Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
A National Broadband	)	
Plan for Our Future	)	**GN Docket No. 09-51**
	)	
International Comparison and Consumer	)	
Survey Requirements in the Broadband	)	
Data Improvement Act	)	**GN Docket No. 09-47**
	)	
Deployment of Advanced	)	
Telecommunications Capability	)	
to All Americans in a Reasonable and	)	
Timely Fashion, and Possible Steps to	)	
Accelerate Such Deployment Pursuant to	)	
Section 706 of the Telecommunications	)	
Act of 1996, as Amended by the	)	
Broadband Data Improvement Act	)	**GN Docket No. 09-137**

NBP Public Notice #24

COMMENTS OF INTEL CORPORATION

December 14, 2009

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NBP Public Notice #24

COMMENTS OF INTEL CORPORATION

Intel Corporation (Intel) hereby submits the following comments on broadband metrics and service quality disclosure in response to NBP Public Notice #24.[1]

I. Introduction

Broadband consumers would benefit from having accurate, consistent and relevant information regarding the quality and performance of the services available to them. Current broadband performance measurement capabilities such as opt-in speed test websites lack several important attributes individually

[1] Intel, the world leader in silicon innovation, develops technologies, products, and initiatives to continually advance how people work and live. Intel has a long history of supporting public policies that promote ubiquitous, affordable, high-quality broadband in the United States (U.S.) and around the world. Additional information about Intel is available at www.intel.com/pressroom and http://blogs.intel.com/policy .

and statistical compatibility collectively. Additionally, broadband disclosures defining the capabilities and limitations of service plans could be similarly improved, as a result of a cohesive performance measurement plan. Intel believes there could be mutually-reinforcing benefits from improving broadband performance metrics and service disclosures simultaneously.[2]

Over the past decade, numerous efforts by industry groups, companies, academics, and several FCC proceedings have toiled over the complex issues involved in broadband performance measures and service disclosure. The Commission, under the national purpose afforded by the Congressional requirement to develop a National Broadband Plan, is revisiting these important topics in preparing that plan.

II. Proposal

Intel recommends the Commission seek a market-driven solution to these difficult issues by directing industry to develop a detailed system by a date-certain. An industry-created set of metrics, procedures, and best practices might well be able to cost-effectively harness market forces to define, collect, store, and analyze broadband performance data. The system to achieve this result should emphasize accurate, consistent, and relevant data at each step. Such a system will have to deal with a number of complicated issues and the Commission should give guidance on the various dimensions of the problem, it expects an industry system to address.

Imposing a regulatory mandate, such as increased FCC Form 477 obligations, in the National Broadband Plan the Commission submits to Congress would be a mistake. The dynamics of end-to-end broadband usage and applications requirements call for a market-driven solution that permits flexibility in response to changing market developments.

Below, Intel proposes a framework for consideration in preparing such guidance, highlighting several issues worthy of deliberation during the development of such system. The Commission, in issuing its guidance directing industry to develop a detailed system, should make clear that if industry fails to develop a satisfactory system by the date-certain, it will act.

[2] Technical and operational differences with mobile/wireless broadband may require separate considerations.

III. Considerations for Commission Guidance to Industry

1). Define a standardized set of metrics, which would be included in each test result.

Intel suggests the following minimum set of broadband metrics be considered for inclusion in each test result:[3]

1.1) Upload throughput
1.2) Download throughput
1.3) Packet loss
1.4) Latency

2). Define standardized test procedures and measurement scope for acquiring/storing the metrics from #1.

Well-defined procedures for collecting and storing each test result are necessary, in order to ensure the consistency and integrity of test results. Virtually any test can be performed in multiple ways, some yielding inflated or unrealistic results if the methods are unspecified and unbounded. Without adequate consistency designed into the test procedures, statistical comparisons can lose their significance. Intel suggests the development of standardized test procedures to measure the metrics including:

2.1) End-to-end measurement results for the 4 metrics.
2.2) Results for the last-mile segment only.[4]
2.3) Latency and packet loss for each intermediate link between routers.[5]
2.4) For all the above, an initial testing focus during the evening busy period.

