The Evolution of ICT Standards Consortia

Tim POHLMANN
Cerna Mines ParisTech; TU Berlin; IPlytics GmbH

Abstract: Theoretical and empirical analyses have, as yet, shed very little light on the role of ICT standards consortia in the standard setting landscape. Standards consortia are private industry alliances of likeminded organizations that share the same interest to sponsor, develop and standardize technologies. This article is the first approach to analyze structures of a large sample of standards consortia to provide evidence on how consortia are formed, organized and why they appear or disappear in the market. Analyses reveal that standards consortia have distinct characteristics, which help to explain and justify their presence in the standard setting context. The observation of consortia existence over the last 15 years identifies relationships between the formation, termination and merger of standards consortia with respect to market and technology development. Moreover we test if organizational structures are connected to the likelihood of consortia termination. Results of a survival analysis reveal that the probability of consortia success is especially connected to structures that determine coordination among members as well as the scope and focus on technology and markets.

Key words: standards consortia, ICT industry, IP policy, technological development.

In the past years the complexity and speed of technological development has constantly been increasing. In the field of information and communication technologies (ICT) multiple market segments are subject to a high variety of products that appear and disappear in a frequent manner (DAVID, 1996). The need for technological standardization is growing (BLIND *et al.,* 2010) but the complexity and speed challenge companies in their coordination activities. Standard setting is a complex process which is dependent on consensus agreements between organizations that are often competing (BARON & POHLMANN, 2013). However, standardization may include very different approaches ranging from rather loose agreements among independent companies to the adoption of consensus based standards by formal organizations (European Commission, 2010a). Consensus based standardization may take several years and in some cases standards projects may not be able to keep up with the market pace (CARGILL, 2002). Since fast changing markets required more flexible solutions to set standards, the standardization landscape has drastically changed over the

past twenty years (UPDEGROVE, 2008). Today, not only formal standard developing organizations (SDOs) [1], but also informal industry driven standard setting organizations such as standards consortia or fora produce widely adopted standards. Other than formal organizations, which produce so called "de jure standards", standards consortia seek to establish "de facto standards", meaning, standards that gain a certain market take up (JAKOBS, 2007). For the latter we can further distinguish between a "de facto standard" developed by a single firm and a "consortia standard", where the standard is set by a group of firms (BUNDUCHI *et al.,* 2008).

Especially in the early years of ICT standardization, formal standardization had a reputation to be time consuming where the development of a standard may take several years. In comparison standards consortia were more flexible and able to anticipate technological development and thus set the standard right in time (CARGILL, 2002). Even though consortia specifications are agreed on without a formal accreditation, they can still be widely accepted and of great importance (BLIND *et al.,* 2010). However, there is no common definition for standards consortia and the consortia landscape has developed to be very heterogeneous in characteristics such as technical issues, structure, members, transparency or IP policies (HAWKINS, 1999). UPDEGROVE (2008) defines standards consortia as being "anything from a loose, unincorporated affiliation of companies, to an incorporated entity with offices, marketing, technical and administrative staff and a multi-million dollar budget". He distinguishes between *specification groups* which agree to promote an industry standard, *research consortia* with the main intent of creating and developing a technical solution and *strategic consortia* which focus on the adoption of a technology or the formulization of a yet informal common practice (UPDEGROVE, 1995). In this article we consider standards consortia, which meet the criteria set by the ISSS CEN Survey:

- The organization must be international in outlook and scope, not simply an instrument of single-nation policy,
- must have an active and international membership,

[1] Formal standard bodies that standardize ICT on a global level are: ISO (International Organization for Standardization), IEC (International Electrotechnical Committee), ITU (International Telecommunication Union) as well as the European organizations CEN (European Committee for Standardization), CENELEC (European Committee for Electrotechnical Standardization) and ETSI (European Telecommunications Standards Institute) as well as the more US orientated IEEE (Institute of Electrical and Electronics Engineers). All of these organizations have harmonized bylaws and IP rules. Also, the standard setting processes and membership structures are comparable in terms of voting procedures and consensus decision making.

- must not be set-up specifically as a single vendor, government, or proprietary technology advocacy group,
- must be of importance to the areas of standardization or its processes (CEN/ISSS, 2009).

Estimations claim that over 60% of all standards in the ICT sector are developed by standards consortia (TAPIA, 2010). In Europe (Council of the European Union, 2000) and in the US (Center for Regulatory Effectiveness, 2000) standards consortia are recognized as being organizations that influence standard setting processes, but which are not officially accredited (EGYEDI, 2001). Still, regulation authorities encourage the cooperation with standards consortia, while maintaining the primacy of formally recognized standards (European Parliament, 2012). There are several formal agreements to foster cooperation between standards consortia and formal standards bodies, e.g. the PAS (Publicly Available Specifications) fast track agreement, JTC1's Approved References Specifications (ARS) or the Partner Standards Development Organization (PSDO). Some standards consortia also enter ad hoc liaison agreements, which are rather broad statements of cooperation with formal standard bodies on specific topics. In this regard several empirical studies have provided evidence that, especially during the last years, standards consortia cooperate and pre-develop specifications that are accredited in formal bodies at a later stage (BARON & POHLMANN, 2013).

So far there has not been much empirical work on the role of standards consortia in the evolution of ICT standardization. Earlier work mostly focuses on theoretical explanations for the existence of consortia (CARGILL & WEISS, 1992; UPDEGROVE, 1995; AXELROD *et al*., 1995; HAWKINS, 1999; BUNDUCHI *et al*., 2008). More current research uses a case study approach and characterizes and compares the processes of informal consortia such as UPDEGROVE (1995): X Consortium and Open GIS Consortia; EGYEDI (2001): W3C and ECMA; COULON (2004): Symbian Alliance; ANDERSON (2008): ECMA, IETF, OASIS, OMG and W3C; KOENIG (2008): FlexRay, Autosar and Jaspar; GROTNES (2009): Open Mobile Alliance (OMA). A first comprehensive analysis on the evolution of standards consortia was done by BLIND & GAUCH (2008). They accessed a dataset of more than 250 consortia to map the change of consortia between the years 2000 and 2004 and found evidence for a complimentary relationship of formal and informal standard setting activities. Other empirical contributions rather focus on the effects of consortia in terms of coordination outcomes and efficiency (LEIPONEN, 2008; DELCAMP & LEIPONEN; 2012; BARON *et al*., 2014).

This paper makes use of a unique dataset of 435 standards consortia assembled from 17 editions of the ISSS CEN survey on ICT standards consortia between 1998-2012. Further information was added exploiting the consortia database of Andrew Updegrove [2]. To retrieve historical information on consortia activity as well as memberships, the paper further makes use of the internet archive waybackmachine [3] and data provided by the Innovation Economics department of the Northwestern Law School [4] and Iplytics [5].

