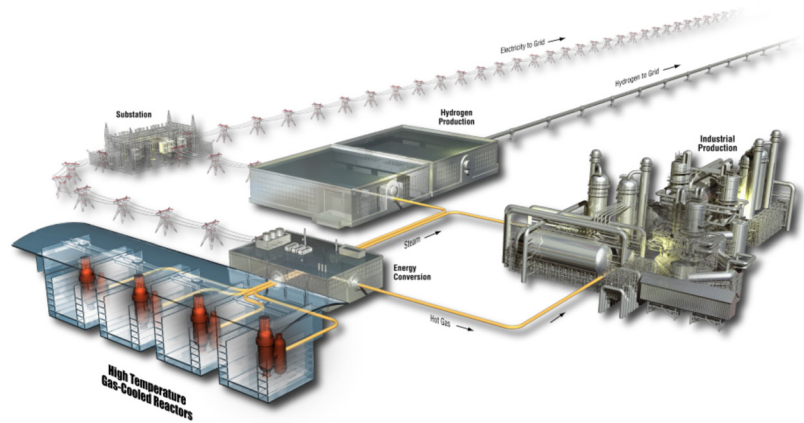


Framework Development Supporting the Safety Portal

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July 2015

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Framework Development Supporting the Safety Portal

July 2015

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SUMMARY

To facilitate collaboration within the scientific research arena, it is important to have an environment where analysts have access to shared information, documents, software tools, and are able to maintain and track historical changes in models. A prototype probabilistic risk assessment called Safety Portal has been developed that provides remote access and collaboration possibilities for risk analysts. Information stored at this environment is protected and is restricted based on user assigned credentials. This report discusses current development of a cloud-based web portal for PRA tools and data that were produced as part of the technical work associated with the Advanced Reactor Technologies Program.

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ACRONYMS

API	Application Program Interface
OpenBUGS	Bayesian inference Using Gibbs Sampling
CAC	Cloud-based Architecture Capabilities
CMS	Content Management System
DOE	Department Of Energy
DMS	Database Management Server
IM	Information Management
INL	Idaho National Laboratory
MVC	Model View Control
PRA	Probabilistic Risk Assessment
PHP	PHP Hypertexts Preprocessor
NRC	Nuclear Regulatory Commission
SSL	Secure Sockets Layer
VOBS	Visual OpenBUGS Scripter

Cloud-based Architecture Capabilities

1. CLOUD PORTAL

1.1 Cloud Portal and Capabilities

The INL has proposed research and development activities that address the formulation and development of a framework for applying modern computational tools to create advanced risk-based methods for identifying design vulnerabilities in advanced small modular reactors (SMRs). This framework will require the fusion of state-of-the-art probabilistic (PRA) methods, advanced 3D visualization methods, and high-performance computation within a flexible open source Framework. The work described in this report was produced as part of the technical research associated with the Advanced Reactor Technologies (ART) Program and describes the capabilities present in the cloud-based risk analysis portal. The overall purpose of the cloud-based SMR PRA Framework is to develop and demonstrate methodologies and tools that can be used to predict plant response and risk for safety. The primary goal of the Framework is to provide a tool that can assist in future design and licensing activities by developing quantitative methods, tools, and the associated analysis framework for assessing a variety of SMR risks. We are addressing this goal within the ART Program by continuing the construction of a cloud-based analysis and modeling framework that will be used to demonstrate the technical basis related to SMR safety margins.

The objective of the work described in this report is to implement selected portions of the Small Modular Reactor Detailed Technical Framework Specification (INL/EXT-13-28974), which details the specific activities necessary to establish the cloud-based Framework, specifically the PRA framework development to provide a structure for supporting modeling, phenomena representation, and risk integration/management via a cloud-based safety portal.

A cloud-based portal is a web application that integrates and manages a comprehensive collection of many different kinds of content including, but not limited to, web pages, web applications and documents where users may store, use, share, modify or otherwise contribute to projects. The portal maintains changes for all documents stored within the portal environment. It also maintains individual or a group of documents with role-based security access. Users are granted access based upon their need to know and are assigned to one or more security level groups. Within each security group, users have specific access to certain documents or application tools that are appropriate for that level.

2. ANALYSIS AND DESIGN

2.1 Traditional Portal Concept

The cloud portal accumulates many different kinds of information that are stored or serviced from different servers. These services (see figure 1) include the Documents Server, Application Server, and Database Management Server. Specific applications may be developed to further summarize available information from various servers and present on the portal.

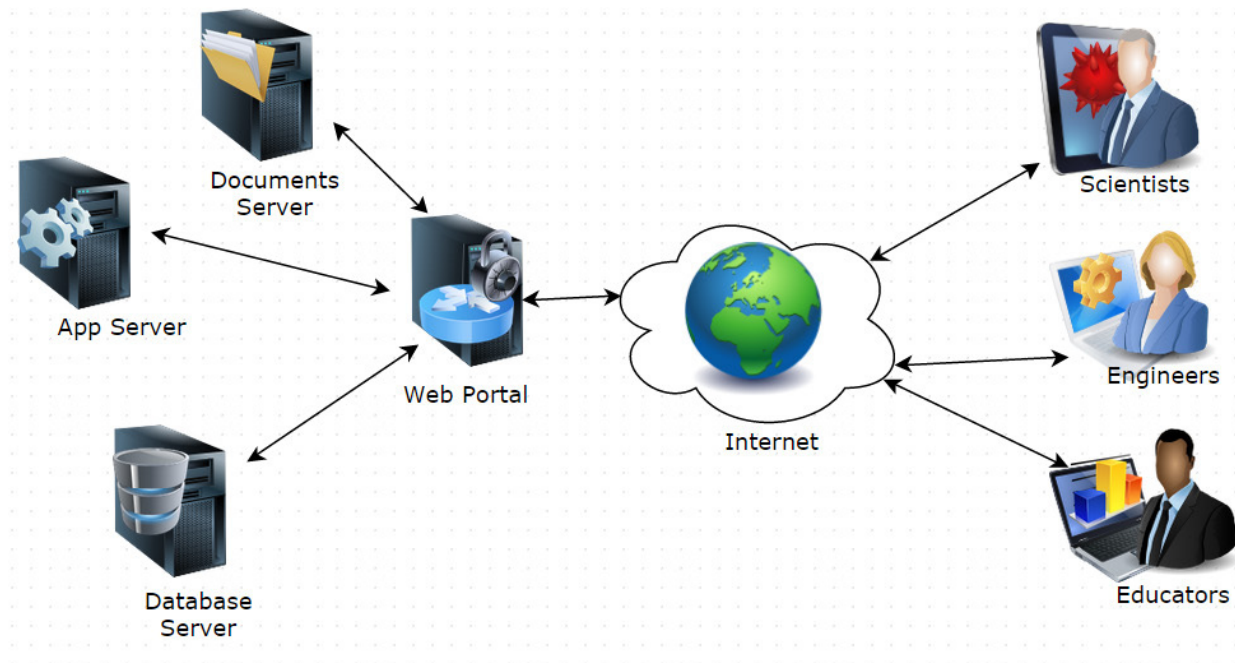


Figure 1: Web portal layout.

