Interop

The Promise and Perils of
Highly Interconnected Systems

John Palfrey
and
Urs Gasser

BASIC BOOKS
A MEMBER OF THE PERSEUS BOOKS GROUP
New York

CHAPTER SIX

Innovation

Interoperability is an especially powerful tool for fostering innovation. Increased levels of interoperability at the right layer in a stack of technologies can lead to innovation at multiple levels. In the digital age, increased technical interoperability typically enables innovation at the human and institutional levels. As an example take Google Maps, a service that provides a basic infrastructure for geolocation information, upon which applications as diverse as restaurant guides or coordinated disaster relief efforts have been built. In theoretical terms, this quality is known as the *generativity* of the Internet.[1]

In other instances, interop-based innovations allow societies to harness the creative spirit of individual citizens. The diversity and creativity of user-generated content shared over platforms such as YouTube or Wikipedia are two impressive illustrations of the enormous creative power increased interoperability among digital devices, applications, and components can help bring about.

Interoperability also can (but does not always) help ensure that we do not lock in substandard technologies. In this way, interoperability does not

just foster innovation directly; rather, it can help lead innovative technologies on the market to become more broadly adopted. This is a particularly important feature of interoperability in the context of innovation. Once a particular technology—such as a computer operating system—has become popular in markets with strong network effects, it is usually very "sticky" and hard to replace, even if a more innovative product or service arrives on the market. The power of interoperability as a means to overcome technological lock-in has been well studied by economists, but it has gained little attention from policy makers.

At the same time, the highest possible level of interoperability does not always advance the goal of promoting innovation. We have studied cases in which interoperability may have a limited or even negative effect on innovation under certain conditions. This is especially the case in situations where companies have strong incentives to innovate because they compete for the entire market instead of just a share of it. Apple's iTunes is an example in this category: Apple created a highly innovative, low-interoperability product that they saw as able to take an entire market.

Even in cases in which high levels of interoperability do lead to innovation in a given market, there is no guarantee that this positive, symbiotic relationship will continue. Interoperability has led to great innovation in the social web, for instance. When companies like Twitter and Facebook open up their APIs to others, innovators can hook in and build their innovations upon the open systems made available by a series of private firms. But problems may arise over time. One or more of the web services providers may decide to pull a bait and switch by introducing a fee for the kinds of connections they initially made open. In turn, the innovative services built on the highly interoperable systems of today may be cut off when companies seek to profit from their central place in the ecosystem. This problem may occur even if companies never seek to charge for interconnection; a company might, for example, go out of business, yanking a key building block out of a complex system. The point is simply that what works in favor of innovation on day one may not work the same way later.

We revere innovation. It is a central goal of public policy at nearly every level. We have embedded the concept of innovation in the US Constitution, in key pieces of legislation and regulation, in court decisions, and in policy statements. Innovation is an official public policy goal of every modern society and of every society striving to modernize itself and to grow. We turn to innovation to help us solve the massive societal challenges we face today—ranging from global warming to the health care crisis. We all have to think hard about how to work together to promote and support innovation.

> A major earthquake struck Haiti a few hours ago. Is there any way for us to help? Thanks, Patrick.
>
> —*January 12, 2010*

A terrible earthquake hit Haiti on January 12, 2010. In its wake, it left somewhere between 92,000 and 220,000 casualties, and around 1.5 million to 1.8 million Haitians homeless. With this brief message, Patrick Meier, a graduate student at the Fletcher School of Law and Diplomacy at Tufts University, reached out to a group of about three hundred volunteers.

Meier and his friends decided there was a way they could help. They worked together to launch a Haiti disaster-relief effort. This lightly structured, instantly formed association brought together Ushahidi (a nonprofit technology company that develops software for information collection, visualization, and interactive mapping), for whom Meier was working as director of crisis mapping; the Fletcher School; the United Nations; and the International Network of Crisis Mappers. Within a few hours, hundreds of humanitarian and technology workers who had not previously known one another signed on to join the start-up initiative.