While most of the empirical research on standards consortia only investigates particular use cases of consortia standardization, this article seeks to provide a more thorough understanding of the whole consortia landscape. In this regard the goal of our research is to shed light on differences of consortia characteristics such as organizational structure, size, industry, scope and purpose. Furthermore we seek to understand differences in consortia's IP policy with regard to industry focus and technological area. Finally we aim to analyze dynamics of consortium formation and termination connected to economic cycles over time. In this regard we seek to compare consortia characteristics and organizational structures that may be connected to the consortia evolution.

■ The role of standards consortia in the international regulation of standardization

The official description of a standard defined by CEN (2014) is a "document, established by consensus decision making and approved by a recognized body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context". The European Commission (2013) further states that standards should be developed and defined through a process of sharing knowledge and building consensus among technical experts nominated by interested parties and other stakeholders - including businesses, consumers and environmental groups, among others. In this context a standard is not written by one expert,

2 http://www.consortiuminfo.org/

3 http://archive.org

4 Access to the data can be retrieved from: http://www.law.northwestern.edu/research-faculty/searlecenter/innovationeconomics/data/technologystandards/

5 www.iplytics.com

but reflects the input and knowledge of all parties concerned. The standardization process can lead to different types of output. The European Commission, e.g. differentiates between standards (EN), technical specifications (TS), technical reports (TR), and workshop agreements (WA). Main differences of the document types can be identified in the development process where compared to, e.g. an EN, no public consultation is needed for publishing a TS that can solely be approved by the technical committee developing it. TSs are usually established for specifications in evolving technologies and experimental markets. In this regard standards consortia in most cases produce TSs that can be accredited at formal standard organizations at a later stage (European Commission, 2010b).

The European Commission recognizes that standard setting may take place on different levels. Worldwide standards are, e.g. developed by ISO (International Organization for Standardization), IEC (International Electrotechnical Committee) and ITU (International Telecommunication Union). European standards are developed by CEN (European Committee for Standardization), CENELEC (European Committee for Electrotechnical Standardization) and ETSI (European Telecommunications Standards Institute), also called the three "European Standardisation Organisations" (ESOs) and national standards are developed at the national standardization bodies (NSB) of each individual country. Regulatory bodies interpret standards consortia to be supporting these formal organizations. This is especially relevant for ICT where "fora and consortia are needed to cope with the ever-growing demand for standards to support interoperability in this fast evolving domain". Furthermore consortia standard setting is seen to improve "complementary interoperability testing and awareness to ensure the effective uptake of standards" (European Commission, 2013). A distinct reform according to the latest standardization regulation in EU Regulation 1025/2012 (The European Parliament, 2012) amending Directive 98/34 officially allows for reference of technical specifications produced by fora and consortia [6] when they are approved by the EU multi-stakeholder platform and when they have a wide market acceptance and stand for public policy requirements such as openness, transparency and balanced processes. In this regard the European Commission (2011) urges the availability of consortia standards for public procurement (Action 19) and strongly supports the referencing of ICT specifications from consortia in public tenders (Action 22).

[6] Such fora and consortia are e.g. OASIS, W3C, IETF, OMG, OMA.

■ Theoretical considerations

In many literature sources, standards consortia are described as explicit alliances or groups, which are formed when the fast evolution of technology requires coordination mechanisms (AXELROD *et al*., 1995). Such alliances are further defined as groups of companies where the benefits of the collective activity arise from a commonly produced public good (OLSON, 1971; CARGILL & WEISS, 1992). Irrespective of the costs of producing the public good, the good is equally available to all members and the public. However, members' benefits and incentives to invest in standard setting may differ (KINDLEBERGER, 1983). Groups emerge when a single firm is incapable of producing a certain good itself. Firms thus join groups when the collective activity is beneficial and exceeds the costs of membership. Incentives to join or leave the group are simply related to a cost-benefit analysis, though groups may scale costs to counteract defection (McGUIRE, 1972). The size of the group matters as a factor of effective coordination. According to OLSON (1971), coordination failures such as "cheating", "free-riding" or "discord" diminish when the group is held respectively small. Furthermore, the costs of coordination increase with the size of the group. Groups are characterized as "exclusive" groups when the collective good increases by excluding others. In comparison "inclusive" groups are those, where it is more beneficial to include as many market participants as possible.

Group formation in standard setting postulates a special case of coordination and collective benefits. Standards are subject to network externalities since users of a standard obtain benefits not only from the technology itself but furthermore, depend on the share of users in the market that use the technology. Thus, the success of a standard always depends on the installed base of users (DAVID & GREENSTEIN, 1990) and thus on the market take up. When network externalities are significant, firms have to coordinate in product development processes. This coordination can be reached by standard-setting committees such as standards consortia (WEISS & SIBRU, 1990). BESEN & JOHNSON (1986) list several conditions for successful coordination in standard setting. In this regard, standards consortia should gather a certain market share of the industry, the group should not be subject to antitrust objections and members should reduce the number of technological alternatives to reach consensus while further eliminating disputes. In the context of the conflict solving role of consortia, BARON & POHLMANN (2013) make the case that companies are more

likely to be consortium co-members when specializing in R&D that is substitutable rather than complementary to their own.

In conclusion, standards consortia are subject to network externalities, while also inhibiting coordination failures of a group. OLSEN (1971) argued that small groups benefit from coordination efficiencies. In comparison AXELROD (1995) states that consortia are especially successful when they gather most of the market players. The latter argument is further connected to the installed base of a standard, which increases with the number of participants sponsoring the standard (DAVID & GREENSTEIN, 1990). To a certain extent standards consortia are inclusive, since a common standardization project is only successful and reaches market take-up when a sufficient number of market players participate. However, standards consortia are subject to particular group characteristics. While formal standardization is bound to consensus decision making and is open to all market participants, standards consortia can be more closed in their membership rules. Membership fees, more regular meetings and a more narrow focus differentiate consortia from formal bodies. To a certain extent, consortia can thus be seen as an exclusive group of firms that have a specific interest in standardization or have a particular market stake on a technology. However, consortia are inclusive to the limits of gathering only likeminded companies that share the same interests. However, standards consortia membership must always be compliant with the regulatory rules of antitrust authorities, allowing every relevant entity in the market to participate in some way (European Commission, 2010a).

