Common Ground
Forum

INTEROPERABILITY STANDARDS FOR THE NEW SPACE ECONOMY

Matera, Italy
19 October 2026

CCSDS Common Ground Forum

A new angle: Common Ground in the New Space Economy

- Objectives:
  - Facilitating a better relationship of CCSDS with the space industrial ecosystem, focusing on new space companies
  - Identify missing standards, prioritize development and prototyping efforts, and establish approaches for collaboration.
  - Encourage active participation in standards development and interoperability testing.
  - Understanding the preferred working model of industry with CCSDS

FORUM AGENDA

TIME	TOPIC and SPEAKER
10:30-10:40	**Welcome & Opening Remarks -** Shannon Rodriguez / Daniel Fischer
10:40-10:50	**CCSDS Standards Portfolio Overview -** Daniel Fischer
10:55-11:15	LuarSpace Team ESA Protocol Development Competition - **Marco Fiscato**
11:15-11:25	Shaping the New Space Economy: NASA's Strategy for an Integrated Space Communications Enterprise - **Greg Heckler**
11:25-11:35	Vyoma - On the use of CCSDS standards within Vyoma - **David Gondelach**
11:35-11:45	Xiphera - SME observations on Interoperability of Security Standards in the New Space Economy - **Petri Jehkonen**
11:45-11:55	Skynopy - A Common applicative framework for adaptive link control for high-throughput mission data downlink in LEO - **Valentine Bourgeois**
12:00-13:00	**Lunch break (on your own)**
13:00-13:10	U-Space: CCSDS Standards and Their Applications in a NewSpace Startup: The Case of U-Space - **Baptiste Guilbert**
13:10-13:20	JAOPS -- Yamcs and CCSDS Standards: Enabling Interoperable Ground Systems for the New Space Economy - **Nicolae Mihalache**
13:20-13:30	Sanctuary - Implementing CCSDS Security: What Broke, What's Missing, and What Could Be Better - **David Koisser**
13:30-13:40	iSpace - iSpace's Experience and Future Missions with CCSDS - **Yoichiro Rokushima**
13:40-13:50	Swedish Space Cooperation (SSC) - Providing Commercial Ground Station as a Service in a CCSDS context -**Petrus Hyvönen**
13:50-14:00	CS- Soprasteria: GOSMIC a Ground Control Segment Product line based on CCSDS Standards - **Pierre-Alban Cros**
14:00-14:10	D3N - Building DTN Stacks for Space and What the Standards Still Need - **Felix Walter**
14:10-14:20	ArkEdge Space - From Space Packets to LunaNet: A New Space View on CCSDS - **Toshihiro Shibukawa**
14:25-14:45	**Interactive Panel & Group Discussion**
14:45-14:50	**Q&A/Closing Remarks**

CCSDS In a Nutshell

- CCSDS is an international standardisation committee tasked with developing and maintaining interoperable standards for space systems
    - 11 Member Agencies
    - 33 Observer Agencies, 140+ Commercial Associates
    - > 1000 missions are flying with CCSDS standards
    - CCSDS acts as ISO/TC20 (Aircraft and Space)/SC13 (Space Data and Transformation Systems) → All CCSDS standards are also ISO standards!
    - Primary Focus of CCSDS standards: Interoperability!, Secondary: Reducing mission cost and risk, boosting the industrial ecosystem
    - CCSDS drives innovation (e.g., adoption novel technologies such as DTN, optical communication, CFDP, and others)



Value Proposition of CCSDS Technical Standards



Competitiveness and commercialisation

Many commercial products have their success story based on CCSDS reference implementations for mission ground and space segment components.



Cross Support

Enabler of cross support between flight projects and Tracking Station Networks of agencies and commercial operators, especially for deep space missions



Interoperability

Enabler of collaborative missions between Agencies and Industry



New Technical Solutions

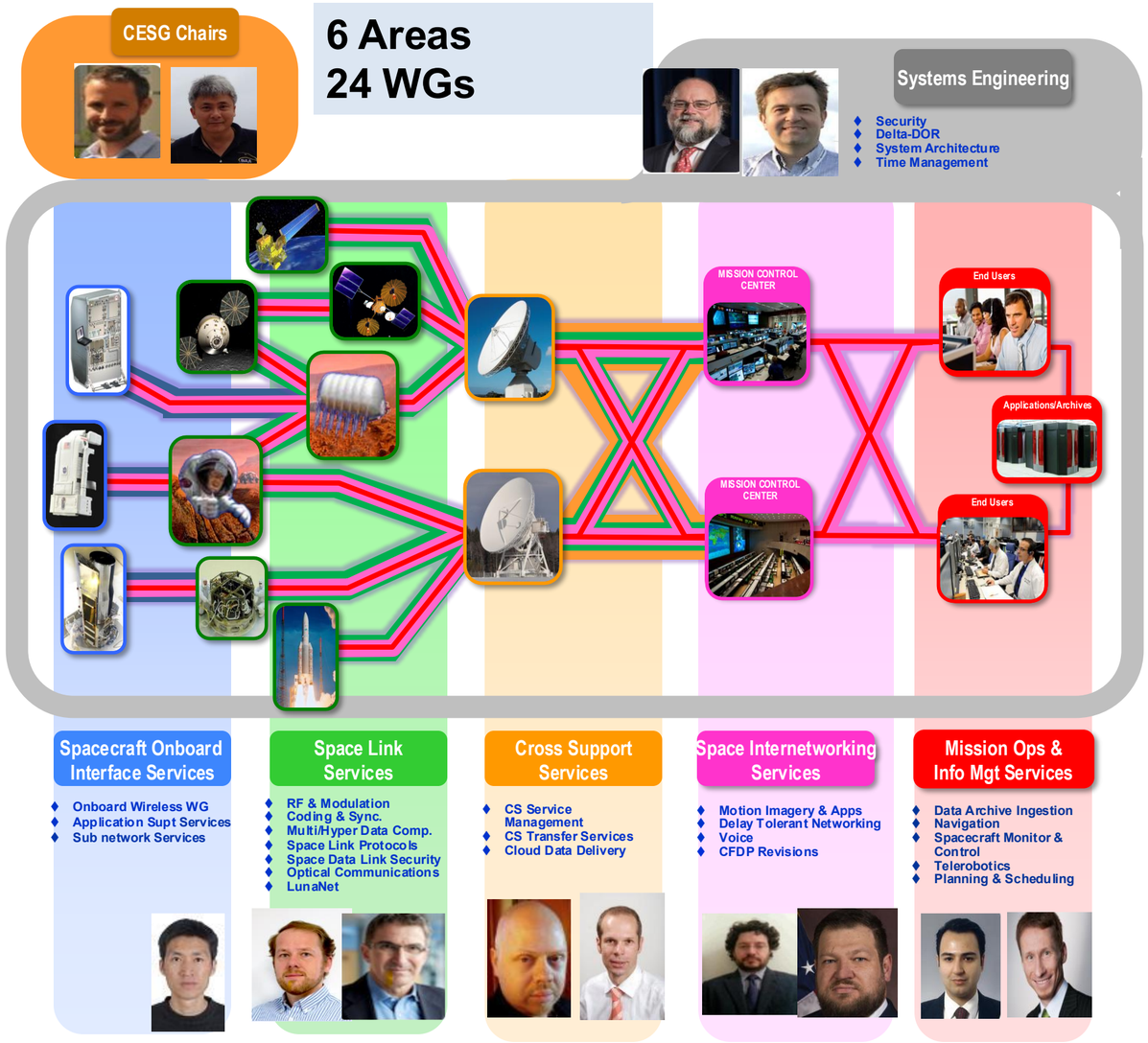
Starting point of developing new technical solutions: File Based Operation, Solar System Internet, Optical Communication



Leading to New Operational Capabilities

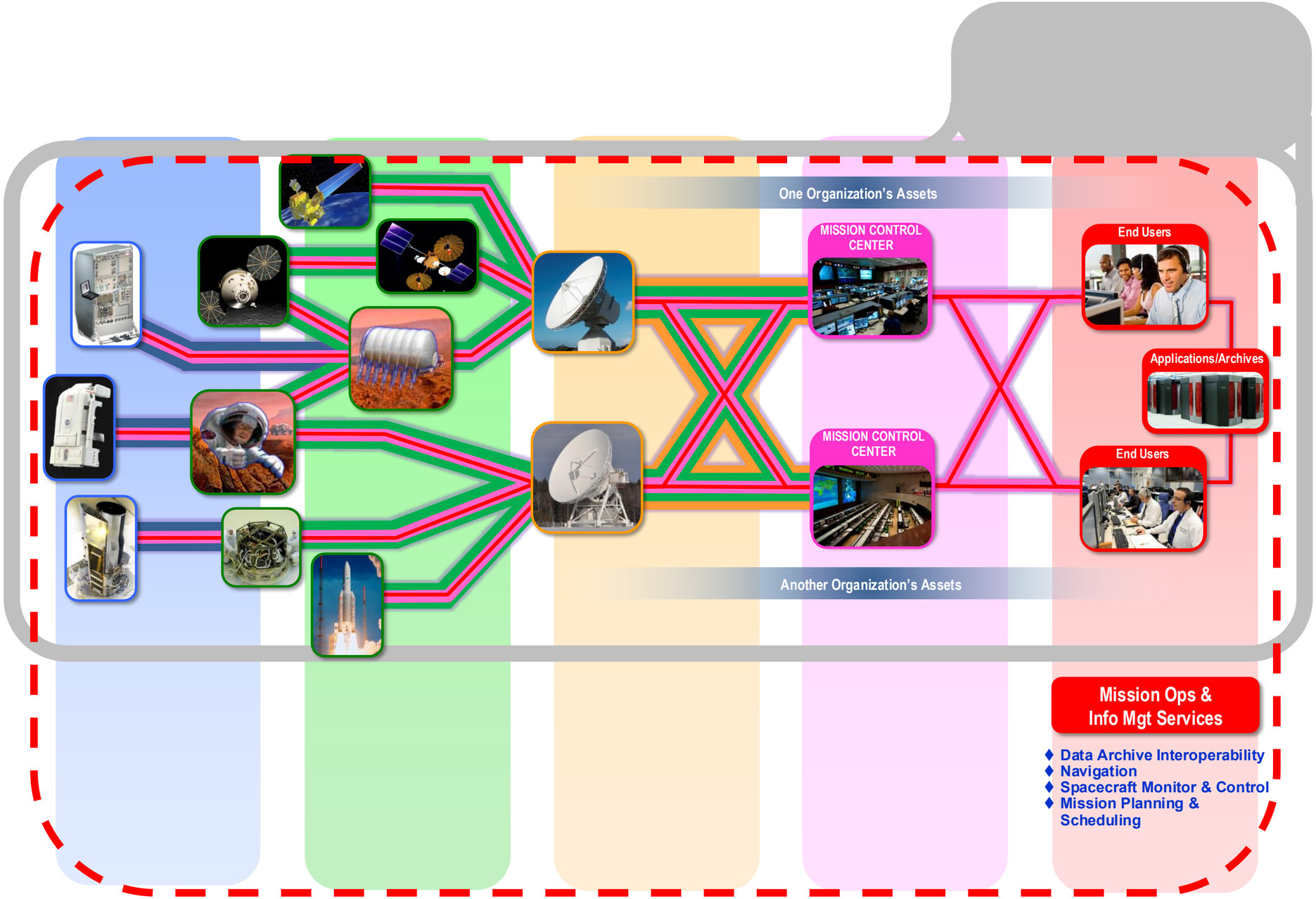
Many of our standards have led to practical operational capabilities in missions e.g. CCSDS Space Link Protocols, Space Link Extension, File Based Operations, Optical Comms,…

CCSDS Areas

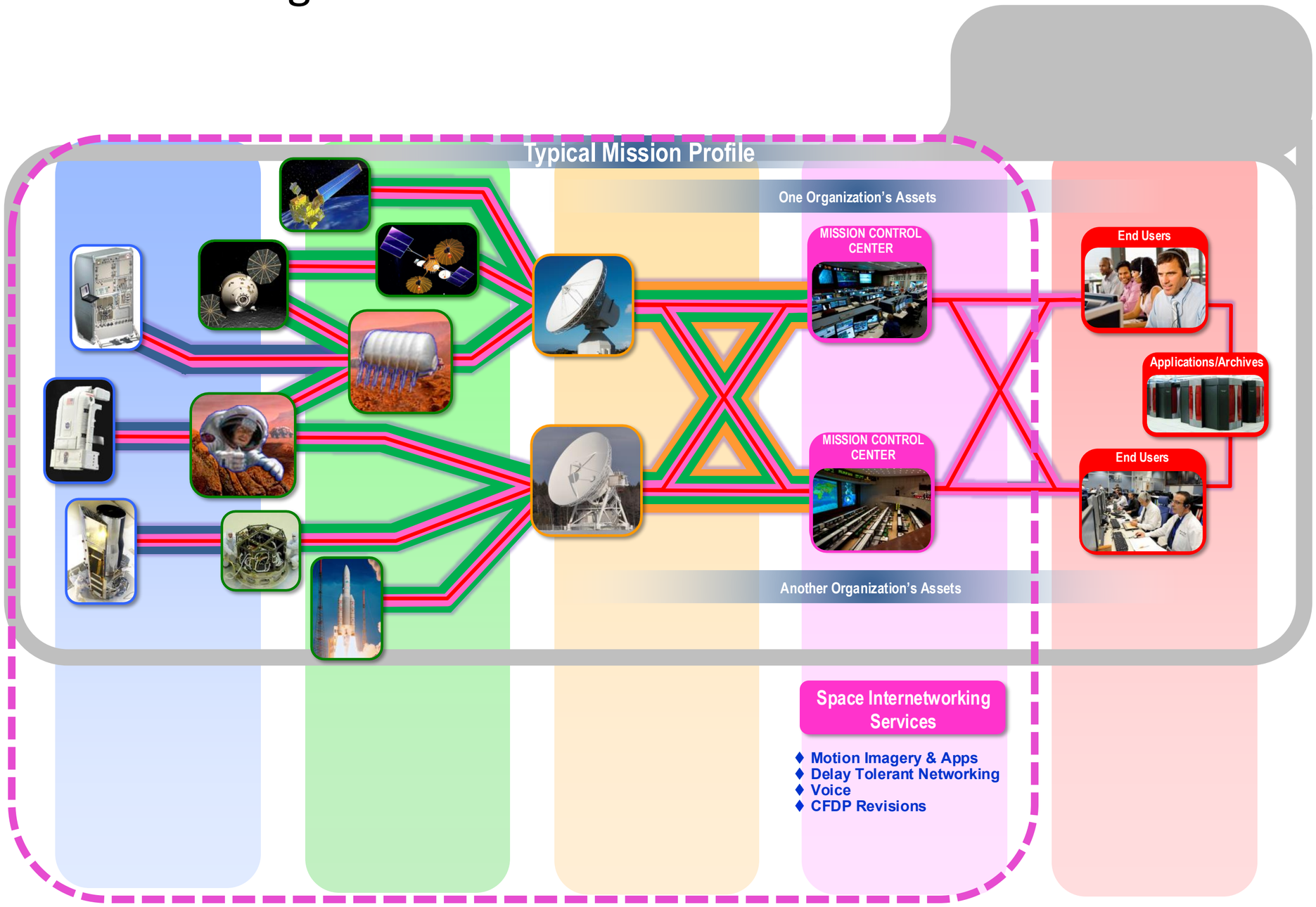


CESG Chair	**Daniel Fischer**
Deputy	***Timothy Pham***
SEA Area Director	**Jim Lux**
Deputy	***Matthew Cosby***
MOIMS Area Director	**Mehran Sarkarati**
Deputy	***Stefan Gärtner***
CSS Area Director	**Erik Barkley**
Deputy	***Holger Dreihahn***
SLS Area Director	**Clemens Heese**
Deputy	***Jean-Luc Issler***
SIS Area Director	**Tomaso de Cola**
Deputy	***'Vinny' Ivica Ristovski***
SOIS Area Director	**Simon Singh**
Deputy	***Xiongwen He***

