CGMS-51-WGI-WP-08
11 April 2023

Prepared by: EUMETSAT
Agenda Item 8.1
Discussed at WG-I

Subject	**Report from the CGMS WGI Task Group on Data Collection Services (incl. latest ToR, status on current & proposed/planned activities)**
In response to CGMS action/recommendation	
HLPP reference	
Executive Summary	The primary task of the group has been to address the need for and make proposals for a new IDCS DCP standard, the development of DCS best practices for DCS data access and for DCP certification, as well as the inclusion of CGMS DCS webpage. The Task Group on DCS, consisting of DCS Managers from each of the satellite operators, have met virtually as part of the WGI Intersessional meetings, but also face-to-face in the context of other already scheduled DCS-related meetings. This paper presents the status of the Task Group on DCS activities and progress since CGMS-50. The discussions of the Enhanced DCP (E-DCP) standard have continued and is a major topic for the group. The group has developed a proposal for the way forward in developing a new IDCS/E-DCP standard but need some guidance.
Action/Recommendation proposed	WGI is invited to take note and comment on: - The status of DCS Task Group on DCS activities and progress since CGMS-50.

1 INTRODUCTION

This paper presents the report from the WGI Task Group on Data Collection Services (DCS). The creation of the group was endorsed at CGMS-46. This report covers the group's activities since CGMS-50.
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 IDCS DCP standard, 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, consisting of DCS Managers from each of the satellite operators, 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.

2 TASK GROUP STRUCTURE AND MANAGEMENT ARRANGEMENTS

2.1 Core Members

As part of WGI, all CGMS members are encouraged to participate in the Task Group on DCS. The core members of this group are the DCS Managers from each of the following agencies:

EUMETSAT	Nicholas Coyne – Co-ordinator
EUMETSAT	Karolina Nikolova
EUMETSAT	Wil Doran
NOAA	William Dronen
NOAA	Letecia Reeves
JMA	Kotaro Bessho
JMA	Yasutaka Hokase

Also the following frequency managers:

NOAA	Beau Backus
EUMETSAT	Markus Dreis

A mailing list server for the WGI Task Group on DCS has been setup - WGI_DCS@LISTSERV.EUMETSAT.INT

The following people are included on the list in addition to those listed above.

Anne Taube
Beau Backus - NOAA Affiliate
Dave Kunkee - Aerospace Corp
Juha-Pekka Luntama – ESA
Mark W. Turner - NOAA
Markus Dreis - EUMETSAT

Melanie Heil - ESA
Nancy Ritchey - NOAA
Olga Ryzhkova - Roshydromet
Sean Dominic Burns - EUMETSAT
Thomas Feroli - NOAA
Yu Deng – NOAA
Hassan Haddouch - WMO

The co-ordinator should be informed of any CGMS members wishing to be included on the list.

2.2 Meetings

Intersessional Meetings

The group has held regular intersessional meetings since the last CGMS report. The plan of a face-to-face meeting at the Met Tech Expo in Paris in October 2022 was finally possible after the lifting of the COVID restrictions. This was a DCS workshop combined with the Satcom Forum (See 3.1). The DCS part focused on reports from each of the member organisations and we were finally able to have some discussions about the Enhanced DCP standard (See 3.2).

The intersessional meetings continued after CGMS-50 with a monthly frequency due to the discussions on the Enhanced DCP standard. In fact there where some meetings every two weeks during the beginning of 2023 to cover the discussions about the EDCP.

2.3 Reporting

This Task Group on DCS provides a report of its Intersessional Meetings to WGI interested parties and a full report of its activities for review to CGMS WGI.

3 ACTIVITIES

3.1 DCS Workshop 12th October 2022

It has finally been possible to have a face to face meeting. This happened as part of the DCS workshop which was organised by the DCS Group. It took place alongside the Satcom Forum. The venue was the Met Tech Expo in Paris and way from the 11th until the 13th of October 2023. Below is the agenda for the DCS workshop.