LERNER & TIROLE (2006) make the case of forum shopping where firms choose the appropriate venue for standardizing their technology. With regard to choosing between standards consortia and formal standards bodies companies face the trade-off between different effects of small and big groups and more explicitly the trade-off between efficient coordination compared to larger network externalities. Due to their inclusive nature, formal standard bodies tend to be rather large and members are often more heterogeneous in their interest and market positions. As a consequence, preferences of the group members become more diverse and it becomes more difficult to reach consensus. Especially if swiftness of a standard project is critical, large groups might not be effective enough to set the standard right in time. However, when instead choosing a more effective smaller group, e.g. a standards consortium, positive effects of network externalities may decrease due to the smaller group of standard supporters (WEISS & SIRBU, 1990). In conclusion group size compared to group efficiency determine the effects resulting from network externalities and

effective decision making. Standard setters must weight these effects as to their particular needs and goals. In the following, the empirical analysis will provide evidence on some of the theoretically discussed considerations.

■ Methodology

This paper uses a broad approach to illustrate the dynamic landscape of ICT standards consortia over the past 15 years. The statistical analysis is based on the 17 editions of the ISSS CEN survey providing information on 435 standards consortia. All of the ICT standards consortia have been identified by CEN, where selection was based on transparent and objective criteria, which are stated above. The survey by Andrew Updegrove [7] provides additional information which was added to the CEN selected sample. Both data sources indicate the tiering of membership, the consortium scope, technical categories, industry sectors, IP policies and years of existence. The number and identification of consortium members (including 30,000 independent entities in more than 250,000 consortium memberships), was provided by the Innovation Economics department of the Northwestern Law School [8] as well as by Iplytics [9].

With regard to the consortia life time analysis, we build up a data panel over the time span of 1998-2012 to calculate and observe organizational effects correlating with consortia survival. We apply one year period observations and use consortia termination as our event of failure. We only include consortia in our estimations that were founded for a long term purpose to rule out planned consortia termination. In order to provide insights on the shape of the survival function for different sample groups, we calculate Kaplan-Meier curves for all categorical predictors. The Kaplan-Meier survival estimator illustrates a series of horizontal steps for each period of observation. The declining magnitude should approach the true survival function of our consortia data comparable to an empirical distribution function. Figure 1 displays the overall survival function and shows that after about 11 years more than 50% of all consortia have been terminated.

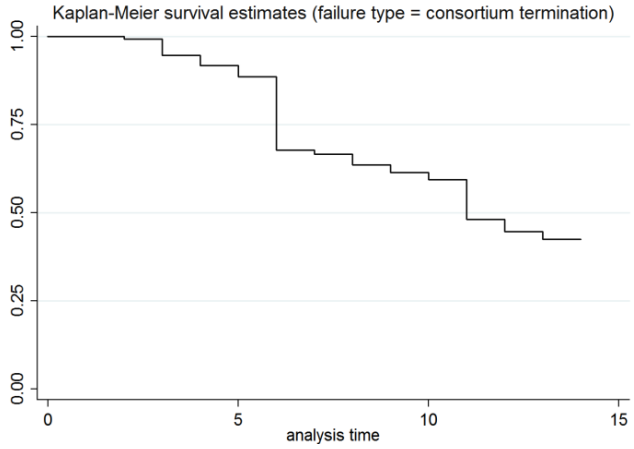
---

7 http://www.consortiuminfo.org/

8 Access to the data can be retrieved from: http://www.law.northwestern.edu/research-faculty/searlecenter/innovationeconomics/data/technologystandards/

9 www.iplytics.com

Figure 1 - Overall Kaplan-Meier survival estimates of consortia termination

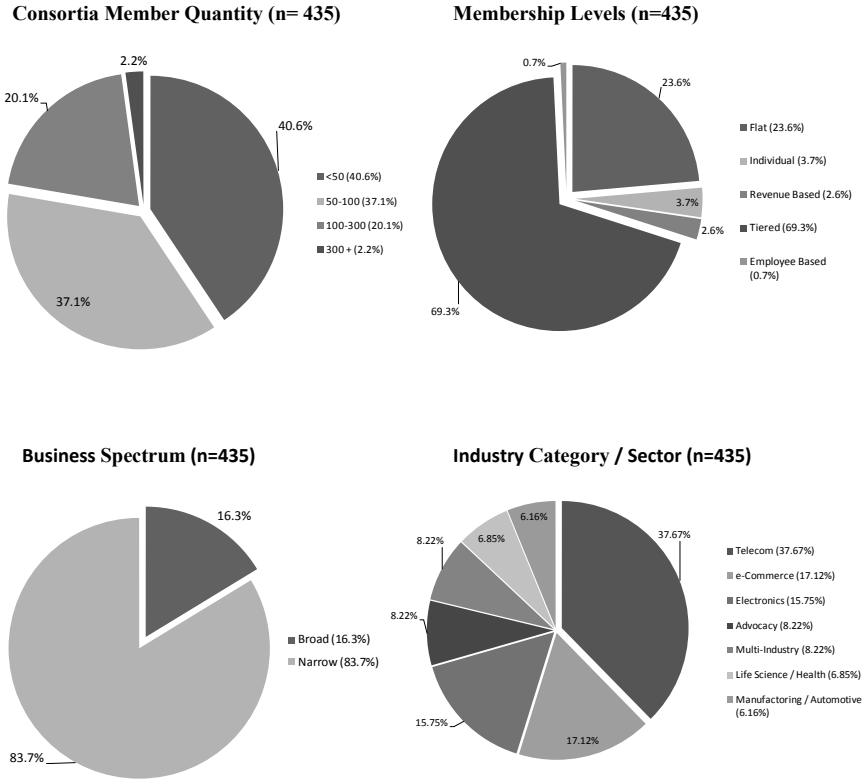


■ Empirical analysis

Consortia characteristics and attributes

The evolution of the standard setting landscape during the last decade reflects that the formation process of standards consortia allowed a variety of organizational choices (CARGILL, 2002). In the following we illustrate characteristics for all standards consortia that were included in at least one of the 17 editions of the CEN survey. The four charts in Figure 2 give a vivid picture of ICT standards consortia characterized by member quantity, membership levels, business spectrum and industry sector. The two former attributes reveal information on specific member information such as quantity and member levels. Since memberships differ over time we always used the maximum values. The latter two charts illustrate the sector and the scope of technology focus. Most consortia have a considerably low amount of members, since 77.7% have less than 100 participants, 20.1% have 100-300 members and only 2.2% list more than 300 members. To illustrate the scope of focus in standard setting among consortia, the business spectrum in the survey was classified into broad and narrow. Only 16.3% of the consortia follow a broad spectrum of standardization, which is comparable to structures in formal standard bodies. Narrow focused consortia usually develop only one standard or specification (83.7%) which is the majority of the sample.

