Interoperability for the Enterprise

David Danko
Senior Consultant – GIS Standards, ESRI
What we are going to talk about

- Defining Interoperability
- Standards – a key component
  - ISO
  - W3C
- Geographic standards
  - The work of ISO TC211 and OGC and others
- Understanding Geospatial Standards
- GeoWeb Service Standards
- Portals
GIS has always required interoperability

- Geographic analysis
  - Multiple sources, multiple organizations
  - Distributed within a community
  - Merging diverse information types

- Enterprise GIS
  - GIS evolving beyond isolated communities
  - GIS merging with broader IT infrastructures

- GIS Web Services
  - Enabled by distributed networks
  - Loosely coupled

- Government Policy
  - EU Directives
  - US E-government Act

Geography is a “Key” an integrating technology
Interoperability

“the ability of two or more systems or components to exchange information and to use the information that has been exchanged” (1)

Be able to:

- find what you need;
- access it;
- understand and employ it;
- have goods and services responsive to the needs of consumers (2)

(1) IEEE
(2) ISO TC211
Types of interoperability

- **Technical**
  - Machine to machine connections
  - Software module interaction
  - APIs
  - Formats...

- **Semantic**
  - Common understanding concepts, terms
  - Interdisciplinary special vocabularies...

- **Human**
  - Cooperation
  - Training...

- **Legal/Policy**
  - Digital rights, ownership
  - Lack of responsibility, ...
Interoperability Enablers

- Authorization
- Copyright
- Business Agreements
- Policy Framework
- Incentives to cooperate
- Business Models
- Infrastructure
- Networks

- Support for multiple
  - Languages
  - Customs
  - Views
  - Data Formats
  - Projections
  - Datums
- Metadata
- Shared Best Practices
- Standards
How does ESRI address interoperability enablers?

- **Participating in Standards**
  - to understand interoperability and implement standards
    - from DIME > SDTS > VPF > KML > GML 3.2
  - with domain specialists to develop standardized data/information models
  - as good GIS citizens to consensually develop good standards and specifications

- **Providing**
  - GIS education, publications
  - ETL capabilities to transform between formats and models
  - the Geography Network and ArcWeb Services
    - experiment and learn about digital rights, business models, ownership, authorization...

- **Supporting**
  - organizations which promote interoperability and the use of standards
    - GSDI, Digital Earth, FGDC, GeoConnections, INSPIRE, GWG...
Participation in Standards

- Implementing
  - Platform
  - GIS standards
  - IT/industry standards

- Development
  - International Standards
  - Regional Standards
  - National Standards
  - Information Community Standards
    - ICAO, IHO, Wireless...
What is a standard?

As defined by ISO

http://www.iso.ch

**Definition:**

- **Documented agreements**
  - between a provider and a consumer
- **Reference documents**
  - used in public contracts or international trade
- **Definitions of characteristics, Technical specifications, precise criteria, rules, guidelines,**

**Function:**

- Ensure materials, products, processes and services are fit for purpose
- Help ensure interoperability
- Promote innovation, competition, commerce and free trade
Standards

Political compromise

Democratic mechanism

Technology transfer

Consensus technical solutions

Functions

From H. Tom – Standards for Enabling International Interoperability
Standards

- Make things work – affect every aspect of life
- Widespread use of Standards
  - Make things work around the world
  - Increase efficiency - globally
- Developing standards is a lot of work
  - Many organizations involved
  - Take time to develop
  - Complicated
  - 20% technical, 80% political
International Organization for Standardization

- ISO from Greek ISOS meaning “equal”
- Founded in 1947
- 146 member nations
  - 1 member per country (represented through national standards organization – ANSI, SAC, etc)
  - 13,700 standards, 3,000 technical bodies, 30,000 experts
- NGO – unlike UN
  - Delegates not national governments
  - Roots in private sector and industry associations
Hallmark of ISO Brand

