**CGMS-48-CGMS-WP-06**
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Prepared by EUMETSAT
Agenda Item: 4.1
Discussed in WGI

# UPDATE OF CGMS AGENCY BEST PRACTICES IN SUPPORT TO LOCAL AND REGIONAL PROCESSING OF LEO DIRECT BROADCAST DATA

In response to CGMS HLPP 1.4,
WGI Recommendations: R43.04, R43.05, R42.03, R42.04, R42.06, R42.09

Working Paper summary:

The endorsed *CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data* is now available as a CGMS document. It is located on the CGMS home page under Publications -> Best Practices.

This paper presents ongoing work and potential evolutions of the *CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data.*

Manufacturers and operators of Direct Broadcast reception stations for the polar orbiting satellites critically depend on support from the satellite operating CGMS agencies. This includes the provision of technical specification of the Direct Broadcast, TLE orbit information, software packages for product processing, auxiliary operational data for instrument processing as well as operational coordination.

The paper has been written in coordination with all CGMS members via dedicated Inter-sessional meetings held after CGMS 47.

WG1 is invited to:

- Consider the proposed new BP.10 Monitoring of the Direct Broadcast Downlink;
- Consider the proposed update to the existing BP.04;
- Consider the proposed update to the existing BP.09;
- Propose to CGMS Plenary the adoption of the new BP.10 and the updated BP.04 and BP.09 in the *CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data* (CGMS/DOC/18/1008274);
- Take note of the positive outcome of the action to initiate a peer review process between the agencies of the *Implementation of CGMS Best Practices for LEO Direct Broadcast Data* documents and consider maintaining this process.

Actions proposed:

- Initiate a peer review process between the agencies (e.g. NOAA, CMA and EUMETSAT) of the Implementation of CGMS Best Practices for LEO Direct Broadcast Data documents prepared by these agencies, with the aim of

improving quality and consistency of these documents and references prior to presentation at the CGMS plenary sessions;

- CGMS operators to consider if the installation of processing S/W packages can be made more user friendly and if there is a potential for standardising the approach, considering the available methods and tools.

# UPDATE OF CGMS AGENCY BEST PRACTICES IN SUPPORT TO LOCAL AND REGIONAL PROCESSING OF LEO DIRECT BROADCAST DATA

## 1 INTRODUCTION

The endorsed *CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data* is available as a CGMS document at https://www.cgms-info.org/documents/CGMS_BP_LEO_DBD_Jun2018.pdf.

This paper presents ongoing work and potential evolutions of the *CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data*.

Manufacturers and operators of Direct Broadcast reception stations for the polar orbiting satellites critically depend on support from the satellite operating CGMS agencies. This includes the provision of technical specification of the Direct Broadcast, TLE orbit information, software packages for product processing, auxiliary operational data for instrument processing as well as operational coordination.

Three related documents, CGMS-48-CMA-WP-04, CGMS-48-NOAA-WP-03 and CGMS-48-EUMETSAT-WP-03, report the status of implementation of the CGMS best practices in support to local and regional processing of LEO direct broadcast data at CMA, NOAA and EUMETSAT respectively. Corresponding documents from other agencies are expected.

## 2 Actions relating to endorsed Best Practices for Direct Broadcast

### 2.1 General Actions

**Action**: Initiate a peer review process between the agencies (e.g. NOAA, CMA and EUMETSAT) of the Implementation of CGMS Best Practices for LEO Direct Broadcast Data documents prepared by these agencies, with the aim of improving quality and consistency of these documents and references prior to presentation at the CGMS plenary sessions.

**Status**: Supported by the three intersessional meetings on Best Practices for Direct Broadcast held since CGMS-47 and direct interactions between the CMA, NOAA and EUMETSAT, an active and productive review process has taken place. The documents CGMS-48-CMA-WP-04, CGMS-48-NOAA-WP-03 and CGMS-48-EUMETSAT-WP-03 are reflecting the outcome of this process.

### 2.2 Actions Relating to BP.04 Provision and Maintenance of Product Processing Software Packages

**Action**: CGMS operators to consider if the installation of processing S/W packages can be made more user friendly and if there is a potential for standardising the approach, considering the available methods and tools.

**Status**: Work between NOAA CIMSS, the EUMETSAT NWP SAF and EUMETSAT to gain experience with different container technologies is ongoing. It remains a developing area with emerging standards still requiring some consolidation. The overall perspective appear promising.

## 3 Proposed new Best Practices and proposed updates to existing Best Practices

### 3.1 Proposed new Best Practice on Monitoring of the Direct Broadcast Downlink

Based on an initial proposal from NOAA, discussions during the intersessional meetings on Best Practices for Direct Broadcast as well as subsequent interaction between NOAA, NASA and EUMETSAT, the following new Best Practice is proposed for inclusion in the document *CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data*, CGMS/DOC/18/1008274:

**BP.10 Monitoring of the Direct Broadcast Downlink**

Operators of satellites with Direct Broadcast (DB) should ensure that the downlink is functioning ~~properly~~ as specified and that application packets generated on the spacecraft are arriving in good condition at the ground system monitoring point(s).

Monitored signal quality parameters should include receive signal strength, signal to noise ratio, spectral power distribution, and carrier, bit and frame lock statistics.

