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Center For Distributed Interactive Simulation Testing: Volume I Technical Proposal

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INSTITUTE FOR SIMULATION AND TRAINING

CENTER FOR DISTRIBUTED
INTERACTIVE SIMULATION TESTING

Volume I

February 1991

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INSTITUTE FOR SIMULATION AND TRAINING

CENTER FOR DISTRIBUTED INTERACTIVE SIMULATION TESTING

VOLUME I TECHNICAL PROPOSAL

**PROPOSAL SUBMITTED TO
PM TRADE
IN RESPONSE TO
PM TRADE BROAD AGENCY ANNOUNCEMENT
BAA NTSC 91-02**

FEBRUARY 1991

Institute for Simulation and Training
12424 Research Parkway, Suite 300
Orlando FL 32826

University of Central Florida
Division of Sponsored Research

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Center for Distributed Interactive Simulation Testing

ABSTRACT

The Institute for Simulation and Training (IST) at the University of Central Florida (UCF) is proposing to take the lead in the creation of a national **Center for Distributed Interactive Simulation Testing (CDIST)** which will provide facilities and capabilities for conducting conformance, interoperability and performance testing for the evolving DoD-sponsored Military Standard for Distributed Interactive Simulation (DIS). The mission of the CDIST will be to:

- 1) establish an organization which will function as a focal point for testing and evaluating products and systems which claim to adhere to the evolving DIS standards;
- 2) facilitate the development of an open network architecture and communications protocol based upon the DIS standards for interconnecting simulation devices; and
- 3) provide products and services which will promulgate acceptance and evolution of DIS concepts and standards for simulation interoperability.

The CDIST will be established as a not-for-profit research and development organization made up of members from industry, government and academia. The initial CDIST effort will be focused on research and development for testing the DIS standard, and making these results available to the DIS community.

In carrying out this proposed project, IST will develop testing software and methods of testing for the DIS standard as it exists today, and as it will evolve over the next two years. IST will also develop a laboratory test facility in which to carry out these development activities, as well as perform actual testing on DIS systems. As testing products, methods and capabilities mature, financial support in the form of CDIST paid membership and CDIST product and services sales will be sought from the DIS industrial community. It is anticipated that within approximately three years after initiation the CDIST will be a fully self-sufficient organization.

1. BACKGROUND

1.1. IST's Role in DIS Research and Standards Development

The Institute for Simulation and Training (IST) at the University of Central Florida (UCF), under the sponsorship of the Army's Project Manager for Training Devices (PM TRADE) has the unique role of developing standards for Distributed Interactive Simulations (DIS). IST is accomplishing the standards development process by conducting research, assimilating requirements, analyzing approaches, and hosting workshops to discuss issues related to the standard.

The workshops, held on a semi-annual basis, have received wide attendance by industry, government and academia. The result of the workshops and IST's research and analytical efforts is a draft standard which describes the types of information to be exchanged between simulations. The first version of the draft DIS standard was released in June, 1990. The draft standard is currently under review and revision at IST and a second version was released in February 1991.

Since the release of the draft DIS standard in July 1990, there has been a need identified by both industry and government for some agency to assume a leadership role to support technical issues concerning the standard, especially in the areas of conformance, performance, and interoperability testing. IST proposes to be that agency.

1.2. Definition of Terms

For the purposes of this proposal, the following concepts are defined:

Conformance Testing . Verifies that DIS products and services comply with published DIS standard specifications. Passing a series of conformance tests would result in receiving a "seal of approval" from the accredited testing facility.

Performance Testing - Provides a technique for measuring how well a system executes a certain function. As related to DIS systems, performance testing is a measure of the system's real-time network capabilities.

Interoperability Testing - Supplements the DIS conformance testing by verifying the application-to-application (simulator-to-simulator) behavior of the specified DIS configurations. It should be noted, however, that the passing of conformance and performance testing by two systems does not guarantee they will fully interoperate. Interoperability testing and analysis will be required to certify simulator interoperability.

1.3. The Role of Testing for DIS

To put the role of testing in perspective, it is useful to consider how a communications protocol evolves from concept to delivery to the user. Figure 1 illustrates this evolution.

DIS Communications Protocol Evolution

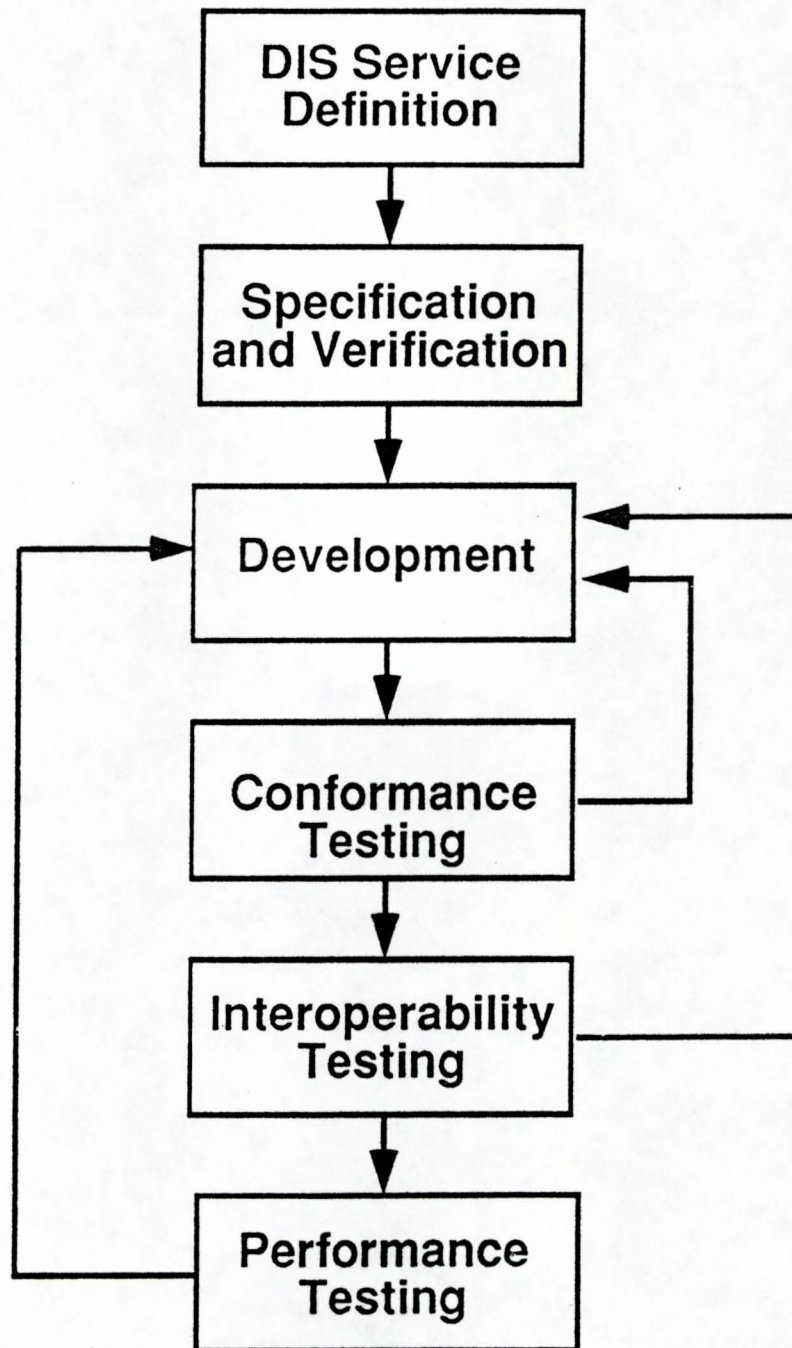


Figure 1

The first step is the DIS service definition in which all behaviors and features of the protocol, as seen by the application, are specified. This step is followed by a specification phase that consists of developing a complete definition of the protocol behaviors needed to produce the required service. The specification must describe what the protocol should do, what it should not do, and how it should react to external stimuli.

It should be noted that in the current release of the DIS Protocol Standard, only the Protocol Data Unit (PDU) structures have been clearly defined. There are some guidelines given as to the behavior of the protocol but they are very general in nature. The ongoing work of the DIS standard workshop groups, along with prototype implementations of the existing DIS standard will provide information which will eventually build the behavior of the protocol. As these behaviors are developed and accepted by the DIS standards body, techniques for testing them will be developed as part of the CDIST project.

A protocol specification must be verified to ensure that it is complete, that it is free of logical and functional errors, and that it correctly delivers the intended service. Verification ensures that a protocol has the desired consistency and robust properties. Consistency insures that anomalies will not happen, and robustness ensures that correct transactions will occur.

The protocol specifications are used to develop products and services. Conformance testing verifies that these products and services comply with their specifications. Interoperability testing supplements conformance testing by verifying application-to-application behavior of specified complex configurations. And performance testing assess the efficiency of how well the protocol executes its functions.

Even after the product or service has passed both conformance, performance and interoperability tests, protocol and functional problems may occur in the field due to unexpected conditions, untested configurations, or faulty administration. Thus, maintenance testing may be needed to troubleshoot and resolve protocol and functional errors while installing new services or equipment, upgrading software, and performing service operations.

1.4. Summary

Over the past three years IST has gained considerable technical expertise in the areas of simulator networking and communications technologies through research programs sponsored by DARPA and PM TRADE. Additionally, a sophisticated networking and communications laboratory capability has been established at IST (see Figure 2). This base of equipment and expertise at IST is being used to support the DIS standards development process and will serve as the foundation for the CDIST project.

