

G-XML 3.0: An Overview of New Features

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Table of contents

| | |
|--|------|
| 1. Abstract of G-XML Protocol..... | 1-1 |
| 1.1 Scope..... | 1-1 |
| 1.2 Framework..... | 1-1 |
| 1.3 Strucure of the specification..... | 1-2 |
| 2. G-XML Geographical Data Protocol (GDP) --- normative | 2-1 |
| 2.1 Schema components --- normative | 2-1 |
| 2.1.1 Definitions in the schema component..... | 2-1 |
| 2.1.2 Explanation of the schema components..... | 2-2 |
| (1) Definition..... | 2-3 |
| (2) Model..... | 2-3 |
| (3) Relation with other schema components..... | 2-3 |
| 2.2 G-XML Base Markup Geographical Data Protocol (BM-GDP) --- normative | 2-5 |
| 2.2.1 Definition in the BM-GDP | 2-5 |
| 2.2.2 Explanation in the BM-GDP | 2-5 |
| (1) Definition..... | 2-6 |
| (2) Structure figure of XML instance..... | 2-6 |
| (3) Sample form of the XML instance..... | 2-7 |
| (4) Role of the element | 2-8 |
| 2.3 G-XML Mobile Markup Geographical Data Protocol --- normative | 2-9 |
| 2.3.1 Explanation of MM-GDP | 2-9 |
| 2.3.2 Explanation of MM-GDP | 2-10 |
| (1) G-XML over SVG..... | 2-10 |
| (2) Markup rules for the MM-GDP..... | 2-12 |
| (3) Mobile Map Distribution Service and Mobile Map Collection Service | 2-15 |
| 3. Methods of creating the APplication Schema according to the GXML Extention Rules (MAPS-ER) --- informative | 3-1 |
| 3.1 Explanation of the MAPS-ER..... | 3-1 |
| 3.2 Explanation in MAPS-ER..... | 3-2 |
| (1) Purpose | 3-2 |
| (2) Rules for defining the types expressing geospacial infomation.... | 3-2 |
| (3) Rules for making XSLT templates..... | 3-2 |
| (4) Example..... | 3-2 |

| | |
|---|-----|
| 4. G-XML GeoSpatial Service Protocol --- informative | 4-1 |
| 4.1 Explanation of GSP..... | 4-1 |
| 4.2 Explanation of the GSP..... | 4-4 |
| 4.2.1 Interface specification of the GSP..... | 4-4 |
| (1) Applicable extents..... | 4-5 |
| (2) Image of implementation..... | 4-5 |
| (3) Conceptual model..... | 4-5 |
| (4) Interfaces..... | 4-6 |
| (5) WSDL defining the interfaces | 4-6 |
| (6) Examples of the implementation..... | 4-6 |
| (7) Examples of the input/output messages | 4-6 |
| 4.2.2 Service chains..... | 4-6 |
| (1) Scenario | 4-7 |
| (2) Dependance | 4-7 |
| (3) Series of Message exchange | 4-7 |
| 4.2.3 Types of geospatial service..... | 4-7 |

1. Abstract of G-XML Protocol

This section describes the scope of the new G-XML specification and its framework.

1.1 Scope

The new G-XML protocol was designed to achieve the following goals:

- Convergence and harmonization with the GML3.0 specification of OGC (Open GIS Consortium)
- Harmonization with the ISO19100 series specifications
- Maintain upward compatibility with G-XML2.0 (JIS X 7199)
- Operate within restricted environments such as portable devices, including mobile phones.
- To allow the combined use of both Geographical Data and Geographical Services.

1.2 Framework

The framework of the new G-XML specification contains the following parts:

- Geographical Data Procotol (normative)
 - Base Markup Geographical Data Procotol
 - Mobile Markup Geographical Data Procotol
- Methods of creating application schemas according to the G-XML extention rules. (informative)
- Geographical Service Protocol (informative)

Figure 1 shows an overview of this framework.

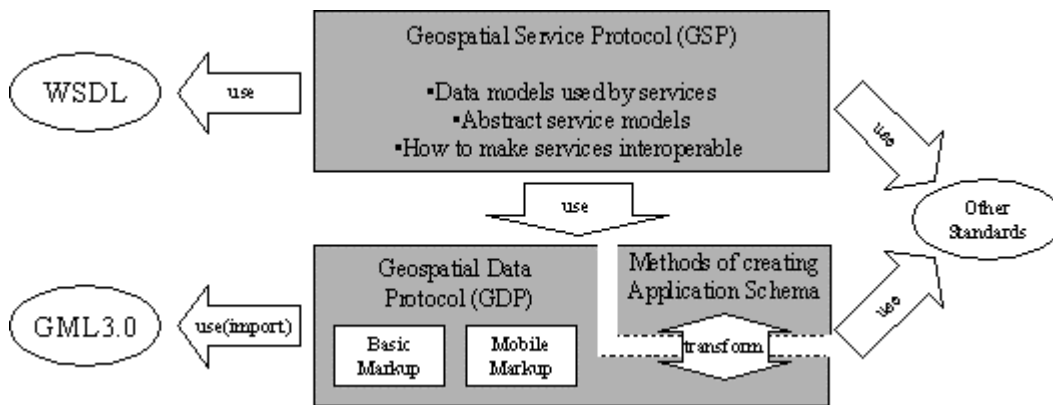


Figure 1 framework of the new G-XML

The Geographical Data Protocol (GDP) defines the XML encoding rules for geographical data using GML3.0 and other international standards. The GDP has two Markup Protocols:

- Base Markup Geographical Data Protocol (BM-GDP)

This protocol maintains compatibility with GXML2.0 and harmonizes with the specification of GML3.0.

- Mobile Markup Geographical Data Protocol (MM-GDP)

This protocol is for use in mobile devices and acts as a 'framework' for those devices to handle geospatial data.

Methods of creating an application schema according to the G-XML extension rules, are provided as 'informative' in the GDP. This informative information provides methods on how to apply the user defined encoding rules. Using these methods, users can make their own encoding rules that they can use to convert to and from the BM-GDP.

The Geospatial Service Protocol (GSP) provides interfaces, based on GDP, to access geospatial data. Defining these interfaces enables the interoperable use of geospatial data. The interfaces are encoded to XML using WSDL.

1.3 Structure of the specification

The specification of the G-XML protocol is arranged as a 'Main Book' with the seven annexes. The Main Book and the first two annexes are normative while the remaining five annexes are informative.

