interactive instruments

GML

Geography Markup Language

Clemens Portele – interactive instruments GmbH

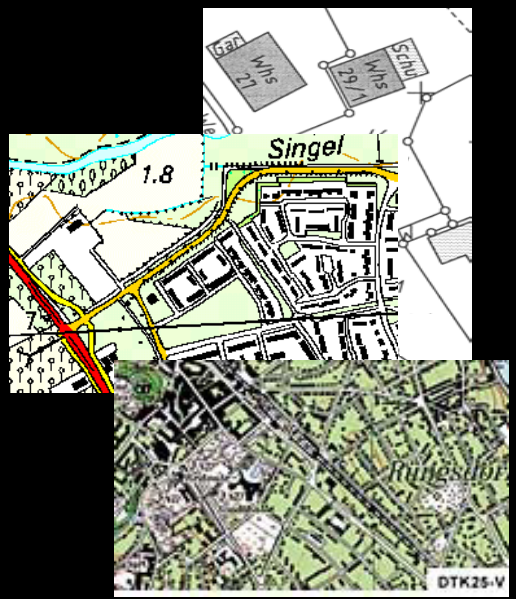
interactive instruments GmbH

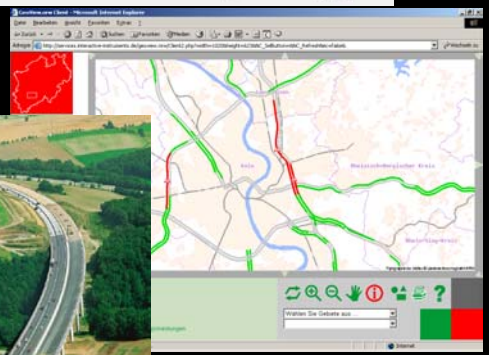
- Founded 1985
- Based in Bonn, Germany
- Solutions for information systems involving spatial information
- Focus: Open systems; designing, developing and integrating standards-based components
- Services: Consulting & Training, Information Modeling, Integration & Implementation, Quality Assurance, Project Management
- Active in ISO/TC 211, Open Geospatial Consortium, CEN/TC 287, and other bodies
  - co-author of GML and Project Leader of ISO 19136

interactive instruments GmbH

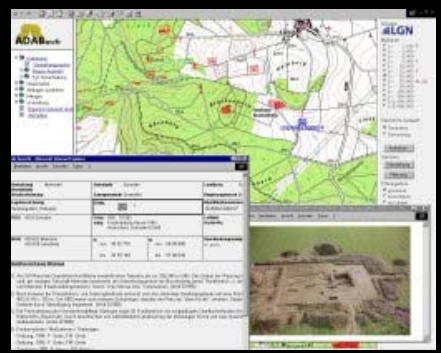
Application Domains

Land Management





Archaeology, Protected Sites & Landmarks



Road and Traffic Management

What is GML?

Scope of GML:

- A modeling language for geographic information
- An encoding for geographic information
- Designed for the web and web-based services

GML is

- an open standard
- enabling a vendor-neutral exchange of spatial data
- ready for service oriented architectures

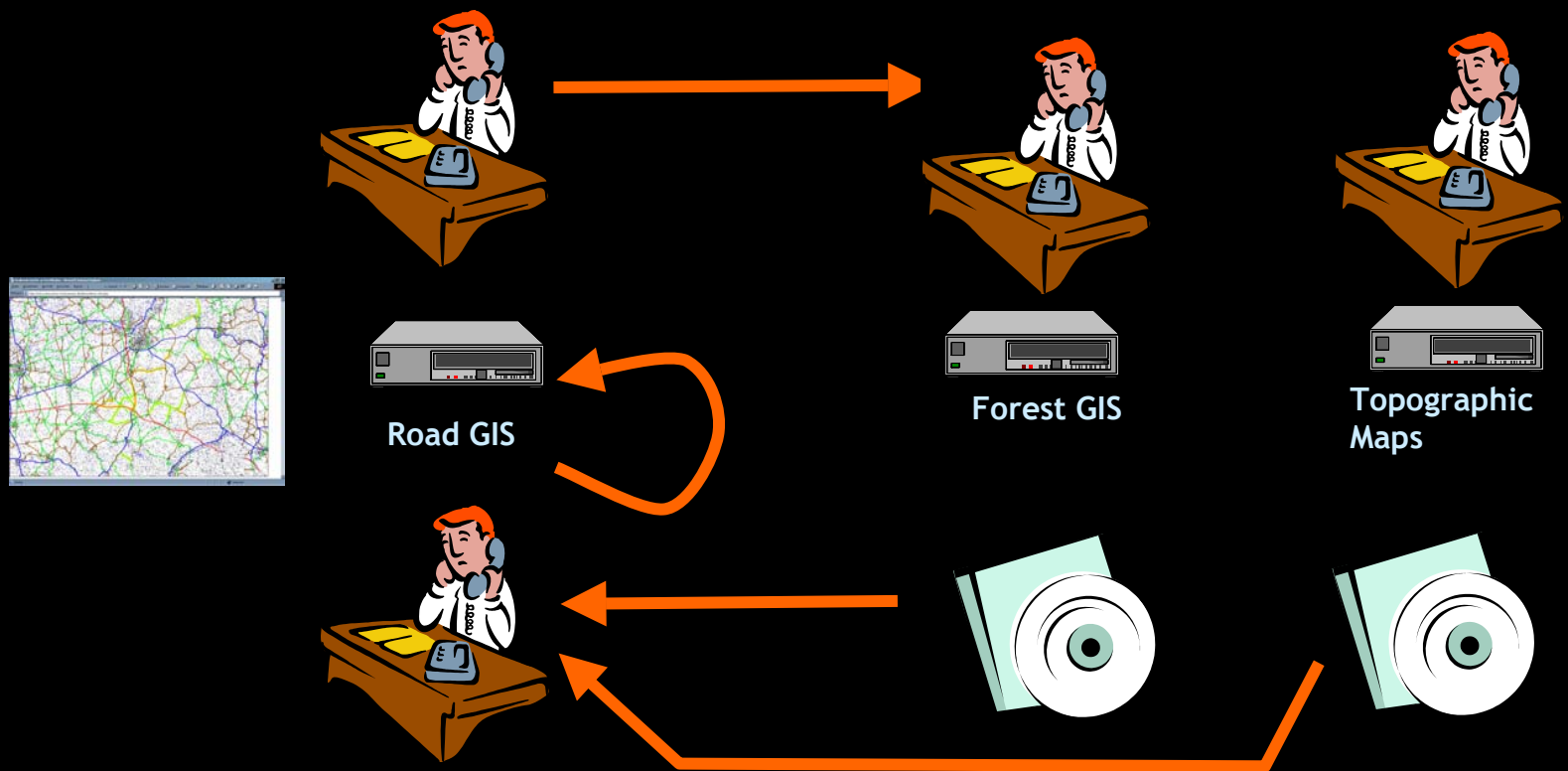
Simple scenario – Example

During the storm disaster in the German state Baden-Wuerttemberg in 1999 (storm „Lothar“) approximately 2 million solid cubic meter wood were felled by the storm. Primarily old trees were affected. After such an event the parts of the road network are to be identified, which are to be examined urgently whether they must be cleared.

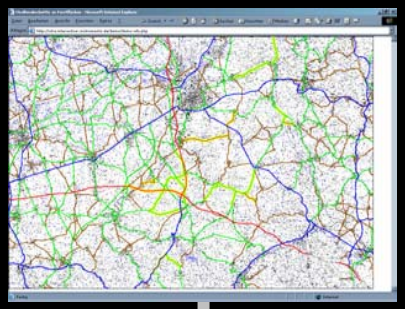
„Show me all roads crossing forest areas, whose age classification is higher than 80 years.“

Simple scenario – Example

Traditional GIS usage:



Simple scenario – Example



Which roads are most propably affected by the storm?

Show me all roads in a map and highlight the most probably affected ones!

