Testimony of

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Mr. Chairman, members of the Subcommittee, thank you for the opportunity to testify here today on a matter of growing importance. I appreciate your efforts to consider the issue of network reliability.

My message to you today has five parts:

1. **Competition solves some issues of reliability, but exacerbates others.** It is not the overall problem-solver for reliability.

2. **Concerns about reliability and the consequences of network failure will only grow in the future.** Network diversification and complexity and growing economic dependence on information transport and processing means that network reliability problems will not disappear with a wave of a magic technological or regulatory wand.

3. **It is not economically possible or even desirable to avoid all reliability problems; our goal must be to provide users with an ability to choose levels of reliability commensurate with their needs and willingness to pay.**

4. **Regulatory oversight in this area should go beyond the collection of information. It should include incentives that tie reliability and quality to financial performance, a role for government as a catalyst for inter-industry collaboration in this area, and international cooperation.**

5. **The investment by government agencies in the reliability of their telecommunications is not necessarily optimal.**

Recent events have brought the critical matter of network reliability to the public's attention. The FCC's recent proposal to collect more information from carriers suffering outages is certainly welcome. But I believe that collecting more information, convening meetings, accelerating research on other industries or even establishing special staff task forces should be supplemented by economic incentives. I will outline a proposal to that effect.

I. The Sources of Problems

1. **The Growth of the Information Economy.** The information economy has yielded a heightened reliance on the information transport infrastructure, especially by the service sector, which in the past decade has been the economy's main growth area.

A recent study by the New York City Partnership in collaboration with Booz Allen & Hamilton estimated that the loss of telecommunications service for a single day in Manhattan would disrupt more than $1 trillion in financial transactions. The ripple effect on other institutions across the country could well be even larger.

Data-dependent users are aware of their vulnerability. According to a survey of banking, securities and insurance executives, network reliability was ranked more important to business location decisions than technology availability, service/support or cost.

2. **The Concentration of Network Traffic.** The economies of scale of network transmission and switching made possible by recent advances in fiber optics and electronic switching have concentrated telecommunications traffic. As a result, vulnerability is increased, especially at information "chokepoints" such as the nodes where long-distance networks interconnect with local exchanges. Thus, while it is a marvel that two hair-thin fiber optic lines can carry 80,000 telephone calls at one time, it also means that one mistake with a backhoe can disrupt millions of calls, affecting more customers than ever before. And fiber trunks take longer to repair than coaxial lines.

3. **Diversification of Networks.** As new networks enter the market, and as users supplement or replace public transmission and software-defined offerings with customized additions, the technical complexity and diversity of the overall network system increases. Competition in telecommunications has led to faster cycles of introduction of new services, technologies and software, with shorter testing periods. We can expect more such cases, and they may happen more frequently.

4. **Increased Network Sophistication.** It's not just a matter of somebody being asleep at the switch. Many of the problems associated with the best-known network failures have been direct outgrowths of network sophistication. The FCC staff's recently found that "most [reliability] problems are attributable to inadvertent side effects of efforts to upgrade network capabilities." Consider, for example, the January 15, 1990, AT&T failure when a bug in the computer code that operates AT&T's SS7 digital system caused a nationwide network failure for

nine hours affecting every switch in the network. It is almost impossible to totally ensure that a bug, hidden within millions of lines of computer code, would be detected before the problem began. This is one negative side-effect of the positive impact of competition on telecommunications progress.

Similar problems have affected other countries, too. Japan and Sweden, two of the world's best telecommunications systems, had to contend with Signalling System 7 failures.

5. **Network Interconnectivity.** The interconnectedness of networks means that faults may become difficult to pinpoint and remedies harder to implement. A break in one carrier's service can have effects on customers of other networks, and degrees of quality offered by the various components become interdependent. When transmission links interconnect into each other in a "chain of transmission" as is common, and without anybody having end-to-end responsibility, competitive pressures can lead to a free-rider problem, as carriers allow their own link to degrade so as to avoid extra costs associated with maintaining their quality above the network's weakest link.

