Sense and Respond Logistics
Technical Approach

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Sense & Respond Logistics
Project Objective

Design and implement a logistics system that will be able to support *distributed, adaptive, effects-based* military operations within a larger security operations context.
Sense & Respond Logistics

Technical Approach

• Develop and evolve the emerging concept of Sense and Respond Logistics
• Perform Agent-Based Modeling to study network behavior
• Develop and iterate an IT prototype of an S&RL system
• Test and evaluate, through broad-based experimentation, the integrated capability
• Produce rapid, periodic releases of the evolving S&RL enhanced capability
• Develop a Transition Plan for the implementation of S&RL
• Integrate diverse project elements and develop a Co-Evolution Framework for rapidly influencing change
• Produce change using the above capabilities by influencing policy and institutions
### Development Activities for Sense and Respond Logistics

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<th>Prototype Development and Testing</th>
<th>Expansion and Documentation</th>
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<td>Develop Project Plan</td>
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<td>Develop/document the Concept</td>
<td>Establish Framework</td>
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<td>S&amp;RL CONOPS</td>
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<td>Conduct Joint Design Sessions</td>
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<td>SIPRNET Implementation Strategy &amp; IATO Documentation</td>
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<td>Process Map, System Design, &amp; Transition Plan Tech Report</td>
<td>Install prototype on SIPRNET</td>
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Sense & Respond Logistics

Co-evolutionary Development Methodology

- Concept Development
- Prototype Development and Testing
- Expansion and Implementation

Month

1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24
Co-Evolution and Spiral Development

- Concepts
- Process
- Technology
- Organization

Incremental Capability Releases

Assessment & Feedback

Planned and Event-Driven Experimentation and Operational Evaluation

Real World Ops

Analysis

Simulation

Demonstrations

Wargames

Rapid, Incremental Sense & Respond Logistics Operational Capability Enhancements

Enhanced Log System Capability

Logistics Capability

Capability Increments

Present

Future

ACTDs

Millennium Challenge

Sea Viking

CJTFEX

Roving Sands

Army Transformation

Navy Global

FLOW
Agent-Based Modeling and the IT Prototype

- Intelligent agents are being used as a research tool and as the key element in the IT Prototype
- We are using Agent-Based Modeling (ABM) to study fundamental network behavior within the context of S&RL
- An agent-based “toy model” is being developed to gain insights into S&RL as a complex adaptive system
- The model is already exhibiting emergent, complex behavior through the simulation of simple agents and simple rules
- These insights, decision rules, and working hypotheses out of the ABM will be used as one source to drive decision rules in the larger Agent-based IT Prototype
**Sense And Respond Logistics**
Transforming Military Logistics...

...Achieving Flexibility, Agility, and Adaptation through a Community of Agents...

...To Support Armed Forces Transformation

**Transforming Military Logistics Operations**
- Flexible, Agile, and Lean Real-Time Support
- Factory to Field Adaptation, Supply Chain Event Management
- Short-Term Inventory, Service, and Transportation Optimization
- Resource Utilization: Prediction and Anticipation
- Risk Assessment and Mitigation
- Information, Processing, Communications Resource Management

**Surrogate Agents for Military Logistics Resources**
- Represent Spare End Items, Logistics Materiel, Consumables, and Logistics Services Available from Legacy Systems, Non-Interoperable Allied/Coalition Systems, and Systems with Processing or Communications Failures

**Resource Agents**
- Represents Spare End Items, Materiel, Consumables Available at Logistics and Operational Units

**Function and Capability Agents**
- Represents Logistics Service Functions and Capabilities Available at Logistics and Operational Units

**Task and Effect Agents**
- Tailored Logistics to Support Command Objectives
- Sense, Predict, Anticipate
- Assess Risk and Alternatives
- Support Planned and Ordered Tasks, Effects
- Negotiate and Arbitrate

**Sense and Respond Logistics Holonic Network Community of Semi-Autonomous Virtual Configurable Agents**

**Task and Effect Agents**
- Tailored Logistics to Support Command Objectives
- Sense, Predict, Anticipate
- Assess Risk and Alternatives
- Support Planned and Ordered Tasks, Effects
- Negotiate and Arbitrate

