Swedish Standard for Geographic Information on Surface Water Systems

Jakob NISELL, Sweden

Key words: Surface Water System, Standard, Network, GML, ISO-19100

SUMMARY

In 2003 a technical committee was formed under the Stanli project at Swedish Institute of Standards, SIS, to create a standard for geographic information on surface water system. The technical committee includes delegates from the following organizations: the Swedish Land Survey, Elforsk, Water Authorities, Swedish Environmental Protection Agency, the Swedish Maritime Administration, the Swedish Association of Local Authorities and Regions, the Swedish Geological Survey, and the Swedish Meteorological and Hydrological Institute, SMHI. The main scope of the committee was to agree upon common definitions of concepts, and to identify requirements regarding rules, structure and content of information to facilitate data interoperability. This work resulted in conceptual and application and XML-schemas. In brief, the main features of the standard are:

- Object oriented approach for description of water systems
- Unique identifiers for each feature, lake, river, sampling station etc
- Description of the networks structure of water system
- Surface water systems can contain a hierarchical structure of sub systems and levels of detail
- Geometry is handled as a non mandatory attribute for the feature
- Uses the ISO geographic standards ISO19103 - 19136 to describe meta data, geometry and temporal aspects
- Exchange of data based on feature not on geometry
- Common XML/GML schema for data exchange
- Description of how to handle updates and versions

The development of the standard involves a close cooperation between producers and users committed to both geographical and non geographic data on water. The SS637008:2006 standard was published in 2006. A manual and GML (ISO 19136:2007) schemas are planned to be published this year.

Swedish Standard for Geographic Information on Surface Water Systems

Jakob NISELL, Sweden

1. WHY STANDARDIZING INFORMATION ON SURFACE WATER

Geographical information is essential for water environmental and resource assessment Many activities are depending on information on flowdirecitions, geometry and depth of waterbodies. Positioning waterbodies within a network is important information for assessment of environmental pressure and impact.

The use of hydro-geographic data has grown the last couple of years. The European Water Frame Directive has set the focus on information and assessment of water quality and status of individual Waterbodies. Both sampled and modeled data from several different data producers will be needed to prepare this information. Lantmäteriet (Swedish Land Survey) the main producer of geographic data in Sweden are moving towards a new, object oriented, approach for storage and delivery of geographic data. SMHI (Swedish Metrological and Hydrological Institute) are responsible for Hydrological information of lakes and rivers. The Dept of Environmental assessment at SLU (Swedish University of Agricultural Sciences) hosts data on inland waters chemistry, and biology. There are a number of data producers that delivers data to the assessment of surface water quality and status. The Water Authorites are responsible for setting up action plans and reports. To make transfer of information smooth there is a need for a common strategy. The demand for the usefulness and interoperability lead to a SIS,Stanli project for a standard. The requirement on the standard was to:

- supply a framework for information content and structure
- supply a common set of terms and concepts
- facilitate exchange of data between organizations
- facilitate consolidation of data from several producers
- simplify development of software applications
- make data sampling more cost effective
- simplify generalizations between different scales
- supply a system independent exchange format

2. CONTENT OF THE STANDARD

The standard contains a conceptual and an application schema. The Conceptual schema contains definitions of terms. The application schema defines the content and structure of information. It also describes relations between different feature types, such as lakes, catchments etc. The Conceptual schema is written in Swedish, and English while the application schema classnames and roles uses only English terms. The standard contains a core of attributes and feature types that are of common interest, Specific needs can be added to be able to exchange data on for example fish fauna, Nutrient loads etc. The standard is focused on the following aspect:

- Definitions terms and concepts are described
- Hierarchy The inherent hierarchy structure. Waterbodies build up systems
- Network Waterbodies and other features as part of a network with defined flowdirection
- Hierachy network All features can be a network
- Identifyers All features must have a unique identifier
- Versioning All information can have versions. Functions for updating is defined
- Geometry Features can have none or many geometries. Geometry is attributes and are described by a geometry data type
- Temporal features can have a temporal validity using data types in ISO-19108
- Metadata Datasets, features and attributes can contain metadata from ISO 19115
- Information structure Application schema describes information in an UML.
- Data exchange XML/GML (ISO 19136:2007) schema are supplied to facilitate information exchange and application development.
- Use of ISO standards The application schema is built on ISO19100 standards.

