UNMANNED AERIAL VEHICLE TACTICAL CONTROL SYSTEM (UAV TCS)

Test and Evaluation Master Plan (TEMP)

TCS 101

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JOINT PROGRAM OFFICE

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TEST AND EVALUATION MASTER PLAN

FOR

THE UNMANNED AERIAL VEHICLE

TACTICAL CONTROL SYSTEM

Program Elements

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1 PART I--SYSTEM INTRODUCTION

1.1 Mission Description

The Joint Requirements Oversight Council (JROC) Memorandum 003-90 of 5 January 1990 promulgated a Mission Needs Statement (MNS) for a Close-Range Reconnaissance, Surveillance, and Target Acquisition (RSTA) capability and an MNS for a Long-Range Endurance RSTA capability. (The Close-Range mission need will now be met with the Tactical Unmanned Aerial Vehicle (TUAV).) Both MNSs state the need to interface with selected standard Department of Defense (DoD) Command, Control, and Intelligence (C3I) systems, architectures, and protocols, both current and planned. JROC Memorandum 135-95 of 31 October 1995 stated the need for "the development of a common ground reception, processing, and control system to ensure full interoperability with other Unmanned Aerial Vehicles (UAVs) and collection systems." JROC Memorandum 010-96 of 12 February 1996 stated "To fully exploit Predator's capability at all levels, it is imperative that the system become fully compatible and interoperable with the UAV Tactical Control System..."

Currently, each UAV system has its own unique ground control, reception, and processing system that is not capable of compatible and interoperable operations with other operating and developing UAV systems; other collections systems; Command, Control, Communications, Computers, Intelligence (C4I) systems; and surveillance and reconnaissance systems. Additionally, each time a software or hardware configuration is developed to be compatible with new or improved warfighting systems, a new software contract must be developed for each type of UAV control station. There is no standard architecture for future tactical UAV systems. There are no nonmaterial alternative solutions that will establish a standard software architecture to provide the control, reception, and processing system for all UAVs.

The Tactical Control System (TCS) is a multiservice, scaleable, and modular control system that will provide a common compatible and interoperable control system that will operate initially with the Predator, Outrider, Pioneer, and later with High-Altitude Endurance (HAE) UAV systems. The system will be able to receive imagery and other payload information from HAE UAVs. TCS will also be compatible and interoperable with C4I architectures and other surveillance and reconnaissance systems designated in the TCS Operational Requirements Document (ORD). TCS will operate in support of the mission areas specified in the TCS ORD, and within existing and future operational environments, ranging from full-scale conflict to peacekeeping operations. TCS will be integrated in various land-based force structures to support UAV system interoperability, and will provide information interconnectivity to various levels of command echelons, such as Corps, Division, Brigade, Marine Expeditionary Force (MEF), Marine Expeditionary Unit (MEU), Battlegroup, Ship, Wing, and Squadron.

1.2 System Threat Assessment

The latest Defense Intelligence Agency validated System Threat Assessment (STA) for the Joint Tactical UAV (UAV-SR/UAV-CR), September 1995, is the baseline

for threat support. UAV threat data are also contained in Office of Naval Intelligence-Threat Assessment #028-93, Medium-Range Unmanned Aerial Vehicle (UAV-MR), September 1993. Information concerning the threat and Information Warfare (IW) is contained in National Air Intelligence Center Report, NAIC-1571-731-95, Electronic Combat Threat Environment Description, April 1995.

Although the TCS may not be subject to the following threats, mission planning and execution software should account for the following considerations. The TCS will control UAVs that are in close proximity to heavily defended areas and will be used to help the UAV avoid the general threat to the unit(s) it supports. The Aerial Vehicle (AV) will be subject to hostile air defenses that may include the full range of anti-aircraft systems, including conventional small arms, automatic anti-aircraft weapons, and crew-served weapons using radar, optics, and electro-optics for tracking and engagement. The threat also will include shoulder-fired Surface-to-Air Missiles (SAMs), launcher-mounted SAMs, air-to-air weapons launched by both fixed-wing aircraft and helicopters, antiradiation missiles, and directed-energy weapons.

As the mission of UAVs is to provide information, the system may be a lucrative target of IW that includes, but is not limited to, Electronic Warfare (EW), physical destruction, deception, and information attack. Communications/data links may also be subjected to enemy EW threats, antiradiation weaponry, and physical destruction.

1.3 Measures of Operational Effectiveness and Suitability

The ORD specifies 123 requirements for the TCS. Table 1-1 lists Measures of Operational Effectiveness (MOEs) that are a subset of these requirements. The primary criterion for selecting this subset is that they have been identified as Key Performance Parameters (KPPs) in the ORD. There are five major key capabilities or characteristics of the TCS listed in the table. The KPPs related to connectivity to external systems have been divided into two logical subsets: connectivity to C4I systems and connectivity to mission planning systems and other TCSs. For each selected characteristic, the related KPP from the ORD is referenced in the second column. For each characteristic, a number of parameters are identified in the third column of the table. In turn, a quantitative (preferable) or a qualitative measure (where it is not possible to quantify the parameter) is associated with each parameter and listed in column 4 of the table. Additional explanatory notes are appended at the end of the table.

Table 1-2 lists Measures of Operational Suitability. No quantitative requirements are provided in the ORD for these measures. However, the TCS ORD requires that the TCS must meet the mission capability criteria established by the TUAV and Medium-Altitude Endurance (MAE) UAV ORDs. The TUAV ORD has specific quantitative requirements for Mission Reliability, Operational Availability, and Reliability for the whole TUAV system of which TCS is one subsystem. The MAE UAV ORD specifies quantitative requirements for both the AV as well as the ground segment. The TCS Measures of Operational Suitability, derived from these sources, are listed in Table 1-2. Additional explanatory notes are appended at the end of the table.

Table 1-1. Measures of Operational Effectiveness.

CHARACTERISTIC	ORD Rqmt	PARAMETER	QUANTITATIVE OR QUALITATIVE MEASURE
Receive, Process, and Disseminate Payload Information **(Level 2)**	ORD016	1. Collect and process payload information from TUAV, MAE **(Threshold)** 2. Support collection from HAE UAVs **(Objective)**	a. Max. Range for Receipt of Payload Information b. Electro-Optic/Infrared/Synthetic Aperture Radar (EO/IR/SAR) Image Quality c. Image Processing
Control UAV Payloads **(Level 3)**	ORD011, 024, 025	1. Control Payloads on TUAV and MAE 2. Control Payload on a UAV that is being controlled by another TCS	1a. Max. Range for Control of Payload 1b. EO/IR/SAR Payload Controls 1c. Receive, Process & Display Payload Status 2. Repeat a, b, c for a payload that is on a UAV being controlled by another TCS
Flight Control of UAVs **(Level 4)**	ORD011, 024, 025, 026	1. Flight Control of TUAV and MAE UAV over entire flight envelopes 2. UAV hand-off to/from another TCS 3. Simultaneous Flight and Payload Control of at least two AVs, beyond line of sight (BLOS), using one TCS **(Threshold)** 4. Interoperable across multiple platforms/payloads simultaneously **(Objective)**	1. Control of UAV flight control system over entire flight envelope, including all autopilot modes, emergency operations, and flight termination **(Note 1)** 2a. Pass control of TUAV to another TCS 2b. Receive control of TUAV from another TCS 3. Simultaneous control of two UAVs and their payloads in the "Relief on Station" mode of operation **(Note 2)** 4. Simultaneous control of two different types of UAVs and their payloads in the "Relief on Station" mode of operation **(Note 2)**
Launch & Recovery of UAVs **(Level 5)** **(Note 3)**	ORD011, 025, 026, 043, 044	1. Take-off & Landing in Visual Flight Rules (VFR) & Instrument Flight Rules (IFR) conditions **(Threshold)** 2. Support automatic launch & recovery system **(Objective)**	1a. Taxiing and Ground Maneuvering 1b. Take-off 1c. Landing 2a. Automated Launch 2b. Automated Recovery Common Automated Reconnaissance System (CARS)
Connectivity to C4I Systems and other TCSs	ORD011, 069	Communicate Payload Information and Status	1a. Transmit EO/IR imagery, freeze frame, digital SAR frames, payload status, and target geolocation data to the C4I systems listed in the ORD and to other TCSs 1b. Receive secondary imagery & data from other TCSs

Table 1-1. Measures of Operational Effectiveness. (Cont.)

CHARACTERISTIC	ORD Rqmt	PARAMETER	QUANTITATIVE OR QUALITATIVE MEASURE
Connectivity to Mission Planning Systems and other TCSs **(Level 1)**; Mission Execution	ORD011, 016, 040	1. Communicate UAV Information and Status 2. Communicate Mission Tasking 3. Conduct Mission Planning and Execute the Mission	1. Transmit UAV position, velocity, and status to Service Mission Planners and other TCSs 2a. Import Maps and Mission Plans **(Threshold)** from Service Mission Planners and other TCSs 2b. Export Mission Status and Mission Plans **(Objective)** to Service Mission Planners 3a. Provide Flight Planning Tools 3b. Program UAVs with Mission Planning Data prior to launch and Modify & Upload Mission Plan to UAVs in-flight 3c. Provide appropriate operator displays 3d. Switch antennas

NOTES:

(1) Flight control of the UAVs is interpreted to mean that the TCS is able to control a UAV throughout its flight envelope, i.e., over its entire speed and altitude range, including normal flight operations, as well as emergency procedures. However, only the flight control system implemented by the TCS needs to be measured for its effectiveness. Therefore, TCS shall be capable of controlling the air vehicle and its payload without degrading the normal performance capabilities of the UAV.

(2) The simultaneous flight and payload control of multiple UAVs with one TCS, as stated in the ORD, can be interpreted in many different ways. A white paper has been prepared by the TCS Requirements, Analysis & Design Integrated Product Team to elaborate and interpret this requirement. It defines the Relief on Station operational mode as the principal interpretation of this requirement.

(3) The ORD requires that the TCS shall provide sufficient cues to allow the pilot to safely take off, land, and navigate under IFR. Therefore, it is necessary to demonstrate that take-offs and landings in poor visibility and low ceilings are possible. The specific weather conditions (Runway Visual Range and Ceiling) are determined by the UAV operating envelope, i.e., whether it is certified for Category I, II or III conditions.

Table 1-2. Measures of Operational Suitability.

CHARACTERISTIC	PARAMETER	QUANTITATIVE MEASURE (Note 1)
Reliability	TCS Reliability	$MTBCF_{TCS}$ = 400 h (threshold), 800 h (objective) (Note 2)
Availability	TCS Availability	TCS A_0 = 0.95 (threshold) >0.99 (objective) (Note 3)

NOTES:

(1) In general, the TCS reliability and availability should be no less than the systems it might replace, such as the current Predator and Outrider ground control stations (GCSs). There are no quantitative reliability, mission success, or availability requirements in the ORD. The ORD only states that the TCS must meet the mission capability criteria established by the MAE UAV and TUAV ORDs [ORD073].

(2) TUAV ORD (Version 3.1 dated 30 October 1996) defines reliability as the Mean Time Between Operational Mission Failures (MTBOMF) and specifies a requirement of 40 h **(Threshold)** and 61.7 h **(Objective)**. The UAV system is composed of many elements, such as the AV, propulsion, payload, onboard avionics, data links, antennas, and the TCS. The TCS unreliability budget can only be a fraction of the allowed total TUAV system unreliability budget. It is assumed here that the TCS budget can be no more than one tenth of the total system unreliability. Hence, desired values for TCS will be 400 h **(Threshold)** and 617 h **(Objective)**, based on TUAV ORD requirements. The final ORD CAF 003-90-I-A for the RQ-1A Predator MAE UAV system defines reliability as Mean Time Between Critical Failures (MTBCF), and specifies 2000 h **(Threshold)** and 3000 h **(Objective)** for the ground segment. However, the maximum time (not *mean*) achieved by Predator GCS is 852 h. The TCS goal is to be as good as or better than existing Predator GCS. Picking the more stringent between the TUAV and the MAE ORDs, we obtain 400 h **(Threshold)** and 800 h **(Objective)** for the TCS MTBCF.

