

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



www.isotc211.org

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

Open GIS Consortium
..... *Spatial connectivity*
for a changing world.

www.opengis.org

- 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,
www.omg.org/mda, www.opengis.org

COMBINE Component Centre

Product Line 1

Planning Group

Architecture
Organization

System Development Organization

Project A

Project C

Project B

Patterns,
Frameworks,
Definitions,
Structures
Process

Development
Process

Dev-time
Environment

Repository

Test
Environment

COTS Products

Production Facility

App D

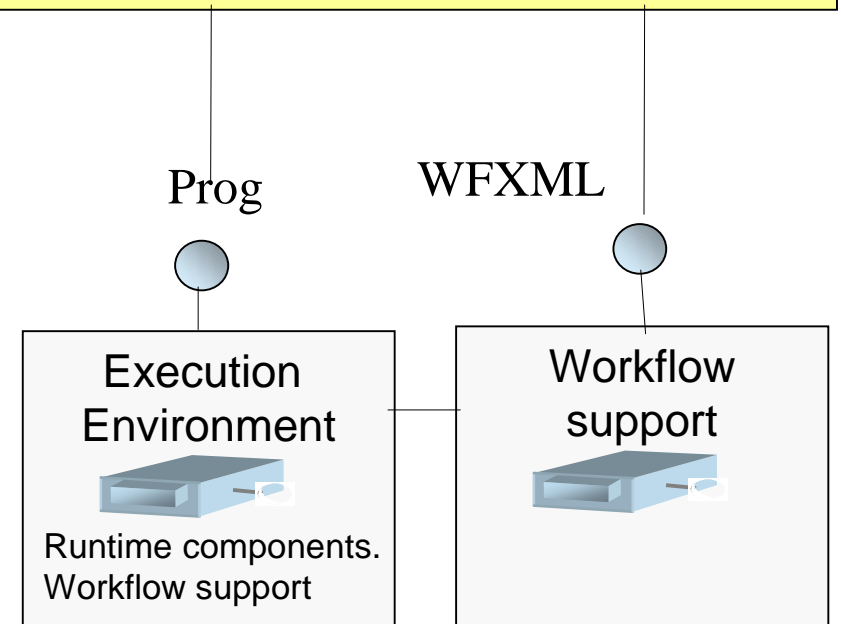
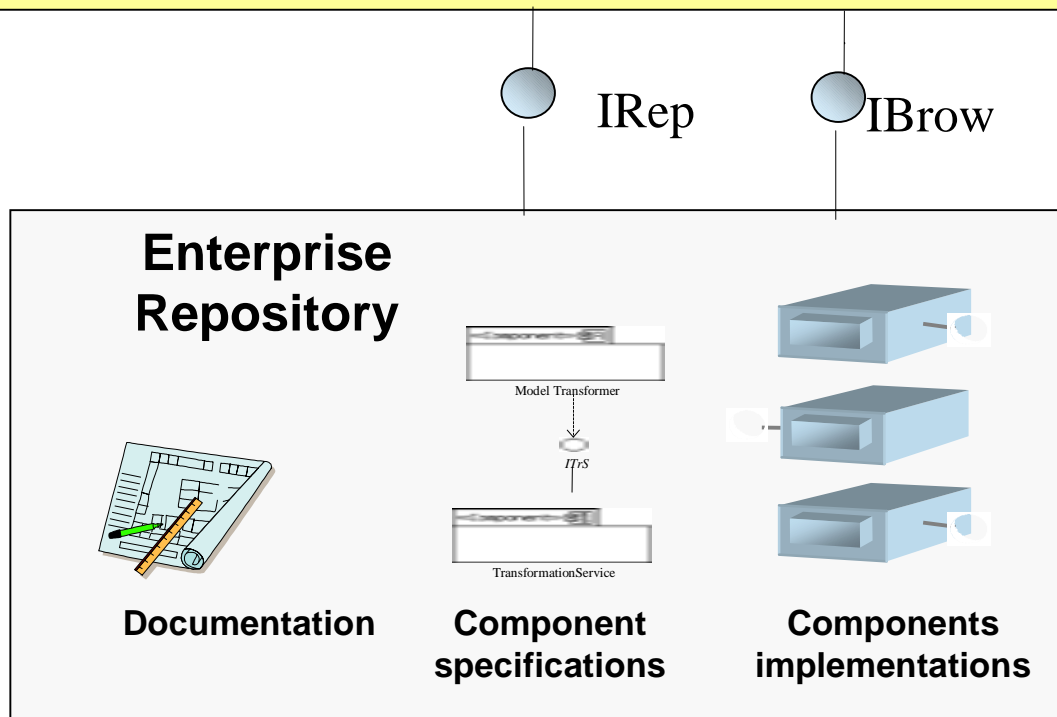
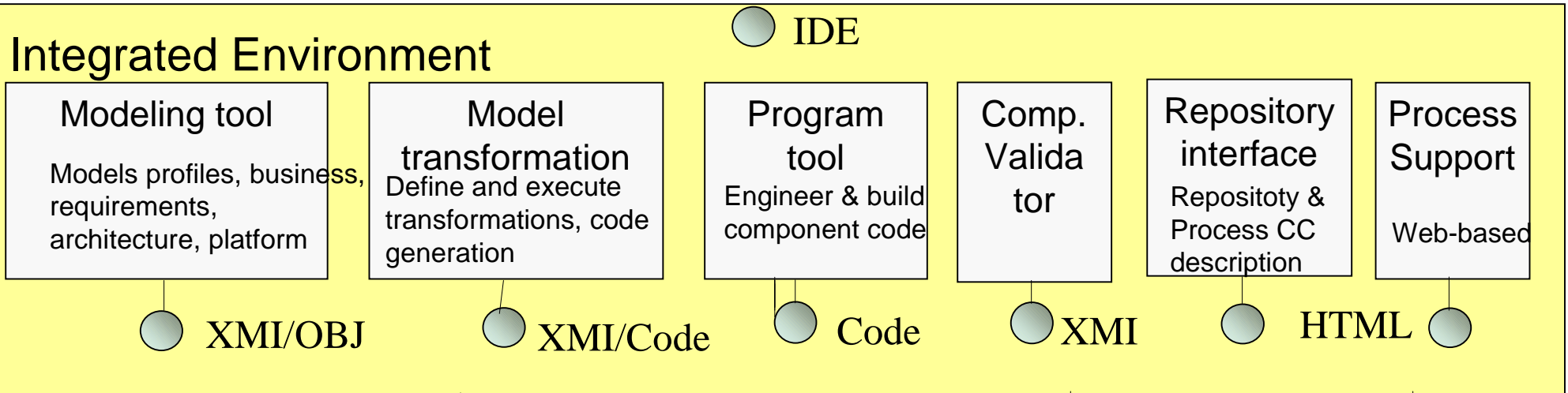
App E

Run-time
Environment

COTS
Products

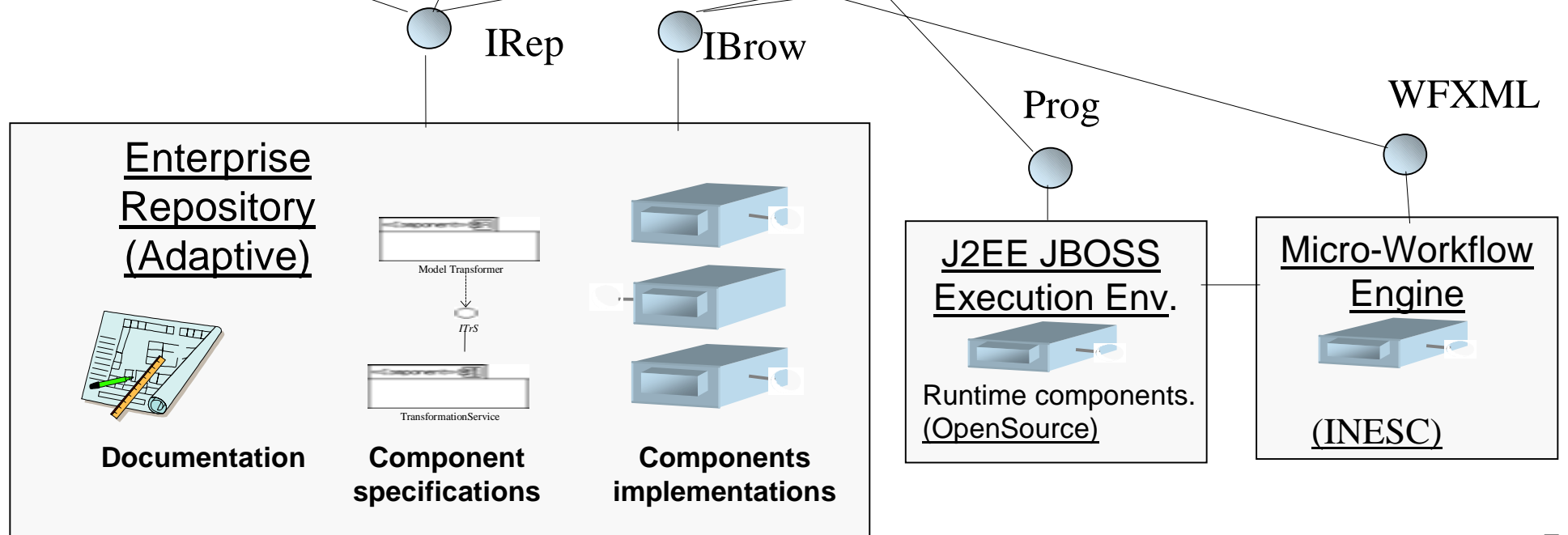
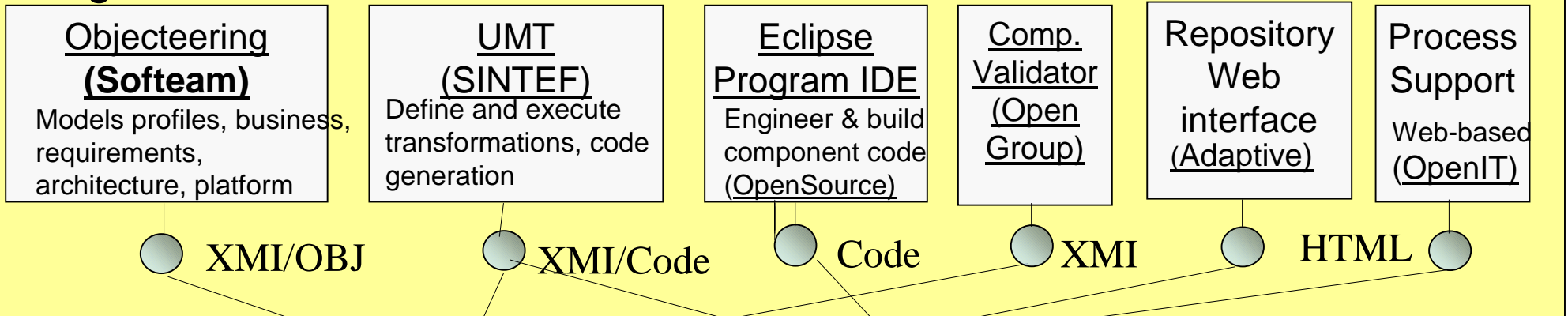
COMBINE Framework for Production Facility

