Fuzzy Logic Method as Determining of Internet Network
VSAT performance in Black Spot Region at District of Enrekang

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Abstract. Internet networks using VSAT have some disadvantages caused by the relative
distance of the satellite and the earth which is a significant propagation delay. To determine
the optimal quality of VSAT internet network, a study of VSAT internet network performance
was performed using Fuzzy Logic method, based on the parameters of bandwidth, delay, packet loss,
and throughput conducted for 2 days in the morning, afternoon and night in 2 villages in
Enrekang Regency, namely Singki Village and Tindalun Village. Retrieval of data parameters at
these locations using a wireshark application software which is then inputted into fuzzy logic so
as to produce three categories of performance, good or sufficient, and bad network quality. It is
said that performance is good if the results on fuzzy logic are 0, sufficient performance
compilation of results from fuzzy logic is 0.5 and performance is poor if the results of fuzzy logic
are valued 1. The VSAT internet network requests optimal compilation parameters of network
quality such as 6 mbps bandwidth, delays below 1,000 ms, packet loss less than 50% and
throughput above 50 kbps which has been designed in fuzzy logic. From the results of the study,
obtained a value for the village of Tindalun 0.5 which means enough. Whereas, for performance
in Singki Village, 2 different values were obtained, while compilation using Wifi was valued at
0.5, which was sufficient, and compilation using WireLAN was 0 which meant good.

1. Introduction
VSAT technology has several weaknesses due to the relative distance of the satellite and the earth
resulting in significant propagation delay and the ability of satellites to send and receive data vulnerable
to weather disturbances [1]. To find out the quality of the VSAT network, a study of VSAT internet
network performance must be carried out in the blank spot area Enrekang Regency with the altitude and
valley topography, until now has many problems related to telecommunications networks, even from 12
existing districts, in almost all districts there are several villages with blank spots or no signal. VSAT
internet network performance in the blank spot area emphasizes the process of monitoring and
calculating network quality parameters, in this case the parameters used to determine the performance
of the VSAT internet network are bandwidth, delay, packet loss and VSAT network throughput.

2. Literature Review
Very Small Aperture Terminal is a satellite signal receiving station with a dish antenna receiving a
diameter of less than three meters [2]. The main function of VSAT is to receive and send data to satellites.
The satellite functions as a successor to the signal to be sent to other points on earth [3]. Actually the
VSAT dish faces a geostationary satellite. Geostationary satellites are satellites that are always in the
same place in line with the rotation of the earth on its axis which is possible because it orbits at the same point above the earth's surface and follows the earth's rotation on its axis. VSAT (Very Small Aperture Terminal), originally a trademark for small earth stations that was marketed around 1980 by Telecom General in America. In its free translation, VSAT can be interpreted as a transmitter and receiver of satellite transmission terminals that are scattered in many locations and are connected to the central hub via satellites using certain diameter satellite dishes [3].

2.1. Bandwidth
Bandwidth is the width or width of the frequency range used by the signal in the transmission medium. in computer networks, bandwidth is often used as a synonym for data transfer speed (transfer rate), which is the amount of data that can be carried from one point to another within a certain period of time (generally in seconds). This type of bandwidth is usually measured in bps (bits per second). Sometimes also stated in Bps (bytes per second) [4].

2.2. Delay
Delay time of a packet caused by the process of transmission from one point to another destination. These points can be computer devices, or other network devices such as routers, modems and so on which are passed by information packets. One Way Delay (OWD) is the time taken by a package from the source to the destination. The time from source to destination returns to the source is called Round Trip Time (RTT). The type of delay measured on the VSAT network are (1) Propagation delay is the time required by the information signal to move in communication media such as cable, optical fiber, microwaves and satellites, (2) Transmission delay is the time needed for a system to pass a number of data packets, and (3) Queue delay is the length of time it takes for a data packet before the packet is forwarded to its destination. ITU-T (International Telecommunication Union - Telecommunication) version of the standard delay value as follows [2].

