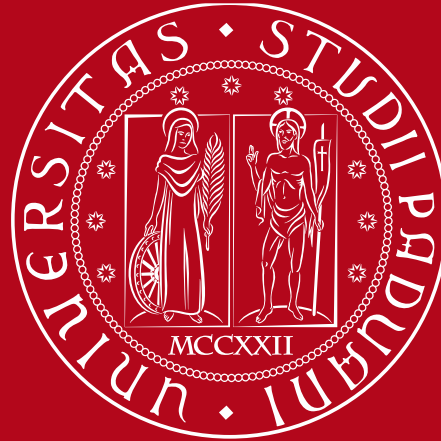


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DI PADOVA

Satellite Communications Systems

INQ1098071, A.A. 2021/22

Lecture 8 (Payload & TTC)

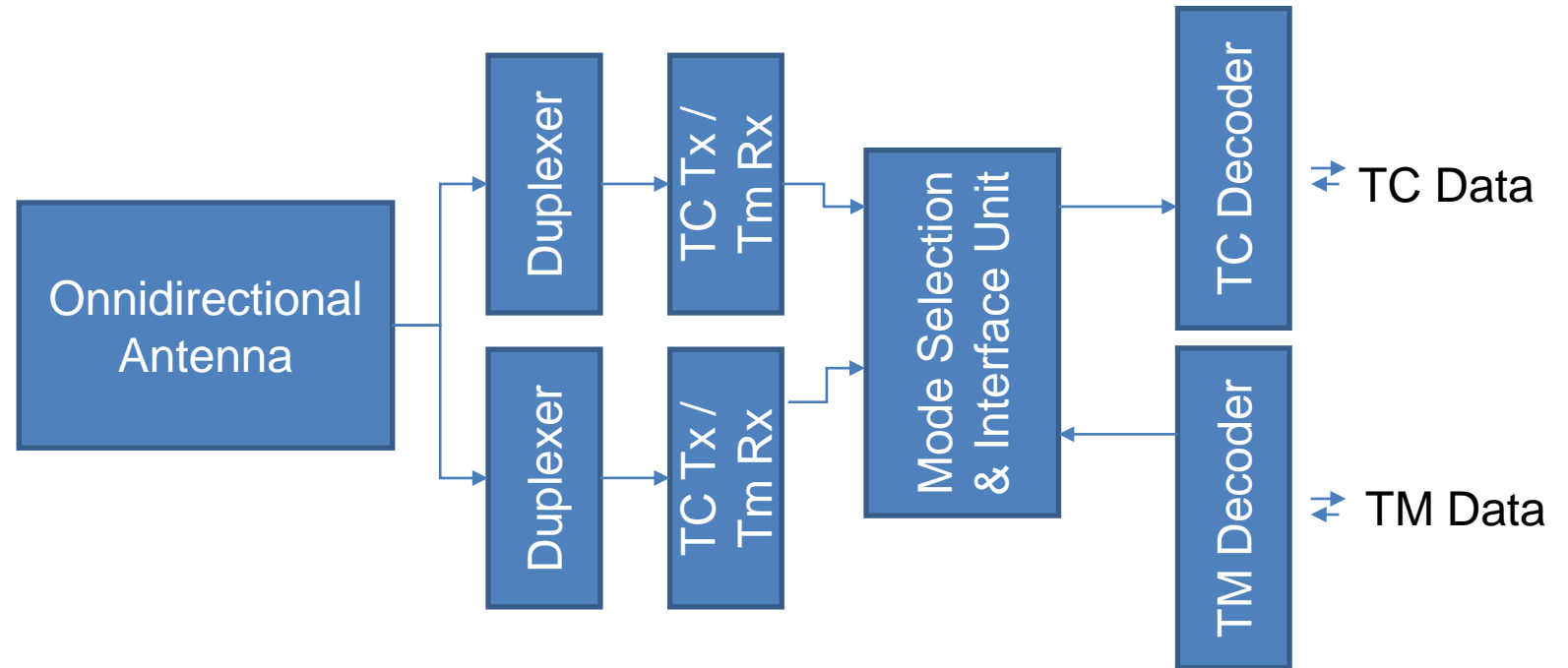
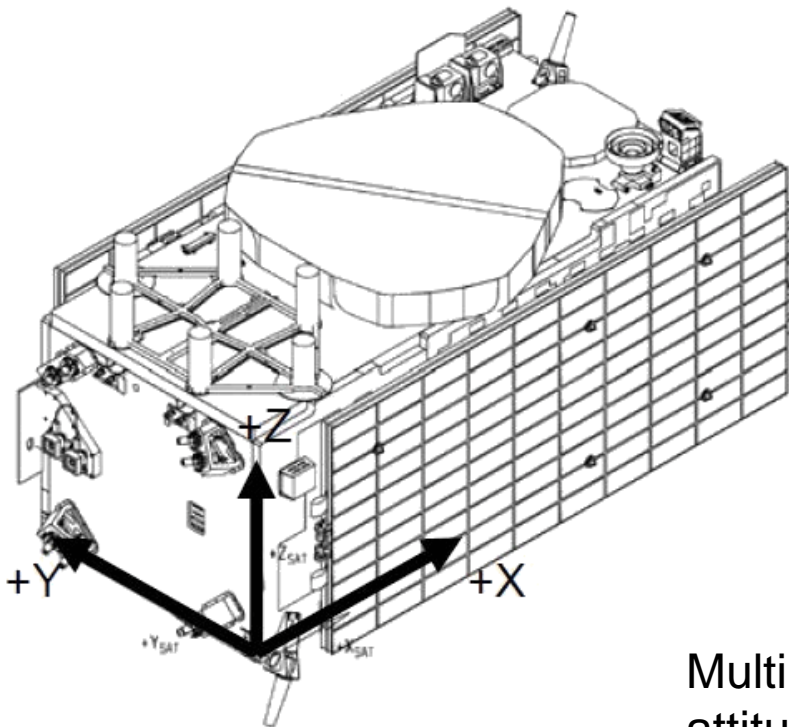
Prof. Oscar Pozzobon

