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TRACING THE EVOLUTION OF STANDARDS AND STANDARD-SETTING ORGANIZATIONS IN THE ICT ERA

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I. INTRODUCTION

Standards and standard-setting organizations (SSOs) have played a crucial role in shaping the innovation landscape for over three decades, especially in the information and communication technologies (ICT) sector.[1] The advancement in mobile telecommunication and the Internet has led to a fundamental change in the way individuals communicate with each other.[2] Devices such as smartphones, tablets, laptops, and smart watches bear complex mechanical and technological features[3] and perform multiple functionalities by connecting seamlessly.[4] However, in order for the interoperability of these devices and their functionalities to come through, there is a requirement of a common set of specifications and interfaces, in the form of standards.[5] Standards are widely acknowledged to be the mainstay of modern economy[6] and can lead to an increase in the value of consumer products, as well as increased rates of innovation.[7] The setting of standards and commercializing of innovation at large is facilitated by voluntary associations called SSOs. Competing firms come together under the auspices of SSOs[8] to collaboratively select and adopt uniform technical standards.[9] It is worth noting that the benefits brought about by these standards have a greater visibility in the ICT sector, primarily on account of two reasons. First, in order to make complex technologies work, there is a

1. James J. Anton & Dennis A. Yao, *Standard-Setting Consortia, Antitrust and High-Technology Industries*, 64 ANTITRUST L.J. 247 (1995).

2. Haris Tsilikas, *Collaborative Standardization and Disruptive Innovation: The Case of Wireless Telecommunication Standards*, MAX PLANCK INST. FOR INNOVATION & COMPETITION, no. 16–06, 2016, at 3 (citing Wolfgang Bock et al., *The Mobile Revolution: How Mobile Technologies Drive a Trillion-Dollar Impact*, BOSTON CONSULTING GROUP (Jan. 15, 2015), https://www.bcg.com/en-in/publications/2015/telecommunications-technology-industries-the-mobile-revolution (last visited May 18, 2016)).

3. Olia Kanevskaia, *Technology Standard-Setting Organizations and their Capture by the Principles of Global Administrative Law*, 3 E-PÚBLICA, no. 3, 2016, at 136.

4. Tsilikas, *supra* note 2.

5. *Id.*

6. OECD, *Intellectual Property and Standard Setting*, ¶ 4, OECD Doc. DAF/COMP/WD(2014)116 (Dec. 8, 2014), http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DAF/COMP/WD(2014)116&doclanguage=en.

7. Joanna Tsai & Joshua D. Wright, *Standard Setting, Intellectual Property Rights, and the Role of Antitrust in Incomplete Contracts*, 80 ANTITRUST L.J. 157, 159 (2015).

8. Tsilikas, *supra* note 2, at 4.

9. Patrick D. Curran, *Standard-Setting Organizations: Patents, Price Fixing, and Per Se Legality*, 70 U. CHI. L. REV. 983 (2003).

requirement of hundreds of thousands of patents.[10] Second, there is a strong need for devices and networks to interoperate in the ICT sector, which makes it absolutely necessary to develop common technical standards.[11]

SSOs are further tasked with the responsibility of fostering a regime of rapid technological innovation[12] by balancing the interests of their members; their membership comprising of patent owners or standard essential patent (SEP) holders on one hand and implementers or licensees on the other. While the patent owners are involved in research and development (R&D) and look to maximize their earnings from licensing out their SEPs, the implementers look to seek licenses from SEP holders[13] on terms that are fair, reasonable, and non-discriminatory (FRAND), in order to use the patented technology in the manufacturing of standard-compliant, end-use products. There is yet, a third category of member companies that are vertically integrated and besides owning SEPs, also operate actively in the downstream market.[14] As members of SSOs, these firms compete in the market on both, horizontal and vertical levels, which gives rise to a possible likelihood of collusion albeit theoretically.[15] It is because of this aspect of standard-setting that the role of SSOs becomes extremely important.

A pertinent question that arises then is, what are SSOs and how do they function? Furthermore, what is the legality of SSOs and how have they helped in the evolution of industry standards? In an attempt to answer the aforementioned questions, the focus of this paper shall center around standardization and SSOs, while tracing the evolution of standards and standard-setting activities in the ICT sector.

II. THE EVOLUTION OF STANDARDS

It all began in 1864, when a man by the name William Sellers took up the cause of standardization. Sellers was fully aware of the end of the hand-tooled machine coming to an end, so he steered the manufacturing elite towards the

10. Marco Lo Bue, *Patent Holdup and Holdout Under the New IEEE's IP Policy: Are These Breaches of Competition Law?* 2015/16 MIPLC MASTER THESIS 1, 5 (2016), http://ssrn.com/abstract=2999806.

11. *See* Marcus Glader, *Standards, Competition and Intellectual Property Rights An Overview of Current Controversies*, NORDIC PERSPS. ON COMPETITION INNOVATION MKTS. 89 (Lidgard & Hans Henrik ed., 2013).

12. *See* David Teece, *Are the IEEE Proposed Changes to IPR Policy Innovation Friendly?* 1 (Tusher Ctr. Mgmt. Intell. Cap., Working Paper No. 2, Feb. 2, 2015).

13. Bue, *supra* note 10, at 5.

14. *Id. at* 6.

15. *Id.*

mass production era.[16] This mass production was given effect to by standards and standardization, be it standard cloth sizes, measurements of the screw, environment, quality or safety standards.[17] But what exactly is a standard? "A standard can be defined as a set of technical specifications which seeks to provide a common design for a product or process."[18] According to the European Telecommunications Standards Institute (ETSI), "a standard is a document that provides rules or guidelines to achieve order in a given context."[19] Standards lie at the heart of digital economy[20] and are directly responsible for the existence of interoperability[21] between products originating from different manufacturers.[22] They have, over the course of history, provided effective and timely solutions to most technical problems.[23] How though have standards evolved? What were the first set of standards to have come into existence? In order to answer these questions, one needs to trace the origin of standards.

A. Historical Background

Standards have existed since early historical times, with the creation of a calendar being the one of the first examples of standardization,[24] followed by King Henry I of England's labelling of the length of his arm as the preferred unit of measurement,[25] back in 1120 AD.[26] Time-unit standards were for the first time put to use by ice age hunters around 20,000 years ago,[27] by carving

16. James Surowiecki, *Turn of the Century*, WIRED (Jan. 1, 2002), www.wired.com/2002/01/standards-2.

17. Saket Sharma & Sumathi Chandrashekaran, *Technology Standards: Promoting Innovation and Competition in India*, 2016 CUTS INST. REG. & COMPETITION 1.

18. Damien Geradin, *European Union Competition Law, Intellectual Property law and Standardization*, *in* THE CAMBRIDGE HANDBOOK OF TECHNICAL STANDARDIZATION LAW: COMPETITION, ANTITRUST, AND PATENTS 78, 80 (Jorge L. Contreras ed., 2017).