3. AN OBJECT ORIENTED MODEL

3.1 Feature types

All features such as ‘Lake Vänern’ or ‘sampling station A32’, belongs to a feature type or feature class such as Lake and Station. Each feature type has a common set of properties like attributes and relations to other feature classes. The feature types are divided into packages

WaterBodies includes:	lakes, riverreach, basin, costal water area etc
HydrologicalArea includes:	catchment area, subcatchment etc.
WaterLocation inclueds:	outflow location, inflow location, shoreline etc.
SurfaceWaterComplex includes:	main river, bifurcation, surface water system etc.

There are around 30 feature classes representing real world phenomenon and about 35 data types and other classes defined in the standard

3.2 Logical network

All features are *Water Network Nodes* in a *Water Network*. Nodes represents real world phenomenon and can contain any attributes including geometry. The nodes can be connected to each other using *Water Network Links*. The links are not features and does not have geometries, this is a logical network unlike a geometrical network. Links are only used to describe the topological relation like flow direction between nodes. Figure 1 shows the representation of two features in a Surface water dataset. all feature has a universal unique identifier.

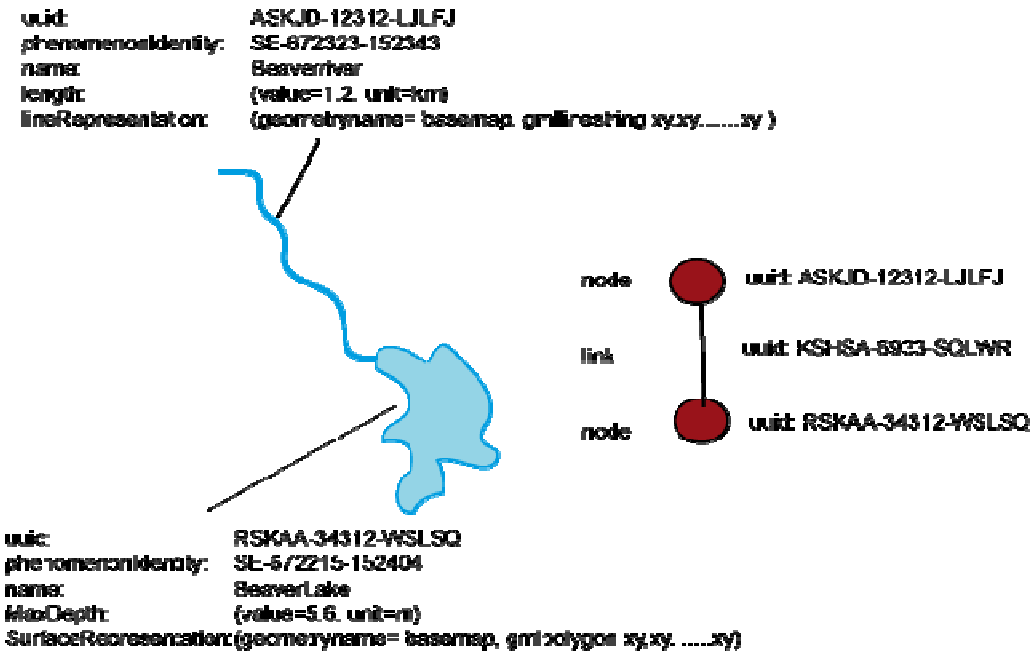

Figure 1. Left: representation of two features in a surface water system with there attributes. Right: the representation of the logical network including the two features, the nodes, in the network.

the network representation shows the hydrological connection between the features and can be implemented as a table of *Water Network Links*

WaterNetworkLink	**startnode**	**endnode**
KSHSA-6933-SQLWR	ASKJD-12312-LJLFJ	RSKAA-34312-WSLSQ

Table 1 WaterNetworkLink

3.3 Network – Node relation

Water Network nodes are nodes that contains an inner structure, all nodes but those representing locations can have an inner structure. In figure 2 a feature representing a water system is shown. The network contains two nodes a *river reach* and a *lake.*

