

The NASA SARP Software Research Infusion Initiative

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Outline

- Background/Motivation
- Proposal Solicitation Process
- Proposal Evaluation Process
- Overview of some projects to date
- Lessons Learned



NASA Software Working Group

- Purpose:

“ ... to develop and oversee the formulation and implementation of an Agency wide plan to work toward continuous, sustained software engineering process and produce improvements in NASA; and to ensure appropriate visibility of software issues within the Agency” .

<http://software.nasa.gov/about>

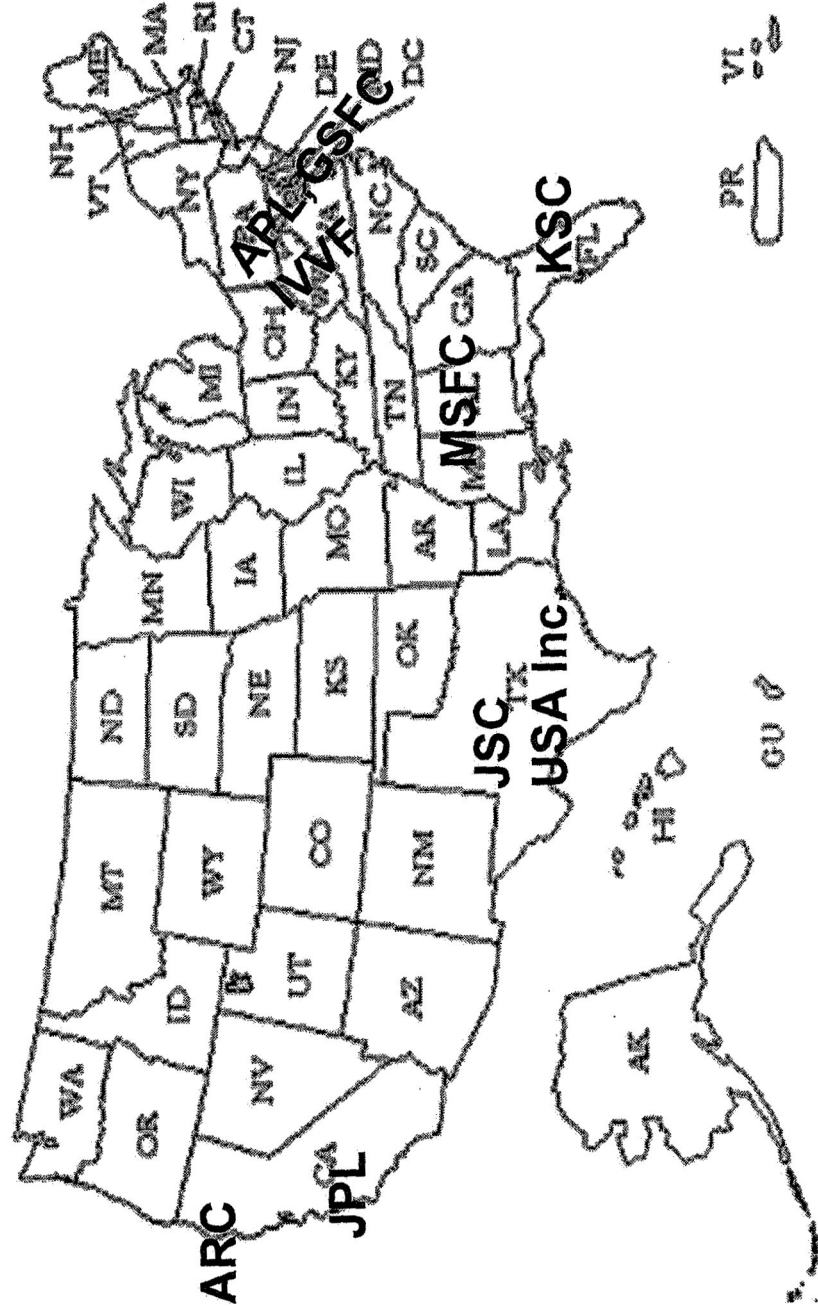


Research Infusion Initiative

- Encourages the uptake of new research results within real NASA missions.
- Attempts to smooth the transfer of technology and partner technology providers with end-users who have a need for the technology.
- Charged with overseeing various small infusion projects, and using Lessons Learned to improve the uptake of new technologies within NASA.