(3) Availability is the average fraction of time that the TCS is up and operating or capable of operating. A_0 is calculated as uptime over uptime plus downtime. TUAV availability requirement is specified in the TUAV ORD to be 0.85 **(Threshold)**. It does not specify availability for the GCS. The Predator UAV ORD specifies A_0 for the ground segment to be 0.95 **(Threshold)** and 0.99 **(Objective)**.

1.4 System Description

As stated in the ORD, TCS is the software, software-related hardware, and the extra ground support hardware (antennae, cabling, etc.) necessary for control of the TUAV, MAE UAV, and future tactical UAVs. The TCS will also provide connectivity to identified C4I systems. The TCS will have the objective capability of receiving HAE UAV payload information. Although developed as a total package, the TCS will have the capability to be configured and downscaled to meet the user's deployability or operator limitations. The TCS will provide the common software architecture between the MAE UAV, TUAV, and future tactical UAVs (excluding legacy systems). Accordingly, the operational concept for the TCS will be the same as the operational concept for the UAV system it supports.

The TCS comprises hardware and software elements integrated into one core system that can be packaged into different configurations to meet the needs of the individual services. The six Low-Rate Initial Production (LRIP) articles will be packaged as follows: the land-based version (LB HMMWV), two sea-based configurations (CV Battle Group and Amphibious Battle Group), the Tactical Operations Center (Task Force

Commander) desktop version, the Predator GCS backfit configuration, and the Outrider HMMWV configuration. Each hardware configuration operates with the same software to support the individual service applications. Each LRIP article will be capable of controlling Outrider and Predator UAVs, communicating via Ku-Band Satcom and LOS links, and receiving and processing SAR imagery. Each LRIP system will also have full Level-5 functionality, including manual launch and recovery. Each TCS system will have the capability to control multiple UAVs and their payloads.

Figure 1-1 is a generic block diagram of the TCS. Because it is designed to be modular and scaleable, different TCS configurations may include only a subset of the components shown. For example, a forward-deployed unit that is only required to control the Outrider AV could operate without the Pioneer or Predator Datalink Control Modules (DCMs). TCS consists of several subsystems described as follows:

(1) **Line-of-Sight (LOS) Antenna Assembly:** The planned LRIP baseline antenna assembly is the Johns Hopkins University/Applied Physics Lab (JHU/APL) antenna. Pedestal control is provided by a separate Sun Sparc workstation, which receives position and orientation input from either TCS or an external source (such as a ship's geopositioning unit).

(2) **Integrated Data Terminal (IDT):** The IDT is an interim subsystem designed to send, code/decode, and receive data between the antenna and AV-specific datalink control modules. Both the IDT and the APL antenna will be replaced by the Tactical Common Datalink (TCDL) in full-scale production.

(3) **Datalink Control Modules:** A DCM is provided for each UAV type with which TCS will operate. Shown in Figure 1-1 are the DCMs for Predator (PDCM), Outrider (ODCM), and Pioneer (PiDCM). The purpose of the DCM is to translate AV commands, control, and telemetry between the generic TCS format and AV-specific formats.

(4) **VME Computer:** The VME computer will handle real-time TCS functions, such as AV control. The interface between the VME computer and the DCM is the AV standard interface, a high-bandwidth fiber link designed to maximize reliability and minimize latency.

(5) **SAR Subsystem:** The SAR components in TCS include the SAR processor and a dedicated recording device, the digital linear tape (DLT) drive. The SAR processor takes raw SAR data from the Ku SATCOM antenna, and creates a series of linked pictures that form a scrolling "waterfall" display, viewable at the TCS workstation.

(6) **Workstation:** The TCS workstation is the primary operator interface to TCS. The workstation is service-specific: TAC-4 for the Navy, CHS II for the Army and Marine Corps, and Sun or SGI for the Air Force. The workstation handles non-real-time TCS functions, such as mission planning, imagery exploitation and dissemination, and TCS-C4I interface.

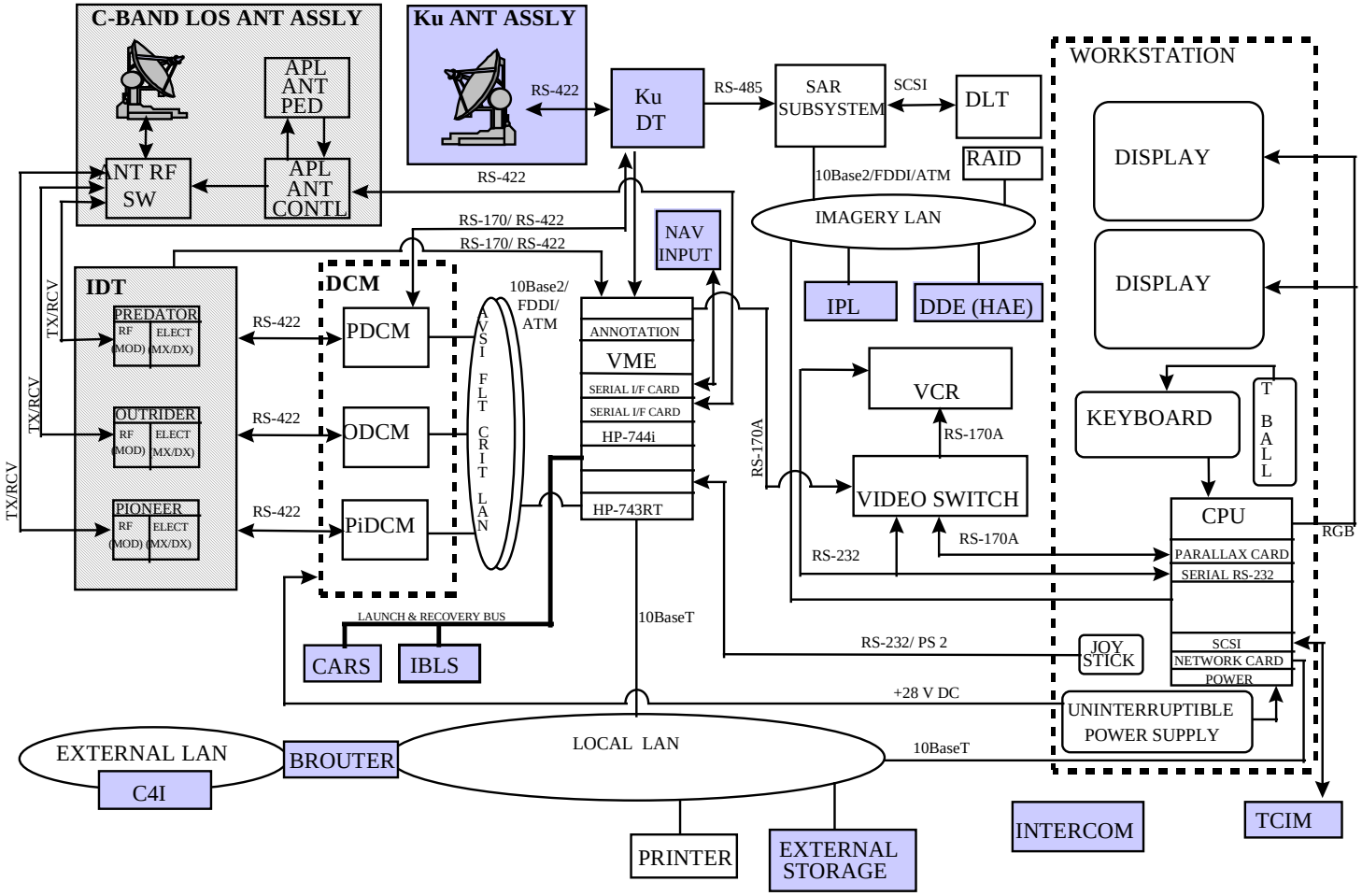

Figure 1.1 TCS Block Diagram

(7) **Video Support Equipment:** This equipment compresses and routes video. It also includes a closed-caption encoder for annotating videos.

1.4.1 Software

1.4.1.1 General

The major focus of the TCS program is software. The software will provide the UAV operator the necessary tools for computer-related communications, mission tasking, mission planning, mission execution, data processing, and data dissemination. The software will provide a high-resolution, computer-generated graphics user interface that enables a UAV operator that is trained on one system to control different types of UAVs or UAV payloads with minimal additional training. The TCS will be in an open architecture and be capable of being hosted on the computers that are typically supported by the using Service. The software developed will be Defense Information Infrastructure/Common Operating Environment (DII-COE) compliant, nonproprietary, and the architectural standard for all future tactical UAVs.

1.4.1.2 Scaled and Modular Design

The TCS will be capable of being hosted on a variety of computers. The initial core of software will be written generically to provide five levels of interaction (see Section 1.4.3) for both TUAV and MAE UAVs, and establish the architecture for future tactical UAVs. Since not all recipients of UAV information require all levels of TCS capabilities, the software and software-related hardware, if required, will be scaleable to meet users' needs. The TCS will prevent users from entering levels of interaction for which they are not authorized by the software and or hardware configuration.

1.4.2 Hardware

1.4.2.1 General

The TCS hardware will be capable of being scaled or being modular to meet varying needs of the Services. The TCS hardware will allow for long-range communications from one TCS to another, data storage expansion, access to other computers to share in processing capability, and multiple external peripherals.

1.4.2.2 U.S. Army and U.S. Marine Corps

The TCS will be an integral part of the TUAV two-HMMWV-based GCSs. The Army will obtain TCSs in addition to those required for the TUAV program to receive/control Predator UAV information.

1.4.2.3 U.S. Navy

The TCS will initially support the TUAV and MAE UAV aboard L-Class ships. The Navy currently does not desire shipboard launch and recovery of Predator. The TCS will be the control system for future ship-based UAVs and UAV operations. Since ships already provide the necessary infrastructure to support a computer-based system

(electrical power, environmental control, radio networks, etc.), the TCS is virtually the Navy GCS.

1.4.2.4 U.S. Air Force

The TCS will be an upgrade of the existing GCS for the MAE UAV.

1.4.3 TCS Levels of Interaction

The TCS will support five levels of UAV interaction:

Level One: Receipt and transmission of secondary imagery and/or data.

Level Two: Direct receipt of imagery and/or data.

Level Three: Control of the UAV payload in addition to direct receipt of imagery/data.

Level Four: Control of the UAV, less launch and recovery, plus all the functions of Level Three.

Level Five: Capability to have full function and control of the UAV from take-off to landing.

1.5 Critical Technical Parameters

Tables 1-3A and 1-3B list the critical technical parameters that will be evaluated during the Early Operational Assessment (EOA) and Developmental Testing and Evaluation (DT&E). Details for some of the Technical Thresholds are provided in Tables 1-4 to 1-11. EOA will be carried out during the Program Definition and Risk Reduction Phase, i.e., Phase I of the TCS program. DT&E will be carried out during both Phase I and Phase II, i.e., the Engineering, Manufacturing, and Development (EM&D) Phase, of the program.

The EOA and DT&E-1 will use the TCS fieldable prototypes that will be deployed in Advanced Warfighting Exercises (AWEs), Joint and Service Exercises, and user demonstrations associated with the Tactical and MAE UAVs. The intent is to not only reduce risk through test and demonstration of prototypes, but also to help set the stage for a successful Operational Test and Evaluation (OT&E) by measuring critical technical parameters during EOAs and having the operations witnessed by the independent test agencies. The DT&E-2 will use the early production versions of the TCS built during the LRIP phase. This is also called the Block 0 version of the TCS. However, the LRIP version is expected to be very similar, if not identical, to the prototype. It will use the same military standard workstations as in the prototype. It will also employ the software developed in Phase I. OT&E will be conducted on Block 0 TCS. Additional capabilities will be added incrementally to production versions, called Block 1, 2, and 3, as detailed in the TCS Program Management Plan. These versions will undergo Future OT&E (FOT&E).