19. *Why Standards*, EUR. TELECOMM. STANDARDS INST., https://www.etsi.org/standards/why-standards (last visited Sept. 5, 2017).

20. Kirti Gupta, *FRAND in India: Emerging Developments*, 2016 ANTITRUST EMERGING & DEVELOPING COUNTRIES, Conference Papers (forthcoming 2d ed., 2017) (manuscript at 8), https://ssrn.com/abstract=2771465.

21. Koren W. Wong-Ervin & Joshua D. Wright, *Intellectual Property and Standard Setting*, 17 FEDERALIST SOC'Y REV., no. 3, 46 (2016).

22. Geradin, *supra* note 18.

23. OECD, *supra* note 6, at 3.

24. *Through History with Standards*, ANSI CONSUMER AFFAIRS, https://www.ansi.org/consumer_affairs/history_standards (last visited Sept. 8, 2017).

25. Alec Liu, *A Brief History of Standards*, RIPPLE (Mar. 24, 2015) https://ripple.com/insights/a-brief-history-of-standards.

26. *Through History with Standards, supra* note 24.

27. NANOTECHNOLOGY STANDARDS 16 (Vladimir Murashov & John Howard eds., Springer 2011).

out lines in caves[28] in order to keep a count of the days between different phases of the moon.[29] The primary aim of these early standards was to bring human activities in line with natural phenomenon,[30] and soon they became symbolic of individual empowerment.[31] That gave way to industrial revolution[32] towards the mid-nineteenth century and it was the French Revolution that played a crucial role in the evolution of standardization, with the state handing over the responsibility of standardization to its scientists.[33] The advent of industrial revolution resulted in the nation states becoming more powerful, which in turn led to the emergence of transnational trade.[34] But in order to give effect to decentralized trade, there was a need for a faster and more economic mode of transport[35] to carry goods from one nation to the other. This need was catered to by the standardization of the railroad gauge, which brought about uniformity in the distance between two rails on a track.[36] Prior to the rail gauge being standardized,[37] carriage of goods between countries and between cities, in some countries, required the goods to be unloaded and shifted to new trains since the rails were of different sizes.[38] It was in the mid-nineteenth century that the British Parliament through the Gauge Act of 1846, set the standard width of a rail gauge at 4 feet and 8.5 inches.[39] Although there was opposition from several quarters within Britain and outside, by 1886, it had also become the United States (U.S.) standard.[40] The standardization of a rail gauge set the wheels in motion in terms of harmonizing cross-country transportation[41] and paved way for further standardization to take place.

The late nineteenth and early-twentieth centuries witnessed the emergence of voluntary organizations[42] and trade associations responsible for the development of standards.[43] These organizations, addressed as SSOs or standards-development organizations (SDOs), focused on improving national productivity

28. *Through History with Standards, supra* note 24.
29. NANOTECHNOLOGY STANDARDS, *supra* note 27.
30. NANOTECHNOLOGY STANDARDS, *supra* note 27.
31. Liu, *supra* note 25.
32. Liu, *supra* note 25.
33. TIM WEITZEL, ECONOMICS OF STANDARDS AND INFORMATION NETWORKS 11 (2004).
34. NANOTECHNOLOGY STANDARDS, *supra* note 27, at 18.
35. *Through History with Standards, supra* note 24.
36. *Through History with Standards, supra* note 24.
37. Liu, *supra* note 25.
38. Liu, *supra* note 25.
39. WEITZEL, *supra* note 33, at 12.
40. *Through History with Standards, supra* note 24.
41. NANOTECHNOLOGY STANDARDS, *supra* note 27, at 18.
42. WEITZEL, *supra* note 33, at 12.
43. NANOTECHNOLOGY STANDARDS, *supra* note 27, at 18.

through standardization,[44] by plugging specific gaps in standards.[45] Standard-setting efforts further facilitated economies of scale,[46] and led to the reduction in heterogeneity of products and processes,[47] and made it possible for interoperability to set in. Towards the second half of the twentieth century, the concept of open standards gained prominence and although there is no fixed definition for open standards,[48] they are usually defined as standards that are available for all to read and implement without any royalty or fee.[49] An Open Standard is "free from legal or technical clauses that limit its utilization by any party or in any business model" and is "managed and further developed independently of any single vendor in a process open to the equal participation of competitors and third parties."[50] The first major open standard emerged in the form of the IBM Personal Computer in 1981, with the ISA bus employed therein "easy to understand, easy to design and build to."[51] Open standards have come a long way since and play a fundamental role in fostering a level playing field vis-à-vis ICT technologies.[52] In addition to the existence of open standards, most of the standards development work today is being taken up by SSOs, with an estimated 840 SSOs[53] operating in the ICT sector, firmly establishing the sector's status as the backbone of modern innovation.

B. Types of Standards

Technical standards have, over the years, become a pervasive feature of high technology industries.[54] What has helped standards gain prominence is the welfare-enhancing aspect of standardization.[55] But all standards may not share the same fate, since the binding nature and enforceability of standards is

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44. WEITZEL, *supra* note 33, at 12.

45. NANOTECHNOLOGY STANDARDS, *supra* note 27, at 22.

46. Andrew L. Russell, *Standardization in History: A Review Essay with an Eye to the Future*, *in* THE STANDARDS EDGE: FUTURE GENERATIONS 46, 49 (Sherrie Bolin ed., 2005).

47. WEITZEL, *supra* note 33, at 12.

48. Liu, *supra* note 25.

49. Bruce Perens, *Open Standards Principles and Practice*, (Jun. 1, 2002), http://perens.com/OpenStandards/Definition.html [http://web.archive.org/web/20081218213743/http://perens.com/OpenStandards/Definition.html].

50. *Open Standards*, FREE SOFTWARE FOUND. EUR., https://fsfe.org/activities/os/def.en.html (last visited Sept. 14, 2017).

51. *Value of Open Standards*, PCI INDUS. COMPUT. MFRS. GRP., https://www.picmg.org/values-of-open-standards (last visited Sept. 14, 2017).

52. *Open Standards*, OPEN F. EUR., http://www.openforumeurope.org/what-we-do/open-standards (last visited Sept. 14, 2017).

53. Tsilikas, *supra* note 2, at 6.

54. Pierre Larouche & Florian Schuett, *Repeated Interaction in Standard Setting* 2 (Tilberg Law & Econ. Ctr., Discussion Paper No. 2016-010, 2016).

55. *Id.*

dependent on their development. Industry standards may be developed through different processes, and depending on the process of their development, may be categorized as *de facto* or *de jure* standards.

