The Utilization of Synthetic Task Environments in Command and Control (C2) Domains

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AFRL/HECP

Who is HECP?


AFRL Air Force Research Laboratory
HE Human Effectiveness Directorate
HEC Warfighter Interface Division
HECB Battlespace Acoustics Branch
HECI System Control Interfaces Branch
HECP Collaborative Interfaces Branch
HECS Cognitive Systems Branch
HECV Battlespace Visualization Branch
JCO Joint Cockpit Office

Network-Centric Warfare

Collaborative Tools for BMC2

Who are our Stakeholders?

- Battle Managers
  - E-3/AWACS
  - E-8/JSTARS
  - E-10A/MC2A
  - BCS-F/M
  - E2-C Hawkeye (USN)
  - Wedgetail (RAAF)
- AWACS EPMR
- AWACS SPO
- AWS Nellis AFB
- BMC2 HMIWG (ACC/DRR/DOY)
- FORCEnet HSI Working Group (USN)

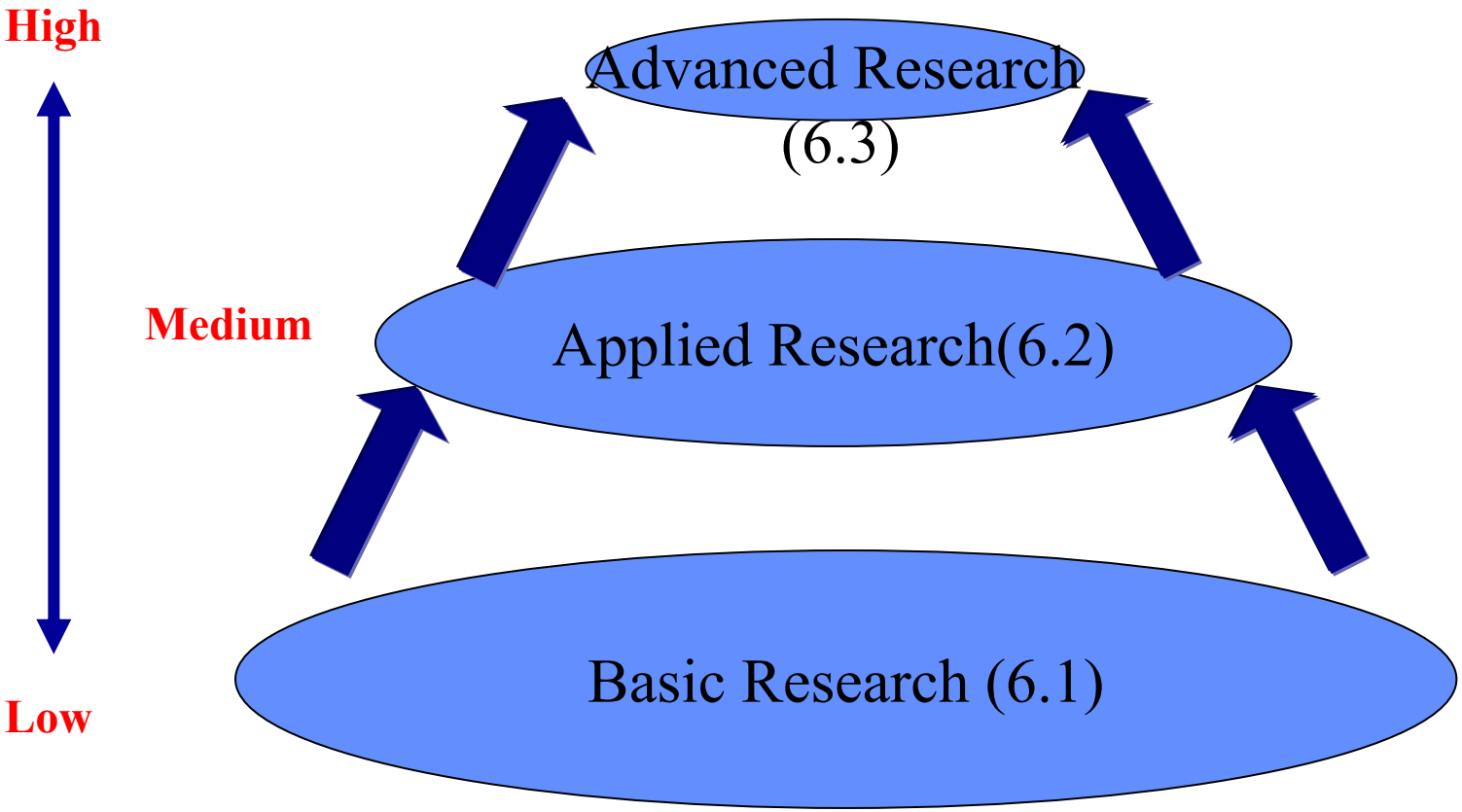
Advanced Interfaces for BMC2

GOAL: Enhance performance efficiency, workload, and situation awareness of air battle managers through the use of advanced interface technologies

