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500 DIRECTOR OF APPLIED ENGINEERING AND TECHNOLOGY (AETD)

In concert with GSFC strategic initiatives, the fundamental responsibilities of the AETD are to:

- Provide the full range of engineering discipline expertise needed to enable end-to-end conceptualization, development, and use of earth and space science missions, including the delivery of appropriate science products.

- Provide leadership and vision to advocate and implement a broad range of advanced technology activities in appropriate discipline areas in order to meet current and future space and earth science mission needs.

- To fulfill these responsibilities the directorate provides expertise in the following engineering skill areas: information systems; electrical systems; mechanical systems; guidance, navigation and control; and instrument technology.

These areas work closely together to enable the definition, development and use of scientific instruments, flight platforms, ground systems, and science data processing systems.

The Directorate provides and advances discipline expertise to implement all phases of a product life cycle from germination of the measurement concepts within the science laboratory, through mission definition, design, manufacture, integration, test, operation, and processing of the resultant data. Each area is responsible for infusing improved processes and technology products throughout the life cycle to improve system performance and better enable future missions.

In order to maintain the capability to fulfill its fundamental responsibilities for mission support and technology development, each skill area provides and maintains appropriate facilities, laboratories, analytic tools, and expertise.

The Directorate provides engineering and technology expertise to other Center elements as required. Additionally, the Directorate is in charge of operating the Integrated Design Centers (IDC). The IDC's consist of the Integrated Mission Design Center (IMDC) and the Instrument Synthesis and Analysis Laboratory (ISAL).

The Directorate interacts with the Space and Earth Science Directorates to plan appropriate technology activities that are responsive to future science mission needs. Those technology activities are implemented both directly by AETD and through cooperative activities with outside organizations.

In fulfilling Agency and GSFC strategic initiatives, engineering capability is also provided to other NASA centers, other government agencies, industry, and academia. Partnerships are forged with this same set of external organizations to cooperatively fulfill the directorate's responsibilities where appropriate. In addition, the directorate proactively works to transfer technology to the private sector, as well as to foster broad community outreach.

501 BUSINESS MANAGEMENT OFFICE

Responsible for the administration and management of all AETD resources in support of the Directorate's institutional and programmatic objectives. These responsibilities include financial planning, budgeting, budget execution, resource analysis, and overall financial management support to all the functional Centers in the Directorate.

Responsible for the business management support to the AETD. These responsibilities include programmatic and institutional manpower planning and analysis, development of tools to assess the availability of the correct manpower skills and to simulate different deployment scenarios to support new business activities, and travel and training budget preparation and tracking.

Responsible for the implementation of full cost accounting within AETD.

Provides leadership and coordination of all AETD outreach and training initiatives.

504 INNOVATIVE PARTNERSHIP PROGRAM

Management responsibilities for the GSFC Innovative Partnership Program Office (IPPO) are accomplished through the implementation of strategic business processes to foster external research and development partnering opportunities for leveraging the utilization of Goddard's expertise, facilities, and technologies. Additionally, the IPPO seeks innovative business practices to formulate technical partnerships with industry, academia, and other government entities. The IPPO is responsible for managing Goddard's intellectual property assets. This is done through directing the registration and assessment of new technologies by Goddard civil servant and contractor innovators. IPPO is then responsible for determining patenting and licensing decisions for Goddard owned technologies. Outreach activities that promote partnership opportunities with industry, academia, and other government agencies are integral to the functionality of the GSFC IPPO. The IPPO also initiates nominations for internal and external technology based awards. The role of the GSFC liaison to NASA's Inventions and Contributions Board regarding internal NASA awards and the responsibility of the Software Release Authority are the responsibility of the GSFC IPPO.

540 MECHANICAL SYSTEMS DIVISION

The Mechanical Systems Division (MSD) is an innovative center of expertise which provides multidisciplinary capabilities and technology development to design, analyze, fabricate, integrate, test, and launch advanced scientific instruments and support platforms for a variety of ground-based, suborbital, and orbital space and earth science missions.

Performs the material selection and qualification, mechanical design, structural analysis, development, assembly, mechanical integration, and testing of spacecraft, subsystems, instruments, payload support structures, deployable mechanical and electromechanical subsystems, and ground support equipment. Develops electromechanical devices for ultra-high precision, low disturbance, cryogenic, long life, and other unique applications. Performs the thermal design, analysis, development, integration, and test of spacecraft, instrument, and payload thermal control subsystems. Responsible for contamination analysis, testing, evaluation, monitoring, and protection of critical subsystems, components, and facilities. Performs multidisciplinary systems trade studies directed toward optimizing the mechanical and thermal performance, as well as resource requirements, of state-of-the-art spacecraft, instruments, and payloads. Provides simulations and assessments of structural integrity, functional performance, and safety during all phases of the mission. Provides support for transportation of the payload to and within the launch site, field operations, and pre- and post-launch activities.

Operates, maintains, and provides engineering support for a comprehensive array of facilities for manufacturing, assembly and integration, environmental simulation, and testing and evaluation. Provides broad technical capabilities in the material sciences, materials assurance technology, and applications directed toward assuring the overall safety and reliability of flight and ground systems.

Provides leadership and vision to plan, implement, and manage an active research and technology program through ground-based and flight experiments to advance the state-of-the-art in areas such as materials performance and technology; advanced heat transport and thermal control devices; ultra-high precision and long-life mechanisms; contamination science; and precision deployable, lightweight, and low-cost structures. Performs advanced research in support of the development of improved design and analytical tools and environmental testing capabilities. Maintains an active outreach program for developing partnerships with other NASA centers, government agencies, industry, and universities.

Coordinates the branches within the MSD and works in close cooperation with other GSFC organizations and integrated product teams to develop products and provide expertise. Interfaces closely with the various Directorate Offices to support proposal

development and conceptual designs; plan and implement technology development; and commercialize new technology. Provides technical oversight, evaluation, consultation, and support to GSFC, NASA, government agencies, industry, and universities for flight project teams, instrument developers, design review teams, anomaly review boards, failure analysis teams, Technical Evaluation Panels, and Source Evaluation Boards.

541 Materials Engineering Branch

Provides the GSFC with a broad technical support capability in the materials sciences, technology, and applications, to support the design and assure the overall reliability of flight projects, experiments, and ground support operations, and, as required, for other NASA facilities and Government agencies. Acts as the GSFC's focal point for consultation, control, and review of all materials, lubricants, materials systems, and designs intended for Goddard flight missions; serves as the central contact for the investigation of all spacecraft materials problems and failures and their resolution; and assists management in arriving at materials policy goals and guidelines of direct benefit in the design, development, and qualification of flight hardware. Provides a wide spectrum of materials expertise in support of GSFC's flight projects, development teams, design review teams, and NASA-wide committees. Maintains a central office directly interfacing with flight projects and experimenters in matters relating to the review of designs and the selection of materials, processes, and lubricants from the conceptual stage to final application. Plans, implements, and manages research and development programs designed to advance materials performance and materials technology, and to develop technical data not available (or at best questionable) for direct application to flight programs. Reviews selected procurement documents to ensure inclusion of materials and lubricants requirements by appropriate contracting officers as provided for in the Procurement Request Handbook (GHB 5150.1) and Contract Drafting Handbook. Provides a repository for materials information and its dissemination via technical memoranda, reports, and papers suitable for publication to the scientific and engineering community.

542 Mechanical Systems Analysis and Simulation Branch

Provides mechanical and multidisciplinary systems modeling, analyses, and simulations for the development of state-of-the-art space flight systems in order to optimize the design and ensure that these systems meet their performance requirements. Provides senior system analysts and analytical discipline support to GSFC managed programs. Conducts supporting system analysis, simulation, trade-off, and evaluation studies to aid in the development, monitoring, and verification of systems. Operates, schedules, and manages general purpose computer facilities to support required analyses and simulations. Conducts research, development, and maintenance of advanced computational capabilities for accurate and efficient systems analysis and simulation of present and planned flight systems.

