CCSDS contribution to the long-term sustainability of Outer Space Activities: DLR View

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Background

- **Request from COPUOS to CCSDS on the 6th of September 2011 by Niklas Hedman**
- **Answer from CCSDS to COPUOS on the 4th of November by CCSDS Secretary**

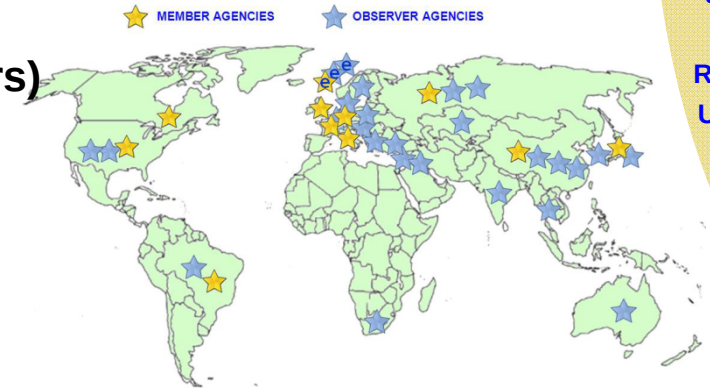
to provide information on their experience and practices that might relate to the long-term sustainability of outer space activities, and on their experiences and practices in the conduct of sustainable space activities

Consultative Committee for Space Data Systems (CCSDS) – why and what

- **The goal: For Space Data Systems, enhance *interoperability* and cross-support, whilst also reducing risk, development time and project costs, for government, industry, agencies, vendors and programs.**
- ***Interoperability* between agencies & teams translates to *operational* flexibility, capability and access to additional resources**
- **CCSDS Started in 1982 developing at the lower layers of protocol stack (Layers 1 to 3)**
- **Scope has grown to cover standards throughout the ISO communications stack layers, plus other Data Systems areas (architecture, archive, security, XML exchange formats, etc.)**

CCSDS – who

- **Produces International Voluntary Consensus Standards**
- **Agency-led international committee**
  - **11 Member agencies**
  - **28 Observer Agencies**
  - **145 Commercial Associates**
  - **~180 workers at the autumn 2011 technical meeting**
- **Also functions as an ISO Committee**
  - **TC20/SC13 - Space Data & Info Transfer Systems**
  - **Represents 18 nations (13 members, 5 observers)**



