Experimenting with C2 Applications and Federated Infrastructures for Integrated Full-Spectrum Operational Environments in Support of Collaborative Planning and Interoperable Execution

Dr. Israel Mayk, Dr. Dirk Klose
israel.mayk@us.army.mil
C2 Directorate (C2D)
US Army Communications-Electronics
Research, Development and Engineering Center (CERDEC)
ATTN: AMSRD-CER-C2-BC, Building 2700
Fort Monmouth, NJ 07703

Abstract

In this paper we describe the design, implementation, and execution of and the results obtained from the SINCE experiment 1a (SINCEx1a) [1]. The goals of this experiment were (a) to test and verify the information exchange among all of the US and German systems connected in the experimentation environment, and (b) to demonstrate and validate with military user participation that the C2 functionality implemented was adequate to support future planned operational experiment, SINCEx1b. SINCEx1a implementation followed, adopted and adapted a code of best practice approach for experimentation [3]. Both adopted features and adapted elements are summarized herein. Clearly, many compromises had to be made considering the limited resources and budget available. Many trade-offs were made in establishing a balance between a) developing the infrastructure not only for SINCEx1a but for the planned follow-on experiments and b) developing the SINCEx1a experimental configuration that was finally used in the conduct of the actual experiment. The infrastructure concepts addressed design issues pertaining to various bilateral and multilateral coupling mechanisms within each federation of C2 systems, within each federation of combat M&S systems, and within the super-federation of C2 and combat M&S systems [2]. An integral part of the solution was the establishment of the methodology by which the various information architectures would be harmonized within federations and across federations. The infrastructure for SINCEx1a was embodied in a Proxy Server (PS) and Portal that included the various adapters and filters that mediated between the various incompatible heterogeneous interfaces inherent in the selected federate systems using a common domain model (CDM) [4] encoded in XML. The selected federates for the experiments represented the deployments of future forces that are required to be not only network-centric with respect to their own assets but also with respect to other Joint, National and Coalition assets. The SINCEx1a addressed the main issue for any network-centric architecture which is the establishment of connectivity, federation, collaboration and interoperability in a self organizing way among all elements of the force to include combat (e.g. maneuver), combat support (maneuver support), combat service support (e.g. maneuver sustainment) and C2 (e.g. battle command) assets. A significant contribution of SINCEx1a was to establish a solid foundation for future experimentation which would identify and reduce the gaps in the information architectures as required by the user through the operational scenario and the information models [4] supported by the various federates.

Objective

The first goal of the technical SINCEx1a was to test and verify the technical approach to enabling information exchanges for collaborative planning and interoperable execution in accordance with multinational user requirements across US and German data boundaries in a single integrated experimentation environment. Such boundaries exist between C2 systems, between modeling and simulation (M&S) systems and between C2 and M&S systems. The second goal was to lay the foundations for a follow-up experiment, SINCEx1b, by demonstrating and validating, with military user participation, the adequacy of the implemented C2 functionality to support a more operationally oriented experiment. In addition, an important goal for SINCEx1a was to establish a baseline for the functionality and performance required for similarly configured national experimentation and future international SINCE experiments.

Introduction

The SINCE experiment 1a (SINCEx1) took place at the MIP facility of WTD-81, Greding, GE on 10-21 November, 2003. Over thirty representatives from the US and German technical and military user communities (USA CERDEC IBCD, USA TRADOC and CALL, German BWB and HeeresAmt (Army Office) plus supporting US and German contractor teams) participated in this experiment. SINCEx1a is the first in a series of experiments being carried out as part of the SINCE Program initiated to enable the conduct of multinational C2 experiments supported by C2 and modeling and simulation (M&S) systems designed to address the transformation of collaborative planning and interoperable execution in a coalition environment. On the US side we used the ASAS Lite systems to automatically collect, develop and disseminate the HICON and US Battalion and below operations centers User-Defined C2 Common Operating Picture (C2COP). The US COP was maintained by ASAS-Lite in a JCDB [11] surrogate. We used the CAPES/MC2 systems to support the conduct of real-time collaborative mission planning and unit tasking of the simulated US forces playing in the SINCE experiment operational scenario. We used the OTB systems [8] to simulate the operational play of the US Blue, and enemy Red forces required to stimulate the users and generate appropriate Situation Awareness (SA) reports to the US C2 Systems. On the GE side, we used the PABST system to simulate the operational play of German Blue forces and generated SA reports on their movement. The German INFIS system enabled the exchange of COP information with the German HEROS C2 system via the Multilateral Interoperability Programme (MIP) Data Exchange Mechanism (DEM) protocol [6,12]. The WebC2P enabled coalition force planners to view the real-time coalition User Defined Operation Picture (UDOP) and also provided an interactive capability to view and modify different aspects of an electronic representation of the coalition OPORD/OPLAN. As depicted in Figure 1, the US Proxy Server provided the automatic information routing and data format/protocol adaptation/conversion processing required to seamlessly exchange real-time COP and OPORD/OPLAN change information between all to these systems. The MCS Lite system is part of the US MIP solution and was embedded as part of the US Proxy Server to support the monitoring and direct display the information that passed across this server.

