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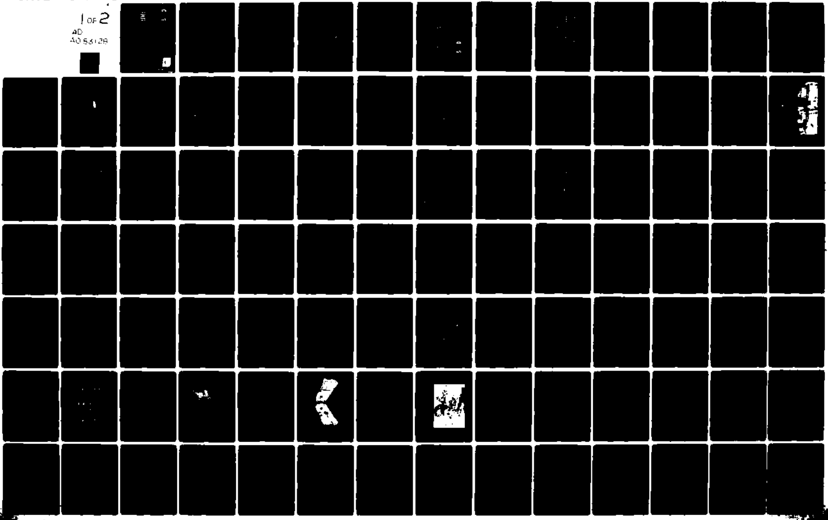

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BRIEFING REPORT

IFFN EVALUATION PROGRAM (U)

Concept Definition

Volume II. Technical and Programmatic Aspects

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LEVEL III

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August 1979

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(U) An evaluation program has been initiated by the U.S. Department of Defense, Test and Evaluation (DTE) to assess the ability of the current and near-term air C^2 system to support the identification requirements of beyond visual range (BVR) air defense weapons. This evaluation program will consist of two phases: (1) a simulation phase, which will employ a geographically distributed testbed consisting of manned simulators and operational units driven by a central simulation facility; and (2) a field test phase, taking advantage of programmed field test exercises (FTXs) to validate the simulation phase, where possible, and enhance program credibility.

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Concept Definition
Volume II. Technical and Programmatic Aspects

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GLOSSARY

AACC	ATAF Airspace Control Center
ACOC	Air Combat Operations Center
ADOC	Air Defense Operations Center
AFTEC	Air Force Test and Evaluation Center
AI	Air Interceptor
ATAF	Allied Tactical Air Force
ATDS	Air Tactical Data System
ATOC	Air Tactical Operations Center
AWACS	Airborne Warning and Control System
BCC	Battery Control Center
BOC	Battalion Operations Center
BVR	Beyond Visual Range
C^2	Command and Control
CRC	Control and Reporting Center
CRP	Control and Reporting Post
CSF	Central Simulation Facility
CWAR	Continuous Wave Acquisition Radar
DTE	Director, Defense Test and Evaluation
FACP	Forward Air Control Post
FOC	Flight Operations Center
GAMO	Ground Amphibious Military Operations
GEADGE	German Air Defense Ground Environment
GOC	Group Operations Center
HAIDE	Hostile Aircraft Identification Design Effort
HIPIR	High Power Illumination Radar
ICC	Information Coordination Central
IDO	Identification Officer
IFFN	Identification of Friend, Foe, or Neutral
IOC	Initial Operational Capability
JINTACCS	Joint Interoperability for Tactical Command and Control System
JTF	Joint Test Force
LPU	Live Participating Unit
MADEM	Modular Air Defense Effectiveness Model
MCRC	Master Control and Reporting Center
MPC	Message Processing Center
MTDS	Marine Tactical Data System
MULTOTS	Multiunit Test and Operational Training System
NADGE	NATO Air Defense Ground Environment
NAEW	NATO Airborne Early Warning
NPC	NATO Programming Center
NTDS	Navy Tactical Data System
OAS	Offensive Air Support
OED	Operational Effectiveness Demonstration
PAR	Pulse Acquisition Radar
PCP	Platoon Command Post
ROEs	Rules of Engagement
ROR	Range Only Radar
RP	Reporting Post
SAM	Surface-to-Air Missile
SIMTRACC	Simulator, Trainer, Command and Control System
SOC	Sector Operations Center
SSU	Satellite Simulation Unit
STEM	System Trainer and Exercise Module
SWHQ	Static War Headquarters
TAB	Tactical Air Base
TACS	Tactical Air Control System
TADIL	Tactical Digital Intelligence Link
TADS	Tactical Air Defense System
WOC	Wing Operations Center
WP	Warsaw Pact

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TECHNICAL FEATURES
OF THE
IFFN EVALUATION TESTBED

11-6-79-1

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BRIEFING OUTLINE

This section of the briefing covers the technical aspects of the identification testbed. The first part is an overview of the approach used to arrive at a technical definition of the testbed. We then discuss what the testbed has to accomplish, in part by reviewing the general technical requirements that have been developed for it. Following this, recommendations are presented on what testbed design can best satisfy these requirements. We identify the particular architecture considered most suitable and state why it is preferred over other candidate architectures. This is followed by a description of what the testbed might look like. We conclude with a summary of the main points covered.

TECHNICAL ASPECTS OF IFFN SIMULATION TESTBED

OUTLINE

- APPROACH
- REVIEW OF GENERAL TECHNICAL REQUIREMENTS
- CANDIDATE ARCHITECTURE
- DESCRIPTION OF STRAWMAN TESTBED CONCEPT

11-6-79-2

OVERVIEW OF APPROACH

The general technical approach we followed resulted in the generation of the three products shown in the boxes: a simulation testbed technical requirements statement, a recommended candidate architectural concept, and a strawman design for that concept.

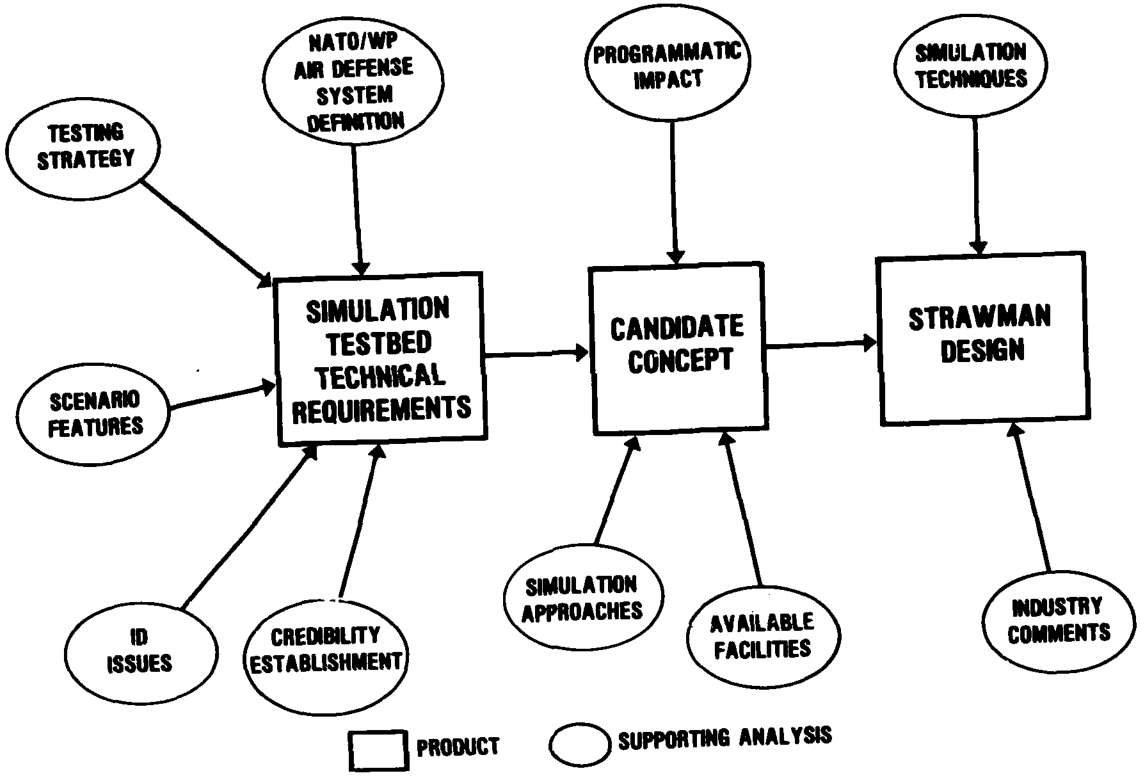
The technical requirements of the testbed depend on several important factors. One is the determination of what NATO/Warsaw Pact facilities must be included in the testbed and to what extent they must be represented. Another is the testing strategy to be pursued. This strategy determines the progression of the testing, which determines the modular buildup of the testbed and the levels of flexibility required. The scenario used is yet another determinant of testbed technical requirements. The scenario features dictate the required testbed capacity and also affect the scope of the testbed. They fix the number of tracks to be handled and the instantaneous loadings on the facilities, and prescribe the extent and intensity of electronic warfare to be simulated.

Early definition of the identification issues to be resolved is also important so that data extraction and instrumentation requirements can be delineated. Finally, credibility establishment—the means by which the simulation results will be established as credible to the interested community—must be considered. This means determining where computer emulation will be perceived to be satisfactory and where actual manned facilities are required. All of these factors were considered in various analytical studies.

Supporting analyses aided in the choice of the candidate concept as well. One reviewed the simulation approaches that have been followed using testbeds similar to the identification evaluation testbed and examined these testbeds to determine basic architectural concepts, common features, differences, and the reasons for differences. Another defined the peculiarities of the IFFN Evaluation Program that would bias the selection of the testbed architecture. Other studies identified available simulator and testbed facilities which could potentially be factored into the testbed.

The strawman design was chosen after investigation of various simulation techniques and design tradeoffs. The initial design will be reviewed by industry experts for feasibility and to identify any potential difficulties with regard to cost and the time required for development. This information will be fed back into the strawman design, which will then be revised and used as the basis for engineering specifications.

APPROACH



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STATEMENT OF REQUIREMENTS

The general technical requirements for the testbed can thus be defined by answering the following questions:

- What is the scope of the testbed, that is, what geographical area must it encompass? What facilities must be included? How extensive an air battle scenario must be accommodated?
- How should all these things be represented, that is, how should facilities, sensors, and aircraft be played? How should we represent interactions between operators and machines?
- What provisions are necessary for test control and assessment of results? What do we need for scenario preparation, stimulation of the testbed, monitoring of activities, and data extraction, recording, and reduction?
- How should the testbed evolve physically? Should it be implemented in a modular fashion? How modifiable must it be? Are future applications envisioned for it which would require expansion?

REQUIREMENTS QUESTIONS

WHAT IS THE SCOPE?

- GEOGRAPHICAL
- FACILITIES
- AIR BATTLE SCENARIO

HOW WOULD THE PLAYERS BE REPRESENTED?

- FACILITIES
- SENSORS
- AIRCRAFT
- HUMAN OPERATORS

WHAT PROVISIONS FOR TEST CONTROL AND ASSESSMENT OF RESULTS?

- SCENARIO PREPARATION
- STIMULATION
- MONITORING
- DATA EXTRACTION, RECORDING, REDUCTION

HOW SHOULD THE TESTBED EVOLVE?

- MODULAR IMPLEMENTATION
- MODIFIABILITY
- FUTURE APPLICATIONS

11-6-79-3

ARENA OF ACTION

We begin our discussion of requirements with the scope of the simulation testbed. As can be seen, the geographical scope is quite large. This area can be viewed conceptually as two regions: a simulation core area, indicated by the black footprint, and a much larger simulation background area, indicated by the shaded area. (The placement of the footprint is hypothetical, and does not necessarily represent the alignment that would actually be used.)

The simulation core area contains the smallest possible slice of NATO and Warsaw Pact systems that still represents all interactions occurring during the process of identification. This core must comprise all the identification situations of interest and all the generic system types that would be involved.

The complete testbed, however, must include a much wider area. This area is centered around the Lauda CRC and encompasses the entire area controlled by this CRC. It extends into Warsaw Pact airspace, so that interactions with the Pact facilities can be studied and early warning surveillance can be simulated. It also extends northward beyond the boundary of the 4ATAF/2ATAF interface so that the effects of ATAF interactions along the boundaries can be included.

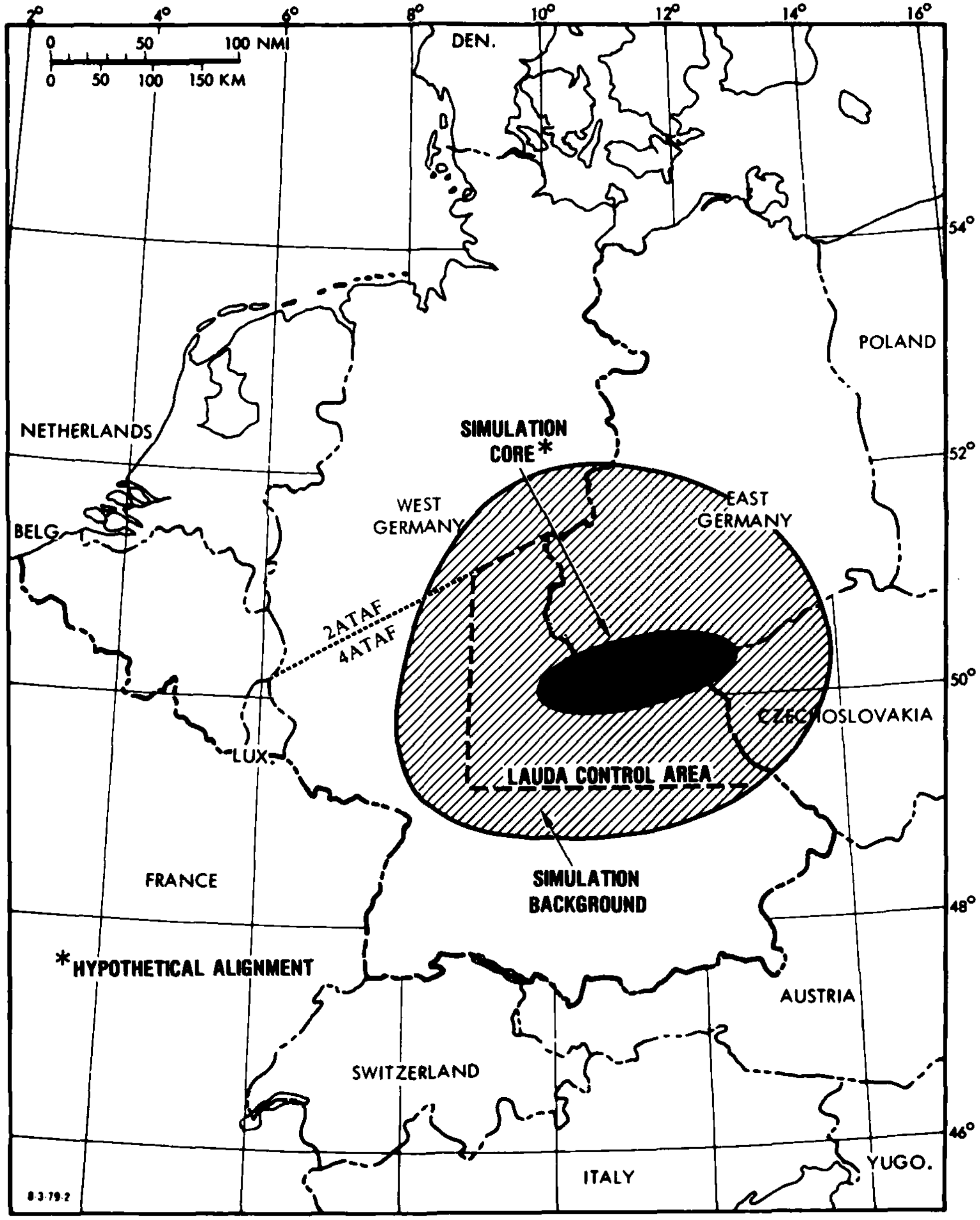
The simulation background area is necessary because actions taken here can have an effect on activities in the simulation core area. For example, suppose a facility in the simulation background area detects a track and cross-tells this information, thus providing an early warning cue to a facility in the simulation core area. This would clearly have an effect on the performance of that core facility in detecting and identifying the aircraft. Since the action taken by the background facility is important only to the extent that it affects the performance of the core facility, a fairly simple probabilistic model of the background facility will suffice.

Another example might be the action of a SAM battery located in the simulation background area in destroying an enemy aircraft before it entered the core area. This would affect the target allocations for the SAMs located in the core area. Because it is necessary only to ensure that killed aircraft are deleted from the threat prior to their appearance in the core area, not to examine the specific actions that killed them, use of a probabilistic computer model to represent the background facility can be justified.

The large simulation background area, therefore, need not be represented at the same level of detail and realism as the simulation core; only the core would require the instrumentation necessary to observe and record all actions occurring therein.

ARENA OF ACTION SELECTED FOR IDENTIFICATION TESTBED

(DENOTED BY SHADED AREA)



*HYPOTHETICAL ALIGNMENT

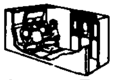
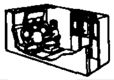
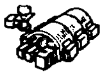
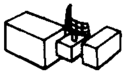
NATO SYSTEMS REPRESENTED

Shown *here are the* particular NATO systems that should be discretely represented—both numbers and types—in the simulation core area and background.

The chart includes only the NATO systems. Shown on the lefthand side is the type of system, in the middle is the number required in the *simulation core, and on the right is the* number required in the simulation background. Included in the simulation core is one unit of each system type dynamically involved in the identification process; neighboring units, higher echelon facilities, and peripheral systems are relegated to the simulation background.

There *are seven* NATO units in the core: an *IHAWK* battery (comprising 2 to 3 fire units), a TSQ-73 battalion operations center (BOC), a TSQ-73 group operations center, a flight of air interceptors (comprising 2 to 4 F-15 fighters), a TSQ-91 *Control and Reporting Post* (CRP), a NATO Airborne Early Warning Concept (NAEW), and a GEADGE control and reporting center (CRC) (Lauda CRC). In the simulation background are numerous other flights of air interceptors, 9 other IHAWK batteries, 2 neighboring BOCs, the other GOC controlled by Lauda, a NADGE CRC adjoining the Lauda CRC, the other GEADGE CRCs, *another* NAEW and several wing operations centers (WOCs). Forward Air Control Posts, which can provide peripheral support to the identification process and higher echelon C^2 facilities (SOC, ATOC, ATAF) would also be included in the background.

NUMBERS AND TYPES OF NATO SYSTEMS DISCRETELY REPRESENTED

TYPE OF SYSTEM	NUMBER REQUIRED	
	SIMULATION CORE	SIMULATION BACKGROUND
HAWK BATTERY 	1	9
BOC (TSQ-73) 	1	2
GOC (TSQ-73) 	1	1
AIR INTERCEPTOR (F-15) FLIGHT 	1	MANY
CRP(TSQ-91) 	1	6
FACP 	0	2
NAEW 	1	1
CRC (GEADGE) (NADGE) 	1 0	3 1
WOC	0	3
SOC	0	1
ATOC	0	1
ATAF	0	1

LEGEND

BOC: BATTALION OPERATIONS CENTER
GOC: GROUP OPERATIONS CENTER
CRP: CONTROL AND REPORTING POST
FACP: FORWARD AIR CONTROL POST
NAEW: NATO AIRBORNE EARLY WARNING AIRCRAFT
CRC: CONTROL AND REPORTING CENTER
WOC: WING OPERATIONS CENTER
SOC: SECTOR OPERATIONS CENTER
ATOC: AIR TACTICAL OPERATIONS CENTER
ATAF: ALLIED TACTICAL AIR FORCE HEADQUARTERS

WARSAW PACT FACILITIES REQUIRED

The decision as to which Warsaw Pact systems should be included in the testbed depends in part on the fact that we are not studying Pact systems per se. Rather, we are interested in how the Pact systems can affect the NATO systems, with regard specifically to the vulnerability of NATO identification methods to spoofing and exploitation, and the ability of the Pact to use NATO identification methods to its own advantage. Pact facilities therefore need not be represented at the level of detail required for the corresponding NATO facilities.

Warsaw Pact air defense operations are being studied to determine which facilities should be represented. The findings so far suggest that, at a minimum, those Pact facilities represented in the simulation core should include higher echelon facilities that can exploit NATO identification methods with results that affect the air battle significantly. These would be facilities that could not only recognize the use of a particular transit route by NATO aircraft, but could also distribute the information in a timely manner to lower echelon C^2 facilities (and their associated air defense weapons).

The facilities that satisfy these criteria are the southern sector air defense control center (ADCC), its associated filter center, and air defense operations center, and the radar nets covering the forward part of the southern sector. The radar nets consist of networks of early warning 2D and height-finding radars manned by operators scanning analog displays. These operators transmit target information over a semi-automatic data link, designating targets manually and using switch action to initiate transmission of coordinate information. At the filter center controllers correlate the information arriving from the various radar networks, establishing a target track and performing the identification function. It is postulated that attempts to recognize the use of specific routes would occur at the filter center, because the identification function is believed to be centralized here. Collocated with the filter center would be an air defense weapons operations center, which controls the allocation of air defense weapons. The filter center and air defense weapons operations center are thought to be functionally analogous to the combination of a NATO sector operations center with a master control and reporting center (SOC/MCRC).

Whether to include the lower echelon command and control facilities and the weapons systems themselves has not been decided. If the consequences of Pact exploitation are to be measured, these elements will have to be included. Another reason to include such facilities would be if dynamic interaction between Pact air defense weapons and other simulation elements were deemed desirable. While having such bottom-line measures and dynamic interactions would be beneficial, it has not yet been established that their inclusion is worth the concomitant cost and complexity.

WARSAW PACT FACILITIES REQUIRED

- ESTABLISHED REQUIREMENT
  - HIGHER ECHELON PACT FACILITIES WHICH ARE IN A POSITION TO EXPLOIT NATO ID METHODS WITH MAJOR IMPACT
  - THESE CONSTITUTE:
    - SECTOR AIR DEFENSE CONTROL CENTER (ADCC)
    - FILTER CENTER FOR SECTOR ADCC
    - AIR DEFENSE WEAPONS OPERATING CENTER FOR SECTOR ADCC
    - SOUTHERN SECTOR RADAR NETS
- TO BE DETERMINED
  - LOWER ECHELON C^2 AND WEAPON SYSTEMS
  - INCLUSION DEPENDS ON:
    - NEED FOR BOTTON-LINE MEASURES OF EXPLOITATION CONSEQUENCES
    - NEED FOR DYNAMIC INTERACTION BETWEEN PACT AIR DEFENSE WEAPONS AND OTHER SIMULATION ELEMENTS

11-6-79-4

AIR BATTLE SCENARIO

The air battle scenarios which must be accommodated are yet another determinant of testbed dimensions. A number of scenarios are being reviewed, such as USAFE's Counterplan, the DIA threat scenario, and others. All the scenarios likely to be used have a number of common features. They all portray a high-intensity early phase of the war, during which literally thousands of aircraft will be airborne simultaneously. They include simultaneous offensive and defensive operations by both Warsaw Pact and NATO aircraft of many different types, including large numbers of NATO and Pact helicopters. Another common key element is the presence of high-intensity electronic warfare, which is expected to affect severely the operation of all surveillance and identification systems of interest. The aircraft missions to be represented should create the full spectrum of possible identification situations. These missions would include defensive counterair, interdiction, close air support, and missions involving aircraft flying on orbits (e.g., airborne early warning, tankers, intelligence collection).

These scenario features determine the numerical dimensions of the capacity and loading capability required in the testbed. Accommodating them will mean representing 15 to 35 different types of NATO/Warsaw Pact aircraft. There will have to be from 100 to 500 simultaneous flights, occurring in formations of 2 to 18 aircraft. Up to 1 hour will be required to ensure sufficient continuity and development of the air battle interactions. Note also that the large number of flights combined with the large number of sensors will require that the testbed be capable of synthesizing over 2,000 simulated sensor reports per second.

AIR BATTLE SCENARIO

- ELEMENTS
  - HIGH INTENSITY EARLY PHASES OF WAR
  - SIMULATIONS OFFENSIVE AND DEFENSIVE OPERATIONS
  - WP AND NATO AIRCRAFT
  - FIXED AND ROTARY WING AIRCRAFT OPERATIONS
  - HIGH INTENSITY ELECTRONIC WARFARE

- MISSIONS
  - DCA
  - INTERDICTION
  - CAS
  - ORBITS

- DIMENSIONS
  - 15 TO 35 AIRCRAFT TYPES
  - 100 TO 500 FLIGHTS (IN FORMATIONS OF 2 TO 18)
  - ONE HOUR EXERCISE DURATION
  - OVER 2000 SENSOR REPORTS PER SECOND

11-6-79-5

DEFINITIONS: REPRESENTATION METHODS

There are two ways to represent the various testbed facilities: by using live participating units (LPUs), or by using computer emulations. The LPU is either an actual production unit or a realistic surrogate for the command and control or weapon system being represented. It includes either the actual consoles or replicas, and is manned by an operational crew. Use of LPUs means that man-machine interactions and interactions between operators can be portrayed realistically.

Computer emulations are computer-based models that emulate the responses of various command and control, weapons, or sensor systems to the tactical situation. They are employed where a less realistic portrayal of the man-machine interaction and the interactions between operators is required. Computer emulations are especially suitable when well-defined physical processes are to be represented or when the facilities being emulated have no direct effect on the identification process.

DEFINITIONS: REPRESENTATION METHODS

- **LIVE PARTICIPATING UNITS (LPUs)**
  - LIVE MANNED PRODUCTION UNITS OR SURROGATES FOR C^2 OR WEAPON SYSTEMS
  - USED WHERE MAN-MACHINE INTERACTIONS MUST BE REALISTICALLY PORTRAYED

- **COMPUTER EMULATIONS**
  - COMPUTER MODELS USED TO EMULATE THE RESPONSES AND ACTIONS OF VARIOUS C^2, WEAPON, OR SENSOR SYSTEMS
  - EMPLOYED WHERE WELL-DEFINED PHYSICAL PROCESSES ARE TO BE PLAYED OR WHERE FACILITIES HAVE ONLY A BACKGROUND IMPACT ON AREA OF FOCUS

LPUs

There are three types of LPUs: actual systems, system simulators, and generic-type manned simulators. Actual systems are actual production units, test units, or preproduction prototypes of the actual system. Their use is preferred. Unfortunately, actual systems are not always available. In that case a system simulator will be sought as an alternative.

System simulators are trainers, hardware integration testbeds, or software development testbeds that are used to support training on or development of the system of interest. These are less realistic than production units because they usually represent a subset of the real system's capabilities; i.e., they may not have the full equipment complement and often they do not portray the ambient work environment realistically. For example, the software development testbed for the NAEW aircraft is not installed in the actual aircraft cabin and does not have the full number of displays.

The last choice, used when even system simulators are not available, is a generic-type manned simulator. These are general purpose simulation facilities developed to represent a general class of command and control or weapon system. They are the least realistic because they are designed to represent only a generic type, not the specific system of interest.

