Developing the new generation control systems – a recipe for success

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The future is here!

On January 19th, ESOC successfully used their new mission control system (EGOS-CC) to operate one of the SWARM earth observation satellites

- First in a series of events planned as part of the shadow operations activities for Swarm constellation
- Target is to complete the migration and fully switch to the new control system by end-2023
- **Afterwards, further missions will follow!**
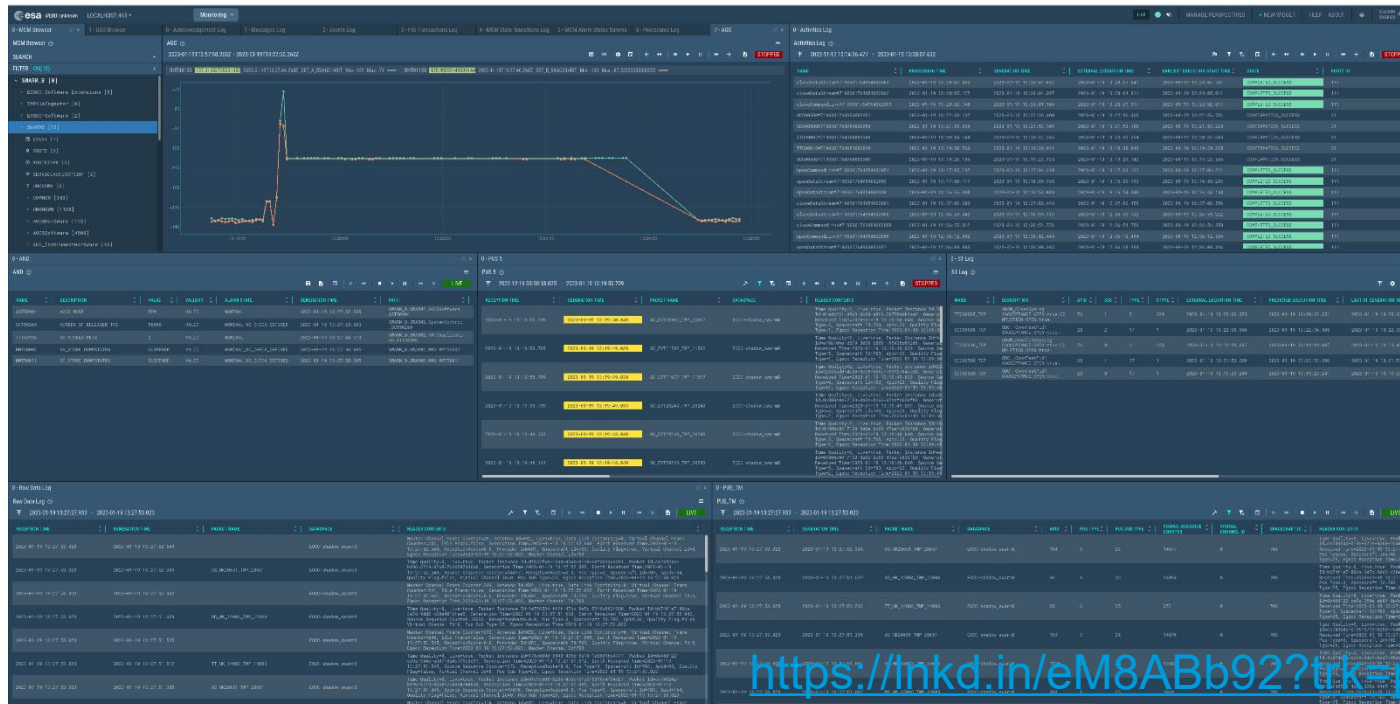
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You might remember that …

… we (European Space Operations Centre - ESOC) started a project in 2016, aiming at replacing the current Ground and Space assets monitoring and control systems at ESOC/European Space Agency (ESA) by a new control system supporting multi-mission operations

And that …

… we decided to build upon the European Ground System - Common Core (EGS-CC), an ESA-led European initiative with early pre-studies starting already in 2011

Now, at least seven years later – a very long time for software – the adoption phase has started and we plan to successively migrate flying missions to the new control system (EGOS-CC) starting end of this year.

Could we have done differently, better, faster?

Non-optimal funding sources

The contractual set-up of the original EGS-CC development contract was very complex

- Lots of different, organisationally and geographically separated teams

- Contract was set-up to comply with ESA geo-return constraints (mandatory)

Difficulties when it came to

- Contract extensions – budget only available for some geographical regions

- Communication and collaboration on a technical level – misunderstandings caused problems which were discovered late in the development cycle

New contract was started in 2020 with a much smaller set of contributing companies working according to agile methodologies, leading to better collaboration and more efficient management
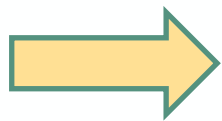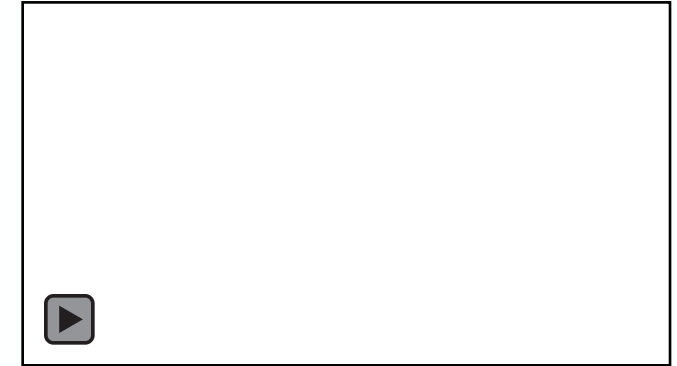
For future projects, the recommendation is to simplify (if possible) the contractual set-up and implement informal communication channels open to every contributor