3) Define a standardized set of identifiers to accompany each test result from #1 and #2:

A minimum set of identifiers should be defined. Identifiers are the necessary descriptive data associated with each test result, so that the eventual collection of aggregated test results can be sorted and analyzed by relevant scenarios

[3] Other parameters and composites of parameters are possible. Intel believes this set of four strikes the right initial balance between complexity, relevance, and data collection density. This should be flexible so that additional parameters such as jitter, and/or composites can be collected. The market will determine the value of additional parameters over time, but Intel believes this core set of four parameters will have performance relevance long into the future.
[4] This is intended to delineate accountability partitions in network performance, i.e. the last mile service provider does not control network performance issues in other parts of the network.
[5] This is intended to aid in identifying performance issues outside the last mile network.

based on these identifiers. Intel suggests the following identifiers should be considered for inclusion in each test result:

3.1) Date and time stamps
This information would allow sorting the results by day or time range of interest, for statistical analysis. Network performance does vary, sometimes considerably, by time and day.

3.2) Geo-location information
This information would allow sorting the results by geographic location, for statistical analysis. For example, zip code or census tract. It is important for statistical relevance, to be able to exclude geographically irrelevant data for a given analysis scenario.

3.3) Service tier code
This information would allow sorting test results by similar service tiers and/or by service providers. For example, getting blended test results of 50Mbps fiber service and 1Mbps DSL service is not statistically meaningful for a subscriber seeking to differentiate the actual performance of different service tier offerings.

To summarize so far, when a particular user device runs a broadband performance test at a particular time/day, the "test result" will be a package of information that includes the identifiers from #3 and the metrics from #1, gathered per the procedure and scope in #2. Each test result should typically take well under a minute to generate. A given user device on a given day may generate many test result packages if online for many hours. Test results from millions of users, over time, are intended to be aggregated for later statistical analysis and comparison purposes.

However, it is important to note that #1-3 above only address the integrity of individual test results. That integrity must be maintained once the results are aggregated as well. A plan that consists of multiple independent industry efforts with dissimilar definitions and procedures for #1-3 cannot necessarily be aggregated for statistical advantage without degrading the statistical integrity. This will have to be evaluated as industry plans emerge.

4) Define a straightforward procedure for test hardware/software vendors to certify the reliability of their product, relative to #1, 2, and 3 above.

This is a separate process from #1-3 above, and is done once, up-front, by a vendor/provider of hardware/software testing capability. The purpose is to certify

the accuracy and consistency[6] of a given test capability, based on a standardized test under controlled conditions. Accuracy and consistency in individual test results would be vital to the statistical validity of the aggregated test results. Products that pass the test should include a certification logo, to allow consumers to know they are using a certified product. Test results from products that are not certified should not be aggregated with test results from certified products, as this would negatively affect the integrity of the overall analysis results.

The certification procedure and the parameters of the controlled test would need to be clearly defined. Vendor self-certification is a viable goal. The acceptable range of results should permit some flexibility in test hardware/software, but must ensure low statistical error margins across the different test products.

5) Define certain standard operating principles of the data storage facilities used to store the results from implementing #1, 2, 3, and 4 above.

Test results that are just snapshots in time (i.e. they are not saved to data storage) are less useful. Greater value to subscribers and to the market in general would come from the analysis of a group of statistically-related entries spanning a time frame of interest and filtered by other relevant variables (the Identifiers in #3).

In order to aggregate certified test results for statistical analysis purposes, some form of data storage infrastructure would be necessary. Ideally, the stored data would have a common and authenticated format (verified as part of #4 above) so the results could be readily analyzed and could not be tampered with.

