



Air Traffic Management-eXploration Testbed for Urban Air Mobility Research and Development

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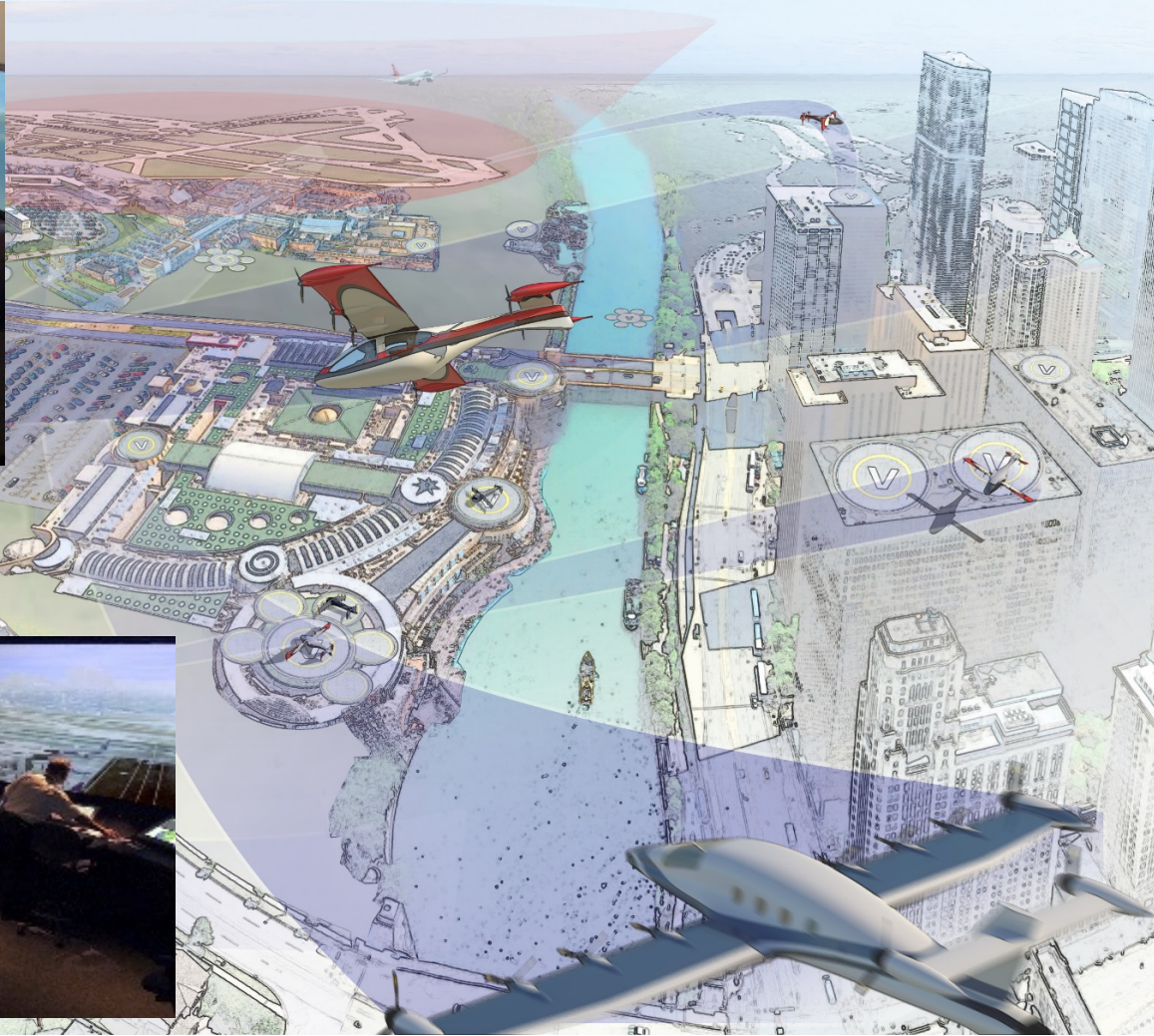
June 28, 2018

Testbed Vision



- Testbed is a distributed air traffic simulation capability to **accelerate** the introduction of technologies in the National Airspace System.
- Its core purpose is to enable **realistic simulations** of proposed air traffic concepts with real systems and data.
- It enables our ATM **community**, consisting of government, industry and academia, to **share** and **leverage** each other's data and tools.

Urban Air Mobility



Outline



- Testbed Goal
- Testbed Features
- Architecture Design
- Progress
- What's Next?
- Take Away

Testbed Goal



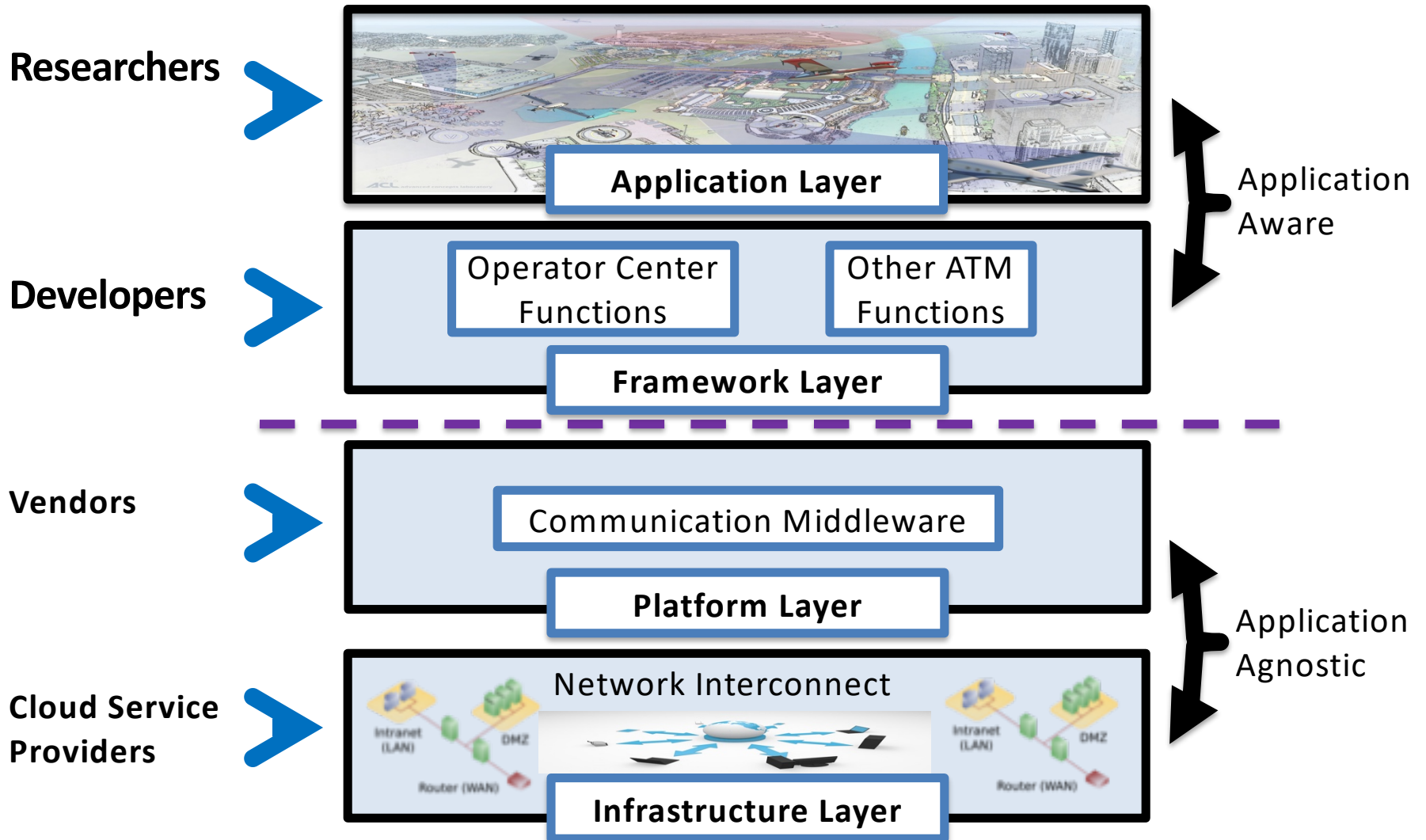
- Accelerate National Airspace System Transformation
 - Simulation
 - What-if Analysis
- Create Best Design (NRA 2014-2015)
 - Architecture Design
 - Cost and Benefit Assessment
- Overcome Challenges
 - Data Sharing
 - Scenario Generation

Testbed Features

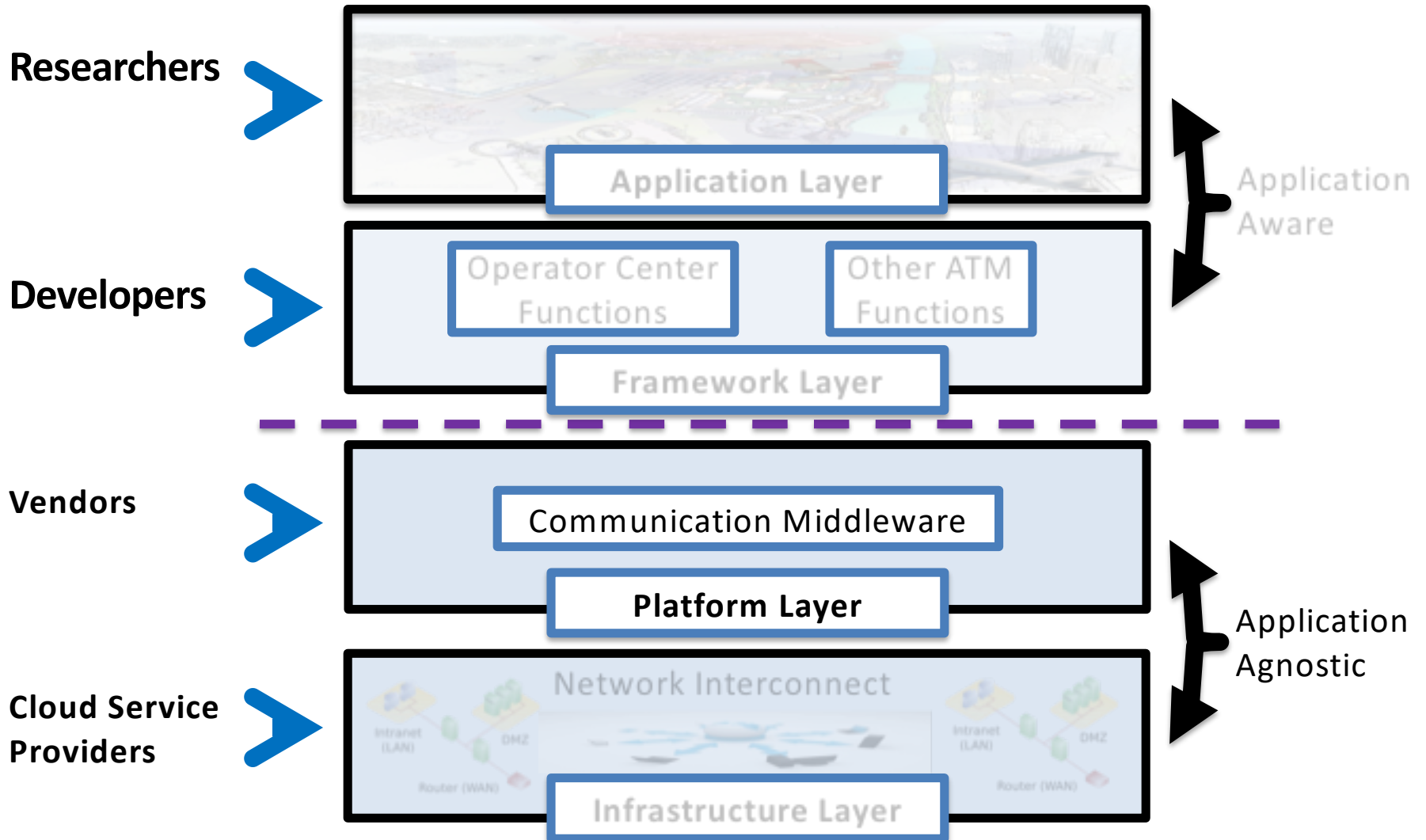


- Community Pooled Resources (e.g., Data)
- Defined Workflow
 - Automated Scenario Generation
 - Simulation Asset Configuration
 - Simulation Execution
- Defined Interfaces
- Standardized System and Data Connectivity

Architecture Design



Architecture Design



Collaboration



- **NASA Provides**
 - Web Access for Simulation Setup
 - Adapter Example
 - ATM simulators & systems
 - ATM Data: e.g., System Wide Information Management
 - Application Programming Interface
- **Required for Partnering with NASA**
 - Space Act Agreement
 - Security Plan
 - Interconnection Security Agreement

