Achievement of Cognitive Interoperability is Key for Coalition Command and Control in the Networked Era

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Abstract

Achievement of Cognitive Interoperability, that is the understanding of an evolving situation and developing collaboratively an agreed upon course of action that is understood the same way by all participants, is vital to the successful execution of coalition force Command and Control (C2) in the network era. A key C2 tenant for future US, Network-centric, Brigade Combat Team (BCT) Forces is the ability to conduct real-time collaborative continuous mission planning and operations management activities during the execution of both joint and coalition force operations. However, to actually conduct such collaborative operations in a lower echelon coalition force operational environment presents many significant technical and multi-cultural problems and issues. Typically the military units comprising a coalition force often have significantly differing technical C2 and information distribution support capabilities i.e.- from highly automated to unsophisticated man intensive systems. Additionally, these multi-cultural units are also trained to fight differently, and at the lower echelon levels may have very limited multi-language communication skills. Even when coalition partners possess a rudimentary understanding of another nation's language, each recipient usually interprets C2 information exchanged between them is in terms of their national specific operational doctrine, tactics and procedures that are not necessarily common to the entire coalition force. Establishment of communication and data exchange capabilities to support joint and coalition force collaborative C2 coordination activities between all echelons are not sufficient to resolve the cognitive interoperability and information/situation understanding issues being addressed in this paper. In this paper we will discuss results of US-German experimentation activities directly focused on finding and demonstrating solutions to these issues.

Introduction

In this paper, we will present the experimental results achieved by the US and Germany in implementing and demonstrating improved cognitive interoperability and situation understanding capabilities required to support the conduct of joint R&D experimentation activities that directly focus on the conduct and execution of real-time collaborative mission planning and operations management activities between coalition forces operating at the Brigade and below levels. This paper will present the

basic concepts, paradigms and sample displays of the solutions implemented in sufficient detail to provide the reader with a good understanding of what was achieved and how it was done. Additional, more in-depth and detailed information on the implementation of discussed solutions and capabilities can be obtained by requesting the unclassified, all ready cleared for public information release documentation that will be referenced and identified in the text of this paper. We will also present and discuss the technical design of a Cognitive Interoperability Transition Product that is being implemented by the US for near-term field transitioning and use by a BCT unit stationed in Germany and operating as part of a joint US-German Division. The R&D experiments that have both produced the results presented in this paper and developed the design concepts for the transition product being developed have been conducted under the joint US-GE Simulation and C2 **In**formation Systems **C**onnectivity **E**xperimentation (SINCE) Project.

Overview

To support the conduct of these experiments in the context of real International Warfighter scenarios, SINCE has created an emulated network-centric simulation test bed that couples US-GE Command Control (C2) Information systems and Combat Simulation systems in a manner that enables real-time information exchange between all test bed systems and their military operators. Figure 1 provides a high level conceptual view of the SINCE experimentation environment setup at Ft. Leavenworth Kansas to support the conduct of SINCE Experiment 1b.

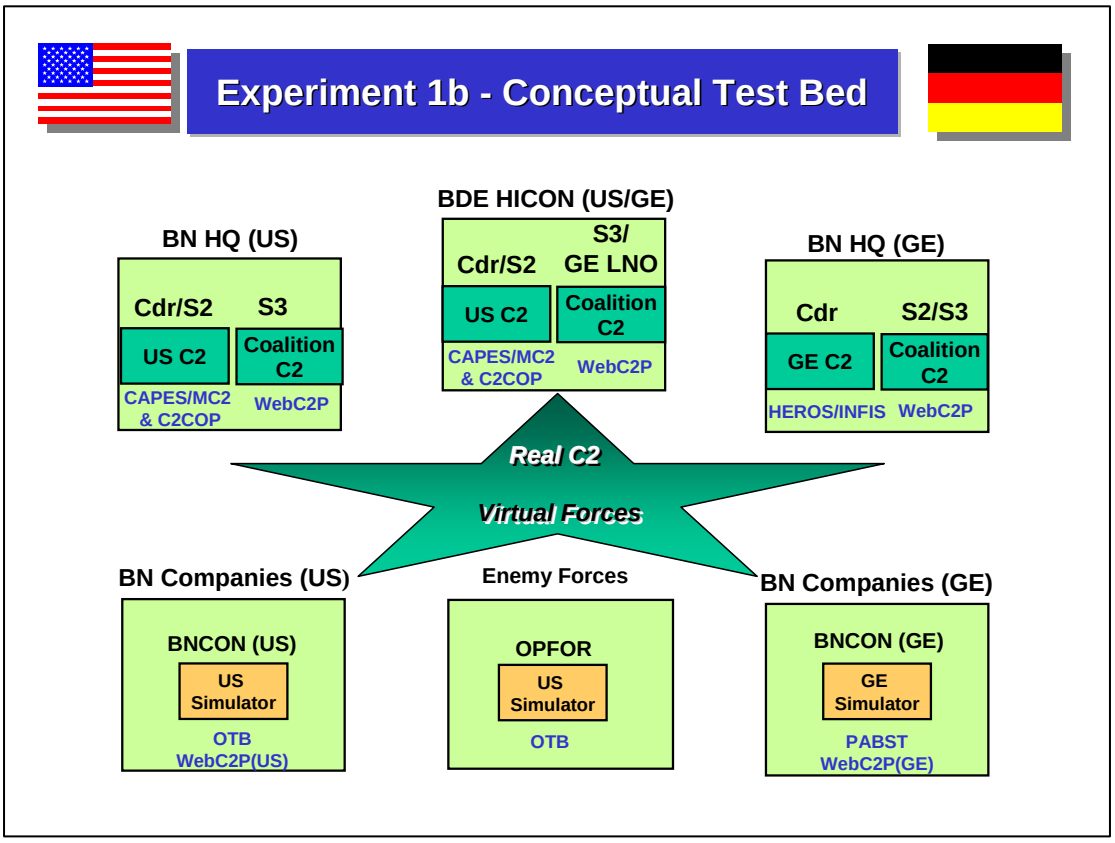


Figure 1: SINCE Experiment 1b (Operation) Experimentation Environment

As indicated in Figure 1 the live components of the experiment consist of three headquarters: HQ (BDE, MN), HQ (BN, US) and HQ (BN, GE). The BDE and Battalion Tactical Operation Centers (TOC) are manned by an appropriate military commander with S2 and S3 and LNO support staff. To support the conduct of the experiment, we adapted an existing scenario which provided a broad mission for a multinational brigade size force BDE (MN). The scenario represented a combined coalition US-GE Brigade consisting of a US battalion, BN (US) and a GE battalion, BN (GE). To support the experiment we connected real C2 systems into appropriate Brigade level HICON and Battalion level TOC configurations. All of these command cells were manned by real troops, on real C2 systems, conducting real planning tasks and coordination activities against a simulated coalition force operation. All of the lower echelon troop unit movements, unit actions, unit engagements and shooting, etc. occur in the simulation world. A network of constructive US and German Combat simulators were used to provide these emulated forces.

As shown in Figure 2, the SINCE experimentation environment is implemented around three evolving network-centric information exchange interfaces and mechanism. The primary technical interface for the exchange of Situation Awareness (SA) data between the coalition force C2 systems is the Multilateral Interoperability Program (MIP) C2 Information Exchange Data Model (C2IEDM) Data Exchange Mechanism (DEM). The primary mechanism for exchanging Combat Simulation systems state synchronization data is the High Level Architecture (HLA) Real Time Interface (RTI) based on a common Federated Object Model (FOM). For the exchange of real-time, collaborative digitized planning information, the focus of the SINCE effort, a hybrid XML and Battle Management Language (BML) based data representation was developed that could be easily exchanged and viewed using evolving web-based information exchange protocols and internet browsers. At the time the US and Germany started SINCE experimentation activities, the implementation of the MIP C2IEDM could only exchange planning information as non-digitized, text documents which were not suitable to support the kind of collaborative planning experimentation activities the SINCE program was addressing. Additionally, the current generation real-world C2 system that were available in both the US and Germany to support SINCE experiments also only used non-digitized , text based documents to support planning. Additionally these C2 systems often did not visually present and display the exchanged planning and SA information the same way. Modifications of these US and German C2 systems or even the evolving MIP C2IEDM implementations to support SINCE experimentation activities was considered beyond scope of SINCE and also too cost prohibitive. The US- GE SINCE Program is sharing the results of SINCE experimentation activities and demonstrated solutions to C2 system Program Managers of record and the MIP community for use in developing their products.

