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Semantic Web for Information Modelling in Energy Efficient Buildings

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Executive Summary

This report summarizes the main aspects of the 3rd SWIMing workshop, held on Thursday 17th September, 2015, at the University Campus of Savona, Italy and aligned with Sustainable Places. It also details activities at two related VoCamp workshops; the first on the 14-15th of September, hosted by Ready4SmartCities and held in Genoa, Italy and the second on the 15–17th of December, hosted by the SEAS project in Paris, France. Finally, a short report is provided regarding the BuildingSMART Conference held on the 12-15 October 2015 in Singapore.

The Sustainable Places workshop focused on the clustering of experts to give presentations and provide discussion on the open BIM approach for building lifecycle (BLC) energy management processes and more generally, on standards and interoperability. It was co-organized by SWIMing and by the EC co-funded project EEBERS (ICT for EeB clusters). Ready4SmartCities also participated by chairing the first session. The main outcomes of this workshop were 1) dissemination of information regarding the clustering efforts of the three CSAs, 2) identification and categorization of use cases which can benefit from the application of ICT technologies and LD.

The Genoa VoCamp gathered 16 experts to discuss on-going work related to open-data / energy efficiency under the umbrella of the Smart City domain. SWIMing contributed by presenting the SWIMing methodology for use case development and provided assistance during the break away sessions, where alignments between the SAREF ontology and IFC were explored. The main outcomes were related to the limits of automated matching for semantic alignment, the need for expert input, the need for clear documentation of models and the need for predefined use cases to frame a set of relevant concepts.

The SEAS VoCamp gathered 50 participants, the majority being partners in the SEAS project. The workshop took place over three days, with three morning plenary sessions with keynote speakers, and six 90 minute parallel working sessions in the afternoons. SWIMing took on the task of leading three of the sessions using the ReqCap tool to capture use cases with members of the SEAS project. SWIMing also led one of the technical sessions giving a tutorial on the use of CSVW for publishing measured data as RDF. The main outcomes of the sessions were the development of two use cases using the ReqCap tool.

The BuildingSMART International Standards Summit, organized by BuildingSMART International, was attended by Pieter Pauwels who participated as a representative of SWIMing, as co-chair of BuildingSMART Linked Data Working Group (LDWG), and as one of the two chairs of the W3C Community Group on Linked Building Data (LBD). The main outcomes were the initiation of the LDWG group and the acceptance of a recommended EXPRESS-to-OWL conversion procedure for obtaining an ifcOWL ontology from the IFC schema, a significant outcome towards enabling BIM Linked Open Data.

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List of Abbreviations

BIM	Building Information Modelling
BIM-LD	Building Information Modelling – Linked Data
BIM-LOD	Building Information Modelling – Linked Open Data
BLC	Building Life Cycle
BLCEM	Building Life Cycle Energy Management
BMS	Building Management System
CSVW	CSV on the Web Working Group
EC	European Commission
EEB	Energy Efficient Building
ICT	Information and Communication Technology
IFC	Industry Foundation Classes
IDM	Information Delivery Manual
ISO	International Organization for Standardization
LBD	Linked Building Data
LD	Linked Data
LOD	Linked Open Data
LDWG	Linked Data Working Group
MDV	Model View Definitions
RDF	Resource Description Framework
W3C	World Wide Web Consortium

Introduction

This report summarizes the main aspects of the 3rd SWIMing workshop, held on Thursday 17th September, 2015, at the University Campus of Savona, Italy and aligned with Sustainable Places. It also details activities at two related VoCamp workshops; the first on the 14-15th of September, hosted by Ready4SmartCities and held in Genoa, Italy and the second on the 15–17th of December, hosted by the SEAS project in Paris, France. Finally, a short report is provided regarding the BuildingSMART Conference held on the 12-15 October 2015 in Singapore. The next sections describe each of these workshops.

Sustainable Places Workshop

Sustainable Places took place from Wednesday 16th to Thursday 17th September, 2015, at the University Campus of Savona, Italy. Sustainable Places sets out to tackle major issues around energy efficiency at building, district and city levels. Information and Communications Technologies (ICT) along with other key research domains (energy, materials, methods and practices, etc.) were at the core of the conference. It has been running for three years, and this year it brought together around 150 representatives from Europe and around the world to engage in networking and clustering among projects funded in the framework of the FP7 and H2020 EeB PPP.

