Harmonisation and Schema Transformation of Existing Spatial Data

June 2012

Agenda

- FME Tools to support INSPIRE
  - Harmonisation principles
  - Key challenges
  - Examples
- con terra’s INSPIRE Solution Pack for FME
  - Examples and demos
- Consuming INSPIRE
  - Reading
  - Building value added services

FME and INSPIRE

- Safe is committed to supporting INSPIRE interoperability including:
  - INSPIRE GML reading, writing and validation
  - Schema mapping to INSPIRE data model
  - Web services, security and metadata support
- Safe works closely with our partners to provide INSPIRE solutions:
  - Conterra: FME INSPIRE Solution Pack
    - Supports ArcGIS for INSPIRE
    - North Rhine Westphalia and others
  - Metria: Swedish Protected Areas Pilot
  - AedSicad: German NAS to INSPIRE transforms
  - HNIT: Lithuania SDI (LGII)

Safe Software Facts

- Private company
- Founded in 1993
- Headquarters in Vancouver, BC, Canada
- 90+ employees
- 50+ value-added resellers & system integrators in 35 countries
- ~100 FME Certified Professionals & Trainers around the globe
- Thousands of customers across 116 countries
Introduction to FME

- What is FME?
- How Does FME Work?
  - Centralized
  - Semantic
  - Transformational

Data Types

Translation

FME supports reading from a wide array of data formats and types
- 300+ formats, with more added each year
- CAD, GIS, XML, raster, database, non-spatial, 3D

Transformation: FME Workbench
Common Spatial ETL Workflows - Cases

- Non-spatial to spatial
- Merge spatial with attributes
- CAD to GIS
- Data validation
- Data cleaning
- Migration between data models
- Database loading, replication and extraction
- Automation

Common Spatial ETL Workflows - Tasks

- Constructing geometry
- Transferring attributes
- Joins to external databases
- Testing geometry and attributes
- Schema mapping (field, feature type)
- Feature merging and fanout

Examples...

CAD<-> GIS
- Exchange data between CAD and GIS

Quality Assurance
- Validate data. Easy to build data validation web service.

Data Integration and Federation
- Combine data from multiple sources

Schema and Spatial Data Restructuring

Examples...

Data Migration and Loading

- "Spatialize" non-spatial data
  - Convert simple non-spatial text files to spatial
  - Exploit Geocoding services to spatialize addresses

Format conversion
- Convert data from one format to other formats. Free example web service

Stream spatial data via the web
- Example real-time web service

Web-based spatial data download
- Example web service
FME Tools for INSPIRE

- Format translation
- Schema mapping
- Data validation
- Database loading and extraction
- WFS, GML, XML: reading, validation, publication
- Web services: WFS, WMS, integration with others
- Metadata support
- Enterprise services with FME Server

FME Tools for INSPIRE XML

- GML reading and writing
- Full support for INSPIRE GML and metadata
- XML Reading – read virtually any XML and extract features
- XML Processing – validate, format, and update XML
- Geometry Extraction (features > GML objects)
- XML Writing - Write XML or GML no matter how complex
- XMLTemplater
  - FME merges attribute values into a template structure
  - Template per feature type and dataset
- XML Validation – validated to ensure compliance with INSPIRE schemas for both data and metadata

INSPIRE - Goals

- Assist EU environmental management
- Extend Member States’ SDIs using:
  - Common data model
  - Open standards
- INSPIRE SDI should:
  - Combine spatial data from different sources
  - Share spatial data between public authorities

INSPIRE - Challenge

- You want to meet INSPIRE data provision requirements, but your data is organized rather differently
### Harmonisation concept

- **Harmonisation**: implied INSPIRE requirement.
- Disparate sources must be mapped to a **common destination data model** to support integration.
- Core to the harmonization workflow is a process called **schema mapping**.
- Delivered by services based on **open standards**.

