



THEATER BATTLE MANAGEMENT CORE SYSTEMS

VIRTUAL UNIVERSITY

FINAL REPORT

PROOF OF CONCEPT TRADE STUDY FOR TYPE-1 OPERATOR TRAINING

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Experimentation

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ACRONYMS

Acronym	Meaning
AOC	Air Operations Center
COTS	Commercial of the Shelf
DOD	Department of Defense
ELMS	Electronic Learning Management System
ENB	Engineering Notebook
ESC	Electronic Systems Center
HTML	Hyper Text Markup Language
HTTP	Hyper Text Transfer Protocol
HTTPS	Hyper Text Transfer Protocol Secure
IE	Internet Explorer
IIS	Internet Information Server
Kbps	Kilo Bites per Second
LM	Lockheed Martin
LMS	Learning Management System
MTT	Mobile Training Team
NAT	Network Address Translation
NS Software	Nelson Stiltner Software
PTT	Part Time Trainer
ROI	Return on Investment
RFQ	Request for Quote
SCORM	Sharable Content Object Reference Model
SPO	System Program Office
SSL	Secure Socket Layer
TBMCS	Theater Battle Management Core Systems
TMS	Topaz Managed Services
TTD	Technical Task Directive
VAR	Value Added Reseller
Vendor #1	Centra
Vendor #2	ILinc/NS Software
VOIP	Voice Over Internet Protocol
VU	Virtual University
WBT	Web Based Training
WWW	World Wide Web
XML	Extensible Markup Language

1 EXECUTIVE SUMMARY

Electronic Systems Center, Hanscom AFB MA in conjunction with Lockheed Martin Mission Systems conducted a two level Virtual University (VU) proof of concept to determine the effectiveness of delivering Command and control (C2) operator type-1 training electronically using synchronous application sharing technology. The level I trade fly-off invited eight vendors to participate in the fly-off to complete a VU Requirements Matrix. The down-select process was based on the results of evaluating responses using a weighted rating methodology. The final candidate solutions were evaluated using the following high-level criteria: product integration, requirements satisfaction, product stability, and SCORM compatibility. According to the responses provided on the requirements matrix only two vendors met all the requirements. Level II gave each of the two vendors the opportunity to install their integrated software products and run tests with the users. After more than three weeks of testing and demonstrations a joint decision was made to cease further demonstrations due to the instability of one of the software products. Based on the completed Test Cards, Tester's Survey (Usability and Technology Acceptance Questionnaire), Observer responses, instructor evaluations and assessments, and performance data VU is a viable solution for meeting the needs of C2 Type-1 operator training.

2 INTRODUCTION

The Virtual University (VU) is described as a computer-based, on-line environment enabling real-time interaction between students and instructors. To leverage the most suitable software for this project LM conducted a two-level proof of concept trade study. For Level I a vendor fly-off was conducted to solicit potential candidates for a virtual classroom solution and of those candidates a down-select process was engaged to determine the two most suitable software products. For Level II informal and formal demonstrations were conducted using a participant forum consisting of instructors, students, and observers.

In Level I a request for quote was provided to each of the potential vendor candidates along with a formalized Requirements Matrix. The Requirements Matrix was based on a set of factors considered to be essential to the function of a VU. These factors included the ability to function as a live classroom, be employed over a network or the WWW using existing military infrastructure, enable hands-on use of TBMCS software and the ability to operate in a secure internet environment (https). Of the eight vendor recipients four responded with a completed Requirements Matrix form. The four respondents were Centra, Click2learn, Intranet U, and iLinc/NS (Nelson Stiltner) Software. A weighted criteria set, based on the TBMCS Engineering Notebook, established the mechanism to collect responses for analysis and to select the two most suitable candidates.

In Level II the two selected vendors conducted formal and informal Government demonstrations using their software. For demonstration purposes a set of Test Cards and

a Tester's Survey were created. The Test Cards and Tester's Survey were representative of the Theater Battle Management (TBMCS) VU University Proof of Concept Test Plan (ref. 12). The demonstrations were designed and conducted in a manner that would provide the necessary results that could be matched to the items listed in the Requirements Matrix and categorized as shown in the TBMCS VU Proof of Concept Test Plan.

During Level II the VU design demonstrated the use of existing military infrastructure for delivery to joint TBMCS users. The design demonstrated an integrated product with capability of both synchronous and asynchronous courses. VU demonstrated the use of the software, pre/post multiple choice testing, the ability for students to have the capability to provide a critique to measure the students self-assessment of his/her learning, conduct of the class, and progress toward their capability to complete the TBMCS processes.

Additionally, as part of the Level II test demonstrations, performance monitoring data was collected assessing total bandwidth usage/requirement, web page response time, audio latency, and graphic latency on shared applications.

2.1 REQUIREMENTS/CONSTRAINTS

The project shall be incrementally developed in two phases:

- Phase I will consist of a technology proof-of-concept demonstration of a TBMCS VU. Phase I will determine:
 - o a) if joint training requirements can be met via synchronous distance learning means,
 - o b) if the current DOD infrastructure can support synchronous distance learning technologies, and
 - o c) if there are cost and time savings in conducting a virtual course vs. mobile training teams.
- Phase II will consist of converting all TBMCS instructor led training to a virtual environment

2.2 STATEMENT OF PROBLEM

The 23 March 2003 TBMCS VU Project Plan (ref. 11) stated that due to real world issues, a strenuous operational tempo has been established among the services that depletes personnel available for training. Future formal classroom training for service personnel is at risk due to less instructor availability coupled with higher costs. This increases the challenge to meet the future battlefield training community. An alternative method for sustaining readiness must be identified and implemented in order to preserve the subject matter expert knowledge in the training field.

