Bandwidth Optimization Techniques for Faster Data Transfer Avoiding Traffic Congestion Using Distributed Bandwidth Network

Dr. R. Naveen kumar[1], Associate Professor,
Department of Computational Sciences, Brainware University, Kolkata, West Bengal.
Email: rnaveenkumarooty@gmail.com
Co – Author: Ms. Moumita Sarkar[2], Assistant Professor,
Department of Computational Sciences, Brainware University, Kolkata, West Bengal.
Email: moumita.kishalay@gmail.com

Abstract:
The premise for managing and controlling bandwidth is the requirement for safe and dependable data transfer through computer networks and the internet. Without bandwidth management, a user or an application won't be able to control all the bandwidth that is available and keep other users or programmers from accessing the networks. It will be difficult to manage which user or programmer gets precedence on the network and impossible to distinguish between different types of network traffic. Applications that need a certain level of quantity and quality of service may not be forecast in terms of bandwidth availability, causing certain apps to perform badly as a result of inefficient bandwidth allocation. This study focuses on the creation of an application to address the difficulties associated with easy data transfer issues in network architecture as business networks increase. The development tools utilized include MySQL, Apache Server, and PHP Script.

Keyword: Bandwidth, Computer Network, Transmitter, Frequency,

Introduction

The term "computer network" describes the connection of two or more computers for the exchange of information, communication, and resource sharing. Users of a network can exchange electronic messages, execute applications on other computers, and share information, files, printers, and other resources. The use of protocols enables logical connections between network applications, controls how packets move through the physical network, and reduces the chances of packet collisions. Network cables and the gadgets that join them all together are examples of the physical elements that bind the computers (or "nodes") together.

The quantity of data that may be sent down a data connection at any one moment is referred to as bandwidth. Network bandwidth is typically defined as the amount of accessible or used data communication resources, represented in bits per second or its multiples (kilobits per second, megabits per second, etc.). Voice, data, pictures, and video are just a few of the services that networks are capable of transporting. The bandwidth, cell loss, latency, etc. requirements for these services vary. The following bandwidth difficulties should be taken into account in order to maximize the quality of service provided during the stressful time, as seen by both the network provider and the customer:

Planning the topology and allocating bandwidth. It focuses on the capacity to dynamically modify a network to effectively utilize network resources Avoiding traffic congestion and controlling the flow. Congestion is avoided via bandwidth management methods, which fundamentally include accepting or rejecting a new-arrival cell. The most important challenge in bandwidth allocation is the successful integration of link capacities through various services. In light of the fact that a virtual path is a logical direct link made up of virtual circuits between any two nodes. The distribution of bandwidth among the network's virtual paths in order to improve quality across all users.

The Internet offers a best effort service to most users, meaning that the network strives to deliver data as efficiently as possible, but there are no guarantees. It's like trying to become a movie star - you may succeed, or you may not. Similarly, the packets carrying your data may arrive quickly or slowly, or they may not arrive at all. It's not uncommon for a file to take longer to download today than it did yesterday, or for a streaming movie to have poor quality one night and then look great the next morning. This behavior is expected, but what causes it?

In the examples mentioned earlier, there are several reasons why the Internet behaves in an unpredictable manner. Firstly, if an Internet link becomes unavailable, packets must be rerouted through different network nodes, or routers. Additionally, weather conditions can also play a role, particularly for wireless connections. For instance, a friend of mine who uses a wireless connection often experiences bandwidth issues during periods of rainfall. Finally, another common factor that can cause disruption is congestion, which occurs when too many users try to access the same resources at once.

In the case of the ISP with up to 1000 customers, each with a maximum rate of 1 Mbps but an average rate of only 300 kbps, the choice of Internet gateway connection speed is an important consideration. While a 1 Gbps link would be able to accommodate all 1000 customers simultaneously, it may not always be necessary or cost-effective. In this scenario, the ISP could opt for a cheaper 600 Mbps connection, which would suffice for most of the time. However, during periods of heavy usage or unexpected traffic spikes, the connection may become congested and cause slower data transfer rates. Therefore, the ISP must carefully balance the need for cost-effectiveness with the need for reliable and efficient data transfer speeds.