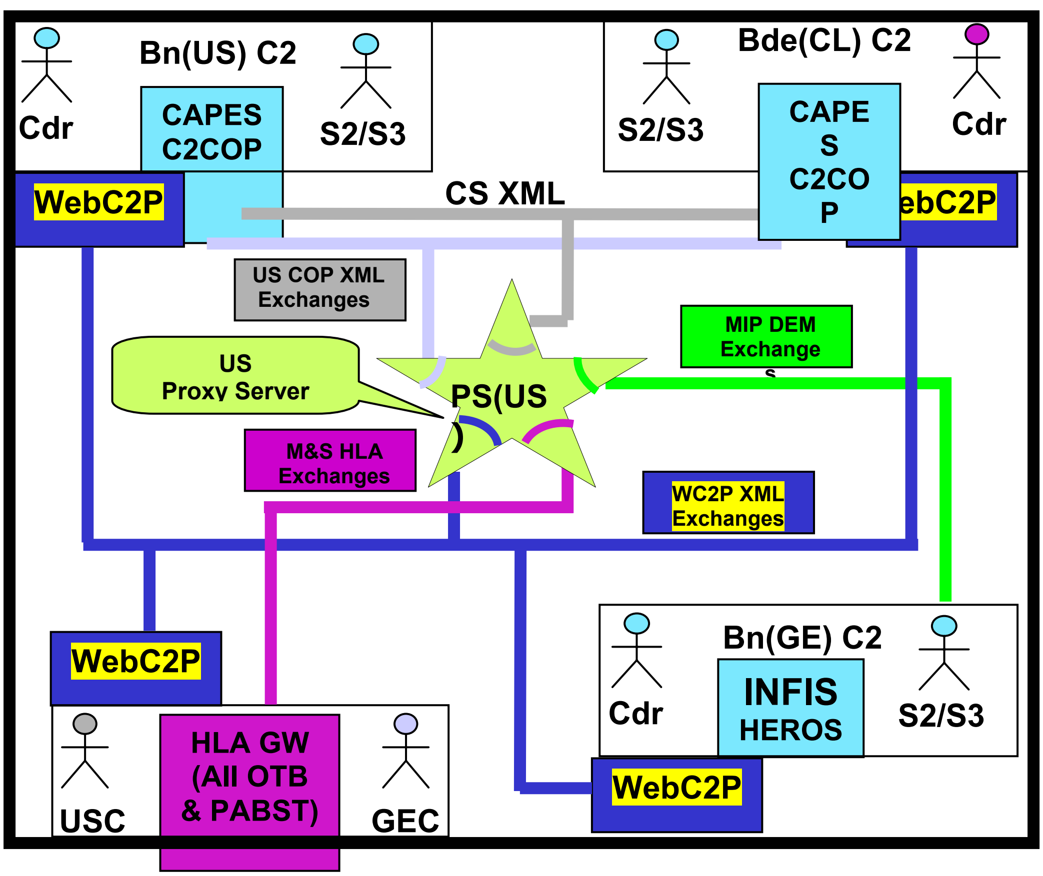

Figure 1: Simplified SINCEx1a Information Flow Diagram

A key technical feature that was implemented and demonstrated was the use of a common XML schema to represent the various C2 products that embodied the information exchange requirements (IERs). C2 products included a mix of messages represented by friendly position reports (positionRpt) and observations of enemy units called SPOT reports as well as operational orders [13] (OPORDs), fragmentary orders, (FRAGO), operational plans (OPLANs), and warning orders (WARNOs). The common schema for SINCEx1a was developed as a W3C XML schema [9] that enabled all instances of information exchange to be checked for being well-formed as well as for being valid. This common schema was used to generate all instances of IER in all phases of SINCEx1a. Publish and subscribe (P&S) mechanisms were also a major feature implemented for both C2 systems as well as for M&S systems and for their cross coupling. The C2 system exchanged Java objects within the framework of the Java Message System (JMS) topics and the M&S systems exchanged Realtime Platform Reports within the framework of the High Level Architecture (HLA) Federation Object Model (RPR FOM) [7]. This enabled a highly flexible and upgradeable filtering mechanism for information that needed to take place to appropriately support effective collaboration and interoperability as well as for stimulating the exchange via combat simulations. Filtering is possible based upon classification, source, content, time and location as basic criteria. SINCEx1a was limited to unclassified coalition data. To facilitate collaboration between current and future allies with disparate means for collaboration, we've found it both necessary and convenient to provide Web services that include a Web C2 Portal (WebC2P) via a standard browser that enables the sharing of coalition domain items such as the user-definable coalition COP initialization and updates and the coalition plans and orders. We have also initiated the representation of the architecture of this experimentation environment in UML [10] and identified key use cases and issues for each of the four phases essential for network-centric C2 system of systems (SoS) integration: inter-connection, inter-federation, inter-collaboration and inter-operation.

SINCE Proxy Server (PS) Actors	**SINCE Proxy Server (PS) Use Cases**
Federate systems: WebC2P, CAPES, C2COP, MIP(AL), OTB	Initialize Federate
USC (info officer/X6)	Interconnect System
	Federate System
(AL – Ally)	Stimulate Federate
(X0/X2/X3 – Cdr/Intel/Ops officers)	Collaborate with Coalition Federate (to Plan operation)
	Interoperate with Coalition Federate (to Monitor Execution)
CAPES Actors	**CAPES Use Cases**
SP_CS	Retrieve COP
User(US):X0/X2/X3	PLAN Operations
CAPES(Higher, Lower and Peer Echelons)	Collaborate on Plan
C2COP Actors	**C2COP Use Cases**
PS_DMA	Monitor Execution
User(US):X0/X2/X3	Manage US DB
C2COP(Higher, Lower and Peer Echelons)	Manage Coalition DB
WebC2P Actors	**WebC2P Use Cases**
PS_IPS	Collaborate on Plan
OTB	View Coalition COP
User:X0/X2/X3 (AL/Liaison)	
MSC(US/AL)	
C2COP(Higher, Lower and Peer Echelons)	
OTB Actors	**OTB Use Cases**
(US) MSC(US):(Red/White/Blue)	Generate Ground Truth
M&S Federate (AL)	Generate Enemy Reports (Red, White)
PS_HRF	Generate Friendly Reports (Blue, White)
MIP Actors	**MIP Use Cases**
PS_DEM	Report Coalition Situation
C2 System(AL)	Report Coalition Execution
	Report Coalition Enemy

Table 1. SINCE System Level Federates, Their Actors (External Interfaces) and Use Cases (Functionality)[1]

