Exhibit R-2, RDT&E Budget Item Justification									Date: June 2001	
APPROPRIATION/BUDGET ACTIVITY RESEARCH, DEVELOPMENT, TEST & EVALUATION, DEFENSE-WIDE, BUDGET ACTIVITY 4					R-1 ITEM NOMENCLATURE JOINT ROBOTICS PROGRAM PE 0603709D8Z					
COST ($ in Millions)	FY 2000	FY 2001	FY 2002						Cost to Complete	Total Cost
Total PE Cost	17.448	13.667	11.302						CONTINUING	CONTINUING
JAUGS	0.200	0.600	0.800						CONTINUING	CONTINUING
BUGS	0.700	0.900	0.900						CONTINUING	CONTINUING
FTUV	1.510	3.167	0.000						CONTINUING	CONTINUING
GLADIATOR	0.000	0.000	1.000							
MPRS	0.000	0.000	1.402							
Technology Base	8.038	0.000	0.000						N/A	CONTINUING
Mobility Enhancements	3.000	5.200	3.000						CONTINUING	CONTINUING
RACS	4.000	3.800	4.200						CONTINUING	CONTINUING

A. Mission Description and Budget Item Justification. This program is a budget activity level 4 based on the demonstration/validation activities ongoing within the program. This PE was established in response to Congressional guidance to consolidate DoD robotic programs on unmanned ground systems and related robotic technologies in order to increase focus of the Services' robotic programs on operational requirements. The program will demonstrate maturity of robotics technologies for their application to the formal acquisition process of land systems and subsystems. Emphasis is on the development of robotic technologies that: are amenable to multi-service applications; provide capability in high hazard environments; provide improved battlefield efficiency using supervised autonomous operational capability; reduce or enhance force manpower and support; and are affordable. This PE consolidates the DoD robotics program for Unmanned Ground Vehicles (UGV) into two activities: (1) advancement of UGV concepts into Advanced Development (AD) acquisition programs and (2) the enhancement and exploitation of critical robotic technologies for today's and future UGV acquisition requirements. Categories under this PE are: (1) the Basic Unexploded Ordnance System (BUGS) - a Joint Service EOD effort to locate and dispose of surface UXO; (2) the Robotics for Agile Combat Support (RACS) - a USAF effort to develop a robotic/autonomous vehicle capability for Force Protection and Active Range Clearance (ARC). RACS platforms include the following: All-purpose Remote Transport System (ARTS), Subsurface Ordnance Characterization System (SOCS), and Automated Ordnance Excavator (AOE). This technology can also be applied to formerly used defense sites for cleanup/disposal. (3) The Mobility Enhancements program is a research and development program aimed at improving the mobility of small, man portable unmanned vehicle systems in support of military police missions. (4) The Family of Tactical Unmanned Vehicles (FTUV) is a joint Army/Marine Corps effort to provide commanders a family of reconnaissance, surveillance and target acquisition UGV's that are properly sized to operate in a variety of tactical situations. Requirements are emerging for small and medium unmanned systems that improve warfighters' situational awareness in scout, mechanized and infantry operations in urban terrain. (5) Man Portable Robotic Systems (MPRS) – is an effort to develop smaller (10-40 lb. Class) UGVs as part of the FTUV program.

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(6) The Joint Architecture for Unmanned Ground Systems (JAUGS) is an approach to standardizing protocols, and software component interfaces of all anticipated DoD unmanned systems. (7) Gladiator is an effort to develop a light (≤ 1000 lbs) unmanned system for the USMC to conduct surveillance, reconnaissance and other selected missions.

(U) FY 2000 Accomplishments

JOINT ARCHITECTURE FOR UNMANNED GROUND SYSTEMS (JAUGS) DEVELOPMENT (0.200 million)

- Continued to update JAUGS based on technology improvements, Joint Technical Architecture (JTA) standards established by DoD, and mission requirements.
- Coordinated JAUGS activities closely with 4D/RCS and Demo III development efforts.
- Continued validation process on the JAUGS.
- Updated and improved documentation that described the UGV domain and set performance specifications.
- Incorporated JAUGS into Standardized Robotic System (SRS) contract (Previously Vehicle Teleoperation (VT)).
- Conducted configuration management functions and activities.

