

Relevance of Reuse in Building Advanced Data Processing Systems

James J. Marshall (Innovim / NASA GSFC)

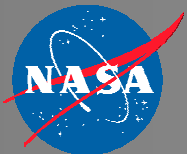
Robert R. Downs (CIESIN, Columbia University)

Shahin Samadi (Innovim / NASA GSFC)

2009 Earth and Space Science Informatics Workshop

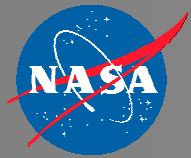
Baltimore, MD

August 4, 2009

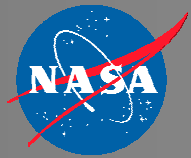


Introduction to Reuse

Some background information

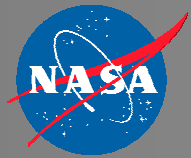


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- Reuse involves **integration into another context**, and can be done with hardware, software, or other assets.
 - Source code, plans, design requirements, system documentation, algorithms, procedures, and other **system components contain the results of previous work, knowledge, and experience**.
 - Reuse of such components allows developers to take advantage of past experience and **avoid starting over** from the beginning with each new system.
 - Reusable assets **exist in all stages of the development life cycle** and can contribute to future development.

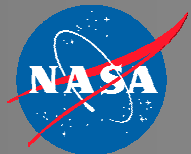


Benefits and Risks of Reuse

- Reuse is often practiced in order to:
 - Reduce cost, time, effort, and risk.
 - Increase productivity, quality, performance, and interoperability.
- However, there are **potential risks** involved with reuse, for example:
 - Assumptions about origin or validation/verification of assets could increase risks, especially in critical systems.
 - Modifications necessary to integrate the asset into its new context could be more expensive than building from scratch.
- Such risks need to be **recognized and assessed to be mitigated**.
- A **planned, directed approach to reuse** will help producers and adopters attain the benefits of reuse while limiting its costs and managing its risks.

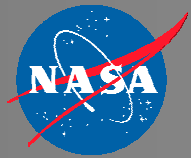


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- System developers must be aware of the **reuse potential** of components they are currently developing.
 - The development of current and future systems can have **similar purposes and motivations**.
 - Currently accumulated **knowledge should be preserved** for reuse by future generations.
 - **Contributing** to the pool of quality resources available for reuse (e.g., in catalogs and repositories) can further **enhance the benefits** of reuse while **reducing risks**.
 - Such contributions must be **cleared for release** from the developer's organization **and licensed as shareable resources** so that others can reuse them.

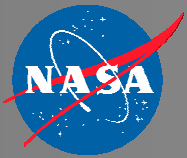


The NASA Earth Science Data Systems (ESDS) Software Reuse Working Group (WG)

Encouraging and enabling reuse within the
Earth science community



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- Purpose
 - Address technical issues required to enable and facilitate reuse of software assets, including open source products, within the NASA Earth science community.
 - Goals
 - To spend less time, money, and effort on software development.
 - To increase productivity and improve quality through reuse.
 - To increase the number of available reusable assets.
 - Scope
 - Facilitating reuse across projects and not interfering with local control of participating systems.
 - Focusing on reuse process and not on technology infusion process.
 - Focusing on reuse of existing assets rather than reusability of newly developed assets.
 - Focusing not only on software code, but also on design artifacts (architectures, software designs, ICDs, test plans, etc.).
 - Focusing on reuse of proven operational and NASA Earth science specific software assets.



Reuse WG Activities

Reuse Implementation Projects

Efforts that result in the publication or use of a reusable component

Outreach and Education Activities

Efforts that increase community awareness and understanding of benefits, best practices, etc.