The Ushahidi platform facilitates large-scale collaboration among disparate, and otherwise uncoordinated, users by allowing them to share information about events and crises in real time.[2] A group of activists developed the original website in the aftermath of Kenya's disputed 2007

election. Across the country, eyewitnesses to both violent acts and graceful efforts to support peace submitted information via web or text messages to the new Ushahidi platform. Ushahidi provided a simple, powerful way for observers to record and situate these incidents on Google Maps.

Ushahidi quickly grew to have over 45,000 users in Kenya alone—despite the country's relatively low level of overall Internet penetration. Ushahidi established an online community of citizen journalists, activists, and ordinary people, most of whom did not know one another beforehand, in a virtual network. Soon, similar sites began to spring up on the platform, focusing on other regions and purposes, including the tracking of anti-immigration violence in South Africa, violence in the eastern Congo, and depleted pharmacy stocks in East Africa.

The Ushahidi model soon extended far beyond Africa, with similar sites being developed to monitor elections in Mexico and India and to collect eyewitness statements during the Gaza War. The platform was used in Russia to set up a map to help volunteer workers during a series of terrible wildfires in 2010. Many of the volunteers worked from countries thousands of miles away to help coordinate the firefighting on the ground.

Interop drives innovation through the Ushahidi platform by letting people create highly interconnected systems on the fly in moments of crisis. The group of young and very engaged activists developed Ushahidi at a low cost and very quickly, and they made it available to the world as a platform for innovation in the public interest. The platform is a particularly creative manifestation of what we have discussed under the rubric of consumer empowerment. Ushahidi has interoperability written all over its DNA. It is grounded in the principle of open source. As a mashup, it combines a number of existing components and elements in innovative ways.

The power of the Ushahidi model derives from the way it establishes and maintains, on behalf of its distributed users, high levels interoperability among a series of devices and data formats. Ushahidi connects different devices, such as computers and mobile phones, and is designed so that it can receive messages regarding events via Short Messaging Service (SMS), e-mail, or tweet or through the website itself. Users tag the reports and then

locate them on a map. Google Maps API performs the necessary geocoding.[3] The interface can be built off of either Google Maps or OpenStreetMap, a collaborative project to create a free and editable map of the world. In addition to text reports, a user can also submit photos and videos that can be integrated into the maps.

Ushahidi's technical features are not the only reasons for its phenomenal success in the Haiti disaster relief effort and for its use in many other crises around the world. Perhaps even more notable than the mashup itself is the fact that its technical interoperability enables innovation at the upper layers of our interoperability framework, including the institutional layer. For example, Ushahidi provides a single information source for individuals and organizations who are on the ground during a crisis and want to work together.

By submitting reports of particular events, which are then tagged and mapped, these disparate operations can organize and coordinate. Various organizations have access to this map and can use it to target rescue efforts, to investigate violence, or to engage in other activities that are made easier and more efficient by facilitated coordination within and among groups. After a crisis has ended, other organizations can make use of data collected over Ushahidi. Chronologically geotagged and verified information, for instance, allows researchers, historians, courts, political movements, and nongovernmental organizations (NGOs) to gain a better understanding of how a certain critical situation has emerged. More profoundly, the knowledge generated by a broad community through Ushahidi informs the way we might develop early warning systems in the future.

The technical and data interoperability harnessed by Ushahidi can in turn generate interoperability at the human and institutional layers. The system enables after-action review and analysis of the initial events and the institutional responses in real time. A review of the Haiti crisis information-management efforts, for instance, graphically demonstrated the need for more coordination within the crisis-mapping community. It also underscored the importance of interoperable processes and cultures across the different constituencies.

Higher levels of interoperability at the human and institutional layers is already leading to next-generation crisis-mapping applications, risk-prevention and risk-reduction programs, and long-term recovery processes. But interoperability does not always drive innovation at these layers, either. The caveat that we explored in Chapter 5 on the effect of interoperability on competition applies here as well: too high a level of interop can also lead to uniformity and lock-in, which can work at cross-purposes to innovation. Despite this potential downside, the overall relationship between innovation and interoperability tends to hold across all four of the layers of interoperability. This relationship helps explain the rapid development not only of specific services like Ushahidi but also of the web itself.