- ❑ increase operator workstation efficiency
- ❑ enhance data visualization
- ❑ increase shared battlespace awareness
- ❑ enhance decision speed and effectiveness
- ❑ reduce training requirements

AF Research Progression

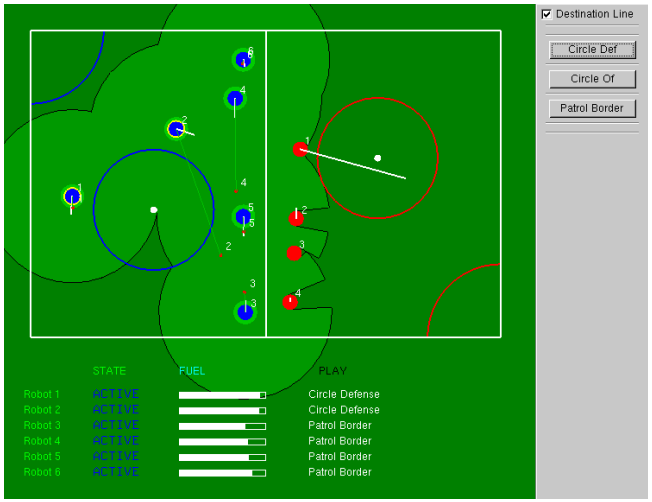
Fidelity



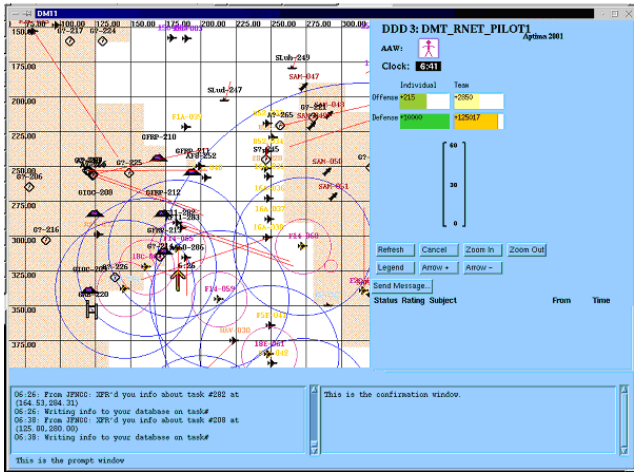
STEs for Basic Research

MIIIRO (Multi-Modal Immersive Intelligent Interface for Remote Operation)

RoboFlag



DDD (Dynamic Distributed Decision Making)

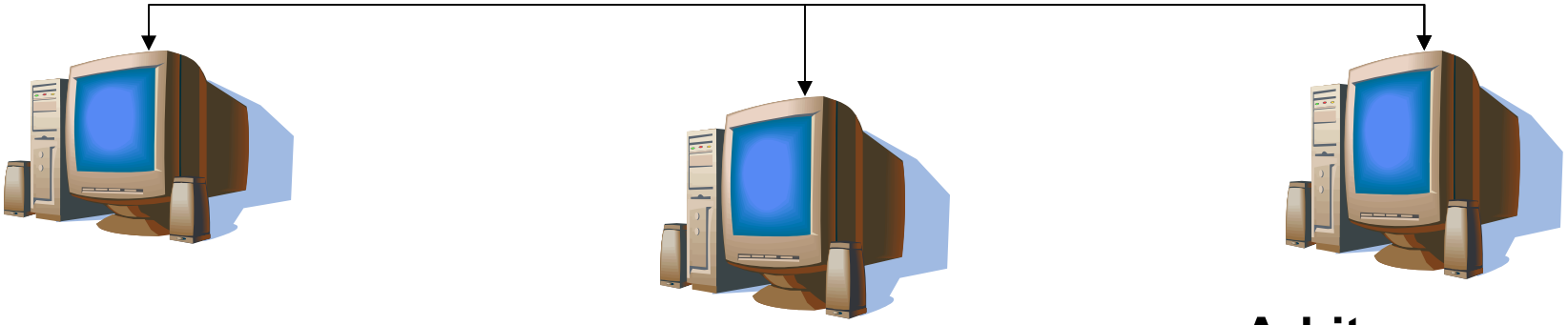


Research Thrust Areas

- Automation levels
- Adaptive automation
- Decision support aids
- Flexible, co-operative task delegation
- Distributive collaboration
- Multi-modal interface concepts

