

An Inventory of Aspirations for the Internet's future

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1 What do we want our future Internet to be?

The goal of this paper is to consider possible future desirable properties of the Internet, and how we might achieve them. We have cataloged a list of aspirations for a future Internet, e.g., ubiquitous access, supporting a wide range of applications, providing a platform for innovation or even to enable some purported universal value such as global connectedness. We catalog these aspirations in order to subject them to critical analysis, and motivate a debate over which of them are desirable, well-specified, realistic and achievable. Our list of aspirations is not original to us, nor do we agree with all of them. We have tried to collate what others have said, so we can consider it all at once.

1.1 From aspiration to structured debate and supporting research agenda

Collecting and considering these aspirations led us to three high-level conclusions, perhaps obvious but often neglected. First, not only are many of them hard to achieve, but some are incompatible with others. Second, many are under-specified and resist operational definition; it is unclear how to translate the aspiration to concrete goals against which to measure progress. Third, most of the current tools society has to shape the future of the Internet seem unequal to the task. While these conclusions seem discouraging, our goal is not pessimism. Our goal is a call to action, along several fronts: a rigorous debate about the merit of the different aspirations, and the potential of various means to achieve them; an attempt to move beyond ill-defined terms and articles of faith; and a technology and policy research agenda that could mitigate or circumvent some barriers to the future that society might choose to pursue.

Governments or advocacy groups express many aspirations on this list as societal goals – desirable outcomes for the citizenry, thus “in the public interest”. And yet the Internet’s architecture and infrastructure are now primarily under the stewardship of the private sector, driven by profitability and commercial viability, constrained by technological and economic circumstances, and sustained by interconnecting and interoperating with competitors in a multistakeholder ecosystem. Navigating the inherent tension between private sector objectives and societal aspirations is essential to shaping the future of the Internet.

This paper has three parts. In Section 2 we catalog the aspirations that we have gathered concerning the future of the Internet, and discuss how one might translate from high-level assertion to more precise definition that could be used to measure progress or frame regulation. Section 3 sorts these aspirations along several dimensions: geographic scope (domestic vs. international); and architectural layers (connectivity vs. content). We offer some preliminary observations on how the aspirations inter-relate – do some of them promote, impede, or entirely exclude others? Section 4 reviews the forces shaping the Internet today, and tools or approaches that might impede or promote a particular outcome. Section 5 briefly discusses means for making progress on inherently international aspirations. Section 6 proposes some directions the research community, policy makers, and funding agencies can pursue to raise the rigor of Internet public policy discourse in pursuit of these and/or some future refined set of aspirations.

1.2 Quantification and measurement

As we discuss each aspiration we consider whether it is amenable to quantitative definition and measurable assessment of progress. Quantification and measurement would not matter if we just accepted the aspirations as high-level expressions of hope for a better tomorrow. But any concerted steps toward these goals will require agreement on what constitutes progress, including the effectiveness of interventions targeted toward a given set of goals. The path from high-level aspiration to measurable action requires steps of refinement, where there is first debate about the merit of specific steps in achieving the overall goal, and then measuring progress on the specific steps. The task of refinement may be more contentious than the task of measuring progress. Attempting to reduce a high-level aspiration to a quantified goal can also reveal that the aspiration is not as well-formed as one might have thought.

2 Catalog of aspirations

We catalog aspirations that have been articulated for the future of the Internet, and attempt to define them.

1. The Internet should reach every person by some means. (**Reach**)

Discussion: The **Reach** aspiration is generally uncontentious; almost every country has some form of it. The differences relate to granularity (household or kiosk?), bandwidth (how much?), and methods to achieve it. Developed countries focus on reaching the yet unserved population, usually rural areas. In developing countries, where most of the population may not have access, the focus may be on the wireless form of *Reach*, (next on the list) i.e., *Ubiquity*.¹

To achieve *Reach* in rural areas that lack sufficient revenue to justify private investment in infrastructure deployment, some nations have provided subsidy or tax incentives to build or maintain networks. In some cases the public sector has directly funded construction. In the United States, direct public investment has happened at multiple levels, from federal stimulus money² to municipal construction of residential broadband networks.

Measuring Progress: There are two aspects to measuring *Reach*: how many people or households are reached, and with what type of service? One can track trends in the number of unserved households using data from providers or independent surveys. The second aspect is more complex, as the definition of minimal acceptable service differs by country [24, Chapter 8, endnote 4, p. 156] and evolves with technology and the basket of applications the general public tends to use. In the U.S., the FCC recently redefined broadband access as having a minimum peak speed of 25 mb/s download and 4 mb/s upload, compared to 4 mb/s download and 1 mb/s upload [25]. This redefinition, not surprisingly, caused major changes in the determination of how many households had access to broadband access, and the degree of competition in the service. In contrast, the ITU [14], defines broadband as a service with at least 256 kb/s download, one percent of the FCC definition. Needless to say, while this definition may make the developing world feel better, it is hardly useful as a metric of quality in the developed world.

Defining and quantifying broadband access

With respect to residential broadband access, the FCC, the OECD and the ITU use *peak speed* to compare offerings across countries. However, a single number or two (e.g., download and upload speeds) can no longer sufficiently represent how well a household is served. In the future, other measures are likely to be equally significant: high traffic volume applications such as streaming video will make usage caps a concern, and voice and conferencing applications that stress real-time interaction will bring attention to metrics of delay and its variance (jitter). As services traditionally covered by PSTN regulations to ensure reliability and availability move onto packet-based technology, we will have to develop new operational definitions that capture meaningful constraints on the feasibility of such services on the public Internet. The definition of broadband access will not only be multi-dimensional, it may also be an evolving function of contemporary usage patterns. An increasingly important metric is the overall cap on data download per billing period. Today, some providers in the U.S. set usage caps of 300 GB/month, which would allow no more than 100 hours a month or about 3 hours a day of Netflix HD video for all devices in the household combined.³

¹The ITU [14] reports that by the end of 2014, 2.9B people, or 40% of the population, will be on line. There will be 6.9B cell phone subscriptions (perhaps 3.4B unique mobile phone users), and 1.9B smartphones.

²See the Broadband Technologies Opportunities Program, <http://www2.ntia.doc.gov>

³Netflix estimates that downloading HD video can consume up to 3 GB/hour. See <https://help.netflix.com/en/node/87>.

2. The Internet should be available to us everywhere. (**Ubiquity**)

Discussion: The *Reach* aspiration has a corollary in the age of mobile communications – every person should have access to the Internet approximately everywhere they go, implying the integration of high-performance wireless technology into the Internet.

Measuring Progress As with *Reach*, given an agreed definition of wireless service capability one can construct maps of coverage, based on data from providers, user surveys or field measurements. But the seamlessness of access is also hard to quantify, e.g., performance when moving across access points. Innovators need to consider variation in broadband service and device capability when developing new applications (covered by *Generality* and *Innovation* below).

