

# Beeldverwerkingsketen GDI-Vlaanderen mobile mapping data hosting services WMS en WFS interface

**Versie 0.1**

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## Document history

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## 1 Introduction

### 1.1 Document scope

In the context of the AGIV ([www.agiv.be](http://www.agiv.be)) and VITO ([www.vito.be](http://www.vito.be)) cooperation with respect to the mobile mapping hosting services, a WFS and WMS has been setup by VITO to disclose the attributes of the panoramic mobile mapping photographs.

The decision to use the OGC (Open Geospatial Consortium, <http://www.opengeospatial.org/>) WFS/WMS is based on INSPIRE interoperability requirements of the geographic data services.

The WMS interface is to be used to request the photo-positions as a bitmap which represents a projected and clipped visualization according the client viewing specifications. A WFS is to be used whenever the underlying attributes of the features (i.e. the photo capture points) must be available.

This document is intended for service developers or GIS analysts which want to integrate the mobile mapping data in their Web or GIS applications. As such, because this audience might not have Dutch as mother-tongue, it was decided to provide the interface documentation in English.

### 1.2 References

	No reference documents
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### 1.3 Terms, definitions en abbreviations

BVK	Beeldverwerkingsketen
BVK-MM	Beeldverwerkingsketen – mobile mapping
Cyclorama	See panoramic photo
OGC	Open Geospatial Consortium
WMS	Web Map Service
WFS	Web Feature Service
Panoramic photo	The panoramic photographs are made by Cyclomedia Technology B.V. ( <a href="http://www.cyclomedia.nl/">http://www.cyclomedia.nl/</a> ). These photographs cover a field of view of 360 by 180 degrees and are also known as “cycloramas”. These photographs are the stitched products of 2 fish-eye cameras which are simultaneously triggered. The sensor model of the resulting panoramic photographs is “equirectangular”. This is a type of projection for mapping a portion of the surface of a sphere to a flat image. It is also called the "non-projection", or plate carre, since the horizontal coordinate is simply longitude, and the vertical coordinate is simply latitude, with no transformation or scaling applied. In an equirectangular panoramic image all verticals remain vertical, and the horizon becomes a straight line across the middle of the image. Coordinates in the image relate linearly to pan and tilt angles in the real world. The poles (Zenith, Nadir) are located at the top and bottom edge and are stretched to the entire width of the image. Areas near the poles get stretched horizontally. The Equirectangular projection is the default output format of a rotating (scanning) panorama camera equipped with a fisheye lens – 180° fisheye giving a full sphere at 360° rotation. (From: <a href="http://wiki.panotools.org/Equirectangular">http://wiki.panotools.org/Equirectangular</a> )

## 2 Service authentication and authorization

The request of a panoramic photograph or photo-metadata is a transaction involving three parties:

- The mandated users through their internet browser or client application (client),
- AGIV which manages the mandates of users (Identity Provider),
- and VITO hosting the mobile mapping data (Service Provider).

AGIV has chosen to implement the roll of “Identity Provider” based on the WS-Federation standard and comes in two “flavors”: (1) a passive scenario and (2) an active scenario.

In the **passive scenario**, the request of the client is redirected to the AGIV STS (Security Token Service) <https://auth.agiv.be/ipsts/Account/LogOn...>. Upon successful logon, the client can start a valid session.

However, the passive scenario is not possible in all clients (e.g. GIS software packages). Therefore, an **active scenario** is provided. In this scenario, client applications can transfer their requests using the “user id” and password basic authentication over HTTPS.

In your favorite browser you can test both security scenarios using the examples in following sections. For testing the interfaces of the active scenario, the mobile mapping development team has used the open source GIS “QuantumGIS” (<http://www.qgis.org/>)

### 3 WMS/WFS service capabilities

In the context of the BVK with respect to the mobile mapping hosting services, a WFS and WMS has been setup to query and retrieve the photo capture locations and their attributes.

Since GeoServer<sup>1</sup> is the reference implementation of the Open Geospatial Consortium (OGC) Web Feature Service (WFS) and Web Coverage Service (WCS) standards, as well as a high performance certified compliant Web Map Service (WMS), the combination Geoserver and PostGIS<sup>2</sup> was chosen to expose the spatial data layers.

#### 3.1 WMS service

The WMS interface is intended to request the photo capture positions as a bitmap. This bitmap has the size of the client map-drawing canvas and can be requested in a geographic projection the client is using. To explore the available options of the WMS one can make a call to the GeoServer using the GetCapabilities request type.

	Passive scenario	Active scenario
Host	mobilemapping.agiv.be	mobilemapping.agiv.be
Path (case sensitive)	/geoserver/wms	/gis/geoserver/wms
Layer (case sensitive)	Agiv:MobileMapping	Agiv:MobileMapping
Protocol	https	https
Http method	GET, POST	GET, POST

GetCapabilities example in active scenario:

<https://mobilemapping.agiv.be/gis/geoserver/wms?SERVICE=WMS&REQUEST=GetCapabilities>

GetCapabilities example in passive scenario:

<https://mobilemapping.agiv.be/geoserver/wms?SERVICE=WMS&REQUEST=GetCapabilities>

#### 3.2 WFS service

The WFS is intended to be used whenever the underlying attributes of the features (i.e. the photo capture points) must be available. To explore the available options of the WFS services, one can make a call to the GeoServer using the GetCapabilities request type.

