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USING IT-21 TOOLS TO PROVIDE ASYNCHRONOUS DISTRIBUTED LEARNING (ADL) TO THE FLEET

by

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June 2000

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13. ABSTRACT *(maximum 200 words)* Information superiority is the foundation of Joint Vision 2010 battlefield dominance. Network Centric Warfare, robust infrastructure and information dissemination to dispersed forces are key elements in achieving information superiority. IT-21 is a fleet driven reprioritization of C4I programs to accelerate the transition to a PC-based tactical support warfighting network. Historically, cost and bandwidth have impeded distributed wargaming. Furthermore, when distributed wargames are conducted, they rarely present the scenario tactical picture to an individual using the same C4I systems used in actual warfighting. A solution is to use IT-21 tools to conduct distributed war games that are able to generate Gold formatted messages. The messages will simulate real-time track information into the Global Command and Control System (GCCS). These tracks can then be displayed on the same IT-21 systems used to fight. Such architecture will enable distributed training with units at sea. This capability would also enable collaborative planning at low costs. A proof-of-concept was conducted as an initial step in developing such a capability. The initial proof-of-concept showed the feasibility of the architecture. It demonstrated its use outside the Asynchronous Distance Learning (ADL) context to provide new collaborative capabilities to the Fleet, virtually anywhere in the world.

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USING IT-21 TOOLS TO PROVIDE ASYNCHRONOUS DISTRIBUTED LEARNING (ADL) TO THE FLEET

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ABSTRACT

Information superiority is the foundation of Joint Vision 2010 battlefield dominance. Network Centric Warfare, robust infrastructure and information dissemination to dispersed forces are key elements in achieving information superiority. IT-21 is a fleet driven reprioritization of C4I programs to accelerate the transition to a PC-based tactical support warfighting network. Historically, cost and bandwidth have impeded distributed wargaming. Furthermore, when distributed wargames are conducted, they rarely present the scenario tactical picture to an individual using the same C4I systems used in actual warfighting. A solution is to use IT-21 tools to conduct distributed war games that are able to generate Gold formatted messages. The messages will simulate real-time track information into the Global Command and Control System (GCCS). These tracks can then be displayed on the same IT-21 systems used to fight. Such architecture will enable distributed training with units at sea. This capability would also enable collaborative planning at low costs. A proof-of-concept was conducted as an initial step in developing such a capability. The initial proof-of-concept showed the feasibility of the architecture. It demonstrated its use outside the Asynchronous Distance Learning (ADL) context to provide new collaborative capabilities to the Fleet, virtually anywhere in the world.

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I. INTRODUCTION

The Genesis of the Naval Postgraduate School (NPS) Asynchronous Distributed Learning (ADL) Information Technology for the 21st Century (IT-21) project was the realization that the major components already exist to provide ADL. The NPS Systems Technology Battle Lab (STBL) is able to provide simulation-based ADL to participants distributed world-wide. The vision of offering educational scenarios to teach various warfare topics twenty-four hours a day, seven days a week, to students located anywhere in the world can now be realized in a cost effective manner. By integrating existing systems in the STBL in a unique way this capability can be made available to students that have an NT-capable PC with access to SIPRNET or NIPRNET. Students can use this capability to receive education credit for courses at NPS, JPME or for professional development. It can also be used for mission operation rehearsals prior to actual missions or for exercises to build confidence, competence, and esprit de corps. Students whose units or activities have SIPRNET access, an internet browser, and a minimum set of IT-21 tools will be able to participate in wargame-driven Distributive Collaborative Planning (DCP) sessions within the context of a realistic scenario. The sessions would allow the users to better understand the benefits of DCP by actually using their site's IT-21 DCP tools to monitor and assess a mission's life cycle.

In the fall quarter of academic year 2000, the NPS STBL provided wargame-driven vignettes that generated track data to simulate the Global Command and Control System (GCCS). The track information was made available for use by operation IT-21

DCP tools over the SIPRNET within the STBL. Students from the Joint Command, Control, Communications, and Intelligence curriculum at NPS participated in the initial execution. They tested the concept prior to it becoming available to a broader audience.

The specific technical architecture of the NPS ADL project involves sending C4I Gold messages from an IT-21 server installed as firmware on the GCCS server. Marine Air Ground Task Force Tactical Warfare Simulation (MTWS) scenarios are run ahead of time. The C4I output from the simulation is saved and later distributed to the IT-21 tools incrementally at appropriate times. Players with SIPRNET or MILNET access were able to log on to the appropriate GCCS/IT-21 server with other players and, by using a web browser and IT-21 tools, display track and messaging data in a collaborative learning environment. Initially, players are presented with web-based tutorials to learn how to use the IT-21 tools, followed by a presentation of the learning objectives for a particular collaborative scenario. Players use a common session and scenario. As the real-time scenario unfolds on their IT-21 PC, they collaborate to achieve the learning objectives. They will submit material to NPS faculty who evaluate it at a later date. Analysis of the data generated during the scenario play is used to score the sessions.

The goal of this thesis is to offer a statement of the problems that an effective, future version of the ADL project can be designed to solve. This thesis is concerned with a description of the project and its components which includes the development of educational material in the form of tutorials. These tutorials will be used to bring the project together in the ADL educational context culminating in a proof-of-concept test.

The results of the test and lessons learned along with conclusions and recommendations for current and future work will also be provided.

A. BACKGROUND

The evolution of command structures, increased pace and scope of operations, and the continuing refinement of force structure and organizations require leaders to have a knowledge of the capabilities of all four services. Without sacrificing their basic service competencies, these future leaders must be schooled in joint operations from the beginning of their careers. This leadership development must begin with rigorous selection processes and extend beyond formal education and training. Hands-on experience in a variety of progressive assignments must stress innovation, dealing with ambiguity, equivocality, and a sophisticated understanding of the military art. In short, leaders must demonstrate the very highest levels of skill and versatility in joint and multinational operations.

Joint doctrine is the foundation that shapes the way joint military operations are understood. The way in which leaders think and organize their forces will be as important as the technology used to conduct future joint operations. Future joint doctrine must not only articulate the process required for successful joint planning but also be flexible enough to serve as a broad framework to guide forces in joint and multinational operations. It is the key to enhanced jointness because it transforms technology, new ideas, and operational concepts into joint capabilities

Education and training programs must prepare joint warriors to meet the challenges of the future battlespace. These programs must emphasize employment of new technologies and achievement of the operational concepts outlined in this vision. It is essential that Joint Professional Military Education (JPME) programs provide warfighters with an understanding of strategic concepts in the future environment where military force will be applied. These concepts will take an in-depth look at individual service systems and how the integration of these systems enhance joint operations. The requirement for high quality training that is stressful and realistic in order to amplify education and fully prepare forces for joint operations is similarly important. Integration of joint capabilities must be emphasized along with the development of skills that increase individual and organizational effectiveness. Training must reflect emerging threats. It must include both information saturation and total interruption of information flow. Enhanced modeling and simulation of the battlespace coupled with on-ground evaluation of soldiers, sailors, airmen, and marines, can improve the realism of training. It will upgrade the levels of day-to-day readiness and increase opportunities to test innovative concepts and new strategies. Simulations must be interconnected globally—creating a near-real-time interactive simulation superhighway between forces in every theater. Each CINC must be able to tap into this global network and connect forces worldwide that would be available for theater operations. This network will allow selected units in CONUS to train with forces located in an overseas theater without actually deploying there. This global simulation network must include Reserve and

National Guard units, as well as selected multinational partners, to increase their readiness and interoperability.

The vision for future joint warfighting is described in Joint Vision 2010 (JV2010). JV2010 introduces the emerging operational concepts of Dominant Maneuver, Precision Engagement, Focused Logistics, and Full-Dimensional Protection enabled by Information Superiority. The Navy's response to adapt and develop new operational concepts in support of Network Centric Warfare is Information Technology for the Twenty First Century (IT-21). IT-21 is a concept; an umbrella term for the consolidation of existing programs and innovative applications. In addition, three Navy battle labs have emerged to test the new operational concepts: the Maritime Battle Center (MBC), the Sea-Based Battle Lab (SBBL), and the Systems Technology Battle Lab (STBL) at the Naval Postgraduate School (NPS). The ADL project, the basis for this thesis, was conducted in the latter.

B. PURPOSE OF IT-21

IT-21 is a reprioritization of existing Command, Control, Communications, Computers, and Intelligence (C4I) programs of record. These programs focus on accelerating the transition to a personal computer (PC)-based tactical and support warfighting network. The goal of IT-21 is to link U.S. forces (and, eventually, coalition forces) together in a Commercial-Off-The-Shelf (COTS) and Government-Off-The-Shelf (GOTS) network environment that enables voice, data, and video transmissions from a single desktop PC. This allows warfighters to exchange classified and unclassified, tactical and non-tactical information from a single desktop computer. It will shorten timelines and increase combat power. [Ref. 1] IT-21 represents a philosophical C4I warfighting process transformation:

- Away from expensive, single-function work stations to affordable, highly capable personal computers.
- Extensive use of web technology to manage data and produce knowledge.
- Seamless ashore/afloat transfer of voice, video, and data information.
- TCP/IP-based, client-server environment with multi-level security.
- Embracing industry standards, open architectures, and COTS.
- Merging of tactical and non-tactical data on a common infrastructure.

