COALITION AGENTS EXPERIMENT (COAX)
BINNI 2001 (18-MONTH) DEMONSTRATION DETAILS

**AFRL Rome, AIAI, BBN, Boeing, Dartmouth,
DSTL, GITI, LM-ATL, Michigan, OBJS,
QinetiQ, UMD, USC/ISI, UWF/IHMC**

**With support from: DARPA, ISX, Mitre, MIT Sloan, Schafer, Stanford, TTCP
See the CoAX web page at <http://www.aiai.ed.ac.uk/project/coax/>**

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COAX 18-MONTH DEMO - STORYBOARD STRAWMAN

1.　　Before developing the 18-month Storyboard it is worth reviewing several things as follows (**see the "General CoAX Implications" at the end of each section**):

- the Coalition Context and the CoAX military aims which fall from it – See also the CoAX Main Document for more details.
- the features of the military Execution environment - as compared to the planning environment,
- the type / notion of agency which we use in the CoAX, and
- the CoAX general Technical aims,

Then the paper covers the 18-month demo Strawman (with timescale / programme issues) and the StoryBoard itself and finally includes notes about the Partner's Technical Contribution.

COALITION CONTEXT AND COAX MILITARY AIMS

2.　　The nature of Coalition operations implies the need to rapidly configure incompatible or foreign systems into a cohesive whole this is especially difficult during the execution of operations (the focus of the 18-month demonstration. Several key principles apply, that:

- the issues relate to those involved in the creation and maintenance of a coherent Coalition organisation (with real and virtual parts) from the diverse and disparate 'come-as-you-are' elements provided by the Coalition Partners (people, processes and systems),
- all Coalitions are a dynamic (ever-changing) mix of heterogeneous and disparate elements and that maintaining the cohesiveness of the Coalition requires a continuous, pro-active readjustment process,
- multiple Coalitions may be active at any one time ('competing' for resources etc) and a decision in one may affect another concurrent operation,
- partners may be part of a Coalition - but their contributions may be anonymous (to protect sources etc),
- Coalition elements should be supported by appropriate IT in achieving 'unity of action',
- "interoperability of the mind" is as, if not more, important than interoperability of systems,
- the difficulties are compounded in the virtual organisation of the Coalition since there will be a mix of doctrines equipment, operational procedures, languages, etc,

- most Coalitions will have commercial / civilian elements - appropriate interoperability will have to be provided with their infrastructures,
- the Command Process is 'command led' and is characterised by a mix of deterministic and naturalistic decision-making styles,
- Coalitions consist of loosely connected elements working semi-autonomously, and within their delegated authority, towards a common goal (as defined in the Commander's Intent). Elements need to rendezvous (and synchronise) only occasionally and must be free to optimise locally / snatch fleeting opportunities etc,
- supporting the achievement of command agility (working in a flexible, unpredictable manner - where the decision-maker is the only thing on the critical path - leading to decision-dominance over the opponent) is vital,
- enabling commanders to access relevant Coalition-wide information *as and when they demand it* to support their decision-making is crucially important to a successful outcome. Information should not be pushed according to some rigid, pre-determined process.
- there is a pressing need to set up Coalition organisations / systems rapidly (in order to respond decisively to emerging crises),
- systems provided to support the humans must be robust, secure, dynamic and adaptable and must not constrain human actions,
- there must be no single point of failure in the Coalition and performance must 'degrade gracefully' and / or systems must self-heal.

DEDUCTION: Coalition operations are complex, heterogeneous and change dynamically and it is difficult to achieve and maintain coherent operations, with shared information and battlespace visualisations.

GENERAL COAX IMPLICATIONS: Our aim is to focus the TIE on these coalition-specific issues, particularly the fact that we are embracing heterogeneity, not excluding it. In doing this, we wish to use a Coalition scenario which will provide a suitable stimulating framework for the research into agent technology which would support an enhance operations in these complex real and virtual organisations.

THE EXECUTION ENVIRONMENT

3.   For the 18-month demo we said that:

"The 18-month Storyboard will feature the monitoring of the lead-up to **[and the activation of]** the execution of the Firestorm Mission with the change of information about the location of Agadez / Gao forces causing a short-notice replanning to take place. **[New / changed plan elements will have to be deconflicted, new orders will have to be disseminated, activated and executed and reported on - often in timescales down to minutes or even seconds]**."

I've added the emphasis in square brackets. What is involved in dealing with execution as opposed to planning? Firstly, of course, there is an opponent; then the fact that execution is event-driven and not process driven; also the process is much more iterative and uncertain and finally the tempo of execution is very fast at many different frequencies simultaneously. For more discussion of the issues see the CoAX Main Document.

DEDUCTION(S): This leads to the fundamental deduction about execution - that there are essentially two conditions: stability and change. During stability, monitoring the state of the 'systems in conflict' and identifying the underlying pressure for change / significant events towards an undesirable state is the task that the agent-enabled environment could assist significantly. During change, events have occurred which were not expected and now action has to be taken to mitigate their effects. So, once problems occur the activities become much more 'human-centred', short time-scale, uncertain and dynamic and the agents would need to take a more subordinate role.

4. GENERAL COAX IMPLICATIONS: The execution environment can be characterised as event-driven, high-tempo, short-timescale, high-bandwidth, uncertain, dynamically varying and very demanding. Software agent technology can assist with supporting the following generic sub-tasks which are likely to include:

- decision-makers demanding information to support brainstorming / re-assessment of options (agents assist with providing on-demand' information),
- 'ad-hoc' problem solving involving creative / novel use of existing tools in a way that was probably never intended (agents assist in the 'composition' of applications from software components),
- sudden increase in 'network traffic' as humans / machines struggle to understand what is going on, to issue modifications of orders / new ones etc (agents assist with monitoring patterns of activity) / resource control,
- reconfiguration of systems to support unexpected changes - eg: systems may be destroyed, forces may be withdrawn, new capabilities / policies may be activated / added (agents assist with activity monitoring, reconfiguration etc). This may involve mobile code (eg: move away from area of threat or bring new capabilities,
- activation of 'dynamic routing' as humans / organisations / functions move to new locations / swap command centres etc / change roles (someone may be killed etc) in response to the current imperatives (agents assist with network monitoring, management, reconfiguration etc) including cloning of agents,
- shortening of timescales for response from hours to minutes / seconds as the pressure to defend a beneficial 'state' mounts (agents adjust their processing demands as the resources in the environment become more scarce and as their constraints activate),
- activation of more secure / assured techniques for communication and the discarding of all non-essential messages as bandwidth availability is compromised - agents will now have to work with incomplete information (agents adjust their information demands / security strategies as the resources in the environment become more scarce. Malicious behaviour detection becomes more crucial),
- there will be increased demand for robustness and the maintenance of levels of service or, if degradation is to occur, that it should be 'graceful' not system-wide and catastrophic (agents have recovery / reconfiguration techniques at their disposal).

COAX GENERAL TECHNICAL AIMS FOR 18-MONTH AND 30-MONTH DEMOS

5.   In a Coalition, the partners will offer capabilities and bring individual goals and policies to the negotiating table. The Coalition will develop and maintain a Campaign Plan and will promulgate the Commander's Intent which will provide the overall context for all tasks. In meeting objectives, the Coalition Teams will negotiate and re-distribute sub-tasks among the partners to meet the Coalition's objectives while respecting individual Coalition partner aims. The partners will negotiate with the Commander and each other throughout the operation and the objectives will be continually reviewed as the progress of the execution is monitored. Changes will need to be made and plans adjusted in timescales from days to seconds. The Coalition will need to reorganise during the execution phase as partners come and go, as events unfold and as the opponent's actions take their toll.

DEDUCTION(S):   The exact same process is carried out by an agent-based software system: individual software agents come online, advertise capabilities and are assigned or select tasks. They may negotiate over which tasks are carried out and what resources will be provided to them in order to perform these tasks. During execution of the tasks, agents may perform badly or fail, so agents may need to reorganise and reassign tasks. There will be no single controller as this is a vulnerable point of failure which would generate a 'brittle' system, rather than the robust one required.