This year, the event included 9 thematic sessions and 11 workshops. Here we present a report detailing Workshop 11 held on the 17th of September around ICT & open data for building life cycle energy management.

ICT & Open Data for Building Life Cycle Energy Management

The workshop was organized by Kris McGlinn (SWIMing) and Isabel Pinto Seppä (EEBERs). Due to the time constraints (two hours) the workshop consisted of one session with several talks relevant to open BIM. The session was chaired by Kris McGlinn (ADAPT), coordinator of the SWIMing project. The workshop began with a short introduction outlining the purpose of the workshop.



Figure 1: Attendance @ Sustainable Places Workshop

Javier Royo (Solintel), presented several slides related to the EEBERs project. This consisted of slides explaining the methodology that is being followed to map the technologies related to ICT that are currently being developed in the EeB domain at European level. The importance of the EEBERs project for researchers, industries, and other main stakeholders was emphasized, as it provides a means for them to see the latest ICT technologies being developed and by whom; giving the possibility to establish alliances for their future research or exploitation.

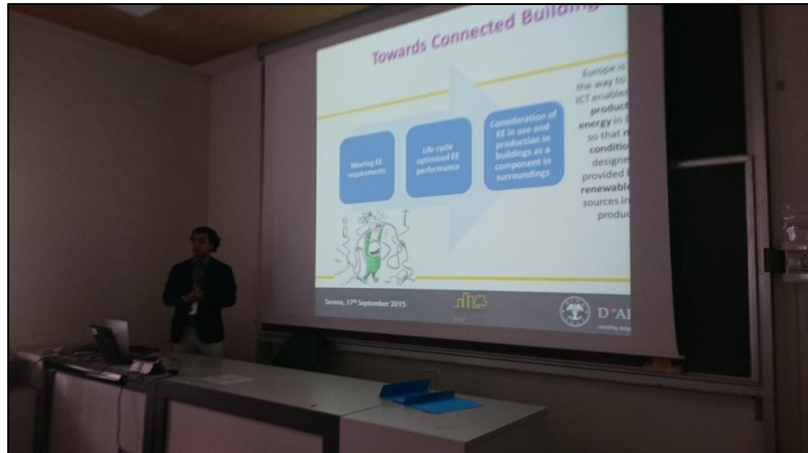


Figure 2: Andrea Cavallaro presenting main outcomes of the R4SC project @ Sustainable Places

Andrea Cavallaro (D'Appolonia), presented the main outcomes of the R4SC project. This included the Roadmap, use of Linked Open Data and the methodology employed. The main goal of the R4SC project is to deliver new data ecosystems to accommodate cross-domain data which can be exploited at a global scale. To identify a set of ontologies relevant to smart cities and different requirements and guidelines on how to use data described by these ontologies, and finally, to identify a holistic and shared vision, allowing feasible step-by-step action plans for relevant stakeholder groups to develop and use ICT-based solutions for energy systems in urban and rural communities towards future Smart Cities.

Mirkka Rekola (VTT), presented an example of applying linked data technology into interoperability in building design, construction, and facility management. The presentation gave an overview of interoperability in building processes, how linked data fits to it, and a case example of a Finnish consortium developing web based interoperability into building design software. Project Drumbeat targets to take building information management into web.

Kris McGlinn (Adapt Centre, Trinity College Dublin), coordinator of the SWIMing project, introduced SWIMing to the audience. Some of the issues related to interoperability across the building life cycle and some of the potential benefits of technologies like Linked Data were described. The LBD wiki was also introduced as a common forum, accessible to anyone and editable by members of the LBD group. The LBD group therefore facilitates access to key players in the BIM and linked data field and this interaction has resulted in

the creation of a set of guidelines for projects to follow when developing new use cases, to better support interoperability both within the project and beyond.

Giammario Incao (S.p.A.), gave a presentation on the EPIC-HUB project. He described the specific use cases the project sets out to address, which are related to energy efficiency, self-generation, emissions reduction, and novel solutions to exploit excess energy generated and unused/unshared storage potential, often available at the neighborhood community level. The aim is to improve energy performance of neighborhoods by combining optimization with seamless integration of pre-existing ICT systems deployed across several buildings in the EU. He also discussed the Energy Hub Model which describes the couplings and interactions between different energy carries.