BASIC UXO GATHERING SYSTEM (BUGS) (0.700 million)

- Implemented cooperative behaviors, tested and demonstrated five vehicle systems for the random-search system.
- Completed initial design, test and demonstrated five-vehicle systems for the directed-search system.

U) FY 2001 Plans

JOINT ARCHITECTURE FOR UNMANNED GROUND SYSTEMS (JAUGS) DEVELOPMENT (0.600 million)

- Evolve, refine, and update to achieve greater autonomous mobility, weapons, recon and manipulation. Inputs will be received primarily from user appraisals, fielded systems feedback, and industry/Tech Base development efforts.
- Implement JAUGS throughout the Joint Robotics Program.
- Place JAUGS under configuration control.

BASIC UXO GATHERING SYSTEM (BUGS) (0.900 million)

- Continue development of ten-vehicle test systems.
- Conduct test and experiments in user-developed scenarios.
- Collect data for input to Analysis of Alternatives study.

Exhibit R-2, RDT&E Budget Item Justification	Date: June 2001

(U) FY 2002 Plans

JOINT ARCHITECTURE FOR UNMANNED GROUND SYSTEMS (JAUGS) DEVELOPMENT (0.800 million)

- Evolve, refine, and update to achieve greater autonomous capability. Inputs will be received primarily from user appraisals, fielded systems feedback, and industry/Tech Base development efforts.
- Continue configuration management and control.

BASIC UXO GATHERING SYSTEM (BUGS) (0.900 million)

- Complete testing and evaluation of prototype systems.
- Initiate formal Analysis of Alternatives study.

B. Program Change Summary ($ million)

	FY2000	FY2001	FY2002	Total Cost
Previous President's Budget Submit	12.937	10.294	11.238	Cont
Appropriated Value	17.937	13.974		
Adjustments to Appropriated Value				
a. Congressionally Directed Appropriation Reduction				
b. Congressionally Directed Undistributed Reduction		(0.096)		
c. OSD Directed Program Reduction/Increase	(0.489)	(0.211)	0.064	
Current Budget Submit/President's Budget	17.448	13.667	11.302	Cont

Change Summary Explanation:

Funding: N/A

Schedule: N/A

Technical: N/A

C. Other Program Funding Summary

D. Acquisition Strategy

Exhibit R-2, RDT&E Budget Item Justification	Date: June 2001

E. Schedule Profile

Fiscal Year actual and planned events:

	FY2000	FY2001	FY2002
Acquisition Milestones			
Engineering Milestones			
T&E Milestones			
Contract Milestones			

Exhibit R-2a, RDT&E Project Justification			Date: June 2001
APPROPRIATION/BUDGET ACTIVITY RDT&E, DEFENSE WIDE, BUDGET ACTIVITY 4	PROGRAM ELEMENT PE 0603709D8Z	PROJECT NAME AND NUMBER Family of Tactical Unmanned Vehicles (FTUV)	

Cost ($ in Millions)	FY 2000	FY 2001	FY 2002						Cost to Complete	Total Cost
FTUV	1.510	3.167	0.000						CONT	CONT
GLADIATOR	0.000	0.000	1.000						CONT	CONT
MPRS	0.000	0.000	1.402						CONT	CONT
RDT&E Articles Qty										

A. Mission Description and Budget Item Justification. FTUV is a joint Army/Marine Corps effort to provide commanders a family of reconnaissance, surveillance and target acquisition UGV's that are properly sized to operate in a variety of tactical situation. There are emerging requirements to provide small, man portable unmanned vehicle systems to support the missions of light military and special operations forces. The program meets mission needs in the areas of reconnaissance for Military Operations in Urban Terrain (MOUT).

