

# Verification and Validation (V&V)

## System-of-Systems Assessment Platform (SoSAP)

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Federal Aviation  
Administration



# NextGen 2025 OV-1

## INTERNATIONAL HARMONIZATION



# NextGen Segment Timeline

Mid-Term

SEGMENT ALPHA

SEGMENT BRAVO

2010

2015

2018

Implementation

## Portfolios

Collaborative Air Traffic Management

Improved Surface Operations

Time-Based Flow Management

Closely Spaced, Parallel, Converging and Intersecting Runway Operations

Improved Approaches and Low Visibility Operations

Performance-Based Navigation

On-Demand NAS Information

Automation Support for Separation Management

Common Services

TBD

# Cultural Shift

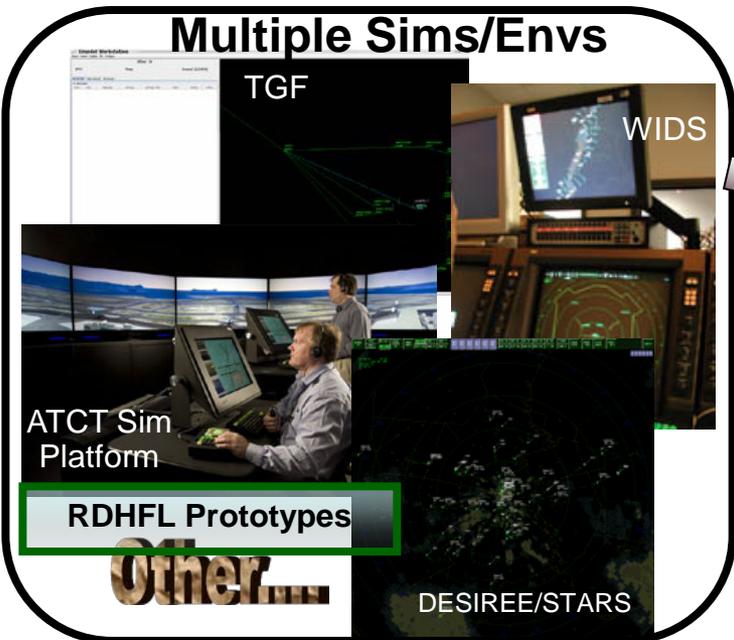


Immerse Operators  
(ATC/Pilot) & Get  
Feedback



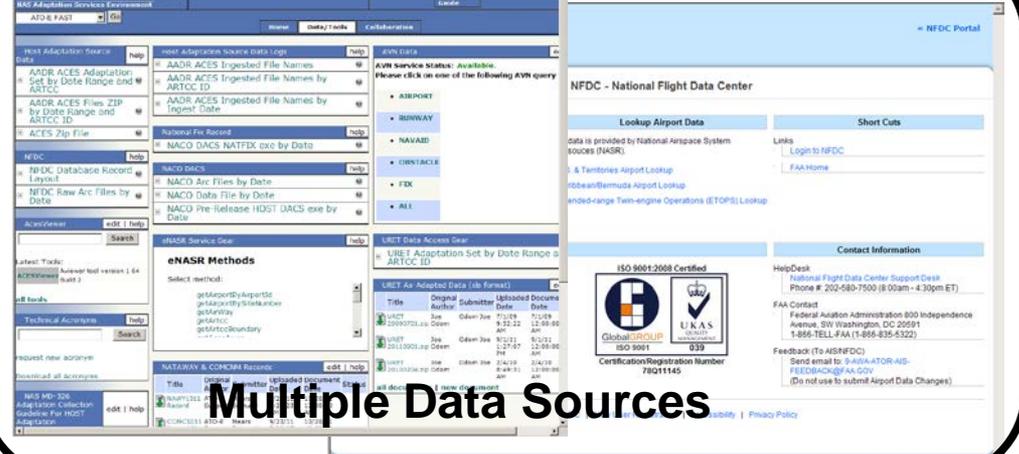
# Platform Consistency

## Multiple Sims/Envs



Single NAS-wide System-of-Systems Assessment Platform

NASE



Various Scenarios

# System-of-Systems Assessment Platform

# SOSAP



# Strategic Intent

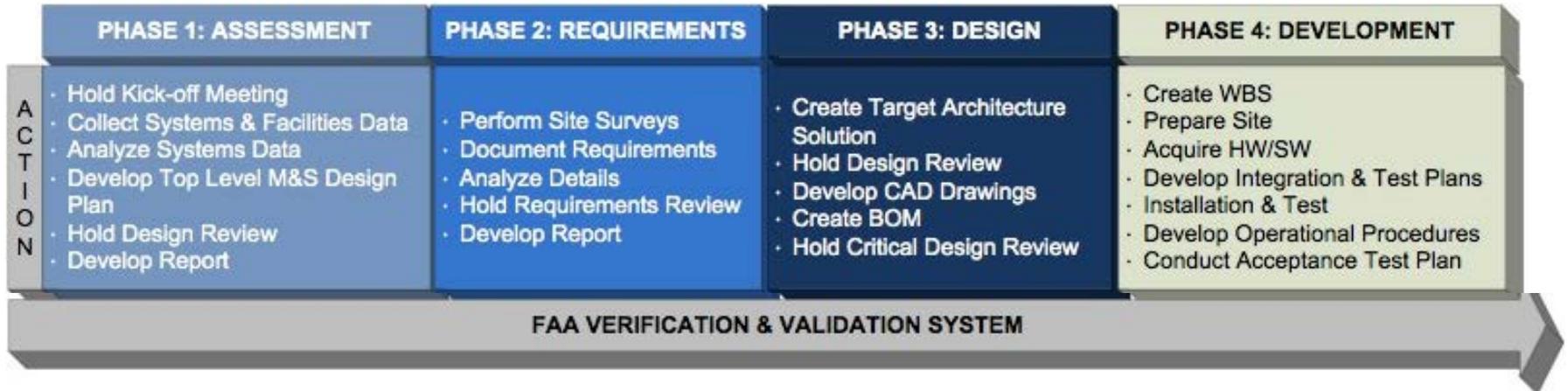
## Mission:

*Enable FAA Leadership, Engineers and other key personnel to understand the complex and emergent behavior of FAA systems throughout the acquisition life cycle in order to make informed decisions on the construction and delivery of FAA systems.*

