Introduction to GML (Geography Markup Language)

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Introduction to GML

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- Standards for Geographic Information
  - Open Geospatial Consortium (OGC)
  - International Organisation for Standardisation (ISO)
- Geography Markup Language (GML)
- Simple feature elements for geometry
- Spatial Reference Systems

History of Open Geospatial Consortium (OGC)

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- Clinton's executive order April 2004
- OGC was formed later in 2004
- Today (2014) around 500 companies, agencies and universities are members
- http://www.opengeospatial.org/

OGC creates industry standards, not formal standards

OGC produce specifications

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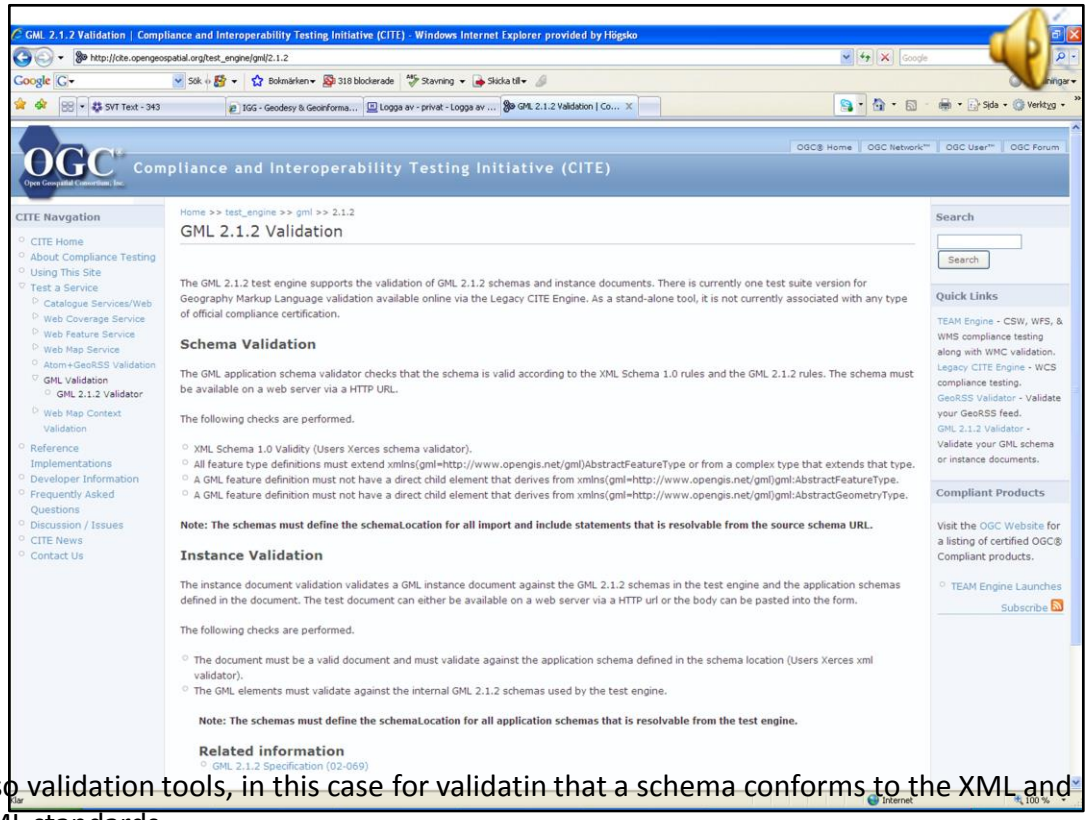
- Web services
  - Web Map Service (WMS)
  - Web Feature Service (WFS)
  - Web Coverage Service (WCS)
  - Catalogue Service (CSW)
  - Etc
- XML schemas (formats)
  - GML
  - KML

Most well known specifications



Also validation tools, in this case for validatin that a schema conforms to the XML and GML standards

ISO (www.iso.org)

