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On involvement in open standards: How do organisations contribute to W3C standards through editorship?

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Abstract. Over the years, a number of open standards have been developed and implemented in software for addressing a number of challenges, such as lock-in, interoperability and longevity of software systems and associated digital artefacts. Understanding organisational involvement and collaboration in standardisation is important for informing any future policy and organisational decisions concerning involvement in standardisation. The overarching goal of the study is to establish how organisations contribute to open standards development through editorship. Specifically, the focus is on open standards development in W3C. Through an analysis of editorship for all W3C recommendations we contribute novel findings concerning organisational involvement and collaboration, and highlight contributions from different types of organisations and countries for headquarter of each organisation. We make three principal contributions. First, we establish an overall characterisation of organisational involvement in W3C standardisation. Second, we report on organisational involvement in W3C standardisation over time. Third, we establish organisational collaboration in W3C standardisation through social network analysis.

1 Introduction

Over the years, a number of ICT standards have been developed and deployed for addressing a number of challenges in the area of software systems, including interoperability and longevity of systems (Lundell, 2012). In the area of ICT standardisation there are a number of efforts and different (sometimes conflicting) interests amongst stakeholders involved. Previous research shows that “companies are the most important and typically the most powerful stakeholders in (ICT) standards setting” (Jakobs, 2014). Further, it has also been argued that “the absence of important players may lead to inadequate standards” (Jakobs, 2006). In addition, previous research reports that some companies “aim to control the strategy of” a standardisation organisation, whereas other merely participate (Jakobs, 2014).

Many ICT standards are implemented in software (including several open source implementations), and in some cases open source implementations have evolved into standards (e.g. Behlendorf, 2009; Allman, 2011). However, previous research shows that some standards may not be implemented in open source software due to inability to clarify conditions for use of standard essential patents which are controlled by some of the organisations contributing to development of those specific standards (Lundell and Gamalielsson, 2015).

Challenges for ICT standardisation have also been recognised by policy makers and organisations developing standards. For example, the ICT rolling plan is an ongoing effort within the EU which recognises the importance of organisational involvement in standardisation for innovation (EC, 2015) and there are also policy initiatives within the EU which recognise the importance of open standards (EC, 2013). Similarly, there are a number of national policy initiatives, such as the national policy for open standards in the U.K. (UK, 2012; UK, 2015). Further, amongst organisations developing standards there are also efforts for how to improve ICT standardisation such as initiatives for considering open source work practices in standardisation addressed in a recent ETSI workshop¹.

From this it is evident that understanding organisational involvement and collaboration in standardisation is a challenge and is important for informing any future policy and organisational decisions on involvement in standardisation. To address this challenge the *overarching goal* of the study is to establish how organisations contribute to open standards development through editorship. Specifically, the focus is on standards development in W3C. Through an analysis of editorship for all W3C standards we investigate organisational involvement and collaboration, and highlight involvement in development of standards by different types of organisations and countries for headquarter of each organisation. We make three principal contributions. *First*, we establish an overall characterisation of organisational involvement in W3C standardisation. *Second*, we report on organisational involvement in W3C standardisation over time. *Third*, we establish organisational collaboration in W3C standardisation.

We focus on W3C standardisation since it has been claimed that W3C standards constitute an exemplar of open standards (Friedrich, 2011) and are widely deployed in software systems. All W3C standards are written in English and all communication is in English. In fact, W3C has adopted a work practice inspired by OSS development (Lundell et al., 2014; Gamalielsson et al., 2015), and work according to an open model with respect to intellectual property rights. This, in turn, facilitates participation from different types of companies and other organisations. There is limited knowledge concerning details on organisational involvement and collaboration in open standards development. To the best of our knowledge, this study contributes novel findings from the first comprehensive analysis of organisational involvement (through editorship) in all standards provided by W3C.

¹ For an overview of outcomes from the ETSI summit, see conclusions from the ETSI general chair (Hicks, 2015) and a position statement presented during the summit by the W3C Legal counsel (Wenning, 2015).

The rest of this paper is organised as follows. We present a background on W3C and previous research (section 2). Thereafter we present research approach (section 3), results (section 4), analysis (section 5), followed by conclusions (section 6).

