RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2008
APPROPRIATION/BUDGET ACTIVITY: RDT&E, Defense-wide; BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE: Guidance Technology; PE 0603768E

COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Total Program Element (PE) Cost	127.170	124.974	110.572	80.238	83.804	92.713	92.719
Guidance Technology GT-01	49.808	44.856	41.125	30.225	29.718	29.718	29.717
Classified GT-CLS	77.362	80.118	69.447	50.013	54.086	62.995	63.002

(U) Mission Description:

(U) The Guidance Technology program element is budgeted in the Advanced Technology Development Budget Activity because it is developing system oriented technologies that will improve our ability to navigate weapon systems with more precision and increase the capability to meet current and emerging threats.

(U) The Guidance Technology project will increase the ability of Global Positioning System (GPS) users to operate effectively in the presence of enemy jamming; to increase the versatility of navigation systems applications by developing microelectromechanical sensor inertial navigation system technologies; and to apply the geolocation technologies/techniques to precision threat geolocation of short-dwell emitters or passive air defense systems. Fire-and-forget standoff weapons need precise targeting information if critical fixed and mobile targets are to be eliminated effectively with minimal collateral damage and minimum cost-per-kill. This requires that: (1) military surveillance and targeting systems geolocate targets accurately in the same coordinate system in which the weapon system navigates; (2) the surveillance, targeting and weapon systems have precision navigation and guidance systems on-board; and (3) navigation and target location systems robustly operate day/night and in adverse weather. In addition, future systems designed to accomplish precision strike missions must be significantly more affordable. The achievement of these characteristics in an integrated system is the goal of this project.

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(U) Program Change Summary: *(In Millions)*

	FY 2007	FY 2008	FY 2009
Previous President's Budget	142.826	127.777	121.704
Current Budget	127.170	124.974	110.572
Total Adjustments	-15.656	-2.803	-11.132
Congressional program reductions	-12.000	-2.803	
Congressional increases	0.000		
Reprogrammings	0.000		
SBIR/STTR transfer	-3.656		

(U) Change Summary Explanation:

FY 2007	Decrease reflects the Section 8043 Recission and the SBIR/STTR transfer.
FY 2008	Decrease reflects reductions for Section 8097 Contractor Efficiencies, Section 8104 Economical Assumptions, and Section 8025(f) FFRDCs.
FY 2009	Decrease reflects program rephasings in Project GT-CLS, offset by expansion of guidance technologies in Project GT-01.

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COST (In Millions)	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Guidance Technology GT-01	49.808	44.856	41.125	30.225	29.718	29.718	29.717

(U) Mission Description:

(U) Fire-and-forget standoff weapons need precise targeting information if critical fixed and mobile targets are to be eliminated effectively with minimal collateral damage and minimum cost-per-kill. This requires that: (1) military surveillance and targeting systems geolocate targets accurately in the same coordinate system in which the weapon system navigates; (2) the surveillance, targeting and weapon systems have precision navigation and guidance systems on-board; and (3) navigation and target location systems robustly operate day/night and in adverse weather. In addition, future systems designed to accomplish precision strike missions must be significantly more affordable. Thrusts are included in this project to improve our ability to navigate when the Global Positioning System (GPS) is jammed or otherwise unavailable; to increase the versatility of navigation systems applications by developing microelectromechanical sensor inertial navigation system technologies; and to apply the geolocation technologies/techniques to precision threat geolocation of short-dwell emitters or passive air defense systems.

(U) Program Accomplishments/Planned Programs:

	FY 2007	FY 2008	FY 2009
Multifunctional Electro-Optics for Defense of U.S. Aircraft (MEDUSA)	13.005	15.000	15.669

(U) The Multifunction Electro-Optics for Defense of U.S. Aircraft (MEDUSA) program will develop the technologies and systems to give the U.S. air dominance at low altitude and at night. This program will develop the technologies to leap-frog reactive end-game countermeasures and enable increased threat warning times, denial of launch, and put Electro Optical-Infrared (EO-IR) air defense threats at risk. MEDUSA is a three-part technology program: (1) conduct phenomenological measurements and develop countermeasures and target classification/identification techniques; (2) develop critical component technologies such as high-power IR laser sources, advanced IR detectors, and fibers for high-power IR transmission; and (3) develop and demonstrate an end-to-end MEDUSA system. The MEDUSA technology is planned for transition to the Air Force and Army at the conclusion of technology development and flight demonstration, which is anticipated to be completed during FY 2011.