LIVE PARTICIPATING UNITS (LPUs)

- ACTUAL SYSTEMS
  - AVAILABLE PRODUCTION, TEST OR PREPRODUCTION-PROTOTYPE UNITS
  - MOST REALISTIC BECAUSE IT IS THE REAL SYSTEM
- SYSTEM SIMULATORS
  - TRAINERS, HARDWARE INTEGRATION TESTBEDS, SOFTWARE DEVELOPMENT TESTBEDS
  - LESS REALISTIC BECAUSE USUALLY REPRESENT A SUBSET OF THE REAL SYSTEM CAPABILITIES AND AMBIENT WORK ENVIRONMENT
- GENERIC-TYPE MANNED SIMULATORS
  - C^2 AND WEAPON SYSTEM GENERAL PURPOSE SIMULATION LABORATORIES
  - LEAST REALISTIC BECAUSE DESIGNED TO REPRESENT ONLY A GENERIC CLASS, NOT THE SPECIFIC SYSTEM OF INTEREST

11-6-79-7

EXAMPLE OF AN LPU

The LPU duplicates the actual man-machine interface and crew environment as closely as possible. Shown here is an LPU meant to represent the NATO Airborne Early Warning (NAEW) aircraft. The cabin interior is that of an existing E-3A aircraft, which is similar to the future NAEW. A multiman crew operates control consoles displaying air situation data. In real operations, these data would be live data derived from the NAEW's on-board sensors (there would also be cross-told data from other systems). During testbed operations, instead of live data there would be synthetic data derived using computer emulations of the NAEW sensors. The sensor models would be stimulated by air truth data supplied by the simulation system. Some of the other LPUs will require analog video signals, as the systems they represent display video data to operators; in these cases the simulation system would include a video generator to provide synthetic video signals.

A variety of facilities are considered to be potentially suitable for serving as the NAEW LPU. These include actual E-3A aircraft (test prototypes of production models), an avionics integration testbed featuring a full cabin mockup, E-3A mission simulators used for crew training, and E-3A software development testbeds.

AN EXAMPLE OF A LIVE PARTICIPATING UNIT NAEW (NATO AIRBORNE EARLY WARNING SYSTEM)

8-8-79-2

TYPES OF MODELS

There are two types of computer emulations or models: interactive models and noninteractive models. Interactive models interact dynamically with LPUs or other interactive models in immediate response to the tactical situation. These models can be initiated automatically and executed without human intervention, or they can be manually controlled.

One example of a manually controlled model would be the model of a BOC. The actions of this facility must be coordinated verbally with the parent GOC, which would be represented by an LPU. Therefore there would have to be a verbal link between the model and the GOC LPU. One example of an automatically controlled model would be a sensor model. No human interfaces are required; the sensor generates its perception of the air situation according to well-defined physical processes.

Noninteractive models are less complex and require substantially less development effort. A noninteractive model simply generates programmed or scripted actions according to a prespecified timetable. An example might be a model that generates scripted directives to other C^2 units, automatically initiating appropriate communications messages at an appointed time. Generally these models are used to represent facilities where actions greatly lag the immediate air situation, such as the ATAF airspace control center (AACC) facility. This facility generates airspace control messages at 6-hour intervals, and obviously does not respond dynamically to the immediate tactical air situation.

DEFINITIONS:
TYPES OF MODELS

- **INTERACTIVE MODELS**
  - DYNAMICALLY REACT WITH LPUs OR OTHER MODELS IN TWO-WAY INTERACTIONS IN RESPONSE TO IMMEDIATE TACTICAL SITUATION
  - MANUALLY OR AUTOMATICALLY CONTROLLED (E.G., BOC VS SENSOR MODEL)
- **NON-INTERACTIVE MODELS**
  - GENERATE PROGRAMMED (SCRIPTED) ACTIONS WHICH GREATLY LAG THE CURRENT PERCEPTION OF THE IMMEDIATE AIR SITUATION (E.G., AACC FACILITY MODEL)

11-6-79-8

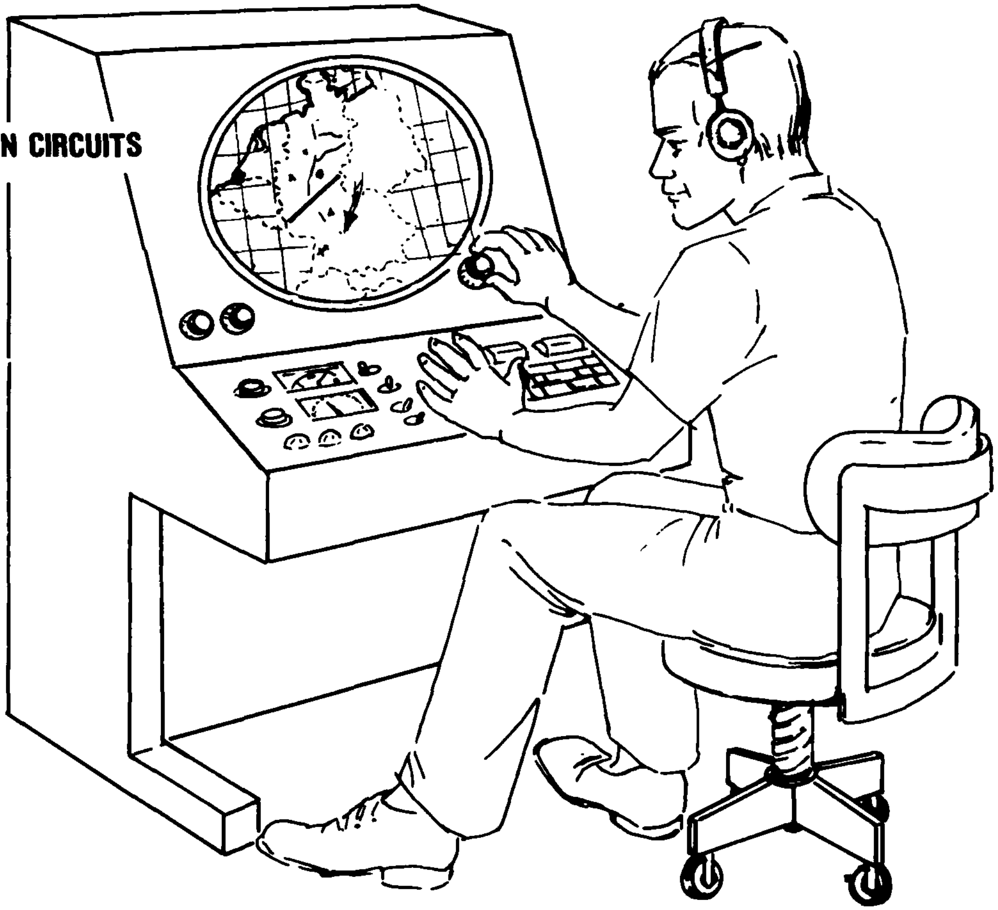
CONCEPT OF OPERATION FOR MANUALLY CONTROLLED EMULATIONS

The operator of the manually controlled model is a member of the testing staff. He serves as the contact between the LPUs and the model, and his presence enables the LPU crewmen to feel that they are interacting with an actual live unit. The operator also controls the model as required, reacting to verbal stimuli and computer-generated cues. One individual can control a number of *models simultaneously*. For example, it is estimated that one operator might control 10 or more IHAWK fire unit emulators. *This operator* would be aided by the type of graphic display shown, which would depict situation data and display the status of the various models being controlled.

Although the model is manually controlled, the computer still plays an important role. It generates the emulated facility's perception of the air situation, using models of the sensors associated with that facility. It executes a model of the logical functions of the facility itself, automatically responding to data link messages received from the LPUs or from other interactive models and initiating messages unilaterally when triggered by the synthesized perception of the air situation. It also cues the model operator to initiate voice transmissions to LPUs when required. All of these transactions conform to the actual facility's logic and incorporate delays similar to those experienced at the facility, so that interactions with the model will be indistinguishable from interactions with the actual facility.

MANUALLY CONTROLLED INTERACTIVE EMULATIONS OF FACILITIES— CONCEPT OF OPERATIONS

- OPERATOR PROVIDES
  - VOICE INTERFACE ON COORDINATION CIRCUITS
  - MODEL CONTROL AS REQUIRED
  - CONTROLS A NUMBER OF MODELS
- COMPUTER PROVIDES
  - PERCEPTION OF AIR SITUATION
  - AUTO RESPONSE TO RECEIVED DATA LINK MESSAGES
  - INITIATES DATA MESSAGES ACCORDING TO AIR SITUATION PERCEPTION
  - CUES OPERATOR TO MAKE VOICE TRANSMISSIONS



REPRESENTATION OF NATO FORCES

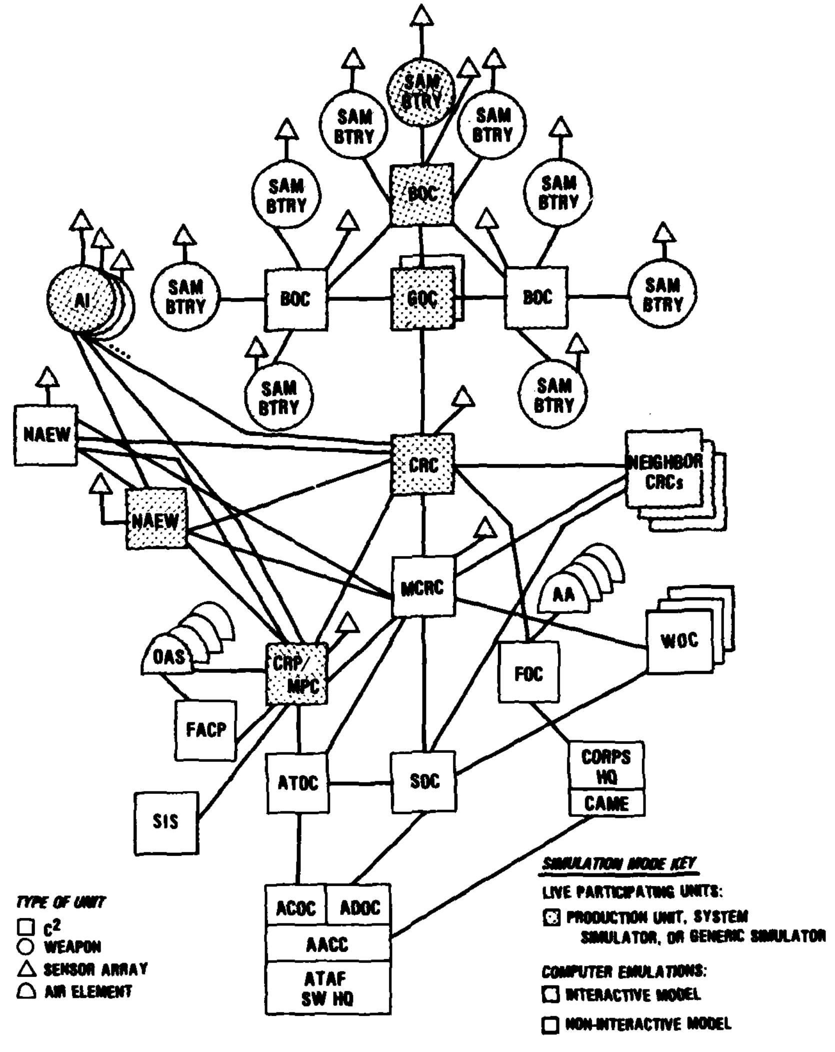
The various simulation methods will be used as follows to represent the NATO forces.

LPUs will be used in the simulation core area to represent one of each *type of facility in the mainstream* of the identification process: an IHAWK SAM Battery, a BOC, a GOC, the Lauda CRC, a CRP/MPC, a NATO airborne early warning aircraft, and a flight of F-15 fighter interceptors.

The LPU SAM Battery will represent one of the batteries of an IHAWK battalion in one of the two SAM Groups controlled by the Lauda CRC. Interactive models will be used to represent the other SAM batteries in this Group and to represent the other two BOCs in the Group. Interactive models will also be used to represent the other CRCs in the GEADGE system along with the neighboring NADGE CRC, a second NAEW aircraft, other flights of fighter interceptors, and OAS *aircraft (these* will be supplemented by preprogrammed flights).

Noninteractive facility models will be used mainly to emulate higher echelon facilities and other facilities not having real-time reactions to the immediate tactical situation.

REPRESENTATION OF NATO FORCES



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REPRESENTATION OF PACT FORCES

The higher echelon facilities of the Warsaw Pact forces, comprising the southern sector ADCC, its filter center and ADWOC, and the supporting radar networks, will be represented by an LPU. It is possible that one manned simulator installation, which would be partitioned to represent various components, would suffice. Therefore only a single LPU is shown.

If the lower echelon command and control and air defense weapons are to be included, these can be represented by adding a fast-time computer model. This would be an aggregated model that includes facilities such as the Army Air Defense Command Center, fighter divisions, GSCCs, fighter regiment GCIs, and the SAMs and fighters controlled by these facilities. This model would react to the air truth and to the commands issued from the facilities encompassed by the LPU. There are a number of models already extant or under development that could provide a foundation for the Pact model. Among these are various AFEWS models, certain models being developed for EW/CAS, and a family of models known as TAC ZINGER that represent the SAM portion of the frontal air defense. Also, models initially developed in order to study NATO air defense, such as MADEM, could be adapted to this purpose. If the fast-time model is included solely to determine engagement outcomes, then it can be executed off-line. If NATO/Pact interactions are to be represented, then the model must be designed to be executed on line.

REPRESENTATION OF PACT FORCES

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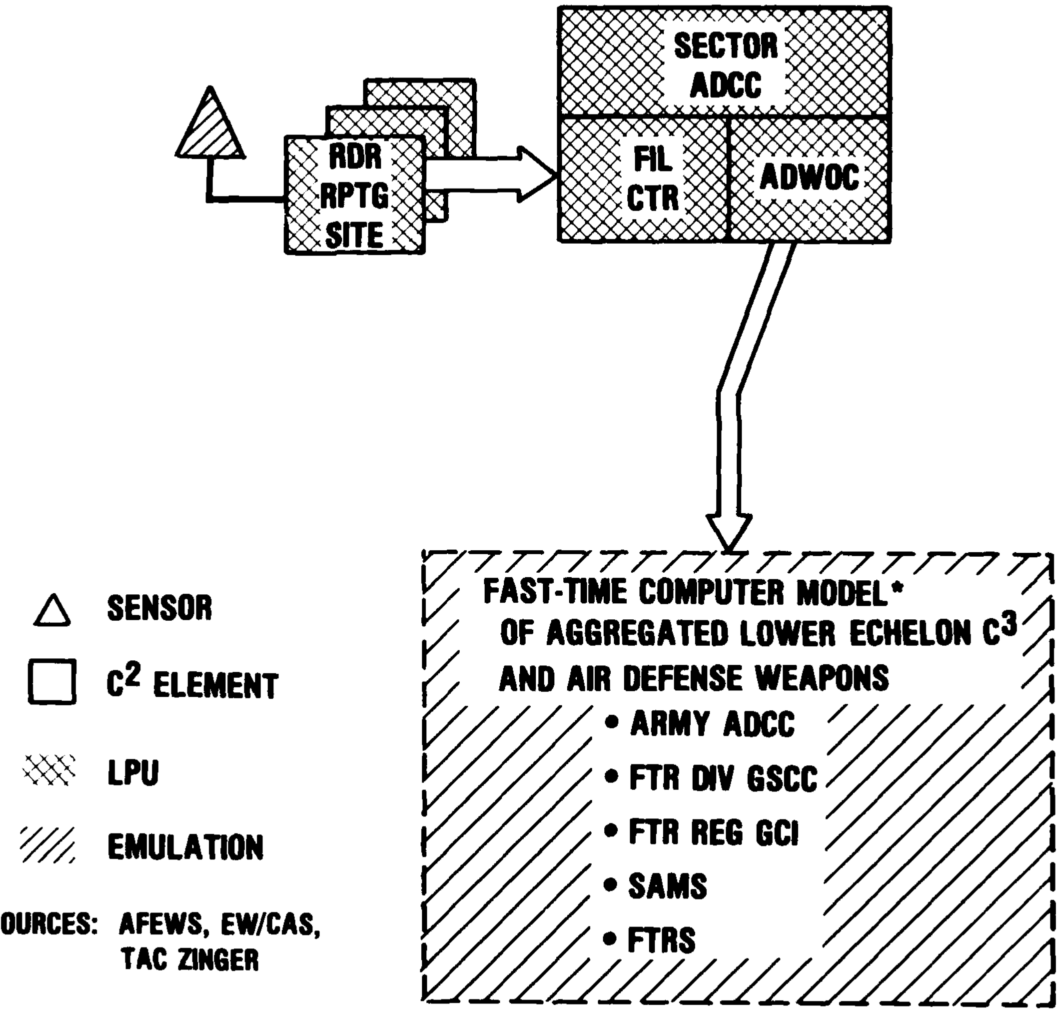

FAST-TIME COMPUTER MODEL*
OF AGGREGATED LOWER ECHELON C^3
AND AIR DEFENSE WEAPONS

- ARMY ADCC
- FTR DIV GSCC
- FTR REG GCI
- SAMS
- FTRS

△ SENSOR

☐ C^2 ELEMENT

▩ LPU

▨ EMULATION

*POTENTIAL SOURCES: AFEWS, EW/CAS, TAC ZINGER

11-6-79-9

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REQUIRED PROVISIONS

The testbed must have adequate provisions for *scenario preparation.* Numerous identification system options will have to be tested in many different situations, requiring that a large number of scenarios be generated. The effort necessary to produce these scenarios can be reduced considerably if existing flight profile libraries, such as the NATO Programming Center's Library, are utilized. The testbed must also provide for interactive editing of scenarios, so that they can be modified or corrected quickly.

The testbed will be composed of many facilities at diverse locations, making it vitally important that there be a common *stimulation* data base. Furthermore, stimulation of the testbed must be closely coordinated so that all facilities receive events simultaneously. Basic stimulation will consist not only of air operations, but also of scripted events such as switch-on or switch-off of avionics equipment and simulated destruction of communication links. Stimulation will be flexible to a moderate degree—while the backbone of the scenarios will be preprogrammed air operations generated prior to the test, these will be supplemented by up to 100 "free play" manually maneuverable flights and there will be provisions for real-time deletion of kills. There will also be provisions to allow automatic reactive maneuvers to be initiated when opposing forces meet; these maneuvers would follow standard air-air engagement tactics.

REQUIRED PROVISIONS

- SCENARIO PREPARATION
  - MANY SCENARIO VARIANTS REQUIRED
  - UTILIZE EXISTING FLIGHT PROFILE LIBRARIES WHERE POSSIBLE
  - INTERACTIVE SCENARIO EDITING
- STIMULATION
  - COMMON STIMULI DRIVING ALL FACILITIES
  - COORDINATED SIMULTANEOUS STIMULATION
  - AIR OPERATIONS PLUS SCRIPTED EVENTS ARE BASIC STIMULI
  - MODERATELY FLEXIBLE
    - PREPROGRAMMED AIR OPERATIONS (SCENARIO BACKBONE)
    - ON-LINE DYNAMIC CONTROL OF UP TO 100 FLIGHTS (OVERLAID)
    - REAL-TIME DELETION OF KILLS
    - AUTOMATIC REACTIVE MANEUVERS

REQUIRED PROVISIONS

Provisions for *monitoring* must include consoles to aid the test controllers, who will monitor testbed status, test progress, communications system actions, and the air situation being perceived by the various participating facilities. An observation gallery with a large-screen display to support rehearsals, training, briefings, demonstrations, and observation of the actual tests will also be required. Adequate provisions for *data extraction, recording, merging,* and *reduction* are absolutely essential for the evaluation program to be a success. The complexity of the test program and the fact that very large volumes of data will be collected from geographically scattered places will make this a challenge.

At the minimum, enough data must be extracted, recorded, and reduced to enable *all* events that affected a simulated aircraft to be reconstructed. Such events would include perception of the aircraft by the various sensors, and the actions taken by human operators and automated elements of the system. Second must important is to record diagnostic data, so that the test analyst will know not only what happened, but also why it happened. These types of data will also support post factum experimentation, in which effects not covered in the formal experiment design are explored using correlation analysis.

An adequate automated data merging and sorting capability is also a necessity, as there is great danger that the analyst will otherwise be overwhelmed by numerous uncorrelated data tapes, and manual data correlation will be a hopeless task. The data recording alignments and tape formats must be strictly controlled so that tapes can be processed successfully.

Finally, software must be developed so that interactive online analysis of critical test measures is possible while tests are actually in progress. Software for post-test interactive data review and programs to analyze data automatically will be necessary to handle the tremendous volumes of data expected. This capability must be available even before testing begins, to assist in checking out and debugging the equipment and programs. Development of such a capability must therefore begin early in the program.

REQUIRED PROVISIONS
(Cont'd)

- MONITORING
  - CONSOLES FOR TEST CONTROLLERS TO MONITOR: TESTBED STATUS, TEST PROGRESS, COMMUNICATIONS, FACILITY ACTIONS AND PERCEIVED AIR SITUATION
  - OBSERVATION GALLERY WITH LARGE SCREEN DISPLAY FOR: REHEARSALS, TRAINING, BRIEFINGS, DEMONSTRATIONS, TEST OBSERVATION
- DATA EXTRACTION, RECORDING, REDUCTION
  - FIRST PRIORITY: DATA TO PERMIT RECONSTRUCTION OF ALL EVENTS AFFECTING A SIMULATED AIRCRAFT
  - SECOND PRIORITY: DIAGNOSTIC DATA
  - DATA MERGING AND SORTING CAPABILITY
  - INTERACTIVE DATA REVIEW AND AUTOMATIC ANALYSIS PROGRAMS

11-6-79-11

FORMATION OF THE TESTBED

The testbed *will* be implemented in a modular fashion, and its formation will follow the 7-stage test progression described previously. The simulation components required in the first stage and in the ultimate full test configuration are shown here. The testbed grows from 1 LPU in the first stage to 8 LPUs. *Initially no interactive models are required; ultimately*, 11 types are required. No noninteractive models are necessary in the initial stages; 7 types are required for the full configuration. Initially sensor software models are required for 8 specific sensor systems; the final *configuration may include* as many as 36.[1] The types of *video generator* units required to furnish the analog signals necessary to drive some LPUs increases from 1 to 4.

The testbed and simulation requirements are thus initially quite limited. There will be a gradual, modular buildup to the full level of complexity required. As the testbed expands, each new stage will build on the experience gained in prior stages. In this way earlier deficiencies can be corrected and the increasing complexity will be accompanied by a growing staff proficiency.

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[1] The full family of sensors can be roughly classified into 10 generic types. Hence, 10 independent model developments–one per generic type–will be all that are actually required. With only minor modifications, this library can represent any specific sensor system of interest. The eight original sensors comprise the following: the normal complement of radars found in the IHAWK system (PAR, CWAR, HIPIR, ROR); active electronic identification systems (Mark X/XII and a Soviet sensor); possible future enhancements (HAIDE, ESM).

FORMATION OF THE TESTBED

TYPE OF TESTBED COMPONENT	NUMBER REQUIRED	
	INITIAL	FINAL
C^2/WEAPONS FACILITIES		
• LIVE PARTICIPATING UNITS	1	8
• INTERACTIVE MODELS	0	11
• NON-INTERACTIVE MODELS	0	7
SENSORS		
• VIDEO GENERATOR UNITS	1	4
• SOFTWARE MODELS	8*	36**
OTHER MODELS		
• AIRCRAFT FLIGHT MODEL	1	2
• ENDGAME MODEL	1	7
• MISCELLANEOUS	2	4

11-6-79-12

*5 generic types

**10 generic types.

MODIFIABILITY AND EXPANDABILITY

We consider here what provisions should be included in the testbed to facilitate modification and expansion of the software and hardware. Modifiability is needed so that unanticipated changes and problems, which are certain to develop in a program as complex as the IFFN evaluation, can be accommodated. The procedures and operational concepts being studied will change, since many of them are not firmly defined and are still evolving. Many of the air defense systems of concern are being updated, and in some cases the *updates are not final. The test program itself is* exploratory and will use adaptive experiment designs, so it is possible that the testbed will have to be altered to study unanticipated effects and issues that arise during testing. Expandability is needed so that if necessary the testbed can grow to a full theater air defense testbed, and also so that its scope can be enlarged to include Navy and Marine systems later.

These requirements mandate the use of a high-level programming language such as FORTRAN and a modular design for the software, so that program modifications can be made independently. It is also important to include an organic software development capability in the computer systems in the testbed, so that software can be developed on-site. To ensure adequate computer capacity and expansion potential, as a rule of thumb the system should be sized at critical points at two to three times the *capacity requirements* currently envisioned. Use of multiprocessor commercial minicomputer systems, which provide a sizable processing capability at a very reasonable cost, is desirable for the sake of economy. Good documentation of the software is essential; otherwise, rapid software modification will be extremely difficult.

MODIFIABILITY AND EXPANDABILITY

- **MODIFIABILITY NEEDED TO:**
  - ACCOMMODATE UNANTICIPATED CHANGES AND PROBLEMS
  - RESPOND TO EVOLVING PROCEDURES AND OPERATIONAL CONCEPTS
  - INCORPORATE AIR DEFENSE SYSTEM UPDATES
  - ACCOMMODATE EXPLORATORY NATURE OF THE TEST PROGRAM

- **EXPANDABILITY NEEDED TO:**
  - PRESERVE OPTION TO GROW INTO A FULL THEATER AIR DEFENSE TESTBED
  - ALLOW LATER INCLUSION OF NAVY AND MARINE SYSTEMS

- **RESULTING TECHNICAL REQUIREMENTS:**
  - USE OF HIGHER LEVEL PROGRAMMING LANGUAGE (E.G., FORTRAN)
  - MODULAR SOFTWARE
  - ORGANIC SOFTWARE DEVELOPMENT CAPABILITY
  - PROVIDE ADEQUATE CPU CAPACITY (E.G., BY USING COMMERCIAL SYSTEMS)
  - GOOD DOCUMENTATION

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TESTBED FEATURES: LOW-RISK REQUIREMENTS

One part of delineating the technical requirements for the testbed is determining how risky they are. These testbed requirements are considered low risk. They *include* requirements such as the use of a hybrid testbed (i.e., mixing live and emulated units); scenario generation flexibility; the use of dynamically controlled aircraft; and using weapon system end-game models for real-time kill removal. All of these have been realized in similar form in previous simulation systems such as the TACS/TADS testbed, 485L STEM, and the NATO Programming Center's NADGE Simulation System.

TESTBED FEATURES
(LOW-RISK)

FEATURE	OBJECTIVE	EXPERIENCE
HYBRID TESTBED	• MIXTURE OF LIVE AND EMULATED UNITS	• REALIZED IN TACS/TADS TESTBED
SCENARIO GENERATION FLEXIBILITY	• INTERACTIVE EDITING AND REVIEW • USE OF OFFLINE LIBRARIES	• FULLY ACHIEVED (MULTOTS, SIMTRACC) • AVAILABLE DATA BASES (E.G., NATO PROGRAMMING CENTER)
DYNAMICALLY CONTROLLED AIRCRAFT	• UP TO 100 AIRCRAFT	• 50 ACHIEVED WITH 6 PILOT STATIONS (485L STEM)
WEAPON SYSTEM END-GAME MODELS	• HIMADS MODELS (E.G., IHAWK) • AIR-TO-AIR MODELS (E.G., SPARROW)	• DEVELOPED AND EXTENSIVELY EXERCISED

11-6-79-14

TESTBED FEATURES: LOW- TO MODERATE-RISK REQUIREMENTS

These items are considered to be in the low- to moderate-risk category:

- The need for a highly realistic emulation of sensors, which has often been done before off line, but only for one or two sensors simultaneously.
- The interconnection of numerous live participating units, which has been accomplished before in the TACS/TADS testbed, but is still a difficult undertaking.
- The need for a large number of simultaneous flights; previous systems have not reached a peak loading of 500, although a total of 370 is achieved in an enhanced MULTOTS.
- On-line test monitoring and control, which has been achieved in TACS/TADS mainly to monitor digital messages, but not done before for the wide array of parameters that need to be monitored in the IFFN Evaluation testbed.

