## POSITION STATEMENT

# NETWORK TRAFFIC MANAGEMENT

***Adopted by the IEEE-USA***
***Board of Directors (19 Nov. 2010)***

The Internet has become key to the U.S. communications infrastructure and our country's economic growth. The health of the Internet is pivotal to U.S. competitiveness, job creation, efficient government and future prosperity. One way of measuring the health of the Internet is to assure fair delivery of Internet services with acceptable performance in the United States, which is often dependent on network traffic management (NTM). NTM consists of techniques to attain optimum performance for diverse classes of users to satisfy their needs and the needs of the public.

Stakeholders in this issue range from network infrastructure providers through Internet Service Providers and content originators to end users, large and small. Conflicting interests among the different stakeholders also must also be reconciled. To resolve these issues, stakeholders should agree on clear and simple principles, whether established by the market, by law, by regulation, or jointly by all three. IEEE-USA proposes six basic principles:

- **Minimal regulation** -- principally to remedy market abuse and to encourage maximum investment
- **Competitive providers** -- to assure user choice, to compel efficient pricing, and to stimulate innovation
- **Transparency** -- to specify service levels and to reveal the degree to which they are achieved
- **Service levels** -- to accommodate different user needs for bandwidth, latency, and availability
- **Performance measures** -- to provide quantitative metrics for evaluating service
- **Nondiscrimination** -- as to lawful originators, consumers, content, applications, or services.

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These principles lead directly to the following recommendations:

- **Congress should authorize regulators to monitor network traffic management practices and metrics, and to remedy any abuses of norms established by authorized rulemaking.**

  This measure would protect consumers through the adoption of transparency in data transport and of standardized metrics (e.g., *bandwidth, packet loss, latency, jitter,* and *availability,* covered in the Background).

  Currently, little regulation of Internet traffic practices exists, especially given the Comcast v. Federal Communications Commission decision [600 F.3d 642 (D.C. Cir. 2010)]. Neither industry nor Congress wants heavy Internet regulation. But if industry adopts transparent norms based on quantitative performance measures, regulators need some authority to monitor practices and metrics and to levy fines for egregious departure from accepted norms.

  Such abuses would consist of norms violations established by rulemaking authority given by Congress. Examples would be improper blocking, throttling, filtering and delaying data, as well as improper preferential treatment of data or content sources.

- **Regulators should provide structural incentives for greater competition among Internet service providers.**

  The result should be to foster competition and innovation. Entrepreneurs and companies can better assess opportunities to innovate and compete.

  Regulators (such as the Federal Communications Commission, Federal Trade Commission, and municipalities) would guide ISP industry structure in the direction of more, not less, competition. Structural incentives might consist of regulatory forbearance, if adequate competition emerges -- or reduced franchise fees if there are multiple ISPs. Competition tends to lower prices and to improve service, with greater speeds for example.

- **Regulators should require full disclosure of service offerings and resulting performance.**

  This requirement would preclude discrimination by relying on parameters that define quality of service, according to user-selected service levels. Policy makers would obviate discrimination against content, sources, and users by requiring transparent, objective performance measures and remedy of abuses.

- **Industry should offer clearly defined, on-request, tiered service levels to users based on quantitative, standardized, and regularly-updated performance measures.**

  Performance measures, recognized industry-wide and based on standardized technological metrics, constitute the basis of network traffic management. They would provide quantitative characterization of Internet service. Both providers and users gain a

complete specification of various Internet service levels. Different users can match levels to their particular needs. Full information about product and price allows orderly market-based buying and selling, as it does for any other good.

- **Internet service providers should differentiate traffic based only on user-purchased service levels, and not on content, originator, or consumer.**

  This practice would further discourage discrimination by relying on parameters that define quality of service, according to user-selected service levels.

- **Network providers, to guarantee quality of service, should construct contractual agreements that adequately reflect capabilities.**

  Following this recommendation would assure orderly delivery of data, voice, images, and video by avoiding congestion. Users would enjoy a pre-selected and dependable quality of service that is consistent with their usage and economic preferences, rather than promises of maximum performance that is seldom achieved.