RoboFlag

- Developed at Cornell University
- http://roboflag.mae.cornell.edu/

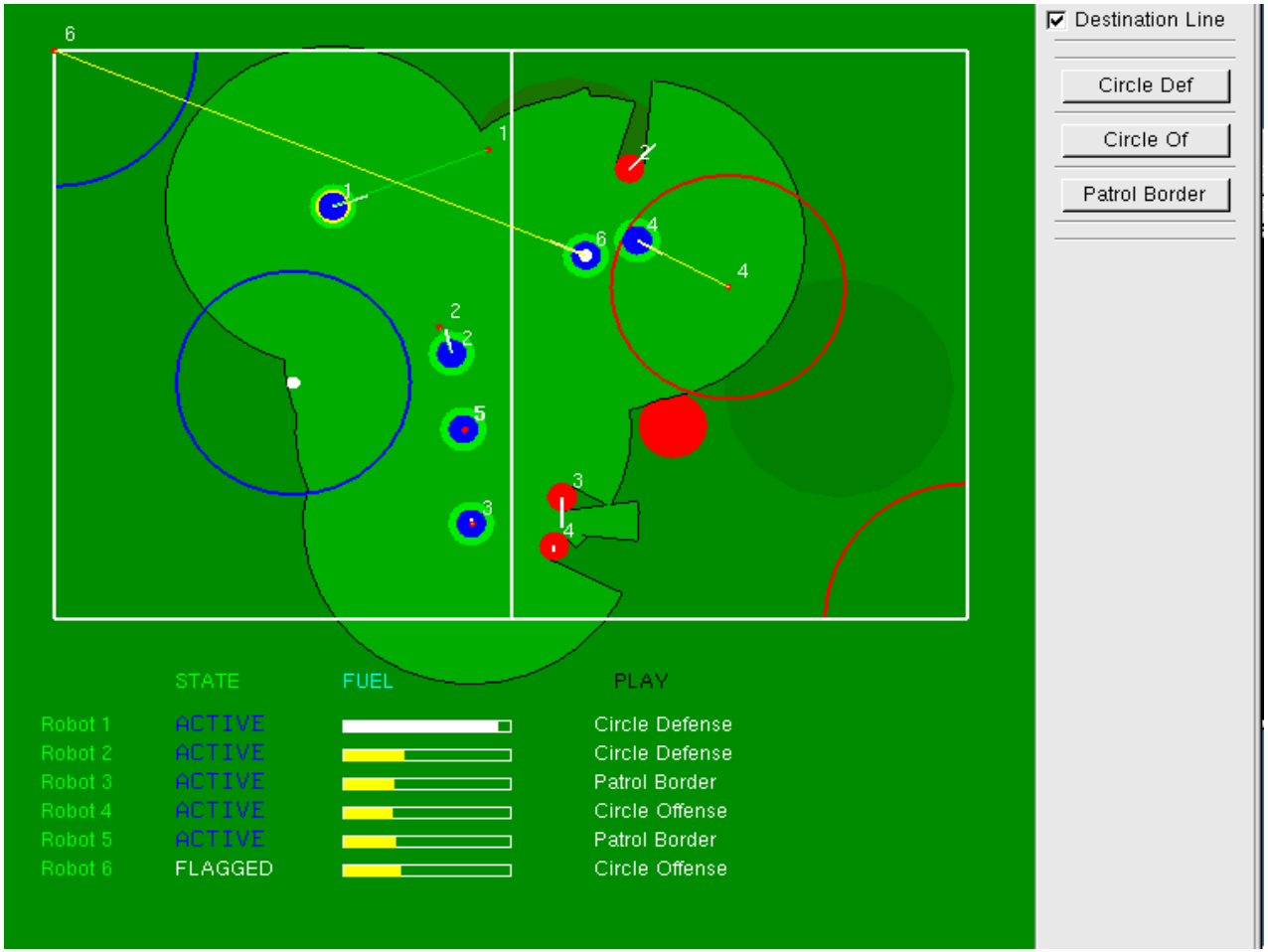


Blue Team
(participant)

Red Team
(scripted)

Arbiter
(both teams,
Experimenter
Station)

RoboFlag Blue Team GUI



Typical UMV Problems

- Managing Data and Information Fusion
- Coordination – Self-Synchronization
- Interface Design
- Level and Scope of Automation to Utilize
- Human Limitations – i.e. working memory, attention
- Information Overload, High Demands on Mental Workload

RoboFlag

Used to evaluate:

