91. The two merging companies have distinctive strategies for residential customers. WorldCom offers residential service plans, but makes only modest efforts to sign up residential customers. The company does not believe it has a comparative advantage in attracting these customers and prefers to focus primarily on business customers, who can be reached through direct sales techniques. As I have stressed earlier, the higher prices that many residential customers are willing to pay is not an indication of failed competition or major profit opportunities for companies like WorldCom. It is expensive to sign up the passive customers—precisely because they are passive—and it is expensive to serve them because of their low volume.

92. MCI is an important player in residential service, with a well developed strategy based on intensive promotion. MCI sets low prices for off-peak residential service and relatively high prices for on-peak service. MCI One charges 5 cents per minute on Sunday, 10 cents at other off-peak times, and 25 cents during the daytime on weekdays.

93. Thus, in my opinion, the merger of WorldCom and MCI would have almost no effect on residential customers. Because of the major differences in the way the two companies have competed for residential customers, those customers will not be harmed by the coordination of MCI's and WorldCom's residential businesses that would occur as a result of the merger.

94. MCI's residential business has built a stock of valuable reputational capital as a result of MCI's promotional efforts, low off-peak prices, and high-quality service. It would be economically irrational for the merged entity not to capture the value of that reputational capital by failing to continue the business. Even a spin-off is economically unlikely, given the profitability and value of residential service, because it would involve substantial transaction costs to accomplish and would sacrifice transactional efficiencies from the existing vertical integration of MCI.

2. Efficiencies Resulting from the Merger

95. The efficiencies that WorldCom and MCI could enjoy from combining the two companies—and would pass on in part to their customers—are primarily reductions in transactions costs and in costs associated with the market power of their suppliers. In the provision of local service and long-distance access, the companies also would benefit from cost reductions associated with sharp increasing returns to scale.

96. MCI's ability to use WorldCom's local network without incurring transactions costs should enable MCI to avoid more of the use of overpriced access provided by dominant local telephone companies.

97. Similarly, WorldCom should be able to reduce its international termination costs by taking advantage—without important transactions costs—of MCI's existing settlement agreements.

98. Because the two companies' product lines are complementary in a number of ways, the merged company would enjoy lower selling costs, as the sales force is able to sell a broader product line to each potential customer.

99. The stock market shows evidence of the efficiencies. The combined value of WorldCom and MCI rose when WorldCom made its offer on October 1, 1997, rose again the morning after GTE made its offer on October 15, and rose a third time when the merger was announced on November 10. The total increase in the combined value of the two companies was less than 5 percent likely to have occurred from random variation in stock market values. As I show below, none of the increase can be attributed to the market's belief that markets would become less competitive as a result of the merger—a portfolio of rivals to WorldCom and MCI showed close to no change over the three merger events. Hence the increase in value of the two companies reflects Wall Street's belief that the merger would create efficiencies.

V. Discussion of Analyses in the Bells' Petitions

A. BellSouth's Prediction that the Merged Company Will Exit Residential

100. BellSouth's petition makes the prediction that the merged company would have the incentive to exit the residential market.[19] On the other hand, BellSouth believes that the residential market is currently non-competitive and will become more so after the merger. Logically, this would make residential highly profitable. Why would the merged company exit?

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[19] *Petition for Conditional Approval of the Applications of WorldCom, Inc. for Transfers of Control of MCI Communications Corporation* BellSouth Corporation, January 5, 1998, p. 11.

101. Separately, BellSouth predicts that the merged entity will spin off residential service.[20] As I discussed in Part IV, a spinoff is a neutral event for consumers. No harm will occur to consumers if the merged company decides to spin off its residential assets. In the same discussion, BellSouth presumes that MCI's existing residential business will go to the incumbents, primarily AT&T, raising the concentration of the long-distance market. In effect, BellSouth is forecasting the immediate demise of the spun-off company. there is no economic basis for that forecast, given the success of MCI's residential business to date.

B. Long-Distance Prices

102. BellSouth states that long-distance carriers have raised their prices despite declining access charges.[21] The detailed factual material I reviewed in Part IV of this declaration shows conclusively that this statement is incorrect. The best measure of the price of long-distance service—revenue per minute—has fallen substantially more than have access charges. Although it is true that AT&T, MCI, and Sprint raised their standard rates through 1996, the authors of the BellSouth petition appear to be unaware of reductions in those rates that occurred in 1997 when the FCC lowered access charges.

