U.S. ATLANTIC COMMAND

UAV TACTICAL CONTROL SYSTEM (TCS)

DRAFT **DRAFT**

JOINT CONCEPT OF OPERATIONS (CONOPS)

VERSION 1.2

13 July 1998

TABLE OF CONTENTS

FIGURES

1.0 EXECUTIVE SUMMARY

The advantages of a system that benefits from interoperability and commonality have been recognized since Congress directed DOD to consolidate divergent unmanned aerial vehicle (UAV) programs in 1988. Early efforts focused on the creation of a common control element operating within established standards and protocols, and interoperable with other UAV and battle management systems. The maturation of such a system was necessary to ensure the proper integration of UAVs into the existing and future battleforce structure and reduce development costs for follow-on UAV programs. The culmination of these efforts produced the UAV Tactical Control System (TCS) concept. TCS is an acquisition category II (ACAT II) program under the aegis of the Joint Project Office for UAVs (JPO-UAV). TCS is the software, software-related hardware and extra ground support hardware necessary for the control of the Advanced Concept Technology Demonstration (ACTD) Outrider Tactical Unmanned Aerial Vehicle (TUAV), the RQ-1A Predator Medium Altitude Endurance (MAE) UAV and future tactical UAVs. A planned Engineering Change Proposal (ECP) will provide TCS interoperability with the RQ-2A Pioneer tactical UAV. TCS will have the objective capability of receiving Global Hawk and Dark Star High Altitude Endurance (HAE) UAV payload information. In addition, TCS incorporates the technical interfaces necessary for the dissemination of UAV imagery and data to 24 selected joint and Service C4I systems. The TCS concept was endorsed by the Vice Chairman, Joint Chiefs of Staff, the Joint Requirements Oversight Council (JROC), and the Under Secretary of Defense (Acquisition and Technology). A TCS Operational Requirements Document (ORD) was signed in February 1997.

TCS realizes its full operational potential when integrated in an institutionally, organizationally, and intellectually joint force. When properly employed and smartly integrated into joint military operations, TCS delivers a capability that significantly enhances the contribution of joint force UAV assets. For the first time, non-UAV units equipped with TCS will have the capability to control a UAV and be primarily responsibility for the management of its product in direct support of a tactical operation. TCS is the product of innovative thinking and its capabilities are wholly aligned with the concept of joint operations as envisioned in Joint Vision 2010. TCS is an integral piece in the joint target engagement system of integrated sensors, communications and precision weapons, and drives real-time, not prearranged, decision making. UNIX based and scaleable, TCS provides its functionality tailored to the user. Augmented with TCS, the warfighter is provided options ranging from passively receiving UAV payload products to full control of multiple air vehicles. The true warfighting potential of TCS is in the level of operational flexibility it provides to warfighters at lower echelons of the force. By providing them with the capability to control an airborne reconnaissance, surveillance, and target acquisition (RSTA) asset, TCS substantially magnifies their joint combat effectiveness. Hence, TCS leverages the inherent maneuverability, firepower, and initiative of individual units with the proven operational advantages of UAVs to enhance force-wide battle management and execution.

TCS is nearing completion of a two year program definition and risk reduction phase with Milestone II (MSII) decision planned for September 1998. Following MSII a one year developmental test/operational test (DT/OT) and low rate initial production (LRIP) cycle will commence. Completion of this phase will lead to full rate production and operational fielding of production TCS systems starting in FY 00. The UAV TCS software is Defense Information Infrastructure/Common Operating Environment (DII/COE) compliant and operates on current Service hardware: Sun/SPARC (Air Force), CHS-II/SPARC-20 (Army/Marine Corps), and TAC-N (Navy). The standards, protocols, interfaces, and formats developed belong to the government and serve as the foundation for future UAV development. This promotes UAV system interoperability and overcomes many current limitations associated with stand-alone, “stovepipe” systems that have been notoriously incompatible with fielded battle management systems. Standard TCS interfaces to joint and Service C4I systems ensures UAV compatibility with fielded combat systems and supports connectivity to lower command echelons. The TCS human computer interfaces (HCI) will become the standard for future UAVs, supporting the establishment of standard operating procedures for operating the family of UAVs. Accordingly, changes to a C4I or air vehicle system need only be incorporated in the TCS open architecture and not in each UAV or C4I system.

TCS construction is modular which promotes the use of common hardware and facilitates increasing or decreasing UAV control capability by adding or removing system components. TCS scaleability permits the system to function at five discrete levels of TCS-to-UAV interaction ranging from receipt and transmission of secondary imagery and data, to full control and operation of a UAV including takeoff and landing. The five levels of interaction include (each level of TCS capability incorporates the functionality of all lower levels):

Level 1	Receipt and transmission of secondary imagery or data.
Level 2	Receipt of imagery or data directly from the UAV.
Level 3	Control of the UAV payload.
Level 4	Control of the UAV, less takeoff and landing.
Level 5	Full function and control of the UAV to include takeoff and landing.

The TCS system operates primarily by internally and externally interfacing specific hardware and software to achieve the functionality of a specific configuration. Internal interfaces support interaction between the various hardware and software components within the TCS core and its associated subsystems. External interfaces involve inputs and outputs between the TCS system and supporting equipment. This functionality is available in four configurations: a land-based (LB) HMMWV-shelter TCS production version, a ship-based (SB) TCS production version, an RQ-1A (Predator) system ground control station (GCS) version, and an RQ-2A (Pioneer) shelter version.

TCS is interoperable with identified joint, Service, and NATO C4I systems at all levels of interaction. This facilitates the accurate and timely dissemination of UAV products to multiple users, and eliminates the need for legacy and future UAVs to develop their own system-unique interfaces with the myriad of C4I systems. TCS workstations are capable of receiving, displaying and transmitting a complete complement of still and motion imagery. TCS supports the dissemination of data in established tactical communication formats. However, TCS is not configured with its own organic communications nor does its deployment automatically provide additional bandwidth. TCS must be integrated into existing theater operational architectures and function within available communications management constructs. Types of products desired and timeliness of delivery will drive TCS-associated communications requirements and priority. Consequently, judicious communications planning and management are required to facilitate warfighter-useful, real time connectivity between TCS and other nodes.

To effectively plan the employment of TCS in the prosecution of Joint Force Commander objectives, centralized planning and tasking processes functioning within existing joint force organizations and structures are required. At the joint force level, the JFC will define supported-supporting relationships among staff organizations, and functional and Service component commanders to accomplish TCS-equipped unit employment planning, tasking, and execution.

Specific training and qualification is required to employ TCS. With both TCS-specific training and qualification and any required Service specific air vehicle/payload training and qualification, Service personnel will be capable of effectively employing TCS. Initial TCS and air vehicle specific training requirements are a function of trainee experience and the TCS operating level being trained to. For legacy UAV systems currency in the level of operations to be performed is also required for TCS operators conducting Levels 3, 4, and 5 operations. Moreover, training and qualification in appropriate controlled airspace procedures to satisfy Federal Aviation Administration (FAA)/International Civil Aviation Organization (ICAO) unmanned air vehicle pilot proficiencies are required.

This joint concept of operations (CONOPS) details TCS employment options available to the JFC. It is designed to assist the warfighter in TCS-related planning and execution coincident with the conduct of military operations. It also provides an operational framework for the TCS development and Service operational testing communities. The CONOPS provides a descriptive overview of the capabilities and limitations of TCS to assist the tactical commander in deciding when, where, and how to deploy TCS equipped units. User involvement is required early in the program to ensure the system satisfies their need and operators are knowledgeable when providing input on TCS use. The CONOPS is a "living " document and updated as exercises, demonstrations and tests reveal new tactics, techniques, and procedures. The goal is to periodically review, update, and coordinate the CONOPS to reflect modifications and upgrades in hardware, and software, and to presage changes in doctrine.

The TCS Joint CONOPS provides the conceptual framework for future employment principles that will leverage the full potential of TCS technology in achieving new levels of effectiveness in joint warfighting. Accordingly, some UAV employment and control concepts presented in this document are more applicable to future joint operations and are not fully consistent with current Service CONOPS for legacy UAV systems or Service employment philosophy. Specific differences from individual Service documents that may impact current TCS employment as discussed in Section 4 are annotated throughout this CONOPS.

SECTION 2. INTRODUCTION

2.1 STATEMENT OF PURPOSE. U.S. Atlantic Command (USACOM) is designated as the lead Commander in Chief (CINC) for the TCS program. In this role USACOM provides oversight and direction of warfighter involvement and is responsible for coordinating operational requirements and development of the Joint CONOPS. This Joint CONOPS document describes operational concepts to guide USACOM forces and Service components in employing TCS in joint or Service training/exercises and in using TCS in actual operations in the USACOM area of responsibility (AOR). Individual Service component commanders are encouraged to develop complementary TCS documents with more definitive, Service-specific TCS employment guidance for their forces. Likewise, theater CINCs may use this document as a template for developing TCS employment guidance tailored to their AOR and operational situation.

This Joint CONOPS document provides a single source reference that describes TCS system capabilities and limitations and also serves as a general TCS "how to" employment guide. It provides an operational framework for and guidance concerning the employment and operation of TCS with system threshold functionality available in production TCS systems at initial operational capability (IOC). The information is meant to be sufficient to assist commanders and their staffs in deciding when, where, and how to employ TCS in support of coherent joint operations. The concepts will assist commanders in realizing the maximum operational benefit from employing the unique capabilities of TCS in supporting precision engagement and enabling information superiority.

This document provides the TCS user with a basic description of the TCS system, threshold capabilities and limitations, general employment concepts and operating guidelines, specific examples of potential applications of TCS, and a broad understanding of TCS-related employment considerations and issues. The information and concepts presented are current with the tested and demonstrated capabilities of the TCS system as of the publication date.

The TCS Joint CONOPS is a "living" document and will be updated to reflect lessons learned from the employment of TCS in exercises, demonstrations, and tests, and in actual joint and Service operations. Changes to TCS-related joint and Service doctrine, and modifications or upgrades to TCS hardware and software will be reflected in updates to this document. Until TCS reaches full operational capability (FOC), this document will be reviewed semi-annually as needed. After FOC, review will be conducted annually. The review process is the responsibility of the Joint Warfighter Planning Group (JWPG), sponsored by the TCS Program Manager, Program Executive Officer for Cruise Missiles and Unmanned Aerial Vehicles (PEO-CU), and chaired by Commander-in-Chief, U.S. Atlantic Command (USCINCACOM). Principal membership in the JWPG is accorded to USACOM Service components; supporting membership includes the Services and other organizations within the operating forces; contributing membership includes TCS, UAV, and command, control, communications, computers, and intelligence (C4I) subject matter experts.

2.2 BACKGROUND. Realizing the advantages of a system with truly joint interoperability and commonality, Congress directed the Department of Defense (DOD) to consolidate UAV programs in 1988. DOD's initial attempts to comply with Congressional direction focused on achieving hardware commonality through the use of a downsized short range UAV ground station and by establishing software interoperability standards through the use of joint integration interfaces (JII).

In January 1990, the JROC approved Mission Need Statements (MNSs) for both a Close Range RSTA capability and a Long Endurance RSTA capability. These MNSs established the need to interface UAVs with selected standard DOD C4I systems, architectures and protocols, both current and planned. The subsequent advent of the MAE and HAE UAV programs highlighted the operational value of integrating air vehicle control and product distribution into an interoperable and scaleable system with established standards and protocols. Fully integrating

UAVs into the existing and planned future battleforce structure required interoperability to be the prime consideration.

Existing software and UAV data links were not compatible or interoperable. The ground control stations had neither the required capabilities nor the capacity for architectural growth to satisfy all joint operational requirements. To be compatible with new or improved warfighting systems, every new software or hardware configuration required the development of new software to interface with each type of UAV control station. There were no non-materiel alternative solutions that would establish a standard software architecture for UAVs.

To overcome this shortfall, in February 1997, the JROC codified the requirement for a UAV TCS to provide common control, ground reception and processing, and to be fully interoperable with the MAE UAV, the TUAV, and future tactical UAVs and collection systems. This Joint ORD also specified the requirement for TCS to fully exploit Predator capability at all levels and to be capable of receiving HAE payload information. The TCS program was structured to design a system and implement the standards and protocols that will make current and future air vehicles interoperable with existing hardware, software and ground stations.

TCS is an ACAT II program that provides military warfighters with a scaleable command, control, and communications, and imagery/data receipt and dissemination capability for the Outrider and RQ-2A Pioneer tactical UAVs and the RQ-1A Predator MAE UAV. As a future capability, TCS will also be capable of receiving and disseminating imagery/data from HAE UAVs. Because TCS is DII/COE compliant and scaleable, its capability can be tailored to meet user needs. The purpose of the resulting UAV/TCS infrastructure is to support joint warfighters with a variety of UAVs utilizing common components and nodes that are deployed throughout all Services at multiple echelons. Joint warfighters include forces from the Joint Force Commander (JFC) down to units that are engaged with the enemy.

The TCS program progresses from threshold (initial) to objective (final) capabilities in three phases. Program specifics are described in more detail in Appendix A.

SECTION 3. TACTICAL CONTROL SYSTEM (TCS) DESCRIPTION

3.1 PURPOSE. This section describes TCS system capabilities, the five levels of TCS interaction, system components and TCS configurations, interoperable functionality with the various families of UAVs and designated C4I systems, and summarizes system operating performance and limitations.

3.2 SYSTEM CAPABILITIES. TCS is a software-focused program that provides the warfighter with a scaleable and modular capability to control UAVs on existing computer systems and interface with current and future C4I systems to disseminate UAV sensor products. Scalablity allows TCS to function at five levels of interaction ranging from receipt and transmission of secondary imagery and data to full control and operation of a UAV to include takeoff and landing. Modularity allows the use of common hardware and facilitates increasing or decreasing capability by adding or removing system components. Consequently, TCS can be configured to meet user needs coincident with deployment or operational constraints. TCS capabilities are primarily provided through software, software-related hardware, and ground support equipment (antenna, cabling, etc.) necessary to interoperate with the current family of tactical UAVs (Outrider and RQ-2A [Pioneer]), the RQ-1A (Predator) system, and future tactical UAVs. In addition, TCS has the objective capability of receiving HAE UAV payload information.

TCS software operates on current Service hardware: Sun/SPARC (Air Force), CHS-II/SPARC-20 (Army/Marine Corps), and TAC-N (Navy). The Air Force incorporates TCS software and selected components into existing RQ-1A GCSs. For Army, TCS is an integral part of the high mobility multi-wheeled vehicle (HMMWV)-based Outrider TUAV GCSs and Tactical Operations Centers (TOCs) at various echelons of command. For Marine Corps, TCS is an integral part of the HMMWV-based TUAV GCSs and TOCs at various echelons of command.

For Navy, TCS is the control system for UAV operations from ships, submarines, and temporary sites ashore.

System capabilities enable TCS operators to:

- Format, send, and receive tactical communications messages
- Send and receive voice communications
- Establish TCS to TCS connectivity
- Interface to a wide range of C4I systems
- Receive and disseminate analog video and NITF digital imagery
- Retrieve and disseminate payload data
- View payload data from multiple payloads simultaneously
- Control and monitor multiple UAV payloads simultaneously
- Plan UAV missions
- Control and monitor multiple air vehicles simultaneously
- Monitor the performance and status of the TCS system

TCS software is developed for open architectures and provides UAV operators the necessary tools for computer related communications mission tasking, route flight planning, mission execution, and data processing. The software provides high resolution, computer generated, video graphics that enable operators trained on one UAV system to control different types of UAVs or UAV payloads after appropriate formal training. TCS core software is Global Command and Control System (GCCS) compliant, non-proprietary, and the architectural standard for future UAVs.

TCS provides a HCI for all UAVs to simplify user operations and training, and to facilitate seamless integration into individual Services' joint C4I infrastructure across all levels of interaction.

TCS does not contain organic communications capability. Therefore, communications requirements to support TCS must be met with existing systems and architectures. In the case of UAVs that have organic communications capability, additional C4I interfaces may be provided by TCS.

3.3 LEVELS OF INTERACTION. TCS is interoperable with different types of UAVs and UAV payloads across five levels of interaction. The levels of interaction are:

Level	Capability
Level 1	Receipt and transmission of secondary imagery or data.
Level 2	Receipt of imagery or data directly from the UAV.
Level 3	Control of the UAV payload.
Level 4	Control of the UAV, less takeoff and landing.
Level 5	Full function and control of the UAV to include takeoff and landing.

Each level of TCS capability incorporates the functionality of all lower levels. For example, Level 5 TCS, in addition to UAV launch and recovery, also provides the operator full capability to control the air vehicle in flight, control payload operations, receive UAV products directly from the air vehicle, and to disseminate those products to other TCS-equipped units. Figure 3-1 provides the five levels of interaction and the functionality provided at each level.

LEVELS OF INTERACTION / FUNCTIONALITY	
Level	**Functionality**

SENSOR DATA RECEIPT/TRANSMISSION
1. INDIRECT PATH (via C4I SYSTEM, TCS, or MCE)
2. DIRECT PATH (UAV to USER)
	• OPERATIONAL COORDINATION
	• RECEIVE & PROCESS SENSOR DATA
	  • ANALOG (RS-170)
	  • DIGITAL (NITF, OTHER)
	• DISPLAY SENSOR DATA
	  • OVERLAY ON GEO (MAP) DISPLAY
	  • ANNOTATE
	• TRANSMIT SELECTED DATA VIA COMMS SYSTEMS (SECONDARY DISSEMINATION)

3. SENSOR CONTROL & DATA RECEIPT/USE	• LEVEL 1 & 2 FUNCTIONALITY
	• DIRECT CONTROL OF SENSOR PAYLOAD
	  • VIA LOS LINK OR SATELLITE LINK
	  • DYNAMIC RETASKING OF SENSOR

4. SENSOR & AIR VEHICLE CONTROL & DATA RECEIPT/USE	• LEVEL 3 FUNCTIONALITY
	• MISSION REPLANNING
	  • AIR VEHICLE ROUTE PLANNING (WAYPOINTS, PRE-DEFINED PATTERNS)
	• AIR VEHICLE FLIGHT CONTROL
	  • DYNAMIC RETASKING OF AIR VEHICLE

5. FULL UAV CONTROL - LAUNCH & RECOVERY	• LEVEL 4 FUNCTIONALITY • MISSION PLANNING • MISSION MONITORING • LAUNCH, RECOVERY, & LANDING

Figure 3-1. Levels of Interaction/Functionality

3.3.1 Level 1. TCS Level 1 interaction involves the receipt and display of UAV-derived product (imagery or data) without direct interaction with the UAV. Imagery and data are received through established communications channels or from connectivity with another TCS system. Level 1 also provides the capability for further product dissemination following initial receipt. Level 1 requires a TCS workstation or a compatible workstation to host TCS and connectivity to an existing information dissemination network. UAV product can be received and disseminated through any C4I system with a TCS interface (see Section 3.7.2, C4I Interoperability). Level 1 TCS operations require minimal TCS-specific training. Personnel totally dedicated to the operation of TCS are not required.

3.3.2 Level 2. TCS Level 2 interaction involves the receipt and display of imagery and data directly from the air vehicle without filtering or processing at another location. This requires a TCS workstation or a compatible workstation to host TCS and hardware necessary to interact with the air vehicle beyond that required for Level 1 operations. At a minimum, TCS Level 2 operations require air vehicle specific data link control modules (DCMs) and companion air vehicle specific ground data terminals (GDTs), or an integrated data link terminal (IDT), and a line-of-sight (LOS) or beyond line-of-sight (BLOS) antenna. DCM/GDT or DCM/IDT and antenna hardware is required to receive imagery and telemetry direct from the UAV. In addition, a synthetic aperture radar (SAR) processor and a digital communications link like tactical common data link (TCDL) or satellite communications (SATCOM) are required to receive and process SAR products from SAR equipped UAVs. Training requirements are more robust than for Level 1.

3.3.3 Level 3. TCS Level 3 interaction involves control of the UAV payload separate from control of the air vehicle. In Level 3 operations, the actual flight of the air vehicle is accomplished from one control node (i.e., dedicated GCS or another TCS) while the payload is controlled from a different TCS node. Two separate up-link signals are required, one for air vehicle control and one for payload control to allow for simultaneous command up-link from two different, geographically separated control nodes. TCS Level 3 operations have the same hardware requirements as Level 2. Level 3 payload control requires additional operator training and operators qualified and current in payload control operations.

Note: Current legacy UAV systems are limited to a single data link uplink signal for payload and air vehicle control. TCS architecture supports remoting payload control to another TCS node through digital connectivity to the AV controlling node. In this case, control latency is inherent due to communications delays and as the payload signal is passed through the AV control node.

3.3.4 Level 4. TCS Level 4 interaction involves control of the air vehicle. Level 4 operations have essentially the same hardware requirements as Level 2 and 3. Level 4 functionality is enabled through the activation of air vehicle control applications in the

TCS software. Level 4 does require the TCS system to have additional hardware (e.g., joystick, pedals, throttle, or touch screen) to provide both manual and automated air vehicle control. Accordingly, TCS incorporates a suite of hardware controls that replicate the functionality of legacy UAV manual controls. Through specific software application, TCS manual air vehicle controls can be dynamically reconfigured to meet the manual control requirements of existing UAV systems. Level 4 operations require appropriate operator training in the flight of specific air vehicles. Air vehicle operators must be trained, qualified, proficient, and current in accordance with the operating Service's training and operations regulations for the air vehicle (AV) being flown.

3.3.5 Level 5. TCS Level 5 interaction involves full function and control of the UAV to include take-off and landing. Level 5 operations have the same hardware requirements as Levels 2-4; future development will add either a UAV Common Automated Recovery System (CARS) or microwave based launch and recovery system, the Integrity Beacon Landing System (IBLS), to provide automated air vehicle recovery capability. Level 5 operations require appropriate operator training in the flight of specific air vehicles. Air vehicle operators must be trained, qualified, proficient, and current in accordance with the operating Service's training and operations regulations for the AV being flown.

3.4 SYSTEM COMPONENTS. The TCS system is functionally and physically partitioned into hardware and software components to provide an open architecture that supports efficient fault isolation and has the following characteristics:

- Complies with the Joint Technical Architecture (JTA).
- Uses DII/COE to the maximum extent practical.
- Maximizes common TCS hardware and software to support different AVs and payloads.

- Provides maximum commonality between TCS configurations.

- Minimizes UAV flight critical hardware and software.

- Minimizes effect of UAV and payload modifications and upgrades on the TCS system.

- Minimizes the impact of C4I system upgrades and modifications on the system.

- Minimizes the integration efforts to control additional air vehicle and payload types.

3.4.1 TCS System/Subsystem. The TCS system consists of a number of subsystems that are comprised of hardware and software components. The subsystems that comprise a complete TCS system include the AV communications subsystem, the launch and recovery subsystem, the real time subsystem, the payload subsystem, the operator station subsystem, the communications subsystem, and the power distribution subsystem. In addition, each TCS system will also have certain configuration dependent subsystem equipment. Figure 3-2 shows the TCS subsystems and the hardware and software configuration items within each subsystem. See Appendix D for a detailed description of hardware, software, and other component functionality.

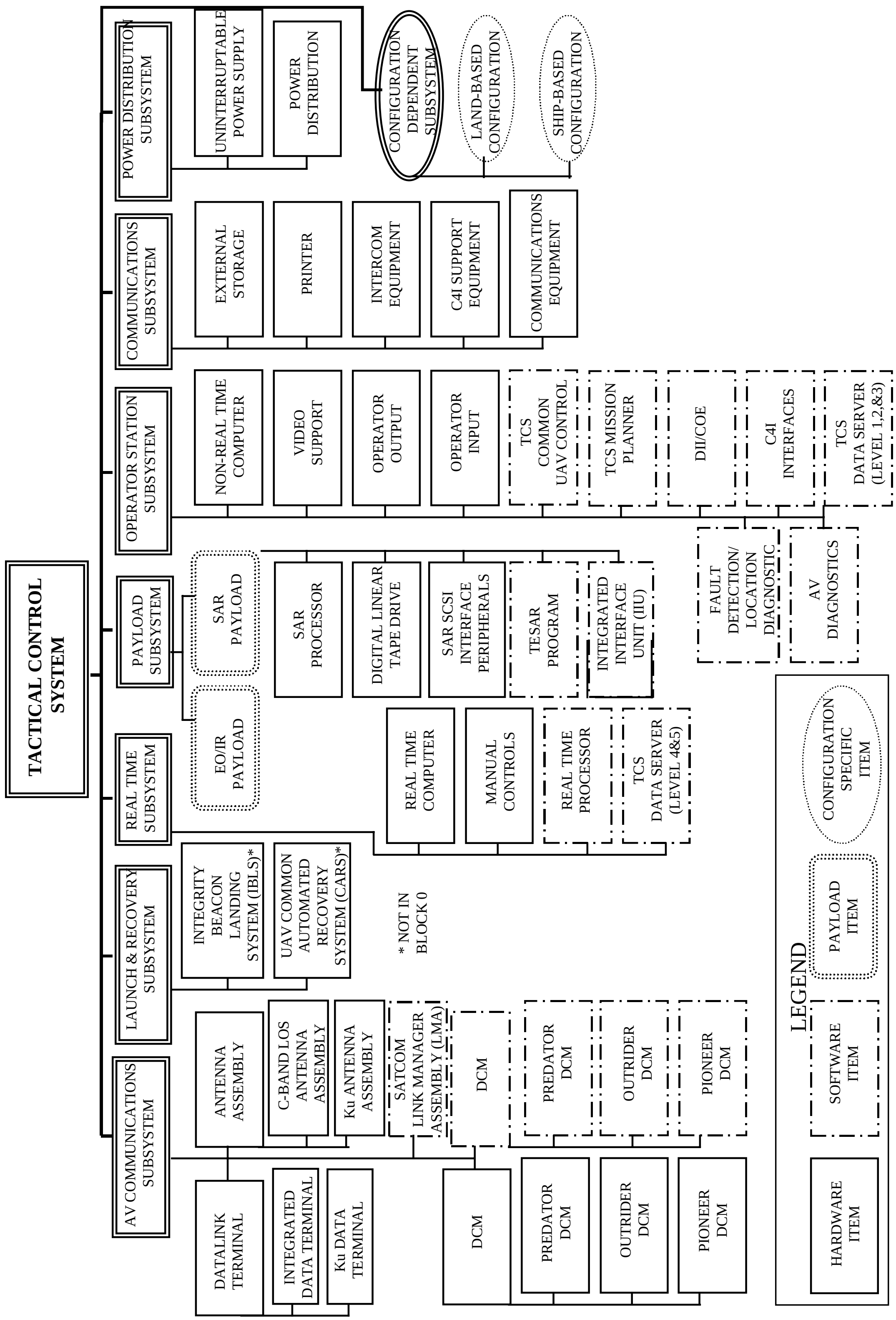

Figure 3-2. TCS System/Subsystems

3.4.2 System Architecture. The variety of hardware and software components that comprise the TCS system/subsystems are architecturally interfaced through hardware-to-hardware, software-to-software, and software-to-hardware interfaces to achieve TCS functionality. Figure 3-3 shows the component architecture of the TCS system.