Integrated Environment

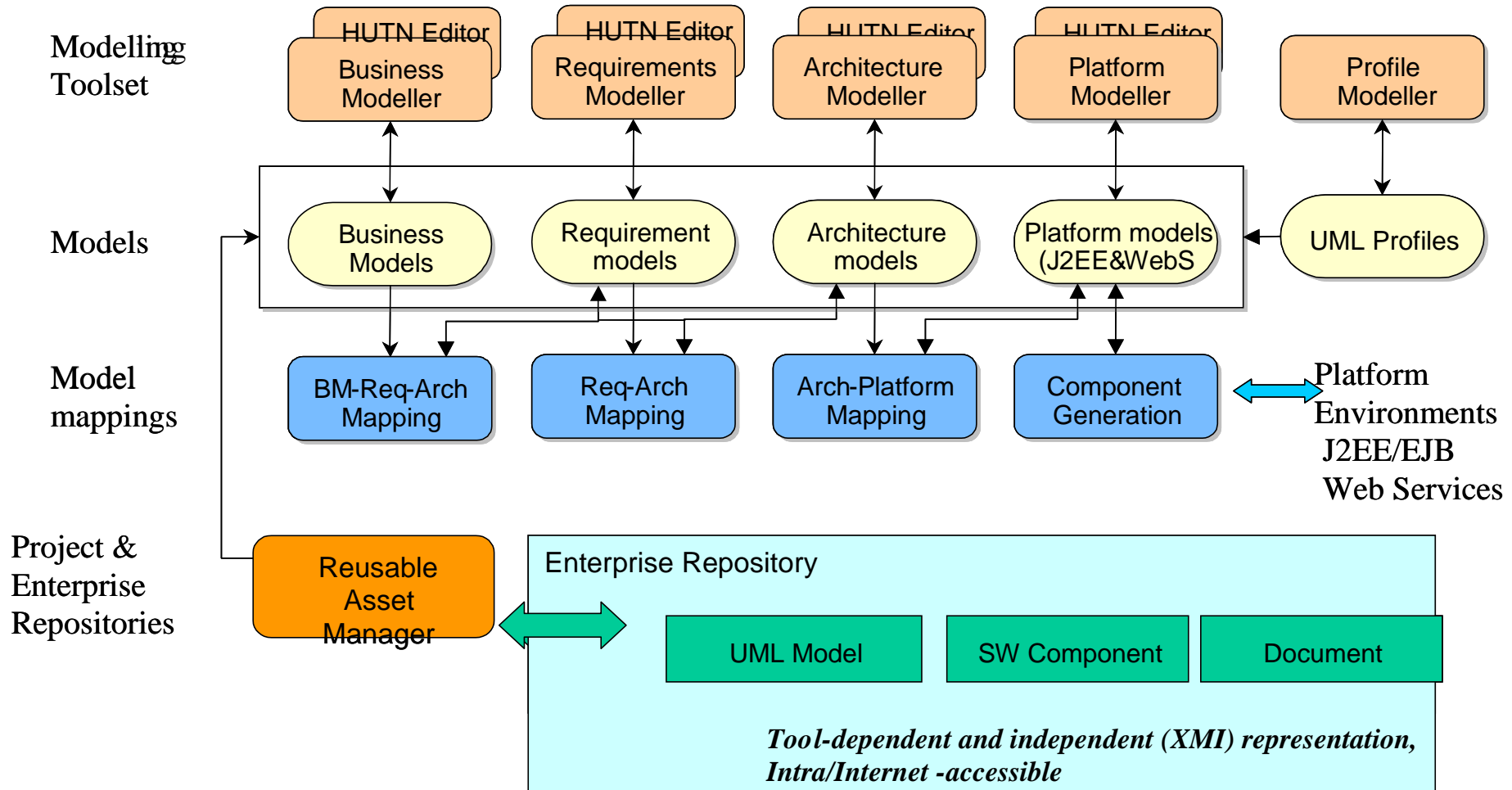


Component Centre Parts

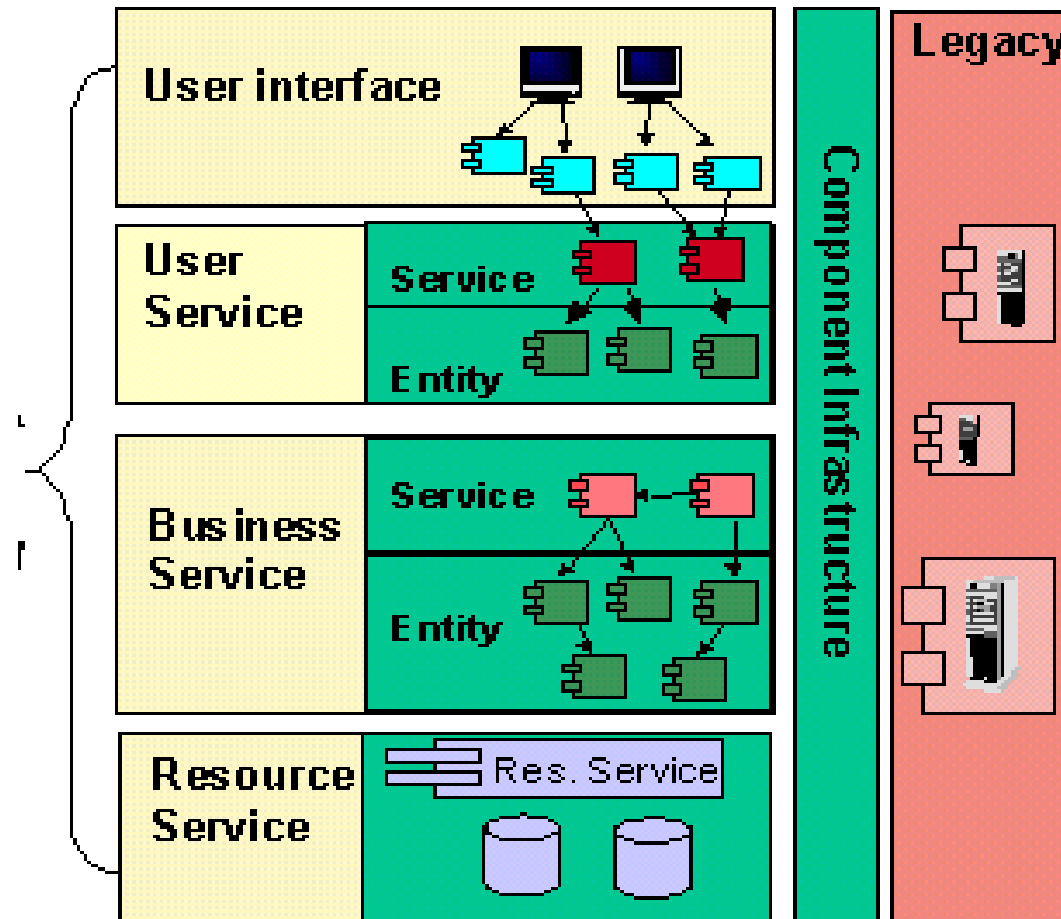
Integrated Environment



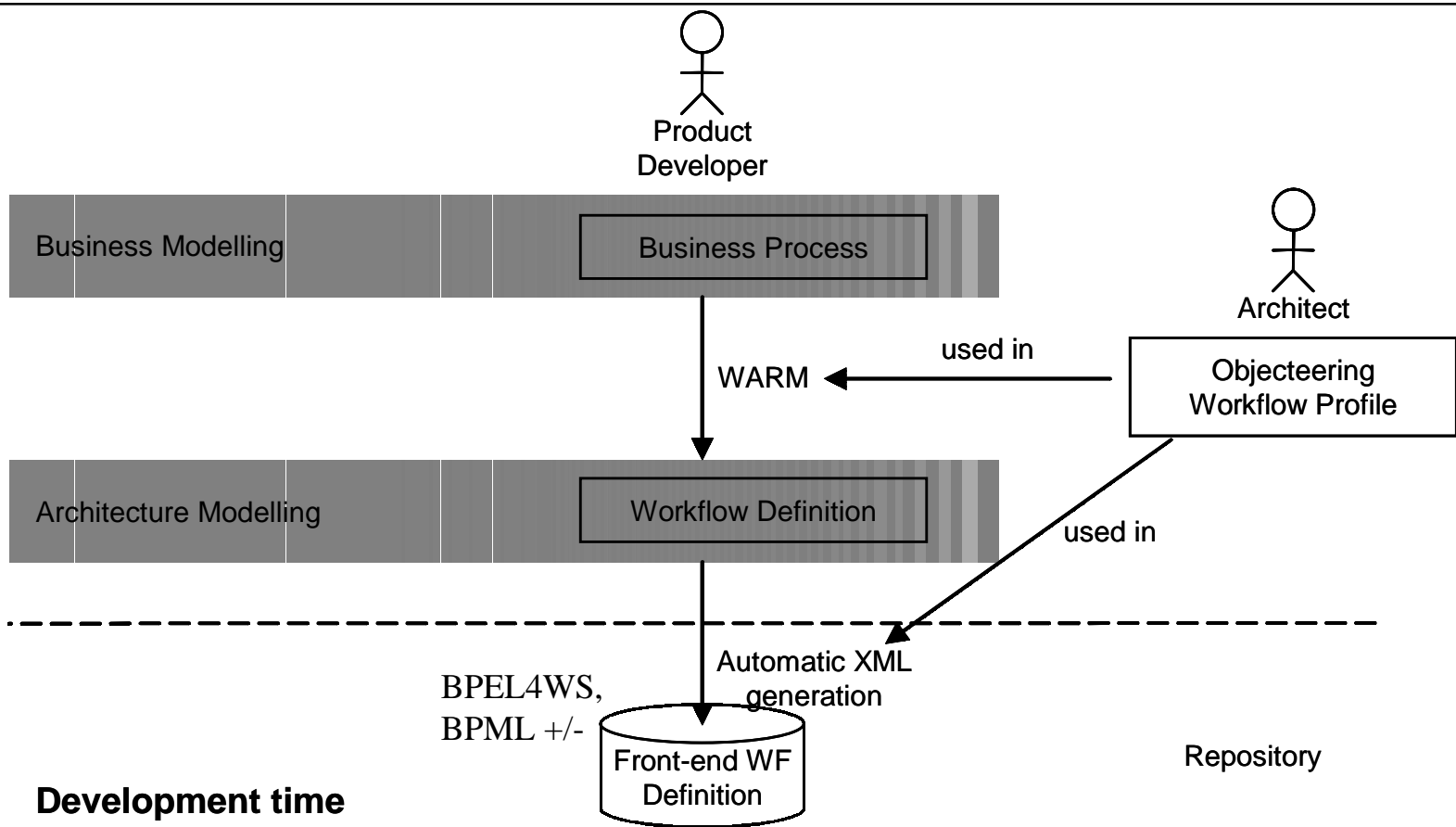
COMBINE MDA Approach



COMBINE Component types

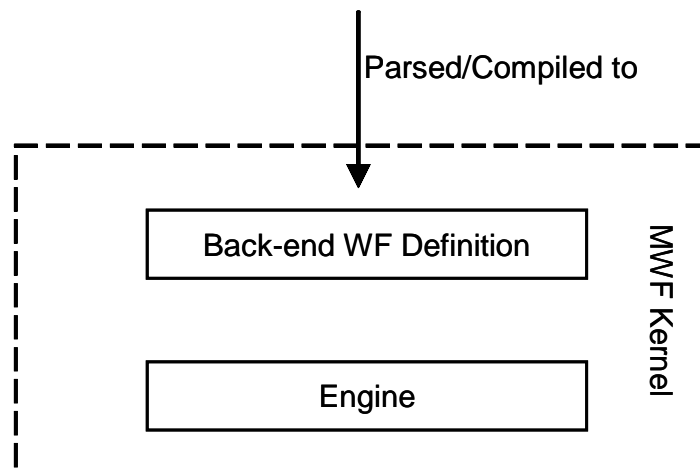


COMBINE Component Architecture



Development time

Run time



**From UML
models to
Workflow/
composition**

UML Class Diagram:

```
classDiagram
    class BookingService
    class BookingServiceNotification
    class File
    class Category
    class Properties
    class BookingServiceAbstract
    class ScheduleModel
    class ActivityInfo

    BookingService "0..1" -- "0..1" File : dbFileHandle
    BookingService "0..1" -- "0..1" Category : logger
    BookingServiceNotification "0..1" -- "0..1" Category : logger
    BookingServiceNotification "0..1" -- "0..1" Properties : serviceProps
    BookingServiceAbstract "0..1" -- "0..1" ScheduleModel : scheduleModel
