Working Paper Series No. 21

Maintaining Ecosystem Innovation by Rewarding Technology Developers: FRAND, *Ex Ante* Rates and Inherent Value

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24 April 2017

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ABSTRACT

Proposals for setting fair, reasonable, and non-discriminatory (FRAND) licensing rates include the *ex ante* and inherent value methods. These set rates that might be agreed before standards adoption based only on the "inherent" contribution of the technology, typically compared to alternatives. Proponents argue that after standardization, rates may reflect unearned bargaining power due to "hold-up." Although these methods have been accepted in several quarters, we believe this is unwarranted, as they fail two basic requirements for reasonable royalties: (a) they do not reflect the full contribution of the IP to the value of the relevant products including standardization, belittling the value of the technology; and (b) they have little resemblance to how technology is developed and standardized in the real world. In attempting to avoid alleged hold-up, these methods exclude technology developers from sharing adequately in the benefits of standardization, a primary object for developing technology. This undercompensates developers and distorts incentives for innovation. In fact, core technology is developed and standardized collaboratively; benefits are expected to be shared, and the technology would not be developed otherwise. In addition, the methods provide little practical guidance for market-relevant rates, which even proponents admit. Advocates have never explained convincingly why the current system for development, standardization, and licensing needs to be changed, given these industries' outstanding economic performance.

We are concerned that despite these weaknesses, the methods may increasingly be adopted as benchmarks for FRAND royalties in courts and standards setting organizations (SSOs). *Ex ante*/inherent value proponents need to explain why the full benefits from standardization should not be shared equitably between all participants in the industry rather than captured primarily by implementers. They also need to provide evidence that there is a need for change. We propose modifications to the *ex ante*/inherent value framework for a more economically effective approach.[2]

[2] Draft Paper. Please do not cite without express permission from the authors. Comment are welcome.

1. INTRODUCTION

In the past few years, there has been increased interest in court-adjudicated fair, reasonable, and non-discriminatory (FRAND) rates as benchmarks for damages and antitrust analysis in standards-related industries such as mobile phones and other information and communications technology (ICT) industries.[3] Courts, antitrust agencies, legislators, corporations, academics, and standards setting organizations (SSOs) have questioned the conditions under which holders of standards essential patents (SEPs) should be able to seek injunctions for patents subject to FRAND commitments.[4] This has followed concerns that higher bargaining power after standards adoption might allow SEP owners to impose excessive licensing terms, reflecting the switching costs of adopters rather than the intrinsic contribution of the technology. A theory behind these changes is that FRAND may be seen as a commitment by the developers of standards essential technology to make their SEPs available for all to practice the standard, implicitly not to seek injunctions and to accept compensation on FRAND terms. Otherwise it is claimed that SEP owners may "hold-up" adopters who have sunk investments in the standard and demand excessive rates and other conditions.[5]

The conditions under which a SEP owner may seek injunctions, and the possible impact of any changes in the ability of the patent owner to enforce its patent rights and close licensing agreements, are important issues and justify being addressed separately.[6] However, a main consequence of these changes has been to bring court/arbitration-determined FRAND rates and the guidelines they use more centrally into the issue.[7] Yet the basis FRAND rates should be set is controversial. It is often alleged that that FRAND is not sufficiently defined to provide adequate guidance for licensing negotiations.[8] This applies to the principles on which FRAND may be determined, as well as its practical implementation.

A result is that for the courts and competition policy, there may be a vacuum—or at least

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[3] In standards setting, owners of standards essential patents (SEPs) are typically required to declare potential IP and commit to license this on FRAND conditions, before the relevant technology can be adopted in a standard (e.g., ETSI, ITU IP policies).

[4] See discussion below. For example, FTC Google undertaking (2013), EC settlement with Samsung and Motorola (2013). In the US, conditions for granting injunctions have reflected the *eBay v. MercExchange* 2006 Supreme Court decision.

[5] For summaries, see US DOJ & FTC (2007); FTC (2011b); Ramirez & Kimmel (2011); US DOJ & USPTO (2013); Sidak (2013); Bekkers (2013). *Ex ante*/inherent value proponents argue that once a standard is widely adopted, SEP owners may be able to extract more than the economic contribution of their patents due to adopters' switching costs and impose rates or terms inconsistent with FRAND. Potential switching costs of trying to avoid using SEPs include loss of access to the main standards network, incompatibility with complementary products, applications and services, changeover costs, and the difficulty of coordinating an alternative standard. The option of avoiding using the SEPs may not be economically feasible.

[6] E.g., Hovenkamp & Cotter (2014).

[7] We leave aside the question of whether court or other agencies may be qualified to decide licensing terms on a "routine" basis; licensing typically depends on complex influences according to individual circumstances and may best be left to market negotiations.

[8] E.g., FTC (2011), p 22; Contreras (2011), p 3; EC DG Enterprise and Industry (2014), p 184–189; http://consultation.cabinetoffice.gov.uk/openstandards/comments/8/5; Geradin (2014), p 919.

a lack of clarity—in how to set FRAND royalty rates. Our concern is that courts may be tempted to take a one-size-fits-all and incomplete approach. In some cases, the courts are adopting *ex ante*, inherent value, or similar approaches. In various forms, these seek to identify the underlying or "inherent" contribution of a technology to product value pre-standardization separate from any additional value or bargaining power resulting from being adopted in a standard, termed "hold-up." A patent owner may claim no more than a share of "inherent" value.

The central problem here is *what is meant by "inherent" value?* Despite seeming simple, the definition has not been made clear and needs to be questioned further. The *ex ante*/inherent value approaches take the normative view that rates should only reflect the direct contribution of the patented technology to product value, such as cost savings or increased product attractiveness. They exclude the impact of additional licensing value after adoption of the technology in a standard, whether due to increased bargaining power or standardization/network effects.[9] The inherent value method defines the problem away; *ex ante* bypasses it by stipulating terms that might be agreed if licensing took place before standards are agreed and technologies (assumed already developed!) are posited to compete on price for adoption (e.g., by auction). Both usually set rates via the "incremental" value compared to the next best alternative, often but not always "non-infringing." Proponents may attempt to justify this by claiming that standardization benefits are the result of a collaborative process and that no share should be captured by the SEP owner; any higher rate might award the developer more than the economic contribution of its technology, raising product prices and restricting use. They also sometimes claim that much standards essential technology has little inherent value and can only seek high royalties due to its adoption in the standard.

By contrast, we believe the "inherent" value of the technology should be based on a share of its full contribution to product value.[10] This coincides with ideas of economic efficiency that require that potential returns to investments in R&D should reflect the full value contribution of resulting inventions. This necessarily includes a share of network effects in addition to pre-standardization value.[11] If we are to use the term "inherent value," this should be defined as a share of the full-value contribution of the SEP technology as designed for and used in standards. In economic terms, this correctly aligns private returns to innovation to the full social contribution of products and services dependent on it, if the standard is successful. Without full returns, firms may have inadequate incentives to innovate or participate in standardization, and too few of society's resources may be devoted to

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[9] Network effects increase the value of products used in networks enabled by compatibility standards. Benefits of standardization include the interoperability of products from different manufacturers (more people to call and cheaper devices due to larger markets and competition between manufacturers), wider availability of complementary goods and services (cheaper components and services due to economies of scale and competition between suppliers), and flexibility to mix-and-match devices from different sources (greater variety and customization). See Farrell & Saloner (1985); Grindley (1995).

[10] A view shared by some commentators, though apparently still a minority. See Siebrasse & Cotter (2014, 2017); Sidak (2013, 2016b); Mariniello (2011), discussed below.

[11] In theory, full contribution extends to further products downstream and services dependent on them; this would depend on the licensing strategy, patent exhaustion issues, and so on.

development.[12]

We see these considerations in action in how firms develop technology for standards in the real world and actual SSO standardization processes.[13] The *ex ante*/inherent value methods do not reflect the realities of how core technology is developed and standardized. Developers typically consider three factors in making R&D investments: the cost to develop the technology, the likely impact on the total market as a result of their technology, and the firm's potential share of the total available earnings. For network technologies, this includes standardization as an integral part of the development effort and the available market. Returns also need to allow for the risk that some technologies will not be successful. These concerns may lie behind the SSOs' emphasis on a balance of returns between developers and implementers in the (two-way) FRAND commitment.[14]

A wider understanding of real-world SSO standards setting in technologically progressive industries such as ICT is vital for FRAND analysis. Standards setting is a collaborative process. Members accept the need for a balance of investments and returns among all parties. This permeates the FRAND commitment and the acceptance of that by all SSO members. In practice, standards are led by a relatively small number of key developers that make high investments in R&D and standardization in the hope that their technologies will be adopted in standards. If included, and if the standard is commercially successful, developers expect to share in the full value created. Standards are usually "anticipative" and set the direction for new technology before it is fully developed. Development continues throughout the standardization process and in standards enhancements over several years. This is light years away from the "off-the-shelf" Bertrand competition on price for adoption between technologies with sunk R&D costs that is central to the *ex ante*/inherent value methods.

As a practical matter, even proponents admit that the methods provide little guidance for negotiating market-relevant rates. It is unrealistic to believe that *ex ante*/inherent rates might be set before technologies are developed, complementary technologies are developed, standards are defined, products using the standards appear on the market, and issues of validity and infringement are clear. In some cases, for strategic reasons, firms may be prepared to commit to rates for their intellectual property before standards are set, or there may be established rates for the IP in previous applications. Normal industry practice is to negotiate rates once

[12] This also reduces the SEPs' value as "bargaining chips" in cross-licensing.
[13] In practice, we prefer the term standards development organization (SDO) to SSO to refer to the kinds of standards organizations typically involved in ICT. The terms SSO and SDO are often used interchangeably. But from an economics and resource allocation perspective, there are important differences between "setting standards" and "developing standards." In particular, significant R&D investment may be needed to advance the technology that is being standardized, and the developmental aspects of standardization may be critical. For this paper, we will not make this distinction here, so as not to distract from the exposition or anticipate the discussion. It belongs in the conclusion that incentivizing development is a main purpose of standardization processes and should be reflected in the returns firms may hope to earn from their innovations and in our approach to standards organizations. See Teece & Sherry (2016).
[14] See ETSI IP policy, etc.

products are developed, revenue prospects are known, and likely infringement is clear.

Real licensing negotiations also have many other factors to consider beyond the potentially higher leverage a developer may have if its technology is adopted in a standard.[15] These are issues that firms are used to dealing with in standardization and accept as part of the FRAND commitment. In practice, both licenses and licensors tend to wait until products are developed before seeking licenses. If implementers are especially concerned that a SEP owner may exploit its bargaining power later on, they have the alternative to privately negotiate licenses or a commitment before adopting the technology. Most do not do so, presumably due to the informational and practical problems of negotiating terms before knowing the market performance of the products, the strength of the IP, and the likelihood of actual infringement.[16]

Most generally, we also question what evidence there is that the current system of technology development, standardization, and IP licensing needs to be changed, given the ICT industries' outstanding record of innovation, growth, competition, and economic performance.

The motivation for *ex ante*/inherent value proponents to exclude developers from sharing the full benefits from standardization is not clear. The focus seems to be on reducing prices paid for existing technology and possibly passed on to consumers, without considering the need to develop the technology in the first place. These methods often result in low rates and allow the bulk of the surplus to be appropriated by downstream implementers, such as some device manufacturers, with possible pass-through to operators, services, and consumers. *Ex ante* proponents claim that SEP owners benefit from having their technologies adopted in the standard, which may give a competitive edge in the product market, and the increased unit sales on which to earn royalties. If the technology developer is not involved in the downstream product market, it can only earn a return by licensing. For royalties, higher unit sales are not the same as having rates determined under market conditions considering the technologies' full contribution, in which royalty rates, product prices, and volumes are considered jointly. No volumes can compensate for unreasonably low *ex ante* rates.

The *ex ante*/inherent value methods may reflect a particular view of the risks and returns to standards developers and implementers. When adopting a technology into a standard, potential licensees usually wait to license *ex post*, when the value of the

[15] Padilla (2014) argues that royalty rates for SEPs depend on the balance of several options and threats in licensing negotiations, of which the availability of injunctions may be one. Injunctions for SEPs "may or may not" lead to excessive rates but considers this may be a "theoretical concern with no empirical support."

[16] Full contribution rates are similar to what may be negotiated *ex post*, after standards and products are introduced in the marketplace and with full knowledge of on the contribution to actual products, patent strength, etc. There is no reason it might not be conducted at other times, before standardization, provided rates consider the full-value contribution possibly with suitable discounting for pre-standardization uncertainty or made contingent use in a successful standard.

IP and its actual infringement are better known, and accept the risk of greater bargaining power *ex post* by the SEP owner. If licensees believe that *ex post* rates might be too high, or can get a better deal by in-licensing early, they may privately negotiate a rate *ex ante* or risk paying for a license that will not be needed. *Ex ante* proponents appear to believe that the risk of *ex post* exploitation dominates and that no standardization increment is acceptable, whether due to bargaining power or network effects—on a "slippery slope" argument that allowing any standardization value opens the infringer to potential exploitation. But this only considers licensee risks.[17]

In Section 2 of this paper, we describe the main features of the *ex ante*/inherent value approaches and examine their main implications for FRAND licensing rates. We outline some of our main concerns with these methods and other criticism in the literature. In Section 3, we consider a framework for determining FRAND rates that would give developers the opportunity to claim an appropriate share in the "gains from trade" (GFT) from standardization. We argue that context-dependent value should include standardization. We review possible modifications to the *ex ante*/inherent value approaches that may provide a route for bringing them more in line with real-world practice. In Section 4, we outline the main features of SSO practice, based on the processes in 3GPP, the global mobile communications standards organization. In Section 5, we briefly summarize the performance of the mobile communications industries over the past few decades, referring to other studies.

In Section 6, we draw some conclusions. Contrary to what has become almost a "given" in some FRAND debates, we believe the existing *ex ante*/inherent value approaches are of little help as a guide to rates. Our concerns are that they do not allow technology developers to share equitably in the benefits from standardization, may distort incentives for technology innovation, and misrepresent how standards technology is developed and standardized in practice. They provide no real-world guidance for market-relevant rates. We also question the assumption that the system needs changing given the outstanding economic performance of ICT industries. *Ex ante*/inherent value proponents need to provide factual evidence that the system is not working and that the proposed methods would promote rather than harm economic performance. All participants in the industry should share equitably in the benefits of innovation and standardization. We propose modifications to the *ex ante*/inherent value framework to incorporate the expected full value of standards products into hypothetical licensing negotiations whenever these take place.

2. *EX ANTE* AND INHERENT VALUE APPROACHES TO FRAND

2.1 *Ex ante*/inherent value proposals

The *ex ante* and inherent value approaches address a theoretical concern that SEP owners may be able to charge excessive rates for licensing their technologies after

[17] The countervailing "hold-out" risks by infringers are often ignored. See Lichtman (2006); Wright (2013); Cotter (2014); Contreras & Gilbert (2015); and others.

standardization, above their economic contribution, due to so-called "hold-up." These approaches are not generally seen in actual licensing or included in SSO IP policies. Nevertheless, they have a significant following among some academics and practitioners and have been a feature of competition policy proposals by antitrust regulators for several years, especially in the United States. They have gained some traction in recent court rulings in the US and to some extent by competition regulators and courts in Europe and the rest of the world.

In most jurisdictions, courts are increasingly unwilling to grant injunctions on FRAND-committed SEPs where there is a "willing licensee" and where the remedy for infringement will be defined via FRAND damages.[18] This has been called the "injunction revolution."[19] Under pressure from regulators, some SEP owners have made voluntary undertakings not to assert SEPs (or to seek injunctive relief or its equivalent in the form of exclusion orders) and will rely on the courts or arbitration to decide a FRAND rate, unless the infringer is clearly not prepared to negotiate a FRAND license or is asserting SEPs against the licensor, in which case defensive assertion may be pursued.[20] In February 2015, the Institute of Electrical and Electronics Engineers (IEEE), a major worldwide organization that sets wireless standards such as Wi-Fi and WiMax, updated its standards IP policy to require participants to commit to rules governing FRAND licensing, including adopting *ex ante* rates for any essential technology they own to exclude benefits from "the inclusion of the technology of an essential patent claim in a standard of the IEEE."[21] A main upshot of these changes has been to place greater focus on FRAND damages as the likely remedy for infringement.[22]

Two main US case rulings have set FRAND rates using *ex ante*/inherent value-friendly

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[18] AIIPI (2014)

[19] Hines (2013). Injunctions for SEPs have proved more difficult to obtain in the US since the Supreme Court decision in *eBay v Merc Exchange* in 2006, which requires the court to apply a four-factor test before granting an injunction. Cotter (2015). The European Commission issued Statements of Objections in 2013 against Samsung and Motorola, taking the view that "dominant SEP holders should not have recourse to injunctions" since these "may distort licensing negotiations unduly in the SEP-holder's favour." EC (2012, 2013). Announcing the settlement of the Samsung and Motorola investigations, the EC stated: "[If] standard implementers … want to be safe from injunctions based on SEPs by the patent holder, they can demonstrate that they are a willing licensee by agreeing that a court or a mutually agreed arbitrator adjudicates the FRAND terms." EC (2014); Treacy & Hopson (2014).

[20] Decision and Order, In re Google, Docket No. C-4410 (July 23, 2013), Paragraph IV, available at http://ftc.gov/os/caselist/1210120/130724googlemotorolado.pdf ; Samsung preliminary settlement proposal to European Commission, 17 October 2013.

[21] https://www.ieee.org/about/news/2015/8_february_2015.html?WT.mc_id=std_8feb; http://patentlyo.com/patent/2015/02/amends-patent-policy.html. A reasonable royalty should also be based on: "The value that the functionality … contributes to the value of the … smallest saleable Compliant Implementation." IEEE-SA (2015a, 2015b).
6. Patents "A Reasonable Rate does not include value arising from the cost or inability of implementers to switch from the Essential Patent Claim's technology included in the standard." IEEE (2015).

[22] Larson (2014); Davis (2014).

approaches.[23] Other US cases have referred in part to these rulings.[24] Although both rulings eventually used modified methods to determine damages, a common theme was that the SEP owners should receive only the inherent or intrinsic value of the technology, and rates should specifically exclude any increase in rates SEP owners may be able to charge after standardization.[25] This would exclude not just the potential effects of increased licensor bargaining power once a standard is established but also any share of network effects due to standardization.[26] It is asserted that the ability to charge excessive rates is due to hold-up and the methods chosen for valuation aim first to neutralize this potential effect.