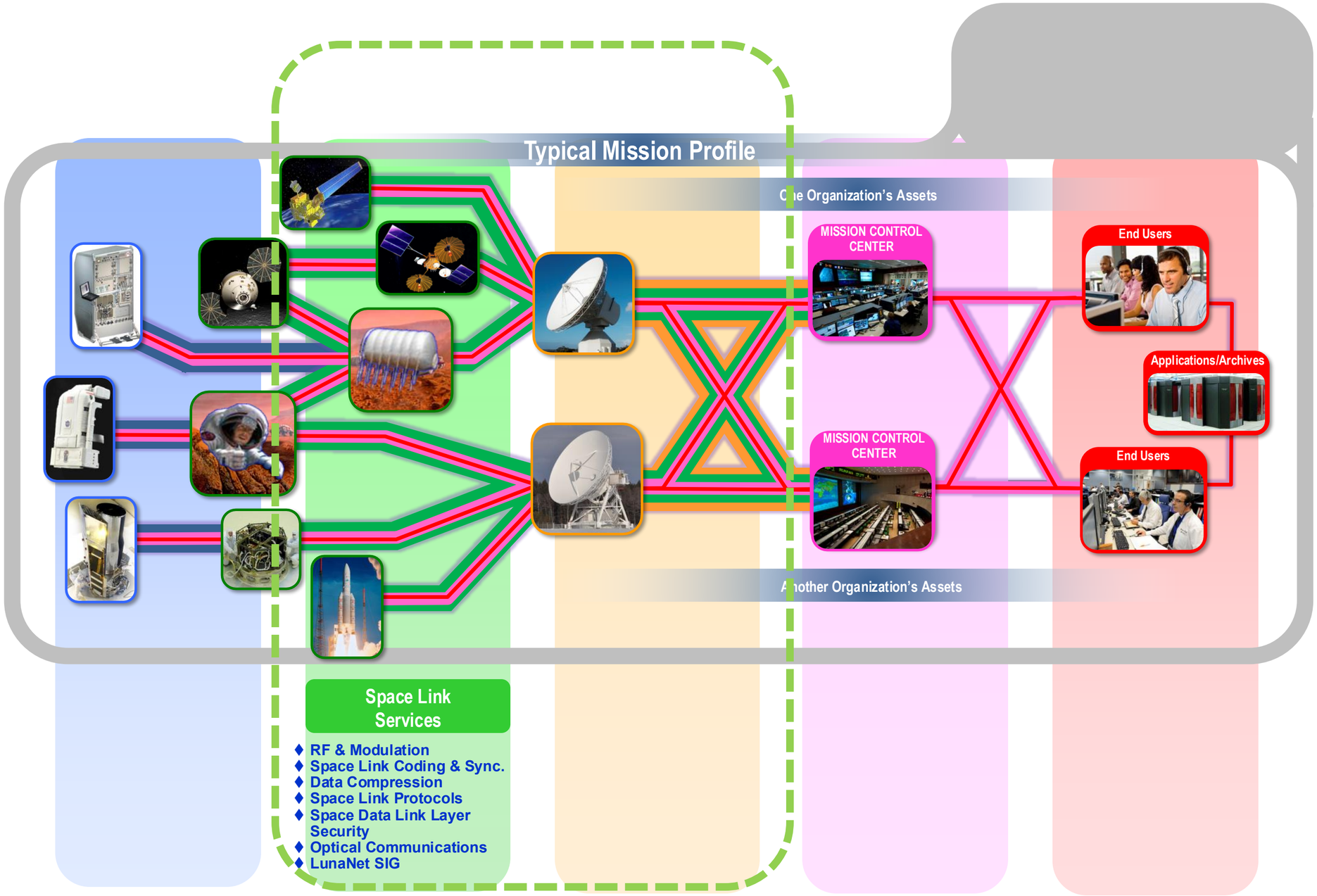
Mission Operations and Information Management



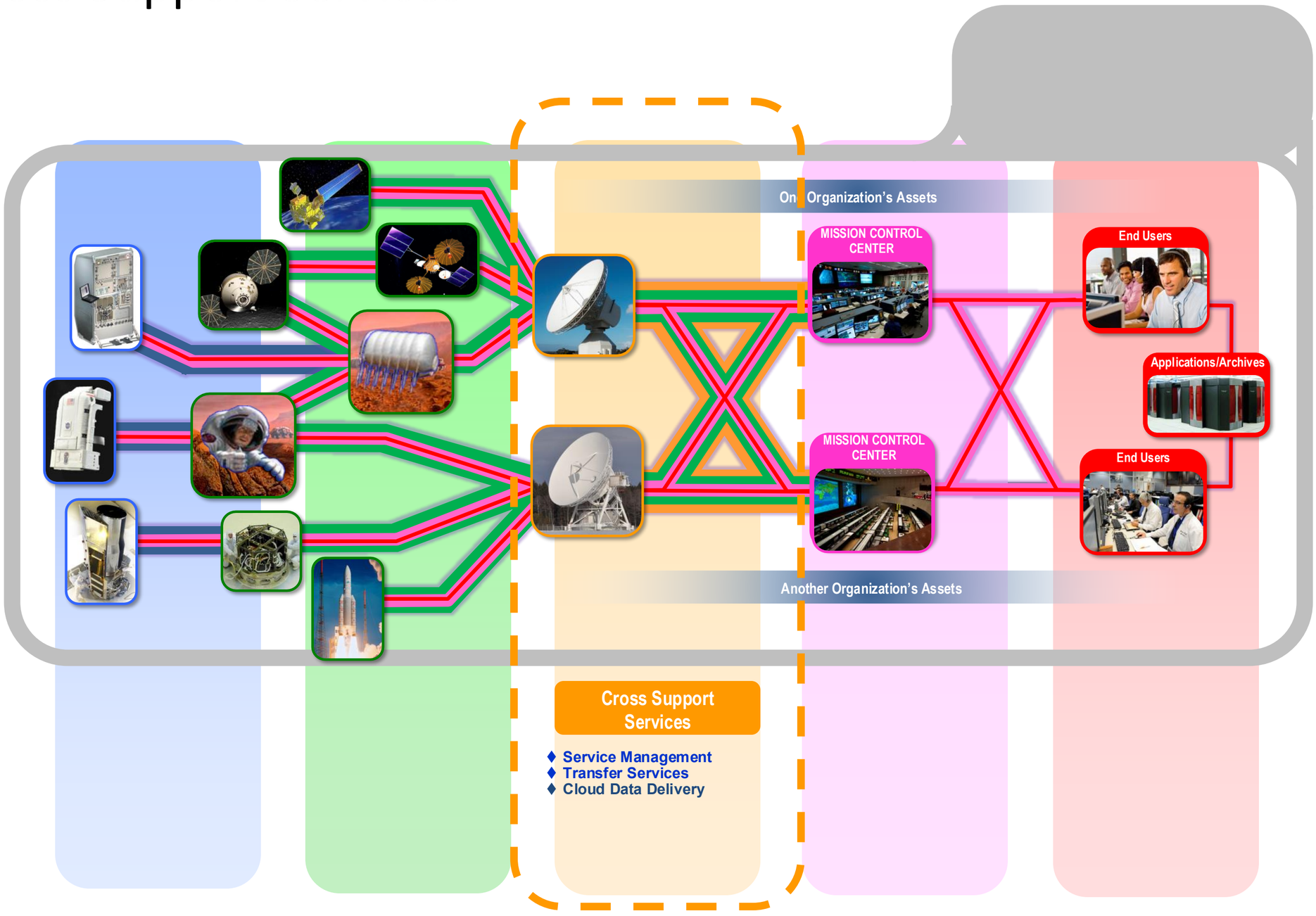
Space Internetworking Area in CCSDS



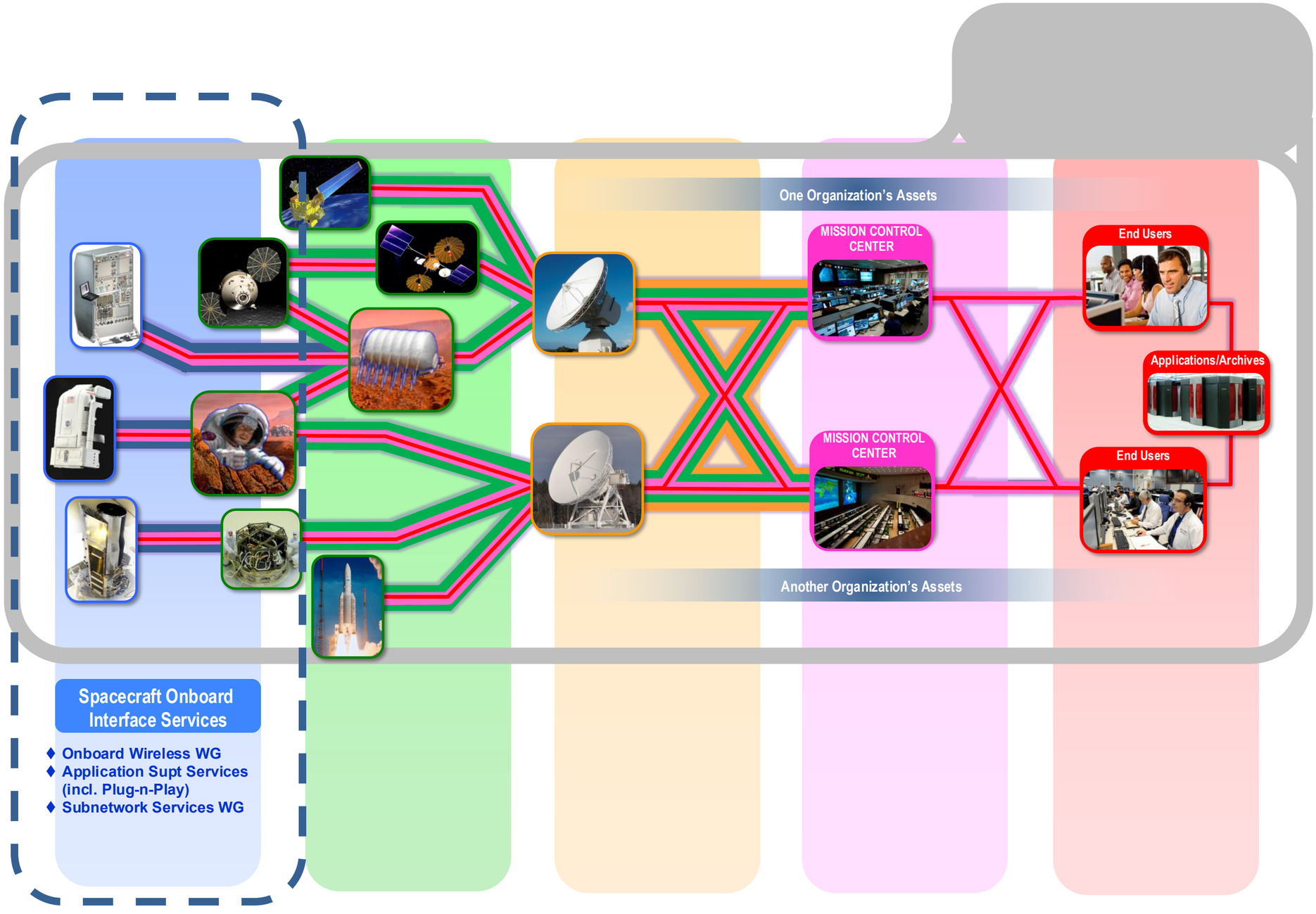
Space Link Services



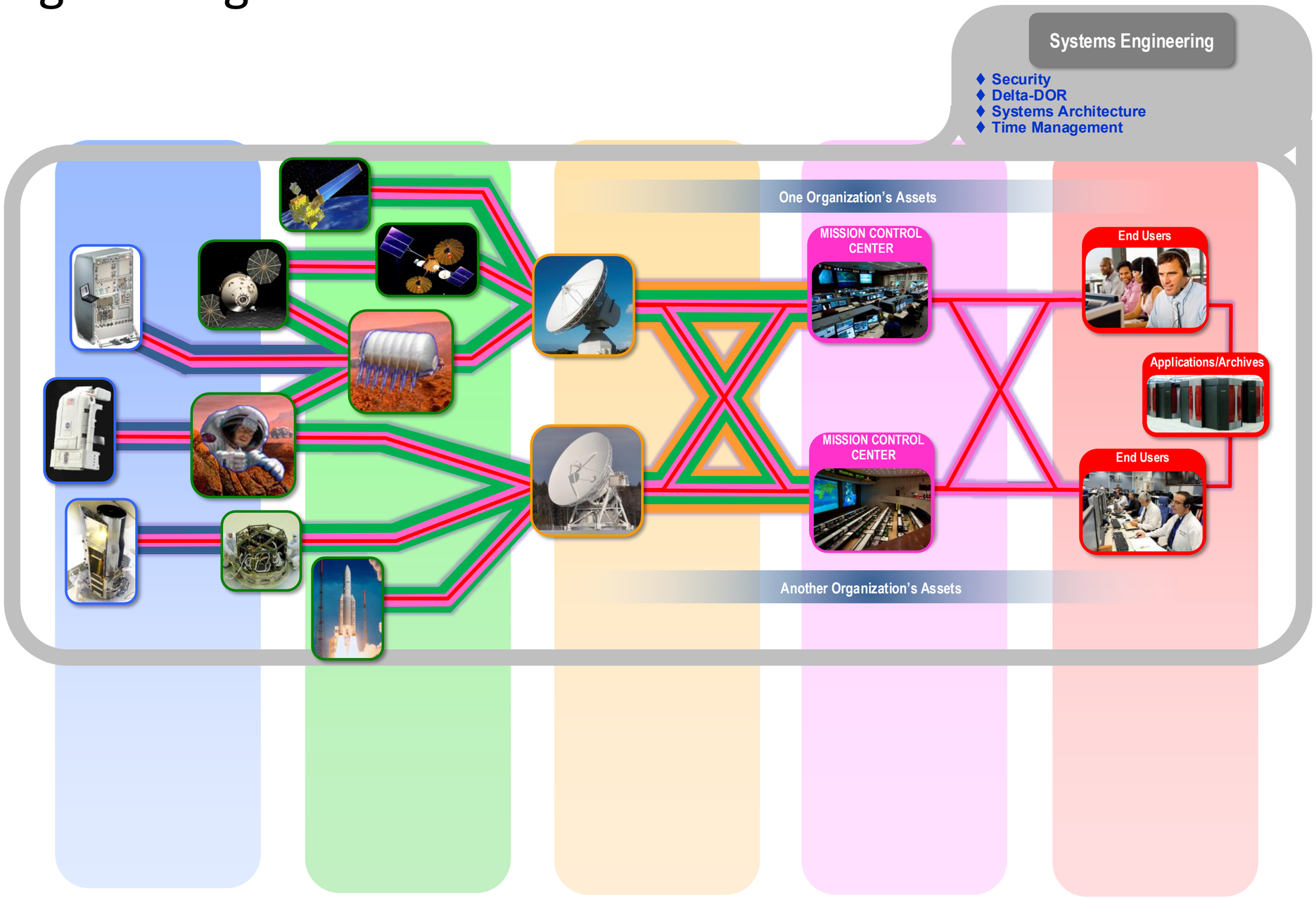
Cross Support Services



Spacecraft Onboard Interface Services



System Engineering



Follow-Up Actions from the last forums

Efficiency & Speed

- The CESG has initiated (with agreement of the CMC) a revision of the CCSDS Procedures with the aim to increase time to standard without sacrificing quality
- Easier creation of new projects and easier facilitation of resolutions and polls
- Transparent Editor Queues

Industry Involvement:

- Faster access to the CCSDS Associate status by reducing the administrative overhead
- Opening up interoperability testing and standards development for early industry involvement
- Opening up to a wider range of industrial partners



October 19, 2026 – CCSDS Conference

New Space Economy

Mr. Greg Heckler

Deputy Program Manager for Capability Development

Space Communications and Navigation Program

NASA

The New Space Era: Commercial Transformation

Proliferated constellations have transformed space communications. Satellite internet, commercial remote sensing, and the push for resilient architectures are driving that change.

NASA is moving its missions from government-owned infrastructure to commercial partnerships.

Rapid commercial growth is reshaping how we design mission architectures and structure partnerships across every domain.



Standards Looking Forward

Our commercial pivot extends beyond Earth. Lunar exploration depends on commercial partners for transport, landing, communications and navigation relays, and surface wireless connectivity.

Interoperability and cross-support remain foundational to building the lunar economy.

Governmentagencies must embrace the inherent tension between open, interoperable standards and proprietary solutions.



