

# Week 6 - Module 4a - Interoperability Standards. WMS, KML and XML

## Overview

- Extensible Markup Language - XML
  - Definition of a markup language
  - Requirements
  - Extensible ???
- KML - AKA Keyhole Markup Language
  - An XML Document Format
  - Combined representation of spatial data and time
- OGC Web Map Services (WMS)
  - Requests and Results
  - GetCapabilities, GetMap, GetFeatureInfo
- Integration of WMS into KML

## Extensible Markup Language - XML

### XML Background

- Defined as a markup language profile of Standard Generalized Markup Language (SGML - ISO 8879:1986)
- XML 1.0 released as a W3C Recommendation in 1998
  - currently in [5th edition](#), released in 2008
  - version 1.1 released in 2004, but is [not recommended](#) for use unless the “[new characters in XML names, new line-end conventions, and references to control characters enabled with XML version 1.1 are needed](#)”.

### XML Design Goals

- XML shall be straightforwardly usable over the Internet.
- XML shall support a wide variety of applications.
- XML shall be compatible with SGML.
- It shall be easy to write programs which process XML documents.
- The number of optional features in XML is to be kept to the absolute minimum, ideally zero.
- XML documents should be human-legible and reasonably clear.
- The XML design should be prepared quickly.
- The design of XML shall be formal and concise.
- XML documents shall be easy to create.
- Terseness in XML markup is of minimal importance.

From XML 1.0 (5th ed.) [Recommendation](#)

