CCSDS can not be ignored when looking beyond the horizon

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GSAW 2017
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WHAT IS HAPPENING AROUND US ?

- The Satellite Front
  - More Primes
  - Surge in demand of constellations (high performance, low cost)
  - Surge in demand of nanosats, cubesats
- The Ground Segment
  - Ultra high capacity GWs
  - Cloud based architecture
  - Smart Antennas
  - Reconfigurable terrestrial networks
  - Ka-band on top of Ku-band
  - Variable coding and modulation
  - Intelligent download
  - Big data: V3, Volume / Velocity (acquisition) / Variability (complexity)

CCSDS STRATEGY

- Collaborative environment (multi Space Agency)
- Advancing Technology
- Paving the way for reusability
- Interoperability and cross support for communications / data systems
- Share of ideas with other people
  - conflict, argument, debate, **consensus**
- Understanding our customers needs
- Open to failure, not all standards are a success
- Prevalence of usefulness of new standards vs. inertia of the orthodox / legacy system
- CCSDS past successes are not enough when looking beyond the horizon
- Reduce Cost
- Increase reliability / reduce risks
- **150 active publications**
- **ca. 800 missions have adopted / used our standards**

ORGANIZATIONAL INTERRELATIONSHIPS

CCSDS participant inputs (plus observers)

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

IOP: Interoperability Plenary – highest level interagency agreements on space interoperability

CCSDS: provides open international standards for space mission interoperability

IOAG: Interagency Operations Advisory Group interoperable mission support infrastructure (Comm & Nav only)