<sup>1</sup> <http://geoserver.org/>

<sup>2</sup> <http://postgis.refractory.net/>



	Passive scenario	Active scenario
Host	mobilemapping.agiv.be	mobilemapping.agiv.be
Path (case sensitive)	/geoserver/wfs	/gis/geoserver/wfs
Layer (case sensitive)	Agiv:MobileMapping	Agiv:MobileMapping
Protocol	https	https
Http method	GET, POST	GET, POST

GetCapabilities example in active scenario:

<https://mobilemapping.agiv.be/gis/geoserver/wfs?SERVICE=WFS&REQUEST=GetCapabilities>

GetCapabilities example in passive scenario:

<https://mobilemapping.agiv.be/geoserver/wfs?SERVICE=WFS&REQUEST=GetCapabilities>

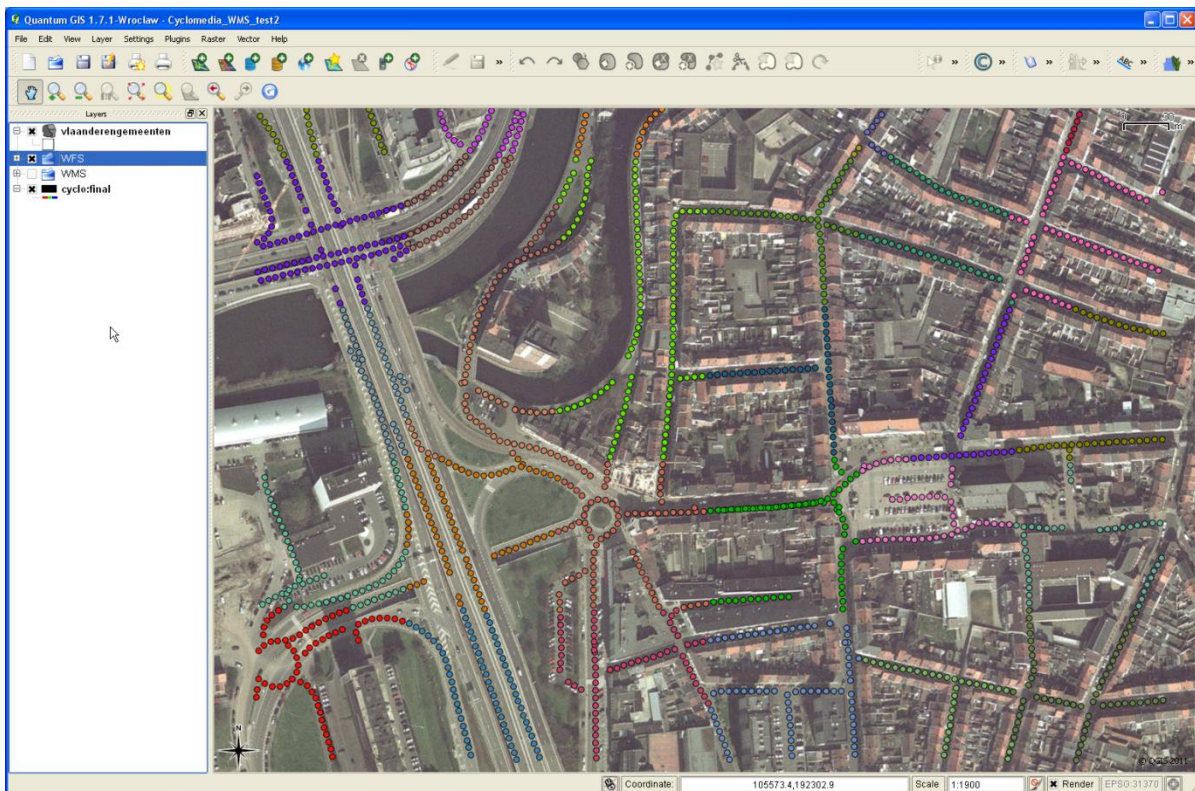
## 4 WMS usage

### 4.1 Choosing for WMS or WFS queries

To display the mobile mapping point layer in a client view, it is strongly recommended to use the WMS service and NOT the WFS service, since the WMS service for the area-wide display of the photo capture points has the smallest network footprint. The WMS network footprint is only dependent on the size of the client view and remains for a standard view under the 100 Kb irrespective the number of points projected in the resulting PNG/JPG bitmap.

The WFS footprint is only dependent on the number of points to display, and ranges – depending on the number of attributes asked – from 554 bytes up to 963 bytes per point. As such, the network overhead of a WFS is a multitude higher than a WMS. This is illustrated in Figure 1.

Consequently, the usage of the WFS service for the area-wide display of the photo capture positions must be avoided.



**Figure 1. QuantumGIS client example: area-wide display of the photo capture points. For this small area, the WMS PNG returned by the Geoserver was 38 Kb, the returned WFS GML files total 1485 Kb.**

### 4.2 Get the attributes of the photo capture points

One can use the WMS service also for requesting the attribute information at a certain photo capture point. A HTTP GET example is given here (active and passive scenario):

[https://mobilemapping.agiv.be/gis/geoserver/wms?SERVICE=WMS&VERSION=1.3.0&REQUEST=GetFeatureInfo&BBOX=107349.043369,189939.511481,107615.265422,190138.174671&CRS=EPSG:31370&WIDTH=1194&HEIGHT=891&LAYERS=Agiv:MobileMapping&STYLES=&FORMAT=image/png&TRANSPARENT=true&QUERY\\_LAYERS=Agiv:MobileMapping&INFO\\_FORMAT=text/html&X=467&Y=261](https://mobilemapping.agiv.be/gis/geoserver/wms?SERVICE=WMS&VERSION=1.3.0&REQUEST=GetFeatureInfo&BBOX=107349.043369,189939.511481,107615.265422,190138.174671&CRS=EPSG:31370&WIDTH=1194&HEIGHT=891&LAYERS=Agiv:MobileMapping&STYLES=&FORMAT=image/png&TRANSPARENT=true&QUERY_LAYERS=Agiv:MobileMapping&INFO_FORMAT=text/html&X=467&Y=261)

