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August 31, 2009

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: NBP Public Notice #1, GN Docket Nos. 09-47, 09-51, and 09-137

Dear Ms. Dortch:

On behalf of ViaSat, Inc. ("ViaSat"), we hereby submit the attached white paper, entitled *Toward a National Broadband Plan: Ensuring a Meaningful Understanding of Broadband Capabilities and Facilitating Competitive Choices*, for the Commission's consideration in connection with NBP Public Notice #1.

The white paper was authored by Mark D. Dankberg, ViaSat's Chairman and CEO, Thomas E. Moore, ViaSat's Senior Vice President and the President of ViaSat Satellite Holdings, LLC, and Girish Chandran, ViaSat's Principal Engineer, Broadband Systems, and addresses key issues raised in the public notice with respect to the definition of "broadband." As such, the white paper should prove a valuable addition to the record in this proceeding.

Please contact the undersigned should you have any questions.

Sincerely,

/s/ John P. Janka
John P. Janka
Jarrett S. Taubman

Counsel for ViaSat, Inc.

Toward a National Broadband Plan: Ensuring a Meaningful Understanding of Broadband Capabilities and Facilitating Competitive Choices

Mark D. Dankberg, Thomas E. Moore, Girish Chandran*

August 31, 2009

As part of the current debate surrounding the development of a national broadband plan, and the desire to facilitate the deployment of broadband Internet access throughout America,[1] questions are being considered about whether and how to define "broadband," including whether to develop a single definition, whether an application-based definitional approach is appropriate, and whether "broadband" should be defined in terms of one or more performance indicators.[2]

While these are worthwhile questions to explore, they mask underlying assumptions that appear counterproductive to the continuing development and implementation of high-speed Internet access services and solutions. In particular, these questions implicitly assume that it is desirable to rigorously define "broadband." As we discuss, any attempt to define "broadband" in terms of specific fixed performance indicators (beyond a bare minimum speed) would fail to account for the fact that consumers' broadband needs vary and evolve, and that "good quality" broadband means different things for different applications and in different contexts.

More specifically, adopting a fixed definition of broadband (even one that is reviewed and revised periodically) would fail to account for the fact that: (i) different users place different values and weights on the various dimensions or capabilities of "broadband" services; (ii) different applications have varying performance requirements; and (iii) network operators establish varying performance objectives and optimization goals in designing and implementing their networks and service offerings, and in pricing their services.

As a result, users and network operators make trade-offs between and among the different characteristics of broadband in order to achieve a balance that is optimal for their needs, or the needs of their customers. For example, some users and applications require high volume data throughput but are largely indifferent to latency (*e.g.*, streaming video). Other users and applications may place a premium on mobility over minimum speed, and yet others demand high service availability (*e.g.*, public safety). Even within a given set of broadband applications,

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1 *See, e.g., Federal Communications Commission Public Notice: Comment Sought on Defining "Broadband"*, NBP Public Notice #1, DA 09-1842 (Aug. 20, 2009).

2 *Id.* at 2-3.

variations exist in user performance requirements that caution against "one-size-fits-all" definitions.[3]

Moreover, no attempt to define "broadband" in terms of specific fixed performance indicators could account adequately for the reality that the most salient of those dimensions, and the relative weights assigned to those dimensions by consumers, evolve over time in response to new technology and new applications that continue to drive the development of Internet access services. Critically, given the nature of technological innovation, consumer preferences, and the marketplace for "broadband" services, this evolution is likely to take place in a non-linear and unpredictable fashion. Thus, any "top-down" definition of "broadband" that is based on predictions of performance characteristics that will be valued in the next few years, and on predictions of changes that *might* occur in the future, is doomed to fail.

At the same time, any "top-down" definition of "broadband" could disrupt the natural evolution of the market for broadband services, as well as continuing efforts to provide innovative broadband solutions to consumers. As such, the government should refrain from defining "broadband" in terms of fixed performance criteria, and from taking any other action that would favor certain technologies over others, or pick "winners" and "losers" in the marketplace.

