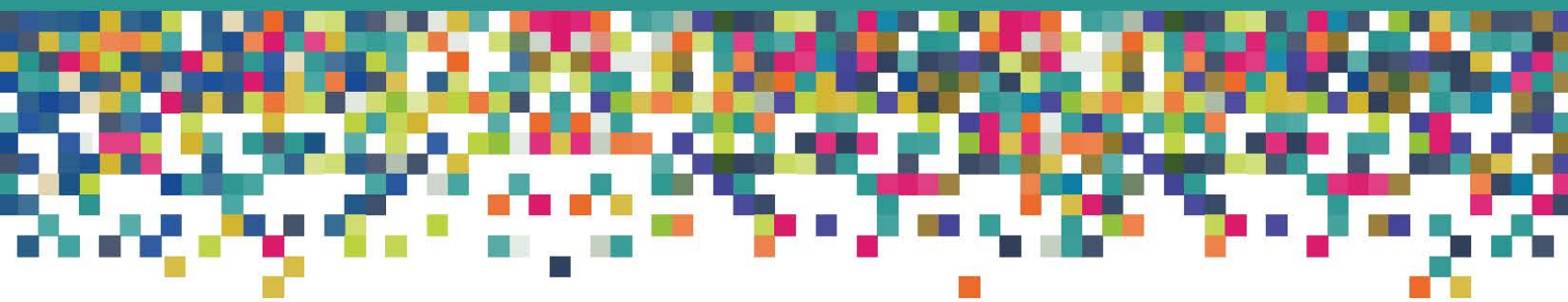
LSE Media and Communications

Media@LSE Working Paper Series

Editor: Bart Cammaerts



Levelling the Standardization Playing Field in a Globalized Digital Economy

Lara Srivastava and Keith Mainwaring

Levelling the Standardization Playing Field in a Globalized Digital Economy

LARA SRIVASTAVA AND KEITH MAINWARING[1]

[1] Lara Srivastava (lara.srivastava@gmail.com and lsrivastava@worldbank.org) works with The World Bank's Digital Development Global Practice and is a Visiting Fellow at the London School of Economics and Political Science (Media@LSE). She has over 25 years of experience in technology foresight, international standardization and digital regulation, spanning regulatory agencies, start-ups, academia, management consultancies, international organizations and standards-making bodies. She is a qualified lawyer (Canada) with a JD in technology law (University of Ottawa), an MSc in Technology Policy (SPRU, University of Sussex), and a PhD focusing on IoT and Smart Homes (University of Aalborg).

Keith Mainwaring (keith.mainwaring@yahoo.com) is an independent consultant specialising in telecommunications standardisation and policy analysis. His areas of expertise are data communication signalling protocols and the homologation of telecommunications equipment. He has been active in the ITU, ETSI, ATIS, IETF and BSI defining standards for ISDN, ATM, Next Generation Networks and the Internet. His career spans a role building the UK Joint Academic Network, through consultancy at Logica plc, to signalling expert at Swedish Telecom and Cisco Systems. More recently he has been advising countries on regulations for telecommunications equipment homologation and the establishment of testing facilities.

The authors would like to thank Professor Robin Mansell for her invaluable input and guidance on this paper.

Published by Media@LSE, London School of Economics and Political Science ("LSE"), Houghton Street, London WC2A 2AE. The LSE is a School of the University of London. It is a Charity and is incorporated in England as a company limited by guarantee under the Companies Act (Reg number 70527).

ISSN: 1474-1938/1946

Other papers of the series can be found at:
https://www.lse.ac.uk/media-and-communications/research/working-paper-series

ABSTRACT

With a focus on the international standardisation of information and communication technologies and applications, this paper examines the benefits of standardisation, the practices of established players in the field and the challenges faced by organisations with a shorter history of standardization - in particular those in lower income countries with fewer resources. Suggestions are made as to how such organisations could become more effective and exert greater influence on the global standardization stage by considering key strategic factors related to participation and decision-making that go beyond solely technical aspects.

The importance of assessing whether standards have been implemented correctly, in part to improve trade efficiencies, is highlighted through an examination of product homologation and mutual recognition agreements. Specific examples are given which bring out the challenges faced by lower income countries in conformity assessment, and in that context the paper highlights the benefit of national coordination, regional cooperation initiatives and the establishment of dedicated facilities such as test laboratories.

A general description of the working procedures of various international standards development organizations in the field of information and communications technology is given in an appendix and provides the essential context for the analysis contained in the paper. Procedures vary greatly across organizations and an understanding of them is critical to effective participation, leadership and influence in standards-making.

.

1 INTRODUCTION

Standards are critical drivers and enablers of the goods and services that make up modern life, most especially in the current fast-paced technological climate. Formal standardization, together with enabling regulations, shape the direction of technological developments which in turn have an impact on economic growth and social welfare (Blind et al., 2017). This holds true across industries, from agriculture and energy to medical devices and mobile phones. With increased globalization, international standards have grown in importance over recent decades, as facilitators of data sharing, best practice and knowledge exchange, and enablers of trade and investment around the world. Despite the important role that standards play, as the "lifeblood of innovation in the global knowledge economy" (Grewal, 2008), research and analysis on international standards development has been relatively limited, with the understanding of the inner workings of standards development organizations (SDOs) often complex and opaque.

The production of standards is very much driven by the stakeholders in the particular area of standardization, namely the companies active in the sector and the countries in which they are based. Technologically advanced countries typically lead the standards work and dominate procedures and outcomes in standardization organizations. A good example of this is the standardization of digital mobile cellular technology in the 1990s, which was initially advanced by the Nordic countries – Finland's Nokia and Sweden's Ericsson, together with Germany's Siemens and South Korea's Samsung. The standardization of the Internet, on the other hand, has very much been driven by the USA. Those countries that are not active in the industry find it difficult to influence the direction and scope of standardization and miss out on important early-mover advantages (Farrell and Saloner, 1985). Although it is generally accepted that countries should not produce national standards if a corresponding international standard already exists (Stephenson, 1997) both on grounds of efficiency and of not introducing technical barriers to trade, some resource-poor countries have experienced issues related to the quality of goods, such as sub-standard and counterfeit products. They have identified a need to exercise more control over their markets and have greater influence on the setting of standards and conformity assessment procedures. Lower-income countries have also been used as a dumping ground for electronic waste, for instance in Ghana, and there is currently much interest in developing product life-cycle standards to meet growing concerns of environmental pollution.

An important development gap in standardization outcomes between traditional industrialized players and lower-income countries stems from disparities between countries in the ability to access and influence standards-making. Successful outcomes in standards

making organizations are highly dependent on the level of participation in relevant organizations (Hawkins, 1995). The analysis in this paper highlights why, even where membership status is equal from a procedural perspective, participation varies greatly, from passive observation to influence and leadership. It is not uncommon for some countries to participate as mere observers, simply attending meetings passively for years without making any proposals for new standards. Even commenting on existing standards, but not proposing new work is insufficient to influence the standards process, particularly when collaborative networks have been well-established. Standardization outcomes and strategies are also shown to be heavily influenced by the type of interests represented, whether these are government (ministry or regulator), private sector, or academic. For example, private sector actors can support, block, or remain neutral with respect to a particular standard, depending on commercial interests, such as ensuring a competitive advantage or locking-in technology (David and Greenstein, 1990). In many industrialized countries, state and industry actors collaborate actively, agreeing on unified strategies regarding any existing or new proposals. This creates systemic barriers to participation and influence by organizations and states that do not have a history of early industrialization and subsequent standardization efforts.

This paper examines standardization in the global context, the main challenges faced by non-traditional players, and strategies and solutions for greater transparency, relevance and international consensus. Although it begins with an overview of standardization processes in key international and regional fora, its main focus is on standards and conformity assessment in the information and communications technology (ICT) field and relies heavily on examples from international organizations such as the International Organization for Standardization (ISO) and the International Telecommunication Union (ITU). The discussion draws upon insights gained by both authors through their collective 60 years of participation in standardization activities, representing state, industry and standardization organizations. Their insights have been generalized in this paper in the interests of confidentiality of standards-making participants and the substance of negotiations.

2 WHY STANDARDS MATTER

Standards are vital engines of industry and lie at the heart of today's global knowledge economy. Without them, the exponential proliferation of network-enabled smart devices and components would hardly have been possible. The success of the internet itself is a result of the global consensus and adoption of IP-based technologies, protocols and standards (Larsen, 2012). Moreover, increased specializations in manufacturing, in the spirit of Adam Smith's division of labour and a post-industrialized economy, means that a single product may be the result of components designed and produced by multiple innovating companies. Standards

often go unnoticed but are ubiquitous in daily life, particularly in digitalized societies. They are in phones, printers, processors, wireless networks and software programmes. Increased technological convergence over the last decades has only served to amplify the crucial role that standards play in an increasingly digital world, with hundreds of different standards at play in a single laptop or smartphone (Biddle et al., 2010)[2].

Technical standards provide the key interfaces that allow different components to interact and exchange data, for a seamless customer experience. They provide an important common language for goods and services. The ISO defines an international standard as "a document containing practical information and best practice", which contains "an agreed way of doing something or a solution to a global problem" (ISO, 2019a). The European Telecommunications Standards Institute (ETSI) defines a standard as "a collection of the minimum requirements necessary for something to co-exist and interoperate correctly with another, meet national and international regulations, or operate safely without causing harm to people or equipment" (ETSI, 2013). International standards are voluntary in nature but laws and regulations maybe enacted by nation states to make them mandatory (Šimunić and Pavić, 2020). Users are mainly unaware of the number of interactions, protocols and exchanges required for a single operation on a smartphone, from accessing the web over a Wi-Fi hotspot and sending a chat message, to watching a video or saving a document on the cloud. On the other hand, a lack of standardization is felt more acutely by consumers, such as having to use different chargers for different smartphones.

Perhaps most crucially, in areas ranging from food production and agriculture to aviation and 5G mobile, safety and reliability standards play a fundamental role in diffusion and adoption of innovations. Standards can help prevent negative impacts on health and on the environment. The role of standards is magnified with disruptive paradigm shifts being brought about by innovations in artificial intelligence, robotics and the Internet of Things, and by growing concerns related to climate change. The growing unpredictability and complexity of an increasingly globalized landscape will require greater international coordination, shared understanding and information transparency (UN, 2015).

[2] According to Biddle et al. (2010), a modern laptop utilizes at least 251 interoperability standards, with the number likely to be much higher, especially when including other types of standards, e.g. environmental or safety standards. This number has only gone up since the article was published, with the proliferation of digital technologies, software and services. Of the 251 standards identified by the authors, 112 (44%) were developed by consortia, 90 (36%) by formal standards development organizations, and 49 (20%) by individual companies.

Standards provide a shared foundation of advanced technological knowledge that can help facilitate the diffusion and adoption of innovations (Acemoglu et al, 2010). One view is that agreed standards stifle innovation (Zoo et al., 2017), but governments slowly have been increasing their focus on standardization as a fundamental part of innovation policy (Mansell, 1985). Although causality between standardization and innovation is difficult to determine, studies have shown a positive correlation or complementarity between the two (Blind, 2013). A 2010 survey of UK firms found that standards were important sources of information that helped support innovation activities (Swann, 2010). The connections between standardization, economic growth and productivity have been established by detailed economic studies in a number of countries. For example, a study conducted for the German Institute for Standardization found that a 1% increase in standards is positively correlated with a 0.7 to 0.8% increase in national economic growth (Blind et al., 2011). Standardization is also seen as an important mechanism to disseminate and commercialize research and development efforts. According to the International Organization for Standardization (ISO), standards support the prevention of market failures (through the transmission of technological information), the creation of network externalities (through greater interoperability), the reduction of production costs and increases in company productivity (due to information being more readily available) (ISO, 2021). Similar national studies have been produced, mainly in industrialized nations. An example is a series of case studies conducted by the Belgian Bureau of Standardization (NBN) in 2020, which found that standards have the following benefits:

- They facilitate dialogue and transactions between customers and supplier, hence they reduce transaction costs.
- They create a level-playing-field on competitive markets.
- They play an important role in improving product quality and safety.
- They facilitate global trade and support competitiveness of domestic companies in global markets.
- They support R&D, innovation and the commercialisation of innovative products and services (NBN, 2020).