The principal elements of IT-21 are Asynchronous Transfer Mode (ATM), local area networks (LANs) afloat, and LANS/wide area networks (WANs) ashore populated by state-of-the shelf PCs. These networks integrate tactical and support applications with connections to enhanced satellite systems and ashore networks. It will be supported by regional network operating centers. All elements will be Defense Information Infrastructure (DII) Common Operating Environment (COE) compliant. [Ref. 2]

The NPS STBL has been updated with IT-21 tools to model the Sea-Based Battle Lab on the USS Coronado and the Maritime Battle Center's lab in Newport, Rhode Island. The purpose of the upgrade is to inject an academic viewpoint into experiments and research sponsored by the MBC and Commander, Third Fleet (COMTHIRDFLT).

C. PROBLEM STATEMENT

The first step in providing a learning environment to participants in our IT-21 Asynchronous Distance Learning (ADL) project is to develop educational materials in the form of web-based tutorials. A process is envisioned whereby military personnel will be provided with the opportunity to learn, through firsthand knowledge, the capabilities of C4I technology. The web-based tutorials will directly support the warfighter using network centric applications. These include GCCS, Common Operational Picture COP, IT-21 tools, and other new and emerging applications. Students will have the opportunity to familiarize themselves with the operation of these applications alone and, more importantly, as an integrated collaborative set of tools. In exploring the capabilities of IT-21 tools, students will develop the necessary skills to communicate ideas for planning and logistics. Web tutorials will be made available for testing in a newly developed Systems Technology Battle Lab course. The current course is focused on familiarizing students with IT-21 Tools, (COP), Enhanced Linked Virtual Information System (ELVIS), Net Meeting, Whiteboards, Chat, Email, Graphics, Desktop VTC, and MTWS. The prototype tutorials developed for the ADL project will serve as teaching aids for the course and are refined to an easily understandable tool. The web page will include tutorials on each of the IT-21 tools and read-ahead material. The intent is to make the products available on SIPRNET/MILNET so that the users may become familiar with them. They will learn to use these products in a more efficient and asynchronous manner. This effort will expose a number of questions related to learning objectives, assessment of learning, how materials will be made available to military personnel throughout the world, and other matters involved in establishing a database of interactive warfighting scenarios

D. THESIS ORGANIZATION

Chapter I provides a basic overview of the concepts and visions that are the background for this thesis. These concepts include Joint Vision 2010, Network Centric Warfare, and the Navy's IT-21. A statement of the problem is also described in this chapter. Chapter II furnishes the overviews of the applications used for the project. Chapter III describes the web-based tutorials developed for the project. Chapter IV covers the educational goals and the functional requirements needed. Chapter V explains what can be accomplished when using the IT-21 tools along with MTWS. Chapter VI describes the concepts that characterize how a prototype course should develop. Chapter VII explores problems that could be encountered during the design process. Chapter VIII provides a skeletal view of the project's early architecture. Chapter IX establishes the project's foundational needs which must be met from a technological standpoint. Chapter X recounts the testing and feedback process. Chapter XI chronicles the progression of events as experienced by students and relates the technical operation of the tools. Chapter XII delves into the difficulties confronting the project's development. Chapter XIII concludes and offers recommendations.

II. OVERVIEW OF PROJECT COMPONENTS

This chapter provides an overview and description of the principal IT-21 tools to be used in the ADL project.

A. ENHANCED LINKED VIRTUAL INFORMATION SYSTEM (ELVIS)

Recent technological advances in computer software and protocols have been the catalysts for an unprecedented level of system connectivity and information exchange. Web applications are now available that provide access to geographic plots and tabular displays of tactical information from remote GCCS hosts using only a browser with TCP/IP connectivity. ELVIS has emerged as the prototypical example with capabilities including high-resolution maps, Common Operational Picture (COP) view, tactical overlays, and Air Tasking Orders (ATOs). The tactical commander can remotely view situational displays maintained by different sites, access tactical databases, and evaluate data consistency between cooperating sites. The traditional C4I "push" of data between systems is augmented in several ways. They include on-demand internet browser "pull" of data, event-by-event webcasting "invited push" of data, or a push/pull custom blend which can be implemented using a variety of web tools (e.g., browser scripting languages and Java). [Ref. 3]

1. System Description

ELVIS I was designed to provide a platform-independent web browser interface to GCCS with sufficient user functionality to support C4I core services including:

- Selection of map products (with zoom, re-center, etc.)
- Control over tactical plotting and filtering (for units and overlays)
- Interrogation of tactical objects via point-and-click and ad hoc search
- Access to Air Tasking Orders (ATOs)
- Access to Airspace Control Orders (ACOs)
- Access to status-of-forces data (readiness, schedules, etc.)

In many settings, a web interface provides the most efficient means to access information from an easy to use browser interface. ELVIS I follows the browser paradigm and facilitates navigation through the information domain by tightly integrating tactical and status-of-forces data. Access control is provided by the challenge/response protocol between web browser and web server, with authentication based on a database of user accounts. ELVIS I is based on standard HTML (no Java) and is completely server-based. Specifically, ELVIS I consists of various Unix-based processes that cooperate with GCCS core services to make HTML documents. The only application running on the client is the web browser. There is no "ELVIS I" client; no additional software is loaded on the client. [Ref. 3]

The most prominent criticism of ELVIS I stems from the lack of dynamic, event-by-event positional updates. ELVIS II solves this problem by using Java. Java offers a true client/server environment with all of the advantages of HTML for remote access and hardware independence. ELVIS II reuses two of the key server components of ELVIS I, the GCCS track database module and GCCS geographic chart module. However, unlike

ELVIS I, the plotting of all tactical data (tracks, overlays, ATOs, etc.) is performed by the ELVIS II client Java applet. This is the basis of the ELVIS II client/server architecture. The GCCS server (coordinated by the ELVIS II server) performs map creation and track correlation. The client plots and declutters. User queries are serviced at either the client or server, depending on the type of query. A track's latest positional data is maintained at the client to permit rapid filtering, plotting, and query. Track histories are maintained at the server to minimize the client's memory footprint and to reduce bandwidth loading. [Ref. 3]

Each ELVIS II client maintains a TCP/IP connection to the ELVIS II server. This allows the ELVIS II server to coordinate and synchronize client operations, thereby enabling a collaborative planning mode. Although the COP is designed to synchronize tactical databases among cooperating sites, there is no provision in the COP to impose or enforce a common display representation. Two sites may have identical databases, but individual users can view different geographic areas with different plot controls (e.g., air picture versus surface picture). The ELVIS II architecture has been carefully designed to support "shared" display controls. The ELVIS II server accepts display/plotting instructions from a "master controller" ELVIS II client and forwards them to all "slave" ELVIS II clients participating in the collaborative session. These instructions are comprehensive across the full range of all map operations, track filtering and plotting, and object activation (for overlays, track groups, ATOs, etc.). It provides a single, shared tactical "canvas" on which users can draw using a set of scribble tools. [Ref. 3]

All users have complete freedom of action to annotate and draw on the shared canvas, but only the master controller can modify the canvas' geographic and tactical reference frame (i.e., the map, plot controls, object activation, etc.). The scribble tools respect geographical references so that map changes maintain the latitude/longitude positions of scribble objects. Furthermore, the state of a collaborative session is preserved so that late joiners to a session inherit the current canvas configuration including all active scribble objects. This single view collaborative feature was designed to facilitate a short planning session after which participants leave the session and return to their own view of the COP. Each user running Elvis over the web has five tabs or five defensive views of the world which each user designs. While one is being viewed the data in the other four tabbed views are also kept current. This facilitates switching views as the situation dictates e.g. air or land theatre views. These views can also be set up for multiple user sessions as described above and shared. [Ref. 3]

2. Technical Description

ELVIS II utilizes a form of communication known as the client-server paradigm. A server application waits passively for contact while a client application initiates communication actively. Information can pass in either or both directions between a client and a server. Typically, a client sends requests to a server and the server returns responses to the client. In the case of ELVIS II, the server provides continuous output without any request—as soon as the client contacts the server, the server begins sending data (e.g., the ELVIS II server sends continuous COP updates). A client and server use a transport protocol to communicate. ELVIS II utilizes TCP/IP. As Figure 1 shows, a ELVIS II interacts directly with a transportation layer protocol to establish communication. It sends or receive information over the Secret Internet Protocol Router Network (SIPRNET), the secret layer of the Defense Information Systems Network (DISN). [Ref. 4]