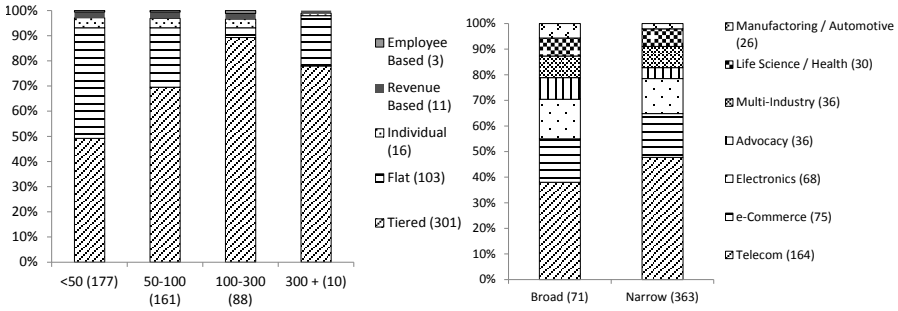
Figure 2 - Characteristics and attributes of informal ICT standards consortia



These findings can be related to the quantity of memberships. The data shows that most narrow consortia tend to have a lower amount of members. A possible assumption is that this leads to more effective and flexible decision making processes within consortia. Both attributes are distinct characteristics to differentiate consortia from formal standard bodies, since the latter mostly follow a broad business spectrum and tend to have a higher number of members. The evaluation of the CEN survey further provides information on the primary and secondary industry sector that a particular consortium is active in. These findings indicate a very heterogeneous picture of the consortia landscape. In order to better frame these results, data was aggregated into seven categories. Over a third of the consortia produce standards for the telecommunication industry (37.67%). E-Commerce (17.2%) and electronics (15.75%) also represent one third of the consortia target industry. Less ICT related industries such as advocacy, life-science, manufacturing and multi-industry summarize the last third of consortia target industries. These results are in line with the assumptions that especially ICT

industries rely on more flexible and quick standard solutions developed by standards consortia. To better categorize the heterogeneous characteristics of standards consortia we conduct cross attribute analyses (Figure 3). In a first step we count the different membership levels per consortium member size category. This analysis shows that the bigger the consortium the more frequent it is structured in tiered membership levels. Flat membership in contrast is more common for smaller consortia. In a second step we compare the consortia business spectrum with the industry sectors. While narrow consortia can usually be found more often in the telecom and e-commerce industry, manufacturing usually follows a more broad focus.

Figure 3 - Cross combined characteristics of informal ICT standards consortia



The chart of membership levels illustrates the hierarchical structures of consortia (Figure 2). A flat membership structure can only be found in 23.6% of the regarded consortia, while more than two thirds of the consortia have a tiered membership organization. Organization types and shares per member level can be consulted in Figure 4. The graph shows that 93.56% of the members are vendors and other commercial entities, whereas universities and colleges account for only 2.52%, governmental entities for 0.17% and consumer groups for a stake of 3.75%.

According to the results of the survey, 69.3% of the standards consortia have tiered membership structures, where the member levels were again differentiated into Leaders, Followers and Spectators. Using this three-dimensional classification by JAKOBS (2007) we have categorized the membership data for tiered membership levels as follows: Leaders are members with veto and voting power, while Followers only have the right to vote and Spectators only get access to documents or are allowed to participate in all meetings but have no decision making authority.

Figure 4 - Consortia membership structure (n=435)

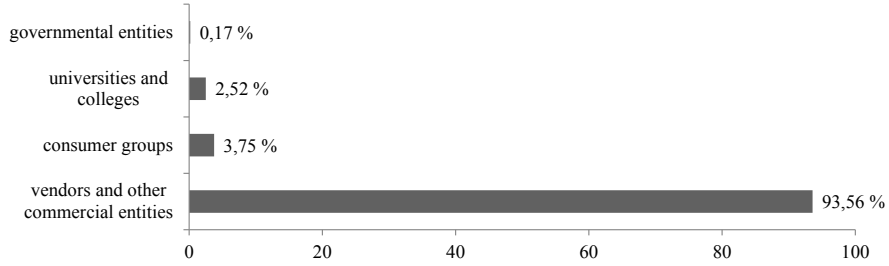
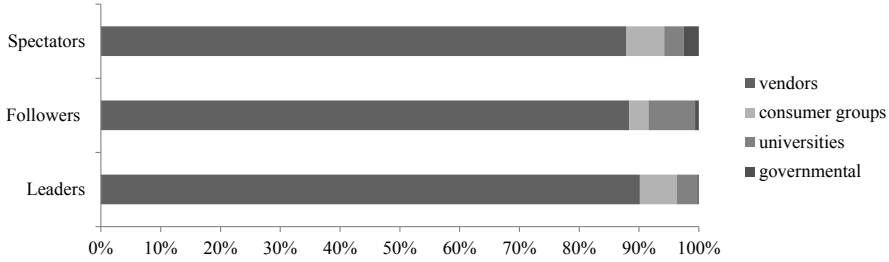


Figure 5 - Consortia membership structure as to shares in tiered levels (n=435)



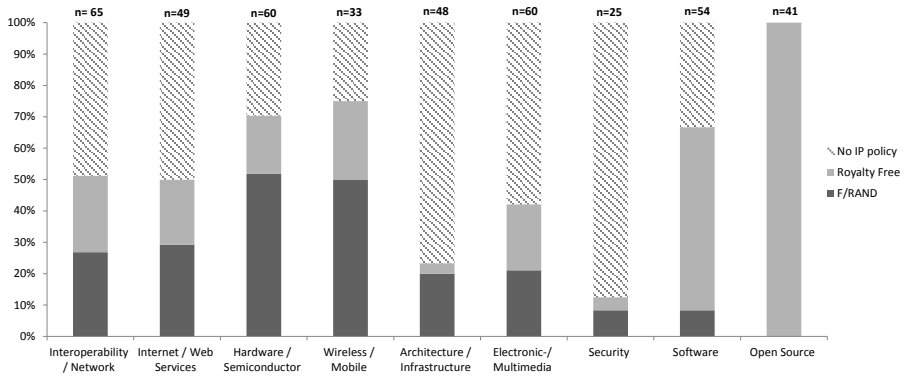
Data analyses indicate that the Leader level is dominated by commercial entities. Most universities can be found in the Follower and Leader level and governmental entities and consumer groups mostly choose the Spectator level (Figure 5). However, all member levels are strongly dominated by vendors. In most cases membership fees are scaled, since Leaders usually pay higher rates. Thus they have more voting or veto power and are able to strategically influence the standard setting process. In consequence membership levels often reflect the balance of member power (UPDEGROVE, 2008).