The key technology enablers developed to support SINCE experiments are the Web-based C2 Collaboration Portal (WCP) and the C2Sim Proxy Service/Server. The WCP, which has been developed by the US is jointly used and tested by both nations and supports the collaborative exchange of continuous planning information and also the display of the Coalition Common Operational Picture (CCOP). The WCP represents the primary tool and mechanism implemented to support SINCE Cognitive Interoperability and Decision Making experimentation activities. Technically, the WCP is implemented as an XML-based web service that any C2 Information system or computer could connect to via an appropriated Internet browser. In concept it acts a gateway between national and coalition C2 planning systems. However, taking this rather simple concept and implementing a transition product that can be integrated into and interoperate with the classified systems associated with a real operational BCT unit represents overcoming several major technical and operational security challenges. These issues will be discussed separately and later in the text of this paper.

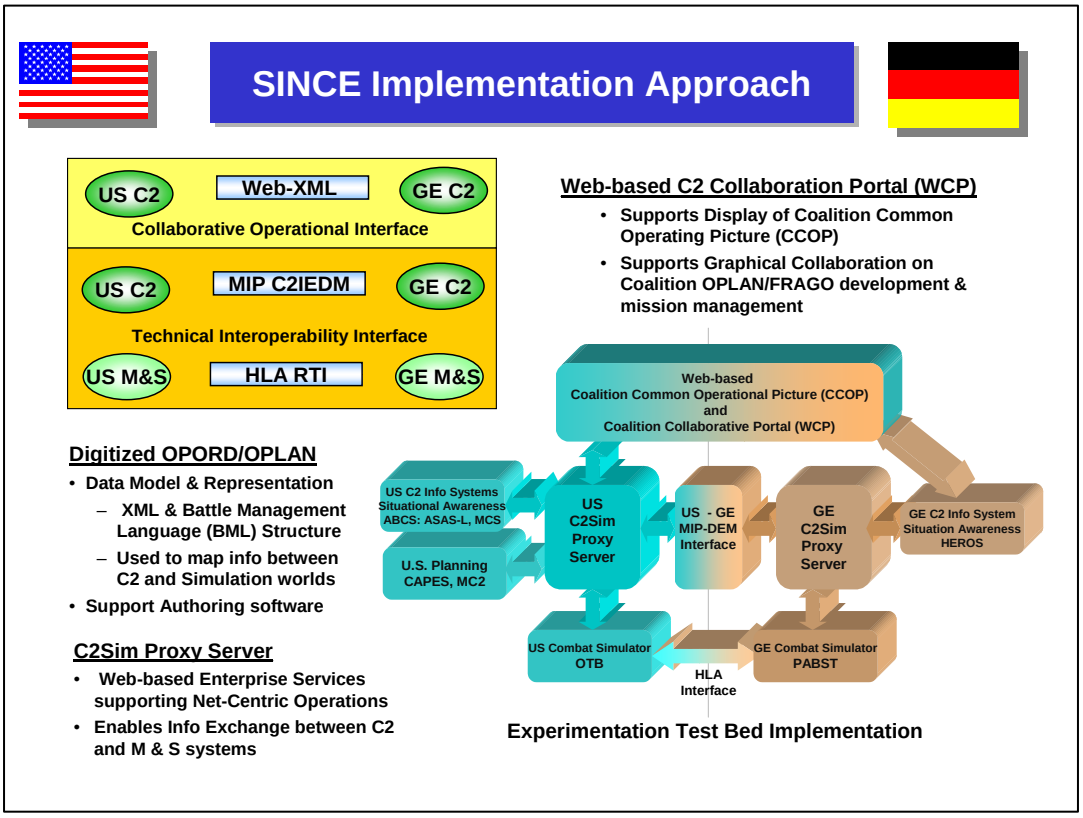


Figure 2: SINCE Test Bed Implementation Approach

Figure 3 depicts the concept architecture and data exchange interfaces of the US C2Sim Proxy Server. In order to emulate the network-centric environment that future forces, US & GE coalition will operate in, the US C2Sim Proxy Server is internally implemented as a loose federation of external enterprise system interfaces and data adaptor/translation services. These system/data adaptor services are Web-based service request oriented agents/clients. Each of these data adaptor services automatically maps information received from an external system's unique format & data representation into a common digitized OPORD/OPLAN XML-based representation and vice versa. Information exchanged between two external systems consists of mapping into and out of a common XML representation, and the connection of new system/software interfaces to the US C2Sim proxy sever reduces to a "1" to "n" solution, rather than the usual "n" to "n" situation. Control and flow of information exchange between external system interfaces is internally implemented in the US C2Sim Proxy Server via a rule-based Publish and Subscribe data exchange mechanism. Each system and its information exchange interface attached to the C2Sim Proxy Server federation is registered with the proxy server's Information Manager/Discovery Service which is responsible for managing and controlling the flow of information between ports/ users in accordance with a prescribed set of information exchange rights and distribution rules. Additionally the proxy server also implements a select set of information aggregation & filtering services, which are used to smooth and reduce the information exchange flow rate between simulation and C2 systems. The US C2Sim Proxy Server has two persistent data repositories to support the functionality of the proxy server and maintain a history of the transactions processed during the conduct of an experiment. All experiment state change information is stored in a MIP C2IEDM database/server. All XML OPORD/OPLAN/FRAGO information exchanges are stored on a Web-Portal server/repository.

The C2Sim Web-Portal and MIP C2IEDM servers are linked together and automatically push and pull information as needed. Table 1 at the end of this paper provides a glossary of abbreviations used in this paper and figures.

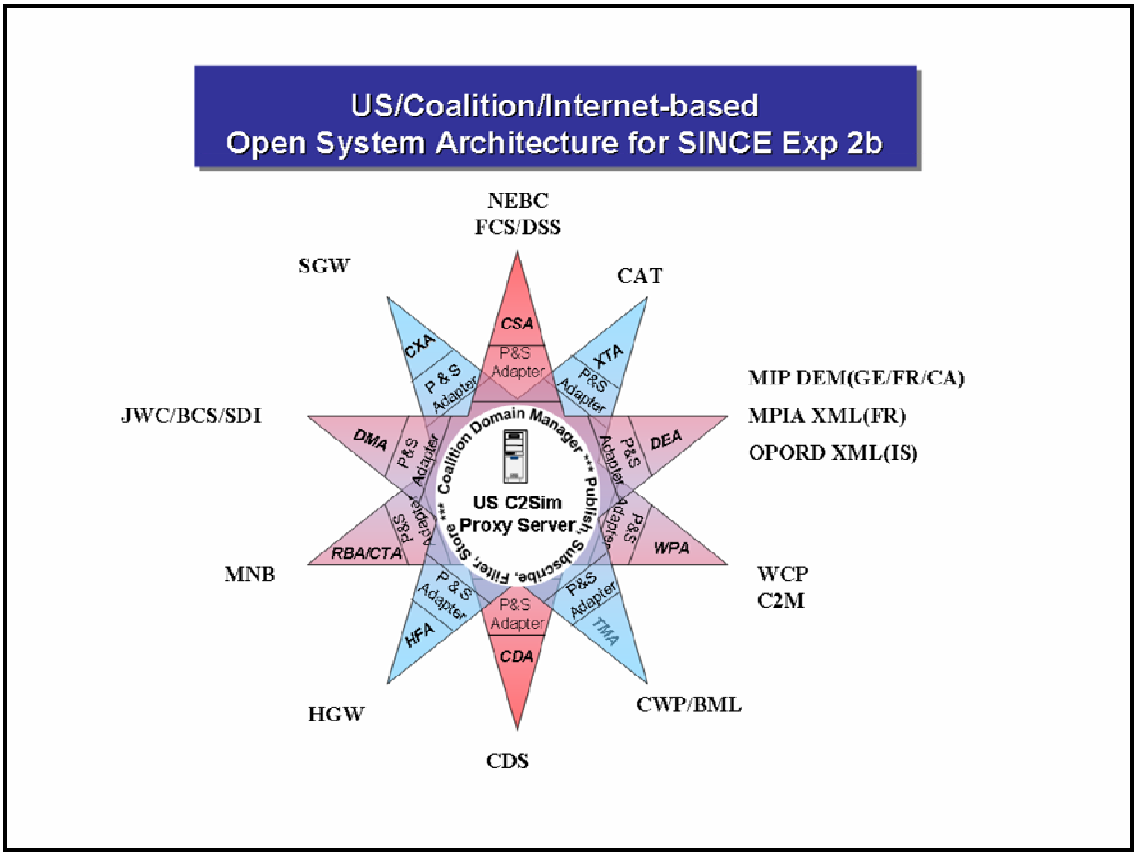


Figure 3: US C2Sim Proxy Server

The Web-based C2 Collaboration Portal

The above described C2IEDM DEM, C2Sim Proxy Server and HLA information exchange interfaces implemented under SINCE basically just facilitate technical interoperability between the connected systems. That is, they enable the routing of the right information to the right C2 system at the right time. The WCP and associated web server are focused on "Operational and Cognitive Interoperability Issues", - that is how the military user visualizes and understands an evolving operational situation and how he can effectively collaborate with his coalition partner in developing plans and concepts of operation during the conduct of a coalition operation. As depicted in Figure 4, the WCP allows the user to see the evolving Coalition Common Operating Picture (COP) and also view from different perspectives of digitized of OPORD, OPLAN and FRAGOs.