GENERAL COAX IMPLICATIONS: From the above it can be seen that the CoAX will need to address the following technical issues to support effective Coalition operations:

- **rapid creation of virtual organisation(s) with agents playing their part,**
- **enabling the unity of command / coherence of action through the creation of shared views / understanding (this involves the negotiation of information sharing between agents acting for Coalition partners),**
- **the need to organise the agents into separate technical domains which can share some common resources and act within policies appropriate to the domain. However, there has to be a mapping between these technical domains and domains with meaning in the 'real' world, which may be:**
- **national / country domains,**
- **organisational / functional domains,**
- **individual decision-maker's domains,**
- **virtual / 'overlapping' domains.**
  - **respecting the autonomy of partners and their agents and providing secure and assured environments supporting different levels of security classification / trust,**
  - **coping with changes of organisation and policies due to the current imperatives of the execution of plans,**
  - **provision of flexibility, adaptability, robustness and command agility using a dynamic reconfigurable dispersed component architecture(s),**
  - **enabling the aggregation and sharing of Coalition capabilities / applications systems / infrastructures,**
  - **providing means to translate information / enable interoperability between systems,**
  - **dealing with the integration of systems that were developed with particular nations' processes and doctrine in mind.**

18-MONTH DEMONSTRATION: STRAWMAN

6.   The 18-month demonstration will focus on the agent support that can be provided once conflict has started and plans are being executed, their outcomes are being monitored and changes being made in response to / to drive events. Time scales will be shorter, the tempo more demanding and there will be dynamic and unplanned changes in organisations, tasks and domains. This part of the Strawman paper explains:

- The 18-month demo technical Integrated structure,
- The agents and domains that will be active at 18-months,
- The StoryBoard for 18-months,
- How that translates into the 'Threads' of activity and agent tasks for each CoAX partner,

7.   The 18-month Storyboard starts by explaining that the UNWAFB forces have been deployed for some time and that the initial planning phase has been completed, information has been gathered and we are now focusing on part of one day of the conflict (29th September 2012) for which a Firestorm mission has been approved, the plans produced and the orders have been issued. We will feature the monitoring of the lead-up to, and the execution of, the Firestorm Mission and will see that new information about the location of wildlife in the Laki Safari Park and of Agadez / Gao forces will cause short-notice replanning to take place. New orders will have to be disseminated, plan elements deconflicted and events tracked and handled. Also, we will see the opponents, Agadez, fly hostile air-to-air missions against UNWAFB 'high-value assets' such as the AWACS.

8.   For the demonstration of execution to work we can only really deal with about 1 - 2 hours of near-real time. In this timescale, very little will happen at the JTFHQ, only a few things in the JFAC HQ Planning Cell, but a lot will happen in Combat Ops / Current Ops part of the organisation (see the diagram below) and out in the field where the Front-line troops and observers are (and the opponent - Agadez). Most activities are now 'event driven' (though within the framework of our overall Plan), hence the introduction of tools to support 'event handling' in the form of the "Event Panel" - based on the AIAI PP.

9.   'Stage Management'.   It was agreed that demonstration CD(s) would be produced as before which would have to include:

a.   Presentations and Screencams.   We would probably need two kinds of screencams: a shortish set (as per the 9-month demos) with associated overview presentations (scene-setting and technical) and longer ones with voice-overs. These longer screencams would focus in on a specific technical area and show it in more detail and would be accompanied by a presentation featuring that technical area.

b.   Technical Compatibility.   It was agreed that, because it might be necessary to run a 9-month demo followed by an 18-month demo, technical compatibility should be retained as far as possible so that an 'end-to-end' demonstration could be given.

c.   Demonstration Scripts and Software.   As well as the type of demonstration script we have now, we would also need:

(1)   Operator Notes.   The operator notes would detail what to click on and what to type in.

(2)   Technical Scripts.   The technical script would include ALL the steps required to run all the software involved in any one demo (so that anyone could run anything from the distribution CDs).

10.   Timescales.   It was noted that, technically, the 18-month demonstration has to be ready for 31 July 2001, but that (in practice) it probably won't be delivered until a suitable TTCP meeting after that date. Other dates to note were:

a.   PI Meeting 7th - 9th Mar 2001.   This would be in the UK (Malvern) and would drill down though the scenario in technical detail to generate the research aims and issues and 'script' Attendees probably AT, MK, JB, PB.

b.   Integration Meeting - 30th April - 4th May 2001.   Deleted.

c.   First Run Through - 25th - 29th Jun 2001   This would be in the UK (Malvern). Attendees TBN.

d.   First Demonstration - CoABS Workshop 23 - 25th July 2001.   Though the demonstration does not have to be formally ready till 31st July a demonstration will be given at this CoABS workshop.

e.   Second Demonstration - TTCP Meeting.   This would be at a suitable TTCP event - probably the TP9 / 10 event at the end of October (29 - 31) 2001.

f.   Millennium Challenge 2002 / JEFX Involvement (18 Jul - 9 Aug 2002).   A modified version supporting the MC2002 scenario will be given, if the submission is accepted.

11.   Other Presentation Opportunities.   JH had been keen for CoAX participants to seek opportunities to talk about CoAX at conferences / seminars - those currently underway include:

- The Knowledge Systems for Coalition Operations conference in Toulouse in April 2002 was one possibility (AT),
- April 12th 2001 TTCP (TP9) meeting (JB),
- A separate agents conference in 2001 may be a target too (who ???),
- The CCRTS conference in Annapolis (Jun 19 - 21, MK, PB).

12.   18-month Demonstration Aim Currently Stated in the CoAX Document.

After 18 months we will give a key TIE demonstration in which the framework is populated with agents / capabilities from each of the TIE partners. There will be a central Coalition domain, containing two subdomains representing Coalition functional units. Our aim is to show that agent technology can be used to provide robust interoperability between a small number of disparate / heterogeneous and legacy systems to form a cohesive whole within a complex and realistic command structure.

The suggested agent architecture for the 18-month demonstration contains elements from the 9-month demonstration plus some changes. Many agents are now governed by a domain,

though some agents work outside the agent domain framework[1] and can be linked in and represented / advertise their capabilities to the parts of the architecture controlled by a domain. This is how many agent-wrapped legacy systems could be included which is an important aspect of demonstrating come-as-you-are and "heterogeneity". There is a Coalition domain which governs most Coalition agents and functional units though there are separate domains for the Coalition sub-functional areas and for participating countries - this reflects the nature of a Coalition - that there is a *single* Coalition plan which is developed and maintained during execution in which all Coalition partners have a share, however, each organisational entity retains its own specialist view as well.

AGENTS AND DOMAINS AT 18 MONTHS

13.   The organisational, functional and national entities involved in the 18-month demonstration have changed because the plan is now being executed. New entities include the tactical-level entities which actually do the fighting. They are described in more detail in the 'Setting' paragraphs below. However, it should be noted that the military / organisational view of the 18-month Demo provided at Figure 1 in the StoryBoard differs from agent domain / technical architecture view which is provided here and the two views are complementary - but not identical.
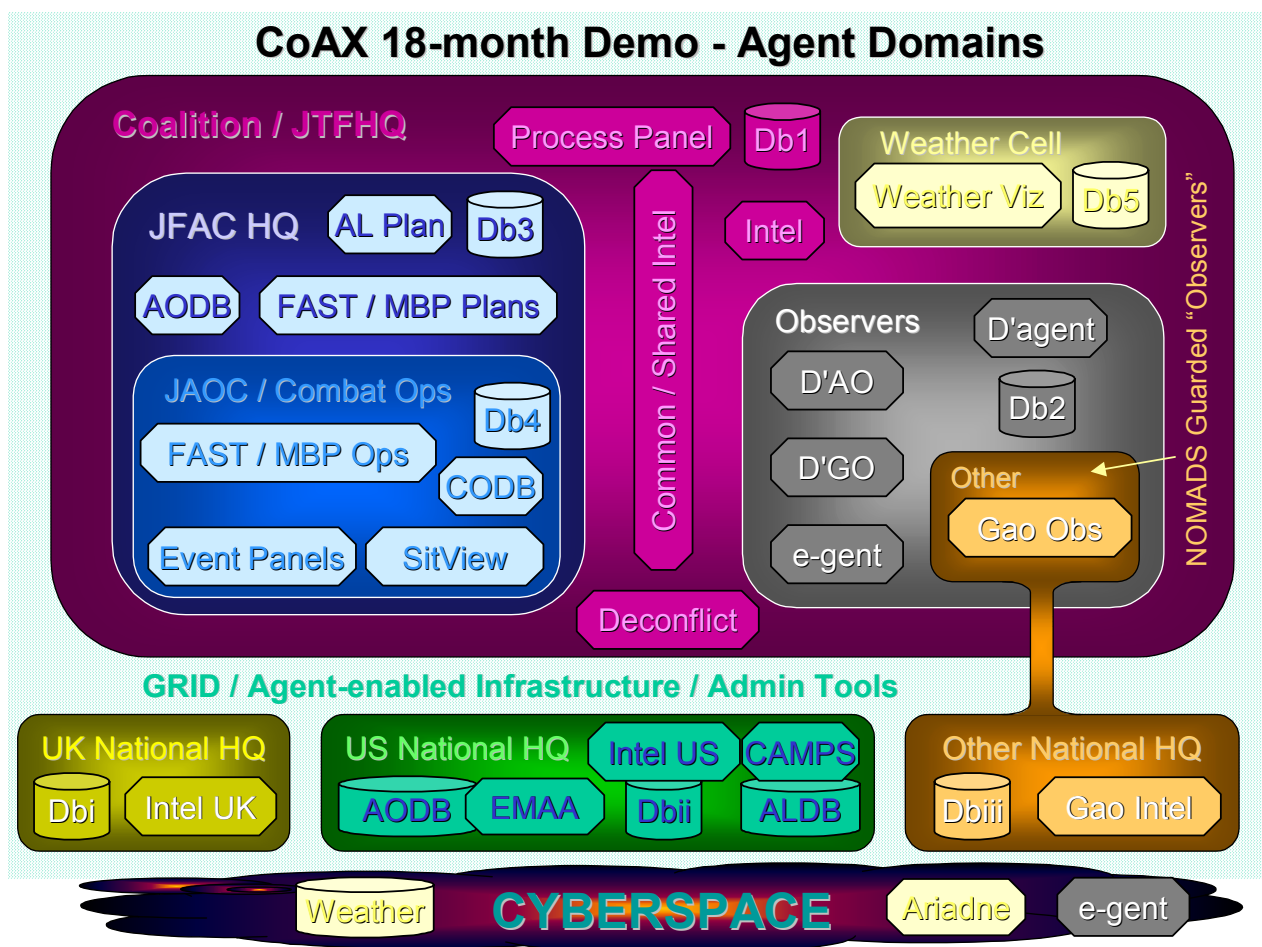

