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Emerging Smart Technologies and the European Standardisation System

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Abstract The standardisation of smart applications and the underlying smart communication infrastructure represent new challenges for European standardisation. This paper identifies and discusses a number of policy issues that the European Standardisation System (ESS) faces or is likely to face in the not-too-distant future. A number of potential steps that the ESS could take to help resolve these issues are sketched.

Keywords: • Smart Applications • Smart infrastructure • European Standardisation •

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1 A Very Brief Introduction

"Standards are not only technical questions. They determine the technology that will implement the Information Society, and consequently the way in which industry, users, consumers and administrations will benefit from it" [EC, 1996; p. 1]. This quote conveys two important insights that are overlooked all too often:

- ICT systems simply would not work without underlying standards.
- Today's (ICT) standards are tomorrow's technology – those that develop (ICT) standards today at the same time shape much of the (ICT) environment we all will use in the future.

This holds for ICT standards in general and for standards for 'smart' technologies in particular. Basically, the 'smartness' emerges from the incorporation of ICT-enabled capabilities into 'traditional' applications; 'Smart Manufacturing' and 'Intelligent Transport Systems' (ITSs) are cases in point. In general, such smart technologies result from the merger of different technologies. The former integrates, among others, production engineering, robotics, control engineering and ICT; the latter transport telematics, traffic engineering and ICT. These applications will deploy a 'smart' infrastructure, comprising Cyber-Physical Systems (CPSs) and deploying the Internet of Things (IoT) for communication.

These merging technologies represent a considerable problem for standardisation. They will require co-operation between standardisation entities with very different cultures, from equally different backgrounds and used to very different technology life cycles. While this is a general problem, this paper aims to contribute to an answer to the question how well the ESS is likely to fare in this increasingly important and complex environment. Is it future-proof? And if it isn't – what needs to be done to change that?
The remainder of the paper is organised as follows. In sect. 2, a SWOT analysis is used to discuss the ESS. The resulting policy issues are addressed in sect. 3. Finally, sect. 4 presents a rudimentary roadmap and outlines some future steps that the ESS might consider taking to overcome these issues.

2 The European Standardisation System – A SWOT Analysis

The SWOT analysis of the ESS aimed at the identification and analysis of the major standardisation-related issues in general and in the field of smart infrastructure and applications in particular. Tables 1 and 2 show the outcome.

Table 1: SWOT analysis of the European standardisation system (general)

Strengths	**Weaknesses**
• A contradiction-free standards system. • Well-established, consistent system with close links to European policy makers. • Close and long-standing co-operation with international counterparts and major NSOs (CEN, CENELEC). • Well respected internationally (ETSI). • Pioneers in innovative approaches towards standardisation (ETSI).	• (Financially) dependent on policy makers. • So far, process not 100% suitable for fast-moving technologies (CEN, CENELEC). • Overly European focus (CEN, CENELEC). • Sub-optimal type of representation (through national delegations; CEN, CENELEC). • Very much a 'rubber-stamping' (of IEC standards) entity (CENELEC). • Limited links between research and innovation (R&I) and standardisation. • Low emphasis on standards education.
Opportunities	**Threats**
• Contradiction-free standards will help sustain the single market. • Good links to international bodies can strengthen the EU position in the global arena. • High reputation attracts both European and international know-how, contributions and members (ETSI). • Higher democratic legitimacy may increase relevance associated with European standards (CEN, CENELEC).	• Financial dependency on policy makers may lead to even stronger European focus and thus reduced international importance (CEN, CENELEC). • The newly imposed focus on speed may be counter-productive when it comes to high-quality standards for long-lasting infrastructures. • Inadequate links between R&I and standards setting hinders exploitation of state-of-the-art technical knowledge, may render European standards inadequate and may delay ESOs from addressing crucial future topics. • Mostly 'rubber-stamping' of IEC standards will reduce European visibility and influence in this body. • Increased market fragmentation through inadequate incorporation of consortium standards into the ESS.

