UNIDATA/UCAR
THE THREDDS PROJECT

THE THREDDS WCS SERVICE

WEB SERVICES TECHNOLOGY FOR INTEROPERABILITY BETWEEN ATMOSPHERIC SCIENCE AND GIS COMMUNITIES

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RATIONALE

WHY WE DID THAT

There is an ongoing process of integration among heterogeneous sectors and Communities of the Society. This integration process will entail Atmospheric Science Communities to be able to speak a "jargon" understandable by Society's heterogeneous applications in order to share results and data in an effective way.

Such scenario widens the actual User Community of Atmospheric Science; new users are going to utilise Atmospheric Science datasets, in order to fulfil Society's need of complex Decision Support Systems (DSS).

Such process is technologically driven, because technology made it possible and has been driving interoperability solutions. Such process has been pushed by:

- The pervasive nature of present Communications networks (wired and wireless);
- The importance of Information in our Society;
- The increasing resolution and availability of remotely-sensed data

GIS Community -and more generally Geo-Information Community- plays a key role to establish this connection between the Atmospheric Science Community and the Society.

THE THREDDS WCS

In the framework of the THREDDS project a **WCS interface to the UNIDATA/UCAR legacy systems** has been implemented.

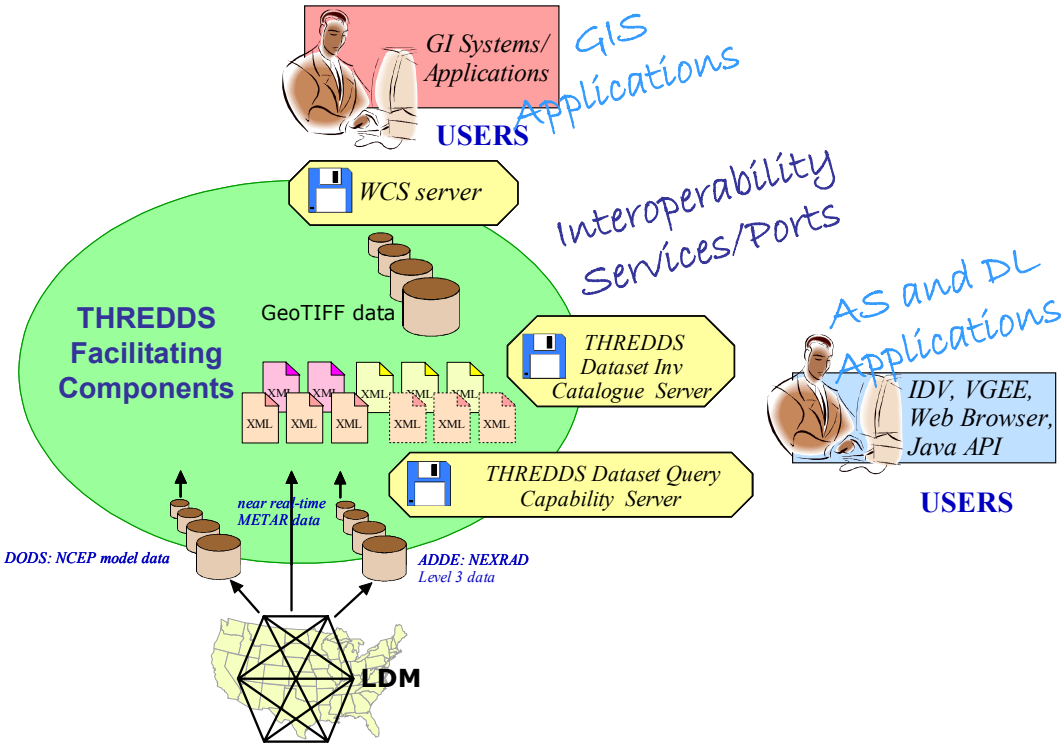
In particular, the version 0.7 of WCS specification was implemented.

WCS interface is one of the interfaces/services that THREDDS has been developing in order to support:

1. Interoperability among Atmospheric Research Applications;
2. Interoperability between the Atmospheric Research Community and the Society.

WCS service, in particular, fits in the second objectives.

The following picture depicts the present interoperability architecture of THREDDS.



THREDDS Interoperability services/ports

INFORMATION VIEW

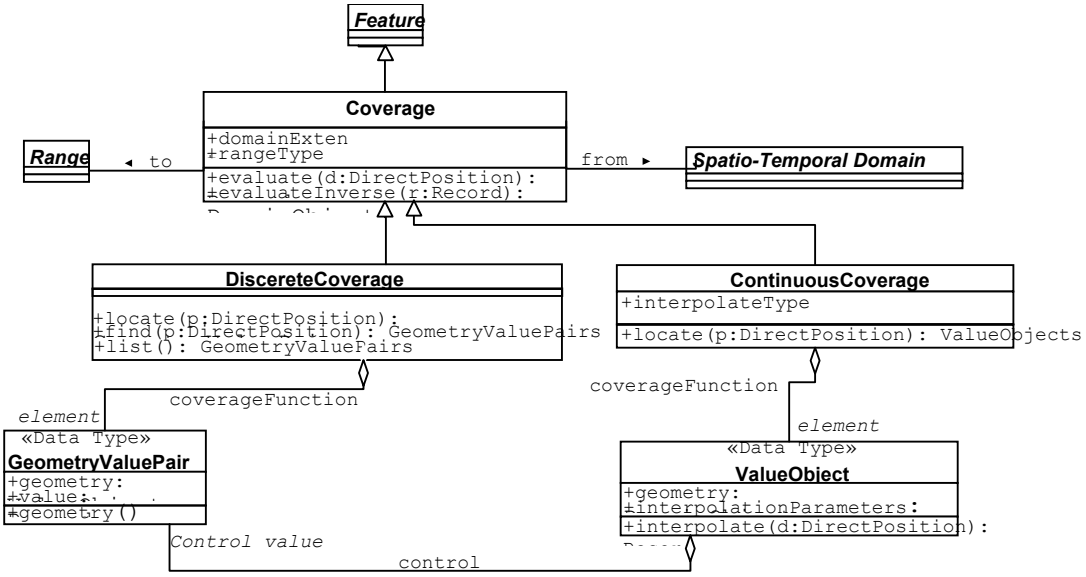
DATA MODELS

The following main data models have been considered for GIS and Atmospheric Science realms, respectively:

- GIS realm
  1. The abstract OGC Image and Gridded Coverage model;
  2. The WCS content and encoding model;
  3. GeoTIFF encoding model.
- Atmospheric Science realm
  4. The NetCDF with convention abstract data model;
  5. The NcML and its extensions content and encoding data model;
  6. THREDDS Inventory Catalogue content and encoding model.

