Logistics of Space Mission Operations

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"Logistics is the management of the flow of resources between the point of origin and the point of consumption in order to meet some requirements …"

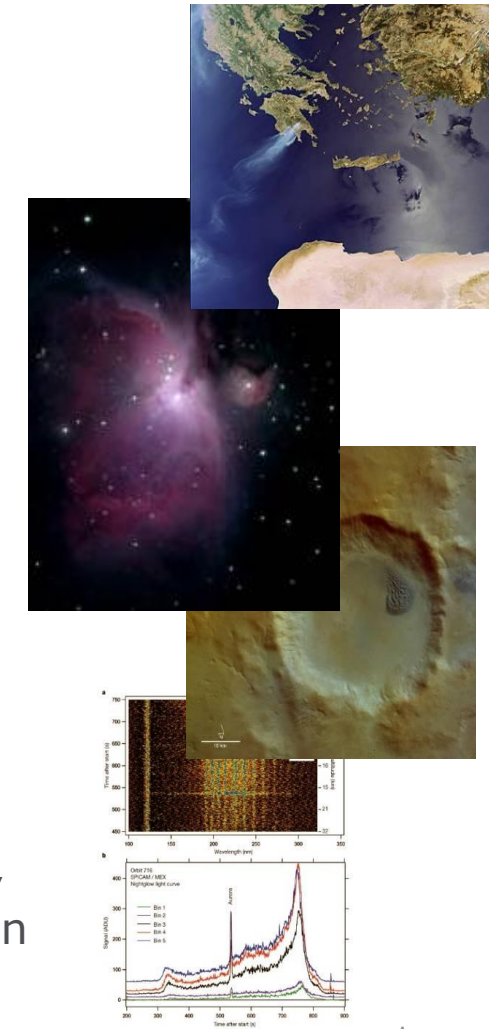
Wikipedia

What is Mission Control?

1. Purpose of space mission control is to deliver mission products in response to requests from users

2. Mission products can be:
    a. Data (e.g. science, earth observation)
    b. Services (e.g. communications, navigation)
    c. Material samples processing (microgravity)

3. Space Mission Control shall ensure:
    a. Spacecraft health and safety
    b. Implementation and maintenance of baseline trajectory/orbit and environmental conditions
    c. Operations of spacecraft subsystems, payload, ground segment for mission product generation

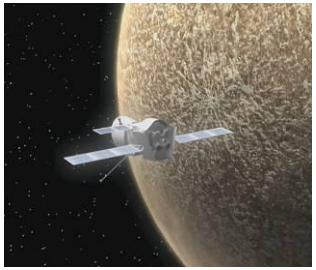


How Can we "Listen" and "Talk" to the Spacecraft?