The establishment of the CDIST at IST will follow industry trends toward utilizing neutral centers for standards compliance testing, such as the Corporation for Open Systems (COS), Government Open Systems Interconnection Profile

IST LABORATORIES NETWORK SCHEMATIC

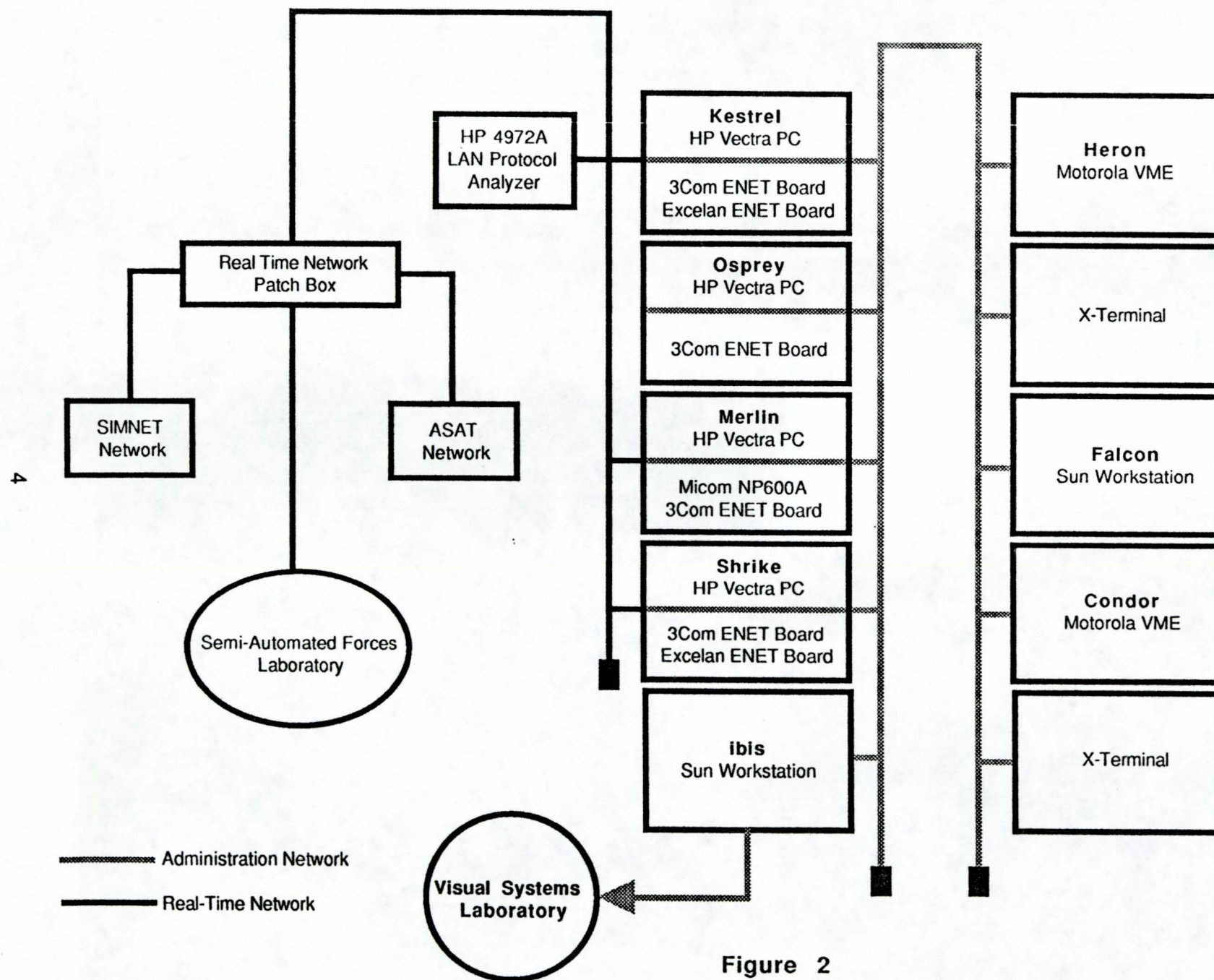


Figure 2

(GOSIP) National Voluntary Lab Accreditation Program, and the ISDN Test Laboratory at North Carolina State University. And further, the CDIST will be the first initiative to formally begin the process of developing methods and facilities for certifying simulators and simulations and their associated communications networks for adherence to the DIS standard.

2. OBJECTIVES

IST's overall objective of the CDIST project is to provide an organization which will function as a focal point for testing and evaluating products or systems claiming to adhere to the evolving DIS standards. Additionally, the CDIST will facilitate the development of an open network architecture and communications protocol based on the DIS standards for interconnecting simulation devices and will provide products and services which will promulgate acceptance and evolution of DIS concepts and standards for simulation interoperability.

IST's objectives for this project are as follows:

- Develop testing methodologies and test programs for DIS.
- Utilize existing facilities (e.g., IST, ADST sites, etc.) to perform DIS conformance, performance and interoperability testing
- Establish a facility at IST where missing pieces of DIS conformance, interoperability and performance testing can be conducted.
- Develop and implement a strategy for establishing and maintaining an organization comprising members from industry, government and academia whose purpose is to facilitate the acceptance of DIS standards and concepts as described above.
- Provide DIS technology transfer.

IST's approach to achieving these objectives is presented below.

3. APPROACH

3.1. Strategy

The primary strategy underlying the establishment of the CDIST involves building a robust organizational infrastructure. It is envisioned the CDIST organization will be set up utilizing the consortium concept. A consortium, according to Webster's Dictionary, is defined as "An agreement, combination, or group (as of companies) formed to undertake an enterprise beyond the resources of any one member." In other words, a consortium is an arrangement between companies or other organizations to pool their resources in order to more effectively focus on and address a given problem or need.

There are a number of successful consortium type organizations in operation today. The Corporation for Open Systems (COS) is a prime example of such an organization.

COS is a research and development (R&D) organization established to address the needs of testing the Open Systems Interconnection (OSI) international computer communications standard. It was founded by industries in the OSI community who recognized the need for standards and the testing thereof. COS, in and of itself, is an organization made up of technical and administrative staff, and laboratory facilities. Funding for COS operations comes from membership fees charged to organizations wishing to belong to the COS consortium. As a result of being a paying consortium member, an organization has the privilege of sitting, with voting rights, on the COS Advisory Board. Additionally, both the Army and the Defense Communications Agency are members of COS and we have indications from COS they will allow IST to attend their meetings initially under these members auspices.

In establishing the organizational infrastructure for the CDIST, IST will draw heavily from the examples of organizations such as COS. A prototype organizational diagram of the CDIST is shown in Figure 3.

As is true for any organizational start-up, resources are needed up-front to "kick-start" the effort. Building upon the base of expertise and equipment residing at IST primarily as a result of PM TRADE and DARPA simulator networking research funding, IST will focus resources on the research and development of methods and products for testing the DIS standard.

IST will develop techniques for testing DIS systems either in-house where it is feasible to bring a system to the testing location, or remotely where it is not feasible to relocate the system to be tested. Also, where existing facilities exist, IST will attempt to arrange collaborative arrangements to facilitate testing at other sites. DIS conformance tests will be developed and carried out at IST.

During the two years of this project, funding will be utilized by IST to prototype products, methods and services for testing the DIS standard. The first year of the project will focus on conformance testing methods and product development. As these testing methods and products mature and gain acceptance in the DIS community, the CDIST will have demonstrated its value to the DIS community and be able to attract organizations to become paying members. In addition to membership fees, the sale of products and services will provide an additional revenue stream.

As DIS systems begin to emerge and interoperability experiments become a reality, issues such as hi-fidelity vs low-fidelity simulator interaction will have to be addressed. The second year of this project will focus on these issues related to DIS simulator interoperability and performance.

At the end of this two year project, the CDIST will be a self-sufficient R&D center for developing test programs and tools and performing testing of the DIS

**Center for Distributed Interactive Simulation Testing
Prototype Organizational Chart**

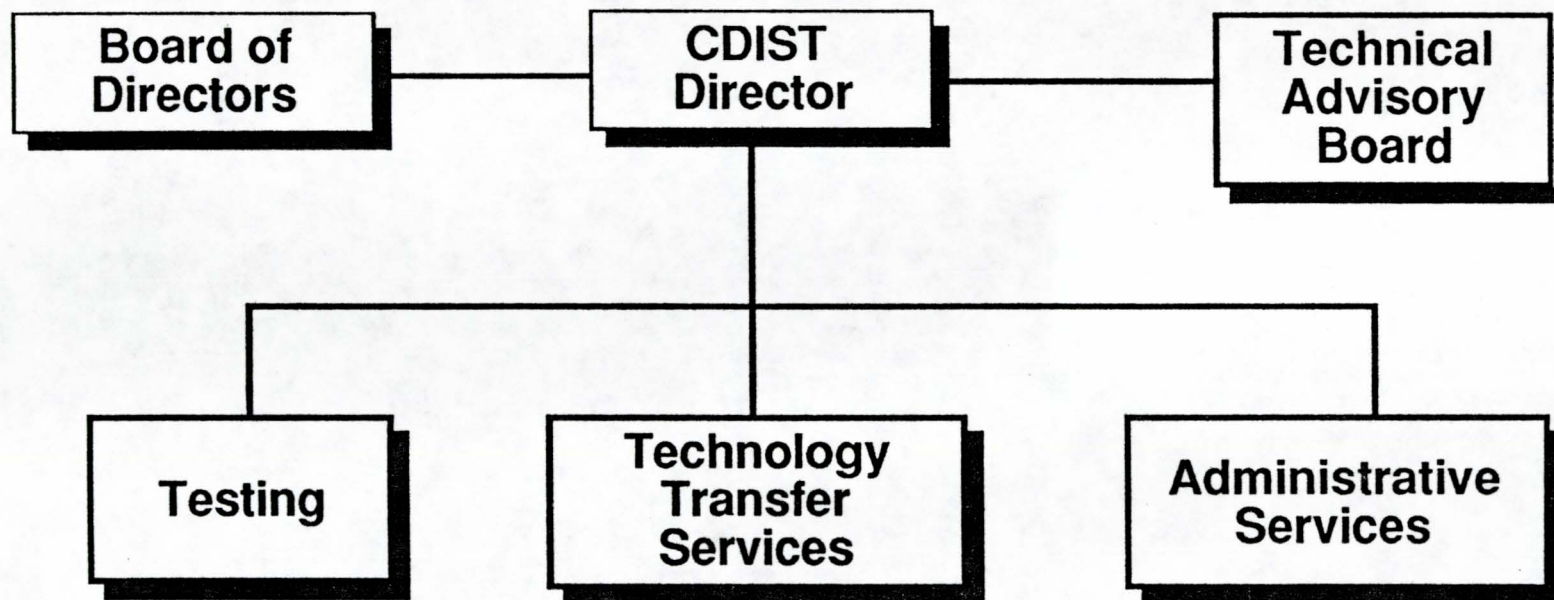


Figure 3

standard. Figure 4 shows IST's perceived steps to simulator interoperability and how the CDIST fits into this process.