THE ABSTRACT OGC IMAGE AND GRIDDED COVERAGE MODEL

The following figure depicts the OGC/ISO abstract model for coverage concept.



COVERAGE maps from a Spatio-temporal Domain to Feature attribute values.

Coverage is defined as:

> *feature that acts as a function to return one or more feature attribute values for any direct position within its spatiotemporal domain*

Examples include a raster image, polygon overlay, or digital elevation matrix.

A SPATIO-TEMPORAL DOMAIN consists of a collection of direct positions in a coordinate space.

CONTINUOUS COVERAGE is a Coverage that returns different values for the same feature attribute at different direct positions within a single Geometric Object in its Spatio-temporal Domain

DISCRETE COVERAGE is a Coverage that returns the same feature attribute values for every direct position within any single Geometric Object in its Spatio-temporal Domain.

GEOMETRIC OBJECT is a spatial object representing a set of direct positions.

A GRID COVERAGE is a specific case of coverage in which a set of grid values covers the surface. Examples of a grid coverage are satellite images, digital elevation models, and digital orthophotos.

THE WCS CONTENT AND ENCODING MODEL

The present version of WCS supports "simple" coverages: regular, rectangular grid or tasselation space.

For a complete description of the WCS data model, please see references.

THE GEOTIFF ENCODING MODEL

To complete

THE NETCDF WITH CONVENTIONS ABSTRACT DATA MODEL

To complete

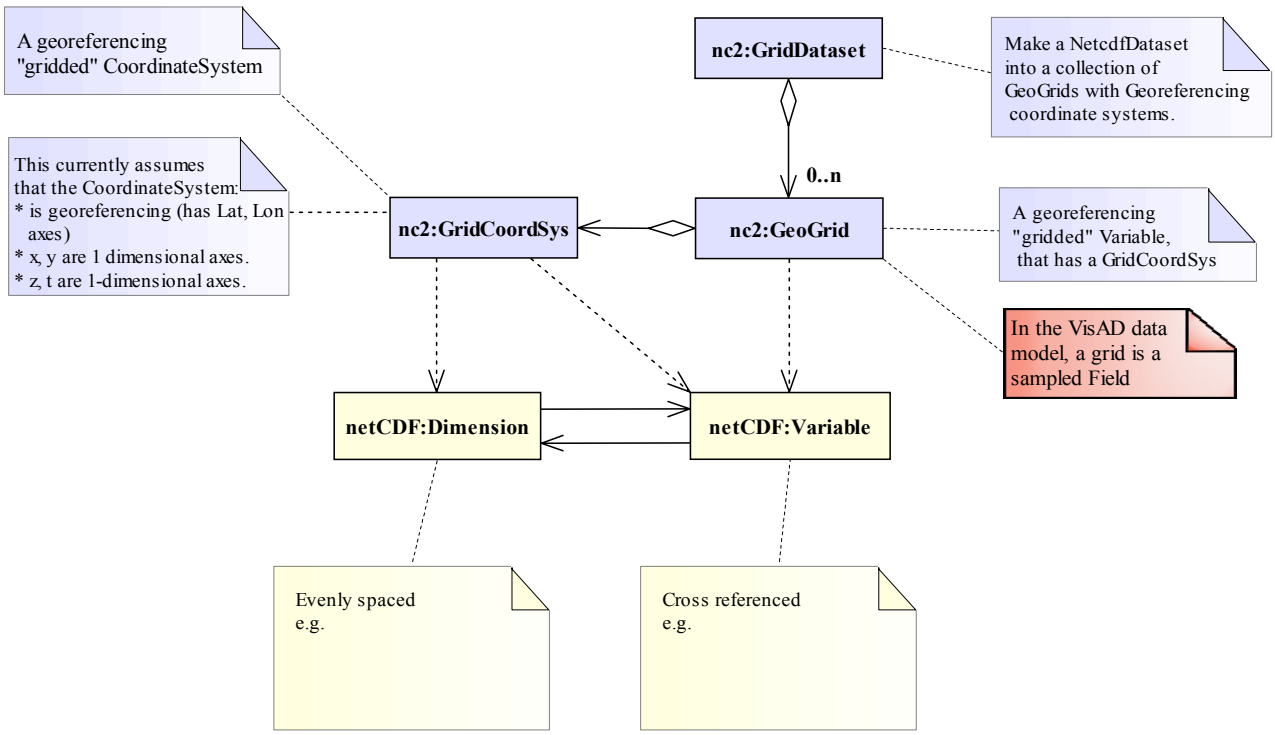


Fig 6: NetCDF plus conventions package model

THE NCML MODEL

Core Model

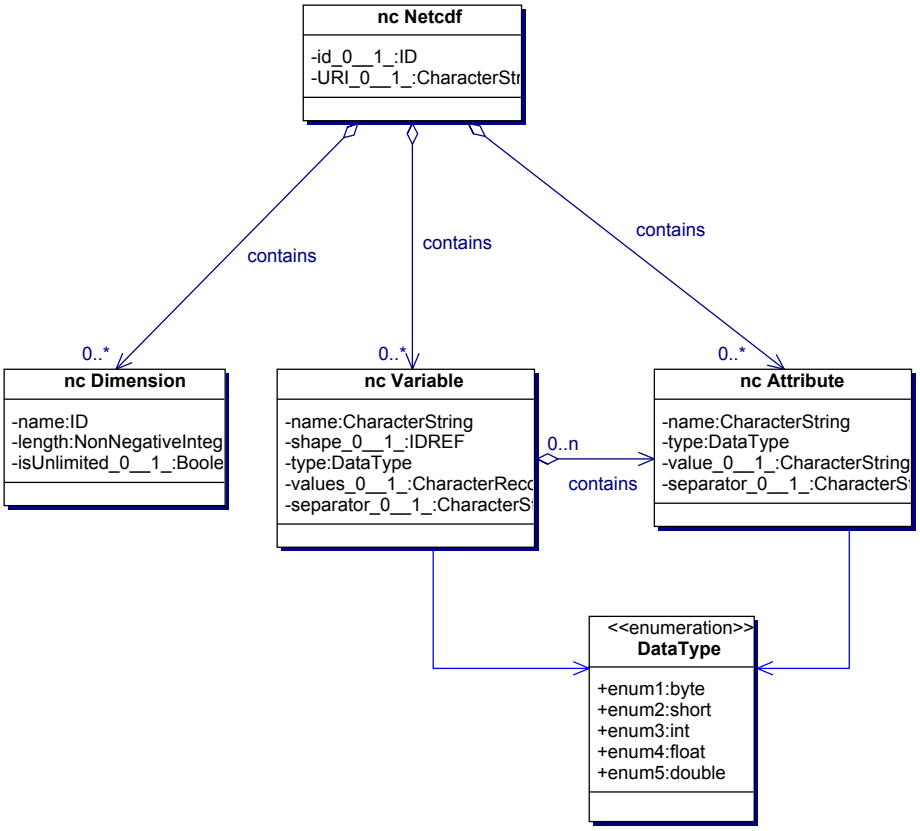


Figure 4: NcML Core Specification Model

Coordinate System Extension (NcML-CS) Model

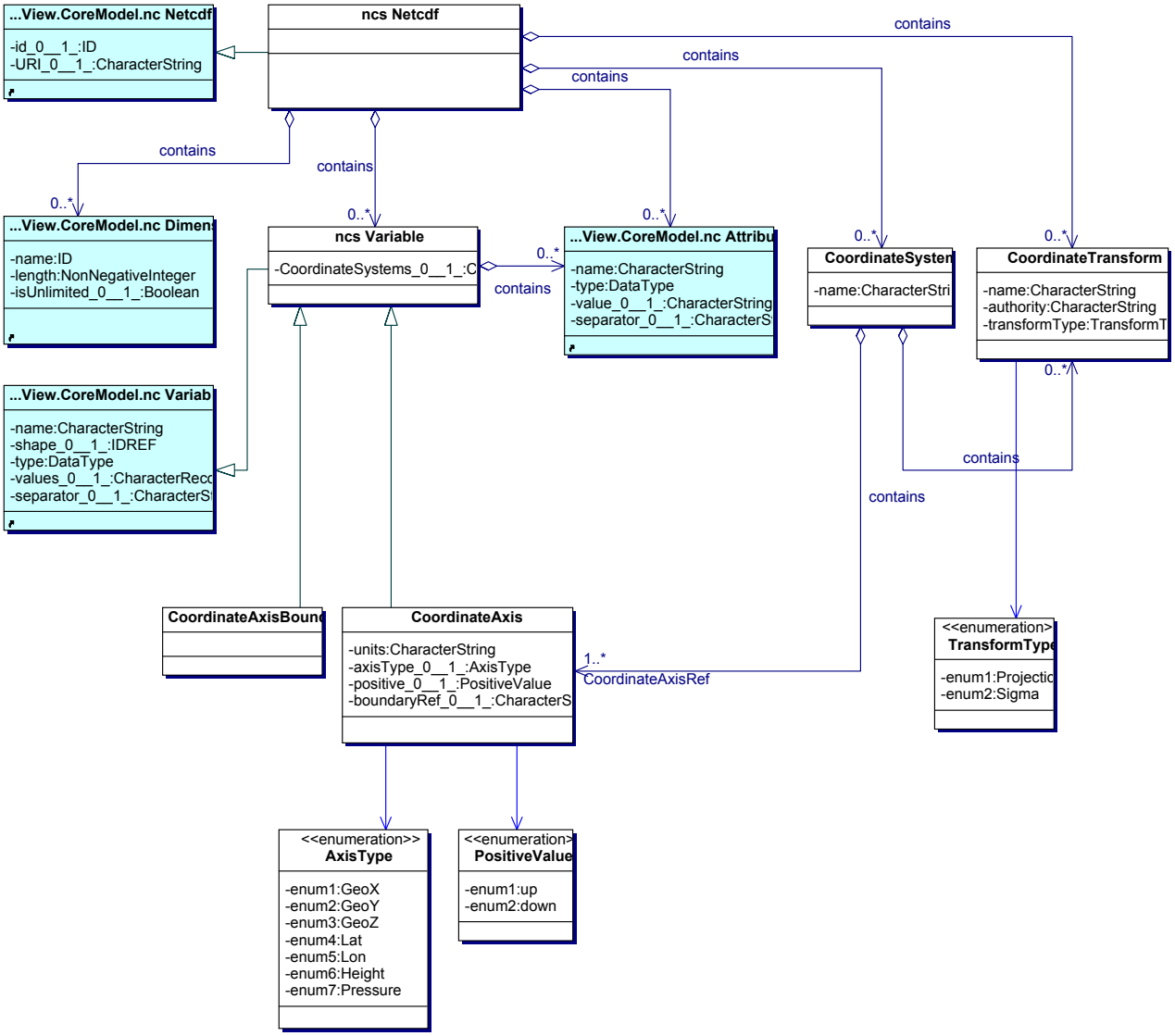
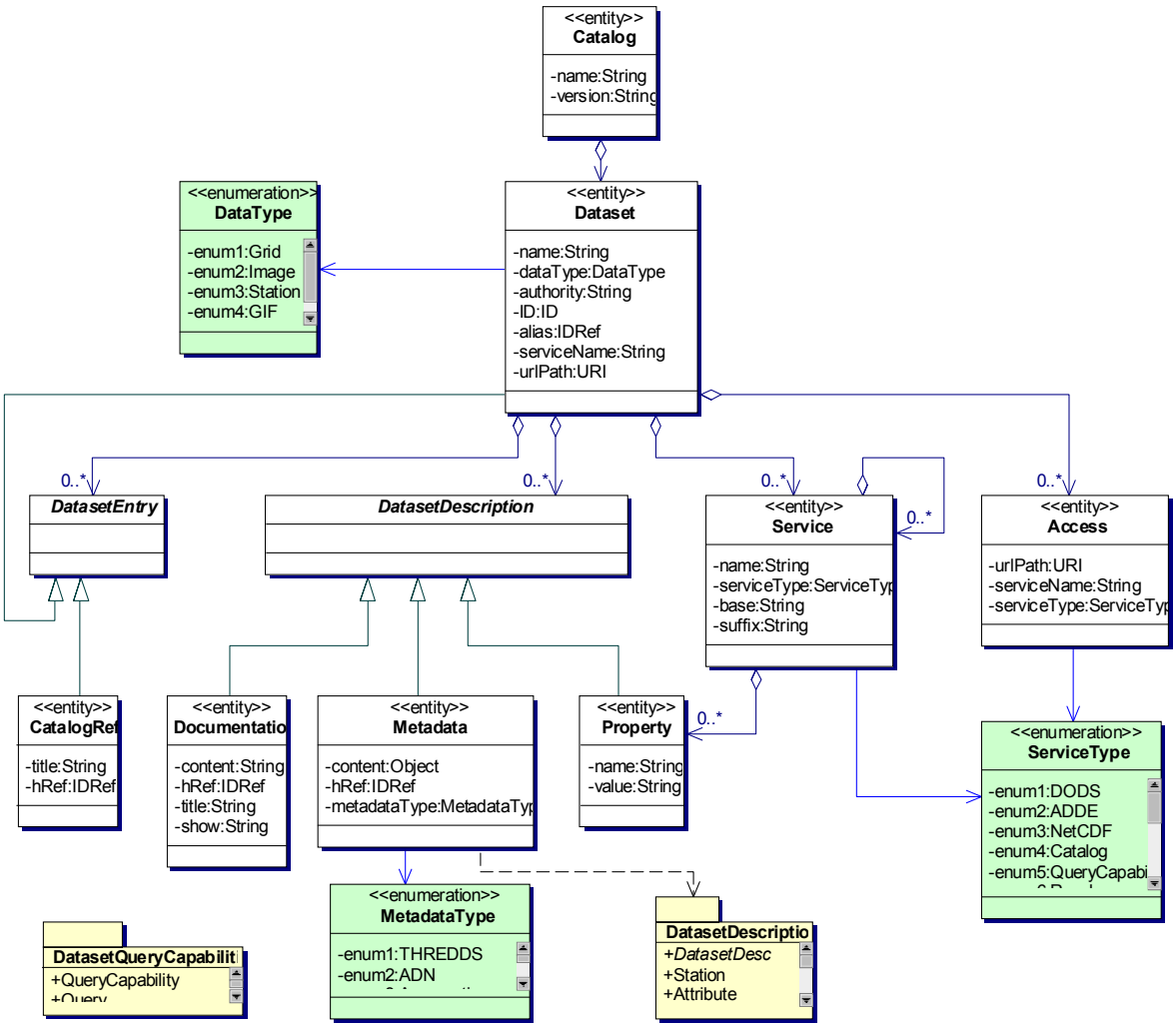
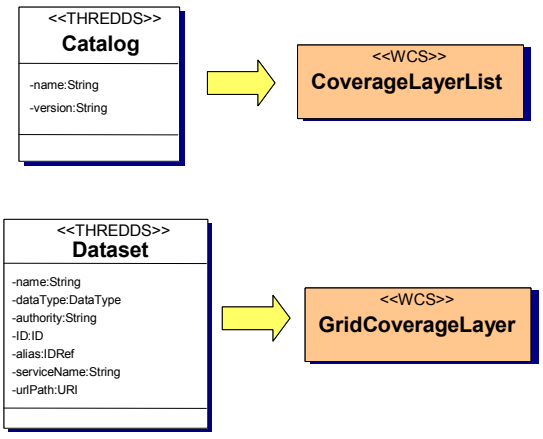