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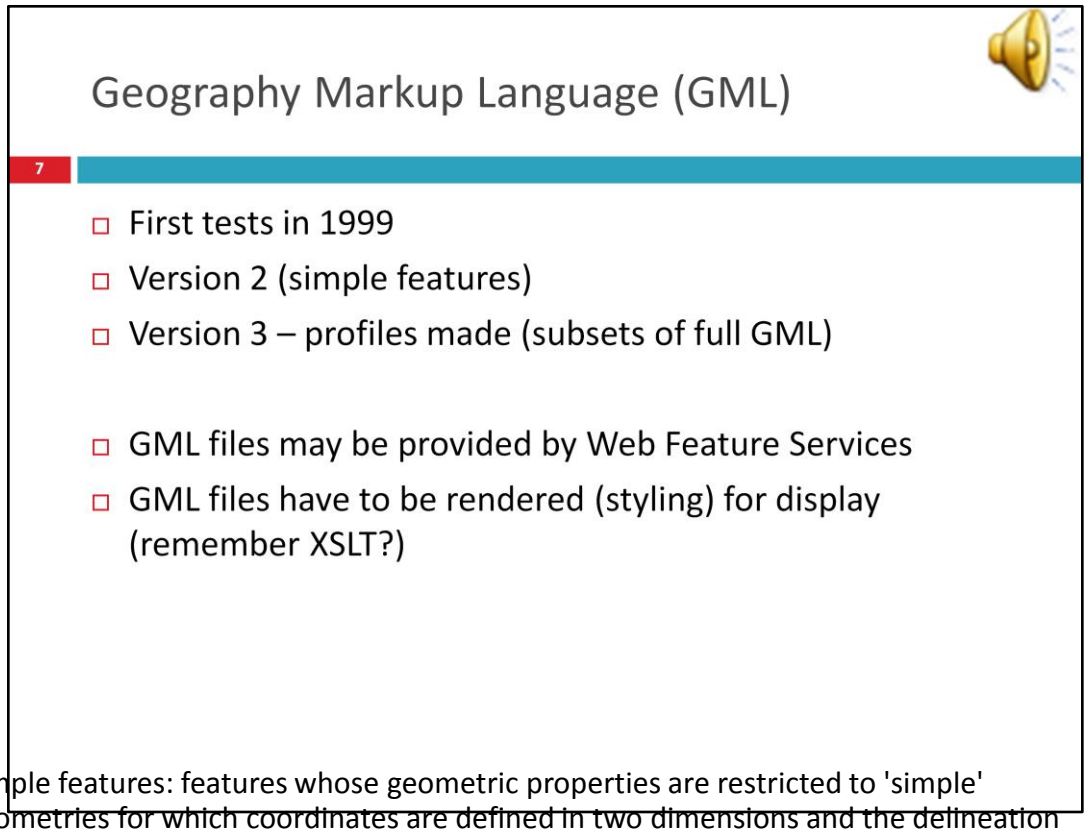
- A network of 157 national standards institutes
- Develop formal standards
- ISO-TC211 is dealing with geographic information
- GML (and some other OGC specifications) has also become an ISO standard (GML = ISO 19136)

ISO standards costs around 100 € each. OGC specs are free of charge



Simple features: features whose geometric properties are restricted to 'simple' geometries for which coordinates are defined in two dimensions and the delineation of a curve is subject to linear interpolation.

Version 3: represent geospatial phenomena in addition to simple 2D linear features, including features with
complex, non-linear, 3D geometry, features with 2D topology, features with temporal properties, dynamic features, coverages, and observations;
· provide more explicit support for properties of features and other objects whose value is complex;
· represent spatial and temporal reference systems, units of measure and standards information;
· use reference system, units and standards information in the representation of geospatial phenomena, observations, and values;
· represent default styles for feature and coverage visualization;
· conform with standards from the ISO 19100 series.

The expansion of GML to meet these needs is reflected in base schemas for GML version 3 that are over eight times as large as the base schemas for GML version 2. However, few applications will use all of the definitions added to GML version 3. Implementers may use a selective subset of the GML version 3 schemas sufficient to support the definitions in their application schemas.