3.2. Project Management

Development of the CDIST will be controlled by standard project management principles. A Project Manager will report to a Technical Director, and will be responsible for maintaining appropriate staffing levels and keeping the project within time and budgetary constraints. The Project Manager will maintain communication with the customer, project technical staff and IST management, and seek an expeditious resolution to any areas of concern which may arise. The Project Manager will utilize IST's existing infrastructure of administrative support to assist him in the execution of his duties. Mr. Brian Goldiez will be the Technical Director for this project. Mr. Jack Thompson will be the Project Manager for this project.

Senior researchers will report to the project manager and will be responsible for administration of the technical aspects of this project. The Project Manager will work closely with all senior researchers who will be responsible for directing the efforts of appropriate technical personnel and resources in order to accomplish stated goals of this project.

Also as part of the management of this project, IST will implement a configuration management program for the CDIST. As the development of the DIS standard progresses, the software developed for conformance, interoperability and performance testing must be continually updated and enhanced to provide for continued accurate testing. IST will provide configuration management for the different software programs developed and their various versions through the use of commercially available configuration management tools.

IST will serve as the prime contractor on this project. IST will use its technical and administrative staff, UCF faculty and graduate students to carry out the majority of the labor effort. Where appropriate, IST will seek the services of various expert groups such as the National Institute for Standards and Technology (NIST), North Carolina State University's Center for Communications and Signal Processing, and the Corporation of Open Systems (COS) to provide technical guidance in during the course of this project.

3.3. Technical Approach

The primary thrust of this project focuses on the research and development activities which must be performed in establishing conformance, performance and interoperability testing methodologies for the DIS standard and providing them to the DIS community. IST proposes a three task approach to this project: 1) the research and development of DIS protocol test programs and accompanying test tools; 2) the development of methods by which to deliver this testing service to the DIS community and; 3) the development of laboratory-based test facilities on which to develop and provide these services.

STEPS TO SIMULATOR INTEROPERABILITY

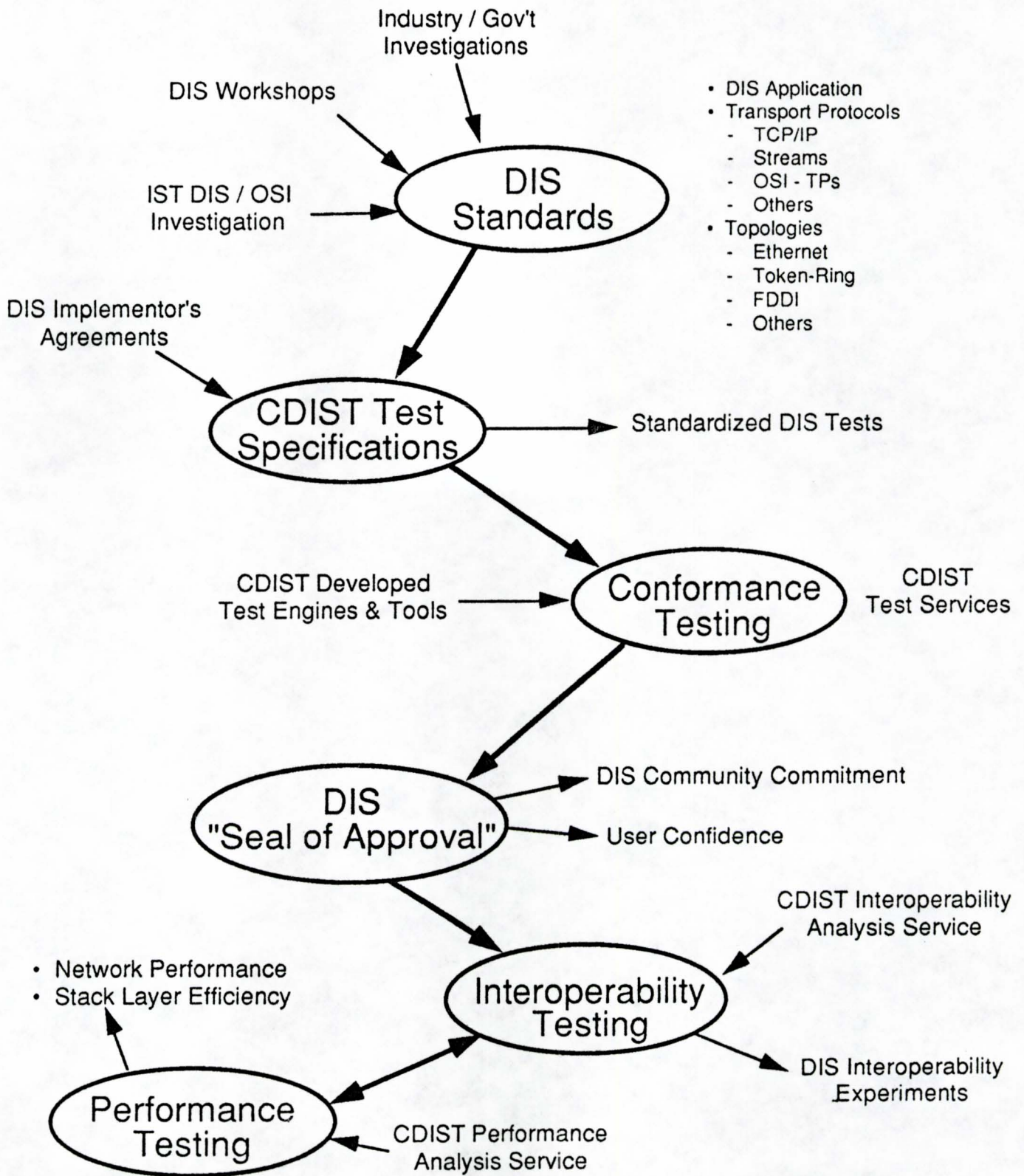


Figure 4

3.3.1. Task 1: Research and Development for DIS Testing

Now that the DIS PDU standard is a reality, methods to certify a system purporting to conform to the standard are required. However, even after a system has passed conformance verification to the DIS standard, there is no guarantee it will interoperate with other DIS-compliant systems. There is an additional need for interoperability and performance testing services to be provided as well. Task 1 is aimed at performing research and development of DIS test programs and tools for conformance, interoperability and performance testing of DIS systems.

Conformance testing of the existing DIS PDU standard will be given highest priority. Due to the nature of the DIS application (i.e., multicast and real-time requirements), interoperability and performance testing methods require research initiatives prior to the development of complete test suites.

3.3.1.1. DIS Conformance Testing

The development of a methodology for testing the DIS standard will proceed in two phases. The first phase will focus on developing techniques for verifying the existing DIS Protocol Data Unit (PDU) structure formats as specified by the draft DIS PDU Military Standard dated in January 25, 1991. The second phase will build on the work done in Phase 1 but will focus on testing these PDUs when they are used in a DIS application.

Beyond the first year, testing will proceed in a manner which tracks the evolving DIS standards and incorporates enhancements and modifications to existing DIS standardized elements, as well as the addition of new DIS features and elements.

3.3.1.1.1. Conformance Testing the DIS PDU Standard

This task will focus on the development of a methodology for performing semi-automated or automated testing of the DIS PDU data structures as defined by the most recent release of the DIS PDU Draft Military standard. More specifically, this task will involve developing test programs, tools and methods to provide the capability of generating, receiving and analyzing DIS PDUs exchanged between a simulation system under test and the host test system.

Due to the nature of this testing (i.e., verification of DIS PDU data structure format), reliable simulator-to-simulator transmission of the PDU will be required with little or no emphasis placed on real-time delivery of the PDU. Accordingly, tests will be developed to assess the implications of utilizing various off-the-shelf communications schemes. For example, TCP/IP, OSI, FDDI/XTP, the Internet IP Streams protocol, and other commercially available communications protocol stack implementations will be examined and testing methods developed to include those protocols operating in conjunction with the DIS application.

Currently, IST is engaged in developing a scheme for testing the syntax, and to a limited degree, the utility of the DIS PDUs. In this work, IST has written a very basic interactive program which allows persons operating from workstation consoles to "battle" against each other in real-time. In this simulation, the players move a graphical symbol of a tank around the screen via a series of keyboard inputs. The player can move the tank forward, backward, left, and right. Additionally, the turret can be slewed and the main gun can be fired. Action occurring on one workstation is relayed to the other using the appropriate DIS PDUs. Currently, this program has incorporated four of the DIS PDUs: Entity Appearance, Fire, Detonation, and Collision. It runs on Sun workstations and communicates over standard Ethernet. Within the program we have the ability to change or modify parameters such as the dead reckoning methods and/or discrepancy thresholds. Also, timing routines are incorporated into the software to aid in the gathering of data for statistical analysis.

