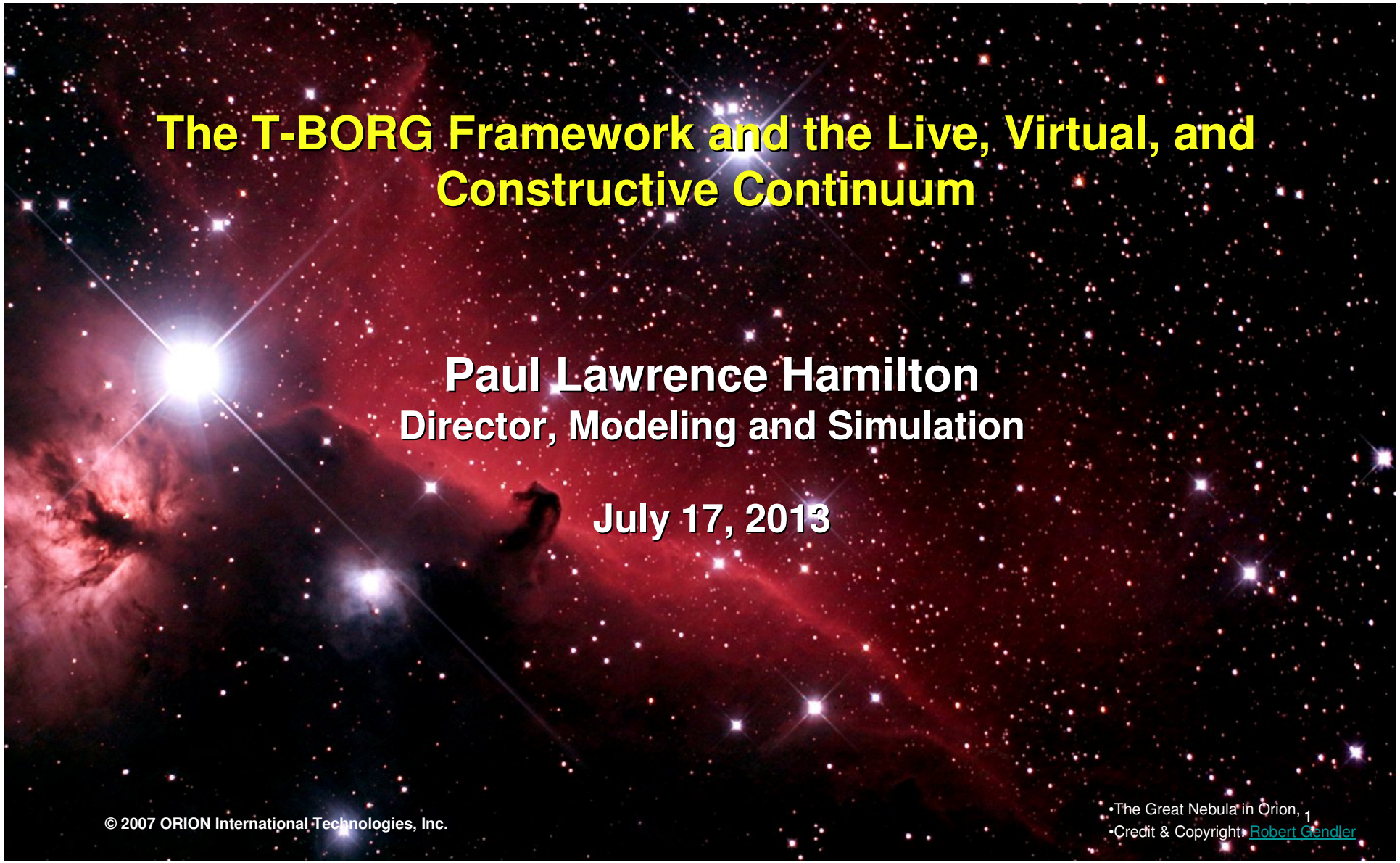

The T-BORG Framework and the Live, Virtual, and Constructive Continuum

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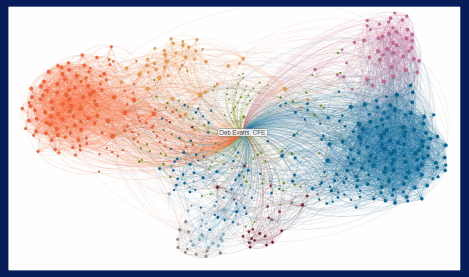
AGENDA