WCP cognitive interoperability information exchanges are based on the use of standardized, digitized, XML-based Operational Order (OPORD), Operation PLAN (OPLAN) and Fragmentary Order (FRAGO) document paradigms. Fundamental to these OPORD, OPLAN and FRAGO XML representations is the incorporation and use of standard Battle Management Language (BML) constructs

as depicted in Figure 4 and NATO Planning Graphics depicted later in Figure 8. These information representation constructs are used by the WCP to support the real-time development and collaboration of OPLANS between military users using commonly understood terms and concepts. These constructs enable the representation and exchange of decision making information between operational users in easily understood "Who, What, Why, Where, When, Which, How (W6H)" paradigm and associated graphical planning symbols that effectively supports rapid, real-time collaboration.

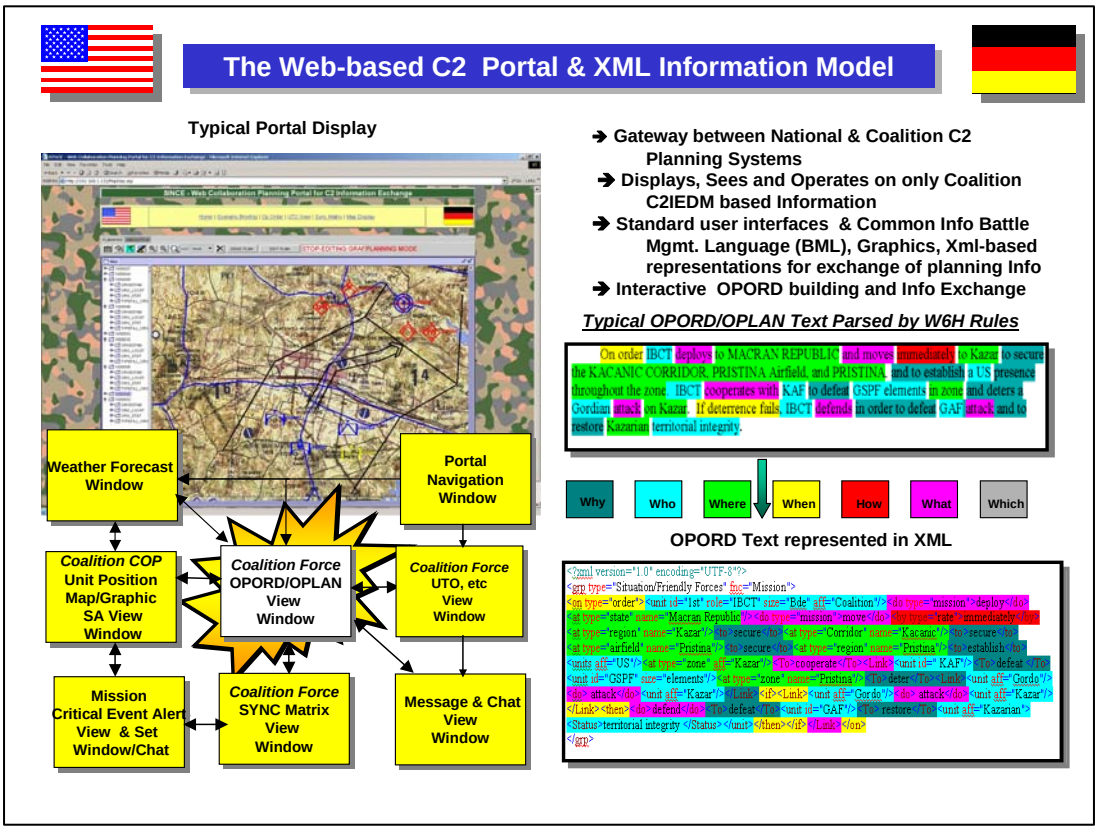


Figure 4: Web C2 Collaboration Portal (WCP)

The Operations Order (OPORD) is the single most overarching, most comprehensive and therefore most important C2 Product Type for Battle Command. It is well documented to provide clear unambiguous context. The OPORD is also highly formalized in Field Manuals and supported by many historical, training or R&D scenarios From a presentation point of view it is also is multimedia presenting graphical realizations of information from strategic to the lowest tactical echelons. Most of all, military users are trained to prepare and use an OPORD. The OPORD provides the context and referential integrity to all related messaging, storage and presentation of information and associated processing applications. Effectively is it spans and relates to all Commander's and Staff information needs, thereby motivating all Information Exchange Requirements (IERs) for all Battlefield Functional Areas (BFAs). Figure 5 provides a high level overview of the information that is contained in a typical OPORD.

C2 Product Example: Operations Order (OPORD)

- **Header** (POC, Time, Location Distribution, References…)
- **Situation**
  - -The Enemy Forces (Where are they? How strong are they?)
  - -The Friendly Forces (Who are they? What kind of unit is it?)
- **Mission**
  - - A clear concise, statement of what the unit should achieve.
- **Execution**
  - - What is the Concept of Operation?
    - What tasks to perform with what priority, rules and constraints?
- **Service Support**
  - - Where and when are logistics available? Logistics support priorities?
  - - How?
- **Command and Signal**
  - - How communications and C2 will be maintained?

Annexes

Figure 5: Typical OPORD Categories of Information

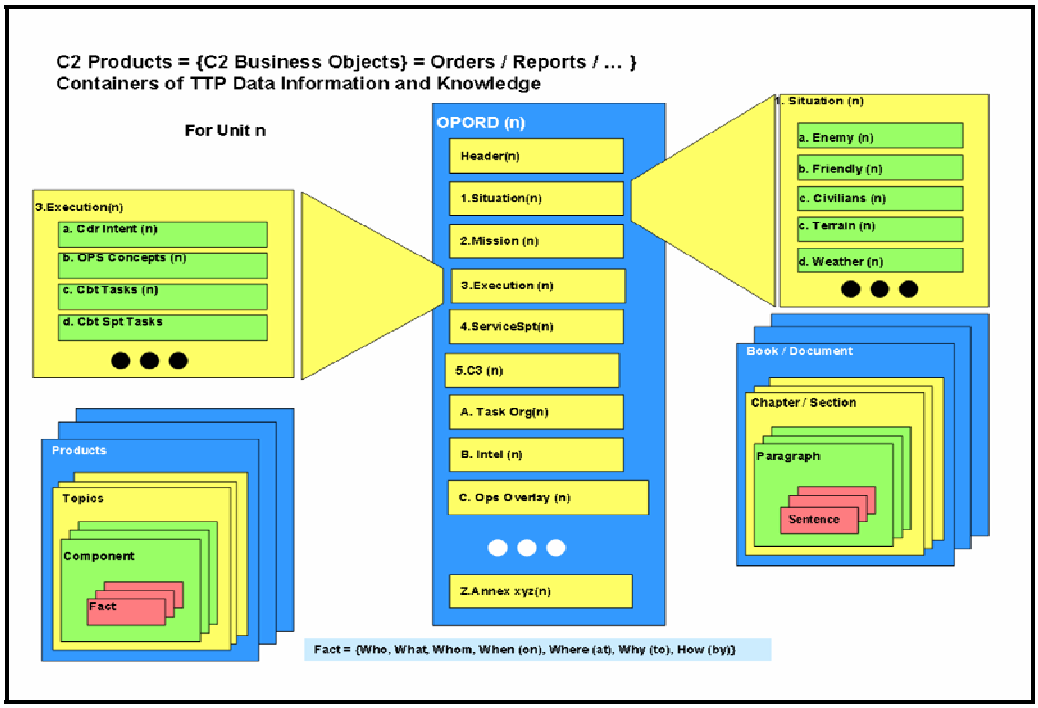


Figure 6: OPORD/OPLAN Business Object Container View

To develop a digitized representation of the information contained in an OPORD, we decided to view the OPORD as a major C2 Business object which is composed of containers representing smaller business objects of information pertinent to different aspects of an operations plan. Figure 6 represents a conceptual view of such a decomposition of an OPORD or OPLAN in terms of containers of business objects.

