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Vermont's FGDC CAP 2004 WFS Project

Establishing Framework Data Services Using the OGC Web Feature Service Specifications in Vermont

Final Technical Report

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I. Summary

The Vermont Center for Geographic Information (VCGI) received a 2004 CAP grant award with the goal of establishing Open Geospatial Consortium (OGC) compliant Web Features Services (WFS) providing statewide, seamless, continually maintained geographic framework data covering the State of Vermont. Vermont's WFS is capable of receiving user queries and responding with GML (Geography Markup Language) extracts of NSDI Framework data. The system provides access to Vermont's statewide Transportation (roads), Governmental Units, and Hydrography themes, and is encoded based on rules defined in ANSI/INCITS L1 Framework standards¹.

II. Accomplishments

VCGI has successfully configured and deployed WFS services capable of receiving user queries and responding with GML extracts of NSDI

¹ <http://www.fgdc.gov/standards/projects/index.html>



Framework data. Three NSDI Framework themes are currently available; 1) hydrography, 2) roads, and 3) governmental units.

The system offers two sets of services: 1) those hosted by ESRI's ArcIMS²™ WFS connector and 2) those hosted by MapServer³™ (an open source Internet mapping solution). The services can be accessed by going to <http://www.vcgi.org/projects/cap2004>.

VCGI collaborated with ESRI (Redlands) on the configuration and deployment of its ArcIMS implementation. The latest release of ArcIMS (9.1) was used, however, it did not support two critical project requirements; 1) GML 3.0 Simple Feature Profile (aka: Level 0) and 2) schema transformation. ESRI was unable to deliver an ArcIMS solution which could address either of these requirements. ESRI has indicated that they will support GML 3.0 Simple Feature Profile in the next release of ArcIMS (9.2), however, ESRI has not committed itself to any sort of schema transformation support.

The limitations of ArcIMS forced VCGI to find a different technical solution. MapServer was selected for its advanced OGC WFS capabilities. Version 4.8.1 of MapServer supported two critical requirements which ArcIMS failed to support (GML 3.0 SF and schema transformation). Technical questions were addressed promptly by the MapServer community⁴, allowing VCGI to quickly configure and deploy MapServer.

III. Technical Details

a. MapServer

MapServer version	MapServer 4.9 (beta)
Data source	Shapefile
GML version support	GML 3.0 (Simple Feature Profile - Level 0)
WFS version support	1.0.0
Schema Transformation?	YES (using MapServer *.map file configuration options)
Validates against FGDC/ANSI	Partial. Full compliance is not possible with the

² <http://www.esri.com/software/arcgis/arcims/index.html>

³ <http://mapserver.gis.umn.edu/>

⁴ VCGI would like to thank Stephen Lime (Lead MapServer developer) for his timely support. We would also like to thank Howard Butler for his help with the latest MapServer builds (4.9).



Framework schema?	current release of MapServer.
WFS client testing	Gaia 2.0.1 beta was used to test the services. Fully functional.

** Refer to Appendix A (WFS URLs) and Appendix B (MapServer Configuration Notes) for additional details*

b. ArcIMS Configuration

ArcIMS version	ArcIMS 9.1
Data source	ArcSDE 9.1
GML version support	GML 2.1.2 (ArcIMS does not support GML-SF 3.0)
WFS version support	1.0.0
Schema Transformation?	NO. ArcIMS does not support schema transformation
Validates against FGDC/ANSI Framework schema?	NO
WFS client testing	Gaia 2.0.1 beta was used to test the services. Fully functional.

** Refer to Appendix A for a list of ArcIMS WFS URLs.*

IV. Conclusion

This project demonstrated that it is possible to configure and deploy OGC compliant Web Feature Services (WFS) that are capable of receiving and responding to user queries of NSDI Framework data (in GML format). It has also demonstrated that these services are in their infancy, with software limitations that make configuration and deployment a complex endeavor. However, FGDC’s CAP WFS initiative has promoted wider adoption of OGC and FGDC standards within the vendor community. This has been especially true within the Open Source community (eg: MapServer).

VCGI is committed to providing OGC compliant WFS services for Vermont’s NSDI Framework datasets. We will continue to host the services developed under this project, and will add additional Framework datasets as time and funding allows. VCGI would like to thank FGDC for their support. None of this would have been possible without their dedication to the NSDI.