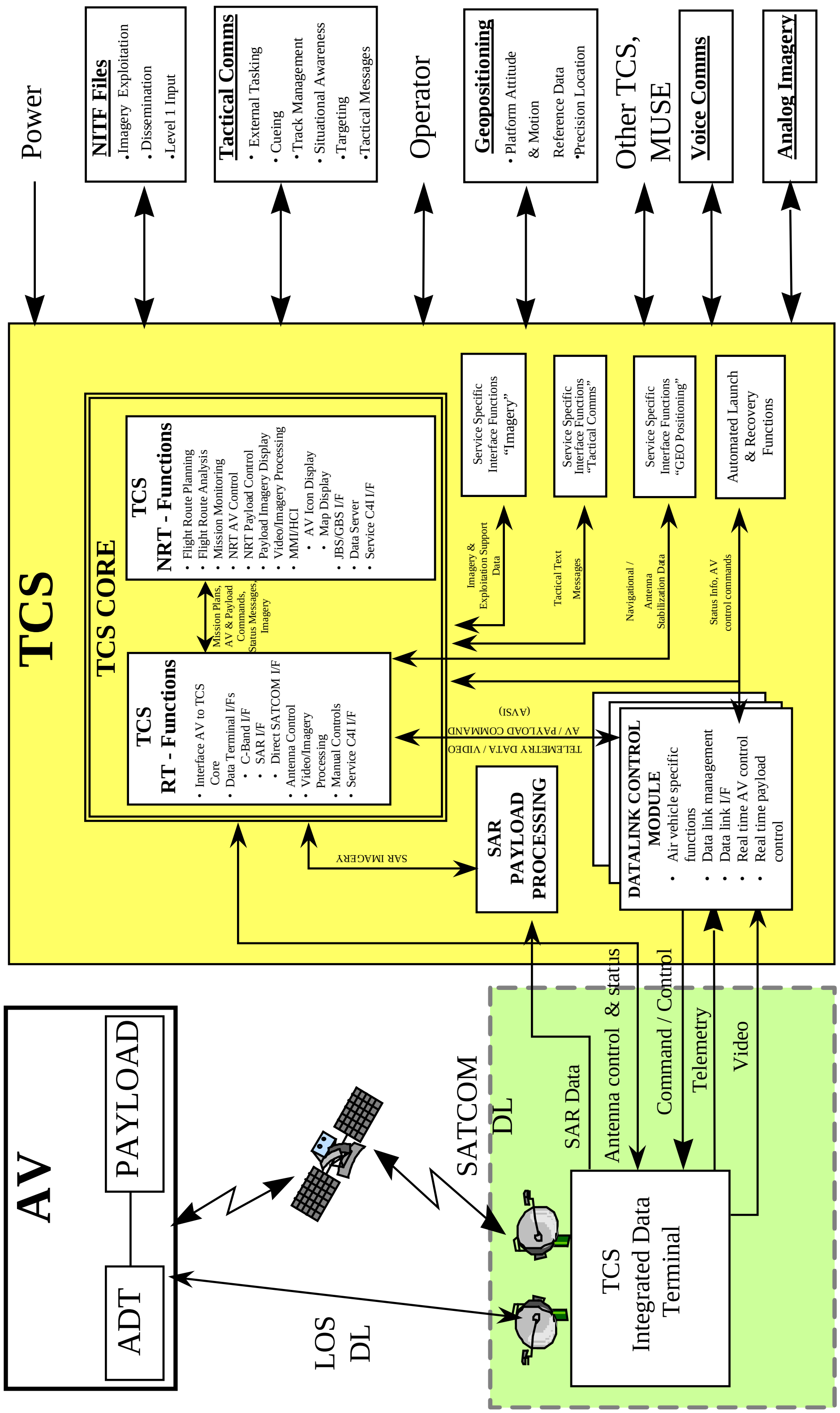

Figure 3-3. TCS Component Architecture

3.5 SYSTEM OPERATION. TCS operates on a set of core functions that are common to all UAVs and that are required for fundamental operations. These core functions include mission planning, mission monitoring, data link monitoring and operator-computer interface. TCS is segregated into three principal segments: real time, non real-time, and AV specific. The real-time segment includes those flight critical interfaces and processes to command and control the air vehicle and data link. The non-real-time interfaces include mission planning, operator input/output, and message handling functions. The air vehicle standard interface (AVSI) is flight and mission critical, and enables the data server software to interface with AV specific DCM hardware. As such it also provides the real-time gateway between the DCM and the non-real time portions of TCS. This feature allows each UAV manufacturer's DCM to retain its proprietary air vehicle unique commands and system controls while enabling operations on the TCS network with core functions.

Each type of air vehicle requires its own unique datalink and antenna assembly. Therefore TCS must be configured with multiple GDTs and antennas, or a single IDT to control different types of air vehicles. Specific GDTs or an IDT are required to synchronize the ground station signal with that of the air vehicle data link terminal (ADT). This will remain a requirement until the advent of the tactical common datalink (TCDL) which will allow a single wide band antenna to transmit and receive multiple UAV signals.

The TCS system operates primarily by internally and externally interfacing hardware and software to achieve the functionality of a specific configuration. Internal interfaces support interaction between the various hardware and software components of the system/subsystems. External interfaces involve inputs and outputs between the TCS system and supporting equipment. See Appendix D for a more detailed discussion of TCS component interfaces.

The TCS system has three states of operation: start-up, operations, and shutdown. Within the operations state, TCS has three modes of operation: Normal Operations Mode, Training Operations Mode, and Maintenance Operations Mode. An Emergency Mode, consistent with legacy UAV systems will be implemented in TCS. Until this mode is implemented, the procedures described in Section 5.3, Emergency Procedures, apply for lost link situations.

3.5.1 Normal Operations Mode. In the Normal Operations Mode, all system software is capable of operating concurrently to support operations at all five levels of TCS functionality. Access to this mode is controlled by DII login/user accounts. User accounts support flight and control of an AV or its payload, monitoring or processing of UAV data, or system configuration and setup. In this mode, TCS supports the functions as shown in Figure 3-4.

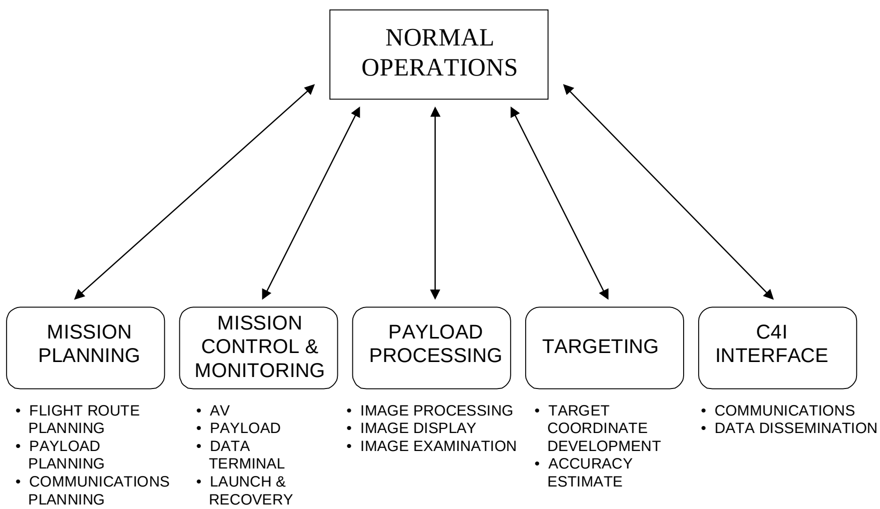

Figure 3-4. Normal Operations Mode Functions

All of these functions can operate concurrently without precluding or excluding any other functions.

3.5.2 Training Operations Mode. The Training Operations Mode provides the capability to train at levels of TCS functionality for which actual hardware is present or a simulation capability is provided. Access to this mode is controlled by the designation of training missions. In this mode, the following software operates: TCS core functionality, mission planner, C4I interfaces, DII/COE, operating system, and data server. All of these functions can operate concurrently without precluding or excluding any other functions. Figure 3-5 shows the Training Operations Mode functions.

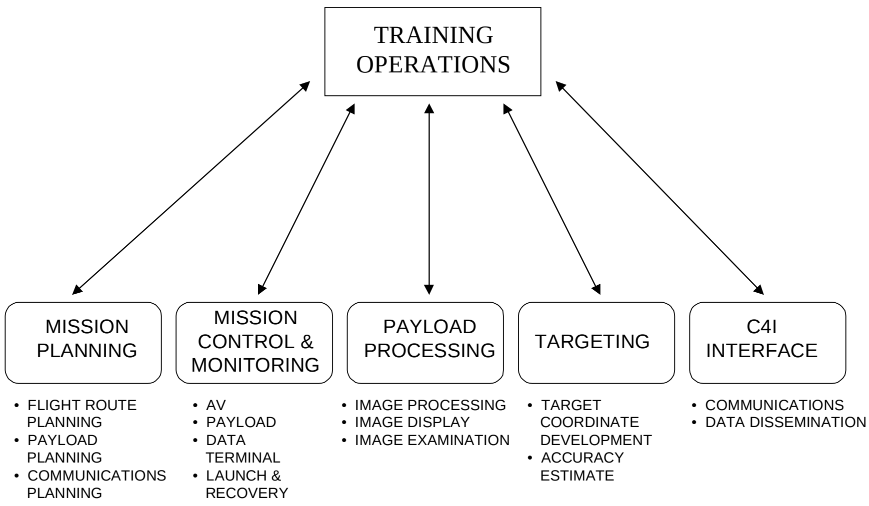

Figure 3-5. Training Operations Mode Functions

3.5.3 Maintenance Operations Mode. In the Maintenance Operations Mode, TCS core functionality software supports the functions as shown in Figure 3-6.

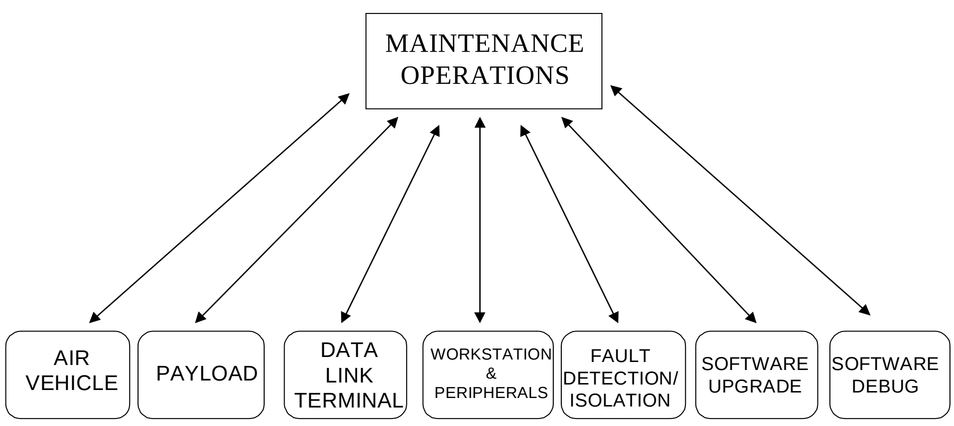

Figure 3-6. Maintenance Operations Mode Functions

Except for software upgrades and debug, all functions can operate concurrently on a not-to-interfere basis without precluding or excluding any other functions.

3.6 CONFIGURATION. TCS functionality is available in four system configurations: a land-based (LB) HMMWV-shelter production version, a ship-based (SB) production version, an RQ-1A system GCS backfit/forward fit version, and a Pioneer shelter retrofit version. *Exact configuration of production TCS systems will be determined based upon the assessment of operational suitability during DT/OT with LRIP systems.* Production TCS systems are identified using a nomenclature that indicates the configuration type, TCS program block, version within the block, and scaleable configuration of the baseline. As an example, the configuration nomenclature of TCS LB 1/1/1A denotes a TCS land-based Baseline 1 configuration with Block 1 Version 1A capability.

TCS configurations are scaleable and modular to enable upgrading or downgrading capability across the different levels of interaction. Options include LOS or BLOS control, single or multiple payload or air vehicle control, EO/IR or SAR imagery processing, and single or multiple TCS workstations. A typical TCS consists of two workstations (a Mission Payload Operator [MPO] and an Air Vehicle Operator [AVO]), associated peripherals, dedicated UAV DCMs, dedicated UAV GDT or IDT/antenna control suite, and associated hardware. Each workstation is functionally identical and hosts the image and data displays, route planner, and payload and vehicle controls. This provides full functionality at all levels of interaction to be accomplished from a single TCS workstation. Configurations differ as specific functionality is added or removed. Level 1 configurations require a minimum of hardware and software components while Level 2 through 5 configurations require air vehicle related hardware (DCMs/GDT or IDT and antenna(s)) to allow TCS – air vehicle interaction.

3.6.1 Land-Based (LB) Configuration. The notional LB TCS configuration is incorporated into an HMMWV-mounted shelter and includes two crew-oriented, independently functioning and interoperable TCS workstations, associated peripherals, DCMs, IDT, and antennas. TCS software is hosted on Sun tactical computers and is fully interoperable with the operating Service tactical C4I system. The land-based TCS configuration will be deployed by Army and Marine Corps at various echelons of command. This configuration is fully transportable to the operating area by air, rail, or sea, and is self-mobile once on the ground. The land-based configuration requires 1 hour to set-up and ½ hour to teardown. Figure 3-7 shows an LRIP, production representative LB configuration.

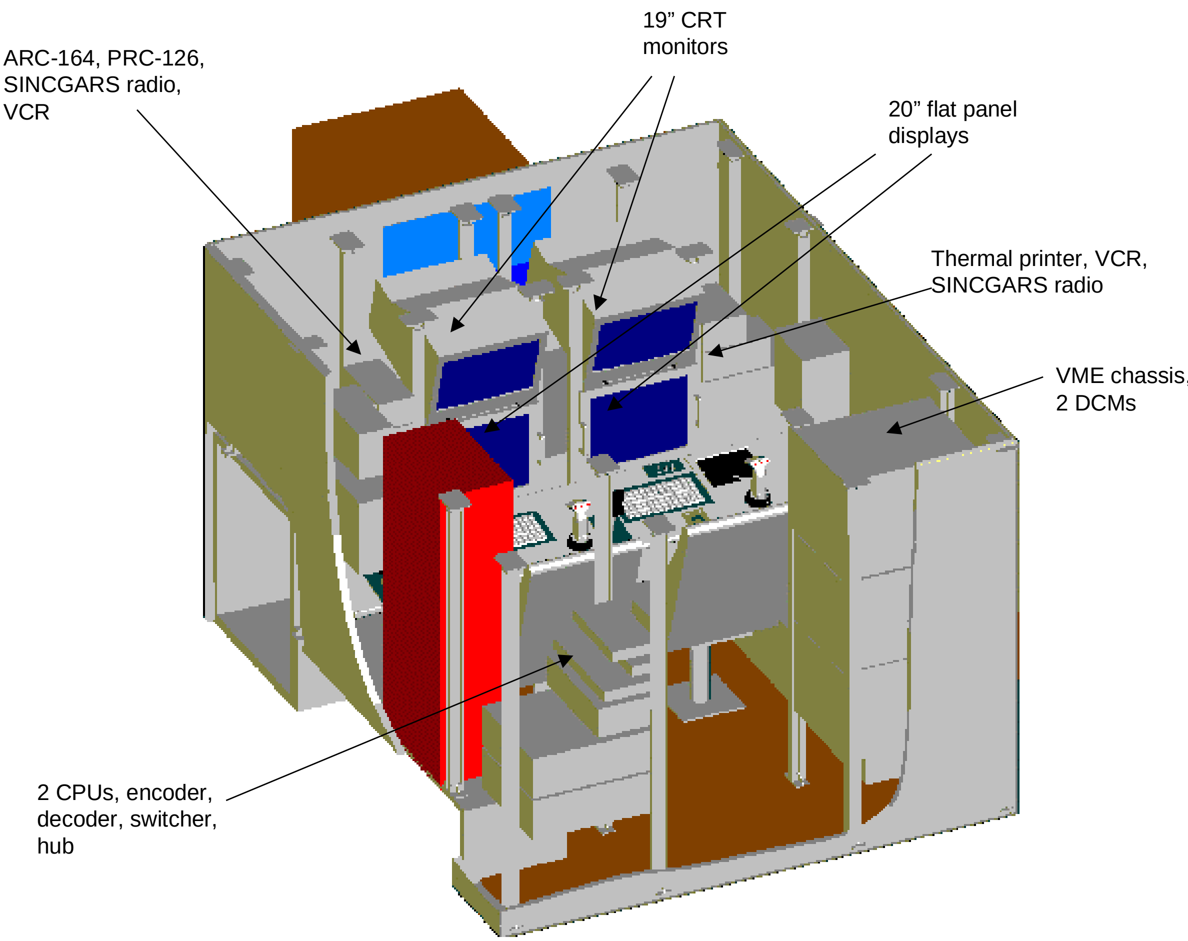

Figure 3-7. TCS Land-Based HMMWV Shelter Configuration

3.6.2 Sea-Based (SB) Configuration. The SB TCS configuration can be incorporated into ships that have undergone the approved TCS ship alteration to install system cabling and antenna(s), and have adequate space to accommodate required TCS components. The notional SB configuration consists of two workstations, associated peripherals, DCMs, IDT, and antenna(s). The sea-based TCS configuration is hosted on TAC-4 computers and is fully interoperable with the shipboard Joint Maritime Command Information System (JMCIS). In the SB configuration, antenna location, polarization, and stabilization are key to successful operations. Most single antenna installations will result in signal blockage as the ship's superstructure masks the signal between the air vehicle and the data link antenna at certain times. In addition, a two antenna installation is required to provide simultaneous multiple UAV control capability. Figure 3-8 shows an equipment schematic of a notional SB configuration prior to incorporation of an IDT. Figure 3-9 shows the schematic for an IDT. Figure 3-10 shows the schematic for the additional equipment to provide payload control and BLOS capability.

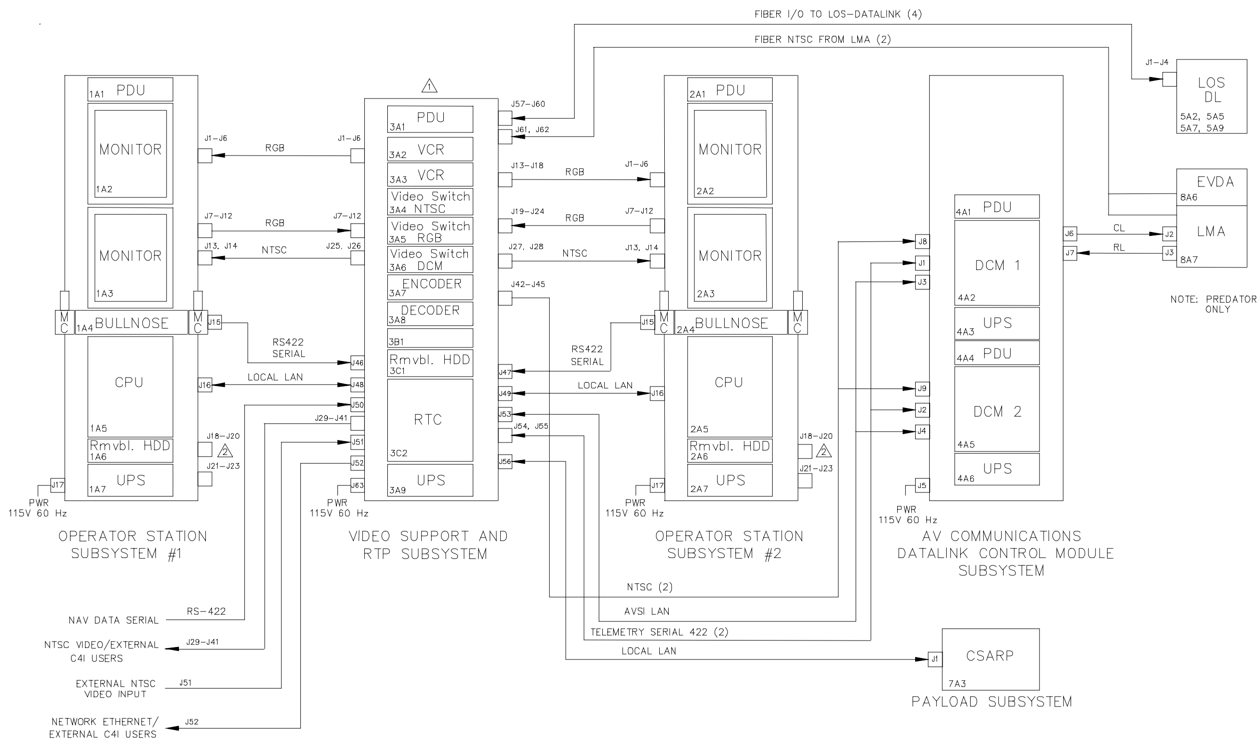

Figure 3-8. TCS Sea-Based Configuration

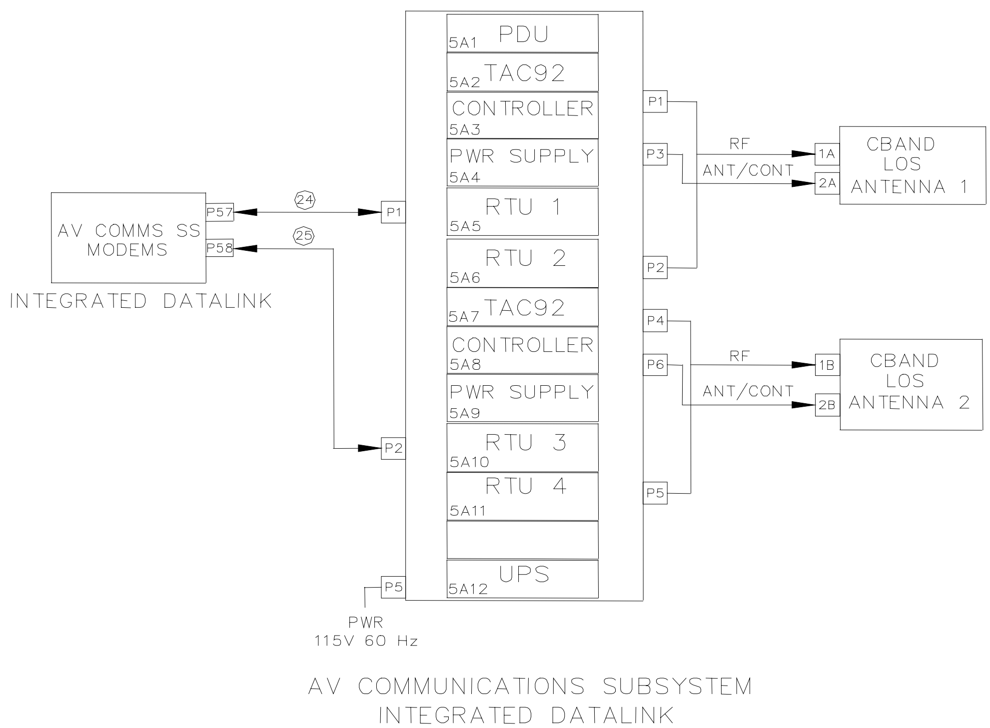

Figure 3-9. IDT Configuration

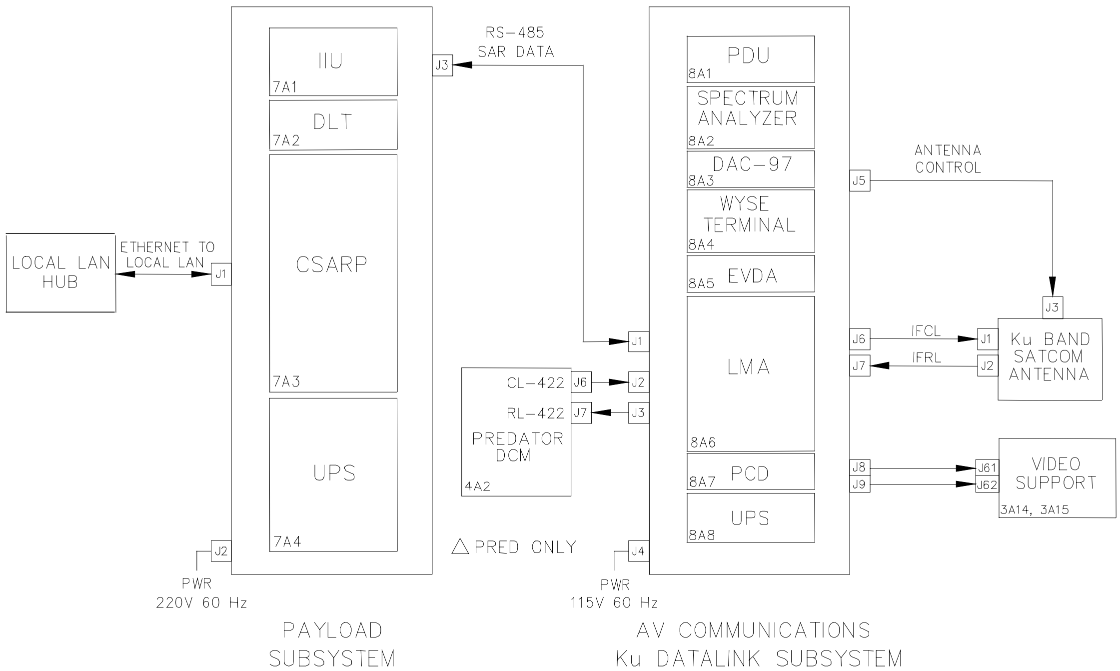

Figure 3-10. Payload and BLOS Configuration

3.6.3 RQ-1A MAE UAV GCS Configuration. Existing RQ-1A GCSs will be modified with selected TCS software and hardware to achieve DII/COE compliance and provide TCS interoperability. This facilitates the dissemination of Predator-derived imagery and data to other TCS nodes or specified joint or Service C4I systems through a TCS-C4I system interface. It also provides the RQ-1A GCS the capability to receive other UAV-derived products. Because the Air Force has no requirement to control either the sensor or AV of other Service tactical UAVs, a TCS modified RQ-1A GCS does not provide that capability.

3.6.4 PIONEER TCS Configuration. TCS software and selected hardware will be fully integrated into existing Pioneer shelter configurations and will essentially serve as the Pioneer GCS. Pioneer will retain its indigenous Tracking and Communications Unit (TCU) that allows for remote flight control of the vehicle. This will facilitate full Level 5 TCS at the Pioneer control station. Figure 3-11 shows a Pioneer shelter configuration modified with TCS. The Pioneer TCS configured shelter is mounted on a five-ton truck for land-based operations.

