Journal of Cyber Forensics and Security (CYFORS)
Vol.2, No.1 (2025)

LOAD BALANCING ANALYSIS ON MIKROTIK ROUTERS USING PCC AND NTH METHODS

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Abstract

This research aims to analyze the ability of load balance to maximize network distribution so that the distribution is evenly distributed. The method in analyzing load balance uses per connection classifier (PCC) and nth. In this study, the internet line uses 2 ISP lines using dedicated services with a ratio of (1: 1). This test measures quality of service (QoS) parameters, namely throughput, packet loss, jitter, and delay. The results show that the value with the per connection classifier (PCC) method is very good, namely for the value of throughput 93.72%, packet loss 7%, jitter 66.8ms and delay 130ms, compared to using the nth method getting throughput 59.42%, packet loss 28%, jitter 273.6ms and delay 306ms. Referring to the information set by ETSI-TIPHON, the research results of the per-connection classifier method are in the very good category.

Keywords **:**
Load Balancing, QoS, Mikrotik, PCC, NTH

Introduction

According to the Indonesian Internet Service Providers Association (APJII), internet penetration in Indonesia has reached 78.19 percent by 2023, covering 215,626,156 people out of a total population of 275,773,901. These figures show that more than half of Indonesia's population are internet users which continues to increase in the country [1].

Nowadays, communication knows no boundaries of space and time, so network technology is a very important requirement in various fields. Internet Service Providers (ISPs) are also in fierce competition to provide the best service to their users to fulfill important data communication needs. However, many users complain of recurring connection problems. These problems include insufficient bandwidth, slow or intermittent connections, excessive traffic, and network disconnections. While users can use two or more internet network connections, it is not the best solution. Load Balance techniques can be an option for consumers to minimize these connection disruptions [2].

In research conducted by Andi Marwan Elhanafi, Imran Lubis, Dedy Irwan, and Abdullah Muhajir (2018) entitled "Simulation of PCC Load Balancing Implementation Using GNS3 Simulator", it is explained that by implementing load balancing using the PCC method, the traffic load becomes smoother without data congestion. If one network is disrupted, internet access will continue to run because there is another network that acts as an internet service provider (ISP). When each computer needs access to the network, it will automatically select the designated network [3].

In research conducted by Muhammad Fauzi Zurkarnaen, M. Iqbal Isnaini (2018) entitled "Implementation of Load Balancing with the Equal Cost Multi-path Method", it is explained that the problems currently experienced at the High School of Informatics and Computer Management (STMIK) Lombok experience an unstable internet network because they often experience lost connections on the network. Therefore, a load-balancing method can be applied to the network at STMIK Lombok. After testing using the ECMP method, it does not distribute all bandwidth but distributes the network load evenly based on the speed ratio obtained from each ISP [4].

In research conducted by Febrian Wahyu Christanto, Susanto, Agus Priyanto (2019), entitled "Load Balancing-Failover Methods using Static Route with Address List, ECMP, PCC, and Nth for Optimizing LAN Network: A Comparison", from the results of the study it was explained that the results of the Load Balancing trial were carried out for 40 (forty) days resulting in download data for each method there was Static Route with Address List (77.5%), ECMP (78.0%), PCC (77.5%), and Nth (79.5%). Data upload for each method is Static Route with Address List (23.4%), ECMP (24.0%), PCC (24.2%), and Nth (27.3%). So it can be concluded that Load Balancing with the Nth method is more optimal and effective when applied to LAN networks compared to other Load Balancing methods. This is because the Nth method is stronger in bandwidth, can share two internet lines when browsing, and downloading, and can run failover well [5].

Then in research conducted by Rasna, Ahmad Ashari (2019) entitled "Application Load Balancing with Nth Method Multiple Gateway Internet Networks", it is explained that from the research results there is a comparison between the quality of the connection before and after the implementation of load balancing. This can be seen from the Tx/Rx monitoring results for each ISP and LAN which show that the incoming throughput has the same average

value. Specifically, the average received by ISP-A (Rx) was 34.75 Mbps, ISP-B was 30.12 Mbps, ISP-C was 7.17 Mbps, and the LAN transmitter (Tx) was 72.03 Mbps [6].