3. The Internet should be used by more of the population. (**Uptake**)

Uptake is about getting more people to use the Internet services already available to them. As more essential social services migrate to the Internet to increase the efficiency of delivering them, non-users may be increasingly disadvantaged.

Discussion: This goal seems generally laudable, but invites the question as to whether policy intervention is appropriate to convert the non-users. The FCC’s survey taken for the National Broadband Plan [23] in 2009 found about 22% of Americans (U.S.) did not use the Internet, for a variety of reasons, including cost (36%), lack of skills (22%), and perception of insufficient value (19%). The National Broadband Plan called for addressing at least the first two of these barriers.⁴ The *Uptake* aspiration also captures the objective of enabling use of the Internet by people with physical limitations.

There is less consensus on *Uptake* as a societal aspiration, compared to others, e.g., *Reach*. Respondents to Pew’s 2010 survey on U.S. home broadband usage [46] split on the question of whether non-users were disadvantaged; the most significant concern for non-users related to finding job opportunities.

Measuring Progress: This aspiration seems amenable to measurement. In the U.S., the surveys by the Pew Internet and American Life project [8] provide a measure over time as to the percent of the population that uses the Internet. Their data shows a steady increase in uptake, from 61% in 2002 to 87% in 2014. As with *Reach*, this measure will change depending on how one defines use: whether the access is from the home, through a local public library, a shared smart phones or kiosks.

4. Cost should not be a barrier to the use of the Internet. (**Affordable**)

This goal is a component of *Uptake*, since cost is a major barrier cited by non-users today. The phrase “cost should not be a barrier...” could be mapped to the simpler phrase “the Internet should be low-cost”. However, we don’t expect wine to cost as little as tap water. Low cost might map to lower value, which might be counter-productive. Perhaps an emphasis on value would be more productive as a means to uptake. However, as the FCC study cited above revealed, 36% of non-users stated cost as a barrier, and thus many might retain lowering the cost barrier as a specific goal.

Discussion: In the legislation authorizing the U.S. Broadband Plan, one high-level objective was “a detailed strategy for achieving affordability of [broadband] and maximum utilization of broadband infrastructure and service by the public”.⁵ On the other hand, a significant fraction of Americans surveyed in 2010 did not believe that the spread of affordable broadband should be a government priority, and that fraction was higher among non-Internet users [46]!

⁴ “All Americans should have access to broadband service with sufficient capabilities, all should be able to afford broadband and all should have the opportunity to develop digital literacy skills to take advantage of broadband” [24, p. xiii].

⁵American Recovery and Reinvestment Act of 2009, Pub.L. 111-5,§6001(k)(2)(B) (2009)

Measuring Progress: The Census Bureau or other survey organizations could survey costs to consumers as a fraction of their income, and correlate it with willingness to pay over time to gauge progress. It is a complex landscape since many people willingly pay over over \$100/mo for smart phone service before they would pay half of that for home broadband, which may mean people value ubiquity more than performance. Another factor is that a certain level of *Reach* is critical for “reasonable civic participation”, especially as the PSTN goes away; affordability is most important for this level of service, a la lifeline phone service in 20th century [22]. *Universal service* regulatory framework has been another approach to policy intervention to manage affordability in high-cost rural areas.⁶

5. The Internet should evolve to match the pace and direction of the larger IT sector. (**Evolution**)

Discussion: The Internet was designed to connect computers together, and this aspiration captures the idea that as computing evolves, so should the Internet. In particular, as computing gets faster and cheaper (e.g., sensors), the net should get faster, and access to it cheaper.⁷ National Policy statements have often had a dual character [50]: getting some level of broadband to everyone (*Reach*) and pushing for deployment of a next generation or broadband (*Evolution*).⁸

Measuring Progress: This aspiration implies that the definition of broadband must evolve, which requires resolution of appropriate dimensions of the definition of minimum acceptable broadband service (see Box *Defining and quantifying broadband access*). Acknowledging this evolving usage, a National Academies report offered two definitions of broadband service performance: *baseline* and *forward-looking*, rooted in constraints on a user’s ability to run today’s applications or encourage development of new applications, respectively [45]. Given sufficient data on the popularity and behavior of current applications, one could establish and periodically update a quantitative definition against which to measure deployment of baseline broadband based on the average needs of the top 20 applications. For example, the basket of apps today, as opposed to a decade ago, would contain streaming video, and over time the kind of video might advance from SD video to HD video to 4k video.

6. The Internet should provide experiences that are sufficiently free of frustration, fears and unpleasant experiences that people are not deterred from using it. (**Trustworthy**)

Discussion: Many users hope, expect, or assume that their use of the Internet does not lead to their behavior and data being used against them. Users also need to be able to (but often can not) assess the safety of a given aspect of their Internet. Today, users fear side effects of Internet use, i.e., their activities being monitored, personal information used in unwelcome ways, e.g. behavioral profiling. Users fear identity theft, loss of passwords and credentials, malware corrupting their computer, losing digital or financial assets through compromised accounts. The threats are real [21, 18, 48], and include not just crimes but violations of norms of behavior, e.g., spam or offensive postings.

Standards organizations have developed various security mechanisms to mitigate the fundamentally insecure aspects of the network architecture underlying the Internet (lack of authentication in addressing, routing, or naming protocols). But each of them increases operational complexity and cost sufficiently as to deter network managers from choosing to invest in them. Many of them are also

⁶“Title II And The Return of the “Gore Tax”. Or, The Debate We Should Be Having”, <http://www.wetmachine.com/tales-of-the-sausage-factory/title-ii-and-the-return-of-the-gore-tax-or-the-debate-we-should-be-having/>

⁷For decades Moore’s law has characterized how (IT-based) demands on broadband infrastructure change much more rapidly than other sorts of infrastructure, such as the power grid. In 2013, the forecast growth of U.S. power consumption was .9% per year [2], while the forecast of Internet traffic growth was 23% per year [9].

⁸The U.S. FCC National Broadband Plan published in 2010 aspired to a 10-year milestone for *Reach* and *Evolution*: “100 million U.S. homes should have affordable access to actual download speeds of at least 100 Mbps and actual upload speeds of at least 50 Mbps by 2020.” [24, p. 9] (which admittedly now looks less impressive compared to Google Fiber’s gigabit-to-the-home deployments around the country since 2011).

incentive-misaligned, in that they help others more than they help the agent who deploys them, e.g., filtering traffic with forged source IP addresses from leaving one's network.

Measuring Progress: The Internet has such a large and varied attack surface (and that is just the *known* attack surface), so many factors influence it, and so many different approaches might mitigate different aspects of it, that the measurement challenge with this aspiration is particularly controversial. One could try to measure the rate of user harms, but their range and diversity is daunting, organizations are reluctant to share information that might reflect badly on them, and relevant metrics are subject to definitional challenges, e.g., at what point does behavioral profiling and sharing of profiles cross a line into harm? Researchers can also measure the rate of deployment of specific security mechanisms mentioned above [49, 20, 17, 41], but the large and dynamic landscape and attack surface makes it difficult to demonstrate what level of penetration of such technologies will yield a significantly more *Trustworthy* Internet. More radical proposals to re-engineer the Internet in a more *Trustworthy* direction, e.g., to ensure that every user's identity is robustly known at all times [37, 40] are highly controversial [10].