- **Equal footing**
  - Every ISO member institution has right to take part
  - 1 nation = 1 vote regardless of size or economic strength

- **Voluntary**
  - ISO has no legal authority
  - Adopted by nations – health, safety, etc

- **Market driven**
  - Developed by experts from industry, technical, business, government, academic

- **Consensus**
  - Ensures widespread applicability
  - Remain current
Benefits of ISO Standards

- **Business/Trade**
  - Wide acceptance of products and services
  - Free to compete in broader market
  - Remove technical trade barriers
  - Support political trade agreements

- **Government**
  - Provides technical and scientific underpinnings for health, safety, environmental legislation

- **Consumers**
  - Provides assurance about quality, safety, & reliability
  - Contribute to quality of life
The ISO Development Process

- **All work performed in technical committees (TC)**

- **Formal Process**
  - Refined over 50 years
  - Stages and timelines fully defined

- **Consensus based**
  - Drafts considered until consensus reached through voting process by P-members

### Stages

- **Proposal Stage**
- **Preparatory Stage**
- **Committee Stage**
- **Enquiry Stage**
- **Approval Stage**
- **Publication Stage**

*This is the stage to start product development*

*This is the stage to use in RFP*

*This is the stage to start prototyping*
Provides a Framework for Integrating GIS and Enterprise Systems

Web Services & Messaging

XML

UDDI

SOAP

World Wide Web

...loosely coupled, coarse grained, distributed
Web Services

- An application that exposes a Web-accessible API.
- A standard platform for building interoperable distributed applications.
- Achieves interoperability by relying on vendor and platform neutral standards such as XML and XSD.

- **XML** - eXtensible Markup Language
- **XSD** - XML Schema Definition Language
Web Services – Technology Stack

- **SOAP** - Simple Object Access Protocol is a lightweight XML based protocol used for **invoking web services** and exchanging **structured data and type information** on the Web.

- **UDDI** - Universal Description Discovery and Integration provides a mechanism for clients to **dynamically find** other web services.

- **WSDL** - Web Services Definition Language (WSDL) is an XML document that describes a web service. It specifies the **location of the service** and the **operations (or methods)** the service exposes.
Service Oriented Architecture

*From Web Service Architecture, 14 Nov. 2002
Geographic Information Standardization
GIS Standardization - functional areas

1. **Basic Geographic Structures** *(semantic interoperability)*
   - SDTS, ISO Spatial Schema, Coordinate Reference System standards

2. **Content Description** *(semantic interoperability)*
   - FACC, SDSFE, Standardized Data Models
   - ISO Feature Catalog Methodology, UML, Application schema, FGDC Metadata, ISO Metadata

3. **Data Management** *(semantic and technical)*
   - OGC Simple Features

4. **Data Formats** *(technical interoperability)*
   - VPF, OGC GML

5. **Visualization** *(semantic and technical)*
   - SLD, MIL-STD 2525

6. **GeoWeb Services** *(technical interoperability)*
   - OGC Catalog, Web Services, SOA
Using standardized spatial schem as using standardized modeling languages and rules for application schema as producing user views.
... building the foundation of the geospatial infrastructure, brick by brick ...
ISO TC 211 Projects

- ISO 6709:1983 - Standard representation of latitude, longitude and altitude for geographic point locations
- ISO 19101 - Reference model
- ISO 19102 (deleted)
- ISO 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
- ISO 19138 - Data Quality Measures
- ISO 19139 - Metadata - Implementation specification
- ISO 19140 - Technical amendment to the Geographic information series of standards for harmonization and enhancements
- ISO 19141 - Moving features
- ISO 19142 - Web Feature Service
- ISO 19143 - Filter Encoding
- ISO 19144 - Classifications Systems
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The Foundation

- **Framework/standards infrastructure**
  - Basic architecture
  - Locate, understand
    - Metadata
    - Quality
  - Basic structure
    - Spatial, temporal schema
    - CRS definition
- **Access**
  - Simple feature access
  - Web map services
- **Data content description**
  - Feature Catalog Methodology
  - Rules for Application Schemas