103. BellSouth states: "The major carriers have, moreover, raised their discounted rates along with the basic rates off of which discounts are taken."[22] Again, the authors are completely out of touch with current practices in the long-distance market. Carriers do not state their lower-priced plans in terms of percentages off basic rates. Rather, as the table in Part IV shows, they state the rates as cents per minute. And those rates have *declined* uniformly.

104. BellSouth makes the remarkable charge that "... mid-volume callers are denied discounts."[23] This is completely preposterous. To take one of hundreds of examples to the contrary, MCI charges 5 cents per minute on Sunday and 10 cents per minute at other off-peak times, with a monthly minimum of only $5. Surely a mid-volume caller saves a great deal with this plan relative to standard rates. And a mid-volume caller who calls frequently during peak hours can sign up for AT&T's One Rate Plus plan, which charges 10 cents per minute at all times with a $4.95 per month base charge.

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[20] *Ibid.*, p. 18.

[21] *Ibid.*, p. 13.

[22] *Ibid.*, p. 13, emphasis in original.

[23] *Ibid.*, p. 14.

105. BellSouth cites the 1995 and 1996 increase in the Consumer Price Index for long distance as support for the claim that long-distance prices are rising.[24] Over a longer period, the CPI shows a sharp decline in long-distance prices, but they do not present a complete picture. The evidence suggests that the CPI understates recent declines in those prices. Construction of price indices for products such as long-distance service presents a serious challenge. For the CPI, the Bureau of Labor Statistics prices a fixed basket of calls placed by households. Until last year, the CPI used the standard rates, without considering the more favorable pricing plans that most consumers use. The long-distance component of the CPI understated price declines that occurred when more favorable plans were introduced. In addition, the CPI's procedure for the introduction of new sellers and new products understates price declines.[25] In light of the extensive use of pricing plans that are far more attractive than the standard rates in the long-distance market since divestiture, the omission of these factors from the CPI has led to a substantial understatement of price decreases. An FCC document warned users that the CPI (and the PPI) were unreliable measures for long-distance prices: "Price indexes are less reliable when industries are changing rapidly." The FCC document further states that "Because of these sorts of difficulties, measures of average revenues are sometimes used as alternatives to price indexes."[26] Although the new CPI may be a more reliable measure of changes in long-distance prices from 1997 onward, the historical CPI, including 1995 and 1996, is seriously biased.

C. Defects in the PNR Bill Harvesting Data

106. BellSouth relies on data from PNR and Associates to measure shares of residential long-distance revenue.[27] In Part IV, Section F, I demonstrated that these data are not representative of residential long-distance customers. They disagree significantly with highly reliable internal data from MCI. I do not believe that the PNR data should be used for the purposes that BellSouth proposes.

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[24] *Ibid.*, p. 13

[25] A good example is the following: Prior to 1987, the CPI included only AT&T calls. When other carriers were added to the index in 1987, the new index was adjusted so that it had the same value as the old index in 1987. Although the cost of a basket of calls was lower if some of the calls were made on other carriers, the effect was eliminated by a multiplicative adjustment. Hence the consumer benefit from the lower prices of other carriers before 1987 never was recorded in the CPI.

[26] Section 5, *Price Index Limitations for Telephone Services*, FCC Trendline Report, Industry Analysis Group, Common Carrier Bureau, Federal Communications Commission, May 7, 1996.

[27] BellSouth *Petition*, p. 10

D. Direct Effect of the Merger on MCI's and WorldCom's Prices

107. BellSouth suggests that "...funding the deal premium will require WorldCom to improve residential margins, either by jettisoning residential customers or by raising residential prices."[28] That suggestion contains a major error of economic analysis. If MCI is currently maximizing profit, raising prices or shedding customers would lower, not raise profit.

E. Reselling Issues

108. BellSouth suggests that WorldCom now cooperates as a bulk capacity supplier to residential resellers, but would withdraw that cooperation if it owned MCI.[29] (p. 17) Bell Atlantic complains about MCI's unwillingness to enter into a reselling arrangement that would enable Bell Atlantic to bid away MCI's customers.[30] I believe that these are insignificant issues from the consumer's perspective.

