THE METEOSAT DATA COLLECTION SYSTEM

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ABSTRACT:

The Meteosat Data Collection and retransmission Service (DCS) enables Data Collection Platform (DCP) Operators to use the Meteosat Meteorological Satellite System to retransmit DCP data collected from remotely located platforms to their own reception stations and to the Global Telecommunication System (GTS) community of the World Meteorological Organisations (WMO).
One application area where DCS is employed is in Tsunami Warning Systems, in particular the Indian Ocean Tsunami Warning System. The Meteosat satellites located at 0° and over the Indian Ocean acquire tide-level data from DCPs situated on moored buoys as part of the Tsunami Warning network. The data collected and transmitted by the platform are received by the Tsunami Warning Centres in the form of bulletins disseminated using the GTS. These messages are used to confirm the presence or absence of a Tsunami following a seismic event. Should a Tsunami be detected and when certain other criteria are met, warning messages are distributed to the affected National Authorities to activate emergency measures. Each DCP transmits at 100 bps every 15 minutes, which is adequate for this type of application; however plans are in place for the implementation of High Rate DCPs. These new type of platforms will be capable of transmitting data at 1200 bps. The increased data rate will allow Tsunami Warning Systems using these new DCPs to transmit data more frequently thereby improving the effectiveness of the overall system.

1. INTRODUCTION

The Data Collection Service (DCS) is one of the core services operated by EUMETSAT in support of meteorology and weather prediction. The service enables data collection platform (DCP) operators to use the Meteosat system to receive environmental data collected from DCP platforms. The DCS is particularly useful for the collection of data from remote and inhospitable locations where it may provide the only possibility for data relay.

The DCS, initially established with the first generation of Meteosat satellites (MFG) in 1977, has continued and expanded with Meteosat Second Generation (MSG) , and will also be embarked on the future Meteosat Third Generation (MTG). The Meteosat satellites are located at 0° longitude as well as over the Indian Ocean and acquire DCP data from operators of DCP platforms which are located within the footprint of the satellites. Similar systems are also operated by the US National Oceanic and Atmospheric Administration (NOAA) and the Japan Meteorological Agency (JMA), providing worldwide coverage. Some of the DCP bandwidth on board all these meteorological spacecraft is reserved for the International Data Collection System. This system allows operators to receive messages from mobile platforms and on ships or aircraft travelling around the world.

The DCS supports the transmission of data from DCPs to the satellite, as well as the immediate relay of data from the satellite to the ground station and the subsequent basic processing and onward transmission of selected data to the user.

This paper will give an overview of the Data Collection System and describe the different types of DCPs. The characteristics of the new High Rate DCPS will be described comparing them to the Standard Rate DCPs. The user applications of the DCS will be described with a recent example of the use of DCPs in Tsunami Warning Networks, finally the advantages of HRDCPs will be outlined especially for increasing Tsunami Warning System

2. DCS SYSTEM OVERVIEW

The operation of the Data Collection System supported by the first and second generation Meteosat satellite systems, MFG and MSG, is very similar. Both DCS support the following basic functions:

- The transmission of data from DCPs to the satellite
- The immediate relay of the data by the satellite to the Ground Station
- The subsequent basic processing and onward transmission of selected data to the user

The operational satellites are located over the equator at a longitude of 0° and around 63°E, hence the DCS can be used by all DCPs situated within its telecommunications field of view. A realistic limit of this view is about 75° great circle arc of the sub-satellite point and corresponding to a ground antenna elevation of 5° (see Figure 1). This field of view can extend to approximately 80° great circle arc depending upon local topographical features.