Leads the mechanical, thermo mechanical, and optomechanical aspects of multidisciplinary systems analyses including Structural Thermal Optical Performance (STOP) and jitter analyses. Supports, through analyses, the development and maintenance of system error budgets. Conducts necessary mechanical discipline and multidiscipline analyses to ensure that the system design is feasible, optimal, and verified for mechanical systems for Phase A, Phase B, and Phase C/D, respectively, and that all mechanical subsystems and components are compatible and will perform within specification. Provides graphical simulations of mechanical systems for a variety of studies including robotic motion studies, field of view interaction, mechanism operation, subassembly integration, vision system verification, as well as supporting system simulation video animations. Coordinates the generation of models, the methods of analysis, the techniques for model verification and validation, and administration of the computer systems needed to perform the work. Responsible for the definition and maintenance of the standard GSFC NASTRAN program.

Conducts structural analysis utilizing NASTRAN or other advanced programs in support of the design and qualification of flight structures. This includes finite-element math modeling, model correlation to test data, and coupled spacecraft/launch vehicle transient dynamic analysis to determine the payload structural dynamic response to the launch vehicle induced environment. Performs analytical predictions of the resulting flight loads, structural stresses, fracture/fatigue life, vibroacoustic environments, and margins of safety. Performs fracture control analysis, recommends nondestructive examinations, and provides safety documentation. Analytically determines test article response to test facility induced loads and determines realistic vibration levels and notching criteria for existing general vibration specifications to aid in reducing test risk and costs. Develops test plans, monitors test programs, reviews test results in design adequacy, and ensures that all structurally relevant safety requirements are satisfied. Performs advanced research in support of the development of improved analytical capabilities, such as spacecraft low-frequency transient and vibroacoustic environments, and the design optimization of advanced composite materials.

543 Mechanical Engineering Branch

Performs structural and mechanical design and/or provides technical oversight for selected in-house and out-of-house Space Transportation System (STS) and Expendable Launch Vehicle (ELV) launched spacecraft and instrument structures, deployment systems, and associated mechanical ground support equipment. Provides supervision and/or support for fabrication, assembly, integration and test, transportation of payloads, and launch site operations. Initiates, develops, and provides plans and procedures for mechanical assembly and qualification testing of spacecraft and instruments. Provides coordination of all mechanical system interfaces between spacecraft and launch vehicle. Performs structural analyses in support of flight hardware design. Provides advanced development and hardware implementation for maintaining state-of-the-art Computer

Aided Design (CAD) technology.

Performs conceptual studies for proposed spacecraft and instruments in support of flight projects and advanced study programs. Generates mechanical systems inputs, including structural and packaging designs, development and verification plans, mass properties, critical clearances, fields of view, and cost estimates. Provides advanced, state-of-the-art, three-dimensional CAD technology to support these conceptual studies as well as detailed mechanical design and drafting efforts. Conducts advanced research and studies in support of new structural design concepts, precision large deployment systems, fabrication and assembly techniques, and aerospace materials, such as advanced composites.

Provides senior-level technical oversight, evaluation, consultation, and review for out-of-house projects, contract proposals, and design review teams. Areas of expertise include structural and mechanism design, structural design analysis, fabrication and assembly, alignment, integration and test, transportation of payloads, and launch site support. Ensures coordination of all mechanical system interfaces among instruments, subsystems, spacecraft, and the launch vehicle. Evaluates spacecraft assembly, alignment, and qualification testing plans to ensure compliance with all safety and performance requirements. Monitors the performance of all system and subsystem level development, qualification, acceptance, and performance testing to ensure compliance with all requirements.

Performs and/or directs the conceptual and detail design, development, integration, and test of major structural and mechanical systems for in-house projects. Performs structural design analyses and supports fabrication and assembly for mission-unique subsystems such as instruments, payload adapters, and solar array, antenna, and experiment release and deployment systems, as well as any necessary mechanical ground support equipment, such as transportation and turnover dollies, lifting slings, and gravity negation systems. Initiates, develops, and provides plans and procedures for mechanical integration and qualification testing of spacecraft systems and instruments. Provides coordination of all mechanical system interfaces between the spacecraft and launch vehicle, performs safety verification, and provides appropriate documentation

544 Electromechanical Systems Branch

Provides discipline support in the area of electromechanical systems engineering. Conceives, analyzes, designs, develops, directs, tests, and provides the required mechanical, optomechanical, magnetic, controls, electrical, and electronics expertise to support the development of in-house electromechanical devices and systems for flight instruments and spacecraft subsystems. Responsible for the design, analysis, fabrication, test, and integration of precision electromechanical systems for scanning, pointing, and tracking applications including the development of state-of-the-art electronic systems to

control the mechanisms. Develops flight structures such as instrument structures, optical benches, telescopes, collimators, and antenna booms. Verifies the performance of electromechanical components and systems through all the stages of development from conceptual design to on-orbit testing. Conceives and conducts advanced and supporting research to develop technology applicable to existing and future space flight electromechanical systems such as deployable appendages, gimbals, cryogenic mechanisms, smart structures, and magnetic bearings. Supports project teams, experimenters, instrument managers, technical review teams, failure analysis teams, Technical Advisory Committees, and Source Evaluation Boards. Provides electromechanical system engineers to on-going flight projects. In cooperation with experimenters and study teams, conducts conceptual and feasibility studies for new instruments that include system level performance, cost, and schedule trade-offs. Provides technical oversight, evaluation, consultation, and review of out-of-house projects and contract proposals.

Develops mechanisms and structures for precision flight instruments and spacecraft subsystems. Designs, analyzes, fabricates, assembles, and tests flight assemblies such as deployable booms and solar array drive systems, choppers, shutters, scanning, and focusing mechanisms. Determines the adequacy of the design, mass properties, and margins of safety of mechanisms, instrument structures, and mechanical components to withstand the launch loads and operate for the specified period of time under environmental conditions that are experienced in orbit. These include bearings design and lubricant selection. Plans and conducts environ-mental tests, including life testing of electromechanical systems to verify the adequacy and accuracy of the design. Conceives and conducts research to develop and apply the state-of-the-art in mechanisms and instrument structure design including new components, materials, and processes and the use of computer aided tools for the design, analysis, and optimization of mechanisms, structures, and electromechanical components and systems. Plans and provides specifications and procedures for the fabrication, assembly, alignment, integration, and test of instrument structures and mechanism systems. Provides ground support equipment such as turnover dollies and environmentally controlled shipping containers. Maintains technical expertise and provides discipline support in the areas of structural design analysis, structural dynamics, and optomechanical design.

Develops devices and systems for the drive, sensing, and control of precision flight instruments and spacecraft subsystems. Designs, analyzes, integrates, and tests electronic systems that control mechanisms driven by electromechanical actuators and provides the required interfaces to the spacecraft power and command and data handling systems. Designs, analyzes, and tests devices used in sensing or actuating electromechanical systems such as tachometers, transformers, electromagnets, and electric motors. Plans, coordinates, and provides specifications and procedures for the design, fabrication, assembly, and packaging of the electronic circuit boards. Designs and conducts analyses and tests to determine the parameters that characterize the dynamic behavior of the

control system and of the various components that comprise the system. Develops mathematical models of the control systems that integrate the dynamic models of the mechanisms, electronics, and instrument structure. Performs analyses and simulation studies of control systems to predict the system performance and assess the sensitivity to parameter variations, system level interactions, and the effect of disturbances. Designs the control system including the control algorithms, determines the choice of sensors and actuators, and develops the control software. Plans and coordinates the tests for performance verification and environmental qualification of sensors, actuators, and mechanism control electronics. Provides ground support equipment to simulate electrical interfaces and verify the performance of the system. Maintains technical expertise and provides discipline support in the areas of analysis, design, and test of control systems, precision and low noise electronics, analog and digital signal processing, logic design and microprocessor systems, power electronics, sensors, and actuators. Conceives and conducts research to develop and apply the state-of-the-art in electronic components and systems, actuators, and sensor technology.