Figure 1 - CoAX Agents Domains / Technical Architecture for the 18-month Demo

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[1] The behaviour of systems outside a domain is controlled by limiting the behaviour of their proxies inside a domain. This approach, therefore, allows for the participation of agents which are outside domains but which can talk with each other, or with the domain, via a proxy. * CAMPS and EMAA are Grid agents (not in any domain).

14.   There are nine agent domains: the Coalition / JTFHQ domain itself containing the JFAC HQ the JAOC / Combat Ops domains, the Observers domain with a Gao / Observers sub-domain and a domain containing weather forecasting agents (Weather Cell). There are three further domains representing countries (US, UK and Gao).

15.   There are 37 agents:

- MBP Plans, MBP Ops and the Coalition Execution Visualiser (QinetiQ / DERA),
- the Process Panel (AIAI),
- the Event Panel (AIAI),
- LM-ATL EMAA/CAST AODB agent and proxy (Lockheed Martin ATL),
- four 'intelligence' agents (Intel UK, Intel US, 8) - otherwise known as 'infoagents',
- Ariadne agent and Weather proxy (USC/ISI),
- CAMPS agent and proxy (AFRL),
- two Dartmouth observer agents (Dartmouth Gao Observer - D'GO and Dartmouth Agadez Observer - D'AO),
- natural language interface agent wrapper (OBJS MBNLI)
- email-connected observer agents which feed into Ariadne and on to the Coalition Execution Visualiser (OBJS eGents),
- a Gao observer agent (GAO),
- a deconfliction agent (MCA),
- a Boeing KAoS Domain Manager (DM) and Match Maker (MM) for each of the nine domains.

16.   For the individual CoAX Partner contributions to the 18-month Demo see the Threads section below.

STORYBOARD AT 18 MONTHS

17.   In our 18-month scenario we are focussing on execution - so an opponent is now involved and things are going to change and we can expect the unexpected. Activities now focus on: execution; execution monitoring; dynamic plan review, maintenance and update (time-scale hours); combat assessment and battle damage assessment; 'information operations', media ops and support activities (logistics, medical personnel admin etc).

   a.   Our Storyboard will activate parts of the Military Stages relating to ongoing operations which are described in Annex B of the CoAX Document. The bottom line here is lots of complexity, intense dynamics etc and small tactical events can have strategic effects. In addition, by signing up to adding the execution element to the 18-month demo, we now add the dimension of TIME and the issues of differing TIME HORIZONS at different command HQ levels (this is described further in the Storyboard Setting below).

   b.   The 18-month Storyboard will feature the monitoring of the lead-up to, and the execution of, the Firestorm Mission with the change of information about the location of wildlife in the Laki Safari Park and of Agadez / Gao forces causing a short-notice replanning to take place. New orders will have to be disseminated, plan elements deconflicted, execution carried out and the resulting events tracked and handled. The opponents, Agadez, fly hostile air-to-air missions against UNWAFB 'high-value assets' such as the AWACS.

For the Military organisations which will be active in the 18-month Demo see Figure 1 above.

18.   <u>Setting</u>. It is 1500 on the 29th September 2012 and the Firestorm mission has been approved, the plans produced and the orders have been issued. All the tasked land, sea and air forces are activating the appropriate parts of their orders. The time-on-target (TOT) for the start of the Firestorm bombing is 1700 and aircrews are in their aircraft, loaded up and preparing to take off. Activity in the various HQs etc is as follows:

   a.   <u>JTFHQ</u>. The JTFC and his staff know that the Firestorm mission is being activated today and the JTFC has delegated the execution of the task to the 'subordinate commanders' (JFACC etc) and their staffs and assigned forces. So they have already considered options other than the Firestorm (such as the use of offensive ground forces or non-lethal weapons and had discounted them) but had chosen the Firestorm because it was the easiest, most effective and lowest risk way to cause a major effect on the Gao and Agadez forces. At present the JTFC and staffs are being briefed on the progress of Phase II of the Campaign Plan to date and its likely future shape (as loaded into the Process Panel). Their focus is on activities **which are 2 - 5 days ahead** of the present time. They will only become involved in the Firestorm mission if something unexpected happens.

   b.   <u>JFACHQ and Subordinates</u>. The JFACC has authorised the Firestorm mission to proceed and is being briefed on the preparations for it. The execution has been delegated to the Chief of Combat Operations (CCO). The JFACC is also working with the other Component Commanders on how their new plans (on MBP(Plans)) for the next two days will fit with the JTFC's requirements and so their focus is on activities **which are 24 - 48 hours ahead** of current time. The JFACC will only become involved in the execution if something unexpected happens.

      (1)   <u>Combat Operations</u>. CCO is receiving reports from the airunits / airbases on the progress of the Firestorm activation. Staffs are monitoring events in and around Binni looking for hostile activity. Their focus is on **the next few hours** and they are continually

monitoring the match between what is supposed to happen (according to the orders) with what is actually happening now / looks likely to happen and they will be looking for discrepancies. They will use MBP(Ops) for this (see Figure ??? below) and the Event Panel will be already loaded with the expected activity and ready to be loaded with new events as they occur / are decided upon.

(2)   Airborne Command Element (on AWACS). The AWACS took off an hour ago and it's staff are preparing to co-ordinate the formation of the 'packages' of offensive aircraft and their escorts, refuelling tankers etc. Their **focus is on now**. The [initial] force dispositions they know about are as shown in Figure 2 below.