IST will use the software described above as a starting point for the development of DIS conformance testing software and tools. This software will be expanded to include all the existing DIS PDUs and will incorporate techniques for verifying their conformance to the DIS standard. Also techniques for performing testing, such as testing scripts consisting of a series pre-recorded testing scenarios which require specific stimulus/response types of interactions which fully test the DIS standard in an application-to-application (simulation-to-simulation) environment will be developed.

The major activities to be performed as part of this task include:

- Investigate ISO standards relating to conformance testing methods
- Develop / implement initial DIS conformance test strategy including:
 - Automated testing techniques for providing automatic communications and test processing between the tester and the system under test (SUT).
 - DIS testing scripts as a means of creating stimulus/response stimulus to the DIS SUT
 - Test specification, pass/fail criteria, and test analysis for DIS conformance test generation and implementation
 - Implement local area network based testing for SUTs brought to the CDIST facility
 - Investigate methods for remote (long-haul) DIS conformance testing for systems which cannot be relocated to a test facility.
- Develop / implement DIS testing software and tools
 - DIS PDU conformance test software for the DIS PDUs

- DIS PDU Protocol Analyzer tool for DIS protocol debugging
- Low-cost DIS Network Traffic Logging and Playback system for DIS development and debugging
- Low-cost DIS <--> SIMNET PDU translator to be used to allow DIS PDUs to be displayed on SIMNET equipment (e.g., STEALTH).

3.3.1.1.2. Conformance Testing Evolving DIS Standard

These tasks would begin approximately 6 months after contract award (MAC) and during the first year of the project would include:

- Implement ISO standard conformance testing methods for the DIS standard
- Design, develop and implement test programs and tools for newly standardized DIS elements
- Enhance / refine existing DIS PDU test programs and tools
- Conduct DIS conformance testing and analysis on candidate systems.

Under this task, the second year's activities will address the following:

- Implement formalized conformance testing program with a DIS conformance "Seal of Approval" based on ISO and GOSIP guidelines
- Develop / enhance DIS test programs, tools and methods as required for expanded DIS PDUs and/or new DIS elements
- Establish a capability for performing remote conformance testing via a long-haul network
- Conduct DIS conformance testing and analysis on candidate systems.

3.3.1.2. DIS Performance Testing

The objective of developing a capability for performance evaluation is to establish a methodology for network capacity measurement. IST has been involved with developing computer models for predicting the performance of computer networks for the last three years. In this task, the network loading characteristics of various devices will be studied in order to establish guidelines for how these models can most effectively be utilized as a tool for predicting DIS communication systems performance. Time delays (overall and network induced) will be measured on actual systems and system performance modeled for high-gain simulated tasks. Potential enhancements, as well as bottlenecks and shortcomings, will be identified. Network performance will be predicted for different types of exercises, and the quality of simulation will be evaluated.

Additionally, this task will focus on investigating techniques in network management and simulator control which may improve DIS network performance. Proposed OSI network management protocols will be evaluated in the context of real-time networked simulations. Features such as file transfer, site monitoring, error reporting, simulator status tracking and simulator control will be evaluated within the context of this task.

This task will begin in month 6 of the project and will include the following activities:

- Develop a DIS performance testing methodology
- Define real-time and non-real-time performance requirements for the DIS application
- Investigate/implement techniques for enhancing DIS communication performance (i.e., network management & arbitration, bandwidth allocation, etc.)

Under this task, the second year's activities include:

- Develop DIS performance test software
- Implement performance testing procedures and processes
- Conduct DIS performance testing and analysis on candidate systems.
- Prototype DIS communications enhancements investigated in year one

3.3.1.3. DIS Interoperability Testing

This task will begin in the second year of the project and will focus on developing test programs and tools, as well as a test strategy for assessing how well DIS systems interoperate with one another. The passing of a DIS conformance test alone is not enough to insure DIS systems will interoperate completely. Interoperability testing is required to address those problems which arise during interoperability experiments and provide feedback to the conformance testing group so that they can modify their tests to include new or expanded tests which would identify the problem at conformance test time.

Interoperability testing will be an extremely important part of the evolution of the DIS standard. In order to have a meaningful interactive session between two simulations, there are many inter-simulator issues which must be taken into account, such as database correlation, sensors, high vs low fidelity, etc. This task will begin to address some of these issues on a case by case basis during actual interoperability experimental sessions between candidate DIS simulators. The results of these early DIS interoperability experiments will provide valuable lessons learned to the DIS community and will drive the definition and specification of the evolving DIS standard. The CDIST laboratory

will contain the necessary communications and computational resources, as well as technical expertise, to allow it to participate in interoperability experiments.

Interoperability testing will be performed in two ways. The first is called "pair-wise" testing and involves interfacing two DIS systems which have each passed the DIS conformance testing (at a minimum), and allowing them to interact. The second is called "reference" testing and involves interoperating with a system considered to be a reference or standard implementation. As part of this task an interoperability reference testing system will be built by IST and made available to the DIS community as a CDIST service. Additionally, IST will be prepared to engage in pairwise testing with organizations such as AFHRL, NOSC, the ADST contractor, and DIS vendors, if and when the opportunities present themselves.

Interoperability problems encountered will be isolated during and corrected between interoperability experimental sessions. As part of the CDIST "Seal of Approval" program, CDIST will provide assistance in resolving interoperability problems between systems holding the Seal.

The interoperability testing task will begin approximately 6 MAC and will include the following activities during the first year of the project:

- Develop a DIS interoperability testing methodology
- Develop initial versions of DIS interoperability testing software
- Establish arrangements with other organizations to perform DIS interoperability pairwise testing experiments
- Enhance computational and communications facilities to support interoperability testing as required

Under this task, the second year's activities will include:

- Develop a DIS interoperability testing reference system
- Refine DIS interoperability testing software
- Perform DIS pairwise and reference system interoperability testing
- Identify and resolve DIS interoperability problems

3.3.2. Task 2: Develop Methods for Providing CDIST Services to DIS Community

As DIS testing programs and tools are developed, methods for utilizing them and making them available to the DIS community must be established. This task focuses on developing these methods or services.

From a DIS conformance testing standpoint, this task will address the issues associated with the development and administration of a CDIST "Seal of

Approval" program which would certify a product's compliance with the DIS standard. Similarly, CDIST offered services in the areas of interoperability and performance will have to be developed and administered.

The sections below describe the types of products and services which would be provided by the CDIST. Ultimately, these products and services will be a major income generator and provide funding for the CDIST's continuing operation in the out years.

3.3.2.1. DIS "Seal of Approval"

The DIS "Seal of Approval" certifying conformance to the DIS standard will by far be the most important offering of the CDIST in the long run. Successful administration of the DIS Seal program is essential to the promulgation of an open DIS standard. As mentioned above, IST will develop and staff a test facility to carry out these testing services. Also, IST will implement a program by which other test facilities can be accredited to perform conformance testing and issue the DIS Seal. CDIST members will receive a substantial discount on fees associated with obtaining the Seal, while non-members will be required to pay for the Seal on a non-discounted fee basis.

3.3.2.2. Products

Products evolving from CDIST research and development such as handbooks, test programs, and software tools will be available for purchase through the UCF College of Extended Studies. As in the case of a DIS conformance test suite or tool, the product would typically include executable software and accompanying documentation.

3.3.2.3. Industry / Academia / Government Working Group (IAGWG) Meetings

In order to facilitate the acceptance of the DIS standard and concept, a goal of this project is to provide DIS technology transfer. As one method of achieving this goal, IST will host a series of IAGWG meetings. These meetings would provide a forum for presenting CDIST R&D products and methods to the DIS community for review and comment. The results of these meetings will impact the direction of CDIST efforts and provide a validation of concepts and products as they are developed.

3.3.2.5. DIS Support

IST will provide limited support to those organizations desiring an understanding of how CDIST and its products can be used by the sponsor.

3.3.2.6. Technology Transfer

As mentioned above, IAGWG meetings will provide DIS technology transfer. Additionally, technology transfer will be achieved by the establishment of a service to provide on-line information accessible over the Internet or dial-up

phone lines, which will provide the DIS community with the latest in DIS information. Contained within these information bases will be literature search results compiled by IST as a part of CDIST development, the DIS standards, DIS rationale, technical reports and lessons learned from DIS community members willing to make that information available.

This task will involve specification and selection of database, hypertext, and related information management software, and development of a PM TRADE approved user interface. This information will be publicly available and accessible through the Internet or by dial-up phone lines to the CDIST database server. Initially, this service will be free. Eventually, CDIST members will provide this service at no charge. Hard copies of any information would be purchased from the UCF College of Extended Studies or obtained from the Defense Technical Information Center (DTIC).

The development, enhancement and refinement of DIS services described above will be continued throughout the life of the CDIST. As products and services are developed, they will be made available to the DIS community. Sales of products and services will be crucial to the financial survival of the CDIST. As the DIS conformance test programs become mature, the CDIST will be in a position to sell its "Seal of Approval" as a guarantee of a product's conformance to the DIS standard. Products developed directly as a part of this project will be made available to the DIS community at no cost, or as seen fit by PM TRADE.

3.3.3. Task 3: Test Facilities Development

The CDIST facility will contain hardware and software resources required to expedite the development of procedures for implementing, testing and assessing the DIS standard in a variety of configurations. A sophisticated networking and communications laboratory capability has been established at IST. This laboratory capability will be enhanced and augmented as appropriate to provide the required communications and computational resources to carry out this project.

The development of this facility will proceed in a sequence of steps, with certain tasks being performed in parallel with others. Essentially, there will be two major steps in this effort: (1) requirements analysis and (2) laboratory implementation.

3.3.3.1. Requirements Analysis

A detailed requirements analysis will be performed to determine the specific requirements of the CDIST facility in order to maximize flexibility and compatibility for interfacing with other sets of hardware and software. This effort will generate a list of requirements which will be used as input to the preliminary design outlined below.