Based on XML technologies

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- XML, XML Namespaces, XML Schema, XLinks
- Implements concepts from the ISO 19100 standards
- Support spatial and non-spatial properties of objects
- Open and vendor neutral

Example

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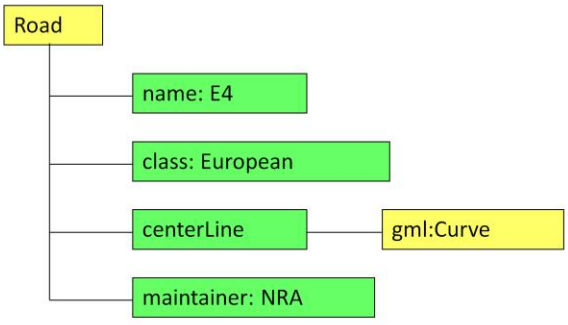
Road
name: E4
class: European
centerLine
gml:Curve
maintainer: NRA

GML example

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```
<Road gml:id=”o.1fg7a3”>
  <name>E4</name>
  <class>European</class>
  <centerLine>
    <gmlCurve>…</gmlCurve>
  </centerLine>
  <maintainer>NRA</maintainer>
</Road>
```

GML example with XLink

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```
<Road gml:id="o.1fg7a3">
  <name>E4</name>
  <class>European</class>
  <centerLine>
    <gml:Curve>…</gml:Curve>
  </centerLine>
  <maintainer xlink:href="urn:x-auth:o.1f7d6e" />
</Road>
```

If maintainer is another object

The object 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 object referenced in the link

The object can be part of the same GML document or anywhere in the internet/intranet

Feature type

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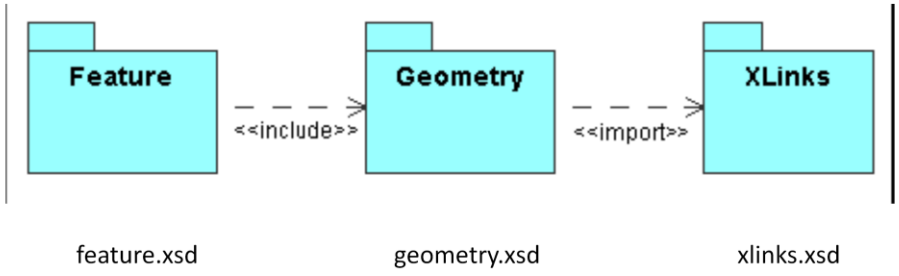

In GML, feature types are represented by an XML Schema. In general terms a "schema" defines the characteristics of a class of objects; in XML a schema also describes how data is marked up. Feature collections can build the root of an XML document carrying geospatial data. GML builds on three (3) basic XML schemas:

geometry.xsd, which includes the detailed geometry components. It includes type definitions for abstract geometry elements as point, line and polygons and complex type definitions for the underlying geometry types. It is based on the OGC Abstract Specification (Topic 1: Feature Geometry).
feature.xsd, which defines the general feature-property model. It includes the GML geometry constructs, which can be used in the feature type definitions
xlinks.xsd, which provides the XLink attributes used to implement linking functionality.

Geometry model (Simple features)

