

Innovation in a Hyper-Connected World

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Living with Exponential Change

Today, we are living in a world of exponential technological change driven by the combined impacts of the ever-increasing power (and falling cost) of computers and the equally dramatic growth of the Internet.

Back in 1965, Gordon Moore, a co-founder of Intel, observed that computing power (measured by the density of transistors on a chip) was doubling every year and would continue to do so for the foreseeable future.¹ Over the past half century, what came to be known as Moore's Law has held remarkably true: After many years of doubling, today's chips are immensely more powerful than previous generations, even as their cost has fallen by an equivalent degree. According to one estimate, the power of a single computer chip today is 1.1 million times greater than it was 40 years ago.²

Paralleling and amplifying the increasing power of digital technology has been the emergence of the Internet which has experienced equivalent growth. From a handful of users in its early days, the Internet now has more than two and half billion users worldwide.³ As Vincent Cerf, one of the leaders in the development of the Internet, recently noted, "Everything [on the Internet] has expanded by a factor of a million since we turned it on in 1973. The number of machines on the network, the speeds of the network, the kind of memory capacity that's available, it's all ten to the sixth."⁴

Because of its open, decentralized architecture, the Internet has made possible a wave of "innovation without permission." And thanks to the constantly declining cost of digital technology, barriers to entry for new ventures have continued to fall, producing a remarkable proliferation of novel services that become instantly available to everyone online.

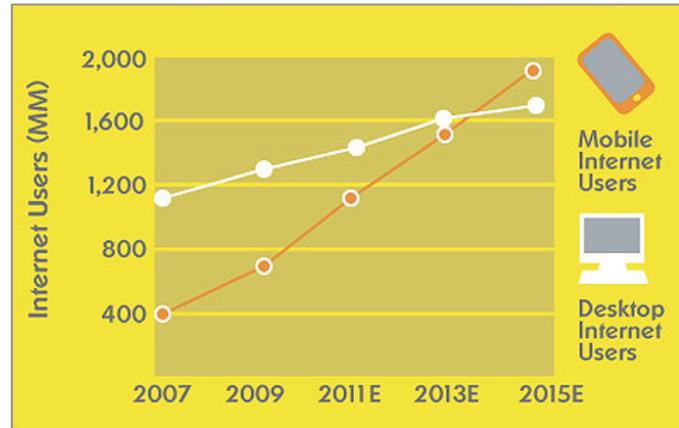
To get a sense of how fast the Internet-based digital world is changing, consider the situation just eight years ago, in January 2006:

- Facebook was available only to high school and college students (it was opened to everyone in September 2006; it reached one billion users just six years later)
- Twitter did not exist (it was launched in the summer of 2006)
- There were no iPhones or iPads (the first iPhone was released in 2007, and the iPad was introduced in 2010)
- Netflix was the fastest growing customer of the U.S. Postal Service, having mailed more than 1 billion DVDs to subscribers (four years later, Netflix had become the leading source of Internet traffic in North America in the evening, having shifted from mail to streaming delivery of movies)
- No one had heard of a MOOC (Coursera and Udacity were founded in 2012, followed by other providers of Massively Open Online Courses)
- Clouds were just something in the sky (Amazon Web Services was introduced in late 2006, sparking the cloud computing movement. AWS now serves over 100,000 companies in 190 countries and has inspired many competitors)

From a Connected to a Hyper-Connected World

As technology continues to evolve, we are now on the brink of another major transition: from a *connected world* to a *hyper-connected world*. We are in the midst of a shift from seeing the Internet as a separate place that we go to periodically in order to get access to information or communicate with others to the Internet as a constant presence in our lives, a pervasive force that keeps us continuously connected to the entire universe of resources available online. Here, again, there are two main driving forces behind this shift: the growth in mobile broadband access and the rise of social media.

