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ncML-G_{ML}: encoding netCDF datasets using GML

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Outline

- Introduction
 - Atmospheric Science and GIS domains
- Context scenario
 - Interoperability issue and proposed approach
- ncML model
 - ncML encoding schemas
- ncML-G extension model
 - ncML-G_{ML} encoding
- Conclusions

Introduction

- Research framework:
 - ncML specification WG:

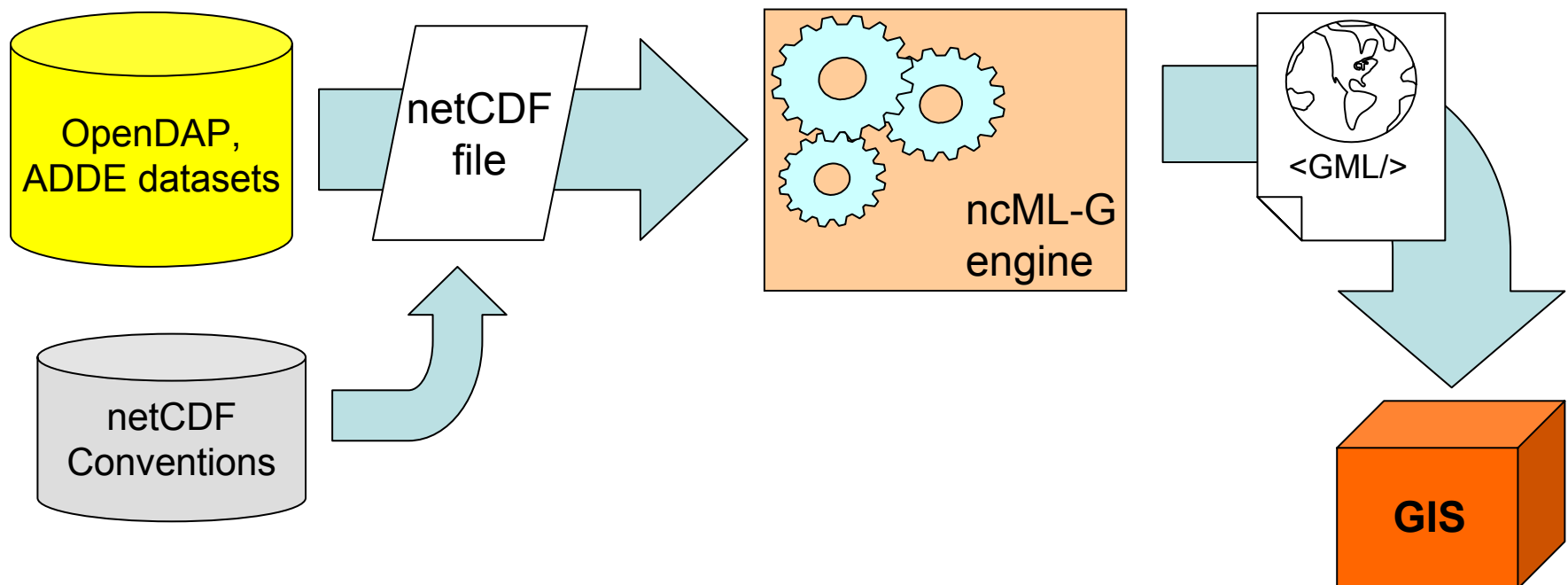
John Caron (Unidata/UCAR)	Luca Cinquini (SCD/NCAR)
Ethan Davis (Unidata/UCAR)	Bob Drach (PCMDI/LLNL)
Stefano Nativi (University of Florence)	Russ Rew (Unidata/UCAR)
 - part of the Unidata Program Center at UCAR (Boulder, Colorado)
- Partially funded by the Thematic Real-time Environmental Distributed Data Services (THREDDS)

Rationale

- Growing need to provide Society with Earth Science disciplines information:
 - Example applications
 - Decision Support Systems (DSS)
 - Science Digital Library
 - Technological drivers
 - Increasing resolution and availability of remote sensing data
 - Growing number of operational satellites
 - Ubiquitous connectivity

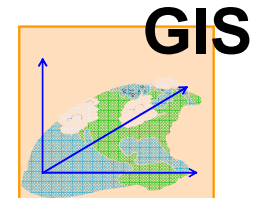
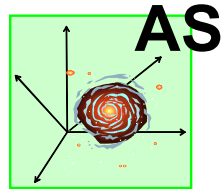
Context scenario

- Providing GIS/Geomatics community with real-time access to Atmospheric Science datasets
 - focus on netCDF and ISO/OpenGIS model



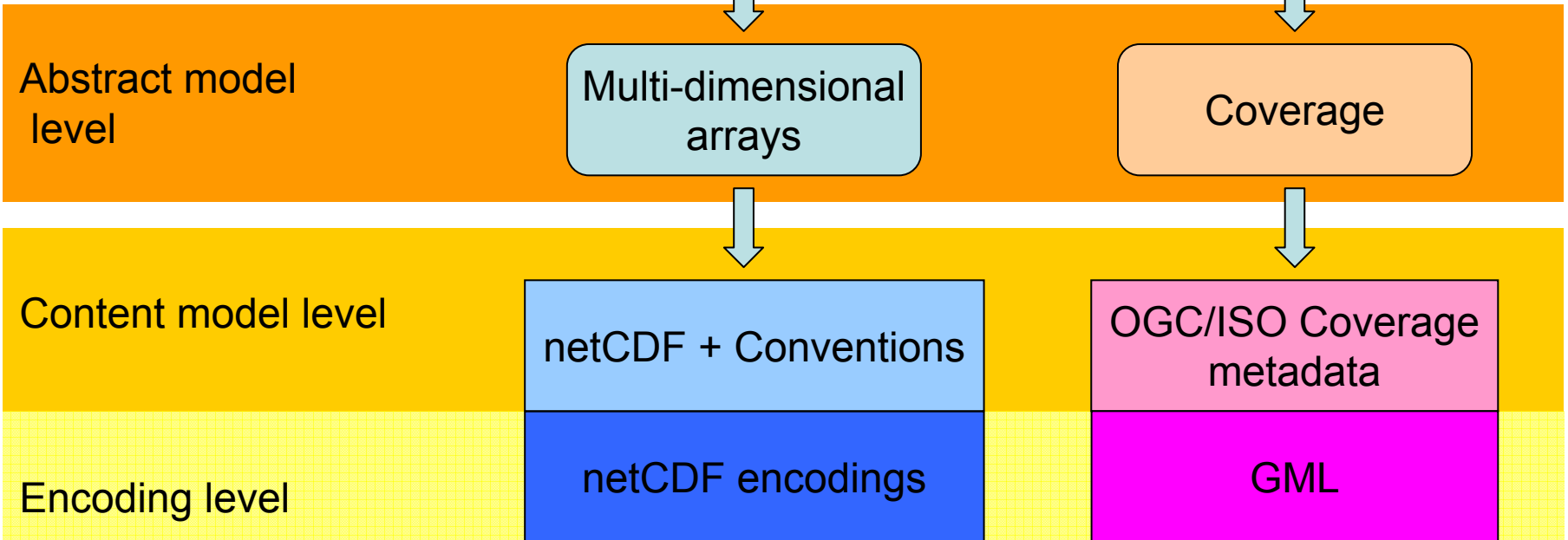
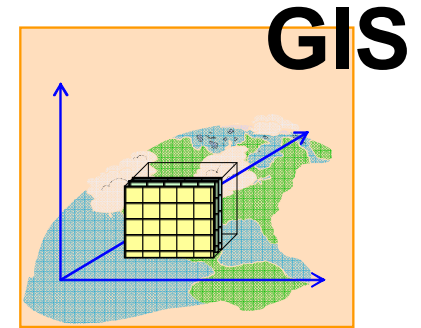
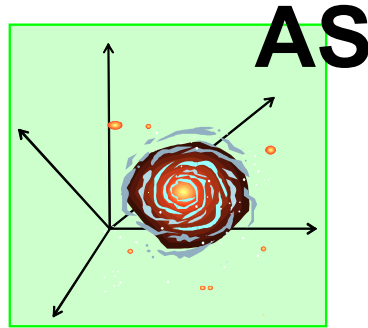
AS and GIS domains