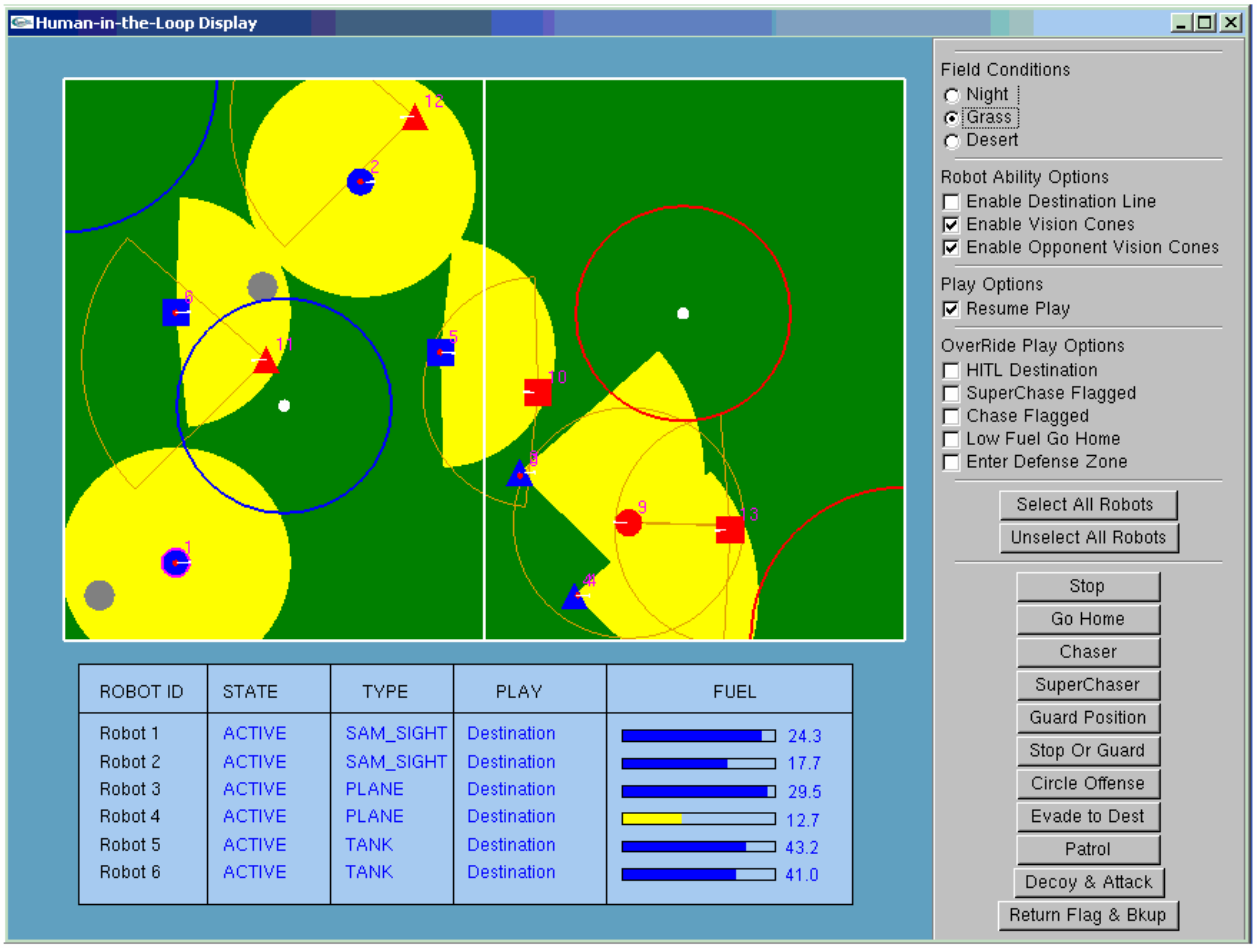
- **Cooperative Estimation Algorithms (Cornell University, Cal Tech)**
- **Manual vs. Automated Control (AFRL, CUA, GMU)**
- **Automation Usage and Delegation Control Architectures (AFRL, SIFT,CUA, GMU)**
- **Interface Evaluations for increased Situation Awareness (SA) (Vanderbilt)**
- **Decision Effectiveness (AFRL)**
- **Team Decision Making and Shared SA (AFRL)**

RoboFlag

Results:

- **Delegation-Type interfaces lead to increased mission success rates and reduced mission completion times.**
- **Increasing the flexibility of the delegation-type interfaces exacerbated the benefits**
- **Delegation-type interfaces were best when supervising four robots rather than eight.**
- **Task-network modeling produced similar results to those seen in empirical studies**

RoboFlag Version 2.0



Multi-UAV Control Station Testbed:

Multi-Modal Immersive Intelligent Interface for Remote Operation

MIIIRO: Supervisory-Control Testbed

Developed by IA Tech, CA (www.ia-tech.com/)

