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Cloud-based Architecture Capabilities Summary Report

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SUMMARY

In a collaborative scientific research approach, it is important to have an environment where analysts have access to shared information, documents, software tools, and models. And, it is important to be able to accurately maintain and track changes in models. A new cloud-based environment to perform probabilistic risk assessment (PRA) would provide these kinds of features and would be accessible from anywhere regardless of computing platforms, given that the platform has available of Internet access and proper browser capabilities. Information stored in this environment could be restricted based on user assigned credentials. By using a cloud-based approach to analysis, the possibility exists for complex analysis using a variety of different physics models (e.g., flooding) and computational resource (e.g., high performance computing). This report reviews the development of Cloud-based Architecture Capabilities (CAC) as a possible web portal for PRA tools being developed at the Idaho National Laboratory.

CONTENTS

FIGURES

ACRONYMS

OpenBUGS	Bayesian inference Using Gibbs Sampling
CAC	Cloud-based Architecture Capabilities
CMS	Content Management System
DS	Document Server
DMS	Database Management Server
IM	Information Management
INL	Idaho National Laboratory
MVC	Model View Control
PHP	PHP Hypertexts Preprocessor

Cloud-based Architecture Capabilities

1. BACKGROUND

As a part of modern risk analysis and online collaborative research with analysts such as engineers, scientists, university professors and colleagues, there is a need to acquire a secured environment where analysts may share documents, software applications, research models, and a centralized data repository where data changes are to be maintained and historically version controlled within the research environment. One leading candidate for this type of approach is through the use of cloud-based technologies. This report describes elements of these technologies.

2. CLOUD PORTAL

2.0 Cloud Portal and Capabilities

A cloud 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. It passively maintains changes for all documents stored within the portal environment. It also maintains individual or group of documents with role-based security access. Users are granted access based upon need to know and is assigned to one or more groups of security level. Within each security group, users have specific access to certain documents or application tools within that level.

3. ANALYSIS AND DESIGN

3.1 Portal Concept

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

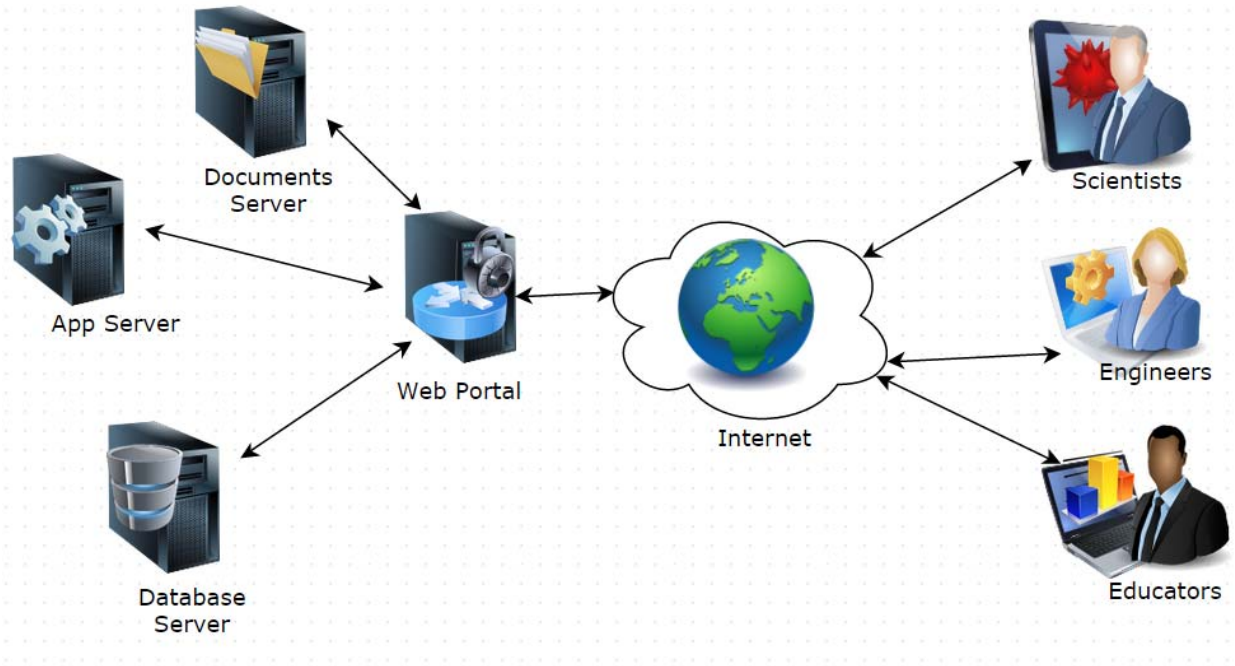

Figure 1: Web portal layout.

