A Survey on Monitoring and Maintaining the Traffic in WAAS Network through Graphs using the Network Statistics

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***Abstract*— In Wide area network it has become difficult to transfer the data and monitor the traffic due to unnecessary bandwidth consumption, Low data rates, Slow delivery of frames (high network latency), Higher rates of packet loss (low reliability). Maintaining the traffic helps WAAS to overcome the most common challenges in transporting data over a wide area. The term WAAS devices is used to refer collectively to the WAAS Central Managers and WAEs in the network. The term WAE(Wide Area Application Engine) refers to WAE appliances and WAE Network Modules (the NME-WAE family of devices). When client and server applications attempt to communicate with each other, the network intercepts and redirects this traffic to the WAEs so that they can act on behalf of the client application and the destination server. The WAEs examine the traffic in the network and use built-in application policies to determine whether to optimize the traffic or allow it to pass through the network unoptimized. The WAAS Central Manager GUI is used to centrally configure and monitor the WAEs and application policies in the network. The graphs can be created and the traffic can be monitored using the graphs. This helps the manager to monitor the network activities and the customer to maintain the traffic in the network.**

Key words* — *WAAS(Wide Area Application Services), Optimization, Network Statistics, WAE(Wide Area Application Engine)

I. INTRODUCTION

A. About WAAS

The WAAS system consists of a set of devices called wide area application engines (WAEs) that work together to optimize TCP traffic over the WAN network. When client and server applications attempt to communicate with each other, the network intercepts and redirects this traffic to the WAEs so that they can act on behalf of the client application and the destination server. The WAEs examine the traffic in the network and use built-in application policies to determine whether to optimize the traffic or allow it to pass through the network unoptimized.

The WAAS Central Manager GUI is used to centrally configure and monitor the WAEs and application policies in the network. It is also used to create new application policies so that the WAAS system can optimize custom applications and less common applications.

B. SMB Protocol

The Server Message Block (SMB) Protocol is a network file sharing protocol, and as implemented in Microsoft Windows is known as Microsoft SMB Protocol. The set of message packets that defines a particular version of the protocol is called a dialect. The Common Internet File System (CIFS) Protocol is a dialect of SMB. Both SMB and CIFS are also available on VMS, several versions of Unix, and other operating systems.

Although its main purpose is file sharing, additional Microsoft SMB Protocol functionality includes
the following

1. Dialect negotiation
2. Determining other Microsoft SMB Protocol servers on the network, or network browsing
3. Printing over a network
4. File, directory, and share access authentication
5. File and record locking
6. File and directory change notification
7. Extended file attribute handling
8. Unicode support

In the OSI networking model, Microsoft SMB Protocol is most often used as an Application layer or a Presentation layer protocol, and it relies on lower-level protocols for transport. The transport layer protocol that Microsoft SMB Protocol is most often used with is NetBIOS over TCP/IP (NBT). However, Microsoft SMB Protocol can also be used without a separate transport protocol, the Microsoft SMB Protocol/NBT combination is generally used for backward compatibility.

The Microsoft SMB Protocol is a client-server implementation and consists of a set of data packets, each containing a request sent by the client or a response sent by the server.

C. Traffic Optimization Process

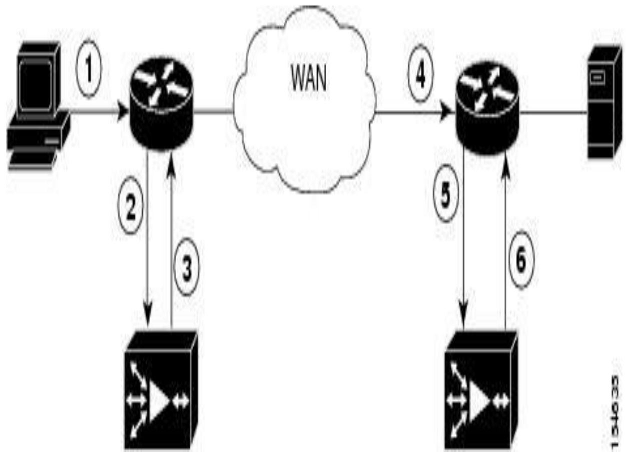

Figure. a Traffic Optimization Process

The following steps describe how your WAAS network optimizes a connection between a branch office client and a destination server:

1. A branch office client attempts to connect to the destination server over the native application port.

2. The WAAS network uses WCCP or PBR to intercept the client request, or if deployed on a WAE with a Cisco WAE Inline Network Adapter, WAAS can intercept the request directly using inline mode.

