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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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In the Matter of	)	
	)	
GTE Telephone Operating Companies	)	
GTOC Tariff FCC No. 1	)	CC Docket No. 98-79
GTOC Trans. No. 1148	)	

REPLY COMMENTS OF HYPERION TELECOMMUNICATIONS, INC.
ON PETITIONS FOR RECONSIDERATION

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SUMMARY

As Hyperion stated in its initial comments, the Commission had no factual basis in the record to support its conclusion that interstate traffic represented more than 10 percent of the total traffic carried over the ADSL special access lines provided by GTE. The comments of several of the incumbent local exchange carriers ("ILECs") that oppose the MCI WorldCom Petition and the NARUC Petition make this point all too clear. While none of them provides any reliable support for a finding of 10 percent interstate traffic, Hyperion has, as stated in its initial comments, commissioned a study to investigate the extent of traffic between an end user and an Internet service provider ("ISP") that is used for interstate communications. The study shows that (i) interstate transmissions related to Web browsing constitute 9.69 percent of the total traffic over the local loop, including both dedicated access and dial-up access, (ii) interstate transmissions related to electronic mail constitute 4.50 percent of the total traffic, and (iii) the weighted average for both types of Internet traffic shows that 6.57 percent of the total traffic between an end user and an ISP can be attributed to interstate communications. Therefore, the Commission erred in its conclusion in the *GTE ADSL Order* that interstate traffic represents 10 percent of the total traffic carried over the special access facilities using GTE's ADSL service. Accordingly, the Commission cannot claim jurisdiction over the service using the "10 percent rule," and, therefore, must reconsider the *GTE ADSL Order.*

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Hyperion Telecommunications, Inc. ("Hyperion"), by its undersigned counsel and pursuant to the Public Notice of December 4, 1998,[1] submits these reply comments on the Petitions for Reconsideration filed by MCI WorldCom, Inc. ("MCI WorldCom Petition") and the National Association of Regulatory Utility Commissioners ("NARUC Petition") of the Commission's Order regarding GTE's provision of ADSL service.[2] As Hyperion stated in its initial comments, the Commission had no factual basis in the record to support its conclusion that interstate traffic represented more than 10 percent of the total traffic carried over the ADSL special access lines provided by GTE.[3] The comments of several of the incumbent local exchange carriers ("ILECs")

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[1]Pleading Cycle Established for Petition of MCI/WorldCom and National Association of Regulatory Utility Commissioners (NARUC) for Reconsideration of GTE DSL Order, Public Notice, CC Docket 98-79, DA 98-2502 (rel. Dec. 4, 1998).

[2]*In the Matter of GTE Telephone Operating Cos., GTOC Tariff No. 1, GTOC Transmittal No. 1148,* CC Docket No. 98-79, Memorandum Opinion and Order (rel. Oct. 30, 1998) ("*GTE ADSL Order*").

[3]As stated in its initial comments, Hyperion disagrees with the Commission's underlying conclusion in the *GTE ADSL Order* that Internet communications represent indivisible telecommunications from the end user to the server from which stored information may be obtained by the end user. Instead, Hyperion asserts that telecommunications originating at the end user

that oppose the MCI WorldCom Petition and the NARUC Petition make this point all too clear. While none of them provides any reliable support for a finding of 10 percent interstate traffic, Hyperion has, as stated in its initial comments, commissioned a study to investigate the extent of traffic between an end user and an Internet service provider ("ISP") that is used for interstate communications. The study shows that (i) interstate transmissions related to Web browsing constitute 9.69 percent of the total traffic over the local loop, including both dedicated access and dial-up access, (ii) interstate transmissions related to electronic mail constitute 4.50 percent of the total traffic, and (iii) the weighted average for both types of Internet traffic shows that 6.57 percent of the total traffic between an end user and an ISP can be attributed to interstate communications. Therefore, the Commission erred in its conclusion in the *GTE ADSL Order* that interstate traffic represents 10 percent of the total traffic carried over the special access facilities using GTE's ADSL service. Accordingly, the Commission cannot claim jurisdiction over the service using the "10 percent rule," and, therefore, must reconsider the *GTE ADSL Order.*

I. THE ILEC COMMENTS HIGHLIGHT THE FACT THAT THERE IS NO SUPPORT FOR A FINDING OF TEN PERCENT INTERSTATE TRAFFIC

The Commission had no support in the record for a finding that 10 percent of the total traffic over the lines using GTE's ADSL service was bound for interstate destinations. MCI WorldCom raised this point in its Petition for Reconsideration. The ILECs that filed comments opposing the MCI WorldCom Petition had every opportunity to rebut MCI WorldCom's claim by referring to

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terminates at the ISP receiving those telecommunications. At that point, the information service provided by the ISP begins. Viewed together, the telecommunications from the end user to the ISP, and the information service provided by the ISP, may constitute "interstate communication by wire" to bring the entire transmission within the jurisdiction of the Commission, but that does not change the fact that the telecommunications service terminates at the ISP.

evidence in the record that substantiated the Commission's conclusion. None did so.[4] In fact, the comments on this topic that were filed only highlight the fact that there is no support in the record, at best only conjecture. US WEST in its comments simply dismisses MCI WorldCom's claim as "pure speculation."[5] In support of this accusation of "pure speculation," US WEST asserts, "[t]here is no question that, overall, the interstate and foreign components of Internet traffic exceed the Commission's ten percent de minimis threshold – probably by a wide margin."[6] Not only is US WEST criticizing "speculation" with speculation of its own, but, in fact, there is a substantial question whether the interstate and foreign components of Internet traffic *over GTE's loops using ADSL service* exceed the ten percent threshold. Hyperion's Study shows that they do not.

GTE rebuts the MCI WorldCom claim by saying "all evidence suggests, and common sense supports, the conclusion that vastly more than ten percent of Internet traffic is interstate."[7] Again, conjecture, not fact, is used to support the Commission's conclusion about traffic over the GTE loops. Rather than relying solely on common sense or suggestion, Hyperion's Study uses empirical data to calculate a percentage of interstate traffic that is well below the Commission's threshold.

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[4]The ILECs do refer to statements made by GTE in its Direct Case and Rebuttal. GTE Comments at 8, US WEST Comments at 9. Those statements, however, are purely conjectural as well, and do not provide support for the conclusion reached by the Commission. For example, to GTE the "overwhelming weight of authority" that the total traffic over its ADSL lines contains more than 10 percent interstate traffic is that the Internet is "global," "international," and "links people . . . around the world." GTE Direct Case at 15-16. The same, of course, could be said of the public switched telephone network, but that does not make all special access lines connected to the PSTN interstate.

[5]US WEST Comments at 8.

[6]*Id.* at 9.

[7]GTE Comments at 8.

Finally, Pacific Bell responds to MCI WorldCom's claim that there is no support in the record for the Commission's conclusion by saying "it is hard to imagine Internet access failing to meet the minimum threshold for it being treated as an interstate line."[8] Pacific Bell even throws down the gauntlet, challenging MCI WorldCom to make a showing that GTE's ADSL service should be tariffed at the state level.[9] Hyperion's Study makes that case, and Pacific Bell need "imagine" no longer: Hyperion's Study shows that the amount of interstate traffic over access lines to ISPs does not pass the threshold.[10] By resort to conjecture, surmise, and estimation, when they had the opportunity to identify support in the record, GTE, Pacific Bell, and US WEST illustrate the weakness of the Commission's conclusion that the total traffic over GTE's ADSL lines contains more than a *de minimis* amount of interstate traffic to be tariffed at the federal level.

II. THE HYPERION STUDY DEMONSTRATES THAT THE *DE MINIMIS* THRESHOLD IS NOT MET

The study of Internet usage was performed at the request of Hyperion by Dr. James G. Williams and Professor Kenneth Sochats of the Department of Information Science and Telecommunications of the University of Pittsburgh. The report of the study is attached hereto as

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[8]Pacific Bell Comments at n.11.

[9]Pacific Bell Comments at 7.

[10]Pacific Bell cites two examples of the "predominantly interstate use of access to the Internet." Pacific Bell Comments at 4. The first, comments of Park Region Telephone Company, has nothing to do with the inquiry here. The percentage of inquiries to a web site is not relevant to the ratio of interstate traffic to total traffic on the lines between an end user and an ISP that may use ADSL service. Pacific Bell also refers to "SBC's analysis" to support a finding that Internet access traffic is interstate. Of course, SBC is Pacific Bell's parent company, so it could scarcely be considered an independent source of information. Moreover, there is no indication that "SBC's analysis" was conducted consistent with Part 36 of the Commission's rules. Hyperion's Study, however, was. In short, Pacific Bell's examples are irrelevant, misleading, and unreliable.

Exhibit A. The study shows that less than 10 percent of the total traffic over lines between end users and ISPs is directed to interstate or foreign locations.