A very political and lately often discussed topic is the interplay of IPR and standards (BLIND & POHLMANN, 2013). It is thus of great importance how patents are handled when they are introduced into a standard. Standards consortia have very different bylaws and regulations on how to license and treat patents that are essential to a standard. The CEN survey broadly differentiates standards consortia's IP policies into Royalty Free, FRAND (Fair Reasonable and Non-Discriminatory) or no IP policy specified. [10]

[10] The legal policies concerning FRAND commitments are mainly harmonized among formal organizations such as ISO, IEC, ETSI, IEEE or ITU. In standards consortia however IP policies may have very different interpretations about FRAND licensing. E.g. standards consortia that require FRAND commitments may in some cases include additional opt-out possibilities in their

Standard setting organizations often require firms participating in standard setting to disclose any patent reading on a technology contribution that might turn out to be essential for the standard in question. Furthermore, in many standards organizations holders of such patents have to submit a declaration on whether they accept to commit on fair, reasonable and non-discriminatory terms for licensing these patents (FRAND commitments). If a firm discloses a patent but refuses to commit on such licensing terms, the standards organization will usually exclude the patented technology from the standard. Even though standardization may be accompanied by complex licensing agreements, the licensing of essential patents occurs outside the ambit of the standard setting body as these are usually bilateral commercial agreements which are at times subject to complex discussions. Nevertheless, FRAND commitments are commonly seen as an important instrument to ensure a balance of reasonable royalty payments with appropriate return on investment. In situations of royalty free commitments firms may include patents into standards but commit upfront to not charge royalties (LAYNE-FARRAR *et al.,* 2007; FARRELL *et al.,* 2007). In the following we have categorized the whole sample of standards consortia as to their IP policy (Figure 6).

Figure 6 - IP policy statements of consortia per technical class (n=435)



According to the CEN survey 54.7% of those consortia that have formulated an IP policy, follow a FRAND policy, whereas 43.3% of the consortia use royalty free IPR regulations. To better assess these results, consortia were also classified in their technical classes. Figure 6 illustrates the IP statutes of consortia per technology. The graph shows that IP policies

bylaws. Also, royalty free commitments may still include cross licensing or territorial scope options.

differ between technologies and it thus seems presumable that the technical topic determines the pursued IP licensing terms. There is an especially high number of royalty free consortia for software which can be explained by the fact that patents on software are restricted in several countries. Another reason could refer to differences of the business models of consortia participants. IP rules especially matter when companies find themselves in situations of high investment risks. These might, for example, be lower for software companies or in the field of security or infrastructure as compared to producers of hardware or wireless technologies. These interpretations are however no evidence for generalizations, since IP policies especially differ between specific products and companies involved which are not analyzed at this point. However, compared to formal bodies, IP policies of standards consortia are very heterogeneous. While formal bodies all include mandatory FRAND commitments in their bylaws, many consortia either have no policies at all or require royalty free licensing. This heterogeinity in IP rules may contribute to a legal uncertainty when adopting consortia standards. The accreditation of consortia standards at formal bodies thus also strongly depends on how these rules are formulated in order to meet the terms of regulatory bodies (The European Parliament, 2012).

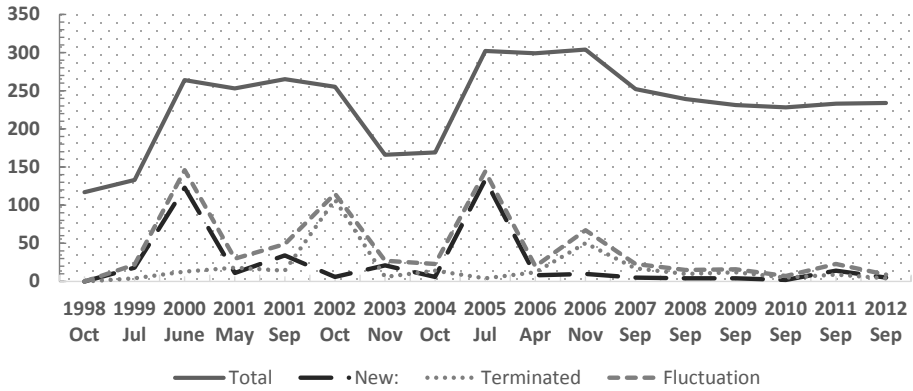
Consortia development phases

There are several studies that describe the development of standardization with respect to the formation and evolution of informal consortia (HAWKINS, 1999; CARGILL 2002; JAKOBS, 2003; UPDEGROVE, 2008). However, as yet, there is no comprehensive quantitative approach to examine the survival of standards consortia over time. Using the CEN survey editions between 1998 and 2012 the data assembles a current list of ICT consortia each year and even twice a year in 2001 and 2006. Figure 7 shows the quantity of consortia at the respective point in time, also indicating the fluctuation rate, as well as the number of new and terminating consortia. To consider consortia evolution with respect to the standardized technologies, Figure 8 illustrates the consortia development assigned to the respective technology class.

Since the mid-1990s the increasing formation of consortia can be explained by the rise of the internet market, where the first peak of development is in June 2000, counting 123 new consortia compared to July 1999. This period is characterized by strong standard battles (*Microsoft Explorer vs. Netscape Navigator*) and the rising importance of very influential

consortia in the internet infrastructure such as the Internet Engineering Task Force (IETF) or the World Wide Web Consortium (W3C) (CARGILL, 2002; UPDEGROVE, 2008). Figure 8 shows that the class Internet / Web Services increased from a share of 14.47% in July 1999 to 20.16% in May 2001.

Figure 7 - Evolution of ICT standards consortia 1998-2012



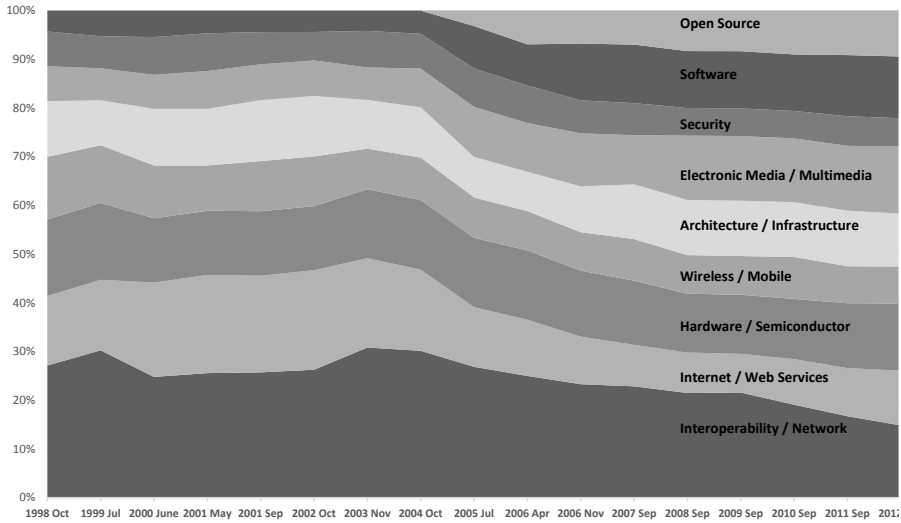
The next fluctuation peak can be found in 2002, where 107 consortia were terminated compared to May 2001. Taking a closer look at the technology class development, especially the percentage of Internet / Web Service, consortia decreased from 20.44% in October 2002 to 16.67% in November 2003. Also Security and Wireless / Mobile decreased in their shares between 2-3%. A look at the consortia termination data also shows a consolidation process. Several consortia were not dissolved but merged with other consortia. The consortia amount remained stable in other technology classes and thus gained an increase of share.

