

ACE GIS Project Overview: Adaptable and Composable E-commerce and Geographic Information Services

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INTRODUCTION

ACE-GIS (Adaptable and Composable E-commerce and Geographic Information Services) is a European project funded under the IST programme, initiated in June 2002 and coming to a close in September 2004. The overall goal of the project is to provide better and more efficient tools for the discovery, development, deployment, and composability (composition) of distributed web services with special emphasis on the key combination of geographical information (GI) and e-commerce (EC) services. The tool platforms provided are intended to be used by web service software developers attempting to create (and bring to market) a novel web service, which they believe would be of interest to a wide range of service users. Secondly, the tools are intended to be used by web service and web application integrators who acquire existing services and attempt to integrate them within a service chain or software composition. ACE-GIS aims at demonstrating composition of web services in practice and to develop tools that support Model Driven Architecture-based creation and composition. The final demonstration is in the form of two plot applications within the fields of environmental assessment and emergency management. This poster presentation illustrates the various parts of the software platforms being created and tested during the third and final phase of the project. Results are to include open software products, on-line conformance tests, and innovations in workflow management and semantic interoperability. Due to space restrictions we will focus here on GI services rather than e-commerce services.

The emerging web services architecture is seen as a means to provide primarily commercial users with more adaptable and reusable software, promising cost reductions, however this also applies to governmental users. Recent experience has shown that implementing web services allows for easier, less costly access to information from the end users' (clients') standpoint, however server-side maintenance costs are still high due to service integration complexity. This paper describes progress made in web service composition, or the creation of service chains aimed at a particular problem area. The problem selected for pilot testing is emergency management, which depends on the rapid integration and exploitation of geographic information.

The ACE-GIS set of tools and service infrastructure will enable:

- developers to efficiently build web-services from scratch, integrate existing services from multiple sources, and compose services to form new value-added compound services;
- service providers to register their services, monitor service use and regulate contracts among users and their service providers; and
- users to efficiently discover, access, configure and use available geographic information and e-commerce services in innovative ways through adaptable applications.

⁶⁴ The co-authors are responsible for dissemination activities of the IST project described in this poster. The technology content of the poster, and of the project, is the result of contributions of the entire consortium, described in more detail at www.acegis.net

ACE-GIS SERVICE INFRASTRUCTURE

The architecture of the ACE-GIS Service Infrastructure is depicted in **Error! Reference source not found.** 1. It is separated into the service creation environment and the service execution environment. The service creation environment provides the service developer with a set of tools for developing his/her Web service or Web application. The tools aid the developer in:

- modelling the service/application in terms of service interfaces, information, workflow, composition and interaction patterns using a UML Design Tool;
- handling composability, adaptability and workflow in services and applications;
- handling semantic information and interoperability;
- transforming models into executable code;
- ensuring that the resulting services and applications conform to international standards.

The services and applications created in the service creation environment are deployed and made available in the service execution environment. Deployment involves making an application or service accessible from the Web that involves announcing it in an open registry. The service execution environment consists of two Web applications, where the first addresses environmental planning and the second emergency management. It consists of two service registries/repositories where one is based on UDDI and the other on ebXML. Finally a number of Web Services are provided that can be grouped into two categories: GI Services and E-commerce Services. The GI services are mainly map image and map object services that adhere to OpenGIS Consortium's Web Map Server (WMS) and Web Feature Server (WFS) interface specifications. Specific geoprocessing services for computing buffers and gas dispersion plumes are being implemented to support the pilot applications. The EC services provided will be a PKI based authentication service and a metered payment service, to allow for government agencies to determine who else within the same government is utilizing their services, when, and in which contexts.

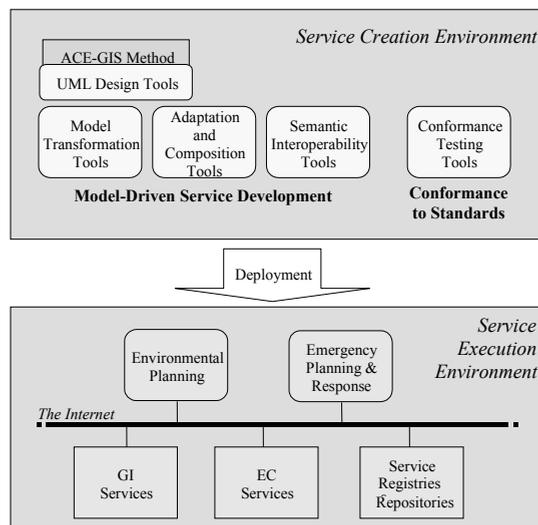


Figure 1: The ACE-GIS Service Infrastructure

SERVICE CREATION ENVIRONMENT

The service creation environment is intended for developers of web services and web applications. This section presents the different tools being made available to developer. Most of these tools are designed to facilitate the use of UML modelling in system development; also, many will become available (or are available) as free software platforms.

Model-Driven Development

The ACE-GIS choice of tools is in line with OMG's Model-Driven Architecture, that is centred around industry-standard UML models. In model-driven development we use models to describe business concerns, user requirements, activities, information structures, components and component interactions. These models govern system development in that they can be transformed to program code. In ACE-GIS we provide tools to automate model transformations for providing specifications for the Web service platform and for composition support. Hence the term model-driven development encompasses both the development of models and tools for code generation.

Model Transformation Tools

Model transformation tools transform models into some kind of code, or vice versa. In ACE-GIS, such tools are developed and collected in (consortium partner) SINTEF's UML Model Transformation Tool (UMT), which is an open-source tool. UMT is being extended to meet ACE-GIS needs such as:

- conversion from information models (UML class diagrams) to Web service descriptions (XML Schema, WSDL)
- import of existing Web service descriptions (XML Schema, WSDL) for the purpose of service composition
- conversion from workflow models (UML activity diagrams) to INESC-ID's workflow description language

UMT enables the developer to create Web service specifications from models and – if necessary – recreate them from updated models.