- Introduction
  - T-BORG
  - The Live-Virtual Constructive Continuum
- Small Aircraft Transportation System (SATS)
- RPA Simulated Operational Communications and Coordination Integration For Aircrew Learning (SOCIAL)
- Joint Theater Air Ground Simulation System (JTAGSS)

The T-BORG Framework



Integration

Simulation

Control

HW / Humans

T-BORG

Lego-Like Software		Complexity	
Modularity	Connectors	Worlds Method Pat. 7,085,694	C-Space Toolkit Pat. 6,407,748
New / Legacy Models Variable Fidelity Code Reuse HW / Humans in the Loop Scaleability Algorithms	Computational Agent Computational	Efficiency Interactivity Steering	Computational Efficiency Event Triggers Dynamic Geometry
Hybrid Time Scales	Scriptable Data Flow	TENA	HLA

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T-BORG Characteristics

- **Any algorithm can be contained in a T-BORG module.**
  - **Completely defined and accessible inputs and outputs.**
  - **Can even be a black box if the algorithm is classified.**
  - **Classified data can be kept separate from algorithms.**
  - **Connection-based execution order ensure valid data at every step.**
  - **World modules permit cross-entity communication mid-step.**
  - **Time scales can be variable.**

- **Interacting modules can do more than component algorithms.**
  - **Vehicle motion effects on detection attempts.**
  - **Communication and cooperation between entities.**
  - **Correlating target positions between multiple viewpoints.**
  - **CONOPS testing: How to best use the technology or system?**

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The LVC Continuum

- **Live – Virtual – Constructive is a common taxonomy**
  - **Live - Real people / real systems**
    - **Real pilot flying a real aircraft**
  - **Virtual - Real people / simulated systems**
    - **Real pilot flying a simulator**
  - **Constructive - Simulated people / simulated systems**
- **Human participation is infinitely variable**
  - **What about simulated people operating real systems?**
- **Complex systems raise challenges in testing and training**
  - **These systems are both social and physics-based**
  - **The key issues are in the interactions**
  - **ORION's approach to this problem**
    - **Systems of systems modeling using T-BORG**
    - **Human behavior and cognition**
    - **Analytical methods**

Small Aircraft Transportation System
Higher Volume Operations (HVO) Concept

Goal: Increase rate of flight operations at small airports during poor weather

What: Enable simultaneous operations by multiple aircraft at non-towered, non-radar airports in near all-weather conditions

Legend:
- RED: Major Hub (35)
- BLUE: Airports with ground infrastructure (829)
- BROWN: SATS (3400+)

How: Pilots assume responsibility for spacing and separation during IMC within designated area using information displayed in the cockpit, while following sequence information given by ground automation

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SATS Integration

T-BORG Dynamically Integrates Simulated and Real World Systems

Virtual Physics

Flight Simulators
Unmanned Vehicles
Weather
Scenarios

Hardware/Humans in the Loop

Real Aircraft
Real Pilots/Simulators
Communications
Data Messages

T-BORG

Legacy Software

Airport Management Module
Cockpit Associate
MS or X-Plane Simulation
GPS Simulation

New Software

Flight Simulator Interface
X-Plane Interface
Cockpit Associate Interface
GPS Interface

