INPE/BRAZIL INPUT TO PANEL IN THE PROCEEDINGS OF THE WORLD SPACE CONGRESS

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- PANEL -

ENABLING SPACE-FARING NATIONS TO WORK TOGETHER AS A TEAM. THE CONSULTATIVE COMMITTEE FOR SPACE DATA SYSTEMS (CCSDS)

- CONTRIBUTION BY -
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PANEL

- TITLE -

Enabling Space-Faring Nations to Work Together as a Team. The Consultative Committee for Space Data Systems (CCSDS)

(Global Space Congress 11:10 – Wednesday, 1 February 2017)

- DESCRIPTOR -

The future of space exploration fundamentally depends on how well the space-faring nations can work together as a team. The Consultative Committee for Space Data Systems (CCSDS), whose membership includes all major space agencies, provide critical coordination, integration and development of internationally-agreed and interoperable space communication standards. These standards enable space agencies to reduce life cycle costs and risks to both science and exploration missions. All space missions in operations or in the planning stages are dependent on interoperable communication and navigation standards produced by CCSDS. For new space agencies this is an opportunity to learn and explore current space communication infrastructure available to them.

Speakers:

Naser Al Rashedi, Director of Space Policy and Regulations, UAE Space Agency

James Afarin, Chair of the CCSDS Management Council), National Aeronautics and Space Administration (NASA)

Eduardo Bergamini, Instituto Nacional de Pesquisas Espaciais (INPE)

Moderator:

Dr. Michael Simpson, Executive Director, Secure World Foundation

PRELIMINARY CONSIDERATIONS

Before considering details that may lead to a response to the main topic "Enabling Space-Faring Nations to Work Together as a Team. The Consultative Committee for Space Data Systems (CCSDS)" that motivated the publication of this content, some very basic, important considerations must be made:

CONSIDERATION 1. **Due to the complexity of space faring systems now days, it is unconceivable that nations may work together in space missions as a team in the planning, build-up, operation and maintenance of the space related systems without the use of a common agreement among them;**

CONSIDERATION 2. **A most reasonable compromise solution in a scenario of space faring nations decided to work together in space missions is to consider, to a best possible extent, the use of standards in order to guarantee interoperability and cross-support among the stakeholders of the space faring can, to say the least, be hardly ignored. To the extent standards are ignored, custom made solutions will have to be in consideration. Depending on the extension and complexity of the space mission in question, in terms of cost x benefit compromise, it may be reasonable that custom made solutions may be, partially or not, justifiable. However, this becomes strongly true for major systems, especially, when legacy of the systems or of part of them have to be in consideration, especially if new missions which may need to rely on them are under consideration or, if a significant segment of the space faring nations already rely their related resources, on standards;**

CONSIDERATION 3. **The initial implementation of standards in a space system may commit an investment that may be considered too high. In counterpart, it has to be taken into consideration not only the potential legacy of the system for use in future missions but also, the possibility that such an investment may open the possibility to offer services to external users who may not be initially predictable.**

THREE *KEY ENABLING FACTORS FOR* THE GATHERING OF STAKEHOLDERS IN SPACE DATA AND INFORMATION TRANSFER SYSTEMS

1. STANDARDS

2. INTEROPERABILITY

3. CROSS - SUPPORTABILITY

IMPORTANT NOTE: **STANDARDS, INTEROPERABILITY and CROSS-SUPPORTABILITY, as *KEY ENABLING FACTORS*, are NOT necessarily restricted for use in the EXTERNAL sense, that is, AMONG Space Agencies. They can ALSO benefit INTERNALLY a SINGLE Space Agency, therefore, for practical use WITHIN its own facilities! Both cases can be advantageous for adoption by a Space Agency.**

A SOLUTION FOR THE THREE KEY ENABLING FACTORS

Adoption of CCSDS RECOMMENDED STANDARDS and BEST PRACTICES or of ISO TC20/SC13 STANDARDS

Permit the achievement of INTEROPERABILITY and CROSS – SUPPORTABILITY The main objectives of the STANDARDS

DISABLING MYTHS AND ENABLING FACTS IN THE USE OF STANDARDS

MYTH 1

Standards "STIFLE" Innovation

FACT 1

CCSDS stimulates advanced technology by adopting, adapting, developing and solidifying innovations with exposure to a wider community.