TESTBED FEATURES
(LOW- TO MODERATE-RISK)

FEATURE	OBJECTIVE	EXPERIENCE
REALISTIC SENSOR EMULATION	• UP TO 10 GENERIC TYPES • ON-LINE OPERATION • INCLUDE SECOND ORDER EFFECTS • VIDEO OUTPUTS (WHERE REQUIRED)	• EXISTING MODELS OF CW, 2-D, 3-D RADARS AND MARK X/XII (E.G., MARINES 15A19, 485L STEM, SIMTRACC)
INTERCONNECTION OF NUMEROUS LIVE PARTICIPATING UNITS (LPUs)	• UP TO 8 LPUs (MIX OF WEAPON SYSTEMS, OPERATIONAL SYSTEMS, MANNED SIMULATORS)	• 10 OPERATIONAL SYSTEMS INTERFACED IN TACS/ TADS
MANY SIMULTANEOUS FLIGHTS	• PEAK LOADINGS UP TO 500	• PEAK LOADINGS OF 370 IN ENCHANCED MULTOTS
ON-LINE TEST MONITORING AND CONTROL	• COORDINATED STIMULATION • REAL-TIME MONITORING	• ACHIEVED IN TACS/TADS (EMPHASIS ON MONITORING DIGITAL MESSAGES)

11-6-79-15

TESTBED FEATURES: MODERATE- TO HIGH-RISK REQUIREMENTS

These requirements are considered to be in the moderate- to high-risk category. The requirement for multiple-system coordinated data reduction implies the necessity to merge data automatically from up to 8 different systems. This is very difficult; success requires extremely close coordination between the sites and the processing facility, tight control over formats and data recording standards, and detailed preparation. Automatic data merging has been accomplished on a limited scale in some DoD and FAA testing programs, and the NATO Programming Center plans to include this capability in Phase III of the Analysis, Data Reduction, and Evaluation System. However, there is little precedent for automatic merging involving 8 different systems.

Another formidable requirement is for online emulation of the numerous C^2 and weapon system facilities that constitute the simulation background. Most experience in this field has been with offline models which have been only partially validated. Online emulation in the past has been limited to modeling simple data link interchanges and has never been attempted on the scale and level of complexity required in the identification testbed. Of particular concern is the adequacy with which human delays, errors, and conditional effects are represented in the models. Furthermore, unknown difficulties may be associated with including two-way voice and data interactions between emulated systems and LPUs, and data link interactions between the various emulated systems themselves.

The final requirement is the proper fidelity level for the family of simulation models being used throughout the testbed. It is quite difficult to determine beforehand how much fidelity is enough; opportunities to verify the models are scarce and experience in testing the adequacy of a particular fidelity level is limited. Determining the suitable balance between the rising cost of higher fidelity and what is needed for valid test results will be mainly a matter of judgment.

TESTBED FEATURES
(MODERATE- TO HIGH-RISK)

FEATURE	OBJECTIVE	EXPERIENCE
MULTIPLE SYSTEM, COORDINATED DATA REDUCTION	• MERGING OF DATA FROM UP TO 8 SYSTEMS	• PARTIALLY ACHIEVED (SIMTRACC, NPC PHASE 3, FAA TESTS)
EMULATION OF BACKGROUND SYSTEMS	• ADEQUATE REPRESENTATION OF DELAYS, ERRORS, AND CONDITIONAL EFFECTS • REPRESENTATION OF TWO-WAY VOICE AND DATA LINK INTERACTIONS	• LIMITED TO OFF-LINE MODELS WHICH HAVE NOT BEEN COMPLETELY VALIDATED (E.G., TAC CONTROLLER, SAINT) • LIMITED TO SIMPLE DATA LINK INTERCHANGES (TACS/TADS, SIMTRACC)
FIDELITY	• ACHIEVE SUFFICIENT FIDELITY TO INFLUENCE ACTIONS REALISTICALLY WITHOUT EXCESSIVE COST	• LIMITED EXPERIENCE IN ESTABLISHING REQUIREMENTS AND VERIFYING ADEQUACY

11-6-79-16

CONCEPT SELECTION

11-6-79-17

SELECTION OF A CANDIDATE ARCHITECTURE CONCEPT

This section describes the architectural concept recommended for the identification testbed and discusses the rationale behind our selection of that concept. The final choice is of course the prerogative of the JTF.

GENERAL APPROACH

The first step in selecting the concept was to review other related simulation testbeds. These testbeds were examined in terms of the architectures they represent, and in each case the rationale behind the choice of architecture was also examined. This enabled us to determine what general tradeoffs govern the selection of an architectural choice.

The next step was to examine the IFFN Evaluation Program to assess how its particular requirements would affect the choice of architecture. The concept deemed most attractive was selected to be validated by a subsequent strawman design.

GENERAL APPROACH

- REVIEW OTHER SIMULATION TESTBEDS AND UNDERLYING RATIONALE
- CHARACTERIZE SPECTRUM OF ARCHITECTURES AND IDENTIFY TRADEOFFS
- ASSESS THE IMPACT OF IFFN PROGRAM ATTRIBUTES ON ARCHITECTURE CHOICES
- SELECT THE MOST SUITABLE CONCEPT

11-6-79-18

SPECTRUM OF ARCHITECTURES

The review of related testbeds established that their architectures could be characterized basically in terms of what degree of centralization each represented. By centralization is meant both centralization of test control functions and physical centralization of facilities. It was found that the architectural spectrum ranges from a fully centralized configuration, with all facilities collocated and centrally controlled, to a fully decentralized configuration where facilities are dispersed geographically and locally controlled.

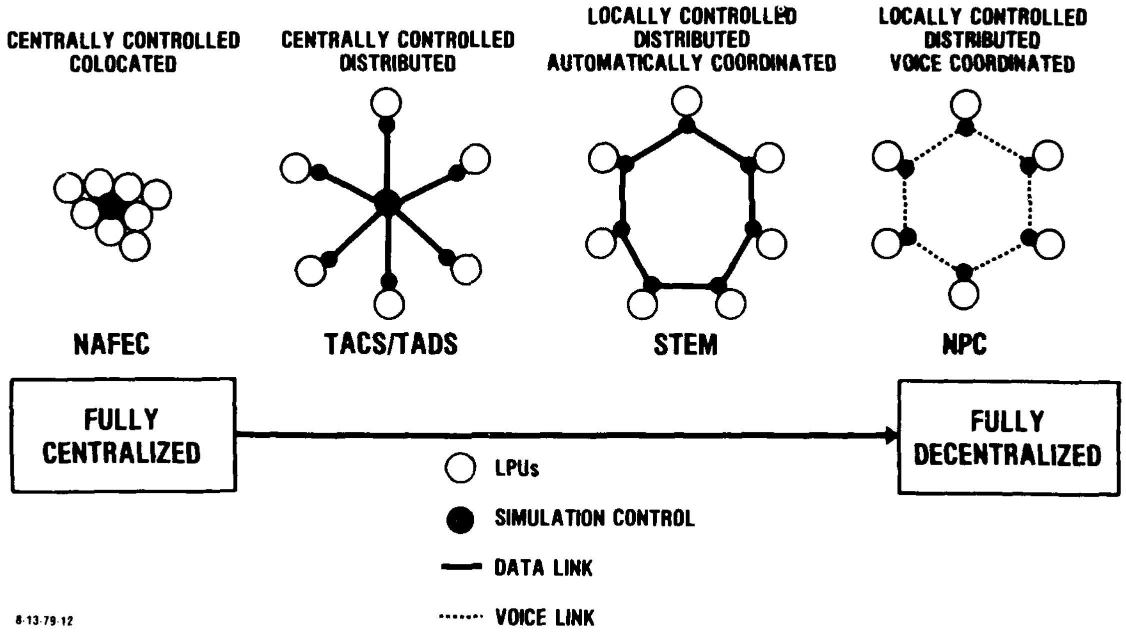
Four of the testbed architectures examined are shown here. These four are for the NAFEC testbed, the TACS/TADS testbed, the STEM test concept, and the NATO Programming Center's NADGE simulation exercise concept. The NAFEC testbed is owned by the Federal Aviation Administration and located at the National Aviation Facility Experimental Center in Atlantic City. This testbed represents the airspace control system for the United States and comprises an en route center, a terminal radar approach control, flight service stations, and commercial airliner flight simulators, among other facilities. All are centrally located, controlled, and stimulated.

The TACS/TADS testbed architecture is one step away from the NAFEC testbed's fully unified architecture. In this case there is central control, but cost savings are achieved by using geographically distributed, previously existing facilities.

The STEM system test concept, which is being developed under the Air Force's 485L program, represents even more decentralization. This architecture is determined by the need to exercise the individual 485L units independently, making the capability for local stimulation of each of the distributed units a necessity. However, the stimulating elements are automatically coordinated via an automatic data link.

Finally, at the other end of the spectrum and representing fully decentralized operations is the NPC's method of exercising the NADGE CRCs. Simulation tapes are distributed by mail to the various CRCs, which have their own local stimulation facilities. The facilities are loosely coordinated via voice links, so that the tapes are started at approximately the same time.

SPECTRUM OF ARCHITECTURES



CENTRALLY CONTROLLED
COLOCATED

NAFEC

CENTRALLY CONTROLLED
DISTRIBUTED

TACS/TADS

LOCALLY CONTROLLED
DISTRIBUTED
AUTOMATICALLY COORDINATED

STEM

LOCALLY CONTROLLED
DISTRIBUTED
VOICE COORDINATED

NPC

FULLY CENTRALIZED

FULLY DECENTRALIZED

○ LPUs

● SIMULATION CONTROL

— DATA LINK

······ VOICE LINK

8-13-79-12

BASIC DIFFERENCES

Architectures such as those represented by the NPC and the STEM testbeds, *which lie* toward the decentralized end of the spectrum, are appropriate when procedural control[1] of testing is sufficient and the investment necessary to provide more positive control[2] is not justified. This is usually the case when the testing process is fairly standardized and does *not entail a long, complex series* of tests.

The TACS/TADS testbed, which is more toward the middle of the spectrum, represents an approach providing effective and immediate positive control over the actual testing, enabling departures from preplanned procedures to be corrected quickly. It also offers the economies inherent in using existing facilities, although at the price of increased difficulty in coordination and scheduling.

Finally, an approach such as that represented by the NAFEC testbed is the ultimate in control and centralization. It provides the luxury of a totally unified testbed, but at a high price, which is usually affordable only when a permanent testbed facility is being created.

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[1] Procedural control consists of issuing preplanned test procedures and assuming that each facility will follow them precisely.

[2] Positive control includes feedback, so that any deviations by the test participants from the planned test procedures are detected; appropriate corrective measures are taken or the test is aborted to prevent wasting time and other resources.

CHARACTERIZATION OF BASIC DIFFERENCES

FULLY DECENTRALIZED	BETS THAT PROCEDURAL CONTROL OF TESTING WILL BE SUFFICIENTLY EFFECTIVE
NPC	
STEM	
TACS/TADS	PROVIDES POSITIVE CONTROL OVER TESTING USING EXISTING LPUs IN SITU
NAFEC	PROVIDES THE FULL LUXURIES OF A UNIFIED TESTBED AT A PRICE WHICH MAY NOT BE AFFORDABLE IN ALL CASES
FULLY CENTRALIZED	

KEY FACTORS

The key factors to consider in viewing the architecture tradeoff are cost, time, and risk. As the testbed becomes more centralized these increase for the development phase but decrease for the test operations phase.

However, the ultimate concern of the program planner is the *total* cost, time, and risk associated with the program (the sum of the development phase and the testing phase) represented by the upper curve on the chart. As the concave shape of this curve implies there is usually a point in the centralization spectrum that offers the best potential for low overall cost, risk, and time expenditure.

It is important to note that the shapes of all three curves are quite dependent on the nature of the program under consideration. For instance, a program involving long, arduous, and complex testing would have curves for time, cost, and risk of test operations that rapidly accelerated as the testbed architecture became decentralized, moving the minima for overall program costs to the left and making a more fully centralized architecture preferable. A program involving many facilities but with a rather short, standardized testing schedule would entail fairly low costs for test operations per se, but very high costs for developing a centralized architecture. In this situation a more decentralized approach would offer the lowest total program costs.

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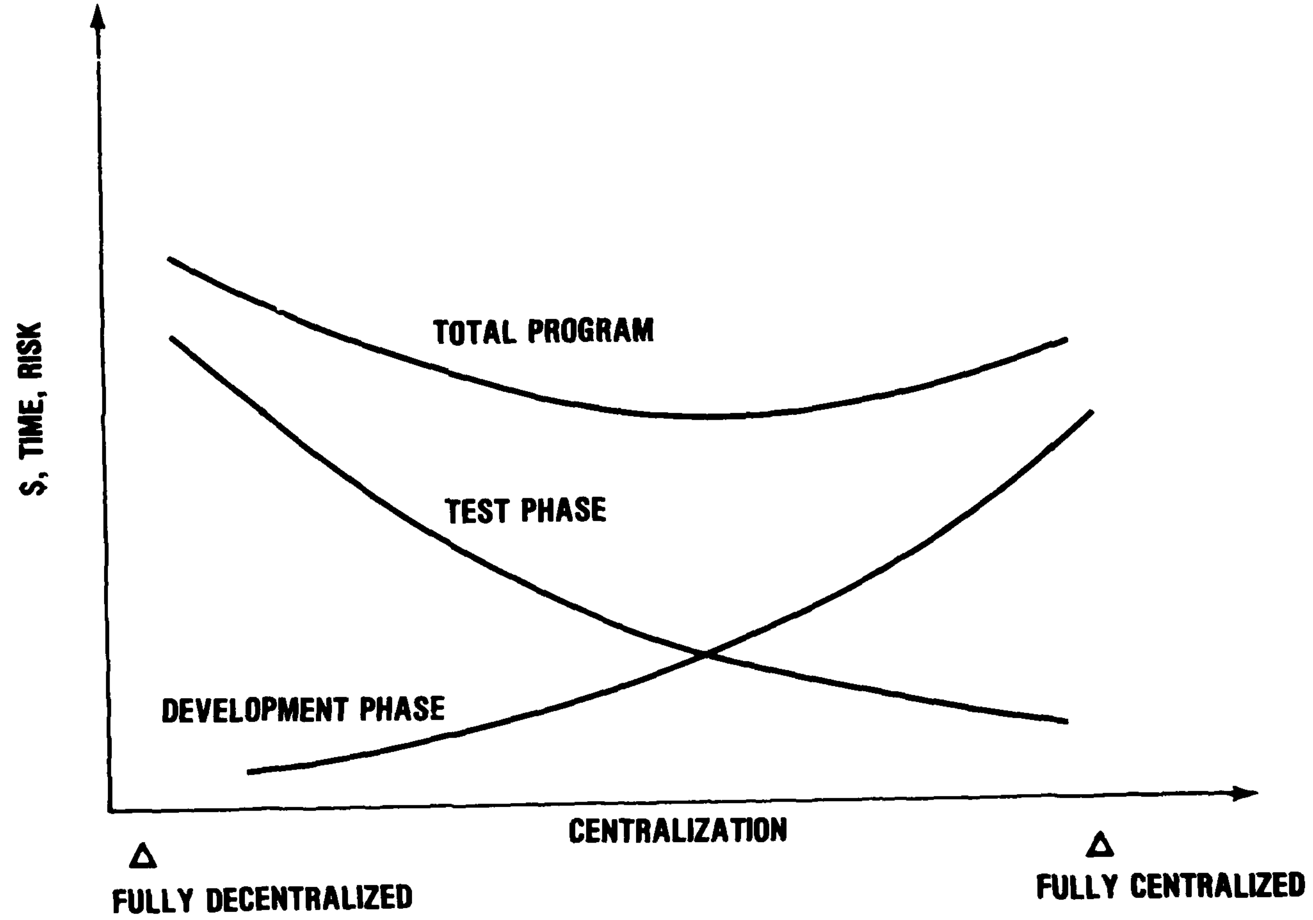
KEY FACTORS IN THE ARCHITECTURE TRADEOFF



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INFLUENCE OF THE IFFN PROGRAM ATTRIBUTES ON ARCHITECTURE

Particular characteristics of the IFFN program have different implications in regard to the desirability of specific architectural features. The IFFN program testing operations will be limited, lasting about 3 years. Therefore, a permanent facility is neither required nor justifiable. The extra expense and time needed to acquire and collocate dedicated LPUs for a unified testbed would outweigh any advantages gained over a testing period of only 3 years. Therefore, a distributed testbed is deemed desirable.

There are important considerations, however, which argue for the inclusion of certain other architectural features to facilitate testing. First, manpower costs for the testing will be the largest program cost element.[1] These costs will be in direct proportion to the amount of time required to complete the planned schedule of tests. Second, as the tests to be performed are quite complex, their success rate is expected to be sensitive to the degree to which positive control can be exercised. It is apparent that large cost savings will ensue if the success rate can be maintained at a satisfactory level. Thus, it is reasonable to expect that the savings attained by centralizing control to facilitate testing far outweigh the extra costs. *The amount of leverage offered by centralized control becomes clear when* we realize that its marginal cost is estimated to be less than one tenth of the testing cost.

Finally, the IFFN testing program will be a continually evolving process. Unless highly flexible scenario data distribution and stimulation mechanisms are employed, there will be many excessive and costly delays in the testing cycle. Therefore, measures to provide such flexibility, by providing for real-time online stimulation of the testbed, can be expected to result in considerable savings.

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[1] The section on programmatic issues provides detailed cost breakdowns.

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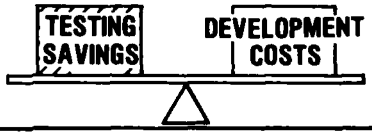
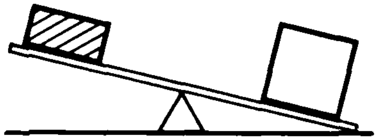
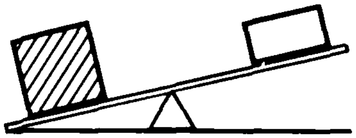
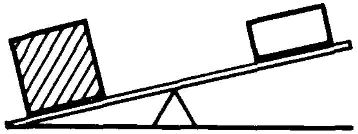
INFLUENCE OF IFFN PROGRAM ATTRIBUTES ON ARCHITECTURE

IFFN PROGRAM ATTRIBUTE	TRADEOFF BALANCE 	ARCHITECTURE IMPACT
• SCOPE OF PROGRAM DOES NOT JUSTIFY ACQUISITION AND COLOCATION OF LPUs		• DISTRIBUTED TESTBED IS DESIRABLE
• MANPOWER COST FOR TESTS ARE LARGEST COST ELEMENT, AND ARE SENSITIVE TO TEST DURATION • TESTS ARE COMPLEX WITH SUCCESS RATE SENSITIVE TO ABILITY TO CONTROL		• HIGH LEVERAGE EXISTS FOR IMPROVING TESTING SUCCESS RATIO VIA CENTRALIZED CONTROL
• TESTING IS LOOSELY DEFINED, AND WILL BE A ADAPTIVE PROCESS		• HIGHLY FLEXIBLE SCENARIO GENERATION AND STIMULATION VIA ON-LINE, REAL-TIME PROCESSING IS NEEDED

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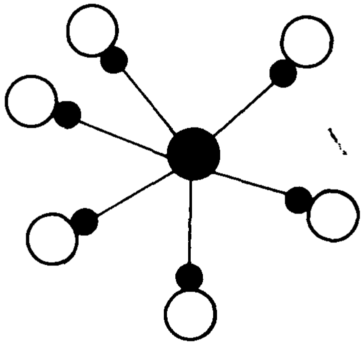
CENTRALLY CONTROLLED DISTRIBUTED TESTBED

The considerations just discussed mark one architecture in particular as being highly suitable for the IFFN testbed. This is a centrally controlled distributed testbed patterned after the TACS/TADS architecture. The major features of this architecture are restated here.

This architecture features the use of dispersed participating units that are interconnected at a central simulation facility from which all stimulation emulates. The simulation data are distributed in real time via an automatic data link. All control and monitoring functions are exercised from the central facility, and are based on information sent back from the dispersed units via automatic data and voice links. These features allow for positive test control and flexibility at a reasonable cost.

CENTRALLY CONTROLLED DISTRIBUTED TESTBED CONCEPT

- BASED ON TACS/TADS
- DISPERSED FACILITIES
- STIMULATION FROM ONE SOURCE
- REAL-TIME SIM DATA DISTRIBUTION VIA AUTOMATIC DATA LINK
- CONTROL AND MONITORING FROM ONE CENTRAL POINT



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ATTRACTIVENESS OF THE TACS/TADS ARCHITECTURE

The recommended concept has its pros and cons.

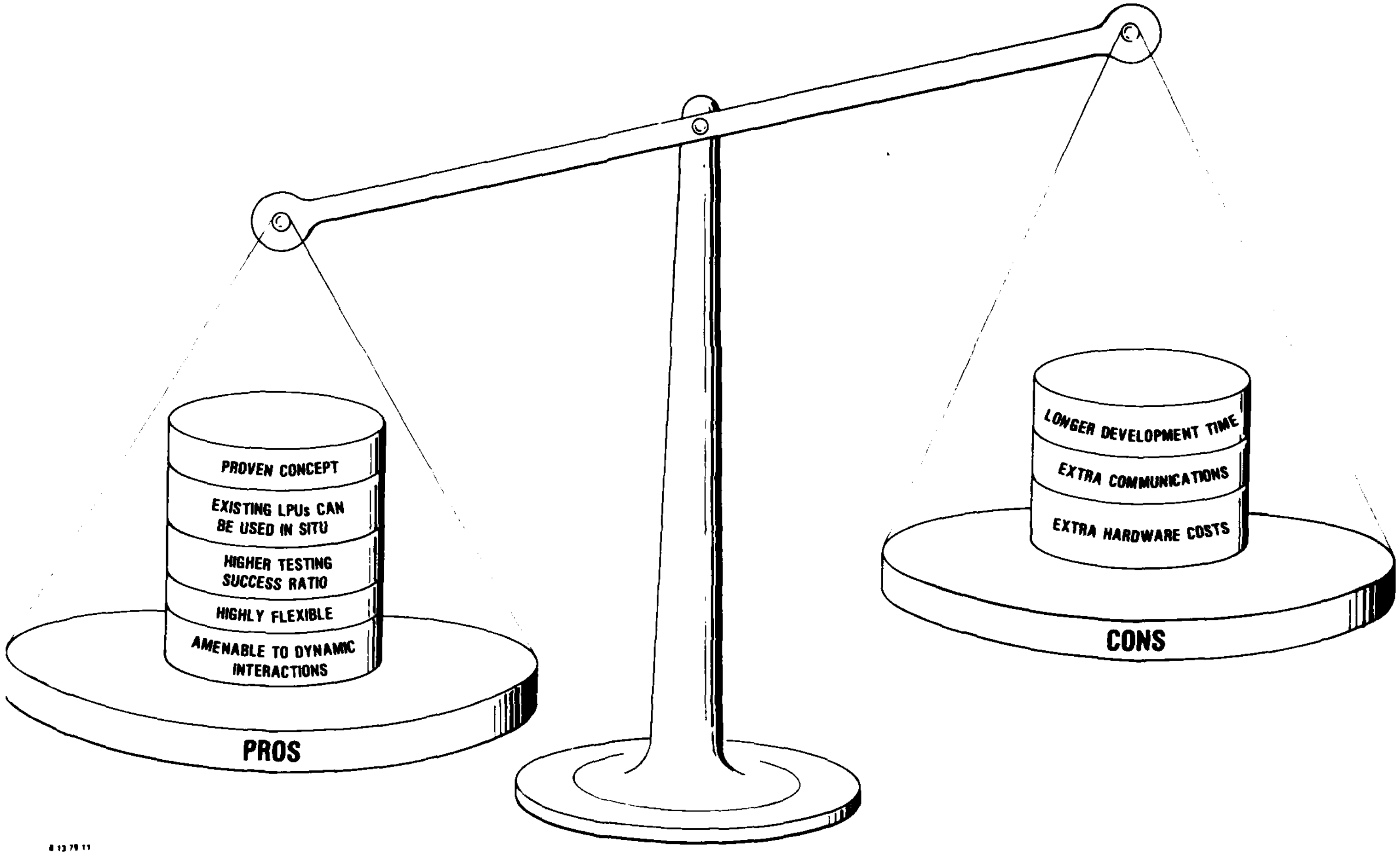
On the positive side, the centrally controlled distributed testbed architecture is a proven concept and represents the results of a body of interoperability testing experience that is directly applicable to the IFFN testbed. This architecture allows for the use of existing LPUs, *left in place.* It thereby avoids the cost of moving facilities or purchasing new ones, allows the operating and support crews to remain at their home base, and simplifies the logistics problem. It also allows new facilities to be added easily or alternate ones to be used.

The degree of positive control offered by this architecture means that there is more potential for a higher testing success ratio, which is a major cost advantage. It is estimated that even a 10-percent variation in this ratio could affect program costs by as much as $5 million. Further cost savings should be realized through reduced testing delays and turnaround times, made possible by the great flexibility inherent in the concept. This architecture will also easily accommodate dynamic scenario variations and two-sided free play interactions between simulation elements.

On the negative side, the concept requires a somewhat longer development time, extra communications costs (although these costs are somewhat marginal in comparison to the operational communications that are required anyway), and the extra facility hardware costs associated with a central simulation facility.

On the whole, in our estimation the pros considerably outweigh the cons.

THE ATTRACTIVENESS OF THE CENTRALLY CONTROLLED DISTRIBUTED (TACS/TADS) TESTBED ARCHITECTURE



CENTRALLY CONTROLLED
DISTRIBUTED TESTBED CONCEPT
"STRAWMAN"

11-6-79-22

CENTRALLY CONTROLLED DISTRIBUTED TESTBED CONCEPT: STRAWMAN DESIGN

This section provides further details on the centrally controlled distributed testbed *concept* by suggesting a strawman design for the IFFN testbed. This strawman design is intended to serve two purposes: it will serve as the basis for engineering specifications (after review and subsequent refinements), and it will give those interested an idea of what the IFFN testbed might look like.

IFFN TESTBED FEATURES

We show here the salient features of an IFFN testbed designed to conform to the centrally controlled distributed testbed architecture. The testbed is composed of two entities: the simulation control system, and a number of LPUs—those manned systems in the simulation core that are being played live.