Adv. G-Strat
WG 2
Geospatial models and operators

WG 3
Geospatial data administration

WG 4
Geospatial services

WG 5
Profiles and Functional standards

Chairman
Olaf Østensen
Norway

Organization 1994-2001
ISO TC211 Standards
Used by ESRI Development

- ISO 6709:1983 Standard representation of latitude, longitude and altitude for geographic point locations
- ISO 19101:2002 Reference model
- ISO/TS 19103:2005 Conceptual schema language
- ISO 19105:2000 Conformance and testing
- ISO 19106:2004 Profiles
- ISO 19107:2003 Spatial schema
- ISO 19108:2002 Temporal schema
- ISO 19109:2005 Rules for application schema
- ISO 19110:2005 Methodology for feature cataloguing
- ISO 19111:2007 Spatial referencing by coordinates
- ISO 19112:2003 Spatial referencing by geographic identifiers
- ISO 19113:2002 Quality principles
- ISO 19114:2003 Quality evaluation procedures
- ISO 19115:2003 Metadata
- ISO 19116:2004 Positioning services
- ISO 19117:2005 Portrayal
- ISO 19118:2005 Encoding
- ISO 19119:2005 Services
- ISO/TR 19120:2001 Functional standards
- ISO/TR 19121:2000 Imagery and gridded data

- ISO/TS 19122:2004 Qualification and certification of personnel
- ISO 19123:2005 Schema for coverage geometry and functions
- ISO 19125-1:2004 Simple feature access — Part 1: Common architecture
- ISO 19125-2:2004 Simple feature access — Part 2: SQL option
- ISO/TS 19127:2005 Geodetic codes and parameters
- ISO 19128:2005 Web map server interface
- ISO 19131:2007 Data product specifications
- ISO 19132:2007 Location-based services — Reference model
- ISO 19133:2005 Location-based services — Tracking and navigation
- ISO 19134:2007 Location-based services — Multimodal routing and navigation
- ISO 19135:2005 Procedures for item registration
- ISO 19136:2007 Geography Markup Language (GML)
- ISO 19137:2007 Core profile of the spatial schema
- ISO/TS 19138:2006 Data quality measures
- ISO/TS 19139:2007 Metadata — XML schema implementation
Open Geospatial Consortium

Spatial connectivity

Vision

◆ A world in which everyone benefits from geographic information and services made available across any network, application, or platform

Mission

◆ Our core mission is to deliver spatial interface specifications that are openly available for global use
What is the OGC?

- **Open Geospatial Consortium (OGC)**
  - Global, not-for-profit, international voluntary consensus standards organization
  - Over 350 industry, government, research and university member organizations
  - Founded in 1994, Incorporated in US, UK, Australia

OGC leads the development, testing, promotion and harmonization of open spatial standards.
Where does OGC fit in the ‘standards’ world?

ISO/Other National Domains: Object/Abstract Models, Content, Vocabulary

OGC Software Interfaces: Instantiate Domain and Dejure into Infrastructure

OASIS/ETF/W3C Infrastructure: WSDL, UDDI, SOAP, XML
Adopted OGC Specifications
Implemented by ESRI

- Catalogue Service
- Coordinate Transformation
- Filter Encoding
- Geographic Objects
- Geography Markup Language
- GML in JPEG 2000
- Grid Coverage Service
- Location Services (OpenLS)
- Observations and Measurements
- Sensor Model Language
- Sensor Observation Service
- Sensor Planning Service

- Simple Features
- Simple Features CORBA
- Simple Features OLE/COM
- Simple Features SQL
- Styled Layer Descriptor
- Symbology Encoding
- Transducer Markup Language
- Web Coverage Service
- Web Feature Service
- Web Map Context
- Web Map Service
- Web Processing Service
- Web Service Common
OGC specs equivalent in ISO