3.2 Design

3.2.1 Internet Cloud and Web Portal

The portal is accessible via public Internet with compatible platforms and browsers. For restricted information within the portal, users are required to register, review and granted an account with necessary security role level to be able to access. There are several software application framework options available to implement the web portal and each comes with different costs as well as advantages and disadvantages associated.

3.2.1.1 Off the Shelf

There are several choices of third-party software packages can be acquired to satisfy the requirement. Regardless of the choice, they all required to develop or customize the user interface and layout.

- Microsoft SharePoint
    - Advantages
        - Document manages with version control
        - Host web application

        - Built-in security
        - No custom development required for functionalities
        - INL Information Management (IM) established and managed
        - Faster to deployment
    - Disadvantages
        - Microsoft proprietary
        - Steeper learning curve
        - Skills required to maintain the custom software with SharePoint are more difficult to find

- Open source Content Management System (CMS) such as DotNetNuke, Orchart, WordPress, or Joomla.
    - Advantages
        - Open source
        - No proprietary modules
    - Disadvantages
        - Need to develop special functionality like security and version control.
        - Based on older technologies
        - INL must secure the server hardware and provide ongoing maintenance support

3.2.1.2 Custom Develop

The option to develop the portal from scratch also has advantages and disadvantages as well. Creating software developed from the ground-up often costs more and takes longer to implement than off-the-shelf packages, however the end product meets specific requirement and can be customized to specific users experience. There are several framework and platform technologies available to custom develop a web portal. These options include Microsoft's ASP.NET MVC (model view control) framework, PHP, Python, or JavaScript in addition to other web application framework just as EXTjs, mxGraph, jQuery, KnowOutJs, AngularJs and many others.

3.2.2 Documents Server

The capability of being able to track and maintain changes to a particular document or model is important. These change management systems are designed to keep a history of changes. These systems passively monitor all document files and version control any modification. There are several software applications available to support this requirement. These include implementing Google Drive, installing

version control software on a server available as open-source and paid off-the-shelve or develop a custom application ourselves.

3.2.3 Application Server

The Application Server hosts all application tools available to be executed as standalone or as part of a model simulation which is shared across many application processes. These applications will access databases and documents throughout the portal environment.

3.2.4 Database Server

The main purpose for a Database Server is for a customizable and centralized repository for all users to store application's generated data. These databases may be shared across applications or users within the portal.

4. Portal Toolsets

A large set of tools can be accessed by the same portal. The following is a set of initial tools to be included.

4.1 Bayesian Engine

The 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 Scripter (VOBS) developed as part of the risk analysis tool for PRA project collection. It is design to be flexible and enables analysts to have access to a shared high performance computing environment for running research models where normally such high computing environment may not be readily available. The software and its accessibility (see figure 2) allows analysts with lower computing capability to visually create, modified, store and share research models via a drawing diagram of shapes representing software code such as properties, functions and procedures. The scripts generated based on the diagram by the tool is then submit to a shared high performance computer for execution (Figure 3). Status and progress reports are then relay back to the analysts through the portal's dashboard.