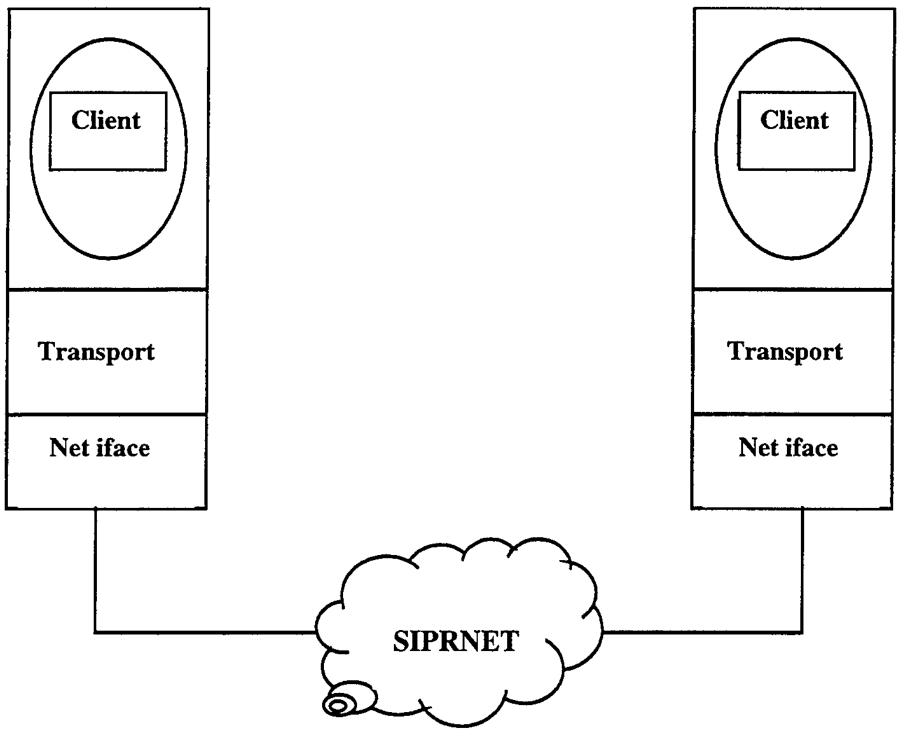

Figure 1 – Asynchronous Distance Learning Concept

B. GLOBAL COMMAND AND CONTROL SYSTEM (GCCS)

The Command, Control, Computers, Communications, and Intelligence for the Warrior (C4IFTW) concept dictates a requirement for the capability to move a U.S. fighting force anywhere on the globe at anytime, and to provide it with the information and direction to complete its mission. The Global Command and Control System is the mid-term implementation of this requirement. GCCS is an automated information system designed to support deliberate and crisis planning with the use of an integrated set of analytic tools and flexible data transfer capabilities. Modular by design, its applications can be shifted among common terminals regardless of the Service owner. When combined with the transmission capabilities of the Defense Information System Network, GCCS provides a global wide area network capability with a fused picture of the battlespace within modern C4I systems.

1. Systems Description

GCCS software applications are categorized into two groups: Common Operating Environment (COE) and Mission applications. [Ref. 5]

The Defense Information Infrastructure (DII) Common Operating Environment (COE) provides a standard environment, "off-the-shelf" software, and a set of programming standards that describe in detail how mission applications will operate in the environment. The COE contains common support applications and platform services required by mission applications. [Ref. 5]

The use of standard data elements is key to any automated system's success. Using standard data eliminates redundancies and provides a common base to facilitate information exchange, reducing time needed to set up a basis for data communication. GCCS is composed of several mission applications built into a single common operating environment networked to support sharing, displaying, and passing of information and databases.

2. Technical Description

The GCCS infrastructure consists of a client server environment incorporating UNIX-based servers and client terminals as well as personal computer (PC) X-terminal workstations operating on a standardized local area network (LAN). The GCCS infrastructure supports a communications capability providing data transfer facilities among workstations and servers. Connectivity between GCCS sites is provided by the SIPRNET. Remote user access is also supported via dial-in communications servers, or via telnet from remote SIPRNET nodes. [Ref. 5]

The baseline GCCS architecture consists of a suite of relational database and application servers. At most GCCS sites, the relational database server acts as a typical file server by hosting user accounts, user specific data, and site specific files that are not part of GCCS. The application servers host the automated message handling system, applications not loaded on the database server, and other databases. At each GCCS site, one application server is configured as the executive manager (EM) providing LAN desktop services. It also hosts applications not loaded on the database server. The EM server acts as the user interface providing access to GCCS applications through user identification and discrete passwords. [Ref. 5]

C. MAGTF TACTICAL WARFARE SIMULATOR (MTWS)

The Marine Air Ground Task Force (MAGTF) Tactical Warfare Simulation (MTWS) is a computer-assisted exercise support tool designed to support training of Marine Corps commanders and their staffs. MTWS is a follow-on program of the Tactical Warfare Simulation, Evaluation and Analysis System (TWSEAS). MTWS is able to support Command Post Exercises (CPX), Field Exercises (FEX), or a combination of both in which combat forces, supporting arms, and results of combat are modeled by the system. MTWS can be used to plan tactical operations, and to evaluate the plan under alternative enemy or environmental conditions. MTWS provides a full range of command and control capabilities including force initialization, planning and scheduling of amphibious operations, air operations and operations ashore, integration and analysis of intelligence data, analysis of comparative combat powers, and calculations and recording of combat losses. [Ref. 6]

1. System Description

MTWS provides a full spectrum of combat models. The major functional areas are Ground Combat, Air Operations, Fire Support, Ship-to-Shore movement, Combat Service Support, Combat Engineering, and Intelligence. The system provides limited play in Electronic Warfare, Communications, and Nuclear, Biological, and Chemical Warfare.

a. Ground Combat

The MTWS ground combat model provides for the direction, management, and simulation of close combat activities for other simulated and real exercise units. Ground unit representations include formation, frontage, heading, posture, assigned mission, and assets. Ground movements are affected by such factors as: terrain or road trafficability; weather conditions; equipment mobility characteristics; natural and man-made obstacles and barriers; and fuel availability. Enemy forces can be detected visually, aurally, or by the use of sensors. [Ref. 6]

b. Air Operations

MTWS models the following types of air missions: air reconnaissance, combat air patrol (CAP), airborne early warning, escort, transport, medical evacuation, tanker, ferry, deep air support, close air support, close-in fire support, and armed reconnaissance. Both fixed wing and rotary aircraft can be represented. Aircraft launch and recovery can be affected by weather conditions or air base status. Aircraft availability for further missions is affected by aircraft turnaround time and maintenance factors. Air defense play includes surface-to-air weapons and vectoring of CAP aircraft to intercept an enemy track. Airborne radar or passive electronic support measures can be used to detect other air or surface objects. [Ref. 6]

c. Ship-to-Shore Movement

Amphibious landing plans and contingency plans can be prepared and rehearsed in the simulated environment. MTWS can be used to identify beaches for surface assaults; landing zones for airborne assaults; amphibious shipping from which pre-loaded landing craft are launched; transport areas; rendezvous points; and special operation force departures. The system represents the variety of operational options including over-the horizon, underway launch, beaching, or causeway offloading. [Ref. 6]

d. Fire Support

The MTWS fire support capability includes ballistic weaponry such as artillery, mortars, multiple rocket launchers, ground-to-ground missiles, naval gunfire, and guided weapons such as surface and air launched cruise missiles. Fire missions can be scheduled, predefined for on-call initiation, or called for immediate fire. MTWS provides representation of control measures to include Coordinated Fire Lines, Fire Support Coordination Lines, Fire Support Areas, unit boundary lines, and Restricted Fire Areas among others. [Ref. 6]

e. Combat Service Support

MTWS models consumption of ammunition, fuel, water, and rations during the simulation to reflect Combat Service Support (CSS) play. MTWS can be used to plan and coordinate re-supply operations from beach supply areas or other supply points using ground, air, or water transportation units.

f. Combat Engineering

MTWS allows for the construction (instantaneously or over time) of structures, obstacles, barriers, minefields, roads, and bridges. Combat Engineering operations performed over time is based on availability and size of the unit or type of activity to be performed.

g. *Other Functions Modeled*

Other factors include weather (temperature, visibility, cloud cover, rain, humidity, sea state, and wind), physiological factors (fatigue), psychological factors (suppression, causalities), and NBC are also modeled.

2. Technical Description

MTWS executes on a UNIX-based distributed architecture consisting of three to six simulation processors, a system control workstation, and several controller workstations. The simulation processors run the combat models. The system control workstation manages the exercise clock, external system interfaces, and data conversions between the simulation processors. [Ref. 6] (Note: As of 07 June 1999, an interface allowing MTWS to access, retrieve, and insert GCCS database information to MTWS wargaming scenarios is possible. It was this capability of MTWS that was explored in the ADL project to send and reload track info for use by the GCCS server.

