High Tech Forum
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Lakewood, Colorado

United States House of Representatives

Committee on Energy and Commerce

Subcommittee on Communications and Technology

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Responses to Additional Questions

Richard Bennett

The Honorable Marsha Blackburn:

Please find my answers to your additional questions following. Thank you again for allowing me to testify before your committee.

1. During the hearing, pre-emption and prioritization over the FirstNet network were used as examples of public safety applications that could benefit from prioritization. Can you elaborate on the need for prioritization and optimization among other applications?

Prioritization is necessary in packet switched networks in order to make the best use of network bandwidth. These networks rely on statistical multiplexing, a technique that shares communication channels with multiple users and multiple applications. This is similar to grocery store checkout lines. While the channel or line may have an average delay that's tolerable to the customer, there are always some periods of time in which a number of users happen to show up at the same time. This increases delay for all.

Network management is capable of re-ordering information packets in such a way that the applications that require low delay can obtain it; these are typically voice and conferencing applications. Re-ordering information packets in this way adds subtle delays to non-prioritized information, but this delays are typically small enough that they're not noticed by consumers.

This is an information processing-intensive task that goes over and beyond the basic requirements of telecommunication service; it is therefore reasonable for firms to charge for performing the service.

In the case of FirstNet, video communication is often necessary for assessing the situation on the ground. If a dispatcher in the headquarters location needs to see, for example, the water flow in a river swollen with heavy rain, glitches in the video stream can create false impressions. It's therefore important for these pictures to be transmitted in real time with a minimum of delay and variation.

Applications such as Aira have a very similar challenge, as video glitches caused by excessive delay or packet loss impair the guide's ability to direct the user.

2. From a network engineering perspective, can you describe what a "user-directed" prioritization or optimization environment might look like?

    a. How would the user implement their choice to optimize or prioritize certain services or applications?

User-directed prioritization requires communication in the form of messages from the user to the network service provider. This can take place in a number of ways, all of which require an application to send the message:

1. The user may have access to a web page that allows them to identify the applications in need of prioritization. This would be similar to the configuration pages in home routers that allow the user to configure Quality of Service options. One unresolved question is how the user would identify inbound data streams in order to specify their treatment.

   The simple solution, often promoted by advocates of heavy Internet regulation, would rely on IP addresses. But services requiring special treatment do not always come from known IP addresses, and not all traffic from any given IP address requires special treatment. The same problems exist for domain names; google.com represents a large number of different services.

   Other approaches would rely on the ISP doing packet inspection (AKA "deep packet inspection") or heuristics such as packet length, frequency, or port numbers. The only reasonable solution requires services to stick to known domains or IP addresses in combination with restricted port numbers and other factors. In most cases, the user will need to know several pieces of information that will sound mysterious and complicated to the average consumer.

2. The application the user wishes to prioritize – such as a video conferencing application – can also send a message to the ISP requesting special treatment. In engineering, this is known as an "Admission Control" message. These messages function like concert tickets, verifying that the party is authorized to enter the theater and occupy a certain seat. The Admission Control message will typically operate in conjunction with a web authorization or similar technique. This is the method used by Wi-Fi and by the Internet's Integrated Services standard.[1]

   Admission Control messages need to be authenticated in real time, a process that's reasonable when performed between the ISP and the service, but unreasonable when the consumer's direct consent is needed for each such transaction. This practice can only be made to conform with the user consent requirement by delegating real-time

[1] R. Braden, D. Clark, and S. Shenker, "RFC 1633 - Integrated Services in the Internet Architecture: An Overview" June 1994, http://tools.ietf.org/rfc/rfc1633.txt.

processing to the ISP and forcing cooperation between the application provider and the ISP.

3. The message can be embedded in information packets sent by the ISP user to the service of their choice and also in the packets sent by the service to the user. This is the method specified by the Internet's Differentiated Services protocol.[2] It is also used by IEEE 802 standards for Ethernet (802.1D) and W-Fi (802.11e).[3] This method is not exclusively user-controlled since the user has no ability to embed signals in the information passing from the service to the user; the user can only control the messages he or she sends. Hence, the use of this service requires communication between the user and the ISP to authorize the service's use of priority signaling.

   In practice, this is very complicated. For practical use, it's most convenient for the user to delegate signaling and authorization to a third party application to manage on the user's behalf. Many features of the Internet assume a high level of technical knowledge in the part of the user because it was originally a research network. In today's world, users often have very little network management knowledge, so decisions that affect network operation and leading-edge application performance are best left to experts.

   One of the leading advocates for "user-controlled prioritization" is Barbara van Schewick of the Stanford Center for Internet and Society. She presented a paper at the TPRC Conference in 2010 making the argument that users alone should be allowed to make prioritization decisions.[4] When I asked her if users should be allowed to delegate this power to ISPs and third party application providers, she answered that she didn't know and would have to think about it. I'm still waiting for her answer.

Thank you for the opportunity to answer these questions and please feel free to contact me in the future.

Sincerely yours,

/signed/ Richard Bennett

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[2] S. Blake et al., "RFC 2475 - An Architecture for Differentiated Services" December 1998, http://tools.ietf.org/rfc/rfc2475.txt.

[3] IEEE Computer Society et al., *IEEE Std 802.11e™-2005: IEEE Standard for Information Technology Telecommunications and Information Exchange between Systems--Local and Metropolitan Area Networks--Specific Requirements. Part 11, Amendment 8, Part 11, Amendment 8,* (New York, NY: Institute of Electrical and Electronics Engineers, 2003), http://ieeexplore.ieee.org/servlet/opac?punumber=10328; IEEE Computer Society; International Electrotechnical Commission; International Organization for Standardization; Institute of Electrical and Electronics Engineers; IEEE Standards Board, *IEEE Std 802.1D™- 2004* (New York, N.Y. USA: Institute of Electrical and Electronics Engineers, 2004), 1.

[4] Barbara van Schewick, "Network Neutrality: What a Non-Discrimination Rule Should Look Like," SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, September 20, 2010), https://papers.ssrn.com/abstract=1684677.