Global Mobile vs. Desktop Internet Use, 2007-2015



Source: http://tag.microsoft.com/community/blog/t/the_growth_of_mobile_marketing_and_tagging.aspx

The year 2013 was the crossover point when more people accessed the Internet on a daily basis via wireless devices (including smartphones and tablets) than by wired desktop computers. Wireless Internet access will grow even faster over the next decade, as the great majority of the next billion people to get online do so via mobile devices rather than by computers.

Go to any public place – a park, a restaurant, a bus or a train, a shopping mall, an airport, or even a sidewalk – and you will encounter lots of people engaged with their mobile devices. People are now doing much more than making calls on their mobile devices: they are taking photos, making and watching videos, listening to music, playing games, getting directions, paying bills, keeping up with the news and staying in touch with friends and family. (A 2013 study showed that typical users interact with their mobile phones 150 times a day or more.⁵) What started as relatively simple “mobile phones” have morphed into intelligent multipurpose wireless computing and communications devices, and how we use them has continued to evolve. Smartphones and tablets are, in fact, becoming our principal means for interfacing with the rest of the world.

Rise of Social Mobile Networking

The most popular use of mobile phones continues to be for staying connected with friends or family, though the ways in which we do this are changing. One of the fastest growing uses for mobile devices is to participate in social media.

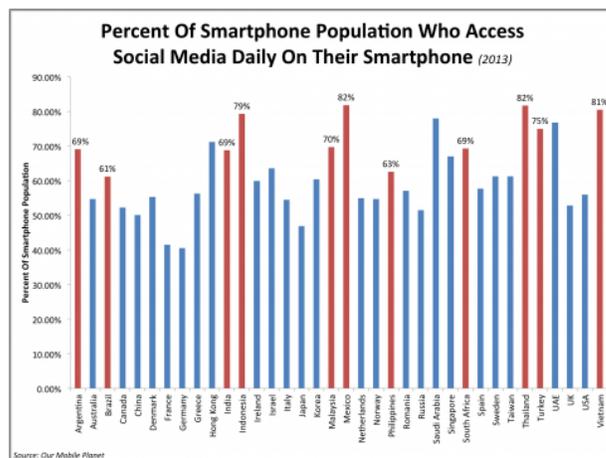
A headline in the 2012 Social Media Report from Incite/A.C. Nielsen reads, “Social Networking is All About Mobile.”⁶ According to the report, more than one-third of time

spent on social media by Americans (34%) now comes from mobile devices. And while social media access from PCs increased slightly from 2011 to 2012, total access time from mobile devices doubled in the same period. Time spent on social networking from mobile devices is particularly high among women (9 hours, 43 minutes per month vs. 6 hours, 44 minutes per month for men) and among younger people (over 10 hours per month for those ages 18-24, compared to 4 hours for those ages 55-64).

Facebook remains the most popular social networking site, generating more than 31 billion minutes of mobile usage in 2012, compared to just over 4 billion minutes for Twitter, in second place, followed by Foursquare (1.9 billion minutes) and Pinterest (840 million minutes of mobile use). However, the fastest growing mobile social network in 2012 was Pinterest in terms number of mobile users (+4,000%) and time spent (6,000%).

“Traditional” Web-based social networking sites, which were once almost entirely PC-centric, are actively shifting their focus to their mobile users. For example, seven out of ten Facebook’s one billion+ users now access the site from a mobile device at least once a month, and in October, 2013, Facebook CEO Mark Zuckerberg revealed that on a typical day, 48% of all users were accessing the service only from a mobile device.⁷ At the same time, Twitter reported that 70% of its users are mobile.⁸ In addition, there has been a sharp increase in social networking services that are purely mobile. Three of the ten largest social sites—Whatsapp, LINE and WeChat – are mobile-only, while mobile photo sharing apps such as Instagram and Snapchat have also been growing very rapidly.

