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Mission



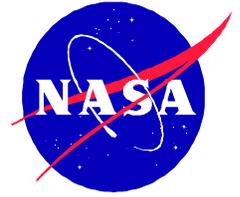
- To be world-class creators and facilitators of innovative, intelligent, high performance, reliable information technologies that enable NASA missions.
 - Increase software safety and quality through error avoidance, early detection and resolution of errors, by utilizing and applying empirically based software engineering best practices.
 - Ensure customer software risks are identified and/or that requirements are met and/or exceeded.
 - Research, develop, apply, verify, and publish software technologies for competitive advantage and the advancement of science.
 - Facilitate the transfer of science and engineering data, methods, and practices to NASA, educational institutions, state agencies, and commercial organizations.

Goals



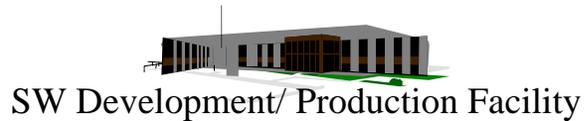
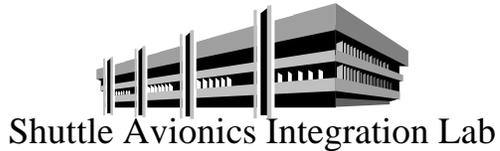
- To become a national Center Of Excellence (COE) in software and system independent verification and validation.
- To become an international leading force in the field of software engineering for improving the safety, quality, reliability, and cost performance of software systems.

What are the Problems we are Trying to Solve?