Instead, the interests of consumers would best be served by educating them about the different performance characteristics of broadband services, and helping them understand which available broadband services best meet their needs. This goal could be accomplished by encouraging the development of objective standards for measuring these various performance factors, as well as by encouraging transparency with respect to the actual performance of broadband Internet access services.

I. MULTIPLE DIMENSIONS OF BROADBAND INTERNET ACCESS AND CONSUMER CHOICE

Current definitions of broadband Internet access typically focus on the "speed" of service, and more specifically on the peak "speed" available on a given network. In doing so, these definitions focus on what broadband *is not* (*e.g.*, slower than X Mbps), rather than trying to define everything that broadband *is*. As some commenters aptly have explained, because there are no real limitations on what broadband can *become*, it is better to avoid rigid definitions at this time.[4]

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[3] For example, while the perception sometimes exists that online gaming requires immediate response times, and thus very low latency, surveys of gamers indicate that the vast majority currently enjoy fantasy-based role playing, where moderate latency is acceptable, as compared to first-person shooter games, where a "twitch" response is important. *See* Bruce Sterling Woodcock, *An Analysis of MMOG Subscription Growth*, Presentation at the ION '08 Game Conference (May 14, 2008).

[4] *See* Valerie D'Costa and Tim Kelly, *Broadband as a platform for economic, social and cultural development: Lessons from Asia*, Presented at Joint OECD-World Bank Conference on "Innovation and Sustainable Growth in the Globalized World," at 2 (Nov.

No doubt, any attempt to define "broadband" would require an examination and quantification of a variety of performance factors. A review of existing and emerging broadband services suggests that the following are but some of the dimensions that are the most salient in understanding and comparing the various broadband solutions that are available today:

- **Peak downstream speed** – The *maximum* speed at which a subscriber can download content from and through the network (typically, the advertised maximum speed).

- **Peak upstream speed** – The *maximum* speed at which a subscriber can upload content to and through the network (typically, the advertised maximum speed).

- **"Typical" downstream speed during busy hours –** The *expected or actual* speed at which a subscriber can download content from and through the network during periods of heavy network usage.

- **"Typical" upstream speed during busy hours –** The *expected or actual* speed at which a subscriber can upload content to and through the network during periods of heavy network usage.

- **Symmetry** – A measure of the difference between downstream and upstream speeds.

- **Latency** – A measure of how long it takes to deliver a packet across the network to its destination, often expressed in terms of "ping time." Latency varies as a function of the target destination, the length of time the packet is "queued" within the network, the delay that results from retransmission when a packet is dropped due to network congestion, and the network's traffic load and congestion level.

- **"Jitter"** – Formally, a measure of the variance in latency over time. More practically, the probability of disruption to streaming services such as video, voice or conferencing. Because "jitter" is a derivative metric, it varies as a function of the same factors that influence latency. Notably, though, a broadband service may have high "jitter" even if it has acceptable levels of latency.

- **Service Availability –** A measure of the percentage of time that a high-speed Internet access service meets advertised performance specifications. Service availability may vary based on the technology used or the manner in which a specific operator implements that technology or loads traffic within its network.

- **"Always On"** – A measure of whether a network enables communications to be initiated at any time. "Always on" access tends to change the way that users perceive and use the Internet, while facilitating certain applications impossible in the absence of continuous access. On the other hand, "always on" access may not

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18-19, 2008) (noting that "although existing definitions [of broadband] focus on what broadband is *not*, there are no real limitations on what it can *become*, and therefore it is better to avoid rigid definitions.").

be desirable due to concerns about security, and increased exposure of end-user devices to "hacking" and other network threats.

- **Mobility and Portability –** The extent to which a broadband service can be used while in motion or at multiple fixed locations. This dimension may be impacted by the availability of roaming and similar arrangements between network operators.

- **Price** – The cost of the broadband service to the consumer.

- **Usage Caps** – The limits placed on the volume of capacity that a consumer may use during a given period (*e.g.,* X MB/GB per month).