Taking into account the bursting of the "dot-com bubble" between 2000 and 2001 where the NASDAQ composite had a historical decrease, these economic developments also led the consortia formation into a recession. The results are evidence for the close relation of market development and consortia formation. Thus the findings show how quickly consortia standard setting activities are able to react to economic developments and changing market needs.

A significant period of consortia formation started in 2005. Between October 2004 and July 2005 the CEN Survey data identifies an amount of 133 new consortia. The technical class development shows that the share of software orientated consortia doubled within one year. The high number of new consortia was also connected to the rise of many open source consortia

starting in 2004. Except for Internet / Web Services a new formation of consortia in all technical classes has taken place. This gives evidence for an increasingly broader appreciation of standard setting consortia.

Figure 8 - Consortia technology development 1998-2012



Since the highest peak level in 2006, counting 304 consortia, the formation of new consortia remained on a constantly low level in the years to come. In contrast between September 2006 and 2007 the second highest peak of consortia termination took place, as 50 consortia ended their business or merged with others. Again, these findings can be linked to economic events, like the US subprime mortgage crisis, which took place in 2007 and later triggered the worldwide financial crisis starting in 2008. The findings are able to reflect the close connection of consortia development and industry performance. The timing of consortia formation and termination again indicates that consortia formation is flexible and dynamic and thus able to react immediately to ups and downs of market development.

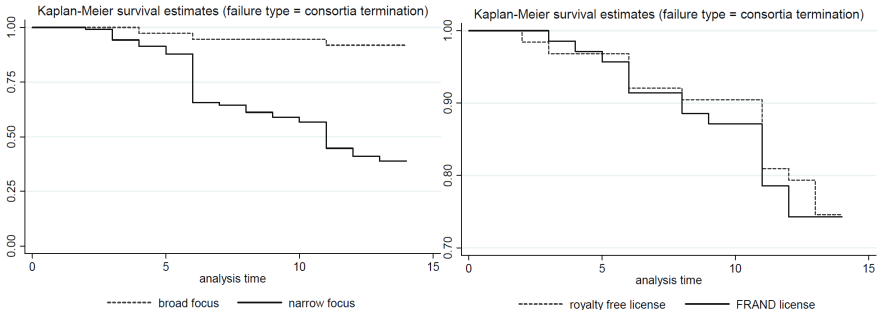
Consortia performance

In order to measure the performance of standards consortia we apply a survival analysis over the sample of our surveyed consortia. Consortia life time may be subject to multiple occurrences. In our preceding section we have discussed consortia termination as a result of technology or market

shocks. Consortia termination may consequently be the implication of technology obsolescence or economic recession. However, reasons for dissolving a consortium may also be connected to organizational structures or performance. In some cases the purpose of forming a consortium is to standardize a specific technology without the intention of continuing development once the project is finalized. Consortia termination would thus be the consequence of previous decisions. To rule out planned consortia termination, we therefore only include consortia in our sample with an intentional long term purpose. We also exclude consortia where we were not able to identify the purpose. These restrictions reduce our sample to 232 standards consortia.

In the following, we seek to measure which consortia survive longer in technology and market conjunctures. We therefore calculate Kaplan-Meier survival estimates for the probability that a consortium terminates. Survival estimates are the likelihood that an observation will "survive" for a specific time. Consortia observation ends with the year of termination, or in the case of active consortia in 2012, which is the last year of observation. The following statistics are therefore not subject to truncation problems. Proceeding that way we work with 232 consortia, 2,024 observations (per consortia year observation) and 103 failures. Downward steps of the survival function represent the percentage of failures in the strata of observation. Groups are stratified as to consortia characteristics that do not change over time. Furthermore our analysis controls for the different technology classifications as illustrated in Figure 8. This ensures that consortia characteristics correlated to certain technologies do not bias our results. In the following graphs, the y axis denotes the percentage of consortia that survive over time as to years on the x axis.

Figure 9 - Kaplan-Meier survival estimates of consortia termination by consortia focus and IP policy (n=232, observations = 2,024 (per consortia year), failures =103)

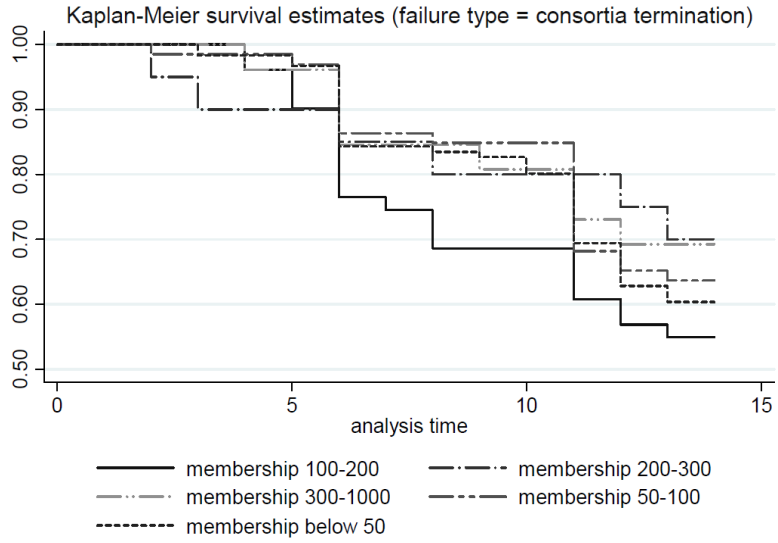


Results from Figure 9 represent the survival functions of consortia as to different strata of consortia focus (broad or narrow) and different strata of IP policy (FRAND or royalty free). The left graph shows that standards consortia which pursue a broad focus in their standards projects survive respectively longer compared to narrow purpose consortia. Results indicate that after 10 years almost 50% of the narrow focused consortia are terminated. This finding may confirm the notion that consortia are in some cases formed to solve a very specific problem that may be too specific to survive over a long time period. One could thus argue that consortia which are able to extend their business focus to additional standards projects are more successful and thus survive respectively longer.