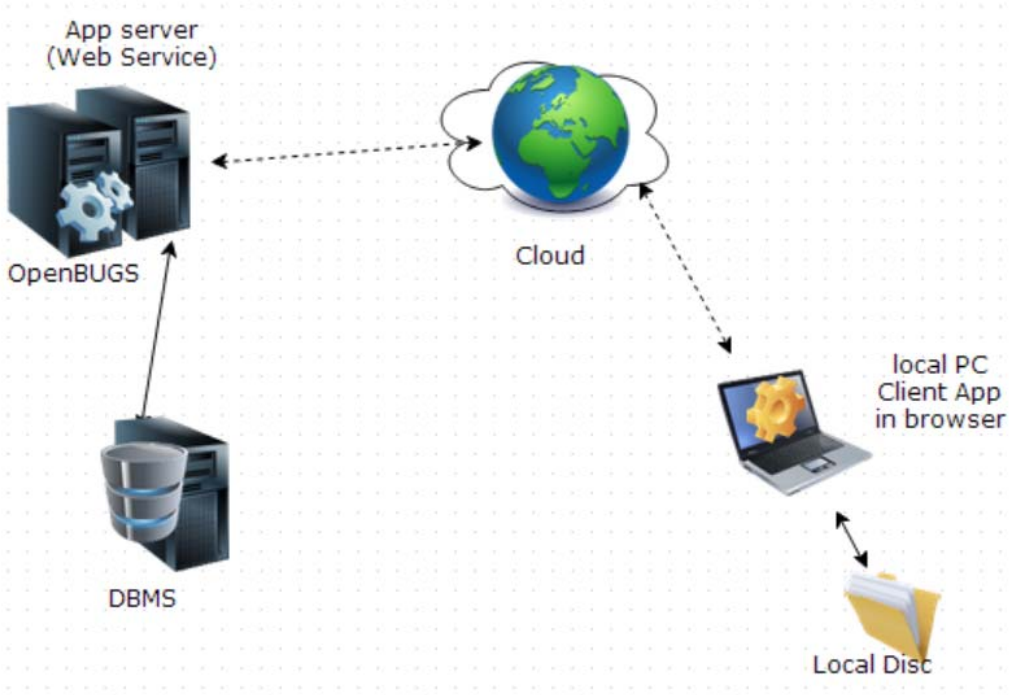

Figure 2 Visual OpenBUGS Scripter Accessibility

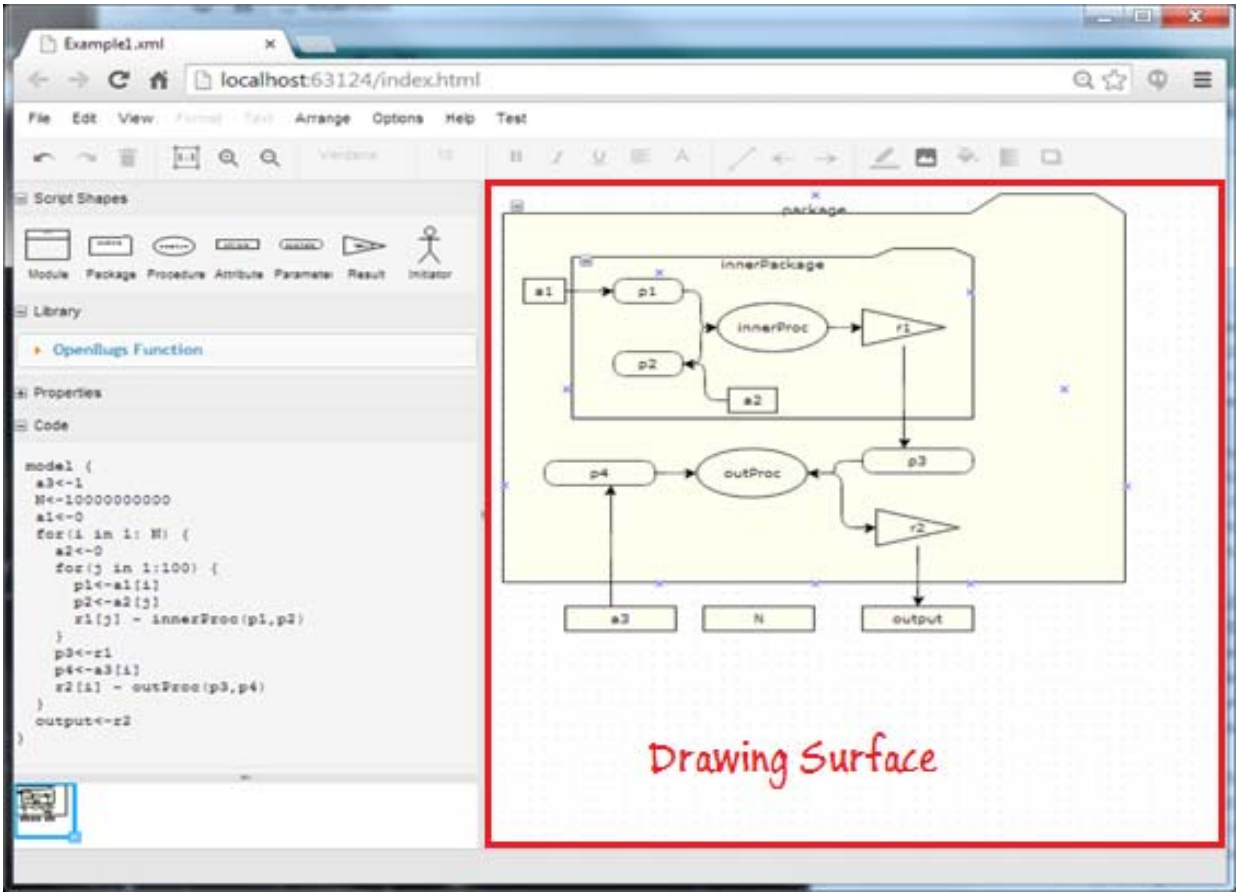

Figure 3: Visual OpenBUGS Scripter

4.2 PRA with 3D Simulation

Work has begun on an interface for integrating 3D simulations with PRA techniques. (See Figure 4) Simulation allows us to better analyze and capture failures from external