Commercial and economic impacts from IPR policy changes

A report for Qualcomm

Ian Corden, Tim Miller, Sarongrat Wongsaroj, Sam Wood

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Plum Consulting, London
T: +44(20) 7047 1919, **www.plumconsulting.co.uk**

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Overview

We provide an independent assessment of commercial and economic impacts that could result in the telecommunications and related sectors, following recent policy changes adopted by the US based IEEE technical standards body.

The IEEE changes, as adopted, are highly contentious and represent a significant shift from established 'FRAND' policy, as currently adopted by Europe's ETSI and others, that has served the industry well for many years.

Telecommunications and the wider digital economy form a significant and vital element of Europe's economy. If the IEEE policy changes affect European markets and firms, significant commercial and economic harm could result.

This report provides an independent assessment of the commercial and economic impacts that could result from important changes in policy associated with Intellectual Property Rights (IPRs) in certain technical standards bodies, as related to research and development (R&D) of commercial products in the telecommunications sector.

Technical standards are, and have been, essential enablers in the development of modern telecommunications systems, providing both platforms for intense and critical R&D activity and global growth via access to economies of scale and market diffusion. Today's global smartphone industry is worth some €400bn in revenues and this is just a part of the modern digital economy which is estimated to be worth around 10% of global GDP (and growing).

The pioneering success of mobile telecommunications systems is part of Europe's modern heritage which saw essential involvement from standards bodies, such as ETSI (European Telecommunications Standards Institute), and the ongoing development of fifth generation (5G) telecommunications systems is a matter of crucial concern for many of Europe's most senior policy makers.

Development of legal protection of intellectual property via established patent processes and policy within standards development organisations (SDOs) is normal procedure in the high technology and telecommunications industries. Where patents are introduced into standards with potentially no possibility for subsequent product implementation without either infringement or legal patent use (i.e. potentially, no technology workaround is feasible in implementations against the standard using the patent), such patents are referred to as Standards Essential Patents (SEPs).

Where SEPs are invoked, some factions have developed a theory suggesting that tension could result with incidences of market power and imbalance conflicting with the objective of making standards widely available for use. We address policy that was implemented in March 2015 by the US based Institute of Electrical and Electronic Engineers (IEEE), which has become known as IEEE-II, following a series of prior revisions, and was driven due to concerns, raised by some, over the ability of existing policy to effectively address such tensions.

However, IEEE-II policy is highly contentious; many see no need for divergence from established Fair, Reasonable, And Non-Discriminatory (FRAND) policy that appears to have served the industry well for many years.

Essentially, IEEE-II implements firmer rules around licensing rates for SEPs and places restrictions on access to injunctive relief (legal protection) which can be required when commercial practices fail.

Purpose and scope

We undertake a detailed review of the IEEE IPR policy changes, developing both qualitative and quantitative assessments of commercial and economic impacts, were the changes to impact European markets and firms.

Our purpose is focused on extraction of commercial and economic meaning of the IEEE-II policy changes, against a baseline of FRAND policy as established within ETSI and others and as recently advocated by CEN (The European Committee for Standardisation) and CENELEC (The European Committee for Electrotechnical Standardisation) – two other important standards bodies within Europe. In order to achieve this, we undertake a detailed review of the policy revisions developed under IEEE-II and surrounding industry debate. We then develop both qualitative and quantitative analysis to estimate commercial and economic impacts that could result if IEEE-II policy or similar were to impact European markets and firms.

The IPR policy field is, by nature, complex and manifold. Our analyses comprise quantitative economic modelling together with deep industry experience and expert judgement in both development of analyses and results.

Our scope excludes any recommendations towards legal and accounting matters.

Key issues

The IEEE policy changes were brought about with significant objections and continue to drive industry debate today.

Evidence for ‘patent hold-up’ – the theory of market power brought about by leverage of standards essential patents, and driver towards IEEE policy revisions – is

Since even before implementation of IEEE-II, contentious debate has ensued. During development of the policy revisions, many held that the policy was agreed despite significant objection. In fact, the policy was implemented with favourable support from the US Department of Justice (DOJ), where it saw pro-competitive value in the revisions with concerns over ‘patent hold-up’ – the theory that SEP owners are able to drive up royalty rates through leverage of market power brought about by control of access to legal implementation on commercially favourable terms.

However, in reality, evidence for ‘patent hold-up’ appears to be hard to find and many position that evidence for patent hold-out, where consumers of SEP materials are able to drive down royalty rates either through illegal infringements or the withholding of payments, is much more accessible. Nevertheless, IEEE-II policy was implemented in March 2015 and parties wishing to leverage standards made under IEEE auspices are subject to that policy.

In the drive to address concerns on ‘patent hold-up’, the new policy

hard to find.

IEEE policy revisions are centred on firmer and restrictive definitions of royalty rates and removal of injunctive relief for patent owners. The legality of these principles has recently been called into question under European competition law.

Implementation of the IEEE policy revisions is likely to lead to reduction in revenues for innovators and patent owners which, in turn, is likely to stem investment in R&D and thus harm innovation and productivity in markets, with no significant countervailing benefits.

Overall, we expect material harm to European and national GDP levels if IEEE-II policy concepts become widespread.

implements a number of revisions. Significant areas include reference to the concept of Smallest Saleable Patent Practicing Unit (SSPPU) for setting of royalty rates and withdrawal of ready access to injunctive relief.

Under FRAND policy, parties are at liberty to bilaterally negotiate royalty rates and other terms and conditions according to unique and particular situations and to access legal protection when deemed necessary.

The concept of SSPPU is particularly contentious; it was introduced in a specific US legal case in 2009 in a dispute over patent infringement and award of damages and develops a theory around division of value in products where SEPs are deployed. The concept of SSPPU was not designed to be used widely for award of patent damages or valuations on commercialised technologies. This theory is difficult to rationalise from an economic perspective, since value cannot easily be segmented in integrated products that are commercialised in the real world.

Further, recent debate[1] has called into question the legality of firm royalty rate policy definition under European competition law (see Articles 101 and 102, TFEU – Treaty on the Functioning of The European Union), and the Court of Justice of the European Union (CJEU) held in 2015, in its deliberations over the Huawei vs ZTE case, that access to injunctive relief must be upheld, where it is required.

We hold that, on balance, the amendments contained in IEEE-II (or similar policy), if implemented, would lead to significantly reduced royalty rates, which would in turn have impacts extending to levels of R&D investment, and therefore R&D output, and would potentially have some impact on product prices if cost reductions were passed along the value chain.

We do not see the potential for significant impact on telecommunications service prices as such are typically driven by operational and annualised costs in service providers' own businesses.

In our analyses, we investigate these issues in some detail; we postulate that R&D investments will be impacted both as a result of near term decline in SEP revenues and as a result of strategic considerations towards R&D budgets which could arise if the currency of SEPs is devalued in the market place. Declines in R&D investment and a shift of R&D away from standards development both have potential to reduce overall productivity in markets. We assess the materiality of this impact through modelling of R&D levels towards European GDP levels. We also assess impacts on product pricing through analysis on smartphone consumption. With nominal price declines in products, consumer welfare can increase and this can be measured via changes in consumer surplus; however, quality levels must also be considered. Our analysis includes consideration of nominal price declines, price elasticities reading on to volume levels, and quality adjusted prices – which we include as changes

[1] Petit, N. (2016) 'The IEEE-SA Revised Patent Policy and Its Definition of 'Reasonable' Rates: A Transatlantic Antitrust Divide?', *Fordham Intellectual Property, Media & Entertainment Law Journal*, Vol. XXVII.

to R&D stock levels will likely affect product quality levels relative to our baseline scenario built on FRAND policy. Of course, if cost benefits are absorbed fully along the value chain, no nominal benefits at all will result for end users, and quality adjustments could then lead quickly to negative impacts on surplus.

Key findings

We have assessed materiality of impacts to European GDP levels via detailed economic modelling.

Our analyses indicate that, with widespread implementation of IEEE like IPR policy, European GDP levels could be harmed significantly – by at least negative 0.5%, with significant risk of contagion to the wider digital economy – worth around 10% of European GDP.

In contrast, we expect only modest benefits from any impacts to smartphone prices. In fact, in the medium to long term, harm is likely due to product quality levels being driven by reductions in R&D investment.

With IEEE-II policy or equivalents in place, we estimate that a decline in overall European R&D of 8% could be precipitated, yielding a negative impact to GDP figures of 0.5% in the long run. Such an impact would amount to €465bn (at 2016 rates).

We believe that this estimate is conservative as it is likely that in addition to reduction in overall R&D investment, diversion of investment could also occur as a result of any actual or perceived devaluation in standards output. With disproportionate decline in standards output, productivity gains associated with standards per se will be lost. We estimate that such effects have the potential to drive a further decline in overall GDP by approximately 1.5 percentage points.

In addition, the high technology and telecommunications industries are significant enablers to the wider digital economy. Estimates put the worth of this at c. 10% of total GDP (across G-20 countries). Whilst it is unlikely that implementation of IEEE-II policy or similar would detriment the entire digital economy, it is certainly true that user access to digital platforms is increasingly shifting towards mobile devices and some level of contagion is likely in the economy as a whole.

In contrast, our analysis on smartphone handset price reductions and impact to consumer welfare suggests only relatively modest benefits, if any. When measured in terms of consumer surplus in Europe, these benefits may amount to just €3bn (at 2016 rates, with material impacts evident only over a five year cycle), with no material impacts to telecommunications service pricing. With no pass through on cost benefits to prices, overall negative impact to consumer surplus is likely (taking into account, in all cases, the negative impact on pace of innovation and product quality levels likely to be precipitated by declines in R&D investment levels).

We conclude, overall, that significant negative impact to national and regional GDP levels is likely with the scale of R&D investment changes that would be precipitated with implementation of IEEE-II like policy in standards bodies, with negligible to no offsetting of this with improvements in consumer welfare.

Recommendations

European policy makers should be aware of the IEEE 2015 IPR policy and its significance.

Our independent analyses indicate the potential for significant overall economic harm if IEEE like policy becomes widespread.

We recommend that European IPR policy is continued in line with established FRAND principles, with no need to adopt revisions in line with IEEE 2015 IPR policy.

With the importance of the telecommunications and high technology industries to Europe's economy and its positioning in global markets, we believe that effective development of policy is of paramount importance for Europe. Particularly, effective positioning on IPR policy in Europe's standards bodies will be critical if Europe is to uphold any leadership in its high technology and telecommunications industries and, more widely, in its digital economy segment.

European policy makers need to be fully briefed on the issues presenting and the importance with IPR policy matters as pertaining to technical standards.

Our analysis indicates that the principles embodied with the IEEE's current IPR standards policy collectively have the potential for economic harm if implemented. We uphold that there is no proven net benefit in implementation of such policy or any similar, and that therefore, there is no need for Europe's esteemed standards organisations to deviate from established FRAND policies that have served European and, in fact, global firms well for many years.

We recommend that European policy makers consider the benefits of established FRAND policy and that any considerations towards policy changes are founded upon sound economic principles.

With the above, we conclude that from an economic standpoint, development of IPR policies within standards bodies – beyond established practices based on FRAND principles towards those based on IEEE-II policy – is not only not economically beneficial, but in fact economically harmful, and is therefore best avoided.

1 Introduction

This Report provides an independent and robust assessment of the commercial and economic impacts that could ensue with changes in Intellectual Property Rights (IPR) policies in certain technical standards bodies as associated with the global telecommunications sector.

Effective coverage of the subject field demands application of wide and deep knowledge covering technical, commercial, economic, legal, and accounting matters, as well as practical operational processes within the high technology and telecommunications industries, especially towards commercial innovation and R&D.

Thus, throughout, we have leveraged relevant data and literature, together with our own experience gained via direct practice in industry on many of the matters to hand and via our commercial and technical consulting experience gained with clients the world over.

1.1 Purpose

Our purpose has been to review recent IPR policy changes in detail, and to lay out expected key commercial and economic impacts, referring along the way to relevant industry debate and knowledge of the telecommunications industry. Our work includes both qualitative and, where feasible, relevant and material, quantitative assessment on impacts.

Our work is based on instruction from Qualcomm and is focused towards review of established IPR policies such as those within Europe's ETSI[2], and recent policy changes as developed by the US based IEEE[3] Standards Association (IEEE-SA). However, our results and findings have not been driven by Qualcomm and this report is independent of Qualcomm's aims and objectives.

1.2 Scope

Our scope excludes any and all advisory on legal and accounting matters.

Our focus has included the following areas.

- Clarification on background, precedent and situation leading to development of policy changes.
- Definition and interpretation of policy changes.
- Review of industry debate and positioning as to impacts of changes.
- Development of an independent view on impacts, inclusive of both qualitative and quantitative analyses.
- Concluding views on merits of changes.

Whilst the issues to hand incorporate global scale and may have wide commercial and economic impact, our assessment is focused towards those matters of particular relevance for Europe.

[2] ETSI: European Telecommunications Standards Institute.

[3] IEEE: Institute of Electrical and Electronic Engineers.

2 Background

In order to understand IPR policy, its importance, and its ramifications, it is necessary to understand why such policy is relevant, how it fits within industry, and to what areas it relates.

Therefore, we begin in this Section, by reviewing key interrelated areas including the purpose of IPR policy, the R&D process and investment approach for firms, industry development of technical standards, and the role of intellectual property rights and the patent system.

2.1 What is IPR policy and why does it matter?

Policy associated with intellectual property and related rights (hence, intellectual property rights – IPR – policy) in the development of technical standards is akin to wider public regulation in the sense that it is developed and required to ensure balance between the rights of private firms (with any developments in research and development – R&D – and patented innovations, as may be used in standards) and levels of industry competition and development (with any consumption of technical standards in the development of products that may apply such innovations).

More specifically, where patented inventions are included in standards and it is not possible to implement on the standard without infringement on such patents, IPR policy becomes particularly important. In such situations, any patents included within standards are referred to as standards essential patents[4] (SEPs). A full discussion of the definition of standards and patents is included below.

With the complexity of value systems in today's global high technology and telecommunications industries, various issues and viewpoints have emerged associated with IPR policies, and no single body of consensus currently exists.

Moreover, changes in such policies have the potential for manifold impacts. Ripples from policy changes can be expected across R&D investment levels, product pricing, rates and levels of industry innovation and ultimately economic performance and wellbeing at national and regional levels.

2.2 R&D in industry

Broadly, R&D is deemed an essential commercial activity, necessary in the production of innovative new products, services and processes, which can drive commercial and economic benefit. Fundamentally, innovation may be associated with increasing value, either through cost reduction in production and activity, or through development of saleable goods.

Levels of R&D and innovation can be strategic to firms, countries and regions with the potential for material wealth creation and the development of competitive differentiation. Effective R&D is traditionally seen as an enabler towards healthy gross domestic product (GDP[5]) levels and the

[4] Note: SEPs are normally defined as patents that are potentially essential to standards.

[5] The Organisation for Economic Co-operation and Development (OECD) defines GDP as 'an aggregate measure of production equal to the sum of the gross values added of all resident, institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs)'. The International Monetary Fund (IMF) states that 'GDP measures the monetary value of final goods and services – that is, those that are bought by the final user – produced in a country in a given period of time (say a quarter or a year)'. Essentially, GDP represents value added in a given economy, with adjustments for inflation; however it is prudent to be cautious, as Robert Kennedy alluded in 1968, much that is valuable is

neoclassical (Solow-Swan) model[6,7] in macroeconomic theory includes the level of technology available within an economy as a driver for GDP.

However, realisation of benefits from investment in R&D is not certain; R&D is inherently a risky business and any positive outcome is reliant upon a complex web of factors including alignment of the products of R&D with market demands at appropriate times and prices, effective commercialisation and product management – ensuring that promising ideas from the 'laboratory' are realised in the marketplace, and alignment to and leverage of international standards and policies.

2.3 What are technical standards?

In the technology sector today, products and systems can often be more effectively exploited, bringing both commercial and economic benefits, if certain technical standards are complied with.

A *technical standard* is an established norm or requirement in regard to technical systems. It is usually a formal document that establishes uniform engineering or technical criteria, methods, processes and practices.

In contrast, a custom, convention, company product, or corporate standard that becomes generally accepted and dominant is often called a *de facto* standard.

2.4 How are standards developed?

Technical standards may be developed under standards development organisations (SDOs) such as ETSI and IEEE and typically involve the submission of technical contributions which may proceed to the development of published technical standards either via edict or formal consensus amongst technical experts. Published technical standards are typically referred to as *specifications*.

In the US, the IEEE-SA's involvement in electrical standards dates back to 1890, when the AIEE (American Institute of Electrical Engineers) proposed a recommendation for the practical unit of self-induction. As a pioneer in voluntary electrical and information technology standards activity, IEEE became a founding member of ANSI (American National Standards Institute) in 1918. In 1963, when the AIEE merged with the IRE (Institute of Radio Engineers) to form the IEEE, a formal standards body was established to support standards development. Envisioning the expanded role that standards were to play in the future and their impact on industry, IEEE formed its first Standards Board in 1963. In 1998, the IEEE Standards Board was reorganised, and given additional autonomy as the IEEE Standards Association[8].

In Europe, ETSI exists as a not-for-profit, standardisation organisation in the telecommunications industry, with worldwide projection. ETSI produces globally applicable standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast and internet technologies. ETSI was created by CEPT in 1988 and is officially recognised by the European

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neither tangible nor tradeable; the usefulness of GDP has been disputed by some, yet nothing has replaced it in the main thus far.

[6] Solow, R. (1956). 'A contribution to the theory of economic growth'. *Quarterly Journal of Economics*. Oxford Journals. 70 (1): 65–94.

[7] Swan, T. (1956). 'Economic growth and capital accumulation'. *Economic Record*. Wiley. 32 (2): 334–361.

[8] See: http://ethw.org/IEEE_Standards_Association_History , accessed August 2016.

Commission (EC) and the EFTA[9] secretariat. Based in Sophia Antipolis (France), ETSI is officially responsible for standardisation of Information and Communication Technologies (ICT) within Europe.

Within the telecommunications industry, various SDOs and collaborations amongst SDOs exist around the world. The Third Generation Partnership Project (3GPP), formed in 1998, (a globally collaborative body with participation now across numerous SDOs including those from Japan, the US, China, Europe, India and Korea) has grown to become the most significant collaborative group in the development of technical standards for cellular radio systems (due to the commercial success of related technologies). Collaboration on technical standards work under 3GPP has given rise to the successful commercial launch and global take-up of 3G (UMTS[10], HSPA[11]) and 4G (LTE[12], LTE-A[13]) cellular radio systems, with work towards fifth generation (5G) technologies ongoing. Similar collaborative work has also taken place under 3GPP2[14].

Standards work under 3GPP encompasses radio, core network and service technologies and architectures. Technical standards developed under 3GPP are contribution driven, with participation from individual members. Specifications agreed and 'frozen' under 3GPP may be published by SDOs, whereupon they may attain legal significance in relevant jurisdictions. As of August 2016, 3GPP had 508 individual members listed.

2.5 Why are standards important?

A clear example of the benefit of technical standards is given in the case of a radio access network in a cellular radio system. Without technical standards defining the radio interface in some technical detail, it would not be possible for different handset vendors to produce devices that functioned with the network; also, proprietary technology solutions tend to create vendor 'lock-in' situations which are generally not supportive towards establishment of effective competition and commercial efficiencies. Standards can also offer benefits including reduced barriers to entry in markets (promoting market competition), improved levels of quality and safety for users and consumers, cost and price advantages (via, for example, enabling of economies of scale) and enhanced trade (with adoption of standards across multiple regions, and diffusion and scaling to enable larger markets).

However, benefits offered through standards are not unambiguously positive; standards development in the technology sector can be time consuming and costly, and consensus making inevitably leads to compromise. The development of the 2G GSM technical standards began in 1982 and the world's first GSM call was made in Finland in 1991; work on standards continued over a period of around 15 years with estimates on effort expended at approximately 108,000 person-days (comparable, for example, to the private 'corporate' development of a suite of complex professional commercial software products). With rising complexity (and participation), collective effort on 4G cellular standards has already exceeded 125,000 person-days[15]. Some would counter these factors in asserting that standards making in the technology sector brings together, globally, the 'best and brightest' talent, enabling

[9] EFTA: European Free Trade Association.

[10] UMTS: Universal Mobile Telecommunications System (radio technology).

[11] HSPA: High Speed Packet Access (radio technology).

[12] Long-Term Evolution (radio technology).

[13] LTE-Advanced (radio technology).

[14] http://www.3gpp2.org/ , accessed August 2016.

[15] Boston Consulting Group, (2015) '*The Mobile Revolution*', a report by the Boston Consulting Group commissioned for Qualcomm Inc., 2015.

efficiencies in R&D work, or at least levels of quality or innovation that might not otherwise be possible. Others take a view that standards making provides an 'arena' for effective competition, akin to a tournament, where the 'best' technology wins – enabling benefits ultimately for consumers, society and innovators.

Overall, implementation of standards has been noted[16] to offer a range of generally net positive economic results, with effects on market scaling and diffusion, plus cost scale economies being particularly important.

2.6 Why are IPRs important?

From an economic standpoint, property rights[17] may be seen as a foundation for the development of wealth and prosperity; it is held by many that '*if a man cannot freely reap the fruits of his labour without fear of seizure by government or others, he will have no incentive to work and to develop himself or his ideas*'[18]. Empirical studies have also supported the notion that a positive relationship between property rights and economic growth[19] exists[20,21]. The importance of property rights is further expounded in the work of the Nobel Prize winning economist Ronald Coase[22].

Thus, we hold that prosperity and property rights are inextricably linked. Broadly, such rights include two main types of rights: so-called *possessory rights* and *rights of transfer*. In the main, possessory rights allow individuals and entities to use things and prevent others from using them; rights of transfer allow the transfer of possessory rights, usually in exchange for something. The importance of property rights extends across both tangible and intangible items, including intellectual property.

In modern usage, the term 'intellectual property' (IP) refers to 'creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce'[23]. Intellectual property rights (IPRs) are the protections granted to the creators of IP, and include trademarks, copyright, patents, industrial design rights, and in some jurisdictions trade secrets. Artistic works including music and literature, as well as discoveries, inventions, words, phrases, symbols, and designs can all be protected as intellectual property[24].

The acknowledgement of rights associated with the development and ownership of intellectual property is seen by many as an essential enabler towards economic growth, with particular importance in knowledge based economies; it has been shown that IPRs do have a positive bearing on investment and R&D in developed countries[25,26].

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[16] Tassey, G. (2015), 'The Impacts of Technical Standards on Global Trade and Economic Efficiency', Economic Policy Research Center, University of Washington, US.

[17] Property rights are theoretical socially-enforced constructs in economics for determining how a resource or economic good is used and owned. See Alchian, A. (2008) '*New Palgrave Dictionary of Economics'*, Palgrave, Second Edition.

[18] Shavell, S. (2002) 'Economic analysis of property law', Discussion Paper No. 399, Harvard Law School, 12/2002.

[19] Economic growth is normally defined as an increase in GDP per capita over time.

[20] Haydaroglu, C. (2016) ,'The relationship between property rights and economic growth: an analysis of OECD and EU countries', *Law and Economics Review*, 6 (4), 217–239.

[21] Roll, R., Talbott, J. (2001*), 'Why Many Developing Countries Just Aren't'*, SSRN, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=292140 , accessed August 2016.

[22] Coase, R. (1960) 'The Problem of Social Cost', *Journal of Law and Economics* 1–44.

[23] See: http://www.wipo.int/about-ip/en/ , accessed August 2016.

[24] See: https://www.wto.org/english/tratop_e/trips_e/intel1_e.htm , accessed August 2016.

[25] Greenhalgh, C., and Rogers, M. (2010*), 'Innovation, Intellectual Property, and Economic Growth',* Princeton.

Critically, in defining effective rights of protection in IP, some balance must always be struck between the enabling of incentives to innovate and the balancing of effective levels of competition within markets.

2.7 What are patents?

A patent is a particular element within the field of IPR that may be recognised under the laws of a given jurisdiction, granting exclusive rights to an inventor or assignee entity, for a limited period of time, in return for public disclosure of an invention. Inventions may offer technical solutions to particular issues and may enable products or services that may be sold in a marketplace.

Significantly, patent law is widely held to be a crucial legal foundation upon which the Industrial Revolution from the 18th Century was able to emerge and flourish[27].