Walter Terkaj (ITIA), gave a presentation on "Advances in ifcOWL standardization: technical overview" which focused on the potential benefits coming from the integration of Building Information Modeling (BIM) and Semantic Web technologies. In particular, the presentation provided details about the initiative for the development of a recommended ifcOWL ontology, i.e. an ontology version of the Industry Foundation Classes (IFC) standard that represents one of the main references in the BIM domain. Also, guidelines for the development of ontology-based software tools were discussed. Finally, an application scenario exploiting ifcOWL in the context of industrial sustainability was outlined.

The session concluded by opening up the floor to open questions and open discussion, the main conclusions of which are detailed next.

Conclusions and Next Steps

The workshop highlighted a number of barriers facing those who wish to improve the interoperability of their solutions and made their data models more accessible.

Some of the identified challenges for use of building data were:

- Representing geometrical data in the Web of Data
- Link generation
- Change discovery (lots of blank nodes in RDF converted from IFC)
- Complex systems with lots of cross-utilization of models need methods to keep track with origin of information
- Security of data
- Provenance of data, authorship and trust.

Some of the barriers to the use of IFC and other building data ontologies which were identified were:

- Lack of awareness of existing standards and ontologies
- The amount of effort to develop and maintain IFC models against the perceived return on investment

The main conclusions of the workshop were that there needs to be greater awareness of existing standards, for example IFC, and that projects which are developing new data structures to meet their needs should look first to map these as best they can with existing



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data structures, and where possible, use existing standards to meet their data requirements.

The next steps therefore for the SWIMing project are to begin further engagement with projects with respect to their business use cases and the identification of standards and models which they are employing. To this end, an online tool is being employed called the ReqCap tool to begin the process of capturing specific data requirements to meet use cases and exploring mappings to existing standards and ontologies. This process has the following objectives.

- For existing projects which already have well defined data models, and may be employing existing standards and ontologies, it serves as a means to align specific use cases with those data models in such a way as to become a quick reference point for other projects thus improving interoperability as more projects begin to harmonize their use case data requirements and make use of shared vocabularies.
- For projects which have data models developed but have not made any alignment to existing standards or ontologies, the process will help with the identification of alignments and thus support the publishing of those data models using those standards and ontologies, again, supporting interoperability beyond the scope of the project.

This process was employed at the Paris VoCamp and is described in more detail in section 'SEAS VoCamp, Paris' below.

A questionnaire was also passed amongst attendees of the workshop, and the results of this questionnaire have been collated with previous results and have been published together in D3.2 'Cluster building and dissemination report year 1' and D3.5 'Report on the swimming Cluster and Community portal – Phase I' [1], [2].

R4SC VoCamp, Genoa

Introduction

In this section we include a short report on the participation of SWIMing in the Ready4SmartCities VoCamp on "supporting open linked data and interoperability for efficient energy systems in smart cities" which took place at D'Appolonia offices in Genova, the 14th and 15th of September 2015. The event was organized by D'Appolonia and CSTB with the support of INRIA and AEC3 project partners. Its focus was on the ontology matching process and analysis, as well as the discussion of the matching process between the SAREF and ifcOWL ontology. 16 participants attended. The main report is to be published by the R4SC project. Here we give a synopsis with a focus on the work conducted by SWIMing.

Description of the VoCamp

The main focus of the VoCamp was to examine the ontology matching process and to analyze and discuss the results of applying an ontology matching process which consist of an alignment of concepts between two ontologies, ifcOWL and SAREF. The first day consisted of presentation sessions to give the attendees a general overview of the



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VoCamp and its goals, to inform them about the activities of the two CSAs (R4SC and SWIMing), and for participants to present some example use cases as a basis for the following alignment sessions.

IFC-SAREF Alignment Session

SWIMing gave two presentations on day 1, the first by Kris McGlenn (TCD) which was on the SWIMing project and was similar to the presentation described above. The second was by Matthias Weise (AEC3) and focused on the methodology to formalize and describe these use-cases as detailed in the Information Delivery Manual (IDM) and Model View Definitions (MVD) as standardized in the frame of BuildingSmart International activities, and how SWIMing is basing its methodology on this approach and applying it to the area of EeB.