Spatial Data Infrastructure

Application

Feature Server Road Network

Map Server Road Network

Feature Server Forestry

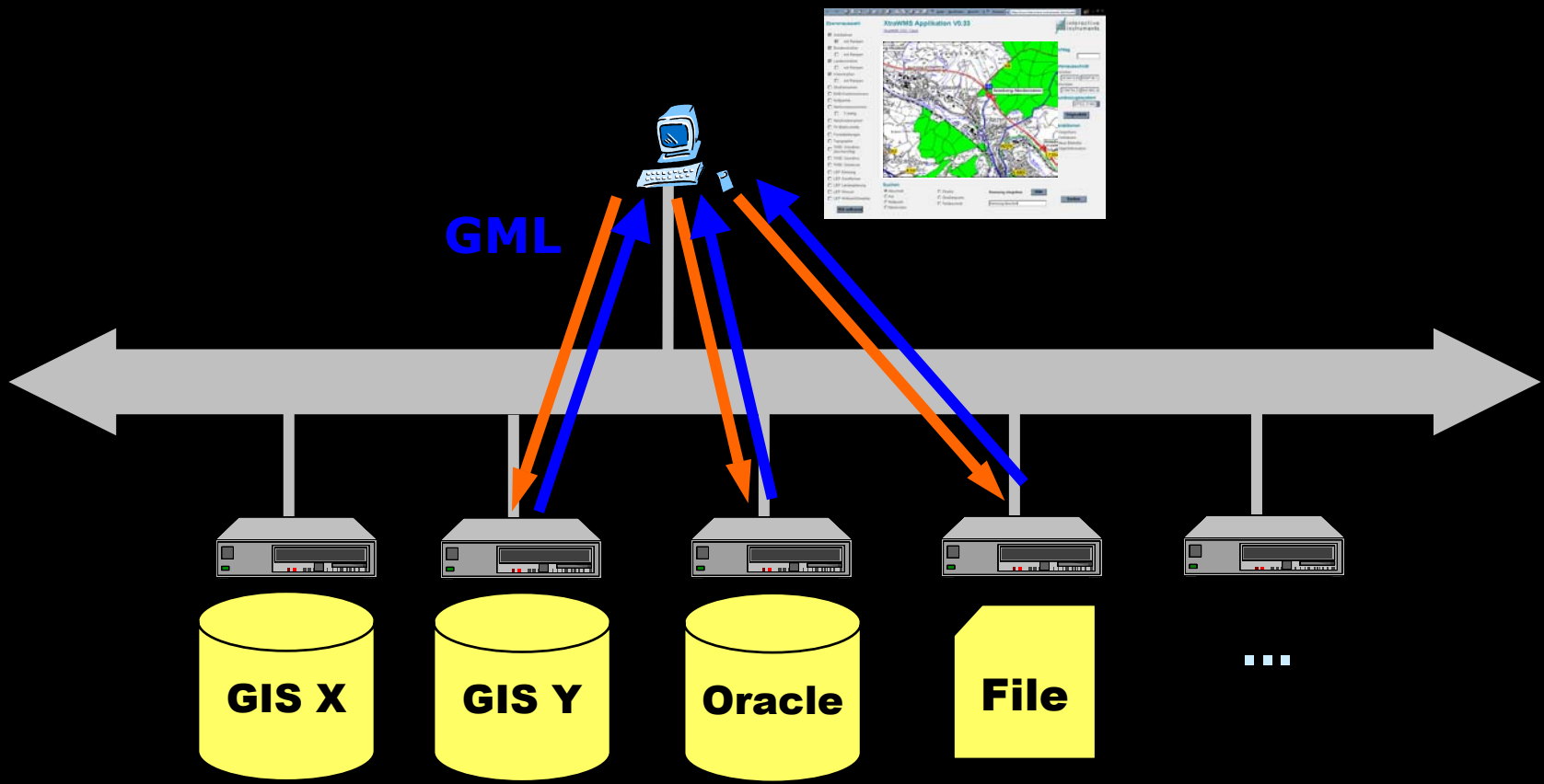
Map Server Topographic Maps

Road DB

Give me all road sections, which run through the affected forest areas!

Give me all forest areas with a tree age classification of 80 years or more (for a certain species)!

GML enables a vendor-neutral exchange of spatial data



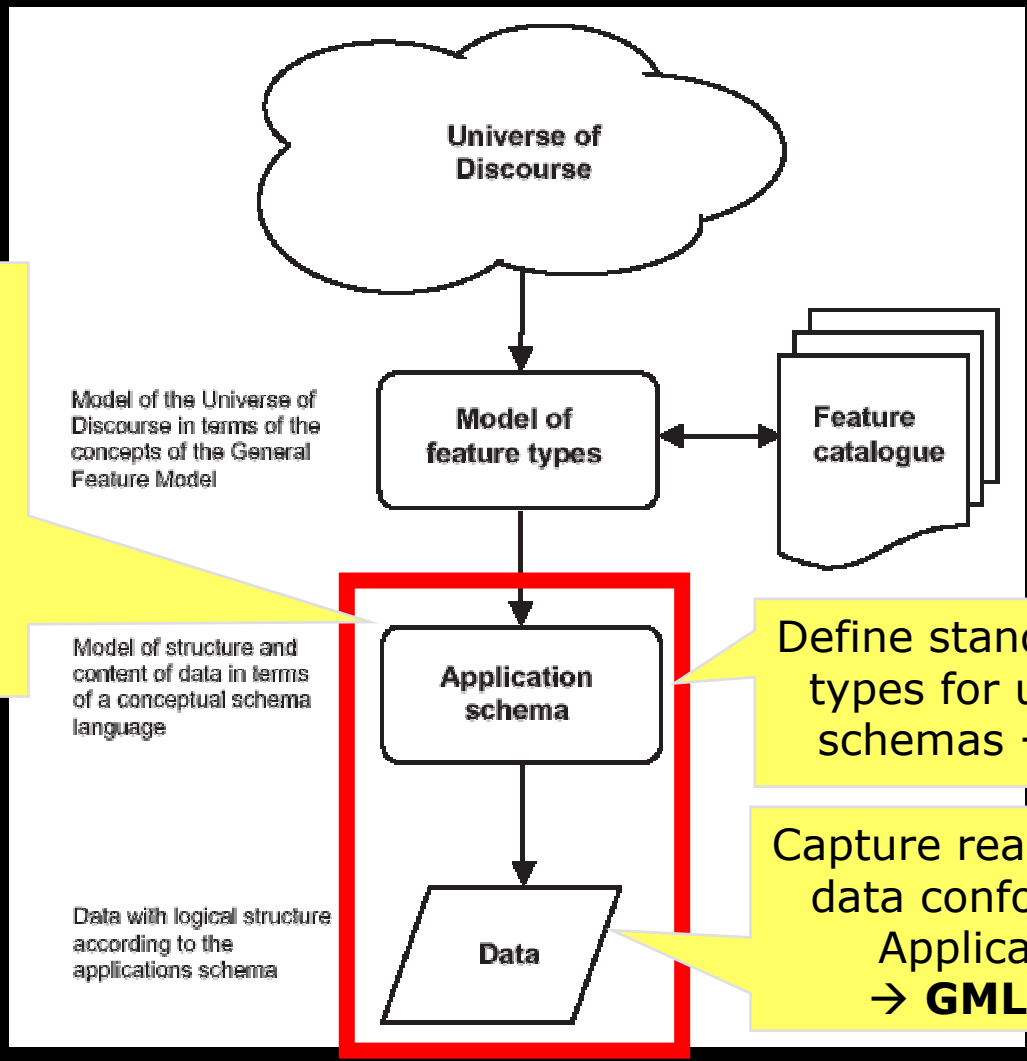
What is GML? – Characteristics

GML

- is based on XML technologies (W3C)
  - XML, XML Namespaces, XML Schema, Xlinks
- implements concepts of the ISO 19100 series
- supports spatial and non-spatial properties of objects
- is open and vendor-neutral
- is extensible
- supports the definition of profiles (proper subsets) of the full GML capabilities

GML Schema, Application Schemas and Documents

Use a schema language to model geographic information in a **GML Application Schema** and define rules for such schemas

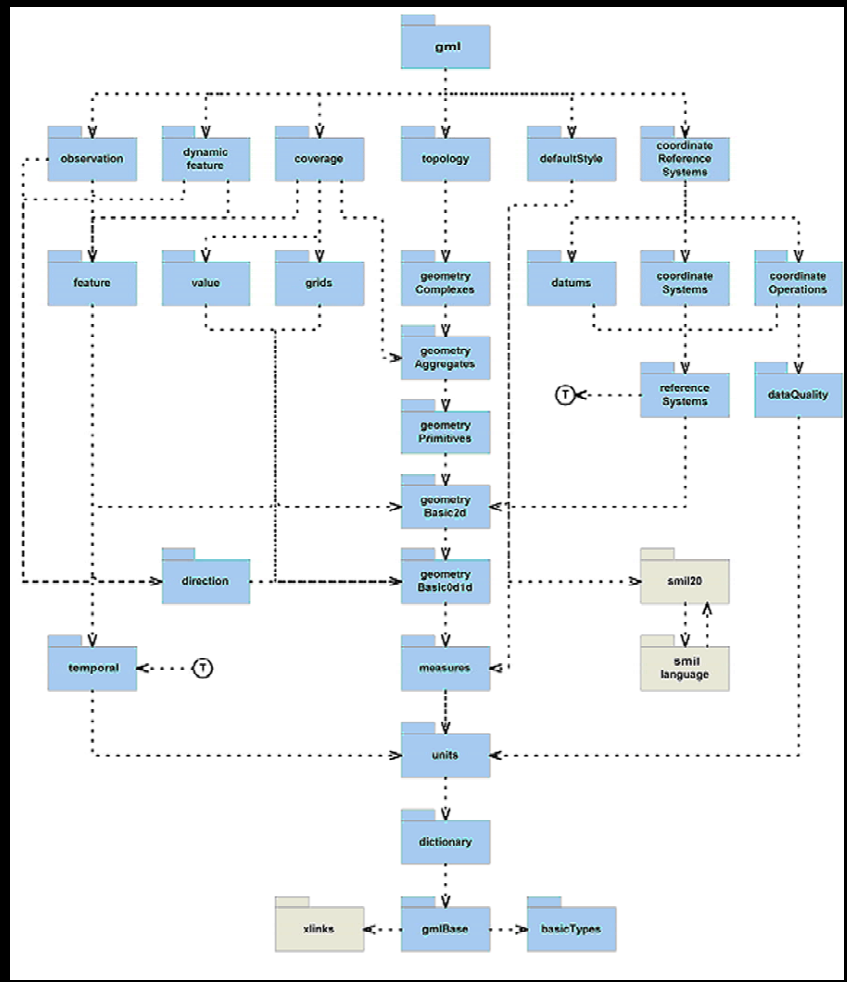


Define standard elements and types for use in application schemas → **GML Schema**