Certain operational attributes of this storage infrastructure should be maintained to preserve the data integrity attributes set up by #1-4. However, there should not be a specific architecture or technology requirement. Intel suggests the following operational attributes be considered for the storage infrastructure:

> 5.1) The storage infrastructure should only accept test results from certified test capabilities, to preserve statistical integrity.
>
> 5.2) Data residing in this infrastructure should be openly available under commercial terms, for any third party to perform analysis on test results.[7]

[6] Since there will be un-resolvable technical debates about one measurement implementation being more accurate than another for particular scenarios, a single "perfect" measurement cannot be the goal. Instead, a goal of a reasonable range of accuracy, and high consistency of that level of accuracy, should drive the certification boundaries. Many different measurement implementations are possible and should be permitted, so long as consistency is achieved. A common and authenticated format for test results is also a desirable attribute.

[7] It is expected that a subscriber would utilize the 3rd party analysis either through reports or web-based interface.

This openness allows the market to determine the most trusted analysis sources.

5.3) In the case of a distributed storage infrastructure, "peering" arrangements for cross-sharing all data could be advantageous to maximize the statistical value in aggregate, and to minimize the effort required for third parties to assemble all data. There is presumed mutual benefit for all parties to have all data.

6) Standardized Service Disclosure Statements

Utilizing the analysis results from implementing a program of statistically-sound broadband measurements, a standardized service disclosure statement could be adopted. Such disclosure statements would leverage the accurate, consistent and relevant performance data produced. A minimum set of performance statistics over a common timeframe could be adopted. Service providers should be free to supplement the minimum set with additional parameters and statistics.

Respectfully Submitted,

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Appendix A. Past and Present Network Performance Initiatives and Tools

Dozens of broadband connectivity performance tools already exist in the marketplace today, ranging from free or low cost tools, to advanced tools aimed at analyzing, characterizing, troubleshooting, and logging the usage patterns and workloads of a collection of users such as an enterprise. Additionally, efforts by academic and non-profit groups (some dating back a decade) have historic and current data on broadband network performance metrics such as round trip delay, upstream/downstream bandwidth, and latency. A non-exhaustive list of examples of the above network measurement product capabilities and methodology development efforts are briefly described below.

A.1 SamKnows

In the U.K., the quality of broadband performance information available was deemed inaccurate and anecdotal. A third-party company named SamKnows partnered with U.K. regulator Ofcom on a performance measurement project to create a single methodology for comparing broadband performance. This involved a dedicated hardware "black box" for 24/7 measurements. Tests currently include latency, packet loss, VoIP quality scores, jitter, upload/download speed, among others. Further details are available at: http://www.samknows.com/broadband/performance.php?page=performance-ofcom-and-samknows and the 2008 report is available at: http://www.samknows.com/broadband/pm/PM_Summer_08.pdf

A.2 M-Lab

M-Lab (Measurement Lab) is an open platform for deploying internet measuring tools, with a goal of providing the public with information about their broadband connection. M-Lab has a suite of tests for diagnosing and measuring the performance and limitations of broadband connections, including a variation of Internet2's NDT mentioned below. See http://www.measurementlab.net/about for additional details.

A.3 The PlanetLab Consortium

PlanetLab is a global consortium of universities that is designed to create new services. PlanetLab users can obtain virtual machines from over a 1000 different servers at over 480 sites. Network Measurement is a common service

implemented on PlanetLab, and Intel has measured its web sites and Internet connectivity from different geographies in the world using PlanetLab (see papers http://portal.acm.org/citation.cfm?id=1497308.1497384&coll=Portal&dl=GUIDE&CFID=54313597&CFTOKEN=69272564 and http://neotextus.net/papers/noms06/)
Additional information on PlanetLab can be found at: http://www.planet-lab.org/impact

A.4 The CoDeen Content Distibution System

Codeen is a content distribution system that consists of high performance proxy servers. It is a free service used by thousands of people to speed up their browsing. This proxy service contains usage logs that can be used to determine network performance from many different Internet Service Providers, and Intel has in the past worked with the Princeton Professors who created Codeen to use their logs for just this purpose. Additional information can be found at: http://codeen.cs.princeton.edu/

