OGC Web Coverage Service (WCS) Specification

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Definition of Some Terms

• Operation
  – Specification of a transformation or query that an object may be called to execute
• Interface
  – Named set of operations that characterize the behaviour of an entity
• Service
  – A distinct part of the functionality provided by an entity through interfaces
• Service instance
  – An actual implementation of a service; synonymous with server
• Client
  – A software component that can invoke an operation from a server
• Request
  – An invocation by a client of an operation
• Response
  – The result of an operation returned from a server to a client
• Capabilities XML
  – Service-level metadata describing the operations and content available at a server
Introduction

• WCS specification defines the way to access real coverage data (raster data).

• WCS 1.0 is the base standard for the coverage service in OGC.
  – This presentation concentrates on the introduction to WCS1.0 because it is the most widely implemented WCS specification.

• A new version of WCS, version 1.1.0 has been developed by OGC.
  – A summary of new functions defined in WCS 1.1.0 will be discussed.

• Currently, the revision working group of WCS is developing a new version of WCS. It will also be summarized in this presentation
Scope, conformance, normative references

• Scope: grid coverages with homogeneous range sets
  – Provide web-based standard interface to access real multi-dimensional grid coverages.
  – Not cover the access to other types of coverage data.
• Conformance: see Annex C
• Normative references: MIME, HTTP, URI, WMS, GML, XML, …
• HTTP request methods: GET and POST
• **Key-value pair encoding** (GET/POST). Names/keys are not case sensitive, but values are. The order is not important.
• http://myserver/myservice?
REQUEST=DescribeCoverage&SERVICE=WCS&version=1.0.0&coverage=Landsat_TM_Mosaic
• Or use HTML form

```html
<form method=post/get action="myservice">
  <input name=request value="DescribeCoverage">
  <input name=service value="WCS">
  <input name=version value="1.0.0">
  <input name=coverage value="Landsat_TM_Mosaic">
  <input type="submit" value="describe this coverage">
</form>
```
Request (cont’d)

• XML encoding

```xml
<DescribeCoverage service="WCS" version="1.0.0">
  <Coverage>Landsat_TM_Mosaic</Coverage>
</DescribeCoverage>

• To support SOAP messaging, enclose XML request in a SOAP envelope as follows:

```xml
<env:Envelope
  xmlns:env="http://www.w3.org/2001/09/soap-envelope">
  <env:Body>
    request document here
  </env:Body>
</env:Envelope>
```
Response

- XML encoding
- If valid request: corresponding exactly to the request as detailed in the appropriate specification. Most top-level element has attributes version (required) and updateSequence (optional).
- If invalid request: Service Exception
Exception Schema:

```xml
  <xs:element name="ServiceExceptionReport">
    <xs:complexType>
      <xs:sequence>
        <xs:element name="ServiceException" type="ogc:ServiceExceptionType" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:attribute name="version" type="xs:string" fixed="1.2.0"/>
    </xs:complexType>
  </xs:element>

  <xs:complexType name="ServiceExceptionType">
    <xs:simpleContent>
      <xs:extension base="xs:string">
        <xs:attribute name="code" type="xs:string" />
        <xs:attribute name="locator" type="xs:string" use="optional" />
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>
</xs:schema>
```
GetCapabilities request

- Key-value pair encoding

<table>
<thead>
<tr>
<th>Request Parameter</th>
<th>Required/ Optional</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>REQUEST=GetCapabilities</td>
<td>Required</td>
<td>Request name</td>
</tr>
<tr>
<td>VERSION=1.0.0</td>
<td>Optional</td>
<td>Request version</td>
</tr>
<tr>
<td>SERVICE=WCS</td>
<td>Required</td>
<td>Service type</td>
</tr>
<tr>
<td>SECTION=/ or /WCS_Capabilities/Service or /WCS_Capabilities/Capability or ?WCS_Capabilities/ContentMetadata</td>
<td>Optional</td>
<td>Section of Capabilities document to be returned</td>
</tr>
<tr>
<td>UPDATESEQUENCE</td>
<td>Optional</td>
<td>Capabilities version</td>
</tr>
</tbody>
</table>
GetCapabilities request (cont’d)

• **XML encoding**