Day 1: Presentations

Of particular relevance to SWIMing was the examination of alignments between IFC and SAREF. This took place as a hands-on session on the second day. It began by identifying some relevant use cases identified on the W3C LBD wiki, with a focus on a use case dealing with “Building Energy Management” and the use of IFC4 and SAREF. Concepts within the two schemas were identified and the group was broken into four sub-groups, with SWIMing leading one of these. Each group was tasked with identifying alignments between a sub set of concepts with similar naming conventions.

Day 2: IFC-SAREF Alignment Session

This process highlighted some of the difficulties when aligning such models, as even when experts were present it was often hard to come to agreement about relationships between objects in IFC and SAREF. For example, the question of whether `IfcDoor` is a subtype of `Saref:BuildingObject` was raised. It would be the case if all `IfcDoors` are building objects. But within SAREF the `saref:BuildingObject` concept for building objects is described as follows ‘A building object is an object in the building that can be controlled by devices, such as a door or a window that can be automatically opened or closed by an actuator.’. SAREF therefore appears to only count objects with an actuator, so then this statement is not really true because “manual” doors are not SAREF:BuildingObjects (in a strict sense).

The other sub groups also made interesting findings with respect to their data modelling requirements, for example the identification of the O&M ontology for describing data measurements. These can also be found in the full report document.

Conclusion and future work

The main conclusion from the perspective of SWIMing was with respect to the difficulties of generating mappings between ontologies. This is an ongoing research problem, and something which is being addressed within BIM through methodologies like the IDM and MVD. These provide a formal way to identify data requirements at a conceptual level before mappings are made to existing ontologies by the appropriate domain expert. SWIMing therefore decided to base its own methodologies for use case and data requirements capture on IDM and MVD, and make use of the AEC3 tool ‘Requirements

Capture' tool to capture data requirements within projects. This methodology has been applied in the Paris VoCamp, discussed next.

SEAS VoCamp, Paris

Introduction

The VoCamp in Paris, France on the 15–17th of December, was organized by the SEAS project and had 50 participants over three days. This consisted of three half-days of plenary sessions with keynote speakers, and six 90 minute parallel working sessions which were animated by knowledge experts. SWIMing took on the task of animators for a 3 one and a half hour session with members of the SEAS project using the ReqCap tool to capture use cases. SWIMing also led one of the technical sessions giving a tutorial on the use of CSVW for publishing measured data as RDF.



Figure 3: Keynote Speech @ SEAS VoCamp on 'Semantic Web and the Web of Data' by Raphaël Schoentgen



Figure 4: Attendance @ SEAS VoCamp, Paris

Description of the VoCamp

SWIMing once again gave two presentations on day 1, the first by Kris McGlinn (TCD) was on the SWIMing project and was similar to the presentation described above. The second was by Matthias Weise (AEC3) again, similar to the above. These presentations again introduced the participants to SWIMing and the methodology for use case capture and data requirements identification. Both presentations can be viewed on the SEAS web portal for the workshop¹.

Use Case Capture Session

There were three use case sessions led by SWIMing (Matthias Weise, Kris McGlinn and Hendro Wicaksono). In these sessions use cases were explored and the different data requirements captured using the ReqCap tool. Participation ranged from 7-10.



Figure 5: ‘Smart Building and its interaction with the Environment’ Session @ SEAS VoCamp, Lead by Matthias Weise

The methodology for this process is addressed in D2.2 [3] and two of the use cases explored during these sessions are detailed. These are explained briefly here:

“Reducing energy consumption for energy constrained RF communication between devices for monitoring”: This use case is concerned with reducing the energy consumption required for RF communication between devices through the use of a lightweight message format. Here we focus on data for monitoring although potentially this should be extended for command data for device configuration and control (see next use case). Additional benefits of this use case which were identified are:

- Reduce amount of storage space required for storing sensor measurements and other messages.
- Reduce time for processing messages, thus reducing risk of bottlenecks in communications infrastructure.
- Reduce bandwidth allowing more data to be transmitted for a given time period.
- A Generic communication protocol for controlling building devices to manage building energy consumption

¹ <http://data.the-smart-energy.com/workshop/2015/12/report.html>

‘A Generic communication protocol for controlling building devices to manage building energy consumption’: This use case is concerned with controlling devices in buildings through generic message structures. All messages are related to command and control and as such only messages communicated by the device back to the ‘controller’ in response to received messages are considered.

