



# The Quality of Internet Service: AT&T's Global IP Network Performance Measurements

In today's economy, corporations need to make the most of opportunities made possible by the Internet, while managing performance issues (access, reliability, and availability) and seeking suppliers who can deliver quality services. AT&T understands the criticality of these issues; we know that there are vital business applications running on our IP backbone. Therefore, we have provided this site for you to check on and compare the performance measurements of the AT&T's US IP backbone as well as the performance measurements across Trans Atlantic and Trans Pacific paths.

## **Descriptions of Performance Measurements**

In order for you to understand the performance measurements given on this site, following is an explanation of the AT&T Global IP network performance measurements of Delay (or latency), Loss (or its converse deliverability) and IP Backbone Availability.

## **Round Trip Delay (or Latency)**

Delay (or latency) is the round-trip transmission time for a data packet to travel between two end points on the Internet. Delay is measured in milliseconds and is most noticeable when an interactive application is being used, such as a real time order entry or inventory checking system.

Delay can be the result of several different factors. These factors include the speed of the computers involved, the size of the facility connecting the end computer to the Internet, overloaded Web servers, poor network routing (too many hops or miles to travel) or congestion on the network. Only some of these factors are within the Internet Service Provider's control (routing and congestion). Others, such as overloaded Web servers and the size of the facility connecting the end computer, have nothing to do with the performance of an IP backbone.

To judge and compare IP network performance, one needs a measurement that is not influenced by delays that are outside of the provider's control. This measure is called network roundtrip delay. Network roundtrip delay measures the round-tip transmission between two points on the Internet Service Provider's network.

Network delay can be affected by transmission delay (the speed of the network circuits) or insertion delay (the rate at which routers can forward the packets). It can also be affected by queuing delay (the rate at which packets arrive at the router) or by propagation delay (the time it takes for light to traverse the physical distance between source and destination).

## **Loss (or its converse Deliverability)**

Loss is defined as the percentage of packets lost in a transmission. The opposite of loss, deliverability, is defined as 100 minus the percentage packet loss and is the percentage of successfully delivered packets. Thus, a network with a one percent packet loss would be said to have a 99 percent deliverability rating. To understand the intricacies of packet loss measurement, an explanation of how backbone routers operate is helpful.

Backbone routers process thousands of simultaneous packet transmissions. As part of this processing the routers use temporary spaces called "buffers" to store the packets until they can be forwarded to their destinations. If the buffers fill up because the routers cannot transmit the packets fast enough or

because the outgoing circuits are too slow, packets can be dropped for lack of buffer space.

The nature of the TCP/IP protocol, on which the Internet runs, allows for the possibility of packets being lost or dropped and instructs that those dropped packets be retransmitted. However, a high level of retransmission can increase the level of traffic on the network, causing network congestion and resulting in a slowing down of the network. If the original loss is due to congestion on the network, the resulting flood of retransmitted packets can heighten the congestion on the network. Therefore, packet loss significantly affects the network's ability to transport data. Thus, a network which offered low delay and high availability, but which had a high packet loss will provide a low level of performance.

However, it should be noted that as in the case of delay, several factors other than packet loss and retransmission could contribute to an apparent network slow down. Once again to measure the Internet Service Provider, it is important to measure network loss – loss that occurs within the IP network that is not due to other non-network causes such as overloaded Web servers.

## **Backbone Availability**

Backbone availability is the time that the backbone is available to route customer packets to every edge of the backbone. Availability is mostly governed by physical factors in the network but also may be affected by routing failures.

## **AT&T's IP Global Network Performance Measurements**

Delay, Loss and Availability are the three significant measures of an Internet Service Provider's network performance. These measurements can be used to compare the AT&T IP network with other providers on IP network performance related issues. In general, our measurement methodology uses active probes to measure most of our metrics. Below we describe the measurements and how they are presented on the AT&T Global IP Network Performance site.

To start with, a general understanding of or familiarity with the site's performance measurement pages is helpful. The AT&T Global IP Network Performance Site provides five pages with measurement information: the Home page, the Current Performance page, the Network Delay page, Network Loss page and the Previous three Months' Averages page.