Innovation in web services has been central to the evolution of the web over the past decade. This innovation derives in large part from the availability of different data sources and functionalities obtained via multiple open APIs.[4] Interoperable web services that are mixed and mashed up allow different types of innovation to occur on top of the technology layer. This approach to web development enables innovation to spring from unexpected places: from unanticipated combinations of existing data, creation of new content by analyzing existing data, the evolution of new business models, and many other forward-looking approaches. Mashups illustrate the key point of this chapter: optimal levels of interoperability in digital environments can foster substantial levels of innovation.

Open APIs allow anybody—professional developers and geeky amateurs alike—to access the data or services of a platform. As one of the key ingredients of web mashups, open APIs are massively powerful drivers of innovation. Moreover, nonprogrammers can gain access to a malleable form of the data. Among the most popular APIs are those associated with Google Maps, Flickr, YouTube, Twitter, Amazon eCommerce, and Facebook. Each of these APIs is asked to transfer data across systems (requests known as API calls) billions of times per day.[5] Many of the companies behind these web services have discovered and benefited from the enormous potential for innovation that is unleashed when the web community is en-

couraged to freely mix data and functionalities in cases where users are tackling a particular problem.

The extraordinarily rapid rise of Twitter demonstrates the relationship between interoperability and innovation. Twitter was created and launched in 2006. It was released as a microblogging service, and it enables users to send and read text-based posts of up to 140 characters ("tweets"). The founders sought to create a new way for users to share information in a concise way. Beyond this, they did not have any specific goal or purpose in mind for Twitter. Twitter gained popularity among early adopters in 2007 but left many wondering whether it would ever really take off. It did. As of February 2011, roughly 190 million users were generating about 65 million tweets daily. Moreover, Twitter has become one of the most visited websites in the world. Once viewed skeptically by some, Twitter now plays a significant role on the global stage—for instance, during the Arab spring in 2011, protesters in several countries relied heavily on Twitter to organize and publicize their cause.[6]

As of 2010, Twitter supported a staggering 70,000 applications—virtually none of them developed by the company itself—and the application base continues to grow.[7] The expansion of Twitter's reach was no doubt supported by the release of its API in September 2006, which effectively allowed many devices and web applications to interoperate with Twitter. The hope was that users on these media would create and disseminate information in new and innovative ways, and indeed, a broad range of Twitter-based applications rapidly emerged. Such applications include a news service for stock traders, an executive search service, tracking services for travel sites, and even a service that lets users submit, vote on, and create T-shirts from tweets.

Facebook is another powerful demonstration of how interoperability via open APIs can drive innovation. When Facebook released the first version of its API in May 2007, third-party developers created thousands of new applications within six months. Just as with Twitter, the applications developed to interoperate with Facebook cover a broad range of functionalities. These applications serve wildly diverse needs—from games and sports

applications to business tools, utilities, and educational applications. Currently, the most successful apps on Facebook are games from a company called Zynga, which has roughly 297 million monthly active users. But new tools have been created not only by companies but also by young entrepreneurs. Scrabulous, a popular adaptation of the word game Scrabble for the Facebook platform, is a prominent example. Recently, Facebook introduced a new and improved API that makes it easier for developers to use Facebook as a platform for their own innovations.[8]

It is also possible for users who are not programmers to create mashups. For example, ZeeMaps allows users to create free, customized, interactive maps and to add to it markers that are submitted in an Excel spreadsheet or created via wiki by crowdsourcing.[9] Pipes is another powerful composition tool used to mash up content from the web. Among other things, it helps users aggregate, sort, filter, and translate feeds and locate and browse items on maps.

