Architecture for SoS Evaluation of NextGen

Federal Aviation Administration

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T&E of Systems-of-Systems

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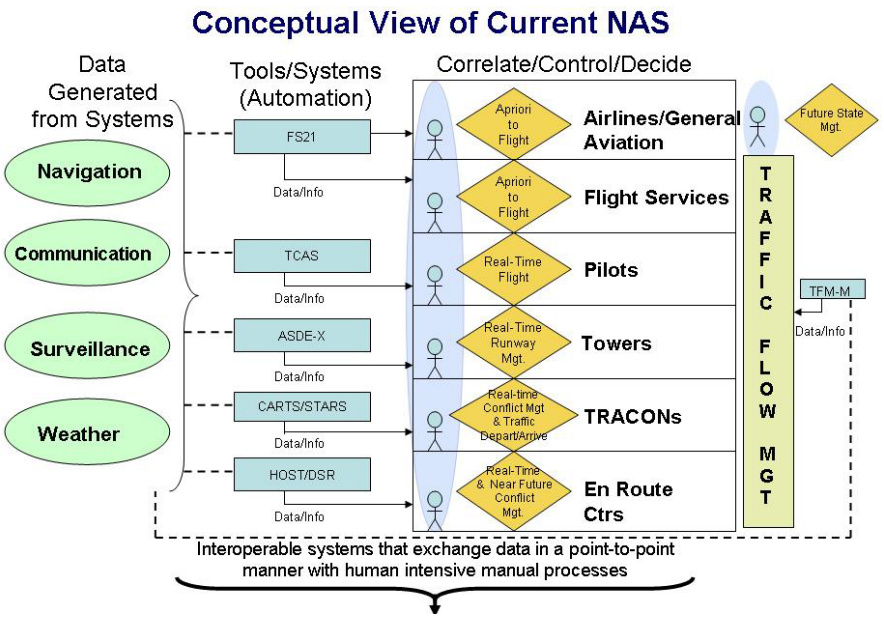
Topics

- NAS/NextGen Challenges
- Need for SoS Evaluation Tools & Underlying Principles
- Important Characteristics of SoSAP
- Initial Lessons Learned
- Next Steps

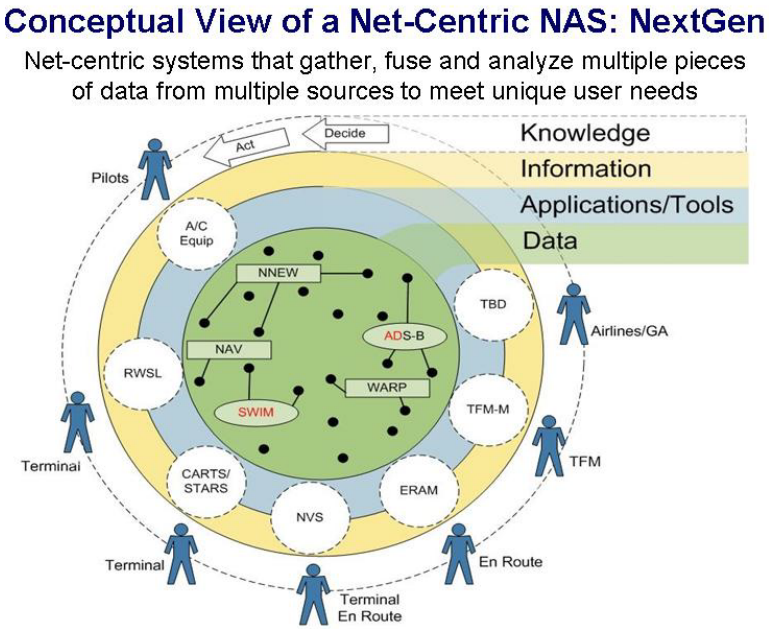

OUR MAIN COMPUTER IS DOWN! THANK GOODNESS FOR THE BACKUP SYSTEM. HAS IT COME ONLINE YET?
YEAH, BUT I DON'T THINK YOU'RE GOING TO LIKE IT-
AIR TRAFFIC CONTROL
Y'ALL BE CAREFUL UP THERE, Y'HERE!
CHICAGO TRIBUNE