For both use cases, four classes were identified of relevance along with several class properties for each class. Some initial mappings between these and existing ontologies were suggested. These can be found described in greater detail in D2.2 [3].

Technical Session: CSVW for Tabular Data to Manage Energy Efficient Buildings.

The technical session was a repeat of the technical session held in the LDAC Workshop in Eindhoven (see D3.8 [4]). There were eight participants involved in the session. It was presented by Kris McGlenn (TCD) and was concerned with managing building data generated by sensors and simulation software and stored in formats which provide little description of the actual data (e.g. CSV, XML, JSON). CSVW is a simple way of providing semantic meaning for CSV values in a JSON document [3]. CSVW allows for the conversion of data into a single format (RDF), meaning that it can be easily interlinked with other relevant data, and also developers no longer must write multiple types of structured queries as SPARQL can be used for all.

The tutorial demonstrated how to convert tabular data into RDF and query that data to meet a specific use case in the Energy Efficient Building domain. Participants got to examine sample data sets (CSV files) and then write a CSVW file to add and link to additional semantics. They then converted the CSV data into RDF, linked that data to another open linked data source and finally, conducted some simple visualizations of the data using SPARQL, a Fuseki server and some HTML5 and JavaScript libraries. The participants were very engaged in the session and were happy to see some practical uses of RDF through the application of HTML5 web services.



Figure 6: CSVW Technical Session @ SEAS VoCamp, Lead by Kris McGlenn

Conclusion and future work

The SEAS VoCamp provided a perfect opportunity to test the steps of the methodology being refined within the SWIMing project for capturing use cases and identifying data requirements. The hands-on session with the different domain experts demonstrated the usefulness of the process for clarifying their thoughts with respect to the types of data that they require in order to meet their specific use cases. People were very open to discuss their different modelling requirements and indicate what aspects of the data were important to them. It was the conclusion of the SWIMing members that this process could be an important first step in projects for the different domain experts to align their different data requirements.

It also gave the opportunity to discuss different data model standards that are available to meet the requirements. So far, it is these face to face encounters that have proved to be the most useful with respect to defining data requirements. Combined with teleconferences, the SWIMing project will continue to identify and add use cases to the wiki and ReqCap tool.

BuildingSMART International Standards Summit

Introduction

The BuildingSMART International Standards Summit is an international event organized by BuildingSMART International, which is an organization that is responsible for devising international data models that are of use for the global construction industry (Architecture, Engineering and Construction – AEC). The proposed data models are evaluated in great detail by many researchers, institutes and (construction) companies over the entire world, before they are accepted as Final International BuildingSMART Standards. These final standards are proposed to the International Organisation for Standardisation (ISO), which is in charge of / entitled to effectuating the proposed standards as ISO standards. The most well-known existing BuildingSMART International standard is the Industry Foundation Classes (IFC), which provides a data model for capturing information in a Building Information Model (BIM) in a neutral and open fashion.

The BuildingSMART International Standards Summit occurs twice each year. During this meeting, the diverse ‘rooms’ of the organization are responsible for presenting the progress that they made over the last half year. There are now 5 rooms in the organization:

- Technical room
- Regulatory room
- Product room
- Building room
- Infrastructure room

Pieter Pauwells participated in this event as one of the two chairs of the BuildingSMART Linked Data Working Group (LDWG), as one of the two chairs of the W3C Community Group on Linked Building Data (LBD), and as a representative of SWIMing.

Original objective(s) of the participation in the Summit

Pieter Pauwels participated primarily in the Technical Room. The main objective for his presence in the Summit was to propose:

1. The official initiation of the BuildingSMART Linked Data Working Group (LDWG), chaired by Jakob Beetz (TUEindhoven) and Pieter Pauwels.
2. The acceptance of a recommended EXPRESS-to-OWL conversion procedure for obtaining an ifcOWL ontology from the IFC schema.