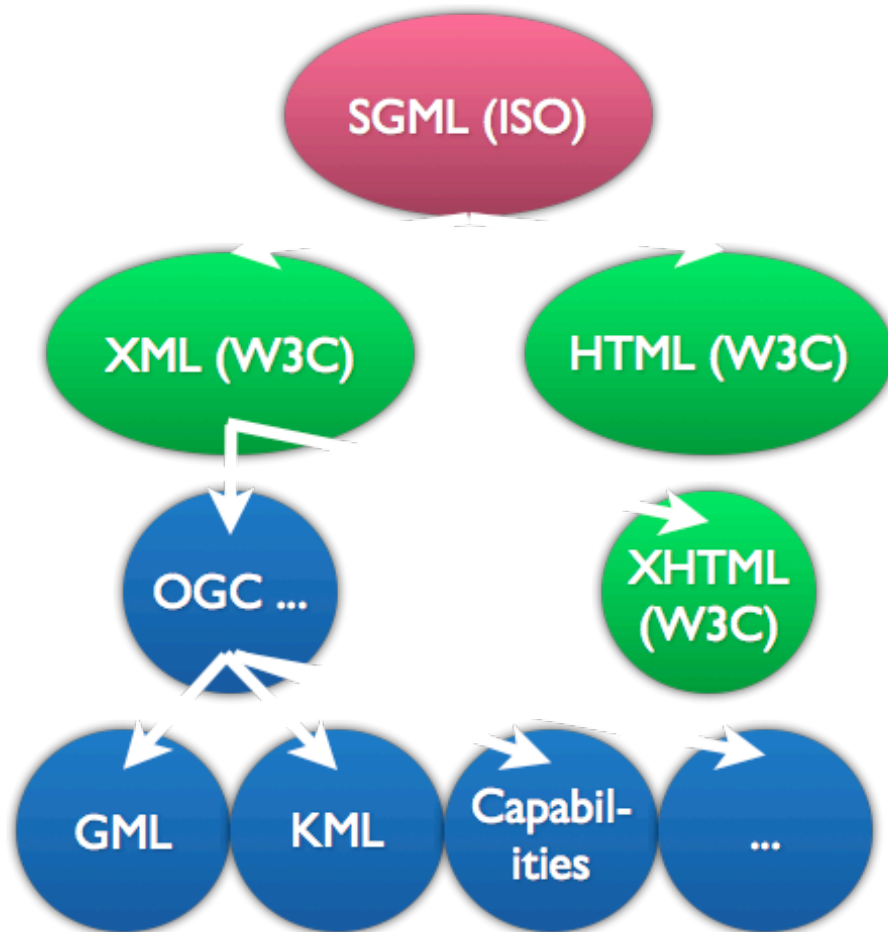


Figure 1: SGML Relationship with XML and HTML

## XML Structure - Well Formed / Valid

- [Well Formed XML](#) - a document that conforms to the structural definition of XML. Either well-formed, or not XML
- [Valid XML](#) - a document that is both well-formed and conforms to a specific content structure defined by
  - A [Document Type Definition \(DTD\)](#) - the original XML specification for the definition of the content of a specific XML document
  - A [Schema document](#) - defined in a variety of languages (e.g. W3C Schema, RELAX NG, Schematron, ISO DSDL, etc.)

## [XML Wikipedia Article](#)

### Simple XML Document

```
1 <?xml version="1.0" encoding="ISO-8859-1"?>
2 <!-- Some comment would go here to describe this document ... -->
3 <note>
4     <to>Tove</to>
5     <from>Jani</from>
6     <heading>Reminder</heading>
7     <body type="instruction" >Don't forget me this weekend!</body>
8 </note>
```

XML Source (modified from original): [w3schools](#)

### XML Prolog

Includes XML Declaration and Comment

```
1 <?xml version="1.0" encoding="ISO-8859-1"?>
2 <!-- Some comment would go here to describe this document ... -->
```

### XML Elements

Define blocks of content

```
3 <note>
4     <to>Tove</to>
5     <from>Jani</from>
6     <heading>Reminder</heading>
7     <body type="instruction" >Don't forget me this weekend!</body>
8 </note>
```

### XML Root Element

- Required
- There is only one
- It must be a pair of opening and closing tags

```

3  <note>
4      ...
5      ...
6      ...
7      ...
8  </note>

```

## XML Content Elements

- Contain all other document content
- May be paired opening and closing tags, *or*
- May be self-closing with a terminal “/” in the element, e.g. `<br />`

```

4  <to>Tove</to>
5  <from>Jani</from>
6  <heading>Reminder</heading>
7  <body type="instruction" >Don't forget me this weekend!</body>

```

## XML Attributes

Define additional information about elements as *name=value* pairs.

```

7  <body type="instruction" >Don't forget me this weekend!</body>

```

## XML Element Content

The material contained between the opening and closing tags of an *Element*.

```

7  <body type="instruction" >Don't forget me this weekend!</body>

```

## Valid XML?

Why is this XML *well-formed* but not *valid*?

*There is no DTD or Schema defined for the document against which it can be validated*

```

1  <?xml version="1.0" encoding="ISO-8859-1"?>
2  <!-- Edited by XMLSpy® -->
3  <note>
4      <to>Tove</to>
5      <from>Jani</from>
6      <heading>Reminder</heading>
7      <body type="instruction" >Don't forget me this weekend!</body>
8  </note>

```

## Common XML Constructs

**Document Type Declaration (DTD) references (PROLOG)** definition, either by reference or by direct inclusion, the allowed structure of an XML document, for example:

```
<!DOCTYPE greeting SYSTEM "hello.dtd">
```

**CDATA Sections** blocks of XML that contain characters that would otherwise be recognized as XML markup, for example:

```
<![CDATA[<greeting>Hello, world!</greeting>]]>
```

**XML Namespace Declarations** additional information included in elements to distinguish between duplicate element names, for example (declared in lines 1-3, used in lines 5-17):

```
1 <root
2   xmlns:h="http://www.w3.org/TR/html4/"
3   xmlns:f="http://www.w3schools.com/furniture">
4
5 <h:table>
6   <h:tr>
7     <h:td>Apples</h:td>
8     <h:td>Bananas</h:td>
9   </h:tr>
10 </h:table>
11 <f:table>
12   <f:legs>4</f:legs>
13   <f:cost>300</f:cost>
14   <f:width>3</f:width>
15   <f:length>5</f:length>
16   <f:height>4</f:height>
17 </f:table>
18 </root>
```

