Analysis Of 4G Internet Technology Quality In Medan City With Mobile Communication System

Mufria J Purba 1,3, Samuel Manurung 2
1 Department of Manajemen Informatika, Universitas Methodist Indonesia, Medan, Indonesia
2 Department of Teknik Informatika, Universitas Methodist Indonesia, Medan, Indonesia
3 jonatan.purba@gmail.com

Abstract. LTE technology is an internet network signal technology that is capable of producing a data rate of 100 Mbps. With the existence of 4G network technology, users can download or upload data with high capacity. But with this ability if done simultaneously by many users, it will cause high interference that can reduce network quality. Some factors that can determine network quality are the lower packet loss, the low delay and high throughput value. The purpose of this study was to observe the quality of internet networks with 4G network signals in densely populated or densely populated areas in Medan City. The method used in this study is the drive test method conducted by researchers and choosing one of the telecommunications providers in Indonesia, then the measurement results will be compared with the calculation in theory. With the existence of this research is expected to be able to provide a concrete picture of the quality of the 4G network in the city of Medan.

1. Introduction
The need for people to access the internet is getting higher and higher. Almost every time the community, both in the village and in the city, uses the internet in every activity. In all aspects of life, people use the internet like aspects of education, aspects of the business world, and what has recently become popular is the aspect of online transportation.
Along with the increasing need for the internet in the community, internet service providers or providers try to provide the best service for their customers. Providers always innovate and be creative in providing services to their customers, one of the services provided by the provider that is, improving network signal quality.
In the research that will be conducted, researchers will analyze how the quality of the 4G network in Medan city from the Throughput, Delay and Packet Loss sides. There are several things that can affect the quality of the network, including the number of users and also the distance of the server to the user.

1.1. Problems
LTE technology is an internet network signal technology that is capable of producing a data rate of 100 Mbps. With the existence of 4G network technology, users can download or upload data with
high capacity. But with this ability if done simultaneously by many users, it will cause high interference that can reduce network quality. The amount of interference will cause an increase in delay and packet loss, and reduce the throughput value. The high value of delay and packet loss and the low throughput value will result in low network quality.

1.2. Limitation of Problems
There are several things that need to be limited so that this research can be carried out according to plan. The problems that will be discussed in this study are:

1. Providers that will be analyzed are Telkomsel, XL, Axis, IM3, Smartfren, Three that are developing in the city of Medan
2. In the research will be carried out the calculation of the quality of the 4G network by observing the process of downloading and uploading data with the method of mobile communication system.
3. The location of the study was conducted at several points in the city of Medan

1.3. Research Objectives
The aim of this research is to analyze the quality of the 4G network in the city of Medan by calculating the value of delay, packet loss and throughput value. By calculating the value of the three parameters, the quality of the 4G network can be calculated.

2. Literature Review

2.1 Long Term Evolution Technology
Long Term Evolution (LTE) is a development of the previous network of 3G networks. LTE is capable of producing a data rate of 100 Mbps. On the other hand, the target of the 4G network is that the connection reaches 100 Mbps with a high level of mobility. The structure of the LTE network is in the form of an IP network where all connections will run when using an IP protocol.

![Figure 1 Structure of an LTE network](source: Fujitsu, 2009)

Another LTE capability is to operate the Multimedia Broadcast Multicast Service (MBMS) feature, which is comparable to DYB-H and WiMAX. Aryanta (2012).
2.2 Throughput
Throughput is a parameter that is used to determine the bandwidth that is actually received by the client or the amount of data received in good condition to the total transmission time required from the source to the receiver. (Priyambudi & Henri, 2013).

\[ \text{Best download time} = \frac{\text{file size}}{\text{bandwidth}} \]  
\[ \text{typical download time} = \frac{\text{file size}}{\text{throughput}} \]

Throughput is a parameter that is used to determine the amount of data received in good condition that is transmitted from the data source to the receiver (Schwartz, & Mischa, 1987).

\[ \gamma = \frac{1}{t_v} = \frac{(1 - \rho_{tot})}{t_1[1 + (\alpha - 1)\rho_{tot}]} \]

Dimana:
\[ \gamma = \text{throughput} \left( \frac{\text{packet}}{s} \right) \]
\[ t_v = \text{Average Transmission time to send the correct package (s)} \]
\[ t_1 = \text{time to transmit a data packet or frame (s)} \]
\[ \rho_{tot} = \text{to packet loss probability} \]
\[ \alpha = \text{comparison constants} \]

The results of the throughput calculation are then divided by the speed offered by the operator and dictated by 100% to find out the percentage of the actual throughput value that the customer gets when compared to the speed offered. The percentage throughput value is formulated in the following equation:

\[ \gamma(\%) = \frac{\gamma}{C_{UE}} \times 100\% \]

