

# **System-Wide Fast-Time Simulation Architecture**

**November 16<sup>th</sup> 2006**



# Background

**FAA has been sponsoring this research since the late 90's:**

- **2000 – Common ATM Information State Space (CAISS v1.0)**
  - Based on the '*Gridded Airspace Concept*' and '*NAS Common Reference*' whitepapers [Bradford, Jehlen]
- **2002 – CAISS v2.0**
- **2003 – NAS Architecture Framework Model**
  - Based around CAISS
  - Support collaboration of simulators, analytical tools & DST
  - For future ATM operational concept validation
  - And supporting SWIM concepts for participating agents

➤ ***Strategy for Information Management and Collaboration (SIM-C)***

# Background #2

## Analysis of operational concepts using the framework:

- **2004 – Trajectory-Based Management (TBM)**
  - Demonstrate how TBM can be used in the NAS
  - ... and potential problem sources (e.g. predictability, coordination, policy etc...)
- **2005 – ERAM, Flight Object & SWIM Demonstrator**
  - Demonstrate harmonisation of the 3 concepts
  - For the NAS in the timeframe 2010 to 2025
  - Using demonstration scenario's
- **2006 – Multi-Sector Planner Coordination Analysis**
  - Incorporate MSP Agents
  - To carry out analysis of multiple MSP's
  - Determining inter-MSP coordination needs

# CAISS (1999 – 2002)

## Objectives:



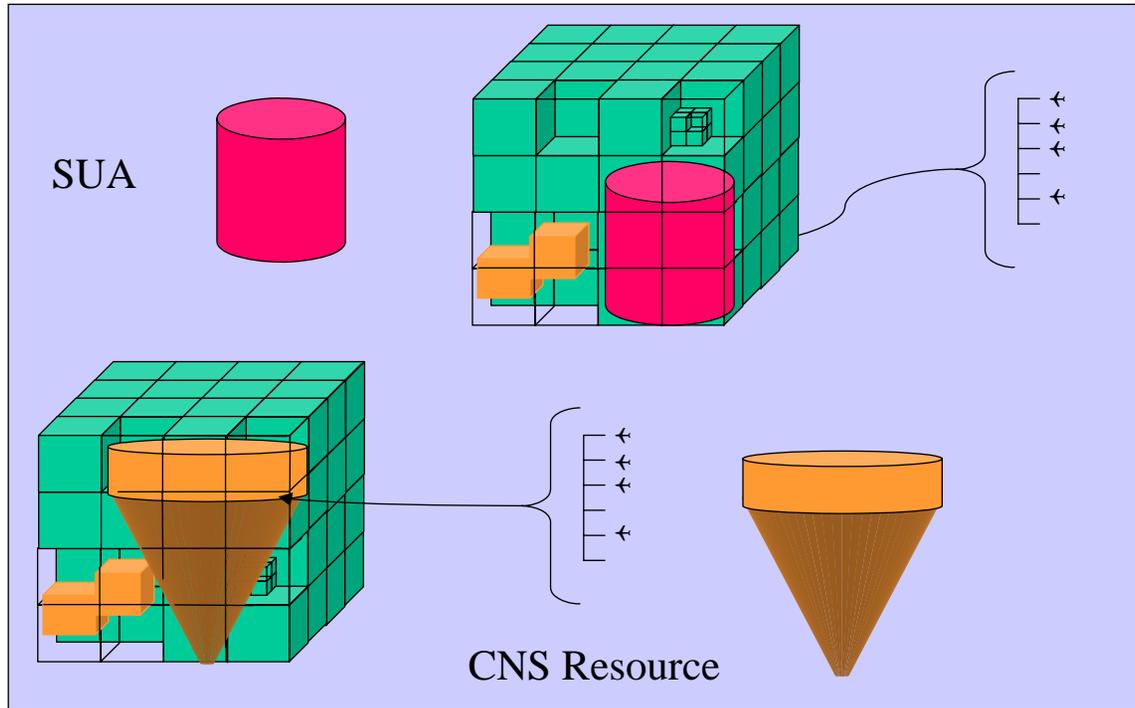
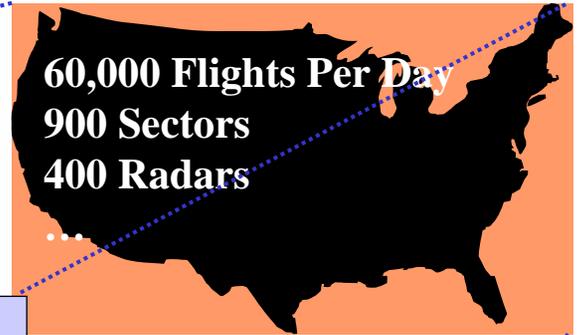
***“SYNTHESIZE SYSTEM-WIDE DATA”***

**!!PROBLEM!!**

**An efficient mechanism is required to cater for the huge quantity of system data**

**...and to support rapid access to stored information**

➤ SOLUTION - "Divide and Conquer"



# CAISS Characteristics

- **CAISS supports many aspects of the future ATM system**
  - Establishment of future operation plan (NOP, NAS-CR)
  - Pre-Operational support
  - Strategic support
  - Dynamic system-wide & regional flow planning
  - Tactical operation
  - Contingency planning
  - Advanced airspace planning
- **...and is a highly suitable mechanism to support the registration, retrieval and update of system-wide information**

# SIM-C (2003)

## RTCA vision (2010+)

- Net-centric architecture
- Supported by System Wide Information (SWIM)
- Intelligent Agents working for Stakeholders
- Publish/Subscribe, service-based architecture
- System-supported coordination (SYSCO / Omni-SYSCO)
- Shared situational awareness (using the *Flight Object*)
- Trajectory-based operation
- Incorporate weather into decisions
- ...etc

### **...to facilitate**

- Shared decision making
- More strategic management/planning
- Trajectory-based ATM
- Performance-based ATM
- ...etc