This real-life example provides a helpful analogy for understanding Internet congestion. In some parts of Tyrol, when a special dish called 'Zillertaler Bauernkrapfen' is sold during a celebration, it is only available in limited quantities and is in high demand due to its taste and difficulty to prepare. Similar to how the dozen Krapfen are only available periodically, Internet resources also have a limited capacity, and users' demands for those resources can fluctuate. If too many users try to access the same resources simultaneously, it can cause congestion, just like too many people trying to buy the limited quantity of Krapfen can lead to long lines and delays. In such cases, users may decide to leave and try again later, just as someone eager for Krapfen may leave the booth and return in half an hour.

Scalability is a critical factor in the success of computer networks, and it can be measured in various dimensions, including the ability to handle large amounts of traffic and the capacity to accommodate growing link capacities. In the context of computer networks, the most common measure of scalability is related to the number of users or communication flows in the system. If a network can scale effectively, it should be able to handle any number of users without degrading performance. The Internet has proven to be highly scalable, as evidenced by its continuous growth over the years. As a result, the Internet community places great emphasis on ensuring scalability at all times, and this mindset has undoubtedly contributed to the Internet's success as a global communications network.

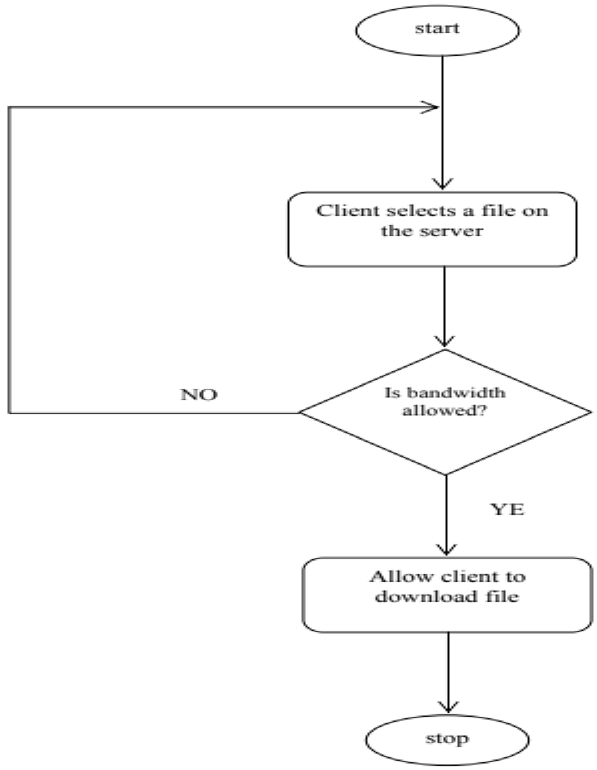
The confusion regarding where to place congestion control in the OSI model stems from differing interpretations of the OSI standard and the evolution of Internet technology. The ISO 1994 standard lists flow control as a function of the network layer, which is concerned with intermediate systems. However, congestion control, which controls the rate of a data flow within the network for the sake of the network itself, is not explicitly listed in the standard.

The majority of introductory networking books correctly identify TCP as a transport layer protocol that implements congestion control in the Internet. However, this violates the OSI model, which aims to hide details concerning the inner network from the transport layer. The reason for making flow control a layer 3 function in the OSI standard is that congestion occurs inside the network, and the network layer is supposed to shield the transport layer from such details.

Despite the violation of the OSI model, TCP's implementation of congestion control has been successful in the Internet. However, it has led to compatibility issues with legacy TCP implementations and problems with TCP over heterogeneous network infrastructures. Researchers have developed various TCP tweaks to enhance its behavior in different environments, but the binding element of the Internet is no longer just IP, but TCP/IP. Today, "IP over everything, everything over TCP" is more accurate than the original catchphrase of "IP over everything, everything over IP."

The amount of data that can be transferred through an internet connection in a given amount of time. Internet speed is sometimes mistaken with bandwidth, which is the amount of data that can be transferred through a connection in a given amount of time, measured in megabits per second (Mbps). When it comes to figuring out the caliber and speed of a network or internet connection, bandwidth is a crucial component. In general, your internet will be speedier and more effective the higher the bandwidth. One thing to keep in mind is that throughput, which relates to speed, should not be mistaken with bandwidth when figuring out how much bandwidth your network will need. While fast networks with high bandwidth are common, this is not always the case. Cars on a highway serve as a useful metaphor for thinking about bandwidth. A high-bandwidth network is comparable to a six-lane motorway that can accommodate hundreds of vehicles simultaneously.

