Silicon Flatirons Exploratory Workshop:

Institutional Responses to Network Management Issues

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On March 31st, 2010, the Silicon Flatirons Center convened an exploratory workshop at the University of Colorado Law School to consider potential institutional responses to network management issues. This workshop brought together a number of technical experts from various providers operating in the Internet "ecosystem" to engage with the workshop's organizers in a high-level discussion on the intersection of network management techniques and regulation.[1] In particular, the group explored the possibility of creating a technical advisory group (TAG) that could assist the policymaking process by providing regulators and consumers with the best possible technical expertise concerning Internet-based services and network management techniques.

Before the workshop commenced, all participants were advised about the "legal parameters" of the discussion. Specifically, discussion of pricing policies, company data (including data on cost of service), production and marketing procedures, territorial restrictions, or any other topic that might risk violating the antitrust laws would not be permitted. Participants were admonished to keep these restrictions in mind throughout the day, and legal counsel was present in order to monitor the discussion and provide additional reminders, if necessary.

The day-long workshop was moderated by Dale Hatfield, Executive Director of the Silicon Flatirons Center and former Chief Engineer of the Federal Communications Commission (FCC). The workshop started with a general dialogue on why the creation of a TAG might be desirable, and the potential "intermediary" role that the TAG might serve. This conversation segued into a discussion of a number of other issues, such as: (1) the alternatives to a TAG and their pros and cons; (2) whether it is possible (or even desirable) to separate technical issues from policy or business issues when it comes to network management; (3) whether a self- or co-regulatory body applying a "common law" approach to network management practices makes sense; (4) how the TAG would initially interface with federal regulators; (5) whether the TAG could perform an informational role for policymakers and consumers in the network neutrality debate; and (6) whether existing standard-setting bodies adequately perform the functions of the proposed TAG.

Additionally, the group engaged in a limited "taxonomy" exercise — listing out a few categories of known network management techniques, their advantages and disadvantages, and their potential unintended consequences — in order to test whether a strictly technical analysis could provide valuable information for policymakers. Although this exercise offered a glimpse into how the TAG might operate in practice, it should be noted that the participants felt it was more important to discuss the institutional aspects of the TAG at the initial workshop.

After discussion of these topics, the workshop culminated with feedback from the technical experts in attendance on whether proceeding with the creation of a TAG would be worthwhile. There appeared to be some agreement among these experts that the TAG has the potential to provide benefits to the public,

[1] The list of workshop participants is attached as Appendix A.

policymakers, and the companies operating in the Internet ecosystem. However, as discussed in further detail below, several participants underscored that they have concerns about the potential "scope" of the TAG.

Discussion

The Goals of the TAG

Mr. Hatfield explained that the motivation behind convening an exploratory workshop with technical experts was the notion that, when these experts come together to address a problem, significant progress can be made and a foundation can be provided for "normative" or policy decisions to be made later. A number of participants agreed with this view, and expressed a preference for the TAG to focus on "fact-finding," rather than making normative judgments or policy recommendations. That being said, there appeared to be a range of views as to whether the TAG might reach beyond factual questions once it is established and has additional guidance from its constituent members on the structure of the organization. For instance, the TAG's mission could be expanded to include the promulgation of "best practices" or other advisory statements. In the near term, however, the key to the TAG's success, as identified by some participants, would be reducing areas of disagreement by providing policymakers with the best technical information possible. In so doing, the TAG would help reduce unintended consequences and other regulatory costs by educating regulators and helping to foster an environment that results in informed policy decisions. In addition, it was noted that the TAG's mission could be expanded once a requisite level of "trust" had been established among the organization's participants.

Further discussion highlighted other potential responsibilities for the TAG, including: (1) the consideration of network management complaints (*i.e.*, dispute resolution); (2) evaluating network management techniques through a voluntary "pre-clearance" or "vetting" process; and/or (3) serving as an engineering forum to generate responses to potential FCC inquiries. Of these three potential responsibilities, there was some discomfort with the notion the TAG would make normative judgments through "vetting" techniques, but there was some consensus that this role could be structured to be a voluntary process only. Finally, some of the participants believed that the TAG should consider the activities of Application Service Providers (ASPs) as well as that of Internet Service Providers (ISPs), with the caveat that the organization, in either event, would need to be structured to ensure that ASPs' interests are well-represented.

