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LINK BACKUP BACKHAUL WITH MACHINE TO MACHINE (M2M) UTILIZING LTE / 4G NETWORKS USING MIKROTIK ROUTER

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ABSTRACT

Backhaul system, currently used in various companies to be able to communicate with several branch offices or remote with a secure network as in the goods delivery system for backhaul is the delivery of goods from the destination point to the origin point or to another distribution and backbone is the infrastructure for the main transportation network that connects distribution points. With this backup backhaul provides a solution to provide the right and fast solution if there is a main backhaul network provided by the internet service provider in the form of fiber optic or Metro E experiencing interference or damage that cannot be resolved in the near future and causes long downtime. . In its own work system Backup Backhaul uses LTE / 4G network using Machine to Machine using quantitative method because in the author's research, data retrieval was carried out where the data was collected and obtained results in the development of a backhaul backup system using Machine to Machine based on LTE / 4G using Mikrotik routers. The data used is data collected by the author on Tuesday 31 working days from 4G / LTE M2M backhaul both from conducting several tests and the resulting traffic results. With this backhaul backup, it can help reduce downtime due to the main backhaul link being broken due to physical damage that requires repairs that take time.

Keywords: *Backhaul; Backbone; Internet Service Provider; LTE, Machine To Machine; Mikrotik.*

INTRODUCTION

Backhaul is the main computer network infrastructure which refers to the main network in information technology so that it is formed like a pipeline that connects several networks into the actual main network, so that the backhaul consists of a core network intermediary which can be called the backbone and small subnetworks at the edge of the network. Backhaul is obliged to carry packets to the backbone network and from the backbone network so that backhaul becomes very important in the movement of data within the backbone. [1]

The need for backhaul links is currently often needed in large companies that really need communication media that is safe and not mixed with other internet networks. Because a secure backhaul system over time requires companies

to have direct links, this requires every company to create a link and have a backhaul link to connect network needs from one office to another, this backhauls itself can also provide filtration to the network as a whole. With the backhaul, link requirements and data entering and leaving the network system can be monitored and monitored controlled and centralized from the server computer.

Virtual Backhaul can now be used as an alternative to backhaul links which have a physical pipe form both via fiber optic cables and metro-e networks. Virtual backhaul is formed by pipes but does not have a physical form, meaning there is no disruption caused by physical network/link breaks like other backhauls which usually experience physical damage. Apart from having no physical form, virtual backhaul is also easy to apply, install, does not take time, and is easy to repair. For this virtual backhaul, you can take advantage of the GSM 4G / LTE signal in the area. [2] Apart from being easy to apply, virtual backhaul does not require downtime if interference occurs, this virtual backhaul link is also relatively cheaper than backhaul which has physical forms such as metro-e backhaul links and backhaul with fiber optic cables.

Mikrotik with a 4G / LTE network using the Machine to Machine method becomes a link that is easy to use by interconnecting the main network with other peripheral subnetwork networks so that backhaul can be formed. The purpose of backhaul with this method can be implemented and also applied with the help of existing 4G / LTE networks. utilized thoroughly to form a secure network that is safe and can be controlled remotely. As a function and use, this method is very affordable, cheap, high speed and also easy to repair and replace devices. With this, the efficiency of the network in the company can be fully maximized and the current needs regarding backhaul links can be resolved, considering that the backhaul network with fiber optic and also Metro-e is an annual contract and cannot be installed suddenly and also when experiencing physical disturbances such as cable cuts or other physical damage it needs to be repaired and also troubleshooted for a long time. Just like the fiber optic network which is used as a backhaul for GSM networks, now with this breakthrough and method it can be transferred as a GSM network using the Machine to Machine (M2M) method, it can be used as a backup backhaul network for fiber optic networks and also metro-e backhaul networks. [3]

