RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2003
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Aerospace Systems PE 0603285E, R-1 #33

COST (In Millions)	FY 2002	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008	FY2009
Total Program Element (PE) Cost	131.954	235.300	323.730	340.567	346.978	385.281	380.120	381.014
Advanced Aerospace Systems ASP-01	131.954	124.783	114.357	109.847	98.372	63.512	33.190	0.000
Space Programs and Technology ASP-02	0.000	110.517	209.373	230.720	248.606	321.769	346.930	381.014

(U) Mission Description:

(U) The Advanced Aerospace Systems program element is budgeted in the Advanced Technology Development budget activity because it addresses high payoff opportunities to dramatically reduce costs associated with advanced aeronautical and space systems and provide revolutionary new system capabilities for satisfying current and projected military mission requirements. Research and development of integrated system concepts, as well as enabling vehicle subsystems will be conducted.

(U) A number of aeronautical programs are funded in the Advanced Aerospace Systems project. The A160 Hummingbird Warrior program exploits a hingeless, rigid, rotor concept operating at the optimum rotational speed to produce a vertical take-off and landing unmanned air vehicle with very low disk loading and rotor tip speeds resulting in an efficient low power loiter and high endurance system. The Canard Rotor/Wing aircraft program focuses on high-speed, rapid response vertical take-off and landing designs with improved range and stealth capabilities.

(U) Also funded within the Advanced Aerospace Systems project are several unmanned combat air vehicles. The Unmanned Combat Air Vehicle program continues to focus on risk reduction and "Concept of Operation" evaluation. The goal of the Naval Unmanned Combat Air Vehicle program is to validate the technical feasibility for a naval unmanned combat air system to effectively and affordably perform naval Suppression of Enemy Air Defense/Strike/Surveillance missions. The goal of the Unmanned Combat Armed Rotorcraft program is to design, develop, integrate and demonstrate the enabling technologies and system capabilities required to perform mobile strike concept of operations.

(U) The Space Programs and Technology Project is developing a space force structure that will be robust against attack. In addition to the ability to detect and characterize potential attacks, robustness against attack is provided by proliferation of assets, ready access to space and a flexible infrastructure for maintaining the capabilities of on-orbit assets. Ready access to space allows the delivery of defensive systems and

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replenishment supplies to orbit. An infrastructure to service the mission spacecraft allows defensive actions to be taken without limiting mission lifetime. The Orbital Express Space Operations Architecture program will develop and demonstrate autonomous techniques for on-orbit refueling and reconfiguration of satellites that could support a broad range of future U.S. national security and commercial space programs. The Space Surveillance Telescope program will develop and demonstrate an advanced ground-based optical system to enable detection and tracking of faint objects in space, while providing rapid, wide-area search capability. The Innovative Space-Based Radar Antenna Technology program addresses the technical and economic feasibility of developing space-based radar antennas necessary for tactical-grade ground moving target indicator performance from space. Deep view is developing a high-resolution radar imaging capability to characterize objects in the earth's orbit. The Responsive Access, Small Cargo, and Affordable Launch program will develop and demonstrate the capability to launch small satellites and commodity payloads into low-earth orbit. The High Frequency Active Auroral Research Project (HAARP) will develop new experimental research capabilities to exploit emerging ionosphere and radio science technologies related to advanced defense applications.

(U) An outgrowth of the space vehicle technologies and Hypersonics (TT-03) initiatives, the HyperSoar program will develop a dual use capability of an intercontinental global delivery vehicle and a first stage reusable space access vehicle. The Rapid On-orbit Anomaly Surveillance and Tracking program seeks to provide a space-based capability to detect and track on-orbit objects with rapid revisit rates and low latencies. The Low Cost Tactical Imager program will develop a spacecraft to provide high resolution imaging day or night using extremely lightweight optics and a compact design capable of being launched on a Pegasus air launch booster. The Tactical Pointing Determination of Imaging Spacecraft program will develop relocatable space surveillance radar to provide near-real time pointing determination of imaging spacecraft to the warfighter.

(U) **Program Change Summary:** *(In Millions)*	**FY 2002**	**FY 2003**	**FY 2004**	**FY2005**
Previous President's Budget	153.700	246.000	394.662	485.549
Current President's Budget	131.954	235.300	323.730	340.567
Total Adjustments	-21.746	-10.700	-70.932	-144.982

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	FY 2002	FY 2003
Congressional program reductions	-16.632	-14.900
Congressional increases	0.000	4.200
Reprogrammings	-0.114	0.000
SBIR/STTR transfer	-5.000	0.000

(U) Change Summary Explanation:

FY 2002	Decrease reflects inflation reduction; Section 8135 and Section 313 reductions.
FY 2003	Decrease reflects congressional program reductions and adds for Suborbital Space Launch and the Hummingbird UAV.
FY 2004-05	Decrease reflects reprioritization of various aerospace efforts and rephasing of several planned space programs.

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COST (In Millions)	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Advanced Aerospace Systems ASP-01	131.954	124.783	114.357	109.847	98.372	63.512	33.190	0.000

(U) Mission Description:

(U) The Advanced Aerospace Systems project addresses high payoff opportunities to dramatically reduce costs associated with advanced aeronautical systems and provide revolutionary new system capabilities for satisfying current and projected military mission requirements. Research and development of integrated system concepts, as well as enabling vehicle subsystems will be conducted.