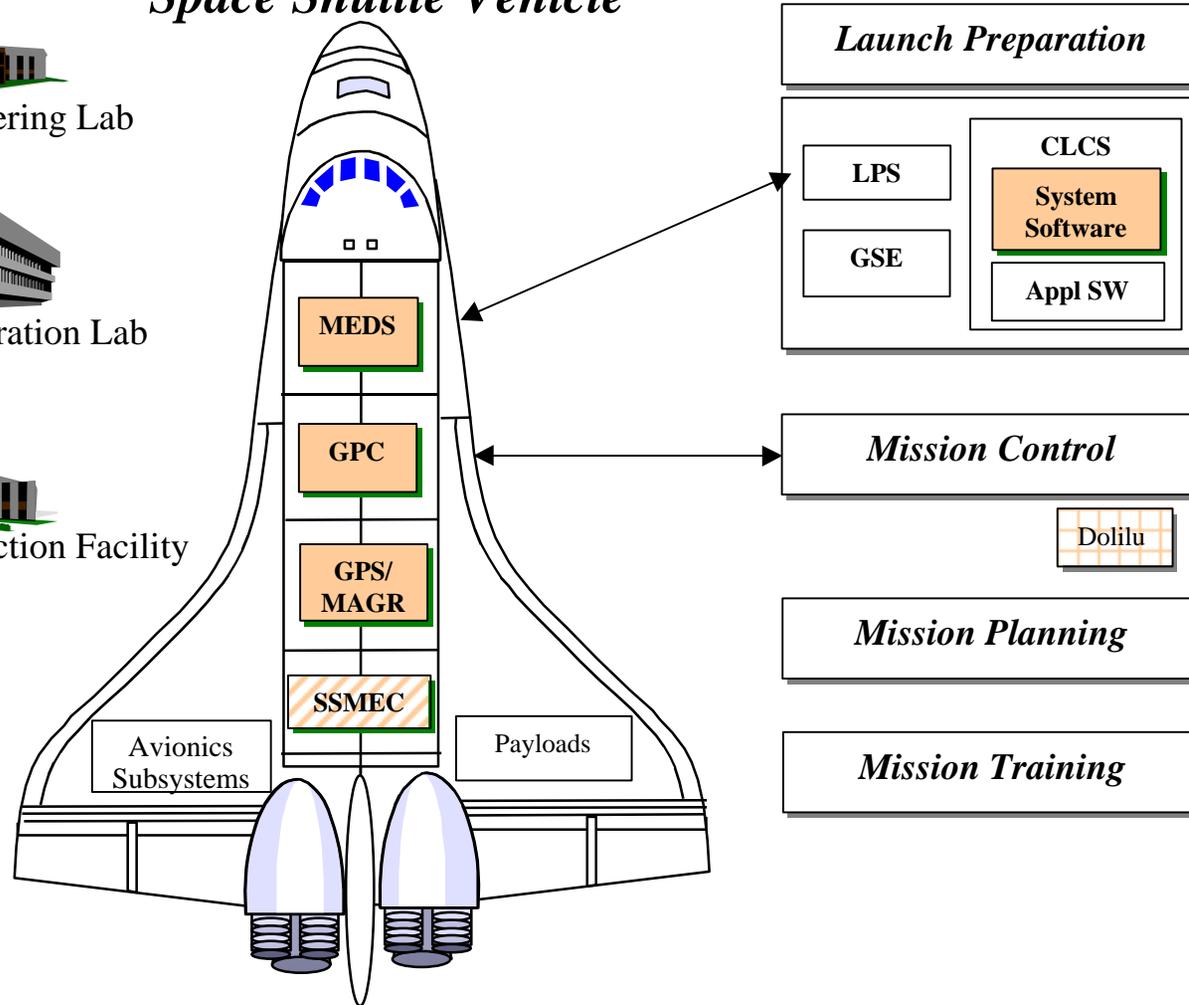


- Ensure safety of NASA missions
- Ensure requirements are met
- Minimize programmatic and technological risks of software development and operations
- Improve software quality
- Reduce costs and time to delivery
- Improve the science of software engineering