3. The branch WAE performs the following actions:

- Examines the parameters in the traffic's TCP headers and then refers to the application policies to determine if the intercepted traffic should be optimized. Information in the TCP header, such as the source and destination IP address, allows the branch WAE to match the traffic to an application policy.
- If the branch WAE determines that the traffic should be optimized, it adds information to the TCP header that informs the next WAE in the network path to optimize the traffic.

4. The branch WAE passes along the client request through the network to its original destination server.

5. The data center WAE performs the following actions:

- Intercepts the traffic going to the destination server.
- Establishes an optimized connection with the branch WAE. If the data center WAE has optimization disabled, then an optimized connection will not be established and the traffic passes over the network unoptimized.

6. WAAS optimizes subsequent traffic between the branch WAE and data center WAE for this connection.

D. Graphs for monitoring

The traffic over the network can be represented using different graphs like the line graph, pie chart or bar graph. The graphs can be built by using the parameters like file type, file size, operating system used. Using graphs we can find the percentage of different types of files and different sizes of files accessed and the operating systems used at the client and server end systems.

II. COMMAN CHALLENGES OF NETWORK

A. *The common challenges of network are*

WAN Issue	WAAS Solution
High network latency	Intelligent protocol adapters reduce the number of roundtrip responses common with chatty application protocols.
Constrained bandwidth	Data caching provided with the file services feature and data compression reduce the amount of data sent over the WAN, which increases data transfer rates. These solutions improve application response time on congested links by reducing the amount of data sent across the WAN.
Poor link utilization	TCP optimization features improve network throughput by reducing the number of TCP errors sent over the WAN and maximizing the TCP window size that determines the amount of data that a client can receive at one time.
Packet loss	Optimized TCP stack in WAAS overcomes the issues associated with high packet loss and protects communicating end points from the state of the WAN.

Table 1. Challenges of network and WAAS Solutions

B. *Creating the graphs*

WAAS project aims at solving the problems like optimizing the files and providing the services easily through the WAN. The WAAS consist of Central Manager and the devices along with the WAEs. The WAE helps to optimize the different files like text files, ppt files etc. Identifying the response time, throughput, file type, file size, operating system used, time consumed, response time etc are all necessary statistics to be measured during the file transfer.

Measuring the different statistics helps the customer to keep track of file transfer between two devices. Hence the graphs for different statistics like Estimated time saving, response time saving, throughput, version detection etc are built. The different graphs like line graph, bar graph, pie charts are used to represent different statistics.

These are the graphs those clearly gives the percentage or amount of parameters used in the network and the devices.

From the graphs customer can do the modifications and the changes required to get better network services.

III. KEY SERVICES OF WAAS

WAAS network Provides the following services that help optimize traffic over the wide area network:

A. TFO Optimization

B. Compression

C. Application-Specific Acceleration

D. Virtualization

A. TFO Optimization

WAAS network uses a variety of transport flow optimization (TFO) features to optimize TCP traffic intercepted by the WAAS devices. TFO protects communicating clients and servers from negative WAN conditions, such as bandwidth constraints, packet loss, congestion, and retransmission.

TFO includes the following optimization features

1. Windows Scaling
2. TCP Initial Window Size Maximization
3. Increased Buffering
4. Selective Acknowledgment
5. BIC TCP

1. Windows Scaling

Windows scaling allows the receiver of a TCP packet to advertise that its TCP receive window can exceed 64 KB. The receiver window size determines the amount of space that the receiver has available for unacknowledged data. By default, TCP headers limit the receive window size to 64 KB, but Windows scaling allows the TCP header to specify receive windows of up to 1 GB.

Windows scaling allows TCP endpoints to take advantage of available bandwidth in the network and not be limited to the default window size specified in the TCP header.

2. TCP Initial Window Size Maximization

WAAS increases the upper bound limit for TCP's initial window from one or two segments to two to four segments (approximately 4 KB). Increasing TCP's initial window size provides the following advantages:

- When the initial TCP window is only one segment, a receiver that uses delayed ACKs is forced to wait for a timeout before generating an ACK response. With an initial window of at least two segments, the receiver generates an ACK response after the second data segment arrives, eliminating the wait on the timeout.
- For connections that transmit only a small amount of data, a larger initial window reduces the transmission time. For many e-mail (SMTP) and web page (HTTP) transfers that are less than 4 KB, the larger initial window reduces the data transfer time to a single round trip time (RTT).
- For connections that use large congestion windows, the larger initial window eliminates up to three RTTs and a delayed ACK timeout during the initial slow-start phase.

