Software Engineering Improvement at NASA: Past, Present, & Future

April 2012
John C. Kelly & Tim Crumbley
Office of Chief Engineer
Contents

• Past
  – Software Engineering Laboratory
  – SMAP Program
  – Early NASA usage of the CMM Model

• Present
  – Policies, Requirements, Guidance, and Lessons Learned
  – Use of the CMMI Framework
  – Software Initiative Structure
    • Research and Innovation

• Current and Future Plans
  – Transition
    • Top NASA SW Issues
    • Benchmark Study
    • Electronic Handbook
    • CAPPS
    • Leveraging Industry Standards
    • Software Costing
    • Tools and Model Based Sys & SW Engineering
Goal: “... to analyze the software development process and the software produced in order to understand the development process, the software products itself, the effect of various “improvements” on the process with respect to the methodology, and to develop quantitative measures that correlate well with intuitive notions of good software”
Purpose: Provide consistent NASA-wide structures for documenting information systems and their components

Component Standards

- The Information System Life-Cycle Standard
- The Management Plan Documentation Standard
- The Product Specification Documentation Standard
- The Assurance Specification Documentation Standard
- The Management Control and Status Reports Documentation Standard
NASA Software Engineering Timeline

- **1950’s**: NASA Created from NACA (1958)
- **1960’s**: 1st Computer & SW in space (Gemini, 1962) ~12,000 Words flight SW
- **1970’s**: Beginning of SW Management and Assurance Program (SMAP)
- **1980’s**: Creation of the Software Engineering Laboratory (1976) NASA GSFC/UMD/CSC
- **1990’s**: 1st NASA Software of the Year Awarded (1994)

**Key Events**

- **1962**: Publication of NASA Information System Life-Cycle And Documentation Standards (SMAP)
- **1969**: 1st Computer & SW in space (Gemini, 1962) ~12,000 Words flight SW
- **1976**: Creation of the Software Engineering Laboratory (1976) NASA GSFC/UMD/CSC
- **1981**: 1st Shuttle Flight (1981) ~790 KSLOC flight SW
- **1989**: Required SW lifecycle & process de-emphasized and reduced on contracts
- **1994**: 1st NASA Software of the Year Awarded (1994)
- **1998**: ISS first segment launched (1998) ~1,800,000 KSLOC flight software

**Milestones**

- **1958**: NASA Created from NACA
- **1962**: Gemini
- **1969**: Apollo 11 Lunar Landing
- **1976**: Viking Landers
- **1981**: 1st Shuttle Flight
- **1989**: CMM ML 5
- **1994**: 1st NASA Software of the Year Awarded
- **1998**: ISS first segment launched
- **1999**: Required SW lifecycle & process de-emphasized and reduced on contracts
Software Engineering
Improvement at NASA: Past, Present, & Future

Present
Actual total system SLOC data: Uncrewed Spacecraft and Crewed Craft

The NASA Software Engineering Initiative (2002 to present)

• What is it?
  • A NASA-wide comprehensive approach for improving software engineering processes and technology

• Why are we doing it?
  • To meet the challenges facing NASA in software engineering (schedule, cost, meet project commitments, ensuring the use of best practices, …)

• What are the elements of OCE’s approach?
  • Component plans from each Center
  • The use of Software Engineering Institute's Capability Maturity Model as a benchmark for assessments
  • Software engineering tool shed infusion
  • Software metrics
  • The integration of sound software engineering principles and standards
  • Enhancing software engineers' knowledge and skills

• Who is deploying it?
  • OCE in collaboration with each Center
  • NASA Software Working Group
  • Center Management Steering Groups (MSGs) and Software Engineering Process Groups (SEPGs & EPGs)
Goal of the NASA Software Engineering Initiative
(2002 to present)

- Advance software engineering practices (development, assurance, and management) to effectively meet the scientific and technological objectives of NASA
  - Consistent performance for software products engineered for or by NASA in the areas of:
    - Schedule
    - Cost
    - Delivered Functionality
    - Quality
  - Infuse improved technology
  - Agency use of best practices for Software Engineering
  - Skilled and knowledgeable Workforce
Strategies for Software Engineering
- 2002 to present -

1. Implement a continuous software process and product improvement program across NASA and its contract community
2. Improve safety, reliability, and quality of software through the establishment and integration of sound software engineering principles and standards
3. Improve NASA’s software engineering practices through research
4. Improve software engineers' knowledge and skills and attract and retain software engineers
The Three Elements of Project Success