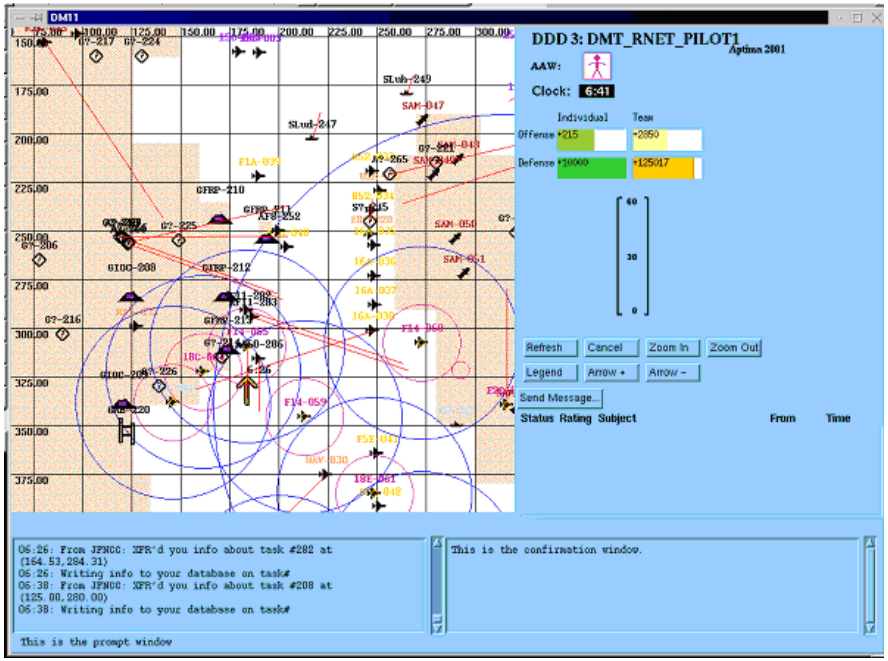
- **Synthetic Task Environment which flexibly emulates envisioned single operator supervision of multiple UAVs**
- **Supports collaboration of UAV assets**
- **Designed to support human factors research on:**
  - Automation levels
  - Adaptive automation
  - Decision support aids
  - Flexible, co-operative task delegation
  - Distributive collaboration
  - Multi-modal interface concepts

- **"Researcher-friendly"**
- **Modularized architecture: easily reconfigured**

Distributed Dynamic Decision making

CTBMC2

- DDD Background
- Previous Investigations
- DDD Issues
- Aptima/DDD SBIR
  - Phase I
  - Phase II
  - Current Status



Aptima®
Human - Centered Engineering

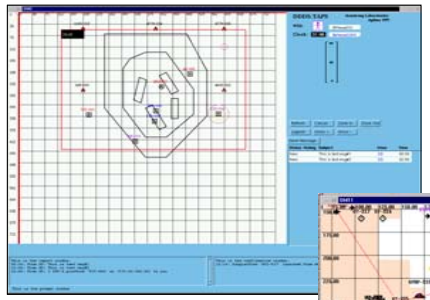
DDD Background

- A distributed multi-person simulation and software tool for understanding decision-making in a dynamic team environment
- Team-in-the-loop testbed
- Developed at UConn in the early 1980's
- Numerous different generations have demonstrated its flexibility
- Allows for high degree of experimental control with low to moderate degree of realism

Previous Investigations

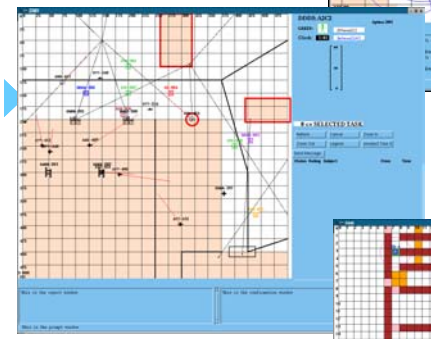
CTBMC2

- Joint Task Force
- Naval Battle Group
- Army Urban Warfare/Special Ops
- Air Force AWACS
- Army Ground Maneuvers
- NASA Search and Rescue
- Joint Peacekeeping Operations