The testbed architecture can be visualized as a ring of LPUs surrounding a central simulation facility. All stimulation emanates from this central facility, and it is also where the monitoring and control functions are concentrated. Between the central simulation facility and each *LPU* is a satellite simulation unit (SSU), located at the LPU site. These SSUs serve as interface buffers between the simulation control system and the LPUs.

Two communications networks are included. The test control communications network (designated by the solid line) comprises those voice and data linkages required to control the test and stimulate the testbed. Air truth data are distributed to LPUs and monitored parameters are sent back to the simulation facility over these links.

The second communications network is the tactical communications net that provides operational communications between the various LPUs. These connections are shown as dotted lines and comprise the various voice coordination circuits and tactical data link circuits[1] that are employed operationally. All circuits are to be routed through the central simulation facility. This will allow monitoring and recording of all messages at the central simulation facility.

Note that the simulation control system includes a support data processing *center, which would be connected* off-line to the central simulation facility via tape. This would be an existing general purpose data processing center with extensive capabilities located in the vicinity of the central simulation facility. The center would perform off-line processing duties requiring computer power beyond that available in the central simulation facility.

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[1] TADIL B, ATDL 1, NATO LINK 1, TADIL J.

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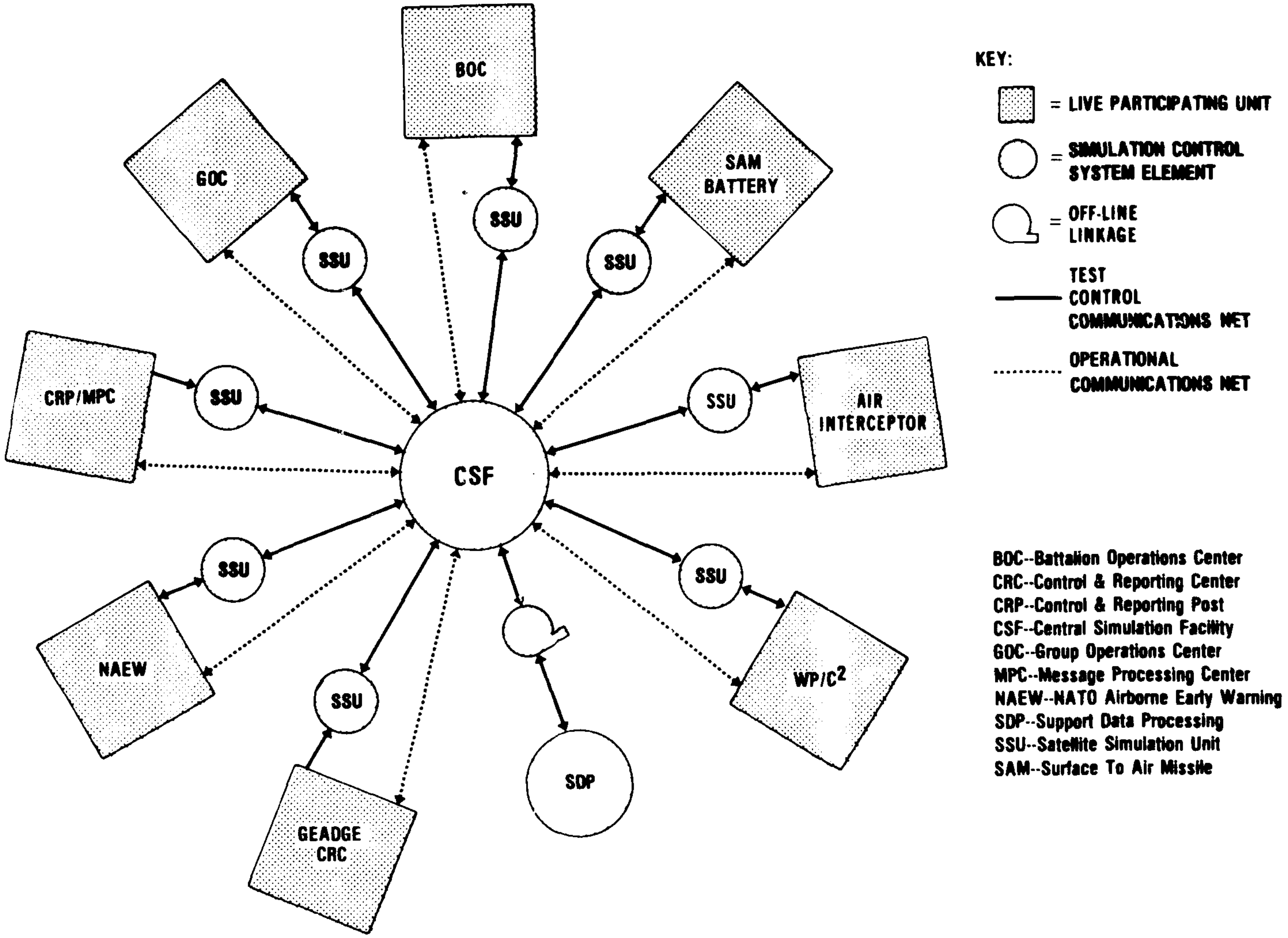
IFFN TESTBED FEATURES



BOC--Battalion Operations Center
CRC--Control & Reporting Center
CRP--Control & Reporting Post
CSF--Central Simulation Facility
GOC--Group Operations Center
MPC--Message Processing Center
NAEW--NATO Airborne Early Warning
SDP--Support Data Processing
SSU--Satellite Simulation Unit
SAM--Surface To Air Missile

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EXAMPLES OF LIVE PARTICIPATING UNITS: IHAWK SAM BATTERY

One of the LPUs that will be incorporated into the testbed is the IHAWK SAM battery LPU.

The diagram depicts the full complement of equipment making up an IHAWK Triad battery of three fire units. This consists of various radars (CWAR, PAR, ROR, HIPIR), the launchers and missiles, data processing and communications equipment (ICC), and two types of local C^2 systems (the Battery Control Central [BCC] and the Platoon Command Post [PCP]). The LPU will consist of the ICC, BCC, and two PCPs, and hence will actually be an amalgamation of four separate components. Note that the LPU will not include the actual radars and missiles; these will be emulated by computer models and video generators.

The IHAWK LPU will probably be one of the operational IHAWK units based at Ft. Bliss.

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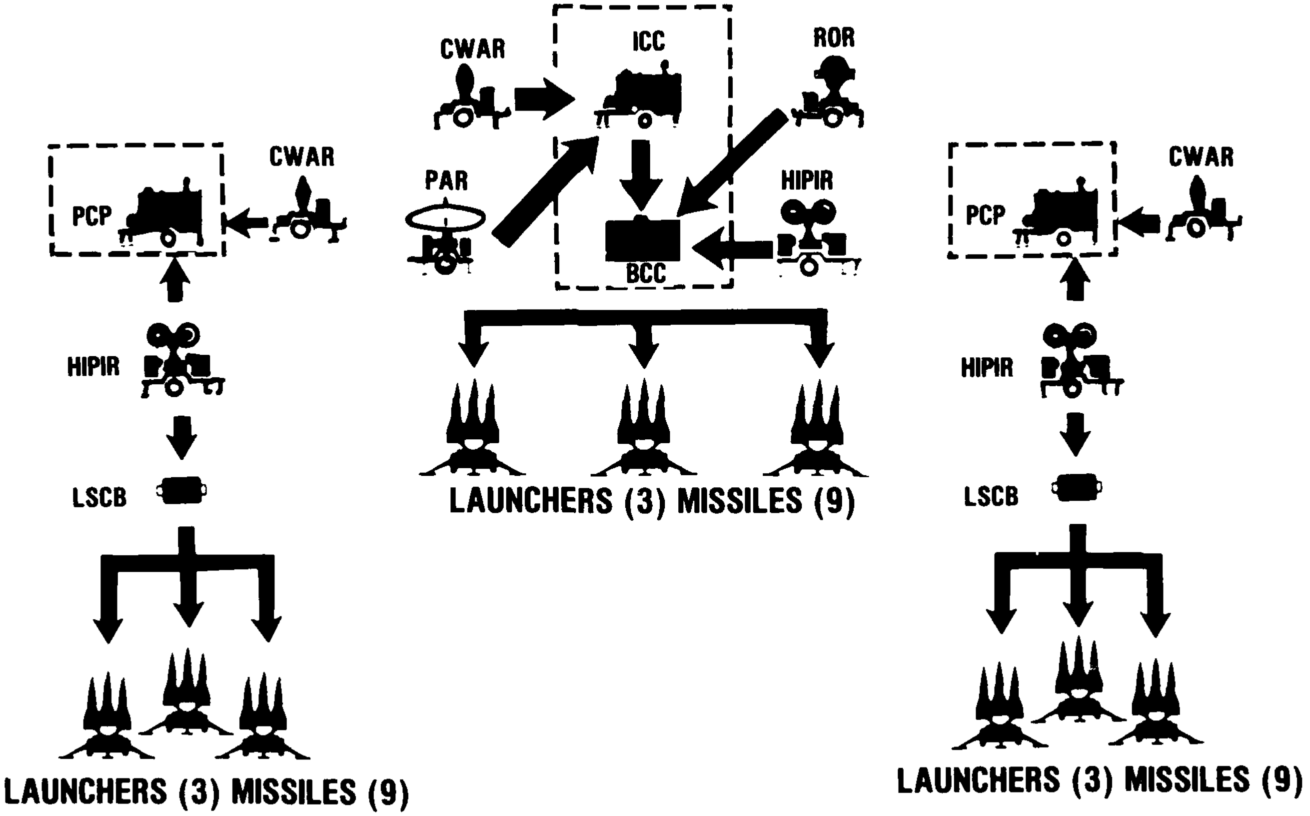
EXAMPLES OF LIVE PARTICIPATION UNITS:
IHAWK BATTERY



- HARDWARE ENCLOSED BY DASHED BOXES IS INCLUDED IN LPU
- ALL OTHER HARDWARE IS SIMULATED BY SIMULATION CONTROL SYSTEM

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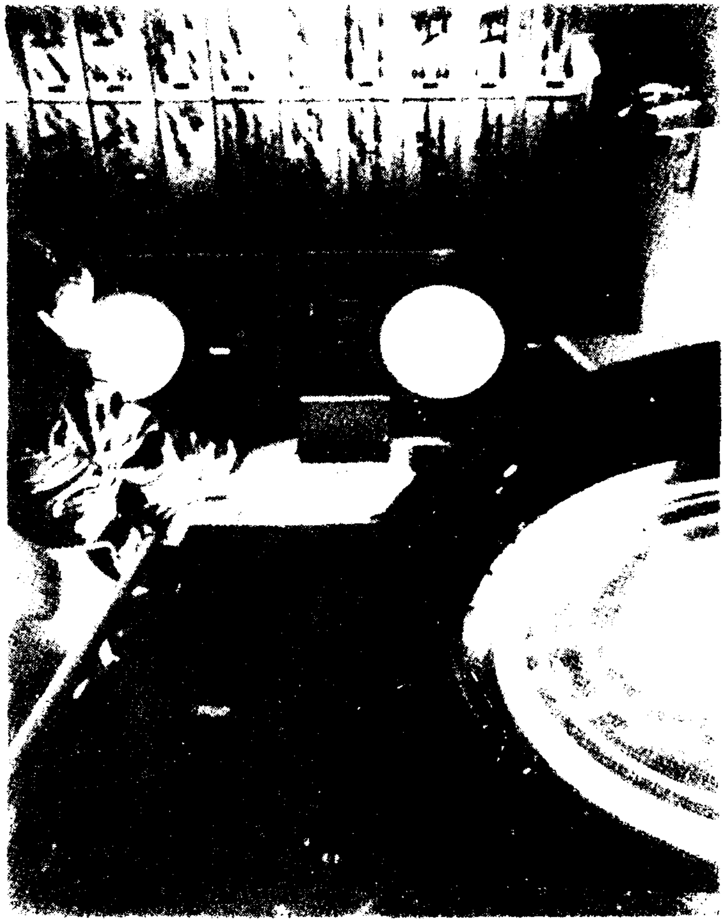
BCC PORTION OF IHAWK LPU

This shows the inside of the IHAWK battery BCC portion of the IHAWK LPU. The two PCPs that are not shown have a similar purpose, but are smaller. The horizontal display in the foreground is used to detect and identify targets and will be driven by simulated CWAR and PAR analog signals supplied by a video generator. The two displays in the background are the HIPIR radar acquisition and tracking displays and will also be driven by simulated analog signals from a video generator. The video generators will act upon outputs from software models of the various radars driven by air truth data from the CSF. The BCC and PCPs will be manned by actual operational crews.

EXAMPLES OF LIVE PARTICIPATING UNITS:
BCC* PORTION OF IHAWK LPU



*BATTERY CONTROL CENTRAL

BOC AND GOC

This shows a TSQ-73 system; two of these will be used to form the LPUs for the BOC and the GOC. Actual production models located at Ft. Bliss will be used.

In a TSQ-73, air situation data are presented on the two displays shown. For the BOC LPU, these data would be a combination of information received from the unit's organic surveillance radar (either a GSS-1, HIPAR, or DAR) and tracks cross-told from subordinate units, neighboring BOCs, and higher echelons via the ATDL operational data link. In the testbed, the BOC's surveillance radar would be simulated by a software model. This would drive a video generator which will furnish synthetic video signals to the TSQ-73's radar digitizer processor. The software model and video generator will be part of the simulation control system and will be stimulated by the air truth data distributed by the CSF. This mechanism will enable the BOC crew to see and respond to a realistic but totally simulated air situation picture. The crew will initiate real operational data link and voice communications messages, as the situation dictates, which will be transmitted to other facilities over the operational communications network.

The GOC *does not have* any sensors of its own, and its air situation displays depict only tracks cross-told from other facilities. Thus the GOC LPU would not receive any air truth data or simulated sensor data *directly* from the simulation control system. Its crew would observe and respond to air situation data being sent over the operational network and hence would not be stimulated directly by the simulation control system.

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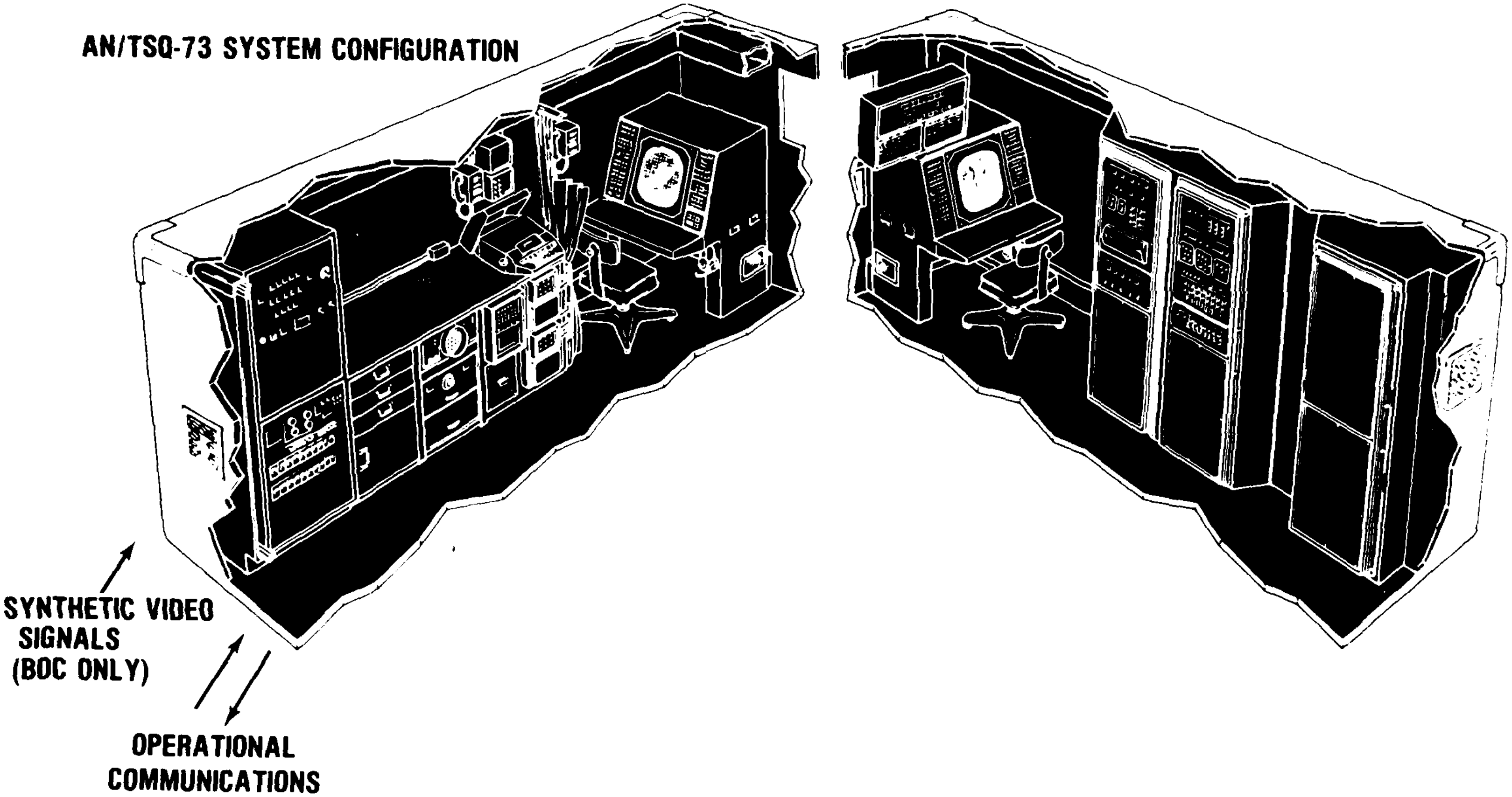
EXAMPLE OF LIVE PARTICIPATING UNITS: BOC AND GOC

AN/TSQ-73 SYSTEM CONFIGURATION



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AIRBORNE INTERCEPTOR

This is one of the flight simulator facilities that could be used for the airborne interceptor LPU. This particular facility is a system simulator and is known as the Manned Air Combat Simulator (MACS). It is owned by the McDonnell Douglas Corporation and is located in St. Louis.

The facility consists of four aircraft cockpits (only two are shown). Two of these cockpits are mockups of the F-15. The remainder of the facilities consists of an extensive computer hardware and data processing complex, which controls these units and models the avionics equipment.

The AVSAIL facility, owned by the Air Force Avionics Laboratory, is also being considered as a possible air interceptor LPU.

Because these facilities have extensive built-in provisions for sensor simulation, it is expected that the simulation control system will have to supply only the air truth data needed to stimulate these models. The synthetic sensor information thus provided to the pilot will be directly responsive to the simulation control system. The pilot will also be reacting to information he receives from other players over the operational data and voice links. At least two of the cockpits should probably be used to represent a flight of at least two aircraft so that the interactions of the pilot and his wingmen can be realistically portrayed.

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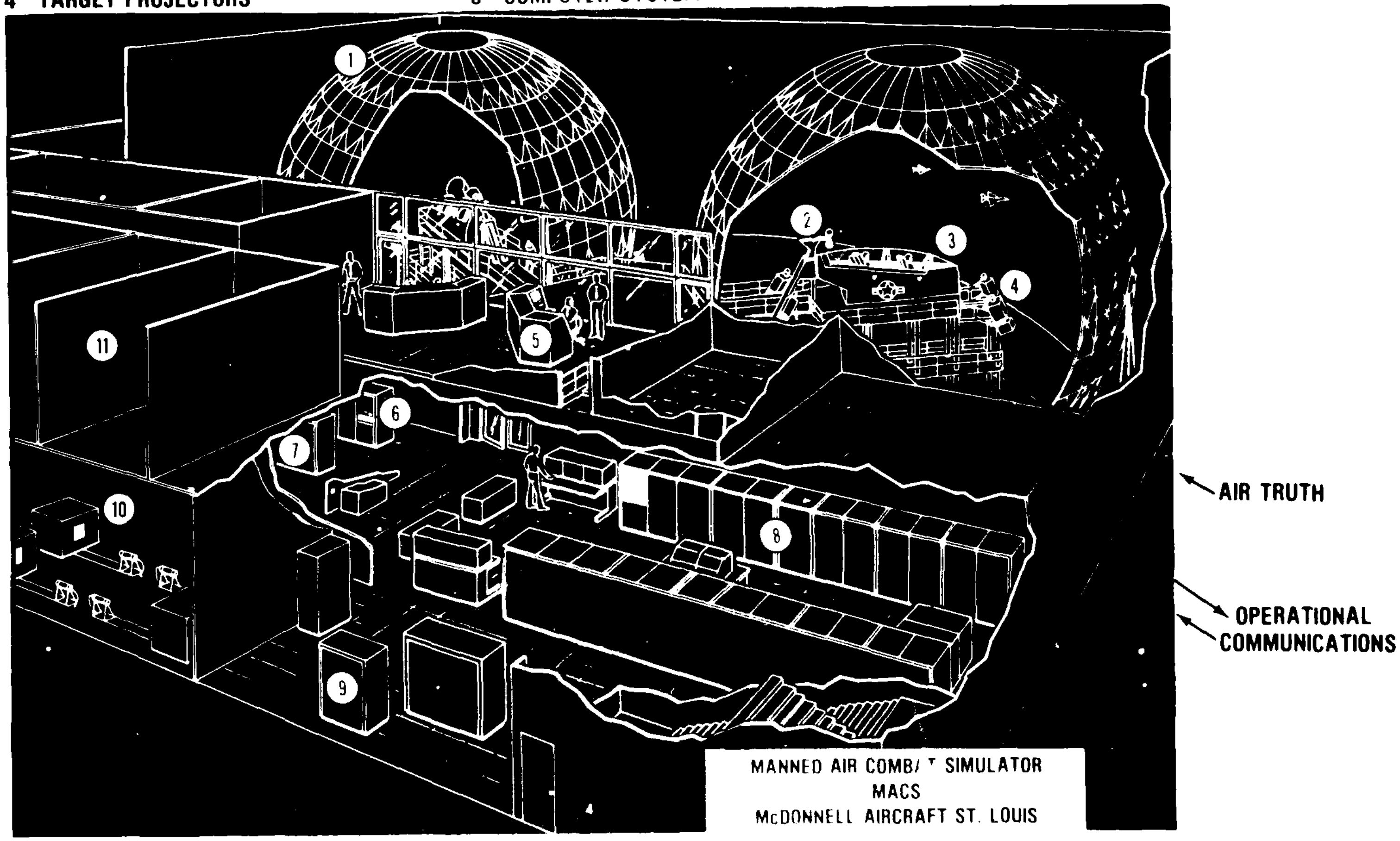
EXAMPLES OF LIVE PARTICIPATING UNITS: AIR INTERCEPTOR FLIGHT

1 40 FT. DIAMETER PROJECTION SCREENS
2 EARTH/SKY PROJECTORS
3 AIRCRAFT COCKPITS
4 TARGET PROJECTORS
5 INSTRUCTOR STATIONS
6 INTERFACE ELECTRONICS
7 EQUIPMENT MONITOR STATION
8 COMPUTER SYSTEM
9 DEBRIEF COMPUTER SYSTEM
10 TARGET GENERATORS
11 BRIEFING/DEBRIEFING ROOMS



MANNED AIR COMB/ T SIMULATOR
MACS
McDONNELL AIRCRAFT ST. LOUIS

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SIMULATION CONTROL SYSTEM MISSIONS

The simulation control system is expected to perform various functions in support of four major missions.

First, the system must support test preparation, which requires that it generate and modify scenario tapes efficiently. This capability will be furnished primarily by the support data processing center which will store threat library data bases and other large data bases, but will be supplemented by intrinsic edit and review capabilities in the CSF. Also important during the test preparation phase is the capability to certify the readiness of the testbed. The central simulation facility and satellite simulation units would have provisions built into them to perform this function.

During test operations, the simulation control system performs numerous functions. It must stimulate the testbed, converting scenario tapes into synthetic sensor data which are then fed to the LPUs. It must emulate any facilities not being played live. It will facilitate the monitoring and positive control of all testing activities and also accomplish the very important data extraction and recording that will go on during these operations.

A third mission is post-test data reduction. Two types of capabilities are needed here. One is a quick-look capability in the CSF where near-real-time critical indicators of test success are extracted and displayed to the JTF personnel. The other capabilities would support offline extended data analysis and would be provided by the support data processing facility. During this time the multiple extracted data tapes would be merged and detailed data analysis and correlation would be performed.

The last mission is software modification to allow the testbed to perform software development and debugging. These are necessary to both support the modular expansion of the testbed through various stages of test progression, and enable numerous unanticipated changes to the software, expected over the life of the evaluation program, to be incorporated.

SIMULATION CONTROL SYSTEM MISSIONS AND FUNCTIONS

- TEST PREPARATION
  - GENERATE AND MODIFY SCENARIO TAPES
  - TESTBED READINESS CHECKING

- TEST OPERATIONS
  - TESTBED STIMULATION
  - FACILITIES EMULATION
  - SENSOR MODELING
  - MONITOR AND CONTROL
  - DATA EXTRACTION AND RECORDING

- DATA REDUCTION
  - QUICK-LOOK
  - EXTENDED ANALYSIS

- SOFTWARE MODIFICATION
  - MODULAR EXPANSION SUPPORT
  - UNANTICIPATED CHANGES

11-6-79-23

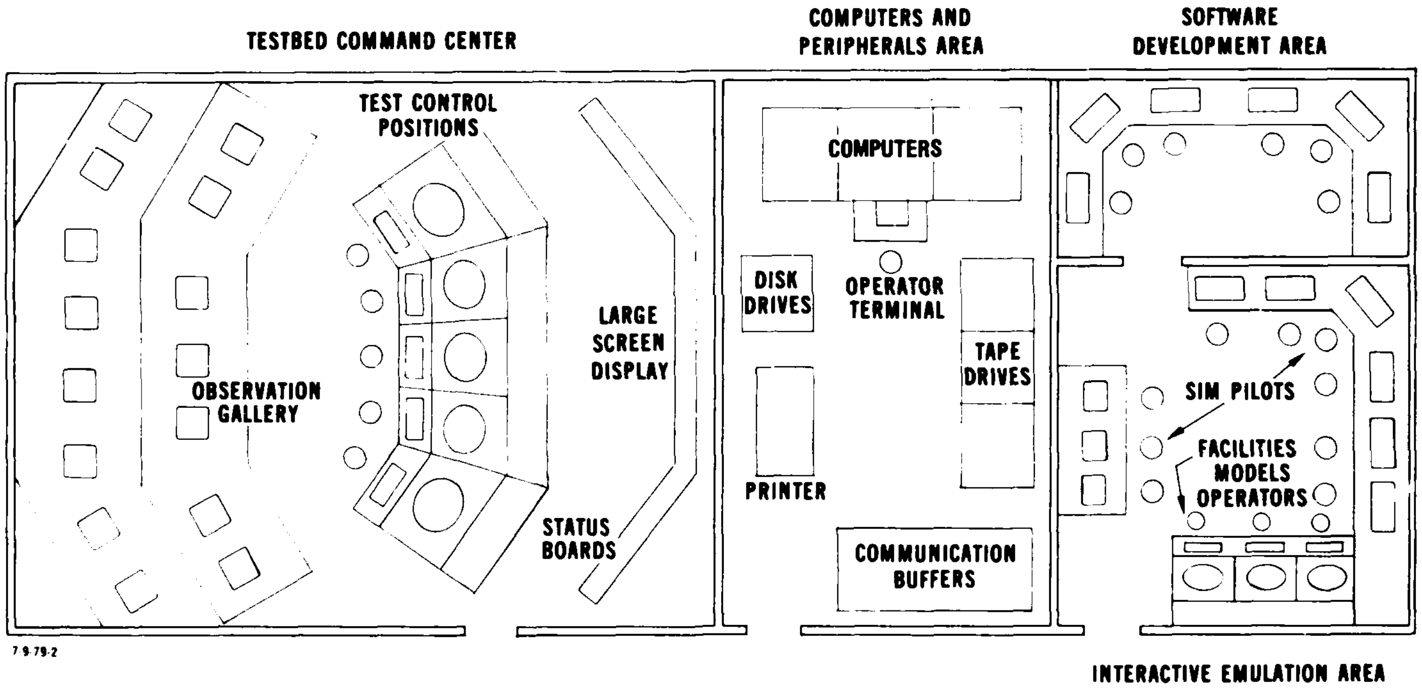
CENTRAL SIMULATION FACILITY LAYOUT

This is one possible layout of the central simulation facility. In this plan the facility is composed of four distinct areas: a testbed command center, a computer and peripheral area, a software development area, and an interactive emulation area.

