

SPACE OPERATIONS SYMPOSIUM (B6)  
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THE EVOLUTION OF SATELLITE OPERATIONS: FROM 5 TO 100'S OF SATELLITES

**Abstract**

Operating 5 satellites is a challenge. Operating 100 satellites requires a new concept of operations and a new operational paradigm. Today large satellite constellations number in the 10's or 100's rather than single digits. Planet operates the Doves: a constellation of more than 100 satellites working to deliver coverage of the Earth at a cadence never seen before. The Doves' primary mission—dubbed Mission 1—is to image the whole Earth, every day and make global change visible, accessible, and actionable. In conjunction with the Flock, Planet operates the RapidEye constellation. RapidEye was launched in 2008 with a novel concept: to allow for daily revisit of any site between +/-84 degrees latitude. Examining the concept of operations for both systems shows the evolution of large imaging systems for Earth observation over the past decade. The paradigm has now shifted from imaging any site using small to medium size spacecraft to imaging all sites using cubesats.

Planet's 5 satellite RapidEye constellation has been operational for more than 8 years and employs a single ground station for image downlink, telemetry, and telecommand control. The Doves were built incrementally and use a variety of orbits. The imaging capacity of the Doves necessitates multiple ground stations to download the huge amount of data generated. The system architecture for RapidEye and the Doves are compared to show how these architectures impact data latency and distribution, mitigate down-time, and affect the nature of telecommand and control for large numbers of spacecraft. Concepts from RapidEye operations are compared with the latest operational best practices for the large scale satellite systems used by the Doves. The discussion is extended to include concepts for collision avoidance, staffing, and how satellite operations has shifted from a centralized spacecraft control center, to a cloud based system.

Telemetry monitoring and alerting has been re-envisioned for increased automation; it's impossible to manually review satellite performance for large constellations. The launch strategy is also reviewed and shows how Planet is leading the industry with a low-risk distributed launch profile that mitigates launch failure. RapidEye set the foundation for large constellation operations in 2008 and today this envelope is being expanded to include more than 100 Dove satellites. Invaluable lessons about operating RapidEye and the Doves can be gained by tracing the similarities and differences and can help provide guidelines for systems that are an order of magnitude higher in number.