MYTH 2

Standards "DELAY" Implementation

FACT 2

Innovation is brought into the Standards processes early. Delay results from reluctance to standardize not from standardization itself.

- JUDICIOUS USE OF STANDARDS LEAD TO -

LOWER COST <--> LOWER RISK <--> INCREASED CAPABILITY

SOURCE: CCSDS, WITH ADAPTIONS

ESSENTIAL MESSAGE FOR ENABLING COOPERATION AMONG MULTIPLE NATIONS

CCSDS - Advancing Technology through the international standardization process

- *What could be more important? –*

- For international collaboration in spaceflight the most critical enabling technology is communications and data systems.
- The domain of CCSDS is INTEROPERABILITY and CROSS SUPPORT for COMMUNICATIONS and DATA SYSTEMS
- INTEROPERABILITY translates to:
  - OPERATIONS – With: Flexibility, Capability and Access to additional resources
  - DEVELOPMENT – Reduces: Risk, Development time and Project costs
  - BENEFITS – For: Government, Industry, Agencies, Vendors, Programs and Projects
- CCSDS focus is MULTI-AGENCY MISSIONS ➔ Enabling CROSS SUPPORT among Space-Faring Nations in work as a Team
- CCSDS scope has grown to cover standards throughout the ISO communications layers, moreover, also including other areas of Data Systems (Architecture, Archiving, Security, XML exchange formats, etc.)
- CCSDS Started in 1982 developing Recommended Standards, mostly focused in the lower layers of ISO protocol stack.

SOURCE: CCSDS, WITH ADAPTIONS

BENEFITS FROM THE USE OF CCSDS AND ISO STANDARDS

BENEFITS FROM STANDARDS

- **Cross-support & Interoperability**
  - Multi-agency support agreements
  - Multi-mission support arrangements
- **Reduction of Costs**
  - Shared (expensive, scarce) resources
  - S/W and H/W reuse (legacy)
  - Commercial implementations
- **Increased Reliability and Reduction of Risks**
  - Systems developed in the Standards Bodies have broader review and external input, hence, are more capable and reliable

EXAMPLE OF USE OF STANDARDS (ESA-2016)

- **Space to Ground and Space to Space Standards**
  - Physical (RF), Modulation & Coding, Link, File delivery
  - Network (in development)
  - Spacecraft On-Board I/F Services
- **Ground to Ground Standards**
  - Service Management
  - Space Link Extension (SLE) and Cross Support Transfer Services (CSTS) interfaces
  - Mission Operations Services
- **End to End Configurations**
  - Standard “ABA” configurations
  - Advanced Solar System Internetworking (SSI)
  - Secure communications approaches

SOURCE: Adapted from ESA (SO 2016-Daejeon)

CCSDS AND THE ENABLING OF SPACE-FARING NATIONS TO WORK TOGETHER AS A TEAM – AN INTRODUCTION

CCSDS (www.ccsds.org) contribution for enabling space faring nations to work together as a team is directly related to the following aspects:

1) The offering of active (currently ~ 92) DOCUMENTS of public domain, named RECOMMENDED STANDARDS and of BEST PRACTICES for use in SPACE DATA AND INFORMATION TRANSFER SYSTEMS, besides other related ones, are publicly available at https://public.ccsds.org/Publications/AllPubs.aspx;

2) Many of the CCSDS RECOMMENDED STANDARDS and BEST PRACTICES are also INTERNATIONAL STANDARDS offered by ISO and are produced by ISO TC20/SC13 Subcommittee in SPACE DATA AND INFORMATION TRANSFER SYSTEMS;

3) CCSDS Secretariat may provide SPACE-FARING nations with direct and or indirect information and or of contacts that may enable them to get acquainted on: a) The status of Recommended Standards, Best Practices and, if any, of related documents (Green Books, Prototypes, etc.); b) Existing Implementations; c) Products offered in the market; d) Space Agencies providing cross-support; e) Eventually, other possible information and or contact;

4) CCSDS RECOMMENDED STANDARDS and BEST PRACTICES have already been adopted in 825 space missions.

5) VERY IMPORTANT !!! – The final approval of a CCSDS RECOMMENDED STANDARD also requires that a corresponding PROTOTYPE may have been implemented and approved by its corresponding CCSDS technical Working Group.