545 Thermal Engineering Branch

Responsible for thermal engineering for all GSFC-managed spacecraft, instruments, experiments, and sensors. Included are free flyers, STS payloads, and STS equipment designed to deploy, retrieve, and maintain free flying spacecraft. Conceives, develops, and reviews the thermal design and associated elements for all of the above. Provides support for tests, launch, and mission operations. Initiates and develops new hardware and software to meet advanced spacecraft and sensor requirements.

Responsible for the development of advanced thermal hardware and thermal technology for future spacecraft, instrument, and sensor applications including heat pipes, two-phase heat transfer systems, high conductivity materials, and heat pumps. Responsible for engineering design, development, and operation of flight experiments to verify thermal control technology and to investigate micro-gravity effects on performance. Develops, operates, and maintains unique test facilities for testing specialized thermal control devices and components. Develops, operates, and maintains thermal vacuum test facilities for space environment simulation to perform flight qualification and characterization tests of thermal control hardware.

Develops and maintains advanced thermal analysis tools, including graphics capability for thermal engineering. Develops and maintains databases of thermal property and test data. Develops and maintains expertise in discrete thermal technologies such as radiative cooler design and thermal analysis, cryogenic temperature thermal design and analysis, and continuum aerodynamic heating. Develops and maintains guidelines for thermal design and analysis, including thermal vacuum test requirements. Plans and coordinates thermal vacuum tests for performance verification and environmental qualification of flight components, instruments, and spacecraft. Serves as part of the spacecraft mission

control team during launch and early spacecraft checkout to ensure that thermal requirements are met and that the thermal control system is working properly.

Supports project teams, experimenters, instrument managers, technical review teams, failure analysis teams, Technical Advisory Committees, and Source Evaluation Boards. In cooperation with experimenters and study teams, conducts conceptual and feasibility studies for new instruments and spacecraft that include system level performance, cost, and schedule issues. Provides technical oversight, evaluation, consultation, and review of out-of-house projects and contract proposals, and serve on review teams and tiger teams.

546 Contamination and Coatings Engineering Branch

Provides all GSFC-managed spacecraft, instruments, experiments, and sensors with contamination and coating systems level technical support to ensure mission success. Contamination engineering and coating design implementation includes space and Earth science free flyers, lunar and planetary missions, STS payloads, robotics, and equipment designed to deploy and/or repair spacecraft and flight experiments. Responsible for developing and reviewing the contamination system design from concept through end of life and for recommending and testing coating systems related to mission end-of-life performance requirements and goals.

Provides GSFC projects and GSFC partner programs with lead role and/or consultation support for ground and on-orbit specific contamination engineering and thermal coating assessments. Assessments include multiple tasks in the areas of: requirements development, plan and procedure generation, coatings application and qualification testing, environmental effects testing of solar radiation and atomic oxygen, project and peer reviews, bakeout and cleanliness requirements and verification, and contamination risk mitigation. Maintains, develops, and operates contamination laboratory capabilities for measuring surface scattering using BRDF, quantifying particulate levels, measuring outgassing and reemission rates using MOLEKIT, and predicting effects of contamination sensitive surfaces. Performs modeling analyses to predict ground and on-orbit outgassing accumulation on contamination sensitive surfaces, thruster plume impingement during orbital maneuvers, venting effects, and atomic oxygen erosion effects. Performs flight qualification and space environmental testing of coatings along with thermal radiative property measurements, thickness measurements, and coating adherence testing. Develops, operates, and maintains GSFC unique facilities to select, apply, and qualify coatings for use on spacecraft and instrument surfaces. Characterizes thermal control surfaces and assess degradation from environmental effects due to UV radiation, thermal cycling, charged particles, electrostatic discharge, outgassing, and humidity. Develops and maintains a database of thermal property test data and coordinates extended shelf life testing of paints.

Initiates and develops new software to meet advanced spacecraft and instrument requirements. Provides technical papers to advance our knowledge and skills in the scientific and engineering community. Develops and modifies thermal control coatings--such as paints, films, and composites--and application techniques to meet the specific requirements of components, instruments, and spacecraft. Partners with NASA Centers, international space agencies, academia, and outside organizations in flight experiment and new technology ventures to advance our understanding of contamination and coatings to more effectively serve our mission. Contributes to Agency/Center level development of contamination/coatings related standards. Participates in knowledge management activities by documenting lessons learned and other significant work.

547 Advanced Manufacturing Branch

The Advanced Manufacturing Branch provides manufacturing and fabrication support for developing state-of-the-art science instruments, spacecraft systems, components, and devices. The Branch provides quick reaction design, development, fabrication, assembly, integration, and modification of science experiments and instruments for ground based aircraft, balloon, space flight, and laboratory research.

To accomplish these activities, the Branch:

- Develops new and innovative machining techniques to fabricate and assemble advanced instruments, mechanisms, and sensor designs for both conventional and microstructures. Examples include: Micro-Electromechanical Systems (MEMS) Packaging and micro-optical structures that support Nanosat missions.

- Provides expert assembly and machining support to GSFC research communities. This support includes instrument development, detectors, laser optics, optics, precision deployables, cryogenics, and mechanisms, among others.

- Advances the use of state-of-the-art techniques for Computer-Aided Manufacturing (CAM) systems and provides automated manufacturing capability. Advises scientists, engineers, and experimenters on the practical design application of current and advanced CAM technology. Provides the links between mechanical design and rapid prototyping equipment.

- Provides conceptual and detailed mechanical design support for the development of flight systems and ground support equipment. Develops designs in both 2-D and 3-D CAD formats, which have concurrent engineering links to CAM and CAE applications.

- Performs and directs studies, develops component hardware, and provides a base of expertise in advanced composite materials processing techniques.

- Provides practical consulting and new process development services in the fields of electroplating, chemical processing, mechanical product finishing, adhesive bonding, and composite H/W development for state-of-the-art instrument and spacecraft components as well as micro-electromechanical and optical structures.

- Supports advanced hardware development by evaluating, investigating, and resolving manufacturing difficulties resulting from process, design, and/or material deficiencies

- Provides design review services regarding the producibility and practicality for fabrication of advanced instrument and sensor designs and spacecraft components.

- Also provides metrology consulting services to GSFC, NASA, contractors, and other government agencies.

- Teams with scientists and engineers to conceive piece part designs that will meet scientific performance goals.

548 Mechanical Systems Branch

Provides mechanical discipline engineering required for the development of scientific payloads and vehicle systems at the Wallops Flight Facility (WFF). The focus of the Branch includes the development of balloon vehicle systems, development and integration of small STS payloads such as Hitchhiker carriers, small ELV payloads, suborbital payloads including sounding rockets, balloons (terrestrial and planetary), aircraft, and watercraft. The Branch supports the mechanical development of scientific instruments and missions for the Earth Sciences Directorate at the WFF.

The Branch is responsible for forming and leading mechanical teams to support these projects and organizations. Develops payload mechanical systems in compliance with Goddard and launch vehicle requirements and advises projects in this regard. Serves as the technical authority for these projects on mechanical issues. Provides mechanical engineering services to payload developers for selected in-house projects.

The Branch maintains basic mechanical engineering expertise applicable to WFF projects in the following discipline areas:

- mechanical systems engineering and design
- structural and dynamic analysis

- thermal design and analysis
- materials engineering and testing
- electromechanical systems
- dynamic testing

The Branch relies on other Branch's across the Mechanical Systems Division for technical guidance and leadership in various discipline areas.

549 Environmental Test Engineering and Integration Branch

Responsible for engineering, management, planning, development, and implementation of environmental tests and test programs for spacecraft, instruments, and subsystems per requirements specified in project verification plans or established by the project customer. Responsible for acquisition, management, upgrade, and operation of the integration and environmental test capabilities located in buildings 7, 10, 15, 29, and the 300 area, including particulate controlled payload integration areas and test facilities for vibration, acoustics, shock, acceleration, modal survey, static load, thermal vacuum, solar vacuum, temperature and humidity, radio frequency interference, magnetic fields, and associated measurements such as mass properties.