Figure 5 NcML Coordinate System specification model



MODELS MAPPING



THREDDS Inventory Catalogue model to WCS model

NC AND WCS MODELS MAPPING

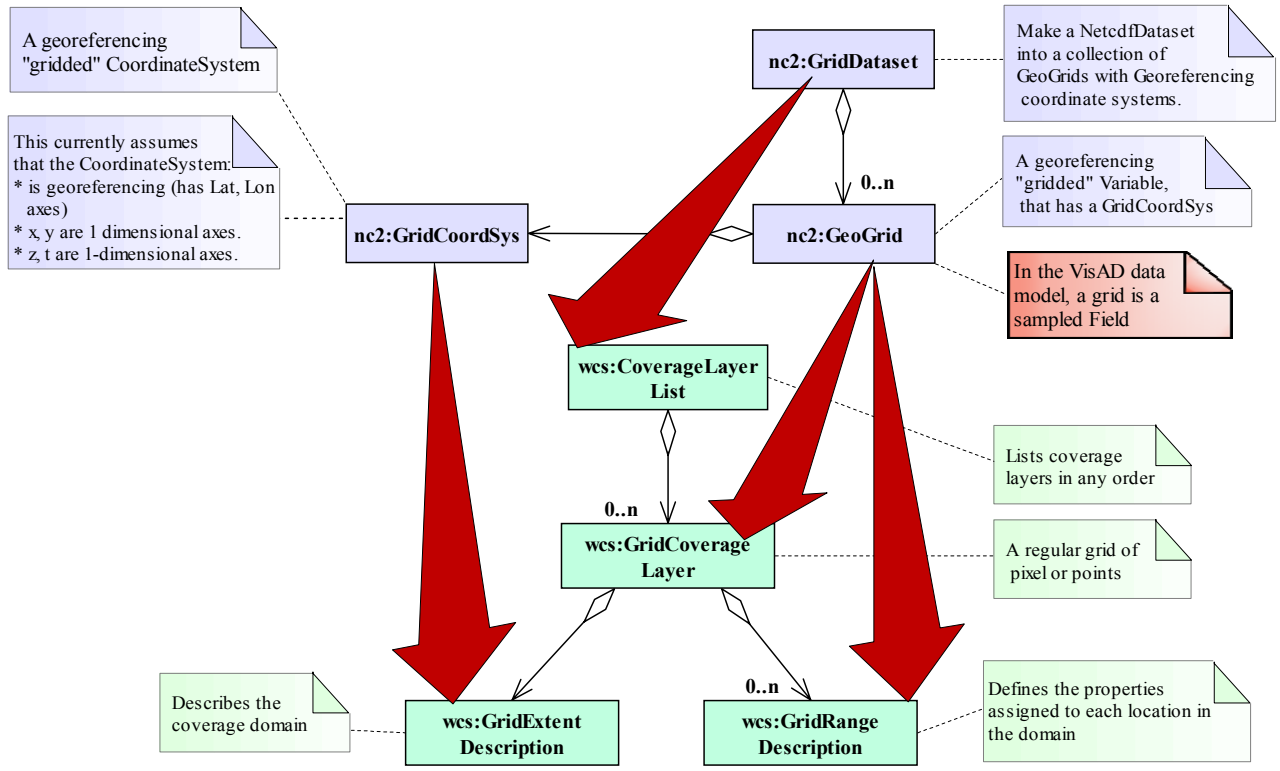
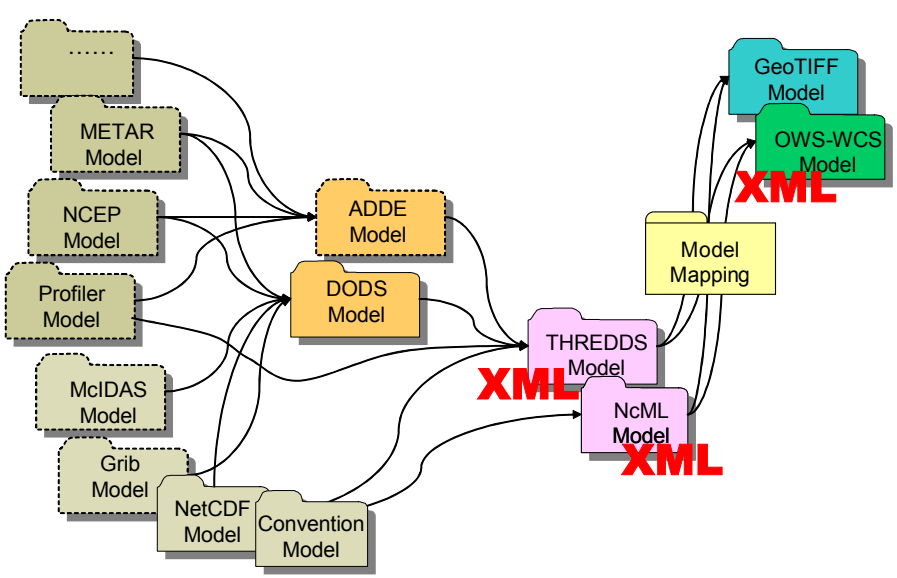


Fig 7: Mapping of NetCDF plus conventions model to WCS model

DATA MODEL ARCHITECTURE



Present Information Architecture

Dashed line packages represents model that are not yet supported, but are considered to be in future.

IMPLEMENTATION ARCHITECTURE

PRESENT SOLUTION

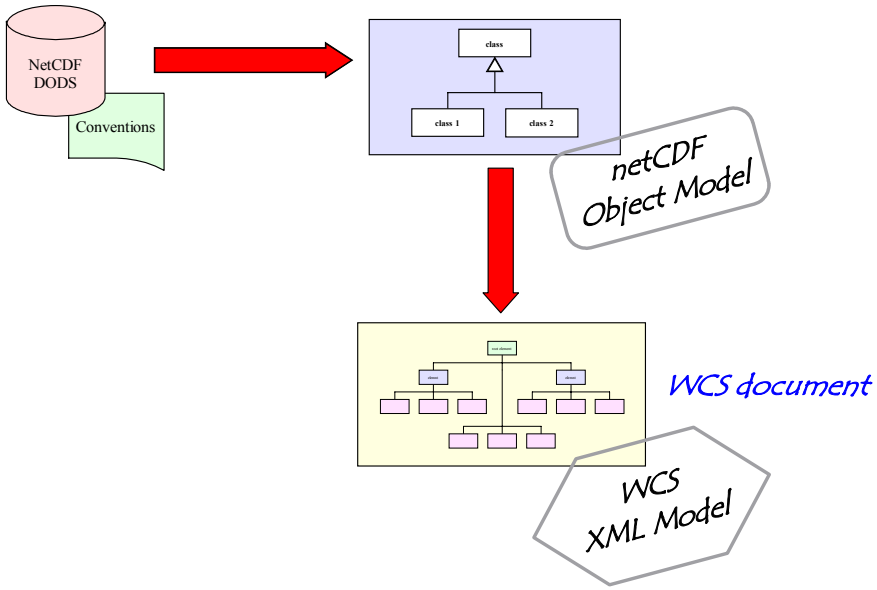


Figure 2: Information view

A MORE LOOSELY-COUPLED SOLUTION

In future a more loosely-coupled solution will be investigated and hopefully developed. It is depicted in the following figure.