7. The Internet should not be an effective space for law-breakers. (**Lawful**)

Discussion: An Internet ecosystem that cannot regulate illegal activities will make it less *Trustworthy* and hinder *Innovation*, impeding the role of the Internet as a *General* and *Unified* platform. Generally, crime is a drag on the economy, and a symptom of erosion of civic character. But much of today's cybercrime is international, and there is significant variation in what different countries consider illegal, as well as inconsistent and in some jurisdictions poor tools to pursue lawless behavior internationally.

Measuring Progress: In its attempt to track Internet crime consistently over time, the Internet Crime Complaint Center found an 8.3% increase in reported losses between 2011 and 2012 [7]. But many crimes go unreported, or are reported to disjoint entities, and definitions of crime vary across the globe. Even child pornography is not consistently defined across jurisdictions [28] (an obvious inconsistency is the age of consent in different jurisdictions). Even within a jurisdiction, definitional debates arise, e.g., what crimes should count as identity theft? Identity theft statistics vary depending on whether one includes simple crimes such as fraudulent charges on a credit card [36, 35, 3]. A well-known definitional (and measurement) problem surrounds sharing of copyrighted materials, i.e., what counts as illegal piracy. Different interests are served by different metrics, e.g., number of downloads, imputed (but highly contested) financial losses to copyright holders, number of hosting servers, and defining the problem is at least as contentious as mitigating it.⁹

8. The Internet should not raise concerns about national security (**National security**)

Discussion: While small-scale intrusions, crimes and attacks may alarm and deter users, a large scale attack might disable large portions of the Internet, or critical systems that run over it. There are legitimate fears that the Internet could be a vector for an attack on other critical infrastructure, such as our power or water supply.

Measuring Progress: The Center for Strategic and International Studies maintains a public list of "cyber" events with national security implications [38]. The scope of the attack surface is unknown and always growing, but many such events are low probability at any given place and time, and determining which remedies will prevent or mitigate a given attack is not generally amenable to rigorous analysis. A few attacks have risen to the level of national security concerns, but they are hard to categorize. As

⁹Rob Reid's TED talk on copyright math provides a delightful example of this phenomenon. <http://blog.ted.com/2012/03/20/the-numbers-behind-the-copyright-math/>

with the *Trustworthy* aspiration, the lack of an overall security architecture for the Internet means that attacks are not only hard to categorize, but hard to align with defenses. As a result, there is continual tension regarding the best way to invest limited budgets in pursuit of security-related aspirations. Many operational security practices have been compared to putting band-aids on lots of individual wounds without an overall plan for patient care. Finally, of course, specific approaches to improving security may be in conflict, such as the tension with surveillance and privacy.

9. The Internet should support a wide range of services and applications. (**Generality**)

Discussion: The original Internet architecture embedded this aspiration, since it was designed to support a cooperative network of time-shared general-purpose computers. Benefits that follow from this aspiration include *Innovation* and *Uptake*, since the more value the Internet can deliver, the more users it will attract. The FCC recognized these benefits in the second of their principles (see box).

Measuring Progress: Although there is no obvious way to quantify progress toward *Generality*, the range of Internet applications demonstrates its success at this aspiration. But not all applications work well on the public Internet today – most problematic are those that require very high reliability and availability, e.g., remote surgery, remote control of autonomous vehicles. Does *Generality* imply the need to evolve to support such ambitious services, or should they be segregated to more controlled private networks? Regardless of what types of applications fall into the generally accepted basket of applications at any given time (see *Evolution*, defining the basket requires identifying measurable network characteristics, such as predictable bandwidth or delay required to enable such applications).

The Four Principles of the FCC

The FCC, in their considerations about network neutrality, first articulated a set of four principles [11], which they later reduced to rules. We are citing the original principles, because they better capture aspirations—the later formulation as rules somewhat obscures the aspirations by hiding them inside obligations that apply to ISPs.

[T]o ensure that broadband networks are widely deployed, open, affordable, and accessible to all consumers, the Commission adopts the following principles:

- To encourage broadband deployment and preserve and promote the open and interconnected nature of the public Internet, consumers are entitled to access the lawful Internet content of their choice.
- To encourage broadband deployment and preserve and promote the open and interconnected nature of the public Internet, consumers are entitled to run applications and use services of their choice, subject to the needs of law enforcement.
- To encourage broadband deployment and preserve and promote the open and interconnected nature of the public Internet, consumers are entitled to connect their choice of legal devices that do not harm the network.
- To encourage broadband deployment and preserve and promote the open and interconnected nature of the public Internet, consumers are entitled to competition among network providers, application and service providers, and content providers.

10. The Internet should be a platform for innovation, and thus a driver of the economy. **(Innovation)**

Discussion: As a key component of the IT space, the Internet has contributed to economic growth by promoting innovation and creativity, technology development, revolutionizing logistics and service industries, among other ecosystem disruptions. One interpretation of the *Innovation* goal is that the Internet must be “open”, a term used to capture many other aspirations. We believe this word is a red flag for muddy (or at least unfinished) thinking. *Open* is a word with strong positive connotations, useful as a rallying cry, but dangerously vague. We will try to refer to more specific objectives in the ill-defined basket called “open”: stability, specification (open standards), freedom from discrimination or from intellectual property restrictions. But even these aspirations are not absolute. For example, some forms of discrimination among uses of a platform can promote innovation, assuming clear and consistent rules [15]. In fact, many traffic discrimination scenarios may benefit users, the most obvious being protecting latency-sensitive traffic from the consequences of co-mingling with other traffic.

Measuring Progress: Measuring Innovation requires agreement on proxy metrics, such as venture capital investments or IPOs, which are only a rough proxy for successful innovation. The deeper and more vexing policy question that is poorly informed by theory or fact relates to causality: what underlying properties (e.g., *Generality*, *Uptake*, *Ubiquity*, *Evolution*, *Unblocked* or access to capital) are key drivers of Innovation?

11. Internet content should be accessible to all without blocking or censorship. **(Unblocked)**

Discussion: This aspiration implies that ISPs and other network operators must not block access to content. It also implies that those with power to compel the blocking or removal of content (e.g. governments) should refrain from doing so. Of course, many blocking and censorship actions taken by governments and private sector actors are legally justified. The FCC recognized this aspiration in the first of their four principles (see box).

This aspiration is not equivalent to the ideal that all information be free – some commercial content may require payment for access, and some content may be illegal to transmit. Rather than describing the relationship between content producers and users, this aspiration describes the role of the Internet in connecting them. Some would elaborate this aspiration to say that intermediate players such as access ISPs should not only be prohibited from blocking traffic of a certain type, but also be prohibited from exercising discrimination in their service. In 2015 the FCC re-affirmed this sub-goal: “A person engaged in the provision of broadband Internet access service ... shall not impair or degrade lawful Internet traffic on the basis of Internet content, application, or service, or use of a non-harmful device, subject to reasonable network management” [13].