Responsible for advancing and improving environmental test techniques, facilities, processes, and approaches. Develops requirements and manages studies and analyses to advance test methods and techniques. Provides integration and environmental test expertise and consulting to GSFC and other project customers for assisting in planning, managing, assessing, procuring, and troubleshooting integration and test activities. Maintains and provides project-level environ-mental verification expertise to assist project customers and systems engineering to ensure that system performance requirements are met.

Provides engineering and technician expertise, facilities, instrumentation, and technical support for the structural and mechanical integration, test, handling, and launch of spacecraft structures, mechanisms, experiments, and spacecraft. Provides the technical interface to customers for planning, coordinating, and executing mechanical integration activities. Manages the operation and use of clean rooms and assigns laboratory space for the integration function. Provides management information and coordination for the shared use of buildings 7, 10, 15, and 29. Provides integration area particulate and molecular contamination control expertise and support to project customers and for top level oversight of clean room operations. Provides Facility Operations Managers for buildings 7, 10, 15, 29, and the 300 area.

550 INSTRUMENT SYSTEMS AND TECHNOLOGY DIVISION

The Instrument Systems and Technology Division (ISTD) provides technical leadership for the full life cycle of instrument development. It is a Division of instrument engineering expertise that provides development of innovative new measurement concepts and techniques, development of advanced instrument concepts, scientific instrument proposal support, instrument system definition, analysis, and implementation as well as advanced technologies and discipline support to enable advanced state-of-the-art Earth and Space science missions. The ISTD collaborates closely with the science community and other customers to identify new and emerging instrument technology requirements. The Division provides leadership and vision in developing and implementing technology programs aimed at satisfying needs and enabling future science missions, reducing mission cost, enhancing instrument performance, and/or simplifying instrument design and development.

The ISTD is an innovative division that provides engineering leadership and support to instrument concept study teams, proposal teams, and development teams to support the end-to-end conceptualization and development of advanced state-of-the-art Earth and Space science missions. It provides engineering discipline expertise, vision, and leadership in the areas of detector systems, optics, cryogenics and fluids, lasers and electro-optics and microwave instrument technologies.

The ISTD provides radiation detection instrument system technologies including design, development, assembly, testing, calibration, and support for measuring all regions of the electromagnetic spectrum. Detector and instrument front-end development encompasses focal plane technology, new materials, electronic readout, and the development and application of semiconductor processing techniques in order to provide a seamless interface to our customers. The Division provides optical design and analysis, component development, and instrument assembly, alignment, and testing support. The ISTD maintains and advances GSFC capabilities in cryogenic aerospace system design and development as well as other associated unique cryogenic and fluid system technologies. Laser and electro-optical capabilities are focused on advanced laser and lidar sensors and components for earth science and space exploration. In the microwave area the emphasis is placed on the development of new instrument unique technology capabilities that will support science goals and require innovation and present Significant challenges to the development of successful instrument systems.

The ISTD provides and operates a comprehensive array of laboratory and computer facilities to support key instrument technology developments and the design, development, manufacture, assembly, integration, calibration, and testing of a broad range of instrument systems and subsystems.

The ISTD interfaces closely with the Space Earth Sciences Directorates to support proposal development and conceptual designs, plan and implement technology developments, and commercialize newly developed technologies. It performs its work in close cooperation and partnership with other AETD divisions, GSFC Directorates, NASA Centers, government agencies, international agencies, industry, and academia. It sustains a program of outreach to minority and educational communities.

551 OPTICS BRANCH

The Optics Branch provides optical engineering and technology expertise to instrument development teams, study teams, and proposal teams to enable the end-to-end conceptualization and development of optical systems for Earth and Space science instruments, specifically:

1. Collaborates with other AETD organizations, the Earth and Space Science Directorates, the AETD, and external customers to provide appropriate technology-enabling activities that are responsive to Goddard's strategic initiatives.

2. Provides and maintains facilities, laboratories, analytic tools, and technical expertise to include: optical system design and analysis, optical component development and test, optical materials and thin films, optical system assembly/alignment/test, and opto-mechanical design and analysis.

3. Provides technology leadership and vision by conceiving, planning, implementing, and conducting in-house or external technology programs that enhance the Branch's core capability and expertise in those areas of advanced optical technologies needed for future Space and Earth science instruments. External technology programs are enabled by partnering with industry, the university community, other government laboratories and NASA Centers. The Optics Branch proactively works to transfer technology to the private sector, as well as foster broad community outreach.

552 CRYOGENIC AND FLUIDS BRANCH

The Cryogenics and Fluids Branch cryogenic and fluid system expertise to instrument development teams, study teams, and proposal teams to enable the end-to-end conceptualization and development of Earth and Space Science instruments. The Branch conceives, designs, analyzes, develops, tests, and evaluates new state-of-the-art aerospace cryogenic cooling and instrument fluid systems. Designs, analyses, develops, tests, and evaluates specialized instrument fluid systems, and leads the NASA effort to develop long life cryogenic coolers. Provides technical leadership in high performance liquid helium systems; sub-Kelvin coolers; hybrid cooling systems consisting of two or more cooling systems such as radiative/mechanical cooler/sub-Kelvin cooler combinations; and using new Superconducting Quantum Interference Device (SQUID) subsystems,

specifically;

1. Collaborates with other AETD organizations, the Earth and Space Sciences Directorates, and external customers to provide appropriate technology-enabling activities that are responsive to Goddard's strategic initiatives.

2. Provides leadership and vision in conducting a broad range of advanced cryogenic and instrument related fluid system development activities by conceiving, planning, implementing, and conducting in-house or external technology programs in order to meet current and future Space and Earth science mission needs. External technology programs are enabled by partnering with industry, the university community, other government laboratories, and NASA Centers. The Cryogenic and Fluid Systems Branch proactively works to transfer technology to the private sector, as well as foster broad community outreach.

3. Provides and maintains ground test facilities required for the development and evaluation of cryogenic systems and components, including unique cryogenic cooler test beds with advanced measurement capabilities to support technology developments.

4. Supports the design, development, testing, and flight of cryogenic systems. This effort encompasses teaming with scientists and technologists in all stages of development, from pre-phase A research in next-generation instruments, through to supporting flight programs.

553 DETECTOR SYSTEMS BRANCH

The Detector Systems Branch provides radiation detector and front-end electronics technology expertise to instrument development teams, study teams, and proposal development teams to enable the end-to-end conceptualization and development of scientific instruments for Earth and Space Science research, specifically:

1. Collaborates with other AETD organizations, the Earth and Space Science Directorates, and external customers to provide appropriate technology enabling activities that are responsive to Goddard's strategic initiatives.

2. Provides leadership and vision in conducting a broad range of advanced instrument technology activities by conceiving, planning, implementing, and conducting in-house or external technology programs in order to meet current and future Space and Earth mission needs. External technology programs are enabled by partnering with industry, the university community, other government laboratories, and NASA Centers. The Detector Systems Branch proactively works to transfer technology to the private sector, as well as foster broad community outreach.

3. Provides and maintains facilities, laboratories, analytic tools, and expertise in the areas of advanced detectors, detector-specific electronics, and custom semiconductor devices.

4. Supports the design, development, testing, and flight of radiation detectors for all regions of the electromagnetic spectrum. This effort encompasses teaming with scientists and technologists in all stages of development, from pre-phase A research in next-generation instruments, through to supporting flight programs.

554 LASER AND ELECTRO-OPTICS BRANCH

The Laser/Electro-Optics Branch provides laser and electro-optical engineering and technology expertise to instrument development teams, study teams, and proposal teams to enable the end-to-end conceptualization and development of laser and electro optical systems for earth and Space Science instruments, specifically:

1. Collaborates with other AETD organizations, the Earth and Space Sciences Directorates, and external customers to provide appropriate technology enabling activities that are responsive to Goddard's strategic initiatives.