A.5 Gomez Networks

This company measures web site performance from many different Internet Service Providers across the world, which can be used to approximate the service quality of those individual Internet Services providers. Intel has used Gomez to monitor the quality of network service. Additional information can be found at: http://www.gomez.com/

A.6 Keynote

Like Gomez networks, this company measures web site performance from many different Service providers. Keynote can also measure web site performance from mobile platforms around the world. Intel has used Keynote's services in the past. Additional information can be found at: http://www.keynote.com/

A.7 The Cooperative Association for Internet Data Analysis (CAIDA)

CAIDA investigates practical and theoretical aspects of the Internet in order to:

- provide insight into the macroscopic function of Internet infrastructure, behavior, usage, and evolution,
- foster a collaborative environment in which data can be acquired, analyzed, and (as appropriate) shared,
- improve the integrity of the field of Internet science,
- inform science, technology, and communications public policies

CAIDA staff has been involved with U.S. telecommunications policy. Intel has been a member of CAIDA. Additional information can be found at: http://www.caida.org/home/

A.8 DUMETER

A software utility known as DUMETER (Download Upload Meter) is installed on end-user computers and gives a real-time display of network bandwidth utilization. The utility also tabulates upload and download bytes of data transferred on an hourly, daily, weekly, and monthly basis, and allows alarms to be set when limits are reached. More information is available at http://www.dumeter.com/

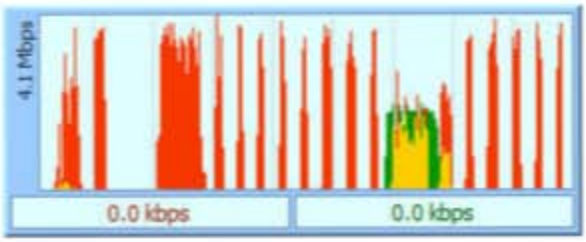

FIGURE 1. Real-time download-upload monitoring software, showing an online replay of a streamed TV show while simultaneously sending an email with a photo attached.

A.9 VisualRoute

Another software tool, known as VisualRoute (see http://www.visualroute.com/index.html) allows numerous measurements and queries, as well as online connectivity tests for several parameters. For example, below are screenshots of the speed test, latency test, the VoIP quality test, and the Video quality test.

FIGURE 2. Capacity test results window, showing the maximum capacity of the connection. The tabs along the left contain additional results and data presentations. A separate test measures the consistency of the achieved upload/download speed. See http://www.myconnectiontest.net/captest/index.html and http://www.myconnectiontest.net/speedtest/index.html

