EESE: Energy-Efficient Communication between Satellite Swarms and Earth Stations

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***Abstract*—The promising projects of satellite swarm have been studied by scientists from NASA, ESA and other institutes around the world. With a massive number of pico-class, low-power and low-weight space-crafts like pico-satellites, nano-satellites, Swarm can exploring outer space environment or taking other tasks that are hard to be fulfilled by common satellites. The other merit of using swarm than common satellite is cost reduction. Besides all the advantages of satellite swarm, developing swarm-based satellite systems from conceptualization to validation is a complex multi-disciplinary activity. Swarm is commonly energy-constrained, so one of the key challenges is how to achieve energy-efficient data transmission between the satellite swarm and terrestrial terminal stations. By employing Lyapunov optimization, we present an online control algorithm called EESE for optimally dispatching traffic load among different satellite-ground links to minimize overall energy consumption over time. Our algorithm is able to independently and simultaneously make control decisions about traffic dispatching on ISLs and UDLs to offer provable energy and delay guarantees, without requiring any statistical information of traffic arrivals and link conditions. Rigorous analysis has demonstrated the performance and robustness of our algorithm.**

Keyword—Satellite Swarm, Optimal Control, Dynamic Scheduling, Wireless Communication, Energy Efficiency.

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