Co-teaching with Prof. Nicola Laurenti

- Telemetry, Tracking & Telecommand deals with:
 - Receiving control signals from the ground to change the state or mode of operations of equipment
 - Transmit results of operation and measurements, verification of execution of commands
 - Enabling measurements on the ground of ground-satellite distance

TTC frequencies

- S band is historically used, trend versus Ka or X band
 - S band uplink 2025 – 2120 Mhz
 - S band downlink 2200-2300 Mhz



Multiple Antenna allow communication in case of attitude anomalies

Telecommand

- Phase or frequency modulated by a subcarrier (normally few Khz such as 8Khz)
- Commands can be:
 - Executed immediately after reception
 - Stored in memory and executed on a specific command
 - Stored in memory and executed at a specific time or by a specific signal of the satellite
- Fundamental of the telecommand is the security
 - Data level (authentication, privacy, integrity)
 - Signal level (Anti jam)

Telemetry

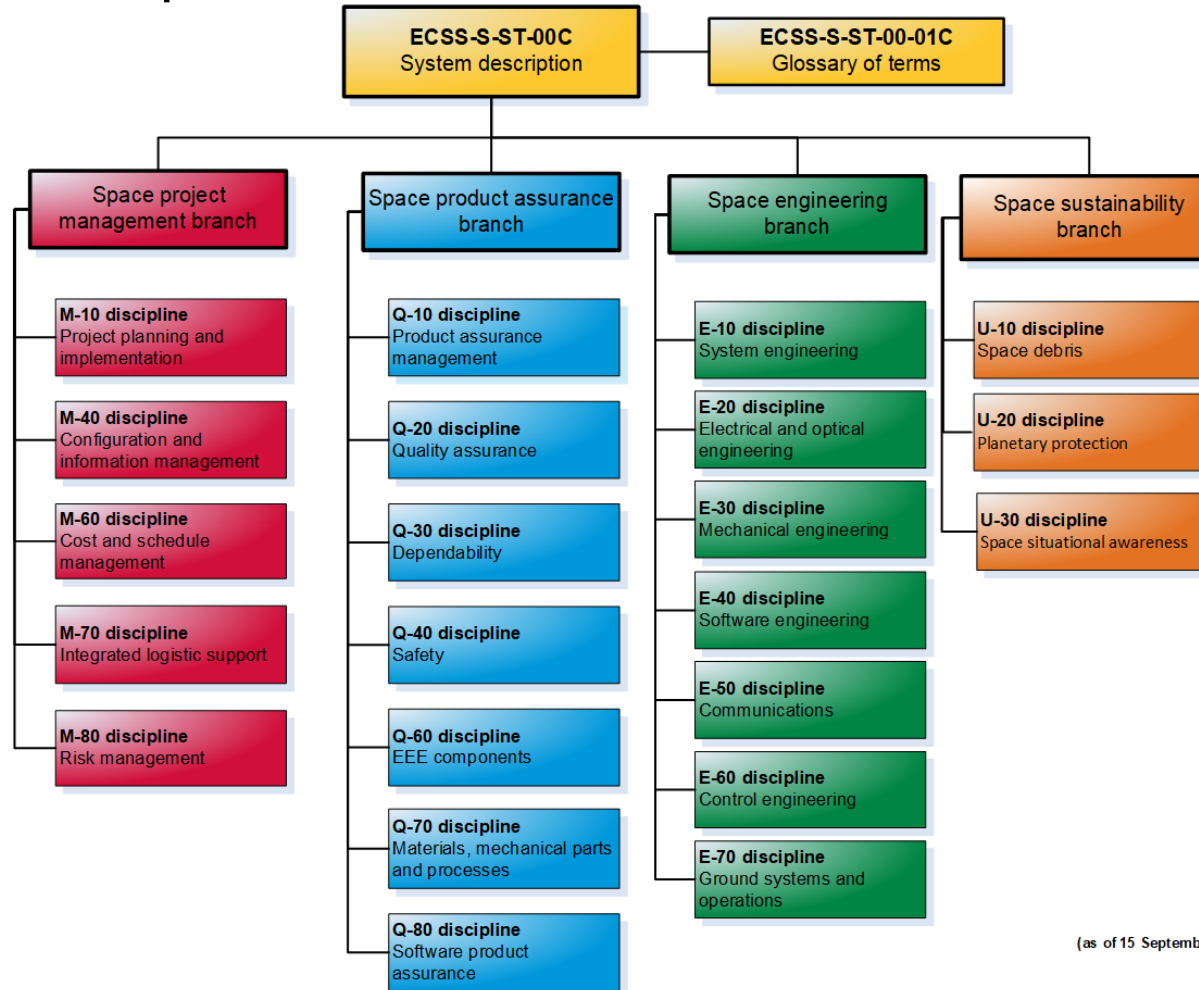
- Phase or frequency modulated by a subcarrier (normally few Khz such as 40.96Khz)
- Telemetry can be:
 - Generated by the telemetry encoder equipment
 - Generated by other payloads
- Security fundamental also for Telemetry

TTC standards

- Two main types of standards
 - Pulse Code Modulation (PCM) defined in ECSS standard (ECSS-E-ST-20-07C Rev. 1)
 - Consultative Committee for space data systems (CCSDS) , such as 100.0-G-1 for telemetry and 200.0-G-6 for telecommands.

