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# Tools for Reusing Earth Science Software

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*Also see: Marshall, Downs, Samadi (2010) Relevance of Software Reuse in Building Advanced Scientific Data Processing Systems. Earth Science Informatics, 3(1), 95-100. Online:*

*<http://dx.doi.org/10.1007/s12145-010-0054-3>*



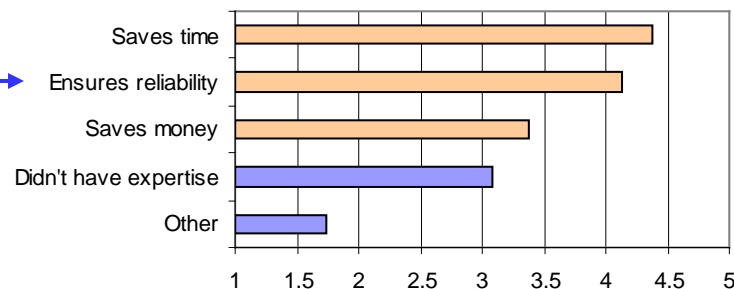
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## **Reuse Enablement System (RES)**

Enabling reuse of software assets within the  
NASA Earth science community



- 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 survey studies show similar results:
  - Developers need capabilities 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 is  
informing and  
improving.



# Development of 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 developed a **prototype RES** built using XOOPS.
  - Additions and modifications were made as needed to meet all of the previously developed RES requirements.

See <http://www.esdswg.org/softwarereuse/Resources/res/> for more information.



# Views of the Prototype

**Login**

Username:

Password:

[+ SIGN IN](#)

[+ 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.

[+ Home](#)

[+ Downloads](#)

[+ Contact Us](#)

SEARCH RES  + GO

[+ Advanced Search](#)

**NASA News**

[+ 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](#)

## 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.

[+ Contact Us](#)

[+ Home > Downloads > Algorithms > Perl](#)

SEARCH RES  + GO

[+ Advanced Search](#)

**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

[+ DOWNLOAD](#)

*Current categories are not final; tagging option under consideration*

**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

## Full detail page for an asset (Provider view)

[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**

[+ REFRESH](#) [+ POST COMMENT](#)

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

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



# Implementation of the RES

- The WG created 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, as needed.
- The WG developed a **test plan** for formal testing of the RES.
- The WG **documented and packaged** the RES for installation at other sites.
- Some of the Earth science decadal survey missions are beginning to **implement** instances of the RES.
  - Soil Moisture Active/Passive (SMAP) is currently installing one.
  - Ice, Cloud, and land Elevation Satellite-2 (ICESat-2) has expressed interest in hosting one.
  - Currently, the WG is engaging other missions as well, including Deformation, Ecosystem Structure and Dynamics of Ice (DESDynI) and Orbiting Carbon Observatory-2 (OCO-2)



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## **Reuse Readiness Levels (RRLs)**

An instrument to measure the potential of a  
technology for reuse



# Developing the RRLs

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- Created for use by developers and adopters to assess software and related artifacts for reuse.
  - Through a series of discussions, the WG decided:
    - To use nine levels, to align with the familiar TRL scale, and
    - 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 RRL summaries, 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.
  - **The RRL v1.0 document has been officially released:**  
**NASA Earth Science Data Systems Software Reuse Working Group (2010). Reuse Readiness Levels (RRLs), Version 1.0. April 30, 2010. Available: <http://www.esdswg.org/softwarereuse/Resources/rrls/>**





The nine RRL Topic Areas include:

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

## Example from Verification and Testing

**RRL 5** – Software application tested and validated in a laboratory context.

The fidelity of the software application testing has not been demonstrated. The software application must be integrated with reasonably realistic supporting elements so that the total application (component level, sub-system level, or system level) can be tested in a “simulated” or somewhat relevant context. At this level, issues such as scalability, load testing, and security are addressed when applicable.