3.3.3.2. Laboratory Implementation

The results of the detailed requirements analysis will be used to direct the implementation of the CDIST laboratory facility. Existing IST computational and communications resources will be utilized to the maximum extent possible throughout this design process. Additional equipment will be specified in this task.

IST will work through UCF's purchasing department, allowing advantage to be taken of educational discounts which most major vendors offer, thereby leveraging the purchasing power of this project. As items are received, they will be tracked by the UCF and IST inventory control systems. IST currently has adequate floor space to accommodate expansion of its present laboratories. Additional floor space is available and will be annexed as required to carry out this project work.

The development and operational support of the CDIST test facility will continue in year two and over the life of the CDIST. Communications and/or computational systems will be acquired or existing systems upgraded to meet the demands of the project. Additionally, appropriate staffing will be maintained to assure efficient operation of the facility.

3.4. Deliverables

The following will be deliverables as part of this project:

- Detailed Project Workplan
- Bi-monthly Status and Management Reports
- Minutes from all reviews
- Conformance testing literature search results
- CDIST Consortium Implementation Plan
- DIS Conformance test software and tools
- DIS Interoperability test software and tools
- DIS Performance test software and tools
- Test plans and methods for Conformance, Performance and Interoperability testing services
- DIS testing results and analysis of results
- DIS "Seal of Approval" Strategy
- DIS "Seal of Approval" Implementation

- Databases containing simulation / simulator interoperability information and a system design for accessing this information

3.5. Meeting and Reviews

The following meetings and reviews will be held as indicated. Minutes from these activities will be provided as a deliverable on this project:

- Work Plan Review
- Quarterly Reviews
- IAGWG Meetings

3.6. Anticipated Results

3.6.1. Anticipated Results Months 1-12

The anticipated results for the first year of this project are listed below:

- The cultivation and development of a DIS consortium made up of members from industry, government and academia whose mission will be to guide and promulgate the development of certified DIS products and DIS research. Such a consortium will be self supporting through membership fees and service and product sales.
- The development of an integrated test and research facility at the CDIST consisting of the appropriate computational, communications, and test equipment required to support conformance, interoperability and performance testing of the DIS standard.
- The design, development and implementation of DIS Protocol Data Unit test programs (software) and accompanying test procedures and other DIS related products.
- The assimilation of literature and other information relevant to DIS and the development of an on-line computer service for accessing the data in a convenient manner. This information would be input into an automated information storage and retrieval system and made accessible to the DIS community via the Internet or conventional modem dial-ups. Information on topics such as: the most current release of the DIS standard, summary reports of the Standards for the Interoperability of Defense Simulations (SIDS) workshops, literature search results for DIS related topics, summaries of lessons learned from DIS types of projects, the status of the individual SIDS workshop sub-groups, DIS Test Programs, and so on, would be available through this system.

3.6.2. Anticipated Results Months 13-24

The anticipated results for the second year of this project focus primarily on the:

- successful functioning of the CDIST
- continued development of DIS conformance, interoperability and performance test tools and programs to meet evolving DIS standards
- verification of DIS systems utilizing IST developed DIS conformance test programs and associated test tools
- continued operation and upgrading of CDIST test facility
- continued technology transfer via various mechanisms (i.e., data bases, workshops, seminars, etc.)

4. SCHEDULE AND LEVEL OF EFFORT

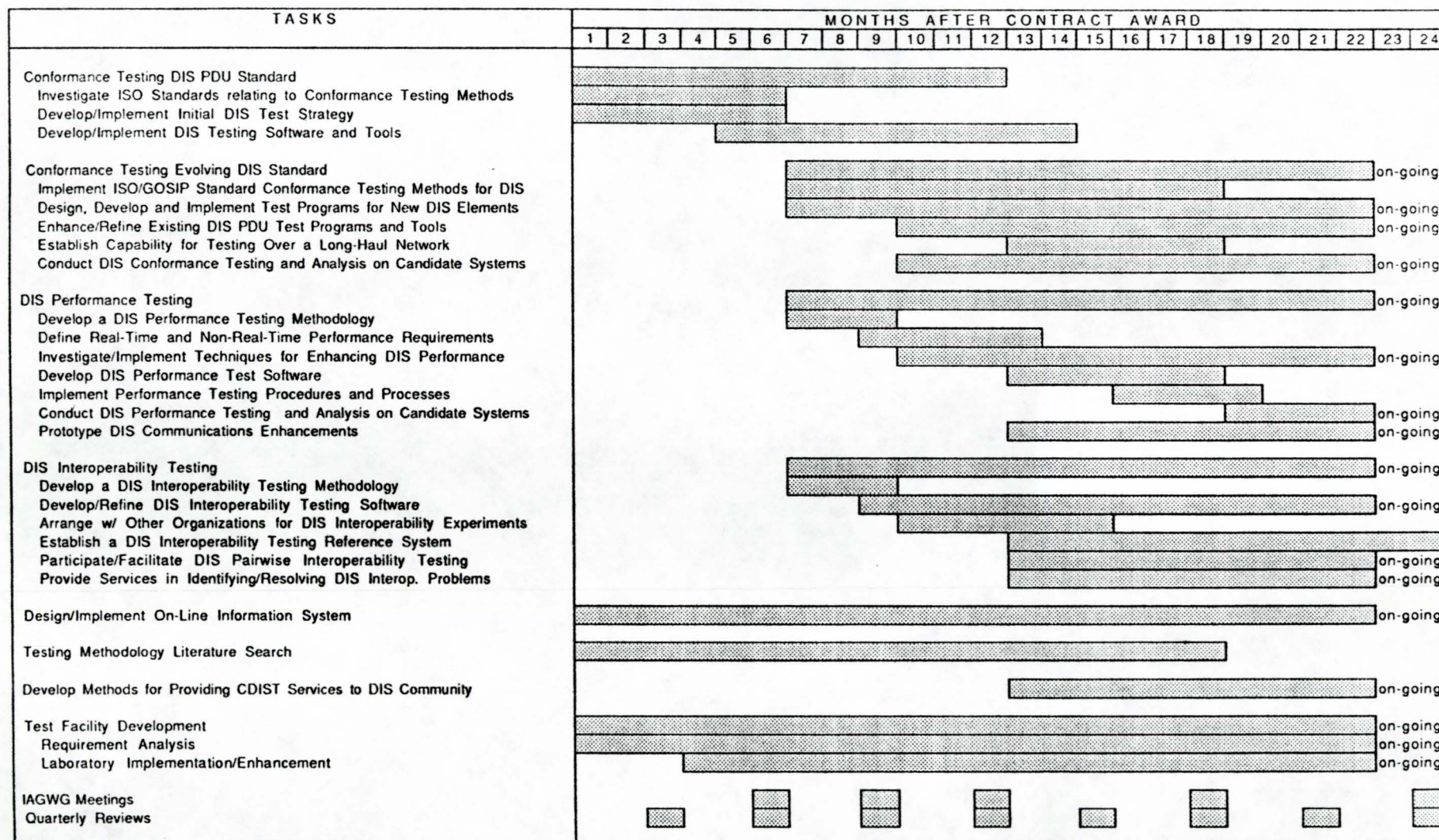
4.1. Schedule

This proposal suggests PM TRADE will provide the initial seed funding (two years) to "kick-start" the CDIST. It is anticipated that after two years, the CDIST will have sufficient membership funding to make it self-sustaining.

The proposed Major Task Schedule showing tasks and their duration for this project is provided in Figure 5. The proposed Deliverables Schedule showing project deliverables is provided in Figure 6.

4.2. Level of Effort

The level of effort required to accomplish the outlined CDIST project is approximately 15 man-years over 24 months. The task schedule provides for a level of effort of approximately 10 man-years during the first 12-month period and 5 man-years during the second 12-month period. Tables 1 and 2 summarize the level of effort by position in hours and by year.



MAJOR TASK SCHEDULE

Figure 5

DELIVERABLES	MONTHS AFTER CONTRACT AWARD																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Detailed Workplan	▲						▲					▲						▲						
Bi-monthly Status and Management Report		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		▲		
Minutes From Quarterly Reviews			▲			▲			▲			▲			▲			▲			▲			▲
DIS Conformance Testing Software and Tools									▲						▲						▲			
DIS Interoperability Testing Software and Tools															▲					▲				▲
DIS Performance Testing Software and Tools																			▲					▲
Testing Methodology Literature Search							▲												▲					
On-line Information System Design and Data												▲												▲
IAGWG Review Minutes							▲		▲			▲							▲					▲
DIS Testing Results and Analysis of Results																								▲
Test Plans and Methods for All Testing Services							▲		▲										▲					

DELIVERABLES

FIGURE 6

CDIST
Level of Effort for Months 1-12

Hours by Position

TECHNICAL DIRECTOR	624
PROJECT MANAGER	2,080
MID-LEVEL TECHNICAL	5,200
ENTRY-LEVEL TECHNICAL	4,160
COMPUTER SCIENCE FACULTY	1,040
COMPUTER ENGINEERING FACULTY	520
TECHNICAL SUPPORT	520
ADMINISTRATIVE SUPPORT	520
GRAD STUDENTS (4)	<u>4,160</u>

TOTAL HOURS 18,824

Table 1

CDIST
Level of Effort for Months 13-24

Hours by Position

TECHNICAL DIRECTOR	624
PROJECT MANAGER	2,080
MID-LEVEL TECHNICAL (3)	3,120
ENTRY-LEVEL TECHNICAL (3)	2,080
COMPUTER SCIENCE FACULTY (25%)	1,040
COMPUTER ENGINEERING FACULTY (13%)	520
TECHNICAL SUPPORT	520
ADMINISTRATIVE SUPPORT	520
GRAD STUDENTS (4)	<u>4,160</u>

TOTAL HOURS 14,664

Table 2

5. CONTRIBUTION TO THE ACCOMPLISHMENT OF PM TRADE OBJECTIVES

Establishment of a Center for Distributed Interactive Simulation Testing would benefit all agencies interested in procuring or developing interoperable training systems. This benefit would be realized in reduced risk with soliciting components of an integrated interoperable system from various manufacturers. The logical interfaces between components would be clearly specified and rigorously tested against standard benchmarks, and could be expected to interact with other approved components with a high degree of confidence.