## JPDO NGATS vision (2025+)

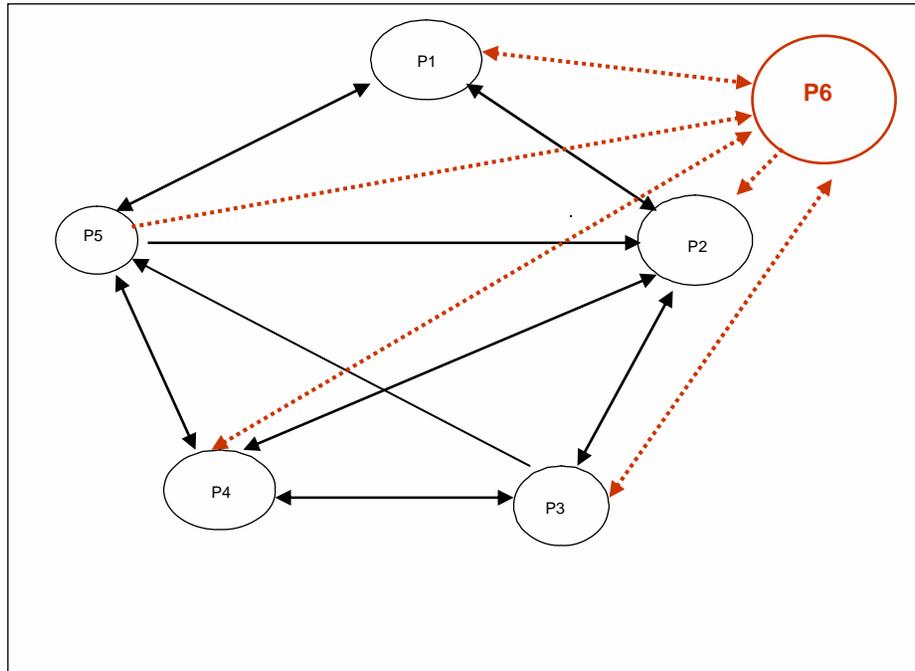
- Eight “*large transformation strategies*”
- Key capabilities needed to achieve transformations
  - Net-enabled information access
  - Performance-based services
  - Weather assimilated decision making
  - Layered adaptive security
  - Broad-area precision navigation
  - Trajectory-based aircraft operations
  - Equivalent visual operations
  - Super-density operations
  - ...etc

# SIM-C Architecture

- Designed to include model of future system architecture
  - Network-based
  - Common information (CAISS)
  - Service publication, subscription and discovery (SVC\_Rep)
  - Shared situational awareness (Flight Object / SWIM)
  - Intelligent agents supporting stakeholder models
  - Event notification (SENS)
- Emulation of key applications
  - Airport demand/capacity balancing
  - Airspace demand/capacity balancing
  - TFM (central & regional)
  - SUA impacts
  - Weather effects
  - ...

# Today's ATM Environment

- Based on point to point communication



... earlier (pre 2000) distributed system-wide simulation solutions we used for FAA were also implemented in this way (e.g. AFDM, RAMS-Midas, LDRR etc..)