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(U) Program Plans:

FY 2007 Accomplishments:

- Initiated development of high-performance 128x128 focal plane arrays (FPAs) to enable the MEDUSA missions.
- Completed design of the Read-Out Integrated Circuit (ROIC) enabling extremely low-power, high-sensitivity (>300 gain), high-speed (>10 kHz frame rate), high-bandwidth (>100 MHz) features for an active receiver in the Near/Mid-Wave Infrared (NMIR) regime.
- Completed design of the ROIC enabling low-power, high-sensitivity, high-speed features for an active receiver in the LWIR regime.
- Fabricated initial NMIR high-speed, low-power, 128x128 ROIC and performed a design validation test of performance.

FY 2008 Plans:

- Fabricate first fully integrated large format 128x128 NMIR FPA integrated with a low-power, high-speed ROIC, demonstrating high-sensitivity and high-gain (>300) performance in an integrated FPA/ROIC compact camera cryo-cooler package.
- Fabricate final Long-Wave Infrared (LWIR) ROIC prior to hybridization with FPA.

FY 2009 Plans:

- Complete fabrication of first fully integrated large format 128x128 LWIR FPA integrated with a low-power, high-speed ROIC, demonstrating high-sensitivity large format heterodyne receiver performance in an integrated FPA/ROIC compact camera cryo-cooler package.

	FY 2007	FY 2008	FY 2009
Precision Inertial Navigation Systems (PINS)	9.259	6.000	4.000

(U) The Precision Inertial Navigation Systems (PINS) program will develop an entirely new class of inertial navigation instruments using atomic inertial force sensors. These sensors utilize the quantum-mechanical wave-like nature of atoms in the atomic analogue of an optical interferometer to provide unprecedented sensitivity to accelerations and rotations. The atomic sensors will further be used to measure the local gravitational field gradient to ensure that instrument alignment is properly maintained throughout vehicle maneuver, thus mitigating gravity-induced navigation errors. Initial program efforts will focus on developing fundamental technology components upon which future systems would be constructed. The PINS technology is planned for transition to the Navy and Air Force at the conclusion of Phase III, which is anticipated to be completed by the end of FY 2009.

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(U) Program Plans:

FY 2007 Accomplishments:

- Demonstrated eight atom cloud, synchronous Inertial Measurement Unit (IMU) in a static environment providing position and angle output at 10 Hz update rate.
- Designed and assembled hardware test bed to evaluate system components in realistic operating environment.

FY 2008 Plans:

- Install stable platform for PINS IMU into ground vehicle for FY 2009 cross-country demonstration.
- Complete open-ocean test campaign with combat swimmers demonstrating <100 meter per hour submerged navigation error.

FY 2009 Plans:

- Demonstrate gravity-compensated atom cloud IMU in ground vehicle that accumulates <5 meters per hour integrated navigation error for path between Palo Alto, CA and Arlington, VA.
- Design and construct pre-production prototype for final evaluation by Marine Corps combat swimmers.

	FY 2007	FY 2008	FY 2009
Robust Surface and Sub-Surface Navigation (RSN/SSN)	12.044	12.000	9.456

(U) The Robust Surface and Sub-Surface Navigation (RSN/SSN) program will provide the U.S. warfighter with the ability to navigate effectively when the GPS is unavailable due to hostile action (e.g. jamming) or blockage by structures and foliage. The RSN/SSN program will use signals of opportunity and specialized signals from a variety of ground, air, and space-based sources and judiciously placed low frequency RF beacons; these will be received on the warfighter's forthcoming software defined radios and use specially tailored algorithms to determine position. Other signals such as the Earth's magnetic field (micro deviations), and cyclic variations in the Earth's gravitational field due to tidal motion, will also be evaluated. The greater strength and diversity of these signals will provide coverage when GPS is denied due to lack of penetration into buildings and underground, and when severe multipath is a problem. This is a two-part program: (1) cataloging and assessing of potential exploitable signals followed by analysis and performance modeling and hardware-based concept validation and (2) designing, testing, and demonstrating of a (non-form-fit) prototype receiver(s) and algorithms for geolocation using the signals of opportunity. The RSN/SSN technology is planned for transition to U.S. Special Operations Command, the U.S. Army and the U.S. Air Force by FY 2010.

