Composable GIS and E-Commerce Services in Crisis Management Systems – Using the COMBINE MDA Approach

Dr. Arne J. Berre
SINTEF, Oslo, Norway
Interoperable Systems
Phone: (+47) 22 06 74 52
E.mail: Arne.J.Berre@sintef.no

- The COMBINE MDA Approach
- Crisis Management Systems
- ISO/TC211 and OpenGIS Consortium
- ACE-GIS project
- OpenGIS Geospatial Objects (GO-1) Initiative
- PIM Models for services – mapping to XML and web services
- Conclusion – The MDA approach is recommended + need for further work
The European project ACE-GIS (Adaptable and Composable GIS and E-Commerce services) addresses a Model Driven Architecture approach to the specification and development of semantic interoperable services for Crisis Management and Environmental planning systems. The methodology and tool-support for service-oriented architecture specification is provided by the COMBINE project (Component-Based Interoperable Enterprise system development), with enhancements for model-based composition, using UML activity diagrams and mappings to BPEL4WS/BPML. The underlying standard services are based on the OGC Open Web Services for GIS components, and on a Web service infrastructure with extended ebXML Registry/Repository support.

COMBINE Component Centre

Product Line 1

Planning Group

System Development Organization

Project A

Project B

Project C

Development Process

Dev-time Environment

Repository

Test Environment

COTS Products

Production Facility

Architecture Organization

Patterns, Frameworks, Definitions, Structures, Process

App D

App E

Run-time Environment

COTS Products
COMBINE Framework for Production Facility

Integrated Environment

- **Modeling tool**
  Models profiles, business, requirements, architecture, platform

- **Model transformation**
  Define and execute transformations, code generation

- **Program tool**
  Engineer & build component code

- **Comp. Validator**

- **Repository interface**
  Repository & Process CC description

- **Process Support**
  Web-based

- **IDE**

- **XMI/OBJ**

- **XMI/Code**

- **Code**

- **XMI**

- **HTML**

- **IRep**

- **IBrow**

Enterprise Repository

- **Documentation**

- **Component specifications**

- **Components implementations**

Execution Environment

- Runtime components. Workflow support

Workflow support

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Component Centre Parts

Integrated Environment

- **Objecteering (Softeam)**
  Models profiles, business, requirements, architecture, platform

- **UMT (SINTEF)**
  Define and execute transformations, code generation

- **Eclipse Program IDE**
  Engineer & build component code (OpenSource)

- **Comp. Validator (Open Group)**

- **Repository Web interface (Adaptive)**

- **Process Support Web-based (OpenIT)**

- **ECLIPSE IDE (OpenSource)**

- **XMI/OBJ**

- **XMI/Code**

- **Code**

- **XMI**

- **HTML**

- **IRep**

- **IBrow**

- **IRep**

- **IBrow**

- **Prog**

- **WFXML**

- **J2EE JBOSS Execution Env.**
  Runtime components. (OpenSource)

- **Micro-Workflow Engine (INESC)**

Enterprise Repository (Adaptive)

- **Documentation**

- **Component specifications**

- **Components implementations**
COMBINE MDA Approach

Modelling Toolset
- HUTN Editor Business Modeller
- HUTN Editor Requirements Modeller
- HUTN Editor Architecture Modeller
- HUTN Editor Platform Modeller
- Profile Modeller

Models
- Business Models
- Requirement models
- Architecture models
- Platform models (J2EE&WebS)
- UML Profiles

Model mappings
- BM-Req-Arch Mapping
- Req-Arch Mapping
- Arch-Platform Mapping
- Component Generation

Tool-dependent and independent (XMI) representation, Intra/Internet -accessible

Reusable Asset Manager

Enterprise Repository
- UML Model
- SW Component
- Document

Project & Enterprise Repositories

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COMBINE Component types

- User interface
- User Service
- Business Service
- Resource Service

Legacy

Component Infrastructure
From UML models to Workflow composition
UML Model Transformation tool

XMI $\rightarrow$ XMI

code generation

model transformations
Problem Goal: Transparent Access to Heterogeneous Geodata and Geoprocessing Services
The Geospatial Community interoperability vision

Individuals, organizations, and systems of all user agencies (Federal, state, local, NGOs, etc.) participating in the Homeland Security Information System

Tools, services, etc. offered by any participating agency for the use of all. Hosting, support, etc., to be provided by the offering agency or by a commercial service under contract. A distributed, virtual environment.

