KEKOA: Knowledge Extraction Kernel for Operational Automation in LEO Constellations

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***Abstract*—The rapid proliferation of Low Earth Orbit (LEO) satellite constellations has created a new paradigm in space infrastructure, characterized by distributed mesh topologies and high-velocity orbital dynamics. However, these systems face unique failure modes—ranging from radiation-induced single-event upsets (SEUs) to collision risks and ground-link cyber interceptions—that traditional ground-in-the-loop control systems cannot address in real-time. This paper proposes KEKOA, a decentralized autonomy framework embedded directly into satellite on-board computers (OBCs).**

KEKOA operates on two distinct functional layers. First, it utilizes Federated Learning (FL) to aggregate telemetry and payload data across the constellation, training global anomaly detection models without consuming critical downlink bandwidth. Second, it deploys Autonomous AI Agents capable of executing "overwatch" protocols—modifying attitude control, managing power distribution, and executing collision avoidance maneuvers without ground intervention. We present a simulation where KEKOA successfully identifies and mitigates a coordinated cyber-physical attack during a solar storm event, demonstrating a 400% increase in response speed compared to traditional telemetry-command loops.