## Objective:

*Develop a Live, Virtual, and Constructive Integrated M&S environment and technical toolset that will assist with making informed decisions from early concept analysis, through design, developmental test and evaluation, integration, and operational test and evaluation.*

# Multiphase Effort



# Phase I Action Plan

## ↑ Design and Prototype Agent-based Framework

- Infrastructure
- Data model
- Scenario Design
- Agents
- Database

## ↑ Research Simulation Systems

- Research available simulation systems
- Establish simulation requirements
- Choose a sim to get us going with demo (TGF)
- Research accessibility to simulation systems
- Compare available sim systems to requirements

## → Data Research and Acquisition

- Determine where NAS data is stored
- Determine what data the simulation components need
- Find path to get all of the NAS data, even though simulations only need pieces of data because we need it all for (routes, airports, fixes, runways, centers, TRACON, tower, etc)

## ↑ Research and Prototype Visualization

- Determine best products to produce visualization
- Develop in house mapping to avoid the web
- Combine simulation, data, and visualization in a common framework
- Research web based visualization to simplify installations
- Render sim planes on map

## ↑ Data Logging - Research and profile data logging

## ↓ White Cell Control

## ↑ Prepare Engineering Report Documenting Initial Analysis

## → Test Sim, agents, hardware, logging, visualization for:

- 7K Simultaneous Aircraft; 50K Daily
- All NAS objects: Waypoints, routes, airports