(3)   Airunits at Airbases. The airunits at the airbases and the Station Commanders are involved in preparing the aircraft and ensuring that they take off at the correct times according to the orders. Their **focus is on now**.
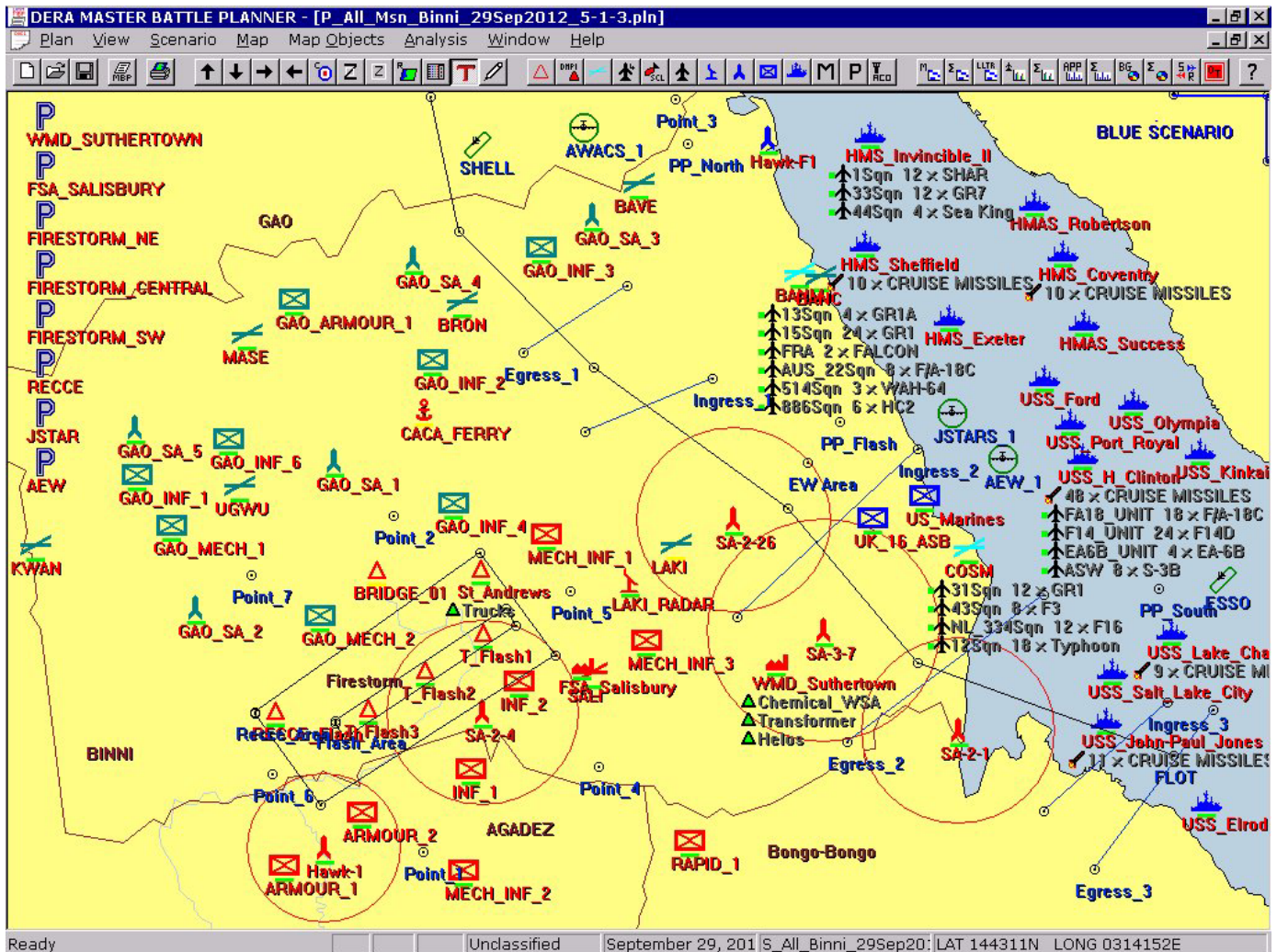

Figure 2 - Current Situation as seen in Combat Ops

c.   Land and Maritime HQs. Not formally part of the 18-month demonstration, but an essential part of the Binni scenario. The Land are active as ground forces supporting the Observers and providing Peace Enforcement patrols on the ground. The Maritime forces

provide an offshore base for UFWAFB commanders and air forces and an amphibious landing and re-supply capability.

d. <u>US Staffs / Liaison Officers</u>. They work on provided updated intelligence into the Theatre of Operations (ie Binni) and on co-ordinating and preparing information (from the field Observers) for Coalition consumption. They will be working behind the scenes to ensure that the personnel and equipment provided to the Coalition by the US are suitably provisioned and operational. Their **focus varies** depending on the task they are supporting.

e. <u>UK Staffs / Liaison Officers</u>. They work on provided updated intelligence into the Theatre of Operations (ie Binni) and on co-ordinating and preparing information for Coalition consumption. They will be working behind the scenes to ensure that the personnel and equipment provided to the Coalition by the UK are suitably provisioned and operational. Their **focus varies** depending on the task they are supporting.

f. <u>Gao HQ</u>. Since its denial of service attack was thwarted, there is very little information coming out of the Gao HQ and its staff are rarely to be seen in the Coalition HQs. Though their presence is still authorised for political reasons they are widely distrusted and relations are 'difficult'. Their **focus varies** depending on the task they are involved with. The activities of Gao ground and air forces is under surveillance and at present there seems little sign of any change from their normal routine.

g. <u>Agadez HQ</u>. The activities of the Agadez HQ (the opponent) are being monitored by the Coalition intelligence services. Essentially, their plans are hidden from the Coalition, though the implications of their decisions (in terms of military activity are not). Their command structure and patterns of activity and event horizons will depend on their doctrine / organisation and will be different from those in the Coalition. At present the Agadez ground and air forces are appear to be following normal routines but Agadez air-to-air fighters will try to attack the UNWAFB's AWACS.

19. <u>Storyboard Events</u>. The storyboard events are in eight parts as follows:

a. <u>Part 1 - 1505</u>. Information on the Firestorm missions has been leaked to the media and the story of the firestorm over the Laki Safari Park (NB this is a wildlife reserve some 60+ miles in length and breadth) is being run in the USA (7-hours behind Binni time) on Breakfast TV and in the UK (2-hours behind Binni time) on lunchtime news.

- The UN Special Representative to the Secretary General (UN SRSG) has contacted the JTFC directly to request confirmation that protected species in the Park will not be at risk from the Firestorm missions.
- The JTFC and his staff refer to the Process Panel to reconsider the other alternatives to the Firestorm:
    - such as employing offensive ground forces (discounted because inadequate forces are available),
    - using non-lethal disabling weapons (discounted as this could also affect the wildlife adversely) or
    - disabling the Gao and Agadez local command and control and communications systems (selected as a possible alternative - especially as it could be arranged to have a temporary effect over a timescale beneficial to the UNWAFB).

- The JTFC notifies the JFACC of the situation and requests all Coalition information sources to try to identify any means of tracking moving objects in the Firestorm area.

- In addition the JTFC wants the reports from Field Observer agents to be reviewed to try to establish if there have been new ground activity by either Gao or Agadez.

- The JFACC is also requested to identify how long the JTFC has before he has to give the 'cancel mission' order. These steps are entered into the PP and activated.

b.   <u>Part 2 - 1515</u>. The take-off preparations continue but the Firestorm missions are not yet committed to attack.

- JFACC staff enter the new event into the Event Panel and check the MBP Ops Mission analysis tool (see MSN000 window and the Mission route on the map in Figure 3 below) to find out how long they have (based on current agent-enabled reports from stations) before the mission HAS to be cancelled.
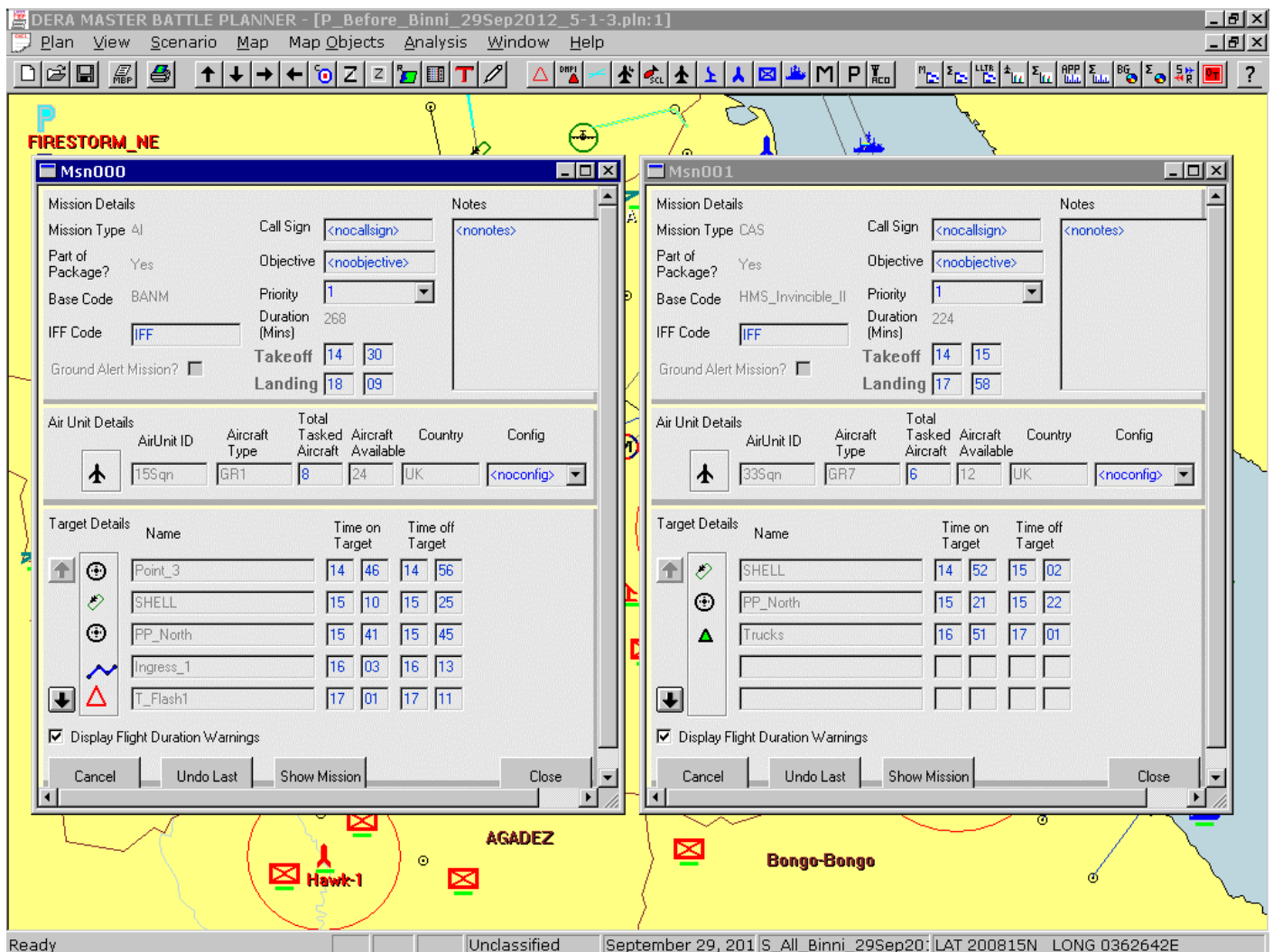