The testbed command center is where test control and monitoring activities would take place. It would include a large-screen display, status boards, a number of graphics display consoles, and an observation gallery. The computer and peripherals area is, as the name implies, where the central simulation facility data processing hardware would be situated. It is here that the computers, disk drives, printers, tape drives, and communications equipment would be installed. The software development area would consist of a number of CRT data terminals and adequate work space for programmers to develop new software and perform debugging for the central simulation facility. Finally, the interactive emulation area would be the area where the dynamic air truth would be generated by simulator pilots. Up to 10 or 12 simulator pilot positions would be required. This would also be the area where the testing personnel controlling the models of emulated facilities would be stationed. As shown, a number of graphics displays would support their activities.

It is estimated that the total facility would occupy about 2,400 square feet of floor space.

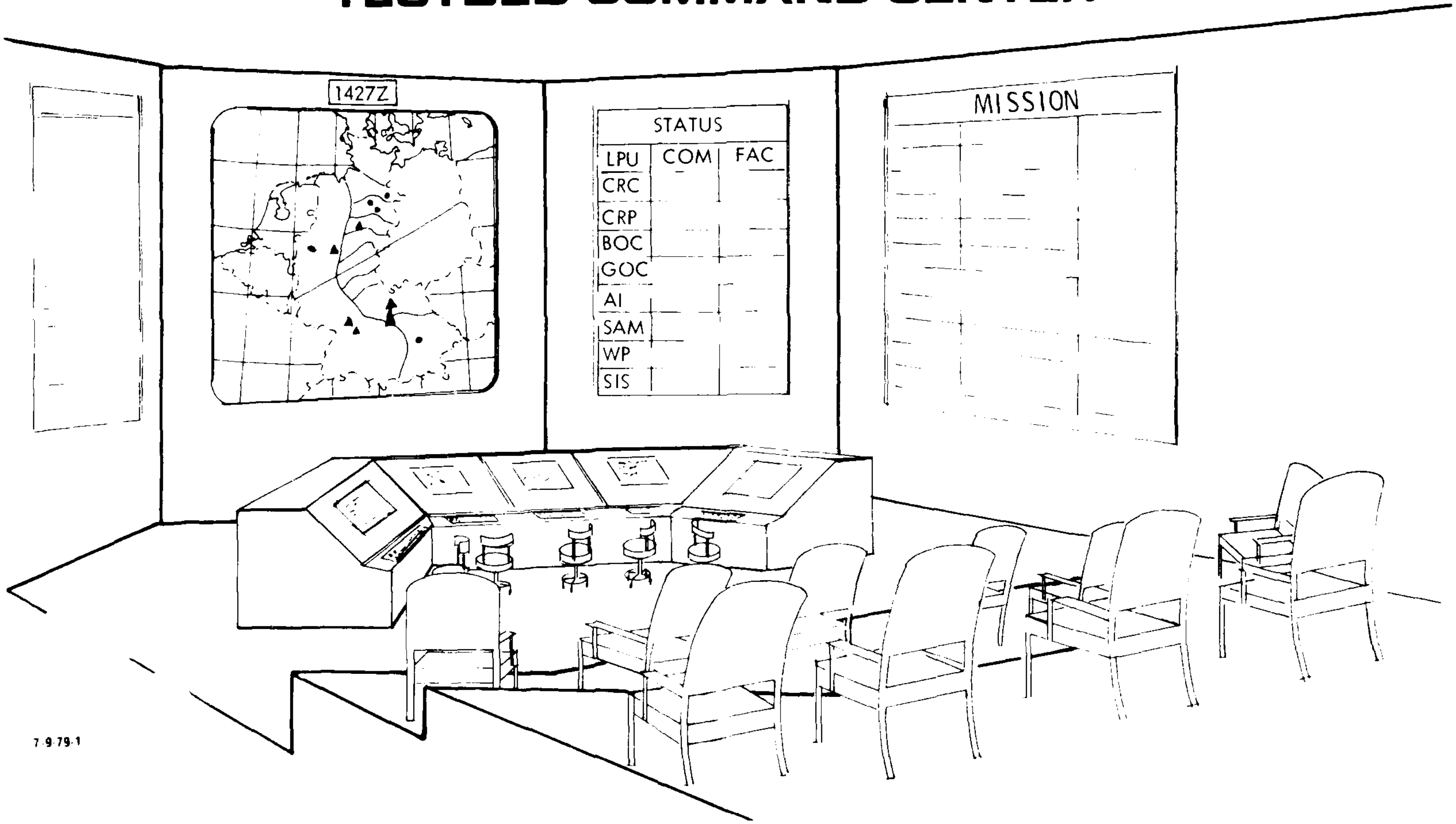
CENTRAL SIMULATOR FACILITY LAYOUT



TESTBED COMMAND CENTER

This is an artist's rendition of what the *testbed command center* might look like. The essential features are the large screen situation display (which would display the true air situation compared to perceived air situations at selected facilities), various status boards (indicating scenario test conditions, facility status, etc.), control consoles for the test director and his assistants, and the observation gallery.

TESTBED COMMAND CENTER



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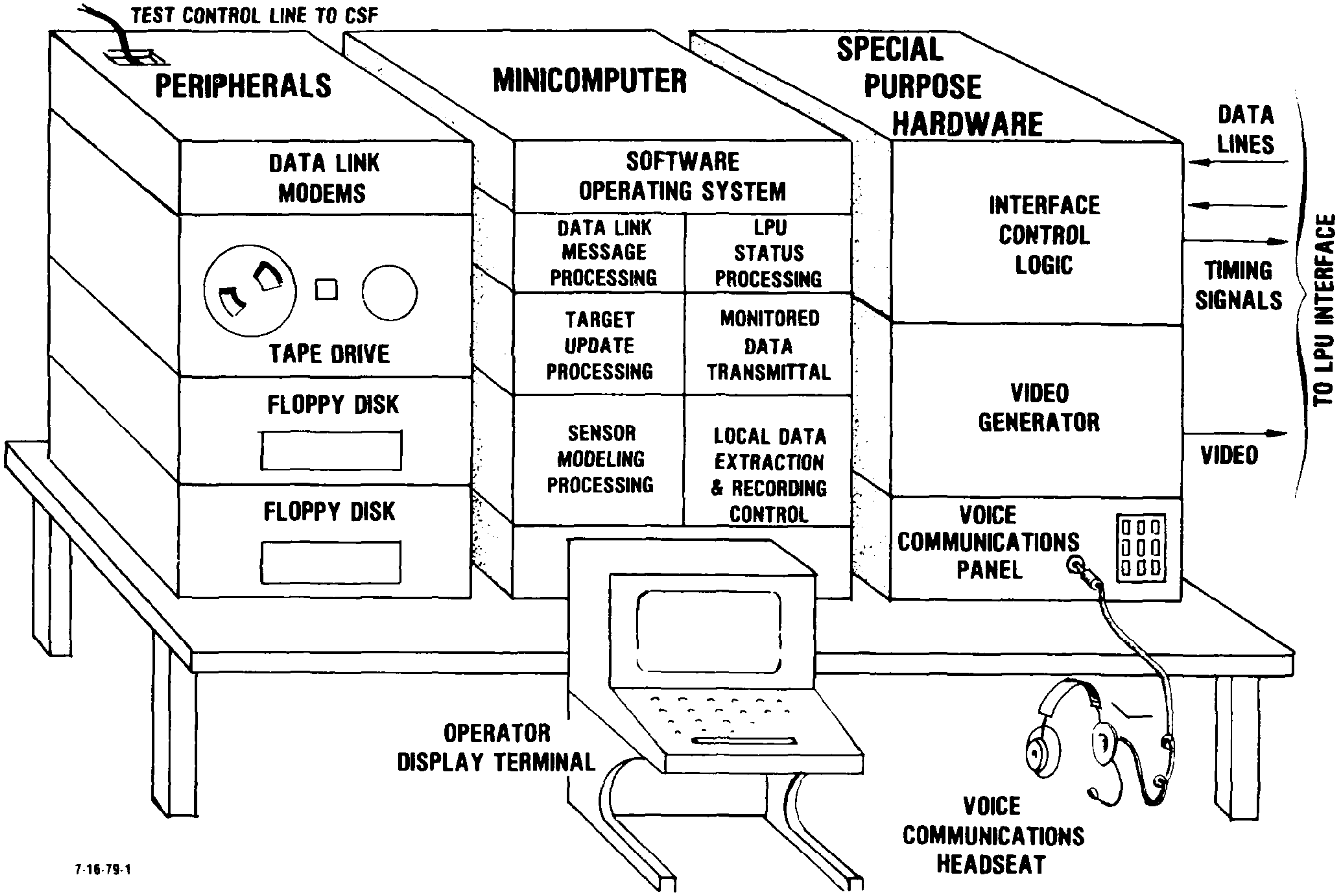
SATELLITE SIMULATION UNIT COMPONENTS

This shows the size and composition envisaged for a typical SSU. An SSU is a small assemblage of equipment that could probably be put on a tabletop. Part of the SSU is a minicomputer, such as a NOVA-800 or equivalent. Shown on the left is a limited number of peripherals, consisting of a small tape drive, floppy disks, and automatic data link modems. Shown on the top right is special purpose hardware, consisting of the interface control logic to accomplish the actual electrical interface with the LPU. *The radar video generator beneath would be required only when raw* radar video must be supplied. At the bottom right is a voice communications panel through which the SSU operator would maintain voice communications with the staff at the central simulation facility.

The SSU is tied to the central simulation facility through the test control data link connected through the data link modem. The minicomputer performs automatic message processing, recognizing and decoding the individual test control messages as they are received. It also computes absolute positions of targets for the times at which they would be observed by the sensors associated with the LPU. These positions are then passed to software models representing the sensor array. The position bookkeeping and sensor modeling are done within the SSU in order to reduce the communications loading on the test control network and reduce the processing load on the CSF. In this way, only air truth event information *(course changes, speed changes) has to be sent through the test control* lines, and that occurs relatively infrequently.

The SSU minicomputer also performs a number of housekeeping functions, extracting status information from the LPU controlling local data extraction and recording, and formatting and transmitting status information and monitored data back to the CSF.

SATELLITE SIMULATION UNIT (SSU) COMPONENTS



AIR SITUATION SIMULATION: AIR TRUTH GENERATION AND DISTRIBUTION

We focus now on the way in which the simulation control system functions during test operations. Of particular concern is how the air situations being perceived by the live and emulated units are developed from the air truth data being generated and distributed by the central simulation facility.

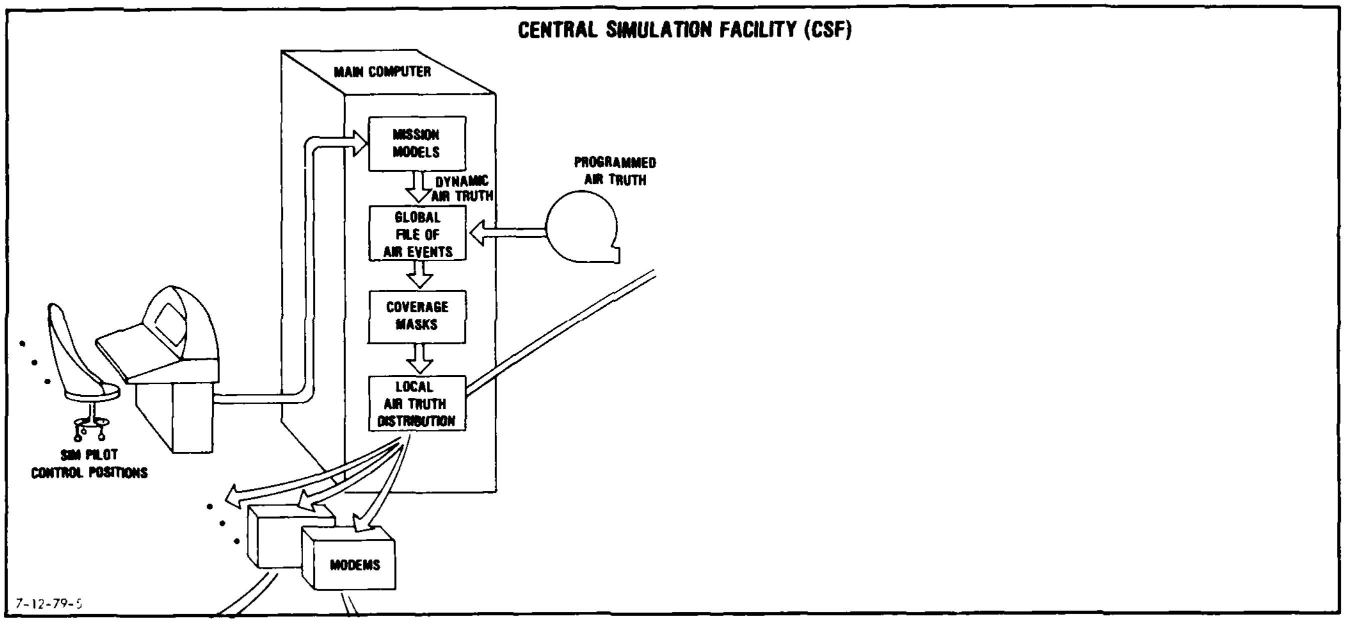
The initial source of all air truth data will be the scenario tape containing aircraft maneuver events, avionics control actions, and other scripted events. This tape will be read periodically and the data entered into a global file of air events in the main computer of the CSF. The preprogrammed events read from the tape will be supplemented by dynamic maneuver and avionics events entered from the various simulator pilot control positions. Each simulator pilot will operate a number of simulated flights simultaneously and will be assisted by canned mission models which will generate standard sequences of maneuvers and aircraft actions on command. In addition, it will also be possible for preprogrammed air events to be overridden by automatic reactive events initiated by the CSF when certain specified tactical situations occur. (For example, a flight of "preprogrammed" penetrators detects attacking "dynamic" interceptors, whereupon the CSF initiates defensive maneuvers, following stored standard air-to-air engagement tactics.)

The dynamic air truth and the preprogrammed air truth will be merged in a global file of current air events contained within the computer's main memory. These air events will then be compared with coverage masks for each of the sensors being simulated in the testbed. The coverage masks, which include effects such as radio horizon and terrain masking, will be specified individually for each sensor.

If it is decided that an air event for a particular aircraft is within the coverage of a particular sensor, a decision will then be made on further distribution of the event data to that sensor. A set of local air truth distribution programs will control the distribution of data to the various sensor models at local and remote locations. Events will be distributed only to those sensors capable of seeing the aircraft, so that communications loading can be minimized.

F-180

CONCEPT FOR AIR SITUATION SIMULATION DURING TEST OPERATIONS



STIMULATION OF THE LPUs

When the sensor model resides in an SSU at a remote LPU site location, the flow of air truth is as follows. From the air truth distribution logic, event data are sent to the appropriate modem for transmission over the test control network to the designated LPU site. At the site, the SSU, as part of its processing of test control network data link messages, will recognize the presence of a message containing air truth event data. Only maneuver event data[1] will be transmitted through the system, not absolute position information. Since only changes in trajectory are sent, this information will be integrated in time to obtain absolute position information, using target update processing programs residing in the SSUs. These programs compute the point mass trajectories of all aircraft flying within coverage of the sensors of interest, thus obtaining the precise location of the aircraft at the time it is being observed by a sensor.

The SSU will also include software models of all the sensors controlled by the host LPU. These models will accept absolute target position information and other data from the target update processing programs and generate a perception of the target's characteristics and a location estimate for the sensor being simulated. The output of the sensor software model is a digital target report. In cases where analog video signals must be furnished to the LPU, this target report will drive a video generator which will convert the digital information into an analog output.

The synthetic digital or analog stimuli are then sent through an interface control unit into the LPU, which will process the data internally and display its perception of the air situation to the human operator. He may react by entering switch actions, initiating voice communications, or sending data link messages to other LPUs or emulated facilities. These messages would be transmitted to other units via the normal operational communications net.[2] At the same time, the LPU crew may themselves be reacting to input data link messages or voice communications coming from other LPUs and emulated facilities. Such messages would be a result of the reaction of these facilities to their local perceptions of the air situation.

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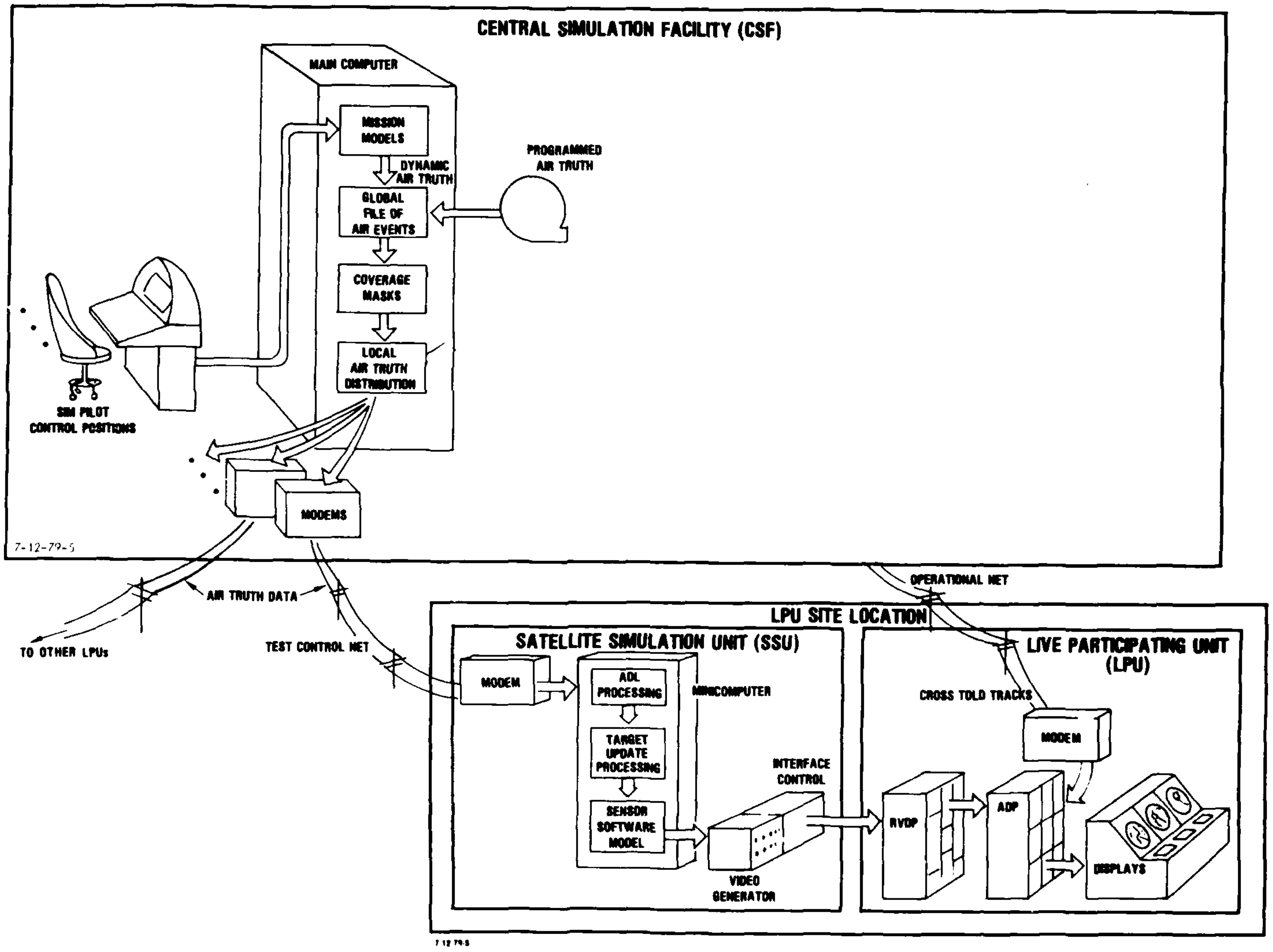
[1] The contents of these data will signal the initiation of maneuvers; in addition, they will describe the maneuvers in terms of vertical rates, turn rates, turn radii, etc., factoring in the specific flight characteristics of the particular aircraft.

[2] Leased telephone lines will serve as the surrogate for the actual combat communications links. Wartime background loadings, jamming conditions, etc., will be simulated by injecting appropriate delays, data errors, audio noise, and other disruptions into the communications traffic. Off-line models such as the Army's SIMIANS simulation will be used to establish the proper levels for these effects.

F-180

CONCEPT FOR AIR SITUATION SIMULATION DURING TEST OPERATIONS



EMULATED FACILITIES PROCESSING

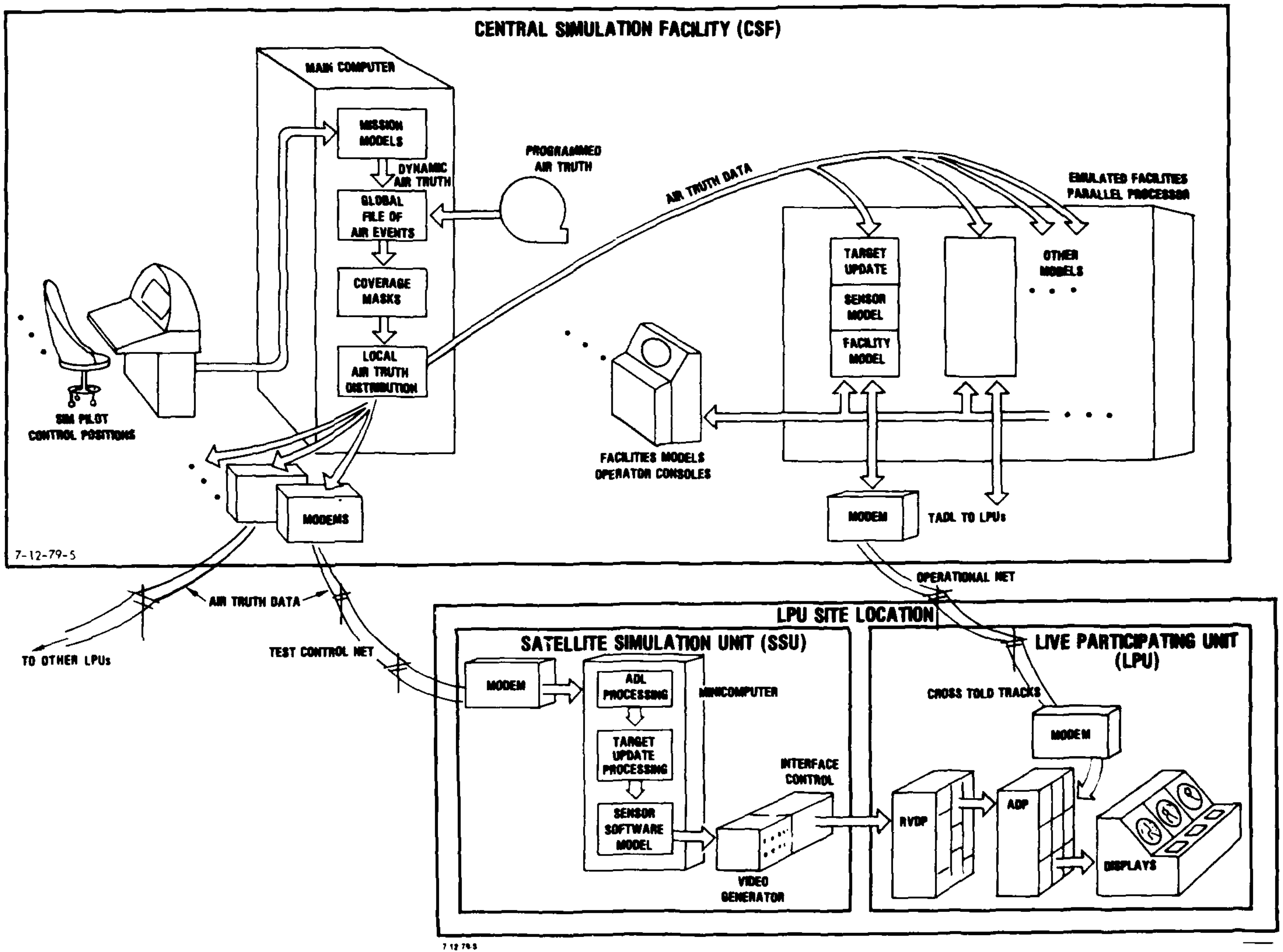
The last output path shown distributes air truth data to emulated facilities, rather than to the LPUs. The air truth data are sent to a unit called the Emulated Facilities Processor, which possibly will be a parallel processor so as to accommodate the heavy computational load expected. (Note, however, that the parallel processor and associated software are highly replicative, as they primarily represent multiple facilities of the same type, such as a number of IHAWK batteries.)

Each parallel processing path includes a target update processing program and a sensor model, which are similar in function to what has been described for the SSU. The third model is the facility model, an emulation of the real facility that will generate valid reactions to sensor data and other inputs. It accounts for all man-machine and personal interactions that would normally occur within the facility. This model will also be stimulated by data link messages sent from other emulated facilities and LPUs, and by commands entered by emulated facilities model controllers responding to voice contacts. In response to these stimuli the facilities models will initiate various events such as engagement of targets, initiation of data link messages, and the cueing of model operators to make voice transmissions. As these actions will result from events initiated by other models and LPUs, there will be two-way interaction between every model and the rest of the testbed.

Note that all data link and voice messages interchanged between the models and LPUs will be transmitted over the normal operational communications networks. Interchanges between models will occur internally within the Emulated Facilities Processor.

F-180

CONCEPT FOR AIR SITUATION SIMULATION DURING TEST OPERATIONS



OFF-THE-SHELF CAPABILITY AND TESTBED REQUIREMENTS

Much of the capability required for the simulation control system is already available in the form of simulation hardware that has been developed for other testbeds and training programs.