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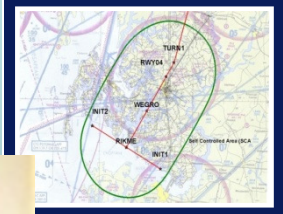
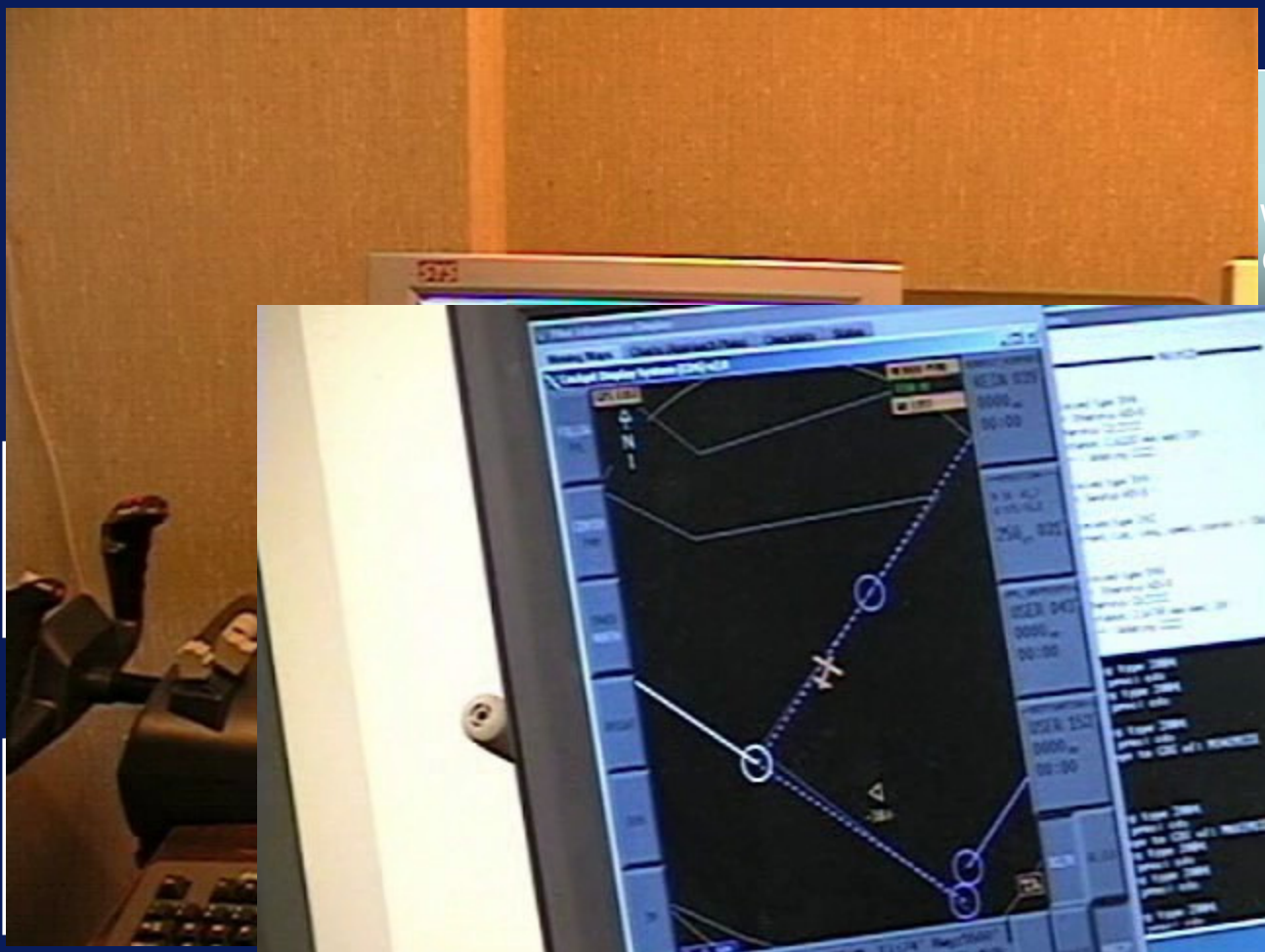
SATS Components

