Maximizing ICA Sessions with Limited Network Bandwidth

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Notice

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Introduction

Ensuring that sufficient wide-area network (WAN) bandwidth is available for ICA traffic is sometimes misunderstood and is the core purpose of this white paper. Just like a house needs a firm foundation, Citrix MetaFrame environments require an adequate network as the basis for deployments that include remote offices and/or clients.

When a MetaFrame administrator hears frequent complaints that users' ICA sessions are dropped at random, the most common reason is insufficient network bandwidth. In order establish and maintain ICA sessions, particularly across WAN links, MetaFrame deployments must have sufficient network bandwidth available.

To add more users or to maximize WAN links that are already in existence, the MetaFrame/Network administrator has three options:

1. Purchase additional bandwidth;
2. Utilize Quality of Service (QoS) for prioritizing specific types of network traffic;
3. Incorporate a network appliance that enables more ICA sessions by using more complex caching technologies in conjunction with the router (Layer 3) device.

Each of these options is discussed in detail within this white paper. Please note that no single technology or solution is right for every client environment; each MetaFrame deployment differs and requires a detailed analysis in order to ensure that the best solution is recommended and implemented.

Further, having a contingency plan in the event that the primary WAN link is not available is an important consideration; however, such is beyond the scope of this paper.

Planning a MetaFrame Deployment with Remote Client Access

Choosing the Best Solution

With the release of Citrix Secure Gateway in December 2001, MetaFrame and Network Administrators now have two options for connecting remote offices to Citrix MetaFrame server farms. Administrators can choose to deploy MetaFrame over traditional WAN Links or utilize Citrix Secure Gateway over Internet circuits. Internet circuits are much less expensive than frame relay, ISDN, or other traditional WAN links. Where possible, Citrix Secure Gateway as deployed with Internet circuits will likely be more cost-effective solution.

Because the deployment of MetaFrame over WAN links is more complex and confusing, the majority of this white paper is focused on this solution.

Minimum ICA Traffic Requirements on the WAN

ICA traffic is optimized to support dialup network bandwidth speeds as low as 28.8 Kbps; however, an average minimum of 20 Kbps per ICA session should be included in planning and design for WAN links. While it is possible that less bandwidth may actually be required to support each ICA session, for planning purposes, the full 20 Kbps should be allotted for ICA sessions across WAN links.

Pre-Implementation Planning

When planning a MetaFrame deployment, there are several factors that must be considered with regard to the remote site(s). Each of these items listed below will have a direct impact on the number of concurrent ICA sessions that can successfully be maintained:

- Number of concurrent ICA sessions per site
    - An average minimum of 20 Kbps should be allocated per ICA session
    - If more bandwidth exists, ICA will actually use up to the full amount available
- Typical habits of users
    - Normal (one or two concurrent applications) or Power (several concurrent applications)
        - Will the user be accessing applications housed on two or more MetaFrame servers? If so, session sharing cannot be employed and multiple ICA sessions will be used.
    - Number of concurrent logons
        - If roaming profiles are being used, these must be copied to the designated MetaFrame server. If the roaming profiles are stored on a file server that is remote, this will add additional traffic.
        - Multiple logons will momentarily spike the CPU of the designated MetaFrame server.
- Available bandwidth
    - Committed Information Rate (CIR) or guaranteed/contracted speed from service provider, not the burst rate.

- Printing
  - All print traffic must traverse the WAN link, and heavy traffic has a great impact.
    - Printer bandwidth throttling can regulate this traffic, but print jobs will be slowed.
- Physical Location/Latency
  - Round-trip time for packets
    - Packets must still physically move from one location to the next, and round-trip time can impact performance as much as insufficient bandwidth
- Other Traffic
  - Additional traffic that is also traversing the WAN link, such as domain controller replication, file transfers, internet traffic, etc.
- Mappings
  - Disabling all unused mappings will result in less bandwidth utilization. For example, by not disabling clipboard mapping, clients are able to cut and paste to and from a MetaFrame application. Especially when graphic files are used, a greater impact will be observed.

Much like CPU usage, a successful remote office implementation does not include a design that immediately plans for 100% utilization. According to Cisco, WAN links should be considered saturated when network utilization reaches 70%[1].

