Chapter 1

Integrated Information and Computing Systems for Advanced Cognition with Natural Sciences

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ABSTRACT

This chapter gives a comprehensive overview of the present status of Integrated Information and Computing Systems for complex use cases and system architectures in order to exploit new resources for opening up new cognitive insights for natural sciences applications. It shows up with the challenges creating complex integrated information and computing components and covers implementation, frameworks, and security issues with these processes and how the overall complexity can be reduced using collaboration frameworks with Distributed and High Performance Computing resources in natural sciences disciplines for building integrated public / commercial information system components within the e-Society. The focus is on using a collaboration framework for integrating computing resources with information system components, interfaces for data and application interchange, based on current developments and embedding development, operational, up to strategical level. Referenced are the case studies within the long-term GEXI project, GISIG framework and Active Source components used in heterogeneous environments. The Collaboration house framework has been created over the last years and is being used for a number of scenarios in research environments, using High End Computing resources. The application of these methods for commercial service structures affords the consideration of various legal, security, and trust aspects. This has already been used by international partners from geosciences, natural sciences, industry, economy, and education though this concept has been found a solution for the component integration and cooperation for information systems, e.g., in natural sciences and archaeology. Nevertheless the different aspects and situations need to be collected in order to provide and disseminate them for wider use. Examples are Envelope Interfaces for geoscientific processing, from advanced scientific computing up to High Performance Computing and Information Systems as well as enabling object security and verification for Integrated Information and Computing Systems.

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INTRODUCTION

Information systems are based on information but as any real world electronic implementation they need computer systems in order to provide their functions and make them widely usable. Many of these implementations have to provide information based on text, image and manyfold multimedia data, views and structures as introduced with information system cognostics (Edwards, 1996; Montello, 1993; Tversky, 1993). Those implementations have been going ahead and providing interactive or complex information for new insight will need increased computing power (The Exascale Report, 2011; Exascale Project, 2012). This is essential for building cognostic components as for example necessary for geocognostics applications, e.g., for geosciences, environmental sciences, for archaeology and cultural heritage information systems and comparable application scenarios. The prominent "Information System" components still completely ignore these advanced aspects and abilities for integration and computing.

From the high level view the system components are tools for gathering advanced cognition. Cognition is not an ability of a system component but the result of the interaction between user and system components. The more these components integrate multidisciplinary aspects the more potential for new insights can be provided.

After decades of isolated system components many application scenarios do need a change in paradigm on how these systems can be build and operated. The basic question "Which parts are needed for building flexible and sustainable systems based in information and computing systems?" is getting in the focus of many disciplines working towards the goal of complex systems, overcoming the development and operational obstacles and legal-technical issues (Rückemann, 2010) with collaboration and implementation. The experiences with real world development and operation of resources has led to three main columns for this goal.

- Resources (hardware, networking, operational services).
- Services (application services, interactive services, batch services).
- Disciplines (algorithms, dynamical components, information systems, databases).

Once building integrated systems, we will have to support these arrangements and leave space for individual concepts necessary for special cases, using a collaboration framework based on the Collaboration house framework (initially with Grid Computing known as Grid-GIS house framework) for operational to strategical level (Figure 1). The Collaboration house implementation based on geosciences, services, and High End Computing gave insight into the employment of scripting languages and source code based persistent object data for enabling the use of computing resources for geoscientific information systems. It enables sole tenants as well as multiple tenants and groups to configure and operate their applications very flexible and to exploit the available resources to their needs. The basic concept of object graphics based on Active Source has been developed within the GISIG actmap project. Dynamical, event based cartography and visualisation using event-triggered databases and using distributed computing resources have been very successfully adopted for different up-to-date use cases (GEXI, 2012). The results and review of the most prominent issues of development and operation and state of the art dynamical integrated systems regarding information systems and disciplines, resources, and computing have been considered (Rückemann, 2011c).

There are various resources and issues interlinked with these implementations. The next sections categorise them for use with modern collaboration frameworks and will give an impression of which complexity we have to think of when discussing complex systems. This chapter compares implementation case studies from natural sciences in order to show the application

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