Process:
a defined method involving steps or operations

People:
Skills, Training, Management

Technology:
Application domains, tools, languages, information, environments

Improved Process + Competent Workforce + Appropriate Technology

= Reduced Risk, Higher Productivity, and Better Quality
Software Engineering Initiative
2002 - present

Objective:
“...advancing SW engineering practices to effectively meet the scientific and technical objectives of NASA”

Also includes:
- NASA SW Process Asset Library
- Software Metrics
- NASA SW Inventory
- NASA NPD 7120.4 & NPR 7150.2
- NASA Engineering Network (Software)
Timeline: NASA Software Engineering Initiative
2002 - present

1. **Started:** NASA SW Eng Improvement Initiative
2. **Signed:** SW Assurance and Safety Standards (updates)
3. **Started:** NASA SW Curriculm DACUM
4. **Created:** Design for NASA SW Curriculum DACUM
5. **Signing:** SW Procedural Req. NPR 7150.2
6. **Signed:** NASA Process Asset Library goes live
7. **Kickoff:** Annual Research Infusion Pilots
8. **Kickoff:** NASA Tech. Authority
9. **Kickoff:** First Annual Software Inventory
10. **First Publication:** NASA Innovations in Sys & SW Engineering Journal
11. **Signed:** SW Assurance and Safety Standards (updates)
12. **Signed:** SW Procedural Req. NPR 7150.2
13. **Signed:** NPD 2820.1 (consolidated SINGLE Software NPD)
14. **Kickoff:** NASA Tech. Authority
15. **Signed:** NEN Software Engineering Portal goes live
16. **Kickoff:** NASA SW Eng Improvement Initiative
17. **Signed:** SW Assurance and Safety Standards (updates)
18. **Signed:** SW Assurance and Safety Standards (updates)
19. **Signed:** Top SW Issues Update
20. **Completed:** NPR 7150.2A
21. **Kickoff:** Top SW Issues Update
22. **Update:** NPR 7150.2A
23. **Kickoff:** Top SW Issues Update
24. **Kickoff:** NPR 7120.4 (supersedes NPD 2820.1)
25. **Kickoff:** OCE Surveys (Software component)
26. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
27. **JSC Re-achieves CMMI Maturity Level 3
28. **Started:** Agency Level Tasks on Consolidated Software Processes, Software Costing, Use of Industry Software Standards and Small Projects
29. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
30. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
31. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
32. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
33. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
34. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
35. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
36. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
37. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
38. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
39. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
40. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
41. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
42. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
43. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
44. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
45. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
46. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
47. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
48. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
49. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
50. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
51. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
52. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
53. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
54. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
55. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
56. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
57. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
58. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
59. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
60. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
61. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
62. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
63. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
64. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
65. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
66. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
67. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
68. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
69. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
70. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
71. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
72. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
73. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
74. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
75. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
76. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
77. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
78. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
79. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
80. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
81. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
82. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
83. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
84. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
85. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
86. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
87. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
88. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
89. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
90. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
91. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
92. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
93. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
94. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
95. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
96. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
97. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
98. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
99. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report
100. **Completed:** Industry/NASA/University/Other Gov Agencies Software Benchmarking Report

**CMMI/CMMI Appraisals & Training at NASA Centers**
NASA Software Engineering Initiative – CMM and CMMI Activities
2000 to present

CMMI Level 3

- MSFC
- GSFC
- LaRC
- JPL
- MSFC (FSW)
- LaRC (SDAB)

CMMI Level 2

- MSFC
- JSC
- GSFC
- LaRC
- JPL
- KSC
- MSFC (SIL)
- GRC
- GSFC (ACQ)

CMM Level 3

- MSFC
- ARC
- JSC

CMM Level 2

- MSFC
- LaRC
- JSC
- GRC
- JPL

In 2004 timeframe 5 of the 10 NASA Centers had experience using the CMM model

By the 2009 timeframe 8 of 10 NASA Centers have experience using the CMMI model

CMMI Requirement for Class A and B software
Class A - CMMI Level 3 and Class B - CMMI Level 2

CMMI Requirement for Class A and B software
CMM Level 2 or CMM Level 3

Software Working Group Charter
Started: NASA SW Eng Improvement Initiative

CMM/CMMI Appraisals & Consultations at NASA Centers
Software Engineering Training and SEI Training at NASA Centers