Social mobile is a global phenomenon. A 2013 survey by BI Intelligence found that a majority of smartphone users worldwide⁹ access social media every day, with the number rising above 70% in Mexico and Thailand (82%), Vietnam (81%), Indonesia (79%), Saudi Arabia (78%), the UAE (77%), Turkey (75%) and Hong Kong (72%).¹⁰



Source: www.businessinsider.com/mobile-first-social-networks-are-taking-over-2013-11

Building the Infrastructure for Mobile Broadband

According to Cisco, global mobile data traffic is expected to grow 13-fold from 2012 to 2017, a rate which is nearly three times faster than the growth of fixed traffic. By 2017, mobile traffic will be 771 times greater than it was ten years earlier!¹¹ Not only will there be a billion more cell phone users in 2017 than in 2012, but Cisco forecasts that each user

will be generating nearly 10 times as much data traffic -- 2,037 megabytes per subscriber per month in 2017, up from 201 megabytes per month in 2012.

Just as the Internet sparked a great deal of innovation, so mobile broadband is emerging as a new platform for development of entirely new kinds of applications and services. But this kind of growth raises serious challenges to the capacity of wireless networks to handle it all.

There are currently two main alternatives for sending and receiving digital data from a mobile device: a cellular network or Wi-Fi. In both cases, there are several different technical standards that support different transmission speeds, but Wi-Fi networks generally offer faster, more reliable connections than cellular networks (see table below).¹² On the other hand, Wi-Fi networks have a more limited range and are accessible only in the immediate vicinity of a “hotspot,” while cellular networks are typically available over wide areas (except where they’re not).

Cellular vs. Wi-Fi Network Speeds

	Cellular		Wi-Fi	
	3G	4G (LTE)	802.11n	802.11 ac
Peak Download	100 Mbps	1 Gbps	600 Mbps	1.7-2.5 Gbps
Peak Upload	5 Mbps	500 Mbps		

Sources: www.diffen.com/difference/3G_vs_4G; www.extremetech.com/computing/160837-what-is-802-11ac-and-how-much-faster-than-802-11n-is-it

Since all wireless networks make use of the electromagnetic spectrum, which is a finite resource, the capacity of any such network is finite. In order to limit usage, most cell phone carriers impose caps on the amount of data subscribers can use each month. And while most carriers provide a monthly package of voice and data use for one flat rate, subscribers who travel abroad typically must pay a “roaming charge” for all usage that can be quite costly. A popular strategy for limiting these charges is for travelers to turn off data roaming on their phones and to seek out a Wi-Fi hotspot to go online to check e-mail, send or receive files, etc. But the number of hotspots in any locale is limited and many may be closed, which restricts travelers to intermittent, hit-or-miss connectivity. A Netherlands-based company called CrowdRoaming has developed a creative approach to addressing this problem.

Bringing Hyperconnectivity to Mobile: Social Bandwidth Sharing

Just as Couchsurfing helps travelers to find inexpensive accommodations from hosts willing to share their homes and Liftshare matches drivers with extra space in their cars with people needing rides, CrowdRoaming has developed a novel approach to lowering the cost of mobile connectivity, especially for international travelers, which they describe as “crowd sourced Internet access.” The company is hoping to create a community in which local residents help travelers abroad to avoid high roaming costs by sharing some of their excess mobile bandwidth. Participants who are willing to share their connectivity at home can get free access to others’ bandwidth when they travel to other countries.

The CrowdRoaming app is relatively simple to use. It turns each user’s phone into a hotspot that announces its availability to other community members. Local participants can decide how much bandwidth they want to share each month with others—in many cases, bandwidth that would otherwise go unused. When travelling, the app searches for

the strongest signal from a local participant and then links securely to it. Each connection is authenticated, and all messages are encrypted to ensure users' privacy.

In addition to lowering roaming costs for travelers abroad, the CrowdRoaming technology could also be used in several novel ways to extend cellular coverage. For example, in areas with poor cellular coverage, it can support "message hopping" that would allow messages to be passed from one phone to another before being delivered normally. This peer-to-peer capability could be important for maintaining connectivity in the wake of a disaster such as a hurricane or an earthquake that knocks out conventional cellular service. It could also provide useful backup capacity when cellular networks are overloaded.