Shared Standards Will Require Government–Industry Partnership

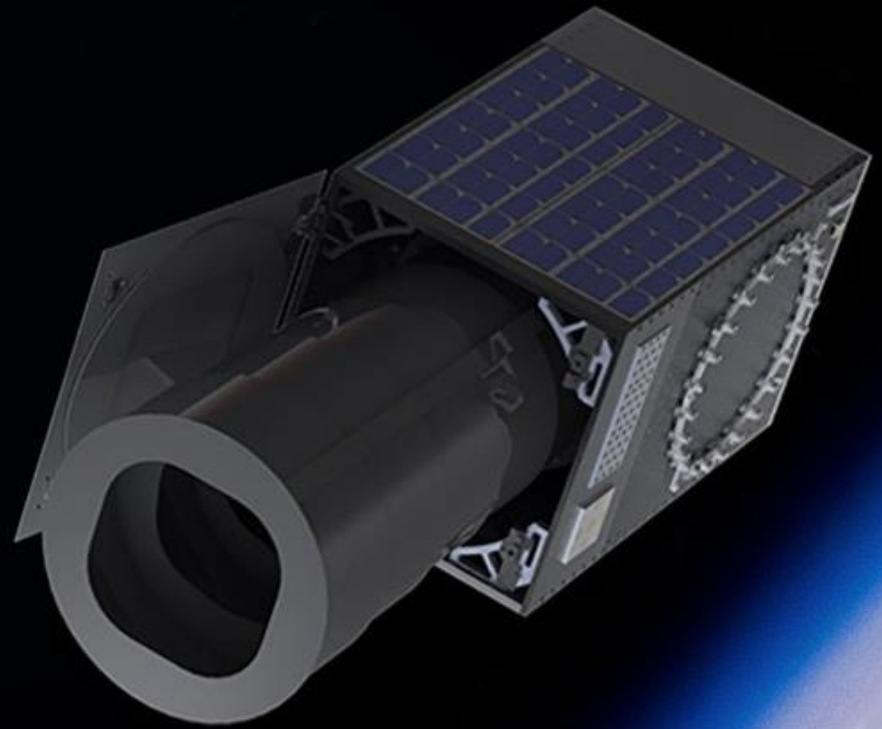
3

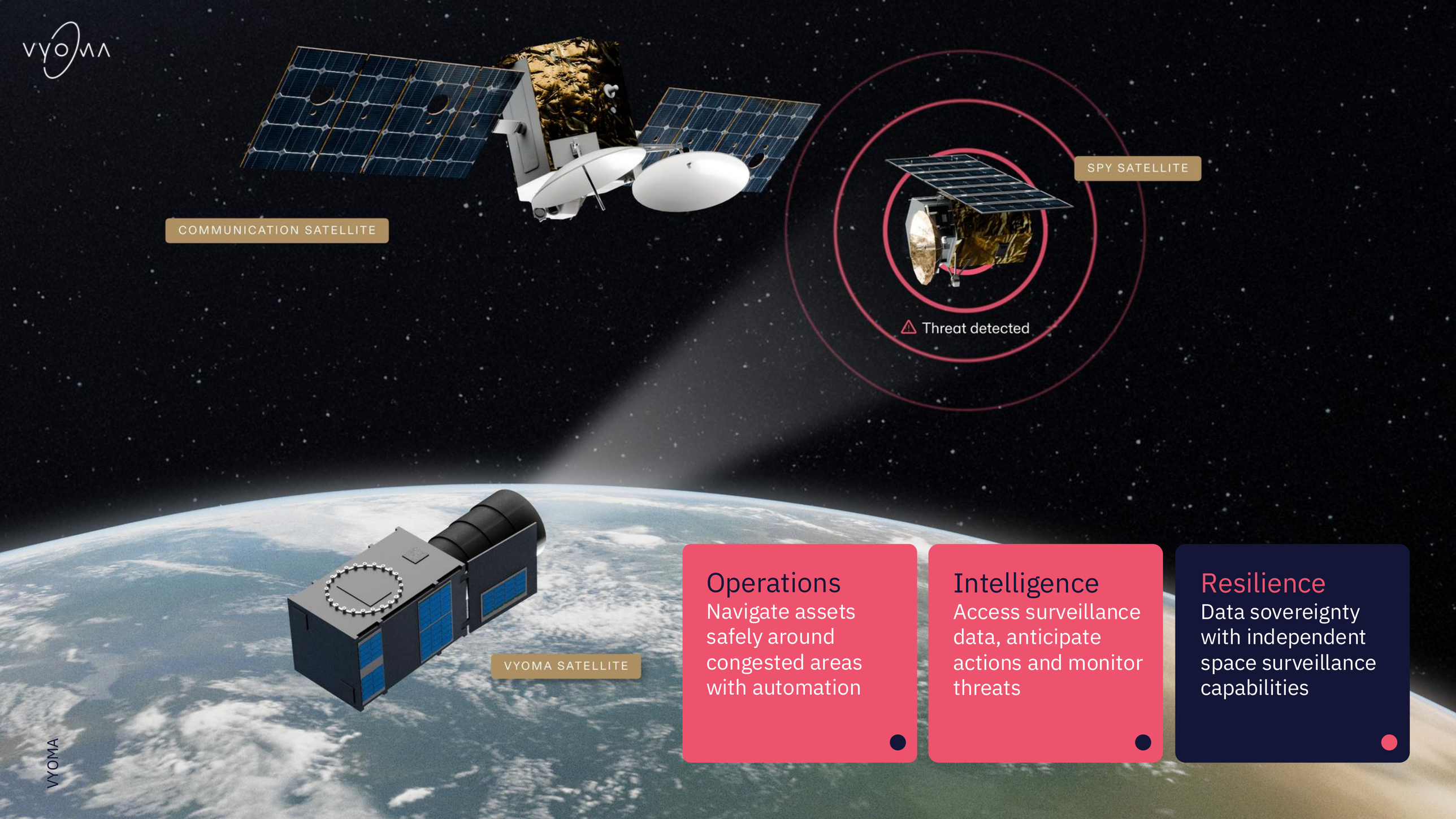
On the Use of CCSDS Standards within Vyoma

David Gondelach, PhD
Head of Astrodynamics

CCSDS Common Ground Forum
19-10-2026

Flamingo Constellation – independent observation of critical space assets 24/7





Operations
Navigate assets safely around congested areas with automation

Intelligence
Access surveillance data, anticipate actions and monitor threats

Resilience
Data sovereignty with independent space surveillance capabilities

Unique Position as Satellite Operator × Space Situational Awareness Authority



Operations services

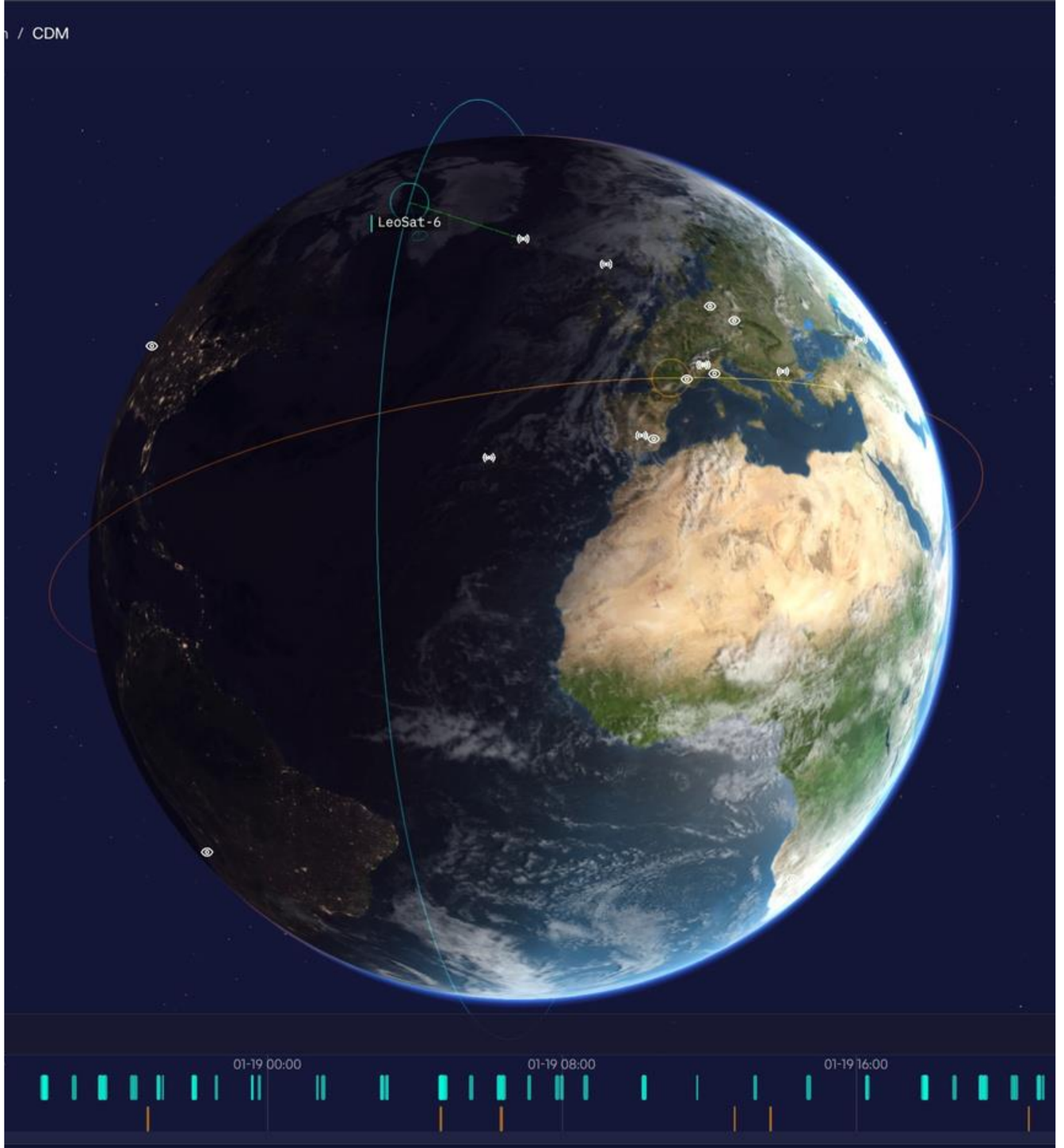
Flight Dynamics

- OrbitDetermination: automated orbit estimation, prediction and distribution
- Collision Avoidance: improved conjunction warnings, automated collision avoidance manoeuvre planning

- Orbit Acquisition and Maintenance: low-thrust trajectory optimization including operational constraints

Mission Planning

- Optimalsatelliteactivity planning: automatedmissionperformance optimization considering user-defined constraints on available power, memory, communication, etc.



Flamingo-1: The first eyes in space

Launched in Jan 2026

Altitude ~510 km, SSO (near polar)

Patented observation strategy and constellation design

Observation Modes

Surveillance: passive, continuous observation of LEO objects

Tracking: sensors booked to follow events or objects of interest




SPEED
27660
KM/H
ALTITUDE
519
KM
T+ 01:05:06
TWILIGHT
G-FORCE
0.0
G

CCSDS standards usage

- OrbitEphemerisMessage (OEM)
  - Orbitandcovariancedata
- Orbit Parameter Message (OPM)
  - Singlestate vectorand/or manoeuvre data
- Orbit Mean Element Message (OMM)
  - Two-line element (TLE) data
- Attitude Ephemeris Message (AEM)
  - Spacecraft attitude data
- TrackingDataMessage (TDM)
  - Observation data
- Conjunction Data Message (CDM)
  - Conjunction data
- SANA registry
  - Welldefined reference frames, time scales, coordinates, models, etc
- Telecommunication standards



Orbit Ephemeris Message (OEM)

Content: Orbit and covariance data



Usage: Store and exchange orbit data including covariances for our Flamingo satellites

- Internal:
  - Share ephemeris between systems
- External:
  - Operational ephemeris sharing for STM with: Spacetrack, EU SST and other satellite operators
  - Sharing observer ephemeris with customers

Essential for mission safety and business

Orbit Mean Element Message (OMM)

Content: Two-Line Element (TLE) data (a.k.a. General Perturbation data)



Usage: Store and retrieve TLE data

- Internal use:
  - Store TLE data
- External use:
  - Retrieve TLE data from Spacetrack and Celestrak

Orbit Parameter Message (OPM)

Content: Orbital state, covariance and manoeuvre data



Usage:

- External:
  - Receive pre/post-launch orbit
  - Share estimated state vectors
  - Share manoeuvre data

Attitude Ephemeris Message (AEM)

Content: Spacecraft attitude data



Usage: Store and exchange planned attitude of our Flamingo satellites

- Internal:
  - Store attitude data
  - Share attitude data between systems

Tracking Data Message (TDM)

Content: Observation/Measurement data



Usage: TDM format is used to exchange observations with external parties

- External:
  - Sharing our space-based optical observations with customers
  - Receiving observations from other organizations

Essential for business

Conjunction Data Message

Content: Conjunction data



Usage:

- Internal:
  - Store up dated conjunction data after screening against our operational ephemeris
- External:
  - Receiving conjunction data from Spacetrack, EU SST and other satellite operators
  - Sharing conjunction data with other operators

Essential for mission safety

SANA Registry

We try to follow SANA registry for:

- Reference frames
  - Celestialbody frames
  - Orbit-relative frames
- Orbital element types
- Time systems
- Gravity models
- Atmospheric models



CCSDS for Telecommunication

Satellite communication protocols used:

- ECSS-E-ST-70-41C – Telemetry and telecommand packet utilization
  - CCSDS AOS Space Data Link Protocol
  - CCSDS SpacePacketProtocol



ØChoice for these standards mostly come from satellite manufacturers or customers.

Use of Navigation Data Messages (NDM)

- We use XML format for all NDM files.
  - Exception for OEM files:
    KVNformatisless verbose, smaller file size
- We use the latest version of all standards.
- We have thought to use OCM format instead of OEM and OPM, but external parties seem to not accept OCM format yet.



Use of Navigation Data Messages (NDM)

- We use Orekit to parse and write NDM files.
  - Orekit is open-source astrodynamicslibrary
  - Orekit is widely used, therefore we trust their CCSDS implementations
  - Open source facilitates adoption of standards by industry and academia



- Orekit is early adapter of new NDM standards (before official release). This allows us to familiarize and adapt new standards very quickly.

- In case of CCSDS questions, we first ask Orekit forum!

CCSDS Communication and Feedback

We use Orekit forum in case of questions or doubts.

- I would not know how to reach CCSDS in case of questions or ideas.

- To get feedback from new space companies on current standards (e.g., missing features):
  - Create place to submit tickets, like GitHub Issues.
- We are open to review draft standards.
- Early access allows fast integration into open source and can hence enable fast adoption by industry.



TDM feedback

- TDM format does not support uncertainty information
  - Being able to share full covariance measurement uncertainty is essential for using the data operationally
  - Currently every company “invents” their own fields to add this data

- Aberration correction fields are insufficient:
  - TDM only support providing annual and diurnal aberration. Neither applies to a space-based observer as the aberration depends on the observer velocity.
  - Term “correction” is ambiguous. Depending on measurement type, aberration should be added or removed from measurement before use. Metadata does not tell if aberration was added or removed.
  - The aberration “correction” is a global value in TDM, but is different for each measurement.
  - In Vyoma, we specify the observer motion relative to which the measurement are defined: Solar system barycenter, Earth center, observer. Measurements contain aberration according that motion.



On JSON format

•Dedicated code is required to parse and write NDM files in

KVN and XML format that follow all rules -> Not straightforward



- JSON might help spread the use of CCSDS NDM standards
  - JSON is usedwidely for APIs and websites
  - Easy to develop code to parse and write
  - Could be beneficial for first-time users, e.g. students or new companies

- XML works well for us. JSON does not bring operational benefits.

Nit picking

- The benefit of segments in NDM files is not understood
  - Difficult to write code to deal with multiple segments
- NDM standard considers underscore “_” equivalent to single blank “ ”
  - It is not understood why and the interpretation of this “rule” has caused many discussions on Orekit Forum



Contact

David Gondelach

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CIPHERA

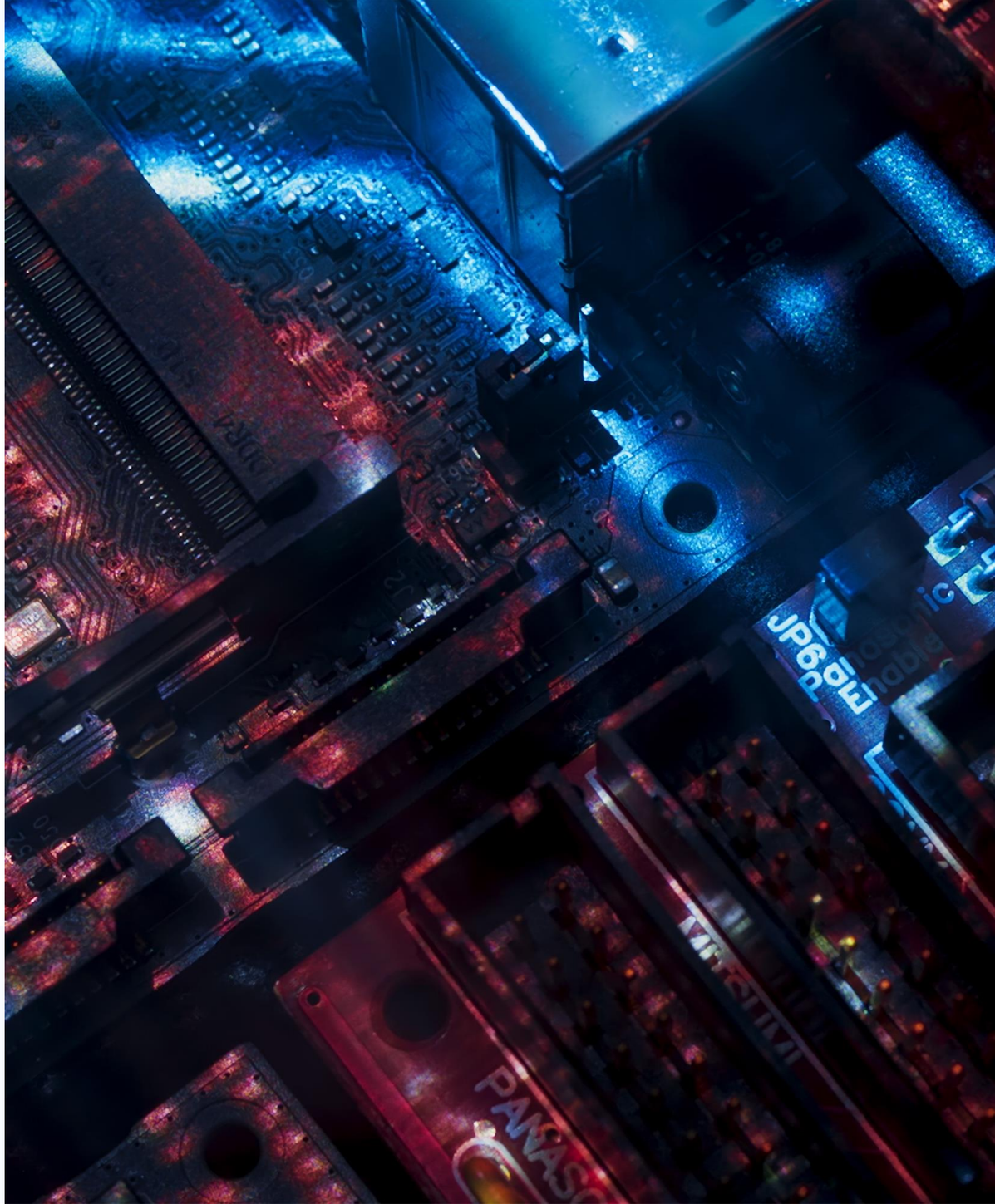
PEACE OF MIND IN A DANGEROUS WORLD

SME observations on Interoperability of Security Standards in the New Space Economy

Petri Jehkonen | Director of Strategic Programs | **October 19, 2026**

Agenda

- Xiphera Oy introduction (short)
- Xiphera involvement and observations about CCSDS standards
- Observations on interoperability in the New Space Market



Hardware-based security solutions with strong cryptographic expertise

CAVP validated

CERTIFICATE INTO CERTIFICATION ISO/IEC 27001

Xiphera designs and implements hardware-based security using proven cryptographic algorithms. Our strong cryptographic expertise and extensive experience in digital system design enable us to help our customers to protect their most valuable assets.

