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DEPARTMENT OF DEFENSE

UNMANNED AERIAL VEHICLES (UAV) MASTER PLAN

1993

INFORMATION IN THIS PLAN IS CURRENT AS OF:

31 MARCH 1993

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I EXECUTIVE SUMMARY

A. OVERVIEW

Unmanned Aerial Vehicles (UAVs)* can make significant contributions to the warfighting capability of operational forces. They greatly improve the quality and timeliness of battlefield information while reducing the risk of capture or loss of troops, thus allowing more rapid and better informed decision making by battlefield commanders. They are cost effective and versatile systems. While reconnaissance, surveillance, and target acquisition (RSTA)** are the premier missions of UAVs, they can also provide substantial capabilities in electronic warfare (EW), electronic support measures (ESM), mine detection, command and control and special operations mission areas. UAVs are a particularly valuable adjunct to the Services' aviation communities. They can readily perform a multitude of inherently hazardous missions: those in contaminated environments, those with extremely long flight times and those with unacceptable political risks for manned aircraft. Allotting these dirty and dangerous missions to UAVs increases the survivability of manned aircraft and frees pilots to do missions that require the flexibility of the manned system. UAVs are a viable alternative as the Services wrestle with the many challenges of downsizing the force structure.

Recognizing the need for common and interoperable systems, Congress in 1988 directed the Department of Defense (DoD) to consolidate the management of DoD nonlethal UAV programs and to prepare an annual UAV Master Plan. DoD responded by forming a UAV Executive Committee (EXCOM), designating the United States Navy (USN) as Executive Service, forming a UAV Joint Project Office (UAV JPO) and submitting the first UAV Master Plan to Congress. Further refining the program in 1991, DoD replaced oversight by the UAV EXCOM with the Defense Acquisition Board (DAB).

This is the fifth update of the UAV Master Plan. It provides requirements, program plans, management and acquisition strategies for nonlethal UAVs. Lethal UAV programs are addressed in the DoD Standoff Weapons Master Plan. In addition to updating last year's material, this year's plan:

- Provides a summary of draft and approved UAV operational requirements documents (ORDs)
- Consolidates discussions of UAV technology,
- Describes new UAV interoperability initiatives with the Joint Precision Strike Demonstration - Task Force (JPSD-TF) and with cruise missiles, and
- Provides appendix discussions of the Federal Aviation Administration (FAA) efforts to establish regulations for the flight of UAVs in nonmilitary airspace and applications of UAVs in the civil and commercial markets. Such information may prove useful to other government agencies working in UAVs and related areas.

* This Master Plan only addresses nonlethal UAVs. See Appendix A for definitions of UAV related terminology.

** Acronyms are defined when first used in text. Appendix B defines acronyms used more than once in the text and acronyms used in figures.

The UAV JPO's mission is to expeditiously field UAV systems which provide a significant tactical advantage to operational commanders. It is the DoD "center of excellence" for UAVs and provides advice and guidance to other agencies interested in employing UAVs for non-military applications.

It is anticipated that through the 1990s the civil, (i.e., nonmilitary federal, state, and local government) and commercial applications of UAVs will grow substantially. The UAV JPO intends to capitalize on the synergism among these three markets and achieve the benefits of:

- Cost savings through combined acquisitions,
- Expanded use of commercial specifications and standards,
- Fostering of technological innovation and new applications, and
- Strengthening of our industrial technology and production base.

A key to growth of UAVs in these markets is the establishment of regulations governing the flight of UAVs in nonmilitary airspace. Appendix C addresses FAA efforts to accomplish this.

The UAV JPO is guided by the following management principles:

- Continuously improve the process to develop, procure, and support UAVs.
- Develop an affordable family of UAV systems that are interoperable.
- Proactively foster the use of nondevelopmental items (NDIs) and commonality in order to achieve lowest operational cost.
- Continuously address and support the expectations of all UAV customers; consider the users as partners with the UAV JPO.

The UAV Master Plan is a reflection of these guiding principles. A summary of the significant 1992 accomplishments in the UAV program and in the program being executed in 1993 is provided below.

B. Calendar Year 1992 Accomplishments

1. Major Defense Acquisition Programs

- **Short Range (SR) UAV System**
  - Completed Technical Evaluation Test (TET) and Limited User Test I (LUT I). The system was determined to be operationally effective and suitable.
  - Completed functional configuration audits (FCAs) in support of the competive down select process.
  - Selected Israel Aircraft Industries (IAI) as the winning SR UAV prime contractor. The contract with IAI was novated (i.e., TRW legally replaced IAI with respect to obligations under the contract) in December 1992. TRW is now the SR prime contractor.

- **Close Range (CR) UAV System**
  - Successfully completed air vehicle and forward looking infrared (FLIR) payload demonstrations.
- **Medium Range (MR) UAV System**
  - Commenced Contractor Flight Tests (CFT-1) and successfully completed the air launched mission portion.
  - Conducted Preliminary Design Review (PDR).
  - Commenced Multi-Service Early Operational Assessment (MSEOA).
  - Definitized the Engineering and Manufacturing Development (E&MD) contract.

2. **Fielded System (Interim SR UAV System)**

- **Pioneer UAV System**
  - Flew over 1100 hours.
  - Supported USN operations for:
    - Tandem Thrust - Operational from an amphibious assault ship and made the first ever aircraft carrier controlled radar approach and recovery during severe inclement weather.
    - Ulchi Focus Lens - Conducted ground based operations in Korea.

3. **Demonstrations**

- **Vertical Takeoff and Landing (VTOL) UAV System**
  - Completed the Maritime VTOL UAV System (MAVUS) I at sea operational experiment.
  - USN approved the VTOL ORD.
  - Completed land based automatic launch and recovery demonstration.
  - Completed Phase I technical and engineering studies with Bell Helicopter Textron Inc. (BHTI) and the Science Applications International Corp. (SAIC) to evaluate the utility of tilt wing/rotor UAV system (TRUS) technology.

- Awarded contract option to BHTI for a flying qualities & performance (FQ&P) demonstration of a tilt wing/rotor air vehicle.

- **EXDRONE UAV System**

  - Completed manufacture of 110 BQM 147 EXDRONE UAVs.

  - Trained and equipped the 101st United States Army (USA) Airborne Division, 24th USA Infantry Division and the 2nd United States Marine (USMC) Division.

  - Incorporated launcher, parachute, global positioning system (GPS), and payload improvements.

- **Pointer Hand Launched UAV System**

  - Completed an evaluation by the USA 7th Infantry Division.

  - Initiated an evaluation with the USA III Corps.

4. **UAV JPO Management Initiatives**

- **Systems Engineering and Analysis**

  - Published the UAV family capstone specification.

  - Continued the development of specifications for heavy fuel engines, modular avionics and automatic recovery systems for UAV family application.

  - Completed verification and published the joint integration interface (JII) documents.

  - Demonstrated feasibility of a millimeter wave (MMW) tracking system for accomplishing automatic landing of VTOL UAVs.

  - Demonstrated the feasibility of lightweight (50 pounds [lbs]), highly efficient, heavy fuel engines for UAVs.

  - Initiated development of battleforce architecture requirements for seamless integration of UAVs and cruise missiles.

  - Prepared the Joint Technology Center/System Integration Laboratory (JTC/SIL) to receive SR UAV hardware.

- **Logistics**

  - Completed the UAV Family Configuration Management Plan (now in final staffing).

  - Stood up the UAV Joint Logistics Center of Excellence (JL-COE) at the USA Missile Command (MICOM).

- Completed the UAV Joint Logistics Management Information System (JLMIS) Master Plan.

- **International**

  - Initiated UAV data exchange agreements (DEAs) with Canada, Germany, Israel, Netherlands and United Kingdom.

  - Initiated a Scientist and Engineer Exchange Program (SEEP) between US and Germany which resulted in the loan of a German national to work international interfaces with the USN UAV program office.

  - Initiated a UAV Technology Transfer Security Assistance Review Board (TTSARB) package. (Establishes policy basis for UAV sales to foreign countries).

C. Calendar Year 1993 Objectives

1. Major Defense Acquisition Programs

- **SR UAV System**

  - Obtain DAB Low Rate Initial Production (LRIP) decision. Note: The DAB approved LRIP on 19 January 1993 and award of the LRIP contract option to TRW occured on 12 February 1993.

  - Conduct operator and maintenance training in support of LUT II.

  - Conduct a logistics demonstration to verify maintenance concept and maintenance tasks.

  - Complete LUT II at Ft. Huachuca, AZ and Elgin Air Force Base (AFB), FL.

- **CR UAV System**

  - Complete Milestone (MS) I/II.

  - Award contracts for SR ground control stations (GCSs), and a downsized SR GCS, ground data terminal (GDT), and remote video terminal (RVT).

- **MR UAV System**

  - Complete CFT-1. Note: The ground launched test was successfully completed in February 1993. This finished CFT-1.

  - Conduct Critical Design Review (CDR).

- Commence Development Flight Test Phase II.
- Commence Government Flight Test Phase I.
- Conduct DAB program review.

2. Fielded System (Interim SR UAV System)

- **Pioneer UAV System**
  - Standardize safety, maintenance, and operational procedures among the USN, USMC, and USA.
  - Complete ship alterations and integration to add Pioneer capability aboard two amphibious transport docks (LPDs).
  - Procure air vehicles to replace Desert Storm losses.

3. Demonstrations

- **VTOL UAV System**
  - Conduct the TRUS FQ&P demonstration.
  - Award a contract to Canadian Commercial Corporation for MAVUS II at sea automatic launch and recovery demonstration.
  - Initiate the systems integration effort to demonstrate use of a USN standard tactical advanced computer-III (TAC-III) workstation and tactical data link (AN/SRQ-4) to operate the SR UAV.
  - Initiate competitive advanced technology FQ&P demonstrations of various prototype VTOL air vehicles.
- **SR UAV Shipboard Demonstration**
  - Conduct technical demonstrations aboard an LHA class ship.
  - Determine ship integration and air vehicle modifications required for implementation of the SR UAV System aboard LHA class ships.
  - Determine compatibility and operational suitabilty of the SR UAV System in a maritime environment.
  - Coordinate SR UAV at-sea demonstration requirements with currently scheduled SR baseline activities.

- **EXDRONE UAV System**

  - Train and equip the 13th Marine Expeditionary Unit (MEU) and USA III Corps.

  - Complete development and integration of low light level television (LLLTV) and FLIR payloads.

  - Complete the EXDRONE field demonstration and publish report.

- **Pointer Hand Launched UAV System**

  - Complete the USA III Corps demonstration. Initiate the USA V Corps demonstration. Develop program acquisition strategy if the demonstration results support a recommendation for an operational requirement.

  - Continue the Defense Evaluation Support Agency (DESA) evaluations with the National Guard Bureau and other agencies.

  - Complete the Drug Enforcement Agency (DEA) evaluation.

4. UAV JPO Management Initiatives

- **Systems Engineering and Analysis**

  - Complete testing of the 50 lb heavy fuel engines.

  - Initiate development of 30 lb heavy fuel engine prototype(s).

  - Continue to evaluate automatic launch and recovery technologies for UAVs.

  - Define an engineering architecture(s) for interoperability between and among applicable Program Executive Officer, Cruise Missiles Project and Unmanned Aerial Vehicles Joint Project (PEO[CU]) systems.

  - Continue analysis of UAV data link requirements.

  - Continue the analysis of battleforce architecture requirements in a joint operations environment.

  - Receive and install SR UAV hardware in JTC/SIL.

  - Begin to relocate all Joint Development Facility (JDF) functions to the JTC/SIL and install JDF hardware and software.

- **Logistics**

  - Expand the influence of the JL-COE.

- Demonstrate the implementation of the JLMIS by developing a prototype JLMIS terminal.

- Conduct joint logistics assessments (JLAs) of CR and MR UAV programs prior to major program reviews.

- Produce a family coordinated Depot Maintenance Interservicing (DMI) submission to the Joint Depot Maintenance Analysis Group (JDMAG) to obtain designation of a joint UAV integrated depot organization.

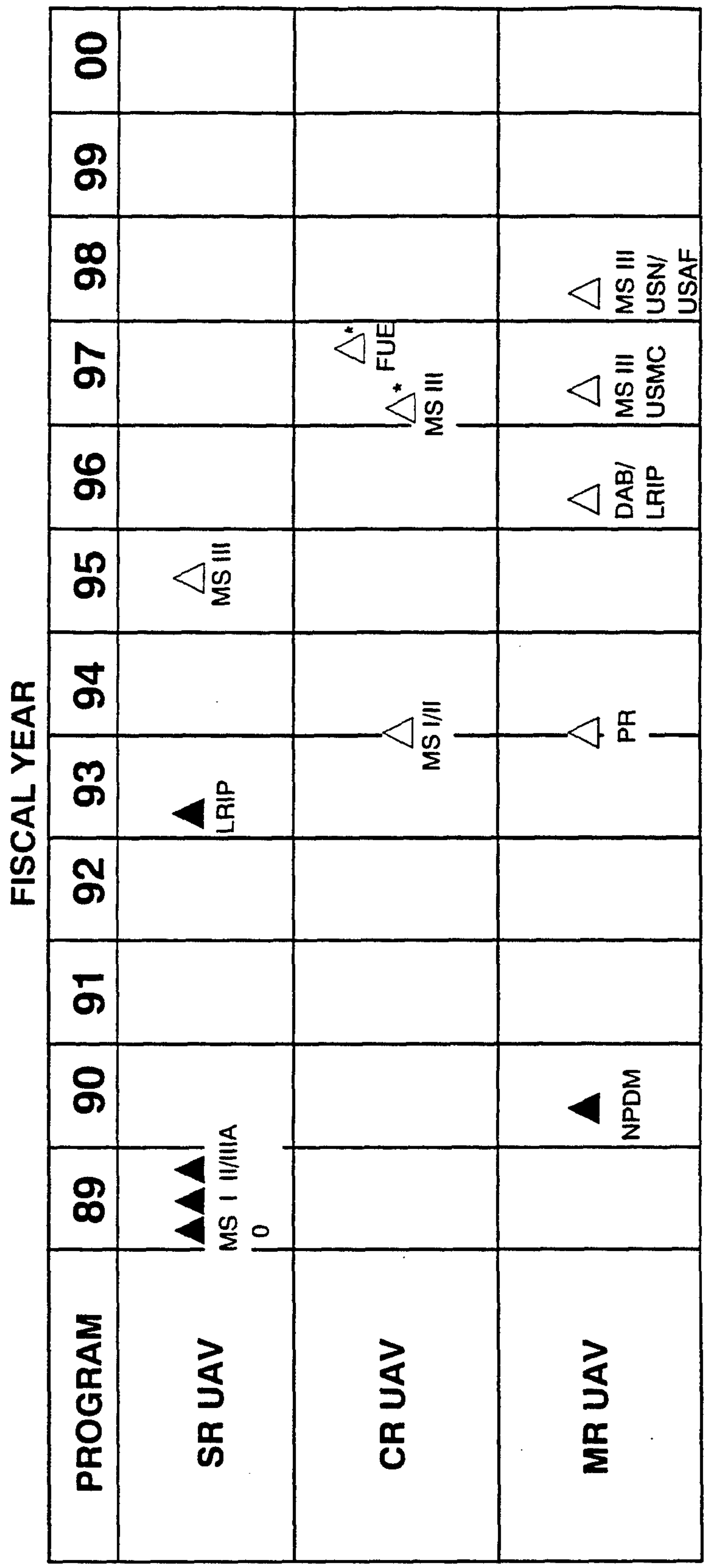
- Determine the need and cost effectiveness of UAV external pilot training simulator and a common family mission planning and control station (MPCS)/payload operator trainer.

- **International**

  - Initiate UAV DEAs with interested Allied countries.

  - Initiate VTOL UAV memorandum of understanding (MOU) with appropriate North Atlantic Treaty Organization (NATO) Project Group-35 (PG-35) member nations.

D. UAV MASTER SCHEDULE



* Not Fully Resourced

Figure 1 UAV Master Schedule

FUE - First Unit Equipped
LRIP - Low Rate Initial Production
MS - Milestone
NPDM - Navy Program Decision Meeting
PR - Program Review

II MANAGEMENT

A. OVERALL

In response to congressional direction in fiscal year (FY)88 to consolidate the management of DoD nonlethal UAV programs, the Under Secretary of Defense (Acquisition) (USD[A]) established the UAV JPO. An EXCOM was established with overall responsibility for DoD UAV programs at the Office of Secretary of Defense (OSD) level. In 1991 the EXCOM oversight was discontinued and DoD UAV programs were brought under DAB procedures and management as described in DoD Directive 5000.1 and DoD Instruction 5000.2. (See Figure 2).

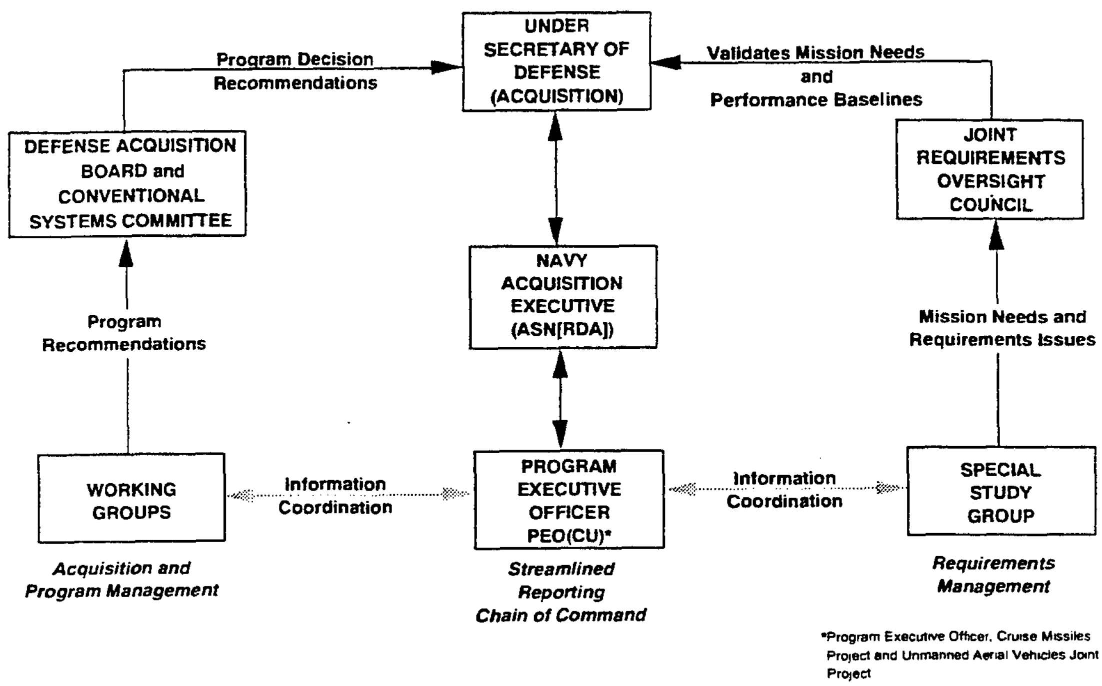


Figure 2 UAV Management Organization

The USN is the Executive Service for the UAV JPO, with responsibility and accountability for designing, developing, procuring and transitioning UAV systems to the Services. The systems must meet the requirements validated by the Joint Requirements Oversight Council (JROC) commensurate with available funding. The DAB and Conventional Systems Committee (CSC) maintain oversight, provide program direction and approve milestones.

The UAV JROC Special Study Group (SSG) is responsible for consolidating and reconciling requirements before presenting them to the JROC for approval. SSG working groups support the SSG. The UAV JPO confers with the working groups and the SSG to resolve requirements related issues.

The UAV Working Group conducts acquisition related activities in support of the DAB and CSC. Chaired by OSD Command, Control, Communications and Intelligence (C^3I), the working group includes representatives of the DAB and CSC, plus the National Security Agency (NSA), Advanced Research Projects Agency (ARPA), UAV JPO and other designated elements of OSD and Service staffs.

B. PROGRAM EXECUTIVE OFFICER FOR CRUISE MISSILES AND UNMANNED AERIAL VEHICLES (PEO[CU])

In 1990 the USN transitioned to the Program Executive Officer (PEO) structure. The UAV JPO became part of PEO(CU), which has acquisition management responsibility for naval cruise missiles, naval targets, and joint Service UAVs. PEO(CU) receives its program guidance via the chain of command depicted in Figure 2.

PEO(CU) is a forward-looking organization, fully committed to the principles of total quality management/total quality leadership (TQM/TQL). This commitment is realized through a strategic planning process whereby its members have established a futuristic vision for the organization and a roadmap of how best to proceed in order to realize that vision. Strategic planning has become the "way-to-do-business" in the PEO and encompasses obligations to:

- Expand and strengthen working relationships with our customers and our stakeholders in order to promote open communication that is responsive to customer expectations.

- Develop affordable, interoperable families of cruise missiles, targets, and UAV systems. Continuously improve the processes to design, develop, test, produce, deploy and support all current and future versions of these systems.

- Actively pursue the use of NDI and interoperability and commonality (I&C) in order to achieve the optimal trades between system ownership costs and operational performance.

- Treat people as our primary and most valued asset. Lead by searching out challenging opportunities for people to change, grow, innovate, and improve their skills.

This Master Plan embodies these strategic planning principles for UAVs.

III NEEDS RATIONALE

This section provides the rationale for the need for UAVs by DoD. Mission and operational requirements, the UAV family concept, threat baselines, significant cost and operational effectiveness analysis (COEA) results are addressed.

A. REQUIREMENTS

1. Mission Needs Statements (MNSs)

MNSs for four categories of UAV capabilities (Close, Short, Medium and Endurance) have been validated by the Chairman of the JROC. Figure 3 provides a summary of UAV MNS required capabilities.

	CLOSE	SHORT	MEDIUM	ENDURANCE
OPERATIONAL NEEDS	RS, TA, TS, EW, MET, NBC	RS, TA, TS, MET, NBC, C2, EW	PRE-AND POST-STRIKE RECONNAISSANCE TA	RS, TA, C2, MET, NBC, SIGINT, EW, SPECIAL OPS
LAUNCH AND RECOVERY	LAND/SHIPBOARD	LAND/SHIPBOARD	AIR/LAND	NOT SPECIFIED
RADIUS OF ACTION	NONE STATED	150 KM BEYOND FORWARD LINE OF OWN TROOPS (FLOT)	650 KM	CLASSIFIED
SPEED	NOT SPECIFIED	DASH >110 KNOTS CRUISE < 90 KNOTS	550 KNOTS < 20,000FT, .9 MACH > 20,000 FT	NOT SPECIFIED
ENDURANCE	24 HRS CONTINUOUS COVERAGE	8 TO 12 HRS	2 HRS	24 HRS ON STATION
INFORMATION TIMELINESS	NEAR-REAL-TIME	NEAR-REAL-TIME	NEAR-REAL-TIME/ RECORDED	NEAR-REAL-TIME
SENSOR TYPE	DAY/NIGHT IMAGING*, EW, NBC	DAY/NIGHT IMAGING*, DATA RELAY, COMM RELAY, RADAR, SIGINT, MET, MASINT, TD, EW	DAY/NIGHT IMAGING*, SIGINT, MET, EW	SIGINT, MET, COMM RELAY, DATA RELAY, NBC, IMAGING, MASINT, EW
AIR VEHICLE CONTROL	NONE STATED	PRE-PROGRAMMED/ REMOTE	PRE-PROGRAMMED	PRE-PROGRAMMED/ REMOTE
GROUND STATION	VEHICLE & SHIP	VEHICLE & SHIP	JSIPS (PROCESSING)	VEHICLE & SHIP
DATA LINK	WORLD WIDE PEACE TIME USAGE, ANTI-JAM CAPABILITY	WORLD WIDE PEACE TIME USAGE, ANTI-JAM CAPABILITY	JSIPS INTEROPERABLE WORLD WIDE PEACE TIME USAGE, ANTI-JAM CAPABILITY	WORLD WIDE PEACE TIME USAGE, ANTI-JAM CAPABILITY
CREW SIZE	MINIMUM	MINIMUM	MINIMUM	MINIMUM
SERVICE NEED/ REQUIREMENT	USA, USN, USMC	USA, USN, USMC	USN, USAF, USMC	USA, USN, USMC

* Baseline Payload Capability

LEGEND
C2 - COMMAND AND CONTROL
EW - ELECTRONIC WARFARE
JSIPS - JOINT SERVICE IMAGERY PROCESSING SYSTEM
MASINT - MEASUREMENT AND SIGNATURES INTELLIGENCE
MET - METEOROLOGY
NBC - NUCLEAR, BIOLOGICAL and CHEMICAL RECONNAISSANCE
RS - RECONNAISSANCE AND SURVEILLANCE
SIGINT - SIGNALS INTELLIGENCE
TA - TARGET ACQUISITION
TS - TARGET SPOTTING
TD - TARGET DESIGNATOR

Figure 3 MNS Summary

2. Categories of Capabilities

The categories of required capabilities, generally described by desired UAV system characteristics in the UAV MNS, are depicted graphically in Figure 4.

CR capabilities address the needs of lower level tactical units such as USA divisions and brigades/battalions and USMC battalions/companies for a capability to investigate activities within their local area of interest, (approximately 30 kilometers [km] beyond the forward line of own troops [FLOT]). Systems must be easy to launch, operate and recover; require minimum manpower, training and logistics; and be relatively inexpensive.

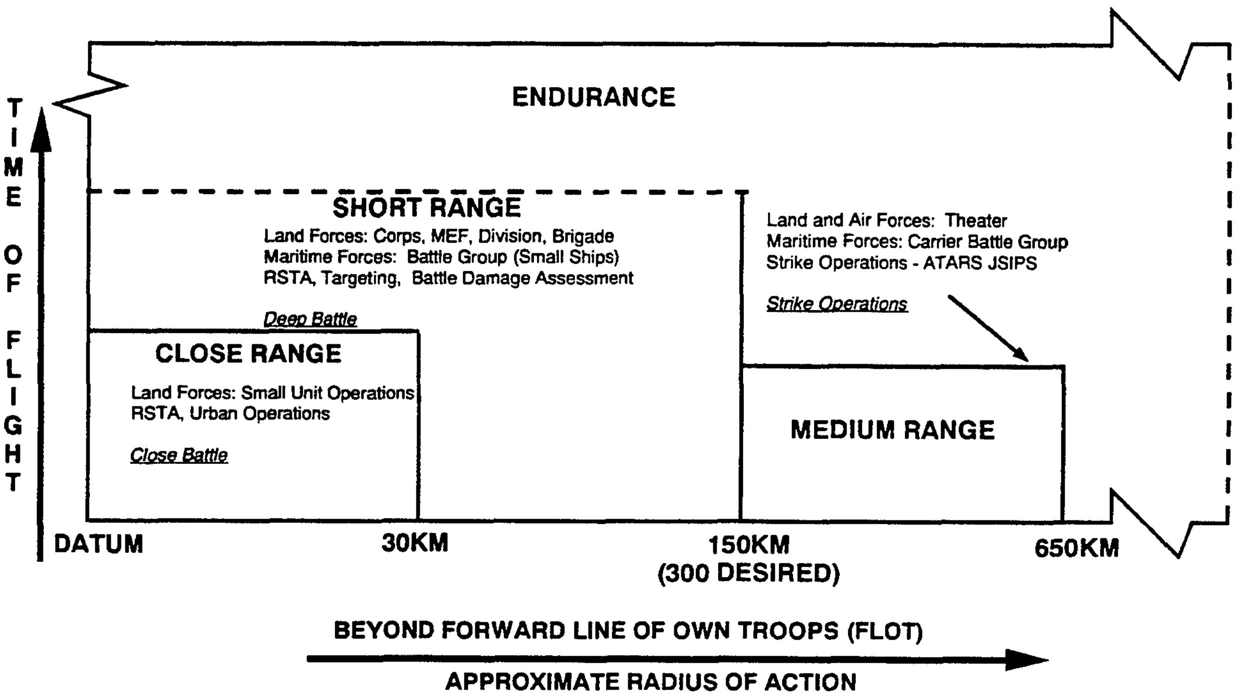


Figure 4 Categories of Capabilities

SR capabilities support USA division through echelons above corps (EAC) level and Marine Air-Ground Task Force (MAGTF) level. Enemy activities out to a range of 150 km or more beyond the FLOT or datum point (in USN operations) are a focus of SR activities. These UAV systems are more robust and sophisticated, can carry a wider variety of payloads, and can perform more kinds of missions than CR systems.

MR capabilities address the need to provide pre and post strike reconnaissance of heavily defended targets and augment manned reconnaissance platforms by providing high quality, near-real-time imagery. They differ from other UAV capabilities in that the vehicle is designed to fly at high subsonic speeds and spend relatively small amounts of time over target areas of interest.

Endurance capabilities respond to wide variety of mission needs and address the capability to carry many types of payloads. Endurance systems are characterized by times of flight measured in days and very great ranges and altitudes of flight.

3. Operational Requirements Documents (ORDs)

A summary matrix of the ACAT I Major Defense Acquisition UAV Program ORDs that expand upon and refine the MNS baselines is provided in Figure 5 below. Only unclassified information is addressed. At present, the CR and MR ORDs are in staffing, while the SR ORD has been approved.