- The Home page presents the overall status of the network.
- The Current Performance page is composed of four sections: a map of the United States, a table reflecting performance results across U.S. beneath the map, a table showing Trans Atlantic performance metrics and another table showing Trans Pacific performance metrics on either side of the map. A user may select a city and the map will dynamically connect it to all available nodes in U.S. At the same time, the table beneath will populate the delay and loss measurements for the path between the selected city and all available U.S. nodes.
- The Network Delay page provides City Pair delay measurements for U.S., Trans Atlantic and Trans Pacific paths. The established threshold will determine the color of each "cell". See the AT&T IP Global network Delay Measurements section for complete details.
- The Network Loss page provides City Pair loss measurements for U.S., Trans Atlantic and Trans Pacific paths. The established threshold will determine the color of each "cell". See the AT&T Global IP Network Loss Measurements section for complete details.
- On a separate page, the previous three months' averages for the loss, delay, and availability for continental U.S. network available.

## **AT&T Global IP Network Delay Measurements**

### **City Pair Measurements for Delay**

The average (city-pair) round-trip delay is used to summarize the round-trip delay time between different source and destination city-pairs. The average round-trip delay is measured in milliseconds. The measurements are made from one edge of the backbone to another for U.S. domestic, from U.S. to cities in Europe for Trans Atlantic and from U.S. to cities in Asia Pacific region. They are taken continuously but are aggregated and reported every 15 minutes across U.S. all city-pair links, Trans Atlantic city pairs and Trans Pacific city pairs. When delay data is unavailable, no value is shown.

### **Delay Thresholds**

The AT&T Global IP network has threshold standards for the network delay metrics. These threshold values are utilized to signal to our network technicians and engineers that a potential problem may be arising before it affects the applications running on the network.

Thresholds are represented on the Current Performance page and the Network Delay and Loss pages by various colors. For example, if a box is colored in yellow, this represents that the performance for that city pair is rated as fair. Similarly if a box is colored in red, this represents that the performance for that city pair has reached the alert threshold.

The city pair delay thresholds on the AT&T Global IP network will differ slightly depending on the city pair. These differences exist because as described earlier, delay is highly dependent on the distance between the cities. This is due to the fact that propagation delay, which is defined as the time it takes for light to traverse the physical distance between the source and destination, is one of the major components of delay.

To help minimize the AT&T Global IP network delay, our thresholds are set very competitively – The highest boundary setting of a yellow threshold for the round trip delay between a U.S domestic city-pair is 95 milliseconds. The highest boundary setting of a red threshold for a U.S domestic city-pair is set at 120 milliseconds. It should be noted that in order to provide a high standard level of performance many city-pairs have significantly lower thresholds.

## **AT&T Global IP Network Loss Measurements**

### **City Pair Measurement for Loss**

The percentage loss is used to summarize deliverability. For example, if the percentage loss is shown as 1 percent, it implies that the deliverability is 99 percent.

The loss probes are sent continuously, although the city-pair loss figures are updated every 15 minutes. Once again the measurement is a round trip measurement between one city to another. Thus the loss between each city-pair is measured. When loss data is unavailable, no value is shown.

Note that it is possible to have values for delay but not for loss and vice versa.

### **Loss Thresholds**

The AT&T Global IP network also has threshold standards for the IP backbone loss metrics. These threshold measurements are utilized to signal to our network technicians and engineers that a potential problem may be arising before it affects the applications running on the network.

Thresholds are represented on the Current Performance page and the Network Delay and Loss pages using various colors. For example, if a box is colored in yellow, this represents that the performance for that city pair is rated as fair. Similarly if a box is colored in red, this represents that the performance for that city pair is at the alert threshold.

The yellow threshold is set at loss greater than 5% for a given city-pair, while the red threshold is triggered when loss is greater than 10% between source-destination city-pairs.

## **Monthly Averages**

Measurements for the previous 3 calendar months' averages are also presented on the site for the following metrics:

U.S domestic: Round trip average delay, loss, and availability.

### **Monthly Average Delay**

The monthly average round trip delay is the round trip delay averaged over all the city-pairs in continental U.S network over all the measurements made in each of the previous 3 calendar months.

### **Monthly Average Loss**

The monthly average loss is the round trip loss averaged over all the city-pairs in continental U.S network averaged over all the measurements made in each of the previous 3 calendar months.

### **Average Availability**

The Backbone Availability is the percentage of time that the continental U.S. AT&T IP backbone was available to accept customer traffic. It is computed network-wide and averaged over all the measurements made in each of the previous 3 calendar months.