Table 1 shows the structure of the G-XML specification and a brief abstract of each annex

Table 1 Structure of G-XML specification

| | title | normative /informative | abstract |
|-----------|--|------------------------|--|
| Main Book | - | N | Definition of the Base Markup Geographical Data Protocol (BM-GDP) and accompanying schema components |
| Annex1 | XML Schema of the G-XML protorocl | N | Specifications of encoding rules of the schema components written in XML Schema |
| Annex2 | Mobile Markup Georgaphic Data Protorol (MM-GDP) | N | Mobile Markup Geographical Data Protocol Definition |
| Annex3 | Methods of creating application schemas according to the G-XML extention rules | I | Reference showing methods of making application schemas according to G-XML's extention rules |
| Annex4 | Geographic Service Protocol | I | Reference for web services pertaining to geographic data |
| Annex5 | Methods of defining and referencing dictionaries | I | Reference for the creation and use of dictionaries for geographical data |
| Annex6 | Examples | I | Use examples of the G-XML protocol |
| Annex7 | Background | I | References and background of the G-XML protocol |

2. G-XML Geographical Data Protocol (GDP) --- **normative**

The GDP defines the schema components and the markup rules for geographic data based on those components. These components compose the schema for geographic data.

2.1 Schema components --- **normative**

Schema components are the abstract model classified by specified themes so as to not lose the meaning of the geographic data. They define the series of abstract data types that belong to the same theme. Each schema offered by GML3.0 is sorted again in the view of G-XML usage.

The schema components take into account compatibility with 'the compound module' and 'the most minimal component' of G-XML2.

2.1.1 Definitions in the schema component

The schema component is defined in Section 7 of the Main Book. The abstract models are described in accordance with the UML descriptions.

Table 2 shows the schema components defined in G-XML. Components defined in GML are also shown.

Table 2 List of the schema component of G-XML

| name | abstract |
|--------------------------------------|--|
| G-XML data schema component | describes the geospatial data as a whole. |
| FeatureWithGeometry schema component | describes the feature with the geometric information as a spatial attribute. |
| FeatureWithTopology schema component | describes the feature with the topological information as a spatial attribute. |
| POI schema component | describes various geospatial informations, such as location, time, and category. |
| MovingObject schema component | describes the information related with a moving object in the geospace. |

| name | abstract |
|---------------------------------------|---|
| LocationRelationship schema component | describes the relationship between the geospatial objects. |
| Metadata schema component | describes the metadata related with the geospatial data. |
| spatialLocator schema component | describes the geospatial location using structured or unstructured strings. |
| thematicProperty schema component | describes the thematic property of features. |
| Picture schema component | describes the picture data as coverages of the geospatial domains. |
| Route schema component | describes the route from a certain geospatial location to another. |

Table 3 List of the schema component of GML

| name | Abstract |
|--|--|
| gmlBase schema component | describes the abstract and basic types referred by other GML schema components |
| feature schema component | describes the abstract feature. |
| geometry schema component | describes the geometries defined in the geospace. |
| topology schema component | describes the topological relationship defined in the geospace. |
| direction schema component | describes the directions by measured values or keywords. |
| observation schema component | describes the measured values as features. |
| coverage schema component | describes the coverages in the geospace. |
| defaultStyle schema component | describes the default styling rules to make maps visible. |
| dictionary schema component | describes the rules of defining the dictionaries of geospatial terms |
| coordinateReferenceSystem schema component | describes the definitions of coordinate system |
| xlink schema component | describes the extended link of XML. |

2.1.2 Explanation of the schema components

Each schema component contains the following contents in its description.

(1) Definition

This defines the concept of the schema component. The schema components of GML3.0 only have this subsection.

(2) Model

This shows the abstract models using UML static structure.

Figure 2 shows the model the feature with geometry which derivates the abstract feature model of GML.

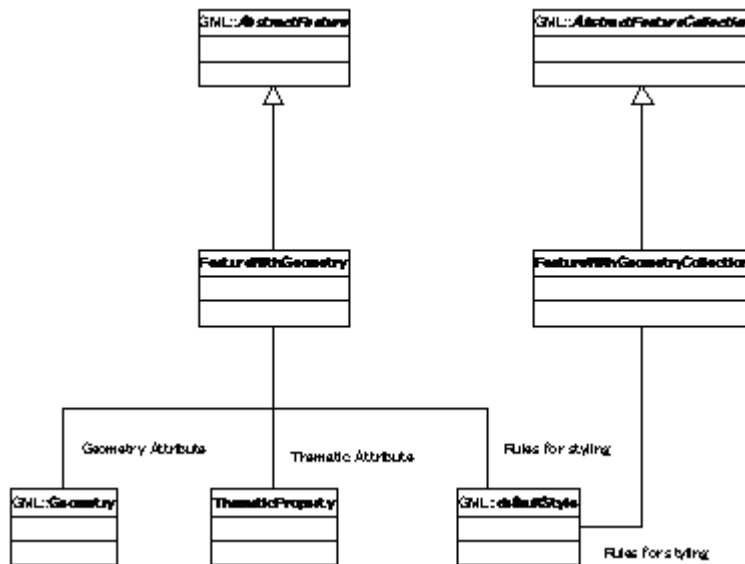


Figure 2 Example of the model of the schema components

(3) Relation with other schema components

The relation of include and import with other schema components are described using the UML static structure.

Figure 3 shows that the FeatureWithTopology schema component imports three different schema components of GML and includes three different components of G-XML.