A. The Sample

The study used data collected from a sample of 114 Internet users, drawn largely from the population of graduate students in the Department of Information Science and Telecommunications of the University of Pittsburgh, and other participants that those graduate students recruited. These users were considered frequent and knowledgeable users of Internet services. In addition, many of the users were from foreign countries. These users frequently visit foreign websites, utilize graphic images extensively (which involve greater transmission times than text files), make extensive use of electronic mail with attachments (thereby extending the transmission time), and communicate frequently by electronic mail with friends and family outside the United States. Therefore, the sample selected presents a worst-case scenario for the percentage of interstate (or international) usage. A sample selected from the general population could be expected to produce results for interstate traffic below those obtained by the study sample.

B. The Data Collected

The study participants recorded information related to their Internet usage on forms designed to collect data regarding, among other things, log-in time, log-out time, the number of mail messages received and sent, the number of web sites visited, and the geographic locations of the web sites visited. The transmission time for the information obtained by the user from interstate locations was determined by using the "PING" utility within the transfer control protocol/Internet protocol ("TCP/IP"). The PING utility sends a signal to a host site to determine whether it is connected to the network, and it has the ability to record the transmission time between the two locations. The

data collected was biased in favor of a finding that the particular transmission was interstate: for example, when a single web site could have both intrastate and interstate geographic locations,[11] the interstate location was used for determining transmission time. Data for both dial-up and direct access to the ISP were collected in the Study.

C. The Study Methodology

The study was commissioned to assess the amount of interstate traffic in a typical Internet session in relation to the amount of total traffic in the session. To determine the percentage of interstate traffic on the line, the total transmission time related to interstate (or international) destinations was divided by the total time of the Internet session. The legal foundation for this methodology is discussed below. Because electronic mail and web browsing represent the great majority of all Internet usage, only those services were considered in this study. Separate consideration of other services, such as file transfer, Internet relay chat, or database processing, would not change the results of the study significantly because the transmission services involved in those applications are similar to those used in electronic mail and Web browsing. When file transfer or other services occurred in the study, they were include as either electronic mail or Web browsing.

D. The Results

The results of the study show that the 10 percent threshold for Commission jurisdiction over mixed-use special access lines is not satisfied. The results of the study indicate that the ratio of

[11]Through the use of caching or mirroring, a website identified by a single universal resource locator ("URL") could be stored on servers located not only within the state but also outside the state. The study does, however, take into consideration that a significant amount of Web browsing occurs with Web pages cached on the user's computer or at the ISP cache server.

interstate holding time to total holding time for electronic mail is 4.5 percent. The results of the study also indicate that the ratio of interstate holding time to total holding time for Web browsing is 9.69 percent. Because electronic mail is used 1.5 times as often as Web browsing, the combined interstate holding time must be weighted accordingly. The weighted total ratio of interstate holding time to total holding time for both electronic mail and Web browsing is 6.57 percent [(4.5*1.5 + 9.69*1)/2.5]. This ratio falls well below the threshold established by the Commission for asserting jurisdiction over mixed-use facilities.[12] Considering that the sample of Internet users providing data for this study uses Internet resources to reach interstate or international destinations more than would be expected from the general population, a broader sample of Internet users would likely produce an even lower result.

III. THE STUDY METHODOLOGY WAS PREMISED ON THE COMMISSION'S PART 36 RULES

As MCI WorldCom, Hyperion, and others have commented already, the Commission lacked support in the record for its conclusion that 10 percent of the total traffic over GTE's ADSL-capable lines is bound for interstate destinations. Instead, the Commission relied on a fairly casual estimate of interstate traffic based on the mere fact that the Internet is a global network. In the *GTE ADSL Order*, the Commission stated that "special access lines carrying more than *de minimis* amounts of interstate traffic to private line systems should be assigned to the interstate jurisdiction. Interstate traffic is deemed *de minimis* when it amounts to ten percent or less of the total traffic on a special

[12]This result may appear counterintuitive when the global reach of the Internet is considered, but this result is based upon applicable Commission rules that compare interstate holding times to total holding times. In a typical Internet session, an end user generates a long holding time while connected to an ISP, but the periods in which interstate facilities beyond the ISP are actually engaged are sporadic and brief.

access line."[13] The Order does not explain how the Commission concluded that ADSL traffic satisfied this requirement. Application of the underlying rules, however, shows that Internet access traffic does not satisfy the requirement.

Section 36.154(a) of the Commission's rules is the basis for the "10 percent rule" cited by the Commission.[14] That section states as follows:

> Subcategory 1.2 - Interstate private lines and interstate WATS lines. This subcategory shall include all private lines and WATS lines that carry exclusively interstate traffic as well as private lines and WATS lines carrying both state and interstate traffic <u>if the interstate traffic on the line involved constitutes more than ten percent of the total traffic on the line.</u>[15]

How one determines the "total traffic" and "ten percent of the total traffic" is not clearly explained in this rule, but they can be determined by examining other sections of the rules. To begin with, the facilities in question here -- the local loops over which ADSL service is provided -- are considered "subscriber plant" within Part 36.[16] The basis for determining the interstate usage of the "subscriber plant" is determined by making the following calculation:

> the interstate use of the subscriber plant [is] measured by the ratio of interstate holding time minutes of use to total holding time minutes of use applicable to traffic originating and terminating in the study area[.][17]

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[13]*GTE ADSL Order* at ¶ 23, *citing* MTS and WATS Market Structure, Amendment of Part 36 of the Commission's Rules and Establishment of a Joint Board, 4 FCC Rcd 5660 (1989) ("*Mixed-Use Decision*").

[14]Although the Commission does not refer to Section 36.154(a) in the *GTE ADSL Order*, this rule was promulgated in the *Mixed-Use Decision* that was cited by the Commission.

[15]47 C.F.R. § 36.145(a) (emphasis added).

[16]47 C.F.R. § 36.2(b)(2).

[17]47 C.F.R. § 36.154(e).

"Holding time" is defined in the glossary to Part 36 as

> the time in which an item of telephone plant is in actual use either by a customer or an operator. For example, on a completed telephone call, holding time includes conversation time as well as other time in use.[18]

Therefore, holding time represents something greater than simple message transmission time. It represents the total time it takes to set up a telephone call, hold it open during the conversation or transmission, and then tear down the call. Of course, the rules were written for circuit-switched communications, not packet-switched communications. They presume an open dedicated communications path. Therefore, when applied to GTE's ADSL service in order to determine "ten percent of the total traffic on the line," one must first determine the "total holding time minutes of use applicable to traffic originating and terminating in the study area." This measurement is the total minutes of use in which telecommunications facilities are engaged by the customer. This correlates to the length of an Internet session in minutes. In the dial-up context, this would mean the total time elapsed from placing the call to the ISP until that call is disconnected. In the ADSL context, this would mean the technological equivalent of going off-hook, enabling the customer to access the ADSL line by either (a) booting up the computer, or (b) opening an Internet browser or e-mail reader, until either (y) the computer is shut down, or (z) one logs out of the browser or e-mail

[18] 47 C.F.R., Part 36, Appendix-Glossary (emphasis added).

reader.[19] The study uses session time from log-in to log-out as the "total holding time minutes of use applicable to traffic originating and terminating in the study area."[20]

The calculation also requires an interstate usage element, the "interstate holding time minutes of use." This measurement captures the total minutes of use in which telecommunications facilities located in other states, and telecommunications facilities used to reach those telecommunications facilities (including the local loop), are engaged by the customer. In the ADSL context, this would mean the total transmission time of a message or request for information from the end user, through the ISP, to the requested server located out of state, and then the responding transmission time from the out of state server back through the ISP to the end user. The Hyperion Study uses the total

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[19]Even though it is a packet-like service over the local loop, ADSL service also uses an open, dedicated communications path (admittedly, a "virtual" one). In fact, because of the "always on" capability of ADSL, the open dedicated communications path could be viewed as continuing around the clock, reducing the percentage of interstate usage of that path to almost nothing. *See* Comments of Southwestern Bell Telephone Company et al. in Support of GTE's ADSL Tariff, Attachment A, at 2 ("The data path created with the [private virtual channel] is always available, seven days a week, 24 hours a day, giving the ADSL subscriber the highly desirable 'always on' feature.") The Hyperion Study uses a more conservative interpretation of holding time: the duration of the Internet session.

[20]Admittedly, the methodology derived from Part 36 was established for circuit-switched voice or data traffic. Although Hyperion anticipates an argument that this methodology is not applicable to packet-switched traffic, it is the methodology that the Commission implicitly relies upon in the *GTE ADSL Order,* and, in the absence of another methodology for packet-switched traffic, it is the only methodology available under Commission rules for special access lines. *See also Amendments of Part 69 of the Commission's Rules Relating to the Creation of Access Charge Subelements for Open Network Architecture Policy and Rules Concerning Rates for Dominant Carriers*, CC Docket Nos. 89-79, 87-313, Report and Order & Order on Further Reconsideration & Supplemental Notice of Proposed Rulemaking, 6 FCC Rcd 4524 (1991) at ¶ 11 (stating, with respect to changes to Part 69 access charge rules, "Our special access rules require no modification, and we conclude that no additional rule changes are necessary to accommodate multiplexing and packet switching.")

amount of time that transmission facilities are used to transmit and receive interstate communications, measured by the TCP/IP PING utility.