1. *De Jure* Standards

De jure standards, also known as legal standards, are standards established by law[56] and are set either through governmental intervention[57] or through industry collaboration.[58] While governmental agencies are responsible for the development of health, safety and environmental standards, interoperability standards are usually developed under the aegis of voluntary associations called SSOs or SDOs[59] (SSOs shall be discussed in detail, later in the paper). Some of the prominent standards developed by SSOs, such as Wi-Fi, Bluetooth, USB, GSM, MP3, MPEG, CDMA, LTE, et cetera, have been successfully adopted by millions of consumer electronic devices worldwide.[60] However, standards developed by SSOs cannot impose any obligations and are voluntary in nature, courtesy of the institutional character of SSOs. They gain legal recognition on being implemented into national legal systems, with their application deemed quintessential for compliance with national law.[61] There is usually the case when standards are developed by private initiatives with varying degrees of governmental intervention. An example of such a standard is the GSM standard for mobile telecommunication.[62]

2. *De Facto* Standards

De facto standards, also commonly known as market-driven standards, on the other hand, are standards that "have evolved to be accepted because of wide public support and market forces."[63] They need not necessarily be the best

56. *De Facto Standard Definition*, LINUX INFO. PROJECT (Nov. 27, 2005), http://www.linfo.org/de_facto_standard.html.

57. Tsilikas, *supra* note 2.

58. OECD Secretariat, *Directorate for Financial and Enterprise Affairs Competition Committee: Standard Setting*, 9, OECD Doc. DAF/COMP(2010)33 (Mar. 8, 2011).

59. Jorge L. Contreras, *Patents, Technical Standards, Standards-Setting Organizations and Intellectual Property: A Survey of the Literature (with an Emphasis on Empirical Approaches)*, *in* 2 RESEARCH HANDBOOK ON THE ECONS. OF INTELLECTUAL PROP. LAW 3 (Peter S. Menell & David Schwartz eds., 2017).

60. Tsilikas, *supra* note 2, at 3–4.

61. Olia Kanevskaia, *Technology Standard-Setting under the Lens of Global Administrative Law: Accountability, Participation and Transparency of Standard-Setting Organizations*, TILBERG L. & ECON. CTR., no. 2016–016, Jul. 21, 2016, at 4.

62. OECD Secretariat, *supra* note 58.

63. *Standards*, BBC: BITESIZE, http://www.bbc.co.uk/education/guides/zdn3d2p/revision/2 (last visited Sept. 17, 2017).

standards[64] but gain their status on account of either first arrival in the market,[65] or a proven track record for continued efficiency and reliability.[66] At times, the continued persistence of *de facto* standards is also down to the high cost of switching to other standards or their imposition by a dominant company.[67] A classic and perhaps one of the most well-known examples of a *de facto* standard[68] remaining on the shelves despite being inferior to its rival, the *Beta standard*,[69] is the *VHS standard* for video recording. Back in the 1970s, most of the industry experts held the opinion that the *Beta standard* was superior to the *VHS standard* from a technical viewpoint.[70] Yet, the proponents of the *VHS standard* were able to steal a march on their rivals and sway the public confidence, due to better marketing tactics.[71] Other examples of *de facto* standards include the *QWERTY* keyboard, the *Windows* operating system[72], Microsoft Word for documents, the railway gauge,[73] et cetera. Depending on how they have been developed, *de facto* standards may be open or closed. While closed standards are only accessible to a closed circle, open standards are free for use by anyone.[74] Although *de facto* standards lack legal backing, they may attain *de jure* status by being approved through formal standard-setting processes.[75]

C. Benefits of Standardization

Standardization has become symbolic of competitiveness and development in an economy.[76] As renowned U.S. journalist James Surowiecki once stated, "[W]ithout standardization there would not be a [modern] economy."[77] In allowing the compatibility and interoperability of complex electronic devices, collaborative standard-setting leads to a host of benefits for consumers as well

64. *De Facto Standard Definition*, *supra* note 56.

65. Kent Beckert, *De Facto Standards in Information Systems: Definition & Overview*, STUDY.COM, http://study.com/academy/lesson/de-facto-standards-in-information-systems-definition-lesson-quiz.html (last visited Sept. 17, 2017).

66. *Standards*, *supra* note 63.

67. *De Facto Standard Definition*, *supra* note 56.

68. *De Facto Standard Definition*, *supra* note 56.

69. Beckert, *supra* note 65.

70. *De Facto Standard Definition*, *supra* note 56.

71. Beckert, *supra* note 65.

72. Beckert, *supra* note 65.

73. *De Facto Standard Definition*, *supra* note 56.

74. Karen Bartleson, *What's the Difference between De Jure and De Facto Standards?*, ELEC. DESIGN (Nov. 13, 2012), http://www.electronicdesign.com/embedded/what-s-difference-between-de-jure-and-de-facto-standards.

75. *Id.*

76. Ravikant Bhardwaj, *Standard Setting in India: Competition Law and IP Issues*, 5 INDORE MGMT. J., Apr.–Dec. 2013, at 92.

77. Sharma & Chandrashekaran, *supra* note 17.

as industry participants. What makes standards invaluable is the fact that despite the growth of technology-dependent domains at an incredibly fast pace, standards have managed to accelerate innovation and drive modern economy to newer heights.[78] One may divide the benefits arising out of standardization into three main categories: greater interoperability, better network effects and higher rates of innovation.[79]

1. Greater Interoperability

One of the key factors behind the development of technology standards is the facilitation of interoperability between products originating from different vendors,[80] so as to ensure part A fits with part B.[81] For instance, for a Sony video-recorder, one is at liberty to choose between Sony and Maxell tapes, due to standardized technical specification for videotapes.[82] This in turn, leads to the enhancement of consumer welfare, since there is price competition between interoperable products.[83] Moreover, interoperability allows consumers to buy products without the fear of incompatibility, especially in the ICT sector, whether one exchanges voice, video or data messages.[84] In order to ensure that the products and services comply with standards to achieve the desired level of interoperability, standards are subjected to tests, as a result of which most SSOs or SDOs[85] have specialized testing centers for interoperability. At the international level, interoperability brings about economies of scale and dynamic efficiency,[86] while also reducing companies' cost of production through the simplification of product designs.[87]

2. Better Network Effects

The benefits of standardization have moved beyond interoperability[88] and into the realm of network effects. Positive network effects are said to accrue when a consumer purchasing a product stands to benefit from the same product

78. Sharma & Chandrashekaran, *supra* note 17.

79. Curran, *supra* note 9, at 983–1009.

80. *Why Standards*, *supra* note 19.

81. Andrew Updegrove, *ICT Standard Setting Today: A System under Stress*, 12 FIRST MONDAY, no. 6 (2007), http://firstmonday.org/article/view/1911/1793.

