CGMS-52-WGI-WP-14
29 May 2024

Prepared by: EUMETSAT
Agenda Item 7.3
Discussed at WG-I

Subject	**EDCP Transmitter Standard Proposal (incl. implementation plan 2024 – 2027 and funding requirements)**
In response to CGMS action/recommendation	
HLPP reference	
Executive Summary	The WGI Task Group on DCS has been working on the Enhanced DCP standard for the last 3 years. The standard is now mature enough to move to building and testing a prototype. This will allow the standard to be tested and the expectations on the performance of the standard to be verified. The standard itself is contained in a standalone document (EUM/CGMS/STD/23/1380795). For reference, the contents of the standard are included in Annex I.
Action/Recommendation proposed	CGMS Plenary is invited to endorse the standard outlined in the document EUM/CGMS/STD/23/1380795 (included for reference in Annex I), as well as the proposed plan for activities leading up to declaring the EDCP standard as operational, and related schedule and funding approach.

1 INTRODUCTION

The DCS WGI Task Group presents the document EUM/CGMS/STD/23/1380795 for endorsement (included for reference in Annex I). The document captures the enhanced standard and is intended to be a reference for industry to use in producing prototype platforms for testing, that comply with the standard. The standard will be refined and republished after the prototype phase.

A study funded by ESA under ARTES 5.1 identified the users' need for a more robust DCP standard. The standard would allow DCP messages to be received reliably with the use of forward error correction and more suitable modulation types. Carefully selecting the standard would also allow to realise DCP transmissions at lower power. If adopted across agencies, the standard would also allow for DCP use internationally and serve as a common standard for DCP transmitter manufacturers. There are some concerns that the standard might not be adopted by all three agencies (EUMETSAT, JMA and NOAA). However, the goal of specifying a new standard that could be used internationally was not the only one. Notably, improvements in the robustness was also an important goal and even if the standard is not employed internationally, there would still be many benefits of using the standard operationally.

These benefits include:

- Ability for the users to dynamically select baud rates between 400 and 800.
- Additional data embedded in the header providing DCP health status.
- Updated forward error correction would protect against message corruption.
- Ability to use lower power modes. Especially useful for solar/battery powered installations.
- Main manufacturers would have a single standard to deliver.
- Improved use of message length allowing better use of bandwidth.

2 SCOPE

This document outlines the plan needed to bring this standard into operation.

3 STANDARD OVERVIEW

The Task Group has been working on this standard for the last 3 years. The full standard and its specifications are detailed in a standalone document EUM/CGMS/STD/23/1380795, whose contents have been included in Annex I for reference.

The standard that has been chosen ensures the realisation of the new standard would be possible with just firmware updates to the existing DCP transmitter hardware. The standard is now mature enough to allow industry to proceed with building a prototype.

It would use a 1500Hz bandwidth for each channel. It will be able to operate at 400 or 800 baud dependent on the modulation type. This is selectable dynamically on the transmitter.

1. Modulation Format 1 – 400 BPS/BPSK
2. Modulation Format 2 – 800 BPS/OQPSK

The ground receivers would be able to automatically detect which mode was being used. It will optionally use different code block sizes which will mean smaller messages could use smaller block sizes. There is a new header defined that would allow the GPS co-ordinates, battery voltage etc. to be included in each transmission. This is one aspect that needs a further discussion to arrive at the agreed definitive list. Some of them would be of benefit to the operators and manufacturers and some would be of benefit to the users. There is naturally a trade-off between the size of the header and using this capacity for the message package. The group believes this could be made configurable making the use of the header optional. The 400-baud setting would provide a platform which would be more robust to movement and interference at the cost of speed. The 800-baud would provide better speed at the cost of robustness. The best mode could be chosen for the environmental conditions. This operational mode would be automatically detected on the receiver side making it very flexible.

An additional point to note is that the receivers would also need to be modified to allow the reception of this new standard. It is expected this would be realised with firmware updates.

4 PLAN

The following plan outlines the proposed activities in the lead up to declaring the EDCP standard as operational.