109. First, pure reselling of long-distance service is a less efficient form of competition than the creation of a long-distance carrier by leasing or building capacity. In the pure reselling arrangement, one firm provides the brand name and sales effort, and a second firm provides the switching and transport. The transactions costs in managing this type of relationship have proven to be substantial. The most vigorous competition in long distance comes from sellers who are responsible for managing their own long-distance operations—even where they lease the transport capacity. Thus Bell Atlantic will have less to offer the consumer during the period when they are just rebranding MCI or other service, in comparison to the time when they control more of their long-distance operations. This point has been made frequently in connection with local service, where competition based on reselling the services of the local carrier is widely seen as less effective than competition based on leasing or owning local capacity. It applies in long distance as well.

110. Second, the high level of competition in both the long-haul fiber capacity market and in the long-distance market mean that Bell Atlantic and other would-be resellers have many other sellers of whatever inputs they wish to purchase for their long-distance operations. The

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[28] *Ibid.*, p. 17.

[29] *Ibid.*, p. 17.

[30] Bell Atlantic, *Petition to Deny the Application of WorldCom or, in the Alternative, to Impose Conditions*, January 5, 1998, p. 14

analysis in Parts III and IV of this declaration explains why the merger will have little effect on the outcome of the deals made in those markets.

F. BellSouth's Analysis of the Effect of the Merger Announcement on the Stock Market

111. BellSouth states that AT&T and Sprint have enjoyed higher prices in the stock market as a result of the announcement of the merger.[31] They do not present a real event study to support this conclusion. Apparently, BellSouth is referring to general changes from all sources, including the overall movement of the stock market during the fall of 1997, and has made no effort to separate the effects of the merger.

112. BellSouth is correct to look to the stock market for information about the potential effects of the proposed merger. The stock market reflects the judgments of the investors who follow and assimilate information about the firms traded there. It is well established that the stock market helps evaluate the competitive effect of a merger. Upon the news arrives of an anticompetitive merger, the prices of the rivals of the merging companies will rise, because the rivals will enjoy the benefits of the increased price.

113. Table 2 shows the standardized price changes of four rivals of MCI and WorldCom on the days when the market recorded the effects of three events related to the merger.

Table 2. Evidence from the Stock Market

Event	*AT&T*	*Sprint*	*IXC*	*LCI*	*Portfolio*
10/1/97 WorldCom's offer	-1.2	2.4	1.8	-.5	-0.2
10/15/97 GTE's offer	-1.7	-2.5	0.0	0.2	-2.0
11/10/97 MCI and WorldCom announce merger agreement	2.4	0.8	-0.1	0.8	2.0
Sum of three price changes	-0.3	0.6	1.0	0.3	-0.1

Explanation: Each entry is the percentage change in the stock price less the percentage change forecasted from the Capital Asset Pricing Model, divided by the standard deviation. The portfolio is the four stocks weighted by the market values of the companies.

[31] BellSouth *Petition*, p. 18

A standardized price change is not statistically remarkable unless it is greater than 2 in magnitude. The general pattern of changes gives no support to the hypothesis that Wall Street viewed the merger as anticompetitive. AT&T and LCI fell a little when WorldCom announced its offer but Sprint and IXC rose. Sprint lost what it gained, though, when GTE made its offer. Then except for Sprint, stock prices moved in opposite directions when the merger agreement was announced from the direction when the offer was made. The net effect, measured by the sum of the three price changes, is close to zero for each company separately and almost precisely zero for the four companies considered together, as shown in the last column of the table.

114. AT&T and Sprint are vertically integrated rivals of WorldCom and MCI. There is no indication that the merger created expectations of higher prices in their markets—long distance service or fiber capacity. IXC and LCI are rivals mainly in the capacity market. Again, Wall Street did not see higher prices in that market creating opportunities for these rivals.

VI. Discussion of Analyses Performed by the Bells' Experts

A. Professor Jerry Hausman

115. Professor Hausman analyzes the list prices of the major long-distance carriers in a framework similar to the one used by other economists engaged by the Bells. As I showed in Part IV, list prices have as little to do with the prices paid for most purchases in this industry as in many others. AT&T may put a list price of 27 cents on its product, but it gets about 12 cents on the average and customers with any significant long-distance volume have only themselves to blame if they pay more than about 10 cents.