Table 2: SWOT analysis of the European standardisation system (for smart applications and infrastructure)

Strengths	**Weaknesses**
• Well positioned in the telecommunication sector (ETSI). • Long-standing activities in ITS (CEN). • Several NSOs are very active on smart applications (e.g. the German DIN on Smart Manufacturing and the British BSI on Smart Cities). • Adequate expertise is available on smart infrastructure/applications (between ESOs and NSOs). • Inclusive approach.	• Very limited activities on smart applications at European level (all ESOs), infrastructure (CEN, CENELEC) and CPSs (all ESOs). • Hardly any formal entities (Technical Committees (TCs), Working Groups (WGs)) in place to address 'smart' aspects (CEN, CENELEC). • No visible approach towards multi-disciplinary standardisation (all ESOs). • Implementation aspects are not considered (mostly CEN, CENELEC). • Hardly any formal links to non-European entities (except ISO/IEC) for all smart applications and the IoT (CEN, CENELEC).
Opportunities	**Threats**
• The combined expertise of NSOs and ESOs should be sufficient to assume a leadership position in some smart applications. • The accommodating attitude towards SMEs and 'non-traditional' stakeholders (e.g. NGOs) should be an asset in the field of smart applications.	• Lack of adequate level of activity on smart applications/infrastructure may lead to marginalisation in these crucial domains (CEN, CENELEC). • The widely held belief that ICT standards in general and IoT-related ones in particular should be global may render regional bodies less relevant (CEN, CENELEC). • Lack of links to international Standards Setting Organisations (SSOs; specifically to consortia) may also contribute to future marginalisation in the field (CEN, CENELEC). • Retained mono-disciplinary approach may contribute to reduced interoperability, e.g. between infrastructure and applications. • Failure to consider implementation issues may nullify any potential first mover advantages.

The tables show that both strengths and weaknesses of the ESS result from it being a well-established, long-standing system. On the one hand, good relations with policy makers and their international counterparts together with time-honoured (and bureaucratic) processes have made CEN and CENELEC major players in many fields and entities to be reckoned with. In addition, a contradiction-free set of standards is a major asset.

Yet, such systems tend to become self-complacent. For example, until very recently the ESS largely ignored the importance of private standards consortia in the ICT sector. A fairly recent European Regulation [EU, 2012] certainly points in the right direction on this and several other aspects, but it still remains to be seen how things will develop in practice. Specifically, it is still unclear how (and if) the call for both greater speed and more inclusiveness can be answered in practice. That said, greater speed is not a desirable feature per-se. In particular, supposedly long-lived technologies like e.g. communication infrastructures may well benefit from a longer, more thorough and less error-prone process that involves all stakeholders. Inclusiveness would be of special importance for smart applications, where many stakeholders will be involved that are typically absent form 'normal' ICT standardisation (e.g. city authorities or NGOs). Moreover, it remains an open issue how the contradiction-free system is to be maintained in the face of the likely wealth of consortium standards eventually used and referenced.

From the SWOT analysis it also would seem that there is a real risk of international marginalisation of at least CEN and CENELEC in the fields of smart infrastructure and, particularly, applications. This is primarily due to:

- Overly strong European focus
  If this focus leads to inadequate international links the situation will become worrisome. This will hold especially if it occurs in a field where global standards (possibly with regional adaptations) are a sine-qua-non.
- Limited activities on smart applications
  Limitations materialise in two ways. Most notably, CENELEC focuses the majority of its activities on transposing IEC standards into European ones . Secondly, with the exception of ITS, the 'smart' aspects of applications have largely been ignored so far; foci, if any, are on the underlying communication side.

The latter is all the more surprising as one of the ESS' strengths is its close link to policy making. This could be exploited through new European standards setting activities that focus on the upper layers of smart applications. Here, the associated governance aspects imply the needs for such close links between standardisation, government and policy making.

Unfortunately, some of the perhaps less obvious issues that may nevertheless have potentially considerable long-term ramifications do not get the attention they deserve.

These include primarily the link between R&I and standards setting and the education about standardisation. A weak link to research may imply that important findings never make it into the standardisation process and that, accordingly, standards will be developed that do not take into account the state-of-the-art. As a result, such standards will either not be taken up by the market or be very soon superseded by others. Inadequate (or rather, virtually non-existing) education about standardisation may, in the medium to long term, lead to (at least initially) poorly equipped European standardisers in the international arena.

3 Policy Issues

This section looks at some of the issues the ESS faces or is likely to face in the near future. This includes some general ones as well as a number of aspects that relate specifically to the standardisation of smart infrastructures and applications.