SFCG: Space Frequency coordination Group: space agency spectrum management forum

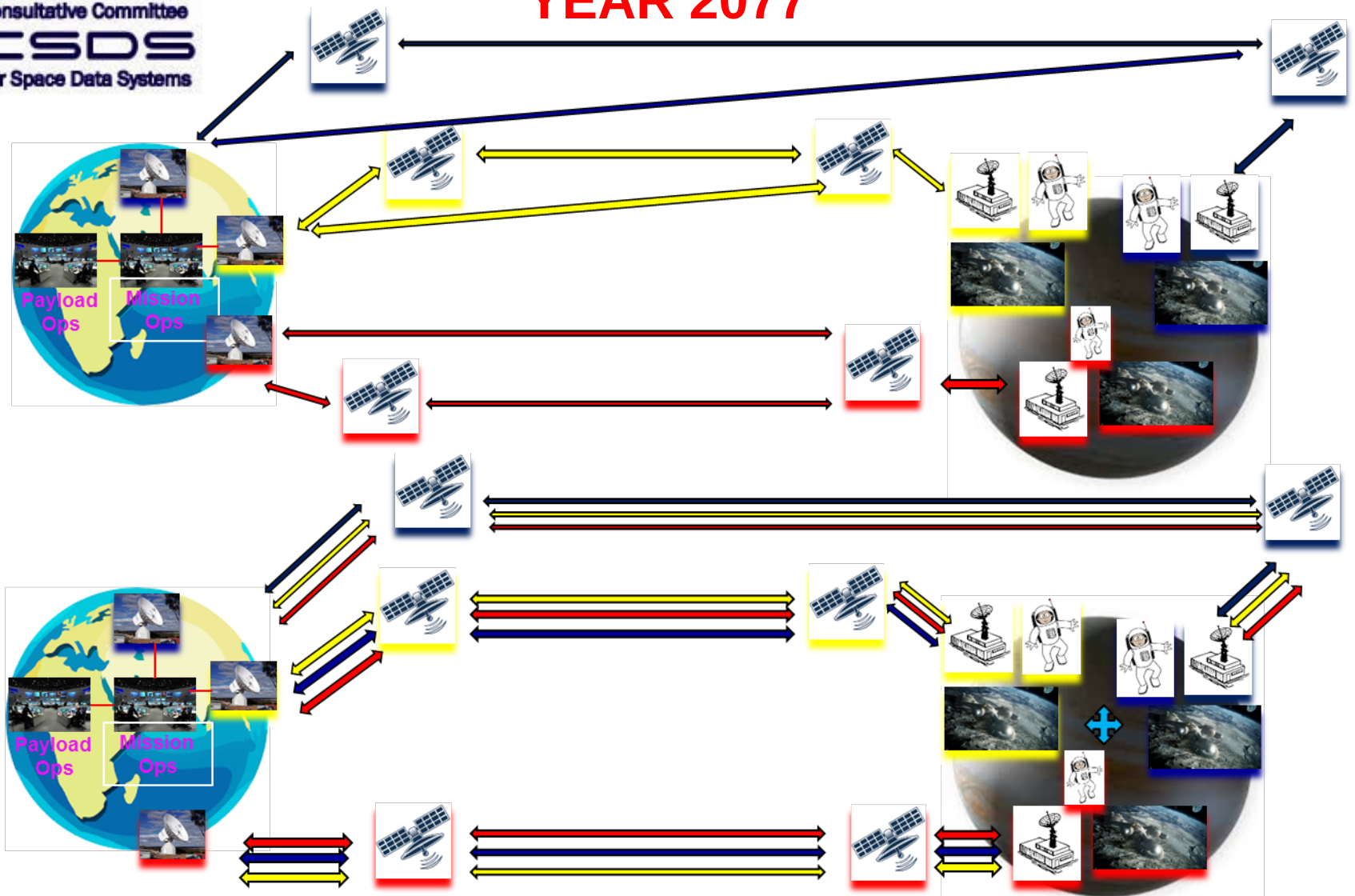
Close Coordination for Internetworking

CCSDS participant inputs bring in needs of individual organizations

IOAG SISG: Space Internet Strategy Group – New Int'l agreements for Internetworking (ISO Layer 3) in Space

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

YEAR 2077



CCSDS

Agree on common frequency bands to grant high degree of interoperability

- **Moon / Earth, Mars / Earth, Lunar / Mars Proximity forward / return links**

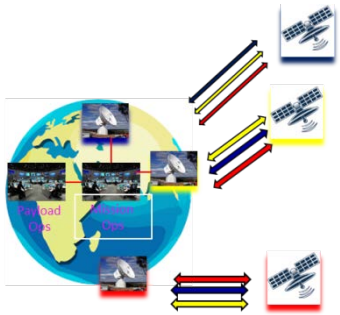
Agree on common coding / modulation schemes

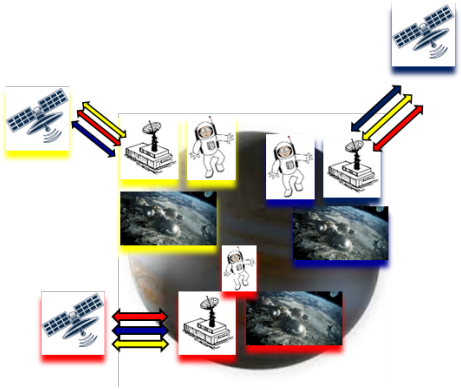
DTN

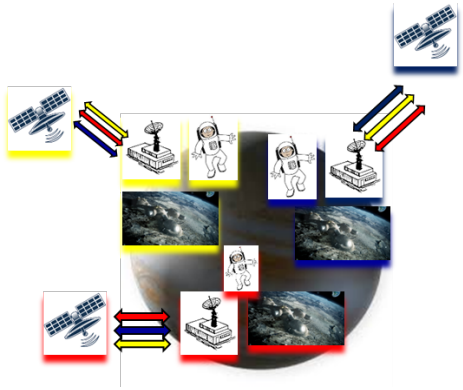
Service Management / Cross Support Services

Optical communication

YEAR 2077







Ground Systems

GSAW

Martian Systems

MSAW

Exoplanet Systems

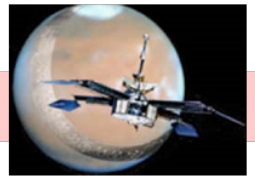
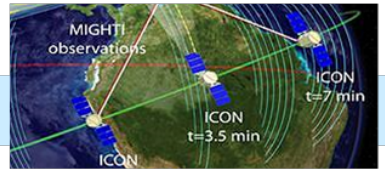
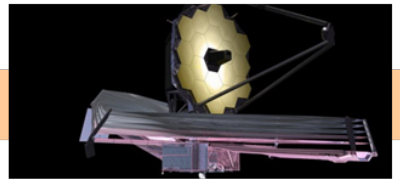
EXSAW