Background

In previous papers [1,2] we described the detailed goals and objectives of the U.S. and German Simulation and C2 Information Systems Connectivity Experiments (SINCE) Program. In summary, SINCE is implementing a reusable experimentation environment specifically tailored to support the conduct of Coalition and Joint Warfighter experimentation across the full spectrum of technical and operational needs. Under the US SINCE effort, evolving C2 and Modeling and Simulation (M&S) systems are being networked and integrated into a flexible testing environment that will allow both the technical and operational communities to experiment with and evaluate concepts for implementing and conducting collaborative military operations in a network-centric coalition force operational environment. The Federal Republic of Germany is also implementing a similar networked environment of C2 systems and M&S system which is linked to the US SINCE environment during the conduct of joint US and German coalition C2 experiments. The primary focus of SINCE experimentation is on exploring concepts, defining technical requirements and evaluating operational utility of real-time collaboration capabilities and information exchange interoperability as needed to support the conduct of coalition and joint operations. SINCE echelon of concentration are Future Force operations at the battalion and below level, operating in highly mobile and dynamically changing battlefield scenarios. Under SINCE, the US and Germany plan to conduct three coalition experiments, each increasing in levels of complexity and operational scale. The conduct of each of these experiments will be partitioned into two distinct parts, a Technical Experiment part and an Operational Experiment part. The rationale for conducting a separate technical experiment is simply to assure that all the technical functionality needed to support the conduct of a planned operational experiment is indeed in place, working as required, and adequately scaled to support the envisioned complexity of the operational experiment.

Experimentation Design and Approach

SINCEx1a was the first of three planned coalition experiments, each with increased level of technical and operational complexity and scale. The conduct of each of these experiments is partitioned into two distinct parts, **Technical** and **Operational**. The conduct of a separate technical experiment is essential to assure that all the technical functionality needed to support the conduct of a planned operational experiment is indeed in place, working as required, and adequately scaled to support the envisioned complexity of the operational experiment. The first week of the two-week experimentation period was dedicated to the technical setup and the system of system integration, performance testing and debugging of the combined US and German SINCE experimentation environment. This is the first time that most of these systems were ever networked under a common environment. The second week of the experimentation period was devoted to exercising the technical and operation capabilities implemented, with the participation of operational users, in a dry run of the operational scenario that would be played out in greater detail and complexity in the planned, future SINCE Operational Experiment 1b (SINCEx1b).

Using the teambuilding paradigm [1] we phased the experiment in accordance with the four phases as shown in Figure 2. These phases characterize the entire SINCE test bed as well as individual federates and user operations. The capability is provided to filter information/reports based upon pre-established criteria: (s)single, (a)aggregated, (c)coalition, (ca)aggregated & coalition. Collaboration on Operational Order (OPORD) was enabled through a flexible cycle of initial draft (i), feedback(fb), update (ud) and final(f). A user issuing an OPORD or any part of it as a C2 product (prdC2), may indicate in the header the level of collaboration desired. By issuing a prdC2(f), no further collaboration is warranted. By issuing a prdC2(i/ud), prdC2(fb) are solicited. The changes were accepted both graphically and textually. The SINCE program is not intended to be a vehicle for enhancing C2 applications or M&S functionality beyond their current capabilities. Our approach is to identify deficiencies and bring them to the attention of the specific system developers. For example, we adjusted the scenario to ensure that only entities whose behavior is already defined by the M&S systems would be called upon to support the experiment. The current version of the applications used (CAPES and WebC2P) did not enable the user to concurrently open and update OPORDs from two different Sources, e.g., Bde/Bn or Bn/Bn. Therefore, collaboration was done sequentially, first on the Bde OPORD, then on each of the Bn OPORDs one at a time. The other two types of IERs implemented to enable situation awareness were prdC2 = positionRpt (Friendly Force Position Report) and prdC2 = SPOTrpt (Enemy Force Position Report). These were generated by the M&S systems.