Research conducted by Zawiyah Saharuna, Rini Nur, and Ahmad Sandi (2020) entitled "Analysis of Service Quality on Load Balance Networks Using PCC and NTH Methods" revealed that the application of load balance can equalize throughput values and minimize Packet Loss. The NTH method shows a more stable throughput value for each client compared to PCC. However, PCC has a smaller Packet Loss value compared to NTH. Delay and Jitter values do not affect the load balance implementation, but PCC has smaller Delay and Jitter values compared to NTH. The failover mechanism runs well in both load balance methods, but the failover mechanism in NTH is faster than PCC with a downtime value of 3 seconds [7].

In research conducted by Ibnu Asyhar Pratama (2021) entitled "Comparative Analysis of Load Balance Performance on Pfsense and Load Balance Per Connection Classifier on Mikrotik Routers", it is explained that based on the tests carried out, overall load balance on Pfsense outperforms load balance on Mikrotik [8].

Research conducted by Umar Ali Ahmad, Aliwarman Tarihoran, and Yuliantho Mardiansyah (2021) entitled "Comparative Analysis of Load Balancing Performance Using PCC and ECMP Methods on MikroTik Routers" discusses the differences in using the ECMP and PCC methods. However, in terms of practical application, the PCC method has proven to be very effective due to the lower packet loss rate compared to ECMP [9].

Research conducted by Ahmad Tantoni, Sofiansyah Fadli, and Arifin Hargianto (2021) with the title "Implementation of Load Balancing with the NTH Method Using Mikrotik at SMKN 2 Kuripan" revealed that after implementation, there was an increase in bandwidth quality. In testing the Quality of Service before and after implementing load balancing with the proxy method, the index for Modem-1, Modem-2, and Nth Router obtained the same result, namely 3.75, which is included in the "Satisfactory" category [10].

Research conducted by Reza Pakiding, Chess Iswahyudi, and Renna Yanwastika Ariyana (2021) entitled "Simulation of Load Balance Comparison Using PCC, ECMP, and NTH Methods Using GNS3" revealed that, based on the results of Quality of Service testing for parameters such as Delay, Jitter, Packet Loss, and throughput, the PCC method is superior to other methods. The PCC method achieves a better score of 61% compared to ECMP which is only 34%. In terms of traffic distribution, the PCC and Nth methods distribute traffic evenly across both internet sources, while the ECMP method only uses one path in its operation [11].

In a study conducted by Harkamsyah Andrianov and Romi Wijaya, they examined the "Load Balance (Pcc) With Recursive Gateway" method. When one of the gateway connection lines is disconnected, the traffic load will automatically move to the backup gateway that will be active as a replacement, utilizing PCC (Per Connection Classifier) technology and recursive gateway failover as an effective load balancing solution. Test results show that the implementation of PCC load balancing between the two internet service providers (ISPs) provides superior quality of service (QoS) [12].

Research conducted by Sutrisno Arianto Pasaribu (2022) entitled "Comparison Analysis of Load Balance Performance Per Connection Classifier (PCC) And Equal Cost Multi-Path (ECMP) Networks for Multiple Path Networks" explained that the measurement of Quality Of Service (QoS) network performance parameters such as throughput, jitter and delay with PCC and ECMP methods between ISP1 and ISP2 is throughput 22113.58 Kbps, Jitter 63.79ms, delay 0.000578ms. So it can be concluded that the PCC method produces Throughput, Jitter, and Delay between ISP1 and ISP2 are more balanced in terms of bandwidth usage compared to the ECMP method [13].

In research conducted by Idham, Rodianto, and Hendra Wahyudi (2022) entitled "Implementation of Load Balancing and Failover on the Internet Network Using the NTH Method", it is explained that the results of Quality of service testing are very satisfying with a throughput value of 79%, packet loss 0.69%, delay 55.3ms and jitter 0.851ms which based on TIPHON standards are included in the very good category [14].

In research conducted by Nola Kerenzia, Gani Indriyanta, Nugroho Agus Haryono (2023) entitled "Review of ECMP Load Balancing Performance with NTH on the Implementation of Several Internet Lines", it is explained that the results before load balancing tend to be worse than after load balancing. The overall results of testing QoS parameters through the switch for the ECMP method show better results compared to NTH, with a Packet Loss value of 0.996%, a Delay of 0.3539ms, and a Jitter of 0.3377ms [15].