2024

- Finalise the EDCP standard with the agreement of all agencies and CGMS (JMA, EUM, NOAA) – *addressed with this document*
- Relocate current DCPs away from the international identified channels
- Confirm the project funding plan – *addressed with this document*

2025

- Produce and test a prototype transmitter
- Modify one of the receive sites to enable the reception of the EDCP
- Test the system and verify the performance of the prototype and ensure it covers the different modes

2026

- Certify the EDCP transmitters from the manufacturers
- Modify the reception systems of all agencies
- Test the reception for all agencies and satellites

2027

- Declare EDCP operational

Once operational these DCP transmitters could be installed in the field. The utilisation and phasing-in of the EDCP standard would be up to each individual agency, but noting the benefits mentioned earlier it would seem logical that this standard would be preferred. This does not mean that the existing DCPs using the previous standards need to be replaced. They can remain in operation.

This would give us the common standard which would once again allow international use of DCPs.

5 FUNDING

The current plan is to split the funding between the agencies. As NOAA already works closely with Microcom on both the receiver and transmitter side, we propose to allow them to work together to produce a prototype and modify the reception system to receive the new standard.

EUMETSAT will work together with OTT-Sutron on the transmitter prototype and directly with the receiver contractor to ensure the new standard could be processed by EUMETSAT.

There is still an open point on the involvement that JMA would like to take and some question as to whether they would adopt the new standard. If they choose not to take part, it would affect the international objective of the new standard. As described in the introduction there are many other benefits provided by the use of this new standard even if the participation of JMA is not possible.

6 CONCLUSIONS

CGMS Plenary is invited to endorse of the standard outlined in the document EUM/CGMS/STD/23/1380795 (included for reference in Annex I), as well as the proposed plan for activities leading up to declaring the EDCP standard as operational, and related schedule and funding approach.

ANNEX I: CGMS ENHANCED DATA COLLECTION PLATFORM TRANSMITTER STANDARD

CGMS

Enhanced Data Collection Platform Transmitter Standard

Endorsed by CGMS-52 Plenary in 2024

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1. INTRODUCTION

The Coordination Group for Meteorological Satellites (CGMS) provides a forum for the exchange of technical information on meteorological and environmental satellite systems as well as research and development missions in support of the World Meteorological Organization's (WMO) Rolling Review of Requirements (RRR), the IOC-UNESCO, and other users. The primary goal of the coordination activities is to support operational monitoring and forecasting of weather, space weather and the climate. CGMS coordinates satellite systems of its members in an end-to-end perspective including, but not limited to protection of on-orbit assets, support to users, and facilitation of shared access to satellite data and products.

1.1 DOCUMENT PURPOSE

This document covers the enhanced data collection platform transmitter standard (EDCP) in support of GEO Data Collection Services [RD-3]. The CGMS WGI Task Group on Data Collection Services has overseen this activity.

This document captures the enhanced standard and is intended to be a reference for industry to use in producing prototype Data Collection Platform (DCP) transmitters for testing, that comply with the standard. The standard will be refined and republished after the prototype phase.

This standard is prepared for presentation to CGMS-52 for endorsement of the progress with the prototype phase [RD-1].

1.2 REFERENCE DOCUMENTS

	Title	Reference	Purpose and Revision cycle (incl. links)
[RD-1]	EDCP Transmitter Standard Proposal (CGMS-52-WGI-WP-14)	CGMS-52-WGI-WP-14	Proposal to CGMS-52 for endorsement of EDCP Standard
[RD-2]	Progress report on the E-DCP (Ref. ESA study) (CGMS-46-EUM-WP-05)	CGMS-46-EUM-WP-05	Paper to CGMS-46 on the progress of ESA study on EDCP
[RD-3]	CGMS Data Collection Services Handbook	CGMS Guides	Overview of GEO Data Collection Services

1.3 DOCUMENT SCOPE

The scope is to provide enough information to be able to realise the prototype transmitters and prove the concept.

1.4 BACKGROUND

The creation of the CGMS Working Group I (WGI) Task Group on DCS was endorsed at CGMS-46. The main purpose of the group is to make continued effective progress with DCS activities and issues in the context of CGMS. The first task of the group has been to address the need for and make proposals for a new International DCS (IDCS) DCP standard. This is referred to as the enhanced DCP standard (EDCP) standard.

The need for this new standard was identified by a study that ESA initiated [RD-2]. The study identified the user need for a more robust DCP standard. The importance of message integrity was rated as very high by the members of the study. The findings of the study addressed the fact that the current standards are not as robust as they could potentially be. This could be addressed by using, among other things, better modulation, lower baud rate and better forward error correction. It was also noted by CGMS that there is currently no compatible international standard and this new DCP standard would address this, if it were to be adopted by EUMETSAT, NOAA and JMA. It was also considered very important that the new standard would only require firmware changes to current transmitters and receivers. The Task Group has worked with the support of the two main manufacturers to try to achieve this.