The success and lessons learned from FTUV has led to the decision to create two separate program lines. Multiple user tests with prototype systems such as SARGE and URBOT, conducted by soldiers and Marines have defined requirements. The MATILDA, a prototype system, is being procured by Civil Support Detachments as a near term solution. The two new programs being developed are Gladiator and MPRS. Gladiator has evolved from the FTUV program efforts to meet USMC requirements for an unmanned system that can conduct scout and surveillance missions in support of dismounted infantry in a shore to objective maneuver mission. The Man Portable Robotic System (MPRS) will meet the joint requirements for a small man portable robot to conduct sewer and tunnel reconnaissance for US Army engineers and to perform reconnaissance and surveillance for Army and USMC dismounted infantry forces in a MOUT environment.

(U) FY 2000 Accomplishments

- Provided SARGE Vehicles to Marine Corps in support of Limited Objective Experiment (LOE) VI at 29 Palms, California.
- Obtained 4 URBOTS for Joint Combined Forces Advanced Warfighting Experiment (JCF-AWE) Sewer and Tunnel Reconnaissance to be conducted at Ft. Drum, NY and Ft. Polk, LA. Participated in the JCF-AWE at Ft. Drum, NY and Ft. Polk, LA.
- Provided Urban Warrior Mesa Associates' Tactical Integrated Light-Force Deployment Assembly (MATILDA) platforms to the 1st, 4th, 5th, and 7th Civil Support Detachments Weapons of Mass Destruction (CSD-WMD) for evaluation. Provided support to the 5th CSD-WMD Comiskey Park exercise.

Exhibit R-2a, RDT&E Project Justification	Date: June 2001

(U) FY 2001 Plans

- Conduct Concept Experimentation Program (CEP) at Ft. Leonard Wood, MO, for Military Police (MP) users.
- Obtain additional FTUV robotic platforms for user appraisal and development of Operational Requirements Document for U.S. Army Engineer School and/or U.S. Army Infantry Center.
- Perform analysis of information received from CSD-WMD and FAST for input into ORD requirements for MPRS program.
- Develop Acquisition Documentation for U. S. Marine Corps “Gladiator” program.
- Conduct baseline testing of URBOT robotic platforms.

(U) FY 2002 Plans

- Award CTD/ System design contract for Gladiator.
- Complete AoA for Gladiator.
- Conduct USMC user experimentation for Gladiator.
- Conduct user experimentation with MPRS for the US Army and USMC.
- Initiate MPRS AoA.
- Support CST-WMD prototype fielding of MATILDA for urgent and compelling reasons.
- Develop joint experimentation for marsupial systems with Army and Air Force.
- Anticipate MS B decision for Gladiator in 3QFY03.

B. Other Program Funding Summary

C. Acquisition Strategy

D. Schedule Profile

Fiscal Year actual and planned events:

	FY2000	FY2001	FY2002
Acquisition Milestones			
Engineering Milestones			
T&E Milestones			
Contract Milestones			

Exhibit R-2a, RDT&E Project Justification									Date: June 2001	
APPROPRIATION/BUDGET ACTIVITY RDT&E, DEFENSE WIDE, BUDGET ACTIVITY 4			PROGRAM ELEMENT PE 0603709D8Z		PROJECT NAME AND NUMBER TECHNOLOGY BASE					
COST ($ in Millions)	FY 2000	FY 2001	FY 2002						Cost to Complete	Total Cost
TECHNOLOGY BASE	8.038	0.000	0.000							

A. Mission Description and Budget Item Justification. The Demo III Experimental Unmanned Vehicle (XUV) Program is designed to advance and demonstrate the technology required to develop future unmanned ground combat vehicles through three major thrusts: (1) concerted technology development; (2) modeling, simulation and experimentation; and (3) technology integration and evaluation with users. Demo III focuses on demonstration of technology that will enable the development of small, highly agile, unmanned vehicles capable of off-road, semi-autonomous operation at speeds of up to 32 km/hr during daylight and 16 km/hr at night by 4Q FY 2001. Demo III supports development of two emerging requirements at the U.S. Army Armor School for a robotic scout system and a robotic leader-follower system. Technologies for these systems are applicable to a wide array of Army programs. This program will be transferred to the Army for funding, beginning in FY 2001. A breakout of the three major thrusts follow:

- Concerted Technology Development: The technology development community, drawn primarily from government laboratories such as National Institute for Standards and Technology (NIST), the Jet Propulsion Laboratory (JPL), and the Army Research Lab (ARL), has organized itself into a series of working groups to address six technology areas deemed critical to the success of the program. The primary focus of the effort has centered on the development of perception for autonomous mobility; algorithms for local planning and autonomous behaviors; an intelligent software architecture; and a small, highly capable control interface that can be integrated into standard display units.