CCSDS RECOMMENDED STANDARDS & BEST PRACTICES AND ISO STANDARDS

PRIMARY SOURCE OF RECOMMENDED STANDARDS AND BEST PRACTICES: CCSDS

- RECOMMENDED STANDARDS (BLUE Books) are considered to be STANDARDS in the domain o CCSDS MEMBERS; Inspired on CCSDS ARCHITECTURE, they may involve at least one of the two following entities: 1) PROTOCOLS, and; 2) SERVICES;
- RECOMMENDED BEST PRACTICES (MAGENTA Books) In the CCSDS sense they are considered to be NORMATIVE practices that can be but are not directly intended to be interoperable. However, they augment systems potential for interoperability in terms of: standard architectures, management procedures and API interfaces; IMPORTANT NOTE: Under ISO TC20/SC13 they are issued as an ISO STANDARD;
- CCSDS MEMBERS are expected to adopt CCSDS RECOMMENDED STANDARDS and they are also encouraged to use CCSDS RECOMMENDED BEST PRACTICES;
- CCSDS OBSERVERS have a status of being permanently invited to adopt CCSDS RECOMMENDATIONS and encouraged to use CCSDS BEST PRACTICES.

SOURCE OF WORLDWIDE STANDARDS: ISO TC20/SC13 Subcommittee

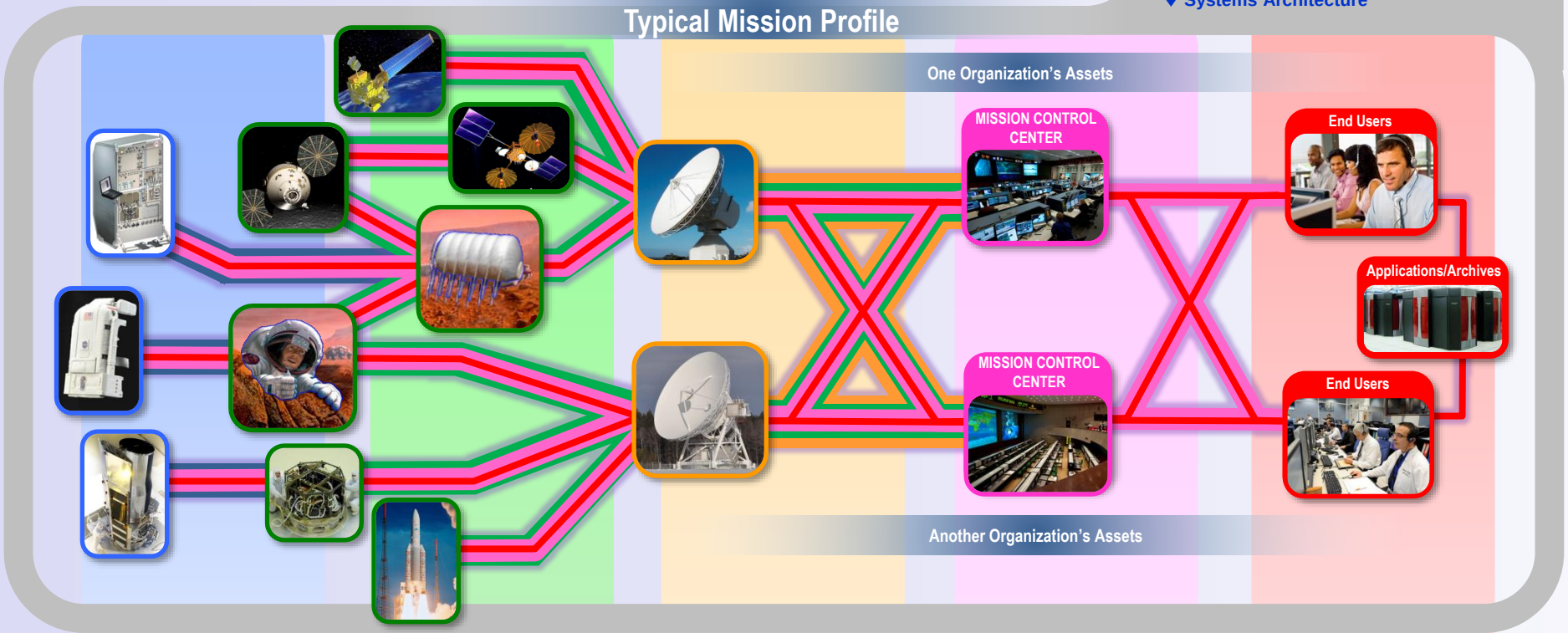
- CCSDS RECOMMENDATIONS and BEST PRACTICES are methodically submitted under a cover sheet process to ISO TC20/SC13 Subcommittee, to be transformed in ISO STANDARDS.

