THE SUPERIOR PERFORMANCE OF VOLUNTARY TECHNOLOGY STANDARDS

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I. INTRODUCTION

There can be few more important questions in competition policy than how to deal with technologies that connect different products and companies. Technological progress is the most important contributor to long-term economic growth, as well as driving social and environmental change. Yet ownership of key technologies creates concerns about concentrated economic and social power, particularly for platforms with which other products must interact. The rules governing these interactions will influence the success and development of firms, new technologies and the economy as a whole.[2]

Some politicians have gone so far as to call for regulation of tech giants such as Google or Facebook as if they were utilities. While still a minority view, such a proposal brings out the dilemmas very clearly. We need the owners of such technologies to be entrepreneurial and dynamic but also to be restrained from abusing their power. We need global businesses, to take advantage of economies of scale, while preserving opportunities for innovative, small firms. We need technology owners to work together and produce compatible products, while also competing in the marketplace and in the race for the next innovation.

These questions are often debated as if these choices are zero-sum. However, there are better solutions and they have arisen within the technology industry itself. In the mobile telephone industry, and other mostly telecoms-related industries, technology standards allow firms with many different specializations to work together both to design products and also advance the underlying technology, without a single supplier owning the process. The Standard Development Organizations ('SDOs") that do this provide a mechanism that, while not perfect, enables innovators and manufacturers to co-operate *and* compete.

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2 This article is based upon a report by the same authors commissioned by Qualcomm Inc.: *The Economic Impact of Technology Standards*, available for download at: http://www.compasslexecon.com/highlights/economic-impact-of-technology-standards/?year=2017. In the interests of space, we have not fully referenced all of the material used here but the longer report contains extensive references.

Standards are not new. Since the nineteenth century, railway tracks have increasingly come to use the so-called "standard gauge" initially established by George Stephenson.[3] The advantages of a single standard for the industry and its consumers are obvious and there are no longer any competing contenders for the dominant standard, yet some alternative gauges persist.

The economics of many information technology industries strongly favor the emergence of a single standard. Such industries often have strong economies of scale and scope, as it costs next to nothing to provide information to more consumers. Network effects, in which users gain value from the presence of other users on the network, are often important too, whether through direct effects (the more people are on Facebook the more each subscriber benefits) or indirect (the more people use Windows, the more software developers will produce applications for Windows).

Standards help these industries achieve scale, giving users and suppliers the confidence to buy or make compatible products. However, economists have also found that industries making use of standards are more innovative and dynamic over the longer term. Galetovic et al. (2015) compare productivity growth rates in industries reliant on standards to those that are not, finding notably better performance in the "standard-reliant" industries, even when comparing only products based on semi-conductors to one another.[4]

Standards seem to do more than simply solve a co-ordination problem, they seem to lead to rapid innovation. We recently published a report exploring why.[5] We conclude that the institutional framework for developing and updating standards is crucial: the "gatekeeper" who defines and updates a standard possesses great power. The gatekeeper has technological power to determine the way in which the industry develops and also economic power to monopolize several levels of the supply chain.

II. WHO IS THE GATEKEEPER?

What kind of organization acts as the gatekeeper will depend on how standards are developed in the industry. There are three broad models.

a. Firstly, a standard might simply "emerge," becoming a *de facto* standard for the industry. Typically, such a standard will be under the proprietary control of a single company. Operating systems ("O/S") used on personal computers provide an example.

b. Secondly, standards can be sponsored by governments. Television broadcasting is an industry which has always relied on government-set standards over most of the world: from the initial "wars" over color TV standards, through to modern standards for digital broadcasting.

c. Finally, wireless telephony standards and many others are set through voluntary participation by experts from many different companies collaborating together in SDOs.[6] In general the process allows for participation both by innovators (technology providers) and implementers (firms that will manufacture the resulting devices). Innovators normally receive license fees payable on Fair, Reasonable and Non-Discriminatory ("FRAND") terms for technology declared essential to implementation of the standard.

3 Stephenson used the 4'8½" gauge for the Liverpool and Manchester railway in 1830, apparently basing it on existing tracks for mine-carts. Sadly, the story that the gauge itself reflects an ancient standard created by the ruts and axle widths in use on British roads, ultimately going back to the wheel base of a Roman chariot, is almost certainly a myth. The gauge is widely agreed to be inefficiently narrow, but the world is surely stuck with it by now.