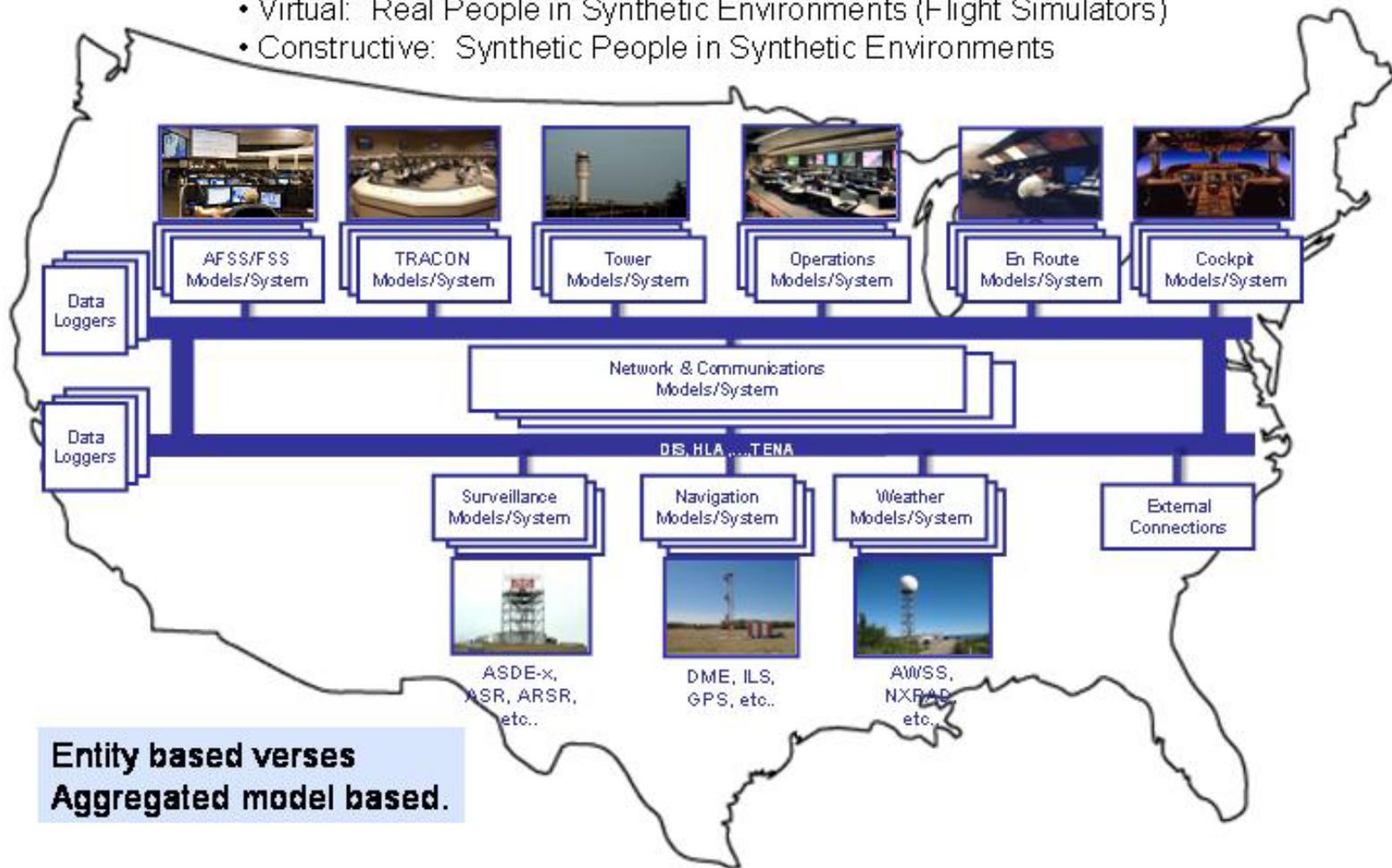
# SoSAP Initial Principles

- **Leverage existing FAA investments**
- **Use intelligent agent technology to model air traffic controllers, pilots, and command center decisions**
- **Model communications using simulated voice and data**
- **Basic design:**
  - Open architecture, non-proprietary
  - Low-cost alternatives
  - Real-time synthetic environment
  - Entire NAS network
  - Variable fidelity, with capability to represent real-world dynamics

