

ThousandEyes for Enterprise and IT Operations

Summary

Enterprise network architectures have been changing rapidly over the last few years. Trends such as BYOD, server and desktop (VDI) virtualization, Video Conference/VoIP and SaaS adoption bring new challenges and requirements to the underlying network infrastructure connecting branch offices and data centers. As more employees work remotely (outside of headquarters), and as servers get virtualized and consolidated in centralized data centers, the pattern of network access in corporate networks is changing from a high-speed/low-latency LAN access to a low-speed/high-latency WAN access. This document describes how ThousandEyes can be used to manage the performance of these environments and address these new challenges.





Performance Challenges in Enterprise Environments

The performance of a corporate network is highly dependent on different factors. Applications like VDI and VoIP are specially sensitive to the real-time state of the network.

As enterprises adopt Software-as-a-Service (SaaS), application performance becomes more dependent on what happens outside of the corporate network.

Infrastructure/Network Performance:

- » **Latency:** Defined as the round-trip time (RTT) between the client and server, network latency depends mostly on the physical distance between the endpoints, as well as the congestion state of the network. Higher latencies cause higher application response times, as well as lower TCP (Transport Control Protocol) throughputs. TCP throughput is actually inversely proportional to the round trip time ($\text{WindowSize}/\text{RTT}$). Also, because of the slow start mechanism, TCP can be quite inefficient in taking advantage of available bandwidth. The impact of the RTT is exacerbated in the case of chatty protocols, that require N rounds to complete a transaction. A transaction that would take Nx5ms inside a LAN can take Nx100ms over the public Internet, making the application virtually unusable.
- » **Packet Loss:** Packet loss can trigger TCP retransmissions and bring the throughput of the connection down. The throughput of a TCP connection is roughly proportional to $\sqrt{p}$ where p is the packet loss probability. So a connection with 2% loss has about 70% of throughput of a 1% loss connection. In fact it can be shown that in steady state, the window size of TCP with 1% loss is less than 10 packets. If each packet is 1,500 bytes long and the RTT is 100ms, that's a throughput of 150 Kbytes/s.
- » **Capacity and Available Bandwidth:** Capacity between two endpoints is the maximum data rate that can be achieved in the absence of any cross-traffic. Cross traffic will use a portion of the capacity, and the remaining is the available bandwidth, which determines how fast TCP connections can go. Available bandwidth in enterprise networks is typically limited by cost, not so much by technology. Currently a WAN MPLS access can cost anywhere from \$300/Mbps/month to \$1,000/Mbps/month (note: Access to broadband Internet is 30x less expensive in comparison). Most enterprises still route Internet traffic through their data centers (e.g. MPLS access) using Internet traffic backhauling because of security and control. This consumes expensive bandwidth in the corporate backbone.
- » **Routing Availability:** Routing inside the enterprise is determined by interior routing protocols such as OSPF or IGRP. But for Internet traffic, different networks need to exchange routing information using the Border Gateway Protocol (BGP). BGP allows independent neighboring networks to talk to each other to decide what traffic they will exchange. This process is usually driven by economics rather than network efficiency, therefore routes are not always optimal from a latency/bandwidth point of view. BGP changes (e.g. misconfigurations) can render an entire network unreachable or induce severe performance degradation on applications (note: bgp convergence times are often in the order of 3-digit seconds.)
- » **Wireless Access (WLAN):** Bad quality 802.11 wireless access in the branch office is a common cause for performance degradation of applications. This can be caused by degradation of the radio signal power (lower RSSI) that can be caused by interference or physical distance between the client and the access point. This is often a hard element to troubleshoot end-to-end since typically there is no access to this information without instrumenting the client or the access point.



Application Performance:

- » **SaaS/Cloud Adoption:** As enterprises adopt Infrastructure-as-a-Service (IaaS) and boost their SaaS consumption, application performance does not depend only on what happens inside the corporate network anymore. Network traffic has to cross multiple third party networks in the public Internet before it gets delivered to the end-user. Most of these hops are outside of the control of both the consumer and the provider (the endpoints) of the application. Traditional enterprise WAN architectures that were designed in the days when most traffic was staying inside the enterprise falls short when increasing volumes of traffic go through the public Internet, mainly because of Internet traffic backhauling and limited bandwidth in the corporate network.
- » **VoIP/Video:** Most VoIP protocols (including RTP) use UDP (instead of TCP), and voice applications need to use loss concealment algorithms to cope with packet loss. Voice applications are also sensitive to jitter (variations in network delay). Each end of the conversation needs to have buffers to accommodate variations of delay in the network. Beyond some point, packets that suffer a very high delay are discarded by the application. These drops can be perceptible in the audio stream. VoIP traffic can be prioritized using different PHB strategies (Per Hop Behavior) with different DSCP codes (e.g. EF or AF).
- » **Desktop Virtualization (VDI):** VDI protocols such as ICA or RDP run on top of TCP which means that excessive packet loss and retransmissions can render VDI unusable. VDI is very sensitive to network latency since the application needs to react quickly to user interactions. Another limiting factor is available bandwidth, especially server-side video streaming, but even in non-streaming scenarios (e.g. printing), a >100kbps requirement per client is reasonable.