Planned for September 2012

* - Implemented part of the model
<table>
<thead>
<tr>
<th>Center/Organization</th>
<th>Rating (SCAMPI A by Certified Appraiser)</th>
<th>Date</th>
<th># Projects</th>
<th>Type</th>
<th>Organizational size</th>
<th>Software Classes Assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>LaRC- ASDC</td>
<td>PP(CL3), CM(CL1)</td>
<td>Nov-06</td>
<td>1</td>
<td>Data Center Support</td>
<td>85</td>
<td>Class C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSFC</td>
<td>ML3</td>
<td>Apr-07</td>
<td>3</td>
<td>Development</td>
<td>63</td>
<td>Class A, B and C</td>
</tr>
<tr>
<td>JPL</td>
<td>ML3</td>
<td>Sep-07</td>
<td>7</td>
<td>Dev &amp; Maintenance</td>
<td>1000</td>
<td>Class A, B and C</td>
</tr>
<tr>
<td>GSFC</td>
<td>ML2 + RSKM(2)</td>
<td>May-08</td>
<td>4</td>
<td>Dev &amp; Maintenance</td>
<td>600</td>
<td>Class A, B and C</td>
</tr>
<tr>
<td>LaRC- FSSB</td>
<td>ML2 + CL3</td>
<td>Oct-08</td>
<td>3</td>
<td>Services</td>
<td>5</td>
<td>Class B &amp; C</td>
</tr>
<tr>
<td>LaRC- SDAB</td>
<td>PP(CL3), REQM(CL3), CM(CL3), MA(CL3)</td>
<td>Mar-09</td>
<td>4</td>
<td>Development</td>
<td>21</td>
<td>Class B &amp; C</td>
</tr>
<tr>
<td>JSC</td>
<td>ML2</td>
<td>Apr-09</td>
<td>4</td>
<td>Development</td>
<td>90</td>
<td>Class A, B, C and D</td>
</tr>
<tr>
<td>KSC</td>
<td>ML2</td>
<td>Sep-09</td>
<td>1</td>
<td>Development</td>
<td>225</td>
<td>Class A, B and C</td>
</tr>
<tr>
<td>GSFC – SIL</td>
<td>ML2 + CL3</td>
<td>May-10</td>
<td>1</td>
<td>Development</td>
<td>50</td>
<td>Class C</td>
</tr>
<tr>
<td>ARC –ISD (Codes TI &amp; QS)</td>
<td>ML2</td>
<td>May-10</td>
<td>6</td>
<td>Development</td>
<td>63</td>
<td>Class B &amp; C</td>
</tr>
<tr>
<td>GRC-Fit SW</td>
<td>ML2</td>
<td>Aug-10</td>
<td>2</td>
<td>Development</td>
<td>22</td>
<td>Class C &amp; D</td>
</tr>
<tr>
<td>MSFC-Fit SW</td>
<td>ML3</td>
<td>Aug-10</td>
<td>1</td>
<td>Development</td>
<td>75</td>
<td>Class A</td>
</tr>
<tr>
<td>JPL – Mission SW</td>
<td>ML3</td>
<td>Sep-10</td>
<td>9</td>
<td>Development &amp; Maintenance</td>
<td>950</td>
<td>Class B and C</td>
</tr>
<tr>
<td>LaRC FSSB</td>
<td>ML2- CL3 for all ML2 process except SAM</td>
<td>Aug-11</td>
<td>4</td>
<td>Development &amp; Maintenance</td>
<td>25</td>
<td>Class A, B and C</td>
</tr>
<tr>
<td>GSFC - In house Development Projects</td>
<td>ML2 + CL2(Risk)</td>
<td>Sep-11</td>
<td>3</td>
<td>Development &amp; Maintenance</td>
<td>200</td>
<td>Class B</td>
</tr>
<tr>
<td>GSFC- Acquisition Projects</td>
<td>CL2 (SAM)</td>
<td>Sep-11</td>
<td>3</td>
<td>Acquisition</td>
<td>30</td>
<td>Class B</td>
</tr>
<tr>
<td>LaRC SDAB</td>
<td>CL3 - in 4 process areas RM, CM, PP, PM&amp;C,</td>
<td>Nov-11</td>
<td>30</td>
<td>Development &amp; Maintenance</td>
<td>59</td>
<td>Class C, D and E</td>
</tr>
<tr>
<td>JSC</td>
<td>ML3</td>
<td>Mar-12</td>
<td>5</td>
<td>Development &amp; Maintenance</td>
<td>75</td>
<td>Class A, B, C and D</td>
</tr>
</tbody>
</table>
### Sample of NASA Industry Partner Ratings

