



RELATION TO STANDARDS VERSION M24

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| Authors: | Keiran Millard |
| Quality Controllers: | UCL |
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Consisting of

| | |
|--------------|---|
| SINTEF | STIFTELSEN SINTEF, Department of Applied Mathematics, Oslo, Norway |
| Fraunhofer | Fraunhofer Institute for Computer Graphics Research, Darmstadt, Germany |
| CNR-IMATI-GE | Institute for Applied Mathematics and Information Technologies of the National Research Council (CNR-IMATI), Genova, Italy |
| MOSS | M.O.S.S. Computer Grafik Systeme GmbH (MOSS), Munich, Germany |
| HRW | HR Wallingford Ltd (HRW), Wallingford, UK |
| FOMI | Hungarian National Mapping and Cadastral Agency (FOMI), Institute of Geodesy, Cartography and Remote Sensing, Budapest, Hungary |
| UCL | University College London (UCL), Research centre for Photogrammetry, 3D Imaging and Metrology, London, UK |
| TU Delft | Delft University of Technology (TU Delft), Department of Earth and Climate Sciences & Man-Machine Interaction Group, Delft, The Netherlands |
| IGN | Institut National de l'Information Géographique et Forestière (IGN), Paris, France |
| UBO | Université de Bretagne Occidentale (UBO), European Institute for Marine Studies, Brest, France |
| Ifremer | L'Institut Français de Recherche pour l'Exploitation de la Mer (Ifremer), Brest, France |
| Liguria | Regione Liguria, Genova, Italy |

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EXECUTIVE SUMMARY

IQmulus maintains a regular checkpoint with de jure and de facto standards bodies throughout the project. The focus of this initiative is standards for data representation and packaging. This has two objectives. First is to ensure that IQmulus does not re-invent standards by building on what communities are already achieving. Second is to allow the experience of IQmulus to contribute to standardisation action activities and accelerate consensus on and deployment of new standards. At the proposal stage a number of standards initiatives were identified as particularly relevant; these include the Open Geospatial Consortium (OGC) and ISO. In addition communities implementing standards were considered such as the EC INSPIRE Directive implementation.

The summary of interactions at M24 is given in the table below

| Community | IQmulus |
|-----------|--|
| ISO | As of 2014, there was limited work on ISO19123 over the last 12 months, which is the main standard for coverages. ISO19159 Part II (Geometric Representation of LIDAR) has been put forward to Committee Draft, however, this covers data capture rather than representation. Other parts to this standard are proposed to cover SONAR and RADAR. |
| OGC | In September 2014, OGC has established a big geospatial data (BGD) special interest group. This is being championed by Peter Bauman and the WCS community. IQmulus has engaged with this community and we have agreed to have a more detailed discussion about cooperation. At this time it looks as if the OGC and IQmulus communities are looking at different aspects of big geospatial data. |
| HADOOP | Investigation of using Spatial Hadoop at the IQmulus code camp in June 2014. Established that its applicability to the scope of tasks in IQmulus is limited. |
| GDAL | Implementation of point cloud data in a postgres database using the GDAL point data library (PDAL). Need to commence wide engagement with this community. |
| INSPIRE | Ongoing tracking of INSPIRE developments. HR Wallingford and MOSS are both involved with the technical development of INSPIRE and have registered as part of the standards maintenance programme. From November 2014, HR Wallingford has been appointed facilitator of the ‘oceans and meteorology’ themes of INSPIRE. |
| OpenMI | OpenMI looks at standards for numerical models. Initial discussions with this community are due to interaction with the EC DRIHM Project (HR Wallingford and IMATI are partners). In 2014 OpenMI was established as a formal OGC standard. Also established limited requirements for OpenMI standard on IQmulus. |

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1 INTRODUCTION

As part of its development IQmulus will need to establish encodings for many ISO 19123 coverage classes. Whilst such encodings presently exist, there has been little effort to try and standardise them for any formal process and furthermore there exist few de-facto standards. As part of its activities IQmulus will engage with the Open Geospatial Consortium (OGC) as a recognised body with a strong interest in geospatial data standards. Fraunhofer and HR Wallingford are active members of the OGC, and HR Wallingford is currently working on the integration of the open modelling standard “OpenMI” into the OGC standards process. Fraunhofer is working in the 3D Information Models Thematic Working Group of the OGC and is leading the Web 3D Service standardisation effort.