Achievements

The two listed proposals have been accepted and both decisions have been published in the buildingSMART International web platform (<http://www.buildingsmart-tech.org/>). These are two very important achievements for the W3C Community Group on Linked Building Data, as well as the SWIMing H2020 project. Namely, the acceptance of these two cornerstones allows the LDWG to look further into standardization of data models for supporting various use cases in the construction industry and beyond the construction industry that rely on multiple data sets. Devising, standardizing, supporting and enabling these use cases are some of the key objectives of the SWIMing project and the W3C LBD Group. Hence, the LDWG is taking shape as a far more solid partner in the SWIMing project and the W3C LBD Group.

To be more specific, the Charter of the newly accepted LDWG includes the following scope statement:

- *The LDWG will work on the following projects after initiation, in close collaboration with the existing groups and working rooms:*
 - *ifcOWL – an Ontology Web Language (OWL) representation, mapping and transformation of the Industry Foundation Classes for different past and current versions (2x3, 4 and their addendums). Currently this includes a conversion of the schema. Future work recommendations will also touch upon the issue of instance file conversion into RDF with different serialization formats (RDF/XML, TTL, N3, NTriples etc.)*
- *Explorations & collaborations within BuildingSMART:*
 - *Product Room: bSDD*
 - *Explore integration/coupling of bSDD with ifcOWL*
 - *Explore publication, processing of bSDD as Linked Data*
 - *Regulatory Room: formal representation of rules*
 - *Building Room: MVD development*
 - *MSG: Close collaboration on schema evolution and technical aspects*
 - *Technical Room: Contribution to discussions over future roadmaps*
 - *Integrated Digital Build Environment: Contribution to discussions and strategical roadmapping*
- *supporting use cases beyond the buildingSMART rooms:*
 - *OGC (Geography)*
 - *SWIMing (EU Project around Energy Efficiency)*
 - *SAREF (EC & TNO deliverable around Smart Appliances)*

- *ReadyForSmartCities (EU CSA project with a number of deliverables on Energy Efficiency)*
- *DURAARK (EU project around Digital Preservation)*

Conclusion and future work

In conclusion, the LDWG will outline how the main ontology in construction industry (ifcOWL) can be combined with key ontologies in related domains in our built environment (OGC Geography, SWIMing energy efficiency, SAREF Smart Appliances, bSDD Building Products and Manufacturing Data, buildingSMART Infrastructure). This will be an invaluable source for the SWIMing project to build upon in supporting the implementation of use cases for energy efficiency in our built environment throughout Europe.

Overall Conclusion and Future Work

The SWIMing project, through the organization and attendance of workshop events, has been building greater awareness among industrial and academic stakeholders about the developments of an open BIM approach for building lifecycle (BLC) energy management processes and more generally, on standards and interoperability. In particular, it has been engaging with EU EeB funded projects in order to identify data requirements and alignments with these to existing standards and ontologies. Finally, it has been engaging with standards bodies to explore the certification of an existing standard (IFC) into ifcOWL, thus further facilitating the Linked Data approach to open data for BIM.

The main outcomes of the workshop and associated events have therefore been to:

- Increase awareness of the advantages of open BIM and the use of standards
- Further identification of use cases to meet BLC energy management processes
- Identification of use case data requirements
- Initial mappings of use case data requirements to existing standards and ontologies
- Steps towards the certification of ifcOWL

The next steps for the SWIMing project will be to continue engaging with EU EeB projects in the process of capturing use cases, identifying data requirements and mapping those data requirements to existing standards and ontologies. It will also continue to encourage and support projects to publish their data models and support the dissemination of their developments among the wider open BIM community.

Bibliography

- [1] P. Ioanna, K. Nikolaos, D. Tzovaras, and K. McGlenn, “SWIMing: D3.2 Cluster building and dissemination report year 1,” 2016.
- [2] P. Ioanna, K. Nikolaos, D. Tzovaras, and K. McGlenn, “SWIMing: D3.5 Report on the SWIMing Cluster and Community portal – Phase I,” 2016.
- [3] M. Weise and K. McGlenn, “SWIMing: D2.2 Guidelines and best practices for BLCEM process and data management - Phase I,” 2015.
- [4] D. Tzovaras and K. McGlenn, “SWIMING : D3.8 2nd Workshop Report,” 2015.