



RELATION TO STANDARDS VERSION M36

Deliverable D8.5.3

Circulation:	PU: Public
Lead partner:	HRW
Contributing partners:	MOSS, SINTEF, FRAUNHOFER
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Version:	1.0
Date:	12.11.2015

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DOCUMENT HISTORY

Version ¹	Issue Date	Stage	Content and Changes
0.1	7.08.2015	3	Initial version for team contributions.
0.2	25.09.2015	3	Draft following initial partner feedback.
1.0	12.11.2015	3	First version of completed report.

¹ Integers correspond to submitted versions

EXECUTIVE SUMMARY

The purpose of this report is to document the IQmulus projects' relations and interactions with standards bodies and interest groups. Ongoing engagement throughout IQmulus project Year 3 has demonstrated that the particular interests of the project are not yet being derived into formal standards by activities within these communities and any plans to do so are early in formulation. IQmulus currently has no concrete plans to spearhead the development of standards concerning big geospatial data but finds itself at the leading edge of deriving workflows and infrastructure components to process point cloud datasets.

The ongoing project task 8.3 on standardisation has a threefold aim, namely:

- (i) to identify communities developing standards in the domain of big geospatial data,
- (ii) to engage in a dialogue with these communities to understand the scope of their work,
- (iii) to maintain a working relationship with these communities where beneficial to IQmulus.

The summary of the current status in this regard is given in the table below.

Community	Status
ISO	There is interest in the field of 'big data' but there remains no active developments in the ISO19000 suite of standards which would be expected to cover Point Cloud data structures.
OGC	The first official Point Cloud Domain Working Group took place at the Technical Committee meeting in Nottingham, UK in September 2015. A Big Data Domain Working Group has also been formed. IQmulus represents a leading initiative in both contexts.
HADOOP	No further action concerning Hadoop was pursued in project year 3 following the conclusion that its applicability to the scope of tasks in IQmulus is limited.
GDAL	Having implemented marine bathymetry into PostgreSQL using the GDAL point data library (PDAL), IQmulus remains a user of this product set and has continued to engage with this open source community.
INSPIRE	There has been ongoing work on encoding models for coverages and also a recognition that 'big data' coverages such as point clouds are not supported by INSPIRE and that this needs to be addressed. It is becoming recognised that INSPIRE is not yet directly able to give solutions for basic gridded data and, as such, point clouds and meshes are not being immediately addressed.
OpenMI	HR Wallingford and CNR-IMATI were part of the DRIHM project which closed during year 3 of IQmulus. DRIHM (and its counterpart US liaison project DRIHM2US) were both active in the use of OpenMI. As part of this work, the standard was used to model flash flooding in Genoa. The model suites used topography derived from point data sources similar to those being studied on IQmulus. As such, the OpenMI community represents a key downstream user of the IQmulus outputs.

IQmulus therefore has opportunities to input practical, real world, experiences of working with Point Cloud datasets into the appropriate standards fora. It will be important to ensure, that as these processes develop, users of point clouds have a strong influence over the standards that are written. Accordingly, the plan for project year 4 is to continue with this engagement and, in particular, to meet with BSI early in 2016 to discuss options.

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1 INTRODUCTION

The purpose of this report is to document the IQmulus projects' relations and interactions with standards bodies and interest groups. It is conducted as part of task 8.3 'Standardisation' within the 'Dissemination and Outreach' work package 8. This standardisation task has a threefold aim, namely:

- (i) to identify communities developing standards in the domain of big geospatial data,
- (ii) to engage in a dialogue with these communities to understand the scope of their work,
- (iii) to maintain a working relationship with these communities where beneficial to IQmulus.

On this last point, the purpose is that IQmulus may benefit from exploiting previously developed or maturing standards or may contribute to an active standard development process. Although we specifically work with established standards bodies such as ISO and OGC, we use the term 'standards' loosely to mean work on 'best-practice' as well as formal standardisation.

This is the third in a series of four reports covering this task and focuses on the progress in project year 3, building on that documented in the former reports for years 1 and 2.

1.1 SCOPE OF THE DOCUMENT

As with previous versions of this report for previous project years, chapters of this document each present standards-related initiatives IQmulus has actively engaged with through either virtual dialogue or face-to-face meetings. It outlines the scope of each initiative, the relevance to IQmulus and the specific activities IQmulus has undertaken.

2 ISO (INTERNATIONAL ORGANISATION FOR STANDARDISATION)

A small amount of additional activities to that reported in year 2 were pursued in project year 3. Notwithstanding the OGC involvement reported elsewhere, this section has only a small addition to that reported previously in D8.5.2.

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 thin client component therefore aims at the exchange and interactive exploration of geospatial data and at industrial applications that use X3D as interchange format, but can link to proprietary databases and hardware.