1.1 SCOPE OF THE DOCUMENT

Each chapter of this document presents a standards-related initiative IQmulus has engaged with. It outlines the scope of the initiative, the relevance to IQmulus and the specific activities IQmulus has undertaken.

1.2 MONTH 24 SUMMARY

At month 24 we have continued our work interacting with ISO, OGC, OpenMI and INSPIRE. For these initiatives there were few developments of relevance to IQmulus until September 2014 when OGC established a special interest group for Big Geospatial Data (BGD). IQmulus has begun a dialogue with this group. In addition we have been in discussion with the Spatial Hadoop community and gained a better understanding as to how this implementation can be used.

2 ISO (INTERNATIONAL ORGANISATION FOR STANDARDISATION)

2.1 ROLE AND REMIT

ISO is a de jure standards body and technically it is the only body that can legitimately call its outputs ‘standards’. ISO is an umbrella organisation for national standardisation initiatives and has a scope by far exceeding standards related to point cloud data sets. ISO 9001 (Quality Management) and ISO 14001 (Environmental Management) are two well used standards developed by ISO.

Work developing ISO standards is undertaken by a series of committees at the national level that cooperate in virtual teams with their counterparts in other countries. There are also regular face-to-face meetings. The process for developing standards is also governed by its own standards that stipulate revision cycles for existing standards, proposals for new standards and the sign-off and acceptance procedure for any changes to standards.

2.2 RELEVANCE TO IQMULUS

2.2.1 X3D76

Although current visualization systems are often highly specialized and rather sophisticated, they still utilize proprietary formats and methods that are neither compatible in their concepts of operation nor in their supported data formats. On the one hand this prevents a harmonization of data from different sources and thereby hinders its distribution and utilization. On the other hand this also leads to parallel developments of incompatible and isolated technologies.

In this context, the ISO standard X3D76 is the only standardized 3D deployment format and differs from other formats like Collada in that it also includes the scene's runtime behavior. The proposed IQmulus volume rendering component therefore aims at the exchange and interactive exploration of volumetric data and at industrial applications that use X3D as interchange format, but can link to proprietary databases and hardware.

With surface, volume, and geo-spatial components X3D thereby provides a solid foundation and is a good starting point for further standardization efforts. Here, using standardized techniques and services enables an automated connection of existing data with the atmospheric, oceanographic, or geological data to be visualized. Hence, the IQmulus consortium will have a pro-active participation in several standardization bodies (OGC, W3C, Khronos Group) to prevent parallel developments of isolated approaches and formats.

2.2.2 ISO 19000

Geospatial information is covered by the ISO 19000 range of standards. Around 50 different aspects of geospatial data are standardised under the ISO 19000 range of standards. Of most relevance to IQmulus is ISO 191123 that describes geospatial coverages (grids, meshes, points). What does not exist at present are standard (or widely adopted) ways of encoding all of these coverages. Also of relevance to IQmulus are:

- ISO 19156 Observation and Measurements that detail how the data set has been created
- ISO 19115 Generic metadata for geospatial data sets
- ISO 19119 Generic metadata for services
- ISO 19139 XML encoding of 19115/19.

2.3 ACTIVITIES

HR Wallingford is a member of IST36, the British Standards committee responsible for ISO 19000. Standards committee meetings have been attended over the last year, as well as email dialogue. There has been little of relevance to IQmulus in the activities of IST36; similarly there has been nothing of significance to IQmulus that could be put forward as a new work item for standardisation.

The one area where there has been some progress is the development of ISO191159 which proposes geographic standardisation for remote sensing techniques. Part 1 covers optical imagery, Part 2 LIDAR, Part 3 SONAR and Part 4 RADAR. Part 1 is an approved standard; Part 2 was put forward as a Committee Draft in 2014 and Parts 3 and 4 are in the proposal stage. These standards mainly cover how data is captured rather than processed and although on the surface they seem relevant to IQmulus, they are not in practice.