Support/Enablement Activities

Efforts that provide tools and mechanisms to enable reuse

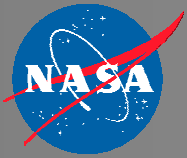
Reuse Incentive Activities

Awards and structural changes that directly or indirectly encourage reuse

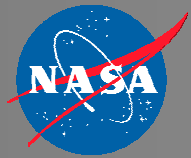
Policy Change Activities

Efforts to reduce policy barriers to reuse

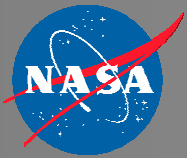
- Examples of work in some of these areas include:
 - Creating a **web site to promote and provide**
 - Recommending that NASA create a **Reuse Enablement System** (repository) for Earth science reusable software assets; development of **Reuse Readiness Levels**
 - Developing a **reuse peer-recognition award**



Software Reuse Portal Web Site

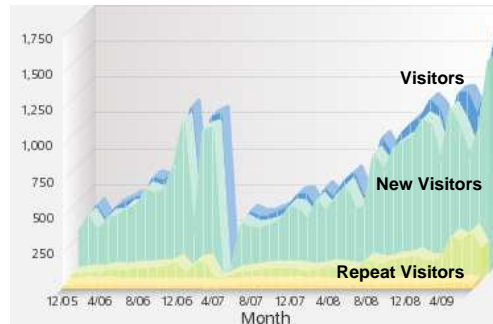
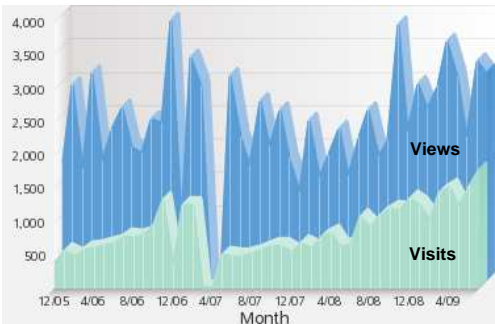


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- Key drivers for the web portal include:
 - Serve the community of Earth science data systems and software developers who are interested in reuse
 - Serve as a [gateway for reuse information](#) relevant to the community
 - Establish a portal for the community to [share resources](#) on reuse
 - [Distribute various resources](#) on reuse to the community
 - Foster [easier access to resources](#) on reuse
 - Major content categories based on purposes identified for the web portal include:
 - List of catalogs of [reusable assets](#), tools, etc.
 - Reference library including events, news, Working Group documents, guidelines, and other [resources](#)
 - Information on [open source](#) software projects and licensing
 - [Funding opportunities](#) within and outside NASA
 - “Suggest content” feature for user-submitted ideas