### SDI Harmonisation Principles

Typical stages:
1. Evaluation
2. Assembly
3. Transformation
4. Validation
5. Publication

**Spatial ETL** concept (Extract, Transform and Load), as applied to INSPIRE SDI’s.

### Evaluation

- Assess destination schema and data requirements
- Assess source datasets and schema
- Closely inspect actual representative datasets
- Consider fundamental differences in representation

### Data Assembly

- Assess the diversity of source data types involved.
  - vector, raster, CAD, GIS, database, text, XML, web, 3D, sensor and non-spatial
- Address format and semantic translation requirements
- Decide how to perform necessary joins
  - ID joins, spatial relates, nearest neighbor, one to many relationships

**Goal is to build a data structure to correspond with INSPIRE requirements.**
FME supports reading from a wide array of data formats and types
- 300+ formats, with more added each year
- CAD, GIS, XML, raster, database, non-spatial, 3D

Transformation: Geometry
- Non-spatial to spatial
- Geometry extraction (spatial to GML)
- Representation transform: CAD drawing lines with labels to GIS polygonal features with attributes
- Coordinate System Reprojection (ED50 to ETRF89)
- Simple to complex geometry
  - Source point and polygon data to multiple geometric representations (city as point / area, river as line / area)
- Generalization and interpolation
  - Highly granular national and regional datasets often require thinning to be usable on pan-European scales

Geometric Transformation
- What is geometric transformation?
  - Example: Intersection

Data Transformation - Schema
- Reshape source data to match required destination schema
- Schema mapping
  - feature type
  - attribute name
  - new attribute creation
  - code lists
  - conditional value mappings
Schema Mapping in FME

Feature Type Mapping in FME Workbench

Attribute Mapping in FME Workbench

FME Data Model Restructuring: Attribute Names & Values

Value Mapping

FME SchemaMapper: INSPIRE geographic names

Name mapping

Name & value mapping

Harmisation Stages: INSPIRE Geographic Names
### Schema Mapping: NVR to INSPIRE

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<thead>
<tr>
<th>Fieldname</th>
<th>Source Attribute</th>
<th>Destination Attribute</th>
<th>Field Insplen</th>
<th>Description</th>
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### Geographic Names: GML Result

- **Validation**
  - INSPIRE schema validation (xsds)
  - Data integrity
    - Unique IDs
    - Geometric integrity (closed polygons)
    - Null values (nullable?)
    - Valid values: ranges and domain codes
    - Data gaps
    - Bounds
    - Network integrity
    - Custom validity rules specific to domain

  *Ensure data quality throughout the data transformation process.*

- **Publication**
  - How to make data most accessible?
    - Support for mandated open standards and OGC services
    - Support for defacto industry standards, proprietary and legacy agency systems
    - Possibilities for Invoke Spatial Data Services as a bridge
      - accepts user request
      - queries required INSPIRE OGC services
      - provides desired web service (KML, PDF)
Publication

- Produce INSPIRE compliant GML
- Provide discovery, view or download services, for WxS, GML and other desired formats
- Publish with FME Server or integrate with your geo web server of choice:
  - ArcServer (ArcGIS for INSPIRE)
  - Others
  - Spatial Data Services

Example INSPIRE Solutions by FME Partners

- INSPIRE Solution Pack from con terra (25+ implementations across Europe)
- Metria, Sweden (Protected Areas Pilot; Swedish Department of Transportation)
- Spatialworld, Finland (National Land Survey)
- HNIT Lithuania (LGII)
- Technical University of Munich (multiple INSPIRE projects)
- AED Sicad (NAS to INSPIRE schema mapping and conversions)

Metadata

- Metadata support and demo

LGII – Lithuania Geospatial Portal Translation Support

File Formats:
- AutoCAD DXF / DWG
- ESRI Personal Geodatabase
- Shape
- MapInfo TAB
- Microstation Design V8
- GML
- GIF / PNG
- JPEG
- TIFF
- ERDAS IMG
- ECW