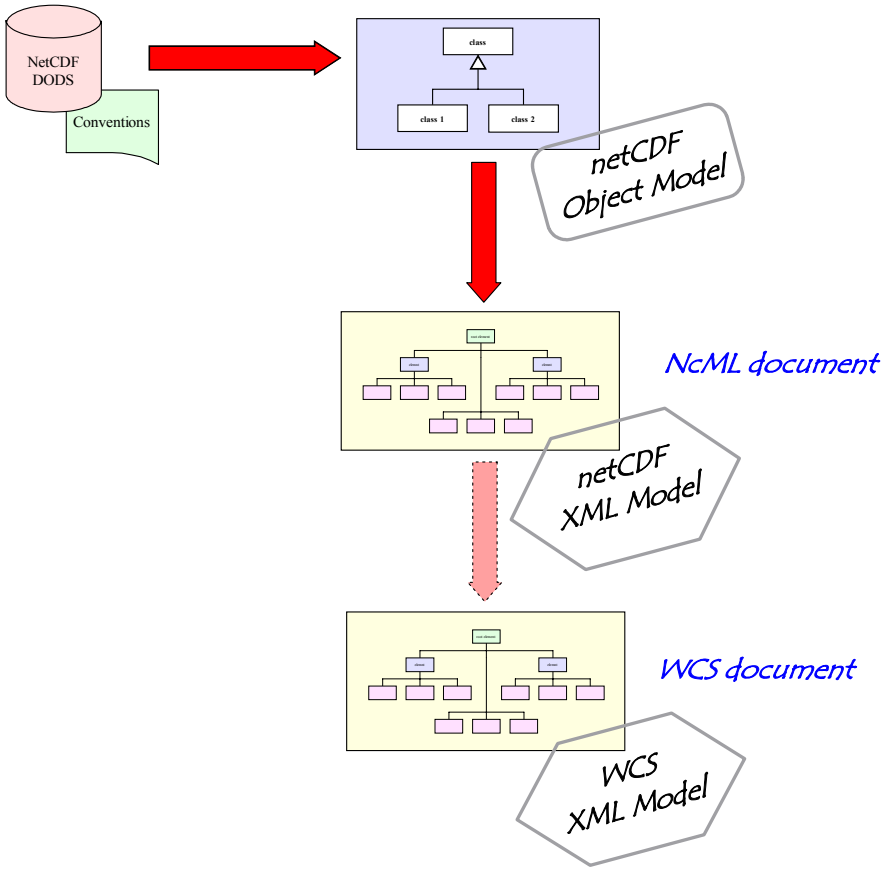
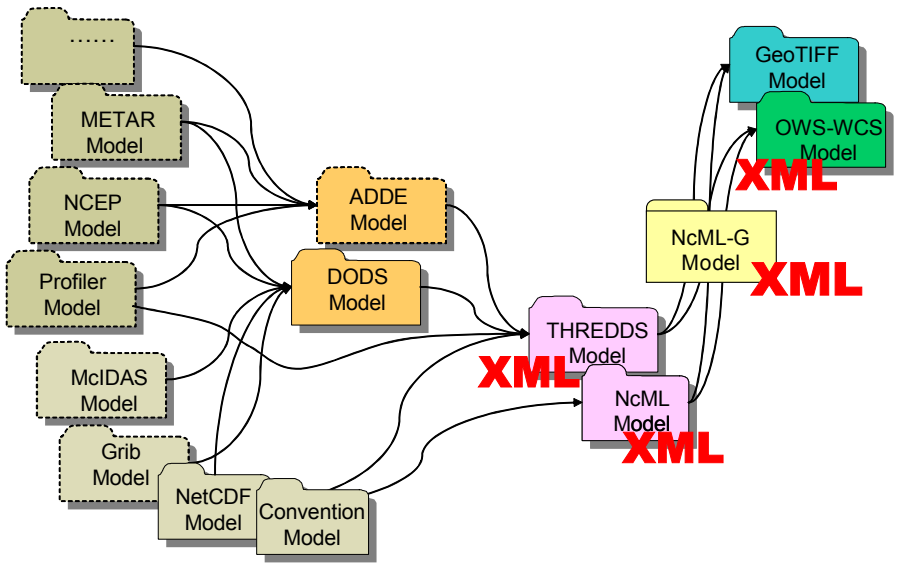


