2019

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Linda van den Brink

Erwin Folmer

Kai Jakobs

32ND BLED ECONFERENCE
HUMANIZING TECHNOLOGY FOR A SUSTAINABLE SOCIETY
JUNE 16 – 19, 2019, BLED, SLOVENIA, CONFERENCE PROCEEDINGS
A. Pucihar (ed. et al.)

University of Maribor Press

On Multi-Disciplinary Standardisation – The Case of Spatial Data on the Web

LINDA VAN DEN BRINK, ERWIN FOLMER & KAI JAKOBS

Abstract With the emergence of smart applications multi-disciplinarity is becoming an issue in standards setting, as is the need to involve a broader range of stakeholders in the process. One approach to accommodate these needs is the creation of dedicated multi-disciplinary Working Groups (WGs). Following some theoretical deliberations about today's standardisation environment in general and the need for multi-disciplinarity in standardisation we present a case study of one such joint multi-disciplinary WG. It turns out that this joint WG is seen as both necessary and helpful by those involved. It also turns out the broader organisational setting needs to be adapted to better address the needs of such joint WGs.

Keywords: • Standardisation • Open Geospatial Consortium • W3C • Multi-Disciplinarity • Spatial Data •

CORRESPONDENCE ADDRESS: Linda van den Brink, PhD, Geonovum, Amersfoort, The Netherlands, e-mail: l.vandenbrink@geonovum.nl. Erwin Folmer, PhD, Kadaster & Unibersity of Twente, Apeldoorn, NL & Twente, The Netherlands, e-mail: Erwin.Folmer@kadaster.nl. Kai Jakobs, RWTH Aachen University, Aachen, Germany, e-mail: kai.jakobs@cs.rwth-aachen.de.

DOI https://doi.org/10.18690/978-961-286-280-0.25 ISBN 978-961-286-280-0
Dostopno na: http://press.um.si

1 Introduction and Some Background

In the past couple of years we have witnessed a development that is going to have major ramifications for society – the merger of Information and Communication Technologies (ICT) with well-known application areas like transport systems, manufacturing or power supply. The resulting 'smart' applications include, for example, Intelligent Transport Systems (ITS), Smart Manufacturing, e-health and Smart Cities.

While these applications represent the most popular outcomes of the injection of ICT into 'traditional' applications, similar developments are going on elsewhere as well. One example would be the educational sector, where the deployment of ICT enables new ways of teaching and learning like 'distance learning', 'blended learning' and 'e-learning'. These methods offer more flexibility to the students, allowing them to better align studying with e.g. work and family life.

Another such example, which will be discussed in more detail below, is the geospatial community and their technologies. In this field, multi-disciplinarity has a long tradition. Aerial photography started to become relevant for cartographers in the 19th century, later on followed by satellites. The use of computers and networks eventually led to geographic information systems (GISs), which may help analyse rather complex socio-economic and environmental phenomena (see e.g. [Krellenberg et al., 2013]).

The above examples show that 'no discipline is an island'. The development and thus the standardisation of smart applications requires co-operation of experts from very different disciplines. For ITS, for example, disciplines to be involved include e.g. Transport Telematics, Traffic Engineering, Power Engineering, Automotive, Computer Science and Telecommunication, but also e.g. Economics and Environmental Studies (see also Table 1 below). Contributions from just one individual discipline simply cannot adequately cover this diversity.

Likewise, in all cases globally accepted standards are a sine-qua-non for the development and eventual implementation of these systems. Standards will shape the technical development and thus, to a certain extent, the future. Therefore, a closer look at how exactly these standards emerge and if and how the

standardisation process caters for multi-disciplinarity may well enable a glimpse into the future and thus (perhaps) even help avoid undesirable outcomes.

The world of ICT standards setting itself will also be affected by these developments. For one, the multi-disciplinary nature of many systems to be standardised will pose extra problems for the traditionally rather more 'mono-disciplinary' ICT standardisation process[1]. It will require co-operation between standardisation entities and individuals from very different backgrounds with equally different cultures. Standardisation experts will have to discuss the integration of technologies with very different life cycles, equally different legal boundary conditions (think Intellectual Property Rights, IPR) and diverse societal ramifications. On top of that, the latter will mandate the co-operation of societal stakeholders who are not normally represented in technical standardisation at all.
Many smart applications are highly likely to become truly omnipresent. Specifically, GISs will form an indispensable building block of the infrastructure supporting smart applications and may also serve as stand-alone applications in their own rights. This requires the widest possible participation of stakeholders in the standardisation process. This inclusiveness will also help increase the eventual standards' legitimacy and thus contribute to a higher degree of their acceptance.

