What TCP Enhancements has Blue Coat implemented?

While the MACH5 TCP stack contains common and necessary TCP features such as Windows Scaling and TCP Selective Acknowledgement (SACK) for WAN Optimization, one additional major enhancement in MACH5 is how packet loss in the network is handled. These particular enhancements are loosely based on RFC 3649 “HighSpeed TCP for Large Congestion Windows” and the research paper “Scalable TCP: Improving Performance in Highspeed Wide Area Networks”.

How will these TCP Enhancements benefit my network?

With more business-critical traffic traversing the WAN than ever before, administrators must tackle latency problems inherent in all WANs, such as latency and packet loss. Since most application protocols are transported over TCP, it makes sense to streamline TCP behavior so that it is as efficient as possible, especially in these types of WANs. By optimizing the overall TCP traffic flow, all application protocols affected by packet loss will benefit. Among these benefits are reduced latency to the application, increased bandwidth utilization, and the elimination of the latency associated with establishing new TCP connections.

How do the TCP Enhancements work?

At the time standard TCP was designed, packet loss was generally the result of congestion in the network. To maintain the connection when packet loss was detected, but at the same time reduce the load on the network, TCP was designed to severely reduce the transmission rate of data, typically 50% initially, and slowly increase the transmission rate after that. This behavior is commonly known as TCP congestion avoidance. While this behavior does have merit and is still in wide use today, it effectively degrades the performance of that connection for a very long time.

Today, with networks often spanning vast distances, packet loss is not necessarily caused by network congestion, but is often perceived congestion by TCP as the result of considerable WAN delay, or due to a “lossy” network. While TCP congestion avoidance can be effective in congested networks, imagine the effect it has if the perceived packet loss is due to WAN delay. Connections already experiencing considerable response time become painstaking slow connections which do not fully utilize available bandwidth. The same can be said for a network in which a single packet was lost. To degrade such a connection due to the loss of a single packet seems excessive.

With Blue Coat’s MACH5 WAN Optimization solution and underlying TCP Enhancements, the negative effects of TCP congestion avoidance are minimized. Instead of reducing the transmission rate by 50%, Blue Coat’s TCP stack intelligently scales back the send window so that if the packet loss was due to an intermittent problem, or was actually perceived packet loss due to WAN delay, the connection is not negatively affected. After reducing the transmission rate by a small percentage, Blue Coat’s TCP stack intelligently increases the TCP send window to maximize overall throughput. As a result of this behavior, the appliance is able to adapt to any environment with packet loss extremely quickly while optimizing bandwidth usage.

Executive Summary

Blue Coat ProxySG appliances utilizing MACH5 WAN Optimization allow IT organizations to accelerate and secure the delivery of business applications for all users across the distributed enterprise - including those near Internet gateways, as well as in branch offices, data centers, and even individual end points. As an underlying part of the MACH5 WAN Optimization framework, Blue Coat has implemented key TCP Enhancements to effectively reduce or eliminate bottlenecks in TCP over a WAN.
The default behavior of TCP leads to significant performance degradation after just one lost packet. Blue Coat’s TCP recovers from packet loss more quickly, restoring performance almost immediately. The advanced TCP stack more rapidly assesses network quality and loss rates, and is able to optimize TCP in more diverse networking conditions than the competition.

With Blue Coat’s enhanced TCP, the impact of packet loss in the network is minimized. File transfer times with Blue Coat MACH5 remain relatively unaffected at higher rates of packet loss; the leading competitor, however, experiences a significant increase in the time it takes to transfer the file under the same conditions.

The Blue Coat Difference

TCP Double Buffer
Since Blue Coat ProxySG appliances terminate connections, TCP connections between the client and the ProxySG appliance are able to exist independently from TCP connections between the ProxySG appliance and server, where a connection is initiated across the WAN. By decoupling these connections, the ProxySG appliance is able to acknowledge client-side transmissions, effectively allowing the client to continue transmitting data, instead of waiting for server-side acknowledgements to traverse the WAN.

TCP Connection Control
Blue Coat ProxySG appliances have the ability to control TCP traffic down to the individual connection level. Using policy, administrators can perform a breadth of actions on selective TCP connections including (but not limited to) block, allow, accelerate, bypass, or manage the bandwidth of TCP connections.

TCP Pipelining
Blue Coat ProxySG appliances have the ability to open many simultaneous TCP connections, which retrieve objects or data more quickly by “pipelining” the connections instead of using serialized connections, where one connection must complete before another can begin. This means that they can make objects and data available at wire speed without any performance lag, which provides better end user response time.