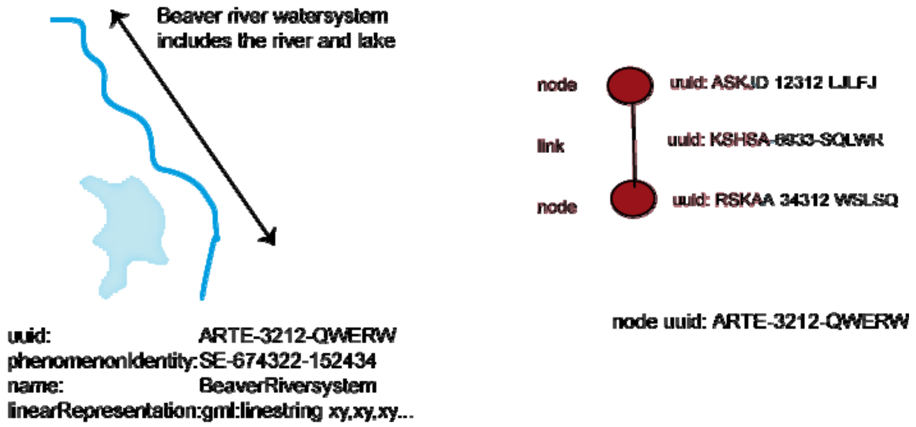

Figure 2 The Water Network nodes can be a network containing nodes in finer level of detail, a water system can contain rivers and lakesThe relation between the Network and contained nodes can be implemented as a water network relation table.

WaterNetworkRelation	member	complex
USKL-3453-TEKLK	ASKJD-12312-LJLFJ	ARTE-3212-QWERW
TSKK-4454-EKSKL	RSKAA-34312-WSLSQ	ARTE-3212-QWERW

Table 2 Relation between Network and Nodes

3.4 Attributes and datatypes

Each feature type, lakes, river reach, has a set of attributes that has been chosen to reflect a minimal set of attributes of common interest independent on applications. All attributes are optional except from an unique identifier. Attributes can be of a general data type such as Character String and Integer or as a data type defined in this or in an ISO 19100 standard. The data types defined in the standard can be composed of many parts. An example is *WaterDepth* that contains unit, accuracy and time of measurement in addition to the actual value.

Geometry for a feature is handled as any other attribute. The standard contains four geometry data types, Point geometry, Line geometry, Surface geometry and Solid geometry. The geometry data types uses ISO19107 or GML data types for geometry and adds accuracy information, representation scale and geometry name. Each feature can have any number of geometrical representations but does not need to have any geometry defined at all. A lake can for example have point representation used in scale 1:1 miljon a simple polygon for scale

1:100 000 and a detailed polygon use in scale 1:50 000 stored for the same feature in the same dataset.

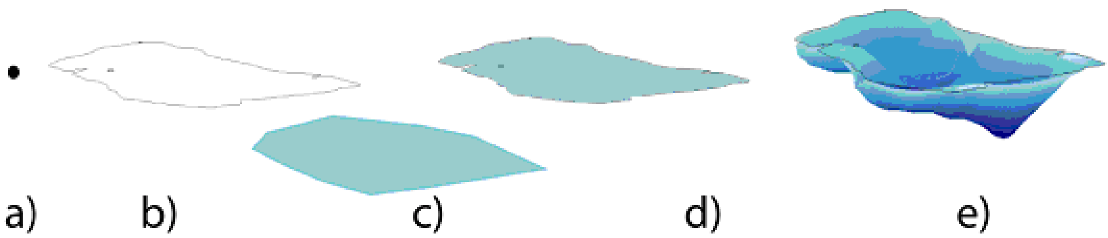

Figure 3. Features can be represented using several types of geometry a) GM:Point /gml:Point b)GM:curve/gml:curve c and d) GM:Surface/gml:surface e)GM:solid/gml:solid

3.5 Identifiers

All features has to have a universally unique identifier, UUID, all real world phenomenon such as sampling station and lakes should should have a phenomenon identity. UUIDs can be created automatically there are several methods for doing this ISO/IEC 11578 describes this. UUID can be use as a foreign key to match data produced by different organizations. The UUID can be produced by the organization that created the feature. To set the phenomenon identity a central registry function is needed that issues and keep the UUID-Phenomenon Identity relations. This is rather an organizational issue then a technical and has to be solved between the main producers of water related information.

4. INFORMATION STRUCTURE

An application schema was built and documented as an UML model following the ISO-19109 standard. UML is a graphical language for developing object oriented models for software, XML-schema and databases development. Class properties, inheritance and relations can be created and visulized graphically. The base class for features is the *Network Node*. All features are subclasses to this class and inherites its properties and relations such as attributes (uuid, name, pointgeometry etc) and roles such as startnode, endnode, complex etc.