Telecommands: < 10
Telemetry Parameters = 0

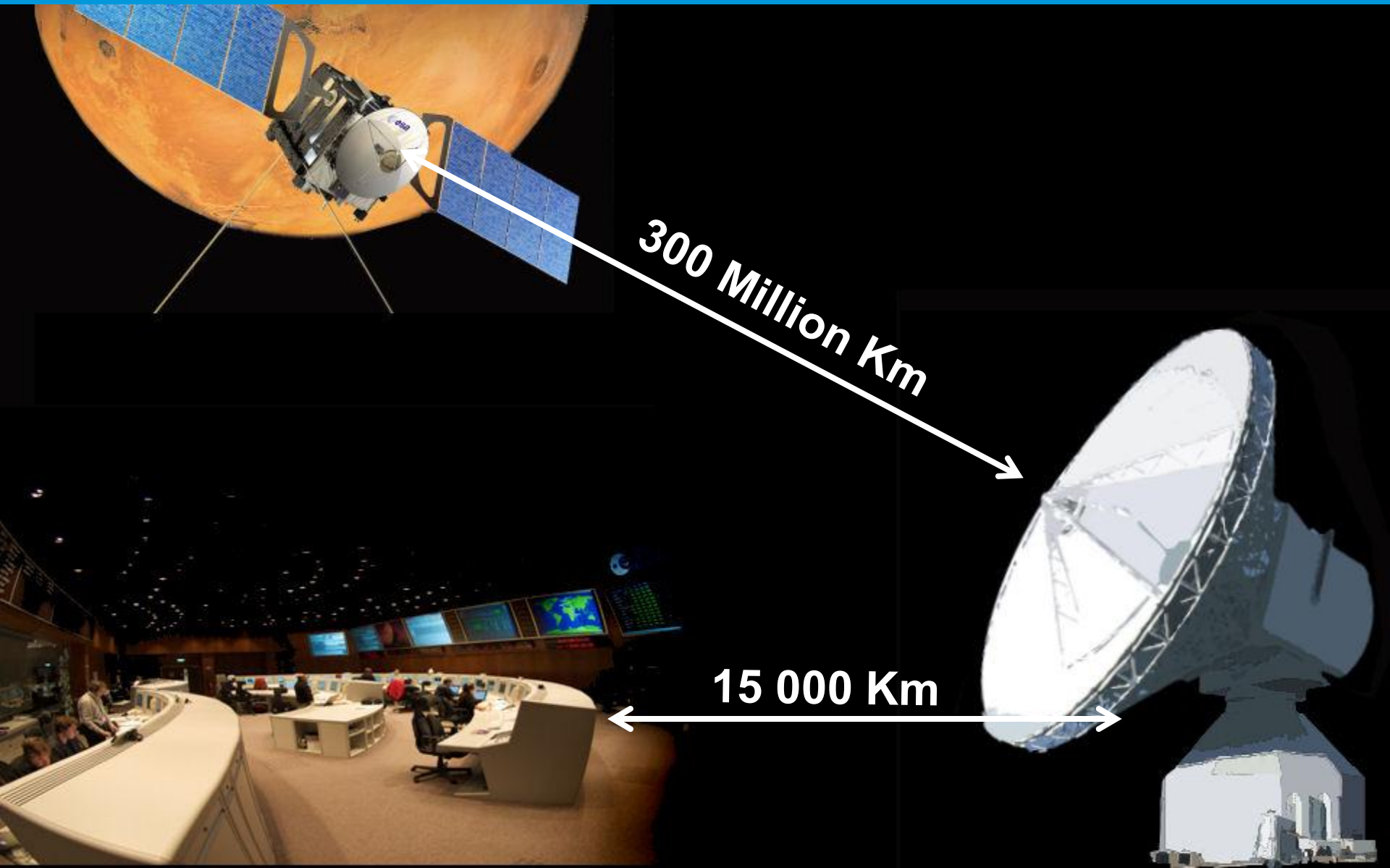
Telecommands: ~ 25
Telemetry Parameters ~100

Telecommands: < 100
Telemetry Parameters ~1000



Telecommands: ~5000
Telemetry Parameters ~30,000

Where is Our Playground?

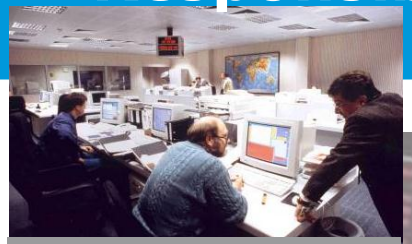


What Does it Take?