- Historical and technological differences:

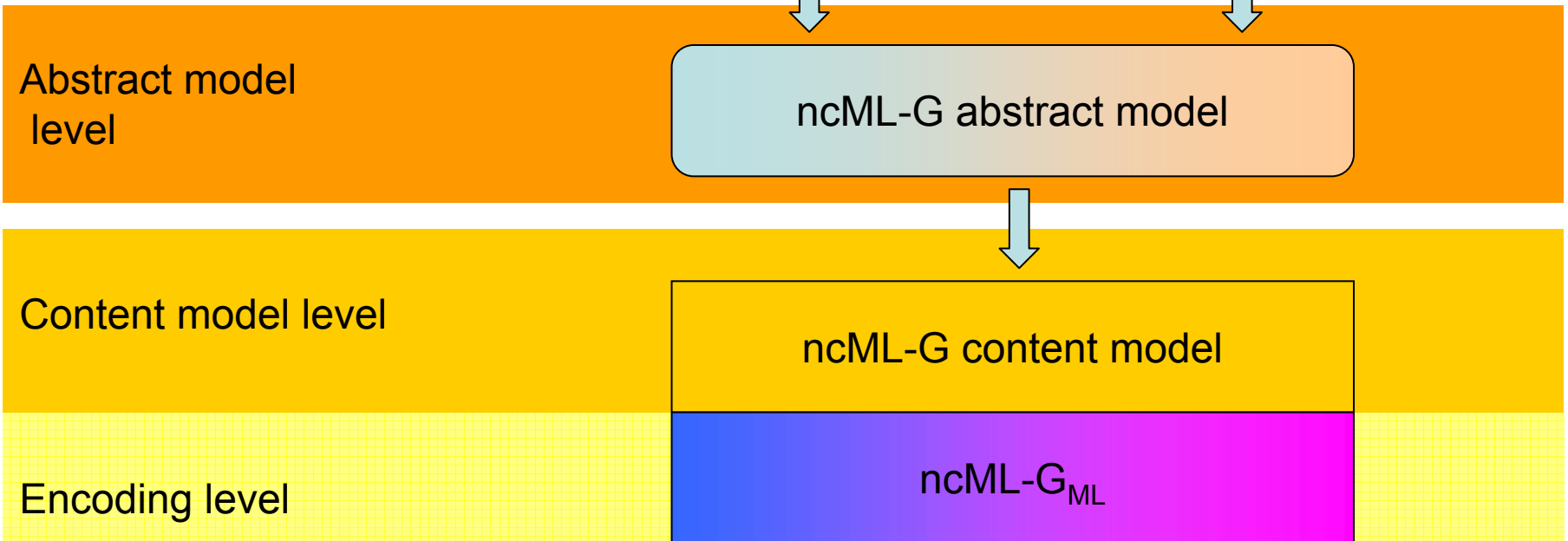
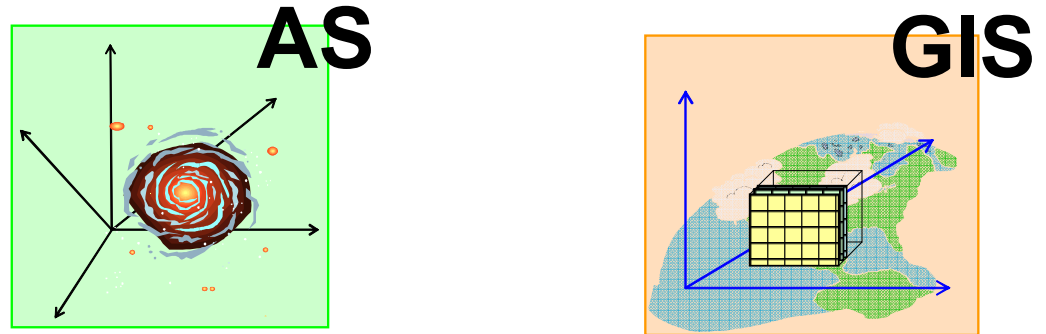


Focus on geo-location	Low (low resolution, intrinsic inaccuracy)	High (spatial queries support, high resolution)
Focus on temporal evolution	High (Temporal series support, high variance: seconds to centuries)	Low (low variance)
Data types	Multi-dimensional arrays (at least 3-D + time)	Topological features (usually 2-D geometry) referred to a geo-datum – special case: Coverage