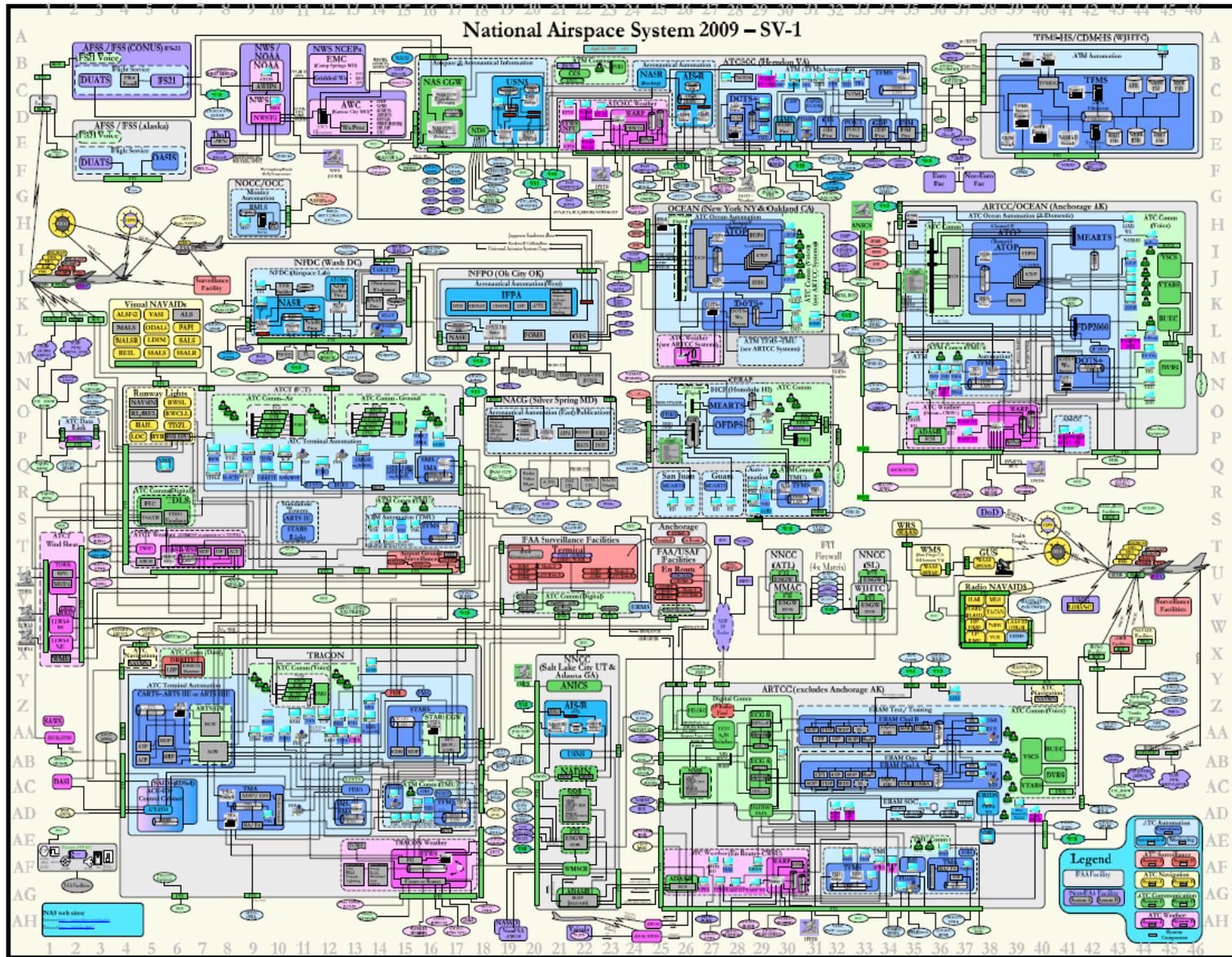
# System-of-Systems V&V Capability: NextGen Synthetic Environment

In combination, these components form the capability:

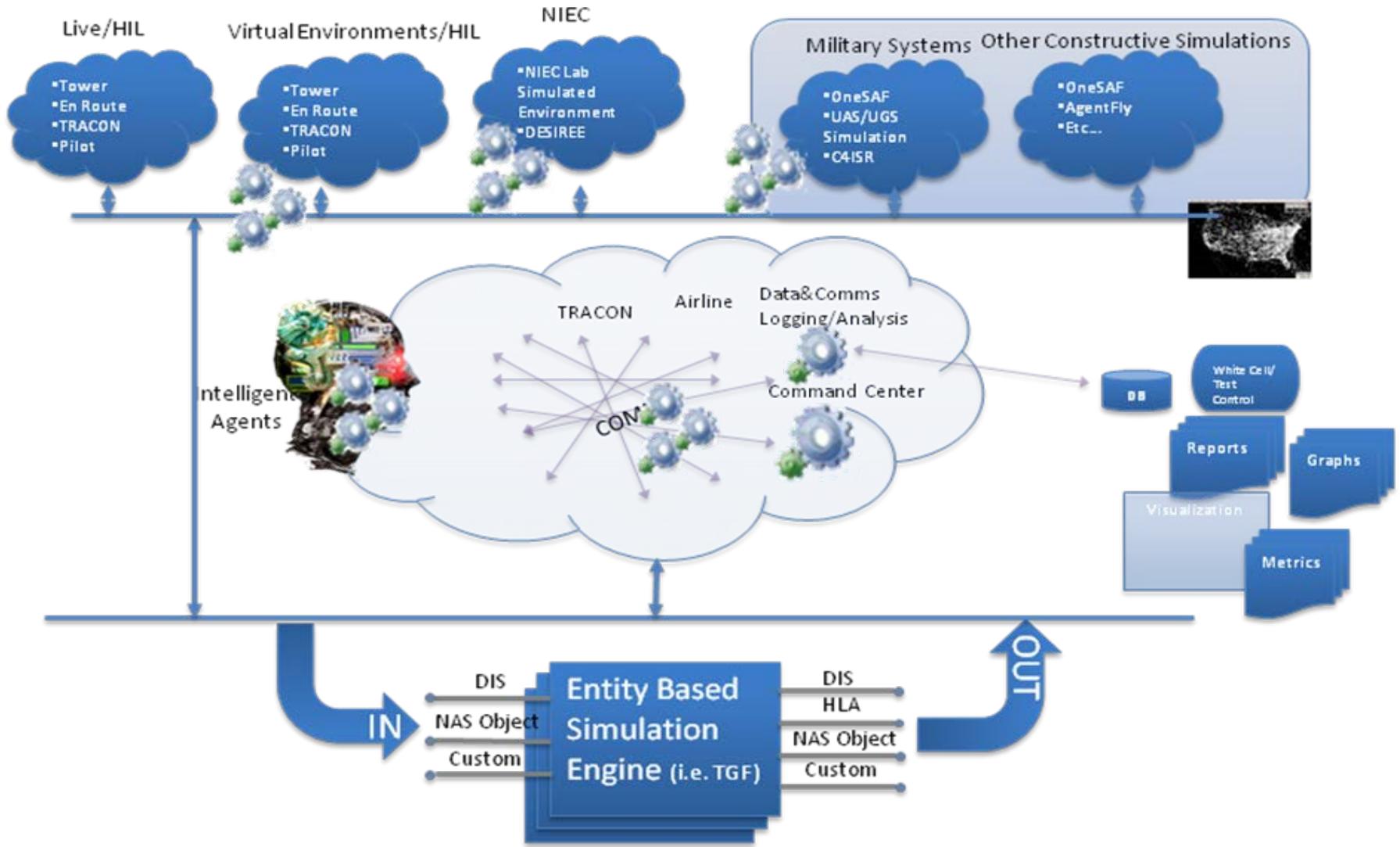
- Live: Real People in Real Environments (Laser Tag)
- Virtual: Real People in Synthetic Environments (Flight Simulators)
- Constructive: Synthetic People in Synthetic Environments