3. Increased Buffering

WAAS enhances the buffering algorithm used by the TCP kernel so that WAEs can more aggressively pull data from branch office clients and remote servers. This increased buffer helps the two WAEs participating in the connection keep the link between them full, increasing link utilization.

4. Selective Acknowledgment

Selective Acknowledgement (SACK) is an efficient packet loss recovery and retransmission feature that allows clients to recover from packet losses more quickly than the default recovery mechanism used by TCP.

By default, TCP uses a cumulative acknowledgement scheme that forces the sender to either wait for a roundtrip to learn if any packets were not received by the recipient or to unnecessarily retransmit segments that may have been correctly received.

SACK allows the receiver to inform the sender about all segments that have arrived successfully, so the sender only needs to retransmit the segments that have actually been lost.

5. BIC TCP

Binary Increase Congestion (BIC) TCP is a congestion management protocol that allows the network to recover more quickly from packet loss events.

When the network experiences a packet loss event, BIC TCP reduces the receiver's window size and sets that reduced size as the new value for the minimum window. BIC TCP then sets the maximum window size value to the size of the window just before the packet loss event occurred. Because packet loss occurred at the maximum window size, the network can transfer traffic without dropping packets whose size falls within the minimum and maximum window size values.

If BIC TCP does not register a packet loss event at the updated maximum window size, that window size becomes the new minimum. If a packet loss event does occur, that window size becomes the new maximum. This process continues until BIC TCP determines the new optimum minimum and maximum window size values.

B. Compression

WAAS network uses the following compression technologies to help reduce the size of data transmitted over your WAN:

- Data Redundancy Elimination (DRE)
- LZ compression

These compression technologies reduce the size of transmitted data by removing redundant information before sending the shortened data stream over the WAN. By reducing the amount of transferred data, WAAS compression can reduce network utilization and application response times.

When a WAE uses compression to optimize TCP traffic, it replaces repeated data in the stream with a much shorter reference, then sends the shortened data stream out across the WAN. The receiving WAE uses its local redundancy library to reconstruct the data stream before passing it along to the destination client or server.

The WAAS compression scheme is based on a shared cache architecture where each WAE involved in compression and decompression shares the same redundancy library. When the cache that stores the redundancy library on a WAE becomes full, WAAS uses a FIFO algorithm (first in, first out) to discard old data and make room for new.

LZ compression operates on smaller data streams and keeps limited compression history. DRE operates on significantly larger streams (typically tens to hundreds of bytes or more) and maintains a much larger compression history. Large chunks of redundant data is common in file system operations when files are incrementally changed from one version to another or when certain elements are common to many files, such as file headers and logos.

C. Application-Specific Acceleration

In addition to the TCP optimization features that speed the flow of traffic over a WAN, Cisco WAAS includes these application acceleration features:

- Operation prediction and batching—Allows a WAAS device to transform a command sequence into a shorter sequence over the WAN to reduce roundtrips.
- Intelligent message suppression—Decreases the response time of remote applications. Even though TFO optimizes traffic over a WAN, protocol messages between branch office clients and remote servers can still cause slow application response time. To resolve this issue, each WAAS device contains application proxies that can respond to messages locally so that the client does not have to wait for a response from the remote server. The application proxies use a variety of techniques including caching, command batching, prediction, and resource prefetch to decrease the response time of remote applications.
- WAFS caching—Allows a WAAS device to reply to client requests using locally cached data instead of retrieving this data from remote file and application servers.
- Preposition—Allows a WAAS device to prefetch resource data and metadata in anticipation of a future client request.

Here the protocol http is used as mandatory protocols and the protocol by name SMB is specially used for file accessing. As different types and sizes of files are transferred through the network it is necessary to monitor the traffic in the network at the fixed time intervals.

D.Virtualization

The WAAS software allows you to configure a virtual blade, which allows you to add services running in their own operating environments to your WAAS system. For example, you could configure a virtual blade in a WAE device to run Windows services such as Print Services, Active Directory Services, DNS, and DHCP services.

