



EGI-Engage

Web portals for tsunami wave propagation simulations and for WRF-based weather simulation

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Abstract

This deliverable describes the first release of two simulation portals developed by the Disaster Mitigation Competence Centre during EGI-Engage: tsunami wave propagation simulation portal and weather simulation portal. The two portals provide stand-alone and ease-of-use simulation tools for entire life cycle of a tsunami event and numerical weather prediction respectively.



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TERMINOLOGY

A complete project glossary is provided at the following page: <http://www.egi.eu/about/glossary/>

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Executive summary

This deliverable describes the first release of two simulation portals developed by the Disaster Mitigation Competence Centre (DMCC) during EGI-Engage: tsunami wave propagation simulation portal (iCOMCOT) and weather simulation portal (gWRF). The two portals provide compact and ease-to-use simulation tools for the full cycle of a tsunami event and numerical weather prediction.

DMCC aims to develop early warning system of disasters by deeper understanding of the target disasters via e-Science infrastructure. The weather simulation framework and tsunami simulation framework are used to investigate the target disaster cases by DMCC such as storm surge, floods, forest fire dust transportation and tsunami impact analysis in-depth. Web portal services are the best way to share the core facility of DMCC and to encourage engagement of wider user communities. The iCOMCOT and gWRF web portals support high performance simulation and significantly reduce the barrier of both grid and scientific complexities.

The portals are now open for researchers and will be used by the Disaster Mitigation Competence Centre of the EGI-Engage project to simulate to storm surge, flood, and tsunami and forest fire dust transportation events from Philippine, Malaysia, Thailand and Taiwan. In parallel with this, Academia Sinica continues further development of the portals. In future releases the web portal services will integrate the interoperable authentication and authorization infrastructure based on EGI services, will be connected to the EGI accounting services, and will be extended with an event database as well as with an API to improve extendibility with custom applications and interfaces.

1 Introduction

DMCC aims to achieve early warning system for target disasters by deeper understanding of disasters with e-Science approach. Based on better scientific models validated by historical events and observation data, faster simulation over the e-Infrastructure could earn more time for potential impacts estimation and quick response. Innovative model is devised by combining atmospheric model and ocean model for and higher resolution observation data of the whole life span of a disaster. Web portal is the best way to share the core tools of DMCC and to encourage engagement of wider communities.

By re-investigating historical events of selected disasters, scientist group, together with local partners, develops new models based on advanced science and high resolution event data from the local partner. Meanwhile, Web portal of the core simulation package is released to facilitate e-Science applications on natural hazards. Web Portal Services are also the key channel for dissemination of DMCC. DMCC e-Science reference architecture is depicted in Figure 1.