Accordingly, pursuant to the rules relied upon by the Commission, the Hyperion Study calculates the ratio of "interstate traffic on the line" to "total traffic on the line" by comparing the amount of time that interstate facilities are engaged by an end user to the total time that an end user engages telecommunications facilities during an Internet session. The Hyperion study has determined that the interstate traffic on the line constitutes 6.57 percent of the total traffic on the line, and therefore fails to satisfy the test established by Commission rules for the mixed-use special access line provided by GTE to fall in the interstate jurisdiction.

IV. CONCLUSION

The Hyperion Study disproves the Commission's unsupported conclusion in the *GTE ADSL Order* that the interstate traffic on a line using GTE's ADSL service constitutes more than ten percent of the total traffic on the line. The comments by ILECs further illustrate the weakness of the Commission's conclusion. As the Hyperion Study demonstrates, because the interstate traffic

on the line using GTE's ADSL service constitutes much less than ten percent of the total traffic on the line, the Commission cannot claim jurisdiction over the service using the "10 percent rule," and, therefore, must reconsider the *GTE ADSL Order.*

Respectfully submitted,

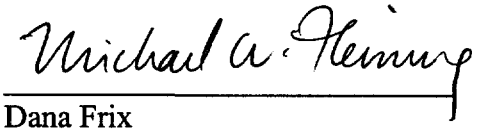

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EXHIBIT A

Investigation of ISP Interstate Traffic

For Selected Internet Applications

By

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Department of Information Science and Telecommunications

University of Pittsburgh

January 19, 1999

Executive Summary

To investigate whether the amount of time Internet applications hold Interstate telecommunication resources is less than 10% of the total time an Internet user is connected to its local ISP, data was logged for 114 Internet e-mail and Web users. Data was logged for 231 e-mail sessions (with 1935 messages received) and 172 Web browser sessions. The data shows that less than 10 percent of the total session holding time is used for the Interstate transmission of data. Interstate transmission of e-mail represents 4.5% of the total traffic. Interstate transmission of data related to Web-browsing represents 9.69% of the total traffic. The unweighted average interstate holding time of e-mail and Web-browsing is 7.095%. The weighted average interstate holding time of e-mail and Web browsing is 6.57%. Analyzing the WWW data by separating the users into those using a direct line and those using dial-up access shows no significant differences. E-mail was not analyzed separately for direct and dial-up access since it is clearly less than 10% of the total mixed traffic. This result is due to the Client/Server model used by Internet applications, the mirroring of servers moving them closer to users and the caching of Web Pages by browsers, local area networks and ISPs. Other Internet applications such as electronic commerce, database searching and chat rooms have characteristics similar to e-mail and Web browsing, and therefore it is hypothesized that empirical data would also show less than 10% Interstate holding time. Applications such as FTP, Telnet, IP Telephony, IP Fax, and IP Video Conferencing may show different characteristics, but they are a very small fraction of Internet usage. As Internet backbone speeds continue to increase, mirrored sites continue to expand, and caching of Web pages by ISPs and local networks becomes even more widespread, the percent of time Internet applications will use the Interstate transmission facilities will continue to decrease.

1.0 Introduction and Background

1.1 The Problem

On October 30, 1998, the Federal Communications Commission (FCC) issued its order regarding whether a tariff for asymmetric digital subscriber line (ADSL) service filed by the GTE Telephone Operating Companies should be accepted for filing as an interstate access service tariff. High –speed digital subscriber line services employ enhancements to the telecommunications over the local loop to connect end users to high-speed data networks, typically those provided by Internet service providers. By rerouting data traffic to ISPs away from the end office switch to a digital subscriber line access multiplexer (DSLAM) and employing high-speed modems on both ends of the connection, DSL services significantly increase transmission speeds between end users and ISPs. In the October 30, 1998 Order, the FCC decided that Internet access services such as the one offered by GTE constituted interstate communications and were within the jurisdiction of the FCC. The FCC, therefore, accepted the GTE ADSL tariff for filing. The FCC also asserted jurisdiction over ADSL services on the grounds that they were special access

lines that carried both interstate and intrastate services, but the amount of interstate traffic was more than a de minimis amount. Under FCC rules, telecommunications lines that carry less than 10 percent interstate traffic are characterized as intrastate lines on the grounds that the interstate usage is de minimis.

There does not appear to be any data to support or refute the 10 percent mixed traffic rule for ISP traffic as of the time of this report. The purpose of this report is to present data relative to this rule for ISP traffic.

1.2 Factual Background

There are presently two ways to obtain access to an ISP: dial-up service and direct access. For dial-up service, ISPs typically purchase "business lines" (PRIs) from local phone companies. Many ISPs are buying PRI lines from CLECs since ILECs have not been able to respond to the demand for PRI lines. Direct access involves use of a dedicated line between the end user and the ISP. Because the cost of dedicated access is significantly higher than the cost of dial-up access, dedicated access is typically used only by high-volume end users, such as businesses, or end users with a particular need for high-speed connections to ISPs. Although ADSL is provided over the local loop, it provides a virtual dedicated connection between an end user and an ISP using a local exchange carrier's ATM or frame relay network.

Federal regulations address the jurisdictional classification of dedicated access lines, also known as special access lines. Section 36.154, subcategory 1.2 , of the FCC's rules states that the category of "Interstate Private Lines and Interstate WATS lines" "shall include all private lines and WATS lines that carry exclusively interstate traffic as well as private lines and WATS lines carrying both state and interstate traffic if interstate traffic on the line involved constitutes more than ten percent of total traffic on the line."

If it can be shown that interstate traffic is less than or equal to 10 percent of total traffic between an end user and an ISP, then the line carrying that traffic, known as "subscriber plant," would be subject to state, and not federal, jurisdiction. Under FCC rules, the interstate use of the subscriber plant is measured by the ratio of interstate holding time minutes of use to total holding time minutes of use applicable to traffic originating and terminating in the study area.

2.0 The Study Context and Methodology

2.1 The Context of the Study

In order to present evidence that supports or refutes the 10 percent mixed traffic rule for ISP access services, it is necessary to define those services that generate ISP traffic on the Internet and then collect data relative to these services. The categories of service

provided by ISPs that generate the majority of traffic are e-mail. Web browsing, and internet based applications such as FTP, Telnet, database searching and E-Commerce (EDI). Increased future uses of the Internet that will generate significant traffic include IP Telephony and IP video conferencing. There are several technologies and technology trends related to the Internet and the World Wide Web (WWW), in particular, which have or will have a profound impact on how much Internet traffic remains local and how much will require long distance resources. Specifically, the technologies are the packet switched Client/Server architecture, large scale web caching, and mirrored server sites. Additionally, as the dial-up subscriber line technology reaches its theoretical transmission speed limit, while the Internet transport and ISP-to-Internet transport speeds continue to grow at a rapid pace, the ratio of interstate transmission time to local transmission time will continue to decrease.

Because of the client/server model, the characteristics of Internet sessions, and the ISP network topology, ISP traffic falls into the category of mixed local and interstate traffic. It is hypothesized that ten percent or less of the holding time for ISP traffic utilizes long distance, interstate, Internet resources or conversely, 90% or more of the holding time by ISP users is for local communication traffic.

2.2 Technologies Impacting Interstate Telecommunication Resource Usage

2.2.1 Internet's Client/Server Architecture vs. Voice Telephone Circuit Switching

The Internet works using a client server model of information delivery as opposed to the circuit switched technology of telephone voice communications. In the client/server model, a client (source) only connects to a server (destination) when the client has a request for service which may include receiving and sending e-mail, sending and receiving Web pages, sending and receiving database queries and results, transferring a file, and other Internet based services. Clients are typically personal computers running workstation operating systems, while servers are usually more powerful machines running Unix, NT or Netware network operating systems. Client and host computers are connected to the Internet via an Internet Service Provider (ISP). The ISP has a direct connection to the Internet via its router and typically a leased line to the nearest Internet Point of Presence (POP), which is an Internet Router. A client computer establishes a connection to its ISP either directly via a leased line or via a dial-up line. When the client makes a request from a server on the Internet, a connection is made to the server and the request is routed from the client to the ISP over the Internet to the destination server using the TCP/IP communication protocol. The server executes the request and transmits the results back to the client over the Internet and the connection is then terminated awaiting the next request from a client to establish another connection to the same or a different server. A session for a client (time connected to the ISP) may involve tens or hundreds of connection requests and terminations depending on the application being utilized. A connection in a client/server model between the client (source) and a server

(destination) only lasts for the duration of a transaction that may range from milliseconds to seconds depending on the request type. Therefore, the holding time for Internet communication facilities in the client/server model is the sum of the transaction holding times during a session. The network resources between the ISP and the destination server on the Internet are only in use for the duration of the transaction, not for the entire session involving the client connection to the ISP. This amount of time is different depending whether the TCP or UDP communications protocol is used as discussed below. There are applications such as reading e-mail where the client computer may never utilize any Internet resources during a session, although Internet resources were used prior to the session to receive e-mail messages from some sources. Different applications will have different holding times for Internet communication resources. ISPs carry local traffic from their local direct and dial-up customers as well as other local ISPs, and long distance traffic to and from servers connected to the Internet throughout the world.