# ERAM (Lockheed) Viewpoint

## Flight Data – Today’s Environment

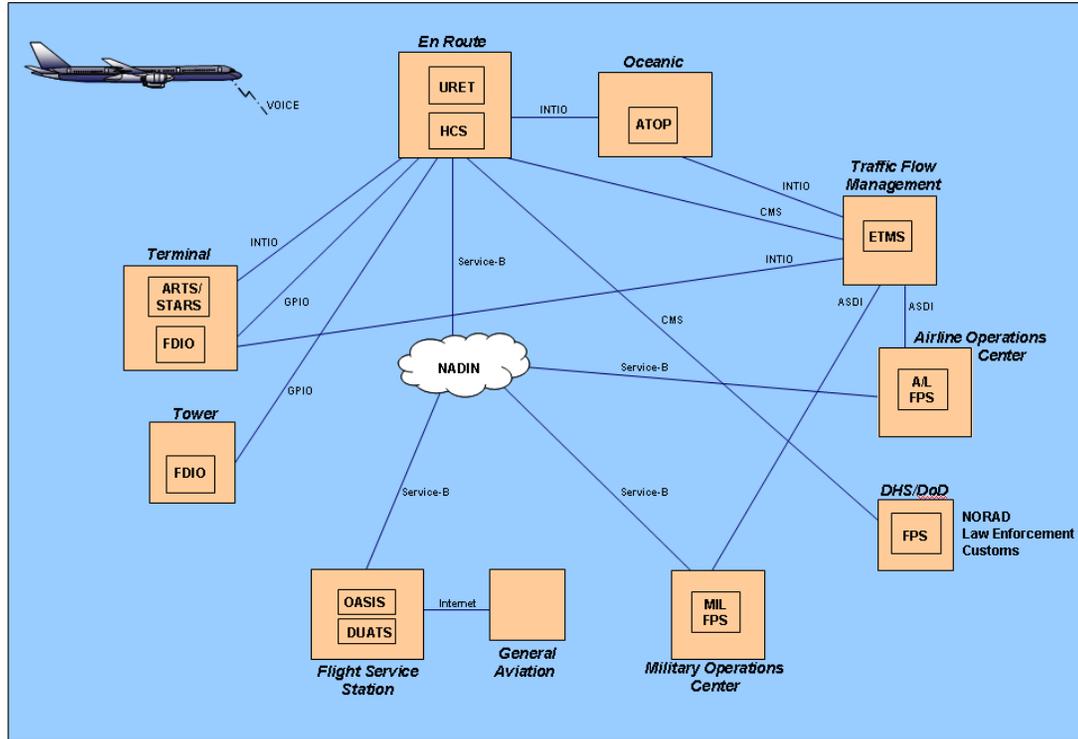


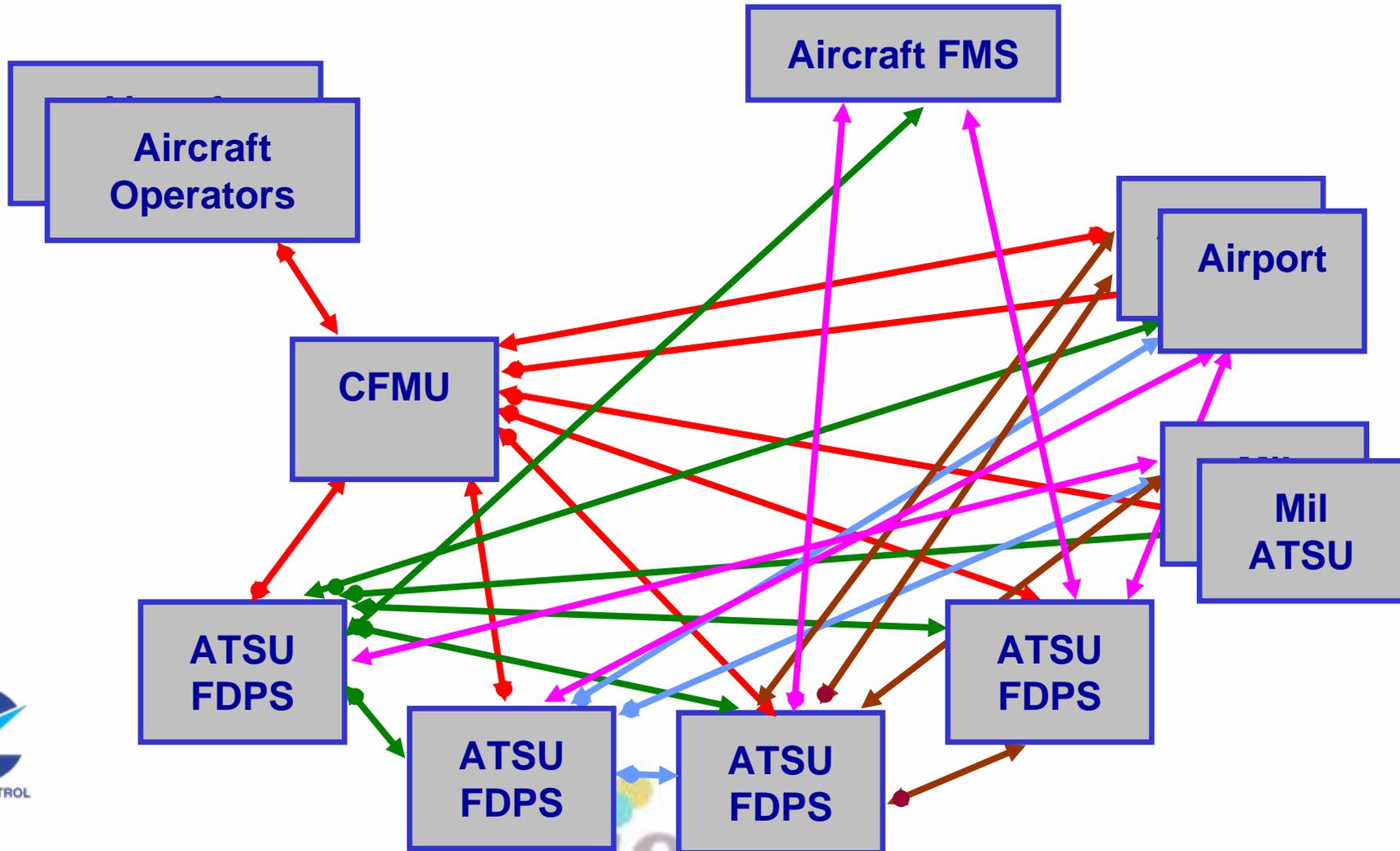
Image from FO workshop presentation:  
 “ERAM Flight Object Update & SWIM Overview”

Sid Rudolph, Lockheed Martin TSS

23 June 2006



# EUROCONTROL Viewpoint

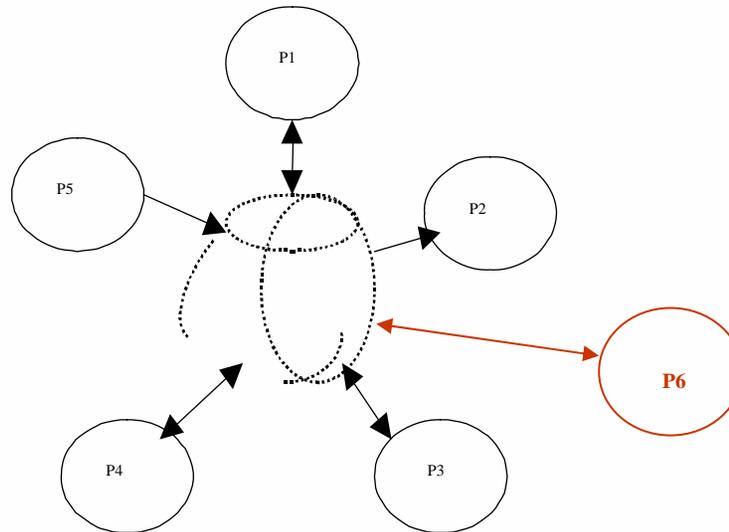


Slide from FO workshop presentation:  
 "Background to the Flight Object"  
 EUROCONTROL HQ, June 2006



# Future ATM Architecture

- Based on a cloud of services (*RTCA Conops, 2000*)
- Supported by System-Wide Information (*RTCS Conops, SWIM Concept*)



- **Single connection point instead of many**
- **Support of the “many-to-many” exchange of information**
- **Support for the growth of decision points**
- **Unanticipated application can easily access the framework, use shared data and collaborate with existing applications**