3.1 General European Standardisation Issues

European standardisation still needs to deal with a number of issues that were identified already many years ago and have been discussed ever since, but in several cases without a satisfactory outcome. These include the need for speed in standards. But speed is not a value in itself. If it supports the timely production of a standard, speed will be beneficial. Otherwise, it may stand in the way of quality and completeness. Accordingly, the popular unqualified focus on speed needs to be questioned. In addition, achieving both 'speed' and 'inclusiveness' is next to impossible – the larger the number of interested parties around the table, the longer it will take to reach consensus. A case-by-case balance needs to be struck – 'speed' must not be the overriding issue when it comes to e.g. standards for security and privacy in smart applications and 'inclusiveness' must not be the show-stopper for standardisation of e.g. interfaces to peripheral devices. That is, the necessary and desirable levels of inclusiveness and speed vary between standards (see also e.g. [Sherif, 2003].

The link between R&I and standardisation is another long-standing issue, which also links to education about standardisation. The European Commission's recent 'Joint Initiative on Standardisation' [EC, 2016a] is but the latest attempt to overcome the barriers that still exist between standardisation, innovation and education and the respective communities. Its eventual outcome remains to be seen. In any case, without a closer integration of these domains neither policy makers nor industry will be able to reap the full benefits standards and standardisation offer.

Close links between policy making and standardisation exist in the EU. This is a bit of a double-edged sword, though. On the one hand, some standards are not so voluntary anymore (especially in the field of public procurement). "If the producer does not manufacture in conformity with these [harmonised European] standards, he has an obligation to prove that his products conform to the essential requirements" [CEU, 1985].

On the other hand, these links may well be beneficial when it comes to the standardisation of smart applications where regulatory aspects may well play a role.

3.2 European Smart Application/Infrastructure Standardisation

From a standardisation perspective, the development over time in both the application areas and the infrastructural technologies show considerable similarities. In all cases, the complexity of the respective web of SSOs has increased dramatically over the past 20 years, as has the number of relevant entities within individual SSOs (TCs, WGs, etc.). The most notable proliferation of such entities could be observed for the past five to seven years, with the exceptions of ITS and mobile communication, where the development was more homogeneous and far less pronounced peaks occurred around 2005 and in the late 2000s, respectively [Jakobs, 2017].

Another similarity lies in the fact that in all cases but one the establishment of formal SDOs (typically working on predecessor technologies) predate those of consortia by decades (ITS being the exception). Overall, it would seem that up to now consortia play a less important role in the development of smart applications and IoT-related technologies than they do e.g. in the mobile communication sector.

ICT systems span the globe and, by definition, the associated standards need to be global as well. The task of regional standards then is to introduce regional specifics (of e.g. regulatory nature) into international standards, while maintaining global interoperability. Alternatively, some such regional specifics may find their way into international standards. However, both cases require dedicated regional standardisation activities.

Against this background, a look at the developments in Europe yields a somewhat ambivalent picture. On the bright side, ETSI's activities on smart applications and, particularly, smart infrastructure through its smartM2M TC and its Partnership Projects (3GPP, oneM2M) are well positioned in the global context. However, the focus is on rather more low-level wireless telecommunication services. On the other hand, the eight CEN Technical Committees identified as being active in the field of 'Smart Technologies' in [CEN/CENELEC, 2016] focus almost exclusively on metering and do not really link to ICT, the IoT or CPSs. The one exception is CEN/TC 294 (Communication systems for meters). However, as the name suggests the focus here as well is on the communication system. Perhaps more notable, CEN has long been playing a prominent role in the ITS sector, also covering more application-oriented services. Apart from that, however, CEN and CENELEC seem to have adopted a 'laggard' role, with CENELEC largely focussing on the transposition of international standards.

According to the 'Rolling Plan for ICT Standardisation' [EC, 2016b], CENELEC "works out methods for safe and secure communication protocols for wired and wireless industrial automation applications" in the field of Smart Manufacturing [EC, 2016b]. Yet, this work as well has so far moastly been limited to the adoption of IEC standards. Given the pioneering role that Europe in general and Germany in particular play in this field

('Industrie 4.0'; see e.g. [GTAI, 2014]), it seems a bit strange that such a leadership position should not be translated into indigenous European standards that could eventually be adopted by ISO or IEC . In fact, the apparent reluctance to play a more active role in smart manufacturing standardisation is also at odds with [EC, 2016a]. This document highlights Europe's long standing leadership in factory automation and that standardisation has an important role to play in helping European industry to secure this leadership The ESOs' Coordination Groups on the Smart Grid, Smart Meters and Smart and Sustainable Cities and Communities, respectively, have so far been more policy advisory entities rather than actually active in standards setting. With respect to the IoT, CEN/CENELEC's standardisation activities are limited to the field of automatic identification and data capture, where a newly (in 2016) formed WG addresses IoT related issues.

