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WAN OPTIMIZATION-a Review

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Abstract: This paper advocate Why there is need of WAN optimization as well as How WAN network gets optimize by using diverse Technologies of different companies. This whole analysis will give a complete framework for setting up a WAN optimizer within the organization. As lot of research has been done to ameliorate the network utilization of WAN (Wide Area Network) and it has achieve substantial success over the LAN (Local Area Network) techniques.

Keywords: WAN, Chatty Protocol, Latency, Riverbed Steelhead Appliance, WOC**.**

I. INTRODUCTION

With the bourgeon of branch offices, outsourcing, telecommuting**,** and an ever more mobile workforce means that end-users can be anywhere in the world. Also the Applications are becoming more diverse and centralized, which required WAN traffic to move at the speed of business [1]. But, in the today's era the WAN Network is choked with high traffic which ultimate causes a huge loss of data and jitter [2]. So in order to provide a solution for this WAN optimizer (E.g. Riverbed) was introduced over the WAN network, as WAN optimization is a collection of techniques for increasing data- transfer efficiencies across WAN networks. The most accustom measures of TCP data transfer efficiencies (i.e. optimization) are throughput, bandwidth requirement, latency, protocol optimization and congestion, as apparent in dropped packets [3]. Almost all the companies has many applications that are running over the network, so the available bandwidth get shared between them [2].The two common business WAN topologies are Branch to Headquarter and Data-Centre to Data-centre. In general, "Branch" WAN links are less apart due to which they consume lesser bandwidth and support more simultaneous, smaller, as well as short-lived connections and handles a large number of protocols. As they are used for business applications like email, content management systems, database application and web delivery. On the flip side "DC2DC" WAN links need larger bandwidth, more distant, and involve fewer connections, but those connections are bigger and of longer duration (Mbit/s to 1 Gbit/s flows). And if the shared bandwidth is not balanced properly then it would lead to dramatic loss in the business [4].

II. WAN PERFORMANCE ISSUE

If applications across the WAN are performing poorly, mostly IT administrators assume the problem to be constrained bandwidth. But this analogy is flawed and WAN performances issued around several factors:

A. Centralization and Response Time

As users and branch offices are distributed across the world, as result IT resources have become more centralized. The distance between a central data center and a branch office often means that applications underperform. It takes some time for the packets to travel. This network latency combined with low bandwidth and inefficient web applications to create sluggish applications, which leads to endless file transfers.

B. Chatty Protocol

When a protocol sends data in small, sequential steps over the network, that protocol is known as chatty. To avoid the loss of data packets, these protocols chop up the data into lots of little packets.

C. Latency

Latency is defined as the time interval between source and destination. Increasing the bandwidth won't solve latency and chattiness problems. Often, the problem isn't bandwidth but latency. So, optimizing latency can include TCP refinements such as window-sizes scaling, selective acknowledgements, and even co-location arrangement in which application is placed in nearer adjacent endpoint to reduce latency.

D. Remote Users

No matter where users are working what device they are using, or how they are connected to the WAN, employees need secure access to the information and applications with the speed and performance of desktop workstation. Also the outsourced staff and remote business partners need to provide secure access limited to only the resources they required [1].

III. BANDWIDTH DILEMMA

In many organisations, recreational and other nonessential traffic can occupies up to 50 percent of the total bandwidth on the WAN. YouTube, iTunes use the same well known ports as business applications. How do they distinguish business-related traffic from goofing-around traffic? The one way that many IT managers of these companies try to address poor WAN performance is simply too due to consumption of large amount of bandwidth for the farthest distance connections among data centres and branch offices, but it's not the necessarily the correct way as bandwidth is very expensive. So how to frame this network, such that the organisation funding becomes agreeable [3].

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A. Criteria's involved in WAN optimization

Whenever the concept of WAN is chosen then there are some prerequisites that are taken into the account like Architecture and blueprint of network (Head office with other Branches), Cable used (Cat e5, 6 within organisation, Fibre optic cable interlink the branches, Core switches), Model of Router, Model of Switches (Layer 2 or 3), capacity of the organisation, Application that will Perform on live environment including network security like ISA, Servers, Data Base. Now after checking all these parameters, the calculations among them are carried out in the following way:

1).Network Bandwidth consumed=**TB**– **TC**
T.B = Total Bandwidth provided by ISP
T.C = Total bandwidth utilized by the organization during peak time and weekends/non-working hours

2). Percentage of data loss = **Data Loss** / **Total Data transmitted** ***100**
For instance:
Data Loss =10000Kbps
Data transmitted = 2500Kbps
Now% of Data Loss=10000/2500*100=4000%
(Ratio becomes 4:1)

3). Network Performance =**Data transmission over Fibre optic + Data Transmission over Cat 6/5e cables**
Data transmission = **Total data transmitted** – **Data loss.**
4)**. % of network performance** = Total Data transmission/ Total bandwidth provided * 100

Note: - Calculate all of them with intermediate values to get an approximate value on each criterion.