2.3 REFERENCES

1. Engineering Notebook (ENB) for the Theater Battle Management Core Systems (TBMCS) Integration and Development Contract, 26 Apr 2002.
2. TBMCS VU Compliance—Centra, 26 Nov 03
3. TBMCS VU Compliance—iLinc, 26 Nov 03
4. TBMCS VU Implementation Schedule, 12 Dec 03
5. TBMCS VU Performance Test Results, 23 Oct 03
6. TBMCS VU Performance Test Results, 05 Dec 03
7. TBMCS VU Trade Study Analysis Centra, 27 Jun 03
8. TBMCS VU Trade Study Analysis iLinc, 2 Jul 03
9. TBMCS VU Vendor Customer Survey, 24 Jul 03
10. TBMCS VU Weighted Trade Study Analysis, 15 Jul 03
11. TBMCS VU Project Plan, 23 Mar 2003.
12. TBMCS VU Proof of Concept Test Plan, 14 Nov 2003.
13. TTD03-16 VU Request for Proposal, 04 Apr 2003.
14. TTD03-16 VU System Architecture, 25 Sept 2003.
15. TBMCS VU Trade Study Requirements Matrix, 11 Sept 2003.

3 LEVEL I/VENDOR TRADE FLY-OFF

3.1 LEVEL I OVERVIEW

The purpose of a vendor trade fly-off was to determine which vendor products meet the needs for the VU. A series of events took place during the trade fly-off. First, the Trade Study Selection Criteria established the basic playing field for determining which vendors would be suitable to participate in VU. Second, the VU Requirements Matrix was created based on the high-level selection criteria. The Requirements Matrix (ref. 15) along with a RFQ was submitted to the identified vendors. Third, based on the results of the returned Requirements Matrix, a weighted study was generated to select the two most suitable products. Forth, a vendor/customer survey was conducted to help insure the two best candidates were selected for the VU demonstrations.

3.2 TRADE STUDY SELECTION CRITERIA

To be an effective tool, the VU software must be able to perform the classroom tasks necessary to teach TBMCS operators to use TBMCS while performing within the WWW and military security environment.

3.2.1 PRODUCT INTEGRATION

- Single Software with all components
- Electronic Learning Management System (ELMS)
- Collaborative virtual classroom
- Scheduling
- Survey Program

3.2.2 REQUIREMENTS SATISFACTION

- Meets requirements
- Special requirements
- Security (HTTPS)
- Platforms supported (Internet Explorer & Netscape)

3.2.3 PRODUCT STABILITY

- Software length in use
- Number of companies using software

3.2.4 SCORM COMPATIBILITY

- Software meets SCORM standards

3.3 VENDOR REQUIREMENTS MATRIX

The following set of VU requirements (ref. 15) was used to compare the candidate solutions in this study. These criteria established the basis for the weighted study. The following list of requirements were answered yes by both vendors during the trade fly-off, validating that they could meet all the requirements. The following requirements were reviewed before, during, and after the demonstration phase of each of the two vendors.

3.3.1 SERVER BASED

The VU solution candidates were evaluated based on the ability to run on a Government furnished server, on the LM extra-network connected to the WWW and .mil NIPERNet with client access through HTTPS Port 443.

3.3.2 CONNECTION

- The VU solution candidates were evaluated based on the following connection criteria:
- Minimum connection speed is 28.8 kbps
- Access through Secure Socket Layer (SSL)
- Access through a stateful inspection firewall
- Access using proxy

3.3.3 SYNCHRONOUS CLASSES

- The VU solution candidates were evaluated based on the following Synchronous criteria;
- Application Sharing – Single User
- Application Sharing – Multiple Simultaneous Users
- Application Sharing – Cross Platform

3.3.4 COLLABORATION

- The VU solution candidates were evaluated on the following collaboration criteria:
- Text Chat – One to One
- Text Chat – One to Many
- Text Chat – Many to One
- Audio – Voice over IP (VOIP)
- Audio – Conference Call
- Electronic Bulletin Board
- Desktop Video session Recording & Playback with audio and editing
- Breakout Rooms
- Hand Raising (polling)
- Threaded discussion

3.3.5 TESTING AND ADMINISTRATION

- Integration of SCORM Compliant Testing in Hyper Text Markup Language (HTML)
- Asynchronous Administration
- Auto grading and feedback for question scoring for individual question or entire test
- Auto posting of test scores to student grade book
- Student remediation on test questions
- Student competency
- Test question analysis

3.3.6 ASYNCHRONOUS CLASSES

- Bookmark capability
- Pre/Post Test Administration
- HTML/Extensible Markup Language (XML) interactive courseware administration
- Create and administer surveys

3.3.7 SCORM COMPLIANCE

- Navigation and sequencing between learning resources
- Sequencing of lesson module SCO into courses

3.3.8 ENROLLMENT ADMINISTRATION

- Training manager enrolls students through browser
- Student can self enroll
- Enrollment by job position or course
- Training manager and student can view and edit the student's training plan
- View student history and progress toward completion of training plan

3.3.9 COURSE SCHEDULING

- Scheduling a single class
- Scheduling courses
- Training Calendar

3.3.10 STUDENT TRACKING

- Lesson start
- Lesson completion
- Tests pass/fail scoring
- Objectives definitions for certification
- Objectives completed for certification
- Competency definitions—student's progress
- Track student performance/progress

- Unique alphanumeric passwords
- Uses official names for students in the enrollment roster
- Uses a 'credit' variable to indicate a pass/fail
- Uses a 'lesson status' variable to indicate a student's status in a lesson
- Uses an 'entry' variable to indicate if a student has started the lesson but never completed

3.3.11 REPORTS

- End-user customizable
- Individual student reports
- Class reports; demographics, total attendance, total completion
- Export delimited file to Excel
- Test question analysis
- Graphic presentation of analysis data
- Cumulative class and course reports
- Performance data collection and reporting

3.3.12 SURVEYS

- Pre-built surveys
- Customizable surveys
- Automated compilation of summary data, and statistical graphing
- End-of-course surveys
- Self-assessment surveys
- Comments survey
- Export delimited file to Excel

3.3.13 COST

- Server media
- Client media (25 students, 50 students, or 75 students)
- Documentation
- Annual maintenance
- Annual technical support
- Initial setup and training

3.4 WEIGHTED STUDY

A weighted study was accomplished to compare the four vendor responses in order to analyze and measure the results based on the Requirements Matrix (ref 15). The weighted study was based on the TBMCS ENB (ref. 1). Below lists the categories of the study and the total score received for each of the four vendors. The two most significant areas that caused the other two vendors to receive lower scores were not having a fully integrated product (including an LMS) and the ability to run on a 28.8 connection.