Figure 1: Backhauling of Internet traffic creates performance challenges for SaaS applications, including increasing round-trip times.

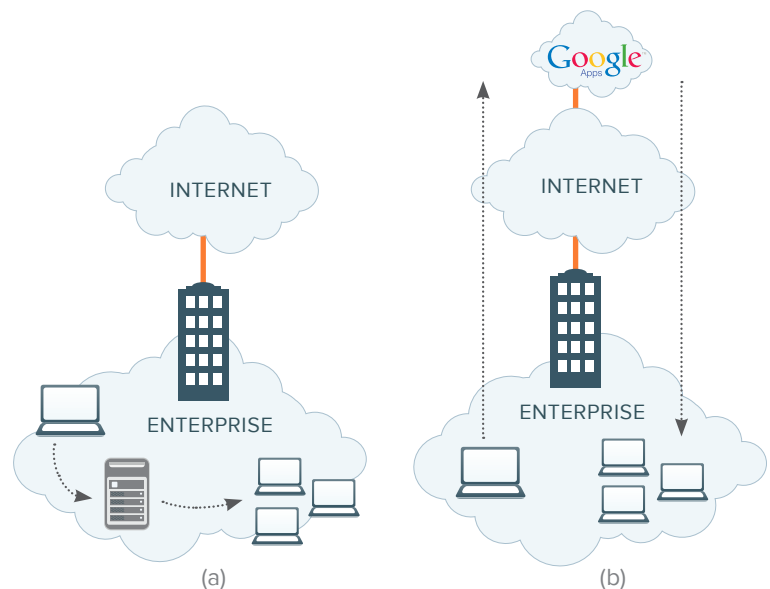
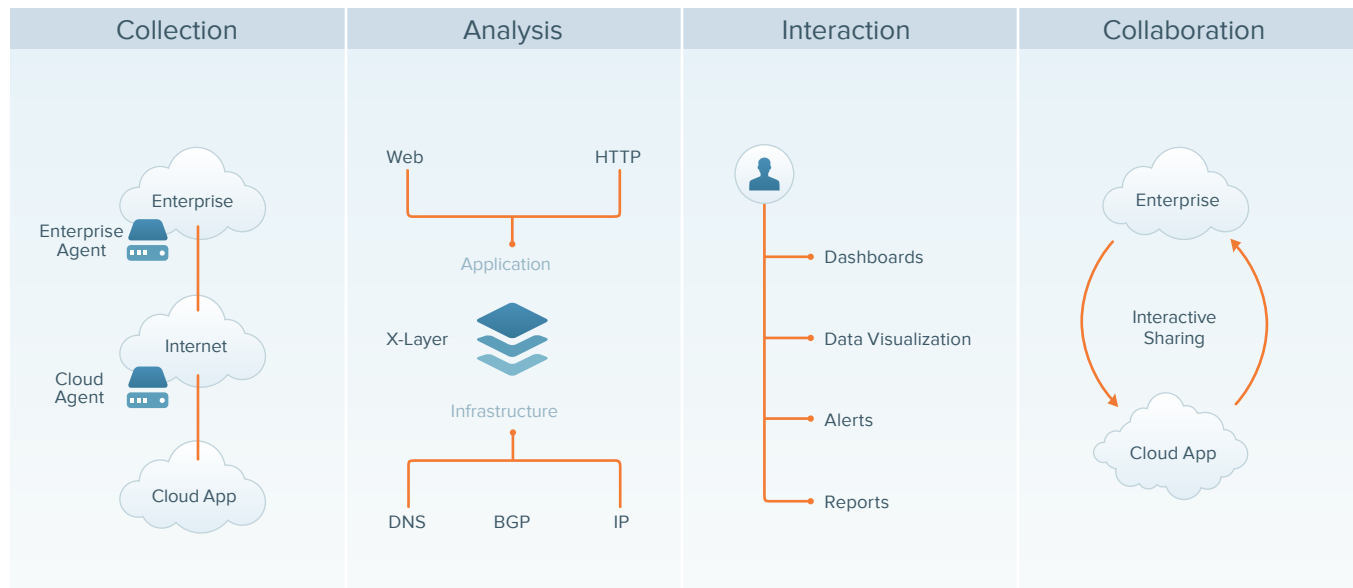


Figure 2: (a) Traditional on-premise email solution, attachments are downloaded by clients using the enterprise network. (b) SaaS-based email, attachment goes through the Internet connection N times, one for each client.