**Liaison and Interface Agents**
- Coordinates with Operational Elements
- Plans and Orders
- Effects Tasking
- Order
- Continuous Planning, Effects Operation Coordination
- Effects-based Operations, Intelligence, Planning, Logistics

**Joint Adaptive Warfare**
- Joint/Coalition Expeditionary Warfare
- Lean, Modular
- Function- and Capability-centric Organizations
- Task-centric, Effects-based Operations
- Speed vs. Mass
- Coordination with other Government Agencies, Coordination with Host Nations, NGOs, PVOs
- Supports Diverse Range of Military Operations

**Network-Centric Warfare**
- Processing, Information, and Communications Resource Management
- Resource Allocation and Management
- Publish and Subscribe/Push and Pull Persistent Queries, Information Dissemination Management

**Global Information Grid**
- Joint/Adapted Expeditionary Force

**Cognitive Decision Support**
- Predictive Courses of Action Analysis
- Branch and Sequence Anticipation
- Battlespace Awareness
- Operational Risk Assessment and Mitigation
- Resource Utilization Predictions

**OTHER SENSE AND RECORD AGENTS**
- Learning and Recording Agents
- Logistics Management and Administration Agents
- S&RL Integrity and Assurance Agents

**Joint/Allied Expeditionary Force**
- Effects Tasking Order, Effects Risk Mitigation
- Continuous Planning, Effects Operation Coordination

**Effects-based Operations, Intelligence, Planning, Logistics**
- Effects Tasking Order, Effects Risk Mitigation
- Continuous Planning, Effects Operation Coordination

**From Factory to Foxhole**
- Lean, Modular
- Function- and Capability-centric Organizations
- Task-centric, Effects-based Operations
- Speed vs. Mass
- Coordination with other Government Agencies, Coordination with Host Nations, NGOs, PVOs
- Supports Diverse Range of Military Operations

**Sense and Respond Logistics: Agile, Flexible Sustainment**
- Adapts to Operational Situations
- Sustains Effects-based Operations
- Considers Entire Battlespace, All Elements as Network of Potential Logistics Materiel, Consumables, Services
A logistics need is sensed or reported

Calculate the tactical envelop for the element’s need

Is the logistics resource needed available organically?

Is their a planned resupply of the needed resource?

Is the planned resupply within the tactical envelop for the need?

Are the additional logistics support to transport, install, repair the needed resource available organically?

Is the need within the boundaries of anticipated needs?

Obtain and replace, repair, or service the needed resource organically

Develop a lessons learned report on the need and its satisfaction

Issue the lessons learned

END

Develop an autonomous request for the needed resource and/or the needed associated logistics support

Develop a request to the appropriate broker for the needed resource and/or the needed associated logistics support

Issue the need request(s)

WAIT FOR RESPONSE

END

END

END

END
S&RL
Agent Structure
for Simulation Testing

Environment

Sense

Process

Respond
1. Sensing
- External Tasking
- External Assistance Requests
- External Responses to Requests
- Other External Factors

2. Internal Processes
- Status Keeping
  - Resources
  - Current Activity
- Planning
  - Projected Activity
  - Projected Resource Posture
  - Capability Evaluation
- Learning
  - Memory persistence
  - Mod Consumption Rates
- Decision Making
  - Change activity
  - Generate help request
  - Respond to help request

3. Responses
- Generate Help Requests
- Report Activity Changes
- Respond to Help Requests

Environment
Network Simulation Elements
Simple autonomous need-supply (SRV 01)
Network Simulation Elements
Simple autonomous need-supply, using surrogates-SRV-01a

Broadcast requests & responses

Surrogate Agent

Resource Need

Negotiation

Entities
Typical SARL Demand / Support Node

- **Demand Agent**
  - Blackboard
  - Common Plug-ins
  - Core Functionality Plug-ins

- **Supply Agent**
  - Blackboard
  - Common Plug-ins
  - Core Functionality Plug-ins

- **Sourcer/Broker Agent**
  - Blackboard
  - Common Plug-ins
  - Core Functionality Plug-ins

- **Buyer Agent**
  - Blackboard
  - Common Plug-ins
  - Core Functionality Plug-ins