[https://mobilemapping.agiv.be/gis/geoserver/wms?SERVICE=WMS&VERSION=1.3.0&REQUEST=GetFeatureInfo&BBOX=107349.043369,189939.511481,107615.265422,190138.174671&CRS=EPSG:31370&WIDTH=1194&HEIGHT=891&LAYERS=Agiv:MobileMapping&STYLES=&FORMAT=image/png&TRANSPARENT=true&QUERY\\_LAYERS=Agiv:MobileMapping&INFO\\_FORMAT=text/html&X=467&Y=261](https://mobilemapping.agiv.be/gis/geoserver/wms?SERVICE=WMS&VERSION=1.3.0&REQUEST=GetFeatureInfo&BBOX=107349.043369,189939.511481,107615.265422,190138.174671&CRS=EPSG:31370&WIDTH=1194&HEIGHT=891&LAYERS=Agiv:MobileMapping&STYLES=&FORMAT=image/png&TRANSPARENT=true&QUERY_LAYERS=Agiv:MobileMapping&INFO_FORMAT=text/html&X=467&Y=261)

In this example, one asks the photo attributes of the photo capture point displayed at row 261 and column 467 of the transparent PNG retrieved through the WMS call.

### 4.3 Styling the WMS results

Every layer registered with GeoServer needs to have at least one style associated with it. GeoServer comes bundled with a few basic styles.

By default the Mobile Mapping WMS service uses a simple SLD to represent a point as a small red square. This default SLD is shown in Table 1. This styling can be changed upon request. A good cookbook on SLD styling can be found online:

<http://docs.geoserver.org/stable/en/user/styling/sld-cookbook/>.

**Table 1. SLD style definition XML of the current default style for the rendering of the photo capture locations in a bitmap.**

```
<?xml version="1.0" encoding="iso-8859-1"?>
<StyledLayerDescriptor version="1.0.0"
  xsi:schemaLocation="http://www.opengis.net/sld StyledLayerDescriptor.xsd"
  xmlns="http://www.opengis.net/sld"
  xmlns:ogc="http://www.opengis.net/ogc"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <!-- a Named Layer is the basic building block of an SLD document -->
  <NamedLayer>
    <Name>default_point</Name>
    <UserStyle>
      <!-- Styles can have names, titles and abstracts -->
      <Title>Default Point</Title>
      <Abstract>A sample style that draws a point</Abstract>
      <!-- FeatureTypeStyles describe how to render different features -->
      <!-- A FeatureTypeStyle for rendering points -->
      <FeatureTypeStyle>
        <Rule>
          <Name>rule1</Name><Title>Red Square</Title>
          <Abstract>A 6 pixel square with a red fill and no stroke</Abstract>
          <PointSymbolizer>
            <Graphic>
              <Mark>
                <WellKnownName>square</WellKnownName>
                <Fill><CssParameter name="fill">#FF0000</CssParameter></Fill>
              </Mark>
              <Size>6</Size>
            </Graphic>
          </PointSymbolizer>
        </Rule>
      </FeatureTypeStyle>
    </UserStyle>
  </NamedLayer>
</StyledLayerDescriptor>
```

To use a custom SLD one can include the SLD as an URL parameter by using the SLD\_BODY tag. For example:

[https://mobilemapping.agiv.be/gis/geoserver/wms?EXCEPTIONS=XML&FORMAT=image/png&TRANSPARENT=TRUE&VERSION=1.3.0&SERVICE=WMS&REQUEST=GetMap&CRS=EPSG:31370&BBOX=105600,191900,106200,192400&WIDTH=1290&HEIGHT=874&SLD\\_BODY=%3CStyledLayerDescriptor%20version%3D%221.0.0%22%20xsi%3AschemaLocation%3D%22http%3A%2F%2Fwww.opengis.net%2Fslid%20StyledLayerDescriptor.xsd%22%20xmlns%3D%22http%3A%2F%2Fwww.opengis.net%2Fslid%22%20xmlns%3Aogc%3D%22http%3A%2F%2Fwww.opengis.net%2Fogc%22%20xmlns%3Axmlns%3D%22http%3A%2F%2Fwww.w3.org%2F1999%2Fxmlns%3Axmlns%3D%22http%3A%2F%2Fwww.w3.org%2F2001%2FXMLSchema-instance%22%3E%3CNamedLayer%3E%3CName%3EAgiv%3AMobileMapping%3C%2FName%3E%3CUserStyle%3E%3CTitle%3EGeoServer%20SLD%20Cook%20Book%3A%20Simple%20point%20with%20stroke%3C%2FTitle%3E%3CFeatureTypeStyle%3E%3CRule%3E%3CPointSymbolizer%3E%3CGraphic%3E%3CMark%3E%3CWellKnownName%3Ecircle%3C%2FWellKnownName%3E%3CFill%3E%3CCssParameter%20name%3D%22fill%22%3E%2300FF00%3C%2FCssParameter%3E%3C%22Fill%3E%3CStroke%3E%3CCssParameter%20name%3D%22stroke%22%3E%23000000%3C%2FCssParameter%3E%3CCssParameter%20name%3D%22stroke-width%22%3E%23000000%3C%2FCssParameter%3E%3C%2FCssParameter%3E%3C%2FStroke%3E%3C%2FMark%3E%3C%2FSize%3E%3C%2FSize%3E%3C%2FGraphic%3E%3C%2FPointSymbolizer%3E%3C%2FRule%3E%3C%2FFeatureTypeStyle%3E%3C%2FUserStyle%3E%3C%2FNamedLayer%3E%3C%2FStyledLayerDescriptor%3E](https://mobilemapping.agiv.be/gis/geoserver/wms?EXCEPTIONS=XML&FORMAT=image/png&TRANSPARENT=TRUE&VERSION=1.3.0&SERVICE=WMS&REQUEST=GetMap&CRS=EPSG:31370&BBOX=105600,191900,106200,192400&WIDTH=1290&HEIGHT=874&SLD_BODY=%3CStyledLayerDescriptor%20version%3D%221.0.0%22%20xsi%3AschemaLocation%3D%22http%3A%2F%2Fwww.opengis.net%2Fslid%20StyledLayerDescriptor.xsd%22%20xmlns%3D%22http%3A%2F%2Fwww.opengis.net%2Fslid%22%20xmlns%3Aogc%3D%22http%3A%2F%2Fwww.opengis.net%2Fogc%22%20xmlns%3Axmlns%3D%22http%3A%2F%2Fwww.w3.org%2F1999%2Fxmlns%3Axmlns%3D%22http%3A%2F%2Fwww.w3.org%2F2001%2FXMLSchema-instance%22%3E%3CNamedLayer%3E%3CName%3EAgiv%3AMobileMapping%3C%2FName%3E%3CUserStyle%3E%3CTitle%3EGeoServer%20SLD%20Cook%20Book%3A%20Simple%20point%20with%20stroke%3C%2FTitle%3E%3CFeatureTypeStyle%3E%3CRule%3E%3CPointSymbolizer%3E%3CGraphic%3E%3CMark%3E%3CWellKnownName%3Ecircle%3C%2FWellKnownName%3E%3CFill%3E%3CCssParameter%20name%3D%22fill%22%3E%2300FF00%3C%2FCssParameter%3E%3C%22Fill%3E%3CStroke%3E%3CCssParameter%20name%3D%22stroke%22%3E%23000000%3C%2FCssParameter%3E%3CCssParameter%20name%3D%22stroke-width%22%3E%23000000%3C%2FCssParameter%3E%3C%2FCssParameter%3E%3C%2FStroke%3E%3C%2FMark%3E%3C%2FSize%3E%3C%2FSize%3E%3C%2FGraphic%3E%3C%2FPointSymbolizer%3E%3C%2FRule%3E%3C%2FFeatureTypeStyle%3E%3C%2FUserStyle%3E%3C%2FNamedLayer%3E%3C%2FStyledLayerDescriptor%3E)