Finnish-founded in **2017**

European owned

Customers in **4** continents

30+ IP cores

XIPHERA

Xiphera involvement

- CCSDS is seen in the following contexts:
  1. Light review of asymmetric PQC algorithm draft.
  2. ESA ARTES 100Gbps security module:
     - Blue: 352.0-B-2, 355.0-B-2, 355.1-B-1, 356.0-B-1, 732.0-B-4.
     - Magenta: 354.0-M-1.
     - Green: 350.1-G-3.
     - Other: IEEE, NIST, GSFC-STD-8012, Savoir, HydRON-DS.
  3. Customer consultancy: Review of CCSDS implementation security.
- We adopt CCSDS because our customers and ESA programmes require it, and to maximize the likelihood of interoperability.





Our experience with CCSDS

- CCSDS books are freely available – this is the right way.
- CCSDS standards are occasionally confusing for newcomers.
  - Use case examples would help to understand why a particular requirement or text is introduced in books.
- Xiphera has not been involved in working groups yet.
- Xiphera is typically a follower of different standardization activities (IEEE, IETF, NIST, 3GPP, CCSDS), instead of sitting in the driver's seat.
- As an SME, Xiphera focuses on hardware implementations of cryptographic algorithms and solutions.
- We welcome invitations to review security-related drafts.

XIPHERA

Observations on the New Space Market

New Space may refer to

- Development of satellite platforms → Constellation.
- Development of satellite payload → Service Platform.
- Creation of non-terrestrial services on payloads.

Some New Space players seem to use de-facto solutions.

The New Space operators that are integrators seem to adopt CCSDS via their selection of platform, hw- or sw-component.

Interoperability test suites would be welcome.

The role of CCSDS may be invisible for service developers.

XIPHERA

Thank You



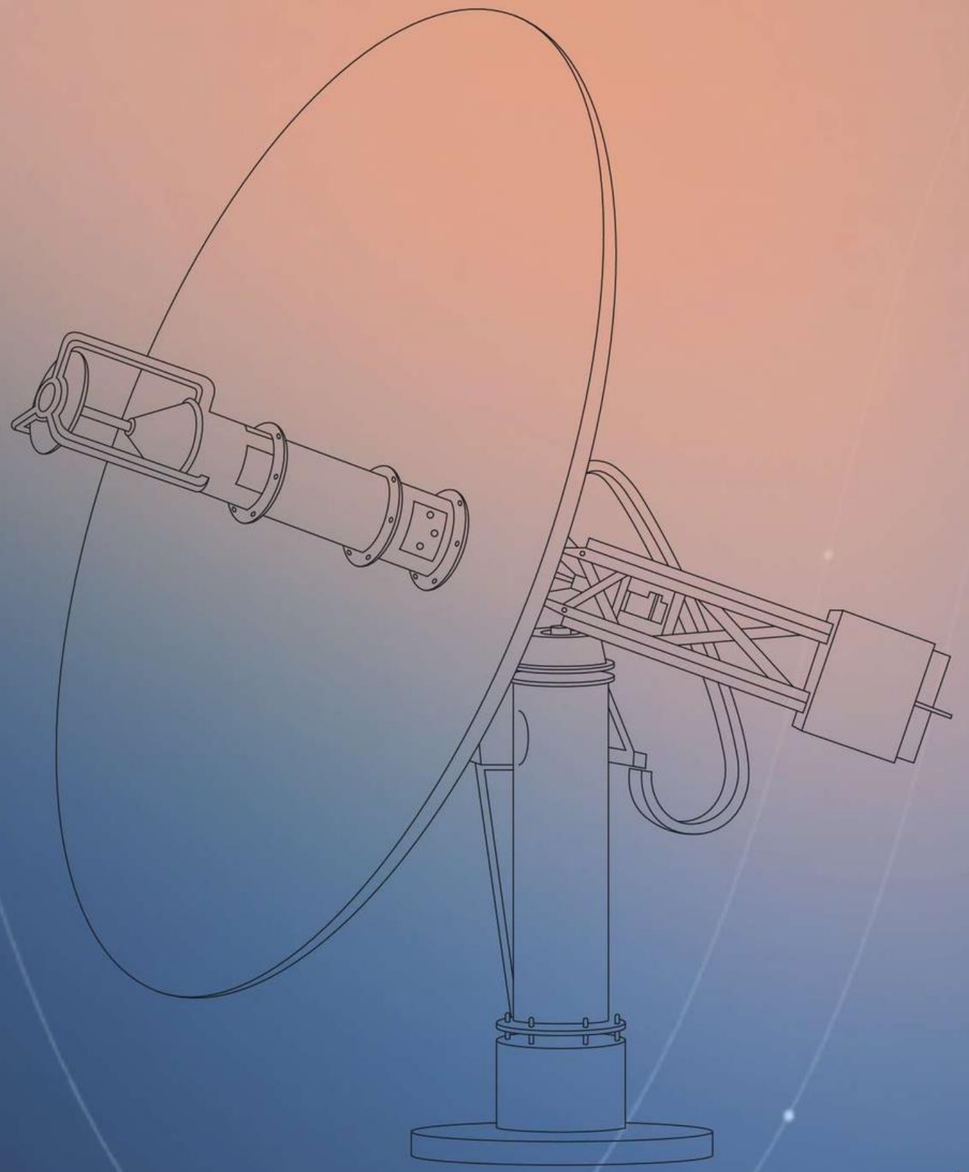
Contact us: www.xiphera.com | petri.jehkonen@xiphera.com

SKYNOPY

Connecting satellites. As a service.

CCSDS Presentation

Oct 2026



Antonin Hirsch - antonin@skynopy.com
Valentine Bourgeois - valentine@skynopy.com

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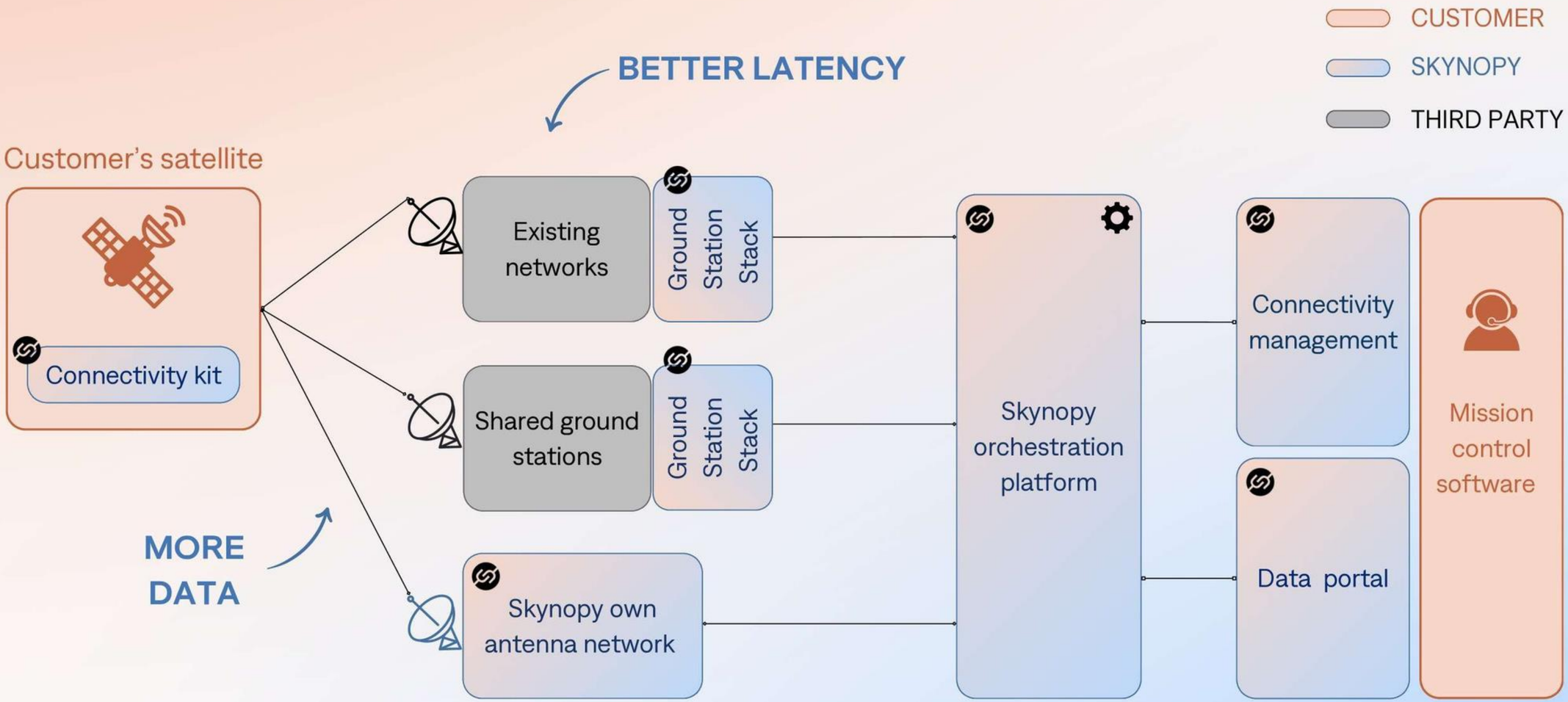
Skynopy global network

SKYNOPY

Skynopy infrastructure unifying and abstracting multiple ground networks in a single interface



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Skynopy global network

SKYNOPY

Today

- 35 antennas on 17 sites
- S- and X-band, 4 to 6 m antennas

Tomorrow: 100+ antennas

- AKAR program, in partnership with Eutelsat
- Reuse of the OneWeb ground segment





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Why standardize ACM/VCM/CCM control?

Context

- More and more LEO systems, with fast-growing data volumes
- ACM and VCM increase throughput and resilience, and are already supported at the physical layer (DVB-S2, CCSDS SCCC)
- Ka-band needs ACM to operate efficiently through atmospheric fades

Problem

- No standard control link: how the ground commands the ModCod (which one, when, for how long)
- No standard onboard logic: timing, validity, fallback between ACM, VCM and CCM
- Proprietary implementations: complex for operators, no interoperability between ground networks and onboard radios

Solution

- One application–layer protocol for CCM, VCM and ACM
- Built on existing CCSDS layers: CLTU, TC Transfer Frames, SDLS
- Common onboard decision rules, with ACM → VCM → CCM fallback
- Any ground segment, any compliant radio

SKYNOPY

ACM/VCM/CCM – Design principles

Objective

Define a secure control link to the onboard transmitter, interoperable across radios and ground segments, for dynamic modulation and coding

01 **Beyond ACM: one logic for all modes**
ACM, VCM and CCM in a single protocol, with automatic fallback ACM → VCM → CCM

02 **Secure by design**
SDLS authentication on a dedicated virtual channel; timestamps reject replayed commands

03 **Built on CCSDS standards**
CLTU, TC Transfer Frames, SDLS: reuses existing TC chains, via nominal TT&C or a dedicated uplink

04 **Independent of the physical layer**
Any band, waveform or radio. DVB-S2 ModCods by default, mission-specific tables allowed

05 **Deterministic and compact**
Time-tagged commands with a validity period

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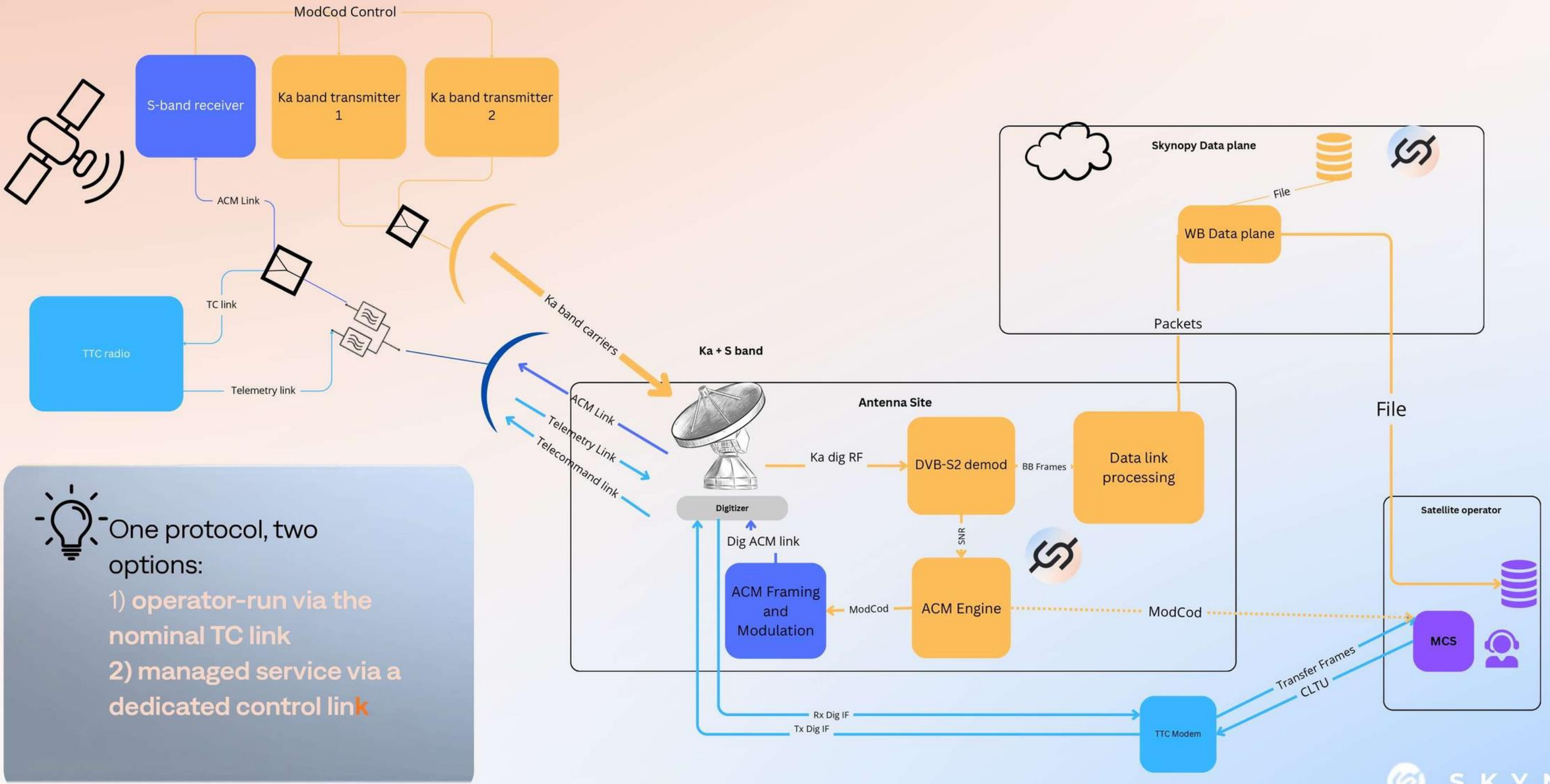
ACM/VCM/CCM – End-to-end system example



One protocol, two options:

1) operator-run via the nominal TC link

2) managed service via a dedicated control link

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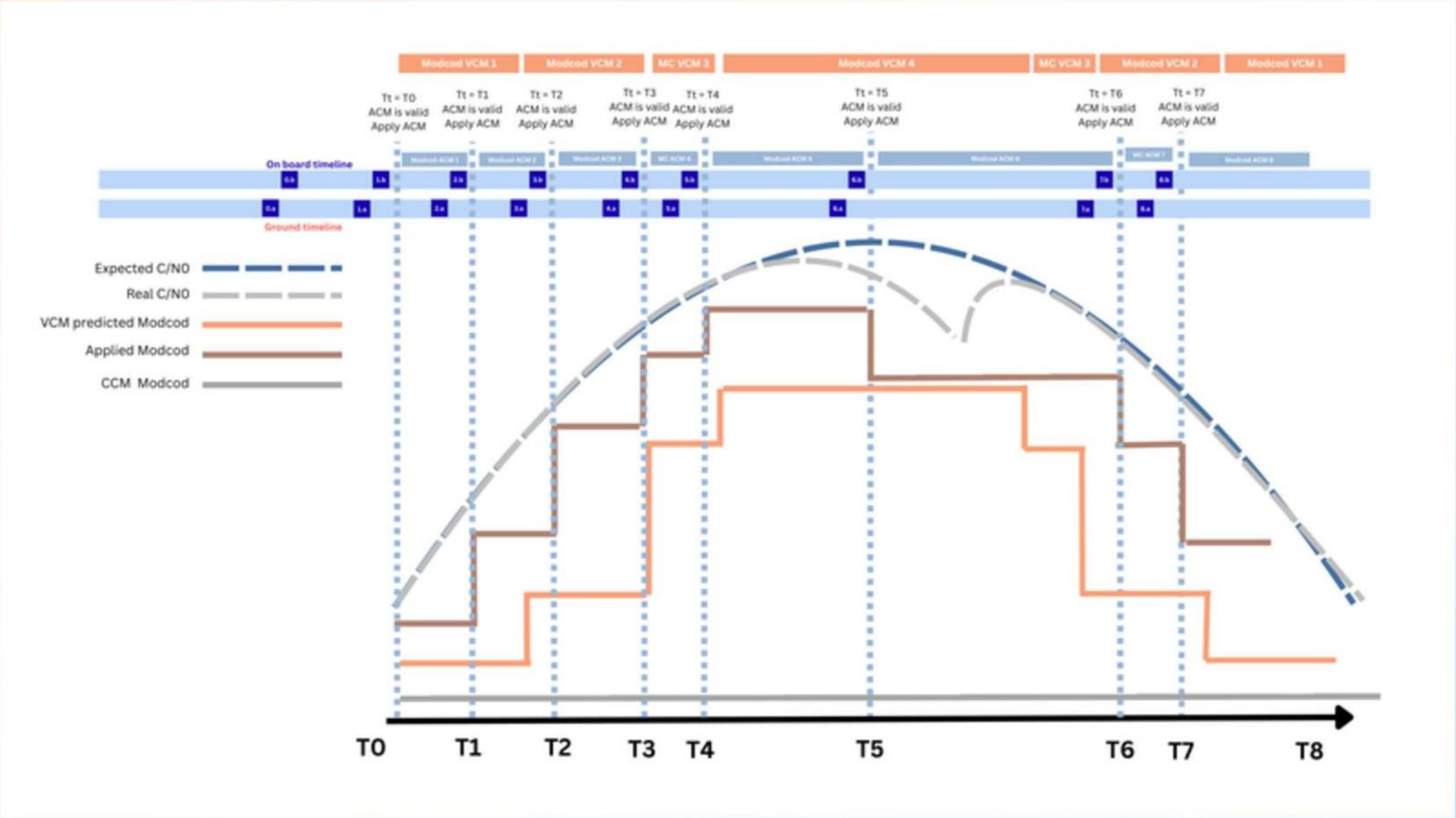
ACM/VCM/CCM – Concept of operations

- CCM: fixed ModCod, sized for the worst case
- VCM: planned from predicted C/N (pass geometry)
- ACM: follows measured C/N in real time

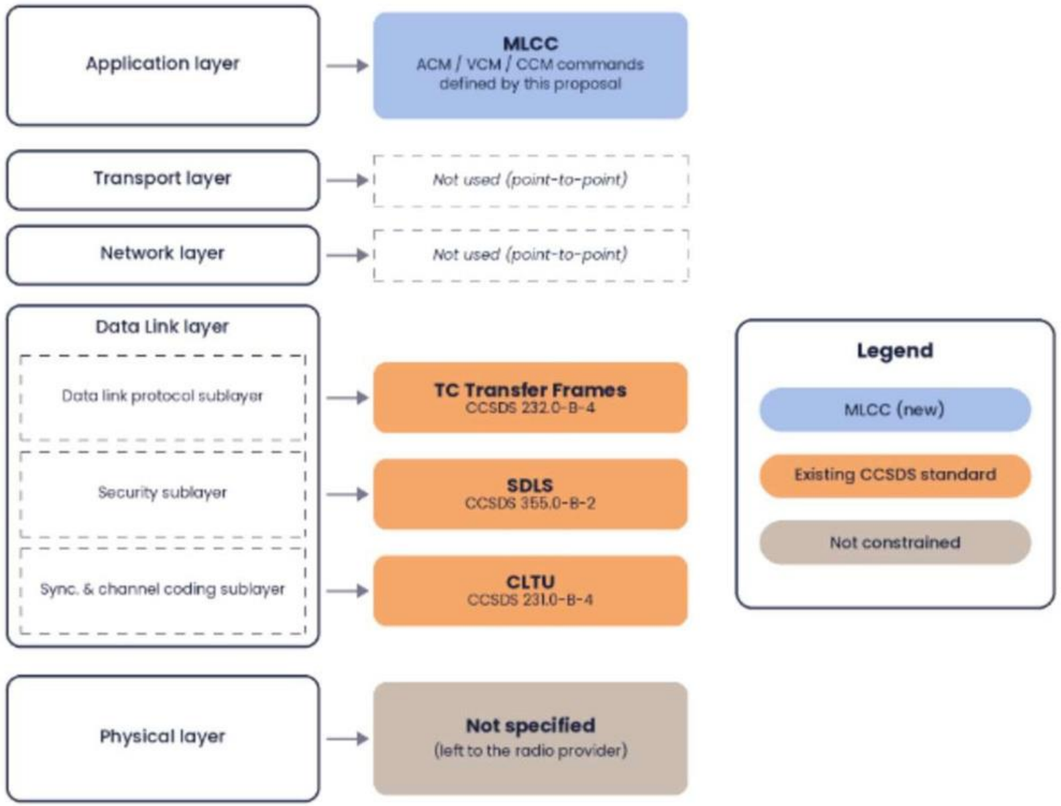
Three modes combined: best trade-off between throughput and robustness, with automatic fallback when ACM is unavailable



Example pass: applied ModCod over time, with fallback when ACM commands expire or are lost

SKYNOPY

MLCC – Protocol stack



1. Only the application layer is new; all lower layers are existing CCSDS standards
2. Point-to-point: no network layer, MLCC carried directly in the TC frame data field
3. Dedicated virtual channel and security association for MLCC
4. Physical layer left to the radio provider

PRINCIPLE

The Managed Link Control Command (MLCC) defines three command formats (CCM, VCM, ACM) sent from any ground segment to the onboard transmitter. Each command sets:

- Which ModCod (or time-tagged VCM plan) to use on the return link
- When it takes effect
- How long it remains valid

Only the MLCC application layer needs standardization – it reuses CCSDS 231.0, 232.0 and 355.0

MLCC – Status and common header

Skynopy × Safran Data Systems

Skynopy (ground segment) and Safran Data Systems are developing a demonstrator, including onboard equipment using MLCC to control Ka-band transmitters

A first definition of the protocol has been completed

In-orbit demonstration planned for 2028

All MLCC messages share a common header, followed by a mode-specific payload (ACM, VCM or CCM)

Command rate ≤ 10 kbps: fits within a nominal TT&C uplink

Field	Size	Type	Range	Description
Message Type	1 B	uint8	0x01 – 0x03	0x01 = ACM · 0x02 = VCM · 0x03 = CCM
Protocol Version	1 B	uint8	0x01 – 0xFF	Application protocol version
Command UUID	1 B	uint8	0x00 – 0xFF	Unique command identifier
Carrier Bitmap	8 B	bitmap	carriers 1 – 64	Carriers addressed by the command
ModCod ID	1 B	uint8	0x00 – 0xFF	ACM / CCM · DVB-S2 IDs 1–28 by default
VCM Plan UUID	1 B	uint8	0x00 – 0xFF	VCM only · identifies the VCM plan
Header: 13 bytes · byte-aligned, fixed offsets · followed by the ACM, VCM or CCM payload				

MLCC – ACM and VCM commands

SDLS-authenticated, anti-replay

VCM command – payload				
Field	**Size**	**Type**	**Range**	**Description**
Table ID	1 B	uint8	0x00 – 0xFF	VCM plan identifier
Timestamp	8 B	uint64	0 – 2^64-1	Plan generation time (0.1 s)
Entry Count	1 B	uint8	0 – 255	Number of entries
Entries	N × 9 B	–	–	Each entry: ModCod ID (1 B) + application timestamp (8 B)
Segment Byte	1 B	uint8	index 0 – 127	Bits 0–6: segment index Bit 7: last segment flag
Variable length · large plans are split across segments				

VCM

Variable length: one entry (ModCod ID + timestamp) per ModCod change

Large plans split into up to 128 segments

Uploaded ahead of the pass; used when no valid ACM command

ACM

Fixed length, time-tagged

Bounded validity, then VCM / CCM fallback

Expired commands rejected

ACM command – payload					
Field	**Size**	**Type**	**Resolution**	**Range**	**Description**
Validity Period	2 B	uint16	0.1 s	0 – 65535	Validity duration of the ModCod
Generation Timestamp	8 B	uint64	0.1 s	0 – 2^64-1	Command generation time
Application Time	8 B	uint64	0.1 s	0 – 2^64-1	Onboard application time
Timestamps in 0.1 s since 2000-01-01 00:00:00 · expired commands are rejected					

ACM/VCM/CCM – Towards a common standard

Standardizing link control to enable interoperability

As data downlinks move to higher frequency bands, especially Ka–band, advanced link control (ACM, VCM, CCM) becomes necessary for efficient and robust operations.

- Today, each implementation is proprietary: no interoperability between onboard radios and ground networks
- A common standard would let any ground segment control any compliant transmitter, and support the development of these advanced functions
- MLCC is a first contribution: built on existing CCSDS layers, under demonstration by Skynopy and Safran Data Systems (in–orbit demo 2028)
- We would welcome the community's feedback and the opportunity to discuss a possible standardization path within CCSDS

GSO-P-26.0984 - Version: 1

U/SPACE

KEEP EXPLORING

CCSDS Common Ground Forum - U-Space: CCSDS Standards and Their Applications in a NewSpace Startup: The Case of U-Space

GSO-P-26.0984

CCSDS Common Ground Forum - U-Space: CCSDS Standards and Their Applications in a NewSpace Startup: The Case of U-Space

Version: 1

Date: 14/10/2026

Rédacteur: Baptiste Guilbert

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GSO

CCSDS Common Ground Forum - U-Space: CCSDS Standards and Their Applications in a NewSpace Startup: The Case of U-Space

14/10/2026

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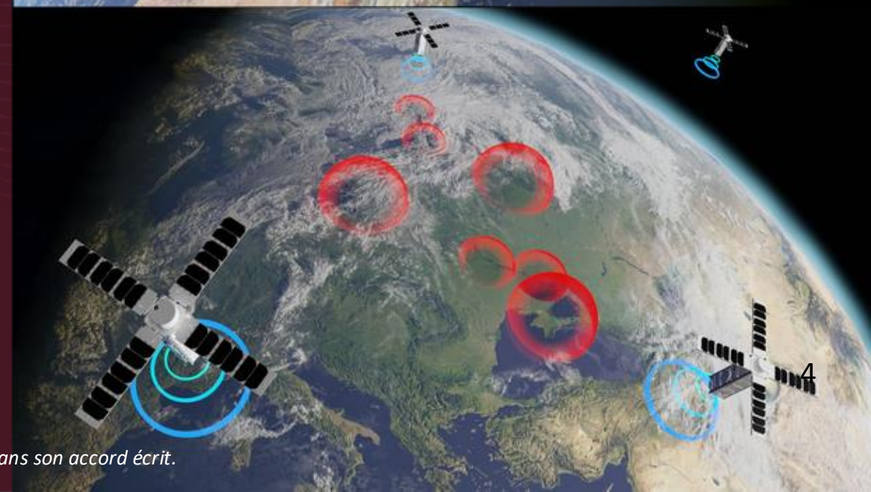
SPACE MISSION ENABLER

CCSDS Standards and Their Applications in a NewSpace Startup: The Case of U-Space

Baptiste GUILBERT
Ground Systems Product Owner
baptiste.guilbert@u-space.fr







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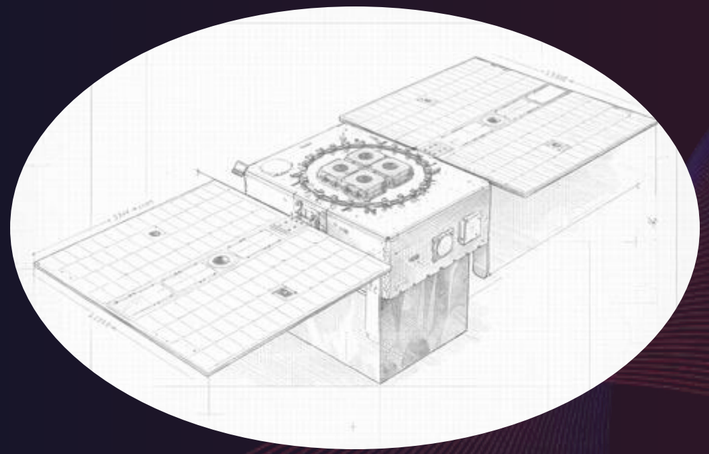
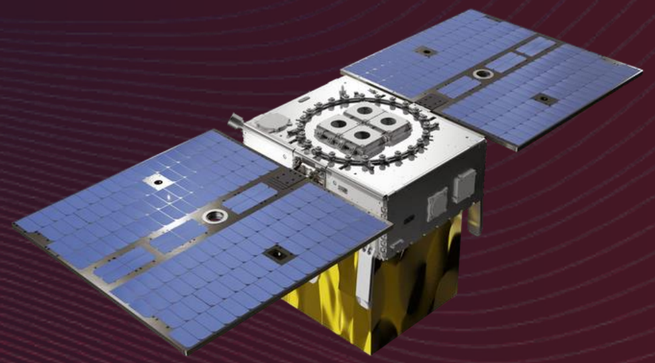
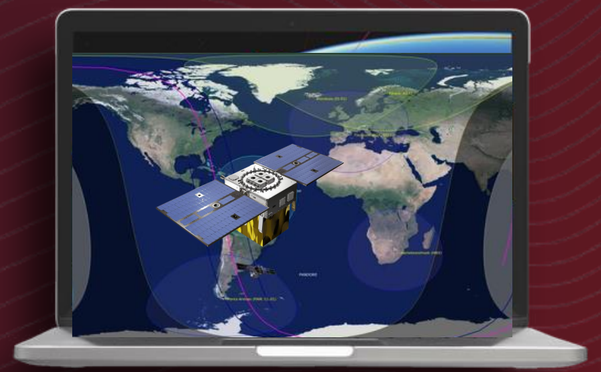
U-Space



DEFINITION



PRODUCTION



OPERATION

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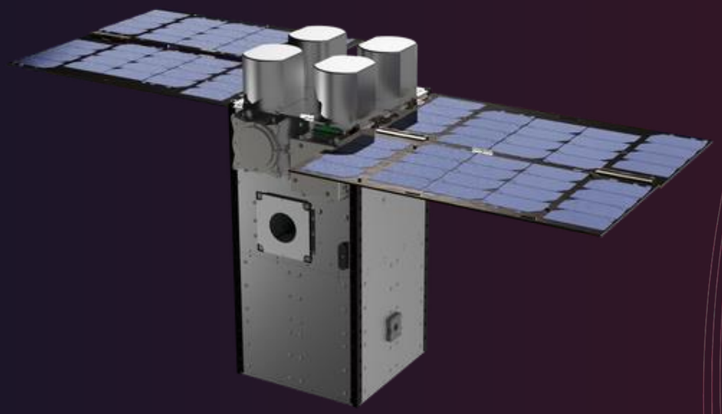
16U30kg