Capture real-world objects as data conforming to a GML Application Schema → **GML Documents**

GML Schema

- The GML Schema is horizontal and not focused on a specific application domain
- But the schema provides common constructs and concepts which may be used by all the different application domains

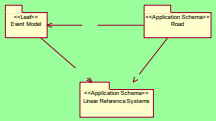


GML Schema

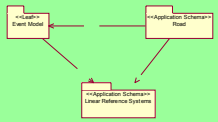
- Base schemas, general syntax, feature model, metadata mechanisms
- Basic geometry (0d, 1d, 2d)
- Additional geometric primitives (0d, 1d, 2d, 3d)
- Geometric composites
- Geometric aggregates
- Coordinate reference systems
- Topology
- Temporal information and dynamic features
- Definitions and dictionaries
- Units, measures and values
- Directions
- Observations
- Coverages
- Default styling

GML Application Schemas

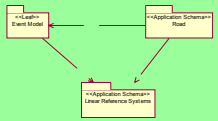
Cadastre, Land Use



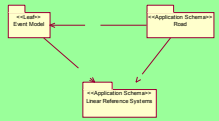
Traffic And Transport



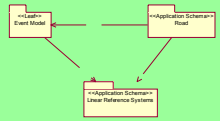
Telecom



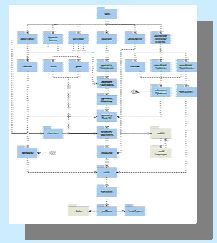
Environ-ment



...



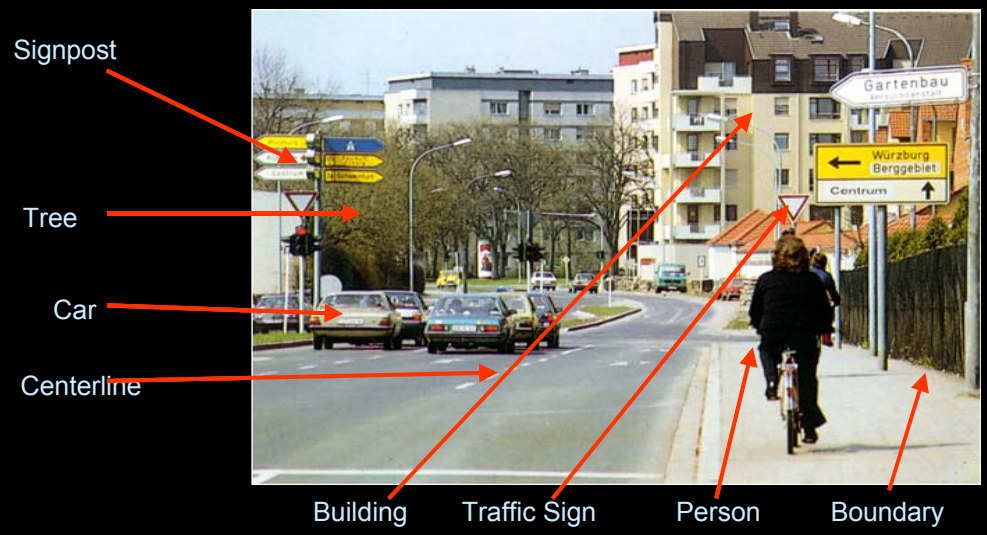
GML Schema



XML Technologies / W3C

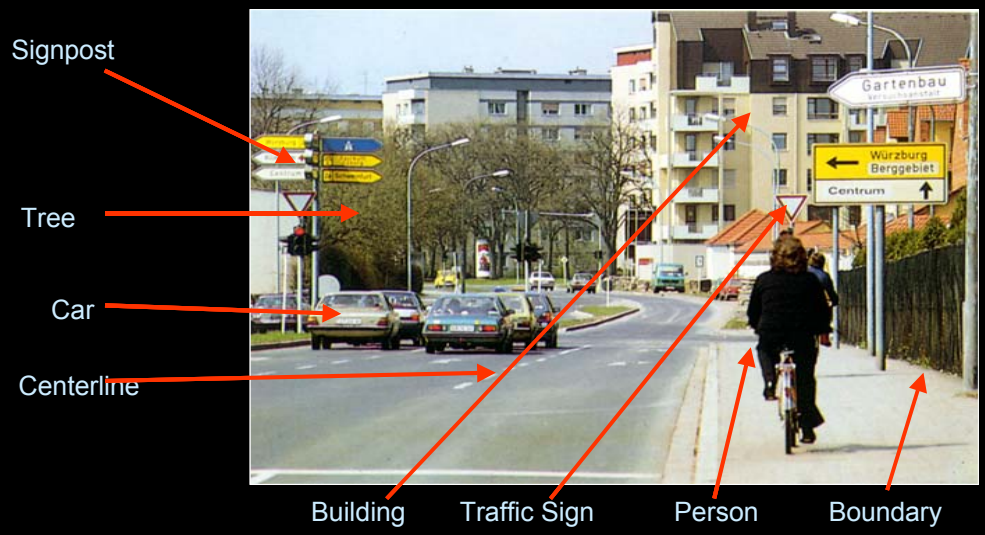
GML – Key concepts

- The core concept of GML is the feature. A feature is the abstraction of the phenomenon in the real world.
- Every feature has a feature type. A feature type in GML is a named classification of a fact of the real world.



GML – Key concepts

- A geographic feature is a feature that is associated with a location relative to the Earth.
- As a result, the real world can be represented – in terms of an application domain – by a collection of features.



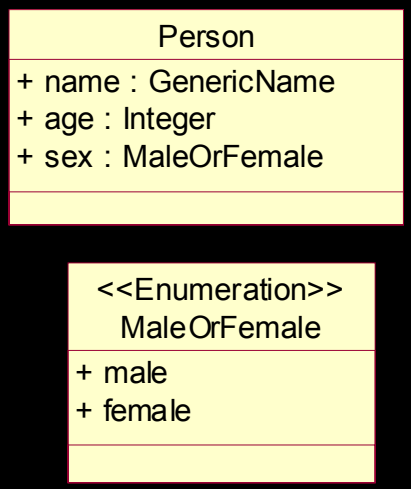
Source: BASt

GML – Key concepts

- The state of a feature is described by a set of properties, in which every property is in principle represented by a triple *{name, type, value}*.
- Spatial properties are those properties that have a geometric object as their value (e.g. a point).
- Properties may be local values or references to remote objects
- The GML Schema specifies a number of pre-defined types (for example a number of geometry types).

GML – Key concepts

- Features with a similar characteristic are grouped to feature types, those features will share a similar set of properties. This structure is specified in a GML Application Schema.




```
<Person gml:id = “p1”>
    <gml:name>Bob</gml:name>
    <age>10</age>
    <sex>male</sex>
</Person>
```

Feature Type declaration – Example from the Top10 NL GML Application Schema

```
<element name="GeografischGebied" type="tdn:GeografischGebiedType"
    substitutionGroup="gml:_Feature"/>

<complexType name="GeografischGebiedType">
    <complexContent>
        <extension base="tdn:Top10ObjectType">
            <sequence>
                <element name="type" type="tdn:typeGeografGebied"/>
                <element ref="gml:geometryProperty"/>
                <element name="naam" type="string"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>
```

Feature Type declaration – Example from the Top10 NL GML Application Schema

```
<complexType name="Top10ObjectType" abstract="true">
    <complexContent>
        <extension base="gml:AbstractFeatureType">
            <sequence>
                <element name="top10_id" type="integer"/>
                <element ref="tdn:bronRef"/>
                <group ref="tdn:Temporeel"/>
                <element name="dimensie" type="tdn:dimensie"/>
                <element name="tdncode" type="integer"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>
```

GML – Key concepts

Three ways to represent a relationship between two features:

```
<Person gml:id="p1">
   <owns xlink:href="#c1"/>
</Person>
<Car gml:id="c1">
   <!-- ... -->
</Car>
```

```
<Person gml:id="p1">
   <owns>
      <Car gml:id="c1">
         <!-- ... -->
      </Car>
   </owns>
</Person>
```

```
<Person gml:id="b1">
   <owns xlink:href="http://www.someserver.com/cars.xml#c1"/>
</Person>
```

