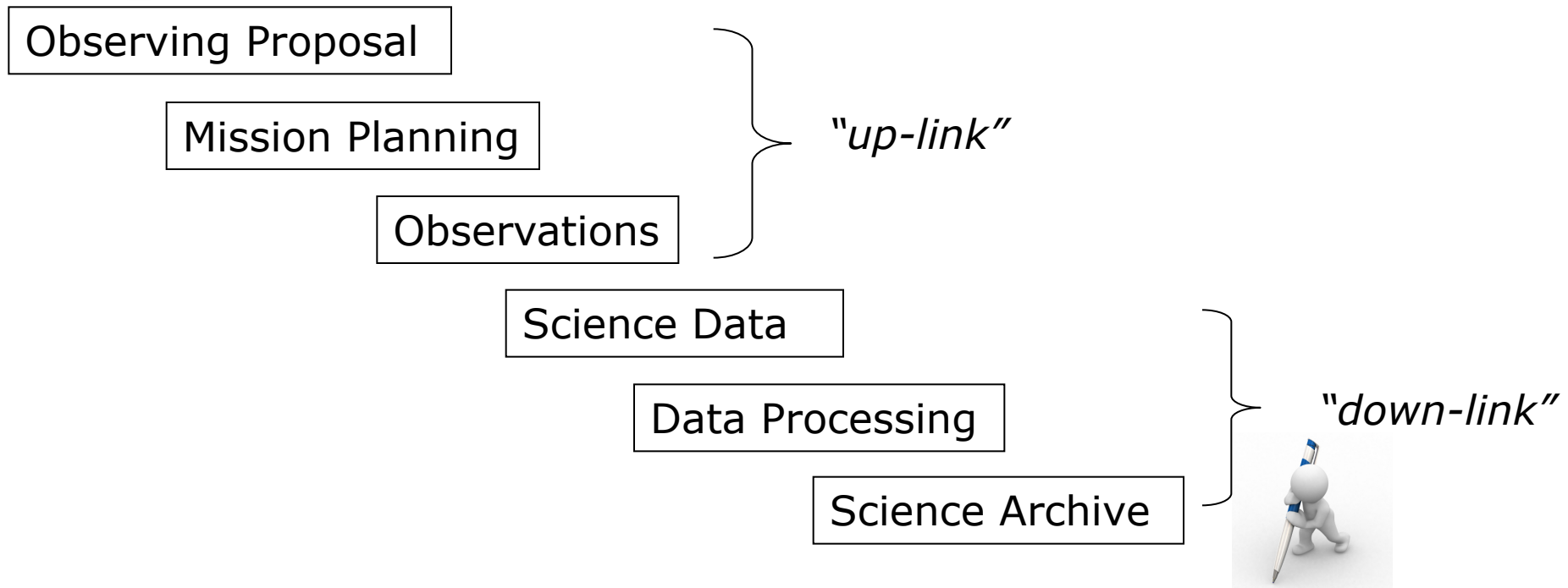


EChO Ground Segment: Overview & Science Operations Assumptions

Matthias Ehle & the “Science Ground Segment Working Group”
EChO Science Operations Study Manager