2 Background

2.1 W3C

W3C (World Wide Web Consortium) is “an international community where Member organizations, a full-time staff, and the public work together to develop Web standards” (W3.org, 2016). Individuals and all types of organisations can become members (including commercial, educational, and governmental entities). Funding stems from membership fees, research grants and other types of public and private funding, sponsorship, and donations. There are some key components in the organisation of the standardisation process. One of these is the advisory committee, which has one representative from each W3C member and performs different kinds of reviews in the process of standardisation, and also elects an advisory board and the technical architecture group (which primarily works on web architecture development and documentation). Further, the W3C director and CEO assess consensus for decisions of W3C-wide impact. There is also a set of chartered groups (working groups, interest groups, and coordination groups) consisting of member representatives and invited experts, which assist in the creation of web standards, guidelines, and supporting materials. W3C standards evolve through different stages through work in these chartered groups (working draft, candidate recommendation, proposed recommendation, and W3C recommendation). “W3C recommendation” represents the most mature development stage, and indicates that the standard is ready for deployment and widespread use.

Development of web standards and their implementations have been characterised by ‘openness’ in terms of development, use, and provision of such technology. In the words of Bekkers and Updegrove (2013):

“Early in the development and deployment of the Web, and partly as a result of Berners-Lee’s decision not to patent its underlying technology, a culture of free license rights for Web infrastructure developed and took firm hold. Concurrently, open source software became increasingly commonly used to provide the software ‘stack’ supporting the servers that enable the Web’s existence. The result was the adoption by W3C in 2003 of an extremely license fee intolerant Patent Policy.” (p. 27)

Further, the W3C is seen as a “prime example for how Open Standards can boost innovation are the internet and the world wide web.” (Friedrich, 2011, p. 6). It is also argued that such standards constitute “a major driver for growth – both on the global scale but also regarding the many small and medium sized enterprises everywhere

that prosper because of the internet and because of implementing the standards. Included are web hosting shops, web design shops, web shops themselves, etc. Open Standards are at the core of this. They promoted the biggest boost in innovation we have seen in the last decades.” (Friedrich, 2011, p. 6)

2.2 Previous research

There are studies that address organisational involvement in open source projects but without addressing standards or their implementations. One such study explored organisational contributions to source code repositories over time for the open source modelling tools Topcased and Papyrus (Gamalielsson et al., 2011) and a different study reported results on organisational contributions to mailing lists for the open source project Nagios through analysis of email address subdomains (Gamalielsson et al., 2010). There are also studies focused on organisational aspects, for example addressing different motivations for firms to participate in open source projects (e.g. Bonaccorsi and Rossi, 2006), community building aspects in communities sponsored by organisations (e.g. West and O’Mahony, 2008), and emerging involvement of professional and commercial organisations in OSS (Fitzgerald, 2006). However, none of these studies explicate how the actual organisational participation occurs in concrete cases.

There are a few closely related studies. One of these explored Drupal and its use of the software standards RDFa, CMIS and OpenID (Gamalielsson et al., 2013) without considering organisational influences. Further, another study focused on influences between implementations of the PDF format and PDF standardisation (Gamalielsson and Lundell, 2013). Further, one study investigated influences between W3C RDFa and the Drupal implementation of RDFa through use of issue trackers (Lundell et al., 2014). There is also an in-depth study of organisational influences in the W3C RDFa standard and its implementation in Drupal (Gamalielsson et al., 2015). However, none of these studies present an overall picture of organisational involvement in all standards for a major standardisation organisation. Hence, this motivates a comprehensive investigation of organisational involvement in W3C standards.

3 Research approach

By conduct of a systematic investigation of editorship for all W3C standards that had reached the status “W3C recommendation” at time of data collection (1 Oct. 2015), we analysed organisational involvement and collaboration in W3C.

