Thinking

…*inside* the box

An Intelligent Interface-Agent Framework for Supervisory Command and Control

Soar Technology

Dr. Scott D. Wood

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Warfighter Challenges in Future Warfare

- System Complexity
  - Systems of systems, Joint operations, Micro-models of automation
- Proliferation of Uninhabited Elements
  - UV's, sensor nets, national assets, raw data
- Demanding Environments
  - MOUT, SASO, Asymmetric threats
- Rapid Operational Tempo
  - Changing environments, windows of opportunity

Intelligent Interaction Layer for C^3

- Objective System: An Intelligent Control Framework for Robotic Control
- Cooperative Interface Agents
  - Transformation of courses of action and commander's intent
    -> executable battle plans.
  - Matching information requirements to battle plans for dynamic battle management.
  - Decision-centric fusion and display of battlespace information.
- Result: A warfighter-centric solution to network-centric warfare.

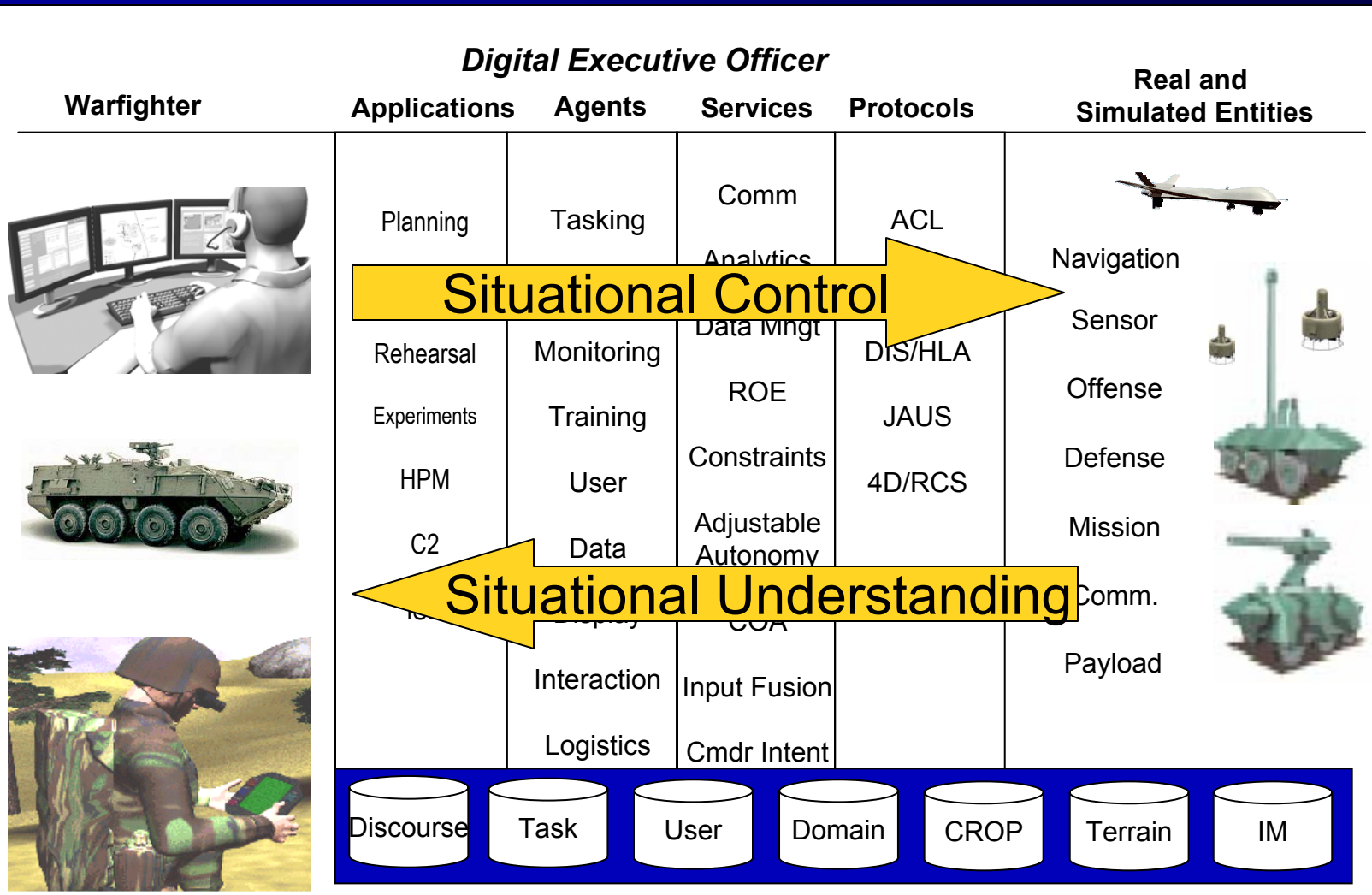
Use Command Staff Model

- Provide timely and accurate information.
- Anticipate requirements and prepare estimates.
- Determine courses of action and make recommendations.
- Prepare plans and orders.
- Supervise execution of decisions.
- Can function in parallel, can scale well, and are reconfigurable - according to specific challenge faced.