Monitored ~~product~~data quality parameters should include discarded frames and packets, missing frames and packets, and frames and packets with bad length or sequence errors.

For an operator of a DB reception system it is relevant to know if a degradation in data quality is attributable to frames or packets discarded or degraded on the spacecraft, prior to transmission to the ground. The satellite operator should monitor for such effects by looking for identical patterns of degradation in data streams acquired ~~at~~by geographically separated DB reception systems. If supported by the spacecraft, spacecraft monitoring telemetry may complement this monitoring.

The ground system monitoring point(s) may not be representative of a typical DB user's ground receive station. Therefore, operators are encouraged to consider installing and operating a reference station. A reference DB reception station can be equipped with monitoring equipment to provide the operator situational awareness. For example, a spectrum analyser can be installed in-line with the RF input to the demodulator. The reference station would have the hardware (reflector, feed, downconverter, demodulator, etc.) corresponding to the minimum requirements of BP.09. The reference station should include RF signal logging, packet inspection and logging, and higher level processing with product generation software.

Once for each satellite, the satellite operator should validate that nominal reception is possible for a DB reception station anywhere within the footprint of the satellite DB antenna. Practically, acquiring all visible passes from a single DB reception station throughout a full satellite ground track repeat cycle provides an even coverage of the full satellite DB antenna footprint.

**Best Practice BP.10**: Operators of satellites with DB should routinely monitor the quality of the DB downlink and address any anomalies in accordance with each organization's established proceduresstake action on anomalies in a timely manner, and notify users of degraded performance. Monitoring should include:

a) For each satellite, once during the six months following DB signal activation, a validation that nominal reception is possible for a DB reception station anywhere within the footprint of the satellite DB antenna by acquiring all passes seeing the satellite at an elevation of 5 degrees or more above the local horizon throughout a full satellite ground track repeat cycle. Nominal reception implies a positive link budget margin as well as the signal and data quality parameters defined under d) and e) being in their nominal range for a reception station corresponding to the minimum requirements of DBBP.09;
b) During at least one pass per day for each satellite, monitoring of the signal quality parameters and the data quality parameters, as defined under d) and e) respectively, for the part of the pass which is at an elevation of 5 degrees or more above the local horizon;
c) During at least one pass per day for each satellite, monitoring of the data quality parameter degradation, attributable to frames or packets discarded or degraded on the spacecraft, prior to transmission ground;

where

d) Signal quality parameters should include receive signal strength, signal to noise ratio, spectral power distribution, and carrier, bit and frame lock statistics;
e) Data quality parameters should include discarded frames and packets (failing error free decoding/reconstruction), missing frames and packets (calculated from measured frame and packet sequence counters), bad lengths (frame or packet out of tolerance length), and sequence errors (frame or packet detected gaps/sequence error) per Virtual Channel Identifier (VCID) for frames and Application Process Identifier (APID) for packets.

### 3.2 Proposed updates to the existing BP.04 Provision and maintenance of Product Processing software packages

Related to the above new BP.10, it is proposed to add a new element k) to the existing *BP.04 Provision and maintenance of Product Processing software packages* aiming at minimising the impact of direct broadcast downlink or reception degradation:

**Best Practice BP.04**: Each LEO satellite operator should therefore ensure that:

….

k) The product processing software is robust against sporadically missing data packets from the instrument or satellite in the sense that the software limits the extent of degraded or lost observations in the generated product(s) to the minimum possible.

### 3.3 Proposed updates to the existing BP.09 Satellite Direct Broadcast and Reception Station Performance Requirements

When originally preparing *BP.09 Satellite Direct Broadcast and Reception Station Performance Requirements*, then intention was to align the required G/T value with the value planned for the JPSS and EPS-SG direct broadcast, namely 22.7 dB/K. Unfortunately, a G/T value of 21.20 dB/K was stated in BP.09 and it is proposed to ~~update~~ change this value to the intended value of 22.7 dB/K In order to keep the change neutral on the overall link budget, it is futher proposed to change the allocation for reception station losses, rain and atmospheric losses, and link budget margin from 7.05 dB to 8.55 dB~~-~~.

## 4 Potential additional topics for consideration as CGMS Best Practice

This section lists topics that require further analysis and discussion before they can be considered for adoption as CGMS Agency Best Practice in support to Local and Regional Processing of LEO Direct Broadcast data.

### 4.1 Future Direct Broadcast Data Rates from Polar Orbiting Satellites

**Action:** CGMS operators to analyse possible solutions to address the expected increase in instrument data from future polar orbiting satellites and to propose new DB standards and/or Best Practices as required.

This topic, originally brought up by NOAA, is now covered in the separate document *Future direct broadcast data rates from polar orbiting satellites*, CGMS-48-EUMETSAT-WP-15.

## 5 CONCLUSIONS

WG1 is invited to:

- Consider the proposed new BP.10 Monitoring of the Direct Broadcast Downlink;
- Consider the proposed update to the existing BP.04;
- Consider the proposed update to the existing BP.09;
- Propose to CGMS Plenary the adoption of the new BP.10 and the updated BP.04 and BP.09 in the *CGMS Agency Best Practices in support to Local and Regional Processing of LEO Direct Broadcast data* (CGMS/DOC/18/1008274);
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