**CCSDS Spring meeting 2024 SLS-CS\_24-01**

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**Proposed Table of contents for VCM Green Book**

**Abstract**

This paper is the formal response to AI\_23-11 of RFM WG (recorded as AI\_23-12 under C&S WG) about providing a table of contents (ToC) for a potential variable coded modulation (VCM) green book, to be pair with the VCM BB [RD1].

# Introduction

During C&S and RFM joint meeting in Huntsville 2023, SEA AD and C&S chair proposed to perform a harmonization of the GBs related to VCM.

Namely, it was observed that DVB-S2 GB [RD2] contains a VCM system description and performance results, while SCCC GB [RD3] focuses on the physical layer performance only (BER/FER, synchronization, etc.).

In this respect, it was proposed to have a new project that would perform the followings:

* make SCCC and DVB-S2 GBs more harmonized each other, by focusing mostly on physical layer aspects;
* create a new VCM green book, that focuses on system results when using VCM with SCCC, DVB-S2, or LDPC codes, that pairs the VCM BB.

As first step, C&S chair provided for The Hague 2024 a draft concept paper about the VCM GB (AI\_23\_01, [RD5]) for formalizing better the proposal.

However, during the joint C&S and RFM meeting, the WGs proposed to have an additional iteration (AI\_23-11), by also defining a ToC. In this way member agencies could better understand the objectives of the proposed GB, and evaluate how they can contribute to it.

Thus, this paper, as response to AI\_23-11, provides in the following sections a ToC with a short description for each chapter.

# ToC

In the following, a proposal for the ToC is reported. It is pointed out that such ToC shall not be considering binding for the future GB, but rather an indication of the intended content. As such, the ToC may be adjusted as part of the normal work.

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| **Section 1** – Introduction Section 1.1 – Purpose and scope Section 1.2 – Organization  Section 1.3 – Terminology Section 1.4 – References**Section 2** – VCM/ACM principles Section 2.1 – VCM  Section 2.2 – ACM Section 2.3 – Modulation and coding formats Section 2.4 – Physical layer frame Section 2.5 – Transfer frame encapsulation and validation**Section 3** – VCM/ACM performance Section 1.1 – Mission scenarios Section 1.2 – Numerical results  Section 1.3 – HW-in-the-loop results**Section 4** – Conclusions |

**Section 1** will be the standard introductory section of CCSDS books, that provides scope, organization, etc., with main reference the VCM BB, and its daughter books, SCCC and DVB-S2.

**Section 2** instead shall provide principles of VCM/ACM, with a level of technical details in a style to help readers to get familiar with the topic. It is foreseen to describe VCM and ACM basics (Section 2.1 and 2.2) and the modulation and coding formats adopted by VCM when using SCCC, DVB-S2, or LDPC codes (Section 2.3), while highlighting common aspects and differences. Then, the concept of physical-layer (PL) frame structure (Section 2.4) is introduced, explaining how this is necessary for VCM/ACM, and by comparing the PL frame of each VCM type (Type 1 and Type 2). Finally, it is explained how transfer frames are encapsulated in PL frames is done, and how these are extracted and validated at the receiving end (Section 2.5).

**Section 3** focuses on the VCM/ACM performance for specific mission scenarios (Section 1.1), taking into account (as minimum) Earth Observation satellites in Sun-synchronous orbit, Science missions in LEO/HEO and at Lagrange points (TBC).

Then, the performance of VCM/ACM for these scenarios will be reported by means of Software simulations numerical results (Section 1.2) and a HW-in-the-loop test results (Section 1.3). For these would be desirable NASA GSFC contribution (as was done in [RD4], Huntsville 2023) ESA ESTEC contribution (see input [RD5], The Hague 2023), and CNES (see Annex B, of DVB-S2 GB [RD2])

Finally, the GB can draw conclusions (Section 4).

# Conclusions

A ToC for the potential VCM GB was provided as per AI\_23-11 under RFM WG (recorded as AI\_23-12 under C&S WG).

# References

1. CCSDS 431.1-B-1, “Variable Coded Modulation Protocol”
2. CCSDS 130.12-G-2, “CCSDS Protocols over DVB-S2 – Summary of definition, implementation, and performance”
3. CCSDS 130.11-G-2, “SCCC – summary of definition and performance”
4. W. Fong, W. Lee, “CCSDS VCM analysis”, SLS-CS\_23-01.
5. A. Modenini, “VCM greenbook project and ESA prototype”, SLS-CS\_23-09.