A patent does not give a right to make or use or sell an invention. Rather, a patent provides, from a legal standpoint, the right to exclude others from making, using, selling, offering for sale, or importing the patented invention for the term of the patent, which is usually 20 years from the filing date, subject to the payment of maintenance fees. From an economic and practical standpoint however, a patent is better and perhaps more precisely regarded as conferring upon its proprietor 'a right to try to exclude by asserting the patent in court', for many granted patents turn out to be invalid once their proprietors attempt to assert them in court. A patent is a limited property right that a government gives inventors in exchange for their agreement to share details of their inventions with the public. Like any other property right, it may be sold, licensed, mortgaged, assigned or transferred, given away, or simply abandoned. A patent, being an exclusionary right, does not necessarily give the patent owner the right to exploit the invention subject to the patent. For example, many inventions are improvements of prior inventions that may still be covered by someone else's patent. If an inventor obtains a patent on improvements to an existing invention which is still under patent, they can only legally use the improved invention if the patent holder of the original invention gives permission, which they may refuse[28].

Patent infringement occurs when a third party, without authorisation from the patentee, makes, uses, or sells a patented invention. Patents, however, are enforced on a nation by nation basis. The making of an item in China, for example, that would infringe a US patent, would not constitute infringement under US patent law unless the item were imported into the US[29]. Also, patent laws differ significantly across nations.

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[26] Park, W., Ginarte, J., (1997) 'Intellectual property rights and economic growth', *Contemporary Economic Policy*, 15:51-61.

[27] Leaffer, M. A. (1990). 'Book Review. Inventing the Industrial Revolution: The English Patent System, 1660-1800'. Articles by Maurer Faculty (666); MacLeod, C. (1988). In: '*Inventing the industrial revolution: The English patent system, 1660-1800.'* Cambridge: Cambridge University Press.

[28] 'A patent is not the grant of a right to make or use or sell. It does not, directly or indirectly, imply any such right. It grants only the right to exclude others. The supposition that a right to make is created by the patent grant is obviously inconsistent with the established distinctions between generic and specific patents, and with the well-known fact that a very considerable portion of the patents granted are in a field covered by a former relatively generic or basic patent, are tributary to such earlier patent, and cannot be practiced unless by licence thereunder.' – *Herman v. Youngstown Car Mfg. Co.*, 191 F. 579, 584–85, 112 CCA 185 (6th Cir. 1911).

[29] Mallor, J. (2015) *'Business Law: The Ethical, Global, and E-Commerce Environment (15th ed.)'* McGraw-Hill/Irwin. p. 266.

In Europe, the system of patents is supported under European laws[30]:

> *'The fact that intellectual property laws grant exclusive rights of exploitation does not imply that … there is an inherent conflict between intellectual property rights and the Community competition rules. Indeed, both bodies of law share the same basic objective of promoting consumer welfare and an efficient allocation of resources. Innovation constitutes an essential and dynamic component of an open and competitive market economy. Intellectual property rights promote dynamic competition by encouraging undertakings to invest in developing new or improved products and processes …'.*
>
> *'… it must be kept in mind that the creation of intellectual property rights often entails substantial investment and that it is often a risky endeavour. In order not to reduce dynamic competition and to maintain the incentive to innovate, the innovator must not be unduly restricted in the exploitation of intellectual property rights that turn out to be valuable. For these reasons the innovator should normally be free to seek compensation for successful projects that is sufficient to maintain investment incentives, taking failed projects into account.'*

Importantly, patents not only provide legal protection for their owners and thus a basis for commercial reward against investment in the development of intellectual capital, but also a basis for trading in such.

2.8 How are patented technologies included in standards?

The inclusion of patented technologies in a standard typically takes place during the standard development process itself.

SDO members participating in standards development are typically under obligation, at an early stage in the standards development process, to declare potentially essential patented technologies that could manifest as so-called Standards Essential Patents (SEPs) (that is, patents wherein a given standard cannot be implemented without infringement on the included patent).

Since standards themselves define essential parameters for development of products, they can read across the entire industry; standards naturally associate with high product volumes in implementations. Any SEPs within standards also therefore associate with high volumes and thus can confer market power and lucrative royalties for owners. Therefore, the IPR licensing and policy framework against SEPs typically forms an important part of SDOs' IPR policies.

We address IPR policy in technical standards further in Section 3.

2.9 Financing R&D

From an accounting perspective, since returns on investment in R&D are deemed generally uncertain, R&D investment is typically written off during the year of expenditure through profit and loss accounts – and capitalisation is generally not preferred[31,32]. From a financial perspective therefore, R&D

[30] See: http://www.cambridgewireless.co.uk/docs/Microsoft%20PowerPoint%20-%20Daniel%20Hermele%20-%20Presentation.pdf , accessed August 2016.

[31] Under US Generally Accepted Accounting Principles (GAAP) (see: http://www.fasb.org/home), R&D costs are generally expensed as they are incurred with certain exceptions related to elements of costs for the development of software (for internal use or to be sold) and website development costs. This accounting model has been well accepted, and capitalisation is neither

investment is typically tied to revenues in any one accounting period, although financial returns on particular elements of R&D – whether from licensing deals or product sales – may accrue some time after related activities. Crucially, annualised margins for firms can be affected by the relationship between R&D investment levels and sales incomes in any one accounting period. From an operational perspective, it is normal practice for firms to set R&D budgets based on sales levels together with strategic considerations, and it is perfectly reasonable for firms to seek returns on any R&D investments to cover such costs and render fair profits.

Intensity[33,34] in R&D investment varies across sectors; within the high technology development sector, intensity typically runs well into the double digit percentages and high technology development firms rank amongst the highest across all sectors. This is due, in part, to the complexity of the high technology sector (driving the need for a high volume of R&D activity against sales) and the need for highly skilled labour within a limited market.

A comparison of R&D intensity levels for various sectors is shown in Figure 2-1; in our own experience, R&D to Sales ratios in high technology firms of course vary, but figures in excess of 20% are certainly not unknown[35].

common nor preferred. Generally Accepted Accounting Principles, also called GAAP or US GAAP, are the generally accepted accounting principles adopted by the US Securities and Exchange Commission (SEC). While the SEC has stated that it intends to move from US GAAP to the International Financial Reporting Standards (IFRS), the latter differ considerably from GAAP and progress has been slow and uncertain.

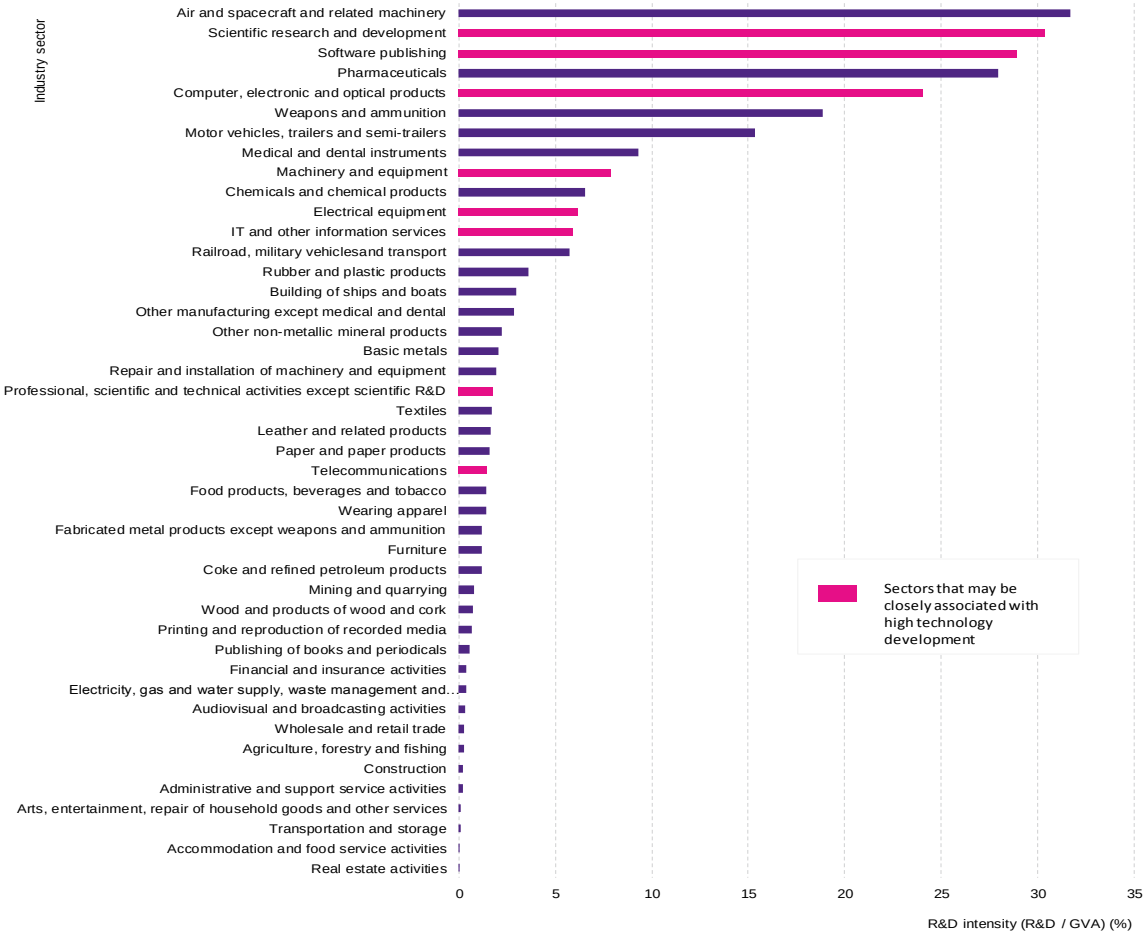
[32] Generally Accepted Accounting Practice in the UK (UK GAAP) is the body of accounting standards and other guidance published by the UK's Financial Reporting Council (FRC) jurisdictions (see: https://www.frc.org.uk/). Generally Accepted Accounting Practice is a statutory term in the UK Taxes Acts. The abbreviation 'UK GAAP' is also accepted as an abbreviation for the term used in other jurisdictions. Under UK GAAP, expenditure on pure and applied research (unless it is expenditure on fixed assets, which should be capitalised and amortised over their useful lives) should be written off in the year of expenditure through the profit and loss account. Development expenditure should also be written off in the year of expenditure except in certain strictly defined circumstances. In situations where all the relevant criteria are met, it is permissible to defer development expenditure to the extent that its recovery can reasonably regarded as assured. Such deferred development costs must be amortised in future years (see: https://frc.org.uk/Our-Work/Codes-Standards/Accounting-and-Reporting-Policy/Standards-in-Issue/SSAP-13-Accounting-for-research-and-development.aspx, accessed August 2016).

[33] Research and development intensity or simply R&D intensity, is generally defined as expenditures by a firm on its research and development (R&D) divided by the firm's output (sales, or gross value added – GVA).

[34] Note: GVA is defined by the OECD as 'the value of output less the value of intermediate consumption; it is a measure of the contribution to GDP made by an individual producer, industry or sector'. GVA may be thought of as an indicator of wealth creation in a given market, measuring the contribution to the economy of an investment in a specific economic activity. GVA may be estimated at the level of any given firm as: Sales (or Revenue) less the cost of bought-in goods or services (excluding employee costs).

[35] See also: http://www.icinsights.com/news/bulletins/Semiconductor-RD-Growth-Slows-In-2015/, accessed August 2016.

Figure 2-1: Levels of R&D investment intensity across different commercial sectors



Source: Analysis based on F Galindo-Rueda and F Verger (2016), "OECD Taxonomy of Economic Activities Based on R&D Intensity", OECD Science, Technology and Industry Working Papers, No. 2016/04, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5jlv73sqqp8r-en

Note: Data shown for year 2011 only.

Scale of R&D in the high technology domain is significant and growing; a recent study[36] estimated that around €91bn per year is invested globally in R&D by the mobile technology industry.

Thus, R&D is a complex domain naturally associated with commercial and financial risk, but also with the promise of economic prosperity to national and regional levels.

Clearly, companies seek adequate returns on their R&D investments. The concept of intellectual property and associated rights and laws, together with patents and standards, have played important and interconnected roles in this regard.

[36] Boston Consulting Group (2015).

3 IPR policies in standards

The areas discussed above as R&D, patents, and standards are tied together in industry through various IPR policies which may be set by the governing boards of various SDOs.

In this Section, we cover the rationale for development of policies associated with inclusion of patents within standards, the nature of established policies, and recent key developments.

As noted in Section 2, with the potential for influence on competitive situations and licensing levels, SEPs have been, and remain, a principal factor in the formation of IPR policies in standards bodies.

3.1 Rationale in IPR policy

The linkage between intellectual property and the development and setting of standards in standards development and setting organisations (SDOs and SSOs) is not new; as early as 1932, The American National Standards Institute (ANSI) Committee on Procedure made the following recommendation:

> *'That as a general proposition patented design or methods not be incorporated in standards. However, each case should be considered on its own merits and if a patentee be willing to grand such rights as will avoid monopolistic tendencies, favourable consideration to the inclusion of such patented designs or methods in a standard might be given.'*[37]

Clearly, from an economic standpoint, the logic incorporated into this argument is one of prevention of unacceptable monopoly and promotion of competitive markets. However, the modern world is not so simple, and the dimensions that must be considered to enable effective economic and commercial policy are manifold. As has been noted in Section 2, the telecommunications and technology industries as innovators are well known to be characterised, on both supply and demand sides, with relatively high research and development (R&D) and capital costs; technology companies often list amongst the highest spenders in global listings in R&D[38]. There is thus an obvious counter argument that investment in innovation should be protected, with some mechanism around the recouping of costs from commercial gains associated with research and development.

Besides motivations such as directing the standard development towards technological solutions where the respective firm is strong and can offer specific services or infrastructure, the prospect of licensing patents that are essential to standards on an industry-wide scale plays an important role in firms' incentives to invest in standardisation activities. However, the exclusive rights conferred by patents on inventors may defeat the object of making standards available to all for public use. In order to address this tension, most SSOs today have defined IPR policies whereby SSO members must commit to licensing their SEPs on particular terms. These commitments are meant to protect technology implementers while ensuring that patent holders receive an appropriate reward for their investments in research and development.

[37] ANSI Minutes of Meeting of Standards Council, November 30, 1932. Item 2564: Relation of Patented Designs or Methods to Standards.

[38] Casey, M., and Hackett, R. (2014) 'The 10 biggest R&D spenders worldwide', *Forbes.*

3.2 The FRAND approach

Industry precedent has been set by various international standards focused bodies such as ETSI, IEEE and others, on the adoption of so-called 'fair, reasonable and non-discriminatory' (FRAND or RAND[39]) policies towards intellectual property in the context of standards making.

Adoption of a FRAND approach within standards bodies has typically meant that proponents holding essential intellectual property (IP) via Standards Essential Patents (SEPs) – wherein a published standard cannot be legally developed and adhered to without infringing such property[40] – are required, by the standards body, to declare the IP within the forum within a reasonable time frame and to openly offer licencing terms to interested parties at commercially reasonable rates often set through bilateral and private negotiations.

Recourse to the law is an option for parties where such negotiations may fail and the law of a specific jurisdiction may become involved in any instances of unlawful behaviour (such as cartels).

3.3 ETSI policy

The FRAND approach is evident through established and published ETSI policy[41] on approach towards intellectual property in standards as:

> '*The ETSI IPR Policy seeks to reduce the risk that our standards-making efforts might be wasted if essential IPRs are unavailable under Fair, Reasonable and Non-Discriminatory (FRAND) terms and conditions. At the same time, we recognize that IPR holders should be fairly and adequately rewarded for the use of their IPRs in the implementation of our standards.*
>
> *The objective of the ETSI IPR Policy is to balance the rights and interests of IPR holders and the need for implementers to get access to the technology defined in our standards under FRAND terms and conditions.'*

Notably, the terms 'fair', 'reasonable', and 'non-discriminatory' are meant to be used as guidelines, rather than as strict definitions, enabling flexibility in any bilateral negotiations.

It is however worth noting that industry precedent establishes the view and practice that 'non-discriminatory' typically means that licences shall be made available, not necessarily on identical bases for all, but on reasonably equitable terms; that is, some companies should not be 'favoured' over others, and that deliberate actions should not drive market imbalance. This understanding carries through in definition of royalty rates; accepted commercial practice is either one of negotiated cross-licensing, or negotiation on licensing rates based on precedent across similar situations[42].

[39] The two terms are generally interchangeable; 'FRAND' seems to be preferred in Europe and 'RAND' in the US. Henceforth we use the term 'FRAND'.

[40] Whilst work-arounds may be a possible means for the avoidance of infringement, such methods may often not be feasible or practicable due to either technical or commercial reasons.

[41] ETSI website (Intellectual Property Rights (IPRs)): http://www.etsi.org/about/how-we-work/intellectual-property-rights-iprs, accessed April 2016.

[42] Geradin, D (2014) 'The Meaning of 'Fair and Reasonable' in the Context of Third-Party Determination of FRAND Terms', George Mason Law Review, 21:4.

3.4 Divergences from FRAND

In recent years, concerns have been raised by certain industry factions as to the commercial and market efficiencies enabled via FRAND approaches. With such observations, various standards bodies have developed ideas beyond established precedent, leading to implemented divergence in IEEE IPR policy from FRAND.

Below, we review the development of policy changes that led up to this divergence, before going on to review the changes themselves.

It is noteworthy that the issue around developing policy on IP and standards has driven a very large literature and heated debate across the legal profession and amongst economists, industry players and academics, as well as at the highest levels in national governments[43] and their competition agencies. This issue has the potential to affect levels of innovation, legality, competition, company performances, and trade levels at national and international levels.

FRAND concepts have also been established under IEEE policy[44] as below.

> *'The licensing assurance shall be either:*
>
> *a) A general disclaimer to the effect that the Submitter without conditions will not enforce any present or future Essential Patent Claims against any person or entity making, having made, using, selling, offering to sell, or importing any Compliant Implementation that practices the Essential Patent Claims for use in conforming with the IEEE Standard; or,*
>
> *b) A statement that the Submitter will make available a licence for Essential Patent Claims to an unrestricted number of Applicants on a worldwide basis without compensation or under Reasonable Rates, with other reasonable terms and conditions that are demonstrably free of any unfair discrimination to make, have made, use, sell, offer to sell, or import any Compliant Implementation that practices the Essential Patent Claims for use in conforming with the IEEE Standard. An Accepted LOA[45] that contains such a statement signifies that reasonable terms and conditions, including without compensation or under Reasonable Rates, are sufficient compensation for a licence to use those Essential Patent Claims and precludes seeking, or seeking to enforce, a Prohibitive Order except as provided in this policy.'*

We review key developments and associated issues as below.

VITA IPR policy

In 2006[46], The US based VITA Standards Organisation (VSO), which sets standards for computer architecture, introduced a policy (VITA IPR policy) that required mandatory disclosure of essential patents and patent applications and for working group members that disclose essential patents to declare ex-ante the maximum royalty rates they would demand for a FRAND licence in a letter of

[43] 'Patent assertion and US innovation', Executive Office of the President, June 2013, Washington DC, US.

[44] IEEE website (extract: IEEE-SA Standards Board Bylaws, Section 6.2 - Policy): http://standards.ieee.org/develop/policies/bylaws/sect6-7.html, accessed April 2016.

[45] LOA: Letter Of Assurance.

[46] Subsequently approved by the VITA Board of Directors and The Executive Standards Council of ANSI in 2007.

assurance (LOA)[47], with stated rationale[48] to prevent so-called 'patent ambush' or 'patent hold-up' – namely the withholding, non-disclosure or leverage of patents associated with unbalanced commercial gain during the development of standards.

IEEE-I IPR policy

In 2007, The IEEE adopted a modification[49] to its established policy that permitted members to disclose their most restrictive licensing terms, including maximum royalty rates. This has been referred to as IEEE-I policy.

In both of these instances, 'patent hold-up' was the major factor cited, where without effective policies in place, it was argued, members participating in standards development were free to drive collective investment in the development of standards, whilst potentially profiting from patented technologies (either directly or via injunctions), delaying innovation, creating undue barriers to entry, establishing market power, blocking markets, raising prices, discouraging take-up of standards, and thus generally creating unwelcome market distortions. In fact, the issue of 'patent hold-up' has been one of the most discussed topics in competition circles on both sides of the Atlantic. Some argued that it has the potential to act as a brake on innovation in general via the effective imposition of taxation on technology.

Several high profile studies have sought to address these and wider issues encompassing both legal and economic angles from varied perspectives [50,51,52]. In its Patent Roundtable discussion event in 2012[53], The International Telecommunications Union (ITU) concluded that the relationship between SEPs and IPR policies remained a difficult issue, noting that, in the context of setting 'reasonable' royalty rates under FRAND:

> '*it is very difficult to determine in advance what is reasonable, particularly since the commercial conditions under which each SEP is licensed merits individual consideration*'.

In a speech at that Roundtable, US Deputy Assistant Attorney General Renata Hesse voiced support for the VITA and IEEE revised policies, but recognised that 'there has been little inclination among standards bodies to follow VITA's and IEEE's lead', going yet further to propose several changes to

[47] VITA, Disclosure and Licensing of Patents in Standards, http://www.vita.com/disclosure ; see also Letter from Robert A. Skitol, Esq., Drinker Biddle & Reath LLP, to Thomas O. Barnett, Assistant Att'y Gen., U.S. Dep't of Justice (June 15, 2006), available at http://www.justice.gov/atr/public/busreview/request-letters/302160.pdf .

[48] 'The objective of this policy change is to eliminate patent ambush,' stated Ray Alderman, executive director of VITA. 'VSO working groups are expected to make sound technical and business decisions. Patent ambushes can delay or undermine the acceptance of new standards.' http://www.vita.com/disclosure , accessed April 2016.

[49] Introduction and Guide to IEEE-SA Patent Policy Effective 1 May 2007, available at https://development.standards.ieee.org/myproject/Public/mytools/mob/patut.pdf ; see also Letter from Michael A. Lindsay, Esq., Dorsey & Whitney LLP, to Thomas O. Barnett, Assistant Att'y Gen., U.S. Dep't of Justice (Nov. 29, 2006) [hereinafter IEEE-I Request], available at http://www.justice.gov/atr/public/busreview/request-letters/302148.pdf .

[50] Kühn, K., Scott Morton, F. and Shelanski, H. (2013) 'Standard Setting Organizations Can Help Solve the Standard Essential Patents Licensing Problem', *CPI Antitrust Chronicle*, March 2013 (Special Issue).

[51] Lemley, M. (2002) 'Intellectual Property Rights and Standard-Setting Organizations', *California Law Review*, Volume 90 | Issue 6.

[52] Kjelland, K. (2015) 'Some Thoughts on Hold-Up, the IEEE Patent Policy, and the Imperilling of Patent Rights', *16th Advanced Patent Law Institute*, Berkeley Centre for Law and Technology, 11 December, 2015.

[53] ITU Patent Roundtable, Geneva, 10 October 2012.

standards patent policy that the 'division has identified … could benefit competition'[54]. Hesse's proposals were later presented at an American National Standards Institute committee meeting on IPR policies[55].

In VITA and IEEE-I, the US Department of Justice (DOJ) saw pro-competitive value in policies that clarify the terms of a FRAND commitment and reduce the risk of expected 'patent hold-up'[56].

There is also risk of reverse hold-up: a firm considering whether to invest in the development of new technologies may consider a variety of factors, including costs, the likelihood of technical success, and return on investment in light of future market conditions. In some sectors, those drivers may include the opportunity to contribute proprietary technology to a standard. If a technical contribution is the best strategy for monetising output from an R&D programme, implementers acting collectively have the power to push licensing returns below market levels, effectively appropriating irreversible R&D expenditures from innovators. Where meaningful, reverse 'patent hold-up' can harm upstream incentives to innovate, reducing the output of cutting-edge technologies needed to drive next-generation standards forward.

Counterargument is provided in perspective on competition[57]. Where a number of players compete for a prize, there is merit in placing high value in such a prize as the dynamics amongst players to attain the prize will drive competition which may in turn promote, in the case of standards development in technology, excellence in innovation and enhanced time to market.

Further, many would argue that the tremendous commercial successes of GSM and other global standards based technologies are direct evidence of the technological leadership and economic value driven by established FRAND collaborative and competitive behaviour in standards bodies. With the huge growth in smartphones over latter years and decreasing prices thereof, consumers globally are seeing direct benefits of competition in mobile telecommunications markets[58]. However, whilst the public face of developments in cellular technologies is perhaps culminated in the convenience and efficiency afforded with smartphone devices, behind this face lies billions of dollars in R&D in networking and IT systems and commercial operations, all of which must also be paid for.

Concerns on 'patent hold-up' are often accompanied by related apprehensions on so-called 'patent thicket' – where groups of patents could be associated with any implementations of products. This in turn has given rise to concerns over 'royalty stacking' where implementers could be burdened by groups of royalty payments. However, detailed studies[59] have found no evidence for the existence of 'royalty stacking'; the concept remains as theory only. We address these issues in further detail in a later section.