```
<GetCapabilities version="1.0.0" service="WCS">
  <section>/WCS_Capabilities/Capability</section>
</GetCapabilities>
```

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Required / Optional</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>version</td>
<td>Optional</td>
<td>Request version. Defaults to the latest available version, currently 1.0.0.</td>
</tr>
<tr>
<td>service</td>
<td>Required</td>
<td>Service type (needed when several services share a single access point)</td>
</tr>
<tr>
<td>update-Sequence</td>
<td>Optional</td>
<td>Used for cache management. A service provider must increase this value when adding new content.</td>
</tr>
</tbody>
</table>
GetCapabilities response

- Top level element WCS_Capabilities has three sub elements: Service, Capability, and ContentMetadata.
- Service
GetCapabilities response (cont’d)

- Capability
GetCapabilities response (cont’d)

- ContentMetadata
DescribeCoverage request

- Key-value pair encoding

<table>
<thead>
<tr>
<th>URL Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>REQUEST=DescribeCoverage</td>
<td>Request name. Must be “DescribeCoverage“. <em>Required.</em></td>
</tr>
<tr>
<td>SERVICE=WCS</td>
<td>Service name. Must be “WCS“. <em>Required.</em></td>
</tr>
<tr>
<td>VERSION=1.0.0</td>
<td>Request protocol version. <em>Required.</em></td>
</tr>
<tr>
<td>COVERAGE=name1, name2, …</td>
<td>A comma-separated list of coverages to describe (identified by their name values in the Capabilities response). <em>Optional.</em> Default is all coverages, if the server supports it.</td>
</tr>
</tbody>
</table>
DescribeCoverage request (cont’d)

• XML encoding

```
<DescribeCoverage service="WCS" version="1.0.0">
  <Coverage>Landsat_TM_Mosaic</Coverage>
  <Coverage>WMO_Daily_Temps</Coverage>
  <Coverage>Census_population_tables</Coverage>
</DescribeCoverage>
```

• two required attributes: service and version
DescribeCoverage response
DescribeCoverage response (cont’d)

- CoverageOffering: additional elements beyond CoverageOfferingBrief

<table>
<thead>
<tr>
<th>Element name</th>
<th>Required / Optional</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>domainSet</td>
<td>Required</td>
<td>The available coverage locations in space and/or time available from a coverage offering</td>
</tr>
<tr>
<td>rangeSet</td>
<td>Required</td>
<td>A description of coverage values available from a coverage offering</td>
</tr>
<tr>
<td>supportedCRSs</td>
<td>Required</td>
<td>The coordinate reference system(s) in which the server can accept requests against this coverage offering and produce coverages from it.</td>
</tr>
<tr>
<td>supported-Formats</td>
<td>Required</td>
<td>The formats (file encodings) in which the server can produce coverages from this coverage offering.</td>
</tr>
<tr>
<td>supported-Interpolations</td>
<td>Optional</td>
<td>The spatial interpolation methods available for resampling or generalizing coverage values when needed to fill a GetCoverage request.</td>
</tr>
</tbody>
</table>
DescribeCoverage response (cont’d)

- **domainSet / SpatialDomain**

![Diagram showing SpatialDomainType and its components]
• domainSet / TemporalDomain
DescribeCoverage response (cont’d)

- rangeSet