Column 2 of the table lists the events during which the parameters will be demonstrated. The threshold and objective values are shown in the next column in

Tables 1-3A and 1-3B, respectively. A number of quantitative measures are determined by the payload and AV characteristics and capabilities. (The values provided in the tables have been obtained from TUAV and MAE specification documents; they must be verified against the latest actual data for those systems.) TCS will be capable of at least replicating the UAV system performance; TCS will not enhance system performance.

Location and schedule for the test events are shown in the following two columns. The table also lists the TCS acquisition or operational test phase before which each critical parameter must be demonstrated. The engineering build (EB) version, which denotes a specific hardware and software configuration, is shown in the last column.

Table 1-3A. Critical Technical Parameters (Threshold).

Critical Technical Parameter	Total Events	Technical Thresholds for Each Test Event	Location	Schedule	Decision Supported	EB
Collect and process payload information from TUAV, MAE (Level 2)	EOA ---------- DT&E-1A DT&E-1B	See Table 1-4	TF XXI ---------- El Mirage,CA FleetEx	3/97 ---------- TBD 11/97	LRIP ---------- LRIP	1 --------- 1 1
Control of the TUAV and MAE payloads (Level 3) a. Control own UAVs payload b. Control payload on a UAV that is being controlled by another TCS	DT&E-1D ---------- DT&E-2A ---------- DT&E-2B ---------- DT&E-2C	a. See Table 1-5 b. Repeat “a” for the detached payload control	TBD ---------- Contractor ---------- Land ---------- Land+Sea	4/98 ---------- TBD ---------- TBD ---------- TBD	LRIP ---------- MS III	3 --------- 3
Flight Control of the TUAV (Level 4) a. Flight Control of TUAV over entire flight envelope b. TUAV hand-off to/from another TCS	DT&E-1E ---------- DT&E-2A ---------- DT&E-2B ---------- DT&E-2C	a. See Table 1-6 b1. Pass control of TUAV to another TCS b2. Receive control of TUAV from another TCS	TBD ---------- Contractor ---------- Land ---------- Land+Sea	8/98 ---------- TBD ---------- TBD ---------- TBD	LRIP ---------- MS III	4 --------- 5
Flight Control of the MAE UAV (Level 4) a. Flight Control of MAE UAV over entire flight envelope b. MAE UAV hand-off to/from another TCS	DT&E-1E ---------- DT&E-2A ---------- DT&E-2B ---------- DT&E-2C	a. See Table 1-7 b1. Pass control of TUAV to another TCS b2. Receive control of TUAV from another TCS	TBD ---------- Contractor ---------- Land ---------- Land+Sea	8/98 ---------- TBD ---------- TBD ---------- TBD	LRIP ---------- MS III	4 --------- 5
Flight Control of the TUAV (Level 5) a. Launch b. Recovery	DT&E-2B ---------- DT&E-2C	See Table 1-8	Land ---------- Land+Sea	TBD ---------- TBD	MS III	5
Flight Control of the MAE UAV (Level 5) a. Launch b. Recovery	DT&E-1F ---------- DT&E-2C	See Table 1-9	Land ---------- Land+Sea	1/99 ---------- TBD	MS III	5

Table 1-3A. Critical Technical Parameters (Threshold). (Cont.)

Critical Technical Parameter	Total Events	Technical Thresholds for Each Test Event	Location	Schedule	Decision Supported	Eng. Build
Simultaneous Flight and Payload Control of at least two AVs, BLOS, using one TCS (Levels 2 to 5)	DT&E-1E DT&E-2B ---------- DT&E-2C	See Table 1-10	TBD Land ---------- Land+Sea	8/98 TBD ---------- TBD	MS III	4 5
Connectivity to the C4I systems and other TCSs (Level 1) a. Communicate Payload Information and Status	EOA-1A, 1B DT&E-1A to 2C (Note 1)	a. Transmit/Receive EO/IR imagery, freeze frame, digital SAR frames, payload status data, and target geolocation data to/from those of the following C4I systems that can accept it/retransmit it: See Table 1-11	Various	3/97 - 6/99	LRIP and MS III	1 to 5
Communicate mission tasking, conduct mission planning, and execute the mission a. Import Map Information b. Import Mission Plans c. Provide Flight Planning Tools d. Program UAVs with Mission Planning Data prior to launch e. Modify & Upload Mission Plan to UAVs in-flight f. Transmit UAV data g. Provide appropriate operator displays h. Switch antennas	DT&E-1B to 2C	a1. National Imagery & Mapping Agency (NIMA) Digital Terrain Elevation Data (DTED), Digital Feature Analysis Data (DFAD), and Arc Digitized Raster Graphic (ADRG) b1. Download Mission Plans from Tactical Aircraft Mission Planning System (TAMPS) b2. Download Mission Plans from Air Force Mission Support System (AFMSS) b3. Download Mission Plans from Army Mission Planning System (AMPS) b4. Download/Export Mission Plans from/to other TCSs c1. Weight & Balance take-off data calculation c2. Fuel calculation c3. Terrain avoidance warning and min. reception altitude calculations for LOS flights c4. Point-and-click route and sensor planning d. Upload Mission Planning Data to UAVs on the ground e1. Modify stored mission plan e2. Upload new plan and sensor retasking to UAVs in-flight f. Transmit UAV position, velocity, and status		11/97 - TBD	LRIP and MS III	1 to 5

Table 1-3A. Critical Technical Parameters (Threshold). (Cont.)

Critical Technical Parameter	Total Events	Technical Objectives for Each Test Event	Location	Schedule	Decision Support-ed	EB
		g1. Display UAV location and payload search footprint g2. Display UAV status and cautions/warnings h. Enable antenna switching when the UAV is masked by obstructions				
Note: TCS connectivity to C4I systems will be developed over several years spanning the three program phases. These interfaces will be tested incrementally in all of the demos and Advanced Warfighting Exercises (AWEs) as they come on-line and as determined by the availability of those C4I systems in the exercises.						

Table 1-3B. Critical Technical Parameters (Objective).

Critical Technical Parameter	Total Events	Technical Objectives for Each Test Event	Location	Schedule	Decision Supported	EB
Support collection of payload information from HAE UAVs (Level 2) a. Range for LOS receipt of EO/IR b. Quality of EO/IR/SAR Imagery c. Processing of EO/IR/SAR Imagery	TBD	a1: HAE: 1000 km b1: EO/IR Quality: Analog Test Patterns b2: SAR Quality: Digital Test Pattern c1. Capture Freeze Frame c2. Compute Target Coordinates	TBD	TBD	None	TBD
Control of the TUAV and MAE payloads (Level 3)	TBD	Interoperable across multiple platforms/payloads simultaneously	TBD	TBD	None	TBD
Flight Control of the TUAV and MAE (Level 4)	TBD	Interoperable across multiple platforms/payloads simultaneously	TBD	TBD	None	TBD
Flight Control of the TUAV and MAE (Level 5)	TBD	a. Automated Launch (CARS) b. Automated Recovery (CARS)	TBD	TBD	None	TBD
Receive mission tasking, conduct mission planning, and execute the mission a. Import Map Information b. Export Mission Plans c. Provide Flight Planning Tools	TBD	a. Vector Format and Compressed ADRG (CADRG) maps b1. Export Mission Plans to TAMPS b2. Export Mission Plans to AFMSS b3. Export Mission Plans to AMPS c. Payload search area info: Visual acuity range, diurnal transition period, lunar & solar terrain shadowing	TBD	TBD	None	TBD
Note: EB denotes the Engineering Build Configuration						

Table 1-4. Reception/Processing of Payload Data.

Parameter	Technical Threshold	Remarks
Max. Range for collection of TUAV payload data	108 nmi (LOS C-Band Antenna)	Outrider Spec Requires 200 km
Max. Range for collection of MAE UAV payload data	100 nmi (LOS C-Band Antenna) 500 nmi (Ku-Band SATCOM Antenna)	
EO and IR Imagery	Receive & Display RS-170 Analog Video from Daylight Television (DLTV) Zoom Lens & Spotter Lens and IR Camera	TCS should not degrade image quality
SAR Imagery	Receive and Display Digital Data in Strip Map with Global Positioning System (GPS) Time and Geographical Reference Data	TCS should not degrade image quality
Image Processing	Capture, Annotate, Store, Retrieve & Display EO/IR Freeze Frame in National Imagery Transmission Format (NITF) 2.0 Format	
Compute Target Coordinates	100-m Circular Error Probable (CEP) for EO/IR; 23-28m for SAR (depends on platform depression angle)	TCS should not degrade target accuracy, given AV nav inputs and payload position variables

Table 1-5. Payload Controls.

Parameter	Technical Threshold	Remarks
Max. Range for control of MAE UAV payload	100 nmi (LOS C-Band Antenna) 500 nmi (Ku-Band SATCOM Antenna)	
Versatron Skyball Controls (Predator EO/IR Payload)	1. Modes of Operation Payload Power - On/Off Sensor/Camera Pointing in Az & El Position Mode/Rate Mode Vertical Mode - Engaged/Disengaged 2. IR Sensor Control Sensor - Engaged/Disengaged Lens Selection - 280 mm, 70 mm, 19 mm 2X Extender lens - Engaged/Disengaged Sensor Sensitivity - Manual/Automatic IR Calibration - Adjustable 3. DLTV Camera Control Zoom Lens Camera - Engaged/Disengaged Spotter Lens Camera - Engaged/Disengaged Iris Control - Manual/Automatic Zoom Lens Field of View - Max. through Min.	These modes of operation and controls are obtained from the EO/IR Payload System Specifications document prepared by General Atomics-AS.
Versatron Skyball Status	Receive & Display Payload Reference Data Gimbal Az & El Pointing Angle Other (TBD)	
SAR Payload Controls (Predator)	1. Modes of Operation Strip Map Mode 1 Strip Map Mode 2 2. Squint Angle: 45˚ to 125˚ 3. Depression Angle: 30˚ to 60˚ 4. Range Gate: 4 km to 11.2 km	These modes of operation and controls are obtained from the SAR Performance Specifications document.
SAR Payload Status (Predator)	Receive & Display Payload Status Normal Status Information Diagnostic Results (Continuous & Operator Initiated Built-In-Tests)	
Max Range for control of TUAV payload	108 nmi (LOS C-Band Antenna)	200 km

Table 1-5. Payload Controls. (Cont.)

Parameter	Technical Threshold	Remarks
Plug-in Optronic Payload (POP) Controls (Outrider EO/IR payload)	I Operating Mode A. Off B. Standby C. Stow D. Point with respect to body E. Inertial point track F. Nonuniformity correction II. IR Sensor Control A. Focus (adjustable) B. Contrast (adjustable) C. Brightness (adjustable) D. Field of view (wide or narrow) E. Polarity (black hot or white hot) F. Gain and level control (manual, autogain, automatic) III. DLTV Camera Control A. Focus (adjustable) B. Field of view (adjustable) C. Iris control (manual or automatic) IV. Video Source Selection (IR or TV)	
Plug-in Optronic Payload (POP) Status(Outrider EO/IR payload)	Receive and display payload status. I. Operating Mode (see POP Controls above) II. Turret Mode A. Initialization B. Inertial pointing C. Heading hold D. Stow E. Auto scan F. Auto scan configuration G. Cage H. Cage configuration III. Servo Status IV. Turret Status	

Table 1-5. Payload Controls. (Cont.)