In addition to connecting mobile phones with each other, the app is able to detect and link to Wi-Fi hotspots that have agreed to become part of CrowdRoaming, which alleviates the need for users to discover and connect manually to each hotspot. If a sufficiently large number of hotspots in one locale join the CrowdRoaming ecosystem, it becomes possible to turn these independent islands of connectivity into a city-wide virtual Wi-Fi network. The ability to create this kind of wide-area network could be particularly useful in countries that are attempting to expand mobile broadband coverage. In fact, by offering easy access to low-cost wireless broadband service, the CrowdRoaming approach could provide a novel way for a nation to appeal to international visitors who are increasingly dependent on ubiquitous mobile connectivity. The first country to adopt such an approach is likely to attract attention from the global community.

The Future of Innovation

The successive waves of innovation powered by the combination of digital technology and the Internet show no signs of abating. In fact, the pace of innovation seems to be growing, much of it fueled by start-ups that are emerging all over the world. Ventures like CrowdRoaming are pioneering promising new ways to achieve affordable, ubiquitous mobile access.

One exciting recent development has been the rise of user-driven open innovation that provides opportunities for many people to contribute to the design of new products and services, blurring the dividing line between producers and consumers. For example, as CrowdRoaming gains traction and grows beyond its initial phase, it may well evolve into a new kind of service, possibly quite different than its original form, shaped by the needs and interests of its users.

What is clear is that innovation is no longer a game that is limited to big enterprises with large R&D budgets, or to "wired" entrepreneurs in Silicon Valley, but is now open to everyone with an idea for change. We are all likely to be the beneficiaries of this shift.

Richard Adler is a Distinguished Fellow at the Institute for the Future in Palo Alto, California. He has written and spoken widely about the future of broadband. He was keynote speaker at the launch of Qatar's National Broadband Plan in December 2013.

Endnotes

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- ⁷ Ingrid Lunden, “Facebook’s Mobile Tipping Point: 48% of Daily Users Are Now Mobile-Only,” TechCrunch, October 30, 2013, <http://techcrunch.com/2013/10/30/nearly-half-48-of-daily-users-of-facebook-are-now-mobile-only-says-ceo-zuckerberg>.
- ⁸ Craig Smith, By the Numbers: 68 Amazing Twitter Stats, DMR, December 1, 2013, <http://expandedramblings.com/index.php/march-2013-by-the-numbers-a-few-amazing-twitter-stats/#.Ur3CuPaALQ4>.
- ⁹ There are now more than one billion smartphones in use worldwide. With a total of 6 billion mobile phone subscriptions globally, smartphone penetration is now estimated at 16.7% of all mobile phone users, while in the U.S. and a number of other developed countries, more than half of all mobile phone subscribers have smartphones. Source: Global mobile statistics 2013: Mobile subscribers; handset market share; mobile operators, mobiThinking, December 2013, <http://mobithinking.com/mobile-marketing-tools/latest-mobile-stats/a>.
- ¹⁰ Cooper Smith, “Mobile-First Networks Are Taking Over Social Media Around The World,” Business Insider, November 11, 2013, www.businessinsider.com/mobile-first-social-networks-are-taking-over-2013-11#ixzz2oLIK9vnq.
- ¹¹ VNI Mobile Forecast Highlights, 2012–2017, CISCO Systems, www.cisco.com/web/solutions/sp/vni/vni_mobile_forecast_highlight/index.html.
- ¹² Even as 4G networks continue to be deployed around the world, work is underway on the next generation of ultra high-speed cellular networks. In May, 2013, Samsung announced that it has successfully tested a prototype 5G network that supports download speeds of up to 1 Gbps. Experts estimate that 5G technology will begin to be rolled out in 2020. See Dan Graziano, “Samsung successfully tests 5G wireless data serve at gigabit speed,” BGR, May 13, 2013, <http://bgr.com/2013/05/13/samsung-5g-networks-1-gbps-2020>.