Four families of hardware systems of particular interest are available from four different manufacturers: MULTOTS, manufactured by Logicon Corporation; the STEM system manufactured by GTE Sylvania for USAF use in 485L system training, the SIMTRACC system, a general-purpose simulation system manufactured by the 4C Corporation; and the Command and Control Systems Laboratory, a fixed simulation facility owned by the Martin-Marietta Corporation in Denver. These systems were examined for *the particular attributes of the simulation control system needed in the* IFFN testbed.

In each requirement area the chart indicates one of three levels of suitability for each off-the-shelf system family: adequate capability existing, some capability existing, little or no capability existing. A comparison of MULTOTS, STEM, and SIMTRACC shows that they all have fairly similar levels of capability. There is a distinct difference, however, between these systems and the C^2 Laboratory. This facility has a considerably more powerful computer processing system, but it presently has neither any provision for data communications nor experience with SSUs and remote facilities operations, making it somewhat less adaptable for use as part of a distributed testbed.

Another important point is that regardless of which system is used, a considerable amount of software will have to be developed, since no system includes the extensive family of software models for sensors and facilities required by the testbed. Therefore, the development of the simulation *control system will be primarily a software development effort rather than* a hardware development effort; any of first three systems mentioned could provide a good foundation for all the CSF/SSU hardware required (with the exception of a new parallel processor to serve as the Emulated Facilities Processor if it is necessary).

MATCH-UP BETWEEN OFF-THE-SHELF CAPABILITY AND TESTBED REQUIREMENTS

SIMULATION CONTROL SYSTEM COMPONENT	SYSTEM FAMILY/MANUFACTURER			
	MULTOTS LOGICON	STEM SYLVANIA	SIMTRACC 4C	C^2 LAB MARTIN MARIETTA
CENTRAL SIMULATION FACILITY				
MAIN COMPUTER SYSTEM HARDWARE	■	■	■	▲
TEST CONTROL SOFTWARE	■	■	■	■
PARALLEL PROCESSOR UNIT OR EQUIVALENT	●	●	●	■
DISPLAYS AND TERMINALS	■	■	▲	▲
PERIPHERALS	▲	▲	▲	▲
COMMUNICATIONS	■	■	▲	●
SATELLITE SIMULATION UNITS				
INTERFACE CONTROL	■	■	■	●
VIDEO GENERATORS	■	■	■	●
MINICOMPUTER SOFTWARE	■	■	■	●
SOFTWARE MODELS				
RADARS/SIF	●	■	■	●
NEW ID SENSORS	●	●	●	●
INTERACTIVE FACILITIES MODELS	●	●	●	●
OTHER MODELS	■	■	■	●

CAPABILITY KEY

▲ ADEQUATE CAPABILITY EXISTS ■ SOME CAPABILITY EXISTS ● LITTLE OR NO EXISTING CAPABILITY

8-10-79-36

A CONCEPT FOR EARLY TESTS AT FT. BLISS

Some pilot tests and initial portions of the Army phase of the program could be begun at Ft. Bliss, utilizing the hardware already in place at that facility according to the plan illustrated here. Some additional hardware and new software would still be required, however, so the time required to develop these items would have to be weighed against the time required to achieve initial capability of the central simulation facility.

The specific units that could be used at Ft. Bliss are shown as the white circles and blocks. The shading denotes those testbed components that would be added at a later date. The SIMTRACC presently located at the Ft. Bliss software development facility would function temporarily as a mini-CSF. Its existing scenario generation software would be used to provide the air truth. In Phase I of the test, which addresses only the autonomous operation of an IHAWK fire unit, the SIMTRACC would drive one of the IHAWK units available at Ft. Bliss via an SSU, which would have to be developed. This SSU would model the IHAWK sensors and generate the analog video required to drive the IHAWK displays.

The video generator unit presently used for these facilities (TPQ-29, manufactured by the ADCOR Corporation) is inadequate for the IFFN testbed because it can only generate 6 targets. While this may suffice for pilot tests, a new video generator would have to be installed for Phase I testing. Candidates are an improved unit proposed by ADCOR or an existing Raytheon simulator called the Operational Training Simulator (OTS), which can generate up to 40 targets.

Once the required SSU achieves operational capability, the IFFN Phase I testing program could begin. Testing could extend into Phase II, if necessary, by adding the TSQ-73 BOC LPU. The SIMTRACC would then be used not only as the CSF but also as the satellite simulation unit for the BOC. This option might prove very useful, should unexpected delays be encountered in the CSF development.

Once Phase III is initiated the addition of a Group Operations Center will be required and the number of emulated facilities included will be beyond the processing capacity of the Ft. Bliss SIMTRACC.

Fortunately, it is reasonable to expect that by this time the CSF's initial operational capability will have been established, at least for that portion of the system involved with this part of the test. At this point the CSF would assume its functions and the Ft. Bliss SIMTRACC unit would revert to the role of SSU for the Ft. Bliss BOC.

A final decision as to the advisability of pursuing this approach will depend on the development schedules for the central simulation facility and the IHAWK SSU, and a fuller definition of the additional software that would be required in the Ft. Bliss SIMTRACC.

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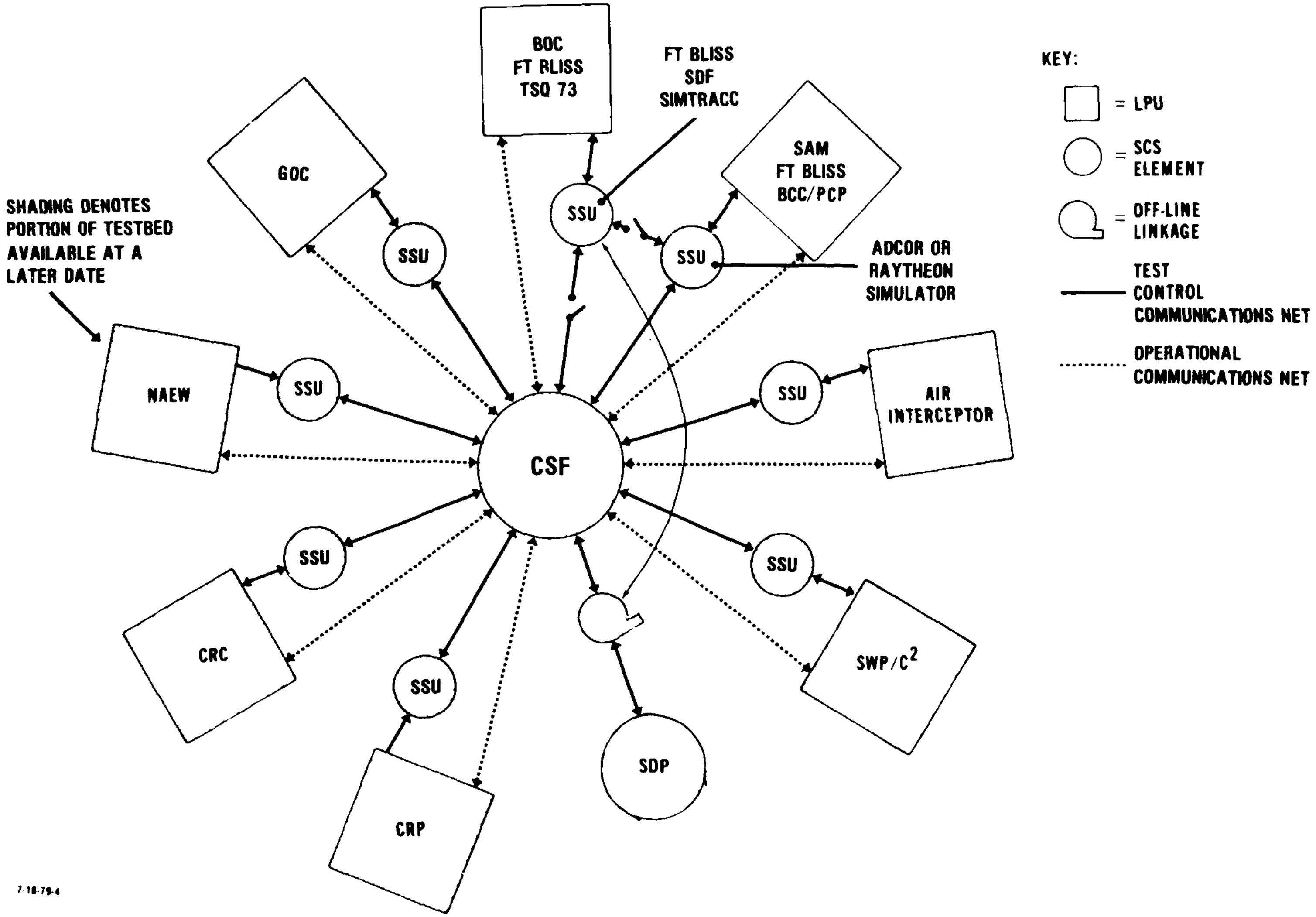
A CONCEPT FOR EARLY EXPLORATORY TESTS AT FT BLISS



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SUMMARY

We summarize here the major points concerning the IFFN testbed technical requirements, the concept recommended, and the critical features of the strawman design.

While the requirements are formidable, most have been achieved fully or in part, in other simulation testbeds. The highest risk item is the requirement for realistic emulation of the numerous simulation background systems and all the associated two-way interactions. Additional analysis should be performed to verify the feasibility of performing emulations at the level required.

The key issue in the selection of the testbed concept is whether the cost of centralization is justified, considering the potential for savings afforded by more efficient testing. The most attractive testbed architecture is a centrally controlled distributed testbed, also known as the TACS/TADS concept. This design has been used successfully before and offers great potential for cost savings in test operations. A further advantage is its great flexibility.

The hardware required to implement the strawman design is mostly off-the-shelf items, with the possible exception of the parallel processing unit for the emulated facilities modeling. However, this unit could be assembled from a number of off-the-shelf low-cost minicomputers or microprocessors. Facilities suitable for use as LPUs already exist, can be interfaced with a CSF, and in some cases, have already been interfaced in the TACS/TADS testbed. In most cases there is more than one backup for the LPU required.

A major software development effort will be required, however, largely in order to model sensors and facilities, create data reduction and analysis programs, and develop test control software. The software development effort must also include modifications to software in the LPUs. These modifications will include adding provisions for additional data extractions, incorporation of special fusion algorithms, and providing the ability to recognize and process sensor data from new sources. These modifications will probably be implemented as special versions of the operational program for the LPUs, to be loaded prior to the test.

SUMMARY

REQUIREMENTS

- FORMIDABLE, BUT MOST HAVE PRECEDENTS IN OTHER SIMULATION TESTBEDS
- HIGHEST RISK: REALISTIC EMULATION OF NUMEROUS SIMULATION BACKGROUND SYSTEMS AND THEIR INTERACTIONS

TESTBED CONCEPT

- KEY TRADEOFF: COST OF CENTRALIZATION VS POTENTIAL FOR MOST EFFICIENT TESTING
- MOST ATTRACTIVE CANDIDATE: CENTRALLY CONTROLLED DISTRIBUTED TESTBED
- RATIONALE: SUCCESSFULLY USED IN TACS/TADS, HIGH LEVERAGE FOR TEST OPERATIONS SAVINGS, FLEXIBLE

STRAWMAN DESIGN

- SIMULATION CONTROL SYSTEM HARDWARE: MOST ITEMS OFF-THE-SHELF
- LPUs: SUITABLE FACILITIES EXIST
- SOFTWARE: LARGE-SCALE SOFTWARE DEVELOPMENT EFFORT REQUIRED

11-6-79-24

AD-A083 128 INSTITUTE FOR DEFENSE ANALYSES ARLINGTON VA SYSTEMS E--ETC F/G 17/2
IFFN EVALUATION PROGRAM. CONCEPT DEFINITION. VOLUME 2: TECHNICA--ETC(U)
AUG 79 S H STARR, J M ALLEN, J H DANIEL MDA903-79-C-0018
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IMPLEMENTATION PLAN

PRELIMINARY IMPLEMENTATION PLAN FOR IFFN SIMULATION TESTBED PROGRAM

This section presents a preliminary plan for the implementation of the IFFN testbed program. The section begins with a summary description of two previous test and evaluation programs that are quite similar to the recommended IFFN program in that they involved the design, construction, and implementation of a geographically dispersed testbed under the control of a central facility. A number of important lessons learned from those programs are applicable to the current program. Some of these are summarized herein.

The section continues with a description of the recommended program plan for the IFFN program, including a summary of the required resources, a preliminary schedule plan for the implementation of the testbed itself and for the later test program, and summary estimates of the cost of the program both to DTE and to the individual participating military Services.

PRELIMINARY IMPLEMENTATION PLAN FOR IFFN/EVALUATION TESTBED PROGRAM

BACKGROUND

- PREVIOUS RELATED PROGRAMS (TACS/TADS, JINTACCS)
- LESSONS LEARNED

IFFN/C^2 PROGRAM

- SURVEY OF CURRENT SIMULATION FACILITIES
- JTF/CSF SITE ANALYSIS
- RECOMMENDED TESTBED CONFIGURATION
- REQUIRED RESOURCES
- PROGRAM SCHEDULES
- PROGRAM COST ESTIMATES
    -DTE
    -SERVICES

8-10-79-35

CASE STUDY: TACS/TADS

The TACS/TADS program was initiated as a direct result of our military experiences in Southeast Asia, during which it was found that tactical command and control systems fielded by individual military Services were not, in fact, able to communicate with each other as they had been designed to do. TACS/TADS was *created*, therefore, to test and to certify that tactical command and control, tactical air control, and tactical air defense systems were technically compatible and interoperable in joint military operations. The U.S. Navy was appointed the Executive Agent under the direction of the Office of the Secretary of Defense. An *Operational Effectiveness Demonstration* (OED) program was established involving all of the military Services and the National Security Agency. To implement the program, the Navy established a central simulation facility, which was interconnected with the actual tactical data systems of the various Services. At the conclusion of the simulation phase of the program, a field test was conducted by CINCLANT in conjunction with the SOLID SHIELD 77 exercise to validate the results of the simulation phase.

CASE STUDY: TACS/TADS

PURPOSE:

TEST AND CERTIFY TECHNICAL COMPATIBILITY AND INTEROPERABILITY OF U.S. TACTICAL AIR CONTROL AND AIR DEFENSE C&C SYSTEMS IN JOINT MILITARY OPERATIONS

PARTICIPANTS:

USN EXECUTIVE AGENT	JITF
USAF TACTICAL AIR CONTROL SYSTEM	TACS 485-L
USA ARMY AIR DEFENSE C&C SYSTEM	AN/TSQ-73
USN NAVAL TACTICAL DATA SYSTEM	NTDS/ATDS
USMC MARINE TACTICAL DATA SYSTEM	MTDS
NSA	

CONCEPT:

DISTRIBUTED TESTBED OF ACTUAL PARTICIPATING DATA SYSTEMS, UNDER CONTROL OF CENTRAL SIMULATION AND MONITORING FACILITY. LATER FIELD TEST TO VALIDATE SIMULATION AND ENHANCE CREDIBILITY

8-10-79-33

TACS/TADS CONFIGURATION MANAGEMENT

This shows the geographical location of the participants in the TACS/TADS program.[1] The central test facility is located in San Diego, California, and employs a control system known as MULTOTS. From this point, the central facility communicates directly with available ATDS units and NTDS units operated by the Navy in the vicinity. Interconnection with all other participating tactical data systems is through leased telephone lines originating in San Diego and extending to the test sites, which include the Marine Corps' Command and Control Facility at Camp Pendleton, California; the U.S. Army's TSQ-73 Air Defense System located at Fort Bliss, Texas; and the Air Force's TSQ-91 Tactical Air Control System located at Langley Air Force Base, Virginia. Additional lines were recently installed between San Diego and the Air Force's E-3A Training Center at Tinker Air Force Base, Oklahoma. The bulk of the compatibility testing under the TACS/TADS program has been completed, and these facilities are now devoted to maintaining the approved configuration of the systems.

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[1] The current geographical distribution differs from the distribution employed during initial testing.

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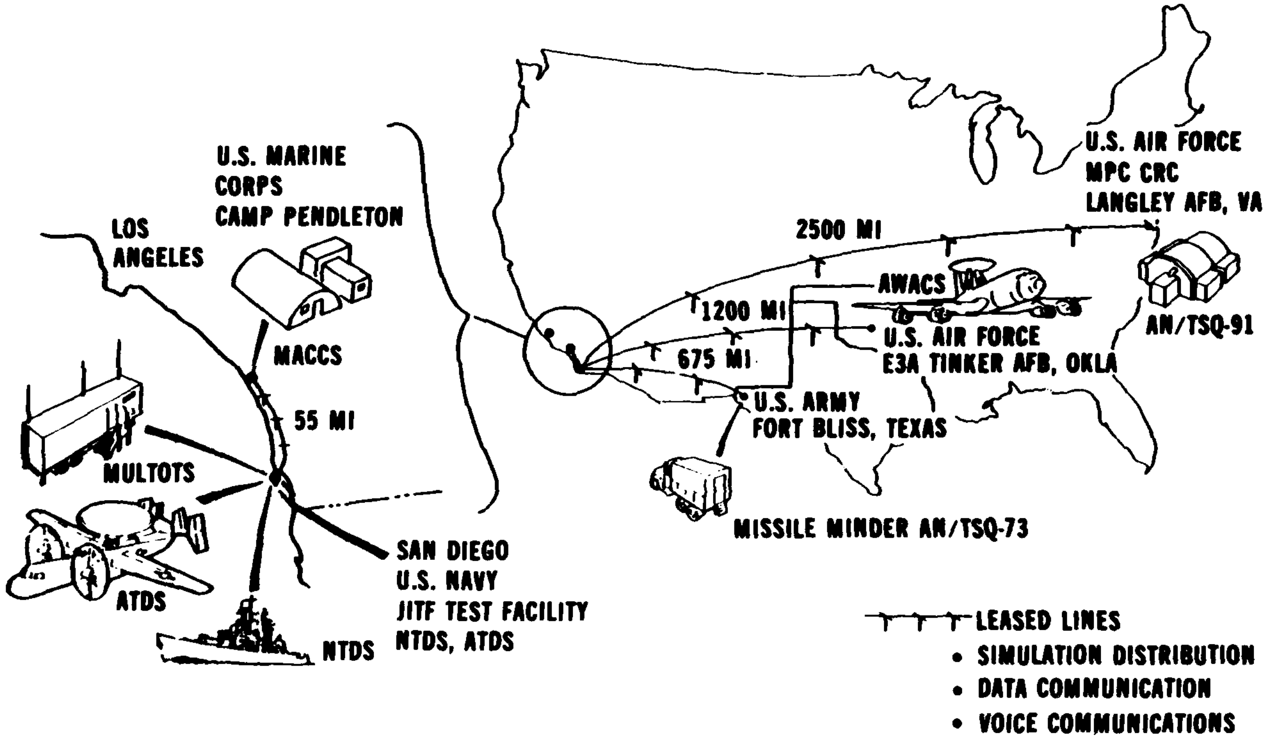
TACS/TADS
CONFIGURATION MANAGEMENT
GEOGRAPHICALLY DISTRIBUTED TEST BED



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CASE STUDY: TACS/TADS

The TACS/TADS program was initiated in 1969, at which time the JITF (Joint Interface Test Force) was established and test planning was begun. Testing did not actually commence, however, until 1971, the intervening period having been spent on the preparation of comprehensive test plans. Later events proved the wisdom of devoting adequate time to this very important function. As the program developed, however, some of the participating Services failed to exercise adequate configuration control of their participating tactical data systems, particularly their computer software. As a result, it became necessary to suspend testing for a full year until such time as the definitions of the software and hardware configurations of the systems could be verified. This standdown occurred when approximately 80 percent of the planned testing had been conducted.

A comprehensive field test using operational data systems and employing standard military communications facilities was conducted in 1977 by CINCLANT in connection with the SOLID SHIELD 77 exercise. Upon the conclusion of the field test, the TACS/TADS program assumed its current configuration management status. This configuration management function is to be transferred to the JINTACCS program in CY 1980 or 1981, at which time the TACS/TADS facility will be disbanded.

The total cost of the TACS/TADS program during the 10 years of its operation amounted to slightly over $71 million.

CASE STUDY: TACS/TADS
(Cont'd)

MAJOR EVENTS:

JITF ESTABLISHED AND TEST PLANNING BEGUN	1969
TESTING COMMENCED	1971
USAF STAND-DOWN (1 YR.) FOR SOFTWARE	1974
TESTING COMPLETED, FIELD TEST PLANNING BEGUN	1976
FIELD TEST RUN (SOLID SHIELD 77)	1977
STATUS: CM + REQUAL/REVAL. AS REQUIRED	CURRENT
TRANSFER TO JINTACCS	1980

COSTS THRU FY 80 (RDT&E):

USN (JITF)	$14.4
USN (OTHER)	10.4
USAF	16.4
USA	20.3
USMC	6.8
NSA	2.8
TOTAL	$71.1M

CASE STUDY: JINTACCS

The JINTACCS program represents a major expansion in scope from that of the TACS/TADS program.[1] It encompasses the entire range of ground and amphibious military operations rather than being limited to the much more restricted area of tactical air defense and tactical air control operations. The objective of the program is to establish interoperability between all of the tactical command and control systems of all of the military Services in joint operations. The JINTACCS program will include the qualification and certification testing of all new tactical command and control systems as they are developed and the maintenance of strict configuration control of those systems as they are fielded.

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[1] The original designation for this program was GAMO (Ground Amphibious Military Operations).

CASE STUDY: JINTACCS (NEE GAMO)

- ***DEFINITIONS:***

  JINTACCS: JOINT INTEROPERABILITY FOR TACTICAL COMMAND AND CONTROL SYSTEMS

  GAMO: GROUND AND AMPHIBIOUS MILITARY OPERATIONS

- ***PURPOSE:***

  PLANNING, CONDUCT, AND EVALUATION OF JCS-DIRECTED COMPATIBILITY AND INTEROPERABILITY TESTING OF TACTICAL C&C SYSTEMS, INCLUDING:

  - CERTIFICATION TESTING OF NEW SYSTEMS
  - CONFIGURATION MANAGEMENT TESTING OF BASELINED SYSTEMS
  - INTEGRATION OF TACS/TADS TESTING

- ***PARTICIPANTS:***

  JITF: EXECUTIVE AGENT: U.S. ARMY
  LOCATION: FORT MONMOUTH, N.J.
  SERVICES: ALL

- ***FUNCTIONS:***

  INTELLIGENCE
  AIR OPERATIONS
  OPERATIONS CONTROL
  AMPHIBIOUS OPERATIONS
  FIRE SUPPORT

8-10-79-31

CASE STUDY: JINTACCS

The JINTACCS program will encompass over 30 tactical data systems, some of which are listed here. As with TACS/TADS, the test concept will involve a central simulation and control facility interconnected with a large group of participating test units. The JINTACCS program is now in the test planning phase, although the testing of the intelligence portion of the program has commenced. The JITF is currently in the process of procuring its central Joint Interface Test System (JITS).

The lower section of this chart indicates the approved funding profile for the JINTACCS program. The upper portion of the profile indicates the funds for presently defined testing of U.S. systems and the lower portion funds for testing other NATO tactical data systems. As noted, the program through fiscal year 1984 will require the expenditure of approximately $100 million.

CASE STUDY: JINTACCS/GAMO

(Cont'd)

- ***SYSTEMS:*** > 30, INCLUDING:

ARMY	NAVY	AIR FORCE	MARINE CORPS	NSA
TOS	NTDS	AWACS E-3A	TYQ-1&2	ROUGH RIDER
TACFIRE	ATDS	TSQ-91	UYQ-4	
ASACAC	ITAWDS	TSQ-92	TCO	
TSQ-73	NIPS	TIPI	MIFASS	
PATRIOT CCG		COMPASS EARS	MAGIS	

- ***CONCEPT:*** JOINT INTERFACE TEST SYSTEM (JITS) AT FORT MONMOUTH, DISTRIBUTED PARTICIPATING TEST UNITS (ABOVE), AS TACS/TADS

- ***STATUS:*** TEST PLANNING & JITS PROCUREMENT; INTELLIGENCE TESTING STARTED

- ***FUNDING PROFILE ($M):***

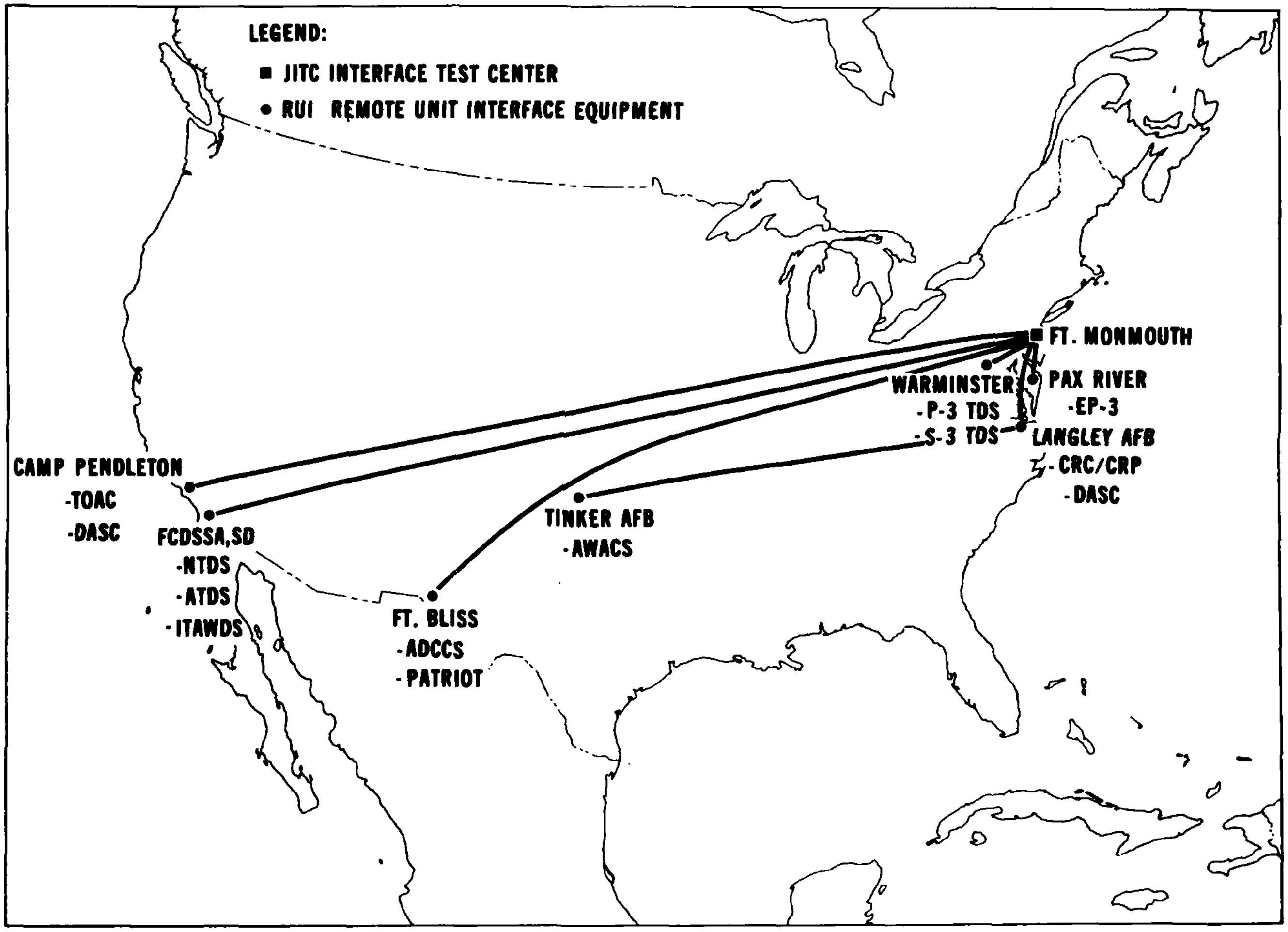
FY	1978	1979	1980	1981	1982	1983	1984	TOTAL
JINTACCS (EXEC AGENT)	2.8	7.2	12.2	14.2	14.2	11.1	11.1	72.8
JINTACCS (NATO)	0	2.0	2.0	2.0	5.0	5.5	10.0	26.5
TOTAL	2.8	9.2	14.2	16.2	19.2	16.6	21.1	99.3

8-10-79-30

JINTACCS TEST COMPLEX

The geographical configuration of a major portion of the JINTACCS test complex is shown here. The central test control facility is located at Fort Monmouth; this center will control tests involving systems and equipment located at various geographical points in CONUS.