Software Engineering Research Infusion Sites





Obstacles to Research Infusion

- “gap” between interpretations of adequate maturity;
- Inadequacy of the TRL scale for quantifying this “gap”;
- Risk-aversion of most NASA developers and most NASA projects;
- Lack of evidence to demonstrate benefits (analyses, ROI, etc.);
- Development takes place in the context of a large mission;
- Fragmented practitioner community.



Overcoming Obstacles

- Information Gathering;
- Information Dissemination;
- Brokering Collaborations.



Information Gathering

- Focus on research/technologies that:
 1. Have particular relevance to software assurance.
 2. Can be incorporated into existing software development practices with a minimum of disruption.
 3. Are mid- to high-TRL research, demonstrating success on a real project, and ready for use more or less “as-is”.
 4. Are either NASA-funded, or are related technologies, or have been suggested by NASA software developers.



Proposal Solicitation Process

- Research Infusion team solicited communication with proposal teams
- Encouraged draft proposals prior to final submission and we responded with suggestions.
 - Not all proposal teams took advantage of this



Information Dissemination

- Via the Research Infusion team's website;
- Via direct contact with developers;
- Via direct "marketing" (email, telephone);
- Via a NASA-wide ViTS.



Brokering Collaborations

- Annual NASA-wide proposal solicitation;
- A small number (+/- 7) of technologies are presented via a NASA-wide ViTS (also available online and via DVD);
- Interested parties are encouraged to submit a proposal, and offered guidance in writing their proposal;
- Introductions are made between the proposal writers (the developers) and the technology provider, and they are encouraged to work closely in writing the proposal.
- Encouraged draft proposals prior to final submission and we responded (not all proposal teams took advantage of this).



Proposal Evaluation Process

- Proposals are evaluated on:
 1. Feasibility;
 2. Impact on NASA;
 3. Likelihood that, if successful, the technology will be adopted as part of the development team's practice;
 4. Adequate feedback is provided to providers (cf. collaboration);
 5. Good use of NASA funds.



Proposal Evaluation Process

- Same process followed each year;
- More proposals received each year (300% increase over 3 years);
- Each RI team member reviewed & evaluated all proposals
 - Numerical;
 - Qualitative;
- Evaluations were combined, questions and concerns noted; in a few cases we recommended reduction in \$ requested;
- Communicated concerns and got feedback from proposal teams;
- Subsequent evaluation meetings held: rankings finalized.



A posteriori Evaluation

1. The success criteria (stated at outset) have been met.
2. The research product is adopted by the software development team for current use.
3. A NASA Center adds the research product to its list of recommended practices.
4. The software development team provides feedback (including performance data) to the research team.
5. Six months later the product is still being used by the development team or a successor project.
6. “Lessons Learned” are recorded irregardless of the success (or otherwise) of the project.



Completed Projects

Technology	Technology Provider	Technology Description	Customer Sites and Target Applications	Outcome/Benefits
Perspective-based Inspections	Fraunhofer Maryland, SARP	Software Manual Inspection Technique	GSFC (Spacecraft FSW) USA (ISS power analyzer)	Defects found in legacy code and that escaped previous inspections. Adopted.
Software Cost Reduction (SCR)	Naval Research Laboratory	Requirements Analysis Tools	ARC (ISS Payload)	Personnel trained. Reqs validated.
SpecTRM	Safeware Engineering Corp. & MIT	Requirements Capture and Analysis	JPL (Capture of Mission Design Rationale)	Personnel trained. MIT student hired.
Orthogonal-Defect Classification	JPL, SARP	Process Improvement Methodology	JPL (Ground SW)	SQA and project personnel trained.
CodeSurfer/CodeSonar	Grammatech, Inc.	Reverse Engineering/defect detection	JSC (ISS, Shuttle), IVVF (Spacecraft FSW)	Found defects that escaped previous inspections.
C Global Surveyor (CGS)	ARC – Intelligent Systems Program	Software defect detection tool	ARC (ISS science payload) MSFC (ISS payload)	Found defects. Good feedback to provider.
Coverity SWAT/Prevent	Coverity, Inc.	Software defect detection tool	MSFC (ISS, Shuttle FSW)	Found defects that escaped testing. Will be adopted.



Some Lessons Learned

- Some developers are not so proficient at research-oriented activities and need more guidance and “hand-holding”.
 - Pro-forma documentation;
 - Frequent oversight to ensure adequate communication and adherence to schedule.
- There is no general solution to the question “What is the next step?”.
 - Some technologies are more easily integrated into the parent organizations processes.



