in the operational parameters on board the instrument. This reaction avoided recurrence of the above more critical on-board reaction. Imaging was successfully resumed after 45 minutes of interruption.
A detailed investigation on this series of events was completed as part of internal Incident #45 and the implementation of the identified actions in on-going.

2.2 Meteosat-8

The satellite was launched on 28 August 2002.

Meteosat-8 (Met-8) is located at 9.5°E and it is the backup spacecraft for the 0° services. In addition, from 13 May 2008 onwards, Met-8 has supported the RSS.

At the end of June 2011 it was estimated to have 35.62 kg of fuel still available. At least 29 kg of fuel need to be reserved for re-orbiting at the end of the satellite's life. The last orbit inclination manoeuvre was performed in October 2010. The satellite will finish its inclination controlled lifetime in autumn 2011. Assuming that the other vital functions are still working as specified, it is estimated that the fuel currently available should allow nominal longitude and attitude control until beyond 2015.

The spacecraft is in imaging mode with the Search And Rescue transponder switched-on (as requested by COSPAS-SARSAT), but without DCP mission.

No changes to the on-board configuration and no failures have occurred during the reporting period.

After the on-board anomalies suffered by Met-8 and in particular after the failure of the electronics driving the nominal propulsion branch, the probability of successfully re-orbiting Met-8 as a function of its in orbit time is monitored by EUMETSAT, ESA and Thales Alenia Space. A recent assessment indicates that, despite the on-board single point failure on the propulsion system (only the redundant branch is currently functional), the probability of successfully re-orbiting the satellite remains above 90% (that is a target proposed by some of the space debris mitigation regulations) at least till January 2015. This probability will be reassessed regularly to ensure that the Met-8 status is properly considered in the long term plan for the geostationary satellites.

Meteosat-8 safe mode on 30-7-10

The Met-8 safe mode on 30-7-10 was classified as Incident #42. The investigation into the anomaly led to the conclusion that it was a recurrence of an anomaly induced by a Single Event Upset very similar to the one which was experienced by Met-9 on 17-4-2009 (Incident #37). Accordingly the recovery was initiated in the same morning of the occurrence (i.e. on 30-7-10) and completed successfully in the evening of same day as the SEVIRI cooler temperature had not yet decreased too much and therefore it was quicker than usual to reach the required detector switch-on temperature. The Met-8 satellite recovery showed that no permanent damage was suffered by the hardware and the Rapid Scanning Service was resumed on 2-8-10, after two days of thermal stabilisation and detection gains adjustments.

2.3 Meteosat-7

The satellite was launched on 2 September 1997.

Meteosat-7 (Met-7) is providing the 57°E Operational Service since 5 December 2006.

At the end of June 2011 it is estimated to have 7.34 kg of fuel still available. At least 3.9 kg of fuel must be reserved for re-orbiting at the end of the satellite's life. Due to the limited amount of fuel left no orbit inclination manoeuvres can be performed. Assuming that the other vital functions are still working as specified, it is estimated that the fuel currently available should allow nominal longitude and attitude control until beyond the year 2016.

The spacecraft configuration remained stable. However a new anomaly on the Mission Support Transmission (MST) Transmitter 1 (TX1) was detected on 1-3-2011.

Regarding the Met-7 satellite, another test has been performed during the spring 2011 eclipse to confirm the capability of Met-7 to support the whole IODC mission also during eclipse crossing after Met-6 re-orbiting. The test was fully satisfactory and it confirmed the validity of the Met-7 configuration for the next eclipses.

As usual, the trend of the Met-7 battery performance during eclipse will need to be closely monitored in the future to detect any sign of degradation due to the increased power load to support the IODC DCP mission

Met-7 MST TX1 Failure

On 1 March 2011, during a routine activation of the Backup Ground Station (BGS) the Mission Support Transmission (MST) Transmitter No 1 (TX 1) of Met-7 showed an anomaly and it could not be switched on. Subsequent investigation confirmed that this is a permanent failure. MST is one of the two methods available on-board Met-7 to uplink commands and to receive telemetry to/from the satellite and therefore this new failure affects a vital sub-system. In addition in the past (see previous status reports), the MST Receiver 2 (RX2) also on board Met-7 had failed. As a result of these two on-board anomalies affecting the MST sub-system, MST ranging is no longer possible while MST commanding is still possible via RX1 and telemetry reception is also possible via TX2. This anomaly is significant, especially as it seems to point to a future complete loss of the MST functionality. This was therefore analysed in detail with the support of Thales Alenia Space and, as a result, it was concluded that this is not critical for the S/C control. Actually, also in case of complete loss of the MST sub-system, commanding, telemetry reception and ranging are still available via the Mission Payload Transmission (MPT) which is still fully functional on-board Met-7. As part of the investigation on the MST failures all operations which imply an unnecessary usage of the MPT have been revisited and simplified. In addition all possible contingencies (e.g. to avoid an inadvertent switch off of the MPT) were implemented both at S/C level and at ground segment level.

2.4 Meteosat-6

The satellite was launched on 20 November 1993 and its re-orbiting operations were completed on 2 May 2011.

Meteosat-6 was located at 67.5°E and was lately used for IODC DCP acquisition and as an imaging backup to Met-7.