In the right graph in Figure 9, we estimate whether the differences of IP polices have an influence on consortia survival. To make results of the Kaplan-Meier survival test visible we changed the scale of our y axis. However, survival developments seem to show no significant differences between the two licensing schemes. Only in periods after seven years consortia with a royalty free policy seem to survive longer, while the survival rate decreases after ten years to the same level as FRAND policy consortia. Yet analysis is far from conclusive to explain the effects of IP policies on the survival of consortia. Our results however show that the general choice of a royalty free or FRAND policy may not be critical to termination.

Consortia size is a crucial factor that influences both consortia coordination among members and market take up. The costs of coordination increase with the number of members. Large groups may invite coordination failures such as "free riding" or "war of attrition" (OLSON, 1971; FARRELL & SIMCOE, 2012). This may result in disputes and in cases of hardship lead to consortia termination. In comparison, we argued that the success of a standard is connected to a large group of companies that sponsor the standardized technology (DAVID & GREENSTEIN, 1990; AXELROD *et al.,* 1995). Figure 10 compares five categories of consortia membership quantity and illustrates the survival curve over time. Even though membership changed over time, consortia usually stayed within their size category. Again we adjusted the scale of survival rates in our y axis to make results visible. Large consortia with 200-300 and 300-1000 members survive the longest over the years. Rather small consortia in comparison <50 and 100-200 terminate in earlier periods. These results support the argument that consortia which gather a larger number of industry players are more successful and seem to operate significantly longer than small consortia.

Figure 10 - Kaplan-Meier survival estimates of consortia termination by membership size (n=232, observations = 2,024 - per consortia year, failures =103)

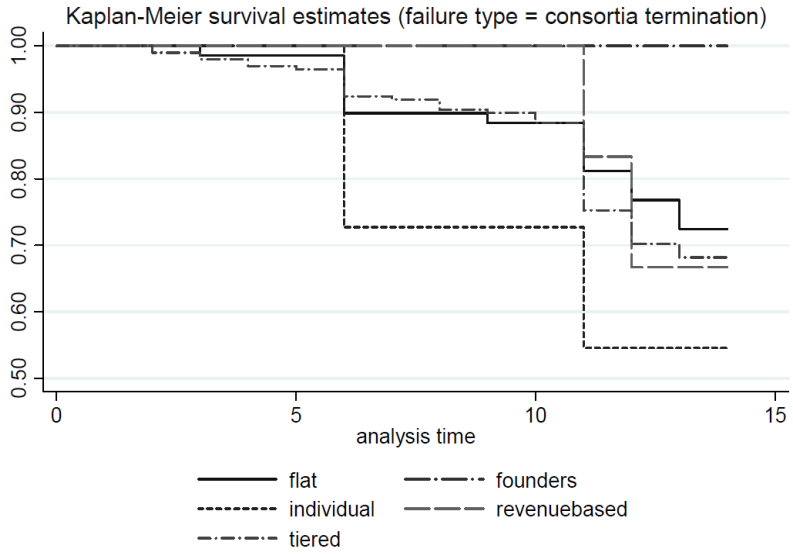


Consortia membership may influence termination not only by size but also by membership structures. We conduct another survival analysis and estimate if different membership tiering influences survival rates. Figure 11 illustrates that for consortia with individual membership structures termination is more likely compared to others. Individual members participate not as a corporation but as individual persons. Members may still serve the interest of a group or company but participate in meetings and conferences individually. These consortia are often very technical and seek to solve specific problems which may not be subject to corporate strategies. Also, since individual membership may be less formal, consortia may follow rather individual interest that may not be connected to commercial aims.

In standards consortia where membership fees are revenue based or tiered, members which pay higher fees obtain more rights than others. As to the categorization of member levels in Figure 4, leader firms may get full and early access to information, may participate in all meetings, may have certain veto or voting rights and may be part of the organizational management of the consortia (JAKOBS, 2007). Tiered member levels thus ensure that strong market players can better influence standardization outcomes and bypass smaller entities which only participate as spectators or followers. Compared to flat membership and founder based membership, consortia with tiered structures more likely terminate over time (Figure 11). These results contradict the assumption that coordination failures would be

solved by hieratical tiered structures. In comparison, in flat membership structures all members have the same rights, which may lead to more discussions. Even though theoretical considerations are opposed to our findings, we could argue that tiered member structures are subject to a selection effect. Companies that pursue certain interests or seek to sponsor technologies that are not shared by other market participants may rather choose to join consortia where they can suppress others. Thus consortia with tiered structures would experience participation of companies that would generate more coordination problems compared to consortia with flat structures.

Figure 11 - Kaplan-Meier survival estimates of consortia termination by membership tiers (n=232, observations = 2,024 (per consortia year), failures =103)



■ Conclusion and discussion

This article intends to give a broad overview of standards consortia, their characteristics, organizational structures, policies and developments over the past 15 years. Even though empirical analysis is rather descriptive, results already introduce coherences in terms of consortia attributes and consortia survival. Several characteristics differentiate the consortia phenomenon from other standard setting activities. By combining the assessed consortia information, our study delivers a more transparent

picture of the consortia landscape. The analysis shows that consortia are very heterogeneous in terms of organizational structures, policies and bylaws, purpose or other characteristics. While it is difficult to generalize differences of consortia standardization and formal standard setting, in many cases standards consortia are smaller in terms of members, frequently follow only one purpose of business, are often hierarchical in the decision making structures and are in many cases organized in rather tiered membership structures. Moreover the analysis reveals that a consortium's IP policy is strongly connected to the developed technology. While IP policies are mostly harmonized among formal standard bodies, IP policies of standard consortia differ in their terms.

The analysis on the evolution of the standard stetting landscape has provided evidence that consortia are very flexible in terms of emergence which leads us to the conclusion that consortia formation directly reacts to market trends. Peaks of formation as well as termination are correlated to the global economic performance. An organization's involvement in consortia standard setting enables quick and flexible participation to influence the development of a certain, often specific, technology.

This article further estimates survival rates to assess which consortia are successful and stable and how consortia features correlate with termination and continuity of business. In consideration of theoretical implications we especially show that structures of member coordination as well as focus and scope determine consortia survival over time. We show that larger consortia survive significantly longer compared to smaller consortia. However, when membership levels are tiered, termination is more likely. Furthermore a narrow focus on certain technologies also leads to earlier termination, while the general choice of IP policy seems to have no effect.

References

ANDERSON, P. (2008): *Evaluation of Ten Standard Setting Organizations with Regard to Open Standards*, Prepared for I T - o g Telestyrelsen, IDC Special Study.

AXELROD, R., S. BENNETT, E. BRUDERER, W. MITCHELL & R. THOMAS (1995): "Coalition formation in standard-setting alliances", *Management Sci*, 41(9) 1493-1508.

BARON, J. & POHLMANN, T. (2013): "Who Cooperates in Standards Consortia: Rivals or Complementors?", *Journal of Competition Law and Economics*, 9 (4), pp. 905-929.