FLOW CHART



A low-bandwidth network is comparable to a one-lane road where vehicles follow one another closely. The big roadway will probably move vehicles more quickly, but rush-hour traffic can easily stop automobiles and trucks in their tracks. Or perhaps the highway is congested with enormous delivery trucks that take up a lot of space on the route, making it difficult for automobiles to enter it swiftly. Similar to this, a network with high capacity might experience slowdown due to issues like congestion and apps that use a lot of bandwidth.

Bits per second or, occasionally, bytes per second are used to describe bandwidth. When determining the proper bandwidth formula for your network, it's crucial to grasp the difference between theoretical throughput and actual outcomes. Network bandwidth indicates the capacity of the network connection. For instance, a 1000BASE-T Gigabit Ethernet (GbE) network, which employs unshielded twisted pair cables, can theoretically provide 1,000 Mbps, but in practice, this speed can never be reached owing to hardware and systems software complexity.

These factors make determining bandwidth allowances and needs difficult, but the repercussions of using the incorrect calculation are severe. If you don't get enough and reach your bandwidth cap, you almost certainly won't have a fast network. However, for the majority of businesses, drastically over provisioning bandwidth may be too expensive. So how can you choose the best formula to satisfy your bandwidth needs? Asking the proper questions is the first step in the process. What programme are customers using, and what is their performance service-level agreement? Some network administrators are only interested in the number of users connected to a virtual LAN. However, you need to know what the users will be doing on the network to estimate real bandwidth demand.

ARCHITECTURE OF THE SYSTEM

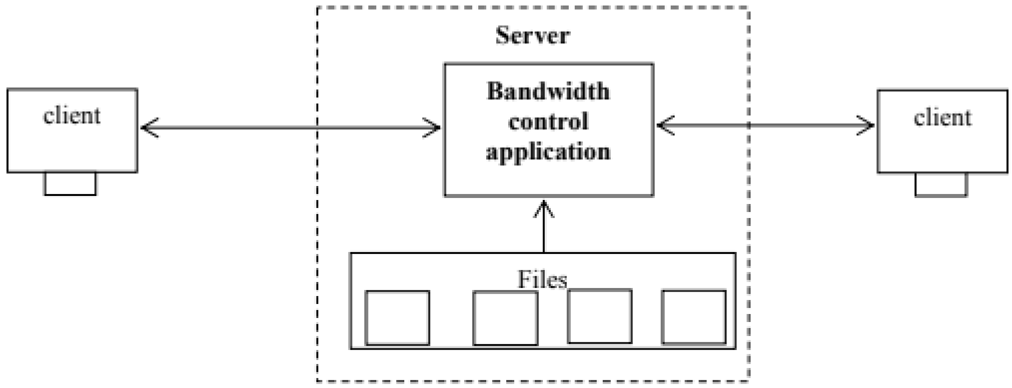


Figure: 1

The system replicates a basic internet network environment based on wireless technology. Any file that is going over the network has its size determined. The transfer procedure is stopped if the file size exceeds the administrator's permitted bandwidth. Additionally, the technology enables an administrator to modify the permitted network bandwidth in accordance with preferences. As long as the files are shared and transferred within the permitted bandwidth range, client systems are permitted to do so.