These are some of the criteria's that will help Infrastructure team to construct the network initially and put some of the operations of an application on live to get an idea on the network utilizing as a system. Based on the whole analysis of network performance, help them to configure the WAN Optimizer that will turn, accelerate the performance of the operations that are performing live [1].

IV. CORE WAN OPTIMIZATION TECHNOLOGIES

WAN optimization is a slightly spoofed term; because it is exactly the WAN itself that an IT staffs is dealing with as it tries to enrich the efficiency of back and forth data transfer. The WAN itself can be imagined as the bridge connecting two or more points. Augmenting the lanes or additional bridges is extremely high in the cost. But reducing the number of vehicles and enhancing traffic pattern are far more efficient ways to deal with the congestion. IT official shaves numerous technologies which basically assist the movement and interaction of applications. Basically these various technologies comes under three categories: Optimization of data, optimization of TCP transmission and optimization of protocols of distinct operation types such as SQL, HTTP. The context of these technologies is best understood with clear definition of WAN optimization: A set of technologies aimed at speeding up the performance of applications and control over what's on distributed network [5].

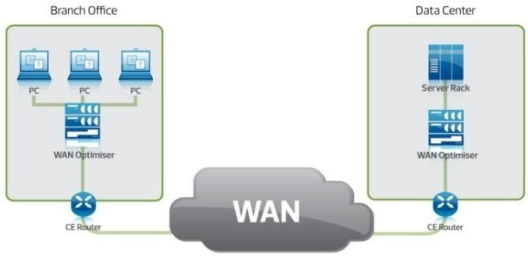

Fig. 1.Physical Appearances of WAN Optimization on WAN Network [3].

A. Data Deduplication

It is process of procrastinating the sending of redundant or surplus data across the WAN by transferring references instead of the data itself. As by working at byte level, benefits are attained across IP applications. For instance, the data file grows when members of workgroup each take turns editing a file of some sort, such as a Word or Excel document [3].

Each editing round is sent to the group, and with each round, the copies keep on augmented. This situation could result into infinite copies of the unique file, or many versions, each with some tiny changes. Yet all that's really needed is a single, authenticate copy that every user can access. In deduplication, only one copy of a file is retained, vastly reducing the network traffic used for backup, replication and even disaster recovery.

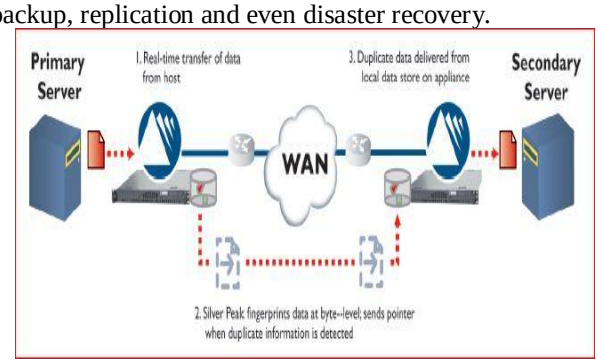

Fig. 2. Data Deduplication

Deduping can occur at the file or data block level. At the file level, the algorithm works by comparing a file as it moves to storage with the previously indexed file already there. If the file has been modified or is new, it proceeds to storage as the software updates the index. If the file already exists, the deduplication software creates a pointer. Subsequent copies are saved only as stubs pointing to the original copy. At the sub-file or block level, each block is checked to see whether it is redundant, and if not, it's marked with a unique identifier [5].

B. TCP Optimization

It can help in gaining the application performance that feels to users as if they are operating on a LAN network

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rather than on the WAN. The idea behind this technique is to overcome delays caused by congestion, latency and packet losses, all of which combine to slowdown traffic on the WAN [3].

In other way, TCP optimization tries to move throughput up to the notch so that it comes close to the bandwidth capacity. The longer the links between data senders and recipients, the less effective adding bandwidth tends to be. It's important to understand that the complex protocol is doing a lot of chatty things at once — checking packets for errors, retransmitting when it finds the lost bits, monitoring the connection for congestion and flow, probing for capacity and, of course, requesting confirmation of receipt and sending notice that packets have been received. TCP also slows down traffic considerably if it senses losses, timeouts or too many packets coming out of order. That can slow web and client server application performance, as well as a file transfers.