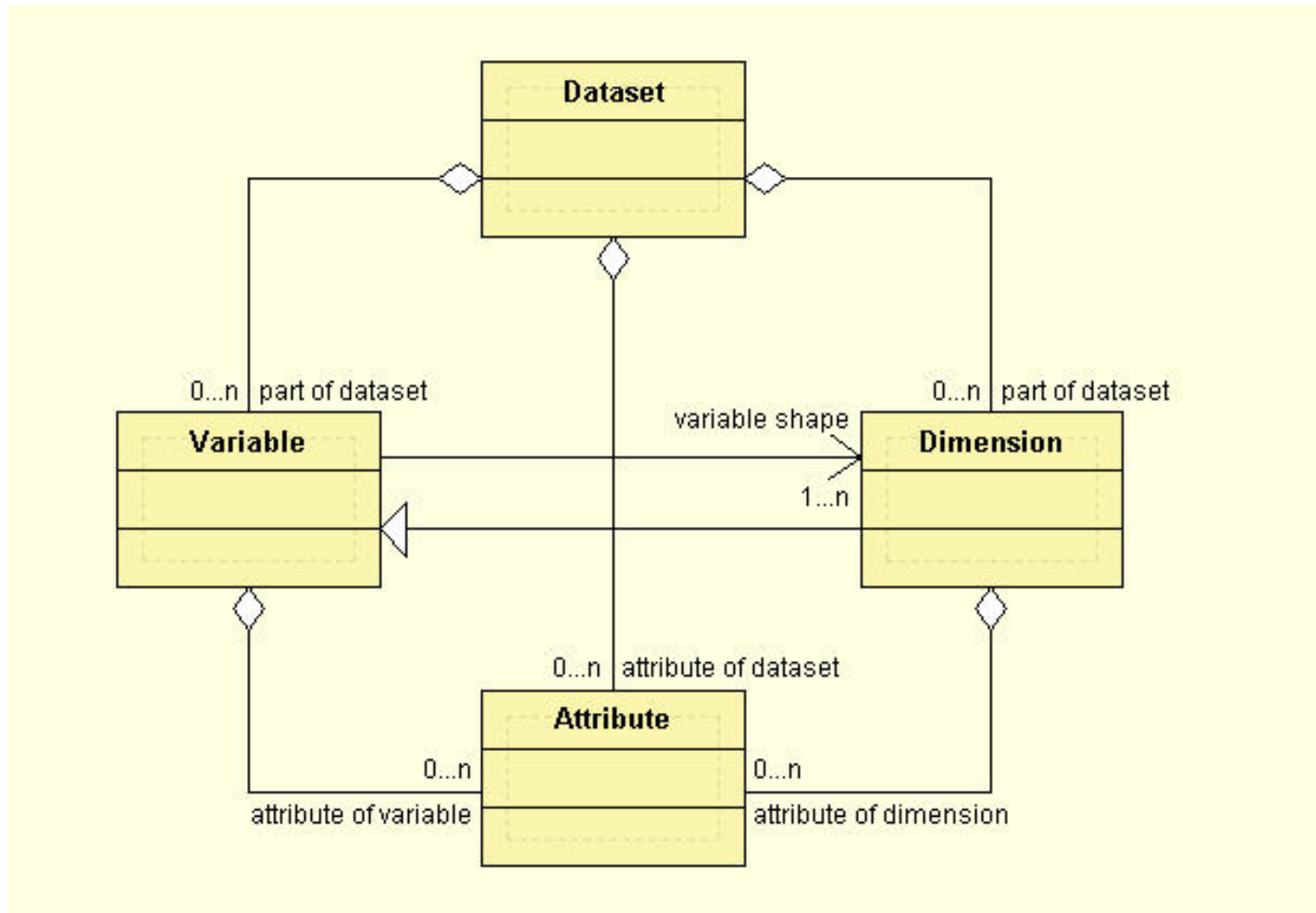
Interoperability issue



Proposed approach



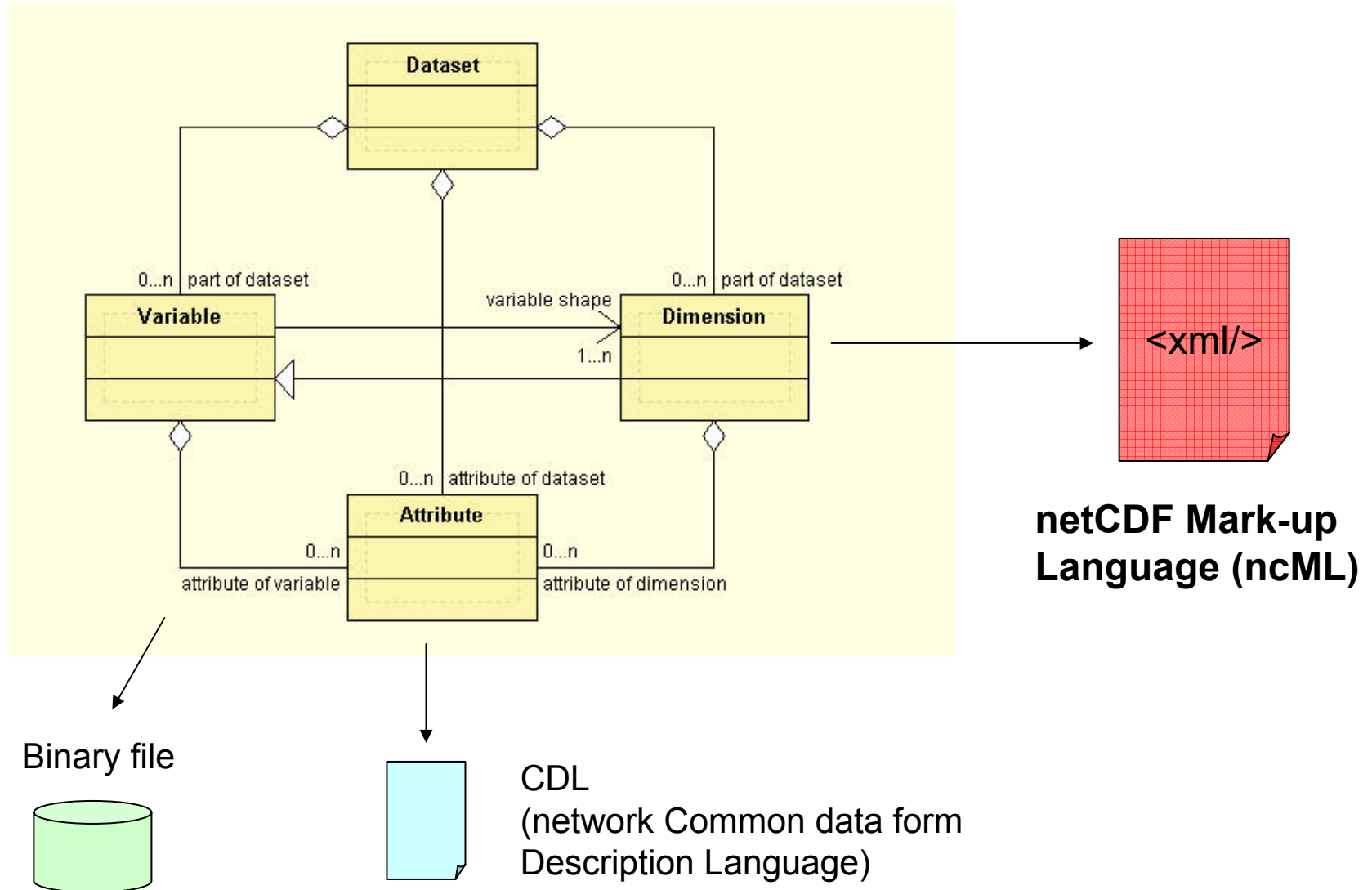
netCDF basic abstract model



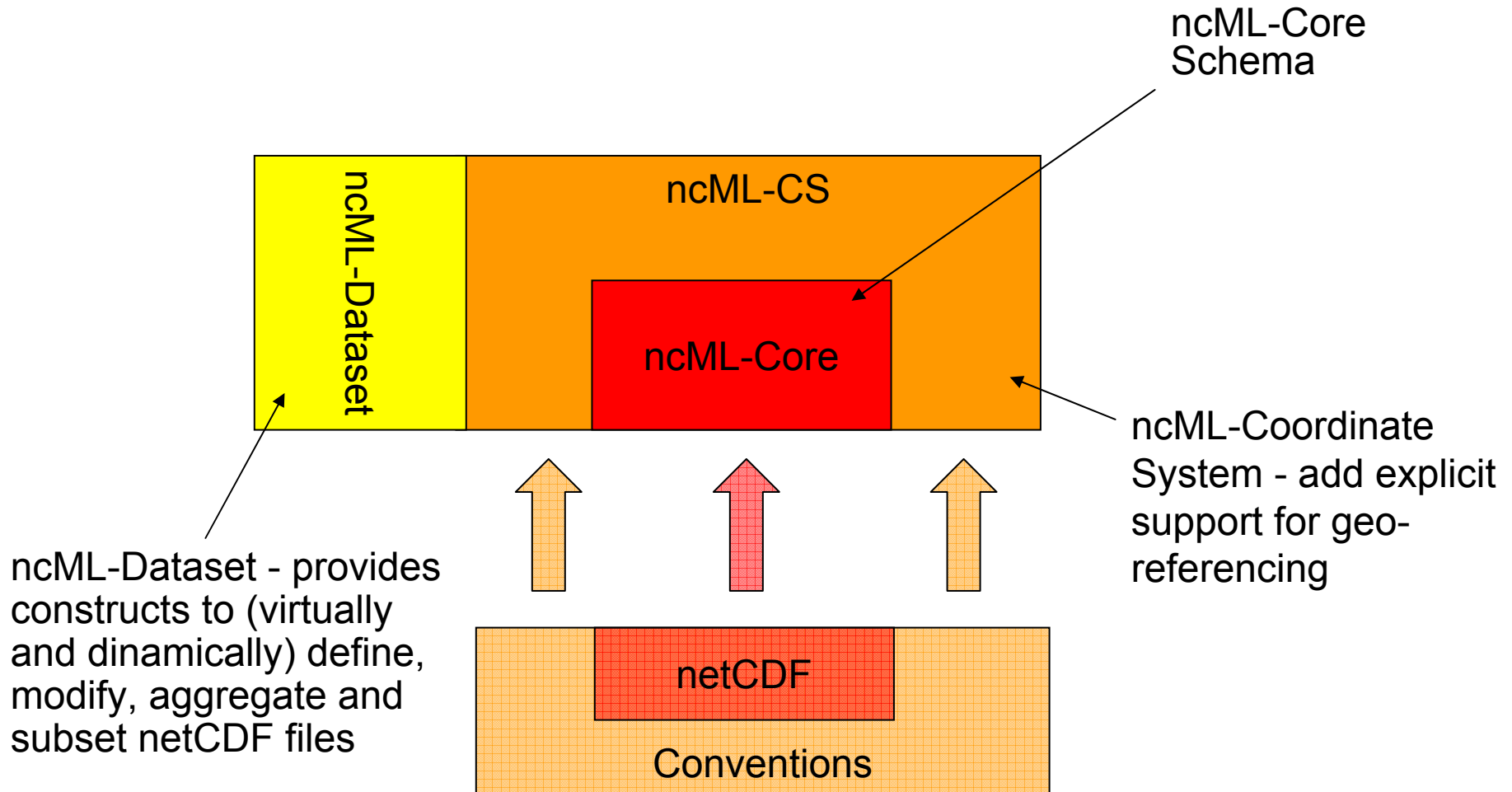
netCDF content models

- Conventions to support application-specific data and semantics, e.g.:
 - Climate and forecast (CF)
 - Cooperative Ocean/Atmosphere Research Data Service (COARDS)
 - Atmospheric data (netCDF Users Working Group/NUWG)
 - Oceanography
- netCDF Coordinate Conventions