Coordinate systems:
- LKS94
- WGS84
- ETRS89
- 1963
- Pulkovo 1942
- UTM (34, 35 zones)

Other data sources:
- WFS
- SDE
- Files
LGII Highlights
- Support for diverse range of formats required by member agencies.
- Solution combines FME, ArcGIS and con terra tools
- Conversion rules critical for harmonisation process
- Centralized workflow and common data model simplified source to destination mapping
- FME Server supports sharing for LGII partners, business, education and research institutions, NGOs
- LGII provides real value with broader access to seamless data via a common INSPIRE schema

LGII Geoportal Central System Components
- con terra’s SDI Suite
  - Content and user management
  - E-Commerce and accounting
  - Reporting
- ArcGIS Server
  - WxS services (WMS, WFS, WCS)
  - Catalog services (CAT)
  - Metadata harvesting (CSW, WAF)
  - Spatial data editing, redlining functionality
- FME Server
  - Data conversion for download
  - Transformation between data schemes, data models and formats

INSPIRE Pilot: Swedish Protected Sites
- Swedish EPA project with Metria of Sweden
- Read from 3 different data sources (pilot):
  - Swedish Protected Areas
  - Helsinki data commission (Helcom)
  - European Natura 2000 habitats
- Perform required joins, generate IDs
- Transform to INSPIRE schema
- Load INSPIRE-like staging database (PostGIS)
- Publish INSPIRE web services based on staging database

Helsinki Commission Source Data
Data provided by Lantmäteriet, the Swedish mapping, cadastral and land registration authority www.lantmateriet.se, and Metria, Sweden www.metria.se.

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FME Import to Staging Database: Swedish NVR Importer

Protected Sites Schema Mapping: NVR to INSPIRE
Swedish Protected Sites Update

- Swedish Environmental Protection Agency
  - Production system for down load services following on the successful pilot last year.
  - Metria hosts the protected sites view services.
  - Metria performs schema mapping for five protected sites source datasets to INSPIRE using FME Server.

Swedish Protected Sites Update

- Swedish Transportation Administration
  - System supports propagation of municipal and regional road data to national dataset
  - Data model transformation and QC to translate 2.5 million road links into NVDB
  - Transform between NVDB and INSPIRE compliant data
  - Workflows automated by FME and FME Server
  - Validation key to support upload services

Validation at Swedish Transportation Administration

Other INSPIRE Examples

- Technical University Of Munich
  - XMI mapping of UML schema transformation rules
  - Maps between AAA and INSPIRE data models
  - Uses FME to perform schema mapping based on XMI

- Nature SDI: Datasiel, Liguria Region, Italy
  - FME used for data harmonization and loading a staging database
  - Generates INSPIRE compliant protected sites GML for publication via WFS

- Croatian NSDI: Geoportal
  - By State Geodetic Administration (SGA)
  - Central register of base map, ortho, spatial units, cadastral
  - Database of geodetic control points
  - FME used primarily in data migration and updates

Example INSPIRE Solutions by FME Partners

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FME provides a full range of tools for INSPIRE, our partners provide complete solutions
- Data modeling interface makes it easier to handle schema mapping - no coding required.
- Automated workflows save time in creating and maintaining transformation processes.
- Self-documenting workspaces ease collaboration
- Easily integrates with INSPIRE-compliant services:
  - Esri ArcGIS Server
  - Others
- Scalability and performance support quality of service requirements
Solution Pack Highlights

- Simplify data transformation and schema mapping for ArcGIS for INSPIRE
- Predefined FME Workbench templates help jump start the data migration and harmonisation process
- Connect your existing databases to the standardized ESRI INSPIRE Geodatabase
- Automate data load and update processes
- Quality assurance and metadata
- Publish once and use many times