Mission Control Team

Ground Segment Systems

Mission Control Team Roles and Responsibilities



FLIGHT DYNAMICS

PROJECT SUPPORT

SYSTEM

SOM

SPACON

AOCS

OBSM

POWER

PROJECT REP

OD

OM

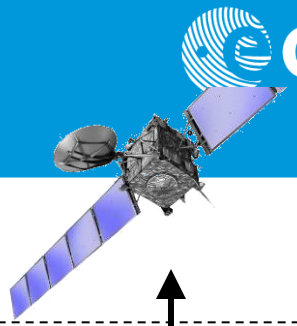
SOFTCOORD

Software Support

NETWORK

COMPUTER

Ground Segment Systems



MOC

Mission Operations Centre

SIM
S/C
Simulator

MCS
Mission Control
System

ECC
ESTRACK
Control Centre

FDS
Flight Dynamics
System

MPS
Mission Planning
System

DDS
Data Disposition
System

ESA

OPSNET
TCP/IP

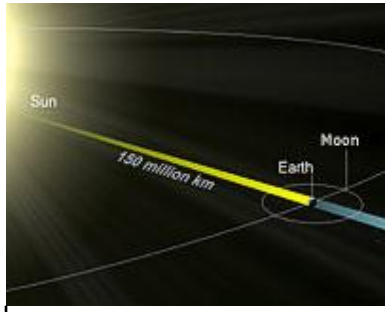
Ground
Station
Network

Payload Exploitation Centre

PI / User

Ground Segment Design Drivers

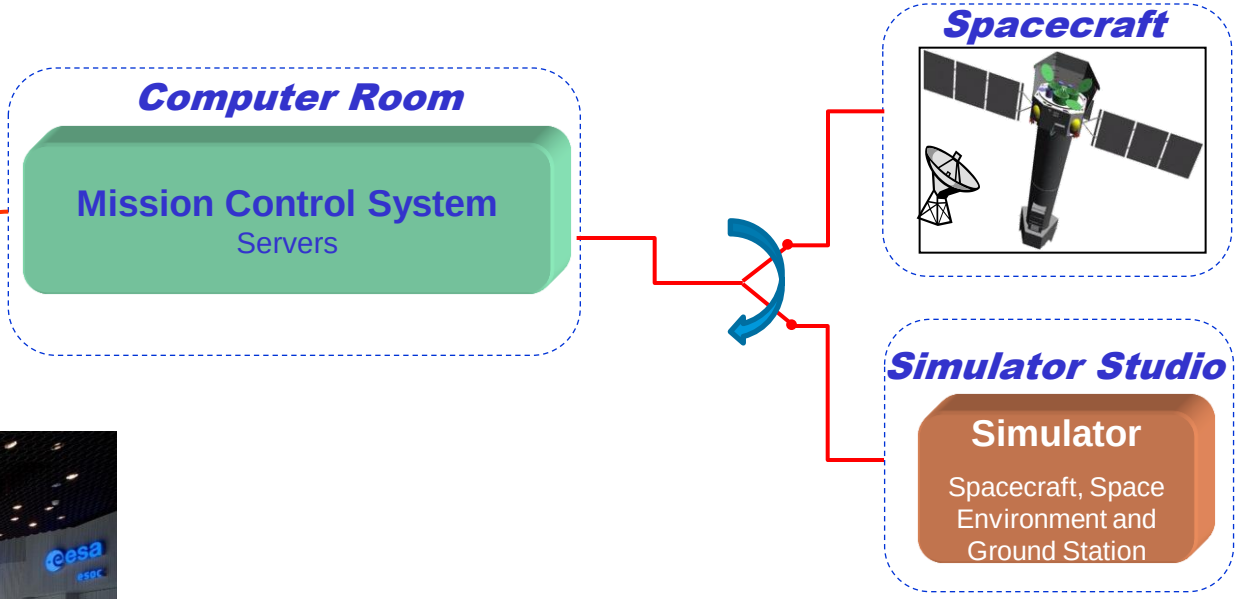
Mission Characteristics



	Near Earth Missions	Deep Space Missions	Low Earth Observers
Distance to Earth	< 2 million Km	=> 2 million Km	~500 km
Ground contact duration	3 - 24 hours	10 hours	5-10 min
Data rates	< 10 Msps +	< 3 Msps +	100-300 Msps