- Modeling, Simulation and Experimentation: A modeling, simulation and experimentation effort conducted by the Mounted Battlespace Battle Lab (MBBL), with assistance from ARL, has been running in parallel with the technology development program. The program has the twin goals of utilizing simulations to estimate the operational effectiveness of differing technological solutions and hardware/software configurations, and developing Tactics, Techniques and Procedures required to employ this technology effectively. An important outcome of this effort will be the technical support package (TSP) that will be required to support the second generation Tactical Unmanned Vehicle (TUV) user appraisal currently scheduled for FY 2002.

- Technology Integration and Evaluation with Users: This final component of the program will integrate technology onto a testbed vehicle and demonstrate autonomous mobility required to conduct the

military scout mission under tactical conditions. Unlike the other program elements, this program element was designed to be conducted by an industrial contractor chosen through a competitive procurement process that is being managed by the U.S. Army Tank–automotive/Armament Command's Research, Development, and Engineering Center (TARDEC). In January 1998 TARDEC awarded a contract to a contractor team led by the former Robotic Systems Technology (RST) now General Dynamic Robotic Systems (GDRS), teaming with Science Applications International Corporation (SAIC) Center for Intelligent Systems (CIS) and Sarnoff Corporation.

(U) FY 2000 Accomplishments

- Conducted quarterly In-Progress Reviews with the members of the Integrated Product Teams in December 1999 and April and August 2000.
- Continued development of tactical behavior models in MODSAF.
- Continued development of baseline autonomous tactical behaviors for application to the scout mission.
- Conducted data collection/engineering evaluation activities in preparation for a Battle Lab Warfighting Experiment scheduled for 1st quarter, FY01.
- Developed a high performance Ladar and transferred it to the MDARS-E Program which exceeded all expectations in its capability to detect negative obstacles.
- Developed the technology that was incorporated into two highly mobile robotic platforms which were built for the Unmanned Ground Vehicle/Systems Joint Program Office (UGV/S JPO).
- Developed an Operator Control Unit and transferred this technology to the UGV/S JPO for incorporation on the Panther Program. This technology will serve as the primary soldier-robot interface as this program moves toward more semi-autonomous operations.

(U) FY 2001 Plans:

- US Army will assume funding responsibility in FY 2001

(U) FY 2002 Plans:

- US Army continues funding responsibility in FY 2002

B. Other Program Funding Summary

C. Acquisition Strategy

Exhibit R-2a, RDT&E Project Justification	Date: June 2001

D. Schedule Profile

Fiscal Year actual and planned events:

	FY2000	FY2001	FY2002
Acquisition Milestones			
Engineering Milestones			
T&E Milestones			
Contract Milestones			

Exhibit R-2a, RDT&E Project Justification			Date: June 2001
APPROPRIATION/BUDGET ACTIVITY RDT&E, DEFENSE WIDE, BUDGET ACTIVITY 4	PROGRAM ELEMENT PE 0603709D8Z	PROJECT NAME AND NUMBER Mobility Enhancements	

Cost ($ in Millions)	FY 2000	FY 2001	FY 2002						Cost to Complete	Total Cost
Mobility Enhancements	3.000	5.200	3.000						CONT	CONT
RDT&E Articles Qty										

A. Mission Description and Budget Item Justification. The Mobility Enhancements program is a research and development program aimed at improving the mobility of small, man portable unmanned vehicle systems in support of urban warfare, engineering, physical security/force protection missions.