JINTACCS TEST COMPLEX



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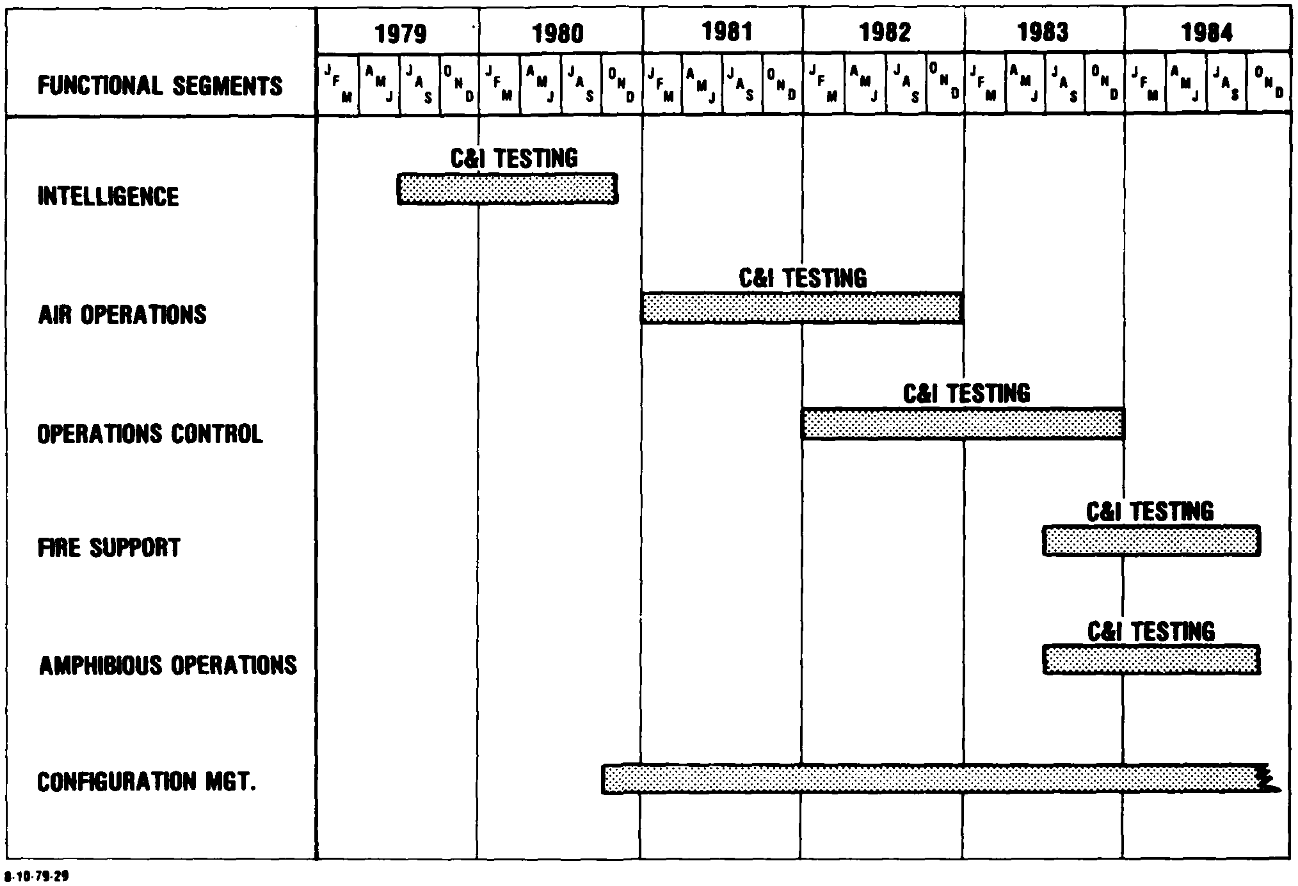
JINTACCS PROGRAM TEST SCHEDULE

The current schedule for the compatibility and interoperability (C&I) testing of the JINTACCS program is shown here. Testing of five major functional areas will extend over a period of approximately 6 years, through CY 1984. The configuration management activity shown at the bottom of the chart will be inherited from the TACS/TADS JITF in the fall of 1980 and will extend well beyond 1985.

It is planned to conduct an appropriate field test at the end of each of the C&I testing phases of the JINTACCS program. The timing of these field tests is not shown.

JINTACCS PROGRAM TEST SCHEDULE



LESSONS LEARNED

The TACS/TADS and the JINTACCS programs have been examined in detail. A few of the lessons learned from them are summarized in this chart and the following one.

The TACS/TADS program in particular was very valuable because it confirmed positively that a simulation testbed system employing a central test control and management facility tied into a group of geographically remote manned simulators and participating tactical data systems is feasible and practical. Because that concept was used successfully for the TACS/TADS program, a similar concept was adopted for the JINTACCS program. The idea appears to be applicable to the IFFN testbed.

Of all the lessons learned from these programs, perhaps the most basic has to do with configuration control. The idea that the configuration must be established and maintained for a program is generally accepted, but the consequences of not doing so on a joint test program were demonstrated graphically by TACS/TADS. Despite the best intentions of all concerned, a number of the participants allowed the hardware/software configurations of their systems to get out of control, with consequences significant enough to require that the program be suspended for a year while the approved configurations were reestablished. It is absolutely necessary to establish iron clad configuration control throughout the entire testbed system and to maintain that control for all the hardware and software elements of the system from the inception of the program until its conclusion.

The TACS/TADS program also illustrated the need to prepare a thorough and well thought-out test plan prior to the initiation of any actual testing. Planning for TACS/TADS took approximately 2-1/2 years and was instrumental in the success of the test program.

LESSONS LEARNED FROM PRIOR PROGRAMS

TACS/TADS FIELD TEST

- **FIELD TEST AFTER SIMULATION PHASE WAS COSTLY, BUT WORTHWHILE:**
  - MORE PARTICIPANTS, REALISM, CREDIBILITY
  - MILITARY COMMUNICATIONS
  - HIGHLIGHT OPERATIONAL PROBLEMS
  - ENHANCE EFFECTIVENESS OF JOINT/COMBINED MILITARY OPERATIONS

8-10-79-22

LESSONS LEARNED

These programs revealed the universal tendency of test planners to underestimate the amount of time required to prepare and conduct tests of this nature. Even after years of operation of the TACS/TADS testbed, it was found that in general no more than 50 percent of the time scheduled for any group of tests could normally be expected to be productive.

The concept of beginning the test program with a simple system configuration and then evolving to a more complex configuration makes good sense, and is one that is particularly adaptable to the IFFN testbed program. In the early phases of a testbed program more time will be required for the participants to learn how to set up the test equipment most efficiently, run through preliminary checks, etc., than will be the case later. Since only a few test participants would be involved in the early phases of such a program, idle time will cost less then.

Although the TACS/TADS field test was rather expensive (costing slightly more than $3 million), the resulting benefits were quite considerable. Since the participating units were actual operational groups rather *than test units, the demonstration had a high level of participation, realism,* and credibility. The field test served to demonstrate that the tactical data systems were, in fact, able to interoperate using standard military communications facilities in place of the leased commercial facilities used in the simulation program. In addition the field test highlighted a variety of operational problems that could only have been revealed in actual practice. Perhaps the greatest benefit derived from the TACS/TADS field test was that it served to demonstrate to the operational commanders involved in the exercise that joint military operations were, in fact, substantially enhanced through the use of modern automated command and control systems.

LESSONS LEARNED FROM PRIOR TESTBED EXPERIENCES

CONTROL

- CENTRALIZED TESTBED CONCEPT IS FEASIBLE AND PRACTICAL
- MAINTAIN *ABSOLUTE, IRONCLAD* CONFIGURATION CONTROL (HARDWARE AND SOFTWARE)
- PROVIDE ADEQUATE TEST MONITORING FEATURES

TIMING

- TAKE TIME TO PREPARE A THOROUGH TEST PLAN
- EXPECT LONG LEAD TIMES ON KEY ITEMS (e.g., LEASED LINES, CRYPTO GEAR, MODEMS)
- RECOGNIZE UNIVERSAL TENDENCY TO UNDERESTIMATE TIME TO:
  - CHECK OUT SITES PRIOR TO TESTS
  - TRAIN SYSTEM OPERATORS IN JOINT/COMBINED OPERATIONS
  - CHECK OUT/DEBUG SOFTWARE

CONSEQUENTLY, 50 PERCENT OF SCHEDULED TEST TIME IS GENERALLY UNPRODUCTIVE

MODULAR GROWTH

- START WITH SIMPLE CONFIGURATION AND EVOLVE
- MAXIMUM USE OF AVAILABLE FACILITIES, OFF-THE-SHELF HARDWARE

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DISTINCTIVE FEATURES OF SIMULATION TESTBEDS

Although the proposed IFFN simulation testbed program is quite similar to the TACS/TADS and JINTACCS programs in concept, there are some important differences. Some of these major differences are illustrated here. As shown by the pattern code, all the programs involve simulation of U.S. command and control systems, but only the IFFN program involves the inclusion of NATO and Warsaw Pact (WP) facilities. Similarly, the IFFN program will be unique in incorporating both surface-to-air missile systems and tactical aircraft weapons. The IFFN program will also strive for both a qualitative and quantitative evaluation of operational benefits.

This highlights the main difference between the TACS/TADS or the JINTACCS program and the IFFN program. Whereas the former programs concentrated on certifying the technical interoperability of data transfer systems, the IFFN program will be oriented more towards conducting exploratory evaluations of programmed/proposed black boxes, subsystems, and systems to assess their impact on overall system effectiveness. In fact, it is presupposed that the technical interoperability of the automatic data links in the participating data systems will have already been established before the IFFN program is implemented. The TACS/TADS program in particular can be viewed as a very necessary precedent to the conduct of the IFFN program.

The last testbed noted, REDCOM, is part of Readiness Command's preliminary plan to implement a testbed program oriented towards the operational training of the operators of those systems that have been TACS/TADS certified. How the REDCOM testbed program will be implemented, and the implementation schedule, have not yet been established.

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DISTINCTIVE FEATURES OF SIMULATION TESTBEDS

FEATURES / TESTBED	C^2 FACILITIES			WEAPON SYSTEMS		EVALUATION		
							OPERATIONAL BENEFITS	
	U.S.	NATO	WP	HIMADS	TACAIR	DATA TRANSFER	QUALITATIVE	QUANTITATIVE
IFFN/C^2	▥	▥	▥	▥	▥	░	▥	▥
TACS/TADS, JINTACCS	▥	▨	▨	▨	▨	▥	▥	░
REDCOM	▥	░	▨	▨	▨	░	▥	░

▥ Included

░ May be included

▨ Excluded

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SURVEY OF CURRENT SIMULATION FACILITIES

Early in the planning of the IFFN testbed program it became apparent that extensive simulation facilities would be required. To avoid duplication of facilities (and minimize cost) a survey was done of the various simulation facilities in the United States. (A detailed tabulation of the responses to the survey is available on request.) This chart is a summary of those responses, and includes in particular those that appear to be most relevant to the IFFN program. The facilities are classified into three categories: those that might serve as the central simulation and control facility (CSF); those that would simulate weapon systems (primarily F-15s); and those that could emulate major command and control centers in the testbed system.

The survey confirmed that currently no facility exists that can fully meet the requirements for a central simulation and test control center and that would be available on a dedicated basis over the planned time period. It is assumed (conservatively) that DTE would need to acquire a new central simulation facility and that the facility would be purchased rather than leased. The same assumption is made with respect to associated satellite simulation units.

The survey also confirmed that all other facilities required for the testbed program exist and can be made available on a lease basis. Alternative facilities exist for some of the emulated C^3 systems (e.g., WP/C^2 and AWACS simulators) and weapon system (F-15) simulators.

No recommendation is made here concerning which is the most appropriate type of central simulation and test control system (e.g., SIMTRACC, MULTOTS, or STEM). That selection should result from an evaluation of contractor proposals. The survey did confirm, however, that the costs and the delivery lead times for all three systems would be about the same.

Two of the emulated facilities (WP/C^2 simulator and GEADGE CRC) are contractor (rather than government) owned, but can be made available on a lease basis for the prescribed time period. d. One potentially attractive vehicle for emulating the WP/C^2 system is the C^3 systems laboratory that is owned and operated by the Denver Division of the Martin-Marietta Corporation. The C^3 SL is a general purpose command and control development laboratory incorporating extensive data processing and display capabilities. The facility is contained within a completely shielded enclosure that has been certified to all applicable TEMPEST requirements.

Other possible candidates for the WP/C^2 function include the Navy's Advanced C&C Architectural Testbed (ACCAT) in San Diego, California, or the REDCAP simulator in Buffalo, New York, which is jointly owned by the USAF and the CALSPAN Corporation. Using a combination of these facilities may be desirable to take advantage of the special features of each.

The System Development Facility (SDF), owned by Hughes Aircraft Corporation and located in Fullerton, California, is a general purpose system development and integration laboratory. However, HAC plans to dedicate the facility for the next few years to developing and checking the GEADGE systems (both hardware and software) for which Hughes is presently under contract. The equipment complement of the SDF will be the same as that which will be deployed in operational GEADGE CRCs (that is, the same computers, display consoles, etc.) so that, for IFFN/C2 testbed purposes, the facility will be an exact counterpart of the operational NATO centers. The GEADGE contract schedule is such that the SDF can be available at a time that fits in with the IFFN testbed schedule.

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SURVEY OF CURRENT SIMULATION FACILITIES

POTENTIAL ROLE	FACILITY	LOCATION	MISSION	AVAILABILITY
CENTRAL SIMULATION CONTROL	MULTOTS	TACS/TADS SITE SAN DIEGO	CENTRAL ADL TEST CONTROL	NONE AVAILABLE BUY: @ $1.4 M.
	SIMTRACC	USAADS (2) FT. BLISS	CENTRAL ADL TEST CONTROL	TIME SHARE USAADS UNITS OR BUY NEW.
	485L STEM	GTE/SYLVANIA (DEV)	TSQ-91 CRC/P OPER. TRAINING	IN DEVELOPMENT, BUY IF NEEDED.
WEAPON SYSTEM SIMULATION	AVSAIL	AVIONICS LAB WPAFB	AVIONICS DEV, SOFTWARE VAL.	HEAVY LOAD, PROB. NON-PRIME TIME
	MANNED AIR COMBAT SIMULATOR (MACS)	MCDONNELL DOUGLAS ST. LOUIS	AIR-AIR COMBAT TRAINING F-15 PILOTS	UNK, PROBABLY OK
EMULATED C^3SYSTEMS	AWACS MISSION SIMULATOR	552 AWAC WING TINKER AFB	AWACS CREW TRAINING	HEAVY LOAD, BUT # 2 IN '81 + DDTS.
	SYSTEM DEVELOPMENT FACILITY	HUGHES AIRCRAFT CORP. FULLERTON	SYSTEM DEV/INTEG. FOR GEADGE	COMPLETE '80, SURROGATE GEADGE CRC
	C^3 SYSTEMS LABORATORY	MARTIN-MARIETTA DENVER	GEN PURPOSE C^3 DEV LAB	GOOD CANDIDATE WP/C^2 SIMULATOR
	ADV. C&C ARCHITECTURAL TESTBED (ACCAT)	NOSC SAN DIEGO	GEN TESTBED USN C^3 PROGRAMS	UNK, PROB. POOR. ALT WP/C^2 SIM.
	REDCAP	CALSPAN BUFFALO	RADAR/EW/C^2 SIMULATION	AVAILABLE ALT WP/C^2 SIM.

8-13-79-7

PRELIMINARY JTF/CSF SITE ANALYSIS

A preliminary analysis was performed to determine. on a qualitative basis, where the IFFN Joint Test Force and its associated central simulation facility might best be located. The evaluation criteria shown across the top of the chart are similar to those that were applied on JINTACCS and other programs. The candidate locations shown were selected on the basis of various factors; particular attention was paid to such items as proximity to the participating test units (PTUs) and overall desirability of the location. Kirtland AFB was included since that base is the location of the Air Force Test and Evaluation Center (AFTEC), which will serve as the Executive Agent for the IFFN program. Of those sites listed, Albuquerque, New Mexico, and Denver, Colorado, appear to be the most promising. Pending further analysis and direction, Kirtland AFB has tentatively been selected as the preferred location for these central facilities.

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PRELIMINARY JTF/CSF SITE ANALYSIS

CANDIDATE LOCATIONS	PROXIMITY TO PTUs	SPACE AVAIL-ABILITY	COMM. ACCESS	SUPPORT AVAIL. (ADP, SEC, ETC.)	TRANSPORTATION		DESIR-ABILITY
					ACCESS	COST	
ALBUQUERQUE, NM (KIRTLAND AFB)	▥	▥	▥	▥	▥ / ░	▥ / ░	▥
DENVER, CO (M-M, LOWRY AFB)	▥	▥ / ░	▥	▥ / ░	▥	▥ / ░	▥
LOS ANGELES, CA AREA (VAND. AFB, HAC, TACS/TADS)	▥ / ░	▥ / ░	▥	░	▥	▥ / ░	▥ / ░
WASHINGTON, DC AREA (e.g., ANDREWS AFB)	▨	▨	▥	▥ / ░	▥	▨	▨
LANGLEY, VA (LANGLEY AFB)	▨	░ / ▨	▥ / ░	▥ / ░	▨	▨	▨
FORT MONMOUTH, NJ (JINTACCS JITF)	▨	░	▥	▥ / ░	░	▨	▨

8-10-79-19

▥ GOOD ░ FAIR ▨ POOR

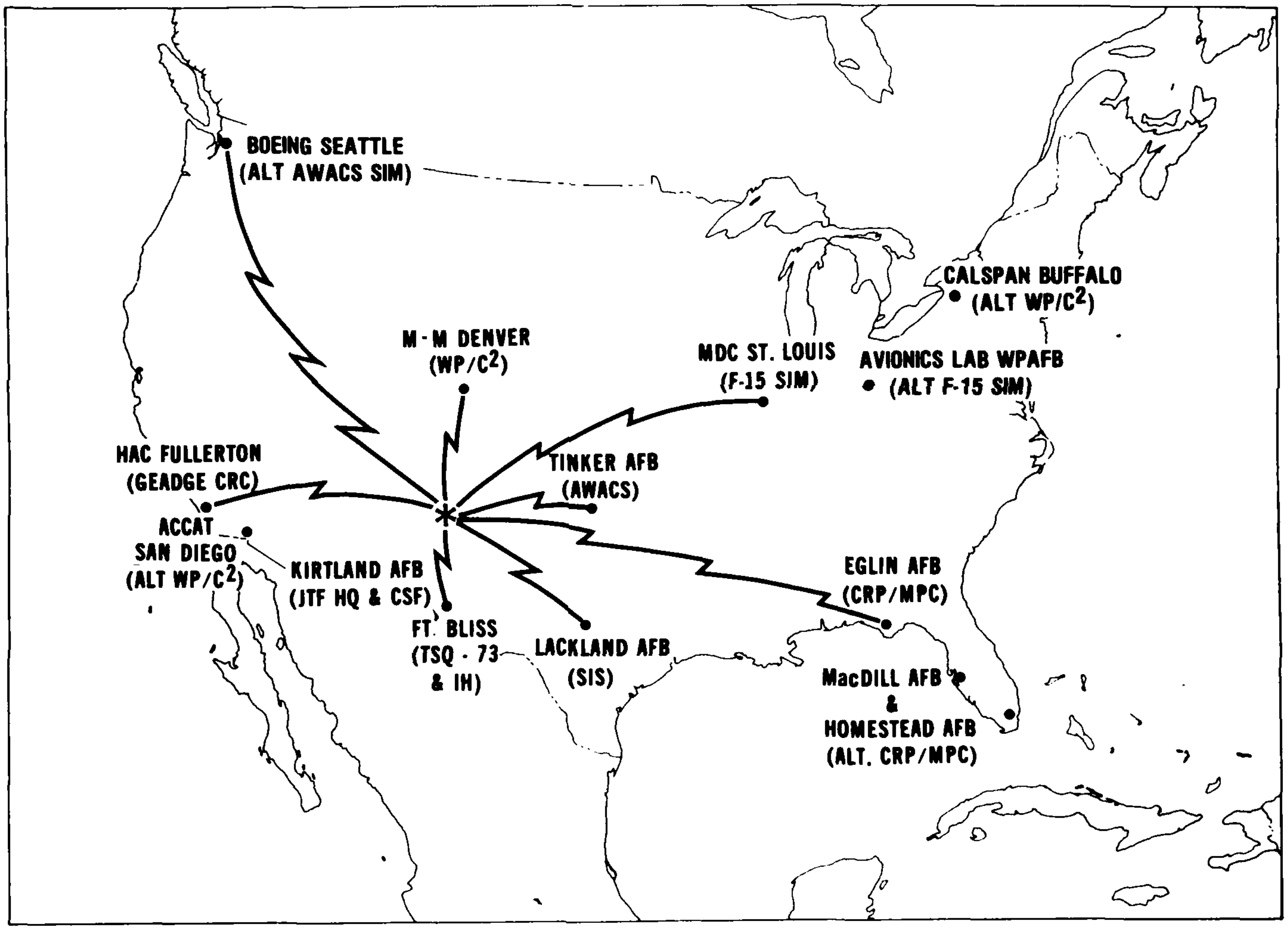
UNCLASSIFIED

LOCATIONS OF PROPOSED IFFN SIMULATION TESTBED PARTICIPANTS

This map shows where the major participants in the IFFN testbed program will be located. The JTF headquarters and the CSF are expected to be located at Kirtland AFB; that location represents the centroid of all the participating sites. A central location would substantially reduce such operating costs as the leasing of communication lines and travel to and from the various sites.

A number of alternatives exist for some of the participating systems. The AVSAIL facility at the Air Force Avionics Laboratory, for example, might be employed in place of the F-15 simulator in St. Louis. In addition, a number of possibilities exist for the 485L CRP/MPC. Those shown here include Eglin AFB, McDill AFB, and Homestead AFB. All of the Army command and control facilities that would participate in the program (that is, the IHAWK battery and the *TSQ-73* systems) *are located at Fort Bliss,* Texas. It may be appropriate to employ the AWACS simulation facility located at the Boeing plant in Seattle, Washington. Similarly, the ACCAT and REDCAP facilities may be employed as alternative or additional WP/C^2 simulators.

LOCATIONS OF PROPOSED IFFN EVALUATION TESTBED PARTICIPANTS



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RESOURCE ALLOCATIONS

This chart introduces preliminary estimates of program costs and schedule time. Costs are allocated between DTE, the designated Executive Agent, and the participating military Services. These allocations are made on the basis of the latest DoD budget guidelines applicable to joint test and evaluation (JT&E) programs, and thus differ somewhat from resource allocations applicable to other programs.

These differences are visible in the costs incurred by military Services participating in joint tests. As a DTE-directed JT&E program, the IFFN evaluation program would be funded under DoD program element 65804D. Such funds are designated to be employed for "...the direction, supervision, and performance of JTE and will be for those areas which are unique to the needs of the JTE. In the accomplishment of DDT&E–directed joint tests, the Components will be reimbursed from these RDT&E funds for any unique costs associated with the directed tests with the exceptions of normal military pay, O&M expenditures, and the hardware utilized for the test." For the sake of completeness, we include an estimate of Service costs later; it should be remembered, however, that these costs will be funded from the existing O&M budgets of the participating Services.

It should also be noted that the TACS/TADS and JINTACCS programs have been designated "Operational Effectiveness Demonstration" programs rather than "Joint Test & Evaluation." Although valid comparisons can be made between the costs of all these programs, different sets of ground rules apply to their funding.

RESOURCE ALLOCATIONS

DOD (DTE):

- JOINT TEST DIRECTOR & SPECIAL PERSONNEL
- HARDWARE & SOFTWARE FOR CENTRAL SIMULATION FACILITY (CSF) & SATELLITE SIMULATION UNITS (SSU)
- COMMUNICATIONS BETWEEN CSF AND ALL SSUs
- COSTS OF SUPPORT CONTRACTOR TO PLAN/CONDUCT/ANALYZE TESTS
- SPECIAL INSTRUMENTATION & TEST-ONLY MODS (INCL. SOFTWARE)
- LEASING OF SPECIAL FACILITIES (AS EMULATED C&C CENTERS)
- ADP SUPPORT
- TRAVEL & PER DIEM
- IDA SUPPORT

EXECUTIVE AGENT (USAF):

- JTF FACILITIES (BUILDINGS, OFFICE SPACE, FURNISHINGS, UTILITIES)
- ADMINISTRATIVE MANAGEMENT SUPPORT
- JTF BASE SUPPORT

PARTICIPATING SERVICES:

- TACTICAL DATA SYSTEMS DESIGNATED TO PARTICIPATE
- ALL PERSONNEL REQUIRED TO OPERATE/MAINTAIN/SUPPORT PARTICIPATING SYSTEMS
- CONTRACTOR SUPPORT FOR PARTICIPATING SYSTEMS, IF REQUIRED
- PERSONNEL ASSIGNED TO JTF STAFF
- TRAINING OF TEST PARTICIPANTS
- JTF LIAISON & COORDINATION

[illegible]

RECOMMENDED PLAN FOR PROCUREMENT AND SUPPORT OF IFFN SIMULATION TESTBED

The basic features of a recommended procurement/support plan for the IFFN testbed program are presented here.

The first major step in the procurement program would be the preparation of a comprehensive system specification, *based on the analysis* performed to date, that defines the functional requirements of the testbed system. The specification should cover both hardware and software requirements, and should include all elements of the system (central simulation facility, satellite simulation units, emulated facilities, communications, and interfaces with the various *participating* test systems).

About 6 months would be *required to assemble* the draft RFP package, which would consist of the aforementioned specification plus standard RFP elements (contract work statement, general provisions, data requirements, etc.). Upon release of the RFP to industry, another 5 months would be required for proposal preparation, evaluation, negotiations, and contract award.

On this basis, a total of 13 months would elapse from program initiation until the award of the support contract. More time spent would mean a corresponding adjustment to the testbed implementation schedule.