D. MICROSOFT NETMEETING

NetMeeting helps small and large organizations take full advantage of the global reach of the Internet or corporate Intranets for real-time communications and collaboration. While connected on the Internet or corporate Intranet, participants can communicate with audio and video, work together on virtually any 32-bit Windows-based application, exchange or mark-up graphics on an electronic whiteboard; transfer files, or use the text-based chat program.

1. System Description

The advent of NetMeeting 1.0 allows people to use voice communication to interact and collaborate over the Internet. NetMeeting was the first to introduce multipoint data conferencing capabilities based on the International Telecommunications Union (ITU) T.120 standard. NetMeeting 2.0 was the next major release of Microsoft's multimedia communications client. Building on NetMeeting 1.0 audio and data conferencing capabilities, NetMeeting 2.0 integrated new features as well as improved functionality and user interface enhancements.

First, NetMeeting utilizes Internet phone/H.323 standards-based audio support. Real-time, point-to-point audio conferencing over the Internet or corporate Intranet enables users to make voice calls to personnel and organizations around the world. NetMeeting audio conferencing offers half-duplex and full-duplex audio support for real-time conversations; automatic microphone sensitivity level setting to ensure that meeting participants hear each other clearly; and microphone muting, which lets users control the audio signal sent during a call. This audio conferencing supports network TCP/IP connections. [Ref. 7]

Second, NetMeeting utilizes H.323 standards-based video conferencing. With NetMeeting, a user can send and receive real-time visual images with another session participant using any video for Windows-compatible equipment. They can share ideas and information face-to-face, and use the camera to instantly view items. The user can display hardware or devices in front of the lens. Combined with the audio and data capabilities of NetMeeting, a user can both see and hear the other session participants as well as share information and applications. [Ref. 7]

Third, NetMeeting contains an Intelligent Audio/Video Stream Control tool. NetMeeting features intelligent control of the audio and video stream which automatically balances the load for network bandwidth, CPU use, and memory use. This intelligent stream control ensures that audio, video, and data are prioritized properly, so that NetMeeting maintains high-quality audio while transmitting and receiving data and video during a call. Using NetMeeting custom settings, organizations can configure the stream control services to limit the bandwidth used for audio and video on a per-session basis. [Ref. 7]

Finally, the bulk of NetMeeting's features are packaged in Multipoint data conferencing. Two or more users can communicate and collaborate as a group in real time. Participants can share applications, exchange information through a shared clipboard, transfer files, collaborate on a shared whiteboard, and use a text-based chat feature. Also, support for the T.120 data conferencing standard enables interoperability with other T.120-based products and services. [Ref. 7]

The following features comprise multipoint data conferencing:

a. Application sharing

A user can share a program running on one computer with other participants in the session. Users can review the same data or information and see the actions as the person sharing the application works on the program (for example, editing content or scrolling through information.) Users can share Windows-based applications transparently without special knowledge of the application's capabilities. The user sharing the application can choose to collaborate with other session participants, and they can take turns editing or controlling the application. Only the user sharing the program needs to have the given application installed on their workstation. [Ref. 8]

b. Shared clipboard

The shared clipboard enables a user to exchange its contents with other participants in a session using familiar cut, copy, and paste operations. For example, a participant can copy information from a local document and paste the contents into a shared application as part of group collaboration. [Ref. 8]

c. File transfer

With the file transfer capability, a user can send a file in the background to one or all of the session participants. When one user drags a file into the main window, the file is automatically sent to each person in the session, who can then accept or decline receipt. This file transfer capability is fully compliant with the T.127 standard. [Ref. 8]

d. Whiteboard

Multiple users can simultaneously collaborate using the whiteboard to review, develop, and update graphic information. The whiteboard is object-oriented enabling participants to manipulate the contents by clicking and dragging with the mouse.

In addition, they can use a remote pointer or highlighting tool to point out specific contents or sections of shared pages. [Ref. 8]

e. Chat

A user can type text messages to share common ideas or topics with other session participants, or record meeting notes and action items as part of a collaborative process. Also, participants in a session can use chat to communicate in the absence of audio support. A "whisper" feature lets a user have a separate, private conversation with another person during a group chat session. [Ref. 8]

2. Technical Description

Designed for corporate communication, NetMeeting 2.0 supports international communication standards for audio, video, and data conferencing. With NetMeeting 2.0, people can connect by modem, ISDN, or local area network using the TCP/IP protocol, and communicate and collaborate with users of NetMeeting 2.0 and other standards-based, compatible products.

NetMeeting is both a client and a platform. The NetMeeting client enables users to experience real-time, multipoint communication and collaboration program. The NetMeeting platform enables third-party vendors to integrate conferencing features into their own products and services. To support this dual purpose, Microsoft implemented NetMeeting capabilities using an open architecture of interworking components. Each component communicates with and passes data to and from the component layer above and below. This open architecture means that vendors can develop products and services that build on the NetMeeting platform and interoperate with NetMeeting client conferencing features. [Ref. 7]

At the core of the NetMeeting architecture is a series of data, audio, and video conferencing and directory service standards. These standards work together with transport, application, user interface, and conferencing components to form the NetMeeting architecture. At its lowest level, standards are responsible for translating, sending, and receiving NetMeeting information. The NetMeeting architecture includes protocols for modem and network TCP/IP connections. The modem protocol supports data-only conferencing connections and TCP/IP connections support NetMeeting audio and video.

The NetMeeting architecture is based on the following industry standards:

- The International Telecommunications Union (ITU) T.120 standard for data conferencing
- The ITU H.323 standard for audio and video conferencing
- The Internet Engineering Task Force (IETF) lightweight directory access protocol (LDAP) standard for directory services support.

These standards provide the framework for managing NetMeeting connections, data conferencing, audio and video capabilities, and directory server access. [Ref. 7]

III. TUTORIAL DEVELOPMENT

The initial step in preparing for a proof-of-concept was the development of educational material. The material was used to produce an ADL educational context and was developed in the form of web-based tutorials. The tutorials explained how to use each tool described in Chapter II. The tutorials were developed in such a way that a student could select the tool he/she wanted to learn how to use. Once the tool was selected, the student read an introduction to the tool and was presented with selections for each aspect of the tool. The student could select the first step in the tutorial or jump to any portion he/she would prefer to learn first. Students from the CC2041, Introduction to STBL, course were used to beta test the tutorials. Before the first session, the players read a primer on each tool. Then, they proceeded with training objectives and tasking in each tool's tutorial. The primer provided them with a chance to operate all the necessary features of each tool. Students worked through each of the IT-21 tutorials individually and in combination with other IT-21 tools. They also worked with other students to demonstrate the collaborative technologies. After the first introduction to the tutorials, results were collected through written survey with specific questions on functionality and usefulness of the tutorials. All surveys were examined and necessary adjustments were made prior to the next session. Subsequent versions of the tutorials had specific tasks for the student to complete in order to develop expertise with the tool.

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IV. EDUCATIONAL GOALS AND REQUIREMENTS

The need exists for resident students and officers world-wide to have access to classified web-based segments of warfare education for academic credit. The proof-of-concept should demonstrate that students whose units or activities have SIPRNET access, an internet browser, and a minimum set of Information Technology for the 21st Century (IT-21) tools would be able to participate in wargame-driven Distributive Collaborative Planning (DCP) sessions. A minimum set of IT-21 tools should include ELVIS-II and Microsoft Netmeeting with audio and minimal video on a PC running NT. The sessions should be within the context of a realistic scenario. The sessions allow the users to better understand the benefits of DCP by actually using their site's IT21 DCP tools to monitor and assess a mission's life cycle. Such activities would include situation assessment, generation of options, selection of course of action, and issue of execution orders. This course segment can also be provided to mobile units such as ships at sea that have SIPRNET access and the IT21 tools described above. [Ref. 9]

The NPS Systems Technology Battle Lab (STBL) provided wargame-driven vignettes that generate track data to simulate the Global Command and Control System (GCCS). The goals for the initial test in class were:

- To provide on-line access to unique, graduate level warfare educational experiences that no civilian institution could provide.
- Establish a basis for developing many more vignettes to support a variety of course work and to support operational commanders as well.

- Develop distributed course to teach the art of warfare, such as the importance of understanding span of control, unity of command, and Network-Centric Warfare (NCW).
- Establish these capabilities in an unclassified System Technology Lab (STL) to provide distributed collaborative warfare segments to a much larger audience using unclassified vignettes available on the NIPRNET.
- Demonstrate instructional capability to NPS personnel and demonstrate how this technical capability can be exported to the Naval War College, Tactical Training Groups, service academies, and other service schools and training activities within DoD.