The power of interoperability extends beyond the consumer domain and into the business world as well. Mashups used in business settings—called enterprise mashups—illustrate another important, and closely related, phenomenon. Driven by business users who want easier access to enterprise data regardless of the application in which it is stored, mashup innovation also plays an increasing role in the enterprise context. Industry heavyweights such as Intel, Bank of America, Hewlett-Packard, and Adobe created an initiative called the Open Mashup Alliance to drive interoperability among business applications. Their approach was to promote usage of the interop-friendly Enterprise Mashup Markup Language. This alliance is another case of an industry-driven standardization process aimed at increasing interoperability among systems.

Facebook, Google, Bank of America, and Hewlett-Packard all have a strong interest in making data and functionality available to their customers and to business partners via open APIs. This is true even though they will not immediately capture all the value from the innovation unleashed through their platforms. Mashups enable companies to pull together disparate information and make it available in a form that is most valuable to customers. For instance, Facebook users may find it useful to see informa-

tion they have posted to other services, such as foursquare or Twitter, appear in their news feed on Facebook as well without having to enter the information twice.

As a corollary, the more easily a programmer can customize data or functionality to serve a certain purpose for end users, the more we will observe the emergence of small, niche mashups. When individual developers modify existing web services for their own needs and then make the resulting mashup freely available to others, many more mashups will be made than would be the case if a significant investment of capital were required. Given that this development is so inexpensive and the developer does not have to get permission for every interconnection, modest advertising revenue can suffice to make a niche mashup profitable.[10] Often, however, mashups are not the primary revenue driver of a new business model. Instead, mashups facilitate or complement another business model, as the Facebook advertising model demonstrates. Facebook has developed a highly profitable business model based largely on advertising rather than on charging developers for interconnection to the service. As a result, the more developers build innovative ways to connect in to Facebook and the more people use the combined services, the more revenue Facebook stands to earn.

Outside the venture capital–funded start-up scene, nonprofits, governments, and private citizens also use mashups to serve the public interest. DataCalifornia is a service using the APIs of Facebook, Twitter, and Google Maps to view details and comments on California's education, health, and other current legislation. It also promotes collaboration by allowing users to submit ideas on how the government should spend or save taxpayer money. Congress111 is an iPhone app that mashes up a number of different Congress-related data sources; with this app, a user can view Congress-related news, votes, videos, tweets, and office maps. The Federal Communication Commission's consumer broadband test API provides up-to-date speed test data for wired and wireless connections.

Web mashups show how higher degrees of interoperability can be good for innovation. In the research for this book, we conducted a series of case-specific studies with our team. We investigated potential examples, such as identity-management systems, to confirm the relationship between increased

levels of interoperability and innovation. In the identity-management business, firms are working to help reduce the number of times a consumer has to log on to one system or another. The common complaint "I can't remember all those usernames and passwords!" is a consequence of noninteroperability across systems. When a site allows users to log on using their Twitter, Facebook, or OpenID accounts, they do not have to waste as much time switching between services and experiences. The more systems agree to work together, by accepting common forms of identity management, the more innovation flourishes in identity management specifically and on the web in general.

Although these narratives provide powerful anecdotal evidence of the connection points between interoperability and innovation, it is much harder to glean why, in a general sense, this positive relationship so often exists. Interoperability theory offers two possible explanations. First, interoperability usually increases competition, which in turn is expected to lead to higher rates of innovation. Second, interoperability also tends to reduce the effect of lock-in and lowers the entry barrier for entrepreneurs. Take a look back at the Microsoft story in Chapter 5. Forcing the software giant to disclose information allowed existing rivals and new market entrants to compete by enabling them to build new—but interoperable—products and services. Such products and services not only permitted users to switch between providers, but they also allowed users more freedom to use applications that were running on top of them. Enhanced competition of this sort benefits users by reducing prices and by providing companies with incentives for product and service innovation.

A word of caution is necessary here. The interoperability-competition-innovation progression can sometimes get complicated. Some economists argue that interoperability can even have a negative effect on innovation by leading to anticompetitive situations. For instance, standards-setting agreements among companies can lead to more interoperability and more innovation in the short run. However, such arrangements may prompt a single firm or a few firms to act anticompetitively in the long run.

