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DATA MODELS USED FOR WEATHER RADAR DATA EXCHANGE

A review of other data models that could be adopted for use with weather radar data exchange

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SUMMARY AND PURPOSE OF DOCUMENT

This document presents alternative data models to those endorsed by WMO which could be adopted to represent data and products from weather radar systems for the purposes of exchange. The scope of what is meant by ”data model” and “other” is first outlined in order to provide some context. Metadata models and a few different categories of file-format encodings are presented and described in brief.

ACTION PROPOSED

Workshop participants are invited to note the information contained in the document.

References

1. WMO CBS-XIV /Doc. 6.2(1) 2009: Expected Result 5. Information systems and services (ISS). Summary and appendices.
2. Michelson D.B., 2006: EUMETNET OPERA Work Package 2.1 “New data representation formats” Final report. Working document WD_2006_06.

OTHER DATA MODELS

1. Introduction and scope

This short document provides an outlook on alternative data models to those already being used for the purposes of representing data and information from scanning weather radar systems.

Weather radar systems are assumed to be operational and running continuously in real time. They do not have to be operated by a National Meteorological or Hydrological Service (HNMS), but it is assumed that they contribute to the national observation system and the data from them are therefore available for exchange, both nationally and internationally.

For the purposes of this document, “data model” refers to both the abstract/logical information model, ie. which information and how it is organized, and also the physical model, ie. how data are represented using file-format encodings. The term “data model” is not used here to address communications issues such as transfer protocols and associated mechanisms.

The term “data model” does not explicitly imply that it is designed or intended for exchange, but presumably could only be constrained to represent weather radar data. Therefore, it must be clarified that this document is largely focussed, but not limited to, data models that can be used for the purposes of exchange.

At CBS-XIV (2009), the following could be considered as belonging to the general set of data models/representations endorsed by WMO: BUFR, CREX, XML, NetCDF or HDF, including BUFR/CREX/GRIB tables. Models/representations not on this list can be categorized as “other”.

During its second incarnation, EUMETNET OPERA conducted work on finding a complementary format to BUFR for weather radar. Some of the results of this work package can be considered to be relevant under the “other” category and can be consulted (Michelson 2006).

2. Metadata models

2.1 Aviation XML - METCE

METCE stands for “Modèle pour l'Échange de Temps, Climate et Eau” (Model for the Exchange of Weather, Climate and Water), or alternatively, the METeorological Community Exchange model. This WMO task is hosted by the European Centre for Medium-Range Weather Forecasting (ECMWF), and its focus is on creating an umbrella data model for application to aviation messages. In short, the “umbrella” consists of a framework containing logical data model that can then be implemented in different file-format encodings. The objective is that a complete separation of logical and physical representations allows the information itself to be maintained independently from the information’s physical representations in file formats. The inherent advantage would be that different format encodings can be added/modified/removed to the framework without having a negative impact on the quality of the information found in the file payload. Also, from the application perspective, a successful software implementation of this framework would render an individual file-format encoding transparent or even invisible through the associated APIs.

In practice, METCE involves applying ISO/TC 211, including Geography Markup Language (GML, see below), which is concerned with the standardization in the field of digital geographic information (specifications numbered in the range starting with 19101). The Uniform Modeling Language (UML) is used to formulate the Observation & Measurement model, and heavy use of XML is used to represent it.

At present, METCE has created a first AvXML version 1.0RC of the model, and it is subject to review with the goal to be adopted mid-year 2013. The task activities end following this adoption.

In principle, WRDE could support the idea of a WMO Task Team on Weather Radar Data Model that bases its work on METCE, elaborating it if such an approach is determined to offer an appropriate means of addressing and achieving a coherent global solution for weather radar data.

3.2 Geography Markup Language (GML)

Open Geospatial Consortium (OGC) software supports a range of open services, including OpenGIS, that makes significant use of GML. OGC software is significant in this context because many national environmental protection and (other agencies) are building web-based portals using OGC solutions with which data subscription services are being established. This is rapidly becoming a *de facto* standard, and the same concept as that being applied in the WMO Information System (WIS) with a higher level of abstraction. Targeting GML specifically for weather radar would probably not be a realistic alternative. This description is included simply to mark

3. File-format encodings

This section addresses various file formats that are known to be used for representing weather radar data, and that could offer pragmatic containers for exchange. Note that these encodings do not necessarily offer corresponding data models in all cases.

3.1 Extendable Markup Language (XML)

XML is often used as a language for managing metadata, but it can (and is) also used as a complete file encoding. XML can be described as a “container” format, meaning that can, in principle, be used to represent any kind of information. Therefore, it becomes important that the use of XML for any given purpose is clearly specified.

XML has become ubiquitous, which unfortunately means that is used in ways that are inconsistent with the World Wide Web Consortium (W3C) XML specification. There has been confusion in the past as to whether it supports binary payloads, but it seems that binary data are acceptable as long as each binary payload is represented as a UUencoded or Base64-encoded string. The alternative, to include the binary data directly using the CDATA tag, is prone to parser vulnerabilities when the binary stream contains null or “end sequence” characters.

XML is used in-house by some NHMSs and also by industry, but the author is unfamiliar with any cases where it is used for exchange, except as a message envelope for HDF5 files used in the operational Nordic weather radar network NORDRAD.

3.2 GeoTIFF

This format is a variation of the Tagged Image File Format (TIFF) industrial graphics format. GeoTIFF contains a limited set of metadata related to Cartesian area characteristics: corner coordinates, projection, horizontal resolution, raster image dimensions. It is unclear how easily other metadata can be added, e.g. analogous geographical referencing metadata for polar (spherical) space and arbitrary commentary as part of the “private tags”. It’s also unclear how easily several layers can be stored in the same file.

OGC solutions mentioned above in section 2.2 contain support for GeoTIFF.

3.3 Portable Network Graphics (PNG) format

This industrial graphics file format is fairly simple. It also contains a relatively flexible header that can accommodate a lot of extra information. Due to this combination of simplicity and flexibility, PNG has been used in some places, and also by industry, as a native production format for weather radar data, both for polar and Cartesian datasets. The resolution of data that PNG can represent is, however, limited to maximum 16 bits per bin/pixel. This can be a problem when

representing radar-based quantities that require greater depth, e.g. new information from dual-polarization radar systems.

The author is unaware of instances of PNG being used for data exchange.

3.4 Proprietary (radar industry) formats

There are a few isolated cases where weather radar data are exchanged using such proprietary file formats used by radar manufacturers. Such cases are regulated by bilateral agreement; they assume that permission has been granted by the holder of the intellectual property rights for the data recipients to use this file format.

3.5 In-house formats

There have been many in-house formats developed over the years, and they often share the important characteristic of being very well adapted to application in a specific environment. Several such formats could be very well suited to exchange, but they would first have to be “discovered” and generally accepted for adoption.