A. PARTICIPANTS

Participants in the ADL project included Professor Gary Porter as the principal investigator, Professor Curt Blais who was MTWS support and Max Garrabrant who was the Visicom project officer in charge of MTWS development and scenario implementation. Dr. Lee Whitt, who is Vice President of INRI, IT-21, Elvis and C2PC Products and session connectivity issues. LT Michael Arguelles, USCG, Information Systems and Technology thesis student, developed and tested the IT-21 tutorials. Maj. Rick Williams and Maj. Chris Schlafer, USMC, Information Systems and Technology students, assisted in scenario development. The NPS CC2041 class, served as Beta testers for the proof-of-concept. Mr. Tom Hazard, Executive Officer of the NPS Distance Learning Resource Center, provided guidance and funded the project.

V. OPERATIONAL CONCEPT

The MTWS system has the capability to represent and execute combat situations involving land, air, sea, and littoral warfare. The system is able to generate a set of Over the Horizon (OTH) and United States Message Text Format (USMTF) messages for insertion into operational C4I systems (GCCS). The messages provide a real-time data feed to the C4I network. IT-21 NCW tools can then be used to visualize and act on the information provided by the messages. This means that MTWS can run a scenario and players can view the tracks and interact with them using C4I clients such as ELVIS and C2PC. The players can collaborate using shared whiteboards, chat, email, and Netmeeting with voice and desktop video teleconferencing (VTC). Experiments such as those conducted for the Adaptive Architecture for Command and Control (A2C2) project could be conducted in this way. MTWS would represent the warfare dynamics and command staffs viewing the tactical situation. They would collaborate with each other through IT21 tools. This approach was used successfully in the Bridge-to-Global exercise conducted in May 1999 at NPS. In this exercise, the Commander, Carrier Group One (CCG1), his staff, and other services representatives used IT-21 NCW tools for C4I interactions while the Common Operational Picture was driven by tactical messages generated by MTWS.

It would be reasonable to expect one or more of the C4I nodes in such an exercise or experiment to be located in a different geographic location other than NPS (e.g., aboard ship, at sea, off San Diego). Typically it would be prohibitive from a cost and bandwidth perspective to extend the operation of MTWS to such a remote user. However, it is possible, practical, and easy to conduct such an interaction from the IT-21 tools standpoint. Entry for the Stennis Combat Information Center (CIC) would be a connection to SIPRNET (already in place), NT machines (already available), and inexpensive, commercially available desktop video cameras and a sound card for NetMeeting. Such an architecture would enable distributed training with units at sea. They would be viewing the scenario (generated by MTWS) but being viewed from the same applications from which they normally operate (IT-21 NCW tools). Such a capability would enable collaborative planning and training over great distances and at low cost. [Ref. 9]

VI. PRELIMINARY ARCHITECTURAL CONCEPTS

In the course of developing tutorials and scenarios, team members came up with initial concepts for the project. The ADL Center should develop a prototype course characterized by these architectural concepts. The prototype course and subsequent courses should be organized around cohorts of learners. These learner cohorts should be identified, given orientation to the ADL, and managed as on-going collaborative learning units. On-line engagement with individuals, especially a group of individuals with whom there has been meaningful engagement, has been shown to increase the persistence and quality of learning.

The prototype course and subsequent courses should maximize the use of on-line resources. Readings should be available on-line and should include hyperlinks to related materials. Particular attention should be given to hyperlinking references to emerging international events. They may provide helpful real-time examples of the issues being exposed in the warfighting scenarios.

The prototype course and subsequent courses should utilize asynchronous discussion groups organized by learning cohort and by specific issue. Participation in these text-based discussion groups should explicitly constitute a significant proportion of the student's grade. The discussion groups will feature faculty facilitation and are likely to change focus on a weekly basis. Early studies have suggested that asynchronous text-based interaction results in more detailed and higher order analysis than oral discussion.

The prototype course and subsequent courses should involve the learners in creating web-based learning materials to be utilized by future learners. The ADL is especially well suited for this purpose. Individual learners, or a cohort operating together, might research a real-time example of a current warfighting event. They would organize the results of such research as an on-line learning mini-module. This process of creation for specific future utilization has often been shown to focus the attention of learners and reinforce the application of core principles.

Given time constraints, it is appropriate to anticipate phased development of the prototype course. In other words, it is likely that not all desired elements of the course will be available in its initial version. The totality of the initial version will provide a learning experience with fundamental quality and will be well-suited for continual improvement.

Taken together, effective implementation of these preliminary architectural concepts would result in a web-based learning structure. In such a structure, there is access to a wide array of historical and contemporary information. Learners and outside experts interact on both synchronous and asynchronous basis. Learning and where is focused on developing analytical skills and applying those skills to the real-world professional lives of military officers.

VII. ARCHITECTURAL PROBLEMS

The context set out in previous chapters reveals several architectural problems for the design of an effective web-based ADL. The following are individual problem statements that best articulate the issues that should be solved by a well architected ADL.

A. PROBLEMS OF FUNCTION

1. How does ADL ensure easy distribution of and access to web-based material?
2. How does the ADL course design ensure effective supplementation of material with meaningful on-line resources?
3. Should the ADL course design ensure the leveraging of the potential for all armed services to develop leadership skills?
4. How does the ADL course design ensure that the asynchronous potential of web-based Learning is optimized and the interaction between faculty and learners and between learners and other learners is sufficient for collaborative engagement of the frameworks, schemas, and fighting scenarios?
5. How does the ADL course design provide for an effective demonstration that the learner is able to apply the frameworks and schemas to direct "real-time" experiences?
6. How does the ADL course design ensure that faculty coaching is facilitated as effectively on line as has been the case in a classroom setting?

7. How does the ADL course design inform the development of appropriate policy amendments related, support for learning, assessment, and more?

B. PROBLEMS OF FORM

1. How does the ADL course design ensure that its design also advances and informs the development of an overall architecture for the course or degree completion?
2. How does the ADL course design ensure that while learners are on-line, their readiness for Network Based Learning is facilitated?
3. How does the ADL course design ensure the experiential potential of Web-based Learning, especially in regard to application of the learning outcome to "real-time" experiences?
4. How does the ADL course design ensure that the needs of diverse learners with different learning styles and preferences are sufficiently addressed so that, potentially, all learners find the learning process meaningful?
5. How does the ADL prototype course design meaningful engagement with learning, even when that engagement is autonomous or asynchronous?

C. PROBLEMS OF ECONOMY

1. How does the Distributed Learning Resource Center ensure that the problems identified in this document are sufficiently solved, and a prototype ADL course is deployed on schedule, within a specified budget?

D. PROBLEMS OF TIME

1. How does the Distributed Learning Resource Center ensure that an effective prototype course is ready for full faculty and learner engagement on a specified date?
2. How does the Distributed Learning Resource Center ensure that the lessons learned from designing and deploying the prototype course are applied quickly and efficiently to the development of subsequent courses?

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VIII. PRELIMINARY ARCHITECTURE

Consistent with the architecture outlined above, a preliminary architecture is proposed. This preliminary architecture is provided to define the scope and scale of the immediate task. Also, to seek confirmation from the Distributed Learning Resource Center that such a solution is coherent with what the Group considered possible and appropriate. If accepted or mandated, this preliminary architecture would provide the foundation for a much more detailed process of architecture.

A. FUNCTIONAL ELEMENTS

The web-based learning version will consist of a series of learning modules, a remotely accessible database of readings, and a multi-track communications suite.

The learning modules will be optimized for delivery via the Internet. The modules will consist largely of:

1. Read ahead materials
2. Tutorials
3. Scenario requirements and deliverables
4. Experiential activities and other learner feedback mechanisms designed to conform learner understanding in real time
5. A collection of hyperlinks selected to reinforce the exercises.

It is anticipated that the ADL learning module will consist of three sequences. The three sequences will focus on: 1) learning how to use the IT-21 tools in individual sessions, 2) logging on with other nodes and completing an IT-21 collaborative planning training session, 3) looking at a scenario on dynamic display and preparing an execution plan which will require collaborative planning under time constraints with other nodes.

B. ELEMENTS OF FORM

All functional features will reside within an overarching web-based structure, including a customized graphical user interface. This structure will anticipate the development of the post-prototype courses. A micro-portal will be included in this structure. This is essentially a homepage which learners will use as a daily access point. This micro-portal will feature tutorials and ongoing updates. It will have linkages to real-time events related to the learning objectives of military strategy in coalition warfare and operations other than war.

Most learners are motivated by being presented with realistic and consequential problems to solve, and having access to a problem-solving tool-kit to apply. The micro-portal should provide regular reinforcement, feedback and ease of navigation.

IX. TECHNOLOGICAL ARCHITECTURE

Technology and the Internet are rapidly changing environments. There is often a desire to use the "latest and greatest" or, conversely, the lowest cost technology while foregoing the effort it takes to understand purpose before seeking solutions. By not expertly completing this crucial first step, the cost to the client is manifested in unused features, inadequate performance, incompatibility, record-keeping problems, and growth limitations, to name but a few.