- OGC Grid Coverages
  - ISO 19123 Schema for coverage geometry and functions
- OGC Simple Feature Specification – SQL
  - ISO 19125-1 Simple feature access – Part 1: Common architecture
  - ISO 19125-2 Simple feature access – Part 2: SQL Option
- OGC Web Map Service
  - ISO 19128 Web Map Server interface
- Geography Markup Language
  - ISO 19136 – GML
- OGC Web Feature Service
  - ISO 19142 Web Feature Service
- OGC Filter Encoding
  - ISO 19143 Filter Encoding
- These last two are now in development in ISO
Examples of Standards and Organizations in which ESRI participates to establish Technical Interoperability

ISO 19139 Metadata XML Schema

OGC WMS

OGC GML
Examples of Standards and Organizations in which ESRI participates to establish Semantic Interoperability

ISO 19115 Metadata

Title = name by which the resource is known

OASIS Common Alerting Protocol-CAP

msgType = the code denoting the nature of the alert message.

<element name="msgType">
  <simpleType name="msgType">
    <restriction base="string">
      <enumeration value="Alert"/>
      <enumeration value="Update"/>
      <enumeration value="Cancel"/>
      <enumeration value="Ack"/>
      <enumeration value="Error"/>
    </restriction>
  </simpleType>
</element>
Community “Domain” Standards
Military/Intel/NATO, Hydrographic, Emergency

- Digital Geographic Information WG
  - Technical Panels and Project Teams
    - Data Access TP
    - Data Structures TP
    - Service and Interface TP

- Multi-National Geospatial Co-production Program

- Geospatial-Intelligence Standards Working Group
  - Community Sensor Model Working Group (CSMWG)
  - Geographic Portrayal Focus Group (PFG)
  - Metadata Focus Group (MFG)
  - Information Transfer & Services Architecture (ITSA FG)

- Transfer Standard Maintenance and Application Development Working Group
- Geospatial Maritime WG 2

- Emergency Management Technical Committee
Regional Standards
ESRI Participation European Activities

European Committee for Standardization
Comité Européen de Normalisation

- CEN TC 287
  - Sponsor secretariat (Development)
  - EU Metadata Profile (Implementing)

INSPIRE
- Spatial Data Interest Communities - SDIC (Development)
- Geo-portal (Implementing)
Development

ESRI is a principle member
INCITS L1 – Subcommittee for geographic information
- Review, comment and approve US National Standards
  - by ANSI/INCITS
- US TAG for ISO TC 211
- Leading the development of a North American Profile of the ISO Metadata standards

Implementing

- ANSI/INCITS 320-1998 - Spatial Data Transfer Standard (SDTS)
- ANSI/INCITS 353-2001 - Information technology - Geographical Information Systems - Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE)
- ISO 19100 standards adopted
The goal

Communicating geographic knowledge
Encapsulating the real world
Semantic Interoperability
GIS Abstracts Geography into a Modern Information Technology Framework

...Abstracting Geographic Knowledge

Encapsulating Real-World Knowledge

Data Management

GIS Models

Applications

Decision Support

GeoVisualization

... an Information System for Geography
GIS abstracts geography into five basic elements:

1. Data Models
2. Geodata Sets
3. Process and Workflow Models
4. Maps and Globes
5. Metadata

Together they represent the building blocks of geographic knowledge.
ISO 19107 Spatial Schema

Data Models

Geometry
ISO 19109 Rules for application schema
Community standardized Schemas to define rules, relationships, definitions, behavior.
Standardized GIS Data Models

Created locally, regionally, nationally, globally by community Subject Matter Experts

- Address
- Agricultural
- Atmospheric
- Base Map
- Biodiversity
- Census-Admin
- Boundaries
- Defense-Intel
- Energy Utilities
- Environmental
- Forestry
- Geology
- Groundwater
- Health
- Historic Preservation & Archaeology
- Homeland Security
- Hydro
- HO
- Land Parcels
- Local Government
- Marine
- National Cadastre
- Petroleum
- Pipeline
- Telecommunications
- Transportation
- Water Utilities