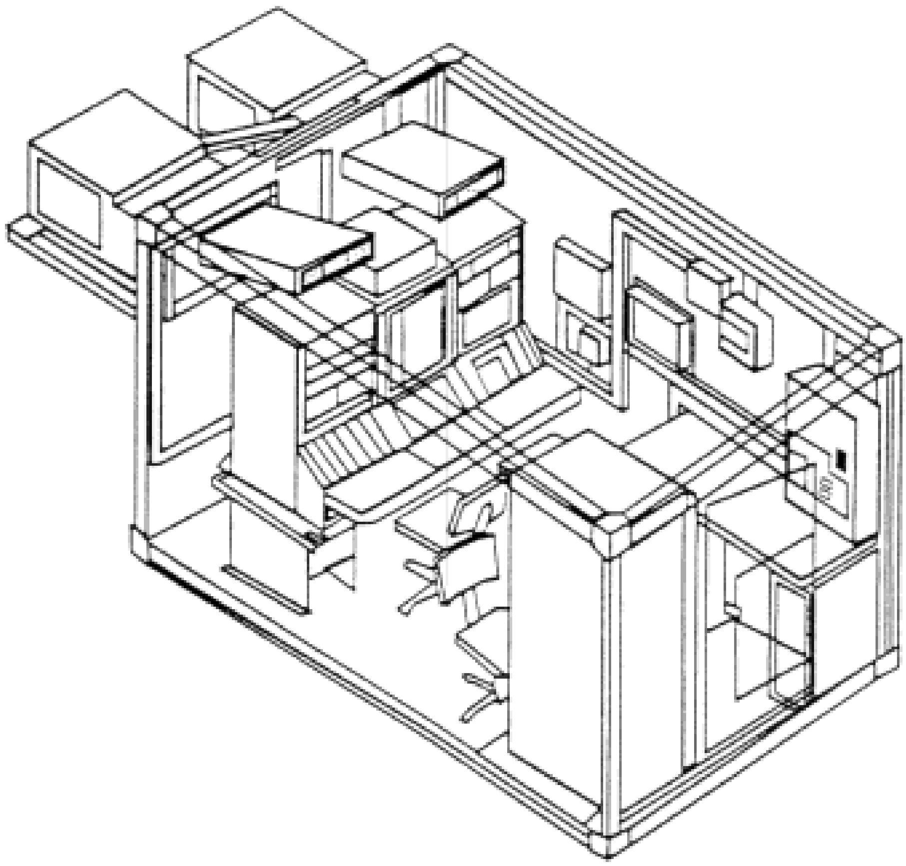

Figure 3-11. Pioneer TCS Configuration

3.7 TCS INTEROPERABILITY. The JROC-approved ORD requires TCS to be fully interoperable with current tactical UAVs and the MAE UAV, and joint and Service C4I systems as threshold capabilities, and to be interoperable with HAE UAV for imagery receipt as an objective capability. TCS is also required to be interoperable with all future UAVs, and joint and Service C4I systems. Open software architecture supports future UAV interoperability by establishing standards, interfaces, and protocols for air vehicle operation and imagery dissemination. TCS is also capable of supporting additional software modules for future payloads and payload capabilities (e.g., autosearch and automatic target tracking) for current UAV systems.

3.7.1 UAV Interoperability.

3.7.1.1 Tactical UAV Interoperability. Army, Navy, and Marine Corps TCS systems are functionally interoperable at Levels 1 through 5 with the currently operational Pioneer tactical UAV system, the Outrider ACTD TUAV system, and all future tactical UAVs. Air Force RQ-1A GCS/TCS systems are functionally interoperable at Levels 1 and 2 with the Pioneer tactical UAV, the Outrider ACTD TUAV system, and all future tactical UAVs.

3.7.1.2 PREDATOR MAE UAV Interoperability. Army, Navy, and Marine Corps TCS systems are functionally interoperable at Levels 1 through 4 with the Predator MAE UAV. Air Force RQ-1A GCS/TCS systems are functionally interoperable through TCS software and hardware with the Predator MAE UAV at Levels 1 and 2. Air Force interoperability with the Predator MAE UAV uses existing RQ-1A GCS software and hardware to provide the functional equivalent of TCS Levels 3 through 5.

Note: Army, Navy, and Marine Corps are currently prohibited by Air Force safety and training policy from conducting Level 3 or 4 operations with the Predator MAE UAV.

3.7.1.3 HAE UAV Interoperability. All Service's TCS systems will be functionally interoperable at Levels 1 and 2 with both the conventional HAE UAV (Global Hawk) and the low observable HAE UAV (Dark Star) as an objective capability. Army is pursuing Level 3 and 4 interoperability in selected non-UAV system equipment including the Enhanced Tactical Radar Correlator

(ETRAC), Tactical Exploitation System (TES), and the GUARDRAIL Integrated Processing Facility (IPF)/Aerial Common Sensor (ACS) Ground Processing Facility.

3.7.2 C4I Interoperability. TCS is interoperable with selected joint, Service, and NATO C4I systems. This interoperability facilitates the dissemination of imagery and data at all levels of interaction and eliminates the requirement for individual UAV systems to develop interfaces with the myriad of C4I systems. The TCS system and individual workstations are capable of receiving, displaying, and transmitting a complete complement of imagery types including still, motion, and video.

Additional communications bandwidth and components, driven by the type of products and timeliness required by the user, are required to enable real time connectivity with other nodes. Near real time full motion video and SAR frame imagery receipt and dissemination impose the greatest requirement and will necessitate a minimum of a T-1 capable circuit. BLOS operations may require a large earth terminal for direct receipt of the product.

The capability of TCS to receive imagery from a UAV can be constrained by the capabilities of the communications path providing that imagery to the TCS system. The capability to further disseminate that received imagery is a function of the physical hardware and software capabilities of the C4I system to which TCS is interfaced. In addition, JFC or Service component commander priorities for imagery dissemination may artificially limit the complete use of those capabilities. Physical limitations affecting TCS/C4I interoperability with respect to specific system processing capabilities for image size, frame rate, transmission speed, compression techniques employed, and bandwidth availability for imagery dissemination are standardized by DII/COE.

TCS integration with C4I systems is accomplished through interfaces that permit information exchange between the TCS and the specified C4I systems. Figure 3-12 shows the various C4I systems with which TCS is interoperable (see Appendix G for system names associated with the acronyms). In addition, TCS interfaces with standard DOD tactical (very high frequency [VHF], ultra-high frequency [UHF], VHF/UHF, and high frequency [HF]) radios, Mobile Subscriber Equipment (MSE), and military and civilian satellite communications.

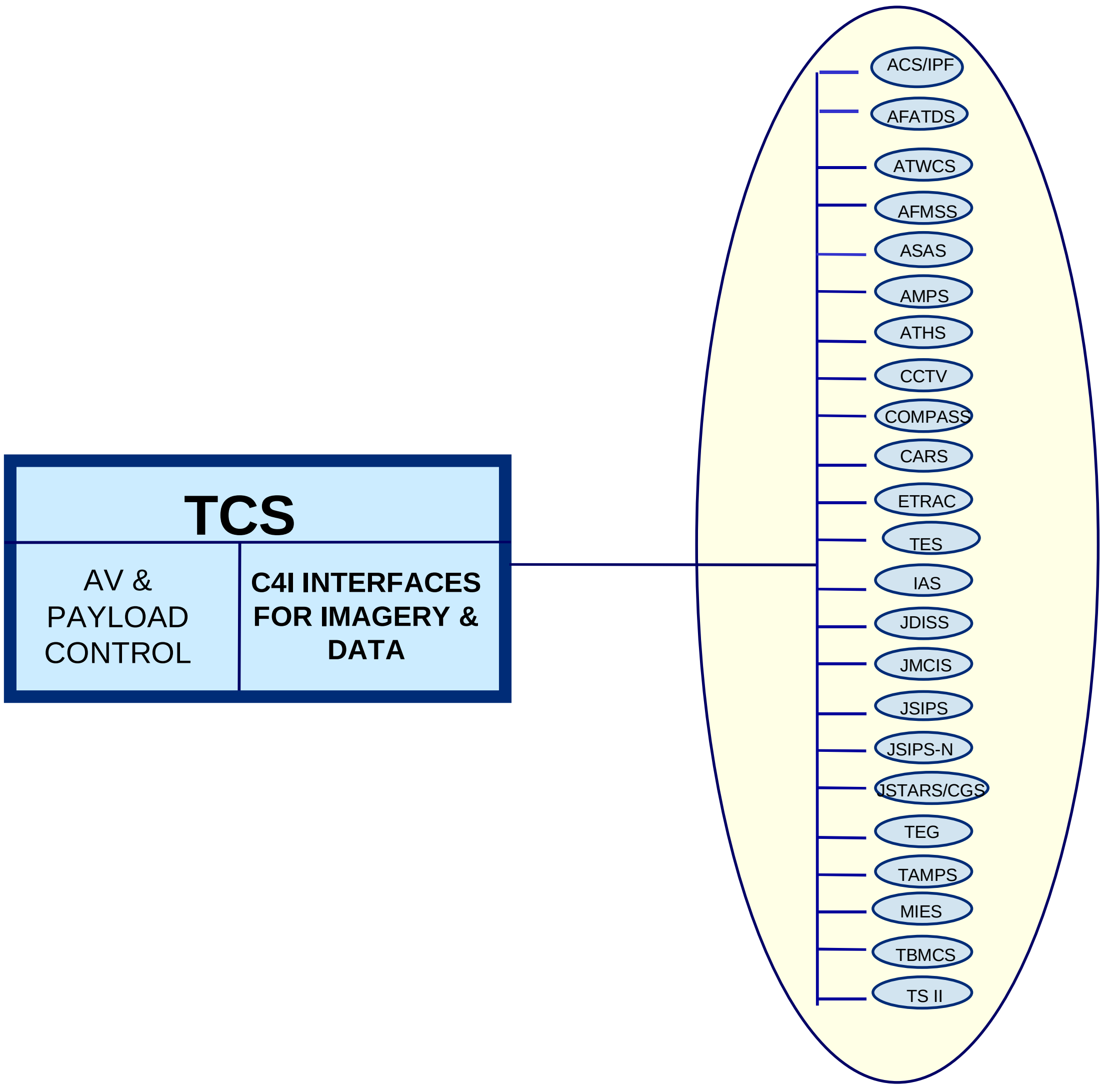

Figure 3-12. TCS-C4I Interoperability

3.8 TCS PERFORMANCE AND LIMITATIONS.

3.8.1 Performance Parameters. TCS is designed to the following performance standards:

Operating continuously in the Operation Mode for a minimum of 72 hours.

An operating availability rate of 90%.

After emplacement at the operational site, planning and conducting a mission within 1 hour of tasking, to include planning a mission with a minimum of one waypoint, preparing two AVs for flight, setting up a data-link terminal, installing safety equipment, and launching a single AV.

A mean-time-between-failure (MTBF) of equal to or greater than 2000 hours.

A mean-time-to-repair (MTTR) of equal to or less than 1.9 hours.

Requiring less than one hour per day of preventative maintenance (PM) on a non-interference basis and less than one hour per week on an interference basis.

Storing 640 column by 480 row 24-bit RGB color still frame images using a 4.0 gigabyte or larger hard drive. Images may be stored in either uncompressed format (approximately 922 Kb) or in JPEG compressed format (approximately 50-53 Kb at 16:1 compression ratio). Image sizes include metadata associated with the image.

The uninterruptable power supply (UPS) is capable of supplying 30 minutes of power to flight critical components.

3.8.2 System Limitations. TCS performance parameters may be less than some systems with which it is interoperable (e.g. Predator and Global Hawk are both designed to operate 24 hours per day/7 days per week). Differences in design performance may impose some potential system operating limitations.

4.0 TCS EMPLOYMENT AND OPERATIONS

4.1 Purpose. This section provides background information and broad guidance concerning the employment and operation of TCS. Emphasis is at the JFC and Service and functional component commander levels. Information and guidance contained herein is intentionally descriptive in nature rather than prescriptive so as to provide all commanders with the greatest flexibility in determining how best to employ TCS capabilities to achieve coherent jointness across the range of military operations.

The general concepts presented in Section 4.3, General Employment Concepts, provide a framework, and guide for operational employment of TCS capabilities. Section 4.4, Specific Employment Concepts, provides the potential TCS user with representative applications of TCS capability in a variety of scenarios across the military operations continuum. When combined with the notional concepts presented in Section 4.3, the representative applications provide a baseline from which UAV command and control (C2) employment and imagery dissemination options may be considered and decisions regarding specific applications of TCS may be made.

4.2 Overview. TCS contributes to both the development of information superiority and the execution of precision engagement. The contribution of TCS is embodied in the fundamental capabilities the system brings to the battlespace. These capabilities provide the warfighter with enhanced functionality in two areas: 1) payload and air vehicle command and control, and 2) imagery routing and dissemination. The common UAV command and control hardware and software suite TCS introduces to the force provides commanders with unlimited flexibility in establishing supported-supporting relationships among forces that have UAV capability or that require non-organic UAV support. The range of potential imagery dissemination interfaces and paths also provides commanders with new opportunities to furnish a wider range of designated users with information that will contribute to achieving information superiority or enable precision engagement.

In combination, endurance UAVs (EUAVs) and tactical UAVs are valuable assets that can assist a joint force in meeting a variety of theater, operational, and tactical objectives. UAVs are force multipliers. They can be used to conduct day or night RSTA tasks, facilitate battle damage assessment (BDA), and contribute to force asset management. UAVs are particularly useful where human safety is a prime factor, the availability of manned systems is limited, or loss of high-value, manned systems is possible, and real-time or near-real-time information is required. Current and projected near term force structure means UAVs are high demand, limited availability resources. In order to create the necessary synergy and optimize the employment of these limited resources, the JFC must ensure the actions of assigned, attached, and supporting UAV capabilities/forces are synchronized in time, space, and purpose. To achieve assigned objectives as rapidly and as effectively as possible, the JFC must also fully exploit the unique characteristics of TCS to interoperate with the families of all UAVs and the range of C4I systems with which TCS is designed to interface.

TCS allows full integration of UAVs within the battlespace as a component of, or in augment to, various weapons systems. The unique capability of UAVs to deliver real time sensor information provides a level of utility well above and beyond traditional reconnaissance and surveillance activities. More pointedly, in most cases the warfighter in the battlespace can understand and interpret real time sensor information effectively without an analysis filter, and can control UAV payloads that are, by in large, less sophisticated than the weapon systems that forces are currently employing to engage the enemy.

Accordingly, employment planning and tasking of TCS capabilities to support joint force objectives will be centralized within existing joint force organizations and processes. At the joint force level, the JFC will define supported-supporting relationships among staff organizations, and functional and Service component commanders to accomplish TCS employment planning, tasking, and execution.

Employment planning and tasking, and dynamic or ad hoc retasking of UAVs made available by components in support of the JFC's operation or campaign objectives, or in support of other components of the joint force, are centralized functions to be performed by organization(s) as designated by the JFC. Centralizing these functions ensures the necessary synergy to coordinate required collection management processes, apportion the joint air effort, and develop the joint air operations plan. This ensures unity of effort in the planning and tasking of UAVs to the benefit of the joint force as a whole. Embedded within that function, the unique UAV C2 interfaces and dissemination capabilities that TCS as a system provides to the force will also be planned and tasked. The organization(s) designated by the JFC to perform these functions will be guided in this process by the JFC's operation or campaign objectives and the commander's intent regarding employment of EUAV assets to support tactical operations and employment of tactical UAV assets to support operational and theater objectives.

During planning for the employment of UAVs, conflicts may develop between Service doctrine or UAV employment concepts and procedures, and concepts and procedures resulting from the enhanced capabilities TCS provides. When such conflicts are identified, they will be resolved on a case-by-case basis between the JFC and the Service component operational control (OPCON) authority.

4.3 General Employment Concepts. The fully scaleable and flexible nature of TCS offers commanders a wide range of options to integrate TCS capabilities into the joint air operations plan and to fulfill forcewide UAV collection and dissemination requirements. TCS employment options are companion considerations in the development of the UAV C2 and payload employment strategy, and the plan for dissemination of UAV products to the warfighter..

When, and exactly how to employ the unique UAV C2 and imagery dissemination capabilities that TCS provides will be a function of specific TCS configurations, available TCS nodes, user requirements, and operator training, qualification and currency to employ the desired level of functionality. The range of TCS functionality is shown in Figure 4-1.

- RECEIVE & DISSEMINATE ANALOG VIDEO & NITF DIGITAL IMAGERY
- CONDUCT VOICE COMMUNICATIONS FOR AIRSPACE CONTROL & INTERFACE FOR TACTICAL VOICE COMMUNICATIONS
- FORMAT, TRANSMIT, & RECEIVE SELECTED TACTICAL COMMUNICATIONS MESSAGES
- RECORD & RETRIEVE PAYLOAD DATA
- VIEW & REVIEW* PAYLOAD DATA FROM MULTIPLE PAYLOADS SIMULTANEOUSLY
- CONTROL & MONITOR MULTIPLE PAYLOADS SIMULTANEOUSLY
- PLAN UAV MISSIONS
- CONTROL & MONITOR MULTIPLE UAVs SIMULTANEOUSLY
- MONITOR THE PERFORMANCE & STATUS OF THE UAV SYSTEM

Figure 4-1. TCS Functionality

* UAV imagery review capability varies by Service component –

Air Force – Air Force capability (within the RQ-1A GCS) involves first look analysis and voice reports.

Army – Army capability varies by echelon. Lower echelons provide less detailed analysis with text reports.

Navy – Navy capability provides first look exploitation and voice reports.

Marine Corps – Marine Corps capability provides limited exploitation and comparative analysis.

Specific training (see Appendix E) is required to effectively employ TCS. With the appropriate TCS and Service specific air vehicle/payload training, Service operator and maintenance personnel should be capable of fully employing TCS at all five levels of functionality. In addition, with the appropriate TCS training, personnel without specific air vehicle training should be capable of employing TCS at Levels 1 and 2. For high tempo operations, it may be prudent to augment TCS-equipped, UAV control units with additional TCS/air vehicle-qualified operator and maintenance personnel. During extended or high tempo operations, individual Service policy will dictate the optimum duty cycle for TCS operators.

4.3.1 TCS Organization. TCS capability will be integrated with all tactical UAV units and with the USAF RQ-1A MAE UAV system. TCS capability may also be integrated into non-UAV units as directed by appropriate authority. Combatant command authority (COCOM), OPCON, tactical control authority (TACON), and administrative control (ADCON) of TCS is exercised through normal organizational command structures.

Geographic CINCs are COCOM of all Service component forces assigned under the Secretary of Defense (SECDEF) "Forces For Unified Commands" memorandum, including all TCS-capable tactical units. USCINCACOM is also COCOM of all RQ-1A MAE UAV forces. OPCON and TACON of TCS-capable units will be exercised through respective JFCs and individual Service component commanders. ADCON of TCS-capable units is an individual Service component commander responsibility.

4.3.1.1 COCOM Responsibilities. Combatant commanders exercising command authority over TCS-capable forces will employ them to meet their own theater operational and training needs, and will deploy TCS-capable forces to satisfy the operational and exercise requirements of other CINCs when the Joint Staff directs such support.

4.3.1.1.1 TCS Deployment. Operational deployment of TCS-capable units will be coordinated between the supported and supporting COCOM authorities. Inter-theater transportation for TCS-capable units with land-based or RQ-1A GCS TCS configurations will normally be by air; intra-theater transportation may be by ground, rail, or air. Since TCS installation aboard Navy ships is a complex and time-consuming operation, deployment of sea-based TCS-capability can only be accomplished by ships already outfitted and configured with TCS.

4.3.1.1.2 TCS-Capable Unit Basing. Unless specifically directed otherwise by the COCOM authority, basing of both UAV and TCS-capable non-UAV units will normally follow Service component command echelon plans.

4.3.1.2 OPCON Responsibilities. JFCs and Service component commanders exercise OPCON of assigned and attached TCS-capable units. OPCON responsibility includes providing housing, security, messing, health care, and supply support for TCS-capable units deployed in support of operational or exercise requirements. Service component OPCON responsibility also includes decision authority regarding employment of TCS-capable units in Service operations, exercises, and demonstrations.

As dictated by JFC operation or campaign objectives, and as tasked by the designated tasking authority, the OPCON authority also has responsibility to provide the required C4I connectivity to support TCS imagery processing, exploitation, and dissemination (PED). In addition, where non-organic TCS control of air vehicles or payloads is anticipated, the OPCON authority should provide the necessary communications path(s) to coordinate handoffs between TCS units.

4.3.1.3 TACON Responsibilities. Commanders of TCS-equipped units exercise TACON of assigned TCS assets. As directed in the Air Tasking Order (ATO), TCS-equipped units also exercise TACON of UAV air vehicles or payloads for specific missions for specific periods of time.

4.3.1.4 ADCON Responsibilities. Service component commanders exercise ADCON of TCS-capable units. TCS logistics support is an ADCON authority responsibility.

4.3.2 TCS Planning and Tasking. Intelligence, surveillance, and reconnaissance (ISR) **planning** involves the collection, processing, validation, and prioritization of ISR collection requirements. ISR **tasking** includes matching collection requirements with collection resources and collection dissemination paths. Centralized ISR planning and tasking optimizes the application of forcewide manned and unmanned ISR resources, lessens the likelihood that more than one sensor will be focused on the same target at the same time, and ensures designated echelons of the force receive ISR products in a timely fashion.

The current families of UAVs are key resources that can support the full range of theater, operational and tactical ISR requirements. Therefore, planning the employment of UAV capabilities to meet forcewide ISR requirements is best accomplished as an integral part of the joint force collection management (CM) process. As air assets, the tasking of UAV missions is best accomplished within the ATO process.

The JFC is responsible for determining how to centralize planning and tasking functions within the force. In most situations, the JFC will designate the J2 CM staff to conduct the ISR planning function within the CM process and designate a Joint Force Air Component Commander (JFACC) to conduct the ISR tasking function within the ATO development process. There may be some situations where designating a component to perform the ISR planning function is advantageous. If the JFC delegates ISR planning responsibility to a component organization, the JFC must establish the necessary supported-supporting relationships within the force to accomplish both routine planning and tasking, and dynamic retasking.

Because TCS can be both the command and control node for UAVs and the imagery dissemination interface to C4I systems, proper TCS integration is critical to the overall ISR plan. Centralizing the planning and tasking of TCS equipped units within existing joint force CM and ATO structures and processes is therefore necessary to synchronize and integrate the unique capabilities of TCS-equipped units with other capabilities of the force. It also minimizes the management requirement to integrate this new capability. TCS employment planning and tasking is correctly part of the joint force CM process; the existing Daily Airborne Reconnaissance Surveillance (DARS) process, discussed in USACOM tactics, techniques, and procedures (TTP), provides a proven methodology for accomplishing centralized CM planning. The tasking of TCS units is correctly accomplished as part of the joint force ATO process.

The organization responsible for UAV/TCS planning and tasking will develop the plan for TCS unit employment. The employment plan development process is synchronized with the joint force ATO development process and ensures the required tasking information is provided to the JFACC Joint Air Operations Center (JAOC) in a timely fashion. This plan should consider the employment factors as shown in Figure 4-2.

- NUMBER AND TYPES OF UAVs AVAILABLE
- THEATER, OPERATIONAL, AND TACTICAL NEEDS FOR THOSE UAVs
- NUMBER, CONFIGURATION and LOCATION OF TCS SYSTEMS AVAILABLE
- C4I EXPLOITATION ARCHITECTURES AND CAPABILITIES AVAILABLE WITHIN THE FORCE
- FREQUENCY MANAGEMENT PRIORITIES (DATA, VOICE, ETC.) AND BANDWIDTH AVAILABILITY
  - ANTENNA FUNCTION AND MANAGEMENT*
- EXPLOITATION ASSETS AVAILABLE TO RECEIVE TCS DATA
- TCS OPERATOR QUALIFICATIONS/CURRENCY
- OPERATING ENVIRONMENT
- RULES OF ENGAGEMENT
- CONTROLLED NATIONAL AIRSPACE CONSIDERATIONS
- SERVICE DOCTRINE OF THE UNITS EXERCISING OPCON OF THE UAV(s)

Figure 4-2. UAV/TCS Employment Considerations

* In both land-based and sea-based applications, antenna blockage during critical segments of UAV flight or payload control evolutions could result in the loss of UAV data and possibly loss of the air vehicle. In the sea-based environment, antenna destabilization can also pose potential problems. Therefore, antenna function and management are key operational factors that must be considered in the planning process.

The UAV/TCS unit employment plan will be provided to the JFACC for mission coordination, airspace deconfliction with the Airspace Control Authority (ACA), assignment of protection assets if required, and incorporation into the daily ATO. TCS unit employment will be reflected in the ATO through the ISR special instructions (SPINS). The SPINS will reflect UAV TACON, launch and recovery units, the unit(s) to command and control the air vehicle, the unit(s) to command and control the payload, and time periods for air vehicle or payload control, and handoff locations and times. In addition, the most efficient UAV product dissemination method (architecture, technique, process, and path) to ensure the required user(s) receive the payload product must be identified. When one component's UAV resources will be used to support another component's requirements, component to component coordination is required to refine UAV-TCS mission details as stipulated in the SPINS.

To support the UAV/TCS planning and tasking process, liaison officers (LNOs) from all components equipped with UAV capability should be assigned to support the organization(s) designated by the JFC. These LNOs provide functional area and mission expertise to support the proper planning and tasking of their component's capabilities and to coordinate cross-component support requirements. They are also responsible for keeping both the planning and tasking authorities aware of their component's specific UAV and TCS unit locations, and equipment and personnel readiness. The designated planning and tasking organizations will be guided by the concepts discussed in this CONOPS and perform their functions in accordance with current theater TTP and

Standard Operating Procedures (SOP) for CM and ISR planning and tasking. The UAV/TCS planning and tasking process is shown in Figure 4-3.