2.2 Customized Safety Portal

INL's Safety Portal is being implemented as a cloud portal with emphasis on supporting PRA tools. In order to meet the needs of a variety of PRA tools that are or may be developed, design features were implemented to facilitate the types of common PRA tools that were anticipated for use in the portal. These features make it easier for existing tools to use the Safety Portal with minimal additions to existing code and for users to monitor changes to data they use.

2.2.1 Publication/Subscription Design

The Safety Portal resource center operates on a publication/subscription model. Of all the tools and data (i.e., publications) available to them, a user can select (i.e., subscribe) to just those items of particular interest.

A user who produces information can publish items to the portal and specify which groups or individual users have permission to see those items. Figure 2 illustrates the publication and subscription model.

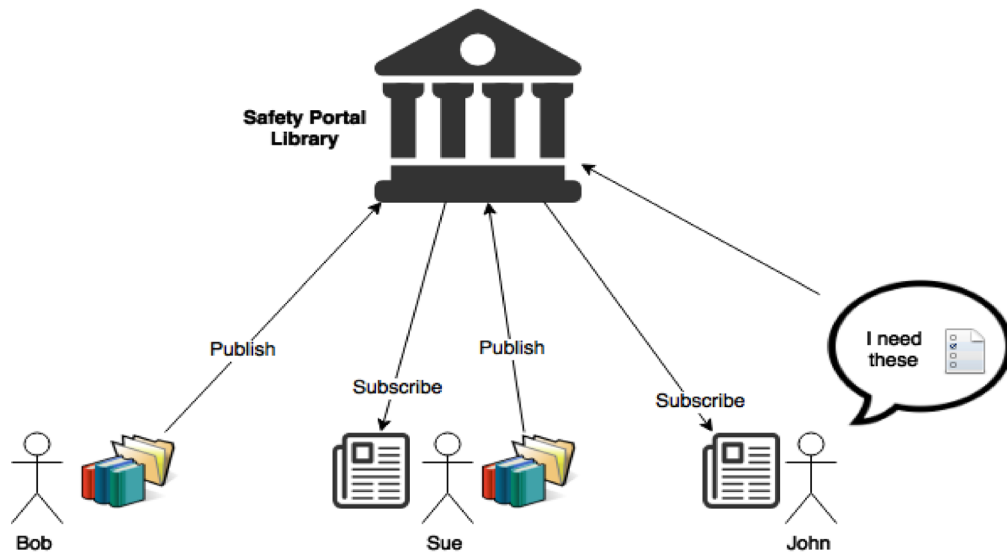


Figure 2: Publications and Subscriptions illustration

2.2.1.1 Authorization, Group, and Individual Permissions

The Safety Portal will exist behind a login area, so that only authorized users can enter the system. (See 2.2.5 for additional details related to security.) Authorized users are approved by an administrator and each individual user will be assigned to a group (such as DOE, INL, or NRC). The user will automatically inherit the permissions granted to that group. In addition, an owner of a publication can grant individual, rather than group, permissions to share information with a small subset of users. For example, a user might share a preliminary report with one or two other individuals prior to making a final report available to a group.

2.2.1.2 Hierarchical Publication and Subscription Grouping

Publications are organized in a hierarchical manner so that information can be logically grouped and named as sets and subsets. Consider the example shown in Figure 3. In this example, a publication folder called “ANO” has a series of publications underneath it, including “ANO Flooding Pictures” and “SDP Documents”. The “ANO Flooding Pictures” further subdivides into several publication groups, including “Circ Water”, which contains two picture files. Notice that the naming of the individual publications and files becomes less important because of the hierarchical publication grouping.

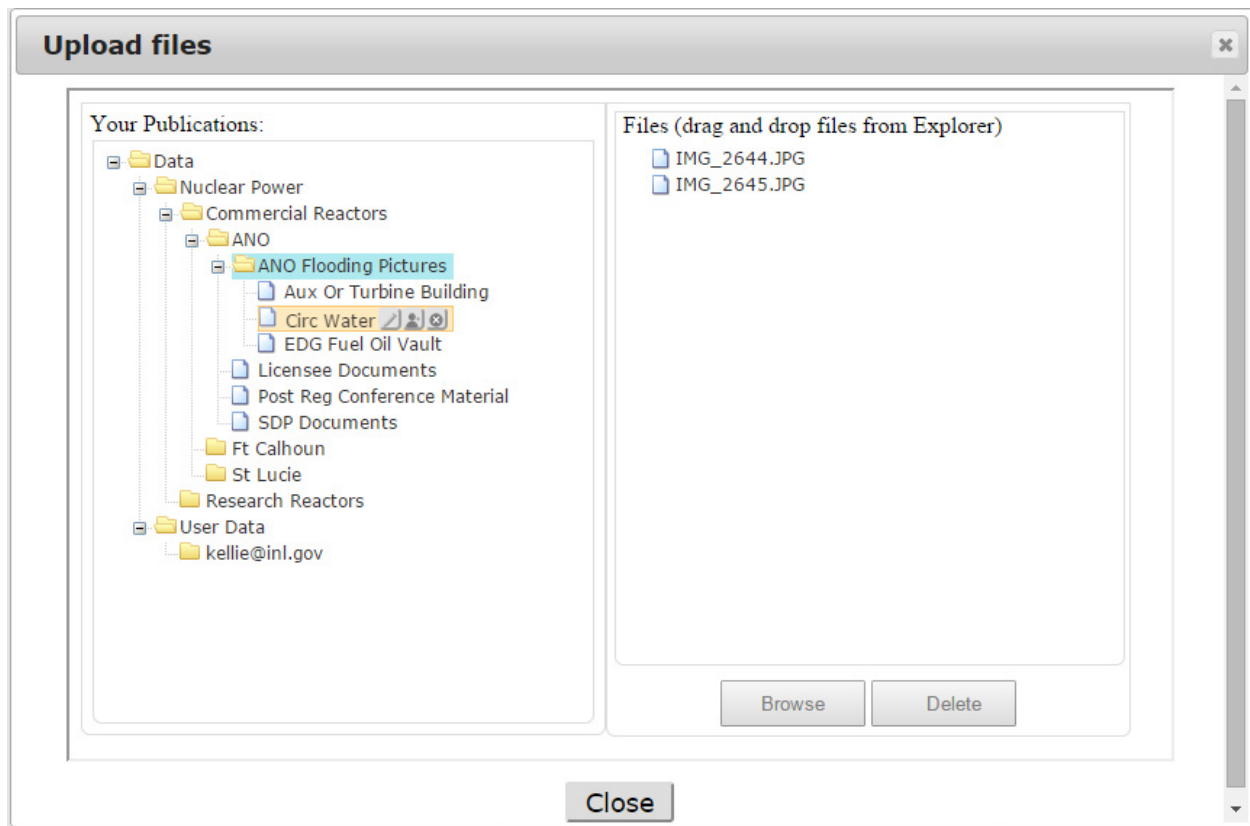


Figure 3: Publication Hierarchy Example

The owner of these publications is the user who uploads the files. The owner can share ownership with other users so that the publications content and sharing can be maintained by more than one person. See Figure 4.



Figure 4: Publication Ownership Example

The owners of the publication can also share it with both individual users and user groups. See Figure 5. A user cannot subscribe to a publication area (see Figure 6) unless it has been shared with them. This is true even for the owner(s) of the publication.