Alternatives to a TAG

The participants felt it was important to discuss the institutional alternatives to a TAG. One participant voiced a concern that, if the *status quo* is maintained, the complaint-driven and litigious process at the FCC would continue unabated. Another participant pointed out the FCC could reform its own processes in the near future to address this concern, but also underscored how difficult it can be for the Commission to attract people with the same skills and real-world experience as the participants attending the workshop.

Participants pointed out another alternative might be an "intermediate" step such as "co-regulation," a framework in which industry self-governance would address regulatory issues under clear government oversight. Traditional public regulation was critiqued as often sweeping facts to the side as political currents change, but it was thought that co-regulation could create a suitable "buffer" between public regulation and private interests.

The Challenge of Separating Technical Discussions from Business and Policy Considerations

Some participants believed it would be difficult for the TAG to focus solely on technical matters without implicating business decisions and running into the potentially conflicting priorities of the companies involved. Another participant thought it best for the group to discuss specific technical issues, such as last-mile discrimination, because anything other discussion would be too theoretical. Yet, other participants felt that such a discussion, like the treatment of VoIP as an example, could be a "slippery slope" that would draw the TAG into the business and policy arena. One participant, however, pointed out how this dynamic could depend on the time horizon involved. Viewed from a short-term perspective, changes in the Internet ecosystem would seem to advantage one party while disadvantaging another, and this is where some of the "jockeying" would come in. If the TAG started with a longer-term perspective and shifted its focus to the short time horizon as trust developed between the TAG members, however, there would be a greater appreciation of the other TAG members' views on the issues and less of a focus on "win/lose" situations.

The participants generally agreed that, while it may be complicated to clearly separate technical issues from the legal, regulatory, and business issues, there is value in a forum that focuses on the technical issues first in order to move the discussion forward and create a record to assist policy makers and regulators.

A Common Law Approach to Network Management Practices

The discussion then moved to whether the TAG would operate similar to a common law court, in the sense that the TAG would decide which practices were acceptable based on the specific facts presented, and then for a review of distinctions or similarities with respect to prior situations. Participants felt this approach would allow for a set of acceptable practices to be built up over time, and would have the added benefit of providing flexibility to alter the criteria in response to changing circumstances. One participant believed that processes to "vet" network management practices are already happening within individual companies, but on an *ad hoc* basis only. This participant stated that it would be beneficial to have a set process, but the TAG and any framework it created should also look beyond the activities of network providers.

The participants then reiterated their concerns with the complaint-driven process at the FCC. Some participants believed that, when it comes to reasonable network management, there will always be some users who perceive that they are negatively affected and/or are unhappy with how they are being treated. One example is where a network provider "black-holes" or discards incoming traffic from an IP address that is being used to attack the network. In this example, the company black-holed the offending IP address, but there were a

number of other virtual websites (and consumers) on the server that were affected as well. Without a framework of acceptable network management principles and practices, the participant asked, how will the FCC or customers know this was a rational approach, and not simply look on it with suspicion?

Reducing Information Asymmetries

Participants also discussed the degree to which the TAG's activities could inform policy debates such as network neutrality. The participants felt that, although there has been a lot of emotion surrounding this set of issues, much of the debate has revolved around a discussion of *potential* harm instead of *demonstrated* harm. Information sharing and transparency, according to the participants, is a critical component of cutting through misconceptions and finding common ground. One participant noted that parties in the network neutrality debate often think they are on opposite sides of the fence, but once efforts are made to share information, there is greater understanding among the parties and barriers to consensus can be broken down.