That being said, in terms of their impact on innovation, standards can be a double-edged sword, with early standardization being regarded as having potential negative effects (Shapiro and Varian, 1999) (David and Steinmueller, 1994). In his 2013 Nesta Working Paper, Blind (2013) categorizes standards into four types to analyze their impact on innovation, though he notes that any one particular standard may fit into one or more such categories: (1) compatibility, (2) variety reduction, (3) minimum quality and (4) information (Blind, 2013). Information standards provide codified knowledge and can therefore reduce costs and facilitate trade (Zoo et al., 2017). Compatibility or interoperability standards can create positive network externalities, increase product variety and avoid technological lock-in, but may also promote monopoly power and the lock-in of older technology. Interoperability is particularly

critical to the diffusion of ICTs, without which network effects in the use of internet and mobile networks would not be possible (Ernst, 2013). Under certain conditions, minimum quality or safety standards can promote trust among consumers, reduce market risk and therefore reduce transaction costs and accelerate the diffusion of innovations. At the same time, they can increase the cost for newer or rival firms. Variety reduction standards can create supply-side economies of scale and can help achieve critical mass, particularly for emerging technologies, but can also lead to market concentration and reduced choice for consumers (see Table 1).

Table 1: Types of standards and their effect on innovation

	Positive effects on innovation	Negative effects on innovation
Compatibility or interoperability standards	+ Creation of network effects + Avoidance of technological lock-in + Increase in variety of products + Supply chain efficiencies	- Creation of monopoly power - Lock-in of old technologies in case of strong network externalities
Minimum quality or safety standards	+ Avoidance of adverse selection + Promotion of trust + Reduced transaction costs	- Increased costs for rival firms - Potential barriers to entry
Variety reduction standards	+ Creation of supply-side economies of scale + Achievement of critical mass in emerging technologies and industries	- Reduced choice - Market concentration - Premature selection of technologies

Source: Adapted from K. Blind, Presentation at OECD Blue Sky III, 20th September 2016, available at https://www.slideshare.net/innovationoecd/blind-standardisation-and-standards-as-research-and-innovation-indicators

The World Trade Organization Committee on Technical Barriers to Trade (TBT) agreed upon six principles for the development of international standards as follows: transparency, openness, impartiality and consensus, effectiveness and relevance, coherence, and the

development dimension[3]. Transparency refers to the need for information on current work and proposals to be transparent and easily accessible to all interested parties (within WTO members), and for procedures to allow sufficient time and opportunity to provide written comments. Openness concerns the non-discriminatory nature of membership and opportunities for meaningful participation, including by developing countries. Impartiality and consensus should also be assured whereby any particular member is not given undue favour or privilege, and where consensus "take[s] into account the views of all parties concerned". The effectiveness and relevance principle urges international standardization bodies to take into consideration market and regulatory needs, together with advances in science and technology, to ensure that standards stay current and appropriate. The coherence principle seeks to avoid conflicting or duplicate standards through collaboration and coordination between international bodies. Finally, the development dimension addresses the "constraints on developing countries" in international standardization and refers to the need for capacity building and technical assistance. In so doing, it refers explicitly to the impartiality and openness principles as requiring effective participation from developing countries.

Standards are often treated as public goods, facilitating trade, fostering innovation, and increasing consumer choice and affordability (Ernst, 2013). However, when large numbers of countries are excluded from decision-making processes, the result is a skewed standards landscape that largely favours corporate interests in highly industrialized states. A common argument in favour of maintaining the status quo in ICT standards-making activities, that is to say, where the interests and expertise of industrialized economies dominate, is that interoperability is a dynamic and evolving process that requires a rapid response in a fast-paced industry (Blind et al., 2017). The rapid pace of change is not, however, a sufficient reason to fail to promote the meaningful and empowered participation of emerging economies and non-traditional actors, either formally or informally. Ensuring the effective participation of lower income countries in standardization can be a win-win for all concerned if it serves to increase the effectiveness of the standards, ensures better buy-in and adoption of appropriate technologies (in economies where demand is greatest), and helps movement towards a level playing field for innovation in the public interest. It can also serve to reduce opportunities for regulatory capture, through transparent consensus-based international agreements.

[3] See WTO, Principles for the Development of International Standards, Guides and Recommendations, available at https://www.wto.org/english/tratop_e/tbt_e/principles_standards_tbt_e.htm

2.1 The Role of Standards in International Policy Coordination

Standards play an important role in regulatory and policy development. In early research and innovation phases, standardization takes on a self-regulatory dimension that can facilitate flexible innovation and adaptation, before more formal mechanisms become necessary and are put into place. The European Commission's Rolling Plan for ICT Standardization highlights the strategic role of standardization in policy-making, and the role of technological innovation, most notably in the context of a changing geo-political landscape, ageing populations, digital transformation and sustainability challenges.[4] In many respects, and even in the case of technical standards, standards-setting is not a mere technical or economic process, but covers core governance questions (Abbott et al., 2001). The public governance aspect of standardization is even more crucial as the impact of an increasingly digital world on human identity, dignity and agency has yet to be fully understood. With the growth of 'big data' and 'fake' news, nowhere does this hold more true than in data governance, particularly with respect to data protection, privacy and freedom of expression (DeNardis, 2009).

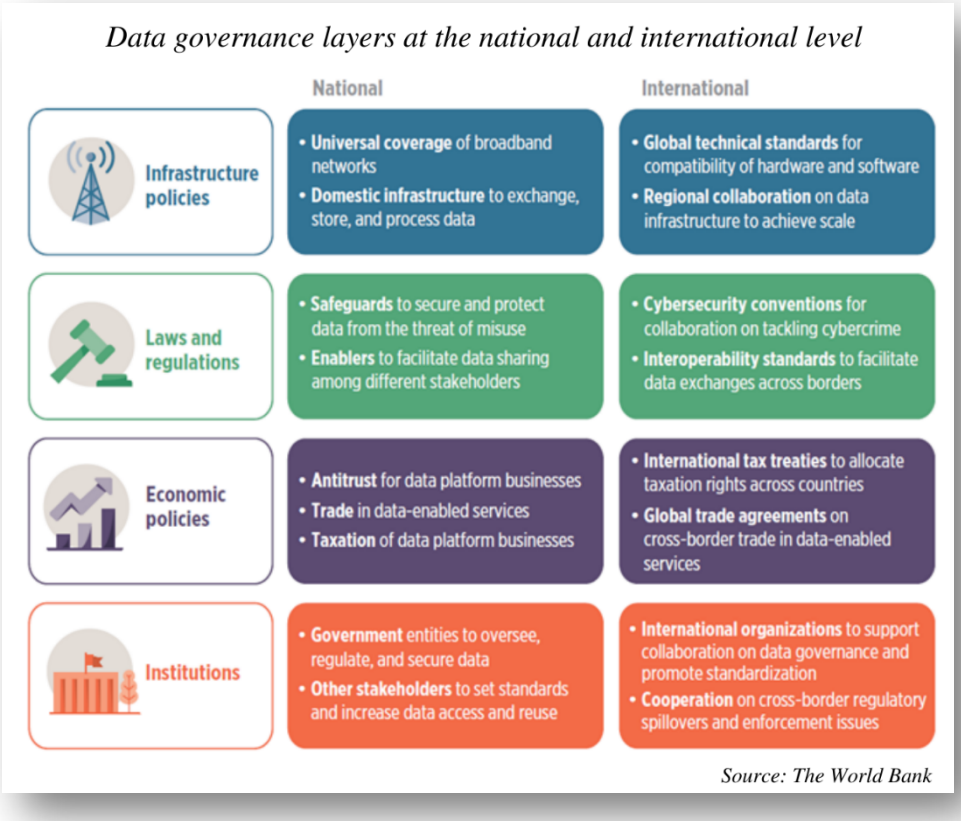
The Covid-19 pandemic has laid bare the perils of growing inequality around the world, and greater opportunities for citizen surveillance. According to Transparency International's 2021 corruption ranking, the pandemic was used as a pretext by governments in many countries to erode human rights and remove important checks and balances[5]. Many countries in the world have acknowledged the need to ensure data protection both by design and by default, for the handling of personal information, including the collection, organization, storage, use, consultation, communication and destruction of personal data. Generally, key data protection principles, such as those enshrined in the European General Data Protection Regulation (GDPR) include limitation of purpose, fairness, lawfulness, transparency, minimization, storage limitation, accuracy, confidentiality, integrity and accountability. There is an urgent need for countries to establish rules and frameworks that facilitate the use and re-use of data, while at the same time safeguarding the rights of users and other stakeholders participating in data-related activities. Standards play a vital role in data governance across multiple layers, from infrastructure to institutions. In its report "Data for Better Lives", the World Bank points

[4] See European Commission, Rolling Plan for ICT Standardisation, 2021, available at https://ec.europa.eu/docsroom/documents/44998 (accessed on 24 January 2022).

[5] See Transparency International, Corruptions Perception Index 2021, January 2022, available at https://images.transparencycdn.org/images/CPI2021_Report_EN-web.pdf (accessed on 25 January 2022).

to the important role that global standards and international organizations can play in a 'big data' world.[6]

An example of standardization in this area is work on digital identity management at the ITU. The ITU, through its ITU-T Study Group 3 in 2020, agreed by consensus the identity management standard entitled "Policy Framework including principles for digital identity infrastructure" (ITU-T D.1140/X.1261)[7]. This international standard encourages member states to apply principles of universality, accessibility, auditability and protection of personally identifiable information (PII) in the creation of digital identity infrastructure.



E-waste is another area of growing concern, for which multi-national and multi-stakeholder collaboration is required. E-waste is now the largest and fastest growing manufacturing waste. The 2020 Global E-Waste Monitor notes that the global generation of e-waste grew by 9.2 million metric tons (Mt) since 2014 and is projected to grow to 74.7 Mt by 2030 (ITU, 2020). Despite the existence of the Basel Convention (on controlling transboundary movement of hazardous wastes and their

[6] See The World Bank, World Development Report 2021: Data for Better Lives, 2021, available at https://www.worldbank.org/en/publication/wdr2021 (accessed 29 January 2022).

[7] See Recommendation ITU-T D.1140/X.1261 (08/2020), August 2020, available at https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=14270 (accessed 29 January 2022).

disposal), much e-waste is still exported. As early as 2011, the BBC was reporting that "77% of e-waste from England and Wales ends up in Africa, primarily Ghana and Nigeria"[8].

It is far cheaper to export this waste than to recycle it in an industrialized country. For example, it is 10 times more expensive to recycle a CRT monitor in the United States (US) than to ship it to Ghana. The US has not ratified the Basel Convention Control of Transboundary Movements of Hazardous Wastes and their Disposal[9]. Many used and scrap mobile phones are shipped from the European Union (EU) and North America to countries in Africa, such as Ghana, under the guise of reuse or as scrap metal. Some of these phones are repaired and find their way back into the market, although they may not meet the specifications of the manufacturer, but most are recycled in the informal sector. The Global E-Waste Monitor indicates that the volume of transboundary movements of electrical and electronic equipment (EEE) ranges from 7-20% of the e-waste generated. Unfortunately, large dumps of electronic waste, such as the one outside Ghana's capital Accra can spread toxins into the soil and the atmosphere, creating risky environments for local workers and residents[10].

It is feasible to track products from creation to recycling or destruction. Standardization of product life-cycle management and the procedures for the handling of products at the end of their use are seen as valuable approaches to minimize environmental degradation. Individual items can be marked with standardized, unique, machine-readable identifiers, encoded for example as bar codes or radio-frequency identification (RFID) tags, and systems defined to track any product at any level of granularity from component to complete complex device (Mainwaring and Srivastava, 2010).

It is often suggested that technology is moving at such a rapid pace that neither law nor behavioural norms can evolve quickly enough – that the world is in a state of future shock (Toffler, 1970). Nevertheless, it can also be argued that a digital imperative exists in everyday business and human life whereby human existence is mediated by some form of technology. Technology provides opportunities to tackle some of society's most pressing problems but, at the same time, many are being left behind. New forms of wealth, on the one hand, and new levels of social exclusion and disparity, on the other, are leading to disenfranchisement around the globe. It is therefore important to work proactively towards avoiding a situation in which

[8] See BBC, "Britain's e-waste illegally leaking into West Africa", available at http://news.bbc.co.uk/panorama/hi/front_page/newsid_9483000/9483148.stm (accessed 4 February 2022).

[9] The Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal available at http://www.basel.int/?tabid=4499#US17 (accessed 14 February 2022).

[10] See BBC News, "Where many of our electronic goods go to die", 8 January 2016, available at https://www.bbc.com/news/business-35244018 (accessed 14 February 2022)

we lack the tools (or worse yet, the will) to moderate or alter the exponential advance of the machines that are being created. Standards and standardization processes provide opportunities to rethink how society's ICT systems function in the interest of the individual and public good. A principal feature of standards setting processes involves conformity and certification both of which present challenges for lower income countries as compared to the wealthier industrialized countries.