(U) Program Accomplishments/Planned Programs:

	FY 2002	FY 2003	FY 2004	FY 2005
Advanced Air Vehicle: A160 Hummingbird Warrior	12.824	12.627	11.377	8.421

(U) The A160 Hummingbird Warrior program will exploit a hingeless, rigid rotor concept operating at the optimum rotational speed to produce a vertical take-off and landing (VTOL) unmanned air vehicle (UAV) with low disk loading and rotor tip speeds resulting in an efficient low power loiter and high endurance system. This unique concept offers the potential for significant increases in VTOL UAV range (more than 2,000 nm) and endurance (24-48 hours). Detailed design, fabrication and testing of this vehic le is being conducted to establish its performance, reliability, and maintainability. The A160 concept is being evaluated for surveillance and targeting, communications and data relay, lethal and non-lethal weapons delivery, assured crew recovery, resupply of forces in the field, and special operations missions in support of Army, Navy, Marine Corps, and other Agency needs. It is being developed as a component of the DARPA/Army Future Combat Systems (FCS) Program. In addition, this program will evaluate application of the optimum speed rotor concept to other systems including heavy lift and tilt rotor capabilities. The program will also conduct development tests of heavy fuel engine technology and coordinate with other DARPA programs developing highly efficient heavy fuel engine technologies to further advance current range and endurance projections as well as improve operational reliability and logistics compatibility.

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(U) Program Plans:

- Fabricate and test low vibration rotor modifications.
- Continue ground and flight test of A160 vehicles.
- Integrate/demonstrate electro-optic/infrared surveillance payload.
- Develop concept design of an unmanned ground vehicle deployment system for A160 vehicle.
- Perform conceptual design and trade studies of A160 variants for a variety of mission roles, including study of technology risk reduction, architecture, survivability, and command and control.
- Fabricate forward pass mini control station.
- Demonstrate forward pass operations with Electro-Optic/Infrared sensor.
- Flight test low vibration four-blade rotor modifications.
- Develop advanced airframe helo modification.
- Investigate application of the optimum speed rotor concept to tilt rotor aircraft, including conceptual design of an unmanned system.
- Conduct tests of advanced engines and coordinate with development of high-efficiency heavy fuel engine technologies.

	FY 2002	FY 2003	FY 2004	FY 2005
Unmanned Combat Air Vehicle (UCAV)	60.000	59.492	0.000	0.000

(U) DARPA and the Air Force are jointly developing and funding the Unmanned Combat Air Vehicle (UCAV) System Demonstration Program (SDP) to demonstrate the technical feasibility, military utility, and operational value of a UCAV system to effectively and affordably prosecute lethal and non-lethal Suppression of Enemy Air Defense (SEAD) and strike missions within the emerging global command and control architecture. The overall purpose of the UCAV SDP is to design, develop, integrate, and demonstrate the critical technologies, processes, and system attributes pertinent to an operational UCAV system. The UCAV SDP is currently executing flight demonstrations with the X-45A air vehicle and is in the design phase for low observable robust prototypes.

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(U) Program Plans:
- Develop and demonstrate core UCAV functionality.
- Coordinate flight and intelligent multi-vehicle flight operations.
- Demonstrate interoperability with Manned Force Packages.
- Design and develop next iteration low observable (LO) robust prototypes.
- Deliver two robust prototype air vehicles and an updated mission control segment.
- Demonstrate production of affordable LO airframe.
- Demonstrate maintenance of LO airframe and apertures.
- Develop provisions for future growth as a robust baseline for operational aircraft.

	FY 2002	FY 2003	FY 2004	FY 2005
Naval Unmanned Combat Air Vehicle (UCAV-N)	10.368	21.527	0.000	0.000

(U) The goal of the Naval Unmanned Combat Air Vehicle (UCAV-N) science and technology program is to validate the technical feasibility for a naval unmanned combat air system to effectively and affordably perform naval Suppression of Enemy Air Defense (SEAD)/Strike/Surveillance missions within the emerging global command and control architecture. This initiative will investigate and validate the critical technologies, processes and system attributes associated with the development of a UCAV-N system. The proposed UCAV-N design will be suitable for aircraft carrier use; however, it will also stress maximum commonality with the Air Force UCAV. Analysis of the potential capability enhancements that would be realized by legacy force carrier air wing through the introduction of 12 to 16 multi-mission Strike, SEAD and Surveillance unmanned combat aircraft that are suitable for aircraft carrier use is currently being investigated. The program will also emphasize a low life cycle cost combat effective design.

(U) Program Plans:
- Conduct demonstrations of technologies, processes, and systems attributes to demonstrate the feasibility of a low observable UCAV-N system capable of routine operation from aircraft carriers.
- Develop a system capable of conducting maritime network centric warfare.

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- Initiate detailed design of a demonstrator aircraft.
- Complete detailed design and initiate construction of demonstrator aircraft.