Some Lessons Learned

- Greater qualification of technology/project combination may be required.
 - One tool previously used successfully did not transition well to another application and another development process.
- Sometimes project personnel already have in mind technologies they are interested in and the research infusion effort serves predominantly to provide seed money so that the desired collaboration can take place, and track its progress once initiated..



Some Lessons Learned

- Collaborations' project plans should explicitly include an iterative approach to technology application, scaling up with each iteration.
- Leading-edge tools sometimes have problems, e.g., needing specialized skills for set-up. Technology providers have made efforts to compensate.
- To succeed, training and continued support are needed. *“The most successful way to do tech transfer is to put a member of the [technology vendor team] on the development team”.*



Some Lessons Learned

- The profile of effort required to learn new technologies varies with the technology.
- Busy researchers and project members may have scheduling pressures that take precedence over infusion studies, which may lead to significant delays in the infusion projects.
- NASA is a dynamic environment. It is important to consider the loss of organizational memory as a risk up front and plan for its mitigation.



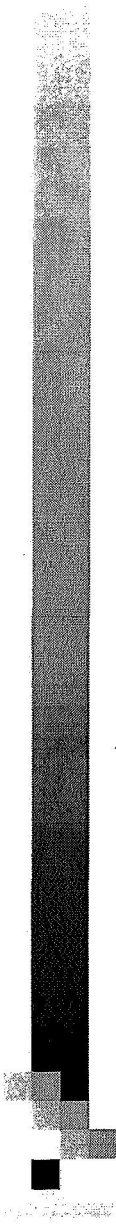
Some Lessons Learned

- If the lead-time between technology proposal and beginning the project is too great, the necessary personnel may be lost, or it may be impractical, or unbeneficial, to use the technology at this stage of the development. Several of our infusion collaborations were affected in this way.



New Infusion Starts

Technology	Technology Provider	Technology Description	Customer Sites and Application
Design Advisor	Siemens Corporate Research	UML style checker	GSFC (Spacecraft Science Instrument Module)
Software Architecture Evaluation	Fraunhofer Maryland	Code/Architecture Consistency Analysis	JHU/APL (Ground SW)
Klocwork Inspect	Klocwork, Inc.	Software defect detection tool	JPL (Ground SW), GSFC (FSW)
CodeSurfer	Grammatech, Inc.	Reverse Engineering/defect detection	KSC (Shuttle Processing CY06) GRC (ASMS)
CASRE	JPL	Software reliability estimation	JPL (MONTE)
RTLlinux	FSMLabs	Real time operating system	LaRC (RSC)



Publications

- T. Pressburger, B. Di Vito, M.S. Feather, M.G. Hinchey, L. Markosian and L. Trevino, "Infusing Software Assurance Research Techniques into Use." In *Proc. 2006 IEEE Aerospace Conference*, Big Sky, MT, 10-14 March 2006, IEEE Computer Society Press.
- M.G. Hinchey, T. Pressburger, L. Markosian and M.S. Feather, "The NASA Software Research Infusion Initiative: Successful Technology Transfer for Software Assurance." In *Proc. TT'06, Workshop on Technology Transfer for Software Engineering, International Conference on Software Engineering*, Shanghai, China, 20-28 May 2006, ACM Press.
- T. Pressburger, M. Hinchey, M.S. Feather and L. Markosian, "Infusing Software Engineering Technology into Practice at NASA," In *Proc. SMC-IT, 2nd IEEE International Conference on Space Mission Challenges for Information Technology*, Pasadena, CA, 17-20 July 2006, IEEE Computer Society Press.



Publications in preparation

- Invited presentation for ISoLA 2006, 2nd IEEE Symposium on Leveraging Applications of Formal Methods, Validation and Verification, Paphos, Cyprus, November.
- Invited paper for *International Journal of Software Tools for Technology Transfer*, “Opinions” column.
- Possible submission for ISSRE 2006, Government Practices track, North Carolina, November.
- Possible submission for ICSE 2007 Experiences track, Minneapolis, May 2007.



Conclusions and Future Direction

- We consider the Research Infusion activity to have been a success, and it will continue with increased funding.
- A modest approach has achieved significant results with only small budgetary requirements.
- We anticipate keeping largely the same procedure for project selection, evaluation, and monitoring, with some minor modifications.