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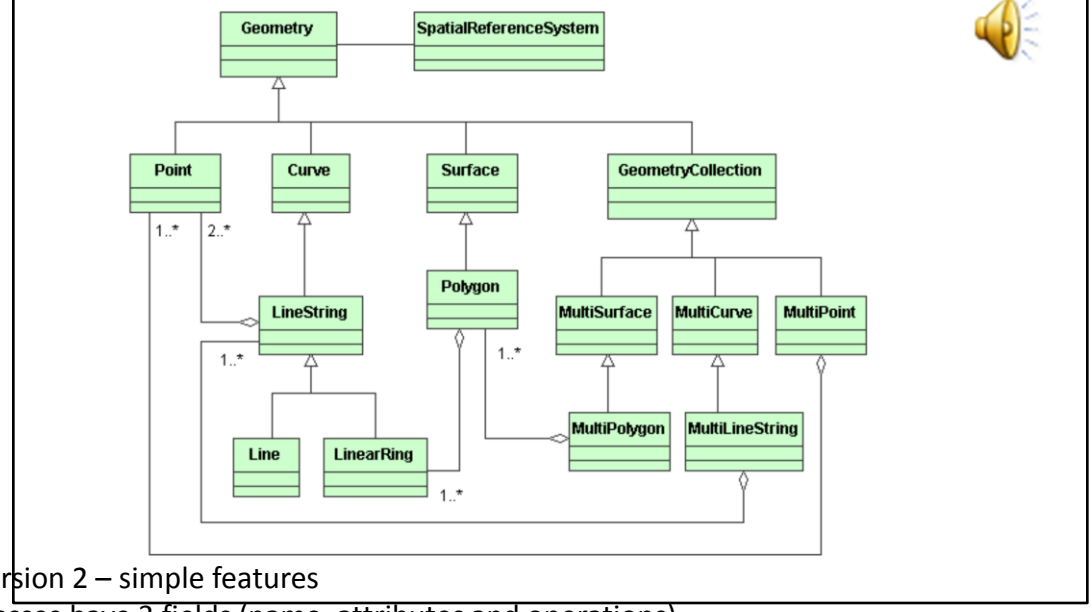

Version 2 – simple features
Classes have 3 fields (name, attributes and operations)
Triangle mean generalisation (Geometry, Curve, Surface)
Diamond mean aggregation
We have SpatialREfSys. We have a separate look at that one later

Point example

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GML 2

```
<gml:Point gml:id=”P1” srsName=”http://www.opengis.net/def/crs/EPSG/0/28992”>
  <gml:coordinates>56.1 , 0.45 </gml:coordinates>
</gml:Point>
```

GML 3

```
<gml:Point gml:id=”P1” srsName=”http://www.opengis.net/def/crs/EPSG/0/28992”>
  <gml:pos srsDimension=”2”> 56.1 0.45 </gml:pos>
</gml:Point>
```

Earlier versions of GML allows the usage of <coord>. Avoid that construction.

```
<Point gid="P1" srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
<coord><X>56.1</X><Y>0.45</Y></coord>
</Point>
```

Line String example

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GML 2

```
<gml:LineString gml:id="L1" srsName="http://www.opengis.net/def/crs/EPSG/0/28992">
  <gml:coordinates> 0.0 , 0.0  20.0 , 35.0  100.0 , 100.0 </gml:coordinates>
</gml:LineString>
```

GML 3

```
<gml:LineString gml:id="L1" srsName="http://www.opengis.net/def/crs/EPSG/0/28992">
  <gml:posList srsDimension="2 "> 0.0  0.0  20.0  35.0  100.0  100.0 </gml:posList>
</gml:LineString>
```

```
<LineString srsName="http://www.opengis.net/gml/srs/epsg.xml#4326">
<coord><X>0.0</X><Y>0.0</Y></coord>
<coord><X>20.0</X><Y>35.0</Y></coord>
<coord><X>100.0</X><Y>100.0</Y></coord>
</LineString>
```