In the telephone circuit switched voice network, the user takes the source (calling) handset off-hook and dials the number (address) of a destination phone handset. The telephone network central office switch establishes a permanent route (connection) between the source and the destination that will remain in effect until the entire session has been completed. The local and long-distance network resources utilized by this connection are not available until the two parties hang-up (go on-hook). Therefore, the session time is equal to the holding time.

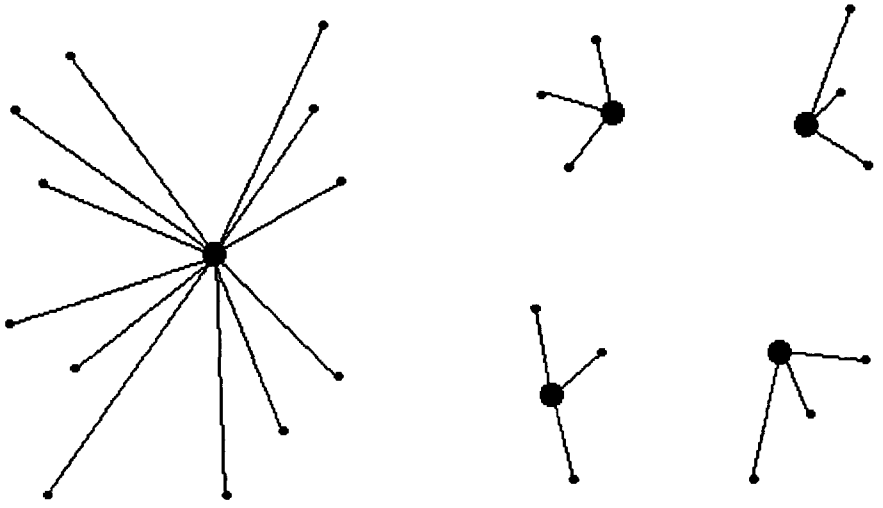
The major difference between these two modes of communications is that the client/server model only uses Internet communication resources for the duration of an information request and receive transaction regardless of how long the local session lasts, while the circuit switched model of the voice telephone network consumes network resources for the entire duration of a session.

2.2.1.1 TCP and UDP Protocol Differences

It should be noted that Internet applications utilize the TCP/IP communications protocol that actually has two different protocols that applications may use. These are the Transmission Control Protocol (TCP) and the Universal Datagram Protocol (UDP). If UDP is utilized by an application, there is no circuit setup between the client and the server and no verification that a message actually arrived or arrived correctly. The client simply sends the packet(s) of data to the host and hopes that it will arrive correctly. Many mail systems use the UDP protocol. TCP, on the other hand, establishes a circuit between the client and the server when a request is made by the client, and typically holds the circuit until the server has satisfied the request or a timeout occurs. Typically the client terminates the connection, but the server can also terminate a TCP connection.

2.2.2 Mirroring Server Sites

Mirroring is a technique used by many web site providers to handle large loads (hits). In mirroring, an organization's web site is duplicated on a number of independent servers, called mirror sites. Routing and other network mechanisms are used to balance the traffic load across these servers, usually sending traffic to the nearest server. Thus, a number of relatively small and inexpensive servers operating independently can service the needs of many web site users. At certain intervals, the data in all of web sites are updated so that each web site is identical to its siblings.

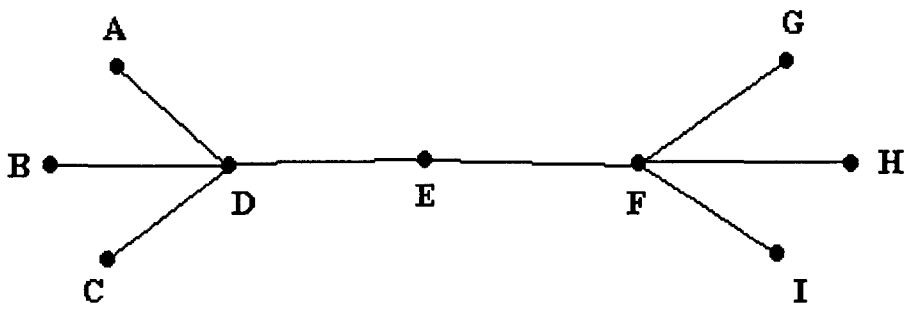


Single Server **Mirrored Servers**

Usually, the mirror sites are located at geographically diverse locations. This provides increased reliability across the network of servers. If one server fails, the web site is not out of business - traffic can simply be routed to the nearest (or least loaded) neighbor server. Additionally, the geographic dispersion of web servers naturally balances the load among the servers.

From the network side, total network traffic is reduced with a mirroring system. Instead of traffic having to traverse the network between the single web site and the user, the user's requests are handled by a closer web server. Traffic is regional rather than network wide. Or, to put it another way, everyone is closer to his or her server.

Consider the example in the simple nine-node network below. For simplicity, assume that the same number of users generating the same amount of web traffic (T) exist at each node of the network resulting in a total of 9T traffic. If a single web server is located at node E, then each user's traffic must be exchanged between the server site and the user. Some of the traffic must travel over more than one (two in this case) links to get to the server. Traffic originating at E does not have to travel over any links. The total link traffic (i.e. the sum of the traffic carried by all links) is 14T.



If two mirror servers are located at nodes D and F, the resulting network link traffic is only 7T.

The example above assumed equal users and traffic. Practically, the benefits of mirroring are even more dramatic when these traffic and users are concentrated. The table below lists the population of the states in terms of numbers and percentages in order of decreasing population. By cleverly selecting the locations of mirror servers, a small number of servers can service locally (i.e. intra-state) a large proportion of the total traffic. A single web site located in the largest state (California) has an intra/interstate ratio of 12%. Only nine servers appropriately located will service over half of the population as local traffic.

State	Population ('000s)	%	Cumulative %
California	32,268	12.06%	12.06%
Texas	19,439	7.26%	19.32%
New York	18,137	6.78%	26.10%
Florida	14,654	5.48%	31.57%
Pennsylvania	12,020	4.49%	36.06%
Illinois	11,896	4.44%	40.51%
Ohio	11,186	4.18%	44.69%
Michigan	9,774	3.65%	48.34%
New Jersey	8,053	3.01%	51.35%
Georgia	7,486	2.80%	54.15%
North Carolina	7,425	2.77%	56.92%
Virginia	6,734	2.52%	59.44%
Massachusetts	6,118	2.29%	61.72%
Indiana	5,864	2.19%	63.91%

Washington	5,610	2.10%	66.01%
Missouri	5,402	2.02%	68.03%
Tennessee	5,368	2.01%	70.03%
Wisconsin	5,170	1.93%	71.97%
Maryland	5,094	1.90%	73.87%
Minnesota	4,686	1.75%	75.62%
Arizona	4,555	1.70%	77.32%
Louisiana	4,352	1.63%	78.95%
Alabama	4,319	1.61%	80.56%
Kentucky	3,908	1.46%	82.02%
Colorado	3,892	1.45%	83.48%
South Carolina	3,760	1.40%	84.88%
Oklahoma	3,317	1.24%	86.12%
Connecticut	3,270	1.22%	87.34%
Oregon	3,243	1.21%	88.55%
Iowa	2,852	1.07%	89.62%
Mississippi	2,730	1.02%	90.64%
Kansas	2,595	0.97%	91.61%
Arkansas	2,522	0.94%	92.55%
Utah	2,060	0.77%	93.32%
West Virginia	1,816	0.68%	94.00%
New Mexico	1,730	0.65%	94.65%
Nevada	1,677	0.63%	95.27%
Nebraska	1,657	0.62%	95.89%
Maine	1,242	0.46%	96.36%
Idaho	1,210	0.45%	96.81%
Hawaii	1,187	0.44%	97.25%
New Hampshire	1,173	0.44%	97.69%
Rhode Island	987	0.37%	98.06%
Montana	879	0.33%	98.39%
South Dakota	738	0.28%	98.66%
Delaware	731	0.27%	98.94%
North Dakota	641	0.24%	99.18%
Alaska	609	0.23%	99.40%
Vermont	589	0.22%	99.62%
District of Columbia	529	0.20%	99.82%
Wyoming	480	0.18%	100.00%
Totals	267,634	100.00%	

For the reasons discussed above, mirroring is rapidly becoming a popular practice by web site providers. Many large web providers (e.g. Microsoft, Canon, etc.) have several mirror sites. Mirroring's benefits are not limited to web service. Mirroring will become an important architecture for other large Internet based applications such as electronic commerce.