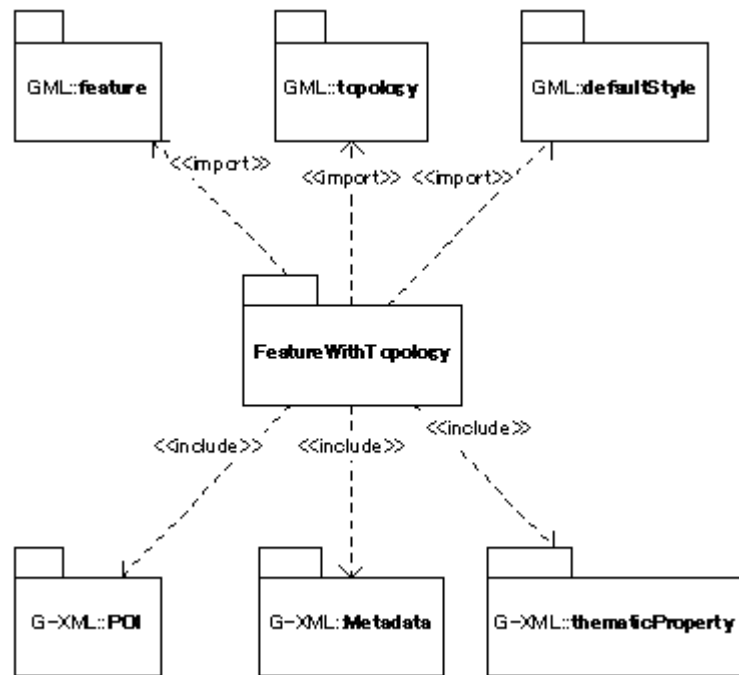


Figure 3 Example of the relation of include and import

2.2 G-XML Base Markup Geographical Data Protocol (BM-GDP) --- ***normative***

The Base Markup Geographical Data Protocol (BM-GDP) of G-XML defines the encoding rules of each abstract idea of the schema components and defines the basic markup rules for geospatial data.

2.2.1 Definition in the BM-GDP

Table 4 shows the markup rules which correspond to the schema components that are defined in BM-GDP.

Table 4 Markup rules in BM-GDP

| name | abstract |
|----------------------------------|--|
| G-XMLdata markup rule | defines the encoding rule to describe the geospatial data as a whole. |
| FeatureWithGeometry markup rule | defines the encoding rules to describe the features with geometry. |
| FeatureWithTopology markup rule | defines the encoding rules to describe the features with topology. |
| POI markup rule | defines the encoding rule to describe various geospatial information such as location, time, and category. |
| MovingObject markup rule | defines the encoding rules to describe the moving object in the geospace. |
| LocationRelationship markup rule | defines the encoding rules to describe the relationship between geospatial objects. |
| Metadata markup rule | defines the encoding rule to describe the metadata about the geospatial data. |
| spatialLocator markup rule | defines the encoding rule to describe the geospatial location. |
| thematicProperty markup rule | defines the encoding rules to describe the thematic property of the geospatial data. |
| Picture markup rule | defines the encoding rules to describe the picture projected to the geospace. |
| Route markup rule | defines the encoding rules to describe the route in the geospace. |

2.2.2 Explanation in the BM-GDP

Each markup rules of BM-GDP shows the following contents in its description.

(1) Definition

This explains the other standards to use and what we can encode by using each markup rules.

(2) Structure figure of XML instance

This figure shows the original description formats which stand for the hierarchical structures of the XML instances based on each markup rule. The formats are introduced in detail in the subsection 3.2.1 of the Main Book.

Those who use the BM-GDP can understand the structures of the XML instances by looking at this figure.

Example shown in Figure 4 describes that an element `<gxml:G-XMLdata>` has elements expressing metadata, elements expressing feature, `<gxml:Route>`, `<gxml:POI>`, etc. as its child elements.

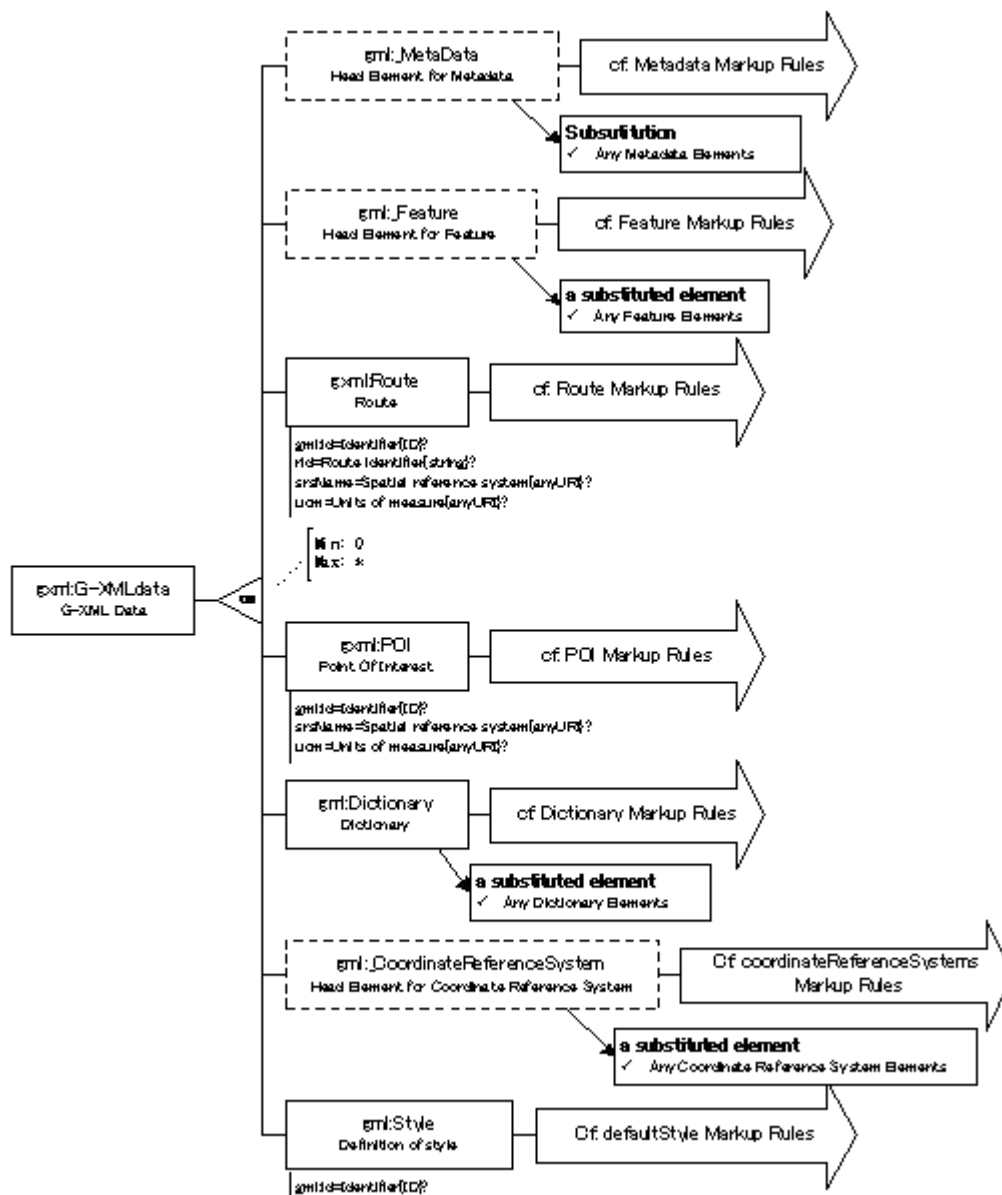


Figure 4 Example of the structure figure of an XML instance

(3) Sample form of the XML instance

This describes how we should create XML instances based on each markup rule by the original description formats as a Sample form. The formats are introduced in detail in the subsection 3.2.2 of the Main Book.