CCSDS

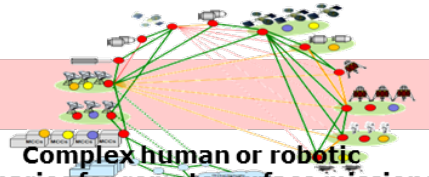
Ground Functions → **Ground Services**

- Service Management
- Cross Support Transfer Services
- M&C
- Navigation
- Mission Planning
- Robotics
- Network Management
- Security

FUTURE MISSION DRIVERS

PAST	PRESENT	DRIVERS FOR THE FUTURE
 Shuttle/SpaceLab CCSDS packets	 International Space Station Adv. Orbital Sys (AOS) Early DTN Prototyping	**In Situ Exploration** • Human Expeditions • Long Duration, High Reliability • Mobile comm protocols • Voice, Video, Medical handling • Onboard Autonomy • Highly integrated ops
 Brief Recon Flyby, Short-Lived Probes Direct-to-Earth links	 Missions designed for orbital relays, Longer duration	**Complex Deep Space Mission** • Human ***or*** robotic exploration • Longer Duration • Mobile comm protocols • Fully automated routing • Network-Managed DTN • Optical Communications
 Single-Spacecraft Survey/Sensors	 Spacecraft Constellations and formation flying	**Orbital Remote Sensing** • Long Duration, high bandwidth • High Spatial, Spectral, & Temporal Resolution • Low Latency Comm • Complex link topologies • *SensorWebs for synchronized remote sensing*
 Single-Spacecraft Observatories in LEO	 Greater Distances Higher bandwidth	**Next Generation Observatories** • More Capability • Multiple Spacecraft drive network needs • Even Greater Capacities require new coding schemes • Located Even Farther from Earth


Asteroid/Surface Exploration
Autonomy, High bandwidth
Multi-Agency Mission Ops


Complex human or robotic
Scenarios for remote surface missions
Fully automated Space Internetworking


Multi-Discipline and
Multi-Resource SensorWebs


Next Generation
Observatory Complexes

CCSDS STRATEGIC PLAN

1. **Systems Engineering: Cross-cutting functions and architecture-wide integration, Security and Delta-DOR Standards**

2. **Towards standardized Mission Operations Services at Application Level on Ground and On-Board including a complete Navigation Message Standardization**

3. **Towards an extensible Space Communications Cross Support Service Management and Transfer Services (Cross Support of Communications Assets)**

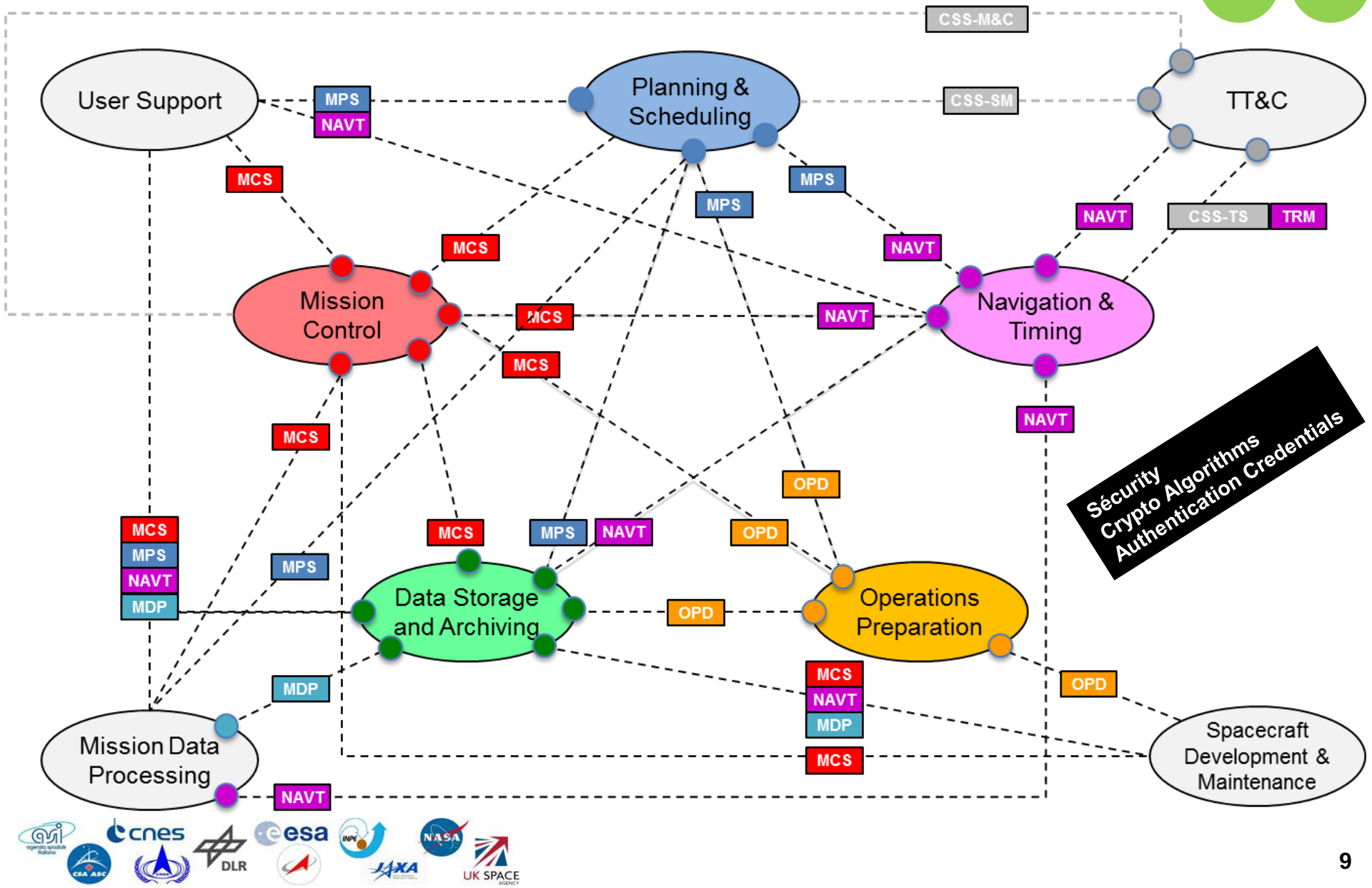
4. **Towards onboard Standardized avionics architectures; wireless *communications and software defined radios***