In practice, the definition of hold-up is rarely carefully specified and can sometimes be little more than "the ability to charge any price higher than what could be charged *ex ante*, before being adopted in the standard."[27] Some definitions link hold-up theory to infringer switching costs.[28] Proponents of *ex ante*/inherent value approaches have made it clear that in excluding the potential for the patent holder to charge higher prices *ex post*, this also bars the licensor from a share of network effects and indeed other complementarities.[29] Yet there are questions whether hold-up ever occurs in practice. If

[23] Robart (2013); Holderman (2013). These rulings broadly supported the "incremental value" approach outlined in FTC 2011b and similar policy statements, with modifications. Posner (2012) sets out basic arguments for using *ex ante* rates as a starting point for RAND/FRAND and excluding hold-up value, though did not set a rate in that case. These cases are still subject to appeals.

[24] *Ericsson. v. D-Link Systems* (Fed. Cir. 2014) referring to the *Innovatio* and *Microsoft* judgments, also accepted the "the royalty award [should exclude] any value added by the standardization of that technology." In *Realtek, 2014* WL 2738216, the jury instruction informed the jury that it "should not consider LSI's advantage resulting from the standard's adoption, if any." A recent opinion in the UK has differed from the interpretations of FRAND in *Innovatio* and *Ericsson. v. D-Link* that would exclude all value due to standardization from FRAND royalties, discussed below. Whether this might influence future US court cases is unknown.

[25] "From an economic perspective, a RAND commitment should be interpreted to limit a patent holder to a reasonable royalty on the economic value of its patented technology itself, apart from the value associated with incorporation of the patented technology into the standard." Robart (2013), para. 74. "The court's RAND rate therefore must, to the extent possible, reflect only the value of the underlying technology and not the hold-up value of standardization." Holderman (2013), pp 14, 16; "The purpose of the FRAND requirements … is to confine the patentee's royalty demand to the value conferred by the patent itself as distinct from the additional value— the hold-up value—conferred by the patent's being designated as standard-essential." Posner (2012), pp 18, 19.

[26] In some formulations, this may also include other complementarities or synergies from technologies working jointly in systems (as distinguished from network effects due to compatibility).

[27] "'[H]old-up' by a patent owner – a demand for higher royalties or other more-costly or burdensome licensing terms after the standard is implemented than could have been obtained before the standard was chosen." FTC (2011a); DOJ/USPTO (2013), p 3. This can be a circular definition, akin to "hold-up is charging more than *ex ante* rates / *ex ante* rates are rates absent hold-up."

[28] "This higher royalty based on switching costs is called the 'hold-up' value of the patent." FTC (2011b), pp 5, 8; Ramirez & Kimmel (2011), pp 3–5; Farrell & Shapiro (2004), p 29.

[29] "If each user's leading alternative to sticking with the standard is unilateral switching, and thus losing compatibility with others, then the patent holder's subsequent advantage V_P includes not only its technology's inherent advantage and the value of the user's own sunk investments, but also the value of compatibility to the user. … The user will adopt the patented technology as long as the royalty demanded is less than $40, composed of $10 of inherent value and $30 of network effect. … *ex ante* the technology user and the patent holder will not negotiate a royalty above the technology's inherent advantage of $10 in our example." FHSS (2007), p 622.

hold-up really were a significant real-world issue, one might expect to see more evidence of standards or products that have been held up, if only to show that threats are sometimes carried out. The evidence from cellular communications suggests that concerns are more theoretical than actual.[30]

Many hold-up arguments depend on showing deception by the patentee, either by keeping the patent's essentiality secret from the SSO or by not keeping to the FRAND commitment *ex post*.[31] But "deceiving buyers" about potential future royalty terms is not the same thing as "keeping [buyers] in the dark about" such terms. Most SSOs allow patent holders to agree to make licenses for their essential patents available on (unspecified) royalty terms. If the patent holder has affirmatively "deceived" the SSO by promising that it will charge one rate, only to subsequently try to charge a different (higher) rate, that can be handled via general laws about fraudulent conduct; it is not something unique to the standards setting context.

Equally worrying is the lack of a coherent definition of "inherent value." It may be explained simply as the "value [of] the patented technology itself."[32] A leading proposal for identifying inherent value is *ex ante* price competition among alternative technologies for adoption in the standard, leading to the technology's incremental value over the next best (non-infringing) alternative prior to standardization, such as by using an auction.[33] It is contended that *ex post* the SEP owner might use the threat of exclusion from the market to extract a share of licensee switching costs (e.g., the opportunity costs of access to the standards market, as well as actual costs of designing around the SEP), which are claimed to be independent of the SEP technology. *Ex ante* competition would eliminate this. *Ex post* rates are said to be economically inefficient because the SEP technology can claim more than its contribution, which could misalign investment and returns and harm consumers.[34] It is claimed that high rates due to hold-up may harm consumers by raising prices.[35] It is also claimed that in such circumstances, higher technology costs would harm downstream product innovation—though the counter

[30] Microsoft experts in the Microsoft v. Motorola trial in the Western District of Washington before Judge Robart were unable to identify a single SEP license that they believed reflected hold-up driven terms. *Microsoft Corp. v. Motorola, Inc*., No. 10-cv-1823 (W.D. Wash. Nov. 16, 2012) (Testimony of Timothy Simcoe): "[I have] no evidence that the dispute between Motorola and Microsoft in this case is in fact based on hold-up [and] can't nail down any particular license from any company as an example of hold-up"; id. at 135–36 (Testimony of Matthew Lynde): "I have no basis from economic evidence to conclude whether or not patent hold-up is a real problem."

[31] "Oliver Williamson famously described opportunism as 'self-interest seeking with guile.'… [Standards hold-up involves] deceiving buyers or keeping them in the dark about the terms on which a technology will be available [which] subverts the competitive process." FHSS (2007), pp 603–4, 609.

[32] Robart (2013), para. 80.

[33] Robart (2013), paras. 77, 80; Shapiro &Varian (1999), p 241; Swanson & Baumol (2005), p 10; FHSS (2007), p 624; FTC (2011b), p 23.

[34] FHSS (2007), pp 603–4, 611.

[35] DOJ/FTC (2007), p 36. In practice, royalty rates may be a relatively small part of total costs and so may have little impact on overall product demand. Mallinson (2011, 2016); Sidak (2016a).

arguments are rarely applied to upstream technology development.[36]

Some proponents of the *ex ante*/inherent value approaches claim that standardization is a collective choice and the technology developers are not "entitled" to benefit from the increased demand due to standardization.[37] They claim that product value derived from standardization belongs to the implementers and is "outside the control" of the developers, which are therefore not entitled to a share.[38] Some proponents claim that patent holders benefit adequately from the volume of royalty-bearing sales if the technology is included in a standard (the "volume effect") or indirectly if integrated into manufacturing. Yet the SEP owner is not allowed to benefit via higher royalty rates applied to these volumes.[39]

According to the *ex ante* approach, core technology developers should receive rates based only on the technology's intrinsic contribution prior to the standard and would not share in network benefits in the form of higher rates. These arguments seem far from the reality of the industry. We are not aware of any SSO that has explicitly taken such a position in its IPR policies.

2.2 Concerns about *ex ante*/inherent value

a) Shared returns and compensation of development

Appropriate economic incentives for development require that potential returns to innovators should be related to the benefits accruing from the innovation. This is a basis for the patent system, which grants inventors rights over the use of their inventions to provide them an opportunity to earn a return related to the market value of the new products. For standardization, the full benefits include network effects.

The *ex ante*/inherent value approaches undervalue the contribution of SEP technology. By seeking to bar SEP owners from benefitting from increased bargaining power after standardization, these approaches also exclude them from sharing appropriately in network or standardization benefits. Standardization adds value to products and technologies by increasing product demand, reducing costs, raising consumer choice for products and services, and increasing competition within the standard. These are the aims of technology development and standardization. Excluding developers from a fair share of standardization benefits reduces incentives to develop further technology and to participate in standards setting. There is no reason why virtually all these benefits of standardization should accrue to the implementers. A technology owner may benefit in part from increased volume of royalty-bearing sales, but unless the full value is also reflected in the rate

[36] FTC (2011b), p 53.
[37] Patterson (2002), pp 1, 12, 39.
[38] Patterson (2002), pp 1, 8, also cited in DOJ/FTC (2007); Lichtman (2010) describes standardization as a group activity. A patent might claim a limited share of standardization benefits in the specific case that the patent contributes technically to interoperability. Patterson (2002), pp 3, fn 8, 30.
[39] FHSS (2007), p 632, fn. 113. Some go further to claim that lower rates will increase product sales volumes and this may lead to higher royalty amounts overall. Lemley & Shapiro (2013), p 12, fn 44.

this may still be inadequate. Rates and volumes should be considered jointly and based on the full contribution.

Standardization is also a result of cooperative efforts, and developers and other organizations should have an opportunity to earn a share of the results. SSO rules encourage shared returns by stressing collaboration and a balance of interests between developers and implementers. The concept of balanced interests is central to the IP policies of SSOs such as at ETSI, IEEE, and ANSI.[40] Balance is needed not only to provide appropriate investment incentives for developers and implementers but also to ensure their effective collaboration in the standards setting process.[41]

Ex ante/inherent value rates are likely to be small because they exclude a main source of value added to standardized products and may be further limited to the incremental difference in values between two similar technologies. No amount of higher volumes of royalty-bearing sales can compensate the developer for tiny rates to yield a significant royalty amount.[42] The impact is likely to be primarily on the allocation of the surplus value due to standardization, the "gains from trade," between developers and implementers rather than consumers. These may be captured almost entirely by the implementers, with some possible pass-through to consumers.

Part of the justification for *ex ante*/inherent value approaches depends on the implied but unsubstantiated assumption that manufacturers may "pass-through" input cost benefits to consumers. This assumption needs to be systematically examined to see what share of the benefits may be manifested in consumer prices and how long it takes for these effects to work. In some cases, product pricing in smartphones may not be very dependent on input costs, and cost savings may not pass clearly down the value chain. Demand for final products may be relatively insensitive to royalty rates, which are usually a small part of total costs and may not even be passed through to consumer prices. Some smartphone makers have been able to maintain high margins, at least in the intermediate term.[43]

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[40] "ETSI IPR POLICY seeks a balance between the needs of standardization for public use in the field of telecommunications and the rights of the owners of IPRs." ETSI (2013); "SDO's patent policy should be designed to balance: Needs of those implementing a standard [and] Comments of intellectual property owners of technology necessary to implement that standard." Mills (IEEE) (2008), p 6; "The terms and conditions used in the development of 'open standards' should balance the interests of those who will implement the standard with the interests and voluntary cooperation of those who own intellectual property rights that are essential to the standard." ANSI (2013); Marasco (2002).

[41] "Unbalanced IPR Policy: The effect on the standards process … Process becomes confrontational; Participants become frustrated and lose confidence in their peers; Time to reach consensus increases dramatically – In other words, the process breaks down" Mills (IEEE) (2008), p 5.

[42] The volumes of standardized products can be huge—billions of units of royalty-bearing sales versus zero if the technology is not included in major standards. However, with rates of a few cents per unit, the level of some recent court-adjudicated rates in Robart and Holderman, even a billion units in sales will reap a royalty amount of only some tens of millions of dollars, compared to R&D budgets in the billions of dollars per year.

[43] "In just 18 months between October 2010 and March 2012, gross margins on iPhone were between 49 and 58%, an almost unheard of figure for a consumer electronics product." Rogowsky (2013); Kim (2012).

b) Implication that SEPs may have little inherent value

These problems are compounded if SEPs are assumed to have only small inherent value or to cover only a minor feature of a standard. *Ex ante*/inherent value approaches sometimes carry within them an implication that many SEPs are of dubious quality and have licensing power mainly from adoption in a standard, and might otherwise be considered trivial.[44] We disagree. There is no evidence that this is the case for SEP technologies as a whole, which are typically developed at great R&D cost and must undergo a rigorous selection process in the SSOs during standardization based on their contribution to the standard's performance.[45] It is possible that some technologies derive their value largely due to an "arbitrary" choice for the standard, but this cannot be true in general. Individual SEPs are likely to have a wide range of values, like other patents, but their cumulative value is clearly high, shown by the outstanding technical and economic advances of these industries.

For some key technologies, the "inherent" value, if properly and fully recognized, may be substantial even before standardization value is added, particularly when this is combined with higher volumes for standards products. Yet even these technologies become more valuable when used in standards networks. More concerning are technologies that depend on systems to work and may have little value outside the standard. Considering their value ex-standardization may have no meaning. These problems are made worse when only the incremental inherent value between technologies is considered.[46] We believe licensed value should allow for the contribution to the full value of the product used in standards.

c) No practical applications or benchmarks

A further concern is that *ex ante*/inherent value methods are not seen in practice in licensing negotiations or current SSO IP policies. Actual licenses usually result from market-based bilateral negotiations, usually taking place after products appear on the market and often as part of portfolio cross-licenses.[47] To our knowledge, no SSO has adopted a policy that specifies that FRAND royalty rates should be interpreted in either an *ex ante* or an "inherent value" sense. Most SSOs say that

[44] "… the bargaining leverage of patents covering minor aspects of the standard far outweighs their contribution." Chen et al. (2013); "…royalty overcharges are especially great for weak patents covering a minor feature of a product with a sizeable price/cost margin" Lemley & Shapiro (2007); "… this study raises concerns over … the degree to which companies drive patents with little technical merit into standards" Bekkers & Martinelli (2012).

[45] Rysman and Simcoe report empirical evidence that "SSOs identify promising solutions and play an important role in promoting their adoption and diffusion." Rysman & Simcoe (2008).

[46] For example, assume two very useful and costly to develop technologies that are close substitutes where the difference in value is small. The incremental value of one versus the other, even including standardization, may be small, but the contribution of either to the total value of the product may be great. To align social incentives and motivate the high-development costs, whichever technology is chosen in the standard should be able to claim a share of the full value. Under the usual version of *ex ante*/inherent value, the rate would be determined by this small increment. Yet the contribution of the chosen technology is very large, and should be the basis on which rates are set.

[47] Grindley & Teece (1997); Hall & Ziedonis (2001).

FRAND royalties are to be negotiated between the parties, outside of the context of the standardization process, and that the SSO does not get involved in determining whether royalties are "reasonable" or "non-discriminatory." Some SSOs say that SSO participants, focused as they are on technical issues associated with adopting "the best" standard, are not qualified to address the commercial issues associated with licensing.

The informational requirements for an *ex ante*/inherent value approach preclude its use in practice. Information needed for negotiating licenses includes the scope of the patents (some of which may only be applications at the time), the detailed claims, whether the declared SEPs are actually essential for the standard, whether the SEPs are valid and infringed, whether the standard will be adopted by the industry, its success in the marketplace, and the actual volumes and prices of infringing products. It is not clear how to value specific patents when these are predominantly licensed in bilateral portfolio cross-licenses. This information is not available at an early stage of standardization. It is hard to imagine how joint *ex ante*/inherent licenses might be negotiated by members of an SSO when each may have different objectives. The interference with the technical process of standards setting and delays this would cause has also not been addressed. These and more factors in real licensing negotiations are largely unpredictable during standards setting.

In consequence, there are no *ex ante* market rates to act as benchmarks. This removes a further requirement for value theory, that it be verifiable against actual market data. *Ex ante*/inherent value is a theory without practical applications.

d) Mischaracterizes standards setting processes

We believe that *ex ante*/inherent value approaches also misrepresent how technology development, standardization, and product adoption of standards take place in network industries. Developers are active participants in standards setting and generally lead technology development and standardization efforts. They make significant investments in R&D with the aim of competing for standards adoption and sharing in the total value created if successful. On economic efficiency and fairness grounds, rates should allow developers an appropriate share of the full standardization benefits as a potential return for their efforts.

e) Outstanding industry performance history

There is also no evidence that current process has harmed these industries, which on the contrary have performed exceptionally well, with strong growth over decades and high levels of innovation and competition, providing consumers with immensely popular products and new services. Proponents of *ex ante* theories should show the practical evidence for overcharging and the need for change. They have presented no such evidence so far, and we have not found any.

2.3 Other commentators

The *ex ante*/inherent value approaches have been criticized on two main grounds: (a) *ex ante* licensing is impractical, and (b) the low rates may undercompensate technology developers, making them less likely to innovate and/or participate in standards setting.[48] *Ex ante* places much stress on alternatives that might have been available during standards setting. Yet close examination often finds that alternatives were impractical.[49] Supporters respond that *ex ante* negotiations are theoretical and intended as a framework for calculating benchmark SEP rates in hypothetical negotiations that do not benefit from hold-up.[50] They add that unless per patent rates are kept low, royalty stacking from multiple SEP owners might represent an unsupportable share of product revenues.[51] This has not been a conclusive debate.

A few recent papers have supported the view that appropriate compensation should allow for the total surplus from standardization and that this should be shared by the SSO participants to ensure adequate incentives for developers and implementers. Sidak (2013) stresses the "combinatorial value" of standards essential patents, and argues that the SSOs select standards by comparing total—not incremental—values.[52] In Sidak's view, an SSO resembles a "market-based joint venture whose purpose is to further the interests of the joint venture partners as sellers of technology inputs into the joint venture's product (SEP owners) and as implementers of the joint venture's output (SEP licensees)."[53] A FRAND rate would implicitly be negotiated to "maximize the surplus resulting from the standard's creation."[54] The FRAND commitment is two sided and may be seen as a way to ensure that both developers and implementers are prepared to accept the usual terms for negotiating rates. Sidak notes that the parties are aware that the SEP owner may have more leverage *ex post* than *ex ante*, and may consider this in their standardization/licensing strategies. Also, rates might be agreed *ex ante* or *ex post*: "[licensors] are free to bargain *ex ante* (if they want to increase the likelihood of volume)

[48] E.g., "[A]ctually implementing an *ex ante* auction within an SSO presents a number of practical challenges that likely rule out this method for anything other than ex post thought experiments. … [T]he adoption of an *ex ante* auction may result in serious under-compensation of productive investment and innovation." Layne-Farrar, Geradin & Padilla (2007). "[P]rices in competitive markets are not formed on the basis of the incremental value of a product compared to its next best alternative." Geradin (2008); Teece, Grindley & Sherry (2012).

[49] For discussions, see Lemley & Shapiro (2007); Sidak (2007).

