The KSCO Community and its Coalition Experiments

http://www.aiai.ed.ac.uk/project/ksco/
KSCO Events

  - Working parties proposed series of Coalition Experiments Binni scenario adopted for community experimentation.
  - Working Group on KSCO formed and first meeting held to plan community activities.
- Coalition Experiments and multi-national joint experimentation encouraged.
- Web site and relevant occasional communications on behalf of community.

KSCO Community - 2
KSCO Working Group

- Jean Berger (DRDC, Canada)
- Jeff Bradshaw (IHMC, USA)
- David Brown (MITRE, USA)
- Richard Davis (DSTO, Australia)
- Roberto Desimone (QinetiQ, UK)
- Jerry Dussault (AFRL, USA; TTCP Representative)
- Dan Fayette (AFRL, USA)
- Scott Fouse (IS, USA)
- Nort Fowler (AFRL, USA; now retired)
- Vladimir Gordoteski (St. Petersburg Inst. for Info. and Automation, Russia)
- Jim Hendler (University of Maryland, USA)
- Jan Jelínek (Honeywell, USA)
- James Lawton (AFRL, USA)
- Paul Losiewicz (EOARD/London, USA)
- Vijay Kowtha (ONR Global/London, USA)
- Dale Lambert (DSTO, Australia)
- Barry McKinney (EOARD/London, USA)
- Rick Metzger (AFRL, USA)
- Jitu Patel (DSTL, UK; TTCP Representative)
- Michal Pěchouček (Czech Technical University in Prague, Czech Republic)
- Tony Rathmell (DSTL, UK)
- Martin Rehák (Czech Technical University in Prague, Czech Republic)
- Niranjan Suri (IHMC, USA)
- Austin Tate (AIAI, University of Edinburgh, UK)
KSCO Topics

- Innovative theory and techniques for coalition formation and support to similar “virtual organisations”
- Applications and requirements for knowledge-based coalition planning and operations management
- Knowledge-based approaches to command and control
- Knowledge-based approaches to coalition logistics
- Knowledge-based approaches to Operations-Other-Than-War - such as peace keeping missions and other humanitarian operations
- Multi-agent systems and the concept of agency in coalitions
- Tools and techniques for knowledge-based simulation and modelling of coalition operations
- Security and maintenance of private information or knowledge in coalition operations
- Autonomous vs. centrally managed coalition operations
KSCO Issues

- Different doctrine, decision making, rules of engagement and, in general, mission "agendas"
- Different technology skill and equipment levels
- Questionable compatibility of respective national information systems
- Limited models for coalition force operations
- Command authorities - agreement and transfers
- Information systems resource sharing agreements & capacity
- Different interpretation of situational information
- Lack of compatible security architectures

From LeRoy Pearce, Canadian MOD
TTCP
The Technical Cooperation Program

- Australia, Canada, New Zealand, UK, USA
- C3I Group - Command, Control, Communication and Information Systems
- Created Binni Scenario
- Encouraged KSCO and Coalition Experiments

http://www.dtic.mil/ttcp/
Binni - Gateway to the Golden Bowl of Africa

Laki Safari Park

Laki Safari Park is a nature preserve administered by the World Foundation for the Protection of Wildlife (WFWW). Located to the west of Laki in the Baka region of NE Africa, the preserve is home to a wide variety of animal and plant life in a natural setting. While the primary purpose of the preserve is conservancy, ongoing scientific studies monitor wildlife on a continuous basis.

Animal Monitoring at Safari Park

In June 2019, Safari Park began an international exploration in animal monitoring program. Larger mammals (elephants and lions at present) were fitted with monitoring devices that capture each animal’s:

- Location: latitude, longitude, altitude
- Directions of movement
- Field conditions: air temperature, humidity
- Animal health conditions: body temperature, pulse, blood pressure, basal stress response

Results of these observations are sent at the beginning of each month by wireless email to a central database which the public can query using a natural language interface (try it out - OBJS API). To see how a query about elephant body location over time might look when plotted on a map, click map. Scientists and the public are invited to subscribe to receive periodic updates on their favorite animals (using OBJS email system - results are shown here: [link])

Binni Vexillology

**Binni**

![Flag of Binni](image)

Represents the hopes of the Binni Founding Fathers that the Sun will rise and set in a cloudless sky over a lush and prosperous landscape.

**Gao**

![Flag of Gao](image)

Reflects the anguish of the history of Gao with nature alternating between poverty and plenty divided by the crimson stained path of tribal conflict.

**Agadez**

![Flag of Agadez](image)

Represents the union of Mountain (blue), Upland (green) and Lowland (brown) peoples of Agadez each maintaining their independence yet united against all opponents.