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[54] Renata H., Deputy Assistant Att'y Gen., Antitrust Div., U.S. Dep't of Justice, Six 'Small' Proposals for SSOs Before Lunch, Remarks as Prepared for the ITU-T Patent Roundtable 13 (Oct. 10, 2012), available at: http://www.justice.gov/atr/public/speeches/287855.pdf .

[55] Renata H., Deputy Assistant Att'y Gen., Antitrust Div., U.S. Dep't of Justice, The Antitrust Division and SSOs: Continuing the Dialogue (Nov. 8, 2012), available at http://www.justice.gov/atr/public/speeches/288580.pdf .

[56] Letter from Thomas O. Barnett, Assistant Att'y Gen., U.S. Dep't of Justice, to Robert A. Skitol, Esq., Drinker Biddle & Reath LLP (Oct. 30, 2006), available at http://www.justice.gov/atr/public/busreview/219380.pdf ; Letter from Thomas O. Barnett, Assistant Att'y Gen., U.S. Dep't of Justice, to Michael A. Lindsay, Esq., Dorsey & Whitney LLP (Apr. 30, 2007) [hereinafter IEEE-I Response], available at http://www.justice.gov/atr/public/busreview/222978.pdf .

[57] Sidak, G. (2015), 'Tournaments and FRAND Royalties', *Hoover IP Working Paper Series,* No. 15015

[58] 'The Mobile Revolution', Boston Consulting Group (commissioned by Qualcomm), January 2015.

[59] See: http://www.law.northwestern.edu/research-faculty/searlecenter/events/innovation/documents/Galetovic_Royalty_stacking_060416_GG.pdf, accessed November 2016.

3.5 Amendments to IEEE policy

More recently, much industry debate and comment has arisen over the revisions that the IEEE has adopted in its approved new policy set in 2015, on grounds that its 2007 policy was not effective. Referred to as IEEE-II, this policy forms the focus of the remainder of this study, and Section 4 looks first at the issues that the amendments were designed to address, before detailing the amendments themselves.

During the development of the new IEEE 2015 patent policy, which may be traced back to the 2012 proposals from Hesse, opponents complained that the composition of the ad-hoc committee tasked with patent policy development did not reflect the interests of patent owners; they claimed that their comments were disregarded, and that the principles of due process and consensus that applied to the development of IEEE technical standards were missing from the development of the patent policy.

On November 21, 2014, the IEEE-SA passed a motion expressing significant concerns about the potential effects of the proposed new policy. Despite this, On 8 February 2015, following a favourable review[60] by the US DOJ towards the IEEE proposals[61], the Board of Governors of The IEEE approved changes[62] to The IEEE Patent Policy that provide additional specificity as to the nature of the obligation attaching to member-owned patents that are essential to an IEEE standard. These changes were subsequently implemented in March of 2015.

We review the nature of the changes further in the following Section.

As in previous cases, DOJ rationale was primarily associated with pro-competitive benefit via mitigation in the expectation of 'patent hold-up'. However, cases on standards patent policy are limited and substantial evidence to support any instantiation of 'patent hold-up' appears hard to find [63,64,65].

In a recent review paper[66] assessing the VITA, IEEE-I and IEEE-II cases and US DOJ Business Review Letters, it is concluded that:

> *'the DOJ has embraced an enforcement framework that may encourage SDOs to adopt policies likely to harm competition and the continued success of ICT-sector standards',*

and that:

[60] See: https://www.justice.gov/atr/response-institute-electrical-and-electronics-engineers-incorporated , accessed April 2016.

[61] See: http://standards.ieee.org/develop/policies/bylaws/approved-changes.pdf .

[62] IEEE Press Release: http://www.ieee.org/about/news/2015/8_february_2015.html , accessed April 2016.

[63] The DOJ's support for concluding that hold-up is a competitive problem is summarised in its analysis of IEEE's second revised policy. IEEE-II Response, supra note 26, at 6 n.28. The DOJ cites to economic theory and the fact of government enforcement actions against SEP owners that pursued injunctions. The DOJ's empirical evidence consists of references to two district court decisions where an initial offer for a portfolio licence exceeded what the court later determined was a RAND rate. To the extent the conduct in these two cases represented an effort to engage in hold-up, implementers never paid the rates demanded and were able to resolve their disputes through the courts under current SDO patent policies. IEEE did not provide any empirical evidence of hold-up in its request. It did not suggest hold-up was a concern under its current policy until it was later asked by DOJ staff whether the update was motived by concerns about 'patent hold-up'. Letter from Michael A. Lindsay, Esq., Dorsey & Whitney LLP, to William J. Baer, Assistant Att'y Gen., U.S. Dep't of Justice (Nov. 7, 2014), available at http://www.gtwassociates.com/answers/DOJ%20PDF/IEEEBRL2015/PatentHold-upasRationaleIEEE_Bus_Review_Document_02_11072014.pdf .

[64] Galetovic, A., Haber, S., and Levine, R. (2015), 'An Empirical Examination of Patent Hold-Up', *Hoover IP Working Paper Series*, No. 15010.

[65] Haber, S. (2016), 'Patents and the Wealth of Nations', *Hoover IP Working Paper Series,* No. 16004.

[66] Kimmel, L. (2015) 'Standards, Patent Policies, and Antitrust: A Critique of IEEE-II', *Antitrust,* Vol. 29.

'Without evidence that IEEE's current policy was inadequate, the DOJ's broad support for the update lacks a strong foundation in either law or economics, and wrongly signals a green light for patent policies that may reflect the exercise of market power by implementers acting through SDOs'.

Thus a significant level of contention exists around the changes, with various factions around the world adopting different stances. With such complexity and myriad dimensions in the field, it is not surprising that debate continues to rage on; as we write, there is no indication of any consensus on policy developing.

3.6 Recent developments in the policy debate

Since the IEEE policy changes were implemented in 2015, we have seen over the last twelve months positioning from some firms seeking to test the boundaries of the new regime, with others looking at ways to obviate it. Essentially, at the time of writing, the situation is at an impasse, with development of two 'camps' – those 'for' and those 'against' the changes. Broadly, these camps may be classified as those 'for' R&D, and those 'for' product implementation, although of course in reality, the situation is more complex, with many firms involved in both pursuits; in some cases, firms may take an approach where their preference on policy is driven according to the source of their majority incomes.

Whilst debate continues and proponents from both sides promote their arguments, many have decreed that it is too early to find evidence supporting a stance either way, but some significant concerns have been raised. At an IEEE committee meeting in January 2016, for instance, claims were made that the development of the latest version of WiFi (arguably the IEEE's 'flagship' standard) had been delayed by four to six months because of uncertainty over the new policy. What's more, according to recent research[67], the rate at which Letters of Assurance (LOAs) are being submitted to the IEEE's 802.11 working group (802.11 is the standard that covers WiFi) also appears to have fallen.

Further, in June 2016, the European Commission published new documentation associated with standardisation policy[68]; though this has fuelled some discussion in Brussels on related issues, no direct stances have as yet been adopted at European government levels that would impact on IPR policy pertaining to technical standards.

In Europe, on July 16, 2015, in the case of *Huawei v ZTE*[69], the Court of Justice of the European Union (CJEU) handed down its long awaited decision on the competition law implications of SEPs. The court issued a ruling that provides guidance on what steps the owner of a FRAND encumbered patent that may be essential to a standard should take before seeking injunctive relief (legally enforceable measures to protect against infringement on its patented technologies). The court ruled that a willing licensee should act without delay, provide a counter-offer, and actively pay royalties (in trust or otherwise) for past and on-going use of the patent while the parties negotiate toward a FRAND licence. The court further ruled that there were no specific pre-filing steps needed for the owner of a FRAND-encumbered patent to file suit seeking solely an accounting and monetary relief for past

[67] Katznelson, R. (2015) 'Decline in non-duplicate licensing Letters of Assurance (LOAs) from Product/System companies for IEEE standards', *IEEE Globecom*, San Diego, December 2015.

[68] See: https://ec.europa.eu/growth/single-market/european-standards/policy_en , accessed August 2016.

[69] In this case, Huawei asserted that a European patent essential to the 4G LTE standard was infringed by ZTE whilst the two firms failed to reach any agreement on licensing terms. ZTE countered by asserting that Huawei's request for injunction was an abuse of market power.

infringement – the court rulings were aligned with development of timely resolution on licensing, payment of royalties due, and maintenance of reasonable access to injunctive relief. In forming its decision, the European Court noted the balance that it must strike between 'maintaining free competition' based on 'Article 102 TFEU[70] prohibit[ing] abuses of a dominate position' and 'the requirement to safeguard th[e] proprietor's intellectual-property rights and its right to judicial protection'. The court further noted the limits of its ruling, stating that, in this case, 'the existence of a dominant position has not been contested' and the questions to be addressed 'relate only to the existence of an abuse', thus 'the analysis must be confined to the latter criterion'. Some have argued that following the Huawei-ZTE case, the environment for SEP affected parties has become less benign.

Significantly, some[71] have recently voiced concerns that IEEE-II policy could yield exposures for SDOs under EU competition law (notably, Article 101 TFEU – which prohibits anti-competitive practices within the internal market, inclusive of pricing distortions).

A recent report[72] commissioned by the European Commission notes that much of the drive and polarisation in the IPR debate comes not from established industry practice, but from the development of theoretic arguments. The report further noted the absence of any firm evidence in the existence of 'patent hold-up', and advises that retention of some flexibility is important in the commercial negotiations associated with SEP(s), because there are significant commercial variations from one case to the next. The report goes on to suggest that one of the obstacles in determining FRAND rates is lack of transparency across commercial negotiations, and that one remedy for this could be mandatory full or partial disclosures[73]. Despite putting forward some ideas on disclosures on rates and patent office practice, the report offers little in the way of firm recommendations for policy development, referring in its conclusions to the need for 'more' research and collection of 'more' data.

In September 2016, the European bodies associated with development of standards concerning safety and quality matters – CEN and CENELEC[74] – published their revised position paper on SEPs and FRAND commitments which endorses a FRAND based policy approach.

In summary, there have been no changes to ETSI policy which still stands, based on established FRAND principles. IEEE-II policy, which was implemented in March of 2015 has attracted heated industry debate with many varied perspectives – some parties 'for', some parties 'against'. Positioning naturally depends on where firms stand in the industry value system and what they may see as commercial benefits. Beyond the interests of commercial firms, governments and policy makers are

[70] TFEU: Treaty on the Functioning of The European Union.

[71] Petit, N. (2016) 'The IEEE-SA Revised Patent Policy and Its Definition of 'Reasonable' Rates: A Transatlantic Antitrust Divide?', *Fordham Intellectual Property, Media & Entertainment Law Journal*, Vol. XXVII.

[72] Ménière, Y. and Thumm, N. (2015) 'Fair, Reasonable and Non-Discriminatory (FRAND) Licensing Terms. Research Analysis of a Controversial Concept', *JRC Science and Policy Report, European Commission*, 2015. http://publications.jrc.ec.europa.eu/repository/handle/JRC96258 , accessed August 2016.

[73] Recall that ex-ante mandatory disclosures on rates was required in the VITA standards group in the US; this policy remains in place today. The challenge on disclosures is not only due to companies' reservations on issues of confidentiality, but also on timing; at what point should a disclosure be made? There can be prime mover issues during what amount to sensitive commercial negotiations and, as we have seen, valuations on R&D are difficult to make against implementations that do not exist at the time of any such negotiations. It is not, however, unreasonable to consider disclosures once negotiations are concluded, thus providing benchmarks as references for future similar cases, although some firms might reasonably posit that for *their* business, such information could be highly strategic and confidential – an argument in favour of case by case analyses where needs arise. Note also that VITA policy in no way forces fairness in rates setting; licensors could remain within policy whilst declaring, ex-ante, 'excessive' rates.

[74] CEN: European Committee for Standardisation; CENELEC: European Committee for Electrotechnical Standardisation.

also accountable to society to ensure effective market balance through the establishment of appropriate policies, and ultimately economic prosperity for all.

In the following Sections, we look further into the nature of the IEEE-II policy amendments, and industry debate surrounding them. We then go on to develop, from an independent perspective, a view on the level of impacts that could result at both industry and wider national and regional levels.

4 Key issues arising from IPR frameworks

In this Section, we look at the key issues that arise from the imposition of the IPR policy frameworks described in Section 3. We first examine issues that were claimed to have arisen from the legacy policy frameworks, and then lay out the IEEE-II amendments which were designed to overcome these issues. However, the amendments themselves have introduced further issues, which are then explored in detail.

Our purpose in this Section is to distil the meaning of the policy changes and to assess industry perspectives; from this, we develop key dimensions as to impacts – as a basis for both qualitative and quantitative analysis in Section 5.

4.1 Issues under legacy IPR policy frameworks

The key issue brought up in industry debate was around the ambiguity of terms associated with FRAND that was in use by ETSI and IEEE pre-2015. The issue over FRAND terms in standards development has driven a very large literature. The debate around it spans the legal profession and amongst economists, industry players, academics, through to the highest levels in governments[75] and national agencies. This is because it has the potential to affect levels of innovation, legality, competition, company performances, and trade volumes at national and international levels.

Concerns have been raised over the commercial and market efficiencies enabled via non-specific FRAND terms. The accepted practice has been to allow a 'reasonable' licensing rate to be set under bilateral commercial negotiations under non-specific FRAND terms after the standard is formally adopted. Under the non-specific FRAND terms, there is nothing to bound the royalty rate during licensing negotiation. Any dispute over the rate has to be resolved through recourse to law or via negotiations.

Without firm definition of royalty rates (per FRAND, which defines guidelines, enabling firms to negotiate freely on terms), some proponents argue that there is potential for royalty rates to climb to excessive levels. This is the basis for the theory of 'patent hold-up', which has driven much of the impetus for the IEEE revised policies. We elaborate on this further below.

4.1.1 'Patent hold-up' and hold-out

The 'patent hold-up' theory is based on assumption.

According to the theory, it is held that 'patent hold-up' may arise where an implementer has made a series of investments towards use of a particular SEP. If royalty negotiations were to take place following such investments, the SEP owner could be in a position of strength with regard to negotiations on royalty rates.

Proponents of the theory argue that if such rate increases occur, it is likely that they would be passed along the value chain, such that end users of products implemented against SEP based standards would experience price increases.

[75] 'Patent assertion and US innovation', Executive Office of the President, June 2013, Washington DC, US.

If it were true that patent holders regularly practise 'patent hold-up', then prices of successive generations of consumer products would be consistently high (or only decline very slowly). Further, if demand for products were price sensitive (i.e. elastic on price variations), demand would be suppressed with high product pricing which could have an impact on innovators' willingness to innovate (i.e. rate of innovation) with a depressed market. The combined effect would be a negative impact towards consumers' access to innovative and affordable products in the market.

However, as we discuss in Section 4.3.1, there appears to be no evidence that 'patent hold-up' exists in reality. In fact, detailed studies have noted that, in reality, royalty rates across the industry are at levels consistently below those that would be experienced if 'patent hold-up' were to be in existence.

It is more likely that 'patent hold-up' will occur in cases of patent 'ambush' – the situation that can arise where a firm may deliberately withhold information on SEP(s) until after technical standards have been developed and published, going on to seek to extort unreasonable licensing payments. However, mitigation for patent ambush is already well covered by most SDOs' policies, requiring early declaration of SEP(s), and can be covered by case by case actions[76].

4.1.2 'Patent thicket' and 'royalty stacking'

'Patent thicket' refers to situations where a web of overlapping IP and associated rights may exist and where such would need to be addressed in order to commercialise a given technology and product to market.

As above, 'royalty stacking' refers to the theory in which a single product potentially infringes on many patents, and thus may bear multiple royalty burdens. Theory states that the total licensing royalty fee for the implementer becomes excessive.

The economics of innovation literature suggests that 'patent thicket' and 'royalty stacking' may have an ambiguous effect on patent transactions. On one hand, dispersion in the volume of patents increases the number of patent transactions where bargains have to be struck, and this may reduce the incentives to conduct patent transactions. But there is a second, countervailing effect: the presence of overlapping patent rights may reduce the value at stake in each individual patent licensing negotiation, and this may facilitate licensing deals with more favourable terms[77,78]. This aligns with our view wherein no evidence to support the theory of 'patent hold-up' has been defined.

4.2 IEEE-II policy amendments

As set out in Section 3.5, between 2014 and 2015 an attempt was made by the IEEE to add specificity to FRAND terms for licensing negotiation.[79] The proposal submitted by Michael Lindsay to the United States Department of Justice (DOJ) was endorsed by the DOJ on pro-competitive grounds[80] and

[76] See: the Rambus Inc. case (http://ec.europa.eu/competition/publications/cpn/2010_1_11.pdf , accessed Jan. 2017), where Rambus agreed (on a case by case basis) to implement royalty caps addressing concerns over marker power.

[77] Galasso, A. and Schankerman, M (2010). 'Patent thickets, courts, and the market for innovation', *RAND Journal of Economics*, 41(3), 472–503.

[78] See: http://www.voxeu.org/article/improving-efficiency-market-innovation , accessed August 2016.

[79] Letter from Michael A. Lindsay, Esq., Dorsey & Whitney LLP, to William J. Baer, Assistant Attorney Gen., U.S. Dep't of Justice 10 (Sept. 30, 2014)

[80] Kimmel (2015)

adopted as part of IEEE's revised IPR policy (IEEE-II) in February 2015. The revised policy is deemed to have the effect of limiting the SEP holders' bargaining power in licensing negotiations, and hence a pre-emptive effect on potential 'patent hold-ups'.

Key amendments included in IEEE-II are as summarised below. A detailed review of the IEEE-II policy amendments is included in Appendix A.

Table 4-1: Summary of amendments as per IEEE-II policy

Key item	Summary of issues with item
Firmer definition of licensing rates and on associated terms	• Definition of licensing rates is built into policy. • Policy defines that such rates should exclude any value that could accrue by virtue of SEP(s) being part of a technical standard. • Also, such rates should be determined based on consideration of the *smallest saleable compliant implementations* of the SEP(s). • Further, that such considerations should be made in light of the value contributed by all SEP claims for the same IEEE standard. • Rates should be defined taking into account any existing licenses (and therefore levels of compensation) that may have been awarded for the SEP(s) under scrutiny. • Submitters and Applicants should seek to engage on matters of negotiations, litigations, or arbitrations, without unreasonable delays. • Clarification is provided in that matters on patent interpretation, validity and essentiality shall not be considered within IEEE technical standards meetings and activities.
Diminished availability of injunctive relief	• Any assurance given (via LOA) for use of SEP(s) under agreed licensing terms shall preclude access to injunctive relief. • Submitters of accepted LOAs shall not seek, nor seek to enforce, injunctions with associated SEP(s), unless an implementer fails, within appropriate deadlines, to accord with adjudicated outcomes that may be defined by courts with appropriate authority. Essentially, the policy makes it difficult for licensors to seek injunctive relief unless matters have already gone to court and licensees have failed to accord with ensuing outcomes.

Key item	Summary of issues with item
Restricted reciprocity in licensing	• Reciprocity in any SEP licensing between licensers and licensees shall be constrained to licensing pertaining to a single technical standard. • Any assurance given in connection with reciprocal licensing shall confirm that no exclusion of the Submitter's Affiliates shall be adopted. • Reciprocity in licensing shall pertain only to SEP(s). • Reciprocity in licensing shall permit compensation from both Submitter to Applicant and vice versa.
A stricter definition of compliant implementation	• A clearer definition of compliant implementation is to be used to provide greater clarity on non-discrimination. • A compliant implementation encompasses end products through to components or sub-assemblies that are incorporated into the end product. • All such implementers can invoke the benefits of an applicable LOA.

In the following sections, we look at how these amendments have impacted on the issues set out in Section 4.1 above, and then discuss further issues that may be associated with impacts of IEEE-II amendments, taking into account notable and recent industry debate that has developed. Additional details on review of industry positions are included in Appendix B.

However, we first look in more detail at how best practice around royalty rate setting is impacted by the IEEE-II amendments, and discuss the purpose of injunctive relief.

4.2.1 Royalty rates and levels

Under IEEE-I, policy permitted members to disclose their most restrictive licensing terms, including maximum royalty rates. As we have seen above, it is commercially impractical to do so at an early point in the standards development cycle. Unsurprisingly, very few firms did disclose such under IEEE-I.

IEEE-II does not require early disclosure on rates, rather that assurance is given at an early stage (the point of planned inclusion of any SEP(s) into technical standards) that licensing will be offered at reasonable rates as defined by IEEE-II policy[81].

Significantly, under IEEE-II, some clear prescription as to the terms associated with licensing rate are given; there are three main factors:

i. value should not be accrued per se because of SEPs' inclusions into standards,

[81] IEEE-II policy requires that 'If the patent holder or patent applicant provides an LOA, it should do so as soon as reasonably feasible in the standards development process once the IEEE Project Authorisation Request (PAR) (IEEE's own approval to begin work on the standard) is approved by the IEEE-SA Standards Board. This LOA should be provided prior to the Standards Board's approval of the standard'. See: http://standards.ieee.org/develop/policies/bylaws/sect6-7.html , (6.2 Policy, para. 2) accessed August 2016. That is, LOAs should be provided during the development of the technical standard under IEEE-II.

ii. value should accord with smallest saleable implementations including SEP(s), and

iii. value accorded with SEP(s) should be balanced against all SEP claims against one technical standard and also against any existing licenses for the SEP(s).

These are highly controversial, as is the practice of inserting rules into how private parties negotiate contracts. For example, who is to say that, within one technical standard, one SEP should be valued equivalently or relatively to another? It could be that one SEP within a standard required an inordinate amount of investment but the result is a true break-through in technology which provides high value in the standard (for example, in terms of efficient design and functionality). Further, it may be that the value of inclusion of an SEP within one standard is significantly different from that that could accrue via its inclusion in another (with simple example, piston technology is significantly valuable in a steam train, but the technology could also be used in an electric locomotive for entirely different reasons such as pneumatic door systems, perhaps with much lesser value).

Also, it is a commercial reality that standards *do* create value. Should any such value be channelled only towards some parts of the value system, yet none to originators of innovation and SEP holders? From the perspective of seeking economic balance, this approach is seriously questionable.

In addition, the setting of licensing values against smallest saleable patent practicing units (SSPPUs) of implementation is novel in standards policy; the doctrine was first set forth in a US based case by a Judge Randall Rader in 2009[82,83]. In essence, the approach with SSPPU calls for the setting of licensing rates reflecting the smallest possible product level that reflects the patented invention used.

We note that the concept of SSPPU was derived to address specific issues within a specific US court case; we do not believe that the concept is well founded in economic theory nor reasonably applicable to the setting of IPR policy in technical standards.

The SSPPU doctrine is one of the more significant factors in the IEEE-II amendments and the approach very questionable; if an SEP contributes to the functionality of a given product, and that product cannot work without it, it can be very reasonably argued that the SEP is intrinsic to the product's value. Further, it is concerning that the logic here is associated with protection on over-compensation, but there is no consideration as to the matter of under-compensation. Further still, there appears to be no firm empirical evidence as to instances where over-compensation has occurred systematically[84]. Without such evidence of systematic failure, it is odd that a systematic remedy should be applied; would not a case by case assessment be better?

The SSPPU concept is complex and has attracted heated debate across the industry. We provide additional detailed review on issues associated with SSPPU in Appendix B.

Common sense dictates that the value ascribed for inclusion of an SEP 'A' in a product ABCDE should derive from the value of the product ABCDE in realistic market circumstances; again, recourse to reality rather than theory will be instructive, as it is in the accounting field and typical commercial practice. The *Cornell University v Hewlett-Packard Company* case is a good example as to where law has triumphed over common sense, on the basis of insufficient presentation of admissible evidence and questionable and theoretic reasoning by the court.

[82] Cornell University v. Hewlett-Packard Company, 609 F. Supp. 2d 279 (N.D.N.Y. 2009).

[83] See: http://www.oceantomo.com/pdf/Cornell%20UniversityvHewlett-PackardCo_0.pdf , accessed August 2016.

[84] Layne-Farrar, A. (2016), 'The Practicalities and Pitfalls of the Smallest Saleable Patent Practicing Unit Doctrine: A Review of Teece and Sherry (February 18, 2016)'. SSRN.

Critically, licensing in SEPs calls for balance; if licensors are not adequately rewarded for the often significant investments in R&D that lead to innovations, incentive to innovate will be depleted. If licensees cannot access SEP encumbered standards at reasonable rates, implementation will wither and efforts in both R&D and standards work will not yield commercial and economic value. Further, if implementers don't implement, royalties don't get paid and R&D investments don't get rewarded. In both cases, serious economic consequences can result.