As the *first* part of our approach we establish an overall characterisation of organisational involvement in W3C standardisation using fundamental statistical metrics. In a *second* part, we report (using a similar approach) on organisational involvement in W3C standardisation over time. *Third*, we establish organisational collaboration in W3C standardisation by undertaking social network analysis

involving fundamental network metrics. A social network (represented as an undirected graph) at organisational level is gradually derived by, for each standard, creating an edge between all organisations that editors are affiliated with for the standard, and increasing the weight of each of these edges by one. Similarly, networks at the level of organisation type and country of headquarter are derived by connection (for each standard) of the mapped organisation type and country for each organisation, and by increase of edge weight by one. For all three parts, we highlight involvement in development of standards by different organisations, types of organisations and countries for headquarter of each organisation.

Data for standards (standard name, date of release, and editors & associated organisations) were manually collected from the W3C website². Mapping of organisation type and country of headquarter for each organisation was established through a systematic manual search for organisation names by use of LinkedIn³, Wikipedia⁴, or (as a last resort) Google search⁵. Custom made scripts were used to parse and analyse the data and derive results. Prior to data processing, collected data were manually cleansed in order to remove redundancy and inconsistency. Social networks were visualised and analysed through use of the Gephi software package⁶.

4 Results

4.1 Characterisation of organisational involvement in W3C standardisation

There are (at time of data collection) 248 specific W3C standards which have reached “W3C recommendation” status. The first of these standards was published 14 Jan. 1997 and the latest 24 Sep. 2015. 230 organisations in total have contributed to W3C standardisation through editorship in standards during these 19 years. There are on average 3,3 organisations contributing through editorship to each of these standards (with a minimum of one organisation and a maximum of 22 organisations). Further, 83% of the standards (205 of the 248 standards) have more than one organisation represented in the editorial board.

Table 1 shows the number (and proportion) of standards for the 15 organisations that through editorship are involved in the largest number of standards (O1 through O15). An organisation has been mapped to one of the following organisation types: Micro Enterprise (MiE, an enterprise with 1-9 employees), Small and Medium-sized Enterprise (SME, an enterprise with 10-250 employees), Larger Enterprise (LE, an enterprise with more than 250 employees), Research Institute (RI), University (Uni), Standardisation Organisation (SO), Non-profit Organisation (NPO), Public

² <http://www.w3.org/TR/tr-date-stds>

³ <https://www.linkedin.com/>

⁴ <https://en.wikipedia.org>

⁵ <https://www.google.com>

⁶ <https://gephi.org/>

Broadcasting Service (PBS), and Hospital (H). The same mapping scheme was used in Gamalielsson et al. (2015). Further, the country of the organisation's headquarter is also stated in the table (according to the ISO 3166-1 alpha-2 character scheme). In Table 1, it can be observed that the vast majority of contributing organisations (11 out of 15) are larger enterprises. Further, we note that amongst the top 15 organisations there are 12 from countries where the majority of citizens are native English speakers⁷ (United States, Great Britain, and Ireland). In particular, the United States is clearly dominating in terms of involvement in number of standards.

Table 1. Number (and proportion) of standards for the top 15 organisations

Org	O1	O2	O3	O4	O5	O6	O7	O8	O9	O10	O11	O12	O13	O14	O15
Type	SO	LE	LE	LE	LE	LE	LE	LE	LE	RI	LE	LE	Uni	Uni	LE
Country	US	US	US	US	US	US	US	US	FI	IE	US	NO	GB	GB	JP
# std	72	60	43	31	26	19	15	14	13	11	11	11	10	10	9
% std	29	24	21	13	10	8	6	6	5	4	4	4	4	4	4

The number (and proportion) of standards for different organisation types is shown in Table 2. It can be noted that large enterprises are clearly involved in the largest number of standards. An interesting observation is that small & medium sized enterprises and micro enterprises are involved in a relatively large number of standards (55 and 46, respectively).