## KML

### KML Background

- An XML grammar originally developed as Keyhole Markup Language by Keyhole, Inc. for use in their Keyhole Earth Viewer.
- Google acquired Keyhole, Inc. in 2004
- KML version 2.2 became an OGC standard in 2008
- Two delivered KML file formats

**KML** an XML document, with a “.kml” extension that is directly readable and editable

**KMZ** a compressed (zipped) file with a “.kmz” extension<sup>1</sup>, that contains at least a KML document, but may contain other files as well.

---

<sup>1</sup>A KMZ file may be extracted and its contents examined by many zipfile utilities if you replace the .kmz extension with .zip prior to trying to extract

## KML Capabilities

- Annotate the Earth
- Specify icons and labels to identify locations on the surface of the planet
- Create different camera positions to define unique views for KML features
- Define image overlays to attach to the ground or screen
- Define styles to specify KML feature appearance
- Write HTML descriptions of KML features, including hyperlinks and embedded images
- Organize KML features into hierarchies using **folder** elements
- Locate and update retrieved KML documents from local or remote network locations
- Define the location and orientation of textured 3D objects

## KML Content

- Model for encoding 2- and 3-dimensional geometries for use in 2-D mappers and 3-D virtual globe applications
- Uses latitude-longitude (based upon WGS84 datum) for encoding horizontal position
- Represents altitude in Meters (based upon the WGS84 ellipsoid and EGM96 geoid)

## 2D and 3D KML Sample

```
1 <kml xmlns="http://www.opengis.net/kml/2.2">
2 <Document>
3   <Placemark>
4     <Polygon>
5       <altitudeMode>
6         clampToGround
7       </altitudeMode>
8       <outerBoundaryIs>
9         <LinearRing>
10          <coordinates>
11            -135,78.5,300000
12            -135,12.5,300000
13            -45,12.5,300000
14            -45,78.5,300000
15            -135,78.5,300000
16          </coordinates>
17        </LinearRing>
18      </outerBoundaryIs>
19    </Polygon>
20  </Placemark>
21 </Document>
22 </kml>
```

## KML Example

Example from: [KML 2.2 Specification \(fig. 6, pg. 21\)](#)

## High-Level KML Content Types

**Features** including documents, folders, placemarks, network links

**Geometries** including points, linestrings, polygons, models, locations

### Polygon in plate carrée (long,lat) plane



### Polygon mapped to terrain surface



Figure 2: Illustration of polygon in both planar and terrain surface

**Overlays** including ground overlays, lat-lon boxes, photo overlays, screen overlays

**Styles** styles, substyles, icons, label styles

**Links** read, update, create, delete, change

**Views** camera, look at

**Time** time span, timestamp

## KML Demonstration and References

New Mexico State Boundary [KML File](#) | [KMZ File](#) (from [NM RGIS](#))

[Google Code KML Documentation](#)

[OGC KML Implementation specification](#)

## OGC Web map Services - WMS

### WMS - Overview

- Open Geospatial Consortium standard for requesting
  - Service Metadata (**GetCapabilities**) - an XML file representing information about a specific WMS service and its component layers
  - Map Images (**GetMap**) - graphic files representing one or more layers from a single WMS service for a specified area of interest, and, optionally, for a specified point in time
  - Feature Information (**GetFeatureInfo**) - a basic representation (in a variety of formats) of the attributes associated with a specific pixel location in a map image
- A WMS will return to the requesting system one of the above products OR an error message (in XML by default)
- Related [Style Layer Descriptor](#) standard supports dynamic updating of visualization options
- [OGC WMS Documentation Access Page](#)

### WMS *GetCapabilities* Request

Request Parameter	1.0	1.1	1.1.1	1.3.0	Description
WMTVER = 1.0.0	R				Request version
VERSION = version		O	O	O	Request version
SERVICE = WMS	R	R	R	R	Service type
REQUEST = capabilities	R				Request name
REQUEST = GetCapabilities		R	R	R	Request name
UPDATESEQUENCE = string		O	O	O	Sequence number or string for cache control
Vendor-specific parameters	O				Vendor-specific parameters