The "interoperability guarantee" could lead to new solicitation strategies as agencies could then allocate portions of an integrated interoperable system among vendors, according to each vendor's area of expertise, in an effort to minimize the total system cost. Industry resources could be more fully utilized as the interoperability market would be accessible to small and disadvantaged businesses who could assure their products conform to established standards without developing expensive testing programs of their own.

This flexibility of acquisition benefits PM TRADE in particular, as it affects systems spawned from the CCTT concept. CCTT acquisitions are expected to approach \$1 billion, and will likely be solicited from many offerors. The CDIST "seal of approval" indicating conformance to the DIS standard on individual CCTT components will eliminate any risk of interoperation between components designed and built by disparate manufacturers.

6. PERSONNEL

IST will draw upon a broad base of technical and administrative expertise during the project. Technical personnel from IST, UCF and other organizations, as appropriate, will be utilized in performing the tasks laid-out in this proposal. IST and UCF will provide the majority of administrative support. The resumes of key IST and UCF technical personnel who will participate in this project are included in Appendix A.

7. GOVERNMENT SUPPORT FOR PROJECT

Government-furnished equipment from current contract N61339-88-C-0043, *Networking / Communications Technology Laboratory*, will be utilized on this project.

8. OTHER PROPOSAL SUBMITTALS

This proposal is not being submitted to any other federal, state, or local agency or any other party.

9. ENVIRONMENTAL IMPACT

Work accomplished under this proposal will not result in any effect on the environment.

10. IST ORGANIZATIONAL BACKGROUND

The purpose of the Institute for Simulation and Training (IST) is to conduct research and to develop technology that advances the state of the art in affordable and effective training systems. IST has built laboratories with unique capabilities for conducting interdisciplinary simulation and training research programs requiring the disciplines of engineering, computer science, human factors and instructional systems. The Institute has a full-time research staff with skills in thesis disciplines, and draws from the University of Central Florida faculty as well as other colleges and universities in Florida and elsewhere to augment capabilities required for particular research programs. The purpose of IST's research efforts are to advance the state of the art in simulation and training, make simulation and training more affordable and effective, transfer technology to the simulation and training community both within and without the Department of Defense, and to provide an environment for simulation and training education. The IST organizational structure is shown in Figure 7.

IST has established Government contracting experience. It currently has a number of active contracts with the Naval Training Systems Center and other Government agencies including contracts N61339-86-D-0008, N61339-85-D-0024, N61339-88-D-0008, N61339-88-D-0009, N61339-88-G-0002, and N61339-89-C-0029. IST has previously provided the Naval Training Systems Center with extensive organizational and capabilities descriptions in response to sources sought announcements and in various proposals. Reference for this material is made to the IST capabilities description provided in conjunction with IST's NAVTRASYS SCEN IQC N61339-88-D-0009.

IST ORGANIZATION

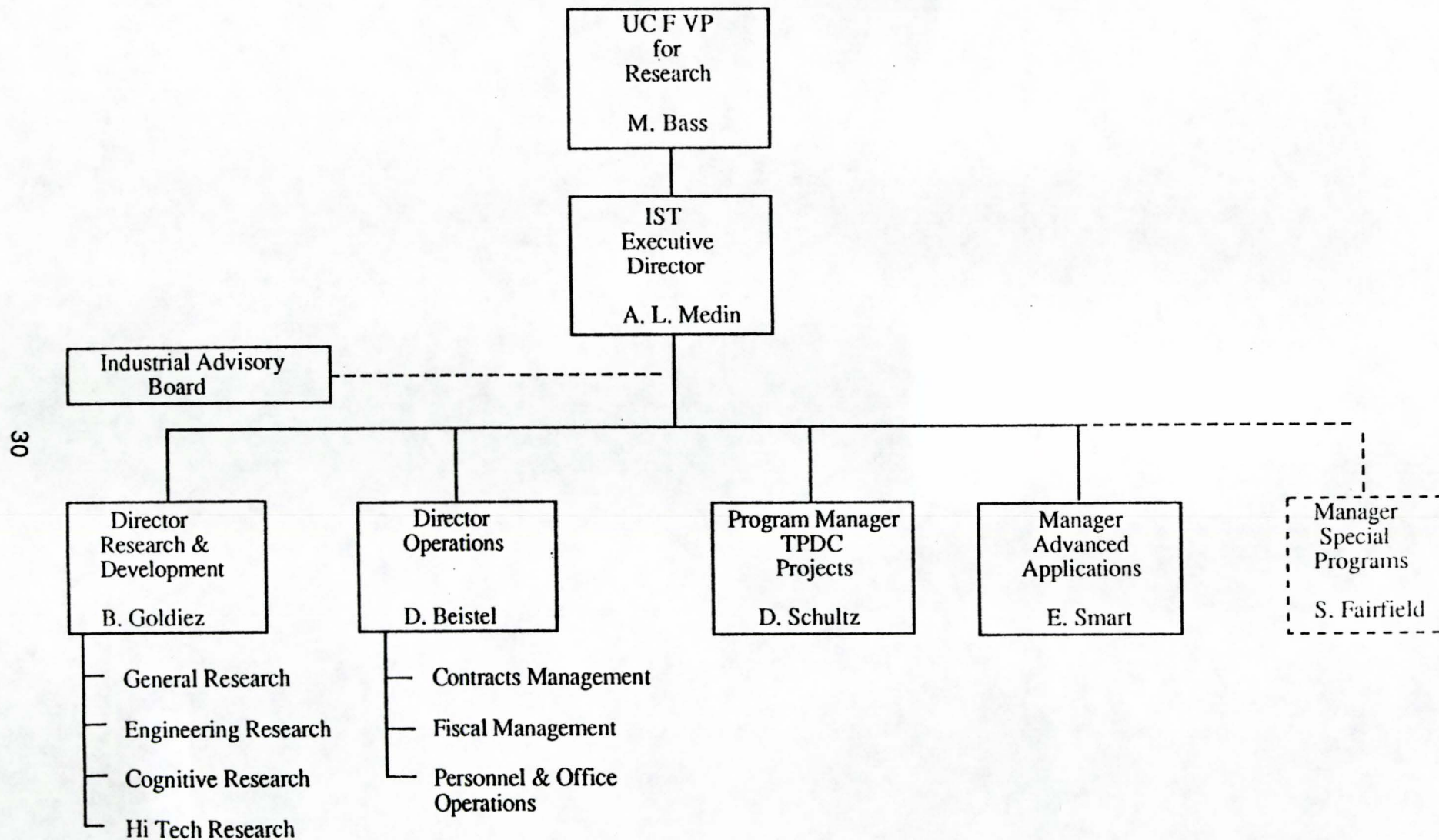


FIGURE 7

11. FACILITIES

The Institute for Simulation and Training at the University of Central Florida is situated in the Central Florida Research Park in Orlando, Florida. The research park is located adjacent to the University of Central Florida campus. IST is located in the Research Pavilion at 12424 Research Parkway, adjacent to the Naval Training Systems Center. IST's facilities include over 20,000 square feet of office space and approximately 7,000 square feet of research laboratory space.

An important feature of IST's laboratories is the ability to conduct research separately, link hardware and software to investigate system level issues, and to link other laboratories so that data and results can be shared. This approach maximizes the utilization of expertise and systems to meet the various levels of granularity of training and simulation-related research. The research facilities of IST currently consist of six separate laboratories: Networking and Communications Technology Laboratory, Visual Systems Laboratory, Low Cost Flight Trainer Laboratory, Team Training Laboratory, Low Cost Part-Task Trainer Laboratory, and the Classroom Educational Laboratory.

The Networking and Communications Technology Laboratory has built up a considerable inventory of computer and communications resources during the period of performance of research for DARPA. Facilities include:

- Harris Nighthawk™ multiprocessor minicomputer
- Sun 1+ SPARCstations (2)
- Motorola VMEsystem 1147
- Motorola VMEsystem 3608
- Hewlett-Packard Vectra RS 80386-25 DOS workstations (6)
- 3Com Etherlink II IEEE 802.3 Ethernet
- 3Com TokenLink IEEE 802.5 Token Ring
- Hewlett-Packard 4972A LAN Protocol Analyzer
- Network programmer's toolkits
- Internet/MILNET access
- Switched 56 Kbps dataphone digital service (2 lines)
- Kentrox TieLink 56™ CSU/DSU (2)

The 56 Kbps service and the CSU/DSUs are currently on order and due to be installed in March 1991. The "switched" capability allows IST/UCF to communicate with other sites with similar service, providing a flexible platform for real-time interoperability research with remote laboratories or training sites.

APPENDIX A

Resumes of Key Personnel

BRIAN GOLDIEZ

EDUCATION: M.S. Engineering Mathematics and Computer Systems,
UCF, 1979
B.S.A.E. Aerospace Engineering, University of Kansas,
1973

EXPERIENCE SUMMARY: Mr. Goldiez' 15 years experience as a design engineer and analyst of simulation and training devices includes extensive work in front-end design, specification development, and directing R&D of new simulators and training systems. His background also encompasses proposal preparation and evaluation, new technology and vendor surveys, and costing of these new projects. Mr. Goldiez has acted as a consultant on math modeling for flight trainers and is a member of several professional organizations.

APPLICABLE EXPERIENCE:

1990 - Present	Director Research and Development	Institute for Simulation and Training
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Mr. Goldiez has responsibility for the technical content of all research and development programs within IST. These programs encompass studies, engineering, and behavioral related research.