Table 2. Number (and proportion) of standards for organisation types

Type	LE	Uni	SO	SME	MiE	RI	NPO	other	H	PBS
# std	182	79	72	55	46	30	24	15	6	2
% std	73	32	29	22	19	12	10	6	2	1

Table 3 shows the number and proportion of standards for the top 15 countries involved in W3C standardisation through editorship. In total there are 26 countries involved (in descending order in terms of involvement these countries are United States, Great Britain, Germany, Canada, Ireland, Japan, France, Finland, Norway, Netherlands, Spain, Sweden, Austria, Italy, Switzerland, Australia, Belgium, South Korea, Thailand, Chile, China, Russia, Czech Republic, Greece, Israel, and United Arab Emirates). Of the remaining 11 (of the 26) countries (excluded from table 3) Australia is involved in four standards; Belgium, South Korea, and Thailand are involved in three; Chile, China, and Russia are involved in two; and Czech Republic, Greece, Israel, and United Arab Emirates are involved in only one standard. Another observation from Table 3 is that United States is clearly dominating overall and involved in the vast majority of all W3C standards. It can also be noted that of the 26 countries involved, the majority of citizens are native English speakers in 4 of the top 5 countries. We also note that for the remaining 22 countries (except Australia), English is not an official language.

⁷ According to https://en.wikipedia.org/wiki/English-speaking_world

Table 3. Number (and proportion) of standards for the top 15 countries

Country	US	GB	DE	CA	IE	JP	FR	FI	NO	NL	ES	SE	AT	IT	CH
# std	223	52	27	21	17	16	15	14	13	12	9	7	6	6	5
% std	90	21	11	8	7	6	6	6	5	5	4	3	2	2	2

4.2 Characterisation of organisational involvement over time

Table 4 shows involvement in number of standards released over time for the top 15 organisations. We note that only the top organisation has been continuously involved in standards released since the beginning of W3C standardisation. It can also be observed that organisations amongst the top 15 have been involved in standards released during a varying number of the total 19 years of W3C standardisation⁸ (for O1 through O15 for standards released during 19, 16, 15, 9, 9, 8, 7, 6, 8, 4, 8, 6, 6, 2, and 5 years, respectively) and with a varying amount of involvement and degree of continuity.

Table 4. Involvement in number of standards released over time for the top 15 organisations

OY	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
O1	1	1	2	4	1	4	1	4	4	1	8	6	2	4	4	6	11	4	4
O2				3	1	1	1	7	2	1	6	1	4	6	10	5	5	5	2
O3				1	2		3	1	4	5	5	1	3	3	5	1	5	1	3
O4								2	1		3			6	9	5	3	1	1
O5				2	1		3	3	3	3	5	2		4					
O6								8			2	1	2	1			2	2	1
O7											2		1	2	1	4	2	3	
O8								2			2		1		7		1	1	
O9		1					1	1	1		2	1					5		1
O10											1					3	4	3	
O11				3			1	1		2		1			1		1	1	
O12												2		1	3	1	2	2	
O13								2		1			1	3		2	1		
O14													1			9			
O15								2		4	1			1				1	

Involvement in number of standards released over time for the different organisation types is shown in Table 5 (listed in the same order as in Table 2). We note that large enterprises have initially been involved in W3C standardisation for standards released in 1998 and continuously since year 2000. Further, it can be observed that organisations of different organisation types have been involved in standards released during a varying number of the total 19 years of W3C standardisation (for organisation type from top to bottom in Table 5 for standards released during 17, 16, 19, 15, 15, 11, 14, 9, 4, and 2 years, respectively) and with a varying amount of involvement and degree of continuity.

⁸ We acknowledge that due to time of data collection, three months remain for 2015

Table 5. Involvement in number of standards released over time for organisation types

TY	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
LE		1		5	4	2	5	20	8	6	15	9	8	18	16	19	20	18	8
Uni		1	2	1	1	2	1	8		1		3	3	4	5	17	20	8	2
SO	1	1	2	4	1	4	1	4	4	1	8	6	2	4	4	6	11	4	4
SME			1	2	1	3	1	3		1	6	6		6	3	3	6	9	4
MiE			3	2			1	4	1	2	1	4	1	7	1	7	1	8	3
RI		1						2	2		1	1	1		1	8	5	7	1
NPO		1	1			1	2	1	1	1		2		1	1	1	4	5	2
other								1	1	1		3	1	1	1	1	5		
H		1									1	1					3		
PBS																1	1		

Table 6 shows involvement in number of standards released over time for the top 15 countries. We note that only the top country (the United States) has been continuously involved in standards released since the beginning of W3C standardisation. Further, it can be observed that countries amongst the top 15 have been involved in standards released during a varying number of the total 19 years of W3C standardisation (for countries from top to bottom in Table 6 during 19, 13, 7, 12, 6, 9, 7, 8, 6, 9, 7, 7, 3, 6 and 4 years, respectively) and with a varying amount of involvement and degree of continuity.