When a standards consortium manipulates the standards-setting process to achieve anticompetitive ends, a related problem can arise. In the

USB 2.0 standards-setting process, companies were working together in the lead-up to the year 2000 to come up with a new protocol for connecting peripherals—such as keyboards—to computers and for sharing data quickly among devices. At least one company is alleged to have used an information advantage for anticompetitive goals in the course of this standards process.[11] These are valid concerns; nonetheless, we argue that such anticompetitive actions reflect the unscrupulous behavior of a specific company rather than a flaw of interoperability itself.

The Microsoft case brings up a further complicating factor in the relationship among interoperability, competition, and innovation. In that case, Microsoft argued that the forced disclosure of interoperability information might result in decreased competition. In essence, Microsoft asserted that the disclosure would have the damaging effect of reducing its incentive to invest in the development of new products and services. More generally, firms may have a stronger incentive to be innovative when low levels of interoperability promise higher or even monopoly profits. This sort of competition (economists call it Schumpeterian competition after the famous Austrian economist Joseph Schumpeter) creates incentives for firms to come up with entirely new generations of technologies or business methods that are proprietary. Apple's iTunes strategy is a case in point of a company competing for the market as a whole rather than for only a share of it.

Despite these complications, there is broad consensus among economists and regulators (recall, for instance, the European Commission's response to Microsoft's argument) that competition is good for innovation at a *marketwide level*, even if not necessarily for an individual firm. Moreover, competition is just one of the theories that links interoperability and innovation. As the mashup example illustrates, innovation in the Internet age does not only happen as a result of the competition-driven activities of companies and their respective R & D labs. Rather, if the underlying platforms are open and designed with interoperability in mind, then end users, intermediaries, and other actors contribute in distributed and often vertical ways to the development of new products and services.

The power of openness and interoperability for innovation is among the most fascinating aspects of the Internet. In his much-acclaimed book *The*

Future of the Internet—And How to Stop It, Harvard professor Jonathan Zittrain put forth what he calls the "theory of generativity." By tracing the Internet's evolution and discussing its trajectory, he argues that ICT platforms should remain broadly open so that users can make creative developments on top of the ICT infrastructure;[12] the Internet would thus remain generative. Interoperability fosters openness of information and communication systems and is therefore a key enabler of generativity.

The powerful idea of horizontal innovation networks adds further heft to this line of argument about interoperability and innovation. Horizontal innovation networks are networks in which firms and users form porous, ad hoc teams to innovate. The work of Eric von Hippel, a professor at the Massachusetts Institute of Technology, highlights a key aspect of this idea: the importance of innovation for users who operate outside the traditional firm. According to von Hippel, two conditions are required to sustain innovation. First, at least some users must have sufficient incentive to innovate and to reveal their innovations. Second, the production and diffusion of these user-created innovations must be low cost and must be competitive with commercial production and distribution. Mashups are a great illustration of this type of user-driven innovation. In each of the successful mashups we have studied, a group of people with a common interest shared a desire to solve a problem and had a clear sense of what creative solutions were possible. Again, interoperability is one of the key enablers of this type of user-generated, low-cost innovation. Interoperability allowed like-minded people to work together, to experiment collectively to solve common problems, and to implement their ideas with limited expense.

The ability to make small changes—incremental innovation as opposed to radical innovation—is a third force that enables interoperability to foster innovation. Many new products and services are actually incremental improvements on an existing product or service. This "small-step" innovation builds largely on prior knowledge and resources. Technological advances associated with incremental innovations can appear rather modest initially, but their impact becomes profound over time. An example is SMS. The ability to send a short, text-based message may seem trivial, yet it has had an

enormous effect on the way humans communicate in the early twenty-first century. (Think also of the short step between SMS and the 140-character tweets one can share, publicly or privately, on Twitter; of the advent of TwitPic, which allows the sharing of images on a similar network; and so on.) These advances occur much more frequently than advances arising out of radical innovations. Small-step innovation throws into sharp relief the role of interoperability in innovation generally: by increasing the level of interoperability, more systems, components, or applications can be combined to make improvements on products and services. The range of potential improvements of the technology, in turn, grows broader over time.