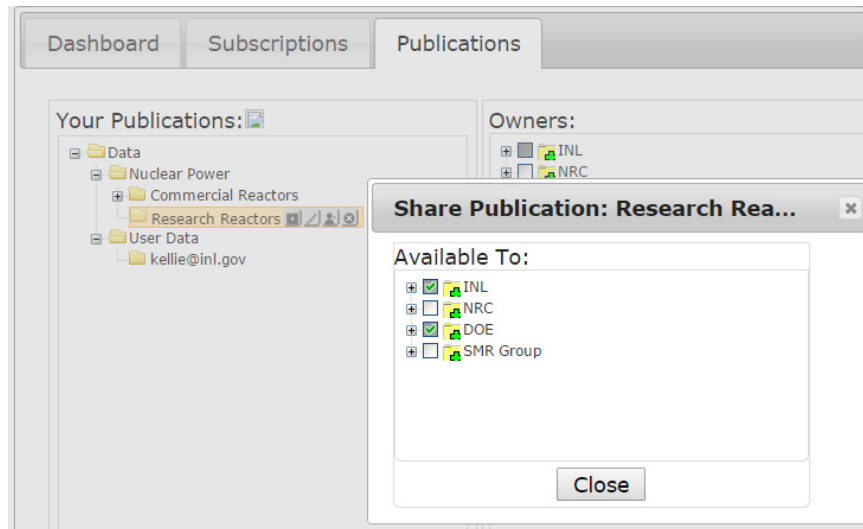


Figure 5: Publication Sharing Example

A user who subscribes to a publication will automatically be subscribed to any publications that currently exist or are added in the future beneath that publication level. In the example shown in Figure 4, a user that subscribed to “ANO” (see Figure 6) will be automatically subscribed to a new child publication called, say, “News Items” that is added beneath “ANO” in the future. In contrast, a different user who subscribed only to “ANO Flooding Pictures” (a publication on the same level as the new “News Items”) will not see that publication folder, but will see when additional pictures are added.

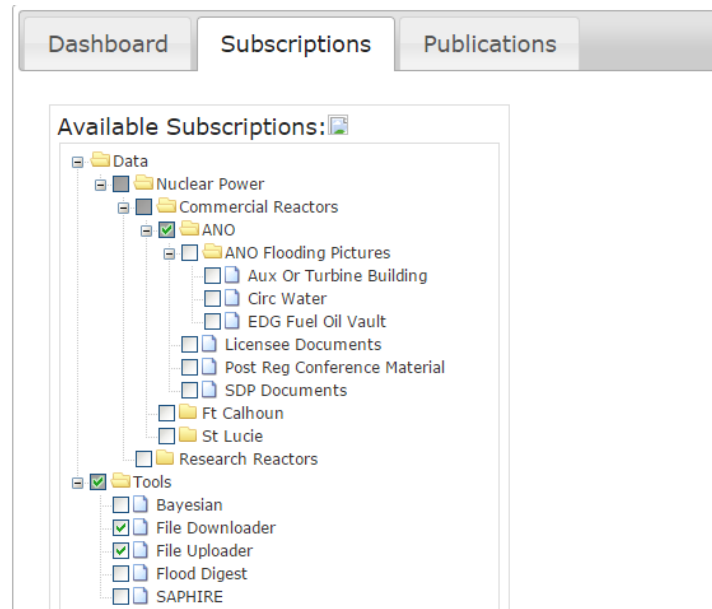


Figure 6: Subscription Example

2.2.2 Tool Service API

For external tool access, the Safety Portal has a web application program interface (API). This API defines a set of standard use procedures and allows for secure communication (see section 2.2.5) between approved tools and the Safety Portal. A java script wrapper for common interface features, general usage,

and to-be-implemented-by-tool functions will provide assistance for existing tools to integrate into the Safety Portal.

As shown in Figure 7, each tool has the ability to dynamically register and define data types that it uses and knows how to import. Any item with these data types can then be published (uploaded) to the Safety Portal by the tool. It can also reference or import data for any item that is of those registered data types and subscribed to by the current tool user.

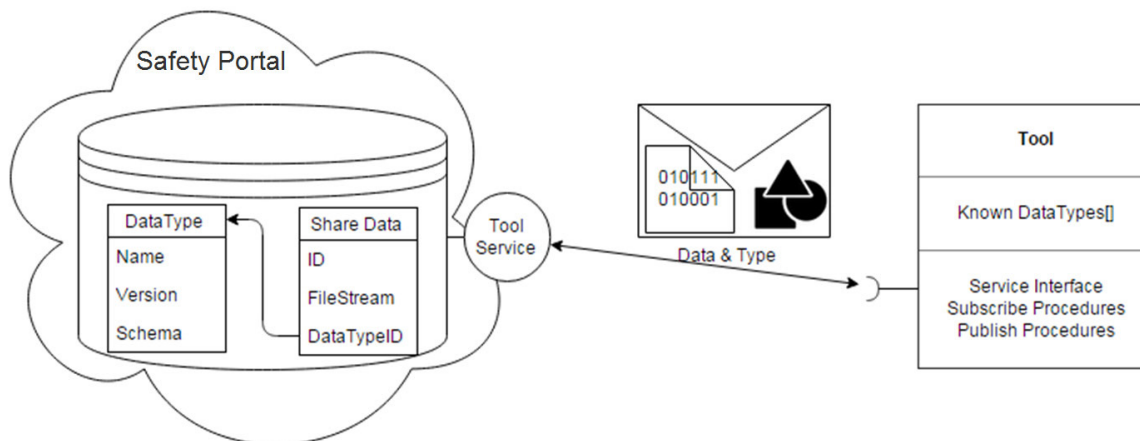


Figure 7: Tool Service API protocol for communication between the Safety Portal and an external tool

2.2.3 Sharing Data & Data Storage

Tools may store their data inside the Safety Portal, and retrieve it using the defined API calls. Because each tool registers the types of data it knows about, the Safety Portal can make the correct associations inside the portal as well. The tool data within a Safety Portal publication can then be shared with other users as desired.

2.2.4 Change Notifications

The Safety Portal will automatically maintain a log of changes. When a new item is uploaded, the change will be noted. When an item is updated (overwritten), that change will also be noted. If the changes relate to subscribed publications in the portal, the changes will be displayed in the change summary area of the Safety Portal (see Figure 11).

2.2.5 Security

Several levels of security are built into the Safety Portal (see Figure 8.) First, all connections and data transfer are done over Secure Sockets Layer SSL. This encrypts all communication and data over the network to prevent third parties from intercepting any understandable data in transit. Second, access to the site itself is available only through password protected and approved user accounts.