In research conducted by Virdiyansyah D Abdillah, and Renna Yanwastika Ariyana (2023) entitled "Network Design Using Load Balancing Equal Cost Multi-Path (ECMP) Method At Lexima Consultant Office", it is explained that based on tests carried out overall load balancing using ECMP runs well at the Lexima Consultant Office [16].

In their research, Ahmad Tantoni, Lalu Mutawalli, and Mohammad Taufan Asri Zaen compared the QoS (Quality of Service) performance of load balancing methods on 4 internet lines. They found that the NTH method was the best in terms of ping testing and throughput (download/upload). The ECMP (Equal-Cost Multi-Path) method also produced good throughput, ranking second. Meanwhile, the PCC (Per-Packet Consistent Hashing) method was not found in this study. Another finding is if one internet

path is interrupted or down, then the other path can back up without having to merge the active path [17]. CV. Adidaya Perkasa Teknologi is a company engaged in the trade of goods and services. Such as the procurement of computers and spare parts, telecommunications equipment, and software consulting services. The CV. Adidaya Perkasa Teknologi office has 3 floors and each floor has been designed for network distribution. However, over time, the network infrastructure in the office experienced a few problems, especially in the network section. The CV. Adidaya Perkasa Teknologi office subscribes to 2 ISPs, each link has a capacity of 50Mbps using the Metro (Dedicated) service type. However, in terms of usage, users often experience unstable connection problems.

Based on the explanation above, the purpose of this research is to analyze and test load balancing comparisons using the PCC and NTH methods on MikroTik routers, and implement load balancing at the CV. Adidaya Perkasa Technology office because from the findings several connections are less stable with the use of 2 internet lines have been used. This test will utilize the open-source Libre NMS application, which will provide data such as average download and upload speeds, as well as maximum download/upload speeds based on usage time.

Therefore, the author will also apply the load balancing method after obtaining the comparative analysis results of the two methods, so that network performance at CV. Adidaya Perkasa Technology can run optimally.

Literature Review

1. Type of Research

In this research, the author analyzes the comparison of PCC and Nth load balance, and then from these results will be implemented in the load balance network at the CV. Adidaya Perkasa Technology office. The research process will be carried out using the Network Development Life Cycle (NDLC) method, followed by concluding the test results obtained from the research.

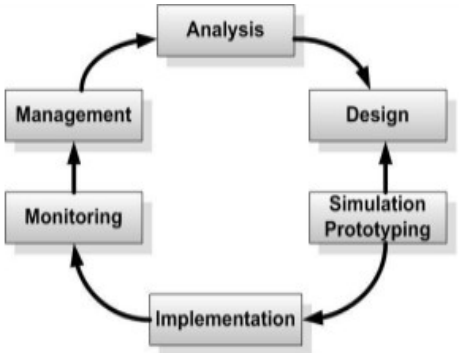

Figure 1. Stages of NDLC research

The NDLC method in Figure 1 above consists of 6 steps which include the following:

A. Analysis

In the first stage, researchers will analyze the problems and needs that exist in the CV. Adidaya Perkasa Technology office is a public service company. The connection at the CV. Adidaya Perkasa Technology office uses 2 ISPs, namely ISP (TE) and ISP (Oke.Net) with each ISP having a dedicated bandwidth capacity of 50mbps in a 1:1 ratio. There are several points that researchers will make for this stage, namely analyzing load balance with the PCC or NTH method by taking data for 5 (five) days during peak hours (07.00 - 17.00 WIB).

B. Design

Then the second stage, researchers will create a load balance network topology design, which will be applied to the CV. Adidaya Perkasa Technology office.

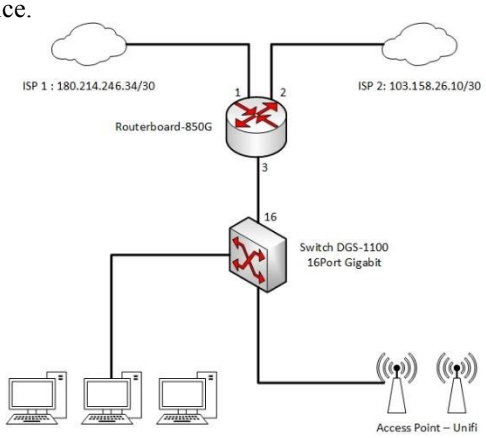

Figure 2. Topology Network

C. Simulation Prototyping

The next stage is simulation prototyping, researchers will simulate the load balance network using a GUI-based application, namely PnetLAB.