FRAND precedent assumes that balance can best be struck by allowing both licensors and licensees to freely negotiate commercial terms on case by case bases; just as prices are set in markets according to realities in supply and demand in specific cases. This approach offers the freedom, case by case, for licensing rates to be set reflecting some negotiated balance between what 'price' licensors need, *in reality*, to reasonably cover their R&D costs and make a fair profit, and what 'price' licensees are willing to pay for use of the IPRs. One can argue reasonably that this is a case of *caveat emptor* in free markets – one party sells a 'good' on the open market, another buys it (in this case, it buys the right to use) according to its own view of the value of the good (the SEP(s)). If, in this case, the price is deemed excessive by market participants, licensees can choose to infringe – acting illegally, or they can decide not to buy (or implement). In the latter case, the SEP 'sits on the shelf' at a loss to the developer (not unreasonably one might argue if its 'prices' are excessive), and yet there may be some loss to industry and society if 'good' but 'expensive' innovation is lost (workarounds or new innovations would need to be found); in the long run, this approach favours cost efficient innovation and competition at the level of R&D production.

We see the issue clearly: if a technical standard is used in taking a given product to market, and that standard is inclusive of an SEP innovation, then any implementers of such a product will be liable for royalty payments to the SEP licensor. The value of inclusion of the SEP innovation will be a function of the product's commercial value in reality since the SEP innovation contributes to the ability to get the product to market. Inclusion of SEP(s) into technical standards is conferred through the standards making process itself.

4.2.2 Injunctive relief

There are differing views on the point of injunctive relief (that is, legal protection and access to such). Whilst some parties posit that availability of such confers undue power on SEP holders, effectively enabling them to exclude potential implementers from a market completely (given the essentiality of any SEP related IPRs), others take the view that without access to relief, SEP holders have no effective means to prevent reverse hold-up.

Further, without reasonable access to injunctive relief, there is the potential for unchecked, illegal and ongoing infringement of intellectual property. There are parallels here with piracy, counterfeiting and illegal trade in media goods that have been rife in the music and film industries; piracy is also a problem in other industries such as clothing and luxury goods. At best, illegal practices can cause deep financial harm to firms; at worst they can destroy livelihoods and cause breakdown in social stability. A recent report[85] from the OECD noted that:

[85] 'Trade in Counterfeit and Pirated Goods Mapping the Economic Impact', DOI:10.1787/9789264252653-en. OECD Publishing, 2016. See: http://www.keepeek.com/Digital-Asset-Management/oecd/governance/trade-in-counterfeit-and-pirated-goods_9789264252653-en#.V9U0qoYrKUk#page2 , accessed August 2016.

'The capacity to develop and fully value innovation is at the heart of a productive and forward-looking global economy. Intangible assets such as ideas, know-how or brands play an instrumental role in rewarding the efforts of rights holders, innovators and investors'.

The OECD report noted that in 2013, global 'trade' in counterfeit and pirated goods amounted to €423bn – equivalent to the national GDP of Austria or around 2.5% of world trade, excluding domestic and internet based activities. Firms cannot easily withhold intangible goods such as knowledge and intellectual property; they must rely upon the law for measures of protection. Also, the financial evidence from the study indicated that as a proportion of overall trade, illegal activities are of more significance in developed economies – in the EU, in 2013, these amounted to approximately 5% of EU imports.

Note also that the existence of illegal activities puts commercial *ecosystems* at risk. If some implementers were to choose to illegally infringe and were 'allowed' to maintain this state for some time, harm would result to markets as any implementers acting legally would likely be undermined by those acting illegally.

We refer further to the European legal case as *Huawei v ZTE*[86], which places requirements upon both SEP owners and implementers to seek negotiated settlements where feasible; further, and importantly, the case upholds benefits of, and access to injunctive relief, where it is required. The case places requirements on both sides in any negotiation; this is distinct from the approach taken in IEEE-II in this regard, which we believe is somewhat 'one-sided'.

4.3 The impact of IEEE-II amendments on legacy issues

Below we discuss how the IEEE-II amendments have impacted on legacy issues, but it is worth noting in advance that the magnitude of these issues is debateable. As well as discussing how the amendments will affect the theoretical issues, therefore, we also examine the question of whether these issues are significant in practice.

4.3.1 Potential impacts on 'patent hold-up'

As described above, the theory of 'patent hold-up' is that undue licensing rate levels could be introduced to the product-technology development cycle by patent holders who could demand unreasonable terms once a patent has been included in a standard. Thus the theory of 'patent hold-up' is seen as a problem requiring a solution and consequently a number of the amendments in IEEE-II were specifically designed to reduce 'patent hold-up':

- The prescription of the basis on which royalty rate is to be computed, including the consideration of the SEP's value contribution to the smallest saleable unit, is meant to give a reasonable bound on the royalty fee. This means that the fee per implementation that the SEP implementer has to pay cannot exceed the price of the smallest saleable unit.
- The prohibition of injunctive relief is meant to remove the threat of the standard implementer being banned from using the SEP. This removes the threat of the standard implementer being

[86] In this case, Huawei asserted that a European patent essential to the 4G LTE standard was infringed by ZTE whilst the two firms failed to reach any agreement on licensing terms. ZTE countered by asserting that Huawei's request for injunction was an abuse of market power.

stopped from implementing the standard by the SEP holder, and hence the threat of being prevented from generating revenues from sale of its products.

- Limiting cross-licensing to SEPs within the same referenced standards prevents SEP holders from demanding access to a multiplicity of patents in other standards in exchange for the SEP's use. Such demands would be a non-monetary substitute to a high royalty fee.
- A more precise, yet wider, definition of compliant implementation gives less ground for SEP holders to refuse to enter into a licensing negotiation with potential SEP implementers. This strengthens the non-discriminatory aspect of FRAND. Potential implementers do not have to worry about the threat that SEP would not enter into a negotiation with them. Such a threat could make SEP implementers feel that they need to offer a higher royalty rate as an incentive right from the start.

However, 'patent hold-up' may occur for bilateral reasons; for example, simply because licensing terms cannot be agreed for whatever reason(s). Also, 'patent hold-up' in itself may be bilateral; reverse 'patent hold-up' (also referred to by some as 'hold-out' or 'freeriding') (that is, the potential for under-compensation to SEP licensors, which may occur if licensees infringe or deliberately withhold payments, seeking reduction in royalty rates, or merely 'playing' the market with expectations that risks and costs with any infringements, litigations or delaying tactics could prove net profitable in the face of perceived high royalty liabilities via the 'legal' route) is no lesser an issue. In fact, some have argued that it is a greater issue as there is significantly more evidence for this than for 'forward' 'patent hold-up'[87].

In theory, if firms planning to implement products against a given standard know of the standards related patents that they will meet and royalty rates that they may be charged, 'patent hold-up' will be avoided. However, in this case, theory does not meet reality; we have seen above that licensing terms are rarely, if ever, concluded in line with the outset of the standards making process.

Significantly, there is as yet no firm evidence that the IEEE-II amendments have actually impacted 'patent hold-up' in any material way. Perhaps even more significantly, any empirical evidence for the *existence* of 'patent hold-up' per se is hard to find[88,89,90]. Indeed, Elhauge[91] argues that the royalties predicted by the 'patent hold-up' models are often *below* the true optimal royalty rate, and further argues that the predicted rates are overstated anyway, because of incorrect assumptions in the Lemley-Shapiro model about inelastic demand,[92] one-shot bargaining[93] and informational symmetry[94]. A paper by Geradin *et al*[95] also raises the issue of reputation in repeated rounds of bargaining:

[87] Fassell, A. (2015), *'More evidence of reverse patent hold-up in SEP FRAND licensing',* http://patentperspectives.blogspot.co.uk/2015/06/more-evidence-of-reverse-patent-hold-up.html , accessed August 2016.

[88] Galetovic, A., Haber, S., and Levine, R. (2015), 'An Empirical Examination of Patent Hold-Up', *Hoover IP Working Paper Series*, No. 15010.

[89] Heiden, B. (2015), *'The Viability of FRAND: How the Seminal Microsoft Ruling Could Impact the Value of Standard Essential Patents and the Future of Telecom Standards'*, Chalmers University of Technology.

[90] Langus, G., Lipatov, V., and Neven, D. (2013), *'Standard essential patents: who is really holding up whom?'*, SSRN.

[91] Elhauge, E. (2008), 'Do Patent Holdup and Royalty Stacking Lead to Systematically Excessive Royalties', *Journal of Competition Law & Economics,* 4(3), p535-570.

[92] In other words, that consumer demand will not change if the price changes. This is significant, since in reality including a patented feature in a product is likely to increase its price (and thus reduce demand). This assumption is therefore likely to lead to an overestimate of the royalty rate.

[93] Lemley-Shapiro assume a one-time negotiation between a patent holder and an implementer. However, it is frequently the case that an implementer has to deal with multiple patent holders. If each patent holder demands an excessive royalty rate, it would render the implementation unprofitable, so the implementer would not use the patent (and the patent holders would make

'Patent holdup, on the other hand, is a short term strategy. Firms gaining a reputation for this kind of tactic will face stronger opposition on the next version of the standard because rival firms are reluctant to accept their technological suggestions or have invented around their technology to pre-empt any future holdups. In fact, the examples of patent holdup put forth in the literature are few in number and indeed often involve firms that have no long term plan in the industry.'

More recent work in the area has been conducted by Gupta[96], Galetovic *et al*[97] and Galetovic and Gupta[98], which has reiterated that there is little in the way of empirical evidence to support the hypothesis of 'patent hold-up'. Galetovic and Gupta examine the mobile wireless industry, finding that between 1994 and 2013 the average selling price of a device fell rapidly, the number of devices sold grew rapidly and the number of manufacturers increased, suggesting that it is unlikely that there is systematic 'patent hold-up'. Galetovic *et al* do a similar analysis for a wider variety of consumer products, with similar findings.

'Patent hold-up' is more likely to occur in cases of patent 'ambush' – the situation that can arise where a firm may deliberately withhold information on SEP(s) until after technical standards have been developed and published, going on to seek to extort unreasonable licensing payments. However, mitigation for patent ambush is already covered by most SDOs' policies, requiring early declaration of SEP(s); litigation may be invoked if firms breach these policies. Further, patent ambush has been considered to be in breach of antitrust competition law in both the United States and the European Union. Development of further legislation to address the actions of a few firms deploying underhand tactics is a little like banning all ice cream sales because just a few children drop them on the floors of some shopping centres.

4.3.2 Impacts on 'patent thicket' and 'royalty stacking'

Thicket and stacking are not specifically addressed under IEEE-II, although some have argued that one potential remedy could be associated with agreements for licensing rates covering whole patent groups or families; in effect, this amounts to a dilution of rates that would be associated with individual SEPs, essentially on the grounds that more value costs more, therefore buyers should be given cheaper prices (scale economies). Whist there is some economic justification for this approach, with balancing of prices amongst vendors and buyers, this is already well provisioned for under FRAND precedent; indeed, broad cross-licensing can mitigate this problem.

However, measures in IPR policies that prevent 'patent hold-ups' should also lower the probability of a royalty stack for a standard becoming prohibitive. The logic here is that the royalty stack can be kept

nothing). Elhauge argues that, knowing this, the patent holders would not demand excessive rates (and that this stance represents a Nash equilibrium for the parties – that is, that neither party is better off by changing its strategy).

[94] Lemley-Shapiro assume symmetric information between the patent holder and implementer. In reality, the implementer is likely to have an informational advantage, as it knows its own costs, profit margins, and the value of the patent to it (and both parties will know information about the patent).

[95] Geradin, D., Layne-Farrar, A., and Padilla, A.J. (2008), 'The Complements Problem Within Standard Setting: Assessing the Evidence on Royalty Stacking', *B.U. J. Sci. & Tech. L.,* Vol. 14:144.

[96] Gupta, K. (2015), 'Technology Standards and Competition in the Mobile Wireless Industry', *Geo. Mason L. Rev.,* Vol 22:4.

[97] Galetovic, Alexander, Haber, Stephen H., and Levine, Ross (2015), 'An Empirical Examination of Patent Hold-Up', *Hoover IP Working Paper Series*, No. 15010.

[98] Galetovic, Alexander, and Gupta, Kirti (2016), 'Royalty Stacking and Standard Essential Patents: Theory and Evidence from the World Mobile Wireless Industry', *Hoover IP Working Paper Series*, No. 15012.

reasonable by preventing SEP holders contributing to a standard being able to command an unreasonably high royalty rate through the practice of 'patent hold-up'. This means that the risk of the extreme consequence of 'royalty stacking', identified in Section 4.1.2, arising can also be mitigated.

Though largely endorsed by implementers, the changes are unwelcome by SEP holders. The changes are deemed to give SEP implementers an unfair advantage. There are many objections to the use of the concept of smallest saleable unit for infringement claim due to the potential to underestimate the actual value that the technology contributes to the entire value chain[99]. In addition, the prohibition on patent holders from seeking injunctive relief makes wilful patent infringement a more attractive strategy for implementers.

4.4 New issues arising from IEEE-II amendments

The amendments may have the potential to preclude certain opportunistic behaviours, in particular potential 'patent hold-up's, through the prescription of more precise terms for licensing negotiations. However, the IEEE amendments do not necessarily make for a more efficient outcome. One reason is that the amendments are based on the premise that opportunistic behaviours are one-sided. Some hold that only SEP holders are likely to abuse their power during licensing negotiation. However, it is also possible for potential SEP implementers to take advantage of the SEP holder by refusing to license in order to put pressure on the royalty fee, especially given that there is a non-zero probability of an infringement claim being ruled invalid[100]. This is called reverse hold-up. Limiting the instruments that SEP users have at their disposal to prevent opportunistic behaviours by implementers could make contributing to standards less attractive.

Moreover, the specificities in the IEEE amendments reduce the SEP holders' scope for negotiation. The SSPPU principle restricts what an SEP holder can do in the process of setting the royalty rate. Prohibition of injunction restricts the instruments SEP holders have access to.

Such restrictions can force a relatively strict upper bound on the rate that could be achieved in the licensing negotiation. Meanwhile, the inclusion of all 'Affiliates'[101] of an SEP holder in the reciprocal licensing commitment makes it possible for the cross-licensing SEP implementer to gain access to the SEP holder's potentially bigger SEP portfolio held through all Affiliates.

The above IEEE-II style amendments, taken together, have the potential to reduce the realisable value of essential patents. In some cases, the negotiated rate may fall below a fair licensing rate for the SEP holder, which represents the economic contribution of the SEP. The costs of licensing can also increase under the new definition of the compliant implementation due to the need for different licences for implementers at different levels of the production chain. This further reduces the attractiveness of committing to FRAND terms.

One likely outcome is that fewer patent owners will be willing to agree to license their technology under FRAND terms. This appears to have already started to manifest itself in the decline in the number of non-duplicate[102] licensing LOAs from product/system companies for IEEE standards. Since

[99] Layne-Farrar, A. (2016a), 'The Practicalities and Pitfalls of the Smallest Saleable Patent Practicing Unit Doctrine: A Review of Teece and Sherry (February 18, 2016)'. SSRN.

[100] Layne-Farrar, A. (2016).

[101] The precise definition of an "Affiliate" can be found in Section 6.1 of the IEEE Standards Board Bylaws.

[102] Duplicate LOAs not counted are LOA restatements filed for standards, amendments, or revisions for which a specific or blanket LOA was previously accepted from the same patent holder.

the introduction of IEEE amendments, there has been an increase in incidence of missing LOAs and of companies declining to issue an LOA altogether[103].

There is also the added problem of FRAND assurances becoming incompatible where changes are introduced unilaterally by an SDO. The iterative nature of standard setting means that often a new standard will incorporate by reference previously developed legacy standards. It is common for at least some of the SEPs from the legacy standards to also be SEPs for the new standard. When there is a change in an SDO's IPR policy, the SDO requires further concessions to be added to an SEP's existing assurance in order to allow its FRAND assurance to be admissible under the new rules. If the SEP holders view these extra concessions to be onerous, they may be unwilling to grant them. This would lead to compatibility issues with FRAND assurances and cause problems in the approval of new standards. A detailed discussion of this issue can be found in Appendix E.

The issues associated with the four key IEEE amendments presented in Section 4.3.1 are discussed in detail in Section 4.4.1 to Section 4.4.4.

4.4.1 Problems with the use of SSPPU

Under the IEEE's new definition of FRAND, the reasonable rate payable to the SEP holder should be based on the value that the patent contributes to the Smallest Saleable Compliant Implementation.

Proponents of the Smallest Saleable Patent Practising Unit (SSPPU) often argue that the use of such a unit for infringement calculation mitigates the problem of overestimating the damage. This problem of overestimation arises from 'framing' and 'anchoring'. Framing refers to the tendency of people to respond to a choice in different ways depending on how the choice is presented. Anchoring refers to the tendency of people to rely too much on the first piece of information in decision making[104].

The concern is that if the jury in a court case is presented with revenue on a multi-component end product when the patent only reads on a small subset of the product's features, then the compensation for the damage may be too large. Because an SEP licensing fee is also a form of compensation, the use of SSPPU should in theory safeguard against overcompensation.

Teece and Sherry, however, point out that the cognitive bias from framing and anchoring works in both directions[105]. This means that overcompensation is not a certainty, and the use of the SSPPU in any compensation negotiation could have the effect of magnifying the downward bias. The result is that the SEP holders could be undercompensated.

More importantly, the use of SSPPU is likely to be unsatisfactory due to the fact that the SEP's value contribution is not limited to the subcomponent that physically incorporates it. Teece and Sherry explain that entities at different levels of the production chain will be able to extract different portions of the total value of the patent. Using the smallest sub-component and the revenue associated with it as the basis for calculating compensation would prevent the value contribution that the patent makes to the subcomponent in lower 'levels' (assuming that the end product is the furthest downstream in the production chain) from being captured by the SEP holder.

[103] Katznelson, R. (2015) 'Decline in non-duplicate licensing Letters of Assurance (LOAs) from Product/System companies for IEEE standards', *IEEE Globecom*, San Diego, December 2015.

[104] A more detailed exposition of the problem with SSPPU is given in Appendix B.

[105] Teece, D. J. and Sherry, E. F., (2016) 'On the 'Smallest Saleable Patent Practicing Unit: An Economic and Public Policy Analysis', *Tusher Centre Working Paper Series*, No. 11.

This point is also corroborated by Petit[106]. In the 2016 paper, Petit argues that the use of SSPPU restricts the licensing talks to the value of the smallest saleable component and thus removes from the negotiating table the positive externalities that are enjoyed by other economic agents – other entities in the production chain including the implementers. Therefore, the imposition of SSPPU doctrine on SEP licensing negotiation can have the effect of undermining the price system. Market pricing can no longer account for the positive externalities of the SEP along the entire production chain.

Katznelson[107] provides the example of *Ericsson v. D-Link Sys. (2013)*, where the defendant's calculation based on a chip usage resulted in royalties per router of fractions of cents, whereas a calculation based on the added value to a network router unit yielded 15 cents per router. Teece and Sherry (2016) give the example of *Cornell University v. Hewlett Packard Company (2006)*, in which the damage *base* was revised from that of a 'CPU brick' (estimated at €23bn) to that of an individual processor (estimated at €6.7bn), while the royalty *rate* remained unchanged[108].

The requirement to use SSPPU is likely to result in substantially lower royalties for SEP holders, as the base unit price for calculating those royalties will be much smaller (for example, a chipset for a cellular phone costs much less than a smartphone)[109]. While the SSPPU amendment may imply setting higher royalty rate on this base unit price, in practice this may be insufficient to offset the smaller royalty base (and courts appear to award smaller total damages when the royalty base is smaller[110]). The reduction in expected royalties will, in turn, make issuing Letters of Assurance less attractive to patent holders.

4.4.2 Problems with reduction in access to injunctive relief

In order to have its patented technology incorporated into an IEEE standard, a patent holder must provide a Letter of Assurance which waives its right to seek an injunction against an infringer[111].

The main motivation for the prohibition of injunction is the concern that that the ability to threaten an SEP implementer with an exclusion order allows the SEP holder to charge an unfairly high royalty rate. However, it can also be argued that injunction may be necessary in some cases. This is because there is an incentive for some SEP implementers to refuse any license, FRAND or otherwise[112], in an extreme form of 'patent hold-up' called 'hold-out'.

This problem of patent hold-out stems from the incongruence between the terms of the commitments made for SEP designation under FRAND and the nature of infringement litigation.

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[106] Petit, N. (2016) 'The IEEE-SA Revised Patent Policy and Its Definition of 'Reasonable' Rates: A Transatlantic Antitrust Divide?', *Fordham Intellectual Property, Media & Entertainment Law Journal*, Vol. XXVII.

[107] Katznelson, R. (2015a) 'Perilous Deviations from FRAND Harmony – Operational Pitfalls of the 2015 IEEE Patent Policy' *IEEE SIIT 2015, 9th Int'l. Conf. on Standardization and Innovation in Information Technology, Sunnyvale, CA. (Oct-8-2015).*

[108] Cornell University v. Hewlett-Packard Company, 609 F.Supp.2d 279 (N.D. N.Y, 2006), available at http://www.oceantomo.com/pdf/Cornell%20UniversityvHewlett-PackardCo_0.pdf .

[109] Sidak, G. (2014), "The Proper Royalty Base for Patent Damages", *Journal of Competition Law & Economics*, 10(4), 989-1037.

[110] Teece and Sherry (2016).

[111] Under the IEEE policy, an Accepted Letter of Assurance is deemed to preclude the Submitter (the patent holder) from seeking a Prohibitive Order except as provided in the policy.

[112] Chien, C. (2014) 'Holding up and Holding Out', Michigan Telecommunications & Technology Law Review, Volume 21 Issue 1.

Firstly, while the SEP holder has to make all essential patents that are compliant with the standard available for licensing, infringement litigation is limited to a handful of patents at a time. This means that it may not be possible to take all infringers to court.

Secondly, the FRAND commitment also means that the compensation payment in royalty terms is capped. When an implementer is found to infringe and ordered to pay damages, this FRAND royalty rate sets the upper limit for the damage payment. This is because the FRAND royalty rate is what would have been paid, had a successful licensing negotiation taken place.

The fact that the infringement damage is capped at the FRAND rate leads to a greater risk being incurred for SEP holders. This is because when they take an infringer to court, 'the patent owner can lose the IPR they believe they have, but if the patent holder wins it gets no more than a FRAND solution, that is, what it should have got under the agreement in the first place'[113]. The infringing SEP users, on the other hand, pay no more than the FRAND rate plus the cost of litigation and may pay nothing at all except for the cost of litigation if the court rules in its favour.

Without the possibility of invoking an injunction, SEP holders cannot stop SEP implementers from infringing and have lower leverage in bringing unwilling licensees to the negotiation table. Given that there is a non-zero probability that they might not have to pay to use the licence at all (effectively giving them an expected net return that is positive), more SEP implementers may be encouraged to infringe. This makes making a FRAND commitment through the submission of LOA less attractive.

4.4.3 Restriction on reciprocal licencing

Under the amended IEEE policy, a submitter of a Letter of Assurance may condition its licence to the applicant on receiving a licence from the applicant only for the applicant's Essential Patent Claims on the same IEEE Standard[114]. The submitter is *not* permitted to condition its licence on the applicant's agreement to:

- Grant a licence to any of its Essential Patent Claims that are not part of the same IEEE standard, or
- Take a licence for any of the submitter's patents that are not Essential Patent Claims for the same IEEE standard.

Further, if a SEP holder indicates a condition of Reciprocal Licencing on its LOA, it has no ability to exclude Affiliates. As Sidak (2016) notes, this may create a situation in which *'an SEP holder with a weak SEP portfolio might be able to force an SEP holder with a strong SEP portfolio to execute a cross license on terms that do not adequately reflect the relative strengths of the parties' respective SEP portfolios'*[115].

In effect, these provisions limit the flexibility in negotiations between SEP holders and implementers, shifting the balance towards pecuniary compensation. Allowing for reciprocal licensing increases liquidity and the exploitation of patent assets[116]. The restriction may limit the scope of the parties to

[113] Hoffinger, R. (2015) 'The 2015 DOJ IEEE Business Review Letter: The Triumph of Industrial Policy Preferences Over Law and Evidence' *CPI Antitrust Chronicle*, March 2015 (2) https://www.competitionpolicyinternational.com/file/view/7357

[114] IEEE (2015), Introduction and guide to the IEEE-SA patent policy effective 15 March 2015

[115] Sidak, J. G. (2016) 'Testing for Bias to Suppress Royalties for Standard-Essential Patents', *The Criterion Journal on Innovation*, Vol.1

[116] Katznelson (2015a)

come to a mutually acceptable arrangement and prevents parties from using their intellectual property to gain access to a SEP from a different standard, reducing the potential benefit of submitting an LOA.