Space Shuttle Program Software Elements

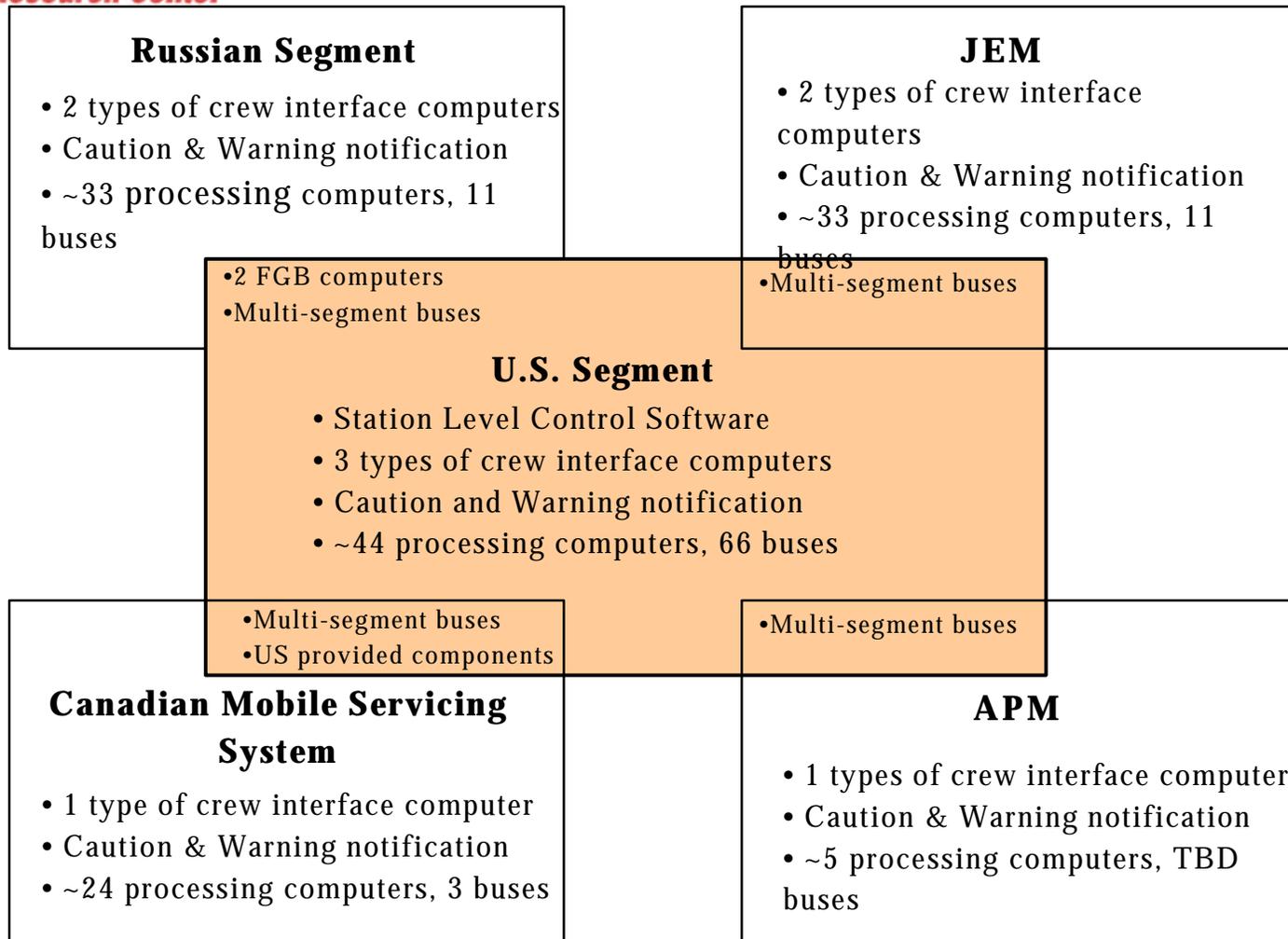