D. Implementation

At this stage, researchers will carry out load balance implementation after the previous stage, namely the simulation prototype that has been running well.

E. Monitoring

At the next stage, namely monitoring, after the previous stage of implementation. At this stage, it is very important because it will monitor the results of internet usage after applying the load balance function that has been carried out by researchers.

F. Management

In this last stage, network management will be carried out after implementing the load balance function because the system that has been built runs smoothly and lasts a long time.

2. Quality of Service

Quality of Service (QoS) refers to the ability of a network to improve the performance of specific data traffic across different technology platforms. QoS is not inherent to existing infrastructure but rather achieved by implementing it within the relevant network [18].

The following is an identification of Quality of Service (QoS), which is as follows:

A. Throughput

Throughput is the amount of data that can be transmitted by the network from the source to the destination in a certain period. Throughput is sometimes referred to as bandwidth because it

represents the value of bandwidth in real conditions. Bandwidth is more fixed, while throughput is dynamic and depends on the existing traffic [19].
Based on standards from ETSI-TIPHON, throughput can be categorized as in Table 1.

Table 1 Category Throughput

Category Throughput	Throughput	Index
Very Good	76% - 100%	4
Good	51% - 75%	3
Medium	26% - 50%	2
Bad	<25%	1

(Source: ETSI_TIPHON)

B. Packet Loss

Packet Loss refers to the difference between the number of packets sent and the number of packets received, in other words, it is the number of packets that have transmission failures and do not reach their destination [20].
According to the standards set by ETSI-TIPHON, Packet Loss can be classified as shown in Table 2.

Table II Category *Packet Loss*

Category Packet Loss	Packet Loss	Index
Very Good	0% - 2%	4
Good	3% - 14%	3
Medium	15% - 24%	2
Bad	>25%	1

(Source: ETSI_TIPHON)

C. Delay

Delay is the time taken by all successfully transmitted packets to transmit data from sender to receiver [21].

Table III Category Delay

Category Delay	Delay	Index
Very Good	<150ms	4
Good	150ms – 300ms	3
Medium	300ms – 450ms	2
Bad	>450ms	1

(Source: ETSI_TIPHON)

D. Jitter

A jitter is the delay of packets in the network. The amount of Jitter is affected by variations in traffic load and the level of congestion in the network. When network traffic becomes heavy, congestion can occur increasing Jitter. This increase in Jitter will hurt network performance [22].

Tabel IV Category Jitter

Category Jitter	Jitter	Index
Very Good	0ms	4
Good	0ms – 75ms	3
Medium	75ms – 125ms	2
Bad	125ms – 255ms	1

(Source: ETSI_TIPHON)

E. Downtime

Downtime refers to the period when a system cannot function as expected. This has a significant impact on device availability [23].

2.3 Load balancing

Load balancing is often used to distribute the traffic load evenly across two or more connection lines, aiming for optimal traffic flow and maximizing the bandwidth obtained from the ISP. In addition, load balance can be used to minimize delays and avoid overloading certain connection lines. Some commonly used load balance methods are as follows [24].

A. PCC Method (Peer Connection Classifier)

PCC is a load balance method that can be used to categorize traffic passing through a router into groups. This allows us to determine the gateway path taken by the initial connection traffic, and subsequent packets associated with the initial connection will be routed through the same gateway path [25].

B. NTH Method

NTH Load Balancing is a load balancing technique that creates a certain order to be used as a queuing system for the mangle rules formed. NTH Load Balancing uses the round-robin algorithm to determine the distribution of connections from the mangling process to the Load Balancing routes. NTH is implemented in a circuit consisting of every, packet, and counter which is realized in a series of integers. In this Load Balancing method, incoming data packets are marked as variable 'n' in integer data type. According to the rules, the path that has been marked as Nth will combine the total bandwidth at its output, which is the sum of the bandwidth of both connections. One of the drawbacks of the Nth method is the possibility of interruptions due to gateway switching caused by Load Balancing. [26].

Results and Discussion

1. Test Results Using Libre NMS Tools

The following are the results of testing using the open-source application, LibreNMS. In this test, the Throughput parameter is measured.