[50] "The ex ante framework, although theoretical, provides a benchmark for the royalties and other terms that a SEP holder would be able to obtain if it had continued to face competition from alternative technologies, i.e., if it lacked the market power … that flows from its inclusion in the standard. … The ex ante framework is not (or need not be) based on an actual negotiation that took place before the standard was set." Ordover & Shampine 2014, pp. 7-8.

[51] Lemley & Shapiro (2007).

[52] For additional comments see Siebrasse (2013) and subsequent posts.

[53] Sidak (2013), p 973.

[54] By contrast, Sidak says the *ex ante* method view is that "no patent holder will share in the combinatorial value that is created by the standard except to the extent that the value is captured in the incremental value of the patent." The "SSO is treated as the hypothetical buyer or licensee … whose role is to facilitate surplus creation by standard implementers and that uses competition to select partners [aimed] toward minimizing the quality-adjusted cost of technology inputs for the benefit of standard implementers." This is implausible since membership of an SSO is voluntary, and unless adequately compensated developers may choose other ways to follow their business plans. It also means that implementers capture the entire standardization surplus, which is unrealistic. Sidak (2013), p 1022.

or *ex post* (if they want to preserve pricing discretion).” Licensees may make similar choices. Sidak argues that in selecting a technology, the SSO compares full values including standardization, knowing that these are the future prices that will need to be paid, not the increment between alternatives.[55] If SEP licenses were to be negotiated prior to standardization, they would be priced on that basis (i.e., according to expected contributions to the full value).

In a recent paper reviewing the Ericsson v D-Link decision, Sidak argues directly, “When the invention covered by the SEPs contributes to the standard’s value, only a FRAND royalty that includes part of that value will properly compensate the SEP holder for the incremental value of its invention. … The Federal Circuit’s decision should not be interpreted to mean that one should exclude from a FRAND royalty any and all of the standard’s value.”[56]

Mariniello (2011) follows a similar argument that FRAND rates should incorporate the total value of the standardization into the analysis, although he still assumes that rates are to be determined by reference to *ex ante* negotiations. He points out that the contest must be conditional on the information that is available *ex post* (i.e., on the standard being adopted) and also on knowing the value of the standard once adopted. This ensures that the SEP holder will get a share of the expected full value of the standard once the standard is actually adopted.[57] This approach is still an *ex ante* negotiation, in the sense that it is assumed to take place before the implementer has sunk costs, which means that the patentee cannot extract any pure hold-up value.

Siebrasse and Cotter (2014) accept the timing of *ex ante* hypothetical licensing negotiations for damages purposes as a means to avoid hold-up, but they argue that rates should be based on a full *ex post* knowledge set. This “contingent *ex ante*” framework would negotiate rates based on knowledge of the technology’s contribution to the full post-standardization value of the products and not its incremental value before standardization.[58] The authors argue that since negotiations are taking place *ex ante* the rates avoid any hold-up element because *ex post* switching costs would not be part of the *ex ante* negotiations.[59]

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[55] “[T]he proper measure of the maximum *ex ante* value of a patent that could become standard-essential is not the patent’s *ex ante* incremental value per se, but rather the sum of the price that the buyer (in this stylized case, the SSO is acting in some collective sense for all the future implementers of the standard) would need to pay for the next-best alternative (B) and the incremental value of A over B.” *id*. p 972.

[56] Sidak (2016b), pp 1862, 1869.

[57] The patentee is not confined to the *ex ante* non-SEP value, even though *ex ante*, the patent is not a SEP.

[58] There is no assumption that technologies would compete for adoption, as in the incremental value approach. Rather, the key to the “contingent *ex ante*” framework is that the value being negotiated over is the full value relative to the next best non-infringing alternative, which can only be known ex post. A licensee can vote on a standard but cannot individually control which technology is adopted. “[T]he overarching principle is that damages should reflect the true value of the invention, and ex post information provides a better measure of the true value of the invention” Siebrasse & Cotter (2014), p 4.

[59] Both parties negotiate in good faith on the basis that the technology will be made available and not that it might be withdrawn once the standard is set. “The *ex ante* timing ensures that switching costs … never will arise because *ex ante* the parties either will negotiate to a license or the defendant will choose an alternative technology.” Siebrasse & Cotter (2014), p 58. The authors argue that the “contingent *ex ante*” framework

In a later paper, Siebrasse and Cotter (2017) argue more directly that a "FRAND royalty should reflect the incremental contribution of the patent to the value of the standard to the user."[60] Significantly, they argue that courts have conflated three phenomena in the "value of the standard," which they refer to as "sunk costs holdup," "network value appropriation," and the "apportionment problem." They argue that the correct alignment of incentives to invent and participate in standards development "require that the SEP owner should be able to capture some portion of the network effects (if any) arising from standardization, though not the sunk costs."[61] Apportionment of royalties among multiple patentees might be approached using appropriate Shapley pricing methods.[62] In this way, using the full post-standardization value contribution, but excluding potential sunk cost effects, can correctly align incentives for development as well as other inputs. This is close to the position in the current paper.

These papers identify a key weakness of the *ex ante* methods in excluding standardization value. They support FRAND rates negotiated between parties on the basis of the joint surplus, as providing more appropriate incentives for firms to develop and implement standards. They implicitly refer to actual standardization processes in SSOs, in which standards setting is collaborative and may be expected to share benefits and risks. In practice, standards setting seems more like the joint venture described by Sidak aimed to maximize the joint benefit than the implementers' selection model portrayed by *ex ante* supporters.[63]

Further support for the view that SEP owners may be entitled to a share of the gains from standardization has been provided by the opinion in the United Kingdom for *Unwired Planet v. Huawei* (2017). Justice Birss rejected the *ex ante* valuation approach as normally interpreted, and stated:

> FRAND [should not be construed] as a scheme which meant the patentee could not appropriate some of the value that is associated with the inclusion of his technology into the standard and the value of the products that are using those standards. … [I]t is not necessary to deprive the patentee of its fair share of those two sources of value in order to eliminate hold up and fulfill the purpose of FRAND. To that extent I may be differing from certain parts of the decisions in *Innovatio IP Ventures* and *Ericsson v D-Link* in the US but it is not necessary to look into that any further since neither side

may be applied more generally to IP licensing damages and is not restricted to FRAND licensing. It might be considered a version of the "Book of Wisdom."

60 Siebrasse & Cotter (2017), p 1164.

61 Siebrasse & Cotter (2017), p 1164–1168. Siebrasse (2014) distinguishes two kinds of hold-up: "standard value hold-up" (attempts by a SEP owner to capture the value of the standard itself) and "sunk cost hold-up" (due to additional leverage as firms make sunk cost investments in implementing the standard). He concludes that standard hold-up has no adverse effects on user behavior, and may have positive effects on incentives to innovate. By contrast, sunk cost hold-up may be a serious problem, but is not unique to SEPs.

62 In Shapley pricing each patent receives the average (over all possible arrival sequences) of its marginal contribution. Layne-FarrarLayne-Farrar, Padilla & Schmalensee (2007).

63 For similar criticisms of the "*ex ante*" approach, see Epstein, Kieff & Spulber (2011); Taffet (2012); and others.

before me took the point.[64]

It is not clear to what extent this judgment might influence future cases worldwide, but it has attracted significant interest.[65]

3. FRAND RATES BASED ON FULL CONTRIBUTION OF IP

3.1 An alternative approach

We propose an alternative approach to setting FRAND rates that bases rates on a share of the contribution of the technology to full product value. This value would include the impact of the "gains from trade" (GFT) from standardization due to network effects that increase demand and reduce costs for standards products and services. This is the basis on which innovators develop technology for use in the standards. Technologies are adopted into SSO standards in the expectation that FRAND rates will be set in future licensing negotiations according to the full value evident at that time. Firms may negotiate licenses earlier if they wish, but on the same basis. By contrast, the *ex ante*/inherent value methods do not allow innovators the opportunity to earn a fair share of the total value contribution and are not seen in practice.

We treat FRAND rate determination as far as possible as a separate issue from the question of the availability of injunctions for SEPs. We believe the two should not be confused in discussions of alleged hold-up. The prevailing conditions under which a SEP owner may seek an injunction may be important factors in the balance of options and threats in licensing negotiations; they may influence market rates or they may serve primarily to bring the parties to the negotiation table. The problem remains of the basis on which a court should assess a FRAND rate. We essentially calculate rates based on the technology's contribution to product value. The contention is what product value we mean.

A "full contribution" principle leads to rates that can correctly align investments and contributions through the value chain, rather than assigning the major share of the gains to implementers in the *ex ante*/inherent value methods. This is potentially economically efficient by equating development and other investments with the full social value and provides appropriate incentives for both. As a practical note, full rates may be grounded in market-negotiated rates that can allow for the full value of successful products, the validity and infringement of the patents, and the complexities of individual bargaining positions.[66]

Rates based on a share of the expected full contribution also provide a consistent framework whenever licensing is assumed to take place. This avoids the inconsistencies between *ex ante* and *ex post* licensing in the *ex ante*/inherent value methods, which suppose quite different processes and knowledge sets for pre-standardization rates and *ex*

[64] *Unwired Planet v. Huawei* (2017) EWHC 711 (Pat), 5 April 2017, para. 97.
[65] Contreras (2017).
[66] Market comparisons would need to allow for equivalent injunction conditions and other factors, if these have changed over time.

post licensing. In the current approach, licenses might be negotiated pre- or post-standardization, but the full contribution basis would apply to both.[67]

3.2 Factors in IP valuation and FRAND

Before describing the alternative approach to FRAND rates, there are some basic characteristics of standards setting and valuation to bear in mind.

a) Standards setting is a cooperative process

Standards setting is a voluntary, collaborative, or "collegial" effort between technology developers, implementers, and users. The objectives for the various types of firms are to develop economically beneficial standards and have the opportunity to share in the commercial benefits. These objectives and the need for a balance of interests among developers and implementers are reflected in SSO rules.[68] Collaboration itself implies that rates should include sharing the full benefits from standardization.[69]

Compatibility standards work by making products more valuable in use and increasing demand by allowing more users to interconnect and take advantage of the network effects associated with standardization. They encourage the provision of more complementary products and services by providing a larger compatible market. They may reduce costs and increase supply, via economies of scale and increased competition across the system, and in complementary goods and services. Network effects may be decisive in determining the success of standards products and defining competition in industries such as ICT. These advantages mean that typically only a single, or very few, leading standard(s) may prevail, until replaced by the next generation.[70] These standards act as "platforms" for other services.[71]

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[67] An actual pre-standardization FRAND license might be contingent on the SEP technology being adopted, the standard successful, and the patents valid and infringed. If not contingent (e.g., an early speculative license), then a rate or lump sum might be discounted according to expectations of these factors. See also the "contingent *ex ante*" framework in Siebrasse & Cotter (2014).

[68] "It is ETSI's objective to create STANDARDS and TECHNICAL SPECIFICATIONS that are based on solutions which best meet the technical objectives of the European telecommunications sector …. In achieving this objective, the ETSI IPR POLICY seeks a balance between the needs of standardization for public use in the field of telecommunications and the rights of the owners of IPRs." ETSI Rules of Procedure, 19 March 2014, Annex 6: ETSI Intellectual Property Rights Policy, section 3.1. "The standards development process should have a balance of interests." ANSI Essential Requirements, January 2014.

[69] Much of the value will generally flow to end users, at least in the long term. However, there is no *a priori* reason to believe that all of it will be passed through to end users in the form of lower prices and higher performance for standards-compliant products. In practice, a large share of the total value may be captured by the implementers, as seen in very high-profit rates for some smartphone manufacturers.

[70] The tendency of standards markets to converge or tip toward a few standards is a well-documented phenomenon, such as the VHS/Betamax standards wars or the convergence of mobile technology markets to two 3G standards. [I think referencing to where we ended up with 3G (or we could say only 1 standard in 4G) is clearer and more forceful]

[71] In mobile communications, wireless standards such as 3GPP act as platforms mediating between device and equipment manufacturers, network operators, and higher operating systems; operating systems such as Android and iOS mediate between device manufacturers and applications and service providers; applications services such a messaging, media, and search mediate between networks, devices, advertisers,

The result is that there are "gains from trade" associated with standardization. In our view, these gains are expected to be shared. There is no economic or public policy reason why *all* of the GFT (beyond the volume effect) should flow to the SSO itself or to the implementers of the standard, and *none* of them should flow to the holders of the patented technology that is incorporated into the standard.[72] In a fundamental sense, the standard is enabled by the SEP technology, and developers should naturally share in the total returns.

b) "Value in use" and "value in exchange"

There are various types of valuation one might use. Economists sometimes differentiate between "value in use" and "value in exchange." Both concepts may be valid in determining FRAND rates. Value in use is the value assigned to an asset in different uses. Value in use is context dependent and may vary according to the particular application. For example, consider a surgical technique that can be used to repair broken limbs, in both a veterinary context and a human context. Even though the technique can be "the same" in both contexts, the value of using the technique to repair animal limbs is different from (and probably lower than) the value of using the technique to repair human limbs.

By contrast, value in exchange is the price observed in the marketplace. Value in exchange may also be context dependent, depending on whether markets for one use are functionally separate from another use, and on whether arbitrage is possible between the two markets. The two measures may not be the same, depending on the structure of the market. Where possible in assigning value they may be used together, one confirming the other.

This applies to technology as much as other assets.[73] The value of being able to use technology in one context can be unrelated to (very different from) the value of being able to use it in a different context. In the case of SEPs, the context for value is the technology's use in standards. Typically, this is the main reason for developing and promoting the technology.

Value-in-use may also be subjective, in that different people perceive different values from the use of ostensibly "the same" good, even in "the same" context. For example, some mobile phone makers may obtain more value than others from the use of mobile communications technology. This is part of the reason why licenses in these industries are usually negotiated bilaterally. For rival-in-use goods, one expects that market forces will lead goods to being used in their "highest and best" use, as those who value the good the highest will bid it away from lower-valued uses. But that need not hold for non-rival

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and customers.

[72] The SSOs themselves generally do not share in the benefits of standardization. Some SSOs charge fees for copies of the standard, but such fees are likely to be very low relative to the benefits from standardization.

[73] For example, the "same" technology T may be able to reduce cost of making X by \$M/unit, while reducing cost of making Y by \$N unit, with N ≠ M. Similarly, for performance-enhancing technology, T may enhance performance of X by amount that consumers value at \$M/unit, while enhancing performance of Y by amount that consumers value at \$N/unit.

goods (including IP), where there is no need to use price to ration the good among alternate uses—the same IP can be reused by different users, who might pay different prices.

The most accessible measure of value-in-exchange is what an asset will sell for in arm's length transactions in the marketplace. Ordinarily, there will be both consumer and supplier surplus associated with inframarginal sales. As a pragmatic matter, it is uncommon for parties to license technology *ex ante* (prior to a standard being adopted) in the same standards-relevant context, even if the same technology may have (though often has not) been licensed in other contexts earlier. Without actual *ex ante* licenses in the same context, there is no readily available market benchmark. One can use the concept of hypothetical *ex ante* negotiations as a "thought experiment," but that is not the same thing. Market value may also be context dependent, selling for different prices in different markets. This depends partly on whether markets can be kept separate or goods in one market can be arbitraged for use in another.

c) *Ex ante*/inherent value in context of standardization

SEPs are valued in the context of standardization. Core technology that is developed for the opportunity to become part of the standard motivates development. Initial development is likely to be speculative, as there is no certainty that the technology will be adopted. Most standards proposals are rejected at some stage during the standards setting process.[74] If a technology is not adopted, it is likely to have much lower residual value. If developers were competing for adoption on the basis that they would only receive the *ex ante*/inherent value of their technology, absent standardization, they would invest far less than they in fact do. Unless developers have a prospect of sharing in the full GFT, incentives for innovation would be lower and much socially beneficial technology would not be developed.

The *ex ante*/inherent value approaches do not allow for this context; in fact, they specifically exclude standardization.[75] Some proposals seek to measure "inherent value" as what would be agreed in actual *ex ante* license negotiations. But for most patented technology, there are no actual *ex ante* negotiations on which to base actual inherent values, so that test is not much help.[76] As a pragmatic matter, rates for SEPs are rarely negotiated *ex ante* (before the standard being adopted), if for no other reason than that the value of being able to make standards-compliant products is often not known until after the standard has been adopted.

Other *ex ante*/inherent market rates for the IP may also be of little help. For physical goods, the ability to arbitrage can keep prices the same across different contexts or uses,

[74] Most SSO submissions never get approved. It has been estimated that only around 16% of all LTE submissions were approved by the pertinent 3GPP working group. Signals Research Group (2010); Gupta (2013).
[75] "Inherent" value is rarely clearly defined, and the language does not recognize the subjective/context-dependent nature of "value." Even if one limits analysis to a single well-specified context, the subjective "different individuals have different subjective values" issue is still present.
[76] In this discussion, "value" can mean per-unit or total value (i.e., per-unit times volume).

as otherwise arbitrageurs could buy goods sold for one use/context at a lower price and resell them for the other use(s) at a higher price. But it is not possible to arbitrage IP licenses in this fashion, not least because license agreements are usually unique to the parties involved. Sometimes a technology has been licensed for use in one context and then is incorporated into a standard in a different context (related or otherwise). Because value is context dependent, there is no *a priori* reason why the value of being able to use "the same" technology is the same in the two different contexts, or why the "reasonable royalty" rate for being able to use the technology in the two different contexts should be the same.

This does not rule out the possibility of using the concept as a "thought experiment'' for hypothetical *ex ante* negotiations for determining FRAND royalties, but that is also unlikely (except in stylized artificial examples) to provide much guidance, since it deprives one of what would otherwise be the most directly relevant information, namely, what would be agreed to in an arm's length negotiations.