Key Elements for Providing Intelligent Assistance

- Accurately assessing the current situation
- Predicting when assistance will be needed
- Understanding how best to provide assistance
- Designing automation systems to support adjustable autonomy
- Reasoning over situation, doctrine, ROE, LoW…
  - In real time
  - In a dynamic, hostile environment.

Intelligent Control Framework



Intelligent User Interface Approach: Interface Agents

- Enhance Human Performance by
  - Reducing workload (delegation)
  - Improving decisions (better, faster info; data fusion)
  - Focusing on task (filtering, prioritizing)
- Challenges
  - Competence & Trust
  - Initiative and Deontics (agent authorization, obligation, prohibition)
  - Common goals & Communications
- Cooperative Interface Agent Framework based on 3 primary agent types:
  - Tasking
  - Coordinating
  - Monitoring
- New sub-agents
  - Maneuver, Sensing, Effects, Interaction

Why Agents?

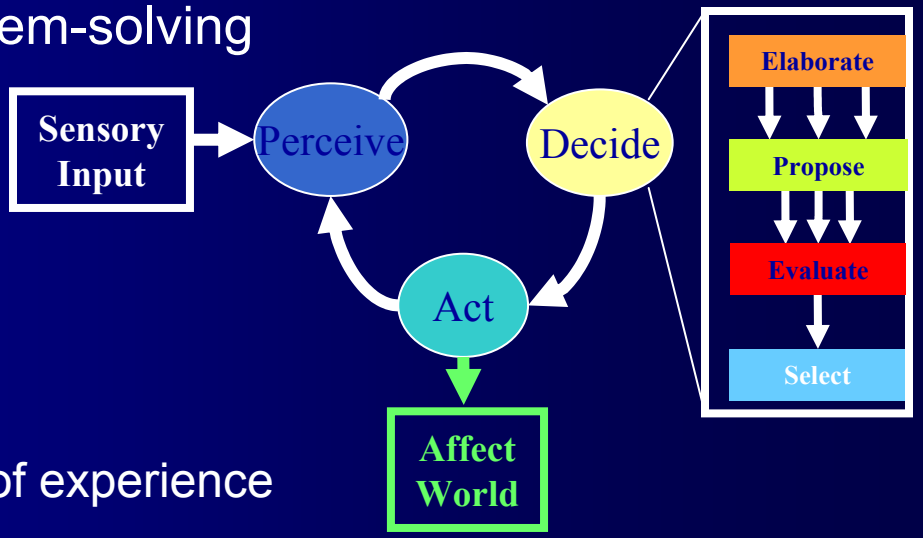
- Distributed problem solving
  - Encapsulation of knowledge
  - Encapsulation of Processing
  - Communication oriented design
  - Reconfigurable design
- Demanding NCW Domain (Potok, et al. 2003)
  - Asynchronous object interaction
  - Sporadic network connections
  - Peer-to-Peer programming models
  - Secure communication with higher level interfaces