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(U) Program Plans:

FY 2007 Accomplishments:

- Evaluated feasibility of RSN candidate approaches using modeling, analysis, and simulation.
- Successfully demonstrated SSN beacon geolocation approach for underground navigation.
- Developed critical RSN/SSN technologies and conducted phenomenological measurements to validate the selected concepts.
- Completed design and component-level testing of SSN system.
- Developed and conducted performance analysis of innovative algorithms for SSN that enhanced form/fit of user receiver.

FY 2008 Plans:

- Design and fabricate prototype SSN system.
- Complete concept design of RSN systems.

FY 2009 Plans:

- Complete fabrication of RSN systems.
- Test functional prototype SSN system for underground use.

	FY 2007	FY 2008	FY 2009
Navigation-Grade MEMS Inertial Measurement Unit (IMU)	15.500	11.000	7.000

(U) The Navigation-Grade MEMS Inertial Measurement Unit (IMU) program will develop micro-scale accelerometers and gyros with navigation-grade performance that use only milli-watts of power. The program will transcend traditional single mass-spring methods for navigation sensing and will explore alternative approaches, such as multiple, interconnected mass-spring systems, micro-levitated spinning structures, micro-optical readout mechanisms, atomic interferometric readout mechanisms, and fluidic contortions. This program will transition to industrial performers by developing wearable inertial measurement units (IMUs) for dismounted warfighters capable of GPS-denied navigation for lengthy periods; small IMUs for unmanned air and underwater vehicles, and for guidance of small, long-range munitions—all of which will go into DoD systems.

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(U) Program Plans:
FY 2007 Accomplishments:
– Achieved 3-D resonator structures (e.g., spheres, full wine-glass structures).
FY 2008 Plans:
– Develop levitation methods.
– Develop fluid contortion sensing.
FY 2009 Plans:
– Develop micro-environmental control.
– Control electronics integration.

	FY 2007	FY 2008	FY 2009
Active Electrol-Optical Mapping and Navigation System (AONS)	0.000	0.856	0.000

(U) The Active Electrol Optical Mapping and Navigation System (AONS) program will provide GPS-denied navigation and detailed building interior mapping to soldiers operating in urban environments. AONS will employ electro-optic system strengths in image registration and precision range to track and map a soldier's or vehicle's position continuously. Using image-flow methods, a compact, power-efficient camera and optional laser radar system will track the imagery from frame-to-frame and estimate camera pose and position information to provide the soldier a very precise determination of current position as well as a continuously updated map of the building or underground facility (UGF) being traversed.

(U) Program Plans:
FY 2008 Plans:
– Conduct feasibility study.

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	FY 2007	FY 2008	FY 2009
COmpact Ultra-stable Gyro for Absolute Reference (COUGAR)	0.000	0.000	5.000

(U) The COmpact Ultra-stable Gyro for Absolute Reference (COUGAR) program goal is to realize the fundamental performance potential of the resonant fiber optic gyro (RFOG) in combination with bandgap optical fiber (BGOF), ultra-stable compact lasers, phase conjugate elements (PCEs), and silicon optical benches: a compact ultra-stable gyro for absolute reference applications. The COUGAR gyro will have a practical and typical size (~ 4 inch diameter) featuring bias stability and sensitivity (or angle random walk), which is more than 100 times better than state-of-the-art gyroscopes.

(U) Program Plans:
FY 2009 Plans:
- Develop purely single-polarization low-loss, low glass-content BGOF.
- Demonstrate compact narrow line-width single-frequency laser technology with ultra-low jitter and the capability of extremely linear frequency scanning.
- Develop resonator-ready (low loss) PCEs for mitigating residual non-linear Kerr Effect errors and relaxing tolerances on laser intensity stabilization requirements.
- Develop silicon optical bench technology for optical ruggedization and a path toward a compact and affordable gyroscope.

(U) Other Program Funding Summary Cost:

- Not Applicable.