Weather
Objects
Module





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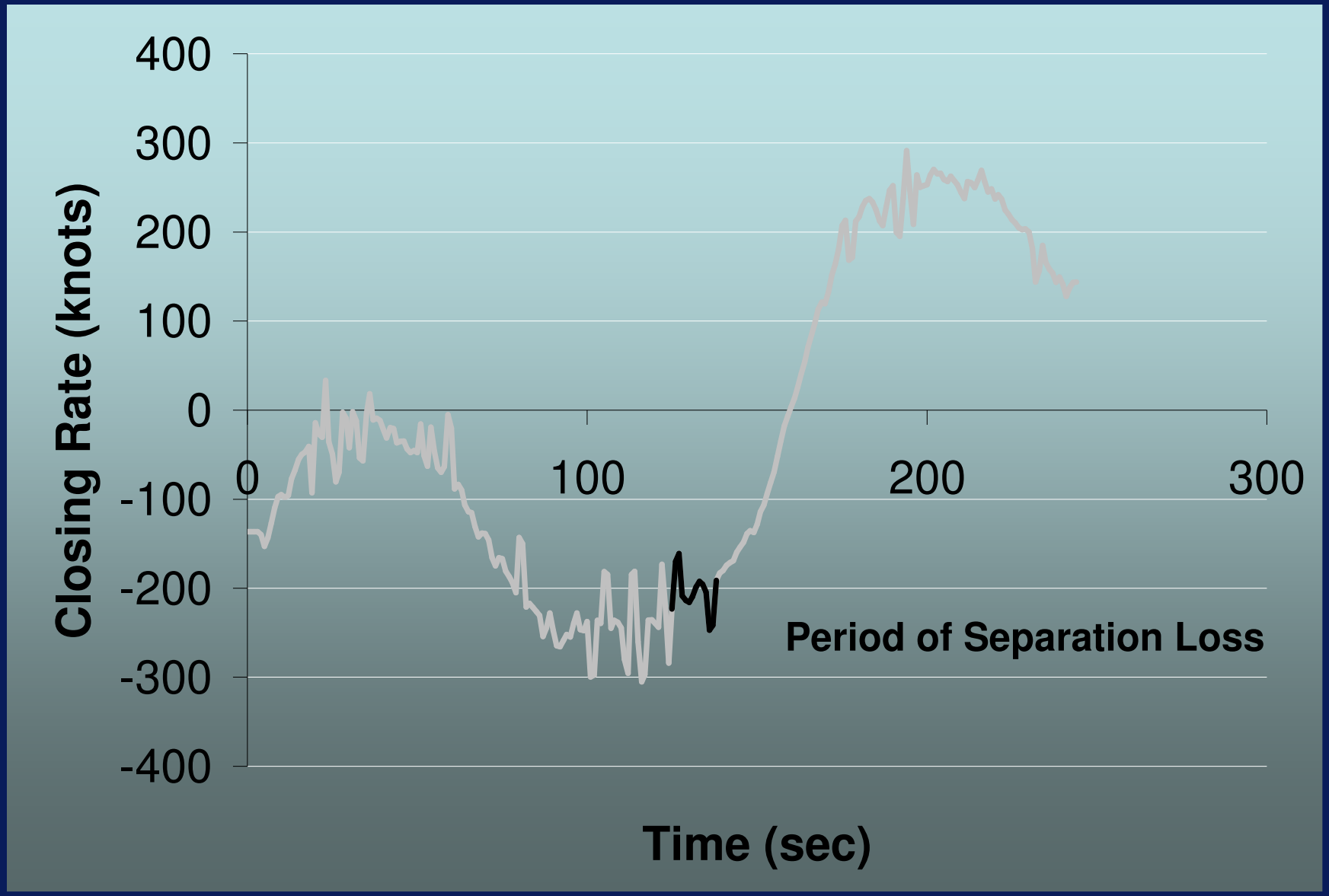
Representative Analysis



SATS Live-Virtual-Constructive

- Virtual aircraft for statistical study of failure modes
- Flight Simulators
- Actual flight data from physical aircraft
- Flight Training Devices

SOCIAL – Flight Communications

- Communication and coordination tends to be overlooked in formal training; skills largely acquired on the job.
- RPA communications can use six active chat windows.

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SOCIAL Challenge

- Realistic training and testing requires at least twelve participants taking part in a simulation training exercise – impractical
- Develop intelligent virtual agents to role-play participants in tactical training and testing
- In this SBIR effort for the AFRL, ORION:
  - Researched the operational needs for communications training.
  - Used T-BORG to develop a Proof-of-Concept training simulation.
  - Demonstrated capabilities to show functionality of each component.