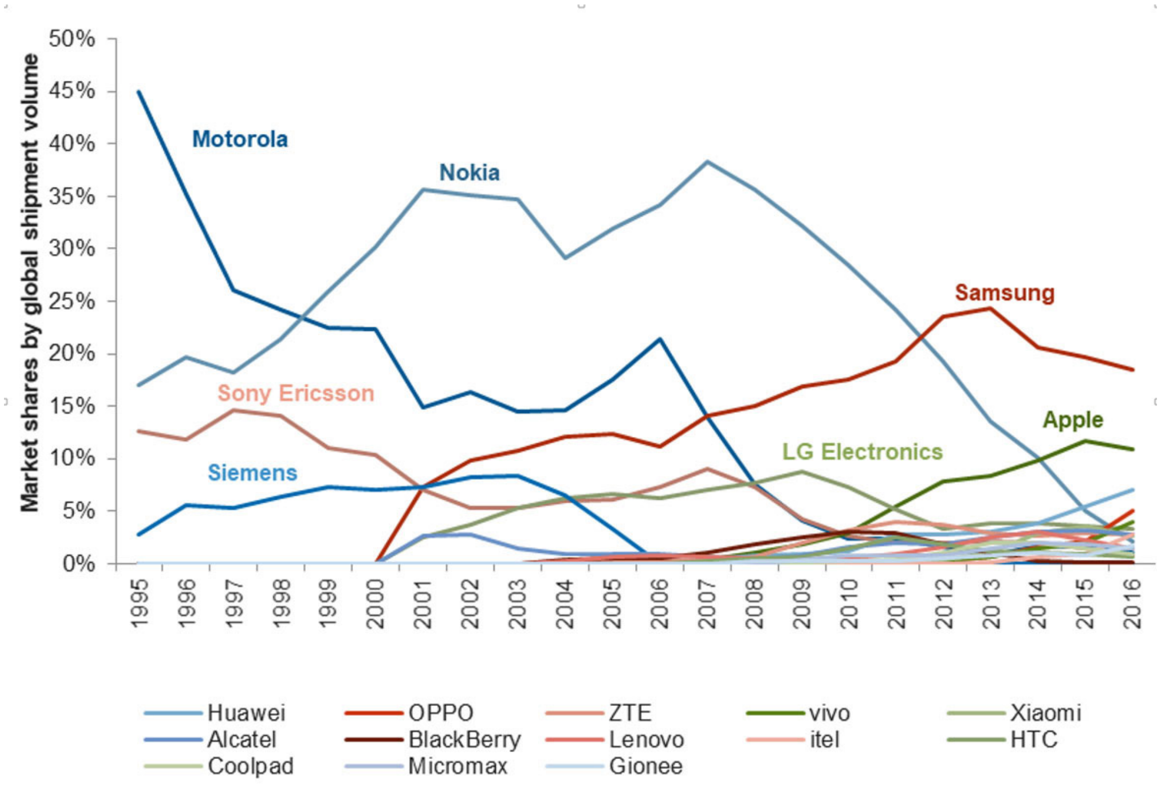
4 Galetovic, Haber & Levine: "An empirical examination of patent hold-up," 2015, Journal of Competition Law and Economics 11(3): 549–578. doi:10.1093/joclec/nhv024.

5 Op cit. 2.

6 Often referred to as "standard-setting organizations;" ("SSOs"), but we prefer the SDO terminology as a better descriptor of what these bodies actually do, as the process of developing a standard is a dynamic and interactive one.

In our report, we conclude that the collaborative, voluntary standard development process in the mobile telephony industry has led to a more competitive market structure than in other industries, where standards have a single proprietary owner or are set by government. In the mobile phone supply chain, for example, there are many producers of telephone handsets, as we illustrate below, and there are even more competitors supplying their components and the software and applications that run on them.

Global market shares of handset manufacturers, 1995 to 2016



Notes: Sony Ericsson data also includes sales of Ericsson (1995-2001) and Sony (2012-2016).
Sources: 1995-2003 sales Strategy Analytics; 2004-2016 sales IDC Worldwide Quarterly Mobile Phone Tracker.