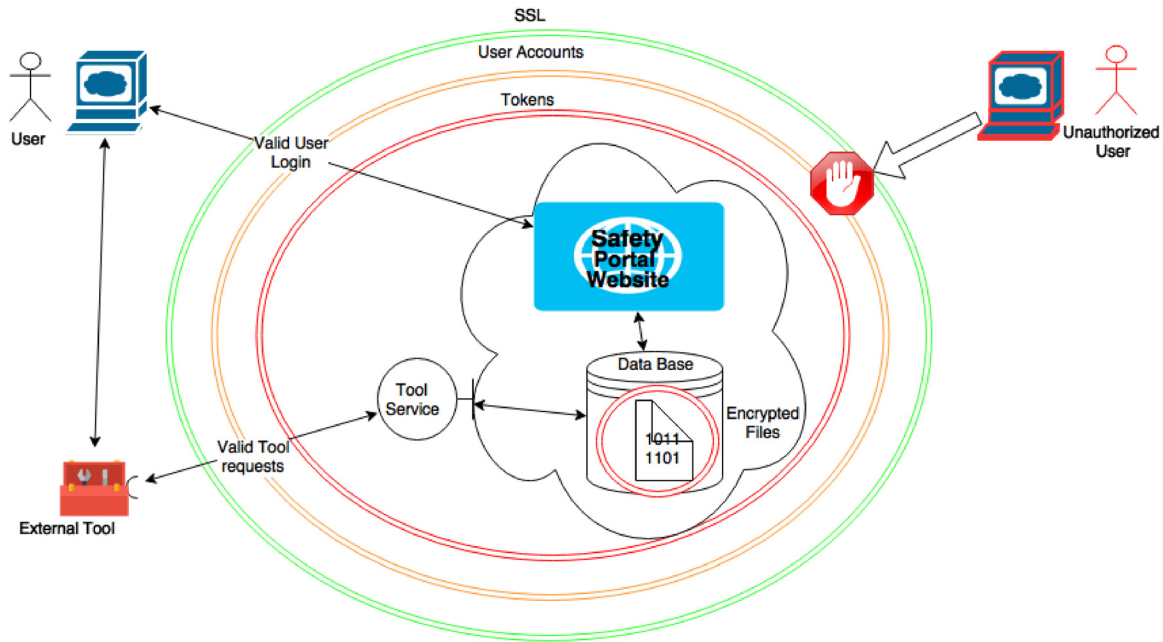


Figure 8: Security Layers through user, tool logins, and tokens

2.2.5.1 Tool Service Security

Security for tool access through the API has two layers. First, a token from the Safety Portal is required for all but one function call. A valid token is generated by the Safety Portal for a tool only if the user is currently logged into the Safety Portal or can successfully login upon the tools request. In addition to the token, the client's machine identity is associated with the token. If a third party machine were to attempt to use the same token, it would be rejected. Because of the SSL connection, the third party would also be prevented from spoofing their identity (an attempt to match the valid identity).

Internal data storage is also secure on the server side. In addition to standard restricted access, all publication data saved inside the safety portal database is encrypted before it saved. This way if the database is ever compromised any files sent by the users or tools would be unusable.

2.2.5.2 User Account Security

Basic account management services include following account management features:

- Account registration
- Automated forgotten password reset
- Change password
- Administrative Role based security for user and web application management

As seen in Figure 9, a public-facing Registration page allows any Internet user to create an account made up of an email and password, provided the email account does not already exist in the system and the password meets application defined complexity requirements. However, account creation by itself does not permit the user to see anything but public-facing information.

SAFETY PORTAL

[Register](#)[Log in](#)

Create a new account.

Email

First Name

Last Name

Justification for Access

Password

Confirm password

Register

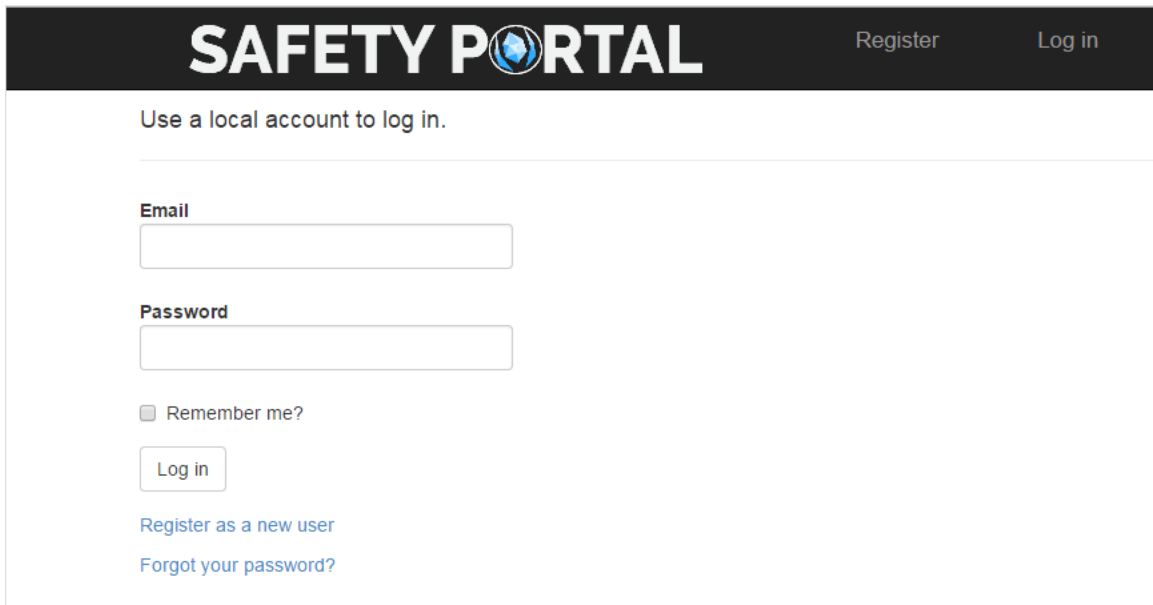
Figure 9 Self Registration Page

Once an account is created, a Safety Portal administrator must manually approve the user and assign them to a group (such as DOE, INL, or other). At that time, the user will assume whatever permissions are assigned to the group, and will be able to view that content upon successful login.

3. USER INTERFACE

3.1 Login Page

To enter the Safety Portal, a user must login to the Safety Portal using her email and self-selected standards-compliant password (see Figure 10).



SAFETY PORTAL [Register](#) [Log in](#)

Use a local account to log in.

Email

Password

☐ Remember me?

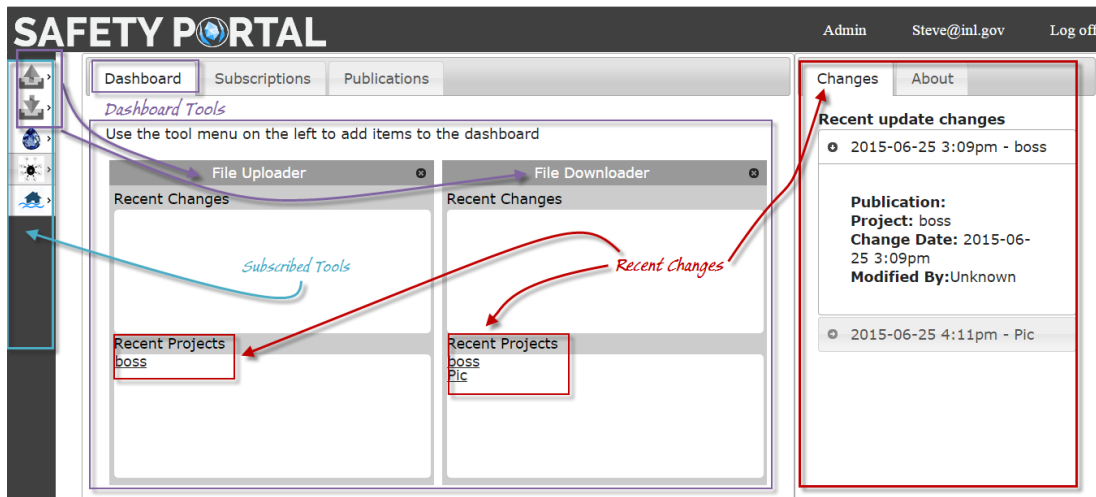
[Register as a new user](#)
[Forgot your password?](#)

Figure 10 Safety Portal Login Page

3.2 Dashboard Tab (Home)

Upon successful login, the user will see a customized home page, as annotated in Figure 11. Tools to which the user has subscribed will appear on the left side toolbar. Any tools the user has selected to appear in the dashboard tab will appear in more detail in the dashboard area. Recent projects and changes for each tool will be summarized within the dashboard. A summarized change list for all subscribed items will appear on the right.