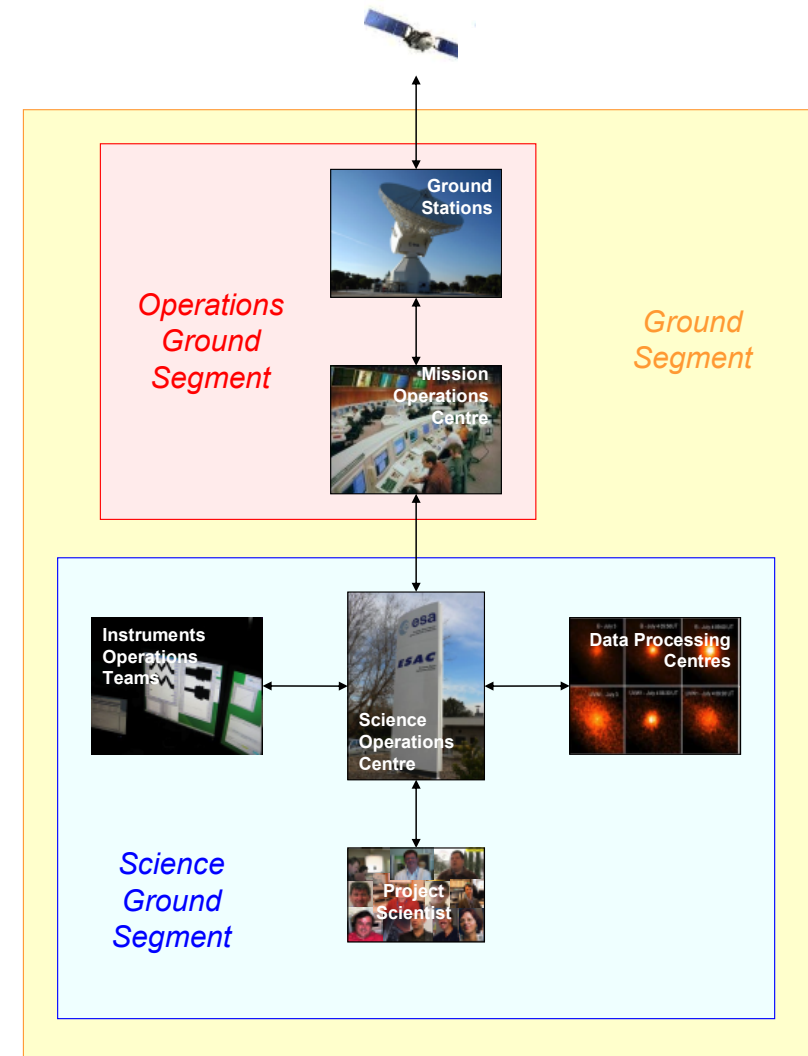
ESA-ESAC, Madrid
Science Operations Department/Division
Directorate of Scientific and Robotic Exploration

- Main Idea is to support Science, i.e. to facilitate all steps **from the idea for an observation to the publication.**



Ground Segment Overview (the ESA approach)

- Main actors of a Ground Segment:
 - **Operations Ground Segment**
 - ⇒ Mission Operations Centre
 - + Ground Stations
 - **Science Ground Segment**
 - ⇒ Science Operations Centre
 - + Instrument Operations Teams
 - + Data processing Centres
 - + Project Scientist
- **ESA funds** the OGS, the SOC & PS
- IOTs & DPCs (for EChO, know as the Instrument Operations and Data Centre, IOSDC) is **nationally funded**
- SGS split is because of costs, but also because of areas of expertise



EChO is a survey mission, with an observatory component, i.e.

there will be a **core** mission sample (key programme) & (some) open time (10-20% TBC)

Nature of the mission has an impact on the SOC requirements:

- Scientific Mission Planning (long term plan & short term scheduling)
- Science Data Processing
- Quick Look Analysis
- Science archive, i.e. proprietary periods and public data
- User Support: including Documentation, HelpDesk

➤ Science Planning:

- Long Term Planning for core programme is to be done by IOSDC
 - (Dedicated **talks to follow**)
 - Adjustments of Ground Station passes (several months in advance) is TBC (MOC)
- Prioritization according to scientific goals, set by Project Scientist
- SOC maintains proposal/observation data base, proposal handling system
- SOC handles Open Time requests as fillers & adds calibrations to Short Term Schedule
- Generation of payload timeline of activities (endorsed by Project Scientist) delivered by SOC to MOC for final timeline generation
- SOC will provide Mission Planner and Coordinator for IOSDC-MOC-SOC interfaces

Note: direct IOSDC-MOC link is foreseen for fast reaction to instrument anomalies

➤ Data Processing:

Data product Levels:

- **Level 0:** Unpackaged/decompressed raw spacecraft data (to include payload, spacecraft/ground segment data) for each observation/target visit;
- **Level 1:** Individual calibrated light curves for each target visit. Data will be in the form of cubes containing spectral timelines that record the observed flux as a function of time (binned per cadence interval), per spectral bin of the EChO spectrometer;
- **Level 1.5:** All available spectral timelines per source (many visits TBD) combined together in a single data structure;
- **Level 2:** Individual transit and/or occultation spectra for each exoplanet observed, stacked to include all transits/occultations observed over the course of the mission. Where orbital phase measurements have been made, spectra will be provided at multiple epochs. In all cases, spectra for individual visits will be included in the product.