In the latter example, the style used was green circles with black stroke lines as defined in SLD presented in Table 2. Note that such XML needs an appropriate URL encoding. The non-alphanumeric characters need to be replaced by the corresponding hexadecimal ASCII value<sup>3</sup>. Also note that the LAYERS parameter is removed in the WMS call since already specified in the SLD\_BODY parameter.

**Table 2. SLD style definition XML: green points with black stroke line. The “Name” tag must contain the name of the spatial layer to query.**

```
<StyledLayerDescriptor version="1.0.0"
  xsi:schemaLocation="http://www.opengis.net/sld StyledLayerDescriptor.xsd
  xmlns="http://www.opengis.net/sld" xmlns:ogc=http://www.opengis.net/ogc
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <NamedLayer>
  <Name>Agiv:MobileMapping</Name>
  <UserStyle>
  <Title>GeoServer SLD Cook Book: Simple point with stroke</Title>
  <FeatureTypeStyle>
  <Rule>
  <PointSymbolizer>
    <Graphic>
      <Mark>
        <WellKnownName>circle</WellKnownName>
        <Fill>
          <CssParameter name="fill">#00FF00</CssParameter>
        </Fill>
        <Stroke>
          <CssParameter name="stroke">#000000</CssParameter>
          <CssParameter name="stroke-width">2</CssParameter>
        </Stroke>
      </Mark>
      <Size>6</Size>
    </Graphic>
  </PointSymbolizer>
  </Rule>
  </FeatureTypeStyle></UserStyle></NamedLayer></StyledLayerDescriptor>
```

Remark that for larger XML style definition documents, the HTTP POST method will have to be used, since the length of the HTTP GET URL will become too large.

<sup>3</sup> For example : one can use <http://meyerweb.com/eric/tools/dencoder/> to encode an XML: copy/paste the XML in the edit field, press the encode button, and copy/paste the result after the “SLD\_BODY=” parameter.