Crucially, many firms also supply technology *into* the mobile communications standards themselves. With more innovators participating "upstream," competing to provide the technology and then collaborating in the resulting standard, there are more independent sources of ideas, there can be more competition and there can be more specialization than would otherwise be the case. For example, Neul, a small company with less than 200 employees founded in 2010, was a major contributor to "weightless" standards. "Weightless" is a set of open standards developed by a Special Interest Group comprising 1400 members including large firms, such as Qualcomm and Huawei.

The resulting technical progress has been astonishing. Download speeds have improved by a factor of 150 since 2004 but more fundamentally there are many more things that mobile telephones can do than before. The contribution of collaborators in research shows its effects not merely in faster performance but in disruptive and transformative technologies, which can come about because innovators of many different types can contribute ideas to the mobile telephony ecosystem.

In contrast, PC operating systems embody a standard for the apps-hardware interface that is usually under the proprietary control of a single company. The great majority of PCs continue to run Microsoft's operating system, which can work with hardware and applications produced by multiple suppliers, but its development is under the control of a single company. Apple is the second player in the industry and its operating system is still more closed: working with Apple hardware and exercising more control over the applications that run on its systems.

It would be wrong to think of the high share of Microsoft O/S on PCs as a problem. The near-universality of this standard provides great benefits, through network effects and economies of scale. Where there are no institutions setting standards, multiple standards might fight out a "standards war" – which is competition in a sense, but it also misses out on efficiencies of a single standard and there is no guarantee that the best technology will win.

However, there are downsides to this proprietary control. Firstly, it is possible that the O/S itself would be better with a more collaborative approach. Studies of handheld computers have shown faster innovation when other companies can participate in development of the O/S itself.[7] Secondly, the standard owner has economic power that enables it to monopolize other layers of the supply chain. Whether that power is used or not, the perception of its can make other firms reluctant to invest in connecting products, for fear that the standard owner might make a change rendering those products incompatible or even itself begin providing the functionality of those products within the O/S.

Alternatively, standards can be set by government. However, the history of government standard development – from TV broadcasting for example, or for that matter in the early days of mobile telephony, shows that competition and innovation can often be stifled. Since the 1960s, Europe has had two standards for analogue broadcasts of color TV: PAL, which was originally German, and SECAM deliberately developed and promoted by the French state out of concerns to protect French TV set producers from their more efficient German rivals. The resulting global map of standards reflects political allegiances more than any economic considerations, with countries historically within the sphere of influence of France and the USSR adopting SECAM while others adopted PAL or the U.S. NTSC standard. Protectionist economic policies rarely succeed even in their own stated aims, and the result was more expensive TVs and eventually an uncompetitive industry.

Lest this story be assumed to belong to the bad old days of state intervention, the more recent adoption of digital TV standards in Latin America has followed a similar pattern. In 2006, Brazil adopted a Japanese standard as part of an agreement to produce sets to that standard, then sought to persuade other Latin American countries to adopt it, to promote its producer interests. Some other countries chose their standard for political reasons – Mexico choosing the U.S. standard, Venezuela rejecting it, for example. None of this is likely to help create an innovative and competitive industry.

III. MARKETS FOR TECHNOLOGY

Why do we see these differences? One reason is that voluntary, collaborative standard-setting allows for a diversity of firms working in R&D. The system makes it easier for many different innovators to contribute technology to a huge technological system (such as the mobile wireless network) and – crucially – be rewarded for it. Licensing of intellectual property rights creates what has been called a "market for technology" in which firms buy and sell the rights to use innovations rather than products embodying them.

Of course, markets for technology can exist without SDOs. Many American inventors in the nineteenth century, including Thomas Edison and Charles Goodyear, relied mainly on others to commercialize their innovations through licensing.[8] Effective legal protection of intellectual property rights is important for licensing to be possible. For example, semi-conductor designs only became clearly covered by IP protection in the U.S. with the Semiconductor Chip Protection Act (1984). Only after that did self-standing "fabless" companies emerge: specialized in design and without any manufacturing activity. Without this development, there would be many fewer firms researching in semi-conductors because of the economics of chip manufacture. The "fabs" where semi-conductors are manufactured are huge, benefiting from large economies of scale. If every semi-conductor designer needed also to be integrated with a "fab" there would be many fewer designers. However, because of the market for technology, it is possible to have a few giant firms in manufacturing, while preserving a diverse field of specialized R&D outfits.