R=Required / O=Optional

### WMS *GetMap* Request (Core)

Request Parameter	1.0	1.1	1.1.1	1.3.0	Description
WMTVER = 1.0.0	R				Request version
VERSION = version		R	R	R	Request version.
REQUEST = map	R				Request name.
REQUEST = GetMap		R	R	R	Request name.
LAYERS = layer_list	R	R	R	R	Comma-separated list of one or more map layers. Optional (ver. 1.1, 1.1.1) if SLD parameter is present.
STYLES = style_list	R	R	R	R	Comma-separated list of one rendering style per requested layer. Optional if SLD parameter is present.
SRS = namespace:identifier	R	R	R		Spatial Reference System.
CRS = namespace:identifier				R	Spatial Reference System.



Request Parameter	1.0	1.1	1.1.1	1.3.0	Description
BBOX = minx,miny,maxx,maxy	R	R	R	R	Bounding box corners (lower left, upper right) in SRS units.
WIDTH = output_width	R	R	R	R	Width in pixels of map picture.
HEIGHT = output_height	R	R	R	R	Height in pixels of map picture.
FORMAT = output_format	R	R	R	R	Output format of map.
TRANSPARENT = TRUE or FALSE	O	O	O	O	Background transparency of map (default = FALSE).
BGCOLOR = color_value	O	O	O	O	Hexadecimal red-green-blue color value for the background color (default = 0xFFFFFF).
EXCEPTIONS = exception_format	O	O	O	O	The format in which exceptions are to be reported by the WMS (default = XML).
TIME = time		O	O	O	Time value of layer desired.
ELEVATION = elevation		O	O	O	Elevation of layer desired.
Other sample dimensions		O	O	O	Values of other dimensions as appropriate.
Vendor specific parameters	O	O	O	O	Vendor specific parameters

## WMS GetFeatureInfo Request

Request Parameter	1.0	1.1	1.1.1	1.3.0	Description
WMTVER = 1.0.0	R				Request version.
VERSION = version		R	R	R	Request version.
REQUEST = feature_info	R				Request name.
REQUEST = GetFeatureInfo		R	R	R	Request name.
<map_request_copy>	R	R	R	R	Partial copy of the Map request parameters that generated the map for which information is desired
QUERY_LAYERS = layer_list	R	R	R	R	Comma-separated list of one or more layers to be queried.
INFO_FORMAT = output_format	O	O	O	R	Return format of feature information (MIME type).
FEATURE_COUNT = number	O	O	O	O	Number of features about which to return information (default = 1).
X = pixel_column	R	R	R		X coordinate in pixels of feature (measured from upper left corner = 0)
I = pixel_column				R	i coordinate in pixels of feature in Map CS
Y = pixel_row	R	R	R		Y coordinate in pixels of feature (measured from upper left corner = 0)
J = pixel_row				R	j coordinate in pixels of feature in Map CS
EXCEPTIONS = exception_format		O	O	O	The format in which exceptions are to be reported by the WMS (default = XML).
Vendor-specific parameters	O	O	O		Optional experimental parameters.

## WMS GetCapabilities

```

1 http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-8120-
2 da70dc92f2cc/services/ogc/wms?
3     SERVICE=wms&
4     REQUEST=GetCapabilities&
5     VERSION=1.1.1

