Tools for Reusing Earth Science Software

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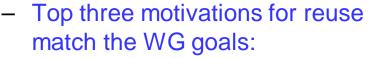# Reuse Enablement System (RES)

Enabling reuse of software assets within the
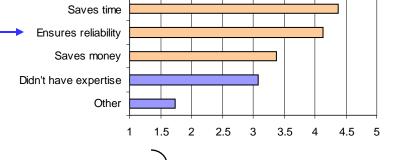NASA Earth science community

- 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.

Source: Marshall, Olding, Wolfe, Delnore. "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.

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

Home page as viewed by an Anonymous User

Full detail page for an asset (Provider view)

Current categories are not final; tagging option under consideration

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.

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)

Reuse Readiness Levels (RRLs)

An instrument to measure the potential of a technology for reuse

Developing the RRLs

- 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/

RRL v1.0 Summaries

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

- 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.

Summary

- 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
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- Software Reuse Working Group
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  - http://www.linkedin.com/groups?gid=2964349

http://www.esdswg.com/softwarereuse