82. Curran, *supra* note 9, at 983–1009.

83. *Id.*

84. INT'L TELECOMM. UNION, UNDERSTANDING PATENTS, COMPETITION & STANDARDIZATION IN AN INTERCONNECTED WORLD 26 (2014).

85. ETSI has a centre dedicated to the provision of necessary expertise vis-à-vis interoperability, called the Centre for Testing and Interoperability; *see Why Standards*, *supra* note 19.

86. Tsilikas, *supra* note 2, at 4.

87. Tsai & Wright, *supra* note 7, at 159.

88. Tsilikas, *supra* note 2, at 4.

being purchased by others.[89] For instance, the value of a mobile handset to an individual increases with an increase in the total number of mobile phone users.[90] Moreover, there is a rapid growth in the value of a mobile phone with more interoperable phones joining the network, which in turn benefits the producers through the expansion of consumer demand for their products and the consumers through an incremental increase in the value of all products within a network.[91] Network effects so to say, may be direct or indirect. Direct network effects arise from additional users joining a network, benefitting all others. Indirect network effects, on the other hand, arise from an increase in the demand for complimentary products or after-purchase services, benefitting consumers through wider choice and higher competition for such products. On account of their application in several information technology markets, network effects have become ever so important for the modern economy.[92]

3. Higher Rates of Innovation

The R&D efforts to create uniform technical specification have substantial risks associated to them, since there is never a guarantee of commercial research yielding favorable outputs.[93] Furthermore, there might also be a possibility of products becoming technically obsolete by the time they are market ready. Uniform standards proceed to eliminate this risk by creating a standardized market for interoperable products, allowing firms to carry out innovative improvements in their existing products, without having to incur any costs on replicating the initial products. So long as the new products are compatible with the existing ones employing the industry standard, firms can rely on a ready-made market for their products.[94] According to the U.S. Department of Justice & Federal Trade Commission, "[b]y agreeing on an industry standard, firms may be able to avoid many of the costs and delays of a standards war, thus substantially reducing transaction costs to both consumers and firms."[95]

89. Alexei Alexandrov, *Anti-Competitive Interconnection: The Effects of the Elasticity of Consumers' Expectations and the Shape of the Network Effects Function,* 63 J. INDUS. ECON. 74 (2015).

90. Matthew T. Clements, *Direct and Indirect Network Effects: Are they Equivalent?,* 22 INT'L J. INDUS. ORG. 633 (2004).

91. Curran, *supra* note 9, at 983–1009.

92. *Id.*

93. The output in such cases would be commercially viable products.

94. Curran, *supra* note 9, at 983–1009.

95. U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, ANTITRUST ENFORCEMENT AND INTELLECTUAL PROPERTY RIGHTS: PROMOTING INNOVATION AND COMPETITION 34 (2007), https://www.ftc.gov/sites/default/files/documents/reports/antitrust-enforcement-and-intellectual-property-rights-promoting-innovation-and-competition-report.s.department-justice-and-federal-trade-commission/p040101promotinginnovationandcompetitionrpt0704.pdf (last visited Oct. 7, 2017).

This provides a degree of certainty to the R&D expenditure incurred by firms[96] and helps in the faster adoption of innovative products in the market.[97] Furthermore, the mere fact of standards being interoperable paves the way for innovation to take center-stage, thereby enabling industry participants to develop best-of-breed products.[98] It is on the back of these powerful effects on innovation that the role of SSOs in developing technical standards has become extremely critical.[99]

III. STANDARD-SETTING ORGANIZATIONS

The development and setting of standards by SSOs is not new and can rather be traced back to the late nineteenth and early-twentieth centuries.[100] Most of the voluntary, consensus-based, standards development takes place through the instrumentality of standard-setting organizations.[101] By providing the necessary leadership required to prevent coordinated failures resulting from network effects in the market,[102] SSOs allow industry competitors to come together under one roof and select specific technologies as industry standards.[103] Most SSOs require their members to commit to license their patents included in the standard, free of charge[104] or on FRAND terms,[105] and in some cases, the most restrictive terms of licensing. Before proceeding towards analyzing the nature of such impositions, it is important to define what exactly are SSOs, what functions do they perform, and what is their legality?

A. The Evolution of SSOs

A standard-setting organization is a voluntary association comprising of groups of market participants[106] that are responsible for the development of technical standards, through a process based on collaboration and consensus.[107] SSOs provide the platform required for striking a balance between the varied

96. Carl Mair, *Openness, Intellectual Property and Standardization in the European ICT Sector*, 2 IP THEORY, no. 2, 52, 56 (2012).

97. OECD, *supra* note 6, at 6.

98. *Id.* at 5.

99. Curran, *supra* note 9, at 983–1009.

100. IAN CORDEN ET AL., PLUM CONSULTING, COMMERCIAL AND ECONOMIC IMPACTS FROM IPR POLICY CHANGES 15 (2007).

101. OECD, *supra* note 6, at 4.

102. *Id.* at 5.

103. Curran, *supra* note 9, at 983–1009.

104. OECD, *supra* note 6, at 4.

105. *Id.*

106. Contreras, *supra* note 59, at 3.

107. Wong-Ervin & Wright, *supra* note 21.

interests of both innovators and implementers of technology.[108] The first SSOs came into existence over a hundred years ago, and for the next seventy years, international standards infrastructure evolved with hundreds of SSOs receiving formal recognition at the national and international level.[109] SSOs may also vary in size and composition.[110] They may either consist of thousands of members and develop several standards at once or may function as a consortia of special interest groups, consisting of a limited number of firms that collaborate to work on a single standard. The latter model is usually followed in developing standards for consumer electronics.[111] For instance, the Third Generation Partnership Project (3GPP) works on the mobile internet standards. While SSOs have been operating in the standard-setting sector for several decades, it was not until the late 1980s that standard-setting consortia first arrived on the scene.[112] The pace at which technical standards were being developed by SSOs was considered a little too slow for the fast-paced technological world and thus, the need for consortia arose.[113] In contrast to SSOs, consortia are narrower in terms of their focus, but in terms of their membership, they are international rather than national; the purpose being to develop standards meant for global implementation. Over the years, standards consortia have multiplied in number and remain actively involved in standards development, especially in the ICT sector.[114]

Today, hundreds of accredited SSOs are involved in the development of thousands of technical standards and participating in all of them would be impractical, if not impossible.[115] Prospective members of SSOs, in pursuit of their goals, therefore need to think intelligently and consider various factors (including the relevance of the SSOs to their business) while making a choice of the SSO/SSOs they wish to join.[116] SSOs might operate at international, regional, or national levels and may have an open or closed membership.[117] Most SSOs have open standard-setting procedures wherein, relevant information about the standard-setting project is furnished to the interested parties, who then undertake the task of attending the standard-setting meetings, voting on decisions

108. *Id.*

109. ANDREW UPDEGROVE, THE ESSENTIAL GUIDE TO STANDARDS, ch. 1 (2007) (ebook).

110. Contreras, *supra* note 59, at 4.

111. *Id.* at 3.

