THE IMPORTANCE OF INTERNATIONAL STANDARDS

Creating a Satellite-data Integration System

CEOP (Coordinated Enhanced Observation Period) is currently working on an integrated global water and energy-cycle observation system for scientific and civilian use. One challenge is the creation of a satellite-data integration system able to combine a multitude of data stemming from a diversity of distributed systems. Data retrieval and combination requires high-performance distributed data-management and archiving systems. But the key is specification of metadata, for which international standards are indispensable.

The prerequisites for developing a Satellite-Data Integration System (SDIS) are, next to specification of metadata, data discovery and data integration, geocoding service and data quality control, and standardisation of image-service interfaces. Users identify data useful for the task at hand during the data discovery stage, usually by consulting metadata.

Vital Metadata
Metadata is also important for integration of data stemming from distributed systems. Satellite data, for example, should be accompanied by metadata sufficient for the carrying out of geometric and radiometric corrections. Such information will include satellite orbit, sensor attitude and calibration parameters. Such metadata is, of course, redundant if all satellite data is already geo-coded and radiometrically corrected. The same metadata can thus be applied for both data discovery and data integration. The important work of developing standards for metadata and imagery data is done by international organisations such as ISO/TC211 (www.isotc211.org/) and OGC (www.opengeospatial.org/). Our SDIS is developed based on these stand-ards and extensions.

System Architecture
The architecture we apply to make the system work on local or wide-area networks consists of four essential components. Of first importance is, without doubt, the development of metadata. The three other parts are discovery and data integration, web services and CEOP portal (Figure 1). Metadata development results in an abstract structure and content for describing imagery data and includes presentation of metadata in a variety of forms and languages, exchange of metadata within data-management systems, and means of assessing conformable and available metadata. Data services and image-service interfaces are designed for data discovery and data integration, including services for geo-coding and accuracy visualisation. Users can also use an image/spatial query service to retrieve data that may be useful for their own purposes. With respect to web services, a local or a wide-area network can be used. Basically web services enable (1) locating and accessing services through the internet, (2) discovering what kinds of services can be used to access the specific data distributed over several systems and (3) developing a common model for publishing and binding. The last essential component of the architecture, the CEOP portal, provides access to all registered geo-information and related online data-services for satellite-imagery, in-situ and simulation data. Here data and documents can be catalogued for discovery.

Standards
A series of international standards is incorporated in the architecture, including ISO metadata and sensor model, OGC web service and image-service specifications. The imagery metadata is based on ISO standards (ISO 19115, ISO 19115 part 2) and combining geo-location information with sensor properties is done on the basis of ISO imagery standard (ISO 19130). This provides an abstract structure and content for describing imagery data by defining a common set of metadata elements, their definitions and inherent dependencies, as well as metadata extension. Figure 2 presents structure and content of the model. A full metadataset contains one or more classes and elements of metadata. A class is a set of metadata elements describing the same data aspects. A possible layout for image datasets is shown in Figure 2(a). Metadata elements are categorised according to three groups (Figure 2(b)):

- core element, defining a minimum number of basic metadata to be maintained for all types of applications; in the design all core elements are mandatory
- extended element, describing specifically the characteristics of, in our case, imagery data

- specific element, consisting of metadata for specific professional and research-community needs.

Service Interface

The integration of satellite data requires management of satellite, in-situ and simulation data, all also referenced to the same spatial and temporal coordinate system. To ensure the geometric quality of data after integration, metadata should contain accuracy information. Taken into account when integrating satellite data should be geo-coding services and services for handling resolution and differences in geometric accuracy. Basic image-processing services, such as geo-coding, are included in many software packages used by researchers. Standardisation of such service interfaces enables the once-only development of the same function for different application software. International organisations put much effort into standardising service interfaces. OGC, for example, describes abstract models for services for image coordinate transformation by describing data types of image-points and ground-points. However, these do not include handling of pixel/grid-based coordinate transformations. Based on OGC standards we have developed a geo-coding algorithm and functions to accommodate additional grid data in the standard image-service interfaces.

Results

Satellite images supplied by JAXA, NASA, ESA and EUMETSAT, include full scenes over the CEOP-focused research areas, Level-3 global grid data, and subset scene data. Satellite data consists of â€˜headerâ€™ and data. The header contains metadata describing product outline and main characteristics. CEOP is currently assisting the science community to develop data services for data discovery (Figure 3). These include detailed description of service interfaces for the use of data: online access satellite data, in-situ data and MOLTS data stored in different archives. A prototype data-discovery system under the CEOP portal has also been developed. One of our other results is visualisation of geometric correction accuracy developed in the standard image-service interfaces; this ensures geometric quality of data overlay. Figure 4 shows the result of geometric correction accuracy visualisation using an ALOS-PRISM image with 2.5m ground resolution. The ALOS-PRISM is an optical sensor onboard Japanâ€™s Daichi, an Advanced Land Observing Satellite (ALOS) launched on 24th January 2006 and operated by the Japan Aerospace Exploration Agency (JAXA).

Concluding Remarks

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Further Reading

- ISO/TC 211, 2002, Text of 19115 Geographic information â€“ metadata, p.143.
- ISO/TC 211, 2005, CD 19115-2 Geographic information â€“ metadata â€“ part 2: metadata for imagery and gridded data, p. 47.
- ISO/TC 211, 2005, CD19130.2 Geographic information â€“ sensor data model for imagery and gridded data, p.160.
- OGC, 2004, The OpenGIS abstract specification Topic 16: image coordinate transformation services, version 6, 04-107, p.93.
- Shibasaki Group, 2006, Report on the establishment of satellite data integration system - metadata design for integrating CEOP satellite imagery data, reference site data and simulation result data, Version II, p. 36.