In this context, the lack of any approach towards truly multi-disciplinary standardisation is worrying. It is also surprising since the European Commission has identified the need for such an approach in [EC, 2016b]. The document calls for multi-disciplinary standardisation in several application areas, including Smart Grid and Smart Cities.

Given the almost frantic activities that are going on at the international level this seemingly rather restrained European approach (at least for smart applications) appears a bit odd. In fact, it is in stark contrast to the recommendations made already in [ProSE, 2011]. While these recommendations relate to the field of embedded systems (the not necessarily interconnected predecessors of CPSs), they are equally valid for the standardisation of the IoT and smart applications. The relevant ones (in this context) read: "Recognise the need to value standardisation and to take leadership of standardisation (in appropriate domains).

Recognise the need to co-operate on standardisation across competitive boundaries and to reconcile and manage the differences that presently inhibit such co-operation.
Invest in the efforts required to bring about standardisation, allowing staff the time and support to bring about long-term benefits.

Invest in people and RTD in order to feed the technology pipeline that provides the basis for standardisation".

The above recommendations should be applied at least to those sectors where Europe has assumed – or aims to assume – a leadership position, technologically and/or in standardisation. Specifically, this holds for the ITS sector, where CEN has been (co)-leading the way for a number of years now. Likewise, existing strengths in Smart Manufacturing should be exploited in the standardisation arena (beyond Additive Manufacturing, which is covered by a CEN TC).

4 Potential Future Steps

4.1 A Very Rough Roadmap for the ESOs in the Field of Smart Infrastructure and Applications

This section aims to deepen these insights by identifying actions potentially to be taken by the ESOs to meet external challenges. Fig. 1 shows the underlying framework.

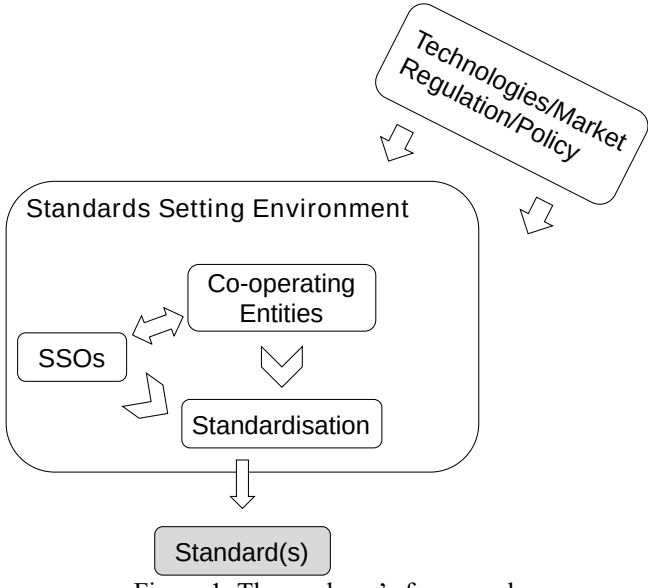

Figure 1: The roadmap's framework

In an environment characterised by uncertainties a roadmap offers a visual representation of alternative paths towards a strategic goal or a vision (see e.g. [Phaal & Muller, 2009]). Here, the overall goal is a global standardisation environment within which the ESOs play a central role in the standardisation of a smart communication infrastructure and smart applications. To this end, a number of external influences have been extracted from a literature review , a survey8 and the SWOT analysis. They are depicted in Fig. 2, along with the associated actions to be taken to adequately address them and to eventually make the vision a reality.

It would appear that two already ongoing trends – strong Asian/Chinese participation in standards setting for smart applications and infrastructure and the need for truly interoperable implementations (as opposed to standards) – may well imply a further reduction of the ESOs' international importance (specifically of CEN and CENELEC). The same holds for the possible (likely?) trend towards all-IP networks (see e.g. [Jara et al., 2013]). This is hardly going to happen anytime soon, but may well be expected in the medium term. The same holds for a wider deployment of CPSs and of smart applications. Given the current fragmented standardisation landscape and the infancy of the associated

standards setting activities, these developments are a) unlikely to be aligned and b) likely to deploy proprietary technology. However, this may increase the need for interoperability and thus for international standards. This, in turn, would represent an opportunity for the ESOs if they managed to position themselves as relevant players in the meantime.