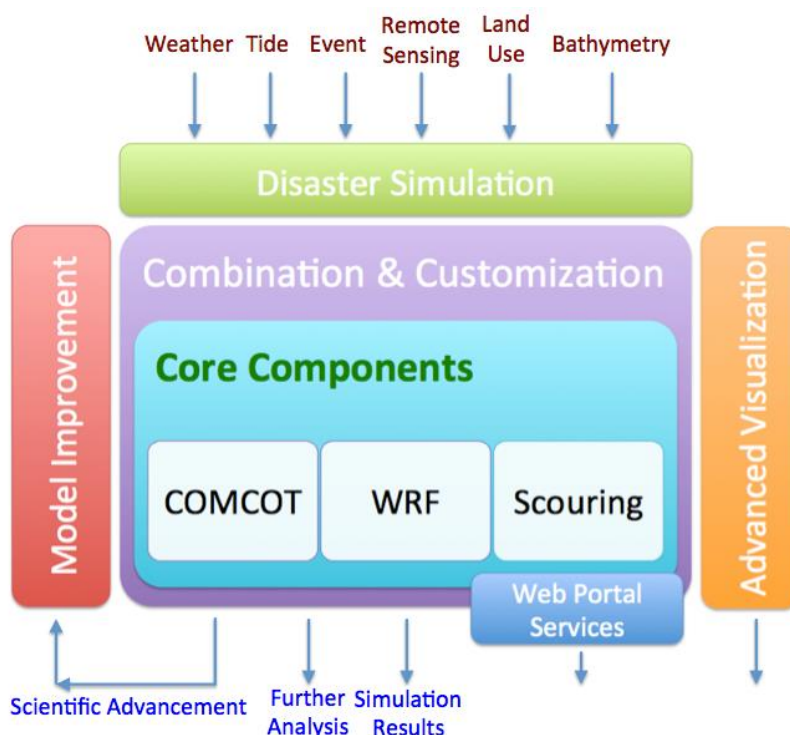


Figure 1 DMCC e-Science reference architecture

Web portal is a viable solution to support scientific community and application community to make effective use of distributed cloud services. Furthermore, via the ease-of-use simulation portals, more application workflows, use cases, application data sets, interdisciplinary collaborations and user communities could be explored. User feedback then directly facilitates the improvement of web

portals and science gateways. Momentum of the mutual beneficial interactions thus advanced the values of disaster mitigation by e-Science.

The following two tables provide a summary of the portals covered in this deliverable.

Tool name	Tsunami simulation portal (iCOMCOT portal)
Tool url	https://icomcot.twgrid.org
Description	iCOMCOT provides web portal services to simulate the entire lifespan of a tsunami, from its generation, propagation and runup/rundown on coastal regions, by the Cornell Multi-grid Coupled Tsunami Model (COMCOT).
Value proposition	The iCOMCOT web portal supports high performance simulation and significantly reduces the barrier of whole lifespan tsunami simulation.
Customer of the tool	Research projects on disaster mitigation or tsunami in Asia Pacific Grid Initiative (APGI) partners countries.
User of the service	Teachers, students, and scholars of research institutes or societies on hydrological and oceanic sciences, disaster mitigation, or earth science.
User Documentation	https://documents.egi.eu/document/2784
Technical Documentation	https://documents.egi.eu/document/2784
Product team	ASGC/AS
License	Apache License, Version 2.0
Source code	https://github.com/hdyen/comcot

Tool name	Weather simulation portal (WRF portal)
Tool url	https://qwrf.twgrid.org
Description	gWRF provides web portal services for numerical weather predication by the Weather Research and Forecasting (WRF) model developed by NCAR.
Value proposition	The gWRF web portal supports high performance simulation and significantly reduces the barrier of numeric weather analysis.
Customer of the tool	Research projects on disaster mitigation or extreme weather in Asia Pacific Grid Initiative (APGI) partners countries.
User of the service	Environmental science research group, individual researcher, teacher and student; Disaster mitigation community; Weather research and forecasting applications and service providers;

User Documentation	https://documents.egi.eu/document/2784
Technical Documentation	https://documents.egi.eu/document/2784
Product team	ASGC/AS
License	Apache License, Version 2.0
Source code	https://github.com/yvr/wrf

2 Service architecture

2.1 High-Level Service architecture

According to the reference architecture of Figure 1, DMCC releases the web portal services on tsunami wave propagation simulation and the weather simulation. DMCC Web Portal Service aims to provide simulation services over the e-Infrastructure. Web portal is made by integration of core tools such as COMCOT and WRF, with the e-Infrastructure and providing the Web User Interface.

iCOMCOT portal provides the easiest web interface to simulate a tsunami event after defining the focal mechanism, simulation region and tidal stations only, since complex scientific configuration process are hidden. In addition, to speed up the simulation, iCOMCOT takes advantages of OpenMP computing model and distributed cloud resources over the e-Infrastructure. iCOMCOT is composed of five major components as depicted in Figure 3: web User Interface (UI), Common Gateway Interface (CGI), storage and database, workload management system as well as distributed computing resources. One could enter COMCOT simulation parameters, trigger the simulation, and obtain visualized results from the web user interface.