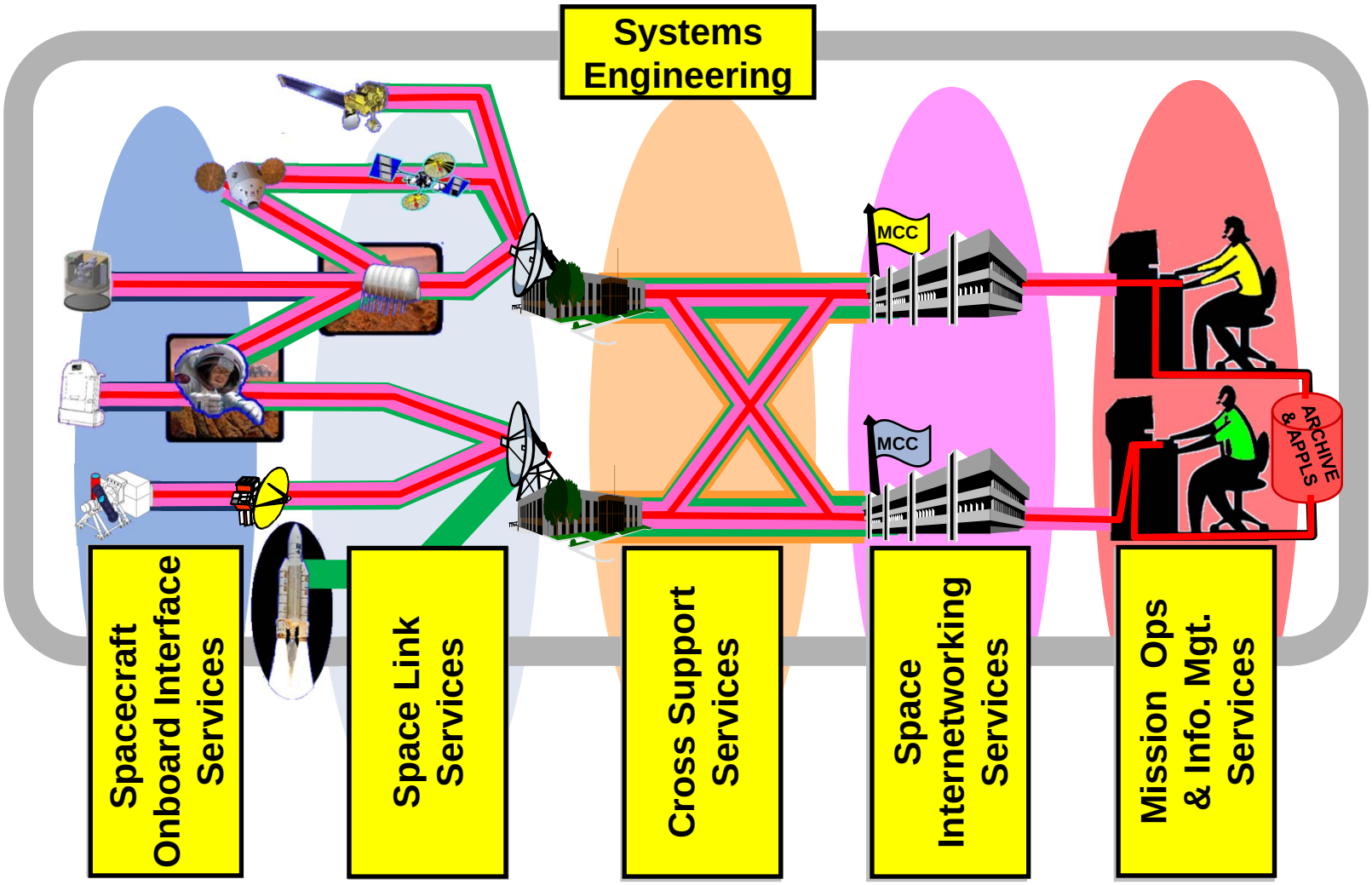
MEMBER AGENCIES

ASI/Italy
CNES/France
CNSA/China
CSA/Canada
DLR/Germany
ESA/Europe
INPE/Brazil
JAXA/Japan
NASA/USA
RFSA/Russia
UKSpace/UK

OBSERVER AGENCIES

ASA/Austria
BFSPO/Belgium
CAST/China
CLTC/BITTT/China
CSIR/South Africa
CSIRO/Australia
DCTA/Brazil
DNSC/Denmark
EUMETSAT/Europe
EUTELSAT/Europe
GISTDA/Thailand
HNSC/Greece
IKI/Russia
ISTRAC/India
KARI/Korea
KFKI/Hungary
MOC/Israel
NCST/USA
NICT/Japan
NOAA/USA
NSARK/Kazakhstan
NSPO/Taipei
NSSC/China
SSC/Sweden
SUPARCO/Pakistan
TsNIIMash/Russia
TUBITAK/Turkey
USGS/USA

CCSDS – Architecture



29 Working Groups (some in formative stages)

CCSDS – ISO

ISO International Organization for Standardization

Technical Committee 20 (ISO/TC20): Aircraft and Space Vehicles

Other TCs

Other SCs

Subcommittee 14 (ISO/TC20/SC14): Space Systems and Operations

(Secretariat: AIAA)

- Space Debris
- Interfaces, Integration & Test
- Operations & Ground Support
- Design Engineering & Production
- Environment (natural & induced)
- Program Management
- Materials and Processes

Subcommittee 13 (ISO/TC20/SC13): Space Data and Information Transfer Systems

TC20/SC13 Heads of Delegation (CCSDS CMC)

(Secretariat: NASA)

- Spacecraft Onboard Interface Services
- Systems Engineering
- Space Internetworking Services
- Space Link Services
- Cross Support Services
- Mission Ops & Info. Mgt. Services

WG's WG's WG's WG's WG's WG's

CCSDS – Relationships

FLOW OF GUIDANCE / REQUIREMENTS
(Note: Agency makeup varies between these groups)

IOP: Interoperability Plenary – highest space agency agreements on interoperability

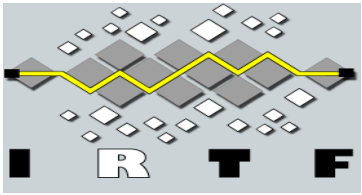
IOAG: Interagency Ops Advisory Group interoperable mission support infrastructure

CCSDS: open international standards for space mission interoperability

SFCG: space agency frequency management forum

PEER ORGANIZATIONAL RELATIONSHIPS

OMG: Object Management Group: industry standards for exchange of application information among vendor products



IETF/IRTF: open international standards for IP suite and Disruption Tolerant Networking (DTN)

ECSS: European Consortium for Space Standards - European regional standards for space mission support

AIAA: North American regional standards for space mission support

CCSDS – Standards Review

CCSDS – Products

Normative:

- **Blue Books – Recommended Standard (55)**
- **Magenta Books – Recommended Practice (19)**

Non Normative:

- **Green Books – International report (44)**
- **Orange Books – Experimental specification (3)**
- **Silver Books – Historical document (111)**

Administrative:

- **Yellow Books – Administrative document (12)**

Changes are done via Pink Sheets.