(U) FY 2000 Accomplishments

- Designed an Omni-Directional Inspection System (ODIS) to survey the underside of suspect vehicles.
- Coordinated with the National Institute of Justice to develop small surveillance vehicles for sensor deployment. Systems will be designed to detect weapons of mass destruction—applicable to both the military needs as well as civilian first responders.
- Developed concept for Systems Integration Laboratory (SIL) and Extreme Environments Test Facility (EETF) to evaluate mobility of UGVs.

(U) FY 2001 Plans

- Provide user community with prototype ODIS vehicle.
- Participate in MP demonstration with ODIS to further refine design.
- Design and begin development of SIL.
- Design and begin development of EETF.

(U) FY 2002 Plans

- Participate in Military Police Concept Experimentation Program.
- Conduct baseline testing of ODIS prototype vehicles.
- Complete SIL development.
- Complete EETF development.

Exhibit R-2a, RDT&E Project Justification	Date: June 2001

B. Other Program Funding Summary

C. Acquisition Strategy

D. Schedule Profile

Fiscal Year actual and planned events:

	FY2000	FY2001	FY2002
Acquisition Milestones			
Engineering Milestones			
T&E Milestones			
Contract Milestones			

Exhibit R-2a, RDT&E Project Justification			Date: June 2001
APPROPRIATION/BUDGET ACTIVITY RDT&E, DEFENSE WIDE, BUDGET ACTIVITY 4	PROGRAM ELEMENT PE 0603709D8Z	PROJECT NAME AND NUMBER ROBOTICS FOR AGILE COMBAT SUPPORT (RACS)	

Cost ($ in Millions)	FY 2000	FY 2001	FY 2002						Cost to Complete	Total Cost
RACS	4.000	3.800	4.200						CONT	CONT

A. Mission Description and Budget Item Justification. The Robotics for Agile Combat Support (RACS) currently addresses [1] needs and requirements for remotely detecting, identifying, and safely clearing surface and buried Unexploded Ordnance (UXO) and [2] urgent and compelling requirements from Air Combat Command (ACC) for a remote platform capable of employing a variety of techniques to diagnose and render safe large vehicle bombs (LVBs) and improvised explosive devices (IEDs), and [3] needs outlined in the Air Force Agile Combat Support (ACS) Mission Area Plan (MAP) in support of infrastructure support and force protection. Requirements Documentation is as follows:

- Agile Combat Support (ACS) Mission Area Plan for FY01.
- Mission Need Statement for Active Range Clearance [MNS CAF 306-98]Mission Need Statement for Enhanced Force Protection Capabilities [MNS CAF 314-97].
- Mission Need Statement for Explosive Ordnance Disposal Capabilities [MNS CAF(USN) 001-97].
- Mission Need Statement for Autonomous Firefighting Capabilities [MNS CAF 311-90].
- Operational Requirements Document for All-Purpose Remote Transport System [ORD CAF(USN) 014-93
- I/II-A].

(U) FY 2000 Accomplishments

- Developed and applied Unexploded Ordnance (UXO) disposal technologies in support of Active Range Clearance (ARC) and Wartime Deployment Support.

  - Provided technical support and consulting to AAC/WMO in support of source selection of All-Purpose Remote Transport System (ARTS). Contract for large scale procurement of JRP developed ARTS system completed:
    - o Competitive bidding and economy of scale resulted in a 25% reduction in the procurement cost of the ARTS and associated attachments.
    - o Total of 37 systems purchased (19 currently fielded world-wide, 18 to be fielded over next two years).

  - Completed navigation, communication, and control upgrade (including modification of hardware and software components) of Advanced Automated Ordnance Excavator (AOE).
    - o Conducted series of explosive range tests to validate survivability of robotic platform during

Exhibit R-2a, RDT&E Project Justification	Date: June 2001

"in the bucket" detonations of unexploded ordnance.
  - o Drafted technology transition plan to outline AOE application in range clearance concepts of operation.