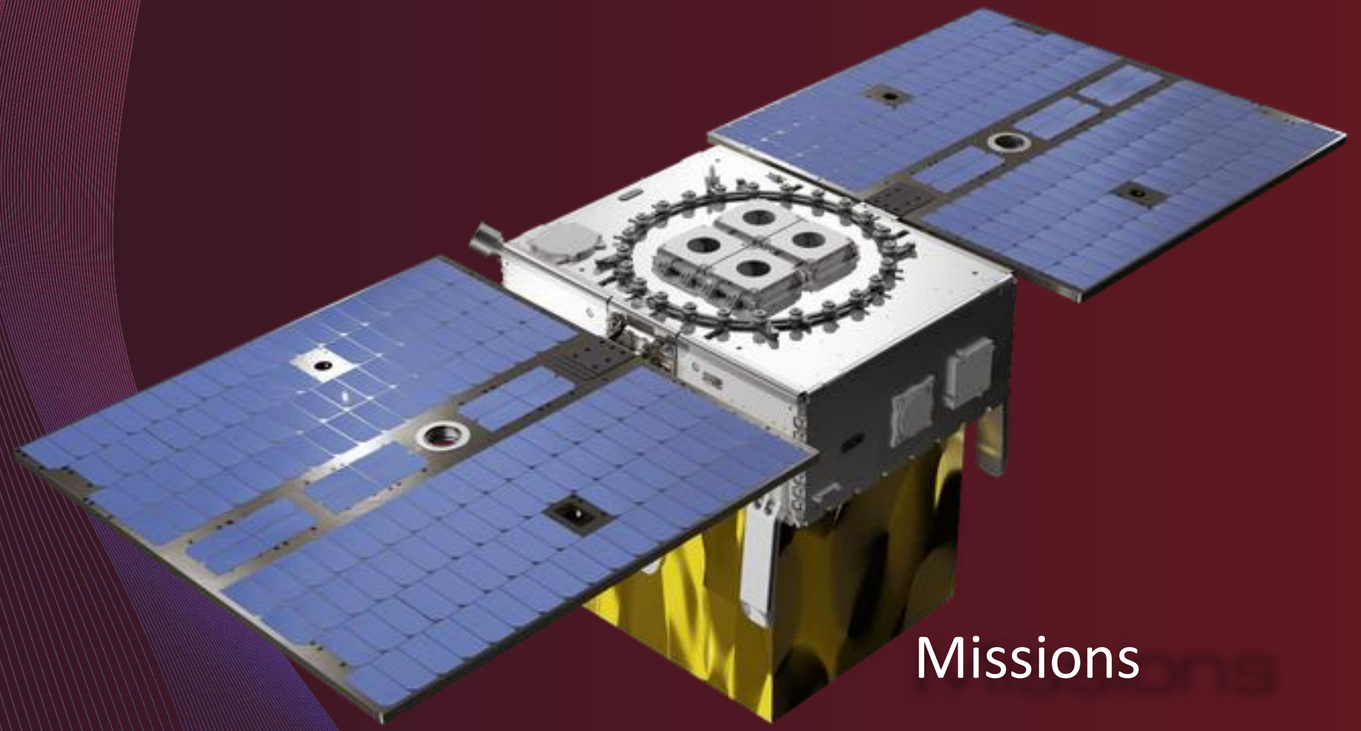


Missions



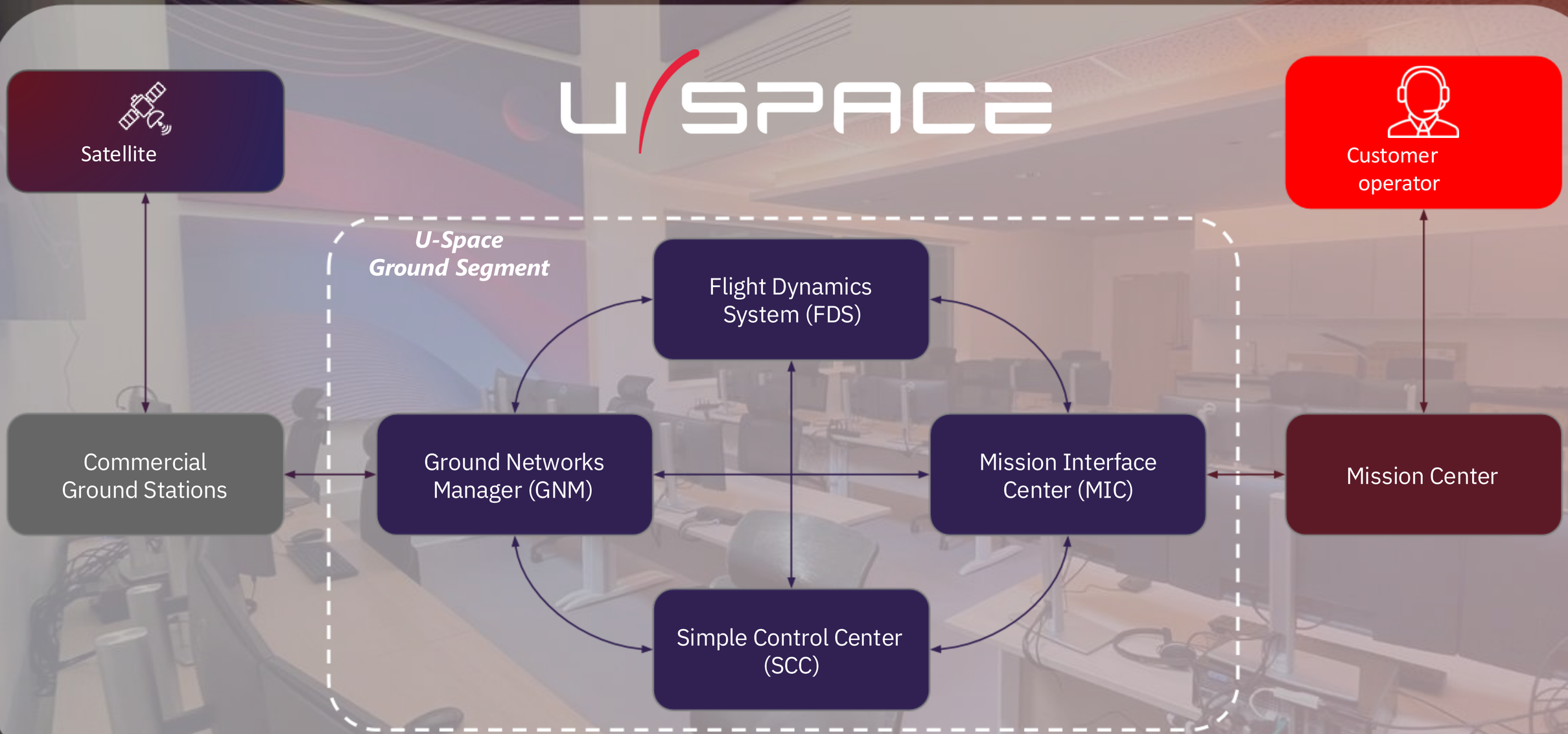
Freeform

140kg



Missions




U/SPACE
Satellite
Customer operator
U-Space Ground Segment
Flight Dynamics System (FDS)
Commercial Ground Stations
Ground Networks Manager (GNM)
Mission Interface Center (MIC)
Mission Center
Simple Control Center (SCC)

Our use of CCSDS standards



Channel Coding and Synchronization

131.0-B - TM Synchronization & Channel Coding

231.0-B - TC Synchronization & Channel Coding



Data Link Protocols

132.0-B - TM Space Data Link Protocol

732.0-B - AOS Space Data Link Protocol

232.0-B - TC Space Data Link Protocol

232.1-B - COP-1



Data Link Security

355.0-B - SDLS

355.1-B - SDLS Extended Procedures (OTAR, Key Verification)

Our use of CCSDS standards

Onboard Data Packets and Formats

133.0-B - Space Packet Protocol

301.0-B - Time Code Formats (CUC)

660.0-B -

XTCE

Navigation Data Messages

502.0-B - ODM : OEM, OPM, OMM

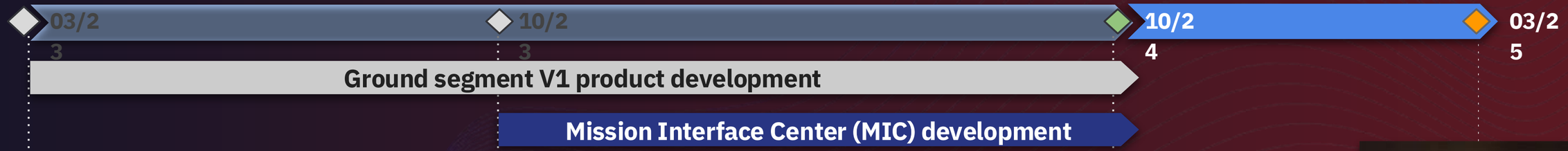
503.0-B - TDM

504.0-B - ADM : AEM, APM 505.0-

B - NDM/XML

Using the CCSDS “Mission Planning and Scheduling Services” Standard

V1 product development



Projects kickoffs
PANDORE & SOAP missions

Early access to new standard CCSDS Mission Planning and Scheduling Services

End of development
Flight Readiness Reviews



Launch
Transporter-13

Our primary need : provide a generic interface for all our clients and partners that allows them to submit scheduling requests in advance and receive their payload data afterward.

What the standard has brought us



Ready-to-use data model

A reference framework for the planning phase of the interface: requests, plans, execution, and statuses.



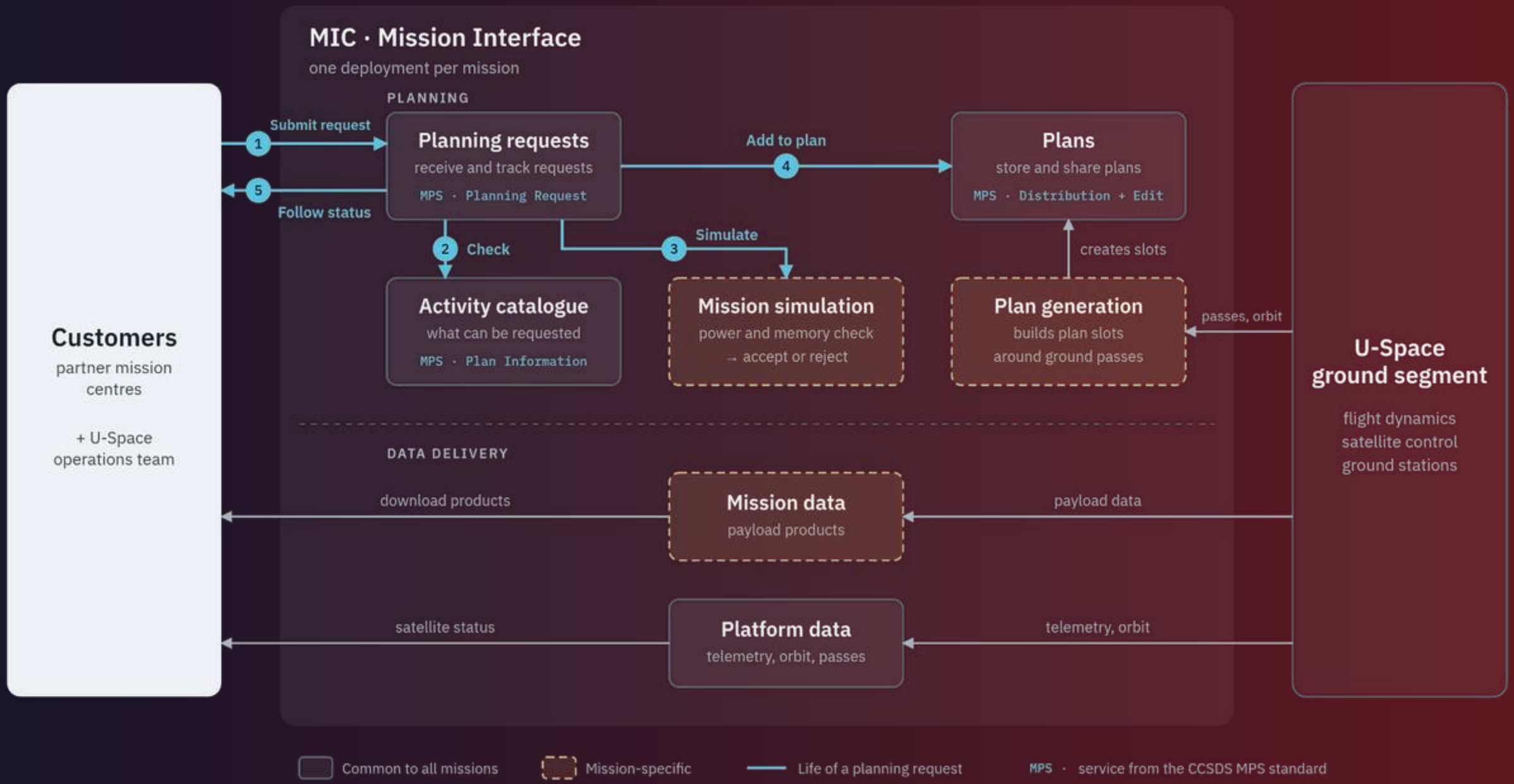
Functional breakdown

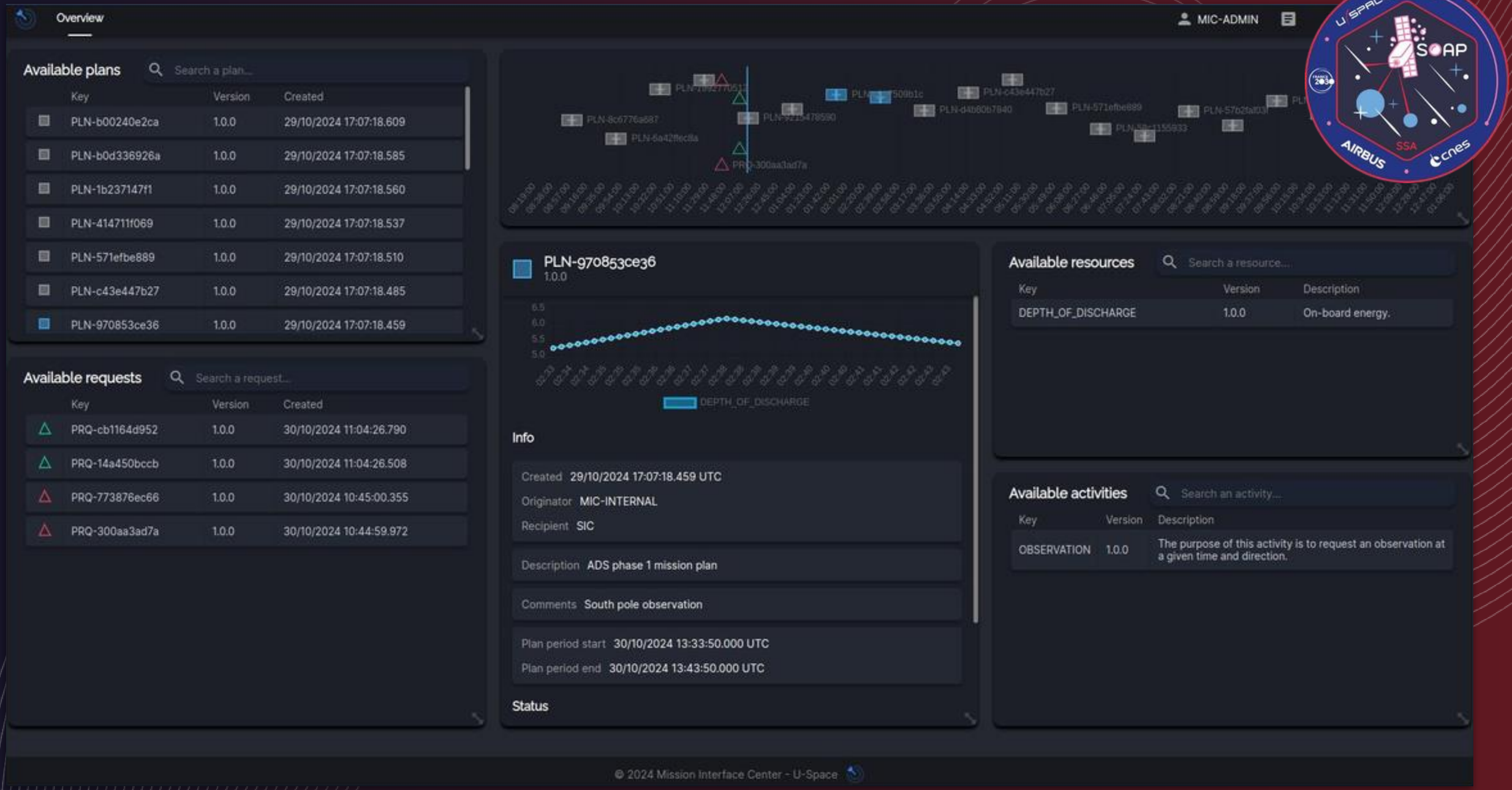
An initial functional breakdown that structured our microservices architecture and provided a clear direction for development.



Reusable, multi-mission architecture

A set of generic services that can be reused and configured specifically for each given mission.


MIC · Mission Interface
one deployment per mission
PLANNING
Submit request
1
Follow status
5
Planning requests
receive and track requests
MPS · Planning Request
Add to plan
4
Plans
store and share plans
MPS · Distribution + Edit
2
Check
3
Simulate
creates slots
Activity catalogue
what can be requested
MPS · Plan Information
Mission simulation
power and memory check
→ accept or reject
Plan generation
builds plan slots
around ground passes
passes, orbit
Customers
partner mission centres
+ U-Space operations team
U-Space ground segment
flight dynamics
satellite control
ground stations
DATA DELIVERY
download products
Mission data
payload products
payload data
satellite status
Platform data
telemetry, orbit, passes
telemetry, orbit
Common to all missions
Mission-specific
Life of a planning request
MPS · service from the CCSDS MPS standard



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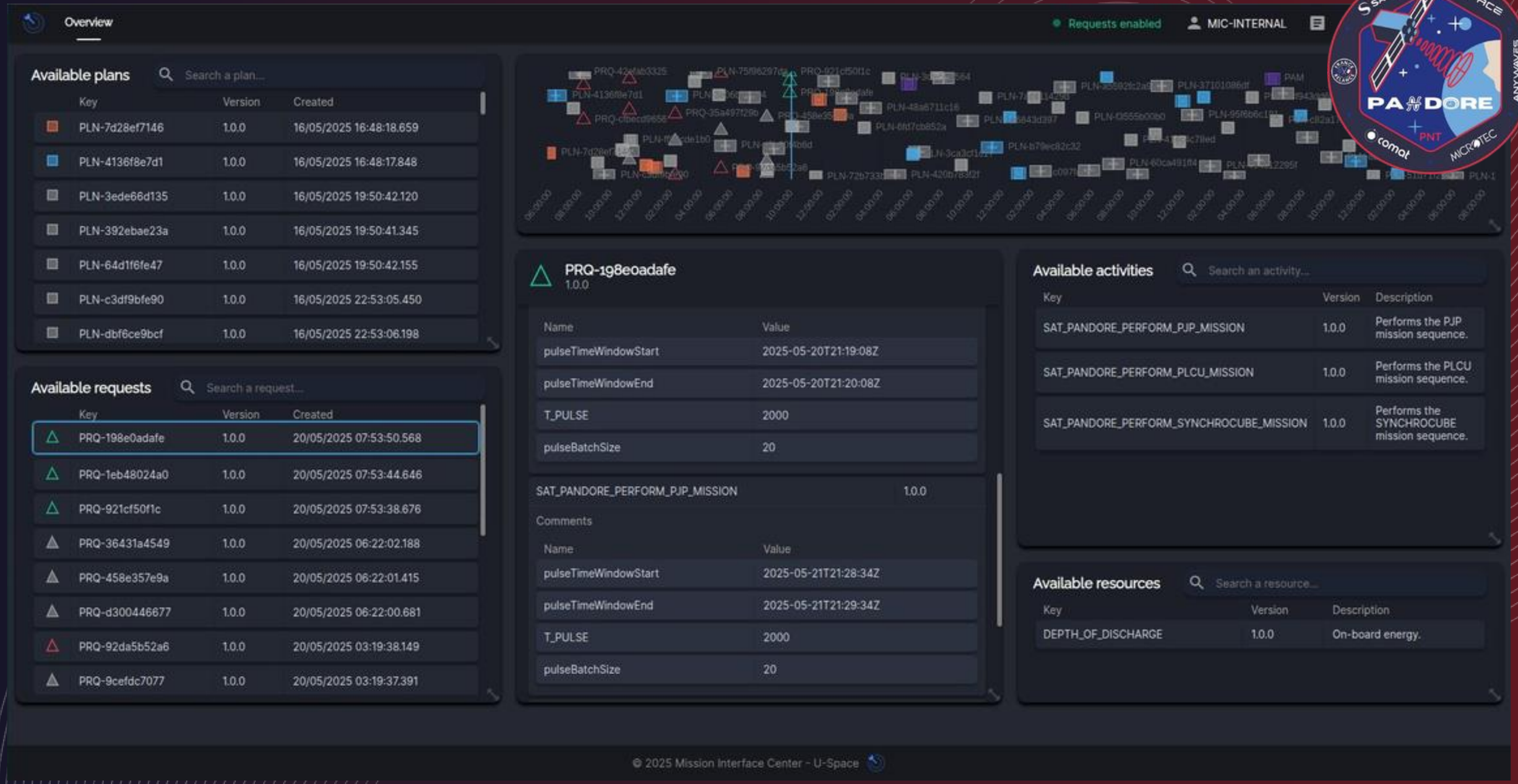

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Limitations of the standard in our context



Learning curve

A standard designed for multi-agency ecosystems. It is modular, but finding the right subset requires a significant effort for a small organization.