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Appendix A

WFS URLs

MapServer WFS URLs

Governmental Units

GET CAPABILITIES

http://mapsdev.vcgi.org:8079/cgi-bin/mapserv_gubs.exe?SERVICE=WFS&VERSION=1.0.0&REQUEST=GetCapabilities

DESCRIBE FEATURE TYPE

http://mapsdev.vcgi.org:8079/cgi-bin/mapserv_gubs.exe?&SERVICE=WFS&VERSION=1.0.0&request=DescribeFeatureType

GET FEATURE

http://mapsdev.vcgi.org:8079/cgi-bin/mapserv_gubs.exe?&SERVICE=WFS&VERSION=1.0.0&REQUEST=GetFeature&TYPENAME=GovermentalUnit&OUTPUTFORMAT=gml3

Transportation - Roads

GET CAPABILITIES

http://64.30.11.84:8079/cgi-bin/mapserv_roads.exe?SERVICE=WFS&VERSION=1.0.0&REQUEST=GetCapabilities

DESCRIBE FEATURE TYPE



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http://64.30.11.84:8079/cgi-bin/mapserv_roads.exe?&SERVICE=WFS&VERSION=1.0.0&request=DescribeFeatureType

GET FEATURE

http://64.30.11.84:8079/cgi-bin/mapserv_roads.exe?&SERVICE=WFS&VERSION=1.0.0&REQUEST=GetFeature&TYPENAME=RoadSeg&OUTPUTFORMAT=gml3

Hydrography

GET CAPABILITIES

http://64.30.11.84:8079/cgi-bin/mapserv_hydro.exe?SERVICE=WFS&VERSION=1.0.0&REQUEST=GetCapabilities

DESCRIBE FEATURE TYPE

http://64.30.11.84:8079/cgi-bin/mapserv_hydro.exe?&SERVICE=WFS&VERSION=1.0.0&request=DescribeFeatureType

GET FEATURE

http://64.30.11.84:8079/cgi-bin/mapserv_hydro.exe?&SERVICE=WFS&VERSION=1.0.0&REQUEST=GetFeature&TYPENAME=HydroElement&OUTPUTFORMAT=gml3

ArcIMS WFS URLs

GET CAPABILITIES (all Framework themes in one)

http://maps.vcgi.org:8080/wfsconnector/com.esri.wfs.Esrimap/CAP2004_TEST?request=getcapabilities&service=wfs&version=1.0.0

Transportation - Roads



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DESCRIBE FEATURE TYPE

http://maps.vcgi.org:8080/wfsconnector/com.esri.wfs.Esrimap/CAP2004_TEST?request=describefeaturetype&typename=TRANS_ROADSEG-1&service=wfs&version=1.0.0

Hydrography

DESCRIBE FEATURE TYPE

http://maps.vcgi.org:8080/wfsconnector/com.esri.wfs.Esrimap/CAP2004_TEST?request=describefeaturetype&typename=HYDRO_PONDS-2&service=wfs&version=1.0.0

http://maps.vcgi.org:8080/wfsconnector/com.esri.wfs.Esrimap/CAP2004_TEST?request=describefeaturetype&typename=HYDRO_LAKES_RIVERS-3&service=wfs&version=1.0.0

http://maps.vcgi.org:8080/wfsconnector/com.esri.wfs.Esrimap/CAP2004_TEST?request=describefeaturetype&typename=HYDRO_STREAMS-4&service=wfs&version=1.0.0

Transportation - Roads

GET FEATURE

http://maps.vcgi.org:8080/wfsconnector/com.esri.wfs.Esrimap/CAP2004_TEST?request=getfeature&featureid=TRANS_ROADSEG-1.1&service=wfs&version=1.0.0

Hydrography

GET FEATURE

http://maps.vcgi.org:8080/wfsconnector/com.esri.wfs.Esrimap/CAP2004_TEST?request=getfeature&featureid=HYDRO_PONDS-2.1&service=wfs&version=1.0.0



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http://maps.vcgi.org:8080/wfsconnector/com.esri.wfs.Esrimap/CAP2004_TEST?request=getfeature&featureid=HYDRO_LAKES_RIVERS-3.1&service=wfs&version=1.0.0

http://maps.vcgi.org:8080/wfsconnector/com.esri.wfs.Esrimap/CAP2004_TEST?request=getfeature&featureid=HYDRO_STREAMS-4.1&service=wfs&version=1.0.0



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Appendix B

MapServer NSDI Framework WFS Configuration Notes

Summary: Appendix B includes MapServer configuration notes. It documents how VCGI configured the three NSDI Framework Web Feature Services (WFS).