Partner Provides

Application and Framework

- Application/Model that Is Shareable/Reusable
- How to Apply/Use your Model in Testbed
- Data if Not Available in Testbed (e.g., adaptation data needed by the model)
- Domain Expertise (e.g., to determine appropriateness or correctness)
- Test or Conduct the Simulation

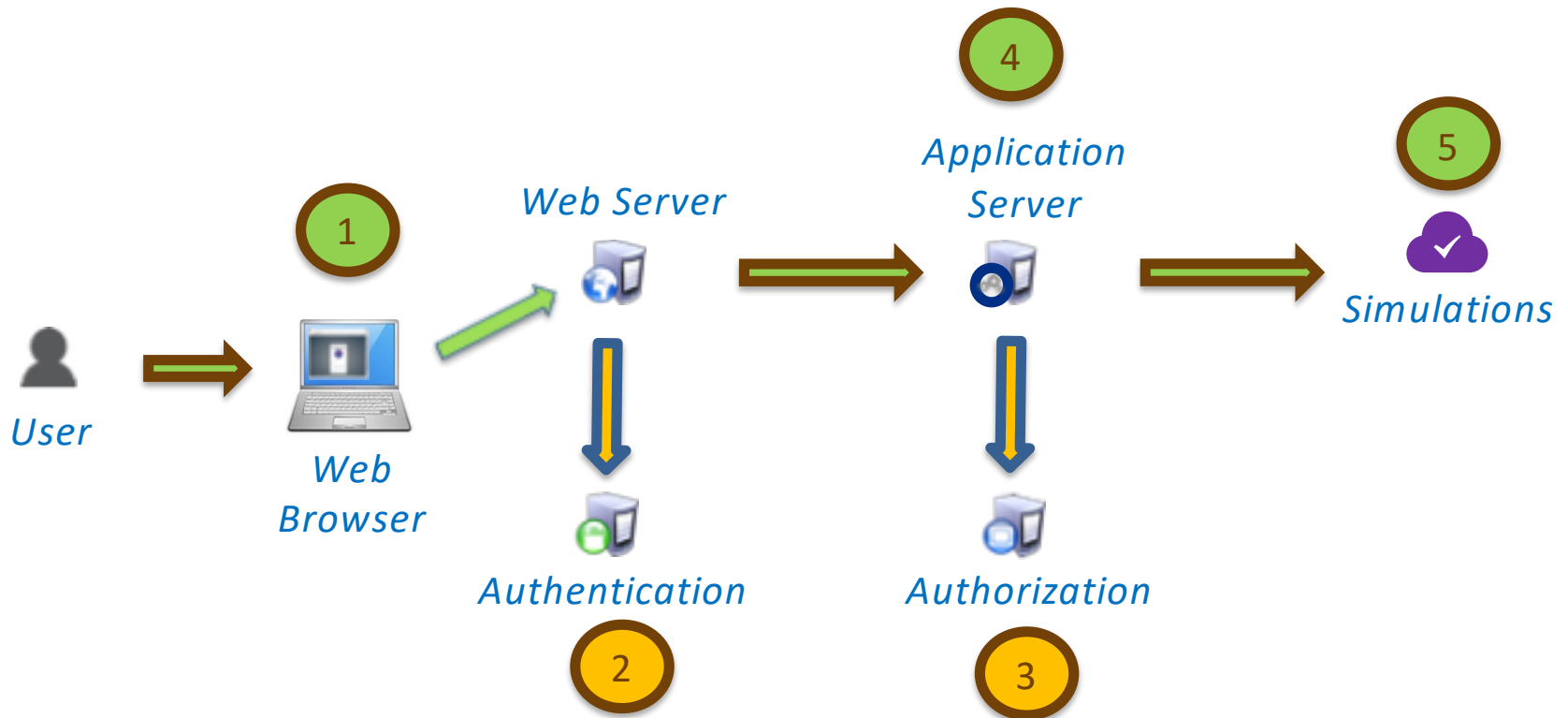
Partner

NASA

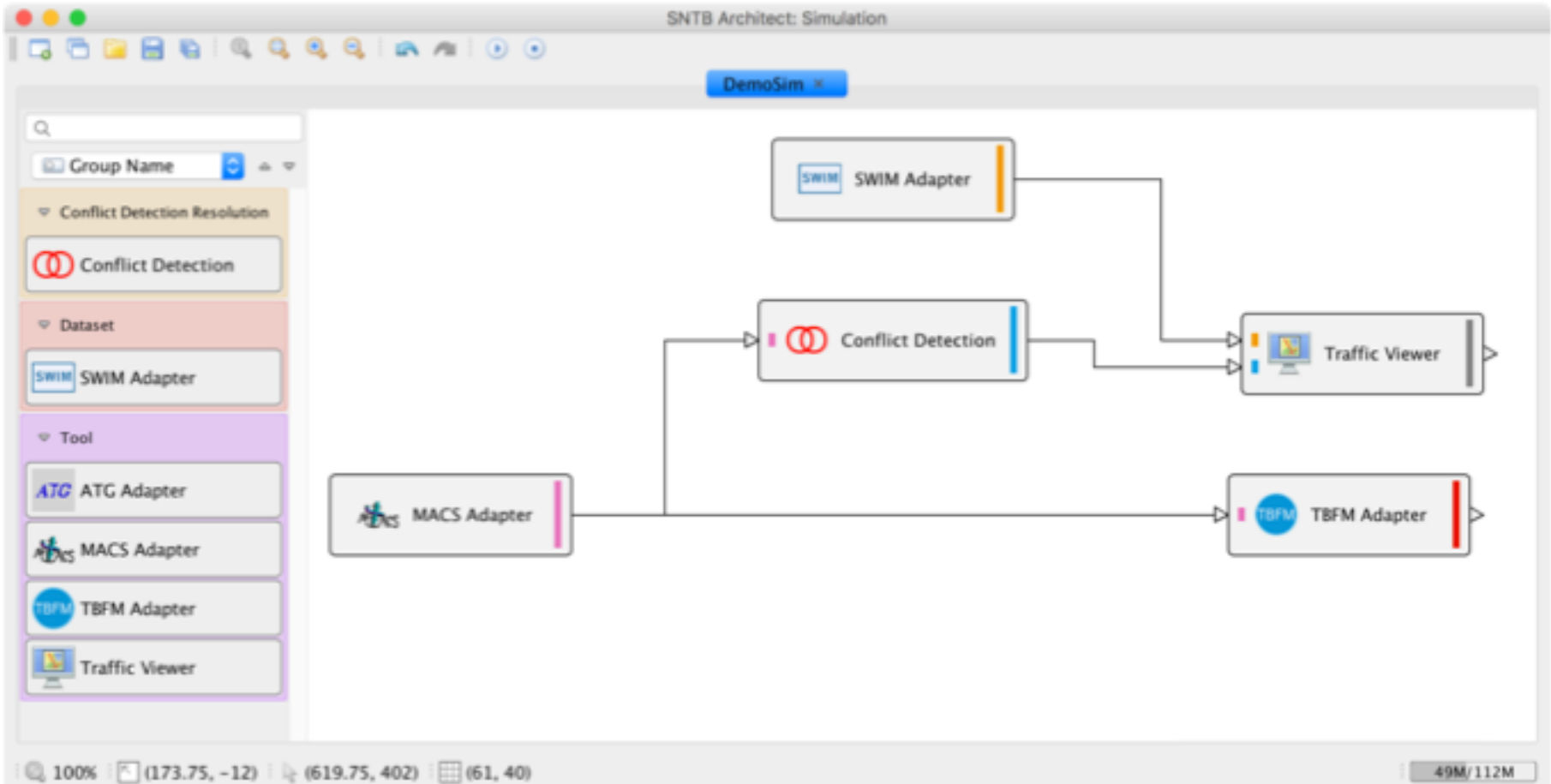


Progress

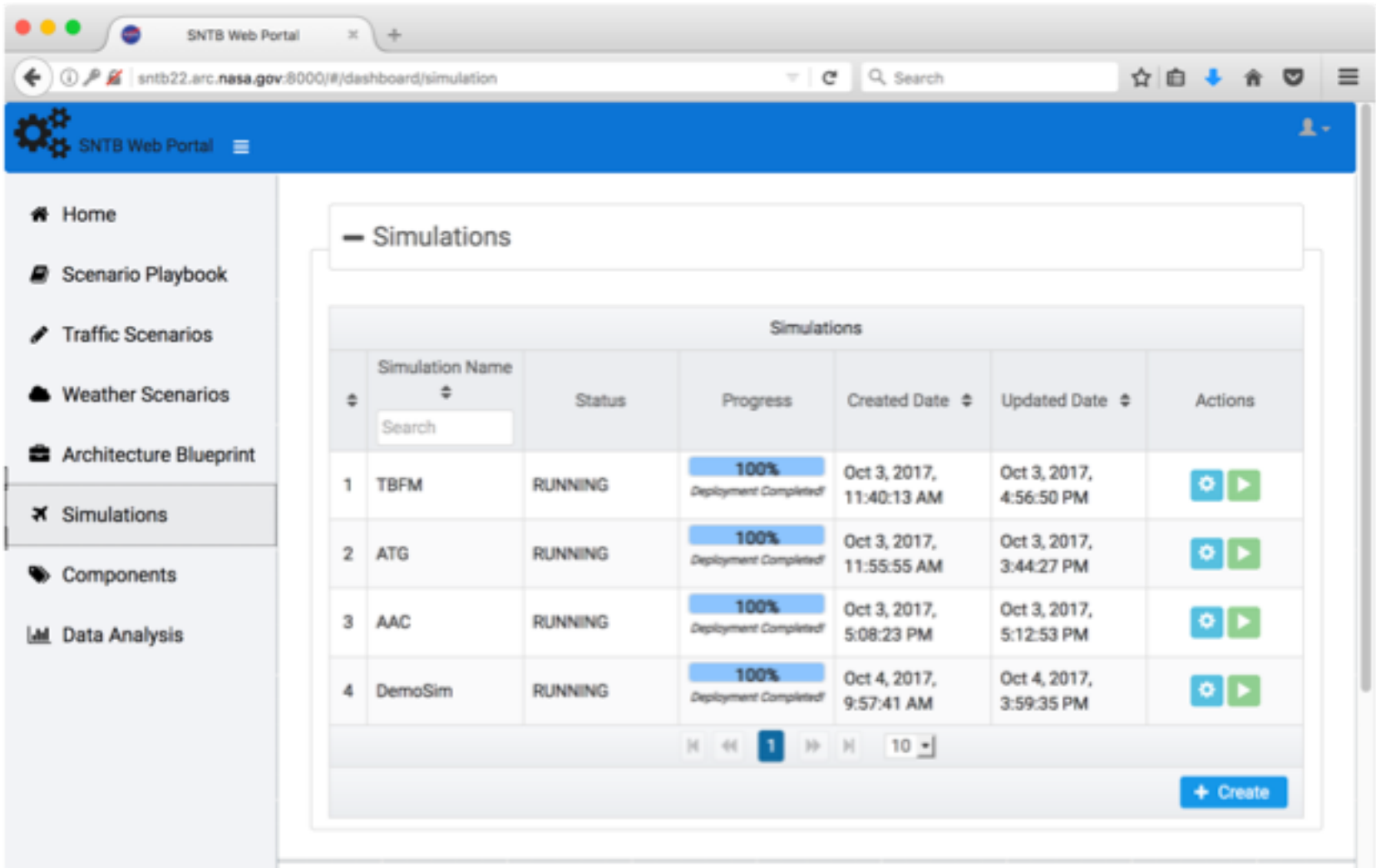
Concept of Operations











Simulation Design User Interface



Library User Interface



The screenshot shows the SNTB Web Portal interface. The browser address bar displays `sntb22.arc.nasa.gov:8000/#/dashboard/simulation`. The page features a blue header with the SNTB Web Portal logo and a user profile icon. A left sidebar contains navigation links: Home, Scenario Playbook, Traffic Scenarios, Weather Scenarios, Architecture Blueprint, Simulations (highlighted), Components, and Data Analysis. The main content area is titled "Simulations" and contains a table with the following data:

	Simulation Name	Status	Progress	Created Date	Updated Date	Actions
1	TBFM	RUNNING	100% <i>Deployment Completed!</i>	Oct 3, 2017, 11:40:13 AM	Oct 3, 2017, 4:56:50 PM	 
2	ATG	RUNNING	100% <i>Deployment Completed!</i>	Oct 3, 2017, 11:55:55 AM	Oct 3, 2017, 3:44:27 PM	 
3	AAC	RUNNING	100% <i>Deployment Completed!</i>	Oct 3, 2017, 5:08:23 PM	Oct 3, 2017, 5:12:53 PM	 
4	DemoSim	RUNNING	100% <i>Deployment Completed!</i>	Oct 4, 2017, 9:57:41 AM	Oct 4, 2017, 3:59:35 PM	 

At the bottom of the table, there is a pagination control showing "1" of 10 items and a "+ Create" button.