	CLOSE RANGE	SHORT RANGE	MEDIUM RANGE
SERVICE	USA, USN, USMC	USA, USN, USMC	USN, USAF, USMC
SERVICE ORGANIZATIONAL LEVEL	DIV, BDE (USA) BN & LOWER	CORPS, EAC, DIV (USA) RPV COMPANY (USMC) Ship (USN)	CVAW (USN); SQUADRON (USAF)
MISSION	RSTA	RSTA	PRE & POST STRIKE RECONNAISSANCE, BDA
RADIUS OF ACTION	50 KM (30 NM)	CLASSIFIED	650 KM (350 NM)
PAYLOAD CAPACITY	50 LBS	200 LBS	350 LBS
SENSOR	IMAGERY, MET	IMAGERY ECM	ATARS
GROWTH	EW, NBC	SIGINT, MET, COMM	EW, COMM/ RELAY, EW JAMMING ELECTRONIC, SIGINT, MET, TARGET DESIGNATION
ENDURANCE	3 HRS	CLASSIFIED	2.5 HRS
LAUNCH/ RECOVERY	STOL	CTOL	AIR LAUNCH; LAND/HELO RECOVERY
GROUND STATION	VEHICLE	VEHICLE	JSIPS (PROCESSING)
TOGW	TWO PERSON TRANSPORTABLE/ 200 LB CLASS	1,700 LBS	2,200 LBS
AIR SPEED	80 KTS	CRUISE < 90 KTS DASH > 110 KTS	500 KTS < 20,000 FT 9 MACH > 20,000 FT
ALTITUDE	10,000 FT	15,000 FT	MIN 500 FT AGL MAX 40,000 FT MSL
DATA LINK	ANTI-JAM CAPABILITY	ANTI-JAM CAPABILITY	JSIPS INTEROPERABLE, ANTI-JAM CAPABILITY

<u>LEGEND</u>

ATARS - ADVANCED TACTICAL AIR RECONNAISSANCE SYSTEM
BDA - BATTLE DAMAGE ASSESSMENT
BDE - BRIGADE
CTOL - CONVENTIONAL TAKEOFF AND LANDING
CVAW - CARRIER AIR WING
EAC - ECHELON ABOVE CORPS
EW - ELECTRONIC WARFARE
JSIPS - JOINT SERVICE IMAGERY PROCESSING SYSTEM
MET - METEOROLOGICAL
NBC - NUCLEAR, BIOLOGICAL, CHEMICAL
RSTA - RECONNAISSANCE, SURVEILLANCE AND TARGET ACQUISITION
SIGINT - SIGNALS INTELLIGENCE
STOL - SHORT TAKEOFF AND LANDING
TOGW - TAKEOFF GROSS WEIGHT

Figure 5 ORDs Summary

4. Family Concept

Establishment of a family of UAV systems that are interoperable and common is the core strategy of the UAV JPO. The SR system is the centerpiece of the strategy (see figure 6 below). It provides a baseline system capability that maximizes I&C with CR and future VTOL UAV systems. The endurance category will be incorporated into the family strategy as an operational requirement is developed.

Due to its unique mission which requires higher resolution imagery and its development start predating the formation of the UAV JPO, the MR system I&C is driven by the Joint Service Imagery Processing System (JSIPS) and the Advanced Tactical Air Reconnaissance System (ATARS) interface requirements, and is therefore considered to be outside the family concept.

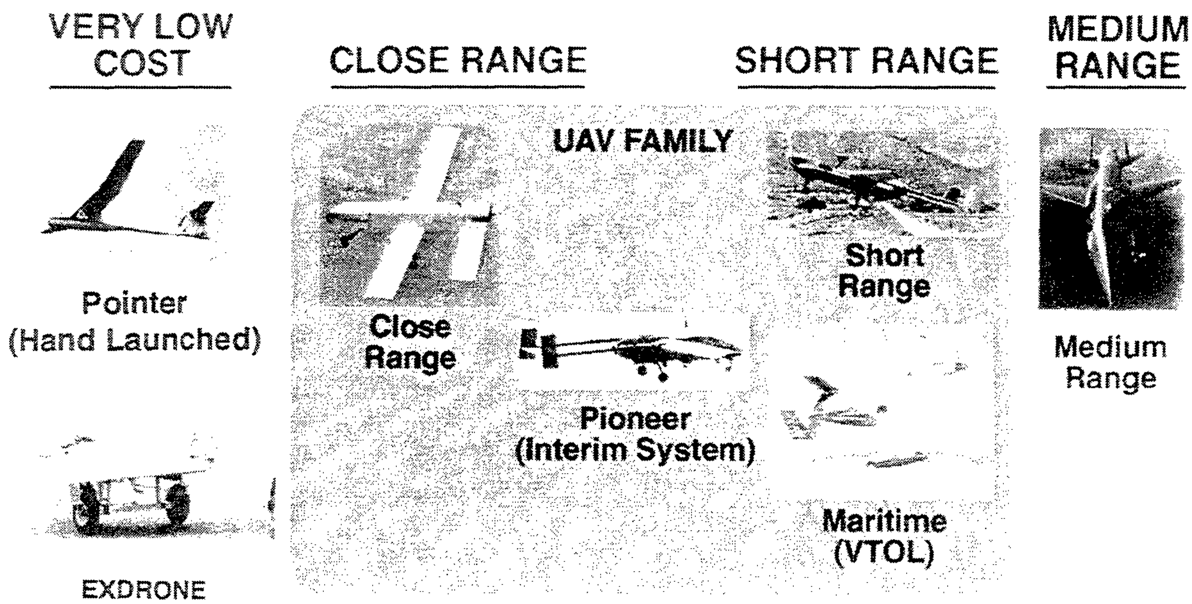


Figure 6 Family of UAV Systems

B. THREAT BASELINES

Descriptions of the threat baselines for UAVs presently in development are contained in individual system threat assessment reports (STARs) produced by the lead developing Service and validated by the Defense Intelligence Agency (DIA). For joint programs, the lead Service is required to coordinate the STAR with the intelligence staffs of participating Services. Threat baselines contain a description of the threat and the target environment at initial operational capability (IOC) and IOC plus ten years. Responsibilities for STAR production, coordination, and validation are provided below:

PROGRAM	STAR PRODUCER	STAR COORDINATION	VALIDATION
SR	HQ DA (DAMI-FIT)	MarIntelCen	DIA
CR	HQ DA (DAMI-FIT)	MarIntelCen	DIA
MR	NAVMIC	AFISA/IN	DIA

C. COST and OPERATIONAL EFFECTIVENESS ANALYSIS (COEA) RESULTS

The UAV JPO is responsible for facilitating the completion of the COEA for the family of UAVs. This analysis began in 1989 under the auspices of the UAV EXCOM and an OSD level Steering Group chaired by OSD C^3I. In 1992 the stewardship of the COEA process was transferred to the office of the Deputy Assistant Secretary of the Navy for Air Programs (DASN[AIR]) during the management realignment that brought all UAV programs under direct DAB management. COEA guidance for each program is provided by USD(A) and executed by the USN as lead Service.

To date there have been three separate UAV family COEA efforts; they are referred to as the Phase I, Phase IIA, and the Phase IIB analyses. The Phase I analysis was done by the Center for Naval Analysis (CNA) and SAIC. It was a broad area study reviewing probable UAV missions and comparing the accomplishment of these missions by UAVs to their accomplishment by the most likely alternative. The study was considered a "first cut" review of UAV cost effectiveness and the results were quite positive, showing that UAVs are more cost effective for many missions for which they had been postulated.

The Phase IIA study, accomplished by the same team, compared the SR UAV to the MR UAV to determine if there was overlap between their missions or if one system could perform the other missions in a more cost effective manner. The results of this review showed that each system was designed to perform a particular type of mission and that neither was capable of substituting for the other in a cost effective manner. The basic reasoning was that the MR UAV was intended to reconnoiter heavily defended targets, static in nature, for pre and post-strike reconnaissance. In this mission its speed, radar cross section (RCS) characteristics, and range made it the only system capable of performing the mission. Conversely, when reviewing the SR UAV mission, the striking features included dynamic retasking of the air vehicle and real time image projection. Both attributes are lacking in the MR UAV, making it much less suitable for the missions that drive the SR UAV requirements.

The Phase IIB analysis was completed in July, 1992 by CNA. The study examined the family of UAVs and missions. Results favored speed in general and a tilt/rotor UAV in particular. However since the assumptions used in the study were general in nature, the overall results had limited value with respect to the UAV family. This study marked the end of UAV family COEA efforts; in the future, COEAs will be much more sharply focused on the individual UAV systems that require them.

To start off this new process, USD(A) provided guidance for a separate study focused on the SR UAV system; the UAV JPO study was completed in September, 1992. The study examined quantity vs quality options for the SR UAV system in the context of a USA Corps level battle, with the Corps being serviced by many other reconnaissance/surveillance systems. Results seemed to indicate that one SR UAV system per Corps made a significant difference in some indicators of battle outcomes and some measures of C^3I completeness; however, after one system/Corps, upgrade options may be more cost-effective than simply buying and operating more SR UAV systems.

In 1993 further analysis is planned in support of the planned MS I/II for the CR UAV system late in FY93, and circa FY95 MS IIIs for the MR UAV and the SR UAV system. COEAs for the VTOL and Endurance UAV systems are not now planned because these systems remain unfunded. If funding priorities change and either system is funded, COEA guidance will be issued and responsive COEAs will be prepared.

IV BASIC TENETS

The basic tenets of the UAV Joint Program are to:

- Harmonize operational requirements among the Services and Unified and Specified Combatant Commands.
- To the maximum extent possible, procure off-the-shelf technologies and commercially available components for initial systems, thereby reducing cost, risk and duration of development.
- Develop specifications for systems after the Services have acquired hands on operational experience. Operational experience is essential for reducing costs by providing users the basis for establishing specific performance specifications.
- Conduct and monitor advanced research and development that enhances the systems' future capabilities. Advanced technologies are incorporated through block upgrades.
- Maintain all equipment interfaces, interface control documents and specifications to ensure effective block upgrades and interchangeability/interoperability of systems and subsystems.
- Employ a competitive and evolutionary acquisition process to incorporate block upgrades to air vehicles, payloads, data links, MPCSs, launch and recovery and logistic support sub-systems. Figure 7 below provides an estimated breakout of representative UAV subsystem acquisition cost. Although a UAV system tends to be characterized by its air vehicle, as can be seen, the air vehicle is not the system cost driver.

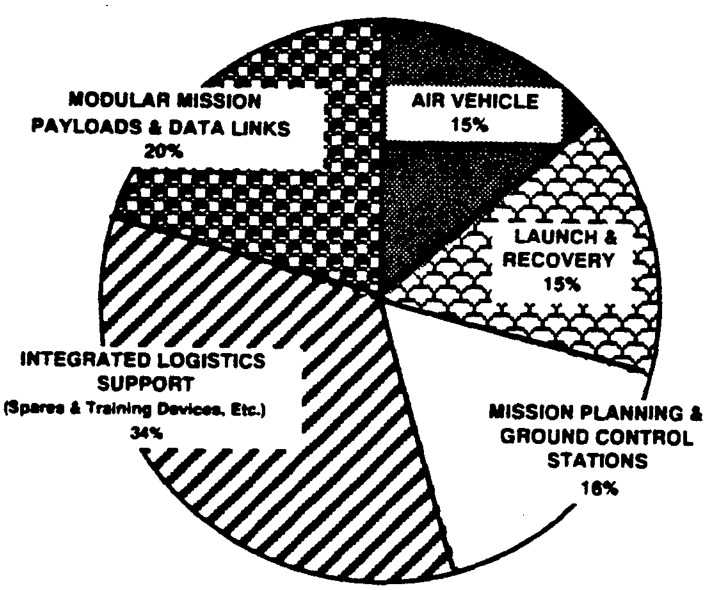


Figure 7 Program Acquisition Cost Breakout (Estimated)

- Ensure interoperability among all systems and subsystems with the Command, Control, Communications and Intelligence (C^3I) systems of the Services and the Unified and Specified Commands.

- Encourage an allied acquisition strategy that will enhance system I&C as a force multiplier.

The previously mentioned tenets are applicable to all the UAV categories; however, as explained in Section III, the parts of the strategy related to I&C have limited applicability to MR UAV.

V PROGRAMS

A. MAJOR DEFENSE ACQUISITION PROGRAMS

1. Short Range (SR) UAV System

(a.) Background

Acquisition of the SR UAV system began with full and open competition in FY89. A draft request for proposal (RFP) was provided to industry in December 1988, followed by a formal RFP in March 1989. On evaluation of the responses from industry, two firm-fixed price contracts were awarded on 15 September 1989 to McDonnell Douglas Missile Systems Company (MDMSC), St. Louis, MO, and IAI, Tel Aviv, Israel. The contractors were allotted 18 months for fabrication and integration of their systems and delivery of complete SR systems and other associated hardware for TET and LUT I. Additionally, both contractors submitted, as required, concepts for upgrade improvements.

TET of the MDMSC and IAI candidate SR UAV systems was completed in April 1992. Training of USA and USMC personnel in preparation for LUT I began in January 1992. As of the scheduled beginning of LUT I in June 1992, only the IAI candidate SR system could be certified to begin LUT I. The MDMSC system failed to achieve a degree of proficiency to warrant certification of the US military students for independent operation of the system during LUT I. Therefore, only the IAI candidate system participated in LUT I. All data accumulated during TET and LUT I was provided to a government source selection board. The source selection authority announced on 30 June 1992 that IAI had been selected as the SR UAV prime contractor. The selected SR air vehicle and its mission planning station (MPS) are shown in Figure 8 on the following page.

Preparation of required documentation to support a DAB review of the SR program continued apace throughout 1992. The DAB review was held on 19 January 1993 and the SR program was approved for continued LRIP, Block II enhancements, acquisition strategy, and exit criteria.

(b.) Purpose

The SR UAV system is the baseline for the family (i.e., SR, CR, VTOL, and Endurance) of UAVs. SR will provide near-real-time RSTA to USA EAC, divisions, and USMC expeditionary brigades out to 150 km beyond the FLOT, day or night, and in limited adverse weather conditions. SR is intended for employment in environments where immediate information feedback is needed, manned aircraft are unavailable, or excessive risk or other conditions render use of manned aircraft less than prudent.

(c.) Concept of Operations

The SR concept of operations (CONOPS) is shown in Figure 9.

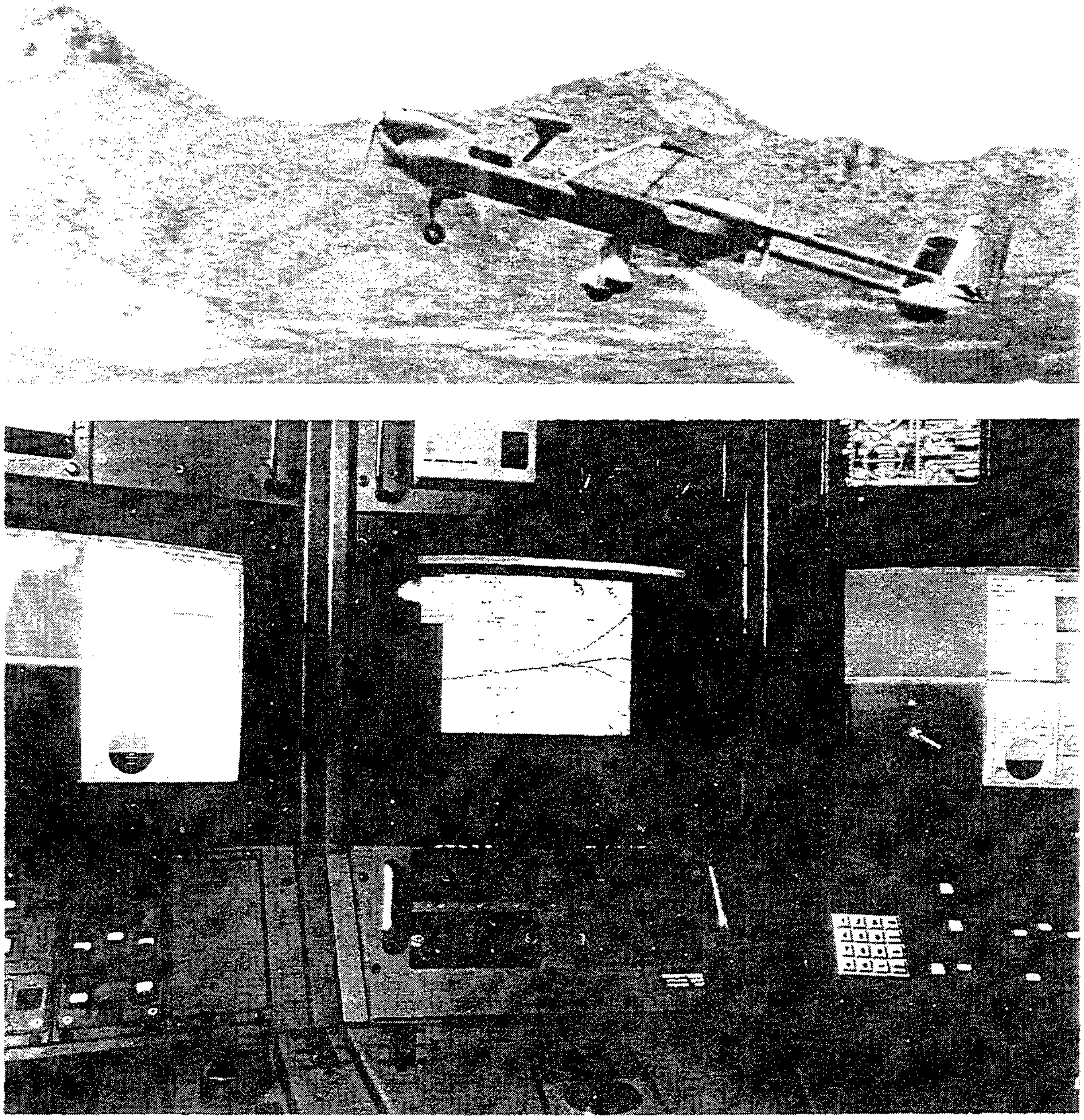


Figure 8 TRW SR Vehicle and MPS

(d.) Acquisition Strategy

A competitive non-developmental acquisition strategy is being followed in the SR UAV acquisition. A market survey, numerous meetings with industry representatives, and a draft RFP confirmed the feasibility of the strategy and refined its terms to conform to Government needs and realistic technical expectations. A full and open competition was initiated from which two contractors with the most promising systems were selected. Firm-fixed price contracts were awarded to each contractor to build two systems in 18 months, and deliver them to the Government for TET and LUT.

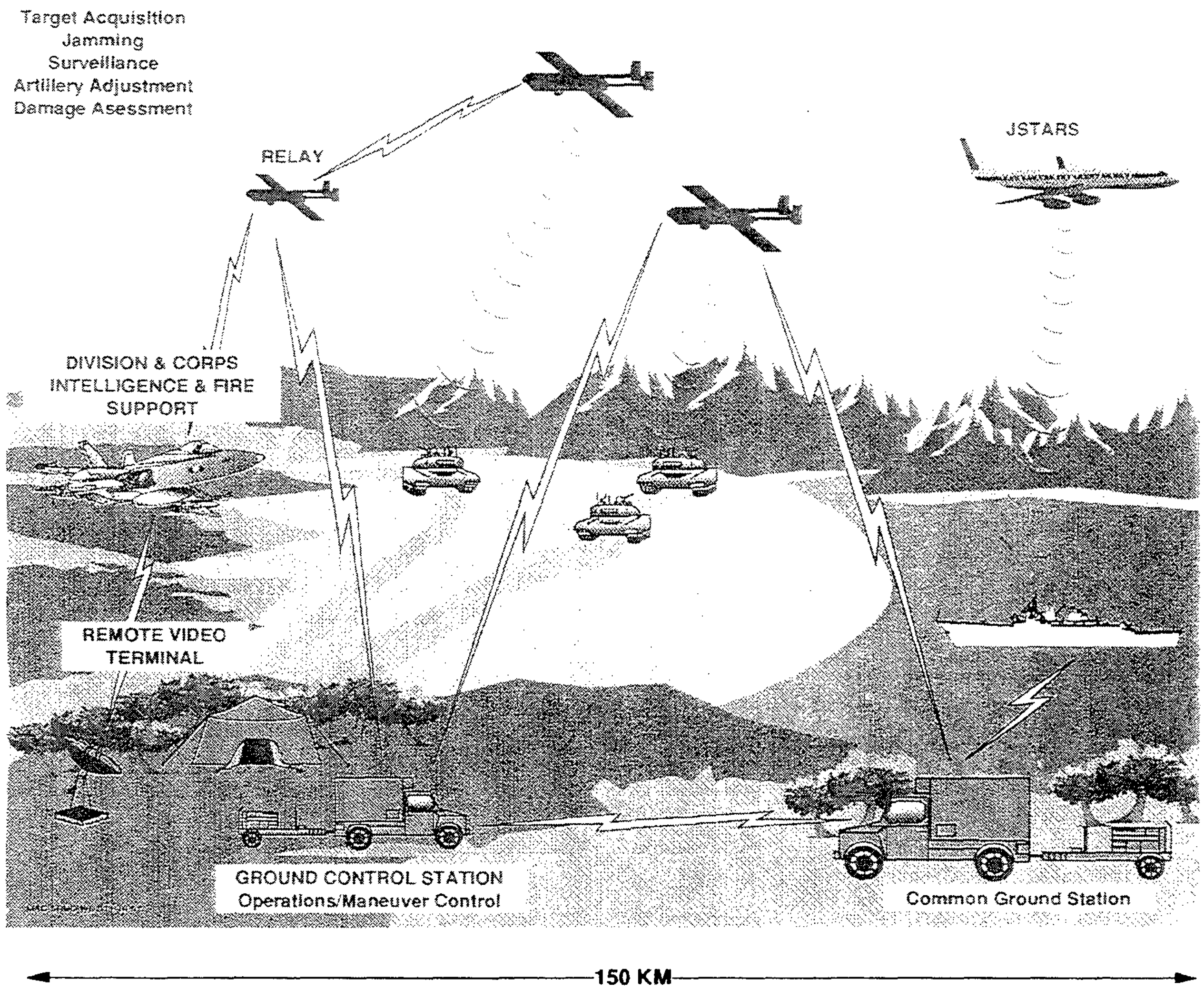


Figure 9 SR UAV CONOPS

Each contractor was obligated to develop a block modification plan including modifications required for their system to meet the full capability desired by the Government users. The initial contract included not-to-exceed pricing of variable quantity options for three subsequent production buys, interim contractor support to testing and fielding, depot level support, training, and technical data (to be procured for the selected system only).

Following TET, LUT I, selection of the "best value" system, and DAB approval, the winning contractor was awarded the LRIP option. The systems produced are required to complete first article test/system qualification testing, a logistics/maintenance demonstration, formal initial operational test and evaluation (IOT&E), and the physical configuration audit (PCA). The contractor must incorporate the block modifications, and transition the training and field level logistic support from the contractor to the Services' organic logistic support base. While the first option quantities are being built during FY93, user training and testing (LUT II) will continue on improved and refurbished systems to confirm production corrections and prepare for IOT&E and transition of the training/logistic support. Deliveries of the first LRIP systems will begin in FY94. IOT&E and first article/system qualification testing will be completed in FY95, and the results used to support a full rate production decision (MS III) in FY95.

(e.) Status

By the end of FY92, all TET and LUT I testing of the two candidate SR systems was completed, an evaluation of all pertinent data had been made by a source selection review board, and the source selection authority had selected a winning prime contractor, IAI, for the SR system. In December 1992 the prime contract with IAI was novated (i.e., TRW legally replaced IAI with respect to obligations under the contract). TRW became the SR prime contractor. The DAB, orginally planned for September 1992, was rescheduled to January 1993 to allow final coordination and approval of program documentation. The documents were approved and the DAB review was successfully completed on 19 January 1993. Award of the LRIP option to TRW occurred on 12 February 1993.

(f.) System Interfaces

The SR system consists of a MPS and two GCSs; RVTs; eight air vehicles; modular mission payloads (MMPs); GDTs; and launch and recovery equipment. (See Figure 10.)

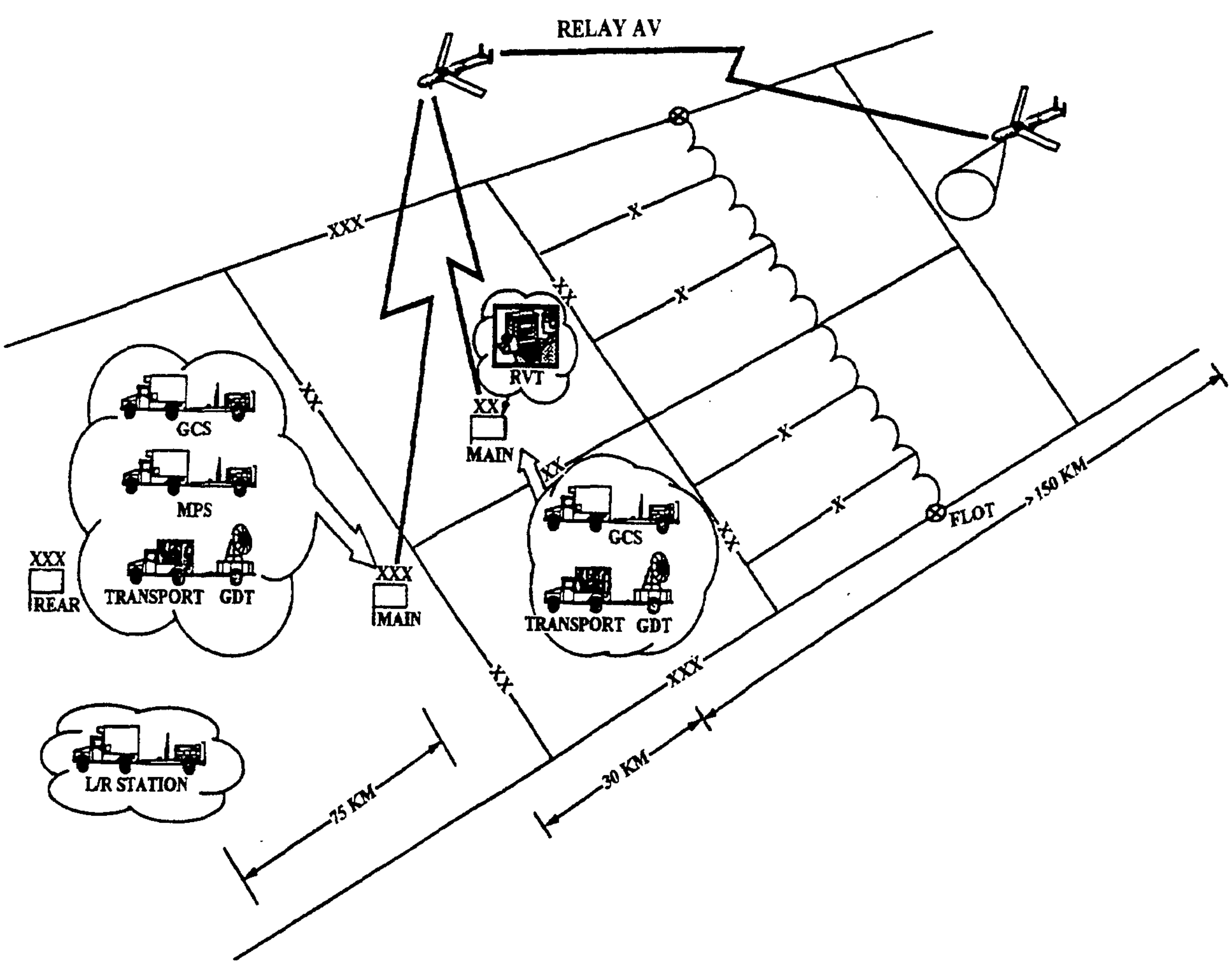


Figure 10 SR UAV Tactical Employment Scenario

The MPCS (the MPS and two GCSs) collects, processes, analyzes, and stores data and distributes battlefield information by interfacing with present/planned Service C^3I systems. Flight and mission commands are sent through ground data terminals to the air vehicle(s) and modular mission payloads from the MPCS. RSTA information and air vehicle position data are sent by downlink either through airborne relays or directly to the MPCS or RVTs. Mission data may also be recorded onboard the air vehicle to prevent loss during interruptions in the downlink data flow. Data is received by the MPCS and can be distributed to RVTs located in tactical operations centers. Mission capability will be enhanced as advanced mission payloads which are discussed below become available.

(g.) Block Upgrades

Block II upgrade options in the existing contract with TRW were exercised subsequent to DAB approval to enter into LRIP. Block II modification kits are planned to be purchased so that all Block 0 (baseline) systems can be upgraded. The specific improvements comprising Block II are as follows:

- **Autosearch** - Automatic pattern search of designated area.
- **Autotrack** - Capability of automatically holding the air vehicle's sensor line-of-sight on a designated target.
- **Manned surrogate trainer** - Allows the system to operate with a manned UH-60 helicopter carrying a sensor pod to provide mission training in restricted areas.

An additional Block II upgrade program being developed is:

- **Heavy fuel engine** - The heavy fuel engine effort will identify an engine with the capability to operate on diesel, JP-5 or JP-8 fuel. The Naval Air Warfare Center - Aircraft Division (NAWC-AD), Trenton, NJ is testing candidate engines and will provide test results in support of a follow-on upgrade program.

The SR program also includes a proposed Block III improvement program that addresses advanced development, prototyping and testing needed to incorporate additional required sensor payloads, command, control and communications (C^3) upgrades, survivability improvements, and data link hardening. The improvement program will capitalize on hardware funded and developed by other activities. Improvement program priorities are being established based on user needs and technology availability. Priorities may change based upon the results of the UAV SSG payload working group. Payload and other activities yet to be funded or scheduled include: electronic intelligence (ELINT), signals intelligence (SIGINT), radars, meteorology, survivability, and a lightweight hardened data link.

(h.) Schedule

The SR UAV program schedule is shown in Figure 11.