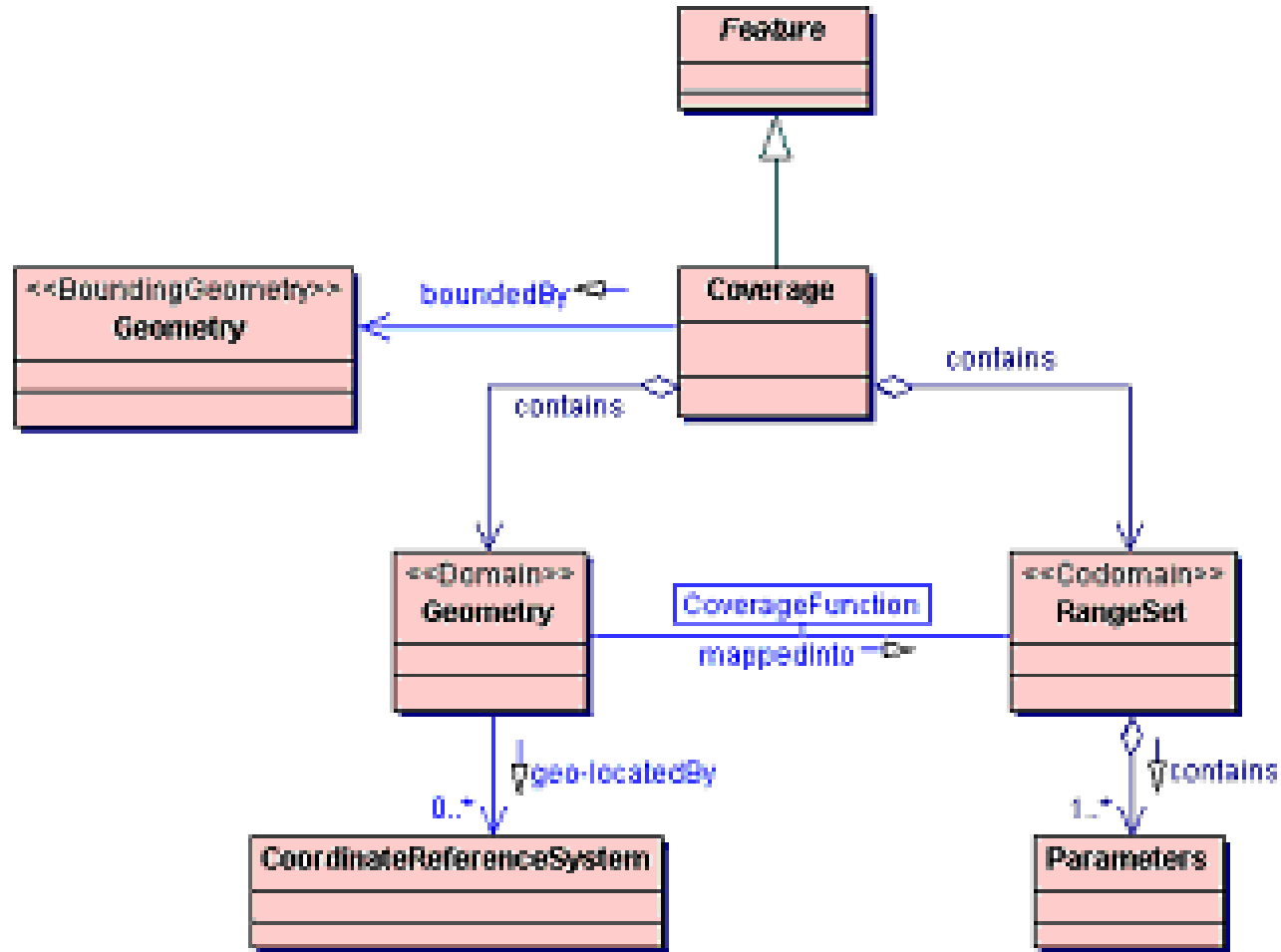
netCDF encodings



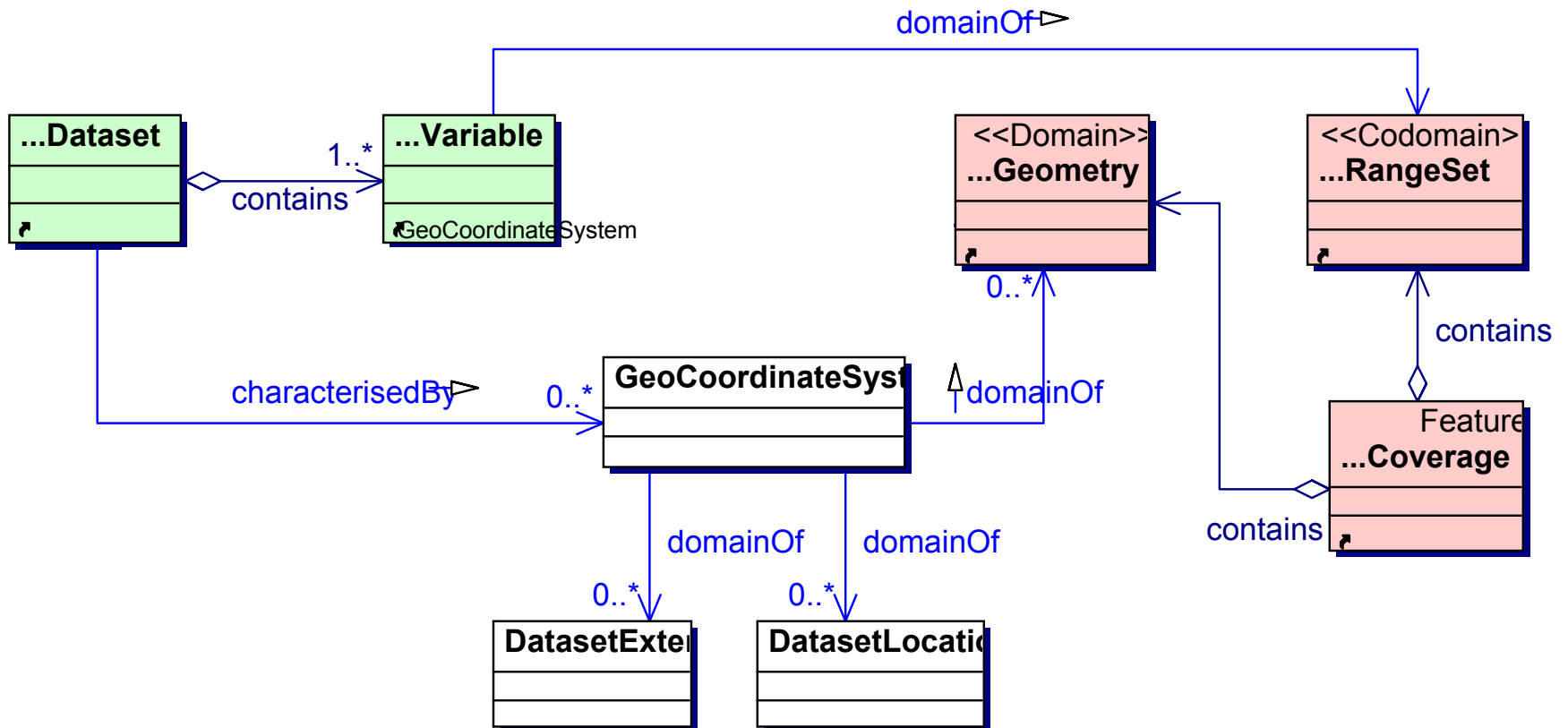
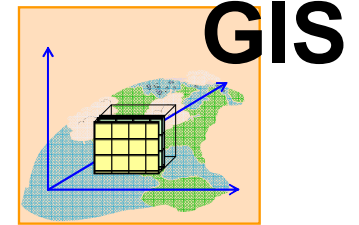
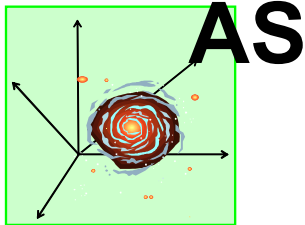
ncML schemas