What's Next?

Testbed Architecture

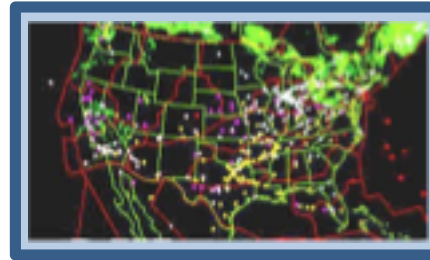
UAS Traffic Management Lab



Other Labs



Visualization



UAS Lab



Communication Middleware

Support Services

Tools

ATC Lab

Data

Conflict Detection

ATM Functional Services

Cloud

Component

Take Away



- Testbed is a community resource for accelerating ATM concept and technology development where **partners** can collaborate and leverage each other's data and tools
- Targeted to be transitioned to community in 2020

References



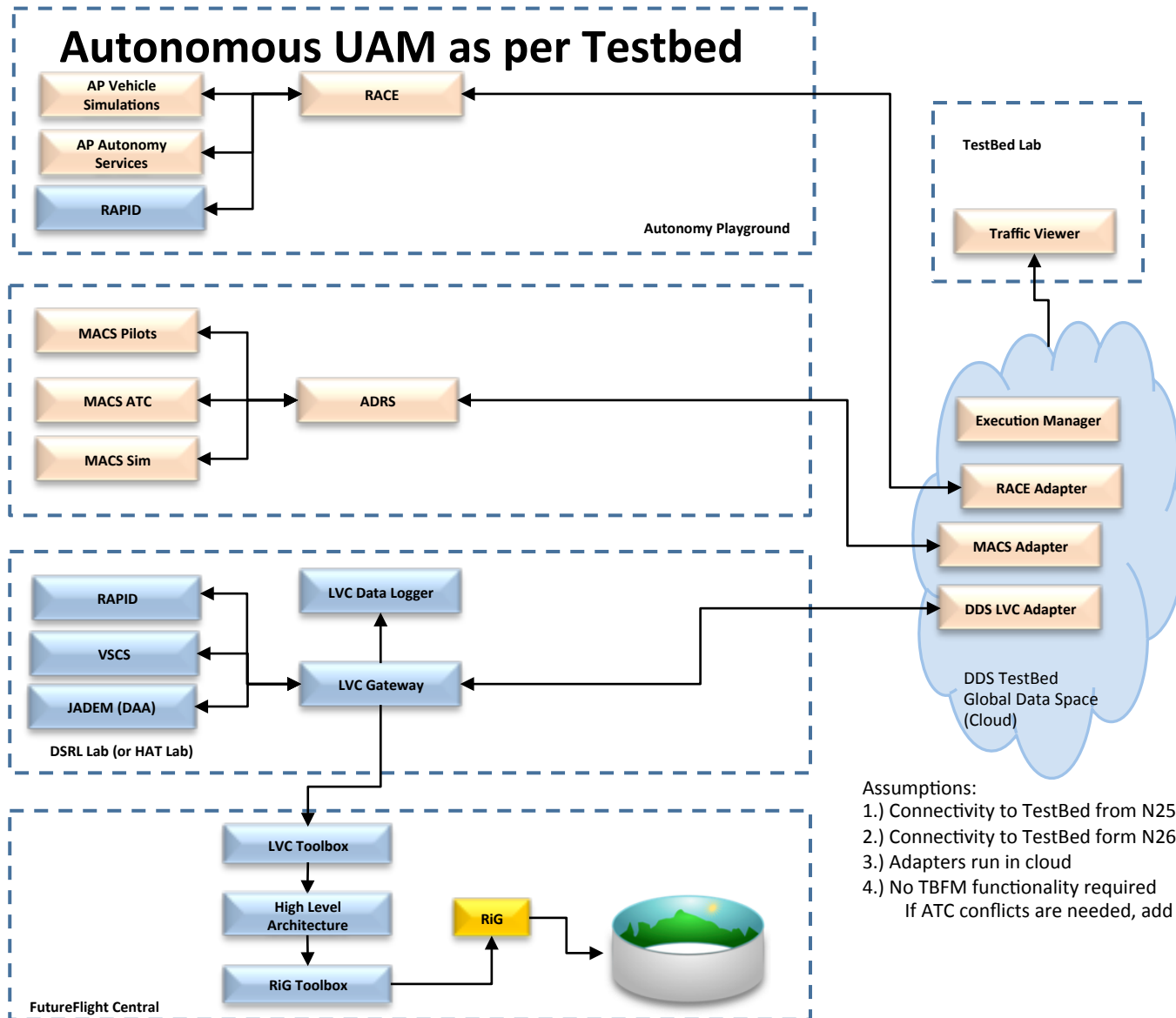
1. Shadow Mode Assessment using Realistic Technologies for the National Airspace System (SMART NAS) Test Bed Development, AIAA Aviation, Dallas, TX, 22-26 June 2015
2. Development of a High-Fidelity Simulation Environment for Shadow-Mode Assessments of Air Traffic Concepts, Royal Aeronautical Society, London, UK, 14-15 November 2017
3. Automated Scenario Generation for Human-in-the-Loop Simulations, AIAA Aviation, Atlanta, GA, 25-29 June 2018



Questions?
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Backup

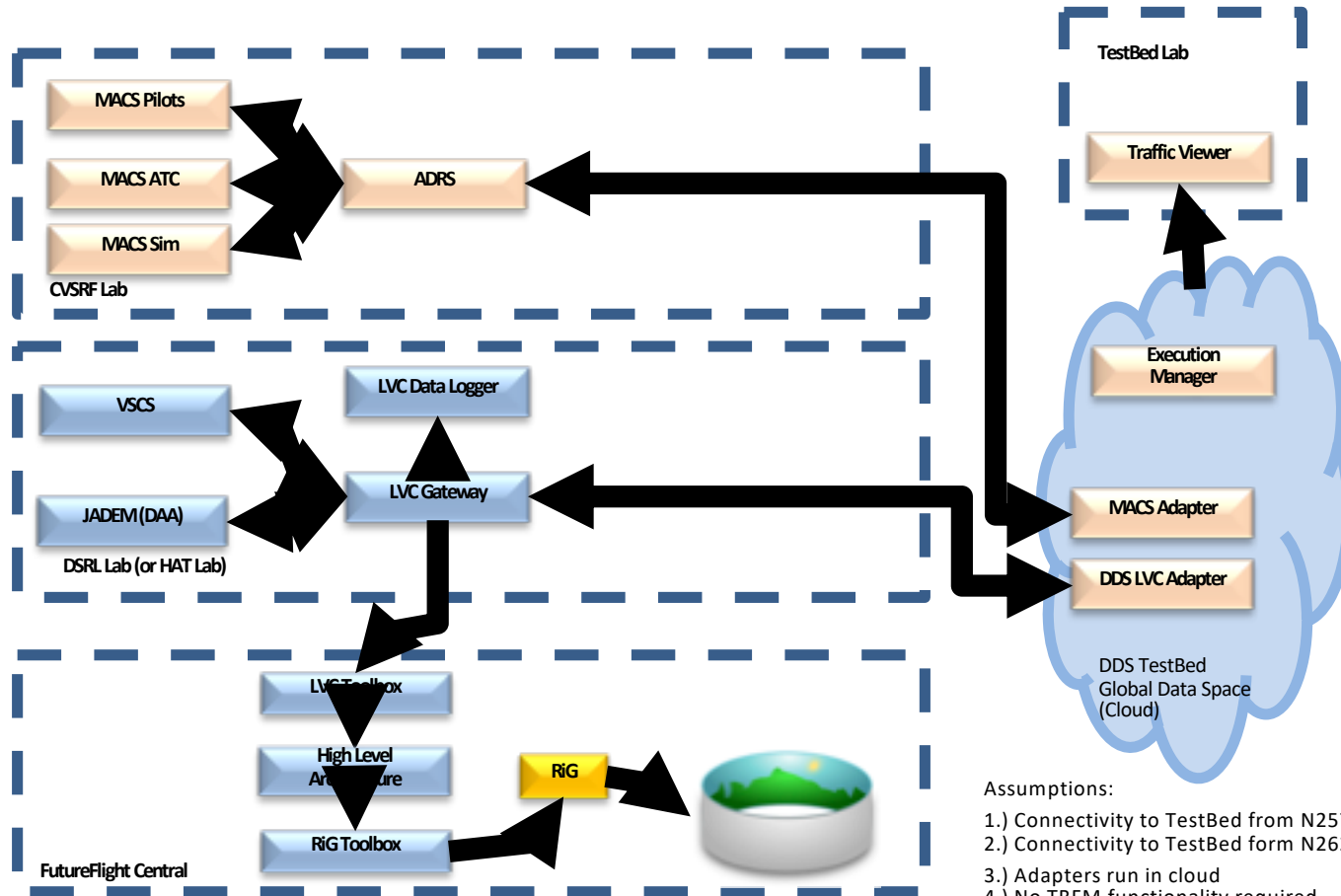
UAM HITL as per Testbed



Assumptions:

- 1.) Connectivity to TestBed from N257
- 2.) Connectivity to TestBed from N262/N269
- 3.) Adapters run in cloud
- 4.) No TBFM functionality required
If ATC conflicts are needed, add to CVSRF domain

UAM HITL Testbed

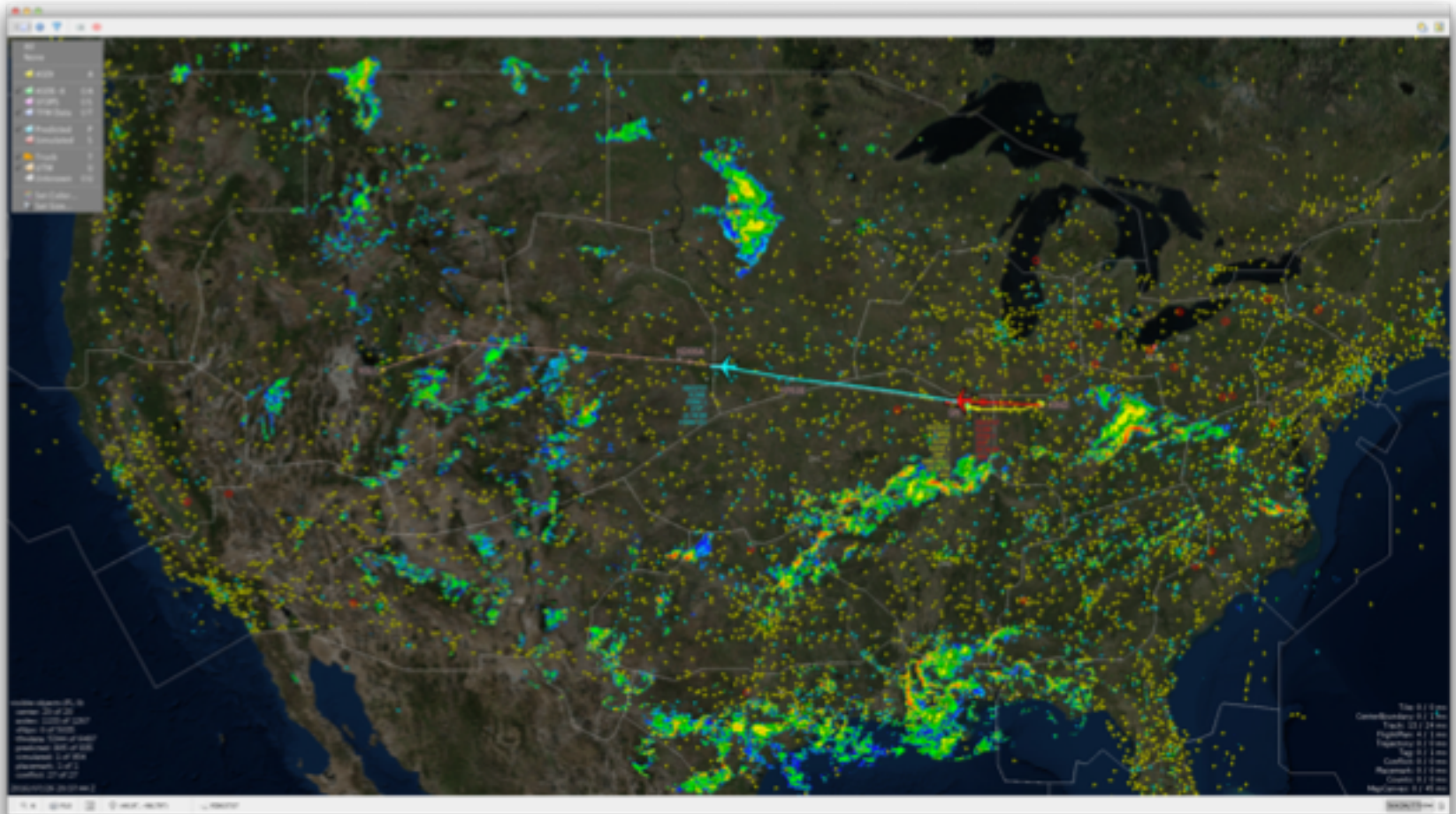


Assumptions:

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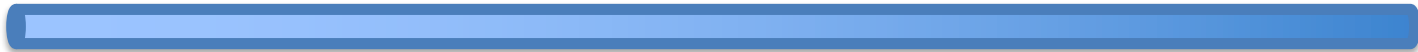
Traffic Viewer



Simulation Components



DDS



Live data



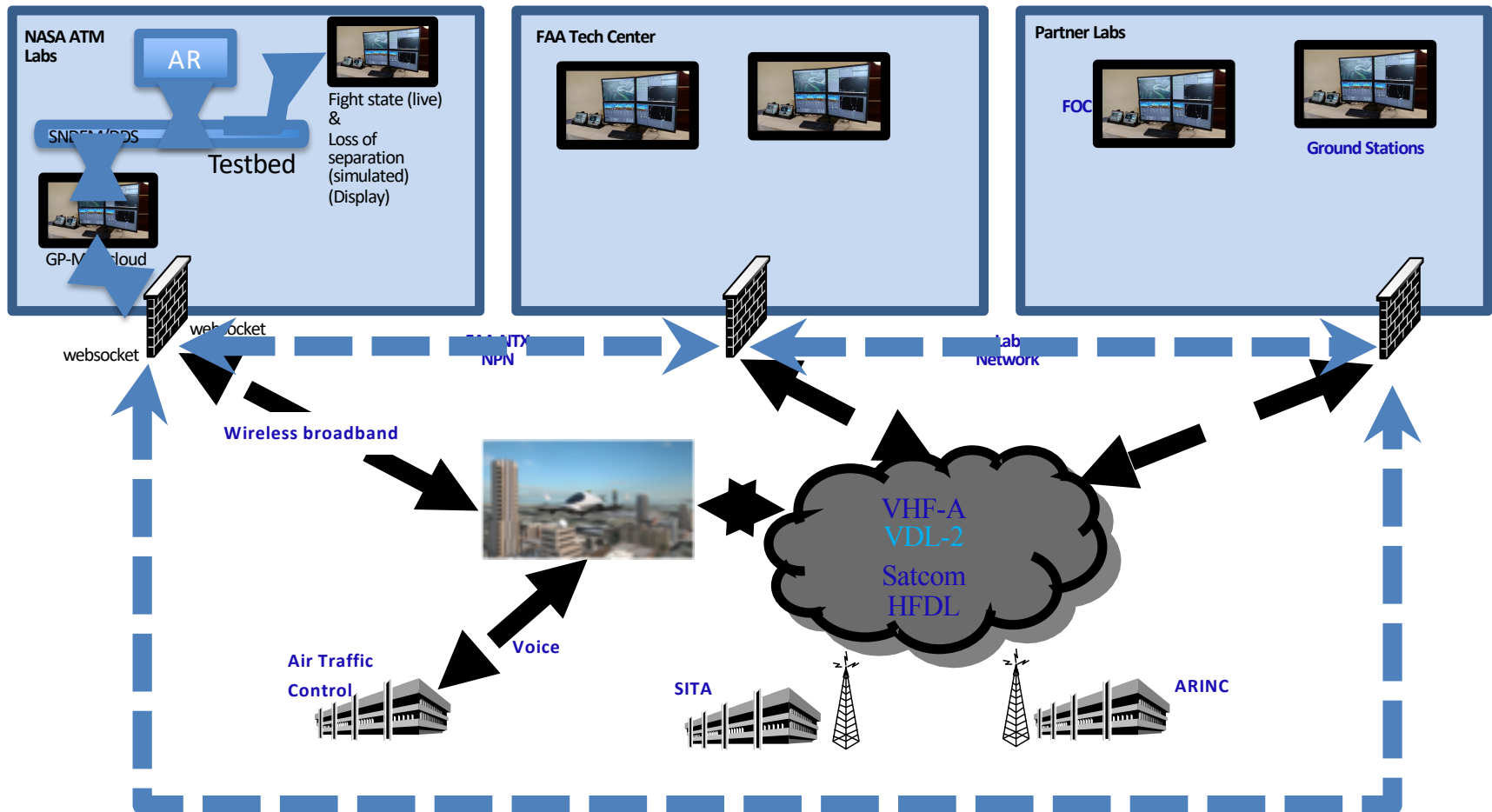
Historical data
Terrain data

ATM Functions

Other
Components

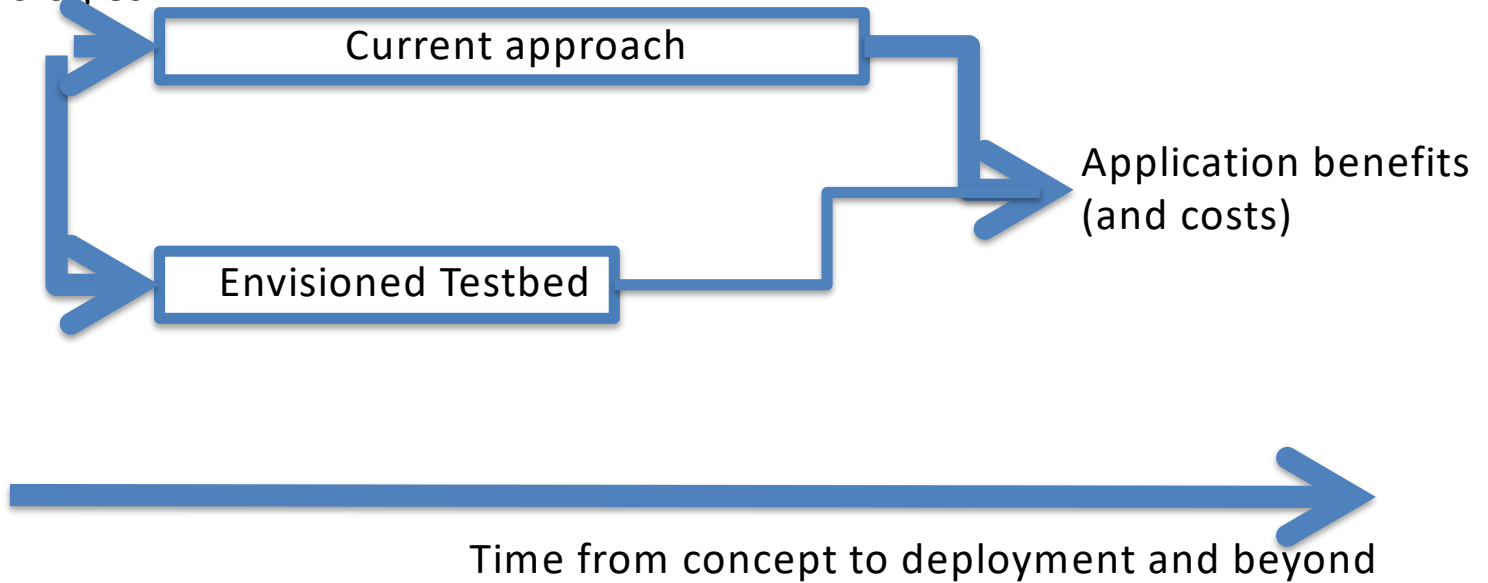
X-Plane/eVTOL flight state,
Loss of separation,
Route structure & Geo fence, metrics

Example Testbed-Partner Architecture



Testbed Role

Trajectory
Based
Operation
Concepts &
Technologies



Testbed Data Tasks

Essential for first cut

- Commercial and GA traffic via SWIM feed.
- List of GA airports and their locations in the Bay Area.
- Population database.

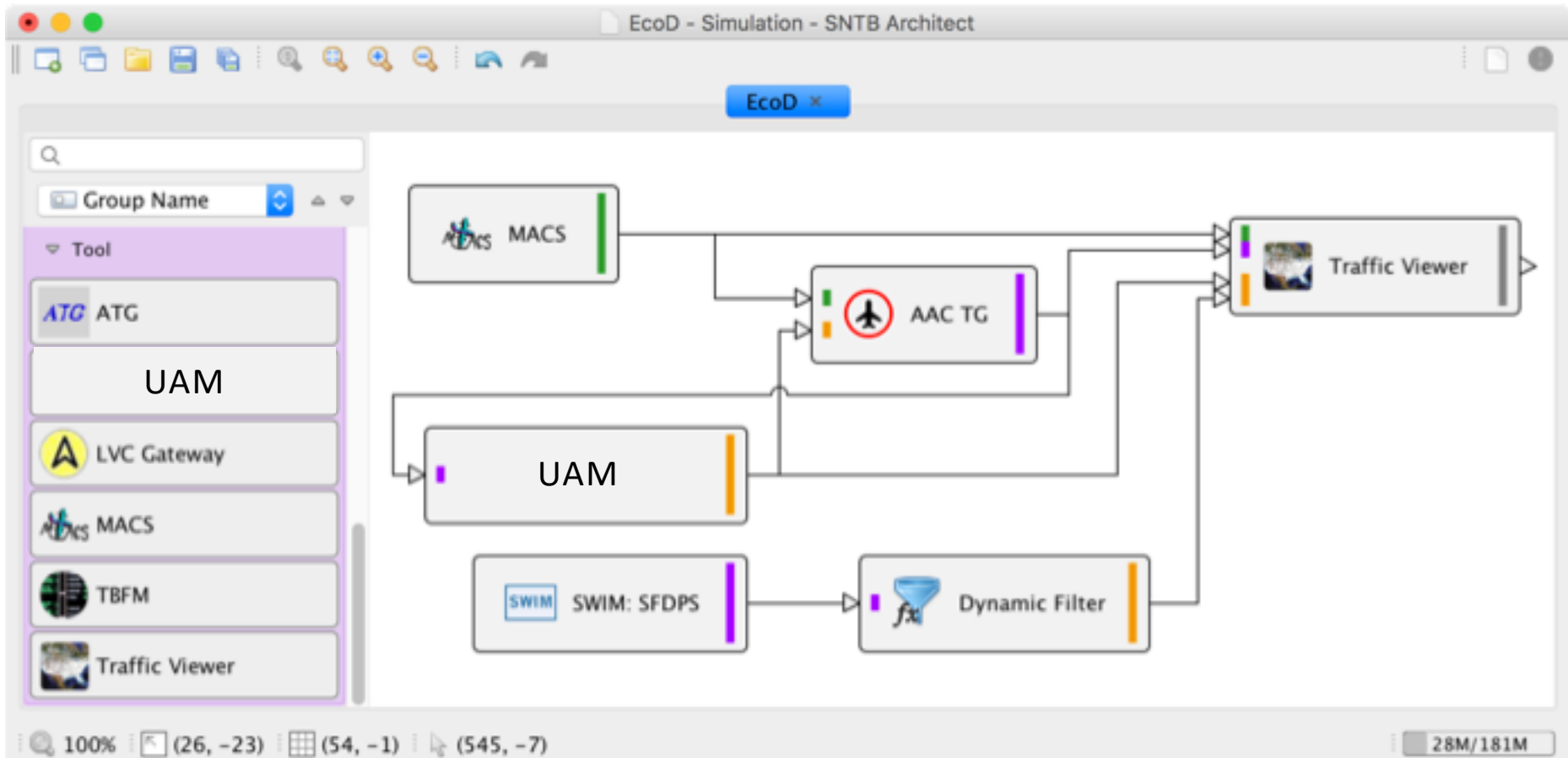
Important for realism

- Cellular coverage database.
- Restricted locations database (SUA, power plants, stadiums, bridges etc.).
- Terrain elevation database.