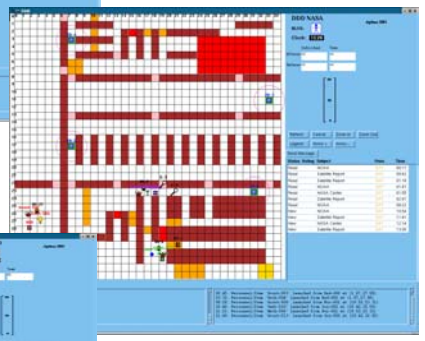


AWACS WD/AWOs

Air Operations



Joint Task Force



NASA Search and Rescue

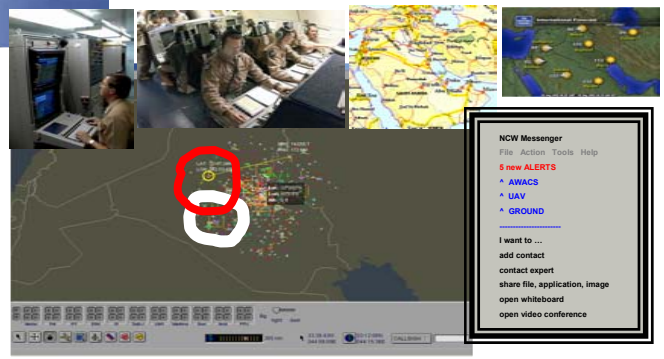
SASO Peacekeeping

Advanced Interfaces for BMC2
Key Research Areas

Spatial Audio Interfaces

Speech Recognition Interfaces

Visual Interface Technologies

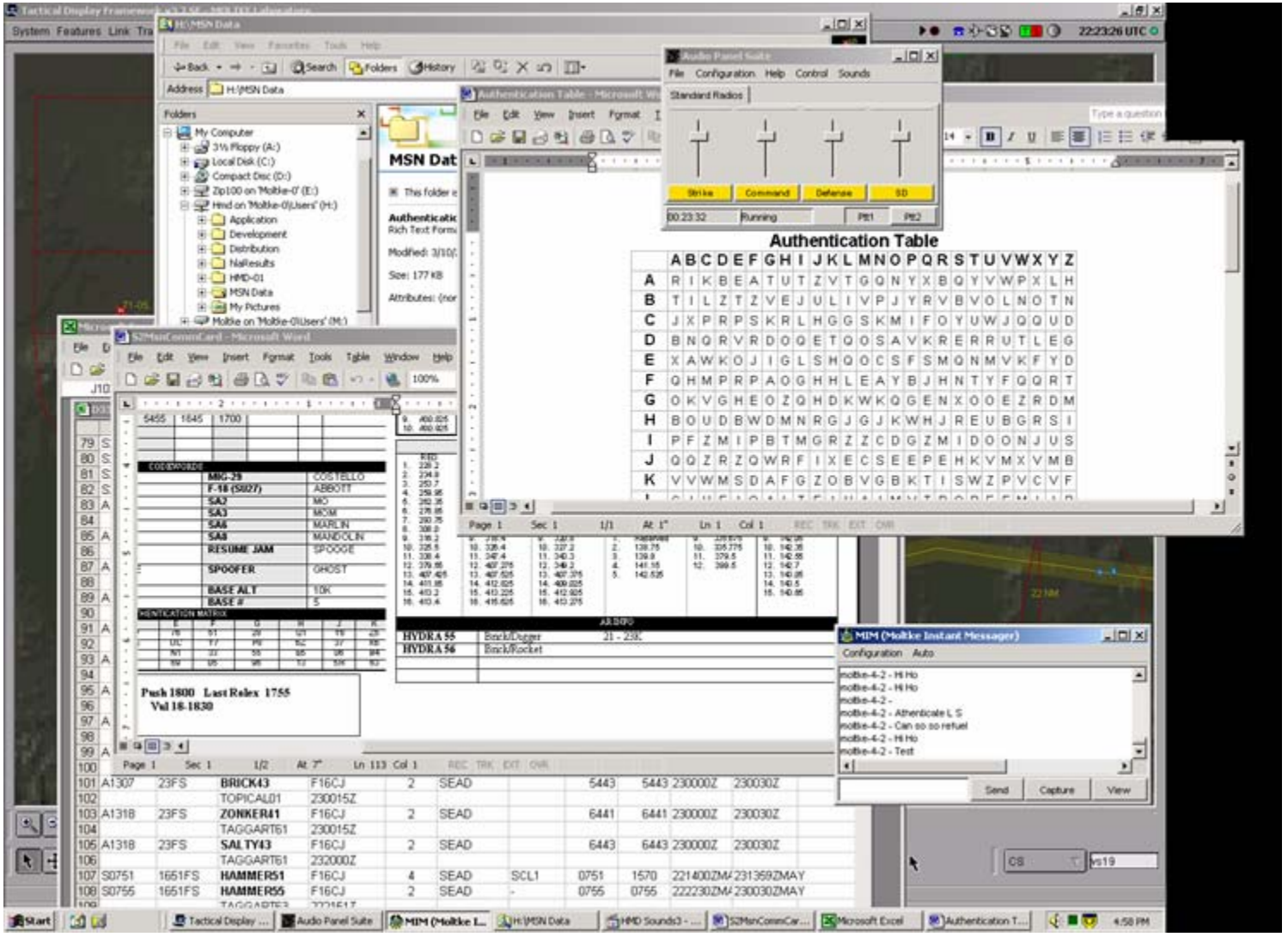


Collaboration Technologies

BMC2 Research ROI

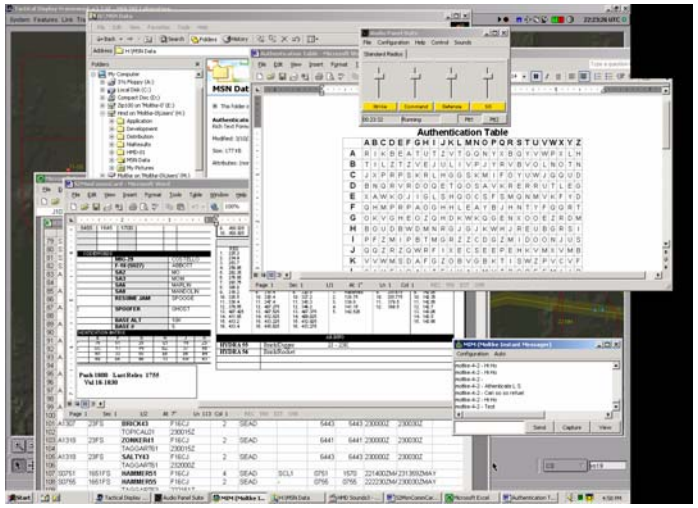
Technology	Operational Payoff	Value Proposition
Spatial Audio	speech intelligibility, comm effectiveness	training, operational safety
Speech Recognition	reduced workload, performance efficiency	manning, training
Head-Mounted Displays	performance efficiency, situation awareness	prosecution time, time critical opportunities
Net-Centric Collaboration Tools	decision effectiveness, shared battlespace awareness	speed of command, time critical opportunities