Review of Normative Books is done in a 3/5 year cycle

ISO TC20/SC13 published 44 Standards, 9 are currently under development

Major points of the Scope of ToR of the WG on the Sustainability of Outer Space Activities

- **Sustainable space utilization supporting sustainable development on Earth**
- **Space Debris**
- **Space Weather**
- **Space Operations**
- **Tools to support collaborative space situational awareness**
- **Regulatory regimes**
- **Guidance for actors in the space arena**

Sustainable space utilization supporting sustainable development on Earth

Compliance with CCSDS standards gives

- **developed countries**
  - **Lower costs by joint collaboration and cost sharing**
- **developing countries**
  - **Entering into exploitation of space**
    - **compatible systems to those of developed countries**
    - **access to the same communications infrastructure as developed countries**

Non DLR owned ground stations are used (especially during the launch and early operation phase (LEOP).
-> Frequency-, coding- and so called space-link-extension (SLE) - standards used for integration

Space Debris

- **CCSDS Navigation WG:**
  - **discipline-oriented forum for detailed discussions**
  - **development of technical flight dynamics standards**
- **CCSDS Conjunction Data Messages (CDM):**
  promote long-term sustainability of the space environment by contributing to efforts to prevent collisions before they happen.

- Available Navigation Standards implemented by DLR.
- For CDM DLR will provide prototyping.

- Collision avoidance: DLR supports own and missions from other agencies.
- Radar measurements provided today via the GRAVES and TIRA systems as stated by the French/German Warsaw (autumn 2011) initiative on SSA

Space Weather

- **Traditional CCSDS protocols provide capabilities and benefits to solar research spaceflight missions that improve space weather prediction capabilities**

- **New advanced space internetworking protocols have the potential of providing “sensorweb” capabilities to automate the reaction of multiple orbital research spacecraft for faster responses to space weather events.**

  - Space Weather Application Center Ionosphere (SWACI) delivers data from CCSDS compliant Grace and Champ mission.
  - Data routinely provided via the Space Weather European Network (SWENET/ESA)

Space Operations

- **Compliance with CCSDS standards can enable short–notice contingency support (e.g. UK's STRV, ESA's XMM-Newton).**

- **Operational efficiencies are achieved when standards are used**
  - **operations and maintenance teams become familiar with the characteristics of the protocols,**
  - **protocols and the associated experience carries over to new missions.**

Tools to support collaborative space situational awareness

- **existing standardized navigation message formats**
- **new message formats as conjunction data message**
- **enhanced communication between Mission Control teams using other ground-to-ground standards**

All this increases situational awareness by spacecraft flight control teams, onboard crews and collaborating control centers

- Support of all develped NAV standards
- other ground-to-ground standards (e.g. voice and video standards) used to enhance ground communiation.

Regulatory regimes

- **CCSDS teams perform technology development and standardization. Everyone can benefit from the technical developments, which are part of the process**

- **For the upcoming age of the Solar System Internet (SSI) coordination functions will be needed (address assignments, etc.)**

  - CCSDS standards undergo a prototyping by at least two independent agencies Prototyping implies technical developments, which are available for the space community.
  - All DLR spacecraft have a registered Spacecraft ID given by the CCSDS SANA.

Guidance for actors in the space arena

- **Technical standards development and compliance is an asset that all agencies need. This includes not only CCSDS!**
- **Interoperability in the area of communications and data exchange provides the greatest benefit to collaborating entities of all the potential technology areas employed for spaceflight.**

COPUOS should actively promote standards for specific technology touch-points where they most enable cooperative missions.
COPUOS should promote that guidance to actors in the space arena, as mankind begins in earnest to explore the Solar System.

Conclusion

Use of standards are one issue in strengthing sustainability of outer space activities

Others could include:

- Development of additional SSA capacities, especially in Europe
- Use of a bond system to enforce compliance in debris mitigation practices as proposed by R.A. Opperman, during IAC 2010 Prague