MapServer Install and Configuration:

VCGI installed and configured the “MapServer for Windows (MS4W)” distribution of MapServer (<http://www.maptools.org/ms4w/>). MS4W is an easy to use installer and for setting up MapServer on Windows platforms. VCGI installed MS4W version 1.4.0 (released 2/7/2006). This version included a pre-compiled version of MapServer CGI 4.8.1. the pre-compiled binary included OGC WMS and WFS support. A few quirks were encountered during installation and configuration.

Note: Version 4.8.1 had a few WFS limitations (it did not support “extended attributes”). As a result VCGI upgraded to version 4.9 beta, which enabled the use of “extended attributes”.

MapServer WFS configuration:

VCGI followed the procedures outline in the “How-tos” section of the MapServer web site (http://mapserver.gis.umn.edu/docs/howto/wfs_server/). Additional map file configuration options were also used, including “layer object” tags (http://mapserver.gis.umn.edu/docs/howto/wfs_server/#layer-object). These tags were used to transform the output schema in an attempt to match the target NSDI Framework schemas. Refer to Appendix C, D, and E for details.



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Appendix C

Governmental Units (MapServer Configuration File)

```
#
# VT Center for Geographic Information - NSDI Framework Governmental Units WFS map configuration file
# Author: Steve Sharp, VCGI
#
#
MAP
  NAME GUBS
  UNITS meters # all VCGI data is provided in VT State Plane Meters NAD83
  EXTENT 333461 25228 672889 279799 # whole state
  SHAPEPATH "E://gisdata/layers_projects/cap2004/framework/govunits/"
  WEB
    IMAGEPATH "d:/ms4w/tmp/ms_tmp/"
    IMAGEURL "/ms_tmp/"
  END

# UTM, Zone 15, NAD83
PROJECTION
  "+init=epsg:32145"
END

WEB
  METADATA
    wfs_title          "VT Center for Geographic Information WFS Server - NSDI Framework Data:Government Unit Boundaries"
    wfs_abstract       "This Web Feature Service provides an alternative method to access Vermont's vector Major Civil Division boundary layer.
Traditional download functionality can be found at http://www.vcgi.org/dataware/?layer=TWNBND."
    wfs_srs            "EPSG:32145 EPSG:42304 EPSG:42101 EPSG:4269 EPSG:4326"
    wfs_onlineResource "http://mapsdev.vcgi.org:8079/cgi-bin/mapserv_gubs.exe?"
    wfs_namespace_prefix "gubs"
    wfs_namespace_uri  "http://mapsdev.vcgi.org:8079/gubs"
    wfs_feature_collection "GovernmentalUnitBoundariesCollection"
```



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```
wfs_metadatal_href "http://www.vcgi.org/metadata/BoundaryOther_BNDHASH.htm"
wfs_metadatal_type "FGDC"
wfs_metadatal_format "HTML"
END
END

#
# available WFS layers follow
#
# MCD Boundaries
LAYER
NAME "GovernmentalUnit"
STATUS OFF
TYPE POLYGON

# data access information
DATA "boundary_twnbnds_poly"
DUMP TRUE

# projection
PROJECTION
"+init=epsg:32145"
END

# metadata
METADATA
wfs_title "Vermont Major Civil Division (MCD) boundaries"
wfs_abstract "Major Civil Division boundaries within the State of Vermont. It is a mosaic of generally best available boundaries from various data sources"
wfs_keywordlist "town boundary, town boundaries, MCD, major civil divisions"
wfs_extent "333461 25228 672889 279799"
gml_featureid "twbnds_id"
gml_include_items "fips6,commtype,townname,fipsname,calc_acres,cnty"
gml_fips6_alias "unitld"
gml_commtype_alias "typeAbbreviation"
```



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```
gml_townname_alias "instanceName"  
gml_fipsname_alias "instanceAlternateName"  
gml_geometries "geometry"  
gml_geometry_type "polygon"  
gml_geometry_occurrences "0,unbounded"  
gml_calc_acres_template "<$namespace:extended><name>acres</name><value>$value</value></$namespace:extended>"  
gml_cnty_template "<$namespace:extended><name>cntyfips</name><value>$value</value></$namespace:extended>"  
END  
END  
  
END # end of Gov Units WFS config file
```