*(which used NASA missions in their SCAMPI appraisals)*

<table>
<thead>
<tr>
<th>NASA Projects</th>
<th>Industry Partners</th>
<th>CMMI Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shuttle Primary Avionics Software System (PASS), Shuttle SAIL test facility,</td>
<td>United Space Alliance Flight Software Element (FSWE)</td>
<td>Level 5</td>
</tr>
<tr>
<td>Orion Crew Exploration Vehicle (Orion)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>International Space Station (C&amp;DH), Ares</td>
<td>Boeing</td>
<td>Level 3</td>
</tr>
<tr>
<td>Orion Crew Exploration Vehicle (Orion)</td>
<td>Lockheed Martin Corporation</td>
<td>Level 3</td>
</tr>
<tr>
<td>Orion Crew Exploration Vehicle (Orion), Ares</td>
<td>Honeywell</td>
<td>Level 3</td>
</tr>
<tr>
<td>Orion Crew Exploration Vehicle (Orion)</td>
<td>ATK</td>
<td>Level 3</td>
</tr>
<tr>
<td>Ares</td>
<td>Draper</td>
<td>Level 3</td>
</tr>
<tr>
<td>Ares J-2X, Orion Crew Exploration Vehicle (Orion), Space Shuttle Main Engine</td>
<td>Hamilton Sundstrand Rocketdyne / Pratt &amp; Whitney Rocketdyne</td>
<td>Level 3</td>
</tr>
<tr>
<td>Ares, Deep Impact 1</td>
<td>Ball</td>
<td>Level 3</td>
</tr>
<tr>
<td>James Webb Space Telescope</td>
<td>Northrop Grumman</td>
<td>Level 3</td>
</tr>
<tr>
<td>GRAIL, Juno</td>
<td>Lockheed-Martin Space and Exploration Systems</td>
<td>Level 3</td>
</tr>
<tr>
<td>Ground Systems Engineering (GSE) Checkout, Assembly and Payload Processing</td>
<td>Boeing</td>
<td>Level 3</td>
</tr>
<tr>
<td>Services (CAPPS) Kennedy Space Center (KSC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISS Environmental Control and Life Support Systems, Orion Crew Exploration</td>
<td>Hamilton Sundstrand</td>
<td>Level 3</td>
</tr>
<tr>
<td>Vehicle (Orion)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GOES-R</td>
<td>Harris IT Services Corporation</td>
<td>Level 3</td>
</tr>
<tr>
<td>MSFC Engineering Support Contractor</td>
<td>Jacobs Engineering</td>
<td>Level 3</td>
</tr>
<tr>
<td>STereo</td>
<td>Johns Hopkins University Applied Physics Laboratory</td>
<td>Level 3</td>
</tr>
<tr>
<td>NASA Software IV&amp;V Services, JSC Support Contractor</td>
<td>L-3 STRATIS</td>
<td>Level 3</td>
</tr>
<tr>
<td>KSC Support Shuttle support</td>
<td>United Space Alliance, LLC</td>
<td>Level 3</td>
</tr>
<tr>
<td>NASA Aircraft Management Information System (NAMIS) software</td>
<td>SAIC, Aircraft Operations Support System (AOSS)</td>
<td>Level 3</td>
</tr>
<tr>
<td>JSC Support Contractor</td>
<td>Tietronix</td>
<td>Level 2</td>
</tr>
</tbody>
</table>
Software Engineering Improvement at NASA: Past, Present, & Future

Current and Future Plans
Future Directions
- Highlights -

FY 12
- SW Engineering Handbook: Agency review and completion 2\textsuperscript{nd} Qtr
- Consolidated Agency-wide Software Processes: Begin Phase 1
- Small Projects and Software Requirements
- Software Cost Estimation Survey, Training, & Guidance
- Update Software Engineering Curriculum & begin filling course gaps

FY 13
- Consolidated Agency-wide Software Processes: Complete Phases 1, Begin Phase 2
- Strategy to adopt/incorporate industry software standards
- SW Engineering Training: complete filling course gaps

FY 14
- Consolidated Agency-wide Software Processes: Complete Phase 2, Begin Phase 3 (Agency-wide appraisal)
- Update NPR 7150.2 to Rev. “B” and submit for NODIS Review
NASA Software Engineering Benchmark

Background: Why and Who?