Candidate ANSI/NCSL 1
FGDC Framework

http://www.esri.com/software/arcgis/geodatabase/about/data-models.html
Conceptual view must be semantically defined (and published) so others can decipher.
GIS abstracts geography into five basic elements:

- Data Models
- Geodata Sets
- Process and Workflow Models
- Maps and Globes
- Metadata

...Together they represent the building blocks of geographic knowledge.
OGC Simple Feature Specification

- Simple Feature specification defines:
  - Data access model
  - Database schema
  - 2D Geometry model for points, lines, polygons
  - “Well-Known” data formats for geometry and spatial reference

- ISO and OGC specifications for simple feature access
**Simple Feature Implementation SQL Profile**

- **Feature Tables** contain rows (features) sharing common properties (Feature Attributes).
- **Geometry** is a Feature Attribute.

<table>
<thead>
<tr>
<th></th>
<th>Feature Table</th>
<th>Feature Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>area1</td>
<td>yellow</td>
</tr>
<tr>
<td>11</td>
<td>area2</td>
<td>green</td>
</tr>
<tr>
<td>12</td>
<td>area3</td>
<td>Blue</td>
</tr>
<tr>
<td>13</td>
<td>area4</td>
<td>red</td>
</tr>
</tbody>
</table>
**Geography Markup Language (GML)**

- **GML is an XML based encoding standard for geographic information**
- **Defines an XML schema for representing geographic features** (attributes, geometries, relationships, etc).
- **GML Objects can represent:**

<table>
<thead>
<tr>
<th>Features</th>
<th>Coverages</th>
<th>Geometries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topologies</td>
<td>Observations</td>
<td>Values</td>
</tr>
<tr>
<td>Coordinate Referencing</td>
<td>Styles</td>
<td>Dynamic Features, ...</td>
</tr>
</tbody>
</table>
What’s special about GML?

- Because GML is based on XML, it leverages a wealth of mainstream (beyond the geographic community) standards, tools and practices for data exchange being developed by several consortia around the world.

- Standard XML technologies exist...
  - For encoding and data modeling expression (DTD, RDF and XSD)
  - For linking and associating resources (XLink)
  - For selecting & pointing (XPath, XPointer)
  - For transforming content (XSLT)
  - For graphical rendering (SVG, VML, X3D)
GML Simple Feature Profile

- Fixed schema
- 3D coordinates
- Simple geometry (points, lines, polygons, multipart)
  - Point, Multipoint - 2D or 3D points
  - Curve, Multicurve - Linear interpolation between points
  - Surface, Multisurface - Polygons with planar faces
  - Geometry, Multigeometry - Potentially heterogeneous geometry collections (mixed point/line/polygon)
- Dynamic codelists (e.g., coded value domain lists)
- Reference links (can href to other resources, e.g., for handling foreign/primary keys)
- Metadata links (can href to metadata)
<element name="Building" substitutionGroup="gml:AbstractFeature">
    <complexType>
        <complexContent>
            <extension base="gml:AbstractFeatureType">
                <sequence>
                    <element name="extent" type="gml:SurfacePropertyType"/>
                    <element name="address">
                        <complexType>
                            <sequence>
                                <element name="Address" type="ex:AddressType"/>
                            </sequence>
                        </complexType>
                    </element>
                    <element name="type" type="ex:BuildingTypeType"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
</element>

<complexType name="BuildingPropertyType">
    <sequence minOccurs="0">
        <element ref="ex:Building"/>
    </sequence>
</complexType>

