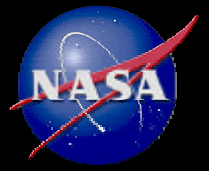


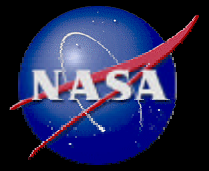

# NASA Initiative for Software Safety and Quality

25th Annual Software Engineering Workshop
Goddard Space Flight Center

*Orlando Figueroa*
*Deputy Chief Engineer - Systems Engineering*
November 30, 2000

# Agenda

- Drivers
- Goals
- Framework
- Approach




# Software Is a National Issue

***President's Information Technology Advisory Committee:***

- Improving Software Capabilities Is the Highest Priority
- The Demand for Software Has Grown Far Faster Than Our Ability to Produce It.
- The Nation Needs Software That Is Far More Usable, Reliable, and Powerful.
- We Have Become Dangerously Dependent on Large Software Systems Whose Behavior Is Not Well Understood and Which Often Fail in Unpredicted Ways.
- Software Research Is Required as the Basis for Improvement

# Software Is a NASA Issue

- Software Has Contributed to Significant Mission Problems/Failures
  - Mars Climate Orbiter - Mission Failure
    - Inadequacies in Verification and Validation Testing
  - Mars Polar Lander - Mission Failure
    - Inadequacies in Verification and Validation Testing
  - CLCS - Significant Schedule Delays
  - EOS DIS - Significant Schedule Delays
  - IFMP - Stop Work Issued

# Software Is a NASA Issue

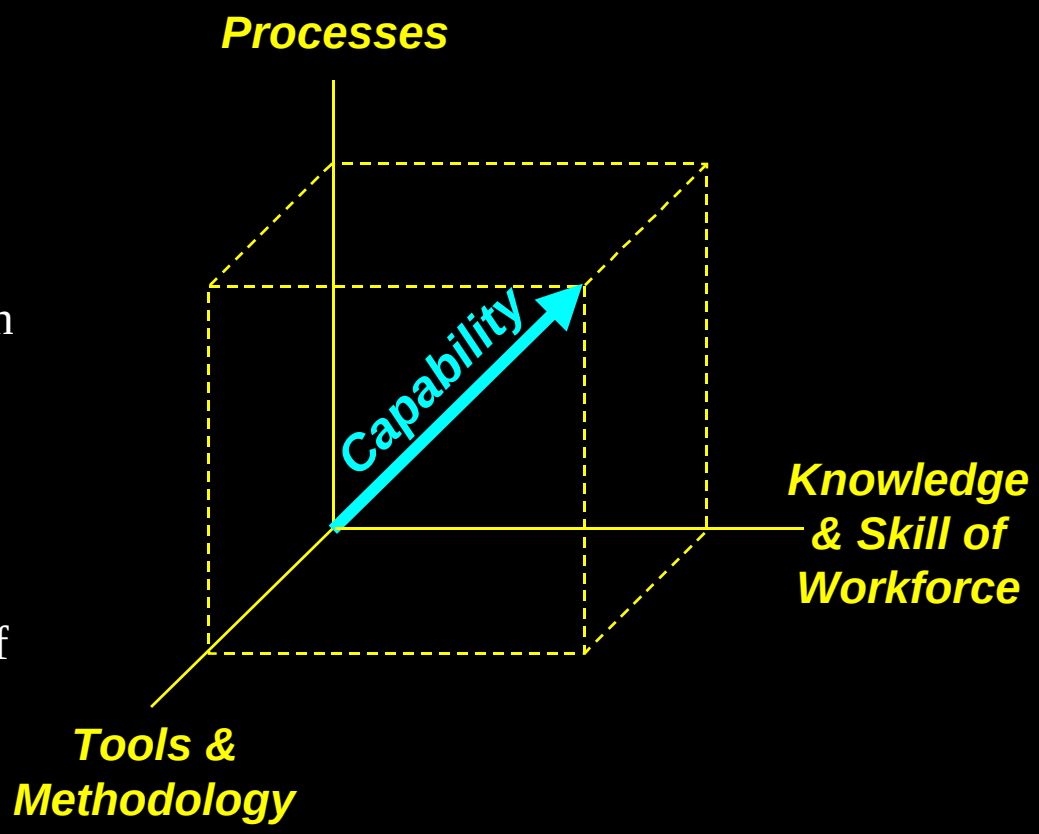
- Software Talent Retention - Highly Competitive Marketplace (33% Turnover for EOS DIS Contractors)
- Lack of Educational Standards/Certification for Software Professionals
- No Uniform Procurement Policies to Insure Quality Software
- Overall, NASA Is at CMM Level 1 (Initial/Unstable) - Shown by Internal Audits (LaRC, MSFC, JPL)
- Complexity/Size of Software Is Growing Faster Than Our Ability to Produce It, and Effectively Manage It