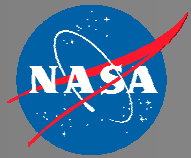


Details on the Portal

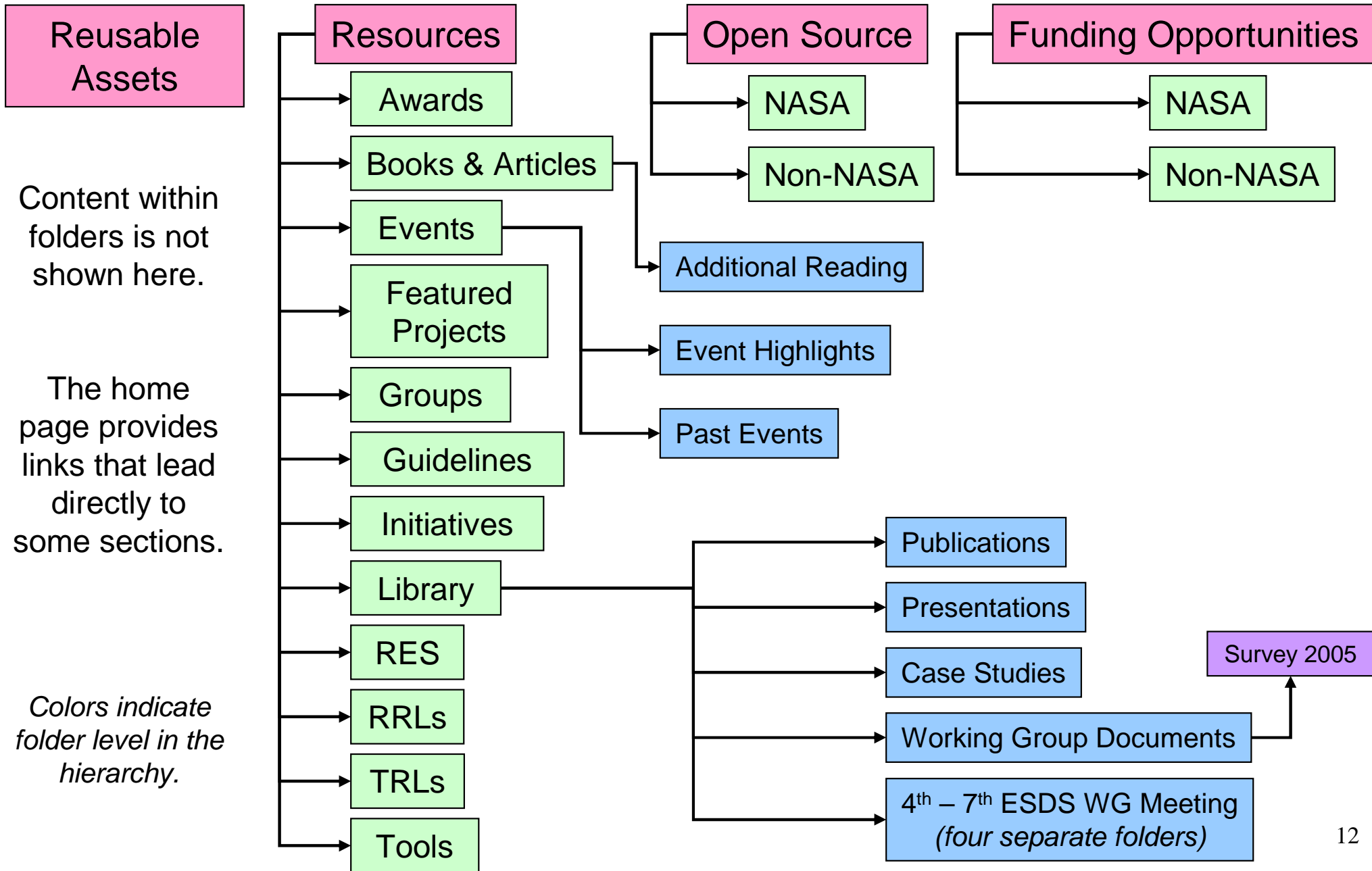
- Content organized into 4 major areas
- Resources section includes:
 - Awards
 - Books and articles
 - Events
 - Guidelines (e.g., on tech. transfer)
 - Library (including WG publications, presentations, and case studies)
- Basic web stats, 12/2005 to 7/2009:
 - Over 36000 visits by more than 26000 unique visitors
 - Over 101000 page views
 - Average 824 visitors per month
 - Site has been in top 3 hits for “software reuse” on major search engines, and still achieves high placement in search results
- A popular community resource that continues to grow:

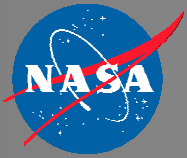


<http://www.esdswg.com/softwarereuse>

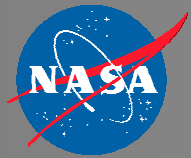


Portal Folder Hierarchy



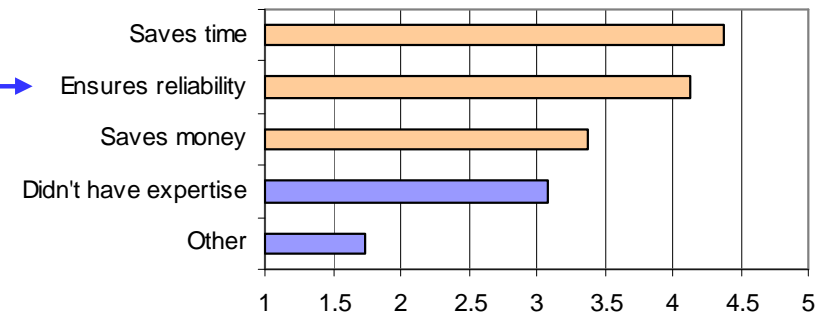


Reuse Enablement System (RES)