<com plexType name="BuildingPropertyType">
    <sequence minOccurs="0">
        <element ref="ex:Building"/>
    </sequence>
</com plexType>
<element name="Building" substitutionGroup="gml:AbstractFeature">
   <complexType>
      <complexContent>
         <extension base="gml:AbstractFeatureType">
            <sequence>
               <element name="extent" type="gml:SurfacePropertyType"/>
               <element name="address">
                  <complexType>
                     <sequence>
                        <element name="Address" type="ex:AddressType"/>
                     </sequence>
                  </complexType>
               </element>
               <element name="type" type="ex:BuildingTypeType"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
</element>

<complexType name="BuildingPropertyType">
   <sequence minOccurs="0">
      <element ref="ex:Building"/>
   </sequence>
</complexType>

<Data Model>
ArcGIS Data Interoperability Extension

Interoperability between formats

GML  S-57  
MapInfo  SDTS  
Intergraph  VML  
Laser Scan  VPF  
Autodesk  WFS  
XML  

And many more...

Mapping  
Analysis  
Visualization
GIS abstracts geography into five basic elements:

- Geodata Sets
- Data Models
- Process and Workflow Models
- Maps and Globes
- Metadata

Together they represent the building blocks of geographic knowledge.
Metadata

- **Data about Data (official definition)**

- Information that describes a resource (data) so it can be understood

- Ensures we find and use the right data for the right purpose
  
  - And used correctly
Would you buy food or drink without knowing what it is?
Geographic Metadata

- **Data about data**
  - Geographic area covered
  - Currency
  - Rules of use
  - Positional accuracy
  - Data dictionary
  - Means of encoding
  - Datum
  - Map projection

- **A Key interoperability technology:**
  - Producers explain their product
  - Users learn about products

- **Non standard products can be understood**
**Metadata Uses**

Understanding the right data for the right purpose

- **Locate**
  - Find
  - Discover
  - Structured searches vs. unstructured

- **Evaluate**
  - Restrictions
  - Quality
  - Reputation

- **Extract**
  - Order
  - Download

- **Employ**
  - Define,
  - Apply,
  - Use,
  & Understand geographic knowledge
**Metadata** — data describing information resources that enable collaboration

**Collaboration** — interoperate purposefully toward a common end

**Interoperability** — share and exchange information

---

<table>
<thead>
<tr>
<th>Stages of Collaboration</th>
<th>Technical (Physical)</th>
<th>Semantic (Information)</th>
<th>Business (Process)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discover</strong></td>
<td>Find each other</td>
<td>Determine meaning and usefulness</td>
<td>Determine business terms and requirements</td>
</tr>
<tr>
<td><strong>Trust</strong></td>
<td>Establish physical connection trust</td>
<td>Establish information provenance trust</td>
<td>Establish business relationship trust</td>
</tr>
<tr>
<td><strong>Prepare</strong></td>
<td>Prepare for physical data exchange</td>
<td>Prepare to use the information</td>
<td>Enter into a commitment with the other party</td>
</tr>
<tr>
<td><strong>Transact</strong></td>
<td>Exchange the physical data</td>
<td>Use the valid information</td>
<td>Establish transaction completeness and accountability</td>
</tr>
<tr>
<td><strong>Steward</strong></td>
<td>Physically safeguard and protect the data</td>
<td>Safeguard the interpretations of the information used</td>
<td>Safeguard the organizations involved in the business relationship</td>
</tr>
</tbody>
</table>

---

From Raphael Sussman, 2003
ISO 19115:2003

- Designed:
  - to support geographic information;
  - to work with wider information technology standards and practices;
  - to support locate, evaluate, extract, employ
  - to support datasets, series, features, attributes...
  - to serve the global community, in a multi-national, multi-language environment;
  - based on a foundation of national, regional, and special information community standards and experiences

- Developed through a rigorous, consensus ISO process
- Provides a foundation for national, regional, and global interoperability

Semantic Interoperability
Metadata is composed of information chapters (packages)