Tools can be launched from the Safety Portal Toolbar, together with a recent project, where applicable (see Figure 12).



SAFETY PORTAL Admin Steve@inl.gov Log off

Dashboard Subscriptions Publications

Dashboard Tools
 Use the tool menu on the left to add items to the dashboard

Subscribed Tools

File Uploader File Downloader

Recent Changes Recent Changes

Recent Changes

Recent Projects Recent Projects

boss boss Pic

Changes About

Recent update changes

- 2015-06-25 3:09pm - boss

Publication:
Project: boss
Change Date: 2015-06-25 3:09pm
Modified By: Unknown

- 2015-06-25 4:11pm - Pic

Figure 11: Annotated Safety Portal Home Page

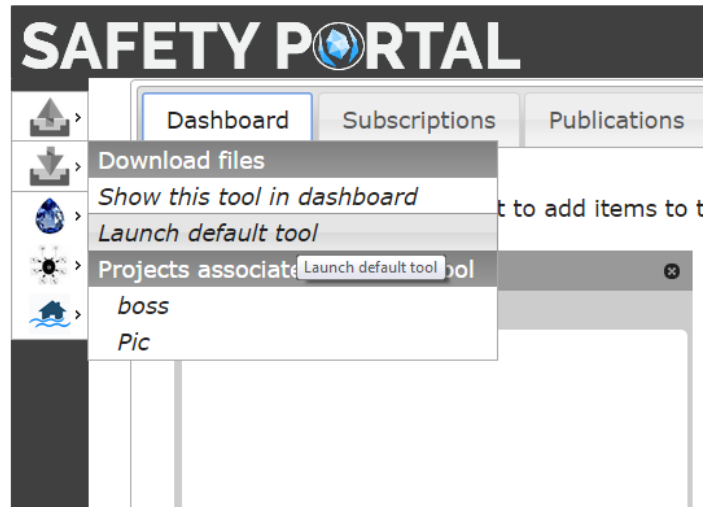


Figure 12: Launch Tool from Toolbar

3.3 Subscriptions Tab

To review or change tool and subscription options, the user will select the Subscriptions tab as seen in Figure 13 and Figure 6.

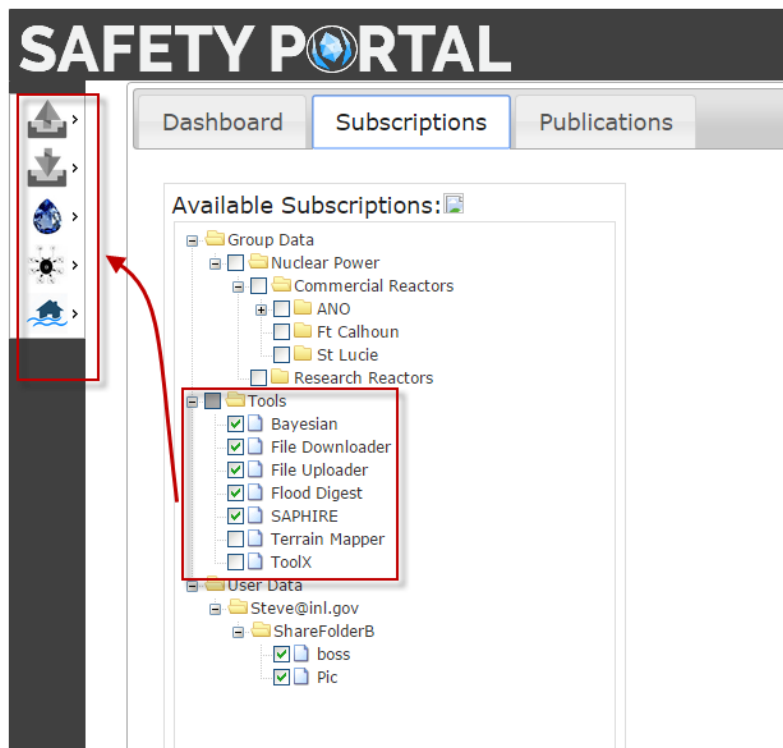


Figure 13: Annotated Tool Subscriptions Example

3.4 Publications Tab

The publications tab will show a list of publications owned by the user. Here, the user can add or remove publication areas, update publication details (see Figure 13), and maintain share permissions for individuals and groups. Ownership privileges can also be shared (see Figure 4). If no publications are owned, this area will be empty. Entries can also be modified (see Figure 14).

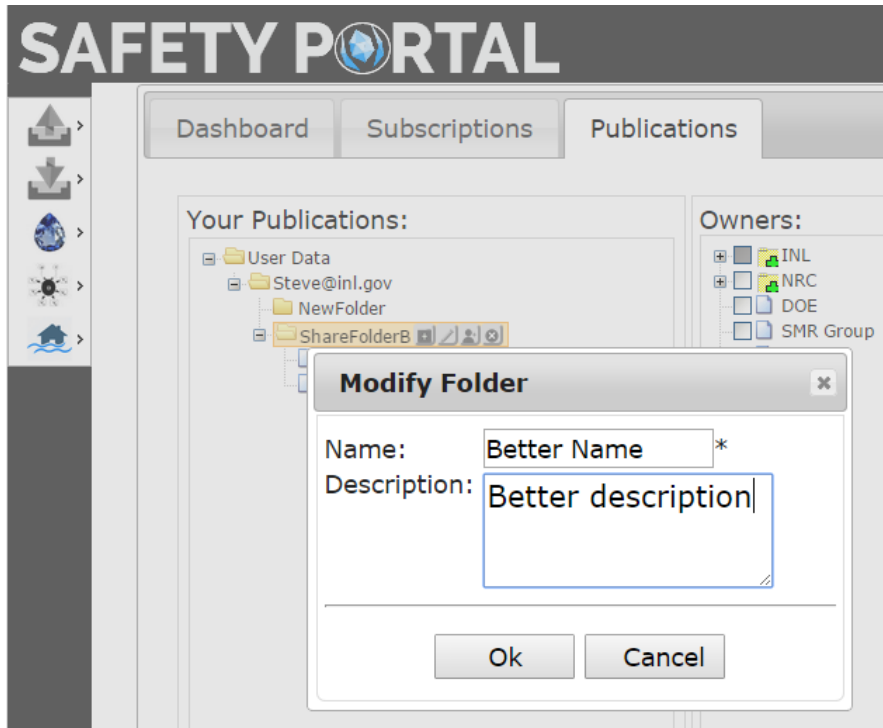


Figure 14 Publications Update Area

4. PORTAL TOOLS

A potentially large set of tools can be accessed by the same portal. The following is a set of initial tools provided by the Portal.