```
rangeSet
  --- RangeSet
    --- metadataLink
    --- description
    --- name
    --- label
    --- axisDescription
    --- HullValues
```
DescribeCoverage response (cont’d)

- AxisDescription
DescribeCoverage response (cont’d)

- Supported CRSs
DescribeCoverage response (cont’d)

- **SupportedFormats** (a simple string): GeoTIFF, HDF-EOS, DTED, NITF, GML (one of the formats has to be supported).
- **SupportedInterpolations**

<table>
<thead>
<tr>
<th>Interpolation Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>nearest neighbor</em> (default)</td>
<td></td>
</tr>
<tr>
<td><em>bilinear</em></td>
<td></td>
</tr>
<tr>
<td><em>bicubic</em></td>
<td></td>
</tr>
<tr>
<td><em>lost area</em></td>
<td></td>
</tr>
<tr>
<td><em>barycentric</em></td>
<td></td>
</tr>
<tr>
<td><em>none</em></td>
<td>No interpolation is available; requests must be for locations that are among the original domain locations.</td>
</tr>
</tbody>
</table>

These are defined in ISO 19123 (Schema for Coverage Geometry and Functions), Annex B.
GetCoverage request

- **Key-value pair encoding**
  - http://server_address/path/script?
  - SERVICE=WCS
  - VERSION=1.0.0
  - REQUEST=GetCoverage
  - COVERAGE=name
  - CRS=crs_identifier
  - RESPONSE_CRS= crs_identifier
  - BBOX=minx, miny, maxx, maxy, minz, maxz
  - TIME= time1,time2,… or TIME= min/max/res, …
  - PARAMETER= val1,val2, … or PARAMETER= min/max/res
  - WIDTH = w (integer)
  - HEIGHT = h (integer)
  - [DEPTH =d (integer)]
  - RESX=x (double)
  - RESY=y (double)
  - [RESZ=z (double)]
  - FORMAT= format
  - EXCEPTIONS= application / vnd.ogc.se_xml
GetCoverage request (cont’d)

• XML encoding
GetCoverage response

• The server has to make the coverage that meets exactly the requirements encoded in the GetCoverage request.
• The returned coverage should be encoded in format specified in the GetCoverage request.
  – The format should be one of the formats listed in supportedFormats for the requested coverage offering.
• Or Exception in case of invalid request.
WCS version 1.1

- WCS Version 1.1 is the latest version of stable OGC WCS Specification.
- Originally the latest version number was 1.1.0, which was almost a complete rewrite of WCS 1.0.0, with many editorial changes and detailed streamlining of schema files resulting from OWS Common conformance.
- Two corrigenda were made to version 1.1.0.
  - Corrigendum 1 fixed minor inconsistencies, spelling mistakes, and added some minor clarifications; and aligned with OWS-Common version 1.1.0.
  - Corrigendum 2 further fixed minor inconsistencies, spelling mistakes, and adds some minor clarifications.
- Thus, some people may refer the latest WCS specification to as WCS1.1.2 while other may use 1.1.0 (or 1.1.1 or WCS1.1).
- The next slide highlights the new functions in WCS 1.1.0.
WCS version 1.1.0

- Additional functions introduced in WCS 1.1.0:
  - Use of GridCRS in coverage descriptions and requests
    - For defining detailed grid information such as origin, offset, and base CRS of the grid.
  - Hierarchical coverage descriptions
    - Allowing common metadata descriptions be inherited/shared.
  - Multiple fields per coverage
    - A very important new feature.
    - Allowing more than one fields (variables) be requested with one getCoverage request.
  - XML and (optionally) asynchronous GetCoverage responses, not one coverage file.
  - Different approach to coverage formats
    - Using encoding profiles, not relying on preferred formats.
WCS version 1.1.0

Service Metadata
WCS version 1.1.0

Content Metadata
## Inheritance of Coverage Summary

<table>
<thead>
<tr>
<th>Name</th>
<th>Definition</th>
<th>Inheritance by subsidiary coverages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Description of a coverage</td>
<td>Not inherited&lt;sup&gt;a, b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Identifier</td>
<td>Unambiguous identifier of this coverage, unique for this WCS server</td>