Chapter 1

Metadata

fileIdentifier: 3A2234641211B12
language: en
characterSet: (default = "utf8")
parentIdentifier: NationalMap TopoSeries 864
hierarchyLevel: (default = "dataset")
hierarchyLevelName: (not needed)
contact: CI_ResponsibleParty
dateStamp: 20060417
metadataStandardName: ISO 19115:2003
metadataStandardVersion: (not needed) or
metadataStandardVersion: North American Profile 1.0
ISO 19115:2003
Defines how metadata applies to a resource

DS_DataSet

<<Abstract>>
DS_Aggregate

MD_Metadata

0..*
1..*
0..*
1..*

GF_FeatureType
FE_Feature

GF_PropertyType
FE_FeatureAttribute

DS_Series

DS_Initiative

DS_Platform
DS_Sensor
DS_ProductionSeries
ISO 19115:2003 Defines how metadata applies to a resource
GIS - Evolving to a web service environment

Providing Geospatial Services

Web Services
Networks

GeoWeb

Providing

- OGC Web Services
- Mapping services
- Viewing services
- Application Services

...Dynamically Integrating Our Common Geospatial Knowledge
Web Services & Messaging

World Wide Web

Environmental

Business Applications

Police

Roads

Utilities

Planning

XML

...loosely coupled, coarse grained, distributed
OGC Web Services

- **Web Mapping Service (WMS)**
  - HTTP protocol for publishing a collection of layers as a map (PNG, GIF, JPEG)

- **Web Feature Service (WFS)**
  - HTTP protocol for publishing feature collections that may be queried and updated by clients (features published as GML 2.1.2, SF GML, GDB GML, ...)

- **Web Coverage Service (WCS)**
  - HTTP protocol for publishing "coverages" (multi-band raster data) that can be accessed by clients—a sort of web based image processing service (GeoTiff, HDF-EOS, DTED, NITF, GML)

- **Catalog Services — Web (CS-W)**
  - Defines several web interfaces for data discovery
How WMS works?

Server

GetCapabilities

Capabilities

GetMap

Map Image

Client

GetfeatureInfo

featureInfo
WMS request flow

Web Browser

Request (HTTP CGI form)

Web Server

Response (JPEG file)

“getMap”

WMS Request

WMS services

Native services

GeoMedia

MapExtreme

Minnesota mapserv

ArcGIS

AutoCAD

Oracle

ArcView

ArcIMS
WMS DOES NOT “give data away.”

WMS GetMap returns a server’s JPEG, GIF or PNG representation of the data on the server. It does NOT return the actual data, only a bitmap of the data.
WMS GetFeatureInfo returns attribute data for a feature or coverage at a specified point.

Lat/Long
elev. = 237 m.
OpenGIS Styled Layer Descriptor

One data file... ...many different maps!

... and non-graphic portrayals!
Web Feature Service (WFS) returns data

Web Feature Server

GetFeature request:

Geometry & attribute data

Features are returned in GML
How WFS works?

Server

- GetCapabilities
- DescribeFeatureType
- GetFeatures

Capabilities
Feature Schema
Features

Client
Web Coverage Service (WCS) 1.0

- **Scope:** Retrieval of gridded, swath, TN or other "coverage" data in binary or other formats (HDF, GeoTIFF, NITF, NetCDF, JPEG2000, etc.)
  - Elevation, Orthoimagery

- **Operations:**
  - GetCapabilities
  - DescribeCoverageType
  - GetCoverage
How WCS works?

Server

GetCapabilities
Capabilties

Capabilities

DescribeCoverageType
Coverage Schema

Coverage

GetCoverage

Client
OpenGIS® Catalog 2 Specification

- Defines a common interface that enables diverse but conformant applications to perform discovery, browse and query operations against distributed and potentially heterogeneous catalog servers.

- Three Parts:
  - Discovery Services: allow a client to locate metadata that describes data.
  - Access Services: provide the client with methods to request services on the data. DirectAccess provides the client with a handle which, when used by the client, provides data to the client.
  - Management Services: defines methods for a client to change the metadata held by a catalog.