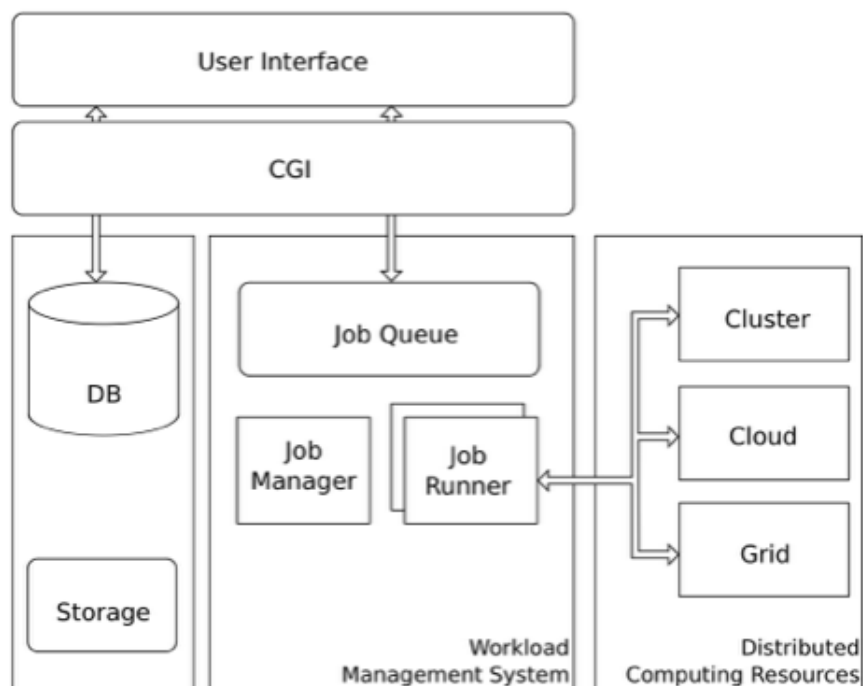


Figure 2 Architecture of iCOMCOT

The web portal of gWRF (grid-based WRF), developed by ASGC, utilizes the global grid computing resources for the weather simulation by the Weather Research and Forecasting (WRF) model. To improve the WRF overall efficiency, gWRF allows computing intensive WRF models to run on the Grid, whereas users handle WPS and post-processing which does not require lot of CPU resources. DMCC designed a package of scripts and made WRF MPI version running on EGI-based Grid infrastructure. Currently this service is only for users of EUAsia VO (i.e. to researchers from Asia-Pacific, and to their international collaborators). In the next release, the gWRF services will be opened to the global academic research community. The workflow of gWRF is depicted in Figure 3.