ThousandEyes at Work

ThousandEyes provides end-to-end visibility of application delivery in the cloud through a combination of lightweight agents and passive analysis. ThousandEyes X-Layer technology provides deep visibility into each layer of application delivery and a connecting thread between these layers, making it possible to jump from layer to layer to find the root cause of problems. Each layer maps to a different subsystem of application delivery with its own set of unique metrics.



The following elements are unique to ThousandEyes:

- » **X-Layer:** Provides deep visibility into each layer of application delivery and a connecting thread between these layers, making it possible to navigate from layer to layer to find the root cause of problems.
- » **Deep Path Analysis:** Microscopic view of the end-to-end path between the client and server, including localization of loss per interface, link delays, route changes and measurement of capacity and available bandwidth.
- » **Interactive Sharing:** Enables enterprises and application providers to share live data with one another, eliminating ad-hoc tests, reducing manual processes and resolving problems faster.

These technology elements are combined to provide a workflow designed to troubleshoot any problem in the application delivery chain of cloud applications.



Using ThousandEyes Inside the Enterprise

ThousandEyes can be deployed inside the Enterprise through Enterprise Agents. Enterprise agents perform periodic synthetic measurements to specified targets and are valuable to troubleshoot performance problems due to the depth of information they provide.

Enterprise Agents

Enterprise Agents can be installed in branch offices and data centers either as a software package or virtual appliance. They can be configured to perform different types of tests that provide visibility over different layers. The agents perform periodic repeatable measurements to targets configured by the user (e.g. web servers, network devices, DNS servers). The agents export their measurements to ThousandEyes collectors in real-time. This data gets organized into layers of application delivery:

- » **Web / HTTP Server Layer:** HTTP transaction data, including service availability, as well as information on which step of the transaction is failing; in the example below some agents are failing to establish a TCP connection to the server (red circles in the world map of Figure 3).
- » **Network / End-to-End Metrics Layer:** Includes network level data to the server in the previous step, including packet loss, latency, capacity and available bandwidth.
- » **Network / Path Visualization Layer:** Provides a hop-by-hop visualization of how traffic is routed between the agents and the destination; it indicates where packets are being lost and which links are having long delays. Figure 4 is the Path Visualization drill-down of Figure 3. Agents are the circles on the left, and the red circles on the right represent interfaces where packet loss is happening.

ThousandEyes Enterprise Agents are valuable to troubleshoot performance problems due to the depth of information they provide.

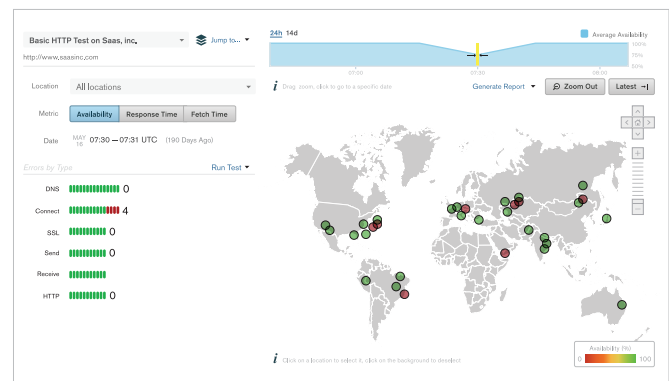


Figure 3: HTTP Server layer visualization indicating agents impacted (in red) in the worldmap, and step where errors are occurring (TCP connection establishment).

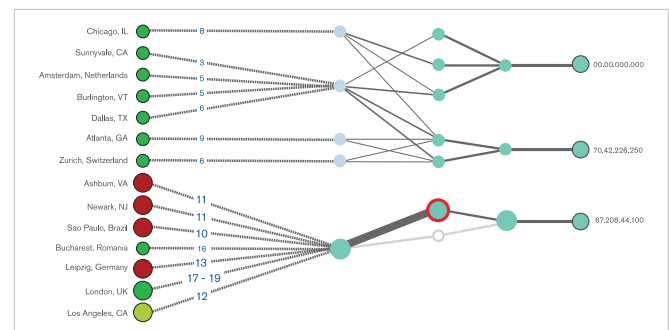


Figure 4: Network Path visualization indicating interfaces with packet loss (red circles).



Conclusion

With ThousandEyes, Enterprises gain the end-to-end level of visibility required to troubleshoot problems inside, but also outside of their environment. ThousandEyes Enterprise Agents are distributed as a lightweight software package that can be installed and configured in minutes. Using the patented X-Layer technology, ThousandEyes is able to relate different layers of application delivery through a common thread that allows users to find the root-cause of problems immediately. ThousandEyes can reduce the MTTR (Mean Time to Resolution) of infrastructure problems from hours and days to minutes.

Please visit www.thousandeyes.com for more information.

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About ThousandEyes

ThousandEyes provides detailed visibility beyond the corporate network perimeter, identifies the root cause of performance problems with cloud applications and enables distributed collaboration to resolve problems quickly.