Measuring Progress: Blocking of access can be estimated by measurement of user experience in different locations, e.g., [43], but such sampling methods are susceptible to selection bias and other distortions. Issues such as acceptable degrees of discrimination are more contentious and less amenable to quantitative metrics. For example, are paid peering and alleged “manufactured congestion” part of a debate about user access to content on equitable terms? The *Generality* and *Unblocked* aspirations bring a secondary definitional problem: to define what has been described as *reasonable network management* – code words for *reasonable level of discrimination*.

12. The consumer should have choices in their Internet experience. **(Choice)**

Discussion: Freedom of choice seems central to U.S. policy thinking – the term “choice” appears in three of the four FCC principles listed above, and “competition”, e.g., choice among providers is in the fourth principle. But like the word “open”, the word “choice” is ill-defined; it is often referred to as a proxy for some other aspiration, for which choice is either a means or a consequence. For example, in the first of the FCC principles, consumer choice was described (questionably) as a means to encourage deployment (Reach). Choice is also described as a positive consequence of a competitive market.¹⁰ The logic is that competition leads to choice, and consumers will choose wisely, so competition disciplines providers toward offering products and services that consumers prefer.

But choice presents tension with other aspirations. Given choice, consumers might pick a network that was more regulated, curated, and/or more stable than today’s Internet (e.g., Apple’s app ecosystem), an outcome aligned with the *Trustworthy* aspiration, but less aligned with *Innovation* and *Generality*. Or a consumer might prefer a network that is totally free of accountability and thus rampant with piracy, which governments and rights-holders would find unacceptable and constrain by other means. Or a consumer might prefer a network that is zero cost but limits the selection of applications, e.g., Facebook Zero.

Measuring Progress: There are many possible sorts of *Choice* in the Internet ecosystem, e.g., of broadband access providers, or of software in an app store. Each requires different approaches to measurement. The NTIA and FCC created a national broadband map to measure how many choices of broadband providers are available across the United States, although the measurement method is asking providers where they serve customers.¹¹ Analyzing the level of *Choice* in the Apple app store may be challenged by the lack of visibility into which apps were not allowed into the store.

13. The Internet should serve as a mechanism for the distribution of wealth among sectors and countries. **(Redistribution)**

Discussion: Thousands of independent firms combine to provide the Internet ecosystem, each typically striving to be profitable and competitive, and the flow of money is integral to its structure. Contentious arguments about redistribution of capital, either to cross-subsidize from more profitable to less profitable sectors of the ecosystem (e.g., commercial to residential, urban to rural), or from more developed to less developed countries, have long characterized telecommunication policy debates and legislation. A recent vivid example is the ongoing tension as to whether high-volume (video) content providers (and transit providers who serve them) should contribute to the costs of the infrastructure.¹² This tension has led to debates on whether access providers should be able to charge content and/or transit providers for access to their customers, and more generally whether interconnection arrangements should be left to industry or regulated to more fairly allocate money flows according to who induces versus carries load on the infrastructure [42].

In addition to cross-subsidizing across industry sectors within one country, governments also aspire to tap into international revenue flows in the Internet ecosystem. The developing world used to bring in substantial hard-currency payments from settlement fees associated with telephone calls into their countries, a revenue source that is diminishing as communication moves onto the Internet. The global controversy about the role of the ITU in regulating international Internet interconnection reflects a motivation by many parties, including governments, to change the current norms for payment for the global flow of Internet traffic to be closer to historical telephony-based norms [32, 30].

¹⁰ “Competition provides the consumer the benefits of choice, better service and lower prices.” [24, p. 36]

¹¹ <http://www.broadbandmap.gov/>

¹² Recent disputes between Level 3 and Comcast [47, 19] were in part a response to the consequences of Level 3 acting as a distributor of content from a dominant provider of video, Netflix.

Measuring Progress: At the domestic level, a regulator could compel the reporting of interconnection agreements and payment arrangements, if it were deemed important. In France, such reporting has been mandated to improve transparency and identify potential abuses of market power [1].

14. The Internet (and Internet technology) should become a unified technology platform for communication. **(Unification)**

Discussion: IP network operators tend to share this aspiration as a source of cost savings, or more generally to maximize return on capital investment. Historically, telephone calls, cable television, and industrial control networks each used independent specialized legacy communications infrastructure. Today, Internet technology can provide a unified platform for any important communications application. Many ISPs today run a “fully converged” IP backbone for economic efficiency, and would resist any regulatory intervention that would cause them to separate infrastructures they have unified or plan to unify. The *Unification* aspiration differs from *Generality*; the latter is about supporting a wide range of services, while *Unification* reflects the economic efficiency of discontinuing other platforms and associated investments. Note that although *Unification* reduces overall costs in some areas, it also may increase costs in others, since the unified platform must support the performance of the most demanding application in each quality of service. For example, a unified IP-based platform must be reliable enough to support critical phone service, have the capacity to carry large bundles of television channels, etc. Unification may also increase risks to *National Security*, since a less diverse infrastructure has higher potential for systemic failure [44, 29], although this fear is debated [27].

Measuring Progress: One could track the ratio of capital investment in Internet vs. other communications infrastructure—this sort of data is tracked by investment analysts, although it is sometimes hard to find in public documents. But perhaps there are only a few actors that would be interested in tracking this sort of measure, since *Unification* may be of interest only to a few actors.

15. For any region of the globe, the behavior of the Internet should be consistent with and reflect region’s core cultural/political values. **(Local values)**

Discussion: Because values differ so much across the global, this aspiration arguably implies some partitioning of the global Internet, at least in terms of user experience. In the U.S., the relevant values would include First Amendment freedoms (speech, association/ assembly, religion, press, petition), but with limitations on certain types of speech and expression. Other regions value more highly an Internet that safeguards social structure or regime stability. Debate about the desirability of this aspiration is a critical aspect of international policy development.

Measuring Progress: One could track incidents where countries have objected to some aspect of the Internet and its applications (see the *Unblocked* aspiration). One could ask global providers of the Internet experience (e.g. Google search, Facebook, or Youtube) how much tailoring they do to their content as it enters different regions, or one could ask about the levels of expenditures on localization, e.g., language translation, local regulatory compliance.

