IAF SPACE SYSTEMS SYMPOSIUM (D1)
Technologies that Enable Space Systems (2)

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SECURING SATELLITE OPERATIONS: A NOVEL APPROACH FOR SPACE ASSETS ON-BOARD SAFETY

Abstract

In an era marked by a rapid increase in satellite deployment and the emergence of highly interconnected constellations, the potential for malicious activities targeting space systems has escalated significantly. Threats such as eavesdropping, jamming of GNSS or Telecommunications, tracking and behaviour monitoring for satellite takeover pose substantial risks to the integrity and functionality of space assets. With standardized hardware and software components becoming more prevalent, targeted exploits not only jeopardize individual spacecraft but can also disrupt entire constellations, mirroring vulnerabilities seen in ground-based systems such as autonomous ground vehicles.

This study delves into the critical need for robust on-board safety measures to mitigate risks posed by unauthorised access to satellites and their stored information. Furthermore, with the shift toward more autonomous systems, it becomes increasingly crucial to detect unusual or uncommon behaviours exhibited by the satellite. On-board solutions can relieve operators of a portion of the diagnostic workload, transferring it to the satellite platform. This enables the ground segment to handle inference and critical actions promptly upon notification of unexpected behaviour. Beyond jamming or eavesdropping attacks, one critical vulnerability lies in the transmission and acceptance of telecommands. As long as these commands can be correctly decoded, they are trusted implicitly. They could interfere with spacecraft operations and perturb mission objectives, or lead to potentially disastrous maneuvers for the payload or the platform.

In response to these emerging challenges, this paper analyses an innovative onboard safety flow aimed at safeguarding satellites. The proposed approach revolves around two primary axes: the identification and detection of potentially hazardous commands through expert system technology; and data-driven analysis to identify anomalies such as jamming or abnormal communication patterns.

The aim is to execute these activities directly on-board the spacecraft, triggering a warning to be sent to the ground segment upon detection of anomalous patterns within the satellite telemetry or telecommand logs. While current space cybersecurity measures predominantly focus on the ground segment, the proposed approach complements these pre-existing solutions.

After an overview of the state-of-the-art, the paper analyses the use cases where this technology can provide an important edge in safe mission operations. The focus then shifts toward the description of the software routine that concretizes the proposed approach for on-board safety. Finally, the prototype is validated against realistic attack data provided by the French Space Agency (CNES).