**Arabello**

![Flag of Arabello](image)

Represents the five fiefdoms of Arabello unified under a sultan of wealth and power.
Binni Scenario Materials

binni.org

or via KSCO web site
Coalition Experiments

- Coalition Logistics 1, 2000 – San Diego, CA, US
- Coalition Logistics 2, 2000 – Malvern, UK
- CoAX Binni 2000 – Malvern, UK
- CoAX Binni 2001 – Malvern, UK
- CoAX Binni 2002 – Newport, RI, USA
Coalition Logistics Challenges

Short/Medium-term

- Define coalition logistics processes for various missions
- Develop shared representation (culture, doctrine, language)
  - Classes of logistics/deployment assets
  - Coalition logistics picture for monitoring execution
- Establish coalition access (with accredited security model)
  - Plethora of logistics systems & databases
  - Logistics validation models & models
- Demonstrate e-commerce approach to bidding & brokering for logistics capabilities
- Capitalise on planning & scheduling technology

In-service 2-5 years
Coalition Logistics Challenges

Long-term (in-service 5-10 years)

- Demonstrate adaptable rapidly re-configurable coalition logistics processes
- Develop shared representation (culture, doctrine, language)
  - Essential tasks, plans, capabilities & options
  - Agent capabilities & authority chain/process
- Support complex planning queries
  - Validated by simulation models at multiple hierarchical levels
- Establish more flexible security domain model
Coalition Logistics Exercise/Workshop

- 5 day duration (3 day exercise + 2 day workshop)
- Objectives
  - Develop coalition plan for prepared scenario
  - Jump-start & refine collaborative programme
- Participants: Logs experts (J4/tech) + 2/4 program managers
  - Exercise lead (J4) - techies on tap & observing
  - Workshop lead (Techies) - J4 on tap & validating
- Inputs
  - Exercise lead (J4) - techies on tap & observing
  - Workshop lead (Techies) - J4 on tap & validating
- Outputs
  - Logistics plan / lessons learned / knowledge acquisition
  - Specific collaboration programme / defined R&D tasks & expts
- Locations/Dates
  - San Diego, USA in May 2000
  - Malvern, UK in September 2000
Coalition Agents eXperiment
http://www.aiai.ed.ac.uk/project/coax/
Context

- Increasing military requirements for coalition operations
- Belief that agent computational model can support:
  - Coalition interoperability requirements
  - Dynamic and Decentralized C3I
- International Agent Research Programmes
  - US DARPA Control of Agent Based Systems (CoABS)
  - UK DSTL/QinetiQ Agents Project
  - Australian and Canadian Agents and Coalition Work
  - TTCP C3I Groups for international involvement
- Need for “middleware” such as is provided by DARPA CoABS Grid Infrastructure
Aim of Coalition TIE

- To address unique aspects of coalition operations through the development and evaluation of:
  - agent domain management services
  - agent task, process and event management services
  - Specific agent services
- Aim will be met through delivery of:
  - Phased technical demonstrations of increasing complexity
  - Integration of diverse agent systems
  - Development of generic Coalition-oriented grid services
- Requirements:
  - Use of a wide variety of different agent systems
  - Use of existing military (non-agent) applications
Key Technical Drivers

- Cannot assume interoperability, reliability or availability of different nations systems
- Need for partial (secure) sharing and visualization of processes, data and facilities
- Need to work with agents in multiple dynamically determined domains
- Need for flexible inter-agent task and process management
- Need for rapid formation, management and change of agent relationships
Demonstration Schedule

- **1-month demo** at kick-off in February 2000 showing direct connection over “CoABS Grid” between two military systems: DERA MBP and LM ATL AODB
- **6-month integration milestone** in July 2000 showing initial integration of selected CoAX components for year 2000 demo
- **CoAX Binni 2000** demo in Fall 2000:
  - Briefing the CoAX TIE and Binni scenario
  - Showing full integration of selected CoAX components in Binni
  - Telling a relevant “story” about agents for information gathering
- **CoAX Binni 2001** demo in Fall 2001:
  - Fully integrating all CoAX components in a rich coalition scenario
  - Expanding scope to cover dynamic re-planning
- **CoAX Binni 2002** demo in Fall 2002:
  - Showing dynamic aspects of coalition organization, domain management, tasking and event handling
  - Expanding scope to cover dynamic planning, coordination and execution.
CoAX Month 1 (February 2000)  
Initial Demo

