Analysis of 4G Data Service Quality: Case Study of Tasikmalaya Area

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Abstract. Due to the increasing use of data on smartphones, telecommunications operators continue to increase capacity and throughput, both for social media and other purposes. This study aims to analyze 4G network throughput with observation locations at several Tasikmalaya area sites and compare them with 3G network throughput in the same area. With this analysis, it can be known the determinants of throughput obtained by users when using data services. The research method used is descriptive comparative, that is, by describing the throughput of each technology theoretically and implemented and then comparing it. The data is taken from the proprietary PRS database which is retested through the CET method. After doing the research, it was found that the conditions in the field for 4G networks obtained the throughput of 54.5 Mbps against the throughput of 11.5 Mbps of existing 3G networks. This result is still below the theoretical throughput of 151.2 Mbps for 4G and 14.4 Mbps networks on 3G networks. To increase the throughput performance again, several determinants of the improvement of the quality of 4G network services include the number of users, the type of package used, the hierarchy of data packages, and the type of handset used.

1. Introduction

The third-generation (3G) of High-Speed Packet Access (HSPA) has a throughput of up to 14 Mbps on the downlink side and 5.6 Mbps on the uplink side. The European Communications Standards Institute (ETSI) calls 3G the term Universal Mobile Telecommunication Services (UMTS) which chooses modulation techniques using the Wideband Code Division Multiple Access (WCDMA) method. Technically on the link that connects mobile equipment (cell phone) with nodeB (Base Transceiver Station) in UMTS network, there is a separation between the use of voice channels with the term circuit switch (CS) and also data channels with the term packet switch (PS). [1] [2] HSPA + as the evolution of HSPA technology, can improve the capabilities of mobile broadband with data rates up to 42Mbps with low latency and delay. Although the ability of HSPA + networks reaches 21 Mbps, if most handset devices on the market are only capable of up to 14 Mbps, HSPA + will not provide maximum results for all customers. [3]

The fourth-generation (4G) or can be called Long Term Evolution (LTE) is a fourth-generation telecommunications technology which is the development of 3G / UMTS / WCDMA and 2G / GSM technology. In theory, using LTE in ideal conditions, we can access data up to more than 100 Mbps. [4] [5] Also, LTE can support all applications that are both voices, data, video, and IPTV on a data packet basis. The capabilities and advantages of LTE to previous technologies can be seen from the speed of data transfer, greater service capacity, reduced operational costs, supports multiple-antenna
usage, flexibility in the use of bandwidth used and also can be connected or integrated with pre-existing technology. [6][7]

The objective to be achieved through this research is to analyze the quality of data services experienced by users through throughput testing carried out through data retrieval from the proprietary Performance Report System (PRS) database which was retested through the Customer Experience Test (CET) method. In addition to analyzing the relationship between the amount of utilization and throughput on 4G and 3G. The contribution of this research is to show why it is necessary to expand and establish 4G technology installations in Indonesia with the benefits of facilities that will be felt by the user. This is evidenced by the throughput analysis carried out in research both on previously established technology, namely 3G and new technologies that are in the development stage, namely 4G.

2. Method

2.1. Object of research

The research object used is the site owned by the Operator of PT XL Axiata as many as 103 sites on the site contain both 3G and 4G technologies. The details of the research location are Tasikmalaya area, and the following site deployment map used in this study:

![Figure 1. 3G HSPA sitemap used.](image)

![Figure 2. 4G LTE sitemap used.](image)

2.2. Ideal speed of 3G HSPA

Research on 3G HSPA will be carried out in ideal conditions to get the best results at 3G data speeds. Factors taken into account in this HSPA are the number of Spreading Factors (SF) and the number of codes used and also the type of modulation used, while the modulation used by PT XL Axiata for 3G
is 64-QAM for mapping. 64 QAM maps 6 bits into a symbol. To know for sure, the ideal data speed is the following formula:

\[
data rate = \frac{\text{chip rate}}{sp} \times \text{code} \tag{1}
\]
\[
data rate (64 \text{ QAM}) = \text{Datrate} \times 6 \tag{2}
\]

2.3. The ideal speed of 4G LTE
Calculation of throughput at 4G is also called peak data rate which is used to determine the highest data rates generated by eNodeB. Ideal assumptions are needed to get maximum results, such as the number of resource blocks (RB) available and also the type of modulation obtained to access the LTE network, while the formula used in calculating peak data rates on 4G LTE is as follows:

\[
\text{Peak data rate} = \text{number of OFDM symbols (bit/ms)} \times \text{number of RB} \times \text{Antenna type} \times \text{QAM} \times \text{Code rate} \times \text{RB effectivity} \tag{3}
\]