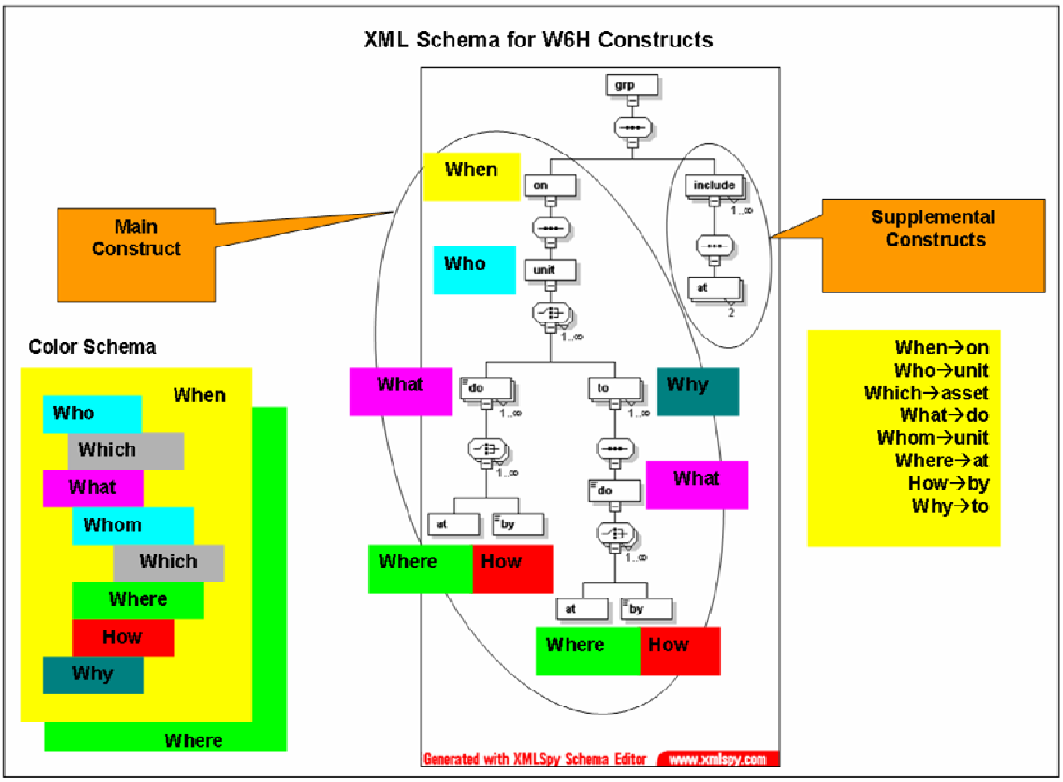


Figure 7: Digitized OPORD/OPLAN XML Schemas

Figure 7 depicts the XML Schema used to digitized the ORORD/OPLAN that is used to drive the SINCE experiments. This schema categorized all OPORD/OPLAN unit task assignments, actions, etc. in terms of the Who, Which, What, Whom, Where, How and Why (W6H) Battle Management Language Metadata indicated previously in Figure 4 and used by the WCP to support exchange of continuous update information. Additionally as illustrated in Figure 8, a coalition user can via a graphical point and click, drag and drop, user planning interface, develop OPORD, OPLAN or FRAGO unit task assignments that are easily understood by all. They can also be view the results of their graphical drag and drop plan building activities in an appropriate man-machine readable "Who, What, Where, When, Why, Which and How" unit task breakdown that can subsequently tweaked and annotated to assure successful execution.

SINCE Experiments are usually played out as a series of operational vignettes which require the military users supporting the conduct of the vignette to have to dynamically change their initially coordinated plans as a result of changing, unforeseen events. These vignettes emulate coalition force "On-the-Move" operations, and the collaborating operational users must rapidly agree on how to redirect their coordinated and supporting actions relative to these changing events as the simulated scenario continues to play.

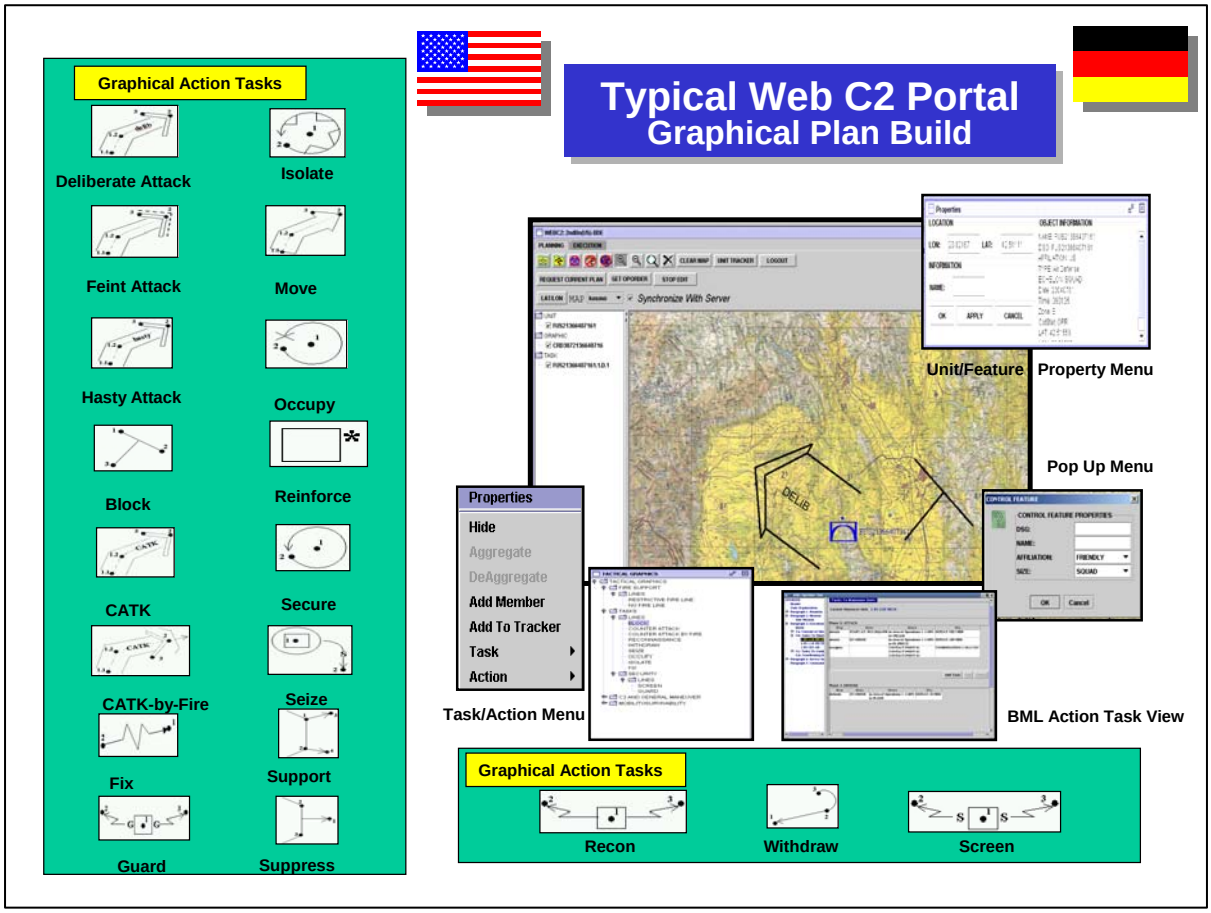


Figure 8: WCP Collaboration Drag and Drop Planning Interface

To illustrate how the WCP is used to support the conduct of a SINCE experiment operational vignette, assume that HQ (BDE, MN) was given the mission to secure an objective area to its north while blocking the enemy from threatening to cut off its logistics by attacking its flank from the east as shown in Figure 9. The BDE Commander had the choice of using any number or combinations of up to 24 "Action Tasks" to generate his concept of operation, course of action and tasking to his subordinate Battalions. For example, the BDE could task HQ (BN, US) to secure the objective area in the north and task HQ (BN, GE) to block the enemy threatening to infiltrate from the east or reverse their tasks. All these tasks can be assigned using the Web C2 Portal graphically displays these tasks using standard military task symbols as described in MIL-STD 22525b [1], FM 101-5-1 [2], NATO AP-6A [3] and the MIP C2IEDM [4]. For more detail on the underlying WCP specifics and XML see reference [8]

Figure 10 shows an expanded view of a subset of these actions tasks symbols. Once the BN orders were coordinated and issued to the constructively simulated subordinate companies, they were recast into the types commands understood by their respective M&S systems. For US companies, tasks are automatically mapped into OTB commands using a Battle Management Language (BML) interpreter. Occasionally some of these interpreted simulator operations need to be readjusted manually by the OTB operators correct for terrain representation discrepancies between C2 systems and simulators.