16. The Internet should promote universal social and political values. **(Universal values)**

Discussion: This aspiration implies the existence of universal values, such as those articulated in the United Nations’ charter or the Universal Declaration of Human Rights (UDHR) [16], namely peace, freedom, social progress, equal rights and human dignity [4]. Although such values are by no means universally accepted, we can imagine translating these values into the Internet (as Barlow passionately did back in 1996 [34]) to yield aspirations such as: for the Internet

- Governments should not restrict their citizens’ ability to interact with people outside their borders, as long as there is no harm to others. The physical world analogue is universal human right of freedom of movement, either within the state, or outside the state with right of return, or to leave permanently [16].
- People should be allowed to communicate directly with citizens of other states and they should be able to hear our message without interference from their government; this is a functional implementation of the global right to free (virtual) assembly and speech.
- The Internet should enable and enhance global interactions (as long as they are not criminal) to foster the exchange of ideas. (But since “criminal” has nation-specific definitions, this aspiration would require a liberal interpretation of acceptable interaction across the globe.)
- The Internet should serve as a forum for an international “marketplace of ideas”.

Perhaps as a cyber-manifestation of American exceptionalism, the U.S. has expressed the view that the technology of cyberspace can be a means to export rather U.S.-centric values we hold as universal, i.e., to change other societies to be more like us.¹³ Other nations take a more inward-facing view of what they want the Internet to do for them.

Measuring Progress: One could track the number of countries that agree to some set of norms about Internet behavior. The aspiration that citizens be able to communicate globally does not imply that *all* of the Internet experience be globally available in a consistent form, only that there is an effective basis for global communication among people, i.e., some tools for discourse and exchange. One could estimate the global penetration of some dominant application or service for communication, such as Facebook or Twitter, and derive and track a per-service “globality index” over time that captures the effect of certain countries blocking a given service.

3 Sorting them out: attributes and interactions

Cataloging these sixteen diverse aspirations reveals insights about barriers to achieving them, including disagreement about their desirability, incompatibilities and inconsistencies among them, and the cost to achieve them. Another impediment to progress is the need for coordinated and aligned actions by many players within the ecosystem who are not inherently aligned with each other or with any given aspiration. The related tension between the public and private sectors poses a daunting challenge.

Some aspirations are more controversial than others, and some, e.g., *Reach* are more amenable to quantification and measurement, although details of how to measure or interpret may also be controversial. But many aspirations are abstract desires for an outcome rather than an approach to achieving or measuring it, or operational definition of its achievement. Each aspiration merits a more detailed and critical assessment, but we also need a more integrated view. How can we reason about this list?

We take three cuts at a higher-level view. First we sort the aspirations along several dimensions: geographic scope (domestic vs. international) and which actors bear the primary role in achieving the aspiration. Although not all aspirations fit neatly into these categories, the process of classifying them may sharpen our consideration of them. We then consider barriers to progress – why have we not achieved these aspirations? We will then present and discuss an annotated matrix reflecting observable or likely interactions between pairs of aspirations that might compete for resources or conceptually conflict.

¹³ *Two billion people are now online, nearly a third of humankind. We hail from every corner of the world, live under every form of government, and subscribe to every system of beliefs. And increasingly, we are turning to the Internet to conduct important aspects of our lives... the freedoms of expression, assembly, and association online comprise what I’ve called the freedom to connect. The United States supports this freedom for people everywhere, and we have called on other nations to do the same. Because we want people to have the chance to exercise this freedom.” – Hillary Clinton, February 2011 [31]*

3.1 Geographic scope: domestic or international

One way to sort the aspirations is to consider whether an aspiration can be addressed as a domestic issue, or whether it requires (likely much more challenging and perhaps impossible) international coordination or cooperation.

- The capital-intensive cluster of *Reach*, *Ubiquity* and *Affordability* are domestic in scope. Countries take different approaches with different time scales, largely without cross-border consequences. Countries also prioritize (and define) *Choice* differently, and use different approaches to *Uptake*, *Evolution* and *Unblocked*. All of these aspirations have at least largely domestic components.
- Aspirations that address the overall character of the Internet – *Generality*, *Unblocked* – are ideally addressed consistently across the globe¹⁴, but can be reduced to domestic issues if necessary. China’s blocking of Facebook need not change the Western experience of using Facebook.
- In one respect *Lawful* is inherently domestic: regulation and law (and all law enforcement) are local. On the other hand, the *Trustworthy* and *Lawful* aspirations are impossible to address as solely domestic issues because so much cybercrime today is cross-border. Countries do what they can domestically, but improved international cooperation is the only viable long-term approach, even if a uniform international response is unlikely.
- Similarly, *National security* is an inherently domestic concept, although mutually trusting allies generally build security-related peering agreements. But attackers will move to less secure regimes where they are less likely to be prosecuted, making *National Security* an inherently global concern.
- *Redistribution* of capital has both international (ITU settlement translated to the Internet) and domestic (content vs access provider payments to resolve congested interconnects) dimensions.
- The *Local Values* aspiration is clearly domestic, or perhaps at most regional. It relates to the *Lawful* and *Trustworthy* aspirations in that activities that are normatively acceptable in one regime may be unacceptable in others.
- The tension between *Local Values* and *Universal Values* reflects the tension between domestic and global responses to shaping the Internet experience. The latter is an optimistic call for a global agreement of some sort on acceptable behavior across the nations of the world.

There is actually a third category of scope, cutting across the spectrum of domestic and international, which we might call *trans-national*. Aspirations in this category have the character that governments are seen trying to influence domestic behavior in other countries to achieve them. The aspiration of *Universal Values* is the most obvious example, where as we discussed above, the U.S. is trying to export its values of open access and *Unblocked* to the rest of the world.

In summary, many of these aspirations can be addressed, at least to some extent, as domestic matters, and the complexity of international collaboration suggests that nations will seek domestic approaches whenever possible. As different nations move forward, perhaps using different approaches and with different priorities, we are likely to see increasing diversity in the Internet experience across the globe.

3.2 What layer is responsible?

We can also sort the aspirations according to which class of actor is most central to achieving each of them. The layered model of the Internet is a useful way to sort out the actors.

¹⁴ “One world. One Internet.” – <http://www.icann.org/en/about/planning/strategic/draft-strategic-plan-2013-2016-clean-24sep12-en.pdf>

The physical layer *Reach* and *Ubiquity* depend on construction of physical infrastructure, and thus investment of capital by the owners of that infrastructure. In the United States, many Internet Service Providers are also facilities owners, and due to recent evolution of the regulatory framework, such facilities owners do not allow other ISPs to provide Internet access over the same facilities. In other parts of the world, many ISPs compete on top of physical infrastructure owned by one firm, due to regulatory requirements for the facilities owners to share physical infrastructure. Sometimes physical infrastructure is explicitly constructed (and regulated) as an open platform on which retail providers can compete. One aspect of *Choice* depends on the physical layer, i.e., *facilities-based competition* depends on multiple physical paths to reach the customer. *Evolution* also depends on investment at this layer.

The Internet layer Many of our aspirations depend on the behavior of actors at this layer. This layer shapes *Evolution*, *Generality*, *Unblocked*, *Innovation*, *Choice*, *Affordable*, *Redistribution*, and *Unification*.