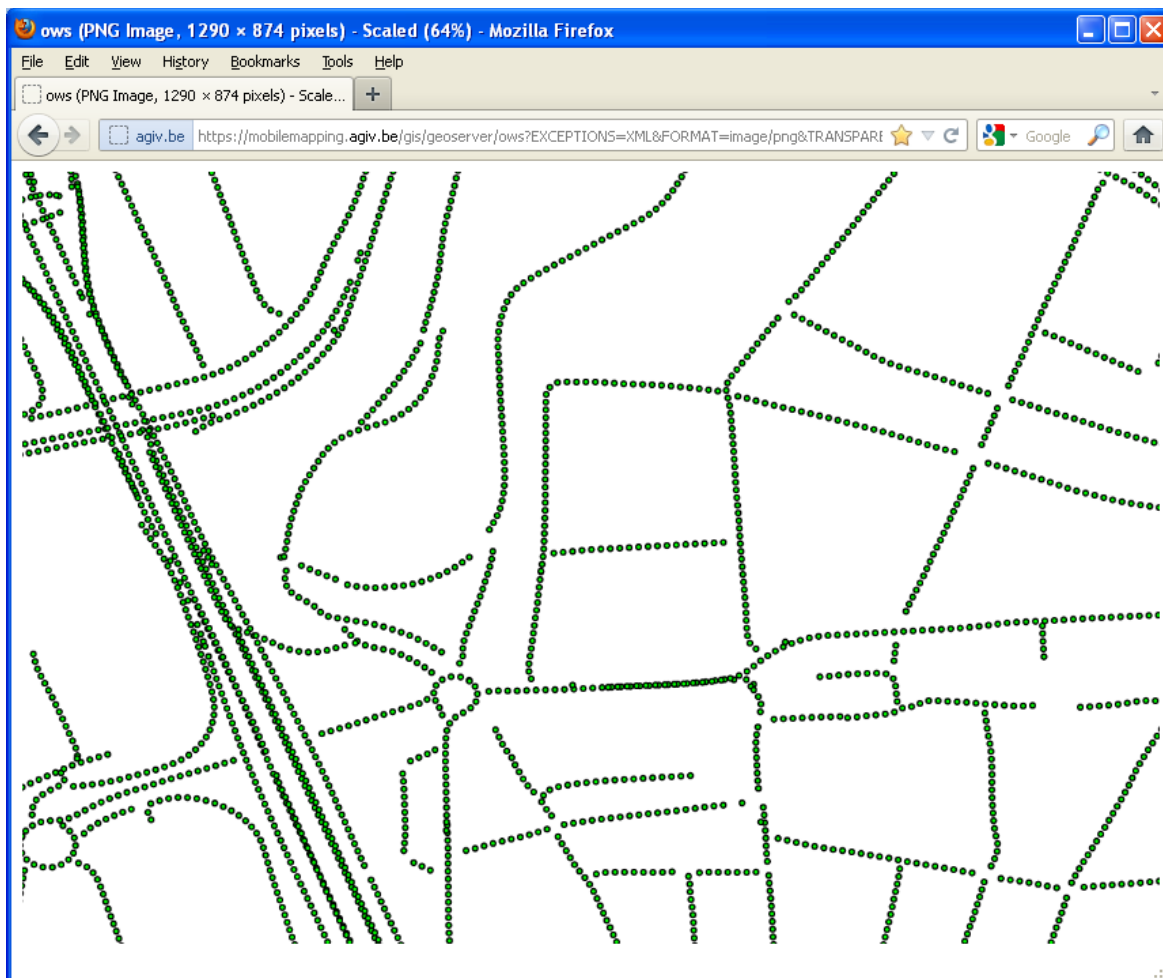


Figure 2. Result of using the SLD style as defined in Table 2 as SLD\_BODY parameter.

#### 4.4 Restrictions

To prevent CPU-expensive WMS queries (e.g. rendering all photo capture positions of Flanders in a bitmap), every single WMS request is restricted to a maximum area of **1 square kilometer**. A HTTP error code 400 is returned when the requested area is larger.

#### 4.5 WMS 1.1.1 and 1.3.0

WMS 1.3 is a standard that is needed for INSPIRE and is increasingly being required by many agencies. WMS 1.3 was only recently added to GeoServer as of version 2.1-beta3. Thus in the current version (2.1.2), WMS 1.3.0 is supported.

The Geoserver manual states:

*“The major differences between WMS versions 1.1.1 and 1.3.0 are: In 1.1.1 geographic coordinate systems specified with the EPSG namespace are defined to have an axis ordering of longitude/latitude. In 1.3.0 the ordering is latitude/longitude. In the GetMap operation the “srs” parameter from 1.1.1 is now “crs” in 1.3.0. Although GeoServer supports both regardless of version.*”

*The specification mandates that the ordering of a geographic crs represented via an epsg identifier (for example EPSG:4326) be ordered latitude/longitude or y/x. This essentially "flips" the regular representation which is longitude/latitude or x/y. Because of the way geoserver internally configures the geotools referencing subsystems, all geographic crs referenced by the historical epsg identifier, EPSG:XXXX, be ordered longitude/latitude. However there is an alternate and explicit notation in which the prefix urn:x-ogc:def:crs:EPSG:XXXX is used. When this prefixed is used it is interpreted to mean latitude/longitude. So the approach to solving the axis order issue is simple. For WMS 1.3 operations simply replace the former prefix with the latter prefix during the request parsing phase of the operation."*

This is proven by following example, following calls deliver identical results:

<https://mobilemapping.agiv.be/gis/geoserver/wms?SERVICE=WMS&SERVICE=WMS&VERSION=1.1.1&REQUEST=GetMap&BBOX=105600,191900,106200,192400&SRS=EPSG:31370&WIDTH=1290&HEIGHT=874&LAYERS=Agiv:MobileMapping&STYLES=&FORMAT=image/png&TRANSPARENT=TRUE>

<https://mobilemapping.agiv.be/gis/geoserver/wms?SERVICE=WMS&SERVICE=WMS&VERSION=1.3.0&REQUEST=GetMap&BBOX=105600,191900,106200,192400&CRS=EPSG:31370&WIDTH=1290&HEIGHT=874&LAYERS=Agiv:MobileMapping&STYLES=&FORMAT=image/png&TRANSPARENT=TRUE>

So, for the Lambert72 projection, it is not needed to flip the bounding box parameters from x/y towards y/x. Otherwise, erroneous results will be obtained.

## 5 WFS usage

The WFS's preferred usage is via HTTP-POST, however for all examples described in this section, the alternative HTTP-GET method will work just fine.

### 5.1 Get layer information: DescribeFeatureType

To discover the properties or attributes of the FeatureType of interest, one first issues a DescribeFeatureType request. The TypeName element shall contain the WFS layer name. Hereunder, the HTTP-GET URLs are given for the active and passive scenario:

<https://mobilemapping.agiv.be/gis/geoserver/wfs?SERVICE=WFS&VERSION=1.0.0&REQUEST=DescribeFeatureType&TYNENAME=Agiv:MobileMapping>

<https://mobilemapping.agiv.be/geoserver/wfs?SERVICE=WFS&VERSION=1.0.0&REQUEST=DescribeFeatureType&TYPE NAME=Agiv:MobileMapping>

The corresponding HTTP-POST XML is given in Table 3. In the result, all the possible attributes will be listed. The result should look like listed in Table 4.