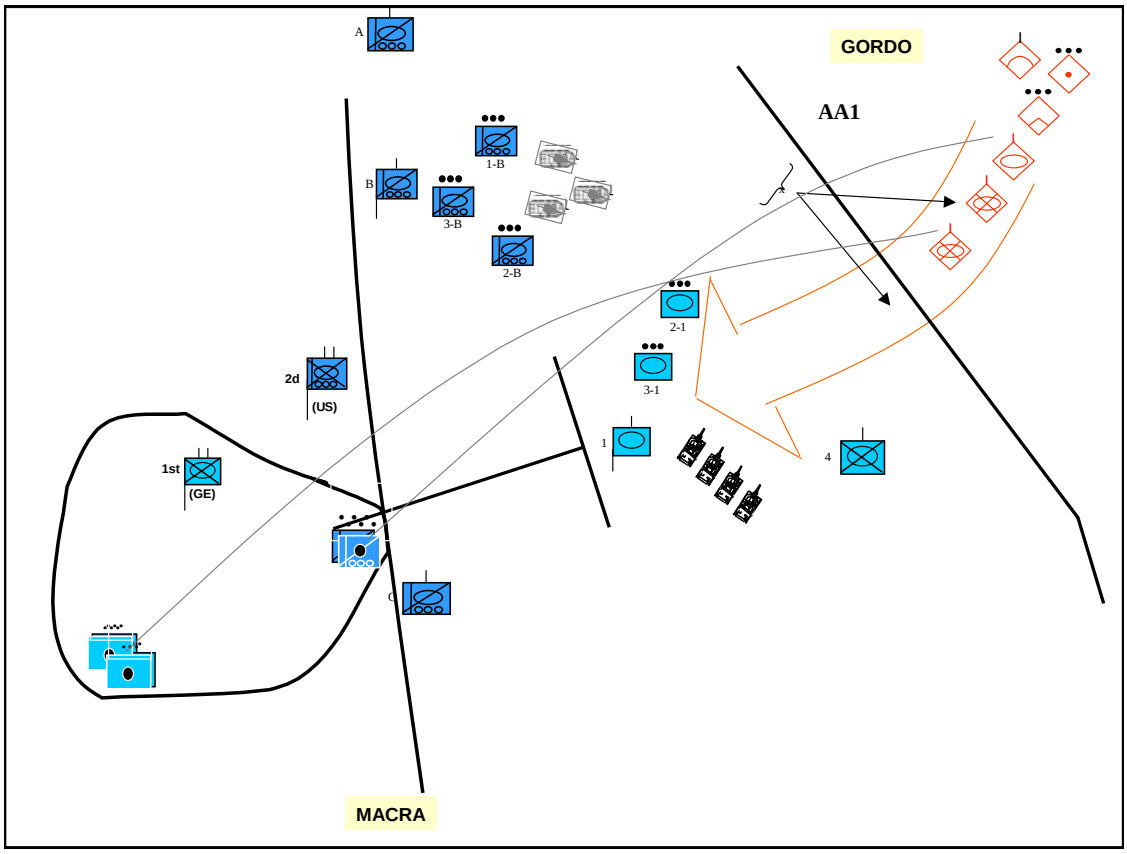


Figure 9: Sample OPORD (BN) Overlay

For GE companies, tasks were manually entered into German PABST simulator. A future implementation of the German's version of the C2Sim Proxy server will use an extended FOM to command HLA entities in PABST

Web C2 Portal Basics

The following conventions have been adopted for the WCP: Units, control features, and tasks in the application are all represented as objects, so they are referred as objects through out this document. The WCP application, as shown in figure 11, consists mainly of three areas:

(1) Map Area: Objects are displayed graphically.
(2) Object Tree: Object tree structure display.
(3) Toolbar: Tools and application options.

The Portal operates in two different modes:

(1) Planning Mode: Users can create and edit the objects and tasks of the Operational Plan.
(2) Execution Mode: Users can monitor the unit activities during the execution.

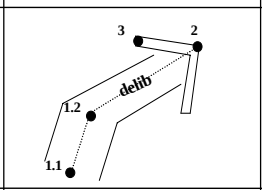
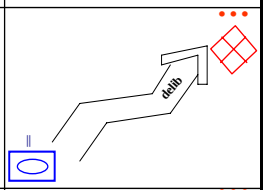
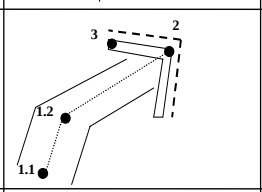
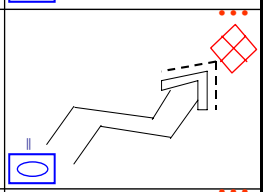
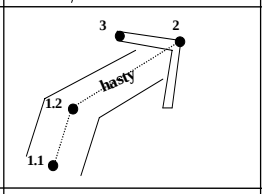
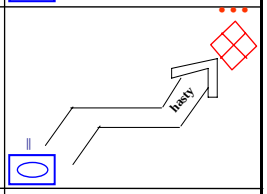
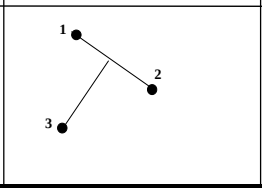
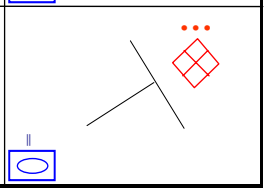
Action: Comments	Graphical Representation	Example
Attack, deliberate: Use Axis of Advance (Main Attack) to represent the path for the unit to attack. The word 'delib' is added to denote such action.		
Attack, feint: Use Axis of Advance for feint to represent the path for the unit to attack.		
Attack, hasty: Use Axis of Advance (Main Attack) to represent the path for the unit to attack. The word 'hasty' is added to denote such action.		
Block: Defined in MIL-2525B.		

Figure 10: WCP Action Tasks for Creating OPORD Overlay

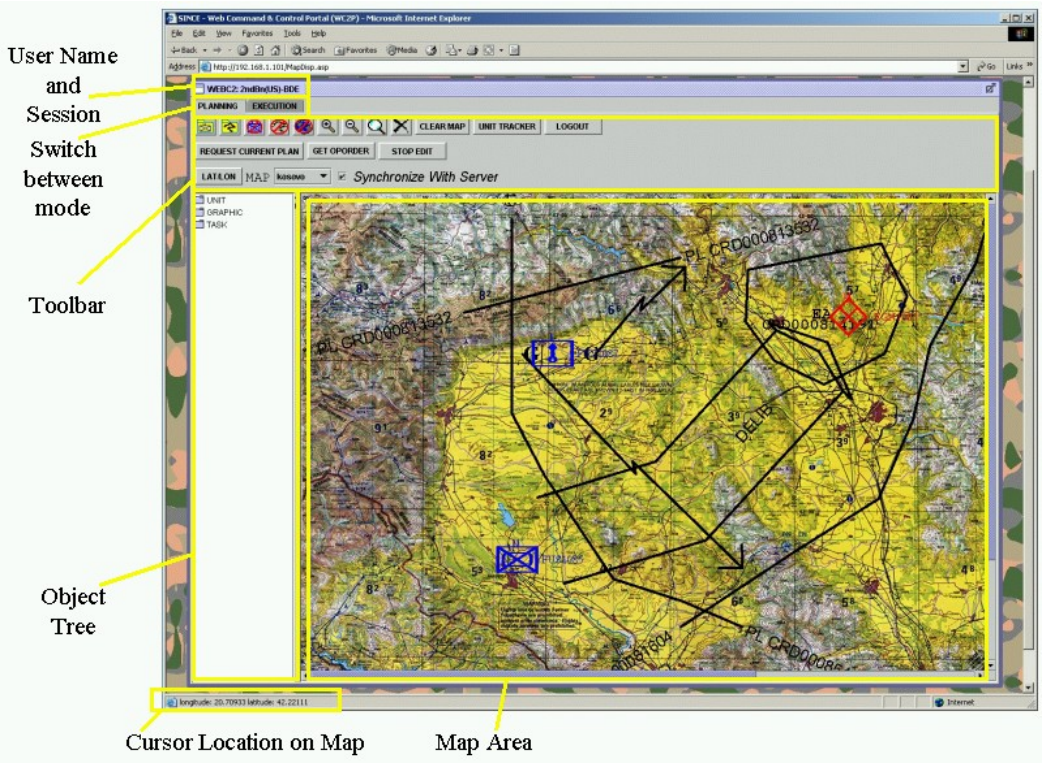


Figure 11: Main WCP Control Areas

Viewing OPORD and Current Situation

Figure 12 shows an example of the OPORD viewer with current situation. This screen shows ID's and Publisher's of the received OPORDs. When a user selects specific OPORD ID they are presented with the latest version of that OPORD as shown in Figure 13. The location of the units in the OPORD is updated with the current situation of the C2COP database.