4.1 File Sharing Tools

File sharing tools are built into the Safety Portal, the Upload (see Figure 15) and Download tools. Together they allow users to do simple file sharing with each other. Although this is a fairly simple concept, they add a necessary capability and allow for testing of most of the features in the tool service API. It also stands as a template for other tools to base their future development.

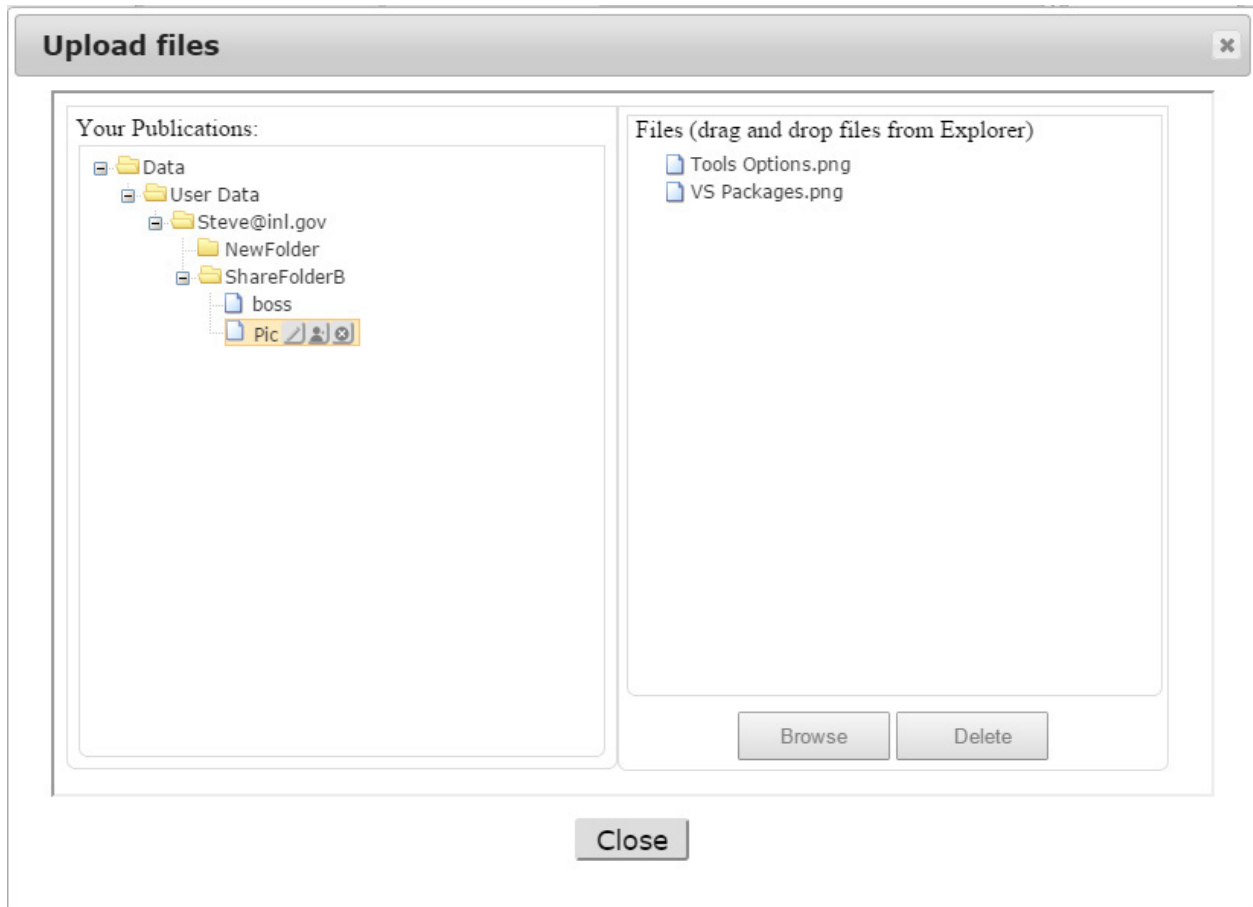


Figure 15: User interface for uploading files

4.2 Bayesian Engine

Bayesian Engine consists of an open-source software package called OpenBUGS (Bayesian inference Using Gibbs Sampling, [Ref. 1]) and a custom tool called Visual OpenBUGS Scriptor (VOBS) developed as part of the risk analysis tool for PRA project collection. It is designed to be flexible and enables analysts to have access to a shared high-performance computing environment for running research models where normally such a high-computing environment may not be readily available. The software and its accessibility (see Figure 16) allows analysts with lower computing capability to visually create, modify, store and share research models via a drawing diagram of shapes representing software code such as properties, functions and procedures. The tool generates scripts based on the diagram, which are then submitted to a shared high-performance computer for execution (Figure 17). Status and progress reports are then relayed back to the analysts through the portal dashboard.