- The feature is either a child element of the property or referenced by an xlink:href attribute in the property element
- The xlink:href attribute is interpreted in the way that the value of the property is the feature referenced in the link

GML Document – Top10NL Example

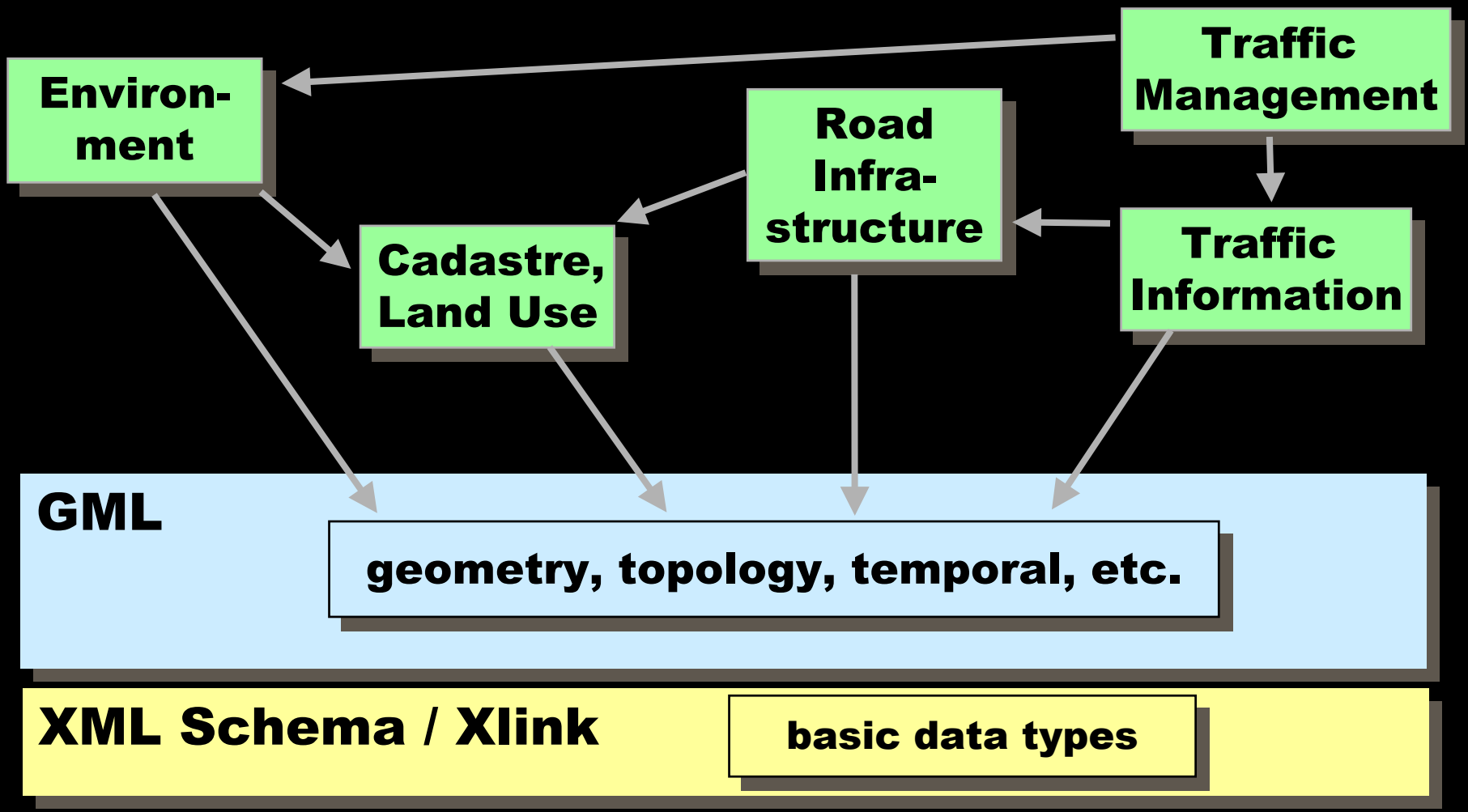
```
<tdn:GeografischeGebieden>
    <gml:boundedBy>
        <gml:Box srsName="EPSG:28992">
            <gml:coordinates>105000,447000 107000,449000</gml:coordinates>
        </gml:Box>
    </gml:boundedBy>
    <tdn:geografischeGebiedenMember>
        <tdn:GeografischGebied fid="TOP10.400275">
            <!-- ... -->
        </tdn:GeografischGebied>
    </tdn:geografischeGebiedenMember>
    <!-- ... -->
</tdn:GeografischeGebieden>
```

Note: This is GML 2

GML Document – Top10NL Example

```
<tdn:GeografischGebied fid="TOP10.400275">
    <tdn:top10_id>7450001</tdn:top10_id>
    <tdn:bronRef xlink:type="simple" xlink:href="metadata.xml#TOP10.9000005"/>
    <tdn:object_begindatum>2001-12-17T13:24:10Z</tdn:object_begindatum>
    <tdn:versienummer>1</tdn:versienummer>
    <tdn:versie_begindatum>2001-12-17T13:24:10Z</tdn:versie_begindatum>
    <tdn:dimensie>2D</tdn:dimensie>
    <tdn:tdncode>8813</tdn:tdncode>
    <tdn:type>Polder</tdn:type>
    <gml:geometryProperty>
        <gml:Polygon srsName="EPSG:28992">
            <!-- … -->
        </gml:Polygon>
    </gml:geometryProperty>
    <tdn:naam>Oostpolder in Schieland</tdn:naam>
</tdn:GeografischGebied>
```