With surface, volume, and geospatial 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 through its visualization team 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 most relevance to IQmulus is ISO 19123 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.

2.2.3 ISO 10303

The ISO standard 10303 on *Automation systems and integration — Product data representation and exchange* is also widely known as STEP (Standard for the Exchange of Product model data). ISO 10303 typically represents 3D objects in Computer-aided design (CAD) and related information. Within CAD and Finite Element Analysis (FEA) there has been little evolution of representation formats in the last 25 years, yet there is a strong belief that changes to shape representations are on the way based on requirements from users and industry.

In IQmulus, the use of shape representations related to locally refined (LR) splines is being proposed by SINTEF as the basis for the digital elevation models (DEMs) generated and processed by the workflows of the Marine showcase and as one tool to handle big data by reducing big data sets to much smaller ones.

Updates concerning LR splines were proposed to the STEP standards ISO 10303-42, 50 and 52, and successfully balloted in April 2014. This extension updates the ISO 10303 STEP Module and Resource Library (SMRL), see the document “SC 4 N2930 SMRL CR10 validation ballot result”. The work related to ISO 10303 was performed in the Factories of the Future project TERRIRIC, (www.terrific-project.eu) that ended in August 31, 2014. This work will be continued in the the Factories of the Future project CaxMan (September 1, 2015 –August 31, 2018, www.caxman.eu), where we will address extension of ISO 10303 (STEP) Part 242 edition 2.

2.3 ACTIVITIES

The IQmulus visualization team led by Fraunhofer is monitoring the activities of several standardization bodies (such as W3C, Khronos Group) concerning X3D76 as a standardized 3D deployment format.

Date	Location	Main Activity	Partner	Representative	Relation to IQmulus
10/08/2014	Darmstadt, Germany	Web3D Consortium Board Member Declarative 3D Community Group Chair	Fraunhofer	Johannes Behr	WP5
10/08/2014	Vancouver, Canada	SIGGRAPH 2014 Web3D Booth	Fraunhofer	Johannes Behr, Tobias Alexander Franke	WP5
10/08/2014	Vancouver, Canada	Web3D 2014: Presentation of first working version of remote rendering service	Fraunhofer	Tobias Alexander Franke	WP5
		Proposals for standard extension and rendering of large data on the web	Fraunhofer	Johannes Behr	WP5
11/08/2015	Los Angeles, USA	SIGGRAPH 2015 Web3D Booth	Fraunhofer	Johannes Behr	WP5
18/06/2015	Heraklion, Greece	Web3D 2015: Proposals for standard extension and rendering of large data on the web	Fraunhofer	Johannes Behr	WP5

Task 5.5 on *Visualization driven data formats* will more specifically collect the requirements on data formats, derived from algorithms developed in work package 5. These requirements will be mapped and compared to existing data formats to be used in the future for developing visualization-aware data formats or extending existing ones so that they are optimally tailored to new graphics hardware architectures and GPU-based algorithms.

Further to attendance of IST36 (the British Standards committee responsible for ISO 19000) meetings in project year 2, HR Wallingford attended two further meetings in project year 3. Within this forum there is interest in the field of ‘big data’ but there remains no active developments in the ISO19000 suite of standards.

3 OGC (OPEN GEOSPATIAL CONSORTIUM)

3.1 ROLE AND REMIT

The Open Geospatial Consortium (OGC) is an international industry consortium of over 400 companies, government agencies and universities participating in a consensus process to develop publicly available interface standards.

OGC@Standards (see <http://www.opengeospatial.org/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 activities take place through a number of fora types, in particular Standards Working Groups (SWGs) and Domain Working Groups (DWGs). The purpose of a SWG is to derive a standard for approval by the OGC members. They are usually private and restricted only to those members who are deriving the standard (although procedures exist for visitors to contribute). A DWG is typically public and has a more open remit for the attendees to explore a particular topic area, with a view to deriving associated standards and best practices in due course.

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).

3.2.2 Point Cloud Domain Working Group

Following an ad-hoc meeting in Boulder, Colorado in June 2015, the first official Point Cloud DWG took place at the Technical Committee meeting in Nottingham, UK in September 2015 (<http://www.opengeospatial.org/projects/groups/pointclouddwg>). The mission of this group is to broaden the understanding of point cloud data interoperability requirements and use cases and to help drive activities to improve interoperability in the point cloud user community. Its specific role is to serve as a forum within the OGC for point based data; to present, refine and focus interoperability-related point cloud issues to other parts of the OGC and to industry.