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Appendix D

Hydrography (MapServer Configuration File)

```
#
# VT Center for Geographic Information - NSDI Framework Hydro WFS map configuration file
# Author: Steve Sharp, VCGI
#
#
MAP
  NAME HYDRO
  UNITS meters # all VCGI data is provided in VT State Plane Meters NAD83
  EXTENT 333461 25228 672889 279799 # whole state

  SHAPEPATH "E://gisdata/layers_projects/cap2004/framework/hydro/"

  WEB
    IMAGEPATH "d:/ms4w/tmp/ms_tmp/"
    IMAGEURL "/ms_tmp/"
  END

  # UTM, Zone 15, NAD83
  PROJECTION
    "+init=epsg:32145"
  END

  WEB
    METADATA
      wfs_title          "VT Center for Geographic Information WFS Server - NSDI Framework Data: Hydro"
      wfs_abstract       "This Web Feature Service provides an alternative method to access Vermont's Hydrography Dataset (VHD). Traditional
download functionality can be found at http://www.vcgi.org/dataware/?layer=WaterHydro\_VHD."
      wfs_srs            "EPSG:32145 EPSG:42304 EPSG:42101 EPSG:4269 EPSG:4326"
      wfs_onlineResource "http://mapsdev.vcgi.org:8079/cgi-bin/mapserv_hydro.exe?"
      wfs_namespace_prefix "hyd"
```



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```
wfs_namespace_uri      "http://mapsdev.vcgi.org:8079/hydro"
wfs_feature_collection  "HydroCollection"
wfs_metadataurl_href   "http://www.vcgi.org/metadata/WaterHydro_VHD.htm"
wfs_metadataurl_type   "FGDC"
wfs_metadataurl_format "HTML"
wfs_maxfeatures        "100"
END
END

#
# available WFS layers follow
#
# VT hydro
LAYER
  NAME "HydroElement"
  STATUS OFF
  TYPE POLYGON

# data access information
DATA "water_swpre_line"
DUMP TRUE

# projection
PROJECTION
  "+init=epsg:32145"
END

# metadata
METADATA
  wfs_title "Vermont Hydrography Dataset river and stream centerlines"
  wfs_abstract "River and stream centerlines extracted from the Vermont Hydrography Dataset, which is a high resolution version of the National Hydrography Dataset (NHD)."
```

Hydrography Dataset (NHD)."

```
  wfs_keywordlist "hydrography,hydro,ponds,rivers,streams,lakes,hydro,vhd,nhd"
  wfs_extent "333461 25228 672889 279799"
  gml_featureid "featureid"
```



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```
gml_include_items "com_id,rch_code,rch_date,meters,gnis_id,name"  
gml_com_id_alias "featureId"  
gml_rch_date_alias "featureDate"  
gml_name_alias "name"  
gml_meters_alias "measure"  
gml_geometries "geometry"  
gml_geometry_type "line"  
gml_geometry_occurrences "0,unbounded"  
gml_gnis_id_template "<${namespace:extended}<name>gnis_id</name><value>$value</value></${namespace:extended}>"  
gml_rch_code_template "<${namespace:extended}<name>rch_code</name><value>$value</value></${namespace:extended}>"  
END  
END
```