Table 6. Involvement in number of standards released over time for the top 15 countries

CY	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
US	1	1	4	6	4	5	5	21	9	6	17	9	10	17	16	24	32	23	13
UK			1				2	6	1	1	1		3	8	1	11	7	8	2
DE				2				1			6			2		6	6	4	
CA				3	1	2		1		2	2	2			1	1	4	1	1
IE						2					1	3				3	5	3	
JP	1							1	3			4	2		1	1		1	2
FR	1								1				3			1	7	1	1
FI	1						1	1	1		2	1					6		1
NO												2		1	3	1	4	2	
NL	1						1	2	1			1				3	1	1	1
ES	1	1	1					1			1	2					2		
SE								1			1	1		1		1		1	1
AT																1	1	4	
IT						1					1	1	1		1	1			
CH	1							1				2				1			

4.3 Organisational collaboration in W3C standardisation

Figure 1 shows a social network representing W3C collaboration at organisational level. There are 1205 edges⁹ between 226 different organisations¹⁰, which reflects

⁹ A fully connected network would comprise 25425 edges.

the degree of diversity in collaboration overall. The degree d of a node represents number of other organisations an organisation has collaborated with. The weight w of an edge represents number of standards that two organisations (represented by the connected nodes) have collaborated in through editorship. The top 15 organisations in terms of collaboration (measured by node degree) are (in descending order) a SO ($d=132$), a LE ($d=98$), a LE ($d=69$), a LE ($d=52$), a LE ($d=48$), a LE ($d=47$), a RI ($d=44$), a Uni ($d=40$), a Uni ($d=37$), a LE ($d=30$), a RI ($d=29$), a LE ($d=27$), a LE ($d=27$), a Uni ($d=25$), and a LE ($d=25$). The top five pairs of organisations collaborating most extensively are a LE and another LE ($w=22$) followed by a LE and a SO ($w=14$), a LE and another LE ($w=13$), a SO and a LE ($w=13$), and a SO and a LE ($w=11$). The remaining 1200 edges have a weight of 8 or less. In fact, 78% (940) of all edges have a weight of one, which means that such organisational collaboration has only taken place for one single standard.

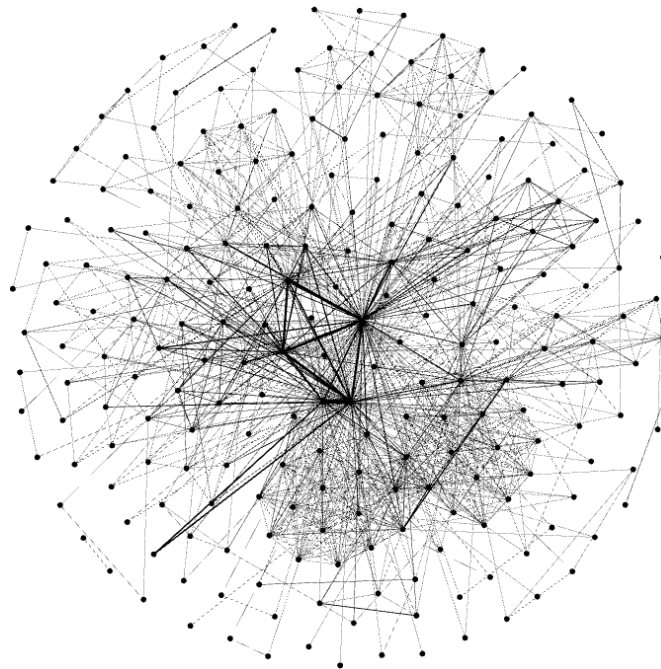


Figure 1. W3C collaboration at organisational level

A social network representing W3C collaboration at organisation type level is shown in Figure 2. There are in total 40 edges¹¹ between the 10 different organisation types, which indicates a diversified collaboration overall at this level. The degree d of a