Figure 3. Test graph using Libre NMS

Based on the test results with the Throughput parameter using the LibreNMS open-source application, it shows a stable internet usage graph after implementing the load balance function on the network device at the CV. Adidaya Perkasa Technology office.

2. Test Results with QoS Parameters

A. Throughput

The following are the results of the Throughput parameter testing that has been carried out:

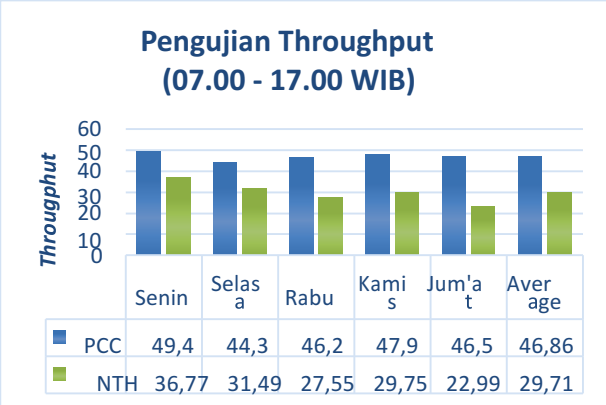

Figure 4. Throughput Testing Graph

Based on the results of the tests obtained, it can be seen in Figure 3 that the throughput value with the PCC method is more stable than the nth method. And the throughput value obtained is almost balanced for the PCC method.

Then based on the data that has been obtained, the examiner calculates the throughput as follows:

- PCC method

(%) Throughput = throughput : bandwidth x 100%
= 46,86 : 50 x 100%
= 93,72%

- NTH method

(%) Throughput = throughput : bandwidth x 100%
= 29,71 : 50 x 100%
= 59,42%

According to the standards set by ETSI-TIPHON, from the throughput calculation results the PCC method can be considered very good with an index value of 4. While the NTH method is considered good with an index value of 3.

B. Packet Loss

The following are the results of testing the packet loss parameters that have been carried out:

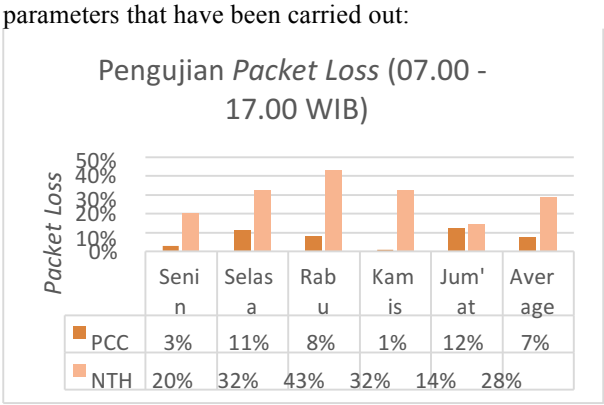

Figure 5. Packet loss test graph

Based on the test results, it can be seen that the packet loss value with the PCC method is smaller than the higher NTH method.

Based on the test results, the author took the average value for the packet loss parameter, and the results obtained were the PCC method with a packet loss of 7%, while the NTH method was 38%. Referring to the information set by ETSI-TIPON, the packet loss parameter with the PCC method can be considered good with an index value of 3. While the NTH method is considered bad with an index value of 1.

C. Jitter

The following are the results of testing the jitter parameters that have been carried out:

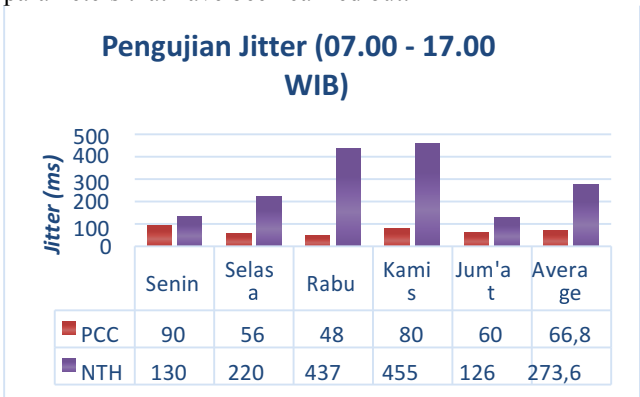

Figure 6. Jitter testing graph

Based on the results of the test, it can be seen that the jitter value with the PCC method is smaller than the NTH method.