Problem: No Existing NAS-Wide SoS Evaluation Capability

Where We've Been



Where We're Going

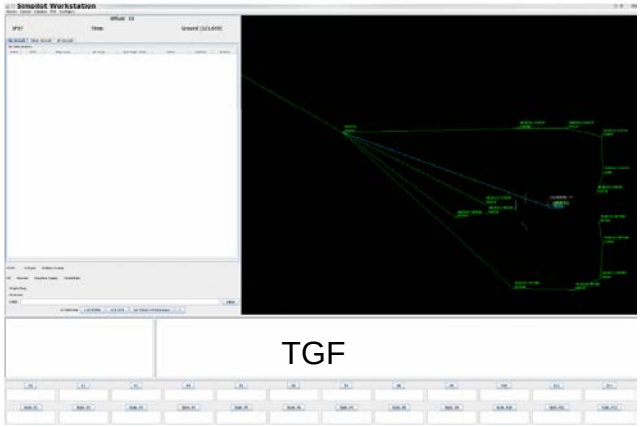


NextGen represents a fundamental paradigm shift from:
stove-piped, analog, point to point systems to ...
an integrated, digital, net-centric architecture


NextGen 2025 OV-1
INTERNATIONAL HARMONIZATION
Increase Flexibility in the Terminal Environment
Transform Facilities
Trajectory Based Operations
Flight Operator
Military
Airlines
NextGen Facilities
Remote Facilities
Cruise
Climb
Metering/ Descent
Approach
Landing
Takeoff
Air Traffic Services
ATC-Advisory
ATC-Separation Assurance
Airspace Management
Emergency and Alerting
Flight Planning
Infrastructure-Information Management
TM-Strategic Flow
TM-Synchronization
Other Government Agencies
Commercial Spaceport
National Weather Service
Increase Arrivals/Departures at High Density Airports
Collaborative Air Traffic Management
Traffic Mgmt
FOC
Pilots
ATC
Reduce Weather Impact
NWP

Need: Framework for SoS Assessment

- **Open =>** **Non-Proprietary system**
- **Low Cost =>** **Leverage existing FAA/DoD investments**
- **Scalable =>** **Model the entire NAS with varying levels of fidelity**
- **Flexible =>** **Ability to immerse real systems, new concepts, and new procedures into the environment**



Solution Concept

The Actors and Objects in the NAS are the touch points on the systems. (System of Systems)