- Product Integration
- Requirements Satisfaction

- Product Stability
- SCORM Compatibility
- Future Product Migration and Implication
- Company Stability
- Company Technical Support

Weighted Study results of the four vendors:

- ILinc/NS Software 308
- Centra 301
- Intranet U 280
- Click2learn 259
-

To further review the results of the weighted study refer to TBMCS VU Weighted Trade Study Analysis (ref. 10)

3.5 VENDOR/CUSTOMER SURVEY

Prior to selecting and procuring the final two vendors for participation in the product demonstrations vendor references were acquired from each of the four vendors. Upon completion and review of the Weighted Trade results, the VU team contacted each of the four vendors for a list of current customers having similar training requirements as the TBMCS VU conceptual environment. The survey suggested that all customers were completely satisfied with the products and the customer service. To further review the results of the customer survey refer to TBMCS VU Vendor Customer Survey (ref. 9)

4 LEVEL II/VENDOR DEMONSTRATIONS

4.1 LEVEL II OVERVIEW

A series of events took place during the vendor demonstrations. First, the two vendors Centra and iLinc/NS Software were procured and schedules were established for technical personnel and Symposium instructor to arrive at the LM facility. Second, performance monitoring was procured and a schedule was established for technical personnel to arrive at the LM facility. Third the Test Plan, Test Cards, and Tester's Survey and created and available to begin testing and demonstration of the vendor products. Fourth, product testing, informal demonstrations, formal demonstrations along with performance monitoring were conducted.

4.2 TEST PLAN

4.2.1 SUMMARY

The purpose of the test plan was to define a mechanism for capturing the necessary data and collection of results needed to insure a competent and comprehensive decision is made. The test plan established a direct correlation between the testing objective and the testing results. The TBMCS VU Proof of Concept Test Plan (ref 12) defines four separate objectives that are correlated to test cards, questionnaires, as well as the requirements matrix that was supplied to the vendors during Level I of the trade fly-off. Each test card lists the related objective.

4.2.2 PROOF OF CONCEPT TEST PLAN OBJECTIVES

To determine the economic feasibility and effectiveness of delivering TBMCS operator type I training the following four objectives was identified for testing and demonstration purposes:

- Objective 1: Assess the VU Performance on the DOD network and computing infrastructure
- Objective 2: Assess the overall capability/functionality of VU software to insure compatibility with TBMCS unique training solutions
- Objective 3: Assess the ease of use of the VU software by students and instructors
- Objective 4: Assess the task-technology fit to determine if the VU is an appropriate technology for teaching TBMCS tasks.

4.2.3 TEST CARDS, TESTER'S SURVEY AND OBSERVER'S GUIDE

During the formal and informal tests, participants were requested to complete and return the Test Cards and a Usability and Technology Acceptance Survey. The results of both the Test Cards and the Survey are documented in sections 4.4.4

An Observer's Guide was provided to inform the test observers who were not participants with standards for evaluating the VU tests.

4.2.3.1 Test Cards

Once a student was identified as a VU participant, he or she was provided a set of the seven test cards. Each student was required to complete and return the Test Cards to LM upon completion of the VU demonstration. Test Cards #1 and #2 were to be completed prior to the beginning of class. The remaining five Test Cards were completed during class. Additionally, students were asked to fill in the results on the test cards of a pretest, a posttest, and a critique that was given during class. The rating criteria for the Test Cards were Pass (4), Some Problems (3), Fail (2), and N/A (1). For those answers with Some Problems or Fail, students were asked to provide written comments on the Test Card. The seven Test Cards are listed below.

- Test Card #1 - Day before class--Student completes Pre-Class Preparation.
- Test Card #2 - Day of class--Student enters classroom and receives and introduction to the class
- Test Card #3 - Student receives an explanation and demonstration of building a mission shell or updating a mission's status,
- Test Card #4 - Supervised Practice--Student attempts to complete first exercise and receives remediation.
- Test Card #5 - Independent Practice—Student completes the second exercise.
- Test Card #6 - Close Class
- Test Card #7 - Student receives a demonstration and lock-step practice of updating a mission status in ESTAT.

4.2.3.2 Usability and Technology Acceptance Survey

Like the Test Cards the students/observers were provided with the Usability and Technology Acceptance Survey. At the completion of class the Survey was to be returned to LM. The rating criteria for the Survey were: Strongly Agree (4), Somewhat Agree (3), Somewhat Disagree (2), and Strongly Disagree (1). For answers other than Strongly Agree, students were asked to provide written comments on the survey. The Survey contained the following seven sections:

- Part I – Tester Information
- Part II – System Capabilities
- Part III – Pre-Class Preparation
- Part IV – Collaboration Software Ease of Use
- Part V – Class Instruction
- Part VI – Resources
- Part VII – Overall User Reaction

4.3 PERFORMANCE MONITORING

The goal of the performance monitoring was to capture objective measurements of key performance metrics that have been identified as success criteria for the TBMCS VU system. In order to monitor the performance of the products several methods were used

during testing and demonstrations as well as methods used to track on-going systems performance.

As part of this effort it was important to have a process that would monitor performance of the software products installed on the TBMCS VU training suite. This process would provide the necessary data to monitor and measure system performance and to record bandwidth. Mercury Interactive was hired to provide products and technical services to monitor the performance of the VU classroom environment. A test plan was initiated by LM personnel and followed through by Mercury Interactive personnel. Topaz Prism and Topaz Managed Services (TMS) were the two products selected to The Mercury Interactive personnel first arrived at LM site on 22 Sep 03 to install and provide training on Topaz Prism server and probe.

Although these products were useful for our demonstrations they were not designed to find network or system problems instantaneously. These products would be more useful in an established environment in an on-going basis.

The performance monitoring results summary is documented in sections 4.4.4 and 4.4.5. To further review the results of VU system performance refer to TBMCS VU Performance Test Results (ref. 5 and 6).