Critically, different broadband solutions combine these dimensions in different ways to respond to consumer demand and achieve a desired price point. Moreover, *because* broadband solutions can vary across a large number of dimensions — and incorporate different combinations of features, performance, and price — at any given point in time a variety of broadband solutions are both technically and economically feasible. Some of these solutions may be quite similar to each other (*e.g.,* cable and DSL), while others may diverge significantly (*e.g.,* mobile and public safety networks). Regardless, users in most areas should have a range of options from which to choose.

In the absence of further constraint, market forces will determine which of these broadband solutions will succeed and which will fail. Given a competitive market, those solutions that are most responsive to consumer needs and preferences should succeed, while those that do not respond to such needs and preferences are likely to fail. More specifically, even in the absence of government-mandated definitions of, or performance criteria for, broadband, consumers can apply their own implicit or explicit performance "thresholds" in evaluating different broadband solutions, which are likely to vary from consumer to consumer. Through this process, the market should give rise to a variety of services that collectively may be viewed as "broadband" — and implicitly defined as such through an emergent, "bottom-up" process.

Among other things, such a "bottom-up" approach accounts for the complex interplay between the fixed technical characteristics of the network and "time-variant" operational factors. Many of the dimensions described above — including, for example, "typical" downstream and upstream speeds, latency, and "jitter" — cannot be measured meaningfully without accounting fully for contextual factors such as network topology, traffic loading, and congestion, all of which directly impact the user's quality-of-experience. These elements can alter dramatically the performance of the network, and the consumer's perceived value of the underlying service.

For example, studies have shown that the performance of shared broadband networks is inversely related to the number of simultaneous network users.[5] Network congestion at any given point in time can have a significant impact on latency, jitter, peak speed, and

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[5] *See* Cable Television Laboratories, Inc., *Cable Data Modem Performance Evaluation: A Primer for Non-Technical Readers*, at 6 (1996).

volume per subscriber. In fact, this impact may be greater than the impact of other, "time-invariant" characteristics, such as propagation delay. Similarly, the geographic distribution of subscribers with respect to a physical network may impact how the network performs. For instance, the proximity of users to cell towers, or the nature of the terrain and obstructions between those users and nearby cell towers, can significantly affect the performance of a wireless network.

Thus, an understanding of specific network traffic models and network topologies (*i.e.*, the number of subscribers in each segment of the network topology and their anticipated usage over time) and of actual traffic loading is essential to determining how a given network is likely to perform, and whether the network does in fact perform as intended. Unfortunately, these "time-variant" factors are often ignored by those seeking to measure broadband performance — further undermining the utility of "top-down" definitions of broadband.

The "bottom-up" approach also recognizes that, much as the dimensions listed above are useful in describing different broadband services, consumer preferences cannot be reduced entirely to a few technical metrics that can be used by "experts" to "score" those services. Often, consumers will place value on aspects of service that either cannot be perceived or that are afforded insufficient value by "experts." For example, from an "expert" perspective, cable television may appear to be "better" than satellite television; satellite television faces significant obstacles, such as rain outages, difficulties in providing local channels, challenges with real time interactive "feedback," and more complex installation. Even so, over 30 million Americans choose to subscribe to satellite television because that service, for one reason or another, provides benefits that outweigh the disadvantages perceived by "experts" (*e.g.*, more content, more HD channels, better perceived picture quality, better content bundles, better customer service, etc.). Satellite broadband has the same opportunity to overcome similar hurdles predicted by "experts" — particularly given the enormous capacity advantages of next-generation broadband satellites and the increasing importance of media and video to broadband service — where satellite has proven customer acceptance and potential advantages.

Perhaps most obviously, a "bottom-up" approach facilitates the development in the marketplace of multiple types of broadband services, which allow consumers to choose from a variety of "broadband" types in selecting the solution that best meets their particular needs. Such competition between close substitutes (*e.g.*, cable and DSL) leads to better service and lower prices for consumers, while even the presence of imperfect substitutes can raise the competitive bar and spur further innovation (*e.g.*, next-generation satellite vs. cable and DSL).