IF

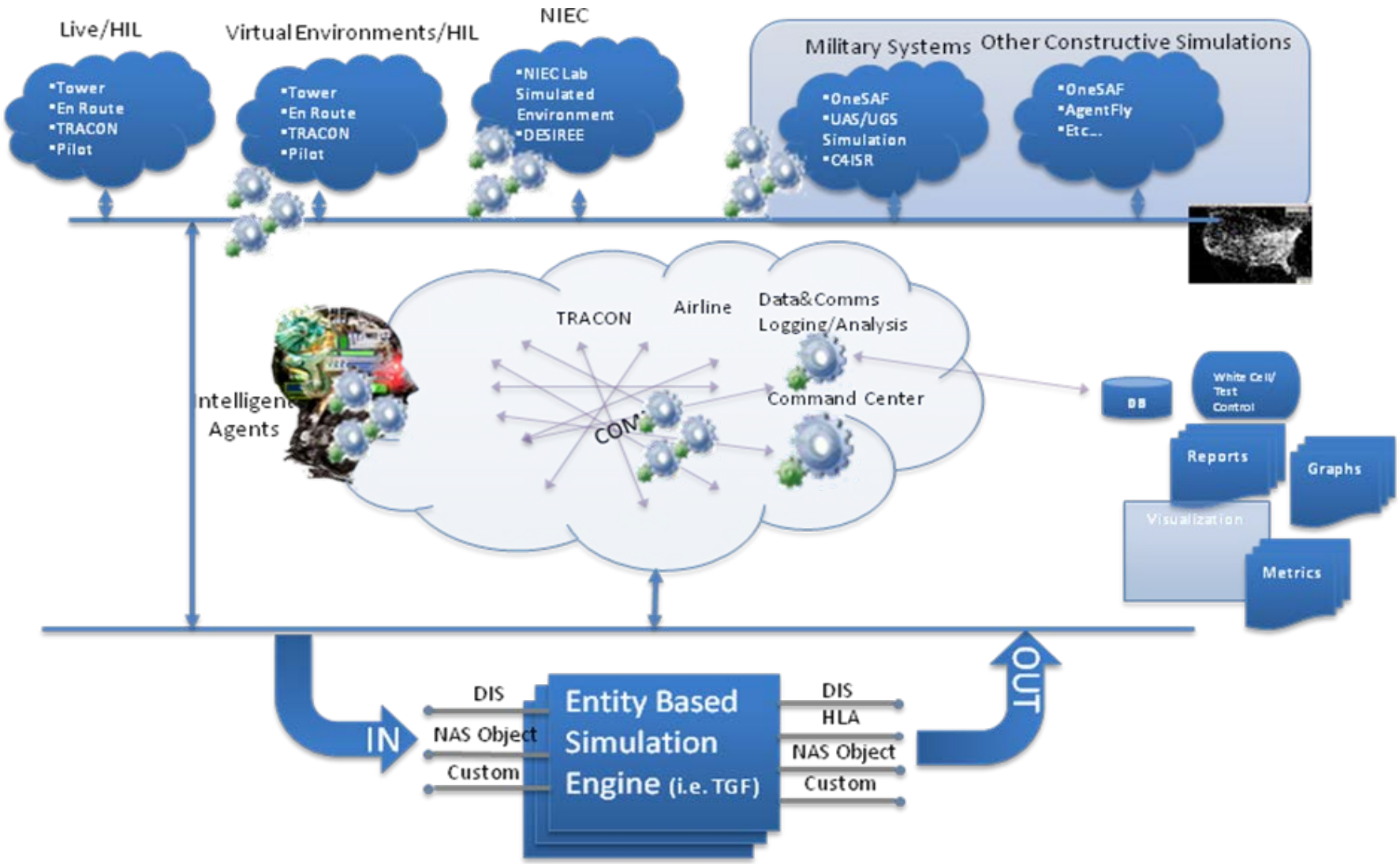
We model those actors and objects based on todays NAS behavior and we can create a baseline model of the NAS…

THEN

We can alter those behaviors based on new concepts, ideas, systems, etc., resulting in new emergent behavior of the System of Systems.

This new behavior might be measured by fuel savings, on-time percentage, capacity, etc., and could be used in the verification and validation (V&V) process.