Clutter Problem



Advanced Interfaces for BMC2
Rationale for Visual Interface Technologies

Problem – limited workstation and display real estate on BMC2 platforms, introduces high memory loads, increases need for paper documents and time away from the primary situation display

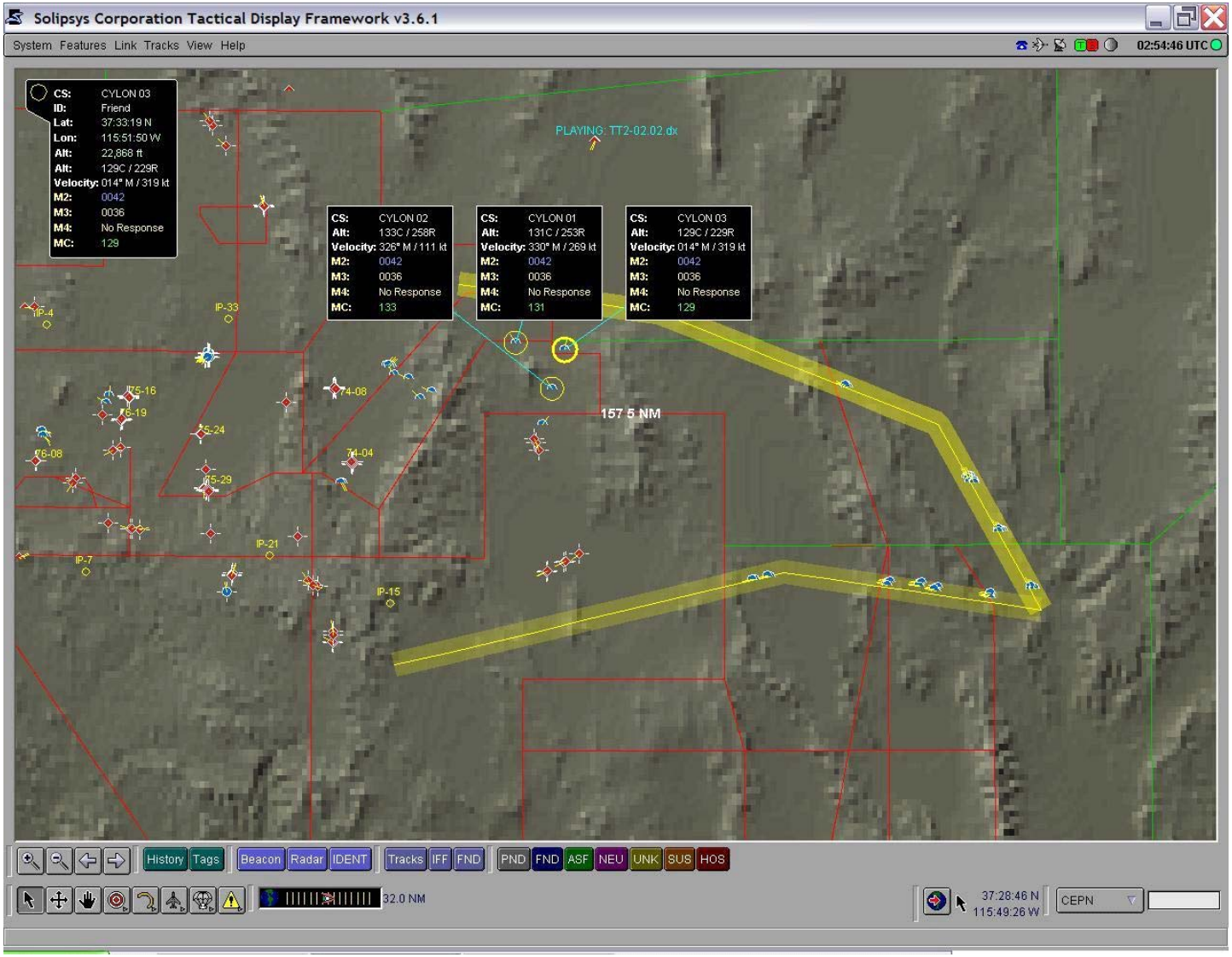


Objective – increase visual display real estate through the use of HMDs and multi-layer displays