Parameter	Technical Threshold	Remarks
Plug-in Optronic Payload (POP) Status(Outrider EO/IR payload) (Cont.)	V. Video Source (TV or IR) VI. TV Field of View (see POP Controls above) VII. IR Field of View (see POP Controls above) VIII. IR Polarity (see POP Controls above) IX. Video Source Command (see POP Controls above) X. TV Field of View Command (see POP Controls above) XI. Focus Command (see POP Controls above) XII. IR Contrast Command (see POP Controls above) XIII. IR Brightness Command (see POP Controls above) XIV. IR Gain and Level Command (see POP Controls above) XV. IR Field of View Command (see POP Controls above) XVI. IR Polarity Command (see POP Controls above) XVII. TV Iris Command (see POP Controls above) XVIII. Pointing Direction (heading, pitch and roll)	
Outrider Payload Data Processor Status	I. Payload Azimuth and Elevation Mounting Offsets (defaults) II. Navigation Data Status (good or bad) III. Command Status (good or bad) IV. POP Response Status (good or bad)	
EO/IR Payload Controls (Outrider)		

Table 1-6. TUAV (Outrider) Flight Controls.

Parameter	Technical Threshold	Remarks
Three-axis 6-degree-of-freedom (DOF) Flight Control of Outrider	Provide Flight Control over following Speed/Altitude Envelope. 〈 Altitude: 0 - 20,000' Mean Sea Level (MSL) (Operational Ceiling) 〈 Speed: 35 to 100 kn Using Following Autopilot Modes of Operation 〈 Startup 〈 Take-off 〈 Climb 〈 Drop 〈 Dash 〈 Standard (operational mission) 〈 Lost Link Receive & Display Flight Control System Parameters	These values reflect the proposed flight envelope and functionality of the Tactical UAV (Outrider)
Monitor Flight Data	Receive & Display Following Flight Data 〈 Position (latitude, longitude and altitude) 〈 Airspeed 〈 Pressure Altitude 〈 Avionics status 〈 Data link status 〈 Air vehicle status 〈 Autopilot operating mode	
Monitor Navigation Data	Receive and Display Pertinent Navigation Data Position C-Band Antenna using Navigation Data	
Monitor Engine Data	〈 rpm 〈 Engine data validity status 〈 Engine temperatures	

Table 1-6. TUAV (Outrider) Flight Controls. (Cont.)

Parameter	Technical Threshold	Remarks
Fuel System	Receive & Display On-Board Fuel Level and Fuel Pressure	
Avionics Cooling Status	Receive & Display Status	
Landing Gear System	Not applicable to Outrider	
Lighting System	Activate/Deactivate 〈 Navigation lights 〈 Strobes Receive & Display Status	
Transponder	Activate and Deactivate the Transponder Receive and Display Transponder Status	
Video Data System	Please see Table 1-5 for Outrider Payload Controls	
Flight Termination System	Terminate Flight in an Emergency or when commanded Receive and Display Flight Termination Status	

Table 1-7. MAE UAV (Predator) Flight Controls.

Parameter	Technical Threshold	Remarks
Three-axis 6-DOF Flight Control of Predator	Provide Flight Control over following Speed/Altitude Envelope... Altitude: 0 - 25,000' MSL (Operational Ceiling) Speed: Min Controllable to 100 kn ...Using Following Autopilot Modes of Operation: Remote Control Mode Roll, Pitch, Yaw Autopilot Mode Hold Mode Preprogrammed Mode (Operational Mission) Preprogrammed Mode (Emergency Mission for Loss of Link Scenario) Receive & Display Flight Control System Parameters	These values reflect the established flight envelope and functionality of the MAE UAV and are obtained from the AV System Specification document prepared by General Atomics.
Monitor Flight Data	Receive & Display Following Flight Data Airspeed Altitude Rate of Climb/Descent	

Table 1-7. MAE UAV (Predator) Flight Controls. (Cont.)

Parameter	Technical Threshold	Remarks
Monitor Flight Data (Cont.)	Outside Air Temperature Angle of Attack Pitch & Roll Angles Magnetic Heading Pitch, Roll, and Yaw Rates	
Monitor Nav Data	Receive and Display Pertinent Nav Data Position C-Band Antenna using Nav Data	
Engine & Propeller Control System	Provide Control of Throttle Servo Engine Kill Switch Relay Ignition Test Relays Propeller Pitch Servo Blade Angle: 0˚ to 90˚ Receive & Display Engine Sensor Values Exhaust Gas Temperature (EGT) Cylinder Head Temperature (CHT) Engine Coolant Temperature Manifold Charge Temperature (MCT) Manifold Air Pressure (MAP) Oil Level Throttle Position	
Fuel System	Receive & Display On-Board Fuel Level	
Fuselage Bay Cooling System	Control Cooling System Receive & Display Status	
Landing Gear System	Retract/Extend Landing Gear Receive & Display Status	
Lighting System	Activate Strobe Lights (Left & Right) Red Rotator Beacon Port Navigation Light Starboard Navigation Light Receive & Display Configuration	

Table 1-7. MAE UAV (Predator) Flight Controls. (Cont.)

Parameter	Technical Threshold	Remarks
Transponder	Provide Following Transponder Controls Real-Time Controls Turn Unit On/Off Squawk a Specified Code Preprogrammed Control Turn Unit On/Off at a Specified Waypoint Squawk Specified Code at Spec. Waypoint	
Video Data System	Select Video Data from... Nose Camera EO/IR Payload (3 Sources) Airborne VCR C-Band Air Data Terminal (ADT) Receiver #1 C-Band ADT Receiver #2 ...and Send the Selected Video to Airborne VCR C-Band ADT (2 Channels) Ku-Band ADT Start/Stop Recording In-Flight Playback Video During Flight	

Table 1-8. TUAV (Outrider) Launch and Recovery.

Parameter	Technical Threshold	Remarks
Launch & Recover Outrider	a. Ground Maneuvering Controlled by Outrider autopilot. b1. Automatic Take-off in VFR & IFR Conditions c1. Automatic Landing in VFR & IFR Conditions	

Table 1-9. MAE UAV (Predator) Launch and Recovery.

Parameter	Technical Threshold	Remarks
Launch & Recover Predator	a. Ground Maneuvering Nose Wheel Steering Differential Braking Receive & Display Landing Gear Status b1. Take-off in VFR & IFR Conditions using Autopilot Stability Augmentation Mode c1. Land in VFR & IFR Conditions using Autopilot Stability Augmentation Mode	

Table 1-10. Simultaneous Flight and Payload Control of 2 AVs.

Parameter	Technical Threshold	Remarks
Simultaneous Flight & Payload Control of at least two air vehicles beyond LOS using one TCS (Levels 2 to 5)	Control 2 UAVs and their Payloads in the Relief-on-Station Scenario	*See the white paper "Simultaneous Control of Multiple UAVs and Payloads"*

Table 1-11. C4I Systems.

C4I System	TCS-C4I Integration Time-Frame	Remarks
1. AFATDS, 2. ADOCS, 3. ASAS, 4. JSTARS-CGS (C), 5. CCTV, 6. JSIPS-Navy, 7. JMCIS (C)	FY97	*Integration with all C4I systems except connectivity only for JSTARS CGS and JMCIS*
8. IAS, 9. JDISS, 10. TROJAN SPIRIT II 11. ETRAC, 4. JSTARS-CGS (I), 12. TEG	FY98	*Integrate with JSTARS-CGS*
13. JSIPS-AF, 14. GCS/ACS IPF, 15. MIES, 16. ATWCS (C), 17. CARS	FY99	*Connectivity only to ATWCS*
18. ATHS, 16. ATWCS (I), 7. JMCIS (I), 19. TBMCS, 20. TAMPS, 21. AFMSS, 22. AMPS, 23. COMPASS 24. TES	FY00	*Integrate with ATWCS and JMCIS* *TES will be integrated when available (beyond FY00)*
25. Other TCSs	FY98	

2. PART II--INTEGRATED TEST PROGRAM SUMMARY

2.1 Integrated Test Program Schedule

The Integrated Test Program Schedule is illustrated in Figure 2-1.

The planned cumulative funding expenditures by appropriation are shown in Figure 2-2.

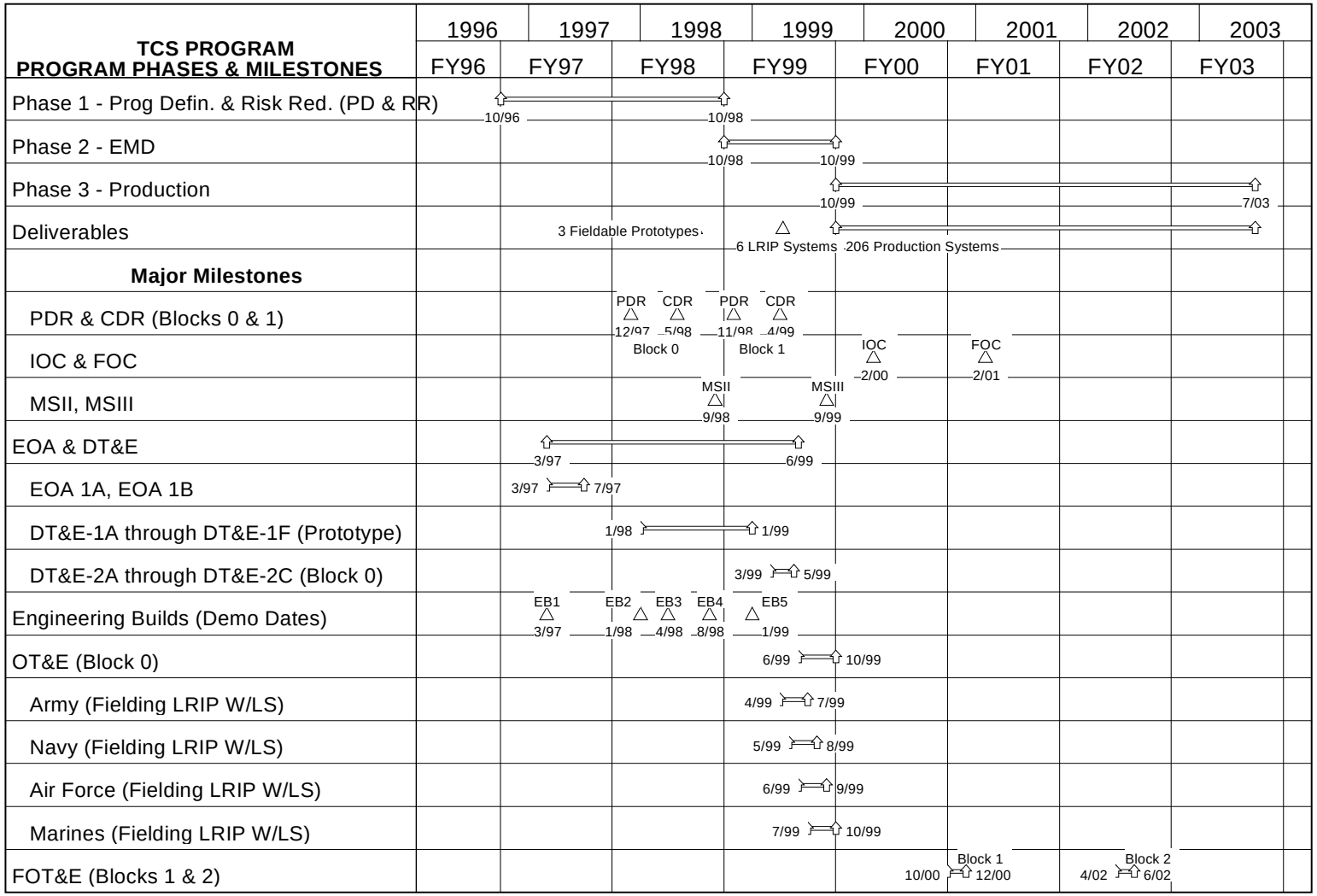

Figure 2-1. Integrated Test Program Schedule.

Funding ($M)	FY 97	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03
MRTFB							
RDT&E (Budget)	$18.8	$34.5	$27.0	$26.8	$17.7	$10.7	$10.7
Production							
Total							

Figure 2-2. Planned Funding Expenditures.