<td>Not inherited&lt;sup&gt;a, c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Metadata</td>
<td>Reference to more metadata about this coverage</td>
<td>Not inherited&lt;sup&gt;a, c&lt;/sup&gt;</td>
</tr>
<tr>
<td>WGS84-BoundingBox</td>
<td>Minimum bounding rectangle surrounding coverage, using WGS 84 CRS with decimal degrees and longitude before latitude</td>
<td>Inherited when not provided&lt;sup&gt;d, e&lt;/sup&gt;</td>
</tr>
<tr>
<td>SupportedCRS</td>
<td>CRS in which GetCoverage operation response may be expressed</td>
<td>Inherited and possibly added to&lt;sup&gt;f, h&lt;/sup&gt;</td>
</tr>
<tr>
<td>Supported Format</td>
<td>Format in which GetCoverage operation response may be encoded</td>
<td>Inherited and possibly added to&lt;sup&gt;g, h&lt;/sup&gt;</td>
</tr>
<tr>
<td>Coverage Summary</td>
<td>Metadata describing one subsidiary coverage available from this server</td>
<td>Not inherited</td>
</tr>
</tbody>
</table>
WCS version 1.1.0

Domain UML
## WCS version 1.1.0

### Domain Data Structure

<table>
<thead>
<tr>
<th>Names</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity and use</th>
</tr>
</thead>
<tbody>
<tr>
<td>boundingBox</td>
<td>Unordered list of bounding boxes whose union covers spatial domain of this coverage</td>
<td>BoundingBox data structure, see Subclause 10.2 in OGC 05-008</td>
<td>One or more (mandatory) Include for each bounding box useful for recording spatial domain</td>
</tr>
<tr>
<td>BoundingBox</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gridCRS</td>
<td>Definition of GridCRS of this coverage</td>
<td>GridCRS data structure, see Annex G</td>
<td>Zero or one (optional) Include when coverage is georectified and thus has GridCRS</td>
</tr>
<tr>
<td>GridCRS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>transformation</td>
<td>Georeferencing coordinate transformation for unrectified coverage</td>
<td>CC_CoordinateOperation, see ISO 19111</td>
<td>Zero or one (optional) Include when available</td>
</tr>
<tr>
<td>Transformation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>imageCRS</td>
<td>Association to ImageCRS of this coverage</td>
<td>Association to ImageCRS</td>
<td>Zero or one (optional) Include when coverage is an image</td>
</tr>
<tr>
<td>imageCRS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>polygon</td>
<td>Unordered list of polygons whose union covers spatial domain of this coverage</td>
<td>GM_Polygon, see ISO 19107</td>
<td>Zero or more (optional) Include one for each polygon needed</td>
</tr>
<tr>
<td>Polygon</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Grid Data Structure

<table>
<thead>
<tr>
<th>Names</th>
<th>Definition</th>
<th>Data type and value</th>
<th>Multiplicity and use</th>
</tr>
</thead>
<tbody>
<tr>
<td>srsName</td>
<td>Name or identifier of this GridCRS</td>
<td>Character string type, not empty</td>
<td>Zero or one (optional)</td>
</tr>
<tr>
<td>srsName</td>
<td></td>
<td></td>
<td>Include when needed so this GridCRS can be referenced</td>
</tr>
<tr>
<td>gridBaseCRS</td>
<td>Reference to definition of base CRS used by this GridCRS</td>
<td>URI</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>gridType</td>
<td>Reference to definition of operation method that specifies quadrilateral grid in GridBaseCRS</td>
<td>URI</td>
<td>Zero or one (optional)</td>
</tr>
<tr>
<td>gridType</td>
<td></td>
<td>Default is &quot;urn:ogc:def:method:WCS:1.1:2dSimpleGrid&quot;</td>
<td>Include when not default GridType</td>
</tr>
<tr>
<td>gridOrigin</td>
<td>Position coordinates of origin of this GridCRS in the GridBaseCRS</td>
<td>Sequence&lt;Double&gt;</td>
<td>Zero or one (optional)</td>
</tr>
<tr>
<td>gridOrigin</td>
<td></td>
<td>Default is &quot;0.0 0.0&quot;</td>
<td>Include when not default origin</td>
</tr>
<tr>
<td>gridOffsets</td>
<td>Position offsets between adjacent points in rectangular grid, in each dimension of GridCS in each dimension of GridBaseCRS</td>