Cross layer aspirations Some of the aspirations do not fit neatly into one primary layer. *Uptake* depends on actions across all the layers to make the service both available and useful. Similarly, the aspirations of *Trustworthy*, *Lawful*, *National security* and *Local values* depend both on the lower layers (actions taken by ISPs and providers of physical assets) and actions at higher layers where applications are defined, and how information is stored, used, shared, linked, sold, etc.

Higher layers The aspiration of *Universal values* (as defined in Section 2, which is not actually a universally held aspiration) does not map well onto any layer. It depends to some extent on ISPs (and the state) maintaining an *Unblocked* infrastructure, as opposed to imposing restrictive limitations on user behavior. But assuming that users of the world have access to common applications, it is up to the users to find and partake of the shared value in these applications.

3.3 Interactions among aspirations

Many of these aspirations are interdependent: some align and amplify others; some interfere with others; and some are in conflict – we cannot have them all. Compromise will be fundamental to progress.

One can cluster the interactions among aspirations along three major tensions: investment (levels and priorities of investment), which collectively contend with *Affordable*; contentions between freedom and security (e.g., between *Unblocked* and *Trustworthy*); and tensions among the various aspirations that make the Internet more or less valuable to its users. Table 1 summarizes our attempt to relate these aspirations to each other. The influence of each aspiration (rows) on others (columns) is captured with some attribute, according to whether they *promote each other*, *conflict with each other*, or *compete for the same budget (priority)*, or *could potentially promote or conflict with each other*, labeled +, - **P**, ?, respectively. These attributions are tentative and arguable – we hope to elicit structured argument and debate that can advance our collective understanding of this space. Below we offer some narrative interpretations of this matrix.

- *Reach, Ubiquity, Evolution*: These three aspirations require capital for infrastructure. With sufficient capital, one can achieve all three, but capital is never infinite, so these aspirations will compete for priority (marked with a "P" in the matrix). Private-sector infrastructure providers set such priorities as they decide how much to invest in building out residential wireline access vs. mobile access. Both AT&T and Verizon [6, 5] have suspended their construction of advanced wireline access infrastructure (*Reach*) in favor of investment in mobile (*Ubiquity*). These aspirations also promote *Innovation*: the more potential customers and customer diversity, the higher potential return on developing new products and services.
- *Uptake*: *Uptake* promotes several other aspirations: *Reach, Ubiquity, Evolution, Affordable, Innovation* and *Choice*. More users bring more revenues into a system with substantial fixed costs, providing more capital to support these other aspirations. Increased uptake increases the incentive for infrastructure providers to invest in *Reach, Ubiquity and Evolution*. All parties, including application and service

	Reach	Ubiquity	Evolution	Uptake	Affordable	Trustworthy	Lawful	National security	Innovation	Generality	Unblocked	Choice	Redistribution	Unification	Local values	Universal values
Reach		P	P		-				+			-				
Ubiquity	P		P		-				+							
Evolution	P	P			-				+							
Uptake	+	+	+		+				+			+				
Affordable	-	-	-	+		-	-	-	?	?	-	-				
Trustworthy				+	-		-	+	+	-?	-					-
Lawful				+	-	-?		+	+	-?	-					-
National security					-	+	+									
Innovation				+		-										
Generality									+							
Unblocked	-	-	-	?	-	-			+						-	+
Choice	-			+												
Redistribution	+/-	+/-	+/-	+/-	+/-				-		-					
Unification	+	+	+		+			-								
Local values				+		+			+		?					?
Universal values															?	

Table 1: Our first attempt to depict interactions and interdependence among aspirations. Narrative description in Section 3. The influence of each aspiration (rows) on others (columns) is captured with some attribute: promote each other, conflict with each other, compete for budget (priority), or could potentially promote or conflict with each other, labeled +, -, P, ?, respectively.

developers, benefit from increased incentive for *Innovation*, and a higher uptake rate in a region may attract more providers into the market, increasing *Choice*.

- **Affordable:** To first order, this aspiration is in tension with other capital-intensive aspirations, and with *Redistribution*, because driving down cost removes capital from the ecosystem that might otherwise be available for investment in infrastructure expansion (*Reach* and *Ubiquity*), security (*Trustworthy* and *Evolution*) or subsidizing other sectors, regions, or uses (*Redistribution*). *Affordability* might also require market consolidation (fewer providers) and reduced *Choice*. In order to generate income (which might improve *Affordability* elsewhere in the ecosystem), ISPs might engage in practices (e.g. violation of privacy for targeted advertising, discrimination in offering service) that detract from (or even conflict with) the *Trustworthy* and *Unblocked* aspirations (marked with an “-” in the matrix.)
- **Trustworthy, Lawful:** These aspirations likely promote *Uptake* (since more users may be attracted to a more *Trustworthy* and *Lawful* system), unless a significant proportion of users are attracted to un-*Lawful* activities. Making the system more *Trustworthy* will probably imply greater blocking of suspect providers of services and content, so *Trustworthy* and *Lawful* may present tension with *Unblocked*, *Generality*, and *Innovation*. These aspirations may increase costs, impeding *Affordability*. They have a complex relationship with *Local* and *Universal Values*, discussed below.

- National security: Benefits of this aspiration do not visibly drive *Uptake*. It adds cost, which conflicts with making Internet service *Affordable*, but might stimulate *Innovation* and *Unification*, by allowing more critical services to use the infrastructure. On the other hand, critical infrastructure security might require such high investment that the most cost-effective approach is to create a separate infrastructure for security-sensitive traffic, preventing *Unification*.
- Innovation: This aspiration promotes *Uptake*, as new experiences attract new users. It can detract from *Trustworthy*, because new applications are often less secure and robust. Innovation at the infrastructure level can directly drive *Reach*, *Ubiquity* and *Evolution*, but innovation at the application layer can drive these only indirectly by driving *Uptake*. Consumers and governments may have different motivations with respect to this aspiration. Consumers may be excited by new applications and services, while governments may care more about the health of the economy, and advocate for the Internet as a vehicle for economic growth.¹⁵
- Generality: The primary consequence of Generality is to drive *Innovation*, *Choice* (at the application layer) and *Uptake*.
- Unblocked: The consequences of *Unblocked* are arguable. An *Unblocked* network promotes *Innovation*, and could promote or discourage *Uptake* depending on its effect on *Trustworthiness*. A network without blocking or discrimination might limit ISP revenue opportunities, impeding *Reach*, *Ubiquity*, *Evolution* and *Affordability*.
- Choice: Choice might drive *Uptake*, if the market offers more diverse and low-cost products, but has a complex and unclear causal relationship with other aspirations. The *Choice* (of broadband providers) and *Reach* aspirations will compete for capital; for instance, it is unrealistic to expect more than one build-out of facilities in rural areas [12, p. 38],
- Redistribution: *Redistribution* shifts money from one set of actors to another. Money flowing into the developing world might benefit *Reach*, *Ubiquity* and *Evolution* there, and consequently *Uptake*. The reverse might be true in the region from which money is shifted. Subsidies from one sector (e.g., content) to another (e.g., infrastructure) would impede *Innovation* at the source of the subsidy, and promote it at the destination of the subsidy, assuming capital is directed toward *Innovation*. Such subsidies could also lead to more blocking (impeding the *Unblocked* aspiration), if content providers refuse to have their content delivered to high-cost providers or regimes.
- Unification: *Unification* presumptively drives down cost, and thus to first order promotes capital-intensive aspirations. It might make *National Security* worse, due to the mono-culture effect.
- Local values: Attention to this aspiration might drive *Uptake* in different regions. It might lead to a more localized and familiar, and thus more *Trustworthy* experience. It might stimulate regional *Innovation*. In general it probably conflicts with the *Unblocked* and *Universal Values* aspirations, as we discuss further below.
- Universal values: Implementation of *Local Values* may directly conflict with what we have described as *Universal values*, although they are complementary in some regions.