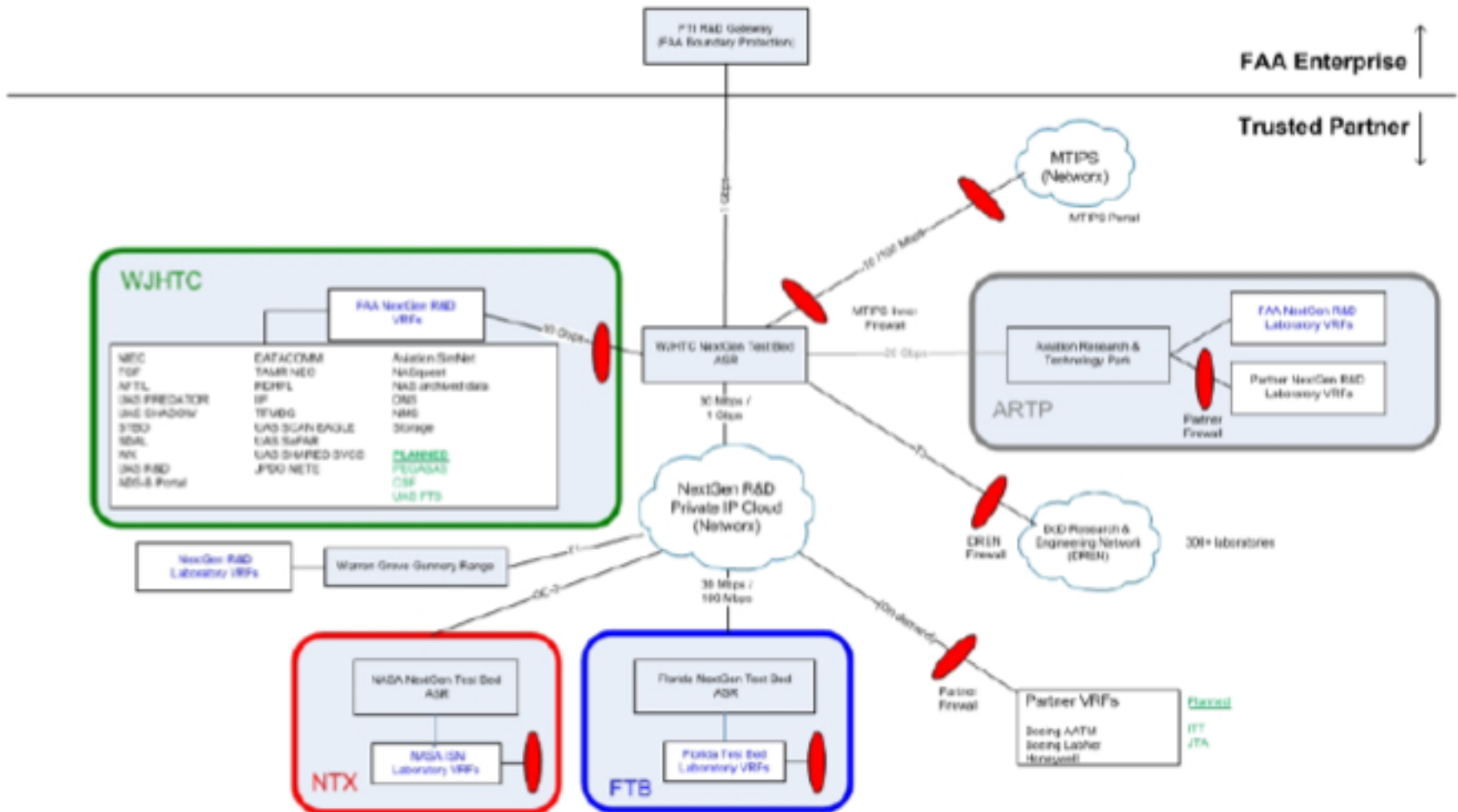
Testbed Modeling Tasks

- Demand generation (number of flights, flight origin and destination).
- Flight planning (route, altitude, speed).
- Trajectory generation (position as a function of time).
- Conflict detection and resolution (AAC, dead-reckoning, actual conflict).
- Noise model (Noise Power Distance (NPD) curve for UAM vehicles)
- Noise model for background commercial and GA traffic (AEDT or simplified model)

Building an Application in Testbed



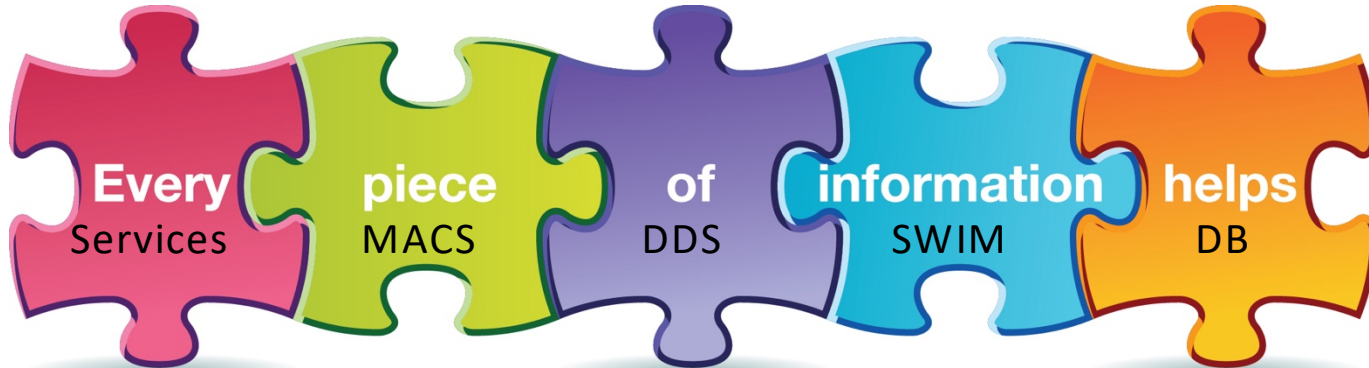
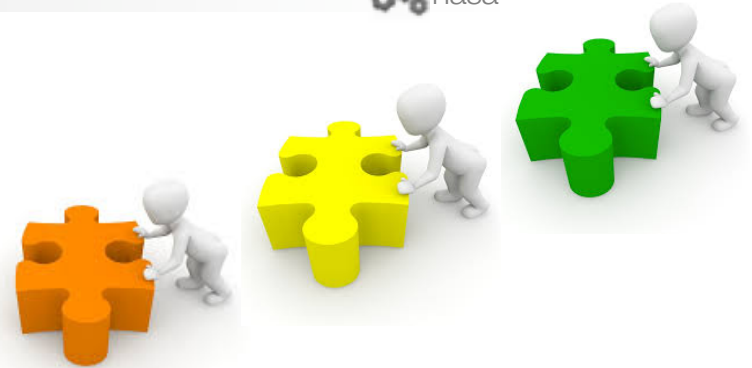
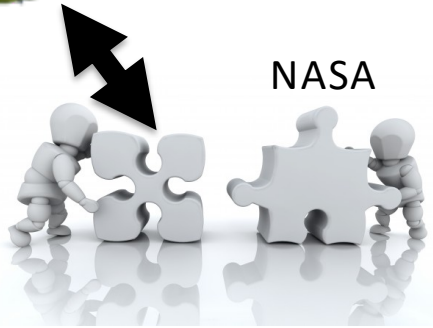
NPN Details



Testbed for Partners



Partner



Capacity HiTL Research Needs 1/2



- Application Layer for
 - GUIs, including traffic viewer, scenario generation, simulation design
 - Remote access
- Components in Framework Layer
 - Scenario, including route structure, adaptation, traffic levels (low, medium, high)
 - MACS
 - Autoresolver
 - UTM, UAS in the NAS, ATD (TBFM, STARSe)?
 - Path Planner
 - Other facilities and simulators

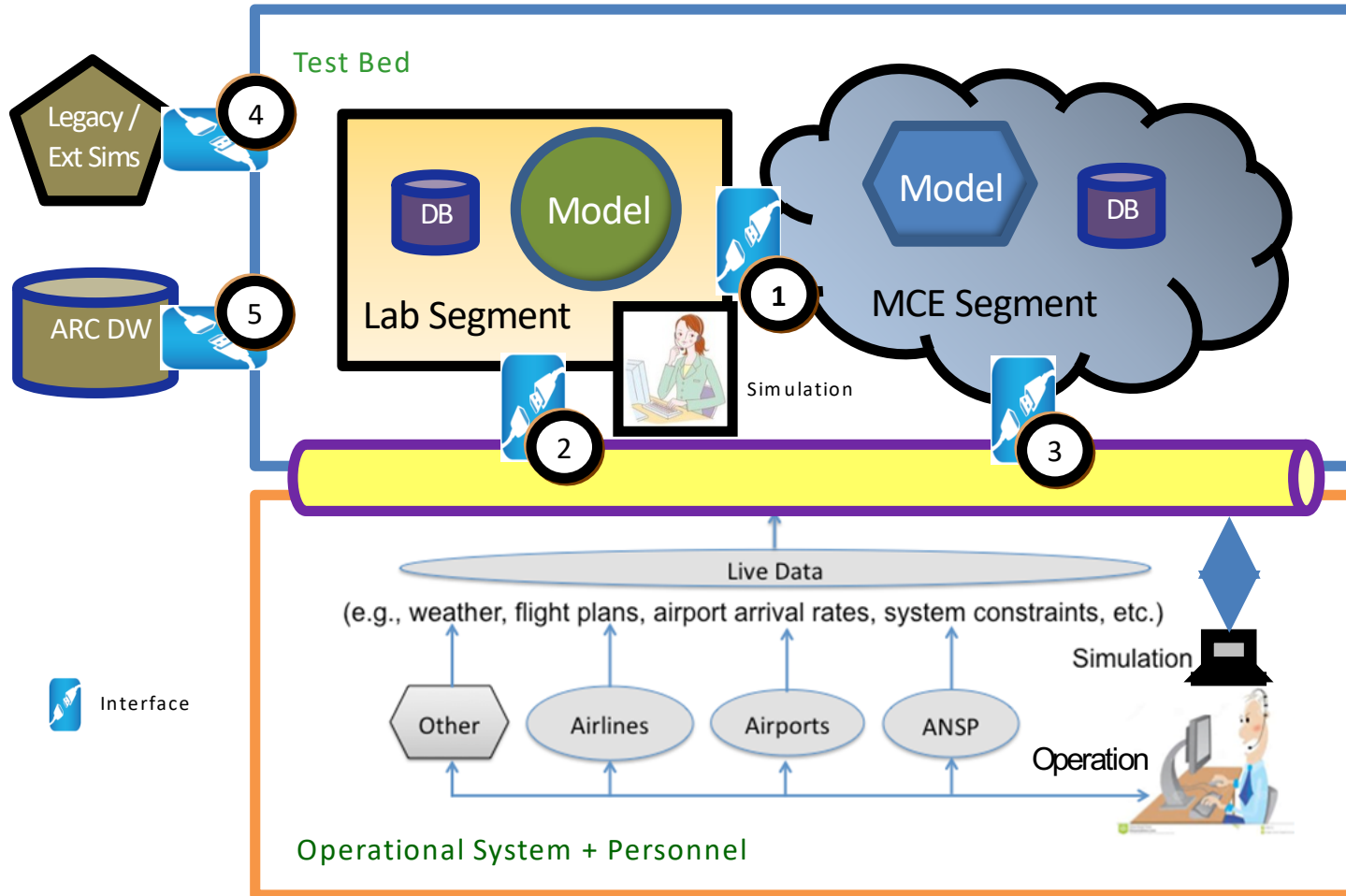
Capacity HiTL Research Needs 2/2



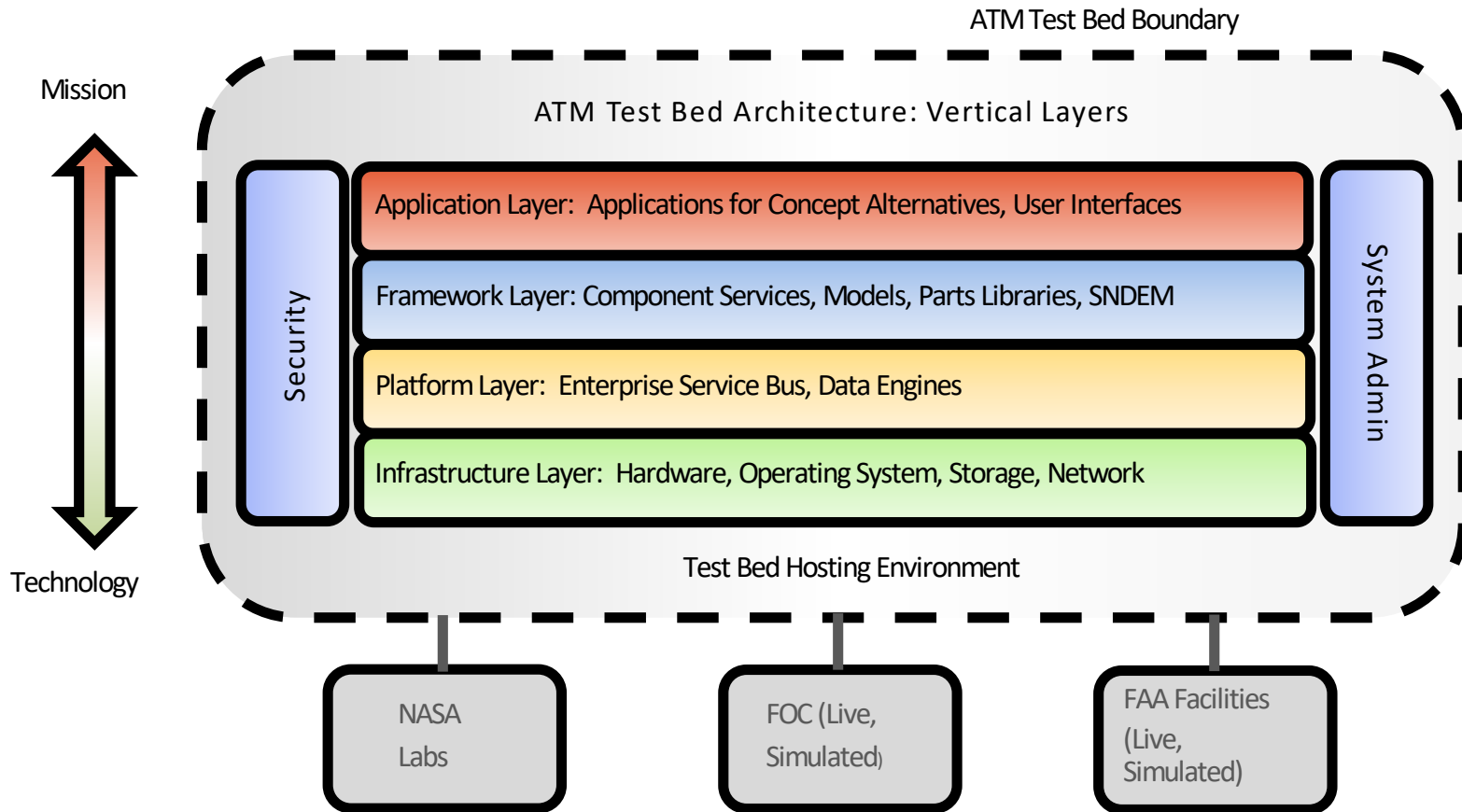
- Platform Layer
 - Access to data: e.g., VFR traffic and terrain
 - Record and Replay
- Infrastructure Layer
 - Local server vs. GovCloud (need stakeholder input)
 - ISA