From the above results, the authors take the average value that has been obtained from the jitter parameter. Then the results obtained are the PCC method with a jitter value of 66.8ms, while the NTH method is 273.6ms. Referring to the information set by ETSI-TIPHON, the jitter parameter with the PCC method can be considered good with an index value of 3. While the NTH method is considered bad with an index value of 1.

D. Delay

The following are the results of the delay parameter testing that has been carried out:

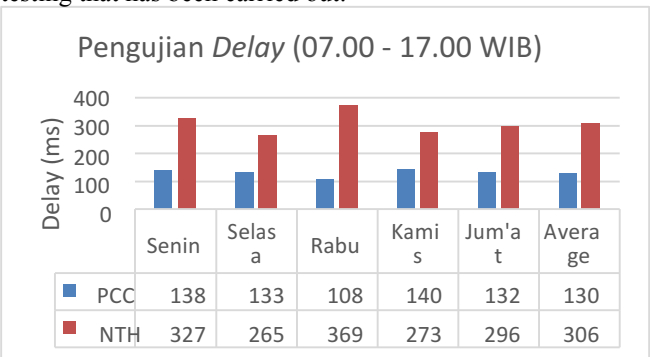

Figure 7. Delay testing graph

Based on the results of the tests that have been carried out, it can be seen that the delay value with the PCC method is smaller than the NTH method which is very high.

From the above data that has been obtained for the delay parameter, the author takes the average value of the delay parameter for each method. Then the results obtained are the PCC method with a delay value of 130ms, while the NTH method is 306ms.

Referring to the information set by ETSI-TIPHON, the delay parameter with the PCC method can be considered very good with an index value of 4. While the NTH method is considered moderate with an index value of 2.

E. FailOver

The following is a test of the failover scheme when in the condition that the first path is broken, then the second path will act as a backup. This failover uses the recursive gateway function, when the first path breaks with an interval of 10 seconds there is no gateway check response, it indicates that the path is experiencing interference, and then the second path will function as a backup.

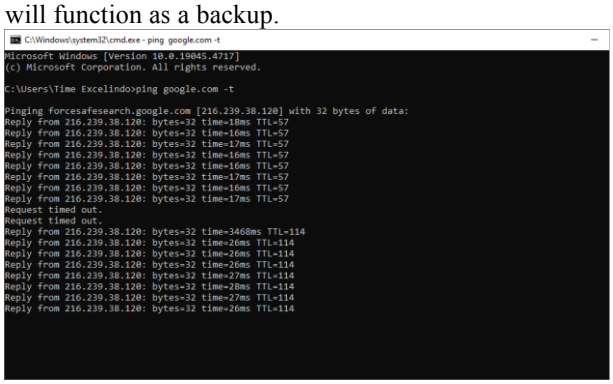

Figure 8. Failover testing

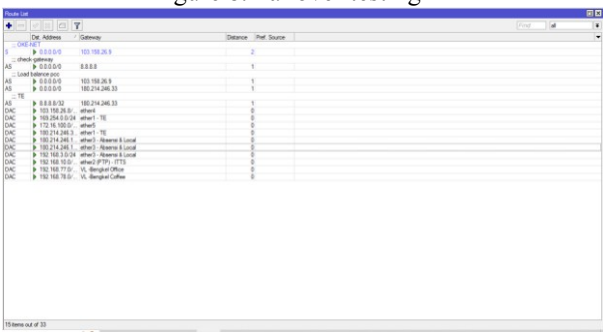

Figure 9. Routing scheme failover

Conclusions and Recommendations

Based on the research that has been done, it can be concluded that the throughput value using the PCC method of 93.72% is better than using the NTH method of 59.42%. For the packet loss value, the PCC method gets a smaller value of 7% while the NTH method gets a value of 28%. Then the jitter value using the PCC method gets a value of 66.8ms while the jitter value using NTH is 273.6ms. For the last result, the delay value when using the PCC method is 130ms, while the delay value when using the NTH method is 306ms. So from the load balance analysis that has been done, the PCC method can be applied as a solution to network connection problems at the CV. Adidaya Perkasa Teknologi office.

Suggestions for the development of future research are greater bandwidth capacity using dedicated services from ISPs and the convenience of dividing bandwidth evenly so that the application of load balance gets maximum results.

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