# Software In NASA

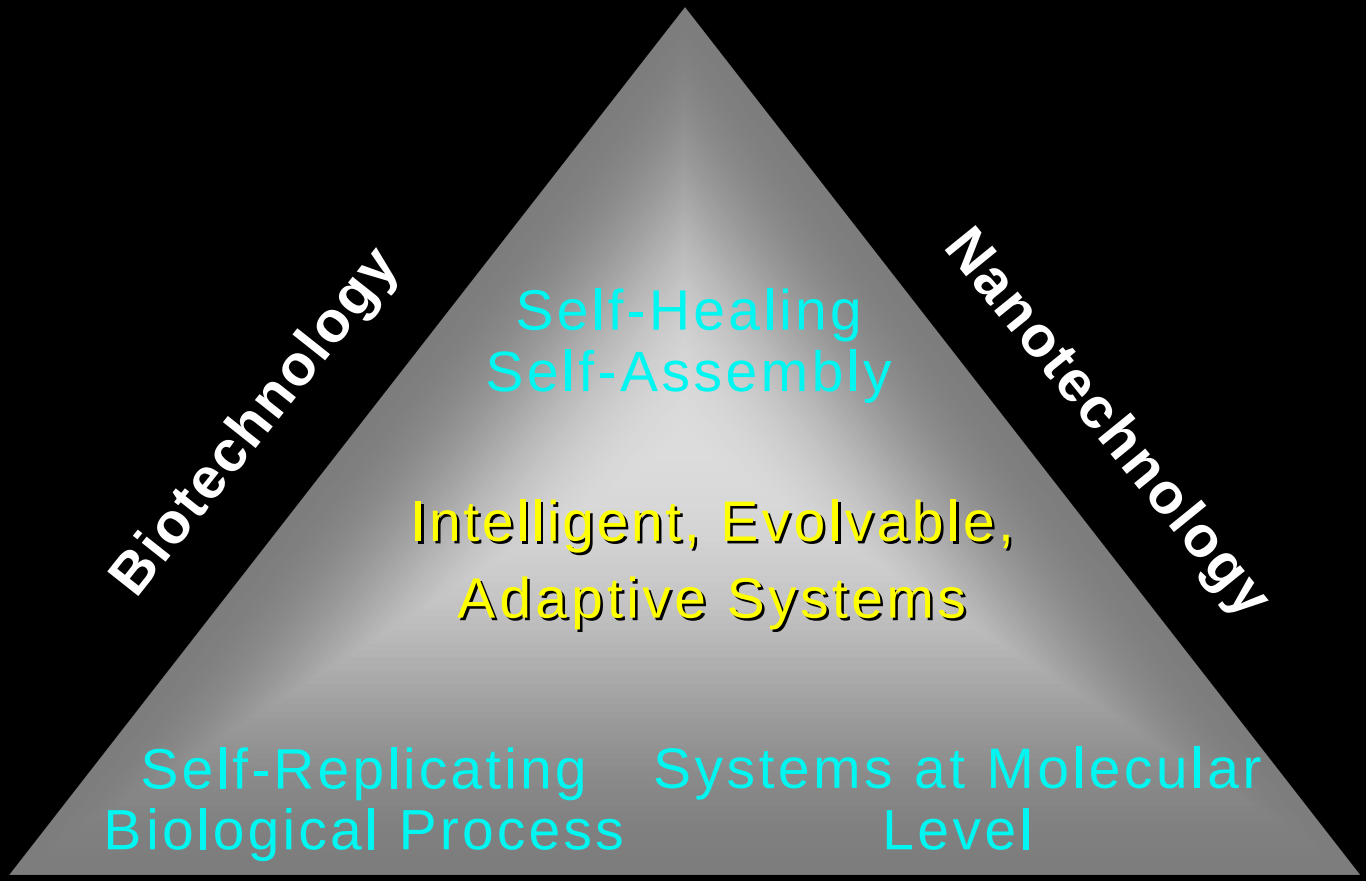
- Foresee exponential growth within NASA as well as industry.
  - Significant increase in on-board computational capability
  - Factor of 2 growth in computer chip complexity every 18 months.
  - Commercial packages such as operating systems, enterprise resource management systems, and telecommunications operations software are over 30 million lines of code.
- Increasingly difficult challenge to mission success.
  - Tools for development and verification of software need improvement to prevent the systemic management and technical problems that traditionally occur in software.