	FY 2002	FY 2003	FY 2004	FY 2005
Joint Unmanned Air Vehicle (UCAV-J)	0.000	0.000	50.590	28.923

(U) DARPA, the Air Force and the Navy will participate in the Joint Unmanned Combat Air Vehicle (UCAV-J) System Demonstration Program (SDP) to demonstrate the technical feasibility, military utility, and operational value of a UCAV family of vehicles. The UCAV-J program will initially identify and assess the common requirements, design space and technology maturity levels that support development of an affordable family of vehicles. The overall goal of the UCAV-J SDP is to design, develop, integrate, and demonstrate the critical technologies, processes, and system attributes pertinent to an objective UCAV-J system that is responsive to service mission requirements. These mission requirements include the capability to effectively and affordably perform lethal and non-lethal Suppression of Enemy Air Defense (SEAD), strike and Surveillance missions. The UCAV-J will be interoperable within the emerging global command and control architecture. The Air Force UCAV SDP program is currently executing flight demonstrations with the X-45A air vehicle and is in the design phase for low observable robust prototypes. The Naval Unmanned Combat Air Vehicle (UCAV-N) science and technology program is currently validating the technical feasibility for a naval unmanned combat air system suitable for aircraft carrier use. Analysis is also being conducted of the potential capability enhancements that would be realized by a legacy force carrier air wing through the introduction of 12 to 16 multi-mission Strike, SEAD and Surveillance UCAV-J that are suitable for aircraft carrier use.

Program Plans:

- Support development of joint service mission and affordability goals through cost-performance tradeoff analysis consistent with technology maturation levels.
- Coordinate technology development roadmaps that are responsive to preferred Weapon System Concepts and development milestones resulting from Joint program objective system analysis.
- Continue high leverage technology maturation efforts in support of future UCAV-J development.
- Complete detailed design and initiate construction of demonstrator aircraft.
- Develop an updated common mission control segment.

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	FY 2002	FY 2003	FY 2004	FY 2005
Unmanned Combat Armed Rotorcraft (UCAR)	5.900	22.805	35.432	55.904

(U) The goal of the Unmanned Combat Armed Rotorcraft (UCAR) program is to design, develop, integrate and demonstrate the enabling technologies and system capabilities required to perform armed reconnaissance and attack missions within the Army's Objective Force system-of-systems environment. The enabling technologies are survivability, autonomous operations, command and control, and targeting/weapons delivery. A highly survivable UCAR system will prosecute enemy high value targets with relative impunity without placing a pilot in harm's way. UCAR's autonomous capabilities will enable effective teaming with manned systems and will eliminate the requirement for a dedicated ground control station. The UCAR capabilities will provide the Objective Force with the mobility, responsiveness, lethality, survivability, and sustainability required to ensure mission success. Specific objectives of the UCAR program include: development and demonstration of an effective, low total ownership cost design for the system; an air and ground-based command and control architecture for UCAR operations that does not require a dedicated ground control station; autonomous multi-ship cooperation and collaboration; autonomous low altitude flight; and system survivability.

(U) Program Plans:

- Complete the System Conceptual Design Review and the Demonstrator System Requirements Review.
- Prepare an initial risk management and mitigation plan and system capabilities document.
- Select up to two teams for Phase II, preliminary design.
- Continue system trades, effectiveness, and affordability analyses through modeling and simulation.
- Develop sufficient system concept fidelity to validate program goals and objectives.
- Complete the preliminary design and the Preliminary Design Review of the Demonstration System.
- Select one team for Phase III, System Demonstration.
- Initiate detailed design of the Demonstration System.
- Complete the Critical Design Review of the Demonstration System.
- Initiate fabrication of two UCAR Demonstrators.
- Perform component risk reduction demonstrations.

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	FY 2002	FY 2003	FY 2004	FY 2005
Quiet Supersonic Platform	1.092	4.800	0.000	0.000

(U) The Quiet Supersonic Platform (QSP) program is directed towards development and validation of critical technology for long-range advanced supersonic aircraft with substantially reduced sonic boom, and increased efficiency relative to current-technology supersonic aircraft. Improved capabilities include supersonic flight over land without adverse sonic boom consequences with boom overpressure rise less than 0.3 pounds per square foot, increased unrefueled range approaching 6,000 nmi, gross take-off weight approaching 100,000 pounds, increased area coverage and lower overall operational cost. Highly integrated vehicle concepts were explored to simultaneously meet the cruise range and noise level goals. Advanced airframe technologies including optimized configuration shaping and laminar flow control were explored and shown to be viable to minimizing sonic boom and vehicle drag. The objective is to develop and demonstrate these technologies in a series of tests to validate performance.

(U) Program Plans:

- Perform technology validation for long-range supersonic aircraft having low noise signature.
- Perform trade-studies and mission utility analysis.
- Conduct integration experiments and demonstrations of enabling technologies.
- Initiate preliminary system designs of highly integrated supersonic long-range aircraft.
- Conduct flight tests to validate optimized vehicle configurations produce shaped sonic boom signatures.
- Perform wind tunnel testing of low drag technology in simulated flight environment.
- Initiate preliminary design of laminar flow control technology integrated into flight test vehicle.
- Perform computational fluid dynamics calculations and conduct low and high speed wind tunnel tests of flight test vehicle to assess safety of flight.
- Conduct critical design review and initiate parts fabrication.
- Conduct flight testing to validate low drag technology in real flight environment.