    BookingServiceAbstract "0..1" -- "0..1" ActivityInfo : notify
    BookingServiceAbstract "0..1" -- "0..1" ActivityInfo : database
```

Project Hierarchy (Left Sidebar):

- COMBINE Pilot
 - mainline
 - surveyBooking
 - com
 - server
 - bookingService
 - BookingService
 - BookingServiceAbstract
 - BookingServiceClientTest
 - BookingServiceNotification
 - FromFile

Source Code (Bottom Pane):

```
BookingService.java
BookingService.java
activityInfo.IActivityInfo db = null;

handleLogging(INFO, "Database reloaded.", null);
db = new activityInfo.ascii.ActivityInfoFileImpl();
// db = new activityInfo.ascii.ActivityInfoFileImpl
// ( dbDirectory, "server_db_sch");

// NB! when change to CoaBase, abortTransaction must be rewritten
// db = new activityInfo.cb.ActivityInfoImpl("/net/consys/prs/surveyBooking_data");

return db;
}

private java.io.File dbFileHandle;

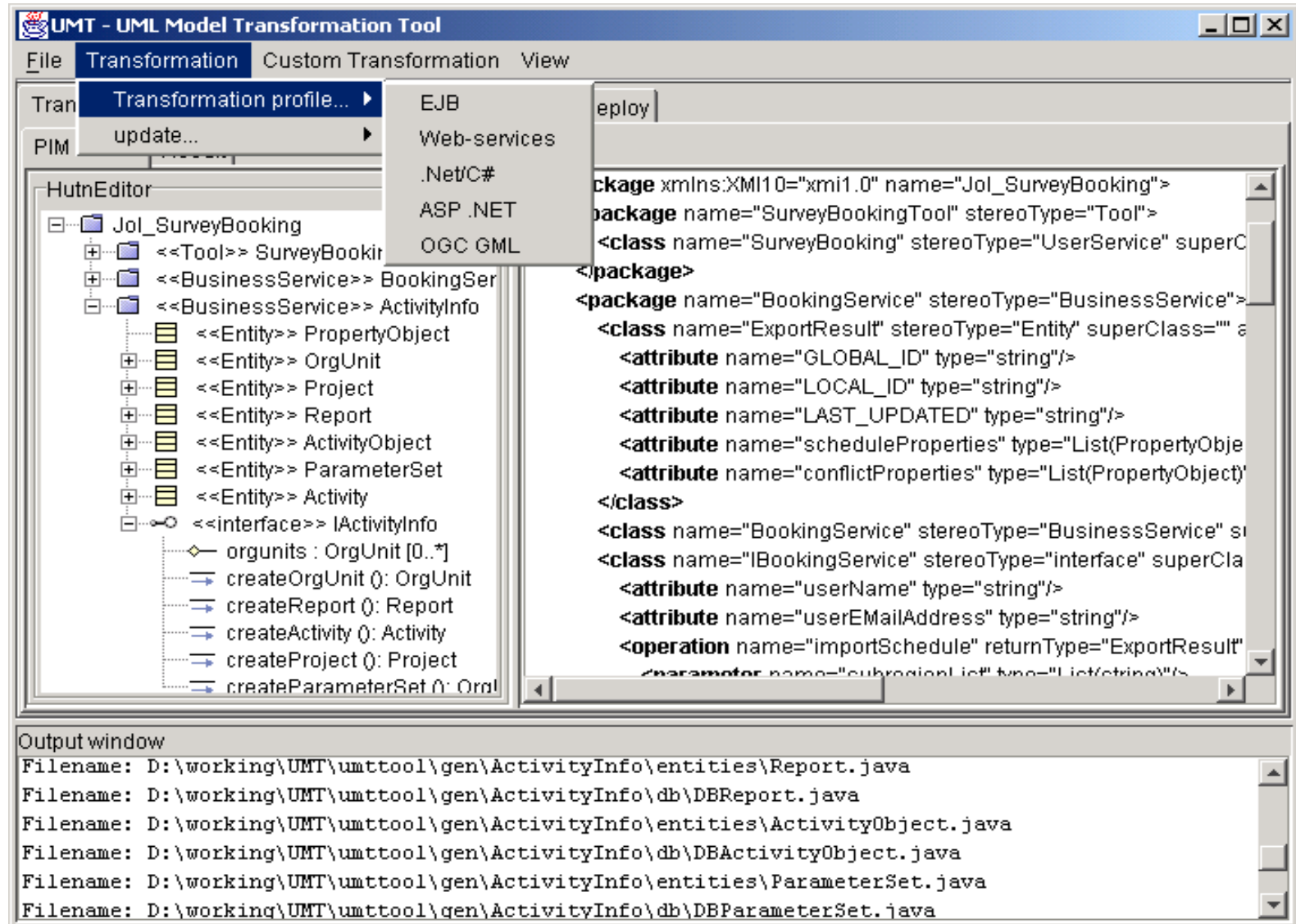
protected boolean beginTransaction (activityInfo.IActivityInfo _database, activityInfo.TransactionType _tr
{
```