ECSS standard

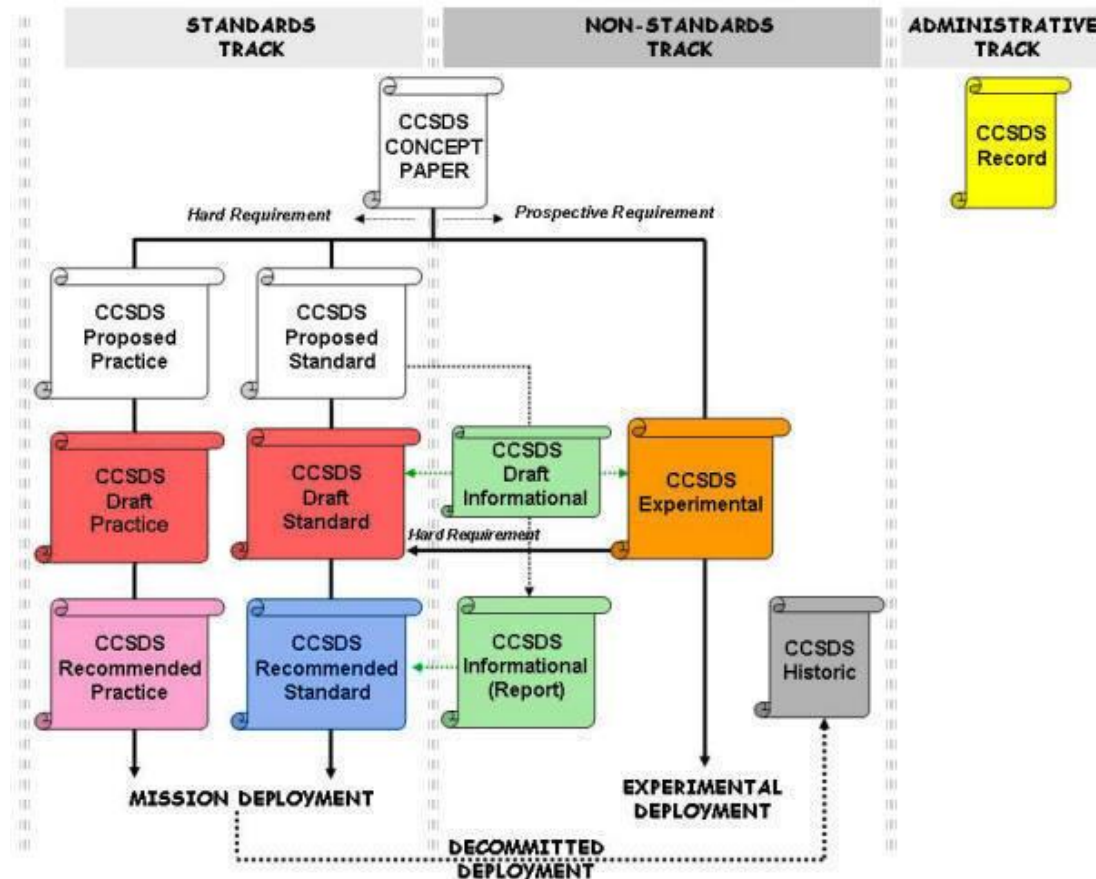
ECSS Disciplines



(as of 15 September 2021)

CCSDS standard

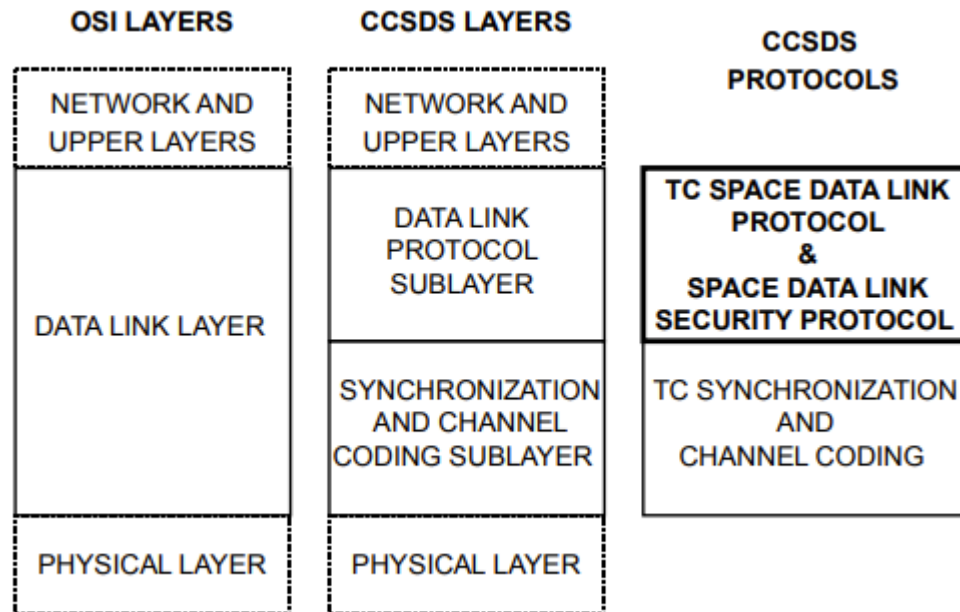
- Blue: Recommended Standards.
- Magenta: Recommended Practices.
- Green: Informational Reports.
- Orange: Experimental.
- Yellow: Record.
- Silver: Historical.



he CCSDS is divided into 6 Technical areas:

- Space Internetworking Services
- Mission Operations And Information Management Services
- Spacecraft Onboard Interface Services
- System Engineering
- Cross Support Services
- Space Link Services

