

The Common Information Space: A Framework for Early Warning Systems

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1. Introduction

Early Warning Systems (EWS) supported by an advanced computing ecosystem can play a key role in mitigating the negative impact of natural disasters. In this paper, we describe the Common Information Space [1], a software framework facilitating (i) EWS development by proposing an EWS reference model and development framework; (ii) EWS deployment through the novel concept of EWS-factory-as-a-service; and (iii) EWS execution by providing a runtime infrastructure for resource allocation, self-healing, mission- and time-critical operation, and urgent computing. While originally intended for Early Warning Systems, CIS is suitable for any mission-critical system which relies on resource-intensive scientific computations.

2. Description: CIS architecture and EWS reference model

The EWS reference model proposed by CIS (Fig. 1) leverages SOA architectural patterns adapted for scientific computing. Domain resources exposed as basic services, orchestrated into application scenarios and exposed as composite services, aka Parts. The Enterprise Application Integration approach and technology is used to enact the workflow of an application scenario. Scientific applications involved in the computations are wrapped as virtual appliances and deployed on demand on computing resources provisioned from a cloud infrastructure.

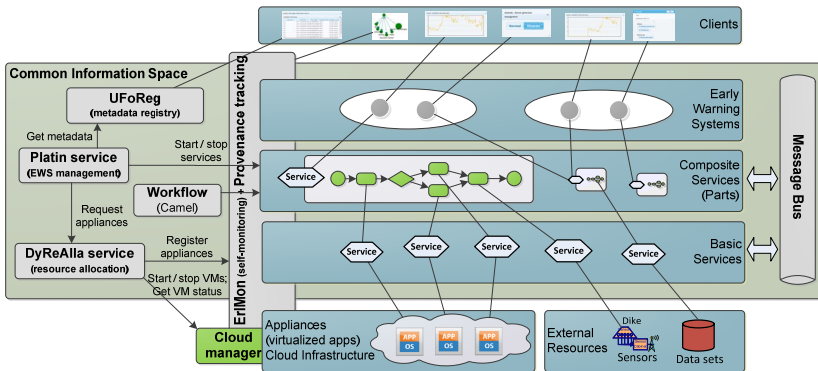


Fig. 1. Architecture of the Common Information Space and its EWS reference model.

EWS execution is supported by CIS runtime services, also shown in Fig. 1. These services include Platin (overall execution management), UFoReg (registry of metadata and state of EWS and resources), DyReAlla (dynamic optimization of resource allocation based on monitoring of performance and resource demands), ErlMon (on-line monitoring) and a provenance tracking service.

3. Results: the Flood EWS and CIS as a geo-ICT solution

CIS has been applied to implement a Flood Early Warning System which leverages in-situ sensors in order to predict flooding threat due to dike failures in urban areas [4]. Application scenarios involved in the Flood EWS include machine-learning-based detection of anomalies in dikes, calculation of dike stability, and simulations for flood prediction, evacuation patterns and loss of life estimation. Thanks to the CIS EWS reference model, the Flood EWS has been deployed as a configurable system factory which can be used to create new instances of the Flood EWS for new settings. Using these factory, the Flood EWS has been deployed for several test locations in Europe including the UK (the Boston dike) and the Netherlands (Stammerdijk, LiveDijk, Rhine dike).

In addition, CIS adopted the guidelines of the INSPIRE directive for building geospatial services [3]. Interfaces of the EWS services are compliant with the OGC standards ensuring interoperability with existing and future geospatial data sets. The flood simulation scenario of the Flood EWS served as a case study showing CIS as a geo-ICT technology [2].

4. Conclusions and future work

The practical applications of the CIS concept and technology have proven its value at least in three areas: (i) CIS as a factory for Early Warning Systems; (ii) CIS as a solution for spatial data processing services supporting the development of spatial data infrastructure in Europe; (iii) CIS as a runtime infrastructure for resource-intensive mission-critical systems. Future work involves further investigations in all these areas. Of our particular interest is the concept of a Framework-as-a Service: a system factory, exposed as a service, reducing the effort to create and deploy new, customized instances of systems.

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