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 2: Data Storage

Objective: Design a hybrid storage solution that leverages both on-premises and cloud-based options, ensuring robust data governance, integrity, security, and compliance.

The second challenge focuses on storage and processing vast amounts of data. The objective is to architect, design and develop a hybrid storage solution that combines on-premises and cloud-based storage options, offering flexibility, scalability, and cost efficiency.

Key to this challenge is the implementation of robust data governance policies that ensure data integrity, security, and compliance. This includes encryption of data at rest and in transit, access controls, audit trails, and implementation of system and data security measures.

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

Architecture & Design Deliverables

- **Solution Architecture Document**
    - Detailed diagrams showing on-prem, cloud, and integration layers
    - Justification for hybrid model choices (e.g. latency, compliance, cost)
    - Data flow mappings and access patterns
- **Storage Tiering Strategy**
    - Definition of hot, warm, and cold storage layers
    - Criteria for data placement and lifecycle policies
- **Technology Stack Overview**
    - Cloud platforms
    - Middleware or data orchestrators used
    - **Governance, Security & Compliance Assets**
- **Data Governance Framework**
    - Policies for ownership, stewardship, metadata, and classification
    - Retention schedules, legal hold procedures
- **Security Implementation Plan**
    - Encryption protocols for data at rest and in transit
    - Identity and Access Management (IAM) strategy
    - Role-based access controls (RBAC), audit logs, intrusion detection

Performance & Operational Readiness

- **Cost Optimization Report**
    - TCO comparison of on-prem vs. cloud
    - Usage forecasting and budget control mechanisms
- **Scalability & Redundancy Framework**
    - Load simulation across hybrid environments
    - Failover strategy validation
- **Monitoring & Alerting Dashboard**
    - Unified visibility into data flows, security alerts, storage consumption
    - SLA tracking and incident response plan

Supporting Materials

- **Deployment & Configuration Guide**
    - Steps for provisioning, integrating, and securing hybrid components
    - Automation scripts (IaC: Terraform/ARM templates) if applicable
- **Proof-of-Concept (PoC) Demonstration**
    - Working demo of hybrid system with sample data
    - KPI measurements: latency, throughput, integrity checks
- **Lessons Learned & Roadmap**
    - Reflections on implementation challenges
    - Suggestions for scaling to multicloud or integrating analytics

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 2: Data Storage

Objective

Design a hybrid storage solution that leverages both on-premises and cloud-based options, ensuring robust data governance, integrity, security, and compliance.

Deliverables and Judging Criteria

Architecture & Design Deliverables

- Solution Architecture Document (0-50 points)
- Detailed diagrams showing on-prem, cloud, and integration layers (0-10 points)
- Justification for hybrid model choices (0-10 points)
- Data flow mappings and access patterns (0-10 points)

Storage Tiering Strategy

- Definition of hot, warm, and cold storage layers (0-10 points)
- Criteria for data placement and lifecycle policies (0-10 points)

Technology Stack Overview

- Cloud platforms (0-10 points)
- Middleware or data orchestrators used (0-10 points)

Governance, Security & Compliance Assets

- Data Governance Framework (0-50 points)
- Policies for ownership, stewardship, metadata, and classification (0-10 points)
- Retention schedules, legal hold procedures (0-10 points)
- Security Implementation Plan (0-10 points)
- Encryption protocols for data at rest and in transit (0-10 points)
- Identity and Access Management (IAM) strategy (0-10 points)
- Role-based access controls (RBAC), audit logs, intrusion detection (0-10 points)

Performance & Operational Readiness

- Cost Optimization Report (0-10 points)
- Total cost of ownership (TCO) comparison of on-prem vs. cloud (0-10 points)
- Usage forecasting and budget control mechanisms (0-10 points)
- Scalability & Redundancy Framework (0-10 points)
- Load simulation across hybrid environments (0-10 points)
- Failover strategy validation (0-10 points)
- Monitoring & Alerting Dashboard (0-10 points)
- Unified visibility into data flows, security alerts, storage consumption (0-10 points)
- SLA tracking and incident response plan (0-10 points)

Supporting Materials

- Deployment & Configuration Guide (0-10 points)
- Steps for provisioning, integrating, and securing hybrid components (0-10 points)
- Automation scripts (IaC: Terraform/ARM templates) if applicable (0-10 points)
- Proof-of-Concept (PoC) Demonstration (0-10 points)
- Working demo of hybrid system with sample data (0-10 points)

- KPI measurements: latency, throughput, integrity checks (0-10 points)
- Lessons Learned & Roadmap (0-10 points)
- Reflections on implementation challenges (0-10 points)
- Suggestions for scaling to multicloud or integrating analytics (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 2 will be the sum of the scores for each deliverable, with a maximum possible score of 410 points.