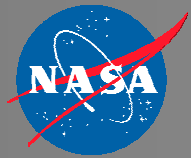
Reuse Surveys

- A survey on the reuse practices of the Earth science community was conducted in 2004 and repeated in 2005 with OMB approval and a wider audience*.
- Both surveys show the same basic results:
 - Developers need to be able to easily locate and evaluate available reusable artifacts.
 - Top three motivations for reuse match the WG goals:
 - Saving time
 - Ensuring reliability
 - Saving money
 - Top three factors to increase reuse:
 - Earth science catalog/repository of reusable assets
 - Greater use of open source licensing
 - More education and guidance on reuse
 - Top two barriers to reuse:
 - Did not know reusable assets existed
 - Did not know where to look for reusable assets



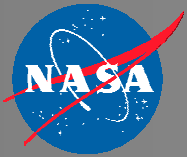
Areas where
the WG can
provide help.

* Source: Marshall, J.J.; Olding, S.W.; Wolfe, R.E.; Delnore, V.E., "Software Reuse Within the Earth Science Community," *Geoscience and Remote Sensing Symposium, 2006. IGARSS 2006. IEEE International Conference on*, pp.2880–2883, July 31, 2006 – Aug. 4, 2006.



Progress Towards the RES

-
- A series of **use cases** and **requirements** for the proposed RES were developed and documented.
 - The WG conducted a **trade study** of various NASA and non-NASA sites.
 - The results showed that none of the existing systems satisfied the needs of the community of Earth science software developers.
 - The WG then conducted an **architecture study** to determine what existing software package/system was most suited for reuse in building the RES.
 - The results showed that the XOOPS content management system met the most requirements and would take the least time to develop.
 - The WG began work on developing a **prototype RES** built using XOOPS.
 - Additions and modifications were made as needed to meet all of the previously developed RES requirements.
 - The WG developed a set of **policies** for the operation and maintenance of the RES.
 - Additional reviews by other relevant offices (e.g., legal, tech. transfer, NASA Headquarters) are planned.
 - The WG is currently developing a **test plan** for formal testing of the prototype, and plans to provide the prototype RES to the NASA community for their use, pending appropriate approvals.



Views of the Prototype

Login

Username:

Password:

[+ Lost Password?](#)
[+ Register now!](#)

NASA Earth Science Data Systems Software Reuse Working Group

Welcome to the Earth Science Data Systems (ESDS) Software Reuse Enablement System.

Software reuse can help the science community by reducing software development timescales, reducing costs, and contributing to the dissemination of knowledge and expertise. This Software Reuse Enablement System (RES) has been established by the Reuse Working Group to bring together a collection of resources that will facilitate reuse within the Earth science community. Over time, we will be collecting a variety of resources in the Earth and space science reuse communities. Our long-term goal is to establish a "marketplace" for reusable software development artifacts, to help establish a knowledge sharing community for software reuse in Earth science. Our software reuse portal web site has additional information about our group. Please use the menus at the top and left side of the page to navigate to other areas of our site.

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- [+ Expedition 16 Soyuz Lands Safely in Kazakhstan](#)
Astronaut Peggy Whitson returns home from a record flight.
- [+ NASA Deputy Administrator and Florida Governor Discuss Benefits of Space Exploration at Miami Future Forum](#)
NASA Deputy Administrator Shana Dale and Florida Gov. Charlie Crist discussed Friday how space exploration gives Floridians a more competitive economy and better quality of life during a NASA Future Forum at the University of Miami.
- [+ NASA to Broadcast Earth Views in High Definition Television](#)
Since humans first flew in space, nothing has captivated astronauts more than the view of home out the window of their spacecraft.