UML Model Transformation tool

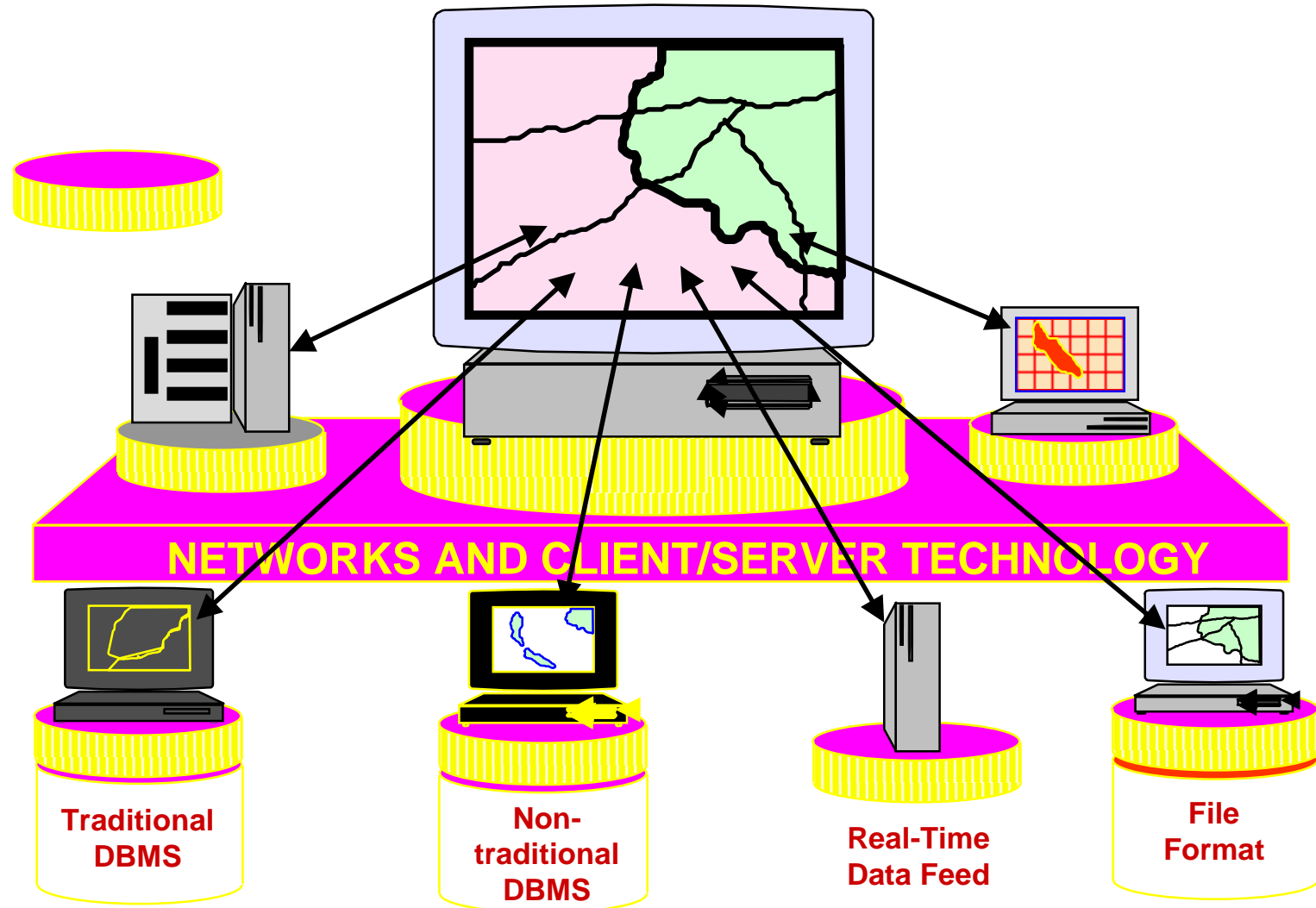
XMI →
← XMI

code generation

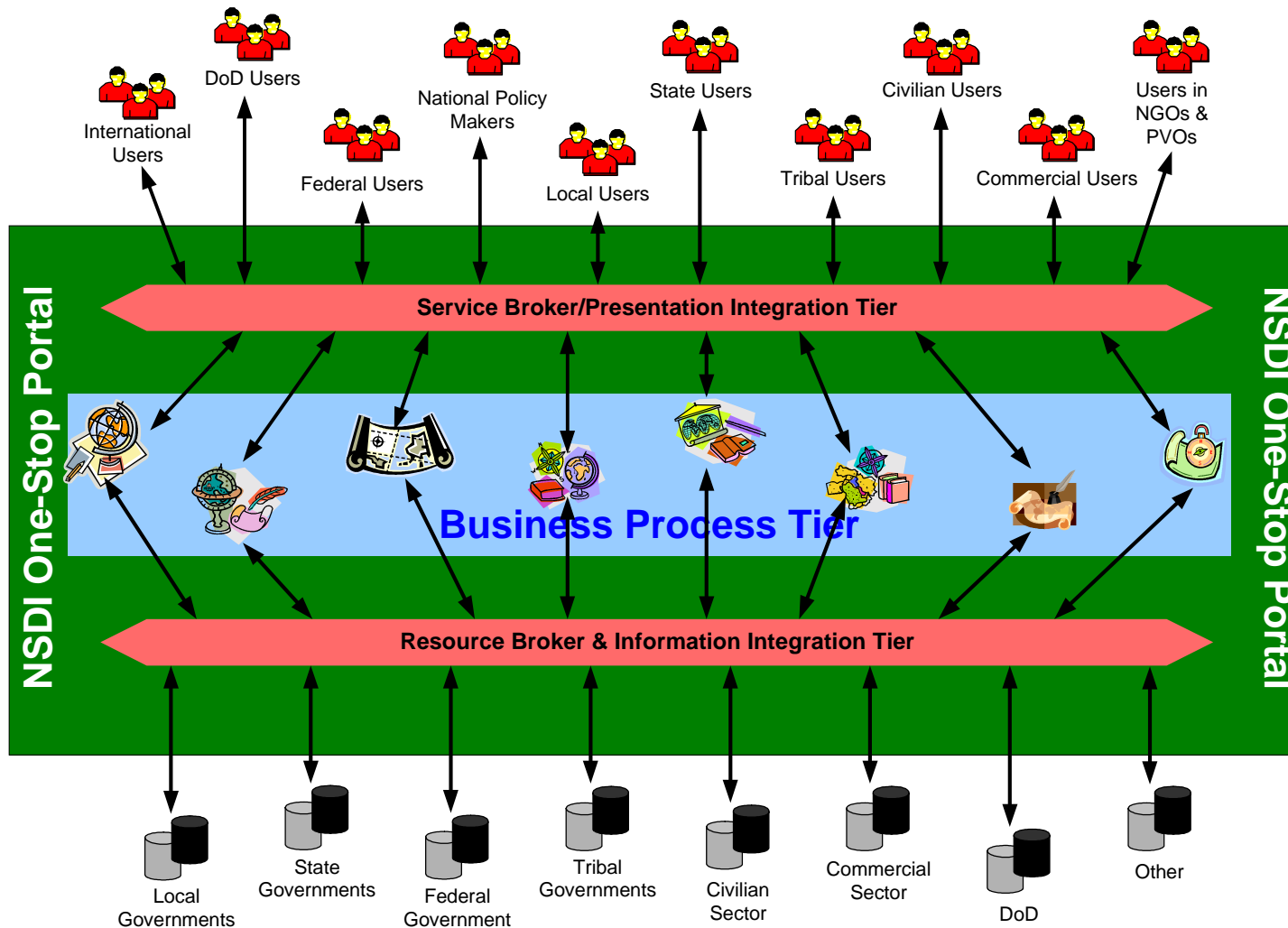
model
transformations



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.

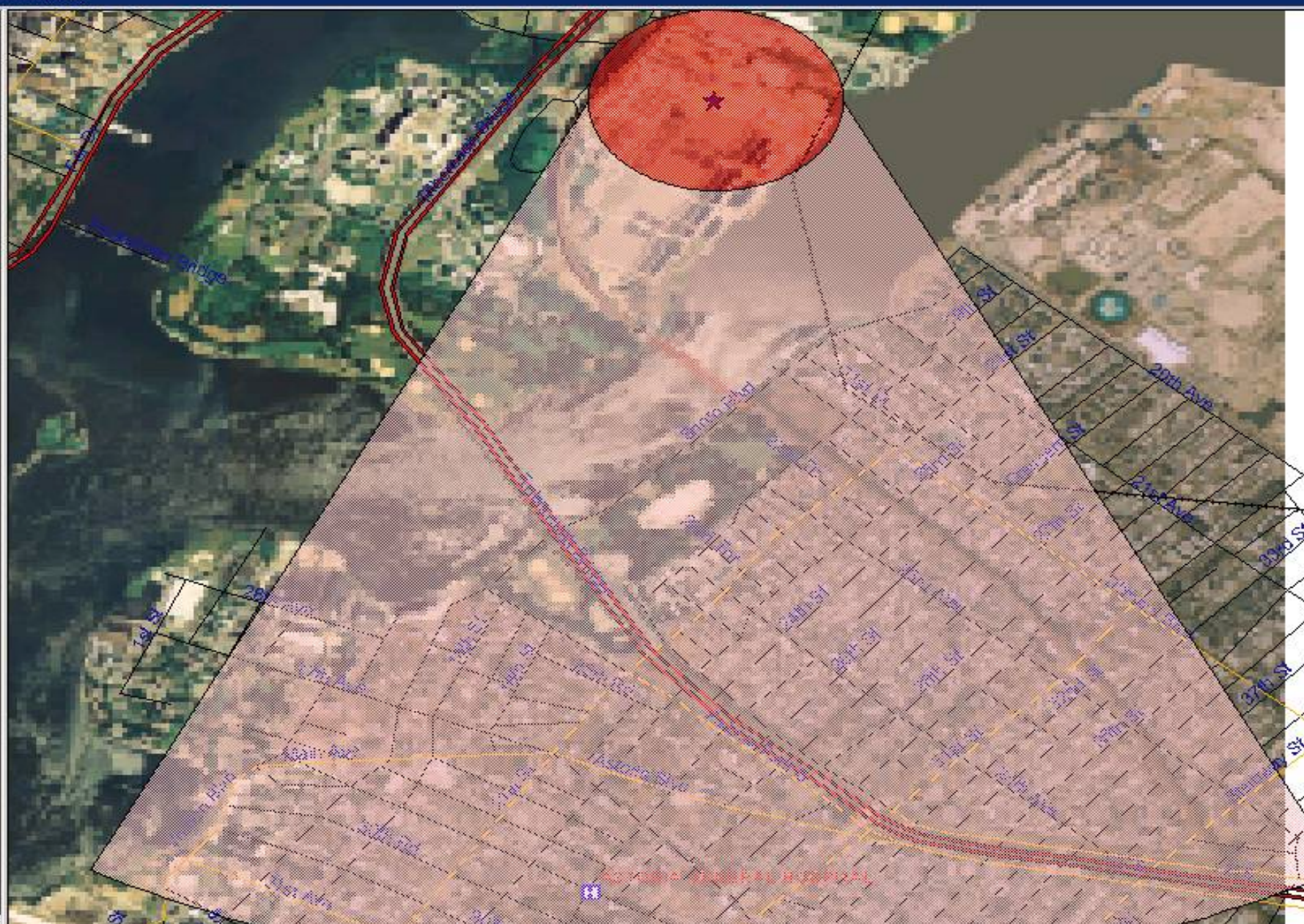
Resources offered by any participating agency or available from commercial providers under contract. Can range from a simple data server to a complete legacy system that provides needed information.