4.4 CENTRA DEMONSTRATIONS AND RESULTS

4.4.1 INFORMATION ABOUT CENTRA SOFTWARE INC

Centra software has been in business for more than eight years. Centra Software provides enterprise software and services for real-time communication, collaboration and learning over the Web, with self-service meetings, web seminars and virtual classes. Centra products are used by more than 1200 organizations worldwide with more than three million users. Centra Software has support, Quality Assurance, and development teams to provide any support to customers. Centra supports all of the software products written and sold by Centra Software. To further review information on Centra refer to TBMCS VU Trade Study Analysis Centra (ref. 7)

4.4.2 DEMONSTRATIONS

4.4.2.1 Demo Set #1 – Informal Demonstration (14 October 2003)

The first Government demonstration was conducted on 14 October 2003 at 1:00 PM Mountain Time. Prior to the demonstration a one hour Pre-test brief was conducted on 12 October 2003 to provide an overview of the VU demo purpose and to provide specific instruction for accessing the TBMCS website and the VU classroom. The scheduled two-hour demonstration lasted for the full two hours, and based on the results of the Test Cards and Tester's Survey, the demonstration was a success.

4.4.2.2 Demo Set #2 – Formal Demonstration (23-24 October 2003)

The second set of Government demonstrations were to be conducted on 23 and 24 October 2003. The first demonstration was conducted at 1:00 PM Mountain Time on 23 Oct. The first hour was moving along smoothly. At approximately 2:00 PM serious system problems occurred and within 10 minutes all 22 participants were dropped out of the course. An attempt was made to have all the participants re-enter the class. Within 10 minutes again everyone was dropped out. The demonstration was stopped. Upon investigating the problem, Centra technical personnel resolved that the occurrence was due to not having the most current Centra Service Pack installed on the TBMCS VU server. Because the system was not operable, the Friday event was cancelled.

At the time the problem was identified a joint decision between the ESC SPO and LM was made to conduct three additional demonstrations 4 – 5 December. The additional demonstrations could not be conducted immediately following the problem occurrence because Vendor #2 was scheduled to arrive at the LM site on Monday 27 October. Testing and demos were scheduled for the following four weeks.

4.4.2.3 Demo Set #3 – Formal Demonstrations (4-5 December 2003)

The third set of Government demonstrations were conducted 4-5 December 2003. Two demonstrations were conducted on 4 December and one demonstration was conducted on 5 December. The first demonstration on 4 December was conducted in its entirety. The second demonstration on 4 December had one student from Osan AB, Korea. The student's homebuilt machine inadvertently rebooted two times. After waiting for 15 minutes for the student to return class was dismissed. The third demonstration on 5 December was conducted in its entirety.

4.4.3 TEST CARD AND TESTER'S SURVEY RESULTS

4.4.3.1 Test Card Results

Survey results illustrate a greater than 92% positive response to VU training overall. Six areas were focused on within the surveys to include: Pre-Class Preparation, Collaboration Software Ease of Use, Class Instruction, Resources and Overall Reaction. In every area surveyed, strong agreement was found in over 75% of respondents as to the positive reception of the VU session. Almost 20% of respondents in every area agreed and less than 5% disagreed strongly.

4.4.3.2 Tester's Survey Results

Survey results indicate a strong willingness to utilize VU training with almost 94% of respondents agreeing or strongly agreeing to VU training. 15 out of 16 respondents would recommend VU training to others. 14 out of 15 respondents stated that VU interactions between instructor and students closely emulated the interactions in a live classroom.

4.4.3.3 Instructor Observations and Assessment

Software offerings that perform the functions required of VU are minimal. Two technologies were compared. Centra Symposium and iLink Learning Center were the two that met all requirements. Utilizing a comparison matrix, Centra Symposium was chosen. Symposium offered a great deal more functionality and ease of use.

4.4.4 PERFORMANCE MONITORING RESULTS

4.4.4.1 Summary

During the 23 October TBMCS VU demonstration the interactive training application was aborted approximately an hour in to the scheduled two hour session. After reviewing the system load, performance, and bandwidth data the problems appeared to be unrelated to the sudden failure.

During the 4-5 December TBMCS VU demonstrations there appeared to be no significant system problems. Some students experienced intermittent problems. These appeared to be problems from the user end. Specific military sites appeared to be more prone to consistent system problems while other military sites did not have systems problems.

To further review the results of VU system performance monitoring refer to TBMCS VU Performance Test Results (ref. 5 and 6).

4.4.4.2 Page Load Time

During the October and December demonstrations page load time averaged sub-second response with maximum page load time and never exceeding 5 seconds. This held true for all client domains and connection speeds. While there appeared to be no problems with bandwidth, response time or latency overall, there did appear to be an unusually high (>6%) dropped packet/retry rate on the traffic from/to the Langley Air Force Base domain. As this is the only client domain to experience such a high retry rate, it is likely that it is a local phenomenon related to Langley AFB's overall network usage versus its capacity.

4.4.4.3 Audio Latency (Delay)

During the October and December demonstrations audio latency for a 28.8 Kbps client ranged between sub-second, five seconds, and ten seconds. Even when intensive application sharing was being done, audio latency did not exceed a 10 second target. Audio latency for a 50 Kbps client ranged from sub-second to approximately 5 seconds. Audio latency for LAN speed connections was less than 5 seconds.

4.4.4.4 Graphic Latency (Delay)

During the October and December demonstrations graphic latency for a 28.8 Kbps client ranged between sub-second, ten seconds, and fifteen seconds. Even when intensive application sharing was being done, graphic latency did not exceed a fifteen second target. Graphic latency for a 50Kbps client ranged from sub-second to approximately ten seconds. Graphic latency for LAN speed connections was less than five seconds.

4.4.4.5 Bandwidth

During the October and December demonstrations the student client connection at 28.8Kbps was the minimum connection speed measured during the demonstration that met the minimum performance requirements. The typical operating range for network data transmission was between 20Kbps and 50Kbps. Higher spikes were noted for clients on LAN connections (example: LM) that could handle a faster data receipt and acknowledgement. The connection at 28.8 Kbps handled the traffic by sustaining its maximum throughput for longer periods for each transmission from the server to the clients. Transmission from the server was never sustained at a high enough volume for a long enough period for the 28.8Kbps client to experience latency greater than ten to fifteen seconds.