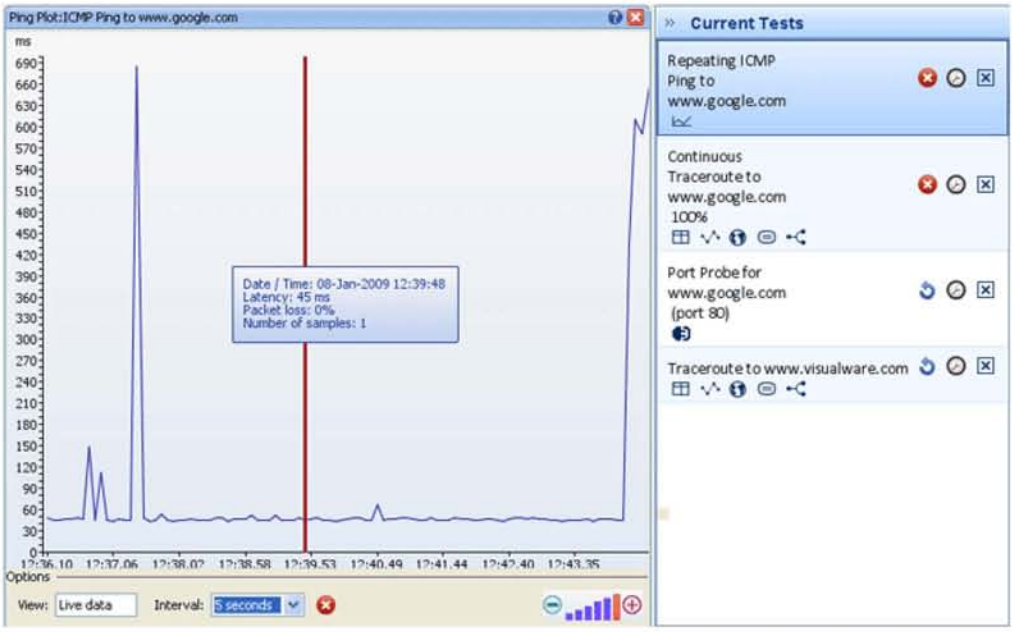

FIGURE 3. Response (latency and packet loss) variations over time, between two network endpoints.

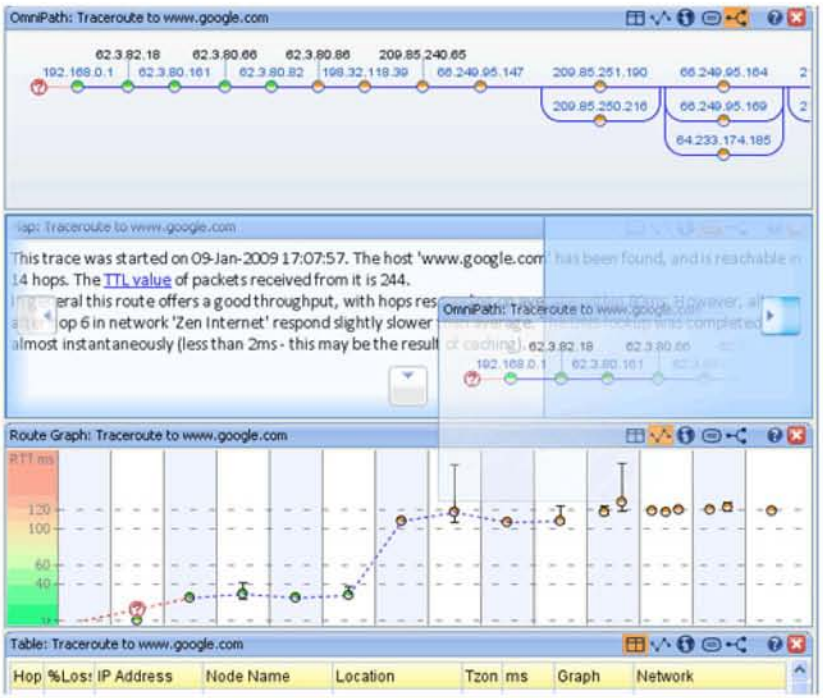

FIGURE 4. Performance of each network segment in an end-to-end path, and alternate routes (the tool performs multiple route discovery).