| No | Latency Category | Delay       |
|----|-----------------|-------------|
| 1  | Good            | <150 ms     |
| 2  | Enough          | 150 s/d 400 ms |
| 3  | Bad             | >400 ms     |

2.3. Packet Loss
Packet Loss is defined as the failure of data packet transmission to reach its destination. The failure of the package to reach its destination, can be caused by several possibilities, including occurrence of traffic overload in the network, collision (congestion) in the network, errors that occur on physical media and failures that occur at the receiving end can be caused, among others, due to overflow that occurs in the buffer. In network implementation, the packet loss value is expected to have a minimum value. In general, based on packet loss values according to the ITU-T version there are three categories of network quality degradation based on the standard packet loss values as follows.

| No | Degradation Category | Delay |
|----|----------------------|-------|
| 1  | Good                 | 3 %   |
| 2  | Enough               | 15 %  |
| 3  | Bad                  | 25    |
2.4. Throughput
Throughput is a measure of the speed at which data can be sent across the network in bits per second (bps). The capability of throughput in sustaining hardware (hardware) is called bandwidth. In fact, the term bandwidth is sometimes used as a synonym of throughput. In determining the quality of data communication networks, especially internet networks, there are two important things, namely the amount of delay and speed of a data packet to pass through a network, and the adequacy of available network bandwidth.

2.5. Fuzzy Logic
In many cases, fuzzy logic is used as a way to map the problem from the input to the expected output. Fuzzy logic can be considered as a black box (black box) that connects the input space to the output space. Fuzzy set has two attributes, namely linguistic and numerical. Linguistic attribute is an attribute used for naming a group that represents a certain state or condition by using natural language, such as young, middle age, old age. While the numerical attribute is a value that indicates the size of a variable. There are several things that need to be known in understanding fuzzy systems such as fuzzy variables are variables discussed in a fuzzy system, fuzzy set is a group that represents a certain condition or condition in a fuzzy variable and entire universe is the total value that is allowed to be operated.

3. Research Method
At the data collection stage, a system study is carried out by conducting a literature study by reading and studying books, journals or articles related to the VSAT internet network, VSAT internet network performance and Fuzzy logic, besides observing directly to the field, namely the blank spot area in Enrekang district, precisely in Singki Village and Tindalun Village.

![Flowchart of the fuzzy logic method to determine internet VSAT network quality](image)

**Figure 1.** Flowchart of the fuzzy logic method to determine internet VSAT network quality
The material used in this study is the Windows 10 Pro operating system, Matlab 2016a [5] and Wireshark. Fuzzy logic is used as a way to determine the problems of input (VSAT network performance) namely bandwidth, packet loss, delay and output to output. The application of VSAT internet network based on fuzzy logic to determine antenna position in the field. The optimal performance of VSAT internet network is said to be optimal if it is in accordance with the performance standards of the VSAT internet network itself, which is a delay of <150ms and a packet loss of 3%. Figure 1 shows the flowchart of the fuzzy logic method system used in this research.

4. Result and Discussion
At the data collection stage, a system study is carried out by conducting a literature study by reading and studying books, journals or articles related to the VSAT internet network, VSAT internet network performance and Fuzzy logic, besides observing directly to the field, namely the blank spot area in Enrekang district, precisely in Singki Village and Tindalun Village. The data obtained using the wireshark application in the two villages shows in Table 3.