116. Professor Hausman makes the statement, "Furthermore, AT&T did not pass on the recent (July 1997) access rate decreases to its one-rate plan customers or indeed, to any of their residential discount plan customers." (p. 23) It is true that AT&T's bargain One Rate Plus plan remained at 10 cents per minute at all times of the day. But recently, AT&T moved this plan from a status where it was provided only to customers who demanded it to a status where it is actively promoted through $100 switchover checks. Surely one of the reasons that AT&T finds it profitable to promote such a low rate is that its costs have fallen. Further, as Section IV showed, revenue per minute has been declining dramatically, faster than the

decline in access charges. AT&T customers are continuing to enjoy rapidly declining prices, and one of the forces contributing to the rapid decline is diminishing access charges.

B. Professor Richard Schmalensee

117. Professor Schmalensee concludes that there is inadequate competition in long distance.[32] The evidence he cites of inadequate competition is first, that the rising market shares of smaller carriers is a sign of high profit margins; second, that AT&T's list prices have risen rather than fallen since 1993, and that this is true even after incorporating flat-rate plans into the analysis; and, third, that prices for residential service exceed cost.

118. Professor Schmalensee observes that AT&T's market share has fallen steadily, Sprint's and MCI's have been steady, and that smaller carriers have expanded. He reaches the carefully hedged conclusion that this pattern is "consistent with tacit price coordination among the Big Three carriers, or at least with a tight-knit oligopoly" (p. 6). I believe that Professor Schmalensee would agree that any pattern of trends in market shares could be consistent with any type of oligopoly model. For example, in a Cournot model, market shares are controlled by cost differences. Perhaps the smaller carriers have more favorable cost trends than do the established firms. I do not disagree with Professor Schmalensee's use of the word "consistent" but do point out that the trends in market shares are also consistent with a workably competitive market where muscular and active smaller companies are squeezing their way into the market by taking advantage of small cost differentials. The dogs are eating the dogs, and the smaller dogs are gaining weight. My analysis of the long-distance industry in Part IV uses the kinds of data that most economists would rely upon to reach conclusions about the factors explaining changes in market shares, and, in my opinion, strongly supports the competitive model for that purpose.

119. Professor Schmalensee bases his conclusions about residential long-distance prices on the PNR "Bill Harvesting" data. In response to earlier section 271 filings by SBC and Ameritech, and as discussed above in Part IV. Section D, I have shown that these data are badly biased. Professor Schmalensee continues to rely on the biased PNR data without responding to this evidence of bias. I do not believe that the PNR data are usable to measure actual residential prices. Instead, I believe that the best way to measure those prices is by revenue per minute. As I showed in Section IV, revenue per minute has fallen every year

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[32] "BellSouth's Prospects for Success in the InterLATA Market," Declaration of Richard L. Schmalensee, August 18, 1997.

since 1985. It has fallen much faster than access charges and its level is far below theoretical calculations based on price plans and hypothetical distributions of customers among plans.

120. Professor Schmalensee's discussion of AT&T's One Rate plan has been rendered completely obsolete by the One Rate Plus plan, which prices all long-distance calls at 10 cents per minute. This plan was in existence when Professor Schmalensee wrote, but he ignored it. It cannot be ignored today, as AT&T is actively promoting the plan by mailing $100 checks to prospective customers. One Rate Plus is a sure bargain for any of the subscribers considered by Professor Schmalensee on pages 9 and 10 of his affidavit.

121. Professor Schmalensee observes that AT&T earns profits on its sales of long distance—its price is above its cost. Although he does not mention the fact, it is reasonably well known that MCI makes profits as well. Although the long-distance market is workably competitive and delivers substantial and rising benefits to the consumer, it is not perfectly competitive, the standard Professor Schmalensee applies. No industry with intellectual property, brand-name capital, and the other intrinsic features of long distance could ever be expected to have marginal cost equal to price, no matter how much rivalry there is. Professor Schmalensee's findings of marginal cost somewhat below price do not have any implications for policy analysis in general or for the evaluation of the proposed merger.

122. Professor Schmalensee considers low-usage customers, who are well known to pay higher rates per minute for long distance than do other customers. His reliance on the biased PNR data to estimate the fraction of AT&T customers who pay list price probably results in a serious overstatement of this fraction. I believe it is not in dispute that AT&T has retained a substantial fraction of low-usage customers and that the carriers that have expanded since 1984 have done so in part by attracting higher-usage customers. Moreover, as Professor Schmalensee discusses, it is understandable that low-usage customers pay more per minute, because there are important fixed costs of serving a customer. In a competitive industry, prices to each class of customers will reflect the costs of serving the class, including the costs associated with adding a customer, even if those costs do not vary over the customer's usage.