- Continued development of a Laser Ordnance Neutralization System (LONS) to utilize a directed energy technology integrated on an unmanned platform to "burn" unexploded ordnance (UXO) and improvised explosive devices (IEDs).
  - o Conducted joint design effort with AFRL/DE (Directed Energy Directorate) at Kirtland AFB to optimize cost, performance, and sustainability laser system
  - o Established joint testing effort with NAVEODTECDIV (Det 63) and Office of Special Technology to validate the performance of laser system against required targets.
  - o Developed preliminary design parameters for the integration of laser system to an unmanned platform.

- Completed the design, development and integration of dual arm, force feedback, multiple degree of freedom, manipulation system (ARMS I) with a unmanned robotic platform (ARTS)
  - o Delivered research and development prototype to 96th CEG/CED (EOD unit) at Eglin AFB for use in the detection, recovery, disassembly, disablement, and disposal of test munitions.
  - o Conducted operational use of ARMS I in six real-world operations at Eglin AFB resulting in significant performance successes (75% cost reduction, reduced recovery time by 50%)
  - o Demonstrated anti-terrorism application of ARMS I in disablement of Improvised Explosive Devices (IEDs).

- Provided Headquarters, Air Education and Training Command (HQ AETC) with several potential technical design solutions (utilizing existing and/or future robotics technology) for unique Luke AFB range residue certification and removal problem.

- Completed modular, snap-on/snap-off integration of Army designed mini-flail onto an Air Force design robotic platform (ARTS).
  - o Demonstrated multi-service application of both the ARTS platform and flail modification
  - o Demonstrated a 75% reduction in research and development costs as a result of using shared, previously proven technologies from multiple services

• Conducted explosive characterization and development of effective anti-terrorism tools and techniques to reduce Weapons of Mass Destruction (WMD) threats.

- Completed design of initial unmanned deployment system for innovative explosively driven water charge system for anti-terrorism missions.

  - o Demonstrated rapid response prototype system to Technical Support Working Group (TSWG) customers including military and federal agencies.
  - o Initiated follow-on effort with TSWG to characterize and optimize system.

- Completed the design, development, validation, and testing of an advanced robotic anti-terrorism response system.
  - o Leveraged JRP research efforts with federal law enforcement funding to facilitate cost effective design approach.
  - o Delivered prototype system to federal law enforcement for use in real-world force protection missions.

• Developed and applied advanced robotic technologies for integration onto existing and future unmanned systems platforms.

- Conducted advanced robotics testing and validation on optimized Advanced Mobility Research and Development System (AMRADS).
  - o Designed, developed, and demonstrated advanced platform (AMRADS) utilizing electronic engine control.
  - o Completed integration and demonstration of previous semi-autonomous mobility modules and algorithms from Subsurface Ordnance Clearance System (SOCS).
  - o Developed and demonstrated improved navigation system using academia developed Ground Penetrating Radar (GPR) and inertial navigation unit. Demonstrated preliminary capabilities in AMRADS vehicle control from multiple Operator Control Units (OCUs).

- Provided extensive support and conducted validation efforts in conjunction with the JRP’s initiative to develop a Joint Architecture for Unmanned Ground Systems (JAUGS).
  - o Demonstrated multiple vehicle control (ARTS, MULE, AMRADS) from a single Operator Control Unit (OCU) using JAUGS compliant commands.
  - o Conducted advanced technology demonstration with industry and academia demonstrating JAUGS application at JAUGS working group.

- Completed phase one investigation of secondary control source, in response to critical operational needs for alternate robotic control methods.
  - o Cooperated with UGV/S JPO to demonstrate use of Army developed fiber optic as control source for the ARTS saving over $500K

Exhibit R-2a, RDT&E Project Justification	Date: June 2001

- Completed phase one investigation of large vehicle, high speed robotics system designed and integrated an advanced robotics package onto a P-19 Fire and Crash Rescue Platform in response to AF needs for unmanned platforms for hazardous fire/crash response and chembio decontamination.
  - o Demonstrated P-19 robotics system operating a high speed (30-40 mph) operated via joystick control.
  - o Developed advanced feedback and software control algorithms to address platform stability (turning speeds, roll-over protection, braking) at high speeds.
  - o Demonstrated use of existing Operator Control Unit (OCU) to operate P-19 robotic system via teleoperation.