Resources offered by any participating agency or available from commercial providers under contract. Can range from a simple data server to a complete legacy system that provides needed information.
ISO/TC211 & OGC – “Standard services”

ISO/TC211 Stds

CEN/TC287 (Europe) ISO/TC211 established UML Adopted
ISO 19103 ISO 19109 ISO 19118 ISO 19119 ISO 191XX ISO 19135


Simple Features Catalog Grid Web Map GML Coordinate Transformation
Adopted Adopted Adopted Adopted Paper Adopted Adopted

OGC Specifications

GFS Gazetteer WFS, WCS GeoLink, LOF Geoparse, Geocode GML XML Schema Thesaurus Type Dictionary
WMS-2 Legend, Style Sheet & S.S.Catalog SLD, Symbol Library GML Extensions: IML, Coverage, Basic Service Model Filter
OpenGIS Web Services

Symbols

Abstract Service
Service
Operation
Generalization

GetCapabilities
OGC Web Service

Web Registry Service
GetDescriptor
RegisterService

Web Map Service
GetMap
GetFeatureInfo

Web Feature Service
GetFeature
DescribeFeatureType

Web Coverage Service
GetCoverage

Styled Layer Descriptor WMS
DescribeLayer

Transaction WFS
LockFeature
Transaction

GeoCoder Service
GeocodeFeature
Starting point:
Dynamic search in registry and binding to services
Composition extension

Select a Service Type

Add a new Service

Use Service in a Chain

Use Chain as a new Service
ACE-GIS Principal Architecture

Service Creation Environment

Model-driven Development Tools

Model Transformation Tools

Conformance Testing Tools

Semantic Interoperability Tools

Adaptation and Composition Tools

Deployment

Service Execution Environment

Applications

GI Services

EC Services

Service Registry Repository

Composition Services
ACCE-GIS Service creation

UML Graphical notation
- FlowComposition
- Service model
- Information model

XMl-representation
- FlowComposition
- Service model
- Information model

MDA PIM
Platfrom Independent Model
In XMI

Flow Composition tool

Registry & Repository
Catalogue & Services

UML Graphical notation

MDA PSM
Platform Specific Model:
Web Services, ebXML, J2EE/EJB, ...

Semantic Interoperability mapper tool

Conformance Testing tool

Service Infrastructure
- GI Services
- EC Services
- Standard Registry Repository
- Composition Services

Existing application

Model mapper

New Application & service

Service interface

FlowComposition model
(ws:WSFL +)

Service model
(ws:WSDL +)

Information model
(WSDL/XSD)

UMT Transformation Toolkit

UML tool
ACE-GIS Service execution

Pilot 1 a/b application Services
- Web Map Integration Viewer
- Environmental Impact Analysis Service (EAIS)
- Dispersion Modelling Service (DMS)
- Risk Identification Service (RIES)
- Movement Restriction Service (MRS)
- Relocation & Evacuation Service (RES)
- Emergency Quality of Services (EQOS)

EC Services
- Application Personalisation / Authentication Services (APAS)
- e-Payment Services (EPS)
- PKI Certificate Services (PCS)
- Trusted Third Party Services (TTS)
- PKI Signature Services (PSS)

GI Services
- Web Mapping Server (WMS)
- Web Feature Server (WFS)
- Web Coverage Server (WCS)
- Web Terrain Server (WTS)
- Portrayal Engine (PE)
- Location Based Services (LBS)

Core services
- Micro Workflow Composition Services (MWS)
- Service Binding Template interpreter (SBT)
- Semantic Ontology Mapping Services (SMS)

Adaptability & Composition Services (ACES)

Provider Registry & Repository Catalogue & Services (PRC)
ACE-GIS Crisis Management Pilot Demonstrator