In contrast, because of the varying technical characteristics of many broadband services, and the different preferences of individual consumers, any effort to define "broadband" in terms of a single set of "top-down" performance criteria would be unwise. Similarly, "composite" measures of broadband quality are of limited value, and in fact run a significant risk of ignoring characteristics that are relevant to consumers. As an initial matter, composite measures typically assign somewhat arbitrary weights in attempting to aggregate measurements of the specified dimensions of broadband service. Of course, if these weights are incorrect, or if salient characteristics that determine a user's quality-of-experience are not included, the

composite measure, and particularly comparisons of different broadband solutions using that measure, are not valuable, and in fact can be misleading.[6]

More importantly, composite measures treat all network operators as if they have the same service objectives in developing broadband solutions, and all consumers as if they have the same needs and preferences in selecting from a variety of broadband solutions. Because network operators can and do provide *divergent* broadband solutions, it makes little sense to evaluate those solutions as if they were designed by network operators to realize a single, *convergent* set of performance targets. At the same time, it makes little sense to measure broadband solutions in a manner that does not reflect the varying weights that different consumers place on each dimension of broadband service.

II. THE EVOLUTION OF BROADBAND DIMENSIONS AND CONSUMER PREFERENCES

Just as it would be a mistake to characterize broadband solutions using only one or two salient characteristics (*e.g.*, "speed" metrics), it also would be a mistake to adopt any fixed *set* of dimensions along which to evaluate or define broadband. While the various dimensions discussed in the preceding section are salient to an evaluation of *today's* broadband networks and applications, there is no guarantee that any of them will have the same relevance in the *future*. Rather, it is likely that some of those dimensions will become less relevant, while other dimensions — including some that cannot be foreseen today — will become more relevant.

This is the case for several reasons. First, technological improvements drive significant modifications in network design, and change the relevance of existing service metrics and the relative weights that consumers assign to those metrics. Second, consumer preferences change, such that certain service metrics or features become more or less important. Third, changes in available applications alter the relevance of certain dimensions in evaluating the utility of a given broadband service to consumers. Fourth, as broadband technologies improve and broadband penetration increases, consumers may place a greater emphasis on non-technical aspects of various broadband solutions, including economic (*i.e.*, price), competitive, or other "go to market" factors.

The following is a non-exhaustive list of broadband service dimensions that are likely to become more relevant in the near future (although there is no guarantee that these dimensions *will* become more relevant):

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[6] Certain proposals have been made to adopt composite broadband quality scores that do not take into account critical factors that affect an end-user's quality-of-experience, such as volume, usage caps, or congestion. *See* Robert Pepper, Presentation at the FCC Broadband Workshops: International Lessons (Aug. 18, 2009), *available at* http://www.broadband.gov/docs/ws_int_lessons/ws_int_lessons_pepper.pdf. Such proposals make value judgments about "broadband" from the perspective of an equipment manufacturer, rather then the consumer. Moreover, they do not take into account the traffic loading and network configuration considerations that directly affect the perceptions of consumer, which should be paramount in setting broadband policy.

- **"Bursting"** – The extent to which a broadband solution provides the ability to temporarily increase service quality to accommodate specific functions (*e.g.*, telemedicine procedures).

- **Application integration** – The extent to which a broadband solution bundles network access with a particular application or particular equipment (*e.g.*, Amazon Kindle, medical devices, etc.).

- **Convenience** – The extent to which a broadband solution incorporates features that allow desired applications to work better or more conveniently (*e.g.*, caching, restoral, multi-casting, etc).

- **Security** – The extent to which a broadband solution protects user data and capacity from unauthorized intrusion, through network design or application integration.

- **Safety** – The extent to which a broadband solution protects the physical and emotional well-being of vulnerable users through network design or application integration (*e.g.*, child protection features).

- **Emergency preparedness and disaster protection** – The extent to which a broadband solution is robust and responsive to emergency conditions.