Those who use the BM-GDP can create XML instances which encode the geospatial data by adding (and/or) deleting the necessary parts according to their

data.

In Figure 5 , you can create XML instances by writing the necessary information at the underlined parts. Figure 6 shows the result of it.

```
<!-- Expressing the top element of the thematic pro1 -->
<gxml:thematicProperty thematicPropertyName='Name of the thematic
property{string}'
datatype='Data type{string}' >
  0 or 1
  able to describe the simple
  link of the XLink
  <!--
    Able to describe all of the object related elements
  -->
  <gxml:thematicValue>Value of the thematic
  property{string}</gxml:thematicValue>
  0 or 1
</gxml:thematicProperty>
```

Figure 5 Sample form of an XML instance

```
<gxml:thematicProperty thematicPropertyName='average temperature'
datatype='double'>
  <gxml:thematicValue>12.3</gxml:thematicValue>
</gxml:thematicProperty>
```

Figure 6 Example of an XML instance

(4) Role of the element

This subsection describes the role of each element defined in the markup rule.

2.3 G-XML Mobile Markup Geographical Data Protocol --- **normative**

The Mobile Markup Geographical Data Protocol or (MM-GDP) of G-XML offers the total framework available for use in the field of mobile communication thus enabling mobile devices, that initially have some functional restrictions, to more easily handle geospatial data.

It is NOT appropriate to use the markup rules of BM-GDP in mobile devices because those rules have very deep nested structures and long element names which lead to complex and redundant structures.

The prime requirement of MM-GDP is for use in mobile devices, such as mobile phones. Encoding rules for MM-GDP are defined with this requirement in mind. Care was placed to keep the encoding rules as simple as possible.

In addition to the primary requirement of MM-GDP, a framework exists allowing for the interoperability between MM-GDP and BM-GDP.

Developers who make use of MM-GDP will be able to more easily use geospatial data in mobile devices based on the definitions of the MM-GDP protocol.

2.3.1 Explanation of MM-GDP

MM-GDP is described in Annex 2 of the specification for the G-XML protocol.

Table 5 shows the total framework of G-XML for use in mobile communication devices.

Table 5 Components of the MM-GDP

| No. | Components | Role | Abstract |
|-----|--|--------------------|---|
| 1. | G-XML over SVG | encoding rules | describes the encoding rule of geospatial data based on SVG 1.1 Tiny Profile. |
| 2. | Markup rules for mobile communications | encoding rules | describes the minimum set of the BM-GDP which has the same meaning as 1. |
| 3. | Mobile Map Distribution Service | geospatial service | describes the geospatial service which links 2. to 1. |
| 4. | Mobile Map Collection Service | geospatial service | describes the geospatial service which links 1. to 2. (the opposite of 3) |

Figure 7 shows the abstract concept of the MM-GDP framework.

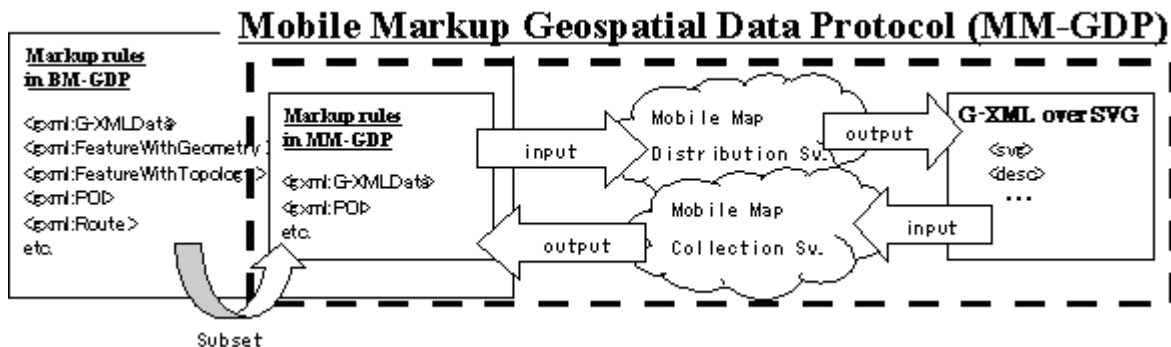


Figure 7 Framework of MM-GDP

'G-XML over SVG' is an encoding rule of geospatial data based on SVG specifications and is designed for use in mobile devices. The Markup rules of MM-GDP are also a partial set of the BM-GDP rules for use in mobile environments and mobile devices.

Both the 'G-XML over SVG' and 'Markup Rules of MM-GDP' encoding rules along with the related Geospatial Services defined in MM-GDP give G-XML a flexible and simple framework for enabling geospatial data use in mobile devices.

2.3.2 Explanation of MM-GDP

The following are described in MM-GDP.

(1) G-XML over SVG

'G-XML over SVG' is an encoding rule to embed geospatial data from G-XML into the extendable parts of the SVG 1.1 Tiny Profile. 'G-XML over SVG' extends the specification of SVG through the addition of geospatial information. The addition of this geospatial data does not effect any application using the original SVG data. Non geo-enabled applications must be able to render the 'G-XML over SVG' data as vector graphics even though there is no need for them to access the geospatial data.

Table 6 shows what in SVG has been extended through 'G-XML over SVG.'