2. Provides leadership and vision in conducting a broad range of advanced instrument technology activities by conceiving, planning, implementing, and conducting in-house or external technology programs in order to meet current and future Space and Earth mission needs. External technology programs are enabled by partnering with industry, the university community, other government laboratories and NASA Centers. The Laser and Electro-Optics Branch proactively works to transfer technology to the private sector, as well as foster broad community outreach.

3. Provides and maintains facilities, laboratories, analytic tools, and expertise in the following technical areas; lidar systems, lidar detector technology, solid state laser transmitters, tunable lasers, image stabilization and pointing, and non-linear optics technologies.

4. Supports the design, development, testing, and flight of laser and electro-optical systems. This effort encompasses teaming with scientists and technologists in all stages of development, from pre-phase A research in next-generation instruments, to supporting flight programs.

555 MICROWAVE INSTRUMENT TECHNOLOGY BRANCH

The Microwave Instruments Technology Branch provides engineering and technology expertise to instrument development teams, study teams, and proposal teams to enable the end-to-end conceptualization and development of microwave instrument systems for Earth and Space Science missions. Emphasis is placed on the development of new

capabilities that require innovation and present significant technology challenge in order to permit successful scientific instrument systems. The Branch provides the Center lead in microwave instrument technology development and serves as the primary AETD interface to the science community for microwave instruments. The Branch advocates and performs cutting-edge technology development to enable new measurements, improved performance, and reduced cost, size, and mass of active and passive sensors over a broad range of Earth and Space science applications. It develops new concepts, analyzes system performance, develops new technology, integrates and tests instrument/detector systems, and supports experimental field campaigns, airborne and space missions, specifically:

1. Collaborates with other AETD organizations, the Earth and Space Sciences Directorates, and external customers to provide appropriate technology enabling activities that are responsive to Goddard's strategic initiatives.

2. Provides leadership and vision in conducting a broad range of advanced instrument technology activities by conceiving, planning, implementing, and conducting in-house or external technology programs in order to meet current and future Space and Earth mission needs. External technology programs are enabled by partnering with industry, the university community, other government laboratories and NASA Centers. The Microwave Instrument Technology Branch proactively works to transfer technology to the private sector, as well as foster broad community outreach.

3. Provides and maintains facilities, laboratories, analytic tools, required to support advanced microwave instrument technology developments.

4. Supports the design, development, testing, and flight of microwave instrument systems. This effort encompasses teaming with scientists and technologists in all stages of development, from pre-phase A research in next-generation instruments, to supporting flight programs.

556 INSTRUMENT SYSTEMS BRANCH

The Instrument Systems Branch provides technical leadership for the full life cycle of instrument development. This includes development of innovative new measurement concepts and techniques, development of advanced instrument concepts, support of scientific instrument proposals, instrument system definition, analysis, and implementation, specifically:

Collaborates with other AETD organizations, the Earth and Space Sciences directorates, and external customers to provide appropriate instrument-enabling activities that are responsive to Goddard's strategic initiatives.

Provides leadership and vision in conducting a broad range of advanced instrument management and instrument systems engineering activities by conceiving, planning, implementing, and conducting in-house or external technology programs in order to meet current and future Space and Earth mission needs. External programs are enabled by partnering with industry, the university community, other government laboratories and NASA Centers. The Instrument Systems Branch proactively works to transfer technology to the private sector, as well as foster broad community outreach.

Provides and maintains facilities, laboratories, analytic tools, required to support instrument systems development.

Supports the design, development, testing, and flight of microwave instrument systems. This effort encompasses teaming with scientists and technologists in all stages of development, from pre-phase A research in next-generation instruments, to supporting flight programs.

560 ELECTRICAL ENGINEERING DIVISION

The EED provides leadership and vision in identifying, sponsoring, advancing, developing, improving, and validating flight electrical/electronics systems and technologies. These cross cutting technologies are specifically aimed at enabling future science missions, reducing mission cost, enhancing data processing and product dissemination, and simplifying mission design, development and operation. The EED achieves this through the close collaboration and leveraging of resources with other NASA Centers, other Government agencies, academia, and industry. Systems and technologies are verified through ground testing in flight testbeds, technology demonstration flights, and science mission insertion. In addition, the EED ensures commercialization to industry partners through an active technology transfer program.

The EED is an innovative Center of expertise in the implementation of flight and ground electrical/electronics systems in support of NASA programs and projects, with specific activities in the GSFC Earth Science, Space Science and Technology focus areas. The EED collaborates with the science community and other customers to meet their electrical/electronics and technology needs through design, implementation, and integration of electrical systems, subsystems, and components. The EED works in close partnership with the other AETD Centers to achieve many of its objectives in the areas of flight hardware (and the required EGSE Integration and Test equipment), flight system architectures, and flight technologies.

The EED provides technology, capability, and products in electrical/electronic system design, development, implementation, and test. It provides expertise in the areas of electrical systems/architecture design, development, implementation, and test; design of digital and analog systems for spacecraft and instrument systems; Integration and Test (I&T) of satellite, rocket, aircraft, shuttle, and balloon-borne scientific instruments, payloads, and spacecraft; flight electrical design, including flight harnesses, health and monitoring systems, and pyrotechnic/mechanism deployment electronics; RF, microwave and millimeter wave instruments, communication systems, ADCs, data compression, etc.,); design capability for custom ASICs and system design/fabrication leading to flight; radiation effects, radiation orbit environment predictions, radiation testing (SEU, SEL, TID), and system analysis; power generation, energy storage, and high and low voltage power management and distribution systems for instruments and spacecraft and advanced photovoltaic, electrochemical, electronic, and other technologies for space power applications; new technology packaging techniques and EGSE systems for flight and I&T. The EED operates and maintains special purpose facilities and laboratories unique to its functions.

The EED represents NASA as a leader in electrical systems and architectures for flight spacecraft, instrument electronics and their associated ground support equipment. It provides expertise in disciplines required to implement flight electrical systems to GSFC product teams and external users. It leads internal and external subteams to implements and deliver electrical/electronics system products, services, and/or capability to GSFC projects to meet mission needs. For flight projects, the EED supports end-to-end simulations and tests to verify readiness to support flight missions. It participates in the planning of future missions and in the development of standards to guide evolution of future flight and ground electrical systems. The EED also sustains a strong program of outreach to minority and educational programs.

561 FLIGHT DATA SYSTEMS AND RADIATION EFFECTS BRANCH

The Flight Data Systems and Radiation Effects Branch is responsible for providing the Center with the technical expertise in the development of Flight Data Systems and its related components for space flight applications, in the discipline area of Command and the Data Handling systems engineering, and in the discipline of space radiation. This engineering support is provided to Earth/Space Science Directorates, and other AETD organizations, and Flight Programs & Projects for both in-house and out-of-house efforts with regards to the analysis, design, fabrication, procurement, test, integration, and operation of Flight Data Systems and related components, and the validation of instrument and spacecraft components for the space radiation environment. The Branch spearheads the development of advanced technologies in instrument/spacecraft data buses, radiation-harden microprocessors, mission unique electronics, instrument and spacecraft subsystems interface devices, and bulk data storage components. The Branch supports the development of new instrument/spacecraft architectures through partnering with industry and other agencies, proposal development, and phase A&B studies; and supports the development of advanced GN&C and mechanism electronics.

562 PARTS, PACKAGING, AND ASSEMBLY TECHNOLOGIES OFFICE

The Parts, Packaging, and Assembly Technologies Office provides unique and essential support in the areas of electronic parts fabrication and validation and the packaging and assembly of electronics to internal and external customers and partners to meet mission reliability, cost, and scheduled goals. The support is provided for Flight Project Support and Applied Research.