Polygon example

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```
<gml:Polygon gml:id=”P1"
srsName=”http://www.opengis.net/def/crs/EPSG/0/28992”>
  <gml:outerBoundaryIs>
    <gml: LinearRing>
      <gml:coordinates>0.0,0.0 100.0,0.0 100.0,100.0 0.0,100.0 0.0,0.0
      </gml:coordinates>
    </gml: LinearRing>
  </gml:outerBoundaryIs>
  <gml:innerBoundaryIs>
    <gml:LinearRing>
      <gml:coordinates>10.0,10.0 10.0,40.0 40.0,40.0 40.0,10.0 10.0,10.0
      </gml:coordinates>
    </gml:LinearRing>
  </gml:innerBoundaryIs>
</gml:Polygon>
```

What is meant by
srsName="http://www.opengis.net/def/crs/EPSG/0/28992"?

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- Specifications of Spatial Reference Systems have been collected by the European Petroleum Survey Group (EPSG)
- Their database is now maintained by the International Association of Oil and Gas Producers (IOGP), www.iogp.org
- Codes are accessible at http://www.epsg-registry.org/

The Dutch reference system has number 28992
We will look at this later.

Some coordinate systems

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Table 4 — Naming constraints for coordinate system axes

CS	CRS	Permitted coordinate system axis names
Cartesian	Geocentric	Geocentric X, Geocentric Y, Geocentric Z
Spherical	Geocentric	Spherical Latitude, Spherical Longitude, Geocentric Radius