Additional functionality

- Template workspaces (destination schema and predefined workspaces)
- Destination data schema for all Annex 1 themes (INSPIRE GDB of ArcGIS for INSPIRE)
- More than 100 additional INSPIRE transformers
  - INSPIRE specific value and attribute mapping (voidable values)
  - Transformer for recurrent tasks (3D management, lifespan setter)

Additional INSPIRE information

- Tutorial workspace (complete sample mapping [AdminUnits])
- Additional HTML Workbench Help (description of INSPIRE GDB data model)
- Direct access to the INSPIRE data specification (link to specific themes)
INSPIRE Transformers (Attribute and Value Mapping)

- Automated filling of obligated attribute
- legalStatus
- legalStatus_void
- Possible values for obligated attributes (if not void)
- agreed
- notAgreed
- Predefined void value reasons (if void)
  - 0 = no reason given
  - 1 = reason: unknown
  - 2 = reason: unpopulated
- AttributeRenamer functionality
  - usable if attribute already existing

INSPIRE Compliant GML – Now What?

FME allows you to consume INSPIRE compliant GML as well as create it.

How is anyone going to use INSPIRE?
- Why not build value on the web services every one else is investing in?
- Extract and flatten complex INSPIRE structures for use within your GIS applications
- Modify INSPIRE structures with XML update functions

Leverage INSPIRE data for business intelligence.
What is XML?

- Extensible Markup Language (XML)
- Defines a set of rules for encoding documents in a format that is both human-readable and machine-readable
- XML 1.0 Specification produced by the W3C
- Design goals emphasize:
  - Simplicity
  - Generality
  - Usability over the Internet


What is XML?

- A textual data format
- Also called “structured text”

E.g.
<br /></br>
</name>Joan</name>
</FMEUser>

Defines the grammar, not the words.

XML Opportunity and Challenges

- Opportunity: XML / GML are growing in use for exchange formats and metadata - open and self-documenting
- Challenge: Not necessarily easy to read or write.
- XML is often very nested or object oriented
- GIS works with flat or relational structures
- Can be hard to convert between the two or modifying elements within the XML structure

XML vs. Relational

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<td>Vancouver</td>
<td>11-22-99</td>
<td>12-11-09</td>
<td></td>
</tr>
</tbody>
</table>
XML Concepts

- Tag `<Course>`
- XML Element `<Course>` FME `</Course>`
  - Child element `<Course>` `<Id>101</Id>` ...
  - Element attribute `<Course id="101">`
- GML Object
  - Object property
  - Object attribute
- XML Schema - xsd’s
- Namespaces
  - `<ps:f:geometry>`

XML Reading

- XML Profile (GML, KML, NAS etc)
- Feature Path (XML tag to match)
- XQuery
- XfMaps
- XRS

XML Profile Readers

- FME supports reading more than 30 XML formats.
- Type XML in the Formats Gallery to see them.
- Examples: GML, KML, GeoRSS, WFS, GPX, CityGML, OSM, NAS, TiGERGML, LandXML, etc
- Don’t forget to check the reader parameters
- Sometimes our profile reader does not support some custom schema variations.
- XML reader + workspace can allow you to read virtually any XML, even if it’s complex GML

XML Formats in FME 2012

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<th>Read/Write</th>
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</table>
Reading INSPIRE GML: with flattening

FME Tools for INSPIRE XML

- GML reading and writing (3.2.1 and earlier)
- XML Reading – read virtually any XML and extract features
- XML Processing – validate, format, and update XML
- Geometry Extraction (features > GML objects)
- XML Writing - Write XML or GML no matter how complex
- XMLTemplater
  - FME merges attribute values into a template structure
  - Template per feature type and dataset
- XML Validation – validated to ensure compliance with INSPIRE schemas

Consuming INSPIRE: Value added Spatial Data Services

- Reading INSPIRE GML
- Building Spatial Data Services that consume INSPIRE services and produce new services adapted to consumer client requirements
  - KML
  - PDF
  - GeoJSON
- Enabled by FME Server
  - Take spatial ETL workflows (FME workspace) and generate a spatial transformation service