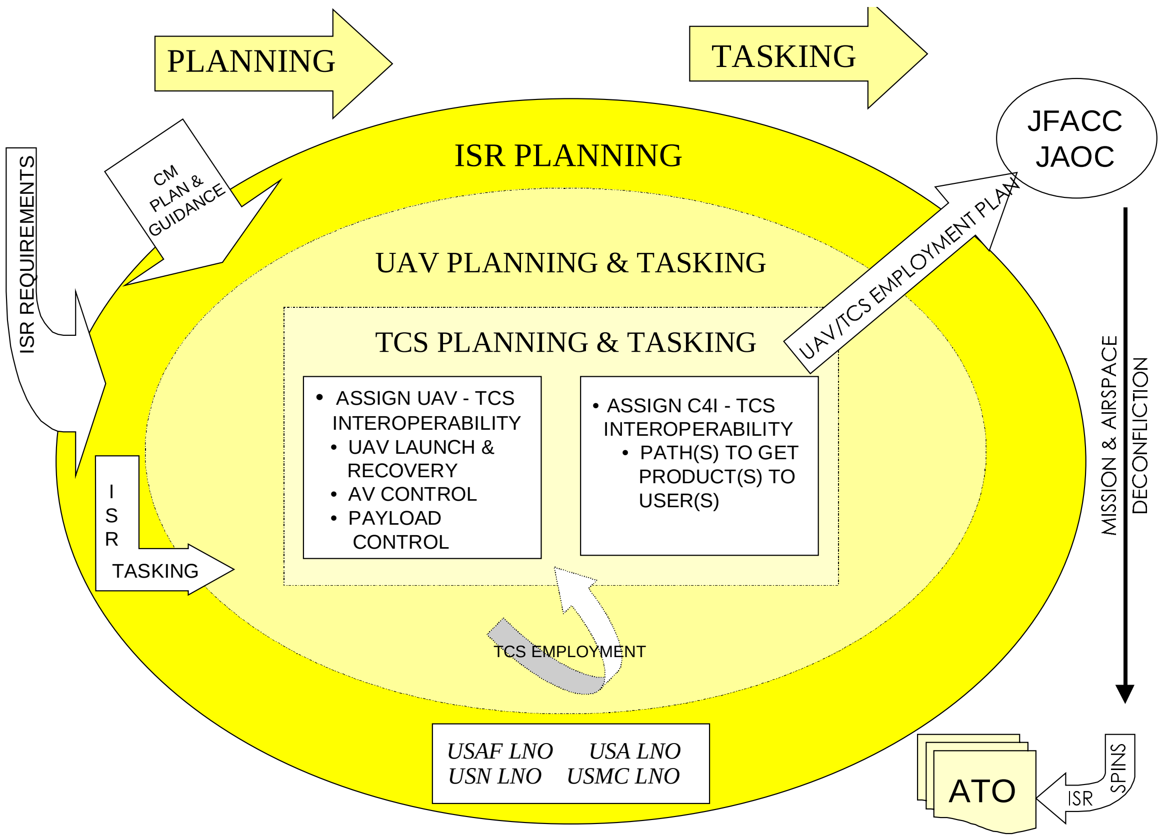

Figure 4-3. UAV/TCS Planning and Tasking Process

To ensure the entire force has the most complete awareness of forcewide ISR tasking, component collection requirements that will be accomplished with organic resources should be identified during the ISR planning and tasking process. Organic UAV missions that will fill these requirements should have mission plans provided to the JFACC to ensure air vehicles are properly protected, airspace is assigned and deconflicted, and that these UAV missions are identified to all airspace users.

After the ATO is published, or missions are in execution, emergent ISR requirements will follow one of two planning and tasking paths.

- When sensor retasking alone can fill the requirement, the component with the requirement can coordinate directly with the respective UAV TACON authority to adjust the sensor plan (including TCS payload control assignments) and to coordinate and assign new tasking. If adjusting the approved sensor plan will impact other portions of the plan, then the JFC collection management authority (CMA) must establish sensor priorities. If the ATO plan will not be impacted by the adjustment, then the JFC CMA and JFACC should be informed once coordination has been completed.

- When a change of UAV mission profile is required to fill the emergent requirement, the component with the requirement must coordinate with both the UAV TACON authority and the JFACC to assess the impact and feasibility of changing the UAV mission profile and then advise the JFC CMA. If a change of mission profile (including TCS payload or AV control assignments) is feasible and warranted, the JFACC will coordinate and issue a change to the ATO for missions not yet in execution. Missions in execution will be dynamically retasked as coordinated by the JFACC.

For single Service operations employing multiple TCSs, UAV planning and tasking will be accomplished in accordance with Service doctrine. In single Service operations the responsible ACA will be provided UAV flight plans and will coordinate them with other flights in the area of operations. In operations where coordination is required with national airspace authorities, the UAV launch and recovery unit will normally be designated by higher authority to conduct that coordination.

4.3.3 Service Employment Concepts. When assigned to a joint force or attached to support a joint operation, TCS equipped Service components will conduct UAV operations under the direction of the JFC and in accordance with Service SOP. The efficient utilization of TCS brings operational enhancements to the employment of UAVs and enhances Service warfighter effectiveness in the conduct of joint military operations.

Individual Service components may employ TCS in different ways and extract unique benefits in support of mission objectives.

4.3.3.1 Air Force. Air Force currently operates the RQ-1A Predator MAE UAV system to support national, theater, and operational tasks as directed by theater CINCs.

TCS interoperability provides the capability to expand Predator missions to support the tactical level of military operations by providing a direct delivery path for Predator imagery products to other component users and Service C4I systems. Such operations could involve RSTA tasks for deep strike operations or theater ballistic missile defense (TBMD), naval gunfire support, maritime surface search and control, or amphibious landing support.

With the incorporation of TCS interoperability into the RQ-1A GCS, Air Force component forces are provided an avenue to access UAV imagery in real time from other Service component UAVs or from storage in the theater intelligence architecture. Additionally, TCS provides a direct electronic interface with the Service LNO at the designated planning and tasking authority. TCS can facilitate echelons below corps and other Service component support by providing communications connectivity between its distributed nodes, enabling faster request-approval-tasking loops and making imagery immediately available to the user.

4.3.3.2 Army. The Army will operate tactical UAV systems to provide RSTA and battle management direct mission support to commanders at the Corps, Division, Armored Cavalry, and maneuver brigade echelons. Tactical UAVs are used primarily as a confirming sensor, cued by other sensors or through the intelligence preparation of the battlefield (IPB) process. Tactical UAVs are capable of supporting the full range of RSTA functions based on the commander's priorities. The capabilities of these systems will be enhanced when they are employed as part of an overall collection plan and fully integrated with and cued by other intelligence collection systems, including other UAVs, in a synchronized effort.

TCS offers Army commanders the potential to integrate multiple tactical UAV and Predator ISR products in support of the ground maneuver commander's RSTA effort. TCS also provides the avenue for Army operated tactical UAV ISR products to be distributed to other Service components and elements of a joint force.

Army objectives require providing UAV payload data to a number of other systems to include the JSTARS CGS. This can be accomplished by collocating TCS with CGS or by hosting TCS on the CGS workstation and providing the same data link receiver elements (a CGS objective requirement).

4.3.3.3 Marine Corps. The Marine Corps will use TCS to conduct UAV operations in support of expeditionary operations and to support Marine Air-Ground Task Force (MAGTF) operations ashore and afloat. TCS will provide a means to control UAVs and disseminate UAV data to Aviation Combat Element (ACE)/Ground Combat Element (GCE) Commander(s), across a wide spectrum of operations, and provide a means to receive and disseminate data from non-organic UAV systems. TCS will allow properly trained personnel from other Services to operate Marine Corps organic tactical UAVs in support of Operational Maneuver from the Sea/Amphibious Operations, while Marine and other landing forces are phasing ashore, providing RSTA/tactical coverage to commanders until landing force facilities ashore become operational.

TCS will support a variety of UAV operational and tactical tasks, afloat and ashore and maximize the effective ranges of Marine Corps weapons systems and aircraft.

4.3.3.4 Navy. The Navy will employ organic tactical UAVs and will use TCS to integrate all UAVs in support of maritime and expeditionary RSTA functions. Navy receipt and dissemination of real time UAV data via TCS is critical in supporting a multitude of operations. Such operations could include strike warfare, communications/data relay, electronic warfare (EW), deep strike, naval surface fire support (NSFS), close air support (CAS); deep, shallow, and surf zone operations, and special operations conducted by Navy forces.

TCS will act as a force multiplier by providing scaleable, direct and indirect UAV system control and data dissemination to all naval forces operationally capable of employing TCS. In addition, TCS provides naval forces the ability to use non-organic UAV assets to support all maritime operations out to the maximum effective ranges of naval weapons systems and aircraft.

TCS provides the means to diversify the methods by which UAVs are deployed/employed and enables the "cross-decking" of UAV systems (contingent upon installation of the necessary ship alteration [SHIPALT]) or embarkation of qualified Air Force, Army, or Marine Corps TCS operators to support UAV operations from selected naval ships. Navy also has rapidly deployable ashore facilities (Mobile Ashore Support Terminal (MAST) and Mobile Integrated Command Facility (MICFAC) with extensive C4I connectivity that could support TCS operations up to Level 4.

4.4 Specific Employment Concepts. In its full configuration, TCS supports operations at five levels of increasing functionality. Those levels of operation, the flexibility with which TCS can be employed, and notional TCS employment considerations are discussed in the following paragraphs. The discussion of each level of operation is complemented with a representative scenario to notionally demonstrate how that level of functionality might be employed.

4.4.1 Level 1 Operations. Level 1 TCS operations involve the receipt and dissemination of UAV-derived imagery and data to a wide variety of users, totally independent of air vehicle or payload control requirements.

Level 1 TCS operations involve passive receipt of UAV sensor products from a secondary source and are accomplished with no direct interaction between UAV and TCS. Level 1 also provides for further dissemination of UAV imagery if operationally required. Though any computer system properly configured and connected can receive imagery or data from a secondary source, TCS provides the air vehicle telemetry and image ephemeris data critical to image manipulation and processing.

4.4.1.1 Operational Considerations. Any TCS-equipped unit can conduct Level 1 operations. TCS Level 1 operations should be considered when the end user is not equipped or configured to receive data directly from the air vehicle. Also, the end user requires the product in a format that will allow more detailed imagery analysis. Level 1 operations are always a subset of higher level operations supported by another TCS disseminating imagery through a C4I system or other TCSs. Level 1 TCS operations do not require external two-way voice communications.

4.4.1.1.1 Mission Planning. Level 1 TCS operations do not require detailed mission planning. Prior planning and coordination are required to ensure that the UAV product is disseminated to the proper user.

4.4.1.1.2 Handoff Procedures. Not applicable.

4.4.1.1.3 Personnel. Additional personnel are not required to support Level 1 TCS operations. There are no specific personnel specialty or sub-specialty codes associated with Level 1 operations.

4.4.1.1.4 Training/Qualification/Currency Standards. Level 1 TCS operations require minimal TCS related training. TCS operators require completion of the TCS Core course (see Appendix E). There are no unique currency standards for Level 1 operations.

4.4.1.2 Service Component Level 1 Capabilities. The following Service component forces/units will be capable of TCS operations at Level 1:

Air Force:

Air Operations Center (AOC)
Wing Operations Center (WOC)
Imagery Exploitation System (IES)
UAV Exploitation System (UES)

Level 1 Representative Scenario
Preparation to conduct major joint military operation.
Mission: Conduct detailed intelligence preparation of the battlefield.

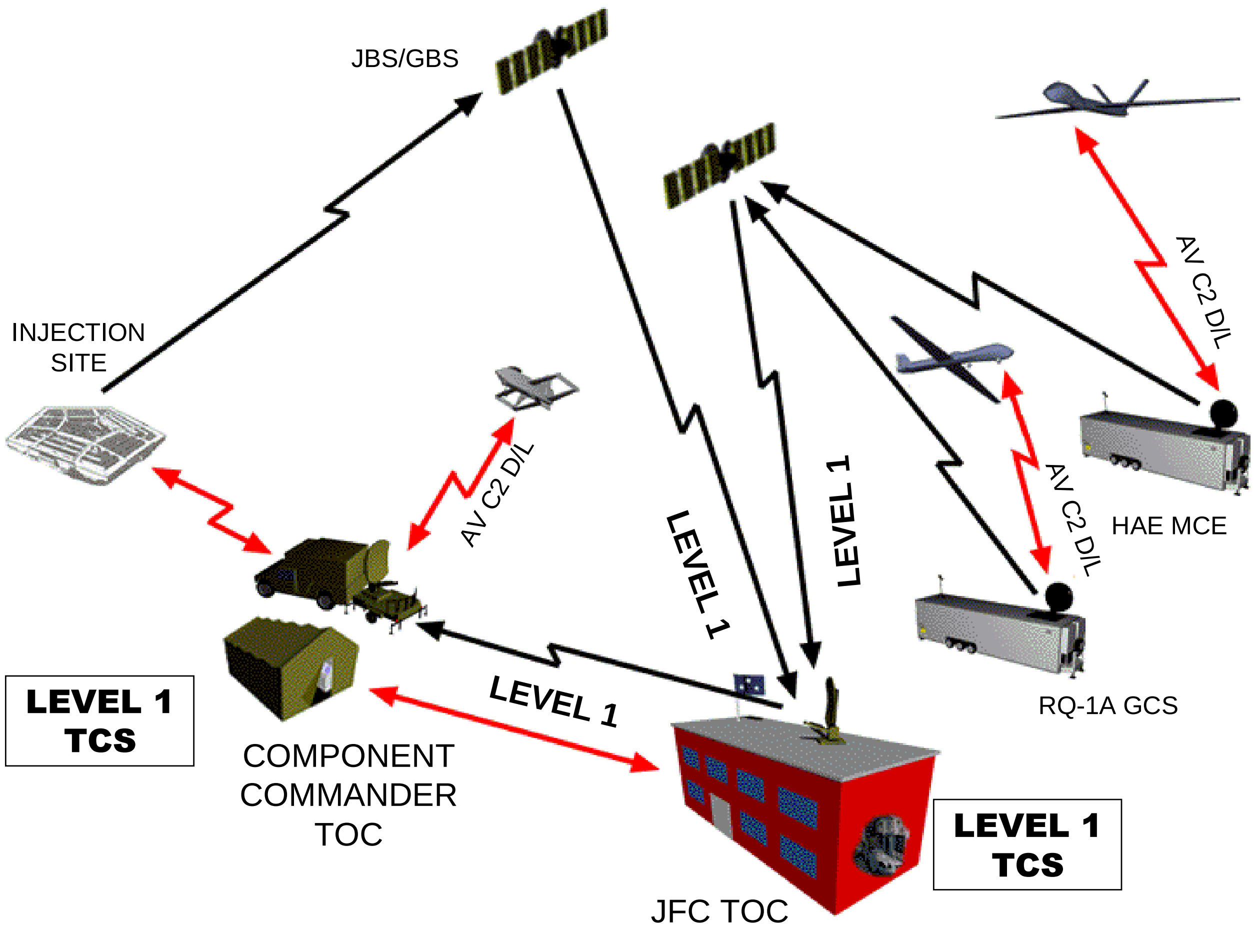

Figure 4-4. Level 1 TCS Operations

Level 1 TCS Employment Concept
JFC intent is to use assigned and attached UAV assets to conduct theater, operational, and tactical ISR missions to obtain imagery of the disposition of enemy forces and to maintain that picture until the start of hostilities. To achieve these objectives, Global Hawk HAE UAV missions are tasked to provide broad area SAR and electro-optical/infrared (EO/IR) imagery support and Predator missions are tasked to provide SAR imagery support of specific sites to the JFC TOC. At the JFC TOC selected imagery is further disseminated to the ground component commander TOC. Tactical UAV assets are tasked to provide EO/IR imagery support to the ground component commander TOC, which further disseminates selected imagery to the JFC TOC. The JFC TOC and ground component commander TOC are both TCS capable and operating at Level 1.

4.4.2 Level 2 Operations. Level 2 TCS operations involve receiving imagery and data directly from UAVs. Since the information is unfiltered and not processed at an intermediate location, Level 2 operations can speed the flow of information to units that need it most in a specific operation. This provides operational commanders with increased flexibility in planning UAV operations and in disseminating UAV products.

Level 2 operations should be considered when the end user is not capable of UAV payload or air vehicle control but requires the information in the most expeditious means possible. However, since the information is unfiltered, the receiving node must be capable of recognizing critical target details.

Level 2 TCS operations involve receipt of UAV sensor products through direct interaction between TCS workstations and UAVs. Level 2 TCS operations may also include dissemination of UAV sensor products to other TCS workstations or C4I systems.

4.4.2.1 Operational Considerations. Level 2 operations require antenna location within the downlink footprint of the UAV and a DCM/GDT or IDT capable of receiving and processing the downlink signal from the UAV. Level 2 TCS operations do not require external two-way voice communications.

4.4.2.1.1 Mission Planning. Level 2 TCS operations do not require detailed mission planning. Prior coordination is required to ensure the TCS user is within the downlink footprint at the specific time.

4.4.2.1.2 Handoff Procedures. Not applicable.

4.4.2.1.3 Personnel. Additional personnel are not required to support Level 2 TCS operations. Personnel must be able to interpret data and recognize key essential elements of information (EEI).

4.4.2.1.4 Training/Qualification/Currency Standards. Level 2 TCS operations require minimal TCS related training. TCS operators require completion of the TCS Core course (see Appendix E). There are no unique currency standards for Level 2 operations.

4.4.2.2 Service Component Level 2 Capabilities. The following Service component forces/units will be capable of TCS operations up to Level 2:

Air Force:

- RQ-1A GCS (Predator only)

Army:

- Brigade
- ACR
- Division
- Corps
- Army
- Military Intelligence Brigade (Echelons above Corps)
- SOF
- Training Base
- Reserve Component Separate Brigade

Level 2 Representative Scenario

Joint non-combatant evacuation operation (NEO) in a potentially non-permissive environment. Mission: Utilize a joint task force to conduct helicopter evacuation of US citizens and key foreign nationals from a designated airfield. Provide perimeter protection throughout the evacuation process.

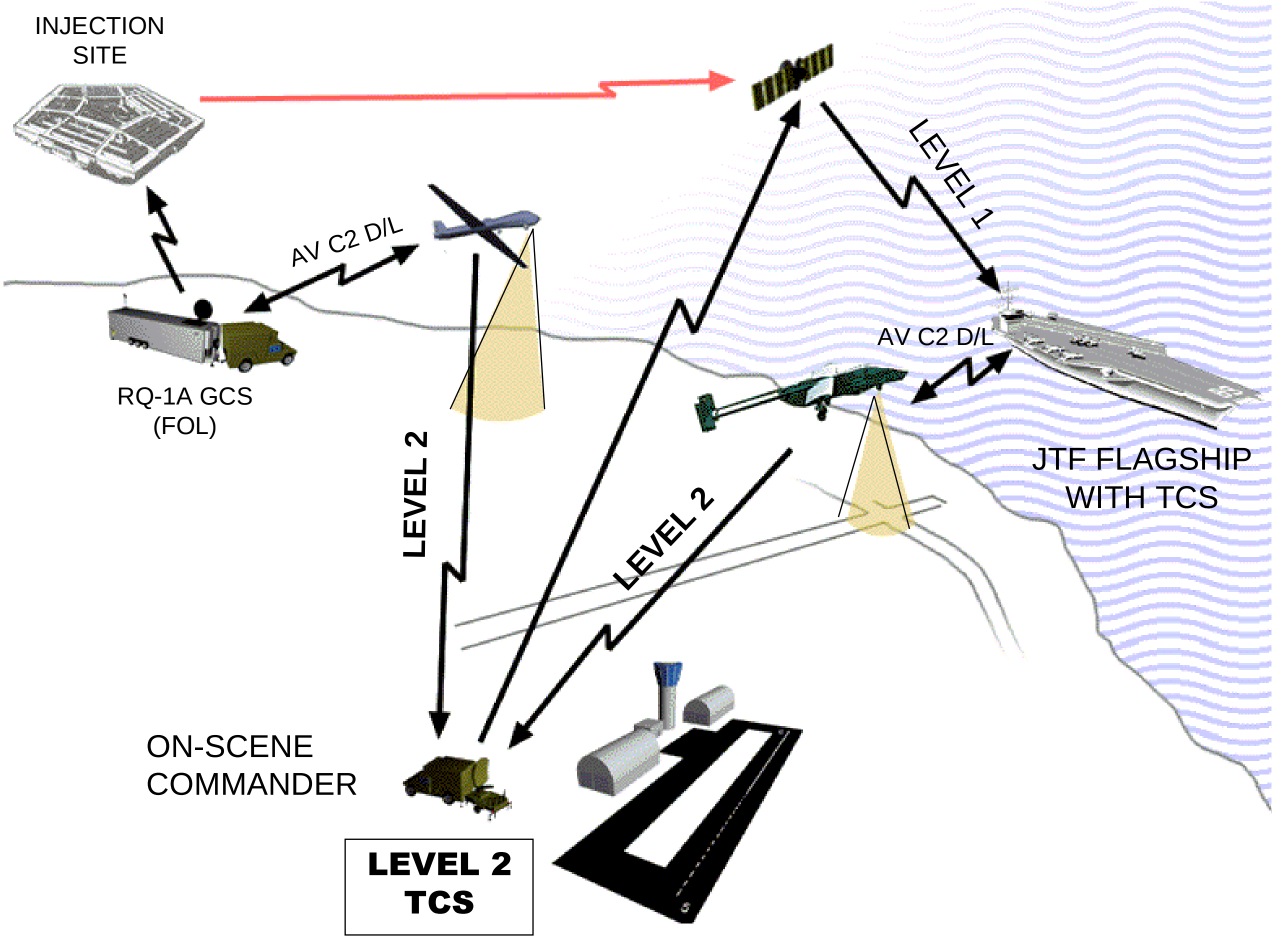

Figure 4-5. Level 2 TCS Operations

Level 2 TCS Employment Concept

JFC intent is to support the NEO force with imagery of the immediate and surrounding area to enable early and swift application of force protection assets as required. Predator missions and sea-based tactical UAV missions are tasked to provide EO/IR imagery directly to the NEO force. The Predator is operating from an RQ-1A forward operating base several hundred kilometers from the potential evacuation site. The tactical UAV is launched from a task force ship stationed close to the coast. The NEO force on-scene commander's tactical operations center TOC (ashore) is TCS capable and is operating at Level 2. The imagery and data arrives unfiltered. Analysts on scene are required to interpret critical aspects of the image and provide immediate feedback to decisionmakers. The JFC (embarked) is TCS capable and is conducting Level 1 operations to receive UAV imagery through SATCOM connectivity.

4.4.3 Level 3 Operations. Level 3 TCS operations assign payload control authority and responsibilities directly to the key users of the information during a specific UAV flight or portion of a flight independent of air vehicle control.

Level 3 TCS operations involve real time control of UAV payloads and both pre-flight and real time payload mission planning. Level 3 TCS operations may also include dissemination of UAV sensor products to other TCS workstations or C4I systems.

Note: Current legacy UAV systems are limited to a single data link uplink signal for payload and air vehicle control. Therefore, the TCS workstation exercising payload control (Level 3) requires digital connectivity with the TCS workstation exercising air vehicle control (Level 4) in order to provide payload control commands to the uplink signal.

4.4.3.1 Operational Considerations. With appropriate operator training and qualification, and subject to operator currency, TCS-equipped units can conduct Level 3 operations. TCS Level 3 operations should be considered when a tactical unit is not equipped with a qualified air vehicle pilot but still requires the operational responsiveness that sensor control offers. Level 3 operations may also require the interfacing of any UAV-peculiar manual control equipment to control the payload of the UAV(s) being utilized. Level 3 TCS operations require digital communications connectivity between the TCS workstation exercising payload control and the TCS workstation exercising air vehicle control. Real time communications between payload operators and air vehicle operators will improve chances for mission success.

4.4.3.1.1 Mission Planning. Level 3 TCS operations provide preflight payload planning capability and the ability to dynamically retask the payload. Prior coordination and planning between the air vehicle controller and payload controller is absolutely essential for effective Level 3 operations.

4.4.3.1.2 Handoff Procedures. Handoff procedures, specific to the UAV and associated payload being operated, are required between the air vehicle operator and payload operator(s), including workstation recognition of positive handoff. Pre-mission planning is required to ensure that the air vehicle arrives on-station to facilitate payload handoff. Dynamic payload handoff (an operation where the air vehicle controller can elect to pass payload control to another TCS station) can occur to satisfy emergent adhoc requirements if proper connectivity is, or can be, established. However, a dynamic payload handoff evolution must be coordinated with the JFC authority to ensure that overall force tasking requirements are not jeopardized. It must also be coordinated with the ACA if airspace adjustment is required.

4.4.3.1.3 Personnel. Additional personnel are not required to support Level 3 TCS operations, however, temporary assignment of additional personnel may be operationally prudent to conduct operations involving simultaneous or multiple payload control.

4.4.3.1.4 Training/Qualification/Currency Standards. Level 3 TCS operations require TCS related training. TCS operators require completion of the TCS Core course (see Appendix E) and Service specific payload operator training and qualification. Payload operator currency standards are as required by individual Services for their UAVs.

4.4.3.2 Service Component Level 3 Capabilities. The following Service component forces/units will be capable of TCS operations up to Level 3:

Army:

Corps

Military Intelligence Brigade (Echelons above Corps)

Marine Corps:

Marine Expeditionary Force (MEF) (Predator only*)

Marine Expeditionary Unit (MEU) (Predator only*)

**Normally, Air Force will provide RQ-1A trained personnel to operate another Service's TCS for operations requiring Predator support.*

Level 3 Representative Scenario

JTF ashore is conducting military operations other than war (MOOTW) peacekeeping operations. Mission: Monitor and report belligerent compliance with United Nations (UN) sanctions. Intervene as necessary, short of armed hostilities, to ensure sanction compliance.

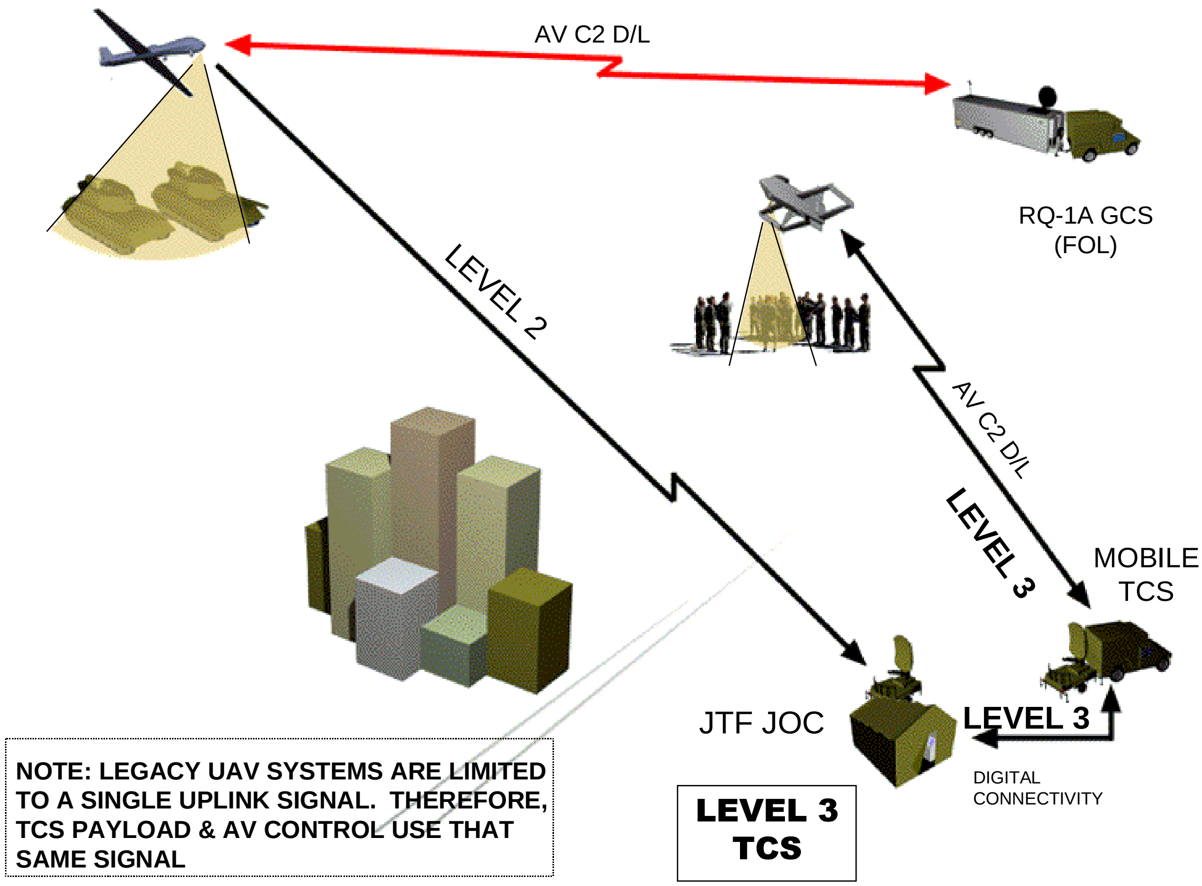

Figure 4-6. Level 3 TCS Operations

Level 3 TCS Employment Concept JFC intent is to optimize the application of limited forces in achieving mission objectives. To improve command and control of this process, the JFC desires to receive real time imagery at Joint Task Force (JTF) headquarters. The preponderance of analytical resources resides at the JFC TOC and payload control from this location will improve situational awareness and quicken sensor retasking. Tactical UAV missions are tasked to provide EO/IR imagery; payload control is assigned to the JTF headquarters. Level 3 operations are conducted remotely through connectivity to the air vehicle control TCS collocated with the JTF TOC. Predator missions are also tasked to provide SAR imagery direct to the TOC. Predator air vehicle and payload control is retained at the RQ-1A GCS/TCS. Imagery is linked directly to the TOC accomplishing Level 2 interaction.