3 OGC (OPEN GEOSPATIAL CONSORTIUM)

3.1 ROLE AND REMIT

The Open Geospatial Consortium (OGC) is an international industry consortium of 474 companies, government agencies and universities participating in a consensus process to develop publicly available interface standards. [OGC® Standards](#) support interoperable solutions that "geo-enable" the Web, wireless and location-based services and mainstream IT. The standards empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications.

OGC has a close symbiotic relationship with ISO TC211. ISOTC211 acts to standardise applications developed through OGC. Similarly OGC creates implementations and application profiles of some ISO TC211 standards.

3.2 RELEVANCE TO IQMULUS

3.2.1 Web Coverage Service (WCS)

WCS is a service for open, flexible and scalable access and processing of Earth data. The OGC Web Coverage Service (WCS) 2.0 Standard now allows providing a comprehensive portion of Earth science data categories through one coherent and implementation-independent interface. The coverage model of WCS 2.0 transcends pure raster data and includes almost all relevant categories, such as irregular and curvilinear grids, general meshes, trajectories, surfaces, solids, and point clouds.

In this regard, the open ISO standard X3D mentioned above also incorporates basic means for point rendering, as well as a geospatial component. Since most geo-referenced data are provided in a geodetic or projective spatial reference frame, X3D therefore provides support for a number of nodes that can use spatial reference frames for modeling purposes. However, there are still several drawbacks like the lack of well-defined terrain rendering. Within the X3D Earth working group there is a strong collaboration of the Web3D Consortium with the Open GeoSpatial Consortium (OGC).

3.3 ACTIVITIES

The OGC WCS community has now established its remit into big geospatial data. This is logical as WCS always had efficient ways to serve up large geospatial data over the web at its core. This extended remit has been realised as a Big Geospatial Data Special Interest Group (SIG) in September 2014. HR Wallingford has been in contact with this group and it is agreed that there is a need to discuss the aims of this SIG and the aims of IQmulus. On the surface it would seem that the feature extraction and visualisation methods proposed in IQmulus are in advance of those being considered by the SIG.

4 HADOOP

4.1 ROLE AND REMIT

Apache™ Hadoop® is an open source software project that enables the distributed processing of large data sets across clusters of commodity servers. It is designed to scale up from a single server to thousands of machines, with a very high degree of fault tolerance. Rather than relying on high-end hardware, the resiliency of these clusters comes from the software's ability to detect and handle failures at the application layer. Apache Hadoop has two main subprojects:

- MapReduce - The framework that understands and assigns work to the nodes in a cluster.
- HDFS - A file system that spans all the nodes in a Hadoop cluster for data storage. It links together the file systems on many local nodes to make them into one big file system. HDFS assumes nodes will fail, so it achieves reliability by replicating data across multiple nodes.

Hadoop is supplemented by an ecosystem of Apache projects, such as Pig, Hive and Zookeeper that extend the value of Hadoop and improve its usability.

4.2 RELEVANCE TO IQMULUS

The work in WP2 identified Hadoop as a suite of technologies that can be used in the IQmulus architecture. Hadoop is widely used for storing and processing big data and so needs consideration by IQmulus.

4.3 ACTIVITIES

Hadoop has been recognised as having limitations with respect to geospatial data. This has been recognised in other user communities and in Year 1 of IQmulus we identified a number of projects exploring the use of Hadoop for 'big geospatial data'. Liaising with these initiatives was a key action for Year 2 of IQmulus and specific liaison activities have been scheduled. One area we needed to explore is the extent to which geospatial coverages (ISO19123) have been considered in these tools for Hadoop as most of the work to date has focussed on indexing by coordinates.

As part of the Year 2 IQmulus activities, SpatialHadoop has been examined, including tests of the current version at the IQmulus code camp in London in June 2014 and an invited lecture on SpatialHadoop at the IQmulus workshop in Cardiff in July 2014. SpatialHadoop is freely available in several formats at <http://spatialhadoop.cs.umn.edu/#downloads>. It allows processing spatial data on a cluster of machines related to the MapReduce paradigm. Note, however, that spatial Hadoop is not a layer on top of standard Hadoop, but a different implementation of Hadoop. This curtails its usefulness for the IQmulus project.