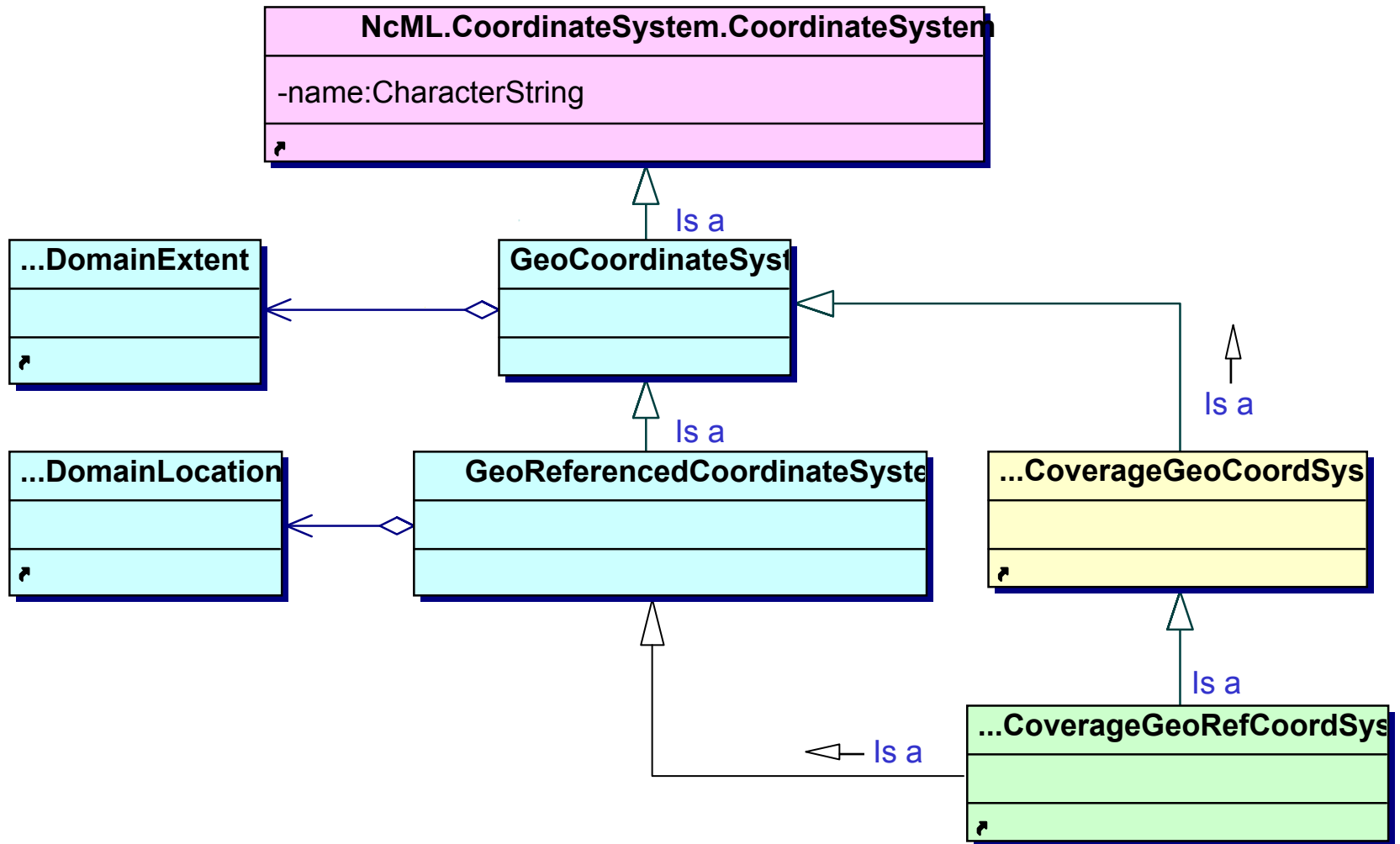
Coverage basic abstract model



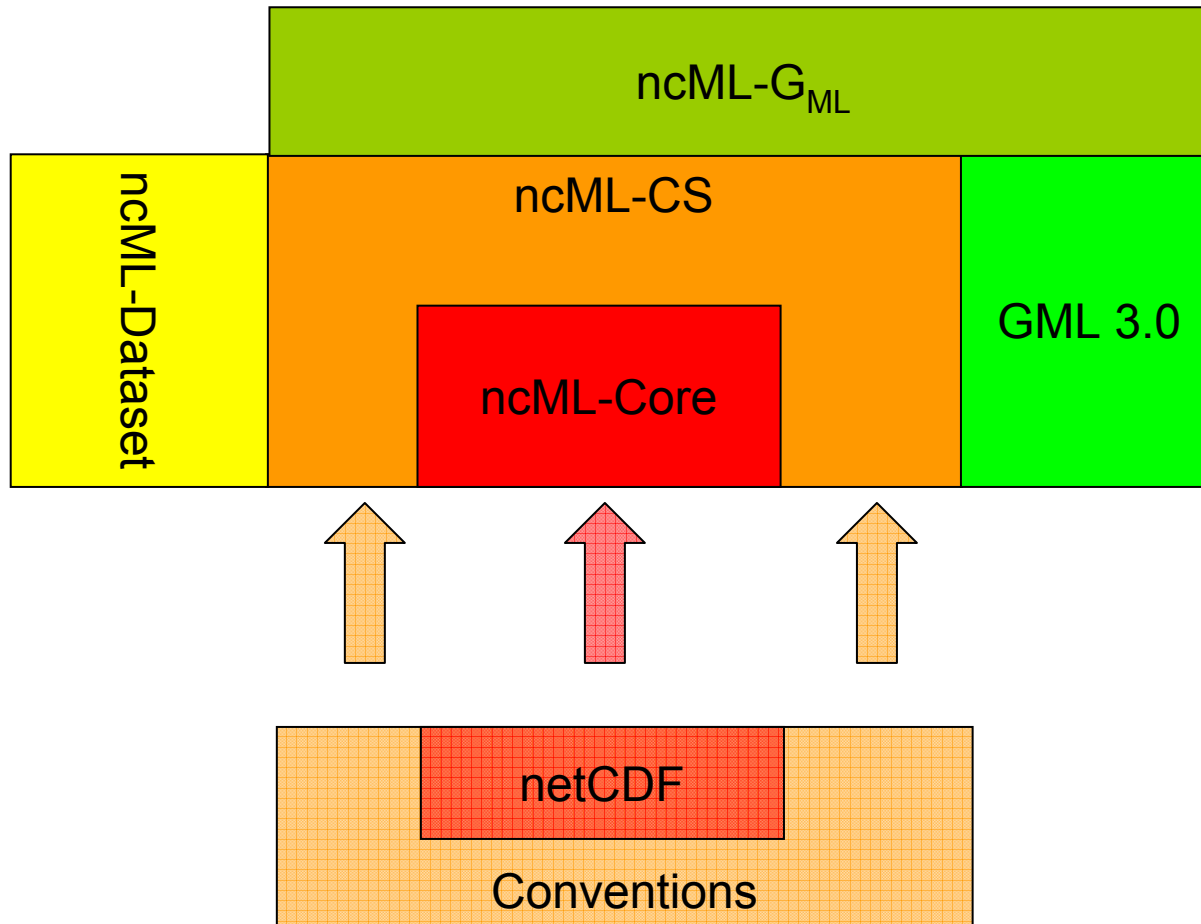
ncML-G abstract model



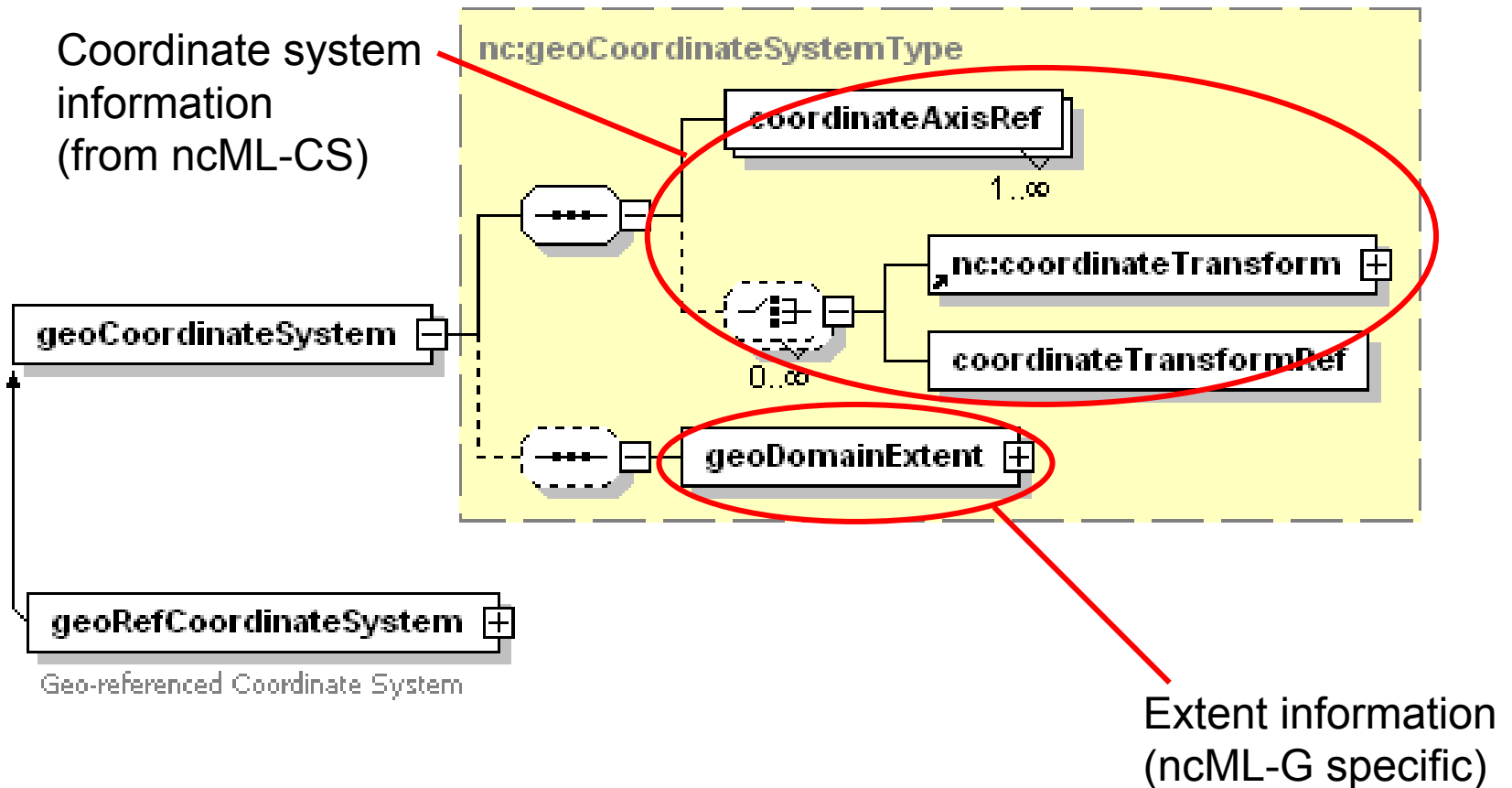
ncML-G content model



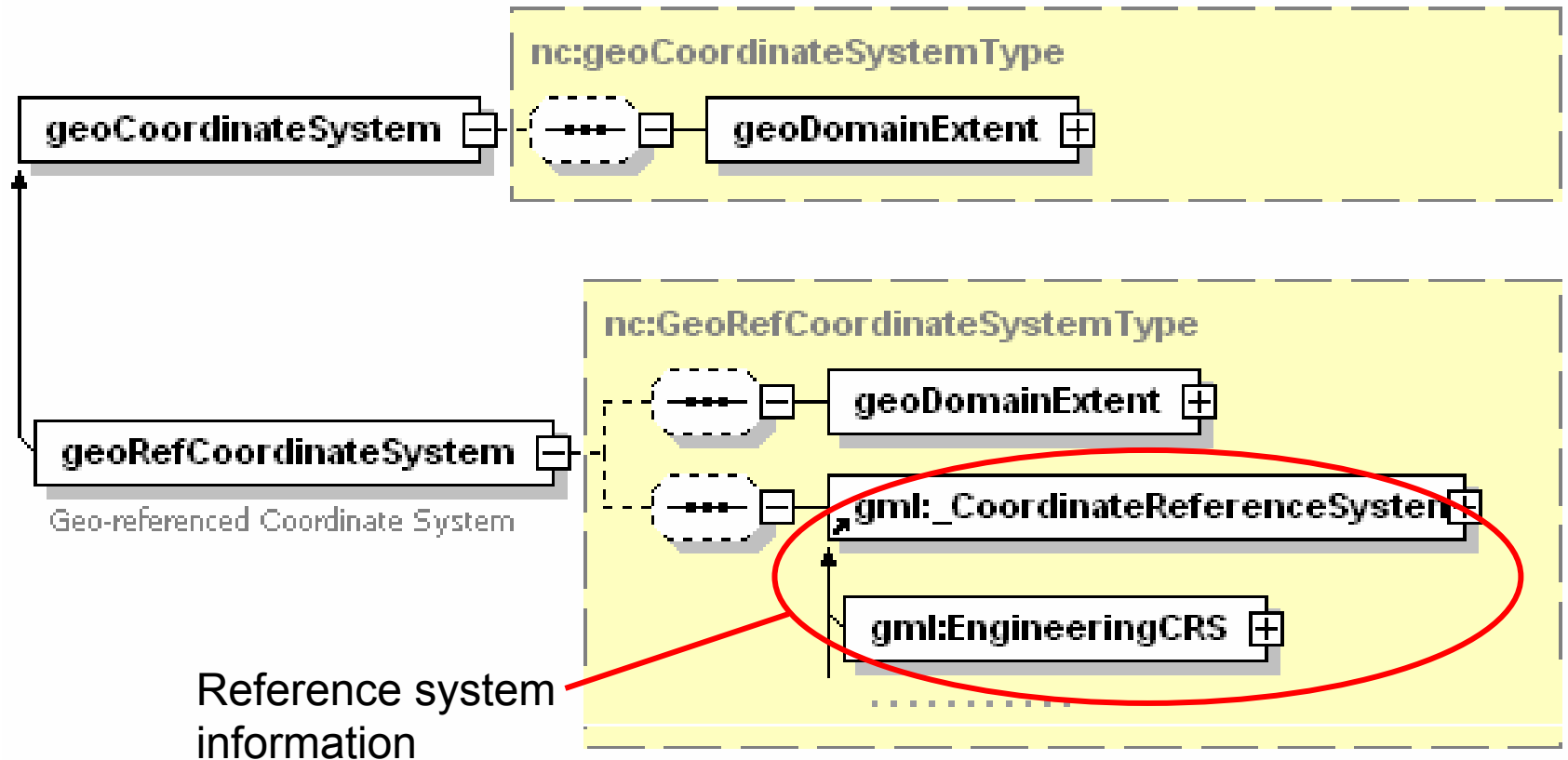
ncML-G_{ML} encoding