CCSDS ARCHITECTURE AND TECHNICAL ORGANIZATION

(www.ccsds.org)

1. CCSDS ARCHITECTURE is one of END-TO-END nature;
2. The space data and information transfer system of CCSDS END-TO-END ARCHITECTURE is BASED ON SIX MAIN TOPICS and is SUPPORTED BY RECOMMENDED STANDARDS and BEST PRACTICES;
3. The six main topics covered by CCSDS are associated to, each of them, CCSDS SIX TECHNICAL AREAS each of them, in turn, supervised by their respective SIX AREA DIRECTORS who and, in turn, each of them, are STRUCTURED AND ORGANIZED by CCSDS ENGINEERING STEERING GROUP (CESG) Directorship.

CCSDS END–TO–END ARCHITECTURE OVERVIEW



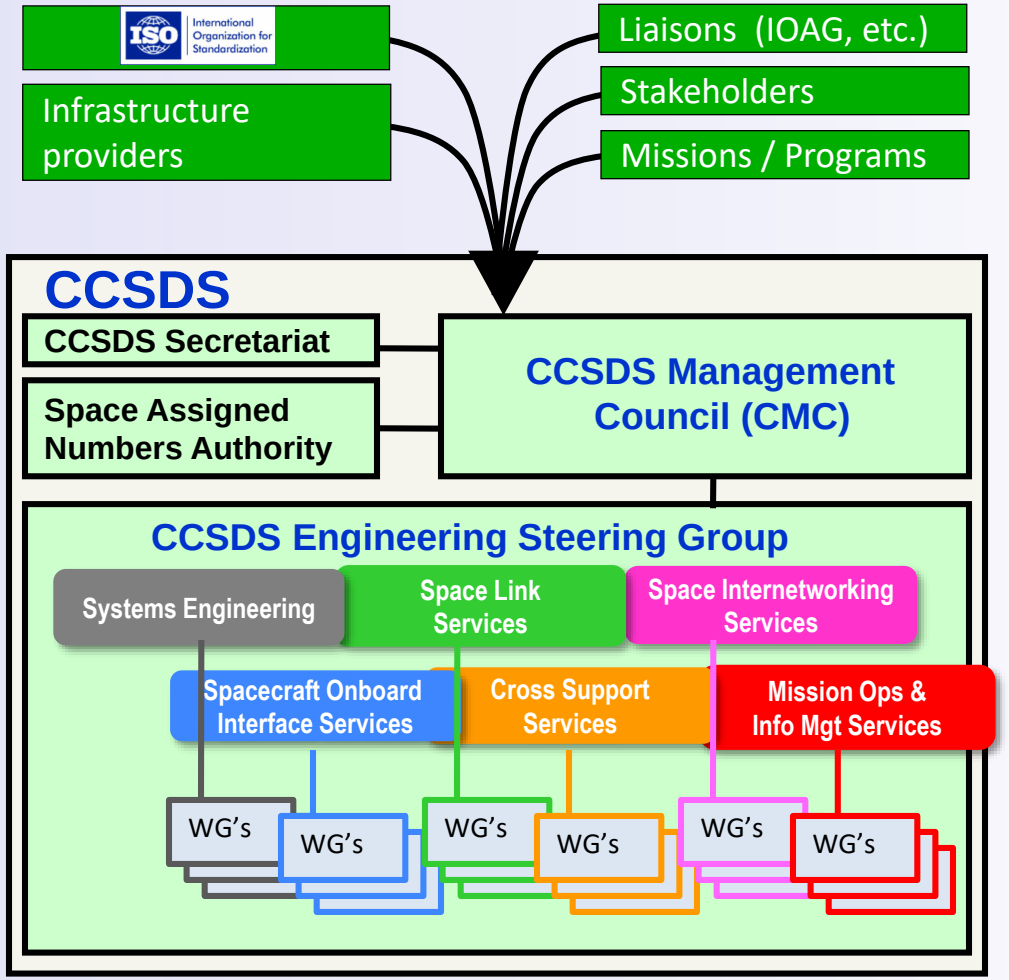
SOURCE: CCSDS

STRATEGICAL ESSENCE OF THE SIX TECHNICAL AREAS OF CCSDS

1. SYSTEMS ENGINEERING: **Cross-cutting of standard functions with coherent architecture-wide integration**