Music Ltd. lists mirror servers in 35 states in its web site. Netscape Communications currently lists mirror servers in nine states. In addition, Netscape has a formal program

for establishing new mirror sites. Details of this program can be found at their web site at the URL: http://home.de.netscape.com/comprod/mirror/mirror.html.

2.2.3 Internet Web Caching

Internet caching involves storing copies of Web pages or other content (databases) on servers that are geographically closer to end-users. Although architectures vary, the concept is to have a cache server act as a middleman between the end user and the home servers of web sites. Located physically closer to the user, the cache server provides a copy of the requested site's pages, thereby relieving the home site from having to process the request, and more importantly, eliminating costly and time consuming Internet back-bone transmission. Studies and surveys of user Web searching behavior consistently show that users tend to visit the same sites repeatedly across Web sessions, and that certain sites are popular across multiple users, thereby making caching an efficient technique. In fact, Zipf's Law has been applied to Web sites, which shows that request frequency is inversely proportional to a site's popularity ranking. From a user's perspective, cached content loads faster but could be outdated. From the network provider's point of view, caching decreases the amount of duplicate traffic on their networks. From the content provider's point of view, it decreases the load on their web servers but at the same time eliminates accurate "hit" statistics and increases worry about outdated information. From a user's perspective, one metric for evaluating an ISP performance is how quickly web pages can be loaded. Adding additional bandwidth only helps marginally because the main factors are 1) Distance between users and servers, and 2) Congestion on heavily networks and popular server sites. Mirroring discussed above is one solution but caching web pages is an addition help that also brings data closer to users. Caches will reside throughout networks, concealing the Web's slowness from clusters of users. ISPs and backbone providers will provide caches at every point of presence and enterprises such as campus networks and company branch offices. Forrester Research estimates that network caches will become as ubiquitous as IP routers: "By 1999, all Fortune 1000 companies, will depend on hardened Web caches to keep their intranets running smoothly." ("Why Caching Matters"). America Online (AOL), Prodigy, MSN, and Earthlink are all currently deploying national networks of cache servers. Both Netscape and Internet Explorer are capable of using network caches. Both are capable of channeling content to their local machine's cache for local processing (after checking for any changes in the content). The statistics on ISP caching shows a minimum of a 30% to 40% hit rate with several showing a 50% to 60% hit rate. (http://ircache.nlanr.net/cache/FAQ/ircache-faq-2.html). Hit rate represents the percentage of times a Web page is found in the ISP's web cache and does not require using the Internet backbone to retrieve the requested page. The Web site at http://ircache.nlanr.net/Cache/FAQ/ircache-faq-2.html in section 2.9 "How Effective is Web Caching" provided the above statistics. In addition, actual hit ratio statistics from NLANR Web caching can be found at ircache.nlanr.net/Cache/Statistics/Reports. The hit ratio is a function of the number of users, cache size, and the refresh parameters. In any case, as Internet Web caching increases, the need to utilize interstate resources across the

Internet backbone will continue to decrease significantly. For a list of Web caching products and services see the URL: http://ircache.nlanr.net/cache/FAQ/ircache-faq-9.html

2.2.4 Dial Access Speeds Vs ISP Internet Access Speeds

ISPs provide Internet access to their customers by providing connectivity to the Internet and protocol processing. The ISP has large numbers of ports accessible by customers through dial-up or leased lines. These access ports are usually attached to modem banks that operate at speeds typical of the modems provided by personal computer hardware vendors, generally 14.4Kbps to 56Kbps. Dial-up access is accomplished through the public switched telephone network. The ISPs attach to the Internet at Internet POPs through high speed leased lines generally PRI or higher. Thus, the nature of the access is circuit or connection oriented between the customer and the ISP, and connectionless between the ISP and Internet.

When holding time is used as a basis to determine the ratio of local to Internet bound traffic, a natural compression occurs. The customer is transferring data to the ISP at low speeds and the ISP is placing that traffic on the Internet at high speeds. For example, if a customer transfers one second's worth of traffic to the ISP at 14.4Kbps, that traffic will occupy less than one one-hundredth of a second on a PRI access line. The table below gives the relative time compressions for the typical speeds at which dial-up customers access ISPs versus ISP/Internet access lines.

	Internet Access Speed (Mbps)	
Customer Access Modem Speed Kbps	1.5	45
9.6	0.0064	0.000213
14.4	0.0096	0.00032
28.8	0.0192	0.00064
56.0	0.037333	0.001244

The table illustrates that, because of time compression, a dial-up customer uses a significantly smaller proportion of the ISPs Internet access line if holding time is used as the basis of measurement. Further, speeds of existing dial-up local access lines have almost reached their theoretical capacity limit. The speeds of the class of access lines that the ISPs use to access the Internet are virtually unbounded. This suggests that the ratio of local to total holding time will become even larger in the future.

Portal Effects

Large ISPs, in addition to providing Internet access, host web sites, create content and engage in other related activities. Their position as gatekeeper or "portal" as it is referred

gives them influence over the default or initial and, in some cases, even ultimate content to which a customer is directed. In other words, it behooves an ISP to direct its customers to the sites of its other customers. This serves to keep as much of the traffic as possible within the ISP's business. Indeed, this power to influence is one of the rationales for the Justice Department's bringing an antitrust action against Microsoft.

2.3 Internet Usage Characteristics

There have been numerous studies performed on Internet usage and they have general agreement in most areas. The Pew Research Center surveyed 1,003 on-line Internet users in October of 1996 and found that 77% of the users receive or send e-mail at least once every few weeks and 26% use e-mail every day, while 19% use it 3 to 5 times a week. On average, e-mail users send 6 messages and receive 12 messages at each Internet session, but a Pitney Bowes study found that office workers send and receive 30 e-mails per day. AOL handles 34 million messages per day for 13 million subscribers, and Forrester Research estimates that about 500 million e-mails are delivered each day. 68% of Internet access is done from the home; 47% go on-line from work; and 24% go on-line from both home and work. The average speed with which users access the Internet is at 28,800 baud, with the next most popular speed being 14,400 baud. Only 7% use a modem with a speed of 9,600 baud or less. The percentage of users using the Internet who come from the suburbs or small towns is approximately equal at 31% and 32%, respectively, while large cities accounted for 22% of use, and rural areas accounted for 14%. The Third MIDS Internet Survey shows that in over 1,000 survey responses, students account for the majority (59.7%) of Internet access, followed by network users of the Internet such as staff in an organization (34.2%) and faculty in a university (3.5%). Approximately 14% of organizations' access to their ISPs was via a dialup mode. This study also showed 49.7% of the respondents' computers mailed out from their workstations, with the most frequently used speed of 64Kbps (22%) followed by 28.8Kbps (17.1%) and 14.4Kbps (12.5%). 1.544Mbps was used by 10.2% of the organizations responding. E-mail was by far the most heavily used application. Web server statistics by several surveys are in close agreement that the .edu domain accounts for the majority of accesses to servers, with the .com domain gaining rapidly. This correlates well with the fact that students and faculty have historically accounted for the majority of use. A survey at www.erg.cuhk.edu.hk shows that .com domains account for over 3.9 million hosts followed by the .edu domain with over 2.65 million hosts. Third in their list of hosts was the .net domain with over 1.5 million. The most frequently used host name was WWW followed by HOST, MAIL, and FTP. This provides an indication of the expected services to be offered by these hosts.

Login and usage statistics from a University of Wisconsin study of 58 selected users between 1/22/1996 to 5/17/1997 (4 months) showed the average number of logins was 17.47 and sessions averaged 22.6 minutes with 51% being between 1 and 10 minutes. (see www.wisc.edu/learntech/firstclass/logstats).

A survey (89 responses) done by the Oil & Gas Industry (http://209.49.75.165/internetresults.htm) showed their members used the Internet in the following ways:

Main Use	Percent of Use
Collaboration	16.9
Competitive Intelligence	23.6
E-mail	47.2
Employment	22.5
File Transfer	25.8
General Info	49.4
Industry Data	31.5
Industry Discussion	8.9
Industry News	32.6
Market Research	11.2
Product Info	29.2
Product Purchase	12.4
recreation/Leisure	22.5
Research	29.2
Software Download	30.3
Travel Reservations	13.5

Oil & Gas Industry Survey – Internet Usage

The above chart shows that web browsing and e-mail are the two major uses of the Internet. The question asked was "What do you mainly use the Internet for?" and people could respond with multiple uses. 47.2% of the respondents indicated that they used it for e-mail while the rest of the responses indicate that it was used for browsing the Web for information, file transfer, and software downloads. This corresponds with surveys done for educational use and home use of the Internet. For instance, Morgan Stanley estimates that the number of e-mail users on a daily basis was 35 million in 1995 and will be 200 million in 2000. They also estimate that the number of web users was 9 million in 1995 and will be 152 million in 2000 (See www.cyberatlas.com/demographics.html). The most intensive use of communication bandwidth resources in a short time period is file transfer and software downloads, but they occur much less frequently than e-mail and web browsing.