4.4.4 The issue of 'Any Compliant Implementation'

According to the amended policy, a submitter of an LOA must make available a licence to any Compliant Implementation that conforms with the IEEE standard. A Compliant Implementation is *'any product (component, sub-assembly, or end-product) or service that conforms to any mandatory or optional portion of a normative clause of an IEEE standard'*[117]*.* A patent holder cannot refuse to license its patents at certain levels of production, though it does have the freedom to negotiate different licensing terms (including royalty rate) at the different levels[118].

However, the need to license at multiple different levels on different terms may raise costs for the SEP holder, and may lead to more disputes. It may also represent the concession of certain patent rights, such as control over the geographical distribution of the technology[119]. This change may therefore make it less attractive to submit an LOA.

4.5 Impacts towards R&D

Whilst legal and economic literature and debate has attracted much around the theory of 'patent hold-up' and royalty rates and levels as proximate issues, there is less on the 'quality' and volume of R&D. This is not too surprising; potential 'patent hold-up', hold-out and royalties are obvious first order considerations from changes in SEP related policies.

What is meant by 'quality' in R&D? In the case of R&D work as undertaken in industry which may result in innovations that may be deployed towards commercial products, firms will naturally be concerned with commercial efficiencies; that is, any investments in R&D should, in theory, result in healthy incomes, providing a return on such investments. In the wider sense, political entities and policy makers will be concerned with the flow of economic benefits that may result from investments in R&D[120].

Note also that R&D innovations can give rise to improved cost efficiencies, which may indirectly improve revenues or contribute to margins in any implementations; net cash flows, rather than revenues therefore are better measures of the value driven by any R&D. Whilst options based approaches can be useful in valuations assessments (to break down net discounted cash flows over time with probability factors), these still rely on accurate data inputs (probability levels) and in practice, accurate results are still hard to attain. Whilst R&D is not an overhead (it has the potential to generate cash incomes), it is most certainly a risky venture.

Firms are of course under ongoing stakeholder pressure to maintain healthy earnings; it is therefore highly likely that any impacts on royalty driven incomes will have to be passed through to levels of investments in R&D, with consequent impacts to levels of R&D. Further, any reduction in value of R&D

[117] IEEE policy, Section 6.1.

[118] https://www.justice.gov/atr/response-institute-electrical-and-electronics-engineers-incorporated

[119] Kjelland, K. (2015) 'Some Thoughts on Hold-Up, the IEEE Patent Policy, and the Imperiling of Patent Rights' *16th Advanced Patent Law Institute*, Berkeley Center for Law and Technology.

[120] Note: public funding is often associated with R&D; see for example Europe's Horizon 2020 programme, with nearly €80bn of funding being made available over the years 2014 to 2020.

output has the potential not only to reduce R&D investment in the near term, but also the *incentive* to invest in R&D and innovation[121] in general.

In practice, R&D investment levels are often set taking the above into account with driving factors as: (i) the need to sustain 'healthy' margins, addressing stakeholders' near term needs, and (ii) the need to sustain future business, addressing stakeholders' longer term needs.

In summary, any reduction in valuation on R&D output is likely to drive reduction in R&D investment via both tactical and strategic considerations.

4.6 Macroeconomic impacts

Whilst there is rich debate as to the economic and commercial impacts of IPR policies on firms, there is limited assessment as to wider macroeconomic implications. The scale of the technology industry in today's markets reaches global proportions; many firms have significant national and multi-national presence and products (such as smartphones) reach markets across the globe.

Therefore, the performance of such firms contributes significantly to national economies either directly (via employment opportunities for citizens, and via tax incomes for governments), or indirectly (through, for example, improved working efficiencies, and development of secondary markets). In broad terms, telecommunications products and services are fundamental enablers to the 'digital economy' and productivity gains can be attained across multiple sectors.

Assessment on the national and regional impacts from R&D and development of technical standards can be developed through review of measures associated with economic performance and consumer wellbeing, namely and respectively GDP and consumer surplus.

Impact to GDP

GDP is an established and well used measure of national economic performance[122]. It has high visibility in commentaries on levels of national performance and is typically used by governments in setting policy and national budgets. As noted in Section 2, GDP essentially measures value *added* in a given economy, with adjustments for inflation, over a given period of time[123]. Total GDP can be broken down into the relative contribution of each industry or sector of the economy[124]. Whilst GDP is used as an indicator of economic activity, it is not a measure of societal 'well-being' (for example, it does not account for rates of poverty, crime, or literacy). Measurement of GDP is well covered in standard economic texts and literature; we provide a brief overview in Appendix C.

As noted, IEEE-II policy has the potential, on the supply (equipment vendor) side, to reduce royalties and hence revenues for licensors, and therefore the immediate potential to reduce margins and investment available for R&D in those firms. In the longer term, reduction in R&D, within a given

[121] 'The IEEE's New IPR Policy: Did the IEEE Shoot Itself in the Foot and Harm Innovation?', David J. Teece and Edward F. Sherry, 3 August 2016. See: http://businessinnovation.berkeley.edu/wp-content/uploads/2014/07/Tusher-Center-Working-Paper-No.-13.pdf , accessed August 2016.

[122] Note: there is some ongoing debate amongst economists as to the usefulness of GDP as a measure of national economic wellbeing; some argue that the concept is dated and perhaps more suited to economies based on manufacturing. However, there is as yet no consensus on any alternatives. In the absence of alternatives, we use GDP here.

[123] Note: GDP adjusted for inflation may be referred to as real or constant GDP.

[124] Dawson, G. (2006) *'Economics and Economic Change*. FT / Prentice Hall. p. 205.

region, may contribute to a weakening in the supply of innovation in technology manufacturing which could then drive reduced competitive advantage for such firms in the global economy. This could yield a significant weakening in the commercial performance of technology development and supply firms in the sense that value added could decline. In turn, this could drive reductions in regional or national GDP levels. In short, if the value of R&D is depleted by too much, value added in production of technology based goods becomes a simple matter of arbitrage in international labour rates and there is potential for real damage to the technology sector of a given economy. With reduction in R&D at global levels, whole sectors of the economy could be damaged (that is, the performance of the 'digital economy' could be affected).

Quantitative assessment of impacts towards GDP are investigated further under Section 5.

Impact to societal welfare

With potential for reduction in SEP licensing rates and levels, there is a possibility that consumer prices could be impacted. We therefore consider the potential for impact to consumer welfare.

GDP per capita is one commonly applied measure for assessment on welfare; with knowledge of national GDP figures (see above) and population data, this is can be computed straightforwardly. However, GDP is a high level, aggregated metric; it does not indicate consumer welfare that can arise via price reductions in an economy. GDP per capita is a measure of productivity or income generated per person.

To reflect consumer benefits that can arise with price reductions in goods, the concept of consumer surplus – the difference between the price that a consumer is *willing* to pay for a good, against what is *actually* paid[125] – can be used. Consumer surplus arises when consumers are willing to pay more for a good or service than the market price. As above, measurement of consumer surplus is well covered in standard economic texts and literature; we provide a brief overview in Appendix C.

Similarly, a quantitative assessment of impacts towards consumer surplus is included in Section 5.

[125] Slesnick, D (1998) 'Empirical approaches to the measurement of welfare', *Journal of Economic Literature*, Vol. XXXVI, Dec. 1998, pp. 2108 – 2165.

5 Impact and assessment

From the above, the amendments conceivably generate both costs and benefits to society.

Whilst the amendments were developed by various factions supposedly to mitigate against the harm of 'patent hold-up', per our review under Section 4, we have found no evidence that such exists.

On the one hand, the amendments have potential to lower consumer prices, but on the other they have potential to weaken firms' incentives to innovate and engage with the standards development process, thus yielding potential for harm to economic activity and growth.

In order to progress understanding of these inter-related issues, it is necessary to engage in some quantitative analysis.

In this Section, we lay out expected commercial and economic impacts associated with IEEE-II policy, developing a framework for analysis together with qualitative and quantitative assessments.

Our analysis includes the following key elements.

- Analysis on impact on R&D funding and associated technical standards work and GDP levels, drawing upon review of relevant industry data.
- Assessment of materiality on impacts on telecommunications services pricing.
- Analysis of impacts on consumer pricing on handsets and associated consumer welfare.

Additional details on analytical methods are provided in Appendix E.

5.1 Impacts from policy changes

From our review of the amendments, we expect that IEEE-II policy will give rise to a number of commercial and economic effects, and our hypotheses on these are laid out below. We have distilled six primary hypotheses, based on combinations of driving factors. We assess the materiality and impacts on these further in later sections.

With IEEE-II policy in place, we anticipate the following as below.

I. Factors associated with so-called 'patent hold-up' and 'hold-out' will be impacted.

   a. SEP royalty rates, available for licensors, will decline, as a result of firmer definition under policy in royalty rates, inclusive of the principle of SSPPU.

      - SSPPU is very likely to act as a firm driver for reduction in royalty rates.
      - Royalty rates will decline due to mandated exclusion of any value attributable to IPR inclusion in standards.
      - Royalty rates may be affected due to required consideration of all SEP claims on one technical standard; this could lead to an 'averaging' effect on the value associated with SEPs and royalty rates associated with 'high value' SEPs could be negatively impacted.
      - Royalty rates may be affected due to required consideration of pre-existing or other licensing terms associated with a particular SEP. Again, this could lead

to an 'averaging' effect, though in this case, royalty rates could go up or down, depending on various separated commercial agreements on licence terms.

- During the course of our study, we have found no evidence to suggest that in the absence of IEEE-II policy, 'patent hold-up' occurs and, therefore, that IEEE-II policy is required to bring balance to 'excessive' levels in royalty rates.
- On balance, we envisage that royalty rates will be negatively impacted (relative to those typically set under FRAND policies), with principal effects driven from SSPPU.

b. Longevity in R&D concept to market cycles, for SEP innovators and implementers, may be impacted.

- Whilst IEEE-II policy calls for negotiations without unreasonable delay, there is no guarantee that such will occur and litigations may take place which may differ from those excepting IEEE-II changes (for example, scale in litigations could increase if firms cannot quickly agree on matters associated with the new policy). During the course of our study, we have unearthed no firm evidence indicating the scale of timing changes that could occur.
- Loss of injunctive options could cause litigation cycles to increase.
- There is some variability in time cycles during any R&D and product development. R&D and standards development cycles may in themselves extend over some years; product development cycles (from standards 'freeze' to product launch or general availability release on products) can take around 12 months in today's markets.
- On balance, we have found no firm evidence or data associated with concept to market cycle timing; therefore, we have excluded this from our quantitative assessment.

II. Stakeholders' businesses will be impacted.

a. Revenues for SEP licensors will be reduced as a result of reduced SEP royalty rates (as above).

- Royalty incomes may be either positively or negatively impacted by changes in terms associated with reciprocity in SEP licensing.

b. Loss of injunctive options will lead to a greater incidence of unchecked infringement causing loss of SEP revenues for SEP innovators.

- On balance, we envisage that there will be significant decline in SEP revenues for SEP licensors, due to changes in royalty rates and other factors as noted.

c. Licence costs will be reduced for SEP licensees, as a result of reduced royalty rates.

- Reductions in royalty rates may yield cost advantages for consumers of SEPs (such as firms focused towards implementation of products, with reliance on usage of licensed SEPs from other firms).

III. R&D investment and its efficiency will be reduced.

a. R&D investment in SEP innovators will be reduced, as a result of reduced revenue incomes for SEP licensors.

- With a primary driver as change in royalty rate and therefore revenues, it is likely that firms will respond with actions to reduce investment in R&D if sales fall. We have assessed the correlation between overall sales and R&D investment levels for a number of high technology firms; our analysis confirms a high correlation between these two factors (see Figure 5-1).
- With the requirement to offer licences, under LOAs, for all compliant implementations, there is an obligation for SEP innovators to offer licences in cases where cost efficiencies may be unattractive (for example, via multiple deals). This could give rise to an overall negative impact on concept to market cost efficiencies for SEP innovators.
- Cost efficiency in R&D has bearing upon levels of R&D output; if efficiency is weakened, R&D yield will decrease (such as the volume of patents, standards contributions).

b. R&D investment in SEP innovators will be reduced, as a result of perception or actual decline in the market value of SEPs.

- On balance, we posit that R&D investment will decline driven by decline in SEP incomes and actual or perceived value of commercially available SEP stock.

IV. Production of technical standards will be impacted.

a. The volume of technical standards produced will reduce, as a result of reduced R&D investment at SEP innovators.

b. The volume of technical standards produced will reduce, as a result of perceived or actual reduction in the market value of SEPs.

c. SEP innovators may elect to keep valuable innovative IPRs proprietary, driving less innovative IPRs into standards, thus diminishing the economic value of standards.

- We envisage that with policy which may weaken market value of R&D investments in standards work, firms will develop strategic decisions to divert R&D funding to other areas (such as proprietary IPR developments).

V. Consumer welfare could be impacted.

a. Reduction in licence costs for implementers could conceivably pass through to consumers in the form of reduced prices, thus enhancing consumer welfare (that is, consumer surplus will be increased if consumer prices are reduced). However, even if this results, we expect that benefits will be short-lived as any negative impacts on innovation will eventually remove any such benefits.

- Licensing cost advantages could give rise to reduced capital expenditures on networking equipment for service providers, if cost advantages are passed through the value system (rather than, for example, being absorbed by network equipment vendors as enhanced margins). Reductions in network capital could give rise to reduced prices in telecommunications service for consumers if cost reductions are passed through the value system (rather

than, for example, being absorbed by service providers as enhanced margins).

- Similarly, licensing cost advantages could give rise to reduced handset prices for consumers, if such cost advantages are passed along the value system.

VI. Regional or national levels of economic prosperity will be damaged.

a. Reduction in R&D investment across innovative SEP developer firms and decline in production of standards will negatively impact productivity and GDP.

Figure 5-1: Relationship between overall sales and R&D investment levels (various firms)

Source: Analysis based on YCharts

Note: Figure shows mean data on reported financials across a sample set of firms including: Qualcomm, Ericsson, Nokia, Interdigital, Apple, Alcatel-Lucent, and Cisco.

In this figure, the correlation coefficient (X,Y) = $\frac{\sum_i (x-\bar{x})(y-\bar{y})}{\sqrt{\sum_i (x-\bar{x})^2 \sum_i (y-\bar{y})^2}}$ = + 0.9210.

5.2 Analytical approach

Effective assessment of the impact of policy changes is dependent upon availability of data of acceptable quality and a sufficiently robust and meaningful framework for analysis, with manageable levels of complexity. With high complexity in the telecommunications value system, some judgement is required, applying industry experience, to ensure effective structure, taking account of materiality in assessment of impacts. In cases where data is not available, or not of sufficient quality, we have applied such judgement, deferring to qualitative assessment where appropriate. Further, we focus on commercial realities, leveraging theoretical stances where relevant.

With regard to SEP royalty rates and revenues, significant evidence exists against the SSPPU principle, which has attracted attention via several high profile legal cases (notably, *HP v Cornell, 2009*[126]). Therefore, our analytical focus on revenues is directed primarily towards SSPPU. Variation in royalty rate is a prime consideration in our analyses as a first order driver from policy changes.

Our analysis is structured to investigate the impact of changes in revenues and R&D investment levels towards commercial and economic factors. We exclude the impact of R&D investment on revenues, due to uncertainties in as above.

Evidence on R&D efficiency variations is sparse and with variations in R&D output[127] according to endemic factors (including variations in patent and standards complexity), we exclude this from our analyses.

In cases where limited or poor quality data exists, sensitivity analysis can be applied to assess impacts.

These factors are taken into account in the development of our framework for analysis, as below.

We have developed a balanced framework for analysis, designed to assess key impacts from IEEE-II policy changes across three main areas as below.

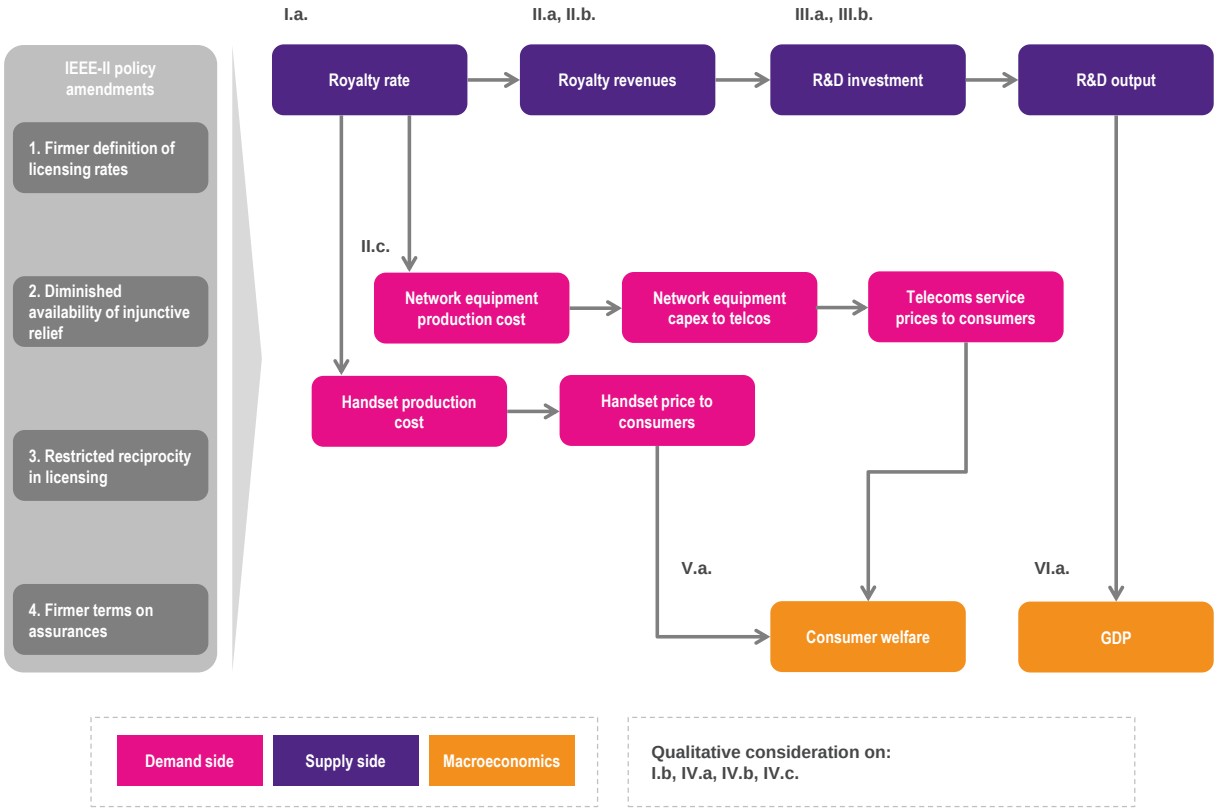
- Supply side (SEP innovators, licensors),
- Demand side (SEP consumers, product implementers, licensees), and
- Macroeconomics (GDP levels, consumer welfare).

This framework is shown below (see Figure 5-2) and is used in following analyses. Key impacts from policy changes (as above) are indicated on the diagram.

[126] Cornell University v. Hewlett-Packard Company, 609 F.Supp.2d 279 (N.D. N.Y, 2006), available at http://www.oceantomo.com/pdf/Cornell%20UniversityvHewlett-PackardCo_0.pdf .

[127] Note: R&D output may include non-SEP patents, SEPs, standards contributions, and other forms of intellectual capital.

Figure 5-2: Framework for modelling of impacts from IEEE-II policy



In the following, we investigate the scale of impacts arising from IEEE-II policy implementation using analysis coupled with empirical data (relative to an established baseline of FRAND policy).

An important aspect of our analysis is consideration on materiality; we focus on areas where our assessment indicates potential for material impacts.

5.3 Impact to R&D investment levels

Below, we examine the impact of changes in royalty rates on the supply side of the industry.

Logically, a change in royalty rate on the supply side will pass through to changes in R&D investment levels and potentially weaken output on R&D and standards development.

Additional details on supply side analytical methods are provided in Appendix E.1.

Levels of R&D investment will be affected by changes in royalty rate and will also be influenced by strategic considerations within firms as to the market values that may accrue as a result of R&D activity. Firms are, of course, at liberty to fund R&D from various sources (including product sales, debt, equity, and others). If there is a perception within firms that R&D returns may be undervalued, this will drive actual investments in R&D. Principal considerations will be around levels of R&D funding and also the type of R&D funded (for example, to what extent R&D resources are deployed towards standards and non-standards work).

We assume that R&D budgets will be set against firms' overall revenues via a mix of both proportional budgeting[128] and strategic considerations, in which case, it is possible to develop the following analysis[129].

$$\frac{R\&D'}{R\&D} = \left\{ 1 - (1 - x\%) \frac{IPR}{Sales} y\% \right\} z\% \qquad (5\text{-}1)$$

Where:

R&D' = R&D budget as set by firm due to diminished revenues with IEEE-II policy in place.

R&D = R&D budget as set by firm, prior to application of IEEE-II policy (under FRAND doctrine).

x% = multiplicative factor on royalty rate, due to implementation of IEEE-II policy (notably SSPPU).

IPR = firm's revenues from IPRs, prior to application of IEEE-II policy.

Sales = firm's total revenues, inclusive of IPR revenues, prior to application of IEEE-II policy.

y% = proportion of IPRs as SEPs in firm's IPR portfolio (SEP revenues = y% × IPR revenues).

z% = adjustment factor, taking into account strategic considerations on setting of R&D budget. z% represents the level to which firms may increase or decrease R&D investment, based on expectations of growth in value of R&D. We assume a base of 100% (that is, if R&D value is expected to decrease, z% may be reduced to less than 100%).

We envisage that impact of policy changes will vary according to scale of changes in royalty rates (x%), the relative level of reliance that firms may have on revenues from SEPs (y%), and the level of strategic consideration in setting R&D budget (z%).

Impacts of changes in these parameters across a range of values are shown below (see Table 5-1).

[128] R&D budgets are typically set in firms with consideration to R&D to Sales ratios and industry norms.

[129] Application of IEEE-II policy is likely to impact only those IPRs as SEPs. 'Under' IEEE-II, IPRs not as SEPs may not be impacted in royalty rates. We apply an adjustment 'y%' to account for this.

Table 5-1: Impact of decline on SEP revenues to R&D investment levels within firms

Revision in royalties due IEEE-II Based on SSPPU evidence	Level of reliance on IPR incomes as a proportion of overall firm's revenues (prior to IEEE-II): A% = IPR_revenues / total_revenues								
A%	1%	5%	10%	20%	30%	40%	60%	80%	100%
SSPPU impact: x%	R&D' / R&D = revised level in R&D investment level due to IEEE-II implementation (z% = 100%)								
10%	99.1%	95.5%	91.0%	82.0%	73.0%	64.0%	46.0%	28.0%	10.0%
20%	99.2%	96.0%	92.0%	84.0%	76.0%	68.0%	52.0%	36.0%	20.0%
50%	99.5%	97.5%	95.0%	90.0%	85.0%	80.0%	70.0%	60.0%	50.0%
SSPPU impact: x%	**R&D' / R&D = revised level in R&D investment level due to IEEE-II implementation (z% = 60%)**								
10%	59.5%	57.3%	54.6%	49.2%	43.8%	38.4%	27.6%	16.8%	6.0%
20%	59.5%	57.6%	55.2%	50.4%	45.6%	40.8%	31.2%	21.6%	12.0%
50%	59.7%	58.5%	57.0%	54.0%	51.0%	48.0%	42.0%	36.0%	30.0%
SSPPU impact: x%	**R&D' / R&D = revised level in R&D investment level due to IEEE-II implementation (z% = 60%)**								
10%	49.6%	47.8%	45.5%	41.0%	36.5%	32.0%	23.0%	14.0%	5.0%
20%	49.6%	48.0%	46.0%	42.0%	38.0%	34.0%	26.0%	18.0%	10.0%
50%	49.8%	48.8%	47.5%	45.0%	42.5%	40.0%	35.0%	30.0%	25.0%
SSPPU impact: x%	**R&D' / R&D = revised level in R&D investment level due to IEEE-II implementation (z% = 60%)**								
10%	39.6%	38.2%	36.4%	32.8%	29.2%	25.6%	18.4%	11.2%	4.0%
20%	39.7%	38.4%	36.8%	33.6%	30.4%	27.2%	20.8%	14.4%	8.0%
50%	39.8%	39.0%	38.0%	36.0%	34.0%	32.0%	28.0%	24.0%	20.0%
SSPPU impact: x%	R&D' / R&D = revised level in R&D investment level due to IEEE-II implementation (z% = 100%)								
10%	9.9%	9.6%	9.1%	8.2%	7.3%	6.4%	4.6%	2.8%	1.0%
20%	9.9%	9.6%	9.2%	8.4%	7.6%	6.8%	5.2%	3.6%	2.0%
50%	10.0%	9.8%	9.5%	9.0%	8.5%	8.0%	7.0%	6.0%	5.0%

Clearly, there is variability in firms' reliance on SEP revenues (as charted via the horizontal dimension shown in Table 5-1); with reduction in SEP royalties, some firms may be forced to reduce R&D investments (due to cash flow necessities), whereas others may be at liberty to fund R&D via alternative means (with funding from product revenues). However, if SEP royalties are decreased, it is likely that firms will reduce R&D investment towards standards work, with implication that R&D will drive proliferation of products less reliant on standards. This could have important implications for the industry; we discuss this further in a later section.