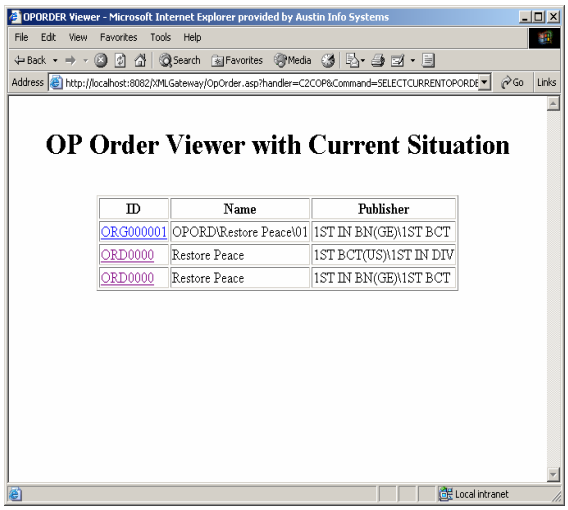


Figure 12: OPORD Viewer

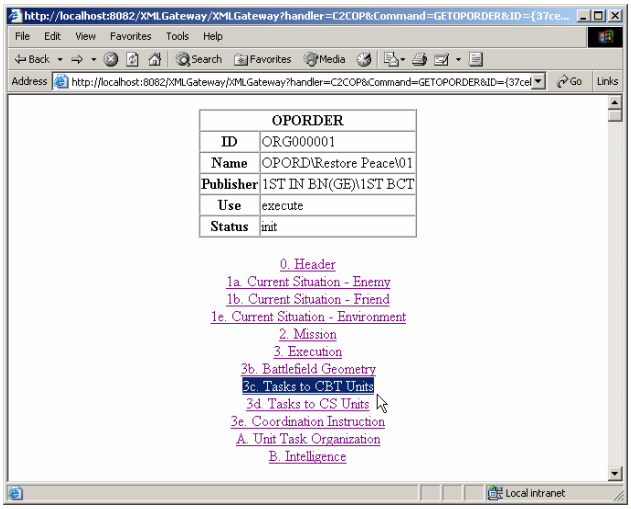


Figure 13: Detailed View of Selected OPORD

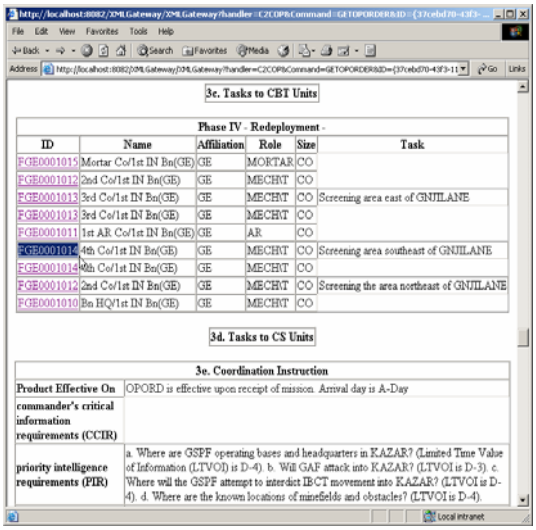


Figure 14: Unit Task Breakdown View

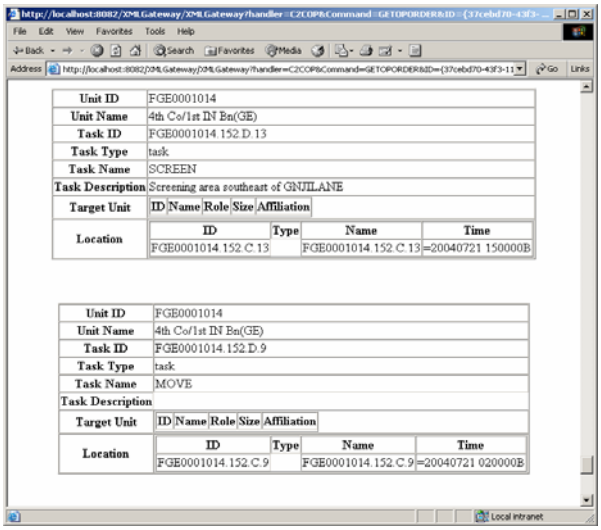


Figure 15: Unit Action Task assignment View

If the user were to select the link to "Tasks to CBT Units", they would see the Figure 14 screen. In this screen, the user is still on the same HTML page, they have just jumped down the page partway. In this section, the units can find various tasks that are assigned to them. For more details about a particular task, the user can select the hyperlink in the ID column. If the user were to select one of the ID hyperlinks, they'd see the following screen indicated in Figure 15. The task decomposition information

displayed in this screen is still part of the main HTML page, but it is located at the very bottom. The user can easily access it by selecting the appropriate hyperlinks.

Cognitive Experimentation Activities

The SINCE program has already successfully conducted three experiments. Two of these R&D experiments were technical functionality experiments. In these experiments the military users that were participating with US and German technical development team played out highly scripted operational vignettes and action events to test and evaluate the quality of the technical functionality and capabilities being implemented to support follow-on, more operationally oriented SINCE experimentation activities. One of these three experiments was an operational experiment where the team of US and GE military users supporting the conduct of the experiment developed the operational vignettes driving the experiment and were in full charge of how they conducted operations to changing events. The three SINCE experiments successfully conducted thus far are:- (a) Experiment 1a (Technical) conducted in November 2003 at WTD 81, Greding, Germany; (b) Experiment 1b (Operational) conducted 12 -23 July 04 at the 35th ID Combat Training Center (CTC) Facilities located near Ft. Leavenworth KS; and (c) Experiment 2a (Technical) conducted 12-16 Sept 05 at Gef Sim Z, Wildfecken, Germany. The conduct of SINCE Experiment 2b (Operational) is currently planned and scheduled to be conducted at Fort Dix, New Jersey, USA during the period of 17 July – 28 July 06. Based on the expressed interest of France, Canada and Israel to become future players in the SINCE program, the US and Germany have invited the participation of these nations, both as observer and as limited players in the US-GE SINCE Experiment 2b activities. The details of these nations participation in SINCE Experiment 2b are currently in coordination and will be discussed during the formal presentation of this paper.

Figure 16 provides a high level overview of both the technical and operational experimentation activities that were undertaken as part of three week, 17 July -28 July 06, conduct period of SINCE Experiment 2b. In concept, SINCE Experiment 2b will be conducted basically using the same sequence of events as Experiment 1b, with some minor modification to allow the addition of three additional nations into the conduct of the experiment. As is indicated in Figure 16, the operational portions of the experiment were played out as vignettes of different aspects of a real coalition force operational scenario, sometimes scripted and other times completely ad hoc in nature. The cognitive planning and collaboration capabilities provided by the WCP will be extensively utilized during the play of these operational vignettes. One of the objectives of the previous SINCE Experiment 1b was to validate the technical and operation functionality of the SINCE experimentation test bed environment and assure it was ready to support more complete and comprehensive operational experimentation activities planned and scheduled for the SINCE 2b and future 3 experiments. Figure 17 depicts the layout of the actual Ft. Dix NJ SINCE Experiment 2b Test Bed facility. This test bed networks together roughly 42 different computer systems support these experimentation activities. As is indicated in Figure 16, Cell 4 is the BDE HICON composed of US, German and French personnel & C2 systems. Next, Cell 5 is the formally US Battalion Cell expanded to a represent a multi-national battalion composed of US, French, Canadian and Israeli personnel and C2 systems. Cell 6 contains the Combat Simulators simulating the Cell 5 Blue force unit movement and actions. Cell 7 contains the Combat simulator simulating the overall experiment Red force movement and actions. Cells 3 and 4 represent the two German Battalions with German personnel, C2 systems and their supporting Blue Force Combat simulators. Cell 1 contains the US and German C2sim Proxy server, the WCP server, and various other data logging etc. equipments need to support the conduct of experiment. Table 1 at the end of this paper provides a glossary of all the abbreviations used in these figures.