One idea considered at the workshop was that the TAG could serve as an educational resource for the FCC when the agency is presented with a network management complaint. The TAG, it was felt, could help to streamline the process and reduce the amount of time it takes the FCC to address these concerns when they arise. Participants felt that the TAG could provide a forum for discussing the benefits and detriments of the practice, and provide feedback to the FCC. To be sure, a number of participants did not believe that the TAG should pass judgment on whether a given practice is "discriminatory," as such a determination is a normative judgment perhaps better left to regulators or other non-technical decisionmakers once they are provided with the necessary technical information. Nevertheless, there was general consensus that these decision makers do not have a sufficient level of real-world technical expertise when it comes to networks, network management techniques, and the underlying technology involved. That said, although the group was generally inclined towards the TAG performing an educational function, there were concerns about whether such efforts would be efficient.[2] For instance, the participants felt it would be too time-consuming for the TAG to put together large amounts of educational information, and oftentimes such an exercise would merely be re-inventing the wheel. Additionally, there were some concerns about the pace of technological advancement and evolving network management techniques, and the resulting difficulty of keeping policymakers abreast of these developments. In summary, while the group appreciated that much of the regulatory world does not understand what engineers in the industry take for granted, the participants thought the educational component of a TAG would come down to a matter of degree — regulators must be educated to a certain extent, but it was unclear exactly how much education would be useful or appropriate.

Another idea was that the TAG could generate a list of network management challenges and current (or potential) solutions to inform consumers

[2] Indeed, one participant asked if it made sense to ask an individual company's engineers to help produce a white paper on technical issues when policymakers could readily obtain similar information at a local book store.

and reduce the possibility of complaints. Generating this list could also lead to a constructive dialogue among actors in the Internet ecosystem on potential solutions and best practices, thereby dispelling the notion there are "bad actors" who need to be regulated.

"Competition" with other Standard-Setting Bodies

The participants noted the efforts of other "self-regulatory" or standard-setting organizations to address issues relating to network management. One participant pointed to the Internet Engineering Task Force (IETF) and similar entities that have processes in place to resolve technical problems, but it was noted that those processes may be somewhat "slow." Other participants thought there were potential similarities between the TAG and the Network Reliability and Interoperability Council.

The participants also discussed the role that "frequency coordinators" play in the FCC licensing context. Frequency coordinators are private organizations certified by the FCC to recommend the most appropriate frequencies for applicants in certain geographic areas. One participant noted that, unlike the frequency coordination situation, parties interested in the network management debate can often have opposing interests. Another participant disagreed and pointed out there is commonality of interest given the complementary nature of players in the Internet ecosystem — according to this view, there is a business and economic question of how everyone divides the "rents," but the technical discussion can still be separated from business and policy considerations to some degree.

A "Taxonomy" of Network Congestion Tools — Testing the Proposition

In an effort to further the goal of educating policymakers, some thought the TAG could provide value by articulating the various network management techniques currently in use. Some participants thought that a list of the different techniques used to manage network congestion could be quite valuable — the FCC Commissioners and other policymakers need this kind of information and they do not have the same type of exposure to the concepts and technology as technical experts. When asked if a simple "taxonomy" of network management techniques would be helpful, there was general agreement that such a list could be helpful for regulators, and could provide something akin to a roadmap on how to think about the technology involved in these problems. In the alternative, some participants thought that, instead of a taxonomy of network management techniques, it might be better to create a list of "best practices." Others felt it might be inappropriate for the TAG to identify "best" practices, as that could imply a normative judgment. Reflecting the real-world concerns with the pace of technological growth, all participants agreed such a list would never be comprehensive or exhaustive, as the technology and techniques will always be evolving.

In a similar vein, some participants thought the TAG could also provide a list of the techniques network providers should *not* be using to manage traffic. There was more traction, however, with the idea of a "best" or "known" practices list that may serve as a starting point for future discussions surrounding management techniques. One idea that sparked some interest was a list of

practices that could serve as a "safe harbor" for network providers that use those specific techniques.

Finally, the participants observed that there are many different ways to manage network traffic and congestion. The group felt that there is a lot of misinformation concerning network management and that it might be useful to dispel these myths. One participant provided an example of a technique that might engender controversy, but one that he said seemed to "make sense and be reasonable," where in the event of a terrorist attack, providers might manage their networks in such a way as to shut down all video applications in order to save bandwidth for emergency services, text, and voice communications. Another participant pointed out that network providers are often blamed when end-users are unable to reach a website when proper network management techniques are being applied; such as where the IP address of a "spamming" server is "black-holed" but non-offending websites reside on that same server.