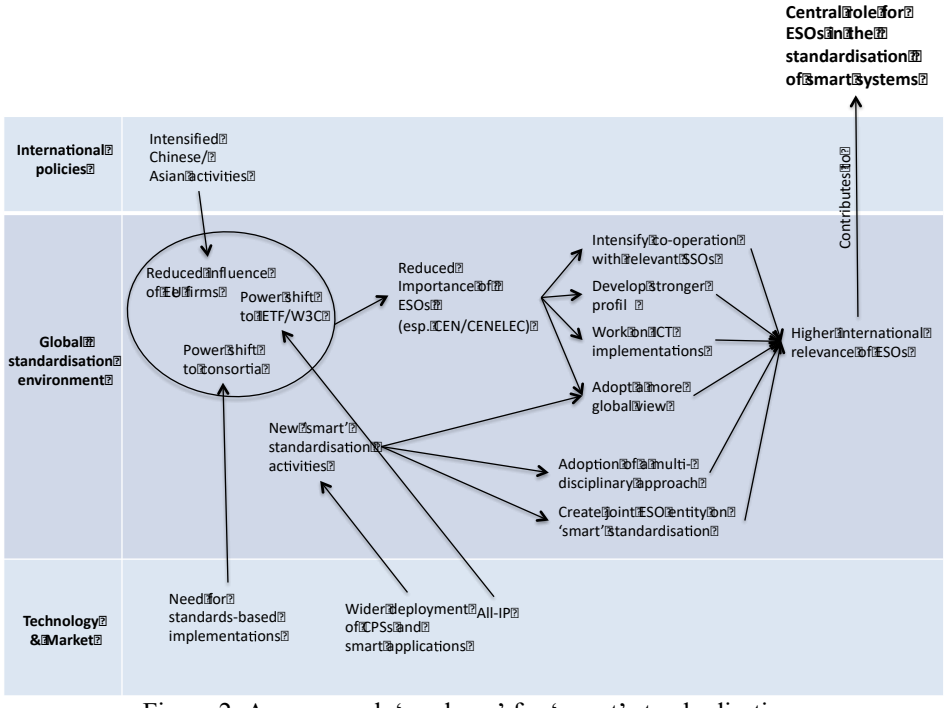

Figure 2: A very rough 'roadmap' for 'smart' standardisation

Fig. 2 shows that the ESOs do not always play the role they could play in the standardisation arena for smart infrastructure/applications. The SWOT analysis revealed a number of issues that need to be addressed. These issues fall into three categories (not all apply to all ESOs):

- Limited relevant activities.
  This has two dimensions. For one, not all relevant technical areas are covered by the ESOs. Moreover, especially CENELEC frequently limits its activities to the transposition of IEC standards into European ones.
- Inadequate international interconnectedness.
  While very good links exist to the ESOs' respective international counterparts the same may not be said for private international standards consortia.
- Process aspects.

- This refers to limited links to relevant research activities, to the equally limited activities in standards education, to the disregard of implementation aspects and to the lack of multi-disciplinary standardisation.

These weaknesses will be discussed in the following.

4.2 Limited relevant activities of the ESOs

A number of gaps in the ESOs' standards setting activities may be identified in the realm of smart infrastructure/applications. For one, with the exception of ETSI's smartM2M group (and its involvement with oneM2M) hardly any activities are to be found. This comes as a bit of a surprise since both CEN and CENELEC have been venturing into the field of communication systems (e.g. in ITS (CEN) and for the smart grid (CENELEC)). Moreover, a smart infrastructure (including particularly the IoT and CPSs) is the basis for all smart applications. Similarly, the activities relating to smart cities are in their infancy at best. Given the necessary tight integration of standards activities on smart applications on the one hand and a smart (communication) infrastructure on the other it would seem that joint ESO activities in the 'smart' realm are called for. How exactly such joint activities may look like would have to be discussed. Joint CEN/CENELEC entities have already been established (TCs, WG, Workshops); an extension of this concept to also include ETSI should be considered. This would, on the one hand, strengthen the expertise on the communication side and support multi-disciplinary and integrated standardisation (of applications and infrastructure) on the other. Along similar lines do the virtually non-existing global standardisation activities for CPSs represent an opportunity for Europe. Research in this field has been going on for quite a while now in Europe . This accumulated know-how could be used as basis for European standardisation activities, also e.g. through a TC managed jointly by all ESOs.

The other issue relates to the fact that in many cases CENELEC's main activity seems to be the transposition of IEC standards. For example, in the field of Smart Manufacturing almost all but ten (out of 250+) standards passed by CLC TC65X originated from the IEC. It certainly makes sense not to unnecessary duplicate any work. However, the thought of CENELEC standards solely being based on IEC documents for both ITS and the Smart Grid is a bit worrying. After all, there are European specifics, most notably in the highly regulated field of the Smart Grid. Specific European boundary conditions may also be assumed for e.g. Smart Cities. A higher level of autonomy in these fields is called for.