Ellipsoidal	Geographic	Geodetic latitude, Geodetic longitude, Ellipsoidal height (if 3D)
Vertical	Vertical	Gravity-related height
Vertical	Vertical	Depth
Cartesian	Projected	Easting, Northing
Cartesian	Projected	Westing, Southing

Geocentric coordinates

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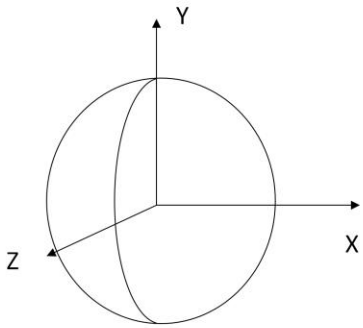

In this case, cartesian coordinates with the origin at the center of the earth
Can also be latitude, longitude and radius (sperical)

Geographical coordinates

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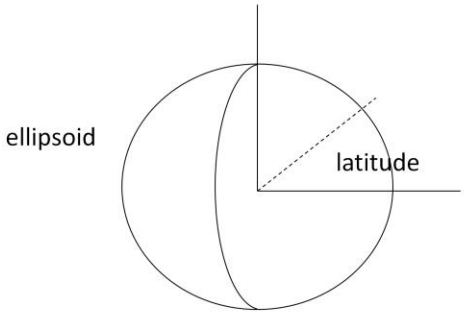
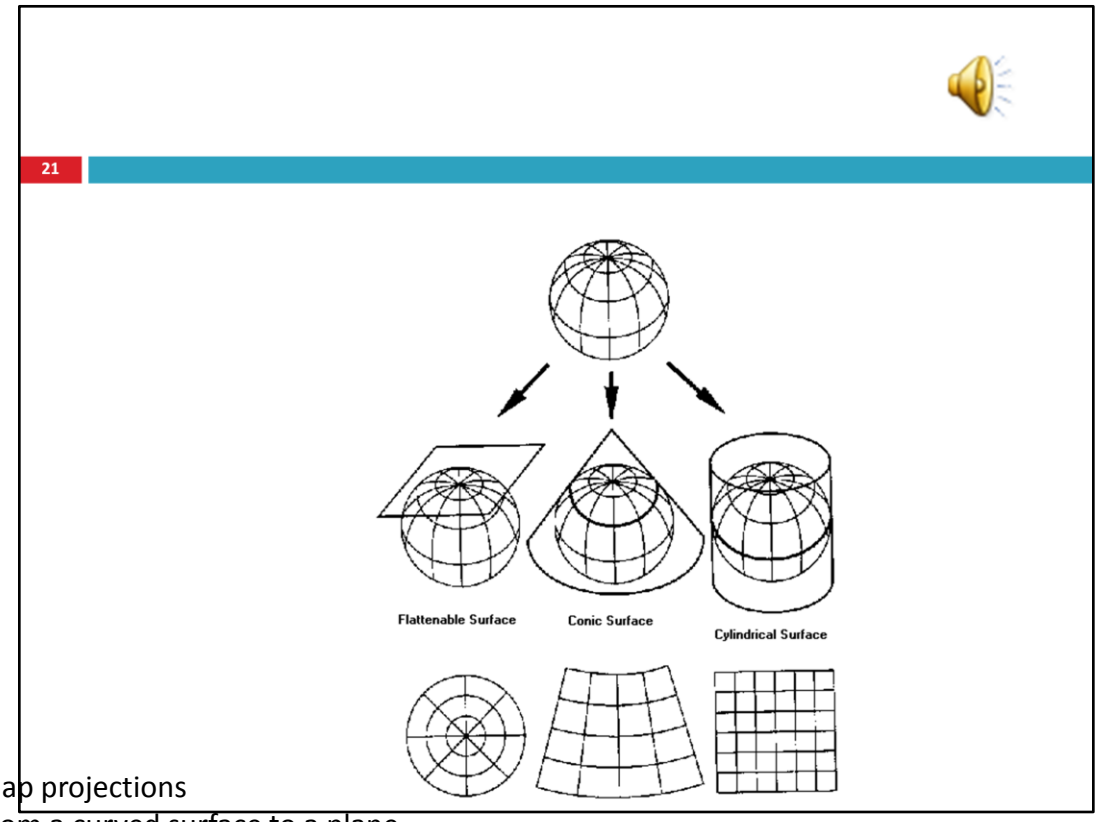
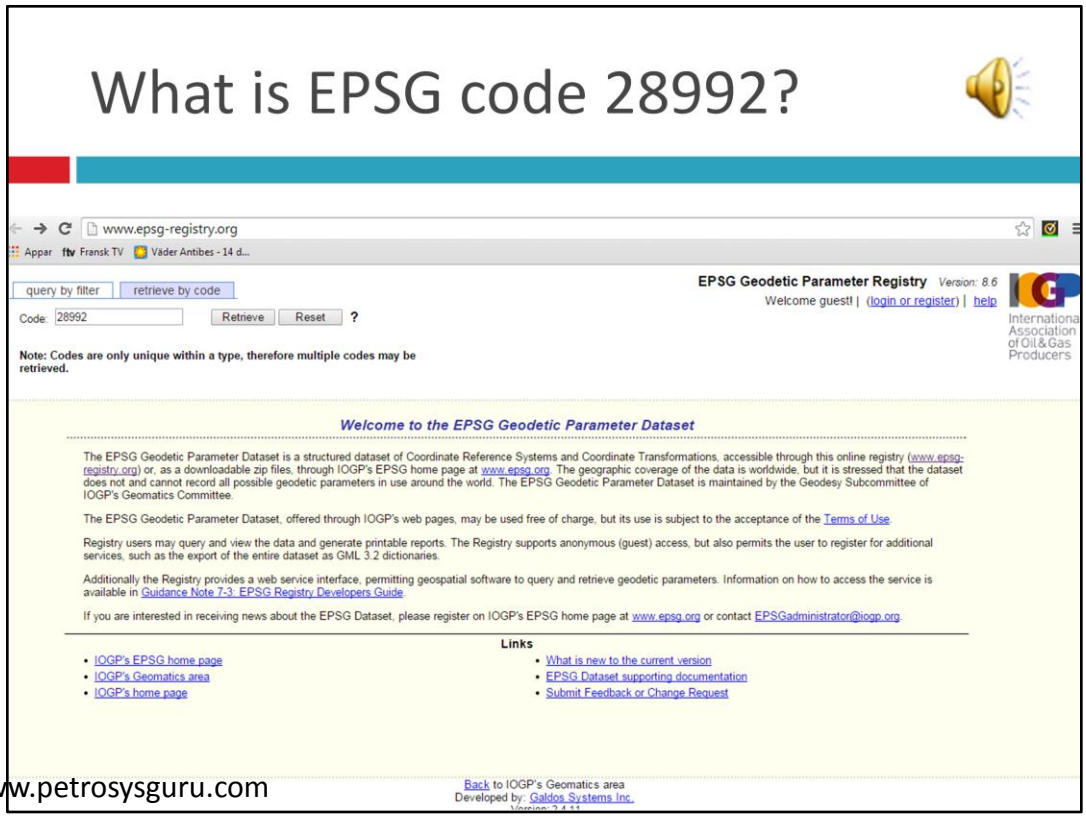


Water should be horisontal.
Due to the rotation of the earth and irregularities in mass distribution of the interior of the earth, the water surface is irregular
The irregular water surface is approximated by an ellipsoid. Different ones in different countries.
The ellipsoid being used is one important part of the specification of a spatial reference system



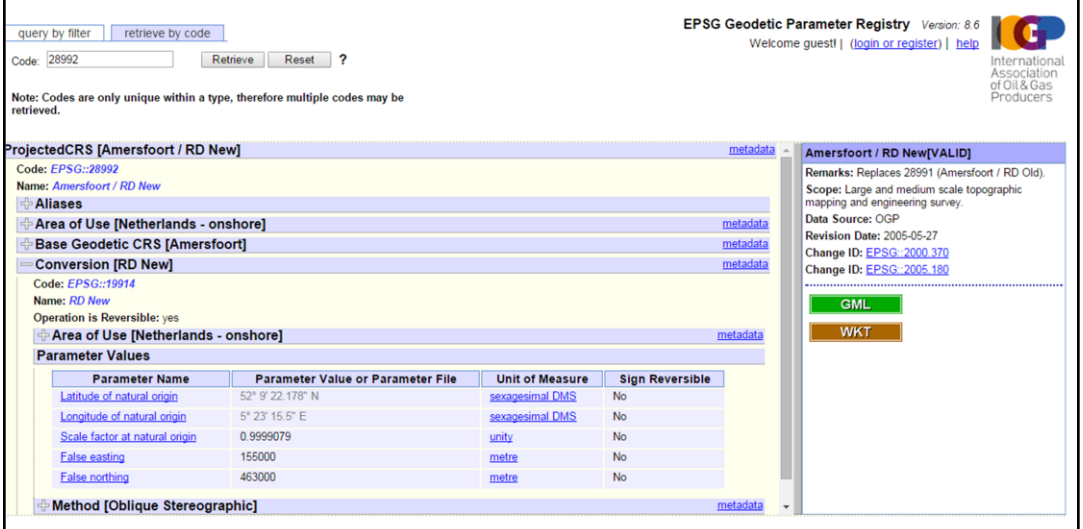
Map projections
From a curved surface to a plane
Cartesian coordinates in X,Y

What is EPSG code 28992?



www.petrosysguru.com

Our result



Note 28992
Amersfoort Geographic CRS
RD New projection

WKT for EPSG 28992