Results of other Internet usage surveys are available upon request.

2.4 Methods Used

To provide evidence related to the problem required obtaining data about how much time was spent using interstate telecommunication resources versus using local telecommunication resources for various types of Internet uses such as e-mail and web searching. Some general data was derived from statistics made available on the Internet by ISPs and various web sites, while other data was collected by having users keep a log of Internet sessions and perform transmission timing experiments based on the Internet session. User data was logged on a paper or spreadsheet using the survey forms shown in Appendix A. The timing experiments were used to determine average transmission time from the user site to an Interstate destination or origination Internet site. Some traffic data was also collected from ISPs to compare session time and utilization of local and

long distance communication resources on the Internet derived from the user-based experiments. The methodology builds a worse case scenario to provide evidence related to the problem. This was done to compensate for the fact that user logged data are approximations.

The methodology is based on a simplified model of how Internet client/server applications function relative to the 10% mixed traffic rule. The critical variables in the federal regulation being tested are **total holding time, long distance holding time and their ratio. Total holding time in this study is equivalent to session time. Session time is defined as the time that elapses between the start of an e-mail or web session and its termination by the user. An e-mail or web session is assumed to start when the e-mail program for web browser is requested to execute by the user. Likewise, an e-mail or Web Browser session is terminated when the user clicks the exit option. Subjects were asked to explicitly initiate and terminate each session in this manner.** These times were recorded by users to the nearest minute and converted to milliseconds. We excluded individuals that keep an e-mail session open all day. This practice is more common than might be expected, but would bias the study in favor of less than 10 percent. **Long distance interstate holding time is defined as the amount of time that a connection is held between the user's client process and an out-of-state site (server process) on the Internet for completing a transaction. A transaction includes a request from a browser or e-mail program and the response from a server. Interstate long distance holding time is calculated as the product of the average number of bytes in an Interstate long distance message or web page and the average time in milliseconds to transmit a byte from the long distance interstate sites as determined by a "PING" experiment as explained below. A Web page is defined as all the data delivered to a web browser in response to a single request. This data was measured in bytes and was averaged across all Web pages retrieved. This data is available in a browser's web page cache file and can be examined by the user.** The bytes (length) in an e-mail message were simply counted manually or the message was saved on disk where the length could be determined automatically.

Data for the study was self-reported by a group of 114 actual Internet users who each logged 1 to 3 e-mail and web browsing sessions selected over a period of several weeks. The type of users ranged from full time graduate students and professional workers to homemakers. The initial set of users was 86 students in a graduate class in Information Science at the University of Pittsburgh who also recruited 28 other participants. The professionals in the study hold a diverse set of positions in a variety of institutional settings. The majority of the users could be considered frequent users as well as knowledgeable about the Internet since the majority were graduate students in an Information Technology intensive program and most worked in technology intensive jobs. These users represent a worst case scenario since they make extensive use of e-mail attachments, visit foreign sites, and utilize graphic images extensively. Additionally, many students are from foreign countries that make extensive use of e-mail to communicate with their family and friends abroad. The student users were asked to recruit non-student participants from friends, colleagues, and family. Internet accesses included accesses from an organizational setting with dialup and direct connections and

dial-up from home. The participants were asked to maintain an accurate log of their Internet e-mail and web-browsing activities from which traffic load (bytes of data sent and received) and timing (transmission and session duration) data was collected and computed for the equivalent of what would be a long distance (interstate) or local telephone call. The subjects were trained on how to gather and record the data during a 30-minute demonstration. The participants used a paper form to log each of their Internet sessions but were permitted to e-mail it as a text document or spreadsheet to the investigators.

Participants were asked to be as accurate as possible in recording the start and end times for an e-mail or web session. If they forgot to record either time, they were asked to simply discard the session and record a new one. If the data was received without such times it was discarded. The most difficult part of the session logging was identifying local sites from interstate sites. An interstate site was considered any site outside the state of Pennsylvania. For e-mail, this was not very difficult since most e-mail is from known individuals with known locations, but for web searching and surfing, the problem was much more difficult. Participants were required to log the URL of each page they accessed. These are actually available in the browser cache and can be examined after a session is competed. The participants were then required to determine whether the location of the server for the URL was instate or out-of-state. For international sites this was simple because the URL indicates the country in the last part of the URL. For many sites in the USA, the URL is also self-evident, such as www.pitt.edu at IP address 136.142.140.120 at the University of Pittsburgh in Pittsburgh, Pa. For sites that were not self-evident, the physical address of the organization owning the server was used. Physical addresses were determined by first looking at the home page to see if an address was provided. Then a search was made on the web to see if a physical address could be found. The use of sites such as www.stocksite.com for commercial sites to get an address was very successful. When two addresses were available (1 in-state, 1 out-out-state), the out-of-state address was used. When no physical address could be determined, the site was discarded. If an interstate site was not PINGable, it was discarded from consideration for timing purposes.

Participants were required to log the number of Web pages they accessed per site and compute the average number of bytes per page by using the browser's cache information. Both of these are important in computing interstate holding time. The average bytes per page in the study is over 20,000 for interstate sites and 22,000 for intra-state sites. These differed slightly for dial access and direct access users. A Web page typically has a combination of text and one or more images but other Web applications may download data files, executables, movies, audio clips, etc.

The web site at ircache.nlanr.net/Cache/Learn/learn-1.html provides average document sizes for different document types as collected during 1 week in April 1997 and is shown below:

Document Types	Average (mean) Size in Bytes
Image	7931
HTML	6419
Directory	6659
Lookup	2420
Query	5308
Applet	4201
Text	26954
Audio	105648
Executable	1206714
Movie	864532
Software	4450
PDF	287994
PostScript	326692
VRML	24371
ISMAP	1250

Over 50% of the total number of bytes transmitted were HTML and images, while the percent of HTML and Image documents transmitted was 84%. Thus, the survey average of 20 to 22 thousand bytes per page is reasonable.

They were also asked to estimate how much time that they spent reading the data they received on a web page.

The TCP/IP PING utility was used to get data on the transmission time to and from the Interstate e-mail and web sites involved. These Internet activities were timed in terms of local resource holding time (session time) versus Interstate long distance holding time for the transport of e-mail and web page data (including text, image, video, audio data, etc.) based on the client/server model. The time for transmitting bytes to/from Interstate sites was longer on average than for Intra-state sites as might be expected. The PING time includes network virtual circuit setup and termination time as well as transport time for TCP and transport time for UDP. **This PING time does not include processing time at a server site for retrieving and processing data. On the other hand, it does include transport time between the end-user and the ISP at both the server and client sites which constitute local connect time and is the slowest part of the transmission pipeline since dial-up users are typically transmitting at 28.8 Kbps while the Internet backbone is transmitting at 45 Mbps and higher. It was not feasible in this study to isolate the processing time at a server or the local transmission portion of the transport. It is suspected that these times may on average offset each other.** The browser cache information was used to determine the URLs of sites visited for PING timing experiments. The percent of cache hits (31.25%) was determined by averaging

cache hit-rate data from Web sites such as ircache.nlanr.net/Cache/Statistics that report such data. This was done by randomly selecting 30 days to use to get sample points. No consideration was given to the rapidly developing mirroring of sites that is being implemented by many of the most popular web sites due to a lack of empirical data. The data was analyzed using descriptive statistics such as the arithmetic mean, but more importantly, the ratio of local holding time (session time) to interstate resource holding time. The Interstate long distance holding time for connection and transport includes the transport from the user workstation to the ISP, as well as from the ISP to the Internet POP. Since these transport facilities are typically much slower than the Internet backbone, there is a bias toward longer Interstate long distance holding time than is actually true. There is no simple way to subtract these times from the total transmission time in this experiment. Based on this data and its analysis, evidence is presented relative to the mixed traffic 10% rule for these applications. The log sheet used by the subjects in this study is contained in Appendix A.

Although empirical data for other types of Internet based applications is not available from this study, we can use the results of the e-mail and Web browsing survey to make some inferences related to applications such as electronic commerce since they have similar characteristics to e-mail and web browsing.