Figure 3: Loosely-coupled Information view

FUTURE INFORMATION ARCHITECTURE



Future Information Architecture

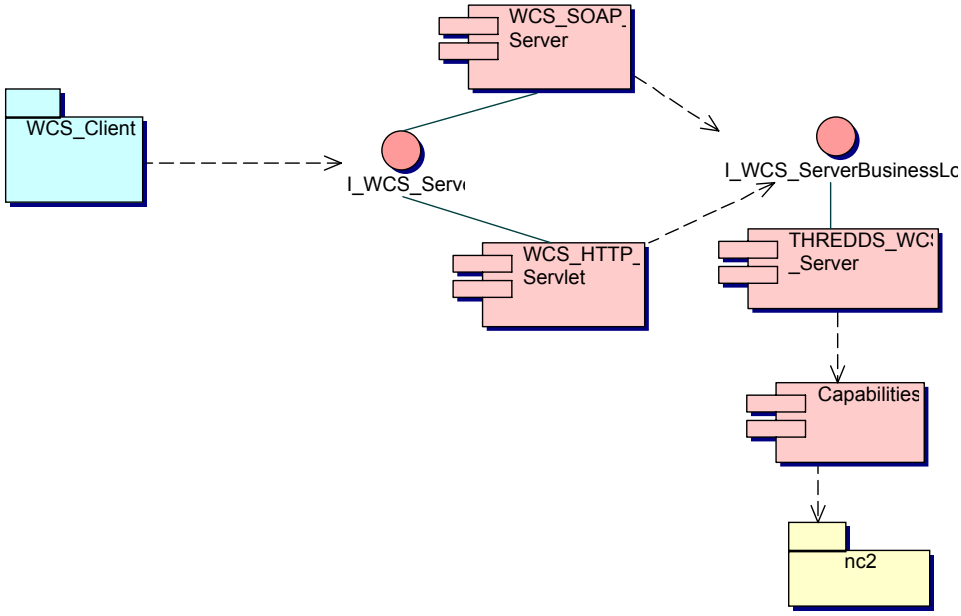
THE NCML-G MODEL

Presently, a proposal for providing NcML with a GIS extension -named NcML-G- is under discussion inside the NcML Specification Group (see references).