RESEARCH METHOD

A. Type of Research

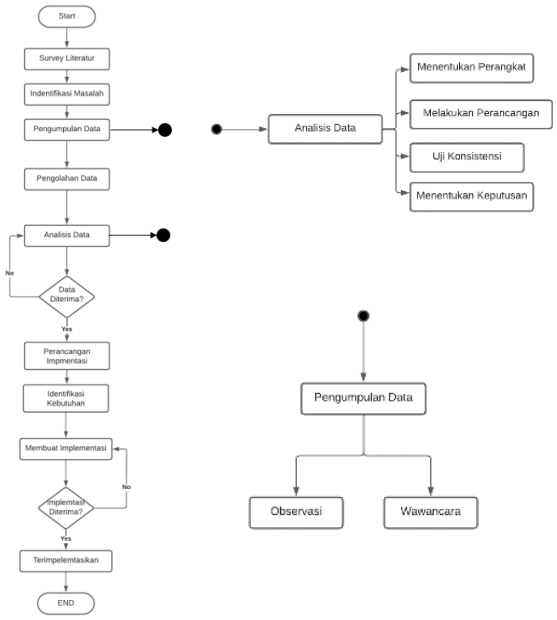
The type of research that the author uses here is a type of qualitative research where from the research raised by the author, the author will describe the use of tools that do not have data or data sets, but the author will carry out tests and look for related information from research sources raised by the author.

Qualitative research itself is a research process that has a general, flexible and dynamic nature, where the results of this qualitative research can develop during the research process and do not have a reference in the form of a collection of data. Colligative research refers to any research and research that is descriptive in nature which has a tendency to analyze and show more clearly the process of meaning, utilizes existing theory to be used as supporting material, refers to data and also produces a theory.

The author uses the qualitative method in this research because the author will carry out a test analysis of the devices used as research sources whose data sources are obtained by conducting tests, searching for information that is not based on a collection of data but from the sources that are researched and tested to obtain a theory. which will become the final goal of writing this research report.

B. Research Stages

In this research stage the author presents a flowchart of backhaul devices using a proxy router by utilizing a 4G / LTE-based cellular / GSM network using a Machine to Machine (M2M) system to be used as a backup backhaul,[4] which can be seen from the schematic below:



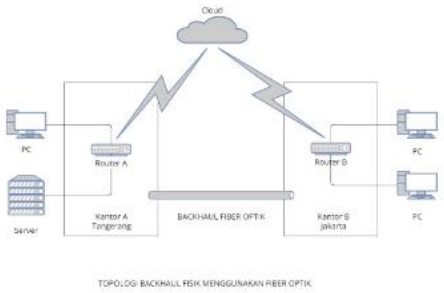
Figurer 1. Flowchart

Source: *private documentation*

This research was held to conduct research on the quality of backhaul which is currently needed to prevent downtime, so this research offers a backup link that can be used as a backup media for backhaul services. In previous research, as a reference from the author, it is a means to be able to develop ideas and also ideas for backhaul links, in which the author raises themes that have not been in previous journals.

C. Theoretical Basis

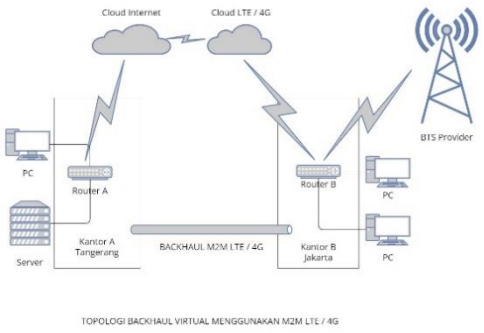
Fiber optic backhaul transmission media uses a technology arrangement that uses data transmission via glass fiber as a link between the Router Server device and the Router on the Client side, where this transmission media does not use signal amplification media or repeaters and to operate this optical fiber does not require electrical power. In the topology below, the connecting arrangement between office A and office B is depicted with a physical fiber optic cable where the cable is planted underground to connect point A to point B so that there are no other cable connections so that this backhaul network can reach its destination without there is interference from other networks on other internet networks.