4.5 ILINC/NS SOFTWARE DEMONSTRATIONS AND RESULTS

4.5.1 ILINC/NS SOFTWARE INFORMATION

EDT Learning (iLinc) has been in business since 1998. Their primary focus is on e-Learning product solutions. As mentioned above NS Software presented to VU a fully integrated product including a ELMS. EDT Learning software has been in business for more than eight years. To further review information on iLinc/NS Software refer to TBMCS VU Trade Study Analysis iLinc (ref. 8)

4.5.2 DEMONSTRATIONS

Because of the instability of the software informal and formal tests were not completed. The continuous participant drop offs prevented the ability to conduct a course in a normal manner.

4.5.3 TEST CARD AND QUESTIONNAIRE RESULTS

Test Cards and Tester's Surveys are not available.

4.5.4 PERFORMANCE MONITORING RESULTS

Although iLinc/NS Software informal and formal demonstrations were not conducted, a high-level analysis was performed. On 17 November an informal test was conducted to determine if iLinc/NS Software was stable enough to continue with the informal and formal Government demonstrations. The test lasted no more than one hour.

5 VIRTUAL UNIVERSITY CONFIGURATION

5.1 SYSTEM ARCHITECTURE

The TBMCS VU system is made up of the following components (ref. 14)

- Lockheed Martin Network Firewall
- LM Network Address Translation (NAT) Router
- TBMCS Training Web Server
- TBMCS VU Web and Virtual Classroom Server
- TBMCS Lite Application Suite
- TBMCS Portal Server
- TBMCS Part Task Trainer (PTT, provides simulated SAA feeds)
- Two Instructor Laptops with a headset for each instructor
- One Moderator Laptop with headset

5.2 NETWORK SECURITY

As with all DOD network computer systems, information security is required. The TBMCS VU system is not connected to an operational system and contains no Real World data that would be considered sensitive or classified. LM has taken steps to secure areas of the actual TBMCS system to protect the database structures and systems calls. The largest measure we have taken is to place the TBMCS VU system behind the TBMCS Corporate Firewall. This stateful inspection firewall protects the network from malicious attacks and code. All access to the VU components are accessed using the Secure Socket Layers (SSL) encryptions for additional security. We have also implemented the requirement of logins and passwords into the VU systems components.

5.3 INFORMATION SENSITIVITY (CONVERSION TO S1.1.3)

Major impacts of the conversion to TBMCS Spiral 1.1.3 will be as follows:

Hardware:

- TBMCS S1.1.3 has specific hardware requirements needed to support the Solaris 8 and Oracle 9i architectures, as well as the WebLogic web server.
- More PC based hardware is needed as the majority of the applications are either web-based or Microsoft Windows GUI-based.
- The VU server will need to be a multi-processor PC-based system with a minimum of 2GB of RAM, and a minimum of 100GB of drive space to allow for storage of multiple recordings of classes.

Software:

- TBMCS S1.1.3 is Solaris 8 based which means an entire rebuild of the TBMCS VU system will need to be implemented.
- TBMCS S1.1.3 is being designed and developed to be compatible with Windows Internet Explorer (IE) 6 and Netscape Navigator 7.
- TBMCS VU is based on the Microsoft Windows 2000 Server architecture using IIS 5 for a web server.

6 RETURN ON INVESTMENT

On the surface, the largest tangible savings for live learning will accrue from:

- Decreased travel expenses for students or instructors
- Decreased physical classroom space

Increased productivity because instructors and students can stay on task and continue to get part of their day job accomplished

- Lower course distribution costs
- Better retention of information/knowledge because the classroom material has been chunked and delivered over time as opposed to being dumped onto students all at once.
- A wider student populace is trained because individuals may not have the time budget, or availability to attend a traditional class.
- The best instructors can be made available worldwide at the same time to support user needs.

7 FINAL CONCLUSIONS

The Proof of Concept classes held using Centra and the results from the Test Cards and Survey showed that the virtual classroom did prove to be a viable alternative method of providing Type I Operator Training via the WWW. The ROI shows that after the initial investment, VU can provide Type I Operator Training at a significantly reduced cost over MTT costs for travel and training.

While VU may not be able to provide all Type I Operator Training in all situations and locations, it can provide required training at a reduced cost and an increased efficiency in terms of response time. VU classes can be scheduled or delivered on an as needed basis with a very short turn time.

8 RECOMMENDATION

Since the second vendor, NS Software, product was not stable enough to conduct the formal demos our recommendation is not to determine which vendor has a more viable solution rather we have provided enough data and results for Centra's virtual classroom that our intent is to recommend implementing Phase II and begin to convert courseware to the VU.



Theater Battle Management Core Systems (TBMCS)

Virtual University

Proof-of-Concept Trade Study

Prepared for:
10th ICCRTS
June 13, 2005

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Overview

- Problem Definition
- Solution – Trade Study
- Research Questions
- Proof-of-Concept Test Phases
- Methodology
- Findings
- Capability Summary
- Expected ROI
- Lessons Learned
- Summary



Problem Definition

- Electronic Systems Center (ESC)/ACF Theater Battle Management Core Systems (TBMCS) system program office training requirements continued to increase and training budget continued to decrease
- TBMCS end users dispersed world wide
- Approximately 50% of training budget for Mobile Training Team (MTT) travel costs
- High ops tempo for user base (military)
 - Need for anytime, anywhere training
- Compliance with DOD Advanced Distributed Learning (ADL) concept
 - Very little lessons learned /best practices amongst the DOD community



Solution – Proof-of-Concept Trade Study

- Requirements committee opened action item for TBMCS System Program Office to research feasibility of implementing alternative training to MTT.
- ESC/ACF conducted trade study Jun-Dec 03 to determine if a Virtual University (VU) is an effective alternative to MTTs. Key concepts included:
 - Asynchronous/Synchronous Training
 - Application Sharing
 - Collaborative Tools
 - Run over NIPRNet/Internet



Key Concepts Defined

- **Synchronous Training**
 - Instructors and students are in the classroom real time
 - Instructor and students are geographically separated but connected by computer network
 - Emulates a live classroom
 - Hands-On Practice with Instructor Over-the Shoulder
- **Asynchronous Training**
 - Recordings of Synchronous classes
 - Self-paced/web-Based training courses
 - Training materials



Research Questions

1. Can joint training requirements be effectively met via synchronous/asynchronous distance learning?
2. Can the current DOD infrastructure support synchronous distance learning technologies?
3. Is there a cost savings for a virtual course vs. MTTs?