For our subsequent analyses, we assume the following parameters (see highlighted cell entries in Table 5-1):

x% = 20% (based on evidence from the US legal case *HP v Cornell*, 2009),

SEP ÷ Sales (that is, y% × IPR ÷ Sales) (at the firm level) = 30% (blended rate across multiple R&D focused firms with varied proportional incomes from SEPs[130]), y% = 100%, and

z% = 50% ± 10% (in addition to R&D investment being cut in line with R&D to Sales ratio with reduced SEP royalties, we envisage that R&D investment will be further set according to some consideration on strategic planning – with a significant cut in SEP royalties due to SSPPU, we assume that firms will be cautious in R&D investment given that return from SEPs could be expected to be devalued). With implications on IEEE-II policy still playing out in markets,

[130] Note: realisation of IPR and SEP revenues as a proportion of overall revenues varies across firms. An overall industry mean would suggest SEP to Sales data at around 5%. However, we assume that some firms will operate with much higher dependencies on IPR revenues. Further, such firms may contribute important R&D innovations. If the flow of such R&D is stemmed due to reduced revenues and strategic considerations, this could lead to important impact at an industry wide level. This is assessed further later in this Chapter.

accurate determination on z% is uncertain; we assume that z% = 100% and z% <=10% are unrealistic.

This results in a change in R&D (measured as R&D' ÷ R&D) to approximately 40% (as shown highlighted in Table 5-1). That is, R&D falls to a level 40% of its initial value. We posit that change in R&D investment of this magnitude has the potential to materially impact on the high technology sector and the wider economy. Key elements of our analysis include:

- Impact of R&D investment level changes on economic performance (via assessment of impact on GDP data), and
- Impact of R&D investment level changes on technical standards development.

These factors are considered further below.

5.4 Impact of R&D investment level changes on economic performance

We assess below the potential for changes in high technology producer firms' R&D investment levels to impact on overall economic growth in Europe.

Our approach draws from established literature and is based on logic as below.

- Firms in the sectors affected are likely to reduce their R&D expenditure in response to the imposition of IEEE-II policy.
- This will result in slower accumulation of R&D 'knowledge capital'.
- Economic productivity across the economy is weakened as a result of diminished availability of innovative products, technologies and processes.
- Future GDP is negatively impacted.

Drawing from the above, under IEEE-II policy, we expect R&D funding to fall to around 40% of the levels sustained under a FRAND regime.

With involvement in technical standards across various sectors, from Eurostat data[131], we estimate that sectors affected by policy change will comprise around 13% of total European firms' R&D, that is – within Europe, we expect around 13% of the total R&D investment to be impacted by IEEE-II policy changes. Therefore, we estimate that overall R&D investment in Europe is likely to decline by around 8% due to IEEE-II policy.

We draw from established economic theory and practice[132,133] which places strong linkage across R&D investment levels, resulting R&D 'stock' and GDP growth levels. R&D results in new goods and services and improved productivity which tends to enhance economic prosperity. R&D can also generate 'spill over' benefits – where R&D innovations in one sector can drive productivity gains in another.

[131] See: http://ec.europa.eu/eurostat , accessed October 2016.

[132] McMorrow, K., and Werner, R., (2009) 'R&D capital and economic growth: The empirical evidence', in: *'R&D and the financing of innovation in Europe'*, EIB Papers, Vol.14, No.1, 2009.

[133] Donselaar, P. and Koopmans, C. (2016*) 'The fruits of R&D: Meta-analyses of the effects of Research and Development on productivity'*, University of Amsterdam, Faculty of Economics and Business Administration Research Memorandum 2016-1.

We develop two scenarios as below. In each, we calculate R&D capital stock using R&D expenditure data drawn from Eurostat data, with adjustments for depreciation. The two cases are developed as below.

- Base (FRAND) case: where overall European annual R&D investment and GDP grows in line with established trends.
- IEEE-II amendments case: where the base case is impacted due to the amendments.

For each scenario, we link growth in the R&D capital stock to GDP growth. Referring to established economic studies[134], we assume an elasticity of overall R&D capital stock to GDP of 0.06; that is, a 10% decrease in R&D investment would yield a decrease in GDP of 0.6%. We believe that our assumption on elasticity is conservative, given that we have consciously selected a figure towards the low end from reported studies and that our assessment is focused towards high tech R&D (which some studies suggest has the potential to contribute relatively more to productivity).

We compute both scenarios to a time horizon of ten years, and calculate total GDP impact from the difference between scenarios (discounting using an EU social discount rate of 4%[135]). We estimate that a decline in overall European R&D investment to around 92% of the levels seen under FRAND would result in a total GDP impact of €465.3bn over 10 years. A full description of our analysis and assumptions is provided in Appendix E.

$$NPV\ \Delta\ GDP_{R\&D} = -\ €465\text{bn} \qquad (5\text{-}2)$$

Clearly, any analysis at macroeconomic level is open to some margin of error and caution must be read into any interpretation on these results. However, it is entirely possible that firms in the high technology sector could be forced into difficult situations if cash flows are stemmed or strategic actions are forced as a result of policy changes. If numerous firms active in R&D are forced into closure or experience significant impacts resulting in decline or shift in R&D outputs, and R&D in this field becomes less attractive for the remaining firms, expenditure on R&D could be substantially reduced, resulting in a decline in productivity and GDP growth.

5.5 Impact of R&D investment level changes on technical standards development

We note in the above that application of R&D investment, as well as absolute levels will have bearing on industry and economic performance. Firms are at liberty to place R&D investment towards various areas including standards development or proprietary developments. If the product of R&D investment into standards work (namely SEP incomes) is devalued, it is likely that firms will divert R&D budgets elsewhere.

Standards serve various purposes, ranging from promotion of public safety, to enabling common access to technologies and communications systems, to enabling economic growth via promotion of economies of scale and improved cost efficiencies. Standards also serve to prevent 'lock-in' (where consumers can face excessively high barriers to change suppliers), thus enabling more effective

[134] Refer to Appendix E for further detail

[135] http://ec.europa.eu/smart-regulation/guidelines/tool_54_en.htm

levels of market competition and trading. Major benefits include access to scale and diffusion, where firms can invest, with contained levels of risk, to build products that will address markets much larger than would be possible with a highly fragmented approach. Further, where the 'quality' of international standards exceeds that available at national levels, evidence exists[136] to suggest that the use of standards brings positive benefits for export performance. Standards making in itself can also promote competition and innovation; in today's markets, firms actively compete to promote the products of their R&D towards standards; technologies as candidates for standards inclusion are invariably subjected to rigorous assessments on technical and commercial merit, rendering benefits ultimately to end users and society. Whilst there can be some negative impacts associated with standards (restrictions on choice, or market concentration, for example), established studies[137] conclude that, overall, productivity gains enabled by standards development yield a positive economic impact. Recent studies[138] have placed the (cross sector) benefit of overall standards development at national levels to the order of 10% of GDP, though some caution must be adopted in interpretation of these results as investment in standards is tightly bound to that in R&D and it can be difficult to segment effects.

Further to our analysis above, if firms divert R&D away from standards development, it is likely that fragmentation will occur within industries; we envisage that this will lead to proliferation of proprietary technologies which will result in decreased connectivity and thus decline in economic benefit for consumers and firms. Thus, relative to our analysis above with overall R&D investment levels, we expect that a shift away from standards work (within a given quantum of R&D investment) will lead to a further incremental negative impact on economic performance. Put another way, our R&D analysis as above is conservative on impact towards GDP as we assume no change in that analysis in the proportionality of R&D efforts towards proprietary work and standards contribution[139].

5.6 Potential for impact on network equipment and service prices

Below, we examine materiality of changes in royalty rates on the demand side of the industry.

Logically, a change in royalty rate on the supply side will pass through to changes in costs and potentially prices on the demand side, if such changes are passed through.

Per Figure 5-2, changes in SEP royalty rate have the potential to impact on costs on both network equipment and handsets in the supply chain.

Additional details on demand side analytical methods are provided in Appendix E.2.

[136] Cebr (2015), *'The Economic Contribution of Standards to the UK Economy'*, BSI, London. http://www.bsigroup.com/LocalFiles/en-GB/standards/BSI-standards-research-report-The-Economic-Contribution-of-Standards-to-the-UK-Economy-UK-EN.pdf , accessed October 2016.

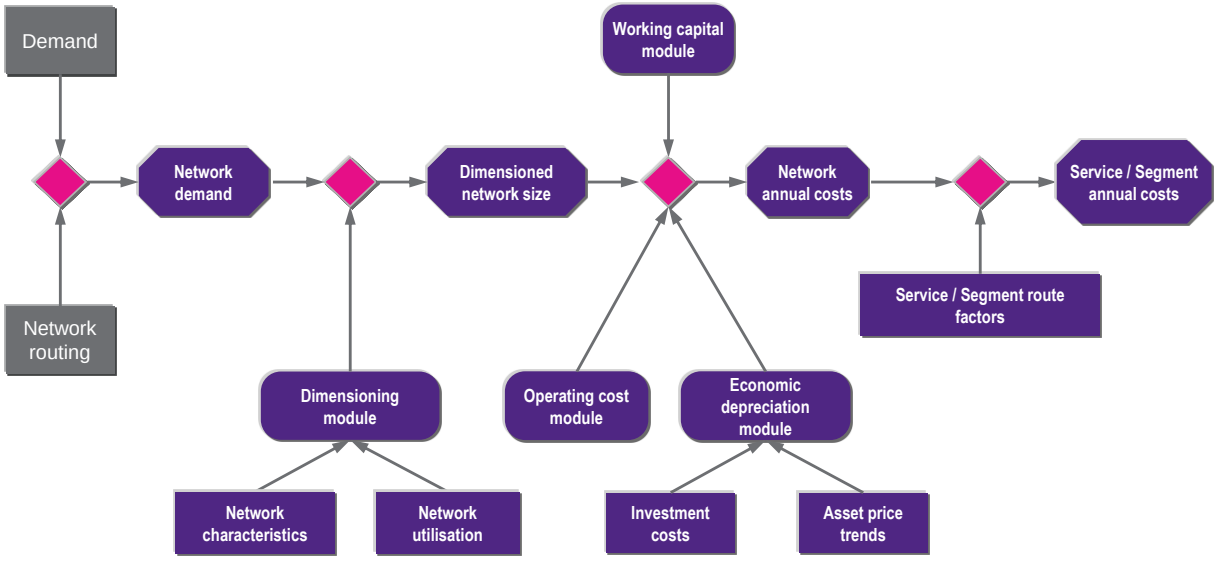
[137] Blind, K., Jungmittag, A. and Mangelsdorf, A. (2011) 'The Economic Benefits of Standardization', DIN. http://www.din.de/blob/89552/68849fab0eeeaafb56c5a3ffee9959c5/economic-benefits-of-standardization-en-data.pdf

[138] Standards Australia (2013), *'Research Paper: The Economic Benefits of Standards'* http://www.standards.org.au/OurOrganisation/News/Documents/Economic%20Benefits%20of%20Standardisation.pdf , accessed October 2016.

[139] Allowing for sectoral effects, we estimate that a complete decline in investment towards ICT sector standards work could yield an impact towards GDP of around 2 percentage points. (Based on proxy data; R&D in the ICT sector varies by region; in the UK, ICT R&D amounts to approximately 20% of total (of which, over 50% goes towards development on software and information services)).

Service pricing in telecommunications is often subject to regulation according to policies that may be defined at regional or national levels; for example, under long run incremental costing (LRIC) methods, service prices may be based, essentially, on determination of annual product specific costs, with appropriate mark-ups. For illustration on service pricing methodology, see Figure 5-3.

Figure 5-3: Typical service costing methodology (cost plus mark-up)



Whilst a detailed assessment of service pricing is beyond our purpose and scope here, we have investigated materiality of changes in SEP royalty rates reading onto service pricing.

Leveraging previous experience, we have reviewed financials associated with a greenfield build-out programme for a 3G or LTE mobile network operator (MNO); in our experience, this presents a high quality, relevant and sufficiently detailed case for analysis. We have reviewed annualised costs inclusive of total operational costs, costs of goods sold (COGS) (including interconnect, roaming, and sales costs), together with charges on capitalised network equipment as cost of capital, plus depreciation. A summary set of profit and loss accounts for the case example used is provided in Appendix D.

Our analysis on key financial elements is shown below (see Table 5-2), wherein we have applied the following key assumptions:

Cost of capital per annum: 12%,

Asset life on network depreciation charges: 7 years,

SEP cost as a proportion of network capex: 5%, and

Impact on SEP royalties, due to SSPPU implementation: reduced to 20% of FRAND value.

We assume for analysis that the full impact of SSPPU royalty decline is passed through to network equipment pricing. In practice, this may not be the case; if none of the royalty rate decline is passed through to equipment prices, instead being absorbed by the implementer as improved margins, then no benefit on service prices would be passed through; with application of the full SSPPU decline in our analysis as below, we illustrate the full potential of SSPPU royalty rate declines on the cost base for service pricing.

Table 5-2: Analysis on potential impact of SSPPU reading on to MNO service prices

Annualised costs for greenfield build-out MNO business:	€ mn	€ mn
Under FRAND:		
Capex items:		
Capex Depreciation	61.40	
Capex CoC	29.47	
Capex depreciation + CoC	**90.88**	
Under SSPPU:		
Capex items:		
Capex Depreciation	58.95	
Capex CoC	28.29	Δ
Capex depreciation + CoC	**87.24**	
COGS items:		
Interconnection and international roaming charges	100.43	
Content cost	7.05	
Handset and SIM Costs	11.14	
Dealer Commissions	0.03	
Sales Commission	10.89	
Total COGS items	129.53	
Opex items:		
Network operating and maintenance	9.64	
Sales & marketing	14.13	
Staff Costs	24.45	
Retention cost	6.07	
IT Opex	0.73	
Billing	2.25	
Start-up cost and others	2.12	
Regulatory fees	33.05	
Fraud & bad debt & other	50.68	
Total opex items	143.12	
Total annualised costs (FRAND)	**363.53**	
Annualised capex items / total annualised costs	25%	
Total annualised costs (SSPPU)	**359.89**	
Annualised capex items / total annualised costs	24%	
Impact on annualised costs under FRAND with SSPPU		**-1.00%**

Our analysis indicates the relative materiality of items in the cost base for service pricing[140].

With this case, we conclude that materiality of changes in SEP royalty rates due to SSPPU implementation, reading on to the cost base for service pricing is relatively low (approximately -1%). Further, we have compared key metrics from this case analysis with industry benchmarks, to assess the positioning of the case against wider industry. Materiality of impacts on service pricing will be due to overall demand side cost structure and relative positioning of changes in network equipment capex levels if changes in SEP royalty rates are passed through from implementer costs to implementer prices, and subsequently operator service prices. The relative scale of annualised costs will be significant; relative scaling on capex and opex items can be assessed via industry benchmarks as

[140] In practice, service prices are typically derived further using appropriate allocations of cost to particular service items, together with mark-ups; we focus here on the overall cost base for service pricing to assess materiality.

below. We summarise key case and industry benchmarks as below, confirming that the cost structure in our case example is in line with industry norms.

Figure 5-4: Selected industry benchmarks

Industry benchmarks ('steady state' businesses)	
Capex to sales ratio	
Plum case example	15%
Industry sample mean	15.20%
EBITDA margin	
Plum case example	39%
Industry sample mean	35%

For established businesses, the cost base on telecommunications services tends to be driven by operational costs, plus annualised capitalised items such as spares and maintenance. With our analysis and with propensity for significant absorption of benefits across multiple value chain entities (implementers and service operators) we envisage negligible impact to service pricing. Consequently, we exclude detailed analysis on service prices, focusing below on handset pricing.

5.7 Impact on handset prices

The scale of the global handsets market is significant; in 2016, global revenues on smartphones exceeded €400bn[141], with sales in Western Europe accounting for around 16% of this figure.

We refer to the '25% rule[142]', industry precedent, and empirical evidence[143] on IPR royalty yields from smartphone sales, indicating mean yield levels on FRAND SEPs of 5% or less, noting that it is more appropriate to examine long run profits and sales, since benefits from IPR often accrue over time once licensing terms have been agreed. With implementation via SSPPU, we refer further to the principles underlying equation (5-1):

$$\frac{P'}{P} = \{1 - (1 - x\%)\, w\%\, p\%\} \qquad (5\text{-}3)$$

Where:

P' = Handset price with diminished SEP costs with IEEE-II policy in place.

P = Handset price, prior to application of IEEE-II policy (under FRAND doctrine).

x% = multiplicative factor on royalty rate, due to implementation of IEEE-II policy (notably SSPPU).

w% = SEP royalty cost per handset ÷ handset price.

[141] See: https://www.statista.com/statistics/237505/global-revenue-from-smartphones-since-2008/ , accessed October 2016.

[142] Goldscheider, R., Jarosz, J. and Mulhern, C. (2002), 'Use of the 25 Per Cent Rule in Valuing IP', Les Nouvelles, December 2012 http://www.bu.edu/otd/files/2009/11/goldscheider-25-percent-rule.pdf , accessed October 2015.

[143] Mallinson, K. (2015) *'Cumulative mobile-SEP royalty payments no more than around 5% of mobile handset revenues',* IP finance, http://www.ip.finance/2015/08/cumulative-mobile-sep-royalty-payments.html , accessed October 2015.

p% = level of pass-through on cost benefits (p% = 100%: all cost benefit passed through).

Equation (5-3) indicates the scaling in handset price that could occur if SEP cost reductions are passed through by an implementer to reductions in handset price. If this does not occur (if cost benefits are not passed through to handset price but instead absorbed by the implementer as improvements in margin), then, in the limit, there will be no price improvement attainable[144]. Equation (5-3) thus represents the maximum in scaling down in handset price with implementation of IEEE-II policy. We have tabulated results from equation (5-3) using empirical data as below (see Table 5-3).

Table 5-3: Assessment of impact on handset price due to IEEE-II policy implementation

Revision in handset price due IEEE-II Based on SSPPU evidence	**SEP licence cost to implementer as a proportion of handset price**			
	w% = SEP_cost / total_revenues			
w% =	1%	5%	10%	20%
SSPPU impact: x%	**Pass-through of cost benefit = 100%**			
	Handset price SSPPU : Handset price FRAND			
10%	99.1%	95.5%	91.0%	82.0%
20%	99.2%	96.0%	92.0%	84.0%
50%	99.5%	97.5%	95.0%	90.0%

SSPPU impact: x%	**Pass-through of cost benefit = 50%**			
	Handset price SSPPU : Handset price FRAND			
10%	99.6%	97.8%	95.5%	91.0%
20%	99.6%	98.0%	96.0%	92.0%
50%	99.8%	98.8%	97.5%	95.0%

SSPPU impact: x%	**Pass-through of cost benefit = 25%**			
	Handset price SSPPU : Handset price FRAND			
10%	99.8%	98.9%	97.8%	95.5%
20%	99.8%	99.0%	98.0%	96.0%
50%	99.9%	99.4%	98.8%	97.5%

SSPPU impact: x%	**Pass-through of cost benefit = 0%**			
	Handset price SSPPU : Handset price FRAND			
10%	100.0%	100.0%	100.0%	100.0%
20%	100.0%	100.0%	100.0%	100.0%
50%	100.0%	100.0%	100.0%	100.0%

These results suggest that nominal handset prices could decline by 4% (relative to FRAND based prices) with IEEE-II policy in place with 100% pass-through on cost benefits (or by 2% with 50% pass-through on costs).

We envisage that, in practice, implementers would absorb some of the benefits if cost declines were to occur; correspondingly, we assume a 'base case' as a pass through level of 50%, with SSPPU impact at x%=20%.

For the European market, a handset price decline of 2% amounts to an annualised revenue decline of approximately €1.28bn (excluding volume impacts).

[144] Note: whilst it is possible that service providers could further impact benefits absorption via resale deals, increasingly handsets are being offered in markets directly from implementers (as 'unlocked' devices, with 'SIM free' service packages), therefore, we focus on implementer pricing.

Such a reduction in handset prices has some potential to impact consumer welfare, as we examine below.

5.8 Impact of changes on consumer welfare

We adopt established practice in estimating consumer welfare via analysis on consumer surplus. We assess two scenarios: with FRAND based policy, and with IEEE-II based policy. Our analysis takes account of handset price variations as above, and volume impacts: as price declines, volume (demand) increases (with negative elasticity). Details of our approach here are elaborated under Appendix E.

We use a non-linear model, with a FRAND scenario, with perturbation to an IEEE-II case; we then estimate change in consumer surplus as follows.

From economic theory, consumer surplus is the difference between the maximum price that a consumer is willing to pay for a product (per a given price demand curve) and the actual price of the product, taking account of overall quantity levels. In our analysis, we assume that there is an endemic downward trend in the quality adjusted price[145] of smartphones in line with our experience in industry.

We define P_n as the quality adjusted price in year 'n' in the FRAND base case, and P_n' as the quality-adjusted price in year 'n' in the IEEE-II case. Change in consumer surplus in year 'n' is the change that results from a shift in handset price from P_n to P_n'.

With IEEE-II policy in place, long term reduction in royalty to SEP holders is likely, so that change in consumer surplus will be observed in years following the policy introduction. However, per our analyses above, change in royalty levels also has negative impact on R&D investment levels and levels of R&D and standards output. Therefore, it is likely that the pace of innovation will be reduced and consequently, in the IEEE-II case, there are two drivers on quality adjusted price: (i) nominal decline due to pass-through on cost reductions, and (ii) impact due to reducing product quality. Over time the nominal reduction in price due to lower royalty may no longer translate to a reduction in price in real terms[146], due to the negative effect of reducing quality in products; this is taken into account in our analysis where we assume that, due to the quality adjustments on price, price effects with IEEE-II policy in place are sustained for a period of five years following policy implementation in the market.

As above we estimate a nominal decline in handset pricing with IEEE-II in place as 2%. We posit that IEEE-II policy drives a decrease in royalty rate on SEPs, which is passed on to consumers as price reduction on products. Consumer surplus then increases as below.

We estimate overall change in consumer surplus as the five year net present value (NPV) on yearly estimates on consumer surplus across the two policy scenarios. With this approach, we attain a result of €3bn for change in consumer surplus.

$$NPV\ \Delta\ CS = +\ €3.00\text{bn} \qquad (5\text{-}4)$$

[145] Note: quality adjusted price refers to a price adjusted on product quality; if product quality is halved for a given price, quality adjusted price doubles (one would need to pay twice as much to get the original quality). We take this into account to adjust across both scenarios for the impact of R&D investment levels on product quality levels.

[146] In fact, it is possible that the pace of technological progress slows so much that the decline in quality-adjusted price grinds to a halt or even reverses. This means that the quality-adjusted price in the FRAND scenario could in fact be lower than that in the IEEE-II case.

As a sense check, with a handset price reduction from P to P', with no variation in quantity, European consumers would experience a gain in consumer surplus equivalent to unit price differential for a given quantity as follows[147]. (This is equivalent to the suppliers' decline in revenues in the case where all cost reductions are passed through to price).

$$(P - P')Q = +\text{€}1.25\text{bn} \quad \text{(5-5)}$$

If no cost benefits were passed through to consumers, there would be no nominal change in consumer surplus, and therefore no net benefit to consumers. In fact, with reduced levels of R&D, per our analyses above, handset quality is likely to reduce, which in turn could lead to overall negative impact on consumer surplus (taking into account quality adjusted pricing).

[147] Using 2016 data.

Appendix A: Review on IEEE-II amendments

Changes to both definitions and policy resulting from the IEEE-II decision of 2015 cover a number of areas, as follows.

Note that under IEEE-II terminology, '*Submitter'* refers to providers of LOAs (which may be owners of SEPs), and '*Applicant'* refers to prospective licensees (such as implementers) for any such SEPs.