The most appropriate technology for the purposes of the client and the end user should be fundamental to the architecture principles. To that end, when architecting the technological framework, requirements are investigated until a clear picture of the primary purpose emerges. This clear picture of the primary purpose is what architects call an "axis of design". IT-21 tools are mandated for this project.

In the case of the ADL project, the axis is clearly the collaborative activities that are expected to facilitate the exchange of ideas while elevating the standards related to students' critical thinking. Further, there is a specific need to support written exchanges. One of the key skills expected of students is the ability to write concise, cogent statements of analysis and/or recommendation. Because the students are geographically dispersed, the use of web-based communications is crucial.

Rather than leaping to what seems to be an obvious solution, an examination and refinement of initial requirements were conducted. In this case, an examination of the collaborative requirements revealed:

1. Logistics: The logistics of holding real-time exercises or discussion are problematic because students are in different time zones and their time availability may differ.

2. Participation: At this time, identifying and scheduling participants in each exercise has not been addressed. A solution will need to be established prior to publishing any materials.

3. Quality: How the student will be evaluated. Has he made sound leadership decisions?

4. Timing: Speed of response for related tasks is appropriately measured in hours, not seconds or minutes.

5. Formats: There may be a need for constructive discussions (debriefings) during or upon completion of the exercises.

6. Records: An archive of classic solutions to exercise scenarios must be kept for comparison and analysis.

7. Brevity: It will be useful to be able to edit and display excerpts of previously solved scenarios during debriefs.

Based on the analysis of these requirements it became clear that a real-time chat utility would be pedagogically appropriate. Because there will be no moderation during each activity, a real time form of communication is necessary. The obvious solution to this problem falls within the parameters of the IT-21 tools. It is free, easy to use, and is proven technology. It is clear that the chat format, by its synchronous nature, would significantly facilitate and, in some cases, actually accelerate that attainment of nearly every objective of the distance learning activity.

With a firm grip on what was required and using the common underlying technology, it is possible to further exploit the site's modular design described below. It is a straightforward task to leverage the digital library component to handle the archiving of forum exchanges. The next step was to develop a browser-based tool to add to the growing tool set with which the forum can be administered.

Simple e-mail was incorporated in the system to provide a back-channel for one-on-one, private exchanges between players. Because of the security of the system, its browser-based tools, and its incorporation of e-mail notification, players can continually be added to each exercise. Imagine the powerful learning opportunities awaiting students when they can be invited to exchange ideas with great minds, diplomats, academics, and military leaders. These notables will have a simple to use forum to share their experiences with a small group of enthusiastic learners. And, of course, those exchanges can and will be archived for future use.

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X. CONCEPTUAL DEMONSTRATION

The NPS STBL provided wargame-driven vignettes that generated track data to simulate the GCCS. The track information was made available for use by operation IT-21 DCP tools over the SIPRNET within the STBL. Students from the Command and Control curriculum (CC2041) at NPS participated in the initial execution.

In addition to the C2 students mentioned above, masters-level thesis students were enlisted to help develop the set of scenarios for the demonstration. Theses students developed educational material used to produce an ADL educational context. For example, before each session, players were provided read-ahead material on a web page or via electronic mail. These materials included a description of each of the tools and a tutorial on their use. The descriptions and tutorials covered use in general and for upcoming training sessions. The web site also provided a feedback mechanism via e-mail or other methods. This allowed the players to critique the process and provide input to a Frequently Asked Questions (FAQ) file. Additional information provided was the Operational Order (OPORD) for the training scenario, Order of Battle (OOB), training objectives, grading criteria, and intelligence summaries. The students filled out forms to provide valuable feedback to the instructional approach.

Industry partners, VisiCom and INRI, were tasked to provide focused expertise in the creation of the initial capability. VisiCom, San Diego, is the developer of the Marine Air-Ground Task Force (MAGTF) Tactical Warfare Simulation (MTWS)), a primary combat simulation and wargaming tool installed in the STBL. VisiCom developed and executed the scenario(s) on MTWS to develope C4I systems manned by the students. INRI is the developer of the ELVIS-II C4I client. INRI helped integrate the IT-21 tools and communications components within the STBL, including the ability to form ADL sessions.

XI. EDUCATIONAL PERSPECTIVE

In preliminary sessions, the students will meet together in the STBL and be provided with instruction and tutorials on operation of the IT-21 tools. Between sessions, students will be given read-ahead materials via e-mail or web site access.

In subsequent sessions, they will log in together via the ELVIS capability to establish "collaborative sessions" with multiple players. The students will form a future operations planning cell (two separate teams) providing recommendations to the Joint Task Force Commander. These recommendations will address the best organization of force authority, establishment of lines of communication, and allocation of resources to conduct the operation.

Prior to the first session of "live" collaborative planning, the students will be provided with a mission order. They will also receive initial information on their own-force assets and preliminary information on the enemy force strength and positions. This information will become more complete as the students proceed through the planning sessions. Between planning sessions, additional information on own-force resources or enemy operations may be provided to the students by e-mail or web site access.

In the first session involving "live" collaborative planning, the students will be presented with the operational situation at D-5 displayed on their IT-21 tools. The students will be required to collaborate (in two separate teams) to prepare and deliver an execution plan. During the session, additional intelligence on the enemy forces will become available through reconnaissance assets employed in the area of operations. This information will be received by the C4I system via tactical messages generated by MTWS (see Figure 2).

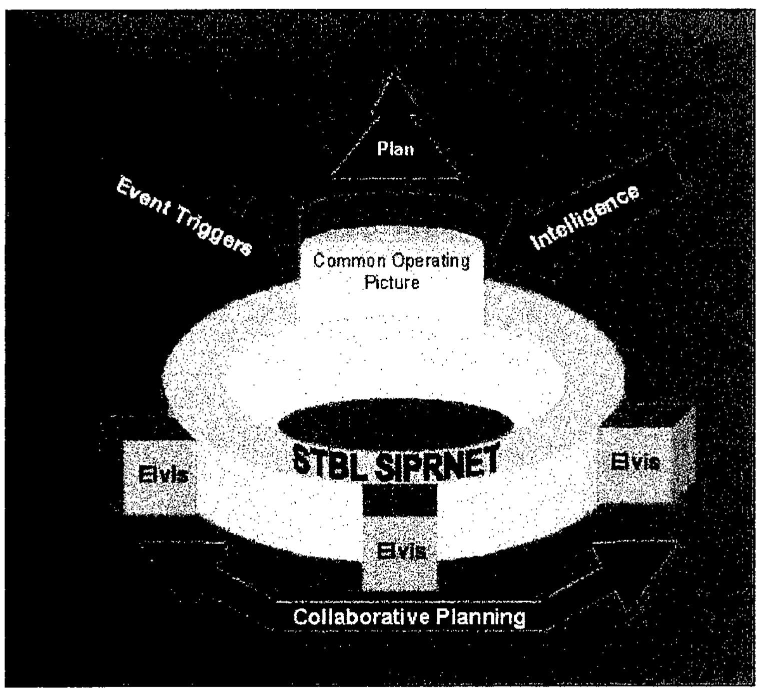

Figure 2 – Asynchronous Distance Learning Concept

dynamic, tactical situation at D-1 day. During the time they are on the system, they will watch the scenario unfold in real time. The system will have instructional "triggers" that will make it necessary for them to collaborate to re-plan the future operation. The new plan will be submitted as a deliverable for grading. Again, the students will be presented with new information (via tactical messages injected into the C4I system from MTWS) as the D-1 scenario plays out during the session.

In the final collaborative planning session, the students will watch the D-Day operation unfold and evaluate the success or failure of the operation. Based on their evaluation, they will be required to submit a recommendation regarding the insertion of follow-on forces. The students will also be asked to evaluate the command, control, and communications organizational structures considered during the exercise.

This instructional sequence is summarized in the course syllabus shown in Table 1.

Table 1. NPS CC2041 Course Syllabus (Fall 00 Quarter)

Session	*Activity*
1	Introduction, security indoctrination, and overview of IT21 applications
2	Complete security indoctrination, WWW/HTML, and home page project
3	WWW/HTML, home page project, and begin learning IT21 tools
4	Hands-on introduction to IT21 Tools: COP, C2PC, ELVIS, NetMeeting, Whiteboards, Chat, Email, Graphics, Desktop VTC
5	Complete hands-on with IT21 tools; Introduction to MTWS
6	Introduction to IT21 Collaborative Planning Homework: Complete IT21 Tools hands-on tutorial
7	Practice use of IT21 Tools in collaborative sessions Homework: Sign up in teams of 2 to complete IT21 collaborative planning training session
8	D Day –5: Use IT21 tools to collaborate during a real time scenario driven by MTWS. Two teams, one of 4 and one of 6 students. One team completes during class time. One team signs up for 2 other hours in STBL.
9	D Day –1: Use IT21 tools to collaborate during a real time scenario driven by MTWS. Maintain same teams and arrangement of times to use STBL.
10	D Day: Use IT21 tools to collaborate during a real time scenario driven by MTWS. Maintain same teams and arrangement of times to use STBL.
11	IT21 ADL wrap-up. Conduct demonstrations of WWW projects.
Grading is pass/fail and is based on the HTML project, the exam, the demonstration of applications knowledge, and on preparation and participation in class and during the AT21 ADL sessions.	