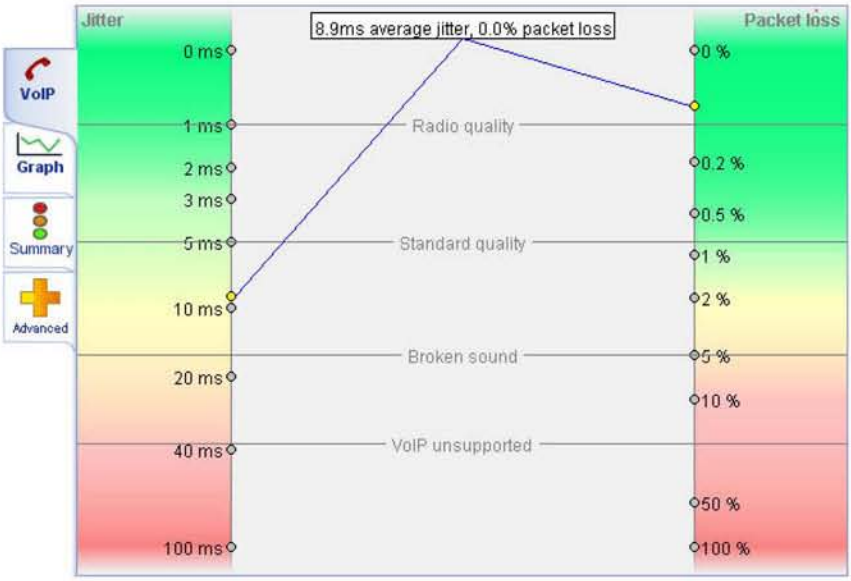

FIGURE 5. VoIP jitter and packet loss results to selectable destination test locations. See http://www.myconnectiontest.net/voiptest/index.html

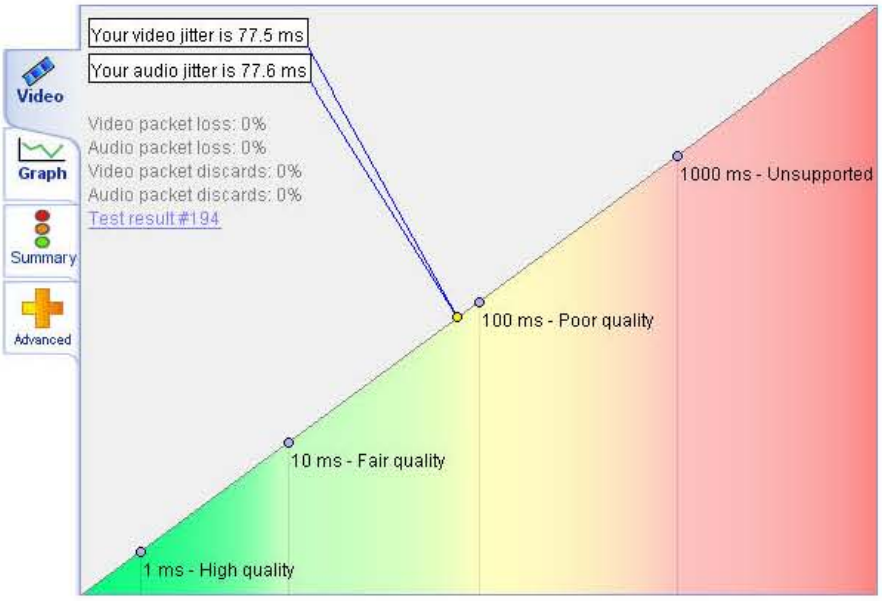

FIGURE 6. Video quality test results. See See http://www.myconnectiontest.net/videotest/index.html

A.10 XIWT

A cross-industry working team (a.k.a. XIWT) set out to develop a measurement architecture and common set of metrics and measurement methodologies to assess, monitor, negotiate, and test service quality. These efforts began about a decade ago, just as cable and DSL broadband deployments were beginning. While the XIWT disbanded shortly thereafter, their efforts and conclusions remain applicable today. The following two papers produced by the XIWT document their conclusions:

"Customer View of Internet Service Performance: Measurement Methodology and Metrics" (available from http://www.xiwt.org/documents/IPERF-paper.pdf) This paper proposes service quality metrics and measurement framework for monitoring the quality of service of a National Information Infrastructure.

"Internet Service Performance: Data Analysis and Visualization" (available from http://www.xiwt.org/documents/IPERF-paper2.pdf)
This is a companion paper to the previous IPERF paper. It describes how to aggregate, analyze, and visualize data for the service metrics described in the above iPERF paper

A.11 iptrafficmonitor

iptrafficmonitor is a real-time bandwidth monitoring software package which shows traffic details and associated application ID for each active connection, as well as providing data logging. Additional details are available at: http://www.skyward-soft.com/iptrafficmonitor.html