Agent Team Design

- Beliefs, Desires, Intents individually
- Joint Intentions collectively
- Separation of knowledge
  - Declarative, procedural, episodic
- Well-defined behavior
- Well-defined communications
- Well-defined deontics

The Soar Cognitive Architecture

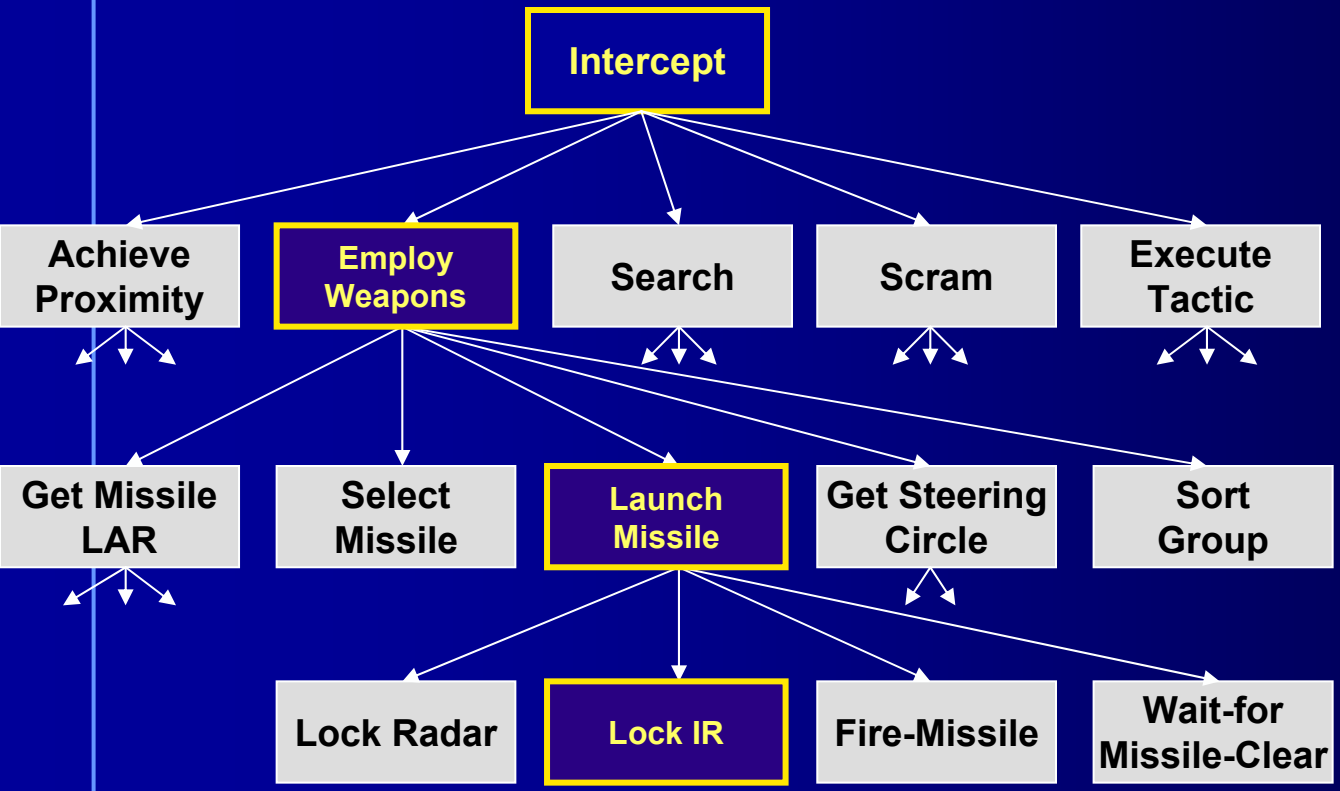
- An architecture for modeling and generating general intelligent behavior
  - Enables large-scale models of wide range of cognitive tasks
  - Supports explainable behavior
  - Employs wide range of problem solving methods
- A language and methodology for apply large amounts of knowledge to human-like problem-solving
- Principles of Operation
  - Parallel, associative memory
  - Belief maintenance
  - Preference-based deliberation
  - Automatic subgoaling
  - Goal decomposition
  - Adaptation via generalization of experience
  - Efficiency and performance



