

# Workshop on Internet Economics (WIE2016) Final Report

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## Keywords

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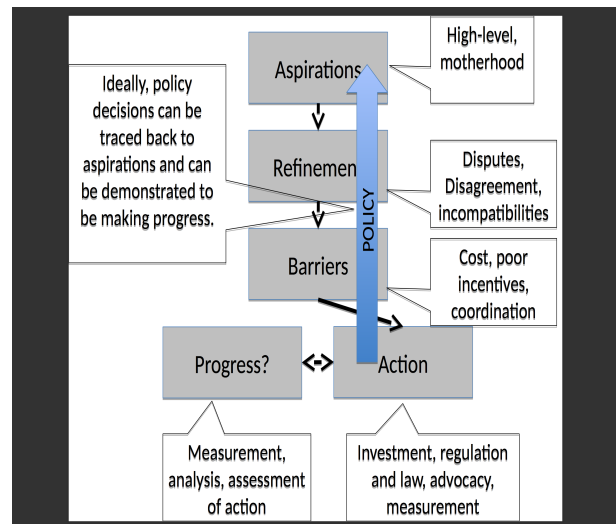
## ABSTRACT

On December 8-9 2016, CAIDA hosted the 7th interdisciplinary Workshop on Internet Economics (WIE) at the UC San Diego's Supercomputer Center. This workshop series provides a forum for researchers, Internet facilities and service providers, technologists, economists, theorists, policy makers, and other stakeholders to inform current and emerging regulatory and policy debates. This year we first returned to the list of aspirations we surveyed at the 2014 workshop, and described the challenges of mapping them to actions and measurable progress. We then reviewed evolutionary shifts in traffic, topology, business, and regulatory models, and (our best understanding of) the economics of the ecosystem. These discussions inspired an extended thought experiment for the second day of the workshop: outlining a new telecommunications legislative framework, including proposing a set of goals and scope of such regulation, and minimal list of sections required to pursue and measure progress toward those goals. The format was a series of focused sessions, where presenters prepared 10-minute talks on relevant issues, followed by in-depth discussions. This report highlights the discussions and presents relevant open research questions identified by participants.<sup>1</sup>

## 1. GROUNDING THE CONVERSATION IN POLICY GOALS (AND FEARS)

We face an interesting decade with respect to telecommunications regulation. After a decade of deregulatory administrative and judicial action, in 2015 the FCC acknowledged that the infrastructure and its usage had evolved sufficiently to justify reclassification of broadband as a telecommunications service, although emphasizing its intent to forbear from most associated regulatory apparatus, at its own discretion. The Trump administration has triggered the question of whether to reverse this decision, and (in the extreme) abolish the FCC or severely limit its authority [20]. At the same time, many policy thinkers, from academia to government to

<sup>1</sup>Slides presented and this report are available at <http://www.caida.org/workshops/wie/1612/>.



industry, now consider the development of new telecommunications legislation services inevitable, and if there is any chance of informing it with empirical data, now is the time to begin informing debate of that effort [25, 10]. Given the precarious state of the policies developed during the Obama administration's FCC, we found the prospect of "starting from scratch" with Internet/telecommunications policy to serve as background inspiration throughout the workshop.

David Clark grounded the meeting by reviewing the list of aspirations for the future of the Internet discussed at the 2014 WIE workshop [9, 7]. One motivation for compiling this list in 2014 was to frame an attempt to reach some consensus on what problems policymakers were trying to solve or prevent. At this year's workshop, we introduced a diagram (Figure 1) to illustrate how, in an ideal world, policy decisions are rooted in clearly articulated aspirations, and lead to measurable progress. We asked each participant to offer their current views of what the most pressing Internet problem(s) would be in five years. The concerns were consistent with our 2014 list, which we can classify into three categories: **Equity** (universal, ubiquitous, affordable, and subscribed service); **Innovation** (evolving network capabilities at pace with the larger IT sector, as a platform for innovation); and **Security** (keeping the Internet trustworthy enough to promote its use).

## 1.1 Trends in traffic, topology, business, and regulatory models

We then shifted gears to a discussion of evolutionary trends in the Internet ecosystem that illustrate the challenges of, and need for, developing sensible policies to protect consumer welfare. The three most profound traffic and topology shifts on the network in the last decade are inter-related. First, the relentless growth of video content delivery via the Internet, though inevitable, has motivated content and network providers to re-engineer their networks to support it, sometimes blurring the distinctions of current regulatory categories, e.g., Title II vs. Title VI. Some researchers have also explored how the both the engineering and economics of media entertainment differ from that of other uses of the Internet as critical communications infrastructure [18].