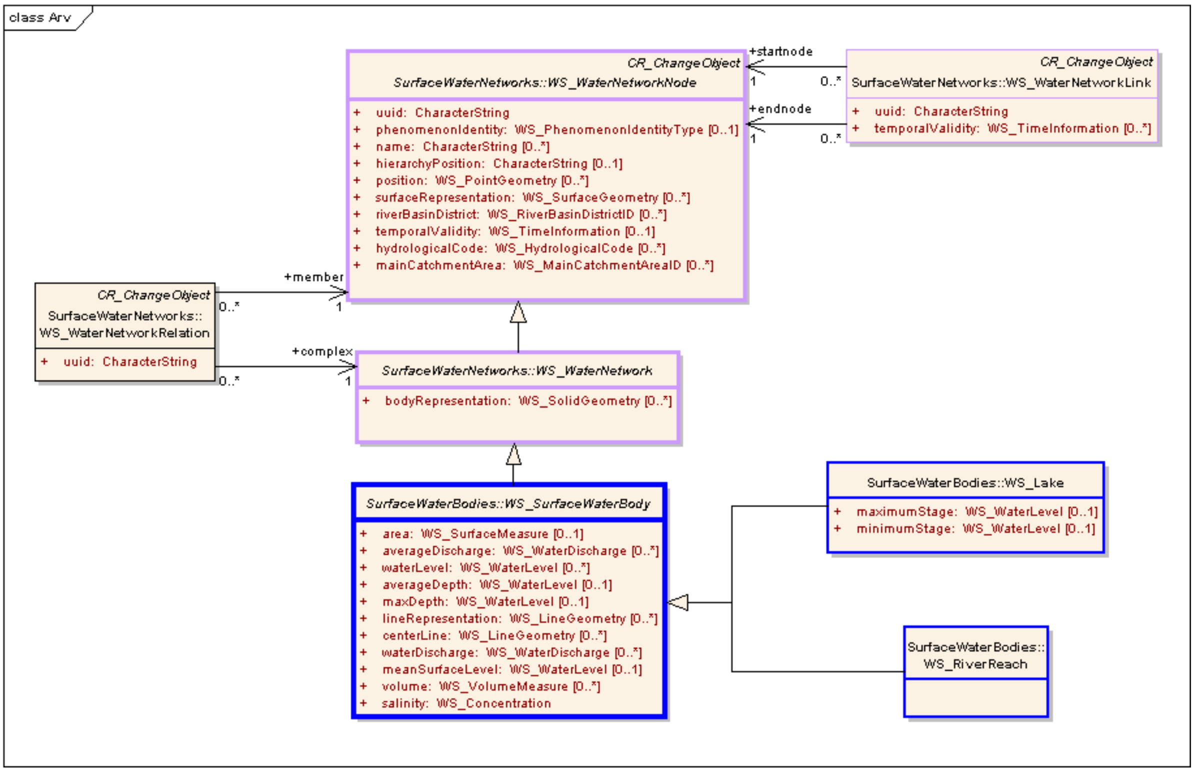

Figure 4 a subset of the UML model for SS-637008.

From the UML graph in figure 4 it can be seen that the feature type *WS_Lake* is a type of *WS_SurfaceWaterbody* which is a *WS_WaterNetwork*. The *WS_WaterNetwork* is a *WS_WaterNetworkNode*, therefore *WS_Lake* has all the attributes and relations of these classes. *WS_WaterNetworkNode*, *WS_WaterNetwork* and *WS_SurfaceWaterbody* are all abstract classes which mean that they do not materialize, only *WS_Lakes* and *WS_RiverReach* exists as real world phenomenon. *WS_Lakes* has the attributes maximum and minimum stage but also, a result of inherantes, attributes from all inherent classes. From NetworkNode, uuid, name etc, from WaterNetwork body representation and from Surfacewater body area, averageDischarge etc. Lakes can also be a member and a complex as well as startnode and endnode.