For example, if a 128 Kbps CIR frame relay link or both channels of an ISDN BRI link are being designated between a remote office and a headquarters location, 30% or 38 Kbps should not be allocated, leaving 90 Kbps available. Using 20 Kbps as the average minimum bandwidth, only 4.5 ICA sessions would be available on this link.

While it may be possible to successfully achieve a higher number of ICA sessions across the WAN link, the impact of the considerations described above will account for variances. It is best to plan for a full 20 Kbps per ICA session.

How Much Bandwidth Do I Need?

General formula:	Example
Contracted bandwidth (CIR or other fixed minimum)	128 Kbps ISDN or frame relay CIR
- 30% (assuming 70% is considered full capacity)	-30%
x available bandwidth	90 Kbps
- other (FTP, printing, other traffic)	- 30 Kbps (assuming 1/3 traffic is FTP & printing*)
y	60 Kbps
/ 20 Kbps (each ICA session)	/20 Kbps
z = number of ICA sessions	3 ICA sessions

*Each client situation is different and this number may be much higher or lower depending on the environment; this number is used for purposes of this example only.

While it may be possible to actually get a higher number of ICA sessions using the available bandwidth, for planning purposes, 20 Kbps should be used as the average minimum bandwidth.

Post-Implementation Growth and Monitoring

If additional users are added to remote site(s), reviewing the available bandwidth along with the factors listed above will determine whether the WAN links can successfully support the expansion.

In addition, continuously monitoring the WAN links to ensure that retransmissions and dropped ICA sessions do not exist will ensure that the user experience is satisfactory.

[1]Cisco Certified Design Professional Study Guide, Page 62

Bandwidth Management Options

Additional Bandwidth

In most cases, purchasing additional bandwidth is the simplest solution; however, it is generally also the least feasible from a cost standpoint. IT organizations typically spend the majority of their budgets on WAN links and must exhaust all other possibilities before contracting for higher capacity links to support additional users.

When researching or negotiating frame relay link costs, there are two parameters commonly used: CIR and Burst. Committed Information Rate (CIR) is the guaranteed minimum throughput that is contracted, whereas Burst is the throughput that will be provided if available. *Please note that there are no guarantees associated with the Burst rate and that it should NOT be used for planning purposes.*

WAN links are costly. There are three factors that comprise the monthly expense for WAN links: port, access, and PVC. The port and access fees are generally fixed fees, whereas the PVC fee increases as the bandwidth increases.

As an example, a 128 Kbps frame relay link from Florida to California costs approximately $2400 per month. To upgrade that link to 384 Kbps, the monthly fee increases to approximately $3500 or the equivalent of a 46% increase.

International Challenges

Outside of the United States, additional network capacity is extremely expensive and increasing bandwidth may be cost prohibitive. Also, the differences in services available from the network service provider must be considered. For example, T-1 connections (1.544 Mbps/24 channels) are used in the US and Canada, J-1 connections are used in Japan (2.048 Mbps/30 channels), and E-1 connections (2.048 Mbps/30 channels) are used in Europe, South America, and most of the rest of the world.

Alternatives

Some potential alternatives to purchasing additional bandwidth are:

- Dial-up connections – If only a few occasional users are being added, it may be more cost-effective to use analog modem dialup to a Remote Access Server (RAS). If a RAS server is not available, an asynchronous connection via a TAPI modem can be made straight into a specific MetaFrame server. Load balancing would be affected because the Zone Data Collector is not making the MetaFrame server selection based on the least-busy server; connection to a specific server is being forced and will impact load balancing. Further, security implications should be considered.
- Citrix Secure Gateway and VPN connections – Both Citrix Secure Gateway and VPN connections, such as Citrix Extranet, use the network bandwidth of an Internet service provider. Thus, so long as Internet connectivity is available from the remote location, via whatever means, users can connect to the MetaFrame server farm without a direct connection to that physical location.

QoS

Quality of Service (QoS) is the prioritization of one or several types of network traffic above all others. There are a variety of prioritization techniques, and most use TCP and/or UDP port numbers as the basis for prioritization. For example, if it is found that the prioritization of MetaFrame traffic is desired, then TCP port 1494 could be prioritized.