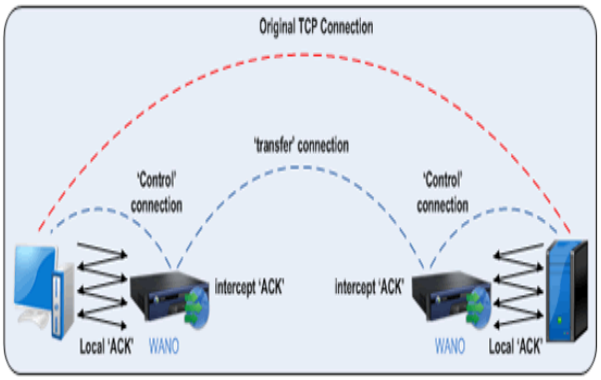

Fig. 3. TCP Optimization

Optimizing TCP involves adjusting the size of TCP "windows" — the size of each load of packets that requires a receipt — and regulating the way data ramps up for transmission when many users are queuing up. It tweaks TCP's existing algorithms depending on traffic conditions, in some instances retarding TCP's "slow start/ramp up" default operation [5].

C. Data Caching

Performance speeds up when data is in live storage rather than on disk. Staging the data in local storage relies on human behavior, so as to access the same data again and again [3].

1) Forward error correction**:** Alleviates packet loss by adding another loss-recovery packet for every "N" packets that are transferred, and this would reduce the need for retransmissions in error-prone and congestion WAN links.
2) Protocol spoofing**:** A bundles multiple requests from chatty applications into one including stream –lining protocols such as CIFS.
3) Traffic Shaping**:** It controls data flows for specific applications. Giving flexibility to network operators/network admin to decide which application has higher priority over the WAN [4].

D. Compression of data before it moves across WAN

Compression Algorithms applies to headers, HTTP objects in java script and spaces within java script code. Also it relies on data patterns that can be represents easily. Prominent compression techniques similar to ZIP, RAR, and ARJ are applied on the fly to data passing through hardware (or virtual machine) based WAN proliferate appliances. An emerging protocol known as SPDY also delivers WAN acceleration benefits. Developed by Google for accelerating content delivery across the Internet, the protocol specifically works on HTTP traffic using a variety of techniques to overcome HTTP's inherent chattiness, which underlies its tendency to cause latency. SPDY aims to enable multiple HTTP requests to run in a single TCP session and also compresses packet headers. Its backers are working to make SPDY [5].

V. WAN OPTIMIZATION CONTROLLER

A WAN optimization controller is a device that uses several functions to get data to run more efficiently across the WAN. WOCs don't actually optimize the WAN itself. Rather, they influence the behaviour of application-related data to reduce the latency that users experience. A WOC also maximizes the available bandwidth by applying QoS policies. Earlier WOCs were designed to improve service to branch offices when the prevailing architecture consisted of a central data center connected to offices in a hub-and spoke arrangement of fixed assets. But that model has given way to new and different setups, making the picture a little more complicated.

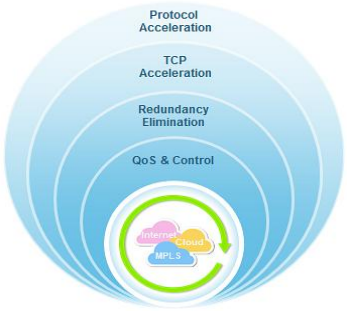

Fig. 5. WAN Optimization Controller (W.O.C).

These changes have made WAN optimization even more important due to new types of traffic traversing networks:

A. Desktop virtualization

It changes the division of network loads between end users and the location of their virtual machines. The VMs may be hosted in a single data center, or for purposes of load balancing they might move among several locations. Or the VM can be in a local server, with applications fetching data from remote servers but executing instructions locally.

B. Mobile computing

Mobile computing greatly increases the use of wireless links, either private or those of the common carriers. But wireless data transmissions, at some point, traverse a complex of proxy servers or gateways and a wired WAN.

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What these computing trends have in common is that they introduce more network-to-network links in transactions, all with the potential to slow down traffic. WOCs help mitigate this with a combination of techniques, including protocol-specific optimization such as for TCP and HTTP, compression, caching, deduplication, load-balancing among available links and servers, and the application of specific QoS policies . Various solutions handle caching differently. WOCs all intercept WAN traffic before files reach the WAN for the purposes of deduplication and compression. But some avoid caching because of the possibility that a wrong version of a file will be transmitted if an interruption occurs in a data center's availability, resulting in a failure to cache the latest version [5].