Specific Elements of Network Operations

The participants then discussed specific elements of network operations after being asked a basic question — what could be done to the packets of information flowing across the network? The group felt taking a snapshot of what is being done and what could be done with these packets would be a good place to start this "taxonomy" exercise.

The different techniques discussed fell into two broad categories: scheduling or "queuing" disciplines. The scheduling and queuing techniques were further divided into: (1) blocking; (2) forwarding; (3) prioritization; and (4) preemption. The classification of packets was only briefly mentioned in regard to "flow-based" classification.

The participants then discussed the implications of each of these methods on various applications riding over the network. At the outset, it was acknowledged that applications providers will often change the behaviors of their individual applications and that such a process is not under the control of the network providers. It was also pointed out how some applications will "adapt" to what the network is doing at any one point in time in order to optimize their performance. The participants still thought it was a fruitful exercise to consider what different network management techniques could do to various applications, and at a high level the participants felt that any negative effect of these techniques would involve packet loss and/or an increase in latency.

Moving into the taxonomy exercise proper, and recognizing that any list of network management techniques will always evolve and will never be exhaustive, the group identified a couple of techniques, described the techniques, and attempted to articulate some of the pros and cons of each. The group started with "blocking," describing this technique as fundamentally "identifying the packet and then filtering it" and not necessarily on a congestion-oriented basis, since often an IP address must be blocked due to an "attack" of some sort. There are many different flavors of blocking: (1) black-listing versus white-listing; (2) blocking originating versus terminating traffic; and (3) packet-by-packet versus flow — which depends on where in the network the blocking is implemented.

With respect to the pros and cons of blocking techniques, the participants noted that blocking can protect end-users and network infrastructure from "bad actors" (*i.e.*, known spammers and "attack IP addresses"). On the other hand, blocking can be seen as anti-competitive depending on which entity is blocked and why, and depending on where in the network the block is implemented. In the end, participants felt that one task for a TAG might be to resolve the nuances in the broad umbrella term of "blocking," though the regulatory imperative may prohibit such a technique altogether.

The group then briefly considered another technique, prioritization, where the network provider can prioritize packets (either by type of packet, individual or class of users, specific application, etc) and guarantee a certain quality of service to an end-user or application. The group did not enumerate the pros and cons of this technique, as the dialogue shifted in another direction.

Taking a Holistic Approach to Network Management Techniques

Some of the participants noted that network management, as understood within industry circles, is very broad and not isolated to a single "layer." As such, the participants briefly discussed whether it would be appropriate for the TAG to address issues beyond just the network layer. One participant described how network management had been performed at the application layer when the Democratic National Convention came to Denver in 2008, and how content delivery networks (CDN) redirected network traffic throughout the world. Participants also gave a negative example in the context of the *Madison River* case, where a local telephone carrier was blocking voice over Internet protocol (VoIP) traffic for anticompetitive reasons. Also mentioned was the reverse case, where a website could instead decide to block all traffic originating from a specific network provider.

Observations and Next Steps

At the end of the workshop, the participants were asked if there would be value in creating a TAG. More specifically, the participants were asked if they could envision a version of the TAG that would be valuable to the companies, policymakers, and ultimately the consumers. There was a general consensus a TAG could play such a beneficial role — particularly in contrast to maintaining the *status quo* — but it was difficult for the participants to provide a more concrete assessment without having a better sense of the TAG's operations and institutional structure.

One participant summarized the three potential characteristics of a TAG as a body that would: (1) educate the FCC and other policymakers; (2) resolve issues before those issues are brought to the FCC; and (3) serve as a sounding board for new ideas or network management techniques. Another participant believed there was value in trying to create something different than the existing model, which the participant characterized as "my hired experts versus your hired experts" when it comes to debating proper network management techniques.

Many of the comments spoke to how the TAG would operate, if created. One participant reiterated the concern that normative and business decisions may loom too large, but felt that if the TAG built up the requisite trust among its

members, then it could evolve towards the creation of a set of best practices. Defining the scope of subject matter addressed by the organization was also a concern — *i.e.*, how large is the domain of technical issues, and is the universe of potential issues small and fairly obvious? One participant asked about the charter that the TAG would operate under — *i.e.*, how and where would the TAG be formed? Another participant pointed out there were other groups performing many of the same functions as the proposed TAG — such as IETF, the North American Network Operators' Group (NANOG), and the Alliance for Telecommunications Industry Solutions (ATIS) — but the general consensus of the group was that these fora do not work particularly well when it comes to network management issues, and might not be broadly representative of the industry players in the Internet ecosystem as a whole.