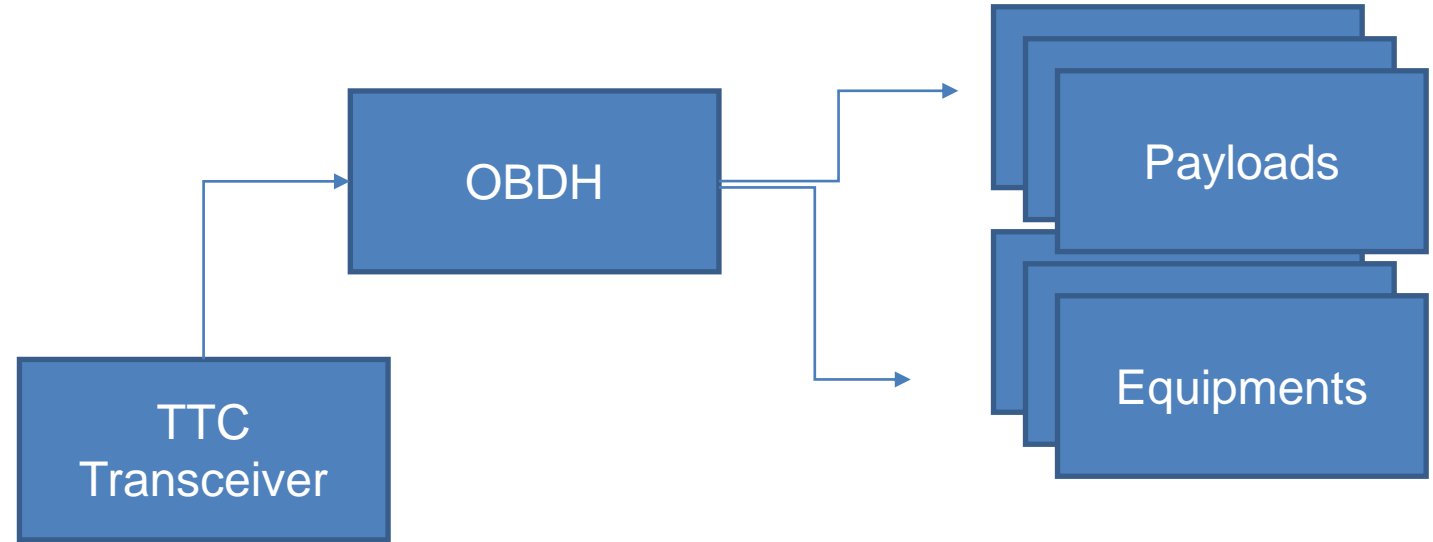
CCSDS OSI Layer



Relation with the OSI Layer

On Board Data Handling (OBDH)

- TC processing
- TM preparation and generation
- Data processing
- Data storage
- Synchronization, data timing and traffic management
- Monitor and control



Bus:

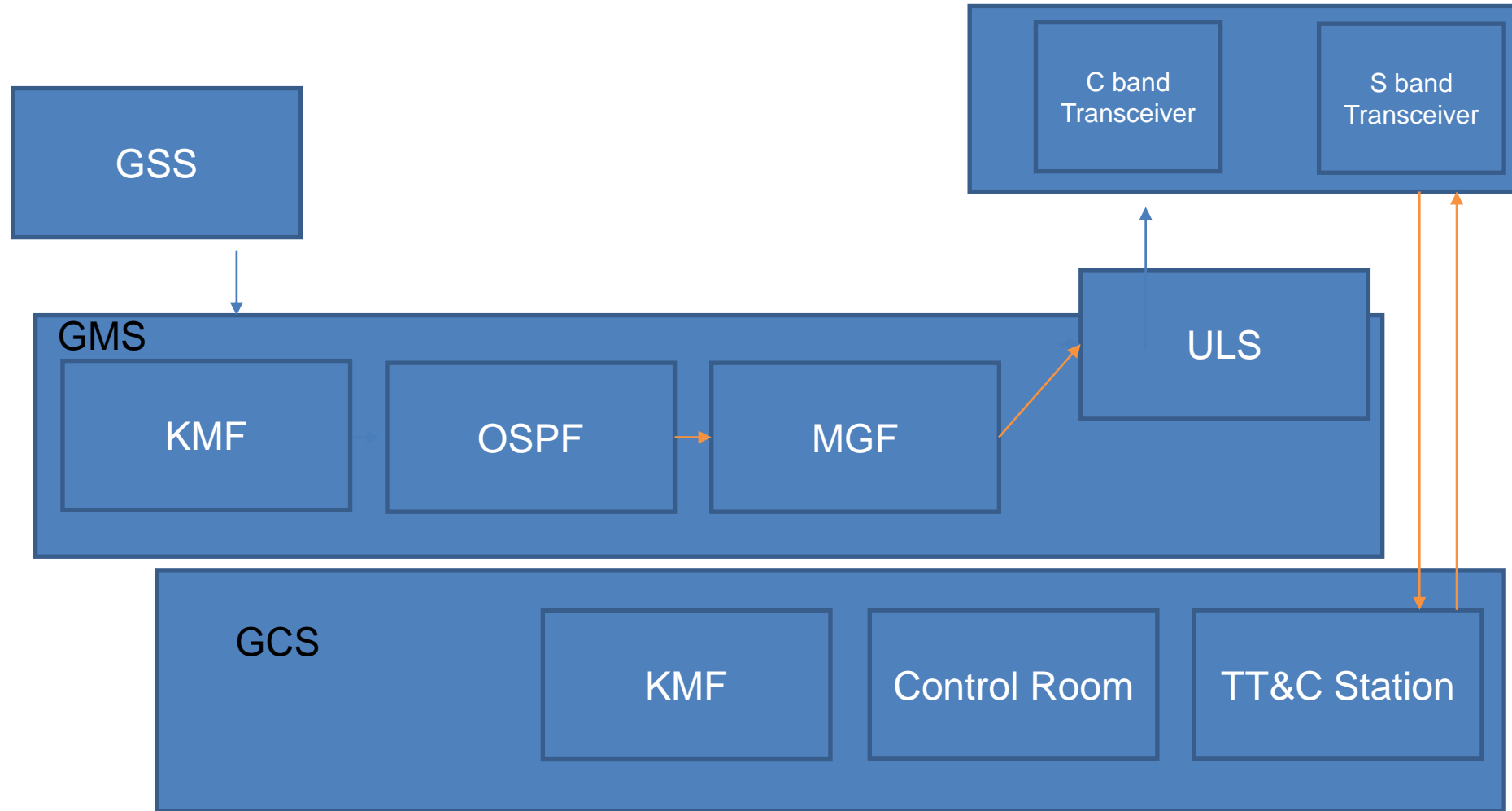
- MIL STD 1553
- RS422
- SpaceWire



OBDH example, Source: ESA

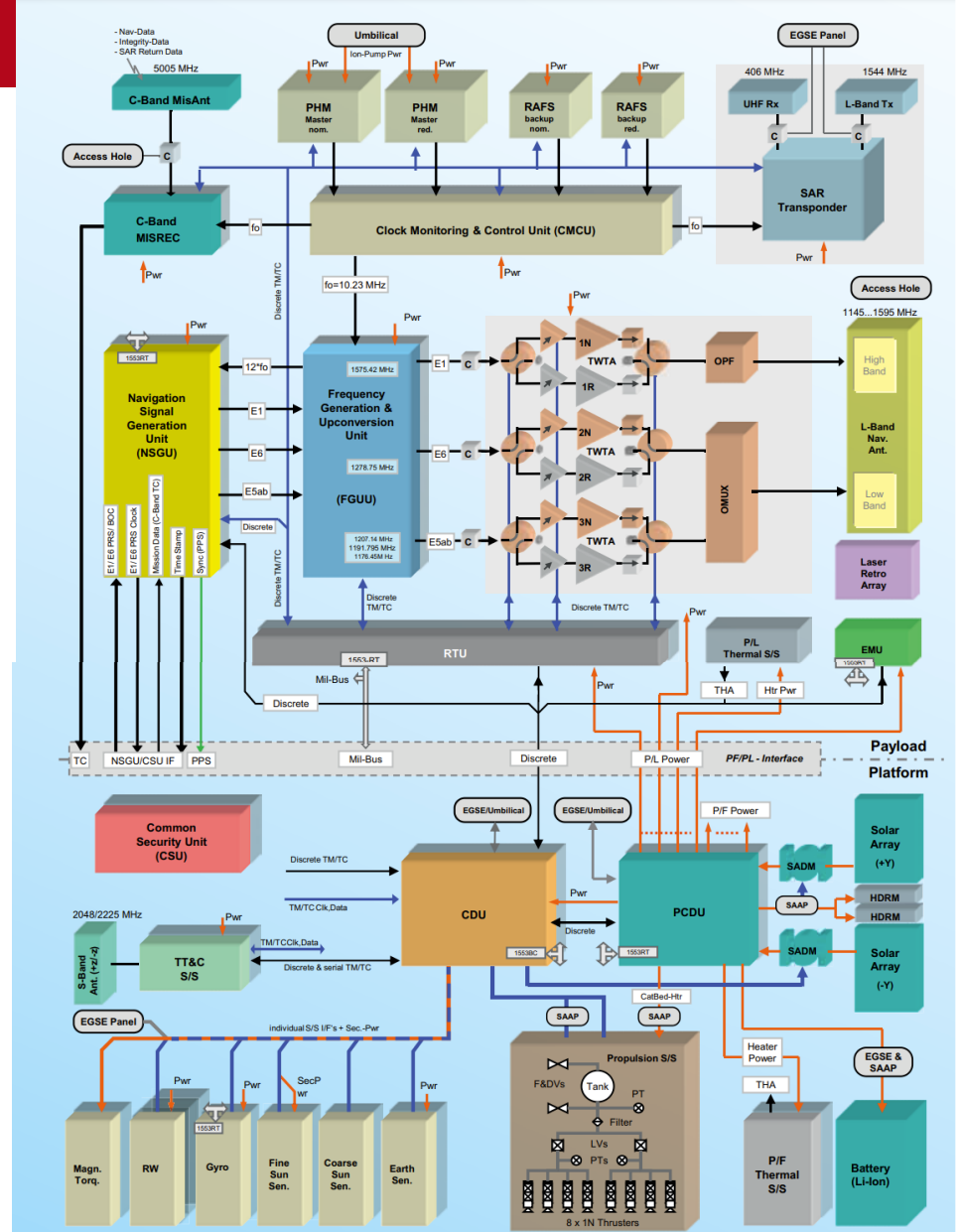
TTC in GNSS

- Galileo Control Centres (GCC).
 - Galileo Control Segment (GCS) and mission functions,
 - Galileo Mission Segment (GMS)