2. SPACECRAFT ONBOARD INTERFACE SERVICES: **Standardized Onboard Interfaces and Services**
3. MISSION OPS & INFO MGT SERVICES: **Standardized Mission Operations Services and complete Navigation Message Standardization**
4. CROSS-SUPPORT SERVICES: **Standardized Extensible Space Communications for Cross Support Service Management and for Transfer Services in association to Cross Support of Communications Assets**
5. SPACE LINK SERVICES: **Unified Space Data Link Protocol Standard for Optical links, Synchronization, Channel Coding and Data Compression schemes and algorithms**
6. SPACE INTERNETWORKING SERVICES: **Standardized Space System Internetworking Services and the Solar System Internet (SSI)**

SOURCE: CCSDS, WITH ADAPTIONS

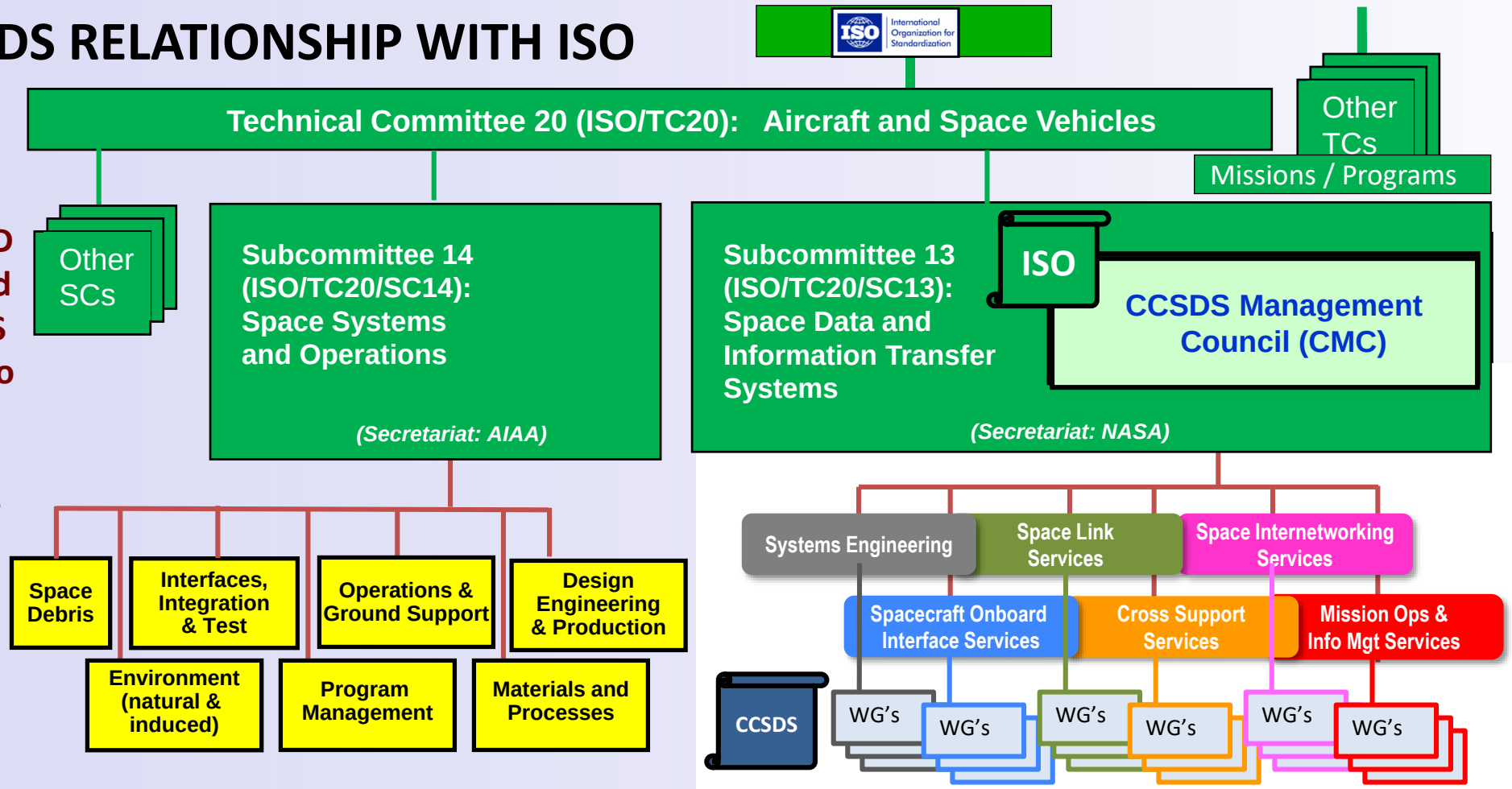
CCSDS RELATIONSHIP WITH EXTERNAL ORGANIZATIONS