Table 6 Extended points based on SVG

| title | points | where extended |
|-------------------------------------|---|---|
| coordinate system description | supports the necessary descriptive information about the coordinate system and how to convert the data to the local coordinate system. | Descriptive data is stored as metadata |
| POI (Point of interest) description | supports the description not only of the category, but location, time, and other properties as a Point Of Interest in geospace. | is done by regarding the element 'use' of SVG as the symbol expressing the Point Of Interest and by describing its information to the element 'desc' of SVG which can have any property without being rendered. |

Figure 8 shows an example of 'G-XML over SVG.'

```

<svg width='320' height='400' viewBox='0 0 160 200'
xmlns='http://www.w3.org/2000/svg' xmlns:gxml='http://www.dpc.or.jp/gxml'>
  <metadata>
    <rdf:RDF xmlns:rdf='http://www.w3.org/1999/02/22-rdf-syntax-ns#'
            xmlns:gxml='http://www.dpc.or.jp/gxml'
            xmlns:svg='http://www.w3.org/2000/svg'>
      <rdf:Description>
        <gxml:crs svg:transform='matrix(800,0,0,-1000,-108000,35200)'
          rdf:resource='http://www.example.org/srs/epsg.xml#4326'/>
      </rdf:Description>
    </rdf:RDF>
  </metadata>
  <defs>
    <rect id='mr' fill='none' stroke='pink' stroke-width='2' width='10' height='10'/>
    <rect fill='none' stroke='red' stroke-width='2' x='-5' y='-5' width='10' height='10'
id='mr2'/>
    <image x='-5' y='-5' width='10' height='10' id='mr3' xlink:href='bil.png'/>
  </defs>
  <polyline fill='none' stroke='purple' stroke-width='1' points='10 0 10 200'/>
  <polyline fill='none' stroke='purple' stroke-width='1' points='50 0 50 200'/>
  <polyline fill='none' stroke='purple' stroke-width='1' points='90 0 90 200'/>
  <polyline fill='none' stroke='purple' stroke-width='1' points='0 10 160 10'/>
  <polyline fill='none' stroke='purple' stroke-width='1' points='0 50 160 50'/>
  <polyline fill='none' stroke='purple' stroke-width='1' points='0 90 160 90'/>
  <polyline fill='none' stroke='purple' stroke-width='1' points='0 130 160 130'/>
  <polyline fill='none' stroke='purple' stroke-width='1' points='0 170 160 170'/>
  <rect fill='none' stroke='green' stroke-width='2' x='0' y='0' width='160'
height='200'/>
  <polyline fill='none' stroke='blue' stroke-width='6' points='30,30 130,30 130,170
30,30'/>

```

Description of the coordinate system as metadata

```

<text x='10' v='130' font-size='10' fill='orange'>
  City Hall
</text>
<!-- G-XML POI over SVG -->
<use x='10' y='10' xlink:href='#mr' poi='point'>
  <desc>
    <gxml:spatialLocator>
      <gxml:AddressString>
        <gxml:unstructuredAddressString>**prefecture**city
      </gxml:unstructuredAddressString>
      </gxml:AddressString>
    </gxml:spatialLocator>
  </desc>
</use>
<use x='10' y='50' xlink:href='#mr2' poi='point'>
  <desc>
    <gxml:thematicProperty thematicPropertyName='tel'>
      <gxml:thematicValue>000-000-000</gxml:thematicValue>
    </gxml:thematicProperty>
  </desc>
</use>
<a xlink:href='http://www.w3.org'>
  <use x='10' y='90' xlink:href='#mr3' poi='point'>
    <desc>
      <gml:timeStamp>
        <gml:TimeInstant>
          <gml:timePosition>2003-02-18T00:00:00:+09:00</gml:timePosition>
        </gml:TimeInstant>
      </gml:timeStamp>
    </desc>
  </use>
</a>
</svg>

```

describing the information about POI to <desc> regarding <use> as a symbol

Figure 8 Example of G-XML over SVG

(2) Markup rules for the MM-GDP

Markup rules for the MM-GDP are the minimum set of rules from the BM-GDP that have the equal meaning with the rules of G-XML over SVG.

Table 7 shows a list of the concrete markup rules adopted in the MM-GDP.

Table 7 List of markup rules adopted in the MM-GDP

| markup rule name | description |
|---------------------------------|---|
| FeatureWithGeometry markup rule | defines the encoding rules to express features with geometry. |

| markup rule name | description |
|------------------------------|---|
| POI markup rule | defines the encoding rules for information about a specific location in geospace. |
| spatialLocator markup rule | defines the encoding rules used to describe a location in geospace. |
| thematicProperty markup rule | defines the encoding rules to express thematic properties in geospace. |
| Picture markup rule | defines the encoding rules to project a picture in geospace. |

Figure 9 shows an example based on markup rules of MM-GDP.

```

<?xml version='1.0' encoding='UTF-8'?>
<gxml:G-XMLdata                                xmlns='http://www.dpc.or.jp/gxml'
xmlns:gxml='http://www.dpc.or.jp/gxml'        xmlns:gml='http://www.opengis.net/gml'
xmlns:xsi='http://www.w3.org/2001/XMLSchema-instance'
xsi:schemaLocation='http://www.dpc.or.jp/gxml
G-XMLdataMobile.xsd'>
  <gxml:FeatureWithGeometry>
    <gml:geometryMember>
      <gml:LineString>
        <gml:coordinates>*,* *,* </gml:coordinates>
      </gml:LineString>
    </gml:geometryMember>
    <gml:defaultStyle>
      <gml:Style>
        <gml:FeatureStyle>
          <gml:GeometryStyle>
            <gml:style>fill: none; stroke: purple; stroke-width: 1;</gml:style>
          </gml:GeometryStyle>
        </gml:FeatureStyle>
      </gml:Style>
    </gml:defaultStyle>
  </gxml:FeatureWithGeometry>
  <gxml:FeatureWithGeometry>
    <gml:geometryMember>
      <gml:LineString>
        <gml:coordinates>*,* *,* </gml:coordinates>
      </gml:LineString>
    </gml:geometryMember>
    <gml:defaultStyle>
      <gml:Style>
        <gml:FeatureStyle>
          <gml:GeometryStyle>
            <gml:style>fill: none; stroke: purple; stroke-width: 1;</gml:style>
          </gml:GeometryStyle>
        </gml:FeatureStyle>
      </gml:Style>
    </gml:defaultStyle>
  </gxml:FeatureWithGeometry>
  <gxml:FeatureWithGeometry>

