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FEDERAL COMMUNICATIONS COMMISSION  
Office of the Secretary

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Re: Comments Regarding the Notice of Inquiry in the Matter of a Framework for Broadband Internet Service (GN Docket No. 10-127)

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**Scott Jordan** is a **Professor of Computer Science** at the University of California, Irvine. He is participating in the **Technical Advisory Process** as part of the Open Internet proceeding. His research focuses on traffic management, including both technical mechanisms and public policy.

The comments here do not necessarily represent the views of anyone but him.

The following comments are presented in response to the following two questions in the NOI:

*60. Some have suggested that the Commission should take account of the different network “layers” that compose the Internet. Are distinctions between the functional “layers” that compose the Internet relevant and useful for classifying broadband Internet service? For example, the Commission could distinguish between physical, logical, and content and application layers, and identify some of those layers as elements of a telecommunications service and others as elements of an information service. (As discussed above, the Commission historically has distinguished between Internet connectivity functions and Internet applications.) If the Commission adopted this approach, which of the services offered by wired broadband Internet service providers should be included in each category? Are the boundaries of each layer sufficiently clear that such an approach would be workable in practice? Would such an approach have implications for services other than broadband Internet service?*

*63. If the Commission were to classify a service provided as part of the broadband Internet service bundle as a telecommunications service, it would be necessary to define what is being so classified. Here we ask commenters to propose approaches to defining the telecommunications service offered as part of wired broadband Internet service, assuming that the Commission finds a separate telecommunications service is being offered today, or must be offered.*

**(1) The important layer boundary lies between the network and transport layers, not between the physical and logical layers or between the logical and content layers.**

The network layers and the layers below it (commonly known as layers 1-3 in either the OSI or Internet layered models) display quite different technical and economic characteristics than the transport layer and the layers above it (commonly known as layers 4-7 in either the OSI or Internet layered models).

From a technical point of view, the network layer and the layers below it must be implemented **in every portion of the network**, including the access network, while the transport layer and the layers above it are traditionally implemented **only at the network endpoints**. As a consequence, the network layer and the layers below it support network functions that must be implemented in every portion of the network, including routing, addressing, and Quality-of-Service (QoS). In contrast, the transport layer and the layers above it support network functions that are implemented at clients, servers, and peers, including email, web-hosting, and caching.

From an economic point of view, the network layer and the layers below it exhibit a **high barrier-to-entry**, resulting in a small number of carriers offering service in any particular location. In contrast, the transport layer and the layers above it exhibit a **low barrier-to-entry**, resulting in a competitive market with a large number of application providers.

This layered delineation also helps with correct application of the **end-to-end principle**. The end-to-end principle suggests that network functionality should be implemented in network infrastructure only if it cannot be implemented effectively in end devices or applications. With the recognition that network layer and the layers below it are implemented in every hop along the transmission path, whereas the transport layer and the layers above it are only implemented in end devices, the end-to-end principle suggests that network functionality should be implemented

at or below the network layer only if it cannot be implemented effectively at and above the transport layer.

This delineation agrees with the intent of the past use of the terms “telecommunication services” and “information services”. The network layer and the layers below it do not change the content of information, similar to telecommunication services. In contrast, the transport layer and the layers above it create, store, or change the presentation of information, similar to information services.

The boundary between the network and transport layers is well recognized by a host of **Internet standards**. The approach would thus be workable in practice.

I recommend that the telecommunications component of broadband Internet service be defined as those services **“that reside at or below the network layer or are required to manage the network and that do not fall under Title VI of the Communications Act”**. The inclusion of services required to manage the network is designed to include a small number of services that reside at or above the transport layer, that are required for Internet access, and that are currently not offered competitively, e.g. IP address assignment using Dynamic Host Control Protocol (DHCP). The exclusion of services that fall under Title VI of the Communications Act is designed to allow Internet Service Providers to have a choice between following the requirements of Open Internet access and following the requirements of Title VI solely for those services that are offered entirely within their own network.

While Internet architecture is based on this distinction between the network and the layers below it versus the transport layer and the layers above it, the communications policy literature and the FCC have not consistently placed the boundary between telecommunication services and information services in the correct place. Much of the literature discusses a **“logical layer”** which often combines the network and transport layers (as well as other layers). However, Internet architecture does not recognize a logical layer. Furthermore, the network and transport layers display quite different technical and economic characteristics, and the network layer should be classified as a telecommunications service while the transport layer should be classified as an information service.