Second, in response to these changing traffic demands, the big edge content providers have begun to connect directly to access providers for performance and cost reasons. The emergence of *remote peering* – where IP networks peer across geographically distant IXPs via layer-2 network services – has also contributed to an increased richness of peering, bringing content closer to users [5]. A related trend is the growing consolidation of cloud and content providers (some of which are the same), which has re-shaped the industry over the last decade, with architectural implications. Some have speculated a shift in how we think about global Internet reachability, and potentially diminished future for the transit market [16].

A third closely related development is the emergence of a *cloud interconnection* ecosystem, the next phase in the division of the Internet into public and private spheres, where the private sphere “offers advantages in predictability and service quality, at a price” [3].

We also talked about two additional and inter-related trends: IoT and 5G. The political economy of the “Internet of Things” is triggering crises and new demands related to security, reliability, resilience, redundancy, and privacy. The term “5G”, which has yet to be instantiated with an actual underlying network architecture, has generated tremendous hype, which serves as a veneer over deep struggles around competing views as to how different actors can explore this next generation of communications technology to acquire or preserve control over the resulting consumer space.

These changes bring to the forefront the question of what the ISP of the future will look like, both in wired and wireless realms, and whether there will emerge an industry differentiation between low-margin packet carriage businesses and providers of more complex (“specialized”) services. The current regulatory structure embeds hard distinctions between, e.g., private vs. public networks, information vs. telecommunication service, but economic realities including analyst expectations for revenue growth have blurred these distinctions as network infrastructure operators have merged horizontally but also moved up the stack into higher margin content-provisioning services and platforms.

Andrew Odlyzko made a comment on the modern IT economy being dominated by search for choke points, with minimal real investments, and assisted by confusology. This observation is consistent with comments made at WIE 2015 about limited economic growth and in particular limited household income growth constraining investment in broadband infrastructure. The set-top box is such a choke point, and illustrates the difficulty of classifying today’s network ser-

vices into existing regulatory categories. Conceptually, the communication circuit into the home forms a telecommunications service. This bearer service is evolving technically into a platform based on the use of the Internet Protocol, with multiple services provided over it. In the context of the cable system, DOCSIS can separate IP flows associated with different services. The Computer I distinction between telecommunication and end-node based data processing services holds thru the Open Internet Order, with the assumption that the higher-level data processing services are competitive and thus do not require regulation. But in this context, how does one consider the set-top box, which is on the one hand an end-node, not a telecommunications device, but on the other hand, is integrated into the “cable television” service. This arena has emerged as a contention point over the last decade with the proliferation of other set-top devices, e.g., AppleTV, Roku, Chromecast, Amazon FireStick/FireTV, Xbox, Playstation.

Further challenging policy development is the fact that economists, technologists, lawyers, and business stakeholders sometimes use different language to describe the same behavior. Given convergence and divergence happening simultaneously, it becomes trickier but more important to identify feedback loops, choke points, and tunable knobs that influence stability, power, and revenue in the ecosystem.

David Clark expressed a growing sense that we were nearing the end of a glorious era of open architecture with open communication. There is no reason to believe that competition would drive us back toward this glorious era; indeed competitive pressures to capture users and extract value may drive innovation, but not necessarily open access for third-party innovation. On the other hand, Title II is not a substitute for competition but intended to discipline discriminatory behaviors. He was also pessimistic about the future of the user experience. If there is reduced competition in higher-level services, there is reduced pressure to deliver services of a high quality, both with respect to the content itself and the possibility of technical impairment degrading the experience of using the service.

## 2. ASPIRATIONS IN TENSION: SECURITY VS FREEDOM

We held a breakout session on the goal of *trustworthiness* of Internet experiences. Users fear their personal information will be used in harmful ways, leading to loss of digital or financial assets, but users may also be deterred by violations of norms of behavior, e.g., spam or cyber-bullying. A breakdown in the trustworthiness of a platform hinders progress toward other aspirations, such as supporting innovation. Security fears also impede the generality of the Internet as a platform, because both providers and users will tend to prefer closed walled gardens for the sake of security [9].

