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ORCHESTRATING OPERATIONS IN THE SATELLITE CONTROL CENTRE AND BEYOND

Abstract

Automation is ubiquitous in today's space missions. Complex tasks, such as preparing and validating commands to send to the spacecraft, are performed automatically by mission support software, with the objective of saving time and reducing the risk of human errors. Despite their automated systems, most commercial missions are still far from the level of autonomy that would enable full "lights-out" operations, i.e. automating operations to such an extent that no human intervention or oversight would be needed in normal situations. However, a higher level of autonomy is highly desirable in almost all space missions: the Covid-19 pandemic has highlighted issues with staff availability during unexpected situations. Furthermore, the increasingly competitive environment adds pressure on the cost of satellite operations, which is still dominated by personnel costs.

Further automation is typically constrained by technical, functional and organisational gaps between the different parts of the ground segment. More often than not, coordination is manual: planning meetings, phone calls, emails, etc. Similarly, data exchanges often rely on manual tasks, such as data extraction to a spreadsheet, reformatting, interpretation, etc.

Our novel approach to fill these gaps is inspired by digital transformation strategies from other industries. Instead of trying to automate each coordination task independently, we coordinate all workflows, i.e. sequences of processes subject to specified business rules, and all data flows in a consolidated manner. Workflows and data flows are intimately bound together, with data providing information that directs workflows. Managing both types of flows conjointly simplifies the traditionally daunting task of formalising and modelling the flows, especially in organisations with organically-evolved processes.

We have developed a distributed orchestrator that coordinates ground segment flows by triggering tasks, keeping track of events and facilitating data transfers between systems according to a user-editable Petri net model. In addition to helping operators increase the autonomy of their missions, our orchestrator improves traceability and security and provides means of verifying the correctness of the workflow. We demonstrate how it can be used to implement a realistic use case: retrieve customer orders from a cloud-based service, validate them, securely transfer them to an internal network, update the spacecraft schedule, retrieve the corresponding telemetry, generate final products and transfer them to the customers.