```

```

<gml:geometryMember>
  <gml:Envelope>
    <gml:coordinates>*,* *,* *,* </gml:coordinates>
  </gml:Envelope>
</gml:geometryMember>
<gml:defaultStyle>
  <gml:Style>
    <gml:FeatureStyle>
      <gml:GeometryStyle>
        <gml:style>fill: none; stroke: green; stroke-width: 2;</gml:style>
      </gml:GeometryStyle>
    </gml:FeatureStyle>
  </gml:Style>
</gml:defaultStyle>
</gxml:FeatureWithGeometry>
<gxml:FeatureWithGeometry>
  <gml:geometryMember>
    <gml:LineString>
      <gml:coordinates>*,* *,* *,* </gml:coordinates>
    </gml:LineString>
  </gml:geometryMember>
  <gml:defaultStyle>
    <gml:Style>
      <gml:FeatureStyle>
        <gml:GeometryStyle>
          <gml:style>fill: none; stroke: blue; stroke-width: 6;</gml:style>
        </gml:GeometryStyle>
      </gml:FeatureStyle>
    </gml:Style>
  </gml:defaultStyle>
</gxml:FeatureWithGeometry>
<gxml:FeatureWithGeometry>
  <gml:geometryMember>
    <gml:Point>
      <gml:coordinates>*,* </gml:coordinates>
    </gml:Point>
  </gml:geometryMember>
  <gml:defaultStyle>
    <gml:Style>
      <gml:FeatureStyle>
        <gml:LabelStyle>
          <gml:style>fill: orange; font-size: 10;</gml:style>
          <gml:label>SHIYAKUSHO</gml:label>
        </gml:LabelStyle>
      </gml:FeatureStyle>
    </gml:Style>
  </gml:defaultStyle>
</gxml:FeatureWithGeometry>
<gxml:POI>
  <gxml:spatialLocator>
    <gml:Point>
      <gml:coordinates>*,* </gml:coordinates>
    </gml:Point>
  </gxml:spatialLocator>

```

```

<gxml:spatialLocator>
  <gxml:AddressString>
    <gxml:unstructuredAddressString>***prefecture***city
</gxml:unstructuredAddressString>
  </gxml:AddressString>
</gxml:spatialLocator>
</gxml:POI>
<gxml:POI>
  <gxml:spatialLocator>
    <gml:Point>
      <gml:coordinates>*,*</gml:coordinates>
    </gml:Point>
  </gxml:spatialLocator>
  <gxml:thematicProperty thematicPropertyName='tel'>
    <gxml:thematicValue>000-000-000</gxml:thematicValue>
  </gxml:thematicProperty>
</gxml:POI>
<gxml:POI>
  <gxml:spatialLocator>
    <gml:Point>
      <gml:coordinates>*,*</gml:coordinates>
    </gml:Point>
  </gxml:spatialLocator>
  <gml:timeStamp>
    <gml:TimeInstant>
      <gml:timePosition>2003-02-18T00:00:00:+09:00</gml:timePosition>
    </gml:TimeInstant>
  </gml:timeStamp>
</gxml:POI>
</gxml:G-XMLdata>

```

Figure 9 Example based on markup rules of MM-GDP

(3) Mobile Map Distribution Service and Mobile Map Collection Service

Mobile Map Distribution Service defines a geospatial service for converting G-XML over SVG to markup rules in MM-GDP.

Mobile Map Collection Service defines the geospatial service for converting markup rules in MM-GDP to G-XML over SVG.

Figure 10 shows an abstraction of these services.

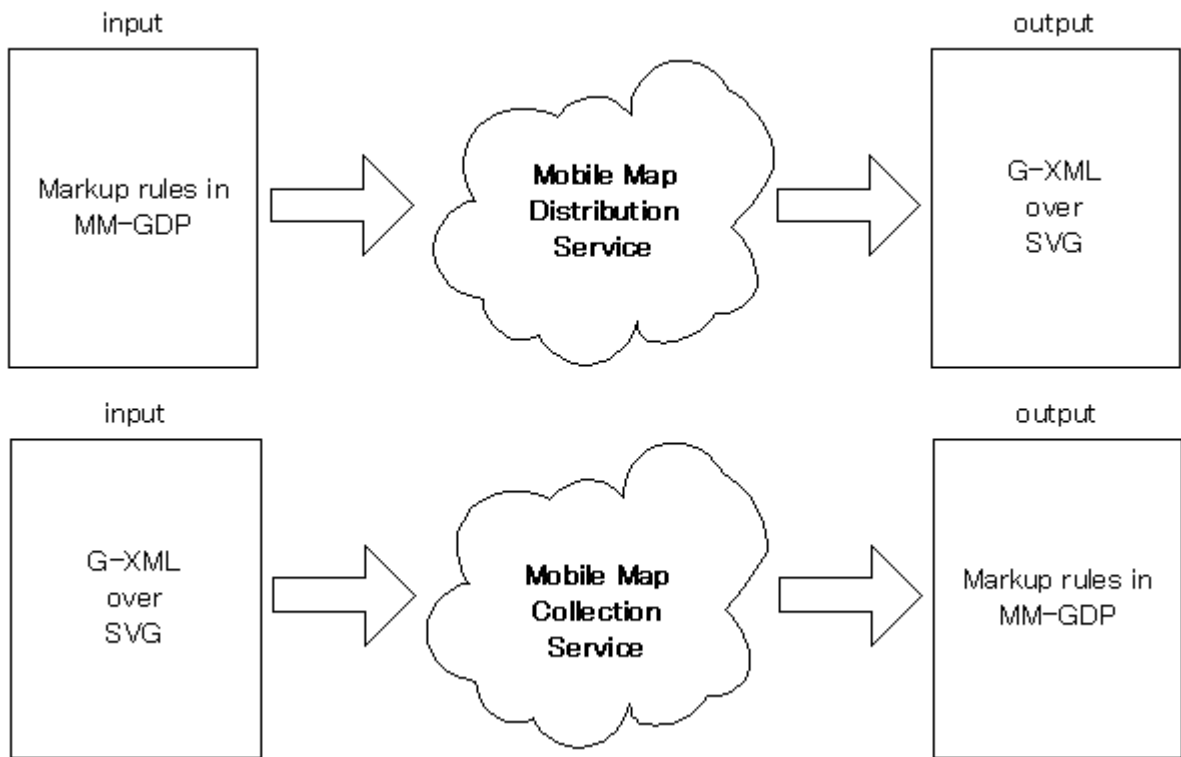


Figure 10 Mobile Map Distribution/Collection Service

3. Methods of creating the APplication Schema according to the G-XML Extention Rules (MAPS-ER) --- ***informative***

MAPS-ER offers a way in which users can define the original encoding rules accorindng to having the complete compatibility with the BM-GDP.

3.1 Explanation of the MAPS-ER

MAPS-ER is described in the Annex 3 of the G-XML specification as informative information.

In the MAPS-ER, setting the following two rules enables the creation of encoding rules that are compatible with BM-GDP.