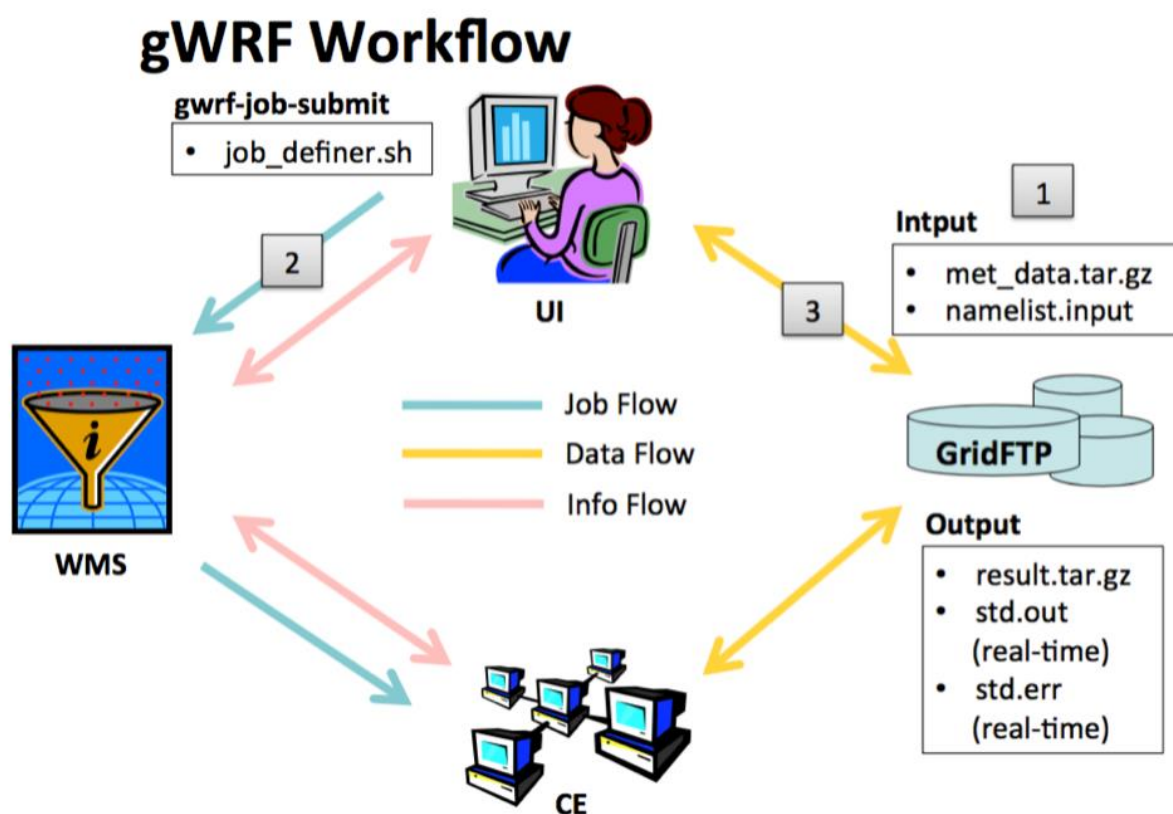


Figure 3 Workflow of gWRF

2.2 Integration and dependencies

Tsunami propagation is a multi-scale problem, ranging from hundred kilometres to several meters. Cornell Multi-grid Coupled Tsunami Model (COMCOT) is a widely used tool developed by University of Cornell. COMCOT is capable of simulating the entire lifespan of a tsunami, from its generation, propagation and runup/rundown on coastal regions.

The iCOMCOT system provides a geographical user interface to easily identify the earthquake epicenter, observation stations, and simulation areas by making use of a web mapping services, such as Google Maps. The user only needs to define these parameters together with simulation name, simulation time, time period to save output data, focal mechanism, and nested-grid arrangement, then the simulation could be carried out by the portal. Among them, fault model, nested-grid and tide station settings will be kept in the system for future reuse.

iCOMCOT is a real-time tsunami simulation system which is fast, accurate, reliable, and user friendly. It proves to be an efficient and low-cost system for tsunami research, disaster mitigation and education, etc. for South China Sea countries. COMCOT is not used just for tsunami case studies of DMCC but also for the simulation of storm surge and typhoon events.

Weather Research and Forecasting (WRF) model is a state-of-the-art regional modelling tool developed at the NCAR. It has been designed to serve both operational forecasting and atmospheric research needs and it has a rapidly growing community of users all around the world.

Running WRF is not a simple task which involves execution of several pre-processing steps for the input data, initial conditions and boundary conditions. After the pre-processing, WRF core itself is computing intensive to generate simulation results of every certain number of time steps and output several result files. To hide the complexity of both Grid and WRF, gWRF provides the Web Portal Services to integrate numerical weather prediction tools and the e-Infrastructure. The long-term goal is to further simplify the workflow and leverage the performance of e-Infrastructure.

Policy of access to these two portals is open to collaborations for the moment. Users working on the target case studies, dissemination and infrastructure providers of DMCC are supported by default. Feedback of users to improve the web portal services as well as the workflow, e-Infrastructure and platform services are essential. Support for science education purposes for both teachers and students are also welcomed.