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	FY 2002	FY 2003	FY 2004	FY 2005
Orbital Express Space Operations Architecture	30.996	0.000	0.000	0.000

(U) The goal of the Orbital Express Space Operations Architecture program is to validate the technical feasibility of robotic, autonomous on-orbit refueling and reconfiguration of satellites to support a broad range of future U.S. national security and commercial space programs. Refueling satellites will enable frequent maneuvers to improve coverage, change arrival times to counter denial and deception, and improve survivability, as well as extend satellite lifetime. Electronics upgrades on-orbit can provide "Moore's Law" performance improvements and dramatically reduce the time to deploy new technology. In addition, a servicing satellite can act as a "mother-ship" for micro-satellites, supporting deployment and operations of micro-satellites for missions such as space asset protection. The Orbital Express advanced technology demonstration will design, develop, and test on-orbit a prototype servicing satellite (ASTRO), a surrogate next generation serviceable satellite (NextSat), and the SPAWN Space Awareness prototype micro-satellite escort, that will provide near-field space situation awareness for U.S. satellites deployed in geo-stationary orbits. SPAWN will be designed with a modular satellite bus architecture, enabling rapid integration of payloads for responsive launch. The elements of the Orbital Express demonstration will be tied together by non-proprietary satellite servicing interfaces (mechanical, electrical, etc.) that will facilitate the development of an industry wide on-orbit servicing infrastructure. NASA will apply the sensors and software developed for autonomous rendezvous and proximity operations to reduce risk on the Orbital Space Plane and to enable future commercial resupply of the International Space Station. Launch of the demonstration system is scheduled for March 2006 on the Air Force Space Test Program MLV-05 mission. Beginning in FY 2003, this program is funded in Project ASP-02, Space Programs and Technology.

(U) Program Plans:

- Develop and validate software for autonomous mission planning, rendezvous, proximity operations and docking.
- Design, fabricate, and test on-orbit robotic satellite servicing, including fuel and electronics transfer, deployment of and operations with a micro-satellite.
- Design, fabricate, and test on orbit a modular micro-satellite for protection of stationary satellites.
- Perform utility assessments of on-orbit servicing in conjunction with operational customers and plan for technology transition.

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	FY 2002	FY 2003	FY 2004	FY 2005
Deep View	4.070	0.000	0.000	0.000

(U) The Deep View program (formerly entitled the "Space Object Identification System") will develop a high-resolution radar imaging capability to characterize objects in earth orbit. A special emphasis will be placed on imaging small objects at orbits ranging from low-earth orbit to geo-stationary orbit. The system will be based upon a large aperture imaging radar system redesigned to operate at very high power over very broad bandwidth at W-band. Key technology development will focus on transmitters capable of providing the required power to image at deep-space ranges over full bandwidth and antenna design that maintains necessary form factor over a very large aperture. The capabilities emerging from this program will enable the classification of unknown objects, such as space debris, as well as the monitoring of the health and status of operational satellites. In FY 2003, this program is funded in Project ASP-02, Space Programs and Technology.

(U) Program Plans:
- Perform analysis of transmitter technology alternatives.
- Analyze antenna design requirements.

	FY 2002	FY 2003	FY 2004	FY 2005
Space Technologies	6.704	0.000	0.000	0.000

(U) The Space Technologies Program developed and demonstrated advances in smart materials, multifunctional materials and power electronics to provide gains in the performance of space structures and systems. This work included materials, devices and novel structural systems that allow for large scale changes in shape and function with minimal energy/power requirements for shape control, and adaptation on-orbit to precisely align highly packaged spacecraft. This task also demonstrated an electronics module that utilizes the hybridization of cryogenic, superconducting and conventional room temperature power electronics for optimum performance of satellite systems. This hybridization translates to modules with increases of efficiency of factors of two to four, at least ten times lower system noise and significant reductions in size and weight that scale with the overall size of the system.

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(U) Program Plans:
- Initiated feasibility studies; developed conceptual designs and figures of merit for morphing/shape control of space vehicles.
- Developed multifunctional structure concepts for reducing weight, improving survivability and adaptively changing capability of space structures.
- Initiated design for integrated hybrid power module and quantify performance improvements in powering radio frequency, microwave and optical system.

	FY 2002	FY 2003	FY 2004	FY 2005
Canard Rotor/Wing (CRW)	0.000	2.600	14.763	14.912

(U) The Army, Navy, Air Force, and Marine Corps have a need for affordable, survivable, vertical take-off and landing (VTOL) air vehicles to support dispersed units. Canard Rotor/Wing (CRW) aircraft offer the potential for a high-speed, rapid response capability from a VTOL air vehicle with significant range and stealth improvements as compared to other VTOL concepts. Design, fabrication, ground and flight test of a scaled vehicle demonstrator will validate the stability and control system and aerodynamic performance required for vertical take-off, landing and hover via a rotating center wing that stops and locks in place for efficient high speed cruise. Following demonstration of the small scale vehicle, the program will proceed to design, development and demonstration of more operationally representative vehicles including manned aircraft. In FY 2002, this program was funded in PE 0602702E, Project TT-07.