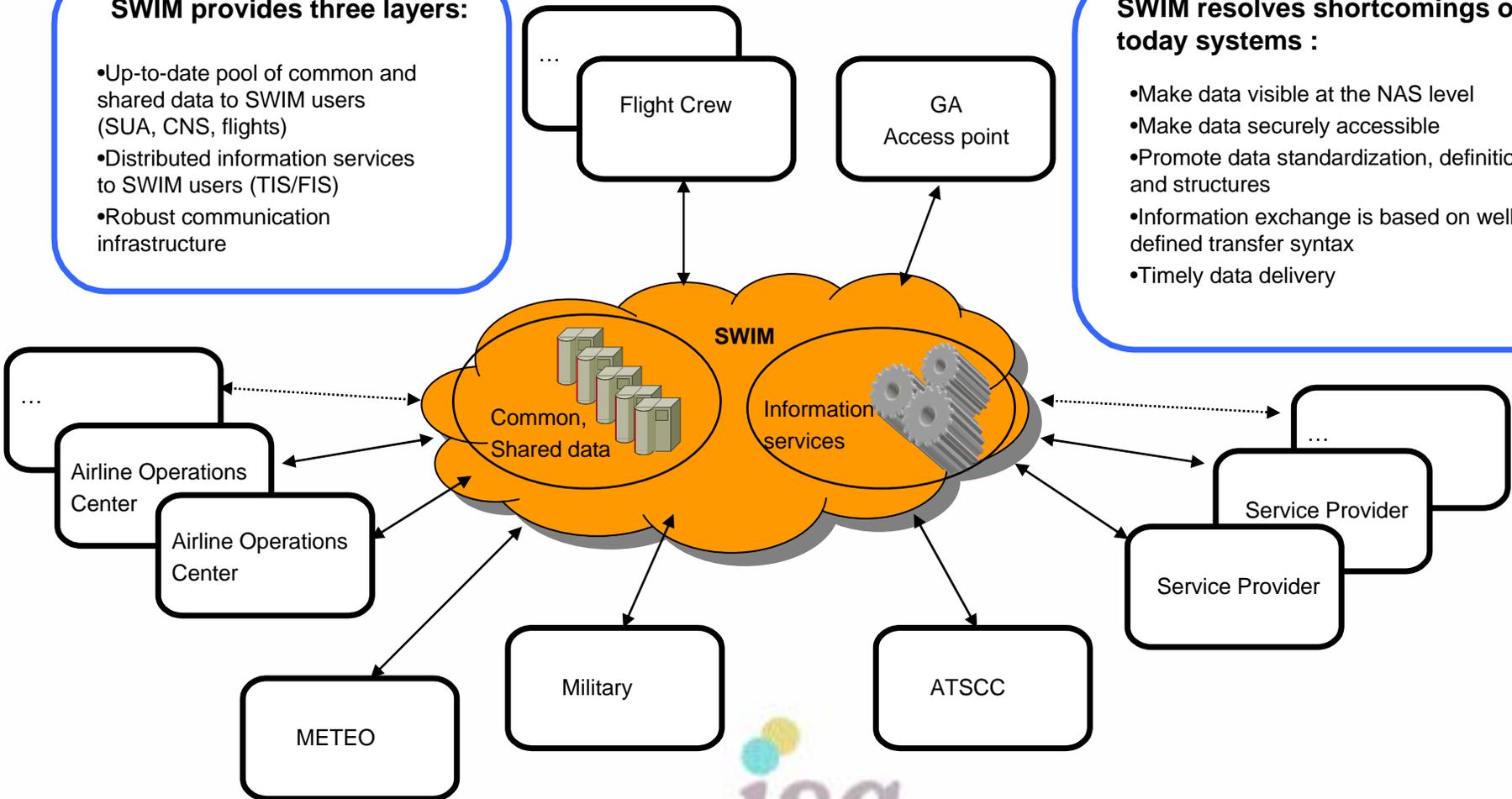
# System Wide Information Management (SWIM)

**SWIM provides three layers:**

- Up-to-date pool of common and shared data to SWIM users (SUA, CNS, flights)
- Distributed information services to SWIM users (TIS/FIS)
- Robust communication infrastructure

**SWIM resolves shortcomings of today systems :**

- Make data visible at the NAS level
- Make data securely accessible
- Promote data standardization, definitions and structures
- Information exchange is based on well defined transfer syntax
- Timely data delivery