3 Release notes

3.1 iCOMCOT Web Portal

- Version Number: 1.0
- Overview: iCOMCOT provides web portal services to simulate the entire lifespan of a tsunami, from its generation, propagation and runup/rundown on coastal regions, by the Cornell Multi-grid Coupled Tsunami Model (COMCOT).
- Date of release: April 1st, 2016
- System requirements: Web browsers in desktop, laptop or mobile device are all working.

3.2 gWRF Web Portal

- Version Number: 1.0
- Overview: gWRF provides web portal services for numerical weather prediction by the Weather Research and Forecasting (WRF) model developed.
- Date of release: April 1st, 2016
- System requirements: Web browsers in desktop, laptop or mobile device are all working.

4 Future plans

For the current target case studies of DMCC, gWRF is applied to storm surge, flood in Malaysia and Thailand, and also the forest fire aerosol transportation. iCOMCOT is used for storm surge and tsunami impact analysis. In addition, planned features for future releases are listed below.

1. Implement an interoperable Authentication and Authorization Infrastructure with levels of assurance by leveraging EGI technologies.
2. Accounting Service: to easily investigate how the resource is utilised considering both CPU and data flow.
3. Event database: For target case studies, compile event data, simulation method and simulation results and share on the portal.
4. Providing API to support flexible usage of the services and integration with user applications.

Appendix I. Web portals for tsunami wave propagation simulations and for WRF-based weather simulation

Introduction

Disaster Mitigation Competence Centre (DMCC) Web Portal Service provides simulation services over the EGI e-Infrastructure. Web portal is made by integration of core simulation tools such as COnell Multi-Grid Coupled Tsunami (COMCOT) model and Weather Research and Forecasting (WRF) model.

DMCC aims to achieve early warning system for target disasters by deeper understanding of disasters with e-Science approach. By collaboration of science groups, e-Infrastructure providers and application supports, DMCC aims to provide accurate models and high performance simulation for disaster event analysis and reduce losses. The high-level collaboration model and objectives of DMCC are depicted as Figure 4.

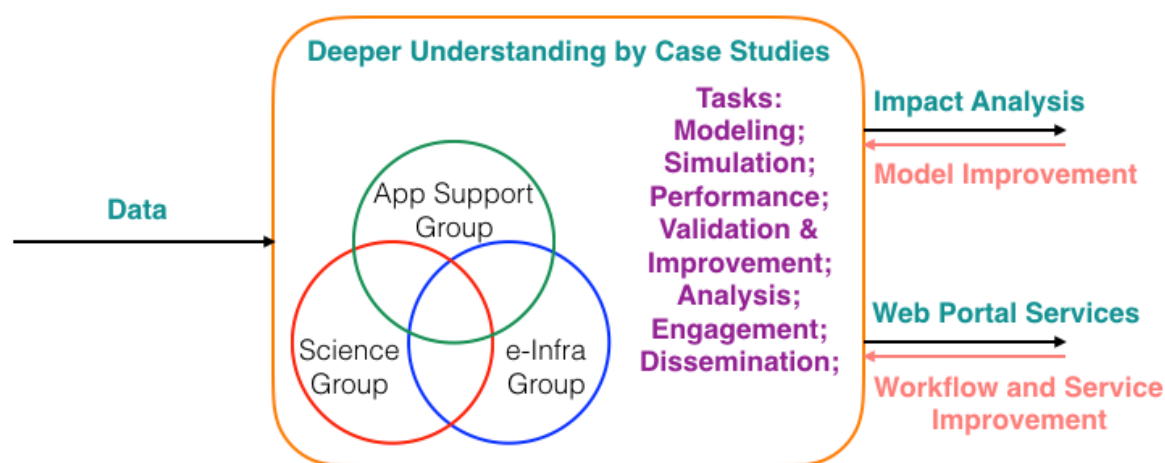


Figure 4 DMCC

Based on better scientific models validated by historical events and observation data, faster simulation over the e-Infrastructure could earn more time for potential impacts estimation and quick response. Innovative model is devised by combining atmospheric model and ocean model and higher resolution observation data of the whole life span of a disaster. Web portal is the best way to share the core tools of DMCC and to facilitate engagement of wider communities.

