Optimizing Wireless Distribution System Network Infrastructure in Hybrid Topology using PCQ Method

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Abstract. A good and efficient network infrastructure design must be considered when first building a computer network system. The position of buildings that are far from each other sometimes becomes a separate problem that results in the quality and performance of computer network signal services not being optimal. The implementation of the Wireless Distribution System (WDS) on the STTM campus network infrastructure will be combined with the use of the Peer Connection Queue (PCQ) method, which is one of the features of the Mikrotik device. The use of the PCQ method aims to optimize internet bandwidth, through a mechanism for distributing bandwidth evenly to each user that has been set on the management bandwidth, also we can observe the throughput, delay, and jitter of the built network infrastructure. The study was carried out following the stages of designing schemes and network topology, designing and configuring network infrastructure, then in the last stage testing connectivity and performance was done through several clients connected to the network. The data obtained from the test results will be analyzed and then evaluated whether it is by the expected target of 0% packet loss, delay below 150ms, and jitter under 75ms.

1. Introduction
Planning for computer network infrastructure in an institution or agency that has a high dependence on information technology needs to be done, it aims to make the performance and quality of internet connection services become more stable and optimal. In some conditions, especially in the environment of institutions or institutions that have several separate buildings, it will be very inefficient if you have to connect it using cable media.

One effort to overcome this wiring obstacle is to implement a Wireless Distribution System (WDS) technology. WDS is a technique of connecting multiple access points through wireless media in a Wireless Local Area Network (WLAN) and only uses one network cable as a backbone path on a central Access Point device. Whereas at other Access Points (clients), the backbone path originates from the central Access Point that is distributed through the wireless network.

With the implementation of WDS, the work area (coverage) of a WLAN can be expanded without having to connect the Access Point with a cable backbone system. Another advantage of the WDS is that the MAC Address header of the packet traffic does not change between the access point links because the connection between clients is connected when in a WDS state, using the MAC Address as the target destination. Not based on the IP address. However, the WDS technique also has weaknesses,
namely, the throughput that can be passed between networks is usually only half of the total throughput because the access point works double (sending and receiving data packets) so that it also impacts on bandwidth reduction.

Earlier in [1], a Wireless Distribution System service quality (QoS) service was tested using the parameters of output, delay and packet loss. Where in the test carried out a comparison of service quality based on the network topology used including Bus, Star, Mesh, Ring, and Tree. Then in [2][3][4], a Peer Connection Queue (PCQ) method is added to further optimize internet bandwidth. From the test results obtained an average value of 85% better throughput, and 200% delay and jitter 150% shorter than without using PCQ. This improved performance allows other service features that require stable network connectivity such as Voice Over Internet Protocol (VOIP) as in [5] to be more optimal.

\[\text{Figure 1. WDS Network Infrastructure Design}\]

2. Material and method

Network Development Life Cycle (NDLC) is a method that depends on the previous development process so that at each stage it will determine the success of the next stage and this is a key in building a computer network infrastructure.[6]
In the initial stage, an analysis of needs, problems that arise, user desires, as well as topology/network analysis that already exists today. The interview involves the management structure top to the bottom level in order to get concrete data and complete. Next step is to conduct a field survey to see the real conditions so that things that might be a factor in the decline in network quality can be traced. From the data obtained in the previous stage, the next step is to create a network topology design drawings that will be built, the results of the topology design will then be simulated using network simulation software to see the extent of its performance and reliability. Then the next step is to implement the topology that was designed in the previous stage to be realized in the field, the last is monitoring and management of the network infrastructure that has been built.

Peer Connection Queue (PCQ) is one of the features found in Mikrotik router OS that is useful for managing traffic rates and packet traffic in a network. The main purpose of this method is to make bandwidth sharing automatic and evenly distributed to multiple clients.

PCQ Working Principle by implementing queue trees where there is only one active client that uses bandwidth, while other clients are in an idle position, the active client can use the maximum available bandwidth, but if another client is active, then the maximum bandwidth can be used by both clients (bandwidth or the number of active clients) so that bandwidth can be distributed fairly for all clients.

![Figure 3. Peer Connection Queue system](image)

![Figure 4. Steps of system design](image)
In this study, the proxy device used was the RB 951-U2nd router board version with router level 4 license OS. Testing was carried out by the client with a laptop operating system Windows 7 and an Android mobile device. Measurements and analyses are carried out in the form of connection quality tests on sector A network (AP_CENTRAL) and sector B network (AP_Station), while for QoS observations are made on packet loss, delay, and jitter.