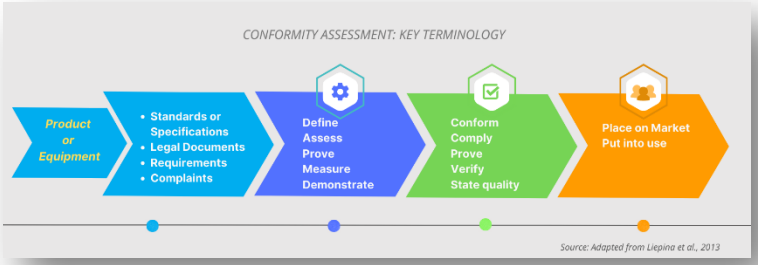
3 CONFORMING TO STANDARDS

The complete or "integrated" standardization process must be considered to include not only the development of the standards themselves, but follow-on activities related to implementation, assessment and conformity. Conformity assessment and certification procedures, implemented either on a voluntary or mandatory basis, facilitate the necessary testing to ensure that products and platforms adhere to agreed standards. In the context of global crises, such as Covid-19, disruptions in the supply of essential goods can be reduced through measures such as ensuring mutual recognition of standards for essential products (WTO, 2021). The ISO defines conformity assessment as: "the term given to techniques and activities that ensure a product, process, service, system, installation, project, data, design, material, claim, person, body or organization, or any combination thereof, fulfils specified requirements"[11]. There are several benefits of conformity assessment. First and foremost, it gives confidence to end-users that key product requirements have been met. For suppliers, such assessments can facilitate market acceptance for products. For regulators and governments, they can help encourage competition and provide best practices. The WTO Agreement on Technical Barriers to Trade (TBT) recognises the importance of both international standards and conformity assessment schemes for "improving efficiency of production and facilitating the conduct of international trade"[12].

[11] See the ISO's CASCO home page at https://casco.iso.org/conformity-assessment.html (accessed on 19 January 2022).

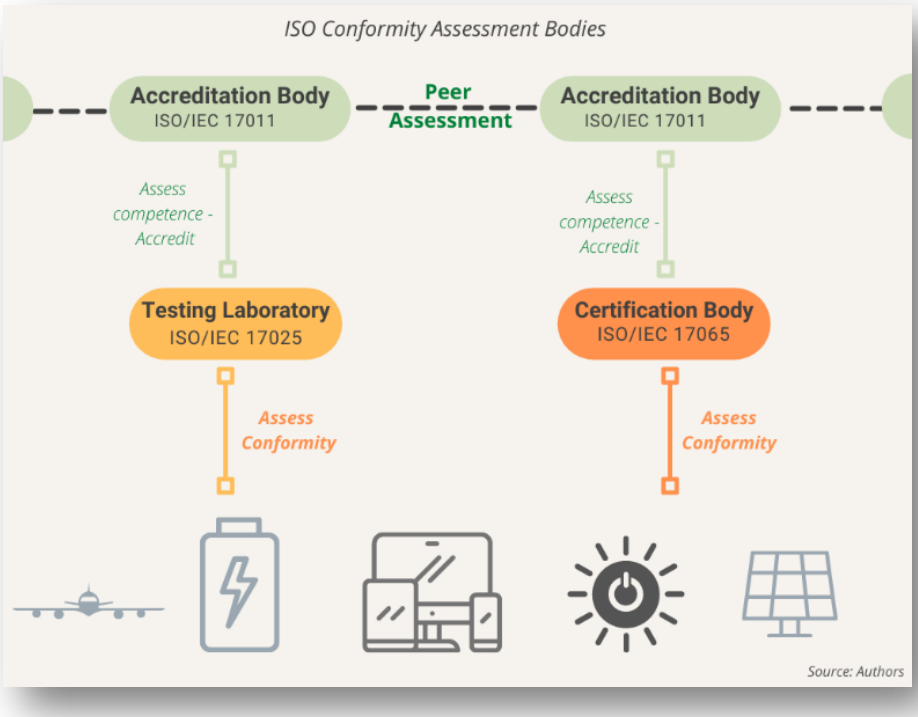
[12] See the WTO Agreement on Technical Barriers to Trade at https://www.wto.org/english/docs_e/legal_e/17-tbt.pdf (accessed on 21 January 2022).

3.1 Principles of Conformity Assessment



Conformity assessments are conducted to ensure that products or services meet specified requirements, such as legal requirements or those included in international standards, before they are placed on the market. Assessment for conformity can include making specific laboratory measurements, and verifying the quality and functionality of the product or equipment.

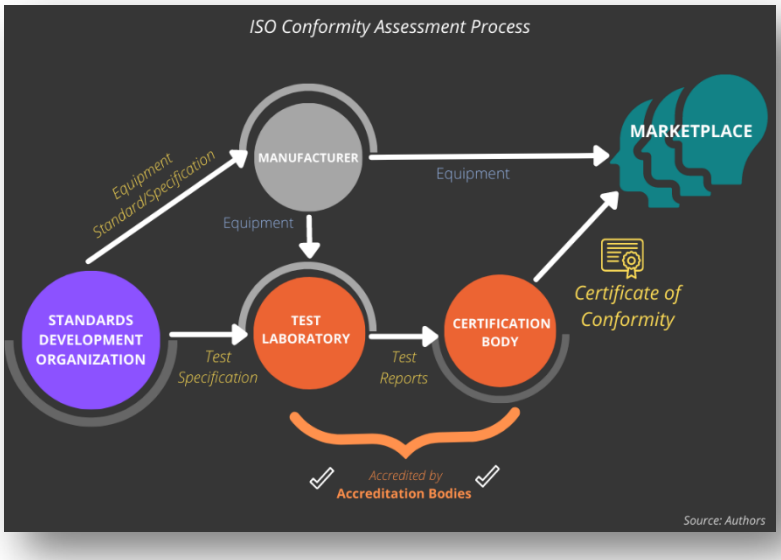
The principles for designing conformity assessment schemes are set out in detail in ISO/IEC (International Electrotechnical Commission) standards. The ISO/IEC conformity assessment and certification model involves three types of body: certification bodies, testing laboratories and accreditation bodies. These organizations need to meet the requirements of ISO/IEC standards 17065, 17025 and 17011 respectively (see Figure). Certification Bodies define the requirements for conformity assessment and issue certificates based on reports from Testing Laboratories. The competence of both Certification Bodies and Testing Laboratories is assessed by Accreditation Bodies. As Accreditation Bodies are the highest entities in the conformity assessment hierarchy, compliance of accreditation bodies with ISO/IEC requirements is performed by peer assessment groups of accreditation bodies (ITU, 2015).



The rigor of conformity assessment procedures should be related to the degree of risk associated with non-compliance with the requirements. For example, if the consequences of non-compliance are severe, such as the endangerment of

equipment users, testing may be required as a condition for approval of equipment to be marketed. However, if such consequences are not severe, and any problems that may occur can be remedied after they arise, a simple supplier declaration of conformity may be sufficient.

According to the ISO/IEC Conformity Assessment scheme, products such as ICT equipment based on standard specifications (produced by SDOs such as ITU or ETSI) are tested in accredited Test Laboratories. The resulting test reports are reviewed by Certification Bodies that issue certificates indicating that products are compliant with the relevant requirements prior to marketing.



Testing may be performed by the supplier (1st party), the user of the equipment (2nd party) or by an independent organization (3rd party). There has been a trend, associated with the liberalization of markets, from 2nd party to 1st and 3rd party testing. For example, when telecommunication services were predominately provided by monopoly operators, these operators often carried out testing of equipment (in other words, 2nd party testing) that covered functional capabilities, interoperability and safety aspects. However, as competition was introduced in telecommunication markets, the scope of requirements that have to be met for equipment to be allowed for sale in a country has often been reduced to focus on safety and limitation of interference with other equipment. During this period of liberalization testing has increasingly been performed by 1st or 3rd parties.

The ISO/IEC conformity assessment guidelines and standards specify 3rd party conformity assessment activities. Conformity assessment requirements should be based on standard specifications and any additional explanation of the application of these specifications should be formulated by an impartial committee possessing the necessary technical competence and be published by a certification body. National standardization organisations or committees established specifically for this purpose with representation from all interested parties usually play this role. However, lower income countries may experience difficulties in forming such committees with the relevant competence.

3.2 Homologation or Type approval

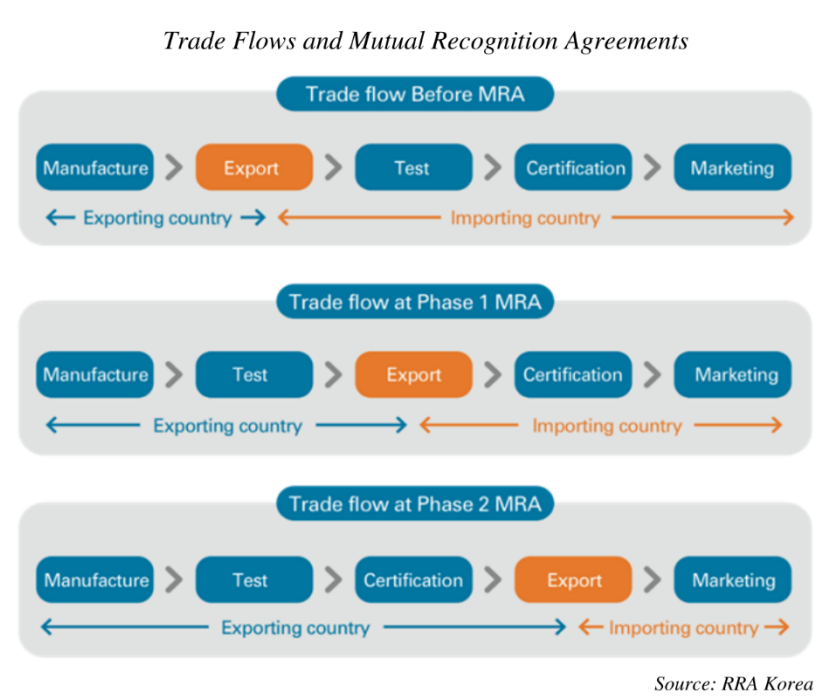
A special type of conformity assessment is that of homologation, often referred to as type approval, which is the process by which products are given authorization to be put on sale in a country or region. The conformity assessment procedures used for homologation often deviate considerably from the requirements specified in ISO/IEC standards. For example, a review of national and regional ICT equipment homologation schemes conducted by the ITU indicated that the principles of conformity assessment developed by ISO/IEC are not rigorously followed; the EU Radio Equipment Directive (RED) not requiring testing by 3rd parties in an ISO/IEC 17025 accredited laboratory, being a case in point.

There is considerable variation between countries in the nature of the technical requirements and the procedures to be followed for manufacturers to obtain type approval for ICT equipment. At one extreme is the EU that has adopted a system of supplier declaration to minimal technical requirements covering safety, electromagnetic compatibility and, for radio equipment, the avoidance of interference with other equipment. At the other end of the spectrum are those countries that require a wider range of telecommunications equipment to be type approved and require testing in specific laboratories, as is the case in Brazil and Iran for example. Some countries base their type approval regulations on the regulations of other larger economies such as the EU or the US. This process may perhaps be better described as "type acceptance". It is a pragmatic approach but one in which the country has no influence over the requirements for homologation and also does not provide an environment in which staff can develop the skills needed to define their own schemes for homologation and the establishment of testing facilities.

3.3 Mutual Recognition Agreements

To avoid the duplication of work in the testing and certification of equipment, Mutual Recognition Agreements (MRAs) have been developed with the aim of eliminating redundant and costly activities and allowing products to be shipped to foreign markets without any further requirements for testing and/or certification, thereby reducing costs and time to market. Competitive trade is facilitated as market access becomes more transparent and non-tariff trade barriers are reduced.

Mutual Recognition Agreements (MRAs) are reciprocal agreements between parties for the recognition of technical requirements; testing laboratories and test reports; or certification bodies and certificates. For example, MRAs allow the testing of equipment to country B's requirements in country A, and recognition of the test report in country B; and vice-versa the testing of equipment to country A's requirements in country B and recognition of the test report in country A. There is no need to harmonize the requirements of countries A and B, which may indeed be different.



An MRA on conformity assessment can be divided into phases, namely:

- *Phase 1* – Mutual recognition of testing laboratories and mutual acceptance of test reports prepared by the testing laboratories.
- *Phase 2* – Mutual recognition of certification bodies and mutual acceptance of certificates prepared by the certification bodies.