# “Simplified” NAS SV-1



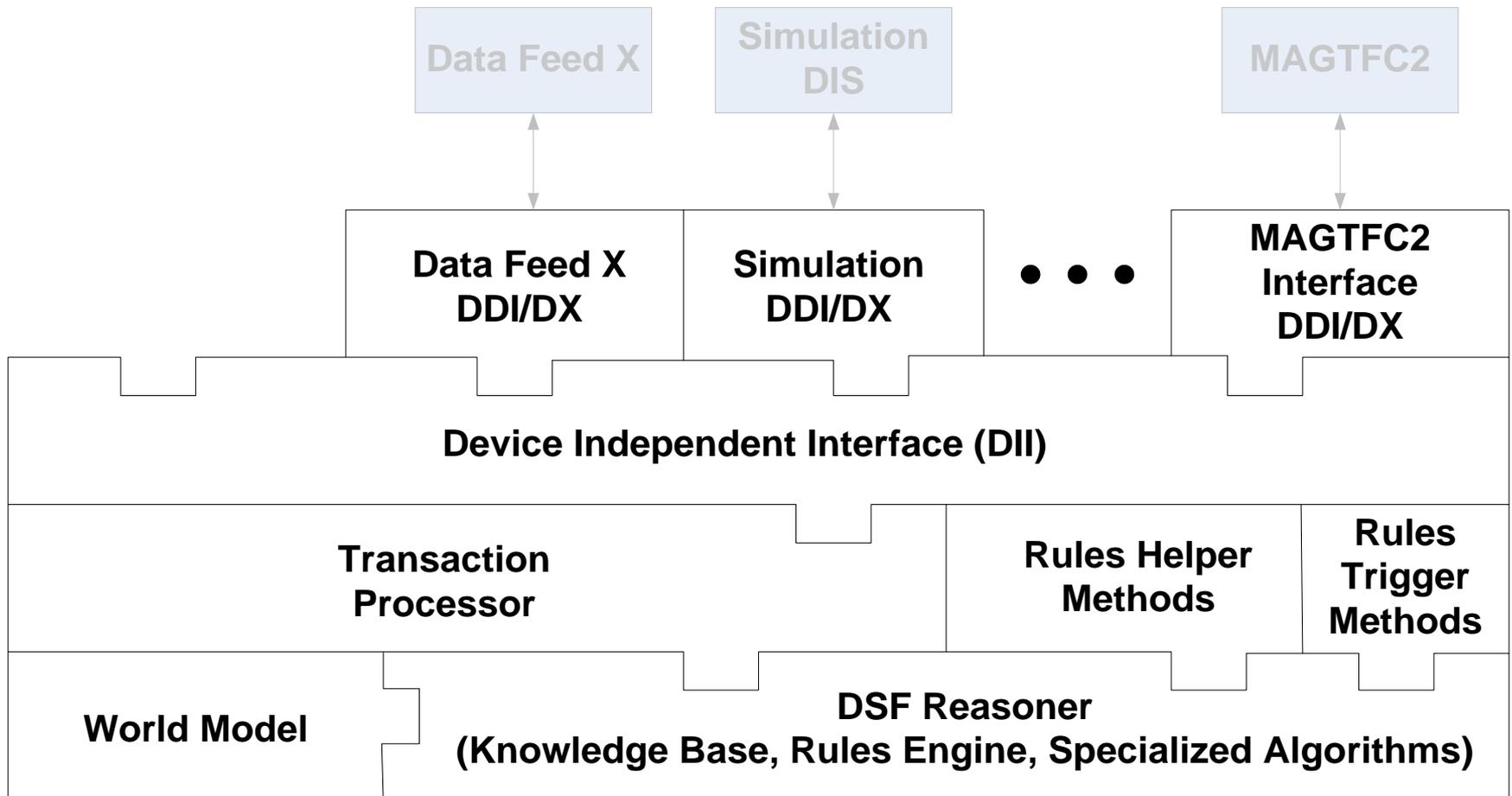
# Design Overview







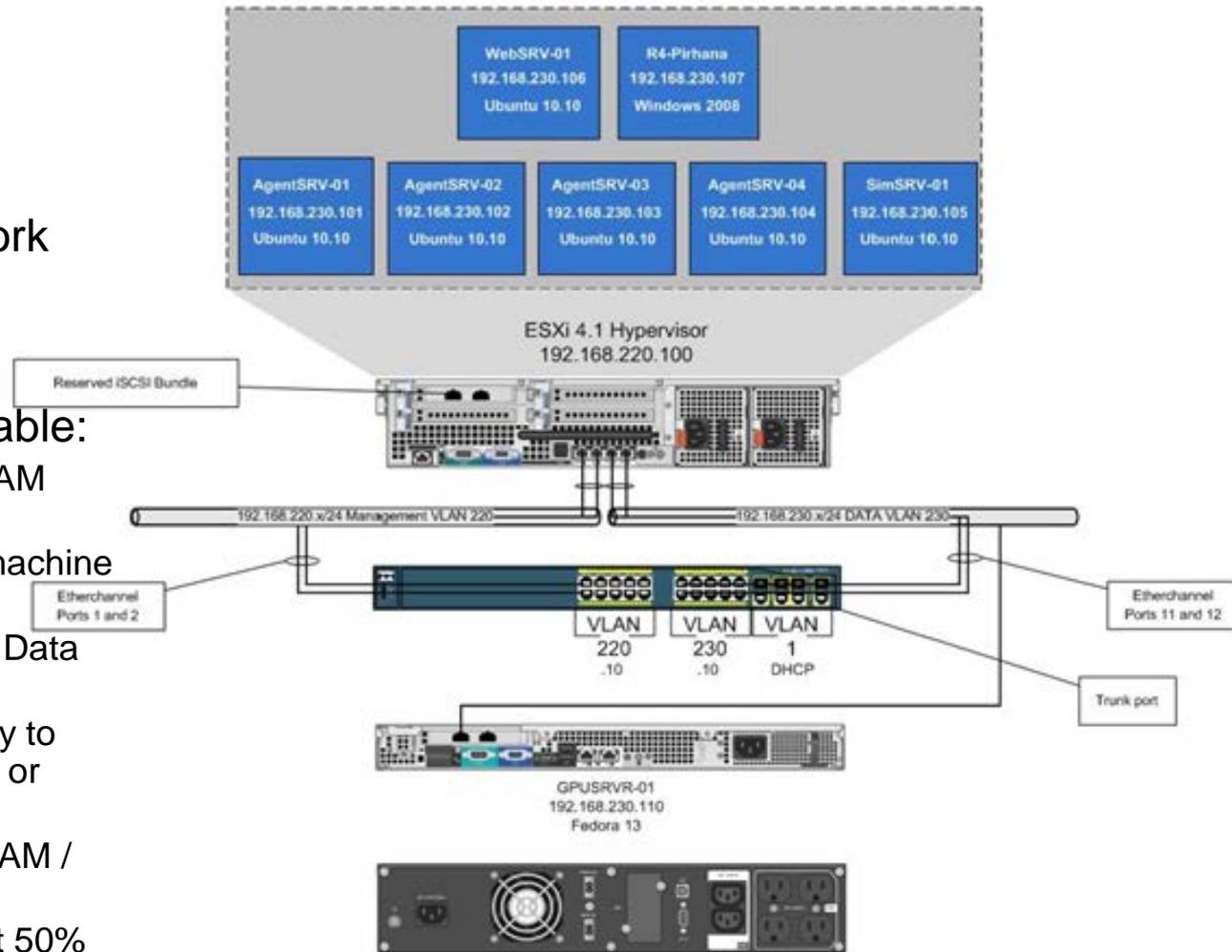
# Prototype Agent Design



# SoSAP Initial Hardware Configuration

## Operational Features

- Standalone mobile network infrastructure
- Low cost
- Reconfigurable and scalable:
  - Dell R710 12 Core / 24GB RAM running ESXi 4.1 Hypervisor
  - 1.7 TB Datastore for virtual machine storage on RAID 5
  - Separated Management and Data networks (VLAN's)
  - Support for iSCSI connectivity to Storage Area Network (SAN) or NAS
  - Supermicro 8 Core / 24GB RAM / Tesla C1060 GPU
  - Dell 1000W UPS (Running at 50% load)



# Phase I Simulation Analysis

Simulation Evaluation Criteria
Open Architecture
Open Source to FAA
Encompass full flight from gate to gate
Support modeling all airports and NAS objects in memory
Support realistic flight dynamics
FAA approved models
Ability to acquire map data and tools to ingest map data
Ability to support 7000 aircraft simultaneously for several days
Ability to program multiple flight plans for a single plane (same plane, different id)
Ability to add new flight plans during a run
Ability to represent a good pool of defined plane types
Ability to connect to other FAA systems (protocols)
Ability to send and receive flight commands
Ability to receive entity state (x, y, z speed, heading, pitch, role, acceleration)
Provide tools to compose and change plane types
Ability to take off and land multiple times
Ability to change source code
Ability to take off and land at multiple airports