Day 2: 12 October (Wednesday) *All sessions today form part of the Data Collection System (DCS) Workshop*		
09:00 – 09:40	DCS workshop (Introduction and Overview, CGMS coordination)	Day2-DCS Workshop-welcome
09:40 – 10:00	DCS workshop (EUMETSAT DCS Overview)	Day2-EUMETSAT DCS
10:00 – 10:20	DCS workshop (GOES DCS Overview)	
10:20 – 10:40	DCS workshop (JMA DCS Overview)	Day2-JMA DCS-Hokase
10:40 – 11:20	DCS workshop (WMO Overview) DCS workshop (WMO WIS2 Presentation)	Day2-WIS2-Rémy GIRAUD
11:20 – 11:40	DCS workshop (Questions time)	
11:40 – 12:00	Improving Situational Awareness with Real-time Weather Observations using Satellite (Synoptic data)	
12:00 – 13:00	Lunch break	
13:00 – 13:30	DCS workshop (Interference register)	
13:30 – 14:00	DCS workshop (Small Satellite DCS Use as an Operational Concept - Beau Backus)	Day2-NOAA-Beau Backus
14:00 – 15:30	DCS workshop (User and Manufacturer Round Table Focusing on Enhanced DCP Standard)	Day2-EDCP
15:30 – 16:00	Coffee break	
16:00 – 17:00	DCS Workshop (User and Manufacturer round table focusing on Enhanced DCP Standard - continued)	
17:00 – 17:30	DCS workshop (Summary of Outcome Actions Next Events)	

There were also DCS related topics within the Satcom Forum and the agenda and access to the presentations can be found under the following link:-
https://community.wmo.int/en/meetings/satcom-forum-2022

On the DCS Task Group side the following people attended in person

EUMETSAT	Nicholas Coyne – Co-ordinator
EUMETSAT	Karolina Nikolova
NOAA	William Dronen
NOAA	Beau Backus
WMO	Remy Giraud

Externals
Microcom Brett Betsill
Satcom Forum Mike Prior Jones

The following attended virtually

JMA Kotaro Bessho
JMA Yasutaka Hokase

Externals
OTT Christopher Buchner

These are the minutes from the DCS Workshop

1. *EDCP Standard Discussion*
   a. *Summary: Good progress has been made and the basic outline has been agreed. Paul Crawford was not able to attend and his input would still be needed. We will have some dedicated follow up intersessionals with a goal of producing a draft standard to the next CGMS. It was confirmed by Microcom and OTT that the proposed standard could be realised with firmware changes to existing platforms. We still need to decide which modulation and which encoding we would use for EDCP.*
   b. *Aux data: Within the new standard we talked about additional aux data in the DCP header like battery voltage, temperature, GPS location, etc. This needs to be considered and a set selected, taking account the benefit to manufacturers, operators and users. The aux data would then need to be coded to ensure the best use of message space.*
   c. *2-way: The use of 2-way should be analysed, we should have a clear idea of which functionality should be controllable. This would be a list like reset, freq change, slot change, mod change etc. These items could also be controlled via an external/hybrid 2-way allowing EUM and JMA DCP to also benefit from 2-way use. Suggest to discuss within the intersessional.*
   Skip mentioned that NOAA are looking to move forward with a proof of concept.
   d. *Baud rate: We discussed either 300 or 400 baud rate as an option. JMA highlighted they think 300 baud rate is their only option.*
   e. *Prototype: A 4-year timeframe would be the earliest for the prototype development. It should not be forgotten that we would also need to update the ground station receivers.*
2. *Manufacturers*
   a. *The following manufacturers attended the workshop – Microcom, OTT*
   b. *The following manufacturers have not responded and need to be contacted again to ensure they have a chance to take part in the definition of the new standard – FTS, Signal Engineering*
   c. *It would be very important to have Paul Crawford alongside the manufacturers inputs*
3. *Channel utilisation*
   a. *Brett pointed out that there are channels allocated to one agency (e.g. NOAA) that can be used by EUMETSAT and JMA and not interfere with each other based on the location of the DCP.*