2.4. Data retrieval of throughput and utilization from the database
Data throughput on 3G and 4G sites is collected regularly on the database, and all sites with Huawei devices on PT XL Axiata use a special application called PRS as the database retrieval interface. In the research conducted, data taken from PRS focused on throughput and utilization as a reference for the real condition in the field. The PRS application display is as follows:

![Figure 3. The PRS application login view.](image)

![Figure 4. Examples of query results in the PRS application.](image)

3. Results and discussion

3.1. Throughput of 3G
For 3G technology used by PT XL Axiata on 103 3G testing sites at Tasikmalaya location is 3G HSDPA technology using five codes as data lines and supports for 64 QAM modulation used. Based on the theories and calculations that have been explained previously, for maximum HSDPA speed with code 5 and modulation of 64 QAM, the throughput speed is obtained:
\[ data rate = \frac{\text{Chip rate}}{SF} \times code = \frac{3.84 M\text{cps}}{16} \times 5 = 1.2 M\text{symbol/s} \]
\[ data rate (64QAM) = 1.2 \times 6 = 7.2 Mbps \]

In PT XL alexita the Dual Carrier method is used, which uses two frequencies and channels simultaneously in one user. Therefore the throughput obtained is doubled with the following calculation details:

\[ data rate (64QAM) = 7.2 Mbps \times 2 = 14.4 Mbps \]

In actual conditions, there will be several factors that will affect the quality of the throughput perceived by the user. The following is the throughput on 103 3G sites with HSPA technology that supports 64 QAM modulation and is located in Tasikmalaya:

![3G Throughput](image)

**Figure 5.** Throughput spread in 103 3G site samples.

From the test results can be seen the highest number of HSDPA throughput is 7.5-9 Mbps with a total of 43 sites from 103 sites and the highest throughput of HSDPA is 9-11.5 Mbps. The factors that influence the throughput are user utilization. The meaning of user utilization is the number of users served by one site, where the more users are served, the smaller the throughput obtained. This can be seen in the spread of user utilization in the 103 testing sites.

![Throughput vs HSDPA User](image)

**Figure 6.** Deployment of throughput vs. user utilization on 103 3G sites.

It can be seen in the distribution of throughput vs. user utilization above that throughput is directly proportional to user utilization, the higher the user utilization or, the more users served by a site, the smaller the throughput obtained. The distribution of throughput and utilization at 103 site sample locations is as follows:

![Distribution of throughput](image)

**Figure 7.** Distribution of throughput on 103 Tasikmalaya 3G sites.
3.2. Throughput of 4G

For the 4G site that was tested, it was a similar site on 3G; the site has 2G; 3G; and 4G functions. The XL axiata channel 4G bandwidth used is 20 MHz and the antenna used is MIMO 2 x 2. The calculation can be throughput as much as:

\[
\text{Peak Data rate} = \text{number of OFDM symbols (bit/ms)} \times \text{number of RB (20 MHz)} \times \text{MIMO (4x4)} \times 64\text{QAM} \times \text{Code Rate} \times \text{effectivity of RB (75%)} \times \text{after minus of signalling overhead (25%)}
\]

\[
\text{Peak Data rate} = 168 \text{ bit/ms} \times 100 \times 2 \times 6 \times 1 \times 0.75 \times 1000 \text{ ms/s} = 151200000 \text{ bit/s} = 151.2 \text{ Mbps}
\]

In real terms, if using a bandwidth of 20Mhz, and the MIMO 2X2 antenna then the throughput that can be obtained is as follows:

![Figure 9. Distribution of throughput on 103 4G sites.](image)

From the results of the throughput testing felt by the most position users is at 20-30 Mbps which is a number of 38 sites, one of the factors that influence the throughput experienced by the user is the resource block (RB) utilization, the smaller the RB utilization or, the more available RB allocations theoretically the throughput that the user gets is getting bigger. The following is a comparison between RB utilization and customer perceived throughput.

![Figure 10. Distribution of throughput vs PRB utilization on 103 4G sites.](image)
When viewed from the diagram above, it can be seen that indeed the amount of throughput obtained by the user is directly proportional to RB utilization. The smaller the RB utilization meal, the greater the throughput obtained by the user. The spread of throughput and RB utilization at 103 sites located in the city of Tasikmalaya are as follows:

4. Conclusion
Based on the researchers obtained the throughput of 3G and 4G technology both in theory and in real results of data retrieval through databases, where the analysis is carried out theoretically and the actual conditions on 103 sites that have 3G and 4G technology at each site. By retrieving the database using PRS and proving by sampling with CET, it can be seen that the highest throughput on 4G networks is 54.5Mbps, and for 3G networks is 11.5Mbps. Meanwhile, ideally by considering the current site conditions of PT XL Axiata, the theoretical throughput on the 4G network is 151.2 Mbps and for the existing 3G network is 14.4 Mbps. Data processing from the PRS database ensures that the higher the utilization, the lower the throughput felt by the user, and vice versa.

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