END # end of Hydro WFS config file



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Appendix E

Transportation/Roads (MapServer Configuration File)

```
#
# VT Center for Geographic Information - NSDI Framework Transportation/Roads WFS map configuration file
# Author: Steve Sharp, VCGI
#
#
MAP
  NAME TRANS
  UNITS meters # all VCGI data is provided in VT State Plane Meters NAD83
  EXTENT 333461 25228 672889 279799 # whole state

  SHAPEPATH "E://gisdata/layers_projects/cap2004/framework/roads/"

  WEB
    IMAGEPATH "d:/ms4w/tmp/ms_tmp/"
    IMAGEURL "/ms_tmp/"
  END

  # UTM, Zone 15, NAD83
  PROJECTION
    "+init=epsg:32145"
  END

  WEB
  METADATA
    wfs_title "VT Center for Geographic Information WFS Server - NSDI Framework Data:Transportation:Roads"
    wfs_abstract "This Web Feature Service provides an alternative method to access Vermont's vector E911 road centerline data. Traditional
download functionality can be found at http://www.vcgi.org/dataware/?layer=EmergencyE911\_RDS."
    wfs_srs "EPSG:32145 EPSG:42304 EPSG:42101 EPSG:4269 EPSG:4326"
    wfs_onlineResource "http://mapsdev.vcgi.org:8079/cgi-bin/mapserv_roads.exe?"
```



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```
wfs_namespace_prefix      "trans"
wfs_namespace_uri         "http://mapsdev.vcgi.org:8079/roads"
wfs_feature_collection    "TransportationRoadsCollection"
wfs_metadataurl_href     "http://www.vcgi.org/metadata/EmergencyE911_RDS.htm"
wfs_metadataurl_type     "FGDC"
wfs_metadataurl_format   "HTML"
wfs_maxfeatures           "100"
END
END

#
# available WFS layers follow
#
# E911 road segs
LAYER
  NAME "RoadSeg"
  STATUS OFF
  TYPE POLYGON

# data access information
DATA "e911_rds_line"
DUMP TRUE

# projection
PROJECTION
  "+init=epsg:32145"
END

# metadata
METADATA
  wfs_title "E911 road centerline segments"
  wfs_abstract "Vermont Enhanced 911 road centerlines."
  wfs_keywordlist "roads, centerlines, e911"
  wfs_extent "333461 25228 672889 279799"
  gml_featureid "featureid"
```



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```
gml_include_items "shape_len,lastupdate,status,fieldmeas,isanchorse,name,llo,lhi,rlo,rhi,predir,streetname,streettype,sufdir,rtno,class,oneway,arcid"  
gml_lastupdate_alias "lastUpdateDate"  
gml_status_alias "status"  
gml_fieldmeas_alias "fieldMeasure"  
gml_shape_len_alias "length"  
gml_geometries "geometry"  
gml_geometry_type "line"  
gml_geometry_occurrences "0,unbounded"  
gml_isanchorse_alias "isAnchorSection"  
gml_llo_template "<${namespace:extended}<name>leftAddressLow</name><value>$value</value></${namespace:extended}>"  
gml_lhi_template "<${namespace:extended}<name>leftAddressHi</name><value>$value</value></${namespace:extended}>"  
gml_rlo_template "<${namespace:extended}<name>rightAddressLow</name><value>$value</value></${namespace:extended}>"  
gml_rhi_template "<${namespace:extended}<name>rightAddressHi</name><value>$value</value></${namespace:extended}>"  
gml_name_template "<${namespace:extended}<name>fullStreetName</name><value>$value</value></${namespace:extended}>"  
gml_predir_template "<${namespace:extended}<name>directionalPrefix</name><value>$value</value></${namespace:extended}>"  
gml_streetname_template "<${namespace:extended}<name>streetName</name><value>$value</value></${namespace:extended}>"  
gml_streettype_template "<${namespace:extended}<name>streetType</name><value>$value</value></${namespace:extended}>"  
gml_sufdir_template "<${namespace:extended}<name>directionalSuffix</name><value>$value</value></${namespace:extended}>"  
gml_rtno_template "<${namespace:extended}<name>routeNumber</name><value>$value</value></${namespace:extended}>"  
gml_class_template "<${namespace:extended}<name>roadClass</name><value>$value</value></${namespace:extended}>"  
gml_oneway_template "<${namespace:extended}<name>onewayRoad</name><value>$value</value></${namespace:extended}>"  
gml_arcid_template "<${namespace:extended}<name>externalIdentifier</name><value>$value</value></${namespace:extended}>"  
END  
END  
  
END # end of transportation WFS config file
```