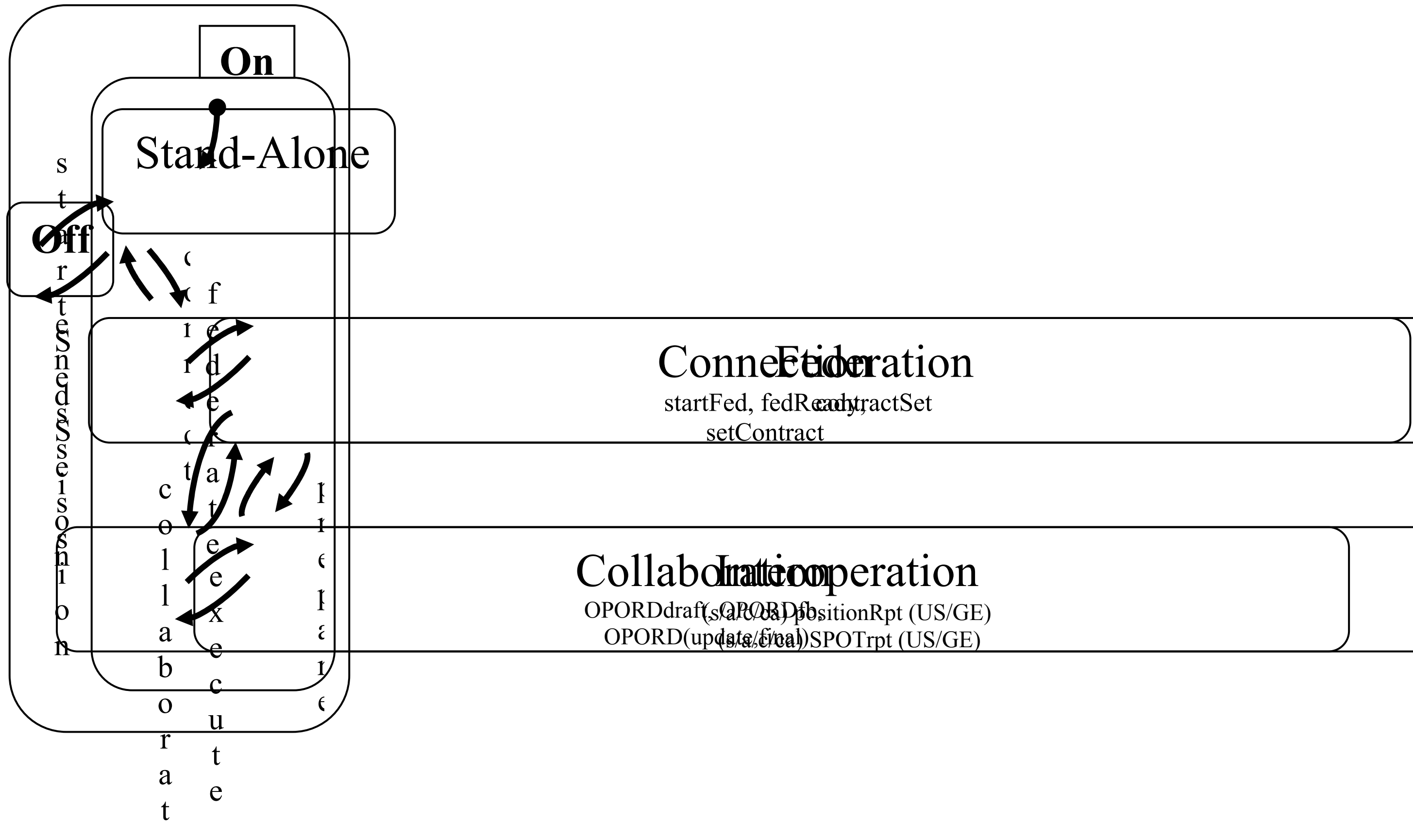

Figure 2. UML State Diagram of SINCE PS (US) and Federates

Each state has its corresponding UML use cases which were tested using three test cases as shown in Figure 3. Since basic networking connectivity was not a major issue for SINCEx1a we addressed the connectivity state and the federation state in a single integrated test case called Initialization. Technical and operational initialization of this network of C2 and M&S systems and subsequent real-time information exchange, was started by electronically publishing an Xml-structured OPORD/OPLAN document from the CAPES/MC2 system to all of the participating systems via the US Proxy Server. The US Proxy Server automatically adapted and distributed this initialization data into the structural formats and protocols required by the participating systems i.e.- US C2 systems USCOP database updates, German C2 system MIP database updates, US and German M&S systems HLA PDUs exchanges/updates**.**

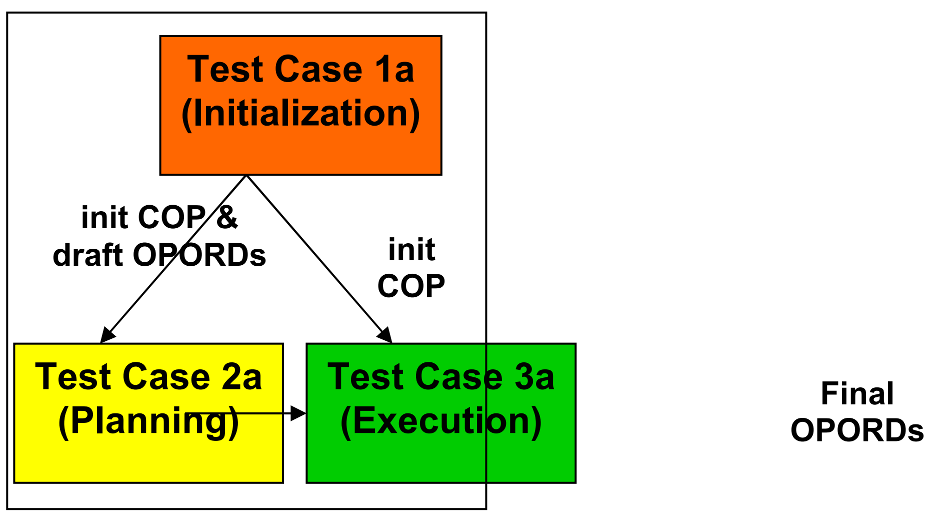

Figure 3. Information Flow across Test Cases

Experimentation

Figure 4 provides a high level approximate view of the physical arrangement of the experiment. All the federate systems, US and GE, were connected via a high speed LAN using TCP/IP and HTTP so that we could focus on the C2 and M&S issues at the transport, session, presentation and application layers. Clearly future experiments will have to contend with less robust means of networking. In addition, the scenario was unclassified and all systems operated using unclassified data. Clearly future experiments will require firewalls and other security measures as required by the scenario. All systems were numbered as well as all logical grouping of IERs as shown in tables 1-3