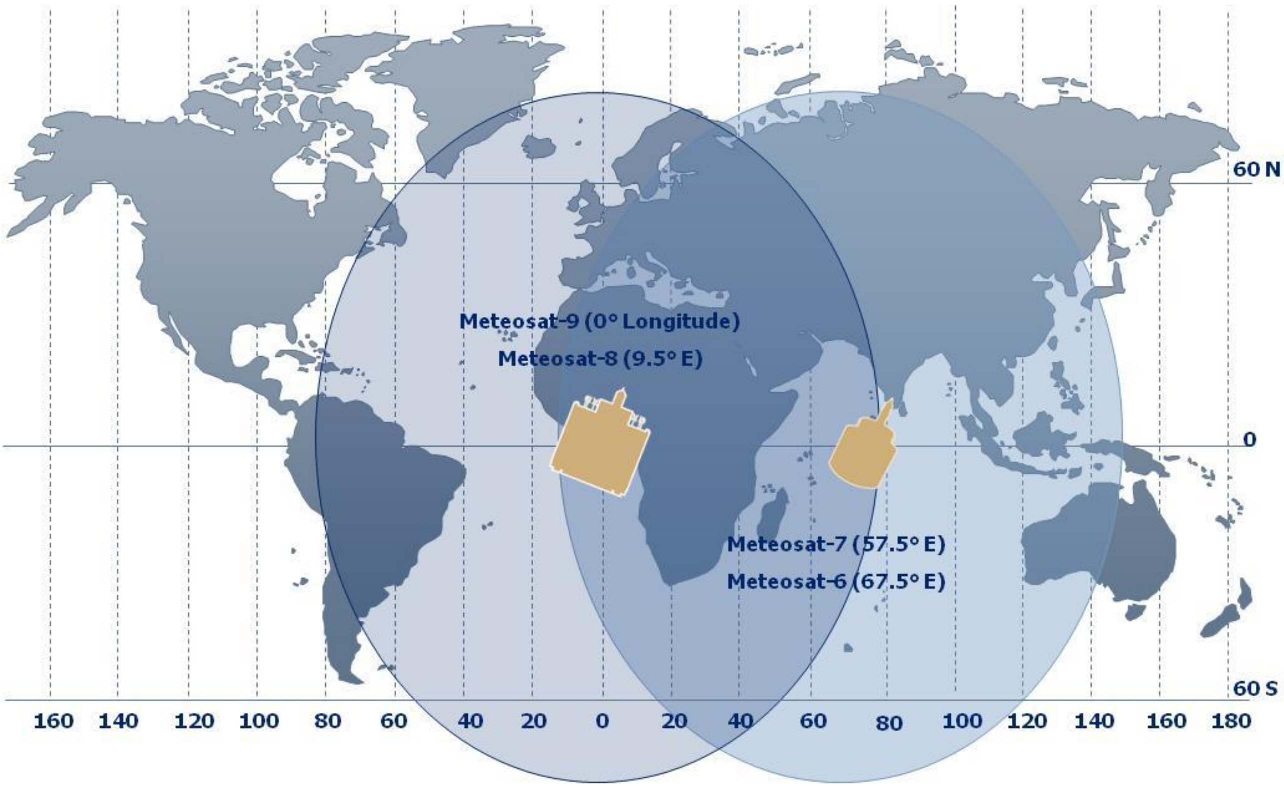

Figure 1. EUMETSAT's Geostationary Satellite Coverage

The DCP first transmits its message to the satellite in the UHF radio frequency band. The satellite then transponds the message and transmits the data to the Primary Ground Station (PGS), for MSG this is located at Usingen, Germany (see Figure 2). At the PGS all messages are routed to the MSG Mission Control Centre, located at Darmstadt, Germany for processing, short-term archive and distribution to the users, either via direct dissemination from the Meteosat satellite at 0° longitude to a Low Rate User Station, the Internet, the GTS or using EUMETCast, EUMETSAT's data dissemination system: see: www.eumetsat.int/Home/Main/Access_to_Data/Delivery_Mechanisms .