VII. Conclusions

123. I have studied both the level of competition in the long-distance market and the change in competition that would result from the proposed merger of WorldCom and MCI. I believe that the merger would be economically beneficial to the consumers of long distance.

The market is currently substantially competitive. In particular, the evidence suggests that every potentially profitable niche in the market has been pursued vigorously by the hundreds of sellers in the market. Even if the merger created some opportunities for profit—which I do not believe it will—new sellers would enter and existing rivals would expand to eliminate that profit in short order.

124. The merger would be positively beneficial for the consumer because the merged company would achieve lower costs, which would make it an even more vigorous competitor in long distance and in other telecommunications markets. Some of the most important benefits would come from avoiding the use of access services of dominant local phone companies, which are still grossly overpriced.

125. One of the reasons that entry and expansion are easy in long distance is the fluid and competitive market for long-haul fiber capacity, one of the important inputs to long distance. As a result of the smooth operation of that market, the sunk costs facing a potential entrant to long distance are low. A firm can enter long distance easily by purchasing capacity in the market, and, if a disappointment follows, the firm can recover the investment by selling in the market.

126. Although WorldCom and MCI are both operators of long-haul fiber networks today, I do not believe that their merger would have any measurable effect on the price of fiber capacity. The rapid pace of entry today shows not only that there are no important barriers to entry and no important returns to scale, but also that the concentration of the fiber capacity market will fall rapidly in just the next two years. Because the new entrants bring the most advanced low-cost technology, their costs will determine prices starting in the near future. Even if the merger had the potential to raise today's price of fiber capacity—which I do not believe it has—that would only accelerate entry of new sellers in the market.

VIII. About the Author

127. I serve as Professor of Economics at Stanford University and also Senior Fellow at Stanford's Hoover Institution. I received a Ph.D. in economics from the Massachusetts Institute of Technology in 1967. I have been elected a fellow of the American Academy of Arts and Sciences and a fellow of the Econometric Society. I have published 7 books and numerous articles in several areas of applied economics. I have extensive experience in the

economics of telecommunications, computers, and software. Recently I served as an expert for the Department of Justice in its case against Microsoft and in its opposition to Microsoft's proposed merger with Intuit. Further information about my professional activities is in my *curriculum vitae*, which is appended to this declaration.

I, Robert E. Hall, declare under penalty of perjury that the foregoing is true and correct.

Robert E. Hall

Executed January 26, 1998.

February 1997

CURRICULUM VITAE

Robert E. Hall
Hoover Institution
Stanford University
Stanford, California 94305
(415) 723-2215
Fax: 725-7320
Email: Hall@Hoover.Stanford.EDU

Born August 13, 1943, Palo Alto, California
Social Security Number: 559-60-0891

PhD in economics, MIT, 1967
BA in economics, University of California, Berkeley, 1964

Senior Fellow, Hoover Institution, and Professor, Department of Economics, Stanford University, since 1978

Previously Professor of Economics, MIT (1974-78), Associate Professor of Economics, MIT (1970-74), Acting Associate Professor of Economics, University of California, Berkeley (1969-70), Assistant Professor (1967-69)

Fellow, American Academy of Arts and Sciences
Fellow, Econometric Society

Director, Research Program on Economic Fluctuations, National Bureau of Economic Research, since 1977
Member, Advisory Committee, Congressional Budget Office, since 1993
Member, Oversight Panel for Economics, National Science Foundation, 1989, and Advisory Panel for Economics, 1970-72
Member, Yale University Council Committee on Social Sciences' Policy, 1989-94
Member or Senior Advisor, Brookings Panel on Economic Activity, since 1970
Member, President's Advisory Committee on Productivity, 1981-82

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Attachment D: Route Entries Methodology

Bell Atlantic's Analysis is Flawed. MCI and WorldCom believe the data used in the Bell Atlantic analysis is incomplete and the analytical method very likely yields distorted and incorrect results. MCI and WorldCom believe that Bell Atlantic only counted routes originating from MCI and WorldCom networks and not routes that belong to customers of MCI and Worldcom. The results, therefore, can be significantly skewed for networks with a high percentage of such customers whose routes were excluded. Some of the data is incorrect, as networks can be counted multiple times. An example can be found by choosing the "Total Number of Routes from AS" report, and entering "AS1673" as the network of interest. This shows several networks listed multiple times. It is unclear from the methodology which networks were included in the Bell Atlantic formula and which networks were used to consider the total number of networks being announced by any specific network. More critically, the simplistic counting of route entries in the database, given the route "aggregation" associated with current Internet routing tables, produces very distorted results. The total number of apparent routes is understated, leading to an overstatement of the percentage of routes announced that are attributable to MCI and WorldCom networks. Accordingly, the conclusion that 58% of customer routes on the Internet would be owned by the merged WorldCom and MCI is a significant exaggeration.