Adaptation and Composition Tools

Web services need to be adaptable to handle changes in their environment. This means the ability to participate in different compositions and for a composite Web service it means the ability to dynamically handle changes in one of its component services, e.g. changes in interface, payment policy changes, or network problems. In order to build value-added Web services we need to compose existing services into new ones.

The approach in ACE-GIS is to adapt existing workflow technology to the Web Services platform to provide support for adaptation and composition. The workflow management system supports the definition and execution of business processes, where the processes are specified in a composition language to define how services and human activities of the process interact among themselves. The ACE-GIS workflow engine is used to execute workflow instances, to manage workflow definitions and to specify and execute the composition of Web services.

The compositions are modelled by means of UML activity diagrams. The activity diagrams are transformed using UMT to the workflow description language. This language is input to the workflow engine, which can be included in applications in order to aid the users' workflow, composition and adaptability at runtime.

Semantic Interoperability Tools

In ACE-GIS, semantic interoperability tools are intended to help developers find semantically appropriate Web services and use them correctly in service chains. For example, a Web application developer wants to benefit from existing Web services that perform geographical analyses (such as shortest path or buffer

computation). The developer would search for candidate Web services, and decide if the application is able to provide the necessary input and make appropriate use of the output of each candidate Web service.

To facilitate the search for appropriate Web services, the services need to be tagged with concepts that are explained in application ontologies. These concepts describe the meaning of the service operators as well as of the input and output data types. The tagging enables semantic (as opposed to purely syntactic) searches, with some measure of semantic similarity. It should also facilitate appropriate chaining of the services, so that the semantics of the output from a service matches the input semantics required by another. The current means for tagging web services are crude and cannot yet provide this search and chaining capability. They provide largely syntactic descriptions of service parameters. Where they venture into semantics (such as in DAML-S), they do it in a way that is decoupled from the semantic descriptions of data types (despite the apparent link to ontology standards like DAML): the meaning of a service operation can be explained independently of the meaning of the data types that it manipulates, and vice versa, violating a basic principle of object-orientation.

In ACE-GIS we pursue, in contrast, an algebraic approach to semantics that couples service and data semantics very tightly. We place services as well as data types in Semantic Reference Systems from which they receive their tags. These tags can then be exposed through any standard ontology mark-up languages, such as RDF. Semantic Reference Systems, however, go beyond static tagging and searches. They provide the computational means for translating across different semantics, enabling service chains that involve different information communities. Once this is achieved, an important question will be to what extent and how semantically appropriate service chaining can be done automatically.

Conformance Testing Tools

Conformance testing provides a means for determining if an implementation satisfies the requirements and specifications of a standard. Conformance tests capture the technical description of a specification and measure whether a product faithfully implements the specification. To facilitate service composition and adaptability it is important that the component Web services adheres to standard they claim conformance with. ACE-GIS has developed conformance and interoperability testing routines, to be accessed on-line, for testing geographic services against current and proposed OGC standards, which assists developers outside the project in producing conformant services. This includes building test cases from the servers' capabilities document (akin to a WSDL file) to test whether or not the server does what it advertises.

SERVICE EXECUTION ENVIRONMENT

ACE-GIS is developing a service execution environment to demonstrate the efficacy of the methodologies and the tools developed in the service creation environment. The service execution environment will consist of services and applications developed in the service creation environment. Existing services that are developed outside the ACE-GIS project will also be made available in the execution environment. The applications and services provided in the service execution environment are pilot applications, GI Services, EC Services and Service registries/repositories.

Pilot Applications

ACE-GIS is developing two pilot applications to demonstrate the methodologies, concepts, tools and techniques developed in the service development environment: e-Environment pilot, and e-Emergency pilot: Emergency Planning and Response.

The e-Environment pilot is a web-based tool for environmental assessment that is intended to improve the quality and increase the efficiency in the planning and building processes ensuring sustainable environmental development in Norway. Planners and the public can access the pilot. It provides functionality for collecting geographical data from different sources, integrating them and analysing them. The e-Emergency pilot is targeted at dealing with accidents involving toxic gas releases from a

Chemical plant located in the Irish Republic. It consists of a web-based command and control application that can be accessed by fire officers, media officers and members of the public. The fire officers can retrieve pre-Emergency plans, model gas dispersion, and submit emergency reports. The media officers can publish reports targeted at the general public. Farmers can query and a livestock tracking system to see if any of his livestock have been exposed to harmful gases.

GI Services

Geographic information services provide geographic data or processing services in the form of maps or geographic data. Geographic information is an important element integrating many application areas, because nearly all entities have a geographical component - everything happens somewhere - and many services are location-dependent. Better interoperability and integration of geospatial and e-commerce services will enable providers to better deploy and chain their services on the web, more dynamically and at a lower cost. The ACE-GIS architecture includes the following GI products and services:

- Web Map Server (providing background topographic maps and land cover themes)
- Web Feature Server (providing geographic objects with the possibility of querying and updating)
- Web Registry Service (see below)

Additional geo-processing services relevant to ACE-GIS are: buffering (establish a buffer zone around selected geographic objects) and dispersion prediction (of a toxic gas cloud).

EC Services

Electronic commerce services are services catered at supporting the commercial aspects of Web service usage, where security and payment are important concepts. It is an emerging area and many standards have been proposed. The e-Infrastructure for ACE-GIS will support: security based on a PKI implementation, and metered payment services.

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