We live on a dynamic planet, however our knowledge to the earth is very little. By e-Science approach, DMCC is not just developing innovative models based on recent knowledge about earth

and environmental science and more detailed observation data, but also providing faster event simulations to understand potential impacts. Web portal services come from the core tools of DMCC and aim to disseminate the DMCC outcomes and the e-Science values.

Architecture of the DMCC Web Portal Services

During the EGI-Engage project period, DMCC web portal services are providing simulation tools for most of the case studies which are the tools for tsunami whole lifecycle and weather forecasting respectively. Basic DMCC Web Portal Services Architecture is depicted in Figure 5.

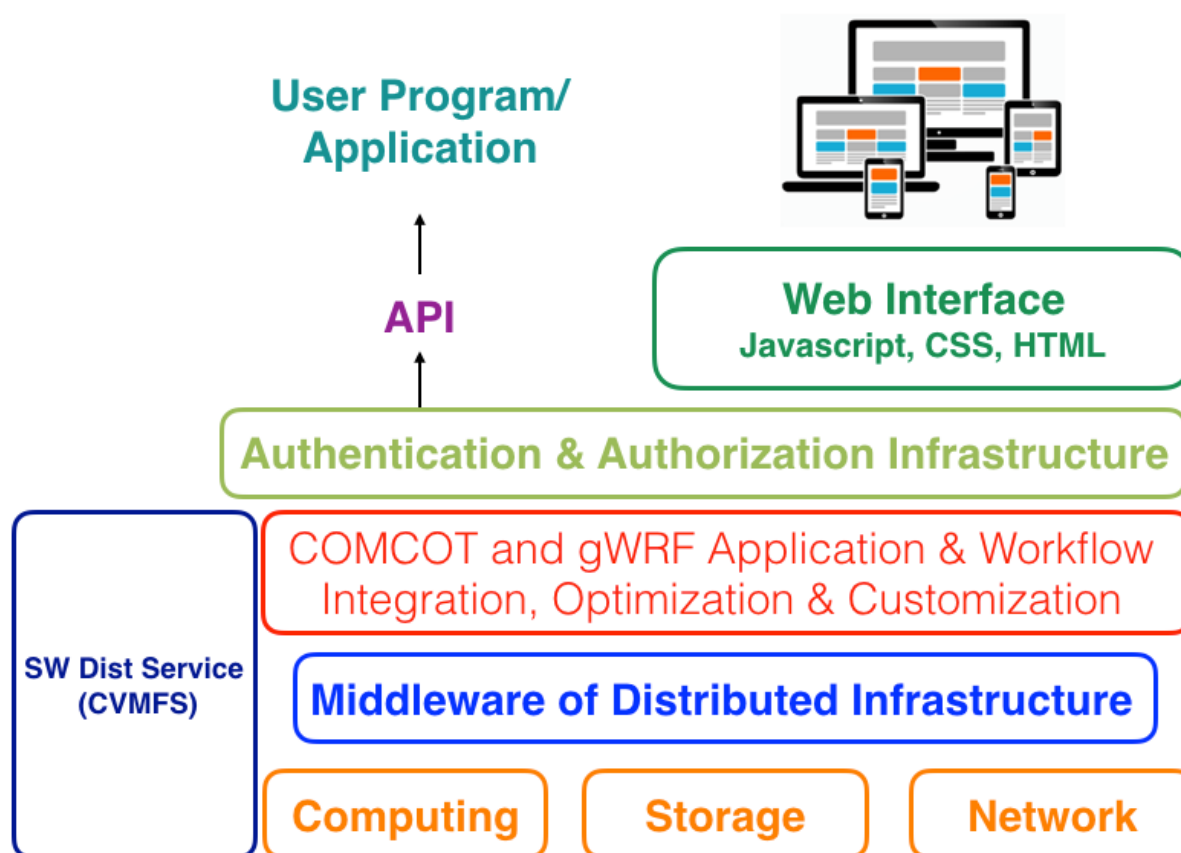


Figure 5 Basic DMCC Web Portal Service Architecture

The two portals were in continuous development since 2010. Portals are based on responsive web design principles and developed by javascript and cascading style sheets (CSS). Simulation software package is mainly recommended by the science group. Once it is determined, integration with the distributed e-Infrastructure and the recommended workflow will be implemented, followed by performance improvement investigation such as parallelisation and optimization. Web user interface then simplifies the workflow and user interactions.