- Rules to define types expressing geospacial infomation
- Rules to make XSLT templates

Following these two rules, makes it possible to use the geospatial data based on the application schema in the existing applications that conform to the BM-GDP.

Table 8 shows the list of the themes where the above two rules could be defined using MAPS-ER.

Table 8 List of MAPS-ER

| theme | abstract |
|---|---|
| Types expressing features with geometry | corresponds to the FeatureWithGeometry markup rules in BM-GDP |
| Types expressing features with topology | corresponds to the FeatureWithTopology markup rules in BM-GDP |
| Types expressing moving object | corresponds to the MovingObject markup rules in BM-GDP |
| Types expressing Point Of Interest | corresponds to the POI markup rules in BM-GDP |
| Types expressing route | corresponds to the Route markup rules in BM-GDP |
| Types expressing picture | corresponds to the Picture markup rules in BM-GDP |
| Types expressing the rendering rules | corresponds to the defaultStyle markup rules in GML |

| theme | abstract |
|------------------------------------|---|
| Types expressing spacial location | corresponds to the spatialLocator markup rules in GML |
| Types expressing thematic property | corresponds to the thematicProperty markup rules in GML |
| Types expressing metadata | corresponds to the Metadata markup rules in GML |

3.2 Explanation in MAPS-ER

In each theme the following contents are described in MAPS-ER.

(1) Purpose

This subsection describes the relation between each theme and the BM-GDP.

(2) Rules for defining the types expressing geospacial infomation

Rules for defining the types are for making certain restrictions to the degree of freedom when making application schema.

These rules restrict users only to define the name of the feature types and the property of the features. Also this is designed to maintain the compatibility between the types defined in MAPS-ER and those defined in BM-GDP.

(3) Rules for making XSLT templates

Rules for making XSLT templates are converting rules for realizing the compatibility defined in the types of (2).

Those who make application schemas can easily produce the XSLT templates as long as they follow the 'rules for defining the types expressing geospacial information,' because these rules for XSLT templates, as described in this subsection, are designed in accordance with the rules for types.

(4) Example

This subsection shows the XML instances made based on each of the defined

rules as follows:

- application schemas made based on the each rule
- XML instances based on the application schema
- XSLT templates made based on the each rule
- results of the conversion from applying XSLT templates to XML instances

4. G-XML GeoSpatial Service Protocol --- ***informative***

The GeoSpatial Service Protocol (GSP) provides users with a method of producing geospatial data and interfaces by which to use that geospatial data based on GDP. Defining these interfaces enables the interoperable framework of more practical use of the geospatial data.

4.1 Explanation of GSP

GSP is defined in Annex 4 of the G-XML specification as informative information.

Following three themes are formulated in GSP:

- Interface specifications of GeoSpatial Services
- service chain for the GeoSpatial Services
- the types for using the GeoSpatial Services

Table 9 shows a list of the GeoSpatial Service interfaces that are formulated by GSP.

Table 9 List of the services in GSP

| name | abstract |
|--------------------|---|
| Geospatial service | describes the specification of the abstract services. All other services in GSP are derived from this service. |
| Data service | describes an abstract service which cannot be implemented. All of services in GSP categorized as 'Data service' derive from this service. |
| Feature service | describes a service which operates and obtains the information of features. |
| Coverage service | describes a service which operates and obtains the information of coverages. |
| Gazetteer service | describes a service which receives a certain location name and returns the corresponding features. |
| Tracking service | describes a service for tracking the location. |
| Directory service | describes a service which offers the information of a certain location. |

| name | abstract |
|----------------------------|---|
| Processing service | describes an abstract service which cannot be implemented. All of services in GSP categorized as 'Processing service' derive from this service. |
| Portrayal service | describes an abstract service which cannot be implemented. All of services in GSP categorized as 'Portrayal service' derive from this service. |
| Map service | describes a service which renders maps according to the given conditions. |
| Coverage Portrayal service | describes a service which renders coverages according to the given conditions. |
| Navigation service | describes a service which offers searching routes to the goal. |
| Geocoding service | describes a service which relates the geospatial information and the location of the geospace. |
| Geoparsing service | describes a service which search geospatial keywords from documents. |

GSP also describes the service scenarios that are realized by linking some related services, which leads to larger functions.

Table 10 shows the list of geospatial service chains formulated in GSP.

Table 10 List of service chain

| scenario | abstract | related services |
|--|---|--|
| Adding coordinate information to text data documents | The service takes text data documents as input data, extracts the names related with the geospace by geoparsing, and obtains the coordinates by geocoding. Geoparsing and geocoding make use of a certain tables of geographical names. | Geoparsing service, Geocoding service, and Gazetteer service |
| Autmatically collecting features by Map service | Map service receives target features in response to the request for rendering maps | Map service and Feature service |
| Rendering the tracks of moving object by Map service | Map service receives the tracks of moving objects and renders them on the maps. | Map service and Tracking service |
| Rendering of POIs by Map service | Map service receives the information of the POIs and renders them onto the maps. | Map service and Directory service |

| scenario | abstract | related services |
|---|---|--|
| Automatically collecting coverages by CoveragePortrayal service | Map service receives target coverages in response to the request for rendering maps | CoveragePortrayal service and Coverage service |

Table 11 shows the list of types used in GSP.

Table 11 Types used in GSP

| name | service using these types | abstract |
|----------------------------|---------------------------|--|
| ServiceExceptionType | All services | types to notify the exception occurred in the service |
| GeneralServiceMetadataType | All services | metadata types expressing the general service properties |
| LayerMetadataType | Portrayal service | metadata types about the layer of the Portrayal service |
| AvailableOperationType | Data service | enumerated types of operations available in Feature service and Coverage service |
| FeatureTypeMetadataType | Feature service | metadata types about the feature types in the Feature service |
| FeatureQueryType | Feature service | searching condition types about the feature types in Feature service |
| FeatureLockType | Feature service | types to instruct the lock operation to features |
| InsertType | Data service | types to instruct the insert operation to features |
| UpdateType | Data service | types to instruct the update operation to features |
| DeleteType | Data service | types to instruct the delete operation to features |
| TransactionResultType | Data service | result types of the transaction operation for features and coverages |
| CoverageMetadataType | Coverage service | metadata types about coverages of Coverage service |
| CoverageQueryType | Coverage service | searching condition types about the coverages in Coverage service |
| CoverageLockType | Coverage service | types to instruct the lock operations to coverages |
| TrackingMetadataType | Tracking service | metadata types about Tracking service |

| name | service using these types | abstract |
|-------------------------|---------------------------|--|
| TrackingConstraintType | Tracking service | restriction condition types about the subjects of tracking in Tracking service |
| DirectoryMetadataType | Directory service | metadata types about the Directory service |
| ProximityConstraintType | Directory service | restriction condition types about the neighborhood |
| GazetteerMetadataType | Gazetteer service | metadata types about the Gazetteer service |
| NetworkMetadataType | Navigation service | metadata types about network data |
| GeocodingMetadataType | Geocoding service | metadata types about Geocoding service |
| GeoparsingMetadataType | Geoparsing service | metadata types about Geoparsing service |
| SpatialNameType | Geoparsing service | geographical name types included in the result of the geoparsing |
| GeoparseResultType | Geoparsing service | result types of the geoparsing |

