



“Optimizing the power of your network!”

Latency in Telecom Networks

The Importance of Low Latency

It used to be that latency — the time it takes for a signal to travel from one point to another in telecom networks — was of concern only to people using specific applications such as international voice calls transmitted via satellite. Such calls are sensitive to high levels of latency which negatively impacts the voice quality of the call. More recently, however, latency has become of interest to a broader audience. Businesses' increased reliance on telecom networks and improved processing speeds for computer networks and the Local Area Networks (LANs)/Wide Area Networks (WANs) that interconnect them, have combined to make the speed at which a signal travels in a telecom network more noticeable and critical.

The Components of Latency

If a simple question such as “how fast will a signal travel through my network?” were asked, one would expect a simple answer. That simple answer is “it depends”. Telecom networks and the LANs/WANs connected to them are extremely complex, so one should expect performance variances among different networks and implementations. The difference is largely based on the specifics of the network in question. However, an understanding of some of the drivers of latency can paint a useful picture to evaluate specific network performance.

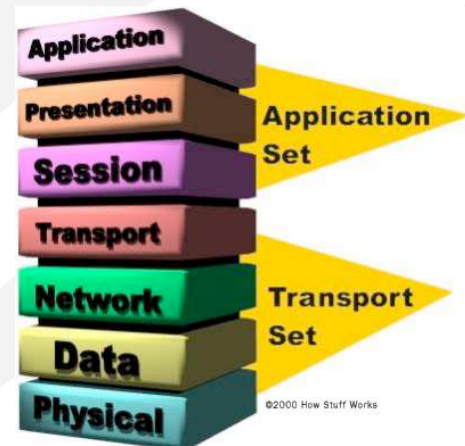
First, the time it takes a signal to travel from point A to point Z is defined by two components:

- Processing Delay
- Transmission Delay

Processing Delay

While both components are variable, processing delay can be the most variable. The diagram below shows the Open Systems Interconnection (OSI) seven layer stack which is used to define and illustrate how computer applications communicate. Although it depicts seven layers, in practice some layers may be combined functionally. This model assists in understanding the dependency of the total time it takes a signal to be processed and transported over a computer application connected to a telecom network.

Processing of information takes place in every layer from a simple conversion of characters on a screen to data bits to be transmitted over the telecom network. Often this processing is application, vendor, and even implementation specific. For example, to determine the processing delay in the physical layer, the specific vendor equipment used (such as an OC12 card) as well as the size of the frames being transmitted must be analyzed. So in order to evaluate the total hardware and software processing delay, the specific behavior related to the equipment and applications being used must be fully understood.



The processing delay added by the transport network varies by the type of connectivity service purchased. The lowest latency is provided by Private Line services because the bandwidth is dedicated. Shared bandwidth services provided on an Ethernet or IP network will incur additional latency due to the processing of each frame or packet in the data stream, which may result in network congestion and slower throughput.

Transmission Delay

The second component, transmission delay, is comprised of various factors including fiber distance, equipment used, and routing in effect. High bandwidth data transmission over long distances is possible via fiber optic cables. In long haul transmissions, most of this delay is related to distance or the time it takes light to travel over fiber optic cables. While information in fiber optic cables travels close to the speed of light, it is slowed down due to refraction of the glass itself.



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This is expressed in the following formula:

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$$\text{Latency (due to fiber distance)} = \frac{\text{distance}}{(\text{speed of light} \div \text{index of refraction for fiber})}$$

Where

- distance is the distance the light has to travel within the fiber optic cable route
- speed of light which is 299,792,458 meters per second
- index of refraction for fiber which is 1.44

This yields 4.8 microseconds per kilometer of fiber optic cable for one-way latency or 9.6 microseconds round trip.

So it follows that in order to understand the distance component, one has to know the route the circuit takes versus driving distance or air miles between cities. However, even this route can be variable depending on network outages and congestion in Ethernet-switched or IP-routed networks. If using a shared network such as the Internet, the response times will vary with the amount of traffic on the network and the route a given frame or packet follows through that network.

Optimizing the Network

On the LAN side, all applications should be optimized for data throughput and connectivity equipment should be upgraded to support the highest connection speeds.

On the WAN side, selecting a Private Line service versus an Ethernet or IP network can optimize latency. Because of distance’s effect on latency, even a Private Line network can be optimized and improved by selecting the shortest route between the end points. Integrators like CFN Service can provide expertise in selecting the carrier with the best route and can design a custom network that combines the best aspects of multiple carrier networks to deliver the shortest overall route resulting in the lowest latency.