<td>Sequence&lt;Double&gt;</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>gridCS</td>
<td>Reference to definition of 2D or 3D CartesianCS used by this GridCRS</td>
<td>URI</td>
<td>Zero or one (optional)</td>
</tr>
<tr>
<td>gridCS</td>
<td></td>
<td>Default is &quot;urn:ogc:def:cs:OGC:0.0:Grid2dSquareCS&quot;</td>
<td>Include when not default GridCS</td>
</tr>
</tbody>
</table>
Range UML
## Field Data Structure

<table>
<thead>
<tr>
<th>Names</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity and use</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Description)</td>
<td>Description of this field</td>
<td>Description data structure, see [OGC 05-008]</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>identifier</td>
<td>Identifier of this field, unique for this coverage</td>
<td>Character string type, not empty</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>definition</td>
<td>Further definition of this field, including meaning, units, etc.</td>
<td>UnNamedDomain data structure, see Annex E</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>nullValue</td>
<td>Value used when valid range values are not available</td>
<td>Code data structure, see [OGC 05-008]</td>
<td>Zero or more (optional) Include when needed</td>
</tr>
<tr>
<td>interpolationMethods</td>
<td>Spatial interpolation method(s) that server can apply to this field</td>
<td>InterpolationMethods data structure, see Subclause I.4</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>axis</td>
<td>Axis ( &quot;control variable&quot;) of vector field for which there are range values</td>
<td>Axis data structure, see Table 20</td>
<td>Zero or one (optional) Include for each axis of a vector field (i.e., one that has axes)</td>
</tr>
</tbody>
</table>
### WCS version 1.1.0

#### Axis Data Structure

<table>
<thead>
<tr>
<th>Names(^a)</th>
<th>Definition</th>
<th>Data type</th>
<th>Multiplicity and use</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Description)(^b)</td>
<td>Description of this field</td>
<td>Description data structure, see [OGC 05-008]</td>
<td>One (mandatory)(^b)</td>
</tr>
<tr>
<td>Identifier</td>
<td>Identifier of this axis, unique for this field</td>
<td>Character string type, not empty</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>availableKeys</td>
<td>List of values of keys for this axis</td>
<td>AvailableKeys data structure, see Table 21</td>
<td>One (mandatory)</td>
</tr>
<tr>
<td>meaning</td>
<td>Reference to meaning or semantics of this value or set of values</td>
<td>DomainMetadata data structure, see Table E.7</td>
<td>Zero or one (optional)</td>
</tr>
<tr>
<td>dataType</td>
<td>Reference to the data type of this set of values</td>
<td>DomainMetadata data structure, see Table E.7</td>
<td>Zero or one (optional)</td>
</tr>
<tr>
<td>valuesUnit</td>
<td>Indicates that this quantity has units or reference system, and provides the value used(^c)</td>
<td>ValuesUnit data structure, see Table E.4</td>
<td>Zero or one (optional)</td>
</tr>
<tr>
<td>metadata</td>
<td>Additional metadata about domain of this quantity</td>
<td>ows:Metadata, see Table 23 of OGC 05-008</td>
<td>Zero or more (optional)</td>
</tr>
</tbody>
</table>

\(^a\) These are the names of the fields.

\(^b\) The description field is mandatory in the WCS, but it is advisable to include a description for other fields as well.

\(^c\) The valuesUnit field is optional, but it is recommended to include units or a reference system.

\(^d\) The metadata field is optional, but it is recommended to include metadata for each such quantity.
## WCS version 1.1.0

<table>
<thead>
<tr>
<th>KVP Encoding</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>**identifier=**identifier</td>
<td>Mandatory</td>
</tr>
<tr>
<td><strong>BoundingBox=47.71, -51.66, urn:ogc:def:crs:EPSG:6.6:6326 6405</strong></td>
<td>Optional, include when spatial subset desired</td>
</tr>
<tr>