Parties can choose to implement the phases of an MRA one at a time or both together. Typically, the parties will implement Phase 1 and after gaining experience and confidence with the Phase 1 procedure, will then proceed to implement the Phase 2 procedure. MRAs may be of a regulatory nature in which case they are referred to as "agreements" or entered into on a voluntary basis and referred to as "arrangements" (ITU, 2013).

Many lower-income countries are interested in the concept of MRAs, but are not in the position of establishing an MRA for recognition of test reports for product homologation, in particular for ICT equipment, as there are so few testing laboratories in these countries capable of performing the required tests. However, the mutual recognition of certificates is feasible and being considered.

3.4 Base standards and testing specifications

A robust conformity assessment scheme requires not only clear unambiguous specification of the product requirements but also specification of the method of demonstrating conformity with those requirements. The production of testing specifications has tended to fall behind the definition of product requirements and this is one area in which lower-income countries have attempted to influence standardization activities at the ITU with the aim of improving the conformity assessment process for telecommunications equipment and creating a conformity assessment scheme relevant to their needs. Many countries, in particular, in Africa, have found a good deal of substandard and counterfeit equipment in their marketplaces and so have sought assistance from the ITU to develop capabilities to judge for themselves whether equipment meets basic requirements. This is an example of the challenges faced by those seeking to successfully participate in international standardization bodies and of a strategy for meeting specified standardization goals. The next section provides an overview of the standards making process.

4 THE MAKING OF STANDARDS: ORGANIZATIONS AND PROCESSES

Standards-making is a largely voluntary process based on consensus among interested stakeholders. Depending on the standards development organization in question, stakeholders come from industry, government and civil society.

Formal standardization organizations are national, regional and international in nature. Examples of national standardization institutions include the British Standards Institute (BSI), the Standards Council of Canada (SCC), the American National Standards Institute (ANSI), the German Institute for Standardization (DIN), the South Africa Bureau of Standards (SABS), the Singapore Standards Council (SSC) and the Korean Agency for Technology and Standards (KATS). Most national standardization bodies are members of ISO. European national standardization bodies are also members of the Comité Européen de Normalisation (CEN). ISO, CEN, and national standardization organizations, have a very wide scope, covering matters as diverse as food safety and IT security standards. In addition, there is a parallel organization for the standardization of electrical equipment, the IEC, in which national standardization organizations worldwide are members; European national standardization organizations also being members of CENELEC (Comité Européen de Normalisation Électrotechnique).

ISO and IEC have a hierarchy of membership categories in which only full members have voting rights. ISO allows "correspondent" membership which allows national standardization organisations in this category to participate in the work of ISO as observers, sell ISO standards and nationally adopt ISO standards; and "subscriber" membership for following the work of ISO but without the rights to sell ISO standards or adopt ISO standards nationally. Similarly, IEC has a category of "associate" which allows a national standardization organization to participate in the work of a limited number of committees but not to occupy management positions. Lower income countries are often challenged to participate as full members of ISO and IEC.

In the ICT space, there are specialized standardization organizations such as the ITU, ETSI, the 3rd Generation Partnership Project (3GPP) for mobile communications, the Internet Engineering Task Force (IETF), the Institute of Electrical and Electronic Engineers (IEEE) Standards Association for local area networking technology, and a number of more specialized industry forums. These organizations vary greatly in terms of membership and working procedures. The ITU, which has sectors addressing telecommunication standardization (ITU-T), radiocommunication (ITU-R) and telecommunication development (ITU-D), is a truly international organization operating as a United Nations agency in which member states have a leading role, whereas any person can participate in the IETF and IEEE Standards Association. Fees also vary greatly with some organisations discounting fees for participants from lower income countries.

The roles and procedures followed by these organizations are outlined in detail in Appendix 1.

5 STATE AND INDUSTRY PARTICIPATION IN STANDARDIZATION ACTIVITIES: BEYOND THE TECHNICAL

Having good ideas and much knowledge of a topic that will benefit from standardization is not sufficient to ensure success in producing and influencing standards. Political and organizational skills are as important as technical knowledge. Non-technical aspects of participation in standardization activities are considered in this section ranging from procedural issues to building consensus.

5.1 Knowing the rules

It is surprising how few participants in standardization meetings have read the rules of procedure for that particular organization, especially considering that delegates who know the rules often play a key role in the progress of work, sometimes objecting to proposals if

rules have not been followed or hastening progress by making sure that all procedural requirements are met.

Following an organization's rules of procedure is essential to ensure smooth working practices and outcomes. Most importantly, therefore, participants must become familiar with the rules and procedures of each standards organization in which they participate, for example, concerning submission of proposals, progression of standard specifications and participation rights at meetings. At most SDOs, there are different types of deliverables available, some being normative with a view to implementation and some merely informative. A simple question, such as where and when a specific decision will be held, takes considerable effort to understand, as there may be several meetings involved (with multiple agendas, dates and locations), and the final decision could require confirmation by different group hierarchies. Most of the historically successful players in standards-making were, and still are, involved in rule-making, with a view to ensuring that they continue to master the game and that any changes are in line with their strategic interests.

A good example is the agreement on the mandate or remit of a particular committee or group. Restricting (or expanding) the remit of a committee or group is one way of achieving standardization objectives that many new entrants are not familiar with. Furthermore, the mandate of study groups or technical committees is generally revised periodically, for example at governing assemblies, but changes can also be made by committees themselves for instance to the wording of subject areas. New proposals need to be submitted as new "work items" with participants volunteering for taking the lead. Low-income countries, and new entrants to the process, often submit contributions to propose a new standard for consideration, but without the necessary attention to the processes and terminology required to build consensus. In some cases, interesting proposals have been merely "noted" by the chairperson, instead of feeding into the work of the study group, simply because the delegate did not specifically request for a work item to be created in the organization's work programmes.

However useful, rules of procedure are also used on occasion to delay or distract from the substance of proposals. For this reason, a good understanding of the rules is vital for delegates to be able to address such objections and to follow through on building consensus for proposals. In some cases, simple issues like the timing of a submission of a proposal, or the mandatory or optional nature of a form, become the rationale to throw out a proposal, request a re-submission, or delay discussion in favour of a lengthy discussion on rule interpretation. In other cases, requests for comments by other organizations or groups (both internal and external) can be used to seek feedback on specific proposals. This is useful in some cases, but in many, serves to delay the adoption or the debate on proposals.

There are also organization-specific cultural practices to adapt to. At ITU, for example, if a delegate wishes to speak, they must raise their flag or their hand to attract the attention of the chairperson. On the other hand, at IETF meetings, delegates join a queue at a microphone in an aisle of the meeting room.

Depending upon the standardization organization there may also be national rules governing the submission of proposals. For example, some countries have established formal procedures for prior consideration of proposals to the ITU as it is a treaty organization in which member states have the final word, whereas other countries allow technical contributions of no regulatory concern to be submitted without national review.

5.2 Taking a strategic approach

Developing a strategy for participation and influence prior to attending meetings is crucial to success. An effective standardization strategy needs to identify national priorities, garner regional and national support, be forward-looking and take into account the timing and agendas of future meetings. General objectives and positions must be established, in order to have an eye on the big picture, but, at the same time, specific strategies for any one particular thematic area need to be developed, together with practical strategies to cover individual meetings. Some states or organizations may have a negative objective. For example, a general strategic objective may be to block the adoption of any new standards that might compete with a country's dominant role in the industry. To support this, a specific strategy may be for the member state to have a private sector member gain a leadership position (such as a vice-chairperson, rapporteur and so on) in the standards group or committee that is handling such a standard and have a delegate from the government as a participant making interventions from the floor. Drilling down further, the strategy for a particular meeting could be to use procedural technicalities to delay discussions, to propose that the draft document become an informative deliverable rather than a standard, or to challenge the very mandate of the group. As influence and negotiation often occurs in informal settings, discussions with delegations that support and oppose a position are often more crucial than plenary sessions, be it over lunch, coffee or dinner. Quid pro quo agreements between delegations are often used to garner support.

Identifying the most appropriate standardization body for the topic to be standardised is important considering the likely obstacles that will be met. For example, all of the ITU-T Study Groups except SG3 are concerned with technical non-regulatory issues and although SG3 is to address tariff and accounting principles and international telecommunication/ICT economic and policy issues, there is a good deal of resistance from the wealthier countries to producing recommendations of a regulatory nature in the ITU-T. This can be illustrated by the reform of the accounting rate system by which settlement payments were made to countries which

terminated more calls than they originated and, more recently, of the reservations from Australia, Canada, USA, Finland, Norway, Switzerland, Sweden, Germany, Poland, Portugal and the United Kingdom to Recommendation D.261 on the principles for market definition and identification of operators with significant market power[13].

5.3 Building and Maintaining Reputation

Delegates must also build a good reputation within the particular group concerned (and/or its sub-groups), through their presence, their knowledge, and their contribution to the work of the group(s). Ideally, this must be done over time and maintained regularly. Reputation is critical to influencing decision-making within such institutions. Participants are not always seen as equal: there are often those whose views have more weight due to previous contributions to the work of the organization. This is regularly seen in how proposals coming from the floor are treated by those chairing meetings. Success at standardization has very little to do with the position (or rank) of an individual within a particular organization, and very much to do with personal expertise, commitment and political savviness. As Grundström and Wilkinson (2004) note, standards "emerge in a bottom-up self-organizing way from the complex set of interactions taking place over time among many involved parties in many types of forums. History matters in terms of the relations formed in earlier stages of technology development impacting on subsequent relations and discussion".

Given that standardization is a complex, multi-faceted and knowledge-intensive activity (Ernst, 2013), most of the larger, active players in standards organizations like the ITU or ISO send delegates with a mix of technical and legal or political experience. These players ensure continuity of representation, and effective succession, with junior delegates "shadowing" senior delegates for some time before becoming active participants.

Moreover, following through on proposals is equally important as submitting them for consideration. That could involve volunteering as necessary to act as a Question Rapporteur or as an Editor for a Draft Recommendation or standard. In order to ensure the success of a particular proposal, delegates often identify suitable rapporteurs prior to submitting the proposal, or volunteer themselves, to ensure that the work gets done and momentum is maintained.

[13] See Recommendation ITU-T D.261, *Regulatory principles for market definition and identification of operators with significant market power* – SMP, https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=12829 (accessed 11 March 2022).

5.4 Covering the field

Successful participants typically attend all meetings relating to their area of expertise and interest, as well as any general meetings that might have an impact on the working methods of the organization, and therefore on how meetings are conducted. Given the vast number of meetings involved in any one standardization committee, this requires significant coordinated effort. Commitment over time, and across all levels of the SDO, enables effective participation and influence. This includes top-level political setting of the agenda down to the submission of technical contributions in the standards drafting process.

At the ITU, for example, it is necessary to agree resolutions defining the areas in which standards are to be produced at the ITU Plenipotentiary Conference and at the appropriate sector assembly (i.e. the World Telecommunication Standardization Assembly (WTSA) or World Radiocommunication Conference (WRC) which specify the topics to be studied. Proposals to work on a standard (known as a Recommendation in ITU terminology) are then submitted to the appropriate study group of the ITU-T or ITU-R to which the topic (or Question in ITU terminology) has been assigned. Participants then steer the document through the approval process, navigating multiple meetings and decision-making instances. The drafting of standards is very much a contribution driven activity relying on companies (primarily manufacturers and network operators) to submit proposals, or draft texts, for Recommendations.

Lower income countries often participate at top-level conferences, achieving the agreement of resolutions to work on certain topics, but then do not necessarily have the institutional commitment or financial resources to follow through on the actual day-to-day standards development work. The same applies within a particular standards body – a study group in the case of ITU. Each study group is broken down by Working Party (WP), which is further broken down into Questions, and each Question has a number of "work items" specifying the deliverables to be produced, that is Recommendations, technical Reports etc. An unsuccessful strategy, not limited to organizations from less industrialized countries but often pursued by organizations that are new to the standardization process, is to not follow through on the approval process. They successfully propose the development of a standard, submit contributions which receive some level of acceptance, leading to a misconception that the job is done. However, if there is no broad agreement to approve the standard, it is possible for it to be downgraded (from Recommendation to Technical Report for example in the ITU) or even to be dropped entirely if there is not enough pressure (or momentum) to approve it. This happens frequently with proposals by new entrants, and often participants are not even aware at the time that a standard they thought had been approved, would never see the light of day.