Point clouds fit into the OGC standards suite via <<FeatureType>> gml 3.2.1 'Abstract Coverage'. Standards such as WCS (above) can be seen as a unifying service giving an identical request for

point clouds derived from in situ earth observation, metocean observation (such as the bathymetry survey surfaces being investigated by WP3 and 6 of IQmulus) and LiDAR. As such, delivery formats can be separated from storage formats.

3.2.3 Big Data Domain Working Group

As reported in the previous version of this report ('Relation to Standards Version M24'), a 'Big Data' DWG has also been formed within the OGC:

(<http://www.opengeospatial.org/projects/groups/bigdatadwg>).

The purpose of this group is to provide an open forum for work on Big Data interoperability, access, and especially analytics. Aspects include volume, the overall size of the data in storage terms; velocity, the rate at which new data arrives; variety, the various forms and formats of big data sets; veracity, issues associated with provenance, quality and trustworthiness.

3.3 ACTIVITIES

IQmulus has maintained regular contact with and contributed to the OGC via its programme of Technical Committee Meetings as summarised below:

Date	Location	Main Activity	Partner	Representative	Relation to IQmulus
27/03/2014	Arlington, USA	3D portrayal SWG: discuss handling large 3D vector data in 3D portrayal service	Fraunhofer	Simon Thum	WP5
09/06/2014	Geneva, Switzerland	3D portrayal SWG: discuss service interface and roadmap, proposal for addressing the variability of 3D approaches	Fraunhofer	Simon Thum	WP5
		3DIM DWG	Fraunhofer	Simon Thum	WP4/WP5
		Observe CityCML SWG	Fraunhofer	Simon Thum	WP4
01/12/2014	Tokyo, Japan	3D portrayal SWG: propose standardization schedule, propose service interface enhancements for spatial precision and coding efficiency	Fraunhofer	Simon Thum	WP5
		3DIM DWG	Fraunhofer	Simon Thum	WP4/WP5
		CityGML Quality Interoperability Experiment	Fraunhofer	Simon Thum	WP4/WP5/WP8/WP9
		Observe CityCML SWG	Fraunhofer	Simon Thum	WP4
03/09/2015	Barcelona, Spain	3D portrayal SWG: announce Adoption Vote	Fraunhofer	Simon Thum	WP5
		Observe CityCML SWG	Fraunhofer	Simon Thum	WP4
01/06/2015	Boulder, USA	Present 3D portrayal standard to TC, guide	Fraunhofer	Simon Thum	WP5

adoption vote					
15/09/2015	Nottingham, UK	Present 'Cloud Platform for Point Cloud Processing', Point Cloud DWG	UCL	Jan Boehm	WP2/WP3/WP4
		Big Data DWG, Point Cloud DWG	HR Wallingford	Quillon Harpham	WP8

Project engagement with OGC Technical Committee meetings increased in late 2015 from that provided by Fraunhofer throughout 2014. Team members from UCL and HR Wallingford also attended on behalf of the project. This new contact was principally in response to the new 'Point Cloud' and 'Big Data' working groups with a view to engaging with fora that would help preserve project outputs.

The more specific of these two working groups and, perhaps, the most directly relevant in scope to main project outputs is the Point Cloud DWG. Indeed, the presentation offered by UCL at this meeting highlighted the point cloud processing service via the cloud platform, categorised as Platform as a Service (PaaS). The need for a more flexible standard than LAS (LASZip) or PLY was also highlighted and in particular with reference to a more open and extensible attribute set than that offered, for example, by LAS. Other presentations revealed significant synergy with IQmulus objectives including the fledgling concept of explorative point clouds which allow immediate use and analysis such as visualisation, length, area and line-of-site.

The wider remit of the Big Data DWG revealed more fundamental questions of understanding and relevance. The forum identified many different interpretations of the term 'Big Data' which, in itself, was consistent with the vision and purpose for the meeting. The conclusion was an agreement for the drafting of a set of white papers on the various definitions of 'Big Data' and the associated key questions and vision.

Overall IQmulus is expecting to continue to engage with these influential fora, but due to the timescales associated with deriving standards from the current base, the project is not expecting to start new SWG meetings to define such standards for point cloud data. Were an appropriate standards working group to be defined immediately – and there is no sign of this given the lack of maturity of these groups – it would be unlikely to be established much prior to the project conclusion.

4 HADOOP

No further action concerning Hadoop was pursued in project year 3. As such, the section given below indicates the final project position as given previously in D8.5.2.

4.1 ROLE AND REMIT

Apache™ Hadoop® (<http://hadoop.apache.org/>) 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.

SpatialHadoop is an open source MapReduce extension designed specifically to handle huge datasets of spatial data on Apache Hadoop. 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.