BARON, J., MÉNIÈRE Y. & POHLMANN, T. (2014): "Standards, Consortia and Innovation", *International Journal of Industrial Organization*, DOI: 10.1016/j.ijindorg.2014.05.004.

BLIND, K. & GAUCH, S. (2008): "Trends in ICT standards in European standardization bodies and standards consortia", *Telecommunication Policy*, 32, 503-513.

BLIND, K., GAUCH, S. & HAWKINS, R. (2010): "How stakeholders view the impacts of international ICT standards", *Telecommunications Policy*, 34, No.3, 162-174.

BLIND, K. & POHLMANN, T. (2013): "Trends In The Interplay Of IPR And Standards, FRAND Commitments And SEP Litigation", les Nouvelles - September 2013, pp. 177-181, September.

BUNDUCHI, R., GRAHAM, I., SMART, A. & WILLIAMS, R. (2008): "Homogeneity and heterogeneity in information technology private standard settings – the institutional account", *Technology Analysis & Strategic Management,* Vol. 20, No. 4, July, 389-407.

CARGILL, C. & WEISS, M. (1992): "Consortia in the Standards Development Process", *Journal of the American Society for Information Science*, Vol. 43, Issue 8, 559-565.

CARGILL, C. (2002): *Intellectual Property Rights and Standards Setting Organizations: An Overview of failed evolution*, A Report Issued By the U.S. Department of Justice and the Federal Trade Commission, March.

CEN/ISSS (2009): *CEN/ISSS survey of standards-related fora and consortia*, 15th ed., Brussels, October.

CEN/CENELEC (no date): "What is a European Standard (EN)?". http://www.cencenelec.eu/standards/DefEN.

CORNES, R. (1996): *The theory of externalities, public goods, and club goods*, Cambridge University Press.

Council of the European Union (2000): 'Council Resolution of 28 October 1999 on the role of standardisation in Europe', *Official Journal of the European Communities*, 2000/C 141/1- 4, 19.5.2000.

CRE, Center for Regulatory Effectiveness (2000): "Market-Driven Consortia, Implications for the FCC's Cable Access proceeding", Working Draft 7/20/00. www.the CRE.com

COULON, F. (2004): "Proprietary standardisation in consortia – the case of the Symbian alliance", *Research Design 9th EURAS Workshop on Standardisation*, 13-14 May, 2004.

DAVID, P. A. & GREENSTEIN, S. (1990): "The economics of compatibility standards: An introduction to recent research", *Economics of Innovation and New Technology*, 1, 3-42.

DAVID, P. A. (1996): "Formal standard-setting for global telecommunications and information services", *Telecommunications Policy*, 20, 789-815.

DELCAMP, H. & LEIPONEN, A. (2012): "Innovating Standards Through Informal Consortia: The Case of Wireless Telecommunications", *International Journal of Industrial Organization*, forthcoming.

EGYEDI, T. M. (2001): *Beyond Consortia, Beyond Standardisation? New Case Material and Policy Threads*, Final Report for the European Commission, Delft, The Netherlands.

European Commission:
- (2010a): *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements*, Brussels, SEC(2010) 528/2.
- (2010b): "QIS5 Technical Specifications", Annex to Call for Advice from CEIOPS on QIS5, Brussels, 5 July 2010.
- (2011): *Communication from the European Commission: A strategic vision for European standards: Moving forward to enhance and accelerate the sustainable growth of the European economy by 2020* (COM(2011) 311), Brussels, 30 September 2011.
- (2013): *Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee*, Brussels, 31.7.2013 COM(2013) 561 final.

European Parliament (2012): "Regulation (EU) No. 1025/2012 of the European Parliament and of the Council", *Official Journal of the European Union*.

FARRELL, J., HAYES, J. SHAPIRO, C. & SULLIVAN, T. (2007): "Standard Setting, Patents, and Hold-Up", *74 Antitrust L. J.* 603.

FARRELL J. & SIMCOE, T. (2012): "Choosing the Rules for Consensus Standardization", Unpublished manuscript. Electronic copy available at: http://ssrn.com/abstract=1396330.

GROTNES, E. (2009): "Standardization as open innovation: two cases from the mobile industry", *Information Technology & People*, Vol. 22, No. 4, 367-381.

HAWKINS, R. (1999): "The rise of consortia in the information and communication industries: emerging implications for policy", *Telecommunication Policy*, 23, 159-173.

JAKOBS, K. (2003): "Information Technology Standards, Standards Setting and Standards Research", Presented at: Stanhope Centers Roundtable on systematic barriers to the inclusion of a public interest voice in the design of ICT, Cotswolds Conference, December 2003.

JAKOBS, K. (2007): "ICT Standards Development-Finding the Best Platform", in *Enterprise Interoperability*, pp. 543-552, Springer London.

KINDLEBERGER, C. P. (1983): "Standards as public, collective, and private goods", *Kyklos*, 36, 377-397.

KOENIG, R. (2008): "New ways of standard-setting in technology-driven industries: the case of automotive electronics in Japan and Germany", DRUID-DIME Academy Winter 2008 Ph.D. Conference.

LAYNE-FARRAR, A., PADILLA, A. J. & SCHMALENSEE, R. (2007): "Pricing Patents for Licensing in Standard-Setting Organizations: Making Sense of Fraud Commitments", *74 Antitrust Law Journal*, 671.

LEIPONEN, A. (2008): "Competing Through Cooperation: The Organization of Standard Setting in Wireless Telecommunications", *Management Science*, 54-11,1904-1919.

LERNER, J. & TIROLE, J. (2006): "A model of forum shopping", *American Economic Review*, 96, 1091-1113.

McGUIRE, M. (1972): "Private Good Clubs and Public Good Clubs: Economic Models of Group Formation", *The Swedish Journal of Economics*, Vol. 74, No. 1, "Economics of Location: Theory and Policy Aspects", pp. 84-99.

OLSON, M. (1971): *The logic of collective action: Public goods and the theory of groups*, Cambridge, MA: Harvard University Press.

UPDEGROVE, A.:

- (1995): "Consortia and the Role of the Government in Standard Setting", in B. KAHIN & J. ABBATE (Eds), *Standards Policy for Information Infrastructure*, Cambridge: MIT Press, 321-348.
- (2008): *The Essential Guide to Standards, Handbook of Consortium Info*. http://www.consortiuminfo.org.

TAPIA C., (2010): *Industrial Property Rights - Technical Standards and Licensing Practices (FRAND) in the Telecommunications Industry*, Köln: Heymanns.

WEISS, M. B. H. & SIRBU, M. A. (1990): "Technological choice in voluntary standards committees: An empirical analysis", *Economics of Innovation and New Technology*, 1, 111-133.