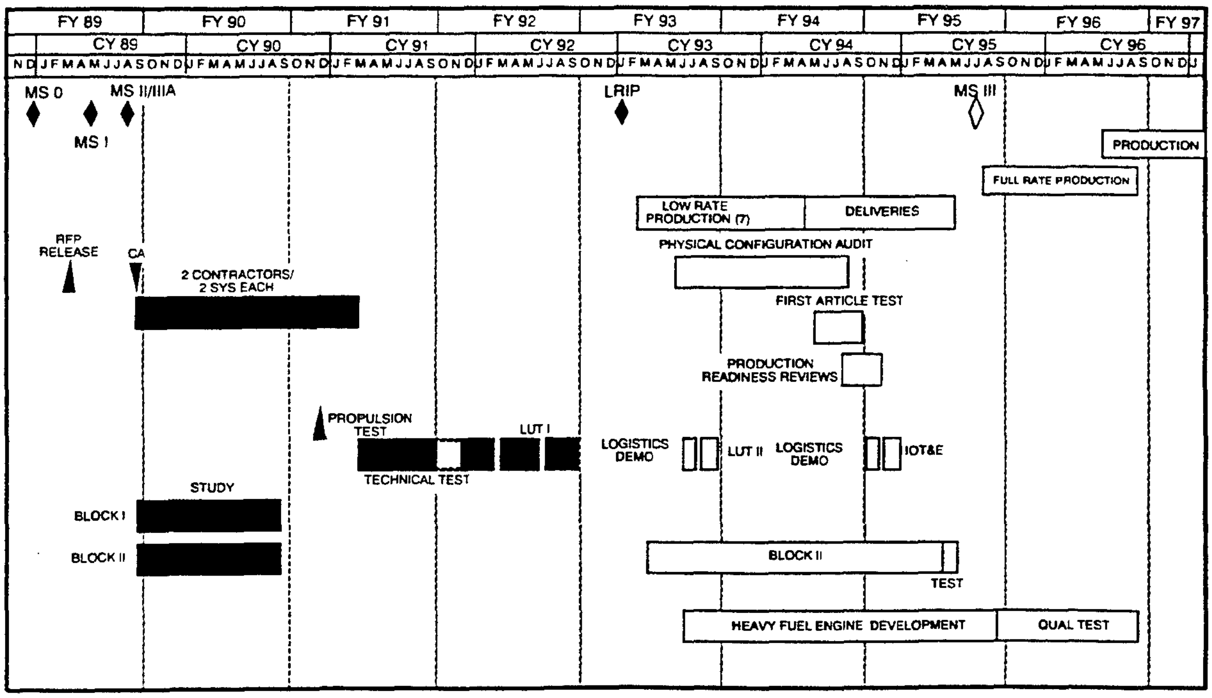


Figure 11 SR UAV Program Schedule

2. Close Range (CR) UAV System

(a.) Background

The CR UAV system is comprised primarily of integrated off-the-shelf technology and is being developed to meet specific requirements of the USA and USMC. A very high degree of I&C with the SR system is enhanced through the use of common and downsized SR UAV hardware. The CR UAV system will be operable by two Service personnel and consists of the equipment shown in Figure 12.

(b.) Purpose

The CR UAV will be used in direct or general support of USA division and divisional elements and will be organic to division military intelligence battalions. The system will be used in direct support of the infantry and separate battalions at all levels of MAGTFs.

The MNS for the CR UAV was approved by the JROC on 17 January 1990. The MNS established the need for a lower echelon, real-time RSTA, EW, and nuclear, biological and chemical (NBC) reconnaissance capability for the Services.

(c.) Concept Of Operations

The CR UAV concept, system requirements, and acquisition/risk management planning have been significantly influenced by the SR UAV progress, formal studies, experimentation with existing domestic and foreign systems, budget realities and lessons learned during Desert Storm.

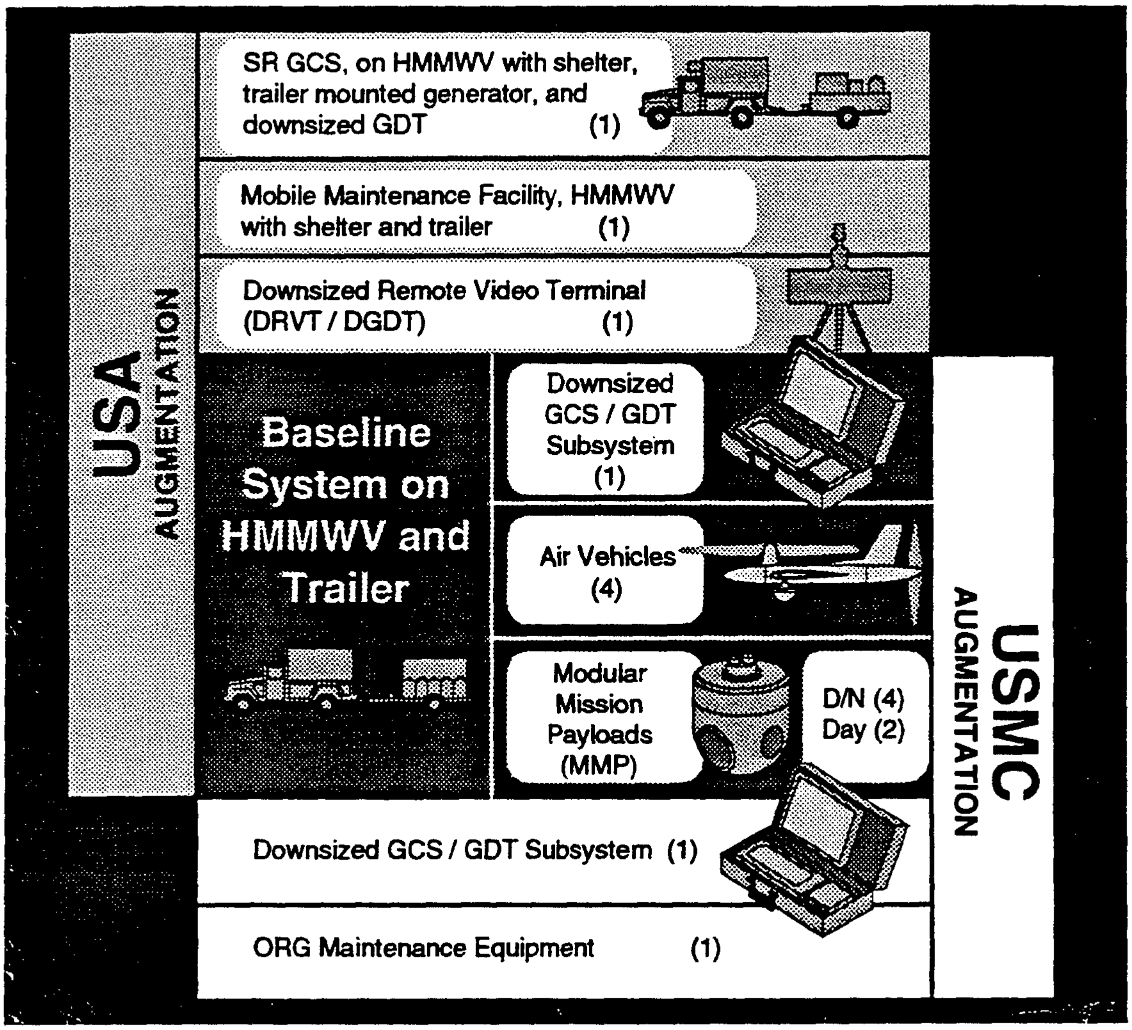


Figure 12 CR UAV System Description

The employment concept for the CR UAV system is to perform launch, recovery, handling, mission/control and data distribution in close proximity to the FLOT. The joint Service requirements at division and subordinate levels of command for near-real-time image intelligence is out to 30 km beyond the FLOT. Also driving the requirement for the CR UAV is the need for a two person transportable system which can operate in a confined launch and recovery area. Figure 13 represents the CR operational employment for a USA division, while Figure 14 portrays the USMC operational employment.

(d.) Acquisition Strategy

The CR program received MS 0 approval from the UAV EXCOM on 30 January 1990. CR UAV has proceeded with concept definition through analyses of data generated from other

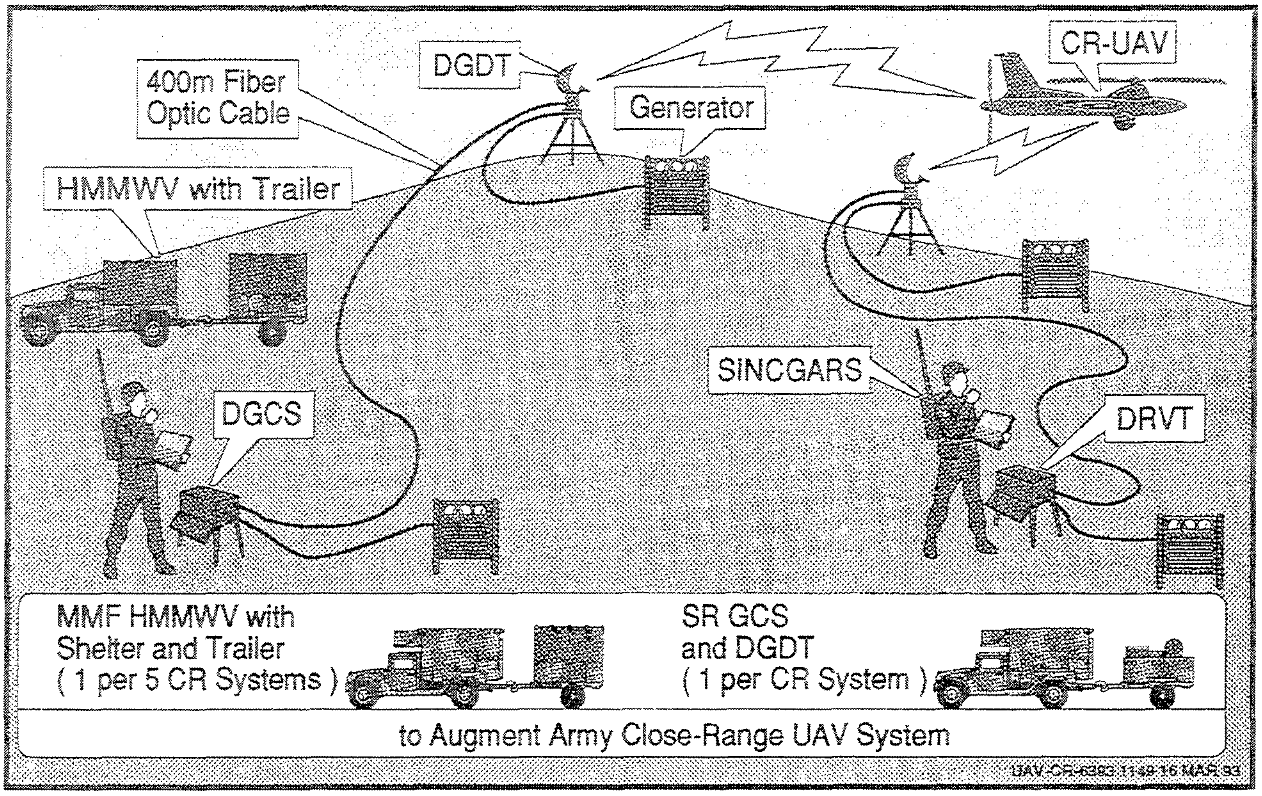


Figure 13 CR UAV Operational Employment for the USA

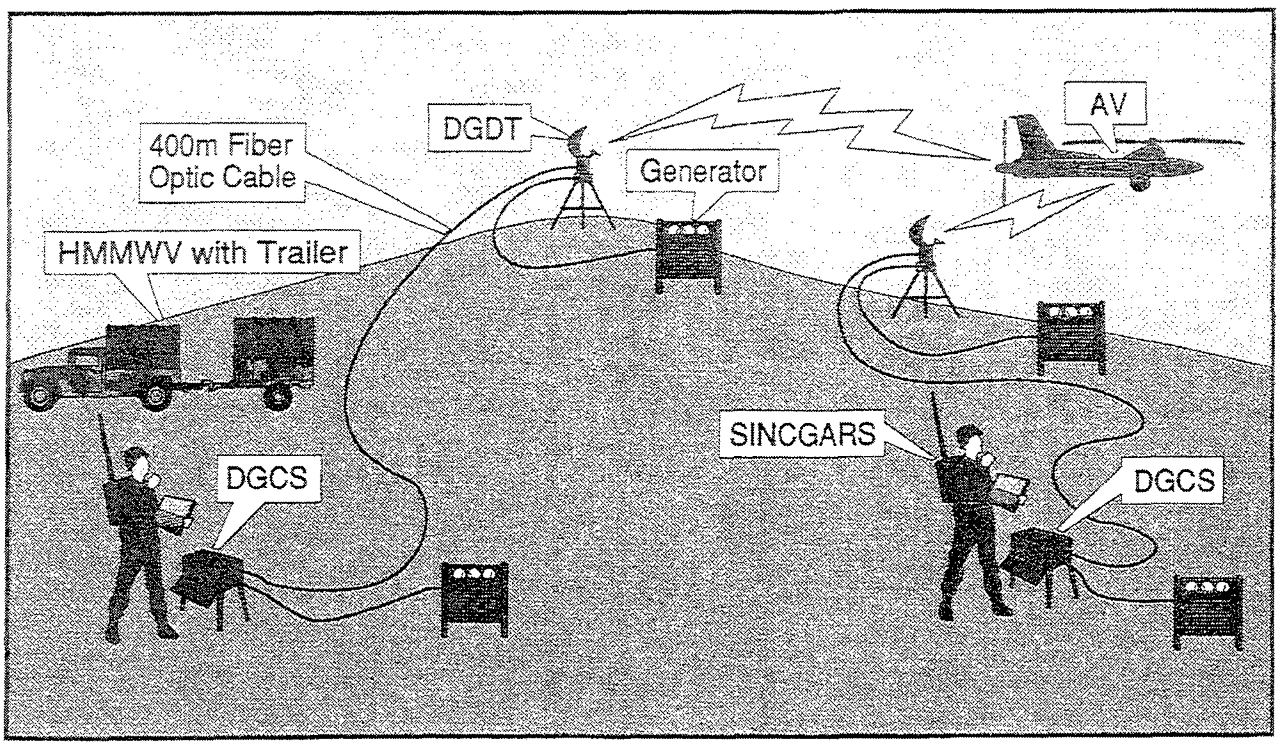


Figure 14 CR UAV Operational Employment for the USMC

UAV programs such as the EXDRONE, Pointer Hand Launched and foreign comparative testing (FCT) UAV programs. This data, along with air vehicle technology demonstration efforts, has been used to define the system concept. The technology demonstration programs provide data relating to technology concepts, their maturity and feasibility, as well as benefits and drawbacks of alternative concepts. Concept exploration and definition have been streamlined through the use of this data from technology demonstrations and from other UAV programs.

In January 1992, the USD(A), established the CR UAV as a separate Acquisition Category (ACAT) ID program. As such, milestone reviews will be in accordance with DoD 5000.1, to include the defense acquisition executive summary (DAES) and selected acquisition reports (SAR), as appropriate. The DAB is the milestone decision authority for the CR UAV.

The basic CR UAV acquisition strategy achieves maximum hardware and software I&C with SR and consists of the integration of several pieces of equipment acquired through three separate contract actions: a contract for SR GCSs; a contract for downsizing the SR GCS, GDT, and RVT; and a system's integration contract to include development of the air vehicle, MMP, downsized air data terminal, and any ancillary support equipment. This philosophy allows the incorporation of SR interoperability through the integration of existing software into new downsized hardware packages. The downsized and common items will be integrated with the CR UAV air vehicles to comprise the total CR UAV system. The common hardware will be produced by the SR prime contractor concurrently with the SR UAV production hardware.

The CR UAV baseline system augmented with a downsized GCS and GDT will support MAGTFs. The system will be deployed with battalion and lower units.

The system will be fielded by the USA at the division and brigade level as the launch/recovery section and will be augmented with a GCS and associated hardware from the SR system. This will provide maximum C^3I I&C to support the USA's battlefield operations.

(e.) Status

In 1992 the CR program completed technical demonstrations of air vehicles and FLIR payloads. The objective of the demonstrations was to reduce risk by demonstrating the maturity of technology for the 200 lb class air vehicle and FLIRs less than 50 lbs. FLIR demonstrations were successfully completed in January 1992, while the air vehicle demonstrations for the 200 lb class were successfully completed in July 1992. Six contractors took part in the demonstration: Westinghouse, AAI Corporation, IAT, General Atomics, Daedalus Research and McDonnell Douglas. Three contractors participated in the FLIR technical demonstrations: Kollmorgen, Rafael and Rockwell. The fourth FLIR contractor was dropped from the technical demonstration program. Figure 15 is a representation of the air vehicles flown during the technical demonstrations by participating contractors.

The demonstrations proved that CR type air vehicles and payloads are capable of performing within the technical parameters required for the CR system. The demonstrations provide a forum for identifying potential problems which could affect schedule or technical performance. This problem identification is used to further decrease risk.

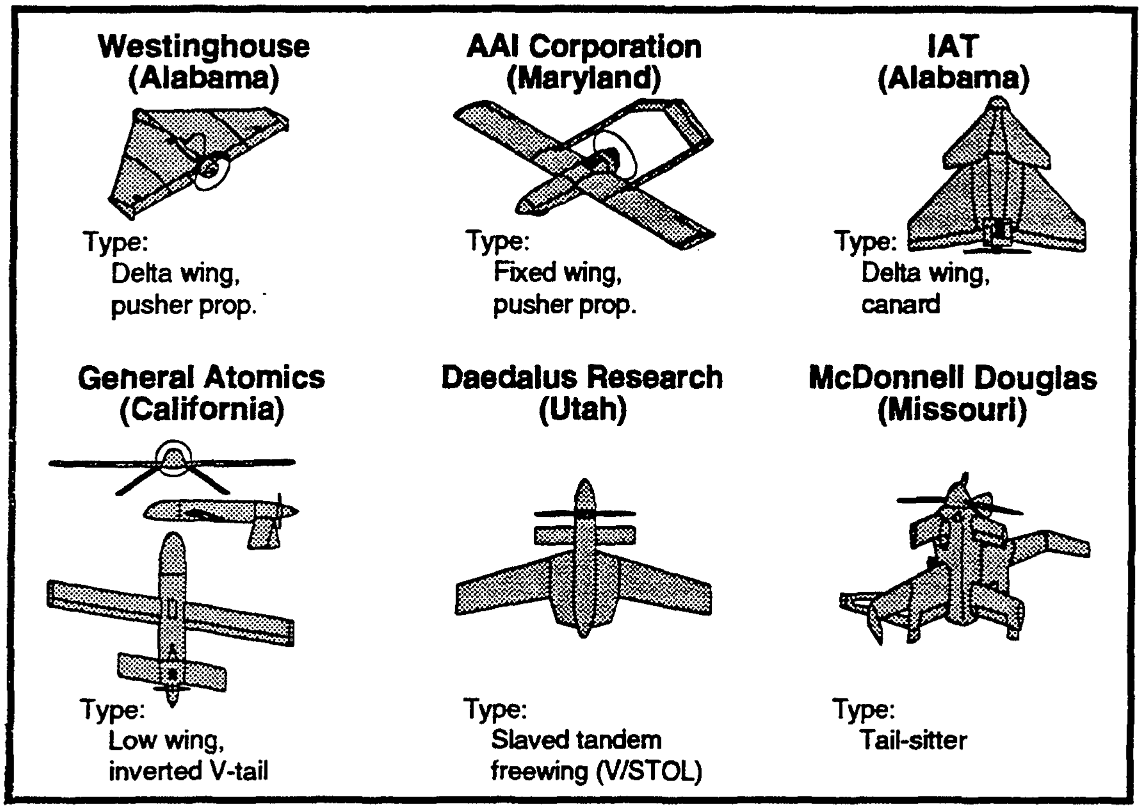
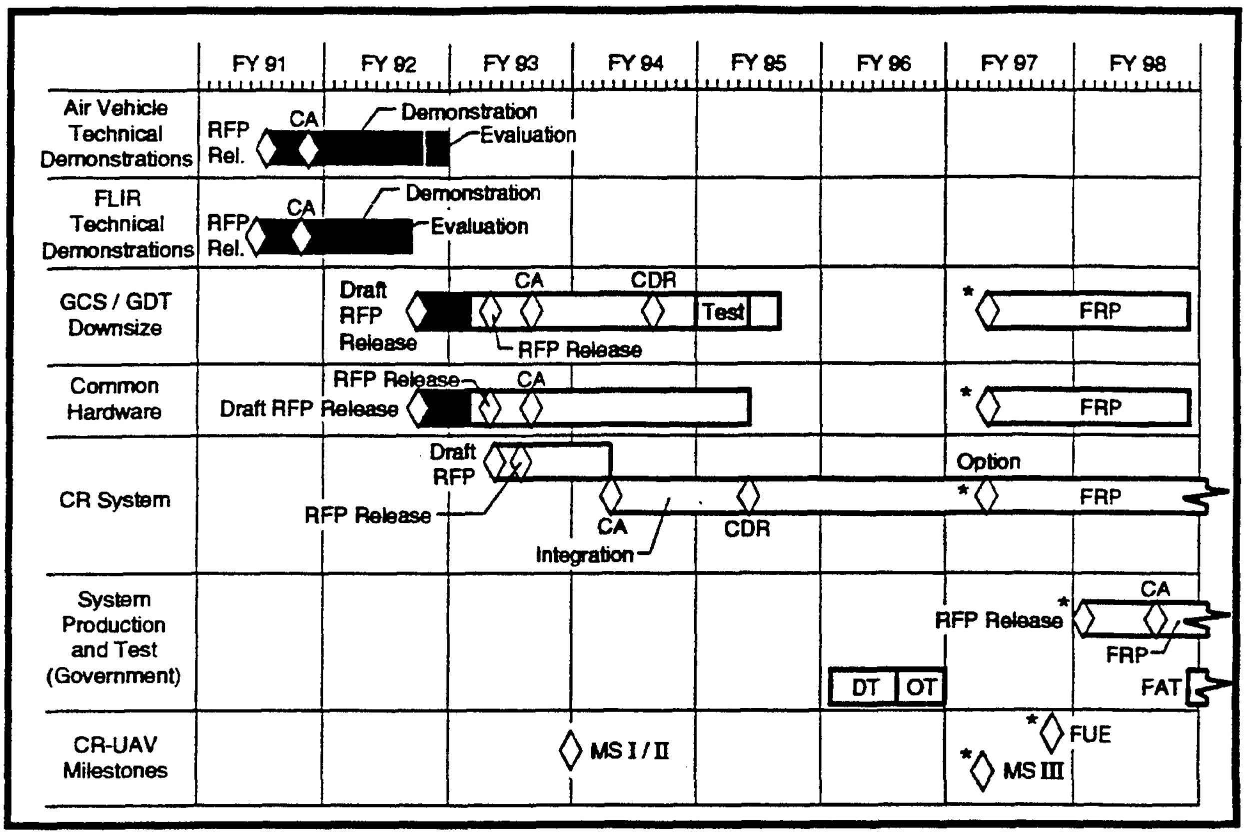


Figure 15 Representative Air Vehicles Flown During Technical Demonstrations

(f.) Schedule

The CR program is proceeding to milestone decision review planned for the first quarter of FY94. The primary objective for CR UAV is to successfully accomplish this milestone review required to meet the program schedule, shown in Figure 16. The CR UAV program office plans to release RFPs for both the SR GCSs and downsized SR GCS, GDT and RVT, and to award both contracts during FY93. The draft RFP and RFP will be released for the CR system integration contract during FY93. Contract award is planned for FY94.



* NOT FULLY RESOURCED

Figure 16 CR UAV Baseline Schedule

3. Medium Range (MR) UAV System

(a.) Background

On 11 March 1985, the USN and the United States Air Force (USAF) signed a memorandum of agreement (MOA) on tactical reconnaissance development activity which assigned the USAF the responsibility for developing electro-optical (EO) imagery sensors for tactical reconnaissance equipment and assigned the USN the responsibility for the concept definition of unmanned tactical reconnaissance vehicles.

In accordance with the Tactical Air Forces (TAF) 301-87 statement of operational need (SON) for day-night/all weather tactical reconnaissance sensor package dated 17 December 1987, the USAF is developing the tactical reconnaissance package for installation in the MR UAV. This system is designated ATARS.

On 8 July 1985, the Secretary of the Navy (SECNAV) promulgated a UAV program decision memorandum (PDM) directing the procurement of a mid range remotely piloted vehicle (RPV) for tactical reconnaissance. This decision led to the approval of acquisition plan (AP) A62-36-0-50 on 13 May 1986. A RFP covering a competitive prototype development phase was released on 25 August 1986. The USAF SON 304-85 in support of the MR UAV requirement was promulgated on 5 November 1986. Original USN and USMC requirements were defined by operational requirement (OR) 142-03-87 dated 12 March 1987. On 31 March 1987, the AP was revised to divide the prototype development phase into two subphases. The first subphase, Phase 0, was to provide engineering analysis for the design of a reconnaissance/target air vehicle and would be completed at a detailed design review. The next subphase would continue through Milestone III. Subsequently, two Phase 0 contracts were awarded in August 1987. In a second AP revision, dated 9 December 1987, a resolicitation at the completion of Phase 0 was directed to meet the urgent requirement to acquire an affordable and effective MR system either as part of a joint remotely piloted vehicle/target program or, if deemed more cost effective, as a stand-alone MR program. An RFP for the E&MD of an MR UAV was released on 29 June 1988.

The MR UAV program was reviewed at a Navy Program Decision Meeting (NPDM). Acquisition Decision Memorandum (ADM) dated 28 June 1989 granted MS II approval to enter E&MD for the reconnaissance, but not the target vehicle.

During April 1991, the USN Service Acquisition Executive (SAE) and the DOD UAV EXCOM approved the risk reduction portion of a redefined program leading to contract modification approval on 10 June 1991. On 10 December 1991, the DAB approved the redefined MR UAV program resulting in the ADM being signed on 3 January 1992.

(b.) Purpose

Military operations in Vietnam, Lebanon, Grenada, and most recently, Southwest Asia, have shown severe tactical deficiencies in the collection of near real time reconnaissance data at radii of up to 350 nautical miles (nm)(650 km). Further, as enemy forces become more mobile and weapon system technology advances, the gathering of tactical reconnaissance data by manned aircraft will become increasingly difficult and more hazardous. Tactical commanders need the capability to acquire real, or near real time reconnaissance data, day or night, in increasingly higher threat environments routinely and quickly. The MR UAV is an organic, low cost, highly survivable asset that can collect EO/infrared (IR) data on fixed targets at radii up to 350 nm, day or night, and provide these data to tactical commanders in near real time.

The MR UAV system is intended to provide multi-mission support to the C^3I efforts required to conduct joint operations. As presently configured, the MR UAV system is capable of performing the following mission as defined by JCS Pub 1-02: reconnaissance, target acquisition, and battle damage assessment (BDA). A multi-theater role is envisioned for the MR UAV in support of war fighting operations.

(c.) Concept of Operations

The MR UAV will complement manned tactical aircraft and other reconnaissance capabilities of the Services for the 1990s and beyond. No existing capability will be replaced. Imagery data will be collected on fixed targets/locations at radii up to 650 km from the launch point. Imagery will be of sufficient resolution and accuracy to support targeting for air and ground delivered weapons and to provide BDA. Fixed locations may include imagery of mobile targets. The MR UAV will fly high risk missions in heavily defended areas over land and sea and provide a needed day/night, under the weather reconnaissance capability. The F/A-18C/D aircraft will be used for air launch by the USN and USMC, while the F-16R will be used by the USAF. A ground launch capability unique to USAF is planned to be used for about 80% of the USAF missions. The MR UAV will use existing Service mission planning/programming systems: the Tactical Aircraft Mission Planning System (TAMPS) for the USN and USMC and the Air Force

Mission Support System (AFMSS) for USAF. The vehicle will be reusable and compatible with recovery on land, water, or in mid-air. See Figure 17 for the MR UAV concept of operations.