Command & Control Client

<<Service>> Pre-Emergency Plans

<<Service>> Chemical

<<Service>> Weather

<<Service>> Command & Control

<<Service>> WFS-Transaction

<<Service>> Gas Dispersion

<<Service>> WMS-Basic

<<Service>> Eurovet-Restriction

<<Service>> e-Payment

<<Service>> Administration

<<Service>> Report

<<Service>> Roles
• Develop a set of standard objects for the development of applications using geographic data
• Develop an architecture for distributed geographic processing that is independent of the implementation platform
• Develop processes to generate implementation platform specific profiles of the abstract architecture
• Validate that the architecture and profiling processes can be used to create working implementations
• *Trying out MDA principles for Web services and Java*
GeoTools2: WMS
OGC Web Feature Server - A web service

Client Applications

Internet

1. GetCapabilities
2. Capabilities document
3. DescribeFeatureType
4. FeatureTypeDescription document (GML Schema)
5. GetFeature
6. Feature Instance (GML Document)

Web Feature Server Interface

Web Feature Server Implementation
Use of COMBINE UMT tool - XSLT-based code generation from UML to GML for data exchange

ISO 19109, ISO 19103

1. Application Schema (UML)
2. UML Tool
3. XMI doc of UML Model
4. simpleXMI doc of UML Model
5. XSLT-file1
6. XSLT-file2
7. XML Schema according to GML 2.0

Document
Data transfer
Process

The conceptual UML model may be mapped to many technologies:

Java, ebXML, CORBA
ISO/TC 211 Conceptual UML model

CityMember

Road
- classification : CharacterString
- number : CharacterString
- linearGeometry : GM_Curve

River
- centerLineOf : GM_Curve

CityModel
- dateCreated : Date

Mountain
- elevation : Integer

+cityMember
0..*
Extract from the GML2.0 spec.
city application schema example

```xml
<complexType name="RiverType">
    <complexContent>
        <extension base="gml:AbstractFeatureType">
            <sequence>
                <element ref="gml:centerLineOf"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>

<complexType name="RoadType">
    <complexContent>
        <extension base="gml:AbstractFeatureType">
            <sequence>
                <element name="linearGeometry" type="gml:LineStringPropertyType"/>
                <element name="classification" type="string"/>
                <element name="number" type="string"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>
```
SimpleXMI - reducing the complexity of XMI

```xml
<class name="Road" superClass="CityFeature" abstract="false">
    <attribute name="classification" type="CharacterString"/>
    <attribute name="number" type="CharacterString"/>
    <attribute name="linearGeometry" type="GM_Curve"/>
</class>

<class name="River" superClass="CityFeature" abstract="false">
    <attribute name="centerLineOf" type="GM_Curve"/>
</class>

<class name="CityModel" abstract="false">
    <attribute name="dateCreated" type="Date"/>
    <relationship name="cityMember" otherClass="CityFeature"
        cardinality="0..*" collectionType="set"
        aggregationType="composite"/>
</class>
```
Advantages with a model-driven approach

- Always up-to-date UML models documenting the underlying platform realisations
- Easier to read and understand UML models than XML Schema
- Technology changes, conceptual models stay the same
- The same UML model may be used to generate multiple output formats (ISO 19118, GML, XMI, Web Services, CORBA, ebXML, DCOM, J2EE, C++...)

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Conclusion

The OMG MDA approach is suitable for the specification of services and information models for multiple platforms, including web services

- *Tool and methodology support is emerging (ref. COMBINE ++)*
- *Further needs:*
  - Well defined rules and tools for creating platform-independent service and information models
  - Well defined rules and tools for mappings to platform-specific models for the most important platforms: Web services/XML, CORBA, J2EE/EJB, SQL, ...
  - A version of XMI (2.0?) that can produce human readable (HUTN) XML – similar to the handcreated XML schema specifications currently being made – (necessary to be accepted in the ”XML” communities)
  - A tool-independent model diagram interchange format that can be used to support interoperability between multiple UML tools (the diagram interchange RFP! + more consistent XMI implementations)
  - Composable security services – to support composable Crisis management and GI services