The group also covers the development of DCS best practices for common DCS data access mechanisms and DCP certification, as well as the inclusion of CGMS DCS webpage. The Task Group on DCS, includes the DCS Managers and other experts from each of the satellite operators. They have regularly met as part of the virtual WGI Intersessional meetings, but also face-to-face in the context of other already scheduled DCS-related meetings.

To ensure that the EDCP standard is one that the manufactures will be able to implement the Task Group has been working together with the industry, in order to arrive at a useable standard.

The two manufacturers are:

- Microcom
- Ott Hydromet

AEM has also recently started to take part in the EDCP meetings. They have acquired FTS (Forest Technology Systems). FTS is now a product line of AEM.

There is one other manufacturer identified and the group reached out to them to get their involvement in the development process.

- Signal Engineering – No response

2. THE EDCP STANDARD

The following Table 1 outlines the new standard.

Some additional points to note are that:

- The receivers will also need to be modified to allow the reception of this new standard.
- This new standard would be realised purely with firmware updates to existing receivers.
- It would use a 1500Hz bandwidth for each channel.
- It will be able to operate at 400 or 800 baud dependent on the modulation type. The 400-baud setting would provide a platform which would be more robust to movement and interference at the cost of speed. The 800-baud would provide better speed at the cost of robustness. The best mode could be chosen for the environmental conditions. This operational mode would be automatically detected on the receiver side making it very flexible.
- The ground receivers would be able to automatically detect which mode was being used.
- It will optionally use different code block sizes which will mean slots and bandwidth, smaller messages could use smaller block sizes.
- There is a new header defined that would allow the GPS co-ordinates, battery voltage etc. to be included in each transmission. This is one aspect that needs a further discussion to arrive at the agreed definitive list. Some of them would be of benefit to the operators and manufacturers and some would be of benefit to the users. There is naturally a tradeoff between the size of the header and using this capacity for the message package. The group believes this could be made configurable making the use of the header optional.
- There is still some fine-tuning needed with the Frame Synchronisation Sequence (FSS), which will be done as part of the prototype testing.

Table 1 EDCP Standard - Technical Characteristics

Parameter	Value	Units	Notes
Common Bandwidth and Frequency Characteristics			
Channel Bandwidth	1500	Hz	
Symbol Rate	800	SPS	Symbols Per Second
Modulation Filter	RRC	N/A	Alpha = 0.5
Occupied Bandwidth	1200	Hz	800 + 0.5*800 = 1200
Transmitter Uncertainty	125	Hz	~0.31 PPM
Preamble Characteristics			
Carrier Time	0.5	secs	
Symbol Sync Symbols	TBD	Symbols	Needs to be discussed
Symbol Sync Modulation	BPSK		0-180

Parameter	Value	Units	Notes
Frame Sync Symbols	TBD	Symbols	Needs to be discussed
Frame Sync Modulation	BPSK		0-180
Frame Sync Pattern	1	08E9	Currently NOAA CS1 Short Interleaver
Flags and Length	31	Symbols	BPSK Modulated and BCH(31,21) Encoded[1&2]
Modulation	3	bits	
Pattern 1	101		Modulation Format 1 – 400 BPS/BPSK
Pattern 2	010		Modulation Format 2 – 800 BPS/OQPSK
Reed Solomon	2	bits	
Pattern 1	10		Reed Solomon Error Correction In Use
Pattern 2	01		Reed Solomon Error Correction Not In Use
Header	2	bits	
Pattern 1	00		No Header in Message (Alert/Random Only)
Pattern 2	01		System Header
Pattern 3	10		System and Health Header
Pattern 4	11		TBD or Reserved for Future
TBD	1	bit	TBD or Reserved for Future
Message Length[1]	13	bits	In total bytes.
Parity Check	10	bits	Minimum 3-bit error detection/2-bit error correction
Modulation Format Option 1			
Modulation	BPSK	N/A	0-180
Outer FEC	Viterbi 1/2	N/A	G1 (171); G2 (133)
Raw Data Rate	400	BPS	Bits Per Second
Modulation Format Option 2			
Modulation	OQPSK	N/A	
Outer FEC	Viterbi 1/2	N/A	I=G1 (171); Q=/G2 (133)
Raw Data Rate	800	BPS	Bits Per Second
Phase Accuracy			
Modulation Bias	±1.0	degree	Average Phase Error
RMS Error	< 2.5	degree	
Carrier Phase Noise	< 2.0	degree	Bandwidth TBD
Message Formatting			
Platform ID	32	bits	
System Header	Bits	Units	
Latitude	26	degrees*X	X = 10,000; signed integer; resolution 0.00001°
Longitude	26	degrees*X	X = 10,000; signed integer; resolution 0.00001°