Table 1. TIPHON QoS parameter standarization

| Grade   | Packet Loss | Delay  | Jitter |
|---------|-------------|--------|--------|
| Perfect | 0 %         | < 150 ms | 0 ms   |
| Good    | < 3 %       | < 250 ms | < 75 ms |
| Medium  | < 15 %      | < 350 ms | < 125 ms |
| Poor    | < 25 %      | < 450 ms | < 225 ms |

Source: ETSI TR 101 329 v.2.1.1, 1999-06, page 26. [8]

3. Results and discussion

Network performance testing is done through a monitoring application found on the Winbox remote desktop. From there we can see the results of the configuration settings that have been made in the PCQ in the form of bandwidth management that controls the use of internet bandwidth, besides that it can also be seen the amount of packet loss, delay, and also its jitter as shown in the picture below:

![Figure 5. Graph monitoring results using win-box](image)

3.1 Quality of service (QoS) monitoring in sector A

In testing conducted in sector A which is the main backbone network, where it can be seen that the implementation of Peer Connection Queue has made the use of internet bandwidth more controlled and between client 1 and other clients there is no bandwidth tug because the system has divided its bandwidth each client is equally equal. Network performance and stability testing are done by doing a youtube streaming test because this activity most requires a connection with large and stable bandwidth. From the observations obtained packet loss value of 0%, delay 81 ms, and jitter 13 ms.
Table 2. QoS monitoring result Sector A

| Value         | Grade  |
|---------------|--------|
| Packet Loss (%) | 0      | Perfect |
| Delay (ms)    | 81     | Perfect |
| Jitter (ms)   | 13     | Good    |

3.2 Quality of service (QoS) monitoring in sector B

Then in testing conducted in sector B which is a WDS client network, it can be seen that the implementation of Peer Connection Queue has also succeeded in making the use of internet bandwidth more controlled and between client 1 and other clients there is no bandwidth tug because the system has divided the bandwidth to each client is even. Testing the performance and stability of the network is still carried out through the YouTube streaming test, and the results of observations made are 0% packet loss, 142 ms delay, and 25 ms jitter.

Table 3. QoS monitoring result Sector B

| Value         | Grade  |
|---------------|--------|
| Packet Loss (%) | 0      | Perfect |
| Delay (ms)    | 142    | Perfect |
| Jitter (ms)   | 25     | Good    |

4. Conclusions

Based on an analysis of the results of testing the implementation of the wireless distribution system and the use of the PCQ method in the network infrastructure created, it was concluded that the WDS network has a wide range of coverage but is economically cheaper than the use of cable media, the use of the PCQ method is proven to have helped the distribution of bandwidth evenly on each client through bandwidth management. The difference in the value of the test results in sector A and sector B, is indicated to be the influence of the weak point of WDS on the position of AP Station (Client) in sector B, which in sector B AP functions as a sender and receiver of data packages so that the ability to pass throughput is reduced. But from the test results, the value of packet loss, delay, and jitter in sector B is still in the area that is standardized by TIPHON.

References

[1] D. I. Haerudin, L. M. B. Aksara, and M. Yamin, “Implementasi Wireless Distribution System (WDS) pada Hotspot (Studi Kasus: SMK Negeri 1 Kendari),” SemantTIK, vol. 3, no. 2, 2018.
[2] S. Supiyandi, “Rancang Bangun Jaringan Menggunakan Mode PPOE Client Mikrotik dan Metode PCQ di Jaringan Internet SMA Negeri 20 Medan,” Comput. Eng. Sci. Syst. J., vol. 3, no. 1, pp. 28–35, 2018.
[3] I. Faisal, “Analisis QoS Pada Implementasi Manajemen Bandwidth Menggunakan Metode Queue Tree dan PCQ (Peer Connection Queueing),” J. Teknol. dan Ilmu Komputer. Prima, vol. 1, no. 1, pp. 137–142, 2018.
[4] H. P. Situmorang and J. C. Chandra, “Implementasi Manajemen Bandwidth Menggunakan Metode Peer Connection Queue pada SMK Budi Mulia Tangerang,” IDEALIS Indones. J. Inf. Syst., vol. 2, no. 3, pp. 202–208, 2019.
[5] R. Hidayat, N. Sri Lestari, A. Sujana, Herlina, and G. Devira Ramady, “Optimizing Branch Telephone Networks for Campus VoIP with Mobile Clients,” in Journal of Physics: Conference Series, 2019, vol. 1175, no. 1.

[6] J. E. Goldman and P. T. Rawles, Applied data communications: a business-oriented approach. Wiley, New York, 2004.

[7] T. U. Di Cafe and A. Yogyakarta, “Perbandingan PCQ pada Simple Queue dan Queue Tree Mikrotik Untuk Pengelolaan Bandwidth.”

[8] European Telecommunications Standards Institute (ETSI) 1999 Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON); General aspects of Quality of Service. ETSI TR 101 329 V2.1.1