112. UPDEGROVE, *supra* note 109.

113. *Id.*

114. *Id.*

115. *Id.* at ch. 2.

116. *Id.*

117. Esteban Burrone, *Standards, Intellectual Property Rights (IPRs) and Standards-Setting Process*, WIPO (2000), http://www.wipo.int/sme/en/documents/ip_standards_fulltext.html (last visited Nov. 19, 2017).

pertaining to standardization, and making technological contributions.[118] However, it may not be possible for an organization to become a part of an SSO and participate in the standard-setting process if the membership of the SSO is limited to a closed group, for instance, a consortia or an alliance.[119] The composition and the membership structure may also differ from one SSO to the other. Depending upon the type of SSO, the members could be vendors and commercial entities, universities, non-governmental organizations, governments, individuals, or consumer groups.[120] While the Institute of Electrical and Electronics Engineers (IEEE) membership is open only to individuals who are engineers, with a pre-condition to disclose their affiliation, the International Telecommunications Union (ITU), an agency of the United Nations (UN) has its members ranging from private entities to state governments of all UN member states.[121] Furthermore, participation in an SSO can turn out to be quite expensive, since participation incurs a substantial fee[122] and international companies often end up joining anywhere between 50 to 100 SSOs at any given time.[123] Some members may also have to incur R&D costs, as part of creating technologies in relation to standards development.[124] The benefits attached to such participation too, are considerably high. All this makes it highly important for the members to make the best out of their membership.

In addition to SSOs, there are some private organizations making significant contributions to the standard-setting process. They could either be in the form of industry "upstream" consortia or industry "downstream" consortia.[125] In the case of industry "upstream" consortia, companies are involved in exchanging ideas and coordinating R&D concerning the standard being developed at an SSO. Industry "downstream" consortia, on the other hand, are involved in the certification of existing standards developed at an SSO. There are also organizations such as the American National Standards Institute (ANSI) and the National Institute of Standards and Technology (NIST) in the U.S., that are not directly involved in the development of standards, however, they are responsible for coordinating the work of different SSOs and defining

118. Justus Baron & Daniel F. Spulber, *Technology Standards and Standards Organizations: Introduction to the Searle Center Database*, 27 J. ECON. & MGMT. STRATEGY, no. 3 (2018).

119. Burrone, *supra* note 117.

120. UPDEGROVE, *supra* note 109, at ch. 2.

121. Charlene M. Morrow, Adam M. Lewin & Tammi L. Hill, Fenwick & West LLP, *To Join or Not to Join: When Membership in a Standard-Setting Organization is the Question*, LEXOLOGY (Dec. 23, 2014), https://www.lexology.com/library/detail.aspx?g=71826d5b-71cd-4e5a-a54e-6add5100e718.

122. Baron & Spulber, *supra* note 118.

123. UPDEGROVE, *supra* note 109, at ch. 3.

124. Baron & Spulber, *supra* note 118.

125. Baron & Spulber, *supra* note 118.

standardization policies, while acting as an interface between private SSOs and the government.[126]

B. Structure and Legality

Structurally speaking, there doesn't exist a "one-size-fits-all" formula for setting up an SSO,[127] and it can range from being an unincorporated affiliation of companies,[128] to a semi-autonomous entity[129] or from a classic corporation with a multi-million-dollar budget to a limited liability corporation (LLC). Most SSOs are based on one of these legal structures and each model comes with its own set of advantages and disadvantages.[130] A detailed description of these models is given in the next four subsections.

1. A Classic Corporation

The classic corporate model is the common structure among SSOs intending to have more than a mere transitory existence. They are usually established under the not-for-profit laws of a jurisdiction and provide sufficient protection to the SSO directors, officers, and members, if maintained properly. One of the reasons for following a corporate model is the existence of well-defined rules under Corporate Law, which in the case of a non-corporate structure need to be created from scratch. The successful formation of a membership corporation facilitates the creation of a liability shield, a set of model documents providing all the statutorily enforceable Bylaws detailing the governance structure as well as the legal and procedural rules driving the operation of the organization and last but not least, a membership application constituting a legally binding contract between the SSO and its members, stating the obligations on the part of the members to comply with the SSO's Bylaws (including its Intellectual Property Right (IPR) policy).[131]

2. A Limited Liability Corporation

The LLC is relatively new and very few SSOs have resorted to this model. The legal protection afforded by an LLC is largely the same as the traditional corporation but for some amount of flexibility in the Bylaws. This flexibility serves a two-fold purpose: on the one hand, it provides the members of an LLC the option to "opt out" of unavoidable constraints flowing out of the

126. Baron & Spulber, *supra* note 118.
127. UPDEGROVE, *supra* note 109, at ch. 6.
128. UPDEGROVE, *supra* note 109.
129. UPDEGROVE, *supra* note 109, at ch. 6.
130. *Id.*
131. *Id.*

membership of corporations, on the other, it necessitates the provision of much more comprehensive documentation for the accomplishment of similar results. The LLC model is usually resorted to only in cases where an important objective cannot be fulfilled through the classic corporate structure.[132]

3. A Semi-Autonomous Entity

Usually standard-setting activities take place in SSOs, however, at times smaller standard-setting initiatives do not end up being a part of the bigger SSO structure and are rather, hosted by an SSO, allowing them to make the most of advantages accorded to an incorporated entity without actually taking any steps towards incorporation. While most of the administrative and allied services are offered by the host SSO for a nominal fee, the bylaws and IPR policy are adopted by the hosted SSO on its own.[133] This entire structure acts as a middle ground between an independent entity and the working group of an SSO, more like a hybrid structure, wherein it is dependent on the host SSO for administrative and infrastructural requirements but in terms of its governance, it is largely autonomous, just like an independent entity.[134] In addition to being provided a corporate liability shield and being exempted from any kind of tax liability, the advantage of having such a model in place is that it allows new initiatives to take off quickly. On the other hand, the disadvantage associated with the hosting arrangement lies in the high costs of investment in relation to the services rendered.[135] That being said, the host SSOs provide a great amount of assistance to the smaller initiatives in becoming incorporated.