*Source: NASA Earth Science Data Systems Software Reuse Working Group (2010). Reuse Readiness Levels (RRLs), Version 1.0. April 30, 2010. Available: <http://www.esdswg.org/softwarereuse/Resources/rrls/>*



Level	Summary
RRL 1	Limited reusability; the software is not recommended for reuse.
RRL 2	Initial reusability; software reuse is not practical.
RRL 3	Basic reusability; the software might be reusable by skilled users at substantial effort, cost, and risk.
RRL 4	Reuse is possible; the software might be reused by most users with some effort, cost, and risk.
RRL 5	Reuse is practical; the software could be reused by most users with reasonable cost and risk.
RRL 6	Software is reusable; the software can be reused by most users although there may be some cost and risk.
RRL 7	Software is highly reusable; the software can be reused by most users with minimum cost and risk.
RRL 8	Demonstrated local reusability; the software has been reused by multiple users.
RRL 9	Demonstrated extensive reusability; the software is being reused by many classes of users over a wide range of systems.

*Detailed Descriptions of each Level are provided in RRL Guideline document*

*Source: NASA Earth Science Data Systems Software Reuse Working Group (2010). Reuse Readiness Levels (RRLs), Version 1.0. April 30, 2010. Available: <http://www.esdswg.org/softwarereuse/Resources/rrls/>*



# Future RRL Work and Tools

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- Since release of the RRL v1.0 document, suggestions for improvement are being considered
  - Additional feedback on the levels has been received.
  - Updates to the RRL document will be included in v1.1.
- The WG is also developing an [RRL Calculator](#) tool.
  - A simple (optionally) weighted average calculator has been developed and is being assessed for community use.
- WG accepting ideas and prototypes
  - Currently evaluating a prototype RRL Calculator that was submitted, built with Excel.



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# Summary

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- The WG conducted surveys of the Earth science software/system development community that indicated a desire for domain-specific catalogs of reusable assets.
  - The WG performed a number of studies and development efforts to create a prototype of such a Reuse Enablement System (RES).
  - This prototype is starting to be used by the near-term Earth science decadal survey missions, and the WG is assisting these missions while also reaching out to other missions.
  - The WG developed a set of Reuse Readiness Levels (RRLs) to assess the maturity, in a reuse sense, of software assets.
  - The version 1.0 document has been officially released on the WG's web site (<http://www.esdswg.com/softwarereuse>)
  - Suggestions for improving the RRLs are being received and RRL Calculator tools are being developed to assist community members with their RRL assessments.



# Reuse WG Contact Information

- NASA Earth Science Data Systems (ESDS) Working Groups
  - Coordinator, Frank Lindsay (<http://esdswg.eosdis.nasa.gov/>)
- Software Reuse Working Group
  - Chair: Chris A. Mattmann ([chris.a.mattmann@jpl.nasa.gov](mailto:chris.a.mattmann@jpl.nasa.gov))
  - Co-chair: Robert R. Downs ([rdowns@ciesin.columbia.edu](mailto:rdowns@ciesin.columbia.edu))
  - General Info: James J. Marshall ([James.J.Marshall@nasa.gov](mailto:James.J.Marshall@nasa.gov))
- Social Networks



[http://twitter.com/esdswg\\_reuse](http://twitter.com/esdswg_reuse)



<http://www.facebook.com/group.php?gid=117453644936920>



<http://www.linkedin.com/groups?gid=2964349>

The screenshot shows the website for the Earth Science Software Reuse Working Group. The header features the NASA logo and 'GODDARD SPACE FLIGHT CENTER'. Below the header is a navigation bar with links: '+ HOME', '+ REUSABLE ASSETS', '+ RESOURCES', '+ OPEN SOURCE', and '+ FUNDING OPPORTUNITIES'. The main content area is titled 'Earth Science Software Reuse' and includes a 'news' section with several items, such as 'WG Technical Reports, First One Available' (2010-06-25) and '2010 Peer-Recognition Award Call for Nominations' (2010-04-15). There is also an 'upcoming events' section listing '2010 World Congress in Computer Science' and 'O'Reilly Open Source Convention 2010'. The page footer contains contact information and social media links.