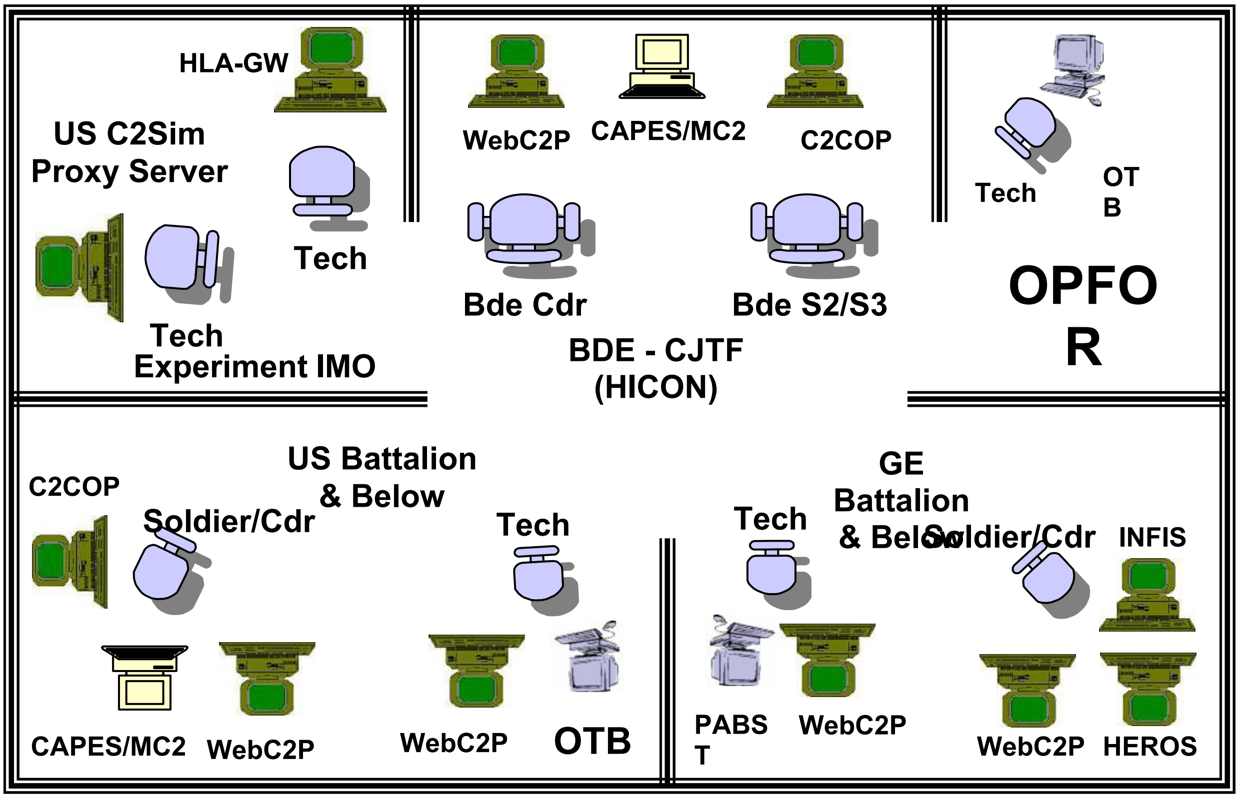

Figure 4: SINCEx1a Test Bed

Each of the federate systems indicated in Figure 1, had a specific role in the experiment that was characterized by its use cases (The use cases as well as the associated actors for each system level federate are listed in Table 1.) The Actor-Use case dependency is associated with one or more IERs. The Use Cases were implemented to enable each federate to interact with its federated actor systems as shown in the sequence diagrams of Figures 5-7 . The IERs were grouped in accordance with the 3 Test Cases. Going through all three Test Cases constituted a single Test Pass, regardless of how long one would dwell within each Test Case. Initial passes were conducted to ensure completeness and accuracy of the information exchanged, subsequent passes were conducted to assess performance under various scenario loads. A simple experiment Test Report was generated and distributed to allow each experiment participant (a federate operator or user) to document and detail observations and findings. Each Test Report was identified with a number, a subject, and as a type (Outcome, Timing, Deficiency, Incompatibility, Limitation, Recommendation). Operators/observers were assigned to each federate and asked to monitor each IER as anticipated in accordance with the sequence diagrams shown if Figures 5-7. In addition each report was judged as to its criticality, and enabled the recording of the context by providing the date and time, federates involved, IERs involved, supporting screen capture, database snapshot and short narrative of the problem and or recommended solution. In SINCEx1a, logging was done in ad hoc manner. Because of display resolution limitations and symbology differences, especially when comparing M&S displays with C2IS displays, it was hard to correlate quickly specific units across displays. This caused the experiment to be slower than anticipated. The lessons learned with respect to data collection procedures, should make SINCEx1b much more rigorous in that regard.

IER #	*IER Name*	*Remarks*
1	InitialC2Entities	IERprdC2exeOPORD1stBCT(US).xml
2a	cCOP(i)	intial coalition situation, TO, BG
2b	geCOP(i)	initial GE situation, TO, BG
2c	usCOP(i)	initial US situation, TO, BG
2d	geTO(i)	PABST initialization (1^{st} Bn GE TO)
2e	usTO(i)+redTO(i)	initial Bn US TO + red TO
2f	filtered (2e)	OTB initialization (2^{nd} Bn US + red TO)

Table 2. IER Reference Table for Test Case 1a - Scenario Initialization

IER #	IER Name	Remarks
7	draftOPORD	IERprdC2exeOPORD1stBCT(US)word/xml
		IERprdC2exeOPORD2ndBn(US)word/xml
		IERprdC2exeOPORD1stBn(GE)word/xml
8a	OPORD(i)	IERprdC2exeOPORD1stBCT(US)word/xml
		IERprdC2exeOPORD2ndBn(US)word/xml
		IERprdC2exeOPORD1stBn(GE)word/xml
8b	OPORD(i)	IERprdC2exeOPORD1stBCT(US)word/xml
		IERprdC2exeOPORD2ndBn(US)word/xml
		IERprdC2exeOPORD1stBn(GE)word/xml
9a	OPORD(fb)	feedback on Bde OPORD(i)
9b	OPORD(fb)	feedback on Bde OPORD(i)
10a	OPORD(ud/f)	update to Bde OPORD(fb)
		final Bde OPORD for execution by BNs
10b	OPORD(ud/f)	Same as 10a
11a	OPORD(f)	final Bde OPORD for execution by BNs
11b	OPORD(f)	final Bde OPORD for execution by BNs
12a	OPORD(fb)	feedback on 2ndBn(US) OPORD(i)
12b	OPORD(fb)	feedback on 2ndBn(US) OPORD(i)
13a	OPORD(ud/f)	update to 2ndBn(US) OPORD(fb)
		final 2ndBn(US) OPORD for execution by 2ndBn(US) Companies
13b	OPORD(ud/f)	Same as 13a
14a	OPORD(f)	final 2ndBn(US) OPORD for execution by 2ndBn(US) Companies
14b	OPORD(f)	final 2ndBn(US) OPORD for execution by 2ndBn(US) Companies
15a	OPORD(fb)	feedback on 1stBn(GE) OPORD(i)
15b	OPORD(fb)	feedback on 1stBn(GE) OPORD(i)
16a	OPORD(ud/f)	update to 1stBn(GE)OPORD(fb)
		final 1stBn(GE) OPORD for execution by 1stBn(GE) Companies
16b	OPORD(ud/f)	Same as 16a
17a	OPORD(f)	final 1stBn(GE) OPORD for execution by 1stBn(GE) Companies
17b	OPORD(f)	final 1stBn(GE) OPORD for execution by 1stBn(GE) Companies

Table 3. IER Reference Table for Test Case 2a – Collaborative Planning

IER #	*IER Name*	*Remarks*
3a	GEsCOP(r)	GEunits Ground Truth HLA
3b	GEsCOP(r)	GEunits Ground Truth DIS
4a	USsCOP(r)	GEunits Ground Truth DIS
4b	USsCOP(r)	GEunits Ground Truth HLA
5	sCOP(r)	positionRPT.xml,SPOTrpt.xml
6a	cCOP(f)	Updated positionRPT.xml,SPOTrpt.xml
6b	geCOP(f)	friend/foe MIP updates
6c	usCOP(i)	Updated positionRPT.xml,SPOTrpt.xml