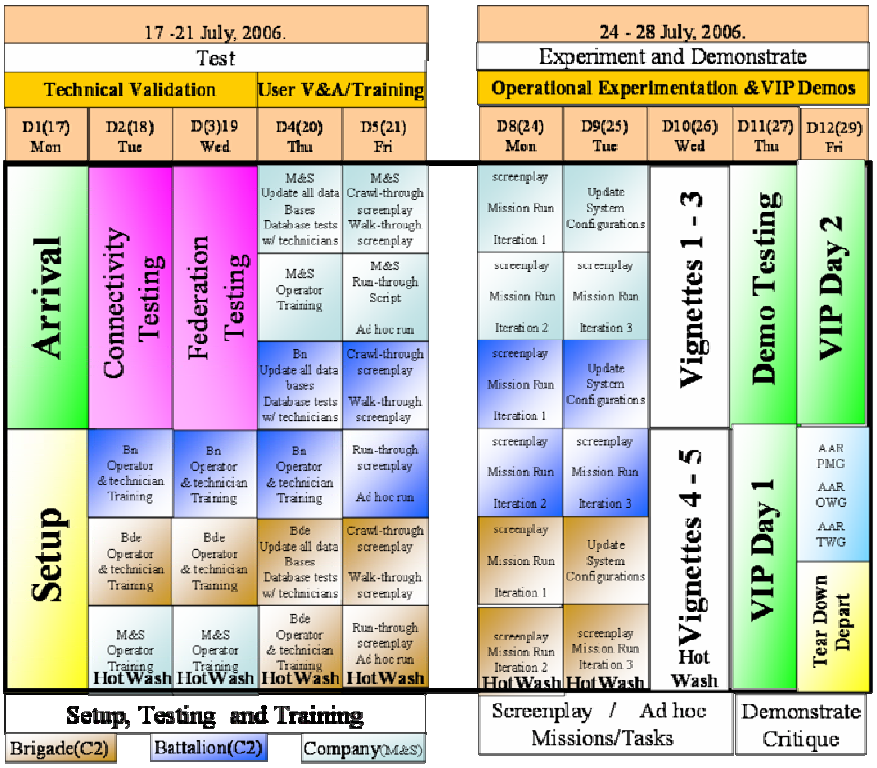


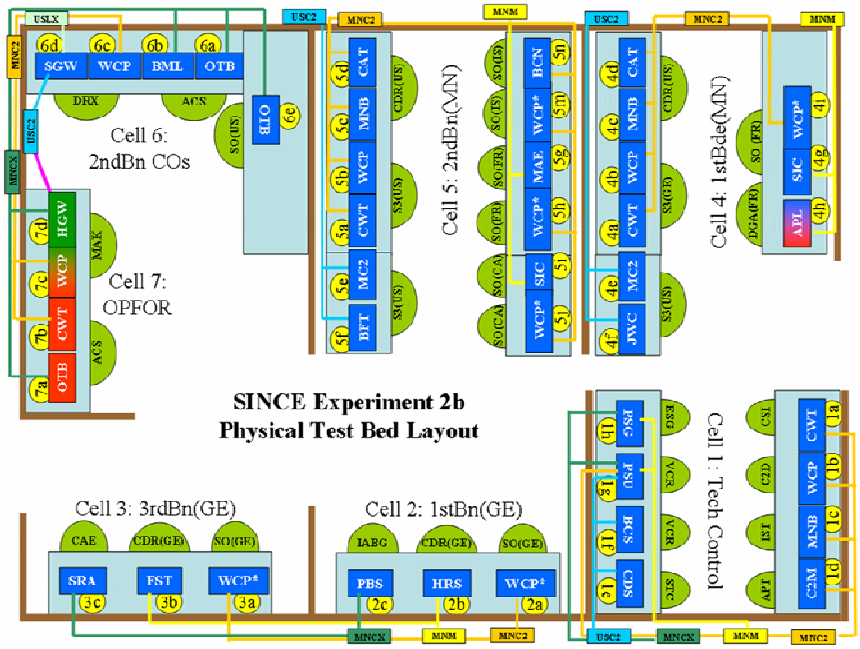
Figure 16: SINCE Experiment 2b Activities

Experiment Play and Lessons Learned

The experiment was conducted by repeating the standard operational cycle of the four fundamental phases inherent in any operation: (a) Connect/Network, (b) Initialize /Federate, (c) Collaborate/Plan, and (d) Interoperate/Execute. The first two phases were predominantly technical in nature and the second pair of phases was predominantly operational. The first two phases were predominantly technical in nature and the second pair of phases was predominantly operational.

In the Connect/Network phase communications connectivity is established between all of the systems participating in the experiment. In the Initialize/Federate phase, three Xml-formatted publish and subscribe topics (Control, Plan and Execute) are communicated to all the C2 systems and M&S system to initialize them with their appropriate starting ground truth or perceived truth states. In this phase we were also the MIP interface to distribute state information between US and coalition C2 systems. In the third phase, we enabled the user to experiment with multiple collaboration planning sessions and multiple workspace SMIs. Finally in the forth phase, the user was able to monitor the current COP and determine when and how to switch back to collaborative re-planning.

During the Collaboration /Plan Phase each operational cell, HICON BDE (MN), and subordinates BN (US), and BN (GE) established WCP workspaces for maintaining configuration management over their planning session as well as workspaces for viewing and providing feedback to their two collaboration partners. This capability was well received by the user and additional overlay needs/requirements were established for future experiments.


SINCE Experiment 2b
Physical Test Bed Layout
Cell 6:
2ndBn COs
Cell 7:
OPFOR
Cell 5: 2ndBn(MN)
Cell 4: 1stBde(MN)
Cell 1: Tech Control
Cell 3: 3rdBn(GE)
Cell 2: 1stBn(GE)
USLX
USC2
MNC2
MNM
MNCX
USC1
SGW
WCP
BML
OTB
DRX
ACS
HGW
MAK
CWT
CAT
MNB
BFT
MC2
BCN
MAE
SIC
JWC
ADL
CAE
CDR(GE)
SO(GE)
SRA
FST
IABG
PBS
HRS
CDR(US)
SO(US)
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SO(PB)
SO(CA)
SO(US)
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SO(FR

understandable graphical interface. These users also provided guidance on how to further improve the WCP; they clearly liked and were satisfied with the initial cognitive interoperability capabilities provided. In fact, not only did these users recognize the value of the portal's cognitive interoperability capabilities for supporting coalition operations, they also indicated that these capabilities were also seriously needed on a national level to improve understanding between national forces during conduct of collaborative activities.

SINCE Transition Product

Based on the success of the previous SINCE experiments DA requested the US SINCE Project Office to define and demonstrate a SINCE Transition Product that could be potentially used by a Brigade Combat Team (BCT) unit stationed in Germany. This BCT unit would be working collaboratively with a German Panzer Brigade as part of a joint US-GE Division. DA International provided some initial FY 06 startup funding to support the implementation and demonstration of this envisioned SINCE Transition Product. During the conduct of SINCE Experiment 2b (Operational) the key technical functionality, information flows, information exchange mechanisms, collaborative planning capabilities and operation of this Transition Product will be interfaced, demonstrated and tested connected to appropriate real or surrogate components of C2 systems and support equipment that would be in a BCT TOC.

The US SINCE WCP and C2Sim Proxy Server/services developed to support Experiment 1a and 1b were basically loosely coupled R&D prototype products spread over several PCs and Laptop computers connected via an Ethernet network. To provide a field deployable version of the SINCE WCP and Proxy Server products requires the integration, expansion and enhancement of core services these R&D products perform. These enhancement efforts fall into three different categories i.e. - (a) WCP military user functional capabilities enhancements; (b) WCP/C2Sim Proxy server information flow, exchange and management improvements to facilitate system integration with BCT TOC C2 equipments; and (c) combined Field WCP/C2SimProxy Server and BCT systems integration testing, security certification testing, support documentation generation and fielding support package development. Figure 17 provides a conceptual overview of the design and architecture of the SINCE Transition Product that the US SINCE Program Office is currently implementing and expecting to functionally demonstrate and test during the conduct of SINCE Experiment 2b.

Basically with the initial funding was made available this year for the development and demonstration of the US SINCE Transition Product we were able to

(a) Redesign of the US SINCE WCP& C2Sim Proxy Server systems so that they could be integrated into a Common Server Platform and with BCT TOC support, and

(b) Upgrade, enhance and add functionality to the WCP and C2Sim Proxy Server component systems so that that they would have the additional capabilities/features needed to support field users.

Specifically, the Web-based C2 Collaboration Portal (WCP) Client & Server received the following enhancements:

- Expanded Task Action Graphics & Drag-Drop Task Planning Overlay Capabilities/Options
- Integrated Digital CJMTK Map Graphics Support and Tools

