Reference Architecture Functional Development Challenge: Space-Based Data Acquisition, Storage and Dissemination

In the rapidly evolving domain of space-based data acquisition, the design and implementation of a robust data architecture present multifaceted challenges that must be addressed to ensure seamless collection, storage, processing, and analysis of data. As organizations venture into the utilization of satellite and space sensor data, it becomes imperative to overcome these challenges to harness the full potential of space-based information. CAL FIRE, the California Department of Forestry and Fire Protection, stands at the forefront of needing such advanced data architectures to effectively monitor, manage, and mitigate wildfires across the state.

As CAL FIRE integrates satellite and space sensor data into their operations, they face three critical challenges in data architecture. First, the diversity and volume of data sources and ingestion mechanisms require efficient and scalable solutions to handle real-time data streams. Second, the data storage and processing layers must be designed to manage vast amounts of data while ensuring data integrity, security, and accessibility. Lastly, the data consumption and analytics layers need to facilitate advanced analytics and decision-making processes, enabling CAL FIRE to respond swiftly and effectively to wildfire threats. These challenges highlight the necessity for a comprehensive and resilient data architecture that can support CAL FIRE's mission in safeguarding California's landscapes and communities.

Challenge 3: Data Consumption and Presentation/Analytic Layers and Platform

Objective: Develop tools and interfaces for data scientists, analysts, and business users to access, visualize, and analyze data, enabling actionable insights while ensuring data security Development of a data clearing house.

The third challenge focuses on the consumption, analysis and presentation of data. It will be crucial to develop datasets and a data library or clearing house to provide secure access to data for the multitude of CAL FIRE partners across the US and worldwide.

The development of a data clearing house for space-based detected data would create a comprehensive platform that accommodates a diverse array of data types, ensuring they can be securely stored, visualized, and analyzed. The platform should integrate advanced data management tools and robust ETL processes, the clearing house must enable seamless ingestion, transformation, and management of a multitude data types. Users, including data scientists, analysts, and business users, will have access to cutting-edge visualization tools and interactive dashboards that support the real-time exploration of data. This would empower them to derive actionable insights and make data-driven decisions. Additionally, secure access mechanisms, such as role-based access controls and encryption, must be

implemented to protect sensitive information from unauthorized access, ensuring the integrity and confidentiality of the data.

Deliverables: CAL FIRE will accept submissions starting Friday, August 22, 2025, and ending at midnight on Sunday, October 26, 2025.

Platform & Interface Deliverables

User-Centric Dashboards

- Role-specific interfaces for data scientists, analysts, and business users
- Customizable views with filter/search capabilities

- **Data Visualization Tools**
  - Built-in charting, geospatial mapping, and time-series analysis
  - Integration with platforms like Power BI, Esri, or open-source equivalents
- **Self-Service Data Access Portal**
  - Query builder and simplified access to datasets
  - Usage tracking and data request workflow management

Security & Governance Artifacts

- **Access Control Framework**
  - Role-based access with least privilege principles
  - SSO integration and multi-factor authentication
- **Audit & Activity Logs**
  - Comprehensive tracking of data usage and modifications
  - Alert mechanisms for anomalous items
- **Data Security Protocols**
  - Encryption at rest and in transit
  - Secure sandbox environments for sensitive data exploration

Backend & Processing Deliverables

- **Metadata Catalog and Data Inventory**
  - Centralized repository for datasets and their lineage
  - Searchable metadata, tags, schema documentation

- **Data Integration Pipelines**
    - ETL/ELT processes defined to populate the clearing house from various systems
    - Design real-time updates or batch sync capability
- **Data Quality Assurance Framework**
    - Validation rules, anomaly detection, and data profiling reports
    - SLA documentation for data freshness, completeness, and consistency
- **Compliance Checklist & Mapping**
    - Evidence of adherence through automation or manual review

Documentation & Enablement Materials

- **Developer & User Documentation**
    - API guides, interface manuals, troubleshooting guides
    - Use case examples for each user persona
- **Training & Onboarding Kits**
    - Tutorials, walkthroughs, and video guides
    - Change management materials for stakeholder adoption
- **Proof of Concept (PoC) and MVP Deployment**
    - Working prototype of core features
    - Initial feedback loop from early adopters

Prize for Challenges

CAL FIRE has secured a $50,000 cash prize from the Gordon and Betty Moore Foundation that will be paid by the Earth Fire Alliance for the winner of the challenge.