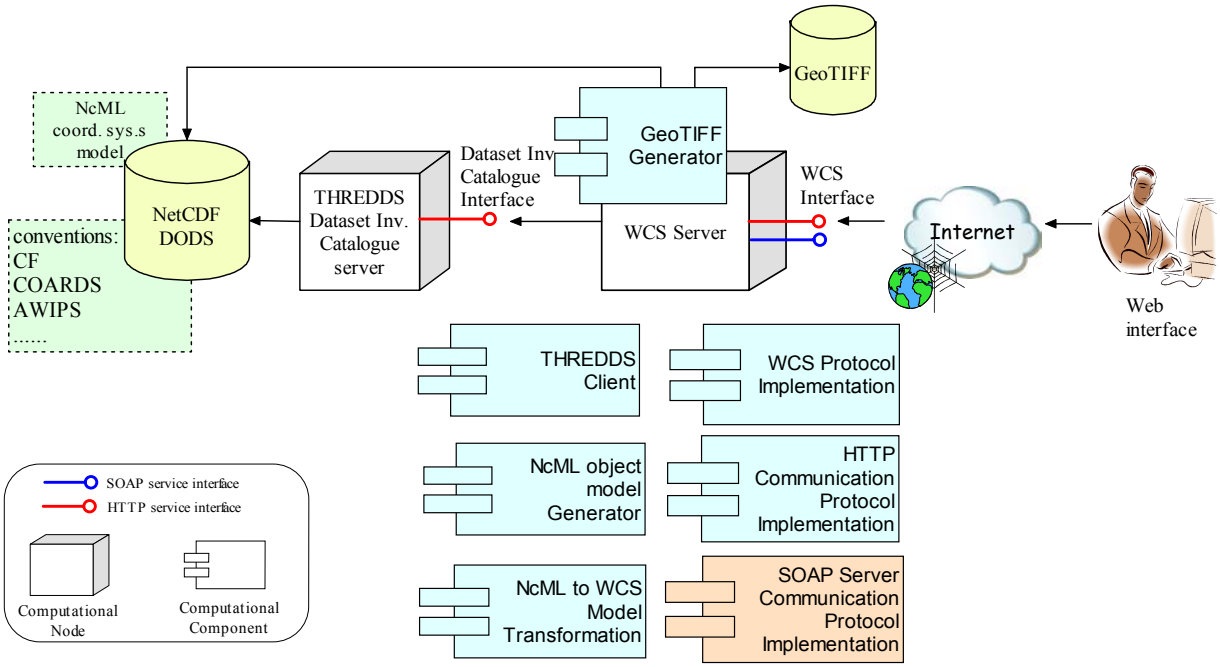
COMPUTATIONAL VIEW

IMPLEMENTATION ARCHITECTURE

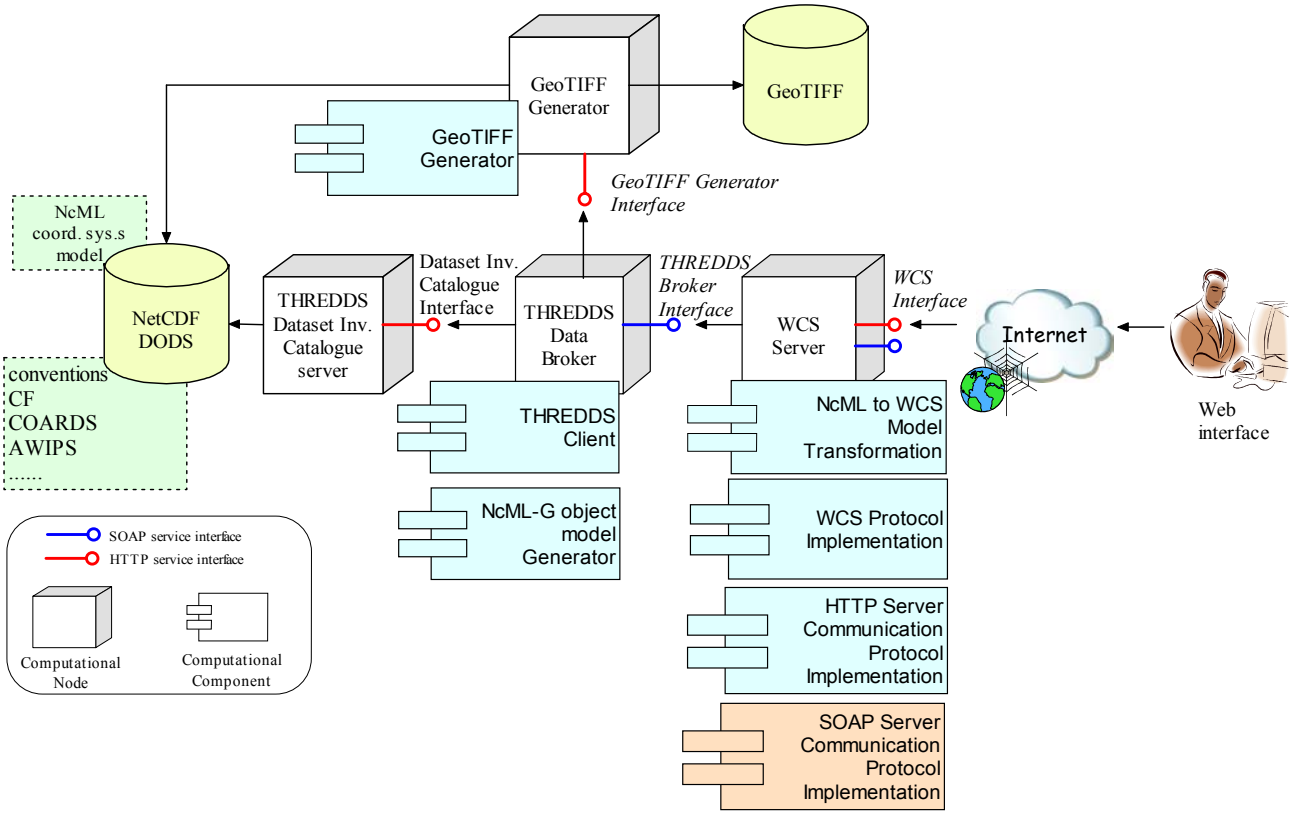
GENERAL VIEW



PRESENT IMPLEMENTATION



A MORE LOOSELY-COUPLED SOLUTION



In particular, the THREDDS Broker Interface returns a valid NcML-G document.

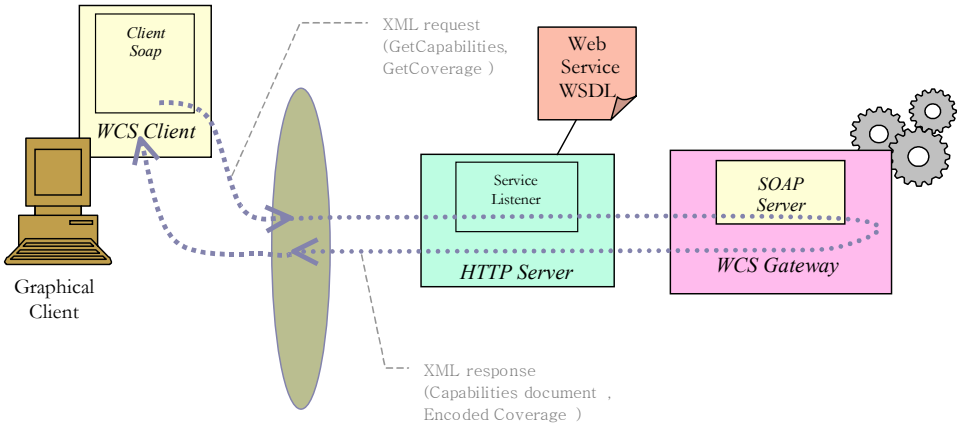
The WCS server is in charge of converting such document into a WCS valid document; hence it performs the data model reconciliation.

ENGINEERING VIEW

The implemented solution utilises both the Servlet (HTTP-based communications interface) and the SOAP/RPC technology for implementing the WCS communications intreface.

HTTP-BASED ENGINEERING ARCHITECTURE

SOAP-BASED ENGINEERING ARCHITECTURE



TECHNOLOGY VIEW

The following technology base-line is going to be utilised

DEVELOPMENT ENVIRONMENT

JBuilder

DEVELOPMENT LANGUAGE

JAVA SDK 1.4

TOOLKITS OR LIBRARIES UTILISED

Electric Glue standard edition

DEPLOYMENT ENVIRONMENT

MS Microsoft or Linux

THE CLIENT

CLIENT FOR HTTP-BASED SERVERS

The developed Test Client

MPGC client

CLIENT FOR SOAP-BASED SERVERS

The developed Test Client

SINOTS3G geoBrowser

HOW TO TEST THE SERVERS