- There are both tightly coupled (like CORBA) and loosely coupled (HTTP/XML – CS Web) profiles.

- Some bindings defined:
  - Z39.50,
  - CS-W: ebRIM, ISO Metadata, OGC Core
Understanding OGC Catalog Services

**Resource**
- Data
- Service (WMS, WFS, WCS, ...)

**Service**
- Service Provider

**Service**
- Service Requester

**Metadata**
- FGDC
- ISO ISO 19115, 19119

**Catalog**
- Stores By

**Specific Data Model**
- Mapped To

**Service Description**

**Registry Information Model**
- eb-RIM
- ISO
- FGDC
- Dublin Core
Catalog Services in A GeoPortal
Gateway to/from your GIS enterprise

The GIS Portal Toolkit addresses critical factors for success:

- Faster Discovery
- Collaboration
- Interoperability
- Technology
- Direct Access
- Improved quality and coverage

Web Services Platform

Enterprise GeoPortal

Service Requester

Catalog Services

WEB Services Platform

GIS Data

Service Provider

Service Broker

Data Warehouse

Service Description

GIS Data Streams

OGC Web Services

Tracking Services

Mobile

Browser

2-D & 3-D Desktop Viewers

Desktop GIS

Geo-processing Services

Geo Explorer

ArcGIS Explorer

Tracker

Download:

ArcGIS Explorer

Toolbar for ArcMap

Search

Channels

Link Browser Map

Download:

ArcGIS Explorer

Toolbar for ArcMap

... Collaboration

Service Provider

Data

Service Description

2-D Base Map (Cache)

3-D Base Map (Cache)
W3C Service Oriented Architecture

*From Web Service Architecture, 14 Nov. 2002
Geoportal Concept ...

OGC Catalog Services (Z39.50 CS-W)

Users

Search Catalog and Find

Publish GIS data and services

Document in catalog

GIS Portal

OGC WMS, WFS, WCS...

GIS Data

ISO 19115 Metadata/
ISO 19139 Metadata

XML Schema Implementation

OAI Protocol for Metadata Harvesting

Data Servers
Resource Producers Publish metadata and provide Content

GIS Portal Integrating Role

Producers
- Topography
- Boundaries
- Hydrology
- Geodetics
- Transportation
- Imagery

Users
- Maps
- Analysis

Internet Map Services

Image Producers
Portals – truly standards in action
Portal Toolkit - Interoperable Architecture

- A web supersite
  - Gateway to a spatial data infrastructure
  - Producers
    - Advertise, expose products
    - Share information about holdings
      - Provide an understanding of data and services
  - Users
    - Perform efficient searches by requirements
    - Discover data and services
    - Determine fitness for use
    - Acquire access information

Based on W3C Service Oriented Architecture
Metadata for data, services, activities, data models – anything geospatial
Bringing the standards together:
  - ISO 19115
  - ISO 19139
  - FGDC Metadata
  - Dublin Core metadata
  - WMS
  - WFS
  - WCS
  - WMC
  - OAI-PMH
  - OAI
  - Metadata harvesting
  - FGDC
  - OpenLS
  - Z39.50
  - W3C SOA
  - SR 168
  - OGC CS-W, ebRIM, ISO, Z39.50
  - Web Folder
  - ArcIMS
ESRI approach to interoperability
Supporting Multiple Approaches

- Technology Standards
  - Web Services
  - OGC/ISO
  - DXF, KML...

- Content Standards
  - Data Models
  - Metadata (19115/19139)

- Basic Structure Standards

Transformation Procedures (ETL)
- Formats
- Schema
- Semantic

- Standards Organizations
- GIS Education
- Providing Data and Services

- Management Standards
- Visualization Standards

...Providing An Open & Standards-based Environment
...And Enabling Successful Collaborative Systems
Standards Support Throughout GIS Life Cycle

1. Create Content
2. Document (Metadata)
3. Catalog
4. Publish
5. Discover
6. Use/Analysis