Note that the concepts of inherent value and incremental value are not the same. The incremental value of being able to use some technology is by definition measured *relative* to some alternative technology that could have been used instead. It is usually measured relative to the next best available (and usually non-infringing) alternative. Again, value-in-use can vary across users and is context dependent. But so too is the "incremental value."[77]

d) "Hold-up" and shared gains from standardization

The choice between the *ex ante*/inherent value approaches and one that allows a share of GFT depends on different views taken on the significance of the potential increase in licensor bargaining power following standardization. If hold-up is taken to mean the developer/SEP owner extracting *any* benefit from its increased bargaining power after standardization (i.e., gets more than the inherent value of technology on per-unit basis), then inevitably this excludes the developers from sharing in the standardization GFT, which then may accrue to the implementers.[78] We believe this cannot be a reasonable interpretation of the FRAND commitment. There are no good reasons why all benefits from cooperative standardization efforts should flow to implementers and none (except

[77] Inherent value may also contain a complementarity component when used in joint products, even before standardization is taken into account. A full pre-standardization inherent value is not just the contribution of the technology to product cost or performance. It should include an allowance for the full contribution when used with other technologies due to complementarities between inputs. It is recognized in economics that for complex products using complementary inputs in fixed proportions, the value of the end product may exceed the sum of the values of the individual components, sometimes known as "super-additive value." Layne-Farrar, Padilla & Schmalensee (2007) discuss methods for allocating royalty rates between owners of patents used in complex products with many IP contributions covering complementary aspects of the product. Also: "[In complex products] price and margin earned on the product as a whole could be relevant in valuing the patented feature, but only to the extent that the patented feature … adds to the unit sales of the product as a whole." Lemley & Shapiro (2007), fn 154.

[78] In other words, if one defines "hold-up" as "patent holder gets more than inherent value of technology on per-unit basis," and if one claims that a purpose of the FRAND commitment is to prevent hold-up, then this effectively says that the patent holder should not share in the full "gains from trade."

volume effects) to technology developers who contributed their patented technology to the standards.

On the contrary, if the intention is for the patent holder to receive a "fair share" of the full contribution of the standard/GFT, then the policy-relevant definition of hold- up may involve situations in which the patent holder extracts more than the inherent value plus a fair share of GFT. But it should not be considered hold-up if the patent holder receives any amount up to that. In consequence, we believe SEP rates should allow for a share of the total value made possible by the use of these and other technologies in standards. We therefore propose that the term "hold-up" be limited to situations in which the patent holder gets more than the sum of "inherent value" plus a fair share of the gains from standardization.

This contests suggestions that "inherent value" of technology should not (or, as proponents use the term, does not) include any portion of gains from standardization.[79] As explained above, our concern here is that standardization is a cooperative effort among two primary groups (developers and implementers) who both stand to make significant gains from standardization.[80] Ordinarily, parties to cooperative efforts share in gains, and not all GFT accrue to one party or another. To do otherwise would distort the incentives for participating in the coalition and lead to economically inefficient allocations of innovative and productive resources.

Ex ante proponents sometimes claim that the SEP owner benefits from the higher volume of royalty-bearing products following standardization. This is misleading. If the *ex ante* rate is so low that even when multiplied by higher sales the net royalty revenue is still less than a fair share of the full GFT amount, this cannot be equitable. The GFT share should be considered as an amount rather than a rate, though it may be converted into a running royalty rate and expected volume for convenience.[81] Rates and volumes should be considered together and should combine "volume effects" (volume of royalty-bearing sales will be higher if the technology is incorporated into standard) and "price effects" (royalty rates determined by post-standardization supply and demand, whether measured in cents-per-unit or on a percentage basis).[82] The *ex ante*/inherent value methods allow only volume effects and set prices independently of the GFT using only pre-standardization product value.[83]

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[79] See cites above to FHSS; Robart; Holderman.
[80] Compare a description of "the SSO as an ordinary, market-based joint venture whose purpose is to further the interests of the joint venture partners as sellers of technology inputs into the joint venture's product (SEP holders) and as implementers of the joint venture's output (licensees)." Sidak (2013), p 973.
[81] This corresponds with how royalties may be calculated in cross-licensing negotiations. These estimate the future expected lump-sum royalty amounts using forecast volumes of infringing sales and target royalties, then (after netting out the expected lump sum payments for both parties) convert these back to a running royalty rate using the parties' expected total sales volumes. The important consideration in bargaining is the total expected royalty amount and the share of that to be paid by the net licensee. See Grindley & Teece (1997).
[82] In practice, post-standardization *product* prices may rise or fall compared to pre-standardization—the total product gains from standardization are the key amount.
[83] Ex ante proponents claim that *ex post* hold-up leads to SEP rates based only on switching costs, not the

Allowing the patent holder to claim more than the "inherent value" of technology runs the risk in theory that the patent holder will engage in hold-up and claim more than warranted. But one should not dismiss the SEP holder's legitimate claim to a "fair share" of GFT on "slippery slope" grounds that there is no constraint on what the patent holder might seek (short of "what market will bear given lock-in"). There are in practice many other constraints on what a patent holder may seek to license SEPs, not least among which are the many uncertainties about whether the patents are valid and infringed, whether they are truly essential, whether an injunction might be granted, whether they can be invented around and still be standards compliant, and other bargaining considerations.[84] The essentiality of the alleged SEPs is only one factor, albeit potentially an important one, in license negotiations and should not lead to a fundamentally different way of setting rates than other important patents.

e) Valuing "full contribution"

Applying this to a policy for FRAND rates involves at least two hurdles. The first is to identify the actual value added by the technology, given that (a) value-in-use is obscured in problems of separating out multiple contributions from complementary technologies and other inputs used in implementing the standard in the marketplace, and (b) there are no-value-in exchange market transactions by means of which to compare *ex ante*/inherent values in practice. The second challenge is to define a fair share of the full GFT, against which to measure claims that SEP owners are using bargaining power to extract more than this.

One approach might be to attempt, at least in principle, to identify directly the contribution of the technology to final product value. This might be achieved by comparing the likely scenario with standard A, including the technology, with standard B, which excludes the technology but as far as possible leaves other inputs the same. As above, it may be difficult to separate the impact of one technology from other complementary inputs needed in the standard.

An alternative approach is to recognize that normal *ex post* SEP licensing takes these factors into account in the context of market-based negotiations. Despite some claims to the contrary, these may represent the most realistic benchmarks for determining FRAND licensing conditions. This would base FRAND rates on comparable rates from actual licenses (typically agreed *ex post*), after adjustment for the characteristics of individual cases.

A concern for using existing market rates as a benchmark may be that the availability of injunctions for SEPs (and non-SEPs) has been changing recently. Any market comparisons might need to allow for changes in the conditions under which injunctions might be granted, and other factors, over time. Rates negotiated under the threat of an injunction may not be easily compared to those with more limited availability of

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contribution of the technology to product value. Ramirez & Kimmel (2011). However, *ex ante*/inherent value methods base rates only on ex-standardization value with no share of the technology's contribution to standardization value.

[84] See Padilla (2014).

injunctions.[85] Conversely, the main value of an injunction to a licensor may be in bringing an obstinate infringer to the negotiating table, and once there it may be only one factor in the negotiations. These are important practical considerations when identifying "comparable" licenses but should not imply that equivalent market benchmarks cannot be found.

The more important feature of both of these proposed approaches is that they consider the full value added in the final products, including standardization effects, and not the *ex ante*/inherent value of the technology pre-standardization.

3.3 Illustration of standardization gains

a) Economic analysis of shared standardization gains

Compatibility standards typically affect both demand and supply for products and services. Standardization network effects increase demand for standards goods both directly, by having larger physical networks to call or interconnect with, and indirectly, via the increased availability of complementary products and services serving the larger primary market. They may open up new markets such as smartphone apps and services. These increase product demand, often spectacularly. They may also increase supply, by reducing costs and attracting more innovation. The larger market enables economies of scale in production and technology development, allows firms to specialize in different segments, and allows the standards technology and products to be applied in more market areas. The increased scale is likely to lead to greater competition between manufacturers of the core products and the complementary products and services. These effects are evident, for example, in the rapid expansion and falling quality-adjusted prices in the mobile communications industry.

A standard may define a "new generation" standard or consist of more incremental improvements to an existing standard. In either case, we evaluate changes relative to prior market conditions. In practice, most standards are developed in stages via enhancements to existing standards, especially if the new standards are required to be backwards compatible with an existing installed base. Even for major changes, the *ex ante*/inherent value methods assume that the impact of the technology can be calculated separately from the network effects (i.e., as an incremental effect on existing supply-and-demand conditions).[86]

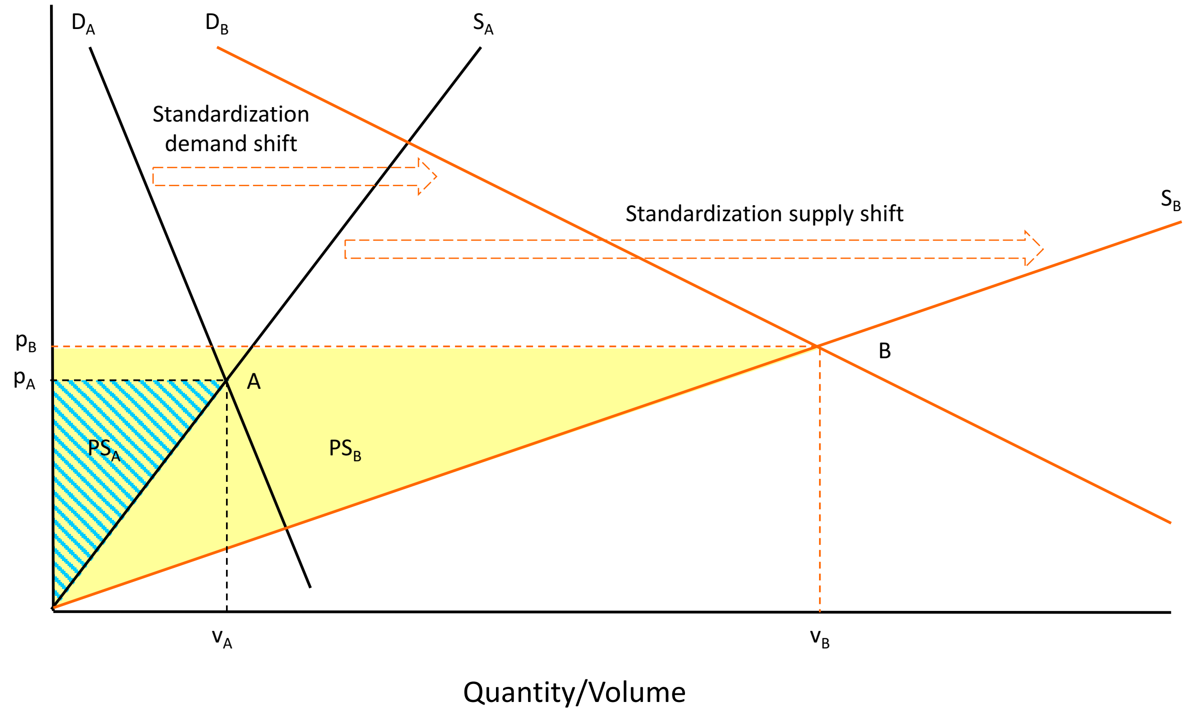
The gains from standardization and appropriate shares of GFT may be illustrated in **Figure 1**, which shows the supply and demand for products before and after the introduction of a new standard. The supply-and-demand curves in the prior situation are S_A and D_A. Before the introduction of a new standard, the market equilibrium may be at

[85] "…without the threat of injunction it is very difficult to bring an obstinate infringer to the negotiating table. [However,] proper application of the hypothetical negotiation framework should not rely on "comparable" licenses that were negotiated in the shadow of an injunction…" Simcoe (2011).

[86] If the standard were to create an entirely new market, there should be no question that the "inherent" value of the technology would be a share of the full product value after standardization, since the standard and product market would likely be nonexistent without the technology.

the intersection of the curves at point A, with volume v_A and price $p_{A.}$ The pre-standardization GFT for the producers may be represented by the producer surplus, PS_A, and the areas above the supply curve, $S_{A,}$ and below the equilibrium price line, p_A.

Figure 1: Standardization effect on product prices and volumes (volume increase, price rise)



Standardization boosts consumer willingness to pay and increases the volume of sales demanded at any product price. In economic terms, the demand curve shifts out, from D_A to D_B. At the same time, costs are reduced and the volume that can be produced for a given price increases, and the supply curve also shifts out, from S_A to S_B. After standardization, the market equilibrium moves to point B. The post-standardization volume moves out to $v_{B,}$ and the price moves to p_B. Volumes unequivocally increase from v_A to v_B. The post-standardization price p_B may be higher or lower than p_A depending on whether demand or supply effects dominate. In Figure 1, demand shifts out more strongly than supply, and the price rises.

Firms ordinarily expect to share the gains from cooperative efforts. This implies that for standardization, developer royalties should be determined to earn a share of the full incremental surplus (PS_B - PS_A). GFT is best thought of as a lump sum rather than a rate, since firms are most likely to think in terms of lump sums when making their R&D investments. It is the prospect of a share of this lump sum that motivates developers to invest fixed amounts in technology and standardization. The GFT might be converted to a per-unit running royalty if wished, by dividing the expected surplus by the expected post-standardization volumes, or to a percentage by dividing by expected product revenues.

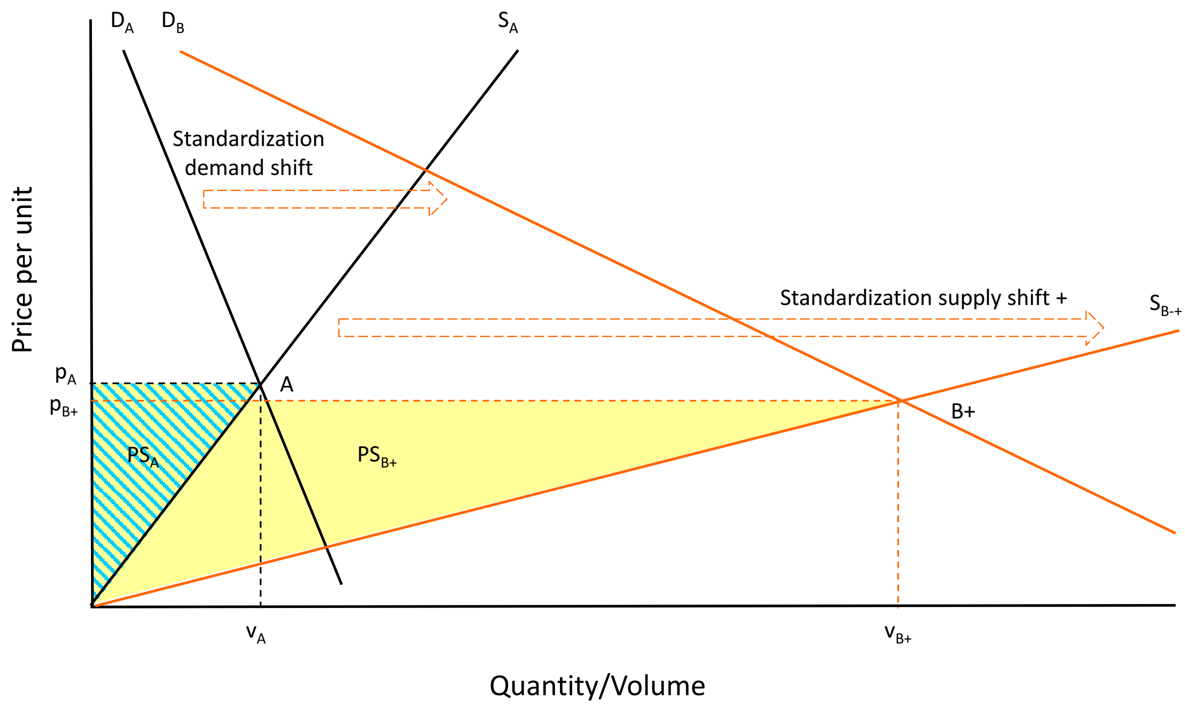
For example, if parties to a licensing agreement agree that the developer has contributed share θ to the value of the post-standardization products, they might negotiate on the basis that the developer claims a share $\theta.(PS_B - PS_A)$ in total or a per unit running royalty of $\theta.(PS_B - PS_A)/v_B$ or percentage rate $\theta.(PS_B - PS_A)/p_B.v_B$. This is the basic share of GFT for the developer. In licensing negotiations, the licensor and licensee might bargain further over the share, according to their other "bargaining power." In that case, the developer might receive more or less than the "objective" share θ. Call this bargaining factor β, which may be more or less than 1. The bargained share would then be $\beta.\theta.(PS_B - PS_A)$.[87]

An additional reason to think of GFT as an amount rather than a rate is that final product prices may be above or below pre-standardization prices, though volumes are likely to increase. If supply efficiencies increase very strongly, the final price for the product might be below the original price due to volume and technology effects that make devices cheaper to produce, even though demand rises.[88] However, the producer surplus is still likely to increase strongly even though the product price falls. This is shown in **Figure 2**, where the supply shift outward dominates the demand shift outward. Supply moves out to S_{B+}, and the resulting equilibrium price p_{B+} is below the pre-standardization price p_A. Post-standardization volumes increase to $V_{A+,}$ and the total producer surplus is PS_{B+}. The GFT are $(PS_{B+} - PS_A)$. The technology innovator is still due a share of the total GFT, as a major contributor to the success of the standard and the products. According to the above notation, the developer may expect a share equal to $\theta.(PS_{B+} - PS_A)$.