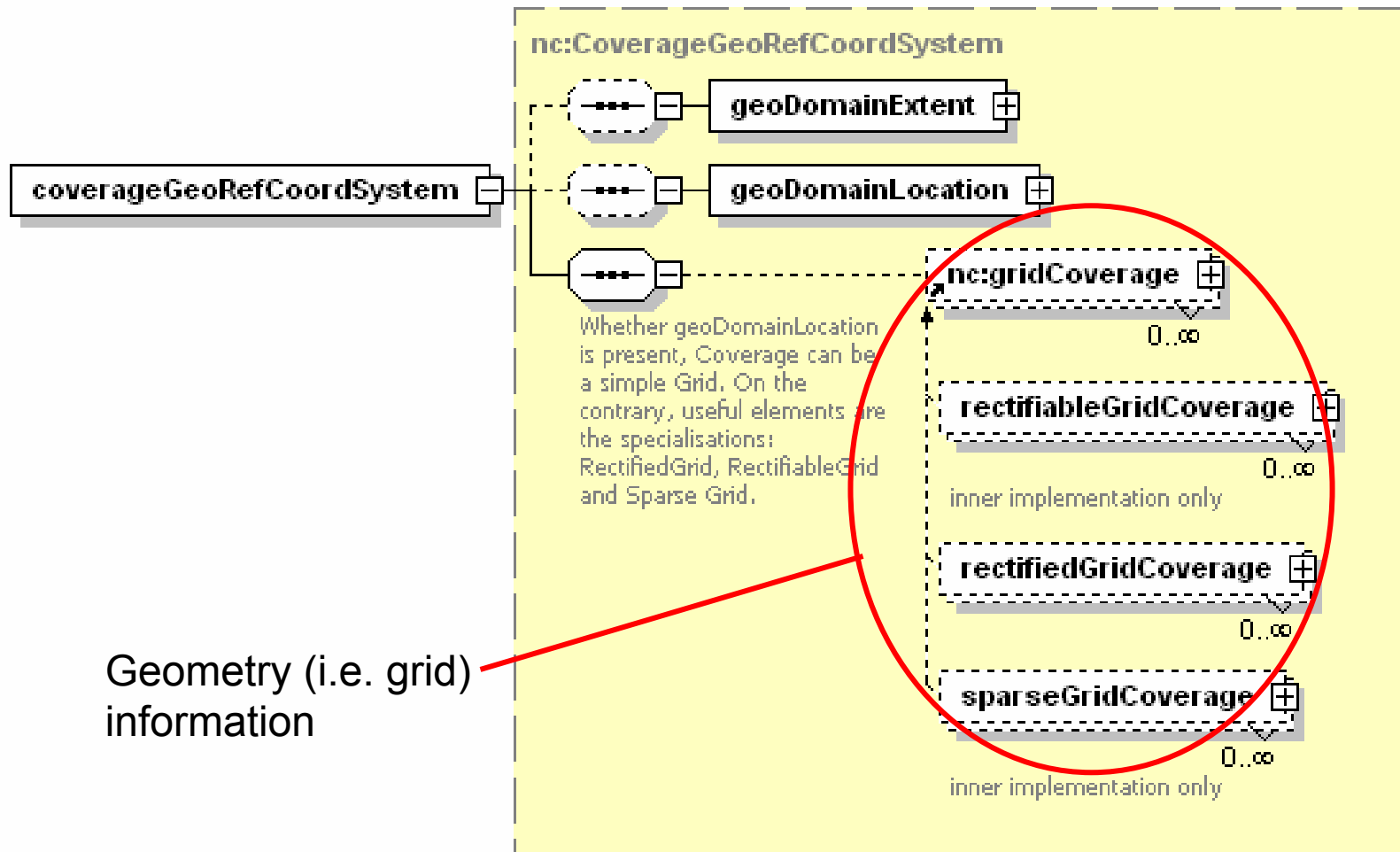
GeoCoordinateSystem



GeoRefCoordinateSystem



CoverageGeoRefCoordSystem



ncML-G_{ML} example

Example ncML document:

```
<netcdf xmlns="http://www.ucar.edu/schemas/netcdf"...>
```

dimensions

```
<dimension name="x" length="3"/>  
<dimension name="y" length="3"/>
```

coordinate
variables

```
<variable name="x" type="int">  
  <values separator=" ,">11.0,11.5,12.0</values>  
</variable>  
<variable name="y" type="int">  
  <values separator=" ,">44.0,44.5,45.0</values>  
</variable>
```