Another problem is known to economists as the "lemon" issue: If sellers (in this case, network operators) anticipate that consumers will be unable to verify the quality or reliability of goods they are being offered, they will have marked incentives to attract consumers with low prices in an attempt to encourage them to buy products of a quality inferior to that they would have otherwise preferred. This problem is particularly acute with goods whose quality cannot

be evaluated before purchase; such is normally the case with network services.[1]

6. **Private Burdens on the Public Network.** The interconnected network of networks poses new challenges to network reliability. For example, the traditional "public" network is available as a back-up if faults develop in a private network or if capacity is reached; hence private networks can adopt a less costly standard for reliability. This, in turn, leads to a greater variance of traffic flow in the public network, which complicates the engineering of such networks for peak capacity.

Thus, with the decentralization of networks and their interconnection, independent suboptimizing decisions on investment and capacity might not result in overall efficiency.

7. **Incentives for Redundancy Are Decreasing.** Because of increases in competitive market forces, network providers are not likely to build as much redundancy into their networks as in the past. Traditionally, networks are engineered with sufficient redundancy to cope with breakdowns — failure in one location channels traffic through an alternate route. But some portion of that redundancy may be ascribed to what economists call the Averch-Johnson effect and regulators call "goldplating." That is, the incentives in traditional rate-of-return regulation may encourage *over*investment. Under the incentive-based price-cap regulation that is becoming more widespread, the cost of overinvestment is borne by shareholders rather than ratepayers. Even if this results in lower quality, this does not necessarily mean a less efficient outcome from

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[1] See G.A. Akerlof, "The Market for 'Lemons': Quality, Uncertainty and the Market Mechanism," 84 *Quart. J. Economics* 488 (1970); P. Nelson, "Information and Consumer Behavior," 78 J. Pol. Econ. 311 (1970).

a societal standpoint. Quality, without reference to cost, is a meaningless concept. Furthermore, to reduce all risk of failure leads to what statisticians call a Type II error, in this case, by over-caution leading to excessively slow introduction of new technology.

The problem is that carriers may not pick the optimal point of reliability. Price caps reward network operators for cutting costs. While this should come through increased productivity and efficiency, the price cap plan also provides incentives for cutting back on maintenance costs and network investment.

Offsetting this problem to some extent is that under price caps, a customer lost is a profit lost, because one cannot simply burden the remaining customers in the way possible under rate-of-return regulation.

This is not to suggest that price caps per se should be dropped. Rather, the price cap formula should be modified, as I will suggest below. In New York State, network quality at first declined with a rate freeze, but then rose after more vigilant regulatory attention. In the United Kingdom, consumer complaints about service quality increased at the same time as price caps were implemented, but subsequently declined again.[2]

8. **Incentives for Government Users to Invest in Redundancy.** As noted above, private sector executives in data intensive industries rank network reliability as a top concern. They have a bottom line to protect, and with full information available they are likely to make the economically correct investment in expensive redundancy. Public sector agencies such as the Federal Aviation Administration, on the other hand, do not have the same incentives,

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[2]. Oftel, 1989, "Telephone Service in 1989," *Oftel Report*, December.

because they do not lose any business. Given tight budgets, they may well drive without a spare tire,[3] and then complain when they have a flat. To set incentives for government agencies right is something this Subcommittee should look into.

II. The Role for Government

1. Federal Standards?

User choice would then settle many reliability issues by allowing users to choose the level of reliability most appropriate to their needs and pocketbooks. For example, one could institute "interruptible service" tariffs similar to those offered by electric utilities, which would allow substantial savings by clipping the expensive peak loads. (Key infrastructure services should be restricted from using such interruptible service.) However, enduser choice may impose negative externalities; in an interconnected network, one subscriber's lower-reliability choice may negatively affect those who wish to reach him. Thus, certain basic levels of reliability need be protected, while higher grades should be left to choice where technically feasible.

Many of the larger states impose minimum quality standards on public networks, such as seconds to dial tone, restoration time of interrupted service, etc. These standards vary somewhat across the country, matching local needs and requirements. I am not aware of any state standards that are unacceptably low and thus requiring a federal floor. On the other hand,

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[3] See New York Times, "Weak Phone Link Known for Years," September 19, 1991, p. D21.

if a federal floor would be set high to pull up some of the states, it will cause some unhappiness about yet another federal mandate that states have, through ratepayers, to pay for. Federal quality standards would be appropriate if it could be shown that inconsistency or low standards in the states were a major problem. Perhaps these hearings could provide such information.