A concern also arose with respect to the decisionmaking process within the TAG, and whether constituent members would have the ability to "opt out" or "dissent" from TAG decisions. One participant pointed out that engineers could sometimes get in arguments over who is more "right" when it comes to finding the correct answer to a problem. One participant also asked how the TAG would interact with the FCC — would the TAG bring matters to the FCC's attention or vice versa? If it is the latter, would the Federal Advisory Committee Act (FACA) be implicated? Other operational concerns included the frequency of TAG meetings, how the membership would communicate, and what implications this had for the expected work product to come out of the TAG. It was noted that many of these operational concerns were somewhat premature and would need to be addressed at a later date.

In general, the participants concluded that educating the FCC and other policymakers would be a valuable role for the TAG to play, given the relative lack of real-world technical knowledge that currently exists within the regulatory sphere. Here too, there were some questions as to the extent of any educational efforts on the part of the TAG, and some participants felt that, at a certain point, the technical issues would bleed into or merely be a proxy for business issues.

One participant put forth the idea that the TAG could produce a white paper concerning quality of service. The white paper would be designed to simply educate, in essence flagging an issue and presenting all views. Other participants pushed back and again pointed out how time consuming and difficult an informational document could be to produce, especially for engineers who are not renowned, fairly or unfairly, for their ability to write.

The participants again considered what the alternatives to the proposed TAG might be. One participant pointed out that the most likely alternative would be a comprehensive rulemaking proceeding — here the participants expressed concern that it would not be clear what "evidence" the FCC would find convincing or dispositive. Some of the participants felt the TAG would be a better alternative than continuing to engage in back and forth discussions with the FCC every time there is a technically misinformed regulatory decision.

Some participants felt that, instead of a strictly technical advisory group, there should be a policy advisory group formed with an "engineering ethos" in mind. There was some resistance to this notion and some participants questioned whether mixing policy and technology considerations would defeat the purpose of the TAG. Other participants stated that an alternative structure could be a

single, overarching organization that contains separate working groups focused solely on policy or technology issues.

Finally, it was noted that policymakers will need to take ownership of, or at least "approve" in some manner, the notion of a TAG. If the FCC does not view the TAG in a favorable light, then the organization cannot be effective. Regardless, there was general consensus that the FCC would recognize and use the TAG if the organization helps to solve the regulators' problems; and if it is a solution that all major stakeholders are comfortable with.

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With the foregoing in mind, the organizers of the workshop stated that, as a next step in the process, they would seek feedback from the participants' companies on the appropriate institutional framework for the TAG, as well as the degree to which the TAG should be given guidance regarding its approach to separating technical from business and policy decisions.

Appendix A—List of Workshop Attendees

Ilya Asnis	Director, Embedded Software, *Sling Media*
Kyle Dixon	Partner, *Wilkinson Barker Knauer, LLP*
Nasser El-Aawar	Principal Network Architect, *Level 3 Communications*
Ray Gifford	Partner, *Wilkinson Barker Knauer, LLP*
Vijay Gill	Engineering Representative, *Google*
Dale Hatfield	Executive Director, Silicon Flatirons Center, *University of Colorado Law School*
Chuck Kalmanek	Vice-President, Networking and Services Research, *AT&T*
Jason Livingood	Executive Director, Internet Systems Engineering, *Comcast Cable*
Barry Ohlson	Partner, *Wilkinson Barker Knauer, LLP*
Adam Peters	Associate, *Wilkinson Barker Knauer, LLP*
Howard Pfeffer	Group Vice President, ATG Broadband Engineering and Technology, *Time Warner Cable*
Dan Reed	Vice President, Technology Strategy & Policy & Extreme Computing, *Microsoft*
Kaleb A. Sieh	Research Fellow, Silicon Flatirons Center, *University of Colorado Law School*
Sanjay Udani	Principal Member of Technical Staff, *Verizon*