```

[Live Link](#)

```

1 <?xml version='1.0' encoding="ISO-8859-1" standalone="no" ?>
2 <!DOCTYPE WMT_MS_Capabilities SYSTEM "http://schemas.opengis.net/wms/1.1.1/
3 WMT_MS_Capabilities.dtd"
4 [
5 <!-- VendorSpecificCapabilities EMPTY -->
6 ]> <!-- end of DOCTYPE declaration -->
7
8 <WMT_MS_Capabilities version="1.1.1">
9
10 <!-- MapServer version 6.0.3 OUTPUT=GIF OUTPUT=PNG OUTPUT=JPEG OUTPUT=KML SUPPORTS=PROJ
11 SUPPORTS=AGG SUPPORTS=FREETYPE SUPPORTS=ICONV SUPPORTS=WMS_SERVER SUPPORTS=WMS_CLIENT
12 SUPPORTS=WFS_SERVER SUPPORTS=WFS_CLIENT SUPPORTS=WCS_SERVER SUPPORTS=SOS_SERVER
13 INPUT=POSTGIS INPUT=OGR INPUT=GDAL INPUT=SHAPEFILE -->

```

```

14
15 <Service>
16   <Name>OGC:WMS</Name>
17   <Title>tl_2010_35_state10</Title>
18   <Abstract>WMS Service for RGIS dataset State Boundary - 2010
19   (6ca5428a-a78c-4c82-8120-da70dc92f2cc)</Abstract>
20   <KeywordList>
21     <Keyword>RGIS</Keyword>
22     <Keyword> New Mexico</Keyword>
23   </KeywordList>
24   <OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
25   xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-8120-
26   da70dc92f2cc/services/ogc/wms"/>
27   <ContactInformation>
28     <ContactPersonPrimary>
29       <ContactPerson>GStore Support</ContactPerson>
30       <ContactOrganization>Earth Data Analysis Center</ContactOrganization>
31     </ContactPersonPrimary>
32     <ContactPosition>technical support</ContactPosition>
33     <ContactAddress>
34       <AddressType>Mailing address</AddressType>
35       <Address>Earth Data Analysis Center, MSC01 1110,
36       1 University of New Mexico</Address>
37       <City>Albuquerque</City>
38       <StateOrProvince>NM</StateOrProvince>
39       <PostCode>87131</PostCode>
40       <Country>US</Country>
41     </ContactAddress>
42     <ContactVoiceTelephone>(505) 277-3622</ContactVoiceTelephone>
43     <ContactFacsimileTelephone>(505) 277-3614</ContactFacsimileTelephone>
44     <ContactElectronicMailAddress>gstore@edac.unm.edu</ContactElectronicMailAddress>
45   </ContactInformation>
46   <Fees>None</Fees>
47   <AccessConstraints>none</AccessConstraints>
48 </Service>
49
50 <Capability>
51   <Request>
52     <GetCapabilities>
53       <Format>application/vnd.ogc.wms_xml</Format>
54       <DCPType>
55         <HTTP>
56           <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
57           xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-
58           8120-da70dc92f2cc/services/ogc/wms?"/></Get>
59           <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
60           xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-
61           8120-da70dc92f2cc/services/ogc/wms?"/></Post>
62         </HTTP>
63       </DCPType>
64     </GetCapabilities>
65     <GetMap>
66       <Format>image/png</Format>
67       <Format>image/gif</Format>

```

```

68     <Format>image/jpeg</Format>
69     <Format>image/png; mode=8bit</Format>
70     <Format>image/tiff</Format>
71     <Format>application/vnd.google-earth.kml+xml</Format>
72     <Format>application/vnd.google-earth.kmz</Format>
73     <DCPType>
74         <HTTP>
75             <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
76                 xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-
77                 8120-da70dc92f2cc/services/ogc/wms?"/></Get>
78             <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
79                 xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-
80                 8120-da70dc92f2cc/services/ogc/wms?"/></Post>
81         </HTTP>
82     </DCPType>
83 </GetMap>
84 <GetFeatureInfo>
85     <Format>text/plain</Format>
86     <Format>application/vnd.ogc.gml</Format>
87     <DCPType>
88         <HTTP>
89             <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
90                 xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-
91                 8120-da70dc92f2cc/services/ogc/wms?"/></Get>
92             <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
93                 xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-
94                 8120-da70dc92f2cc/services/ogc/wms?"/></Post>
95         </HTTP>
96     </DCPType>
97 </GetFeatureInfo>
98 <DescribeLayer>
99     <Format>text/xml</Format>
100     <DCPType>
101         <HTTP>
102             <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
103                 xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-8120-
104                 da70dc92f2cc/services/ogc/wms?"/></Get>
105             <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
106                 xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-8120-
107                 da70dc92f2cc/services/ogc/wms?"/></Post>
108         </HTTP>
109     </DCPType>
110 </DescribeLayer>
111 <GetLegendGraphic>
112     <Format>image/png</Format>
113     <Format>image/gif</Format>
114     <Format>image/jpeg</Format>
115     <Format>image/png; mode=8bit</Format>
116     <DCPType>
117         <HTTP>
118             <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
119                 xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-8120-
120                 da70dc92f2cc/services/ogc/wms?"/></Get>
121             <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"