Space Shuttle Vehicle



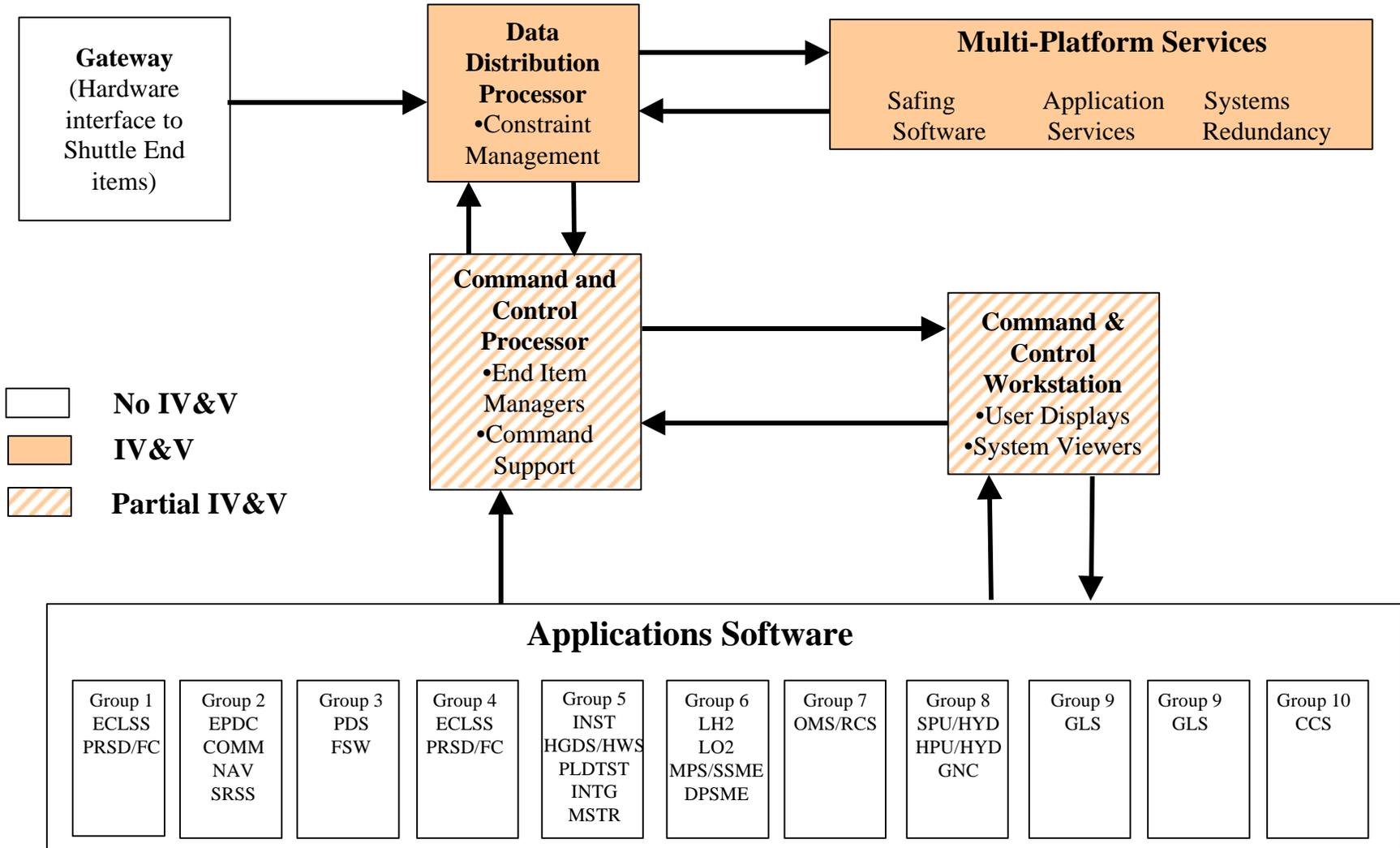
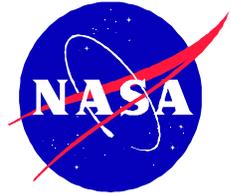