4. A Non-Incorporated Entity

The last of the four models open to a standards organization is a non-incorporated entity. A non-incorporated entity may be further categorized into "muddle along" and "documented." As compared to the traditional, more determined standard-setting efforts, the "muddle along" initiatives, being modest, are limited in scale and ambition, with them usually being promotional or educational in nature.[136] In case of the initiative gaining continuity, the non-documented entity becomes documented or gets converted into an incorporation, sans a liability shield. The non-incorporated model is a popular choice for many small consortia of companies wishing to create standards, involving specifications likely to infringe upon patents owned by members of the consortia.[137]

132. *Id.*
133. *Id.*
134. *Id.*
135. *Id.*
136. *Id.*
137. *Id.*

This model follows the "promoter-adopter" structure, with the core members entering into a promoter agreement for the use of a specification contributed by other members or for the purpose of jointly creating a specification required by a new product on grounds of interoperability. Third parties get the implementation rights to the specification via an adopter agreement. The "promoter-adopter" model is mostly adopted by companies with large patent portfolios,[138] but despite its popularity, one of the major disadvantages of this model is the lack of certainty in terms of legal enforceability, as compared to the corporate structure, since all the terms are required to be legally interpreted on merit. Irrespective of how the operative agreement in a non-incorporated consortium is worded, for the purposes of liability, the arrangement might be treated as a partnership under the applicable law, with the members being held jointly liable not only vis-à-vis the debts or organizational actions but also for the acts of members acting in the capacity of representatives of the organization.[139]

The IEEE and the ETSI are examples of classic corporations, established with a *not-for-profit* purpose. While the former is incorporated under the New York Not-For-Profit Corporation Law,[140] the latter is incorporated as an association under French Law.[141] On the other hand, the Indian SSO contributing to the development of telecommunication standards, the Telecommunications Standards Development Society, India (TSDSI), is a "not-for-profit" autonomous organization in Public–Private Partnership (PPP) mode, registered as a society under the Indian Societies Registration Act XXI of 1860.[142] Well-established SSOs might also come together in order to give effect to a partnership project, such as the 3GPP, which was a collaborative agreement meant for producing the Third Generation Mobile System specifications.[143] Generally speaking, SSOs do not engage themselves in any high-risk activities but that may not be true in cases where majority of the market competitors are members of the same SSO, thereby attracting higher scrutiny by competition agencies. In such situations, there might be resistance on the part of SSO members in taking any front-line liability on behalf of the organization or their fellow members, leading to the corporate model being preferred over the non-incorporated ones.[144]

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138. *Id.*

139. *Id.*

140. *IEEE Governing Documents*, INST. ELEC. & ELECS. ENG'RS, https://www.ieee.org/about/corporate/governance/index.html (last visited Dec. 5, 2017).

141. *About ETSI*, EUR. TELECOMM. STANDARDS INST., https://www.etsi.org/about (last visited Dec. 5, 2017).

142. *About TSDSI*, TELECOMMS. STANDARDS DEV. SOC'Y INDIA, https://tsdsi.in/about (last visited Dec. 5, 2017).

143. *Third Generation Partnership Project Agreement*, THIRD GENERATION P'SHIP PROJECT (Dec. 4, 1998), http://www.3gpp.org/ftp/Inbox/2008_web_files/3gppagre.pdf.

144. UPDEGROVE, *supra* note 109, at ch. 6.

IV. THE STANDARDS DEVELOPMENT PROCESS

In a world of rapid globalization, technical standards have led to a major transformation in the ICT sector, spearheaded by mobile telecommunications and the Internet.[145] Standards facilitate not just product interoperability but also foster innovation and competition,[146] which necessitates focusing on the standards development process.[147] The process of standards development or standardization involves consensus-based development and implementation of specifications, taking into account the views of various stakeholders such as firms, users, governments and other interest groups.[148] Standards may be developed by organizations operating at national, regional or international levels.[149] Although standards may emerge through other means as well, the focus of the present paper shall be on standards developed by SSOs or SDOs.

SSOs facilitate the process of developing standards, while maintaining strict adherence to fair and equitable processes, so as to ensure output of the highest quality as well as maintaining the relevance of standards in the market.[150] Typically, SSOs comprise of a diverse membership, which includes commercial entities (both technology contributors and technology implementers), the government, universities, and individuals.[151] The standards promulgated by such SSOs are through joint action of the required majority[152] and often in response to market-driven priorities determined by private or public membership.[153] Furthermore, in order to lend integrity to the process of standards development, every SSO comprises of Boards, Committees and staff involved in the establishment and maintenance of policies, procedures and guidelines[154] governing the participation of SSO members in the standards development process.[155] While almost all SSOs share similar goals, however,

145. Tsilikas, *supra* note 2.

146. Damien Geradin, *Moving Away from High-Level Theories: A Market-Driven Analysis of FRAND in the Context of Standardization*, ANTITRUST BULL. (forthcoming 2014) (manuscript at 1).

147. Olia Kanevskaia*, Disciplining Standard-Setting: Which Approach to Choose (If Any)?* 1 (Tilberg Law & Econ. Ctr., Discussion Paper No. 2017–036, 2017).

148. Zongjie Xie et al., *Standardization Efforts: The Relationship Between Knowledge Dimensions, Search Processes and Innovation Outcomes*, 48 TECHNOVATION 69, 69 (2016).

149. Bart Brusse & Rigo Wenning, *How Do Standardization Processes Work*, Cooperation Platform Research & Standards, https://www.w3.org/2004/copras/docu/faq/faq05.html (last updated Jan. 15, 2007)..

150. *Develop Standards*, INST. ELEC. & ELECS. ENG'RS STANDARDS ASS'N, https://standards.ieee.org/develop/process.html (last visited Oct. 16, 2017).

151. UPDEGROVE, *supra* note 109, at ch. 2.

152. Raymond T. Nimmer, *Technical Standards Setting Organizations and Competition: A Case for Deference to the Market* 17 (Wash. Legal Found., Working Paper No. 155, 2008).

153. INT'L TELECOMM. UNION, *supra* note 84, at 19.

154. *Develop Standards*, *supra* note 150.

155. INT'L TELECOMM. UNION, *supra* note 84, at 19.

the rules, processes, and terminology applied by every SSO to the process of standards development may vary.[156] In order to bring out the differences between the standards development process in the U.S. and the European Union, it will be worthwhile to study the development of standards at two of the biggest and the most prominent SSOs in the world—the IEEE and the ETSI.[157]

A. The IEEE Model

If one has a look at the standards development process at IEEE, what triggers the development of a new standard is usually a formal request, put in by a sponsoring body (which is either an individual or an entity), for the purpose of review and evaluation, and the entire responsibility for the development of such a standard as well as the organization of the standards development team rests on the sponsor. Once the request for a new standards development project is approved by the SSO, the next step requires the sponsor to put together a team of individuals, popularly known as a "Working Group."[158] The main task of Working Groups is to remain actively involved in the development of standards. Working Groups might be addressed differently across SSOs and are composed of individuals or entities (companies, universities, governmental or non-governmental agencies) volunteering to support the standards development process.[159] As stakeholders, members of the Working Groups retain an interest in specific areas of standards development and elect Working Group officers to oversee the concerned standards development project, in line with the rules and processes of the SSO. The rules established by the standards body allow dedicated participants to make significant contributions at various levels to the standards development process, while also ensuring no single interest becomes dominant. In order to build consensus democratically and examine and review data, participants involved in the standards development process engage in active discussions, debates, and meetings.[160] These discussions and deliberations culminate into a draft standard, which then undergoes multiple revisions. In the IEEE, once the Working Group finalizes and approves a standard, it is then submitted for Sponsor balloting to the Sponsor. On achieving the Sponsor ballot, the draft standard is forwarded to the Review Committee (RevCom) for carrying out its review. Post review, the draft standard is submitted to the Standards Board for the final approval. Upon being approved by the Standards Board, the approved standard is finally published and made available for