Soar Enables Application of Large Amounts of Structured Knowledge & Behavior

Complex goals are dynamically decomposed

- Rules propose and select alternatives, and implement actions
- 9000 rules currently in TacAir-Soar



If intercepting an enemy and the enemy is within range ROE are met, then propose employ-weapons

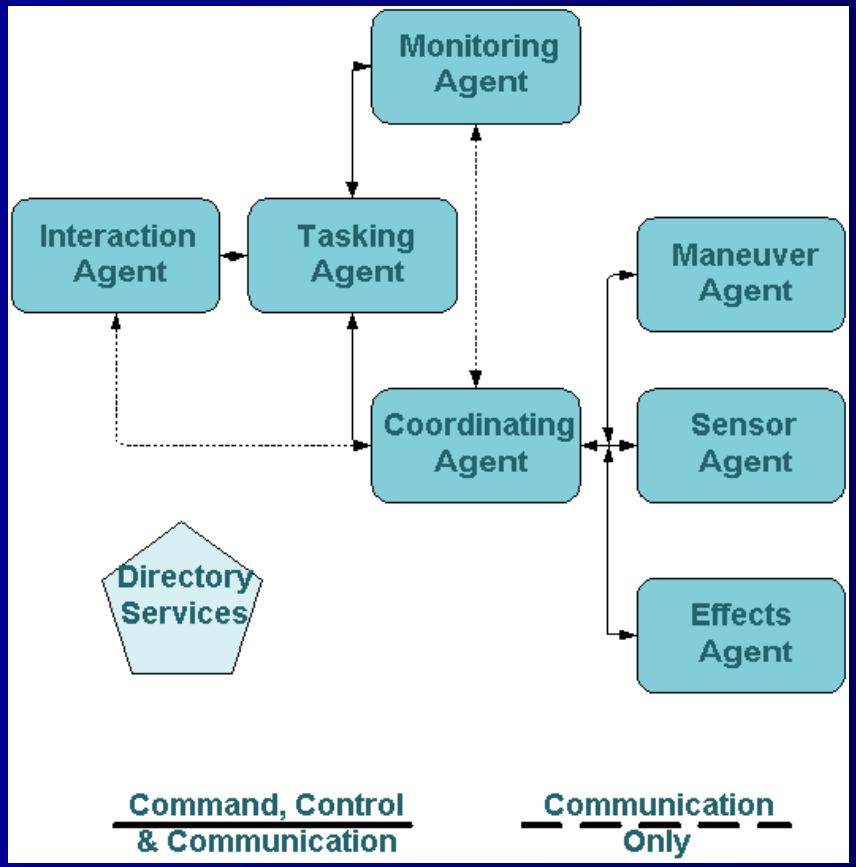
If employing-weapons and missile has been selected and the enemy is in the steering circle and LAR has been achieved, then propose launch-missile

If launching a missile and it is an IR missile and there is currently no IR lock, then propose lock-IR