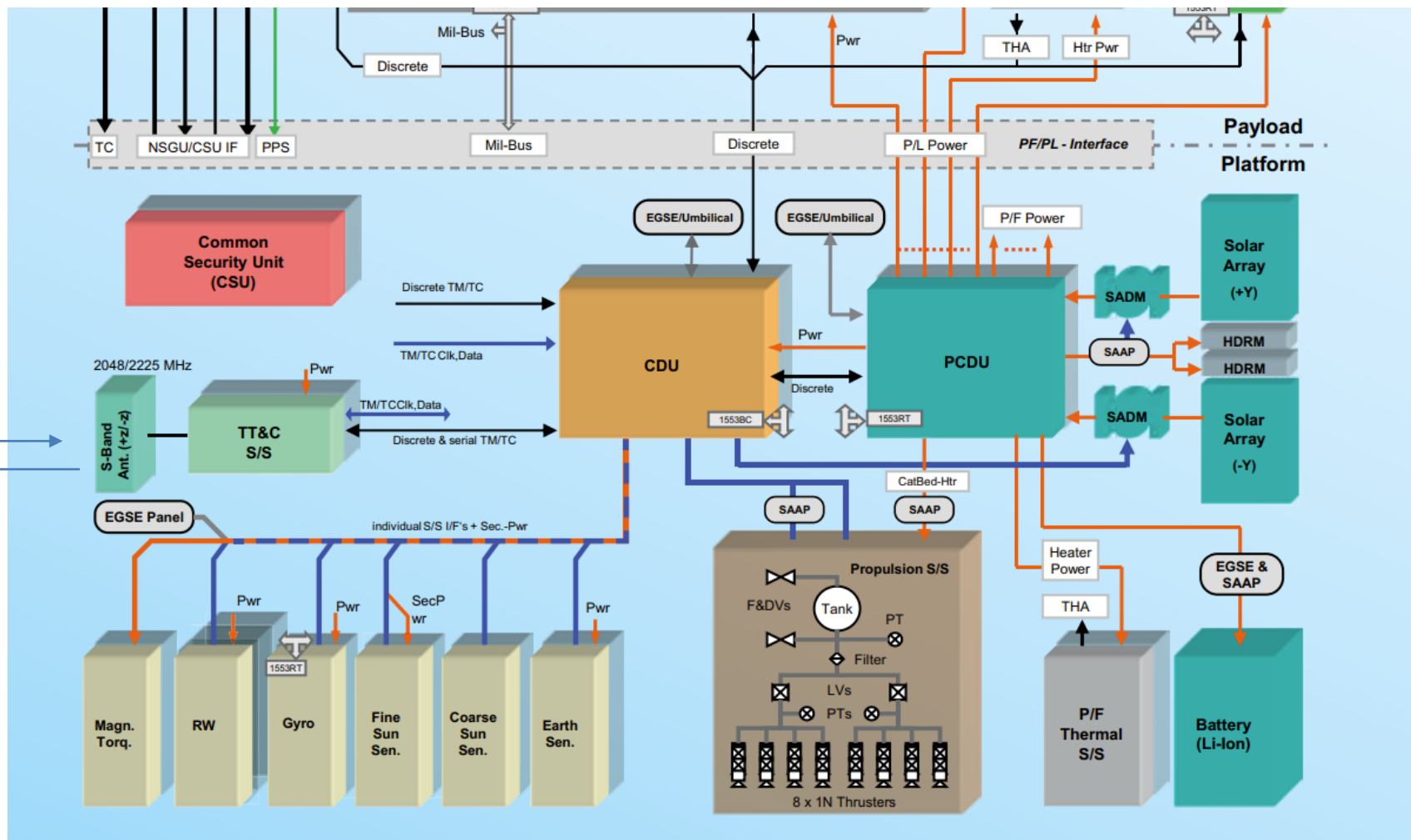


TTC in GNSS

- Overall Galileo FOC satellite Architecture