5.5 Creating Networks and Gaining Support

Advancing standards is simpler and more efficient if more than one organization has an interest in furthering the work. In standardization, it is difficult for one player to go it alone. It is not surprising therefore that many countries have employed a strategy of developing proposals cooperatively in a region and then forwarding common contributions to an organization with wider relevance. For example, in the development of Integrated Services Digital Network (ISDN) standards defining integrated voice and data services prior to the wide adoption of the internet, the Nordic countries met to agree joint proposals to be made to ETSI and ETSI, in its turn, submitted proposals that had been considered and achieved some degree of consensus within Europe to ITU-T. Regional cooperation is often very useful in gaining traction in the production of standards. An increase in participation of lower-income countries in the standardization process at ITU benefitted from the creation and growth of Regional Groups of ITU-T Study Groups[14].

Success in standards making depends on gaining support through both informal and formal channels, before, during and after standardization meetings. Standards are developed over time through a complex series of interactions and negotiations by experts and delegates, with varying interests and reputations at stake, often influenced by geo-political factors, technology adoption, industry politics and market dynamics. It is therefore necessary for delegates to build credibility, establish networks, and utilize networks to achieve their goals. This is a challenge for new entrants, with shorter track records and limited credibility in such forums. There is also a misconception among new entrants that meetings themselves decide outcomes. The reality is that very often, the larger committee or plenary sessions only confirm decisions and consensus reached in smaller groups. Therefore, reaching out to potential supporters, and building on previous agreements and negotiations, creates the trust indispensable to success in the standardization process. For sensitive matters or more urgent matters, email or formal letters are not sufficient. For many lower-income countries and new entrants (not representing well-known organizations), it is not feasible to get on the phone to contact other delegates, not only for financial reasons, but also for the simple reason they do not have relevant well-developed networks.

There are both informal and formal ways of gaining support. Formal ways result in the recording of a statement of support or opposition in written form, or taking the floor in a live committee or working group session to raise concerns or offer constructive feedback. Informal ways to reach consensus bring parties together to discuss matters in a less confrontational

[14] See Note by the Secretary General of the ITU, Effectiveness of regional groups for Bridging the Standardization Gap (WTSA RESOLUTION 44), available at https://www.itu.int/dms_pub/itu-s/md/17/cl/inf/S17-CL-INF-0009!!PDF-E.pdf.

setting, such as at coffee breaks, lunch or evening sessions after group meetings. Many agreements reached in plenary sessions have been built over a long series of smaller informal sessions.

Having access to pre-established networks also enables delegates to better understand the daily running of a group. In any one committee or study group, there are many different proposals and decisions being considered and being made at any given time. It is near impossible for a single delegate, and often a single delegation, to keep track of where and when a crucial decision is being made. Delegates therefore rely on the relationships and trust they have built with each other to keep up to date on when and where meetings are being held. Newcomers to the process often find themselves lost in the agendas, sub-agendas, proposals, meeting rooms and times, missing important discussions and opportunities to gain support. In some cases, meeting rooms and schedules are changed with only a few minutes notice, and the use of this tactic to defer agreement or block proposals has been used very effectively. Chairs of meetings may also use the timings of coffee breaks strategically, and are also known to extend meetings in an attempt to achieve "consensus by exhaustion". Many newcomers, and lower-income countries, tend to view coffee breaks as breaks in the work rather than strategic opportunities to further the work, and mistakenly consider weekend or evening meetings as optional. Unfortunately, dominant and more experienced players in the standardization process and seasoned participants may use these techniques to effectively exclude a certain member, or even an entire region, from decision-making.

5.6 Making Decisions

Decisions in the standards-making process are usually made by consensus. Consensus does not imply unanimity but general agreement and the lack of any sustained opposition: ISO/IEC Guide 2 defines consensus as "general agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments." For its part, the American National Standards Institute (ANSI) states that consensus "means that substantial agreement has been reached by directly and materially affected interests. This signifies the concurrence of more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that an effort be made toward their resolution."

Determining whether there is a consensus is therefore often a rather delicate issue and one of the most difficult to be handled by those chairing meetings. Decision making in SDOs is a multi-level process, with decisions made in working groups subject to reversal in higher level committees. In the ITU-T for example, Rapporteurs make decisions for their Questions which

are confirmed in Working Party plenary meetings and these Working Party plenary decisions are, in turn, confirmed in Study Group plenary meetings.

6 TOWARDS EFFECTIVE INFLUENCE BY NON-TRADITIONAL PLAYERS

New entrants to standardization activities are presented with a number of challenges ranging from adapting to the particular institutional culture to securing sufficient budget and defining the strategic aims to be achieved.

6.1 Identification of the appropriate standards bodies

An organization with an interest in standardization needs to first identify the most appropriate standardization body taking into account such factors as the importance and relevance of the topics of standardization, the openness of the organization, the cost of membership and the ease of participation, including whether it is possible to successfully achieve one's aims with remote access only, when attendance in person at meetings would be preferable (or required), the feasibility of travel, the costs involved, and the need for visas. Participation in standardization organizations, with the notable exception of the IETF, requires membership of the organization and payment of a membership fee. These fees vary considerably and some organizations have lower fees for participants from less wealthy countries. The ITU, for example, may also provide fellowships to people from the least developed countries and other countries with a GDP per capita of less than USD 2000 to attend its meetings. This is not always well-known to new entrants. And although many standards organizations have held their meetings online during the Covid-19 pandemic, normally attendance at face-to-face meetings in major cities in North America, Europe and Asia is required to make progress. Accommodation in most of these cities, such as Geneva, where both ISO and ITU have their headquarters, is extremely expensive.

If the most appropriate standardization organization is the ITU then the national communications ministry and regulatory authority will probably need to be on-board with any proposals made. If ISO or IEC is the target standardization organization, the national standardization organization would need to be involved. Organisations wishing to participate in the ITU can expect some advice on procedures from their communications ministry or ICT regulatory authority, as most UN member states participate in the governing conferences of the ITU. Similarly, national standardization institutes that are members of ISO can provide valuable guidance on such issues as quality standards and laboratory accreditation.

6.2 Institutional Commitment

In many cases, technological governance issues are relegated to the private sector, in other cases public actors and civil society are involved. There are advantages and disadvantages to each approach. When standards-making is done by state actors, this can have positive effects on competition, increased consumer choice and protection. However, processes can be protracted, due to the bureaucratic nature of decision-making, and technical expertise may be limited. When the private sector dominates the standards-making processes, although there is the necessary technical expertise and operational flexibility, decisions can favour dominant actors, limit market entry and be based on purely short-term economic interests (McCormick, 2007). This may often be to the detriment of important human values such as environmental sustainability and human rights. Thus, the participation of both public and private actors needs to be enabled by the standards-making process. This is not often the case, particularly in the Global South, where industry participation has not been encouraged, and state actors tend to be the ones sending delegations to international institutions, more often than not in a piecemeal fashion.

As noted above, success in standardization involves the formation of networks of individuals at all levels of an organization which also requires managerial commitment at all levels to allow these individual experts to participate freely and make contacts as they see fit. Institutional commitment, by a government or industry member, guarantees consistency and credibility within the standardization process. Participants that represent organizations that value the standardization process are more likely to succeed, as they have the consistent backing needed to enable them to participate across different levels and groups.

Organisations that send different delegates to standardization meetings every year are not able to build the reputation required to exert influence in standardization. In some countries, the perception persists that travel to these standardization meetings is a perk that comes with the job, rather than a valuable job (or even difficult job) in and itself. This perception hinders effective participation and does not build credibility, trust or expertise. Strong institutional commitment is therefore vital to successful standards-making and influence.

6.3 Mainstreaming of proposals

In some standards groups, proposals from low-income countries are often sent to a separate internal working group dedicated to developing country issues. These proposals are frequently noted, with no consequence, especially if they do not contain concrete proposals (utilizing the correct terminology) for moving the work forward. Although laudable in terms of providing a platform to discuss the needs of lower-income countries, these sessions tend to marginalize the proposals and do little to facilitate exchange and negotiation between

members. Many low-income countries submit case studies or descriptive material that is not suitable to standards-making, mainly because there is a lack of awareness of the impact of submitting specific actionable proposals to the right working group or committee. There is also the perception, institutionally, that participating in standards meetings consists of the presentation of a document in a plenary session, whereas in reality, it is much more about making a request for action on the part of the group, and building support around it. The presentation of the document is only a fraction of the work. When documents are sent to sessions devoted to developing countries, they do not appear in the mainstream work of the group, and this hinders inclusion and international involvement in decision-making. To be successful in their standards-making initiatives, countries need to be aware of this practice where it exists and insist that their proposals be considered as part of the main activity of the group, rather than being sidelined or sent elsewhere.

6.4 Coordination of national approaches towards a collaborative standardization ecosystem

Standardization has been used by newly industrialised countries, such as South Korea, as a strategic driver of national economic growth and greater technology leadership (Shin et al., 2015). Success in standardization may require commitment of resources from and coordination between companies, academia, regulatory authorities and government. Realizing standardization goals may require setting policy objectives by government, implementation of regulations and participation in national and international standardization organizations by public and private sector representatives. Strong coordination between research and innovation in academic contexts, entrepreneurship and product development could be encouraged, for instance, through the development of an ecosystem of relevant support organizations, incubators, and accelerators. Other national approaches include the establishment of test laboratories and regulatory sandboxes, where products can be tested together with regulators before they are launched onto the market.

In particular, the creation of dedicated national standardization secretariats (NSS) to coordinate activities related to participation in standardization has been seen as a useful tool to increase effectiveness, avoid conflicting positions, pool resources and coordinate positions. An NSS can take on a number of functions, including preparation of meetings; development and submission of proposals; authorization of delegations; development of responses to consultations; development of national strategies on standardization; capacity-building; and coordination of the implementation of standards nationally. In 2018, the ITU issued guidelines for the establishment of National Standardization Secretariats, as part of its Bridging the

Standardization Gap Programme, aimed at reducing the disparities between developed and developing countries in accessing and influencing standards.[15]

A good example of a collaborative ecosystem approach involving multiple agencies is Ghana's transition to Digital Terrestrial Television (DTT). The ground for this transition was set by the ITU-R (the ITU Sector responsible for international radio spectrum allocation) in the 2006 agreement on the frequency plan for DTT. Based on this, the Ghana Ministry of Communications published a DTT Broadcasting Policy. The National Communications Authority (NCA) and Ghana Standards Authority (GSA) worked together to develop minimal DTT receiver standards which were subsequently submitted to ECOWAS to be agreed as regional standards. The NCA accredited a total 21 testing laboratories in nine different countries to perform tests based on the Ghana standards and have also established their own basic DTT test lab in Ghana

6.5 Regional cooperation and coordination

Regional cooperation and coordination are important to ensure that the interests of smaller countries are taken into account in international standardization. Building consensus is simpler in smaller groups, e.g., in regional groupings, and these agreements can then be taken to international negotiations. An example is the regional groups of ITU-T Study Groups, which have been used effectively to build consensus and momentum within specific regions, such as the African region, and have enabled participation of delegates with limited resources to travel to Geneva.

Although most countries have a national standardization organization, the scope of activity of these standardisation bureaus is limited in less wealthy countries, reflecting the dominance of primary commodity production in these economies. For example, the Malawi Bureau of Standards (MBS), which is responsible for the development of national standards and the dissemination of standards and standards-related information, does not extend to areas such as ICT. MBS provides inspection and certification, metrology services and testing. Its testing laboratories cover general chemistry, food chemistry, petrochemicals, pesticide residues, microbiology, radiochemistry, and engineering and materials. These laboratories are compliant with ISO 17025 (Laboratory Testing) and accredited by the Southern African Development Community Accreditation Service (SADCAS). SADCAS provides accreditation services to those countries in Southern Africa that do not have a national accreditation body,

[15] See ITU, Bridging the Standardization Gap, Guidelines for the Establishment of National Standardization Secretariats, available at https://www.itu.int/en/ITU-T/gap/Documents/nss-rep-may.pdf (accessed 16 February 2022).

namely Angola, Botswana, Democratic Republic of Congo (DRC), Lesotho, Madagascar, Malawi, Mozambique, Namibia, Seychelles, Eswatini, Tanzania, Zambia and Zimbabwe.

The recently formed nation of South Sudan provides a good example of the trend towards regional collaboration. South Sudan established its National Bureau of Standards (NBS) and National Communications Authority (NCA) in 2012. In 2017, its NBS signed a Memorandum of Understanding on standardization and conformity assessment with Uganda's National Bureau of Standards[16], which initiated "enhanced cooperation on a number of standards related topics, from harmonization of specified standards with international standards, mutual recognition of test results, quality marks, product verification, metrological assessment and calibration of the measure instruments; [to] research and cooperation". In addition, as South Sudan had no regulation on the homologation of ICT equipment, the South Sudanese regulator (NCA) adopted Uganda's existing regulation on homologation. South Sudan has also expressed interest in regional mutual recognition of type approval certifications and cooperation in provision of testing facilities[17].