4. *Interference register*
   a. *This was discussed by the workshop and it was agreed to be a good idea. We will produce a document for the next CGMS as our proposed interference register. We will include details on how this will be implemented.*
5. *Ashish Synoptic Data*
   a. *They have an API that makes AWS data from various providers available. They collect, process, standardise and normalise real-time data.*
   b. *Use of their API for the data access / display of DCS data as an augmented service.*
6. *WIS2*
   a. *There are still some questions that need to be addressed but the benefits to DCS could be quite significant. It seems that anyone on the internet should be able to access these data. We will work on the details and see if the DCP data can be made part of the pilot scheme in 2023.*
7. *NOAA 2 Way*
   a. *NOAA still intend to do something with the 2 way system. It is still not clear when this will be implemented. NOAA are finalizing their specifications for the next generation of GOES and it is still not decided if this will include 2 way support.*
8. *SmallSat- Onging. Next launches look to be sometime in the beginning of 2023.*

Satcom Forum 11-13 October 2022
https://community.wmo.int/meetings/satcom-forum-2022
1. *IoT – how the technologies are developing that would allow greater possibilities in in situ data collection, maybe making the DCS redundant in the coming years.*
2. *Cheap services being planned with 2 way capability costing as little as $2 per month.*
3. *Presentations form Inmarsat and Iridium.*

In conclusion the DCS workshop was a great success and proved to be the very catalyst needed to start the Enhanced DCP ball really rolling. Evidence of that can be seen in the next section.

3.2 New DCP Standards and Applications (A49.03)

The group had moved further with the subject of new standards and have identified a draft standard. We believe that we have locked down the key elements of the standard. There is still work to be done though. We will present this current draft standard and hope for the endorsement from CGMS-51. We would also request that the CGMS indicate to the group the next steps and inform us how these steps are to be financed.

New EDCP

As previously reported we had aimed at realising a new standard that would only require firmware changes to current transmitters and receivers. We have worked with the support of the two main manufacturers to try to achieve this. The two manufacturers are:

- Microcom
- OTT

We have not been able to get involvement from Signal Engineering or FTS.

Draft Standard

From the study funded by ESA for ATRES 5.2 it was clear that a target baud rate of 400 should be the target. We have had some very constructive discussions in the intersessional meeting and now have a draft standard based around 400 baud. We have also taken many other ideas into account and included these within the standard. From our discussion Microcom produced the following table which we used as our discussion point.

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	**3**	**Symbols**	
Symbol Sync Modulation	**BPSK**		0-180
Frame Sync Symbols	**15**	**Symbols**	
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**	π/2 or 0-180 TBD
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°
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, Is	> 669 bytes	Combination of 2/3 interleaved RS Blocks to balance error detection/correction with zero fill evenly distributed across all blocks.[5] Is = 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. The table below provides the RS Block breakdown for an information size from 224 to 2676 bytes.

Information Bytes (Is) Min	Max	RS Blocks	Total 3 Interleave Blocks (a)	Total 2 Interleave Blocks (B)	Order
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 table is included to demonstrate the progress that has been made. The main points to note are that we have defined something that will only require firmware updates to the existing transmitters. The receivers would eventually also need to be modified as well and this would also be expected to be realised with firmware updates. It would take 1500Hz of bandwidth. It can operate at 400 or 800 baud dependant on the modulation type. It can optionally use different code block sizes. There is a new header defined that would allow the GPS co-ordinates, battery voltage etc. to be included in each transmission. There are some of these aspects that we need to refine and agree upon. Some of them would be of benefit to the operatoprs and manufacturers and some would be of benefit to the users. There is naturally a trade of between the size of the header and using this capacity for the message package. We believe this could be made configurable. The 400-baud setting would provide a platform which would be more robust to movement and interference at the cost of speed. The 800 would provide the 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.

Conclusion of EDCP

There are still refinements needed but the main elements have been defined. We need to have some additional sessions to finalise those. We propose to capture the EDCP standard in a separate document with a view to publishing the first draft version in Q3 2023.

After this draft is reviewed and endorsed, we would could imagine the following schedule:

2024

1. Finalise the EDCP standard with the agreement of all agencies and CGMS.
2. Relocate current DCPs away from the international identified channels.
3. Define how the project would be funded.

