GML
Geography Markup Language

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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 GIS Consortium, CEN/TC 287, and other bodies
  - co-author of GML and Project Leader of ISO 19136
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
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

- Give me all forest areas with a tree age classification of 80 years or more (for a certain species)!
- Give me all road sections, which run through the affected forest areas!
- Which roads are most probably affected by the storm?
- Show me all roads in a map and highlight the most probably affected ones!

GML enables a vendor-neutral exchange of spatial data

- GIS X
- GIS Y
- Oracle
- File
- ...
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
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.

- 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
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.

The state of a feature is described by a set of properties, in which every property is in principle represented by a triple \( \{ \text{name}, \text{type}, \text{value} \} \).
- 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).
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>
```

```
<<Enumeration>>
  MaleOrFemale
  + male
  + female
</<<Enumeration>>>
```

```
Person
+ name : GenericName
+ age : Integer
+ sex : MaleOrFemale
```

Three ways to represent a relationship between two features:

1. The feature is either a child element of the property or referenced by an xlink:href attribute in the property element
2. The xlink:href attribute is interpreted in the way that the value of the property is the feature referenced in the link
3. The referenced feature can be part of the same GML document or anywhere in the internet/intranet

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

```
<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>
```
Linking GML Application Schemas

- Environment
- Cadastre, Land Use
- Road Infrastructure
- Traffic Management
- Traffic Information

GML - geometry, topology, temporal, etc.

XML Schema / Xlink - basic data types

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.

- Traffic Messages
- Roads
- Administrative Boundaries
- Buildings
- Parcels
Learn from the HTML Web ...

... and use GML as the lingua franca of the geospatial web
GML Development

Open GIS 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

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

ISO/TC 211 Editing Committee

GML 3.2 → 2005

ISO CD 19136 = GML 3.1
February/March 2004

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 - Presentation
- 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
- ISO 19138 - Geocoding services
GML and ISO 19100

User-defined Application Schema (UML, ISO 19109)

Profile of the ISO 19100 Harmonized Model

implements

GML Schema (XML Schema)

Encoding Rules

GML Application Schema (XML Schema)

(simplified)

Support for Application Schema designers

- 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
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

Solid Model in VRML

Images from Galdos Inc.

SVG Views

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

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
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

- 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 cadastral 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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