The promotion of progress and human welfare depends not only on the development of new technology but also on its *diffusion*.[13] Interoperability also facilitates user adoption of high-tech innovations. The problem of adoption in high-tech markets goes back to the phenomenon of network effects. Consumer expectations regarding the future success of a new technology in a network market is a crucial factor in its success. This insight is relevant where consumers face choices with uncertain ramifications. They can stick with a well-established, even if outdated, system or switch to the latest and hottest technology, which may never catch on.

There is plenty of empirical evidence that shows how consumers' expectations about the availability, price, and quality of the components of high-tech systems shape whether or not they adopt a new technology. Consider the less-than-smooth transition from good-old analog television to high-definition television (HDTV). From the 1990s to the early 2000s, the FCC and Congress tried to shift broadcasting from analog to digital, with the hope that the transition would free up precious spectrum for other uses while enhancing the sound and image quality for consumers. Officially, the digital television transition—often somewhat more dramatically called the "analog switch-off"—occurred in 2009. But the FCC and Congress had planned such a move since at least 1987. Consumers who were reluctant to make the leap were viewed as the primary holdup: why buy new, expensive HDTV sets when the variety, availability, and quality of HD

broadcasting is uncertain? A brand-new TV is not of much value if there are few programs a consumer can watch on it. An economist with similar concerns might say that the utility of HDTV sets to consumers only increases when more HD broadcasting becomes available.

More problematic, broadcasters ensured that the availability of more HD broadcasting would be contingent upon increased HDTV set sales. It would not make much sense to produce TV programs using a cutting-edge technological standard that would be viewed by only a handful of households. Network effects give rise to what is essentially a chicken-and-egg problem. Rational consumers wait to adopt the new hardware (HDTV sets) until enough software (HD programming) is available. Conversely, software producers will probably delay investment in software (HD programming) until a critical mass of consumers have adopted the hardware (HDTV sets).

There is an additional wrinkle. Economists have observed that users tend to stick with an established technology even if they would benefit from switching to a new but incompatible technology. This wrinkle arises out of a mismatch of cost and benefit to current and future consumers. Consumers of an established product must bear the transition costs from the old to the new technology. All things being equal, they are less likely to switch than if they had not purchased the old technology in the first place. However, *future* consumers, who do not face this switching cost, would prefer widespread adoption of the new technology. As a result, markets for systems lock parties in to obsolete standards or old, suboptimal technologies.

The HDTV story is a good illustration of the problem. Consider a consumer who recently purchased an analog TV set. She currently receives all her favorite TV shows and movies, along with hundreds of channels. As it stands, she has little incentive to switch to digital TV—in terms of both the TV set itself and the availability of programming. At the same time, however, other consumers may be willing to buy an HDTV set because more programming has become available. The consumers who drive the adoption of a new technology often ignore the fact that some consumers will be stranded with the old technology.

In the case of HDTV in the United States, the government played an important role in overcoming these inherent problems by managing the transition from analog to digital TV. It used a multipronged approach to solve the problem, which included both an awareness and education campaign for consumers and legislative action.

Here, interoperability comes back into play. Among other measures, the government launched a program that provided households with coupons to buy a converter box that would enable them to receive digital signals, even on their analog TV sets. This was an inelegant yet effective way to create a modest level of interoperability between the old technology (analog TV sets) and the new (HDTV). Technical interoperability not only fosters innovation; it can also reduce the likelihood that consumers might be "stranded," or locked in to outdated systems.