A WAAS virtual blade provides an emulated hardware environment within your WAE device that acts as a generic computer. You can install an operating system and applications to work with your WAAS system and provide additional services for the users on your network.

Monitoring the traffic

The main reasons why traffic monitoring is necessary are

1. It helps the administrator to keep track of traffic so that he can easily slow down traffic whenever necessary, depending on the customer needs.
2. Customer can easily see the traffic over the network through the graphs.

The traffic over the network can be represented using different graphs like the line graph, pie chart or bar graph. The graphs can be built by using the parameters like file type, file size, operating system used. Using graphs we can find the percentage of different types of files and different sizes of files accessed and the operating systems used at the client and server end.

IV. SYSTEM MODEL

Manager logins and checks the status of the network. Amount of different types and sizes of files and different operating systems used on the devices can be seen through graphs. The Manager checks the traffic and changes the statistics if necessary.

The Customer can also checks the traffic through graphs and he can request the Manager to do the necessary changes in network statistics.

A. *Flowchart*

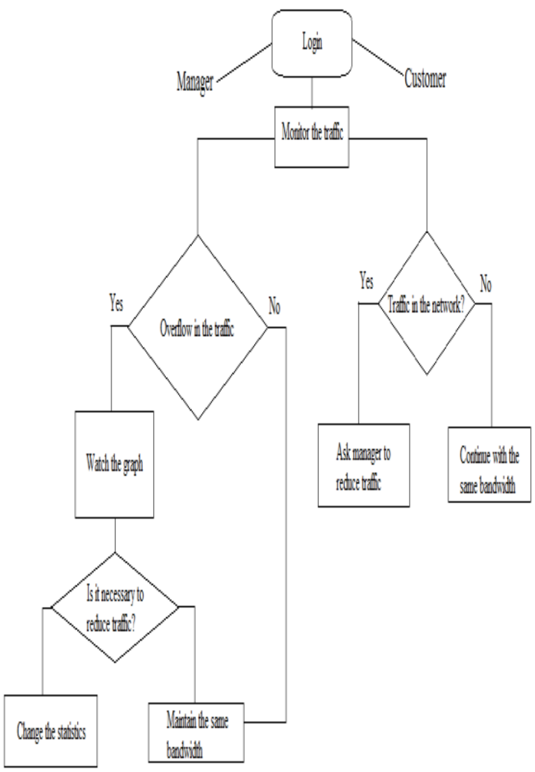

Figure 2. Flow chart

Flowchart starts with Manager or Customer(user) login. After login both Manager and Customer gets access to watch the network statistics. Based on observing the graphs and traffic moving through the network Manager and Customer decides whether to change the network statistics or not. Manager can change the network statistics or change the bandwidth if needed. Depending on the traffic Manager controls/maintains the network .But the customer doesn't have any rights to change the statistics, he can approach the Manager to do the needful changes. So that the traffic in the WAAS network can be controlled and maintained.

V. CREATING GRAPHS TO DETECT DIFFERENT TYPES, SIZES OF FILES AND THE OPERATING SYSTEMS

The following graphs like line graph and the bar graph represents the types of files transferred

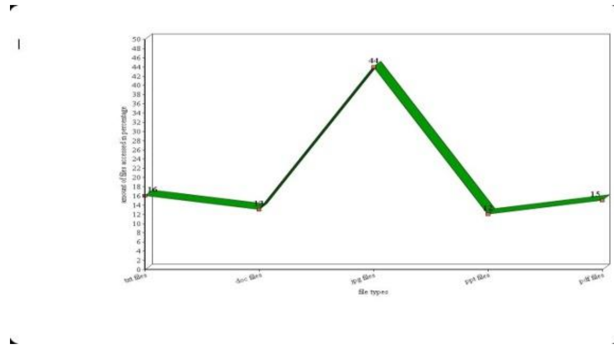

Figure 3. Line graph showing different types of files accessed

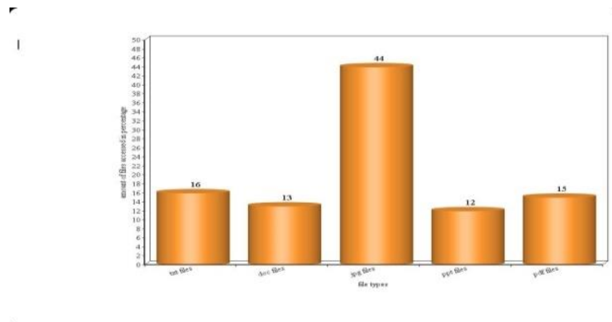

Figure 4. Bar graph for accessing files of different types

The different types of files transferring through the WAAS network can be estimated, the graphs are built based on amount of different types of files found.