4.4.4 Level 4 Operations. Level 4 operations involve a TCS node other than the launching and recovering station(s) to control the flight of the air vehicle. This enables air vehicle control to be assigned in direct support of a tactical commander closet to the scene of action. This provides that commander with the capability to employ the air vehicle and payload to best meet that force's needs and to speed the delivery of the UAV product to the echelon(s) of the force with the most critical need.

Level 4 operations involve real time control of air vehicles and both pre-flight and real-time air vehicle mission planning. Level 4 operations may also include dissemination of UAV sensor products to other TCS workstations or C4I systems.

4.4.4.1 Operational Considerations TCS Level 4 operations should be considered when the tactical unit is not equipped with UAV launch and recovery capability and requires air vehicle control to better focus mission support. With proper training, cross-component Level 4 operations can also be conducted by TCS-equipped units. Level 4 TCS operations should have external two-way voice communications, between prospective air vehicle control nodes and the launch and recovery node to promote better mission coordination and improve chances for success.

4.4.4.1.1 Mission Planning. Level 4 TCS operations provide preflight mission planning capability and the ability to dynamically retask the air vehicle in flight. Both the launch and recovery station and the ultimate TCS control node require detailed mission planning. Precise route planning is required to ensure the air vehicle arrives in position at the appointed time to facilitate efficient air vehicle handoff. To the extent possible, the launch and recovery station will monitor the flight of the UAV throughout the mission.

4.4.4.1.2 Handoff Procedures. Handoff procedures between air vehicle operators and the launch and recovery operator are required, including workstation recognition of positive handoff. Handoff procedures may vary among air vehicles

4.4.4.1.3 Personnel. Additional personnel are not required to support Level 4 TCS operations, however, temporary assignment of additional personnel may be operationally prudent to support high tempo operations.

4.4.4.1.4 Training/Qualification/Currency Standards. Level 4 TCS operations require TCS related training. TCS operators require completion of the TCS Core course for single UAV operations and completion of the TCS Advanced course for multiple UAV operations (see Appendix E). TCS operators also require Service specific air vehicle operator training and qualification. Service requirements for air vehicle operator currency also applies.

4.4.4.2 Service Component Level 4 Capabilities. The following Service component forces/units will be capable of TCS operations up to Level 4:

<u>Army:</u>

Reserve Component Separate Brigade

<u>Marine Corps:</u>

MEF/MEU (Outrider and Pioneer)

<u>Navy:</u>

Aircraft carrier (CV)/aircraft carrier (nuclear) (CV[N]) (Outrider, Pioneer, and Predator*)

Amphibious assault ship (LHA)/amphibious assault ship (internal dock) (LHD) (Pioneer and Predator*)

Amphibious transport dock (LPD) (Outrider and Predator*)

Cruiser/Destroyer (CruDes) ships (Outrider, Pioneer, and Predator*)

Amphibious command ship (LCC)/Fleet commander flagship (AGF) (Outrider, Pioneer, and Predator*)

Attack submarine (nuclear) (SSN) (Outrider, Pioneer, and Predator*)

MAST/MICFAC (Outrider, Pioneer, and Predator*)

**Normally, Air Force will provide RQ-1A trained personnel to operate another Service's TCS for operations requiring Predator support*

Level 4 Representative Scenario

Amphibious task force (ATF) conducting an amphibious operation.
Mission: Conduct a joint amphibious landing to seize military objectives ashore. Transfer joint force command ashore once objectives are seized.

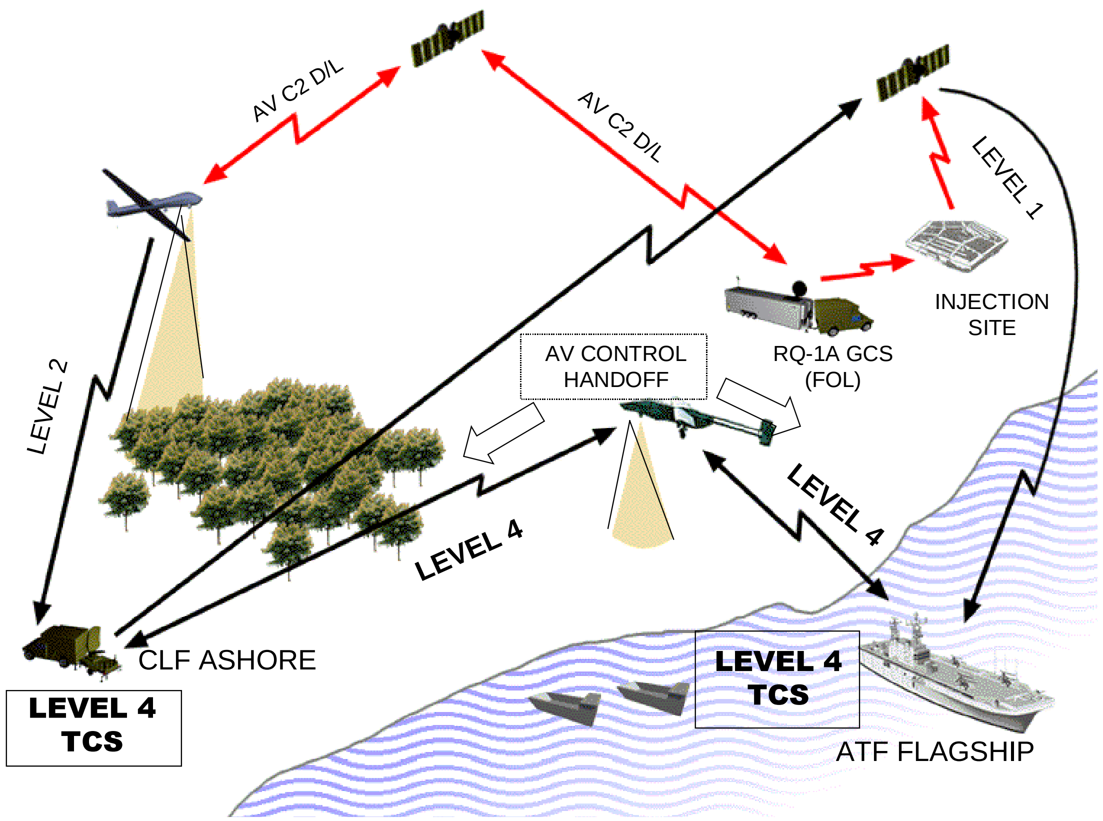

Figure 4-7. Level 4 TCS Operations

Level 4 TCS Employment Concept

JFC intent is to use real-time imagery prior to the landing operation to assist in IPB. Once the amphibious landing is commenced, real time imagery is required to support targeting of key targets ashore by naval surface fire support. Once forces are ashore, real time imagery will support further maneuver of those forces and establishment of the lodgment. Organic sea-based tactical UAV missions are tasked to provide EO/IR imagery; air vehicle control is assigned to the ATF flagship prior to and during the landing. Air vehicle handoff to the Commander, Landing Force (CLF) TOC will occur once established ashore. Predator missions are flown from an RQ-1A forward operating base and are tasked to provide SAR imagery throughout the operation. The ATF flagship is receiving Predator video via Level 1 TCS interaction. Once the CLF has assumed command of the operation, Predator missions will provide Level 2 support to the CLF TOC. Later, as the need arises, the CLF TOC may conduct Predator Level 4 operations.*

**The current ACC Endurance UAV CONOPS prohibits control of the Predator AV or its sensors from being passed to any non-Air Force operator or ground station regardless of TCS operating level.*

4.4.5 Level 5 Operations. Level 5 operations involve all of the functionality of Levels 1 through 4, plus both manual or automatic launch and recovery of the air vehicle. Level 5 operations also involve responsibility for air vehicle beddown and maintenance support. Level 5 operations may also include dissemination of UAV sensor products to other TCS workstations or C4I systems.

4.4.5.1 Operational Considerations. Though TCS will support cross-component Level 5 operations, current Service reporting custodian policies permit UAV launch and recovery operations by the parent Service only. However, launch of a UAV by one TCS workstation and subsequent recovery by a different TCS workstation within the same Service component provides added operational flexibility and may be exercised if the success of the mission requires. In addition, certain airborne emergencies may require recovery by a TCS node other than the launching station.

4.4.5.1.1 Mission Planning. Level 5 TCS operations provide preflight mission planning capability and the ability to dynamically retask the air vehicle in flight.

4.4.5.1.2 Handoff Procedures. Level 5 TCS operations incur no additional handoff requirements above those associated with TCS Levels 3 and 4.

4.4.5.1.3 Personnel. Personnel are required to prepare the air vehicle for launch and to service it upon recovery. For Pioneer, an external pilot (EP) is required to launch and recover the air vehicle.

4.4.5.1.4 Training/Qualification/Currency Standards. Level 5 TCS operations require TCS related training. TCS operators require completion of the TCS Core course and the TCS Advanced course plus

Service specific UAV training curricula (see Appendix E). Service requirements for air vehicle operator currency also applies.

4.4.5.2 Service Component Level 5 Capabilities. The following Service component forces/units will be capable of TCS operations up to Level 5:

Army:

- Brigade
- ACR
- Division
- Corps
- Military Intelligence Brigade (Echelons above Corps)
- Training Base

Marine Corps:

- TOC (Outrider and Pioneer):

Navy:

- LPD (Pioneer only)

Level 5 Representative Scenario

Battlefield maneuver of a joint ground force component. Mission: As part of a joint force campaign, maneuver to engage and defeat enemy ground forces in forward deployed positions.

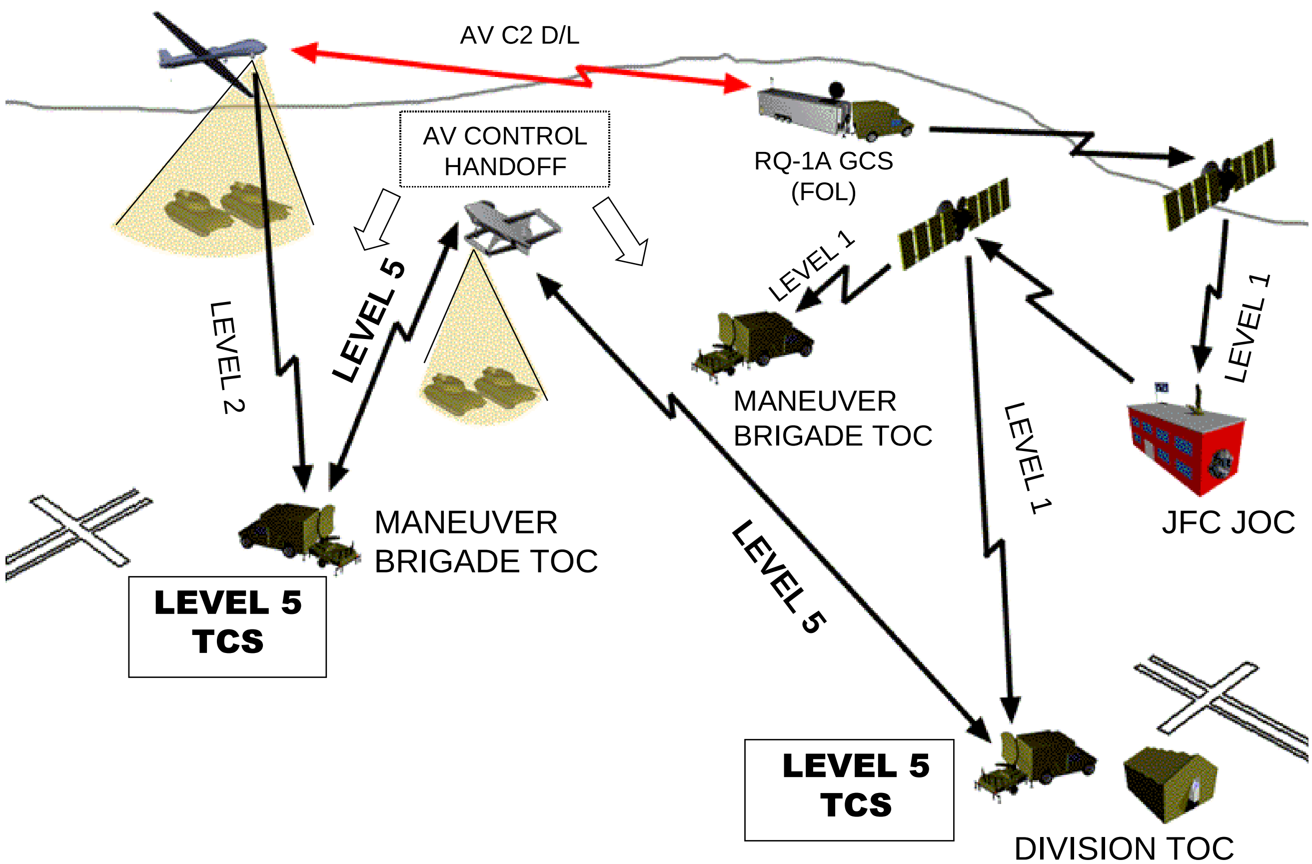

Figure 4-8. Level 5 TCS Operations

Level 5 TCS Employment Concept The JFC has initiated combat operations against the enemy and authorized components to employ assigned UAVs for direct mission support. Tactical operations include an air and ground campaign. The ground component commander desires to support the maneuver of tactical ground forces with imagery for RSTA. The ground component commander has assigned Level 5 direct support control of organic tactical UAV assets to maneuver brigades for EO/IR targeting of enemy forces. Authorization includes launch of tactical UAV assets from one location with subsequent handoff and recovery at another location as the tactical situation warrants. Predator missions have also been authorized by the JFC to provide SAR imagery directly to ground forces within the Predator footprint.

5.0 OTHER EMPLOYMENT CONCEPTS

5.1 Purpose. To summarize additional considerations and factors which influence the operational planning and employment of TCS.

5.2 Safety.

5.2.1 Controlled Airspace Operations. Current FAA and ICAO regulations neither endorse nor provide procedures for the employment of UAVs across national and international divisions of airspace. In some countries and geographic areas, UAV flight is strictly controlled or prohibited. Both the FAA and ICAO are considering amendments to standing regulations to clarify and establish a methodology for integrating manned and unmanned systems in controlled airspace. Until a unified set of standards is established, TCS operation of UAVs in controlled airspace will have to be coordinated on a case-by-case basis with the governing airspace organization.

5.2.2 TCS Operator Training and Qualifications. TCS operators require initial training and qualification for the level of operations to be performed. Additionally, TCS operators conducting Level 4 and 5 operations also require currency in the level of operations to be performed and with the specific air vehicle(s) being controlled.

The TCS system is designed to minimize training requirements for TCS operators. Initial training requirements are a function of trainee experience and the TCS operating level being trained to. For Levels 3, 4, or 5, additional factors impacting single vehicle or multi-vehicle (two or more of the same or different air vehicles) operations will have to be considered. Initial TCS operator training for Levels 1 and 2, and currency maintenance for all levels will be accomplished through computer-based training (CBT) and simulation to the maximum extent possible. TCS Level 4 and 5 operator training will require training and qualification in appropriate controlled airspace procedures to satisfy FAA/ICAO unmanned air vehicle pilot requirements.

Specific TCS operator training, qualification, and currency standards and maintenance training requirements are detailed in Appendix E. In addition to meeting initial training and qualification requirements for the level of TCS operations that they will perform, TCS operators must also meet Service specific air vehicle or payload control qualification and currency requirements.

5.2.3 Air Vehicle Handoff. Pre-planned or dynamically retasked handoffs of air vehicle control between TCS operators must be properly coordinated. Exact handoff procedures will be specific to the air vehicle involved and must be clearly understood by the TCS operators involved in the AV handoff. TCS software provides pulldown menus of AV-specific handoff requirements and procedures.

5.2.4 Command Override/Abort. The Service component/UAV unit with reporting custodian responsibility for an air vehicle retains command override/abort capability. When the commander of the UAV unit or that commander's designated representative determines that AV flight safety is jeopardized, a command override or abort may be issued. In such cases, immediate notification of the TCS operator from whom control is being assumed and the TCS tasking authority is required.

5.3 Emergency Procedures. For improved operating performance and asset conservation, TCS-controlled multiple air vehicle operations should normally integrate more than one TCS controlling authority/station. When multiple TCS controlling authorities are integrated, the JFC/Service component commander will ensure the existence of emergency procedures between those controlling stations to handle contingency situations when control links or C4I connectivity is interrupted. The following general considerations apply:

5.3.1 Lost Link – Air Vehicle. Lost link instructions are the responsibility of the UAV launch and recovery unit and are part of the mission plan. TCS will be capable of adjusting those lost link instructions with the concurrence of the launch and recovery station.

Whenever dynamic retasking modifies an air vehicle programmed flight path, the lost link instructions should be reviewed and updated as required. TCS can perform this update by automatically identifying restricted areas, minimum safe altitude in the current area of operations, fuel required to return to the launch and recovery station, and furnishing other appropriate warnings as they occur so lost link instructions can be updated immediately when required. This precludes the UAV from flying from an ad hoc position back to the first point of the lost link procedure on a route of flight that could endanger the air vehicle. Updating the lost link instructions prevents the air vehicle from crossing a restricted area, encountering a terrain obstacle that was not planned for, or creating a longer than planned return route that may result in the AV running out of fuel.

5.3.2 Lost Link - Payload Control. When the TCS operator exercising control loses payload control, notification will be made to the TCS operator exercising air vehicle control at that point. The TCS operator that lost the link will provide the controlling TCS operator with an assessment of the reason for loss of control and whether payload control can be regained. The TCS operator with air vehicle control will attempt to reestablish payload control, and if successful, coordinate a payload handoff back to the operator scheduled to have payload control at that point in the mission. If payload control cannot be regained, the mission commander exercising command override/abort authority will provide payload control to continue the mission at the direction of the supported unit or, if this is not possible, abort the mission and inform the appropriate authority.

5.3.3 Lost Authorized Level of Interaction. When conditions preclude a TCS operating station from performing TCS operations at the level assigned, the appropriate authority will be informed with an estimate of the time to reestablish operating capability at the assigned level. Prompt notification will ensure a reassignment of TCS responsibilities can be accomplished as soon as possible, if required.

5.3.4 Lost C4I Interactivity. When a TCS operating station loses its C4I connectivity, the appropriate intelligence, operations, and C4I representatives on the JFC/Service component/other staff will be informed with an estimate of the time to reestablish connectivity. Prompt notification enables the appropriate C4I authority to determine the necessity of establishing alternate C4I paths for TCS products or coordinating the reassignment of TCS responsibilities within the force.

5.4 Logistics/Maintenance Concepts.

5.4.1 General. TCS logistics and maintenance support will be accomplished in accordance with the Integrated Logistics Support Plan (ILSP) and the maintenance concepts and policies of the individual Services exercising OPCON of TCS assets. TCS shall adhere to DOD regulations and policy governing military standards for logistics, tools, and Test, Measurement, and Diagnostic Equipment (TMDE). To the maximum extent possible, general purpose test equipment (GPTE) and common tools resident in each Service will be used to perform all corrective and preventative maintenance at all authorized levels of maintenance. Required tools and test equipment not available within Service inventories will be identified as special tools and special purpose test equipment (SPTE).

5.4.2 Supply Support. Government supply support for the TCS system will be managed by the Naval Inventory Control Point (NAVICP), formerly the Aviation Supply Office (ASO). The NAVICP has been designated program support inventory control point (PSICP) for TCS and related support equipment (SE).

Shipment of TCS and SE spares and repair parts may be commercial on a government bill of lading for continental US (CONUS) destinations and commercial/government transportation for overseas destinations. The most economical mode of transportation consistent with the priority, required delivery date, and transportability constraints will be used. When deemed necessary by the government, automatic test equipment will be shipped commercially in CONUS by air-ride van or equivalent. Shipments will be made in accordance with DOD directives. TCS hardware will be ruggedized to withstand inter and intra theater movement. Shipping containers will be reusable and enable operators to set up equipment within the established timelines for the UAV system being used.

5.4.3 Maintenance Support. TCS maintenance is accomplished at the organizational, intermediate, and depot levels depending upon the nature of repair required. At the organizational and intermediate levels, Services will support TCS as an integral part of their organic UAV system. Maintenance will be in accordance with each Service's UAV maintenance concepts and procedures. Technical manuals will be in a digital format and be suitable for display on joint computer-aided acquisition logistics support (JCALS) compatible equipment or capable of hard copy printout.

- Air Force - Air Force maintenance involves both intermediate and operating level maintenance at Forward Operating Locations (FOL) and will use the maintenance concepts established in Air Combat Command Instruction (ACCI) 21-101, Objective Wing Aircraft Maintenance. 2Exxx Air Force Specialty Code (AFSC) personnel will be responsible for organizational sustainment of TCS equipment.

- Army - Army will use maintenance practices established for Communication, Intelligence and Electronic Warfare (IEW), Aviation, and Ground Systems.

- Marine Corps - TCS will be supported the same way as a Marine Corps squadron with detachments. TCS and equipment specifically related to the flying of UAVs will be handled in accordance with the Naval Aviation Maintenance Program (NAMP).

- Navy - Navy will utilize the NAMP and aviation supply system to support TCS.

5.5 Security.

5.5.1 Classification Guidance. TCS hardware and software components are unclassified, however, for system classification purposes TCS is an automated information system (AIS). As such, TCS software will satisfy all security requirements imposed by DOD Regulations and Directives. Accordingly, TCS software will be accredited by the designated approving authority prior to processing classified information. TCS software is capable of interfacing with air vehicles and C4I systems and internally processing and storing classified imagery and data files through established interfaces. When interfaced to a classified C4I system or when classified image processing/storage is accomplished, the TCS system is classified at the level of the connected system or the information being processed/stored. TCS is not currently a multi-level secure system. Until the incorporation of approved software security guards, TCS must be sanitized by appropriate security personnel when switching interfaces among UAVs and C4I systems with different classification levels.

TCS operators, maintenance technicians, and other personnel with access to TCS displays, hardware, or software shall be cleared to the highest classification level of the data that TCS is processing, storing, or transferring.

5.5.2 Physical Security. Although TCS hardware, software, and documentation are unclassified, they shall be physically protected to prevent unintentional disclosure to unauthorized individuals and inadvertent destruction or modification. In addition, while interfaced to classified systems, TCS software shall be physically secured and protected to the same classification level as the systems with which TCS is connected.

Local procedures are required to prevent the unintentional disclosure of classified information to unauthorized individuals. These procedures will include the use of passwords for access to TCS software.

5.5.3 Operational Security (OPSEC). TCS OPSEC requirements are no more stringent than the OPSEC requirements for the UAV and C4I systems with which TCS can interface. Accordingly, TCS OPSEC procedures will parallel those for the UAVs and C4I systems with which TCS is interacting.

TCS employs unencrypted data links to interact with the various families of UAVs. These links are susceptible to intercept and jamming. Both active and passive enemy electronic warfare capabilities can be used to provide warning of UAV employment and to target UAVs and TCS control stations. The use of numerous types of camouflage, concealment, and deception (CCD) devices, including multi-spectral netting and radar corner deflectors, can also be effective in reducing the quality and value of the payload product. Depending on the operating environment and hostile electronic combat systems present, the threat to TCS operations could range from negligible to active jamming of the ground station and air vehicle.

5.5.4 Communications Security (COMSEC). To ensure minimum chance of accidental or unauthorized intrusion into the TCS/UAV C2 link, local procedures must be implemented to ensure positive control of the UAV from launch through recovery. To ensure emissions security TCS is compliant with National Security Agency (NSA) standards for collateral level information processing and interfacing to secure networks. TCS also complies with service information protection measures, strategies, and architectures to the level of COMSEC supported by the networks to which TCS is interfaced.

5.6 North Atlantic Treaty Organization (NATO)/Allied Interoperability. TCS can support NATO reconnaissance requirements. Early identification of interoperability considerations will assist in developing the interface standards between TCS, NATO UAVs and, C4I architectures that will be adopted as NATO Standardization Agreements (STANAGS). Data links are the critical interoperability issue. Three standard data links are being considered. The US common data link (CDL) including tactical interoperable ground data link (TIGDL) is being considered as a line-of-sight, point-to-point data link operating in the I or X Band. No data link has yet been prescribed for the UHF band; however, the Hunter data link is a possible choice. The British have committed to developing an omni-directional broadcast data link. Standards for satellite data links must be compliant with commercial standards established by the various international satellite consortiums (international telecommunications satellite (INTELSAT), Pan-American satellite (PANAMSAT), etc.). Military SATCOM can also be used as a possible solution.

APPENDIX A - TACTICAL CONTROL SYSTEM (TCS) PROGRAM

A.1 Program Management. The TCS Program Manager (PM), office code: PM-TCS, resides in the Navy Program Executive Office for Cruise Missiles and Joint Unmanned Aerial Vehicles (PEO-CU). The PM is responsible for the day-to-day direction of the TCS program. Matrix support is provided through the Naval Aviation (NAVAIR) Systems Command Naval Air Warfare Center Aircraft Division (NAWCAD), the Naval Surface Warfare Center Dahlgren Division (NSWCDD), the Systems Integration Laboratory (SIL), Army Aviation and Missile Command (AMCOM) and other field activities and support offices.