Figure 2: Standardization effect on product prices and volumes (volume increase, price fall)

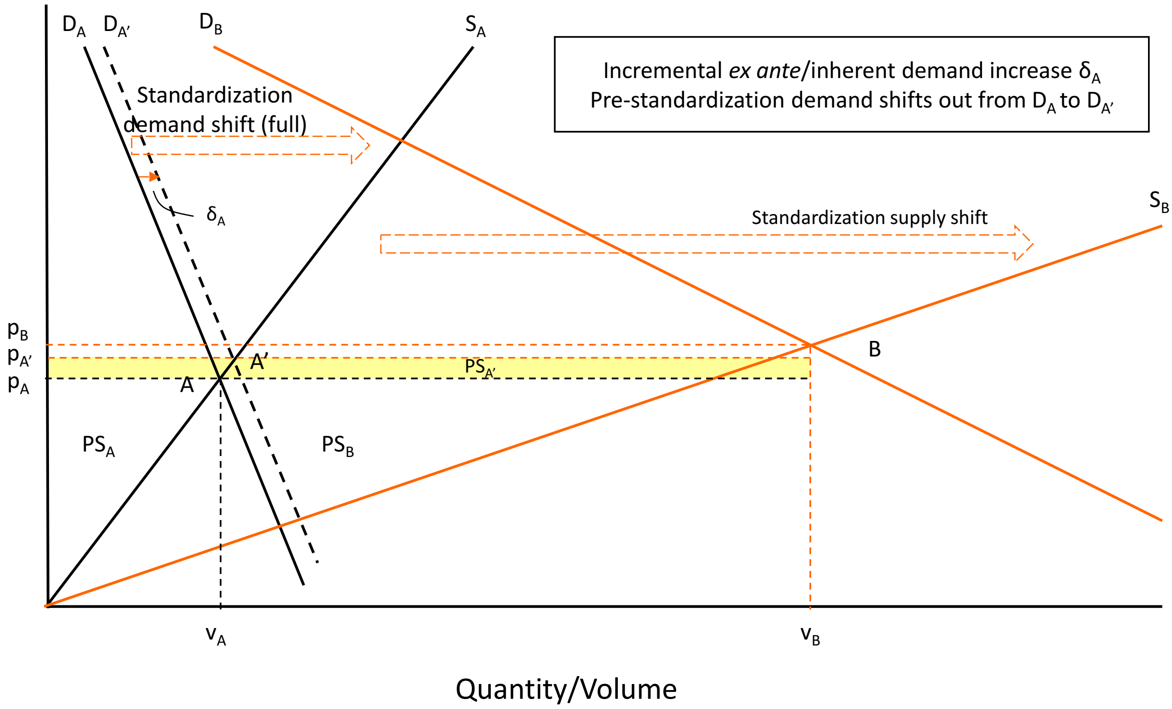
[87] Shapiro models a royalty rate in which the licensor and licensee are assumed to bargain over the total "value" of the technology v. The benchmark rate is to $r = \beta.\theta.v$, where v is the value of the patented feature, θ is the patent strength, and β is the underlying bargaining skill of the patent holder, where $0 \leq \beta \leq 1$. The current framework differs from this, in that θ represents the share of the total product value attributable to the technology after allowing for the manufacturing and other technologies' contributions. Shapiro (2006, 2010); Lemley & Shapiro (2007).

[88] In practice, the technical performance and quality of the products are likely to be massively improved over time once the standardization effects have worked through the industry, so that the quality adjusted price of a standardized product is likely to be considerably lower than pre-standardization, even though the actual unit price might rise. Within segments in the mobile phone industry, such as smartphones, unit prices have tended to fall gradually over the years due to the combination of these effects. (See Section 5 below) http://www.icharts.net/chartchannel/smartphone-average-selling-price-asp-operating-system-usd-q4-2013_m3prwixmc



We may contrast this with the *ex ante*/inherent value methods. In these, the SEP owner would receive an amount based on the potential increase in product price (decrease in cost) attributable to the technology *before* standardization multiplied by the product volume *after* standardization has worked through the market. This is shown in **Figure 3** for the case where the technology leads to an increase in pre-standardization demand (a similar analysis for a cost fall is shown in the **Appendix**). Although proponents are often vague about how to define inherent value, it might be illustrated as follows. The first step is to identify the incremental impact on product prices due to the technology before standardization (i.e., relative to existing supply and demand conditions). Because this is before standardization effects have worked through the industry, the effect on demand and price is likely to be small. The price increment defines the royalty rate. Once standardization effects work through the industry, the volume of final products may increase significantly. The second step is to multiply the royalty rate by the post-standardization volumes. However, since the *ex ante* price increment is likely to be very small, the total amount received is also likely to be small.

Figure 3: Standardization with ex ante incremental demand increase



In Figure 3, it is assumed that prior to standardization the SEP technology would shift the demand curve out by a small amount δ_A to $D_{A'}$ compared to the demand using the prior/alternative technology D_A. This leads to an *ex ante* price $p_{A'}$.[89] The rate for using the technology in the standard is set by the incremental product price difference ($p_{A'}$ - p_A). After bargaining, the patent holder may expect a proportion of this difference. Following standardization, the volume of sales increase to v_B, but the SEP developer only receives a share of the amount (($p_{A'}$ - p_A) × v_B), denoted by the area $PS_{A'}$.

Using this definition, the *ex ante*/inherent value rate is likely to be small, and the total surplus $PS_{A'}$ is likely to be well below a share of the full surplus (PS_B - PS_A). There is a volume effect, but the price is set to exclude the gains from standardization. Since the rate is determined only by the pre-standardization demand shift, which may be tiny, the increased volume is unlikely to compensate the developer adequately according to the GFT.

This may also help illustrate the disconnect in the *ex ante*/inherent value methods between the total gains from standardization and returns to the developer—and the resulting impact on incentives for innovation. We have argued that developers commit large investments in technology and standardization with the prospect that if successful they will share in the total market created by the standards. Under *ex ante*/inherent value,

[89] A similar effect applies if the intrinsic advantage is a small cost reduction from using the technology. In that case, the supply curve would shift right by a small amount, and the equilibrium price would fall by a small amount. If product prices are sticky and do not fall, the *ex ante*/inherent value royalty rate would be determined as a share just of the cost savings. See **Appendix**. The example of a decrease in costs, often used explanations of the *ex ante*/inherent value approaches, requires that the cost decrease is not fully passed through to lower prices for the developer to achieve any returns at all.

the returns are only indirectly related to the total earnings in the standards ecosystem and are likely to provide inadequate incentives for development.

b) Shared gains—a numerical example

The following numerical example may help illustrate the sharing of GFT between developers and implementers. Suppose that, in the absence of any standard, consumers would be willing to pay $40/unit, manufacturing costs are $20/unit, and profits are $20/unit. Assume patent holders as a group receive 2.5% of sales price *ex ante* royalties, or $1/unit (5% of the profits), as the "inherent" value of the technology in a non-standardized product, leaving $19/unit profit to manufacturers. Suppose that, as a result of the network effects associated with standardization, consumers find the product more valuable and are willing to pay more for it, possibly a lot more (demand shifts out). Competition between suppliers and economies of scale due to the much higher volumes of standardized products may also reduce costs and limit the prices they need to pay in the marketplace (supply shifts out). After standardization, consumers may pay $50/unit, an increase of $10/unit over the no-standardization situation (but still possibly less than they might be prepared to pay for a more valuable product—the difference belonging to their "consumer surplus"). The manufacturing cost falls to $15/unit. If the rate stays at $1/unit (the inherent value per unit), then patent holders receive no more per unit after standardization and all the per unit GFT go to the manufacturer. Total profits are now $35/unit, split $1 to royalties and $34/unit to manufacturers. The GFT are $15/unit = (50−15) − (40−20) = (35−20), split $15/unit to manufacturer and zero to the developer.

We may allow for the effect of volume increases on royalties. Suppose that in the absence of a standard, manufacturers sell 1 million units per year and after standardization they sell 10 million units per year, with prices and costs as above. The total revenues increase from $40 million to $500 million; available profits go from $20 million to $350 million, for a total GFT $330 million. Of these, royalties go from $1 million to $10 million, a $9 million gain, and manufacturers profits go from $19 million to $340 million, a $321 million gain. Thus, royalties go from a 5% share of total profits to 10/350 = 3.3%. The developer gets 9/330 (2.8%) of the GFT, the manufacturers 97.2%.

Limiting patent holders to the *ex ante* per unit value would limit their royalties to $1/unit that they would have earned in the absence of the standard, leaving the $15/unit increase in profits due to standardization for manufacturers. The argument that patent holders "should not" be entitled to more than the *ex ante* value could equally be applied to manufacturers; why should manufacturers be able to get an additional $15/unit windfall? After all, they were no more "solely" responsible for the benefits from the collective standardization efforts than the patent holders were. These figures are changed somewhat when allowance is made for volume increases, assuming a running royalty structure, but the result is still that the bulk of the gains from standardization go to the manufacturers.

If instead we were to conclude that patent holders "should" be entitled to the same 5% share of the $15/unit profit gains from the collective standardization process, then patent holders' share would be royalties of $1.75/unit or $17.5 million in total. If instead we were to conclude that they and the manufacturers should each be entitled to a 50% share of the gains (with consumers assumed to be already compensated via the higher-quality standardized products for sale at below their reservation price), then the gain would be shared $7.50/unit to developer and manufacturer.[90]

The key point here is that not all of the incremental royalties associated with giving patent holders a "fair share" of the gains from standardization constitutes "hold-up." Only if the patent holder seeks to extract *more* than its "fair share" of the gains from standardization does it make sense to talk of hold-up. Otherwise, one is treating innovators and implementers asymmetrically when it comes to dividing up the gains from standardization, and favoring implementers over innovators.[91]

It is difficult to specify what constitutes a "fair share" of the gains from standardization. But that is no justification for going to the other extreme and failing to differentiate between the situations where the patent holder is (a) seeking only a fair share of the gains from standardization, and (b) going beyond that and seeking to hold-up implementers by demanding more than its fair share.

3.4 Modifications of *ex ante*/inherent value

Modifications to the *ex ante*/inherent value framework have been suggested by some commentators, which may relieve some of the most pressing concerns. These mainly question the incremental value approaches to *ex ante*/inherent value. However, these still may not address the basic concern that licensing rates should consider the full contribution of the SEP technology and the appropriate balance of returns and incentives to developers and implementers. We propose a FRAND methodology in which rates, whenever negotiated, reflect the full post-standardization value, though excluding, if possible, potential impact on negotiated rates due purely to implementers' switching costs.

a) Incremental value compared to non-infringing alternative

The version of *ex ante*/inherent value most often used is a rate determined by the incremental value between the SEP technology and the next best alternative just before standards are set. This assumes that all costs of development are already sunk, that rates will be set via Bertrand price competition, and that firms do not allow for fixed development costs.[92] Competition may be by auction or an equivalent. If the next-best alternative is itself also patented, this obviously may lead to unrealistic outcomes. Rates can be very low or near zero as the incremental difference between the inherent values of two near alternatives. Rather than receiving a rate based on the technology's contribution to the product, even *ex ante* and excluding standardization effects, the developer may

[90] An alternative example might use a split of 33% to implementers and 33% to end users. However, these are to illustrate a point only. We avoid trying to calibrate what is and is not hold-up; rather, we leave rates as matters to be determined in market negotiations.
[91] FHSS (2007) show a similar example, in which the major share of the network benefits is captured by the manufacturer, with the developer left with the much smaller inherent value. FHSS (2007), pp 616, 622. See footnote 27 above.
[92] Swanson & Baumol (2005); FHSS (2007).

receive a tiny increment. No developer would consider development with such a poor prospect of returns.[93] It also neglects the important fact that in the real world the patentee may prefer to go to another SSO or launch a proprietary technology offering rather than accept next to nothing in royalties.[94] With respect to patented alternatives, the "incremental value" approach has been rejected by many commentators, and notably in the recent Holderman court ruling.[95]

Less-extreme versions of *ex ante* may avoid this particular problem. This would define inherent value from the *ex ante* comparison of the contribution (cost saving) of the SEP technology to the next best non-patented or public domain technology. This at least allows for the inherent increment compared to existing "free" technology and corresponds to a more normal view of pricing. This might be seen as the typical version of *ex ante* as currently proposed. However, the assumption is still that the development costs of the technology are sunk. It does not consider return on development investment, the full contribution of the technology including standardization, or the incentives this implies for the developer.

b) *Ex ante* prior to starting development

A revised version of *ex ante* improves on this by allowing for development costs in the rate. The timing of a truly *ex ante* competition, symmetrical for developer and adopter, should be before either party has made sunk investments. This should be not just before the standard is set (selecting between existing technologies for which development costs are sunk) but earlier, before development work has begun. Prices bid by the developers would include allowances for the estimated fixed investment costs of developing the technology. A developer would only take on the project if the final price might allow it to recover its full costs. Developers would no longer bid each other down to only a marginal increment. A developer might also price its bids to be able to recover the averaged costs of its failures from the profits of successes if it wins adoption.

The practical problems of implementing such an approach are even higher that traditional *ex ante*. A truly *ex ante* contest (prior to sunk investment by innovators) would need to be able to predict what alternative technologies might be developed for the standard, their costs and benefits, timing, and so on, making pre-development *ex ante* negotiations unrealistic. The uncertainty and risk may be unpredictable. However, as a hypothetical benchmark for rates, it is more in line with normal project pricing and would partially allow for the effects on incentives for developers to invest in the technology and

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[93] See Teece testimony in Holderman (2013).
[94] See Sidak (2013), discussed above.
[95] "[N]o patent holder would accept a royalty that is effectively zero, because innovators must be compensated for their work or they will not participate in the standard. As Dr. Teece explained, the economic models suggesting that two holders of patented technology would negotiate down to practically zero is based on the implausible assumption that the only negotiating factor is price…. The court agrees that it is implausible that in the real world, patent holders would accept effectively nothing to license their technology. … Accordingly, the court will consider patented alternatives, but will recognize that they will not drive down the royalty in the hypothetical negotiation by as much as technology in the public domain." Holderman (2013), p 37.

participate in standards setting.

c) Proposed FRAND rates should reflect full standardization value

Although these alternatives improve on the *ex ante*/inherent value methods, they do not address the main problem of the full contribution of the SEP technology to final product value.[96] The development and introduction of core technology in ICT is a cooperative process orchestrated via standards setting.[97] These are typically "anticipatory standards" set before technologies are fully developed and before investments are made in products and services. Investments take place within a standardization context, and the returns to individual firms cannot be isolated from the returns to the system as a whole.

This implies that the value contributed by SEP technology should include a "fair share" of the full value of the standardized products, including network effects. We propose this "full contribution" principle as a basic for determining FRAND rates. We believe a share of full contribution is understood by SSO members as the FRAND basis on which SEP owners will seek licenses when accepting the FRAND commitment and when adopting the SEP technology in the standard. We also believe this applies whenever licensing negotiations are assumed to take place. Actual or hypothetical negotiations taking place "pre-standardization," if any, would be made on the basis that rates reflect the full contribution, adjusted for expectations if needed.

Full contribution also applies if there is competition between technologies for the standard. Developers are likely to price their technology to attempt to cover their full costs if their technology is successful.[98] Some developers may be prepared to reduce their rates in order to make their technology more attractive for adoption *vis-à-vis* alternatives.[99] Some may even decide for strategic reasons to offer their technology for free, if they believe this is in their long-term interests. But this is not the same as *ex ante*/inherent values, in which standardization benefits are excluded from the rate or adoption of the technology is conditional on its being offered at the lowest price and assuming patentees are prepared to accept any non-zero price.[100]

[96] This also applies to *ex ante* competition applied prior to starting development, which also excludes any *ex post* standardization value or bargaining power from the incremental value. The winning bidder A gets its competitor B's development cost plus its own A's incremental inherent value over B, for whichever firm $D_B + I_A$ is highest. (Neither firm will accept less than its development cost D_A or D_B. Assume A's inherent value is I_A higher than B's. If $D_B + I_A > D_A$, then A wins and gets $D_B + I_A$. If $D_B + I_A < D_A$, then B wins and gets D_A.) Lower costs from network effects are an addition to any inherent cost advantage. An innovative technology might be fundamentally (e.g., 25% more) power efficiency enhancing, for example.

[97] Technology development, product development, manufacturing, infrastructure investment, applications development, operations, and services all take place within a standardization system. In mobile communications, standardization takes place in SSOs such as 3GPP and its regional organizational SSO partners, including ETSI in Europe, ATIS in the USA, and others. The IEEE also sets wireless standards including Wi-Fi and mobile WiMAX.

[98] Target returns might include allowances for other R&D costs for unsuccessful "dry well" technology not adopted in standards.

[99] Ratliff & Rubinfeld (2013), p 4; Cary et al. (2011), p 920.

[100] Pre-standardization negotiations should not be "coordinated" between licensees or made a condition for adoption in the standard, as this might run the risk of being seen as a buyers' cartel. However, an SSO may

Actual or hypothetical pre-standardization negotiations might need to allow for expectations about future patent and standard value, or might be made contingent on future performance, depending on what knowledge is assumed to exist at the time.[101] As a benchmark for FRAND rates, we assume that it would be possible to identify the contribution of the SEP technology to full product value. This is separate from the possible impact of post-standardization changes in relative bargaining power in actual negotiations. We leave open the issue of the extent to which *ex post* switching costs may affect royalty terms when taken in conjunction with other factors affecting real licensing negotiations, and whether the parties to the FRAND agreement expect this to be a factor in rates.

3.5 Implication that SEPs may be trivial

Ex ante proponents often imply that most SEPs may be weak and/or cover only minor features of a standard, and may derive their value mainly from adoption in standards. At the extreme, the choice of a particular technology for a standards feature might be arbitrary and only used to ensure compatibility. Given the effort put into the working groups, it seems unlikely that many standards features fall into this category. As discussed in detail below, standards setting is a rigorous business and proposals are thoroughly evaluated before being approved. The costs of including a new feature in products are significant and unlikely to be incurred unnecessarily. This may also apply within features to particular technical solutions—these are selected via detailed working group procedures during which many proposals are eliminated before final selection.

Clearly, on average the value of essential technologies is large, how else can one explain the long-term growth, performance, and huge total worth of the mobile communications industry? Also, complementary technologies are designed to work together, and it is hard to separate out individual contributions. “Weaker” technologies may be supportive and enable the application of “breakthrough” technologies, so also make valuable contributions. Even so, there are likely to be differences in the economic and technical significance of different standards features and in the quality of the declared SEPs associated with them. Some standards features, such as the basic CDMA modulation technique used in UMTS 3G mobile standards, are central to the standard. Others may be optional. SEPs themselves have a range of values. Only a small percentage of declared SEPs may be actually essential, and a smaller percentage of SEPs may prove to be valid and infringed in litigation.[102] Given this variation, it cannot be assumed that SEPs have

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legitimately consider how much a proposed technology will cost before adopting it. The current proposal assumes the SSO would not organize an *ex ante* bidding game. The fact that no SSO behaves this way indicates that its members do not believe this is appropriate as a balance of interests. Collective purchasing behavior might be challenged by competition authorities. SSO rules typically require that members do not discuss competition-sensitive issues such as royalty rates in the SSO.

[101] In their “contingent *ex ante*” framework, Siebrasse & Cotter (2014) propose FRAND rates agreed in hypothetical negotiations taking place *ex ante*, in order to exclude the impact of *ex post* market power on rates. However, they also assume the parties have full knowledge of the future full-value contribution of the SEP technology and negotiate rates on that basis.

[102] It has been estimated that only around 40% of declared essential patents for LTE standards are actually essential. Cyber Creative Institute (2013); PA Consulting Group (2012). A study of recent mobile communications litigations found that “only 1 of every 8 SEPs tested in court has, in fact, been valid and

low value until they have been thoroughly reviewed. Assuming low value should certainly not be a starting point for a theory of FRAND value.