Figurer 2. Backhaul Topology

Source: *private documentation*

The M2M (Machine to Machine) backhaul mode which can be used to connect office A and office B with a private network that does not have a physical meaning that it does not have fiber optic cable pulls or Metro E mode, but with M2M it offers backhaul in the form of a virtual network by utilizing GSM network waves on BTS Radio which will later be forwarded to Cloud Internet, what distinguishes this network is that M2M-based backhaul has a Virtual Private Network where this network can turn the wide network into a private network to send and receive networks simultaneously on the internet so that the computing network connected to one private network and not mixed and through the existing networks of GSM and Internet providers.



Figurer 3. M2M Backhaul Topology

Source: *private documentation*

In the course of the M2M (Machine to Machine) Based Backhaul Network, the authors use several tools to compile and conduct research related to Virtual Backhaul which is used as a backhaul backup in case of disruption to the main backhaul network including:

- Router VPN Server (On the ISP Server)

The use of the VPN Server Router itself is to organize and manage in and out routes for backhaul networks that will forward and manage edge networks to the central network.

Figurer 4. Router VPN Server

Source: *private documentation*

- Mikrotik hAp-AC-Lite Router

This router acts as a virtual Backhaul connecting medium from the VPN Server Router to the Client Router which will later be distributed or branched to the Office's internal network, so that the office can access the destination server via Backhaul with predetermined management from Server and Router Server management.

Figurer 5. Router M2M Backhaul

Source: *private documentation*

- GSM 4G Modem

In the virtual backhaul design, the GSM Modem is used to convert the existing network that is obtained from the network service provider and then connected to the Router device to be forwarded with the designed backhaul path.

Figurer 6. Modem GSM 4G

Source: *private documentation*

- Indosat Provider Card

This SIM card functions as a medium that is used to be able to access the network provided by the provider by exchanging data packets/quota with 4G network services which can be accessed via the near cable network.

Figurer 7. Sim card Indosat

Source: *private documentation*

- Lan cable

This lan cable serves to connect the laptop with the router to be able to communicate and consulate the router connected to the laptop.

Figurer 8. LAN Cable

Source: *private documentation*

- Winbox application

Winbox is the key to the success of changes and settings that exist in Router devices, in building backhaul Winbox is used in designing, monitoring and also viewing data from devices used, paths used, as well as interfaces and any devices that are connected to each other on the router Mikrotik.

Figurer 9. Winbox Application

Source: *private documentation*

RESULT AND DISCUSSION

A. Data Collection

In data collection, the authors collected data for 31 hours to obtain data from the appropriate results from the 4G / LTE-based M2M (Machine to Machine) Backhaul where this data is obtained collectively every day to see the results of the test, things collected include[5] :

- Ping Test Results
- Signal Bars
- Bandwidth Test
- LTE interface 1
- Traffic Bridge and Traffic L2TP-Out

B. Data Acquisition

From the attributes used in data collection, data obtained from research results and backhaul testing based on M2M (Machine to Machine) by utilizing the 4G / LTE network were obtained manually by the author in monitoring for 31 working days to determine and obtain results from research on virtual backhaul backups. The following data acquisition obtained by the author is divided into 4 (four) weeks:

Table 1. Result of 30 Days Monitoring

No	Hari Ke	Tes Ping 100x	Signal Bar	Bandwidth Test		Perangkat	Interface LTE 1		Traffic Bridge	Traffic L2TP-Out
		0-100%	(1- 5)	Up (Mb)	Down (Mb)	Terhubung	Tx (kb)	Rx (kb)	Mb	Mb
1	1	98%	1	26,9	1,7	2	264	68	0	4,09
2	2	100%	3	29,6	3,2	1	29	48	0,2	9
3	3	91%	1	15,9	7,7	1	72	1002	0,3	0,043
4	4	76%	2	8,6	0,91	1	169	2200	2,38	9,72
5	5	100%	2	16,4	3	1	203	2400	2,49	0,835
6	6	99%	1	18,9	0,73	1	372	4600	0,051	0,015
7	7	97%	1	0,23	3	1	231	2700	3,25	0,349
8	8	100%	3	23	4,1	1	192	2700	4,32	0,349
9	9	99%	3	18,9	0,49	1	51	36	3,12	3,97
10	10	99%	2	35,8	16,7	3	336	4000	4,89	1,83
11	11	98%	2	32,9	0,696	3	137	274	4,3	1,4
12	12	96%	1	32,4	14,8	4	7,7	20	2,8	2,57
13	13	100%	1	28,2	7,6	4	67	67	3	1,57
14	14	100%	3	37,9	16,6	4	7	5,3	4,8	2,5
15	15	100%	1	34,1	18,7	4	106	59	4,7	2,52
16	16	100%	1	25,1	5,5	3	387	284	2,14	2,1
17	17	100%	3	29,1	29,4	4	12	10	8,18	5,73
18	18	100%	1	34,4	11,8	2	25000	3800	4,9	1,9
19	19	100%	1	27,8	3,8	3	41	29	4,82	2,6
20	20	99%	2	32,2	6,1	4	217	112	3,07	1,27
21	21	100%	2	13	14,6	4	26	104	3,14	0,656
22	22	100%	3	25,7	19,5	4	88,9	575	4,8	1,32
23	23	100%	3	14,2	21,6	6	27,1	20,4	8,17	1,22
24	24	100%	1	35,9	17,6	1	2,1	1,7	4,89	2,7
25	25	100%	2	34,5	25,9	3	37,9	52,7	4	2,56
26	26	98%	1	31,7	13,4	4	92	22	4,91	2,72
27	27	100%	3	31,4	2,8	2	438000	1053	4,88	2,68
28	28	100%	3	33,3	19,3	4	114	377	4,7	2,78
29	29	96%	1	36,2	12,1	4	7,6	6,4	4,6	2,55
30	30	100%	2	32,4	21,7	3	20	1650	4,84	1,42
31	31	100%	2	34,1	17,4	3	84	17,8	4,48	0,52

Source: *private documentation*

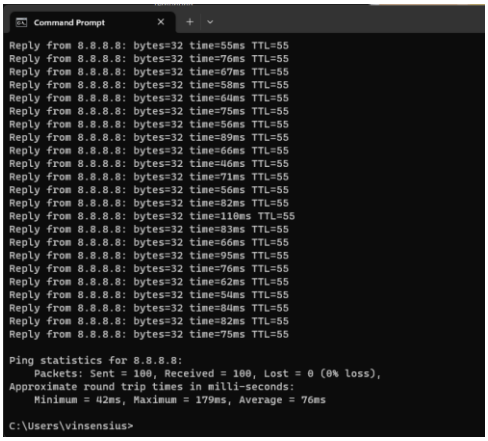
C. Comparison of Method Results

- Ping Results

The Ping command itself has a category in which this category indicates whether the quality of the monitored link is smooth and normal, in this case it can be seen from the existing lost packets where this lost packet is a failure of IP transmission to reach its destination, in achieving this transmission goal it can influenced by several things including [6]:

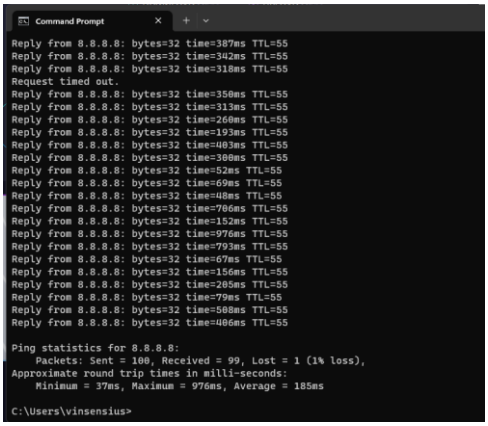
- There is an overload on a traffic network.
- There is a crash or collision problem where this happens in the existing network.
- Damage that occurs to physical media such as existing links, whether based on FO, Radio, or VSAT.

$$Paket\ Loss = \frac{(\ Paket\ data\ Dikiri - Paket\ data\ Diterima\ )x\ 100\%}{Paket\ Data\ yang\ dikirim}$$



Figurer 10. Ping DNS Google with backhaul

Source: *private documentation*



Figurer 11. Ping DNS Google without backhaul

Source: *private documentation*

By standardizing the implementation on this network, there are four categories that become a reference for network performance based on the value of packet loss performed in the Ping command. The following table shows the package loss categories:

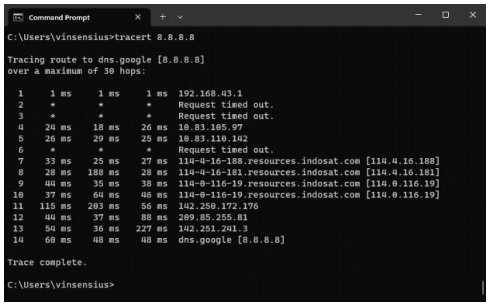
Table 2. Loss Ping Package Category

Kategori Paket Loss	Paket Loss (%)	Indeks
Sangat Bagus	0	4
Bagus	3	3
Sedang	15	2
Buruk	25	1

Source: *private documentation*

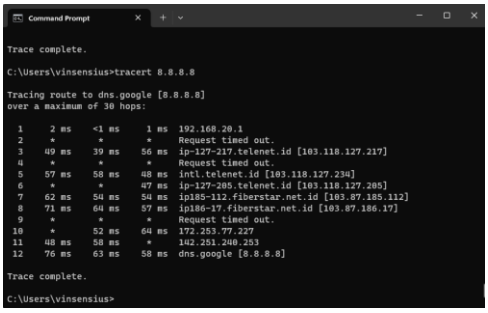
- Tracert

The backhaul network will pass through the addresses provided by the backhaul provider to reach the destination IP server with restrictions and access provided from the backhaul / server provider, while for networks using the internet from GSM / GSM-based Wifi this will use the public address provided by the backhaul provider. use by GSM service providers / providers to be able to reach certain IPs. The following tracert uses a GSM-based Wifi network and M2M backhaul-based Wifi:



Figurer 12. Tracert Wifi with GSM Network

Source: *private documentation*



Figurer 13. Tracert with Backhaul M2M

Source: *private documentation*

From the two photos above, you can see a clear comparison and difference between backhaul lines and provider-based lines where the backhaul lines use several public IP lines from backhaul service providers while networks that use GSM provider-based services pass private IP lines provided by the provider. to reach the Google server which is the final destination.

- Latencies

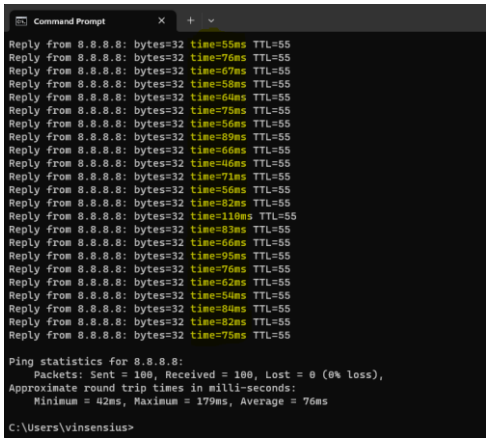
Latency is the delay or length of time needed in sending data packets from the sending side (client) to the receiving side (server) and vice versa, in this case if there is low latency you can be sure there is only a slight delay in the data transfer process so that data transmission is faster, while high latency indicates a longer delay and slower data transmission. In viewing this latency, it can also be seen when pinging the IP Server or Google's DNS IP address as the main destination. In the picture below the latency which

is the time delay is given a yellow mark where the time delay in each data transmission has a different latency. To ensure the latency category using the GSM network, namely 4G / LTE, it can be seen from the following table:

Table 3. Latency Category

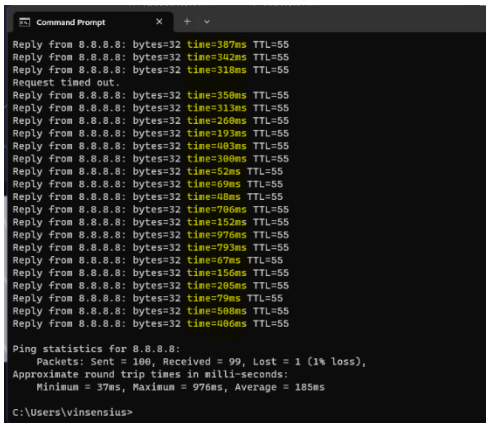
Kategori Delay	Besar Delay (ms)	Indeks
Sangat Bagus	<150	4
Bagus	150 – 300	3
Sedang	300 – 450	2
Buruk	>450	1