1988 - 1990	Engineering Manager	Institute for Simulation and Training
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Primary duties with IST involve providing planning and technical direction for the Institute's engineering efforts. Responsibilities include leading the engineering effort for development of the IST Simulator Laboratory, and management of several advanced technology programs at IST. Additional responsibilities also include review of ongoing and proposed research efforts for technical merit and applicability to training devices.

1986 - 1988	Senior Design Analyst	AAI Corporation
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Mr. Goldiez served as the Systems Engineering and Interface Manager of the A-6F/F-14D Air Crew Training System. Duties include responsibility for the AAI engineering effort in Orlando and systems engineering and interface definition for the entire training system. This effort includes developing design approaches, reviewing and approving designs, and acting as liaison to other specialties for the A-6F and selected portions of the F-14D training devices.

1985 - 1986	Design Analyst	AAI Corporation
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Responsibilities included systems engineering design efforts on new simulators, including proposal preparation (technical, management, and cost portions); and management of selected IR&D programs. Also worked as visual system engineering specialist which included developing visual system design

approaches, performing vendor surveys, preparing specifications, and reviewing systems programs with visual system components.

1978 - 1985

Visual System
R&D Lead Engineer

Project Manager for
Training Devices
U.S. Army

Responsibilities included identifying, funding, and developing visual system technology for Army simulators. Also acted as lead engineer for aviation and wargaming devices. This work involved front-end design, specification development, resolution of technical problems in prototype simulators, and costing for new training devices.

1975 - 1978

Consultant

Naval Training Equipment
Center

Work involved consulting on math modeling for flight trainers, developing specifications, and preparing and evaluating proposals. Gained experience in training device acceptance testing.

1973 - 1975

Design Engineer

Sikorsky Aircraft

Experience included helicopter handling qualities, control surface design, wind tunnel testing, reliability/maintainability analysis, and simulation of new design concepts.

CURRENT STATUS: Full-time employee -- University of Central Florida

JACK R. THOMPSON

EDUCATION: B.S. Electrical Engineering, UCF, 1978

EXPERIENCE SUMMARY: Mr. Thompson is a graduate of UCF with 13 years of experience in the field of electrical engineering, as an Electronic Design Engineer/Production Maintenance Supervisor with AT&T Technology Systems and currently as the IST Principle Investigator for the DARPA / PM TRADE sponsored Networking and Communications Technology Laboratory (NCTL) project.

APPLICABLE EXPERIENCE:

1987-Present	Systems Engineer	Institute for Simulation & Training
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Mr. Thompson is the IST Principal Investigator for the NCTL project. Primary duties involve planning and technical direction of the project, organizing project teams, generating and submitting project deliverables, writing and publishing research papers, and interfacing with the project's sponsors. Additional responsibilities include specification and procurement of communications and computational equipment used in the laboratory and coordinating the day-to-day operations of the NCTL project.

1984-1987	Electrical Test Engineer	AT&T Microelectronics Division
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Responsible for electrical testing of integrated circuits at wafer and package level. Activities include: test program generation, modification and implementation; specifying, order and installation of manufacturing testing equipment; technical documentation; manufacturing production support; electrical failure mode analysis; design and construction of electronic test fixtures. Other responsibilities included maintenance technician and equipment operator training; department representative for participative management program; and editor of departmental newsletter. Responsibilities as Production Maintenance Supervisor from January 1986 to June 1986 included supervision and direction of 15 maintenance technicians. Activities included: processing work orders; employee performance tracking; supervisor's paperwork such as time cards, vouchers, reviews, etc.; and maintenance/production coordination.

1979-1984	Electronic Design Engineer	AT&T Federal Systems Division
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Mr. Thompson was responsible for the design, construction and documentation of custom electronic equipment for Navy Contract. Activities included: design and fabrication of both analog and digital circuits; microprocessor programming; both high level and assembly languages; selection and ordering of electronic components; printed circuit board layout and fabrication; and engineering

documentation proposal writing projects in response to requests for proposals from the U.S. Government for new and follow-up business.

CURRENT STATUS: Full time employee--University of Central Florida

M.A. BASSIOUNI

EDUCATION: Ph.D. Computer Science, Penn State Univ, 1982
 M.Sc. Computer Science, Alexandria Univ., 1977
 B.Sc. Computer Science, Alexandria Univ., 1974

EXPERIENCE SUMMARY: Dr. Bassiouni has in excess of 10 years experience in the field of Computer Sciences. He has published extensively in national and international journals. These research publications have included such documents as "Computing estimates of waiting times in local area networks with priority classes", "Single-site and distributed optimistic protocols for concurrency control", "A VLSI chip for efficient transmission and retrieval of information", "Algorithms for reducing rollbacks in concurrency control by certification", "Software specification and design using Petri nets", "Evaluation of a distributed database transaction module", "Multiple-interface information systems", and "A semi-Markov model for file-access behavior of tasks". Dr. Bassiouni has taught Computer Sciences, supervised research fellows and graduate students, and conducted individual research projects. He has received research awards for the study of Database management, File allocation on disk storage devices, File access modeling, and Optimistic Concurrency Control. He is currently working on developing a Analytic and Simulation Models of Distributed and Local Area Networking.

APPLICABLE EXPERIENCE:

1982-Present	Associate Professor	University of Central Florida Computer Science Dept.
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As Associate Professor in the Computer Sciences Department, Dr. Bassiouni is responsible for the curriculum development and course conduct within the Computer Sciences Department. He supervises the research of graduate students engaged in Computer Sciences research projects in the Computer Sciences field, for example "System and program models of storage allocation", "Optimization of buffer sizes in static allocation schemes". He is currently engaged in developing analytical models for workload characterization of computer systems and a simulation system (written SIMSCRIPT), and Supercomputer algorithms for data transmission and encoding.

Dr. Bassiouni has played a key role in the Networking and Communications Technology Laboratory (NCTL) project, serving as a co-Principal Investigator. His work in the project has focused on developing Ada based simulation models for predicting the performance of a fiber-optic based communications network (FDDI) which might be used to interconnect simulators. Additionally, he has performed experiments in interconnecting multiple local area networks carrying networked simulator information and assessing each network's performance and has published several papers in technical journals detailing these results.

1977-1982

Associate Professor

Pennsylvania State
University

As Assistant Professor and Associate Professor, in the Computer Sciences Department, Dr. Bassiouni was responsible for teaching computer sciences, supervising students engaged in research in the computer sciences area and conducting his own individual research projects. Dr. Bassiouni published several research papers during this time period, among which was "A multi-group technique for data compression.

CURRENT STATUS: Full time employee--University of Central Florida

HENRY L. WILLIAMS

EDUCATION: Ph.D., Mathematics, Washington University, 1978
M.Sc., Mathematics, Washington University, 1975
B.A. , Mathematics, Wesleyan University, 1971

EXPERIENCE SUMMARY: Dr. Williams has accumulated over ten years of professional experience in the fields of systems analysis, design, and implementation of computer systems. Currently, he is teaching computer engineering courses and conducting research in the areas of computer networking and simulation at The University of Central Florida. Over the years, he has developed expertise in IBM large-scale systems environments, MVS systems control programming, VM systems control programming, hardware and software configuration analysis and design, telecommunications from a data processing standpoint, local area networks, and development and presentation of briefings and seminars on computer hardware and software systems. Prior to joining the faculty at UCF, Dr. Williams was primarily responsible for the establishment of a Computer Studies Department at the University of Zimbabwe in Zimbabwe, Africa. This international assignment included the installation planning for nearly one million dollars worth of computer hardware and software donated to Zimbabwe by the U.S. Government as well as developing and teaching computer courses and programs to facilitate the introduction of new technology into the country.

APPLICABLE EXPERIENCE:

1989-Present Assistant Professor

University of Central Fla.
Computer Engineering Dept.

As Assistant Professor in the Computer Engineering Department, Dr. Williams is responsible for curriculum development and teaching undergraduate and graduate courses within the Computer Engineering Department. He supervises the research efforts of several graduate students currently pursuing Masters level degrees in the area of computer communications architecture for interactive, real-time distributed simulators. Dr. Williams has also been working closely with the Networking and Communications Technology Laboratory (NCTL) project at the Institute for Simulation and Training to bring focus on the relevance of standardized protocols for communications architecture for interactive, distributed simulations.

1987-1989

Computer Consultant

University of Zimbabwe
Bulawayo, Zimbabwe

Under a USAID-funded project, Dr. Williams undertook a two-year assignment to provide technical training and implementation assistance for a large shipment of IBM micro hardware and software for the University of Zimbabwe to establish a computing Centre which would support both the computer instructional needs as well as the automation requirements within the overall administration of the University. He developed the overall implementation plan for the Computer Centre and was primarily responsible for its execution. During the establishment of the Centre, he developed a formal structure and curriculum for the Computer Studies Department and taught computer courses in the various programmes at the University. Dr.

Williams wrote numerous technical reports dealing with this project.

1986-1987

Computer Consultant

Springfield, Virginia

In January, Dr. Williams pursued free-lance consulting contracts relating to the application of various computer tools to solve business and scientific problems. One of the major contracting efforts included the systems management activities for an IBM SNA environment based upon a VM/SP/DOS/VSE operating systems environment running RSCS Networking, CICS/VS and ACF/VTAM networking applications. In another major project, Dr. Williams developed an IBM SNA networking strategy to connect five heterogeneous mainframes (IBM, SPERRY, BURROUGHS, and AMDAHL) together in a long-haul networking environment to support a large-scale contracts management and procurement application for the joint military services. Dr. Williams also conducted short courses on the IBM VM/SP/CMS and RSCS Networking operating systems environment.