2.2 Management

The Defense Airborne Reconnaissance Office (DARO) provides funding and oversight of the TCS program at the Offices of the Secretary of Defense (OSD) level. The Assistant Secretary of the Navy is designated Milestone Decision Authority (MDA). The TCS was designated an ACAT II Program by the MDA on 12 September 1997. The responsibilities of other organizations involved in the test and evaluation of the TCS are described in the following subsections.

2.2.1 Navy

(1) The Deputy Chief of Naval Operations and the Director, Navy Test and Evaluation and Technology Requirements (N091) as the program sponsor and test and evaluation coordinator, respectively, are responsible for the coordination of the developmental and operational test programs.

(2) The Program Executive Officer, Cruise Missile and Unmanned Aerial Vehicles (PEO(CU)), exercises overall management responsibility, direction, and control of TCS testing including the scope, duration, and completeness of developmental testing and the expenditure of test funds. The PEO accomplishes test and evaluation responsibilities for the TCS through the organizations listed below.

(3) Joint Project Office, TCS Project Management Office (JPO TCS PM) is responsible for the management of TCS test and evaluation, including development of the Test and Evaluation Master Plan (TEMP).

(4) Naval Air Systems Command provides technical and engineering support to the TCS project manager and tasks the various Naval Air Warfare Centers (NAWCs) to provide technical support on specific aspects of the test and evaluation effort as required. These tasks include reviewing the Contract Data Requirements Lists (CDRLs), providing Government-Furnished Equipment (GFE), and conducting test activities.

(5) Program Manager for Training Systems (PMA-205) provides training systems support to the TCS project manager.

(6) Naval Surface Warfare Center, Dahlgren Division (NSWCDD) is technical lead for system integration. NSWCDD provides concept and design

formulation, system and software engineering, Test and Evaluation (T&E) support, and ship integration of TCS-related equipment and services. NSWCDD is responsible for Technical Evaluation (TECHEVAL).

(7) Naval Sea Systems Command (NAVSEASYSCOM) provides technical and ship integration support to the TCS project manager.

(8) Commander Operational Test and Evaluation Force has overall responsibility for multiservice Operational Test (OT), and provides the input for the TCS TEMP, PART IV-OPERATIONAL TEST AND EVALUATION OUTLINE, and PART V - RESOURCES.

2.2.2 Marine Corps

TBD

2.2.3 Army

The U.S. Army Test & Evaluation Command (USATECOM) is the Developmental Tester and is responsible for managing and conducting the developmental testing, preparing the hardware and software safety releases, and the safety confirmation for materiel release. USATECOM also provides inputs to the TEMP, participates as a voting member of the T&E Integrated Product Team (IPT), provides test resources for and coordinates all Government-performed developmental testing of the system, witnesses contractor testing, and reviews all contractor and Government test plans and reports for their completeness in addressing the technical issues presented by the evaluator.

The U.S. Army Operational Test and Evaluation Command (OPTEC), through the OPTEC System Team, is responsible for resource, planning, and execution of Army developmental and operational test and independent evaluation and continuous evaluation (CE). Responsibilities include development and execution of test and evaluation documents including: System Evaluation Plan, Outline Test Plan, Event Design Plan, Detailed Test Plan, Test Data Report, Test Report, System Analysis Report, and System Evaluation Report. OPTEC will also participate in contractor and/or government testing conducted during engineering development. Participation will include monitoring test activities as well as participating in testing where applicable to ensure that user needs are addressed during the development of the equipment. OPTEC participates as a voting member in RAM scoring, and chairs scoring conferences for the operational test.

2.2.4 Air Force

TBD

2.2.5 Joint

United States Atlantic Command (USACOM): USACOM has accepted a role in TCS development as the user representative. T&E responsibilities include oversight

and direction for Warfighter involvement with the program, planning and directing operational demonstrations and exercises, coordinating with the Services to identify and provide manning resources for fielded systems and in conjunction with the Services and other CINCs, and evaluate and report on the TCS military utility at the end of the demonstration phase.

2.2.6 Other

(1) **Integrated Product Teams:** IPTs (industry and government) have been established to address TCS development and fielding requirements, including system testing and demonstrations.

(2) **C4I Program Offices and Contractors:** Provide support for development of C4I interface requirements, integration of TCS and C4I systems, and test and demonstrations.

(3) **Alliant TechSystems:** Alliant TechSystems is under sole-source contract to the JPO to provide Outrider system support to TCS development and demonstrations, including support to TCS system testing and simulation, integration, installation, and flight demonstrations using the Outrider UAV.

(4) **General Atomics (GA):** GA is under sole-source contract to the JPO to provide Predator system support to TCS development and demonstrations, including support to TCS system testing and simulation, integration, installation, and flight demonstrations using the Predator UAV.

3. PART III--DEVELOPMENTAL, TEST, AND EVALUATION OUTLINE

3.1 Developmental Test and Evaluation Overview

DT&E is conducted to demonstrate that the engineering design and development process is complete, design risks have been minimized, and to ensure that the TCS is compatible with designated UAV platforms, payloads, and C4I system interfaces. The TCS PM, hereafter referred to as the Developing Agency (DA), has overall responsibility for conducting DT&E. Developmental testing of TCS encompasses two phases: DT&E Phase 1 testing conducted by the DA using prototype hardware during the risk reduction phase, followed by DT&E Phase 2 testing using the LRIP hardware developed during the EM&D phase. Early testing of prototypes in Phase 1, the Program Definition and Risk Reduction phase, includes EOA and DT&E demonstrations that are intended to assist in identifying risks. EOA testing used simulations to proof the system design concepts and reduce program risks during DT&E testing. Phase 2 DT&E testing will include the TCS contractor and Government supporting agencies. Throughout DT&E, the DA and the (Operational Test Agency - Commander, Operational Test and Evaluation (Navy) (OTA - COMOPTEVFOR)) will determine the appropriate tests to minimize duplication, risk, cost, and to identify operational issues for resolution as early in the program as possible.

DT&E Phase 1 development testing of the TCS prototype includes a series of EOA tests and early demonstrations and participation in exercises to assess TCS capabilities. These exercises are intended to secure user feedback, identify significant operational issues early in the program, and minimize program risk.

DT&E Phase 2 testing, conducted by the TCS contractor and the OTA, also referred to as combined T&E, will use LRIP-configured TCS equipment with operational software developed during the risk reduction phase. The LRIP configuration of TCS is also known as Block 0. (See Section 1.5 for a discussion of the incremental build of TCS capabilities.) To ensure the integrity of system interfaces and the overall design, DT&E Phase 2 testing will consist of contractor-conducted first-article-test (FAT) followed by end-to-end system testing including all C4I interfaces. The purpose of these compatibility tests is to detect interface design anomalies prior to acceptance and deployment with operational units during OT&E.

All DT&E testing, with the exception of FAT testing, will be conducted at Government facilities, depending on which is determined to be most cost-effective and suitable based on the test schedule. The TCS contractor will conduct all integration and ground testing as part of the TCS qualification effort at the contractor's facility. These tests will use contractor-furnished equipment, except for items that can be provided as GFE.

3.1.1 Technology

The following TCS technical areas represent challenges:

(1) Integration of multiple UAV platforms with TCS: While each UAV platform has a different mission and sensor group, the concurrent

development of UAV platforms with TCS development represents a challenge. These challenges are accommodated by the series of demonstrations that are intended to identify user and integration issues early in the TCS risk reduction program. In addition, the development and implementation of a common data link will mitigate these risks.

(2) The requirement for the operator to perform simultaneous control of multiple UAVs and payloads represents a challenge. Operating multiple UAVs in relief-on-station mode may alleviate the operator workload.

(3) The requirement for the TCS to interface with 24 C4I systems and mission planning systems represents a challenge because these systems themselves are undergoing upgrades and modifications. They represent moving targets. Complying with standards such as DII COE and interfacing with fielded (rather than developmental) versions of these systems will help meet this challenge.

3.1.2 Hardware and Software Stability

The TCS system consists primarily of commercial-off-the-shelf hardware combined with TCS unique software. In addition, proprietary components control UAV data link communications and antenna positioning. The software supports UAV vehicle and payload communications and control (including AV launch and recovery), formatting and displaying data to the operator, and dissemination of imagery and text data to C4I systems and other TCS installations.

An incremental implementation of TCS functionality will result in five releases of hardware and software during Phase I and early Phase II. These releases are called Engineering Builds (EB) - EB1 to EB5. The incremental capabilities of the builds roughly correspond to the levels of UAV interaction as follows:

EB1: Passive Receipt of Data from UAV

EB2: UAV Waypoint Control

EB3 UAV Payload Control

EB4: Flight Control of Single UAV and Multiple UAVs

EB5: Manual Launch & Recovery

To manage programmatic risk, a series of demonstrations will be conducted as part of warfighting exercises. These warfighting exercises consist of an incremental buildup of test assets/capabilities focusing on testing of more complex capabilities from Level 2 to Level 5 using EB1 to EB5 hardware and software. This approach will lead to a fully integrated prototype system prior to initiating the EM&D Phase 2 of the program. These early demonstrations conducted during the risk reduction phase of the program with the OTA will enable the early identification of the technical risks associated with TCS design and operation.

3.2 DT&E to Date

Table 3-1 illustrates the full range of Phase 1 and 2 DT&E testing (from passive listening to simultaneous control of multiple AVs) planned for the TCS program. In Section 5, Table 5-2 illustrates the projected schedule for testing all C4I systems. To date, EOA-1A, EOA-1B, DT&E-1A, and DT&E-1B have been completed. The major TCS hardware components or subsystems tested to date are: (1) TCS core computer system and (2) the Predator AV RTP. The following C4I system communications links were exercised: Army Defense Operations Coordination System (ADOCS) and All-Source Analysis System (ASAS).

Table 3-1. Summary of EOA/DT&E Phases, Test Objectives, and Test Events.

EOA/DT Phase	Summary of Test Objectives & Major Test Events	Demo Date (CY)	Demo	H/W	EB
EOA-1A	**Passive Receipt/Predator Surrogate/Land (Level 2)**	3/97	TF XXI	Prot.	1
	a. EO/IR Imagery to TCS				
	b. Text to ASAS & ADOCS				
EOA-1B	**Connectivity to C4I Systems**	7/97	JWID97	Prot.	1
	a. NWCS-P, AFATDS, NIMA Server				
DT&E-1A	**Passive Listen/Predator/Land (Level 2)**	1/98	El Mirage	Prot.	1
	a. SAR Imagery to TCS Using Ku-Band Antenna BLOS				
DT&E-1B	**Passive Listen/Predator/Sea/Tarawa (LHA1)**	11/97	FleetEx	Prot.	1
	a. EO/IR LOS Imagery to TCS				
	b. C4I Interfaces - Closed-Circuit TV (CCTV), Joint Maritime Command Information System (JMCIS)				
DT&E-1C	**Connectivity to C4I Systems**	11/97	DIV XXI	Prot.	1
	a. ASAS				
DT&E-1D	**Waypoint & Payload Cntl, Predator/Land (4/98) and Outrider/Land (6/98) (Level 4 - Partial)**	4/98 6/98	El Mirage, CA Hondo, TX	Prot.	3
	a. EO/IR/SAR Imagery to TCS				
	b. Import Operational Area Map(s) (NIMA formats)				
	c. Display AV Location Overlaid on Operational Map				
	d. TCS Waypoint Control & Mission Plan/Reroute Demo				
	e. Receive SAR Imagery Via BLOS Data Link				
	f. SAR Imagery Video to C4I - TBD				
	g. Demo Antenna Switch (LOS to BLOS)				
	h. AV Control and Payload Monitor Using SBPCS				

Table 3-1. Summary of EOA/DT&E Phases, Test Objectives, and Test Events. (Cont.)