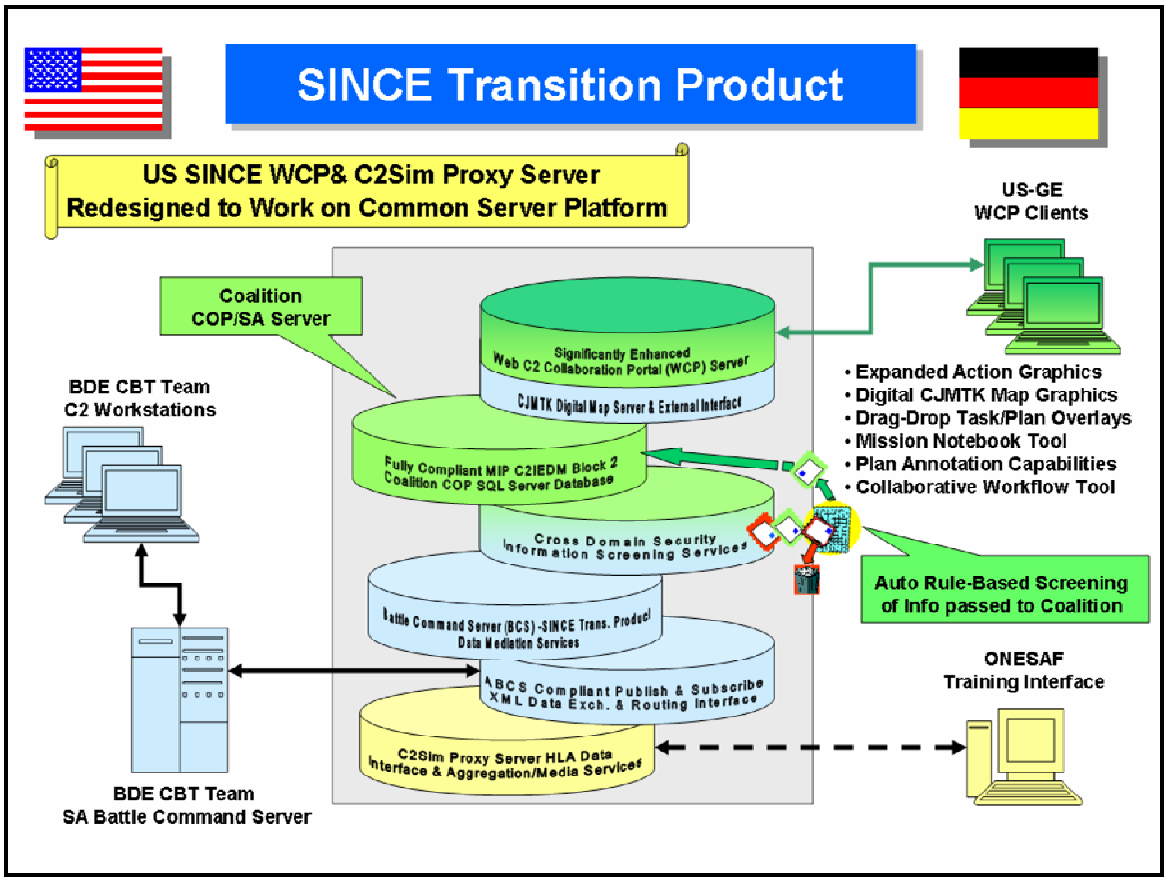

Figure17: Conceptual SINCE Transition Product

- Mission Notebook Tool for direct Authoring of Digital OPORD
- Addition of Plan Annotation Capabilities for Drag-Drop Task Action Plan/Overlay generation
- Collaborative Workflow Tool automatically generates sub-unit action templates that can be rapidly edited and modified by commanders

Additionally, we upgraded and enhanced the data storage and information distribution services of the C2Sim Proxy Server as follows:

- Upgraded to Fully Complaint ABCS Published & Subscribe Capability
- Added MIP C2IEDM Block2 Database and Data Exchange Mechanism (DEM) to support real-time storage and distribution of Coalition COP and SA information
- Added Automated Rule –based "Cross Domain Security Information Screening Services" to screen information transferred from US SA sources to Coalition COP/SA server
- Implemented Pub-Sub interface with BDE CMB Team ABCS SA Battle Command Server (BCS)
- C2Sim Proxy Server simulation system interface is also being upgrade to interface with ONESAF with enhanced unit entity state and status collecting, aggregation and reporting capabilities

During the conduct of SINCE Experiment 2b (Operational) the key technical functionality, information flows, information exchange mechanisms, collaborative planning capabilities and operation of this Transition Product will be interfaced, demonstrated, tested and connected to appropriate real or surrogate components of equipment that would be in a BCT TOC . However, due to the availability of only funds and the short timeline associated with getting ready to execute the SINCE Experiment 2b, the demonstration of this SINCE Transition Product during the conduct of the experiment will still be spread across several interconnected PC's and Laptops. The results of the transition product demonstration and testing conducted during the SINCE experiment will be presented during the formal presentation of this paper. Final integration of the SINCE Transition Product for field use will continue after the conclusion of the SINCE Experiment 2b activities in preparation for potential 2007 file user demonstration and evaluation testing.

SUMMARY AND CONCLUSIONS

From a US and German perspective the past three SINCE experiments were all successful in their own right. The successes of these experiments were based on meeting several different objectives. We successfully demonstrated that the US-GE SINCE Experimentation environment could scale to support realistic coalition force operational experiments, mission rehearsal and training activities. We also demonstrated seamless information flow and interoperability between the C2 systems and Combat simulation systems connected in the test bed - see references [5], [6], [7] and [8]. However, the real success story of the SINCE experiment was the acceptance by our military users of the cognitive interoperability capabilities embodied in the initial functionality WCP and its supporting Digitized OPLAN/OPORD and FRAGO representations. These cognitive interoperability decision support capabilities clearly demonstrated improved support for real-time collaborative mission planning information exchange between US-GE at BDE and BN level command cells. The military users participating in the experiment had high praise for WCP and its graphical point & click plan generation capabilities. The forty-three VIP's that attended the SINCE Experiment 1b VIP Day Demo also expressed positive praise for what they saw at the demo. The US and Germany expect that SINCE Experiment 2b will achieve similar results on a grander scale. However, SINCE Experiment 2b does represent a significant step forward for these US-German experimentation activities. This is the first time that we have invited the active participation of other nations, specifically Canada, France, and Israel in the conduct of the experiment. SINCE is demonstrating new vistas for implementing cognitive and collaborative interoperability between coalition forces and enabling the future use of real-world Warfighter C2 systems in conduct of simulation-based training exercises.

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Table 1: Glossary of Abbreviations

CAT – Collaborative multimedia Slide Annotation Tool (aka CSLANT)
CWP – Collaborative Workflow Portal synchronization and expansion.
SRA – SIRA M&S System (GE)
PBS – Pabst M&S System (GE)
FST – Faust C2 System (GE)
HRS – HEROS C2 system (GE)
CDM – C2 –M&S Proxy Server Coalition Domain Manager
CSP – C2sim Proxy Server
PSG – CSP used by GE
PSU – CSP used by US
BCS – Battle Command Server w/SADI
WCP – Web C2 Portal
WCP* - WCP enhanced with CWT / MNB / CAT
CDS – Cross Domain Server
MNB – Mission Notebook
BML – Battle Management Language
SIC – SIC-F C2 System (FR/CA)
MAE – Maestro C2 system (FR)
APL – Applet M&S System (FR)
BCN – Beacon C2 System (IS)
OTB – OneSAF Test Bed M&S System
SGW – Secure Wireless Agent Technology (SWAT) Gateway
DRX – Drexel University developers of SGW
C2M –C2 Mate an AAR Tool
JTC – Joint Tactical COP Workstation (formerly MCS/C2PC)
JWC – Joint Web COP
BFT – Blue Force Tracking / FBCB2
FBCB2 - Force Battle Command Battalion and Below)
IPR – IP Router
SO – Staff Officer, (S2/S3/S4)
VCR – Viecore FSD (US)
ACS – Atlantic Consulting Services Inc. (US)
MAK - MAK Technologies, Inc. (US)
CSI - Cougaar Software, Inc. (US)
C2D – Command and Control Directorate (US)
STC – Space and Terrestrial Communications Directorate (US)
IST – Intelligent Systems Technologies, Inc. (US)
APT – Aptima, Inc. (US)
ESG –Developers of PSG (GE)
HGW – HLA Gateway
NEBC – Network Enabled Battle Command
FCS/DSS – Future Combat System –Decision Support Service
CSA – Collaboration Server Adaptor
CAT – aka CSLANT – Collaborative Annotation Tool
XTA – eXplanation Tool Adaptor
MIP DEM – Multilateral Interoperability Program Data Exchange Mechanism
DEA – Data Exchange Adaptor
CdrPortal –Commander's Portal
BML – Battle Management Language
TMA – Time Management Adaptor / Synchronization Matrix Adaptor
CTA – ConText Adaptor
RBA – Reach Back Adaptor
webMNB – web Mission Notebook
HFA – HLA Federation Adaptor
HGW – aka HLA GW – High Level Architecture Gateway
ABCS – Army Battle Command System
DMA - Data Model Adaptor – which then publishes to BCS
SGW - SWAT Gateway for Secure Wireless Agent Technology
CXA – Compressed XML Adaptor
SDI - SADI (Situation Awareness Data Interoperability)
CDS – Cross Domain Services
CDA – CDS Adaptor
WPA – Web Portal Adapter (for the WCP)

SINCE Networks:
MNC2 – Multinational C2[Planning(P)+Monitoring(M)]
MNM – Multinational Monitoring
MNCX – Multinational Constructive Simulation Execution
USC2 – US C2
USRB – US Reach Back / Open Source Internet
USLX – US Live Simulation Execution (using SWAT PDAs)