Ground Station Network

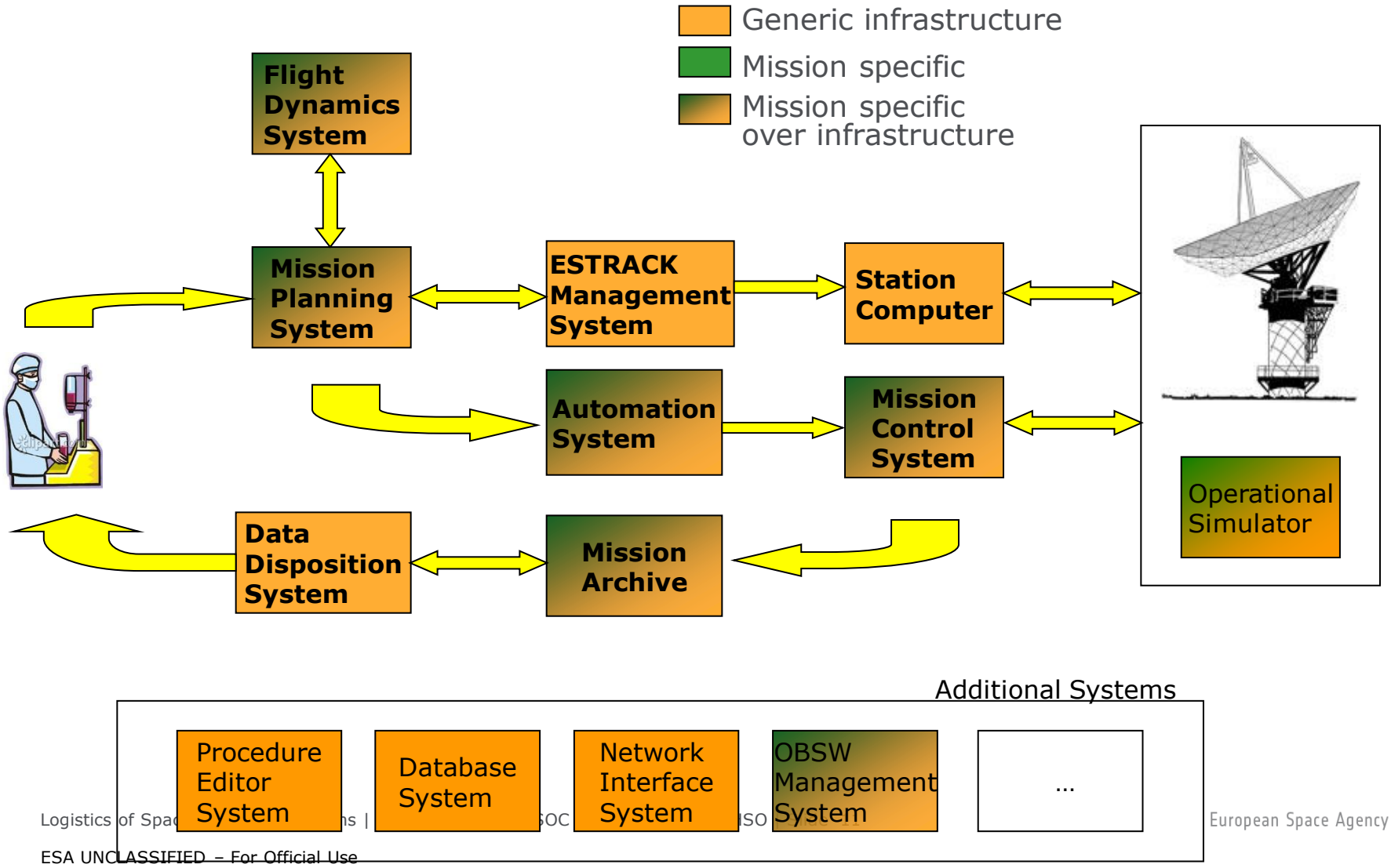
Preparing for Mission Operations



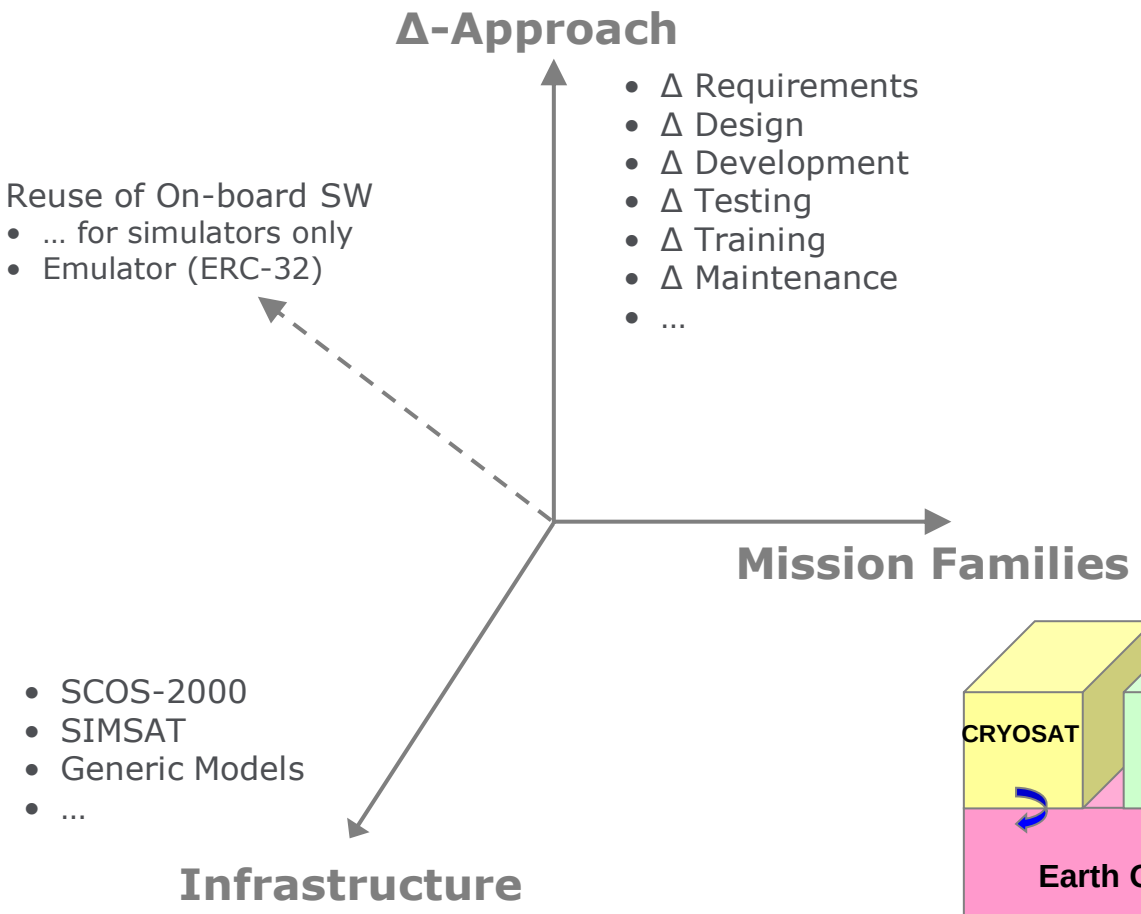
Main Control Room

- Training of Mission Control Team
- Validation of ground systems
- Validation of flight control procedures
- Testing spacecraft without destruction
- Spacecraft maintenance