# ERAM (Lockheed) Viewpoint

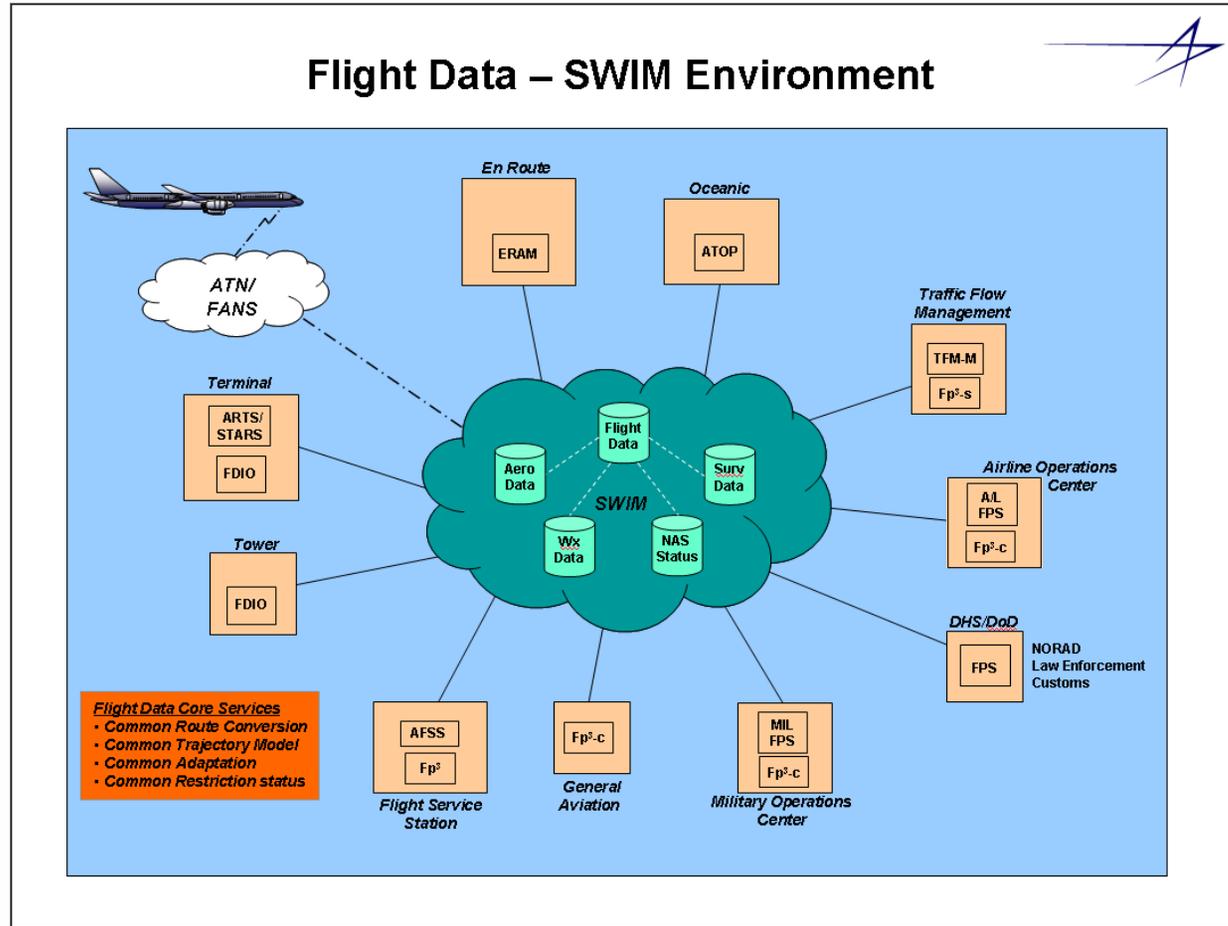
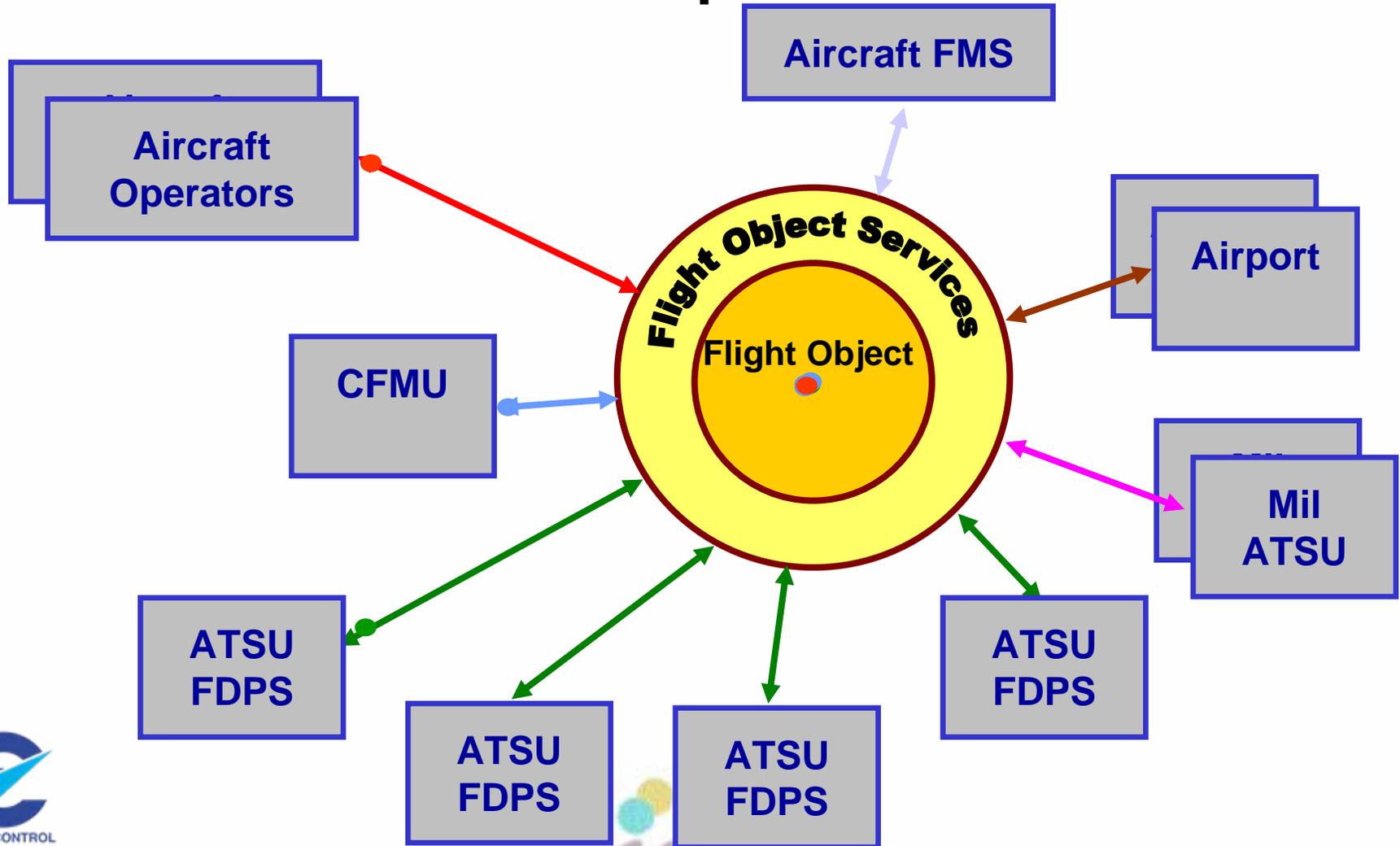