All policy aspirations and goals have measurement challenges, but security could be the poster child for measurement challenges, not only because of definitional issues (do fraudulent charges on a credit card count as identify theft), but because there is significant variation in what different jurisdictions consider illegal and poor mechanisms to pursue lawless behavior internationally. The two most cited examples are sharing of child pornography (where at least age of consent differs across countries) and sharing of copyrighted materials, i.e., what counts as illegal piracy. Defining the

problem is at least as contentious as mitigating it, because different interests are served by different metrics, exemplified well by the highly contested figures for financial losses to copyright holders from piracy. As far as cyber-crime goes, the lack of consistent measurements or reporting, and lack of incentives for such transparency, hinders the ability to assess progress toward better security. Another challenge is the correlation, or lack thereof, between perceptions and reality, e.g., misplaced trust. We do not yet know whether consumer perception survey responses correlate with observations of actual behavior. Is Facebook uptake or use correlated with how much people trust it?

As fundamental as the measurement challenges is the fact that security as an aspiration operates in tension with many others, notably *freedom* or choice. Although in the U.S. framework, choice is often convolved with competition, which has long been considered the key mechanism for disciplining markets, we considered choice in a broader context. Decades ago, the Internet served a small community and could support rapid innovation, but on today's global network, choice and unrestricted innovation are in tension with reliability and security. Given choice, consumers might pick a more heavily curated, controlled network, and/or one more stable than today's Internet (e.g., Apple's app ecosystem), an outcome aligned with security, but less aligned with freedom to innovate. Or a consumer might prefer a network that is zero cost but limits the choice of applications, e.g., Facebook Zero and Free Basics from internet.org. The fact that these platforms have strong network effects can result in limited choice (if you have to be on Facebook to participate in society) and pressure for regulation.

### 3. THOUGHT EXPERIMENT: FRAMING A NEW TELECOMMUNICATIONS ACT?

The 1996 Act did not consider many challenges we now face, related to rapid and unpredictable convergence of services and technologies that blur boundaries between regulatory categories. One obvious example is where Title II service begins and ends. Under the current framework, only services classified as telecommunications are regulated under Title II; this includes broadband Internet access service (BIAS) as well as the arrangements such as interconnection that are required to provide that service. Pay-television service could be considered to either be a service regulated under Title VI or an unregulated service offered over BIAS. IP transit services remain unclassified, as do non-BIAS data services (e.g., home alarm systems).

Some predicted that in 5 years, a new telecommunications act would be in front of Congress, and we used most of the second day to draw contours around such a piece of legislation, drill into some details, and suggest topics for future workshops to gain more depth. Doug Sicker and Bill Lehr led a discussion of how we might approach turning aspirations into concrete proposals for new legislation. Our goals for this session were to discuss the following questions: What sections (titles) might a 2021 Telecommunications Act need? What services might be the target of regulatory attention, and why? What structure at the FCC would most constructively be able to pursue/track/prioritize aspirations for the future of Internet infrastructure? We did not consider details on the feasibility of specific approaches to transition to a new regulatory framework, or interpretative challenges

of the current Act. Rather, we considered a "clean slate" experiment, starting with a list of initial goals.

Doug and Bill proposed their own (they emphasized, incomplete, and derived from recent policies) list of critical topics which a new Act would need to address: scope of jurisdiction, open Internet, reliability, security, privacy, availability, affordability, interconnection, public safety, CALEA, e911, media rules (ownership, must carry, access), and spectrum management. They then offered an outline of hypothetical sections for a Communications Act of 2021:

1. Title I: goals, scope, authority (what do we want from communications infrastructure?)
2. Title II: Bottleneck Facilities Regulation (open access, interconnection, structural remedies)
3. Title III: Communications Market Monitoring and Enforcement (universal service, measurement, rule-making authority and process)
4. Title IV: Spectrum Management (manage as scarce resource, not industrial policy)
5. Title V: Public Safety and Critical Infrastructure (where does this belong? agency or regulator)
6. Title VI: Transition Plan

We did not expect to cover all these topics at this workshop; we aimed for a draft outline that might help frame a series of future workshops to tackle different aspects of the conversation. One idea was to hold a workshop specifically to consider, for each goal, how are we trying to accomplish it now, and is that approach appropriate and right for the future, or what might be a better approach if we could start from scratch? This approach is more holistic than the Biennial Review process [11], which periodically assesses what parts of the Telecommunications Act can be rescinded. But there was agreement that although decomposing the current Act in a similar spirit would also be a useful exercise, that is, for each title, what is its purpose today, how well does it achieve that purpose. For example, one exercise would be to conceptually eliminate the universal service provisions, and see what needs to come back to achieve the goals originally motivating those provisions. We discussed topics in the first three hypothetical titles, and discussed the role and structure of privacy regulation, whether national or sector-specific, punting deeper discussions to future workshops.