Flight Project support encompasses aspects of reliable systems development which include:

- Parts selection, evaluation, and testing
- Packaging design and analysis
- Characterization and validation of component technologies

- Anomaly and failure investigations
- Maintain databases for parts information
- Unique electronics assembly

The applied research aspects of the office include efforts in:

- Parts fabrication/manufacturing technology issues
- Emerging and State-of-the-Art component technology developments
- Advanced microelectronics development
- Novel materials and nanotechnologies
- Emerging fiber optics technologies
- Research collaborations with external partners
- Technology transfer to industry and infusion on flight projects

To fulfill this mission, the office establishes and maintains extensive laboratories and computer-based simulation and analysis capabilities, and an active presence in the aerospace community through conference participation, partnerships, and data dissemination.

563 POWER SYSTEMS BRANCH

The Power Systems Branch provides the Center with technical expertise in the field of electrical power for space applications. Power subsystem engineering is provided to support for all phases of scientific instrument, special payload, and spacecraft flight programs from conceptual design, through hardware development and test, to end-of-life operations. Electromechanical discipline engineering support is provided to advance energy storage technologies by developing longer life and higher energy density primary and secondary batteries, respectively, for special payloads and spacecraft applications. Photovoltaic discipline engineering support is provided to advance solar-electric energy conversion technologies by developing higher efficiency solar cell arrays for space flight applications. Electronics discipline engineering is provided to advance power management, distribution, and conditioning technologies by developing efficient, low noise, high and low voltage power regulators and converters for scientific instruments, special payloads, and spacecraft.

564 MICROELECTRONICS AND SIGNAL PROCESSING BRANCH

The charter of the Microelectronics and Signal Processing Branch is to design, develop and infuse leading edge microelectronics devices and components for flight and ground customer applications, including the development and delivery of flight analog and digital systems that process science data and the development of the advanced technology associated with these systems. This includes but is not limited to front-end electronics, interface, analog signal filtering and conditioning, analog cryo temperature control

systems, analog multiplexing and A/D conversion, digital signal processing and compression, C&DH and downlink interfaces. In addition, the Branch is responsible for the analog and digital circuits that support various sensors and actuators. The Branch develops concepts and design, prototypes and tests these designs, builds engineering and flight models and performs subsystems testing and delivers these systems to the instrument or spacecraft developer. Pre-Phase A and Phase A studies and proposals are also supported by the Microelectronics and Signal Processing Branch, including support for the development of advanced electronic architectures.

The Branch will provide expert personnel and maintain tools capable of developing highly integrated ASIC and VLSI devices and modules for instrument, spacecraft and ground components. The efforts of the Branch will be focused on the needs of the instruments, missions, and advanced technology development projects. The Branch will develop the requirements for, evaluate, and use state-of-the-art analog and digital design, test, simulation, and validation tools and equipment. In conjunction with industry, the Branch will sponsor and further the development and capability for the design and simulation of custom circuits.

Overall the Branch will maintain expertise in advanced and high speed analog and digital device for both flight and ground applications, VLSI design experts in custom, semi-custom, and programmable devices, device packaging techniques (such as multi-chip modules and state-of-the-art surface mount technology), circuit design methodologies (VHDL, Verilog) advanced algorithmic development, and reconfigurable computing technology.

565 ELECTRICAL SYSTEMS BRANCH

Designs and develops electrical systems, distribution systems hardware (such as harnesses, fiber optic networks, and unique interface hardware) and ground support equipment for flight instruments and spacecraft. The Branch provides electrical systems lead to instruments, and spacecraft project teams who develop electrical interfaces, performance requirements, functional test procedures, and electrical specification for in-house space programs; and provides electrical systems expertise and technical oversight to out-of-house space programs; and provides electrical systems expertise and technical oversight to out-of-house space programs for flight and ground systems. The Branch develops integration and test systems, subsystem and component bench test equipment, and interface simulators; develops project unique electromagnetic compatibility requirements, and generates the criteria and test approach needed to ensure the electromagnetic compatibility of instrument and spacecraft hardware. The Branch provides Electrical Leads to Science Principle Investigators to support unusual, quick reaction missions or proposal development; and provides Electrical Systems Managers and/or Electrical System leads to out-of-house programs. The Branch provides expertise for new technology (such as fiber optic harnesses) and electrical troubleshooting of flight

and ground systems.

567 MICROWAVE AND COMMUNICATION SYSTEMS BRANCH

The Microwave and Communication Systems Branch is responsible for the conception, analysis, design, and development of state-of-the-art Radio Frequency (RF), microwave, millimeter wave, and higher frequency components and systems. The Branch maintains core microwave and millimeter wave engineering discipline support and facilities for the Applied Engineering and Technology Directorate (AETD). The Branch especially provides expertise in the use of these technologies for communication and science instrument applications.

The Branch provides world-class expertise in communication systems engineering, including both Space and Ground Network support. Branch personnel work closely with spacecraft designers, as well as flight project and mission services personnel to develop space-to-space and space-to-Earth communication systems. The Branch conducts theoretical studies, develops simulations and models, and provides contract technical oversight. The Branch performs “hands-on” engineering to research and develop future communication technologies. The Branch also works with industry to develop next generation spacecraft transponders, transceivers, and other communication components. As experts in communication systems engineering, Branch personnel develop and evaluate future space communication systems to support unique mission requirements, including technologies for multi-satellite constellations, Internet-in-space, and high data-rate optical communications. The Branch provides support to implement the international Search and Rescue (SAR) system and to develop technologies to improve the SAR systems.

The Branch maintains core microwave engineering discipline support and facilities for AETD, and supports the ISTC, Codes 400, 600, and 900 through the provision of microwave instrument engineering expertise and infrastructure and the development and implementation of flight microwave instruments. Branch personnel support the development and implementation of flight microwave instruments and conduct analytical studies and experimental investigations of relevant new technologies. The Branch develops and maintains key test facilities for microwave instrument development and test including electronics laboratories and anechoic chambers.

Technology developments in the Branch emphasize state-of-the-art antennas, low noise receivers, radiometers, high-speed communication electronics, solid-state power amplifiers, and other advanced communication and science instrument components. The Branch concentrates on developing compact, lower power, and lightweight technologies to enable increasingly sophisticated Earth and space science missions. The Branch also evaluated and manages SBIRs and other technology commercialization activities. The Branch partners extensively with universities, other NASA centers, and other Government agencies.

568 FLIGHT SYSTEMS INTEGRATION AND TEST BRANCH

The Space Integration & Test Branch is responsible for Integration and Test activities of Spacecraft, Instruments, Orbital Carrier Systems and Suborbital Carrier Systems, including complete functional and environmental testing and verification. Systems, subsystem, and payload/launch vehicle integration are included. As required by the Project and/or Principle Investigators, the Branch supplies I&T Lead Engineers/Managers, Test Conductors and I&T Technicians to Teams, providing support from systems development, pre-launch and mission operations, and post-mission deintegration. The Branch flight qualifies instruments, spacecraft and suborbital systems, and requalifies reusable carrier electronics. The Branch works closely with flight and ground system developers to ensure that designs are compatible with test and verification requirements.

569 WALLOPS ELECTRICAL ENGINEERING BRANCH

The Wallops Electrical Engineering Branch is responsible for conception, analysis, design, development, validation, and implementation of electrical/electronic, RF, microwave, and millimeter wave components and systems in support of the Wallops Flight Facility (WFF) mission, projects, and technology initiatives. Primary customers include suborbital and special projects, mission services, and observational science initiatives at WFF, as well as other NASA programs.