As part of the Year 2 IQmulus activities, SpatialHadoop has been examined by the consortium, arranging an invited lecture on SpatialHadoop at the IQmulus workshop in Cardiff in July 2014 and tests of the current version at the IQmulus code camp in London in June 2014. Practical investigations at the code camp and beyond established that SpatialHadoop's applicability to the scope of the tasks in IQmulus is limited and its use will not be pursued any further in the project.

5 GDAL

5.1 ROLE AND REMIT

The Geospatial Data Abstraction Library (GDAL, <http://www.gdal.org/>) 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 (<http://www.pdal.io/>). 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 continued to make use of the PDAL library for storing point cloud data in a PostGres (PostGIS) database. During Year 2, HR Wallingford has moved its bathymetric data into a point cloud database to support IQmulus and it is this data which has been serving the bathymetric aspects of the Marine Showcase.

HR Wallingford has continued to engage with the PostGres community with attendance at the PostGIS day in London in November 2014.

6 INSPIRE

6.1 ROLE AND REMIT

The INSPIRE directive (<http://inspire.ec.europa.eu/>) 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 implementations 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 issue.

6.3 ACTIVITIES

HR Wallingford and MOSS are both involved with the technical development of INSPIRE and have registered as part of the standards maintenance programme. HR Wallingford was the facilitator of the INSPIRE themes 'Oceanographic Geographic Features' (OF) and 'Sea Regions' (SR).

Alongside Year 3 of IQmulus and funded from elsewhere, HR Wallingford continued progress on the Marine and Atmosphere cluster of INSPIRE. There has been ongoing work on encoding models for coverages (<https://themes.jrc.ec.europa.eu/file/view/59232/example-elevation->

[grid-coverages-single-coverage-tested-final](#)) and also a recognition that 'big data' coverages such as point clouds are not supported by INSPIRE and that this needs to be addressed (<https://themes.jrc.ec.europa.eu/pages/view/44063/of-mf-data-in-non-supported-representations>). It is becoming recognised that INSPIRE is not yet directly able to give solutions for basic gridded data and, as such, point clouds and meshes are not being immediately addressed. Recommendations concerning storage models for point cloud data and implementations to access this data via services such as those specified by the OGC would contribute to this ongoing discussion. INSPIRE 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 (see <http://www.openmi.org/>) 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 Harmon-IT and has subsequently been updated and maintained by a consortium of European hydraulic laboratories.

7.2 RELEVANCE TO IQMULUS

OpenMI originated in the hydraulic modelling domain and is still mainly used in the numerical modelling of water systems, on land (e.g. flooding, water supply), in the sea (coasts and estuaries, nearshore, offshore) and below ground (groundwater). It has been observed that the approaches taken by OpenMI implementations regarding workflow could be used as part of either the IQmulus DSLs (Domain Specific Languages) or actually to implement workflows and, indeed, these similarities hold, but the most traction can be found in supporting these modelling domains through the production of supporting data.

7.3 ACTIVITIES

HR Wallingford and CNR-IMATI were part of the DRIHM project which closed during year 3 of IQmulus. DRIHM (and its counterpart US liaison project DRIHM2US) were both active in the use of OpenMI. As part of this work, the standard was used to model flash flooding in Genoa. The model suites used topography derived from point data sources similar to those being studied on IQmulus. Also, bathymetry and structures below ground are derived from similar point sources. Since these modelling suites rely heavily on the accuracy of their supporting data, there is scope for IQmulus to offer improved datasets for setting up this type of numerical model. Although this is not exclusively dependent on OpenMI – which is an example implementation of numerical modelling in this field – the established links with this community provide an avenue for exploration and will be maintained.

8 CONCLUSION

The drivers behind IQmulus engagement with these standard bodies and interest groups is to ensure that the project is not replicating what others are doing and to see if IQmulus outputs could be input into standardisation processes in any way. Ongoing engagement with these communities throughout Year 3 has demonstrated that the particular interests of the project are not yet being derived into formal standards by activities within these standards bodies and interest groups and any plans to do so are early in formulation. IQmulus currently has no concrete plans to spearhead the development of standards concerning big geospatial data but finds itself at the leading edge of deriving workflows and infrastructure components to process point cloud datasets. Indeed, at the time of writing, the Point Cloud Domain Working Group at the OGC is going through a scoping process to define which of the many avenues the working group could explore. A survey is being circulated to the community early in 2016.

IQmulus therefore has opportunities to input practical, real world, experiences of working with Point Cloud datasets into the appropriate standards fora. It will be important to ensure, that as these processes develop, users of point clouds have a strong influence over the standards that are written. Accordingly, the plan for project year 4 is twofold:

- To continue to engage with the standards communities that are relevant and active and input IQmulus approaches;
- Meet with BSI early in 2016 to discuss how the project could contribute to any future standardisation in this area.