VU Proof-of-Concept Test Phases

- Phase I – Request for Information
 - Select Vendor Candidates
- Phase II – Fly-off Between Vendor Finalists*

*Focus of report



Phase II

VU Fly-off Testing

Four Objectives

1. Assess the VU performance on DOD network and computing infrastructure
2. Assess the overall capability/functionality of VU SW to insure compatibility with TBMCS unique training solutions
3. Assess the ease of use of the VU by students and instructors
4. Assess the task-technology fit to determine if the VU is an appropriate technology for teaching TBMCS tasks



Methodology

*Evaluation Types**

Approach	Description	Collection Method
Objective-oriented Approach	The focus of this approach is on specifying goals and objective and determining the extent to which they have been attained.	<u>Type:</u> Test Cards <u>Who:</u> Participants, Observers, Instructors
Participant-oriented Approach	This is dependent upon the involvement of the participants. Stakeholders are central in determining the values, criteria, needs and data for the evaluation.	<u>Type:</u> Test Cards/TAM Survey <u>Who:</u> Participants, Instructors
Experience-oriented Approach	This approach is dependent upon the direct application of professional expertise to judge the training objectives can be met in a virtual environment.	<u>Type:</u> Observation <u>Who:</u> Subject Matter Experts
Management-oriented Approach	This approach is used when the central concern is on identifying and meeting the informational needs of managerial decision makers.	<u>Type:</u> Systems Evaluation Approach <u>Who:</u> Program Manager

*Worthen, B., Sanders, J., Fitzpatrick, J (1997). *Program Evaluation alternative Approaches and Practical Guidelines*. Longman NY.



Methodology

VU Test Collection Instruments

- **Test Cards – Derived from Test Plan Objectives**
 - Individual test cards to measure: ease of use for pre-class preparation, entering/exiting classroom, capability for student to receive lecture/demonstration of a learning objective, student attempts to complete exercises, independent practice, etc.
- **Observer Field Notes – Log**
 - Student reactions, voice/data quality, etc.
- **Technology Acceptance Model Survey* – Captured Qualitative, Overall Impressions**
 - Perceived usability & ease of use
- **Performance Monitoring – System Metrics**
 - Topaz Prism/Mercury Interactive tool

*Technology Acceptance Model Defined -- http://www.absoluteastronomy.com/encyclopedia/T/Te/Technology_acceptance_model.htm



Methodology

VU Test Activities

- Student logs-in and enrolls
- Student takes pre-test
- Student down-loads needed worksheets and handouts
- Class in session*
 - Instructor explains and demonstrates TBMCS operation
 - Students practice using real application
 - Instructor provides individual over-the-shoulder help as needed
 - Student takes post test and completes critique

*system performance metrics collected

Activities emulate a traditional classroom environment



Methodology

VU Test Participants

Organization	Location	Number of Testers	Number of Tests They Participated In
12AF	Davis-Monthan	3	2
7AF	Osan	1	1
8AF	Barksdale	2	2
9AF	Shaw	5	2
ACC/DOY	Langley	2	4
CENTAF	Al Udeid	1	1
ESC/ACF	Hanscom	6	7
NORAD	CMOC	3	4
PACAF/DOQ	Hickam	1	3
USAFE	Ramstein	3	1
USMC	Hanscom/Hurlburt	3	1
USN	St. Juliens Creek	2	3

Representative of target audience



Methodology

Limitations

- Paradigm Change
 - Perceptions/attitudes that on-line environments are not as efficient (both instructors and students)
 - A new way of teaching/learning for everyone
 - Determining non-verbal feedback from students
- Bandwidth at Selected DoD Installations
- Program Level Security



Findings

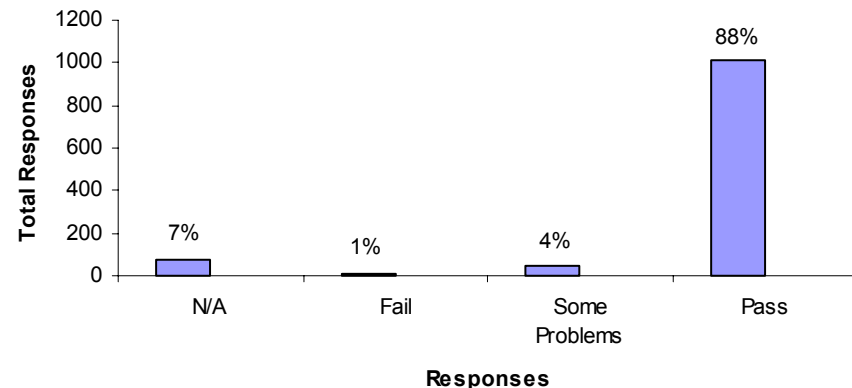
Data Results – Test Cards

- Tests
 - One Connectivity Test
 - Two Informal Tests
 - Four Formal Tests
- Seven Test Cards
 - Class Prep
 - Classroom Entry
 - Intro to Class
 - Instructor Demo
 - Supervised Practice
 - Independent Practice
 - Close Class
- Participants
 - 42 total participants
 - 28 returned surveys
 - 66% response rate