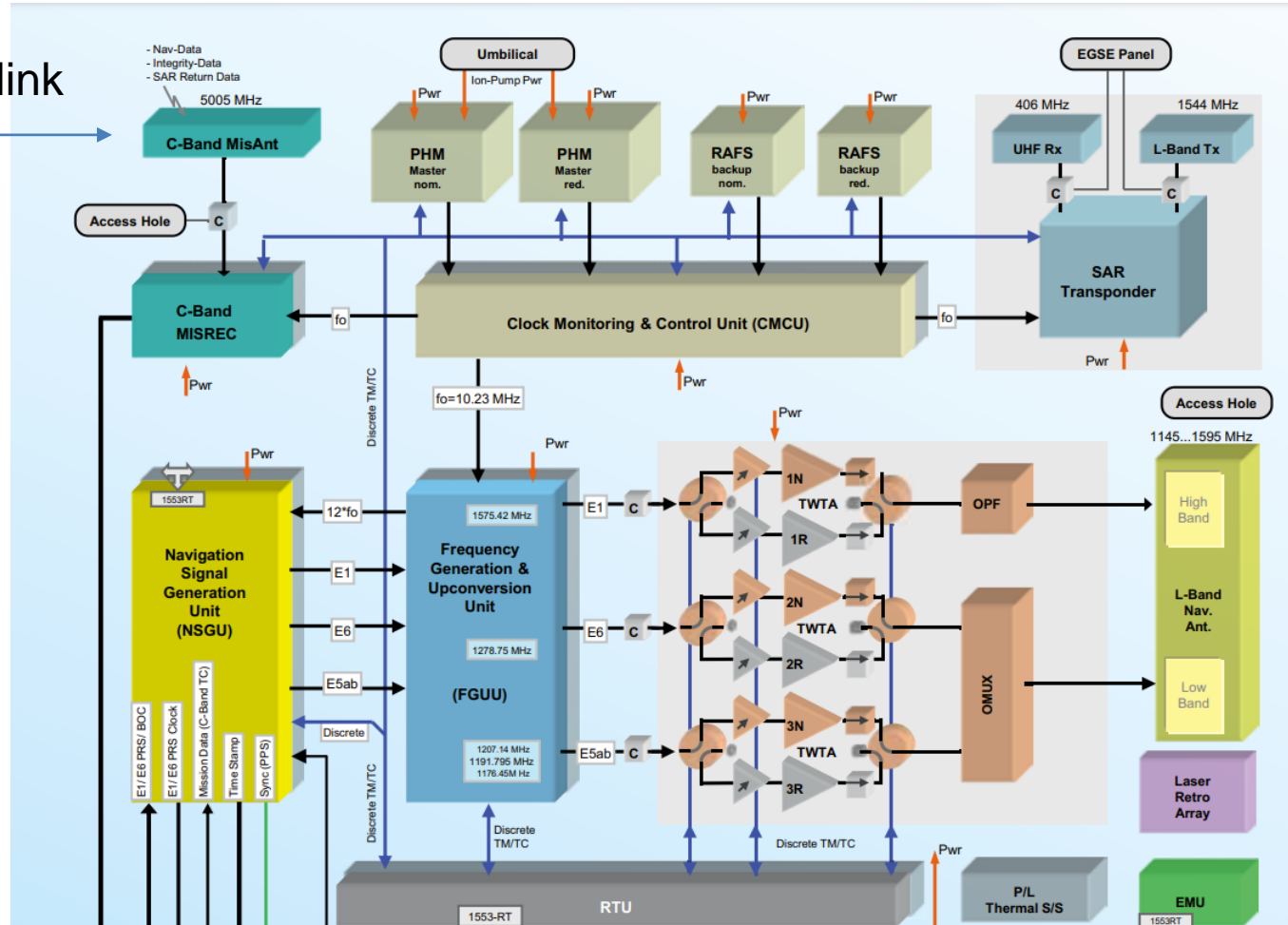
S band communication



C band communication

ULS

C band link



Receiver