Tailoring the New Observing Strategies Testbed to Earth Science Test Cases

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New Observing Strategies Testbed (NOS-T) Design and Development

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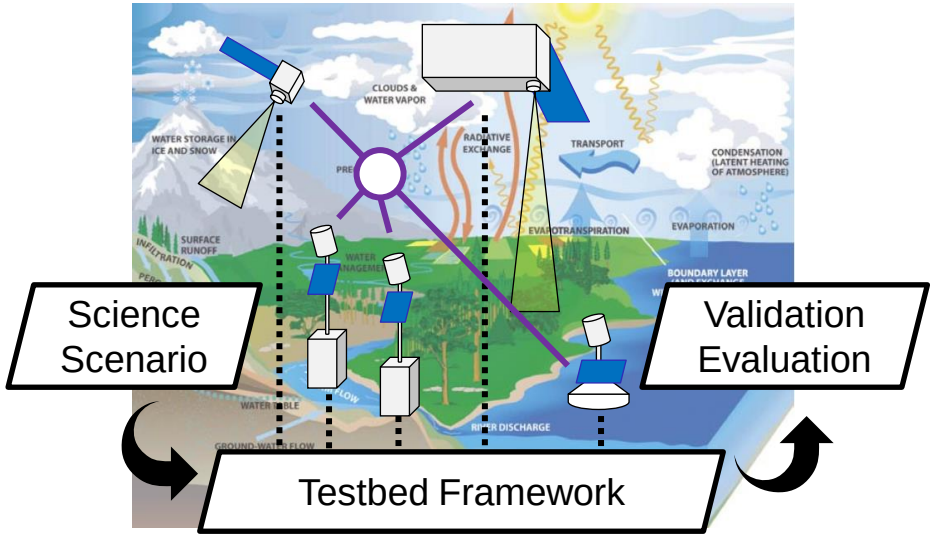
Objective

- Design and develop the NOS-T framework for disparate organizations to propose and participate in developing NOS software and information systems technology capabilities and services
  - Individually validate new NOS technologies
  - Debug and demonstrate novel NOS concepts
  - Compare competing technologies
  - Socialize NOS technologies and concepts
- Identify appropriate NOS-T governance model
- Identify appropriate NOS-T concept of operations



Approach

- Enterprise system architecting processes
  - Identify and trace value streams for program objectives
  - Model-based systems engineering methods for traceability
- Loosely-coupled information system architecture
  - Achieve nonfunctional requirements such as modularity, extensibility, security, and scalability
  - Provide technical functions such as data distribution, time synchronization, and interoperability
- Engage with Earth Science community to support emerging NOS technologies and scenarios of interest
  - Adopt representative Earth Science use case
  - Demonstrate proposed NOS-T technology for community

Key Milestones

- Framework Design v1.0: Nov. 8, 2020
  - Initial architecture/governance/operations
  - Development plan
- Framework Architecture v1.0: May 5, 2021
  - Refine requirements
  - Propose architecture
- Framework Development v1.0: Feb. 1, 2022
  - Define representative use case
  - Perform framework demonstration
  - Develop Interface Control Document
- Framework Development v1.1: Aug. 10, 2023
  Entry TRL: 2 Current TRL: 4

