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SUPPORTING DECISION SUPPORT WITH EVENT-DRIVEN DATA DELIVERY

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1 INTRODUCTION

To support better data preparedness for decision support of disasters and other events, an Event-Driven Data delivery (ED3) framework has been created that provides reusable services and configurations to rapidly provide pre-planned access to data, special processing, modeling and other capabilities, all executed in response to criteria-based events. ED3 facilitates decision makers to plan in advance of disasters and other types of events for the data necessary for decisions and response activities. A layer of services provided in the ED3 framework allows systems to support user definition of subscriptions for data plans that will be triggered when events matching specified criteria occur. Pre-planning for data in response to events lessens the burden on decision makers in the aftermath of an event and allows planners to think through the desired processing for specialized data products. Additionally the ED3 framework provides support for listening for event alerts and support for multiple workflow managers that provide data and processing functionality in response to events. This abstract briefly discusses the details of the framework and provides use case examples of how ED3 is already being used for event response through the Northern Gulf Coastal Hazards Collaboratory, a multi-state coalition, and state agencies within Alabama dealing with hazards and disaster response efforts. NASA's Applied Science Program has funded a feasibility study of this technology and as a result the capability is on track be integrated into existing decision support systems, with an initial reference implementation hosted at the Global Hydrology Resource Center, a NASA distributed active archive center (DAAC).

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2 Framework

The ED3 framework is designed as loosely-coupled components using a central service layer to generate data preparedness plans, trigger plan workflows based on event notifications, and query and update plans based on workflow progress and completion. Using the service interfaces the independent components can be implemented by any provider using any platform capable of interfacing with the simple HTTP-based RESTful services. This flexibility allows implementations of the framework to fit any domain's computing environments. The main components of the framework are explained below and a illustration of the architecture of this framework is depicted in Figure 1.

2.1 Plans and Services

The ED3 framework includes a centralized plan and service layer that acts as the core of the system. Services allow decision support users to generate data processing plans that includes the type of disaster event of interest, triggering criteria for the event (e.g. magnitude of an earthquake, wind speed of a tropical storm, etc.), the data products requested to be accessed or generated when the selected event occurs, include spatial and temporal buffers to be used for data filtering (e.g. get all data within 100km range of an event). The plans, and associated user information, is maintained in a relational database. The service layer provides functionality to generate plans,

trigger plans based on matching event notices, request for plans queued for execution, update plans on progress and completion, and query the status of plans.

2.2 Decision Support and Applications

Decision support systems and other applications are supported through the centralized plan service layer (Figure 1). Services are provided to support applications creating new plans detailing the type of disaster event, the triggering criteria of the specified event, and the data products to be generated in response to an event. That information is maintained as a subscription in the plan database until a matching event occurs and triggers the specified data processing workflows. The applications may also query the plan manager for the status of a triggered plan and to retrieve information about the resulting data products. As mentioned, the applications are loosely coupled to the framework using the service layer to be able to allow virtually any application to interface with ED3.

2.3 Event Listeners and Notifications

Alerts and notices for events originate from many different agencies and authoritative sources, and typically are available in many different formats and methods of delivery. ED3 handles this lack of consistency by allowing any externally developed event listener to send event notices to the plan manager through the service layer. This allows specialized event listeners that know how to receive alerts and notices from a particular source to generate an ED3-compatible event notice. ED3 supports the Common Alert Protocol (CAP) that is a simple XML-formatted structure utilized by several alert notification systems. If a source is already generating CAP messages then that message may just be passed through to ED3, otherwise the specialized event listeners reformat the message from the original source into the CAP format and then submit it to ED3. Upon receipt of a notification, ED3 compares the notification's event type and criteria to the database, to determine if there is a match with any existing plans. If a match is found, the plan is marked for processing. If the servicing workflow manager has provided a call-back function then the plan manager initiates the call-back to activate the workflow, otherwise the marked plan is queued for the next time the corresponding workflow manager polls for new jobs.

2.4 Data Workflow Managers

The processing of pre-defined data workflows is by design open-ended in that virtually any workflow or data processing step can be supported through the ED3 framework, to include access to data from known data centers, tasking of sensors, generation of on-demand products, execution of models, etc. The implementation of a workflow manager component is left up to the developer or provider of the functionality, with the requirement of either polling the ED3 plan manager through the provided service layer, or by providing a call-back function through which the workflow can be initiated when a plan has been activated in response to an event occurrence.

