NASA Gateways to Blue Skies Competition

Innovative Airborne Platforms for Inspecting Land-Based Infrastructure
Understanding the Present Requires Knowing the Past

Challenge Statement
The infrastructure industry is pursuing transformative improvements in productivity, sustainability, resilience, and cost efficiency. Industry leaders have identified opportunities to achieve up to 40% performance improvements through next-generation digital delivery and integrated infrastructure ecosystems as outlined in *Operating System 2.0: Redefining the Capital Projects Business Model* developed through the Construction Industry Institute (CII) and Construction Users Roundtable (CURT).

At the same time, advances in autonomous airborne systems, digital twins, AI, and remote sensing are creating unprecedented opportunities to inspect and manage critical infrastructure.

However, AI's effectiveness is constrained by the quality, consistency, and interoperability of the underlying data.

Understanding the present requires knowing the past.
Real-time imagery alone cannot provide trustworthy decision support. The imagery must be compared against authoritative historical records, digital twin information, financial data, lifecycle information, and engineering context.

Vision
Develop a new generation of airborne infrastructure inspection platforms capable of comparing real-time imagery and sensor data against high-integrity digital twin environments built upon open standards and interoperable digital ecosystems.

The system would create actionable intelligence for:

- Transportation infrastructure
- Energy facilities
- Water systems
- Buildings
- Industrial facilities
- Future space infrastructure

Rather than simply collecting images, airborne systems would become intelligent digital ecosystem participants.

Concept
The proposed platform combines:
Real-Time Airborne Data Collection

- Drones
- Autonomous aircraft
- Satellite observations
- Advanced imaging systems
- LiDAR and sensor fusion

Digital Twin Ecosystems
Using:

- buildingSMART IFC
- ISO standards
- Open digital twin frameworks
- Asset lifecycle information

Financially Aware Infrastructure Systems
Extending digital twins beyond physical representation to include:

- Asset financing
- Capital project performance
- Lifecycle costs
- Risk indicators
- Investment data

supported through XBRL-enabled financial information standards.

AI-Powered Infrastructure Intelligence
AI systems would compare:
What the infrastructure should look like versus **What the infrastructure actually looks like today**
using:

- Historical digital twin records
- Asset condition history
- Construction data
- Operational data
- Real-time imagery

This significantly improves confidence, explainability, and accuracy.

Innovation
High-Integrity AI
Most AI systems depend upon large quantities of unstructured data.
This concept focuses on:

- Trusted data
- Verifiable data
- Standardized data
- Auditable data

allowing AI to operate with far greater precision and accountability.

Open Standards Architecture
The proposal leverages:
- buildingSMART IFC
- XBRL
- ISO standards
- Government interoperability initiatives

to avoid proprietary lock-in while supporting innovation and competition.

Digital Ecosystem Integration
The solution connects:
- Airborne inspection systems
- Digital twins
- Asset management systems
- Financial systems
- Government reporting systems
- Capital markets

through a common information framework.

Alignment with NASA Interests
The proposal extends beyond infrastructure inspection.
NASA has long demonstrated the value of interoperable systems and digital engineering in complex environments.

This concept supports:
- Earth observation applications
- Digital engineering
- Autonomous systems
- AI-enabled decision support
- Infrastructure resilience
- Technology transfer to commercial markets

The architecture also aligns with future space infrastructure needs where digital representations, inspection systems, financial accountability, and interoperability must coexist.

Alignment with Federal Priorities
FHWA Advanced Digital Construction Management Systems (ADCMS)
The concept directly supports ADCMS objectives by enabling:
- Digital twins
- Real-time monitoring
- Lifecycle asset management
- Interoperable infrastructure information
- Open data ecosystems

Government-Wide Data Interoperability
The proposal supports federal efforts to improve government-wide data interoperability and trusted digital records through open standards-based information exchange.

Infrastructure Modernization
The concept supports national objectives to improve:

- Safety
- Asset performance
- Resilience
- Transparency
- Productivity

while reducing lifecycle costs.

Role of the Infrastructure Financial Data (IFD) Working Group
The Infrastructure Financial Data (IFD) Working Group will serve as mentors and advisors. The working group provides expertise at the intersection of infrastructure, digital twins, finance, and data standards.

University and Industry Collaboration
University participation provides:

- Independent research
- Transparency
- Workforce development
- Student engagement
- Testbed environments
- Cross-disciplinary innovation

Potential collaboration among universities, industry, standards organizations, and government agencies creates a scalable ecosystem for long-term advancement.

Expected Outcomes
Technical Outcomes

- AI-enabled airborne inspection systems
- Real-time digital twin validation
- Open standards interoperability
- Trusted data pipelines
- Automated condition assessment

Economic Outcomes

- Reduced inspection costs
- Improved infrastructure performance
- Accelerated digital transformation
- Increased productivity
- Support for Operating System 2.0 objectives

Strategic Outcomes

- Stronger collaboration between NASA and infrastructure stakeholders
- Alignment of capital markets with the built environment
- Advancement of digital ecosystem approaches
- Foundation for future terrestrial and space infrastructure systems

Closing Statement

Understanding the present requires knowing the past.
By combining real-time airborne observations with trusted digital twins, financial data, and open standards-based digital ecosystems, this concept transforms infrastructure inspection from image collection into actionable intelligence.

The result is a new generation of infrastructure systems that are not only digitally connected, but also financially aware, interoperable, auditable, and capable of fully leveraging the promise of artificial intelligence. For projects on earth and in space.