SOURCE: CCSDS, WITH ADAPTIONS

CCSDS RELATIONSHIP WITH ISO

NOTE: CCSDS RECOMMENDED STANDARDS and BEST PRACTICES are submitted to ISO TC20/SC13 Subcommittee under a COVER-SHEET PROCESS to generate ISO STANDARDS.

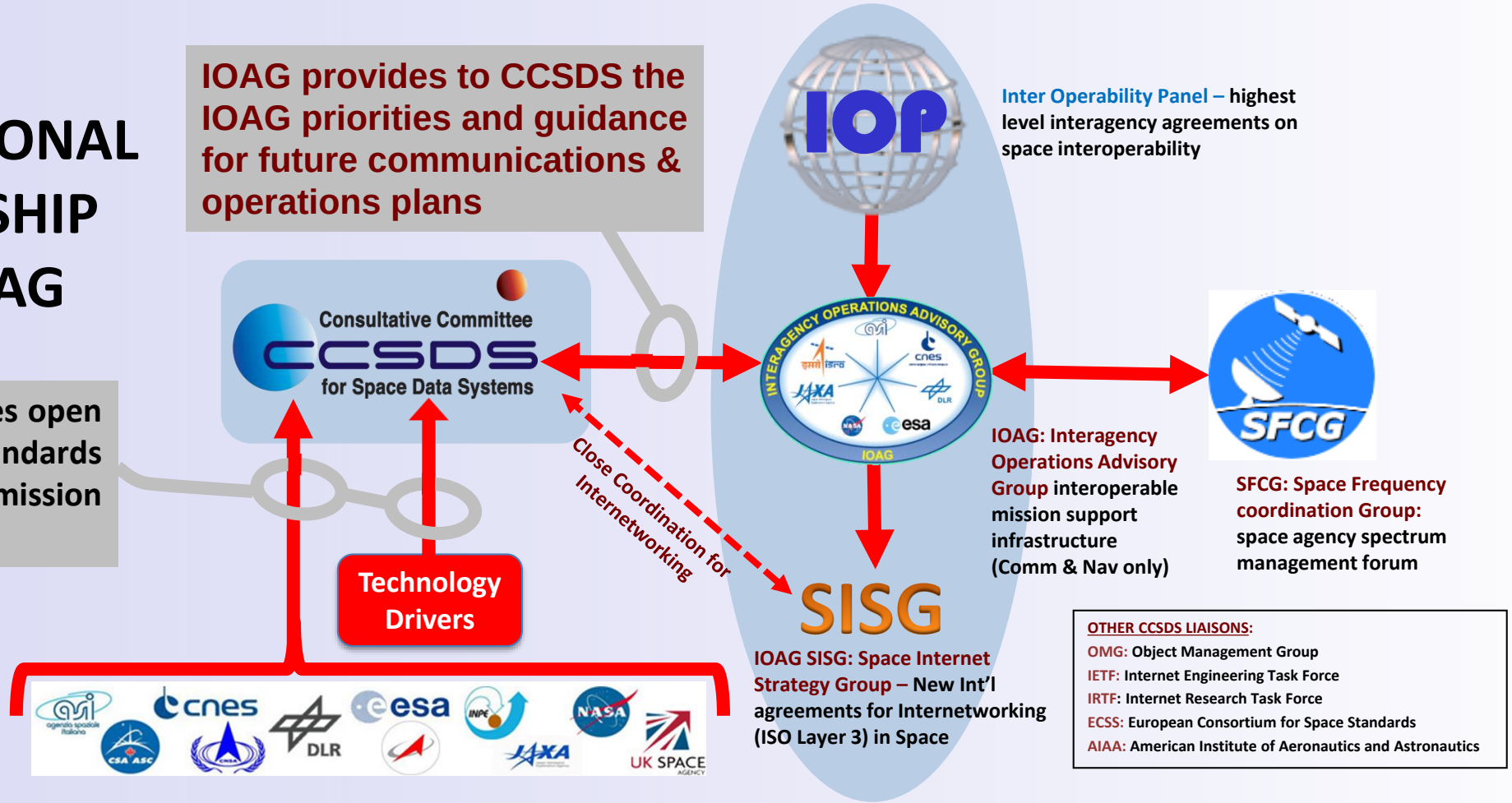


SOURCE: CCSDS, WITH ADAPTIONS

CCSDS ORGANIZATIONAL RELATIONSHIP WITH IOAG

IOAG provides to CCSDS the IOAG priorities and guidance for future communications & operations plans

CCSDS provides open international standards for space mission interoperability



OTHER CCSDS LIAISONS:
- OMG: Object Management Group
- IETF: Internet Engineering Task Force
- IRTF: Internet Research Task Force
- ECSS: European Consortium for Space Standards
- AIAA: American Institute of Aeronautics and Astronautics

SOURCE: CCSDS, WITH ADAPTIONS

CCSDS RELATIONSHIP WITH SOME OF OTHER ORGANIZATIONS

1. **OMG: Object Management Group (Liaison)**

   NOTE 1: OMG industry standards rely on exchange of application information among vendor products

   NOTE 2: CCSDS and OMG have some common standards

2. **IETF: Internet Engineering Task Force & IRTF: Internet Research Task Force (Li.)**

   NOTE 1: Source of open international standards for IP suite and DTN (Delay Tolerant Networks)

   NOTE 2: CCSDS, whenever possible or applicable, uses these industry standards as a basis

3. **ECSS: European Consortium for Space Standards (Liaison)**

   NOTE 1: European regional standards for space mission support

   NOTE 2: CCSDS and ECSS cooperate between them in coordination for compatible standards

SOURCE: CCSDS, WITH ADAPTIONS

CCSDS RELATIONSHIP TO ASSOCIATES AND LIAISONS

CCSDS ASSOCIATES

CCSDS Associates are scientific and industrial entities desiring a formal tie with the CCSDS, which allows them to more closely monitor and possibly influence the technical document development process. Associates may participate in the working groups and in the document development process with the explicit