Regional cooperation has also been seen to be beneficial for the establishment and sharing of testing facilities for ICT equipment. Many countries, in particular in the global south, experience significant problems with the importation of substandard ICT equipment and wish to enhance their capabilities to identify such equipment and keep it out of the marketplace. To address this issue, a top-down approach was initially taken whereby several lower-income countries, led by Ghana's Ministry of Communications, collaborated on making proposals to ITU's top-level governing conferences. These proposals resulted in the Resolutions at the WTSA[18], ITU plenipotentiary conference[19], WTDC[20] and WRC[21] committing the all agencies of the ITU to work on conformity assessment. However, these Resolutions had limited practical

[16] See Uganda National Bureau of Standards, "UNBS signs MoU with South Sudan National Bureau of Standards (SSNBS)", 11 May 2017, https://www.unbs.go.ug/news-highlights.php?news=37&read (accessed 15 February 2022).

[17] Based on confidential meetings and reporting to government clients in South Sudan.

[18] See WTSA 2008 Resolution 76 "Studies related to conformance and interoperability testing, assistance to developing countries, and a possible future ITU Mark".

[19] See Plenipotentiary Conference 2010 Resolution 177 "Conformance and Interoperability"

[20] See WTDC 2010 Resolution 47 "Enhancement of knowledge and effective application of ITU Recommendations in developing countries, including conformance and interoperability testing of systems manufactured on the basis of ITU Recommendations".

[21] See WRC 2012 Resolution 62-1 "Studies related to testing for conformance with ITU R Recommendations and interoperability of radiocommunication equipment and systems".

impact, because testing laboratories remain costly to implement and very few ITU conformance testing specifications had been produced to support the implementation of the ITU Mark of Conformance as proposed in Resolution 76. Although efforts were being made to develop more test specifications through the work of ITU-T Study Group 11 (SG11), and Ghana followed up on its earlier proposals by providing a rapporteur to lead some of the work, there was still reliance on other organizations to develop the testing specifications.

With respect to the establishment of testing laboratories, the interest from many countries in Africa is in performing tests required for homologation (type approval) of telecommunications equipment. However, the costs involved in building a laboratory to perform all tests required for the full scope of type approval is often prohibitive: a 10-metre semi-anechoic chamber required for electromagnetic compatibility (EMC) testing, for example, costs in the region of USD 1.6 million. One way of addressing this is to establish laboratories that perform a restricted number of tests using less expensive facilities. This was the approach taken by Ghana's National Communications Authority (NCA) when it decided to establish limited-scope laboratories in line with their own specific requirements. For example, they set up an on-site EMF (Electro Magnetic Field) measurement laboratory vehicle to respond to concerns regarding the health impact of mobile masts. In addition, they established a laboratory for RF (Radio Frequency) and DTT (Digital Terrestrial Television) testing, which do not necessitate a specialized environment and for which equipment is relatively affordable. A SAR (Specific Absorption Rate) laboratory has also been implemented, despite the more costly equipment, because of health concerns among the local population. It is noteworthy that these facilities are now being used to train staff from other African countries, and are providing a useful forum to discuss how African countries can cooperate on ICT equipment testing so that laboratories capable of performing all tests are not needed in every country. There is also much interest in Africa in the development of mutual recognition agreements for test results and conformity assessment certificates. It is clear that there is much to be gained from South-South collaboration in this area. The examples cited here provide a good starting point to increase the global relevance of standardization, conformity assessment and policy making.

The need for newly independent states to cooperate in order to achieve self-determination and resist continued domination by the former imperialist states was clearly identified by the key actors in the 20th century decolonization movements, such as Kwame Nkrumah and Eric Williams, who proposed to cooperate by forming federations (Getachew, 2019). Federal structures were implemented in Africa and the Caribbean in the 1950's, the Union of African States and West Indian Federation respectively, but these were short lived. In Africa, the more loosely structured Organisation of African Unity, modelled on the United Nations, was preferred and it existed until 2002 when it was superseded by the African Union. Although the creation of federations and other attempts at creating a more egalitarian and equitable

economic order, such as the UN New International Economic Order (NIEO) have failed, and neoliberal principles of market discipline apply, ad-hoc cooperation between developing countries in specific areas can be used to reduce dependence on the industrialized states.

Standardisation and policy coordination are means to work towards national and regional self-determination and there is great potential to further develop coordination activities in the African Organisation for Standardisation (ARSO) and regional bodies such as Southern African Development Community (SADC) and other regional economic cooperation organizations such as the East African Community (EAC) and the Economic Community of West African States (ECOWAS).

7 CONCLUSION

This paper has examined some of the challenges facing new participants in standardization activities, how successful standardizers operate, providing examples of how these challenges are being addressed in some countries of the Global South. Standardization is essential to underpin equitable trading relationships. This has been recognized for millennia. The very first civilisations adopted standard weights and measures, the Greeks in 360 BC standardised the composition of bronze (McNeil, 1990), there was a standardization revolution associated with the 18th century industrial revolution and the first national standardization institute was established in 1901 (the Engineering Standards Committee later to become the British Standards Institution). As Grewal notes, the "creation and diffusion of standards underlying new technologies is a driving element of contemporary globalization" (Grewal, 2008), notwithstanding critiques of globalization and geopolitical regionalization pressures.

Many countries have little influence over the technologies they are expected to use and the rules governing international trade such as those for homologation. They are often advised that this is the best way to ensure the efficiency of international trade. Organizations in lower-income countries face significant challenges in participating in standardization activities as outlined in this paper and in implementing trade policies that address their needs. Many of the processes of standards-making operate as a form of technological and regulatory 'imperialism'. This flies in the face of the UN's efforts under Sustainable Development Goal 10 on reducing inequality among countries - Goal 10.6 aims to "ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions". The increasing dominance and transformative nature of social media, data analytics, artificial intelligence and the internet of things with implications for society and for development, together with the concentration of data in a handful of global corporations, is amplifying these imperialistic tendencies. It is for this reason that standards-making needs to

be more inclusive and to address the requirements of a larger proportion of the world's population. This is even more critical since many emerging policy issues such as human rights and environmental degradation, are being tackled on the global level.

There is growing realization in the Global South that better national and regional coordination is needed in making and influencing standards, as well as in setting regulations. National coordination, with institutional commitment at all levels, can help to ensure that all interests are represented and the best advice is drawn from those with expertise in a country from across the innovation ecosystem of universities, start-ups, established businesses and public sector agencies. This suggests that interested organizations need to appoint delegates who can attend relevant forums and meetings consistently, actively drive the work forward, and establish reputations that benefit the organization over time. Regional coordination between countries with shared interests is likely to create a larger market and lend greater weight to proposals submitted to international organizations. For their part, standards-making organizations need to encourage the effective participation of new entrants and lower-income countries through the promotion of knowledge exchanges, capacity building and training, and by actively discouraging the marginalization of proposals coming from less experienced players. The ISO's Action Plan for Developing Countries[22] and the ITU-T's Bridging the Standardization Gap (BSG) Programme, which offers training on effective participation in standards-making, are steps that can facilitate this[23]. Much more work is needed, however, on the part of all parties involved, nationally, regionally and internationally, if there is to be movement towards a more level playing field for standards-making in an increasingly borderless and global digital economy.

[22] See ISO Action Plan for Developing Countries (2021-2025), available at https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100374.pdf (accessed on 16 February 2022).

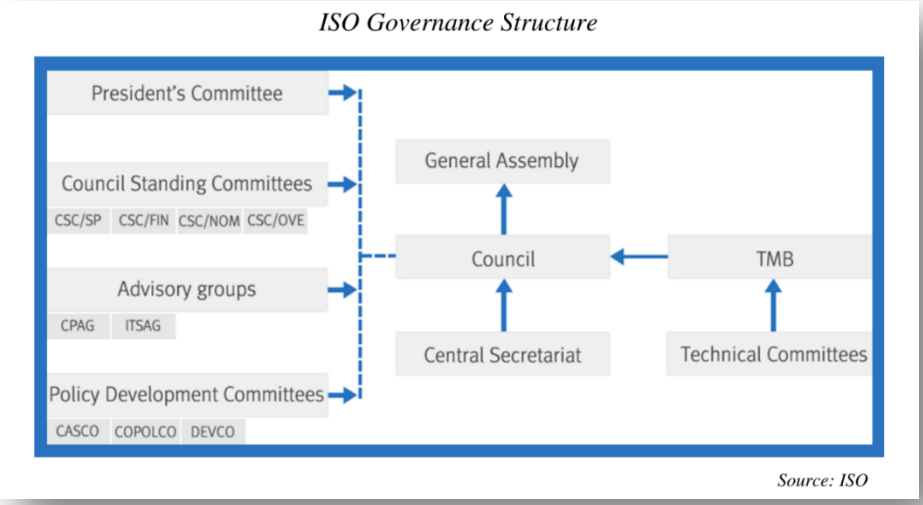
[23] See the website of ITU's Bridging the Standardization Gap programme available at https://www.itu.int/en/ITU-T/gap/Pages/default.aspx (accessed 1 February 2022).

APPENDIX: KEY STANDARDIZATION ORGANIZATIONS AND PROCESSES

This section lays out the main standards development organizations (SDOs), their structure and decision-making processes.

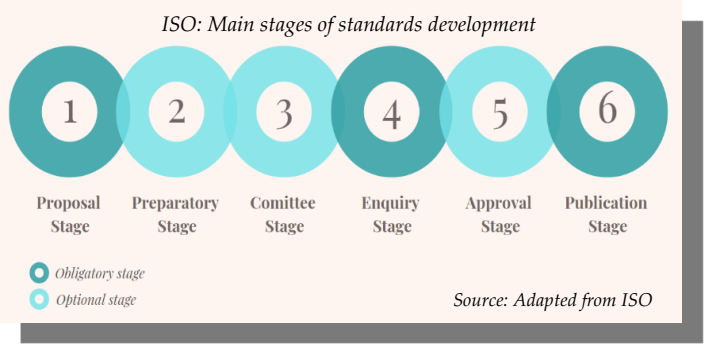
ISO and IEC

The most well-known international standards-setting organization, the International Organization for Standardization (ISO), was established in 1947. ISO sets voluntary standards in a broad range of sectors, from construction to agriculture, and in different areas such as quality management, environmental management, energy management, food and health safety, and IT security. ISO's sister organization, IEC, was set up in 1906 with a focus on electrical and electronic engineering. Although they were not well known in the first decades of their existence, the two organizations gained in prominence after the 1980s due to increased globalization (Mattli and Buthe, 2003). ISO has published a total of 24,167 standards, with its largest proportion (over 20%) in IT, Graphics and photography (ISO, 2019b). Popular examples include quality management (ISO 9000 family), social responsibility (ISO 26000), currency codes (ISO 4217) and date/time format (ISO 8601). IEC has over 100 active technical committees and has published more than 10,000 standards. ISO and IEC have established several joint technical committees to produce information technology standards.



Membership in ISO and IEC is open only to national bodies that are concerned with standardization in their countries. Most high-income countries are represented by well-

established national standards development organizations, e.g., American National Standards Institute (ANSI), the Royal Netherlands Standardization Institute (NEN) or Standards Australia[24]. Lower income countries sometimes struggle to find adequate representation, but have over the years created bodies to participate in ISO and IEC. However, many remain correspondent or subscriber members in ISO or associate members in IEC, rather than full members ("member bodies"), e.g., Angola, Cambodia, Chad, Haiti, Honduras, Moldova, Zambia are correspondent members of ISO. Full members have voting rights and can influence standards development. Correspondent members and subscriber members cannot hold secretariat positions, or most importantly, propose new work items for developing standards. Delegates participate as part of a national committee. ISO currently has 167 members, of which 124 are member bodies, 39 are correspondent members and 4 are subscriber members. IEC currently has 62 full members and 26 Associate members. Both organizations have relatively small secretariats based in Geneva. ISO conducts its work through a large network of technical committees (and subcommittees), and working groups: as of 2020, there were 756 technical committees and 2'832 working groups. According to ISO's website, 23 countries coordinate ISO's worldwide activities (see ISO in figures at iso.org). IEC has a similar structure, on a smaller scale, with 212 technical committees and sub-committees, and 1'580 working groups[25]. ISO is funded through subscriptions by national members to meet the operational costs of the secretariat in Geneva. The subscription paid by each member is proportionate to a country's gross national income and trade figures. ISO also sells standards to generate revenue.