V&V components that are managed by Testbed core team

ATM Test Bed



Structural View, Vertical Perspective



The SMART-NAS Test Bed provides a standardized and unified simulation and test environment suitable for high-fidelity evaluations to overcome barriers to:

NAS-wide Evaluations: Permit evaluation of concepts spanning multiple NAS domains and having significant architectural changes

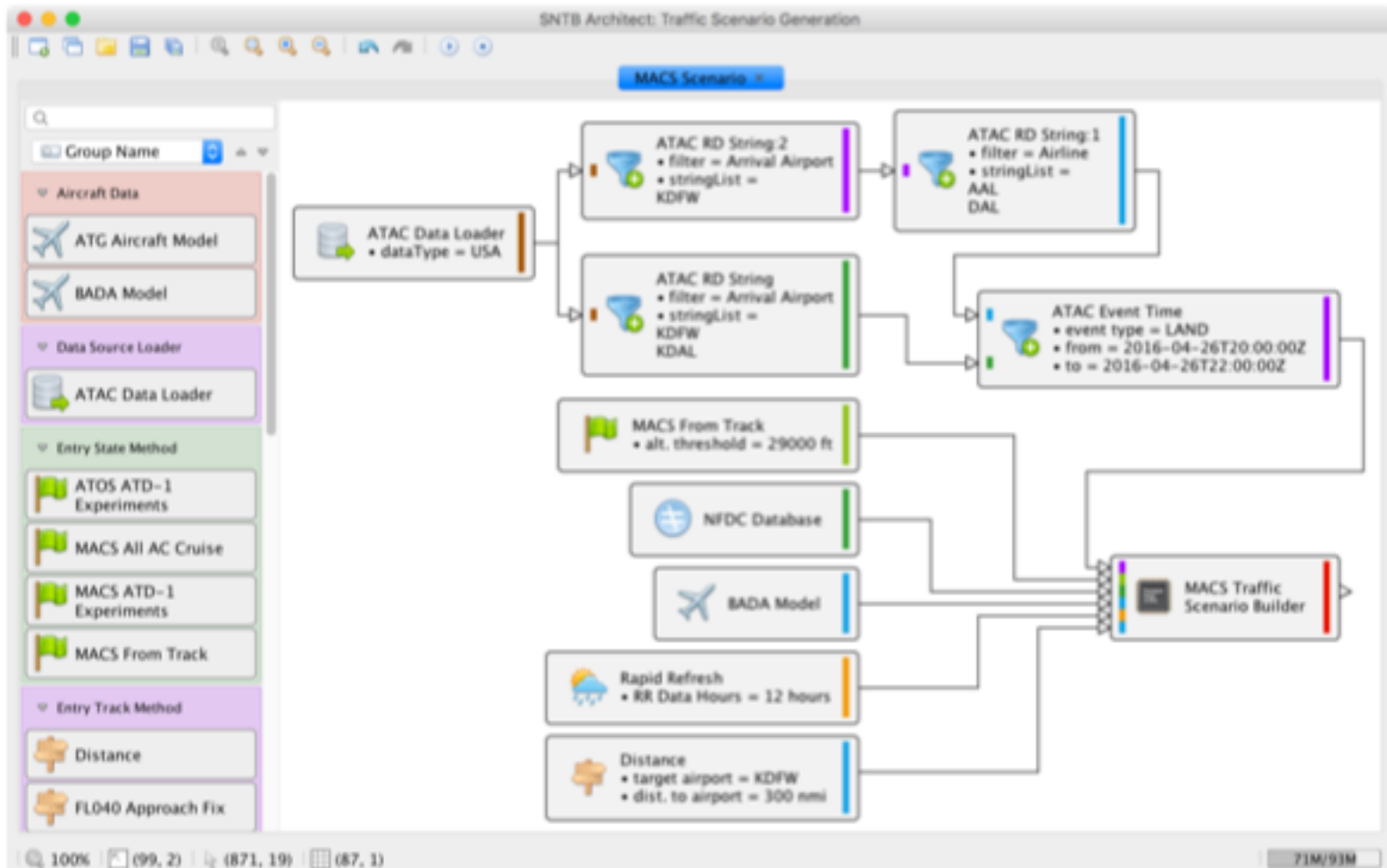
Stakeholder Collaborations: Permit frequent, large-scale, distributed collaborations with stakeholder assets

End-to-End Testing: Enable testing from concept development through operational testing with enterprise systems

Live, Virtual and Constructive Operations: Enable shadowing of live NAS operations with real NextGen systems

Assessment Pace: Automate simulation preparation and execution that is resource intensive, error-prone and limited by capabilities of individual facilities

Scenario Design



- Scenario generation, specific capability
- Ease of connection, limited to training plus some support building out infrastructure
- High fidelity of systems (connecting operational system surrogates; e.g., TBFM emulator/CTAS)
- Breadth of systems (connecting systems with NAS scope tools, even if low TRL, airport, tower, TRACON, Center, Sys Command Center, AOC, Geographical data and tools (Adaptation, Terrain, Population))

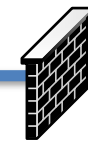
Urban Air Mobility



Ground Stations



Industry
firewall



NASA
firewall

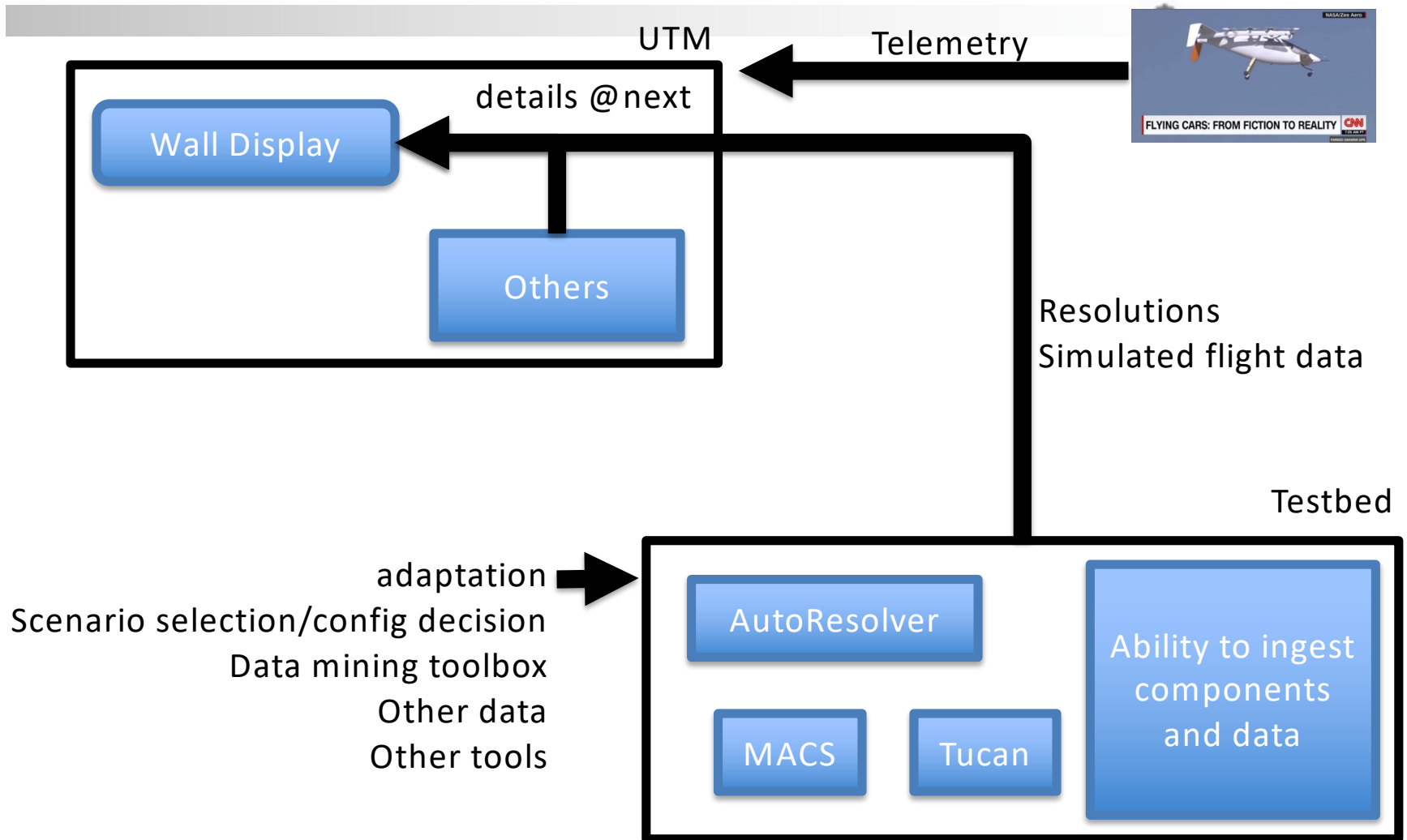


Testbed



adapters

UAM Live Flight Test using UTM



Scenario Repository



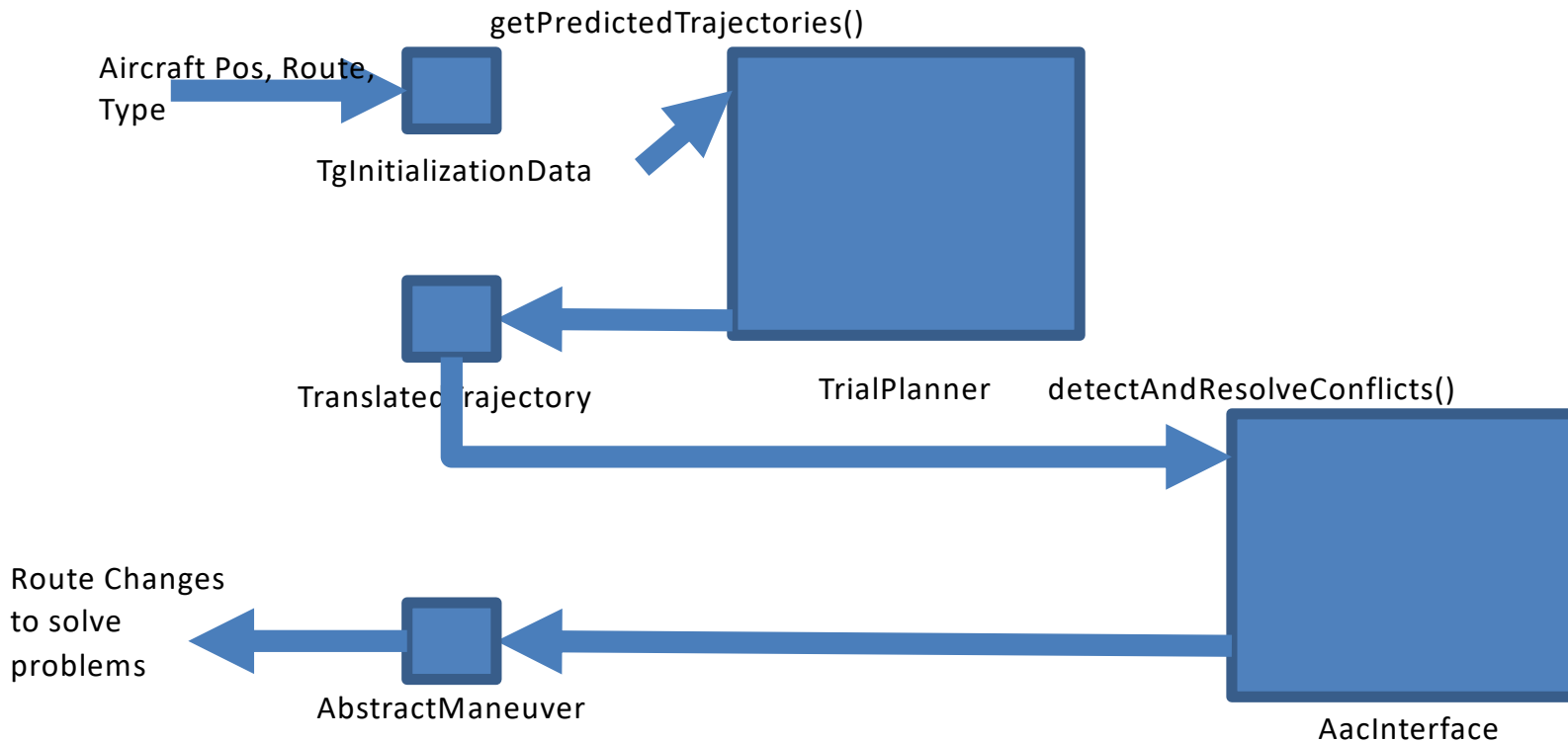
Traffic Scenario Generation

Traffic Scenarios						
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2	ATG Scenario	FINISHED	100% Creating Scenario Data... Completed!	Oct 3, 2017, 6:03:37 PM	Oct 4, 2017, 10:57:15 AM	
3	MACS Scenario	FINISHED	100% Creating Scenario Data... Completed!	Oct 3, 2017, 6:15:30 PM	Oct 4, 2017, 4:18:17 PM	