2. Disclosure

For user choice to be effectively exercised, accurate information is imperative. One of the FCCs responsibilities should be to require the disclosure of quality performance in a way that is useful to users, much as the SEC mandates disclosure to investors rather than judge the merits of securities.

3. Catalyst for Carrier Information Cooperation

Another flow of information that needs to be assured is the interchange of operating information among carriers. Where one carrier detects and solves an operational reliability problem likely to affect other carriers, it should be obliged to report such information. This would be analogous to airlines' reporting to the FAA problems with an aircraft, for the benefit of other airlines, too. Ultimately, we are all better off. A similar information exchange is needed among various countries. The U.S. is not unique in experiencing service problems with new technology.

In New York State, one of my last actions as a PSC Commissioner was to convene a government-carrier-user meeting on network reliability. What was especially heartening was the willingness of all participants to cooperate, once prodded. This effort is now being continued

on the level of New York City.

4. Catalyst for Carrier Operational Cooperation

Another way to create collaboration would be for the FCC to initiate measures that grant mutual access between all or a majority of physical networks, both public and private, in times of emergency, similar to the Emergency Broadcasting System for broadcasters, and similar to the passenger transfers by airlines. Traffic priorities for emergencies need to be established.

5. Incentives

Most important for network performance is to link reliability and quality performance to financial rewards. One possible scheme would involve the following steps:

a. Identify the relevant dimensions of reliability and define reliability criteria.

One metric for service reliability was suggested in previous testimony of John C. McDonald to this Subcommittee. He proposes a logarithmic measure based upon the number of Erlangs lost in each failure. This may assist in quantifying the effects of network failures. It appears to be a good scheme. However, as mentioned above, many other additional dimensions define service quality — for example, time to dial tone, network busy times, etc. It would therefore be even better to adopt an aggregate index of overall reliability. To do so, one must first pick the relevant dimensions of quality and reliability.

b. Assign weights to reliability factors.

Since all reliability factors may not be of equal performance, weights are assigned to them based on user surveys on their relative importance.[4]

c. Monitor reliability.

With this system one can measure the overall reliability performance of a network. It would be left to the carrier how it would reach a target index. The strength of this system is that it permits flexibility by allowing network operators to respond to their markets and costs in a variety of ways as long as *overall* reliability is above a target level. If improvements in all dimensions of reliability cost the same, improvements would first be undertaken for the most critical dimensions. If marginal improvements differ in cost, as seems likely, a company could calculate the optimum improvement strategy. The results would be more reliability for the money, and greater managerial flexibility in reaching the overall goal.

d. Linking Network Reliability to Financial Incentives.

Under the system I have outlined, overall reliability can then be linked to a system of financial rewards and penalties. It would become part of a price cap formula, by factoring the overall reliability index into the equation, just as it is done now for inflation and productivity. This would provide incentives for increasing overall network reliability by rewarding reliability and punishing for its absence.

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[4]. Berg, Sanford, Thomas Buzas and John Lynch, 1989, "Regulatory Measurement and Evaluation of Telephone Service Quality," Unpublished manuscript.

III. Conclusion

The broader question which is posed here today is whether competition will provide quality and reliability. The conclusion is that this will not necessarily be the case.

Reliability will require regulatory attention. This would include:

1. The setting of incentives for improvements in reliability instead of choosing the path of micro-managing companies' reliability investments and performance along many dimensions.

2. Information disclosure should be required as part of a wider effort to convene task forces of industry and government to provide organized, focused, and collaborative attention to the issues of reliability.

3. Intercarrier emergency operations procedures should be instituted.

4. Users should be assured the ability to select appropriate redundancy levels.

5. Government agencies should not be permitted to underinvest in redundancy.

By initiating these various steps, the FCC would signal to service providers and users alike its seriousness to protect the information transport infrastructure of a society increasingly dependent on information flows.

Such a role is, more generally, part of the FCC's mandate for the 1990s. The agency has successfully opened telecommunications to competition, and should continue to do so. But as the cohesive force of the old AT&T gives way to a more centrifugal system, the FCC must provide some of the glue to hold the system together. It should let market forces operate, but take on new responsibility as a kind of national systems-integrator of last resort. This is a gradual

process, in which we are all learning, government, users, and independent experts. The FCC has already made progress in this process, and your hearings will further encourage it.