3.0 Results of the Study

3.1 E-mail

E-mail is the most highly used application on the Internet. An E-mail transaction has several phases as outlined below:

- Connect to a local ISP via dialup or direct access
- Download messages to the local desktop machine from the ISP mail server
- Get a list of waiting messages
- Select a waiting message to read
- Read messages and viewing or saving attachments
- Reply to messages and composing new messages
  - Addressing the message (local or long distance)
  - Composing the message text
  - Appending attachments
  - Transmission of messages to the local ISP from the user's local machine
  - Queuing of the message at the ISP mail server
  - Placing the message in a local mailbox if destination is same ISP
  - Performing a URL IP address resolution
  - Transmitting the message as packets over the Internet towards its destination (Same state or Interstate)
  - Intermediate processing at routers and the destination host mail sever

- Saving, replying (sending) or deleting messages at the local machine
- Disconnect from the local ISP

Since another Internet user sends the e-mail received, either receiving time or sending time as calculated from the number of Interstate Long Distance (LD) bytes received or sent in messages should be used as holding time but not both. Otherwise, an e-mail message would be counted twice in the calculation (at both the sender and receiver ends). We have opted to use the Interstate LD computed receive time since the Interstate LD holding time is the larger of the two times in our sample. The Interstate (LD) holding time is calculated as the product of the average number of Interstate LD bytes received and the average time to transmit a byte to the PINGable sites. The total Interstate LD bytes received is the product of the average number of Interstate LD messages received per e-mail session and the average message length in bytes of a received e-mail message ,plus the product of the average number of attachments per session and the average size of an attachment. The transmission time is the average of the PING time to all Interstate LD sites from which e-mail was received.

Two hundred thirty one (231) e-mail sessions with 1935 e-mail messages received and 260 Interstate PINGable sites were analyzed with the following results:

Variable	**Average Value (Arithmetic Mean)**
Number Local Messages	4.80
Number Long Distance (LD) Messages	4.26
Number Interstate LD Messages	3.47
Bytes per Message	907.73
Number Attachments per Session	.995
Number Attachments per Message	.110
Bytes per Attachment	27,968.26
Number Responses to Messages per Session	2.63
Number Bytes per Response	578.96
Number Responses to Local Messages	1.59
Number Responses to LD Messages	1.20
Time to Compose a Response	4.33 Min
Number New Messages sent/session	1.29
Bytes per New Message sent	842.37
Time to Compose a New Message	6.12 Min
Session Length – Total Holding time	31.74 Min (1,904,299 ms)
E-mail Interstate Site PING Time (Round Trip)	274.49 ms
Bytes per PING	49.6
Byte Transmit Time	2.767 ms
Total Bytes Received per e-mail Session	36,063.40
Total LD Interstate Bytes Received per Session	30,988.94
Total LD Interstate Holding Time	85,746.40 ms
Total Holding (Session) Time	1,904,299 ms

The ratio of Total Holding time (session time) to Long Distance Holding Time is 85,746.40 ms / 1,904,299 ms = .045 or 4.5 percent. This would indicate that the holding time for long distance resources is less than 10 percent of the total holding time (session time). The PING time used in computing transmission time includes network overhead. Network overhead includes the hand-shaking protocol and network control messages between the client and server to establish a session and any retransmissions caused by errors of any type.

3.2 World Wide Web (WWW) Searching and other Web-based Applications

Searching the World Wide Web (WWW) is composed of the following phases using a client/server mode:

- A connection is made to an ISP
- A URL is specified to the client browser (this may be a default URL at startup)
- The Client browser looks in its local cache to see if the requested page is stored and if so retrieves and displays it without any need to use the network facilities.
- If the page is not cached, then the client browser performs a Domain Name Resolution Request to get an IP address for the URL
- The individual end user's computer or local network, or an ISP using a caching web server, will attempt to find the requested page, and if found send it to the browser without using the Internet.
- If there is no caching by the local network or an ISP, then the client browser establishes a connection over the Internet with the IP addressed destination server site
- The client browser transmits its request to the destination server site
- The WWW server at the destination site processes the client browser request
- An HTML page with possible links to text, image, audio, and video are transmitted as series of packets to the client requestor site
- The server terminates the connection with the client requestor
- The ISP or organization server may cache the pages locally
- The client browser processes the received HTML page and associated data for display and/or sound
- The client caches the pages locally for speeding up another reference to the page
- The client browser uses the preceding steps to follow links (HREF) to retrieve referenced pages
- The user views and processes the received data
- The client browser waits for the user to initiate the next request and the above steps are performed as applicable

This process is different from e-mail since the user is typically performing a search task to find information as opposed to retrieving mail locally. It is possible that a user's mail server could be located at an interstate location relative to the user's location, but this would be an exception and not the rule. It would most likely occur via home use since organizations tend to have local mail server resources. Even if the main server were at an interstate site, the transfer time for mail to the local machine occurs at file transfer speeds since all messages are downloaded to the desktop mail client and responding using mostly local resources. Although the browser does get some data from the local client to transmit to a remote server, this data is minimal in nearly every case comprising a few words for search arguments. The transmission of data from the browser to a server is NOT included in the calculations below and is assumed to have very little impact in any case. One complicating factor for computing data transmitted from remote sites to a client (browser) is that browsers and servers cache the Web page data most recently

accessed. This decreases the need to revisit sites for which the Web page data is in the local cache. Web cache statistics were gathered from several web sites such as the ones found at ircache.nlanr.net/Cache/Statistics and netstat.uu.se/Stat/Squid. The question is how much time is spent using Internet interstate facilities to retrieve updated or new Web pages in comparison to the total time spent connected to an ISP.

One hundred seventy two (172) web-browsing sessions with 356 PINGable sites were analyzed with the following results:

Variable	**Average (Arithmetic Mean)**
Number of Local Sites Visited	2.63
Number Long Distant (LD) Sites Visited	4.97
Number LD Intra-State Sites Visited	1.01
Number LD Inter-State Sites Visited	4.01
Number Pages Retrieved per Site	3.14
Number Bytes per Page from LD Sites	20,930.42
Number Bytes per Page from Local Sites	22,678.99
Time to View/Read All Pages	24.89 Min
Session Length (Total Holding Time)	66.58 Min (3,994,884 ms)
All Sites PING Time per PINGable Site	179.77 ms
All Sites Bytes per PINGable Site	43.61
All Sites Transmit Time per Byte	2.06 ms
Interstate Sites PING Time per PINGable Site	186.11 ms
Interstate Sites Bytes per PING	43.47
Interstate Sites Transmit Time per Byte	2.14 ms
Total Bytes Received per Session (All Sites)	513,221.40
Total Bytes Received from Interstate Sites	263,123.10
Estimated Percent of Pages Retrieved From Cache(s)	31.25%
Estimated Number LD Bytes Retrieved From Cache(s)	82,225.97
Number LD Bytes for Interstate Holding Time	180,897.10
Interstate Time for Receiving Web Pages	387,119.90 ms

The ratio of total session time (total holding time) to long distance holding time for pages received when browsing the WWW is: 387,119.0.1 ms / 3,994,884 ms = .0969 or 9.69 percent

This percentage does not exceed the 10% criteria of the mixed traffic rule and should be considered a worse case scenario based upon the characteristics of a majority of the selected subjects.

3.2.1 WWW Dialup Access Only

If we analyze only those sessions where dial-up access was used, we get approximately the same results as before from the 99 dial-up WWW sessions in the sample as shown below:

Variable	Average (Arithmetic Mean)
Number of Local Sites Visited	3.05
Number Long Distant (LD) Sites Visited	5.36
Number LD Intra-State Sites Visited	1.24
Number LD Inter-State Sites Visited	4.12
Number Pages Retrieved per Site	3.01
Number Bytes per Page from LD Sites	22,485.35
Number Bytes per Page from Local Sites	23,714.58
Time to View/Read All Pages	31.38 Min
Session Length (Total Holding Time)	72.19 Min (4,331,515.2 ms)
All Sites PING Time per PINGable Site	179.77 ms
All Sites Bytes per PINGable Site	43.61
All Sites Transmit Time per Byte	2.06 ms
Interstate Sites PING Time per PINGable Site	186.11 ms
Interstate Sites Bytes per PING	43.47
Interstate Sites Transmit Time per Byte	2.14 ms
Total Bytes Received per Session (All Sites)	598,323.48
Total Bytes Received from Interstate Sites	287,361.10
Estimated Percent of Pages Retrieved From Cache(s)	31.25%
Estimated Number LD Bytes Retrieved From Cache(s)	89,800.30
Number LD Bytes for Interstate Holding Time	197,560.69
Interstate Time for Receiving Web Pages	422,779.87 ms

The ratio of total session time (total holding time) to long distance holding time for pages received when browsing the WWW is: 422,779.87 ms / 4,331,515.2 ms = .0976 or 9.76 percent.

This percentage also does not exceed the 10% criteria of the mixed traffic rule.