NASA Image Of The

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SEARCH RES + GO

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calc

Description:
This web page offers a calculator Perl script that includes mathematical functions and pre-defined constants commonly used in astronomy.

by Alexey Vikhlinin

Submitter: RES Admin
Released: Mon, 15-Oct-2007

Version: 0
Downloads: 12
File Size: 8.00 KB
Platform: None
Checksum:
Home Page: Astronomy aware Unix Calculator

Rating:
 (2 Votes)

Download Times:
Modem(56k) : 1s
ISDN(64k) : 1s
DSL(768k) : 0.09s
LAN(10M) : 0.01s

[+ DOWNLOAD](#)

Current categories are not final; tagging option under consideration

Full detail page
for an asset
(Provider view)

Home page as
viewed by an
Anonymous User

Other highlights:

- When logged in, a menu bar appears above the reuse banner.
- Registered users can sign up for notifications.
- Consumers see a note about registering for provider status if they want to submit assets to the RES.

[Rate Resource](#) | [Report Broken](#) | [Modify](#) | [Recommend](#) | [Comments \(1\)](#)

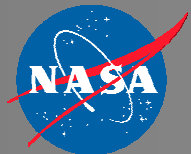
Other files by: RES Admin

- [test download](#) (Wed, 24-Oct-2007)
- [Perl Limericks](#) (Tue, 16-Oct-2007)
- [coord_conv.pl](#) (Tue, 16-Oct-2007)
- [circle.c](#) (Tue, 16-Oct-2007)
- [calc](#) (Mon, 15-Oct-2007)
- [linept.c](#) (Mon, 15-Oct-2007)
- [linreg.c](#) (Mon, 15-Oct-2007)
- [ESDS Software Reuse Working Group Year End Report 2006](#) (Tue, 11-Sep-2007)

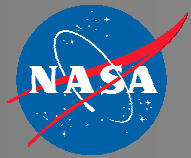
Comments

The comments are owned by the poster. We aren't responsible for their content.

Poster	Thread
marshall Joined: 2008/3/21	Posted: 2008/4/1 13:49 Updated: 2008/4/1 13:49 Re: calc I've used this tool since grad school. It's useful as a general

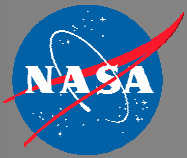


Reuse Readiness Levels (RRLs)



- Being created for use by developers and adopters to assess software and related artifacts for reuse.
- Through discussions on weekly and monthly telecons, the Software Reuse WG made the following decisions:
 - To use nine levels, to align with the familiar TRL scale.
 - To look at nine topic areas that the WG thought were important for measuring the reuse maturity of software.
- In an iterative process, volunteers from the WG:
 - Wrote an initial set of levels for each topic,
 - Drafted summaries of each RRL, looking across all topic areas at each level,
 - Created a set of summary RRLs with descriptions by combining information from all topics at the same level, and
 - Made suggested revisions to RRLs and topic area levels based on feedback received from the community.
- Use cases have also been developed and are being reviewed and revised by the WG.

Note: RRLs presented here are still under development.



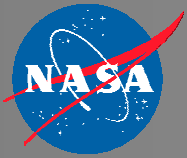
Topic areas included:

- Documentation
- Extensibility
- Intellectual Property Issues
- Modularity
- Packaging
- Portability
- Standards compliance
- Support
- Verification and Testing

Example from Verification and Testing

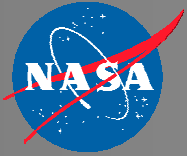
RRL 4 – Software application tested and validated in laboratory environment

Following successful testing of inputs and outputs, the testing would include integrating an application to establish that the “pieces” will work together to achieve concept-enabling levels. This validation must be devised to support the concept that was formulated earlier and should also be consistent with the requirements of potential system applications. The validation is relatively “low-fidelity” compared to the eventual system: it could be composed of ad hoc discrete components in a laboratory; for example, an application tested with simulated inputs.

