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

Modularity
- New / Legacy Models
- Variable Fidelity
- Code Reuse
- HW / Humans in the Loop
- Scaleability
- Algorithms
- Hybrid Time Scales

Connectors
- Computational
- Agent
- Scriptable Data Flow
- TENA

Integration

Control

HW / Humans

Complexity
- Worlds Method Pat. 7,085,694
- C-Space Toolkit Pat. 6,407,746
- Efficiency
- Interactivity
- Steering
- TENA
- HLA
• 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?
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**

**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
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

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
SATS Components

- Traffic Generation Module
- Primary Pilot Station
- Second Pilot Station
- Third Pilot Station
- Weather Objects Module
- Cockpit Associate
- Cockpit Traffic Display
- T-BORG Simulation Environment
- Airport Management Module (AMM)
- Manager and Fourth Pilot Station
Representative Analysis

Period of Separation Loss

Time (sec) vs. Closing Rate (knots)
SATS Live-Virtual-Constructive

- Virtual aircraft for statistical study of failure modes
- Flight Simulators
- Actual flight data from physical aircraft
- Flight Training Devices
• Communication and coordination tends to be overlooked in formal training; skills largely acquired on the job.
• RPA communications can use six active chat windows.

Coordination breakdowns can result in the loss of a high-valued target, failure to detect an emerging threat, or worse.
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.
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)
The result was a fast-paced Proof of Concept, realistic simulation for RPA communications and coordination training.
JTAGSS – ASOC Simulation
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

JTAGSS
System flow for Agent (i)
Red = voice, Blue = text, White = all

Text In (i)

Voice Input (i)

Speech Recognition

Lexicon Data (i)

Communications Agent (i)

Agent Data (i)

Speech Synthesis

Speech?

Speech Output (i)

Text Out (i)

Text Output (i)

Behavior Agent (i)

Action Output (i)

System Status

Text Input (i)

Action Input (i)
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 Environment (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
Questions?