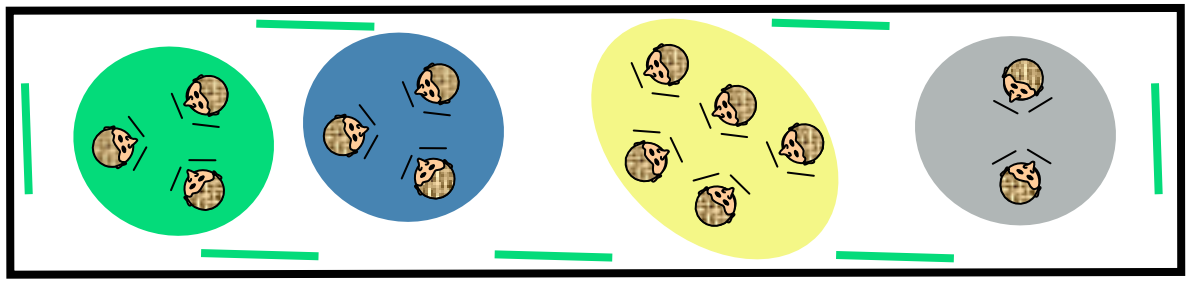
Approach – identify high payoff display content, evaluate candidate technologies through user testing and simulation experiments

Benefits – increase operator efficiency and situation awareness through more effective display of critical visual information

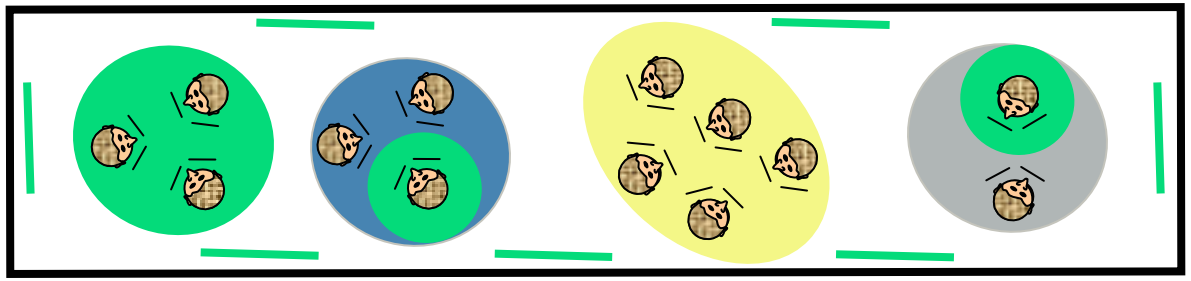
Primary Display



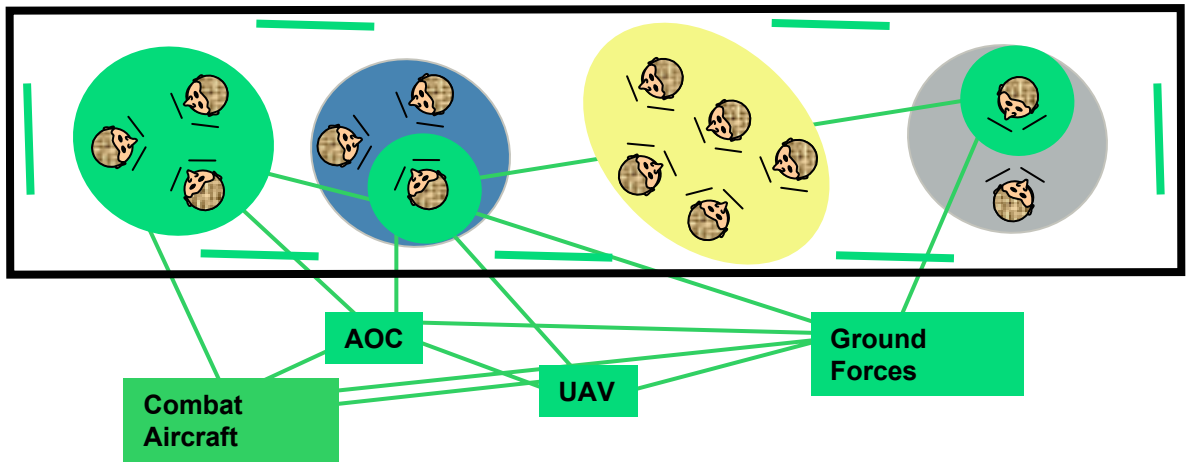
Advanced Interfaces for BMC2
Rationale for Collaboration Technologies



Face-to-Face



Local Remote



Distant Remote

Collaboration Technologies for BMC2

COTS Collaborative Interface Technology

- **Face-to-Face, Local Remote, and Distant Remote**
  - **Advanced Displays**
  - **Data Visualization Tools**
  - **Decision Support Tools**
  - **File and Application Transfer**
  - **Video Conferencing**
  - **Interactive Virtual Whiteboards**
  - **Chat and Discussion Groups**
  - **Broadcast and Alerts**
  - **Data Capture and Replay**
  - **Expertise and Knowledge Locators**
  - **Opinion and Polling Tools**
  - **Knowledge and Content Management Tools**
  - **Automated Workflow**
  - **Calendar and Timelines**

Taxonomy

- Tractability
  - Can the STE answer the research question?
  - Theoretical Continuum
- Realism
  - Functional relationship between STE and real-world systems
  - Levels of Abstraction
- Experimental Control
  - Allowance of Variability and resultant behaviors
  - Risk and applicability of the data

Questions?

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