Typically, involved Grid middleware components are the gLite UI, Workload Management System (gLite WMS), Computing Element (CE), Storage Element (SE) and GridFTP. Asia Pacific regional e-

Infrastructure composed by Asia Pacific Grid Initiative partners are the primary resources for the portals at first. To keep a consistent environment in all available resources for the DMCC applications, CVMFS is used for a reliable software distribution services maintained by ASGC. This is one of the core components of the release process which will be described in detail in next Section. In the second project year, glide-submit and condor will be the new workload management mechanism of the regional e-Infrastructure supporting DMCC applications.

Because of different needs from different user communities in the beginning, iCOMCOT is opening to research community and education purposes by username and password. However, gWRF is providing to APGI partners by IGTF user certificate and EUAsia VO. Strategically, to make the portal services scalable to EGI, DMCC Web Portals will incorporate EGI AAI solutions in the next stage to implement a common authentication mode across organizations. From users' feedback, certificate-based authentication mechanism is still too complicated for most users. Apart from integrating with existing institute identity management mechanism, multimodal authentication methods will be provided for various user groups in the future. EGI new AAI development (such as AARC) will be deployed in future release.

Processes

DMCC Web Portal Services keep improving according to users' experiences, more case studies and new collaborations. In order to guarantee the quality of Web Portal Services, DMCC manages the changes, release, and requirement gathering according to EGI instructions for production tools team¹.

Requirement Gathering Process

First release of the two Web Portals provide basic simulation functions with simplified and geographical user interface supported interfaces according to suggestions from science group. From more case studies, collaborations and dissemination events, DMCC keeps collecting user requirements to improve the services. As iCOMCOT is also used for education, comments from teachers and students have helped to correct some mistakes and to make the workflow easier. Currently, email contact is the primary online channel to anticipate user feedback to the Web Portal services.

The Web Portal Expert Group formed by representatives from the scientists, application support group, e-Infrastructure provider group and dissemination group will investigate the collected requirements and determine the priority of development.

Release Management and Process

According to the user requirements with identified priorities, DMCC Web Portal Services production team will review the development plan every month and confirm the release plan for the next 6 months. The release plan is finalised with approval of the Web Portal Expert Group.

¹ https://wiki.edi.eu/wiki/Instructions_for_Production_Tools_teams

From development, test, pre-production and final release, the whole delivery pipeline is supported by Jenkins. Testbed is the last platform for the production team to validate if the new version could be move to pre-production. Well verified case studies are used at the pre-production platform to verify the version for next release. Production release is distributed by CVMFS to ensure the platform consistency at all e-Infrastructure resources. Savane² is used internally for issue tracking on bugs, tasks, and team member management etc. during the development and release process.

Roadmap

Below is the summary of current roadmap of DMCC Web Portal Services.

Task	Goals	Expected Release Schedule	Remarks
EGI Integration	AAI flexible, multimodal and simples but secure authentication and authorization mechanism	March 2017	Federated identity management with user institutes; Level of Assurance capability; Ref. to AARC outcomes;
Event Database Buildup	Compile event data with Web Portal for users reference	March 2017	started from target case studies; will provide interface for users input; together with event data under data access policy;
Accounting Service	Provide detailed resource utilisation statistics with views of user, resource, etc.	March 2017	Will make use of EGI Accounting Portal first;
API	Providing Restful APIs	March 2017	Support flexible usage of DMCC services and easy integration with user existing applications

² <https://gna.org/projects/savane>