¹⁰ Four of the 230 organisations reported in section 4.1 have not collaborated with other organisations and therefore the network contains 226 nodes

¹¹ A fully connected network would comprise 45 edges.

node represents number of other organisation types an organisation type has been associated with during organisational collaboration through editorship. The weight w of an edge represents number of standards that organisations of two organisation types (represented by the connected nodes) have collaborated in through editorship. The rank order of the 10 organisation types in terms of collaboration (measured by node degree) are (in descending order) SO ($d=9$), Uni ($d=9$), LE ($d=9$), RI ($d=9$), SME ($d=9$), NPO ($d=8$), MiE ($d=7$), PBS ($d=7$), H ($d=6$), and other ($d=6$). The top five pairs of organisation types collaborating most extensively are LE and Uni ($w=169$) followed by LE and SME ($w=156$), LE and SO ($w=129$), LE and MiE ($w=87$), and RI and Uni ($w=85$). The remaining 35 edges have a weight of 58 or less. Further, 7 edges have a weight of three or less, and one edge has a weight of one.

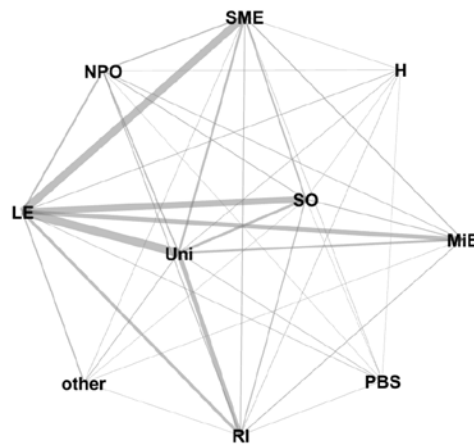


Figure 2. W3C collaboration at organisation type level

Figure 3 shows a social network representing W3C collaboration at country level. There are in total 129 edges¹² between 26 different countries, which reflects the degree of diversity in collaboration overall. The degree d of a node represents number of other countries a country has been associated with during organisational collaboration through editorship. The weight w of an edge represents number of standards that two countries (represented by the connected nodes) have collaborated in through editorship. The top 15 countries in terms of collaboration (measured by node degree) are (in descending order) a US ($d=25$), FR ($d=18$), DE ($d=18$), GB ($d=16$), CH ($d=15$), SE ($d=14$), NL ($d=14$), NO ($d=13$), ES ($d=13$), JP ($d=12$), CA ($d=12$), IE ($d=12$), FI ($d=12$), AT ($d=11$), and KR ($d=10$). The top five pairs of countries collaborating most extensively are GB and US ($w=166$) followed by DE and US ($w=104$), US and FR ($w=62$), US and CA ($w=56$), and US and JP ($w=54$). The remaining 124 edges have a weight of 43 or less. In fact, 86 edges have a weight of three or less, and 39 edges have a weight of one.

¹² A fully connected network would comprise 325 edges.