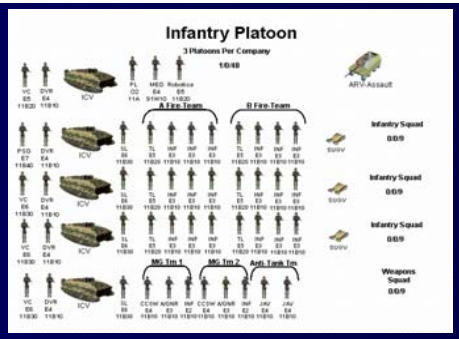
CIANC^3 Organization

Commander

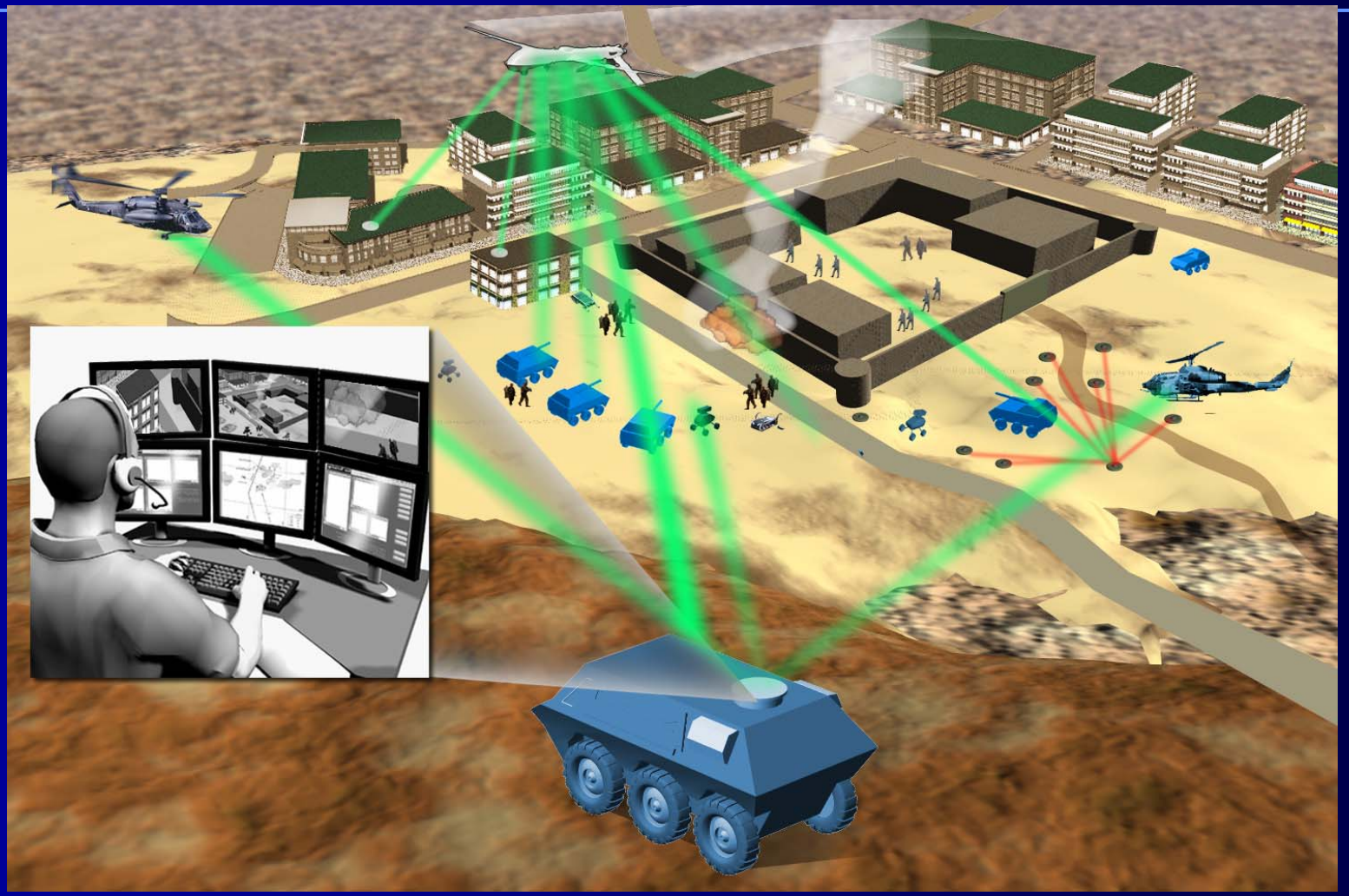
CIANC^3 Agents



Entities

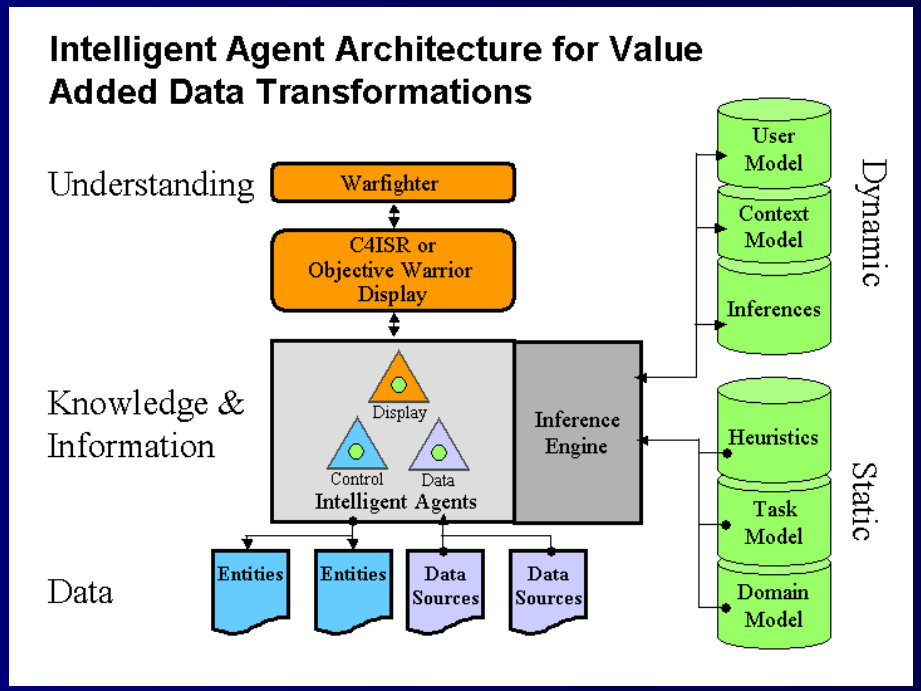


FCS Company Scenario
Isolate and Secure Compound



BINAH: Battlespace Information and Notification through Adaptive Heuristics

- Intelligent data pipeline can respond to changes in data and user readiness.
- Data and display agents reasoning based on heuristic formalism.
- External models store knowledge of task, domain and inferences about current user and world context.
- Allows Human System Interaction principles to inform AI transformation of data.