The explosive growth and expansion of the Internet demands better methods for handling its traffic. The key recommendation here -- quantitative specifications of tiered service levels -- offers the basis for such improvement. Greater efficiency in the use of Internet resources lessens the need for new facilities, and promotes lower costs and pricing for service delivery. Industry-wide adoption of objective, standardized, and updated transport metrics, coupled with transparency and responsiveness to abuses, guards against practices that discriminate only by content and source. Hence, a goal of network neutrality is advanced through technical means.

This statement was developed by the IEEE-USA Committee on Communications Policy and represents the considered judgment of a group of U.S. IEEE members with expertise in the subject field. IEEE-USA advances the public good and promotes the careers and public-policy interests of the more than 215,000 engineers, scientists and allied professionals who are U.S. members of the IEEE. The positions taken by IEEE-USA do not necessarily reflect the views of the IEEE, or its other organizational units.

For more information, please see IEEE-USA's White Paper
"Network Traffic Management and the Evolving Internet," (2 Nov. 2010),
available at: http://www.ieeeusa.org/volunteers/committees/ccp/docs/NTM-whitepaper.pdf

# BACKGROUND

Digital data makes the Internet an attractive tool for all. The Internet Protocol (IP)-based, packet-switched Internet of today is becoming the world's primary platform for multimedia point-to-point and broadcast communications.

## Internet Characteristics

As the Internet replaces specialized networks, questions remain about how to manage it – especially in view of the following:

- The always-on and 24-by-7 nature of the Internet
- Users' expectation of a consistent level of services
- End-users' tendency to consume all available bandwidth
- The option of providers to build more facilities to accommodate traffic increase, to manage traffic more efficiently, or both
- Networks' responsibility to accommodate new applications that demand bandwidth and quality of service, such as the inevitable advent of entertainment high definition television in both 2D and 3D, video uploads and downloads, cloud computing, and voice over internet protocol, without discriminating as to source or content.

One techniques of NTM is control of performance measures to assure quality of service (QoS). According to the International Telecommunication Union (ITU), the part of the United Nations that addresses international telecommunications policy and standards issues, QoS is "*the collective effect of service performance which determines the degree of satisfaction of a user of the service.*" Another technique is optional service levels tailored to different user needs. Given that much of today's Internet traffic does not stay within a single service provider's network, techniques may need to be developed to support end-to-end traffic management.

Further, an artificial differentiation has been introduced: a distinction, with regard to NTM, between wireless and wireline communications. In fact, network traffic management is applicable to both, especially for the Internet. How a network is built and how content is delivered does not alter the need for network management, though it may alter the particular techniques.

Innovation and fair competition depend on the evolution of an Internet that is balanced and economically viable. To achieve and maintain such balance requires the ability to manage traffic efficaciously. Internet network management policies are molded by business, economic, operational, legal, and regulatory issues. Clear procedures must be pervasive and accepted by all providers and users.

## Stakeholders and Their Interests

**Stakeholders** in the network traffic management debate are numerous but can be grouped by their functions and aims.

**Network Facilities Providers** operate networks that connect ISPs together. They face needed capital expansion of their networks to meet increasing demand.

**Internet Service Providers** deliver Internet service to end-users. They need to provide superior quality of service to preserve and expand their subscriber base.

**Content and Application Providers** connect servers to the Internet or deploy software for peer-to-peer services across the Internet. They require prompt, reliable delivery suited to the nature of their material.

**End-users** are composed of both individuals and enterprises. Individuals wish to download and upload material conveniently and affordably. Enterprises rely on the Internet for effective communication with customers, suppliers, and employees.

**Legislators** propose legislation that promotes economic and social benefits of the Internet.

**Regulators**, including federal, state and municipal public officials, administer such legislation, and establish regulations and guidance when feasible, and within their authorities.

Accordingly, the framework for network operation and traffic management should be based on the principles, to reconcile complex stakeholder interests.

## Performance Measures and Service Levels

Standardized performance measures — using the fundamental metrics of *bandwidth, packet loss, latency, jitter,* and *availability (uptime)* — form the technological foundation for fair and transparent network traffic management as well as for efficiently buying and selling Internet service. Bandwidth refers to the rate, or speed, at which data is transmitted. Internet messages are subdivided into separate packets that separately traverse the network. Packets are susceptible to being dropped, or lost in transmission. Latency is the delay between sending and receiving a packet. Jitter is the variation in this delay. Availability is the percentage of time a connection is available from the user to the Internet. These five performance measures are used most frequently in network traffic management as quality of service measures.