- Demonstration involves AFRL Rome, DERA Malvern and LM ATL and is a first (risk reduction) step toward CoAX
- Demo shows legacy applications can be usefully integrated into an agent framework (over CoABS Grid)

Master Battle Planner v2.1  
(DERA, UK)
Prototype CoABS Grid allows heterogeneous agent and legacy systems to:

- Register themselves
- Advertise their capabilities & needs
- Find available resources
- Communicate among themselves
- Form task-based teams
- Encrypt conversations
CoAX 6-Month (July 2000) Milestone

- Eleven agents in three separate agent domains representing coalition functional units (JTF HQ, JFAC HQ, Gao Intel)
- Binni scenario information used to drive storyboard
- Tasking and control across coalition functional units
- Visualization of coalition C2 process via a simple process model
- Simple policy administration tool for selective information sharing and communication blocking
CoAX Binni 2000 – Coalition TIE
Technology Integration Experiment
TTCP Meeting - Malvern - September 2000

AFRL Rome, AIAI, Boeing, Dartmouth, DERA Malvern, Lockheed Martin ATL, Michigan, MIT Sloan, Stanford, USC/ISI, UWF/IHMC
Support from BBN, GITI, ISX, MITRE, Schafer

http://www.aiai.ed.ac.uk/project/coax/
CoAX 9-Month (October 2000)  
Binni 2000 Demo

◆ Focus on information-gathering phase
◆ First interoperation of agent-wrapped legacy US and UK systems
◆ New agents and domains
  ◆ Three additional agent domains (6 domains and ~25 agents)
  ◆ Incorporation of domain-aware CAMPS airlift planning system
  ◆ Ariadne agent providing publicly available weather information
  ◆ More powerful I-X Process Panels
◆ New domain management functionality
  ◆ Malicious observer agent thwarted by domain management and NOMADS resource control mechanisms
  ◆ KAoS Policy Administration Tool (KPAT) administering communication, registration, and resource policies
◆ New stand-alone demonstrations:
  ◆ MIT exception handling
  ◆ Stanford incentive management
  ◆ U. Michigan plan deconfliction
  ◆ Dartmouth ‘observer agents’
CoAX 2000 Components

**Agent Frameworks**
- KAoS Agents (Boeing, IHMC)
- D’Agents (Dartmouth)
- EMAA/CAST Agents (LM ATL)

**Agent Grid Services**
- Task and Process Management (AIAI)
- Domain Management Services (Boeing, IHMC)
- Plan Deconfliction (Michigan)
- Exception Handling (MIT)
- Incentive Management (Stanford)

**Military Systems**
- CAMPS (AFRL, GITI, BBN)
- MBP (DERA)

**Agents on the Grid**
- AODB Agent (LM ATL)
- Observer Agents (Dartmouth)
- Malicious Agents (IHMC, Boeing)
- Web Weather Agent (USC/ISI)

**Grid**

**DARPA CoABS Grid**
- (GITI, ISX)
CoAX – Coalition Agents eXperiment

AIAI, BBN, CMU, Dartmouth, DSTO, GITI, Lockheed Martin ATL, NRL, Potomac Inst., U.Maryland, U.Michigan, QinetiQ, USC/ISI, UTexas, UWF/IHMC

Support from AFRL, ARL, Boeing, DREV, DSTL, ISX, MITRE, MIT Sloan, NWDC, OBJS, Schafer, Stanford, TTCP

http://www.aiai.ed.ac.uk/project/coax/
CoAX 18-Month (July 2001)  
Binni 2001 Demo

◆ More realism in coalition structures  
  ◆ All CoAX members integrated (9 domains and ~35 agents)  
  ◆ Coalition agents playing multiple roles in different domains  
  ◆ New policies add additional robustness and security  
  ◆ Added functionality in process and task management

◆ Increased scope of Binni scenario demonstration  
  ◆ Richer information gathering phase  
  ◆ Planning and execution phases of Binni added in

◆ Incorporating coalition functionality becomes easier  
  ◆ Packaging capabilities as pluggable grid services
CoAX Binni 2001 Demo Emphasis

Initial Planning
- Political aims
- Military guidance
- Campaign planning
- Commander's intent
- Deployment

Execution
- Variable Organizations
- An opponent
- Campaign re-planning
- Short-notice taskings
- Operation execution
- Execution monitoring
- Reporting / feedback
- Outcome assessment

Dynamic / iterative uncertain

Recovery
- Conflict resolution
- Re-deployment
- Peace support

Focus of the CoAX Binni 2000 Demo

Focus of the CoAX Binni 2001 Demo
CoAX 2001 Components

Agent Frameworks
- KAoS Agents (IHMC, Boeing)
- NOMADS Mobile Agents (IHMC)
- EMAA/CAST Agents (LM-ATL)
- GMAS (Dartmouth, IHMC, LM-ATL)
- D’Agents (Dartmouth)
- eGents (OBJS)