Navigation: Home, Scenario Playbook, **Traffic Scenarios**, Weather Scenarios, Architecture Blueprint, Simulations, Components, Data Analysis

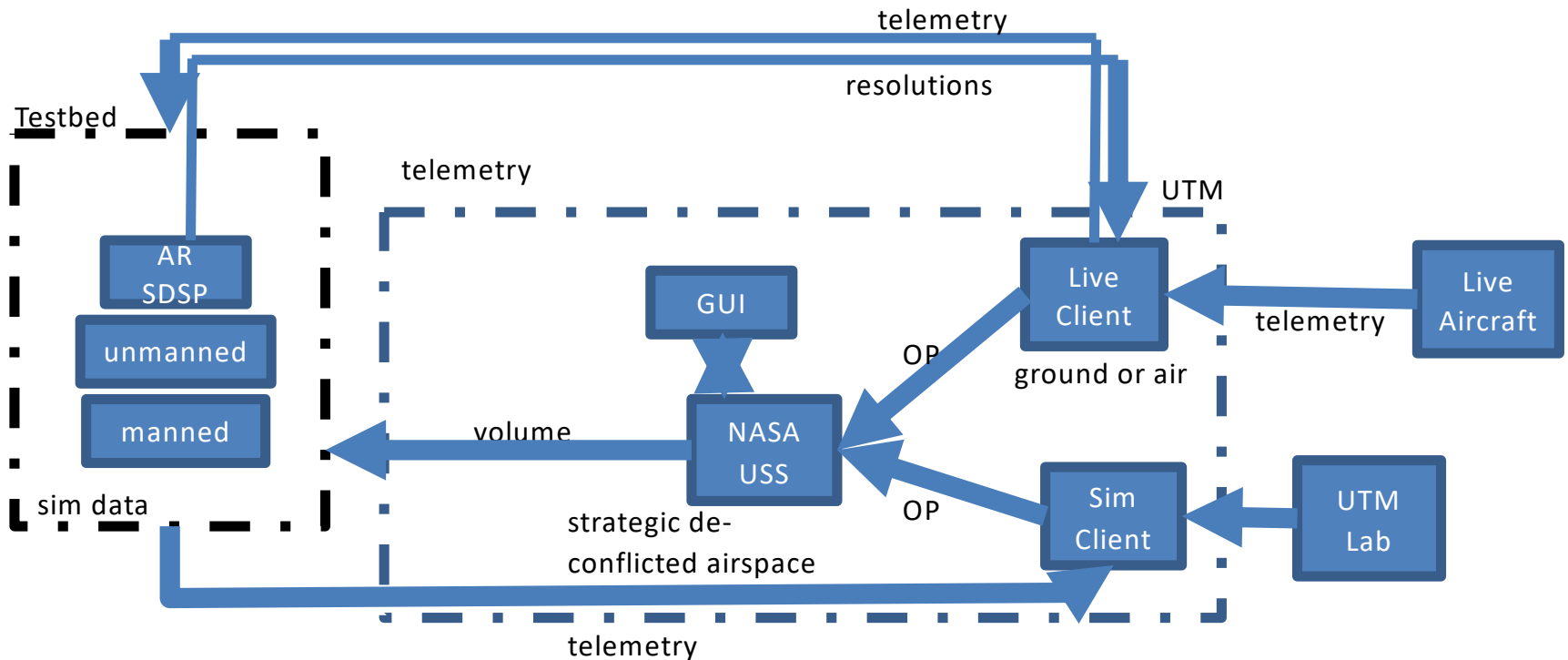
Page Controls: 1 / 10, Upload, Create

Using AAC



See gov.nasa.test.AACTest

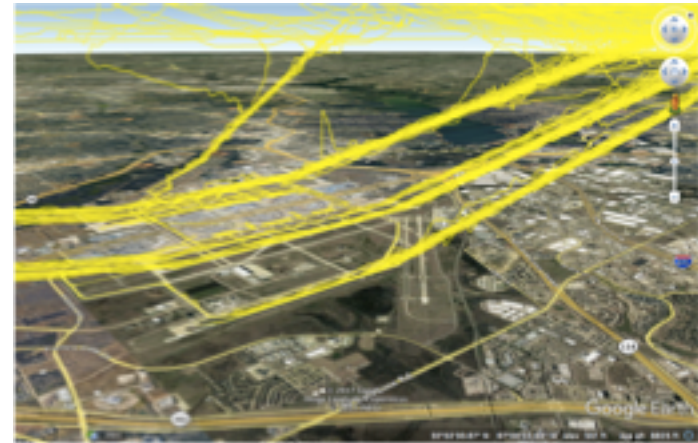
Connectivity



Operational Plan (OP): inter-connected volume of airspaces

Candidate Simulation Components

X-Plane/eVTOL flight state,
Loss of separation,
Route structure & Geo fence, metrics



PaxApp

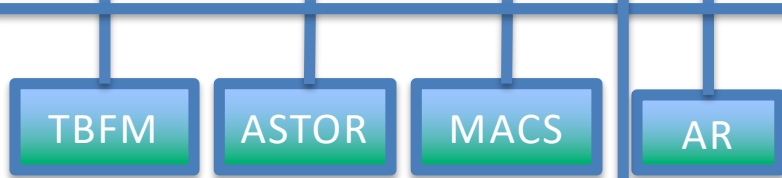
FleetManager

DDS

Live data



Historical data
Terrain data



nCTOP



Labs

Path Planning

Scheduler

COMETTS

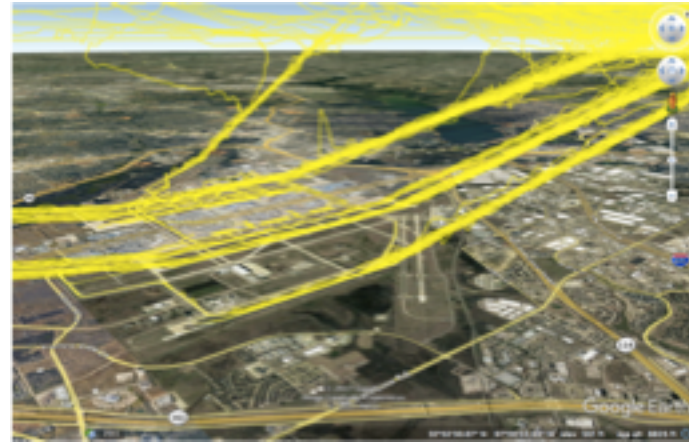
RTSM

FE³

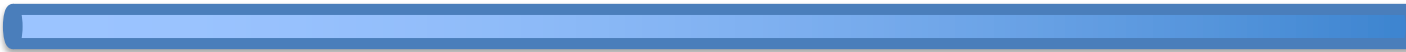
2018-2020



X-Plane/VTOL flight state,
Loss of separation,
Route structure & Geo fence,
metrics



DDS

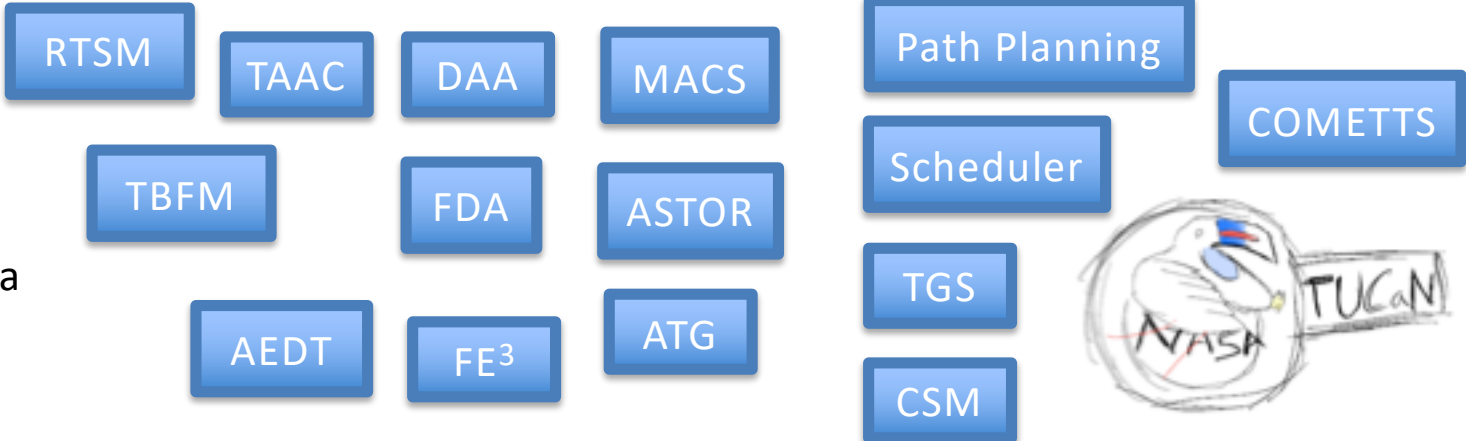


Cloud

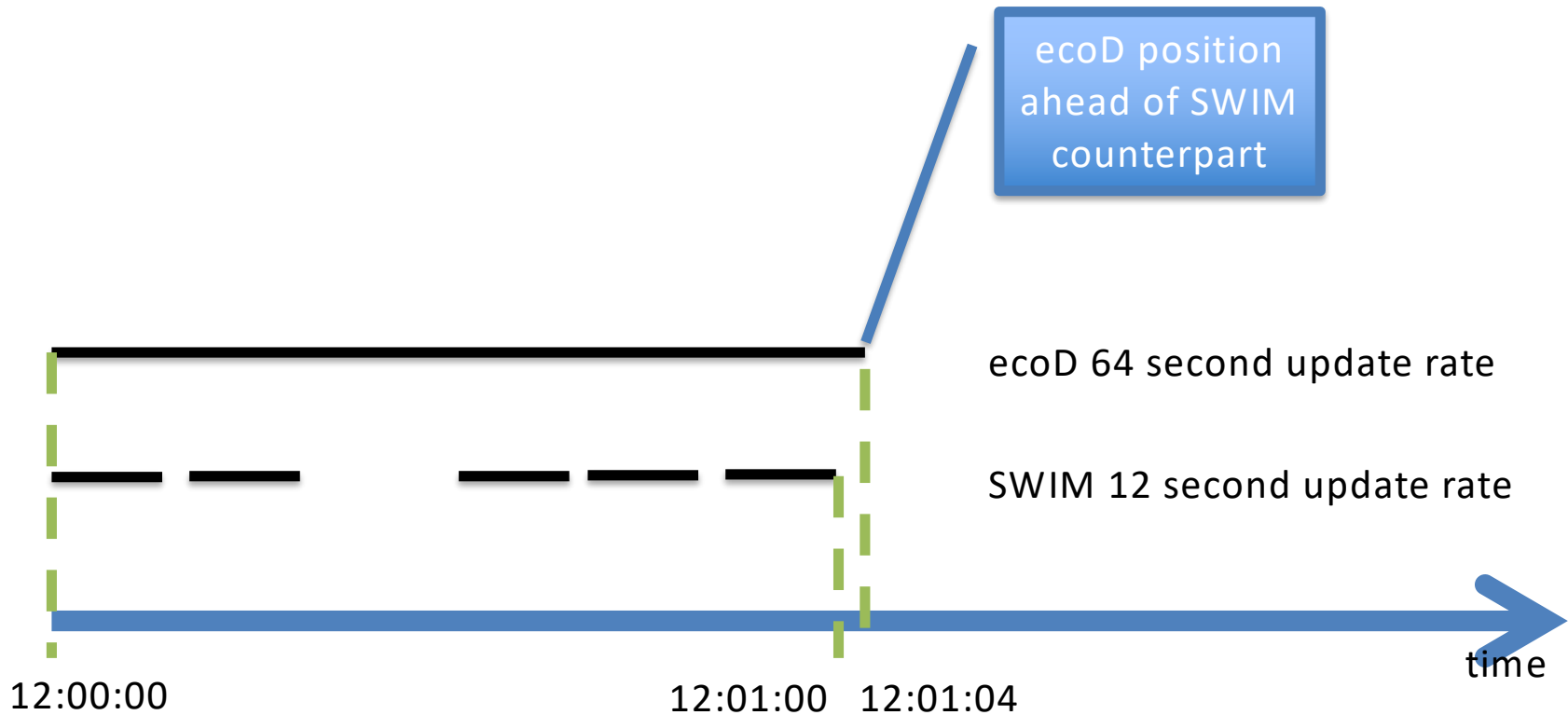
Live data



Historical data
Terrain data
Population
Etc.