Table 4. IER Reference Table for Test Case 3a – Interoperable Execution

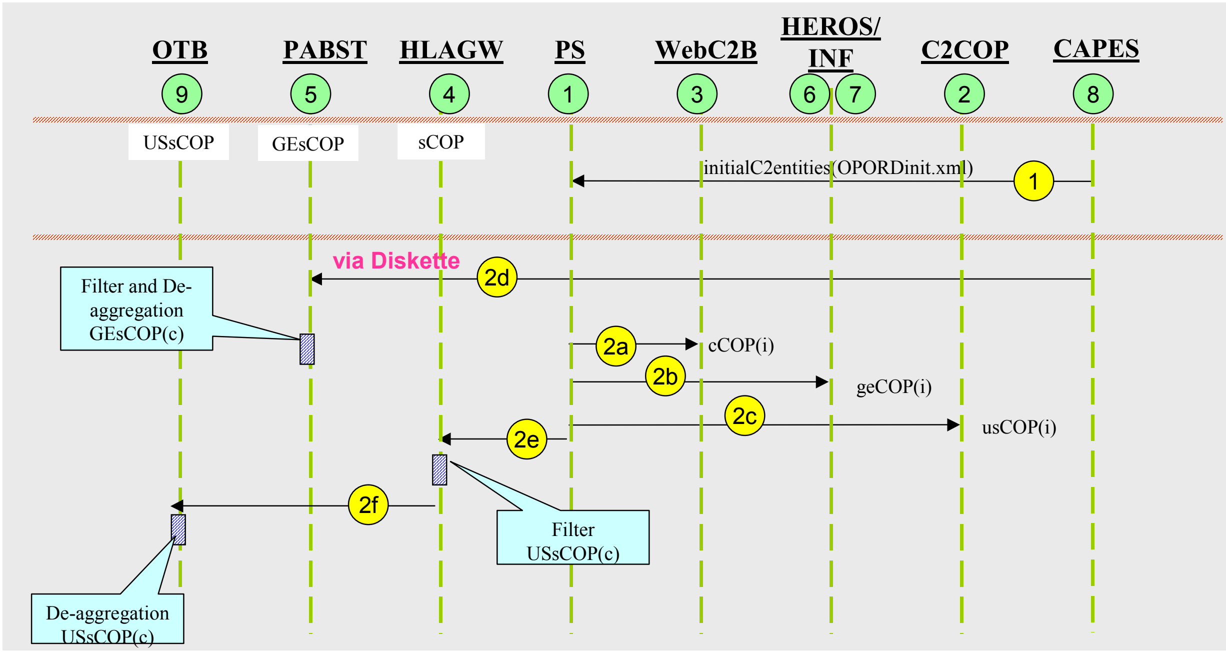

Figure 5. IERs (in Yellow) for Test Case 1a: Initialization. M&S federates on Left, C2IS federates on right

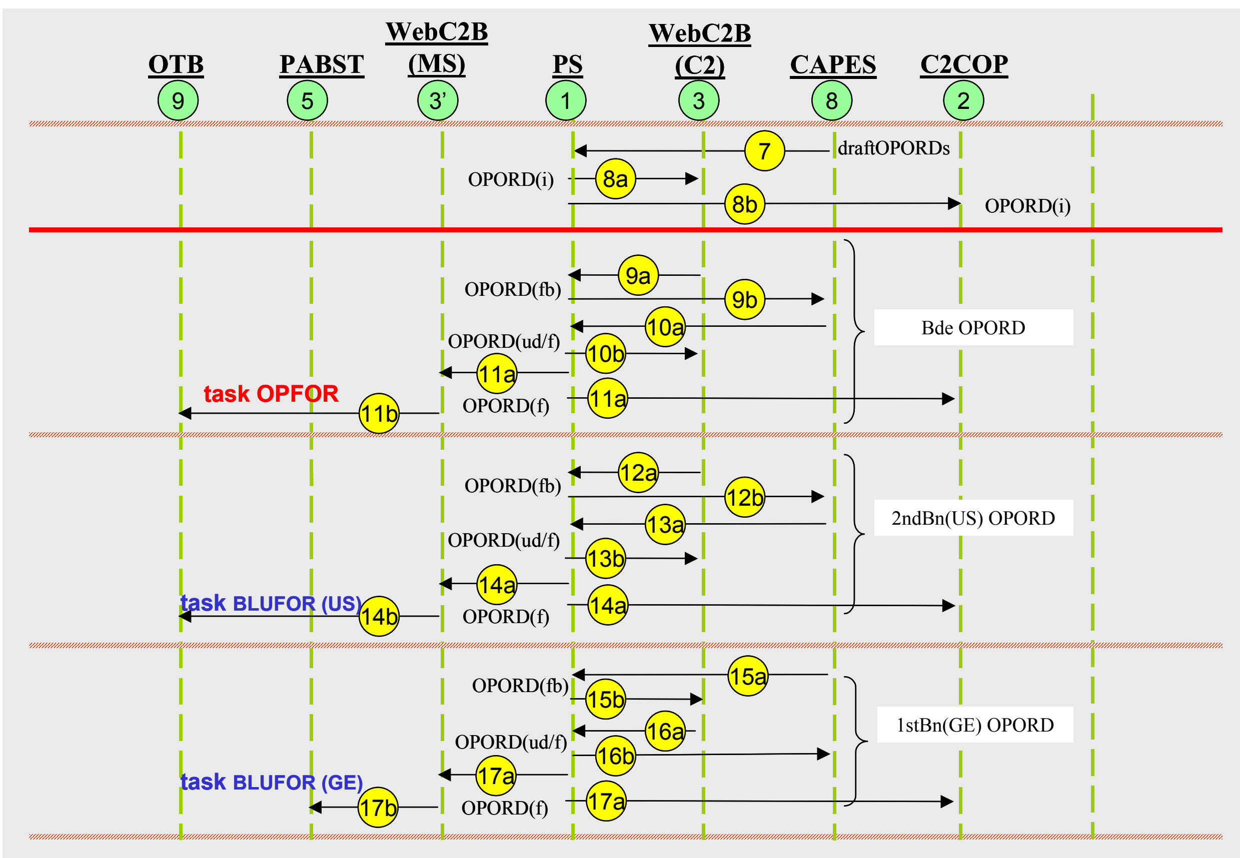

Figure 6. IERs (in Yellow) for Test Case 2a: Collaboration of OPORDs. M&S federates on Left, C2IS federates on right.