C. WOC Form Factor

Generally, WAN optimization controllers are "bookend" devices, meaning that one is needed at the client or branch office and one at the data center. The two basic formats are physical and virtual.

1) Physical WOC: Physical WOC is a rack-mounted appliance. Vendors offer them in a shelf or desktop configuration, or as 1U, 2U and taller rack amount devices. One consideration that IT managers should keep in mind is that physical controllers, as data center workhorses, have hard-disk drives and can consume a significant amount of power, some as much as 500 watts. An IT shop that deploys these appliances should have a strategy for heat dissipation. Look for hot swappable drives.

2) Virtual WOC: Virtual WOC applications are available for the major virtualization platforms. A virtual solution works well in specialized situations; for example, where limited data center space makes it impractical to add another appliance. Virtual WOCs also are available for mobile computing, residing on a user's endpoint device, such as a notebook computer. Mobile users who rely heavily on Wi-Fi or cellular connections can benefit from deduplication and compression techniques when they send and receive documents and presentations, or when they use web applications hosted on corporate or cloud servers. The mobile computer becomes the client bookend of the paired WOCs [5].

VI. APPLICATION DELIVERY CONTROLLER

Application delivery controllers are devices that typically reside in the data centre and extenuate the traffic between clients requesting data or execution of logic on web. The cornerstone function of ADC is load-balancing, dividing the workload between two or more servers. In load balancing, an organisation uses instance of application either physical servers or virtualized.

An ADC administrator can configure the device to respond to clients request according to priorities that the organization set by using its own specific policies. To increase the performance of applications, ADC can hold the request relating to trafficking and data back and forth, by leaving application servers free to execute their logic more efficiently. To illustrate, some ADC perform encryption and authentication from secure sockets Layer (SSL) requests [5].

Fig. 6.Application Delivery Controller

VII. RIVERBED TECHNOLOGY

Making the WAN behave more like a LAN has two components:

- Delivering dramatic performance improvements, especially for those applications or protocols that show the worst degradation when running over a WAN.
- Contending with a wide spectrum of protocols that are crossing the networks of a distributed organization.

Solutions that deliver this broad-spectrum improvement of WANs go by the name of WAN Optimization. With Riverbed products, enterprises can implement solutions that help them empower their distributed workforce while eliminating IT capital expenditures and simplifying IT management [6].

With Riverbed organizations can Centralize distributed infrastructure like file servers, mail servers, network attached storage (NAS), and remote office backup systems without affecting remote users.

Share large files among colleagues on different continents – as if they were in the same building – leading to more productive users. Deliver significantly more services on existing WANs – without upgrading bandwidth.

A. Riverbed Steelhead Products

Riverbed is the pioneer and market and technology leader in WAN optimization – the first comprehensive solution to a host of problems that plague enterprise applications operating across the WAN.

Using solutions from Riverbed, enterprises can improve application performance across the network typically by five to 50 times and in some cases up to 100 times, and can simultaneously reduce WAN bandwidth utilization by 65 to 95%.

These dramatic results allow businesses to take advantage of their networks, infrastructure, and applications in ways they had never imagined possible [6].

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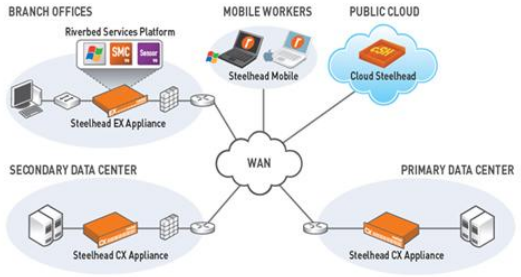

Fig. 7.Riverbed Steel Head Appliances in WAN Network.

B. Riverbed Services Platform (RSP)

Riverbed provides customers with the capability to run additional services and applications in a protected zone on Steelhead products. This revolutionary approach, called the Riverbed Services Platform (RSP), provides dedicated resource instances for certified software modules to run on. The RSP offers software vendors a unique development platform and easy interoperability with data and applications at the network level.

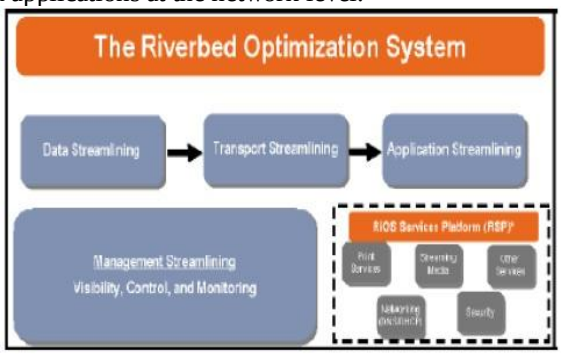

Fig.8.The RSP provide a platform for virtualized services.