By contrast, the *ex ante*/inherent value approach is essentially a "zero-value" method.[103] Setting rates at the incremental *ex ante* value ultimately requires the patents to be relatively trivial. If the SEP technology is difficult to design around, it is hard to argue that it does not contribute to the value of the standard as a whole, since the standard would be different without it. It is generally recognized that if technology is so superior that it would be used whether or not it was adopted in the standard, or there are no feasible alternatives, then the standard does not confer market power and makes no difference to the royalties the technology can command.[104] In that case, the rate would reflect the technology's total economic contribution, including network effects. But it should not be assumed that that logic works only for a few "key" SEPs, while the rest are worthless.

The economic valuation of SEPs is a matter for individual licensing negotiations or, where those fail, the courts. If SEPs are indeed "weak" (in terms of their contributions to product value, their validity, or the evidence of infringement), they are unlikely to command a high royalty whether essential or not.[105] The *ex ante* approaches assume that essentiality gives all SEPs, however minor, equal blocking power *ex post* and allows them to extract similar excessive rates. The reality indicates that there are differences in SEPs, that on average their contribution is high, and that it is a matter for market negotiations or the courts to determine individual contributions and shares.

4. STANDARDS DEVELOPMENT IN PRACTICE

4.1 Institutional understanding of standardization processes

A critical missing element in policy debates over the role of standards setting has been an institutional understanding of the standards setting process.[106] This underlies the methodological concerns with the *ex ante*/inherent value approaches. By focusing on

technically essential to practice the standard." Jurata and Smith (2013).

[103] "Implicit in the *ex ante* incremental value approach is the assumption that the patent has close to zero value if not incorporated into the standard." Sidak (2013), p 19.

[104] "[S]tandardization only grants additional market power and thus enhances the essential patent holder's ability to charge royalties when the patented technology can be easily designed around. In the presence of a technology for which there is no alternative as is often the case in complex industries, the ability of the holder of essential patents to seek significant royalty rates exists prior to the adoption of the standard." Geradin & Rato (2006), p 22; "[M]arket power may be created when one of several roughly equivalent patented technologies is selected as an interoperability standard and the standard corresponds to a relevant market. … But the incorporation of a patented technology into a standard does not always create market power. A patented technology may be so fundamental to the subject matter of a standard as to have no viable alternatives." Kattan (2002), p 23.

[105] Proving validity and infringement of any patent is a difficult process, as seen in the lengthy patent infringement court battles in the mobile industry in recent years, which despite years of effort and huge legal expenses only very few SEPs have survived. In practice, validity may be never proven or determined affirmatively by the courts who merely find patents "invalid" or "not invalid." Having withstood close scrutiny in the courts and not been found invalid, a patent may be presumed valid unless further challenged.

[106] See also Gupta (2013), p 1.

patents and licensing (i.e., issues of financial and legal rights), these approaches often overlook how innovations are developed, standardized, and implemented in practice.

A premise for the *ex ante*/inherent value approaches is that technical development costs have been sunk before standardization and standards setting consists of selecting from amongst alternatives which already exist. The approaches consider the potential for SEP owners to extract more than their "economic value" but do not articulate what that value is and how it is created. Developers are assumed ready to accept either any non-zero price or a value that excludes any benefit following standardization. This impacts unfavorably on incentives to innovate and participate in standards setting. Yet in practice, these incentives are central to the FRAND commitment and may be the purpose of developing the technology in the first place.[107]

This simplification misrepresents the ongoing nature of technology development and the cooperative nature of standards setting. It limits developers to an inadequate pre-standardization return. This is not how technology is developed and standardized in practice. R&D investments are made throughout the standardization process, and SSO members cooperate to set standards. Firms, especially developers, expect to share in some way in the results; they would not take part otherwise. The prototypical *ex ante* auction, in which implementers select from a shelf of fully developed technologies and developers accept any non-zero price, is unrecognizable to firms involved in the development of technology and standards in practice.

These are critical issues in which policy needs a foundation of a more complete understanding of technology development and standards setting. The *ex ante*/inherent value approaches might attract less support if there were broader understanding of the standards process. There is scope for greater awareness of how standardization works to inform the theoretical FRAND arguments. In this section we summarize some of the main features of real-world standardization.

4.2 Technology development and standardization

Core technology in ICT industries is typically developed expressly for use in standards. Wireless communications or computer memory technology may have little value unless it is adopted across an industry. Inclusion of compatibility standards is part—though only one part—of making this possible. A technology may have little value unless it is included in a leading standard; the potential for a major success drives the high R&D investments needed to develop such technology.

Developers make large investments at several stages of the standardization process. They either develop the technology specifically for the standard or adapt technology to meet the proposed needs of the standard. They expend significant resources in terms of engineering time and supporting development sponsoring and promoting their proposed solution within the SSOs, including testing and compliance programs and other

[107] The dynamic effects of innovation on economic performance may be more valuable long-term than short-term price allocation effects. E.g., EC (2004), p 276.

investments needed to ensure adoption.

They also continue to develop the technology to a usable form after formal standards adoption and as it is being brought to market. Standards in ICT are usually anticipatory, setting specifications for future products using technologies not yet fully developed. Much of the technology development, adaptation, simulations, and conformance testing needed to make the standard real, let alone product development using the standard, is expected to take place after formal standard specifications are stabilized. A standard may be adopted on the understanding that the sponsor will undertake further development.

Technology proposals for the standard are often developed in parallel and compete for support from others in the standards working groups and, indeed, in standards developed in other SSOs. There are unlikely to be equivalent alternatives available "off the shelf." SEP technology involves considerable investment directed at ensuring the success of the standard and its wide adoption. This occurs before, during, and after formal standards setting.

Alternative proposals may compete strongly for adoption, and developers make investments to develop and "sell" their technology to the SSO, with a likelihood that many proposals—the majority—may fail to be adopted and the sponsors may receive no return.[108] Even when one standard is adopted, similar competition occurs between other standards in the marketplace, many of which may never succeed.[109] The developer must earn sufficient returns over the long term with its successful technologies to cover the costs of the rejected technologies and standards, as well as the successful ones. This is another reason why limiting (successful) innovators to the "inherent value" or *ex ante* rates is likely to undercompensate innovators generally, as such an approach fails to compensate for the costs and risks of the "dry wells" associated with technologies that are *not* adopted for standardization.

4.3 Role of standardization in technology development

There are at least three critical aspects of standardization relevant to a proper assessment of FRAND licensing.

a) ICT industries are centered around standardization

[108] As discussed below, accepted proposals are likely to be a minority of total submissions to the standards working groups. Failed proposals may represent as much as 75% or even 85% on average of original proposals, and a similar proportion of the total effort during the standards setting. See Gupta (2013); Signals Research (2010).

[109] For example, core OFDMA technology is fundamental to 802.20 FlashOFDM, 3GPP2 UMB, 802.16 WiMAX, and 3GPP LTE, but only LTE has gained sufficient traction in the market for long enough to generate much in the way of revenues for anyone. There are many other examples of standards developed at great expense and incorporated into products but which ultimately failed in the marketplace, such as Betamax in VCRs, Digital Audio Tape, and Telepoint (the attempted commercialization in the UK of CT-2 technology). Grindley (1995). In terms of numbers of prospective standards, the winners may be relatively few, though individually often phenomenally successful. Mobile phones and smartphones are the "exceptions."

In network industries such as ICT, technologies and products are developed primarily to be used in networks. This includes the preparation and promotion of individual technologies for standards adoption. SSOs provide a forum for firms to coordinate development and compare potential technologies.[110] Essential technologies are not selected "off the shelf." They are developed, or adapted, for standards and compete for adoption. If successfully adopted, they may still need much further development. Many proposals are never used (they may be scrapped, absorbed into another proposal, or reused in another application) and may have little residual value. The investments are therefore risky. Firms would not have adequate incentives to take part in this development unless they believed they had an opportunity to recover their costs, including those for unsuccessful "dry wells." The appropriate contribution made by the successful SEP technologies, motivating these investments, is the full value of the final products and services enabled by the standards, not just the incremental value between competing proposal technologies *ex ante*.

b) Standards setting is a complex process

Standardization is a long and complex process that involves significant development and coordination efforts by multiple firms over several years.[111] Technologies are not selected for a standard in a single step. Preliminary investments in development and coordination may begin well before the scope of a future standard is outlined. They continue during the process of developing individual standards and selecting between proposals, and may increase as a potentially successful candidate nears acceptance. Formal adoption takes place when the standard has "stabilized" in committee, but even this is not necessarily the end of the process. The sponsor may commit to further developments and product support to gain acceptance by other manufacturers and ensure the standard is successfully introduced in the marketplace. Many standards are adopted in SSOs but fail in the market, and commitment by the sponsor may be critical.[112] Subsequent efforts related

[110] Aspects of standards setting as a combination of competition and cooperation are described in Leiponen (2008); Baron & Pohlmann (2011). Traditionally, commentators have stressed the voluntary collaborative aspects of SSOs and policies SSOs might use to help speed agreement (which might support a view that any value from standardization should accrue to those implementing the standards): "[SSOs] use a consensus process to create new compatibility standards." Simcoe (2008); "[SSOs] try to replace the bandwagon de facto standards process with an orderly explicit search for consensus. This process mingles technical discussion and political negotiation." Farrell (1996), p 2; "Such careful and explicit cooperation is a natural response to the need for coordination." Farrell & Saloner (1988), p 2. More recently, commentators have stressed standardization as an arena for competition between technologies (which implies technology companies expect to be rewarded for their investments): "[A]lthough some may view SSOs' processes as collaborations among competitors, standardization at SSOs are subject to a rigorous evaluation process where contributing members compete to have their technology incorporated into the standard. The collaborations and the SSOs are, in fact, a playground for competition among competitors." Wright (2013), p 23. Relationships between standardization and patenting strategies are studied in Kang & Bekkers (2013); Kang & Motohashi (2013); Bekkers, Bongard & Nuvolari (2011).
[111] Hildebrand (2002).
[112] Sometimes this may be perceived as due to a lack of full commitment by the sponsor to ensure further development and supporting product availability in the marketplace. E.g., see Intel sponsorship of "D33" memory technologies in 1990s, which left the PC industry unconvinced, or Intel's efforts to force DRAM manufacturers to make RDRAM by (initially) refusing to support non-RDRAM chips with its controller chips.

directly to standardization include testing and conformance certification procedures that need to be established (often by specialist firms that need information and inputs such as simulations and experimental data). Peripheral technologies not incorporated in the standard itself may also need to be developed to apply the standard.[113] Not all may be within the formal standard specification, but they are part of the requirements for success.

A standard is also developed over time. Following the initial standard, there are usually amendments, corrections, and revisions to rectify omissions and add features following experience in a marketplace. There may be major new additions to a standard to raise performance and open new applications. Radical modifications effectively define new generations of the standard, such as 2G, 3G, and 4G in mobile communications and SDR, DDR, DDR2, and DDR3 SDRAM standards in computer memory. In a decade, a standard may have a number of amendments for minor corrections interspersed with major revisions to consolidate previous amendments and introduce substantially new features.[114] The potential for such advances and the implied commitment by the sponsor to support and participate in these are part of the original adoption decision by the SSO.

Investment in standards technology development may therefore occur over a long period. Before embarking on this process, a standards sponsor must expect to have an opportunity for an adequate return if successful and to finance further innovation. The expected sharing of the returns, and the incentives to make investments both in developing technology and in developing and marketing standards-compliant products, should be seen as a balance between the players in the industry. Some of this takes place within the SSOs, some in the marketplace.

c) Standards and licensing in ICT

Innovation is a continuous process in ICT industries. Streams of innovations are developed by multiple firms, and there may be no clear boundary between one technology generation and another. With this rate of development, normal licensing practice is via worldwide, field-of-use, portfolio cross-licensing, applying to all of a licensor's patents in a field of use for a licensing period.[115] Since many firms may be developing technologies in the same area, it is usually infeasible to identify all patents and patent applications that might be infringed, especially when both patents and products may not be known when the license is agreed. By cross-licensing all a patent holder's present and future patents in a field of use, firms have a "freedom to operate" without worrying about possible infringement, and save transactions costs of continually renegotiating licenses. Royalty payments are agreed based on expected sales of infringing products and the estimated value of the portfolio to the licensee. If arranged as a cross-

[113] Other technologies might themselves be subject to some other standards (including those royalty free or open source).
[114] Over the period from 1992 to 2002, GSM standards had more than five major revisions and introduced new technologies such as SMS, MMS, GPRS, and EDGE. These significantly advanced GSM capability. The UMTS standard has so far appeared in 12 versions, the latest of which have taken it from 3G UMTS to 4G LTE, partly by evolution, partly revolution. http://www.3gpp.org/specifications/gsm-history; http://www.3gpp.org/specifications/releases; http://www.radio-electronics.com/info/cellulartelecomms/gsm_technical/gsm-history.php
[115] Grindley & Teece (1997).

license, the projected royalties are balanced out with a net payment by the firm with the most use of the other's patents. This reflects also in patents used in standards. Some licenses may cover just SEPs, others may cover both SEPs and non-SEPs. They may simply apply to patents used in "all current (wireless) standards" rather than individual standards. Sometimes individual patents are specified for inclusion or exclusion from the agreement. One-way licenses, including those from non-manufacturing entities (NMEs), are usually similarly structured on a portfolio, field-of-use basis.

Portfolio cross-licensing is *ex post* in the sense that it is based on how actual products and patents are performing at the time and forecast over the next licensing period. It is not normal to license patents *ex ante* for standards that are still under development, though firms may do so if both sides wish. Developers make a FRAND commitment for potential SEPs and may sometimes also make assurances that future licenses will be available at rates not to exceed a given amount.[116] The point is that firms expect portfolio licensing to be the normal basis on which licenses are negotiated and accept this in proprietary technology into the standard. Rates are expected to reflect normal conditions applying if and when licenses are needed, set via the usual evaluations of factors such as the contribution of the patents to product value, cost of inventing around, and the quality, validity, and infringement of the patents. We recognize that among several other factors, negotiating conditions may depend on the availability of injunctions for SEPs, which is still being clarified by the courts in the US and elsewhere and may be in some flux. This does not remove the key condition that rates are based on the contribution to the value of products in use, not prior to standardization.

Provided the basis for developing technology is to share in the full value contribution of standardized products, then the timing of licensing negotiations need not be critical to setting rates. If firms want to take licenses earlier, before a particular standards adoption or product market development, they might do so on terms that might be adjusted to allow for uncertainty about future conditions. If firms choose to wait, as they normally do, until the standard is adopted and has had a chance to perform in the market, then rates can be negotiated with better information. This recognizes that changes in bargaining power and switching costs may be real concerns and may be sensitive to when the negotiations take place. But positive standardization benefits are also real concerns that are only fully effective once the development of the market is known. Normal cross-licensing negotiations allow for a balance of positive and negative effects. Pre-standardization licensing might discount for the parties' expectations of both effects. If expectations were perfect, then pre-standardization "expected" negotiations would parallel future "actual" negotiations.[117]

[116] Many firms have pre-announced maximum future rates for LTE licenses. Stasik (2010).

[117] As a practical matter, the future market is likely to be unpredictable, so it makes sense to wait to negotiate a license to save unnecessary transactions costs. However, licensees usually have the option to negotiate for a license privately before a standard is adopted if they believe future terms might be onerous, or if they can get a better deal by licensing early, and occasionally do so. For damages purposes, licensing negotiations may be assumed to take place hypothetically at the time of first infringement or another date. However, such hypothetical negotiations should take place on the assumption that rate negotiations would consider the "full-value" contributions of the patented technologies, not just the "incremental value," as

4.4 SSO standardization processes

Standards in ICT industries are usually developed within standards setting organizations. These voluntary organizations coordinate the developing and adoption of technical specifications for products and services across the industries. Members include technology developers, device and equipment manufacturers, network operators, and application and service providers, as well as other organizations. Standards combine two main aims: (a) compatibility, so that devices from different firms can interoperate and use common components; and (b) quality, to select the most effective technologies for development and use. In high-tech industries, standards are usually anticipatory and identify the most appropriate new technology for the next-generation products before it is fully developed so as to coordinate R&D and other investments, avoid duplication, and speed adoption. This sets the schedule for the introduction of new technology generations.

Standardization is a lengthy process. It includes planning for future standards, developing and selecting standards features in working groups, adopting standards for publication, and testing and verification. Mobile standards have provided the focus for the development and introduction of successive mobile communications generations, which could not have happened so effectively otherwise.[118]

Key aspects of standardization include inception, specification, validation and testing, and adoption and publication. They continue with overlapping modifications and extensions. The following summary focuses on 3GPP, the leading worldwide wireless standards organization, but similar processes apply to other SSOs such as IEEE, Jedec, and ANSI–accredited organizations.

a) Inception

The first stages in standardization may occur well before the main standards setting effort as interested firms and possibly government organizations start to outline the needs for new standards. Typically, an industry consensus forms within an SSO for general requirements for a new generation of standards, such as for 3G mobile communications or Wi-Fi wireless local area networks (WLANs). Task forces in appropriate SSOs study long-term needs. The result may be a set of top-level requirements that, when approved by the general assemblies of the SSOs, give rise to new standards programs.

b) Specification

The core of standards development is the generation of technical specifications for new products. Member firms submit (sponsor) particular specifications to task groups and working groups within the SSO. In practice, proposals may come primarily from a few leading core technology developers.[119] Many technology developers are at least partially

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discussed above.

118 The technical advances and introduction of mobile communications standards GSM (2G) and 3GPP (3G, 4G) standards are reviewed in Hildebrand (2002); Gupta, Grindley & Quaglione (2015) (draft paper).

119 Gupta (2013); Signals Research Group (2010).

vertically integrated into component and device manufacturing. Other members, such as other manufacturers or operators, which are typically more numerous, participate by reviewing and contributing to the proposals and notably by voting for the standards. They may participate in the SSOs primarily to keep abreast of standards development and be prepared for the new technologies. Member firms' representatives, mostly engineers not likely to be involved in IP issues, work together to define specifications in working groups. Proposals are selected in the working groups using a consensus process based mainly on technical merit. There may initially be several proposals for a function. Representatives meet to present their solutions and discuss the pros and cons. Sponsors continue to develop and test their proposals during this process and respond to feedback. Proposals are eliminated at successive meetings by formal or informal voting until there is a consensus for the final selection. In the early stages, voting may be by elimination of the least popular in each round, but typically a proposal must achieve a super majority (70% for 3GPP) of voting membership for final adoption. Sometimes features from proposals are combined to gain consensus. To be eligible for voting, members must have maintained regular attendance in the working group as a precondition for being able to make useful comments on the proposals and demonstrate their commitment.