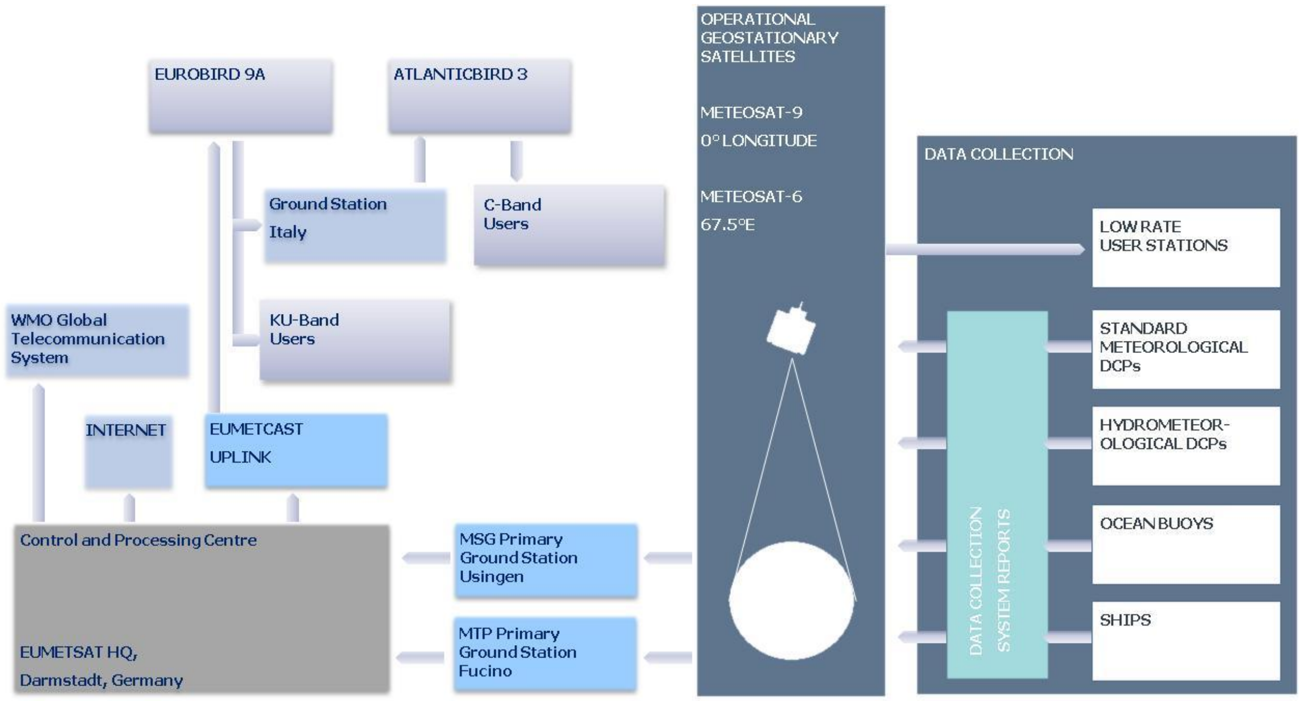

Figure 2. Overview of the Meteosat Data Collection System

3. DCP AND DCS CHARACTERISTICS

There are two types of DCP: Standard and High rate DCPs.

3.1 Standard Rate Data Collection Platforms (SRDCP):

Several thousand of these DCPs are in use around the globe. They transmit at 100 bauds and can transmit 649 bytes of platform data in 60 seconds (including 5 seconds unmodulated carrier, preamble, sync code and address) with a timing accuracy better than +/- 15 seconds

3.2 High Rate Data Collection Platform:

A new system of High-Rate DCPs (HRDCPs) was announced and following extensive testing is planned for operations during 2010. They transmit at 1200 bauds and can transmit 653 bytes of data in 10 seconds. The timing accuracy is also improved to +/- 0.5 seconds. The minimum transmission length will be 7.1 seconds (2 seconds of unmodulated carrier, preamble and ASM with 5.1 seconds) although the minimum assignment will be 10 second slots.

The two types of DCP are compared in table 1.

Characteristic		Standard DCP	High-Rate DCP
Baud rate		100	1,200
Current slot allocation		1 minute, 30 seconds	10 seconds minimum
Timing accuracy		+/- 15 seconds	+/- 0.5 seconds
Data per DCP message		649 bytes minimum	653 bytes for 10 second time slot
Channel bandwidth	MTP	3 KHz	2.25 KHz
	MSG	1.5 KHz	
Maximum number of messages per channel per day		960	8,640
Maximum message size of single message		649 bytes	65535 bytes

Table 1. Comparison of characteristics of current standard DCPs with high-rate DCPs

3.2.1 Key characteristics of the HRDCP design

In addition to the changes mentioned above, several other design improvements design provide significant advantages over the standard rate DCP

- The use of Offset QPSK modulation scheme allows reasonable bandwidth efficiency and phase noise tolerance.
- Concatenated Forward Error Correction (FEC) using CCSDS (CCSDS, 2006) recommended convolution coding & Reed-Solomon codes provide robustness against pulsed interference.
- The binary message system with error checking using a 32 bit Cyclic Redundancy Check, is suited to compressed or uncompressed data of any type.

3.3 Transmission Schedules

DCPs can operate within one of the following defined transmission schedules:

- Self-Timed: These DCPs transmit at regular intervals and are controlled by an internal clock, according to a schedule jointly agreed by the user and the satellite operator. The standard transmission intervals are hourly or three-hourly, but depending on the program and channel availability this repetition rate could be increased. GPS is used to synchronise the DCP
- Alert: These DCPs transmit short messages, not exceeding 10 seconds in duration, when the value of one or more measured parameters exceeds a pre-set threshold. The platform will repeat the message two or three times every 10 to 15 minutes in order to reduce the risk of possible interference by other alert DCP messages on the same dedicated channel.
- Hybrid: This is a DCP that combines the self-timed and alert modes of operation. The DCP will also be assigned to two different channels.

3.4 International and Regional

The DCS up-link bandwidth is divided into a number of channels, and depending upon its role, each DCP will be allocated to one of them. The DCS bandwidth is also grouped into two subsets.