Where
\[ \gamma = \text{Throughput} \]
\[ C_{UE} = \text{Speed offered by the operator} \]

Throughput analysis is performed to determine the amount of data received in good condition that is transmitted from the data source to the recipient. After calculating, the author will calculate the percentage of the actual throughput value obtained. Thus the author can analyze the quality of throughput using the TIPHON standard as in table 1

| Quality Category | Throughput (%) | Index |
|------------------|----------------|-------|
| Very Good        | 75 < \gamma \leq 100 | 4     |
| Good             | 50 < \gamma \leq 75  | 3     |
| Medium           | 25 \leq \gamma \leq 50 | 2     |
| Bad              | \gamma > 25          | 1     |
2.3 Packet Loss
Packet Loss is a parameter that shows the number of packages lost or not reaching the destination when sending data from source to destination. (ITU-T. 2001). The smaller the value of Packet Loss in a network, the better the performance of the network.

| Quality Category | Packet Loss (%) | Index |
|------------------|-----------------|-------|
| Very Good        | $0 \leq \rho < 3$ | 4     |
| Good             | $3 \leq \rho < 15$ | 3     |
| Medium           | $15 \leq \rho \leq 25$ | 2     |
| Bad              | $\rho > 25$      | 1     |

2.4 Value of Quality of Service
After analyzing the parameters of Quality of Service (QoS), the next step to be taken by the author is to calculate the Quality of Service (QoS) value, based on the quality of each parameter. The steps to be taken to calculate QoS is by adding up all the index values of each QoS parameter, then dividing the sum of the sums. Thus the quality analysis based on QoS from a network can be done using the TIPHON standard. The intended standard can be seen in table 3

| Index      | Percentage (%) | value       |
|------------|----------------|-------------|
| Very Good  | 95-100         | $QoS > 3,8$ |
| Good       | 75-94,75       | $3 \leq QoS \leq 3,79$ |
| Medium     | 50-74,75       | $2 \leq QoS \leq 2,99$ |
| Bad        | 25-49,75       | $1 \leq QoS < 2$ |

2.5 Signal Quality
Signal is an internet packet data system network which is one of various kinds of cellphone signals and their speed. Signal strength does not always correlate with operator service performance. Full signal is not necessarily smooth to use on telephone and internet.

| No | Range          | Status          |
|----|----------------|-----------------|
| 1  | -98 to - 113 dBm | Excellent (green) |
| 2  | -70 to – 97 dBm | Good (Green)    |
| 3  | - 50 to – 69 dBm | Fair (Yellow)   |
| 4  | >=50 dBm        | Poor (Red)      |
3. Discussion And Result

Dynamic IP for smartphones used to access the internet, and the IP address used to conduct experiments is 104.19.195.29 (www.mediafire.com). While the data processed in this study is a file with the name Burju Marnatoras.mp3 with a file size of 7.003 KiloByte (KB) or 57368576 bits. The package will be uploaded and downloaded in each trial.

This research was conducted for 24 (twenty four days) for all providers. The division of research time for each provider is presented in table 5.

| No. | Provider Name | Location per Day | Status |
|-----|---------------|------------------|--------|
| 1   | Telkomsel     | Terminal Amplas – Simpang Pos | USU-Stasiun Kreta Api |
|     |               | Simpang Pos – RS. Adam Malik |        |
| 2   | XL            | Terminal Amplas – Simpang Pos | USU-Stasiun Kreta Api |
|     |               | Simpang Pos – RS. Adam Malik |        |
| 3   | Axis          | Terminal Amplas – Simpang Pos | USU-Stasiun Kreta Api |
|     |               | Simpang Pos – RS. Adam Malik |        |
| 4   | IM3           | Terminal Amplas – Simpang Pos | USU-Stasiun Kreta Api |
|     |               | Simpang Pos – RS. Adam Malik |        |
| 5   | Smartfren     | Terminal Amplas – Simpang Pos | USU-Stasiun Kreta Api |
|     |               | Simpang Pos – RS. Adam Malik |        |
| 6   | Three (3)     | Terminal Amplas – Simpang Pos | USU-Stasiun Kreta Api |
|     |               | Simpang Pos – RS. Adam Malik |        |