5. **Towards an unified Space Data Link Protocol, optical links, new sync and channel coding schemes and compression**

6. **Towards standardized Space System Internetworking Services and the Solar System Internet (SSI)**

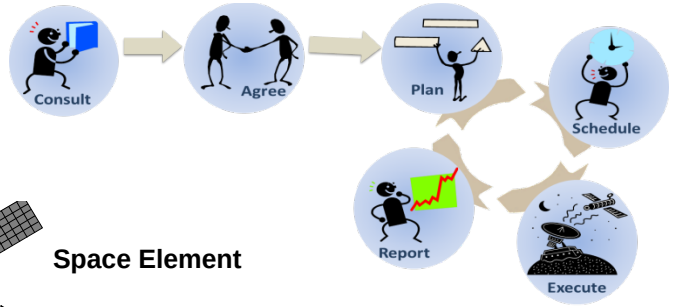
MISSION OPERATIONS SERVICES AND ARCHITECTURE

1 2



SERVICE MANAGEMENT

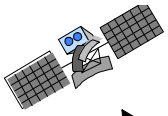
- Objective
  - Define management service standards cross support management of Telemetry, Command, Ranging and future CCSDS inter-agency services



Service Management Recommendation

- **Service Package**
  - Scheduled service times
  - Off-line service data management
  - Contingency Scenarios
- **Service Configuration Profile**
  - Telecommunication Configuration
  - Event Sequences
  - Ground data transfer configuration
- **Trajectory Prediction**
- Service Agreement

NO MORE BILATERAL AGREEMENTS



Space Element

Data Transfer Interface (Spacelink)

Managed Services, Spacelink Component; CCSDS 401, PT, etc recommendations

- Command
- Telemetry
- *(Tracking)*

SCCS Complex

Complex Management

Internal Management

Space Link Services (Transfer Service Production)

Transfer Service Provision

RF and Modulation Equipment

Frames Service Provider

CLTU Service Provider

Service Mgmt Interface

Data Transfer Interfaces (Terrestrial)