events. Incorporating this tool into the portal will allow the user to draw upon tools from other areas, such as components, failure rates, and design structures. These results can then also be accessed and integrated with other portal tools.

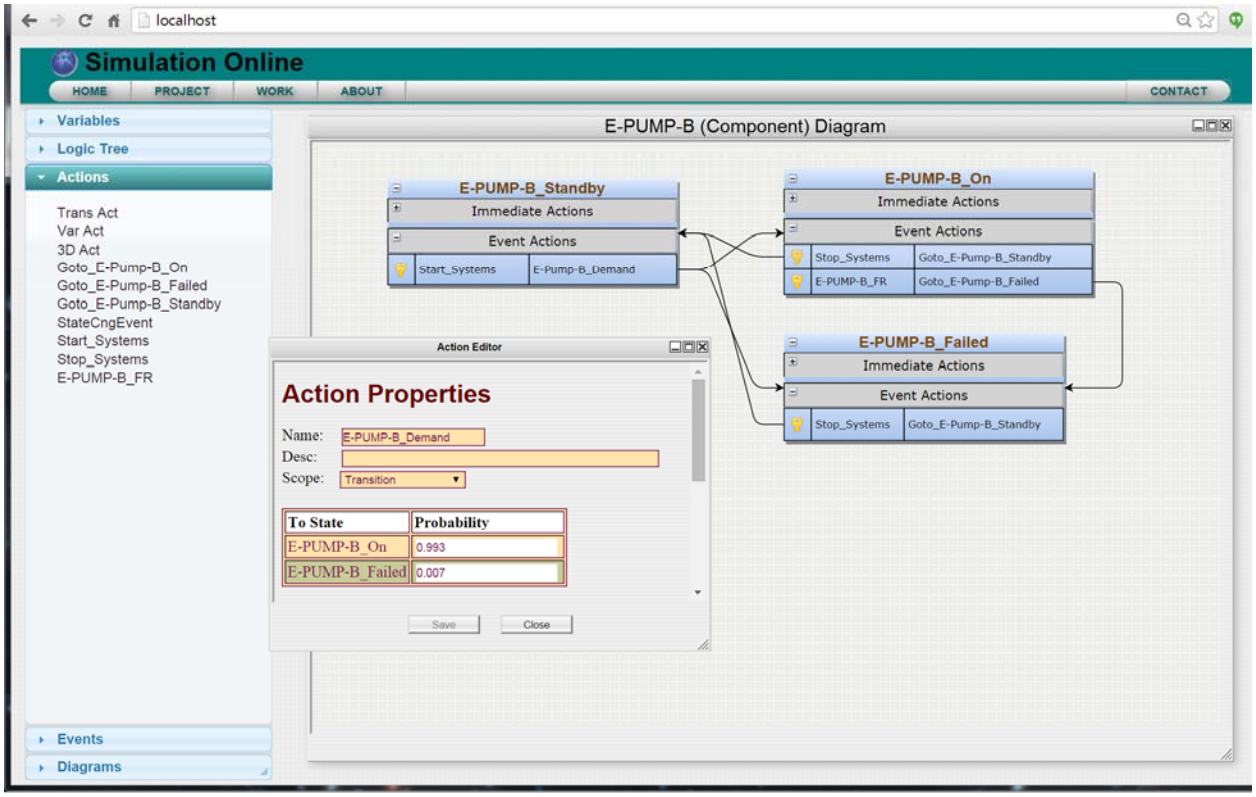

Figure 4: Screenshot of the user interface for modeling State Diagram 3D Simulations.