The SSO groups meet regularly to present, discuss, and vote on proposals, and it may take many meetings, over periods of months or years, before a standard emerges. During this time, many proposals are eliminated, others may combine into joint proposals, and all proposals are likely to be modified to respond to comments and requests. An initial proposal may be an outline only and must be more fully developed and specified over time. Indeed, the bulk of development effort may take place once the standardization process is underway. Formally, this takes place in response to "change requests" to first define the proposal and then modify the proposal to meet comments by the working group. At each stage in standardization, the meetings represent the outcome of months of development effort by the sponsors.

Standardization involves rigorous comparisons among technological alternatives. In some cases, these are investigated and compared closely, and go through repeated balloting procedures. In others, the performance of one alternative may be so clearly superior that alternatives are eliminated early on.

c) Validation and testing

Technical specification is the major part of development effort, but there is more before a standard is complete. As a specification nears completion, and before a standard is ready for adoption, the working groups must develop validation programs to verify that product designs meet the standard and can interoperate, and testing procedures to enable certification agencies to check that products meet the performance requirements. As a specification stabilizes, these steps needed for implementing the standard become more important. This starts during the later specification phase, when review, modeling, prototyping, and field "plug-tests" provide feedback about how the standard will work in practice. These form the basis for future validation and testing procedures.

Much of the effort in developing these procedures naturally falls to the original sponsors.

Some later effort for validation and testing may be shared more broadly within the SSO. Functions such as conformance testing are usually performed privately outside the SSO once the standard is complete by agencies accredited by the SSO.

d) Adoption and publication

As a proposal moves through the working group, it stabilizes, with fewer outstanding changes, until the specification is accepted as mostly complete. Once all steps are complete, and following final voting by the working group and coordinating group, a specification is deemed ready to be adopted as a formal part of the standard. Specifications are ratified by higher committees and become part of the published standard.

e) Generations of mobile standards

Standardization is not a single step but continues with corrections, amendments, and revisions over time. A standard is published once it is "stable," but it may be understood that some issues will need to be addressed in the next version. After an initial release, there may be corrections and amendments, perhaps annually. These are followed by new releases every two to three years, to add significant enhancements and consolidate previous changes. From time to time, perhaps in ten years, there is a major new standards release taking it to the next "generation."[120]

The boundaries between generations may not be clear. Technology shifts are normally introduced in stages as more capabilities are added to an existing standard. For example, digital mobile communications standards have had three major underlying technology shifts, from 2G GSM in 1991 to 3G WCDMA/UMTS in 1998 and 4G LTE in about 2008.[121] There have also been major enhancements to the existing generation in the meantime, such as the addition to GSM of SMS 1993, MMS 1998, GPRS 1998, and EDGE 1999, with the high-speed-data-capable GSM versions sometimes referred to as 2.5G or 2.75G. Enhancements to 3GPP WCDMA—such as HSPDA 2002 Release 5, HSPUA and MBMS 2003 Release 6, and HSPA+ 2007 Release 7—gradually increased its capacity and speed. These are sometimes referred to as 3.5G, 3.75G, or 3.9G and may be described commercially as 4G.[122] The first "LTE" standard was in 2008 Release 8, which included some performance features required for LTE capability. The first version of 3GPP that met the IMT Advanced 4G requirements was introduced in 2011 Release 10.

Similarly, releases of Wi-Fi IEEE 802.11 standards have increased the speed and capabilities significantly between the original 802.11 in 1997 to 802.11b in 1999,

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[120] Such "progressive" technology development with repeated upgrading of standards via amendments, major releases, and new generations of standards technology is typical for mobile standards, though not necessarily for all standards.
[121] The major change from UMTS to LTE was in 2008 with Rel LTE (which was still only 3G). However, "true" 4G standards date from around 2011 when 4G LTE Advanced was standardized, as below.
[122] In the US specifically, there was a tendency for T-Mobile and AT&T to call HSPA+ 4G. This was in response to Sprint and Clearwire calling WiMax 4G, whereas strictly speaking, even LTE Release 8 did not meet the formal 4G requirements.

802.11g in 2003, and 802.11n in 2009. There has been a major "roll-up" of previous standards into 802.11-2012. Newer Wi-Fi standards, notably 802.11ac and 802.11ad, are under development. Some standards may be upgraded significantly over time yet still not be ultimately successful commercially in the marketplace. The IEEE 802.16 (WiMAX) family of standards began with the release of 802.16-2001 in 2001 and has been further developed with major new releases including 802.16e-2005 in 2005 and 802.16-2009 in 2009, with 802.16m-2011 standard as the core technology for WiMAX 2. Yet despite being one of the two main contenders for 4G mobile and being deployed in many mobile networks worldwide, WiMAX has generally been supplanted by LTE for most deployments of 4G mobile in the major markets.[123]

Core technology development is continuous. Unless this is adequately rewarded, there will be fewer incentives for developers to contribute to the next-generation standard. This does not necessarily mean the same firms will do the development every cycle—in high-tech industries, there are often rapid changes in leadership. But it does imply that opportunities to earn returns from development have to be present and commensurate with the substantial investments needed.

Standards setting is not a "one-shot" game. If a firm whose patented technology was incorporated into one version of a standard tried to "hold-up" the industry with respect to that version, it would run the risk that its technology would be rejected for future versions or for other standards. If firms routinely behaved in such a way, even if individual leaders change over time, this would reduce the general confidence in standards setting and ruin the basis for cooperation. The fact that standards often go successfully through several generations shows that firms do not in general behave in such a short-termist way. This "repeat play" consideration significantly constrains the real-world ability of patent holders to hold-up the industry.

f) Cooperative effort revisited

Standards development can be a long process. It involves significant effort by all members, such as participating in meetings and providing technical support. The bulk of the effort in the earlier stages is by the developers, who must not only develop and adapt the technology but also promote it. Combined with the preliminary development before the proposal, development effort for a primary proposal is likely to be significant. As well as technical support, the successful standard will need to convince other members of the value of its solution, adding to the effort needed in sponsoring a standard. There is also likely to be further effort needed after formal adoption of a standard in supporting testing and validation efforts. Later, as products are introduced in the market, the focus of effort in the industry shifts from being mostly development to being a balance among technology development, product development and manufacturing, and further ongoing technology development for the newer-generation standards.

The sponsor's ability to support the introduction of the standard in the marketplace,

[123] Duffy, Jim (2010) LTE vs WiMAX: Has mobile WiMAX been permanently crippled in the 4G technology battle?, Network World, June 7, 2010. http://www.networkworld.com/news/2010/060710-tech-argument-lte-wimax.html

including commercial support such as ensuring adequate manufacturing partners and complementary services like software and applications support, though not part of standardization, may be a factor in promoting the standard to the SSO adoption as a low-risk, high-potential option. The sponsor may need to have demonstrated this broader support. Recently, the ecosystem of support for products such as smartphone services and operating systems has also become an important part of the overall effort needed to promote standards; this is not part of standardization per se but may be part of the investments that developers and manufacturers may need to make in order to promote its technology.[124]

4.5 Standardization processes in 3GPP

These processes can be seen in action for 3rd Generation Partnership Project (3GPP), a consortium of major SSOs and their member companies.[125] 3GPP is the main SSO coordinating the development of mobile communications standards. It was created in 1998 to manage the introduction of 3G WCDMA/UMTS standards, bringing together versions developed by the regional SSOs. It is organized within ETSI, the original developer of 2G GSM standards and 3G W-CDMA, the predominant UMTS standard.[126] 3GPP currently is concentrated on developing 4G LTE standards.

3GPP standards include the sequence of ETSI/3GPP standards from the first Phase 1 GSM standards in 1992, WCDMA/UMTS in 1999 Release 99 through to LTE 2012 Release 11, with more to follow. Although there have been significant changes of underlying technology in the 20 years between 2G, 3G, and 4G, these are considered part of the same family; an aim of 3GPP throughout this series has been to maintain backward compatibility (in one way or another) with the earlier standards.

The organizational structure for 3GPP standards setting is shown in **Figure 4**.[127]

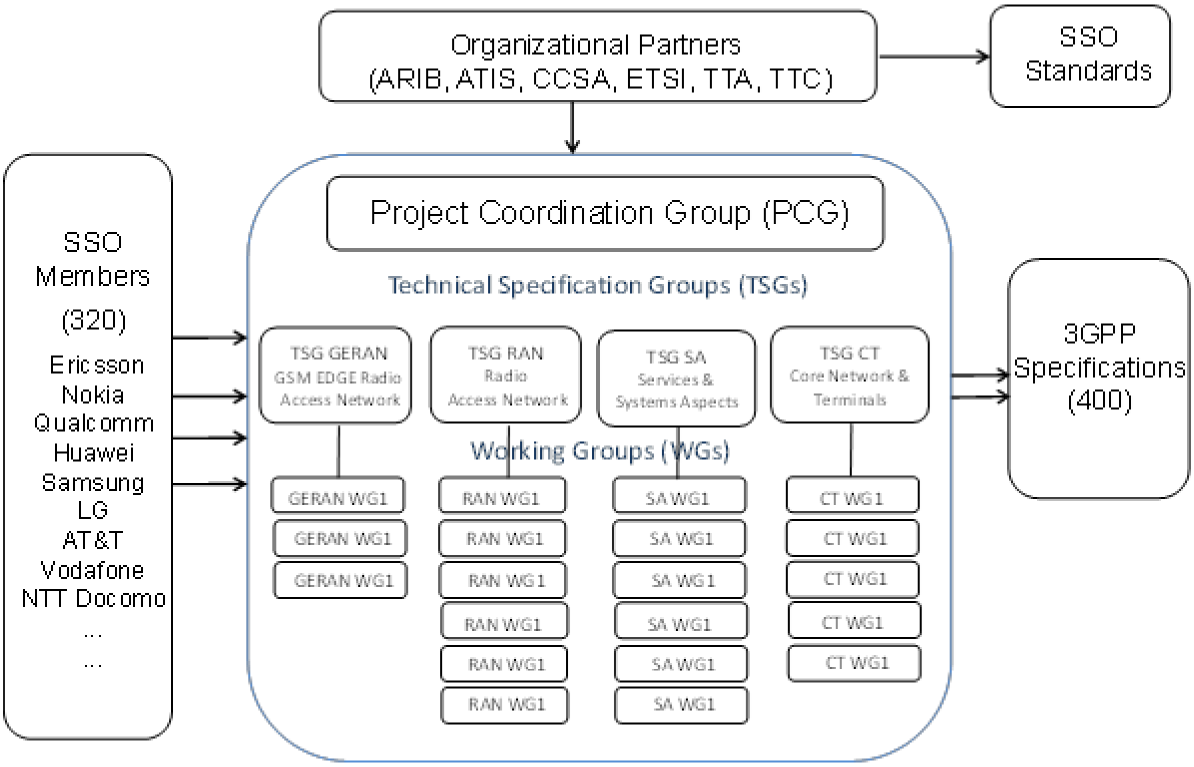
Figure 4: 3GPP Organization

[124] Gupta, Grindley & Quaglione (2014) (draft).

[125] http://www.3gpp.org/

[126] The other leading 3G standard worldwide is CDMA2000 developed by the 3rd Generation Partnership Project 2 (3GPP2) collaboration and used by some mobile operators in the US, Canada, Korea, and Japan. http://www.3gpp2.org/Public_html/Misc/AboutHome.cfm

[127] Gupta (2013); http://www.3gpp.org/Specification-Groups ; http://www.3gpp.org/About-3GPP



3GPP unites seven telecommunications standard development organizations known as "organizational partners."[128] It provides their members with a stable environment to produce the reports and specifications that define 3GPP technologies. 3GPP is effectively run by companies, participating via their membership of one of the organizational partners, which send representatives to serve on the committees and working groups. There are currently 400 individual company members listed on the 3GPP website, 295 of which (76%) are members of ETSI, as well as 14 market representatives (industry associations), 3 observers and 6 guests.[129]

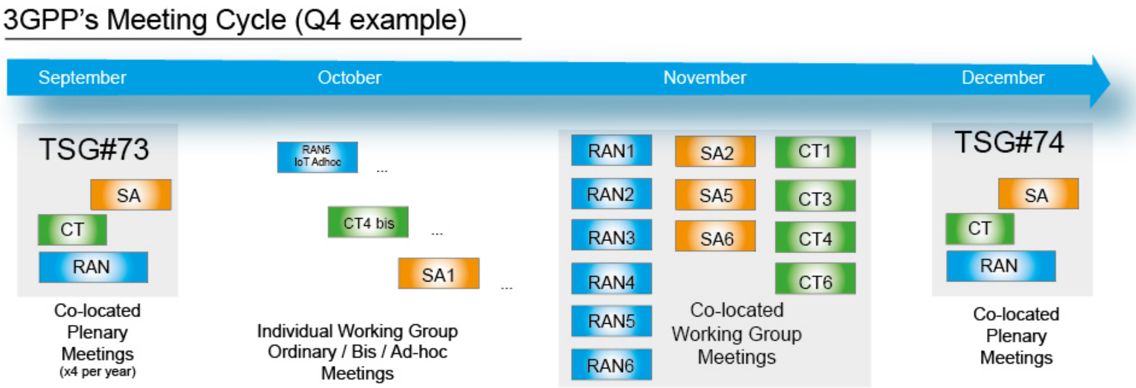
3GPP specifications are developed in Technical Specification Groups (TSGs) and Working Groups (WGs). Each TSG has a particular area of responsibility for the reports and specifications within its terms of reference. There are currently four TSGs in 3GPP: Radio Access Networks (RAN), Core Network and Terminals (CT), GSM EDGE Radio Access networks (GERAN), and Service and Systems Aspects (SA). Each TSG has a set of WGs, which meet regularly four to six times a year. Each TSG has its own quarterly plenary meeting where the work items from its WGs are presented for information, discussion, and approval. The last meeting of each cycle of plenary meetings is TSG-SA, which is responsible for the overall architecture and service capabilities of systems, and for cross TSG co-ordination. TSG SA, which also has responsibility for the overall

[128] The seven 3GPP Organizational Partners are: The Association of Radio Industries and Businesses, Japan (ARIB), The Alliance for Telecommunications Industry Solutions, USA (ATIS), China Communications Standards Association (CCSA), ETSI, Telecommunications Technology Association, Korea (TTA), and Telecommunication Technology Committee, Japan (TTC), and (since 2015) Telecommunications Standards Development Society, India (TSDSI). http://www.3gpp.org/About-3GPP
[129] http://3gpp.org/about-3gpp/membership

coordination of work and for the monitoring of its progress. The highest decision making body in 3GPP is the Project Coordination Group (PCG), which meets formally every six months to carry out the final adoption of TSG work items, to ratify election results and the resources committed to 3GPP.

The cycle of meetings for the working groups involved in developing RAN specifications (as an example) is shown in **Figure 5**.[130] TSG RAN coordinates the work of the individual working groups and interfaces with other TSGs in the plenary sessions. The whole is coordinated via the PCG. There may be a number of cycles before a standard is defined.

Figure 5: 3GPP working group and plenary meeting cycles



Kang and Bekkers (2013) studied the full series of meetings for the 3GPP RAN1 group from this group's first meeting, in January 1999, until its last, in February 2010, a total of 77 meetings. The average spacing between the start days of each cycle was slightly under two months (52 days). This is composed of an average of 7 working days by the participating firms preparing for the next meeting, a 4.5-day meeting, and a 40.5-day "idle" period before the next cycle. However, this is an idle period only for the standards working group. The firms sponsoring technology for standardization continue to develop the technology during the whole period in preparation for the next meeting. The majority of SEPs have priority dates within the idle period, showing that much development goes on outside the SDO.[131] The study also finds that SEP patenting activity peaks just before the quarterly meetings, which may be interpreted to indicate that much development is geared to developing technology specifically for inclusion in the standards.

The timeline of the various releases of 3GPP standards since 1999 is shown in **Table 1**.[132] These show the regular addition to standards in standard releases over time. A typical standards release may take about two to four years to develop. These processes overlap—groups start working on new issues for the next release before the current release is

[130] http://www.3gpp.org/about-3gpp The meeting cycles in the illustration do not include TSG-GERAN.
[131] Kang & Bekkers (2013), pp. 9-11.
[132] http://www.3gpp.org/about-3gpp

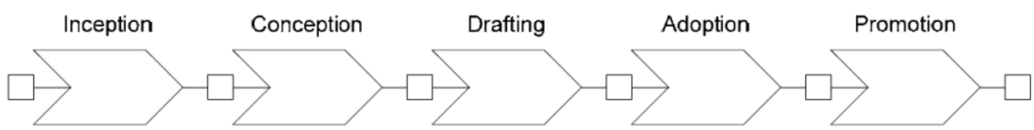
finalized.[133] Although not shown in Table 1, as the future schedule and content of new standards releases are subject to change, work in 3GPP is already underway in 2017 for Release 14 and the first preparatory 5G standards, Releases 15 and 16.