#### 3.1 Goals, scope, authority

Sid Karin repeatedly reminded us of the need for a proactive approach to agreeing on a list of principles (aspirations) for communications infrastructure, lest the future be led purely by market forces and court decisions. Indeed, the 2010 Open Internet Order [13], as well as the Broadband Plan for America [12] both had extensive discussion of goals and principles, but their assumed and articulated method for achieving them was to pray for competition, without any mention of a preferred industry structure. Competition has for many years itself been elevated as a goal rather than a means to achieve other goals. In the case of the 2010 Order, the Court struck down the FCC for lacking authority to pursue its stated principles under Title I classification of Broadband Internet access service. The FCC tried to get it

right for the 2015 Report and Order [14], using Title II, despite acknowledging its limitations as a statutory framework applied to the Internet.

Sid suggested reconsideration of a long-discarded traditional telecommunications policy principle: structural separation, i.e., separation of content owners from infrastructure operators, since one cannot reasonably expect someone who provides both to do either consistent with the public interest, i.e., not discriminating in favor of its own content.

### 3.2 Bottleneck Facilities Regulation

Although one goal of a future act might be to design for competitiveness, there is growing (re-)recognition of the pipe to the home as a natural monopoly in most regions. For parts of the ecosystem that are a natural monopoly, regulation is the only effective way to ensure open, non-discriminatory access to upstream resources. Similarly, to the extent that players have market power over interconnection, regulatory remedies require consideration as in other industries with interconnection structural bottlenecks.

This section should also address data caps, to ensure that incumbents do not use them to create artificial scarcity in order to protect their own services. A related issue is *zero rating*: when a provider exempts some data from the data cap. Zero rating lets last mile ISPs shift some cost of content delivery away from consumers toward the content provider (which is sometimes itself). Proponents frame zero rating as marketing that has nothing to do with traffic prioritization, while opponents suspect ISPs of artificially rationing access to resources [15].

Scott Jordan offered four distinct zero rating scenarios that likely trigger different levels of policy concerns based on the metric of likely harm (or benefit) to consumers. (1) sponsored data, i.e., non-discriminatory zero-rating offered to all (2) zero-rating a particular class of app, e.g., T-Mobile's Binge On; (3) zero-rating a particular content provider, e.g., Facebook Zero; (4) zero-rating my but not other services, e.g., ATT's offer with DirecTV. Trying to order these scenarios in terms of consumer welfare revealed the lack of an accepted ontology to describe the space of services, much less consensus in the room on which scenarios were more preferable. Even policy analysts and economists might use different metrics to evaluate potential harm, e.g., how much it seems to violate the Open Internet Order, versus how much it will increase social welfare.

### 3.3 Communications Market Monitoring and Enforcement

The primary challenge with evaluating the effectiveness of a policy is often the lack of ability to measure the metric being targeted by the policy. The biggest gap in current telecommunications policy is relevant measurement and explanations of data [17, 8]. The European approach to regulation of broadband Internet access service (BIAS) is to require minimum performance standards to ensure an acceptable service, and then letting providers be free to provide whatever services they want [23, Article 23, paragraph 2]. But there is no standard parameterization of such a level of acceptability.

Until the 2010 Open Internet Order, the FCC had largely not leveraged transparency as a tool for disciplining BIAS service market, with one notable exception. The FCC's Measuring Broadband America (MBA program) was devel-

oped as a response to a specific repeated accusation that consumers were not receiving the advertised bandwidth for their service. Although the accusations were themselves based on poor data methodologies [24], the FCC invested years in developing a cooperative measurement program with ISPs and consumers to estimate access link bandwidth of the top 15 broadband providers. It bears emphasizing that as access link bandwidth speeds increase, this sort of measurement capability is an open research problem [2]. Indeed, the measurement and monitoring challenges are many: measuring interconnection link performance and congestion [21, 8] or metrics that will faithfully capture user quality of experience [26]. The FCC has no such capabilities, nor are other research funding agencies focused on methods to assess complaints from various stakeholders, e.g., network providers, edge providers and consumers. This gap will become increasingly problematic in the design and enforcement of any new telecommunication policies [8].