- **Seller Agent**
  - Blackboard
  - Common Plug-ins
  - Core Functionality Plug-ins

**Connections**
- Required Inventory & Threshold Levels
- Demand Transaction(s)
- Supply Contract
- Distribution
- Request(s)
- Negotiation
- Distribution
- Contract(s)
- Inventory Availability
- Available Inventory & Threshold Levels
- Offerer Response(s)
- Negotiation
- Supply Request(s)
- Distribution Contract(s)

**SARL Demand Network**
Demand / Support Node Overview

- Each Node will be comprised of six Agents
- Cougaar / UltraLog “Plug-ins” and their associated Business Rules define each Agent’s “personality”
- S&RL Hybrid Architecture accommodates a variety of input mechanisms indicating a demand via of a specifically designed Plug-in(s):
  - Human issues a demand via some sort of S&RL IT device
  - Database threshold breached
  - Sensor input, etc.
- Network viewable components (Portal, Map Interface, Digital Dashboard Stoplight tools) support
  - Network and Agent behavior monitoring
  - Decision support aids
  - Capture Nodal Arcs to facilitate trend and performance analysis
The Adaptive, Event-Driven Enterprise

**Enabler**
- Infrastructure

**Process for generating awareness**
- Sensor Netting
- Data Fusion
- Information Management

**Enabler**
- Vastly Improved Awareness
  - Shared Awareness

**Process for exploiting awareness**
- Virtual Collaboration
- Virtual Organizations
- Substitution of Info for People and Material
- Self-Synchronization

**Results**
- Increased Tempo
- Increased Responsiveness
- Lower Risks
- Lower Costs
- Higher Profits

**The Entry Fee**

**The Bottom Line**

(Measurable)
Sense & Respond
Logistics
Prototype Overview

Databases
Alerts
Decision Support
News

Stoplight View
Map View
Portal

Network Monitoring
Metrics Analysis

Legacy Apps
New Apps

JOPES
Data Warehouse
Sea Viking-04: Mission

The Marine Corps conducts the Sea Viking 04 Experimentation Campaign to inform decisions and strategies for achieving 2015 transformational goals

- Examine Sea Basing & OMFTS within the Joint context
- Provide a foundation for Naval Transformation
- Establish main effort of Marine Corps Service Experimentation
- Provide hard data to inform planning and programming decisions
- Examine Sense and Respond Logistics
Experimentation Plan Development Process

Concept of Operations

Architecture and Concept

Prototype Design

S&RL Functional Transactions and Agent Design Components

Functional and Operational Vignette Primitives

Exercise Scenarios

Other Scenarios and Vignettes (e.g., from Functional Concept)

ETC.

GE VII

UC04

SV-04

Exercise Opportunities to Demonstrate and Test S&RL

Experiment Vignettes and Design

SME Seminars and LTA/LOE Design

S&RL Experimentation Plan
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<thead>
<tr>
<th>Tab</th>
<th>Title</th>
<th>Description</th>
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<tbody>
<tr>
<td>I</td>
<td>Overview</td>
<td>Structure of workbook and definitions of Tabs of Experimentation Framework</td>
</tr>
<tr>
<td>II</td>
<td>S&amp;R Vignettes</td>
<td>Primitive functional elements required to demonstrate S&amp;RL. Stand-alone, and basis for other vignettes. Includes LTAs. Includes cross-reference to military transformation elements</td>
</tr>
<tr>
<td>III</td>
<td>Operational Context</td>
<td>Operational assumptions and context overall, and related to specific experiments</td>
</tr>
<tr>
<td>IV</td>
<td>SV-04 S&amp;R LTAs/LOEs</td>
<td>Sea Viking 04 S&amp;RL Limited Technical Assessments, Limited Operational Experiments, and insertion of S&amp;RL objectives</td>
</tr>
<tr>
<td>V</td>
<td>UC-04 S&amp;R Play</td>
<td>Unified Course 04 insertion of S&amp;RL objectives</td>
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<tr>
<td>VI</td>
<td>GE VII S&amp;R Play</td>
<td>Global Engagement VII insertion of S&amp;RL objectives</td>
</tr>
<tr>
<td>VII</td>
<td>Use Cases</td>
<td>How user will interact with system given a specific operational Vignette. Gives detailed descriptions that gives operational relevance to S&amp;RL. Devised to communicate requirements for system interface of transactions, reports, and screens. Must prove tenets of S&amp;RL</td>
</tr>
<tr>
<td>VIII</td>
<td>Lessons Learned &amp; LTA/ LTE Results</td>
<td>Lessons Learned from Exercises, Demonstrations, LTAs, LOEs. Inputs from SMEs in LTAs/LOEs</td>
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## S&R Primitive Vignettes: Examples of Increasing Complexity