➤ Data Processing: IOSDC & SOC shared responsibilities:

IOSDC tasks:

➤ IOSDC will provide software modules and processing blocks:

- payload-specific software to convert instrument telemetry, FGS data and spacecraft HK data to Level 0 products;
- for the generation of Level 1 and Level 1.5 products;
- for generation of Level 2 products that are specific to observations of exoplanets; It is noted that products up to Level 1.5 can be produced in a standard way (on a per observation basis) while Level 2 will need proposal information and programmatic information included. In case automatic generation of Level 2 is not possible, IOSDC will provide recipes, threads and documentation needed to allow the user repeating the IOSDC provided 'manual' Level2 product generation.

➤ IOSDC will generate, maintain and deliver **calibration files** necessary for the processing.

➤ IOSDC will **provide s/w storage, quality and version control, as well as s/w issue tracking system.**

➤ Data Processing: IOSDC & SOC shared responsibilities:

➤ SOC tasks:

- **SOC will operate IOSDC provided data processing pipeline** needed for the generation of data products up to Level 1.5. It is TBD whether the generation of Level 2 products will be achievable via a single set of algorithm run in an automated way. SOC will also **perform bulk re-processing** at TBD periods.
- **Level 0, 1, 1.5 and 2 (at a later stage) data will be pipeline-generated by the SOC** and made available, in case of data belonging to the core programme, to the IOSDC; all these products will also be used **to populate the EChO archive** and will be made available to the science community following expiration of the proprietary period.

At the beginning of the mission Level 2 products will be delivered by IOSDC, with the expectation that a pipeline with customizable scripts will be available by the end of the mission.

*Note: processing related to s/c **Pointing Reconstruction** is considered a **critical ESA responsibility: MOC-SOC-Industry with possible involvement of IOSDC***

➤ Quick Look Analysis (QLA):

Needed as fast quality control (at SOC) to check that observational data fulfils principal criteria for further pipeline processing and correct application of current calibration.

- It is assumed that QLA can be done within the science data processing environment:
 - In addition to instrument monitoring tools at IOSD: TBD QLA products (based on TBD metrics for science and/or HK data) will be generated
 - SOC, operating the pipeline, will submit anomaly reports into issue tracking system, accessible to IOSDC and SOC members
 - **Whether an observation needs to** be repeated will depend on TBD thresholds and approval by Project Scientist

➤ Data Archiving:

- At ESAC – **for all current & future ESA scientific missions** (Science Archive Team expertise); in order **to guarantee maintenance and long term access**; currently hosting:



Two views of a single EChO Archive:

- “Operational” Archive: to support science operations (e.g. data exchange, instrument monitoring, calibration, file repository for pipeline processing)
⇒ privileged access PI team and observers ⇒ controlled access
- “Legacy” Archive: **providing** community access to data products of the mission (similar interfaces, same “look and feel” **for all ESA missions**); keeping all mission relevant information long into the future: **all data (raw, calibration, processed), products, ancillary data, documentation, processing s/w, ...** ⇒ public access (for many years)

➤ Other Activities:

- Support to instrument monitoring and calibration (some expertise in payload h/w and instrument operations needed)
 - Instrument Operations Scientists, a.k.a. Liaison/Disciplinary/Calibration Scientists, part-time collocated in PI teams during Development Phase & Operations
- **Open Time proposal handling**
 - TAC support, observations enhancement
- **User Support to Scientific Community**
 - Help Desk, both for general users and guest observers
 - Documentation: EChO Users Handbook, Archive Guide, Data Processing Guides (IOSDC responsibility), ...
 - Outreach activities, including data processing workshops, conferences
 - EChO SOC web portal

IOSDC will be required to support many of these activities, esp. where instrument expertise is needed.

EChO (Science) Ground Segment Elements