Using a normal Web Browser, it is possible to test the server issuing the following HTTP:GET request:

To be completed

LESSONS LEARNT

WCS MODEL

To complete

WCS IMPLEMENTATION SPECIFICATIONS

To complete

REFERENCES

J.D. Evans, "OpenGIS® Web Coverage Service (WCS) Implementation Specification", OGC Inc. Project Document OGC 02-024r1, 2002.

The NetCDF Markup Language (NcML), http://www.unidata.ucar.edu/packages/netcdf/ncml/

The NcML-G Proposal, http://www.unidata.ucar.edu/projects/THREDDS/Nativi/NcML-G/NcML-G.htm

B.Domenico, J.Caron, E.Davis, R.Kambic and S.Nativi, "Thematic Real-time Environmental Distributed Data Services (THREDDS): Incorporating Interactive Analysis Tools into NSDL", Journal of Digital Information, Vol.2 Issue 4, May 2002, http://jodi.ecs.soton.ac.uk/Articles/v02/i04/Domenico/

J. Caron and S. Nativi, "NetCDF into GIS: the good, the bad, and the ugly", submitted to the AMS – 20th IIPS Conference, Seattle (WA), Jan 2004.

S. Nativi and J. Caron "Interoperability issues in serving THREDDS data", ESIP '03 Meeting, Boulder (CO), Jul 2003.
http://www.unidata.ucar.edu/projects/THREDDS/Nativi/ESIP03/ESIP03Presentation.pdf

??? GeoTIFF spec