Parameter	Value	Units	Notes
Tx Model	12	number	Assigned Upon Certification
Total	64	bits	8 Bytes
Health Header			
Battery Voltage	8	Volts*10	0.0 to 25.5V
Forward Power	8	dBW*10	-12.7 to +12.7 dBW (0.05 W to 18.6 Watts)
Reflected Factor	8	dB*10	0 to 25.5 dB below Forward Power
Sequence Counter	16	Number	Rolling Value
Spare/TBD	24	bits	TBD (Reserved for Future Use)
Total	64	bits	8 Bytes
Inner FEC[3]	RS(255,223)	Used/Truncated based on Information Size[2]	
Information Size	≤ 75 bytes	None (Not Used)	
Information Size	> 75, ≤223	Single RS Block; truncated below 223 bytes. Assume zero fill.	
Information Size	> 223, ≤ 446	Two interleaved RS Blocks; truncated below 446 bytes. Assume zero fill; evenly distributed across both blocks.[5]	
Information Size	> 446, ≤ 669	Three interleaved RS Blocks; truncated below 669 bytes. Assume zero fill; evenly distributed across three blocks.[5]	
Information Size, I_S	> 669 bytes	Combination of 2/3 interleaved RS Blocks to balance error detection/correction with zero fill evenly distributed across all blocks.[5] I_S = a*669+b*446; a & b integers, a ≥ 0, b = 0, 1, or 2; where a is the number of 3 interleaved blocks and b is the number of 2 interleaved blocks (i.e. total RS Blocks = 3*a+2*b).[4]	
Data CRC	Value	Units	Notes
Size	16	bits	
Frequency	4000	bytes	And inserted at end of last partial 4000 byte block.
Polynomial	0xD175	N/A	$x^{16} + x^{15} + x^{13} + x^9 + x^7 + x^6 + x^5 + x^3 + x + 1$
Other Characteristics			
Scrambling	TBD		
Flush	8	bits	
Radiated Power	TBD	dBm EIRP	
Carrier On/Off Time	0.5 to 5.0	mS	On: -30dB to -1 dB Off: -1 dB to -30 dB
Timing Accuracy	±0.25	seconds	
Antenna Axial Ratio	6.0	dB	Right-Hand Circular Polarization

- Notes:
    1. 13 bits for message length assumes maximum transmission length of 60 seconds, which at 800 BPS equates to an upper limit of 48,000 bits, 6000 bytes, (not factoring in overhead).

2. Knowing the message length with a high degree of reliability allows to more efficient and targeted use of the Reed Solomon Forward Error Correction; i.e. not sending unused information bytes while still sending the proper amount of parity check bytes.

3. Reed Solomon Inner Forward Error Correction (FEC) can be selectively used (enabled/disabled) based on BCH encoded flag patterns.

4. Table 2 below provides the RS Block breakdown for an information size from 224 to 2676 bytes.

Table 2 RS Block breakdown for an information size from 224 to 2676 bytes

Information Bytes (I_S)		RS Blocks	Total 3 Interleave Blocks (a)	Total 2 Interleave Blocks (B)	Order
Min	Max				
224	446	2	0	1	2
447	669	3	1	0	3
670	892	4	0	2	2,2
893	1115	5	1	2	3,2
1116	1338	6	2	0	3,3
1339	1561	7	1	2	3,2,2
1562	1784	8	2	1	3,3,2
1785	2007	9	3	0	3,3,3
2008	2230	10	2	2	3,3,2,2
2231	2453	11	3	1	3,3,3,2
2454	2676	12	4	0	3,3,3,3

5. When the zero fill total (F_T) is not evenly divisible by the total number of RS Blocks (B_{RS}), i.e. F_T / $B_{RS} \neq 0$; then one extra 0 fill byte shall be used in the first [F_T modulo B_{RS}] blocks.

This information needs to be turned into a full technical document equivalent to those that currently define the standards in use. It is intended to produce that document after the prototypes have been built and tested.