A.2 TCS Schedule. TCS is being developed as an ACAT II program under a three-phase development process as shown in Figure A-1.

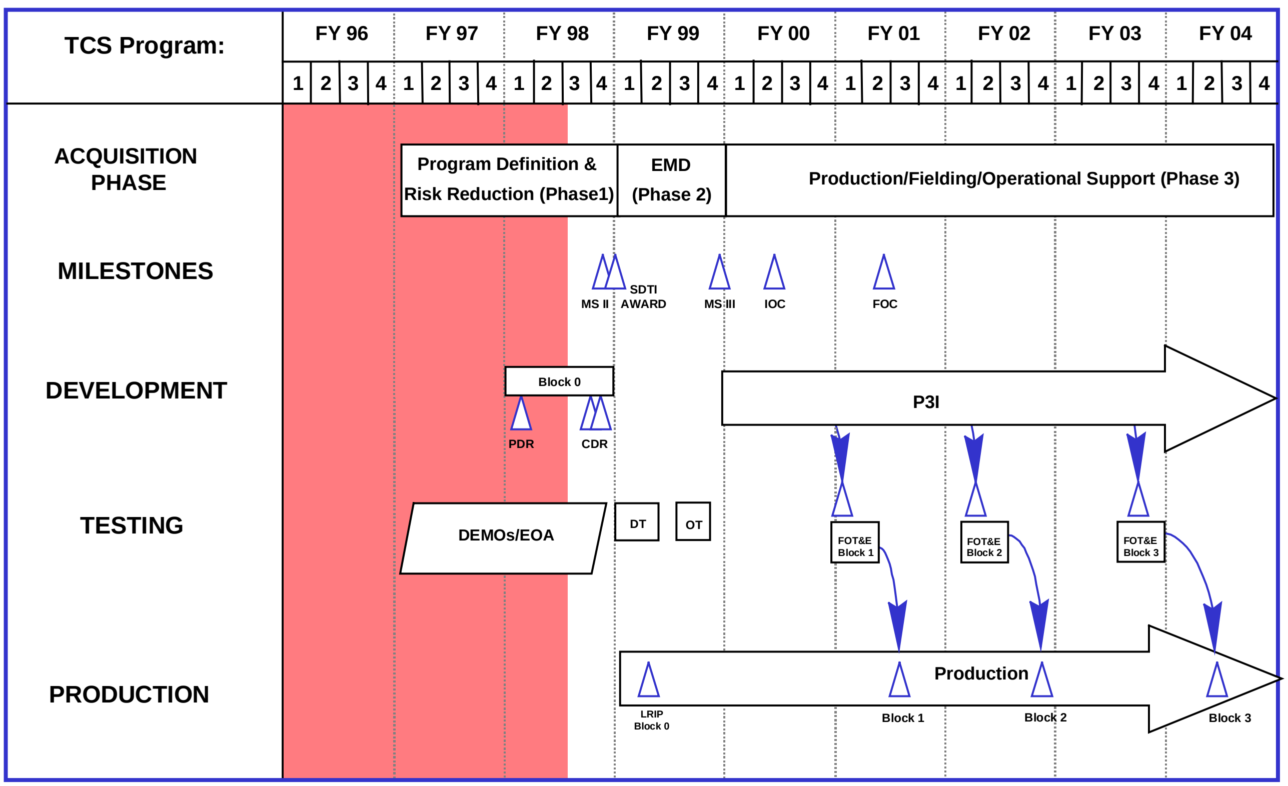

Figure A-1 TCS Schedule

Phase I of the TCS program began in FY 97 and will provide program definition and risk reduction through the use of three fieldable prototypes (1 sea-based & 2 land-based) over a 24-month demonstration period. During this phase TCS common core functions will be interfaced with Outrider and RQ-1A air vehicles and payloads. System demonstrations will include air vehicle and payload control of Outrider and Predator. The TCS prototypes will also be interfaced with user selected C4I systems such as the All Source Analysis System (ASAS), Imagery Analysis System (IAS), JMCIS, etc. Lessons learned from TCS demonstrations and employment of TCS in actual joint and Service exercises will be incorporated into the TCS development process and acquisition documentation developed during this phase. Phase I will conclude with a Milestone II decision in fourth quarter FY 98.

Phase II will focus on engineering and manufacturing development (EMD) and the production of four LRIP systems to conduct system DT/OT. System documentation and software developed under Phase I will be provided as government furnished equipment (GFE)/government furnished installation (GFI) to support DT/OT. During this phase fully scaleable and modular sea and land-based systems will be integrated with existing platform hardware. Final production system hardware and software configurations will be determined. Phase II will conclude with a Milestone III decision in fourth quarter FY 99.

Phase III encompasses production, fielding/deployment and operational support of TCS. At this point TCS will have become the command, control, and data dissemination system for Outrider, Pioneer, and all future tactical UAV air vehicles and payloads. For the RQ-1A system, TCS provides additional C4I interfaces. A cost plus contract to construct production systems will be awarded. Additionally, retrofit of Outrider and RQ-1A systems modified during Phase I or II and validation of remaining C4I interfaces will be accomplished.

A.3 Initial Operational Capability (IOC). IOC will be declared by each Service when TCS has completed DT/OT and each Service has fielded one production representative TCS and integrated logistics support (ILS) procurement (training, spares, technical publications, and support equipment) is in place. The level of performance necessary to achieve IOC is defined as one system in a final configuration with operators and maintenance personnel trained and initial spares with interim repair support in place. The IOC target is the second quarter FY00.

A.4 Full Operational Capability (FOC). FOC will be declared by each Service when all TCS maintenance and repair support, software support, test equipment and spares are in place and TCS systems are effectively employed. The FOC target is the second quarter FY01.

A.5 Service Acquisition. The number of TCS systems to be acquired by the Services and system capabilities are based upon individual Service requirements. Air Force TCS capability will be provided by integrating TCS software into the RQ-1A GCSs by forward-fitting future production systems and backfitting existing systems. Army TCS capability will support Army requirements at corps, division, brigade, and ACR echelons. Navy TCS capability will support Navy requirements aboard amphibious ships, surface combatants, aircraft carriers, command ships, and submarines. Marine Corps TCS capability will support Marine Corps requirements for expeditionary forces, pre-positioning, and war reserve.

The potential acquisition profile is shown in Figure A-2. Appendix B delineates individual Service requirements for TCS capability for existing UAVs and at various command locations.

SERVICE	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FUTURE	TOTALS
Air Force	1	1						10	12
Army	1	97	32	40	19	39	TBD	309	537
Navy	1	5	6	5	5	4	4	71	101
Marine Corps	1	4	2	2	2	2		4	17
TOTALS	4	107	40	46	26	45	TBD	394	667

Figure A-2 Potential Acquisition Profile

A.6 TCS Demonstration/Exercise Schedule. TCS will meet its developmental objectives through a rigorous schedule of system demonstrations and participation in exercises to validate system functionality and UAV and C4I interfaces. Figure A-3 depicts Phase I demonstration milestones.

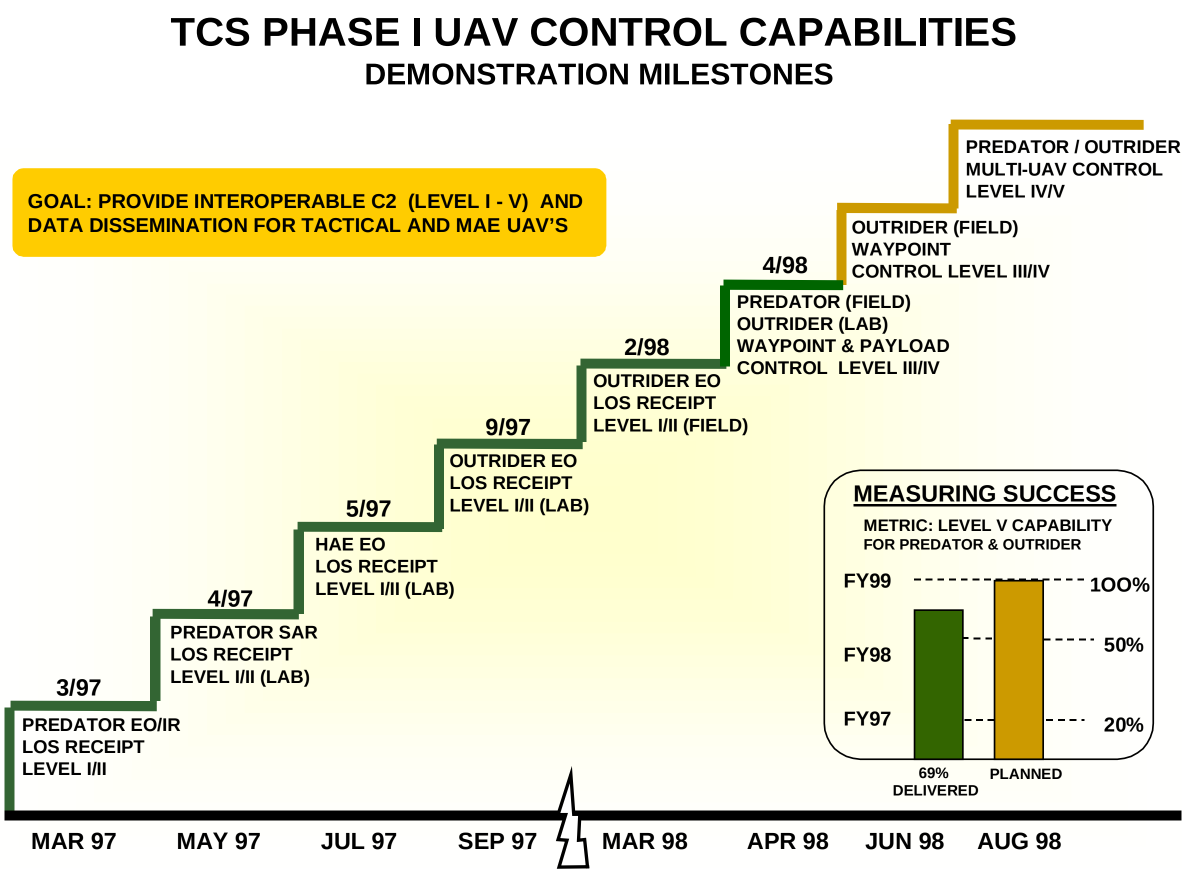

Figure A-3 Phase I Demonstration Milestones

APPENDIX B – OPERATIONAL CONFIGURATIONS

Specific capabilities of each TCS will vary according to the hardware configuration based upon the operational requirements of the user. Scalability of hardware allows individual system tailoring to meet the operator's needs for UAV command and control (LOS or BLOS and single UAV or multiple UAV) and type of imagery processing (EO/IR or SAR).

The configurations contained in the following charts represent the desired/planned capability mixes of Service TCSs by location at which they will be operationally employed:

B.1 AIR FORCE CAPABILITIES.

UNIT/LOCATION UAV TYPE	TCS LEVEL	LOS	BLOS	EO/IR	SAR	MULTIPLE UAV CONTROL	AUTO LAUNCH & RECOVERY
RQ-1A GCS/TCS							
Predator	2 (1)	X	X	X	X	X (2)	
AOC/WOC/IES							
Outrider	1						
Pioneer	1						
Predator	1						

Note: (1) Level 3 through 5 capability is provided by the Predator GCS system.

(2) Relief on station (ROS) capability.

B.2 ARMY CAPABILITIES.

UNIT/LOCATION UAV TYPE	TCS LEVEL	LOS	BLOS	EO/IR	SAR	MULTIPLE UAV CONTROL	AUTO LAUNCH & RECOVERY
TUAV units (Brigade level, Heavy Division)							
HAE	1					X	
Outrider	5	X		X	X	X	X
Predator	4 (1)	X		X	X	X	
ACR/Division/Corps/ EAC							
HAE	4		X	X	X	X	
Outrider	4/5 (2)	X		X	X	X	X (2)
Predator	4 (1)	X	X	X	X	X	
TOC (Army level)							
HAE	2		X	X	X		
Outrider	2	X		X	X		
Predator	2	X	X	X	X		

Note: (1) The current ACC Endurance UAV CONOPS prohibits control of the Predator AV or its sensors from being passed to any non-Air Force operator or ground station regardless of TCS operating level.

(2) For Outrider at ACR and Light Divisions.

B.3 MARINE CORPS CAPABILITIES.

UNIT/LOCATION UAV TYPE	TCS LEVEL	LOS	BLOS	EO/IR	SAR	MULTIPLE UAV CONTROL	AUTO LAUNCH & RECOVERY
TOC							
HAE	2						
Outrider	5	X		X		X	X
Pioneer	5	X		X		X	X
Predator	4 (1)	X		X			

Note: (1) The current ACC Endurance UAV CONOPS prohibits control of the Predator AV or its sensors from being passed to any non-Air Force operator or ground station regardless of TCS operating level.

B. 4 NAVY CAPABILITIES.

UNIT/LOCATION UAV TYPE	TCS LEVEL	LOS	BLOS	EO/IR	SAR	MULTIPLE UAV CONTROL	AUTO LAUNCH & RECOVERY
CV (1)							
HAE	2	X	X	X	X		
Outrider	4	X		X		X	
Pioneer	4	X		X		X	
Predator	4 (2)	X	X	X	X		
LHA/LHD (1)							
HAE	2	X	X	X	X		
Outrider	5	X		X		X	X
Pioneer	4	X		X		X	
Predator	4 (2)	X	X	X	X		
LPD (1)							
HAE	2	X	X	X	X		
Outrider	4	X		X		X	
Pioneer	5	X		X		X	
Predator	4 (2)	X	X	X	X		
LCC/AGF (1)							
HAE	2	X	X	X	X		
Outrider	4	X		X		X	
Pioneer	4	X		X		X	
Predator	4 (2)	X	X	X	X		

UNIT/LOCATION	TCS	LOS	BLOS	EO/IR	SAR	MULTIPLE	AUTO

UAV TYPE	**LEVEL**					**UAV CONTROL**	**LAUNCH & RECOVERY**
CruDes (1)							
HAE	2	X	X	X	X		
Outrider	4	X		X			
Pioneer	4	X		X			
Predator	4 (2)	X	X	X	X		
SSN (1)							
HAE	1						
Outrider	4	X		X			
Pioneer	4	X		X			
Predator	4 (2)	X		X			

Note: (1) Not all ships in each ship class will have TCS or if equipped with TCS, the full range of capabilities.

(2) The current ACC Endurance UAV CONOPS prohibits control of the Predator AV or its sensors from being passed to any non-Air Force operator or ground station regardless of TCS operating level.

APPENDIX C – COMMUNICATIONS AND C4I INTERFACES

C.1. COMMUNICATIONS INTERFACES. TCS is interoperable with a wide range of communications media and can interface with existing and future tactical communications networks and systems. TCS can be interfaced to standard DOD deployable (tactical) VHF and UHF line of sight, UHF demand assigned multiple access (DAMA) SATCOM, and HF radios, MSE, and military and commercial satellite communications.

TCS is not equipped with its own communications support system and must operate within an existing theater operational architecture.

C.1.1. Communications Media. Figure C-1 contains a partial list of current communications equipment with which TCS can interface. Data rates shown vary depending on the distance and specific application.

COMMUNICATIONS INTERFACE	INTERFACE EQUIPMENT (1)	SENSOR PRODUCT/ INFORMATION TYPE	DATA RATE (2)	ENCRYPTION EQUIPMENT
VHF radio	AN/VRC-89/90/91 SINCGARS	Analog voice, digital voice, message, & image	16 KB/S	KY-57
UHF radio	LST-5, AN/PSC-3, AN/CSZ-4A, ARC-164, AN/WSC-3	Analog voice, digital voice, message, & data	16 KB/S	KY-57/58, KYV-5, KG-84
HF radio	AN/GRC-26D, URT-23/ R-2368, HFRG	Analog voice, digital voice, message, & data	2.4 KB/S	KG-84
UHF SATCOM	LST-5, AN/PSC-3, AN/CSZ-4A, AN/WSC-3	Analog voice, digital voice, message, & data	16 KB/S	KY-57/58, KYV-5, KG-84

COMMUNICATIONS INTERFACE	INTERFACE EQUIPMENT (1)	SENSOR PRODUCT/ INFORMATION TYPE	DATA RATE (2)	ENCRYPTION EQUIPMENT
LAN	DTE, DCE	Digital data, imagery, & video	100 KB/S	N/A
RG-59	Cameras, monitors	Analog video	NA	NA
Serial (RS-232) (3)	DTE, DCE	Digital data & imagery	32 KB/S	KG-84, KY-57, KY-68
Serial (RS-422)	DTE, DCE	Digital data, imagery, & video	100 KB/S	KG-84
4 wire (includes MSE)	TA-954, KY-68	Digital voice & data	16 KB/S	KY-68
62.5/125 Multimode Fiber Optic Cable	Cameras, monitors, video switches	Analog video	10/100 MB/S	N/A

Figure C-1. Communications Media

Notes: (1) This table is a partial list of currently fielded equipment. Not all models or types are listed.

(2) Data rates vary depending on distance and specific application.

(3) Digital video, serial, and 2 and 4 wire communications media are required to interoperate with designated C4I systems.

C.1.1.1 TCS Protocols. TCS communications protocols involve the use of interface protocols such as (1) Transmission Control Protocol/Internet Protocol (TCP/IP), (2) Network File System (NFS), (3) Simple Mail Transfer Protocol

(SMTP), (4) File Transfer Protocol (FTP), and (5) X.25. These protocols transfer messages and data elements as shown below.

C.1.1.1.1 Messages. The Common Message Processor (CMP) will be used by TCS to generate tactical messages in the following formats:

- Variable Message Format (VMF). VMF is the approved data exchange standard for information transfer between systems requiring variable bit-oriented messages. TCS can transmit and receive VMF messages.

- US Message Text Format (USMTF). USMTF messages are fixed format, character-oriented messages that are man-readable and machine-processable. TCS can transmit and receive USMTF messages.

- Army Command and Control System (ACCS). Army unique messages are currently undergoing conversion to USMTF standard.

- Intelligence and Electronic Warfare Communications Catalog (IEWCOMCAT). IEWCOMCAT messages are IEW unique and are the forerunners to USMTF.

- Architecture, Design, Analysis and Planning Tool (ADATP-3). ADAPT-3 messages are the NATO equivalent to USMTF.

- Field Artillery Tactical Data Messages (FATDS). TCS is capable of transmitting and receiving FATDS TACFIRE messages.

C.1.1.1.2 Data Elements. The following typical data elements are those data representative of acceptable TCS input (for mission planning, status query) or TCS output (mission monitoring, status reporting).

- Common data elements. Mission number, mission date and air vehicle tail numbers are common to all UAV mission related message files transmitted from or to TCS.

- Flight route data elements. These elements describe the mission plan of the UAV, both as input for mission planning and dynamic retasking purposes, and output for monitoring of mission status. Typical information includes the common data elements, time of update, latitude/longitude, altitude in feet above mean sea level (msl), and true heading in degrees.

- Collection tasking elements. Collection tasking elements are used to create a data collection plan for upload to the air vehicle.

- Communications data elements. These elements describe the communications configuration.

- Threat information data elements. The elements are used to automatically or manually update a threat.

- Weather information data elements. Elements that compose the weather information message.

- Imagery data elements. These elements describe the footprint of an image.

C.2 C4I INTERFACES. TCS is capable of interfacing with 24 different current joint and Service C4I systems. 23 of those systems will be operationally interfaced (see figure C-2 below). In addition, TCS architecture, hardware, and software are designed such that all future C4I systems will also be interoperable with TCS. Current TCS capabilities to output imagery and data, however, exceed the exploitation capabilities of some C4I systems with which TCS can interface. As an example, TCS can disseminate EO/IR payload video imagery, but not all C4I systems are able to receive and process video imagery.

The TCS-C4I interface involves the exchange of information between the software application running on the TCS core and the software application running on the C4I system. The types of information exchanged include: payload information or sensor products such as EO/IR full motion video and freeze frame imagery, SAR imagery, and metadata such as payload pointing information. The exchange can also include air vehicle state and geoposition data. The information exchange may be uni- or bi-directional. C4I information that can be input to TCS includes mission tasking, maps, and mission planning information such as waypoints, altitudes, weather, and threat information.

The wide variety of Service C4I systems with which TCS can interface is shown in Figure C-2.

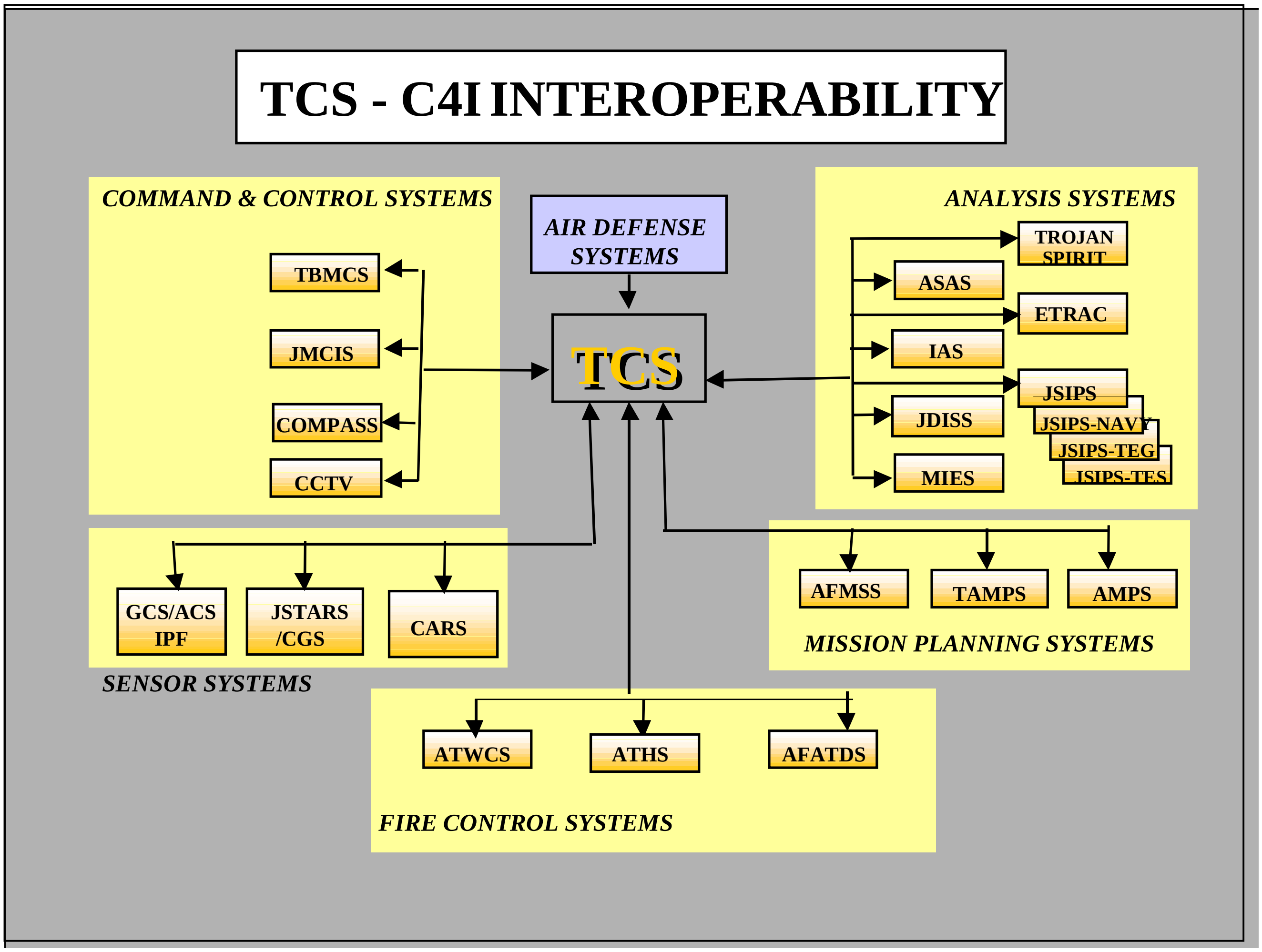

Figure C-2. TCS-C4I Interoperability

The TCS-C4I interface includes two basic forms of information: 1) sensor products, and 2) mission planning and tasking, status query, and mission status reports.

C.2.1 Sensor Products. The following sensor products are available from TCS and can be both received and disseminated by a TCS workstation. TCS imagery products may be verbal or text reports, freeze frame images, short full motion video clips, or continuous, high fidelity, full motion video.

C.2.1.1 Digital Text. Digital text sensor products include messages that contain target descriptive information.

C.2.1.2 Digital Imagery. Digital imagery products include National Image Transmission Format (NITF) still imagery frames from both EO/IR and SAR payloads and motion picture experts group (MPEG-2) imagery with metadata encoded in the private data field and metadata overlays via closed caption. NITF is considered to be the suite of standards specified for the exchange, storage, and transmission of digital still frame imagery.

C.2.1.3 Analog Imagery. Analog imagery is transmitted as National Transmission Standards Committee (NTSC) video in RS-170A formats with metadata in either closed caption overlays or encoded via closed caption.

C.2.1.4 Analog Voice. TCS can disseminate sensor product information via analog voice over VHF, UHF links, SATCOM, and 2-wire TA-312 landlines. Information consists of either a formatted or unformatted verbal description of imagery.

C.2.1.5 Digital Voice. TCS can disseminate sensor product information via digital voice over VHF, UHF and HF links, SATCOM, and 4-wire landlines including MSE. Information consists of either a formatted or unformatted verbal description of imagery.

C.2.2 Mission Planning and Tasking, Status Queries, and Mission Status Reports. Mission planning and tasking, status queries, and mission status reports are communicated through the use of various message standards (e.g., VMF, USMTF, and FATDS).

C.2.2.1 Mission Tasking and Plans. Mission tasking and planning includes flight route planning, payload/collection planning, communications planning, and dissemination planning. This information is imported and exported through interfaces with Service mission planning systems.

C.2.2.2 Status Queries. Status queries are requests from a C4I system to transmit or receive information regarding the UAV or TCS system status or requests for sensor products.

C.2.2.3 Mission Status Reports. Mission status reports are sent to and received from C4I systems and contain information regarding UAV or TCS system status. Status reports may be sent periodically or on demand.

C.2.3 C4I Connectivity. Figure C-3 shows the products TCS provides to various C4I systems and the backbones, intermediate systems or architectures through which TCS connects to disseminate those products.