Table 5-4: Amendments[148] with IEEE-II definitions and policy

IEEE-II amendments	**Summary comments on amendments**
IEEE-II Definitions	
'Prohibitive Order' shall mean an interim or permanent injunction, exclusion order, or similar adjudicative directive that limits or prevents making, having made, using, selling, offering to sell, or importing a Compliant Implementation.	Reference to injunctive relief is introduced, where such could be used to restrict or prevent an implementer from commercialising products or services that may be associated with any SEP(s).
'Reasonable Rate' shall mean appropriate compensation to the patent holder for the practice of an Essential Patent Claim excluding the value, if any, resulting from the inclusion of that Essential Patent Claim's technology in the IEEE Standard. In addition, determination of such Reasonable Rates should include, but need not be limited to, the consideration of: The value that the functionality of the claimed invention or inventive feature within the Essential Patent Claim contributes to the value of the relevant functionality of the smallest saleable Compliant Implementation that practices the Essential Patent Claim. The value that the Essential Patent Claim contributes to the smallest saleable Compliant Implementation that practices that claim, in light of the value contributed by all Essential Patent Claims for the same IEEE Standard practiced in that Compliant Implementation. Existing licenses covering use of the Essential Patent Claim, where such licenses were not	A more precise definition of the commercial rate associated with licensing of SEPs to implementers is adopted than had been the case prior to IEEE-II. The amendment clarifies that the rate shall exclude any value that may accrue as a result of the SEP(s) inclusion in the standard; there should be no undue commercial leverage of value *because* SEP(s) are included in standards. In addition, it is stated that determination of licensing rates for SEP(s) should include consideration of the value of the SEP(s) that may accrue with any *smallest saleable compliant implementations* with such, and that this consideration should be made in light of the value contributed by all SEP claims for the same IEEE standard. Further, consideration should also be made towards any existing licences covering the SEP under scrutiny (where such licences were not obtained under any forms of injunctive relief);

[148] We refer here to what may be considered as substantive amendments with the IEEE-II revisions, over the established IEEE policy. For IEEE-II revised policy see: http://standards.ieee.org/develop/policies/bylaws/sect6-7.html ; for redline revisions, see: http://grouper.ieee.org/groups/pp-dialog/drafts_comments/SBBylaws_100614_redline_current.pdf , accessed August 2016. Note that IEEE-II revisions extend to both definitions and policy.

obtained under the explicit or implicit threat of a Prohibitive Order, and where the circumstances and resulting licenses are otherwise sufficiently comparable to the circumstances of the contemplated license.	essentially, if SEP value has elsewhere been reasonably compensated, this should be taken into account in the definition of any rates.
'Reciprocal Licensing' shall mean that the Submitter of an LOA has conditioned its granting of a licence for its Essential Patent Claims upon the Applicant's agreement to grant a licence to the Submitter with Reasonable Rates and other reasonable licensing terms and conditions to the Applicant's Essential Patent Claims, if any, for the referenced IEEE Standard, including any amendments, corrigenda, editions, and revisions. If an LOA references an amendment or corrigendum, the scope of reciprocity includes the base IEEE Standard and its amendments, corrigenda, editions, and revisions.	It is clarified that reciprocal licensing shall refer to the situation where the Submitter will condition the terms of its licensing of any SEP(s) to the Applicant upon terms that may be offered by the Applicant to the Submitter in association with any SEP(s) that it may have *in association with the same technical standard*.
IEEE-II Policy	
The licensing assurance shall be either: a) A general disclaimer to the effect that the Submitter without conditions will not enforce any present or future Essential Patent Claims against any person or entity making, having made, using, selling, offering to sell, or importing any Compliant Implementation that practices the Essential Patent Claims for use in conforming with the IEEE Standard; or, b) A statement that the Submitter will make available a licence for Essential Patent Claims to an unrestricted number of Applicants on a worldwide basis without compensation or under Reasonable Rates, with other reasonable terms and conditions that are demonstrably free of any unfair discrimination to make, have made, use, sell, offer to sell, or import any Compliant Implementation that practices the Essential Patent Claims for use in conforming with the IEEE Standard. An Accepted LOA that contains such a statement signifies that reasonable terms and conditions, including without compensation or under Reasonable Rates, are sufficient compensation for a licence to use those Essential	The new definition of Reasonable Rates is incorporated into policy with an LOA based assurance commitment that such rates, or exception of compensation, together with affirmation as to reasonable terms and conditions, are sufficient compensation for an Applicant to gain a licence to use SEP(s). Further, it is stated that any LOA will include affirmation that the seeking of, or seeking enforcement of, a Prohibitive Order (as newly defined with IEEE-II) (for example, an injunction imposed by the Submitter towards the Applicant, to prevent use of SEP(s) such as with implementation of goods or services) is precluded.

Patent Claims and precludes seeking, or seeking to enforce, a Prohibitive Order except as provided in this policy.	
An Accepted Letter of Assurance shall apply to the Submitter, including its Affiliates. The Submitter, however, may specifically exclude certain Affiliates identified in the Letter of Assurance, except that a Submitter shall have no ability to exclude Affiliates if the Submitter has indicated Reciprocal Licensing on an Accepted Letter of Assurance.	Terms related to LOAs are further expounded in that the Submitter shall have no ability to exclude its Affiliates where Reciprocal Licensing is indicated in a related LOA.
The Submitter shall not condition a licence on the Applicant's agreeing (a) to grant a licence to any of the Applicant's Patent Claims that are not Essential Patent Claims for the referenced IEEE standard, or (b) to take a licence for any of the Submitter's Patent Claims that are not Essential Patent Claims for the referenced IEEE standard.	A licence issued by the Submitter shall not be conditioned on (a) the Applicant's agreeing to grant a (reciprocal) licence for any non-essential patents (issued or pending) in the referenced IEEE standard, or (b) the Applicant's agreeing to take a licence for any of the Submitter's non-essential patents (issued or pending) in the referenced IEEE standard.
On a Letter of Assurance, the Submitter may indicate a condition of Reciprocal Licensing. If an Applicant requires compensation under Reciprocal Licensing to its Essential Patent Claims, then a Submitter may require compensation for its Essential Patent Claims from that Applicant even if the Submitter has otherwise indicated that it would make licenses available without compensation.	Reciprocal licensing may be undertaken. Where, under reciprocal licensing, compensation is required by an Applicant for its SEP(s) from a Submitter, then compensation may be required by the Submitter from the Applicant for its SEP(s), even in cases where the Submitter has otherwise indicated that licences could be made available without compensation.
The Submitter and all Affiliates (other than those Affiliates excluded in a Letter of Assurance) shall not, with the intent of circumventing or negating any of the representations and commitments made in the Accepted Letter of Assurance, assign or otherwise transfer any rights in any Essential Patent Claims that they hold, control, or have the ability to licence and for which licensing assurance was provided on the Accepted Letter of Assurance.	The Submitter and all relevant Affiliates shall not seek to circumvent or negate any representations or commitments on licensing assurance made in an accepted LOA via assignment or transference of any rights in any SEP(s) under their power.
An Accepted Letter of Assurance is intended to be binding upon any and all assignees and transferees of any Essential Patent Claim covered by such LOA. The Submitter agrees (a) to provide notice of an Accepted Letter of Assurance either through a Statement of Encumbrance or by binding its assignee or transferee to the terms of such Letter	Affirmation is provided wherein: an accepted LOA is intended to be binding upon any and all assignees and transferees of any SEP(s) covered by such an LOA.

of Assurance; and (b) to require its assignee or transferee to (i) agree to similarly provide such notice and (ii) to bind its assignees or transferees to agree to provide such notice as described in (a) and (b).	
The Submitter and the Applicant should engage in good faith negotiations (if sought by either party) without unreasonable delay or may litigate or, with the parties' mutual agreement, arbitrate: over patent validity, enforceability, essentiality, or infringement; Reasonable Rates or other reasonable licensing terms and conditions; compensation for unpaid past royalties or a future royalty rate; any defences or counterclaims; or any other related issues.	Where relevant, the Submitter and the Applicant should engage, without unreasonable delay, in negotiations, litigation or arbitration concerning patent related matters, which may include licensing rates and terms and compensation.
The Submitter of an Accepted LOA who has committed to make available a licence for one or more Essential Patent Claims agrees that it shall neither seek nor seek to enforce a Prohibitive Order based on such Essential Patent Claim(s) in a jurisdiction unless the implementer fails to participate in, or to comply with the outcome of, an adjudication, including an affirming first-level appellate review, if sought by any party within applicable deadlines, in that jurisdiction by one or more courts that have the authority to: determine Reasonable Rates and other reasonable terms and conditions; adjudicate patent validity, enforceability, essentiality, and infringement; award monetary damages; and resolve any defences and counterclaims. In jurisdictions where the failure to request a Prohibitive Order in a pleading waives the right to seek a Prohibitive Order at a later time, a Submitter may conditionally plead the right to seek a Prohibitive Order to preserve its right to do so later, if and when this policy's conditions for seeking, or seeking to enforce, a Prohibitive Order are met.	The Submitter of an accepted LOA, who has committed to make available a licence for one or more SEPs, agrees that it shall neither seek, nor seek to enforce, a Prohibitive Order based on such SEP(s) in a jurisdiction, unless: the implementer fails to participate in, or comply with, the outcome of an adjudication by one or more courts (with appropriate authority), including first-level appellate review[149], if sought by any party within applicable deadlines. Court authority is defined where any such courts will have authority to rule on matters including: determination of licensing rates and related reasonable terms and conditions. In cases where Prohibitive Orders may be sought (according to IEEE-II policy), it is clarified that such shall be supported under relevant jurisdiction law.
Nothing in this policy shall preclude a Submitter and an implementer from agreeing to arbitrate over	It is clarified that, under IEEE-II policy, nothing shall prevent arbitration or voluntary negotiation

[149] 'Appellate review' is the general term for the process by which courts with appellate jurisdiction take jurisdiction of matters decided by lower courts. It is distinguished from judicial review, which refers to the court's overriding constitutional or statutory right to determine if a legislative act or administrative decision is defective for jurisdictional or other reasons (which may vary by jurisdiction).

patent validity, enforceability, essentiality, or infringement; Reasonable Rates or other reasonable licensing terms and conditions; compensation for unpaid past royalties or a future royalty rate; any defences or counterclaims; reciprocal obligations; or any other issues that the parties choose to arbitrate. Nothing in this policy shall preclude a licensor and licensee from voluntarily negotiating any licence under terms mutually agreeable to both parties.	of licensing between Submitter and Applicant parties under mutually agreeable terms.
Copies of an Accepted Letter of Assurance may be provided to participants in a standards development meeting. Discussion of essentiality, interpretation, or validity of Patent Claims is prohibited during IEEE-SA standards-development meetings or other duly authorized IEEE-SA standards-development technical activities. IEEE-SA shall provide procedures stating when and the extent to which patent licensing terms may be discussed (see sub clause 5.3.10 of the *IEEE-SA Standards Board Operations Manual*). The IEEE is not responsible for 1. Identifying Essential Patent Claims for which a licence may be required; 2. Determining the validity, essentiality, or interpretation of Patent Claims; 3. Determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory; or, 4. Determining whether an implementation is a Compliant Implementation.	It is clarified that matters of patent interpretation, validity, and essentiality shall not be considered during IEEE-SA standards development meetings, or other IEEE-SA authorised technical activities. Essentially, any non-technical dialogue on patent matters is forcibly moved out of the technical domain to the legal domain.

Appendix B: Review on SSPPU issues

The logic behind introduction of the SSPPU doctrine is manifold and open to debate and apparently runs three ways as follows.

(i) *Cognitive bias*

Proponents in support of SSPPU postulate that in court proceedings, juries can become biased according to the manner in which information is presented. Specifically, if an SEP contributes only 'small' value to a product, it is argued that any damages that may be awarded in any case on infringement could be 'too large' if the jury 'sees' only the value of the product in question as a whole.

The danger of course, as has been discussed elsewhere[150], is that bias can run both ways and damages could be awarded that are 'too small', not adequately reflecting the value of any SEP(s) included in such product(s).

(ii) *Contribution to value*

Here, proponents for SSPPU claim that value associated with a given SEP(s) in a product should be derived with consideration of the relative value contributed by other elements (not covered by the SEP(s)) to that product. In simple terms, innovations can be added up to yield overall product market value. There is some precedence (see the 2009 case presided over by Judge Rader) under US law which states that '*hypothetical sales or estimated revenues is entirely permissible in connection with a reasonable patent royalty analysis*'.

However, a good analogy can be seen from the accounting world in the valuation of intangible assets (such as commercial brands); such valuations are couched in reality, not theory. Accountants look to evidence of costs used to create an asset, prices that markets are willing to pay for it, and cash flows from similar or comparable cases. These points indicate that assessments on value should be made on case by case bases.

This logic has been encompassed in the Entire Market Value Rule (EMVR) which has been developed in US courts over numerous cases. Within US infringement law, if defendants cannot prove that SEP(s) are a basis for market demand (and thus a product base or revenues volume) and that SEP(s) are sold within a functional unit or 'single assembly' (with reasonable analogies), then the rule of SSPPU could be invoked. 'Single assembly' is critical here; whilst it might be reasonable to apply SSPPU to cases where, for example, chassis or sub-assemblies might be used to forge products (for example, electronic line cards in a rack assembly for a digital telephone exchange switching centre), it is odd to apply SSPPU to all cases, as with IEEE-II policy.

In fact, the original legal case invoking SSPPU (as with Judge Randall Rader) was concerned with an invention (from a party associated with Cornell University in the US) pertaining to an '*instruction issuing mechanism*' (that is, an algorithm) for use in connection with electronic chips (processing units – processors), deemed in this case the smallest saleable unit, where the invention was held to infringe products from the Hewlett-Packard (HP) company. In this case, such processors formed part of 'CPU modules' which in turn were components used in the production of HP's 'CPU bricks'. Such CPU bricks would then be inserted into a circuit board and this would finally be inserted into a server (an electronic computing platform).

[150] Teece and Sherry (2016).

Critically, in this case, whilst the evidence showed that HP primarily sold servers and workstations containing the alleged infringed processors, the record also showed that HP sold processors as individual units. Thus, in this case, in fact (rather than theory), the evidence showed that processors were saleable units in their own right.

Following the case hearing, it was held that, on the evidence presented, EMVR could not be invoked.

There are a few points to note here. The outcome of the court was defined based on evidence presented at the time; that is not to say that such evidence did not exist. Secondly, the logic remains open to debate; products (servers and workstations) *were* sold that infringed the invention. Significantly, however HP also sold processors in their own right.

Perhaps most significant, is the matter of product value that may be impacted by any infringement in any particular case; by definition, this can vary on a case by case basis.

Consequently, even under established US law, it is odd that IEEE-II adopts and mandates a blanket SSPPU approach for all standards.

(iii) *Royalty rates*

Proponents for SSPPU assert that innovations hold value that is essentially constant, irrespective of application. Put another way, it is asserted that royalties should not be charged in different ways across different products, 'for the same amount of use'. This appears overly theoretical and underly realistic. In reality, revenues, cash flows and commercial value stem from propensity in markets for consumers to buy.

The logic in proponents' assertions is that product value may be driven by elements that may be exclusive and unrelated to the SEP(s) in question. However, this again invokes the notional idea that products and their values are divisible. Apple's iPhone provides a good example. Suppose that an iPhone is produced inclusive of an SEP associated with 'phone antenna technology. The SEP, in this example, is a key element of the radio standards and is used across all iPhones, regardless of product segmentation such as device memory (Apple sells iPhones with various on-board memory sizes such as 16 GB[151] or 64 GB).

Vendor gate prices for the different iPhone products with different memory size are different (for example, €600 for a 16 GB unit, €700 for the 64 GB device). With an SSPPU doctrine in place, any infringements on the antenna technology covered by the SEP would be considered against the smallest saleable device, in this case the 16 GB unit; there would be no incremental value ascribed due to the extra memory included in the larger device and essentially, any calculations for damages could ensue from infringement of the SEP covering *both* products would not accurately reflect the market value attained with the 64 GB product.

In this case, assertion on SSPPU misses the consideration of synergies that may exist within a product. In reality, an integrated product forms a system. In the example cited, more memory on the 64 GB iPhone enables greater functionality and such functionality may only be possible with integrated use of both the antenna and the memory as embodied and integrated within the iPhone product.

A similar argument can be extended to use of camera technology in smartphones. A camera focusing system in a smartphone may be much more valuable than the same in a non-WiFi

[151] GB: Gigabyte.

enabled mechanical camera, *because* it is in a smartphone; product context does *in fact* matter in the assessment of SEP value. With legal precedent in some jurisdictions, these examples might not clear the US EMVR rule, but that is not to say that SSPPU is therefore appropriate. Without proper consideration of synergies and product or system level integration, SEPs could well be under-valued with application of the SSPPU rule.

In fact, one of the biggest challenges with any application of SSPPU ruling is deciding just what this really means as the definition of SSPPU is unclear in IEEE-II and legal precedent has not brought any firm clarification thus far; the legal field and courts, despite a number of cases, have not provided any guidance as to how 'smallest' units might be identified. The SSPPU argument goes thus: if we have an SEP 'A' that is used by an implementer in a product ABCDE, but that SEP is also used in smaller products ABC, ADE, ABD, wherein the value of the SEP 'A' may differ across all such products, what is the value of the SEP that we should ascribe when considering any infringements on product ABCDE?

Further, under SSPPU, the term 'saleable' is not well defined. It is unclear whether saleable means is *actually* sold, or *could* be sold, and in the real world, firms are wary of any lack of objectivity in the preparation of accounts; imputed results are seen as a last resort in the accounting profession.

Recent legal precedent in The United States has developed wherein the SSPPU approach has begun to attract some serious questioning. Following a case involving Ericsson in 2014[152], wherein royalty rates were investigated, it was ruled that SSPPU is not the only way to arrive at a view on royalty levels and that the use of comparable licences is also valid. Then, in December 2015, in a case involving Cisco[153], a US Federal court held that 'The rule Cisco advances – which would require all damages models to begin with the smallest saleable patent practicing unit [SSPPU] – is untenable. It conflicts with our prior approvals of a methodology that values the asserted patent based on comparable licenses'.

Clearly, the complexity and lack of firm precedent in these cases further means that each must be looked at on a case by case basis.

As was noted in a separate case in the US[154], '*the benefit of the patent lies in the [technological] idea, not in the small amount of silicon that happens to be where that idea is physically implemented. Basing a royalty solely on chip price is like valuing a copyrighted book based only on the costs of the binding, paper and ink needed to actually produce the physical product. While such a calculation captures the cost of the physical product, it provides no indication of its actual value*'.

Similarly, because chipset prices and profits are driven by competition and costs at the chipset level, which are in turn driven by factors such as Moore's law, there is no reason to believe that royalties based on chipset prices or profits will be 'adequate to compensate' the patent holder for use of its technology at the handset or cellular service level, especially if chipset manufacturers have not built adequate royalties into the prices they charge for chipsets (as would be the case, for example, if there were widespread infringement)[155].

[152] Ericsson v. D-Link, 773 F.3d 1201 (Fed. Cir. 2014).

[153] CSIRO v. Cisco. Federal Circuit. December 1, 2015.

[154] Commonwealth Scientific & Industrial Research Organization v. Cisco Systems, No. 6-11-cv-00343, 2014 WL 3805817, at 11 (E.D. Tex, July 23, 2014).

[155] Teece and Sherry (2016).

Appendix C: Measures on economic performance

C.1 GDP

Measurement of GDP is usually undertaken by national statistical offices, typically within government agencies and can be measured in three different ways, referred to as the 'production', 'income' and 'expenditure' approaches, which under ideal circumstances, yield equivalent results. Some countries release separated GDP estimates across these methods, whereas some combine them into one overall estimate.

In the US, GDP is measured under the US Department of Commerce according to the income based approach; essentially, this sums the monetary incomes across a value chain for production of products and services within the economy. In the UK, GDP is estimated across all three methods and a combined estimate is produced. Within the EU, data from individual European countries are aggregated by Eurostat – the EU's office for compilation of statistical data.

GDP reflects incremental value contribution from finished goods or services within a given economy over a given period; for example, if one were to pick up a ubiquitous rock in a desert for 'free', with zero cost and price, then shape this into a piece of valuable art using some paints which had to be purchased, value added within the economy, for the period, would be determined (under local currency) according to the market price of the finished good (the rock art), less the market price of the paints used, essentially reflecting the value of labour (in this case, the artist's time) and any assets used in production (such as an art studio – it might not have been possible for the artist to exercise his or her talent had an appropriate studio not been available). Note that GDP is a gross measure of value added; it does not include apportionment of value that would be required to replace assets as they may wear out (become depreciated). For measurement of wealth creation, one would need to look to 'Net Domestic Product' (NDP) which reflects GDP less any investment required to replace work items (such as buildings, cars, printers, machines, tools, and so forth). At an international level, valuable goods or services can be bought into a country from abroad in exchange for cash (imports), or such valuable items can be sold abroad in exchange for cash (exports); any export-import trade surplus (which may arise when the value of exports exceeds the value of imports via any international arbitrage on value) may contribute positively to GDP.

GDP is related to GVA as: GVA = GDP + subsidies on goods – taxes on goods; the two measures, GVA and GDP, are related with some adjustments for government financials.

C.2 Consumer surplus

Consumer surplus is based on the economic theory of marginal utility, namely that the price an individual is willing to spend on a particular good or service reflects the amount of utility he or she receives from that good or service. The utility a good or service provides varies from individual to individual based on personal preference. Economic theory holds that the more a consumer has of a good the less he is willing to spend for more due to the diminishing marginal utility he receives.

Appendix D: Case example data

A summary set of profit and loss accounts for the MNO case referred to under Section 5 are shown below.

Table E-1: Summary profit and loss accounts for case example used in analyses

Case example: 3G/4G MNO greenfield network build-out programme										
€ mn	Network build out programme									
Summary profit and loss accounts										
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Revenues										
Connection	1.69	4.14	3.39	2.07	1.40	0.32	0.32	0.36	0.38	0.40
Subscription	0.18	1.33	2.60	3.86	5.04	5.97	6.57	7.20	7.88	8.58
Voice	5.08	45.97	91.65	131.81	164.23	183.06	194.22	212.57	233.07	254.71
Data and VAS	0.81	9.29	20.34	31.31	42.28	51.36	58.39	67.62	79.10	92.50
Interconnection & roaming	4.88	23.23	40.78	57.51	70.75	82.35	86.11	97.15	110.53	125.88
Equipment sales	0.79	2.12	2.27	1.93	2.13	1.53	1.58	1.58	1.67	1.77
	13.43	86.08	161.02	228.50	285.83	324.61	347.19	386.48	432.63	483.83
Cost of goods sold										
Interconnection and international roaming charges	2.08	18.11	33.90	49.76	62.36	73.54	78.14	87.03	96.73	109.46
Content cost	0.05	0.65	1.47	2.32	3.22	4.01	4.64	5.45	6.48	7.68
Handset and SIM Costs	1.13	4.49	6.61	7.83	9.36	9.34	9.70	10.31	11.19	12.14
Dealer Commissions	0.08	0.18	0.16	0.10	0.08	0.03	0.03	0.03	0.03	0.03
Sales Commission	0.25	2.47	4.85	6.78	8.21	8.93	9.26	10.03	10.92	11.87
	3.59	25.90	46.99	66.80	83.23	95.85	101.77	112.85	125.35	141.19
Operational costs										
Network operating and maintenance	5.36	7.55	8.30	8.67	9.01	9.33	9.62	9.92	10.22	10.51
Leased lines (core only)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Site leasing	1.12	1.76	1.94	2.10	2.26	2.42	2.59	2.75	2.92	3.09
Power Utilities	0.39	0.57	0.62	0.65	0.69	0.72	0.76	0.80	0.84	0.88
Network support	3.85	5.22	5.74	5.92	6.07	6.18	6.28	6.37	6.46	6.55
Training	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sales & marketing	8.85	7.40	8.40	9.40	10.40	11.40	12.40	13.40	14.40	15.40
Staff Costs	6.72	12.66	15.44	17.82	20.66	21.95	23.59	24.35	25.40	26.65
Retention cost	0.13	0.90	1.72	2.62	3.39	4.06	4.52	5.17	5.87	6.62
IT Opex	0.14	0.31	0.43	0.54	0.63	0.69	0.70	0.72	0.76	0.79
Billing	0.05	0.38	0.74	1.10	1.44	1.71	1.88	2.06	2.25	2.45
Start-up cost and others	5.84	1.32	1.46	1.57	1.69	1.82	1.94	2.06	2.19	2.32
Regulatory fees	7.15	10.77	15.36	19.83	23.42	25.97	27.68	30.22	32.98	36.03
Fraud & bad debt & other	0.72	4.66	16.81	23.93	31.29	33.55	33.00	38.30	47.21	55.24
	34.96	45.95	68.68	85.49	101.95	110.47	115.33	126.20	141.28	156.00
Gross profit	9.84	60.18	114.04	161.70	202.60	228.76	245.42	273.63	307.28	342.64
EBITDA	-25.12	14.22	45.36	76.21	100.65	118.29	130.09	147.43	166.00	186.64
EBITDA margin	-187%	17%	28%	33%	35%	36%	37%	38%	38%	39%
Capex										
Civil works	15.75	4.50	2.25	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Core network	4.30	1.20	1.03	0.68	0.56	0.58	0.51	0.55	0.55	0.49
Access network	20.05	9.77	3.42	1.70	1.53	1.38	1.24	1.11	0.99	0.88
Service layer	6.51	2.85	2.24	2.07	1.54	1.55	1.46	1.49	1.33	1.23
Transmission network	2.45	0.70	0.35	0.07	0.07	0.07	0.07	0.07	0.07	0.07
IT	9.81	3.80	1.86	0.99	0.83	0.81	0.75	0.73	0.68	0.62
Network rollout (I&C)	3.50	1.00	0.50	0.10	0.10	0.10	0.10	0.10	0.10	0.10
One time license fee	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Spares	1.00	0.44	0.21	0.14	0.11	0.11	0.10	0.10	0.09	0.08
Other capex	6.76	3.10	7.51	32.63	43.84	47.73	48.32	50.19	58.60	67.79
Total capex	70.14	27.36	19.38	38.82	49.04	52.77	52.99	54.79	62.85	71.71
Total capex (cumulative)	70.14	97.50	116.88	155.70	204.74	257.51	310.50	365.29	428.15	499.86
Network equipment capex	50.89	21.86	16.63	38.27	48.49	52.22	52.44	54.24	62.30	71.16
Network capex / total capex	73%	80%	86%	99%	99%	99%	99%	99%	99%	99%
Capex/Sales	522%	32%	12%	17%	17%	16%	15%	14%	15%	15%
Network capex / sales	379%	25%	10%	17%	17%	16%	15%	14%	14%	15%

Appendix E: Details of analyses

Further details of our analyses on economic and consumer welfare impacts are laid out as below.