WorldCom and MCI Analysis of Route Entries. In the WorldCom and MCI analysis, the number of unique preferred paths in the internet choosing WorldCom or MCI was tabulated. Because of the connectivity of the Internet, a given ISP may appear on many paths linking a source network to a destination network. Accurate information on the number of ASs (Autonomous Systems) to which each North American network is connected is not available. An AS is a collection of routers under one administrative authority. Each Autonomous System is assigned an identifier, an Autonomous System Number (ASN) by the Internet Assigned Numbers Authority (IANA). Most ISPs have at least one, but may have more than one ASN. WorldCom and MCI used the U.S. network registry database RADB (Routing Arbiter Database) data showing connections among Autonomous Systems to guide their analysis. RADB is not yet fully populated and accordingly, data generated for the North American Internet backbone providers is understated. Thus, even in this analysis, the resulting fraction of routes attributable to MCI and WorldCom is, in all probability, overstated. In their analysis, all route entries showing WorldCom or MCI as lying on the preferred path, were attributed to WorldCom or MCI. WorldCom and MCI each separately obtained the route entry information from two different routers on the East Coast of the United States and as a consequence (because routers have a preponderance of localized information) North American route and therefore, path, information is over-emphasized.

Performing the measurements using different routers in North America would yield somewhat different measurements. There may also be some duplication of route entries in the WorldCom and MCI aggregate tabulations. Nevertheless, WorldCom's analysis yielded aggregate route entries of 20.47% for WorldCom and MCI, and MCI's analysis yielded aggregate route entries of 22.43% for WorldCom and MCI, each using unique preferred paths for each network prefix evaluated (for example, 208.192/16) as a route entry.

Counting Route Entries is Not an Appropriate Measure of ISP Market Position. To appreciate why simplistically counting the number of route entries in routing tables is not a reliable indicator of the market position of a given ISP, it is necessary to understand the way in which the routing table functions. In order for the interconnected networks of the Internet to guide traffic properly from source to destination, the routers of all networks need to maintain tables which determine where an Internet packet bearing a given destination IP address is to be forwarded (the so-called "next hop"). The Internet community has arrived at certain procedures to minimize the number of routing table entries required to maximize efficiency of maintaining and exchanging routing information. Counting routing table entries does not give a very good indicator of the size of an ISP's network or the size of the customer base served because each routing table entry may represent a different sized network. Accordingly, a single entry might represent anywhere between 256 and 16 million addresses depending on the size of the network referenced by that route entry. In addition, the measurements represent a snapshot of a specific point in time. For the foregoing reasons, these measurements are almost impossible to duplicate. If the measurements were taken from routers in widely different locations, they are likely to vary, perhaps significantly. However, if the measurements were taken from the same router repeatedly over the course of several days, or routers in relatively close geographic proximity, the measurements are likely to vary only slightly. Given the inability to identify accurately the whole and the technical limitations inherent in measuring the units, WorldCom and MCI believe counting route entries is an inappropriate measure of market position.

Attachment E: A Brief History of Internet Addressing Policies

The Internet grew out of the development of the ARPANET which came into being in 1969. A central authority for keeping track of the assignment of addresses and other identifiers was created for ARPANET and, as the Internet emerged in 1983 from its research roots, the responsibility for maintaining the records of address and identifier assignment fell to an entity now called the Internet Assigned Numbers Authority (IANA). This very small organization kept track of Internet Protocol addresses (IP addresses) assigned to the networks of the Internet, as well as domain names (e.g. www.mci.com, www.uu.net).

From the period from 1973 to 1990, the availability and size of the Internet address space was not an issue. As the Internet's geometric growth became apparent, the technical community, principally in the Internet Engineering Task Force (IETF) began to worry about the size of the routing tables needed to determine how to guide traffic from source to destination in the rapidly growing global network.