Architecture Data Flow Diagram

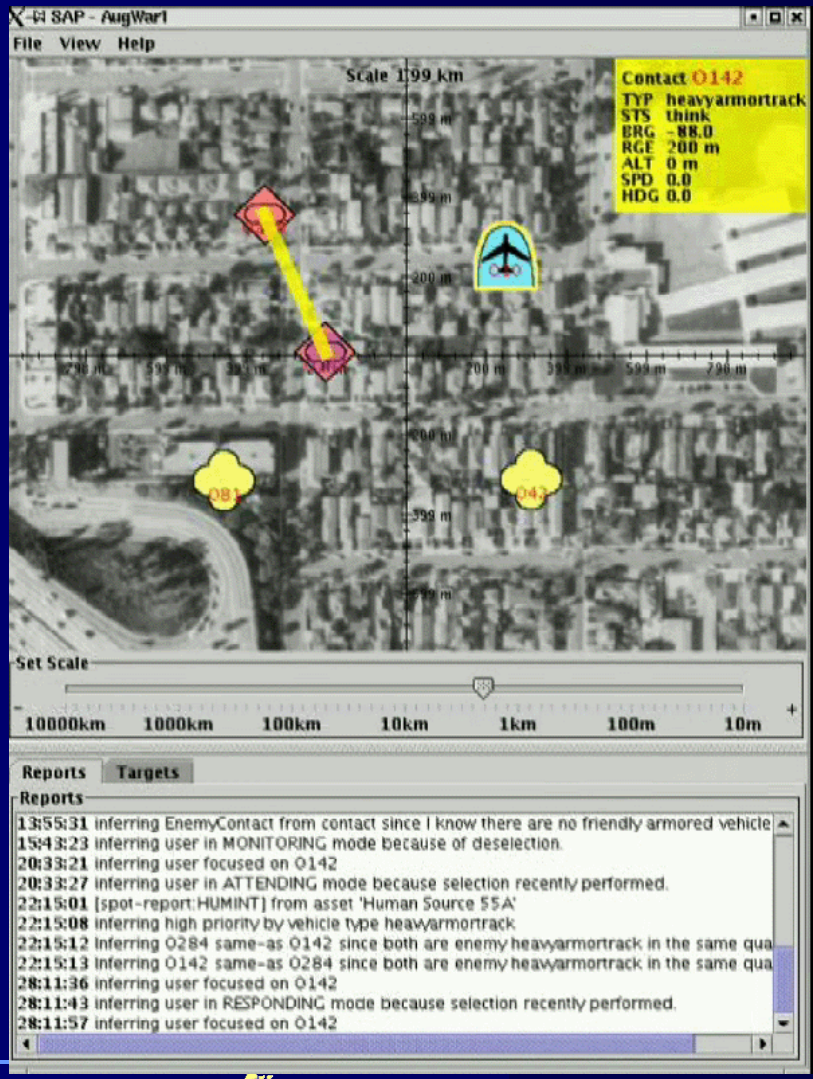
Demonstration: Time Critical Targeting Information Analysis Scenario

Target Scenario:

- Intelligence Analysis
- Detection and track file initiation.
- Evidence accrual through multiple source correlation.
- MOUT environment.
- Based on VITec ELT 'Electronic Light Table'.

Steps

1. Initial assessment of user and context.
2. First round of spot reports.
3. MASINT report, possible hostile vehicle.
4. HUMINT report, possible hostile vehicle
5. Warfighter interacts with system, viewing correlations and available ISR assets.