**Table 3. “DescribeFeatureType” HTTP-POST request**

```
<DescribeFeatureType
  version="1.1.0"
  service="WFS"
  xmlns="http://www.opengis.net/wfs"
  xmlns:topp="http://www.openplans.org/topp"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/wfs
http://schemas.opengis.net/wfs/1.1.0/wfs.xsd">
  <TypeName>Agiv:MobileMapping</TypeName>
</DescribeFeatureType>
```

**Table 4. Result of a “DescribeFeatureType” request.**

```
<xsd:schema elementFormDefault="qualified" targetNamespace="agiv.be">
<xsd:import namespace="http://www.opengis.net/gml"
schemaLocation="https://mobilemapping.agiv.be/gis/geoserver/schemas/gml/2.1.2/feature.xsd"/>
<xsd:complexType name="MobileMappingType">
<xsd:complexContent>
<xsd:extension base="gml:AbstractFeatureType">
<xsd:sequence>
<xsd:element maxOccurs="1" minOccurs="0" name="id" nillable="true" type="xsd:int"/>
<xsd:element maxOccurs="1" minOccurs="0" name="filelocation" nillable="true"
type="xsd:string"/>
<xsd:element maxOccurs="1" minOccurs="0" name="position" nillable="true"
type="gml:GeometryPropertyType"/>
<xsd:element maxOccurs="1" minOccurs="0" name="x" nillable="true" type="xsd:double"/>
<xsd:element maxOccurs="1" minOccurs="0" name="y" nillable="true" type="xsd:double"/>
<xsd:element maxOccurs="1" minOccurs="0" name="z" nillable="true" type="xsd:double"/>
<xsd:element maxOccurs="1" minOccurs="0" name="heading" nillable="true" type="xsd:double"/>
<xsd:element maxOccurs="1" minOccurs="0" name="deviation" nillable="true"
type="xsd:double"/>
<xsd:element maxOccurs="1" minOccurs="0" name="velocity" nillable="true" type="xsd:double"/>
<xsd:element maxOccurs="1" minOccurs="0" name="adate" nillable="true" type="xsd:dateTime"/>
<xsd:element maxOccurs="1" minOccurs="0" name="julianday" nillable="true"
type="xsd:double"/>
<xsd:element maxOccurs="1" minOccurs="0" name="niscode" nillable="true" type="xsd:int"/>
<xsd:element maxOccurs="1" minOccurs="0" name="lon" nillable="true" type="xsd:double"/>
<xsd:element maxOccurs="1" minOccurs="0" name="lat" nillable="true" type="xsd:double"/>
</xsd:sequence>
</xsd:extension>
```

```

</xsd:complexContent>
</xsd:complexType>
<xsd:element name="MobileMapping" substitutionGroup="gml:_Feature"
type="Agiv:MobileMappingType"/>
</xsd:schema>

```

Now the consumer of this service knows that he can pick attributes out of the <sequence> element. Important to note here is that the attributes should be prefixed with the namespace, currently being "Agiv". So to use these attributes in a GetFeature request, one should use Agiv:deviation for example.

## 5.2 Query photo capture point metadata: GetFeature

To perform a spatial query, multiple options can be used. These options are listed in Table 5.

**Table 5. Spatial query options taken from the "GetCapabilities" results.**

```

<ogc:SpatialOperator name="Disjoint"/>
<ogc:SpatialOperator name="Equals"/>
<ogc:SpatialOperator name="DWithin"/>
<ogc:SpatialOperator name="Beyond"/>
<ogc:SpatialOperator name="Intersects"/>
<ogc:SpatialOperator name="Touches"/>
<ogc:SpatialOperator name="Crosses"/>
<ogc:SpatialOperator name="Contains"/>
<ogc:SpatialOperator name="Overlaps"/>
<ogc:SpatialOperator name="BBOX"/>

```

From experiments, it was noticed that the BBOX query performs superior because this type of filtering can make optimal use of the R-tree that is used in the underlying PostGIS database.

Here, both DWithin and BBOX filtering mechanism will be described below. Note that in the GetFeature examples below, we request only three attributes: position, id and filelocation. The consumer of the service can request any attribute that comes out of the DescribeFeatureType call.

**Table 6. GetFeature request using Dwithin.**

```

<wfs:GetFeature maxFeatures="45" service="WFS" version="1.0.0"
outputFormat="GML2"
xmlns:topp="http://www.openplans.org/topp"
xmlns:wfs="http://www.opengis.net/wfs"
xmlns:ogc="http://www.opengis.net/ogc"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:gml="http://www.opengis.net/gml">
  <wfs:Query typeName=" Agiv:MobileMapping">
    <wfs:PropertyName>Agiv:position</wfs:PropertyName>
    <wfs:PropertyName>Agiv:id</wfs:PropertyName>
    <wfs:PropertyName>Agiv:filelocation</wfs:PropertyName>
    <ogc:Filter>
      <ogc:DWithin>
        <ogc:PropertyName>Agiv:position</ogc:PropertyName>
        <gml:Point srsName="http://www.opengis.net/gml/srs/epsg.xml#31300">
          <gml:coordinates>106119.74,193870.00</gml:coordinates>
        </gml:Point>
        <Distance units="meters">20</Distance>
      </ogc:DWithin>
    </ogc:Filter>
  </wfs:Query>
</wfs:GetFeature>

```



**Table 7. Result of a GetFeature request using Dwithin (not all featureMembers are shown).**

```

<?xml version="1.0" ?>
<wfs:FeatureCollection xmlns="http://www.opengis.net/wfs"
xmlns:Agiv="mobilemapping.agiv.be:Agiv" xmlns:gml="http://www.opengis.net/gml"
xmlns:wfs="http://www.opengis.net/wfs" xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="mobilemapping.agiv.be:Agiv
https://mobilemapping.agiv.be/geoserver/wfs?service=WFS&version=1.0.0&request=Descr
ibeFeatureType&typeName=Agiv%3AMobileMapping http://www.opengis.net/wfs
https://mobilemapping.agiv.be/geoserver/schemas/wfs/1.0.0/WFS-basic.xsd">
<gml:boundedBy>
  <gml:null>
    unknown
  </gml:null>
</gml:boundedBy>
<gml:featureMember>
<Agiv:MobileMapping fid="MobileMapping.fid--98d9802_1326d5c3059_-544c">
  <Agiv:id>
    865321
  </Agiv:id>
  <Agiv:filelocation>
    kontich/panoramic_images/4/344460_27_4800_2400_0.jpg
  </Agiv:filelocation>
  <Agiv:position>
    <gml:Point srsName="http://www.opengis.net/gml/srs/epsg.xml#31370">
      <gml:coordinates cs="," decimal="." ts=" "
xmlns:gml="http://www.opengis.net/gml">
        106134.948998,193860.309978
      </gml:coordinates>
    </gml:Point>
  </Agiv:position>
</Agiv:MobileMapping>
</gml:featureMember>
<gml:featureMember>
<Agiv:MobileMapping fid="MobileMapping.fid--98d9802_1326d5c3059_-544b">
  <Agiv:id>
    865322
  </Agiv:id>
  <Agiv:filelocation>
    kontich/panoramic_images/7/344706_27_4800_2400_0.jpg
  </Agiv:filelocation>
  <Agiv:position>
    <gml:Point srsName="http://www.opengis.net/gml/srs/epsg.xml#31370">
      <gml:coordinates cs="," decimal="." ts=" "
xmlns:gml="http://www.opengis.net/gml">
        106130.738951,193868.397633
      </gml:coordinates>
    </gml:Point>
  </Agiv:position>
</Agiv:MobileMapping>
</gml:featureMember>
.....
</wfs:FeatureCollection>