Table 1 reveals three clusters of interaction. First, there is the inevitable tradeoff among the capital-intensive cluster of aspirations (*Reach*, *Evolution*, *Ubiquity*), which we indicated with a "P" in the table, and which compete with the cost-reducing *Affordable*. Second, there is a positive feedback loop where *Innovation* could drive *Uptake* with a positive effect on the capital-intensive cluster, which could in turn drive *Innovation*. Third, there is the conflict between *Unblocked* and *Universal values*, which favor unregulated flow of content and communication across national boundaries, and *Trustworthy*, *Lawful*, *National security*, and (in some

¹⁵The word "innovation" occurs 260 times in the FCC National Broadband Plan, lauded as an American strength and a driver of the economy.

cases) *Local Values*, which favor more regulation and control. *Trustworthy* and *Lawful* operation drives up costs for operators, but might enhance *Uptake* and thus revenues. *Innovation* and *Generality* might drive up costs for operators, as they invest in enhancing the platform, but limits on discrimination to promote the *Unblocked* aspiration might preclude certain options for monetizing these enhancements. On the other hand, *Innovation* that allows for multiple service qualities might promote *Uptake* by those who need better than best-effort service, and the associated pricing premiums might allow for a more *Affordable* best-effort service. The interplay among aspirations created by uses and sources of capital is remarkably complex, and itself an evolving set of dynamics.

Policy-makers may focus on one aspiration while acknowledging tensions with others. Liberty vs. security, transparency vs. confidentiality, free expression vs. tolerance and civility have been societal aspirations in conflict, especially in a global context, long before the Internet existed.

4 Toward the future: means and measurement

The private sector is not going to drive toward a specific set of societal aspirations; corporations pursue profits, not a globally accepted vision of the future. If we are comfortable with the Internet that results from whatever the private sector chooses to construct and operate, then our job is to sit back and see what it is. But many social goals require governments, philanthropy, public interest groups, academic researchers and others to lead the charge. These civic actors have their own set of complexities, organizational limitations, and misaligned interests. In this section we review a list of tools and approaches governments or other actors use to overcome barriers to achieving the aspirations. We focus first on domestic means and measurement, since governments can impose or incent mechanisms for supporting specific aspirations and measurement of progress toward them.

Governments have several tools at their disposal to pursue these aspirations, including law and regulation, funding of R&D, direct investment in the Internet, encouragement of competition, participation in standards bodies, and so on. However, these tools are of different utility depending on which set of actors in the ecosystem are best positioned to pursue the aspiration.

4.1 Shaping the physical layer

As we noted above, some aspirations depend on capital investments in the physical layer: *Reach*, *Ubiquity*, *Evolution* and aspects of *Choice*. Governments have taken several approaches to shape this layer, but a primary tool has been to depend on the power of competition.

Competition at the access level: Broadband access competition in the Internet takes many forms. Under the right conditions, multiple providers may construct separate connections to the homes (e.g., fiber and cable), which leads to a capital-intensive form of competition called facilities-based competition. Today, in parts of the U.S., competing firms have deployed cable (hybrid fiber/coax or HFC) and fiber to millions of homes. This competition drove advances in performance over time (*Evolution*), but also drove up costs – it is not economically sustainable to support multiple facilities providers in under-served regions. Facilities-based competition is now faltering in the U.S., leaving access in many locations as a natural monopoly (again) with its potential harms to consumers (pursuit of monopoly rents). Given U.S. laws, this development will require a total rethinking of how to use law and regulation to guide the Internet toward desired outcomes. Other countries have similar concerns, although perhaps starting from a different basis in law and actual deployment.

Using regulation to create competition: In many countries across the globe, the approach taken to regulate the capital-intensive broadband access facilities providers is mandatory unbundling of physical facilities or services, so that retail competition can arise over a common physical platform. This pattern of competition might arise as a result of cooperation between competitors, but often arises through a regulatory requirement that the owner of a facility (copper wire, fiber, etc.) allow competitors to use it at a regulated

price. This practice, widely adopted around the world [50], was abandoned in the U.S. Mandatory unbundling does promote some aspirations, including driving down retail prices (*Affordable*), but it also limits the incentive of the owner of the facilities to invest in upgrades (since the upgrades are equally available to competitors), impeding *Evolution*.

Misplaced faith in competition?

The U.S. and many other Western countries have great faith in the power of competition to drive the market toward preferred outcomes. But competition cannot guarantee a specific outcome in the marketplace. It is fuzzy thinking to argue that competition will achieve any particular aspiration, and it is certainly unproven that regulation that attempts to mimic the consequences of competition will do so. Yet this presumption that competition will bring specific desired outcomes is widespread. The Telecomm Act of 1996 begins:

An Act to promote competition and reduce regulation in order to secure lower prices and higher quality services for American telecommunications consumers and encourage the rapid deployment of new telecommunications technologies.

The U.S. National Broadband Plan takes a similar approach:

Instead of choosing a specific path for broadband in America, this plan describes actions government should take to encourage more private innovation and investment. The policies and actions recommended in this plan fall into three categories: fostering innovation and competition in networks, devices and applications; redirecting assets that government controls or influences in order to spur investment and inclusion; and optimizing the use of broadband to help achieve national priorities. [24, p. 5].

This faith in competition is also embedded in our general intuition. John Gilmore wrote:

Any ISP that tried to restrict what its customers did, or to discriminate against its customers' traffic, would lose those customers to a competing ISP. AOL, MCI, Compuserve were all forced to open their walled gardens that only let you talk to their other customers.[33]

The trouble with this last argument is that a walled garden is an extreme form of discrimination. Customers may be far more receptive to less extreme and more beneficial forms of discrimination.

Direct (e.g. public sector) investment in infrastructure: An alternative to relying on (or regulating) the private sector providers of infrastructure is to use public investment to shape the Internet, e.g., municipal build-out of fiber. This fragmentary approach allows for context-specific experimentation [39]. However, many countries have strong fiscal and political pressures to minimize the role of government in providing telecommunications infrastructure and services, and facilities construction requires considerable levels of investment.¹⁶ Evaluation of public sector investment requires two perspectives: long-term financial and operational viability in an industry where outcomes are highly variable; and how effectively public sector investment achieves a set of aspirations. For example, if public sector investment allows consumer-driven competition at the IP layer, is that competition promoting any other aspirations?