ISO is governed by the ISO Council, made up of 20 full member bodies (on a rotational basis), the ISO Officers and the Chairs of the Policy Development Committees (CASCO on conformity assessment, COPOLCO on consumer issues and DEVCO on developing country issues). Reporting to the Council, ISO's Technical Management Board (TMB) manages the technical work of the organization (including its technical committees). There are six main stages to standards development at ISO and IEC: proposal stage, preparatory stage, committee stage, enquiry stage, approval stage and publication. ISO not only develops international standards,

[24] See ISO list of members at https://www.iso.org/members.html (accessed on 22 January 2022)

[25] See the IEC Website at https://www.iec.ch/technical-committees-and-subcommittees (accessed on 14 February 2022).

but has other types of deliverables, such as technical reports and technical specifications (see table below). Similarly, IEC publishes international standards, amendments, technical reports, specifications, guides, technical corrigenda and interpretation sheets.

Main ISO Deliverables

International Standards	Technical Specifications	Technical Reports	Publicly Available Specifications	International Workshop Agreements
• Rules, guidelines or characteristics for activities or results of activities • Forms include product standards, but also test methods, codes of practice, guideline standards and management system standards	• Work still under development • Possibility of an agreement on an international standard in future • Can be used immediately but also provides opportunity for feedback • Aim is for it to be transformed into a published international standard	• Differ from standards and specifications as these are often informative • May contain results of a survey or state-of-the-art information	• Used when there is an urgent market need • Based on consensus of experts in a working group, or in an external organization • Can be used immediately but also provides opportunity for feedback for standard development • Expire after six years, by which they should be transformed into international standards or withdrawn	• Agreement developed outside technical committee system, to allow negotiation in a more flexible and open workshop environment • Expire after six years, after which they are either transformed into another deliverable or withdrawn

Source: ISO

CEN and CENELEC

CEN and CENELEC are the regional organizations for European national standardization organizations. CENELEC has a focus on electrotechnology and includes sectors such as Defense and Security; Electric Equipment and Apparatus; Electronic, Electromechanical and Electro-Technical Supplies; Household Appliances; Energy and Utilities; and Transport and Packaging.

CEN and CENELEC have links to the global ISO and IEC bodies through the Vienna and Frankfurt Agreements. Of around 3,500 CEN/CENELEC standards cited in the Official Journal, 44% are based on international standards.

International Telecommunication Union (ITU)

The ITU was established in 1865 and has a long history in standards-making. It was in 1924 that the ITU set up two technical committees to standardize technical and operational questions of international long-distance telephony and telegraphy. These two technical committees were merged in 1956 to become the International Telegraph and Telephone Consultative Committee (CCITT), the organ later renamed ITU-T (or the ITU Standardization Sector). ITU, ISO and IEC established the World Standards Cooperation (WSC) in 2001 to further their work on international consensus-based standards[26]. The ITU is a treaty-based organization and is the United Nations specialized agency for information and communication technologies. It consists of three sectors: ITU-R (Radiocommunication), ITU-T (Standardization), and ITU-D (Development).

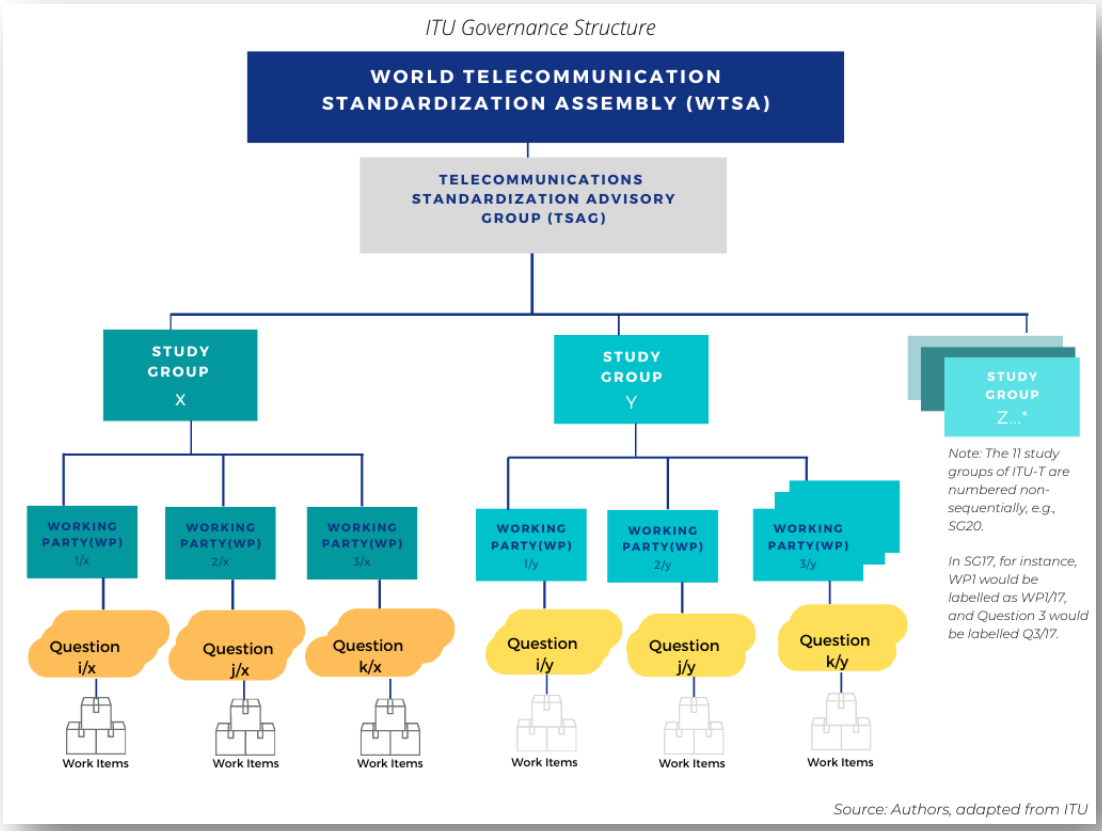
The activities of the ITU and its sectors are defined in resolutions of conferences occurring every 4 years: the Plenipotentiary Conference of the ITU, the World Telecommunication Standardization Assembly (WTSA), the World Telecommunication Development Conference (WTDC) and the World Radiocommunication Conference (WRC)

The standardization sector of the ITU, the ITU-T coordinates standards for ICT and telecommunications, with the exception of standards related to the radiocommunication system. The radiocommunication sector, the ITU-R, is responsible for coordinating standards for radiocommunication systems that enable the safe and effective use of the radio spectrum.

ITU's standards-making work is conducted by Study Groups (SGs). Each group has its own specific area of responsibility and leadership team. Each SG has the authority to initiate, develop and propose standards (or Recommendations in ITU terminology) and other types of deliverables. The ITU-T has eleven study groups in the following areas: Operational aspects (SG2), Economic and policy issues (SG3), Environment and climate change (SG5), Broadband cable and TV (SG9), Protocols and test specifications (SG11), Performance, QoS and QoE (SG12), Future networks (SG13), Transport and access (SG15), Multimedia (SG16), Security (SG17) and IoT & Smart Cities (SG20). The ITU-R has seven study groups as follows: Spectrum Management (SG1), Radiowave propagation (SG3), Satellite Services (SG4), Terrestrial services (SG5), Broadcasting service (SG6) and Science Services (SG7).

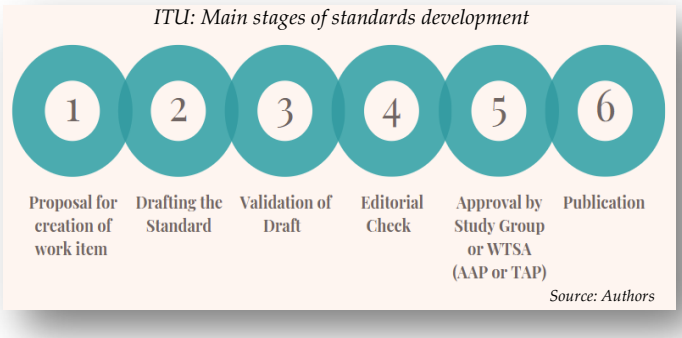
Each SG establishes Working Parties (WP) to study specific topics (Questions in ITU terminology) with each Question being assigned a Rapporteur responsible for chairing

[26] See https://www.worldstandardscooperation.org/



discussions and advancing work on standards (Recommendations in ITU terminology) related to that Question.

Although the development sector has two Study Groups on enabling environment (SG1) and ICT for the promotion of sustainable development (SG2), the sector does not produce international standards, but rather serves as a platform for the sharing of knowledge and ideas on topics of importance to developing countries.



Typically, a proposal is made for the creation of a work item, which if there is sufficient support, is approved and drafting begins. The draft is validated through various meetings before being finalized and edited. Final approval is based on consensus through various levels of the Study Group, but the final decision rests with the plenary meeting of the Study Group. In the case of ITU-T, once a Study Group has approved the standard in a plenary meeting, this triggers the

Alternative Approval Procedure (AAP) or the Traditional Approval Procedure (TAP). TAP is used in those cases where the standards have policy or regulatory implications. AAP is usually assumed with the exception of standards produced by ITU-T Study Group 3 on economic and policy issues, for which TAP is assumed and has always been used as the final decision on regulatory issues rests with Member States. The AAP is a more expedited version and includes both members states and member organizations (such as private sector members) in the decision process. When consensus cannot be reached in a study group, and the standard has policy or regulatory implications, the study group may send the standard to the ITU-T's governing body, the World Telecommunication Standardization Assembly (WTSA) for approval.

Participation in ITU-T standards-making work is open to member states, regulators, private sector companies, regional and international organizations, NGOs, user groups and so on. However, on matters with policy or regulatory implications, only Member States may decide, although other members may participate in discussions and influence the process.

The ITU is funded by contributions from member states and membership fees. Member states make voluntary contributions of between 1/16 and 40 contributory units of CHF 318,000 although only least-developed countries may pay 1/16 or 1/8 contributory units. Sector, associate and academia membership fees of the ITU-T and ITU-R are as follows:

- **Sector member**: CHF 31'800 (CHF 3'975 if organization is from a country with GDP per capita of <USD 2'000)
- **Associate**: CHF 10'600 (CHF 3'975 / CHF 1'978.50 if developing country SME)
- **Academia**: CHF 3'975 (CHF 1'978.50 if developing country)

Like ISO/IEC, ITU develops international Recommendations (standards), but also agrees on other types of deliverables, such as technical reports and supplements.

Main ITU-T Deliverables

International Recommendations	Regional Recommendations	Technical Supplements	Technical Reports and Papers	Focus Group Reports
• **Normative** • Agreed by international meetings of Study Groups	• **Normative** • Agreed by regional study groups (so far, only for ITU-T Study Group 3 on economic and policy issues)	• **Non-normative** • Agreed by Study Groups	• **Non-normative** • Typically informative • Agreed by Study Groups	• **Non-normative** • Represent outcomes of focus group meetings • Aim is to transfer focus group meeting outcomes into the formal standardization process

Source: Authors

European Telecommunications Standards Institute (ETSI)

ETSI is the primary standardization body for telecommunications in Europe but any company or organization, from any country, can become a member of ETSI and participate in the work of its technical groups. More than 900 organizations, including equipment manufacturers, government bodies and universities, from over 60 countries on 5 continents are members[27].

ETSI identifies six main stages for standards development, with each pre-publication phase allowing for feedback into the drafting process: 1) create the work item, 2) develop the draft standard, 3) validate the draft, 4) submit the draft for editorial checking, 5) approve and publish the standard, 6) maintain and evolve the standard.

ETSI, like other SDOs, has a number of deliverables as laid out below, some of which are normative and some of which are of a more informative nature.

Main ETSI Deliverables

Document	Type	Approval body
ETSI Technical Specification	**Normative**	ETSI technical committee
ETSI Standard	**Normative**	ETSI membership
European Standard	**Normative** (intended to be transposed into national standards of European Union Member States)	ETSI technical committee + European national standards organizations and/or ETSI national delegations
ETSI Group specification	**Normative or informative**	ETSI Industry specification group
ETSI Technical Report	**Informative** (the preferred informative type of deliverable unless other considerations demand an ETSI Guide or Special Report)	ETSI technical committee
ETSI Guide	**Informative** (guidance for the ETSI technical organization in general)	ETSI membership
ETSI Special Report	**Informative** (information made publicly available for reference purposes)	ETSI technical committee

Source: ETSI

[27] See https://www.etsi.org/membership/members

3GPP

The 3rd Generation Partnership Project (3GPP) is a partnership of seven telecommunications standard development organizations, known as organization partners, as follows: ARIB (Japan), ATIS (US), CCSA (China), ETSI (Europe), TSDSI (India), TTA (Korea) and TTC (Japan). 3GPP focuses on mobile cellular technologies, from radio access to core networks and services.