E.1 Details on R&D to GDP analysis

Fundamentally, there are two ways of improving the output of the economy: by increasing the labour or capital inputs to the economy, or by generating more output from the same inputs (improving productivity). Early growth accounting studies found that growth in inputs only accounted for around 15% of economic growth, with the remainder attributable to enhanced productivity. As Paul Krugman said in 1994, *'Productivity isn't everything, but in the long run, it is almost everything'.*

R&D and innovation are widely recognised in the economic literature as being substantial contributors to economic growth by enhancing productivity[156]. R&D results in new goods and services, higher quality of output and new production processes, all of which generate productivity growth at the firm level and the macroeconomic level.

Numerous studies have attempted to empirically link R&D to TFP[157] and economic output[158]. These studies use a variety of methods, including regression analysis of time series or cross-sectional data, growth accounting, calibrated models, case studies and surveys, at the firm, industry and country levels. Many studies attempt to estimate both the direct impact of 'own' R&D on a firm or country's productivity and output, and the indirect spill over effects of R&D undertaken by other firms, industries and countries[159].

A large body of work attempts to link the R&D capital stock – the accumulated knowledge from R&D expenditure, adjusted for depreciation, to economic output at either the micro or macroeconomic level (the 'output elasticity' of R&D). In a recent paper, Donselaar and Koopmans conduct a meta-analysis of a large number of studies of this kind, ultimately forming a 'best guess' of a macro output elasticity of 0.06 for domestic private R&D capital (a 10% increase in a country's R&D capital stock is predicted to lead to 0.6% more productivity).

Similar studies at the macro-level include Guellec and Pottelsberge de la Potterie (2001), who estimate an elasticity of TFP to the R&D capital stock of 0.13[160], Ulku (2004), who estimates an elasticity of GDP to the patent stock of between 0.06 to 0.11[161], and Gumus and Celikay (2015), who estimate an elasticity of GDP to R&D expenditure of 0.56 to 1[162]. The US Congressional Budget Office

[156] Uppenberg, K. (2009) 'Innovation and economic growth', in: *'R&D and the financing of innovation in Europe'*, EIB Papers, Vol.14, No.1, 2009.

[157] TFP: Total factor productivity.

[158] See, for example, literature surveys by Cameron (1998), the EIB (2009) and Donselaar and Koopmans (2016).

[159] For example, Coe, Helpman and Hoffmaister (2008) attempt to analyse international R&D spillovers.

[160] Guellec, D. and van Pottelsberge de la Potterie, B. (2001) 'R&D and Productivity Growth: Panel Data Analysis of 16 OECD countries', *OECD Economic Studies,* No. 33, 2001/II.

[161] Ulku, H. (2005) 'R&D, Innovation and Growth: Evidence from four manufacturing sectors in OECD countries'*, University of Manchester Working Paper Series*, Paper No. 12.

[162] Gumus, E. and Celikay, F. (2015) 'R&D Expenditure and Economic Growth: New Empirical Evidence', *Margin – The Journal of Applied Economic Research*, 9:3 (2015), p205–217.

(2005) settles on an output elasticity of between 0.02 and 0.05[163], while a recent publication by the IMF (2016) uses an elasticity of 0.13[164].

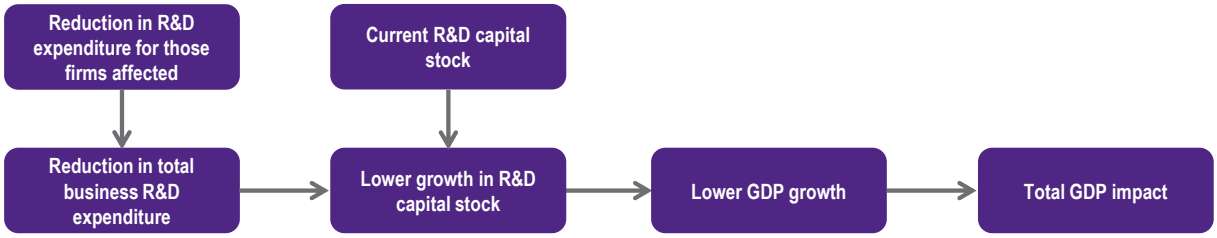
The literature generally finds that the impact of private R&D tends to be substantially stronger than that of public R&D[165]. Other work assesses the differential impact of R&D investment across industries. For example, Potters *et al* (2008) finds that R&D undertaken by high technology sectors has a more significant impact on productivity at the firm and sectoral level, with an elasticity ranging from a minimum of 0.05 to 0.07 (for low-tech sectors) to 0.16 to 0.18 (for high-tech sectors)[166].

As explored in the report, a key impact of the proposed amendments will be to reduce the expected royalties from SEPs. This is likely to prompt firms that receive such royalties to cut their R&D expenditure (they will receive lower revenues, reducing their ability to fund R&D, and they will have less incentive to invest in R&D, as the potential rewards will be lower). In turn, this will lead to slower growth of Europe's domestic R&D capital stock, and hence to slower growth in GDP. This strand of modelling estimates that change in GDP.

E.1.1 Description of model methodology

The modelling strategy is set out in Figure E-1.

Figure E-1: Modelling strategy for R&D and GDP impact



The key steps in the modelling are outlined below.

1. Estimate the reduction in R&D expenditure by those firms affected by the amendments

As discussed in the report, we estimate that the proposed amendments could reduce SEP revenues by as much as 80%. We note that a firm's R&D expenditure typically tracks its revenues, which could imply a 'pure' innovator deriving 100% of its revenues from IPR would reduce its R&D expenditure by 80%. The impact on a diversified firm's revenue would be smaller; however, strategic considerations might prompt it to compensate for the fall in revenue by cutting R&D expenditure disproportionately.

[163] US Congressional Budget Office (2005) *'R&D and Productivity Growth: A Background Paper'.*.

[164] IMF (2016) 'Fiscal Policies for Innovation and Growth', in: IMF (2016) *'Fiscal Monitor April 2016'* Ch.2, World Economic and Financial Surveys.

[165] Sveikauskas, L. (2007) 'R&D and Productivity Growth: A Review of the Literature', BLS Working Paper 408, US Bureau of Labour Statistics Office of Productivity and Technology.

[166] Potters, L., Ortega-Argilés, R., Vivarelli, M. (2008), 'R&D and Productivity: Testing Sectoral Peculiarities Using Micro Data', *Institute for the Study of Labor (IZA) Discussion Paper Series*, IZA DP No. 3338.

We assume a 'blended' innovation firm derives 30% of its revenue from SEPs. We estimate that, faced with an 80% fall in SEP revenues, such a firm might lower its annual R&D expenditure by around 60%.

2. Estimate the reduction in total business R&D expenditure

From Eurostat data, we estimate that the sectors affected comprise around 13% of total European business R&D[167]. Based on Step 1 above, we therefore estimate that total annual business R&D expenditure could decline by roughly 8% due to the amendments. This decline in R&D expenditure will lead to slower growth of the R&D capital stock over time.

3. Compute the R&D capital stock

We compute the R&D capital stock using the perpetual inventory method – the stock in a given year is the R&D expenditure in a given year, *plus* the depreciated value of the previous year's R&D capital stock[168]. This is expressed mathematically in the equation below, where R represents the R&D capital stock, r represents R&D expenditure and ð the depreciation rate.

$$R_t = r_t + (1 - \delta)R_{t-1}$$

We use a depreciation rate of 20%, as used by van Ark *et al* (2009) and Ulku (2004), and for high-tech sectors by Ortega-Argilés (2009). We calculate the current stock of European domestic R&D capital using historic European business R&D expenditure data sourced from Eurostat.

We then calculate two scenarios for the future R&D capital stock:

- A base case where annual R&D expenditure grows in line with the historic trend; and
- An 'amendments' case, where the annual R&D expenditure is smaller (so the R&D capital stock grows more slowly).

4. Link the R&D capital stock to GDP growth

We assume an elasticity of the R&D capital stock to GDP of 0.06 – that is, a 10% increase in R&D capital will lead to a 0.6% increase in GDP. This figure is in line with the conclusions of Donselaar and Koopmans (2016), Ulku (2004) and the CBO (2005). We believe this figure is conservative given that it is towards the low end of the meta-studies surveyed[169] and that we are assessing a reduction in high-tech R&D (which contributes more to productivity gains[170]). However, this may be balanced by the fact that some firms within our chosen sectors may not be as strongly affected by the amendments.

Using the elasticity estimate, we are able to link the R&D capital stock to GDP growth. For the base case, we assume European GDP grows in line with the trend over the past 10 years – around 2.5% per annum. For the 'amendments' scenario, this GDP growth is reduced due to a slower increase in the stock of R&D capital. We calculate both scenarios to a ten-year time horizon, discounting at a

[167] To estimate the affected sectors we use NACE classifications C26 (Manufacture of computer, electronic and optical products) and J61 (Telecommunications).

[168] See Ulka (2004) and Guellec and van Pottelsberge de la Potterie (2001) for further discussion.

[169] Donselaar and Koopmans (2016) and Cameron (1998).

[170] Potters *et al.* (2008).

social discount rate of 4%. The difference is the GDP impact of the reduction in R&D expenditure due to the amendments.

5. Compute total GDP impact

We compute both scenarios to a time horizon of ten years, and calculate a total GDP impact from the difference between the scenarios (discounting using the EU recommended social discount rate of 4%[171]). We compute the NPV of the total GDP impact to be €465.3bn (discounted over 10 years).

E.2 Details on handset price to consumer welfare analysis

Our starting point is a demand curve with a constant elasticity of the form:

$$P = \frac{k}{Q^{\frac{1}{\eta}}}$$

Where P and Q are the product price and quantity, and k and η are constants. It can be shown for demand curve of this form that -η is the price elasticity of demand[172].

The consumer surplus at price P_1, which corresponds to quantity Q_1, is the area under the demand curve above the price P_1. This is the integral of the demand curve from Q=0 to Q= Q_1 minus the rectangular area $P_1 \times Q_1$. Therefore, the consumer surplus can be written as follows.

$$Consumer\ surplus = \int_0^{Q_1} P\ dQ - P_1 Q_1$$

Since $\int P\ dQ = \left[\frac{k}{\left(1-\frac{1}{\eta}\right)} Q^{1-\frac{1}{\eta}}\right] + C$,

$$Consumer\ surplus = \left[\frac{k}{\left(1-\frac{1}{\eta}\right)} Q^{1-\frac{1}{\eta}}\right]_0^{Q_1} - k{Q_1}^{1-\frac{1}{\eta}}$$

From this the change in consumer surplus following a price reduction from P_1 to P_2 and a corresponding increase in quantity from Q_1 to Q_2 is:

$$\Delta\ consumer\ surplus = \left[\frac{k}{\left(1-\frac{1}{\eta}\right)} Q^{1-\frac{1}{\eta}}\right]_{Q_1}^{Q_2} - k\left[{Q_2}^{1-\frac{1}{\eta}} - {Q_1}^{1-\frac{1}{\eta}}\right]$$

By rearranging the terms, the change in consumer surplus can be rewritten as:

$$\Delta\ consumer\ surplus = k\left(\frac{1}{\left(1-\frac{1}{\eta}\right)} - 1\right)\left[{Q_2}^{1-\frac{1}{\eta}} - {Q_1}^{1-\frac{1}{\eta}}\right]$$

[171] http://ec.europa.eu/smart-regulation/guidelines/tool_54_en.htm .

[172] $\frac{dQ}{dP}\frac{P}{Q} = -\eta k^{\eta} P^{-\eta-1} \times P \times \left(\frac{k}{P}\right)^{\eta} = -\eta$.

E.2.1 The case of inelastic demand

We show here that:

- For an inelastic demand curve with constant elasticity (that is, where 0<η<1) the change in consumer surplus is positive when quantity increases; and
- For an inelastic demand curve with constant elasticity, the size of the change in consumer surplus for a constant percentage increase in quantity decreases the bigger the starting quantity.

From above,

$$\Delta\ consumer\ surplus = k\left(\frac{1}{\left(1-\frac{1}{\eta}\right)}-1\right)\left[{Q_2}^{1-\frac{1}{\eta}}-{Q_1}^{1-\frac{1}{\eta}}\right]$$

If demand is inelastic (0<η<1), then

$$\frac{1}{\left(1-\frac{1}{\eta}\right)}<0$$

So that

$$\left(\frac{1}{\left(1-\frac{1}{\eta}\right)}-1\right)<0$$

Because $Q^{1-\frac{1}{\eta}}$ is monotonically decreasing with Q, for $Q_2 > Q_1$

$$\left[{Q_2}^{1-\frac{1}{\eta}}-{Q_1}^{1-\frac{1}{\eta}}\right]<0$$

This means that both terms in the formula for the change in consumer surplus are negative as we move down the curve. Therefore, the change in consumer surplus, which is their product, is positive.

Result I: For a downward sloping demand curve of the form

$$P=\frac{k}{Q^{\frac{1}{\eta}}}$$

If 0<η<1, the change in consumer surplus as quantity changes from Q_1 to Q_2, where $Q_2 > Q_1$, is positive.

When $Q_2 = (1+m)Q_1$, where m is a positive constant expressed as a percentage, then:

$$\left[{Q_2}^{1-\frac{1}{\eta}}-{Q_1}^{1-\frac{1}{\eta}}\right]=\left[(1+m)^{1-\frac{1}{\eta}}-1\right]\left[{Q_1}^{1-\frac{1}{\eta}}\right]$$

This means that the modulus of the change in consumer surplus, $\left|k\left(\frac{1}{\left(1-\frac{1}{\eta}\right)}-1\right)\right|\left|{Q_2}^{1-\frac{1}{\eta}}-{Q_1}^{1-\frac{1}{\eta}}\right|$ is proportional to $\left|{Q_1}^{1-\frac{1}{\eta}}\right|$.

Therefore, as Q_1 increases the magnitude of the change in consumer surplus decreases. In other words, the change in consumer surplus decreases in size with the starting quantity for a constant

percentage change represented by *m*. Because price is a decreasing function of quantity, as the starting price declines, the size of the change in consumer surplus becomes smaller.

Result II: For a downward sloping demand curve of the form

$$P = \frac{k}{Q^{\frac{1}{\eta}}}$$

If $0<\eta<1$, the size of the change in consumer surplus for a given percentage change in quantity, m ($(Q_2/Q_1)-1$), decreases with the starting quantity Q_1.

E.2.2 Assumptions on the effect of reduction in royalty rate

If the new IEEE-II-like concessions are introduced and are accepted by SEP holders, then there is likely to be a reduction in royalty rate. This, in turn, means that the SEP holders' overall revenue declines. The SEP holders reduce their R&D spending in line with this, which in the long term has the effect of decreasing the rate of innovation and patent production.

When there are fewer new patents available, it may be more difficult to develop standards, and any standard sets may be inferior to those in a world where SEP holders have more incentive to invest in R&D. There would be few newer standards, and new standards may represent more of an incremental improvement to existing ones compared to the previous generations of standards. This is expected to have an effect on the rate of improvement in quality of end-user products in the long-term.

It may also be the case that overall R&D spend does not decline by as much as the reduction in revenue from SEP licensing. Innovators may instead divert their R&D efforts to proprietary technology away from designing technology for standards. It is reasonable to argue that even in this case, there will be a negative impact on consumers. This is because there would still be fewer standards developed, which could result in less product market competition. The end effect is a slower decline in price of user products in the long run.

Based on this line of reasoning, the quality-adjusted prices of user equipment such as smartphones are likely to decline more slowly in the long run under the scenario where IEEE-II-like changes to an SDO's IPR policy are implemented.

To summarise, there is a short-term reduction in price due to the decrease in royalty rate. In the long term, this effect of lower price is likely to be negated by the slower improvement in quality. This means a slower decline in quality-adjusted price of end-user products. Alternatively, where investment in R&D continues in the long run, firms' diversion of R&D efforts to proprietary technology would result in fewer standards being developed and more user products that are based on proprietary technology. This reduces product market competition, which would have the effect of slowing down the decline in price and hence quality-adjusted price.

In our modelling, we assume that a reduction in royalty due to the amendments leads to a decrease in the manufacturers' cost of production. This is then passed on in the form of price reduction in the end-use product, enhancing consumer welfare. However, this effect is temporary: in the long run, innovators adjust their investment behaviours due to the lower return on investment from their contributions to standards. This means there will be an initial step change in the quality-adjusted price, but the long-term decline in the quality-adjusted price will be slower. Under the best case scenario, the new quality-adjusted price curve converges with the original. It is this best case that we assume for our modelling.

We further assume that the market for smartphones is saturated in the region we are examining. This means that new purchases made each year are replacement handsets. Handset purchases should be reasonably constant under this assumption. A drop in price will shorten the replacement cycle and increase the total quantity purchased in the year of the price drop. In subsequent years, if there is a continued reduction in quality-adjusted price, then the increase in quantity relative to the base case continues – the base case here is defined as the situation where there is no change in existing IPR policy. When the quality-adjusted price converges with the quality-adjusted price under the base case, quantity change ceases, and the change in consumer surplus compared to the base case goes to zero.

In summary, we assume that:

- Demand for smartphones is inelastic due to market saturation;
- The effect of royalty reduction on smartphone price is temporary; and
- After several years, the step-change price reduction disappears due to the slower pace of technological progress as a consequence of slower innovation.

E.2.3 Approximation of total change in consumer surplus

We assume that the quality-adjusted demand curve for smartphones has the form as below:

$$P = \frac{k}{Q^{\frac{1}{\eta}}}$$

and $0<\eta<1$ – demand is inelastic.

Based on Galetovic *et al* (2015), the quality-adjusted price of telephone equipment has been declining every year since 1997. We assume that this trend also applies to smartphones and that it will continue into the future. Therefore, we move further along the demand curve to the right every year in the future: P_n and Q_n are the price and quantity in year n, and $P_{n+1} < P_n$, and $Q_n < Q_{n+1}$.

It is assumed that the reduction in royalty rate that results from IEEE-II-like amendments will lead to a constant percentage reduction in the price of smartphones. Therefore, there will also be a constant percentage change in quantity given that price elasticity of demand is constant. The price reduction causes P_n to change to P^*_n, where $P^*_n < P_n$. Correspondingly, this causes Q_n to change to Q^*_n, where $Q_n < Q^*_n$.

This means that the change in consumer surplus in year n (ΔCS_n) is the change that arises from the reduction in price from P_n to P^*_n and the increase in quantity from Q_n to Q^*_n. In year n+1, the change in consumer surplus (ΔCS_{n+1}) arises from the reduction in price from P_{n+1} to P^*_{n+1} and the increase in quantity from Q_{n+1} to Q^*_{n+1}.

From *Result I* and *Result II*, $\Delta CS_{n+1} < \Delta CS_n$. This is because the starting quantity in each year is bigger than the previous year – $Q_n < Q_{n+1}$.

Therefore, based on the demand curve specified, using the change in consumer surplus in the first year as a proxy for the surplus in subsequent years in the calculation of the total consumer surplus over time will tend to overestimate the size of the total consumer surplus. This will give an upper bound of the benefits that accrue to the change in smartphone price resulting from the reduction in royalty rate.

E.2.4 Calculations of parameters for consumer surplus estimate

Price elasticity of demand

The price elasticity of demand for smartphones for Europe is calculated based on information available in the public domain, assuming that there has been no shift in the demand curve between 2011 and 2015. The inputs into the calculation and the resulting elasticity are tabulated as below.

Table E-1: Data used in price elasticity of demand (PED) calculations

Year	Average price of smart phone globally[173] (€)	Quality-adjusted price index used[174] (2012 = base year)	Western Europe shipment[175] (million units)	PED
2011	508	1.10	95.8	N/A
2012	419	1.00	103.4	0.5
2013	336	0.92	115.4	0.6
2014	284	0.83	127.9	0.7
2015	251	0.75	135.4	0.5

In our calculation of the change in consumer surplus, we use a price elasticity of demand of 0.6.

Constant k in the demand curve

The quality-adjusted price of smartphones in 2015 and the shipment number along with the elasticity of demand of 0.6 are used to derive the constant k from the equation representing the constant-elasticity demand curve above. This gives a value of 9×10^{15}.

[173] Sourced from Statista and adjusted for quality using the index in the next column.

[174] Galetovic, Alexander, and Gupta, Kirti (2016), 'Royalty Stacking and Standard Essential Patents: Theory and Evidence from the World Mobile Wireless Industry', *Hoover IP Working Paper Series*, No. 15012.

[175] Sourced from Statista; adjusted to reconcile the two data sets analysed.

About this report

We cannot guarantee that we have had sight of all relevant materials that may be in existence and that may be relevant to our purpose. Nevertheless, our review has included rigorous analysis of materials that we have gained access to and that we deem relevant at the time of preparation of this Report; such materials are referenced throughout.

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About the authors

Ian Corden is a Director with Plum, based in the firm's London offices. Formerly with PwC Strategy Consulting (TMT) in London, Ian brings over 20 years of experience in strategy consulting and industry in the telecommunications sector. He holds PhD and BSc (1st Class Hons) degrees in Engineering and a PgD in Management and is a UK Chartered Engineer and a Fellow of the UK based Institution of Engineering and Technology.

Tim Miller is a Partner at Plum and specialises in the application of economic theory to telecommunications issues, with a particular focus on regulation, competition, and spectrum policy and strategy. Formerly with Deloitte, Tim holds an MSc in Economics from the University of Bristol, specialising in auction and game theory, and a BSc in Economics and Mathematics from the same institution.

Sarongrat Wongsaroj is a Consultant at Plum and specialises in economic research and analysis in the fixed and mobile communications industry. He has extensive experience in conducting economic analysis on the benefit of spectrum release programmes. Sarongrat holds an MA in Economics and Management from Balliol College, University of Oxford, and an MSc in Mathematics and Physics from University College London.

Sam Wood is a Consultant at Plum with a range of experience, ranging from spectrum valuation to estimating cost of capital. He has worked on issues as diverse as fibre regulation, platform neutrality and interoperability and broadcasting technology, as well as on numerous spectrum valuation projects. He holds a Masters degree in Economics from the University of Warwick.

Contact details

If you would like to discuss this Report, please contact Ian Corden, Tim Miller, or Tony Lavender.

Ian Corden
Director
+44 7399 581978
ian.corden@plumconsulting.co.uk

Tim Miller
Partner
+44 7904 971056
tim.miller@plumconsulting.co.uk

Tony Lavender
CEO and Managing Partner
+44 7775 940356
tony.lavender@plumconsulting.co.uk

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