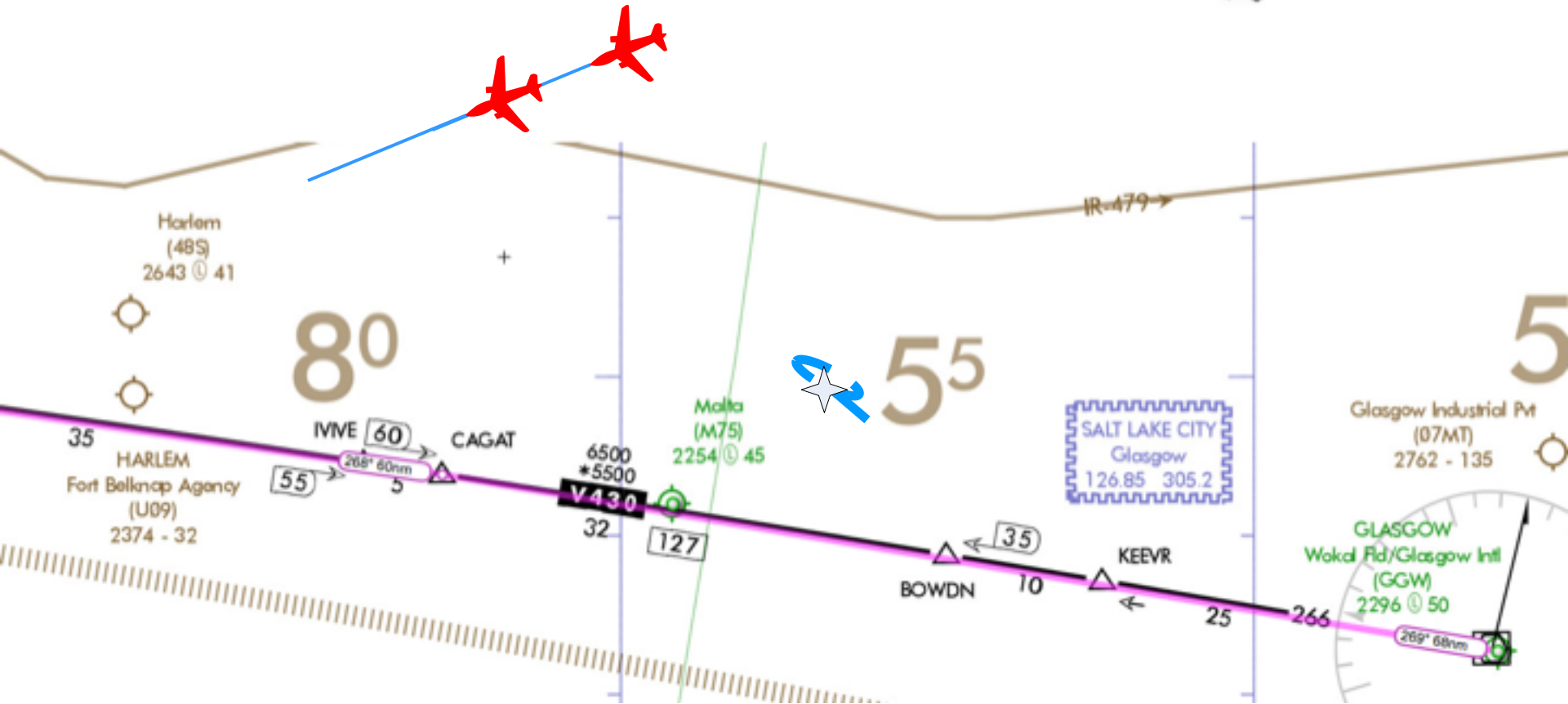


Notional Time Steps





Merge Point at HVR



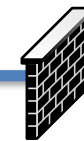
Increasing Diverse Operation



Ground Stations



Industry
firewall



NASA
firewall

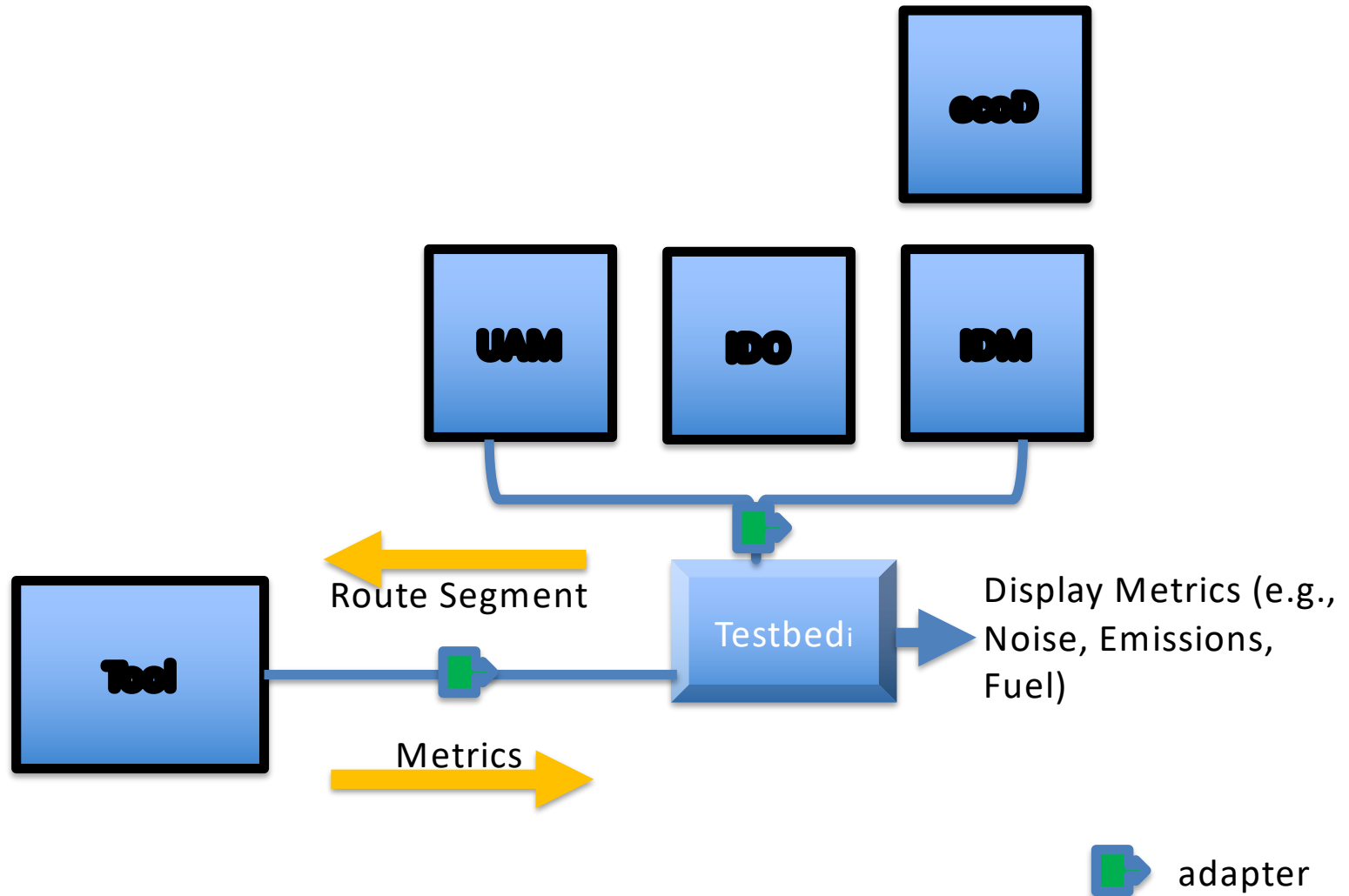


Testbed

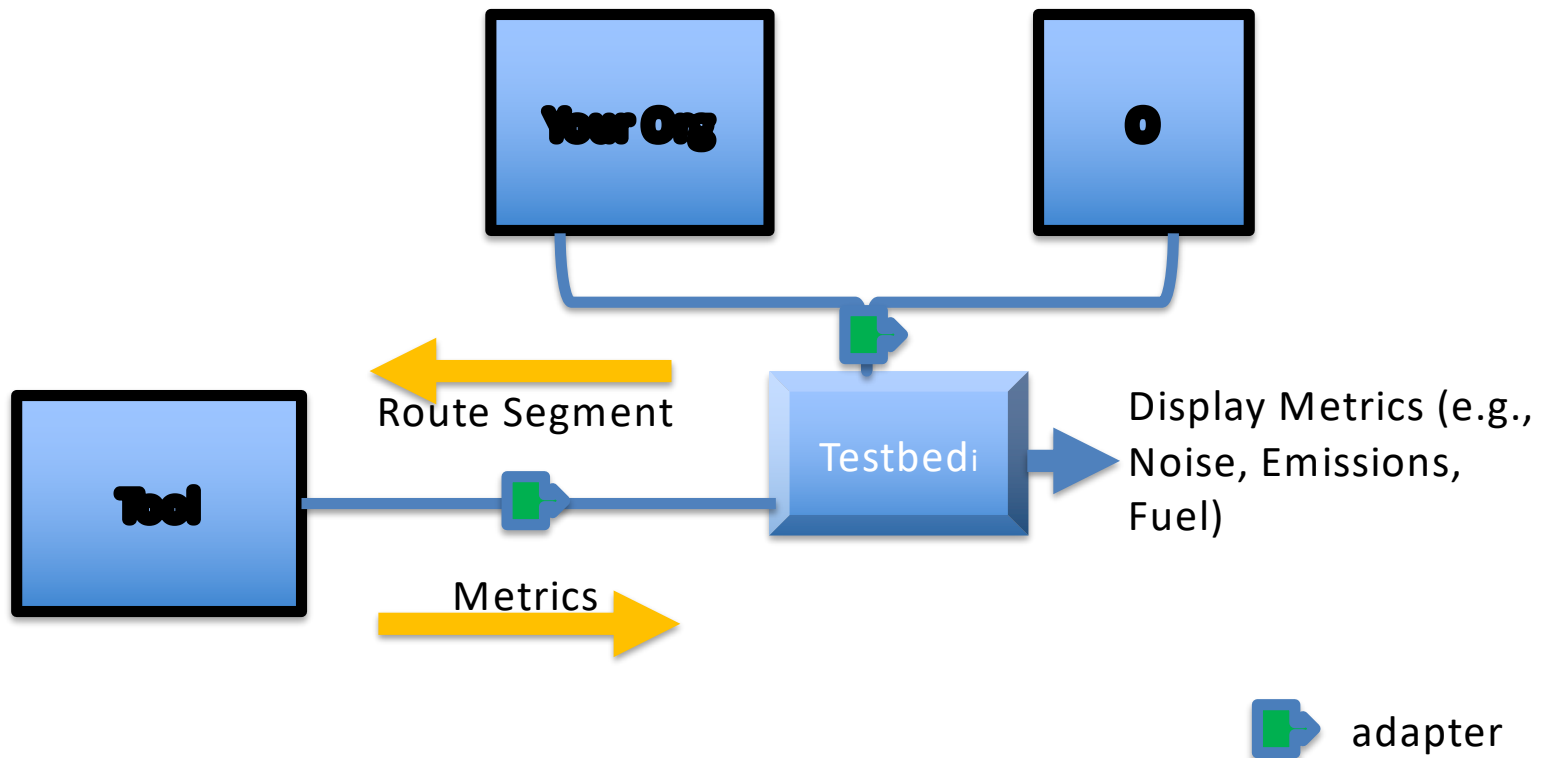


adapters

Application Programming Interface



Testbed Hands-on Developer Meeting



Training Configuration