| SRV-01-01 | Autonomous need-supply from logistics element, using supplier transportation | Demonstrate autonomous S&RL operations, within service, from logistics element supplier, using logistics element transportation. | An element requires consumables that may be in supply at other elements (e.g. fuel). Its ruleset permits the issuance of an autonomous need for fuel. A single logistics element, whose ruleset permits responses to autonomous requests, responds that it has a sufficient amount of fuel to supply within its tasking and resupply situation. A simple negotiation occurs to select a rendezvous. Assumes that the supplier is an element of the same military service as the requestor. Assumes that transportation to the rendezvous is available organically, in the logistics element. Assumes that the supplier's tasking does not require brokering with other operational/logistics or intelligence agents relative to the use of spare fuel. |
| --- | --- | --- | |
| SRV-01-06 | Autonomous need-supply between two units in same service and in different organizations | Demonstrate autonomous S&RL operations, within service, unit-to-unit, in different organizations, where logistics support elements are not involved. | An element requires consumables that may be in supply at other elements (e.g. fuel). Its ruleset permits the issuance of an autonomous need for fuel. A single element, in the same service but in a different organization, whose ruleset permits responses to autonomous requests, responds that it has a sufficient amount of fuel to supply within its tasking and resupply situation. A simple negotiation occurs to select a rendezvous. Assumes that transportation to the rendezvous is available organically at the requestor. Assumes that the supplier's tasking does not require brokering with other operational/logistics or intelligence agents relative to the use of spare fuel. |
### Linking SV04 and S&R Experimentation

| Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **CY 03** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **BASELINE** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| CONOPS Path |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| All CDT Products for Baseline |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| UC04 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| JFMCC Wargame |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Assessment Report |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **EFDC (Conceptual Pathway)** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **JFMCC MEB CONOPS Path** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| CDT Product Development |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| ETCS LTA 1 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| ETCS LTA 2/OTM COC LTA 1 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| ETCS LTA 3/OTM COC LTA 2 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| OTM COC LOE/TriWar LOE |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Recon Mobility LOE |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| AWE Part 1 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| AWE Part 2 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **MCWL (Prototype Pathway)** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Water LOE |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| MD LOE 1 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **EFDC (Conceptual Pathway)** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| **S&R LTAs/LOEs** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| S&R LTA 1 | S&R LTA 2 | S&R LTA 3 | S&R LTA 4 | S&R LTA 5 | S&R LTA 6 | S&R LTA 7 | S&R LTA 8 | S&R LTA 9 | S&R LTA 10 | S&R LTA 11 | S&R LTA 12 |     |     |     |     |     |     |     |     |     |     |     |     |
| **S&R LTA 1** | **S&R LTA 2** | **S&R LTA 3** | **S&R LTA 4** | **S&R LTA 5** | **S&R LTA 6** | **S&R LTA 7** | **S&R LTA 8** | **S&R LTA 9** | **S&R LTA 10** | **S&R LTA 11** | **S&R LTA 12** |     |     |     |     |     |     |     |     |     |     |     |     |
| **Exact Dates in Detail Slides** |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

### JAGTF CONOPS Path

- CONOPS
- Updated CDT products for JAGTF
- Seminar WG
Near Term Areas of Focus

• Building an S&RL Road Map and Transition Plan
• Working with OSD-ATL, JFCOM, Services, and other DoD organizations to implement and instantiate capability as it evolves
• Leveraging S&RL approach and applying to Joint Adaptive Command and Control and Joint Intelligence, Surveillance, and Reconnaissance