(U) FY 2001 Plans

- Research and develop robotics systems to support of Agile Combat Support /Force Protection missions (i.e. UXO Disposal, WMD Threat Reduction, Structural Protection, Physical Security).
  - Advanced Mobility Research and Development System (AMRADS)
  - All-Purpose Remote Transport System (ARTS)
  - Next Generation EOD Robotic System

- Develop and apply advanced robotic technologies for integration onto existing and future unmanned system platforms in support of Agile Combat Support /Force Protection missions (i.e. UXO Disposal, WMD Threat Reduction, Structural Protection, Physical Security, mobility).
  - (**MOBILITY**) Examine existing off-the-shelf units, build custom components for specialized mission requirements, and test these mobility platforms in various mission scenarios.
    - o Assessment of commercial and existing platforms for next generation force protection robotics systems
    - o High speed vehicles
    - o Low cost mobility

  - (**NAVIGATION and SENSOR INTEGRATION**) Investigate acquisition of vehicle system specific parameters for intelligent operations and integrate environmental data acquisition units to detect, classify, and characterize environmental features for mission operations.
    - o Global Positioning System (GPS) / Inertial Navigation
    - o Obstacle Detection and Recognition
    - o Stereo Vision
    - o Forward Looking Infrared (FLIR) and Night Vision for teleportation

- (**COMMUNICATION**) Determine communications requirements for a network of mobile systems performing a mission.
  - o SMART communication
  - o Non-Line-of-Sight Communication

- (**MAN/MACHINE INTERFACE and CONTROL**) Determine requirements for user interface to mobile systems and mission specific tools. Implement both high and low-end user interfaces for multiple mobile systems.
  - o Robot to robot control (marsupial communication)
  - o Multiple vehicle control
  - o Alternate control input (fiber optics)

- (**INTELLIGENCE**) Determine the requirements for intelligent behaviors and implement an expanding intelligence system in the mobile systems for mission success. This area includes path planning, navigation, and intelligent behavior implementation.
  - o Three-dimensional (3D) path planning.

- (**PAYLOAD DEVELOPMENT and INTEGRATION**) Develop and integrate the tools needed to perform the mission once the mobility platform reaches the destination. Tools range from an articulated robotic manipulator arm to a simple device to gain entry into a building.
  - o Manipulation
  - o Water-Jet Cutter
  - o Explosive Ordnance Disposal tools (Explosively Driven Water Charge)
  - o Laser Ordnance Neutralization System (LONS)

(U) FY 2002 Plans

- Research and develop robotics systems to support Agile Combat Support /Force Protection missions (i.e. UXO Disposal, WMD Threat Reduction, Structural Protection, Physical Security).
  - Advanced Mobility Research and Development System (AMRADS)
  - Next Generation EOD Robotic System
  - Robots Support Environmental Security (ROSES)
  - Next Generation Small Robotics System (Mark IV replacement)

- Develop and apply advanced robotic technologies for integration onto existing and future unmanned system platforms in support of Agile Combat Support /Force Protection missions (i.e. UXO Disposal, WMD Threat Reduction, Structural Protection, Physical Security).

Exhibit R-2a, RDT&E Project Justification	Date: June 2001

- (**MOBILITY**) Examine existing off-the-shelf units, build custom components for specialized mission requirements, and test these mobility platforms in various mission scenarios.
  - o Specialized / optimized platforms for next generation force protection robotics systems
  - o High speed vehicles
  - o Low cost mobility

- (**NAVIGATION and SENSOR INTEGRATION**) Investigate acquisition of vehicle system specific parameters for intelligent operations and integrate environmental data acquisition units to detect, classify, and characterize environmental features for mission operations.
  - o Global Positioning System (GPS) / Inertial Navigation
  - o Scene-Based / Visual Navigation
  - o Obstacle Detection and Recognition (ultrasonic sensors, laser line scanner)
  - o Stereo Vision
  - o Forward Looking Infrared (FLIR) and Night Vision for teleoperation
  - o Auto-mapping and database mapping/modeling