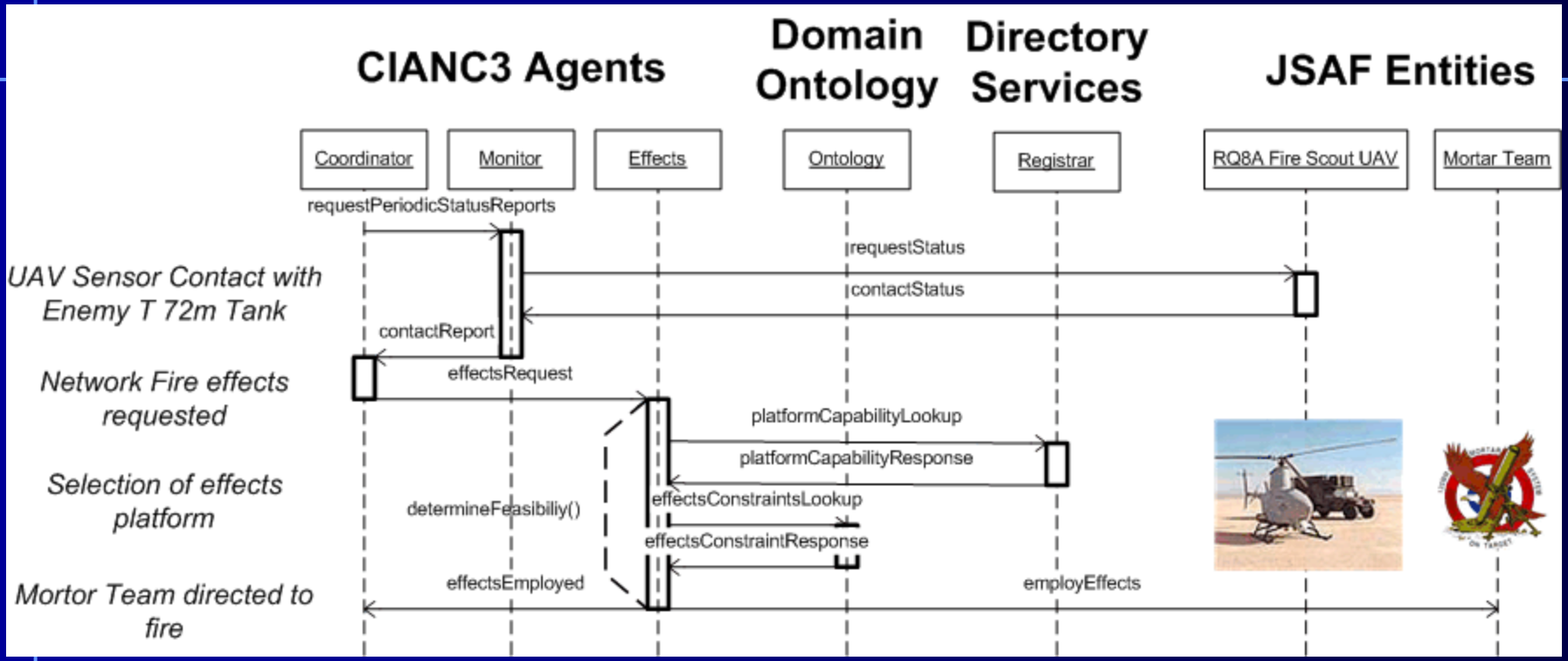


Current Agent Capabilities

1. System selection of sensor assets, based on mission objectives and available assets
2. System selection of maneuver assets to position sensors, based on sensor platform type and mission objective
3. System tasking of maneuver assets to move to area of interest
4. System tasking of sensor assets to sense and report
5. System monitoring of sensor report to verify that area of interest is being reconnoitered
6. System makes sensor signals available to be reasoned on; including UAV supplied sensed entity locations, entity types, entity mobility and lethality percentages
7. System replanning based on limited set of mission events

Infrastructure and Organization Functional…
Limited Primarily by Knowledge

Dynamic Response



Sensor Contact: T72 Tank Detected

- If change in situation can be addressed without changing plan and according to ROE, CA acts
- If change in situation requires plan change, TA replans and coordinates with Commander if appropriate

Early CIANC^3 Display Mockup

Entity Control

Location Creation

Status & Pane Navigation

Task Assignment

Tasks & Task Status, Objective boxes provide sequencing

Decision point control.
>> for Continue Automatically
! For Inform / Approve

Unit / Entity / Task Status Panel

Discussion

- Agents are a useful, perhaps, necessary technology for implementing NCW goals.
- Need common and well-defined language for human-agent and agent-agent interaction
- Can't depend on acceptable results to just emerge from independently-designed systems – there must be a rigorous definition of authority, permission, obligation, and jointly-held goals for multi-agent systems to work.
- With agent and system organization in place, next step is human interaction.

The 7 Habit of Highly Effective Agents

(paraphrased from Covey, 1990)

- Be Proactive®
  - Anticipate needs before they exist
- Begin with the End in Mind®
  - Understand how actions will effect results
- First Things First®
  - Effective, knowledge-based prioritization
- Think Win - Win®
  - Distribute, Cooperate, Win
- Understand then be Understood®
  - Robust communications and deontics
- Synergize®
  - True value is in cooperation and coordination
- Sharpen the Saw®
  - Try, learn, renew (still working on this)

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