approval of a sponsoring CCSDS Member or Observer Agency. Associates may also submit concept or position papers through their sponsoring Member or Observer Agency. Generally, the sponsor agency and CCSDS Commercial Associate shall be from the same country; however, multinational organizations (e.g., ESA) can sponsor an Associate provided that the Associate candidate is from a country affiliated with the sponsor agency.

CCSDS LIAISONS

Liaison organizations are governmental or private activities with developmental programs in the areas of space-related data and information systems. Liaison participation in the working groups is encouraged but not required. When Liaison participation occurs, it usually will be focused on a particular subject of interest to the Liaison organization as opposed to standing involvement, which is not precluded.

SOURCE: CCSDS, WITH ADAPTIONS

CONCLUSIVE SUGGESTIONS FOR A NATION

The following five, brief SUGGESTIONS are proposed for consideration by any nation that may be interested in the exploration of enabling factors in space-faring initiatives with the use of STANDARDS in SPACE DATA AND INFORMATION TRANSFER SYSTEMS. Under this approach, judicious space-faring initiatives allow the nation to work as a team, jointly with other nations in a consequent and lasting fashion, permitting truly insertion of the nation in worldwide space exploration.

SUGGESTION 1 - INVEST in competence for use of STANDARDS; Also, possible participation in their development;

SUGGESTION 2 - APPROACH CCSDS and ISO TC20/SC13 for INFORMATION, CONSULTANCY and RECOMMENDATION;

SUGGESTION 3 - Definition of a STRATEGY FOR USE of STANDARDS (scenarios, graduality, implementation plan, etc.);

SUGGESTION 4 - IMPLEMENT, OPERATE and MAINTAIN STANDARD SERVICES, as applicable, for internal and external use;

SUGGESTION 5 – Consider the OFFERING of STANDARD CROSS SUPPORTABLE SERVICES for EXTERNAL USERS.

THANK YOU