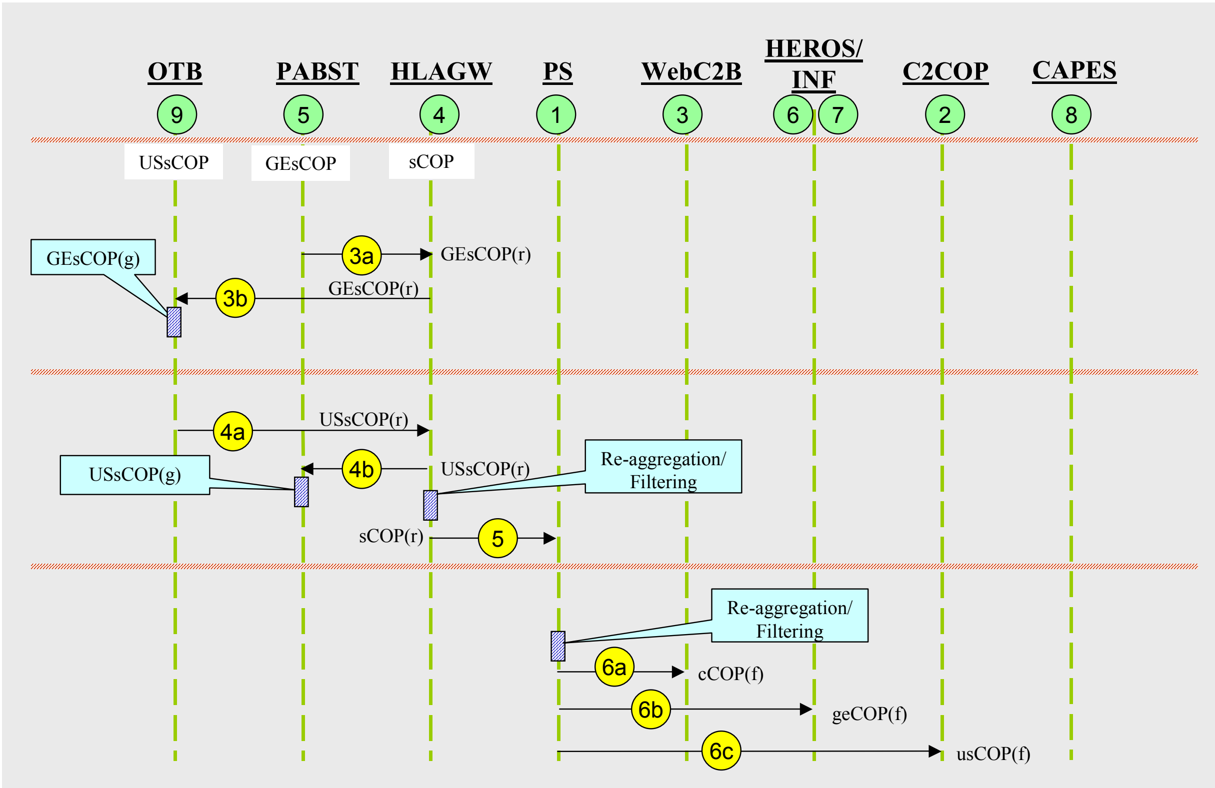

Figure 7. IERs (in Yellow) for Test Case 3a: Execution of OPORDs. M&S federates on Left, C2IS federates on right.

Experimental Results

The automatic initialization of all these C2 and M&S systems and confirmation that they could all display the same starting, Common Operating Picture (COP), i.e.- Blue and Red Force Unit locations and appropriated BDE and BN level OPORD/OPLAN mission tasking was demonstrated and is viewed as a significant accomplishment. This initialization process was completed by all systems in approximately 5 minutes and validated for correctness by military users from TRADOC, CALL and the German HeeresAmt (Army Office). The second accomplishment demonstrated that simulated Blue and Red Force movement, and associated position updates generated in either the ONESAF or PABST M&S systems could be published to and viewed in real-time on the displays of all the US & German C2 systems, the WC2P and on US and German M&S systems. Real-time Blue and Red Force COP tracking and synchronization between C2 and M&S systems was successfully demonstrated to approximately the 600-entity level for the current implemented coalition experimentation environment. The third accomplishment demonstrated in this experiment was a capability enabling coalition force commanders to collaboratively plan, modify plans and synchronize coalition force operations via use of the WebC2P interactive, XML-based OPORD/OPLAN information exchange mechanisms. Both TRADOC and HeeresAmt military users evaluated and positively praised the value of this evolving capability. Key to the success of this SINCE experiment was the implementation of common XML-based information exchange mechanism that supported real-time interoperability between all the systems playing in the experiment. The publish and subscribe information exchange mechanisms implemented in the US Proxy Server automatically mapped and translated all of these XML - based data exchanges into the formats required by the real C2 and M&S systems, and vice versa. The key technology enabling the demonstrated SINCE interoperability capabilities is the implementation of a common, consistent XML-based OPORD/OPLAN representation to which all information exchanges can be consistently referenced into and out of, without loss of traceability. The US and German military user community participating in this experiment indicated that SINCE had successfully demonstrated the linking of real C2 and M&S systems thereby opening the potential for future use of real-world warfighter C2 systems in simulation-based training exercises.

