

European Space Operations Centre

Lessons Learned at ESA?

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Itinerary

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ESOC Responsibilities

- Development of Infrastructure for the operation of ESA satellites (Ground Segment)
- Operation of ESA and external customer satellites in all mission phases
- Coordination of satellite operation activities throughout Europe
- Development of technical space-related standards
- Competence centre for Space Debris investigation in Europe

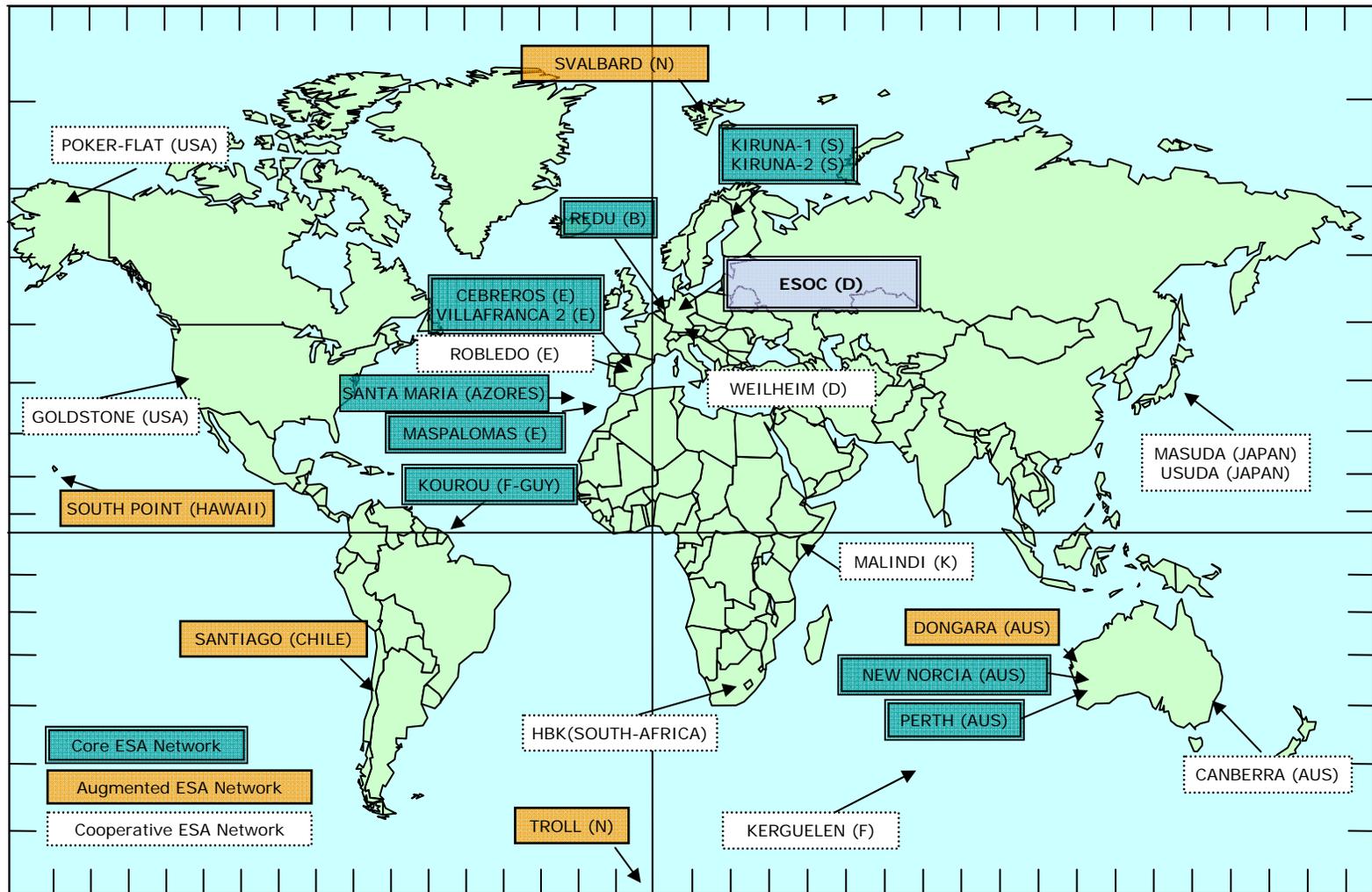


Operating Satellites since 1967

- More than 55 ESA satellites / 57 non ESA (100% success rate)
- All phases:
 - Preparation
 - Launch and Early Orbit
 - Commissioning
 - Routine
- Almost all types of orbits:
 - Low Earth
 - Geostationary
 - Highly eccentric
 - Interplanetary
- 7 missions rescued after failure in orbit
- Presently 10 missions / 13 spacecraft operated in-flight



ESA Station Tracking Network (ESTRACK)



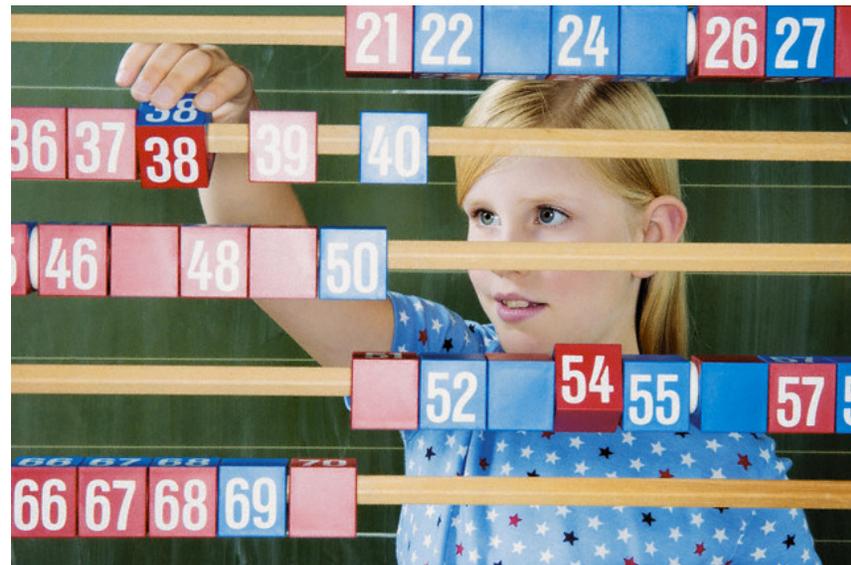
Knowledge Management (KM) Context

- 1999 - Need for KM driven by Rosetta leading to ROSKY
- 2002 - Internal review of ESOC confirmed the need for KM
- 2004 - KM Working Group set up: benchmarking
- 2006 - KM Initiative in OPS
 - Developed a knowledge audit methodology
 - Completed a pilot project in the domain of Flight Dynamics:
 - Performed a survey division-wide with questionnaire
 - Performed experts + managers interviews
 - Analyzed results from survey + audits
 - Compiled a Knowledge Handbook & Audit report for the division
- 2007 ongoing – Start of OPSKM project



Lessons Learned Principles

- Operating space- and ground systems, shall encompass amongst others:
 - address past experience!!
- Any lesson learned, whether positive or negative, shall be properly tabled and related messages passed to those involved in:
 - defining, implementing, validating and operating space/ground segment assets.
- Process must involve
 - industrial partners procuring systems on prime- or subcontractor level
 - national/ international partners cooperating



Past ESOC Lessons Learned Approach

- For each project delegated to ESOC for preparation and execution an informal lessons learned process was established
- After launch and in-flight commissioning activities were completed and shortly after the start of routine operations a dedicated Lessons Learned (LL) Meeting was convened.
- The Ground Segment Team (GSM, SOM, DSM, FDM, SFM and QAR) have prepared presentations for their domain of expertise to specifically address things they wish to
 - STOP (avoid in the future)
 - START (forgotten)
 - CONTINUE (found good and worth to retain)
- LL Meetings were attended by cognizant ESOC staff from within and outside the project, and senior management. Project participation was not always ensured.
- LL meetings were triggering source of specific workshops held with industry and projects