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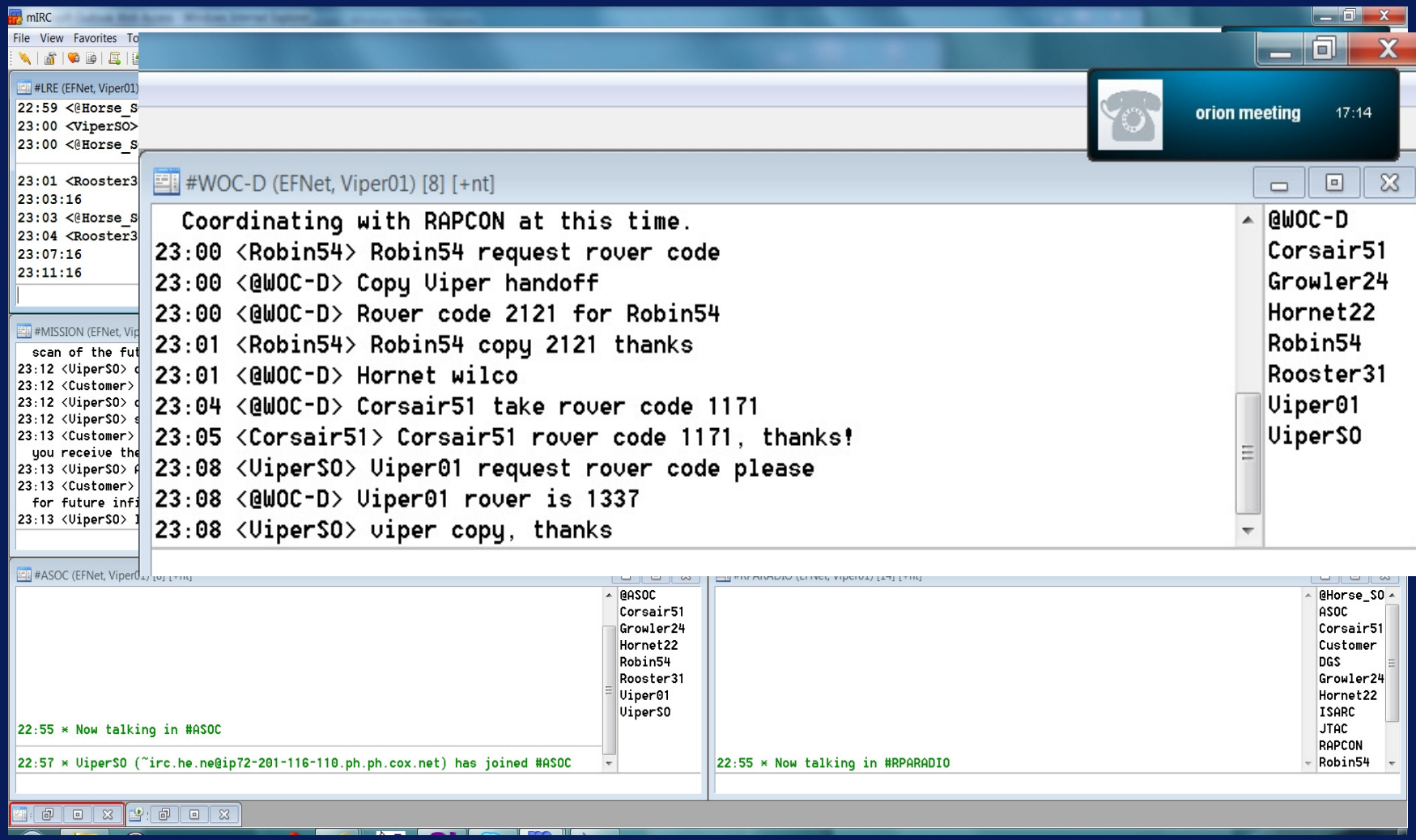
SOCIAL Characteristics

- Prototype simulation of RPA communication and coordination
- Adaptive learning for realistic crew mission task saturation
  - Observes crew performance
  - Adjusts simulated communications workload accordingly
- Enhanced integration and coordination across an operational testbed environment
- Ability to prototype, integrate and evaluate intelligent agents and synthetic teammates at various levels of fidelity
- Interfaces with a variety of ground trainers, including:
  - The Predator Mission Aircrew Training System (PMATS)
  - AFRL's Integrated Combat Operations Training Testbed (ICOTT)

SOCIAL Results



The result was a fast-paced Proof of Concept, realistic simulation for RPA communications and coordination training.

JTAGSS – ASOC Simulation

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Current Work

We are supporting L-3, the System Integrator for AFRL, by creating reflex agents for the Joint Theater Air Ground Simulation System (JTAGSS), a training and planning simulation of an Air Support Operations Center (ASOC).