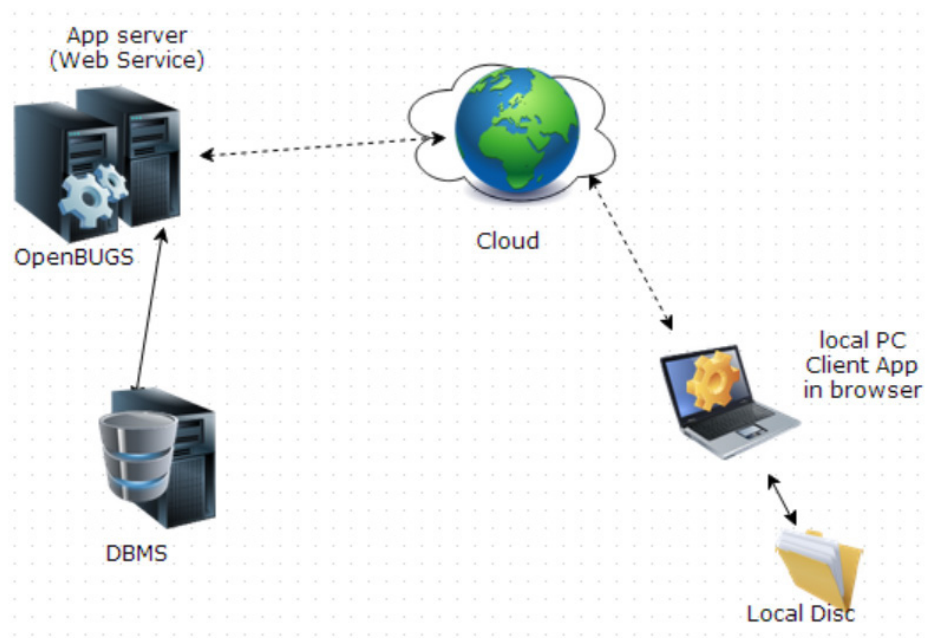


Figure 16: Visual OpenBUGS Scripter Accessibility

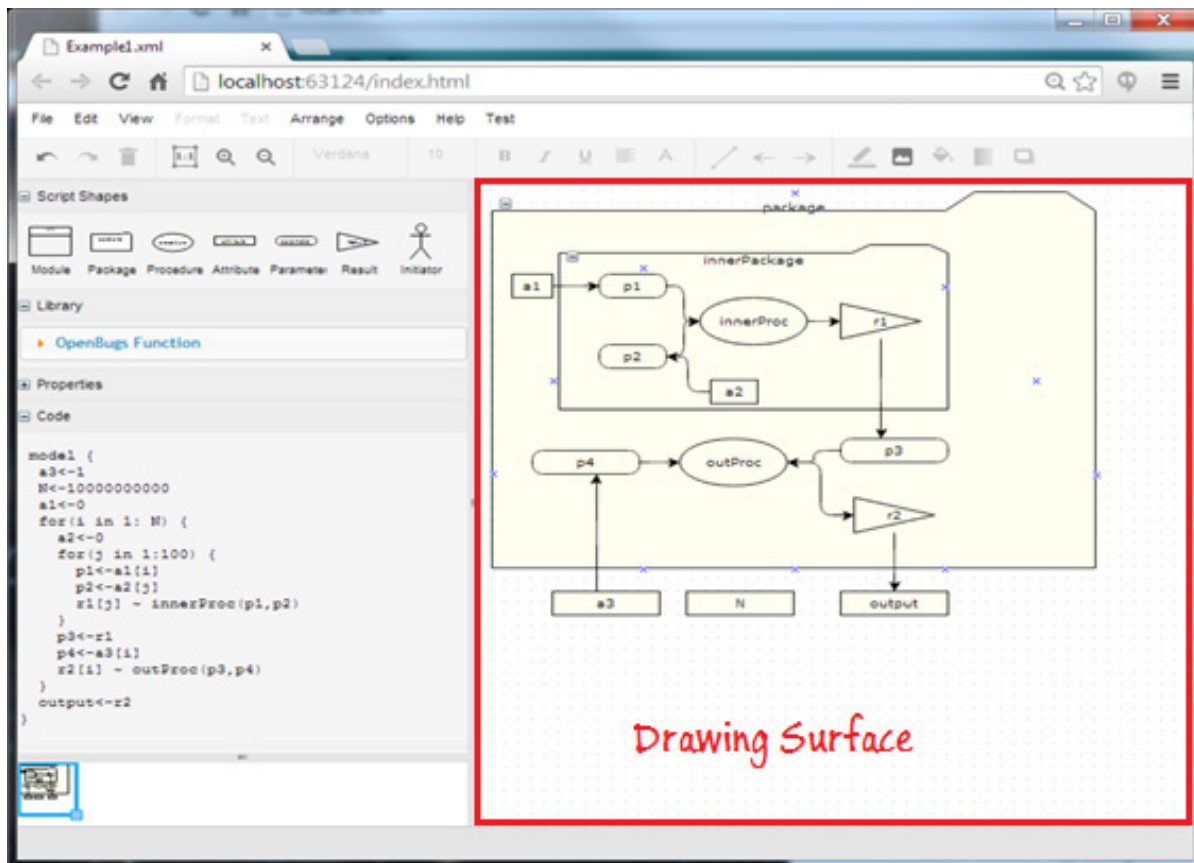


Figure 17: Visual OpenBUGS Scripter

4.3 Terrain Mapping Tool

The Terrain Mesh Mapper is a web tool that allows the user to select an area on the globe and convert it into a 3D polygon mesh. These 3D models can then be used in other analysis applications such as flooding scenarios.

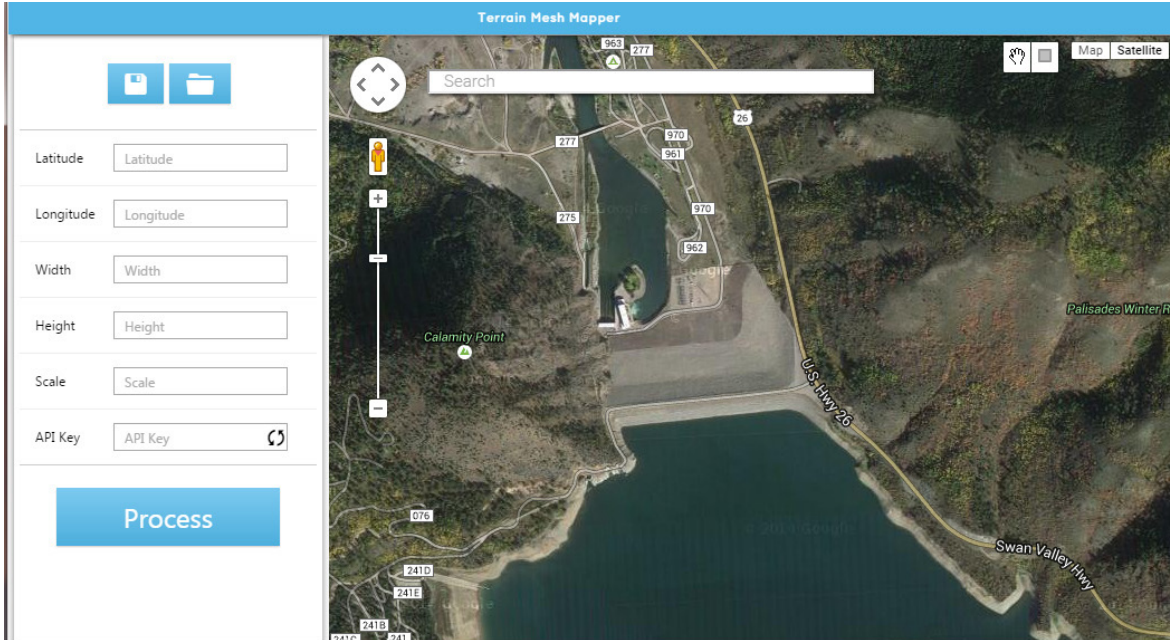


Figure 18: User interface for the Terrain Mesh Mapping tool

5. PORTAL TOOLS UNDER DEVELOPMENT

Initial development has been done for other tools, but they are currently not ready for use, and thus are not included for use in the Safety Portal at this time.

5.1 PRA Simulation Tool

Work has begun on an interface for a state-based simulation tool. This tool will allow you to design a PRA model using a combination of states, events, and actions (see Figure 18). This model is then simulated over multiple runs to calculate failure probabilities. It is designed to run with 3D simulations and incorporate those failures using PRA techniques. Simulation allows us analyze and capture failures from time based external events. Incorporating this tool into the portal will allow the user to import existing items from other tools, such as models, components, failure rates, and design structures. These results can then in turn also be accessed for use in other portal tools. Initial testing and result comparisons on the back end have been done, but the web based user interface is still in development.