Station Computer Systems at Assembly Complete

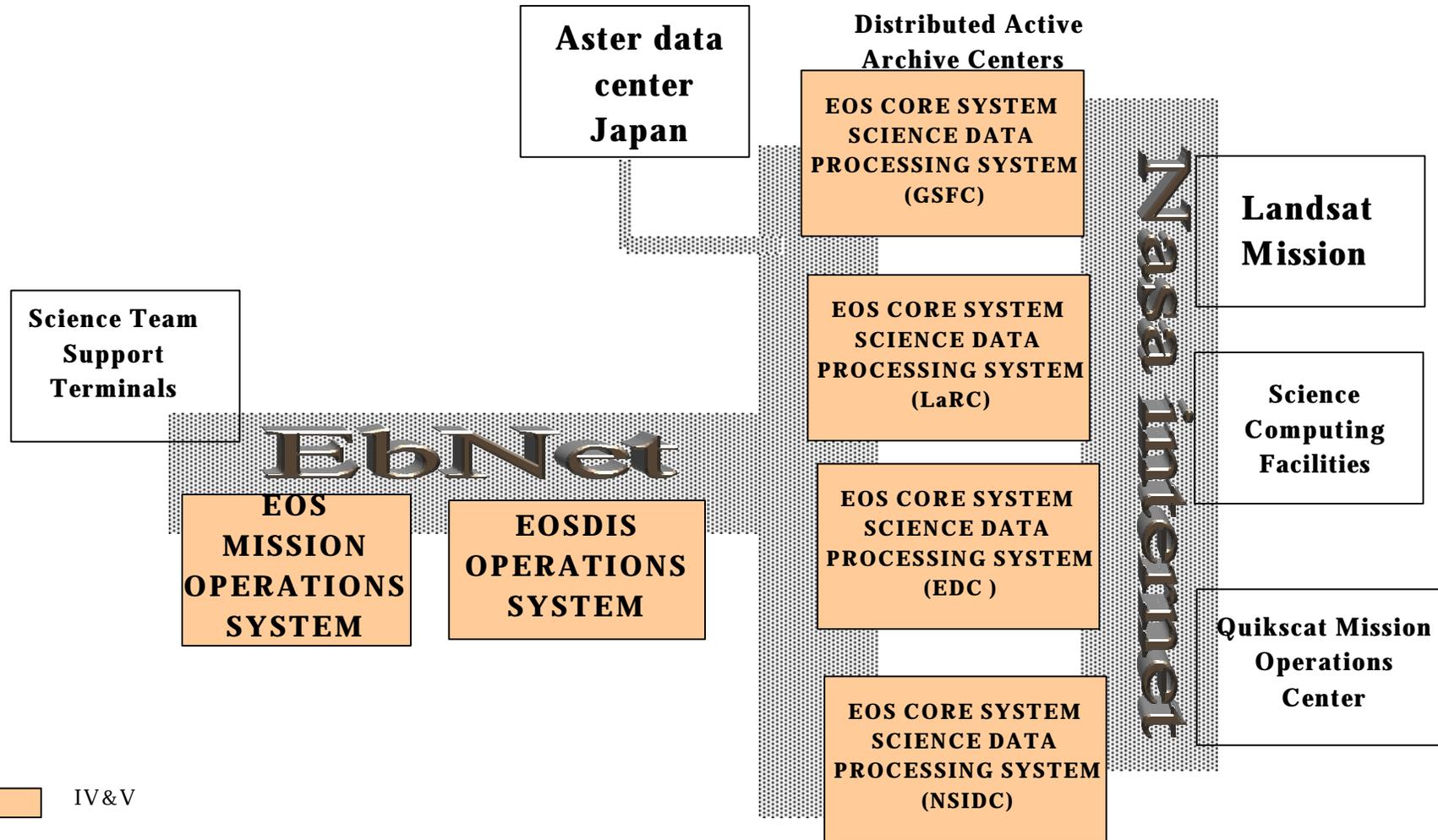


 IV&V
 No IV&V

CLCS System Architecture



EOSDIS Systems Architecture



* reference EOS Ground system Architecture Concept (diagram), ESDIS ICWG
 EOS Ground System contains approximately 30 component types, hundreds of components



Major IV&V Project Accomplishments



Accomplishments FY99

- Shuttle
 - Identified 15 software errors that could produce a loss of Shuttle or crew (e.g., shutdown of all SSME, loss of control during ascent)
- Station
 - Identified critical discrepancy in Mode Control software that rendered orbiter docking zero fault tolerant
- CLCS
 - Identify critical discrepancy with Command Management computer software that controlled the Hypergolic Maintenance Facility

Program Benefits

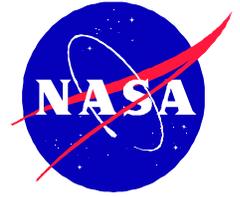
- Shuttle
 - Increased mission safety, reliability, and reduce cost
- Station
 - Enhanced reliability
- CLCS
 - Enhanced system reliability

Applied Software Technology Research Program



- **Software Metrics**
 - Return On Investment (ROI)
 - IV&V test method/practice effectiveness
 - Program effectiveness measures (schedule, cost, quality, productivity)
- **Software Reliability**
 - Curvilinear regression models
 - Diagnostic tools
 - Static code analysis
- **Software Risk Assessment**
 - Model Fidelity Assessment

Applied Software Technology Research Program



- **V&V for Intelligent Systems**
 - Autonomous spacecraft & rovers
 - Automated verification and validation
 - Predictive hazard analyses
- **V&V for Cost Estimating**
 - Predictive cost estimating
- **Software Requirements Engineering**
 - Abductive reasoning
 - Model based reasoning

Applied Software Technology Research Program



- **Specification-based Testing**
 - Automatic test case generation
 - Test coverage analysis
 - Empirically based formal verification
- **Software Architectural Analysis**
 - Safety, reliability, evolveability of different architectures
 - V&V of COTS
- **Software Re-use and the development of product families**
 - High assurance software
 - Domain engineering