(U) Program Plans:
- Complete ground testing and conduct demonstrator flight tests at Yuma Proving Grounds.
- Conduct demonstrator flight tests.
- Begin design and development of follow-on manned and unmanned vehicles.

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	FY 2002	FY 2003	FY 2004	FY 2005
Heavy Fuel Engine for A160	0.000	0.932	2.195	1.687

(U) The Heavy Fuel Engine for A160 program will develop and demonstrate a heavy-fuel, lightweight, and efficient engine for the A160 air vehicle. In the future, heavy fuel (diesel or JP-8) will be the only logistic fuel for the battlefield. Conventional heavy-fuel engines are too heavy for air vehicles and, at the desired size, not efficient enough. An innovative and advanced diesel engine concept will be developed to achieve both efficiency and a significant reduction in weight. This engine will enable the A160 to achieve maximum range and endurance while operating on diesel fuel.

(U) Program Plans:
- Detail design of the engine.
- Demonstrate performance of prototype engine at 33% efficiency and 0.83 hp/lb.
- Demonstrate performance and reliability of optimized engine at 39% efficiency and 1.0 hp/lb.

(U) Other Program Funding Summary Cost:

Advanced Air Vehicle: Hummingbird Warrior	FY 2002	FY 2003	FY 2004	FY 2005
SOCOM	5.700	9.000	0.000	0.000

Unmanned Combat Air Vehicle (UCAV)	FY 2002	FY 2003	FY 2004	FY 2005
PE 0603333F, Air Force	18.903	17.608	0.000	0.000
PE 0604731F, Air Force	0.000	39.127	TBD	TBD
PE 0207256F, Air Force	0.000	0.000	TBD	TBD

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Unmanned Combat Armed Rotorcraft (UCAR)	FY 2002	FY 2003	FY 2004	FY 2005
PE 0602211, Project 47A, Army	6.000	10.000	0.000	0.000
PE 0603003, Project 313, Army	0.000	0.000	14.000	20.000

Orbital Express Space Operations Architecture	FY 2002	FY 2003	FY 2004	FY 2005
NASA	8.000	9.000	8.000	0.000

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COST (In Millions)	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Space Programs and Technology, ASP-02	0.000	110.517	209.373	230.720	248.606	321.769	346.930	381.014

(U) Mission Description:

(U) A space force structure that is robust against attack represents a stabilizing deterrent against adversary attacks on space assets. In addition to the ability to detect and characterize potential attacks, robustness against attack is provided by proliferation of assets, ready access to space, and a flexible infrastructure for maintaining the capabilities of on-orbit assets. Ready access to space allows the delivery of defensive systems and replenishment supplies to orbit. An infrastructure to service the mission spacecraft allows defensive actions to be taken without limiting mission lifetime. In addition, developing space access and spacecraft servicing technologies will lead to reduced ownership costs of space systems and new opportunities for introducing technologies for the exploitation of space. Systems development is also required to increase the interactivity of space systems, space-derived information and services with terrestrial users. Because of the increasing national importance of this area, and the expanded resource allocations devoted to it, a separate project, ASP-02, has been created.

(U) Program Accomplishments/Planned Programs:

	FY 2002	FY 2003	FY 2004	FY 2005
Orbital Express Space Operations Architecture	0.000	39.565	55.110	45.100

(U) The goal of the Orbital Express Space Operations Architecture program is to validate the technical feasibility of robotic, autonomous on-orbit refueling and reconfiguration of satellites to support a broad range of future U.S. national security and commercial space programs. Refueling satellites will enable frequent maneuver to improve coverage, change arrival times to counter denial and deception and improve survivability, as well as extend satellite lifetime. Electronics upgrades on-orbit can provide regular performance improvements and dramatically reduce the time to deploy new technology on-orbit. In addition, a servicing satellite can act as a "mother-ship" for micro-satellites, supporting deployment and operations of micro-satellites for missions such as space asset protection and sparse aperture formation flying. The Orbital Express advanced technology demonstration will design, develop and test on-orbit a prototype servicing satellite (ASTRO), a surrogate next

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generation serviceable satellite (NextSat), and the Space Awareness (SPAWN) prototype micro-satellite escort, that will provide near-field space situation awareness for U.S. satellites deployed in geo-stationary orbits. SPAWN will be designed with modular satellite bus architecture, enabling rapid integration of payloads for responsive launch. The elements of the Orbital Express demonstration will be tied together by non-proprietary satellite servicing interfaces (mechanical, electrical, etc.) that will facilitate the development of an industry wide on-orbit servicing infrastructure. NASA will apply the sensors and software developed for autonomous rendezvous and proximity operations to reduce risk on the Orbital Space Plane and to enable future commercial resupply of the International Space Station. Launch of the demonstration system is scheduled for March 2006 on the Air Force Space Test Program MLV-05 mission. In FY 2002, this program was funded from PE 0603285E, Project ASP-01, Advanced Aerospace Systems.

(U) Program Plans:

- Develop and validate software for autonomous mission planning, rendezvous, proximity operations and docking.
- Design, fabricate, and test on-orbit robotic satellite servicing, including fuel and electronics transfer, deployment of and operations with a micro-satellite.
- Design, fabricate and test on orbit a modular micro-satellite for protection of U.S. geo-stationary satellites.
- Perform utility assessments of on-orbit servicing in conjunction with operational customers and plan for technology transition.