```

**Table 8. GetFeature request using BBOX.**

```

<wfs:GetFeature maxFeatures="45" service="WFS" version="1.1.0"
xmlns:topp="http://www.openplans.org/topp"
xmlns:wfs="http://www.opengis.net/wfs"
xmlns:ogc="http://www.opengis.net/ogc"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/wfs
http://schemas.opengis.net/wfs/1.1.0/wfs.xsd">
<wfs:Query typeName="Agiv:MobileMapping">
<wfs:PropertyName>Agiv:position</wfs:PropertyName>
<wfs:PropertyName>Agiv:id</wfs:PropertyName>
<ogc:Filter>
  <ogc:BBOX>
    <ogc:PropertyName>Agiv:position</ogc:PropertyName>
    <gml:Envelope srsName="http://www.opengis.net/gml/srs/epsg.xml#31300">
      <gml:lowerCorner>106109.74 193860.00</gml:lowerCorner>
      <gml:upperCorner>106129.74 193880.00</gml:upperCorner>
    </gml:Envelope>
  </ogc:BBOX>
</ogc:Filter>
</wfs:Query>
</wfs:GetFeature>

```

**Table 9. Result of a GetFeature request using BBOX (not all featureMembers are shown).**

```

<?xml version="1.0" ?>
<wfs:FeatureCollection numberOfFeatures="6" timeStamp="2011-09-16T13:58:37.643+02:00"
xmlns:cite="http://www.opengeospatial.net/cite" xmlns:Agiv="mobilemapping.agiv.be:Agiv"
xmlns:gml="http://www.opengis.net/gml" xmlns:it.geosolutions="http://www.geo-solutions.it"
xmlns:nurc="http://www.nurc.nato.int" xmlns:ogc="http://www.opengis.net/ogc"
xmlns:ows="http://www.opengis.net/ows" xmlns:sde="http://geoserver.sf.net"
xmlns:sf="http://www.openplans.org/spearfish" xmlns:tiger="http://www.census.gov"
xmlns:topp="http://www.openplans.org/topp" xmlns:wfs="http://www.opengis.net/wfs"
xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" xsi:schemaLocation="mobilemapping.agiv.be:Agiv
https://mobilemapping.agiv.be/geoserver/wfs?service=WFS&version=1.1.0&request=DescribeFeatureType&typeName=Agiv%3AMobileMapping http://www.opengis.net/wfs
https://mobilemapping.agiv.be/geoserver/schemas/wfs/1.1.0/wfs.xsd">
<gml:featureMembers>
<Agiv:MobileMapping gml:id="MobileMapping.fid--98d9802_1326d5c3059_-543d">
  <Agiv:id>865323</Agiv:id>
  <Agiv:filelocation>
    kontich/panoramic_images/3/345771_27_4800_2400_0.jpg
  </Agiv:filelocation>
  <Agiv:position>
    <gml:Point srsDimension="2" srsName="urn:x-ogc:def:crs:EPSG:31370">
      <gml:pos>
        106121.128715 193867.31476
      </gml:pos>
    </gml:Point>
  </Agiv:position>
</Agiv:MobileMapping>
<Agiv:MobileMapping gml:id="MobileMapping.fid--98d9802_1326d5c3059_-543c">
  <Agiv:id>865324</Agiv:id>
  <Agiv:filelocation>
    kontich/panoramic_images/3/345031_27_4800_2400_0.jpg
  </Agiv:filelocation>
  <Agiv:position>
    <gml:Point srsDimension="2" srsName="urn:x-ogc:def:crs:EPSG:31370">
      <gml:pos>
        106112.63857 193862.140279
      </gml:pos>
    </gml:Point>
  </Agiv:position>
</Agiv:MobileMapping>
...
</gml:featureMembers>
</wfs:FeatureCollection>

```

### 5.3 GetFeature restrictions

To avoid “network-expensive” WFS calls (e.g. all photo capture points in a province or entire Flanders), the WFS service has a hard limit on the number of features that are returned. This limit is set at 10,000. The user can lower this limit by using the maxFeatures attribute that is foreseen in the OGC WFS standard.

### 5.4 Output format

The default format of the WFS result is GML. One can choose other formats as described in the GetCapabilities result. A popular alternative for GML, which also has a smaller network footprint is the comma delimited format. An example HTTP-GET call which results in a 2.9 MB result (instead of 8.8 MB as GML) is given here:

[https://mobilemapping.agiv.be/geoserver/wfs?SERVICE=WFS&VERSION=1.0.0&REQUEST=GetFeature&TYPE\\_NAME=Agiv:MobileMapping&SRSNAME=EPSG:31370&BBOX=104944.635393,191400.586162,107025.49059,192718.313228&outputformat=csv](https://mobilemapping.agiv.be/geoserver/wfs?SERVICE=WFS&VERSION=1.0.0&REQUEST=GetFeature&TYPE_NAME=Agiv:MobileMapping&SRSNAME=EPSG:31370&BBOX=104944.635393,191400.586162,107025.49059,192718.313228&outputformat=csv)

## 6 Photo metadata

All photo attributes are listed in Table 10.