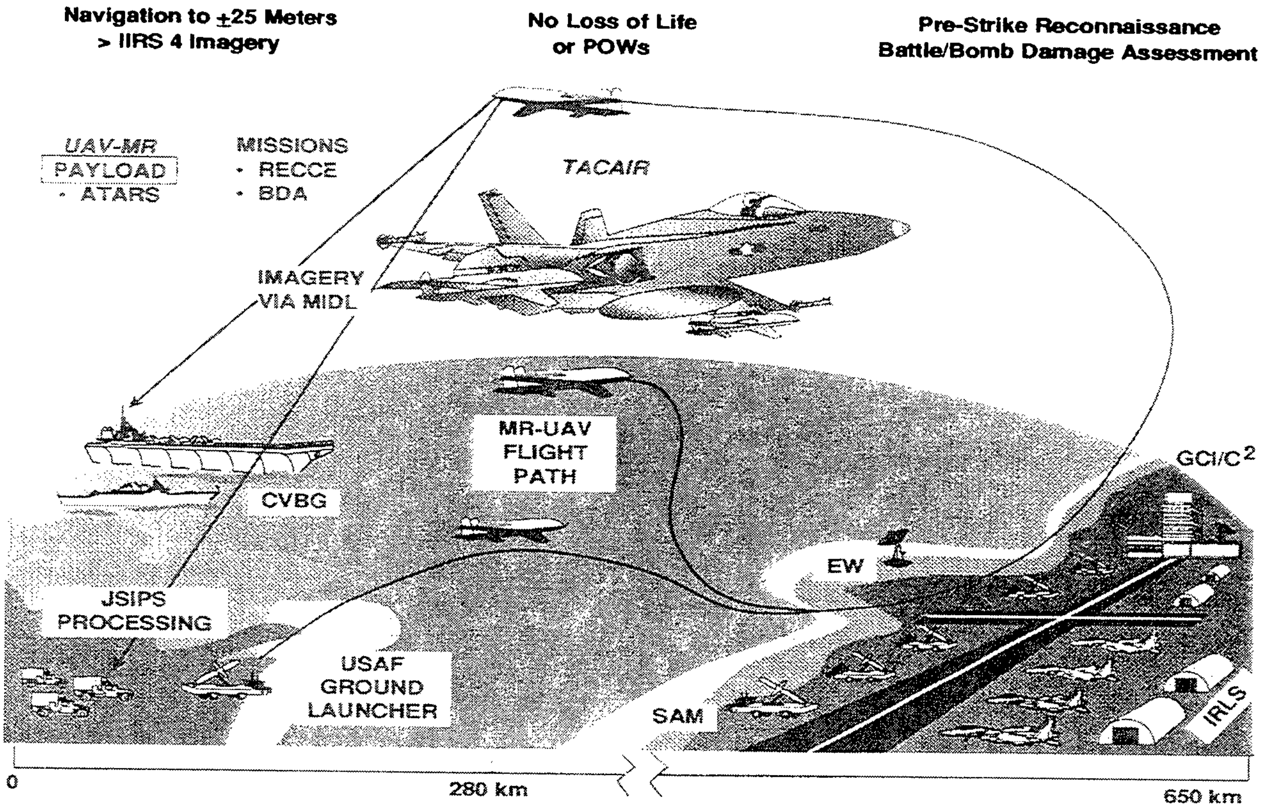


Figure 17 MR UAV Concept of Operations

(d.) Acquisition Strategy

On 30 June 1989, a fixed price incentive contract was competitively awarded to Teledyne Ryan Aeronautical (TRA) for E&MD. Initial air vehicle developmental efforts surfaced maintainability and supportability concerns with the graphite epoxy/aluminum honeycomb structure originally under contract. In August 1990, the decision was made to redesign the MR UAV with metallic primary structures to resolve these concerns, and to accommodate the increase in volume and weight of the ATARS payload. Concurrent with this redefinition of the MR UAV program, additional capabilities and requirements were implemented, i.e., Mode 4 identification, friend or foe (IFF), precision altimeter and accommodation of an encoded GPS. Additionally, the testing program was revised to comply with increased multi-Service testing requirements. Under this competitively awarded contract, the Government secured not-to-exceed options for both LRIP and a limited number of full rate production (FRP) systems (Government option for 30 LRIP and 105 FRP air vehicles). Under the program redefinition, these not-to-exceed options were retained. However, the prices will be adjusted to reflect changes in the air vehicle as well as schedule changes.

(e.) Status

The program is currently proceeding with both the risk-reduction and E&MD portions of the redefined program. The risk reduction effort involves contractor flight testing of two graphite composite vehicles with developmental reconnaissance payloads. The first powered flight of the MR UAV was conducted in May 1992, during which successful engine start, air launch, powered flight and recovery of the air vehicle were demonstrated. A second air-launched mission in July 1992 demonstrated autonomous flight, imagery collection, and recovery for the MR UAV. The first boosted, ground-launched mission in September 1992 failed shortly after launch, resulting in the loss of one of the two risk reduction vehicles. An air launched flight in December 1992 demonstrated the GPS navigation capability of the MR UAV as it traversed an instrumented course on the Utah test range. A successful ground launch in February 1993 closed out the risk reduction phase of testing. The E&MD portion of the program is also underway. PDRs on both vehicle and ground launcher were conducted in 1992, and the design continues to mature as the program approaches the FY93 CDR. In support of E&MD design efforts, an additional risk reduction test commenced in December 1992. An F/A-18 loaded with an inert MR UAV will be operated in a simulated aircraft carrier environment to assess compatibility of the production design. Testing will examine critical F/A-18 launch, recovery, and flying qualities considerations with emphasis on vehicle-to-aircraft, and vehicle-to-deck clearance during arrested landing. The MR UAV program schedule is shown in Figure 18 below.

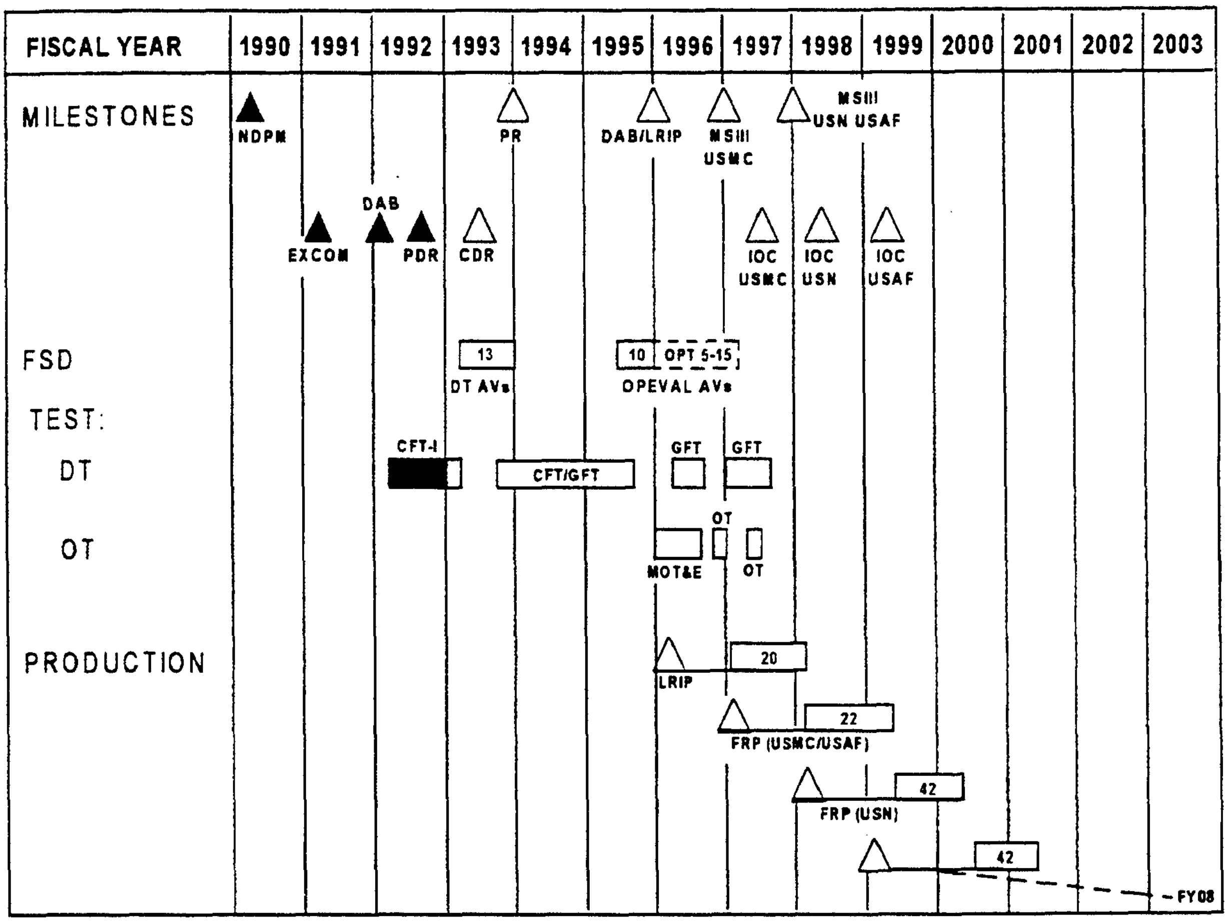


Figure 18 MR UAV Program Schedule

The air launch and parachute recovery of the MR UAV (Figure 19) and MR UAV interfaces (Figure 20) are shown on the following page.

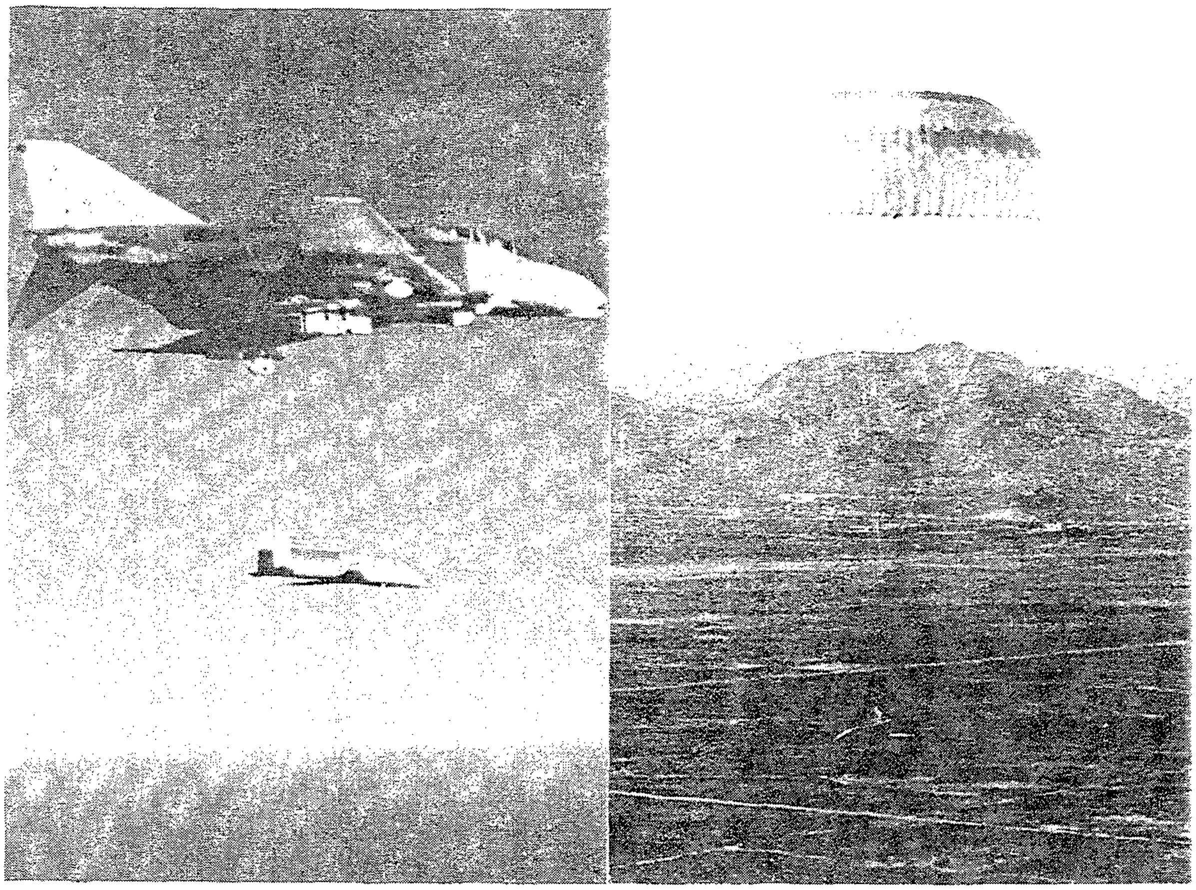


Figure 19 MR UAV Launch & Parachute Recovery

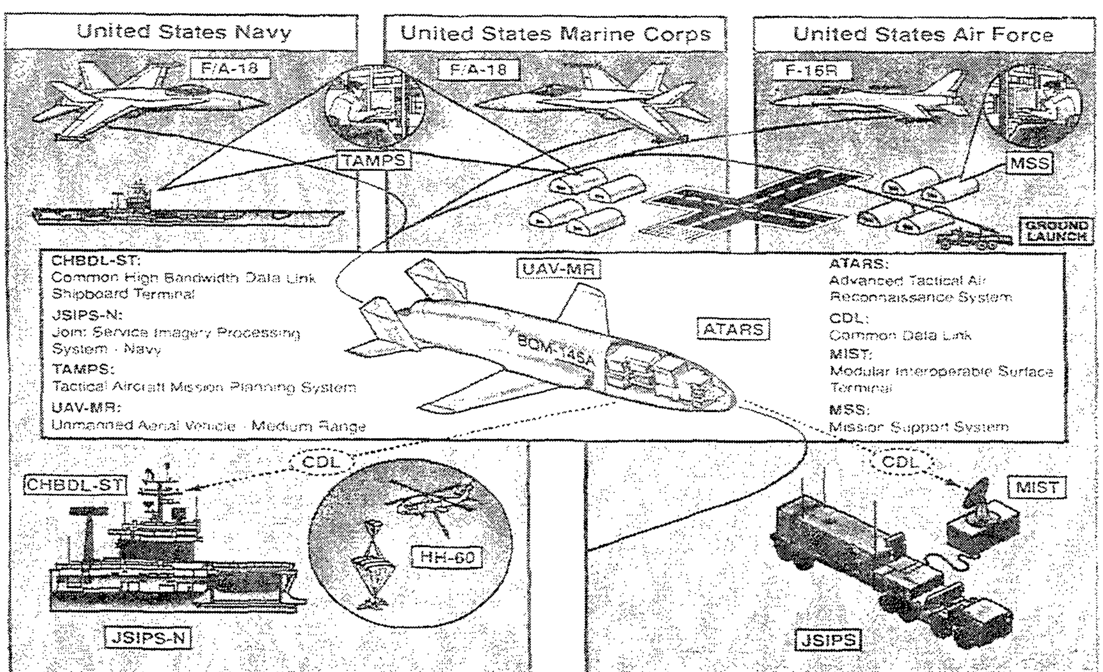


Figure 20 MR UAV System Interfaces

B. Fielded System (Interim SR UAV System)

1. Pioneer UAV System

(a.) Background

Operations in Grenada, Lebanon, and Libya identified a need for an on-call, inexpensive, unmanned, over the horizon targeting, reconnaissance and BDA capability for local commanders. As a result, in July 1985, the SECNAV directed the expeditious acquisition of RPV systems for fleet operations using nondevelopmental technology. Two Pioneer systems were procured by the USN for an accelerated testing program in 1986. This effort culminated in development on board the USS IOWA (BB-61) in December of that year. In September 1987, routine deployment of the Pioneer system on board battleships commenced. During 1987 three systems were delivered to the USMC, and within the next seven months they deployed to Morocco in support of an allied amphibious assault training operation and to USMC base at Camp Pendleton, CA for Exercise Kernel Blitz. In 1990 a system was delivered to the USA. Between 1986 and 1992, over 7,500 Pioneer flight hours have been logged. The USN has deployed Pioneer on four battleships supporting world wide operations in Africa, northern Europe, the North Atlantic, Korea, the Mediterranean, and contingency operations in the Persian Gulf. The USMC has integrated Pioneer support with weapons and tactics instruction, Kernal Blitz exercises, and the US Customs Service in drug interdiction missions. The USA has used Pioneer in support of exercises at the National Training Center and elsewhere. During Operation Desert Shield/Desert Storm, the six operational USA, USN, and USMC units flew over 300 missions. Only one air vehicle was shot down while three others were hit by ground fire during combat missions and safely recovered. During Operations Desert Shield/Desert Storm, USN assets were used for battleship target selection, spotting naval gunfire and BDA. The USMC used Pioneer to direct air strikes and provide near-real-time reconnaissance for special operations and the USA used Pioneer to accomplish BDA, area searches, route reconnaissance and target location. The SR UAV will replace Pioneer in the USA and USMC to accomplish BDA area searches, route reconnaissance and target location. During FY95 USMC and USA Pioneer systems will begin transition to the USN to operate until replaced. The Pioneer UAV is shown in Figure 21 on the following page.

(b.) Purpose

The Pioneer system was acquired rapidly, as an interim system, to fill an immediate need to provide the operational forces with deployable tactical assets. The system provides day and night near-real-time RSTA, BDA, artillery fire correction/adjustment of fire, and battlefield management within line of sight of its GCS. The air vehicle's low RCS and IR signature, and its ability to operate by remote control make it particularly useful in high threat environments where manned aircraft would be vulnerable.

(c.) Concept of Operations

A Pioneer system consists of five air vehicles, five day television and four FLIR payloads, a GCS, a portable control station (PCS), one to four remote receiving stations, pneumatic or rocket assisted launcher and net or runway arrestment recovery systems. The air vehicle is a short range, remotely piloted, pusher propeller driven, small fixed wing aircraft that may either be landbased or shipbased. A representation of the Pioneer landbased system is shown at Figure 22. It operates between 1,000 and 12,000 feet, 60 to 95 knots, and in excess of 100

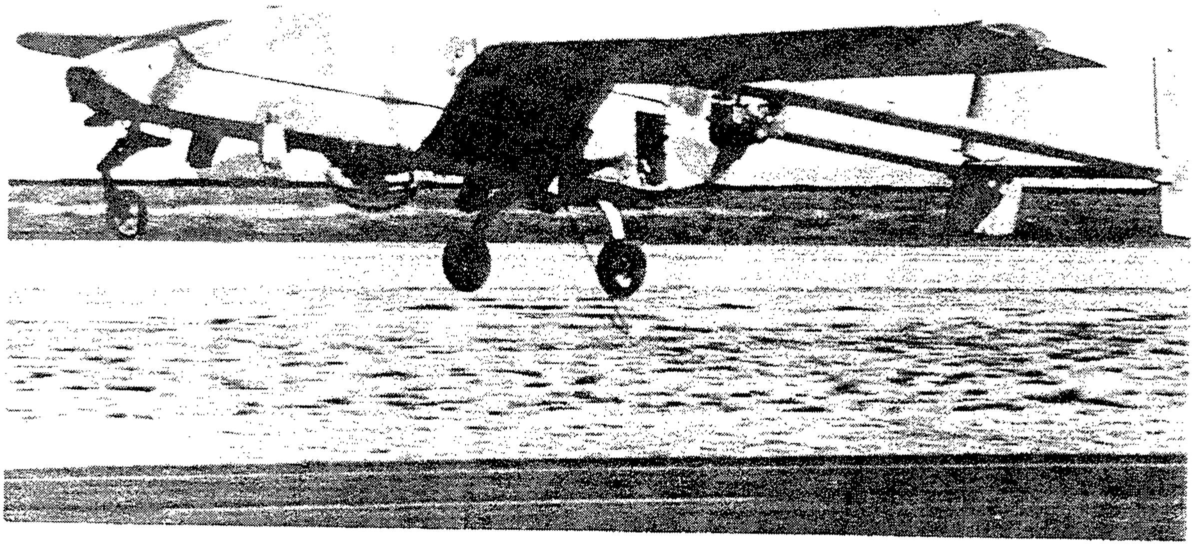


Figure 21 Pioneer UAV

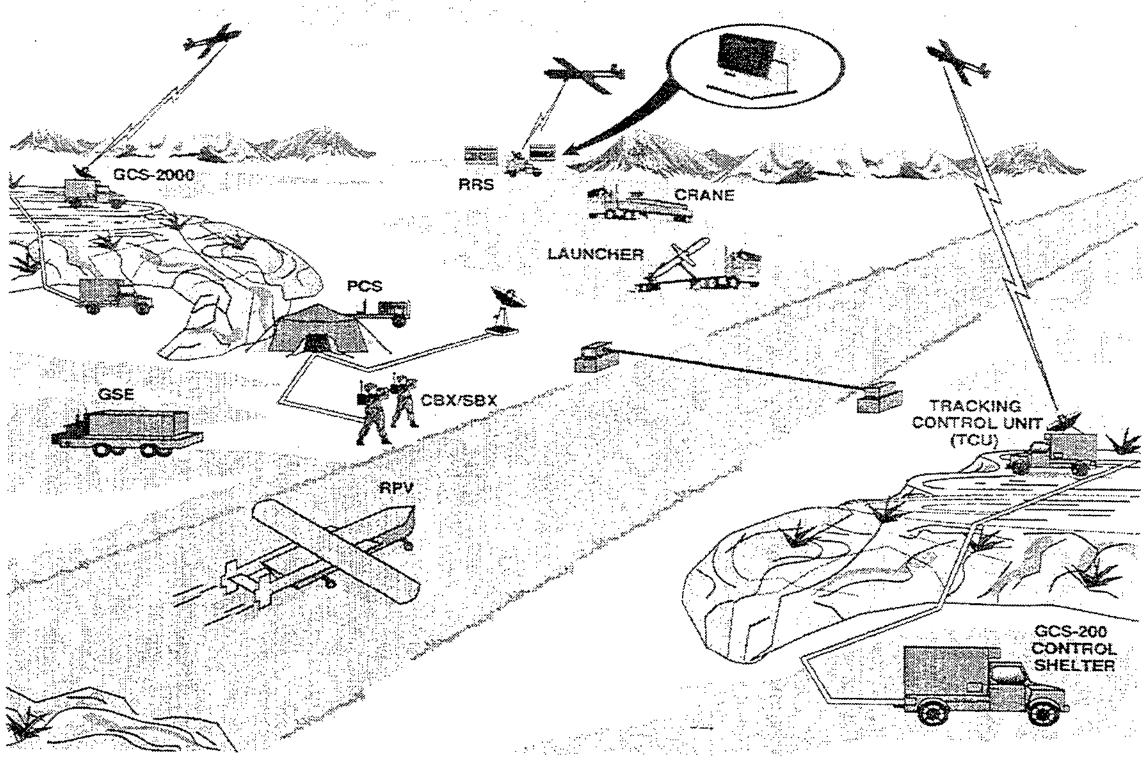


Figure 22 Pioneer Land Based System

nm from the GCS. The Pioneer air vehicle is operated real-time from a control station or can be programmed to fly independently. It relays video and/or telemetry information from its on-board reconnaissance payload systems. Line of sight between Pioneer and a GCS must be maintained at all times for positive flight control and imagery data link. The air vehicle may be handed off from GCS to GCS, effectively increasing the air vehicle's range to its fuel limit. This allows launch from one site and recovery at another. The Pioneer system can control two air vehicles simultaneously, although the video downlink and positive control can be managed for only one air vehicle at a time. In wartime, the Pioneer systems are deployed by MAGTFs, USN battle group commanders, or USA division commanders to provide real-time tactical information. During peacetime, Pioneer units will be tasked with proficiency and mobilization training, tactical intelligence collection, tactics and operational concept development, support and force structure deployment planning, follow on system development, and support of MAGTF, battle group, and divisional training exercises. Since decommissioning of the battleships, plans have been developed to install USN Pioneer systems on LPD class ships in FY93. The entire landbased system can be transported with vehicles and trailers.

(d.) Acquisition Strategy

The operational Pioneer systems will continue to operate as interim assets until they are replaced by the SR UAVs. Initial acquisitions of Pioneer systems were procured between FY86 and FY88 with final deliveries made in FY90. Additional air vehicles and payloads were procured in FY92 to replace assets lost during Desert Shield/Storm. Procurement of spare parts is programmed for FY93 and a requirement for spare parts exists for FY94 and beyond. When replaced by SR, USA and USMC Pioneer systems will be used to provide spares support to operating USN units.

(e.) Status

Pioneer is fully operational and currently fielded with two ship-deployable UAV detachments, three USMC RPV companies, and one USA RPV company. Additional systems are located at the Pioneer RPV Training Center at Ft Huachuca, AZ and the fleet assistance support team at Pt Mugu, CA. Ship deployable detachments are preparing to deploy with the USN's amphibious forces aboard LPDs. The USA and USMC units will phase out Pioneer as the SR UAV is introduced. All remaining Pioneer assets will be redistributed to the USN detachments which will remain operational until eventually replaced. (See Figure 23)

As a result of air vehicle attrition due to mishaps since 1985, the number of air vehicles per system has reduced from eight to five. An additional 12-15 air vehicles in the pipeline (repair and overhaul) are required to support the 45 operational aircraft. There are currently 23 Pioneer air vehicles available in the field, 21 in the pipeline and 12 more being procured to replace Desert Storm losses. Even with the new procurements, Pioneer assets are well below operational requirements and, with expected attrition, will remain below requirements through Pioneer's life cycle.

(f.) System Interfaces

The Pioneer system has two basic configurations, ship installed and shore based. The ship installation currently being completed for LPD is similar to the previous battleship installation in that permanent antennae, fuel storage, and recovery net fixtures must be in place. Aviation gasoline (AVGAS) for the air vehicle and the rocket assisted take off (RATO) launch bottle

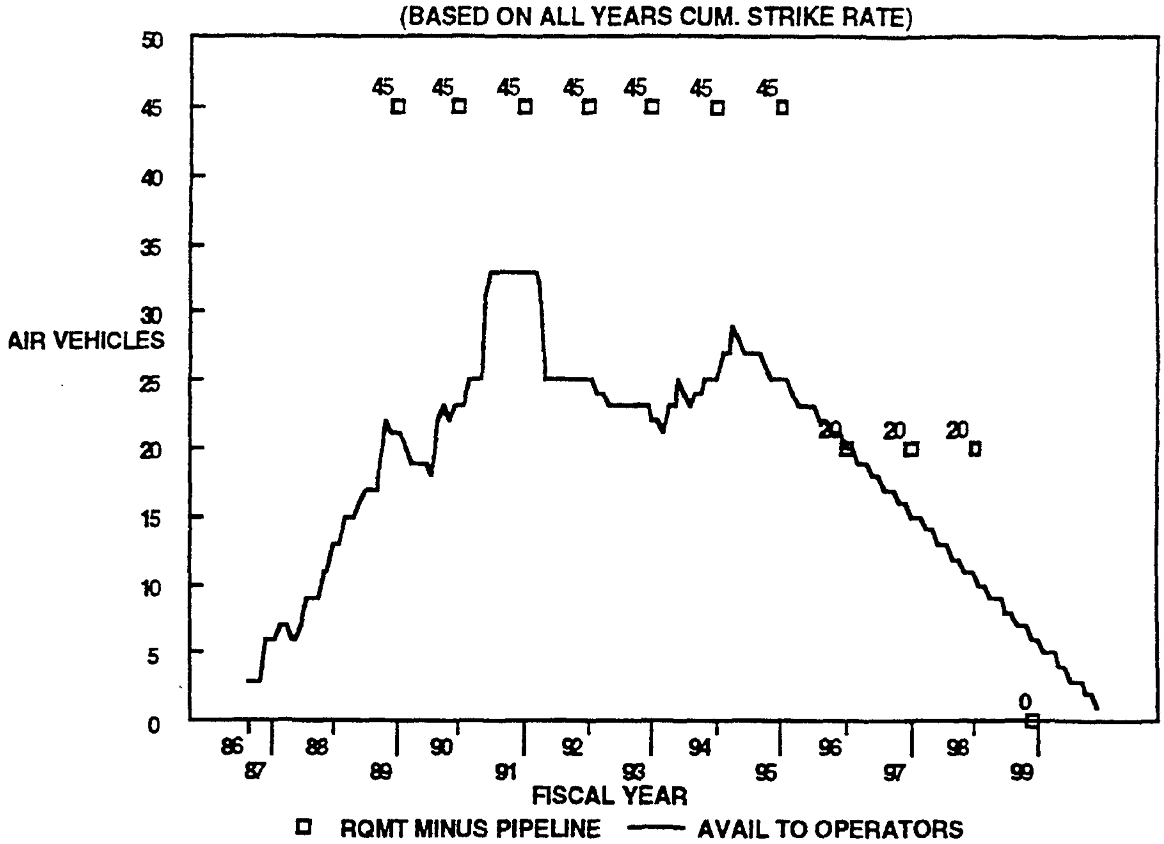


Figure 23 Pioneer Air Vehicle Inventory

require special handling and storage procedures on board ship. Shipboard flight operations require special consideration of air space allocation, control frequency allocation, and electromagnetic interference caused by the launch ship and other ships in company. The Pioneer LPD configuration is shown in Figure 24.

The landbased systems are self contained. However, they also require special facilities to operate. The air vehicle needs a prepared landing surface or runway to set up the arresting gear. There must be sufficient area cleared for the various ground support equipment. Safe AVGAS and RATO storage and handling facilities need to be in place. The vehicles used to transport the Pioneer system require service and maintenance facilities.

(g.) Schedule

The Pioneer RPV will continue to be operated until the SR UAV system achieves IOC or assets are reduced due to attrition. All USA and USMC systems will be transferred to the USN between FY94 and FY96, and all USN Pioneer support will be phased out by the end of FY99. The plan calls for withdrawing the USA Pioneer system mid FY94, one USMC system during the second quarter FY95, two other USMC systems in fourth quarter FY95 and first quarter FY96, and the system at Ft. Huachuca in early FY95, as Pioneer training is transferred to Commander, Naval Air Forces, Atlantic. Spares procurement is currently planned through FY93, while outyear material support will be provided by operations and maintenance, funded component repair and through the use of withdrawn system assets as spares. (See Figure 25).