	FY 2002	FY 2003	FY 2004	FY 2005
Space Surveillance Telescope	0.000	3.966	9.000	17.000

(U) The Space Surveillance Telescope program will develop and demonstrate an advanced ground-based optical system to enable detection and tracking of faint objects in space, while providing rapid, wide-area search capability. The program will leverage recent advances in curved focal plane array sensor technology and novel optics design to build a telescope with a large aperture that provides detection sensitivity with a low-aberration wide field-of-view to provide rapid wide-area search coverage. This capability will enable ground-based detection of un-cued objects in space for purposes such as asteroid detection and other defense missions. In FY 2002, this program was funded from PE 0603762E, Project SGT-02, Aerospace Surveillance Technology.

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(U) Program Plans:
- Complete telescope design.
- Complete focal plane design.
- Fabricate and test first curved focal plane tile.
- Fabricate remaining sensor elements.
- Begin optics fabrication.

	FY 2002	FY 2003	FY 2004	FY 2005
Innovative Space-Based Radar Antenna Technology (ISAT)	0.000	14.873	39.800	48.000

(U) The Innovative Space-Based Radar Antenna Technology (ISAT) effort is building on the FY 2002 conceptual designs addressing the technical and economic feasibility of developing space-based radar antennas necessary for tactical-grade ground moving target indication performance from space using rigidized inflatable technologies – a potentially key enabling technology. Ultra-low cost, lightweight technologies offer the potential for developing and deploying extremely large apertures in space – including RF and possibly optical apertures. Antennas of 100 – 300 meters in length, if feasible and affordable, will enable the revolutionary performance required to conduct true tactical sensing from space. Two competing conceptual designs, including a detailed technical design, and focused testing of key design components such as flexible transmit/receive modules, thin-film solar cells, and membrane designs will be developed. Additionally, the program will conduct ground-based risk reduction experiments demonstrating the accuracy of the constitutive models for deployment and control of rigidized inflatable structures, and will develop performance predictions on the selected designs as well as lifecycle cost models. One design will be selected to carry out a space-based experiment, culminating in a demonstration of tactical targeting from space. In FY 2002, a series of studies and lab tests to prepare for this activity was funded in PE 0603762E, Project SGT-03, Air Defense Initiative.

(U) Program Plans:
- Develop next-generation lightweight electronics, materials and deployment structures.
- Perform ground-based risk reduction experiments for packaging and deployment mechanisms and materials, including simulation of mechanical and thermal loads.

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– Complete systems designs for space-based experiment; downselect to single design; build, integrate and demonstrate tactical targeting from space.

	FY 2002	FY 2003	FY 2004	FY 2005
Deep View	0.000	4.199	9.520	10.220

(U) The Deep View program (formerly entitled the "Space Object Identification System") will develop a high-resolution radar imaging capability to characterize objects in earth orbit. A special emphasis will be placed on imaging small objects at orbits ranging from low-earth orbit to geo-stationary orbit. The system will be based upon a large aperture imaging radar system redesigned to operate at very high power over very broad bandwidth at W-band. Key technology development will focus on transmitters capable of providing the required power to image at deep-space ranges over full bandwidth and antenna design that maintains necessary form factor over a very large aperture. The program will investigate the feasibility of designing a transportable version of such a system. The capabilities emerging from this program will enable the classification of unknown objects, such as space debris, as well as the monitoring of the health and status of operational satellites. In FY 2002, this program was funded in Project ASP-01, Advanced Aerospace Systems.

(U) Program Plans:

– Perform transmitter power combiner experiments.
– Complete transmitter design and radar system design.
– Begin signal processing software development.

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	FY 2002	FY 2003	FY 2004	FY 2005
Responsive Access, Small Cargo, Affordable Launch (RASCAL)	0.000	24.303	38.500	33.400

(U) The Responsive Access, Small Cargo, Affordable Launch (RASCAL) program will design and develop a low cost orbital insertion capability for dedicated micro-size satellite payloads. The concept is to develop a responsive, routine, small payload delivery system capable of providing flexible access to space using a combination of reusable and low cost expendable vehicle elements. Specifically, the RASCAL system will be comprised of a reusable airplane-like first stage vehicle called the reusable launch vehicle and a second stage expendable rocket vehicle. The RASCAL demonstration objectives are to place satellites and commodity payloads, between 50 and 130 kilograms in weight, into low-earth orbit at any time, with launch efficiency of $20,000 per kilogram or less. While the cost goal is commensurate with current large payload launch systems, the operational system, through production economies of scale, will be more than a factor of three less than current capabilities for the dedicated micro payload size. This capability will enable cost effective use of on-orbit replacement and re-supply and provide a means for rapid launch of orbital assets for changing national security needs. This program will utilize reusable aircraft technology for the first stage and will take advantage of low-cost rocket technologies for the expendable upper stages. With recent advances in design tools and simulations, this program will prudently reduce design margins and trade-off system reliability to maximize cost effectiveness. This program will also leverage advancements in autonomous range safety, first-stage guidance; and predictive vehicle health diagnosis, management and reporting to lower the recurring costs of space launch. In FY 2002, this program was funded from Project TT-06, Advanced Tactical Technology.