Experimenting with Coalition Liaison

One important operational hypothesis that we began to address is the impact of collaborative technology on the role of the liaison officer. With the advent of decision support, collaborative planning, and situation awareness technologies, the need for continuous liaison presence for face-to-face discussions may become unnecessary and even a waste. What we have begun to observe and hope to pursue with more scrutiny in SINCEx1b is that for the given level of complexity of the scenario used in this experiment, there did not appear to be a need for a liaison officer to continuously monitor and assist in the collaborative planning part. Each planning cell respected the role of their counterpart and was able to monitor collaborative drafts, feedback and updates on their own and made recommendations that were understood by and minimized the impact on their coalition partners. This observation is highly subjective and is not meant to imply that periodic face-to-face contact may be totally eliminated. It is certainly important to ensure, as per STANAG 2101 [5], cooperation and understanding between units that are working together, and to establish tactical unity and mutual support of adjacent units. But as the commander and staff engage each other across coalition data boundaries using the functionality provided by collaborative tools, the role the liaison is reduced and possible transformed by the capability of collaboration.

Summarizing Conclusion

Overall, SINCEx1a provides a repeatable baseline from which to grow a test bed environment suitable for supporting a broad range of coalition C2 technical and operational experimentation activities directed at defining, developing, evaluating and demonstrating improved, collaborative coalition force command and control while operating in highly dynamic and mobile military operational environments. In addition, the SINCE1xa provides a repeatable baseline within which one may readily demonstrate the importance of being able to adopt and adapt evolving mechanisms to assure interoperability between multinational C2 systems stimulated as a direct result of events generated in real-time by the M&S systems. This is key to driving and evolving a combat situation represented by a user definable/common operational picture (UDOP/COP) that provides context to these experiments from a technical as well as an operational perspective. Results of SINCEx1a should prove to be invaluable not only to future SINCE experiments but to support other related efforts. Initial experimental results obtained from SINCEx1a show significant promise in being able to address not only technical issues but operational ones as well. SINCEx1a is a significant step towards developing and establishing a comprehensive international R&D program to support transformation to FF and transition to MIP. The use of UML to design the experimental architecture has proven invaluable. The use of XML to provide a common coalition domain model is facilitating integration and bridging between disparate data models. By leveraging existing C2 prototypes for planning and execution monitoring and coupling them to existing M&S systems to provide a dynamic operational environment we are able to provide valuable feedback for enhancements. Our first experiment with Germany has met all expectations and set the stage for SINCEx1b scheduled for implementation in July 2004. Both countries are continuing to collaborate on a common scenario, hypotheses, and establishing mechanisms to couple complementary C2 systems to national M&S systems.

.

Acknowledgment

The authors would like to acknowledge our sponsors at HQDA and OSD, Our AMC facilitators, Stephen Connors and Hank Themak, our systems and subsystem developers and our user representatives. Our own internal program staff (Hobbie Negaran, Joe Hnat, Gunther Kainz, and Mohamed Meshal) are acknowledged for coordinating with the user, establishing the contractual vehicles to develop our architecture and infrastructure as well as to make sure that all items needed for the experiment were provided in a timely manner. Our SINCE developers are acknowledged for supporting the experiment in development and integration of the HW/SW and Networking environments. In particular we would like to thank the SINCE program developers from C2D (Andrew Chan, Mike Mai, and Bernard Goren), Gestalt (Kevin Sheehan), Viecore (Lynn Kershner), MAK (Nils Reker), AIS (Erik Eilerts) and LNK (Parag Talekar and Dr. Ravi Kulkarni) who played a key role in implementing their US Proxy Server modules, to the MIP program (Paul Ulrich, Venice Knight, and Tim Friest) for their collaborative support, and to Frank Farance for meta-data modeling support. In addition we would like to thank our GE Counterparts Michael Sieber, Dr. Hans-Peter Menzler and their contingency of highly skilled and dedicated contractors including IABG mbH (Dr. Eckehard Neugebauer, Dr. Lugering) ESGmbH (Dr. Bodo Probst, Elke Weisgerber, H. Muschik), FGAN (Henriette Schuller) and users (O Dieter Schmaglowoski, OTL Bernd Zimmermann and OTL Kottman). Also many thanks are due to Chris Hughes and Liaison Officer, Maik Kammerman for facilitating the collaboration with our GE counterparts, and to our Exchange Engineers, MAJ Avi Yariv (IDF) and Alfred Schloesser (GE) for valuable UML and XML analysis and design contributions. Our own user representatives LTC Michael Wickman, COL Karl Gunzelman (Ret) , LTC John Langston (Ret.), and COL Jeff Earley (Ret.) jointly with the GE military users mentioned above are acknowledged for tailoring and adapting the scenario to operational aspects of the experiment, identifying key IERs and providing invaluable feedback.

References

1. Mayk, Israel and Klose, Dirk R, "Multinational C2 Experiments Supported by C2 and Modeling and Simulation (M&S) Systems Addressing Army Transformation of Collaborative Planning and Interoperable Execution in a Coalition Environment," Proceeding of 8th International Command and Control, Research and Technology Symposium, June 17 – 19, 2003, National Defense University, Washington, DC.
2. Menzler, Hans-Peter and Michael Sieber, "Non-Hierarchical Approach to Couple CCIS with M&S," Proceedings of the NATO-PfP/Industry/National Modelling and Simulation Partnerships, October 24-25, 2002, Paris, France. See also - http://since.c3sys.army.mil
3. Alberts, David S. , and Hayes, Richard E. Code of Best Practice eXperimentation, CCRP, Information Age Transformation Series, July 2002
4. Mayk, Israel and Goren, Bernard "C2 Product-Centric Approach to Transforming Current C4ISR Information Architectures", Proceeding 2004 Command and Control Research and Technology Symposium (CCRTS), June 15 – 17, 2004, SAN Diego, CA.
5. STANAG 2101, Edition 9, Establishing Liaison, 25 April 1996.
6. MIP - http://www.mip-site.org/home.htm, http://www.mip-site.org/MIP_Baseline_1.htm
7. HLA - https://www.dmso.mil/public/transition/hla/
8. OTB - http://www.onesaf.org/
9. XML - http://www.w3.org/XML/
10. UML - http://www.omg.org/technology/uml/index.htm
11. JCDB - http://diides.ncr.disa.mil/shade/dbsegments/dbseg_list.cfm
12. ATCCIS/LC2IEDM - http://www.mip-site.org/ATCCIS/ATCCIS_Home.htm
13. OPORD - FM101-5 Staff Organization and Operations, HQ, Department of the Army, (in PDF format)