MDOS

Utilization Management

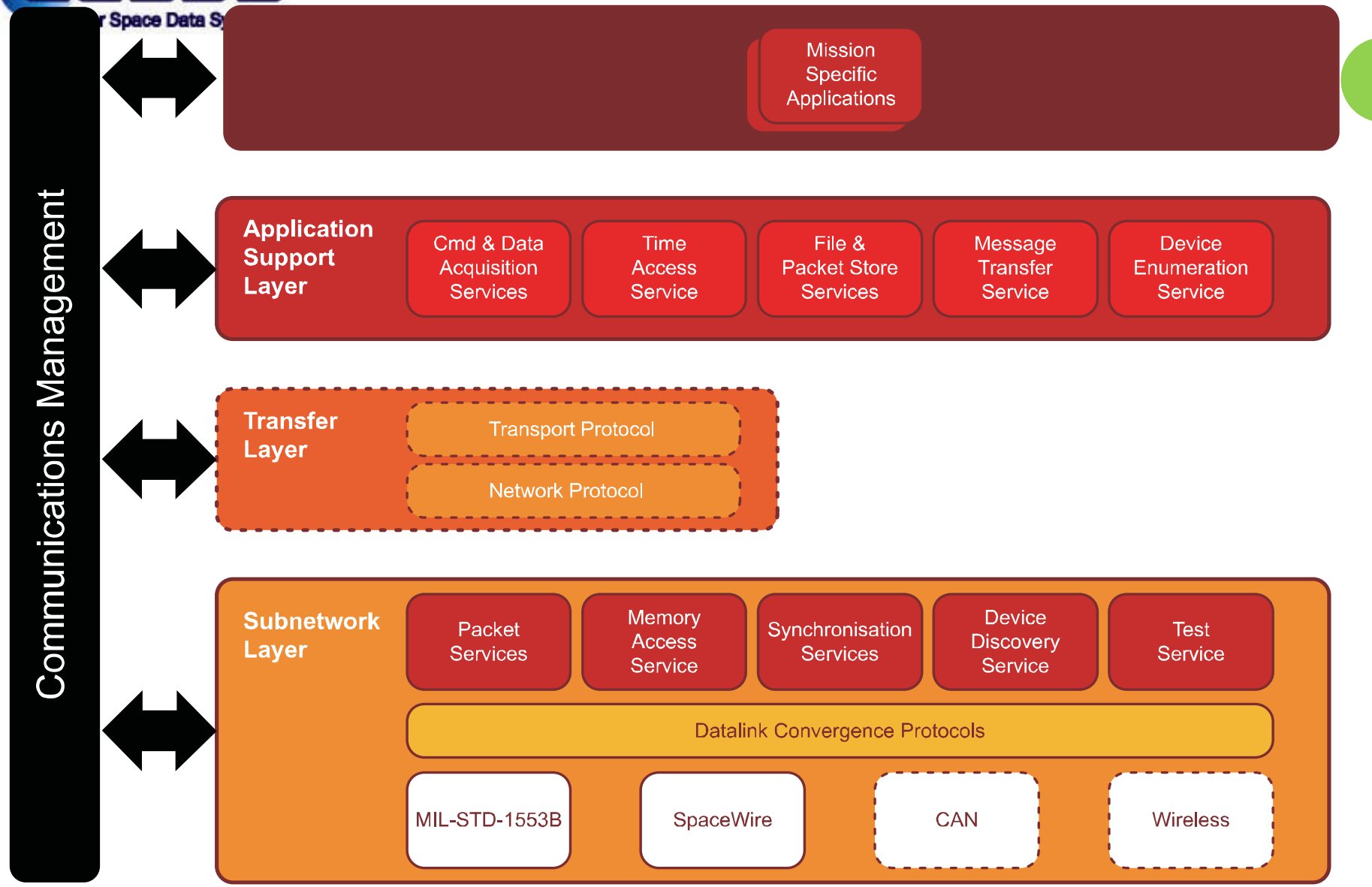
Internal Management

Transfer Service Users

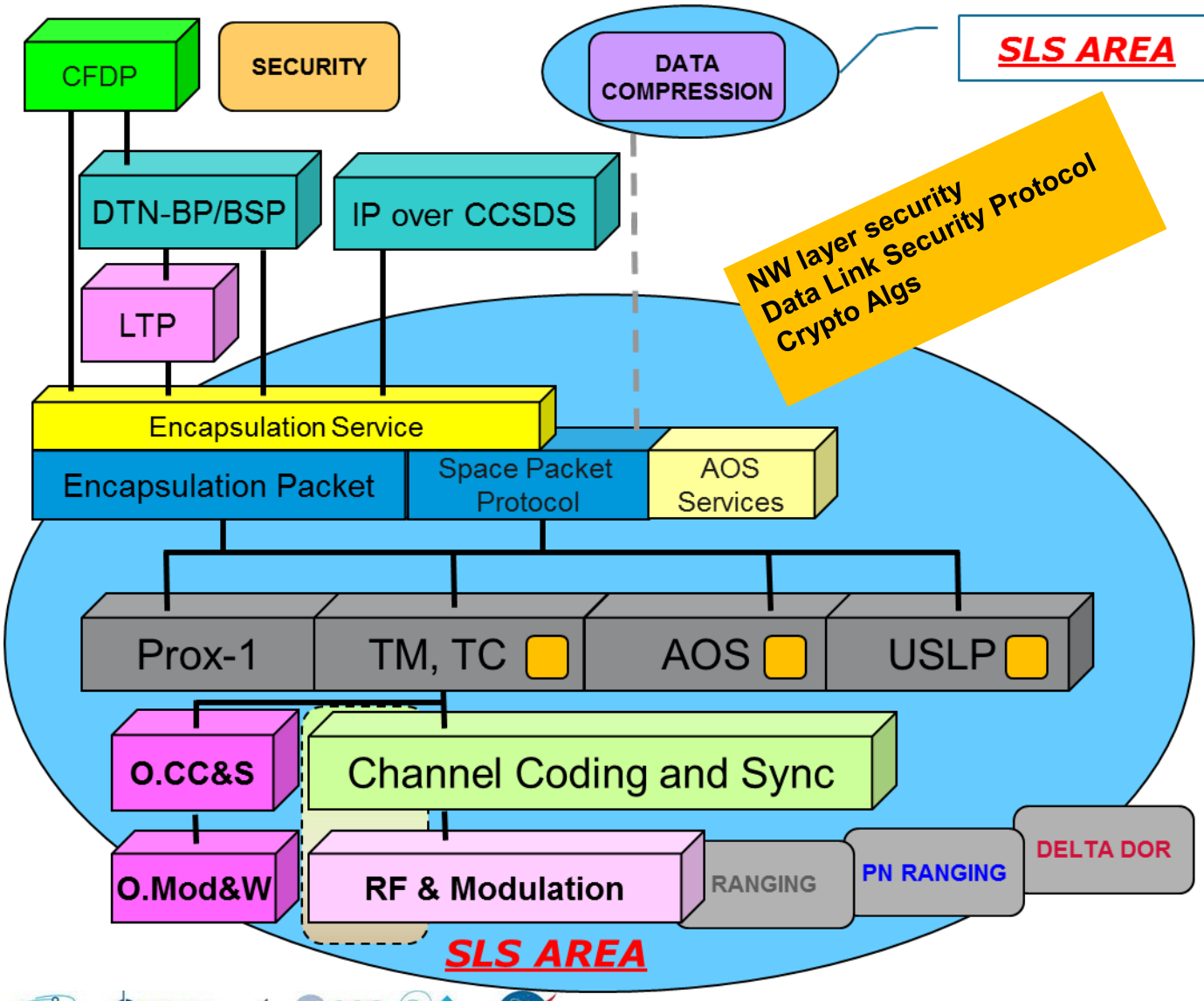
Managed Services, Ground Component; SLE Recommendations, CSTS Recommendations

- **Command, Forward Frame**
- **Telemetry**
- ***Tracking***
- ***Service Control***
- ***Near-RT Monitoring***

ON-BOARD SERVICES AND ARCHITECTURE



SPACE LINK SERVICES: LAYERED APPROACH



- Optical Communications WG
- Multispectral Hyperspectral Data Compression WG
- **Space Data Link Security WG** (SDLS Protocol Function for Authentication and Confidentiality)
- Space Link Protocols WG
- Coding & Synchronization WG
- RF & Modulation WG

SPACE INTERNETWORKING SERVICES

6

CFDP | AMS | BP Network Management | BP Routing | Voice and Audio Communications | Motion Imagery — L7

[Many of the applications can function in both environments] — L5

High-Delay / Disrupted Environments

BP Security

BP (DTN)