Figure 3 - MBP Planned Mission Timings

- The staff find out that it is only 2 minutes from now to take off of the first of the bombers but 48 minutes from now till the forces will commit to attack, though it is some 106 minutes to the intended 'time-on-target'.

- This and a number of other event management actions are entered into the Event Panel in Combat Ops and, as a result, appropriate information is notified by the Event Panel to the PP at the JTFHQ. [IHMC would like to show that reporting policies can be changed on the fly. In this case, event panel policies would be changed from "report to x when y is finished", to "report all changes" - this also relates to the CoAX 'shared activity representation ontology' required for several tasks.]

c.   Part 3 - 1520. A member of the JFACC Staff initiates a Request for Information (RFI) from the Intelligence Staff and then searches the Internet (using a standard search engine and finds reference to the Laki Safari Park on the WFPW website.

- A member of the JFACC Staff receives word from the Intelligence Staff that a webpage describing Safari Park (found by a standard search engine or perhaps in a later phase a DAML enhanced search engine) has been found and indicates there is a mammal monitoring program available over the web.

- The web page indicates animal data is available in a database and provides a menu-based natural language query capability provided by OBJS MBNLI. A query is made to find the elephant migration "Find herd and location and time for elephants". The data indicates the elephants may be in the north edge of the firestorm area but the database is only refreshed at the beginning of each month. Historical trend information is revealed which shows the cyclic nature of the migration.
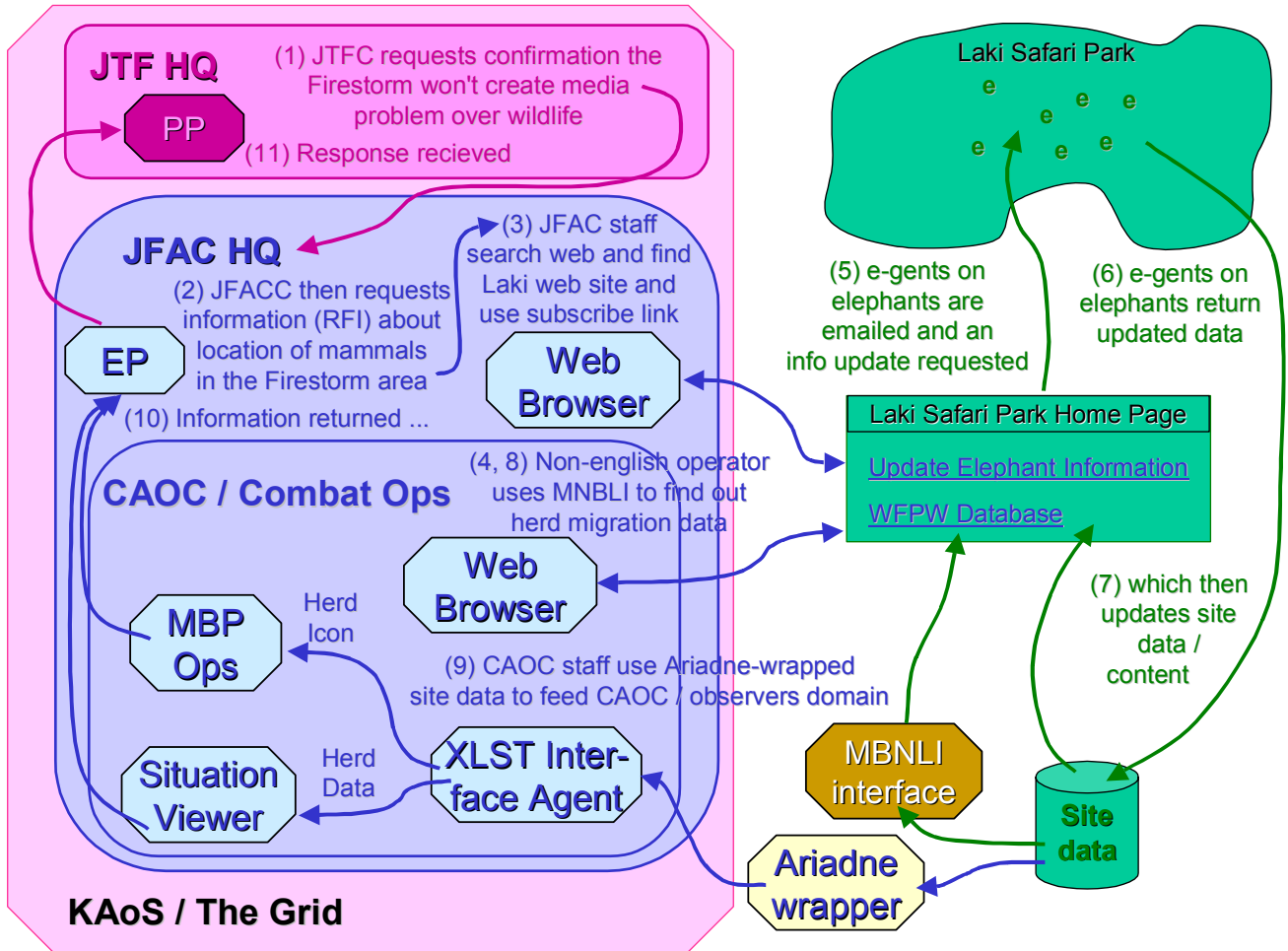
Figure 4 - Information flows to / from eGents

- Further digging indicates the web site supports continuous monitoring of the mammals using the OBJS eGents system (which uses wireless email store and forward technology). This permits staff to request information on the current position and status of individual animals. The staff subscribe to the service and the webpage is updated regularly with personalised information which now has to be wrapped and made available to the Coalition C4I systems.

d. Part 4 - 1525.   With this information a suitable mechanism has to be found to make the information available to warfighters on their C4I systems:

- The JFACC staffs decide they need a feed from the Laki site into the HQ / onto MBP Ops' screen and create an Ariadne wrapper (using a suitable translation tool) which uses the eXtensible Style-sheet Language Transformations (XSLT) to feed aggregated herd movement via the display agent / interface agent (which does the necessary conversion) into the Coalition information pool (from where it can be displayed in the Coalition SitViewer).

- An icon also needs to be displayed on MBP Ops, so the information is formatted to appear as a special icon [use MBP 'Freehand Drawing' to do this] with a migration trend arrow. This information is made available to all HQs.