However, because communications between the client and server are made via a dynamically chosen port, the return traffic will not be prioritized on the router unless some type of advanced QoS mechanism, such as Cisco's Network-Based Application Recognition technology, is used.

QoS does not actually create any additional bandwidth nor increase the capacity of the WAN link in any way. It instead prioritizes certain type(s) of traffic so that the network device places it in front of other the traffic. For example, if a remote office has a 256 Kbps Committed Information Rate (CIR) link to its home office that supports multiple MetaFrame sessions and non-critical Internet browsing, then prioritizing the ICA traffic is likely an excellent solution. Of course, this assumes that Internet browsing packets can be dropped without an adverse user reaction.

At the router level, the implementation of QoS requires that the router analyze each packet as it traverses the router to determine if and how it should be queued. Depending on the queuing technique used and the respective configuration, the higher priority packets are routed first, and all other packets wait or even get dropped if there is contention for network bandwidth.

Non-Technical Intricacies

The politics associated with QoS implementation should be considered. By prioritizing one or more types of network traffic, the remaining traffic falls farther back in the queue and could be dropped, delayed, or completely discarded when there is contention. Determining exactly which types of traffic are prioritized while others are not is an extremely politically sensitive issue within most organizations. As a result, QoS implementations are often slow and difficult, and few companies have implemented QoS to date.

Which Devices Support Which OSI Layers?

Most routers include some basic QoS capabilities within the operating system. This enables QoS implementation up to Layer 4, i.e., TCP and/or UDP ports. Network appliances that can utilize higher layers of the OSI model are available from vendors such as Packeteer, Sitara, Network Appliance, and Cisco.

Complex Caching & Encapsulation

Expand Networks offers network appliances that use patented caching technologies that transparently maximize network bandwidth. This technology inherently includes numerous ICA-related features. While the ICA protocol caches on a per-session basis, Expand takes that one step further by caching unchanged portions of the screen for multiple sessions based on the entire location. Thus, if users typically access one or few applications, it is likely that many of the screen bitmaps are housed on the local Expand device closest to the clients. Further, Expand encapsulates multiple ICA packets so that fewer large packets traverse the WAN link instead of many small packets.

When testing Expand under optimal conditions (only ICA traffic and no printing), it was found that as many as three times the number of ICA sessions could successfully be supported on low-bandwidth (64 and 128 Kbps) connections. Typical client environments include many types of WAN traffic, thus the actual number of additional ICA sessions that can be supported may vary. WAN emulation should be fully tested under conditions that closely resemble the production environment.

Particularly where WAN links are very expensive, such as outside of the United States, the cost/benefit of an Expand Networks solution may be an effective alternative to purchasing additional bandwidth. Hardware is required at each remote location, and these network appliances require configuration using a Cisco IOS-like operating system. Expand network appliances inherently automatically sense one another, enabling this technology to be implemented at some remote locations (such as international offices) and not others (such as US domestic sales offices).

Conclusion

From a cost standpoint, there is no single "silver bullet" solution to maximizing the number of ICA sessions across limited WAN links. The least expensive solution from a cost standpoint, if available, is to use the Quality of Service (QoS) capabilities of the network routers already in existence. This may require an upgrade of the router operating system, but this is generally free or very inexpensive. Although this solution has little or no financial impact, the political cost may be significant.

If contacting for additional bandwidth is not an option, the remaining options require the implementation of additional hardware. Options include engaging a third-party vendor that offers more complex QoS such as Packeteer, Sitara, Network Appliance, or Cisco or to employ a complex caching technology such as that offered by Expand Networks.

Citrix Secure Gateway represents a solution wherein only Internet circuits are required, not point-to-point links, such as frame relay. Thus, if WAN links will be used only to support ICA traffic, a more cost-effective solution may be to contract with a local service provider for Internet circuits only and utilize Citrix Secure Gateway for MetaFrame server farm access.

Each client environment should be reviewed in detail to determine the existing constraints and the solution that best addresses the initial and ongoing financial, political, and maintenance costs.

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