• **Identify best practices that will**
  – improve the management and engineering of software intensive systems
  – enhance software collaboration among centers, Prog/Projects, international partners and external relationships
  – provide guidance or solve current NASA software issues

• **Benchmarked 18 Organizational Groups:**
  – Within NASA (5 of the 10 Centers were included)
  – NASA Industry Partners (5 Aerospace/Defense Contractors)
  – Government Agencies (4 groups from Army, Navy, Air Force)
  – NASA Academic Partners (4 Universities, University labs who do Aerospace work)
NASA Software Engineering Benchmark

*What Did We Ask?*

- **Background:** to understand the organization
  
  Org structure, types, sizes of software, criticality, SW relation to SA, languages, life cycle, major projects

- **Training**
  
  Responsible parties, plans, strategy, preferred method, best classes, mentoring, mandatory or not

- **Acquisition**
  
  How much, how is it managed, communication of policies

- **Software Policies**
  
  Organization, level of detail, compliance checks, communication

- **Processes for Small Projects**
  
  Policies and compliance, CMMI, tailoring, infrastructure support, tools

- **Testing**
  
  Strategy, levels, life cycle, test team, metrics, tools, completion criteria

- **CMMI**
  
  Drivers, implementation strategies, benefits, obstacles
What Have We Learned? CMMI Levels of Organizations:

13 of the 14 interviewed organizations (NASA Centers, Industry Partners, and Other Government Agencies) interviewed are working with the CMMI model to improve their software engineering processes and software quality.
Effective utilization of workforce goes hand-in-hand with common processes for related organizations

Economics, affordability and competition is driving organizations into the use of common organizational level processes

Common organizational processes facilitated cross organizational projects

Common Processes to allow moving people around, faster start up time, faster product development

Advantage will be to share projects in a seamless manner across the sister organizations

Strategy to share common processes across sister organizations
  - Telecons
  - Enterprise level Software Engineering Process Groups in place to support the development and management of common organizational processes
  - Enterprise approach can take 2 – 3 years to implement
  - Advantage will be to share projects in a seamless manner across the sister organizations
  - Will be able to compete as an organization with a workforce of 3000 people, instead of separate 1000 tech workforce organizations
NASA Software Engineering Benchmark

Summary

• Benchmarking was very interesting and provided a wealth of information
  – We did see potential solutions to some of our “top 10” issues
  – We have an assessment of where NASA stands with relation to other aerospace/defense groups

• We formed new contacts and potential collaborations
  – Several organizations sent us examples of their templates, processes
  – Many of the organizations were interested in future collaboration: sharing of training, metrics, CMMI appraisers, instructors, etc.

• We received feedback from some of our contractors/ partners
  – Desires to participate in our training; provide feedback on procedures
  – Welcomed opportunity to provide feedback on working with NASA
Top Software Issues 2010 → 2012+ Improvement Tasks

- **Internal NASA-wide requirements (NPD, NPR, & Standards)** → Consolidated Processes and Principles for SW (CAPPS); Leveraging Industry Standards Task
- **Software Cost Estimation** → SW Cost Estimation Improvement Task
- **Software Workforce level** → Mission SW Steering Committee’s Workforce Study
- **Systems Eng. / Software Eng. Interface** → SW Engineering e-Handbook; Updated NPR 7150.2 (SW); Inputs to current update cycle of NPR 7123.1 (Systems)
- **Small Project Implementations** → Tailoring for Small Projects Task
- **Empowerment of SW Personnel** → Technical Authority Process
- **SW Requirements** → CMMI REQM; Training in SW Requirements
- **Complex Electronics** → NASA CE Assurance & Safety Handbook created; Engineering PLD Handbook being drafted
- **Training & Skill Development** → updated NASA SW Engineering Excellence Training curriculum; SW Assurance and Safety track in NASA STEP program
- **Insufficient attention to SW on Contracts** → Broader use of SAM; added questions on Surveys at Centers; section developed for SW Engineering e-Handbook
- **SW Architectural Analysis & Review** → NASA Software Architectural Review Board created; NEN Community of Practice formed
- **Model Based SW Development** → included in NASA-wide Model Based Systems Engineering task begun in 2011
NASA’s Software Engineering Initiative

- Reduces risk of software failure - Increases mission safety
- More predictable software cost estimates and delivery schedules
- Smarter buyer of contracted out software
- More defects found and removed earlier
- Reduces duplication of efforts between projects
- Increases ability to meet the challenges of evolving software technology