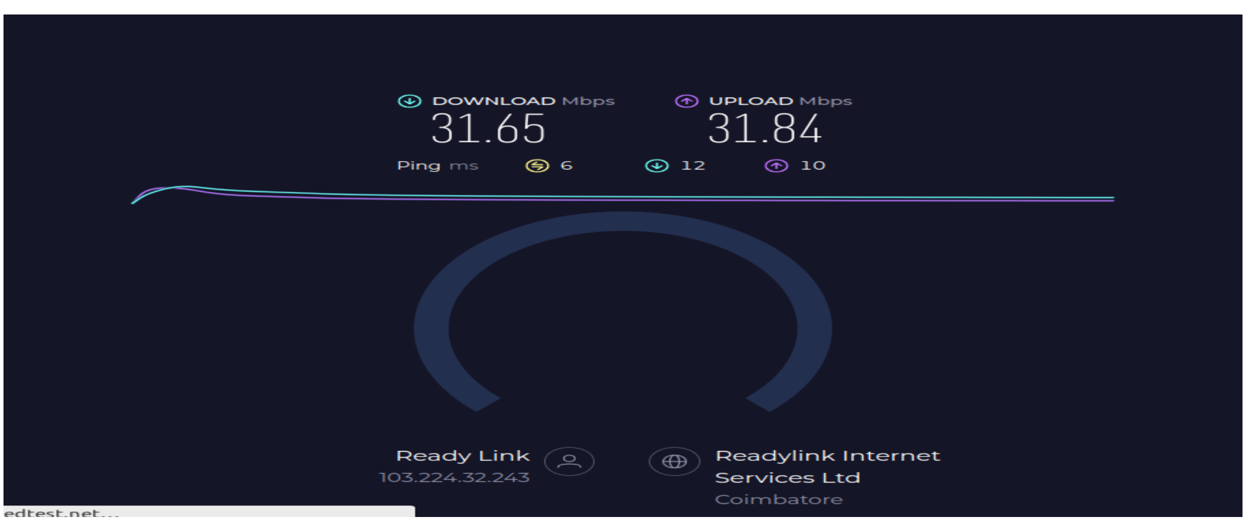


Figure:2

IMPLEMENTATION

Through a single interface, the numerous components are interconnected with one another. Each module has its own set of criteria, however they are all typically satisfied by the modules after they have been packed and installed on the testing server. The modules have been installed on the testing server after being packaged. A frequency range within a continuous collection of frequencies is referred to as a bandwidth. It's expressed in Hertz. A communication system's goal is to convey data from a transmitter that is situated in one location to a receiver that is typically placed distant from the transmitter.

