

# Enabling Scalable FAIR Data Archiving for High-Cadence Commercial Planetary Missions

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The NASA Commercial Lunar Payload Services (CLPS) initiative has significantly increased the cadence of lunar exploration, enabling commercial providers to deliver multiple NASA science and technology payloads to the Moon within short timeframes. This shift from infrequent flagship missions to distributed, high-frequency commercial deliveries presents new challenges for the Planetary Data System (PDS). To ensure that CLPS and related lunar mission data are archived in a timely, consistent, and FAIR-compliant manner [1], scalable and standardized data management processes are essential.

Beginning in 2023, PDS nodes implemented a structured framework to support CLPS instrument teams in developing PDS4-compliant data archives [2] with reduced need for continuous direct oversight. Approximately six months prior to launch, PDS engages with mission project scientists and instrument teams to establish archive development timelines aligned with expected data release dates. A centralized collaboration environment provides standardized checklists, task schedules, documentation templates, naming conventions, and validation guidance. These shared resources define responsibilities across PDS nodes, instrument teams, and supporting organizations.

At the core of this approach is a detailed archive development schedule that outlines required steps including Logical Identifier assignment, DOI reservation, archive design, label template development, data dictionary updates when necessary, generation of XML labels, documentation preparation, validation, and external peer review. Clearly defined milestones and scheduled check-ins improve accountability and reduce late-stage corrections. Instrument teams can upload draft products for iterative feedback, enabling early identification of metadata or structural issues.

This framework directly supports adherence to the FAIR data principles. PDS4 XML labels enforce structured metadata and persistent identifiers, improving findability and interoperability. Open public distribution ensures accessibility, while standardized data formats and detailed documentation enhance reusability. External peer review further validates scientific clarity and usability prior to release.

Lessons learned from early CLPS deliveries are informing refinements to this process and are being applied to upcoming commercial and resource-constrained missions. As the volume and diversity of commercial and crewed mission data increase, scalable archive development infrastructure and clearly defined community standards become increasingly critical. The CLPS experience demonstrates that proactive engagement, standardized workflows, and shared digital infrastructure can enable high-cadence commercial missions to meet rigorous archival standards without compromising scientific quality. Continued evolution of these processes will be essential to sustaining robust planetary data stewardship in an era of accelerated exploration.

[1] Wilkinson M. D. et al. (2016) *Scientific Data*, 3(1), 1-9. [2] Planetary Data System. (2025). Planetary Data System Standards Reference, v. 1.25.0,

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