C4I SYSTEM	PRODUCT(S) FROM TCS	BACKBONE, INTERMEDIATE SYSTEM/ARCHITECTURES
AFATDS	Tactical messages	MSE, SINCGARS, wireline
ASAS	NITF, tactical messages	Army tactical LAN, MSE, SINCGARS, wireline
ATHS	*TBD*	*TBD*
ATWCS	NITF	LAN
CARS	NITF	IPA, SIPRNET LAN
CCTV	NTSC video	RG-59U cable, 62.5/125 fiber
COMPASS	Mission planning data, tactical messages	LAN
ETRAC	NITF	IPL, LAN
GUARDRAIL ACS/IPF	SIGINT data	*TBD*
IAS	NITF, tactical messages	LAN, MSE, SINCGARS
JDISS	NITF, NTSC video, tactical messages	LAN, RG-59U, SIPRNET LAN, 62.5/125 fiber
JMCIS (GCCS-M)	NITF, NTSC video, tactical messages	IPL, LAN, RG-59U, 62.5/125 fiber
JSIPS	NITF	IPA, SIPRNET LAN
JSIPS-N	NITF	IPL, LAN
JSTARS CGS	NTSC video	IPL, LAN, RG-59U, 62.5/125 fiber
MIES	NITF	IPL, LAN

C4I SYSTEM	**PRODUCT(S) FROM TCS**	**BACKBONE, INTERMEDIATE SYSTEM/ARCHITECTURES**
Mission planners AFMSS/TAMPS/AMPS	Mission data, tactical messages	SIPRNET LAN
TBMCS	NITF, NTSC video, tactical messages	SIPRNET LAN
TEG	NITF, tactical messages	IPL, SIPRNET LAN
TES	NITF	IPL, SIPRNET LAN
TROJAN SPIRIT II	NITF, NTSC video	LAN, RG-59U, 62.5/125 fiber

Figure C-3. C4I Connectivity

APPENDIX D – SYSTEM DESIGN, INTERFACES AND FUNCTIONALITY

D.1 SYSTEM DESIGN AND INTERFACES. The scaleable and modular capabilities of TCS are inherent design features of the system that are achieved through interfacing the internal hardware and software components of the TCS with each other and interfacing the entire system externally to supporting equipment and other systems. There are three types of component interfaces: 1) software-to-software, 2) software-to-hardware, and 3) hardware-to-hardware. There are also a number of external system-to-system interfaces.

D.1.1 Software-to-Software Interfaces. TCS has the following software-to-software interfaces:

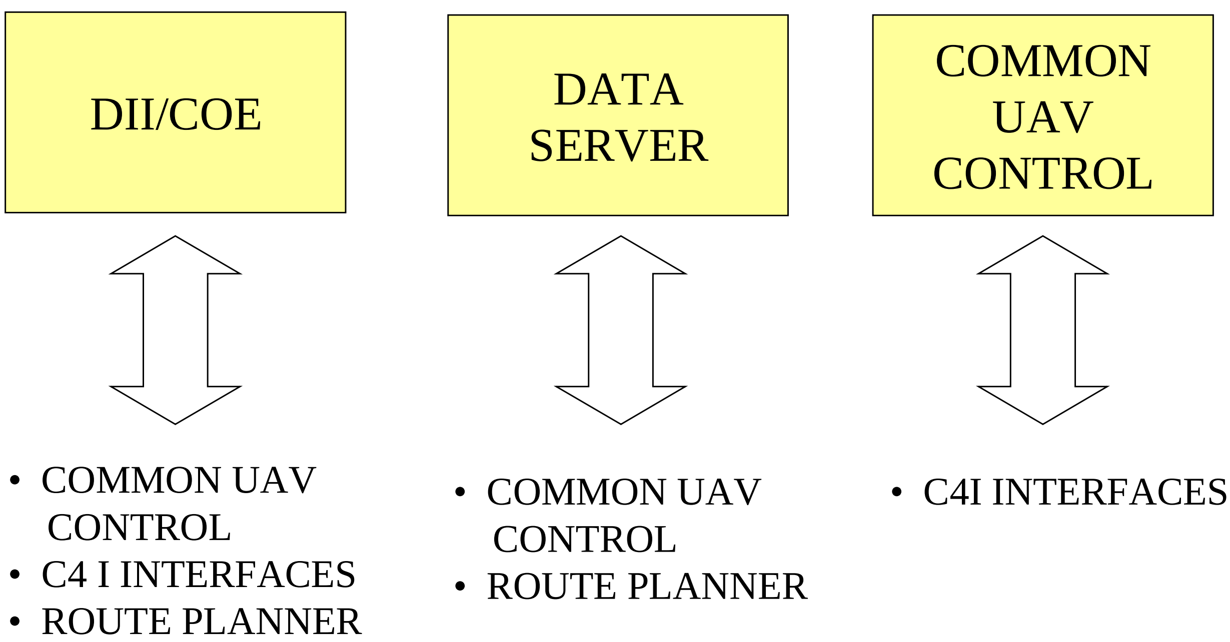

Figure D-1. Software-to-Software Interfaces

D.1.2 Software-to-Hardware Interfaces. TCS has the following software-to-hardware interfaces:

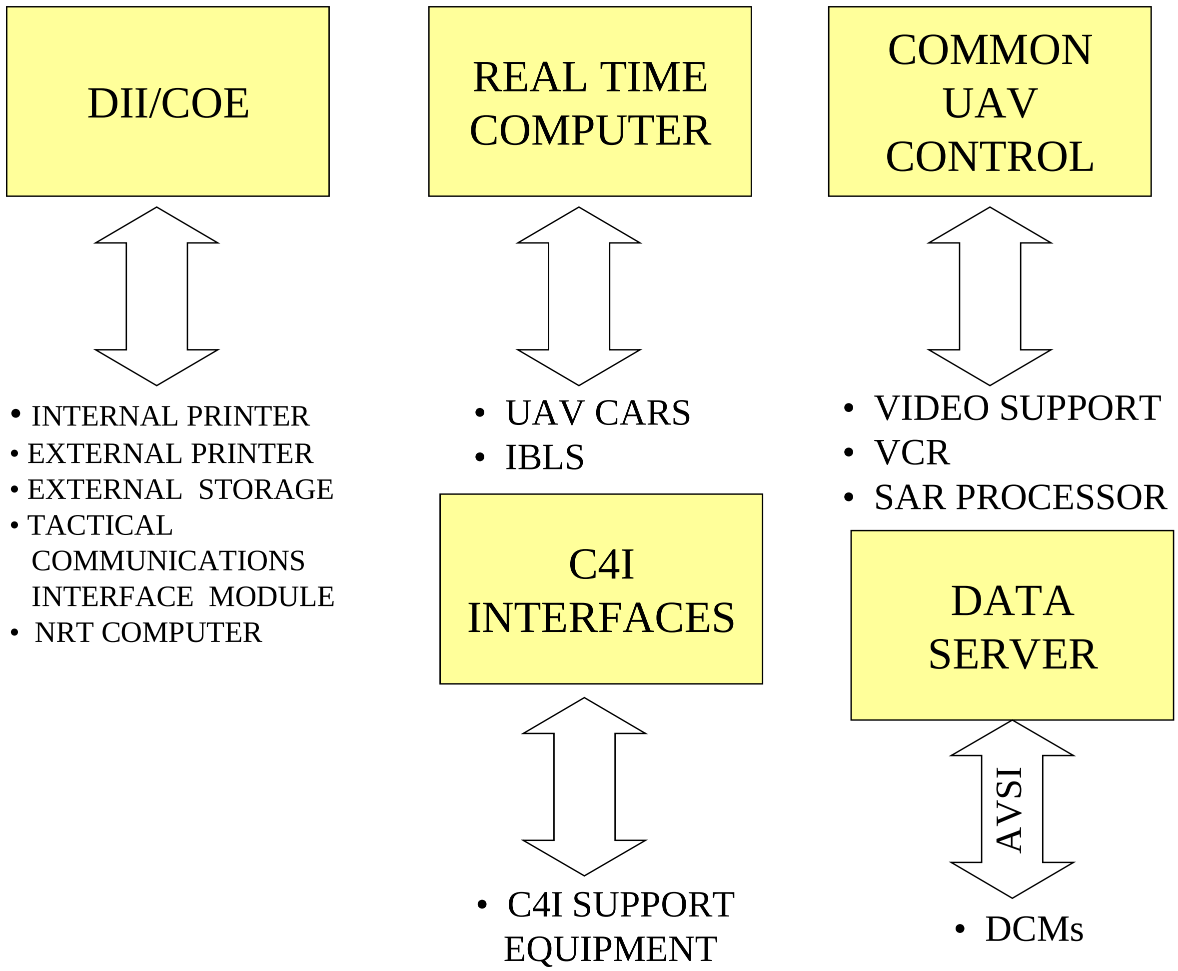

Figure D-2. Software-to-Hardware Interfaces

D.1.3 Hardware-to-Hardware Interfaces. TCS has the following hardware-to-hardware interfaces:

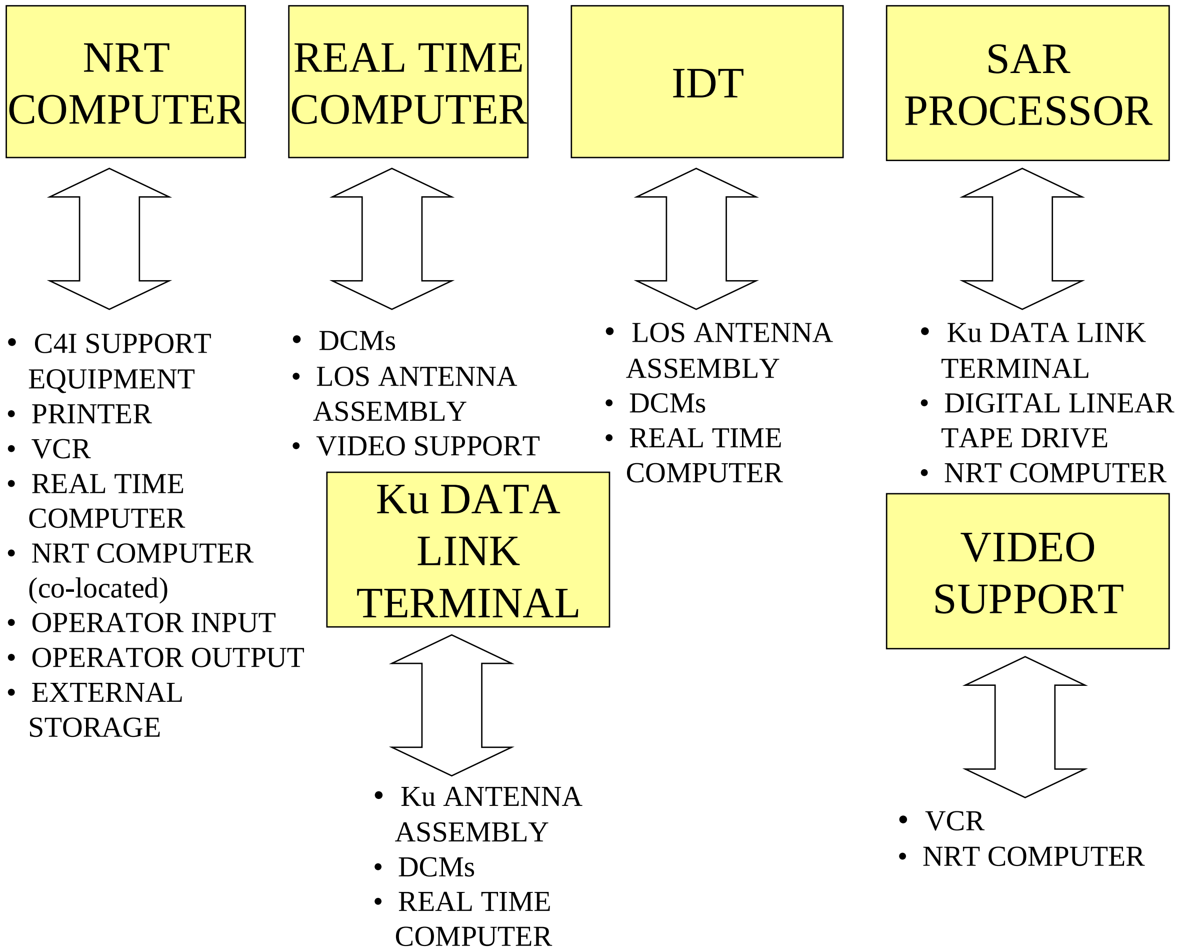

Figure D-3. Hardware-to-Hardware Interfaces

D.1.4 EXTERNAL INTERFACES.

D.1.4.1 Power Interfaces. TCS has the following power interfaces: uninterruptable power supply (UPS) to Power Distribution hardware components, UPS to the non-real time (NRT) computer, and UPS to the DCMs.

D.1.4.2 Imagery System Interfaces. TCS will be provided an interface between the NRT computer and the Image Product Library (IPL) as an objective capability.

The IPL supports lower level echelon UAV operating sites, imagery exploitation sites, and TOCs. The IPL stores and manages both still and motion imagery in a single unitary domain (both still and motion imagery may be accessed together) primarily in support of near term tactical requirements. A TCS site IPL serves as a short-term imagery buffer for supporting distribution of motion imagery segments to designated users and designated imagery exploitation sites. It also supports preparation of mission archives. The IPL at TCS sites assigned in support of tactical operations will be very localized and address immediate operational imagery needs.

The TCS system is capable of storing a minimum 4.0 gigabytes worth of text and still and motion imagery. Organic storage capability enables each TCS site to maintain its own IPL where selected imagery files can be archived, managed, and exploited for certain periods of time. This allows TCS systems to operate independently without C4I connectivity to another IPL or higher echelon image library and to pass high interest archived imagery to that library once connectivity can be established.

D.1.4.3 Launch and Recovery Interfaces. TCS will be provided with interfaces between the real time computer and the UAV CARS and the IBLS as objective capabilities.

D.1.4.4 C4I Interfaces. TCS is capable of interfacing with a wide variety of current joint and Service C4I systems (see Appendix C, figure C-2). In addition, TCS architecture, hardware, and software are designed such that all future C4I systems will also be interoperable with TCS. Current TCS capabilities to output imagery and data, however, exceed the exploitation capabilities of some C4I systems with which TCS can interface.

D.2 SUBSYSTEM FUNCTIONALITY. TCS subsystems are designed with the following functionality. Unless noted otherwise, all functions described are threshold capabilities:

D.2.1 AV Communications Subsystem. The AV Communications Subsystem consists of hardware and software components necessary for communications between TCS and a UAV.

D.2.1.1 Data Link Terminal. Data Link Terminal hardware provides concurrent data uplink and downlink between TCS and an AV.

D.2.1.1.1 Integrated Data Link Terminal (IDT). IDT hardware provides the interface between the DCM hardware and the LOS Antenna Assembly hardware. The IDT performs the same function as the individual GDTs for each specific air vehicle, thereby eliminating the requirement for separate GDTs/antenna assemblies for each air vehicle to be controlled.

D.2.1.1.2 Ku Data Link Terminal. The Ku Data Link Terminal provides the interface between DCM hardware and Ku-equipped AVs.

D.2.1.1.3 Link Manager Assembly (LMA). The function of the Link Manager Assembly (LMA) hardware and software is TBD.

D.2.1.2 DCMs. DCMs for the Outrider, Pioneer, and Predator consist of both hardware and software specific to the air vehicle. The DCM hardware performs real time processing in order to maintain closed-loop communication and control of the AV as well as the required control of the ground-based data link components and communications. DCM hardware also transfers data to the Real

Time Processor (RTP) software through the Air Vehicle Standard Interface (AVSI).

D.2.1.3 Antenna Assembly. Antenna Assembly hardware consists of both a C-Band LOS Antenna and a Ku-Band SATCOM Antenna. Both antenna assemblies enable TCS to communicate over the appropriate frequency band with AVs equipped to operate in those bands.

D.2.2 Launch and Recovery Subsystem. The Launch and Recovery Subsystem consists of hardware only and is provided as an objective capability. There are two types of hardware: 1) the IBLS which provides TCS with a differential Global Positioning System (GPS) to launch and recover IBLS capable AVs, and 2) the UAV CARS which provides a microwave based Ka-band system to control and recover UAV CARS-capable AVs.

D.2.3 Real Time Subsystem. The Real Time Subsystem consists of the hardware and software necessary for the real time processing of information.

D.2.3.1 Real Time Computer. Real Time Computer hardware provides the real time processing capability to TCS.

D.2.3.2 Manual Controls. The Manual Controls are TBD.

D.2.3.3 Real Time Processor. Real Time Processor software provides the following functionality:

- Antenna control.
- AVSI conversion.
- IBLS conversion.
- UAV CARS conversion.

D.2.3.4 Data Server. Data Server software for TCS Levels 4 and 5 resides on the Real Time Computer and supports information flow to and from the AV and provides interfaces to all other internal software.

D.2.4 Payload Subsystem. The Payload Subsystem consists of EO/IR and SAR payloads.

D.2.4.1 EO/IR Payload. The EO/IR Payload has no TCS-specific hardware or software.

D.2.4.2 SAR Payload. The SAR Payload consists of the following hardware and software necessary for SAR payload operations.

D.2.4.2.1 SAR Processor. The SAR Processor hardware provides front end processing of raw SAR imagery and telemetry data for input into the NRT Computer.

D.2.4.2.2 Digital Linear Tape Drive. The Digital Linear Tape Drive hardware records raw SAR data.

D.2.4.2.3 Redundant Array of Inexpensive Disks (RAID). RAID hardware provides buffer storage for approximately 10 minutes of SAR data.

D.2.4.2.4 SAR Payload Computer. The SAR Payload Computer software provides the capability to control and monitor the SAR payload, process and store payload product data, and generate NITF files.

D.2.4.2.5 Integrated Interface Unit (IIU). The functionality of the IIU is TBD.

D.2.5 Operator Station Subsystem. The Operator Station Subsystem consists of operator output and operator input hardware to display waypoints on a map using a pointing device with keyboard redundancy.

D.2.5.1 NRT Computer. NRT Computer hardware provides the functionality to perform mission planning, mission control and monitoring, payload processing, targeting, and C4I interfacing.

D.2.5.2 Video Support. Video Support hardware provides the capability to receive, amplify, convert, annotate, display, and distribute analog video and the capability to capture still frames of analog video.

D.2.5.3 Operator Output. Operator Output hardware allows TCS operators to receive information from the NRT Computer.

D.2.5.4 Operator Input. Operator Input hardware consists of keyboard, trackball, and joystick (at a minimum) and enables operators to input information into the NRT Computer.

D.2.5.5. Common UAV Control. Common UAV Control software provides the UAV operator with the necessary tools for computer related communications, mission tasking, mission planning, mission execution, data receipt, data processing, and data dissemination.

D.2.5.6 Mission Planner. Mission Planner software consists of the following basic elements: Route Planner, Payload Planner, Data Link Planner, Communications Planner, Plan Monitoring, Training, and Maintenance.

D.2.5.7 DII/COE. DII/COE software provides information services to include mapping, charting, geodesy, imagery exploitation, and NITF file generation, message processing, and printer control.

D.2.5.8 C4I Interfaces. C4I Interface software provides the capability to:

- Send and receive tactical communications messages.
- Send and receive annotated and unannotated digital imagery.
- Establish and terminate digital communications with C4I systems.
- Establish and terminate digital communications to peripheral devices.
- Send and receive analog imagery in RS-170A format with or without overlay.
- Establish and terminate analog communications to C4I systems.
- Establish and terminate analog communications to peripheral devices.
- Establish a voice interface via intercom systems, headsets, SINCGARS radio, or LAN
- Send and receive flight route and mission list data to C4I systems.

D.2.5.9 Fault Detection/Location (FD/L) and Diagnostics. FD/L and Diagnostics software functionality is TBD.

D.2.5.10 Air Vehicle Diagnostics. Air Vehicle Diagnostics software functionality is TBD.

D.2.5.11 Data Server. Data Server software to support Levels 1, 2 and 3 resides on the NRT Computer and supports information flow to and from the AV and provides interfaces to all other internal software.

D.2.6 Communications Subsystem. The Communications Subsystem consists of hardware and software necessary for external voice and data communications.

D.2.6.1 External Storage. External Storage hardware provides additional storage space to the NRT Computer.

D.2.6.2 Printer. TCS Printer hardware provides the capability to print hard copies of digital imagery, mission plans, C4I messages, and FD/L information.

D.2.6.3 Intercom Equipment. Intercom hardware provides verbal communications between multiple TCS operators.

D.2.6.4 C4I Support Equipment. C4I Support Equipment hardware provides the interface with military and commercial satellite communications equipment.

D.2.6.5 Communications Equipment. Communications Equipment hardware provides communications with other military units via MSE or SINCGARS interfaces.

D.2.7 Power Distribution Subsystem. The Power Distribution Subsystem consists of hardware and software to meet TCS power requirements.

D.2.7.1 UPS. The UPS consists of operator station UPS hardware, which varies dependent upon computer type, and support equipment UPS which provides uninterrupted power for critical phases of mission execution, take-off, and landing to avoid loss of air vehicle control.

D.2.7.2 Power Distribution. Power Distribution hardware provides conditioned and necessary power to the various TCS components.

D.2.8 Configuration Dependent Subsystem. Each TCS configuration contains hardware specific to that configuration's footprint limitations and desired operational capabilities as specified by the user.

APPENDIX E - TRAINING/QUALIFICATION/CURRENCY

E.1 Training and Qualification. Both Service-specific UAV and TCS-specific training and qualification are required for TCS operators and maintenance technicians.

Service specific training and qualification fulfills Service mandated requirements for UAV air vehicle and sensor command and control and maintenance of associated Service unique hardware and software.

TCS specific training and qualification supports the five levels of TCS interaction with both existing and future UAV systems. Training accommodates both single-UAV and multiple-UAV operations and is constructed in modules, scaleable to the level of interaction achievable by the supported TCS configuration or operator qualification. Courseware is designed such that it can incorporate new UAVs and capabilities, when available.

E.1.1 Service Training and Qualification. Service UAV operator and maintenance technician training and qualification will be conducted in accordance with formal requirements as prescribed by Service training commands.

E.1.1.1 Air Force. Air Force Instructions 11-2RQ-1, Volume 1 (Draft: 24 Mar 1998 Version), 11-2RQ-1 Volume 2 (expected publication date 1 Jul 98) and 11-2RQ-1, Volume 3 (Draft: 22 May 1998 Version) prescribe Air Force UAV training, qualification, and operating standards. Air Force requires RQ-1A air vehicle operators to be Rated Officers. Imagery payload operators require an AFSC of 1N1 (Intelligence Imagery Analyst). Communications electronics maintenance technicians require a 2Axxx (Maintenance Career Field) AFSC and system administrators require a 3C0X1 (Communications-Computer Systems Operator) AFSC.

E.1.1.2 Army. Aircrew Training Manual – TC 34-212/UAV Aircrew Training Manual prescribes Army UAV training and qualification standards. Army requires tactical UAV air vehicle operators, including those conducting payload operations and limited data exploitation, to have an MOS code of 96U (UAV Operator). Technicians require a 33R MOS (Airborne EW Systems Repairman). Mechanics currently require a 52D MOS (Small Engine Repairman).

E.1.1.3 Marine Corps. JUAVTOPS Manual prescribes UAV training and qualification standards. Marine Corps requires tactical UAV operators to have a 7314 MOS (UAV internal pilot/payload operator) and a 7316 MOS (UAV external pilot). Technicians and mechanics require 6314 (UAV technician) and 6014 (UAV mechanic) MOSs, respectively.

E.1.1.4 Navy. JUAVTOPS Manual prescribes Navy UAV training and qualification standards. Navy requires qualified personnel as follows: 13XX designator (Mission Commander) and NEC 8362 (External Pilot, Internal Pilot, and Payload Operator). Mechanics and technicians require an NEC code of 8361 (UAV Maintenance Mechanic/UAV Technician).

E.1.2 TCS Training and Qualification.

E.1.2.1 TCS Training Architecture and Design. Training software leverages the core HCI enabling sensor operators trained and qualified in one UAV system to control different types of payloads with additional TCS training. The software is portable and exportable to the field. The training architecture will use an Interactive Courseware Program (ICW) that is independent but compatible with the TCS core software so that it performs as a stand alone unit or as an embedded non-real time functional element. TCS training software uses internal simulation capabilities and also takes advantage of external simulation sources.

In the Training Operations Mode, TCS provides the capability to train and qualify personnel, and maintain proficiency in the operation of the TCS system, perform simulated TCS UAV control functions, and conduct on-line system troubleshooting. This training capability is alterable without affecting the configuration of the operational software. This capability provides TCS operators and maintenance technicians with embedded or add-on self-paced interactive courseware that duplicates UAV flight performance characteristics, capabilities, and limitations.

The Operations Mode of TCS does not accommodate concurrent training operations with the execution of actual missions, however, in the Operations Mode the processing of training messages, if identified as training messages (i.e., use of the terms ‘DRILL’ or ‘EXERCISE’), can be accomplished concurrently with actual mission communications message processing. TCS operator and maintenance technician training actions and retrievable TCS and UAV parameters are recorded to measure performance and for self-assessment and performance enhancement.

E.1.2.2 TCS Training Implementation. Implementation of TCS training is a Service responsibility. TCS training will be integrated into existing institutional UAV training programs. Training will be balanced between institutional, new equipment, and unit training. Initial training efforts will focus on new equipment training and developing an instructor cadre while maintaining operational capability until institutions and field units can stand-alone. Sustainment training will encompass training at the institutional level and in-service training at the unit level. Training will initially emphasize training of individual Service training teams and key personnel who will integrate TCS core training into existing Service/UAV system training curricula. Once institutionalized within Service/system curricula, training emphasis will shift to instructors and operators to support the fielded systems and then finally provide advanced training for designated personnel.

E.1.2.3 TCS Training Curriculum. Three training courses will be provided for UAV unit personnel. All courses will be developed in modular format to allow grouping and mixing and matching of functional areas and individual lessons to support differences in existing training syllabi. Training will also be available for non-UAV unit personnel to qualify them to conduct TCS Level 1 and 2 operations.

E.1.2.3.1 TCS Operator Core Course: The TCS Operator Core Course will be integrated into existing Initial Qualification Training (IQT)/Replacement Operator training programs. This course trains operators in basic system operation (menus, buttons, windows, etc.) for TCS Levels 1 – 4 for single UAV operations. It consists of training in the following specific areas:

- System Initialization/Shutdown
  - System administrator set-up
    - TCS interactivity level
    - Map display
  - Built in test (BIT)

- Route and Payload Planning
  - Map display
  - Air vehicle route
  - Payload

Communications

- Mission Control & Monitor
  - Air vehicle
  - Payload
  - Data link
  - Launch & recovery (Level 5 training)

- Payload Processing
  - Image process
  - Image display
  - Image exploitation

- C4I Interface
  - Communications (text and imagery exchange)
  - Tactical communications (voice and preformatted messages)
  - Data dissemination

- Fault Detection/Isolation
  - BIT
  - Troubleshooting

E.1.2.3.2 TCS Operator Advanced Course. The TCS operator advanced course provides follow-on training and qualification for selected operators in TCS Levels 3-5 for multi-UAV operations. This training expands the skills and knowledge of TCS operators to enable them to control other UAVs at Levels 3 – 5.