The need for both multi-disciplinarity and inclusiveness raises the question whether or not the current standardisation system provides an adequate platform for such multi-disciplinary, multi-stakeholder standardisation or if new mechanisms and/or new standards setting entities need to be established and if so, which ones.

This paper focuses on the field of geospatial technologies. There are three motivations for this not exactly obvious choice. For one, these technologies represent constituents of both a smart infrastructure and (stand-alone) applications. Specifically, GISs will be crucially important for a range of smart applications (including e.g. Intelligent Transport Systems and Smart Cities) and will thus contribute to a societal impact way beyond what one would normally

[1] By way of an example: For the standardisation of IEEE 802.11 Jakobs et al. [2011, p. 98] oberved that "*Almost all the respondents have a strictly technical background, with job titles such as 'communication engineer' or 'system architect*'".

associate with geospatial data. Moreover, the level of multi-disciplinarity is rather high compared to what you will find in most standards working group (disciplines represented include cartographers, geologists, meteorologists and computer scientists), but still manageable. More importantly, the Open Geospatial Consortium (OGC) had established a co-operation with the World Wide Web Consortium (W3C) in the form of a joint working group (WG). Jakobs [2018] identifies such dedicated WGs as one potential mechanism for addressing multi-disciplinary standardisation for smart systems. This joint WG represents a real-world case in a very similar setting where effects and outcomes of such a joint endeavour may be analysed.

The remainder of the paper is organised like this: Following brief discussions of the current standardisation environment and the need for multi-disciplinarity in standards setting, respectively, the paper will study the OGC/W3C WG in detail by explaining the research approach, providing the detailed formal description of the situation and discussing the outcome of a survey held among participants. The final discussion and conclusions will integrate the respective insights.

2 The Standardisation Environment – A Very Brief Recap

Most industry sectors have a rather simple standardisation environment. A number of National Standards Organisations (NSOs) contribute to the work of ISO and IEC at the international level. An additional regional level in between has been established in Europe through the European Standards Organisations (ESOs).

The situation is different for ICT (specifically in telecommunication). This sector is characterised by a number of national/regional bodies and, particularly, by more than 250 private standards setting consortia[2] . The number of consortia and the complex links that exist between them and the Standards Developing Organisations[3] (SDOs) yield an almost impenetrable maze of Standards Setting Organisations[4] (SSOs). Figure 1 gives a rough idea of this complexity.

[2] Like the W3C or the OGC.
[3] 'Formal' or accredited bodies like ISO, IEC, ITU.
[4] Both private consortia and SDOs are SSOs.

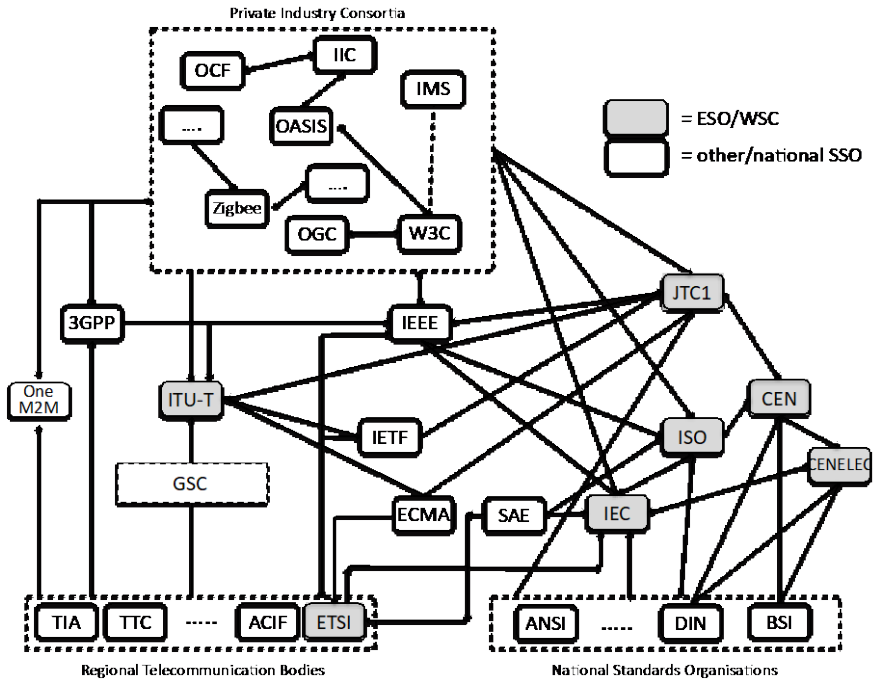

Figure 1: The web of relevant SSOs (excerpt, in terms of both entities and links; adapted from [Jakobs, 2017]).