Source: *private documentation*



Figurer 14. Latency Backhaul

Source: *private documentation*



Figurer 15. Latency Without Backhaul

Source: *private documentation*

Latency calculation equation:

$$Latency = \frac{Average\ Time\ Send\ Packet}{n}$$

- Analysis

Analysis of the implementation of Backhaul Machine to Machine (M2M) by utilizing the LTE / 4G network as a backup backhaul for network service providers is carried out based on research and also measurements using existing data in the field, especially in the Karawaci area, Tangerang, Banten in the work area of PT TeleNet. This research was conducted by observing the parameters of the Mikrotik Router as an LTE / 4G-based backhaul and also measuring bandwidth and link quality using bandwidth, generated traffic, signal quality, ping quality, latency, and also the path used to achieve the goal, namely to connect networks. client with server network with a secure link and can be monitored from anywhere.

To determine whether the quality of the link is suitable for use or not as a backhaul network, it can be calculated from the average usage and also the quality of the link in a full month of use with the actual conditions in the field, including signal quality, results from bandwidth tests, ping results, then traffic. which is obtained in one full month. The following is the average

obtained from the study and also one month's measurement:

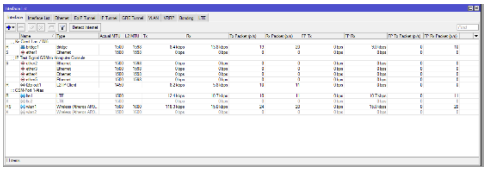
Table 4. Latency Category

	Ping	Signal GSM (Bar)	Bandwidth Up (Mb)	Bandwidth Down (Mb)	Perangkat terhubung	Int Tx Lte (kb)	Int Rx Lte (kb)	Traffic Bridge (Mb)	Traffic L2TP-Out (Mb)
Rata-rata	98%	2	29,49	14,34	3	36714,58	722,19	4,52	2,37
Nilai Tinggi	100%	3	37,90	29,40	6	438000,00	4600,00	8,18	9,72
Nilai Kecil	76%	1	0,23	0,49	1	2,10	1,70	0,00	0,02

Source: *private documentation*

From the data table, the average result from monitoring and research for one month is getting a decent average result for this M2M link to become a backup backhaul link if the main backhaul service is interrupted with ping results reaching 98%, bandwidth up/down 29.49 Mb / 14.34 Mb, with daily traffic in the bridge of 4.52 Mb and Traffic on L2TP-Out of 2.37 Mb which values are values that can be categorized as very good, this is seen from research and monitoring as well as several sources that become reference in obtaining value for application in Machine to Machine (M2M) based Backhaul backup links utilizing the GSM LTE / 4G network. Thus this backhaul can provide a solution for Internet Service Providers (ISPs) in providing a solution if there is damage to the backhaul link based on Fiber Optic, Metro-E and others can be backed up using the Backhaul Network based on GSM LTE / 4G.

The following is the result of the analysis that is seen and monitored from the existing interface on Mikrotik:

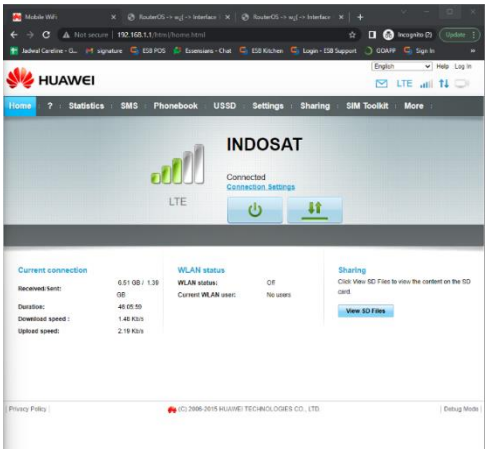


Figurer 16. Interface Backhaul Mikrotik

Source: *private documentation*

From the results of monitoring the interface above, you can see live traffic and also running data, as well as what interfaces are running and working on the proxy router, including from the bridge that leads to the client device, then l2tp-out as a VPN to the router server, as well as lte1 as monitoring towards the GSM LTE / 4G modem.