Software interface

A standard that is agnostic on paper, but whose interaction model (MAL, pub/sub, broker) and ecosystem (XML) are less readily compatible with the technologies our customers expect (e.g., REST APIs).

Potential extension of the standard: propose a generic API specification?



Scope limited to mission planning

A scope limited to mission planning: the mission data deliveries that were part of our requirements fall under other standards or specific developments.

Outlook

CCSDS Mission Planning and Scheduling Services Blue Book
The standard was officially published in September 2026, so this is an opportunity for us to review it again, drawing on all the operational feedback we've gathered over the past two years.

CCSDS standards give us a proven framework, a common language with space agencies and a clear architectural direction, even if they require us to select the right subset and adapt them to our own interfaces needs. Used wisely, they remain a key enabler for the interoperability and success of our future missions.




Overview
U-Operate
SAT2
Requests enabled
MCC
15/10/2026 06:44:28 UTC
Activity catalogue
Drag an activity onto the "Mission activities" row of the timeline.
Payload acquisition
MCC · MIC pointing
Custom mission (client TCs)
MCC · No pointing
Checks
No issues
Max DoD · next 3 days
7.5 %
estimated at 08:29 · limit 20 %
Max onboard memory · next 3 days
8.0 GB
estimated at 07:41 / 32 GB
Data freshness · next 3 days
4 / 4 met
avg 40 min · worst Payload acquisition (1 h 40)
Scheduler
Plan passes
TCs
Map
Legend
Validate
UTC · 12/10
07:30
07:45
08:00
Passes
Svalbard
07:47
07:53
Mission activities
TC uplink
HK TM
Payload TM
07:32–07:35
07:38–07:41
Client TCs
x: time-tag · y: size (log)
Satellite mode
payload On
eclipse
Battery charge
estimated
limit 80 % (DoD 20 %)
pass
Onboard memory
estimated
capacity 32 GB
Satellite position
2026-10-15T06:44:29Z · now
SAT2
Satellite status
Position · 400 km
13.5° S · 26.4° W
Mode
Sun-pointing (standby)
Payload
Off
Lighting
Eclipse
Battery
97 %
Memory
0.0 GB
Ongoing
—
© 2026 Mission Interface Center · U-Space · U-Operate mockup

THANK U

Baptiste GUILBERT
Ground Systems Product Owner

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The Embedded
Security Experts

Implementing CCSDS Security:
What Broke, What's Missing, and What Could Be Better

Dr.-Ing. ~~David Koisser~~ Patrick Jauernig

19.10.2026

> Context

- We are currently defining a symmetric key management for BPSec

- Goal 1: Align with existing CCSDS standards
- Goal 2: Consider and provide path to practical interoperability

> Fragmented Key Management

- Four different books apply:
  - Key Management (KM): Green & Magenta
  - SDLS Exter
- Magenta &
  - KM Mage
  - SDLS Gree
    (Key Un-/
  - KM Green
    in another agrees with Magenta but disagrees with SDLS Green (Key Generation*)
- Result: Redundancy & Unclear scope for designing a compatible approach

Most things align!
Yet when discovering a discrepancy,
a laborious “full scan” is required to
identify *all* discrepancies



* Bonus: CCSDS Cryptographic Algorithms Green Book
does not mention any key generation algorithm

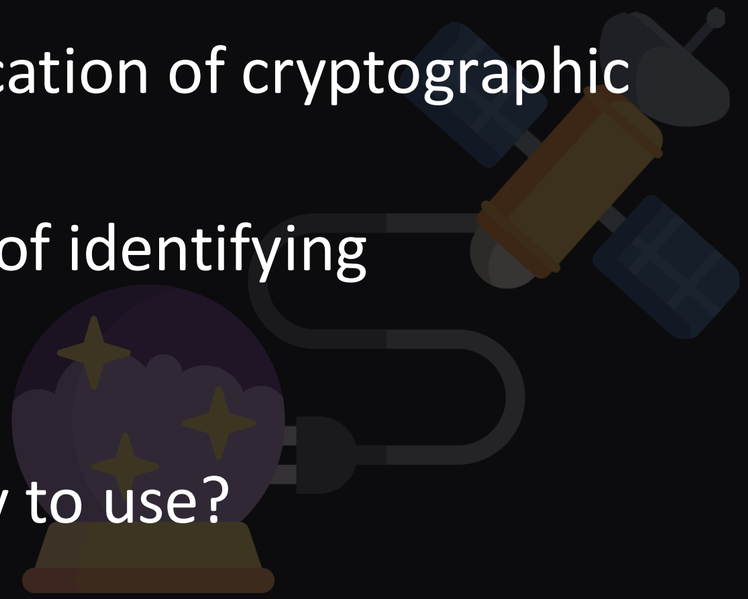
sanctuary

> Suggested Remedy

- Remedy 1:
  - Simply define key management services in **one** book and avoid redundancy
  - Let other books reference this and only state modifications
- Remedy 2:
  - Option 1: Keep *all* relevant books up-to-date, especially the rationale
  - Option 2: Overall rationale book covering all four books:
    Why & when does which rationale apply in practice?
- Result: Clear path for leveraging CCSDS standards for new approaches (and missions for that matter)

> *Practical* Interoperability Gap

- At this point, mostly IETF RFCs, yet CCSDS assumes them
- BPSec Default Contexts have *no* field to send identification of cryptographic material (i.e., key ID)
- BPSec COSE Context has (essentially) *unlimited* ways of identifying cryptographic material
- Two extremes, same problem:
  How do different parties properly signal on which key to use?
- Interoperability tests defined so far assume keys are already in-place and parties know which one to use



> Suggested Remedy

- Option 1 (ideal):
  - Define a practical overall multi-party approach with key management (at least keeping it in mind for the main standard)
  - Representative interoperability tests with more than one key (in the same context), for more than two parties
- Option 2 (minimum):
  - At least discuss practical interoperability concerns directly in the standards to outline these aspects and give implementers & planners an early notice to consider these aspects carefully

> Opaqueness to Outsiders

- Public version of BPSec Red Book is from 2023
  - We are sure there have been updates since
  - No way to request a recent version, aside “knowing someone”
- We found a severe security bug in Symmetric Key Management Magenta Book
  - No way to report this, aside “knowing someone”
- Many questions regarding current movement (e.g., Which algorithm will be *soon* allowed for Key Generation?!)
  - No way of asking for *important* clarifications, aside “knowing someone”
- Remedy 1: (Semi-)Public access to current drafts
- Remedy 2: Some form of direct contact / ticket system



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www.linkedin.com/company/sanctuary-dev/

Security Designs

Fuzzing

Attestation

IP Protection

Secure Boot

Public Key Infrastructures

SBOM

CVE Scanning

Real-time Hypervisor

OT Asset Management

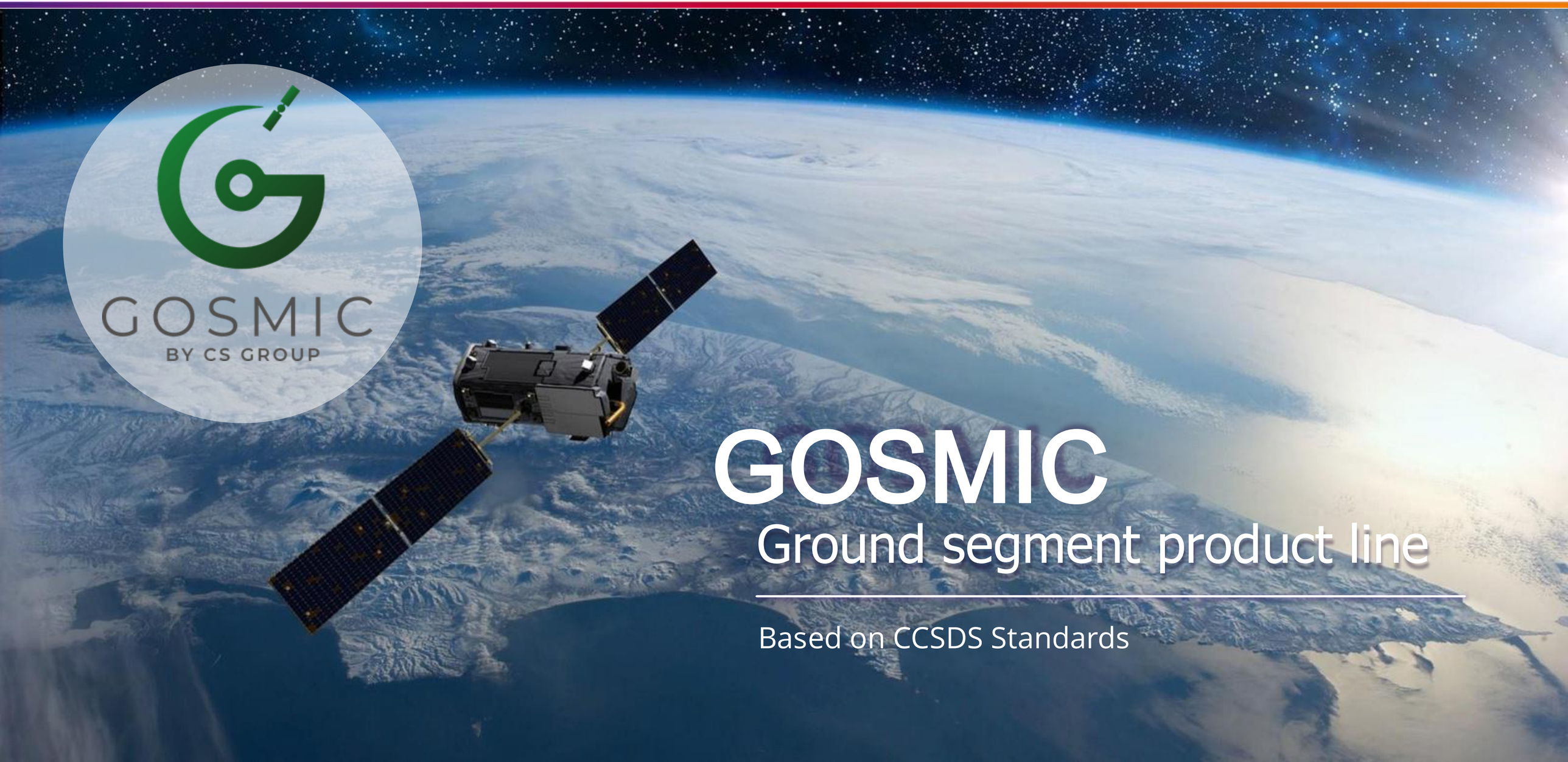
Arm TrustZone

TPM

Zero Trust Concepts

a Sopra Steria company

sopra steria



GOSMIC
BY CS GROUP

GOSMIC

Ground segment product line

Based on CCSDS Standards

GOSMIC
BY CS GROUP

Satellite operations platform & services developed by CS GROUP.

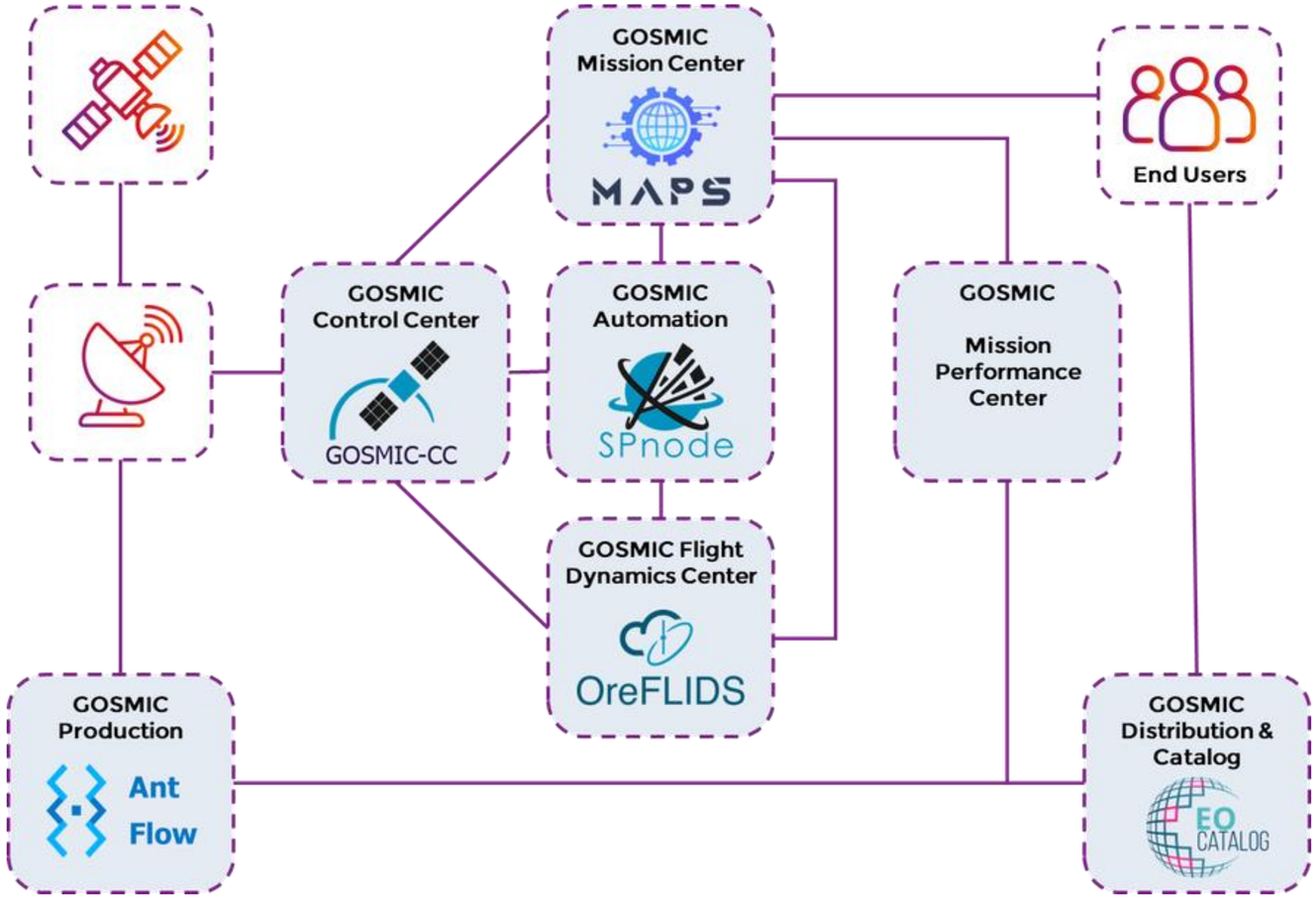
Cloud-nativesolution,scalable,securedandoptimized for autonomy.
Designed for constellations and new space missions.

Modular Components and Integration

GOSMIC is based on the integration of CS GROUP products for each ground segment functional block

Features and scope flexibility: GOSMIC can be deployed either as a **full end-to-end solution** or through **selected components** integrated into the client's ground segment.

Deployment flexibility and scalability: GOSMIC can be deployed from single laptop to very large cluster, either in the Cloud or on-premise.





Command & Control Center

Designed for wide constellations and new space missions

GOSMIC
BY CS GROUP

Specify behavior and interface

Standards are used as specification for all the TM/TC chain processing services and are also used to interface with external system or internally between GOSMIC product line components.

TM/TC Kernel (CCnode)

- **SDLP/SDLSP**: fully implemented for telemetry and telecommands. Default protocol used for interfacing with a satellite, highly configurable to adapt to specific mission tailoring.
- **COP-1**: Ful implementation of the FOP part of the protocol. Managed by operational procedures.
- **Space Packet**: implemented as baseline for other protocols (PUS for example).

Ground Station Management (GSnode)

- **SLE:**implementation based on the ESA Java library. Support RAF, RCF, ROCF and F-CLTU services.