The figure shows an excerpt of the web of the major relevant SSOs. These SSOs differ widely in terms of e.g. coverage (both topical and geographical), processes, by-laws, voting procedures, IPR policies and membership bases. ISO, for example, covers all areas of standards setting except for electro technology (covered by IEC) and telecommunication (covered by ITU); its membership base comprises national standards organisations (NSOs). In contrast, the IETF focuses on standards for the Internet (with individual 'membership'), the W3C on web standards, the Global Learning Consortium (IMS) on standards for e-learning and the OGC on standards for the geospatial community; the membership bases of the latter three are made up of companies, universities, research institutes and (in the case of OGC and W3C) governmental and other organisations.

The figure also shows some of the links that exist between SSOs. Generally speaking, such a link represents some level of formal co-operation. Such co-

operation may take the form of an information exchange about planned new work items, the joint development of standards or anything in between. These links currently represent the most important (distributed) formal co-ordination mechanism in standards setting.

Not least for readability reasons the figure does not include the various national, domain-specific organisations that develop e.g. national profiles based on the international standards for individual domains. There are about thirty such organisation in the Netherlands alone. Folmer et al. [2011] discuss how to deal with and to manage this variety from a Dutch perspective.

3 The Need for Multi-Disciplinary Standardisation

Multi-disciplinarity is not an entirely new phenomenon in the ICT domain. After all, ICT itself is the outcome of a merger of Information Technology (IT) and Telecommunication. The former is mostly the domain of computer scientists, the latter of telecommunication engineers. Despite the differences that may be identified in the discipline-specific approaches and tools these disciplines are still close enough to enable a comparably seamless co-operation (similar backgrounds, terminologies and mind sets). Nevertheless, in standards setting the two domains never really converged. On the bottom left hand side of Figure 1 you will find the SSOs active in telecommunication, with rather limited links to their counterparts active more on IT or the application side.

Things become much more complex when more diverse disciplines (and stakeholders) are (or should be) involved. Table 1 gives three examples of the diversity of stakeholders that should be involved in the standardisation of Intelligent Transport Systems, e-Learning and Geospatial Technologies, respectively. Some of the disciplines identified for the latter two are not normally involved in standardisation at all. It can easily be imagined that finding a common ground in such cases will be problematic and thus time consuming.

Table 1: Disciplines involved in different application areas (no claim for completeness)

Intelligent Transport Systems	e-Learning	Geospatial Technologies
Transport Telematics	Pedagogy	Cartography
Traffic Engineering	Management Sciences	Geology
Power Engineering	Psychology	Meteorology
Automotive	Information Studies	Linguistics
Computer Science,	Computer Science	Information Systems
Telecommunication	Telecommunication	Computer Science
Logistics	…..	…..
…..		

'Disciplines' is one dimension of diversity in the standardisation activities shown above, 'stakeholders' is another one. The development of standards that are not just technically sound but also economically viable, sustainable and of societal value will necessitate the involvement of an extremely wide range of stakeholders. In addition to representatives of the numerous technical disciplines listed in Table 1, these include other groups that are not normally represented in standards setting: e.g. citizens, professional associations, NGOs and unions.

As mentioned above, standardisation has typically been rather mono-disciplinary. Moreover, at least the ICT sector has traditionally been dominated by large vendors. Accordingly, the meaningful involvement of 'non-standard' disciplines and stakeholders is a non-trivial task.

This involvement may materialise in different forms. Co-operation between different more or less 'mono-disciplinary' WGs could be an option. In this case, individual activities could continue as usual, problems would occur 'only' at the interface between the WGs. These problems might, for one, stem from different boundary conditions of the individual WGs. Those in ICT standardisation are different from those in most other areas. Reasons include, among others, ICT's typically short technology life cycle (compared to e.g. geographic information), that necessitates a speedier process. Different standardisation 'cultures' represent a related problem. In ICT, the amount of money that frequently is at stake may

well lead to a more competitive environment. Plus, the inter-WG communication problem as well as the issue of broad stakeholder involvement in the individual WGs would persist.