- The overall flow is shown in Figure 4 above. The elephants are seen to be in the far north of the firezone area and moving North, so the JFACC knows that the Firestorm mission can proceed - as long as the NE area is the last to be targeted - rather than the first (as at present) - so part of the plan needs to be changed.

e.   Part 5 - 1526. The review of information from Dartmouth Field Observer agents is completed (re-query all sources) and the new positions of ground forces are shown. [IHMC want to show a Grid Helper (with a JVM command-line option) which would allow Dartmouth to join the Grid / KaoS domain without any modification]

- The ground-observer (wireless) agents recent updates are reviewed and ground force movement by both Gao and Agadez are perceived - this makes it even more imperative that the Firestorm mission proceeds.

- This new information is also made available to all HQs and as a result of comparing the information on the positions of ground forces and wildlife the JTFC confirms that most of the Firestorm can proceed.

- The missions which were to drop their bombs first at the NE end of the Firestorm area are diverted to their secondary target (the Weapons of Mass destruction (WMD) facility at Suthertown). The NE missions are deferred and this is noted in the Event Panel as a reminder of a task to be carried out later in the day.

f.   Part 6 - 1535. Because of the delay, the missions timings have to be adjusted in MBP Ops and any resulting plan conflicts evaluated and highlighted.

- The modified orders are transmitted and acknowledged, with the acknowledgements appearing in the Event Panel.

- Persistent queries are initiated on the AODB for change in status of missions so that Combat Ops is notified as missions take off.

- Because of the importance of this alert information getting through the policies are changed to give the US Country policy priority (in the use of resources) over the Coalition policy. [This was not actually shown at the Sep 2001 demonstration. The policy change alters a "timing constraint" on conversation policies (eg: timing constraint for all messages from Combat Ops is more exacting AND give more resources to those handling the messages) old conversations are discarded and task prioritisation changes that gives more CPU / comms resources to US agents. AIAI suggestion here that change the priority of a task in the PP and show it triggering some of these changes - this shows the policy flowing down to all agents]. PB to add sub-tasks to Ongoing Operation, Stages 3 - 8 in command model to give AIAI suitable verbs to use.

- Also, to protect the next crucial stage against subversion (by Gao or Agadez) Grid encryption is switched on [Also not actually shown at the Sep 2001 demonstration. GITI think this would be done via KPAT to Grid].

g.   Part 7 - 1601. First of the Firestorm missions begin to assemble over the Red Sea ready to commence their attack run through the 'push-point' at 1622. Agadez air-to-air fighter aircraft are detected and appear to be going to attack the UNWAFB's JSTARS / AWACS - a high-value asset attack (HVAA).

- This action is ticked off on the Event Panel and notified to the JFACC HQ and on to the JTFHQ. The Firestorm Mission is now GO!

- The Agadez air attack is seen in near-real time on the Coalition SitViewer as this information is fed-forward from the Coalition sensors into the agent environment.

- As the Agadez fighters attack the JSTARS / AWACS take the decision to 'regress' away from the threat and this reduces the radar warning cover provided to the Firestorm package.

- Mobile observer agents, which have been using the JSTARS as an airborne observation and 'relay' point, have their 'SCRAM' mechanisms activated which sends them to alternative (though less optimal) locations. [This relates to 'mobility policies' based on where they've been / want to go etc (Gao may have to go 'home'!).]

THREADS FOR THE EIGHTEEN-MONTH DEMONSTRATION

20.   The CoAX provides a very rich environment to research and assess agent technology. For the 18-month demo the CoAX partners are looking for specific vignettes that will allow them do develop and demonstrate their agent research issues / capabilities / features. The information flows for the 18-month demo is shown below in Figure 5.
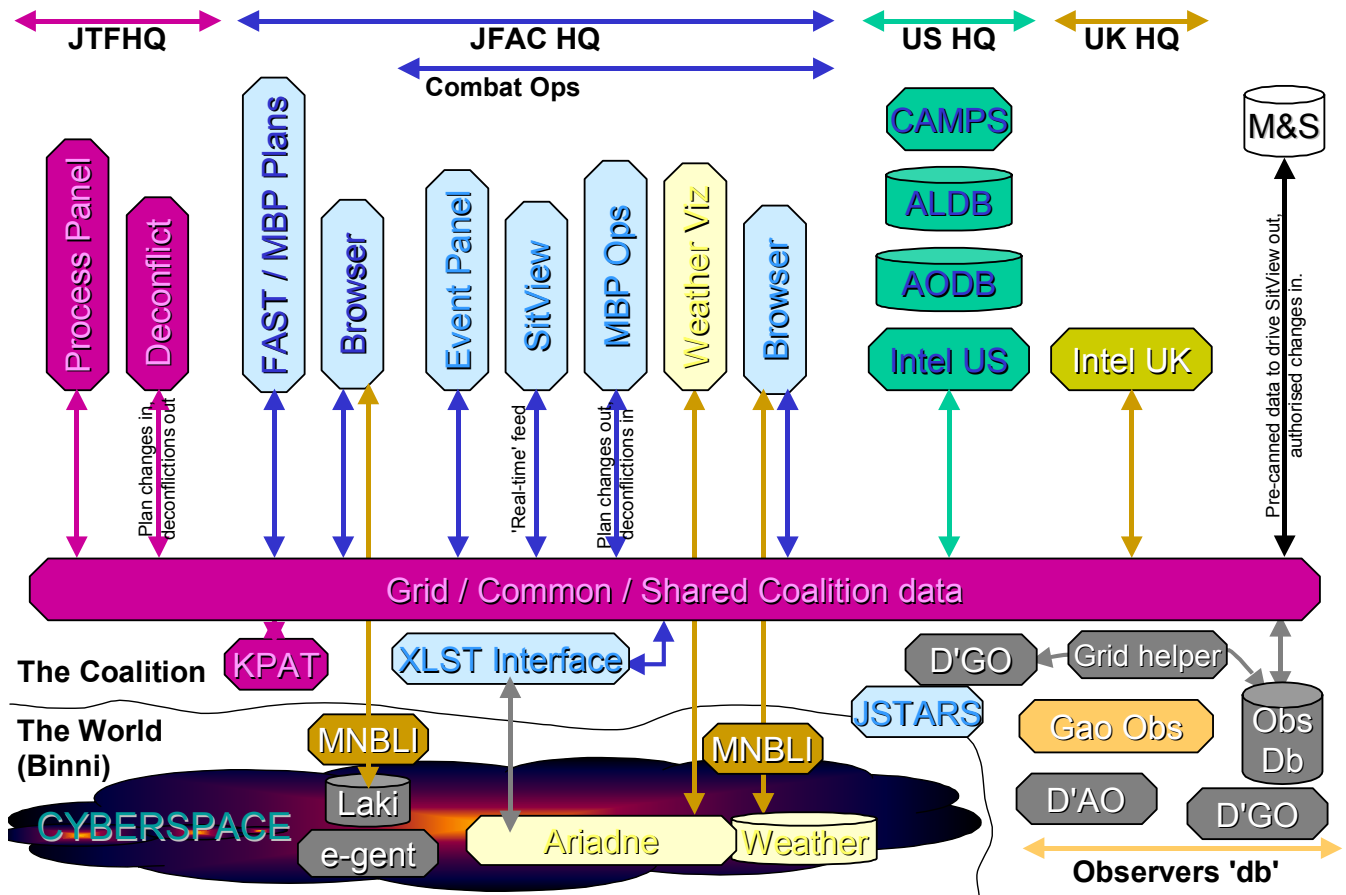

Figure 5 - Information Flows in the 18-month Demonstration

21.   The basic threads of activity in the 18-month demo are as follows:

a.   <u>Process and Task Management</u>.   AIAI.

b.   <u>Domain Management / Malicious Agents / Mobile Agents (KAoS / NOMADS / MAS)</u>. Boeing, UWF / IHMC.

c.   <u>Coalition Visualisation (SitViewer)</u>.   QinetiQ.

d.   <u>Information Feeds / Observer (MBNLI)</u>.   Dartmouth, OBJS.

e.   <u>Information Wrapping / Translation and Integration (XSLT etc)</u>.   QinetiQ.

f.   <u>Asynchronous / email agent communication (eGents)</u>.   OBJS.

g.　Execution Task Deconfliction Threads (MCA).　UMICH.

h.　Execution Event List Management (Event Panels).　AIAI, QinetiQ.

i.　Threads / Agents included in an unchanged way from the 9-month demos.

- DERA MBP Planning Agents - Air Battle Planning Thread.
- GITI / BBN / AFRL (CAMPS) - Airlift Thread.
- LM-ATL EMAA/CAST agents - US Air Intelligence Provision Thread.
- MIT Contingent Workflow Contracts Agents.
- USC / ISI Ariadne Agents - Public Domain Weather Provision Thread.

j.　Threads as yet to be finally defined:

- QinetiQ Interface Agent enhancements.

k.　Integration / Presentation Tasks:　These tasks are not part of any particular thread as such - but are here as a placeholder.