A. TECHNICAL PERSPECTIVE

MTWS will not be employed directly to support the initial ADL demonstration. Instead, MTWS scenarios will be run ahead of time. The C4I output from the simulation will be saved and fed to the IT-21 tools incrementally at appropriate times. This reduces the number of personnel required to support the collaborative planning sessions considerably. Also, running the simulation simultaneously with the planning sessions could cause the students to want to be more reactive to the operational situation. It is more important for them to look ahead to future operations based on information obtained from the status of the current operation. Therefore, the scenario can be pre-played in MTWS and the C4I messages generated by MTWS during the executions will be saved for later replay (see Figure 3).

Software will be developed to enable the operations staff in the STBL to initiate replay of stored C4I messages generated during execution of the scenarios on MTWS. The software will enable the user to identify the file of saved messages desired for this planning session with the students. The user will enter the actual time the scenario was run in order for the messages to be properly synchronized with the real-time clocks in the C4I systems (i.e., GCCS). When the time is entered, the software will a pass through the logged messages and will make adjustments to the message timestamps accordingly.

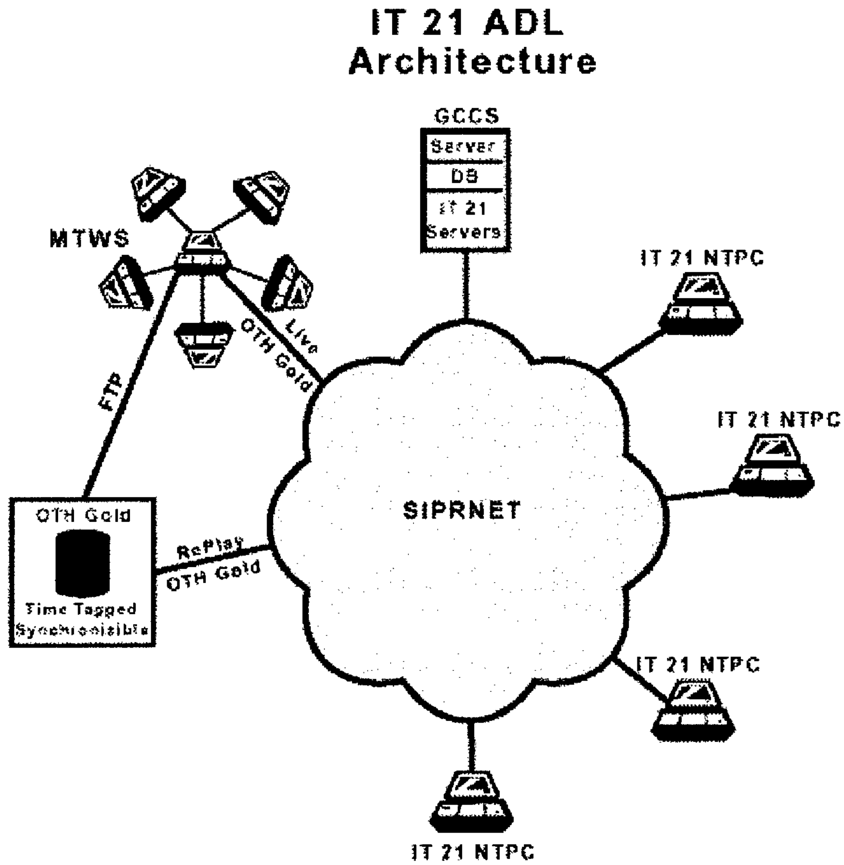

Figure 3 – Initial ADL Support Concept

After pre-processing the messages, the software will enable the user to initiate injection of the messages to the C4I system (GCCS). This will employ the same mechanisms normally used by MTWS to communicate with real-world C4I systems.

VisiCom will be tasked with development of this software to use saved message files generated by MTWS. VisiCom has also prepared the game files and will execute the scenarios to produce the message logs for the D-5, D-1, and D-Day situations. [Ref. 9]

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XII. LESSONS LEARNED

The initial phase of the project exceeded the objectives for this first iteration of the ADL concept. The work was extremely successful in demonstrating what possibilities there are for the future. The following remarks provide a brief summary of observations from the first implementation of the C4I Asynchronous Distance Learning (ADL) capability.

A. PRE-PLANNING AND SCENARIO PREPARATION

During preparation of the scenario files and execution in MTWS, there was some confusion over terminology such as command batch files and message playback. This made planning a bit more difficult. There should be more up-front planning and discussion to ensure that everyone has the same understanding of capabilities, objectives, and approach. A plan of action with milestones should be agreed upon and worked toward. This will minimize variance in the performance of the work.

A realistic, practical, and attainable scenario needs to be agreed upon as early as possible. Establishment of the scenario should ensure availability of map and terrain data for the area of operations. Due to unavailability of such resources, it became necessary to shift the location of the scenario which introduced some situational artifacts. With the appropriate data, the scenario could have more closely followed previous iterations of the A2C2 experiment.

There was a problem with the source message file developed for the D-Day iteration of the 4-node organization. JUNIT messages with positions of Blue ground forces were not being transmitted to GCCS. This hindered student interactions with the C4I system on the final day of the instructional sequence. There were no problems with the other message log files. [note: the problem in the source message log file has been corrected but needs to be verified in the lab]. The plan of action with milestones should allow for more testing time at the contractor facility prior to installation and testing at NPS.

B. APPLICATION OF MTWS AND THE MESSAGE INJECTION TOOL

The message injection tool has the capability to adjust timestamps in the messages generated during execution of the scenario on MTWS. In JUNIT messages, the timestamp in the message header and timestamps in the JPOS lines were adjusted. In CTC messages, only the message header was adjusted. This resulted in apparent time-late indications on tracks in GCCS (e.g., ships).

After generating the message injection file with modified timestamps, it would be good to have the capability to choose a starting time. For example, if the timestamps were adjusted relative to 301200Z NOV 99, the user needs the capability to tell the software to start sending the messages that are timestamped after a certain time (e.g., 301230Z NOV 99). The user should have the option to either inject the prior messages immediately (without delay) or to bypass those messages altogether. In practice, based on the experience in this first iteration, the first option would be the one generally employed.

In order to reach the scenario H-Hour early in the 2-hour class session, it was necessary to initiate the message injection quite frequently before the class session started. Having this option would have simplified control over injection of the message traffic.

When the message injection has completed (or has been stopped by the user), it would be useful to have an option to direct the software to send drop-track messages to clear the simulated tracks out of GCCS. This would enable rapid clean-up of the GCCS track database after each session (although manual deletion of the tracks on GCCS proved to be very easy to perform).

Since the NPS students come from all branches of the military, MTWS spot reports should provide both UTM and Lat-Long positions in the report content. This would simplify understanding and plotting of data by the students.

C. GCCS COMMUNICATIONS HANDLING:

A very useful feature was the ability to set up an e-mail channel with multiple users and the ability to auto-forward the tactical messages to the e-mail accounts. We were not able to auto-forward messages that did not have a decoder assigned in GCCS; specifically, the INTREP and RECCEXREP messages. An attempt to modify the COE MprTable that assigns decoder actions to certain message types did not work. We would like to see this capability corrected in GCCS if possible. It did prove possible to manually forward these messages to e-mail accounts.

We were unable to find a way in GCCS to assign different message types to different e-mail users in the auto-forward table. This feature would be useful to enable us to direct intel-related messages to one user (or set of users) and operations-related message to another user (or set of users), or other such combinations. The possibility of creating message routing filters on the mail server side was discussed. It needs to be investigated to determine if it would be a viable alternative to having the capability in GCCS.

It might be useful for MTWS to support one or more email channels for some message types. This would provide additional flexibility in routing messages – flexibility which would not be dependent on the GCCS email channel. This would allow scenarios to include real email messages (i.e., free form text which is not in any DoD message format). It is noteworthy that this form of correspondence is becoming increasingly predominant in military operations.

D. ELVIS, THE IT-21 COLLABORATIVE TOOLS, AND THE LEARNING ENVIRONMENT

Either the students did not receive sufficient instruction in the use of the tools or they did not apply themselves fully to becoming proficient in the tools, particularly use of ELVIS. As demonstrated on the final day, the ability to preset ELVIS map tabs is a useful collaboration feature that was not exploited effectively by the students. There may be other features that should be emphasized in their training, possibly by creating the dynamic environment earlier in the course. They can become familiar with the tools and the message traffic before the actual problem play occurs.