3.1. Signal Observation Results
After testing for 24 days, the researcher gets the results of signal strength data, where when the process is carried out when the vehicle is running then recording the signal strength of each provider. For example when testing the signal quality from the sandpaper terminal to the postal intersection the lowest signal is -73 dBm and the highest is -137 dBm. Signal data obtained from the measurement results are:

| No | Provider | Lokasi | Range | Status |
|----|----------|--------|-------|--------|
| 1  | Telkomsel | Terminal Amplas – Simpang Pos | -70 -105 -87.5 | Good |
|    |          | Simpang Pos – RS. Adam Malik | -83 -91 -87 | Good |
|    |          | RS. Adam Malik - USU | -55 -96 -75.5 | Good |
|    |          | USU-Stasiun Kreta Api | -80 -85 -82.5 | Good |
| 2  | XL       | Terminal Amplas – Simpang Pos | -68 -114 -91 | Good |
Based on table 6 it can be seen that using the Telkomsel provider the lowest signal occurs in the hospital. Adam Malik - USU with the lowest signal average of -75.5 dBm and the highest signal in Amplas Terminal - Simpang Pos - average - 82.5 dBm. Using the lowest XL signal provider occurs at the Post - RS intersection. Adam Malik with the lowest signal average of -83.5 dBm and the highest signal at Adam Malik Hospital - USU with the highest signal average of -96 dBm. Using the lowest Axis signal provider occurs at Simpang Pos - Adam Malik Hospital with the lowest signal average of -73 dBm, and the highest signal in Amplas Terminal - the intersection with the highest signal - average of -81.5 dBm. Using the lowest signal IM3 provider occurred at Adam Malik Hospital - USU with the lowest signal average of -87.5 dBm and the highest signal at Simpang Pos - Adam Malik Hospital with the highest signal average - 99.5 dBm. Using the Smartfren provider the lowest signal occurred at the Ampals Terminal - Simapng post with the lowest signal average of -86.5 dBm and the highest signal at USU - Railway Station with the highest signal average - 99.5 dBm. Using the provider 3 (Three) the lowest signal occurs at Amplas Terminal - The intersection with the lowest signal - an average of -87 dBm and the highest signal at USU - S Railway Station with the highest signal - 137 dBm on average.

### 3.2 Bandwidth

Bandwidth data obtained during the upload and download process, where when the process is running the application will record the lowest and highest size of data traffic and generate an average when the process runs in one data transfer.

| No | Provider    | Location                     | Bandwidth bit per second (bps) |
|----|-------------|------------------------------|--------------------------------|
|    |             |                              | Min                             | Max                             | Rerata           |
| 1  | Telkomsel   | Terminal Amplas – Simpang Pos| 19629342.72                    | 151833804.8                    | 85731573.76      |
|    |             | Simpang Pos – RS. Adam Malik | 160977387.5                    | 1230608794                     | 695793090.6      |
|    |             | RS. Adam Malik – USU         | 5249433.6                      | 41523609.6                     | 23386521.6       |
Throughput

From the results of the tests carried out obtained the lowest and highest download and upload data for each provider. Throughtput data obtained during trials in all locations in each provider are presented in table 8.

| No | Provider | Location | Throughput bit per second (bps) | |
|----|----------|----------|---------------------------------|-----|
|    |          |          | Down | Up | Down(%) | |
| 1  | Telkomsel| Terminal Amplas – Simpang Pos | 66018344.96 | 2147942.4 | 660183.4496 | |
|    |          | Simpang Pos – RS. Adam Malik | 120422.4 | 2889318.4 | 1204.224 | |
|    |          | RS. Adam Malik – USU | 131072 | 1075713.2 | 1310.72 | |
|    |          | USU- Stasiun Kreta Api | 134348.8 | 1842152.3 | 1343.488 | |
| 2  | XL       | Terminal Amplas – Simpang Pos | 35143.68 | 209715.2 | 351.4368 | |
|    |          | Simpang Pos – RS. Adam Malik | 163020.8 | 805273.6 | 1630.208 | |
|    |          | RS. Adam Malik – USU | 2724659.2 | 13757317.12 | 2724659.2 | |
|    |          | USU- Stasiun Kreta Api | 4096000 | 37748736 | 4096000 | |

Table 8. Throughput Calculation
3.4. Delay

Similar to measurement of bandwidth data, delay data is generated when uploading and downloading, where when the process is running the application will record the time of the lowest delay and the highest delay time and generate an average delay. Data delay obtained during trials in all locations in each provider is presented in table 9.

| No | Provider | Location | Max   | Min   | Rerata | TIPHON |
|----|----------|----------|-------|-------|--------|--------|
|    |          |          |       |       |        | I      | KK     |
| 1  | Telkomsel| Terminal Amplas – Simpang Pos | 46    | 74    | 60     | 4      | SB     |
|    |          | Simpang Pos – RS. Adam Malik | 66    | 68    | 67     | 4      | SB     |
|    |          | RS. Adam Malik – USU | 57    | 66    | 61.5   | 4      | SB     |
|    |          | USU- Stasiun Kreta Api | 53    | 69    | 61     | 4      | SB     |
| 2  | XL       | Terminal Amplas – Simpang Pos | 71    | 161   | 116    | 4      | SB     |
|    |          | Simpang Pos – RS. Adam Malik | 107   | 117   | 112    | 4      | SB     |
|    |          | RS. Adam Malik – USU | 120   | 134   | 127    | 4      | SB     |
|    |          | USU- Stasiun Kreta Api | 91    | 134   | 112.5  | 4      | SB     |
| 3  | Axis     | Terminal Amplas – Simpang Pos | 54    | 61    | 57.5   | 4      | SB     |
|    |          | Simpang Pos – RS. Adam Malik | 54    | 61    | 57.5   | 4      | SB     |
|    |          | RS. Adam Malik – USU | 65    | 69    | 67     | 4      | SB     |