Membership categories include partners, individual members, representatives from ITU, observers and guests. Partners are standards development organizations and they may invite market representation partners. An individual member must be a member of an organizational partner. Observers must be qualified to be future partners and guests must be qualified to become individual members[28].

3GPP specifications and studies (known as Technical Specifications (TS) and Technical Reports (TR) respectively) are produced on the basis of contributions from member companies. There are three distinct technical specification groups: Radio Access Networks (RAN), Services and Systems Aspects (SA) and Core network and Terminals (CT). Each of these groups has several working groups. 3GPP Technical Specifications and Reports are transposed by the organizational partner standards bodies into appropriate documents such as standards.

IEEE Standards Association

The IEEE develops standards in telecommunications, information technology and power generation products, in particular the IEEE 802 standards for local and wide area networks, including Ethernet and WiFi. Membership in IEEE is open to individuals and corporations. The individual membership fee is US$ 262 or US$ 99 for members from the developing country category. Corporate membership fees depend upon the annual revenue of the corporation and whether the category of membership is basic (working group attendance as observers) or advanced (working group attendance as participants) in a range from US$ 1500 to US$ 16000[29].

Internet Engineering Task Force (IETF)

The IETF produces specifications of internet technology. These specifications are called Requests For Comments (RFCs). Each RFC is assigned a status, falling into one of three

[28] See 3GPP working procedures, available at https://www.3gpp.org/ftp/Information/Working_Procedures/3GPP_WP.pdf

[29] Information about IEEE Membership is available at https://standards.ieee.org/about/membership

categories: standards track (proposed standard, draft standard, internet standard), informational and experimental.

Any person may participate in the work of the IETF. The IETF meets 3 times a year and performs much of the technical work on mailing lists. Working Groups are created with a charter describing the specific problem to be studied or deliverable to be produced. There are typically over 100 WGs and each WG is assigned to an IETF Area.

The current IETF Areas are as follows:

- Applications and Real-Time (art)
- General (gen)
- Internet (int)
- Operations and Management (ops)
- Routing (rtg)
- Security (sec)
- Transport (tsv)

Industry-driven bodies

In addition to the SDOs described above, a number of industry forums operate in specific areas, producing technical specifications and often also operating conformity certification schemes with the key aim of promoting adoption of the technology. For example, the Global Certification Forum (GCF) operates a certification scheme for any type of product incorporating 3GPP (GSM, 3G UMTS, LTE) and 3GPP2 (CDMA2000) mobile connectivity. The certification process is based on a supplier's declaration of conformity as defined in ISO/IEC 17050 to requirements specified by 3GPP primarily and also the Open Mobile Alliance (OMA) and Near Field Communication (NFC) Forum. The membership of the GCF consists of mobile network operators, manufacturers and other industry stakeholders including testing laboratories and test system manufacturers as observer members. The 2022 annual membership fees range from US$ 5700 for an observer to US$ 11400 for operators and manufacturers[30].

Certification schemes are also operated by industry forums such as the WiFi Alliance, WiMax Forum, Bluetooth SIG, Metro Ethernet Forum, Broadband Forum (BBF), HomeGrid Forum (HGF), CableLabs and IPv6 Forum.

[30] See https://www.globalcertificationforum.org/membership.html .

REFERENCES

Abbott K.W. and Snidal D. (2001) International 'standards' and International Governance. *Journal of European Public Policy* 8(3): 345–70.

Acemoglu D., Gancia G. and Zilibotti F. (2012). Competing Engines of Growth: Innovation and Standardization. *Journal of Economic Theory* 147(2): 570-601.e3.

Biddle B., White A. and Woods S. (2010) How Many Standards in a Laptop? (And Other Empirical Questions). *SSRN Scholarly Paper*. Rochester: Social Science Research Network.

Blind K. (2013) The Impact of Standardization and Standards on Innovation. NESTA Compendium of Evidence on Innovation Policy Intervention. *Nesta Working Paper Series* 13/15.

Blind K., Jungmittag A. and Mangelsdorf A. (2011). The Economic Benefits of Standardization: An update of the study carried out by DIN in 2000. German Institute for Standardization (DIN).

Blind K., Petersen S and Riillo C. (2017) The impact of standards and regulation on innovation in uncertain markets. *Research Policy* 46(1): 249-64.

David P. and Greenstein S. (1990) The Economics Of Compatibility Standards: An Introduction To Recent Research. *Economics of Innovation and New Technology* 1(1–2): 3–41.

David P. and Steinmueller E. (1994) Economics of Compatibility Standards and Competition in Telecommunication Networks. *Information Economics and Policy* 6(3-4): 217–41.

DeNardis L. (2009) *Protocol Politics: The Globalization of Internet Governance*, Cambridge: MIT Press.

Ernst D. (2013) Standards, Innovation, and Latecomer Economic Development A Conceptual Framework. *East-West Center Working Papers - Economic Series* No. 134.

European Telecommunications Standards Institute (ETSI). (2013) A guide to writing world class standards, available at https://portal.etsi.org/portals/0/tbpages/edithelp/docs/aguidetowritingworldclassstandards.pdf (accessed on 21 January 2022).

European Commission. (2021) Rolling Plan for ICT Standardisation, available at https://ec.europa.eu/docsroom/documents/44998 (accessed on 24 January 2022).

Farrell, J. and Saloner, G. (1985) Economic Issues in Standardization, *MIT Working Paper* No. 393.

Getachew, A. (2019) *Worldmaking after Empire. The Rise and Fall of Self-Determination*, Princeton: Princeton University Press.

Grewal D.S. (2008) *Network Power: The Social Dynamics of Globalization*, New Haven: Yale University Press.

Grundström, C. and Wilkinson, I. (2004) The Role of Personal Networks in the Development of Industry Standards: A Case Study of 3G Mobile Telephony. *Journal of Business & Industrial Marketing* 19(4): 283–93.

Hawkins R.W. (1995) Standards-Making as Technical Diplomacy: Assessing the Objectives and Methodologies in Standards Institutions, pp. 147-58 in R. Hawkins, R. Mansell and J. Skea (eds) *Standards, Innovation and*

Competitiveness: The Politics and Economics of Standards in Natural and Technical Environments. Cheltenham: Edward Elgar.

International Organization for Standardization (ISO). (2021) Standards & economic growth: ISO members' research on the impact of standards on their national economies, available at https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100456.pdf (accessed on 21 January 2022).

International Organization for Standardization (ISO). (2019a) ISO in Brief, available at https://www.iso.org/publication/PUB100007.html (accessed on 22 January 2022)

International Organization for Standardization (ISO). (2019b) Journey to a New Strategy - Annual Report 2019, available at https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100385.pdf (accessed on 22 January 2022)

International Telecommunications Union (ITU). (2020) Global E-waste Monitor, available at https://www.itu.int/en/ITU-D/Environment/Documents/Toolbox/GEM_2020_def.pdf (accessed on 4 February 2022).

International Telecommunications Union (ITU). (2013) Guidelines for the development, implementation and management of a Mutual Recognition Arrangement/Agreement (MRA) on conformity assessment of telecommunication equipment, available at https://www.itu.int/en/ITU-D/Technology/Documents/ConformanceInteroperability/GuidelinesMRAs_E.pdf (accessed on 24 March 2022).

International Telecommunications Union (ITU). (2015) Establishing conformity and interoperability regimes: Complete guidelines, available at https://www.itu.int/en/ITU-D/Technology/Documents/ConformanceInteroperability/CI_Guidelines_preliminary.pdf (accessed on 24 March 2022).

Larsen R. (2012) The Political Nature of TCP/IP. *Momentum* 1(1): 1-54.

Liepiņa R., Lapiņa I. and Mazais J. (2013) Improvement of Conformity Assessment System: Technical Harmonization Adjustment', *The 17th World Multi-Conference on Systemics, Cybernetics and Informatics Conference Proceedings (Orlando)*.

Mansell R. (1995) Standards, Industrial Policy and Innovation, pp. 213–27 in R. Hawkins, R. Mansell and J. Skea (eds) *Standards, Innovation and Competitiveness: The Politics and Economics of Standards in Natural and Technical Environments*. Cheltenham: Edward Elgar.

Mainwaring K. and Srivastava L. (2010) The Internet of Things – Setting the Standard, pp. 191-222 in H. Chaouchi (Ed.) *The Internet of Things: Connecting Objects*. London: Wiley.

Mattli W. and Buthe, T. (2003) Setting International Standards: Technological Rationality or Primacy of Power? *World Politics* 56(1): 1–42.

McCormick P. (2007) Private sector influence in the International Telecommunication Union. *Info* 9(4): 70-80.

McNeil I. (Ed.) (1990). *An Encyclopedia of the History of Technology* (1st ed.), London: Routledge.

NBN. (2020) *The Impact of Standards on the Belgian Economy* available at https://ibebvi.be/src/Frontend/Files/userfiles /files/NBN_impactStandards_Keymessages.pdf (accessed on 21 January 2022)

Shapiro C. and Varian, H. (1999) The Art of Standards Wars. *California Management Review* 41(2): 8–32.

Shin D-H., Kim H. and Hwang J. (2015) Standardization Revisited: A Critical Literature Review on Standards and Innovation. *Computer Standards & Interfaces* 38: 152–57.

Šimunić D. and Pavić I. (2020) *Standards and Innovations in Information Technology and Communications*, Cham: Springer International Publishing.

Swann P.G.M. (2010) *The Economics of Standardization: An Update (Report for the UK Department of Business, Innovation and Skills)*, Innovative Economics Limited, available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/32444/10-1135-economics-of-standardization-update.pdf (accessed on 21 January 2022).

Stephenson S. M. (1997) Standards and Conformity Assessment as Nontariff barriers to trade. *Policy Research Working Paper 1826*, The World Bank Development Research Group.

Toffler A. (1970) *Future Shock*, New York: Random House.

Transparency International. (2022) *Corruptions Perception Index 2021*, January, available at https://images.transparencycdn.org/images/CPI2021_Report_EN-web.pdf (accessed on 25 January 2022).

The World Bank. (2021) *World Development Report 2021: Data for Better Lives*, available at https://www.worldbank.org/en/publication/wdr2021 (accessed 29 January 2022).

World Trade Organization (WTO). (2021) *World Trade Report 2021: Economic resilience and trade*, available at https://www.wto.org/english/res_e/booksp_e/wtr21_e/00_wtr21_e.pdf (accessed on 21 January 2022).

UN General Assembly. (2015). *Transforming our world : the 2030 Agenda for Sustainable Development, 21 October*, A/RES/70/.

Zoo H., de Vries H. and Lee H. (2017) Interplay of Innovation and Standardization: Exploring the Relevance in Developing Countries. *Technological Forecasting and Social Change* 118: 334–48.

The Media@LSE Working Paper Series:

- Presents high quality research and writing (including research in-progress) to a wide audience of academics, policy-makers and commercial/media organisations.
- Sets the agenda in the broad field of media and communication studies.
- Stimulates and informs debate and policy.

All papers will be published electronically as PDF files, subject to review and approval by the Editors and will be given an ISSN. An advantage of the series is a quick turnaround between submission and publication. Authors retain copyright, and publication here does not preclude the subsequent development of the paper for publication elsewhere.

The Editor of the series is Bart Cammaerts. The editorial board is made up of other LSE academics and friends of Media@LSE with a wide range of interests in information and communication technologies, the media and communications from a variety of disciplinary perspectives (including economics, geography, law, politics, sociology, politics and information systems, cultural, gender and development studies).

Notes for contributors:

Contributors are encouraged to submit papers that address the social, political, economic and cultural context of the media and communication, including their forms, institutions, audiences and experiences, and their global, national, regional and local development. Papers addressing any of the themes mentioned below are welcome, but other themes related to media and communication are also acceptable:

Communication and Difference	Mediation and Resistance
Globalisation and Comparative Studies	Media and Identity
Innovation, Governance and Policy	Media and New Media Literacies
Democracy, Politics and Journalism Ethics	The Cultural Economy

Contributions are welcomed from academics and PhD students. In the Autumn Term we also invite selected Master's students from the preceding year to submit their dissertations which will be hosted in a separate part of this site as 'dissertations' rather than as Working Papers. Contributors should bear in mind when they are preparing their paper that it will be read online.

Papers should conform to the following format:

6,000-10,000 words, 150-200 word abstract, papers should be prepared as a Word file, Graphs, pictures and tables should be included as appropriate in the same file as the paper, The paper should be sent by email to Bart Cammaerts (b.cammaerts@lse.ac.uk), the editor of the Media@LSE Working Paper Series

ISSN: 1474-1938/1946