FY00 Center Initiatives Research Program



Table 1. FY00 Center Initiatives

Projects	
Ames Research Center (ARC)	
1	Verification and Validation of Model Based Autonomous Systems
2	Specifying Planning, Execution and Monitoring behaviors for Autonomous Systems
3	The High Quality Knowledge Based Initiative
4	Automation of Testing, Monitoring, and Troubleshooting for Control Systems utilizing Automatic Code Generators
IV&V Facility	
5	University Research
6	Science and Engineering Technical Assessments
7	NASA Affiliate Membership in the Software Productivity Consortium
8	Development of Return on Investment (ROI) Model and Metrics for Software System Independent Verification and Validation
9	Safety Metrics for Human-Computer Controlled Systems
10	Investigation of the Engineering and Research Issues in Model-Based Verification for SW Systems
Glenn Research Center (GRC)	
11	Update of NASA Guidebook for Safety Critical Software Analysis and Development
12	Software Development Planning Tool with Cost Estimation and Risk Assessment
Goddard Space Flight Center (GSFC)	
13	Software Assurance Tools
14	Software Reliability Metrics
15	Intelligent Data Filtering
16	Software Reuse Frameworks for Flight Software
17	COTS Classification, Lifecycle management, Metrics, Reliability



FY00 Center Initiatives Research Program



Table 1. FY00 Center Initiatives

Projects	
Jet Propulsion Laboratory (JPL)	
18	Reducing Software Security Risk through an Integrated Approach
19	Formalized Pilot Study of Safety Critical Software Anomalies - JPL
20	Advanced Risk Reduction Tool (ARRT)
Johnson Space Center (JSC)	
21	MicroElectro-Mechanical Systems (MEMS) Data Security for Human Exploration and Development of Space (HEDS)
22	Real-Time Embedded Software Verification and Validation
Langley Research Center (LaRC)	
23	Using Software Engineering Methods and Techniques to Improve the Simulation Environment
24	Software Process Improvement
Marshall Space Flight Center (MSFC)	
25	V&V of Embedded Real-Time COTS Operating Systems for Space Flight Projects
26	Improvement of Software Development Processes through an Innovative Software Process Improvement Methodology
Stennis Space Center (SSC)	



Research Accomplishments



Accomplishments

Program Benefits

<ul style="list-style-type: none"> Space Station <ul style="list-style-type: none"> Discovered anomaly in requirements that specify behavior of Fault Detection, Isolation, and Recovery (FDIR) procedures in the 1553 Bus 	<p>Space Station Increased mission safety by initiating extensive redesign and simplification of Space Station main bus Fault Detection, Isolation, and Recovery procedures</p>
<ul style="list-style-type: none"> Space Shuttle <ul style="list-style-type: none"> Discovered potential anomalies in Miniaturized Airborne GPS Receiver (MAGR S3S) software used for onboard GPS-based GN&C 	<p>Space Shuttle Increased mission safety by identifying causes of current and potential lockups in MAGR GPS - Shuttle GPC link</p>
<ul style="list-style-type: none"> CLCS <ul style="list-style-type: none"> Discovered anomaly in Redundancy management/Reliable messaging protocols that controls selection of Master-Slave workstation relationships 	<p>CLCS Enhanced design and robustness of reliable multicast protocol used in core CLCS data distribution scheme</p>
<ul style="list-style-type: none"> Cassini - Mission to Saturn <ul style="list-style-type: none"> Discovered anomaly in mark-and-rollback state table broadcast algorithm that controls error recovery procedures in onboard Command and Data Subsystem 	<p>Cassini - Mission to Saturn Increased mission safety and viability by triggering redesign of core operating system fault recovery procedures during critical sequence execution</p>
<ul style="list-style-type: none"> DFRC F-18 PSFCC V&V <ul style="list-style-type: none"> Discovered anomaly in embedded flight software written in Ada programming language that controls dynamic flights surfaces on experimental F-18 	<p>DFRC F-18 PSFCC V&V Increased flight safety during experimental flights by increasing confidence in frame completion deadlines for real-time software</p>