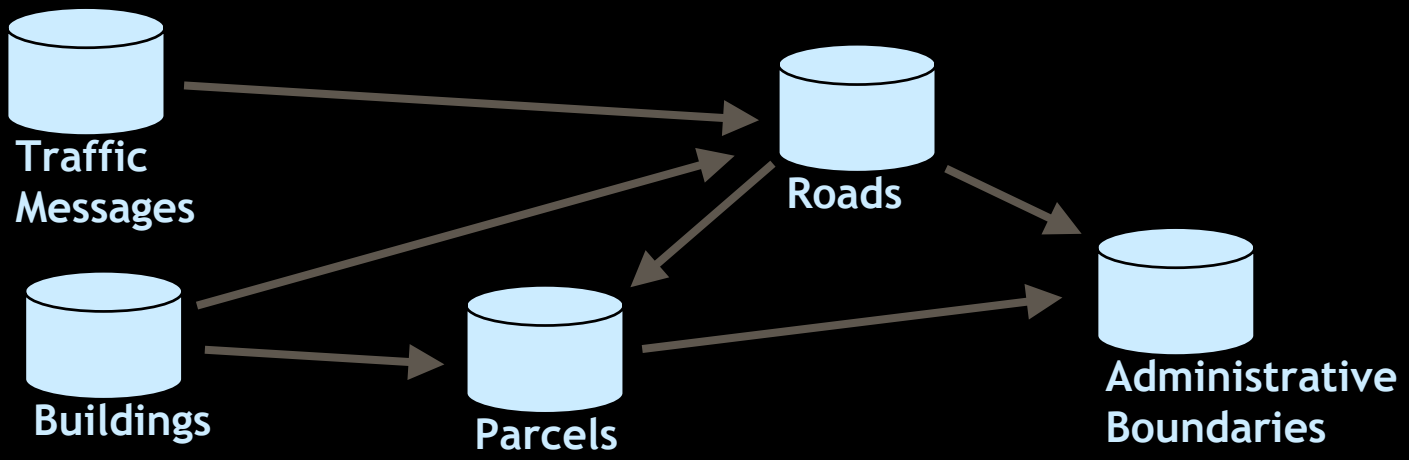
Linking GML Application Schemas



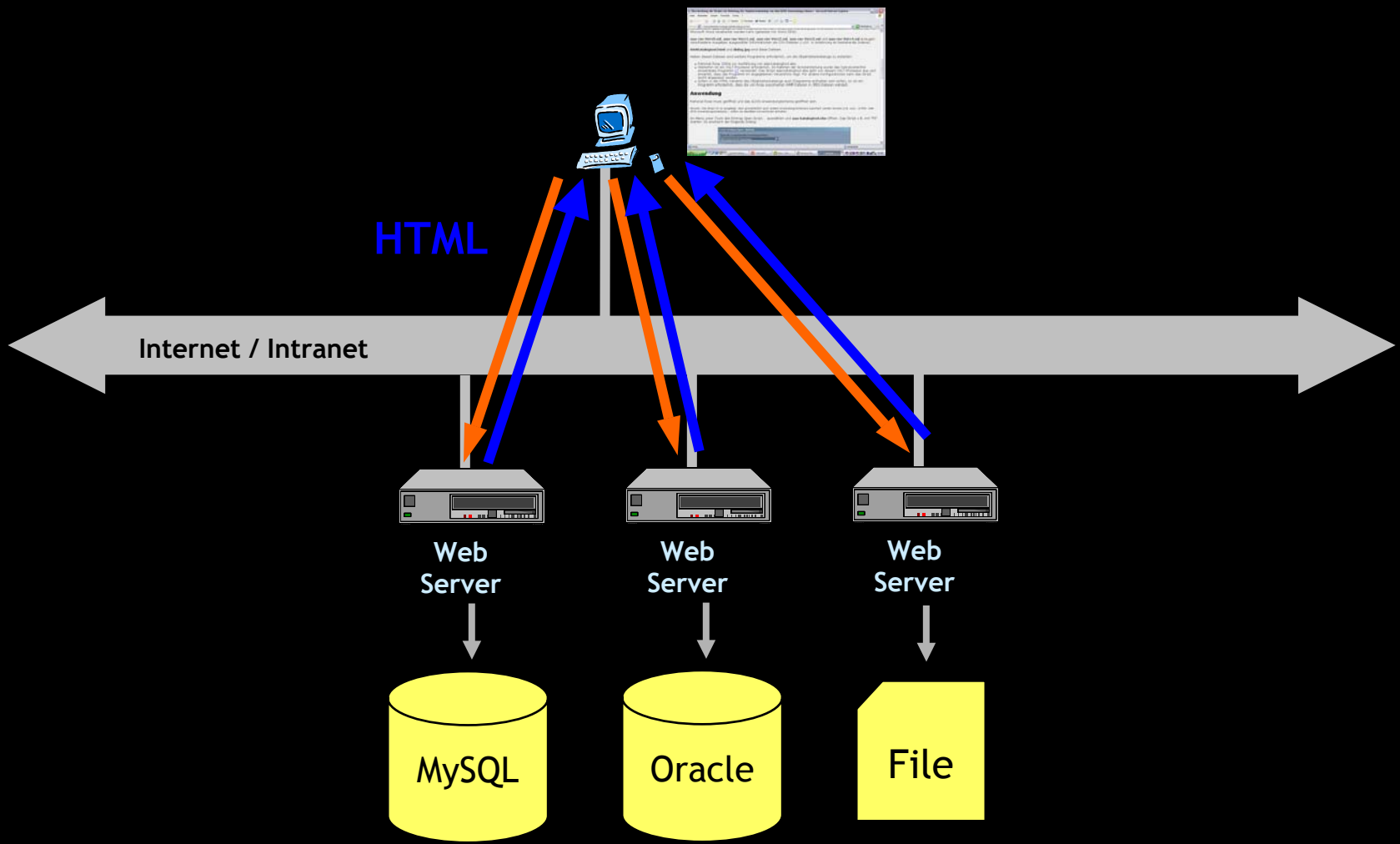
Enabling the geospatial web

- Information Communities publish their Application Schemas (preferably in some sort of registry) so that it can be found, accessed and understood by others
- This enables that also the features can have properties whose values are maintained by other authorities

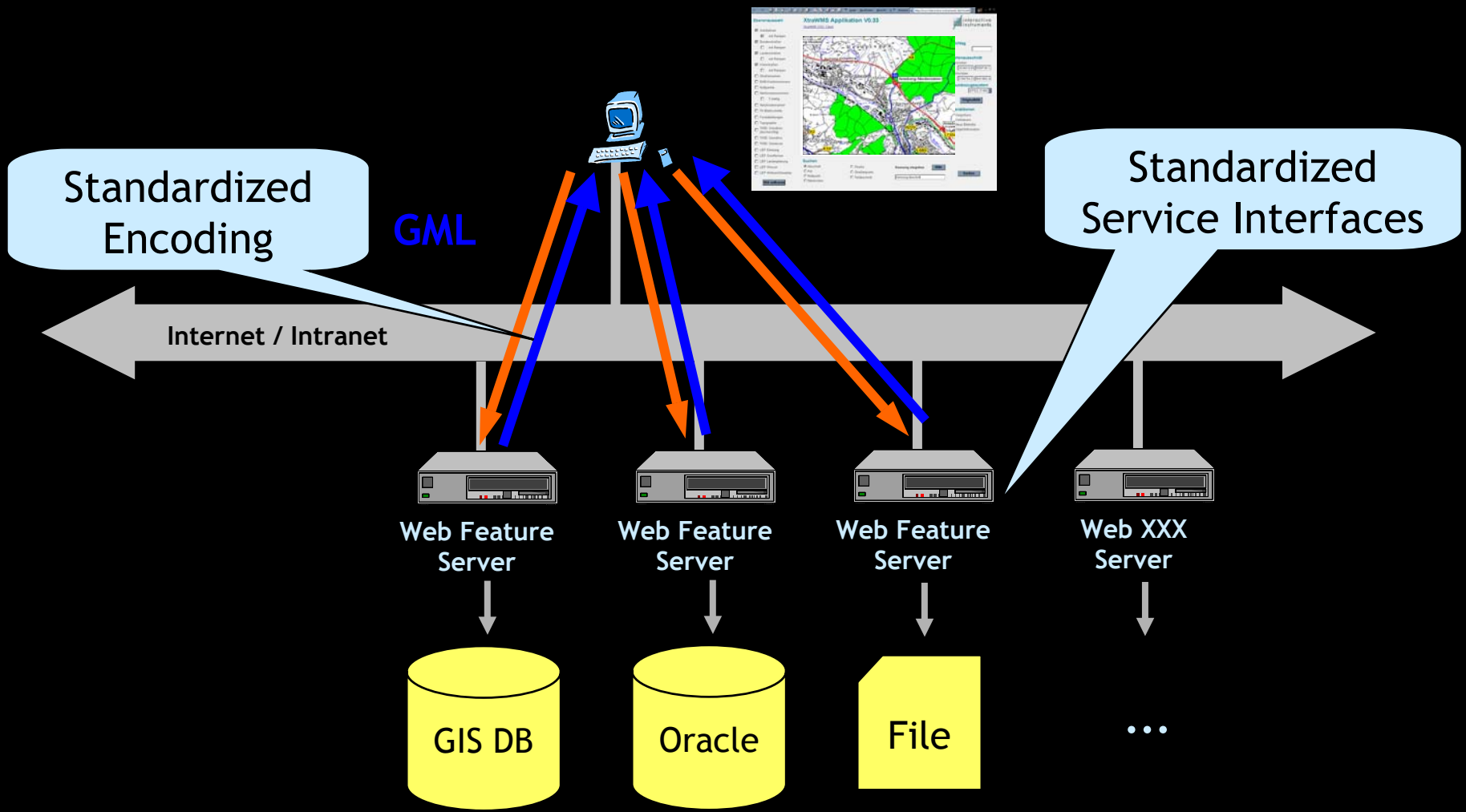
  → a web of geospatial features is created



Learn from the HTML Web ...



… and use GML as the lingua franca of the geospatial web



GML Development

Open Geospatial Consortium

- GML 1.0 Recommendation
  - May 2000
- GML 2.0 Adopted Specification
  - February 2001
- *WFS 1.0 Adopted Specification*
  - *September 2002*
- GML 3.0 Adopted Specification
  - January 2003