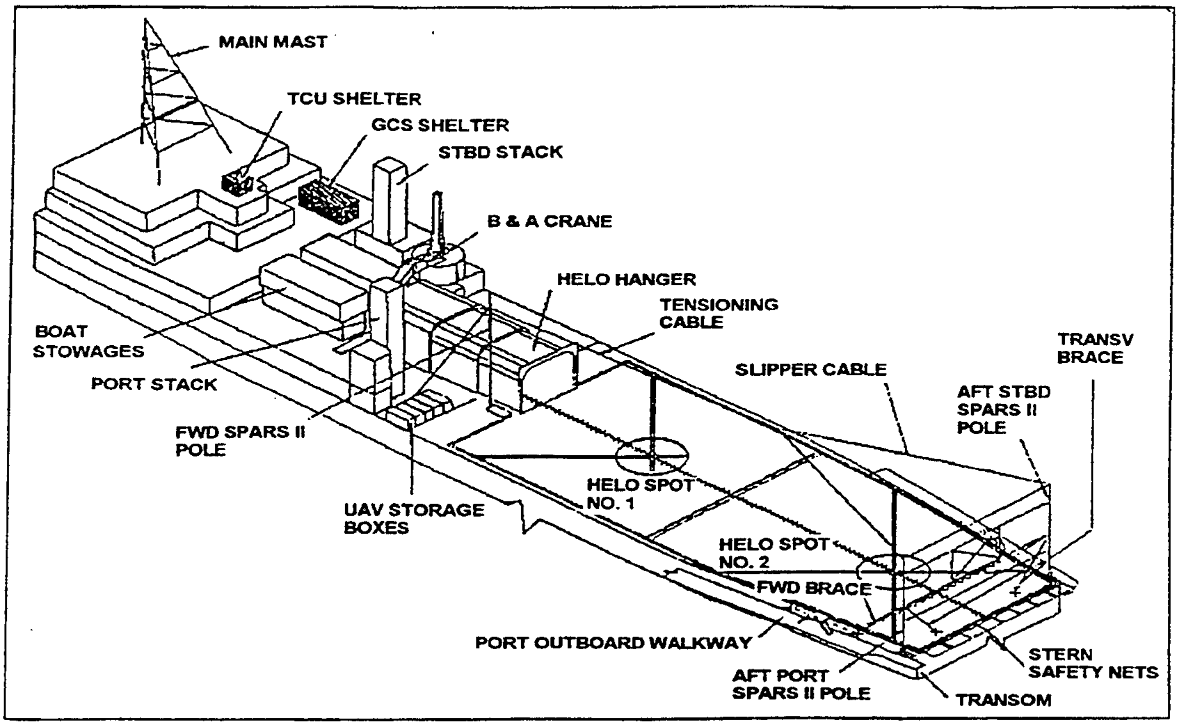
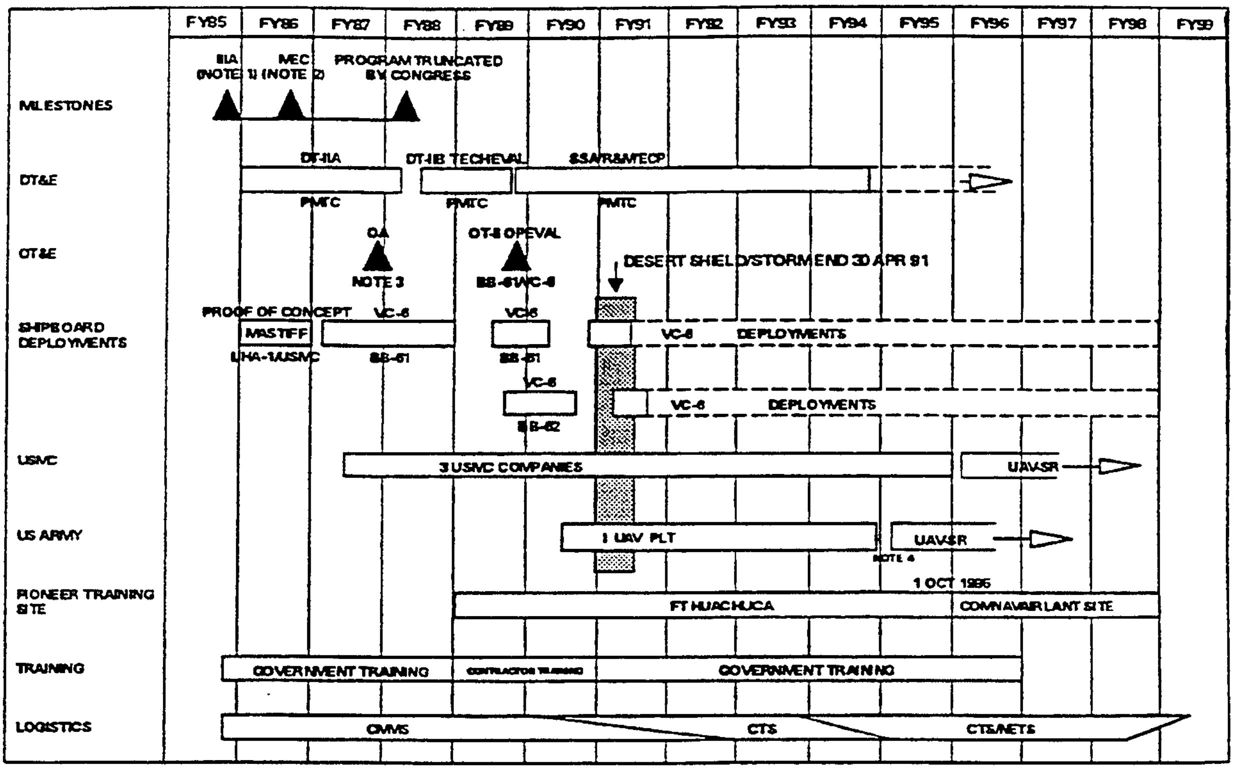


Figure 24 Pioneer LPD Configuration



NOTES:
1. SECNAV/PDM 08 JUL 85.
2. INITIAL FLEET CAPACITY TO FACILITATE TRAINING AND SUPPORT OPERATIONAL CONTINGENCIES. NO IOC PLANNED WITH MINIMUM ESSENTIAL CAPABILITY MILESTONE.
3. OPERATIONAL ASSESSMENT - VC-6 DET 1 ONBOARD USS IOWA AND 2ND RPV CO AT CAMP LEJEUNE
4. TSM - UAV 26 APR 91 ARMY MUST RETAIN PIONEER CAPABILITY UNTIL UAV-SR ON LINE, AT LEAST ONE DEPLOYABLE UNIT.

Figure 25 Pioneer Schedule

C. Demonstrations

1. Vertical Takeoff and Landing (VTOL) UAV System

(a.) Background

To provide UAV capability to meet joint US forces' requirements, the MNS for a SR UAV was developed and approved in December 1988. Since then, the UAV JPO has been executing a coordinated acquisition strategy to provide the services with systems satisfying these requirements. A minimal land based, RSTA capability (Block 0) was authorized by Under Secretary of the Navy Memorandum of 8 May 1989, with block modifications to adapt the system to Navy ships. In early 1990, an in depth assessment was initiated to evaluate system capabilities required for the SR UAV to operate effectively in a maritime environment (SR UAV Block I Program). On 12 September 1991, the UAV EXCOM was briefed that a different SR air vehicle might be required to achieve maritime mission requirements. The UAV EXCOM concurred with the findings and determined that the program was not financially executable as funded. The UAV EXCOM directed the UAV JPO to develop a program plan for the Block I modification program and that the OSD, Deputy Director for Research and Engineering, and the OSD Comptroller, develop a program budget decision (PBD) alternative to adequately fund the program. Citing absence of a documented requirement and the unexecutability of the program as funded, OSD(C) deleted funding for SR Block I from the FY92 budget request. PBD 191 directed the UAV JPO to continue to define SR Block I requirements using existing UAV JPO resources. PEO(CU) allocated $0.5 million of UAV JPO FY92 funds to support staffing of the SR UAV Block I ORD and technology demonstration (Tech Demo) efforts. The absence of adequate development funding for the SR UAV Block I system and the requirement to maintain the program schedule on the SR UAV Block 0 system mandated that the programs be decoupled. During the 10 December 1991 DAB, the USN SAE commented on the VTOL UAV risk assessment and proposed that a Tech Demo program be accomplished prior to entering E&MD. The DAB concurred with this proposal and authorized use of FY92 Congressionally added funds to accomplish a VTOL UAV Tech Demo program. A request for inclusion of VTOL UAV funding in the FY93 President's Budget was made, but it was not approved. FY93 funds were subsequently made available by Congress for alternative VTOL air vehicle demonstrations.

(b.) Purpose

The objective is to complete a risk reduction demonstration of a VTOL UAV capability which complements the SR Block 0 system and which is integral to ship's combat systems. The VTOL UAV system will provide: over the horizon classification; targeting and BDA; offboard electronic countermeasures (ECM) for anti-ship missile defense; and RSTA support for land forces.

(c.) Concept of Operations

A fielded VTOL UAV would incorporate the requirements of the UAV family architecture, achieve operational interoperability through incorporation of JIIs, and would provide USN, USMC, and USA an organic, tactical RSTA capability. The VTOL system concept for naval applications focuses on integrating SR UAV system software and hardware into ship subsystems. Thus, USN and USA forces may operate either the SR UAV or the VTOL UAV using organic command and control assets or may share resources and exchange air vehicle with another Service's control stations. The air vehicle would be a high speed VTOL capable of carrying imaging sensors common with the SR and CR UAV programs, incorporating the SR command and control and video down link to ensure interoperability. SR system software will be hosted on an existing USN Tactical Advanced Computer-III (TAC III). An existing USN LAMPS MK-III AN/SRQ-4 datalink will be modified to operate both SR and VTOL. A VTOL UAV operational scenario is shown at Figure 26.

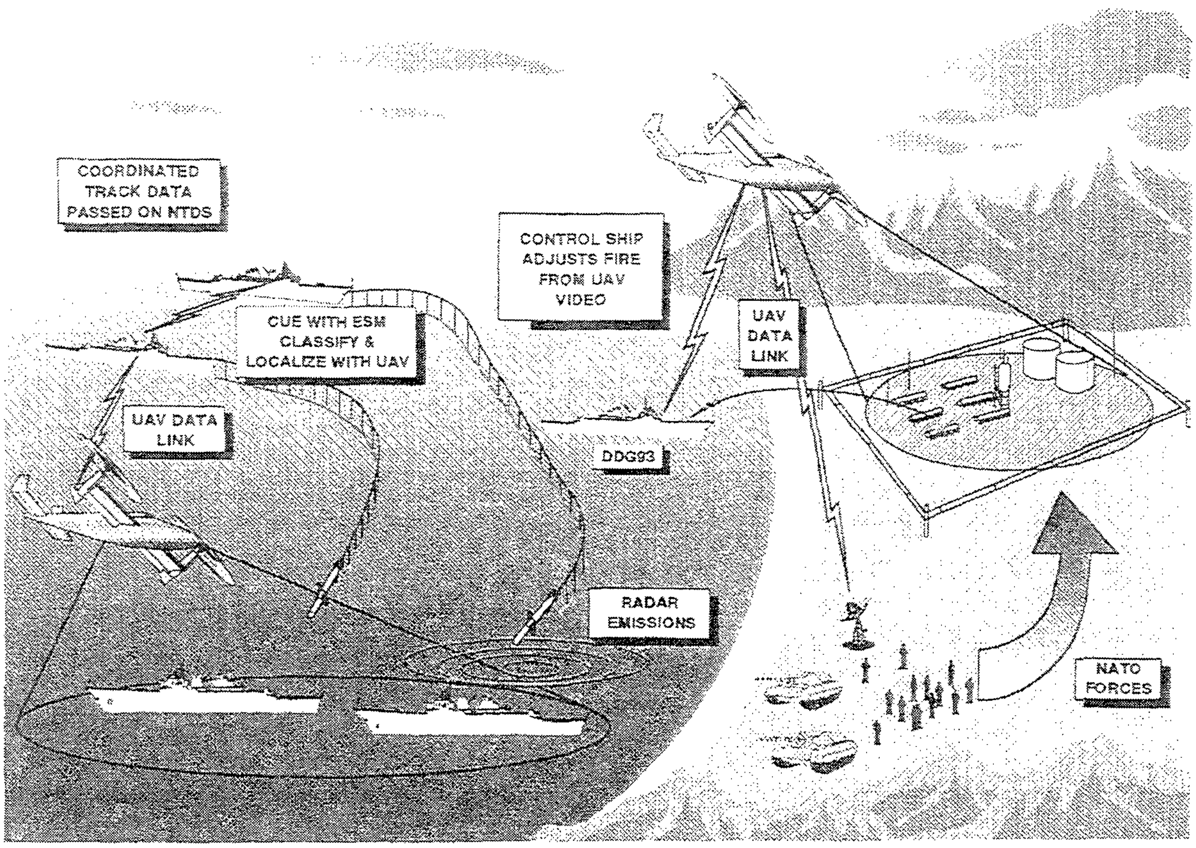


Figure 26 VTOL UAV Operational Scenario

(d.) Acquisition Strategy

The VTOL UAV Tech Demo program consists of demonstrating the I&C between the VTOL and SR UAV systems. In addition, examinations of the flying qualities, performance, and dynamic interface of VTOL UAVs will occur along with reduction of technical risks in the areas of data link, software rehosting, combat system integration, automated recovery, and advanced VTOL air vehicles. There are four major elements in the Tech Demo program:

- **Demonstrate automated takeoff and landing system:** Safe and reliable VTOL operations on small ships requires automated takeoff and recovery in all types of weather. An at sea operational demonstration of an automated takeoff and landing system, including demonstrations with the Canadair, Inc, Sentinel CL-227 system (see Figure 27), will be conducted. Land based automated landing demonstrations were conducted in FY92.

- **Demonstrate high speed VTOL air vehicle:** Tilt wing/rotor vehicle technology is well suited to support the long range and high speeds required for over-the-horizon targeting for ship missile systems and RSTA for USMC fire support elements while maintaining VTOL capability required for small combatant ships operations. Small tilt wing/rotor air vehicle technology is unproven. The demonstration program will test basic FQ&P of the BHTI TRUS air vehicle in FY93. See Figure 27.

- **Demonstrate system integration:** Ship topside space is very limited, and additional weight adversely effects ship stability. Additional data link equipment would impact systems already deployed. Use of existing antennas is the optimum solution to this problem and studies have indicated that the LAMPS MK-III data link (the AN/SRQ-4) may be compatible with the SR UAV datalinks. The systems integration effort will integrate a modified AN/SRQ-4 with a USN TAC-III based workstation which will host SR UAV software. The prototype MPCS and the modified AN/SRQ-4 will be integrated with the SR UAV for flight demonstration. A phased demonstration approach is planned consisting of modeling, system integration, testbed simulations, hardware-in-the-loop demonstrations, land based flight tests and shipboard demonstrations.

- **Demonstrate alternate air vehicle technologies:** The MAVUS II and TRUS Phase II efforts will evaluate the ability of co-axial helicopter and tilt rotor air vehicles to meet Service requirements for VTOL UAVs. Other advanced technologies have the potential to meet these requirements. Candidates include intermeshing rotor, canard rotor/wing, ducted fan, and tail sitter air vehicles. One or more advanced technology prototype air vehicles will be competitively selected for demonstration and evaluation of basic FQ&P in hovering and forward flight regimes.

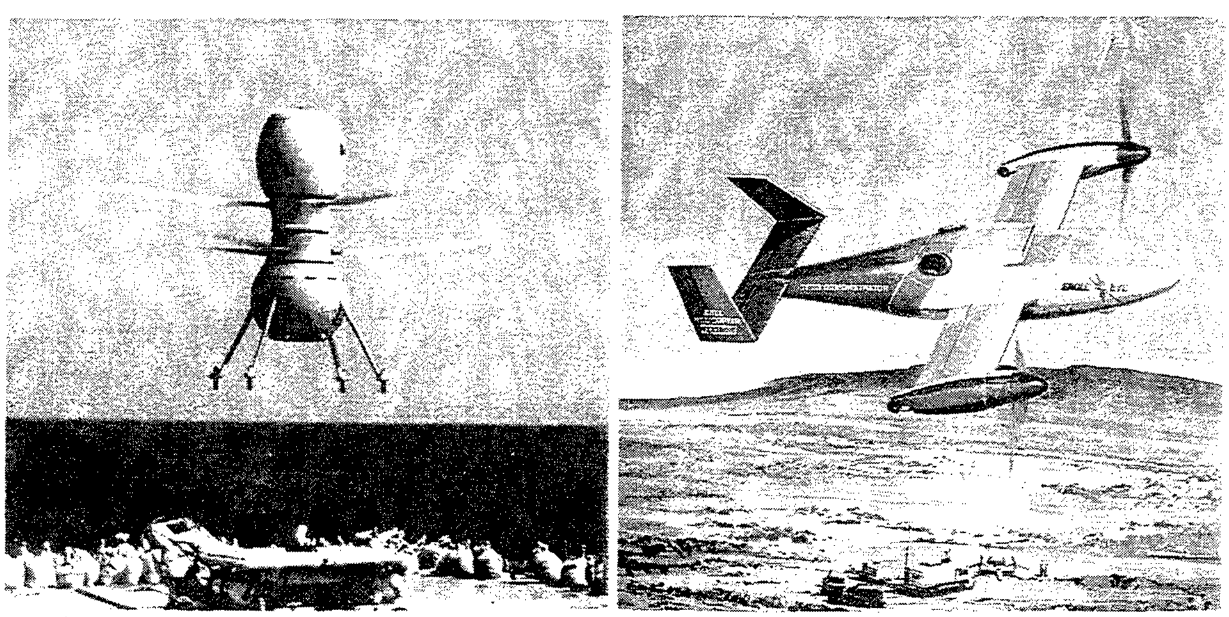


Figure 27 CL-227 and BHTI Demonstrators

(e.) Status

- **Automated take-off and landing systems:** This effort involves demonstrations with the CL-227 (MAVUS II) and a full automatic takeoff and landing system. These demonstrations include land testing and the sea based automatic takeoff and automatic landing flight demonstrations. Contract award is expected during the second quarter of FY93, with at sea demonstrations in the first quarter of FY94.

- **High speed VTOL air vehicle:** Phase II of the competitively awarded tilt wing/rotor program is presently under contract. The contractor (BHTI) is required to complete land based FQ&P testing at Yuma Proving Grounds, Yuma, AZ during the third quarter of FY93.

- **System integration:** Planning is underway for combat system integration efforts. A flight demonstration test of SR UAV software and hardware with a prototype MPCS is scheduled for first quarter FY94.

- **Alternate air vehicles technology:** The UAV JPO will examine potential air vehicle technologies which may meet the performance requirements of the VTOL UAV. Possible candidates include but are not limited to intermeshing rotor, canard rotor/wing, ducted fan, and tail sitter air vehicles. It is anticipated that industry will be solicited during the second quarter of FY93 for potential candidates for FQ&P demonstration to be conducted in the third and fourth quarter of FY94.

(f.) Systems Interfaces

The UAV JPO is coordinating with the SR program office and several other agencies for the VTOL UAV Tech Demo program. Coordination with Navy agencies include Space and Naval Warfare Systems Command (SPAWAR) for data link and battle force integration and Naval Sea Systems Command (NAVSEASYSCOM) for ship integration. Coordination with external agencies include ARPA for concept evaluations using distributed battle force simulations.

(g.) Schedule

The VTOL Tech Demo program schedule is shown in Figure 28.

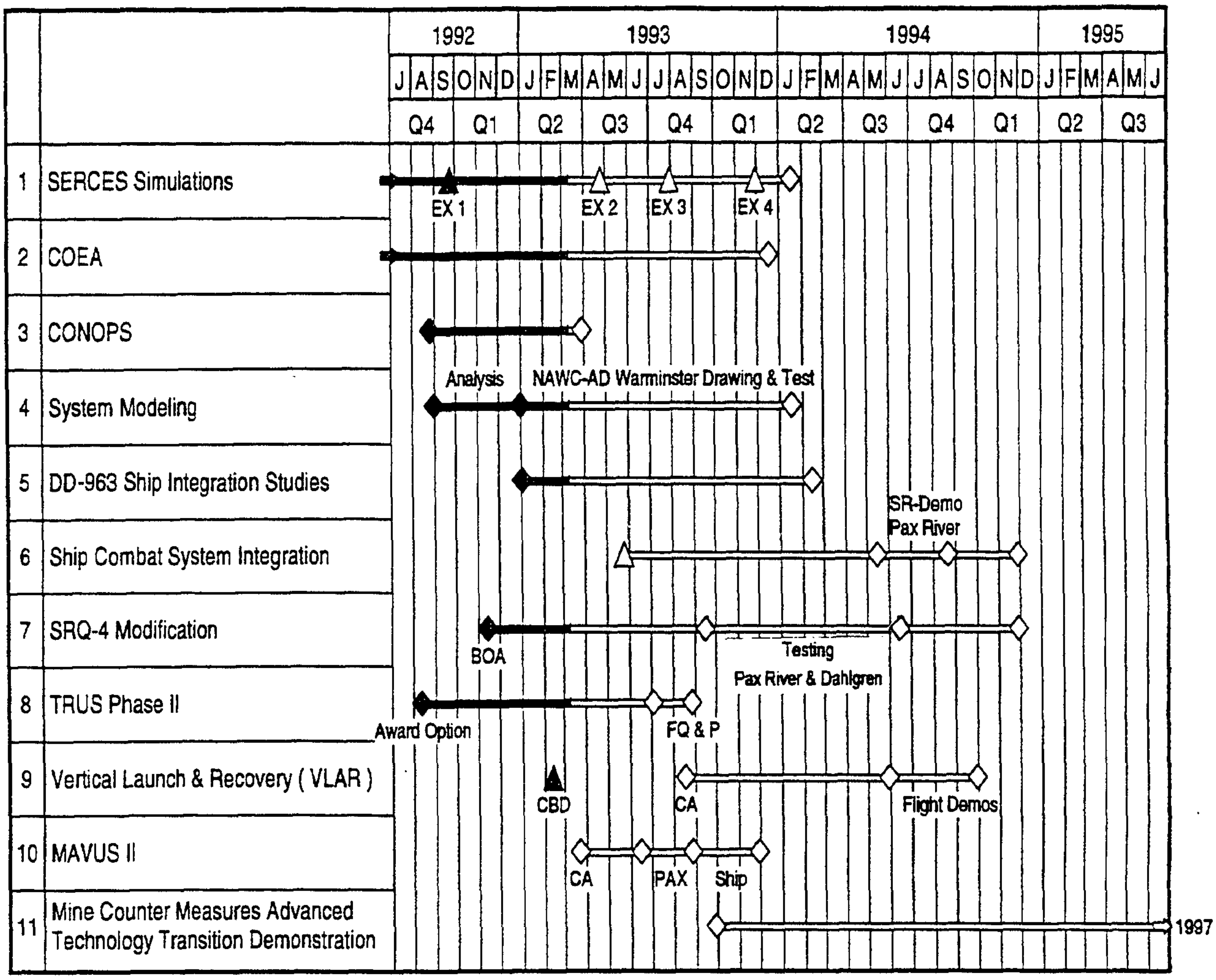


Figure 28 VTOL Tech Demo Program Schedule

(2.) SR UAV Shipboard Demonstration

(a) Background

The SR UAV DAB of 19 January 1993 directed that the SR UAV acquisition program baseline be modified to indicate the objective of shipboard compatibility for the SR UAV. To assist in evaluating this objective, a shipboard demonstration using the SR UAV System aboard an amphibious assault ship is planned. However, before fielding the SR UAV for USN requirements, the adaptation of the SR UAV for the shipboard environment is required. In addition, the operational suitability of the SR UAV in this environment must be evaluated as an integral part of determining compatibility for USN application. The operational suitability and compatibility of the SR UAV on flat deck ships requires that critical issues related to launch and recovery, availability of heavy fuel engines, electromagnetic interference (EMI) hardening, arrested recovery, ship alterations, and deconfliction of flight operations and procedures be adequately resolved.

(b) Purpose

The shipboard demonstration of the SR UAV System on an LPH will complement the VTOL Tech Demo previously described. The SR UAV shipboard demonstration will determine air vehicle compatibility with the shipboard environment and potential SR operational suitability in the maritime environment. The results of both demonstrations will provide inputs for determining and assessing follow-on shipboard UAV requirements.

(c) Concept of Operations

The Amphibious and Joint Warfare Commander will have a functional shipbased UAV capability. Capabilities will include: RSTA; over the horizon classification and targeting; naval gun fire support; BDA; and communications and data relay.

(d) Acquisition Strategy

The Navy may need as many as 18 marinized SR UAV systems for implementation on flat deck ships (L-Class and CV/CVN). This projection is based upon Carrier Battle Group and Amphibious Ready Group requirements.

(e) Status

A technical demonstration plan has been formulated to assess the technical feasibility and operational suitability of the SR UAV on LPH class ships. The demonstration is contingent upon the availability of funds to initiate the effort.

(f) System Interfaces

A baseline SR UAV system analysis will be conducted to determine functional interfaces required for implementation of SR aboard L-Class ships as well as system modifications required for compatibility with the maritime environment.

(g) Schedule

The demonstration is contingent upon the availability of SR UAV assets. Schedules are being developed to insure that the demonstration can be conducted for the at-sea phase without impact to currently scheduled SR UAV baseline activities. The goal is to conduct the demonstration by the end of 1993.

3. EXDRONE UAV System

The UAV JPO's program manager for very low cost (VLC) UAVs is conducting a field demonstration with the BQM-147A (EXDRONE). The EXDRONE is a delta wing air vehicle powered by a two cycle gasoline engine. It has a payload capacity of 25 lbs, 45 km range (line of sight), 2.5 hour endurance and top speed of 100 miles per hour (MPH). The payload is a forward looking color camera used for both navigation and reconnaissance. It is capable of preprogrammed autonomous flight with up to three dash way points and three repeat way points and uses the GPS to provide navigation data to the autopilot. A system consists of ten air vehicles, two GCSs, a launcher and ground support equipment. The GCS can interface with any equipment that has a standard RS-170 connector and has been successfully integrated with the USMC's intelligence analysis system.

The baseline vehicle was developed by the Johns Hopkins University Applied Physics Laboratory in the early 1980s, and the production vehicle incorporates modifications developed by NAWC-AD, Patuxent River, MD, and the National Aeronautical & Space Administration (NASA), Langley Research Center, Hampton, VA. In November, 1991, BAI Aerosystems of Easton, MD, won a contract for the production of 100 vehicles, and subsequently completed deliveries in September, 1992. See Figure 29 for pictures of the EXDRONE during launch preparation and launch.

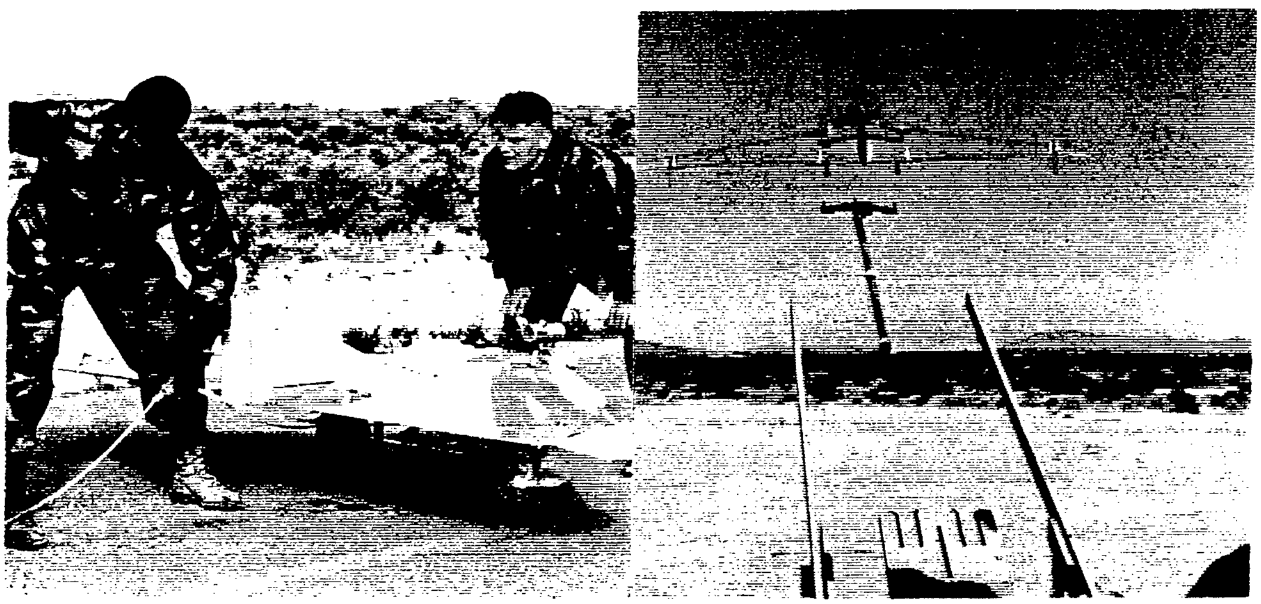


Figure 29 BQM-147A (EXDRONE)

USMC and USA units are being trained and equipped with BQM-147A systems. The goal of the demonstration is to assist in refining/validating CR UAV requirements and developing UAV command and control, airspace coordination, air tasking, and unit standard operating procedures.

Personnel from the 2nd Marine Division, 101st Airborne Air Assault Division and 24th Infantry Division have been trained and equipped with EXDRONE systems. Training is being planned and scheduled for the Army III Corps and 13th Marine Expeditionary Unit (MEU).

Based on user input and training experiences, several improvements have been made or are being developed for the system. These include:

- **Improved powerplant.** A new, more powerful engine and a more efficient propeller to improve climb performance at high altitude, temperature and weight are being evaluated.

- **Pneumatic launcher.** Five launchers were competitively procured from Continental RPV, of Barstow, California. Prior to procuring the launchers several vehicles were lost during bungi launches. The pneumatic launcher has simplied launching and, combined with the recovery parachute, deleted the requirement for a runway. The vehicle can launch from almost any open area and recover on any reasonably flat surface.

- **Parachute.** A safety of flight/recovery parachute is being procured. The launcher and parachute will negate the requirement for a prepared runway. The system will be able to take off and land in any open area.

- **Down looking camera system (DLCS).** Thirty air vehicles are being modified to accept a DLCS in addition to the forward looking camera. Experience has shown that this is much more effective for reconnaissance since the operator receives a "picture" from each camera, one for navigation and one for surveillance.