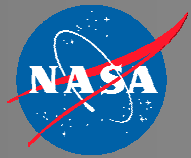


Draft RRL Summaries

Level	Summary	Description
RRL 1	Limited reusability; the software is not recommended for reuse.	Little is provided beyond limited source code or pre-compiled, executable binaries. There is no support, contact information for developers or rights for reuse specified, the software is not extensible, and there is inadequate or no documentation.
RRL 2	Initial reusability; software reuse is not practical.	Some source code, documentation, and contact information are provided, but these are still very limited. Initial testing has been done, but reuse rights are still unclear. Reuse would be challenging and cost-prohibitive.
RRL 3	Basic reusability; the software might be reusable by skilled users at substantial effort, cost, and risk.	Software has some modularity and standards compliance, some support is provided by developers, and detailed installation instructions are available, but rights are unspecified. An expert may be able to reuse the software, but general users would not.
RRL 4	Reuse is possible; the software might be reused by most users with some effort, cost, and risk.	Software and documentation are complete and understandable. Software has been demonstrated in a lab on one or more specific platforms, infrequent patches are available, and intellectual property issues would need to be negotiated. Reuse is possible, but may be difficult.
RRL 5	Reuse is practical; the software could be reused by most users with reasonable cost and risk.	Software is moderately portable, modular, extendable, and configurable, has low-fidelity standards compliance, a user manual, and has been tested in a lab. A user community exists, but may be a small community of experts. Developers may be contacted to request limited rights for reuse.
RRL 6	Software is reusable; the software can be reused by most users although there may be some cost and risk.	Software has been designed for extensibility, modularity, and portability, but software and documentation may still have limited applicability. Tutorials are available, and the software has been demonstrated in a relevant context. Developers may be contacted to obtain formal statements on restricted rights or to negotiate additional rights.
RRL 7	Software is highly reusable; the software can be reused by most users with minimum cost and risk.	Software is highly portable and modular, has high-fidelity standards compliance, provides auto-build installation, and has been tested in a relevant context. Support is developer-organized, and an interface guide is available. Software and documentation are applicable for most systems. Brief statements are available describing limited rights for reuse and developers may be contacted to negotiate additional rights.
RRL 8	Demonstrated local reusability; the software has been reused by multiple users.	Software has been shown to be extensible, and has been qualified through test and demonstration. An extension guide and organization-provided support are available. Brief statements are available describing unrestricted rights for reuse and developers may be contacted to obtain formal rights statements.
RRL 9	Demonstrated extensive reusability; the software is being reused by many classes of users over a wide range of systems.	Software is fully portable and modular, with all appropriate documentation and standards compliance, encapsulated packaging, a GUI installer, and a large support community that provides patches. Software has been tested and validated through successful use of application output. Multiple statements describing unrestricted rights for reuse and the recommended citation are embedded into the product..

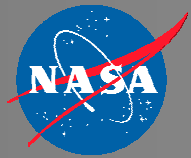


Peer-Recognition Award



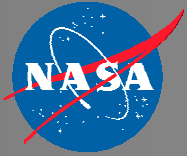
Peer-Recognition Award

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- The WG developed a Peer-Recognition Software Reuse Award to recognize those people whose efforts and projects contribute to the practice of software reuse in the Earth science community.
 - There are three categories of the Reuse Award:
 - *Contribution*, for the creation and offering of reusable software assets
 - *Utilization*, for the reuse of existing software assets in new projects and the demonstration of reuse for the benefit of the community
 - *Peer Education*, for providing guidance to others on preparing or adopting software for reuse
 - Follow the “peer-recognition award” link on the main page of <http://www.esdswg.com/softwarereuse> for more information.
 - Nominations for this year’s award have been received, and the WG is beginning the process of reviewing them and selecting recipients.