ISO/TC 211

- ISO 19136 New Work Item
  - May 2002
- ISO WD 19136 = GML 3.0

ISO CD 19136 = GML 3.1
February/March 2004

Joint Working Team:
OGC GML Revision Working Group &
ISO Project Team

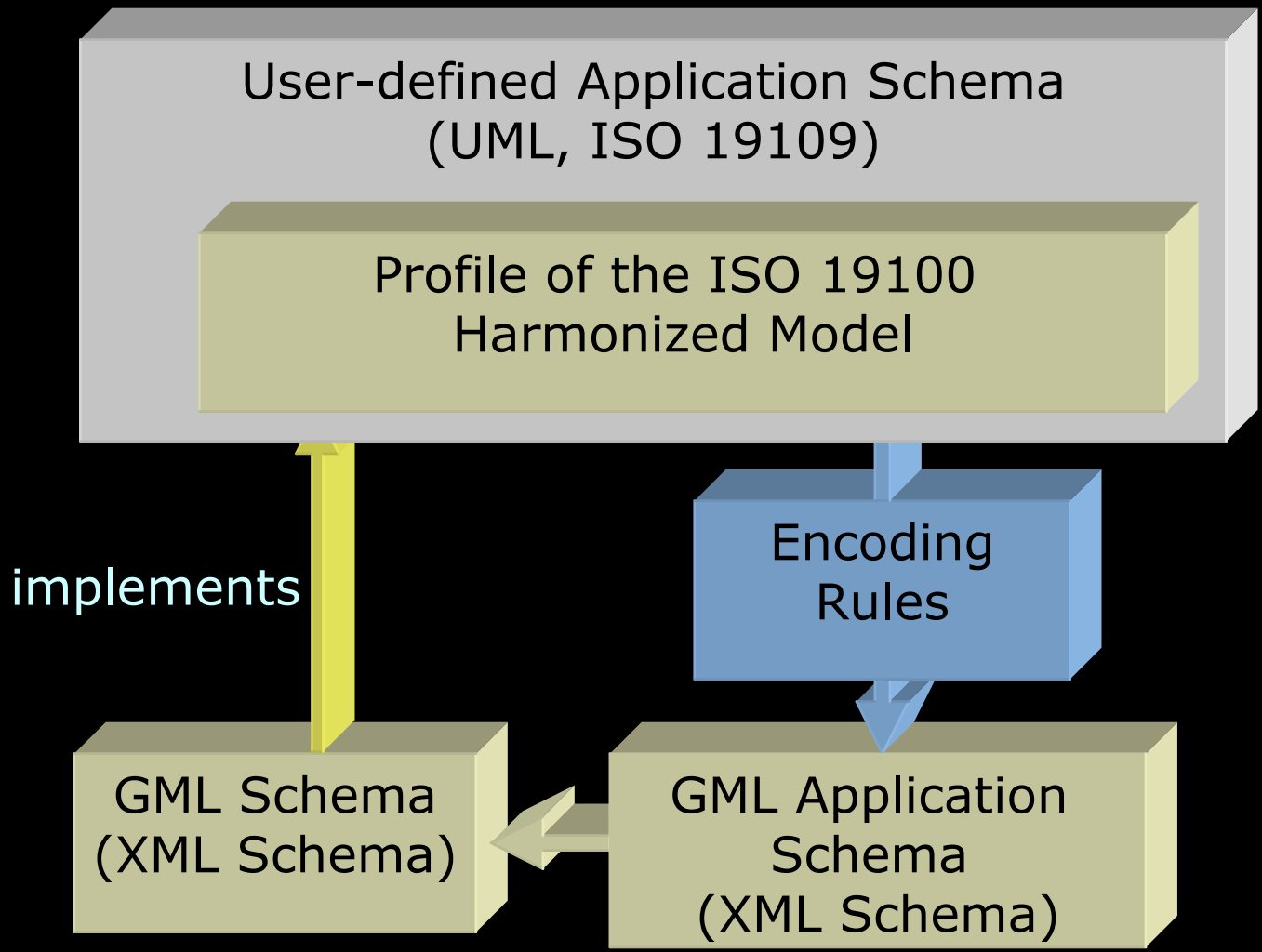
GML 3.2 → 2005

ISO/TC 211
Editing Committee

GML and ISO 19100

- ISO 6709:1983, Standard representation of latitude, longitude and altitude for geographic point locations
- ISO 19101 - Reference model
- ISO/TS 19103 - Conceptual schema language
- ISO 19104 - Terminology
- ISO 19105 - Conformance and testing
- ISO 19106 - Profiles
- ISO 19107 - Spatial schema
- ISO 19108 - Temporal schema
- ISO 19109 - Rules for application schema
- ISO 19110 - Feature cataloguing methodology
- ISO 19111 - Spatial referencing by coordinates
- ISO 19112 - Spatial referencing by geographic identifiers
- ISO 19113 - Quality principles
- ISO 19114 - Quality evaluation procedures
- ISO 19115 - Metadata
- ISO 19116 - Positioning services
- ISO 19117 - Portrayal
- ISO 19118 - Encoding
- ISO 19119 - Services
- ISO/TR 19120 - Functional standards + new rev
- ISO/TR 19121 - Imagery and gridded data
- ISO/TR 19122 - Qualifications and certification of personnel
- ISO 19123 - Schema for coverage geometry and functions
- ISO/RS 19124 - Imagery and gridded data components
- ISO 19125 - Simple feature access – Part 1-3
- ISO 19126 - Profile - FACC Data Dictionary
- ISO 19127 - Geodetic codes and parameters
- ISO 19128 - Web Map Server Interface
- ISO 19129 - Imagery, gridded and coverage data framework
- ISO 19130 - Sensor and data model for imagery and gridded data
- ISO 19131 - Data product specification
- ISO 19132 - Location based services possible standards
- ISO 19133 - Location based services tracking and navigation
- ISO 19134 - Multimodal location based services for routing and navigation
- ISO 19135 - Procedures for registration of geographic information items
- ISO 19136 - Geography Markup Language (GML)
- ISO 19137 - Generally used profiles of the spatial schema and of similar important other schemas
- …

GML and ISO 19100

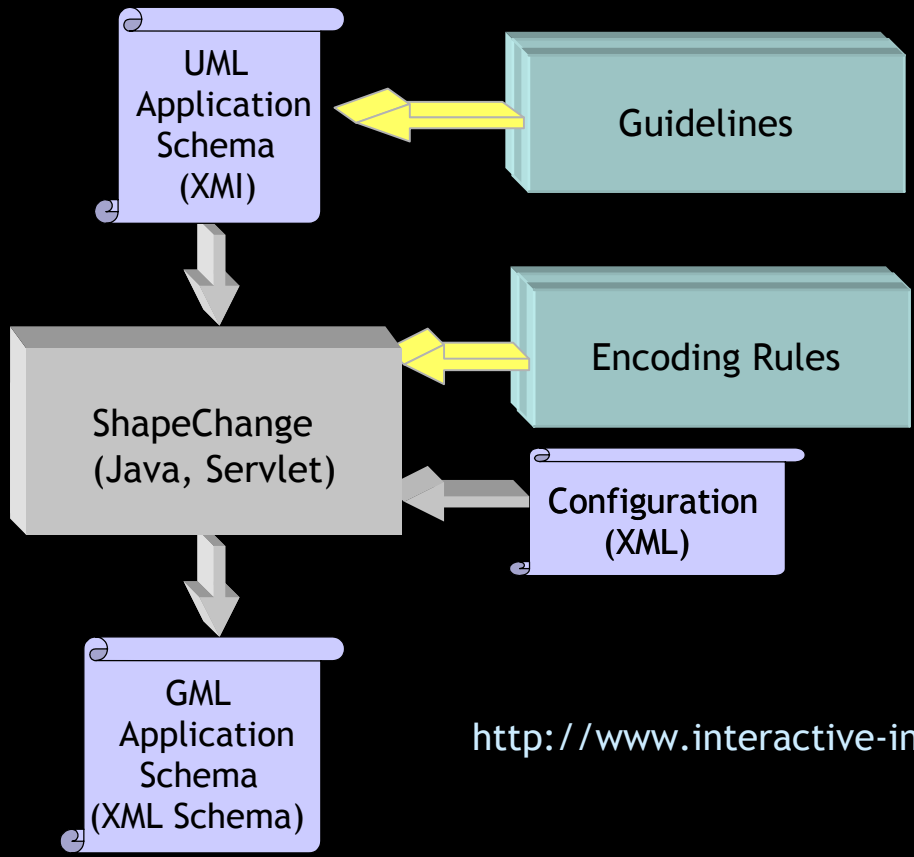


(simplified)

Support for Application Schema designers and software developers

- Rules for Application Schemas
  - Guidelines for the usage of XML Schema
  - GML documents can be interpreted more easily by software („GML parsers“)
- Tools to map from UML or other modelling languages to GML (Open Source tools are available)
- Using a GML Profile in an Application Schema
  - A declaration of the subset of GML used by an application
  - GML itself includes a simple tool that allows to create such a GML profile automatically
- A book about GML is available

Application Schemas: Mapping tool from UML to GML – Example



http://www.interactive-instruments.de/ugas/

Support for software developers

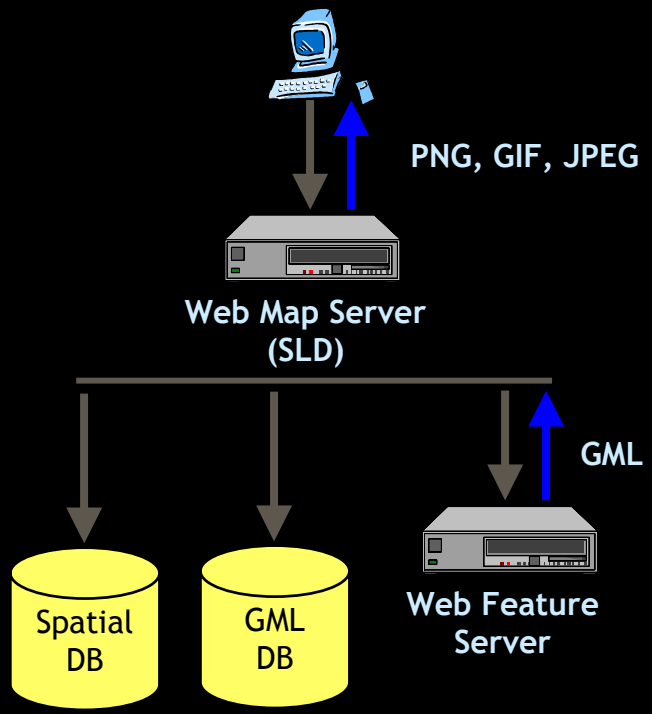
- XML Parsers, XSLT processors, etc. are available (including Open Source ones); as XML is popular in general many developers know how to work with and process XML documents
- GML Schema Analyzers (i.e. GML-aware XML Schema parsers understanding the GML model and syntax) are emerging
- Most major GIS products have in their latest releases built-in support for GML; in addition a significant number of new products providing OGC Web Service interfaces and serving GML documents are available