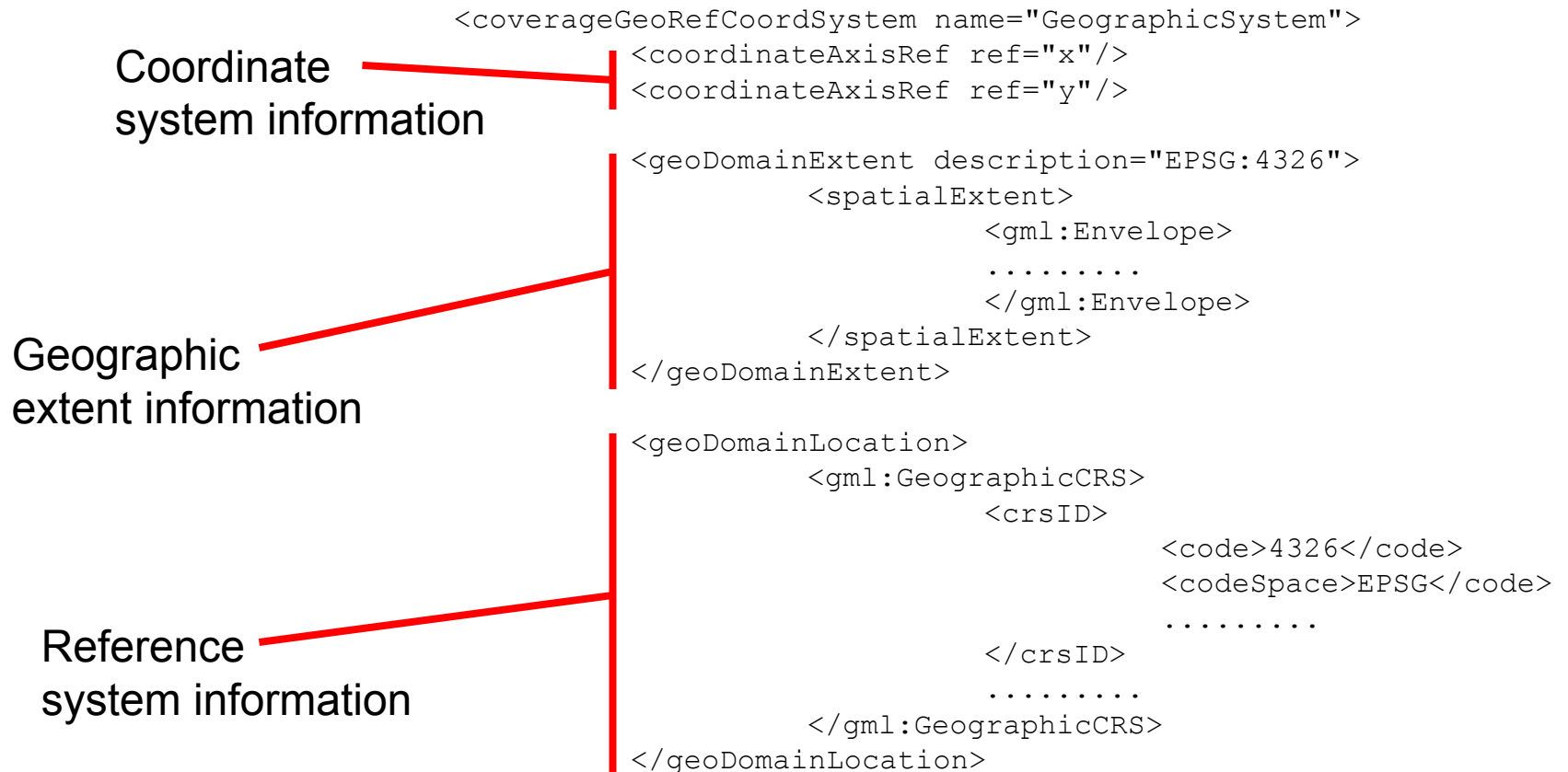
variables

```
<variable name="temperature" type="double" shape="x,y">  
  <values separator=",">237.6,258.7,260.2,276.3,  
    270.4,269.8,271.1,270.4,268.6  
</values>  
</variable>  
<variable name="WV" type="double" shape="x,y">  
  <values separator=",">4.6,4.7,5.2,  
    5.3,5.4,6.8,6.1,6.4,6.6  
</values>  
</variable>
```

```
</netcdf>
```

ncML-G_{ML} example

ncML-G_{ML} encoding:



ncML-G_{ML} example

ncML-G_{ML} encoding (continue):

Grid geometry
information

```
<gridCoverage>
  <grid dimension="2">
    <limits>
      <gridEnvelope>
        ....
      </gridEnvelope>
    </limits>
    <axisName>Longitude</axisName>
    <axisName>Latitude</axisName>
  </grid>
  <rangeValues>
    <rangeInfo>
      <values>
        <variable>temperature</variable>
        <variable>WV</variable>
      </values>
    </rangeInfo>
  </rangeValues>
</gridCoverage>
```

Pointers to ncML *variable* elements
(ncML explicitly manages value collections).
It is conceivable to resort to GML ValueCollection elements.

Current status

- Current implementation version:
 - ncML specification rel. 1.0
 - ncML-CS specification rel. 1.0 beta
 - ncML-G_{ML} specification rel. 0.2
- Reference implementations in the netCDF java library, version 2.1

Useful links

- THREDDS homepage
<http://my.unidata.ucar.edu/content/projects/THREDDS>
- ncML homepage
<http://my.unidata.ucar.edu/content/software/netcdf/ncml/index.html>
- S. Nativi, J. Caron, E. Davis and B. Domenico - NetCDF Markup Language (NcML) and its GML-based extension (NcML-G_{ML}) [submitted to Computers & Geosciences Journal]
<http://my.unidata.ucar.edu/content/projects/THREDDS/BenStuff/Documents/NcMLPaper9June2004.htm>
- S. Nativi et al. - Differences among the data models used by the Geographic Information Systems and Atmospheric Science communities
<http://ams.confex.com/ams/pdfpapers/73229.pdf>
- J. Caron, S. Nativi - NetCDF into GIS: the good, the bad, and the ugly
<http://ams.confex.com/ams/pdfpapers/72459.pdf>

Conclusions

- We have introduced:
 - **ncML**, an XML encoding of netCDF
 - **ncML-G**, an extension to netCDF abstract model to accommodate reference systems and ISO/OGC Coverage
 - **ncML-G_{ML}**, an encoding of ncML-G exploiting GML
- **ncML-G_{ML}** is a valuable example of scientific mark-up language for interoperability, useful for integrating AS and GIS community