4.3 Inadequate international interconnectedness

The focus of both CEN and CENELEC is clearly on Europe. This is not a bad thing per-se for an ESO. However, the ICT sector is, almost by definition, global. Accordingly, in this sector, which includes smart infrastructure and applications, globally accepted standards are a sine-qua-non. The European Commission has realised that; the Regulation on European standardisation [EU, 2012], which notes that "… the Union should

encourage contact between European standardisation organisations and private forums and consortia, while maintaining the primacy of European standardisation". Nevertheless, CEN and CENELEC together have so far established links with only four international organisations that are of some relevance for the standardisation of smart infrastructure and applications. It may be assumed that this isolation also contributes to the fact that regional standards bodies' importance in the field is seen as either limited to the identification of specific regional requirements and the associated adaptation of global standards or is questioned altogether [Jakobs & Wehrle, 2017]. As a first step, links to relevant non-European players should quickly be established through formal co-operation and co-ordination mechanisms.

4.4 Process aspects

A number of rather diverse aspects fall under this heading. For one, the need for education about standardisation has been highlighted by several sources. Recently, the EU's 'Joint Initiative on Standardisation' observes that "… there is a clear need to explore and promote standardisation as an element of formal education, academic & vocational training, …" [EC, 2016a]. So far, in Europe coverage of standardisation has been very limited in tertiary education. Continuous education is primarily provided by the NSOs and typically focuses on the practical aspects of standards setting, as opposed to e.g. economic or other academic ones. The problem has long been realised; a 'Joint Working Group on Education about standardization' was established by the ESOs in 2010. However, the group has been dormant for quite a while. Work on the 'Programmes for education in Standardisation/Training and awareness on standardisation' [EC, 2016a] has commenced after initial difficulties; its outcome remains to be seen.

Moreover, links between standardisation and Research & Innovation (R&I) need to be improved. This issue has also been on the agenda for quite a while now. Both the 'Interest' [Interest, 2007] and, more recently, the 'Bridgit' project [Bridgit, 2014] made a number of similar recommendations on how to bridge the gap between standardisation and R&I. In unison, they highlight the need to increase awareness on both sides and to mutually promote and educate. Likewise, incentives need to be offered to researchers to spend resources on standardisation activities; this should be of relevance for research funding organisations (including the EU). For the ESOs, this would include adapted or new processes that are more 'research-friendly', i.e. short-lived (akin to e.g. IETF Working Groups). CEN/CENELEC Workshops and ETSI's Industry Specification Groups are certainly steps in the right direction. However, their usefulness is limited by the fact that no mechanism exists to feed their output into the standardisation process proper (e.g. through the transition of a CEN Workshop to a Working Group). Taking the various recommendations made by the two projects on board would definitely help improve the situation.

Not unlike their international counterparts, both CEN and CENELEC stay clear off any implementation aspects. The situation for ETSI is slightly different; their 'Plugtests' represent at least a step towards taking implementation issues into account. In any case,

the success of SSOs like the IETF and the W3C may to no small part be attributed to the fact that they consider implementations and proven interoperability as part of their respective standardisation process (see e.g. [Lehr, 1995]). It seems highly unlikely that CEN and CENELEC will change their stance on implementations. Nevertheless, at least for the ICT sector steps ought to be taken to provide the market with what it needs – interoperability. Perhaps a new entity that develops and/or certifies interoperable implementations might be a way forward.

The lack of multi-disciplinary standardisation is another issue. The need for such a new way of setting standards for the field of smart infrastructure and applications has been corroborated by survey respondents in [Jakobs & Wehrle, 2017]. A standards setting platform jointly managed by the ESOs has already been suggested above. Such a platform would have the potential to kill two birds with one stone. On the one hand, it would help improve the level of the ESOs' involvement in the international standardisation of smart infrastructure and smart applications. As the European expertise from the different relevant fields would likely be concentrated on this platform it would also contribute to the goal of multi-disciplinary standardisation. A 'third bird' would be the fact that such a major 'hub' of standardisation in the 'smart' field could also attract other SSOs to enter into co-operation agreements. Such a platform would allow experts from different backgrounds and from several SSOs to meet and to address inherently multi-disciplinary standardisation problems (eventually not necessarily limited to smart infrastructure and applications).

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