```

```

122         xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-8120-
123         da70dc92f2cc/services/ogc/wms?"/></Post>
124     </HTTP>
125 </DCPType>
126 </GetLegendGraphic>
127 <GetStyles>
128     <Format>text/xml</Format>
129     <DCPType>
130         <HTTP>
131             <Get><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
132             xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-8120-
133             da70dc92f2cc/services/ogc/wms?"/></Get>
134             <Post><OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink"
135             xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-8120-
136             da70dc92f2cc/services/ogc/wms?"/></Post>
137         </HTTP>
138     </DCPType>
139 </GetStyles>
140 </Request>
141 <Exception>
142     <Format>application/vnd.ogc.se_xml</Format>
143     <Format>application/vnd.ogc.se_inimage</Format>
144     <Format>application/vnd.ogc.se_blank</Format>
145 </Exception>
146 <VendorSpecificCapabilities />
147 <UserDefinedSymbolization SupportSLD="1" UserLayer="0" UserStyle="1" RemoteWFS="0"/>
148 <Layer>
149     <Name>t1_2010_35_state10</Name>
150     <Title>t1_2010_35_state10</Title>
151     <Abstract>WMS Service for RGIS dataset State Boundary - 2010
152     (6ca5428a-a78c-4c82-8120-da70dc92f2cc)</Abstract>
153     <KeywordList>
154         <Keyword>RGIS</Keyword>
155         <Keyword> New Mexico</Keyword>
156     </KeywordList>
157     <SRS>EPSG:4269</SRS>
158     <SRS>EPSG:4326</SRS>
159     <SRS>EPSG:4267</SRS>
160     <SRS>EPSG:26913</SRS>
161     <SRS>EPSG:26912</SRS>
162     <SRS>EPSG:26914</SRS>
163     <SRS>EPSG:26713</SRS>
164     <SRS>EPSG:26712</SRS>
165     <SRS>EPSG:26714</SRS>
166     <SRS>EPSG:3857</SRS>
167     <LatLonBoundingBox minx="-109.05" miny="31.3322" maxx="-103.002" maxy="37.0003" />
168     <BoundingBox SRS="EPSG:4326"
169         minx="-109.05" miny="31.3322" maxx="-103.002" maxy="37.0003" />
170     <Layer queryable="1" opaque="0" cascaded="0">
171         <Name>t1_2010_35_state10</Name>
172         <Title>t1_2010_35_state10</Title>
173         <Abstract>State Boundary - 2010</Abstract>
174         <KeywordList>
175             <Keyword></Keyword>

```

```

176     </KeywordList>
177     <SRS>epsg:4326</SRS>
178     <LatLonBoundingBox minx="-109.05" miny="31.3322" maxx="-103.002" maxy="37.0003" />
179     <BoundingBox SRS="epsg:4326"
180         minx="-109.05" miny="31.3322" maxx="-103.002" maxy="37.0003" />
181     <MetadataURL type="FGDC-STD-001-1998">
182         <Format>text/xml</Format>
183         <OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink" xlink:type="simple"
184             xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-8120-da70dc92f2cc/met
185     </MetadataURL>
186     <Style>
187         <Name>default</Name>
188         <Title>default</Title>
189         <LegendURL width="72" height="22">
190             <Format>image/png</Format>
191             <OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink" xlink:type="simple"
192                 xlink:href="http://gstore.unm.edu/apps/rgis/datasets/6ca5428a-a78c-4c82-8120-da70dc92f2cc/
193             </LegendURL>
194         </Style>
195     </Layer>
196 </Layer>
197 </Capability>
198 </WMT_MS_Capabilities>