# Framework for Engineering Excellence

- Consistency in systems engineering approach at all levels
- Rapid prototyping, modeling and simulation capability
- Experienced, well trained engineers in application of process, tools, methodology, and customer relationship/interaction
- Continuous improvement through self assessment at the personal and organizational level

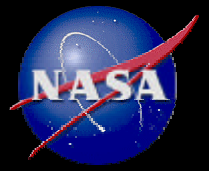


# Software Plays an Ever Increasing Role in NASA's Vision



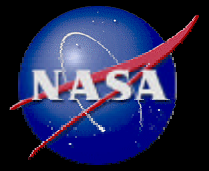
# Goals

- Establish NASA Engineering and Management Processes that Enable Development of Safe Quality Software
  - For All Software
    - NASA Developed
    - Contractor Developed
  - Preclude Catastrophic Failures (Loss of Life, Loss of Mission, Significant Loss of Equipment)
  - Meet or Exceed Mission/Project Requirements
  - Meet Program Costs and Schedules




# Goals (cont'd)

- Conduct and Transfer Software Research That Addresses:
  - High Reliability and Error Tolerance
  - Productivity Increases
  - Reusability of Software and Process
  - Increased Automation
  - Emerging Paradigms




# Framework

***Framework for Addressing These Goals***

- Process Improvement
- Establishment of Software Metrics
- Verification and Validation, and Independent Verification and Validation
- Software Research

# Approach - Improve the Process

***NASA Organizational Changes***

- Office of Chief Engineer "Champion" for NASA Software Initiative
- Strengthen the Software Working Group (SWG)
  - Chaired by Headquarters
  - Senior Membership from Each Center
  - The SWG Will Provide the Forum to:
    - Focus on the S/W Lifecycle Management and Process
    - Recommend Software Lifecycle Processes (Tailoring of IEEE 12207)
    - Identify Agency Needed Software Research Requirements to Support the Initiative

# Approach - Improve the Process

***Center Organizational Changes***

- Establish Software Engineering Process "Champions" (SEPs) at each Center to Provide:
  - Definition and Improvement of Center Software Processes
  - A Pool of S/W Experts to Participate in Project Reviews
  - Transfer of Agency Software Research
  - Feedback to the SWG on Center Successes and Concerns

# Approach - Improve the Process

***Move To Capability Maturity Commensurate with CMM Level 3 Per Criteria***

- Establish the Current CMM Level of Each Center Project and Major Software Contract
  - Led by Headquarters Software "Champion"
  - Each Center's SEP Assess Levels
  - Report Through the SWG
- Each Center Develop a Plan to Move Critical Software Development to Level 3 per Criteria
- Develop Contract Language Requiring CMM Level 3

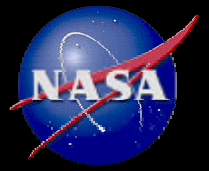
# Approach

***Verification and Validation***

- Systems Management Offices at Each Center to Inventory All NASA Programs for Appropriate Levels of V&V

***Independent Verification and Validation***

- Agency Policy Including Criteria for Project Assessment
- Center of Excellence at West Virginia IV&V Facility



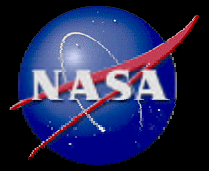

# Approach - Metrics

***Software and Project Characteristics***

- Identification (Name, Center, POC)
- Key Characteristics of Software Effort
- Capability Maturity of Developer
- Programmatic Performance
- Technical Performance
- Configuration Control

# Approach - Software Research

- NASA Software Research Focus
  - High Reliability (Leverage Hardware Models)
  - Error Tolerant Systems
  - Executive Reasoning
  - Planning and Scheduling
  - Software and Process Reuse
  - Emerging Paradigms (Autonomy)
- Leverage the Strengths of the Centers
  - ARC - Fundamental Research
  - JPL, GSFC, IV&V, LaRC - Applied Research

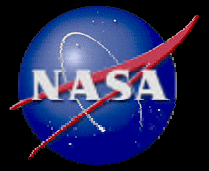



# Approach - Research

- Partner With Academia and Other Government Agencies to Conduct Long-term Software Research
- SEPs Support Transfer of New Methods/Tools into NASA Practice

# Near Term Milestones

- Complete Pilots and Establish Software Performance Metrics for Projects
- Approval of NASA Processes and Guidelines for Software
- Develop Agency Plan for Capability Maturity Improvements




# Survey Information

# Survey Results

| # of Yes Responses | Implication | CMMI SE Level |
|---|---|---|
| 16 | World Class | 4 - 5 Quantitatively Managed/ Optimized |
| 10 - 15 | Lighthouse Living | 3 Defined |
| 5 - 9 | Firehouse Living | 1-2 Performed/ Managed |
| < 5 | Ad Hoc & Chaotic | 0 Incomplete |