5. DATA EXCHANGE

Presently data exchange concerning water information uses many different formats and structures. There are a number of defacto standard for geographic information such as ESRI shape files and geodatabases. Different parties has there own structure and software platforms such as ESRI ArcGIS, MapInfo, Oracle Spatial, or PostGreSQL/Postgis. XML/GML is an open and system independent format that can be used as a bridge between any defined format. GML was recently accepted as an international standard, ISO19136. GML is widely used in web map, feature services and as a general exchange format. Within the SS637008 standardization project a XML-schema was created using the guidelines in ISO 19118. The schema can be used for validating XML-files and as a tool to build transformations between other formats such as database tables, GIS formats or websites. XML-files is based on tagged data values. The set of allowed and required tags or elements are defined in the XML schema which is based on the classes and relations in the application schema. The root element <GI> can contain three different elements <exchangeMetadata>, <dataset> or <update>. To send a request to update a dataset that was delivered earlier the <update> tag is used. All features are versioned through the use the SS-637007 standard. The update function can contain either <add> <modify> or <delete>. Add is used to add an object to the dataset. Modify is used to change information about an object that is already in the dataset, for example a new geometry. Delete is used to remove an object, referred by its UUID, from the dataset


```xml
<?xml version="1.0" encoding="utf-8"?>
<GI version="1.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="D:\projekt\tk452\xmlschema_v1.0\xsd\SS637008.xsd">
	<exchangeMetadata>
		<datasetCitation>
			<title>add to lake register</title>
			<date>
				<date>2006-11-24</date>
				<dateType>YYYY-MM-DD</dateType>
			</date>
		</datasetCitation>
	…………………………………………………………
	</exchangeMetadata>
	<update>
		<add>
			<WS_Lake>
				<versionID>3.1</versionID>
				<uuid>RSKAA-34312-WSLSQ</uuid>
				<name>storsjön</name>
				<position>
					<representationScale>1:100000</representationScale>
					<geometryName>basemap</geometryName>
					<pointPosition>
						<position>
							<coordinate>
								<Number>1635023</Number>
								<Number>6731109</Number>
							</coordinate>
						</position>
					</pointPosition>
				</position>
			</WS_Lake>
```

</add>
</update>
</GI>
The xml file above shows an example of an update. A new lake is added to the dataset that was sent earlier. The delivery contains the new lake UUID, its name and its position as a point geometery. The data past the <add> tags is to be added to the dataset. Inside the <exchangeMetadata> tags there is metadata about the delivery.

6. STATUS OF IMPLEMENTATION

The Swedish standard was published in June 2006 the document is available in Swedish and English. There is a swedish handbook on it's way and a GML-schema. The standard are currently being extend to include groundwater. The concepts used in the standard is currently being adopted by the main producers of hydrographic data, SMHI and Lantmäteriet. There is a need for a common implementation strategy for handling UUIDs and phenomenon identities and to define responsibilities for these functions, a work that has just started. Today there is no dataset that comply with all aspects of the standard. It is however easy to adopt many of them. Information needed to build a detaild network can be constructed gradually in different levels of detail as the network can be constructed independently of geometries. Each organization can supply there information to fill different parts like network, hierarchy, depth, area, geometry etc as long as they use a commonly decided identifier for each feature.
The work to set up as Swedish standard was not just a matter of writing a document, probably more important was the forum it gave for cooperation and discussions on common strategies for geographic information on water. The Stanli project area at SIS is registred in SDIC (Spatial data intrest community) of INSPIRE (Infrastructure for Spatial Information in Europe) and the SS637008 document has been registred as a reference document.

REFERENCES

SS637008:2006 Geographic information – Surface Water Systems Conceptual and Application Schema, http://www.sis.se/stanli/
SS637007:2006 Geographic information – Representation of changes in datasets http://www.sis.se/stanli/
ISO 19109:2005 Rules for Applications schema, http://www.isotc211.org/
ISO 19107:2003 Spatial schema, http://www.isotc211.org/
ISO 19108:2002 Temporal schema, http://www.isotc211.org/
ISO 19115:2003 Metadata, http://www.isotc211.org/
ISO 19118:2005 Encoding, http://www.isotc211.org/
ISO 19136:2007 GML, Geography Markup Language, http://www.isotc211.org/
ISO/IEC 11578 Open Systems Interconnection – Remote procedure call. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=2229
INSPIRE - Infrastructure for Spatial Information in Europe, http://www.ec-gis.org/inspire

BIOGRAPHICAL NOTES

Jakob Nisell born in 1962, Obtained a licenciate degree in remote sensing, image analysis and GIS within the field of environmental assessment. Currently working with system engineering and GIS at the Swedish University of Agricultural Sciences. Member of the technical committee and workgroups developing the standard for surface water system.

CONTACTS

Jakob Nisell
Dept. of Environmental Assessment SLU
Box 7050
750 07 Uppsala
SWEDEN
Tel. +46-18673123
Fax +46-18673156
Email:jakob.nisell@ma.slu.se
Web site: www.ma.slu.se