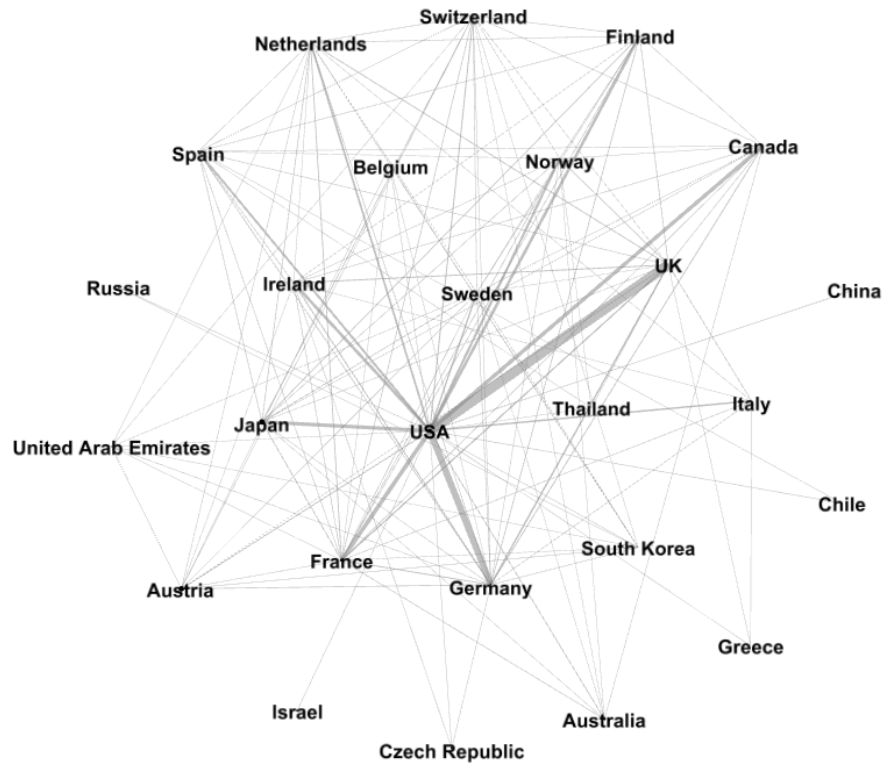


Figure 3. W3C collaboration at country level

5 Analysis

First, from the results it is clear that a standardisation organisation and larger enterprises are dominating involvement in W3C standards overall with respect to editorship. The observation that small & medium sized enterprises and micro enterprises are involved in a relatively large number of standards indicates that participation in standardisation in W3C is open and inclusive. This is in-line with earlier findings which suggest that “contributions to W3C standards have a low barrier for entry and participation“ (Gamalielsson et al., 2015).

We note that the United States and other countries where the majority of citizens are native English speakers dominate involvement in W3C standards with respect to editorship. Further, our results show rather limited involvement in W3C standardisation through editorship from Asian organisations compared to involvement from US and Europe, something which is in contrast with their corresponding involvement in IETF standardisation (Contreras, 2014, p. 915). Amongst Asian countries, Japanese organisations are the most actively involved in W3C standardisation, whereas related research shows that Chinese authors of IETF

documents are more active than Japanese (Contreras, 2014, p. 926). Further, it has been reported that China is extensively involved in development of ITU-T standards, whereas there is limited involvement in development of IETF, OASIS, and W3C standards (Jakobs, 2014b) despite a large number of users.

Second, from the results it is evident that a standardisation organisation and the United States have been continuously involved in standards released since the beginning of W3C standardisation. Other organisations, organisation types, and countries have been involved in standards released during a varying number of the total 19 years of W3C standardisation. In these results it should be noted that involvement in development of a standard in many cases takes place over several years before the year for the release of the W3C recommendation.

Third, from the results it is clear that there is extensive collaboration between different organisations, types of organisations, and countries. Further, by comparison of the top 15 organisations in terms of involvement (section 4.1) and the top 15 organisations in terms of collaboration (section 4.3) we note that 9 out of 15 organisations are in the intersection with similar rankings. This indicates that the majority of organisations with extensive involvement also have extensive collaboration. Similarly, by comparison of the top 15 countries concerning involvement and collaboration it can be noted that 14 out of 15 countries are in the intersection with similar rankings, which indicates that the vast majority of countries with extensive involvement also have extensive collaboration. Further, by comparing metric values for involvement and collaboration for the organisation types we note that rankings are similar (LE, Uni, SO, and SME are top four types in both cases).

6 Conclusions

Findings from the study show that the vast majority of W3C standards have involvement from more than one organisation (often involving collaboration between smaller and larger organisations) with respect to editorship, which is a strong indication of the open and inclusive nature of W3C standardisation. Further, findings show that involvement and collaboration in many cases include international participation from organisations with headquarters in a variety of different countries.

The study also shows that involvement stems from organisations from countries with a majority of native English speaking citizens, something which may be unsurprising given that all standards are written in English. We acknowledge that only editorship has been considered in our study. Accounting for working group participation in W3C standards development could provide for a richer picture of involvement and collaboration.

In conclusion, our study establishes novel details on, and promotes understanding of, organisational involvement and collaboration in open standards development. The findings from our study make a contribution important for informing any future policy and organisational decisions concerning involvement in standardisation.

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