7 Boudreau, "Opening the Platform vs. Opening the Complementary Good? The Effect on Product Innovation in Handheld Computing," 2008, available at: https://ssrn.com/abstract=1251167.

8 Edison should have made more use of licensing than he did: his manufacturing efforts were less successful, as Henry Ford noted when describing him as "the world's greatest inventor and the world's worst businessman."

The mobile phone industry demonstrates how licensing combined with collaborative standard-setting can lead to more diversity in R&D. An astonishing number of inventions are incorporated in each mobile standard. The top 40 companies contributing technology to each standard together held 2802 patents in 2G, 7088 patents in 3G and 10,476 patents in 4G. This increasing complexity has not, however, been accompanied by more concentrated ownership. Quite the reverse: the top five companies held 69 percent of inventions in the 2G standard, 58 percent of the 3G and just 48 percent of the 4G standard. Even the top 20 companies own only around 90 percent of the inventions in any of the generations, implying a very long tail of smaller contributors to the technology. In contrast, in TV broadcasting standards, the top five patent-holders hold between 83 percent and 98 percent of technologies in the standard, while obviously in PC operating systems, only Microsoft and Apple own technologies in Windows and O/S, respectively.[9]

Small firms contributing significant R&D runs against traditional economic thinking, which saw R&D expenditure as being almost entirely carried out by larger industrial concerns. Economists have often regarded R&D – like advertising or the creation of brands – as a strategic tool by which larger firms keep smaller rivals out of their industry. Empirical studies have reliably found that higher R&D/sales ratios are associated with more concentrated industries – those dominated by larger firms. Indeed, this makes perfect sense if the only way to make money from an invention is to produce a product that incorporates it.

However, if successful innovation can be rewarded directly through licensing this link becomes weaker. To be sure, the majority of industrial R&D is still carried out in larger firms, but the trend has started to reverse. U.S. National Science Foundation surveys find around 12 percent of R&D carried out in firms with less than 500 employees in the early 1990s and between 16 and 20 percent in recent years. It is becoming more viable to be a small R&D player and indeed to be a "pure-play" researcher, as it was in the nineteenth century U.S. Perhaps the assumption that R&D is usually conducted in an integrated R&D department in a large industrial firm should be seen as a twentieth-century historical aberration. Licensing is essential to this development. Standards can be still more effective in promoting R&D, because the smaller innovator does not need separately to demonstrate its ownership of the technology rights through bilateral negotiations.

The more firms there are engaged in R&D, the more independent solutions to problems will emerge. Furthermore, these firms can specialize. So innovation will be faster but there may be wider benefits as well. This market structure seems likely to reward individual inventors more than would a more concentrated industry. When technology markets are dominated by a few giants, an inventor might have very few alternative possible buyers for their innovation. If you have a suggestion for how to improve Microsoft Windows, you need to talk to Microsoft about it. However, with standardized technologies, there can be multiple implementers of an innovation, making it more likely that innovators will be rewarded for their creativity and hard work.

IV. THE IMPORTANCE OF FRAND AND DEPENDABLE OUTCOMES

These impressive economic outcomes arise from many firms working together, through institutions that set the rules of the game: SDOs. To understand the importance of the rules, consider a very simple arrangement with just one innovator ("she") developing technology and one implementer ("he") who can manufacture and sell devices. If the resulting product can be sold for more than enough to cover each of their investments, they should be able to strike a deal to work together, but whether they will be able to do this depends on the rules of the game.

The problem is one of timing and commitment. If the innovator invests time and money in the new technology and then seeks a deal with the implementer, her bargaining power may be weak. The implementer knows that the innovator's costs are sunk – at that point, she will accept a deal giving her less than her investment costs because it is better than nothing. However, if the innovator fears this outcome in advance, most likely she will not invest. A similar problem arises if the implementer invests first, building a factory, or indeed if they both invest before attempting to negotiate a deal. If negotiations on licensing take place after investment, there is no reason to think the split will cover both parties' investments.

9 References for all data are in our main report, op. cit. 2.

It therefore makes sense, instead, to negotiate before investment has taken place. However, innovation is an uncertain business. It is by no means certain what value the two should put upon the finished product and it is very risky to commit to a particular number. One solution to this dilemma is for the two to merge together into a single integrated firm – it is precisely for this reason that we might expect to see industries dominated by vertically-integrated firms doing their own R&D and making devices that incorporate its results. As we have seen, however, this industry structure is far from ideal.