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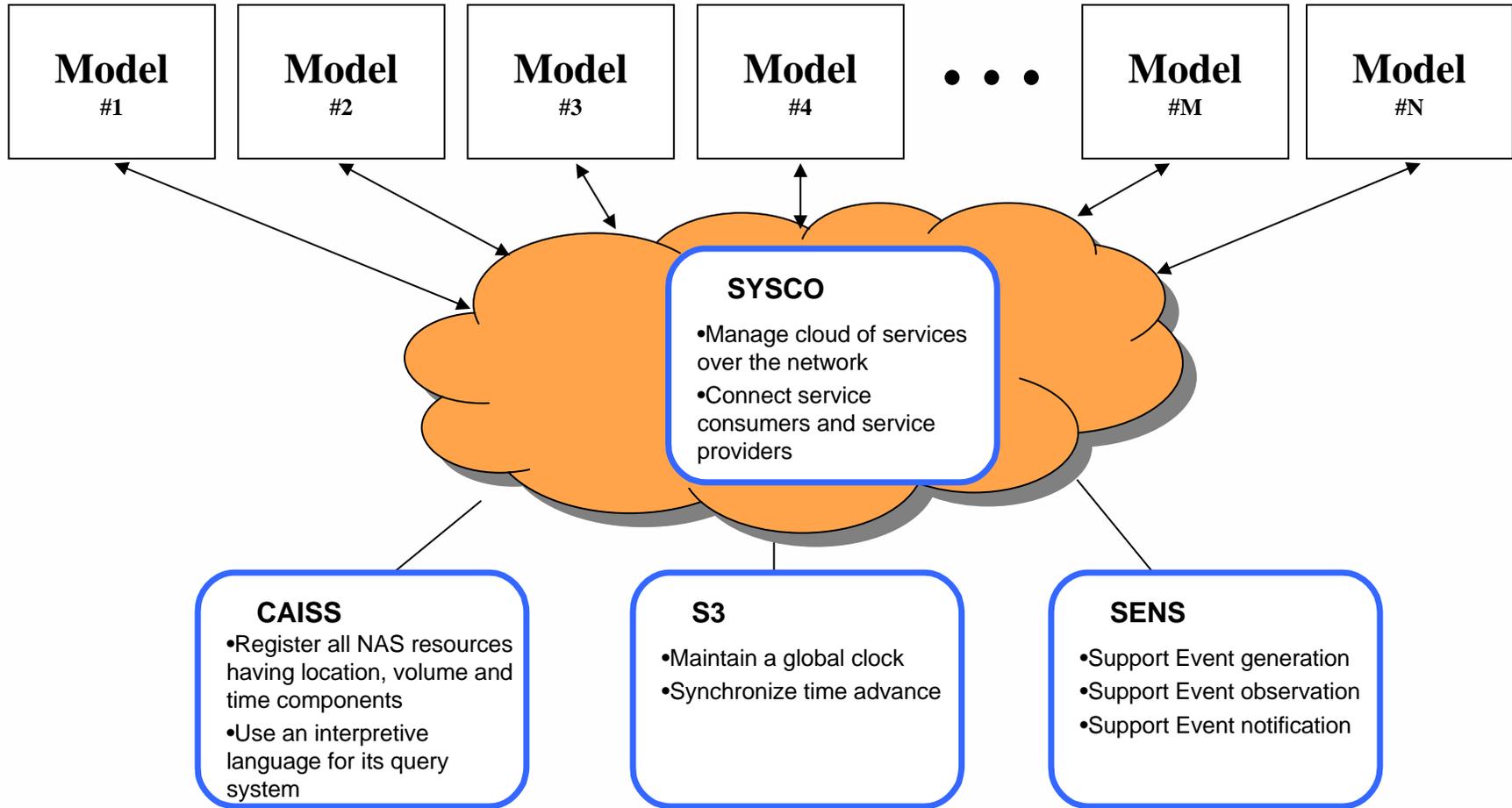
# EUROCONTROL Viewpoint