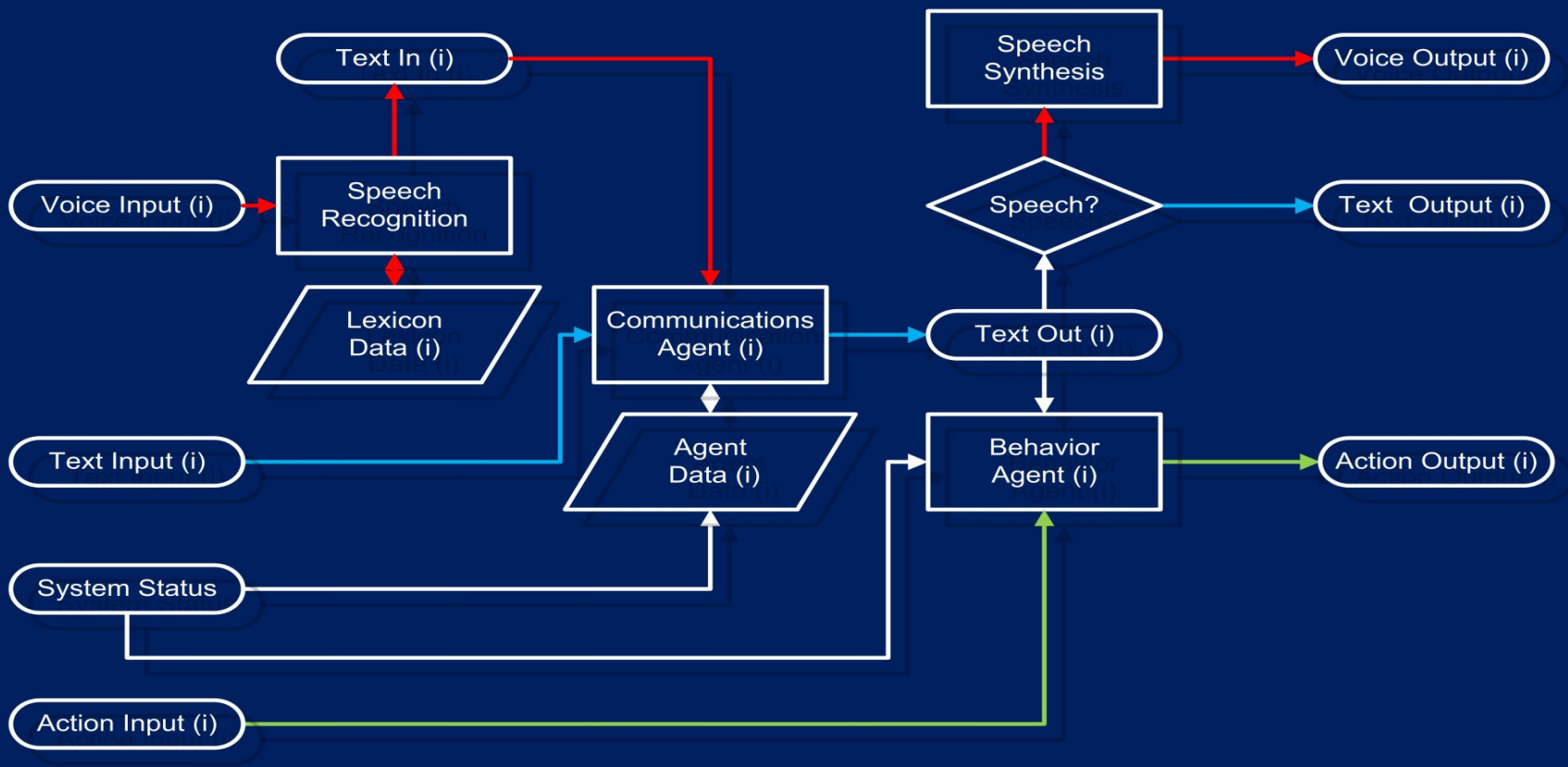
JTAGSS supports single personnel and multiple station training up to a full complement of 9 ASOC training stations for the following positions:

- Senior Air Director
- Senior Air Technician
- Procedural Controller 1/2
- JARN-Digital Voice
- Intel Duty Office
- Airspace Manager
- Air Tasking Order Manager
- Ground Track Manager

JTAGSS is much like SOCIAL

- **adding voice recognition and speech synthesis**
- **agents will be bound to a large number of simulated aircraft and other battlefield entities.**

ORION's Approach



ORION's Objectives

- Develop Reflex Agents to interact with ASOC positions
  - Aircraft (A/C) Agent
  - Tactical Air Control Party (TACP) /Joint terminal attack controller (JTAC)
  - Fire Cell
  - Senior Intelligence Duty Officer (SIDO)
  - Control and Reporting Center (CRC) / Airborne Warning and Control System (AWACS)
  - Close Air Support Duty Office (CASDO) / Senior Operations Duty Officer (SODO)
  - Airspace Command and Control (AC2)
- Phase I Agents will
  - Communicate with trainees via voice and text
  - Bind to objects (mostly aircraft) in the Modern Air Combat Environnent (MACE) simulation.
  - Follow doctrine on communications and tasks
- Phase II Agents will
  - Employ cognitive modeling
  - Replicate human performance of communications and tasks
- Air Combat Command will use for training/testing; AFRL for research

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