Agent Grid Services
- Task, Process and Event Management (AIAI)
- Domain Management Services (IHMC, Boeing)
- Asynchronous Wireless Connectivity (OBJS)
- Plan Deconfliction (Michigan)

Military Systems
- CAMPS (AFRL, GITI, BBN)
- MBP (QinetiQ)
- Situation Viewer (QinetiQ)

Agents on the Grid
- AODB Agent (LM-ATL)
- Observer Agents (Dartmouth)
- eGents E-mail Agents (OBJS)
- Malicious Agents (IHMC)
- Web Weather Agent (USC/ISI)
- ...
CoAX – Coalition Agents eXperiment

AIAI, BBN, CMU, Dartmouth, DSTO, GITI,
Lockheed Martin ATL, NRL, Potomac Inst., U.Maryland,
U.Michigan, QinetiQ, UT-Austin, UWF/IHMC
Support from AFRL, ARL, Boeing, DRDC, DSTL, ISX, MITRE,
MIT Sloan, NWDC, OBJ5, Schafer, Stanford, TTCP, USC/ISI, USPACOM

http://www.aiai.ed.ac.uk/project/coax/
CoAX Binni 2002 (Fall 2002) Demo

- Dynamic “come as you are” coalition formation
  - Dynamic creation of ‘virtual coalition organization’
  - Agents and domains added to coalition structure ‘on-the-fly’
  - Dynamic coalition tasks and processes
- Tailored visualizations / interface agents
- Tools to improve human / software agent interaction
- High-level tools usable without specialized training
- Packaged generic Grid services:
  - Domain management and DAML-based policy analysis
  - Task, process, and event management
- Involvement of more countries and organizations
  - USA – BBN – Mixed initiative agents & dynamic information flow
  - Australia – DSTO – Logistics planning and information analysis
  - Canada – DREV – Domain models
Course of Events

- **Part 1:** Agadez submarine attack - agents alert appropriate HQs.

- **Part 2:** Casualty data collected by agents and used to effect timely medevac.

- **Part 3:** A new country, Arabello, joins the Coalition 'on-the-fly' - integrated by agent technologies.

- **Part 4:** Arabello's ASW sensor grid data fused with Coalition - translator agents generated on-demand.

- **Part 5:** Agent-mediated tasking - countermeasures deployed based on predicted locations.
CoAX Technology Contributions

- AIIAl's I-X Task, Process and Event Panel Technology
- CMU's Retsina Grid Agent Communications Visualisation and DAML-S Matchmaker. See here for more details.
- DSTO's Future Operations Centre Analysis Laboratory (FOCAL) and Logistics Planning using the ATTITUDE multi-agent architecture.
- Dartmouth College's Field-observation System and Mobile Agents for Medical Monitoring
- GITI/ISX CoABS Program Grid Infrastructure
- Lockheed Martin ATL’s EMAA mobile agent technology, CAST information management agents, and I2AT agent development toolkit
- Michigan's Multilevel Coordination Agent
- MIT's Robustness Service
- NRL's Intelligent Agents for GCCS-M
- OBJS's eGents E-mail Agents and AgentGram
- QinetiQ's Decision Desktop and Master Battle Planner
- Stanford's Market Mechanisms Technology
- UMD's IMPACT agents for reasoning with probabilistic temporal information
- UTexas at Austin's Sensible Agent technology - Trust Evaluation and Organization Adaptation
- USC/ISI's Ariadne Project
- UWF/IHMC and Boeing's KAoS Technology
- UWF/IHMC NOMADS Technology
Coalition Search and Rescue - Task Support
Intelligent Task Achieving Agents on the Semantic Web

*Austin Tate & Jeff Dalton*
AIAI, Informatics, University of Edinburgh

*Jeff Bradshaw & Andrzej Uszok*
IHMC, Pensacola, FL

Artificial Intelligence Applications Institute, University of Edinburgh, UK
Institute for Human and Machine Cognition, Pensacola, Florida
Project Summery

- To provide capabilities linking:
  - models of organizational structures, policies, and doctrines
  - with intelligent task support software
- The project integrates:
  - AIAI’s I-X planning and collaboration technology
  - IHMC’s KAoS policy and domain services
  - Semantic Web Services of various kinds
- Search and rescue operations - rapid dynamic composition of available policy-constrained services - good use case for Semantic Web
- Other participants in the application include: BBN Technologies, SPAWAR, AFRL, and CMU
CoSAR-TS Scenario