Judging Criteria and Methodology for Challenge

Introduction

The following document outlines the judging criteria and methodology for evaluating the deliverables of three distinct challenges. Each challenge focuses on a different aspect of data management, storage, and consumption. The judging criteria are designed to ensure that teams meet all the requirements of the deliverables in each challenge. A numeric scale will be used to judge each deliverable. The challenge will be judged by [Scott Gregory, Phil SeLegue, Ben Rogers, Ann Kapusta, Brian Collins, Sean McFadden, and

Chris Anthony. CAL FIRE has not sponsored challenges like this before but based on anecdotal evidence and discussions with industry CAL FIRE expects approximately 100 participants.

Challenge 3: Data Storage

Objective

Develop tools and interfaces for data scientists, analysts, and business users to access, visualize, and analyze data, enabling actionable insights while ensuring data security Development of a data clearing house.

Deliverables and Judging Criteria

Platform & Interface Deliverables

- User-Centric Dashboards (0-10 points)
- Role-specific interfaces for data scientists, analysts, and business users (0-10 points)
- Customizable views with filter/search capabilities (0-10 points)
- Data Visualization Tools (0-10 points)
- Built-in charting, geospatial mapping, and time-series analysis (0-10 points)
- Integration with platforms like Power BI, Esri, or open-source equivalents (0-10 points)

Self-Service Data Access Portal

- Query builder and simplified access to datasets (0-10 points)
- Usage tracking and data request workflow management (0-10 points)

Security & Governance Artifacts

- Access Control Framework (0-10 points)
- Role-based access with least privilege principles (0-10 points)
- SSO integration and multi-factor authentication (0-10 points)
- Audit & Activity Logs (0-10 points)
- Comprehensive tracking of data usage and modifications (0-10 points)
- Alert mechanisms for anomalous items (0-10 points)
- Data Security Protocols (0-10 points)
- Encryption at rest and in transit (0-10 points)
- Secure sandbox environments for sensitive data exploration (0-10 points)

Backend & Processing Deliverables

- Metadata Catalog and Data Inventory (0-10 points)
- Centralized repository for datasets and their lineage (0-10 points)
- Searchable metadata, tags, schema documentation (0-10 points)
- Data Integration Pipelines (0-10 points)
- ETL/ELT processes defined to populate the clearing house from various systems (0-10 points)
- Design real-time updates or batch sync capability (0-10 points)

Data Quality Assurance Framework

- Validation rules, anomaly detection, and data profiling reports (0-10 points)
- SLA documentation for data freshness, completeness, and consistency (0-10 points)

Compliance Checklist & Mapping

- Evidence of adherence through automation or manual review (0-10 points)

Documentation & Enablement Materials

- Developer & User Documentation (0-10 points)
- API guides, interface manuals, troubleshooting guides (0-10 points)
- Use case examples for each user persona (0-10 points)
- Training & Onboarding Kits (0-10 points)
- Tutorials, walkthroughs, and video guides (0-10 points)
- Change management materials for stakeholder adoption (0-10 points)
- Proof of Concept (PoC) and MVP Deployment (0-10 points)
- Working prototype of core features (0-10 points)
- Initial feedback loop from early adopters (0-10 points)

Methodology

Each deliverable will be judged on a scale of 0 to 10 points based on the completeness, functionality, and quality of the submission. The total score for Challenge 3 will be the sum of the scores for each deliverable, with a maximum possible score of 350 points.