UNIFYING HUMANS, ARTIFICIAL INTELLIGENCE (AI) AND MULTI-AGENT SYSTEMS (MAS)
Who we are...

• Our Mission?
  – To make the world a better place through advanced Artificial Intelligence (AI)

• How do we do that?
  – Through the Cougaar Way: Architecture/Technology, Methodology, Tools, and Training/Education

• What do we provide?
  – Agent-based Decision Support Systems for Operations, Logistics, Supply Chain and Supervisory Control
4 Pieces of an Autonomy Architecture

Robotics / IoT
- Platforms
- Sensors / Actuators
- Communications
- Control Sys
- Ambient

Artificial Intelligence
- Planning
- Reasoning
- Situational Understanding
- Execution Monitoring

Multi-Agent Systems
- Architecture Structure
- Distributed, Collaborative
- Organizational, Control
- Design Patterns/Methodology

Hybrid Knowledge Graphs
- Situational Representation
- Dynamic Analytics
- Complex Pattern Analysis

Autonomy Architecture
- Autonomy-in-Motion (Unmanned Systems)
- Autonomy-at-Rest (Decision Support Systems)
- Hybrid Autonomy Systems
- Ambient Autonomy Systems
- Supervisory Control Systems

Integrated, Distributed System
The Vision of AI

Building robust systems that can ...

- Pursue Goals
- Reason
- Plan
- Communicate
- Remember
- Manage knowledge
- Learn
- Adapt
- Monitor
- Recognize patterns
- Project future state
- Share / Acquire Behaviors

- Develop expectations
- Sched & allocate resources
- Meta-plan
- Collaborate / Share
- Observe
- Infer
- Deduce
- Hypothesize
- Evaluate
- Model
- Discover new knowledge
The goal of AI Platform Development is to create the architectures and behavior components to emulate in software the **human cognitive reasoning processes**.

### Human Innate

<table>
<thead>
<tr>
<th>Core Capabilities</th>
<th>Architectural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory</td>
<td>Blackboard</td>
</tr>
<tr>
<td>Thinking Processes</td>
<td>Cognitive Model</td>
</tr>
<tr>
<td>Learning Processes</td>
<td>Machine Learning</td>
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<tr>
<td>Observation</td>
<td>Event Monitoring</td>
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<tr>
<td>Communication</td>
<td>Messaging</td>
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<tr>
<td>Comprehension</td>
<td>Situational Reasoning</td>
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<tr>
<td>Etc.</td>
<td>Etc.</td>
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</tbody>
</table>

### Human Acquired

<table>
<thead>
<tr>
<th>Domain Capabilities</th>
<th>Programmed</th>
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</thead>
<tbody>
<tr>
<td>Skills</td>
<td>Algorithms</td>
</tr>
<tr>
<td>Tool use</td>
<td>Services/Interfaces</td>
</tr>
<tr>
<td>Behaviors</td>
<td>Workflows (Processes) + Plugins</td>
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<tr>
<td>Organizational Processes</td>
<td>Roles/Relationships/Tasking</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Knowledge Bases</td>
</tr>
<tr>
<td>Planning</td>
<td>AI Planning/Optimization</td>
</tr>
<tr>
<td>Etc.</td>
<td>Etc.</td>
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</tbody>
</table>
AI is an umbrella ‘area’ that includes many disciplines, though the Media is quick to call individual elements ‘AI’.

Machine Learning
Deep Learning
Feedback Learning
Reinforcement Learning
Hybrid Learning

While the pieces are themselves valuable, the real power is building systems that utilize all the pieces in concert.
Agents Work Together Like a Team...

- Each player has same basic skills
- Each player has specialized skills
- Each player has a position & role
- They operate together executing plays
- They communicate explicitly & implicitly
- Each maintains situational awareness
- The coach oversees and directs as necessary

GOAL: Minimize inventory while ensuring customer demand met

Theater Ammo Application
Agents Teams Solve Problems
[we call them a Society of Agents]
Essential Concept:
A shared representation that allows both people and computers to understand the underlying meaning of the information.
Let's look at some examples, to answer

**IS IT REALLY READY?**
Examples of Cougaar Software AI Solutions

- **Class V Adaptive Demand Estimation System**
  - Automated Class V resupply & asset inventory management
  - Machine learning & predictive analytics
  - Dynamic stockage objectives
  - Monitors consumption rates and calculates future demand

- **Distribution and Retrograde APEX Management**
  - Network construction, monitoring & management
  - Automated movement request & fulfillment process
  - Optimized multi-mode transportation planning
  - Theater movement program (TMP) generation & management

- **Industrial Base Assessment Methods (IBAM)**
  - Supply chain risk assessment
  - Production planning optimization
  - Total cost of ownership (TCO)
  - Automated reasoning for "what-if" impact analysis

- **Automated Supply Point – Scalable**
  - AI-enabled automation & supervisory control
  - Integrates automation, enablers, optimized planning
  - Improves throughput, order fulfillment, stock location resolution
  - Focuses on asset management-TSAs, ASPs, ATHPs & CONUS storage

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Duration – 13 months
Cost - $2.5m
Field test in progress

Duration – 24 months
Cost - $2.5m
Initial field test completed
Second field test in progress

Duration – 24 months
Cost - $1.8m
Completed – Being Extended

Duration – 16 months
Cost - $1.7m
Phase I Complete
Phase 2 in progress
The Power of CSI’s approach?

<table>
<thead>
<tr>
<th>Automation</th>
<th>Transform routine data processing and activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>Optimized inventories, maintenance, and acquisition</td>
</tr>
<tr>
<td>Inventories</td>
<td>Global perspective, managed at the item level against demand</td>
</tr>
<tr>
<td>Planning</td>
<td>Collaborated, synchronized activities across organizations</td>
</tr>
<tr>
<td>Execution</td>
<td>Continuous data / equipment / personnel monitoring</td>
</tr>
<tr>
<td>Value from Data</td>
<td>Timely decisions leveraging current data</td>
</tr>
<tr>
<td>Near Real Time</td>
<td>Immediate processing of streaming / transaction data</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Improved through precision, accountability and control</td>
</tr>
<tr>
<td>Visibility</td>
<td>Continuous and complete global visibility of assets, people and inventory</td>
</tr>
<tr>
<td>Context</td>
<td>Increased situational awareness and understanding</td>
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</table>

**complexity management**

*timely management of all the details, everywhere, all the time*
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