EOA/DT Phase	Summary of Test Objectives & Major Test Events	Demo Date (CY)	Demo	H/W	EB
	i. C4I interfaces - JMCIS/Joint Deployable Intelligence Support System (JDISS), Joint Service Imagery Processing System (JSIPS)-N, CCTV				
DT&E-1E	**One TCS- Control Two AVs (Predator)/Land (Level 4)**	8/98	TBD	Prot.	4
	a. Simultaneous Control of 2 AVs				
	b. C4I - IAS, TROJAN SPIRIT II, ETRAC, Joint Standoff Target Attack Radar System (JSTARS)-CGS, Tactical Exploitation Group (TEG)				
DT&E-1F	**One TCS & AV (Predator)/Land (Level 5)**	1/99	TBD	Prot.	5
	a. Manual Launch & Recovery				
DT&E-2A	**Two TCSs & Two AVs (Predator & Outrider)/Land (Level 5)**	* TBD	FAT	LRIP	5
	a. TCS System Integration (FAT at Integrator's Facility)				
DT&E-2B	**Two TCSs & Two AVs (Predator & Outrider)/Land (Level 5)**	* TBD	TBD	LRIP	5
	a. Control 2 AV & Payload				
	b. Manual Launch & Recovery				
	c. Xchange TCS Payload Ctrl & Data Via LAN				
	d. TCS AV Handoff				
	e. NITF 2.0 Imagery and Text Message to Single-Channel Ground & Airborne Radio Service (SINCGARS)				
	f. NTSC, 422, Ethernet to JSTARS-CGS				
	g. Import AFMSS Mission Plan(s), Modify In-Flight Mission				
DT&E-2C	**Two TCSs & Two AVs (Predator & Outrider)/Land & Sea (Level 5)**	* TBD	TBD	LRIP	5
	a. Repeat DT&E-2B, a through d				
	b. Import TAMPS Mission Plan(S), Modify In-Flight Mission				
	c. Demo Reliability and Portability				

Notes: (1) DT&E tests conducted in accordance with formal test plans and procedures. All EOA testing performed without formal test plans and procedures. (2) * DT Phase 2 tests conducted from 3/99 through 6/99. (3) EB denotes the EB configuration.

3.2.1 EOA-1A Passive Receipt/Predator Surrogate/Land (Level 2)

(1) **Configuration Description:** EOA-1A testing included passive UAV listening tests conducted during TF XXI by NSWCDD and the Joint Technology Center/System Integration Laboratory (JTC/SIL) using EB1 of TCS. The APL LOS data links were used to track the AV and transfer and display imagery on the TCS monitors. This test evaluated TCS Local Area Network (LAN) connectivity and video interfaces to C4I systems.

(2) **Test Objectives:** The objectives of this test were to: (a) demonstrate TCS C4I interfaces in the field and demo TCS portability, and (b) disseminate imagery data to ADOCS and ASAS C4I systems.

(3) **Test Events, Scope of Testing, and Basic Scenarios:** This TCS Concept of Operations (CONOPS) interface demonstration used UAV imagery received from the Predator in an operational environment.

(4) **Limitations:** No known test resource limitations exist.

3.2.2 EOA-1B Connectivity to C4I Systems

(1) **Configuration Description:** EOA-1B testing was conducted during JWID97. It used the Multiple UAV Simulation Environment (MUSE) as a simulator (input device) for the TCS. Testing included exercising TCS C4I interface drivers.

(2) **Test Objectives:** The objective of this test was to demonstrate TCS C4I interfaces in the field using simulated imagery and text inputs from the MUSE. TCS interfaced with the following C4I systems: NWCS-P (Naval Surface Fire Support (NSFS) Weapon Control System - Prototype), Advanced Field Artillery Tactical Data System (AFATDS), and the NIMA image product archive.

(3) **Test Events, Scope of Testing, and Basic Scenarios:** EOA-1B was conducted by the DA with technical support from NSWCDD and JTC/SIL.

(4) **Limitations:** No known test resource limitations exist.

3.3 Future DT&E

DT&E-1C through DT&E-1F will be conducted using TCS prototypes during the Program Definition and Risk Reduction Phase, or Phase 1, of the TCS program. Complete system integration and final DT&E integration testing will be performed on LRIP units during DT&E Phase 2 or the EM&D phase of the program. The following sections summarize the DT&E test configurations, objectives, and DT&E test events.

3.3.1 DT&E-1A Passive Listen/Predator/Land (Level 2)

(1) **Configuration Description:** DT&E-1A will be conducted during El Mirage exercises using TCS EB1 located within the Mobile Test Bed (MTB) shelter to receive Predator imagery and data. TCS will acquire SAR imagery data and transmit these imagery data to C4I systems TBD.

(2) **Test Objectives:** The objective of the land-based test are: (a) receive SAR imagery, and (b) disseminate imagery and text data to TBD C4I systems.

(3) **Test Events, Scope of Testing, and Basic Scenarios:** DT&E-1A will be conducted by the DA with technical support from NSWCDD and JTC/SIL. The scope of this testing will demonstrate the ability of TCS to receive SAR imagery and forward it to TBD C4I systems. It is anticipated that 24 hours will be required to perform this test.

(4) **Limitations***:* No known test resource limitations exist.

3.3.2 DT&E-1B Passive Listen/Predator/Sea/Tarawa (LHA 1)

(1) **Configuration Description:** DT&E-1B will be conducted during FLEETEX 98 1-M exercises using TCS EB1 located on the USS Tarawa to receive UAV imagery data. TCS will acquire EO/IR imagery, and transmit this imagery to the ship's JMCIS and CCTV C4I systems. The Ship-Based Predator Control System (SBPCS) and the APL antenna system will be used to control and communicate with the UAV.

(2) **Test Objectives:** The primary objective of this test is to demonstrate Level 2 compliance in a shipboard environment, obtain direct user feedback concerning the CONOPS development, and to gather and refine data associated with shipboard combat systems integration. MUSE will also be used to provide a simulated integrated tactical environment.

(3) **Test Events, Scope of Testing, and Basic Scenarios:** DT&E-1B will be conducted by the DA with technical support from NSWCDD and JTC/SIL. The scope of this testing includes the acquisition of imagery from the GNAT 750 UAV/payload and the Pioneer UAV/payload, processing this imagery, and forwarding the imagery to the C4I systems. A total of five live missions is anticipated, each with a 4- to 6-h duration for a total of 20 to 30 flight hours after handover.

(4) **Limitations:** No known test resource limitations exist.

3.3.3 DT&E-1C Connectivity to C4I Systems

(1) **Configuration Description:** DT&E-1C testing will be conducted using TCS EB1 during Division XXI exercises. The test will consist of generating imagery using the MUSE as a simulator for the TCS. Imagery data will be passed to the ASAS C4I system.

(2) **Test Objectives:** The objective of this test is to demonstrate TCS C4I interfaces in the field using simulated imagery and text inputs from the MUSE.

(3) **Test Events, Scope of Testing, and Basic Scenarios:** DT&E-1C will be conducted by the DA with technical support from NSWCDD and JTC/SIL.

(4) **Limitations:** No known test resource limitations exist.

3.3.4 DT&E-1D Waypoint and Payload Control/Monitor (Predator)/Land (4/98), (Outrider)/Land (6/98) (Level 4).

(1) **Configuration Description:** DT&E-1D will be conducted during two demos with the prototype TCS EB3, one Predator UAV (in April '98 at El Mirage, CA), and one Outrider UAV (in June '98 at Hondo, TX), with their respective payload configurations, including EO/IR and SAR sensors. Major system components include the fieldable TCS prototype, SBPCS, the APL antenna system including LOS and BLOS antenna systems, and

support equipment as required. The primary differences between the DT&E-1D configuration and the production TCS functionality are the use of TCS prototype hardware and that the testing of TCS software will be limited to a single AV at a time (Predator or Outrider).

(2) **Test Objectives:** The objectives of this test are to: (a) demonstrate AV control, waypoint control, and monitoring of one AV and the payload using one TCS system; (b) import NIMA, DTED, DFAD, and ADRG maps and hard copy scanned operational area maps and selectively overlay the AV position onto the operational maps; (c) demonstrate TCS ability to reroute the AV by generating new waypoint(s) via pointing and clicking; (d) receive, process, and transmit a SAR image for display on TCS monitors and transmission to C4I JMCIS/JDISS, JSIPS-N, CCTV; (e) demonstrate switching from LOS to BLOS antenna system and demonstrate AV and payload control using the BLOS antenna.

(3) **Test Events, Scope of Testing, and Basic Scenarios:** DT&E-1D will be conducted by the DA with technical support from NSWCDD and JTC/SIL. The scope of this test is limited to demonstrating flight control of one AV and monitoring the payload. Testing will include the acquisition of EO/IR/SAR imagery and control of AV flight by the TCS system. EO/IR imagery will be processed and disseminated to C4I systems in near real time to evaluate interoperability. There are nine major test events illustrated in Table 3-1 involving representative operational systems. It is anticipated that 100 test hours will be required to perform this testing.

(4) **Limitations:** No known test resource limitations exist.

3.3.5 DT&E-1E One TCS - Control Two AVs (Predator)/Land (Level 4)

(1) **Configuration Description:** DT&E-1E will be conducted by the DA during the TBD exercises with the prototype TCS EB4 and two Predator UAVs configured with EO/IR/SAR payloads. Major system components include the fieldable TCS prototype, the APL antenna system, including the LOS, BLOS, and support equipment as required. The primary differences between the DT&E-1E configuration and the production TCS functionality will be the TCS prototype hardware and the TCS software version.

(2) **Test Objectives:** The objectives of the tests are to repeat the DT&E-1D tests (a through d) in addition to demonstrating simultaneous control of 2 AVs with one TCS system. Payload imagery data will be disseminated to C4I systems IAS, TROJAN SPIRIT II, ETRAC, JSTARS-CGS, and TEG.

(3) **Test Events, Scope of Testing, and Basic Scenarios:** DT&E-1E will be conducted by the DA with technical support from NSWCDD and JTC/SIL. The scope of this sea-based testing includes demonstrating simultaneous control of two AVs. Testing will include the acquisition of EO/IR/SAR imagery and AV control. Imagery data will be processed, annotated with

text, and disseminated to C4I systems TBD. There are five major test events illustrated in Table 3-1 involving TCS interaction with operational systems. The projected test time required to complete DT&E-1E testing is 70 hours.

(4) **Limitations:** Test limitations are to be identified by the Contractors 90 days prior to the beginning of testing.

3.3.6 DT&E-1F One TCS and AV (Predator)/Land (Level 5)

(1) **Configuration Description:** DT&E-1F will be conducted using prototype TCS EB5 by the DA with technical support from NSWCDD and the JTC/SIL. The scope of this testing consists of demonstrating manual launch and recovery procedures with one AV. The projected test time is 16 h over 3 days.

(2) **Test Objectives:** The primary objective of this test is to manually control the launch and recovery of the AV.

(3) **Test Events, Scope of Testing, and Basic Scenarios:** TBD.

(4) **Limitations:** No known test resource limitations exist.

3.3.7 DT&E-2A Two TCSs & Two AVs (Predator & Outrider)/Land (Level 5)

(1) **Configuration Description:** Using the TCS LRIP hardware and operational software (TCS Block 0), DT&E-2A FAT will be conducted by the TCS Integration Contractor with support from the Predator and Outrider Contractors. The Contractors will conduct this testing using the DT&E-2B test plan as a guide.

(2) **Test Objectives:** The primary objective of this land-based test is to ensure that the LRIP TCS hardware and software can be integrated with the Predator and Outrider AV systems.

(3) **Test Events, Scope of Testing, and Basic Scenarios:** The scope of these integration tests will be defined by the Integration Contractor with DA approval. At a minimum, the testing will include static AV launch and recovery demonstrations in addition to testing the AV communications links in preparation for DT&E-2B testing.

(4) **Limitations:** Test limitations are to be identified by the Contractors 90 days prior to the beginning of testing.