Graph to find different sizes of files transferred

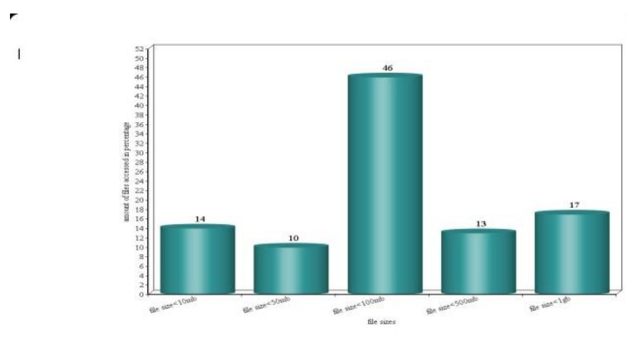

Figure 5. Bar graph to find different sizes of files transferred

Graph to find different types of operating systems used on different devices of network

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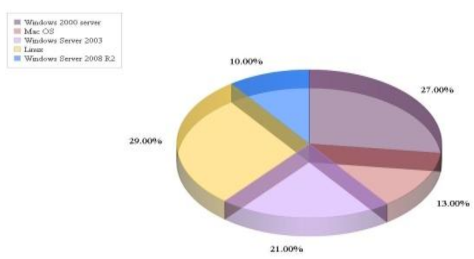

Figure 6. Pie chart for usage of server operating systems

Analyzing the statistics and monitoring helps the administrator to keep track of traffic so that he can easily slow down traffic whenever necessary, depending on the customer needs and the customer can easily see the traffic over the network through the graphs and he can make the necessary modifications.

VI. BENEFITS

The SMB protocol used in the network offers the following benefits:

- Reliability—Maintains its own internal message queuing and ordering, enabling it to overcome transient disconnects, network jitters, and message loss. The Cisco WAAS transport layer handles temporary network failures by reestablishing the connection, then retransmitting requests that did not receive a response on the disconnected socket.
- Efficiency—Supports compound requests, grouping multiple, dependent requests and responses into a single message. The processing of individual calls within a compound message is serialized, enabling the output of one command to be used as input for the next.
- Link utilization optimization—Uses multiple concurrent TCP connections for each branch WAE-to-data center WAE link. Requests and responses may be delivered across any open connection. For example, multiple requests (and responses) for data delivery can be split across multiple connections to increase the effective use of the network in cases of high-latency or high-loss WAN connections, where TCP performance degrades.
- Command prioritization—Assigns high priority to requests from active clients, minimizing the WAN latency experienced by users. Batch tasks (such as preposition, for example) are assigned a lower priority and are performed in the background.
- Bandwidth conservation—Compresses all requests and responses. Before compression, the message is encoded, allowing efficient delivery of both textual and binary data. The protocol layer applies the compression automatically, regardless of the message content.
- Firewall-friendly—Is layered over TCP/IP and uses TCP port 4050. You should configure firewalls to open TCP port 4050 to traffic.

VII. CONCLUSION

WAAS helps enterprises to meet the objectives. It Provide branch office employees with LAN-like access to information and applications across a geographically distributed network. Migrate application and file servers from branch offices into centrally managed data centers. Minimize unnecessary WAN bandwidth consumption through the use of advanced compression algorithms. Virtualize print and other local services to branch office users. WAAS allows you to configure a WAE with Windows in a virtual blade so that you do not need to deploy a dedicated system to provide local services such as Print Services, Active Directory Services, DNS, and DHCP services. It Improves application performance over the WAN by addressing the following common issues which are Low data rates (constrained bandwidth), Slow delivery of frames (high network latency), Higher rates of packet loss (low reliability).

Graphs helps the administrator to keep track of traffic so that he can easily slow down traffic whenever necessary, depending on the customer needs. Customer can easily see the traffic over the network through the graphs.

The traffic over the network can be represented using different graphs like the line graph, pie chart or bar graph. The graphs can be built by using the parameters like file type, file size, operating system used. Using graphs we can find the percentage of different types of files and different sizes of files accessed and the operating systems used at the client and server end systems.

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