The Branch provides world-class expertise for development of flight and ground instrumentation, communication, and radar components and systems for WFF ELVs, sounding rockets, aircraft, balloons, university satellites, small shuttle payloads, and ocean-borne payloads. Design and development is provided for products and systems involving command and data handling systems; power generation and distribution systems; RF, microwave and millimeter wave telemetry, radar, and command systems; antenna systems; communication systems; control systems; data acquisition and storage systems; and pyrotechnic/mechanism development electronics. Branch personnel work closely with the WFF program and project offices to develop these components/systems and their associated infrastructure. The Branch conducts theoretical studies, develops simulations and models, and provides contractor oversight. The Branch partners with other GSFC organizations, NASA Centers, and Government agencies on these development efforts. The Branch also works with industry to develop next generation airborne, space, and ground electrical, communication and radar components and systems. Integration and Test capabilities are provided for technology development efforts, flight projects, and end-to-end mission systems support with skills in flight harness development; flight component electronic packaging; airborne and ground telecommunication, radar, and instrumentation systems; antennas, electromagnetic compatibility and RF interference analysis; and ground system implementation.

Mission Engineering capabilities include spectrum management; RF link budget analysis; mission planning analysis; and consultation for evaluation of mission readiness, and systems operation and maintenance performance. Technical representation is provided for membership to national level committees involving spectrum management and range instrumentation. Engineering expertise contributes to the conceptual planning of future missions, experiments, and advancements in technology associated with flight systems for WFF missions.

580 SOFTWARE ENGINEERING DIVISION

The Software Engineering Division (SED) is responsible for the engineering of software and information systems throughout all phases (formulation through on-orbit operations) of NASA programs and projects. These systems include: flight, ground, and science data software for spacecraft monitoring, control, on-orbit performance management and perations; spacecraft data processing and analysis, and information management; and science data analysis and management. The SED focuses on the development of reusable flight and ground architectures and frameworks to reduce mission cost, decrease development time, minimize customer risk, and increase the scientific value of information products. The SED provides expertise in software systems engineering, secure environments, and the software product development lifecycle to ensure the delivery of reliable software and information systems solutions.

The SED's leadership and vision in identifying and applying emerging software technologies enables future science and exploration missions, enhances science return, and simplifies system development and operation. The SED accomplishes this through close collaboration within GSFC, and with other NASA Centers, Government agencies, academia, and industry.

581 SOFTWARE SYSTEMS ENGINEERING BRANCH

The Software Systems Engineering Branch provides end-to-end software systems engineering for the development and the support of conceptual design, requirements specification, implementation and maintenance of software systems that enable current and future NASA missions, programs and projects. Branch personnel represent expertise in all aspects of information, communication and technology software systems from flight and ground software components to science data systems and management. Branch personnel plan, coordinate, and lead the end-to-end development of such systems.

Formulation and conceptual design of future missions represent one of the core activities of the Branch, and Branch personnel actively lead and participate in collaborative proposals with other Goddard branches, Divisions and Directorates and with external partners (other NASA Centers, universities or industry). The Software Systems Engineering Branch also provides leadership within the Integrated Design Center (IDC) to enable scientists and engineers in the exploration of new design concepts for proposed space systems and missions, remote sensing instruments and advanced technology applications. This facility promotes rapid development and efficient trade studies through end-to-end simulations and analysis, such as functional systems concepts, system requirements, risk and cost studies. The Branch also provides consulting services to customers as needed, as well as expertise for trade studies, technical reviews, engineering insight, and working group activities.

582 FLIGHT SOFTWARE SYSTEMS BRANCH

The Flight Software Systems Branch provides on-board, embedded software products that enable spacecraft hardware, science instruments and flight components to operate as an integrated on-orbit science observatory. This includes flight software and associated high fidelity simulation test systems. Branch personnel provide life-cycle flight software engineering; including early mission formulations and designs, requirements analysis, development, verification and validation, and mission-life sustaining engineering. Flight software leadership strives for effective advancements in flight hardware and software architectures, operations ground/flight interfaces, onboard autonomy, onboard science data analysis and test-beds. Flight software prototypes are implemented as proofs-of-concept for future missions. Formalized reuse of flight software products plus the utilization of Standards and commercially available products reduce flight program complexities, risks, costs and schedules.

583 GROUND SOFTWARE SYSTEMS BRANCH

The Ground Software Systems Branch provides software products and expertise that satisfy ground system requirements for Earth and space science missions. Branch personnel perform requirements analysis, design, implementation, verification, validation, deployment and sustaining engineering for all types of ground software applications and architectures. System functionality may include spacecraft command and control, flight dynamics, mission planning and scheduling, event monitoring and assessment, and telemetry trend analysis. Branch personnel also investigate and apply state-of-the-art technologies and commercially available products to ensure cost effective solutions that optimally meet customer needs.

584 MISSION VALIDATION AND OPERATIONS BRANCH

The Mission Validation and Operations Branch provides expertise in operations engineering, operations planning and systems validation to ensure optimal operability of information systems. In support of the Earth Science, and Space Science Missions, and the Exploration and Technology focus areas, the Branch develops and analyzes operational concepts, requirements, plans, schedules and documentation for planning, conducting, and evaluating spacecraft operations. Branch personnel plan, coordinate, and take responsibility for the end-to-end testing of mission systems. Pre-launch end-to-end simulations of launch and early orbit scenarios are developed, coordinated and tested by this Branch to ensure launch readiness of ground and flight systems. Branch personnel direct the mission Flight Operations Teams in preparation and training for launch, in-orbit checkout and daily mission operations. Branch personnel prepare and define budgets and schedules for operations functions. The Branch works closely with other Center personnel, other NASA Centers and contractor personnel, to assure compatibility

of performance, interfaces, schedules and budgets.

585 COMPUTING ENVIRONMENTS AND COLABORATIVE TECHNOLOGIES BRANCH

The Computing Environments and Collaborative Technologies Branch provides a diverse variety of services and tools in support of activities within the Software Engineering Division (SED). Branch personnel integrate, maintain and manage the secure Information Technology (IT) environment supporting research, engineering, and administrative information requirements. The branch further develops web based collaborative and knowledge management systems; while deploying prototypes to foster the adoption of these systems in partnership with customer groups. The branch serves as Goddard's focal point for all Software Process Improvement (SPI) activities, including; developing and maintaining the process asset and tool library, deploying process assets and tools through mentoring and software training programs, and implementing the division measurement program.

586 SCIENCE DATA SYSTEMS BRANCH

The Science Data Systems Branch is responsible for the specification, design, development, installation, validation, modification, and operation of data systems for the acquisition, production, and distribution of data products that support NASA's science and Exploration missions. These systems may range in complexity from those that handle single, small instrument data streams with a limited user community to multi-mission data systems serving diverse multidisciplinary user communities. The Branch supports all aspects of the science data management life-cycle which includes: processing systems, archives, distribution systems, networking, query systems, and user interfaces. Branch personnel have expertise in metadata definition, data formats, mass storage technologies, cost modeling, and contract management. In addition, the Branch supports new and evolving data system concepts, such as virtual data systems, grid computing, distributed archives, data workflows, visual data queries, and data modeling.

587 SCIENCE DATA PROCESSING BRANCH

The Science Data Processing Branch is responsible for the design, development, implementation and integration of science data processing applications and science data processing technology for flight, in-situ and ground based systems. The Branch supports all phases of instrument, spacecraft and mission development, from concept through post-mission analysis, for Earth Science, Space Science and Exploration Systems customers. Areas of expertise include embedded science data processing, modeling/simulation, data visualization, image/sensor data processing, sensor webs, application architectures/frameworks, automation, intelligent agents, algorithm development, data

compression, distributed systems, data mining, human-computer interaction, information fusion and the development of data analysis tools.

Systems engineering and consultative services are also provided to support the development of end-to-end system concepts, requirements and functional specifications for flight project, study and proposal efforts. The Branch works in collaboration with other Divisions within the Applied Engineering and Technology Directorate (500), Science and Exploration Directorate (600), Flight Projects Directorate (400), government, university and industry organizations to develop effective science data processing solutions that enable scientific investigation and meet customer needs.