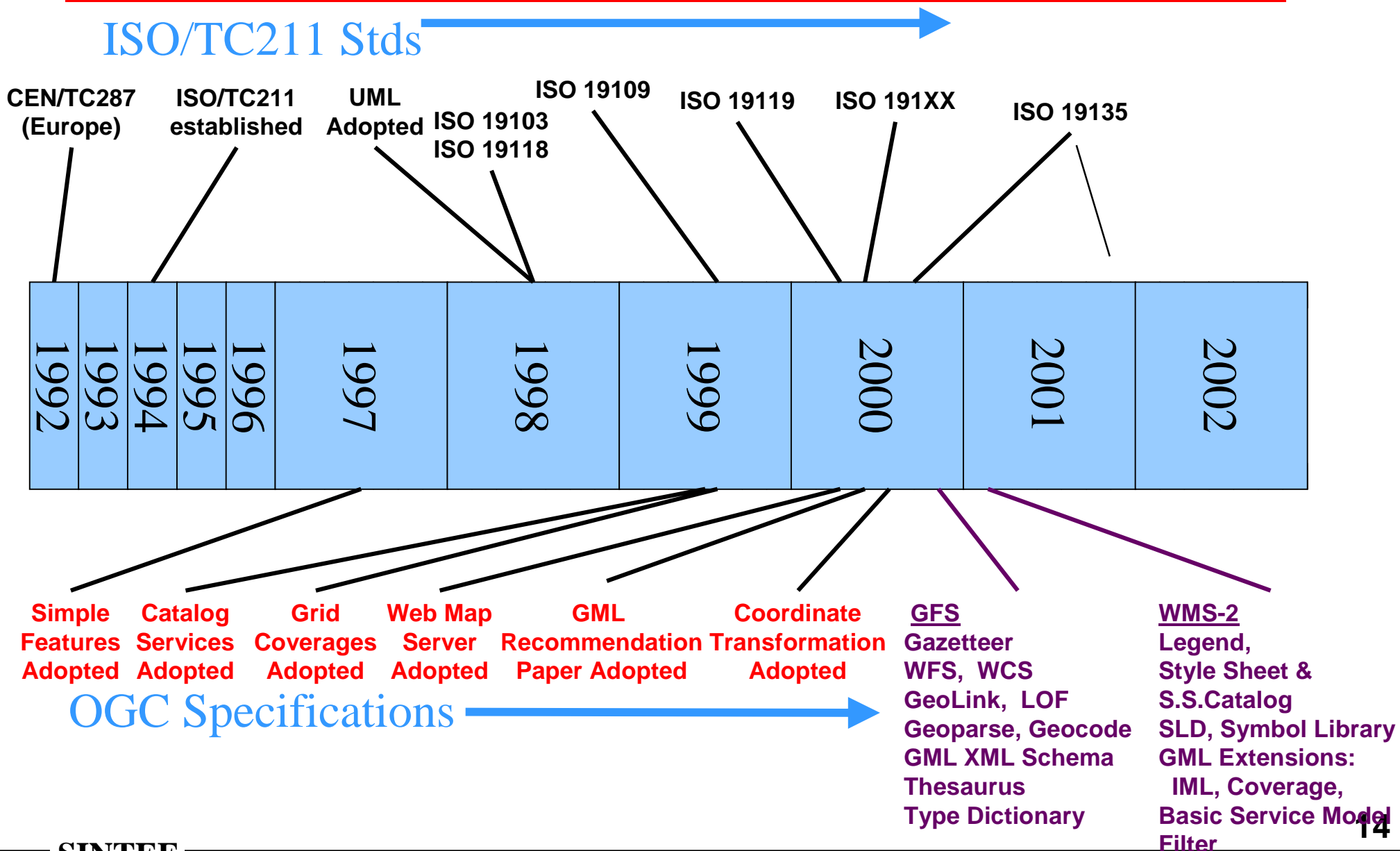
Scale 1:17,459

CATS Analysis View 1.00000000

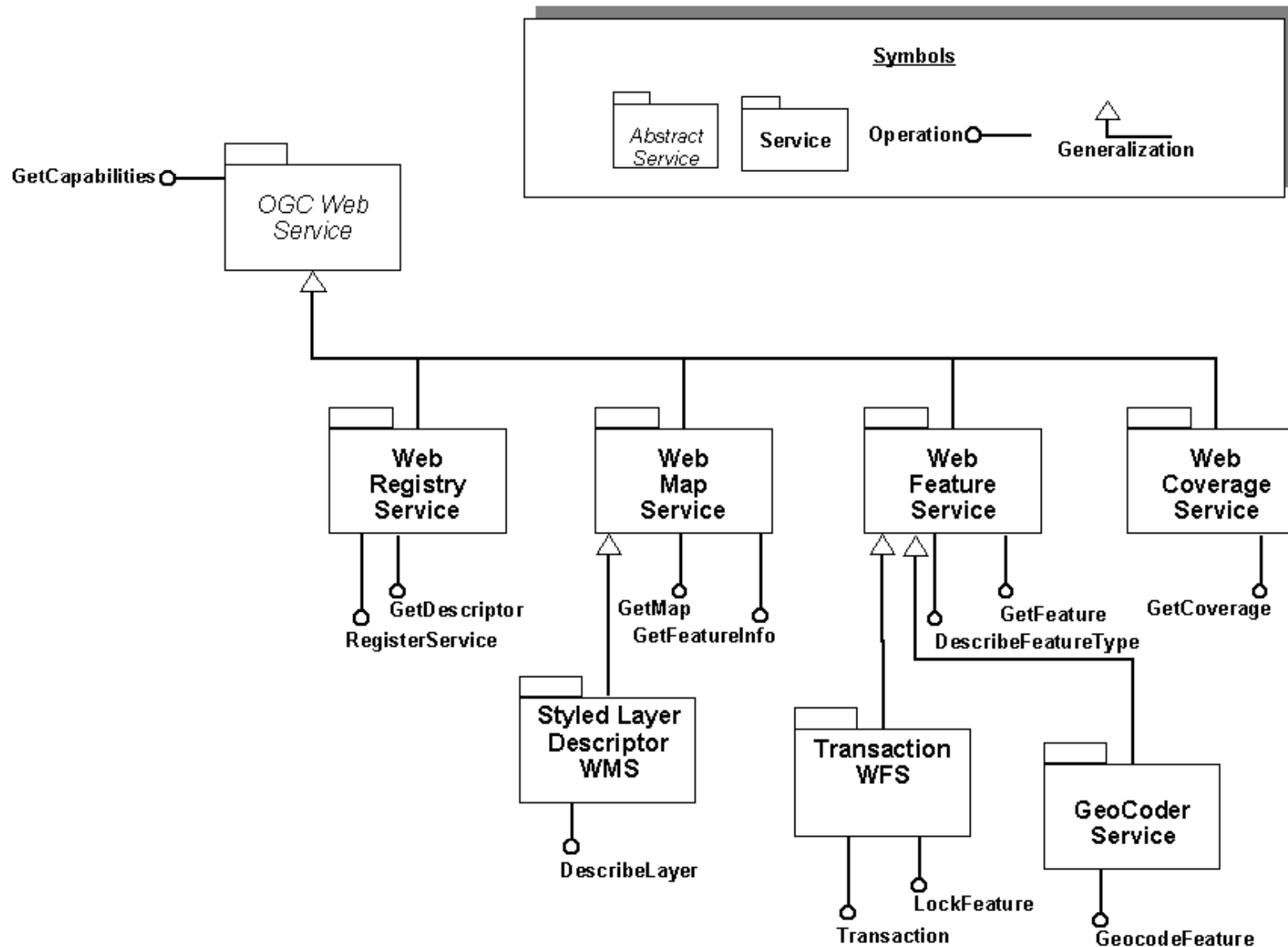
- ☐ SCSTMP29.shp
- ☐ SCSTMP28.shp
- ☒ AIRPORTS - NTS
 - Helopad
 - Single Runway
 - Multiple Runway
- ☐ VA HOSPITALS
 - Hospital
- ☐ HOSPITALS (US)
 - Hospital
- ☒ NUCLEAR REACTOR
 - Nuclear Reactor
- ☒ POPULATED PLACES
 - Populated Place
 - Urban Area
 - Village
 - Kampong
 - Circular Village
- ☒ ERG2000 28 : Chlorine
 - Initial Isolation
 - Protective Action
- ☒ ERG2000 28 Event
 - Event
- ☐ HAZ ABOVE
- ☒ RAILROADS (US)
 - Railroad
- ☒ ESRI STREETMAP
 - Airport
 - Hospital
 - Highway
 - Primary road



ISO/TC211 & OGC – “Standard services”



OpenGIS Web Services



Starting point: Dynamic search in registry and binding to services

The screenshot shows a web browser window titled "IONIC Software - G.A.F. - Microsoft Internet Explorer". The address bar displays "http://www.ionicsoft.com:8080/OWSDemo/frameset.jsp". The main content area is divided into two panels. The left panel, titled "Services", has a red background and contains a section for "My preferred services" with a list of bookmarked services and an "Add Service" button. Below this is a "Find in a Registry" section with a "Selected services" list and a "Remove Service" button. The right panel, titled "Find in a Registry", has a white background and shows a search interface with a "Select Registry" dropdown set to "Ionic Catalog Service", a "Search for" section with dropdowns for "Layer Name" and "Equal", and a "Go!" button. Below the search results, there is a list of discovered services and an "Add Service" button. A speech bubble points to the "Add Service" button in the right panel with the text "Select and bind discovered Service".

Services | Layers | Overview | Contexts

Services

Enter service's URL

Select a bookmarked service

- Ortho New York 14/09/2001
- Ortho NYC 2 14/09/2001 (better quality)
- OWS-1 Dataset (WFS)
- LandSat RGB image 12/09/2001
- NASA Globe Program

Add Service

Find in a Registry

Selected services

- ionic Software Image Server
- ionic WFS over Manhattan (09/2001)
- Nasa Globe Program

Remove Service

Find in a Registry

Select Registry: Ionic Catalog Service

Search for: Layer Name - Equal - Coast Go!

ESRI OGC Compliant Basic Web Map Server
Demis World Map
The GLOBE Program Visualization Server
IONIC World Map Server

Add Service

Select and bind discovered Service

Composition extension

The screenshot shows the IONIC Software G.A.F. web application in a Microsoft Internet Explorer browser. The address bar shows the URL: <http://www.ionicsoft.com:8080/OWSDemo/frameset.jsp>. The application has a red-themed sidebar on the left with the following sections:

- Services**: Includes a text input for "Enter service's URL", a "Select a bookmark" dropdown, a list of bookmarks (Ortho New York 1, Ortho NYC 2 14/0, CWS-1 Dataset, Landsat RGB image, NASA Globe Program, Cubewerx Basemap server, Syncline), and an "Add Service" button.
- Find in a Registry**: Includes a red arrow icon.
- Selected services**: Lists "Ionic Software Image Server", "Ionic WFS over Manhattan (09/2001)", and "Nasa Globe Program".

The main content area features a map with a red dashed outline. Overlaid on the map is a "WebService Chain" dialog box. The dialog box has a title bar with a close button (X). Inside, there is a "Service's Type" dropdown menu set to "[OGC-1100] Portrayal Service" and an "Add Service" button. The central part of the dialog shows a flow diagram of services:

- On the left, two boxes labeled "ESA Fire Feature Server" and "JSDA Fire Feature Server" are connected by a yellow line to a central box labeled "IONIC Semantic Matcher".
- The "IONIC Semantic Matcher" box is connected by a blue line to a box labeled "IONIC Portrayal Service".
- The "IONIC Portrayal Service" box is connected by a red line to a final box labeled "IONIC SLD Library".
- A "bind" button is located to the right of the "IONIC Portrayal Service" box.

Below the flow diagram, there is a legend with colored circles and text:

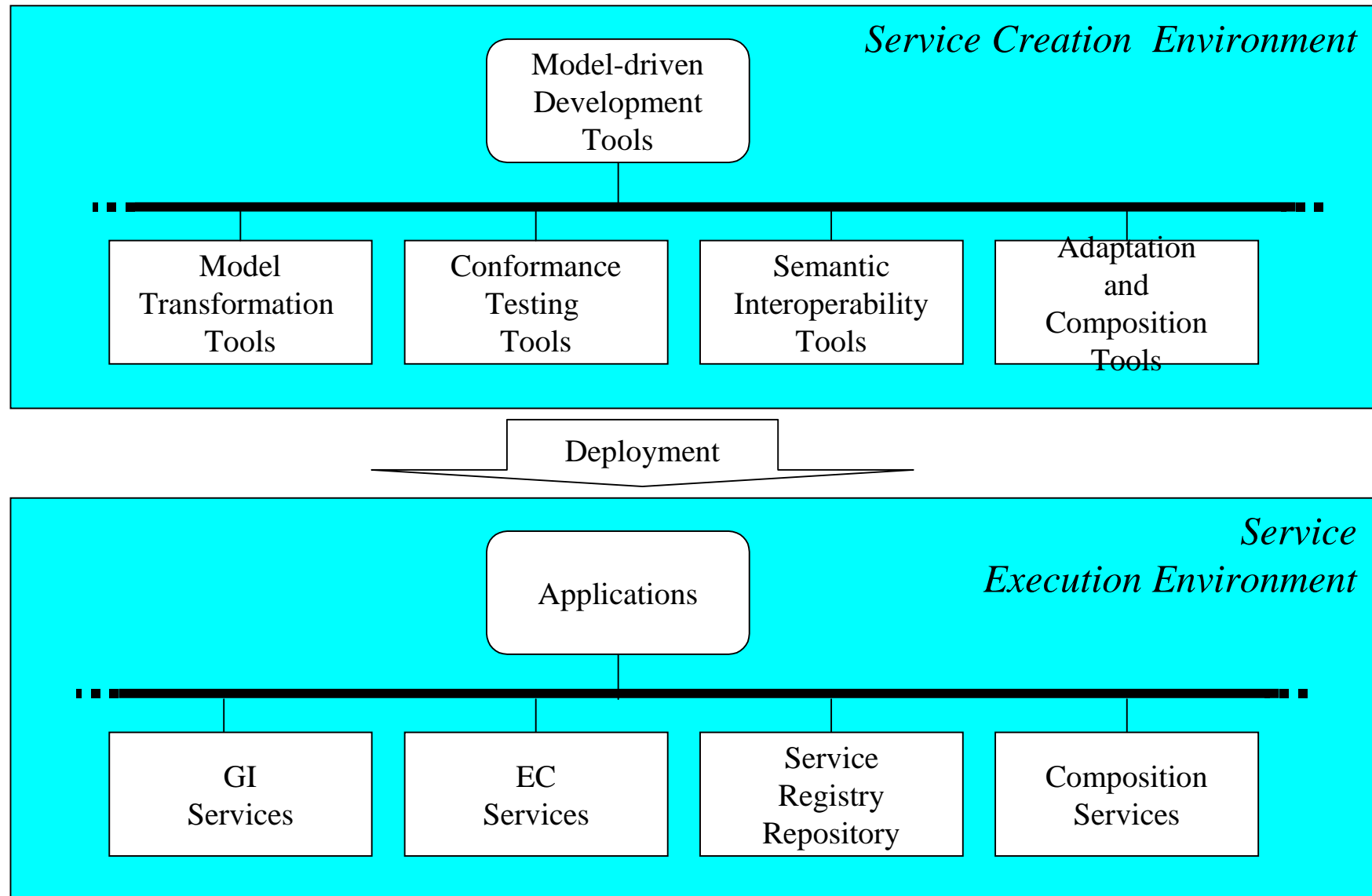
- Yellow circle: GML 3
- Red circle: OGC WMS
- Green circle: Image
- Blue circle: OGC WFS
- Orange circle: SLD

At the bottom right of the dialog box is a "Go !" button. A tooltip is visible over the "IONIC Semantic Matcher" box, stating: "IONIC Semantic Matcher Service Version : 1.0.2 Semantical match of features based on strongly typed properties".