Table 9. Calculation of data Delay Provider
3.5. Loss Package

As with Bandwidth and delay, packet loss is generated when uploading and downloading, when the process is running it will record the packet to be sent. Packet loss data obtained during trials in all locations in each provider is presented in Table 10.

| No | Provider   | Terminal Amplas – Simpang Pos | Simpang Pos – RS. Adam Malik | RS. Adam Malik – USU | USU- Stasiun Kreta Api |
|----|------------|-------------------------------|-----------------------------|----------------------|------------------------|
| 1  | Telkomsel  | 0                             | 1                           | 0                    | 1                      |
| 2  | XL         | 1                             | 1                           | 2                    | 0                      |
| 3  | Axis       | 1                             | 3                           | 2                    | 1                      |
| 4  | IM3        | 1                             | 6                           | 1                    | 1                      |
| 5  | Smartfren  | 1                             | 1                           | 1                    | 1                      |
| 6  | Three (3)  | 1                             | 1                           | 1                    | 1                      |

Chapter 4 Conclusion

After doing research, the authors conclude that from the data generated signal quality in the city of Medan for all providers is good. The best signal quality obtained from each provider is: the best signal quality at Telkomsel providers is obtained at Amplas Terminal - Post intersection which is an average of -87.5 dBm with status good, the best signal quality XL provider is obtained at Adam Malik Hospital - USU that is average of -96 dBm with good status, provider Axis the best signal quality is obtained at USU - Railway Station which is - average of -81.5 dBm with good status, the best signal quality IM3 Provider is obtained at the postal intersection - Adam Malik Hospital with an average of -99.5 dBm with Excelent status, Smartfren Provider with the best signal quality obtained at USU - Railway Station with an average value of -99.5dBm with excellent status, and provider 3 (Three) signal quality best obtained at USU - Railway Station with an average value of -137 dBm with excellent status. Of all providers examined, the best average signal obtained is provider 3 (Three) with a signal strength of -101,625 dBm.

Of the highest average total throughput for the upload process is the Telkomsel provider with an average speed of 1988813 bps, for the highest average download process is the IM3 Provider with an average speed of 17304576 bps. From the total average of the highest delay of all providers has the highest data delay owned by the Xl provider with an average delay value of 116.88 ms. Seta from the
data that has been studied that the provider of Telkomsel has a good loss package that is at Amлас Terminal - the intersection is obtained obtained packet loss value of 0. Post intersection - Adam Malik Hospital is obtained 1, Adam Malik Hospital - USU is 0, and USU - Railway Station is 1.

References

[1] Adokar, D.U., Rajput, P.J. 2012. Wireless Evolution with 4G Technologies.
[2] Artanta., D. 2012. Analisis Pengalokasian Frekuensi Teknologi Long TermEvolution (LTE) di Indonesia.
[3] Astiti, N.M.E.P., Dewi., & Wirastuti. 2013. Implementasi teknologi 4G LTE di Indonesia.
[4] Esmailpour, A., dkk. 2013. Integration of 4G Wireless Technologies In a Test-Bed Environment.
[5] Fujitsu. 2009. Fujitsu Network Communication inc
[6] Fauzi, F., Harly, G.S., & Hanrais HS. 2012. Analisis Penerapan Teknologi Jaringan LTE 4G di Indonesia.
[7] Purba, M.J. 2015. Perbandingan Performansi Internet berbasis Code Division Multiple Acces Pada Sistem Internet Mobile. Tesis. Universitas Sumatera Utara.
[8] Riyasa, D.N., Priyono, W.A., & Asmungi, G. 2012. Analisis Kualitas Jaringan Internet Berbasis High Speed Downlink Packet Access (HSDPA) Pada Wilayah Urban Di Kota Malang Dengan Metode Drive Test. Universitas Brawijara. Malang.
[9] Shukla, A., Purwar, D., & Kumar, D. 2011. Multiple Access Scheme for Future (4G) Communication: A Comparison Survey
[10] TIPHON.1999. “Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON) General Aspects of Quality of Service (QoS)”, DTR/TIPHON-05006. (cb0010cs.PDF)