### 3.4 Spectrum Management

Spectrum management is an illustrative example of how policy has organically grown over a century. For historical reasons we have developed an inefficient process for managing access to spectrum, in part because policymakers use spectrum management as a tool for industrial policy rather than as a tool for maximizing utilization of a scarce resource. In the current approach, the FCC and NTIA split governance of spectrum by commercial vs. government use; some unification of this role would allow greater optimization of efficiency of allocation and usage.

There is growing interest in and recognition of the need for policy support, including for funding research to mitigate obstacles to more efficient spectrum sharing. A recent NIST/NTIA working group published a comprehensive report on R&D challenges in wireless research [22], many of which talked about the measurement gaps, both to inform as well as enforce present and future policies.

### 3.5 Privacy

There was no consensus in the room on whether privacy should be a sector-specific regulation within the FCC, or regulated as part of an over-arching privacy law, but we reviewed the recent 2016 FCC privacy order to stimulate debate on first principles of privacy in a telecommunications setting.<sup>2</sup> In 2016 the FCC culminated a long dialogue with various stakeholders with a privacy order for broadband Internet access service (BIAS) providers. This sector-specific order focused on how to protect use of individually identifiable information, i.e., that which can be easily linked to a specific consumer, without that consumer's explicit consent. Otherwise, providers are free to broadly use (without customer approval) anonymized data for any research that might improve the network or service.

This particular privacy ruling was a follow-up to the reclassification of broadband Internet service into Title II, which potentially triggered application of Section 222 [1], so the FCC provided guidance specific to broadband providers, sensitive to the unique visibility broadband provider have

<sup>2</sup>As some at the workshop predicted, the new administration's FCC has recently stayed a portion of this Privacy Order. The rest of the Order remains as is for now, until the FCC acts on petitions for reconsideration (which might result in other changes to the Order).

into subscribers' behavior.

We contrasted the national over-arching nature of EU privacy law (since 2003 when it was taken away from specific sectors) with the sector-specific approach taken in the U.S., and discussed whether the U.S. should develop a national privacy law, and if so how to keep pace with rapid technological evolution that continually yield new ways to invade privacy.

#### 4. FUTURE WORKSHOP TOPICS

There was broad interest in pursuing a series of structured workshops on the prospect of a new telecommunications act, which would incorporate empirically grounded assessments of lessons learned from previous legislative efforts. Participants were interested in pursuing such a workshop series across several hosting institutions over the next several years. Two daunting challenges in developing a new telecommunications act are achieving a holistic understanding of its goals and how they interact/interfere with each other, and ensuring there are measurable metrics reflecting each targeted policy goal.

Participants also shared three additional related topics of interest for future workshops. First, there are some fundamental misunderstandings of the ecosystem dynamics, or at least misleading use of inappropriate models. For example, the two-side market model only applies to a small slice of the market, and applying it in a broader context to the Internet is misleading and will lead to poor policy decisions [6].

Second, FCC policy development must recognize the FCC's role as a hands-off regulator, but they do play the role of observing trends, and in some cases brokering data. Their data science capabilities could use re-architecting to include more technical Internet expertise [19, 4].

Finally, when we consider our list of goals, it would help to also consider how they would apply in a future Internet architecture world, e.g., Named Data Networking [27].

We left the planning to launch a workshop series that would allow us to explore all of these issues more deeply.

#### 5. WORKSHOP PARTICIPANTS

- Co-Host: kc claffy, (CAIDA/UCSD)
- Co-Host: Dave Clark (MIT)
- Steven Bauer (MIT)
- Roger Bohn (GPS/UCSD)
- David Clark (MIT/CSAIL)
- Amogh Dhamdhere (CAIDA/UCSD)
- Vasileios Giotsas (CAIDA/UC San Diego)
- Bradley Huffake (CAIDA/UCSD)
- Silvia Elaluf-Calderwood (Oxford Brookes)
- Rob Frieden (Penn State)
- Scott Jordan (University of California Irvine)
- Sid Karin (UCSD/SDSC)
- Erin Kenneally (DHS)

- William Lehr (MIT)
- Steve McKinnon (FCC)
- James Miller (FCC)
- Bill Norton (Console)
- Andrew Odlyzko (University of Minnesota)
- Achilles Petras (BT Research)
- David Reed (UC Boulder)
- Doug Sicker (CMU)
- Tony Tauber (Comcast)
- kc claffy (CAIDA/UC San Diego)

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