An alternative solution is therefore to agree to the broad rules of how a licensing negotiation will be conducted in advance, without agreeing to a specific number. This is why SDOs typically require innovators to commit to FRAND licensing terms when innovators declare their inventions to be essential to implement a standard. All the participants in the SDO commit to this rule in order to provide one another with the certainty required to invest – the rule provides a commitment device, which is essential because after investment has taken place, each side would prefer a deal that does not reward the other's investment, as we have seen.

Crucially, however, the rules-setting organization must stick to the rule. There is nothing more likely to harm the incentives of innovators and implementers to invest than to change the rules for how license fees should be set after the participants have committed to investments. In a few cases, SDOs have indeed changed their rules and have seen a fall in participation by innovators as a result.

In 2015, in an attempt to address issues arising from the vagueness of FRAND commitments, the Institute of Electrical and Electronics Engineers ("IEEE") amended its policy which required licensors to offer licences to all applicants, to forego their right to injunction except under limited circumstances and also recommended a method of calculation of reasonable royalty rates. Katznelson (2016) examines rates of licensing Letters of Assurance ("LOAs") at IEEE and finds a sharp (and statistically significant) reduction when changes to patent policy were brought in 2015.[10] Not only did the rate of new LOAs fall, some patent holders actually declined to license under the new terms, on previously-issued LOAs.

More common, however, are appeals to outside parties with the power to over-rule the SDOs' own internal decision-making: such as competition authorities.

Superficially, it is very attractive for a competition authority to intervene to prevent (for example) the holder of some intellectual property rights embodied in a standard from insisting on a particular license fee from manufacturers of equipment that use that standard. After all, the R&D has already taken place and the invention is there. The same considerations would apply to – for example – contracts put in place prior to the construction of a bridge or a pipeline or any other large sunk investment. Once it has been built, it might as well be used for free. However, competition authorities and other public bodies will normally be very reluctant indeed to break contracts in this way, because of the dismal effect this would have on future such arrangements.

In the case of a contract, with well-defined rates agreed in advance, this reasoning is clear. If one side appeals to a public body to break the contract, that public body should treat such an application with great skepticism. Yet in the area of IP licensing, such calls to break the agreement *ex-post* are common – perhaps because the inevitable uncertainty of invention requires that terms be less specific than they would be in a contract. Nonetheless, it would be poor public policy to accept such appeals, as this would damage confidence that innovators will be rewarded fairly, which must lead to a decline in invention.

Furthermore, as our report shows, such a change would have wider economic effects. Economists understand very well what an innovator and a manufacturer will do if they cannot commit to dealing with one another fairly in a market for innovation, after each has invested. They will merge instead, thus eliminating any uncertainties that they might create for one another. Yet to do this would be to lose the benefits that we have tried to highlight in this article.

10 Katznelson, "The IEEE controversial policy on Standard Essential Patents – the empirical record since adoption," 2016. Symposium on Antitrust, Standard Essential Patents, and the Fallacy of the Anticommons Tragedy, Berkeley, CA, available at: http://bit.ly/IEEE-LOAs.

V. CONCLUSIONS

The success of industries needing technological standards depends crucially on the gatekeeper – the organization that develops and updates the standards. Industries in which SDOs act as gatekeepers seem to be more competitive and innovative than those in which a single private company or the government plays that role. The SDOs and the licensing arrangements they support enable a "market for technology," in which smaller and specialized technology providers can thrive. However, to be effective this system depends on achieving a balance of incentives between innovators and implementers – and not undermining confidence by changing that balance once one or other party has made irreversible commitments.

As a matter of sound economic policy, therefore, competition authorities and others should take a very skeptical attitude to complaints that steps to enforce FRAND principles are anti-competitive. Harm to this system will only result in vertical integration, closed systems and proprietary technologies – the very opposite of what competition authorities should want.

This is important not merely to preserve the dynamic and effective mobile telephony industry that we currently have. Communications technologies are likely to appear in many, many more products in the "Internet of Things." As more industries start to depend on communications technologies, they too will participate in the collaborative standard development process. On the evidence we have seen, for how those processes have driven innovation and competition in the mobile telephone industry, that will not be a bad thing.