- **Differentiated service or pricing models –** The extent to which a broadband solution is available under a variety of service and pricing options that are differentiated by factors other than speed (*e.g.*, daily, hourly, or weekly vs. monthly rates, pre-paid vs. post-paid models).

While relevant dimensions of broadband service evolve over time, so, too, do the "thresholds" implicitly or explicitly used by consumers to evaluate different broadband options and select from among them. This is true because the performance of available broadband solutions with respect to any given dimension, and in light of changing consumer needs and preferences, vary over time for a variety of reasons. For example:

- The geographic distribution of a network operator's subscriber base relative to its network infrastructure may change over time (*e.g.*, how subscribers are dispersed within wireless coverage zones, how subscribers are dispersed within cable or fiber nodes, how subscribers are dispersed among xDSL central offices or within satellite spot beams, etc.).

- Consumers may demand new or different network capabilities in light of newly-introduced applications, or existing applications that become more desirable.

- Consumer demand for and usage of specific applications may increase (or decrease) over time, even if speed requirements do not (*e.g.*, subscribers may watch more video per week at the same speed of video delivery).

- The same applications may require higher speeds over time as they evolve, also resulting in increased volume per unit of time (*e.g.*, the evolution to high-definition video).

- The same applications may require lower speeds or become more tolerant of latency and other network limitations over time due to improvements in compression technology, protocol spoofing or proxy, or application modifications.

- Subscribers may adopt new applications that result in quantum changes in their expectations for broadband service (*e.g.*, emergence of streaming video and video downloads drastically increasing consumer expectations with respect to available network capacity).

- Subscribers may take advantage of alternative services to substitute for some elements of an existing service, decreasing expectations with respect to related dimensions of broadband service while increasing expectations with respect to other such dimensions (*e.g.*, substituting mobile phone service for DSL-based VoIP, but demanding better media delivery capabilities).

- The use of the Internet for "real time media events" (*e.g.*, the Olympics, other sporting events, the funeral of a major public figure, breaking news coverage, etc.) may create much higher aggregate concentrations of demand per geographic area over short periods of time (even if aggregate usage levels per month do not change).

The evolving nature of salient broadband dimensions and consumer expectations with respect to those dimensions provides further reason to avoid defining "broadband" in terms of a single set of performance criteria, or a set of performance criteria designed to change over time in accordance with fixed expectations about the future. Not only is there a wide variation in available broadband solutions and consumer expectations at any given point in time, but those broadband solutions and consumer expectations evolve over time in response to complex and unpredictable technical and market dynamics.

As we have seen already, the applications identified as important by consumers who *do not currently have broadband Internet access at home* are far different than the applications that many people "assume" are driving factors for the development of broadband policy. Studies show that downloading movies and music, and streaming audio files, are far more important drivers of consumers' broadband decisions than in the past.[7] Indeed, five years ago, few would have predicted the development of services such as Hulu, or Netflix's delivery of movie rentals via the Internet, both of which are placing pressures on Internet access providers to evolve their systems.[8] Similarly, the development of the iPhone and new applications for that

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[7] *See* Consumer Electronics Association, *Broadband in America: Access, Use and Outlook*, at 8 (Jul. 2007), *available at* http://www.ce.org/PDF/CEA_Broadband_America.pdf.

[8] *See* Amogh Dhamdhere and Constantine Dovrolis, *Can ISPs be Profitable Without Violating "Network Neutrality"?*, Paper delivered at NetEcon '08 (Aug. 22, 2008).

device is placing positive pressure on wireless networks to upgrade their existing plant to keep up with consumer demands.

Consequently, any definition of "broadband" stated in terms of a fixed set of performance criteria is likely to become increasingly inaccurate over time, and thus would ill-serve network operators and consumers. Even if such a definition were to include a built-in mechanism for changing performance "thresholds" over time (*e.g.*, evolving speed minimums), there would be no basis upon which to conclude that either the dimensions targeted or timetable enforced would be appropriate. Further, there is little reason to believe that government regulators could respond effectively to changes in prevalent technology and market conditions to adjust the definition of "broadband." Government agencies are deliberative by design — and rightly so — leading to an inevitable "regulatory lag" that precludes the careful tailoring of regulations to current market conditions.