589 WALLOPS SYSTEMS SOFTWARE ENGINEERING BRANCH

The Wallops System Software Engineering Branch develops flight and ground data systems for sub-orbital and special orbital Earth and space science missions. Branch personnel participate in teams with flight projects, principal investigators, other AETD Divisions and other organizations to develop integrated hardware and software systems for mission support. The system functionality includes carrier, payload, and ground system monitoring and control, launch and tracking services, and data display and analysis. Branch personnel provide system engineering, system planning, conceptualization, requirements analysis, design, implementation, verification and sustaining engineering for its products. Branch products include integrated Commercial Off-The-Shelf (COTS) elements, custom capabilities, components, consulting and brokering on behalf of customers. Branch personnel apply state-of-the-art technologies and COTS/heritage products to develop cost-effective data systems to meet customer needs. The Branch performs prototyping in collaboration with other NASA and government organizations, universities, and commercial partners to advance the state-of-the-art in implementation of its functions and related technologies. In addition, the Branch develops test-beds to prove concepts in operational and laboratory environments. It assists in transferring and commercializing technology developments to industry, other government agencies and academia as appropriate.

590 MISSION ENGINEERING AND SYSTEMS ANALYSIS DIVISION

The Mission Engineering and Systems Analysis (MESA) Division has the overall responsibility for end-to-end systems engineering and analysis for new and existing space missions, done either in the "in house" or "out-of-house" mode.

Mission systems engineering connotes all the traditional processes, such as requirements flowdown from level 2, systems analysis and verification, integrated modeling and simulation, and systems budgeting, but in addition includes providing leadership in areas such as internal IRAD co-investment, technology development roadmapping and other elements of the strategic planning process.

The typical space mission development sequence begins with an assessment and trade studies of several top level parameters, most often including launch-to-orbit, pointing, and wavefront control (if applicable). MESA will provide the leadership in all of these top level mission trades, including the technology, design and implementation of guidance, navigation and control systems for Earth and space science missions, ranging from nanosat class to facility class in scale.

591 Guidance, Navigation, and Control (GN&C) Systems Engineering Branch

The GN&C Systems Engineering Branch is to serve as the focus of systems level efforts related to GN&C systems within the MESA Division. As such, the branch will be the initial point of contact and primary interface for customers requiring GN&C engineering services. The branch will be source of control system expertise and will provide leadership in the integration of analytical, hardware, and software disciplines into flightworthy GN&C systems. Conceptual designs of GN&C control systems will be created and evaluated by analysis and simulation. A primary function of the branch is to ensure the training and development of engineers with a high level of systems engineering expertise in anticipation of the future needs of GSFC.

592 Systems Engineering Services and Advanced Concepts Branch

The Systems Engineering Services and Advanced Concepts Branch provides fundamental systems engineering services to the entire Division and leads the development of advanced mission concepts. These fundamental services include consultation and services to study/initiative and project teams from a core staff of senior advisors and mentors, leadership and support to Agency and GSFC advanced concept development initiatives, services and support to proposal and concept development teams, support to Agency review panels, liaisons to Enterprise developments and support to training and skills development initiatives. The Branch provides feasible mission concepts from partnership development, requirements generation and systems architecture development through the

development of comprehensive preliminary mission concepts. The SESAC Branch also provides advanced systems engineering services to the MESA Division and the science and engineering directorates. The SESAC Branch also offers a comprehensive portfolio of services in Information Based Systems Engineering, including consultation to project teams, development of systems engineering tools and interdisciplinary tool sets, as well as the development and deployment of collaborative environments and capabilities and capabilities for NASA and GSFC project teams. The SESAC Branch also manages Goddard's implementation of advanced engineering environment initiatives and architects the strategic planning and implementation of advanced engineering tools, capabilities environments and facilities. These facilities include the Integrated Mission Design Center (IMDC) and the Instrument Synthesis and Analysis Laboratory (ISAL). The branch serves as the GSFC's liaison to the Agency's work in advanced engineering environments. The SESAC Branch also serves as the science/customer liaison for cost effective access to systems architecture development facilities that provide concurrent design and simulation capabilities.

595 FLIGHT DYNAMICS ANAYSIS BRANCH

The Flight Dynamics Analysis Branch is responsible for providing Guidance, Navigation and Control analytic expertise for all trajectory and attitude systems. This includes the performance of dynamics and control analyses and simulation of launch and space vehicles. The Branch creates and maintains state-of-the-art analysis tools for mission design, trajectory optimization, orbit analysis, navigation, attitude determination, and control analysis. The Branch synthesizes strategies and algorithms for trajectory guidance and attitude control systems for launch vehicles and spacecraft that satisfy mission requirements. The Branch assesses by analysis and simulations the stability, robustness, and performance of trajectory guidance and attitude control systems for both orbital and sub-orbital launch systems and spacecraft.

596 COMPONENT AND HARDWARE SYSTEMS BRANCH

The Components and Hardware Systems Branch is responsible for the development of advanced GN&C component technologies that enable current and future GN&C systems. Specifically, it leads the development of new guidance, navigation and control system sensors, actuators, propulsive devices and their interfaces to support space vehicle and instrument design and development. These activities include conducting market surveys, making sensors and/or actuator build or buy recommendations, procuring or designing and building sensors and/or actuators along with providing their associated GSE. The Branch provides, maintains, and manages the component test facilities for both conventional and advanced components to validate their performance while also providing and maintaining an inventory of components. The Branch is chartered with conceiving, analyzing, designing, building, and testing GN&C unique electronics and hybrid dynamic simulators, and supporting integration, test, and validation of these.

597 PROPULSION BRANCH

The Propulsion Branch provides engineering expertise in spacecraft propulsion subsystem, design, analysis, fabrication, assembly, integration, test, and launch and post launch operations, including spacecraft propellant loading. The branch provides expertise in fluid systems in support of propulsion subsystem efforts, including test equipment and ground support equipment. It also provides engineering management, procurement technical support, performance evaluation, and anomaly assessment of flight projects for spacecraft propulsion subsystems and expendable launch vehicle propulsion systems. The branch conducts performance evaluation of sub-orbital class launch vehicle propulsion systems and provides chemical analyses and test in support of propulsion related efforts.

The Propulsion Branch defines next generation propulsion technology requirements and analyzes, develops, tests, and integrates advanced propulsion system technologies. This involves collaborating with GN&C customers and stakeholders to assure effective interchange of information and coordination of propulsion technology programs. The branch specifies, procures, and tests propulsion components to meet mission and/or advanced technology requirements. To that end, the branch operates the Propulsion Test Site to evaluate propulsion and fluid components, including providing precision cleaning of plumbing and providing residual gas analyses.

598 Guidance, Navigation, and Control (GN&C) & Mission Systems Engineering Branch at WFF

The GN&C and Mission Systems Engineering Branch is to serve as the focus of systems level efforts related to GN&C systems and mission systems engineering at the Wallops Flight Facility (WFF). As such, the branch will be the primary interface for customers requiring GN&C engineering and Mission Systems engineering services at WFF. The branch will be a source of control system expertise and mission systems engineering expertise. It will provide leadership in the integration of the analytical, hardware, and software disciplines into flight-worthy GN&C systems. It will also provide leadership in the integration of the various engineering discipline activities to develop flight-worthy mission systems for balloons, sounding rockets, and other mission system initiatives performed at the WFF. A primary function of the branch is to ensure the training and development of engineers with a high level of systems engineering expertise in anticipation of the future needs of GSFC.

599 Mission Systems Engineering Branch

The Mission Systems Engineering Branch enables scientific discovery and technology advancement by providing end-to-end systems engineering for the NASA Exploration and Science activities. These activities include requirements and architecture development and span the entire life cycle from advanced concepts through implementation. The scope of these systems engineering activities includes technical

leadership for all flight and ground system elements, including end-to-end data flow from the instrument / detector to the end user. The Mission Systems Engineering Branch also develops implementation and risk mitigation strategies for the infusion of new technologies into these Exploration and Science efforts, ensuring that technology advancements are carried from concept through final design.