Incentives: While regulation can try to prevent undesirable behavior, it is hard for regulation to compel investment, and these aspirations require investment. Structural separation can create retail competition at

¹⁶The FCC has estimated that to reach the last 7M unserved (and not profitable to serve) households will require \$15.3B in capex and \$17.1B opex, (~\$4.6k per household) and would require a subsidy of \$24B to compensate a provider for the estimated revenue shortfall over a presumed 20 year lifetime of the infrastructure[24, Section 8.1, p.136].

higher layers, but does not necessarily stimulate investment at the physical layer. There are methods that governments can use to stimulate investment, including tax credits, regulated return on investments, and so on, but these are in disrepute at the present time, as they seem to take us back to the days of the highly regulated telephone monopoly.

4.2 Shaping the Internet layer

The providers of the Internet layer have a powerful influence over many of the aspirations, including *Evolution, Generality, Unblocked, Innovation, Choice, Affordable, Redistribution, and Unification*. This layer also plays an important role in *Uptake, Trustworthy, Lawful, National security* and *Local values*.

At the present time, the emphasis, at least in the U.S., has been to focus on regulation to prevent behavior that adversely affects *Generality, Unblocked, Innovation, Choice, and Redistribution*, in particular, *unreasonable discrimination*. The assumption embedded in such a policy is that a neutral platform that treats all higher-level services equally satisfies the goal of *Generality* and *Unblocked*, and thus the goals of *Innovation* and *Choice*. Regulation of interconnection will serve to prevent abusive aspects of *Redistribution*.

Neutrality regulation: We sidestep here the legal debates as to whether the justification for neutrality regulation arises from a logic built on competition policy (an argument that neutrality regulation is attempting to induce a scenario that would arise naturally through increased competition), or whether the justification arises more generally from the authority of the government to shape important social infrastructure (essential facilities doctrine). In the U.S., regulatory attempts to enforce such non-discrimination have twice failed due to constraints on the FCC's ability to regulate the behavior of ISPs. In early 2015, the FCC put forward a third attempt, in which they reclassify Internet access as a telecommunications service, rather than as an information service. It remains to be seen how this attempt will survive in the courts. These legal tangles have to some extent distracted the debate away from more fundamental questions, such as the persistent challenge of defining the term *network neutrality* or its successor term, *reasonable network management*, both of which are contentious and lacking in bright-line precision. One option is to let such a line emerge through ex post rulings by the regulator, a sort of administrative case law approach. This approach gives tremendous discretion to the regulator, lacks an overarching precedent, and most seriously, requires time and resources to fight powerful ISPs who benefit from (and thus lobby for) the ability to discriminate.

Incentives and protection: The government can try to shape behavior by direct regulation that prohibits or mandates certain behavior, but it can also proceed by the development and promulgation of "best practice" documents that describe normatively preferred behavior. Such documents, which have less authority than regulation, encourage certain behaviors by providing a shield of protection against complaints about those behaviors. Governments can offer other (e.g., tax or procurement) incentives that encourage certain behavior in the public interest.

4.3 Shaping the higher layers

The higher layers, associated with applications and information, are populated by many more actors than the lower Internet and physical layers. Some providers are huge (e.g., Google); some are tiny (the creator of an app for a mobile device). These actors play an important role with respect to many aspirations, including *Uptake, Trustworthy, Lawful, National security* and *Local values*. However, these layers tend to receive less attention from governments and advocates than the lower layers.

Competition among applications and services: One reason for lesser regulatory attention to these layers is the arguably healthy and vigorous competition at this layer (although some networked applications are also arguably emerging as natural monopolies, e.g., search, auction sites) especially with web-based services, and (as noted above) there may be excessive faith in the power of competition to yield generally beneficial outcomes. But one should ask critically how much this competition, and the *Choice* it enables, advances

other aspirations. Given the prevalence of reported data breaches and cyber-attacks, the widespread concern over consumer profiling and misuse of personal information, and overall weak security, either competition is not breeding *Trustworthy* choices for consumers, or consumers do not select *Trustworthy* alternatives, perhaps because they cannot judge (or do not prioritize) security issues.

Regulation of content: The aspiration of *Unblocked*, and its tension with the aspirations of *Trustworthy* and *Lawful*, is a area of active tussle. In the U.S., government regulation of content is limited, due to concerns about First Amendment rights and freedom of speech. However, the government has passed laws to empower private sector actors to protect themselves, e.g., the Digital Millennium Copyright Act allows content rights-holders to demand take-down of content they own. Other countries who place less value on freedom of speech have orchestrated sophisticated methods to identify and remove unacceptable content, and view these actions as aligned with the aspirations of *Trustworthy* and *Lawful*, and perhaps with a higher-level goal of *regime stability*.

The U.S. government has passed laws to limit specific forms of unwelcome behavior, for example the CanSpam Act, which, due to First Amendment concerns, cannot ban spam but only regulate it. The private sector, not limited by the U.S. Constitution, has more flexibility in attempts to directly constrain content-related unwelcome behavior, and anti-abuse organizations such as the Messaging, Malware and Mobile Anti-Abuse Working Group (M3AAWG) have a number of initiatives that align with the *Trustworthy* aspiration. Organizations like M3AAWG also operate internationally, in contrast to actions by individual governments that are necessarily domestic.

Incentives and protection: Just as with the Internet layer, the government can try to shape behavior by the development and promulgation of “best practice” documents. For example, the FTC released a set of recommendations concerning privacy [26]. Again, best practice documents may be easier to promulgate than formal regulations that impose mandatory obligations.

5 International means and measurement

The previous approaches are largely domestic: while their consequences may spill over into other countries, their applicability is mostly to aspirations with a domestic scope. We can imagine means and measurement approaches with an inherently international scope: development of new technology, standards, treaties, research efforts, cross-border organizations. For example, in pursuit of what it considers to be *Universal Values*, the U.S. government has funded the development of software to bypass censorship and filtering, which it makes available to activists in other countries. Although a domestic activity, its goal is international impact, a scope we earlier called *trans-national*.

6 Next steps

In this paper we have focused on articulating and describing interactions among a set of aspirations that we have compiled from examining public discourse. We believe the next step is to try to articulate a research agenda that will promote clearer definition of the aspirations, and how to define and implement measurements to track progress. Some issues have a strong technical component, such as defining *broadband*. But we believe the (network and policy) research community should carefully look at each aspiration and consider what challenges it raises, what new technology might help promote it (or its measurement), and whether we can create novel means to reduce conflict among aspirations. We are confident the process will be interdisciplinary, and require among other tough challenges, rethinking several relevant bodies of law. We also believe there is merit to revisit this list of aspirations from time to time, considering our fears as well as our hopes.

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