Table 4: 3GPP standards releases

3GPP Release	Release date	Content
Release 99	2000	First UMTS standard: based on W-CDMA
Release 4	2001	1.28Mcps TDD, All-IP core network
Release 5	2002	Added HSDPA, IMS
Release 6	2005	Added HSUPA, MBMS, integrated with WLAN, GAN, PoC
Release 7	2007	Added HSPA+ (MIMO, HOM, etc.), EDGE Evolution
Release 8	2008	First LTE,: all-IP Network (SAE), OFDMA, FDE and MIMO radio interface
Release 9	2010	LTE enhancements: WiMax interoperability, Dual-Cell HSDPA , HSUPA
Release 10	2011	LTE Advanced: IMT Advanced 4G requirements, multi-Cell HSDPA
Release 11	2013	Further LTE enhancements, detailed 4G LTE Advanced
Release 12	2014	LTE-B: Wi-Fi integration, LTE-Hi hotspot & small cells, 3D beamforming
Release 13	2016	Further enhancement: 30x LTE capacity

The overall standards making process, here for ETSI, is shown in **Figure 6**.[134]

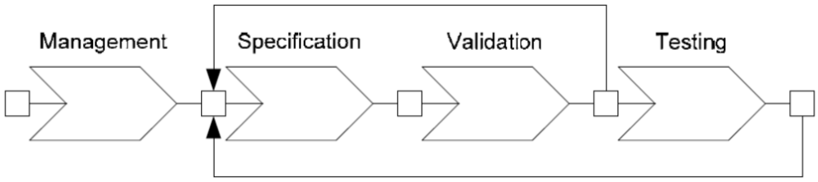
Figure 6: Standards Making Process (SMP) at ETSI



The main focus for standards generation is the drafting phase. Drafting takes place in stages of management, specification validation, and testing, shown in **Figure 7**. Within this the central activity is specification, but the others are also important. Standards need to be designed for interoperability from the beginning of this phase. Feedback from the validation and testing activities is critical, and may call for further development of the original technology or changes in the specifications. This feedback is introduced into the ETSI SMP as shown. Steps in validation include review, modeling, prototyping, and "plugtests."[135]

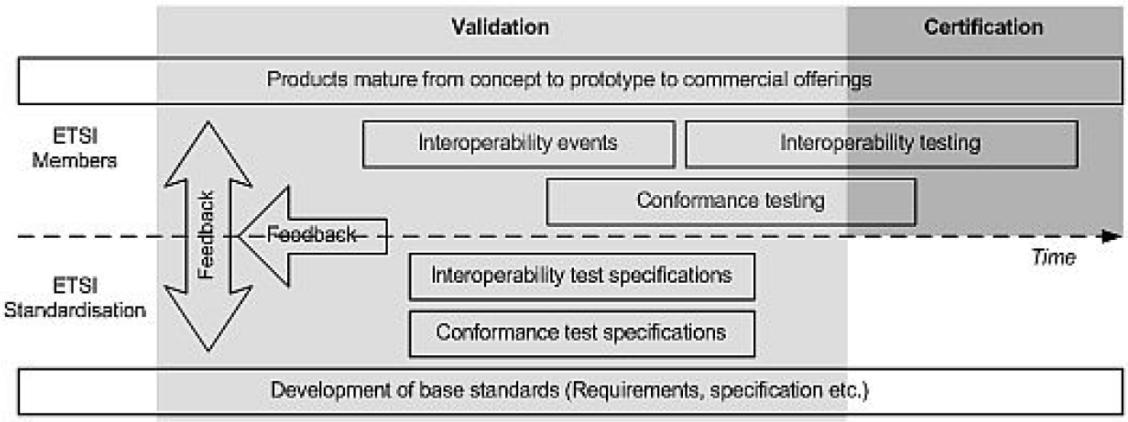
[133] There is also not necessarily a clear break between standards "generations." LTE 4G standards are reckoned to start with 3GPP Release 8, but many of the features being added to the standard, such as enhancements to HSDPA and HSUPA, are essentially continuations of W-CDMA 3G standards.
[134] van der Veer & Wiles (2008); http://portal.etsi.org/Chaircor/process.asp
[135] Plugtests (or plugfests) are events in which the designers of equipment or software using the standards test the interoperability of their products or designs with those of other manufacturers.

Figure 7: The drafting phase of the SMP, with feedback



Much of the technical development incorporated in standards takes place within the member firms as the standards are being developed. This is most clearly illustrated during the later stages of validation and testing, shown in **Figure 8**.[136] Once the basic standards are developed, conformance test specifications are developed within ETSI and put into effect by member firms operating outside ETSI. As testing proceeds and as products mature from concept to prototype to commercial products in the marketplace, the developer and testing firms provide feedback to the ETSI standardization process. This may require adjustments, large or small, to the technology or the standards.

Figure 8: Relative time-line of standards development, validation, and testing



4.6 Empirical studies of standardization

There have been an increasing number of empirical investigations of SSO processes and the contributions of members. The following two studies report data analyses relevant to the current discussion.

Gupta (2013) reviewed meeting participation in 3GPP over a period from 1999 to 2012. Some findings were:

- Total firm efforts just for meeting attendances are very large. In the 12-year period, there were 989 meetings for the working groups, with nearly three million man hours for meetings alone at an estimated cost to the member firms of around

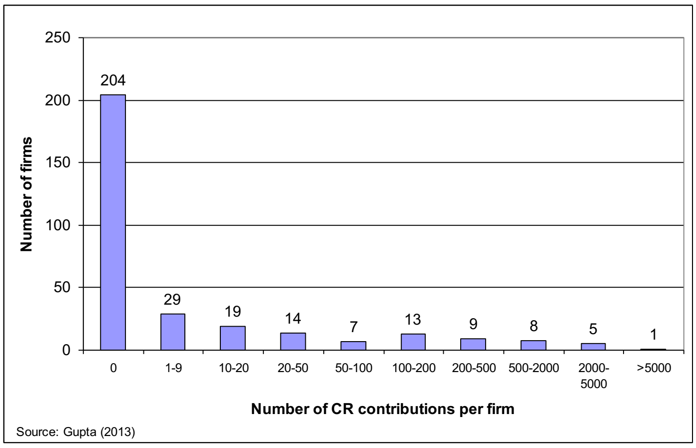
[136] Wiles (2008).

$150 million. For developers, time in meetings is the tip of an iceberg; much more work would be expended outside the SSO to develop the technology and the proposals.

- Many more proposals are made than are ever approved. For the RAN working group, only 31% of the overall contributions are approved in the standards. There is competition between proposals, and firms cannot be sure their development effort will lead to successful adoption.

- Technical contributions are concentrated in a few large developers (see **Figure 9**). About 66% of the 320 member organizations make no change requests (CRs) (technical proposals), while 2% of firms make 65% of the CRs. This indicates the different roles of the players. Developers lead the technical development. Manufacturers and operators are active in the meetings, but this appears mainly to keep abreast of development, make comments, and be prepared for the standards when complete. However, the broad participation also implies that cooperation is working and that benefits are expected to be shared among all parties.[137]

Figure 9: Distribution of CR contributions in 3GPP RAN (1999-2012)



- The concentration of technology development in a few main innovator firms is also seen in the number of SEP declarations. Of the 347 organizations involved in all 3GPP groups, only 22% had at least one declared patent, while 2% declared 80%. This does not imply that smaller companies do not also make important technological contributions.

- There is good evidence of consensus building. There is no evidence that the larger firms (in terms of numbers of contributions) have an advantage over others in the probability of their contributions being adopted. As standards go through revision iterations, multiple firms may combine proposals and work together toward final

[137] "Majority of the attendees in the standards meeting seem to be passive participants, with equal right to influence the decision of what is adopted or not in the standards, without making active technical proposals or contributions. … [A]ctive contribution requires upfront investment in risky R&D, which is undertaken by a smaller proportion of the attendees." Gupta (2013), p 28.

acceptance of the standard.[138]

Gupta believes that understanding the institutions and the data behind SSOs can help in addressing some SEP policy concerns. Comparing the time and effort spent across working groups indicates that all technologies are not equal in their value—some are fundamental to the standard, others more peripheral. Standards setting is also not a one-shot game. Following the adoption of the initial standard, "[s]everal iterations and revisions are made over the years to technical specifications."[139] This indicates the role of the key developers in leading standardization over long periods, and the fact that "the standards world is not divided neatly into an ex-ante and ex-post universe."[140] .

Signals Research (2010) studied submissions to 3GPP standards working groups (55% of them for LTE) between 2007 and 2008. It found high attrition of individual and incremental contributions to standards. Of 42,318 technological suggestions, including those subject to SEPs, most did not make it into the standard. Of the LTE-specific submissions, only16% (fewer than one in six) were approved by the pertinent 3GPP working group.[141] Among other things, this implies that return on investment for adopted submission in successful standards must provide payback for all the core technology development and standards setting work for the other five-sixths that are not adopted.[142]

To put development costs in context, total R&D in 2013 for the 12 global leading mobile technology companies was over $40 billion, with revenues of $583 billion.[143] Over 1.8 billion mobile phones were shipped in 2013, of which 55% were smartphones.[144] Global revenues in 2012 are estimated at $305 billion for handsets, $55 billion for cellular network equipment, and $1.16 trillion for mobile operators.[145] There is a huge ecosystem in the mobile industry built on wireless technology and standards, with high R&D costs to be funded.

5. Development of the mobile communications industry

Critics of the current system may also be challenged to show why the proposed *ex ante*/inherent value rates are better for the mobile industry compared to the current system. The mobile industry has been and remains remarkably dynamic and competitive. We summarize key aspects of mobile industry performance below, drawing on Mallinson

[138] Gupta (2013), p 26.
[139] Gupta (2013), p 27.
[140] *Ibid*,
[141] "The remaining LTE submissions were withdrawn, noted (but not approved), revised, or not acted upon by the working group. Most of the unapproved submissions fell into the latter classification." Signals Research (2010).
[142] On costs of standardization, Dini (2013) estimates that for MP3 standards, CCETT (France) alone spent €11.2 million over seven years of R&D and participation on the standardization process for the MPEG audio technology. In all, 17 companies/R&D centers were involved in MP3, implying a total cost of about €190 million.
[143] Mallinson (2014).
[144] Zeman (2014); Raman (2011)
[145] Figures from Credit Suisse (handsets and network equipment) and GSMA Intelligence database (operator revenues).

(2013) and other reports.[146]

- The cellular industry has been very successful economically in terms of technologies, devices, networks, and services. This is based on various and numerous interdependent technologies whose development has been coordinated via standards. These are subject to thousands of patents with extensive licensing among technology developers and manufacturers.

- Mobile technology has been extraordinarily successful in the market place. Over 1.8 billion mobile phones were shipped globally in 2013, of which one billion (55%) were smartphones.

- The scope and structure of the industry are constantly evolving. New entrants such as high-level operating systems, applications, and mobile data services have contributed to a new mobile ecosystem in which mobile communications are increasingly seen as the hub for future ICT industry.

- Since the introduction of GSM in 1992, aggregate royalty rates have reduced and may be considered modest in comparison to all associated revenues.

- Mobile devices and networks have been totally transformed, with substantially increasing performance and reducing prices.

- While performance specifications have vastly increased, unsubsidized prices have actually reduced since 2006.

- Perhaps the most vivid illustration of the dynamic competition in the industry is the dramatic change in handset market leadership over the past two decades.

This success begs the question of what is wrong with the current organization of returns that indicates a need for change. In particular, why should it be assumed that the contribution of essential technology is low and that rates should be reduced? The mobile phone industry is one of the most successful, innovative, and competitive of recent history. This is based on standards and licensing practices that have proven their value for decades. The current system of market-negotiated cross-licensing has undoubtedly contributed centrally to the success of ICT industries.

6. CONCLUSION

Standardization is central to development, manufacturing, operations, and service provision in ICT industries by anticipating new technology and ensuring interoperability. It is an essentially collaborative process, as reflected in SSO policies that aim to balance the interests of all parties. As part of this process, core technology is developed to be adopted and implemented via standards, on the understanding that the innovators will have an opportunity to earn an appropriate return, by licensing or manufacturing, if

[146] Industry performance is summarized in Mallinson (2013). See also Ericsson (2014); Sharma (2014); ITU (2013).

successful. The potentially large market for standards technology helps motivate firms to take the risks of developing technology.

We argue that as an integral part of standardization, returns to development should be commensurate with the full returns. Licensing practices have evolved to support this. The FRAND commitment is part of this, designed to enable beneficial collaboration between competitors while avoiding potential blocking and possible antitrust concerns.[147] There are two parts to the FRAND commitment. First, and often overlooked, owners of potentially essential IP commit to "make licenses available" for essential IP for use in the standards to *all* standards implementers, whether the licensees took part in standards setting or not. This is a significant undertaking for the IP owner. Second, the terms of such licenses should be FRAND, to ensure that these are not used constructively to bar entrants, place competitors at a disadvantage, or favor some implementers, and so do not negate the first commitment. Significantly, FRAND is not a commitment to *low* rates, just to FRAND terms including rates.

The concerns voiced in the *ex ante*/inherent value methods are that licensors might abuse potential market power and demand "too high" a price. Yet there are equivalent concerns that licensees might operate as buyers' cartels in the SSOs to force lower rates or individually "hold out" against SEP owners seeking to out-license their IP. These two concerns might be seen as part of the "balance" of interests between developers and implementers in standardization, which has served in the past to ensure that both groups have appropriate economic incentives. Courts and policymakers are now altering this balance by suggesting policies that could significantly reduce returns to developers. Proposals may either increase licensee collective power (via *ex ante* auctions or changed SSO policies) or reduce the unilateral power of the licensors (setting rates based on ex-standardization value). These approaches would strip royalty rates of any effective share of the value due to standardization.

This makes no sense. The approaches are based on a theory that SEP owners may extract "too much," which ultimately asserts that the technology developers are not entitled to share the network benefits of cooperative standards. Our assessment of incentives for development and implementation of standards and the practice of SSOs indicates that rates should reflect the full-value contribution, including a share of standardization benefits. The impact on standardization as a whole has also been taken out of the *ex ante* equation. Unless all groups are appropriately incentivized, some may reduce innovation and/or withdraw from standards setting, with general economic harm.

Given the depth of developers' involvement in standards setting, a presumption should be that all SEP owners have contributed to the full product value. The extent of the contribution is likely to be unearthed in normal licensing negotiations, which also include factors such as patent "essentiality," strength, validity, infringement, design-around costs, and individual firm circumstances. As a practical matter, such evaluations are normally

[147] A main motive for including the FRAND commitment in SSO IP policies was, and is, to ensure that standards bodies can set standards without raising antitrust concerns, such as potential collusion to bar entry or jointly raise prices. To avoid antitrust concerns, participants in standards setting are expected to focus on technical issues and not discuss commercial matters within the SSO.

performed *ex post*, in portfolio cross-licenses, though might be performed at any time provided the "full-contribution" context remains. We are aware that a factor in *ex post* licensing negotiations may be the enhanced bargaining power of the licensor due to the potential difficulty infringers may have in avoiding SEPs. It may be difficult to allocate a "fair share" of the GFT from standardization. However, these are only part of the many factors involved in actual licensing negotiations, which have generally worked effectively to date. Concerns about the balance of bargaining power may be more properly topics for the conditions under which injunctions may be granted for SEPs and/or non-SEPs, not for removing the basis on which technology is remunerated. There are also many practical problems with trying to implement the *ex ante*/inherent value methods.

Proponents of change should demonstrate that the existing system is failing and why *ex ante* proposals would improve this. A great risk is that ill thought through changes to licensing conditions or damages awards for SEPs may have harmful effects on incentives for technology developers to contribute their best technology to standards. This could severely disrupt these historically very successful industries.

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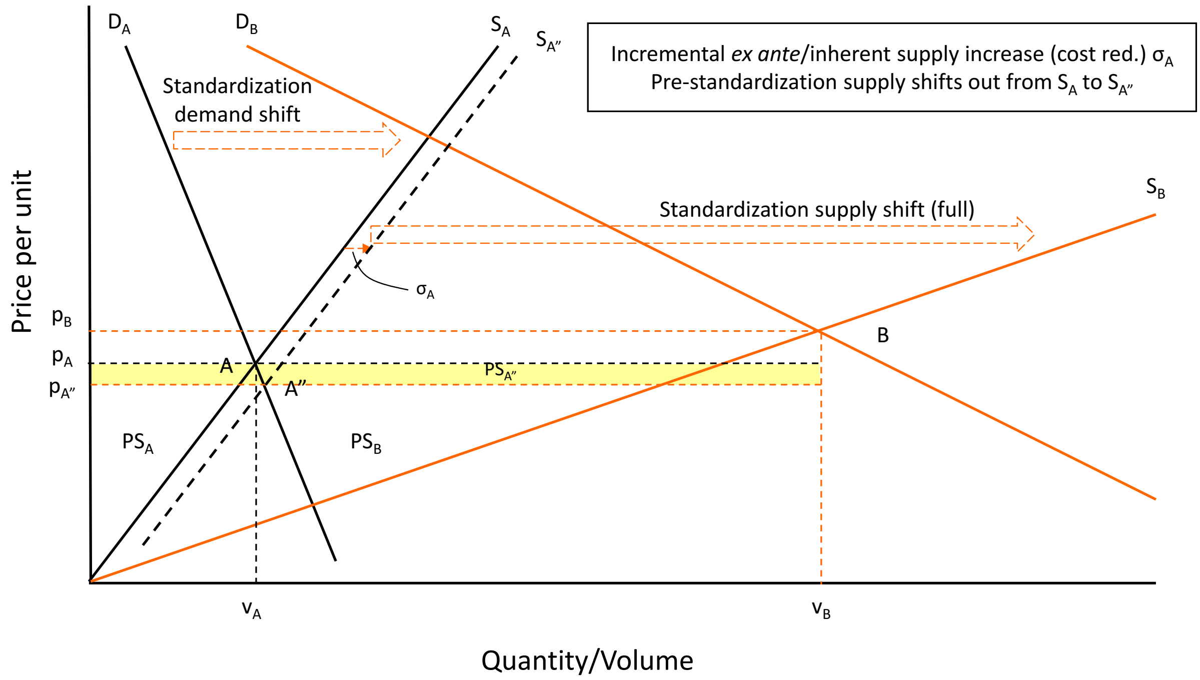
APPENDIX: *EX ANTE* RATES WITH COST REDUCTION

The effect of incremental *ex ante* rates on innovator earnings when the intrinsic advantage from using the technology is a small cost reduction is shown in **Figure A1**. An incremental reduction in the cost of manufacturing the product before standardization shifts the supply curve right by a small amount σA to SA” (i.e., a higher quantity σA of product can be manufactured for a given per-unit cost). Pre-standardization, this would reduce the market equilibrium price from pA to pA”. After standardization, the supply and demand curves move out to their full amount SB and DB as before.

If a running royalty rate is set by a (bargained) share of the price reduction, then after standardization this is multiplied by the total volume VB, and the total royalty earnings are represented by a share of the area $PS_{A''}$. Although the SEP owner levies a running royalty over the increased standardization volume VB, the total royalty earnings are likely to be smaller than the total available producer surplus PSB. Clearly, the returns to the innovator depend primarily on the pre-standardization benefit (pA-pA”). This may be a small amount if the *ex ante* cost reduction being bargained over is just the increment between the SEP technology and the next best alternative. Also, the contribution of the technology is assumed to have no impact on the perceived attractiveness of the standard, and benefits passively from the increase in volume. In practice, bringing the cost down below a target range may be critical to wide consumer standards adoption, so should not be considered separately from the total surplus.

Figure A1: Standardization with ex ante incremental cost reduction



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