4.2 Explanation of the GSP

4.2.1 Interface specification of the GSP

The interface specifications of the GSP are categorized and structured heirarchaly by applying the abstract services. Figure 11 shows the hierarchy of these services.

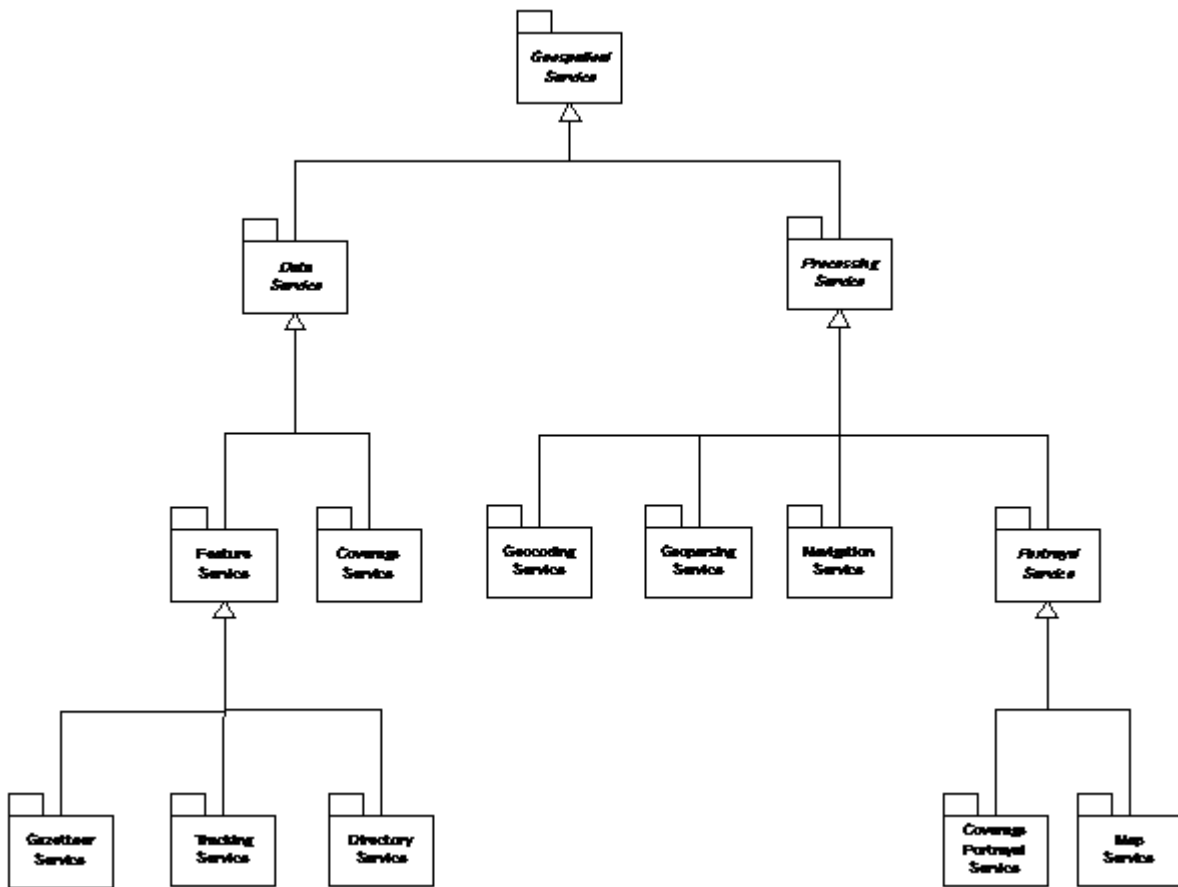


Figure 11 Hierarchy of the GeoSpatial Services

Each of the specifications for the interfaces in the GSP have the following content.

(1) Applicable extents

This subsection shows the scope and abstract of the corresponding service.

(2) Image of implementation

This subsection shows the images of input and output of the operations provided by the corresponding services by using examples of XML instances. Of course the description of these images are omitted in the abstract services.

(3) Conceptual model

This subsection describes the conceptual model of each service with the other

related service models. These models are written in UML format.

(4) Interfaces

This subsection shows a list of the following components for each service.

- interfaces composing each service
- operations included in the interfaces
- messages which operations uses as input and/or output

Abstract services do not have explanations for the above items.

(5) WSDL defining the interfaces

This subsection describes WSDL formulating the interfaces of each service by XML. These WSDL only define the interfaces that DO NOT depend on the implementations

(6) Examples of the implementation

This subsection shows examples of WSDL for the implementation of the services. These examples use WSDL addressed in (5) and shows the description which **DEPENDS ON** the implementation.

Abstract services do not have explanations of the above.

(7) Examples of the input/output messages

This subsection shows the XML type messages used as the input/output data for the implementation of each service.

Abstract services don't have explanations of the above.

4.2.2 Service chains

The description of the service chain in GSP contains the following contents about each service chain.

(1) Scenario

This subsection shows what kinds of functions are realized by making chains in the GSP one after the other.

(2) Dependance

This subsection describes the relations between the geospatial services that are related to the service chains. These relations are written using the UML activity figure.

(3) Series of Message exchange

This subsection shows the messages exchanged between the geospatial services related as to the service chains. These series of message exchanges are expressed using the UML collaboration figure.

4.2.3 Types of geospatial service

This subsection describes the data types formulated for the use in geospatial services. These are the data types are can be used as parameters of messages which are the input and output of the geospatial services.

The contents of their schema files are shown as the types for the geospatial services.