```

## WMS GetMap

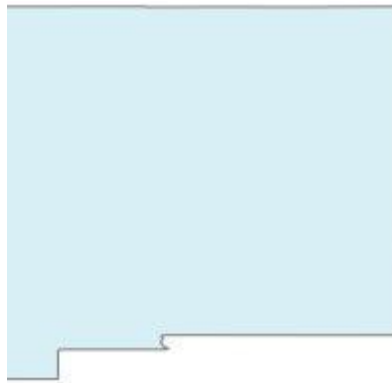


Figure 3: Sample WMS response #1

```

1  http://gstore.unm.edu/apps/rgis/datasets/
2  6ca5428a-a78c-4c82-8120-da70dc92f2cc/
3  services/ogc/wms?
4      VERSION=1.1.1&
5      SERVICE=WMS&
6      REQUEST=GetMap&
7      BBOX=-109,31,-102.9,37.1&
8      LAYERS=tl_2010_35_state10&
9      WIDTH=200&
10     HEIGHT=200&
11     SRS=EPSG:4326&

```

```
12  FORMAT=image/jpeg&
13  STYLES=
```

[link](#)



Figure 4: Sample WMS response #2

```
1  http://gstore.unm.edu/apps/rgis/datasets/
2  6ca5428a-a78c-4c82-8120-da70dc92f2cc/
3  services/ogc/wms?
4  VERSION=1.1.1&
5  SERVICE=WMS&
6  REQUEST=GetMap&
7  BBOX=-109,31,-102.9,37.1&
8  LAYERS=t1_2010_35_state10&
9  WIDTH=300&
10 HEIGHT=300&
11 SRS=EPSG:4326&
12 TRANSPARENT=TRUE&
13 FORMAT=image/png&
14 STYLES=
```

[link](#)

### Integraton of WMS and KML

- The KML GroundOverlay element may be used to integrate a network accessible map image into a client
- A WMS service may be used to as the source of a KML GroundOverlay element
- KML includes parameterizations that allow for dynamic generation of WMS requests using client bounding box information
- Time-enabled WMS may be accessed through use of manually configured time parameters in WMS URLs and TimeStamp or TimeSpan KML elements

## Sample WMS-KML Integration

```
1 <?xml version="1.0" encoding="UTF-8"?>
2 <kml xmlns="http://www.opengis.net/kml/2.2" xmlns:gx="http://www.google.com/kml/ext/2.2"
3   xmlns:kml="http://www.opengis.net/kml/2.2" xmlns:atom="http://www.w3.org/2005/Atom">
4   <GroundOverlay>
5     <name>RGIS Counties WMS</name>
6     <Icon>
7       <href>http://gstore.unm.edu/apps/rgis/datasets/107046/services/ogc/wms?
8         VERSION=1.1.1&SERVICE=WMS&REQUEST=GetMap&BBOX=-109,31,-102.9,37.1
9         &LAYERS=tl_2010_35_state10&WIDTH=800&HEIGHT=800&SRS=EPSG:4326
10        &FORMAT=image/png&STYLES=</href>
11      <viewRefreshMode>onStop</viewRefreshMode>
12    </Icon>
13    <LatLonBox>
14      <north>37.32753828398865</north>
15      <south>30.86418272137246</south>
16      <east>-101.3630220689848</east>
17      <west>-110.6891149310152</west>
18    </LatLonBox>
19  </GroundOverlay>
20 </kml>
```

## Sample KML File

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