CGMS

Enhanced Data Collection Platform Transmitter Standard

Endorsed by CGMS-52 Plenary in 2024

This is currently a working document

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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 we 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. We believe 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
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

Parameter	Value	Units	Notes
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.