1984-1985

Branch Chief
Systems Software

USAISEC-ATSC-ASD
Department of Army

Dr. Williams held a technical management position in which his responsibilities included the supervision of seventeen branch personnel in providing mostly IBM systems software and computer facility support for a multi-site, multiple CPU environment used in program development and production. The main application was a large IBM assembler-based message processing system supporting the National Military Command Authority. Dr. Williams also conducted studies and made formal recommendations pertaining to executive software, program products, programming languages and utilities as well as state-of-the-art hardware

1982-1984

IBM Systems Programmer

USARCPAC
St. Louis, Missouri

Dr. Williams was an IBM systems programmer responsible for conducting research and development activities in the areas of information processing hardware, executive software, and programmer productivity products. He was specifically responsible for the systems programming tasks relating to the IBM operating systems - VM/SP, CMS and RSCS Networking, MVS/SP.

1978-1982

IBM Systems Engineer

IBM Corporation
St. Louis, Missouri

Dr. Williams was a large systems specialist with responsibilities which included providing technical assistance and guidance in the design and implementation of large-scale IBM computer environments. In particular, he specialized in the area of distributed processing hardware and software configurations. He also conducting numerous studies on systems performance and capacity using IBM automated tools.

CURRENT STATUS:

Full time employee--University of Central Florida

CHRISTINA L. BOUWENS

EDUCATION: M.S. Mathematical Science, UCF, 1990
B.S. Mathematics, Geneva College, 1984

Additional course work: VMS Systems Management I
Network Protocols & Standards

EXPERIENCE SUMMARY: Mrs. Bouwens has more one and a half years of experience as a research associate working in the areas of networking technology and analysis of numerical integration methods at the Institute for Simulation and Training. She has been the project engineer for development of the draft Military Standard for Distributed Interactive Simulation and has been involved in IST's research with alternative communication architectures for real-time distributed simulation. In addition to her experience as a research associate, Mrs. Bouwens has 5 years of teaching experience at the high school and college levels. She is a member of Pi Mu Epsilon, the national honorary mathematics society.

APPLICABLE EXPERIENCE:

Sept. 1989-Present	Research Associate	Institute for Simulation & Training
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Current duties include providing technical direction in IST's interoperability standards development. This standards work includes co-authoring the draft standard and rationale document for protocol data units for Distributive Interactive Simulation, research of various problems related to networked real-time simulation, providing guidance for Open Systems Interconnection (OSI) related work, and participating in research associated with alternative communication architectures. Other research activities include investigation and analysis of integration algorithms for use in real-time simulation systems.

Aug. 1990 - Dec. 1990	Adjunct Faculty	University of Central Florida
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Course instructor for a College Algebra class.

Aug. 1989 - Dec. 1989	Adjunct Faculty	Valencia Community College Orlando, FL
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Course instructor for Introductory and Intermediate Algebra at the University of Central Florida/Valencia Community College's Academic Skills Center.

Aug. 1988 - May 1989	Graduate Teaching Assistant	University of Central FL
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Course instructor for several Business Calculus classes.

Aug. 1984 - May 1988 Teacher

Orangewood Christian
School, Maitland, FL

Developed and taught mathematics curriculum for grades 7-12 and computer curriculum for grades 1-12. Mathematics courses include: Pre-Algebra, Algebra I & II, Geometry, Trigonometry and Analytic Geometry, AP Calculus

ROBERT GLASGOW

EDUCATION: B.S. Industrial Engineering, UCF, 1985

EXPERIENCE SUMMARY: Mr Glasgow has nearly ten years of experience in the aerospace and simulation industries. He has researched networked simulation systems, designed simulation software, integrated avionics hardware and software, and tested and analyzed jet engines. Mr Glasgow is a recognized candidate for registration as a Professional Engineer in the state of Florida, and is a member and former officer of several professional organizations.

APPLICABLE EXPERIENCE

1987-Present	Systems Engineer	Institute for Simulation & Training
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Studied software and networking issues related to implementation of low-cost, microprocessor-based avionics system training suite. Performed design tradeoff analyses related to specification of a standard inter-simulator connection protocol.

1986-1989	Engineer	AAI Corporation
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Designed simulation software for high-fidelity real time flight simulator. Studied issues related to the design and development of a flight trainer implemented on a multiple parallel microprocessor architecture. Authored technical proposals.

1982-1984	Assistant Engineer	Martin Marietta Corporation
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Part of development team for a floating-point microprocessor and three-axis fiber-optic rate sensor for integration with digital missile autopilots.

1979-1980	Assistant Engineer	Pratt & Whitney Corporation
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Investigated compressor stagnation phenomena in high-performance gas turbine engines. Performed extensive systems simulation and analysis. Designed and supervised tests of experimental and production engines on sea-level static test stand.

1976 - 1979	Stationary Engineer	U.S. Navy
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Performed analysis, operation, and maintenance of 600 psi nuclear-powered turbomachinery related to ship propulsion and electrical power generation.

Successfully completed Naval Propulsion Engineering School and Naval Nuclear Power School.

HUAT KENG NG

EDUCATION: M.S. Electrical Engineering, UCF, 1989
B.S. Computer Engineering, UCF, 1986

EXPERIENCE SUMMARY: Mr. Ng has over one year of experience in software development. He has experience in computer programming and analysis for Electrical Engineering designs. Mr. Ng is also familiar with simulator designs utilizing low-cost workstations. He is a member of IEEE, and several professional honor societies.

APPLICABLE EXPERIENCE:

Sept. 1990 - Present	Associate Engineer	Institute for Simulation & Training
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Currently involve in investigating a network of interactive simulators. Work involved with research aimed at investigating the feasibility of using an Open Systems Interconnection (OSI) network protocol to provide network services for a distributed interactive simulation (DIS) application. Test programs are written in C/Unix on the Sun Workstations. Information exchanged by computers, packaged in messages called protocol data units (PDUs) are tested on the Ethernet communication network.

May. 1990 - Aug. 1990	Systems Analyst	Communications Electronics International
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Software development and writing test plans of the Aviation Training Support System II (ATSS II). Tasks include writing a database software package to keep track of the aviation training. Development was done using BASIC Plus 2, DCL and User 11 database management system.

Jan. 1987 - Dec. 1989	Research Assistant	University of Central Florida
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Investigated on FIR Filter Design Using the Superposition of Sampling Functions by Computer Aided Design. Developed and designed filters by an algorithm implemented in C language, to yield closed form time and frequency domain expressions. Also, developed a program written in Fortran for quartz resonator model measurement and sensitivity study. A data reduction technique approach was investigated to extract the model parameters. All software development was done on a IBM PC.

CURRENT STATUS:

Full time employee -- University of Central Florida

DAVID T. SHEN

EDUCATION: B.S. Statistics, UNIVERSIDADE DE SAO PAULO, 1986
Masters Candidate in Computer Engineering, UCF (expected August 1991)

EXPERIENCE SUMMARY: Mr. Shen is pursuing his Masters degree in Computer Engineering from the University of Central Florida. His research area includes Network and Transport Layer protocols. He has over one year of experience in computer communication protocols, specializing in the Open System Interconnection (OSI) Reference Model. He has an extensive academic background in Statistics, and has accumulated experience in the C programming language and the UNIX operating system.

APPLICABLE EXPERIENCES:

1990-Present Systems Engineer Institute for Simulation and Training

Worked with computer communication protocol software called ISO Development Environment (ISODE). Developed performance measurement programs using services provided by ISODE, namely, Remote Operations.

Attended Conferences in the area of computer inter-operability, and participated in Distributed Interactive Simulation (DIS) standardization process, specifically in the area of communication protocol architecture and security.

1987-1989 Staff Accountant GDP Realty Group, Inc.
Orlando, FL

Developed automated processes using LOTUS1-2-3 to process company's periodical payroll.

1986-1987 Statistician Institute of Technological Research
Brazil

Worked with Computerized statistical analysis on data obtained from researches in the areas of health, public utility, and industry.

STATUS: Full Time Employee -- University of Central Florida

AMY F. VANZANT-HODGE

EDUCATION: M.S. Computer Science, UCF, 1989
B.S. Computer Science, UCF, 1983

EXPERIENCE SUMMARY: Ms. Vanzant-Hodge has over four years of cumulative experience in systems/application programming, database design, software design, and hardware setup, procurement, and administration. She has completed research in the areas of routing algorithms for Very Large Scale Integrated (VLSI) circuit design, network protocols, and object oriented design. Ms. Vanzant-Hodge gained experience in user interface design and implementation as well as customer support for problem resolution while working for Software Design Group, Inc. She is a member of IEEE Computer Society and IEEE Circuits and Systems Society.

APPLICABLE EXPERIENCE:

Feb. 1990-Present	Research Associate	Institute for Simulation & Training
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Current duties include supervising software development of test programs for the Distributed Interactive Simulation (DIS) protocol under the Networking and Communications Technology Laboratory project. Responsible for management of entry-level employees and student workers, procurement of software and equipment, and aiding with design and implementation of software within the networking lab. Currently tasked to write the software functional specification for the incorporation of the Vehicle Integrated Defense System (VIDS) into the SIMNET M1A1 simulation computer.

Sept.1986-Feb.1990	Lead Programmer/Analyst	Software Design Group, Inc. Winter Park, FL
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Administer planning and scheduling of new customer requirements and change requests and serve as customer liaison. Responsible for designing, coding and debugging shared logic applications running in a multi-tasking environment. Functioned as System Administrator over development system.

Jan.1985-May 1986	Teaching Assistantships	UCF, Orlando, FL, and World Information Systems Enterprises, Inc. Beijing, China
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As a graduate teaching assistant, taught lab portion of "Computer Systems Concepts/Programming" and "Introduction to Computer Science" course. As a contractor, taught Microprocessor Development course at Beijing University and 68000 assembly programming.

April 1989-Sept.1990

Programmer/Design
Consultant

UCF

Continuing work as a volunteer on a High Rise Fire Simulation trainer for training fire chiefs at a command post during a high rise fire. This trainer is being implemented in an object oriented language on a PC.

CURRENT STATUS: Full time employee -- University of Central Florida

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