Table 3. Data Collection results from Singki village and Tindalun village

| Location     | Parameter            | Youtube | Gmail |
|--------------|----------------------|---------|-------|
|              |                      | Morning | Afternoon | Night | Morning | Afternoon | Night |
| Tindalun Wifi| Bandwidth (Mb)       | 6       | 6       | 6     | 6       | 6         | 6     |
|              | Delay (m/s)          | 15874   | 5260    | 26680 | 6898    | 6840      | 53845 |
|              | Packet Loss (%)      | 0       | 0       | 0     | 0       | 0         | 0     |
|              | Throughput (Kbps)    | 124 k   | 310 k   | 120 k | 641 k   | 645 k     | 14 k  |
| Tindalun Lan | Bandwidth (Mb)       | 6       | 6       | 6     | 6       | 6         | 6     |
|              | Delay (m/s)          | 17023   | 10200   | 16229 | 24402   | 80910     | 60507 |
|              | Packet Loss (%)      | 0       | 0       | 0     | 0       | 0         | 0     |
|              | Throughput (Kbps)    | 347 k   | 967 k   | 484 k | 185 k   | 20 k      | 71 k  |
| Singki Lan   | Bandwidth (Mb)       | 6       | 6       | 6     | 6       | 6         | 6     |
|              | Delay (m/s)          | 13488   | 11923   | 17381 | 15596   | 14165     | 16199 |
|              | Packet Loss (%)      | 0       | 0       | 0     | 0       | 0         | 0     |
|              | Throughput (Kbps)    | 1124 k  | 194 k   | 214 k | 832 k   | 619 k     | 507 k |
| Singki Wifi  | Bandwidth (Mb)       | 6       | 6       | 6     | 6       | 6         | 6     |
|              | Delay (m/s)          | 5247    | 9796    | 3404  | 5619    | 6266      | 5800  |
|              | Packet Loss (%)      | 0       | 0       | 0     | 0       | 0         | 0     |

Based on data from the test results in Singki Village, angeraja sub-districts using either WiFi or LAn networks, the parameters obtained are bandwidth, delay, packet loss and throughput. The test results are entered into fuzzy logic which will determine whether the quality of the VSAT internet network in the area is in bad, moderate or good condition according to the parameters defined earlier. Table 4 shows the data of the parameter testing results using WiFi and LAN in Singki village.

Table 4. Testing parameters using WiFi and LAM connections

| Parameter | Youtube | Gmail |
|-----------|---------|-------|
|           | WiFi    | LAN   | WiFi  | LAN  |
| Bandwidth | 6.13    | 6.13  | 6.13  | 6.13 |
| Delay     | 676.614 | 98981.79133 | 46126001.7 | 227880.1 |
| Packet Loss | 84%    | 96%   | 60%   | 0.3% |
| Throughput | 16.0   | 12.1  | 6.3   | 26   |
The fuzzy logic display used for the four parameters of VSAT internet network quality is shown in Figure 2.

Figure 2. VSAT internet network quality data input of fuzzy logic

Parameters that indicate the quality of the VSAt internet network in the village of Singki will be a measure of the merits of the existing network in the area. If poor quality is obtained, then the antenna position is moved to obtain a good network quality. The parameters of bandwidth, delay, packet loss and throughput are shown in Figure 3.

Figure 3. Plot result of bandwidth, delay, packet loss and throughput using WiFi connection
Figure 4. Output performance in fuzzy logic using a wifi connection in the village of Singki

The final result that will be obtained from the fuzzy logic application in this study is to provide convenience in determining optimal performance on a VSAT internet network. Determination of the optimal parameters is shown in the Figure 5.

Figure 5. Fuzzy logic performance results

From the results of inputting data in the field which has been processed by Fuzzy Logic where there are differences in the results of network performance, namely in Desa Tindalun using WireLAN (youtube) which gets 0.5 results, which is sufficient. Whereas, in Singki Village using WireLAN (youtube) got 0 which means good. This proves that in Singki Village the quality of the VSAT internet network is more optimal by using the same connection (WireLan) and running the youtube website.

5. Conclusion
The delay on the VSAT internet network is indeed quite high, because it uses satellite transmission within 36000 km from the earth. So the process of sending and receiving data takes quite a long time. From the observations on fuzzy logic there are three categories of performance or network quality, namely good, sufficient, and bad. It is said that the performance is good if the result of fuzzy logic is 0, while the performance is sufficient when the result of fuzzy logic is 0.5 and the performance is bad if the result of fuzzy logic is 1. Optimal performance is obtained when the user uses WireLAN.
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