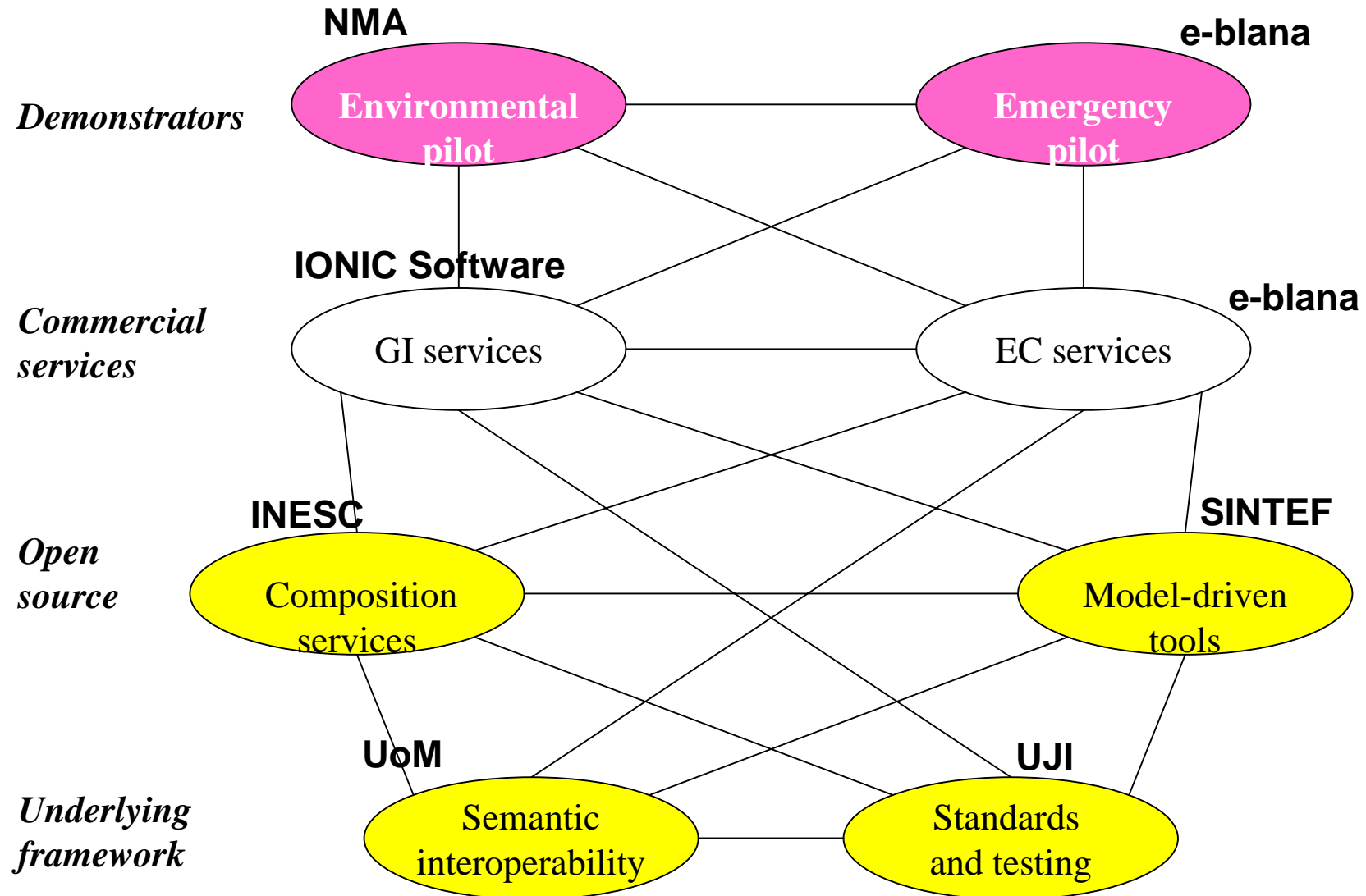
Four callout boxes provide instructions:

- "Select a Service Type" points to the "Service's Type" dropdown.
- "Add a new Service" points to the "Add Service" button.
- "Use Service in a Chain" points to the "IONIC Semantic Matcher" box in the flow diagram.
- "Use Chain as a new Service" points to the "Go !" button.

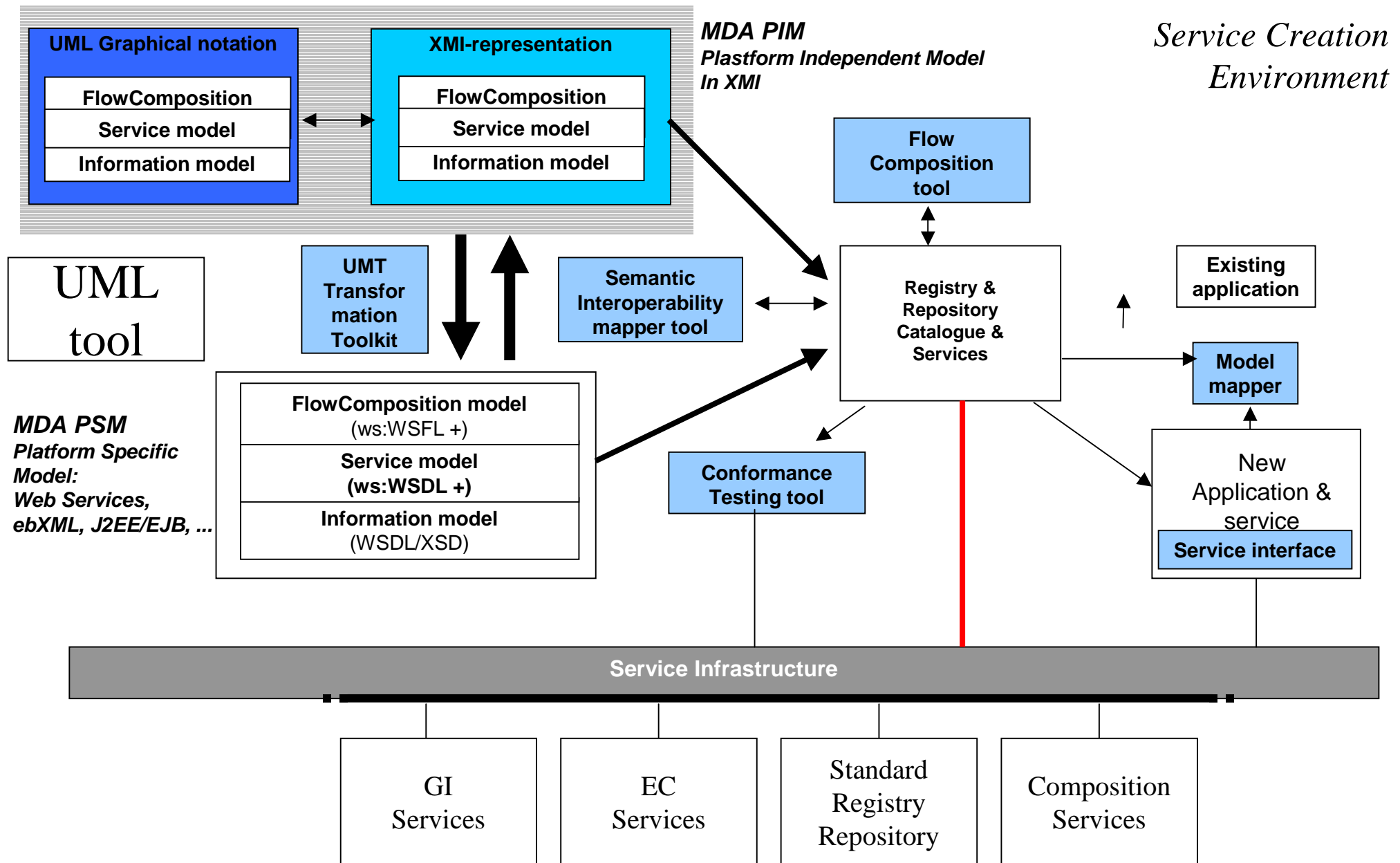
ACE-GIS Principal Architecture



ACE-GIS Work areas and partners



ACE-GIS Service creation



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)

Service Infrastructure

**EC
Services**

Application
Personalisation /
Authentication
Services
(APAS)

e-Payment
Services
(EPS)

PKI
Certificate
Services
(PCS)

Trusted
Third
Party
Services
(TTS)

PKI
Signature
Services
(PSS)

Service Infrastructure

S
e
r
v
i
c
e
I
n
f
r
a
s
t
r
u
c
t
u
r
e

Provider
Registry &
Repository
Catalogue &
Services
(PRC)

**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)

Service Infrastructure

**Core
services**

Micro
Workflow
Composition
Services
(MWS)