The routers available have not been well-suited to handling extremely large tables, both because of memory space limitations and also because of the limited processing power available to process large routing table updates from the network. Moreover, large tables imply large update and this consumes transmission capacity which might be better put to work servicing customer traffic.

It was with these limitations in mind that the IETF developed a set of procedures to reduce the effective size of the routing tables, conserving memory and also reducing the capacity needed to move routing table updates around the Internet. These procedures are referenced as Classless Inter-Domain Routing (CIDR) guidelines and their application helps to trim the actual sizes of the routing tables and speed their processing in routers of the Internet.

IANA promulgated recommendations for the assignment of address space by the organizations charged with this responsibility to ISPs and their customers. In essence, the three bodies,[1] which perform address allocation under the oversight of IANA follow the CIDR guidelines as do ISPs, including backbone service providers, making subsidiary assignments to customers.

These guidelines essentially confine ISPs to assign what are called "non-portable" IP address space to customers. This restriction, which requires that address space be returned if a customer changes ISPs helps to keep the routing tables small and compact.

There are exceptions for ISPs and for large customers withbona fide requirement to interconnect with more than one service provider concurrently. Portable address space must be obtained from one of the three Internet Address registries or, in some circumstances, from IANA

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[1]ARIN - American Registry for Internet Numbers in the Americas; RIPE NCC - Reseaux IP Europeenne Network Control Center; APNIC - Asia Pacific Network Information Center.

directly.

MCI and Worldcom/UUNET follow the CIDR guidelines for the benefit of the worldwide Internet community.

Attachment F: A Brief History of Peering,
Network Access Points (NAPs) and Internet Exchanges

The earliest Internet had a single backbone, the ARPANET, to which most other Internet networks were connected. Local Nets connected to ARPANET or to the Packet Radio Net(s) or the Atlantic SATNET, which formed the original triumvirate of the primary networks of the Internet. As various U.S. Government agencies built their own networks, these needed to be interconnected and, eventually, rather than using the ARPANET as the primary interconnecting medium, two Federal Internet eXchange points (FIX-East and FIX-West) were established to link the ARPANET with the National Science Foundation Network (NSFNET), Department of Energy's ESNET, and the National Air and Space Administration's NASA Science Internet. These FIX sites were precursors to today's Network Access Points (NAPs).

Protocols were developed which allowed networks that interfaced with each other to exchange routing information using what was called an Exterior Gateway Protocol (EGP) and the procedures for this exchange eventually came to be known as "peering" - as in the exchange of routing information between equals or peers.

As the Internet grew, connectivity among the non-Government networks in the US moved from the ARPANET, which was retired in 1990, to the NSFNET. Essentially, the costs of most of this interconnection was underwritten by the U.S. Government. The NSFNET instituted what it called an Appropriate Use Policy (AUP) to restrict use of the Government-provided interconnection.

By 1990, these restrictions began to interfere with the growing commercial interest in Internet services. To avoid the AUP limitations, a number of Internet Service Providers, notably UUNET and PSINet among others, formed the Commercial Internet eXchange (CIX). This non-profit organization provided facilities for the exchange of traffic among all its members at a site in the San Francisco Bay area. The terms and conditions were simple: all members would accept and send traffic to all other members without additional costs, and each member would underwrite its costs to reach the CIX location.

When the National Science Foundation concluded that it was no longer necessary to provide backbone connectivity, because of the rapid growth of commercial alternatives, it retired the NSFNET in April 1995. In its place, to assure that the Internet would remain "connected", NSF sponsored the formation of several Network Access Points (NAPs) which became neutral meeting points for any networks interested in exchanging traffic. Connection to a NAP did *not* require that all parties exchange traffic - this was left to the ISPs to work out on a bilateral basis at each NAP.

Parties exchanging routing information and traffic at NAPs were said "peer" with each other and the practice has historically not involved any exchange of payment, other than payments to the NAP operator for access to the facility and colocation of ISP equipment on the site.

As the Internet became more richly interconnected, it became vital to tailor the information exchanged at the interfaces between networks to avoid creating "loops" in the routing tables which would doom packets to circulate in the Internet without reaching their destinations. This led to the development of the Border Gateway Protocol (BGP) which allowed selective "announcement" of connectivity information between the networks. Peering has come to mean provision of exchange of traffic only between the customers of the peering ISPs not the peers of these ISPs. "Transit" adds to this the carriage of traffic from customers to all parties with which the serving ISP connects.