- Scenario / storyboard design,
- CoAX document maintenance,
- Integration tasks - ensuring interoperability between partners technical contributions,
- Configuration management / versioning,
- Stage management of machines, projectors and screens,
- Technical script (s) / technical operators,
- Narrator's script (s) / narrating,
- Screencams,
- Integrating partner's presentations,
- Scene-setting / overview presentation,
- Overview Handout(s),
- DVD / CD for distribution,
- Posters,
- Web-site maintenance.
- All are involved, but especially AIAI, QinetiQ / DERA, UWF / IHMC.

22.　**Detailed Partner Contributions by Thread Type**.　The CoAX Partner 'threads' for the eighteen-month demonstration will build on those from the 6 and 9-month demonstrations and will add the following (though this list is still open to review) which follow from the Storyboard above:

a.　Process and Task Management.

(1)　For AIAI Agents:

- AIAI will take primary responsibility for task and process management on the Grid. AIAI's technical contributions will include:
  - From CoAX Document scenario: See CoAX Main Document.
  - Use of shared models to facilitate coalition task driven co-operation.
  - Use of agent organisational structures with explicit tasking and authority management.
  - Development of techniques for multiple co-operative agent domains (jointly between Boeing's KAoS, Boeing's Policy Manager and AIAI's I-X).

b.   Domain Management / Malicious Agent Threads.

(1)   For Boeing KAoS agents:

- Boeing will take primary responsibility for **agent domain management services** on the grid. These services will evolve from and enhance existing services available within the Boeing KAoS agent framework. For the 18-month demo these will need to be able to deal with the dynamic formation and destruction of domains / their members. Also there may be a DAML-based policy language???
  - 'Packaging' of KAoS domain facilities as Grid services (so agents don't 'have' to be a KAoS agent).
  - Multiple domain membership.
  - From CoAX Document scenario: See CoAX Main Document.

(2)   For UWF / IHMC agents:

- UWF / IHMC: The Coalition TIE exploits the security and resource control aspects of NOMADS. In particular, the resource control mechanisms can protect hosts from denial-of-service attacks from malicious agents. In the 18-month demonstration:
  - Timescales of actions (eg of converting data - a response is needed back in 'x' timeframe - relates to e-gents).
  - Reporting structures - 'who' must you report to when you have an answer.
  - Now integrated with Grid security.
  - Have 'SCRAM' facility to trigger mobile agent movement, eg: away from a threat / a server going down.
  - Agents altering their resource usage according to their internal constraint rules as Grid services etc move from 'rich' to 'spartan'.
  - Have mobile agents which can take new code / capabilities to other agents / clone themselves.
  - From CoAX Document scenario: See CoAX Main Document.

c.   Information Feeds / Observer Threads. Observations and information from a number of sources (Dartmouth / OBJS, Ariadne / AODB etc) - provided via a number of mechanisms - are integrated in a single visualisation (the Coalition SitViewer) where the information can be queried (MBP → MBNLI interface??? / MBNLI pop-up from MBP button???).

(1)   For Dartmouth Agents:

- Dartmouth: In the context of the CoAX demonstrations, the Dartmouth system should be viewed as a *large "legacy" system* that needs to be made Grid-aware at its boundary so that the observations can be fed to other coalition agents. In other words, the Dartmouth system serves as an interesting and effective test of interoperability. For the 18-month demo this will deal with high-tempo / short notice exchanges of information.

- From CoAX Document scenario: See CoAX Main Document. This lists the Dartmouth task as "providing information updates from observers in the field".

- The best thing for my field observers to observe would be the WMD development area (e.g., observe vehicle and people traffic to determine which buildings are being used for the main development effort). However, the write-up suggests that we will be de-emphasising the WMD portion, and focusing on the firestorm portion. Given this, I think it makes sense to have my observers checking out the Agadez forces (as already suggested in a comment in the write-up). The most natural fit with my current software would be for the observers to report on all vehicle traffic in some particular region, so that analysts back at headquarters can draw some conclusions about actual Agadez troop/equipment movements (as opposed to Gao's reports). It would also make sense to observe air flights into and out of some particular air base. There are other possibilities too. It just has to be a situation where ground-based observers make sense.

- This would trigger issues on the process panel that reflected an observation from a Dartmouth observer agent. The Issue was meant to reflect something like

    - Note Observation <lat> <long> <date> <time> <observer> <observation string>

- The <Lat> and <long> of the North East side of the firestorm area is the place to use, the observations should of Gao truck movements say, they should be moving South, the date should be 29-Sep-2012, and add any string that makes sense in that context can be the entry for the observation.

- Dartmouth observer agent(s)

    - Issue: note <type> <position> <sighting line> <distance> <data>

- where type = observation

      position: latitude, longitude [of observer]

      sighting line: direction, inclination [to observed entity]

      distance: metres [to observed entity]

      data string of text.

- the observation data contains different fields depending on what is being observed. In the case of vehicle, it consists of vehicle type and subtype, affiliation (if observer can make a determination), vehicle heading and speed (as estimated by observer, possibly using range-finding or tools), and optional text for whatever description the soldier wants to add.

- Observers will observe the positions / movements of Gao and Agadez ground forces and the status / condition of critical infrastructure (bridges etc).

(2) For the OBJS MBNLI and eGents:

- OBJS: Will provide (a) natural language interface agent wrappers providing a way to wrap agents and other resources to make it easy for end-users to query and task them and (b) email agent communications of observations - which is an example of a de-coupled way to input and use information across secure systems.

- From CoAX Document scenario: See CoAX Main Document.

- The firestorm has been planned in part of Binni near the Laki Safari Park. The elephants in the Park were fitted with tags in 2009 as part of a WFPW programme to monitor the effect on the elephants of the climate / agricultural changes in the area. The tags report information on the elephants (position etc) using eGents (picking up on your " ...everything is alive" theme, part of pervasive computing / mesh-and-the-net stuff etc.).

- The media have heard about the firestorm mission and there has always been political disquiet about it - but they now get a 'leak' which tells them that the mission is near the Safari Park. The JTFC is ordered to monitor the Park and finds out about the WFPW tags and uses the information from them the to locate the elephants. MBP can show the position of the herd as a single icon which updates as eGents send in new position information.

- JTFC wants to find out more about the elephants and how far they roam. Uses MBNLI to access the WFPW's database of information collected by the tags over the last three years and finds that the elephants tend to move north-west in September but current information in the database is stale by a few weeks and we need to know now where the elephants are. So, we subscribe directly to the eGents monitoring the elephant herds - and information that the Egents are currently collecting shows that indeed that this is what is currently occurring.

- The firestorm is potentially compromised and a go / no-go decision has to made at the highest level as by now the aircraft will be about to take off and time on target is only about 48 minutes away ....

d.   Execution Task Deconfliction Threads. Detection of potential conflicts between new, short-notice task elements (added during execution monitoring) and existing Coalition Plans.

    (1)   For Michigan Plan Deconfliction / Exception Handling:

- UMICH: In a Coalition exercise, objectives and responsibilities will be distributed among numerous functional teams, such as warfighting, logistics, media relations, etc., with their own human and computational agents. Occasionally, operational choices made by one team have unintended consequences on what other teams should or can do (e.g., conflict over transportation resources, friendly fire). In the CoAX demonstrations, Michigan will provide one or more instances of a Multilevel Co-ordination Agent (MCA) that implements plan conflict detection, resolution, monitoring, and enforcement capabilities. In the 18-month demonstration this will consist of checking new / short-notice taskings or plan changes forced on the Coalition by circumstances.

- The Michigan plan deconfliction capability runs as a separate agent on the Grid. It accepts hierarchical plan descriptions from any agents that request it services, and can summarise the potential needs and effects of the plans, and can accept selected plans on the parts of several agents and can detect and recommend

resolutions for conflicts between plans. So there would be the addition of another agent: the Multilevel Co-ordination Agent in this 18-month point.