(U) Program Plans:

- Develop Contractor Life Cycle Cost Model (CLCC).
- Prototype Mass Injection Pre-compressor Cooling (MIPCC) manifold – engine testing.
- Select Phase II preferred system concept(s).
- Establish Preliminary and Critical Design of full system.
- Conduct mission cycle testing of the first-stage reuseable launch vehicle propulsion in direct connect wind tunnel.
- Conduct early Risk Reduction testing of subsystems: wind tunnel, scaled static fires, Guidance, Navigation & Control (GN&C) simulation, material coupon testing, and Radar Cross Section (RCS) firing.
- Select Phase III team(s) for preferred flight test program.
- Conduct static fire of potential new rocket motor designs.
- Flight test MIPCC equipped aircraft.

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- Integrate low cost expendable rocket vehicle and common head steering stage design.
- Develop instrumentation package for maiden payload.
- Conduct two orbital insertion missions for final demonstration.

	FY 2002	FY 2003	FY 2004	FY 2005
Low Cost Tactical Imager	0.000	3.472	12.210	15.000

(U) The Low Cost Tactical Imager (LCTI) program will develop an inexpensive, high-resolution, day/night imaging spacecraft able to be rapidly manufactured and launched on-demand, anywhere, into any orbit to support the tactical warfighter. LCTI will provide the first-ever ability to task the spacecraft and downlink the imagery in the same pass to support near real time imaging and targeting, perform rapid bomb damage assessment, and defeat denial and deception techniques. The Low Cost Tactical Imager (LCTI) will also investigate space-based optical designs capable of performing broad area surveillance and moving target indication through such methods as foveated imaging. LCTI will demonstrate novel technologies to reduce the spacecraft mass by half and the telescope by a factor of ten to enable launch on an air launched booster such as Pegasus or RASCAL. Today's imaging spacecraft require years of lead time to manufacture the primary optic; LCTI will reduce the build time to a month using just-in-time manufacturing to enable short notice call up and eliminate the need for spare spacecraft. Key enabling technologies include lightweight optics such as Fresnel lenses, nanolaminates, membranes, deployables, inflated substrates, composite bus structures and electric propulsion.

(U) Program Plans:

- Develop candidate designs for low-cost, light-weight imaging system; estimate performance for candidate designs.
- Develop component technologies, including very light weight optics that are easy to deploy.
- Evaluate feasibility of optical moving target identification for wide area surveillance.
- Perform ground-based risk reduction experiments.
- Design, build and integrate space-based prototype.

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	FY 2002	FY 2003	FY 2004	FY 2005
HyperSoar	0.000	7.500	17.500	25.000

(U) The HyperSoar program objectives are to develop and demonstrate technologies that will enable both near-term and far-term capability to execute time-critical, global reach missions. Near-term capability will be accomplished via development of a rocket boosted, expendable munitions delivery system that delivers its payload to the target by executing unpowered boost-glide maneuvers at hypersonic speed. This concept called the Common Aero Vehicle (CAV) would be capable of delivering up to 1,000 pounds of munitions to a target 3,000 nautical miles down-range. An Operational Responsive Spacelift (ORS) booster vehicle will place CAV at the required altitude and velocity. The HyperSoar program will develop a low cost rocket booster to meet these requirements and demonstrate this capability in a series of flight tests culminating with the launch of an operable CAV-like payload. Far-term capability is envisioned to entail a reusable, hypersonic aircraft capable of delivering 12,000 pounds of payload to a target 9,000 nautical miles from CONUS in less than two hours. Many of the technologies required by CAV are also applicable to this vision vehicle concept such as high lift-to-drag technologies, high temperature materials, thermal protection systems, and periodic guidance, navigation, and control. Initiated under the Space Vehicle Technologies program, and leveraging technology developed under the Hypersonics program, HyperSoar will build on these technologies to address the implications of powered hypersonic flight and reusability required to enable this far-term capability. The HyperSoar program addresses many high priority mission areas and applications such as global presence, space control, and space lift.

(U) Program Plans:

- Complete Common Aero Vehicle (CAV) and Operational Responsive Spacelift (ORS) system designs.
- Perform periodic trajectory analysis for vision vehicle.
- Complete vision vehicle system level design.
- Initiate preliminary design of CAV and ORS vehicles.
- Perform technology validation for reusable, hypersonic aircraft.
- Conduct critical design review of CAV and ORS and initiate fabrication.
- Initiate preliminary design of the reusable technology demonstration vehicle.
- Conduct CAV flight experiments using existing boosters.
- Conduct ORS flight experiments.
- Conduct ORS flight test with CAV prototype separation.

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- Conduct critical design review of X-vehicle and initiate fabrication.
- Conduct flight testing of advanced reusable technologies.