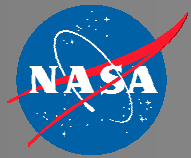


2008 NASA ESDS Software Reuse Award Recipients:

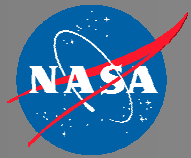
- Contribution Award Category: 2 recipients
 - **Mercury Consortium**, Oak Ridge National Laboratory
 - *Mercury Distributed Metadata Management, Data Discovery and Access System*
 - **UAHuntsville Subset Team**, University of Alabama in Huntsville
 - *HDF-EOS Web-based subsetter (HEW) family of subsetting software*
- Utilization Award Category: 1 recipient
 - **Data Management Systems and Technologies Group**, NASA JPL
 - *Object-Oriented Data Technology (OODT) Catalog and Archive Service (CAS)*
- Peer Education Award Category: 2 recipients
 - **Dr. Victor E. Delnore**, NASA Langley
 - *Reuse education, in part with NASA ESDS Software Reuse Working Group*
 - **Dr. Robert R. Downs**, Columbia University
 - *Reuse education, in part with NASA ESDS Software Reuse Working Group*



Conclusion



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- Reuse leverages past experience to achieve benefits such as:
 - Saving time
 - Ensuring reliability
 - Saving money
 - The WG works to encourage and enable reuse within the Earth science community, to achieve the benefits of reuse, through a variety of activities including:
 - Portal web site (<http://www.esdswg.com/softwarereuse/>)
 - Reuse Enablement System (RES)
 - Reuse Readiness Levels (RRLs)
 - Peer-recognition award
 - System developers can improve their ability to realize these benefits by improving their capabilities for reuse and assessing/mitigating potential risks.
 - By recognizing the reuse potential of their current efforts, developers who prepare software for reuse by others can help developers of the future, next generation of data systems realize the benefits of reuse.



Reuse WG Contact Information

- NASA Earth Science Data Systems (ESDS) Working Groups
 - Coordinator, Frank Lindsay
(<http://esdswg.gsfc.nasa.gov/>)
- Software Reuse Working Group
 - General Information:
James J. Marshall
(James.J.Marshall@nasa.gov)
 - Outreach and Education Team Leader:
Robert R. Downs
(rdowns@ciesin.columbia.edu)

The screenshot shows the website for the Earth Science Software Reuse Working Group. The header includes the NASA logo and 'GODDARD SPACE FLIGHT CENTER'. The main navigation bar has links for HOME, REUSABLE ASSETS, RESOURCES, OPEN SOURCE, and FUNDING OPPORTUNITIES. The page content is organized into several sections:

- news**: A list of recent news items, including 'Fall AGU Session Proposals Due June 12' (2009-05-12), '2009 Peer-Recognition Award Call for Nominations' (2009-04-15), 'New RSS Feeds' (2009-03-19), 'Additional Reading Suggestions Added' (2009-03-12), and 'More Past Presentations Added' (2009-03-12).
- upcoming events**: A list of upcoming events, including '2009 ESIP Federation Summer Meeting' (Santa Barbara, California, 2009-07-07), '2009 World Congress in Computer Science (WORLDCOMP09)' (Las Vegas, Nevada, 2009-07-13), and '2009 IEEE International Geoscience and Remote Sensing Symposium (IGARSS 2009)' (Capetown, South Africa, 2009-07-13).
- Main Text Area**: Contains several paragraphs of text, including a welcome message, an announcement about the 2008 Peer-Recognition Award recipients, updates on reuse definitions and publications, and information about the 2008 annual meeting and the 8th ESDS WG Meeting.
- Footer**: Features two call-to-action boxes. The first is 'Developing an internal marketplace for reusable software development artifacts' with an icon of people. The second is 'Demand: Demonstrate the feasibility and value of reuse through focused projects' with an icon of a person and a bar chart.