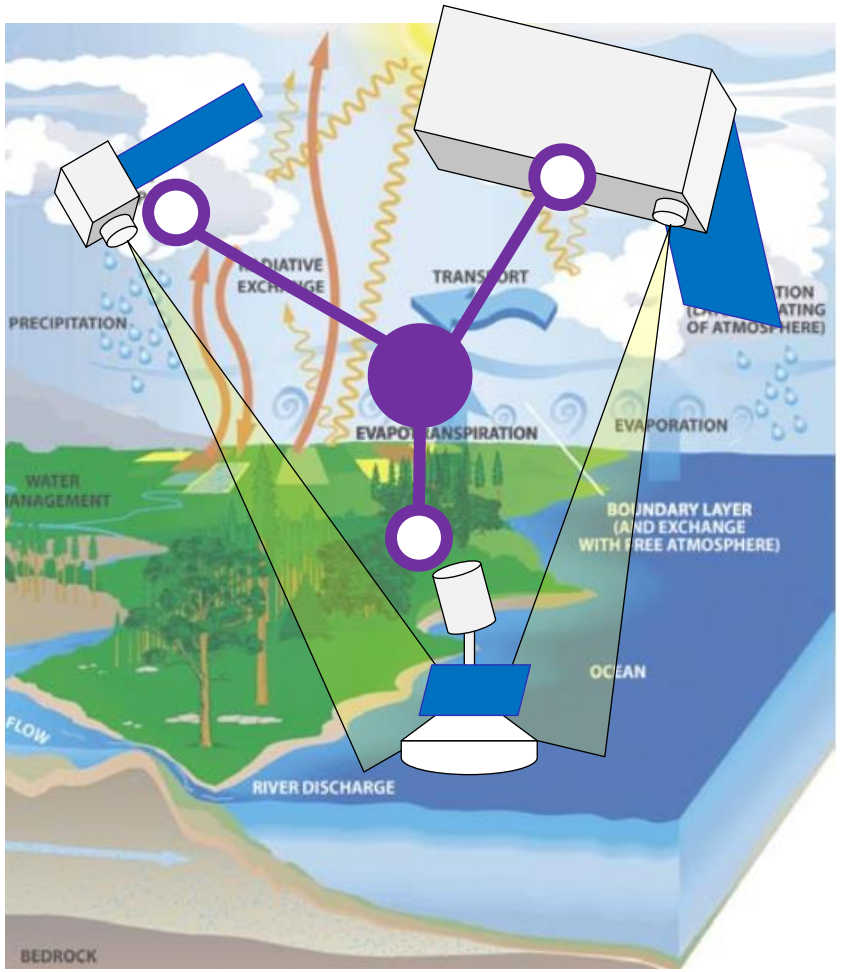
Presentation Contents

- Motivation/Problem Statement
- NOS-T Concept and Architecture
- Test Cases:
  - Satellite Constellation
  - Real-time Sensor Network
  - Coordinated Observations
  - Commercial Satellite Tasking

Problem Statement: New Observing Systems (NOS)

NOS encompasses distributed or decentralized observing systems that can:

- Optimize measurement acquisition using diverse observing capabilities
- Observe phenomena from different spatial, temporal, and spectral vantage points
- Coordinate observations based on events, forecasts, or science models
- Leverage NASA and non-NASA assets and data sources



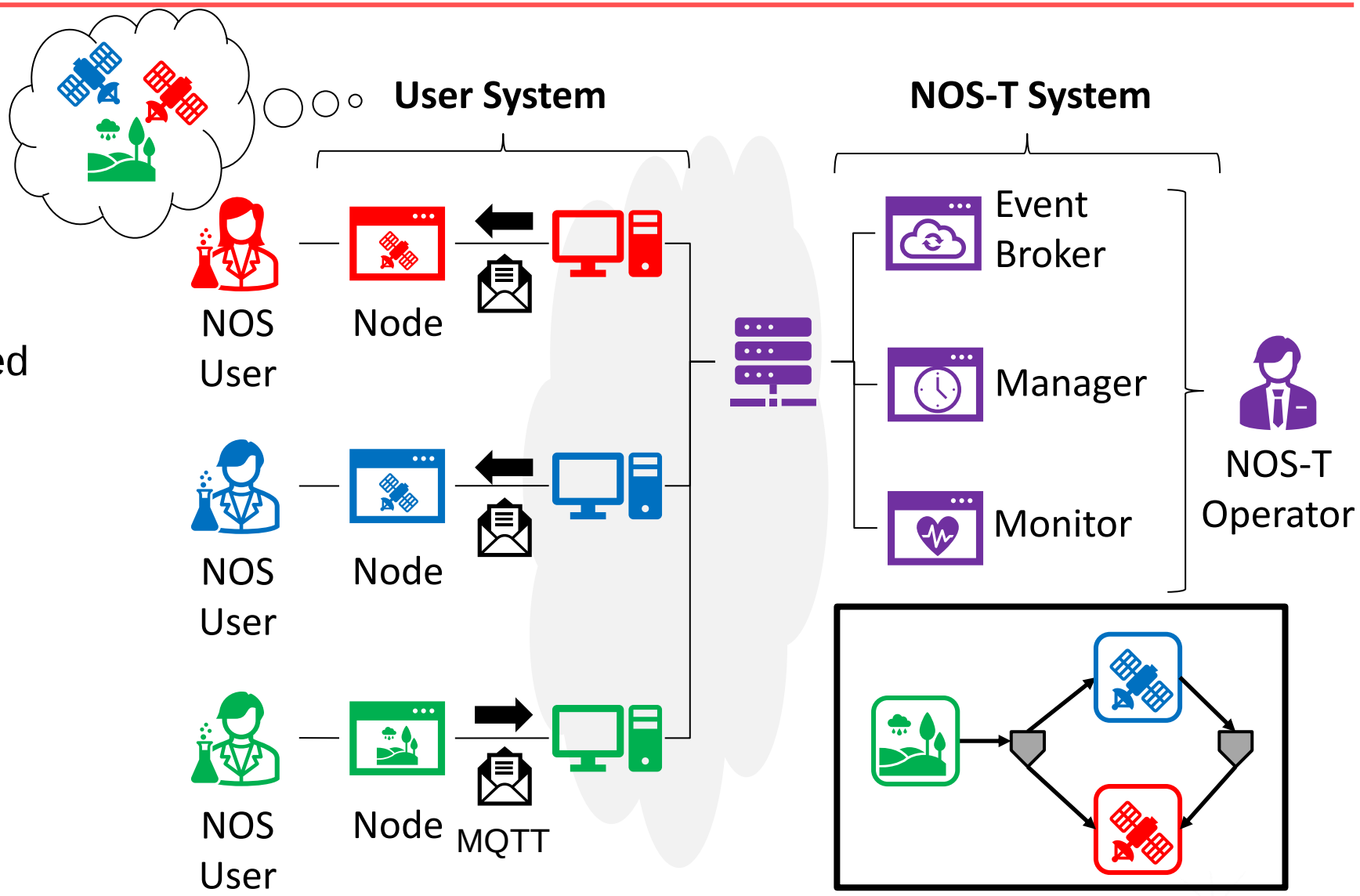
NOS Challenges:

- Compose both existing and future systems into a system-of-systems
- Develop collaborative agreements among partners
- Specify interaction protocols and information interfaces to coordinate operations
- Manage inter-organizational policies and procedures

NOS Testbed (NOS-T) Concept and Architecture

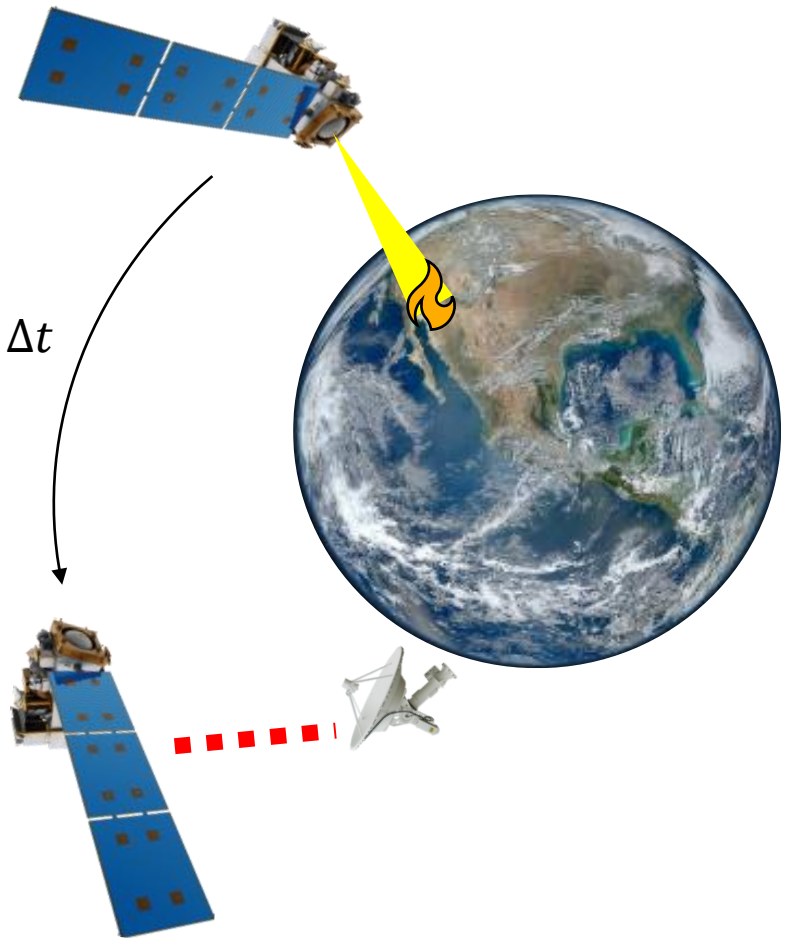
NOS-T provides a virtual testing environment to:

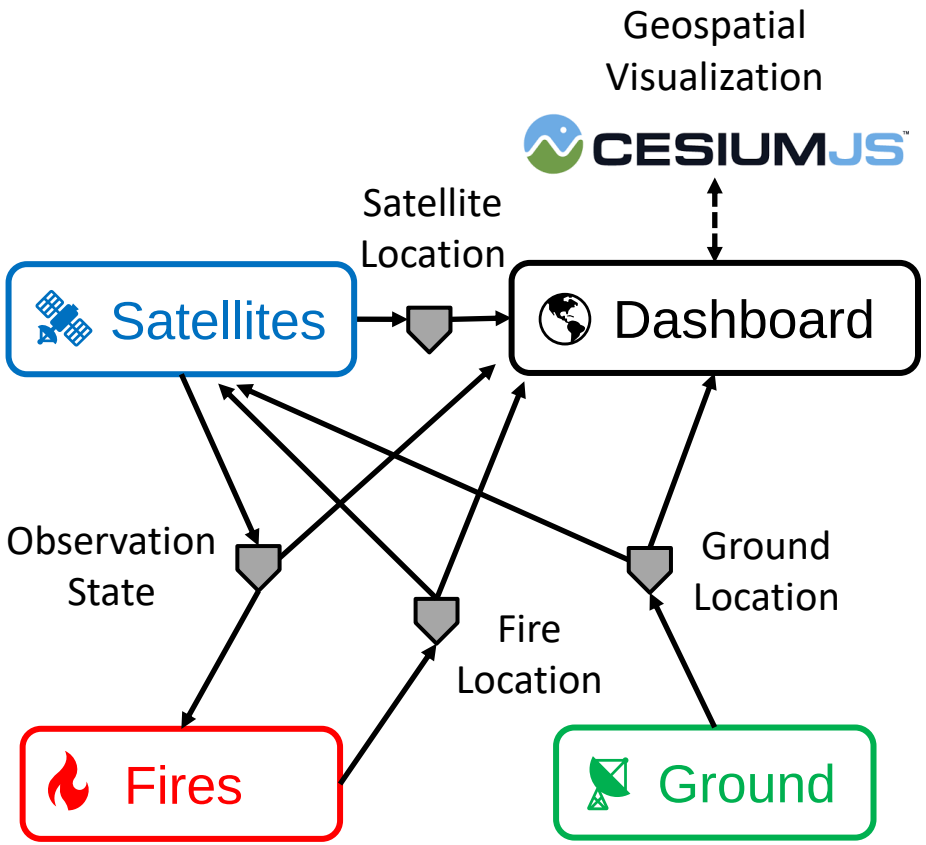
- Validate NOS technologies independently and as a system
- Demonstrate new distributed operational concepts
- Enable comparisons of competing technologies
- Socialize new technologies and concepts with the science community and reduce risk



Test Case 1: Satellite Constellation

- Detect and report fire hazards in CONUS
- Initiate fires using 2020 Visible Infrared Imaging Radiometer Suite (VIIRS) data
- Observe fires using a three-satellite constellation
- Downlink observations to ground station
- Evaluate observation latency