Met-6 Re-orbiting Operations

Met-6's re-orbiting was performed in accordance with the Space Debris regulations and in particular the with the International Standards Organisation "Space Systems – Space Debris Mitigation" document ISO TC 20/SC 14 N 24113, 1 February 2010. The activities took place between 28 March 2011 and 2 May 2011. The following activities were performed:

Pre-Re-orbiting Tests:

- Full Earth Imaging with redundant electronics;
- Full Earth Imaging with nominal electronics;
- Rapid Scans Imaging with nominal electronics;
- Redundant Detectors test;

MPT Coaxial Switch Test;
Fuel On-Board measurement Test;

Re-orbiting Manoeuvres;
Spacecraft payload and platform passivation operations;
Final orbit determination.

After the end-of-life tests whose aim was mainly to check the status of the redundant units after so many years in orbit, the proper re-orbiting operations started on 11-4-11 as planned. The Met-6 re-orbiting operations were prepared by EUMETSAT using as a basis the sequences used in April 2007 for the Met-5 re-orbiting. The re-orbiting operations were reviewed by Thales Alenia Space and were provided for comments also to ESOC and CNES. Regular teleconferences with Thales Alenia Space were organised throughout the most critical phases of the re-orbiting operations to get the necessary support and advice in case of unexpected behaviours.

In compliance with the space debris mitigation guidelines of the International Standards Organisation “Space Systems – Space Debris Mitigation” document ISO TC 20/SC 14 N 24113, 1 February 2010, the objective was to raise the orbit of Met-6 at least 250 km above the geostationary ring and, at the same time, to reduce the satellite spin rate. The reduction of spin rate minimises the risk that satellite debris re-enter the geostationary ring should the satellite decompose itself in fragments in the very long term.

For the re-orbiting operations a fuel budget of 3.9 kg was estimated based on a book keeping method. Several manoeuvres followed by venting of the fuel pipes and tanks were performed from 11 April till 15 April 2011 to achieve a final orbit of approximately 350 km (perigee) x 384 km (apogee) above the geostationary ring together with a final spin rate of approximately 72 rpm (starting from a spin rate of about 99.9 rpm). The actual fuel mass was found to be about 3.7 kg (i.e. about 200g difference between estimated and actual mass).

The satellite switch off was then completed on 2-5-11 when the last command to Meteosat-6 was sent at 09:08 UTC, marking the end-of-life of this satellite that has been operated for more than 17 years.

The Meteosat-6 re-orbiting operations were fully successful, the fuel budget was quite accurate and the ISO 24113 recommendations fulfilled with margins.

3 GROUND SEGMENT

3.1 MSG ground segment

The availability of the MSG ground segment has been nominal for the reporting period.

Image Processing Facility: operations have been smooth and reliable. Regular maintenance continues to solve minor software issues and to prepare for MSG-3.

Primary and Backup Ground Stations: Routine operations at the Primary Ground Station (PGS) in Usingen, Germany include the weekly activation of the Backup Satellite Control Centre (BSCC). TTC and ranging of Met-8 and Met-9 are performed alternately with PGS and Back-up and Ranging Ground Station (BRGS) in Maspalomas. Both PGS and BRGS are regularly maintained to cope with obsolescence. A third antenna was implemented at PGS to avoid interruptions of the Rapid Scanning Service at the time of MSG-3 and MSG-4 commissioning.

The **Secondary Backup Ground Station** (SBGS) located in Cheia is activated routinely to support Met-7, Met-8 and 9.

The **Meteorological Product Extraction Facility** (MPEF) generated products over 0° using Meteosat-9 image data and RSS products using Meteosat-8 at 9.5°. During the reporting period (in Feb 2011) the MPEF hardware changed from HP-workstations to SUN servers. Due to the changed operating system and compilers the software did undergo significant changes.

3.2 MTP Ground Segment

The availability of the MTP ground segment was nominal for the reporting period.

MTP Control Centre: Operations were nominal for the reporting period.

Communication Links: The terrestrial E1 link is used as prime link for all traffic between Darmstadt and Fucino.

Primary and Backup Ground Stations: Routine weekly activation of the Backup Ground Station (BGS) in Cheia, Romania and the Backup Satellite Control Centre (BSCC) in Fucino, Italy continues.

The **Meteorological Product Extraction Facility** for the IODC service used Meteosat-7 at 57° E as the operational source of image data.

4 SERVICES PERFORMANCE

4.1 0° Meteosat-9 Service Performance

The 0° operational services - Level 1.5 SEVIRI and meteorological products - continued nominally throughout the reporting period with a monthly performance above 99%.

Service interruptions affecting more than one repeat cycle were mainly caused by two Meteosat-9 SEVIRI outages in March, by problems in the image processing facility and by EUMETCast. However, the impact on the monthly performance was minor.

At end of June 2011 there are 1030 DCPs allocated and 580 of them remain active (reporting regularly - also includes IODC allocations and reporting). The acquisition and dissemination of 0° DCP was carried out by Meteosat-9.

4.2 Meteosat-8 RSS Performance

The end-to-end performance of Level 1.5 SEVIRI product repeat cycles and meteorological products is consistently above 99.5%, not including the planned interruptions due to manoeuvres and the regular full earth imaging periods performed to preserve the Met-8 SEVIRI scan mechanism.

4.3 IODC Service Performance

The IODC service performance was nominal for the reporting period with monthly end-to-end availability figures above 99%.

The IODC DCP acquisition and dissemination service over the Indian Ocean was carried out by Met-7.

At end of June 2011 there were 44 DCPs allocated and 40 of them remain active. The acquisition and dissemination of IODC DCPs was nominal during the reporting period.

5 CONCLUSIONS

This paper reports the status of the Meteosat System from 1 July 10 until 30 June 2011.