- From CoAX Document scenario: See CoAX Main Document.
- Sources of information will be in AODB / MBP Plan and Scenario files.
- Deconfliction will be of:
  - the changes in the Firestorm missions (new times and those diverted to the Secondary WMD Targets at Suthertown)
  - with the movements of Observers out of the Firestorm areas by helicopter (helo)
  - at same time as logistics supplies are being brought in to resupply one of the UNWAFB's forward bases which has been established at UGWULU
  - and with a Medevac helo which is moving injured UNWAFB soldiers out of the other forward base which was established (opposed) at Laki airfield.
- NB: these will all be options in the Event Panel

- The kind of messages we could potentially generate that would be of interest to the human operators would be of the type "Potential conflict found between plans of agents X and Y." And "Suggested resolution is to postpone Y's plan until completion of X's."
- Issue: resolve potential conflict between plans of agents <agents>
  - where <agents> is replaced by terms that identify all the agents involved.
- Resolution: postpone <agent 1>'s plan until completion of <agent 2>'s

- An example of a "plan hierarchy" for each of at least two functional teams (Firestorm and Logistics?). The hierarchy would give a task decomposition for a mission assigned to each team, such as:
  - Logistic's objective O is to deliver weapon W to location L To accomplish O, Logistics has a choice:
    - It can fly W to an airport near L, and then drive W from there to L
    - It can use a helicopter to drop W at L
  - (The first plan is preferred as having lower cost and risk.) Flying W to an airport near L can in turn be accomplished by any of a number of plans (such as different plans for different airports near L)...
- The hierarchy would be best if it were at several (3 or more) levels. Same for Firestorm. We'd make sure that we associate with the various plan steps the preconditions and effects they involve. Then our tools can analyse the hierarchies to, for example, determine that some airport choices for Logistics should not be considered due to Firestorm's plans, or that Firestorm should wait until Logistics has delivered the weapon, or that Logistics should use the helicopter...

e.   Execution Event List Management Threads. The provision of tools for assisting with the creation, tracking and manipulation of Dynamic Execution Event Lists (DEELs). Ideas include:

(1)   <u>For AIAI Combat Ops Event Panels</u>:   Basic events would be something like this (remember they are not followed like a cook-book, just examples of the kinds of events / responses / issues that decision-makers might deal with / create for themselves - though 'event list' templates could be prepared before a conflict based on previous experience and / or could be saved after an event and used as a template in future conflicts:

- User role specific task and process support panels with plug-in sub-panels appropriate to user, user role and application in use (Event Panel for Combat Operations).
- Ability to support process enactment in response to events.

- From CoAX Document scenario – See CoAX Main Document.

EXAMPLE 1 (They're all air-related, but similar things happen in land / maritime):

- A refuelling aircraft goes unserviceable and is not available to refuel a group of aircraft which will be flying together as part of the Firestorm 'package', so, likely actions would be:
    - Is another tanker available?
    - Does it have the correct type of fuel hose and connector?
    - Can it get to the RV point on time (triggers separate issue thread to answer this)?
    - Any other events the user wants to generate would be put in here.
    - Can we task it in time? If so:
        - Have we issued the tasking?
        - Have we told the package leader of the change?
        - Have we told the control elements?
        - Any other events the user wants to generate would be put in here.
    - If none of this is possible have we carried out recovery action:
        - Any other events the user wants to generate would be put in here.

EXAMPLE 2:

- A hostile aircraft approaches the UNWAFB Air Defence Exclusion zone - likely actions to check off would be:
    - Are there any existing Rules of Engagement (ROE) that apply?
    - Assign someone to monitor the aircraft's activity.
    - Inform higher JTFC and request guidance?
    - Has the guidance been received?
    - Any other events the user wants to generate would be put in here, eg:
        - What effect might this have on our actions?
        - Have we got aircraft available to deal with the intruder?

EXAMPLE 3:

- A new, short-notice tasking is received to attack a radar site which is being used to jam UNWAFB message traffic, likely actions to check off would be:
    - Has the guidance / tasking detail been received?
    - What's the planning window (ie how long have we got? - so, initiate an event countdown reminder.)
    - Is other information / resources needed? If so:
        - Any other task-specific events the user wants to generate would be put in here, eg:
            - Initiate request for information (FRI).
            - Chase up RFI,
            - Have we got aircraft available to deal with the task?
            - Other task-specific events the user wants to generate would be put in here....
    - Action tasking and implications:
        - Create and deconflict,
        - Disseminate and confirm receipt,
    - Are any post missions actions required? If so?
        - In-flight / other short-notice reports required? (Might need to 'hand-off' this issue to someone else's DEEL, introduces the idea of DEEL objects which agents can move around between the appropriate decision-makers).
            - Who needed the information? Has it been actioned etc etc

- Relates to Michigan Deconfliction Task – see CoAX Main Document:
    - the changes in the Firestorm missions (new times and those diverted to the Secondary WMD Targets at Suthertown)
    - with the movements of Observers out of the Firestorm areas by helicopter (helo)
    - at same time as logistics supplies are being brought in to resupply one of the UNWAFB's forward bases which has been established at UGWULU
    - and with a Medevac helo which is moving injured UNWAFB soldiers out of the other forward base which was established (opposed) at Laki airfield.

    NB: these will all therefore be options in the Event Panel

(2) <u>For QinetiQ's Execution Monitoring Agents</u>:

- QinetiQ's main contribution to the 18-month demo in the CoAX TIE will be to provide an agent-enabled version of the Master Battle Planner (MBP) to support Current / Combat Operations which will support near-real-time event monitoring and Battle Management of the events described above and in the storyboard.

f. <u>QinetiQ's Visualisation and Decision-Aid Agents</u>:

- In addition, QinetiQ will provide execution-monitoring and visualisation capabilities in the forma of a Coalition-wide situational awareness tool - the SitViewer.
- From CoAX Document scenario – see CoAX Main Document.

- This will be enhanced to support the research and prototyping of human / agent interactions through 'Interface Agents'.

g.   <u>USC / ISI Ariadne Agents - Public Domain Web-site Wrapping</u>:   Ariadne is a system for building agents for accessing data from web-based information sources. We have developed machine learning techniques for rapidly constructing wrappers that turn online sources into sources that can be queries as if they were databases. Under the CoABS program we are currently working on the ability to automatically verify that the wrappers are still functioning correctly and when problems are detected to automatically repair the wrapper as long as the required information is still available from the source.

- Ariadne wraps the Laki Safari Park web site which is then picked up by the XSLT Translator agent.

23. **Threads / Agents included in an unchanged way from the 9-month demos:**

a.   DERA MBP Planning Agents - Air Battle Planning Thread: Provision of an agent-enabled version of the Master Battle Planner (MBP) to provide Coalition-wide Air Operations planning.

- From CoAX Document scenario: See CoAX Main Document.

b.   GITI / BBN / AFRL (CAMPS) - Airlift Thread: Provision of Air Transport plans for incorporation / deconfliction with the Air Operations Plan via MBP.

- From CoAX Document scenario: See CoAX Main Document.

c.   LM-ATL EMAA/CAST agents - US Air Intelligence Provision Thread: These are present as "come-as-you-are" agent providing MBP with access to a mocked up United States Air Operations Database (AODB). During the 9-month demo, the requests for information from AODB will be controlled by a domain aware proxy created by DERA. The agents will allow other authorised coalition participants to use EMAA's IDDM capabilities to perform customised queries on US owned data sources. These agents will be full Grid agents in the COAX 18-month scenario.

- May employ their re-useable agent suite (which supports mobile communications (CCOM) in the CoAX environment.
- "Sentinels" which can watch for events.
- From CoAX Document scenario: See CoAX Main Document.

d.   MIT Exception Handling - CoAX Demonstration Exception Idea: "Agent Death": this exception occurs when agents that decompose and allocate subtasks amongst each other die.

e.   USC / ISI Ariadne Agents - Public Domain Weather Provision Thread: Ariadne is a system for building agents for accessing data from web-based information sources. We have developed machine learning techniques for rapidly constructing wrappers that turn online sources into sources that can be queries as if they were databases. Under the CoABS program we are currently working on the ability to automatically verify that the wrappers are still functioning correctly and when problems are detected to automatically repair the wrapper as long as the required information is still available from the source.

- From CoAX Document scenario: See CoAX Main Document.

24. **<u>Threads as yet to be finally defined</u>**:

    a.   <u>MIT Contingent Workflow Contracts Agents</u>:

- MIT: We wrapped up the agent death project and are now doing something new, concerning agents negotiating contingent workflow contracts (applied to the supply chain domain). See attached description if you are interested [???].I'd rather leave the Agent Death work standalone and demonstrate the contingent contract negotiation capability at the summer PI meeting.

    b.   <u>GITI - Grid Logging</u>.   This may be added as requested by JH.

    c.   GITI - Grid security / encryption

If browsing the document electronically, please use these links to aid rapid navigation:

Contents.

+++++ End of CoAX Binni 2001 Approach +++++