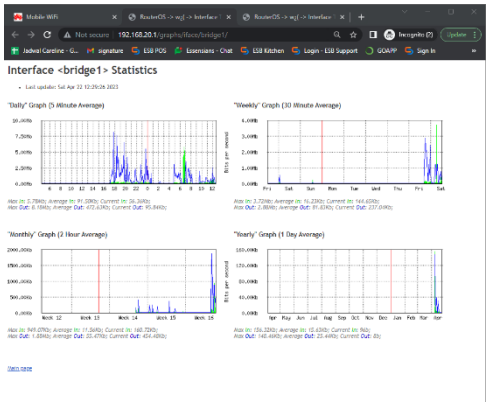
The following is the result of the analysis that is seen and monitored from the signal captured by the GSM LTE / 4G modem which is then used as an incoming network or in interface on the Mikrotik router to serve as a link on this GSM-based backhaul:



Figurer 17. Signal GSM Analysis

Source: *private documentation*

The following are the results of the analysis that is seen and monitored from the traffic generated on a daily, weekly, monthly and yearly basis from the Bridge and L2TP-Out interfaces:



Figurer 18. Traffic Bridge Analysis

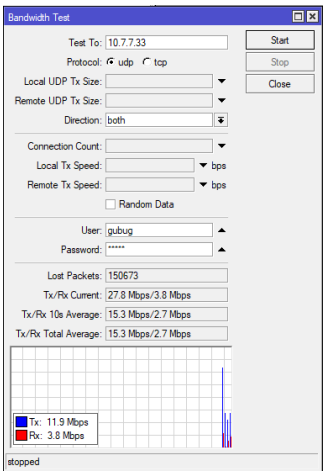
Source: *private documentation*

Figurer 19. Traffic L2TP-Out Analysis

Source: *private documentation*

From the results of monitoring traffic that occurs in the Bridge interface, it can be seen that the use of backhaul links that occur on user/client devices from backhaul links from mobile devices, laptops, or computers, and in the l2tp-out interface, traffic data that occurs is recorded daily, weekly , monthly and yearly of this traffic indicates that there is a GSM LTE / 4G-based M2M backhaul performance that occurs in the VPN interconnection between the client proxy router and towards the server router.

The following is the result of the analysis that is seen and monitored from the results of the bandwidth test where this bandwidth is not a reference for speed but how much speed can be generated from backhaul with GSM LTE / 4G providers with this you can see the standard speed produced in one period bandwidth test, here are the results of one of the bandwidth tests on the GMM LTE / 4G-based M2M backhaul link and Speed Test using a regular GSM network :



Figurer 20. Bandwidth Test Analysis

Source: *private documentation*

Figurer 21. Bandwidth Test GSM Network Analysis

Source: *private documentation*

The following is a comparison table after and before using Machine to Machine backhaul backups utilizing the GSM LTE / 4G network using a Mikrotik Router:

Table 5. Comparison of M2M and GSM Backhaul

Jaringan yang ditunakan	Ping	Latency	Tracert	Bandwidth Test	
				RX	TX
Backhaul	100%	76ms	12 Hope	11,9Mb	3,8Mb
Tanpa Backhaul	99%	185ms	14 Hope	1,17Mb	4,17Mb

Source: *private documentation*

CONCLUSION

After conducting analysis and research on the implementation of Backup Backhaul With Machine to Machine (M2M) Utilizing the LTE / 4G Network Using a Mikrotik Router which was monitored for one full month, it can be concluded that Backup Backhaul using M2M with 4G / LTE Network connection able to use when main backhaul has fail to connection and with backup backhaul can to reduce downtime.

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