Total Responses*

N/A	Fail	Some Problems	Pass
79	11	49	1011

Test Cards Totals Summary



*frequency count



Findings

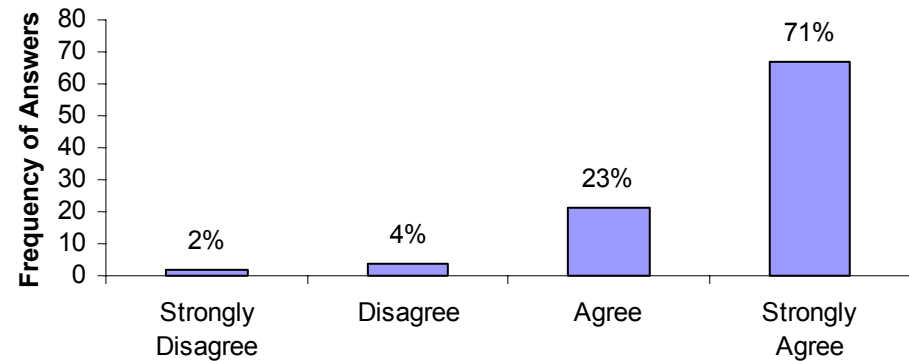
Data Results – TAM Survey

- Test
 - Surveys conducted simultaneously with the test cards and were turned in at the conclusion of each test
- Survey focus
 - **Perceived usefulness** – “The degree to which a person believes that using a particular system would enhance his or her job performance” (Davis, 1989).
 - **Perceived ease-of-use** – “The degree to which a person believes that using a particular system would be free from effort” (Davis, 1989).
- Participants
 - 51 total participants
 - 14 returned surveys
 - 27% response rate

Total Responses

Strongly Disagree	Disagree	Agree	Strongly Agree
2	4	21	67

TAM Survey



*frequency count

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319-340.



Findings

Data Results – Observations

- Test
 - Observations were conducted simultaneously with formal tests
- Observer Log
 - Detailed notes to annotate observations as they occur.
- Focus Group
 - Facilitate discussions through posing initial questions to obtain reactions from others in the group.

“Just wanted to give you my two-cents worth of impressions about Virtual University. It's great!

'Nuff said!?”

Bill Smith/46 Test Squadron

“Great product. Good tool for collaborative training”

Sherry Robinson/ESC Langley AFB

“Product is easy to use and captured interests/needs of testers. Excellent choice for on-line application sharing”

Meredith Briscollino/AOC Training Manager



Capability Summary (At End of Testing)

- VU can emulate live classroom
 - Delays in audio and video negligible
 - Instructor able to demonstrate as live classroom
 - Q&A interactions as effective as live classroom
 - Students easily able to operate actual TBMCS applications
 - Over-the-Shoulder Help as effective as live classroom
 - Once users participated, the attitudes were quickly changed



ROI Expectations

- Decreased travel expenses for students or instructors
- Decreased physical classroom space
- Increased productivity because instructors can stay on task and continue to get part of their day job accomplished
- Lower course distribution costs
- A wider student populace is trained because individuals may not have the time or budget to attend a traditional class
- The best instructors can be made available worldwide at the same time to support user needs



Return On Investment (ROI) – Projected Estimates

- Cost Per Student Training Hour
- MTT Specific Costs (Travel)

	Year 1	Year 2
– 240 Students –	\$24.68	\$26.41
– 480 Students –	\$12.34	\$13.20

- VU Specific Costs (Setup/Sustainment)

	Year 1	Year 2
– 240 Students –	\$25.87	\$6.45
– 480 Students –	\$12.94	\$3.23



Research Questions – Concluded

1. Can joint training requirements be met via synchronous distance learning?
 - Yes
2. Can the current DOD infrastructure support synchronous distance learning technologies?
 - Yes
3. Is there a cost savings for a virtual course vs. MTTs?
 - Yes (projected)



Lessons Learned

- Limit Class Size to 10-15
- Provide “101” class separate from course
- Provide clearer registration and enrollment instructions
- Early sign-in required
- Local NIPRNet workstations security lockdowns problematic



Summary

- VU Proof-of-Concept trade study was an effective means to identify, assess and select a vendor that would best meet the Government needs
- Final vendor demonstrated on-line synchronous/asynchronous, application sharing capability which is beneficial to the Government in solving training problems
- VU product is a viable solution as an alternative to MTTs

**Training when
you need it!**



**Virtual University
delivers training
when you need it,
wherever you are.**

Virtual University is being pioneered through the Theater Battle Management Core Systems (TBMCS) program, the system that plans and manages all joint and coalition air operations.

