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
Abstract

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.

See: www.opengroup.org/combine, www.agegis.net,
Product Line 1

Architecture Organization
- Patterns, Frameworks, Definitions, Structures, Processes
- Development Process

System Development Organization
- Project A
- Project B
- Project C

Planning Group

Run-time Environment
- App D
- App E

COTS Products

Production Facility
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

- **Enterprise Repository**
  - Documentation
  - Component specifications
  - Components implementations

- **Execution Environment**
  - Runtime components. Workflow support

- **Workflow support**

- **IDE**
  - XMI/OBJ
  - XMI/Code
  - Code
  - XMI
  - HTML

- **Tools**
  - IRep
  - IBrow
  - Prog
  - WFXML

SINTEF
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**

- **Prog**

- **WFXML**

**Enterprise Repository (Adaptive)**

- **Documentation**

- **Component specifications**

- **Components implementations**

**J2EE JBOSS Execution Env.**

- Runtime components (OpenSource)

**Micro-Workflow Engine (INESC)**
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

Project & Enterprise Repositories

- Reusable Asset Manager
- Enterprise Repository
  - UML Model
  - SW Component
  - Document

Tool-dependent and independent (XMI) representation, Intra/Internet-accessible
COMBINE Component types
UML Model Transformation tool

XMI $\rightarrow$ XMI

code generation

model transformations
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 19109  ISO 19119  ISO 191XX  ISO 19135


ISO/TC211 Stds


ISO 19103
ISO 19118
ISO 19109
ISO 19119
ISO 191XX
ISO 19135

OGC Specifications

Simple Features  Catalog Services  Grid Coverages  Web Map  GML  Coordinate Transformation  Coordinate System
Adopted  Adopted  Adopted  Adopted  Paper Adopted  Adopted

GFS  Gazetteer  WFS, WCS  GeoLink, LOF  Geoparse, Geocode  GML XML Schema  Thesaurus  Type Dictionary
Adopted  Adopted  Adopted  Adopted  Adopted  Adopted  Adopted  Adopted

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
- Conformance Testing Tools
- Semantic Interoperability Tools
- Adaptation and Composition Tools

Deployment

Service Execution Environment

- Applications
- GI Services
- EC Services
- Service Registry Repository
- Composition Services
ACE-GIS Work areas and partners

Demonstrators

- Environmental pilot
- Emergency pilot

Commercial services

- GI services
- EC services

Open source

- Composition services
- Model-driven tools

Underlying framework

- Semantic interoperability
- Standards and testing

INESC
- NMA
- e-blana

IONIC Software

UoM

UJI

SINTEF
ACE-GIS Service creation

Service Creation Environment

UML Graphical notation
FlowComposition
Service model
Information model

XML-representation
FlowComposition
Service model
Information model

MDA PIM
Platform Independent Model
In XMI

Flow Composition tool

Registry & Repository
Catalogue & Services

Semantic Interoperability
mapper tool

Conformance Testing tool

UMT Transformation Toolkit

FlowComposition model
(ws:WSFL +)

Service model
(ws:WSDL +)

Information model
(WSDL/XSD)

Existing application

Model mapper

New Application & service
Service interface

Service Infrastructure

GI Services
EC Services
Standard Registry Repository
Composition Services

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

UML tool

Information model
Service model
FlowComposition

Transformation

ACE-GIS Crisis Management Pilot Demonstrator

- Command & Control Client
- Pre-Emergency Plans
- Chemical
- Weather
- Command & Control
- WFS-Transaction
- Gas Dispersion
- WMS-Basic
- Eurovet-Restriction
- e-Payment
- Administration
- Report
- 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
OGC GO-1 Architecture
Computational View - Service Framework

Mission Applications
- Mission Planning
- Cross-Country Mobility
- Situational Awareness
- Air Defense
- Logistics
- Others

Application Platform
- GIS
- Portal
- Other

Encodings
- GML
- SLD
- XIMA
- SensorML
- Filter
- Service Metadata

Data Services
- FAS
- CAS
- FAS-T
- SCS
- GAZ

Portrayal Services
- MPS
- CPS
- SMS

Registry Services
- Data Registry
- Service Registry
- Sensor Registry

Processing Services
- SPS
- CTS

= OGC/IP Interface
GeoTools2: WMS
OGC Web Feature Server - A web service

Client Applications

2. Capabilities document

4. FeatureTypeDescription document (GML Schema)

6. Feature Instance (GML Document)

1. GetCapabilities

3. DescribeFeatureType

5. GetFeature

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
+cityMember
0..*

Road
classification : CharacterString
number : CharacterString
linearGeometry : GM_Curve

River
centerLineOf : GM_Curve

CityModel
dateCreated : Date

Mountain
elevation : Integer
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++...)
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