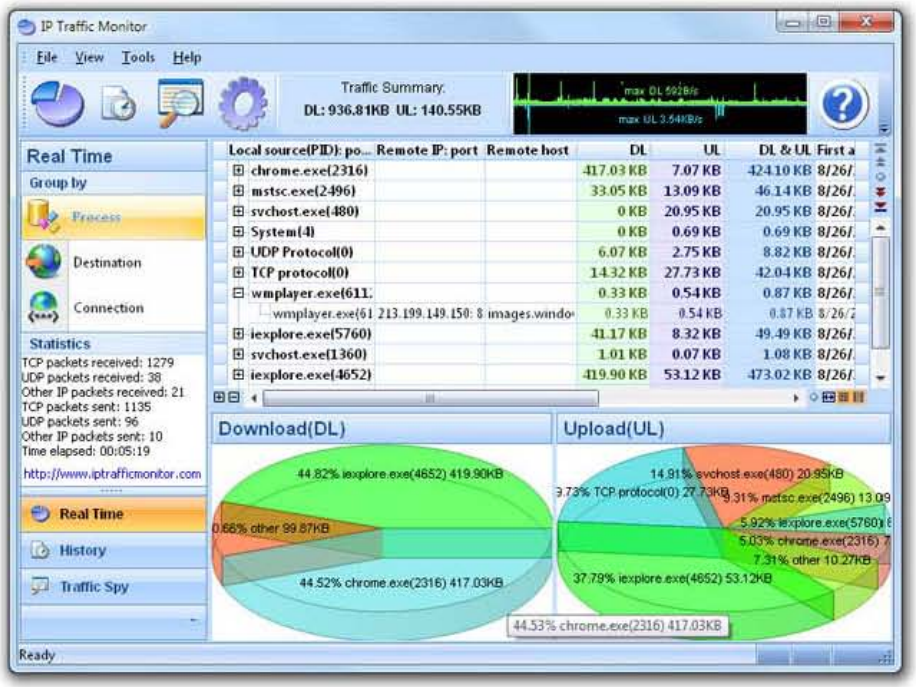

FIGURE 7. Real-time upstream/downstream monitoring and logging software.

A.12 IETF

The IETF (Internet Engineering Task Force) has an Internet Performance Metrics Working Group that has, over the course of several years of effort, developed a standard set of metrics relating to the performance and reliability of Internet data services, as well as measurement procedures and reporting protocols. Additional information is available at: http://www.ietf.org/dyn/wg/charter/ippm-charter.html

A.13 NDT

Internet2 has a number of network performance monitoring and measuring initiatives, including the Network Diagnostic Tool (NDT), a client/server program

used by broadbandcensus.com in their broadband benchmarking efforts. See http://www.internet2.edu/performance/ for additional details on the multiple initiatives

A.14 Stanford Linear Accelerator Center (SLAC)

SLAC and its partners monitor connectivity parameters such as latency, packet loss, and round trip delay, for their affiliated research community worldwide. The monitoring has grown to include over 800 remote nodes in about 165 countries. These efforts first began in 1995, with continuous data and progress reports being issued. The January 2009 report can be downloaded at: http://www.slac.stanford.edu/xorg/icfa/icfa-net-paper-jan09/report-jan09.doc

A.15 Alexa

Alexa is a company that provides web and internet usage data with data gleaned from users who have the Alexa toolbar. This data can shed insights on service provider performance and on the behavior of Internet users. Additional information can be found at: http://www.alexa.com/

A.16 Patent on the Real Time Performance Assessment of Large Area Network User Experience

Bickerstaff, et al., US Patent No 7523190, Real-time performance assessment of large area network user experience

http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PALL&p=1&u=%2Fnetahtml%2FPTO%2Fsrchnum.htm&r=1&f=G&l=50&s1=7523190.PN.&OS=PN/7523190&RS=PN/7523190
OR http://tinyurl.com/y8s45uk

This patent was created by some of the same people who created the XIWT documents. The patent describes a technique for assessing Internet user experience by looking at a combination of active and passive measurements. Passive measurement of Internet service quality includes looking at web server logs.