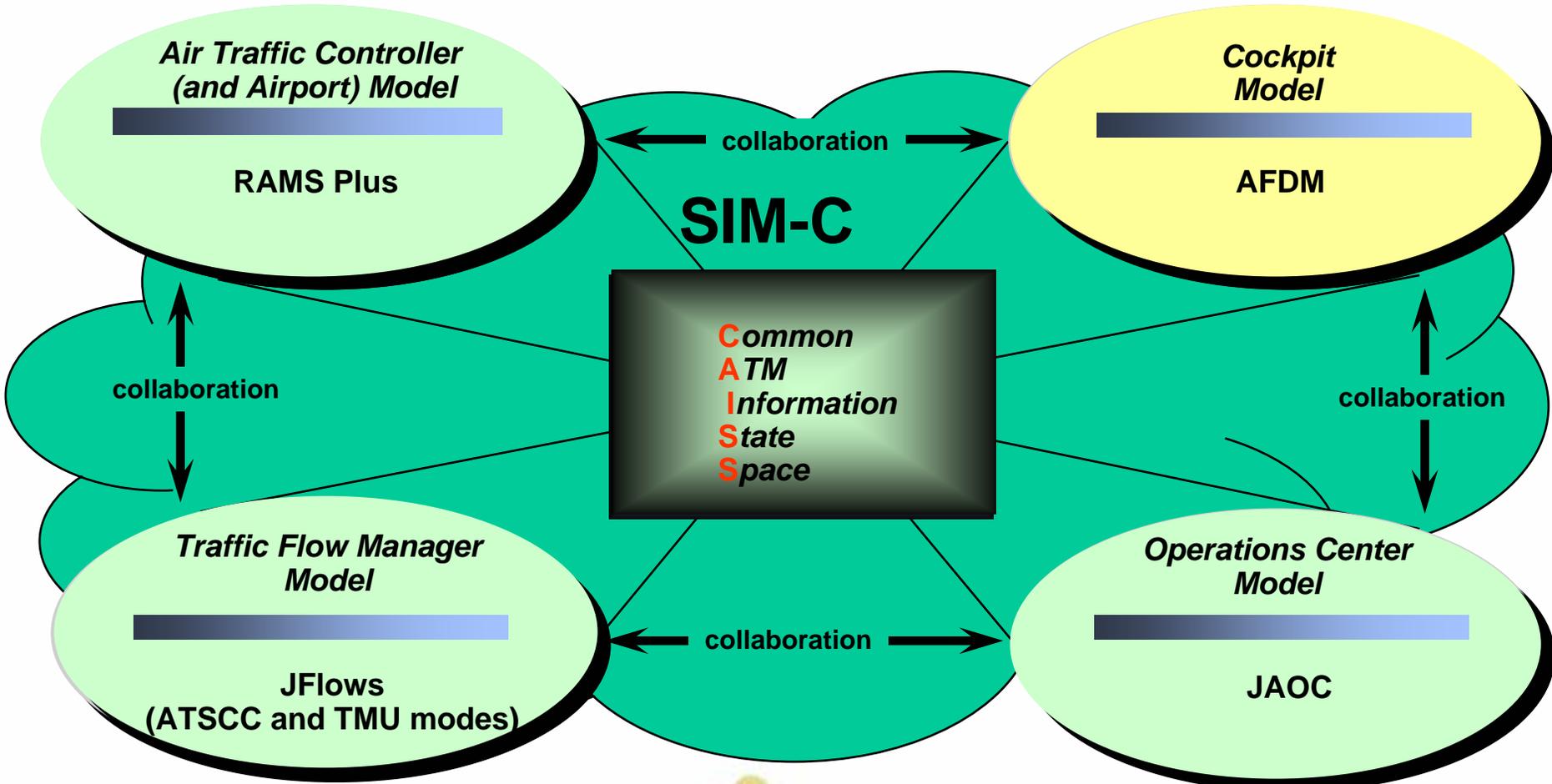


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# SIM-C Reference Model

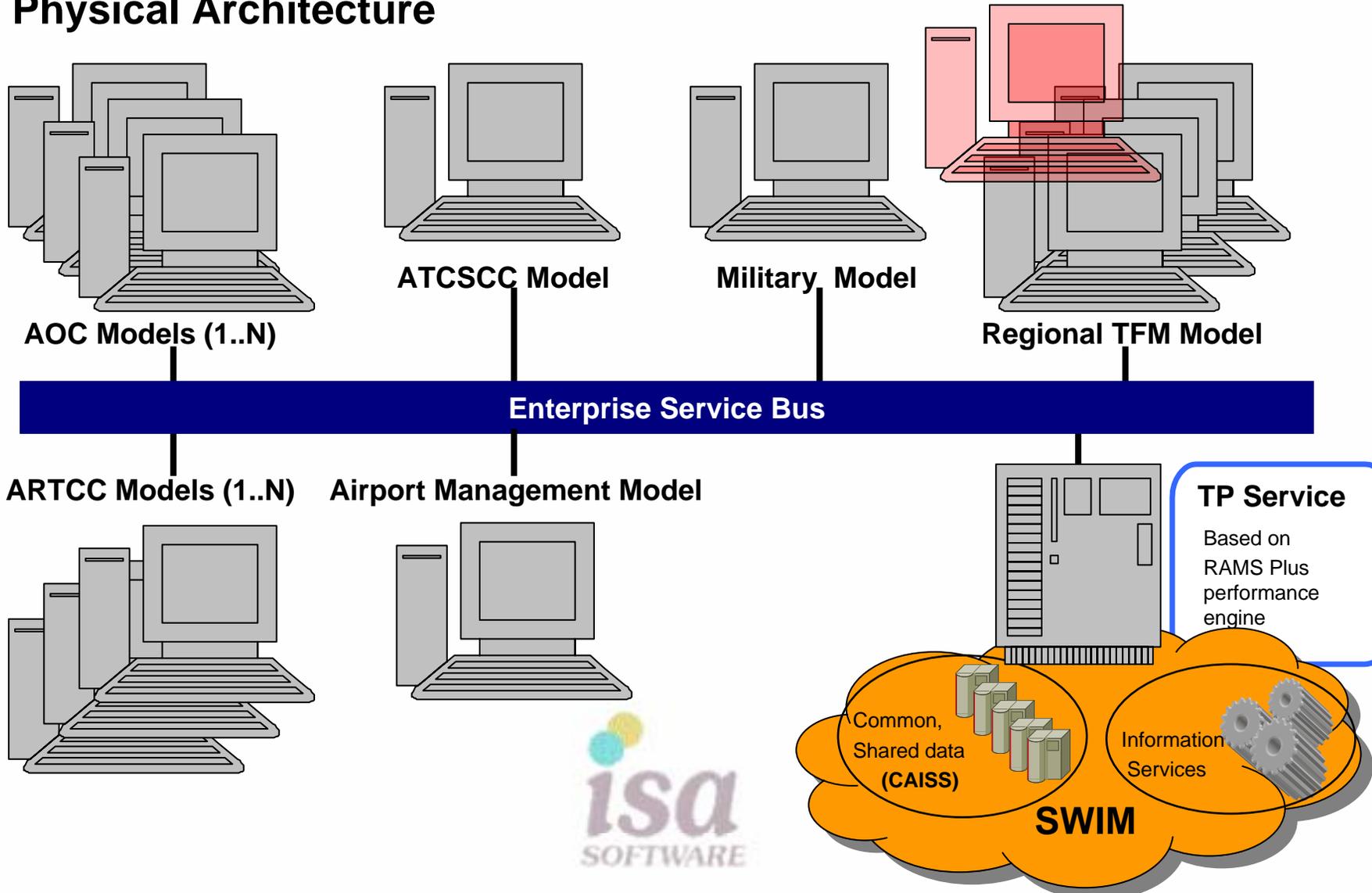




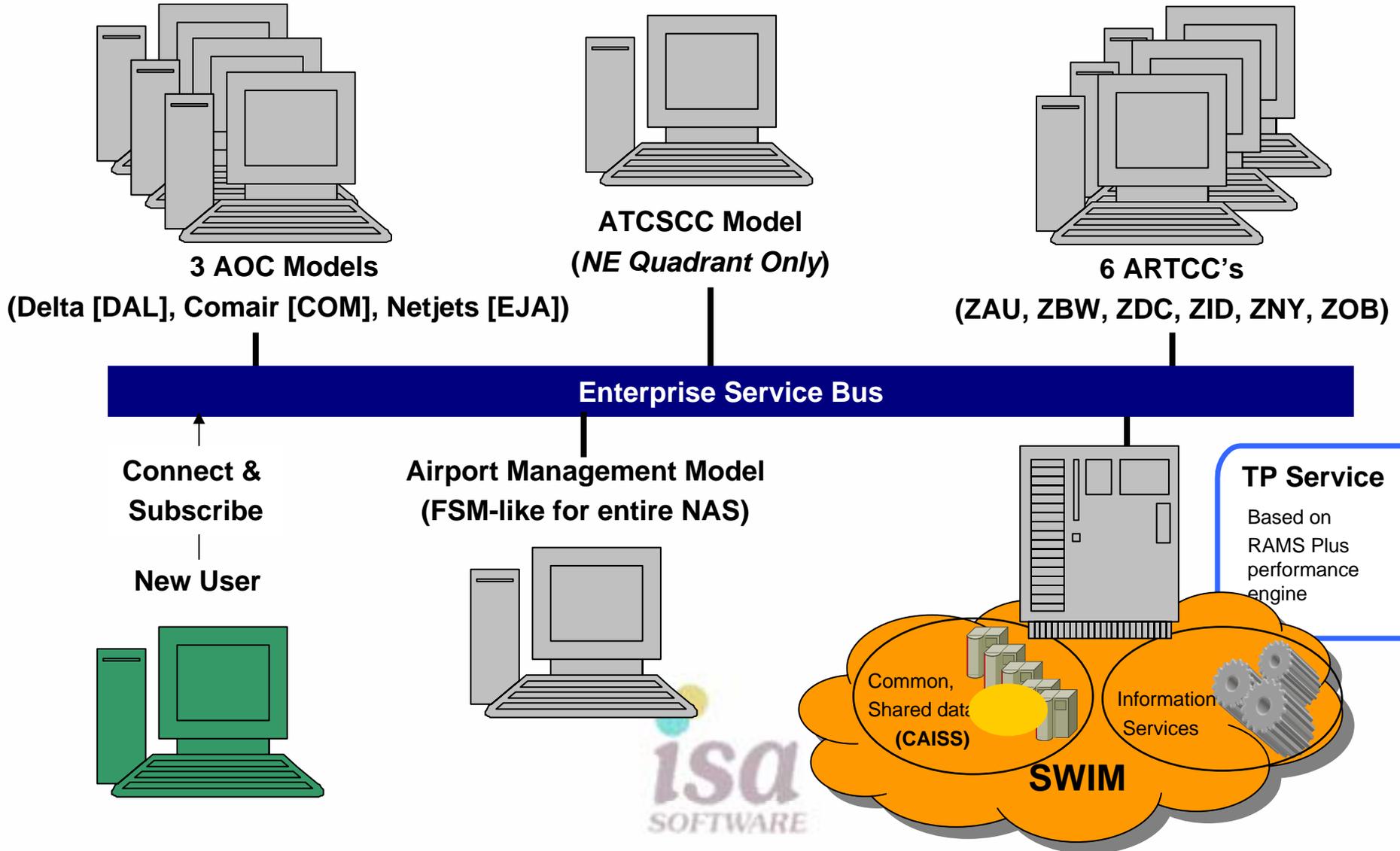
# SIM-C: FO, ERAM, SWIM Demonstrator

MSP Model

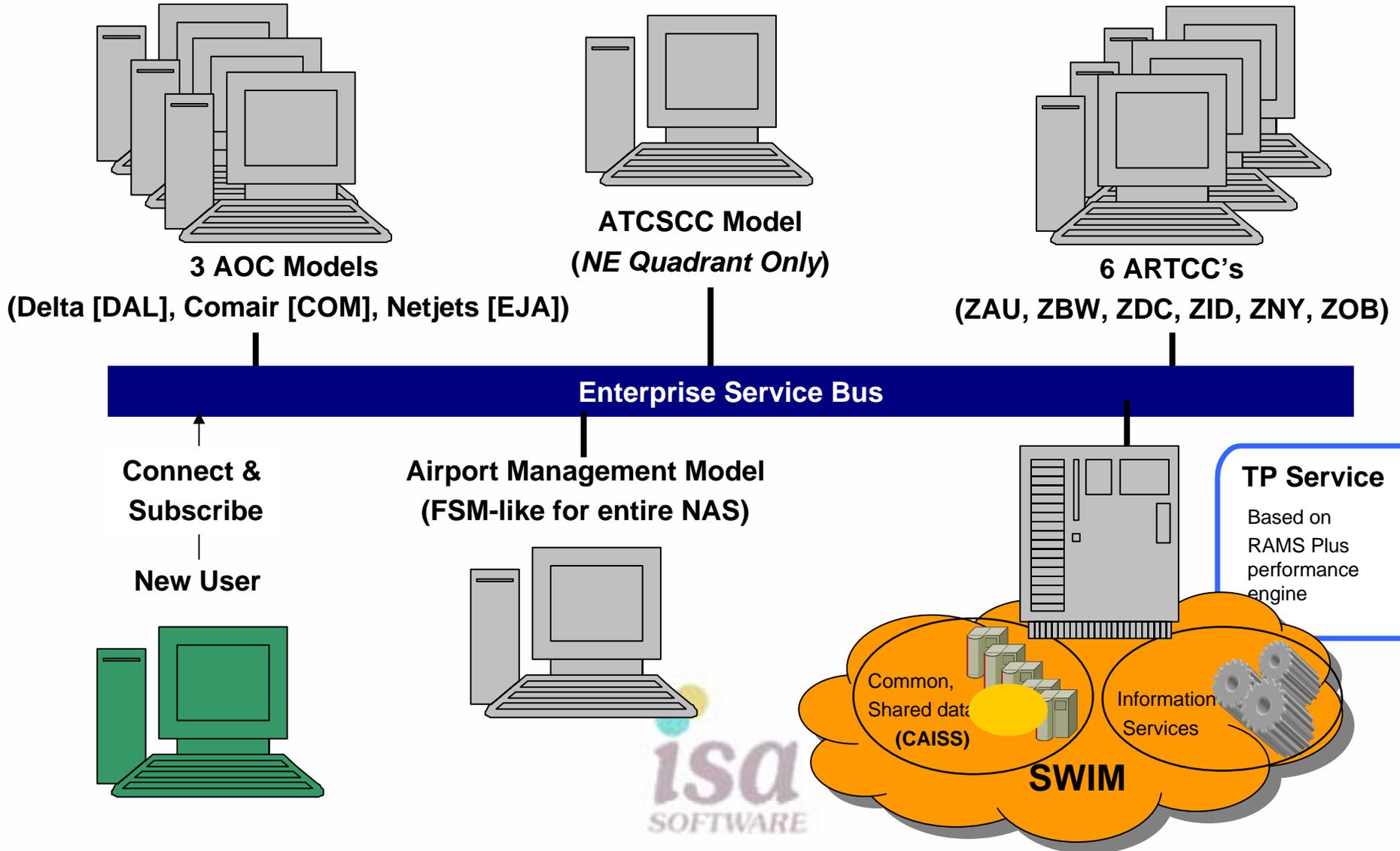
## Physical Architecture



# FO, ERAM, SWIM Demonstration Scenario



# FO, ERAM, SWIM Demonstration Scenario



# SIM-C modelling framework today

**Incorporates all the concept and architectural elements discussed:**

- Proof of concept for a **SWIM** infrastructure
- Incorporation of **Flight Object** Concepts
- Including target fast-time simulators, Real-Time and Analytical tools
- Supported as a **Network-centric** modeling **Infrastructure**
- Providing access to **Common** and **Shared Information**
- Ensuring **Common Situational Awareness**
- Is a publish/subscribe enterprise architecture as foreseen in **ERAM**
- Disseminating information to all models that are impacted by information update or event occurrence
- Supports **Collaborative Decision-Making** processes
- for **System-wide Analysis**
- ...to evaluate cooperative ATM concepts using model-based agents
- ...at a variety of timeframes ranging from pre-flight to actual execution

# Operational Concept Refinement & Gaming

## Based on SIM-C, the CHILL platform supports

- Interactive assessment and refinement of future operational concepts
- Collaborative capacity / demand balancing exercises
- Development of system-wide performance metrics
- ... in support of Strategic Planning
- ...and future Decision Support Automation
- Ensuring Common Situational Awareness
- Demonstrates the collaborative negotiation process
- ...where all impacted agents are included in the negotiation

**... to support JPDO in their NGATS validation  
and EU Episode 3 (SESAR concept validation)**