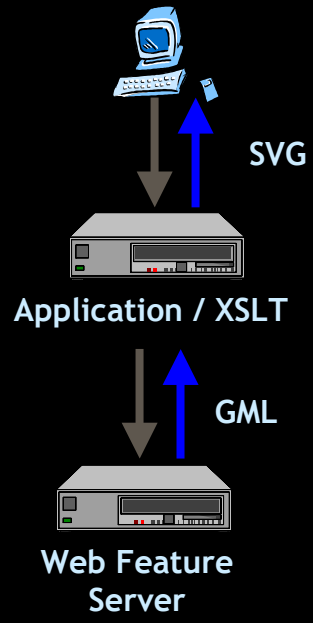
GML Issues

- Technical Enhancements
- GML is perceived as complex
  - Better support through tools and education
  - Reduce complexity
- Best-practices required
  - Development of consensus-based profiles
  - Dictionaries for Coordinate Reference Systems, Units of Measurements
- Performance

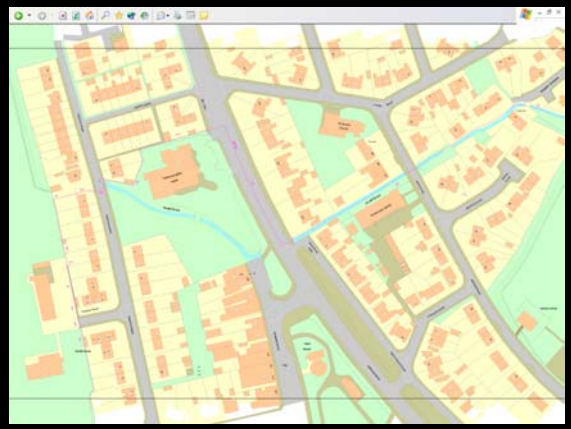
Mapping GML Data

GML is focused on content!

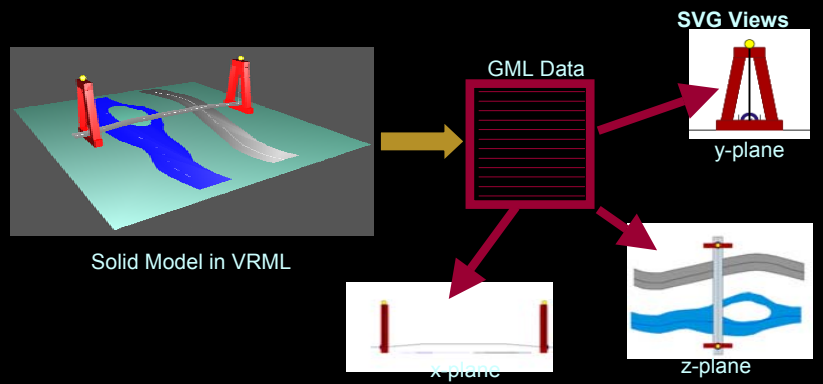


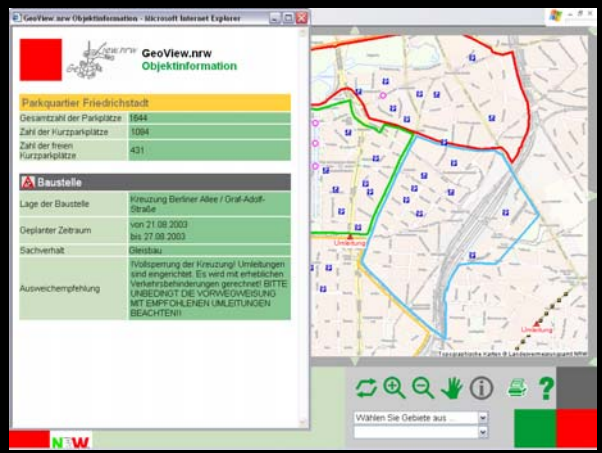


VRML, SVG and Web Mapping Examples



Images from Galdos Inc.





Co-ordination of Surveying and Mapping in Germany

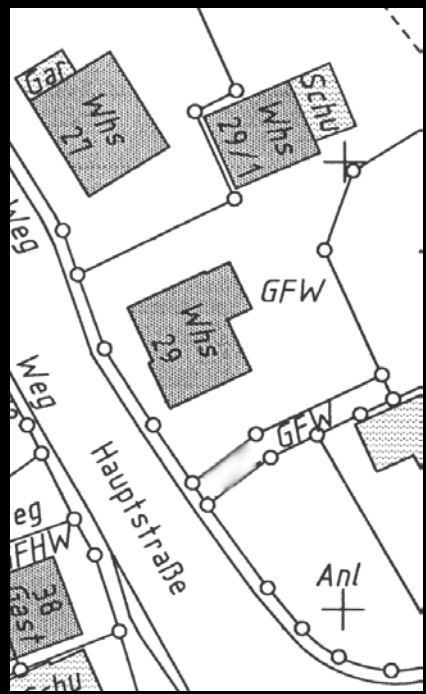
Surveying is a responsibility of the 16 States

Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany (AdV)