- Based on the scenario from the CoAX (Coalition Agents eXperiment) project.
- Follows on from events of Binni 2002
- The story begins with an event that reports a downed airman in the Red Sea
- Rescue resources (transportation, medical, notification) represented as dynamic Semantic Web Services
  - Description based on ontology developed for the DARPA SONAT experiment
- The selection of a SAR resource is made using the CMU Semantic Matchmaker (Sycara) to find a suitable service
- Intelligent Notification done through CMU agents (Sadeh)
- These lookups comply with KAoS policies
KAoS Domain & Policy Management Tools

CoABS Grid Manager

KAoS Policy Admin. Tool (KPAT)
I-X Task Support Tools

Activity Editor

Process Panel

Domain Editor

Messenger

I-Space
I-Plan Tool

### Coalition Search and Rescue Coordinator

#### Issues

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<tr>
<th>Description</th>
<th>Annotations</th>
<th>Priority</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>are country and sar-resource</td>
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<td>Normal</td>
<td>No Action</td>
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#### Activities

<table>
<thead>
<tr>
<th>Description</th>
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<th>Action</th>
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</thead>
<tbody>
<tr>
<td>rescue F15-Pilot sea burns 10.0 40.0</td>
<td></td>
<td>High</td>
<td>No Action</td>
</tr>
<tr>
<td>select-hospital burns [1:?hospital] [2:?country]</td>
<td></td>
<td>High</td>
<td>No Action</td>
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<tr>
<td>lookup-hospitals</td>
<td></td>
<td>Done</td>
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<tr>
<td>load-plan &quot;domain-library/plan-after-full-hospital-loc...&quot;</td>
<td></td>
<td>High</td>
<td>No Action</td>
</tr>
<tr>
<td>select (hospital [1:?hospital]) [medical-capability [1:?h...</td>
<td></td>
<td>High</td>
<td>No Action</td>
</tr>
<tr>
<td>select-sar-resource sea [2:?country] [3:?sar-resource]</td>
<td></td>
<td>High</td>
<td>No Action</td>
</tr>
<tr>
<td>lookup-sar-resources sea [2:?country]</td>
<td></td>
<td>High</td>
<td>No Action</td>
</tr>
<tr>
<td>select (sar-resource [3:?sar-resource])</td>
<td></td>
<td>High</td>
<td>No Action</td>
</tr>
<tr>
<td>notify SAR-Mission-001 [3:?sar-resource] [3:?sar-resource]</td>
<td></td>
<td>High</td>
<td>No Action</td>
</tr>
<tr>
<td>notify SAR-Mission-001 [3:?sar-resource] [1:?hospital] F...</td>
<td></td>
<td>High</td>
<td>No Action</td>
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#### State

<table>
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<tbody>
<tr>
<td>institute USS_Michigan</td>
<td>18.9</td>
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<tr>
<td>longitude AAI</td>
<td>-3.188</td>
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#### Annotations

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>CoSAR</td>
<td>I-Plan Panels Based on I-K Technology</td>
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</tbody>
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---

Planning statistics:
- Steps taken = 5
- Alternatives posted = 0
- Alternatives picked = 0
- Alternatives remaining = 0
- Number of nodes = 10

Longest node-end path length = 17

Executing end_of_item(Activity)lookup-sar-resources sea [2:?country]...
Executing begin_of_item(Activity)select (sar-resource [3:?sar-resource]...
CoSAR-TS Results

- Initial Coalition SAR scenario defined
- SONAT ENP data base extended with Binni data
- Direct DAML file processing from I-X to SONAT via HP JENA Toolkit
- SOAP Access to SAR Resources from KAoS and I-X via Katia Sycara’s CMU MatchMaker and MM client code
- I-X linked to Norman Sadeh’s CMU context-aware Notification Agent for personalised notifications
- KAoS policy-governed access to SAR Resources
- Initial demonstration framework with CoSAR and US-SAR I-X Panels and 2 Information Access Agents
- Integration of BBN OpenMap with I-X Process Panels
The KSCO Community and its Coalition Experiments

http://www.aiai.ed.ac.uk/project/ksco/
KSCO Further Information and Involvement

- KSCO, Binni, CoAX materials and documentation:
  - http://binni.org
  - http://www.aiai.ed.ac.uk/project/ksco/
  - http://www.aiai.ed.ac.uk/project/coax/

- We encourage your participation…
  - In addressing key coalition and technical drivers
  - In seeking operational opportunities
  - In future demonstrations