5 GDAL

5.1 ROLE AND REMIT

GDAL is a translator library for raster and vector geospatial data formats that is released under an X/MIT style Open Source license by the Open Source Geospatial Foundation. As a library, it presents a single raster abstract data model and vector abstract data model to the calling application for all supported formats. It also comes with a variety of useful command line utilities for data translation and processing.

5.2 RELEVANCE TO IQMULUS

GDAL is developing an open source library of geospatial processing tools which has been recently extended with the PDAL library for point cloud data processing. The PDAL library is used to load point cloud data from LAS files into a point cloud database in PostGres.

5.3 ACTIVITIES

IQmulus has made use of the PDAL library for storing point cloud data in a PostGres database. Actually, HR Wallingford has moved its bathymetric data into a point cloud database; however, it has proved difficult to implement services in IQmulus that work directly against this data storage implementation.

6 INSPIRE

6.1 ROLE AND REMIT

The INSPIRE directive came into force on 15 May 2007 and will be implemented in various stages, with full implementation required by 2019. The INSPIRE directive aims to create a European Union (EU) spatial data infrastructure. This will enable the sharing of environmental spatial information among public sector organisations and better facilitate public access to spatial information across Europe. A European Spatial Data Infrastructure will assist in policy-making across boundaries. Therefore the spatial information considered under the directive is extensive and includes a great variety of topical and technical themes.

6.2 RELEVANCE TO IQMULUS

INSPIRE provides reference models and implementations of a range of data standards. Included amongst these are implantations of coverage classes for elevation models and simulation models. Not all the encoding models for INSPIRE coverages have been standardised; mainly due to a lack of resources to address this.

6.3 ACTIVITIES

HR Wallingford was the facilitator of the INSPIRE themes ‘oceanographic geographic features’ (OF) and Sea Regions (SR). Now the AnnexIII data specifications have been published, HR Wallingford is involved in the update and management of the standards. In October 2014 HR

Wallingford was appointed as facilitator for the maintenance programme for the oceanographic and meteorological data specifications. These data themes will require standard data models for large coverage datasets and these will be developed as part of the maintenance programme.

7 OPENMI (OPEN MODEL INTERFACE)

7.1 ROLE AND REMIT

OpenMI defines a standard for numerical simulations to communicate to one another. It was generated to enable simulations to be developed in a modular way such that users can combine the best simulations for a given location. A combination of simulations is referred to as a composition and this can include several interacting models. Communication between models is a time-step by time-step process and allows for each model to modify shared parameters. For example, a rainfall-runoff model modifies water depth, which in turn modifies the rate of rainfall run-off. OpenMI was the result of the EC FP5 project Harnmon-IT and has subsequently been updated and maintained by a consortium of European hydraulic laboratories.

7.2 RELEVANCE TO IQMULUS

This approach could be used as part of either the IQmulus DSLs (Domain Specific Languages) or actually to implement workflows, based on the OpenMI implementations that exist. This standard has also been used by the EC FP7 DRIHM project to underpin workflows that link hydrological models with flood forecasting models. Currently we are considering how IQmulus could process point clouds to deliver elevation models (DEM and DTM) for use in DRIHM.

7.3 ACTIVITIES

HR Wallingford and CNR-IMATI are part of the DRIHM project and HR Wallingford is part of the technical board for OPEN-MI. IQmulus and DRIHM have maintained a dialogue from M12 to M24.

8 SPECIFIC IQMULUS PLANS

There are a number of de jure and de facto standard activities that IQmulus has engaged with. Most of these activities operate over longer timescales than IQmulus and many of their activities have development programmes longer than the duration of IQmulus. In this context IQmulus can at best influence the direction or provide specific input to a component of these activities.

Within the remaining two years of the project, IQmulus will look to standardise storage implementations of point cloud data. This will address file-based as well as database implementations. IQmulus will connect to the OGC SIG during this work as well with the implementation activities of the G/PDAL community.