E.1.2.3.3 TCS Maintenance Technician Course. The TCS Maintenance Technician course provides training specific to the different hardware suites of the individual Services and generic training for TCS unique items (DCM, etc.).

E.1.2.3.4 Non-UAV Unit Personnel Training. Personnel not assigned to UAV units or who do not posses the Air Force Specialty (AFSC)/Military Occupational Specialty (MOS)/Navy Enlisted Classification (NEC) codes but who require TCS training and qualification will be provided "just in time" training in the field or use embedded CBT included in the TCS. This training supports the qualification of designated individuals to conduct Level 1 and 2 operations. Individuals that may require this training include shipboard Combat Information Center personnel, JFC staff, SOF, etc. Currency/recurrency training is not required.

E.2 Currency. TCS operator currency is required for payload and air vehicle operation. Currency standards are as directed by individual Service directives.

E.2.1 Air Force (RQ-1A Predator UAV). Currency standards are contained in Air Force Instruction 11-2RQ-1, Volume 1 (Draft: 24 Mar 1998 Version). The following table summarizes currency requirements for RQ-1 aircrew. If an aircrew loses a particular currency, that individual may not perform that sortie or event except for the purpose of regaining currency.

EVENT	INEXPERIENCED	EXPERIENCED*	TO REGAIN CURRENCY	NOTE
Air Vehicle Operator (AVO)				
Local proficiency sortie (LPS)	90	120	Fly LPS	1
Launch procedures	30	45	Fly event	1
Engine out pattern	45	60	Fly event	1

EVENT	INEXPERIENCED	EXPERIENCED*	TO REGAIN CURRENCY	NOTE
Air Vehicle Operator (AVO)				
Precision approach	30	45	Fly event	2
Nose camera landing	30	45	Fly event	1 & 5
IR landing	30	45	Fly event	1 & 5
Instructor	N/A	60	Fly event	3
Sensor Operator (SO)				
Ready Aircrew Program (RAP) sortie	30	45	Fly sortie	1
Operational mission planning	30	45	Fly event	1
Emergency mission planning	30	45	Fly event	1
Mission monitoring	30	45	Fly event	1
Ku target acquisition	30	45	Fly event	4
LOS target acquisition	30	45	Fly event	4
SAR target acquisition	30	45	Fly event	4
Menu drills	15	30	Fly event	4
Instructor	N/A	60	Fly event	3

*More than 100 RQ-1A and 1000 total USAF flight hours or more than 200 RQ-1A hours.

NOTES:

1. Supervision level is an instructor qualified and current in the sortie/event.
2. If day and visual flight rules, the supervision level is an AVO, current and qualified in the event; all other times require an instructor.
3. Instructor aircrew currency is 60 days. Non-currency for 61-180 days requires a recurrency flight with an instructor. Non-currency for 181 days and beyond requires a flight evaluation.
4. The supervision level is an SO, current and qualified in the event. Non-currency for over 90 days requires instructor supervision for recurrency.
5. AVOs may accomplish a total of three touch-and-go landings per sortie. A full-stop taxi—back landing is counted and limited the same as a touch-and-go landing. Initial qualification training (IQT), LPS and Sensor Qualification (SQ) supervisor directed training sorties are not limited for touch-and-go landings.

Aircrew require recurrency whenever they exceed a currency requirement. They must satisfy overdue training requirements before performing tasks applicable to the type of training in which delinquent.

Loss of landing/sortie recurrency requires the following action:

- 31-90 days (46-90 days for experienced aircrew) – regain landing/sortie currency. Supervision level is an instructor qualified and current in the sortie/event.
- 91-135 days – same as above plus instructor supervised OFT.
- 136-210 days (136-245 days for experienced aircrew) – same as above plus qualification and tactical written examinations and emergency procedures examination
- 211 or more days (246 or more days for experienced aircrew) – sorties/events/OFTs as determined by the unit commander plus qualification and tactical written examinations, emergency procedures examination, and qualification/mission flight evaluation.

E.2.2 Army. Currency standards, which are summarized below, are contained in TC 34-212/UAV Aircrew Training Manual.

- Payload control:
  - Less than 90 days – one local flight of 30 minutes duration.
  - More than 90 days – satisfactory completion of a hands-on performance test conducted by an Instructor Pilot, Standardization Instructor Pilot, or Maintenance Test Flight Evaluator.
- Air vehicle control:
  - Less than 90 days – one local flight of 30 minutes duration to include preflight, launch, traffic pattern, emergencies and landing.
  - More than 90 days – satisfactory completion of a hands-on performance test conducted by an Instructor Pilot, Standardization Instructor Pilot, or Maintenance Test Flight Evaluator.

- Air vehicle launch and recovery (EP):
    - Day
        - Less than 45 days – one rolling takeoff, one full stop landing, 30 minutes of local flight time including touch and go landings and simulated emergencies, and passing of bold face action emergency procedures written exam.
    - Night
        - Less than 90 days – one rolling takeoff, one full stop landing, 30 minutes of local flight time including touch and go landings and simulated emergencies, and runway set-up for night operations. Day currency requirements must be met within 5 days prior to night flight operations to include one daytime takeoff and landing.

When currency has lapsed over 90 days, the operator must undergo simulator training to the satisfaction of an instructor pilot (IP) and then meet the less than 90 day currency requirement.

Note: Tasks that can be accomplished in the simulator may be utilized to meet currency requirements with the exception that the simulator may not be utilized for two consecutive currency flights.

- Semi-annual hour requirements:
    - EP – 12 hours
    - VO – 10 hours
    - PO – 10 hours

Note: Operators qualified as both VO and PO require 5 hours of VO time and 5 hours of PO time.

E.5.3 Marine Corps. Currency standards, which are summarized below, are contained in the JUAVTOPS Manual.

- Internal pilots, mission commanders, and payload operators that have not operated a tactical UAV in their respective positions within the last 90 days require a refresher flight under the supervision of a certified instructor.

- External pilot currency is based requirements contained in the following chart. These requirements must be met every 60-day period. If currency lapses, a recurrency flight with an EP instructor is required consisting of one takeoff, five touch and goes or low approaches, and one landing. Before the recurrency flight, one hour of training device time with an EP instructor is required.

EP Currency	Takeoff/Launch	Touch & go (T&G) or low approach (LA)	Landings	Training Device
Shore day	2	10	2	6 hours
Shore night	1	5	1	2 hours
Sea day	2	15	2	6 hours
Sea night	1	5	1	2 hours

- External pilots that have not flown in one week require a 1 hour training device flight prior to an actual tactical UAV flight (note: a day flight must be flown within 5 days prior to a night flight).

- Each crew position is required to complete a written examination and flight evaluation annually.

- Unit commanders are authorized to waive, in writing, minimum flight and training requirements where recent experience and knowledge of UAV operations warrant.

E.2.4 Navy. Currency standards, which are summarized below, are contained in the JUAVTOPS Manual.

- Payload control:
  - Less than 90 days – one flight
  - Greater than 90 days – one refresher flight under the supervision of an instructor pilot
- Air vehicle control:
  - Less than 90 days – one flight
  - Greater than 90 days – one refresher flight under the supervision of an instructor pilot
- Air vehicle launch and recovery:
  - Shorebased operations –
    - Less than 45 days – one flight with one takeoff, five touch and go landings, and one recovery
    - Greater than 45 days – one training device flight under the supervision of a qualified external pilot
  - Shipboard operations –
    - Less than 45 days – one flight with one takeoff, five approaches, and one recovery
    - Greater than 45 days – one training device flight under the supervision of a qualified external pilot
    - Night currency – one night flight within 5 days of a day flight

APPENDIX F – REFERENCES

The documents and publications listed below were used in the preparation of this Concept of Operations or provide amplifying or more detailed information regarding TCS.

F.1 DOD DOCUMENTS.

DARO UAV Annual Report, 6 Nov 97

DUSD (A & T) Memorandum dated 21 Dec 95, Initiating the TUAV ACTD

ASN (RDA) Memorandum dated 12 Sep 1997, Tactical Control System, Acquisition Category II Designation

DOD Directive 5200.28(D), Security Requirements for Automated Information Systems

F.2 JCS DOCUMENTS.

JROCM 011-97 dated 3 Feb 97, Unmanned Aerial Vehicle (UAV) Tactical Control System (TCS) Operational Requirements Document (ORD)

JROCM 010-96 dated 12 Feb 96, Predator Unmanned Aerial Vehicle

JROCM 135-95 dated 31 Oct 95, Tactical Unmanned Aerial Vehicle

JROCM 003-90 dated 5 Jan 90, Mission Needs Statements for Close Range Reconnaissance, Surveillance, and Target Acquisition (RSTA) Capability and Long Endurance Reconnaissance, Surveillance, and Target Acquisition (RSTA) Capability

Joint Pub 2-0, Doctrine for Intelligence Support to Joint Operations, 5 May 95

Joint Pub 2-01, Joint Intelligence Support to Military Operations, 20 Nov 96

Joint Pub 3-01.4, JTTP for Suppression of Enemy Air Defenses, 25 Jul 95

Joint Pub 3-01.5, Joint Doctrine for Theater Missile Defense, 22 Feb 96

Joint Pub 3-02, Joint Doctrine for Amphibious Operations, 8 Oct 92

Joint Pub 3-07.4, Joint Counterdrug Operations, 17 Feb 98

Joint Pub 3-50.2, Doctrine for Joint Combat Search and Rescue, 26 Jan 96

Joint Pub 3-52, Doctrine for Joint Airspace Control in a Combat Zone, 22 Jul 95

Joint Pub 3-55, Doctrine for Reconnaissance, Surveillance, and Target Acquisition Support for Joint Operations, 14 Apr 93

Joint Pub 3-55.1, JTTP for Unmanned Aerial Vehicles, 27 Aug 93

Joint Pub 3-56.1, Command and Control for Joint Air Operations, 14 Nov 94

CJCSI 3250.1, Sensitive Reconnaissance Operations, Apr 96

CJCSM 3500.4A, Universal Joint Task List, 13 Sep 96

F.3 PEO-CU DOCUMENTS.

TCS Joint Interoperability Interface 2, TCS to Service Command, Control, Communications, and Intelligence (C4I) Systems, Version 1.1, 8 May 98

TCS System/Subsystem Specification (SSS), Version 1.0, 30 Jun 97

UAV TCS Program Management Plan (PMP), Version 4.1, 6 Aug 1997

TCS System/Subsystem Design Description (SSDD), 5 Dec 97

Configuration Management (CM) Plan for the UAV Tactical Control System (TCS) Version 1.0, April 98

TCS Block 0 Software Requirements Specification (SRS), Version 1.3.2, 22 Jun 98

F.4 SERVICE DOCUMENTS.

<u>Air Force</u>

Air Combat Command (ACC) Concept of Operations for Endurance Unmanned Aerial Vehicles, Version 3, 1 Apr 98

Air Force Instruction (AFI) 11-2RQ-1 Volume 1, RQ-1 Aircrew Training, Draft Version, 24 Mar 98

Air Force Instruction (AFI) 11-2RQ-1 Volume 2, RQ-1 Aircrew Evaluation Criteria, Draft Version, expected date of publication 1 Jul 98

Air Force Instruction (AFI) 11-2RQ-1 Volume 3, RQ-1 Operations Procedures, Draft Version, 22 May 98

Army

Army TC 34-212, UAV Aircrew Training Manual, 27 Aug 97

Marine Corps

JUAVTOPS Flight Manual, Pioneer Unmanned Aerial Vehicle, 5 Mar 97

Navy

JUAVTOPS Flight Manual, Pioneer Unmanned Aerial Vehicle, 5 Mar 97

F.5 MISCELLANEOUS DOCUMENTS.

USACOM HAE UAV Joint Employment CONOPS, 1 Jun 98

Variable Message Format Technical Interface Design Plan (VMF TIDP)

APPENDIX G – GLOSSARY

PART I - ABBREVIATIONS and ACRONYMS

ACA	Airspace Control Authority
ACAT	acquisition category
ACC	Air Combat Command
ACCI	ACC Instruction
ACCS	Army Command and Control System
ACE	Aviation Combat Element (MAGTF)
ACOM	United States Atlantic Command
ACR	Armored Cavalry Regiment
ACS	Aerial Common Sensor
ACTD	Advanced Concept Technology Demonstration
ADATP	Architecture, Design, Analysis, and Planning
ADCON	administrative control
ADT	air vehicle data terminal
AFATDS	Advanced Field Artillery Tactical Data System
AFI	Air Force Instruction
AFMSS	Air Force Mission Support System
AFSC	Air Force Specialty Code
AGF	amphibious flagship
AIS	automated information system
AMCOM	Army Aviation and Missile Command
AMPS	Aviation Mission Planning System
AOC	Air Operations Center
AOR	area of responsibility
ASAS	All Source Analysis System

ASO	Aviation Supply Office
ATF	amphibious task force
ATHS	Automated Target Handoff System
ATM	Army Training Manual, Asynchronous Transfer Mode
ATO	Air Tasking Order
ATWCS	Advanced Tomahawk Weapons Control System
AV	air vehicle
AVO	air vehicle operator
AVSI	air vehicle standard interface
BDA	battle damage assessment
BIT	built in test
BLOS	beyond line-of-sight
C2	command and control
C4I	command, control, communications, computers and intelligence
CARS	Contingency Airborne Reconnaissance System, Common Automated Recovery System
CAS	close air support
CBT	computer-based training
CCD	camouflage, concealment, and deception
CCTV	closed circuit TV
CDL	common data link
CIGSS	Common Imagery Ground/Surface Station
CINC	Commander in Chief
CGS	common ground segment, common ground station
CJCS	Chairman of the Joint Chiefs of Staff

CLF	Commander, Landing Force
CM	collection manager/collection management
CMA	collection management authority
CMP	Common Message Processor
COCOM	combatant command
COE	Common Operating Environment
COMPASS	Common Operational Modeling, Planning, and Simulation System
COMSEC	communications security
CONOPS	concept of operations
CONUS	Continental United States
CV/CV(N)	aircraft carrier/aircraft carrier (nuclear)

DAMA	demand assigned multiple access
DARO	Defense Airborne Reconnaissance Office
DARS	Daily Airborne Reconnaissance Surveillance
DCM	data link control module
DII	Defense Information Infrastructure
DOD	Department of Defense
DT	developmental testing
DUSD (A & T)	Deputy Under Secretary of Defense (Acquisition and Technology)

EMD	engineering, manufacturing, development
EO	electro-optical
EP	external pilot
ETRAC	Enhanced Tactical Radar Correlator
EUAV	endurance UAV
EW	electronic warfare

FAA	Federal Aviation Administration
FATDS	Field Artillery Tactical Data System
FOC	full operational capability
FOL	forward operating location
FTP	file transfer protocol
Gb	gigabyte
GBS	Global Broadcast Service
GCCS	Global Command and Control System
GCE	Ground Combat Element
GCS	Guardrail Common Sensor/ground control station
GDT	ground data terminal
GFE	government furnished equipment
GFI	government furnished installation
GPS	Global Positioning System
GPTE	general purpose test equipment
HAE	high altitude endurance
HCI	human computer interface
HF	high frequency
HMMWV	high mobility multi-purpose wheeled vehicle
IAS	Imagery Analysis System
IBLS	Integrity Beacon Landing System

ICAO	International Civil Aviation Organization
IDT	integrated data terminal
IES	Imagery Exploitation System
IEW	intelligence and electronic warfare
IEWCOMCAT	Intelligence and Electronic Warfare Communications Catalog
IIU	integrated interface unit
ILS	integrated logistics support
ILSP	Integrated Logistics Support Plan
IMINT	imagery intelligence
INTELSAT	international telecommunications satellite
IOC	initial operational capability
IP	internal pilot, Internet protocol
IPA	imagery product archive
IPB	intelligence preparation of the battlefield
IPF	Integrated Processing Facility
IPL	imagery product library
IQT	initial qualification training
IR	infrared
ISR	intelligence, surveillance, reconnaissance

J2	Intelligence Officer
J3	Operations Officer
JAOC	Joint Air Operations Center
JCALS	joint computer-aided acquisition logistics support
JCS	Joint Chiefs of Staff
JDISS	Joint Deployable Intelligence Support System
JFACC	Joint Force Air Component Commander
JFC	Joint Force Commander

JIC	Joint Intelligence Center
JII	joint integration interface
JMCIS	Joint Maritime Command Information System
JPEG	joint photographic experts group
JPO	Joint Project Office
JROC	Joint Requirements Oversight Council
JROCM	JROC Memorandum
JSIPS	Joint Service Imagery Processing System
JSIPS-N	Joint Service Imagery Processing System-Navy
JSTARS	Joint Surveillance, Target Attack Radar System
JTA	Joint Technical Architecture
JTF	Joint Task Force
JUAVTOPS	Joint UAV Training Operating Procedures
JWICS	Joint Worldwide Intelligence Communications System
JWPG	Joint Warfighter Planning Group

Kb	kilobyte
Kbs	kilobytes per second

LA	low approach
LAN	local area network
LB	land-based
LCC	amphibious command ship
LHA	amphibious assault ship
LHD	amphibious assault ship (internal dock)
LMA	Link Manager Assembly
LNO	liaison officer
LO	low observable

LOS	line-of-sight
LPD	amphibious transport dock ship
LRIP	low rate initial production
MAE	medium altitude endurance
MAGTF	Marine Air-Ground Task Force
MAST	Mobile Ashore Support Terminal
Mb	megabyte
Mbs	megabytes per second
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MICFAC	Mobile Integrated Command Facility
MIES	Modernized Imagery Exploitation System
MNS	mission need statement
MOOTW	military operations other than war
MOS	military occupational specialty
MPEG	motion pictures experts group
MPO	mission payload operator
MSE	Mobile Subscriber Equipment
msl	mean sea level
MTBF	mean team between failure
MTTR	mean time to repair
NAMP	Naval Aviation Maintenance Program
NATO	North Atlantic Treaty Organization
NAVAIR	Naval Air Systems Command
NAVICP	Naval Inventory Control Point

NAWCAD	Naval Air Warfare Center Aircraft Division
NEC	Navy enlisted classification
NEO	non-combatant evacuation operation
NFS	network file server
NIMA	National Imagery & Mapping Agency
NIPRNET	non-secure Internet protocol router network
NITF	National Image Transmission Format
NRT	non real-time, near real-time
NSFS	naval surface fire support
NSWCDD	Naval Surface Warfare Center Dahlgren Division
NTSC	National Transmission Standards Committee
ODCM	Outrider DCM
OPCON	operational control
OPLAN	operations plan
OPORD	operations order
OPSEC	operational security
OT	operational testing
PANAMSAT	Pan-American satellite
PDCM	Predator DCM
PDU	power distribution unit
PED	processing, exploitation, dissemination
PEO-CU	Program Executive Officer-Cruise Missiles and Unmanned Aerial Vehicles
PiDCM	Pioneer DCM
PM	preventative maintenance, program manager
PO	payload operator

PSICP	program support inventory control point
RAID	Redundant Array of Inexpensive Disks
ROS	relief on station
RSTA	reconnaissance, surveillance, and target acquisition
RTP	real time processor
SAR	synthetic aperture radar
SATCOM	satellite communications
SB	sea-based
SE	support equipment
SECDEF	Secretary of Defense
SHIPALT	ship alteration
SIGINT	signals intelligence
SIL	System Integration Laboratory
SINCGARS	Single Channel Ground and Airborne Radio System
SIPRNET	secret Internet protocol router network
SMTP	simple mail transfer protocol
SOF	Special Operations Force
SOP	standard operating procedures
SPINS	special instructions
SPTE	special purpose test equipment
SRO	Sensitive Reconnaissance Operations
SSN	attack submarine (nuclear)
STANAG	Standardization Agreement (NATO)

T&G	touch and go landing
TACON	tactical control
TAMPS	Tactical Aircraft Mission Planning System
TBD	to be determined
TBMCS	Theater Battle Management Core System
TBMD	Theater Ballistic Missile Defense
TCDL	tactical CDL
TCP	transmission control protocol
TCS	Tactical Control System
TEG	Tactical Exploitation Group
TES	Tactical Exploitation System
TIGDL	Tactical Interoperable Ground Data Link
TMDE	test, measurement, and diagnostic equipment
TOC	Tactical Operations Center
TTP	tactics, techniques, and procedures
TUAV	tactical UAV (Outrider)

UAV	unmanned aerial vehicle
UES	UAV Exploitation System
UHF	ultra high frequency
UPS	uninterruptable power supply
USACOM	United States Atlantic Command
UCARS	UAV Common Automated Recovery System
US	United States
USCINCACOM	Commander in Chief, United States Atlantic Command
USMTF	US message text format

VCR	Video cassette recorder
VHF	very high frequency
VMF	variable message format
VO	vehicle operator
WOC	Wing Operations Center

PART II – TERMS AND DEFINITIONS

(except where noted as to source, all terms and definitions contained herein are specific to this CONOPS)

commonality – A quality that applies to materiel or systems: a. possessing like and interchangeable characteristics enabling each to be utilized, or operated and maintained, by personnel trained on the others without additional specialized training. b. having interchangeable repair parts and/or components. c. applying to consumable items interchangeably equivalent without adjustment. For TCS: use of the same hardware, software or user display. (DOD Dictionary)

compatibility – Capability of two or more items or components of equipment or material to exist or function in the same system or environment without mutual interference. (DOD Dictionary)

Dark Star UAV – Low observable (LO) HAE unmanned aerial vehicle capable of greater than 8 hours endurance at altitudes in excess of 45,000 feet at an operating radius of 500 nm; currently under development as an ACTD. Also known as Tier III- UAV. Dark Star is capable of fully automatic flight. Dark Star is intended to provide critical imagery intelligence from highly defended areas. Air vehicle performance and payload capacity are traded for survivability features against air defenses, such as the use of low observable technology to minimize the air vehicles' radar return. The Dark Star payload may be either SAR or EO. The air vehicle is self-deployable over intermediate ranges. (UAV Annual Report)

endurance UAV – Unmanned aerial vehicle designed to support JTF commanders and theater/national C2 nodes with long-range, long-dwell, near-real time theater/tactical intelligence via deep penetration/wide-area surveillance. Endurance UAVs are fully autonomous, dynamically retaskable, medium to high altitude, long endurance, survivable UAVs that can gather and provide near real time, high quality IMINT and SIGINT of areas where enemy defenses have not been adequately suppressed, in heavily defended areas, in open ocean environments, and in contaminated environments. (UAV Annual Report)

Global Hawk UAV – Conventional HAE unmanned aerial vehicle capable of 20 hours endurance at 60,000+ feet altitude at an operating radius of 3,000 nm; currently under development as an ACTD. Also known as Tier II+ UAV. Global Hawk is capable of fully automatic flight. Global Hawk will be directly deployable from well outside the theater of operations, followed by extended on-station time in low- to moderate-risk environments to look into high-threat areas to provide both wide-area and spot imagery. Global Hawk can carry EO, IR, and SAR sensors concurrently and operate SAR and either EO or IR payloads simultaneously. Survivability derives from the very high operating altitude and self-defense measures. (UAV Annual Report)

HAE UAV – High altitude endurance unmanned aerial vehicle. The HAE UAV family includes Global Hawk and Dark Star UAVs that are under development as an ACTD. (UAV Annual Report)

Hunter UAV – A joint tactical UAV originally developed to provide both ground and maritime forces with near-real time IMINT within a 200 km direct radius of action, extendable to 300+ km by using another Hunter as an airborne relay. Capable of operating from unimproved airstrips to support ground tactical force commanders. Operates at altitudes up to 15,000 feet and at ranges greater than 100 nm. (UAV Annual Report)

integration – Two or more systems working together toward a common or mutually supportive mission.

interaction – A one or two way exchange of data among two or more systems/sub-systems.

interface – A point common to two or more similar or dissimilar C2 systems, sub-systems, or other entities at which necessary information flow takes place. Compliant with necessary protocols and formats. (DOD Dictionary)

interoperability – 1. The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together. 2. The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. The degree of interoperability should be defined when referring to specific cases. (DOD Dictionary)

MAE UAV – Medium altitude endurance unmanned aerial vehicle. The MAE UAV family includes the RQ-1A Predator UAV system currently in procurement and being operated by the Air Force. (UAV Annual Report)

modularity – The use of sub-systems or components from one system to function properly as part of another system. The interface at the sub-system level is sufficiently defined.

motion imagery – A sequence of images, with metadata, which are managed as a discrete object in standard motion imagery format and displayed as a time sequence of images. (NIMA Preliminary Motion Imagery Study)

non-real time processing – Non-flight critical processing accomplished within the host system software including interface to C4I system(s). Pertaining to the timeliness of data or information that has been delayed by the time required for electronic communication and automatic data processing. This implies that there are no significant delays.

Outrider UAV – A tactical UAV program developed as an ACTD to support tactical commanders with near-real time IMINT at ranges beyond 200 km and with on-station endurance of greater than four hours. Designed to replace the maneuver UAV program by providing RSTA and combat assessment (CA) at Army brigade, Navy task force and Marine Corps regimental/battalion levels. Commonly referred to as TUAV. (UAV Annual Report)

Pioneer UAV – DOD's first operational UAV system. Developed as an interim capability to provide IMINT for tactical commanders on land and at sea. Operates at altitudes up to 15,000 feet and at ranges greater than 100 nm. (UAV Annual Report)

Predator UAV – MAE UAV system, officially designated RQ-1A, designed to provide long-range/dwell, near real-time tactical intelligence, RSTA, and BDA with EO/IR and high-resolution SAR IMINT. Also known as Tier II UAV. Operates at altitudes up to 25,000 feet at a radius of up to 500 nm. (UAV Annual Report)

real-time processing – AV command and control info including antenna positioning and AV video receipt and processing. Pertaining to the timeliness of data or information that has been delayed only by the time required for electronic communication. This implies that there are no noticeable delays.

scalability – The characteristic that enables system size and capability to be tailored dependent on user needs.

still imagery – An individual image or image set, with metadata, which is managed as a discrete object in standard format and displayed as a static image. (NIMA Preliminary Motion Imagery Study)

tactical UAV – Unmanned aerial vehicle designed to support Army battalions, brigades, and light divisions, Marine Corps regiments, and deployed Navy units with near-real time RSTA, and BDA. (UAV Annual Report)

TCS operator – An individual specifically trained in the operation of the TCS system who is functioning at a TCS workstation.

TCS user – An individual not necessarily specifically trained in the operation of the TCS system who is receiving and using TCS-derived imagery products either directly from a TCS workstation or through a C4I system.

TUAV – Outrider tactical UAV. (UAV Annual Report)

video imagery – A sequence of images, with metadata, which is collected as a timed sequence of images in standard motion imagery format, managed as a discrete object in standard motion imagery format, and displayed as a time sequence of images. Video imagery is a subset of the class of motion imagery. (NIMA Preliminary Motion Imagery Study)

waypoint control – Semi-autonomous or man-in-the-loop method of air vehicle control involving the use of defined points (latitude/longitude/altitude) to cause the UAV (air vehicle, sensor(s), or onboard systems) to accomplish certain actions.