4.3 Web Fault Trees

Fault tree analysis has been traditionally a desktop application (e.g., through applications such as CAFTA or SAPHIRE), but currently work is being done on developing a web version. With a web interface and sever side calculation capabilities, this tool would also be available to the portal toolset. (See Figure 5)

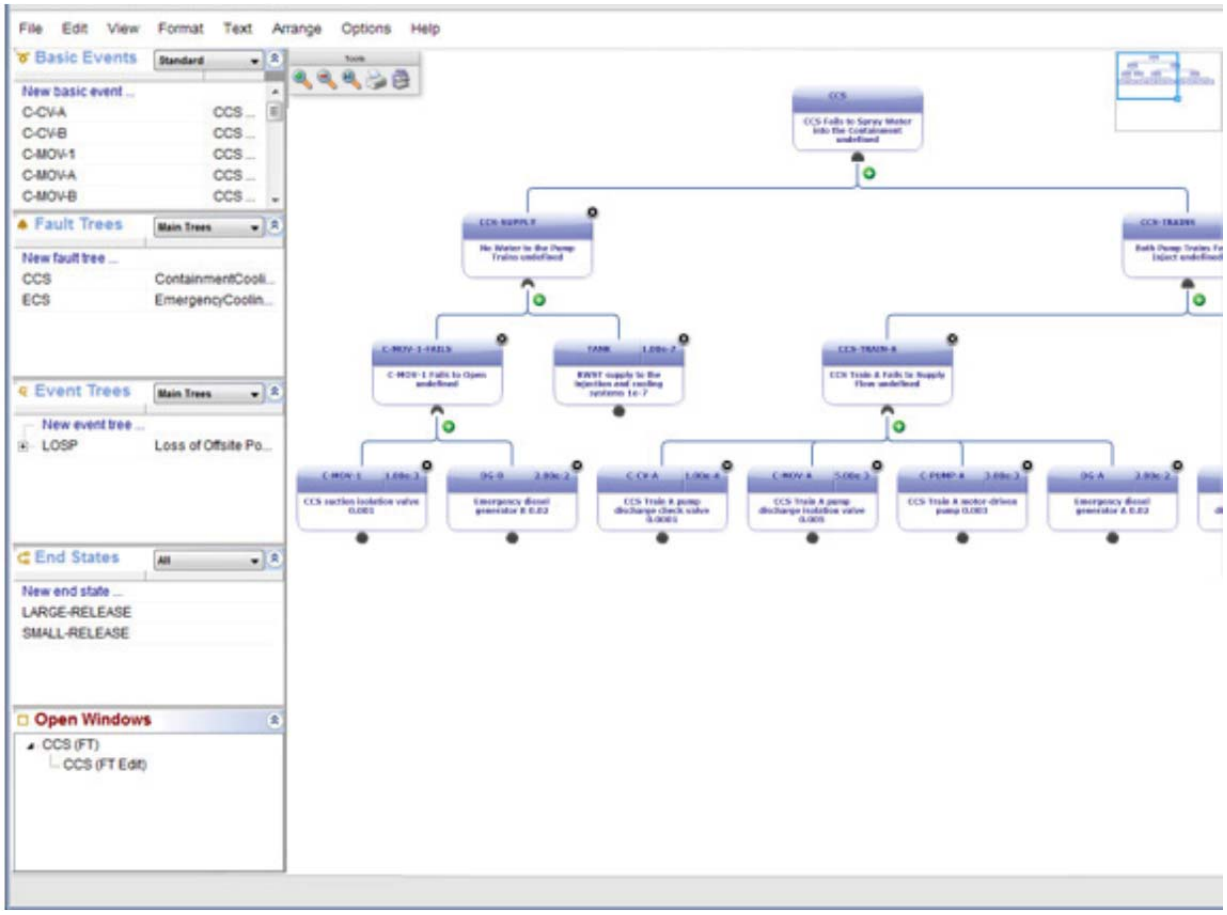

Figure 5: User interface design for the fault tree web version.

4.4 Reports

By having all the tools under the same portal, reporting capabilities will also be expanded. Users will no longer have to combine reports to portray all the required data. A single reporting tool will be able to collect and display diagrams and data from all areas.

5. CONCLUSIONS

When the cloud-based portal capabilities are implemented, it will provide a distributed platform for analysts to remotely collaborate and cooperative on risk analysis projects. The portal's unique capabilities allow users to store, copy, modify, and manage changes on all documents/models. Analysts will be able to develop models, invite others to participate, run, analyze and monitor reporting status of those models directly from the portal.

6. REFERENCES

1. **Kelly, Dana and Smith, Curtis.** *Bayesian Inference for Probabilistic Risk Assessment: A Practitioner's Guidebook.* s.l. : Springer, 2011. ISBN 978-1-84996-186-8.