- (**COMMUNICATION**) Determine communications requirements for a network of mobile systems performing a mission.
  - o SMART Communication
  - o Non-Line of Sight Communication
  - o Secure Communication Schemes

- (**MAN/MACHINE INTERFACE and CONTROL**) Determine requirements for user interface to mobile systems and mission specific tools. Implement both high- and low-end user interfaces for multiple mobile systems.
  - o Robot to Robot Control (Marsupial Communication)
  - o Multiple vehicle control
  - o Augmented Reality Interfaces

- (**INTELLIGENCE**) Determine the requirements for intelligent behaviors and implement an expanding intelligence system in the mobile systems for mission success. This area includes path planning, navigation, and intelligent behavior implementation.
  - o Three-dimensional (3D) path planning
  - o Robotic Cooperative Behavior

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- (**PAYLOAD DEVELOPMENT and INTEGRATION**) The tools to perform the mission once the mobility platform reaches the destination. Tools range from an articulated robotic manipulator arm to a simple device to gain entry into a building.
  - o Manipulation
  - o Inspection Sensors
  - o Explosive Ordnance Disposal Tools (Explosively Driven Water Charge)
  - o Laser Ordnance Neutralization System (LONS)
  - o Directed Energy Access System
  - o Projectile Neutralization

B. Other Program Funding Summary

The United States Air Force (USAF), Headquarters Air Combat Command (ACC) has programmed 3600 funding to support Advanced Research and Development (R&D) and Engineering, Manufacturing, and Development (EMD) for advanced force robotic systems designed under the RACS program. In addition, ACC has programmed 3080 funding for the procurement, fielding, and sustainment of advanced force robotic systems/technologies developed under the RACS program.

	FY01	FY02
3600(64617)	0.200	1.700
3080(28028)	3.800	6.200

C. Acquisition Strategy

Technologies developed under the RACS program are transitioned to the Airbase Systems Program Office (AFMC AAC/WMO) for acquisition and procurement. In addition some technologies are transitioned to existing programs both on Air Force Platforms as well as joint service and other DoD platforms. Transfer of dual-use technologies (both military and commercial use) to industry has also been accomplished on several RACS initiatives and continues to be a valid alternative for technology uses.

Exhibit R-3 Cost Analysis (page 1)							Date:	June 2001				
DEFENSE-WIDE BUDGET ACTIVITY		Program Element PE 0603709D8Z					FTUV					
Cost Categories (Tailor to WBS, or System/Item Requirements)	Contract Method & Type	Performing Activity & Location	Total 2000 Cost	2001 Cost	2001 Award Date	2002 Cost	2002 Award Date			Cost To Complete	Total Cost	Target Value of Contract
Primary Hardware Development				0.598								
Ancilliary Hardware Development				0.150								
Systems Engineering				0.150								
Liscenses												
tooling												
GFE												
Award Fees												
Subtotal Product Development				0.898								
Remarks:												
Development Support				0.300								
Software Development				0.200								
Training Development				0.200								
Integrated Logistics Support				0.050								
Configuration Management				0.050								
Technical Data				0.050								
GFE												
Subtotal Support				0.850								
Remarks:												

Exhibit R-3 Cost Analysis (page 2)							Date:	June 2001				
DEFENSE-WIDE BUDGET ACTIVITY 0		Program Element PE 0603709D8Z					FTUV					
Cost Categories (Tailor to WBS, or System/Item Requirements)	Contract Method & Type	Performing Activity & Location	Total 2000 Cost	2001 Cost	2001 Award Date	2002 Cost	2002 Award Date			Cost To Complete	Total Cost	Target Value of Contract
DT				0.400								
IOT&E				0.200								
User Appraisal												
Subtotal T&E				0.600								
Remarks:												
Contractor Engineering Support				0.169								
Government Engineering Support				0.100								
Program Management Support				0.050								
Program Management Personnel				0.100								
Travel				0.050								
Labor (Research Personnel)				0.100								
Miscellaneous				0.250								
Subtotal Management				0.819								
Remarks:												
Total Cost				3.167								
Remarks:												