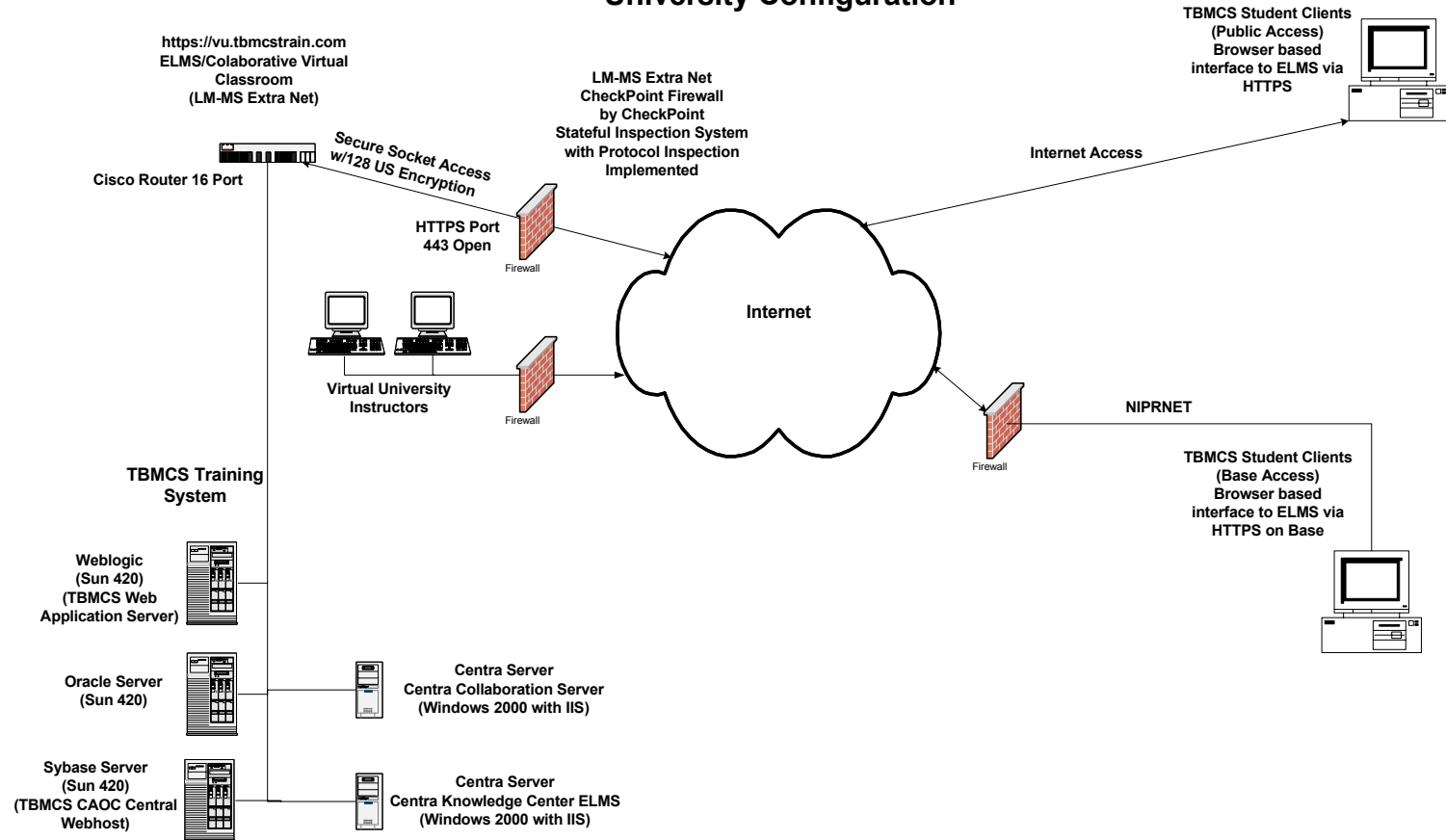


Back Ups



Network Architecture

TBMCS Training Virtual University Configuration





VU Test Suite Hardware

- Windows PC with Headset or Microphone and Speakers
 - 2 Instructor Workstations
 - 1 Moderator Workstation
 - 1 Support (Help Desk) Workstation
 - Multiple Student Workstations
- TBMCS Lite Application Suite (Unclassified)
 - ORASVR (Fictional Dataset)
 - SYBSVR (Fictional Dataset)
 - WebLogic (Enhanced Web Applications)



VU Test Suite Software

- Software Plugin (Automatically downloaded)
 - Collaboration Software and Web Browser
- Certificate (Verisign) for Secure Connection
- Asynchronous Downloads of Course Materials
- Communicates Via the Internet and NIPRNET
 - Viable Voice Over IP (VOIP) Performance Via Connections As Low As 28Kbps Dial-Up
 - All Communication Transferred Via HTTP and HTTPS Ports 80, and 443



Phase I – Request for Information Select Vendor Candidates

- RFI sent to 8 vendors – 4 responded
 - ATC – Intranet U
 - Centra
 - Click2Learn
 - LearnLinc (NS Software)
- VU Team researched all 4 vendors for current customer satisfaction
 - Centra and Learnlinc customers – Highly Satisfied
- Based on a Weighted Rating Scale two vendors – Centra and Learnlinc products – received the highest score
 - Centra and Learnlinc met all of the requirements
- *Proceed with Phase II – VU Testing*



Example Test Instruments

Test Card Example

Test Card #2, Classroom Entry

Student enters classroom and receives an introduction to the class

- 1 You access TBMCS Website
- 2 You log into the TBMCS-Centra VU Homepage
- 3 You enter the VU classroom within 30 minutes of class start time
- 4 Voice communication established between tester (you) and instructor
- 5 You observe introduction slides
- 6 You can easily identify each slide
- 7 Instructor can easily display an earlier slide in response to a student's question
- 8 Screen and audio stay in sync

N/A	Fail	Some Problems	Pass

TAM Example

Technology Acceptance Model Survey

- 7.1 I would encourage my unit to use the VU for TBMCS training.
- 7.2 If I'm unable to get live TBMCS training, I will make time to attend VU TBMCS classes.
- 7.3 The VU technology provides a suitable alternative to live training.
- 7.4 I would recommend the VU system to others for training.
- 7.5 If I couldn't have a live instructor, I would want to attend the VU.
- 7.6 The VU interactions between instructor and students closely emulated the interactions in a live classroom.

Strongly Disagree	Disagree	Agree	Strongly Agree



Methodology Test Schedule

<u>Event</u>	<u>Type Test</u>	<u>Dates</u>
Vendor 1	Informal	Oct 03
Vendor 1	Formal/User Community	Oct 03
Vendor 2	Informal	Nov 03
Vendor 2	Formal/User Community	Nov 03
Vendor 1	Informal	Nov 03
Vendor 1	Formal/User Community*	Dec 04
Vendor 1	Formal/User Community*	Dec 04
Vendor 1	Formal/User Community*	Dec 04

*Multiple time zones



Test Results

<u>Event</u>	<u>Type Test</u>	<u>Dates</u>	<u>Results#</u>
Vendor 1	Informal	14 Oct 03	Satisfactory
Vendor 1	Formal/User Community	23 Oct 03	Unsatisfactory*
Vendor 2	Informal	17 Nov 03	Unsatisfactory
Vendor 2	Comparative Connection Test*	17 Nov 03	Elimination of Vendor #2 Satisfactory (2 hr connection)
Vendor 1	Stress Test*	20 Nov 03	
Vendor 2	Formal/User Community	4 Dec 04	Satisfactory
Vendor 2	Formal/User Community	4 Dec 04	Satisfactory
Vendor 2	Formal/User Community	5 Dec 04	Satisfactory

* 23 Oct test resulted in an unknown loss in connectivity. Performance metrics did not show loss in bandwidth...required additional connection/stress testing to determine cause

Total results included system capabilities, overall user reaction, and the notation of any significant problems encountered

06/13/05

Not sure if I like this
slide