**(2) Network layers are a simple and effective way to classify the telecommunications component of broadband Internet service and to implement the goals of an Open Internet.**

Internet Service Providers (ISPs) should be ensured that they have the right to apply network management mechanisms that do not threaten a level playing field, including the use of QoS. However, ISPs should be prohibited from refusing to provide, or providing at inflated prices, telecommunications service to competing providers of information services in order to differentiate or favor the ISP’s own application offerings. ISPs should also be prohibited from making exclusive deals to provide telecommunications service to certain application providers. ISPs should also be ensured that regulation does not impede an ISP from making arrangements with consumers, application providers, and peering ISPs for telecommunications service in a manner that does not conflict with the above goals.

This balancing act between allowing reasonable network management while simultaneously prohibiting use of telecommunications service that threatens a level playing field can be **simply and effectively implemented by using network layers to define the telecommunications**

**component of broadband Internet service.** The prohibitions should apply only to those services that must be implemented in an ISP's network in order for the application to work effectively. Services that reside at or below the network layer or required to manage the network fall into this category, and thus should be classified as telecommunication services. Services that reside at or above the transport layer and are not required to manage the network do not fall into this category, and thus should be classified as information services.

In particular with respect to QoS, an ISP should be ensured that it can implement QoS at any network layer. However, if an ISP implements QoS at or below the network layer (as one would expect), then it should be prohibited from using this service to tilt the playing field of applications offered at or above the transport layer.

Reasonable traffic management practices that are implemented at or above the transport layer, e.g. caching of content, can be implemented not only by a broadband Internet service provider but also by competing non-facilities based providers. Such higher layer services should be classified as information services and should be excluded from Open Internet regulations.

The FCC, however, should also retain the authority to **prohibit unreasonable traffic management practices implemented at or above the transport layer.** I have recommended that a traffic management practice implemented in transit routers be considered unreasonable if it blocks connections or prioritizes traffic based on source, destination, service provider, or unreasonable application provider payment, and is not done by user choice.

With this layered approach to defining telecommunication service, there is no need for an exception for **"managed services"**. The intent of creating a category of "managed services" seems to be to allow implementation of QoS to enable high quality services. However, if managed services are not subject to the same rules as unmanaged services, then providers of broadband Internet access service **may be allowed to implement QoS solely to support their own managed services.** This would completely undermine the Commission's goal of promoting competition in services that require QoS. **The need for a separate class of managed services can be eliminated by refining the rule on nondiscrimination to apply only to telecommunications services,** as defined above. With this refinement, broadband Internet access providers would be allowed to implement QoS at or below the network layer to support voice and video services without being required to designate such services as managed services. However, if a broadband Internet access service provider uses QoS to support its own services, then it would be required to make available QoS at reasonable prices to its own subscribers and to the provider's peering providers.

### **(3) The same approach works effectively for other types of networks, including wireless networks.**

This same layered approach can be simply and effectively applied to other types of networks, including wireless networks and telephone networks.

Although wireless networks require substantially greater traffic management than wired networks, these differences occur only below the transport layer. Therefore, the same rules should apply to wireless and wired networks, and the application of the rules to wireless and wired networks **should only differ below the transport layer.**

A proper layered definition of telecommunication services can address this concern effectively, since the rules can be equally applied to all forms of broadband Internet access, independent of the technology used. Wireless networks may use more stringent traffic practices below the

transport layer, but these would not violate any of the proposed rules. Wireless networks, as with wired networks, should allow access to lower layer QoS through an interface at the network layer. Such an interface would then allow wireless broadband Internet access service providers to practice efficient and effective traffic management, without the need for them to prohibit particular applications or prohibit tethering.

Taking a longer term view, for at least 25 years there has been a trend toward technology convergence of the Internet, telephone networks, cable networks, and wireless networks. Although lower layer protocols will continue to differ based on the characteristics of the physical connection, these four types of networks will continue to converge at the network layer and above, and to offer an increasingly similar set of highly diversified services and applications. In due course, I hope that Congress will recognize this technology convergence in a thorough rewrite of the Communications Act, and I hope that this rewrite will similarly recognize the importance of this interface between the network and transport layers.

**(4) A layered approach can be used in conjunction with Section 202 to ensure an Open Internet and to define reasonable network management, and in conjunction with Section 254 to apply universal service to converged networks.**

The following attached papers give more detail:

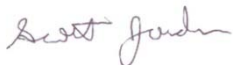
Scott Jordan, *A Layered Network Approach to Net Neutrality*, International Journal of Communication, vol. 1, 2007, pp. 427-460.

Scott Jordan, *Do Wireless Networks Merit Different Net Neutrality than Wired Networks?*, Research Conference on Communication, Information and Internet Policy (TPRC), 2010.

Scott Jordan and Arijit Ghosh, *How to Determine Whether a Traffic Management Practice is Reasonable*, Research Conference on Communication, Information and Internet Policy (TPRC), 2009.

Scott Jordan, *A Layered United States Universal Service Fund for an Everything-over-IP world*, Telecommunications Policy, vol. 33, 2009, pp. 111-128.

Respectfully submitted,



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