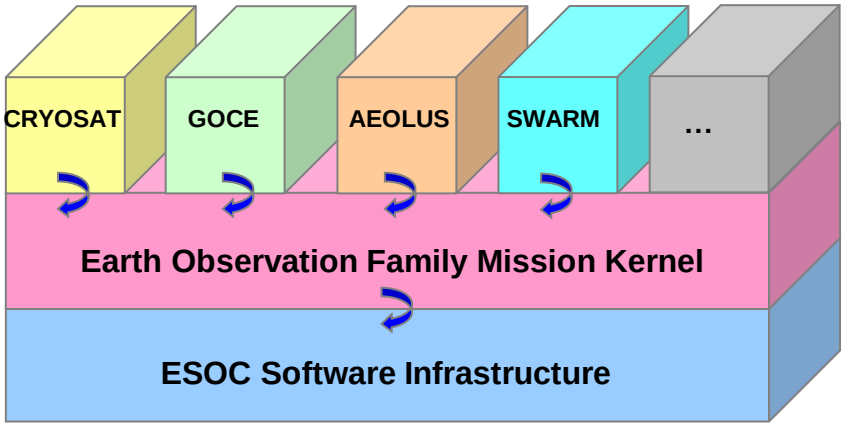
The Mission Data Systems "Orchestra"



Software Reuse in Data Systems: a success story



- **Interplanetary Family:** Rosetta, Mars Express, Venus Express, BepiColombo, Solar Orbiter, …
- **Earth Observation Family:** Cryosat, Goce, Aeolus, Cryosat-2, Swarm, EarthCare, Sentinel, …
- …



Missions in Preparation