```
PROJCRS["Amersfoort / RD New",
  BASEGEODCRS["Amersfoort",
    DATUM["Amersfoort",
      ELLIPSOID["Bessel 1841",6377397.155,299.1528128,LENGTHUNIT["metre",1.0]]]],
  CONVERSION["RD New",
    METHOD["Oblique Stereographic",ID["EPSG",9809]],
    PARAMETER["Latitude of natural origin",52.156160555556,ANGLEUNIT["degree",0.01745329252]],
    PARAMETER["Longitude of natural origin",5.387638888889,ANGLEUNIT["degree",0.01745329252]],
    PARAMETER["Scale factor at natural origin",0.9999079,SCALEUNIT["unity",1.0]],
    PARAMETER["False easting",155000,LENGTHUNIT["metre",1.0]],
    PARAMETER["False northing",463000,LENGTHUNIT["metre",1.0]]],
  CS[cartesian,2],
    AXIS["easting (X)",east,ORDER[1]],
    AXIS["northing (Y)",north,ORDER[2]],
    LENGTHUNIT["metre",1.0],
  ID["EPSG",28992]]
```

The Amersfoort CRS is based on the Bessel ellipsoid
RD new projection is an Oblique Stereographic

That's all

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- Read the literature
- Make the assignment

Introduction to XML and UML

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Source:
EuroSDR Educational Services - EduServ, (EuroSDR).