	FY 2002	FY 2003	FY 2004	FY 2005
Rapid On-Orbit Anomaly Surveillance and Tracking (ROAST)	0.000	0.000	5.000	9.000

(U) The Rapid On-Orbit Anomaly Surveillance and Tracking (ROAST) program will provide a space-based capability to detect and track on-orbit objects with rapid revisit rates and low latencies. The system will feature a moderate-sensitivity, wide-field-of-view optical telescope hosted in a low-cost, rapid deployment microsatellite constellation. Space-based deployment facilitates event detection with extremely low latency, and low-cost deployment allows sufficient assets to provide global coverage. Key technologies include light-weight mirror technology to provide moderate apertures within extremely constrained spacecraft weight constraints and dynamic frame read-out charge coupled device sensors to allow adaptive tasking.

(U) Program Plans:

- Demonstrate light-weight optics fabrication capability.
- Complete telescope design.
- Complete charged coupled device design lay-out.
- Complete system design.

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	FY 2002	FY 2003	FY 2004	FY 2005
High Frequency Active Auroral Research Project (HAARP)	0.000	10.200	15.000	15.000

(U) The High Frequency Active Auroral Research Project (HAARP) will develop new experimental research capabilities and will conduct research programs to exploit emerging ionosphere and radio science technologies related to advanced defense applications. The FY 1990 Appropriation Act provided funds for the creation of HAARP, jointly managed by the Air Force Research Laboratory and the Office of Naval Research to exploit emerging ionosphere and high power radio technology for new military systems applications. Key to this effort is the expansion of an experimental research facility that includes a 3.6 MW high-frequency transmitter and a variety of diagnostic instruments, to conduct investigations to characterize the physical processes that can be initiated and controlled in the ionosphere and space, via interactions with high power radio waves. Among these are: (1) the generation of extremely low frequency/very low frequency radio waves for submarine and other subsurface communication, the imaging of underground features and deeply buried targets, and the reduction of charged particle populations in the radiation belts (through direct coupling or with augmenting electro-dynamic (ED) tethers) to ensure safe spacecraft systems operations; (2) the control of electron density gradients and the refractive properties in selected regions of the ionosphere to create radio wave propagation channels; and (3) the generation of optical and infrared emissions in space to calibrate space sensors. To date, the facility has been developed to include a suite of optical and radio diagnostics and an advanced, modern, high frequency transmitting array that has a radiated power of 960 kW, about one-third of the 3.6MW called for in the original concept and plan. The current facility has proven to be extremely reliable and flexible, and has shown the feasibility of the overall concept. Basic and exploratory development research programs are now being conducted routinely with it. Results to date indicate that advanced applications-related research activities and new military system concept demonstrations envisioned under the program require that the high frequency transmitting capability at the site be increased from the present 960 kW level to the originally planned 3.6 MW level. A recent study completed by an Air Force/Navy Panel also points to additional high-value functions that can potentially be accomplished with the a 3.6 MW capability, in particular, the exploration and refinement of scientific principles that could lead to the development and deployment of a system to provide protection for space-based assets from emergent asymmetric threats.

(U) Program Plans:

- Complete the HAARP physical facility at the HAARP Research Station, Gakona, AK.
- Operate and maintain the physical facility.
- Conduct advanced ionosphere and radio science research and analysis of applications including space-based asset protection and phenomena related to its implementation.

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	FY 2002	FY 2003	FY 2004	FY 2005
Suborbital Space Launch Operations	0.000	2.439	0.000	0.000

(U) The goal of the Suborbital Space Launch Operations program is to develop and demonstrate a piloted, reusable suborbital launch vehicle initially to perform short duration testing of space flight hardware, and ultimately to provide a platform for tactical battlefield surveillance.

(U) Program Plans:
- Design fabricate and test restartable modular propulsion system capable of providing both ascent and descent propulsion.
- Demonstrate propulsion system operation including restart without maintenance or refueling.

	FY 2002	FY 2003	FY 2004	FY 2005
Space Assembly and Manufacture	0.000	0.000	7.733	13.000

(U) The goal of the Space Assembly and Manufacture program is to examine and validate technical options for manufacturing large space structures outside the confines of the Earth's gravity. Manufacturing in the space environment will enable novel structures that could not survive the loads experienced during terrestrial launch. Extremely large structures enable resolution and accuracy from optical and radar systems that are not otherwise conceivable. Such structures are important to antennas, optics, solar collectors and other technologies to address both National security and energy issues. The Space Assembly and Manufacture program will comprise resource utilization, robotic processing, enabling structures, micro-satellite sensors, propellants and power generation. Manufacturing processes, such as vacuum deposition, that can take advantage of the space environment will be included. Mass and complexity minimization of key components will drive the design of the system.

(U) Program Plans:
- Identify key technical challenges and define a demonstration mission to resolve critical issues for space manufacture.
- Develop microsatellite sensor platforms that can determine chemical composition and location of resources on non-terrestrial objects.
- Design, fabricate and test miniaturized robotics capable of remotely processing materials and building rudimentary structures.
- Perform utility assessments of space manufacture in conjunction with operational customers and plan for technology transition.

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(U) Other Program Funding Summary Cost:

Orbital Express Space Operations Architecture	FY 2002	FY 2003	FY 2004	FY 2005
NASA	8.000	9.000	8.000	0.000

High Frequency Active Auroral Research Project (HAARP)	FY 2002	FY 2003	FY 2004	FY 2005
PE 0601153N, Navy	0.000	12.500	15.000	16.000
PE 0602601F, Air Force	0.000	0.000	10.000	10.000