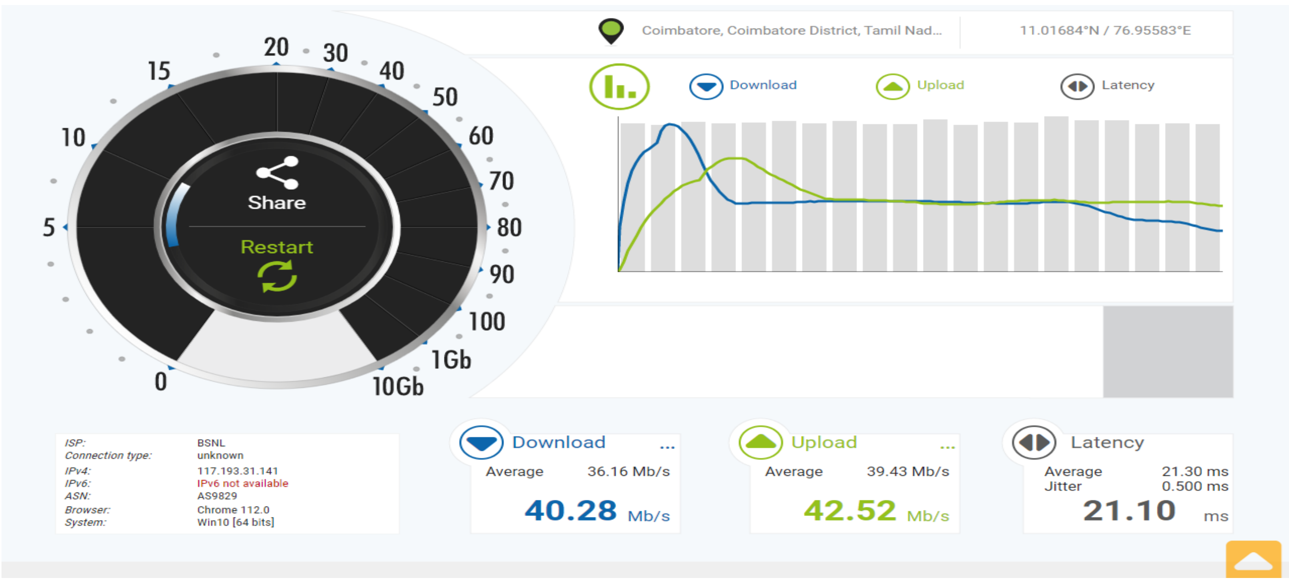


Figure:3

These days, frequency bandwidth is both costly and extremely limited. Every day, thousands of different telecommunications apps are employed, and each one needs a certain amount of bandwidth. It is necessary for one application to not "leak" into the frequency spectrum of the other in order to share these scarce frequencies. In reality, the nonlinear behavior of parts and systems is what causes this "frequency leaking". Therefore, it is crucial to understand how much in- and out-of-band nonlinear distortion the devices would produce when developing RF systems. The Adjacent Co-Channel Power Ratio (ACPR), which is defined as the ratio of the average power in the adjacent frequency channel to the average power in the transmitted frequency channel, is used to describe the amount of interference, or power, in the adjacent frequency channel [24,25]. The ACPR, which describes the degree of distortions caused by the nonlinear behavior of RF components, is frequently used to assess a device's linearity. A powerful nonlinear device has a high ACPR.

CONCLUSION

The majority of network links are shared by several users or apps, indicating that all users and all program are using the same amount of bandwidth. Traffic congestion on the network can be avoided by using bandwidth management to distribute bandwidth to applications or users at peak times. By adopting bandwidth management, temporary network congestion can be reduced; however, if a network is always overloaded, connection upgrades that increase capacity are required. It is simple to move data and communications when bandwidth is purchased and managed. Networks are incredibly helpful for people that need to transfer information quickly. This study proposes a testable application that addresses the difficulties associated with simple data flow concerns in network architecture as business networks develop. To help major organizations monitor and regulate the bandwidth of their computer networks, further development of the system is advised.

REFERENCE:

[1] Mason Technologies. (2014) Mason Technology Website. [Online]. http://mason247.com/voip-integrated-voip.html

[2] Uchenna P. Ani Daniel, "Voice-Over-IP (Voip) Bandwidth Optimization: A Survey of Schemes and Techniques," in Second International Conference on Cyber Security, Cyber Peace fare and Digital Forensic (CyberSec2013), Kuala Lumpur, 2013, pp. 124-129.

[3] Aikaterin Gkritsi, "Introduction to Voip Technology and Its Security Issues," in 4th Annual Multimedia Systems, Electronics and Computer Science, Southampton.UK, 2003, pp. 1-6.

[4] S Ganguly et al., "Performance Optimizations for Deploying VoIP Services in Mesh Networks," USA, 2007.

[5] G Thomsen and Y Jani, "Internet telephony: Going like crazy," IEEE SPECTRUM, pp. 52-58, May 2000.

[6] Uchenna Peter Daniel, "Voice-Over-IP (Voip) Bandwidth Optimization: A Survey of Schemes and Techniques," in Second International Conference on Cyber Security, Cyber Peacefare and Digital Forensic (CyberSec2013), Kuala Lumpu, Malaysia, 2013, pp. 124-129.

[7] Hui Min Chong and H S Matthews, "Comparative analysis of traditional telephone and voice-over-Internet protocol (VoIP) systems," in 2004 IEEE International Symposium on Electronics and the Environment, 2004, pp. 106-111.

[8] XipLink, "XipLink Real Time Optimizations: Header Compression, Packet Coalescing and Packet Prioritization," 2011.

[9] S Shenker, C Partridge, and R Guerin, "Specification of Guaranteed Quality of Service. Request for Comments RFC," 1997

[10] M. L. Umashankar, and M. V. Ramakrishna, “Optimization techniques in wireless sensor networks: A survey,” International Journal of Scientific Research Engineering & Technology, vol 6, no. 7, pp. 704 – 708, 2017.

[11] L. Wang, W. Wu, J. Qi, and Z. Jia, “Wireless sensor network coverage optimization based on whale group algorithm,” Computer Science and Information Systems, vol. 15, no. 3, pp. 569-583, 2018

[12] C. Jiang, H. Zhang, Y. Ren, Z. Han, K. C. Chen, and L. Hanzo, "Machine learning paradigms for next-generation wireless networks," IEEE Wireless Communications, vol. 24, no. 2, pp. 98- 105, 2017.

[13] S. Ahmad, R. M. Nadeem, B. Ehsan, M. Ullah and A. B. Siddique, "Wireless networks throughput enhancement using artificial intelligence," Indian Journal of Science and Technology, vol. 10, no. 26, pp. 1 – 5, 2017.

[14] S. Orike and T. J. Alalibo, "Comparative analysis of computer network protocols in wireless communication technology," International Journal of Electronics Communication and Computer Engineering, vol. 10, no. 3, pp. 76 – 85, 2019.