3.2.2 WWW Direct Access Only

If we analyze only those sessions where direct access was used (DSL, TI, T3, etc.), we get approximately the same result as before from the 74 direct access WWW sessions in the sample as shown below:

Variable	Average (Arithmetic Mean)
Number of Local Sites Visited	2.07
Number Long Distant (LD) Sites Visited	4.44
Number LD Intra-State Sites Visited	.68
Number LD Inter-State Sites Visited	3.86
Number Pages Retrieved per Site	3.18
Number Bytes per Page from LD Sites	18,812.12
Number Bytes per Page from Local Sites	21,359.12
Time to View/Read All Pages	16.08 Min
Session Length (Total Holding Time)	58.97 Min (3,538,356 ms)
All Sites PING Time per PINGable Site	179.77 ms
All Sites Bytes per PINGable Site	43.61
All Sites Transmit Time per Byte	2.06 ms
Interstate Sites PING Time per PINGable Site	186.11 ms
Interstate Sites Bytes per PING	43.47
Interstate Sites Transmit Time per Byte	2.14 ms
Total Bytes Received per Session (All Sites)	405,765.00
Total Bytes Received from Interstate Sites	230,955.90
Estimated Percent of Pages Retrieved From Cache(s)	31.25%
Estimated Number LD Bytes Retrieved From Cache(s)	72,173.71
Number LD Bytes for Interstate Holding Time	150,782.20
Interstate Time for Receiving Web Pages	339,793.80 ms

The ratio of total session time (total holding time) to long distance holding time for pages received when browsing the WWW is: 339,793.8 ms / 3,538,356 ms = .0960 or 9.60 percent.

This percentage also does not exceed the 10% criteria of the mixed traffic rule.

If caching Web pages is ignored for Web searching, the ratio of Interstate holding time to total holding time (session time) is .141 = 563083.40 ms /3,994,884 ms or 14.1 % where 563083.4 = Total Interstate bytes transmitted * 2.14ms per byte or 263,123.1 * 2.14.

3.3 Summary of E-mail and WEB Browsing

The combined average of Interstate Long Distance holding time is (9.69 + 4.50)/2 = 7.095, but this is an unweighted average. Since e-mail is used 1.5 times as much as WWW searching and surfing according to several Internet surveys, a weighted average should be utilized. Thus, the weighted average is 6.57 = [(4.50* 1.5 + 9.69*1)/2.5], which is less than the 10% threshold. Thus, the data collected shows that a combination of e-mail and Web browsing account for less than 10% of Interstate traffic based on holding times as calculated.

Even if caching of Web pages is ignored for Web browsing, the combined average of Interstate Long Distance holding time is less than 10%, or (14.1 + 4.50)/2= 9.30 on an unweighted basis, or [(4.50*1.5) + (14.1*1)/2.5] = 8.34 on a weighted basis.

3.4 Internet Electronic Commerce

Electronic Commerce (EC) has two major categories of transactions, namely retail sales and trading partners. Trading partners utilize Electronic Data Interchange (EDI) which has characteristics similar to **e-mail** in that most of the time is consumed locally generating or processing an order or other business transaction with very little holding time required to transmit the data in the business transaction to its destination. It is estimated that EDI transactions will exhibit the same ratio of holding times as e-mail. A retail sale is more like a combination of web searching and e-mail. The shopping phase of a retail sale is like web searching (but with more reading time) but the buying phase is like e-mail in that it requires a form be completed (like composing a response to an e-mail message) and consumes very little time to transmit the relatively small amount of data involved. It is estimated that Electronic Commerce sessions will have holding time characteristics similar to the average of web browsing and e-mail and will utilize less than 10% for long distance Interstate holding time.

3.5 Internet Telephony and Fax

There are two forms of using the Internet for telephony. One requires a desktop at each end of the connection equipped with microphones and special hardware and software for digitizing voice. The entire end-to-end call is routed from the originating workstation to the local ISP, over the Internet to the destination ISP, and finally to the destination workstation. The second type of IP telephony utilizes the normal telephone handsets at each end for communicating but the call goes through special gateways at each end of the call with the middle portion being transported over the Internet. Internet telephony in this mode can be thought of as having three components:

1. A local call to the originator's ISP using the PSTN.
2. Routing to an IP-Telephony gateway, digitizing and compression of the voice signals, transport over the Internet for directory lookup,

connection to the destination IP-telephony gateway nearest the destination and transport of packets of digitized voice-using TCP/IP.

3. A local call from the ISP's IP-telephony gateway to the destination handset using the PSTN.

Although IP fax is a technical reality, there is growing evidence that e-mail attachments may provide a better technical solution that for many applications. In this case, the IP fax data should look similar to the e-mail data in this study. In any case, the sending of a fax over the Internet involves compression at the sender and decompression at the receiver. The majority of time is spent in the local loop with transmission time being a small portion of the total time similar to e-mail over the Internet.

3.6 Web Based Videoconferencing

Videoconferencing over the Web has a similar structure and uses mechanisms like Internet telephony. The system is comprised of two local calls and an Internet connection. The Internet connection appears to be 1/3 of the resources but based on compression techniques the actual holding time should be similar to IP Telephony. One difference is that a special computer may be designated as a reflector that is host to many videoconferences to which people can join. The user simply logs onto the reflector host. A reflector is not necessary for videoconferencing if the IP address of the other person is known but it is a one-to-one session. The major difference in this type of system is that digitizing, encoding and compression are most likely to occur at the user's site. In addition, systems may employ portal-based compression/packet handling schemes that would reduce the Internet transport requirements. This technology is in its infancy in terms of use and little empirical data is available.

3.7 Other Internet Applications

Database Processing

These applications fit Internet Web browsing characteristics in that a user provides search criteria or form-filling data to the Browser that sends the data to a server where a store or retrieval operation takes place. The server sends back a confirmation message to the user or a series of Web pages resulting from a search which the user must process. The majority of time is spent in the local look. As popular databases are mirrored through the world, there will be less need to use Interstate resources to access such databases.

Telnet

Telnet provides the capability to log onto an Internet server located anywhere in the world from a client machine. It makes the client appear to be a terminal connected to the host machine which communicate using the Telnet protocol. The Telnet protocol assumes that each end of the connection is a Virtual Terminal with a Virtual Keyboard

and a Virtual Printer. As text is typed at the client, it is accumulated into a buffer and when a complete line of text has been typed (by pressing the Enter or Return Key), it is then transmitted to the destination. While the typing is being completed, no data is being transmitted and no transmission facilities are being used. If the text sent by the client is a command, then the host will execute the command and return the results to the client and await the next command to be transmitted. The user at the client end will spend much more time typing and reading the screen display than is spent transmitting data between the client and the host.

File Transfer Protocol (FTP)

The file transfer protocol (FTP) is used to transfer large amounts of data between a server and a client. This is often referred to as downloading or uploading files. FTP uses the client server model. Initially, a connection is made between a client and a server in command mode but when a command to upload or download a file is made, a second connection is opened called the data connection. The command link stays open for the entire session but the data link opens and closes at the start and end of each file transfer. The command link consumes very few transmission resources since the command are very short (GET, PUT, LS, etc.) and result in small amounts of data for transmission from the server to the client. Data link transfers are transmission intensive. In order to reduce time of transmission, most large files are compressed (Zipped) prior to transmission thereby reducing by 10 to 50 percent the file size and transmission time.

Internet Relay Chat (IRC)

This provides the capability for people all over the world to chat or talk with one another. It works using the client server model. The client software connects to a chat server where the user joins a channel. As anyone connected to the channel types a line of text, t is sent to the server which in turn sends it to others connected directly to the chat server or to other chat servers in the world closest to those logged into the channel. The servers are connected in a minimum spanning tree architecture so as to minimize transmission of messages on the Internet. Very popular chat servers are mirrored across many locations in the world. Most messages are short and consume very little transmission time compared to the composition and reading time. It is hypothesized that Chat sessions are similar to e-mail in terms of interstate and local holding times

Appendix A User Data Logs for E-Mail and WWW Browsing

Role of User:
Type of Organization:
ISP Vendor:
Speed of Connection in bits/second:
Date:
Country of Citizenship:
Type of Connection:

E-mail:
Time Session starts:
INBOX:
Number of 'local' messages:
Number of 'long distance' messages:
Number of instate: Number of out-of-state:
Average characters exclusive of attachments:
Number of messages with attachments:
Average attachments per message:
Types of attachments:
Average bytes of attachments:
RESPONSES TO E-MAIL:
Number of responses:
Average characters per response:
Number of 'local' responses:
Number of 'long distance' responses:
Average minutes composing a response:
ORIGINATING E-MAIL:
Number of messages composed:
Average characters in a message:
Average minutes composing a message:

Time session ends:
Time to get to a long distance call site:
PINGed long distance sites and recorded time:

Message	Site	Avg. Time (Ms)	Bytes/PING

Web Browsing:

Type of Connection:
Transmission Speed of Connection:
Purpose of the Session:
Time session starts:

Number of 'local' sites visited:
Number of 'long distance' sites visited:
Number of instate sites:
Number of out-of-state sites:
Average pages from a site:
Average bytes on a long distance site page:
Average bytes on a local site page:
Average minutes reading/viewing all pages at a site:

Time session ends:

PINGed long distance sites and recorded time:

Site	Site Identification	Average Time (Ms)	Bytes/PING

CERTIFICATE OF SERVICE

I, Michael W. Fleming, hereby certify that the foregoing REPLY COMMENTS OF HYPERION TELECOMMUNICATIONS, INC. ON PETITIONS FOR RECONSIDERATION was served on this 19th day of January, 1999 upon the following persons by first class mail, postage prepaid, except as indicated.

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