Ability to support weather effects on aircraft dynamics

TGF is currently recommended...

- Interfaces to existing systems
- Has FAA approved models
- Is familiar to FAA
- Has accessible code

...but it will need some enhancements

# Phase I Lessons Learned

- ***Agent technology is the best suited solution for scalability and configurability.***
- ***Knowledge acquisition is complex. No one set of rules for a particular ATC function is the same across locations and domains.***
- ***Data Acquisition and synchronization is complex and vast.***
- ***Open M&S systems, handling a full complement of ATC and airplane functions covering gate to gate operation across the NAS, do not exist.***

# Summary

- **NextGen - complex SoS with unknown behaviors yet to emerge**
- **Resulting Challenges:**
  - Shift in *cultural thinking* – operational & functional
  - Strategy for *portfolio testing*
  - *Consistent platform* to unify disparate simulations, data and concepts that will provide baseline for comparative analysis of NAS-wide concepts throughout lifecycle
- **A System-of-Systems Assessment Platform (SoSAP):**
  - Enables operator immersion into simulated NAS/NextGen environment
  - Is applicable to training, concept exploration and system evaluation
  - Presents an approach to portfolio testing of interdependent systems on asynchronous schedules
  - Provides a common baseline of tools (data, models, scenarios) for SoS assessment
  - Leverages existing FAA simulations and non-proprietary commercial