Nowadays, technologies are changing rapidly…

The initial technology stack to be used was selected as part of pre-studies prior to the start of the development contract
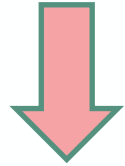
Technology stack was already partly obsolete when the project started

Technical debt continuously increasing during the first years of the project

Not benefitting from technology evolution

Significant changes, also on design level, late in the project

Technology stack modernized

Still some way to go (storage solutions, use of microservices architectures)

For future projects, the recommendation is to re-evaluate technology choices at start of development, minimize dependencies on a specific technology and have a proper evolution/change process in place

# The importance of efficient development processes

Back in 2017, an incremental waterfall approach was used

- Fixed requirements

- Relied on manual system level tests
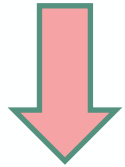
Loss of stakeholder trust and commitment

- Long delays in delivering the releases due to fixed release contents

- High efforts for executing system level tests and hence not frequently executed

- Inefficient change process
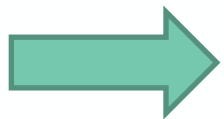
Investment in test automation and continuous delivery processes

Fixed release dates, flexible scope

Stakeholder trust and commitment

For future projects, the recommendation is to implement continuous delivery and automate tests from the start – enabling an early feedback loop

It's not all about features

End users pushed for features, and early development phases prioritised features before usability and maintainability
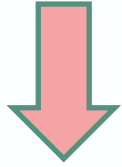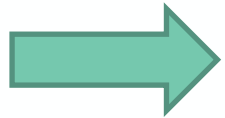
Performance and usability suffered

Features could not be easily validated due to lack of usable deployment approach

Documentation out of date or targeting the wrong level of details

High familiarization and on-boarding efforts required for new people

Wiki based documentation allowing for frequent updates and ease of access

Priorities take features and maintainability/usability improvements into account

For future projects, the recommendation is to develop end-user features hand in hand with items needed to ensure a smooth process for developing, extending, installing, configuring and using the system.
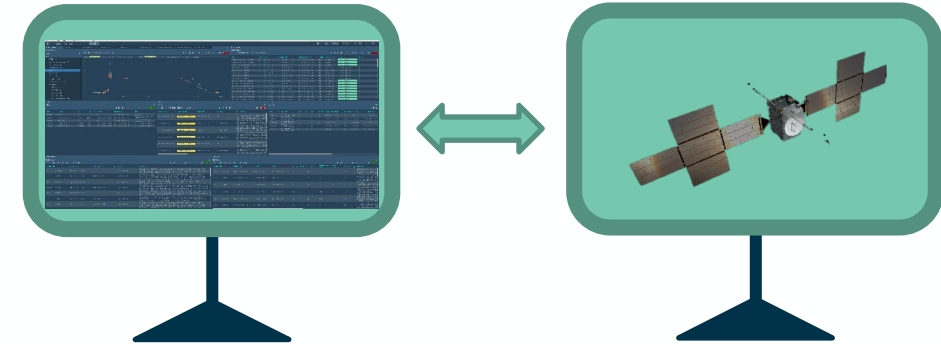
On the topic of testing …

Initially, the validation scenarios were only partly representative in terms of scenario definitions, and in terms of data set used for the validation

Validation focused on atomic requirements rather than end to end scenarios
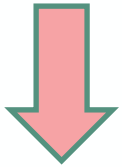
Performance issues spotted very late

Software budget out of limits

Representative scenarios defined in collaboration with end-users, driving the development

Representative data sets and validation tools identified and used

Performance issues being addressed

For future projects, the recommendation is to go for a test-driven development – allowing for EARLY identification and addressing of issues. Early involvement and participation of end users is KEY.

Downstream projects considerations

At ESOC, we had the ambition to leverage upon EGS-CC and develop a mission control system for Juice. This was a very aggressive schedule and had virtually zero slack
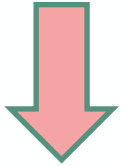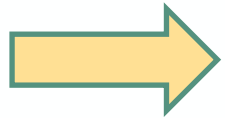
Development of components depending on EGS-CC started in parallel to the EGS-CC development

Delays were impacting downstream projects

Significant effort needed to re-align the downstream applications when the upstream dependencies changed

Loss of trust from end-users

Target mission was changed, and project timeline adjusted

Downstream components still being aligned

For future projects, the recommendation is to wait until there is confidence in the upstream dependencies before kicking off main development activities to avoid significant rework and prevent loss of trust, or pause (some) downstream activities in case of issues

A successful project doesn't end with the development

At ESOC, effort was allocated only for the development of the mission control system infrastructure. The roll-out was not considered
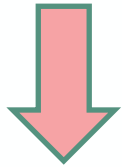
No effort for operational roll-out

No incentive to adopt the new mission control system

Essentially the first mission needs to "pave the way" for following missions, with associated costs

Adoption projects created to prepare for adoption of EGS-CC by science and earth observation missions

Actual mission migration will need to be funded by the missions, potentially with a lower or at least slower adoption rate as a consequence

For future projects, the recommendation is to include the roll-out phase in the project definition from the start and incentivize the mission adoption and migration in order to speed up the "time to market"

Takeaway in a nutshell

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Thanks for your attention!

I would like to acknowledge the excellent work of all the members of the EGS-CC and EGOS-CC project teams.