2025

1. Produce and test a prototype transmitter.
2. Modify on of the receive sites to enable the reception of the EDCP.
3. Test the system and verify the performance of the prototype and ensure it covers the different modes.

2026

1. Certify the EDCP transmitters from the manufacturers.
2. Modify the reception systems of all agencies.
3. Test the reception for all agencies and satellites.

2027

Declare EDCP operational.

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

3.3 Interference register (From Swot proposals)

During the DCS workshop NOAA gave a presentation on some DCS interference problems they had observed. Their investigation revealed that the interference was produced by hand held two way radios. A presentation from Microcom can be found on the Satcom web site.
https://filecloud.wmo.int/share/s/7DPe2FXJRQes_ZVjf4NB7Q

EUMETSAT has also in the past suffered from some external interference which was suspected to come from ground based Radars.

This led the group to the idea to produce an interference register. This would be in the form of a CGMS document that would be populated with the history of known interference. It would be added to for any new incidents. This would be shared with the Task group on radio interference. Although we wanted to present this document during this CGMS round it was not possible. We are proposing that we would do this for the next round and would ask for endorsement for this approach.

3.4 SWOT Progress

During the 50th CGMS the group had proposed the following SWOT opportunities. Below is a recap of the status of these.

RFI Mitigation

Please see 3.3 above

Joint DCS PR Materials

Although we have some ideas that came from the group there is no actual output yet. One of the items that will be worked on is the new IDCS (Blue Book) which would describe the international use of DCS. This can only be populated when we have finalised the Enhanced DCP standard.

DCS Introduction Video

Nick Coyne was in communication with the world bank with a prospect of making a promotional video. This idea is still ongoing but the arm of the world bank was not quite as it seemed and it has been necessary to check that there was not a hiden agenda with this offer and not to promote a particular commercial vendor.

Manufacturers Workshop

See section 3.1

4 TERMS OF REFERENCE

4.1 Responsibilities

- To identify the needs for new international capable DCP standards taking into account the outcome of the ATRE 5.2 study commissioned by ESA.
- To propose to CGMS the new international standard.
- To facilitate the development towards on operational international standard
- Develop and maintain a DCS handbook
- The development of DCS best practices
- Develop and maintain the content for a CGMS DCS webpage
- Organisation of regular DCS workshops in co-ordination with the Satcom Forum
- Co-ordination of International DCS between the organisations
- Maintain an RFI DCS register
- Suggest improvements to the DCS especially based on the output of the SWOT analysis

4.2 Interactions

The Task Group will meet as part of the WG I Intersessional meetings with a goal of somewhere between 6 and 12 meetings per year. The majority of these meetings will be virtual but also some face-to-face meetings could be realised in the context of other already scheduled DCS-related meetings or meeting were a majority of the members would be present.

In addition to the regular intersessional meetings the Task Group will plan to convene a DCS workshop every 2 years. This will be arranged in co-ordination with the Satcom Forum, which is traditionally hosted during the Met Tech Expo. The goal of this workshop is to facilitate interactions between the operators, users and manufacturers.

5 ACTIONS/RECOMMENDATIONS FOR CONSIDERATION BY CGMS-50 WGI

CGMS is invited to take note of the Task Group on DCS activities and progress since CGMS-49, along with the proposed updated actions.

Action: A49.03: Updated

Analyse existing DCP standards taking into account user feedback, and propose a common standard that could be used as a future IDCS standard. This would be an evolution of an existing standard. There would also be workshops with the manufacturers to understand the best way to identify and implement this standard taking into account the SWOT analysis and the results of the survey commissioned by ESA.

The section 3.2 details the progress we have made on this action.

6 CONCLUSION

Since the creation of the WGI Task Group on DCS, progress has been made in several areas including standardisation of data access and DCP certification. The group has identified the need for a usable IDCS standard (Enhanced DCP) as the current standard as described is only supported by EUMETSAT and JMA. Once identified the IDCS Guide would need to be updated including a specification for DCS formats. This international standard would also be important for any applications that may be possible after the proof of concept on the small sat activities.

A clear process is needed for the funding of the EDCP project. The group has not been able to identify this process.