- **Low light payloads.** Image intensifying and FLIR payloads have been procured for integration and testing. Initial flight testing is scheduled for the 2nd quarter of FY93.

The demonstration has been successful, with units logging over 100 flights, 200 flight hours and participation in seven major exercises. EXDRONE has successfully followed convoys, provided route reconnaissance and been used to successfully adjust artillery fire. The units have begun standard operating procedures for air space coordination and communication procedures/requirements. The lessons learned have been used by the USMC to help refine the CR UAV requirement. The demonstration will continue through FY93. Units/Services that desire to maintain the systems after that may do so but will be required to fund the systems' operations and maintenance (O&M) costs.

The USMC UAV office is also working with the DEA to procure two fixed wing UAVs and one lighter than air system for evaluation. The goal of the project is to validate the concept of field agents using small UAVs for surveillance in counternarcotics operations. Testing is scheduled to begin the second quarter of FY93.

4. Pointer Hand Launched UAV System

Hand launched UAV demonstrations and evaluations continued throughout 1992. Using the FQM-151A Pointer UAV, the following activities occurred:

- An evaluation by the USA's 7th Infantry Division (ID) was completed.
- At the request of the USA's III Corps, a demonstration and evaluation program was initiated.
- An evaluation effort with the DEA was initiated.
- Demonstrations to various government agencies were conducted by DESA.

Pointer is an inexpensive battery powered UAV with both black and white and color camera payload capability. The air vehicle has a nine foot wingspan and is six feet long. Launch evaluation should be concluded by October 1993. The evaluation will also determine the utility of an autonavigation capability for this system.

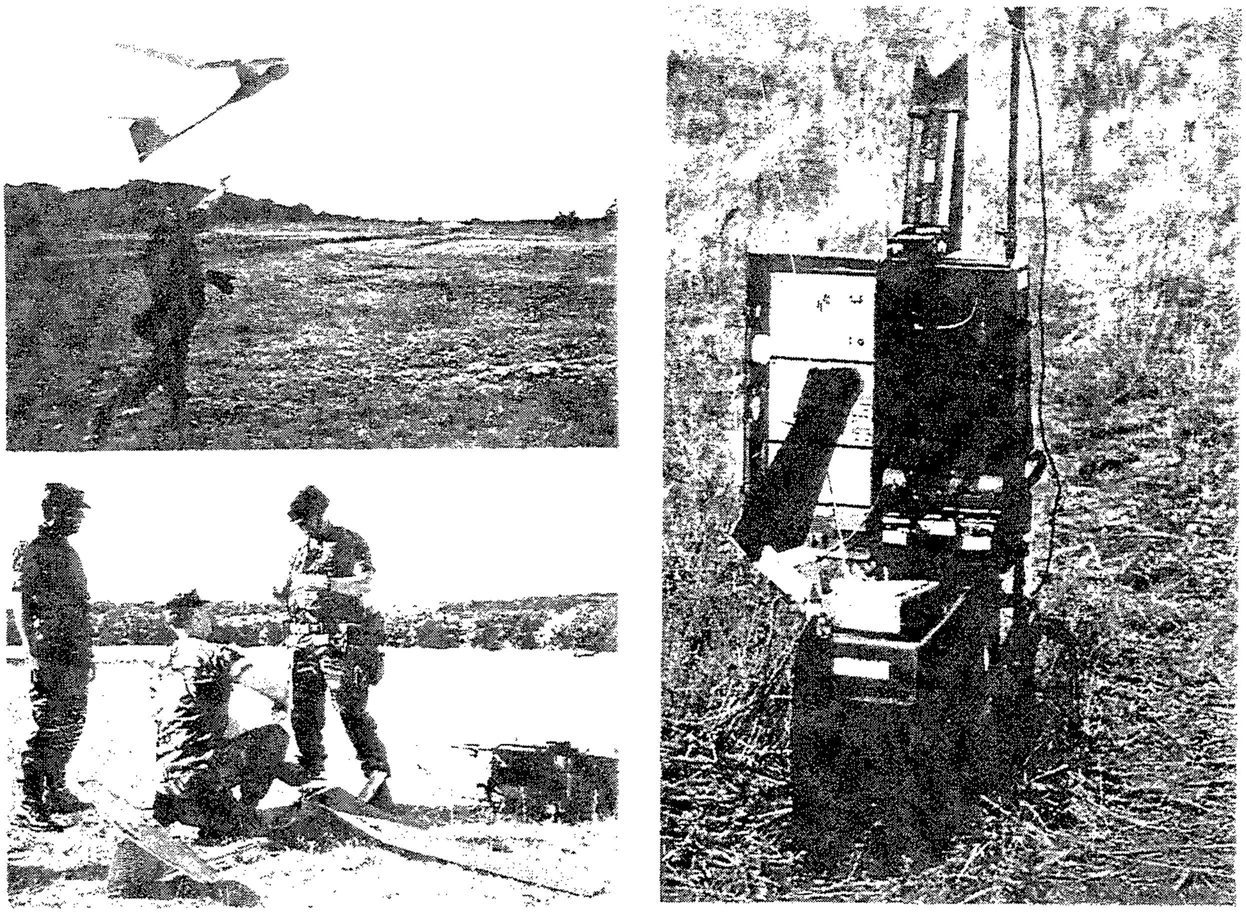


Figure 30 USA III Corps Hand Launched UAV Demonstration

5. Joint Precision Strike Demonstration

The UAV JPO is participating with the JPSD-TF in a demonstration program in which a UAV is used to decrease the time required to place weapons on a mobile target. The architecture to communicate, target and assess battle damage is presently being evaluated by a team of government laboratories, industry and military advisors. A UAV demonstration of non line-of-sight control and imagery dissemination is planned for September 1993. A memorandum of agreement (MOA) addressing future joint activities between the UAV JPO and JPSD-TF is in staffing.

6. Endurance

The Defense Support Project Office (DSPO) has the responsibility for satisfying the requirements of the Endurance MNS. At present there is no activity to consider a joint ORD for an Endurance UAV. The UAV JPO is involved in cooperative efforts with other Endurance

- **Improved powerplant.** A new, more powerful engine and a more efficient propeller to improve climb performance at high altitude, temperature and weight are being evaluated.

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- An evaluation effort with the DEA was initiated.
- Demonstrations to various government agencies were conducted by DESA.

Pointer is an inexpensive battery powered UAV with both black and white and color camera payload capability. The air vehicle has a nine foot wingspan and is six feet long. Launch weight is approximately eight pounds. Recovery is executed by a deep-stall maneuver to a soft landing in a flat altitude in restricted areas. Pointer can be prepared for launch by two people in less than five minutes. The air vehicle has a range of five km and a flight duration of over one hour.

The evaluation by the USA's 7th ID (Light) was conducted at Camp Roberts and Fort Ord, CA 6-14 January 1992 and at Fort Chaffee, AR 25 January - 10 February 1992. The operational test proved the potential utility of the Pointer UAV in support of light infantry operations and the 7th ID reported that Pointer works well as a capable reconnaissance, surveillance, and security asset. The 7th ID made several recommendations for modifications to the system and these were incorporated into a white paper (prepared by the UAV JPO) which discussed a notional hand launched UAV system.

The white paper on a hand launched UAV has been distributed to all the units which had evaluated the Pointer system, interested industry representatives, and selected training commands. The intent of the white paper is to elicit comments on the potential missions of a hand launched UAV and to begin the process of defining the characteristics of a system to conduct those missions. Potential missions include:

- Reconnaissance and surveillance
- Camouflage assessment
- Battle damage assessment
- Convoy route support
- Rear area security
- Target acquisition
- Communications relay (for an unmanned ground vehicle).

Target acquisition will require a GPS capability and communications relay capability requires the development of the payload.

On 10 May 1992, the Pointer system was demonstrated for the Commanding General of the USA's III Corps (see Figure 30). As a result of this demonstration, III Corps requested Pointer systems for a follow on evaluation to determine the utility of hand launched systems to support maneuver units. The system was seen as the lowest risk method of seeing over the next hill and getting the combat information required to focus combat power at the battalion, company, and platoon level. Two Pointer systems were refurbished, updated with second generation color cameras, and provided to III Corps in November 1992 for a four month evaluation.

In early November, 11 personnel from the Ist Cavalry Division were trained in Pointer operations. In mid November, the two systems successfully deployed with the Division to the National Training Center (NTC), Ft Irwin, CA during a one month user operational evaluation. A second deployment is now underway at the NTC. As a result of the III Corps demonstrations, the USA Training and Doctrine Command (TRADOC) has tasked the Armor School at Ft. Knox, KY to explore UAV concepts in the Combined Arms Battle Laboratory and develop a requirement for the limited fielding of a hand launched UAV capability.

A contract is presently in negotiation with AeroVironment to modify two Pointer systems with a GPS based autonavigation capability, second generation color cameras, and a pan and tilt capability for the camera system. These systems will be evaluated by the DEA. The evaluation should be concluded by October 1993. The evaluation will also determine the utility of an autonavigation capability for this system.

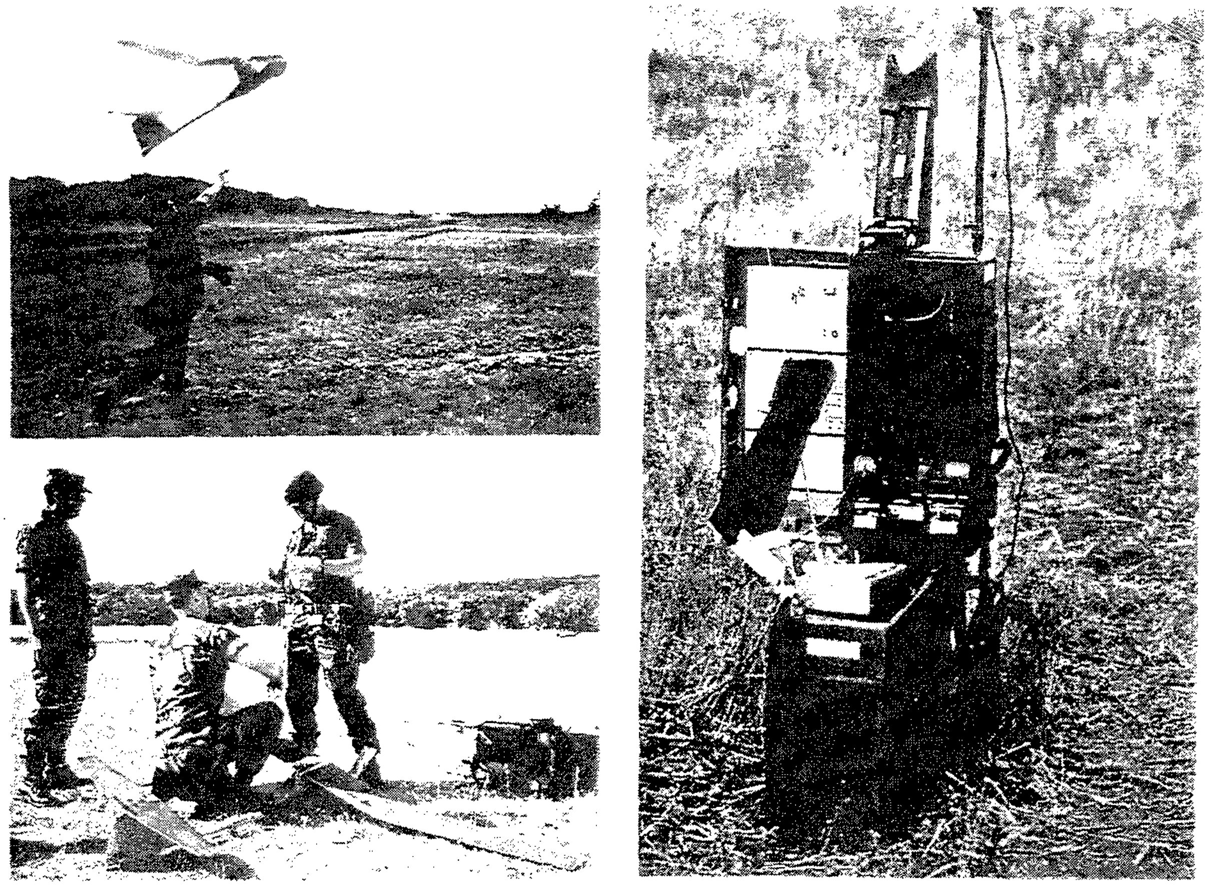

Figure 30 USA III Corps Hand Launched UAV Demonstration

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6. Endurance

The Defense Support Project Office (DSPO) has the responsibility for satisfying the requirements of the Endurance MNS. At present there is no activity to consider a joint ORD for an Endurance UAV. The UAV JPO is involved in cooperative efforts with other Endurance program initiatives, including the Strategic Defense Initiative Organization (SDIO) RAPTOR "Demonstrator" UAV program.

The RAPTOR "Demonstrator," (RAPTOR stands for Responsive Aircraft Program for Theater Operations) is being developed by Scaled Composites, Inc., under contract to the Lawrence Livermore National Laboratory for the SDIO. The RAPTOR is a high altitude, long endurance UAV platform; its mission is to carry sensors to autonomously detect and track launches of theater ballistic missiles (TBM) and then use TALON (TALON stands for Theater Applications - Launch on Notice) air-to-air missiles to kinetically destroy the TBMs. The "Demonstrator" provides a stepping stone in technology and capabilities toward an operational RAPTOR. The "Demonstrator" is a composite construction monoplane, powered by a turbocharged engine wingspan of 66 ft., and a gross weight of 1,800 lbs. It has a capability of carrying several hundred pounds of payload. Endurance is about two days at altitude. The program will commence flight test in summer 1993, leading to a kill demonstration of a SCUD-like high altitude TBM in 1995. Additionally, SDIO plans to demonstrate a solar electric UAV, called Pathfinder, for the same mission.

7. Relationship With Unmanned Ground Vehicle (UGV) Program

A MOA addressing possible working relationships between the UAV JPO and the Unmanned Ground Vehicles Joint Project Office (UGV JPO) has been drafted concerning areas of common interest between the two programs. The MOA should be signed by the fourth quarter of FY93. The intent is to enhance the coordination, management, and technical processes between two major players in the overall DoD robotics effort. The MOA would be applicable to common and complementary mission concepts, I&C of hardware and software, coordination of battlefield information, and, potentially, joint demonstrations of capabilities. Planning for an initial joint demonstration in the latter part of FY93 is underway.

8. Defense Evaluation Support Activity (DESA) UAV Efforts

The UAV JPO has established a MOU with DESA, Kirtland AFB, NM, to conduct joint UAV operations and systems evaluation efforts. DESA is an OSD activity, reporting to the Director, Test and Evaluation, that is chartered to provide a broad spectrum of test and evaluation (T&E) support to both DoD and non-DoD agencies. Primary objectives and goals concerning DESA support to the UAV JPO include:

- Consolidation of dormant UAV systems developed and owned by DoD such as Raven, Tern, EXDRONE, the SR losing contractor's system, and Amber.

- Development of an operations and technical maintenance capability to support UAV systems demonstrations and evaluations.

- Development of a T&E strategy and use of DESA's T&E capability and association with multiple government agencies (both DoD and non-DoD) to conduct timely evaluations of UAV systems and associated sensors for DoD and non-DoD mission applications.

- Provide a cost effective UAV support capability geared towards rapid evaluation of UAV systems and associated equipment.

During the past year DESA has provided or supported operational demonstrations of UAV capabilities using the Pointer UAV system for various government and nongovernment activities. In particular, a UAV evaluation effort has been established with the National Guard Bureau to evaluate UAV applications in both federal and state National Guard mission areas. Initial evaluation efforts are ongoing with the Pointer UAV in support of the Oregon National Guard. National Guard support is provided to many civilian agencies and this effort provides an excellent opportunity to identify and assess civilian applications of UAVs and to establish baseline data on the UAV JPO's hand launched UAV concept. Additionally, DESA is working with local, regional and national FAA elements to address airspace management and safety certification processes for UAV operations in both military and civilian applications.

VI INTEROPERABILITY AND COMMONALITY (I&C)

The modern battlefield environment, within which UAV systems must operate over the next decade, is complex and will involve combined forces from various Service elements. The UAV JPO strategy recognizes that UAV system I&C is basic to the successful acquisition of a family of affordable and operationally effective UAV systems. Interoperability is defined as 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. Commonality is the ability to identify and capitalize on opportunities for savings and efficiencies through the use of common systems, subsystems, and components within the UAV family and with other DoD programs. Interoperability is an operational requirement, while commonality is a life cycle cost decision. I&C concepts which shape the UAV JPO program are:

- UAV systems must be designed to fit into Service C^3I architectures and with other UAV systems to be used effectively in multi-Service and Unified and Specified Command operations.
- UAV systems have many common functions and should share as much common equipment and associated software as is practical to reduce life cycle cost and simplify logistics support functions.
- UAV systems must allow for growth in performance and readily accommodate new component technologies to have long term utility in the field.

These concepts require a disciplined system engineering approach to the acquisition and fielding of a family of affordable and operationally effective UAV systems. The elements of this approach are illustrated in Figure 31 and described subsequently.

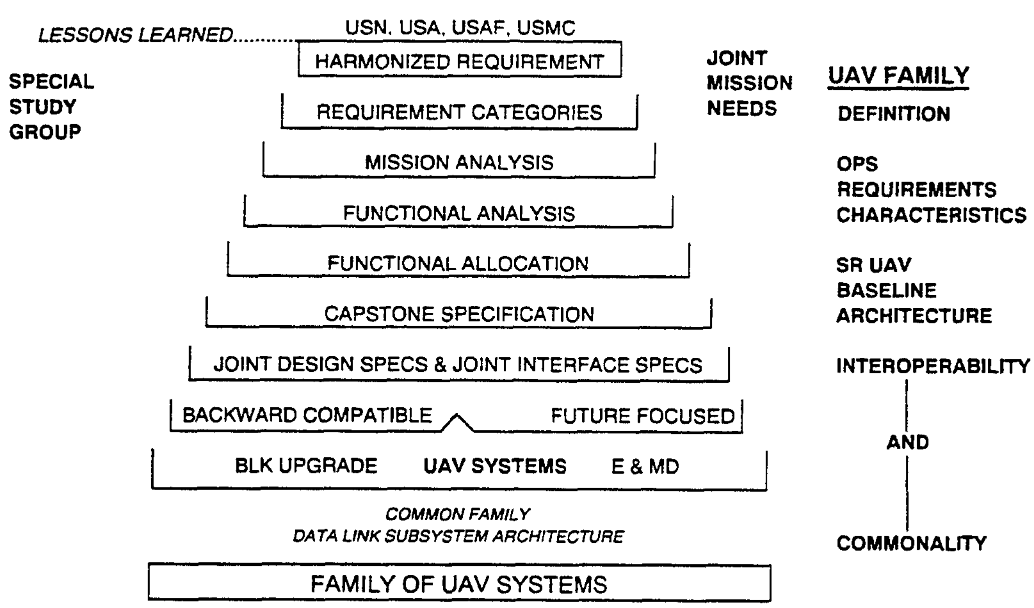

Figure 31 Requirements Based Approach to UAV Family Design

The challenge of implementing interoperability is designing systems that are both interoperable with each other and with future systems when fielded. A feasible solution to this challenge is the development of JII specifications as described further. Even though the UAV JPO is concentrating on interoperability, the necessity to employ open system architectures is acknowledged. While all aspects of an open system architecture are not necessary to achieve interoperability, it provides a number of benefits including: regular and rapid infusion of technology, increased numbers of potential suppliers, availibility of modular/adaptable designs, and lower costs due to competition. The UAV JPO will employ open system architecture standards that enhance competition and reduce dependence on vendor specific proprietary designs.

A. ARCHITECTURE CONTROL

The elements of architecture control are to:

- Establish a common UAV system design architecture and develop a "capstone specification" using the winning SR UAV system design as a developmental baseline.

- Standardize and control a requirements based set of subsystem operating interfaces through the use of JIIs. Develop appropriate design guidelines.

- Develop an interoperable data link subsystem architecture for the UAV family to ensure communications connectivity.

- Establish a library of common/reusable software utilizing SR UAV software as the baseline.

A Joint UAV Steering Committee, chaired by the UAV JPO, has been established to review and control joint architecture and interoperability initiatives.

The capstone specification is a UAV JPO document that defines the requirements for the family of UAVs. The capstone requirements were derived from the MNSs and ORDs for the members of the UAV family. The capstone specification serves as the top level UAV JPO document to ensure consistent flow down of requirements to specific UAV systems and provides the basis for development of a particular UAV system specification. It defines the system architecture, family members, functional allocation, interfaces, top level design practices, interoperability and commonality, and will be released in FY93.

Once the architecture is established, it is also essential that UAV systems interoperate with communication systems. All UAV GCSs should be able to control, receive and exploit mission data from, different air vehicles regardless of the system mix.

It is essential that UAV systems interoperate with each other. All UAV GCSs and shipboard control stations should be able to control, and receive and exploit mission data from different air vehicles, using a common and interoperable data link, regardless of system mix.

- The January 1993 CSC reviewed and discussed data link alternatives for all UAVs and it was decided that the existing SR data link was acceptable to all Services and would be used as the primary data link for all UAVs (with the exception of the MR which uses the common data link [CDL] standard) and all UAV control/receiving terminals, including shipboard terminals and any potential VTOL UAVs. This decision was endorsed at the subsequent DAB.

- Growth data link - As new UAV mission requirements are identified and the growth data link issues addressed, a key UAV JPO objective is to minimize the number of new data links required as a result of the UAV integration into the Services' force structure. Therefore, the UAV JPO is evaluating the existing data links of the Services' C^3I systems for possible co-use as UAV data links. This is challenging since such a data link must first be interoperable with the SR baseline system, and all subsequent UAV systems including CR and future VTOL and Endurance. An initial study indicates that scaled down and low cost versions of the CDL could have potential for use for UAVs. Cooperative UAV JPO/Program Executive Officer, Intelligence and Electronic Warfare (PEO[IEW]) evaluation of a prototype low cost, CDL, air data terminal (ADT) to assess integrated system functionality is planned in 1993. Assuming the concept of low cost and lightweight CDL is proven, it could be added to the family baseline architecture during future block upgrades. Development of a family data link architecture incorporating the SR baseline data link and the CDL as selectable primary and alternate links could provide the needed communication network for the internal interoperability within the UAV family as well as external interoperability with the Services' battleforce/C^3I systems. A notional design concept of UAV family data link interconnectivity is shown in Figure 32.

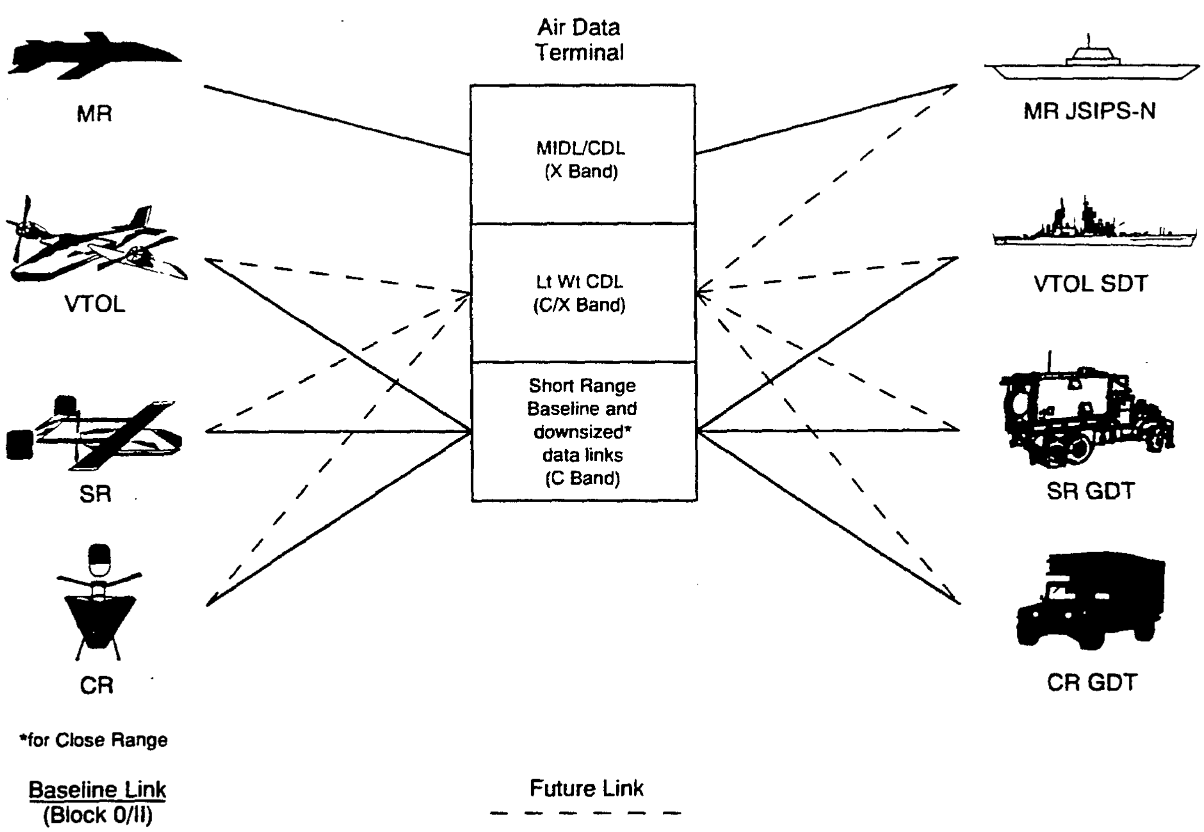

Figure 32 Notional Concept of UAV Family Data Link Interoperability

B. INTEROPERABILITY

To achieve I&C, UAV systems must be integrated in a manner which provides functional interfaces between systems, subsystems and components of the UAV family. The UAV JPO concept of a UAV family architecture accommodates off-the-shelf equipment and future insertion of advanced technologies. A system engineering and integration agent (SEIA) maintains all system and subsystem interfaces, interface control documents, and specifications to ensure effectiveness, block upgrades and interchangeability of systems and subsystems. JIIs are being developed and verified in accordance with the Figure 33 schedule.

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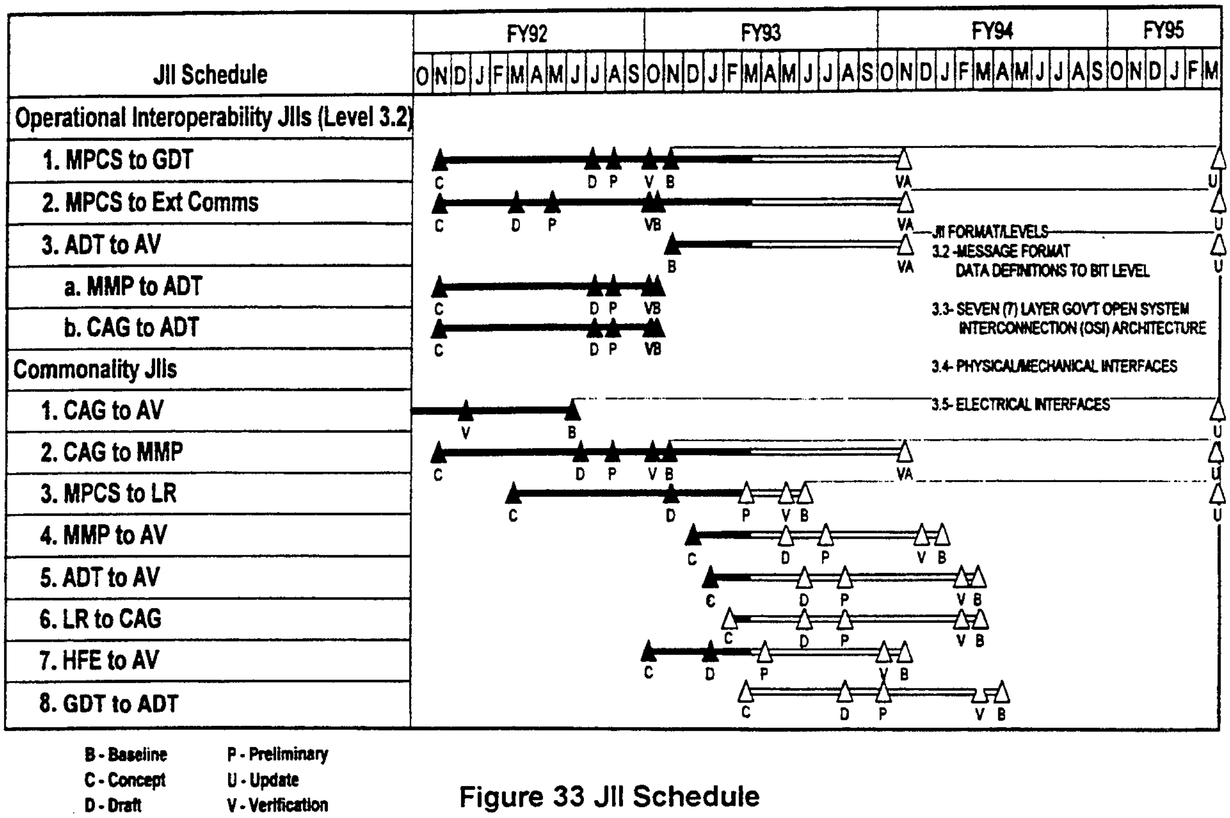

Figure 33 JII Schedule

JIIs provide the architecture and interface framework required to ensure I&C. A JII consists of appropriate UAV SR Block 0 interface control document (ICD) parameters plus upgrades based on new or state-of-the-art technologies. Maximum design flexibility will be incorporated in each JII in order to accomodate new technologies. Each JII, as its specification is developed, is verified for functional integrity and performance at the UAV JPO JII JDF. JIIs will also be validated for functional performance with UAV hardware at the JTC/SIL. JDF and the JTC/SIL capabilities ensure successful implementation of JIIs and achievement of I&C objectives for the family. The description of each JII is presented below:

Operational Interoperability JIIs

1. **MPCS TO GDT** - This JII is required to permit the control of any air vehicle and its payload from any family ground control system and to enable the use of a family of data link subsystems for the UAV. This JII is an essential ingredient of operational

interoperability because it provides the description and signal definition of all the inputs and outputs to the data link subsystem. By conforming to this interface, ground systems can interface with any air vehicle via the appropriate data link.