In the past three decades, the debate about how, precisely, societies can foster innovation has become intense. Some people believe that the answer lies in the structure and breadth of intellectual property (IP) regimes. They argue that we should increase the IP rights we award to creators in order to promote higher levels of technological innovation. Critics of the stronger-IP strategy, in contrast, warn that the expansion of IP rights is not the main catalyst for innovation. They argue that a stronger and broader IP regime will actually backfire by unduly raising the costs for future innovation.

There is broad consensus that the Internet is among the most innovative catalysts of our age. However, there is disagreement as to the appropriate means of fostering continued innovation of the Internet and related technologies. Proponents of an open Internet believe that an open and decentralized infrastructure maximizes its potential for innovation. Those opposed to this viewpoint see network owners, rather than users, as the primary motor of innovation. As a result, they favor a much more controlled Internet with strong property rights. Admittedly, each position has its merits and demerits.

For our part, we belong to a school of thought that believes in the innovative power of an open Internet. Our preference is for balanced systems

of intellectual property protection that rewards creators while also recognizing the importance of the public domain. However, this debate, though still raging, is not the point of this particular book. We are focused here on the role of interoperability, as well as on those policies and practices that support interop in its best forms.

The key point we want to make here is that in these controversies about intellectual property policy, interoperability plays an important role. Our argument is that interoperability is one of the keys to innovation, especially in the case of information technologies (but, as we have seen, not limited to this sector). It is one of the key enablers of Internet generativity. Interoperability in this sense is important because it fosters the development of innovative technologies on top of the core technological infrastructure of the Internet itself. In turn, systems can function in much more efficient ways, to the benefit of individual firms, consumers, and society at large. Public policy ought to recognize and make explicit society's shared interest in accomplishing optimal levels of interoperability in order to foster higher levels of innovation.

The important role of interoperability for innovation should also be acknowledged more explicitly and considered more carefully in the heated debates about IP rights. The relation between IP rights and interoperability is complicated, and much depends on the specifics of the law. From a bird's-eye perspective, there is plenty of reason to believe that the current IP system is not designed in such a way that it will lead to optimum levels of interoperability in areas that are particularly relevant in the digital age. Take, for instance, the controversial case of patents protecting business methods or software, which can make it very hard and risky—and sometimes even outright impossible—for competing Internet companies to build interoperable services at the technology and data layers. Such strong intellectual property protections work at cross-purposes to interoperability and, thus to innovation in this case.

But it is not only the general and steadily expanding scope of what can be protected under today's IP regimes that tends to be bad for interoperability. To make things worse, lawmakers around the world, heavily influ-

enced by the copyright lobby, have even enacted legal provisions that directly *prevent* the creation of interoperable services. Anti-circumvention laws have added a top layer of legal protection to the "digital locks," such as copy and access controls, aimed at securing copyrighted materials like music, movies, or e-books. In many countries, these regulations do not include exceptions that would allow competitors to open up the digital locks for the sake of interoperability.

We believe that specific laws preventing interoperability in the digital age are a bad idea, as they will have negative effects on innovation in the long run and thus should be changed or abandoned altogether. But IP law does not necessarily need to be in conflict with interoperability. Legal provisions, for instance, that carve out exemptions for reverse engineering of software for purposes of interoperability are a specific example in this category. More generally, IP regimes can be designed so that they make it easier for rights holders to enter licensing agreements—which is one approach to increasing interoperability as we have seen before.

The effect of IP rights on interoperability and innovation depends heavily on how those rights—regardless of their scope and shape—are actually *exercised* by rights holders. The use of Creative Commons (CC) licenses is illustrative in this respect. In the case of CC licenses, copyright enables the exchange of creative materials across systems, applications, and components. Creative Commons takes a permissive approach to IP and lowers the transaction costs of deal making, which in turn fosters interoperability at the data layer. We face not only the challenge of getting IP law right as a policy matter, but also the challenge of thinking more creatively and openly about how to wield IP rights on behalf of interop and innovation in the high-tech environment. That is the shared responsibility of lawmakers, company leaders, and consumers alike. The net result, if we are work together well, can be lower transaction costs and greater innovation across the board.