Joint participation in a dedicated individual WG would be another option. In this case as well, problems likely to be encountered will relate to the actual active involvement of primarily the non-technical stakeholders and the lack of common ground and of mutual understanding. These are problem generally encountered in multi-disciplinary co-operation (see e.g. [Bruce et al., 2004]) and standardisation is no exception. On the other hand, once these difficulties have been overcome this setting would experience less friction losses than the one above.

4 Approach

In the previous sections we discussed multi-disciplinary standardisation from a generic, broad and rather more theoretical perspective. In this part we will dive deeper into the subject by studying a specific case in the geospatial domain. In this section we will explain why we selected this case study and which research method we applied. This is followed by a description of the situation in section 5; the results of the survey are being presented in section 6.

The research approach we applied is a case study approach, with some action research characteristics. The case study allows us to do a specific in depth qualitative study (Yin, 1984) on the standardisation process of the multi-disciplinary OGC/W3C working group (WG). This research also features some 'action research' components as one of the authors was intensively involved in this WG. Based on this involvement we had the opportunity to organise a survey among the participants of the WG. The combination of Action Research and Case Study research allowed us to gain in-depth knowledge, however the lack of repeatability and rigour is seen as disadvantage of action research (Baskerville & Wood-Harper, 1996).

The case study at hand is the OGC/W3C Spatial Data on the Web Work Group (https://www.w3.org/2015/spatial/wiki/Main_Page).

Our research goal is to learn about the need for multidisciplinary standardisation, the setting in practice, and the future plans

The questionnaire consisted of 10 open questions in 6 themes. It was sent out to the WG, a total of 90 e-mail addresses. The survey was sent to all members that had been participating in the working group at a certain point. Since the working group was quite dynamic, several people were only active for a minimum time. Others were following the work, but not participating actively. Also several e-mail addresses bounced. We received six (mostly extensive) responses, which were used for the analysis in section 6. The responses (e-mails) were anonymously processed and used, the respondents were all heavily involved in the Work Group; half of the respondents from W3C perspective, while the other half either both W3C/OGC or OGC affiliation.

5 Description of the Situation

For sections 5 and 6 we use the same structure: First, we study the problem/need for which the multi-disciplinary WG was needed. Second, we study the organisational setting in which the WG had to work, and third we look at how the WG worked in practice. Finally, we discuss the future aspects of the WG.

Problem/Need

In many ways OGC and W3C are comparable standards organisations. Both were founded in the late nineties, are concerned with technical standards, and are member driven organisations that publishing open, freely accessible standards. The OGC is focussed on standards for publishing geospatial data and services. The W3C is focussed on standards for the world wide web. As described in [Taylor and Parsons, 2015], both organisations recognised a need for co-operation when it became obvious that OGC needed input from the Web standards community in order to enable the dissemination of geospatial data to a larger audience, beyond the geospatial domain. The W3C, in turn, needed input from the geospatial standards domain in order to make spatial data a native member of the Web.

The organisational setting/construct

To address the need for co-operation, OGC and W3C created a joint working group, the Spatial Data on the Web working group (SDWWG), in 2014. On the W3C side, this was a Working Group – a group mandated to produce standards. On the OGC side, it was a subgroup of a Domain Working Group – not a group officially in charge of producing standards. The 'real' WG was thus living within the W3C organisation. To become a part of the WG, one had to be a member of either OGC or W3C. It was also possible to join without being a member of either, but this was an exception. The W3C standards creation process and tools were used. All OGC members who joined the WG were given 'invited expert' status by W3C staff so that they could access W3C member-only resources and attend meetings. Upon joining the group, participants had to declare to have reviewed the W3C process document[5] on individual participant qualifications, Invited Expert participation in a WG and good standing and to agree with the participation conditions in the charter and the W3C patent policy.

The W3C tools for a WG include two mailing lists (one public, one publicly archived but only usable by group members), a GitHub repository for file storage and issue tracking, used in combination with ReSpec for collaborative open document authoring, the WebEx conference tool, IRC to chat and mainly to record minutes during meetings, another issue and action tracker which could be easily managed using IRC during meetings, and a wiki for publishing working group minutes and group documentation.

In order to satisfy legal requirements of both SSOs, every meeting started with a patent call. The intellectual property rights policies by OGC and W3C were compatible. In the W3C process, group participants are made aware of the IPR policy when joining the group; in the OGC process attendees have to be made aware of it at the start of each (virtual or physical) meeting.

[5] The then current W3C process document can be found at https://www.w3.org/2014/Process-20140801/.