- The **[filelocation]** parameter presents the physical location of the image and can be used to construct the http get command to retrieve the image. The URLs for retrieving an image in the active and passive security scenario are respectively (the **[filelocation]** path is highlighted in blue):

[https://mobilemapping.agiv.be/gis/cyclorama/5/Delivery\\_Gent\\_09/844000/844011\\_44\\_4800\\_2400\\_0.jpg](https://mobilemapping.agiv.be/gis/cyclorama/5/Delivery_Gent_09/844000/844011_44_4800_2400_0.jpg)

[https://mobilemapping.agiv.be/mmdata/5/Delivery\\_Gent\\_09/844000/844011\\_44\\_4800\\_2400\\_0.jpg](https://mobilemapping.agiv.be/mmdata/5/Delivery_Gent_09/844000/844011_44_4800_2400_0.jpg)

- The geographic coordinates – named **[x]**, **[y]** – are in Lambert72 meters (**EPSG:31370**).
- The **[z]** coordinate is given in m TAW (tweede algemene waterpassing). During database ingestion, all images having a z coordinate within the range [-20.0, 700.0] were accepted for ingestion. Since there were a decent number of images where the elevation was not known (mainly on highways), the Z-coordinate was assigned a value of -999.0 during data ingestion. Negative Z-values are thus possible (e.g. in the Antwerp harbor area)
- The **[heading]** parameter (degrees) is the instantaneous yaw angle of the car.
- The **[deviation]** parameter (degrees) is a yaw correction factor.
- The **[velocity]** parameter (m/s) is the instantaneous speed of the car. Given the Cyclorama sensor model, this parameter is not needed for photogrammetric applications. However this parameter can be used to estimate smear-effects in the image.
- The **[adate]** string presents the UTC time in text format. However, during database ingestion, it was decided to add an additional floating point parameter **[julianday]**. The later parameter

presents the UTC time in an astronomical fashion. Julian days allow for direct time computations or time comparisons.

- The [niscode] parameters is an 5 digit integer. Every community, district and region in Belgium has a unique code. The nis-code definition can be found in: <http://statbel.fgov.be/nl/statistieken/gegevensinzameling/nomenclaturen/admin-geo/>. During database ingestion, each point was assigned a NIS code by using its x and y coordinate and the AGIV shapefile "voorlopigrefbestandgemeentegrenzen.shp"
- The WGS84 longitude [lon] and latitude [lat] parameters (degrees) are not stored in the database, but calculated "on-the-fly" using following PostGIS data with respect to the datum and coordinate transformation (i.e. from **EPSG:31370** to **EPSG:4326**):

```
31370;"EPSG";31370;"PROJCS["Belge 1972 / Belgian Lambert 72",GEOGCS["Belge 1972",
DATUM["Reseau_National_Belge_1972",SPHEROID["International 1924", 6378388, 297,
AUTHORITY["EPSG","7022"]],TOWGS84[106.869, -52.2978, 103.724, -0.33657, 0.456955,-
1.84218,1],AUTHORITY["EPSG","6313"]],PRIMEM["Greenwich",0,AUTHORITY["EPSG","8901"]],UNI
T["degree",0.01745329251994328,AUTHORITY["EPSG","9122"]],AUTHORITY["EPSG","4313"]],UNIT
["metre",1,AUTHORITY["EPSG","9001"]],PROJECTION["Lambert_Conformal_Conic_2SP"],PARAMETE
R["standard_parallel_1",51.16666723333333],PARAMETER["standard_parallel_2",49.8333339],
PARAMETER["latitude_of_origin",90],PARAMETER["central_meridian",4.367486666666666],PARA
METER["false_easting",150000.013],PARAMETER["false_northing",5400088.438],AUTHORITY["EP
SG","31370"],AXIS["X",EAST],AXIS["Y",NORTH]]";"+proj=lcc +lat_1=51.16666723333333
+lat_2=49.8333339 +lat_0=90 +lon_0=4.367486666666666 +x_0=150000.013 +y_0=5400088.438
+ellps=intl +towgs84=-106.868628, 52.297783, -103.723893, 0.336570, -0.456955,
1.842183, 1.2747 +units=m +no_defs "
```

**Table 10. The photo attributes (WFS GML formatted)**

```
<gml:featureMember>
<Agiv:MobileMapping fid="MobileMapping.fid-1324607_135156d178a_31d">
<Agiv:id>37620938</Agiv:id>
<Agiv:filelocation>1/Gent_10_Snelwegen/4968250/4968327_148_4800_2400_0.jpg</Agiv:filelocati
on>
<Agiv:position>
<gml:Point srsName="http://www.opengis.net/gml/srs/epsg.xml#31370">
<gml:coordinates decimal="." cs="," ts="
">105888.07222601,191404.35597193</gml:coordinates>
</gml:Point>
</Agiv:position>
<Agiv:x>105888.072226008</Agiv:x>
<Agiv:y>191404.355971926</Agiv:y>
<Agiv:z>-999.0</Agiv:z>
<Agiv:heading>9.157095519554</Agiv:heading>
<Agiv:deviation>0.484700020135</Agiv:deviation>
<Agiv:velocity>17.651284159211</Agiv:velocity>
<Agiv:adate>2009-07-26T07:11:50</Agiv:adate>
<Agiv:julianday>2455038.7998842592</Agiv:julianday>
<Agiv:niscode>44021</Agiv:niscode>
<Agiv:lon>3.7399201494834107</Agiv:lon>
<Agiv:lat>51.03114490027468</Agiv:lat>
</Agiv:MobileMapping>
</gml:featureMember>
```