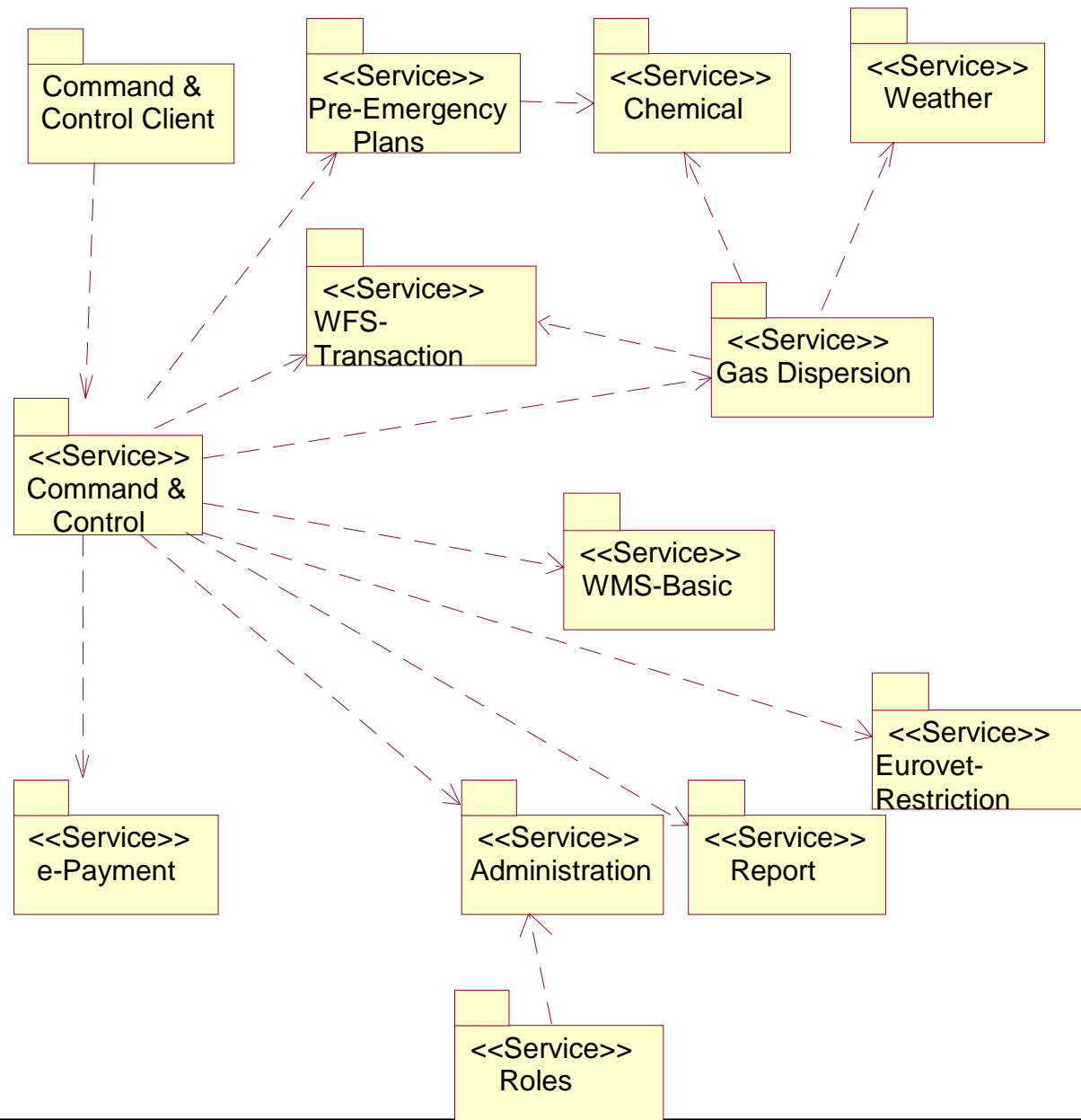
Service
Binding
Template
interpreter
(SBT)

Semantic
Ontology
Mapping
Services
(SMS)

Standard
Registry &
Repository
Catalogue &
Services
(SRS)

Adaptability & Composition Services (ACES)

ACE-GIS Crisis Management Pilot Demonstrator



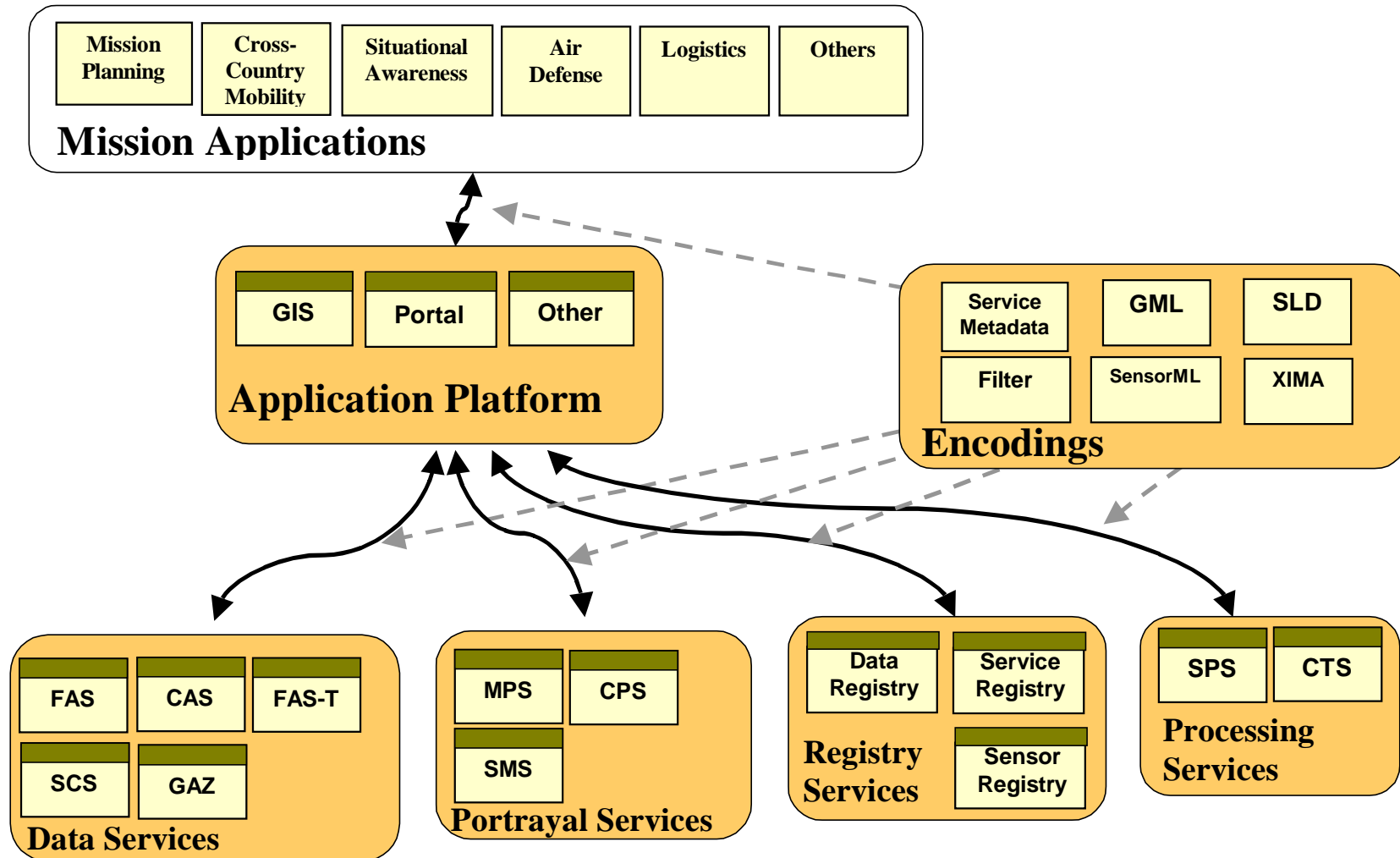
OGC – GO-1 – Geospatial Objects Initiative

February 2003 – June 2003

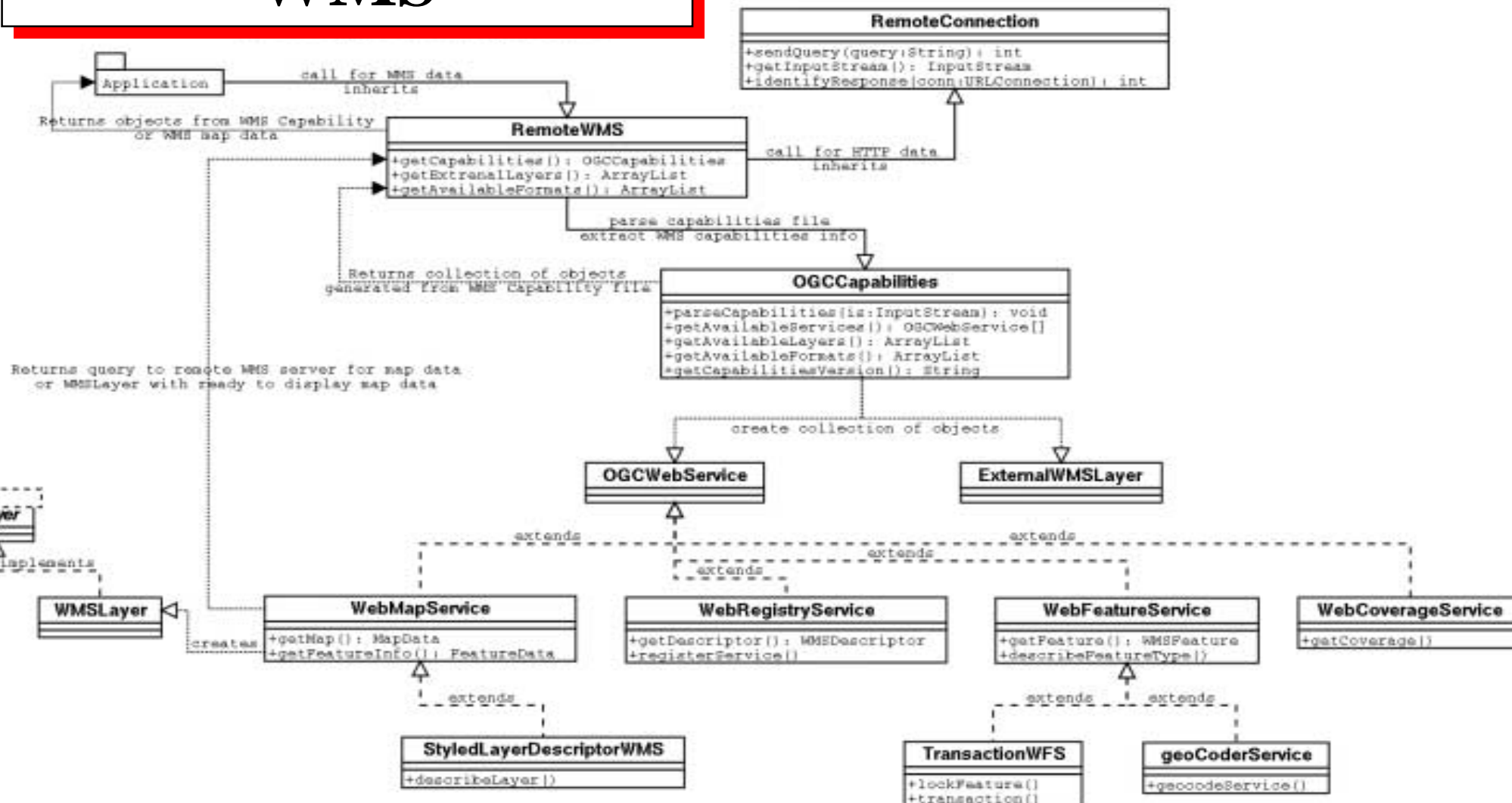
- **Develop a set of standard objects for the development of applications using geographic data**
- **Develop an architecture for distributed geographic processing that is independent of the implementation platform**
- **Develop processes to generate implementation platform specific profiles of the abstract 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