The working group in practice

The working group charter stated that every effort would be made to have at least two face to face meetings each year, one at an OGC meeting and one at a W3C meeting. The two SSOs have different meeting frequencies, and both have varying meeting locations related to member organisations who offer to host. The W3C has one annual meeting where the working groups have the opportunity of organising a face to face meeting: the TPAC (Technical Plenary / Advisory Committee) meeting. During the years the working group was active, they met each year at the annual TPAC meeting. The OGC has four meetings per year where WGs can meet: the OGC TC (Technical Committee) meetings. The working group polled its members to determine the best suited OGC meeting in each year. In practice, if TPAC was outside Europe, an OGC meeting in Europe was selected, and the other way round. In addition, a third face to face meeting was held each year. These meetings were not hosted at an OGC or W3C meeting, but by a member of the working group.

The frequency of web meetings (teleconferences) was biweekly. After a startup period it became clear that members were invested in several topics, with little overlap (i.e. members interested in one topic were often only interested in that specific topic, and less able to make active contributions on other topics). It was, therefore, decided to have a 'plenary' teleconference every other week where highlights and progress of all topics were to be discussed, and 'subgroup' teleconferences in the alternate week to discuss specific topics in depth. There were three subgroups: One working on the spatial data on the web best practice (SDWBP), one working on the Semantics Sensor Networks ontology (SSN), and one working on coverage data on the Web. Other topics, such as OWL Time[6] , were mostly collaborative efforts using e-mail and GitHub, in addition to the plenary teleconferences and face to face meetings.

The first WG meeting was a teleconference held in January 2015. The group's first product was a Use Cases and Requirements document, the first draft of which was published in July 2015; the first draft of the SDWBP followed in January of 2016. For this document, an agile process was adopted after a slow start, featuring short development cycles and many working draft releases. The

[6] Time Ontology in the Web Ontology Language (OWL).

final release was published in September 2017. SSN and OWL Time followed in October 2017. A notable detail is that these are the publication dates of these two documents as W3C standards; the same standards are going through the OGC standards endorsement process at the time of writing, after a belated start of this process.

Future

In W3C, standards WGs always have an end date. In this case, the working group got a term of two years. This was extended by six months in order to be able to finish the key deliverables, SDWBP, SSN, and OWL Time. After the closing of the working group, an 'interest group' was formed as a joint OGC/W3C group, also with a two year term. An interest group in W3C terms cannot publish standards, although it can publish other products as long as they are not 'normative'. On the OGC side this is called a domain working group. This group focuses on finding and co-ordinating standardisation topics to be addressed in the scope of spatial and web. The group can publish errata for the published standards, but cannot make other changes: in that case a new working group would have to be formed.

6 Evaluation of the Working Group

This section reports on the qualitative analysis of the survey being held among the participants of the working group. The coding of individual respondents is given in brackets.

Problem/Need

The WG originated from a workshop in which the participants made clear that the collaboration was needed. That is, the whole collaboration was driven by actual needs and bottom-up, rather than top-down, initiated by the standardisation organisations involved. From the knowledge perspective it was obvious that geospatial expertise was needed as well as Internet expertise; having both dimensions on board should be beneficial for the quality of the WG deliverables. Yet, this was also important for adoption purposes as the outcome would have the appraisal of both OGC and W3C. Interviewees' replies indicate that the collaboration was beneficial (#6) or at least necessary (#2,3,4,5).

The organisational setting/construct
Practically:

> *"In my view, the infrastructure used by W3C surpasses anything used in other standards development processes." (#1)*

which is likely the explanation why the W3C infrastructure was used and did not lead to negative remarks. Only the deviation by the WG from the W3C infrastructure, by introducing Github, was not appreciated by all:

> *"...the mess triggered by the transition to GitHub... " (#3).*

The use of the W3C infrastructure might be the obvious choice, but

> *"The environment is a bit unwelcoming for OGC members that are not W3C members though…" (#5)*

Organisationally: The original setting did not lead to major issues (at least none were mentioned), but from this response it is clear that the setting was certainly not perfect and could be improved for further collaborations:

> *"This didn't happen - thankfully - but there was always the possibility that one SDO would refuse to formally publish a document that the other one did. There is also a potential future problem of one SDO wanting to update a standard without the involvement of the other. The whole collaboration depends on goodwill and that goodwill must be institutional and not based entirely on individual relationships." (#1)*

The working group in practice

None of the respondents felt two camps of W3C and OGC members in the working group, or misunderstandings or culture issues between the W3C and OGC members. Rather, the issues mentioned relate to commitment (limited time of members and dropping in/out) and ego's as shown by the following statements:

> *"That was not a W3C - OGC split, more the presence of too many strong egos/low availability to contribute in the contributors" (#3) and*
> *"Overall experience I have to say was mixed. Mostly due to the part-timeness (of most people) and stop- start (of some people) with strong personalities." (#4)*

Although time commitment is likely to be a general problem in standardisation WGs, it might have a stronger impact for this group as both types of group members did need time to learn from the other group background:

> *"But as always, this [knowledge transfer] adds complexity and is more resource intensive." (#5).*

Future

The respondents see a future for continuation of multi-disciplinary standardisation for the spatial and web domain:

> *"It should be continued if possible. Because AR [Augmented Reality] is around the corner, and is the ultimate mix between geospatial and web concepts." (#5).*

This is also supported by the following quote:

> *"Yes, there is ample opportunity for collaboration between the W3C and OGC and also other standardisation bodies. Examples are data models/ontologies for moving objects and their environments (autonomous driving), IoT, AR/VR etc. The latter two could also involve IEEE and ISO." (#6)*

Lessons Learned

Although the respondents were critical about the process, it does not seem to have affected the produced standards as results:

> *"the group produced a set of standards and formal documents endorsed and published by two SDOs simultaneously, so that members of either community would feel comfortable using them." #1. And although our survey did not explicitly ask about quality, the first signs are positive:*

> *"the BP doco which is quite good - you should investigate how much it contributed to the adoption of linked data in Ireland (GeoHive, CSO), Switzerland ....) (#3).*

A major lesson learned is the higher resource intensity of multi-disciplinary standardisation WGs:

> *"More resource intensive overall and also individually, as more time is required to understand different domains and different processes" #6.*

This higher resource intensity leads to higher costs:

> *"the cost of running larger and more diverse groups (SDOs hubs) is higher (and possibly not sustainable for organisations like W3C). The money which could go into such initiatives is more likely to be spend through national (or European) data integration initiatives (e.g. INSPIRE, ...)" (#3)*

If improvements were made in the organisational setting, multi-disciplinary standardisation could be easier:

> *"Having been one of the people who set up the OGC/W3C collaboration I know it's much harder to do than one might imagine. But I definitely felt it was worth it and that the same principle could easily be applied elsewhere." (#1)*

and

> *"But it is hard. SDOs have membership rules, IP policies and ways of working (in public, in private, somewhere in between) and so working together does present real problems that need to be overcome." (#1)*

And then it comes down to the business model of standardisation organisations:

> *"What makes such collaborations difficult to setup or continue on a long-term basis is the business model of most standardization organizations, based on membership fees." (#5).*

By having this membership model standardisation organisations have become competitors which is not beneficial for co-operation in multi-disciplinary standardisation.

7 Brief Conclusions & Further Research

This paper touches upon the topic of multi-disciplinary standardisation by first of all providing a brief overview of the standardisation context. Multi-disciplinary standardisation will increasingly be necessary when standards are to solve real problems. A trend currently going on is that standards no longer remain within the artificial boundaries of individual SSOs. Rather, standards (will) increasingly have cross-domain characteristics. One approach to address this phenomenon are multi-disciplinary standardisation working groups through which standardisation organisations work together.

The Spatial Data on the Web Working Group is a successful example of such multi-disciplinary co-operation between the geospatial domain (OGC) and the Web domain (W3C); its outcome is widely perceived as valuable for both communities. On the one hand, this supports the call for a more centralised entity for multi-disciplinary standardisation made in [Jakobs, 2018]. On the other hand, the majority of experts surveyed there were opposed to such a new entity or new entities, typically arguing that the situation is complex enough as it is, without any additional new entities. A major difference between the two groups of experts studied in [Jakobs, 2018] and in this paper, however, is the fact that the latter have actually experienced multi-disciplinary standardisation in a new, dedicated entity (the WG). Whether or not this is the only reason for the diverging views or if other aspects are also decisive remains to be seen.

In any case, we may expect to see more multi-disciplinary standardisation WGs in the near future. With this research we hope to contribute to the knowledge base of how successful multi-disciplinary standardisation may be performed. However, from our research it also became apparent that it is not an easy task for SSOs to work together in such a way and that it may well require a rethinking of SSOs' business models. The wider organisational setting for multi-disciplinary standardisation, therefore, needs improvement. Further research on an optimal such setting is still needed. Moreover, the quality of the outcome should be studied: Did the multi-disciplinary nature of the WG lead to a better standard?

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