RECOMMENDED PLAN FOR PROCUREMENT & SUPPORT OF IFFN/EVALUATION TESTBED

GROUND RULES:

- JTF CONTRACT FOR PREPARATION OF TESTBED SYSTEM SPECIFICATION, TO SERVE AS BASIS FOR TESTBED PROCUREMENT
- SPEC PREPARATION COMMENCE IMMEDIATELY, IN PARALLEL WITH IDA TEST DESIGN PHASE
- COMPETITIVE TESTBED PROCUREMENT; CPFF OR CPIF CONTRACT TYPE
- SINGLE CONTRACT FOR ALL ASPECTS OF TESTBED IMPLEMENTATION & SUPPORT, INCLUDING:
  - DETAILED SYSTEM DESIGN;
  - PROCUREMENT/FABRICATION/ASSEMBLY/INTEGRATION OF ALL SYSTEM HARDWARE;
  - DESIGN/DEVELOPMENT/DEBUG/INTEGRATION OF ALL COMPUTER SOFTWARE;
  - PREPARATION OF ALL TEST SCENARIOS/PROCEDURES/SCHEDULES;
  - CONDUCT OF ALL TESTS, UNDER DIRECTION OF JTF STAFF; AND
  - REDUCTION/ANALYSIS OF TEST DATA & PREPARATION OF TEST REPORTS

PROCUREMENT SCHEDULE:

	MONTHS
• IDA DRAFT WORK STATEMENT FOR PREPARATION OF SYSTEM SPECIFICATION	1
• PREPARE SYSTEM SPECIFICATION & OTHER RFP DOCUMENTATION	6
• REVIEW/RELEASE RFP	1
• BIDDERS PREPARE PROPOSALS IN RESPONSE TO RFP	2
• EVALUATE PROPOSALS	2
• NEGOTIATE/AWARD CONTRACT	1
TOTAL	13

ASSUMING 1 SEPT 79 START, AWARD CONTRACT 1 OCT 80.

10-3-79-2

PRELIMINARY MASTER SCHEDULE

The IFFN program is expected to require about 6 years to complete. It is assumed that the testbed system will be dedicated to use for the IFFN program until its completion.

Primary DTE and JTF activities are shown across the top of the master schedule. DTE activities, with IDA support, would concentrate on the derivation of an appropriate test design concept, review of test plans, and monitoring of the test program.

After selecting the primary support contractor, the JTF staff will be involved in directing the testbed implementation program and the ensuing test program. One important JTF activity during test phases will be the incorporation of the various participating units (including emulated facilities) into the overall testbed system by the dates called for in the test progression schedule. The approximate "need" dates of these participating systems are indicated here. In all cases, need dates are specified one or more months prior to the initiation of tests involving those systems, to allow sufficient time for integration and check-out. All participating systems will remain integrated in the testbed until the conclusion of the test program; however, they would only be required to support testing on a part-time basis, and would be available to the Services for other purposes (e.g., training or configuration).

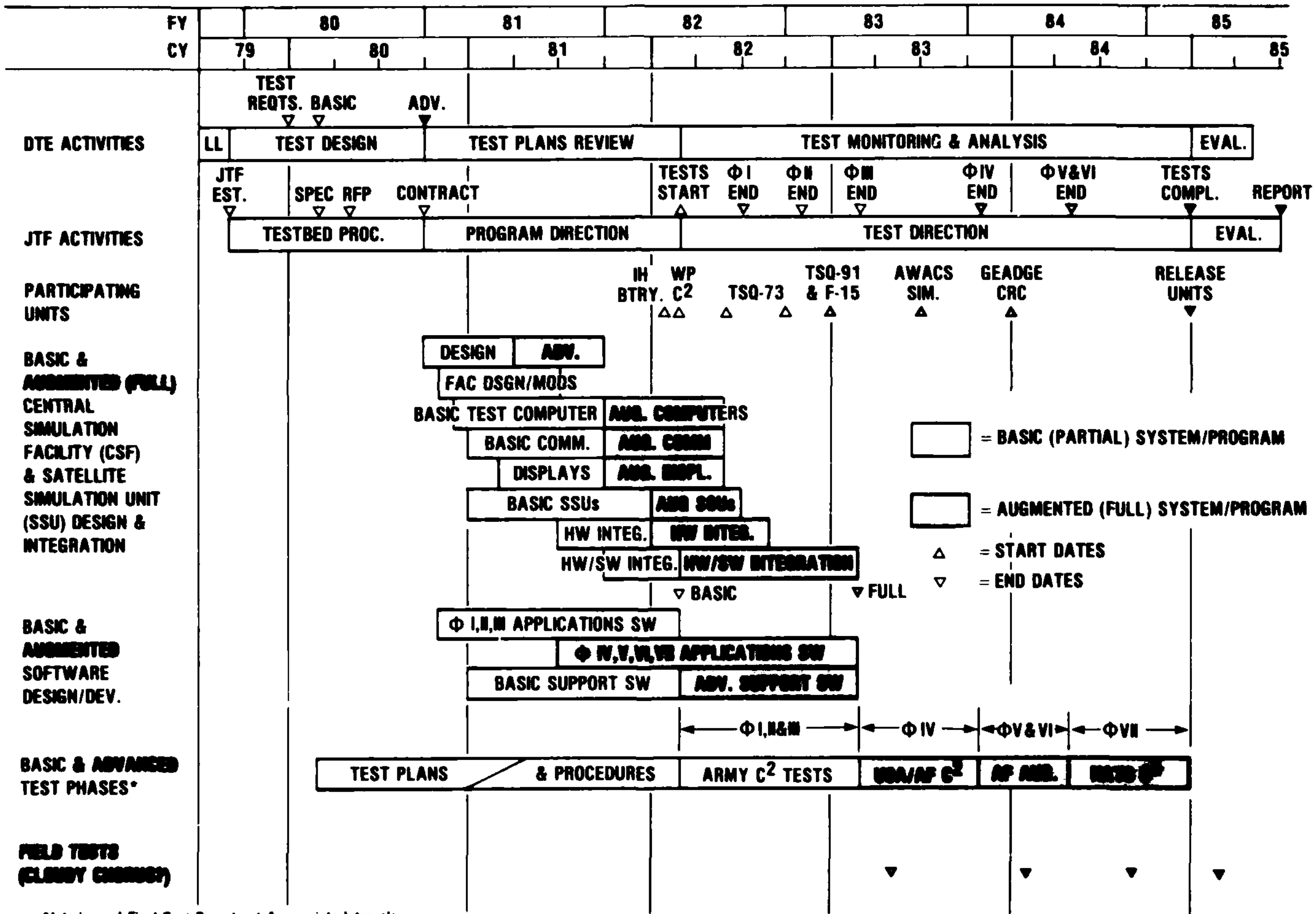
The CSF/SSU implementation program, shown in the central portion of the chart, covers two systems: (1) a "basic" or partial system capable of evaluating the identification function as performed within U.S. Army command and control and weapons systems (test Phases I, II, and III, involving IHAWK missile batteries and AN/TSQ-73 Air Defense Systems) and (2) an "augmented" or full-up testbed system that will include additional equipment and software to carry out the advanced phases of the test program (Phases IV through VII, involving Air Force and NATO command and control systems). By starting the test program using the "basic" testbed system, the total time span of the IFFN program is reduced by about 1 year (with concomitant reduction in program cost).

Although depicted here as developing in discrete steps, the augmented testbed system would actually evolve continuously from the basic system, with all the hardware and software of the basic configuration retained. As the additional equipment and software making up the augmented system are installed, they would be interfaced with the basic system during scheduled lulls in the early test phases. As a result, no specific time span is shown here for the transition from the basic to the augmented configuration.

The times required for individual test phases are preliminary estimates; more definitive estimates must await the preparation of an approved test design and associated test plans and procedures. Judging from previous programs of this type, however, a test period of about 3 years appears to be reasonable.

As previously mentioned, it may be feasible and practical to validate some of the results of the IFFN simulation program through "piggybacking" on planned field test exercises. One possible vehicle for such "graduation exercises" is the CLOUDY CHORUS FTXs conducted in the Central Region of NATO Europe three times a year. The approximate dates of such field tests are shown at the bottom of the chart. It may also be feasible to participate in certain command post exercises such as BLUE FLAG and WINTEX-81, depending on the purpose and scope of the CPXs.

PRELIMINARY MASTER SCHEDULE



*Interim and Final Test Reports at Appropriate Intervals.

9-28-79-29

ASSUMPTIONS MADE IN PREPARING COST ESTIMATES

In order to prepare initial estimates of the cost of the IFFN simulation program, it was necessary to make certain assumptions about the allocation and distribution of costs. These assumptions are listed opposite. Note that only the overall cost summary has been adjusted for inflation using current DoD guidelines.

No estimates are included herein for any flight test programs (either dedicated or nondedicated) for validating the simulation results, as feasible FTX concepts will be considered during the ensuing test design phase of the IFFN Evaluation Program.

These estimates are considered to be strictly preliminary and were prepared without the active participation of the Services, since neither the exact configuration of the participating systems nor the need for supporting services has been well defined. It is recommended that the *participating Services prepare their own independent* "bottoms up" estimates of expected O&M costs.

ASSUMPTIONS MADE IN PREPARING COST ESTIMATES

- ESTIMATES IN CONSTANT 1979 DOLLARS; INFLATION FACTORS APPLIED ONLY IN OVERALL COST SUMMARY
- TACS/TADS ACTUAL & JINTACCS PROJECTED COSTS USED TO VALIDATE ESTIMATES WHERE APPLICABLE
- SALARIES/ALLOWANCES OF ALL MILITARY PERSONNEL, INCLUDING JTF STAFF, PAID BY PARENT SERVICES
- JTF PAYS ALL SUPPORT CONTRACTOR COSTS
- ALL FACILITIES REQUIRED BY JTF STAFF (OFFICE SPACE, FURNISHINGS, UTILITIES, CSF BUILDING, CONVERSION COSTS) PROVIDED FREE BY HOST BASE
- LEASED COMM LINES BETWEEN CSF AND SSUs AT PARTICIPATING TEST UNITS (PTU) PROVIDED BY JTF; COMM TERMINAL EQUIPMENT AT PTUs PROVIDED BY SERVICES
- OPERATION/MAINTENANCE/SUPPORT OF ALL PTUs PROVIDED BY SERVICES
- OPERATION/SUPPORT OF EMULATED SYSTEMS (GEADGE, WP/C^2 SIM, F-15 SIM) PROVIDED BY JTF
- NO COSTS INCLUDED FOR FIELD TESTS OR OTHER VALIDATION PROGRAMS

9-28-79-36

EQUIPMENT REQUIREMENTS

This is a summary list of the numbers and types of equipment estimated to be required at the CSF and at the supporting SSUs. Where possible, informal cost estimates were obtained from suppliers. Where supplier estimates were not available, costs were estimated conservatively.

The major cost items in the CSF are the test control and monitoring computers and the associated memory, input/output, and display systems. Rather than procuring this data processing equipment as a series of individual items, the equipment would likely be procured as an integrated test control and monitoring system. (SIMTRACC and MULTOTS are examples of such systems.) The total cost of these items is estimated at approximately $1.4 million.

EQUIPMENT REQUIREMENTS

AT CSF:	# REQD.	UNIT COST	TOTAL COST ($ M)
• COMPUTERS & MEMORY			
PARALLEL PROCESSORS (PDP-8 OR EQUIV.)	10	20K	0.200
MINICOMPUTERS (ECLIPSE S-130 OR EQUIV.)	5	*	
HIGH CAPACITY DISK (~192 MBYTE)	1	*	
CARTRIDGE DISK UNIT (~5 MBYTE)	2	*	
MAG TAPE DRIVES	4	*	
• INPUT/OUTPUT & DISPLAYS:			
CARD READER/PUNCH	1	*	TOTALS
HIGH SPEED PRINTER/PLOTTER	1	*	1.400
GRAPHIC DISPLAY CONSOLES	7	*	
A/N DISPLAY TERMINALS (TEST CONTROL)	6	*	
A/N DISPLAY TERMINALS (SIM. PILOTS)	10	20K	0.200
LARGE SCREEN DISPLAY	1	200K	0.200
• COMM TERMINAL EQPT:			
PATCH PANELS & BRIDGING NETWORKS	1 SET	20K	0.020
CHANNEL SELECT CONTROL UNITS	20	5K	0.100
HIGH SPEED DATA MODEMS(9600 BAUD)	8	5K	0.040
8-CHANNEL MULTIPLEXERS	8	10K	0.080
LINE MONITORING & TEST SET	1 SET	10K	0.010
VOICE COMM EQPT (INTERNAL & EXTERNAL)	1 SET	20K	0.020
• POWER CONTROL & CONVERSION, MISC. TEST EQPT.	1 SET	200K	0.200
		SUBTOTAL	$2.47M

9-28-79-35

EQUIPMENT REQUIREMENTS

Each SSU will contain an almost identical basic complement of data processing, display, and communications equipment. A basic SSU package has been configured and its cost is estimated here.

The additional SSU equipment listed at the bottom of the chart includes those items that will be required at the unique participating test units to generate simulated video information. In the case of three sites (GEADGE CRC, F-15 simulator, and TSQ-73 GOC) no radar video is employed, so that the facilities required at those sites consist of the basic SSU package.

Total equipment cost, exclusive of spares and support cost, is estimated at $5.14 million

EQUIPMENT REQUIREMENTS

(Cont'd)

AT SSUs:	# REQD.	UNIT COST	TOTAL COST ($ M)
BASIC SSU PKG (ADP/DISPLAY/COMM) COMMON TO ALL SSUs:			
MINICOMPUTER (NOVA 800 OR EQUIV.)	8 (1/SSU)	20K	0.160
FLOPPY DISK	16 (2/SSU)	5K	0.080
MULTIPLEXER & ADL MODEM	8 (1/SSU)	10K	0.080
TAPE DRIVE	8 (1/SSU)	10K	0.080
DISPLAY CONSOLE	8 (1/SSU)	10K	0.080
VOICE COMM	10	14K	0.140
• ADDITIONAL SSU EQUIPMENT:			
AT IHAWK BATTERY: RAYTHEON OTS	3 (TRIAD)	100K	0.300
AT TSQ-73 BOC: STEM VIDEO GEN.	1	300K	0.300
AT TSQ-73 GOC: BASIC SSU PKG	1	INCL.	INCL.
AT TSQ-91 CRP: STEM VIDEO GEN.	1	300K	0.300
AT AWACS SIM: TACS/TADS RSSU	1	150K	0.150
AT GEADGE CRC: BASIC SSU PKG.	1	INCL.	INCL.
AT WP/C^2 SIM: NEW VIDEO GEN. (3 TYPES)	10	100K	1.000
AT F-15 SIM: BASIC SSU PKG.	1	INCL.	INCL.
		SUBTOTAL	$2.67M
		EQUIPMENT TOTAL:	$5.14M

9-28-79-34

SOFTWARE REQUIREMENTS

The basic software package anticipated to be required in the IFFN simulation testbed program is shown here. Note that the individual groups of computer programs are broken down between those required at the CSF, the SSUs, and the LPUs. The first column on the chart indicates the estimated number of FORTRAN instructions that will be required to implement each program package. The next column indicates what number of such program packages will probably be required. The last column indicates the cost of the preparation of the total required number of program packages based on the assumption that each instruction will cost $20 to design, implement, debug, and document.

These software requirements would undoubtedly be much larger were it not for the fact that much of the test data processing software has already been developed for previous programs and has been designed to run on the same types of computers that will probably be used in the testbed. It has been estimated, for example, that over $4 million has already been expended for the development of software to run on MULTOTS for the TACS/TADS program. That software should be usable for the IFFN testbed program with little or no modification.

The software requirements listed here do not include the software that will be required to implement the WP/C^2 simulator and the GEADGE CRC. Those requirements have been estimated separately and are shown on the next chart.

The bottom line on the chart (labeled "Other") represents a gross estimate of the cost to modify existing software and implement new software programs, the need for which has not yet been defined. As noted, the cost of these software programs is likely to equal the total cost of all the other software packages already defined.

It is estimated that the preparation of some 200,000 new and modified instructions will be required, at a total cost of approximately $4 million.

SOFTWARE REQUIREMENTS

	EST. # INST. PER PKG.	EST. # PACKAGES	COST @ $20 PER INST. ($K)
CSF:			
EMULATED FACILITIES (INTERACTIVE MODELS)	1,500	6	180
EMULATED FACILITIES (NON-INTERACTIVE MODELS)	500	5	50
AIRCRAFT FLIGHT MODELS	2,500	1	50
AIRCRAFT MISSION MODELS	1,000	3	60
SENSOR MODELS (GENERIC TYPES)	2,500	10	500
AIR TRUTH DISTRIBUTION PROCESSING	1,000	1	20
CONTROL & MONITORING GRAPHICS	2,000	1	40
DYNAMIC AIR TRUTH CONTROL	1,000	1	20
DATA RECORDING CONTROL	1,500	1	30
DATA LINK MESSAGE PROCESSING	2,000	1	40
SCENARIO EDITING & REVIEW	1,000	1	20
REAL-TIME DATA REDUCTION & REVIEW	2,000	1	40
REAL-TIME OPERATING SYSTEM	2,000	1	40
SSUs:			
COMM DATA LINK MESSAGE HANDLERS	1,000	1	10
SENSOR & FLIGHT MODELS	2,000	6	240
UNIT INTERFACE CONTROL	1,000	7	140
LPUs:			
FUSION ALGORITHMS	2,500	5	250
NEW SENSOR DATA SOURCES	1,000	4	80
EXPANDED DATA EXTRACTION	1,000	5	100
SSU INTERFACE & TRANSMISSION	1,000	4	80
OTHER (MODS & UNDEFINED):	1,000	100	2,000
TOTAL # INSTRUCTIONS:	200,000	TOTAL COST:	$4.0 MILLION

9-28-79-33

ESTIMATED DTE COSTS

By combining the hardware and software costs shown on the previous charts and the costs allocable to DTE in accordance with current budgeting guidelines for joint test and evaluation programs, DTE costs are estimated to total about $29 million over a period of 6 fiscal years. The breakdown of costs per fiscal year is based on the preliminary master schedule.

Of the almost $29 million total cost, only about $7.5 million is attributable to CSF/SSU hardware, spares, and maintenance, and test-only modifications. This demonstrates once again that, in programs of this type, personnel costs far outweigh equipment costs. Software costs are themselves greater than the total cost of procuring and supporting the hardware, even though some of the software already exists.

Spares and maintenance costs were estimated at 30 percent of equipment acquisition cost, spread over the 4-year period of testbed integration and testing.

The estimate of $1 million for leasing dedicated telephone lines between the CSF and participating test units was derived from (and is consistent with) the costs incurred on the TACS/TADS program for similar communications services. Should the test design phase indicate the need for test data transmission requirements larger than those currently estimated, however, the cost of the item could increase substantially.

ESTIMATED DTE COSTS

(DOLLARS IN MILLIONS)

FY	1980	1981	1982	1983	1984	1985	TOTAL
JTF PERSONNEL	0.050	0.150	0.200	0.200	0.200	0.100	0.900
TRAVEL & PER DIEM	0.050	0.130	0.150	0.150	0.150	0.130	0.760
CSF & SSU HARDWARE		2.040	2.900	0.200			5.140
CSF & SSU SOFTWARE		1.500	1.500	0.600	0.400		4.000
LEASED COMM LINES		0.050	0.100	0.300	0.400	0.150	1.000
GEADGE RENTAL & SOFTWARE			0.200	0.600	0.600	0.200	1.600
WP/C^2 SIM. RENTAL & SOFTWARE		0.300	0.800	0.800	0.400	0.200	2.500
TEST-ONLY MODS (HW & SW)		0.100	0.300	0.300	0.100		0.800
ADP SUPPORT SERVICES	0.100	0.200	0.400	0.400	0.300	0.200	1.600
SUPPORT CONTRACTOR(S)	0.300	0.800	1.200	1.400	1.400	0.500	5.600
IDA SUPPORT	0.405	0.550	0.550	0.550	0.550	0.275	2.880
CSF/SSU SPARES & MAINTENANCE		0.150	0.460	0.460	0.460		1.530
MISCELLANEOUS	0.050	0.100	0.100	0.100	0.100	0.050	0.500
TOTAL	0.955	6.070	8.860	6.060	5.060	1.805	28.810

9-28-79-32

ESTIMATE OF SERVICE COSTS

It is estimated that providing supporting services to the IFFN testbed program will cost the individual military Services slightly more than $35 million (in constant 1979 dollars).

Since detailed requirements for military supporting services have not yet been defined, these cost estimates were extrapolated from the actual cost of the TACS/TADS *program. They were derived by first calculating* the average annual cost incurred by each of the Services over the 7 years of the TACS/TADS program that preceded the OED exercise. (These cost figures were provided by the TACS/TADS JITF and can be considered entirely reliable.) These average costs were then updated using an average inflation rate of 6 percent per year.

Multiplying factors were applied for each military Service to correlate *the degree of activity expended on the* TACS/TADS *program with the level* of activity that will likely be required on the IFFN program. Note that, in the case of the Army and Air Force, this factor is greater than one, since those Services would be using more assets than in the TACS/TADS program. In the case of the Navy and Marine Corps, the level of activity is expected to be somewhat less than what was required by TACS/TADS (the particular level and type of activity required of those organizations has not yet been fully defined).

The expected average yearly costs for Service participation in the IFFN program thus derived were then spread over the 6-year period of the IFFN testbed program to arrive at the total costs shown.

Although these estimates help in calculating the overall cost of the program, the individual Services should prepare their own independent estimates based on actual program commitments rather than relying on the type of simple extrapolation shown here. Those estimates should then serve as the basis for allocation of yearly O&M budgets.

ESTIMATE OF SERVICE COSTS FOR IFFN EVALUATION PROGRAM

(BASED ON EXTRAPOLATIONS FROM TACS/TADS ACTUALS)

SERVICE	AVERAGE TACS/TADS FOR 7 YRS PRE-OED	T/T AVERAGE UPDATED FOR INFLATION AT 6%/YR	MULT. FACTOR FOR % OF ACTIVITY	AVERAGE YEARLY COST FOR IFFN/C^2	FY REQUIREMENTS ($M)						IFFN/C^2 TOTAL COST ($M)
					1980	1981	1982	1983	1984	1985	
• USA	1.957	2.619	1.5	3.929	0.80	2.35	3.92	3.92	3.14	1.57	15.700
• USAF	2.106	2.818	1.2	3.382	0.40	1.84	3.20	3.50	3.60	1.00	13.540
• USN	1.207	1.615	0.5	0.808		0.40	0.80	0.80	0.80	0.40	3.200
• USMC	0.733	0.981	0.7	0.687		0.24	0.70	0.70	0.70	0.40	2.740
				TOTALS	1.20	4.83	8.62	8.92	8.24	3.37	35.180

9-28-79-31

SIMULATION PROGRAM COST ESTIMATES

The total cost for the simulation portion of the IFFN program based on constant 1979 dollars is shown here. This cost is considered to be a rather high estimate.

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SUMMARY OF COST ESTIMATES FOR IFFN SIMULATION PROGRAM

(IN CONSTANT 1979 DOLLARS)

FY	1980	1981	1982	1983	1984	1985	TOTAL
DTE COSTS: ($M)							
• CSF&SSU HARDWARE & SOFTWARE		3.540	4.400	0.800	0.400		9.140
• SUPPORT CONTRACTOR	0.300	0.800	1.200	1.400	1.400	0.500	5.600
• WP/C^2 & GEADGE FAC. & SOFTWARE		0.300	1.000	1.400	1.000	0.400	4.100
• IDA SUPPORT	0.405	0.550	0.550	0.550	0.550	0.275	2.880
• LEASED COMM LINES & ADP SUPPORT	0.100	0.250	0.500	0.700	0.700	0.350	2.600
• JTF PERSONNEL/TRAVEL/PER DIEM	0.100	0.280	0.350	0.350	0.350	0.230	1.660
• CSF/SSU SPARES & MAINT.		0.150	0.460	0.460	0.460		1.530
• TEST-ONLY MODS & MISCELLANEOUS	0.050	0.200	0.400	0.400	0.200	0.050	1.300
TOTAL DTE	0.955	6.070	8.860	6.060	5.060	1.805	28.810
SERVICE COSTS: ($M)							
• ARMY	0.800	2.350	3.920	3.920	3.140	1.570	15.700
• AIR FORCE	0.400	1.840	3.200	3.500	3.600	1.000	13.540
• NAVY		0.400	0.800	0.800	0.800	0.400	3.200
• MARINE CORPS		0.240	0.700	0.700	0.700	0.400	2.740
TOTAL SERVICES	1.200	4.830	8.620	8.920	8.240	3.370	35.180
TOTAL	2.155	10.900	17.480	14.980	13.300	5.175	63.990

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SUMMARY COST ESTIMATE IFFN SIMULATION PROGRAM

These summary cost estimates are adjusted to accommodate forecast inflation levels over the program time period by using DoD-approved inflation rates and indexes in effect on 31 May 1979. The particular rates and indexes used, which are applicable to both procurement and O&M costs, are shown across the top of the chart.

Inflation rates forecast for more than 2 or 3 years in the future are, of course, quite uncertain, and could vary substantially from those shown.

SUMMARY COST ESTIMATE
IFFN EVALUATION PROGRAM
(ADJUSTED FOR INFLATION)

FISCAL YEAR	1980	1981	1982	1983	1984	1985	TOTAL
BASE YEAR 1979 DoD INFLATION RATES	6.9%	5.8%	4.5%	3.3%	2.2%	1.1%	
BASE YEAR 1979 DoD INFLATION INDEXES	1.069	1.131	1.182	1.221	1.248	1.262	
DTE COSTS ($M):							
• CSF & SSU HARDWARE & SOFTWARE		4.004	5.201	0.977	0.499		10.681
• SUPPORT CONTRACTOR	0.321	0.905	1.418	1.709	1.747	0.631	6.731
• WP/C^2 & GEADGE FAC. & SOFTWARE		0.339	1.182	1.709	1.248	0.505	4.983
• IDA SUPPORT	0.405	0.622	0.650	0.672	0.686	0.347	3.382
• LEASED COMM LINES & ADP SUPPORT	0.107	0.283	0.591	0.855	0.874	0.442	3.152
• JTF PERSONNEL/TRAVEL/PER DIEM	0.107	0.317	0.414	0.427	0.437	0.290	1.992
• CSF/SSU SPARES & MAINT.		0.170	0.544	0.562	0.574		1.850
• TEST-ONLY MODS & MISCELLANEOUS	0.053	0.226	0.473	0.488	0.250	0.063	1.553
TOTAL DTE	0.993	6.866	10.473	7.399	6.315	2.278	34.324
SERVICE COSTS ($M):							
• ARMY	0.855	2.658	4.633	4.786	3.919	1.981	18.832
• AIR FORCE	0.428	2.081	3.782	4.274	4.493	1.262	16.320
• NAVY		0.452	0.946	0.977	0.998	0.505	3.878
• MARINE CORPS		0.271	0.827	0.855	0.874	0.505	3.332
TOTAL SERVICES	1.283	5.462	10.188	10.892	10.284	4.253	42.362
TOTAL DTE & SERVICES	2.276	12.328	20.661	18.291	16.599	6.531	76.686

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