International: The International Data Collection System (IDCS) is designed to support mobile DCPs, i.e. those DCPs on ships, ocean buoys, aircraft or balloons which move from the telecommunications field of view of one geostationary spacecraft to another.

Use of the IDCS allows coordinated DCP design and message formats, thus permitting the uninterrupted collection of messages from mobile DCPs to be received and processed by any of the Coordination Group for Meteorological Satellites (CGMS) geostationary meteorological satellite operators. By this means, almost continuous telecommunication coverage is possible in most regions of the globe, with the exception of the poles.

Only self-timed DCPs can use the IDCS channels. Although the normal time slots on IDCS channels are of 1.5 minutes, DCP transmissions must not exceed 60 seconds. The additional time within the slot is used as a ‘guard-band’ to protect neighbouring time slots in case of drift in the clock controlling transmissions from the DCP.

The IDCS operates in the Meteorological Satellite Service in compliance with ITU Radio Regulations.

Regional: Regional DCPs are DCPs that transmit within the footprint of one satellite and are generally in a fixed position. NOAA and JMA operate regional data collection services comprising several thousands of DCPs. Each satellite operator is responsible for the administration of its DCS. In the EUMETSAT system, older Meteosat First Generation compatible DCPs are allocated with 3 kHz channel spacing assignments and are confined to the frequency range 402.0685 – 402.1990 MHz. The MSG satellites have an additional capacity of 124 regional channels when assigned to 1.5 kHz channel spacing within the frequency range 402.2005 – 402.4345 MHz

High Rate DCPs will also use a separate area of the bandwidth within the 402.2005 – 402.4345 MHz range to avoid interference with Standard Rate DCPs. Use of the bandwidth for HRDCP will reduce the number of SRDCP channels without affecting established DCPs. These channel frequencies will be assigned as required.

4. DCP APPLICATIONS

The Meteosat DCS is used to gather a wide variety of measured environmental parameters; the following examples serve to demonstrate some of the possibilities offered by the system.

Meteorological data collection at remote land sites: The availability of meteorological observations from sparsely inhabited land areas is often poor. The use of automatically operated DCPs in such areas can provide this information, which is essential for accurate weather prediction. Many such systems have been deployed across Africa under the sponsorship of the World Meteorological Organization.

Water management: The management of water resources can be greatly assisted by making use of DCPs. The measurement of precipitation, river levels, river flow rates and water quality are just some of the parameters that can easily be relayed with a DCP. This type of DCP might also be operated in alert mode; for example, a special message might be transmitted once a particular parameter threshold has been exceeded to warn of impending flood danger resulting from the high-water level of a river.

Tsunami Warning Systems: The Meteosat satellites located at 0° and over the Indian Ocean acquire tide-level data from DCPs situated on moored buoys as part of tsunami warning networks. The data is collected and transmitted by the platforms every 10 minutes then distributed to to the tsunami warning centres in the form of bulletins using the GTS. These messages are used to confirm the presence or absence of a tsunami following a seismic event. If a tsunami is detected and when certain other criteria are met, warning messages are distributed to the affected national authorities to activate emergency measures.

A recent example showed the benefit of having DCPs fitted to sea-level stations as part of a Tsunami Warning Network. On the 30th September an undersea earthquake occurred close to Sumatra. The Pacific Tsunami Warning Centre in Hawaii used the data from the sea level station at Padang, transmitted through Meteosat, to determine that a basin-wide Indian Ocean tsunami warning was not necessary. A decade ago this would not have been possible. A picture of a sea-level station is shown in figure 3.

Figure 3. Sea-level Gauge

The introduction of HRDCPs will greatly enhance the potential for use in applications that require rapid reporting of environmental parameters. In the case of the Tsunami Warning Networks HRDCPs will be able to transmit far more often allowing warning centres to react even more quickly to a seismic event, thereby giving more timely warnings to affected populaces.

5. CONCLUSION

The Meteosat DCS provides a mechanism to collect and distribute environmental data from remote locations in near real-time. The Indian Ocean Tsunami Warning System uses the system to relay sea-level data following a seismic event to confirm presence or absence of destructive Tsunami waves allowing timely warnings to the civil protection authorities. The introduction of High Rate Data Collection Platforms (HRDCP) will allow more frequent and robust reporting of data thereby increasing the overall effectiveness of this and similar systems and applications.

REFERENCES

CCSDS 130.1-G1 Green Book, June 2006. TM Synchronization and Channel Coding – Summary of concept and Rationale Informational report.