**Table 1. Sample Network Requirements by Application**

| Application | Bandwidth (Mb/s) | Acceptable Packet Loss | Target Latency (milliseconds) | Target Jitter (milliseconds) |
|---|---|---|---|---|
| VoIP | 1 – 5 | Up to 1% | 150 | 50 |
| Telepresence | 8-10 | Up to 0.05% | 150 | 30 |
| Ordinary Power System Control | Negligible | Generally much greater than 1% | 2000 - 6000 | Not applicable |

**Sources:**

T. J. Kostas, M. S. Borella, I. Sidhu, G. M. Schuster, J. Grabiec, and J. Mahler, "Real-time voice over packet-switched networks ", *IEEE Network*, vol. 12, no. 1, pp. 18 - 27, Jan/Feb 1998.

T. Szigeti, C. Hattingh. "Quality of Service Design Overview". *End-to-End QoS Network Design*. Cisco Press: Nov. 2004.

Sample network requirements for availability are not generally published, but they should be established. For example, extremely high requirements are observed for the public-switched telephone network.

To manage expectations, *tiered service levels* group ranges of quality of service into simple, easily understood options. An ISP can differentiate on service level, rather than on content, source, or destination.

Tiered service levels can create opportunities for a variety of innovative value/economic models, but need standards and safeguards to create an open and fair market. User-selected, on-request tiered service levels designed to accommodate widely different user needs can facilitate the traffic management problem. To guarantee QoS, the network provider reserves network resources for the requesting customer, according to a service level agreement (SLA)[1], a contract between the user and the provider. Current SLAs for individual consumers are inflexible, and difficult to compare among providers.

## Models for Managing Traffic

Two main categories, plus *end-to-end,* of network traffic management approaches have evolved: managing traffic in the *core,* or backbone facilities, and managing traffic at the *edge,* where the users are.

**Managing at the Core** -- Several strategies are used to manage services at the core, such as tagged priority routing, bundled QoS management, and latency management through priority queuing. When excessive network congestion surfaces, another important tool is to selectively discard packets. Monitoring the efficacy of these strategies is usually accomplished by analyzing

[1] According to Meddeb in *IEEE Communications Magazine,* Jan. 2010, Service Level Agreement, or SLA, is generally business oriented and does not deal with technical aspects. In fact, the residential SLA serves more to limit ISP responsibilities, rather than to protect residential users. On the other hand, corporate SLAs are usually more stringent than residential ones. In general, there are objectives on network availability, latency, jitter, and packet loss.

performance metrics discussed earlier. Standardizing these metrics facilitates industry-wide analysis and performance expectations.

**Managing at the Edge** -- Most traffic comes from providing service to the individual user. Techniques developed to manage high traffic volume include blocking, filtering, and most notably, throttling. Standardized metrics help both providers and subscribers understand network performance, and how different needs demand different service levels. Voice over Internet Protocol (VoIP) and movie downloads, for example, are two very different applications with different measures of quality and performance. Metrics can help determine the variance in costs among service levels.

The cost of expanding edge facilities to accommodate increased traffic is high because of widely separated wireless cell sites and highly dispersed subscribers to digital subscriber line, coaxial cable, and fiber. Accordingly, a high return on traffic management efforts is likely to occur at the edge.

**Managing End-to-End** -- Comprehensive end-to-end traffic management across the Internet is not currently feasible. However, large consumers of service provider resources often employ service level agreements to guarantee QoS within a single provider's network.

## Action

Without strong-arming the management of the Internet, largely a product of U.S. ingenuity and policy guidance, the United States must reassert its influence in guiding the Internet. In particular, federal policymakers should urge industry-wide standards to be accepted that will permit fair and transparent network traffic management practices. Competing interests have big stakes in the efficient, economical and fair Internet management. A sound network traffic management policy must address and support these complex interests.

Additionally, industry and government alike must agree on performance measures in network traffic management. Such measures, recognized by industry in the form of metrics for bandwidth, packet loss, latency, jitter and availability — form the technological foundation for fair and transparent network traffic management.

Finally, focusing on purely technological performance measures and user-selected service levels precludes any improper preferential treatment of data. Thus, network traffic management mitigates controversial discrimination issues surrounding network neutrality.