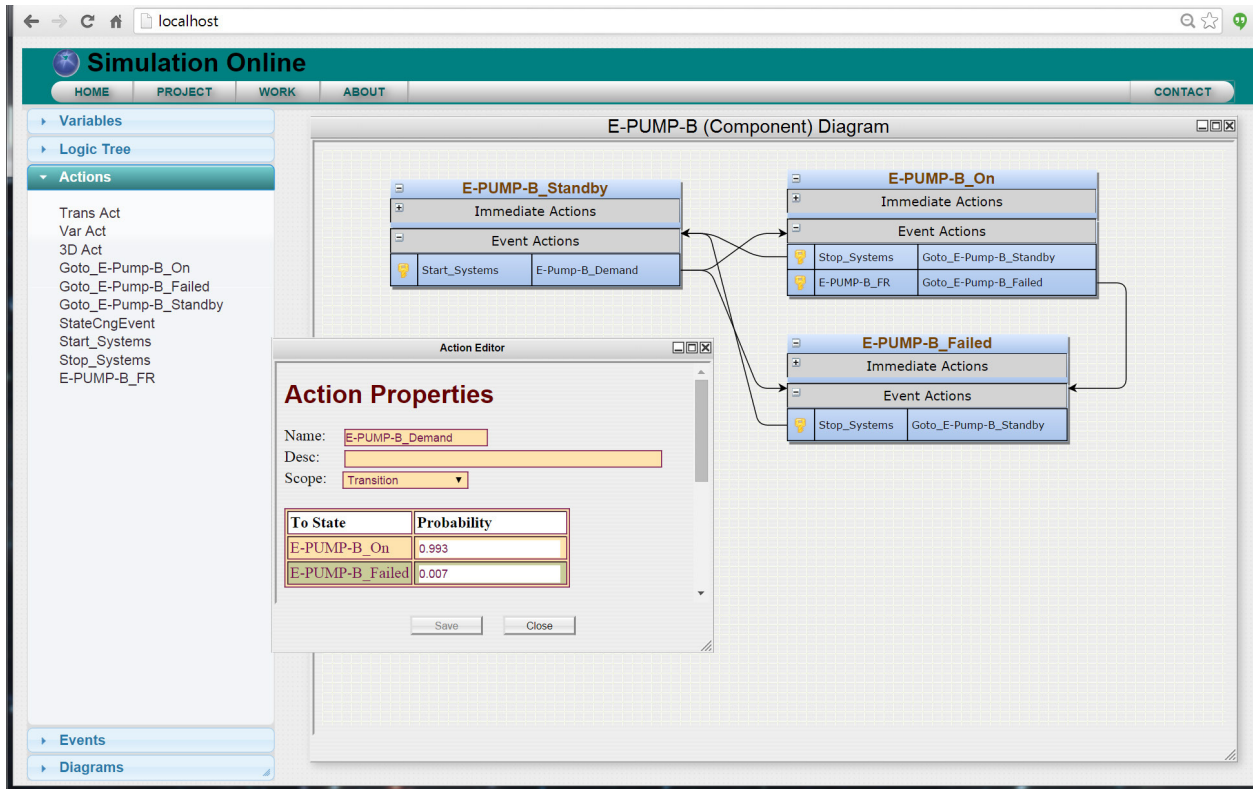


Figure 19: Screenshot of the user interface for modeling State Diagram 3D Simulations

5.2 Fault Tree Solver

Fault tree analysis has been traditionally a desktop application (e.g., through applications such as CAFTA or SAPHIRE). We are currently working on a web based Fault Tree solver. With browser tools used for the user interface and server side calculation capabilities, this tool would also contribute to the portal toolset (see Figure 20). By retrieving data for components directly from published data in the repository, calculations and model information could consistently be up to date. In addition, users could share pieces of the model.

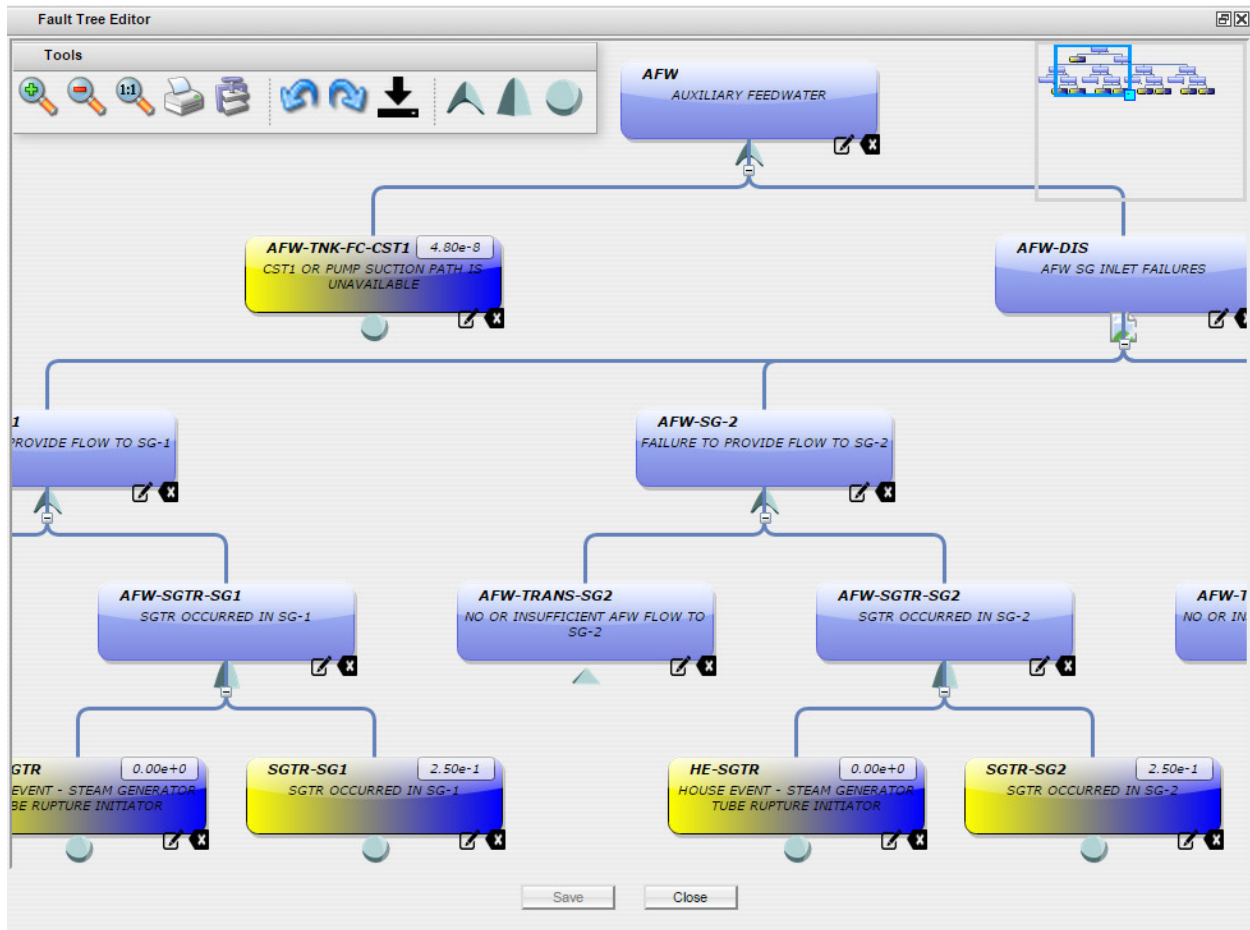


Figure 20: User interface design for the fault tree solver

6. CONCLUSIONS

The Safety Portal is being designed to provide cloud services that facilitate collaboration within the scientific research community. The portal provides a common entry point, API, and storage mechanisms to safely share tools and data among users whose role-based security allows it. The Safety Portal provides a simple Publication/Subscription model that allows for refining what users see and use.

Beta tools currently or soon to be available in the Safety Portal include file sharing tools, a Bayesian Engine, and a Terrain Mapping tool. Tools in earlier phases of development include a PRA Simulation Tool and Fault Tree Solver. Over time, the set of available tools is expected to grow, and the service capabilities provided by the portal will enable these tools to integrate data providing a completely integrated risk analysis toolset.

7. REFERENCES

Kelly, D., & Smith, C. (2011). *Bayesian Inference for Probabilistic Risk Assessment: A Practitioner's Guidebook*. Springer.