ESA Reviews to address Lessons Learned

- Agency's policy that all projects shall be subject to a review process.
- ESOC Quality Management System defines working instructions for ground segment reviews:
 - Ground Segment Requirements Review (L-5 years)
 - Ground Segment Design Review (L-3 years)
 - Ground Segment Implementation Review (L-1 year)
 - Ground Segment Readiness Review (L-3 months)
 - Mission Commissioning Results Review (L+ 3 months)
- As part of the Agencies "lessons learned" and KM process reviews also address experience gained (positive or negative) applicable to other projects.



Scope of ESOC QMS Lessons Learned (1/2)

- A "Lesson Learned" (LL) is a documentation of an unexpected experience gained (either positive or negative) with the execution of a particular procedure or task. A given LL document contains:
 - administrative information (Issue Date, status, Domain Responsible etc)
 - the context in which the experience has been gained
 - a description of the experience gained
 - a statement of the Lesson Learned to be extracted from the experience
 - a description of the tradeoffs that should be considered when evaluating the Lesson Learned for potential usage
 - a statement of relevance of the Lesson Learned to other potential projects.
- LL come from the work performed in ESOC, which is organized in projects and services.
- The LL procedure applies for any project (whether Mission or Infrastructure).

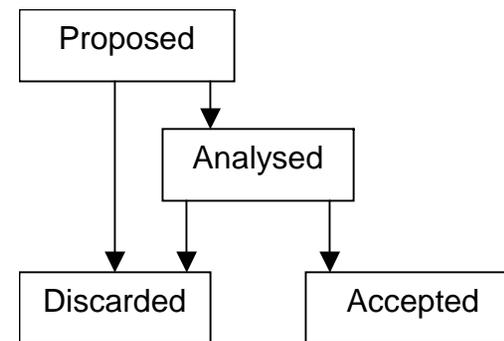
Scope of ESOC QMS Lessons Learned (2/2)

- Lessons Learned may be proposed in the following situations:
 - during reviews of the specification, development, verification, integration, validation, operations and disposal of items under the control of D/OPS
 - as a result of anomaly investigation activities
 - ad-hoc proposals, at any other time, by members of the relevant team.
- LL procedure further specifies process, and criteria, with which a proposed Lesson Learned is reviewed and approved by an appropriate authority, competent in the domain concerned, before adoption as a formal LL.
- As LL are reflections of “best practice” in a given domain they also require periodic review to ensure their continued applicability and relevance. The procedure specifies responsibilities and mechanisms to perform this maintenance.
- Finally, it is necessary to ensure that other groups actively consider the available LL for adoption. The procedure therefore defines necessary activities for review of applicability of LL.
- The procedure does not specify mechanisms or tools for the storage and dissemination of Lessons Learned records within D/OPS although a central repository mechanism is assumed to exist.

General LL Life Cycle

- LL can be seen as a document, whether it is actually stored as paper or in some electronic repository.
- LL can be in a number of states during its lifetime. (see Fig.)
- Once a LL has been initially proposed, it is submitted for detailed technical assessment.
- If the analysis is positive, the LL becomes accepted and gives rise to specific recommendations.
- Each proposed recommendation of an accepted LL is submitted for validation.