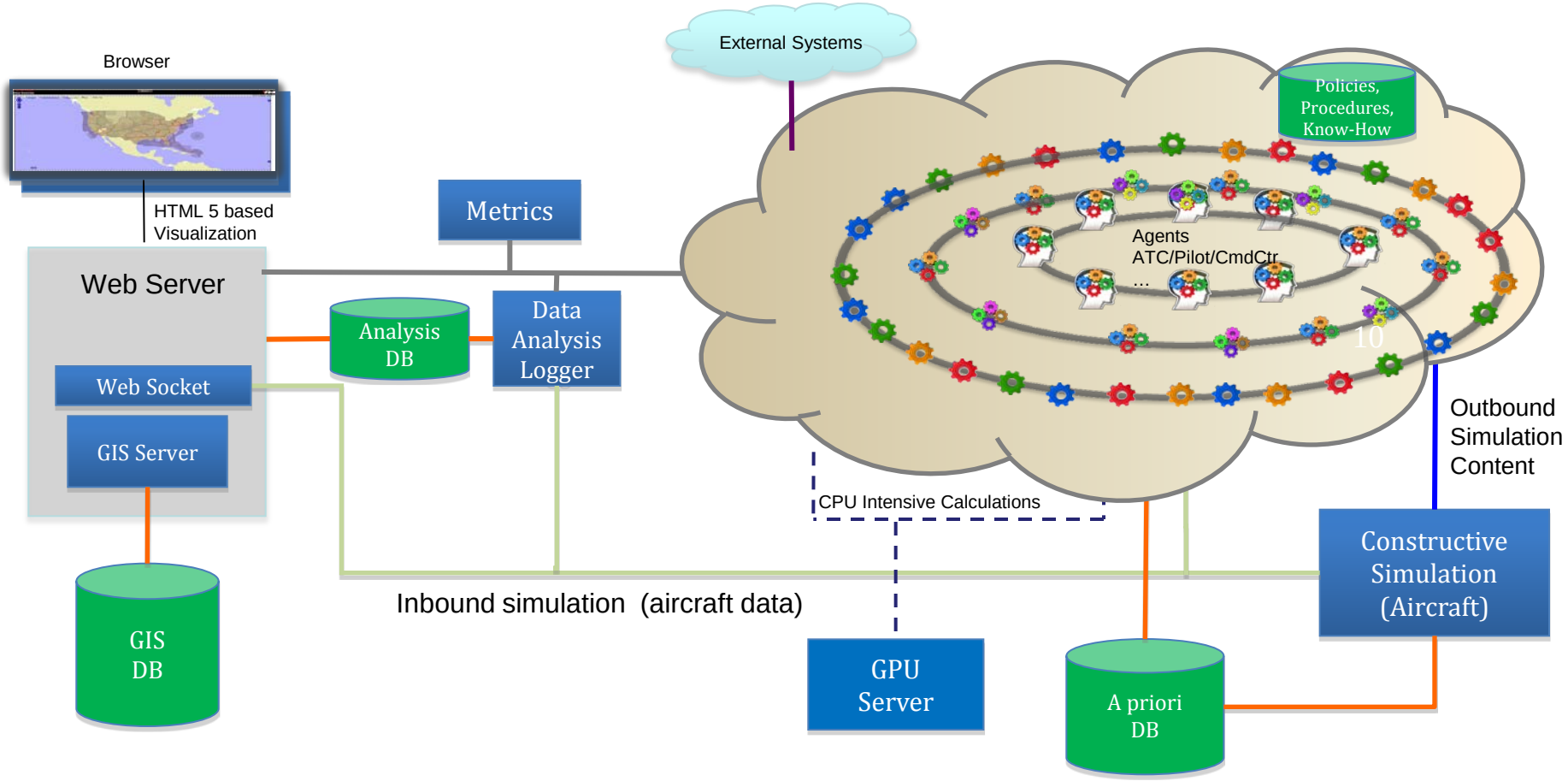
Solution Overview



Model Decision-Making of Each Agent

- **Use a combination of business rules and predictive analytics.**
- **Encode regulation, policy, know-how, and analytical insight into a knowledge base for each agent**
- **Each instantiation of an agent could have a different levels of knowledge**

Solution Architecture



Framework Tools

- Ex. Control
- Data Acq.
- Rules Acq.
- Flight Plans Editor
- ATC Guidance Matrices

Initial 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 real-time M&S systems, handling a full complement of ATC and airplane functions covering gate to gate operation across the NAS, do not exist.***

Next Steps

- ***Continue integration with some systems within FAA***
- ***Enhance IA capabilities/fidelity***
- ***Work with academia for knowledge capture from ATC professionals for IA enhancement – document***
- ***Work with academia in area of anomaly detection for future application to SoSAP experiment analysis***
- ***Continue working on solutions for data acquisition and use***
- ***Refine architecture***
- ***Enhance current visualization tools and integrate with others***
- ***Conduct demonstration of refined prototype architecture and use to solidify detailed architecture requirements identification***

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