3 NGCHC Use Cases

While a number of use cases have been implemented and tested during the feasibility study of this framework, the implementation for the Northern Gulf Coastal Hazards Collaboratory (NGCHC) is representative of the functionality. Louisiana, Mississippi, and Alabama have formed the NGCHC to leverage their partnerships, proximity, and significant prior investments to advance science and engineering of coastal hazards across the region. The NG CHC is developing a regional-scale integrated cyberinfrastructure for multidisciplinary research and education capable of simulating relevant interacting processes from the watershed to the coast to capture the dynamic nature of earth surface processes. This includes the ability to couple models, invoke dynamic algorithms based on streams of sensor and satellite data, locate data and computational resources, and create workflows associated with different simulation demands. As an ED3 reference implementation, NGCHC successfully incorporated the use of the ED3 framework architecture into a tropical storm workflow for the collaboratory. By generating an ED3 plan for tropical storms impacting the northern Gulf of Mexico region, workflows returning the latest ADCIRC (water level) model results for the region are executed as soon as the National Hurricane Center (NHC) issues a tropical storm alert for the area. The implementation involved the configuration of an event listener for the NHC alerts, the generation of a plan listing tropical storms impacting the northern Gulf region and requesting ADCIRC model products, and a workflow manager knowing how to request and access the latest ADCIRC model results from the Renaissance Computing Institute (RENCI.org). The resulting ADCIRC model images are then made available to NGCHC users as a data layer in the collaboratory's web-based visualization tool. This is an example of how decision makers can plan ahead to automatically have the data products they rely on for specific types of events generated immediately upon receipt of alerts.

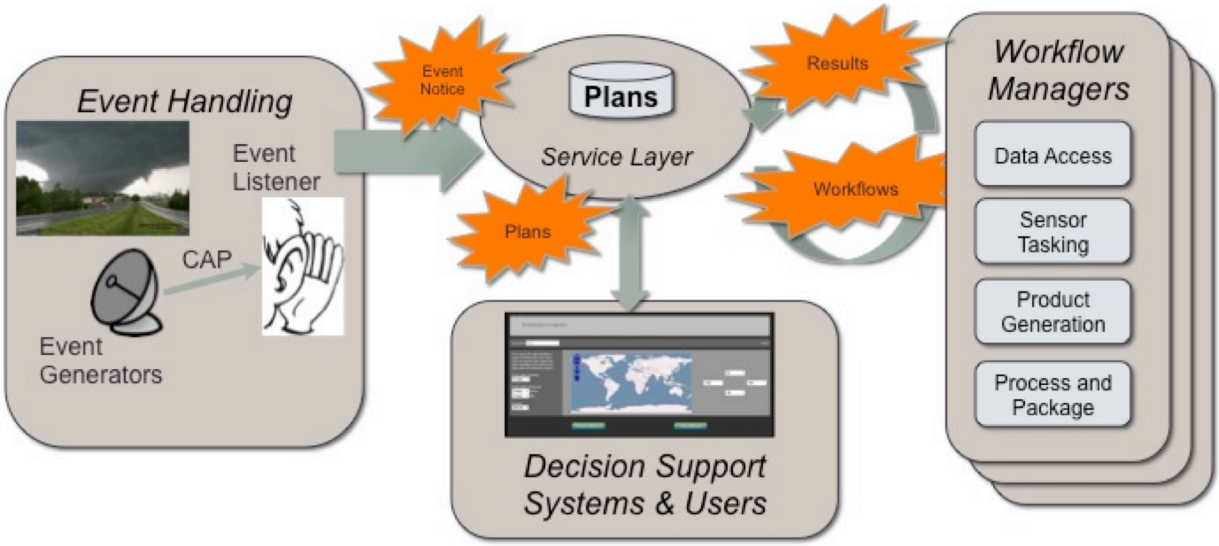

Figure 1: High Level ED3 Architecture.

4 RESULTS

The initial feasibility study of ED3 applicability for disaster preparedness was successfully completed with the implementation of the core

framework components and the development of initial reference implementations of functionality for decision support, event listening and data processing workflows. These initial implementations were developed to demonstrate the use of the framework interfaces and functionality for some real world applications. The next phase of this project will involve an operational implementation of the core ED3 framework at the Global Hydrology Resource Center, a NASA distributed active archive center operated by the University of Alabama in Huntsville. More information about the ED3 framework and the ongoing project is available at http://ed3.itsc.uah.edu.

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