It might be worthwhile to develop a training guide focused on a specific scenario (versus a guide on the use of each application window) as a way to "seed" the students' thinking processes. It has always been a challenge to teach the operational use of a C2 system versus the "static" use of each window. The introduction of collaboration introduces significant complexity into the employment of C2 systems. We are not aware of any DoD documentation that describes how collaboration should be used in C2. With the significant focus on the use of collaboration, this seems to be a glaring deficiency.

It would be helpful if students could develop and link HTML pages to the tactical display. Since ELVIS-II allows a user to add a URL to the tactical display, this capability allows tacticians to easily annotate the display with amplifying information. In order to fully exploit this capability, IT-21 tools for web page creation need to be available and utilized by students.

The students need a brief instruction to the format of MTWS spot reports embedded in OTH-Gold OPNOTE messages. They also need instructions in reading the typical C4I formatted messages that were provided in the scenario (TACREP, RECCEXREP, INTREP).

The students need to be provided with a list of the identification of own-force and suspected enemy force units. When identified enemy forces appeared in tactical messages, the students had difficulty recognizing which units belonged to which side. This misunderstanding may be prevented simply by better knowledge of own-force units and by providing instruction in interpreting MTWS information embedded in the tactical message formats, as discussed above.

One of the keys to collaboration is to establish a common focus on all key tactical "objects", which include non-track objects such as hilltops, ports, and airports. Perhaps these should be included in the MTWS scenario. If not included, they should be used to gauge/measure the students' ability to identify and input key reference points. These reference points, taken from the mission statements and operations plans, should be shared among participants. Collaboration will be more effective if there is a common frame of reference extending beyond the background map and the COP tracks. This common frame of reference forms the basis for decision analysis throughout the scenario.

Prior to the start of each lab session, each student workstation should be prepared for the activities to be performed that day. It appeared that too much time was lost while students logged on and brought up the various programs for that day's activities. In some cases, initialization procedures had to be performed if the students were not already set up properly. Also, the students did not necessarily bring up all products that might have been useful for that session.

E. THE CC2041 COURSE OBJECTIVES AND SCHEDULE

The A2C2 background provided a good foundation for the context of the class and the scenario. However, future learning objectives and C4I research avenues may be better served by moving away from the A2C2 experimental objectives. They should look deeper into the use of the collaborative tools. For example, the learning objectives of future versions of this course could emphasize learning the collaborative environment including the ELVIS C4I client. Emphasis on learning the collaboration environment would give insights into new technology and allow feedback from students. This feedback should include ideas for better ways to employ the tools and recommended enhancements to the tools. [Ref. 9]

XIII. RECOMMENDATIONS AND CONCLUSION

The initial proof-of-concept clearly demonstrated the technical feasibility of the concept. As a side benefit, it provided an initial set of instructional and tutorial material for the C4I client systems and for the IT-21 collaborative tools. The initial capability can be readily replicated for follow-on use. Additional scenarios can be defined and executed in MTWS to produce a broader set of problems for students.

A. RECOMMENDATIONS

The following new work is recommended to extend the initial capability and to maintain momentum in this development toward a fieldable Fleet capability:

- Continue to enhance on-line tutorial materials and scenario support materials.
- Determine and implement the architecture necessary to extend the capability to the unclassified MILNET in order to reach a larger audience. This requires access to an unclassified GCCS/ELVIS environment by INRI and creation of an NPS web site where the scenario replay files (message logs) can be executed to dynamically populate the C4I database.
- Design and develop the runtime environment to enable geographically distributed students using ELVIS and other IT-21 DCP tools to independently and asynchronously join these DCP sessions. This would require coordination over selection and execution of the injection of the C4I message log into the C4I system. The long-term goal is for users to be able to select from a library of scenario files and to be able to conduct collaborative planning sessions on-

demand. As an intermediate step, the scenarios can be scheduled for execution at specific times. The schedule would be provided to the user community via a web site. For example, a collection of scenario vignettes could execute in a continuous loop, 24 hours a day, 7 days a week.

Implement the following enhancements identified in the Lessons Learned from the initial phase:

- Correct the timestamp inconsistency in the C4I messages generated by MTWS.
- Provide the capability to choose a starting time after generating the time-adjusted message file.
- To facilitate repeated execution of the scenarios, modify the message injection software to initiate automatic deletion of synthetically introduced tracks in the C4I system after completion of the session.
- Modify MTWS spot report formats to provide both UTM and Lat-Long positions in the report content to allow a broad set of users to better understand the data contents.
- Determine and implement a method for auto forwarding selected message types to specific users on the network. To augment the capability in GCCS, determine the feasibility of having MTWS support one or more email channels for selected message types. This would provide additional flexibility

in routing messages – flexibility which would not be dependent on the GCCS email channel and would allow scenarios to include real email messages.

- Develop learning objectives and tasks that lead the students to more effective and extensive employment of the DCP tools. Include tools and techniques such as creating and linking HTML pages to the tactical display and creating predefined display tabs to enhance collaboration.
- Develop a training guide focused on a specific scenario (versus a guide on the use of each application window) as a way to "seed" the students' thinking process.
- Develop on-line instructional materials describing the format of MTWS spot reports embedded in OTH-Gold OPNOTE messages and on reading the typical C4I formatted messages that occur in the scenario (TACREP, RECCEXREP, INTREP).
- Determine and implement improved lab management procedures to facilitate initialization of the tools needed by the students in the lab environment. Develop guidelines for creation/configuration of the learning environment on remote systems.

B. CONCLUSION

Clearly, the process demonstrated in the initial proof-of-concept can be used outside of the ADL context to provide new capabilities to the Fleet. It can be done at a very low cost of entry virtually anywhere in the world, including at sea, using the same

IT-21 tools that the warfighters normally use. Mission planning and rehearsal is a key target for this capability. Consider an operation in which two Battle Groups and an Amphibious Readiness Group are going to be operating together in a month from now. MTWS can be used to place the units together at the distant location (virtually). Using their IT21 tools, the players can start now to learn how to collaborate in the distant environment as though they were already there. This will result in more cohesive staffs when they deploy. Also, during the "zero-dark-thirty" watch in some command post, the watch team could run scenarios to learn or hone their skills in different warfare areas.

In the future, it is envisioned that students will use their own mobile or fixed site's IT-21 DCP tools (or dynamically download the Java-based DCP tools in ELVIS-II to their site) to complete the assignment by actually conducting distributed planning with students at other remote sites. Students will be able to asynchronously join the DCP vignettes without STBL staff intervention.

From an NPS perspective, segments could be offered for credit and for tuition. Tuition would provide students access to the web site, web-based course material, schedules of vignettes, and information required to join the vignettes. Students would provide specified deliverables such as plans and execution orders via email to faculty. The student material would be critiqued and graded by NPS staff at a later time. Since the staff would generate scenarios, grading criteria could be established on a priority basis.

C. OTHER COMMENTS

A "Netscape" model could be used where potential students are allowed to participate in demonstration sessions and then decide if they wish to participate for credit and associated tuition. Tuition funds could be used to reimburse course development and administration, STBL staff, and recapitalization of STBL equipment.

A new dimension to the concept would be to enable users to have direct control over creation and manipulation of the scenario play in MTWS. This would enable students or operational users to develop courses of action, play them out, evaluate the outcomes, and then iterate the process. The Marine Corps is funding a set of enhancements to MTWS to facilitate its operation for course of action assessment support. These modifications will enable a smaller number of MTWS operators to more efficiently control larger forces. However, further modifications are needed to further improve its ability to support operations of this type.

Web-based access and game control. The MTWS program is fielding a PC-based user workstation in Government FY00. Mechanisms need to be provided to enable a user possessing this workstation to be able to access an MTWS site over a network (e.g., SIPRNET to the STBL) and to establish an execution or to join one in progress.

Semi-automated combat models. Greater automation in areas such as ground combat, fire support, and air support would reduce the control and command entry tasks for users.

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GLOSSARY OF TERMS AND ACRONYMS

A2C2	Adaptive Architectures for Command and Control
ADL	Asynchronous Distance Learning
C2PC	Command and Control Personal Computer
C4I	Command, Control, Communications, Computers, and Intelligence
CCG1	Commander, Carrier Group One
CIC	Combat Information Center
COP	Common Operating Picture
DCP	Distributed Collaborative Planning
DoD	Department of Defense
FAQ	Frequently Asked Questions
GCCS	Global Command and Control System
HTML	Hypertext Markup Language
IT21	Information Technology for the 21st Century
MAGTF	Marine Air-Ground Task Force
MILNET	Military Network
MTWS	MAGTF Tactical Warfare Simulation
NCW	Network-Centric Warfare
NIPRNET	Non-classified Internet Protocol Router Network
NPS	Naval Postgraduate School
OOB	Order of Battle
OPORD	Operational Order
OTH	Over-the-Horizon
PC	Personal Computer
SIPRNET	Secret Internet Protocol Router Network
STBL	Systems Technology Battle Laboratory
STL	System Technology Laboratory
USMTF	United States Message Text Format
VTC	Video Teleconferencing
WWW	World-Wide Web

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