<td><strong>TimeSequence= 20060801, 20060811, ... OR TimeSequence = 20060801/2006-0901/P1D, ...</strong></td>
<td>Optional, include when temporal subset desired other than default</td>
</tr>
<tr>
<td>**RangeSubset=**temp:nearest; radiance[band[1,2,5]] (see syntax below)</td>
<td>Optional; include when requesting values for only some of the available fields or field keys; or non-default interpolation types on fields.</td>
</tr>
<tr>
<td>**format=**image/netcdf</td>
<td>Mandatory</td>
</tr>
<tr>
<td><strong>store=true</strong></td>
<td>Optional, include when supported and not false</td>
</tr>
<tr>
<td><strong>GridBaseCRS=urn:ogc:def:crs:EPSG:6.6:32618</strong></td>
<td>Optional, include all of five GridCRS parameters, except for defaulted parameters, to request output in a CRS other than the ImageCRS of stored coverage</td>
</tr>
<tr>
<td><strong>GridType=urn:ogc:def:method:WCS:1.1:2dGridIn2dCrs</strong></td>
<td>Reference to grid type of desired output GridCRS, a URN</td>
</tr>
<tr>
<td><strong>GridCS=urn:ogc:def:cs:OGC:0.0:Grid2dSquareCS</strong></td>
<td>Reference to coordinate system of desired output GridCRS, a URN</td>
</tr>
<tr>
<td><strong>GridOrigin=0.0</strong></td>
<td>Position coordinates of one possible grid origin, in baseCRS of desired output GridCRS</td>
</tr>
<tr>
<td><strong>GridOffsets=0.0707, -0.0707, 0.1414, 0.1414</strong></td>
<td>Offsets between adjacent grid points, in baseCRS of desired output GridCRS</td>
</tr>
</tbody>
</table>
WCS version 1.1.0

- WCS1.0.0 does not explicitly specify the difference between grid point and grid cell. Sometimes people use different ways in defining a grid’s boundary.
- WCS1.1.0 clarifies this point by explicitly referring to ISO 19123.
- Grid points, grid cells, and sample spaces are shown as the following:
WCS version 1.1.0

Support SOAP Encoding

• SOAP (Simple Object Access Protocol): exchanging XML-based messages over networks, normally using HTTP/HTTPS.
• SOAP provides a basic messaging framework upon which abstract layers can be built.
• SOAP envelope, header, body.
  <SOAP:Envelope>
    <SOAP:Header>
    </SOAP:Header>
    <SOAP:Body>
    </SOAP:Body>
  </SOAP:Envelope>
SOAP with attachment: support getCoverage response.

MIME-Version: 1.0
Content-Type: Multipart/Related; boundary=MIME_boundary; type=text/xml;
            start="<claim061400a.xml@claiming-it.com>"
Content-Description: This is the optional message description.

--MIME_boundary
Content-Type: text/xml; charset=UTF-8
Content-Transfer-Encoding: 8bit
Content-ID: <claim061400a.xml@claiming-it.com>

<?xml version='1.0' ?>
  <SOAP-ENV:Body>
    ...
    <theSignedForm href="cid:claim061400a.tiff@claiming-it.com"/>
    ...
  </SOAP-ENV:Body>
</SOAP-ENV:Envelope>

--MIME_boundary
Content-Type: image/tiff Content-Transfer-Encoding: binary
Content-ID: <claim061400a.tiff@claiming-it.com>

...binary TIFF image...
--MIME_boundary--
Revisions and Related Specifications

- The WCS revision working group is working on revising WCS.
- Newer version will be WCS 1.2 (on-going)
- Defining requirements for WCS Base and Extensions
- WCS - Processing Extension
- WCS – Transaction Operation Extension
- JPEG2000/JPIP/netCDF/HDF coverage encoding profiles
- Non-grid Coverages (use case from the GALEON project)
GMU WCS Implementation

• WCS 1.0 and 1.1 have been implemented by GMU to support distribution of HDF-EOS data to users.
  – Both HDF4-EOS and HDF5-EOS are supported.
  – WCS transaction
  – Support GeoTIFF data and simple binary
  – On-the-flying georectification
  – On-the-flying reprojection (Supporting all projections in USGS map projection software)
  – Output coverage to over 30 formats, including netCDF, HDF-EOS, and others.

• Our experience indicated that it is not an easy task to support all HDF-EOS products because
  – Diverse in HDF-EOS
  – Product not following the HDF-EOS standards.
  – We have to test and customize for individual products.