German land management systems today

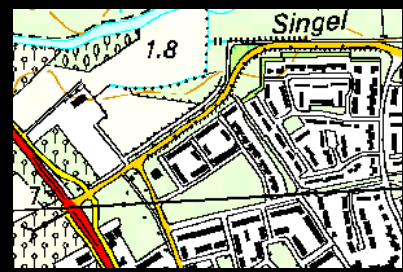
ALB - Automated Real Estate Register

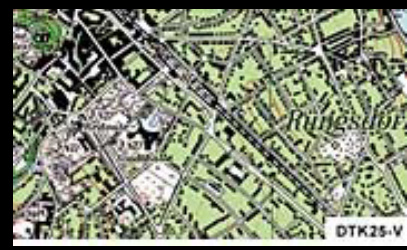
ALK - Automated Real Estate Map



Authoritative Topographic-Cartographic Information System

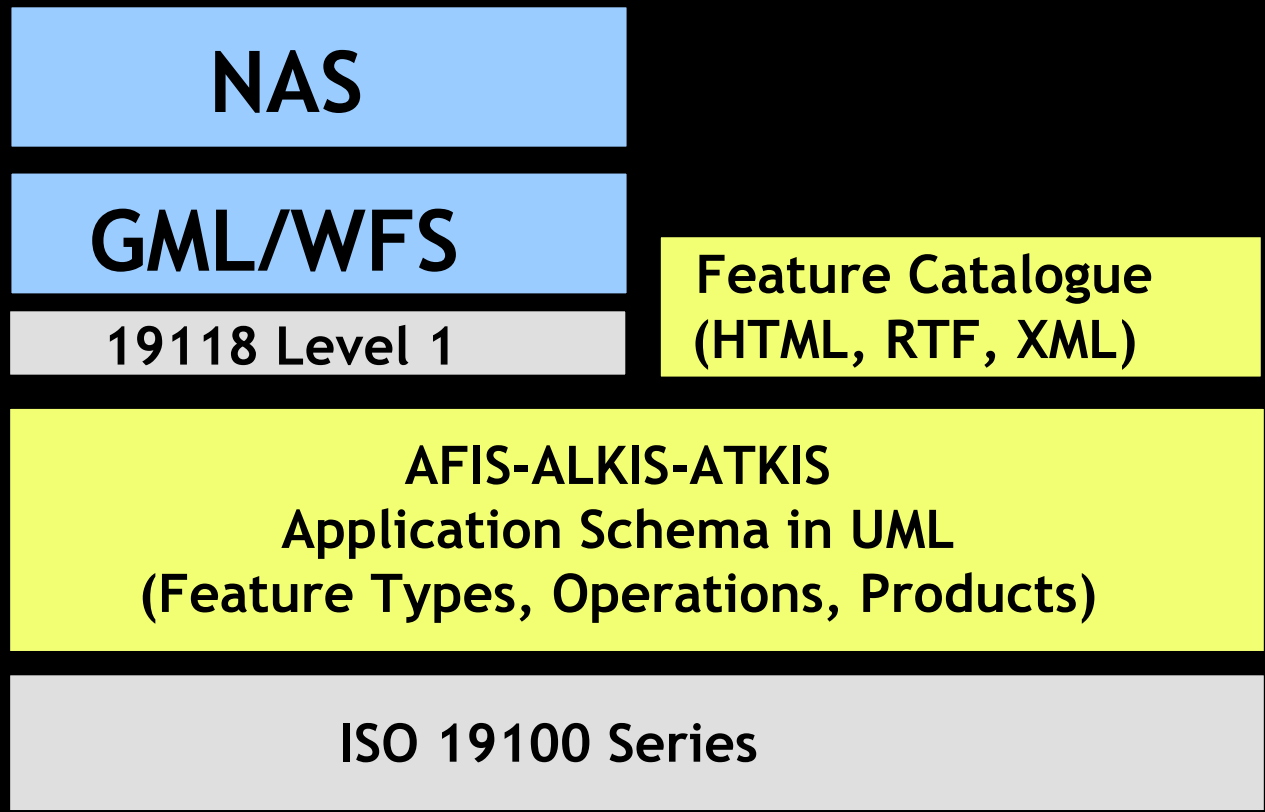
ATKIS



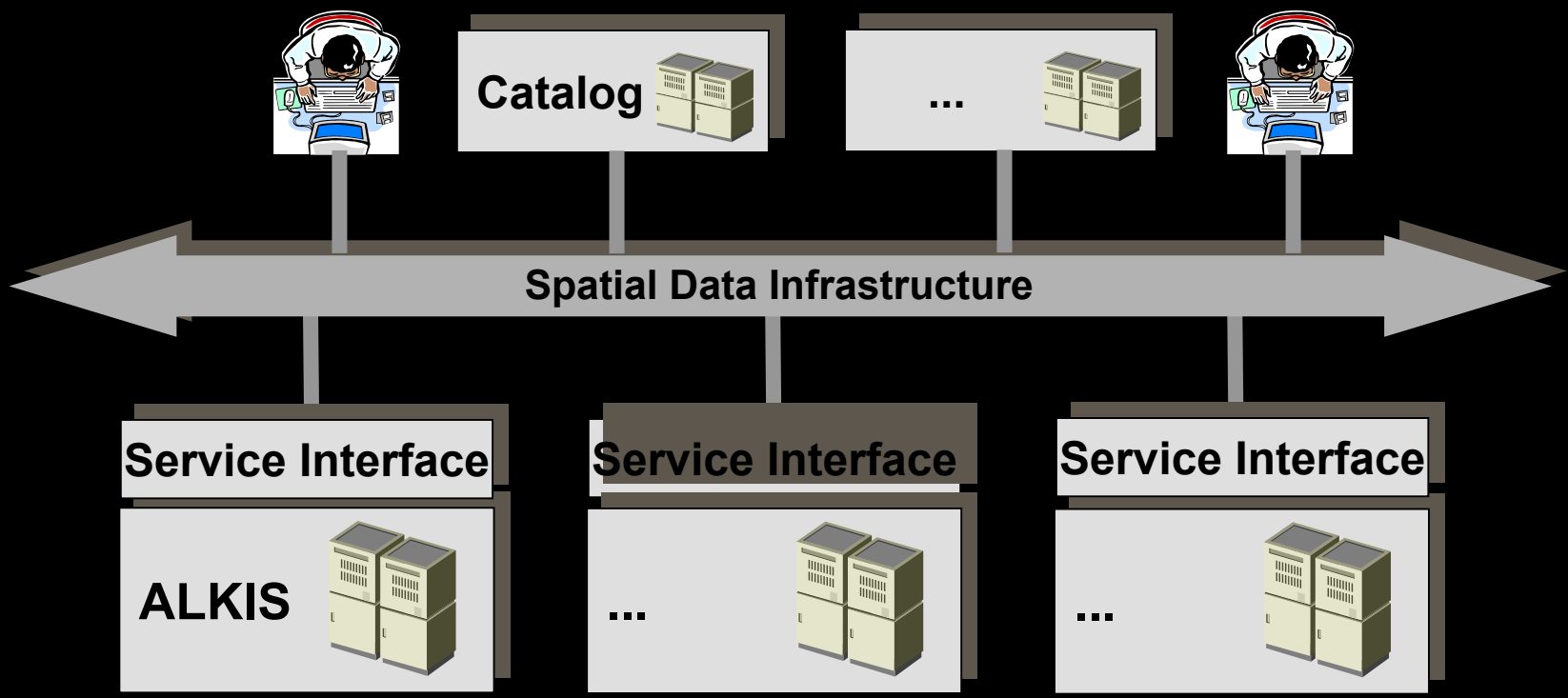


German land management systems 2005+ AFIS-ALKIS-ATKIS

- Integrated Feature Definitions
- Uses GML to represent its features
- ... and WFS/Filter Encoding schema components to encode operations

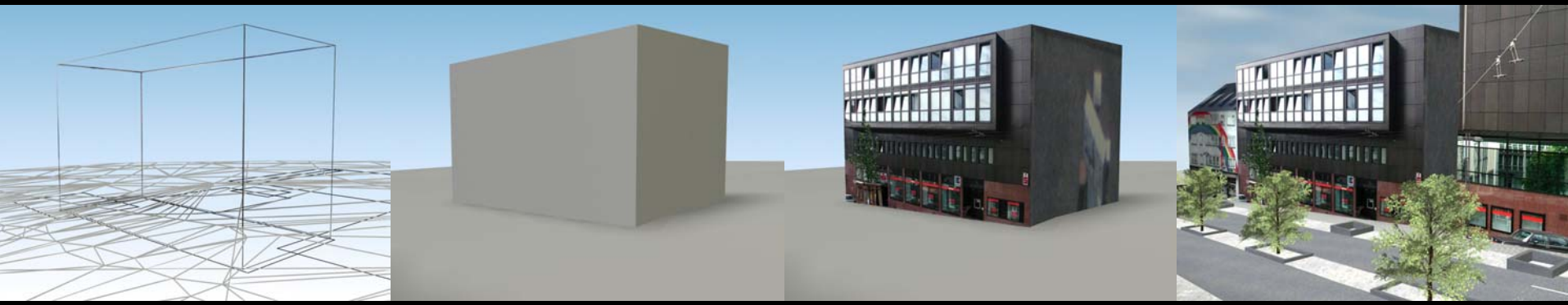


German land management systems 2005+ AFIS-ALKIS-ATKIS



- Integration into SDIs and providing on-demand services to users originally not in the focus of most states
- Now this is getting more and more important

CityGML: Interoperable exchange of 3D city models



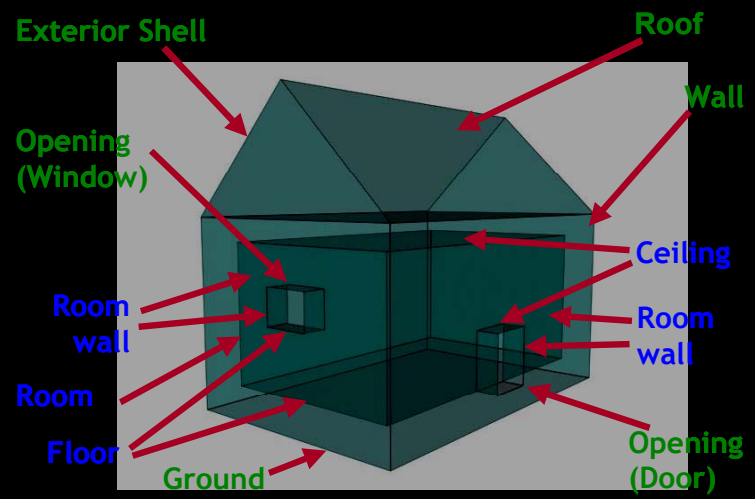
INITIATIVE Geodaten Infrastruktur NRW

CityGML slides by Th. Kolbe / G. Groeger (University of Bonn)

- **Digital Terrain Model / Relief**
- **Sites**
  - Buildings
  - Bridges
  - Tunnels
  - Walls
  - Landfills
  - Excavations
- **Transportation objects**
  - Streets
  - Railways
- **Water bodies**
- **Vegetation objects**
- **City furniture**
  - e.g. street lights, traffic lights, benches

CityGML: Highlights

- Geometric-topological model
- Recursive aggregation of objects and geometries
- Textured surfaces
- Feature-centric
- Subsurface objects (tunnels, pedestrian underpasses)
- Generic concept for external references
  - every object can have a link to external resources
- Multi-scale model: five levels of detail (LoD 0-4)
- Conceptual "3D City" Data Model
  - Specified as UML class diagrams
  - Geometry / topology according to ISO 19107
    - 'Simple Topology' (extended to 3D)



CityGML: Mapping to GML

- According to ‚Rules for application schemas'
- First phase: subset of the "3D City" data model:
  - Digital Terrain Models in LoD1 and LoD2
  - Buildings in LoD1 and LoD2
- No explicit representation of topology
  - Simple profile (easier for readers), like in the German cadastre standard ALKIS / NAS
  - Topological profile in the future

CityGML: 3D Pilot

- GDI NRW Testbed for CityGML 07/2004 – 03/2005
- Aim: Interoperable access to / exchange of 3D city models
- Realization of CityGML readers / writers and a visualization tool by different partners
  - Roundtrip evaluation (crosswise data exchange)
- 6 Project groups (each consisting of municipalities, software companies, and research institutes):
  - Cities: Berlin, Hamburg, Cologne, Düsseldorf, Leverkusen, Recklinghausen, Erkelenz
  - Universities: Bonn, Dortmund, Braunschweig, Freiberg; Fraunhofer Institute for Computer Graphics Darmstadt
  - GIS software companies from Germany

Summary

- GML is an adopted OpenGIS® Specification and plays a key role in the OGC Architecture
- GML enabled products are available
- A joint work item with ISO/TC 211 (→ ISO 19136)
- Provides a rich set of predefined types for Application Schemas - implementing many of the core ISO 19100 concepts
- Has an underlying model that makes processing GML documents easier and supports distributed datasets
- Separates presentation and content
- Works well in a Web Service environment

→ a building block of the Geospatial Web

Thank you for your attention !

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