Satellite Database Management (SDBnode)

- **XTCE**: implementation used to interface with external entities. Support only import behavior into internal Satellite Database model (SDB).

a Sopra Steria company



Flight Dynamics System

GOSMIC
BY CS GROUP

Expendable Flight Dynamics System

Interface definition

CCSDS standards are mainly used in ***OREFLIDS*** to define consumed and produced interfaces. Implementations provided by the ***Orekit*** library.

- **OPM**: Used as state vector for initial and final products (orbit propagation, orbit determination)
- **OEM/OMM**: Output from the Orbit Propagation module. Can also be ingested from external sources to compute orbital events and serve as basis for lots of other modules. Also used as a basic format for GNSS measurements(position and/or velocity)
- **AEM**: external interface provided as tabulated attitude model. Produced for computed attitude model from orbit propagation.
- **TDM:** Used to ingest station measurements and perform orbit determination. They can also be generated internally for mission analysis purpose
- **CDM**: Ingested from external SSA provider or as output of conjunction monitoring.Itcanalso beusedtocomputecollisionavoidance maneuvers

a Sopra Steria company



Mission Center

Dedicated to earth observation constellations

GOSMIC
BY CS GROUP

Interface definition

Standards are mainly used as Interface between the FDS and the Mission Center providing:

- **OEM**: Calculate acquisition opportunities based on the most recent orbital state information computed by the FDS.
- **OPM**: Compute satellite trajectories and identify future acquisition opportunities.
- **AEM**: Facilitating the computation of sequences that connect the mission plan to the maneuver plan.

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Benefits and Lessons learned

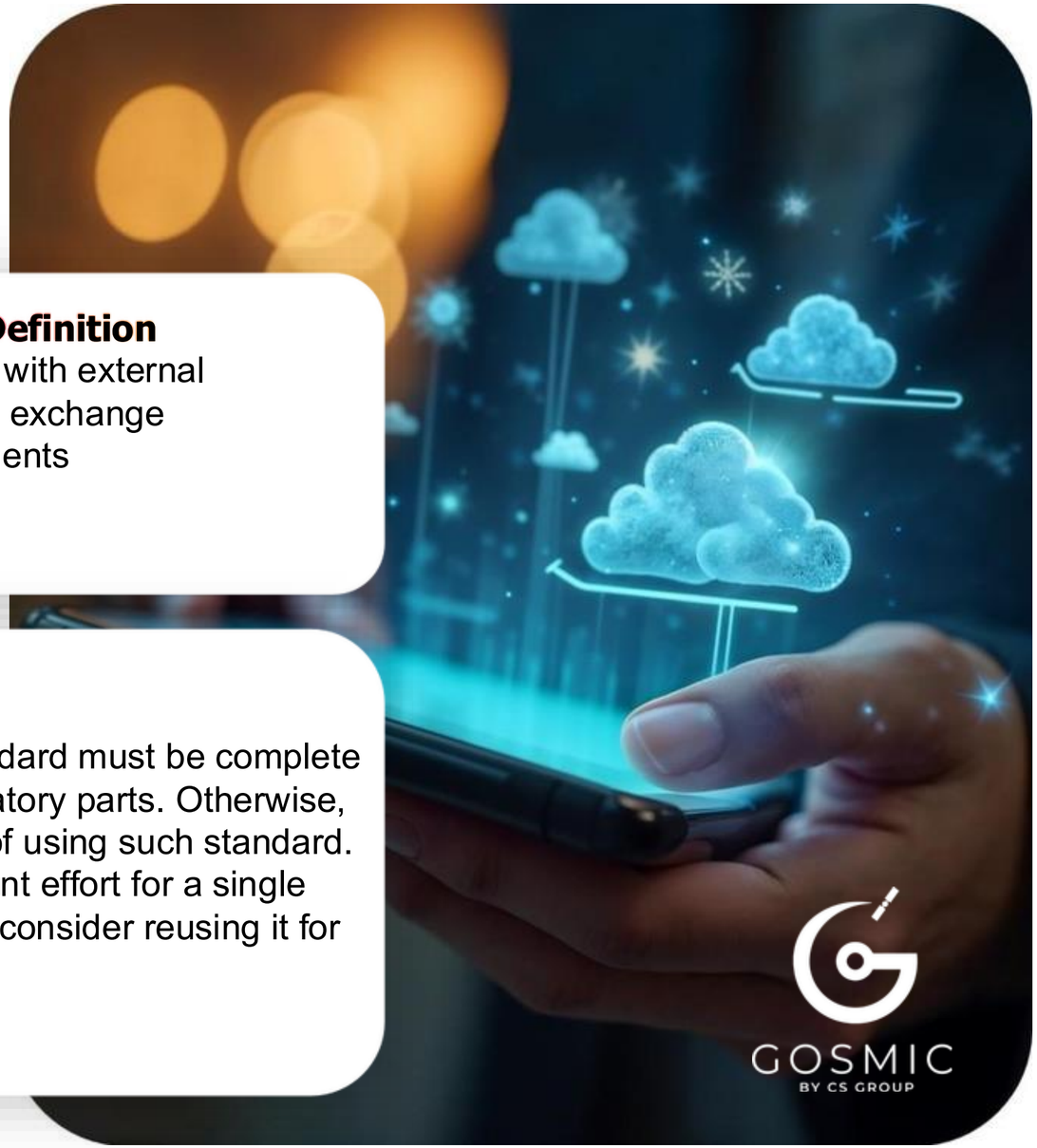
Clear definition of capabilities
Define what capabilities are supported
Define what kind of data can be processed and how.

Formal Interface Definition
Leverage integration with external systems Standardize exchange between our components

Provide interoperability.

Shared understanding
CCSDS standards are already widely adopted in the space industry.
Usually, it is enough to say that Spacecraft is compliant with SDLP/SDLSP for example to have a shared understanding of the integration and mission tailoring efforts.

But…
Implementing a standard must be complete at least for all mandatory parts. Otherwise, we lose the benefit of using such standard. It may be an important effort for a single mission if we do not consider reusing it for several customers.



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CCSDS inter-action

Relationship andimprovements

CCSDS notification

It could be great to have a way to be notified on a specific or all standards when new versions are released, or when a new emerging standards writing is decided,…

Having statistics on how much a standard is used could also be very valuable in order todecide if we jump in the implementation of it.

CCSDS Industry participation

Having a simplified way for industrial users to share their operational

feedback without necessarily to actively participate in working groups.

8 GOSMIC –Ground Segment Product Line

SpaceForce

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Building DTN Stacks for Space and What the Standards Still Need

FelixWalter|CTO, D3TN

CCSDS Fall Meeting | 19 Oct 2026 | Matera

D3TN in a Nutshell

COMMUNICATE BEYOND FRONTIERS

- Small enterprise founded in **2018**, headquartered in **Dresden**,
- Germany Team of **12 people** (as of October 2026), **all with a DTN background**
- **Core competences:**
  - Networking protocols for challenged environments and Post-TCP/IP networks
  - Delay-/Disruption-tolerant Networking: Space and underwater communication
    → own implementations of the Bundle Protocol v7 (RFC 9171): “µD3TN” and “picoD3TN” Simulation and development of network protocols and architectures, SDN
- **Business focus:**
  - **Integrating DTN capabilities** into different platforms and solutions
  - **Enterprise-grade support** for the integrated solutions

Image: NASA/JPL-Caltech

Selected Activities

COLDSUN
COMMUNICATE BEYOND ELEMENTS | esa

Test #1: buoy prototype connecting underwater sensors with the Internet

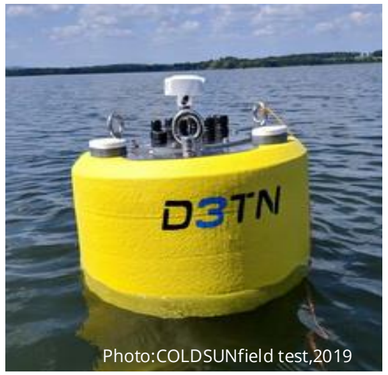


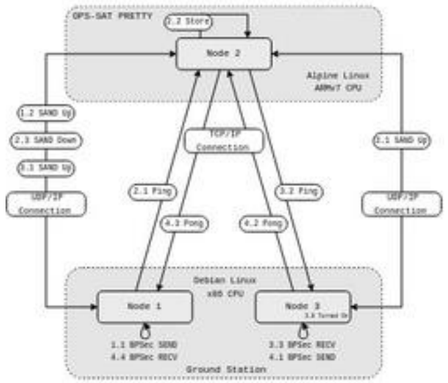
Photo:COLDSUNfield test,2019

REDMARS 2 | Bundesministerium für Bildung und Forschung

Test #4: emulation of a Mars-to-Earth network with ad-hoc connectivity on Mars via UAVs



Photo: REDMARS 2 field test, 2022



COLDSUN 2019 → OPS-SAT 2020/2 → REDMARS 2021-22 → Lunar IceCube 2023 → SSI PPA Study 2024 → OPS-SAT PRETTY 2026


Model of OPS-SAT

Tests #2 and #3: µD3TN on a LEO satellite + interoperability test in ground infrastructure



Test #5: Experiment to provide data from the satellite through a Web API (collaboration with NASA and ESA)

- **Test #6 - #8:** Different DTN communication tests including BPSec and SAND using picoD3TN

D3TN-ES and D3TN-EP

D3TN's Commercial Full-service DTN Product Offerings

D3TN Enterprise Stack (D3TN-ES)

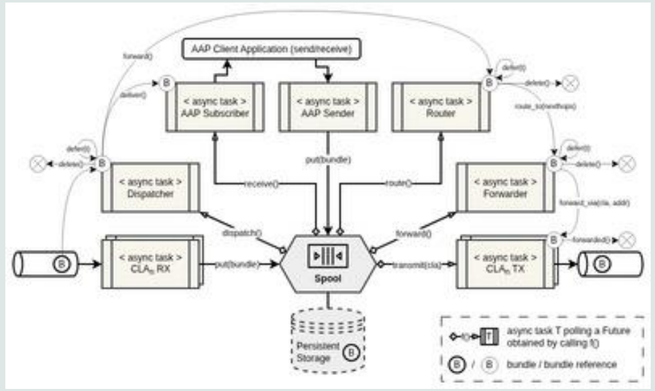
- Enterprise software repository providing ready-to-use binaries
- SLAs and email support with guaranteed response times
- Backward-compatibility guarantees with tested migration paths for new software releases

D3TN Enterprise Platform (D3TN-EP)

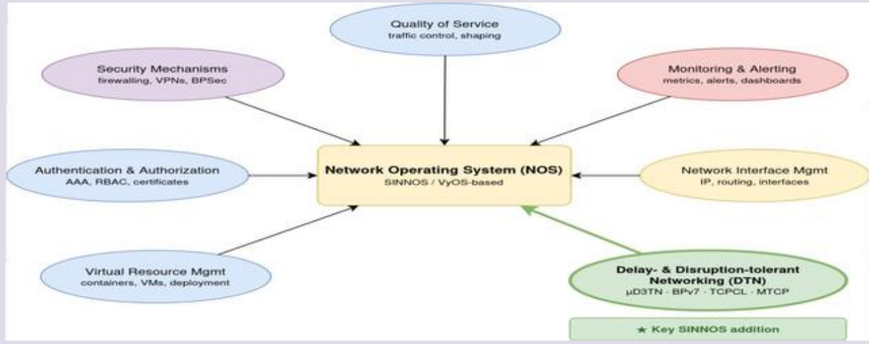
- *D3TN-ES+ customer-specific integration*
- Maintenance and SLAs for the *customers' integrated platform*
- Full individual support
- Integration of custom & defined solutions and stacks (incl. customer-BP)

One-time adjustments & integrations for the customer platform and infrastructure (e.g. CLAs, monitoring interfaces) as well as DTN trainings can be offered on an individual basis.

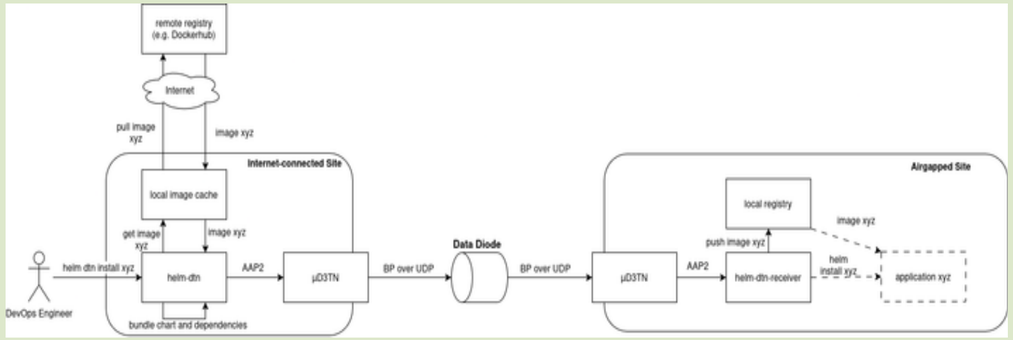
Current Development Activities



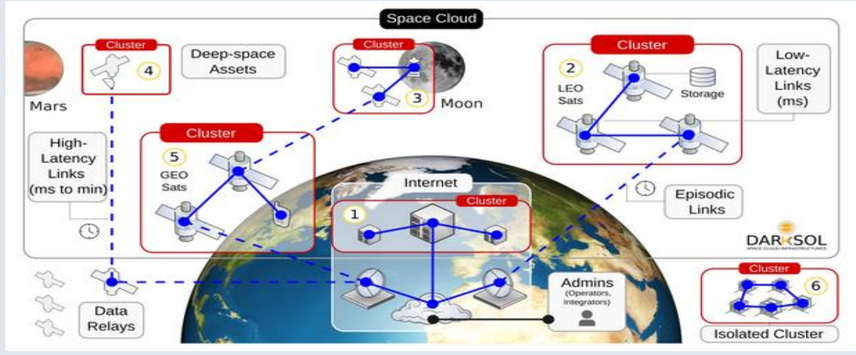
picoD3TN – a BP implementation for the Edge



D3TNOS – a Network Operating System simplifying DTN usage



DTcargo – secure software transfer approach using BP



kubeDTN – DTN capabilities for K8S clusters

Specifications Implemented in D3TN's Software

- **DTN Bundle Protocol** (RFC 9171 / CCSDS 734.20-O-1)
- **BPSec** (RFC 9172) + Default Security Contexts (RFC 9173)
- **ipn EID scheme** (RFC 9758)
- **Space Packet Protocol** (CCSDS 133.0-B-2) + Time Code Formats (CCSDS
- 301.0-B-4) **TCPCLv3** (RFC 7242)
- **Schedule-Aware Bundle Routing** (CCSDS 734.3-B-1)
- **Several drafts:**
  - draft-ietf-dtn-mtcpcl draft-
  - ietf-dtn-bibect draft-ietf-
  - dtn-udpcl draft-ietf-dtn-
  - bp-sand (WIP) HPRP
  - draft (WIP)

Industry Perspective: General Feedback on the Implementation of Standards

- **Final specifications**, both IETF and CCSDS ones, are **clear and well-written**
- If (minor) gaps or misunderstandings are identified, the **community helps out**
  - We cannot always wait for a standard to be final
  - Implementation experience also provides valuable **feedback for standardization**
  - This is also true **with IETF drafts**, which are publicly available
- We consider it important to **integrate and test extensively, as early as possible**
  - Sometimes, only decoupled implementations are built and tested (against each other) during standards development
  - Field tests / experimental deployments point out gaps that lie often outside of the happy path (in code *and* spec.)

    → **We should focus on integrated setups early on**

- For several use cases, drafts need to be implemented ...
  - an important

Industry Perspective: Issues with DTN Standards

The **DTN standards landscape** currently has **two essential drawbacks** from an industry perspective:

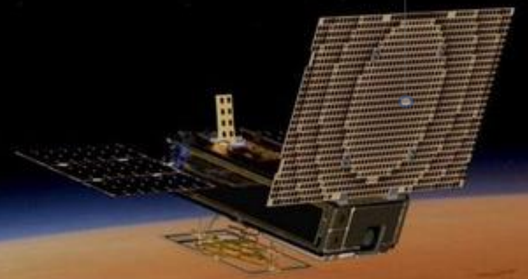
1) **No de-facto standards for deploying and operating DTN solutions are available**
   - Various DTN protocol implementations with different standardized features are available from which a selection has to be made
   - Several tools for configuration management, monitoring, or deployment have to be designed and implemented from scratch for each mission
   - Industry is lacking “DTN boxes” implementing de-facto standards / best practices that can be easily configured, deployed, and used in the field

2) **Consumption of DTN capabilities is not standardized (northbound API towards application)**
   - Implementations expose different APIs to applications
   - Each application requires custom bindings to the specific DTN stack
   - In the case the DTN protocol implementation is exchanged, significant migration effort is generated

STINT Association

- **Plan**: Kick-starting a ***Space-terrestrial Internetworking Association***
- **Motivation**: Foster the product and service provider ecosystem of an emerging market for STINT technologies
- **Planned activities**:
  - Work jointly on standards which are outside the scope of existing
  - bodies
  - Organize community events (STINT Workshop)
  - Intensify information exchange among product/service providers
- **Governance**: Create a lean e. V. (registered association under German law) plus set up internationally operating governance structure within it
- **Timeline**: Preparation/consolidation phase until end of Q1 2027 → founding of association

D3TN is a company with operations in **Dresden** and **Miami**, from where we develop the **key technologies** for the **Solar System Internet.**



D3TN

COMMUNICATE BEYOND FRONTIERS

Want to know more? Reach out!

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