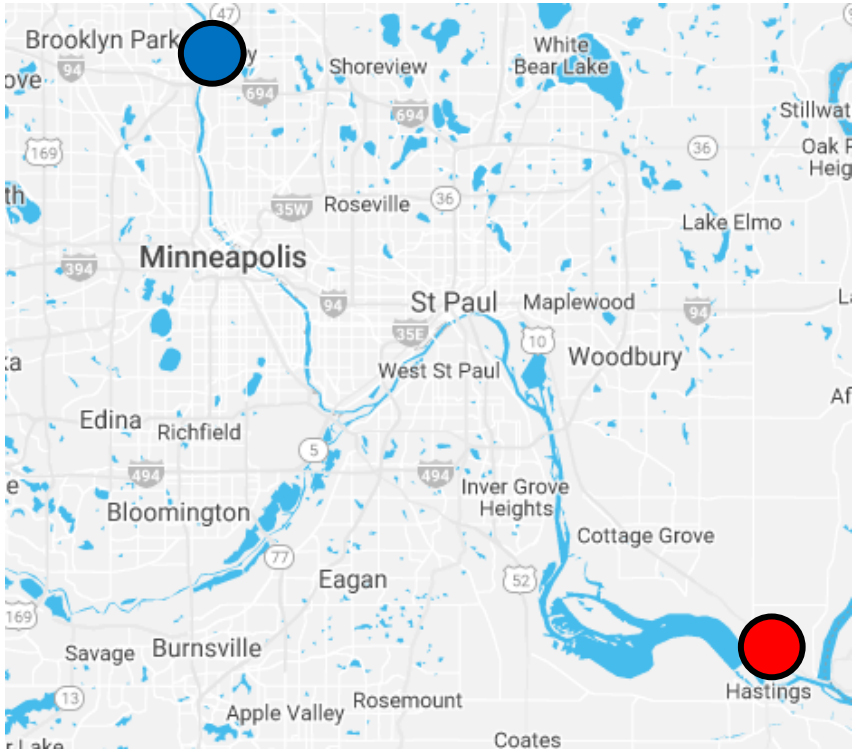


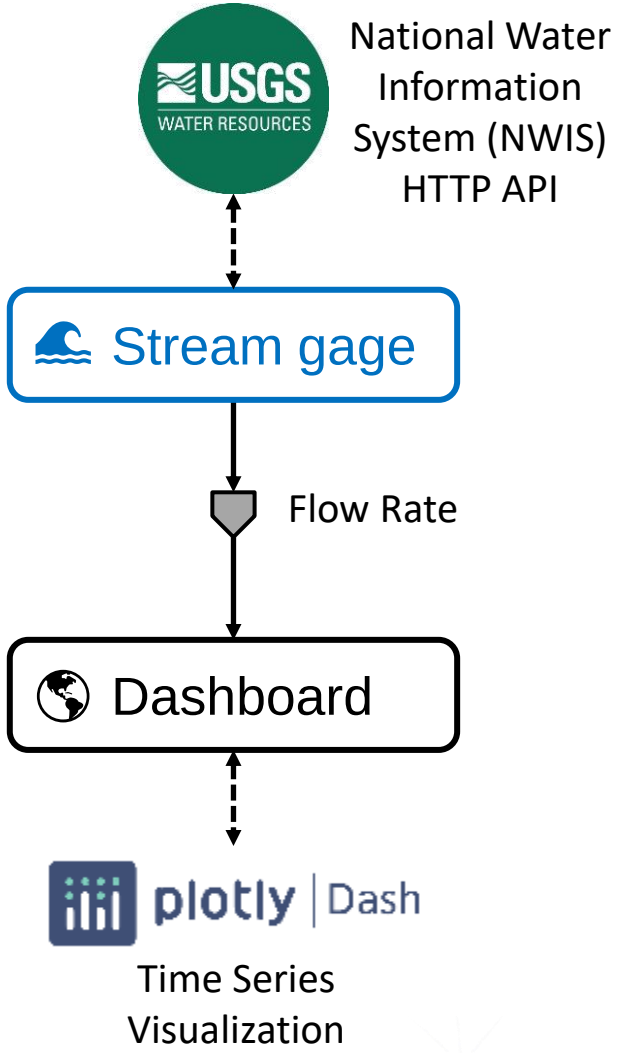


5-day (at 60x Speedup) Scenario; Playback Speed ~90x

Test Case 2: Real-time Sensor Network

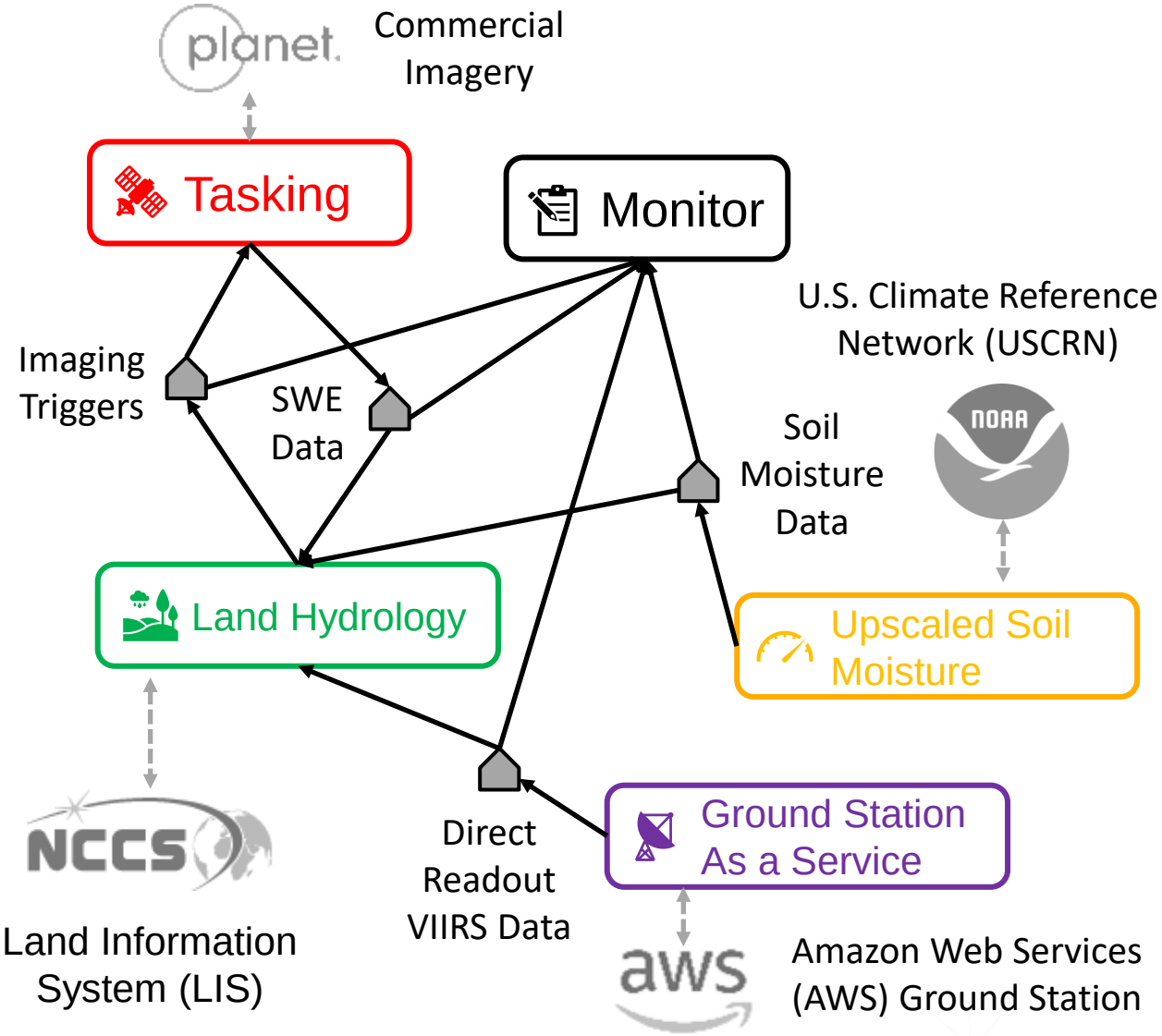
- Retrieve real-time stream gage data from the USGS National Water Information System (NWIS) HTTP API
- Display flow rates from two sensors on a dashboard – Mississippi River above and below Minneapolis/St. Paul
- Demonstrate ability to use real-time data for a test case