156. *Develop Standards*, *supra* note 150.
157. While the IEEE operates in the U.S., the ETSI plies its trade in Europe.
158. The IEEE uses the term "Working Group" in common parlance.
159. *Develop Standards*, *supra* note 150.
160. *Id.*

purchase at various outlets (inclusive of the SSO itself).[161] Standards thus published, are referred to as specifications.[162]

B. The ETSI Model

The standards development process at ETSI is wholly based on consensus,[163] for it is essential to reconcile the diverse interests of its members.[164] At times, there may also be constraints imposed on the standards body by the European Commission mandates. There are different stages to the process of standards development at ETSI. Any good standard, to begin with, hinges on the preparation of a well-written Work Item proposal, so as to provide a strong and clear platform for the standard development to take place. The Work Item proposal is followed by the development of a draft standard and validation of the draft. It is essential to have a document describing the requirements of the standard in clear, unambiguous, and accurate terms, as well as the possibility of testing every requirement included in the description. The document then goes through the process of validation, with feedback being provided on deficiencies, inconsistencies, and ambiguities, if any.[165] The validated draft is then submitted for editorial checking, which is undertaken by a Technical Officer of the concerned drafting committee. The Technical Officer holds expertise in the technology to which the standard relates as well as the rules and procedures of ETSI. His expertise is critical to the development of high-quality standards. In addition to the Technical Officer's expertise, there are several centers of expertise present within the ETSI Secretariat, for the purpose of lending out specialist advice in case of need. The validation process is followed by approval and publication of the standard. The approval process varies from standard to standard and it is usually the responsibility of the Technical Officer to ensure the smooth passage of the draft through the different stages of approval.[166] After obtaining the necessary approval, the standard is finally published. Standards, once in use, undergo maintenance and evolution[167] with a constant need to correct defects found post publication of the standard.[168] While IEEE and

161. *Id.*

162. IAN CORDEN ET AL., *supra* note 100, at 8.

163. *Our Operations*, EUR. TELECOMM. STANDARDS INST., https://www.etsi.org/about/our-operations (last visited Nov. 9, 2017).

164. *A Guide to Writing World Class Standards*, EUR. TELECOMM. STANDARDS INST. 8 (2013), https://www.etsi.org/images/files/Brochures/AGuideToWritingWorldClassStandards.pdf (last visited Nov. 10, 2017).

165. *Id.*

166. *Id.* at 10.

167. *Id.*

168. *Id.*

ETSI might differ in terms of the standards development process, they continue to maintain their status as two of the strongest SSOs in the world.[169]

Although IEEE and ETSI operate in three different jurisdictions, the standards development activities in each of these organizations is based on consensus, fairness, and transparency.

V. CHALLENGES ASSOCIATED WITH STANDARD-SETTING AND STANDARD-SETTING ORGANIZATIONS

The rapid development and growth of competition in today's digital economy is in many ways attributable to the contribution made by SSOs and the standards adopted under their umbrella.[170] Despite their contribution, voluntary standards have, over the course of the last decade,[171] not only attracted scrutiny from government regulators and policy makers,[172] but also have been at the center of significant private litigation[173] involving technology makers and technology users, with the former looking to maximize returns on their R&D investments and the latter seeking access to the technology on terms that are fairly reasonable.[174] Some of major challenges arising out of standardization are discussed in the following subsections of the paper.

A. Patent Hold-Up

As discussed earlier in the paper, most SSOs require their members to license patents essential to the implementation of the standard, on FRAND terms. But once technology involving patents is locked into a standard and investments towards the development of standard-complaint products have been made, working around the technology, or switching over to an alternative may become difficult for the technology implementers, leading to an increase in the bargaining power of the SEP holders.[175] The collective interest of the standards implementers gives way to the private interest of the SEP holders[176] and there is a potential likelihood of the latter being able to exploit its position to extract more favorable rate of royalties ex post standardization,[177] due to the vagueness

169. *Id.* at 8; *Develop Standards*, *supra* note 150.

170. Geradin, *supra* note 18, at 81–2.

171. Contreras, *supra* note 59.

172. Gupta, *supra* note 20.

173. Contreras, *supra* note 59.

174. *See* Pierre Larouche & Geertrui Van Overwalle, *Interoperability Standards, Patents and Competition Policy*, in THE LAW, ECONOMICS AND POLITICS OF INTERNATIONAL STANDARDISATION 367 (Panagiotis Delimatsis ed., 2015).

175. Geradin, *supra* note 18, at 82.

176. Larouche & Overwalle, *supra* note 173.

177. Geradin, *supra* note 18, at 82.

of FRAND terms.[178] This phenomenon is commonly referred to as "patent hold-up" and has led to calls for a more precise definition of FRAND in the IPR policies of SSOs.[179] Another area of contention has been the theory and empirical evidence of "hold-up" being at odds with each other, due to there being almost no empirical evidence of hold-up, since the very inception of the term in the context of standardization.[180]

B. Patent Hold-Out

Based on the above discussion, one would be led into assuming that the entire bargaining power is concentrated in the hands of technology developers, with none lying with the technology implementers.[181] However, there is also a possibility of opportunistic conduct on behalf of technology implementers in the forms of *reverse hold-up* or *hold-out*. "Reverse hold-up" or "hold-out" situations arise on the refusal of technology implementers to pay royalties to SEP holders at a reasonable rate,[182] after the standard has been set and significant R&D costs have been incurred by the SEP holders.[183] Since it is obligatory on the part of licensors to charge royalties based on FRAND terms, even on successful litigation by the SEP holders, the maximum royalties recovered from licensees are, what they would have paid to the licensors in the first place, had they not indulged in hold-out. In such a scenario, one would like to believe there is a significant incentive for technology implementers to hold-out and refuse to pay royalties to the SEP holders and such behavior has been duly recognized by antitrust agencies globally.[184]

C. Royalty Stacking

While "patent hold-up" is mostly restricted to situations involving the assertion of a single patent against a particular product, royalty stacking, on the other hand, is likely to take place when there are multiple patents reading on a single product, requiring a technology implementer to pay royalties to two or more patent holders.[185] The resultant aggregate royalty rate can be considerably high for the manufacturer of the end product.[186] It has been argued that royalty

178. Tsai & Wright, *supra* note 7, at 162.

179. Tsai & Wright, *supra* note 7, at 163.

180. Gupta, *supra* note 20.

181. *Id.*

182. Contreras, *supra* note 59, at 93.

183. Gupta, *supra* note 20, at 8.

184. Contreras, *supra* note 59, at 93.

185. Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991, 1993 (2010).