The RSP creates an extensible platform for multiple technology partners to deploy their services without the need for an additional dedicated server or product in remote offices. The RSP helps customers by enabling branch services such as IP address management (IPAM), video streaming, and local print server capabilities.

C. Application of Riverbed

1) Bandwidth Optimization: Sometimes the goal is as simple as avoiding a WAN upgrade, and Riverbed products can help with that too. Riverbed Steelhead products typically reduce existing WAN traffic by 60% to 98%, which means that an existing WAN can often support many more users, new applications like VOIP can be rolled out, and an expensive WAN upgrade can be delayed or avoided.

2) Data Replication: Whether data needs to be replicated to support data replication plans, or to mirror data so it's available for users around the world, data replication is critical. Riverbed solutions canaccelerate data replication processes by a factor of 10 or more, even those using already optimized products like SnapMirror™. Steelhead products remove all the redundant traffic from the WAN, and optimize TCP. The two together make a huge difference in the time required to complete a replication.

3) In-sourcing: Distributed organizations doing knowledge work often find that they have spare capacity in some locations and insufficient capacity in others. By enabling more flexible sharing of information and applications across geographic boundaries, Riverbed's Steelhead products make it possible to use idle internal resources to assist in situations that might otherwise require additional local consultants or other temporary help. This in-sourcing saves money and helps lower the volatility of work life by spreadingwork more evenly across locations.

D. The Riverbed Optimization System (RIOS)

RIOS is designed to provide the highest performance across the applications that enterprises care about the most, while at the same time making easy to deploy, manage and monitor WAN optimization [7]. The Riverbed optimization system is software that is based on the individualized technologies that solve a varieties of problems affecting the WAN and application network including :

- Inadequate WAN bandwidth
- Inefficacious transport protocols in high -latency environment
- Inefficient application protocols in high latency environment.

Technology	Description	Result
Data Streamlining	Data deduplication to optimize WAN bandwidth utilization	WAN bandwidth utilization reduced by up to 60% to 95% Prioritize applications by bandwidth and latency
Transport Streamlining	Eliminate transport protocol inefficiencies	Applications accelerated by up to 100x
Application Streamlining	Optimize application protocol performance on WANs	Up to 98% reduction in packet roundtrips
Management Streamlining	Enable transparent deployment, centralized management, and virtualized branch office services	Fewer IT resources required for deployment and management. Simplify branch office infrastructure by virtualizing core services.

Fig. 3.Components of RIOS

VIII. CONCLUSION

Overall, it can be concluded from this paper that besides of updating aging switches and routers, majority of organisation uses load balancers and WAN optimization controller to improve application performance.

As network have become integral part for every kind of organisation. The connections they make allow communication to take place 24*7 hours among the customers from diverse loactions.

The WAN has become the nervous system that connects the entites with the customers and trading partners. Due to which WAN optimization has evolved into a complete system that optimizes traffic across a broad range of applications that enterprises use the most, while providing deep, actionable visibility into performance.

Also Optimization results into proper usage of bandwidth without lossing the critical data and transaction integrity.This goal had been achieved with riverbed steelhead appliances ,in which applications are designed to apply a variety of techniques to streamline network traffic.

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BIOGRAPHIES

Gurpreet Singh received his B.Tech. degree in Information Technology from DAV Institute of Engineering & Technology, Jalandhar, Punjab, India in 2009 and M.Tech. degree in Computer Engineering from University College of Engineering, Punjabi University, Patiala, India in 2011. He was teaching as a Lecturer at Rayat Bahra College of Engineering and Bio-Technology for Women, Mohali, Punjab, India. Presently, he is teaching as Assistant Professor at Guru Nanak Dev University, Regional Campus Sultanpur Lodhi, Kapurthala. He has more than 25 research publications in International, National Conferences and Journals. His research interest includes Wireless Communication, Network Security, Computer Networks and Data Communication.

Lovepreet Singh is pursuing his B.Tech. in Computer Science & Engineering from Guru Nanak Dev University Regional Campus, Fattu Dhinga, Kapurthala, India and intended to pursue Master science from US. My predominant research interest has evolved into three categories that I believe are interrelated. The three bailiwicks are Cloud computing, Network Communication, Network security.

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