2. **MPCS TO EXTERNAL COMMUNICATIONS** - This JII is required to permit communications to and from the UAV ground component and the external command and control nodes. This has been deemed an operational interoperable JII because the operational tasking and coordination required before handover is accomplished over this interface.

3. **ADT TO AIR VEHICLE** - (Avionics and payloads) - This JII is the airborne equivalent of the MPCS to GDT JII. It defines the interface between, the airborne data link component and the airborne subsystems (i.e., the MMP, air vehicle and common avionics group [CAG]) to allow control of the air vehicle and the MMP. This JII comprised of two separate interfaces; the ADT to CAG and the CAG to MMP. Navigation, mission programming, air vehicle control and payload control are accomplished on this interface.

Commonality JIIs

1. **CAG TO AIR VEHICLE** - The forward focus portion of this JII has been generated and verified. This JII should be modified to include backwards compatibility with the selected SR system. The necessary interface control documents to accomplish this were generated by the SR contractor as a result of the SR functional configuration audit. This JII can also be updated to include the physical interfaces when a common component is identified.

2. **CAG TO MMP** - This JII, which was verified in November 1992, will contain the messages required to allow the use of payloads developed by a UAV system throughout the UAV family.

3. **MPCS TO LAUNCH AND RECOVERY (COMMON AUTO RECOVERY SYSTEM)** - This JII is primarily associated with the automatic recovery of the UAV. The positional and velocity information of the air vehicle and the recovery platform measured by the precision tracker in the recovery system is routed over this interface to accomplish automatic recovery. This JII has been classified as a commonality JII because it will document the interface between the ground component of a common recovery system and the control station.

4. **MMP TO AIR VEHICLE** - This is a physical interface which will document for all vehicles the size, space, weight, moment, electrical and power limitations for the UAV. The purpose of this interface is to permit the design of MMPs which can be utilized in any air vehicle or in selected combinations of air vehicles.

5. **ADT TO AIR VEHICLE** - This is a physical interface which will document the UAV family physical requirements for the airborne element of a common data link. This JII will facilitate the design of a common datalink by listing the size, space, power, weight, antenna locations, etc., available in the air vehicle.

6. **LAUNCH AND RECOVERY TO CAG (AIRBORNE RECOVERY COMPONENT)** - Documentation of this interface will enable the precision tracking system in the launch and recovery system to operate exclusive of the data link. Positional and velocity information generated in the precision tracker will be routed directly to the CAG (autopilot/automatic flight control) via this interface. This JII is required if the implementation of the autoland function will utilize the autoland precision tracker as the means of communicating uplink data to the air vehicle.

7. **HEAVY FUEL ENGINE TO AV** - This interface will document the entire interface between the common heavy fuel engine and the air vehicle including engine controls and status as well as physical and mechanical interfaces. The purpose of this interface is to permit the development of a family or a set of engines which could be used through the UAV family.

8. **GDT TO ADT** - This JII will be generated when the UAV data link requirements/ capabilities are finalized. When the frequency band, type of modulation bit error rate, power, sensitivity and other physical attributes are determined, then development of this JII can begin.

C. COMMONALITY APPROACH

The key elements of the UAV JPO commonality approach are:

- Consider use of existing UAV system components and software modules when formulating development options for new UAV capabilities. The CR UAV development (and future VTOL and Endurance UAV developments) will maximize use of SR UAV components and associated software.
- Develop a commonality plan which defines the UAV JPO approach for phased implementation of commonality within the UAV family. Particular focus is on developing state-of-the-art components which support common UAV system function, (e.g., avionics, engine, etc) and on payload components (e.g., sensors, communication relays, etc.).
- Develop a software reuse plan that minimizes software development and support costs.

D. UAV/CRUISE MISSILE INTEROPERABILITY

The UAV JPO strategy for ensuring I&C must include a complete understanding of the employment or joint concept of operations for all UAVs. The UAV JPO has undertaken as a strategic goal the coordination of a joint concept of operations with cruise missiles. This will be be accomplished through close coordination with the individual Services and joint commands in order to understand their specific requirements, C^3I architecture, user vs payload(s) requirements, and operational doctrine. This joint concept of operations will form the basis for identifying upgrade priorities and demonstrations, and be a common ground for discussing UAV operations and interoperability initiatives and issues. It will also be the top level guidance for identifying and developing the critical interface requirements to joint and individual Service architectures, and will be the basis to define demonstrations designed to lessen the risk in introducing new technologies or payloads. Finally, it will be a fluid document that will incorporate lessons learned as they become available.

The plan for FY93 is to define a baseline joint concept of operations and define initial demonstrations that can validate this initial understanding. FY94 will further validate the joint concept of operations through field tests with existing systems and available payloads to identify interoperability and architectural interface issues.

E. JOINT DEVELOPMENT FACILITY (JDF)

The JDF is chartered by the UAV JPO to verify JIIs used in UAV systems. The JDF provides a "closed loop" simulation of a generic UAV system.

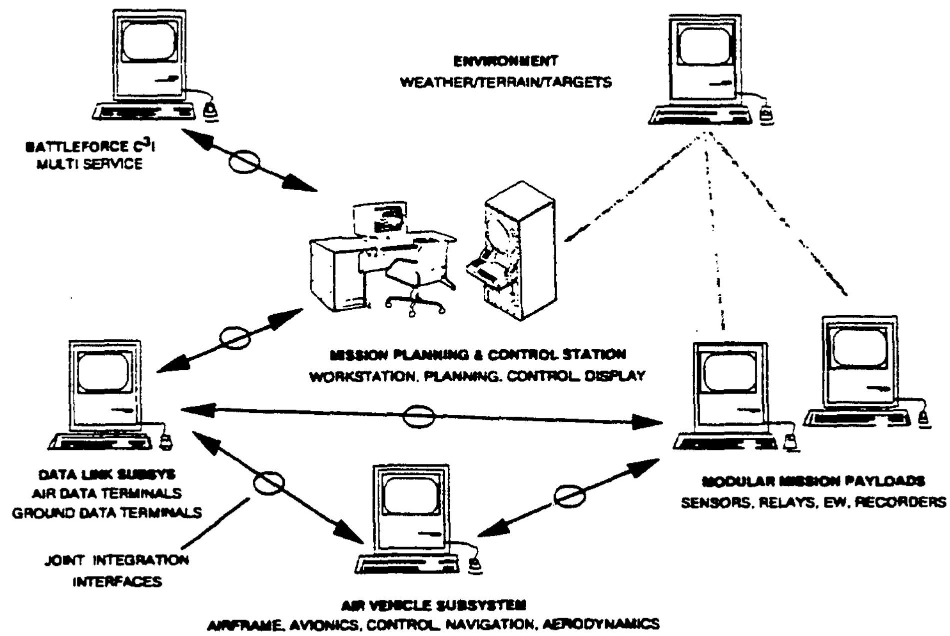

Figure 34 Joint Development Facility

The system simulation architecture is based on the capstone specification, UAV family specifications, UAV family concept of operations, and technology inputs (e.g., existing, planned or emerging components). The JDF will be accredited in FY93. Accreditation verifies that the simulation represents a working UAV and meets the family system architecture requirements. The simulations are real time man-in-the-loop tests representative of the mission requirements of the UAV design under test. Each UAV subsystem/component is normally represented by a simulation and/or hardware interface module. Component simulations may also be replaced by an actual UAV component, such as the workstation shown in Figure 34, to verify component functionality. The JDF is being moved to Redstone Arsenal, AL and will become a part of the JTC/SIL.

F. JOINT TECHNOLOGY CENTER AND SYSTEM INTEGRATION LABRATORY (JTC/SIL)

The JTC/SIL (located at Redstone Arsenal, AL) is the UAV JPO bureau of standards/test bed for the family of UAVs. It is an integral part of the UAV JPO systems engineering process, which defines the functional characteristics of system hardware, software, facilities, etc., and translates them into design requirements during the life cycle of the UAV systems. Under the direction of the UAV JPO, the JTC/SIL management is responsible for staffing, training of staff, scheduling of activities, selection of required MICOM's Research, Development and Engineering Center (RDEC) and other activities, hardware and software resources, and management of funds provides by the UAV JPO. It also reports to the UAV JPO in accordance with the approved plan of actions and milestones.

The SIL facilities in FY93 are shown in Figure 35. It consists of a life cycle software engineering center (LCSEC), a test bed (TB), support laboratories, and a communication gateway to various noncollocated laboratories, test sites, and other system developers. The LCSEC includes the JDF, which provides a "closed loop" simulation of the UAV system based

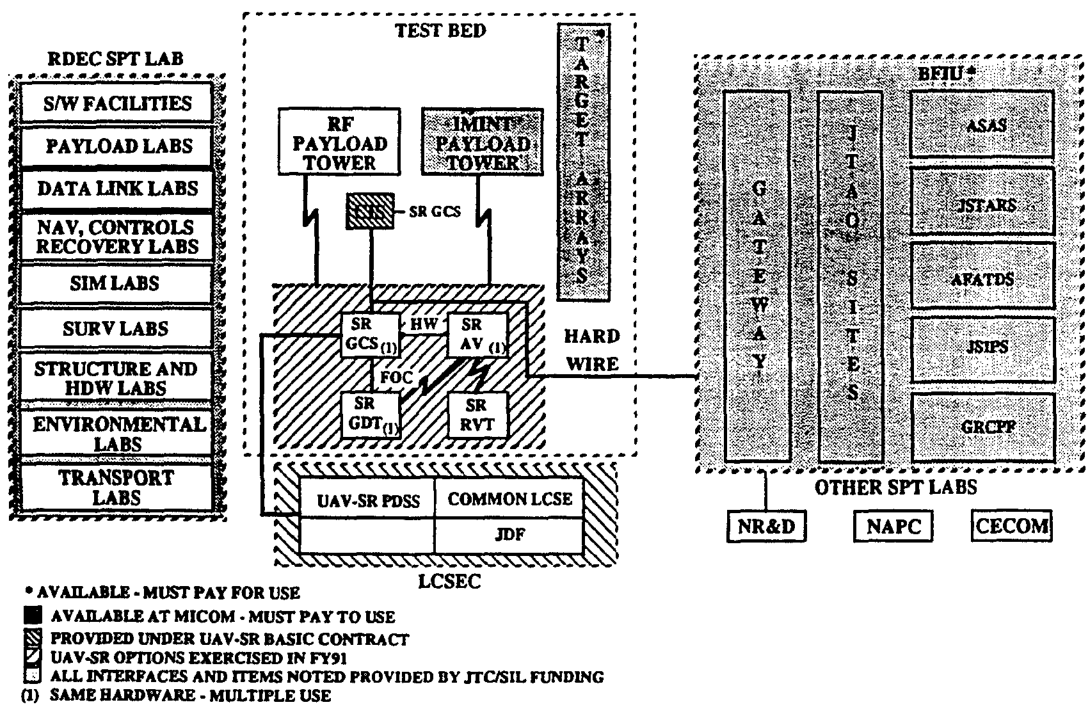

Figure 35 UAV JTC/SIL Facilities

on concepts of operations from each UAV program and a common life cycle software environment (LCSE) which provides the environmental input to the post development software support facility which will have a unit provided for each system. The JDF functions will become part of the LCSE when the LCSE is complete. The LCSEC is connected to the test bed which will include in FY93 SR UAV hardware, a communications integration simulator which operates as a surrogate tactical operation center, an imagery intelligence (IMINT) payload tower, a radio frequency (RF) payload tower, and target arrays. The test bed is connected to a gateway which provides connectivity to the system developers and external laboratories shown in

Figure 35 and all the sites shown in Figure 36.

Figure 36 Interoperability Testing Sites

The MICOM RDEC support laboratories shown in Figure 35 are also available to the SIL on a pay for use basis. CR UAV hardware and post development software support facilities will be added as they become available.

The SIL provides facilities for complete simulation of hardware in-the-loop evaluation of UAV systems and integrated UAV hardware and software elements. I&C can be validated and hardware and software baseline configurations of field systems can be established. The JTC/SIL also performs independent varification and validation of resident UAV system software and hardware during the development phase of programs and provides post development software and hardware support to the UAV project managers. The facility permits the integration of new technology as it becomes available. Battlefield/battleforce communication and data distribution systems can be developed, verified, and validated. The JTC/SIL also provides a capability for industry to demonstrate the application of new hardware and software in existing UAV systems.

VII TECHNOLOGY

A. OVERVIEW

The cornerstone of the UAV JPO technology strategy is to capitalize on related development activities by the Services and other agencies and to integrate off-the-shelf equipment to provide advanced capabilities for new UAV systems and upgrades to fielded UAV systems. Only to a very limited extent is the UAV JPO resourced to conduct technology development. And this occurs only when it addresses applications that are truly unique to UAVs. Five elements compose the technology strategy:

1. Collaborate with ARPA and Service laboratories to identify and coordinate UAV related technology development efforts.

A Joint Technology Steering Committee (JTSC), chaired by the UAV JPO, with ARPA, NSA and Service laboratory membership, has been formed. The function of the JTSC is to identify, monitor, and coordinate UAV related technology development efforts and to provide advice on UAV technology matters. A MOU between ARPA and the UAV JPO dealing with UAV related technology is being established. For UAV systems, the JTSC provides a coordinated input to the UAV JPO and ARPA Advanced Technology Plan.

2. Collaborate with government and industry to identify opportunities to evaluate component technology for common application to the family of UAV systems.

MOUs are being established between the UAV JPO and NSA, and the UAV JPO and PEO (IEW) for coordination of SIGINT ESM technology applications. The UAV JPO utilizes the Association for Unmanned Vehicle Systems (AUVS) and briefings to professional societies as forums for government and industry information exchange.

3. Conduct laboratory experimentation to determine maturity and feasibility associated with integration of developing UAV component technologies.

4. Demonstrate and evaluate matured UAV component technologies to determine suitability, effectiveness and risk associated with application to UAV family requirements.

5. Transition component technology to UAV systems in the form of low risk specifications derived from UAV JPO technology performance evaluations.

B. PAYLOADS

Multi-mission payloads provide UAV systems with the capability to perform their assigned functions such as RSTA, EW, and communication relay. As the UAV project progresses and technology advances, the Services will call on the UAV family of systems to perform these functions in support of their missions through employment of various mission payloads. The Services' needs will determine payload priorities for development and integration into UAV.

The following provides discussions of a number of UAV payload related technology activities that are resourced by a variety of Service and other agency sponsors (other than the UAV

JPO). The UAV JPO is monitoring and coordinating these efforts for potential future UAV applications. Development test results will be analyzed to assist in UAV mission payload definition and to develop specifications for future potential transition into the UAV family of systems.

1. **MOVING TARGET INDICATOR (MTI) RADAR** - This effort addresses a 100 lb class moving target indicator (MTI) radar payload for both the SR UAV and any future VTOL UAV. Recent experiences in the Gulf War proved the operational utility of the joint surveillance target attack radar system (JSTARS), which can provide a large surveillance picture to the theatre and Corps/Division commanders in support of interdiction and precision strike missions. A UAV MTI radar could complement the JSTARS by providing surveillance over the blind spot due to shadowing or by concentrating on regions of immediate concern to the lower echelon commanders. The UAV MTI radar should be able to detect and automatically track many moving targets, and classify moving vehicles. In addition, it is desirable to incorporate a spotlight mode synthetic aperture radar (SAR)/inverse synthetic aperture radar (ISAR) on the MTI to detect stationary targets by highlighting a small selected area at a time. Finally, the UAV MTI radar could be used for surface search over sea, to track ships formation, while the ISAR mode can be used to highlight individual ships for target identification. The USA UAV TRADOC system manager (TSM) at Ft. Huachuca, AZ is currently evaluating a prototype NDI MTI radar in FY93 to further refine USA's requirements. The UAV JPO started a technology assessment and requirements study in FY92 and will develop a specification in FY93.

2. **SIGNALS INTELLIGENCE (SIGINT)** - This effort addresses a UAV SIGINT capability for the SR UAV and the rest of the family of UAVs. A UAV communications intelligence (COMINT) system would be capable of intercepting and locating enemy communications in support of US forces on land or at sea. The UAV COMINT could also provide non-obtrusive monitoring of potential adversaries in peacetime. A UAV ELINT system capable of intercepting and locating enemy radars could provide information concerning to the enemy's electronic order of battle. The developed threat emitters data base could then be used to conduct suppression of enemy air defense (SEAD) campaigns. If resourced, a family of common hardware and software modules could be developed. Using common modules, a UAV COMINT/ELINT mission payload could be reconfigured for each category of UAV based on the mission needs. Initially, a COMINT and a ELINT payload will be considered for the SR UAV. Through P^3I, additional modules could be developed in the future to provide a more capable SIGINT payload suitable for any future endurance UAV. The Joint Electronic Warfare Center (JEWC) at San Antonio, TX is currently planning to procure both a prototype COMINT and ELINT payload for flight test and evaluation in FY93. The result of the test will aid the USA UAV TSM to further refine its SIGINT requirements. The UAV JPO will conduct a technology assessment and requirements study in FY94, and a specification will be generated in FY94.

3. **LASER DESIGNATOR** - A laser designator boresighted to a FLIR performs accurate ranging and target designation for precision guided munitions. An NDI

derivative of the AQUILA's FLIR/laser designator was installed on the UH-1N helicopter and performed successfully during Desert Storm. If resourced, this effort would procure a laser designator and integrate it into the SR UAV for evaluation, test and verification of the UAV integration interfaces. The UAV JPO plans to start a requirements analysis and develop a specification in FY95.

4. **METEOROLOGICAL (MET) SENSOR** - This effort addresses a lightweight UAV meteorological (MET) payload for the family of UAVs. The MET payload would measure the temperature, humidity, and atmospheric pressure, and would contain software for computation of wind velocity using the UAV's navigation data. Three dimensional weather data could be extrapolated from the atmospheric conditions at the UAV flight altitude to surface conditions. The UAV MET payload could provide data for a wide range of applications to include delivery and use of battlefield obscurants, artillery fire adjustment, smart munition performance prediction, and weather forecast to aid aviation flight safety and support operational planning. The USA Atmospheric Sciences Laboratory (ASL) developed and demonstrated a small, lightweight MET sensor in FY88. The UAV JPO intends to initiate a requirements study of the MET sensor for the family of UAVs and subsequently develop a specification for a common MET sensor in FY94.

5. **LIGHTWEIGHT COMMON FLIR** - A FLIR is the primary imaging sensor for the UAV in performing RTSA functions. Recent advances in FLIR technology allows better sensitivity and greater resolution, resulting in improved performance. In addition, multispectral coverage will improve target detection capability and aid automatic target recognition/cueing. Three lightweight FLIR payloads (fifty lbs) have been evaluated as part of the CR UAV technology demonstration. The UAV JPO will define a UAV lightweight common FLIR payload for the family of UAVs in FY93, employing the USA baseline concept of common FLIR modules. A plan for future advanced technology insertion, (i.e., automatic target recognition/cuing, multispectral sensor) will be incorporated into the design.

6. **MULTICHANNEL UHF/VHF COMMUNICATION RELAY** - This effort addresses a UAV communication relay capability for the family of UAVs. The relay system would provide range extension of communications and overcome horizon limitations. It would enhance command and control of forces operating over a wide geographical area. The USA desires a UHF/VHF relay capability for SR. The USMC has a requirement for a five channel SINCGARS (VHF) relay, while the USN is looking for a four channel VHF/UHF relay. The Naval Command, Control, and Ocean Surveillance Center has built and demonstrated a lightweight miniaturized four channel UHF relay. If resourced, the UAV JPO plans to develop a lightweight miniaturized five channel VHF/UHF relay to satisfy immediate needs of the Services. The prototype payload integration and testing is planned to begin in FY95.

7. **MINE-COUNTER MEASURE (MCM)** - This effort addresses two MCM payloads that are being developed by the USA and USN. The land mine countermeasure payload can detect/map individual land mines or patterned minefield, while the amphibious mine countermeasure payload can detect/localize the mines in the surf

zone/shallow water. Both technologies were demonstrated at Ft. Hunter Ligget, CA in 1991. The USA standoff mine detection system is scheduled to go into the demonstration and validation phase in FY93, and the USN's UAV mine countermeasure payload advanced technology demonstration program will start in FY94. If resourced, integration of the land mine payload into the SR UAV is planned to begin in FY96.

8. **ELECTRONIC COUNTERMEASURES (ECM)/DECOY** - This effort addresses ECM/decoy payloads for the family of UAVs. The UAV ECM system could disrupt/harass/deny operation of the enemy's communications/radars. The UAV decoy could perform the countertargeting mission through deception. The UAV JPO integrated a SSQ-95 active electronic buoy (AEB) into the MAVUS for sea trials on USS Doyle in FY91. The JEWC is currently procuring four EW payloads for flight test and evaluation in FY93. These four EW payloads are: very high frequency (VHF) noise jammer, high frequency jammer, VHF frequency hopping jammer and radar jammer. The result of the JEWC's EW payloads evaluation will aid the USA TSM toward refining the UAV EW requirements. The UAV JPO plans to start a technology assessment and EW requirements analysis in FY94.

9. **CHEMICAL AGENT DETECTION** - This effort addresses a UAV chemical agent detection payload. This payload uses an interferometric IR sensor to analyze chemical agent clouds. It would provide a standoff capability in alerting military forces of chemical munition events. The Army Chemical Research, Development and Engineering Center has been pursuing a chemical agents detection technology demonstration program since FY91. A prototype will be test flown in FY93. The UAV JPO will initiate a chemical agents detection payload requirements analysis in FY95.

10. **RADIOACTIVITY DETECTION, INDICATION and COMPUTATION (RADIAC)** - This effort seeks to develop a radiation fallout detection payload for the family of UAVs. This payload would detect nuclear fallout patterns on the ground from altitude and map the contaminated areas on the battlefield in real time. The USA Communications and Electronics Command (CECOM) Laboratory has modified the ground portable RADIAC sensor (AV/VDR-12) for airborne application. A prototype was demonstrated on an OH-58 Kiowa Warrior aircraft in FY91. The UAV JPO plans to start a UAV RADIAC payload requirement analysis in FY96.

11. **MULTIFUNCTION RF SYSTEM** - This effort addresses an advanced payload that would increase UAV mission flexibility and contribute to air vehicle survivability by performing a variety of tasks associated with RF transmission, reception, and signal processing. These functions include air vehicle navigation, terrain avoidance, radar altimeter, mid-air collision avoidance, and telemetry data link, etc.; all performed by several standard "building blocks", and under advanced microprocessor control for easy reconfiguration. It would incorporate the latest low-probability-of-intercept/detection and anti-jamming technology. It is envisioned that future UAVs could be equipped with two or more of these multifunction RF systems, thereby providing redundancy and simultaneous system operation in several modes/functions. This multifunction RF system would increase the future air vehicle function's redundancy, improve its reliability, and enhance its mission

effectiveness. If resourced, this effort will begin with system definition and demonstration phase in FY96, and result in a specification by FY98.

12. **MULTIMODE/MULTIFUNCTION EO/IR SENSOR SYSTEM** - This effort addresses an EO/IR sensor system which would provide multiple modes of operation and/or multiple functions, including sensor cross-cueing and sensor output correlation to: (1) reduce susceptibility to enemy countermeasures; (2) increase overall sensor effectiveness and mission flexibility; and (3) reduce overall size, weight and power requirements through use of common electronics, shared apertures, etc. A multimodal system could incorporate a generation (GEN) FLIR, a GEN III LLLTV, and a CO2 laser radar, and/or an IR line scanner for wide area search. Such an advanced payload would provide potential air vehicle weight savings, reduced logistics requirements, and enhance operational mission effectiveness, while reducing ownership cost through commonality implementation. If resourced this effort will start with system definition and demonstration in FY96, and result in a specification in FY98.

13. **SELF PROTECTION RADAR WARNING RECEIVER JAMMER/DECOY PAYLOAD** - This payload is needed to improve survivability of future UAVs in a hostile and saturated air defense environment. This system would operate in several modes by providing for: radar/missile warning, defensive self-screen jamming, and electronic decoy functions. This effort would integrate capabilities of several separate EW avionics systems into an affordable package which is within both size and weight constraints of the UAV. This advanced payload could become part of the standard avionics suite to be carried onboard all future UAVs to increase their combat survivability. If resourced, this effort will start system definition and demonstration in FY97, and result in a "B" Level specification in FY98.

C. ENGINES

The UAV JPO's heavy fuel engine program provides the technology base for lightweight, fuel efficient engines capable of burning multiple military supportable fuels (JP-5, JP-8, and diesel). Three contractor engine designs are being tested by NAWC-AD Trenton:

- A lightweight two cycle, two cylinder liquid cooled reciprocating engine by Southwest Research Institute (SRI)
- A liquid and air cooled, single rotor Norton rotary engine by AAI, and
- A liquid cooled, single rotor Wankel rotary engine by Defense Group Industries (DGI).

These engines achieve heavy fuel capabilities through advances in specific technology areas of: high speed direct injections, combustion/thermodynamics characterization, cooling techniques, control parameters definitions, and engine control methods. Test results have been promising. All the engines have met two or more of the established program goals; i.e., power density, operability, and brake specific fuel consumption. Testing will be completed by mid FY93 and a performance specification based on the results will be prepared.

Future potential efforts, if resourced, include:

- A 30 lb engine demonstration. This effort would exploit advanced technologies, leading to a very small multi fuel engine suitable for UAVs.

- A common modular engine demonstration. This effort would investigate advanced technologies that are applicable to modular, high power duty cycle, multi fuel engines consisting of 100 horsepower modules that could be assembled into 100 to 300 horsepower engines.

D. AVIONICS

The UAV JPO is monitoring the USN/USAF Joint Integration Avionics Working Group (JIAWG) efforts for applicable technology transfer. The fault tolerance, modularity, and performance of the JIAWG products have been incorporated in the recently completed UAV modular integrated avionics group (MIAG) specification.

E. LAUNCH AND RECOVERY

The UAV JPO continues to evaluate automated recovery system technology for the family of UAVs, and is developing the common automated recovery system (CARS) specification (CARS) for the SR and CR UAV systems. A performance specification is near completion. A request for information on automated recovery systems which meet, or have the potential to meet, UAV family requirements has been published in the Commerce Business Daily. Responses from industry will provide the Government an idea of technologies that meet the UAV family requirements and automated recovery systems that have been demonstrated.

A portable, millimeter wave tracking radar technology which has potential of meeting the common automated recovery system requirements was successfully demonstrated with the MAVUS system in July 1992. This automated recovery system was designed and developed by Sierra Nevada Corporation (SNC). It consists of a tracking subsystem, an airborne subsystem, and a recovery control module. A total of eight automated recovery flights was performed at Ft. Sill, OK. All landings had dispersions of less than a foot from the designated touchdown point. Dornier has successfully demonstrated an automated recovery system on the moving platform using laser tracking technology in December 1991. This automated recovery system consists of a laser tracker, precision altimeter and laser reflectors, and recovery control equations. More than six automated recoveries have been demonstrated with a drone helicopter in support of NATO PG-35 efforts. All landings were within a one meter square area. Since both SNC and Dornier autoland systems have been demonstrated in a benign environment, additional automated recoveries in a shipboard operational environment are required to reduce technical risks. Such a demonstration will be conducted as part of the VTOL Tech Demo program.

F. MISSION PLANNING AND CONTROL

See Section V for CR and VTOL discussions of downsizing and interoperability initiatives involving the SR MPCS and its associated software.

VIII ANALYSIS AND SIMULATION

The UAV JPO has initiated an effort to develop a UAV simulation environment that will assist in the design and test of UAV systems and subsystems. The goal is to reduce both acquisition costs and time to system fielding. This environment, created from the high fidelity engineering level models developed for the JII process and the distributed simulation project begun in 1992 with ARPA, will combine state of the art engineering case tools with requirements tracing software and distributed simulation technologies such as the ARPA initiated Synthetic Environment Requirements Concept Evaluation and Synthesis (SERCES). The end result will be an environment in which users, engineers, logisticians, and testers can examine requirement statements, concepts of operations, and designs within the confines of a laboratory without ever "bending metal" (See Figure 37). The purpose of this initiative is to change the acquisition process from an essentially linear process where requirements feed a design which feeds a contract specification, etc., to one of constant improvement by placing multiple feedback mechanisms within the system. This will result in a better understanding of requirements trade off issues and should reduce the design cycle time.