LTP

Low-Delay / Connected Environments

TCP/UDP/SCPS-TP — L4

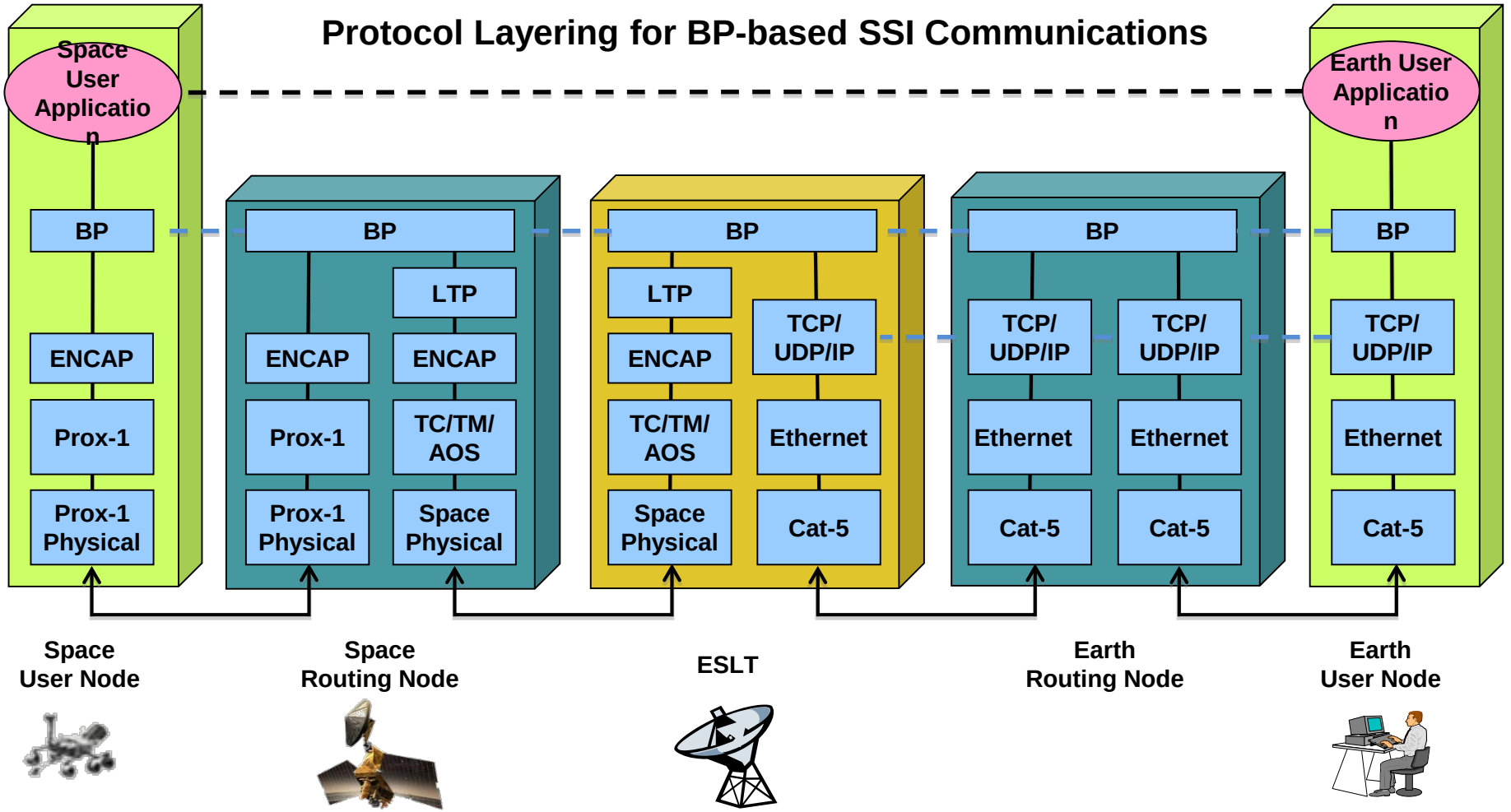
IPSec*

Internet Protocol (IPv4/IPv6)* — L3

Robust Header Compression (ROHC)*

Space Packet | Encapsulation Packet | IP over CCSDS Link

SPACE INTERNETWORKING SERVICES



CONCLUSION

- **CCSDS represents a story of success**

  Interoperability, Cross Support, International Consensus

  are our strength

- **We need 10 – 15 years to complete our current vision**

  Our Work Plan has ca. 100 Recommended Standard, Practices and Informational Reports

- **As technology evolves**

  New standards will be included in our long term strategy

  And the process cycle re-starts again