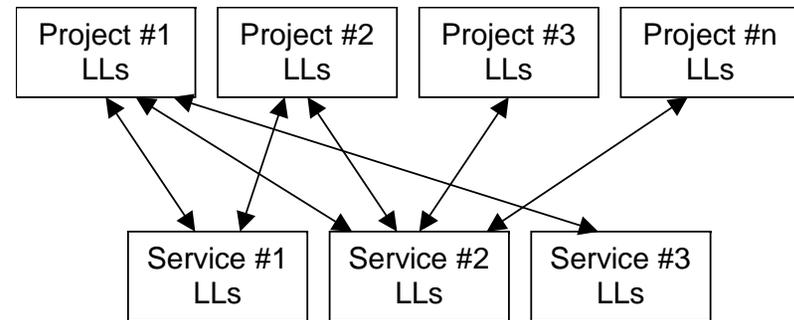
- A validated recommendation can live as it is, as an approved practice. Or the new validated practice can be enforced in an update of applicable standards (e.g. QMS procedures).



LL Life Cycle

Levels of Lessons Learned

- The life cycle of a LL depends on its context. There are two levels of Lessons Learned:
 - LL at project level
 - LL at service level
- When a LL successfully completes its life cycle at project level (i.e. it is accepted at project level), it may be proposed as LL at service level.
- The splitting in two levels allows for separate validation: new practices validated and enforced at project level may be not suitable for the entire affected ESOC domain.
- This is also to be considered vice-versa, i.e. from Service LLs to Project LLs.



Levels of Lessons Learned

Roles & Responsibilities of LL Life Cycle

	Project/ Service team member	Domain Responsible (Sec) / (Div)	Project/ Service Review Board
<i>Proposal</i>	1) Generate project /service LLs from occurred unexpected experience or validated project LLs.		1) Generate project/ service LLs from reported unexpected experience.
<i>Assessment</i>		2) Analyze candidate project LLs for acceptance/ rejection. 3) On project accepted LLs, propose recommendations for project follow on activities/ recommendations for service new practices.	
<i>Validation</i>			4) Analyze proposed project/ service recommendations for validation/ rejection. 5) On project/ service validated recommendations, decide for mandatory application.

Domain Examples / Technical expertise on:

- Software (Development, Validation, Maintenance, Activities Management)
- Hardware (Design, Integration, Upgrade, Activities Management)
- Systems & Operations (Equipment I/F, Procedure Definition, Operations/Maintenance Planning & Execution, System Activities Management)

Workshops with Industry/ Projects

- On the request/ initiative of industry (Astrium GmbH) bi-annual workshop was/ is conducted
- Initially for XMM and Envisat, later also for Rosetta mission to give feed-back on in-flight performance of spacecraft systems and subsystems
- Workshops are attended by project managers and their key staff
- Similar workshop held at ESTEC to brief ESA project team members (Sep 2007) but only limited attendance
- Astrium SaS (F) has signalled interest to have feed-back on Mars Express, Venus Express in-flight performance, but workshop still to be held
- ESA Inspector General was contacted with a view to formalize and coordinate workshops.

Exchange of In-orbit Anomalies

- ESA and CNES have established a weekly exchange of in-orbit anomalies, which is considered very useful.
- To fully appreciate the currently exchanged set of information requires knowledge of the system and the different acronyms. Hence, in-flight anomalies should be discussed in a forum and/or a periodic lessons-learned review meeting, possibly extended to design aspects (every 12-18 Months).
- A further element of improvement would be a database (as-built CIDL) associating affected spacecraft components with a list where used or planned to be used. This would allow to improve the correlation of subsystem across the missions.
- Due consideration has to be given to the aspect of confidentiality. This requires “owner” agreement to provide all necessary clarification on specific in-orbit anomaly exchange protocol.

Conclusions

- When operating space- and ground systems, Safety and Mission Assurance shall also encompass to address past experience
- The Lessons Learned process is an essential means to implement this important aspect
- Whether done formal or informal the LL process will allow to share knowledge and help avoiding to repeat mistakes or to hint on design flaws of spacecraft subsystems/ components
- Intellectual Property Rights have to be respected, but in the interest of both providers and users a sensible scheme could be envisaged.
- ESA has started LL process and is ready to reinforce for a more uniform and wider application.