A "top-down" approach to defining "broadband" would not only be ineffective, but also could damage continuing efforts to provide innovative broadband solutions throughout the United States. By placing its imprimatur on certain types of broadband services, the government could encourage network operators to provide those types of services to the exclusion of others. At the same time, consumers could perceive this standard as a strong signal about what services they *should* be using — even if those services do not provide the best objective mix of features, performance, and price.

Further, to the extent that government regulators were to implement a "top-down" definition by imposing performance mandates or tying benefits to a network operator's ability to meet certain performance targets on a "voluntary" basis, doing so could distort the market and adversely affect continuing efforts to provide innovative broadband offerings. At the same time, such action could bias the development of broadband technologies, services, and solutions in favor of the government's pre-ordained "solution." Experience has shown that when governments pick technological winners, consumers lose. Instead, technological winners and losers should emerge organically as the product of market dynamics.

III. CONCLUSION: ACCOUNTING FOR MULTI-DIMENSIONALITY

These considerations lead to several conclusions about the proper role of the government in defining "broadband." Most importantly, the government should refrain from defining "broadband" in terms of fixed performance criteria, or in any other manner that would favor certain technologies over others. As discussed above, consumer expectations with respect to broadband service vary markedly, and are likely to vary in complex and unpredictable ways over time. As such, no such definition would be accurate, either in the present or the future, while such a definition would harm continuing innovation by network operators and service providers. Instead, the government's definition of "broadband," whether implicit or explicit, should remain flexible, particularly given the inability of government to react quickly to changes in prevalent technologies and market dynamics.[9]

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[9] It may be reasonable to impose *some* minimum screen to filter out services that clearly are not broadband (*e.g.*, services supporting only "dial-up" speeds). However, such a screen should be used to specify what broadband *is not*, rather than what broadband *is*.

Nevertheless, the government can make a valuable contribution in ensuring that markets for broadband services function effectively. As in other industries, the government can take measures to improve the ability of consumers to evaluate and select from among the various broadband services and solutions available now and that will be available in the future. The following measures would help to facilitate the workings of a competitive market, and allow consumers to realize the full benefits of competitive broadband service offerings:

- **Educate consumers with respect to various "broadband" offerings –** Steps should be taken to make certain that consumers are aware of the different types of available broadband services, and to assist consumers in evaluating the various dimensions of those services. These steps would facilitate the ability of consumers to make intelligent, informed choices about the type of offering most likely to meet their individual needs.

- **Create common standards or ratings for broadband metrics** – The development of standardized metrics with which network operators can measure and express the various dimensions of their services would ensure that consumers can perform "apples-to-apples" comparisons among different network operators and service providers. The government also should consider ways to facilitate the development of standardized traffic and configuration modeling methodologies to enable consumers to rate broadband service performance claims and meaningfully compare those claims across providers.

- **Encourage network operators and service providers to disclose standard metrics with respect to each of their service offerings** – Identifying the most salient dimensions of broadband services (at intervals over time) and having network operators and service providers disclose how their services perform in accordance with standardized metrics would allow consumers to make meaningful comparisons between and among those offerings.

- **Continue to collect data with respect to *all* high-speed Internet access offerings –** The FCC should continue to monitor progress in increasing access to broadband services. Data collection (*e.g.*, through FCC Form 477) facilitates this goal, as will mapping initiatives pursuant to the Recovery Act.

Many of these goals could be satisfied through self-reporting and analysis by broadband service providers, and some could be supplemented through "ratings" performed by consumer-oriented non-profit organizations that are well-situated to respond promptly to changes in the marketplace. At this point in the development of broadband Internet access, however, it is important that the government regulate with a light touch to avoid stifling the competitive forces that continue to foster innovation and the development of new services and networks.