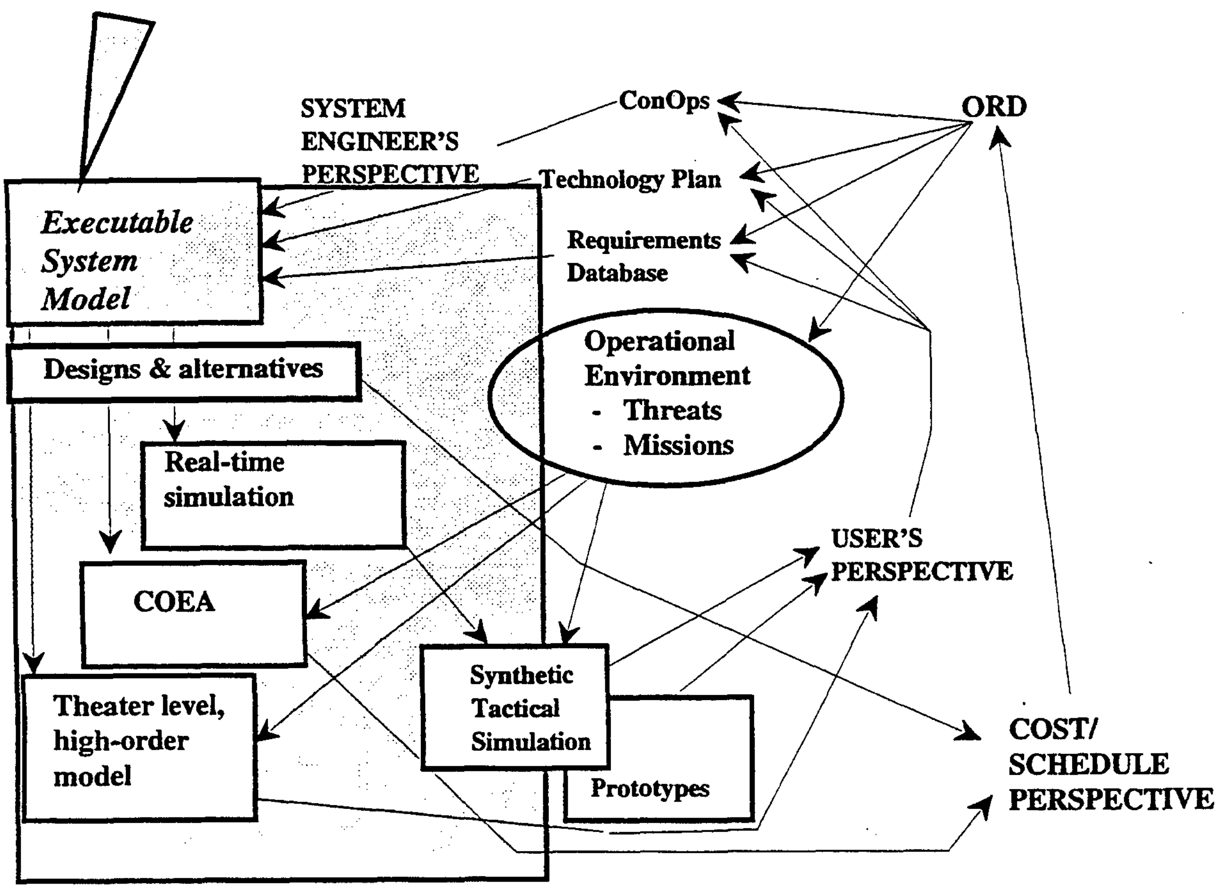

Figure 37 An Approach to the Improvement of the Acquisition Process Based on Use of Executable System Models.

REQUIREMENTS TRACING

Requirements tracing is the concept of highlighting the salient performance criteria placed on a system during the requirements generation process and the design process, and then tracking them between user originated documents such as an ORD and program management documents such as the system specification. This process has two immediate benefits. The first is programmatic in nature. Once the requirements are entered into a database and tied to the appropriate acquisition documents, any changes can be implemented in all other documents quickly with little chance for error or omission. The second benefit is realized in the systems engineering process. In tracing the requirements in this fashion, the design team can identify exactly what requirements are driving the design of the system and perform sensitivity analyses to determine if changes to the requirements would result in a more cost effective system or if changes to the design would still comply with the user's original need. In order to perform the type of analyses described, engineering case tools and high fidelity subsystem models must be connected to the requirements data base structure.

ENGINEERING CASE TOOLS

The majority of this portion of the environment is in place, as a result of the JII verification process. With these subsystem models connected to the requirements tracing module, an engineer will be able to reconfigure the design and highlight changes that affect stated requirements or analyze how various requirement statements are affecting the systems design.

DISTRIBUTED SIMULATION NETWORK

Under ARPA oversight, distributed simulation technology has made large gains in the past few years. The concept is to link dissimilar simulation capabilities at different geographic locations together in a common network. In the past this technology has been used for the purpose of training small groups in combined tactics. The simulations revolve around creating a "virtual reality" of some degree of fidelity which places the participants in battle situations where decisions must be made. At this moment distributed simulation is poised to move into the arena of systems engineering. Once linked, the environment created can be used to investigate how users will incorporate new technology into their concepts of operation and to determine what performance requirements are in fact needed to support the user. The UAV JPO, with the assistance of ARPA, is actively involved in bringing these concepts to the acquisition process. The SERCES project is using the detailed engineering level simulations created for the JII process now resident at the JDF and interfacing them with high order force-on-force models at Naval Command, Control and Ocean Surveillance Center, San Diego, CA. This experiment is allowing USN fleet personnel to participate in exercises using a simulated UAV to develop concepts of operation and to determine performance envelopes for the planned VTOL UAV. Exercises planned for 1993 will look at the man-machine interface questions and integration issues aboard a small surface combatant. Additional exercises will look at EO/IR payload requirements for the SR UAV and the CR UAV. These types of exercises will validate requirements prior to development.

SURVIVABILITY

During 1992 the UAV JPO promulgated the Joint UAV Survivability and Vulnerability Procedures. These procedures are to be used in the creation of survivability documentation for each program milestone. Both the MR UAV and the SR UAV have followed the procedures and as a result have very well defined survivability programs as they approach their respective milestones. The UAV JPO is also developing a standard data base of scenarios to use in the investigation of system effectiveness and survivability. These scenarios will be in compliance with the Defense Planning Guidance and will be reviewed by DIA prior to use.

IX INTERNATIONAL

The UAV Joint International Programs Directorate is the UAV JPO focal point for all foreign or international programs. Established in 1991, its mission is to recommend policy and provide guidance for the development of international UAV program operations, plan for and implement a consolidated joint management structure to coordinate international foreign military sales (FMS) efforts for participating Services, and foster cooperation with Allied countries.

DEFENSE COOPERATION

Defense cooperation is a major area of focus for the UAV JPO. The major advantages of international cooperation are: promoting the more efficient use of scarce defense resources, aiding industrial modernization, reducing research and development costs, improving access to technology, and strengthening US/Allied defense relationships. UAV JPO cooperative initiatives are being focused in the areas of DEAs, personnel exchanges, cooperative agreements, NATO working groups and FCT.

DEAs are being developed with Canada, Germany, Israel, Netherlands and United Kingdom. Additionally, the International Programs Directorate is in the process of assuming the role of technical project officer for an existing UAV DEA with the Republic of Korea. DEAs serve as vehicles for the exchange of scientific and technical data and information on a quid pro quo basis. Development of DEAs are anticipated with other friendly nations where there exist mutually beneficial opportunities for data and information exchange. Primary goals of UAV DEAs are to create closer alliances, enhance mutual security, reduce costs/duplication, improve interoperability standardization, identify other cooperative opportunities and serve as a catalyst to marshal DoD and friendly foreign nations' technological capabilities.

Personnel exchanges offer additional opportunities for defense cooperation with friendly nations. The first UAV SEEP was initiated with the government of Germany. It has resulted in the loan of a German national to work with the USN UAV program office. Additional SEEP possibilities exist with the United Kingdom, Canada, Netherlands and other interested US allies.

In the cooperative agreement area, the initial drafting of the project nomination proposal for a cooperative program between the US and Canada for development, test and evaluation of a maritimized VTOL UAV system (MAVUS II) has been completed. Approval of this project will allow the US to benefit from the availability of a proven test vehicle, the Canadian CL-227, and potential Canadian funding to test systems and sub-systems for the USN VTOL UAV Tech Demo program. It will allow the USN to conduct hardware/software integration, incorporate an automated takeoff and landing system, and conduct land/sea based flight testing and system evaluation.

The International Programs Directorate has been a primary participant in the NATO AGARD study group in the development of a paper on the "Future Use Of UAVs In The Maritime Environment." Additionally, the Directorate is participating in NATO PG 35 (dependent group of Naval Armaments Group) discussions on a maritime UAV system. Participation in NATO studies and working groups relating to UAVs will be an area of continuing cooperation with our Allies.

INTERNATIONAL SALES

One of the primary goals of the UAV JPO is to brief the advantages of US developed UAVs to interested foreign countries. Potential UAV sales (FMS or commercial) to foreign countries offer significant advantages, including creating economies of scale (larger productive runs), preserving production lines (DoD mobilization base) and making a direct and positive impact on the US domestic economy (preservation of US employment base and generation of US exports).

The UAV TTSARB package has been prepared to accommodate potential UAV sales to foreign countries. UAV TTSARB, currently undergoing staffing at the USN International Programs Office, will provide the policy basis for UAVs and payloads which will be considered for sale to friendly countries. Over 15 foreign countries have indicated some interest in US developed UAV systems.

Due to worldwide interest in US UAVs, in 1993 the UAV JPO will be briefing Unified Command Staff members on current UAV status and soliciting their perspective and assistance on anticipated UAV sales to countries in their respective regions. Additionally, briefings to the embassy military representatives of those countries interested in DoD UAVs will be conducted during 1993.

X TEST AND EVALUATION

OVERVIEW

The Joint Test and Evaluation Directorate is the focal point and interface for UAV developmental test and evaluation (DT&E) among the program management offices and supporting multiservice field test activities which comprise the UAV Joint Test Force. The Directorate provides liaison to individual Service headquarters and OSD (Director, Test and Evaluation; Director, Operational Test and Evaluation) with regard to both developmental and operational test and evaluation (OT&E) of UAV systems. Additionally, the Directorate provides liaison to the individual Service OT&E agencies for the planning and support of UAV operational testing. The Directorate maintains the status of capabilities, limitations, policies and procedures associated with national and international facilities, as well as the environments which are suitable for UAV test and evaluation activities. The respective test and evaluation master plans (TEMPS) for each of the UAV programs readily serve as a source for scope, objectives, structure and resources of developmental and operational test programs.

A. DEVELOPMENTAL TESTING

Individual program mangers are responsible for the overall DT&E programs conducted by participating field test activities and respective contractors. Government test ranges possessing adequate restricted airspace, terrain and sea areas to support UAV DT&E are limited in number and are generally located in the western United States. As with most test facilities, projected workloads may require prioritization of test projects and early scheduling of DT&E programs. Accomplishment of UAV DT&E requirements requires the resourcing and scheduling of DT&E activities among the multi-service test facilities without any significant investment in improvements to the various facilities. Coordination between the UAV JPO and the NAWC is underway in order to develop a land based ship motion simulator through modifications of existing simulator hardware in order to meet the objectives of the VTOL UAV Tech Demo program.

B. OPERATIONAL TESTING

The overall planning and execution of OT&E for UAVs is conducted by the Multiservice Operational Test and Evaluation Force with the Operational Test and Evaluation Force as the executive service lead. At this time, the USA Operational Evaluation Command has been designated the principal operational test agency for conduct of SR UAV operational testing.

Several potential limitations have been recognized in the overall execution of UAV operational testing. Through the system integration of numerous technologies in their development, the capabilities and overall operational effectiveness of respective UAV systems are just being recognized. As such, the multiservice user community has been actively involved in the development of doctrine and organizational guidance for the employment of UAV systems throughout the spectrum of threat scenarios confronting our forces. However, such doctrine and concepts, to include a suitably trained force structure, are integral to the planning and execution of formal OT&E that will be needed to support overall program milestones.

Adequate OT&E entails portraying operational test realism that requires test sites possessing representative topographical and climatic environments of areas where the UAV system may be deployed, integration of interfacing and supporting units, as well as threat forces depicting complex target arrays. Accordingly, formal operational testing for UAV systems may potentially require substantial resourcing in personnel, material and test sites.

Integrated logistics support (ILS) for UAV systems is evolving and will require definition and maturity to support formal OT&E. Respective ILS plans for each of the UAV systems are an integral part of both developmental and operational test planning and execution and will be employed to insure early identification and optimization of critical logistical elements. Generally, logistics support for a UAV system is not mature during DT&E and OT&E. However, logistic support must be sufficiently developed to allow operational personnel to perform organizational level maintenance during OT&E.

C. SURVIVABILITY TESTING

The predicted survivability of a UAV system in a combat environment is a critical factor which must be quantified in a cost effective manner to a reasonable level of confidence. The use of destructive field tests involving a panoply of air defense weapons integrated into a realistic combat scenario and firing live ammunition is extremely expensive. However, using non-destructive field tests, vulnerability and survivability can be determined to a reasonable level of confidence using computer simulations incorporating force-on-force models. Operational training exercises also hold potential for determining UAV survivability at reasonable cost.

To accurately predict UAV system survivability in an operational environment, representative user personnel must be employed to obtain tactical expertise and specific training. Such personnel will perform mission planning to determine the best solution comprising both mission accomplishment and system survivability. To assure that only certified computer models are employed in the analysis of operational UAV survivability, the services of the Survivability Information and Analysis Center (SURVIAC), a DoD technical center with acknowledged expertise in aircraft survivability, is used.

XI INTEGRATED LOGISTICS SUPPORT (ILS) AND HUMAN SYSTEMS INTEGRATION (HSI)

A. INTEGRATED LOGISTICS SUPPORT (ILS)

New initiatives for improving UAV ILS management capability continue to emerge from implementation actions begun in 1992 and prior years. Building on 1992 accomplishments and lessons learned, the 1993 plan expands the horizon for consolidation and coordination of the Services' UAV ILS matrices under the guidance of the UAV JPO. The 1993 systemic improvements will enhance the opportunity for greater I&C of hardware, software, and logistics procedures among the UAV systems, thereby providing logistics life cycle cost savings for the UAV family.

The UAV Joint Logistics Steering Panel (JLSP), which consists of the UAV JPO, the Defense Logistics Agency (DLA), and each UAV program ILS manager (lead and participating), was established in January 1992. The JLSP provides consolidated and coordinated ILS guidance for the UAV ILS community, including UAV initiatives with organizations and systems such as:

- Joint Logistics Center of Excellence (JL-COE)
- Joint Logistics Management Information System (JLMIS)
- Joint Logistics Assessment (JLA)
- Joint Logistics Assessment Review Group (JLARG)
- UAV Computer Aided Acquisition and Logistics Support (CALS) System
- Joint Logistics Systems Center (JLSC)
- Joint Depot Maintenance Analysis Group (JDMAG)

In 1993, efforts will continue to refine joint logistics operating policy, plans and procedures compatible with OSD and USN guidance for the family of UAVs. New ILS opportunities for improving UAV operational readiness with economy will be identified and nurtured to fruition.

In March 1991 the Joint Logistics Commanders (JLC) approved a UAV JL-COE concept of designating an existing logistics organization to enhance and coordinate support for the ILS of UAV programs. In August 1991 the UAV JL-COE was assigned to the Integrated Material Management Center (IMMC) at Huntsville, AL. The following are major functions that will be tasked to the JL-COE in 1993:

- Identify and support an ILS infrastructure utilizing the IMMC and other Service cognizant field activities.

- Host JLSP meetings with all UAV logistics personnel.

- Encourage all UAV system program/logistics managers to implement MOAs with the JL-COE to obtain common core ILS support and benefits of lessons learned.

- Interface with the JDMAG for selection of a common UAV depot level maintenance support initiatives. At the field level, this will include ensuring that when UAV systems are fielded, all elements of logistics support are fully available and that the support system is mature.

Other 1993 ILS initiatives planned include:

- Finalize UAV Family Configuration Management Plan and establish the UAV Family Configuration Control Board.

- Develop and implement a joint standardized nomenclature and mission design series numbering system for nonlethal UAVs to provide a common identification that accurately describes the current and future UAV programs.

- Survey and identify existing common and peculiar support equipment and automatic test equipment which may be applicable to UAV systems to minimize cost and reduce inventory redundancy.

- Review UAV systems acquisition program documentation to ensure supportability characteristics are accorded consideration equal to performance, cost and schedule.

- Develop and publish a capstone UAV ILS Planning Guide for use by program personnel.

- Establish logistics constraints for maximum weight and volume of organizational level support equipment. This should provide the most efficient and effective support with the maximum amount of personnel and equipment. The JLCOE continues to address logistics supportability of organizational level support equipment to ensure consistency of standards/policies across the UAV family. A logistics support equipment I&C strategy approach continues to be refined and a UAV Capstone ILS guide which addresses support equipment supportability initiatives is being reviewed by UAV program personnel. In addition, FY93 efforts include an analysis of individual UAV organizational support equipment requirements.

The JLMIS is a UAV JPO initiative started in 1991 to provide UAV program offices with access to UAV related logistics data. The JLMIS will reflect DoD Computer Aided Acquisition Logistics Support (CALS) and Corporate Information Management (CIM) requirements. This system will provide the capability to connect UAV logistics activities with UAV related data bases (Integrated Weapon System Database (IWSDB), Contractor Integrated Technical Information Service [CITIS] and Government Integrated Technical Information Service [GITIS]) for rapid and integrated analyses to enhance logistics support and assessments. System planning will allow this capability to support the program offices with information required to help determine system specifications, readiness levels and supportability requirements. A phased implementation allows the system to grow with the increase in UAV systems. Maximum use of existing modified/ standardized software programs within the Services' logistics community will be required whenever they can meet the joint requirements. This capability will be available to all UAV activities to encourage commonality within the joint support arena. Goals for 1993 include:

- Develop JLMIS Phase II concept document, requirements statement and user guide.

- Develop software modules for ILS assessment which will interface future software logistics modules with IWSDB.

- Introduce a prototype module that will access disparate data sources and demonstrate the utility of the JLMIS workstation.

- Continue dialog with the CALS logistics program to share logistics analysis enhancement experience and workstation development knowledge.

The JLA is a joint logistics evaluation of the adequacy of the planning, management, budgeting and execution of ILS for UAV programs. The intent of the multi-service logistics assessment is to eliminate redundancy in Service logistic assessments while ensuring all Services' legitimate logistics requirements are covered. The JLA draft report will be presented to the JLARG comprised of flag level representation from all Services and chaired by PEO(CU). The final JLA report will recommend whether or not PEO(CU) should certify the adequacy of the logistics support program for the impending milestone/program review.

The UAV CALS strategy will be compatible with OSD, USN, CALS and JLSC requirements and will define the methodology for developing UAV CALS related documentation, a concept of operations, and an acquisition strategy. Implementation of a UAV CALS strategy will enable more effective generation, exchange and use of data for UAV systems and equipment, including management, design/engineering, manufacturing, logistics support and operations data. UAV CALS requirements will be included in the development of and installed on the UAV JLMIS.

The Joint Logistics Systems Center (JLSC), located at Wright-Patterson AFB, OH is chartered by OSD to provide hierarchical logistics support system standardization and commonality to the Services and DLA in the areas of development, procurement, inventory and disposal management of weapons systems and support assets. Goals for 1993 include continuation of coordination with the USAF led JLSC to enable PEO(CU) to benefit from joint logistics standardization and commonality initiatives produced by JLSC.

B. HUMAN SYSTEMS INTEGRATION (HSI)

In support of documentation requirements of DoD Directive 5000.1 and DoD Instruction 5000.2, each UAV program will prepare both Human Systems Integration (HSI) Plans and Training Development Plans. Both plans will address trade-offs between cost and performance and, in addition, will address HSI impacts upon design and schedule. UAV programs will follow USN and UAV JPO policy and guidance for development of these plans. Each UAV program will identify an individual responsible for HSI.

The HSI inititatives began in the UAV programs are being continued and will be expanded. These initiatives will influence design throughout the acquisition cycle by identification of manpower personnel and training trade-offs in connection with emerging LSA information. Other trade-offs with HSI include cost, schedule, performance and risk. Existing skills will be stressed to minimize unique requirements in the force structure. Additional manpower requirements are being minimized. Training and training device requirements will be continuously evaluated to streamline and minimize time and material resources, training aids and facilities; modularity; embedded training; and on-the-job training. Human factors, safety, and health hazard issues will also receive similar analysis for optimization of the entire HSI program throughout the UAV program. Manpower Estimate Reports completed and planned will be applied to ensure that force structure is not unduly impacted.

The JLSP will monitor these plans to ensure they are consistent with joint UAV family HSI objectives. The 1993 goals include:

- Develop a joint UAV family HSI Plan.
- Monitor the HSI Plan generated by each UAV system.
- Monitor UAV technical development plans TDPs and concepts generated by each UAV system. Minimize manpower requirements consistent with the joint ORD for each UAV system.

Training for UAVs will reflect congressional guidance to minimize personnel and training. Centralized formal UAV training for common core modules and standardized common core training materials will be the focus. Common core training may be conducted at one or more training sites. The USA has been designated as UAV JPO training agent for the SR and CR UAVs. On 15 February 1993 a ground breaking ceremony was held at Ft. Huachuca, AZ to initiate the construction of a UAV Joint Service Training Center. The Center will support both the SR and CR UAV systems. The goals for 1993 include:

- Continue to coordinate the development and use of "common core" training materials in support of CR and SR UAV training requirements and by the MR and UAV training sites when selected.
- Satisfy UAV common training at common core sites where practicable and economical.
- Provide guidance to UAV system managers to assist in satisfying UAV system peculiar training requirements.
- Explore developing an external pilot training simulator program integrating existing Government owned hardware and software utilizing Government training device experts from the Naval Training Systems Center, the USA's Simulation, Training and Instrumentation Command, and the USAF's Simulation Systems Program Office.
- Pursue creating an operator trainer combined with a UAV payload operator trainer, utilizing computer based training materials, interface courseware and imbedded training techniques.

The personnel required to support UAVs will be directly related to the specific UAV system that is to be fielded. Each Service will assess the individual skills required to operate a system and determine if an existing military occupational specialty/Navy enlisted classification (MOS/NEC) can be used to accommodate the UAV operation and maintenance requirements. If after analyzing the personnel needs, the Service determines that a new MOS or NEC is required, the Service will identify the knowledge, skills and experience levels required for the UAV tasks.

XII RESOURCES

The DoD fiscal resource sponsors for UAV systems are OSD Tactical Systems (TS) and OSD C^3I. Funds execution is accomplished by the UAV JPO. Research, Development, Test & Evaluation (RDT&E) and procurement UAV activities (nonlethal) are programmed and budgeted in Program Element (PE) 0305141D.

A. RESEARCH, DEVELOPMENT, TEST AND EVALUATION (RDT&E)

Most RDT&E is programmed and budgeted in OSD PE 0305141D. These funds support systems, component and I&C RDT&E. Additional RDT&E is programmed and budgeted in related Service and agency PEs following coordination with the UAV JPO. For example, systems evaluated in the FCT program are funded in PE 0605130D.

B. PROCUREMENT

Procurement is programmed and budgeted in OSD PE 0305141D.

C. OPERATIONS AND MAINTENANCE (O&M)

O&M is individually programmed and budgeted by the Services.

D. MILITARY PERSONNEL (MILPERS)

Military personnel end strengths and pay are individually programmed and budgeted by the Services.

E. MILITARY CONSTRUCTION (MILCON)

Military construction is the responsibility of the requiring Service.

F. FUNDING (IN OSD PE0305141D)

	FY93	FY94	FY95-FY99
RDT&E	$130.8M	$187.5M	$211.8M
Procurement	$137.1M	$69.3M	$1667.2M

APPENDIX A
GLOSSARY OF TERMS

Commonality - A quality which applies to material 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 adjustments. Commonality is a life cycle cost decision.

Conventional Standoff Weapon - An unmanned, surface attack, powered or unpowered ballistic missile, semi-ballistic missile, cruise missile, or UAV having an explosive or otherwise lethal nonnuclear warhead and having an effective operational range exceeding five nautical miles from its lowest operational launch altitude. USA deep fire systems are considered standoff weapons, but USA artillery and artillery-like close fire systems are not.

Family - The set of UAV systems that maximizes I&C.

Interface - A boundary or point common to two or more similar or dissimilar command and control systems, sub-systems, or other entities against which or at which necessary information flow takes place.

Interoperability - 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. Interoperability is an operational requirement.

Remotely Piloted Vehicle (RPV) - An unmanned vehicle capable of being controlled from a distant location through a communication link. It is normally designed to be recoverable. A nonautonomous UAV.

Subsystems - The major elements of a UAV including: air vehicle, MPCS, mission payload, data link, launch and recovery, and logistics support.

Unmanned Aerial Vehicle (UAV) - A powered aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or nonlethal payload. Ballistic or semi-ballistic vehicles and artillery projectiles are not considered UAVs.

> **Lethal UAV** - A UAV, normally autonomous and expendable, that carries a payload used to attack, damage and/or destroy enemy targets.
>
> **Nonlethal UAV** - A UAV that does not carry a payload for physical damage and/or destruction of enemy targets. A nonlethal UAV carries payloads for mission such as RSTA; target spotting; command and control; meteorological data collection; NBC detection; special operations support; communications relay; and electronic disruption and deception. In the context of this document the term "UAV" is equivalent to the term "nonlethal UAV."

APPENDIX B
ACRONYMS

ACAT	Acquisition Category
ADM	Acquisition Decision Memorandum
ADT	Air Data Terminal
AFB	Air Force Base
AFMSS	Air Force Mission Support System
AN/SRQ-4	Navy Tactical Data Link and Synthesis
AP	Acquisition Plan
ARPA	Advanced Research Projects Agency
ASAS	All Sources Analysis System
ASL	Atmospheric Sciences Laboratory (USA)
ATARS	Advanced Tactical Air Reconnaissance System
ATC	Air Traffic Control
AURA	Aeromet Unmanned Reconnaissance Aircraft
AUVS	Association for Unmanned Vehicle Systems
AV	Air Vehicle
AVGAS	Aviation Gasoline
BDA	Battle Damage Assessment
BHTI	Bell Helicopter, Textron Incorporated
C^3	Command, Control, and Communications
C^3I	Command, Control, Communications & Intelligence
CAG	Common Avionics Group
CALS	Computer Aided Acquisition and Logistics Support
CARS	Common Automated Recovery System
CDL	Common Data Link
CDR	Critical Design Review
CECOM	Communications and Electronics Command
CFT	Contractor Flight Test
CIM	Corporate Information Management
CITIS	Contractor Integrated Technical Information Service
CNA	Center for Naval Analysis
COEA	Cost and Operational Effectiveness Analysis
COMINT	Communications Intelligence
CONOPS	Concept of Operations
CP	Command Post
CR	Close Range
CSC	Conventional Systems Committee
CTS	Contractor Technical Support
CVBG	Carrier Battle Group
D/N	Day/Night

DAB	Defense Acquisition Board
DAES	Defense Acquisition Executive Summary
DASN(AIR)	Deputy Assistant Secretary of the Navy for Air Programs
DEA	Data Exchange Agreement
DEA	Drug Enforcement Agency
DESA	Defense Evaluation Support Activity
DGCS	Downsized Ground Control Station
DGDT	Downsized Ground Data Terminal
DGI	Defense Group Industries
DIA	Defense Intelligence Agency
DLA	Defense Logistics Agency
DLCS	Down Looking Camera System
DMI	Depot Maintenance Interservicing
DoD	Department of Defense
DoE	Department of Energy
DRVT	Downsized Remote Video Terminal
DSPO	Defense Support Project Office
DT	Development Test
DT&E	Development Test and Evaluation
E&MD	Engineering and Manufacturing Development
EAC	Echelons Above Corps
ECM	Electronic Countermeasures
ELINT	Electronic Intelligence
EMI	Electromagnetic Interference
EO	Electro-Optical
ESM	Electronic Support Measures
EW	Electronic Warfare
EXCOM	Executive Committee
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FAT	First Article Test
FCA	Functional Configuration Audit
FCT	Foreign Comparative Test
FLIR	Forward Looking Infrared
FLOT	Forward Line of Own Troops
FMS	Foreign Military Sales
FQ&P	Flying Qualities and Performance
FRP	Full Rate Production
FUE	First Unit Equipped
FY	Fiscal Year
GAO	General Accounting Office
GCS	Ground Control Station
GDT	Ground Data Terminal
GEN	Generation

GITIS	Government Integrated Technical Information Service
GPS	Global Positioning System
HALE	High-Altitude, Long-Endurance
HMMWV	High Mobility Muti-purpose Wheeled Vehicle
HSI	Human Systems Integration
I&C	Interoperability and Commonality
IAI	Israel Aircraft Industries
ICD	Interface Control Document
IFF	Identification, Friend or Foe
IIRS	Imagery Interpretability Rating Scale
ILS	Instrument Landing System
ILS	Integrated Logistics Support
IMINT	Imagery Intelligence
IMMC	Integrated Material Management Center
IOC	Initial Operating Capability
IOT&E	Initial Operational Test and Evaluation
IR	Infrared
ISAR	Inverse Synthetic Aperture Radar
IWSDB	Integrated Weapon System Data Base
JDF	Joint Development Facility
JDMAG	Joint Depot Maintenance Analysis Group
JEWC	Joint Electronic Warfare Center
JIAWG	Joint Integrated Avionics Working Group (USN/USAF)
JII	Joint Integration Interface
JL-COE	Joint Logistics-Center of Excellence
JLA	Joint Logistic Assessment
JLARG	Joint Logistics Assessment Review Group
JLC	Joint Logistics Commanders
JLMIS	Joint Logistics Management Information System
JLSC	Joint Logistics Systems Center
JLSP	Joint Logistics Steering Panel
JPSD-TF	Joint Precision Strike Demonstration - Task Force
JROC	Joint Requirements Oversight Council
JSIPS	Joint Service Imagery Processing System
JSTARS	Joint Surveillance Target Attack Radar System
JTC	Joint Technology Center
JTC/SIL	Joint Technology Center/Systems Integration Laboratory
JTSC	Joint Technology Steering Committee
kg	Kilogram
km	Kilometer
L/R	Launch and Recovery