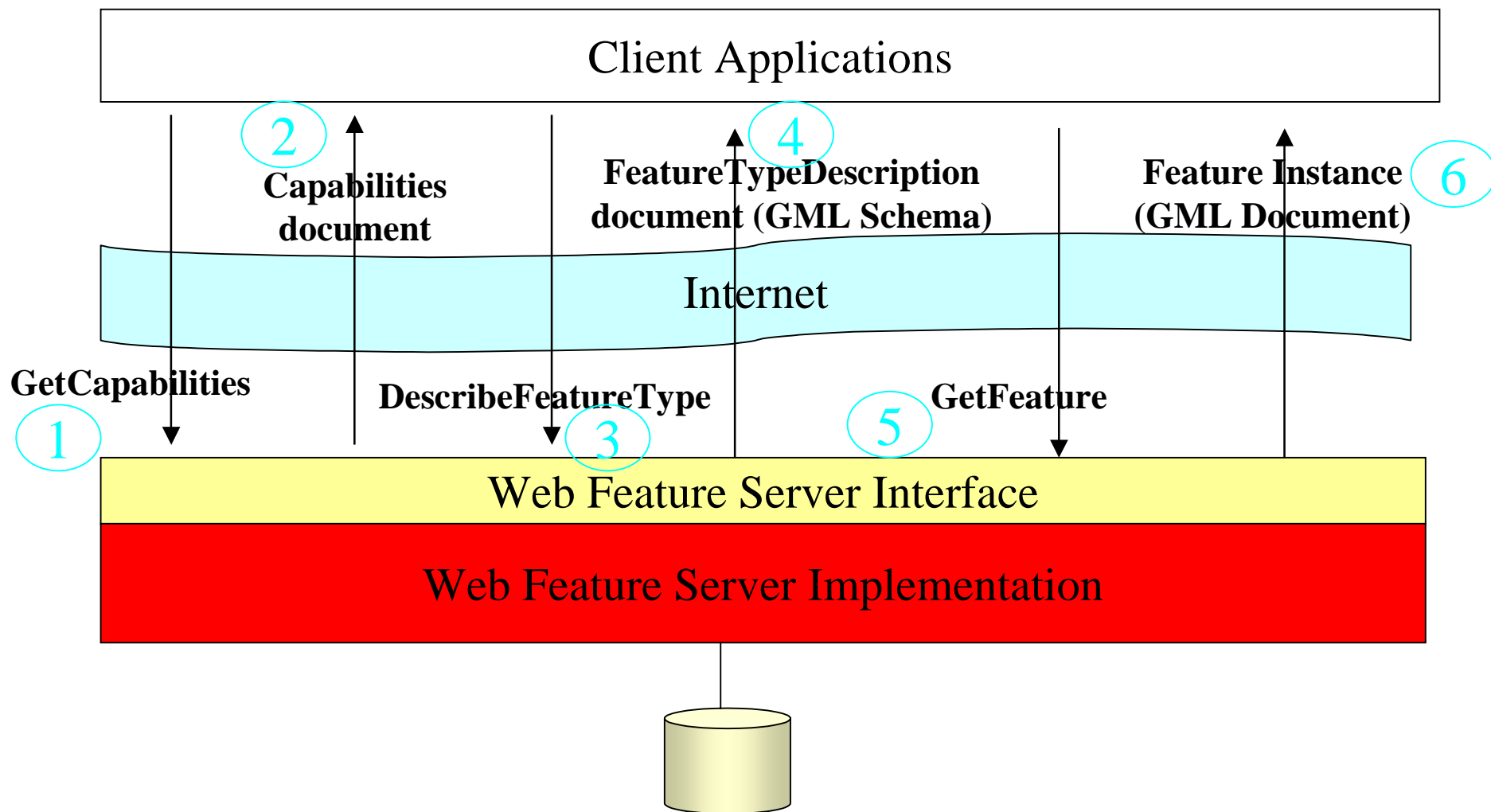
Computational View - Service Framework



GeoTools2: WMS

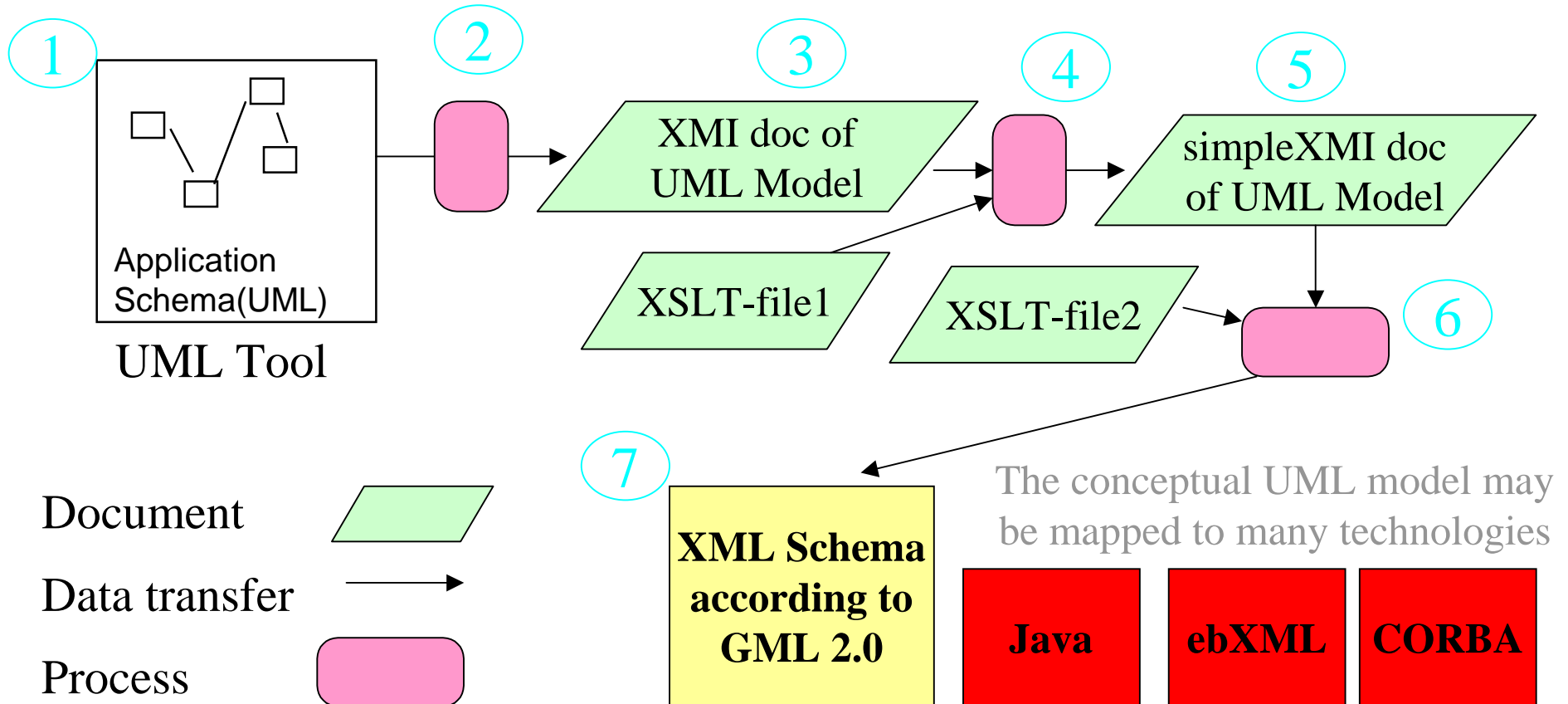


OGC Web Feature Server - A web service

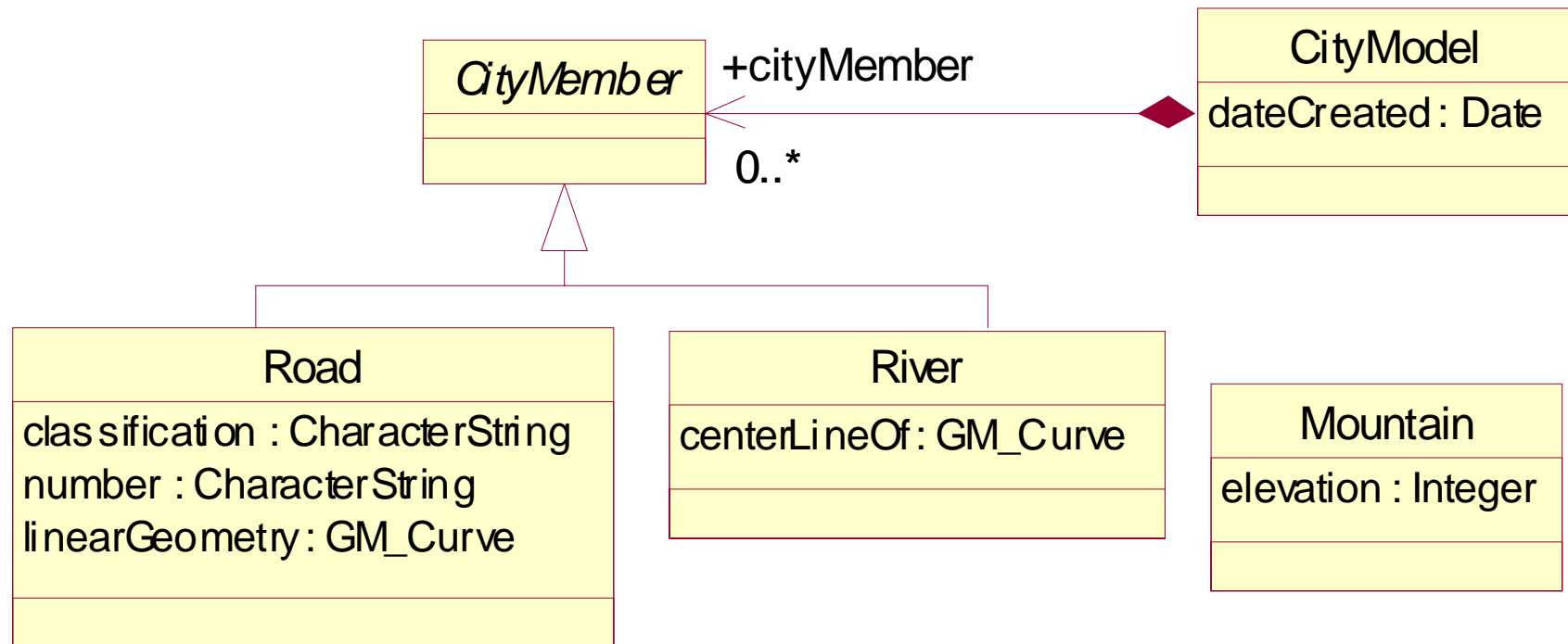


Use of COMBINE UMT tool - XSLT-based code generation from UML to GML for data exchange

ISO 19109, ISO 19103



ISO/ TC 211 Conceptual UML model



Extract from the GML2.0 spec. city application schema example

```
<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

```
<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**