186. OECD Directorate, *supra* note 58, at 11.

stacking is a direct manifestation of the Cournot–Complements Model,[187] with the necessary inputs to production being controlled by different firms[188] acting in a non-cooperative manner and charging excessively for the bundle of inputs, as compared to a single monopolist.[189] Furthermore, royalty stacking is said to slow down introduction of new products, hike the prices paid by consumers, and even jeopardize innovation, leading to the possibility of a market collapse,[190] although there is disagreement among commentators on the impact of royalty stacking on innovation and prices in the ICT sector.[191] Another line of argument proceeds on there being a likelihood of patent hold-up on a bigger scale due to the introduction of multiple patent holders possessing the power of holding-up.[192] Yet, there are researchers downplaying royalty stacking as a significant issue, in the absence of any empirical evidence.[193]

D. Patent Ambush

Another inherent risk associated with SSOs is that of patent ambush and typically arises on the failure of an SSO participant to disclose information[194] pertaining to a patent relevant to the development of an industry standard, from other SSO members,[195] allowing the patented technology of the participant to be in incorporated in the standard adopted by the SSO.[196] On the standard being set, the patent holder goes on to assert his patent against the implementers, who by now have become "locked in" to the standard and have incurred considerable expenditure on the manufacturing of standard-compliant products, leaving the patent holder in an economically advantageous position.[197] In order to combat the issue of patent ambush, SSOs have in place, specific rules in the form of IPR policies, governing the conduct of SSO members during the setting of a new standard.[198] IPR policies of SSOs make it mandatory for owners of patents

187. Alexander Galetovic & Kirti Gupta, *Royalty Stacking and Standard Essential Patents: Theory and Evidence from the World Mobile Wireless Industry* 2 (Stanford Univ. Hoover Inst. IP2 Working Paper Grp., Paper No. 15012, 2016).

188. Jorge L. Contreras, *Aggregated Royalties for Top-Down FRAND Determinations: Revisiting* Joint Negotiation, 62 ANTITRUST BULL., no. 4, 690, 691 (2017).

189. Galetovic & Gupta, *supra* note 186.

190. *Id.*

191. Contreras, *supra* note 187.

192. Contreras, *supra* note 59, at 93.

193. Contreras, *supra* note 187.

194. M. Sean Royall, Amanda Tessar & Adam Di Vicenzo, *Deterring* Patent Ambush *in Standard Setting: Lessons from* Rambus *and* Qualcomm, 23 ANTITRUST, no. 3, 34, 34 (2009).

195. Larouche & Overwalle, *supra* note 173.

196. Royall, Tessar & Vicenzo, *supra* note 193.

197. *Id.*

198. *What is a Patent Ambush?*, SMIT & VAN WYK, http://www.svw.co.za/what-is-a-patent-ambush (last visited Dec. 21, 2017).

to disclose all patents reading on the standard being developed, prior to the patented technology being included in the standard.[199] Once the standard is set and the aforementioned patent has become an SEP, patent holders are required to license their patents on FRAND terms.[200] Patent ambush has, over the years, attracted significant scrutiny by competition authorities.

VI. CONCLUSION

From railway gauges to the most recent 5G technology, standards have come a long way in the past century and a half. Under the umbrella of SSOs, collaborative standard-setting has remodeled itself into an indomitable force in the innovation landscape, with standards acting as building blocks, fundamental in facilitating product compatibility and interoperability.[201] However, the success of any SSO or the standards coming through its ranks is largely governed by the care and caution exercised in structuring it from its very inception.[202] Whether it is a classic corporation or one with limited liability, an SSO must provide an effective platform supporting standardization activities, rather than impeding them.[203] Since the standard-setting process at SSOs involves participants from competing industries coming together to select interoperable technical standards,[204] there is an inherent risk of collusion on the part of certain market players in using the standardization process to drive their rivals out of the market.[205] Furthermore, technology included in standards is often the subject of patents,[206] thereby affording patent holders the opportunity to abuse the standardization process and assert their patents covering standardized technology, over implementers of such technology, and in the process, attracting scrutiny by competition agencies.[207] Despite the SSOs requiring patent holders to license their technologies on FRAND terms, competition concerns have arisen time and again, with patent holders likely to indulge in activities such as *hold-up*, royalty stacking and patent ambush, while at the same time, having to face the likelihood of *hold-out* from the implementers.

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199. Larouche & Overwalle, *supra* note 173.

200. Royall, Tessar & Vicenzo, *supra* note 193.

201. *What are Standards? Why are they Important?*, INST. ELEC. & ELECS. ENG'RS STANDARDS ASS'N BEYOND STANDARDS (Oct. 3, 2011), https://beyondstandards.ieee.org/general-news/what-are-standards-why-are-they-important.

202. UPDEGROVE, *supra* note 109, at ch. 6.

203. *Id.*

204. Curran, *supra* note 9, at 983–1009.

205. OECD*, supra* note 6.

206. Wong-Ervin & Wright, *supra* note 21, at 16–48.

207. Jorge L. Contreras, *From Private Ordering to Public Law: The Legal Frameworks Governing Standards-Essential Patents*, 30 HARV. J. L. & TECH. 211, 211–212 (2017).

Although collaborative standard-setting runs the risk of antitrust violation, the role of SSOs in driving technological innovation has been duly recognized by antitrust agencies.[208] Having said that, the task of balancing the varied interests of stakeholders is entrusted upon SSOs, which necessitates the creation of internal IPR policies. These policies are the focal point of all the standardization activity taking place in SSOs and play a key role in incentivizing the development of new technologies.[209] With changing standards, the SSOs also end up amending their IPR policies from time to time. Sometimes, these IPR policy amendments might come in the way of standardization and cause the standardization process to slow down, while on other occasions, they might run the risk of attracting antitrust scrutiny. In the era of highly complex telecommunications industries, various viewpoints have been put forward vis-à-vis IPR policies of SSOs, without any consensus being achieved. Since IPR policy changes have the potential of a ripple effect across innovation circles, it is essential to analyze these changes at a microscopic level.

208. Curran, *supra* note 9, at 983–1009.

209. Mark A. Lemley, *Intellectual Property Rights and Standard-Setting Organizations*, 90 CAL. L. REV., no. 6, 1889, 1893 (2002).