3.3.8 DT&E-2B Two TCSs and Two AVs (Predator and Outrider)/Land (Level 5)

(1) **Configuration Description:** DT&E-2B will be conducted during TBD exercises with the LRIP TCS Block 0, one Outrider, and one Predator AV with operational payload configurations, including EO/IR and SAR sensors. Major land-based system components include the LRIP HMMWV TCS, the LOS and BLOS antenna systems, and support equipment as required. Major

sea-based system components include TCS, LOS, and BLOS antenna systems, and support equipment as required. There will be no functional differences between the DT&E-2B configuration and the production TCS.

(2) **Test Objectives:** The objectives of this test are to: (a) demonstrate control and monitoring of the two AVs and payloads using one TCS system, (b) demonstrate launch and recovery of Predator and Outrider AVs, (c) exchange AV status and payload information between two TCSs over the LAN (Ethernet) (d) demonstrate the hand-off or exchange of AVs between two TCSs, (e) demonstrate TCS processing of imagery data overlaid with text and UAV position data and transmit NITF 2.0 formatted imagery and text message to the SINCGARS, (f) transmit SAR image with text to the JSTARS-CGS, and (g) import mission plans from the AFMSS and demonstrate uploading a new UAV mission.

(3) **Test Events, Scope of Testing, and Basic Scenarios:** DT&E-2B will be conducted by the DA with technical support from NSWCDD and JTC/SIL. Testing will include the acquisition and processing of EO/IR/SAR imagery and monitoring AV status from two AVs by two TCS systems. EO/IR/SAR imagery will be processed and disseminated to several C4I systems in near real time to evaluate interoperability. The AFMSS mission planning system will be used to create at least four separate mission plans prior to starting the test. These plans will be loaded into TCS and uploaded to the AV to modify the mission in flight. There are seven major test events illustrated in Table 3-1 involving representative operational systems. It is anticipated 120 test hours will be required to perform this testing.

(4) **Limitations:** No known test resource limitations exist.

3.3.9 DT&E-2C Two TCSs & Two AVs /Predator & Outrider/Land & Sea (Level 5)

(1) **Configuration Description:** DT&E-2C will be conducted during TBD exercises with the LRIP TCS Block 0, one Outrider, and one Predator AVs with operational payload configurations, including EO/IR and SAR sensors. Major land-based system components include the LRIP HMMWV TCS, the LOS and BLOS antenna systems, and support equipment as required. Major sea-based system components include the shipboard TCS, the LOS and BLOS antenna systems, and support equipment as required. There will be no functional differences between the DT&E-2C configuration and the production TCS.

(2) **Test Objectives:** The objectives of this test are: (a) the same as DT&E-2B ((a) through (e)) with the exception that all inter-TCS communications will be accomplished via SATCOM and LAN data communication links, (b) import TAMPS mission plans for the purpose of uploading via telemetry new AV routes to demonstrate dynamic mission retasking and, (c) initiate the demonstration of TCS portability and reliability in preparation for OT&E.

(3) **Test Events, Scope of Testing, and Basic Scenarios:** DT&E-2C will be conducted by the DA with technical support from NSWCDD and JTC/SIL. Testing will include the acquisition and processing of EO/IR/SAR imagery and AV status data from two AVs by two TCS systems. EO/IR/SAR imagery will be processed and disseminated to several C4I systems in near real time to evaluate interoperability. The AFMSS mission planning system will be used to create at least four separate mission plans prior to starting the test. These plans will be loaded into TCS and uploaded via telemetry to the AV to modify the mission in flight. There are eight major test events illustrated in Table 3-1 involving representative operational systems. It is anticipated that 120 test hours will be required to complete the first seven major objectives. The portability and reliability testing will require TBD test hours to complete.

(4) **Limitations:** No known test resource limitations exist.

3.3.10 Suitability

(1) **Configuration Description:** Using the TCS LRIP hardware and software, the suitability tests, demonstrations, and analyses will be conducted by the TCS Integration Contractor with support from the Outrider and Predator Contractors.

(2) **Test Objectives:** The objective of front-end suitability tests, demonstrations and modeling is to identify suitability design improvements relating to safety, reliability, maintainability human factors, interoperability, training, and logistics support.

(3) **Test Events, Scope of Testing, and Basic Scenarios:** The scope of these suitability tests, demonstrations, and analyses will be defined by the TCS Integration Contractor with DA approval. At a minimum, testing shall include a logistics/maintainability demonstration and the validation of technical manuals.

(4) **Limitations:** Test limitations are to be identified by the Integration Contractor 90 days prior to the beginning of testing.

4. PART IV--OPERATIONAL TEST AND EVALUATION

Part IV is the responsibility of the OTA. A list of possible critical operational issues is provided as a starting point.

4.1 Operational Test and Evaluation Overview

4.2 Critical Operational Issues

This section lists the critical operational issues. Critical operational issues are the operational effectiveness and operational suitability issues (not parameters, objectives, or thresholds) that must be examined in OT&E to evaluate/assess the system's capability to perform its mission.

4.2.1 Effectiveness Issues

(1) How well can the TCS collect and process data from the TUAV, MAE, and HAE UAVs? (ORD016, KPP)

(a) Can the TCS receive and transmit secondary imagery and data? (Level 1)

(b) Can the TCS receive imagery and data directly from the TUAV and MAE UAV and process data? (Level 2)

(c) Can the TCS receive imagery and data directly from HAE UAVs and process data? (Level 2 - Objective)

(2) How well can the TCS control the TUAV and MAE payloads? (ORD011, ORD024, ORD025, KPP)

(a) Can the TCS control the TUAV payloads? (Level 3)

(b) Can the TCS control the MAE payloads? (Level 3)

(3) How well can the TCS control the TUAV and MAE air vehicles? (ORD011, ORD024, ORD025, KPP)

(a) Can the TCS perform flight control of the TUAV? (Level 4)

(b) Can the TCS perform TUAV take-off and landings? (Level 5)

(c) Can the TCS perform flight control of the MAE? (Level 4)

(d) Can the TCS perform MAE take-off and landings? (Level 5)

(4) How well can the TCS provide connectivity to the C4I systems? (ORD068, KPP)

(Per the ORD, connectivity to all C4I systems is not required at Initial Operational Capability (IOC). The TCS System/Subsystem Specification (SSS) lists the schedule for connecting to and integrating with specific C4I systems.)

(a) How well can the TCS disseminate data from the TUAV, MAE and HAE UAVs to C4I systems?

(a1) AFATDS, (a2) ADOCS, (a3) ASAS, (a4) JSTARS CGS, (a5) JMCIS, (a6) ATWCS, (a7) JDISS, (a8) TROJAN SPIRIT II, (a9) JSIPS, JSIPS-TEG, JSIPS-TES, (a10) TBMCS, (a11) Guardrail CS/ACS IPF, (a12) MIES, (a13) ETRAC, (a14) CARS.

(b) How well can the TCS receive maps, mission planning, geopositioning and other commands and data from the service specific mission planning systems?

(b1) TAMPS, (b2) AFMSS, (b3) AMPS.

(5) How well does the TCS allow the UAV operator to receive mission tasking, conduct mission planning, and execute the mission? (ORD016, KPP)

(6) How well does the TCS allow operators to have simultaneous flight and payload control of at least two AVs, BLOS, using one TCS? (ORD024, KPP)

(7) How capable is the TCS of being interoperable with different types of UAVs and UAV payloads across the 5 levels of UAV interaction? (ORD025, KPP)

(8) How capable is the TCS of being interoperable across multiple platforms/payloads simultaneously? (ORD026 - Objective, KPP)

(9) How well can the TCS support future payloads? (ORD012, ORD023)

(10) How well can the TCS support future tactical UAVs? (ORD013, ORD017, ORD023)

4.2.2 Suitability Issues

(1) Safety.

(2) Mission Reliability.

(3) Human Factors and Human/Computer Interface (HCI).

(4) Interoperability.

(5) Training.

(6) Availability.

(7) Maintainability.

(8) Integrated Logistics Support (ILS): Evaluate how well can the TCS support structure and resources respond to system sustainment and mission execution. (ORD 085, ORD 111)

(9) Documentation: Ensure that supporting reports and analyses have been completed to support the suitability evaluation, which includes the

Transportability Engineering Analysis, Environmental Assessment, Manpower Evaluation Report/QQPRI & BIOP reports.

4.3 Future Operational Test and Evaluation

4.3.1 Configuration Description

4.3.2 Developmental Test and Evaluation Objectives

4.3.3 Live Fire Test and Evaluation

Not applicable to TCS.

5. PART V--TEST AND EVALUATION RESOURCE SUMMARY

5.1 Overview

This section presents a summary of Developmental Test (DT) and Operational Test (OT) resources required to test and evaluate the prototype and LRIP TCS system. Since this test and evaluation process focuses on the TCS system, the development status of support articles such as AVs and C4I systems are not included in this document. The designated OTA, on completion of Part IV, shall update the funding and test resources sections relating to OT testing.

5.1.1 Test Articles

Table 5-1 illustrates a summary and quantity of test articles, support equipment, simulation, and general support equipment, including software EB versions for EOA-1A and DT tests 1A through DT-2C. DT-1A through DT-1F consist of development testing conducted during operational exercises using prototype TCS hardware. LRIP TCS testing commences with DT-2A to support contractor integration testing followed by DT-2B and C to complete development testing.

5.1.2 Test Sites and Instrumentation

All land-based DT and OT test phases, starting from DT-1A, will require operating facilities including ramp, hangar, and office space at each test site. Sea-based DT testing will require TBD site resources. Table 5-2 illustrates the required land- and sea-based C4I systems to support DT&E testing.

DT-1A through DT-1F will be conducted in conjunction with prescheduled warfighting exercises. These demonstrations will be conducted under simulated conditions that replicate as closely as possible the natural environments likely to be encountered by the TCS system. Typical exercise locations will include El Mirage, National Training Center (NTC) at Ft. Erwin, and the Electronic Proving Ground (EPG).

5.1.3 Test Support Equipment

For land and sea test locations, test support equipment required for DT and OT will include UAV and C4I system peculiar support equipment as required. Access to general-purpose test equipment is required at all test locations.

5.1.4 Threat Representation

Enemy threats to the TCS system during land-based testing, exclusive of the AVs, consists primarily of Electromagnet Interference (EMI) ground-based threats. A ground-based EMI threat simulator, located 0.5 mi from the TCS system will be required. The threat simulator is TBD.

Table 5-1. Summary of Key Government DT&E Test Resources.

DT Phase →	EOA-1B	DT-1A	DT-1B	DT-1C	DT-1D	DT-1E	DT-1F	DT-2A	DT-2B	DT-2C
Test Date	**3/97, 7/97**	**1/98**	**11/97**	**11/97**	**4/98**	**8/98**	**1/99**	**TBD**	**TBD**	**TBD**
Test Resources										
TCS-LS Prototype./HMMWV Shelter	1	1	1	1	1					
TCS-LS LRIP & HMMWV Shelter								2	2	2
TCS-S Prototype with MTB				1						
TCS-S LRIP								2	2	2
Primary Support Articles										
Predator AV					2	2	1	2	2	2
- Payload EO/IR										
- Payload EO/IR/SAR		1	1		1	2	1	2	2	2
- GDT & GCS		1	1		1	2	1	2		2
- LOS Antenna & Support Equip.		1	1		1	2	1	2		2
- BLOS Antenna & Support Equip.		1	1		1			2		2
Outrider AV					1			2		2
- Payload EO/IR					1			2	2	2
- GDT & GCS					1			2	2	2
- LOS Antenna & Support Equip.					1			2	2	2
- BLOS (Ship to Shore)								2	2	2
Pioneer										
- Payload										
- GCS										
MSE/SINCGARS Radio									2	
Primary Support Equipment										
Demo Asset Van (Land Based)		1					1			
- HMMWV, Shelter		1					1			
- SBPCS with Assoc Data Link		1			1					
- APL Antenna & Workstation		1	1	1	1		1			
- Computer Hardware & Monitors	1	1	1	1	1		1			
Ship Based Assets										
- RF Box			1						1	1
- UPS (2000VA)			1						1	1
Simulation and Comm Links										
MUSE	1	1								
SATCOM (Channels)		1			1			1	2	2
Modem/Router/Phone Lines										2
Operational Force Support										
- Flying Hours										
- Ship Steaming Days										
- Carriers										3
- Amphibious Ships			3							3
- Chase Plane Flying Hours			12				12	12		12
General Support Equipment										
Coax cables (100 ft)	6	6	6	6	6	6	6			
RGB cables (100 ft)	6	6	6	6	6	6	6			
Generators	2	2	2	2	2	2	2			
Test Location (L=land, S=sea)	L	L	S	L	L	L	L	L	L	L,S
Engineering Build Version	1	1	1	1	3	4	5	5	5	5

Table 5-2. DT&E TCS C4I System Availability Requirements.