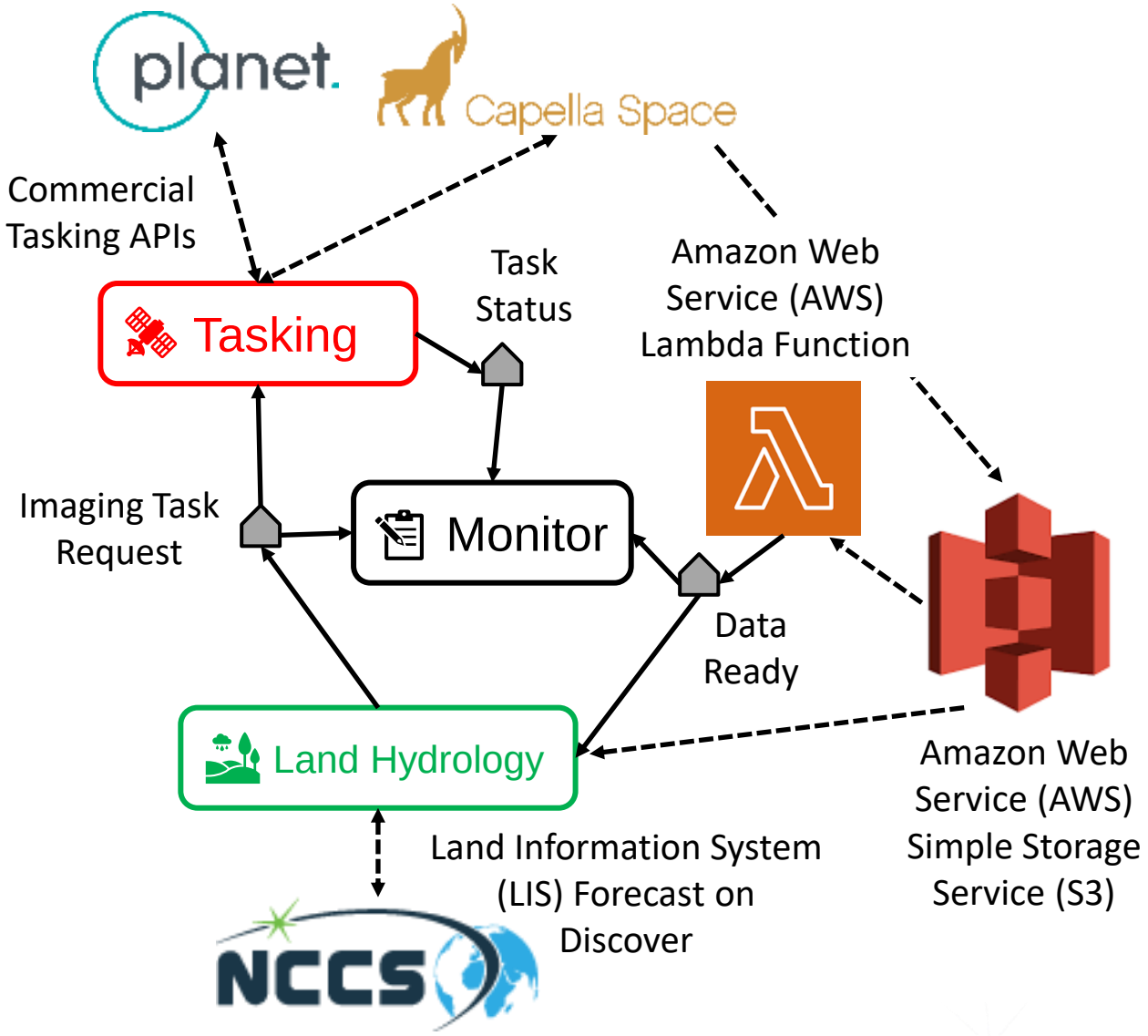
Test Case 3: Coordinated Observations (NOS "Flood")

- Collaborative pilot project (GSFC, LaRC, ARC, JPL, USC/MIT)
- Historical case from March 2019 Missouri River flood (Omaha, NE)
- Assimilate soil moisture and low-latency VIIRS data into Land Information System (LIS)
- Trigger requests for commercial Surface Water Extent (SWE) data



Test Case 4: Commercial Satellite Tasking (NOS-Live "Fire/Flood")

- Collaborative pilot project (UMD, GSFC, JPL, Capella/Planet)
- Forecast land hydrology for flood-prone burned areas and prioritize target areas
- Dynamically task commercial imaging spacecraft to retrieve Surface Water Extent (SWE) data
- Automatically assimilate data into next forecast run



Summary of Accomplishments

- NOS-T provides a virtual environment to prototype and mature NOS technology
- NOS-T Framework enables participation by disparate organizations
  - Loosely-coupled structure via an event-driven architecture
  - Information exchange based on lightweight MQTT protocol
  - Supports simulated and real-time scenario execution
  - 2 major multi-organization pilot test cases (NOS "Flood" and NOS-Live "Fire/Flood")
- Completed initial release of NOS-T Framework
  - NOS-T Interface Control Document (v1.0, Feb. 2022)
  - Open-source release of NOS-T Tools library with examples
    - GitHub source code repository: https://github.com/code-lab-org/nost-tools
    - ReadTheDocs documentation: https://nost-tools.readthedocs.io/
  - Incremental updates added more examples and improved documentation

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