How FME Server Works with FME Desktop

FME Desktop
Author and run spatial ETL tasks

FME Server
Run and share spatial ETL capabilities
Five Key FME Server Services

1. Spatial Data Download & Streaming Services
2. Scheduled, Centrally Managed Data Transformation
3. Server-Based Spatial Data Conversion Service
4. Spatial Data Upload and Validation Service
5. Bulk Data Loading and Migration Service

FME Server Architecture

- Brings spatial ETL capabilities to server
  - Federate data on the fly.
  - Transform data so user’s get view they need.
  - Serve data in any supported format.
- Service Oriented Architecture (SOA)
  - Makes data available in a wide variety of different services.
- Model Driven Approach (MDA)
  - Workbench is the authoring environment!
  - FME Server operations are specified with workspaces
- Provide data access in a myriad of Web services.
  - Standards-based access protocols.
  - Defacto standards access protocols.
  - Variety of APIs.

Access Protocols are the formats of the Web!

FME Server

- Scalable, efficient spatial ETL solution
  - Provide users with access to spatial data - where, when & how they need it
  - Centralize spatial data transformation and distribution tasks in a server environment
Share Spatial ETL Tasks over the Web

- Author spatial data flows in FME Workbench
- Available as part of a FME Desktop license
- Publish to FME Server with one click
- For storage in a central repository
- Enable others to run FME workspaces – right over the web

Transform Large Volumes of Spatial Data

- Offload intensive spatial ETL processing tasks to FME Server for faster throughput
- Scalable, services-oriented architecture
- Large jobs can be split into many small jobs.

Stream Spatial Data to Web Applications

- Dynamically transform and stream data on the fly in any FME-supported format
- Raster formats (PNG, GIF, TIFF and JPEG)
- Web-friendly streaming formats like KML (Google Earth), GeoRSS and GeoJSON
- Supply data to mash-ups
- Integrate with popular web mapping apps
  - Google Earth/Maps, Virtual Earth, OpenLayers and more

Offer a Spatial Data Download Service

- Let users download the spatial data they need in the exact format and projection they want
- clip, manip’ zip and ship

- Create a spatial data clearing house
Summary: FME Benefits

- **Improve efficiency**
  - Eliminate manual, hand coding
  - Validate and QA your data before it goes into your database
  - Service diverse spatial data requests quickly and easily
- **Reduce costs**
  - Learn, use and maintain a single integrated solution
  - Re-use FME workspaces across multiple projects/users
- **Eliminate risks**
  - Invest in a proven, long-term solution
    - FME is consistently chosen by the best in GIS
    - FME is always ahead of format changes in the market

FME Tools for INSPIRE

- Format translation
- Schema mapping
- Data validation
- Database loading and extraction
- WFS, GML, XML: reading, validation, publication
- Web services: WFS, WMS, integration with others
- Metadata support
- Enterprise services with FME Server

FME Tools for INSPIRE

- FME provides a full range of tools for INSPIRE, our partners provide complete solutions
- Data modeling interface makes it easier to handle schema mapping - no coding required.
- Automated workflows save time in creating and maintaining transformation processes.
- Self-documenting workspaces ease collaboration
- Easily integrates with INSPIRE-compliant services:
  - leading OGC servers such as Deegree, MapServer and GeoServer
  - Esri ArcGIS Server
- Scalability and performance support quality of service requirements

INSPIRE Trends

- Integration between proprietary and open standards – especially as deployment moves to regional and local agencies
- Increased focus on consuming INSPIRE services and GML
- More opportunities for spatial data and invoke services to bridge this gap
- Examples: machine to machine communication to provide seamless support for KML and PDF streaming
- Success = User isn’t aware they are accessing INSPIRE
Thank You!

Questions?

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