EOA/DT Phase	EOA-1A, 1B	DT-1A	DT-1B	DT-1C	DT-1D	DT-1E	DT-1F	DT-2A	DT-2B	DT-2C
Test Date	**3/97, 7/97**	**1/98**	**11/97**	**11/97**	**4/98, 6/98**	**8/98**	**1/99**	**TBD**	**TBD**	**TBD**
C4I Systems										
AFATDS	X									
ADOCS	X									
ASAS	X			X						
JSTARS (C-97, I-98)						X				
JMCIS (C-97, I-00)			X		X					
CCTV			X		X					
JSIPS-N					X					
IAS						X				
JDISS					X					
TROJAN SPIRIT II						X				
ETRAC						X				
JSIPS-TEG										
JSIPS-TES										
MIES										
ATWCS (C-99, I-00)	X									
CARS										
Guardrail CS/ACS IPF										
TAMPS										X
AFMSS									X	
COMPASS										
ATHS										
TBMCS										

Notes: (1) C = Connectivity availability, I = Integration complete (2) ASAS and AFATDS require TCIM, (3) DT-1D Includes land and sea testing.

5.1.5 Test Targets and Expendables

No test targets or expendables are required for DT or OT testing.

5.1.6 Operational Force Test Support

Refer to Table 5-3 for a list of flying hours, ship requirements, and satellite coverage for each DT test phase.

5.1.7 Simulations and Models

The MUSE provides UAV imagery test scenarios and limited man-in-the-loop simulations. MUSE also supports UAV operator training. The MUSE will be used to provide simulated imagery inputs to support TCS during EOA and DT- Phase 1 testing.

Table 5-3. DT Operational Test Support/ Manpower Requirements.

DT Phase	EOA-1A	DT-1A	DT-1B	DT-1C	DT-1D	DT-1E	DT-1F	DT-2A	DT-2B	DT-2C	OT
Test Date	**3/97**	**1/98**	**11/97**	**11/97**	**4/98**	**8/98**	**1/99**	**TBD**	**TBD**	**TBD**	**TBD**
Test Resources											
Operational Force Support											
- UAV Flight Hours	N/A	16	24	24	24	24	24	16	40	40	
- Chase Plane Flight Hours	N/A	16	24	24	24	24	24	16	40	40	
- Ship (CV) Steaming Days			2							4	
- Satellite Coverage (hours)	0	32	0	0	40	0	0	32	80	80	
- Ship (Amphibious) Steaming Days			3							4	
Manpower/Personnel Training											
Estimated Number of Test Days	4	4	5	5	5	5	5	4	10	10	
- UAV Operator Training (days)											
- TCS Operators	2	2	2	2	2	2	2	2	4	4	
- Test Support per (NAWCDD)											
- Test Support per (JTC/SIL)											
- Test Supervision (DA)											
- SIL Support per (days)											
- Test Base Support Per (Tech)	2	2	2	2	2	2	2	0	3	3	
- Base Support Personnel (Eng)	1	1	1	1	1	1	1	1	2	2	
Test Location (L=land, S=Sea)	L	L	S	L	L	L	L	L	L	L	
TCS Engineering Build	1	1	1	1	3	4	5	5	5	5	
Notes: DT-1D includes land and sea testing											

5.1.8 Special Requirements

There are no special data processing requirements external to the TCS system. There will be a need for support from NIMA to provide digitized maps. The estimated support during DT testing is TBD days of engineering support.

5.1.9 Test and Evaluation Funding Requirements

Cumulative funding requirements for DT and OT testing are: FY 97 - TBD, FY 98 - TBD, FY 99 - TBD.

5.1.10 Manpower/Personnel Training

TCS operators will require training in the use and operation of Predator and Outrider GCS operations prior to TCS DT testing. These trained operators will have access to TCS training via the TCS embedded training system. Table 5-3 illustrates operator training requirements.

ANNEX A--BIBLIOGRAPHY

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ANNEX B--ACRONYMS

A_0	Availability (uptime/uptime + downtime)
ACS	Aerial Common Sensor
ACTD	Advanced Concept Technology Demonstration
ADOCS	Automated Deep Operations Coordination System
ADRG	Arc Digitized Raster Graphic
ADT	Air Data Terminal
AF	Air Force
AFATDS	Advanced Field Artillery Tactical Data Systems
AFMSS	Air Force Mission Support System
AMPS	Army Mission Planning System
APL	Applied Physics Laboratory
ASAS	All Source Analysis System
ASD(C3I)	Assistant Secretary of Defense for Command, Control, Communications, and Intelligence
ATHS	Automatic Target Hand-off Systems
ATWCS	Advanced Tactical Weapons Control System
AV	Air Vehicle
AWE	Advanced Warfighting Exercises
BLOS	Beyond Line of Sight
CADRG	Compressed Arc Digitized Raster Graphic
CARS	Common Automated Recovery System
CCTV	Closed Circuit Television
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CE	Continuous Evaluation
CEP	Circular Error of Probability
CHT	Cylinder Head Temperature
CIGSS	Common Imagery/Ground/ Surface Station
CINC	Commander in Chief
COMOPTEVFOR	Commander, Operational Test and Evaluation Force (Navy)
COMPASS	Common Operational Modeling, Planning, and Simulation System
CONOPS	Concept of Operations
CTP	Critical Technical Parameters
C3I	Command, Control, Communications, Intelligence
C4I	Command, Control, Communications, Computers, Intelligence
DA	Developing Agency
DARO	Defense Airborne Reconnaissance Office
DCM	Datalink Control Module
DFAD	Digital Feature Analysis Data
DII/COE	Defense Information Infrastructure/Common Operating Environment
DLT	Digital Linear Tape
DLTV	Daylight Television
DoD	Department of Defense
DOF	Degrees of Freedom
DOT&E	Director, Operational Test and Evaluation
DT	Developmental Test
DT&E	Developmental Test and Evaluation
DTED	Digital Terrain Elevation Data
EB	Engineering Build
EGT	Exhaust Gas Temperature
EM&D	Engineering, Manufacturing, and Development
EMI	Electromagnetic Interference
EO	Electro-Optical
EOA	Early Operational Assessment
EO/IR	Electro-Optical/Infrared
EPG	Electronic Proving Ground
ETRAC	Enhanced Tactical Radar Correlator
EW	Electronic Warfare
FAT	First Article Test
FD/L	Fault Detection/Location
FOC	Full Operational Capability
FOT&T	Future Operational Test and Evaluation
FY	Fiscal Year
GA	General Atomics
GCS	Ground Control Station
GCCS	Global Command and Control System
GDT	Ground Data Terminal
GFE	Government-Furnished Equipment
Govt	Government
GPS	Global Positioning System

GSM/CGS	Ground Station Module/ Common Ground Station
h	Hour
HAE	High Altitude Endurance
HCI	Human/Computer Interface
HF	High Frequency
HMMWV	High Mobility Multipurpose Wheeled Vehicle
IAS	Intelligence Analysis System
IBLS	Integrated Beacon Landing System
ICD	Interface Control Document
IDT	Integrated Data Terminal
IEW	Intelligence and Electronic Warfare
IFR	Instrument Flight Rules
ILS	Integrated Logistics Support
ILSP	Integrated Logistical Support Plan
IOC	Initial Operational Capability
IPF	Integrated Processing Facility
IPT	Integrated Product Team
IR	Infrared
IW	Information Warfare
JDISS	Joint Deployable Intelligence Support System
JHU	John Hopkins University
JMCIS	Joint Maritime Command Information System
JPO	Joint Projects Office
JPO TCS PM	Joint Projects Office Tactical Control System Program Manager
JROC	Joint Requirements Oversight Council
JSIPS	Joint Service Imagery Processing System
JSTARS	Joint Standoff Target Attack Radar System
JTA	Joint Technical Architecture
JTC/SIL	Joint Technology Center/System Integration Laboratory
JT UAV PMO	Joint Tactical Unmanned Aerial Vehicle Program Management Office
JWID	Joint Warrior Interoperability Demonstration
KPP	Key Performance Parameter
LAN	Local Area Network
LOS	Line of Sight
LRIP	Low Rate Initial Production
MAE	Medium Altitude Endurance
MAIS	Major Automated Information System
MAP	Manifold Air Pressure
MCT	Manifold Charge Temperature
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Procedure
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MOE	Measures of Operational Effectiveness
MIES	Modernized Imagery Exploitation Exploitation System
MNS	Mission Needs Statement
MS	Milestone
MSL	Mean Sea Level
MTB	Mobile Test Bed
MTBCF	Mean Time Between Critical Failure
MTBOMF	Mean Time Between Operational Mission Failure
MUSE	Multiple UAV Simulation Environment
NAIC	National Air Intelligence Center
NAVAIRSYSCOM	Naval Air Systems Command
NAVSEASYSCOM	Naval Sea Systems Command
NAWC	Naval Air Warfare Center
NSFS	Naval Surface Fire Support
NIMA	National Imagery and Mapping Agency
NITF	National Imagery Transmission Format
NRT	Non-Real-Time
NSWCDD	Naval Surface Warfare Center, Dahlgren Division
NTSC	National Television Standards Committee
NTC	National Training Center
NWCS-P	NSFS Weapon Control System - Prototype
OPTEC	Operational Test and Evaluation Command
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
OT	Operational Test
OTA	Operational Test Agency
OT&E	Operational Test and Evaluation
OUSD	Office of the Undersecretary of Defense
PEO	Program Executive Officer
PEO (CU)	Program Executive Office, Cruise Missiles/ Joint Unmanned Aerial Vehicles

RDT&E	Research, Development, Test and Evaluation
RF	Radio Frequency
RPM	Revolutions Per Minute
RTP	Real-Time Processor
RSTA	Reconnaissance, Surveillance, and Target Acquisition
SAM	Surface-to-Air Missile
SAR	Synthetic Aperture Radar
SATCOM	Satellite Communication
SBPCS	Ship-Based Predator Control System
SINCGARS	Single-Channel Ground and Airborne Radio System
SPIRIT	Special-Purpose Integrated Remote Intelligence Terminal
SSS	System Subsystem Specification
TAMPS	Tactical Aircraft Mission Planning System
TBD	To Be Determined
TBMCS	Theater Battle Management Core System
TCDL	Tactical Common Data Link
TCS	Tactical Control System
T&E	Test and Evaluation
TECHEVAL	Technical Evaluation
TEG	Tactical Exploitation Group
TEMP	Test and Evaluation Master Plan
TES	Tactical Exploitation System
TUAV	Tactical Unmanned Aerial Vehicle
TV	Television
UAV	Unmanned Aerial Vehicle
UHF	Ultra High Frequency
USACOM	United States Atlantic Command
USATECOM	U. S. Army Test and Evaluation Command
USD (A&T)	Under Secretary of Defense (Acquisition and Technology)
USIS	United States Imagery Standards
VFR	Visual Flight Rules
VHF	Very High Frequency
VME	Versa Module Europa
VMF	Variable Message Format

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