

IoT Implementation of Madura Tourism Dictionary: A study on mobile networks performance in Madura

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Abstract—Madura is one of the islands in Indonesia located on the north side of the island of Java. Madura has several tourist attractions that have the potential to develop. Internet of Things (IoT) is the concept of a device capable of transferring data by utilizing the internet as a media. IoT can be used to send tourist photos regularly to the server. The application of IoT in Madura tourist attractions can increase tourist visits in Madura. The application of IoT requires adequate internet infrastructure. Therefore, study related to internet services in Madura is needed. In this paper, we conduct measurement tests on products of the four major mobile network in Madura, i.e., XL Axiata, Tri Indonesia, Telkomsel, and Indosat Ooredoo. The results show that XL Axiata performs as the best operator in Madura.

Keywords—IoT; Madura Tourism Dictionary; Mobile Network; Performance

I. INTRODUCTION

Madura is an island in Indonesia located in the northeast coast of Java island. It is administered as part of the East Java province and is divided into four regencies: Bangkalan, Pamekasan, Sampang, and Sumenep. Madura has many beautiful tourist attractions, yet they have not been explored and promoted sufficiently. In other words, tourists do not yet know many tourist attractions in Madura. One of the causes is due to poor transportation lines.

In our previous work, we had built the Madura Tourism Dictionary application [1] that lists the complete information of tourist attractions in Madura. The number of tourist attractions in Bangkalan, Sampang, Pamekasan, and Sumenep regions is recorded as 13, 13, 23, and 16 respectively. The type of attractions is categorized into eight categories, i.e., nature tourism, religious tourism, artificial tourism, souvenir shop, culinary tourism, cultural tourism, hotel, and tour package. The information details the description, address, GPS location, access to location, facilities, entrance ticket (if any), photo galleries, and infrastructure of each tourist attraction. The application is built using two languages, i.e., Indonesian and English, making it usable for both the domestic and international tourists.

To date, the type of information available in the Madura Tourism Dictionary application is static. This means that every update regarding the tourist attractions must be conducted manually. However, to periodically update photo galleries via a manual approach is not an option in this case. The main reason is that the procedure is time-consuming and quite costly, given that the location of tourist attractions are scattered within the 4,079 km² area of Madura. For this reason, this research proposed to implement the Internet of Things (IoT) approach to update the galleries of Madura Tourism Dictionary application automatically.

IoT is a system that allows any smart devices or objects to be identified and linked to each other such that they can communicate through internet connectivity or network [2, 3]. The type of networks implemented can be in the form of a mobile network (2G/3G/4G), ZigBee, Wired, Bluetooth, WiFi, and NFC[2]. The implementation of IoT makes physical objects to be virtually displayed. In this case, we can use it to capture real-time views from the tourist attractions, supporting the exploration and promotion of Madura tourism.

The mobile network is one of IoT implementation backbones in Madura. The quality of service in mobile networks and the price of mobile data plans varies amongst operators. Investigating the performance of mobile network operators in Indonesia, especially in Madura, is beneficial in deciding which operator used to implement IoT for Madura tourism.

The objective of this paper is to compare the quality of mobile networks in Madura. The study is conducted on four mobile network products operated by four different operators that serve the Madura region. Experimental results show that the quality of XL mobile network run by XL Axiata operator outperforms others in terms of internet and video streaming speeds.

The rest of this paper is organized as follows. Section 2 provides the comprehensive literature reviews. Section 3 details the measurement methodology. Section 4 describes the measurement results. Section 5 presents the discussion and Section 6 concludes the paper.

II. LITERATURE REVIEW

Using the Internet of Things (IoT), any smart devices or objects can be identified and linked to each other such that they can communicate through the networks [2, 3]. Figure 1 shows an illustration of using networks in IoT. Note that there are various types of networks used in the system, i.e., mobile network (2G/3G/4G), ZigBee, Wired, Bluetooth, WiFi, and NFC.

The mobile network becomes the most crucial component for the implementation of IoT in Indonesia, especially in Madura. Customers, in Indonesia, can choose which operator to be used amongst the six operators available to date: XL Axiata, Telkomsel, Tri Indonesia, Indosat Ooredoo, BOLT!, and Smartfren. Each operator competes to provide the best service. All of them provide services in 3G and 4G networks, but speed standards are used differently. The range of services owned by each operator varies, depending on the coverage of the BTS towers owned. The price of internet packages sold by each operator is also different. Note that not all operators can serve all areas in Madura.

In general, Telkomsel is considered the most popular and the best operator in Indonesia. According to a survey conducted by Databox in 2015 and 2016, as shown in Figure 2, Telkomsel has the highest number of mobile network customers in Indonesia [4]. In terms of performance, Telkomsel also outperforms other operators [5, 6].

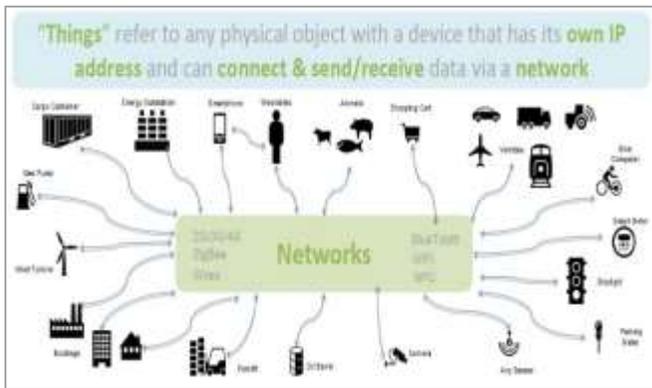


Figure 1. IoT Networks [2]

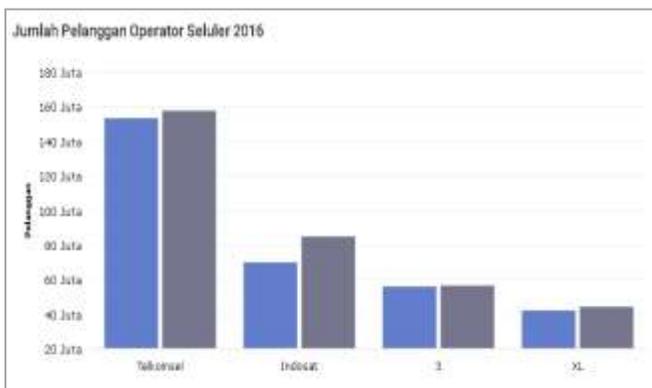


Figure 2. Number of customers of the mobile network in Indonesia in 2015 and 2016 [4]

Despite its general level of performance, the actual quality of each mobile network operator could vary in different regions since each operator has different best service region [7, 8]. The performance of each operator varies depending on the metrics used as the measurement test. Deciding which operator to be used should be based on the comparison of the quality of various mobile network operators in that particular region.

In this paper, we compare the performance of four mobile networks available in Madura, i.e., XL Axiata, Tri Indonesia, Telkomsel, and Indosat Ooredoo. The comparison is conducted based on the average performance scores of upload and download speed metrics, measured using two websites of speed test, i.e., SpeedTest and SpeedOf.me. Note that those websites are chosen based on the list of recommended internet speed test tools [9].

III. MEASUREMENT METHODOLOGY

We perform our measurements on four mobile network products operated by four different operators, listed in Table 1, that serve the Madura region. Our measurements are designed to investigate which mobile network performs the best in Madura. This mobile network will be used as the backbone of IoT implementation of Madura Tourism Dictionary, as shown in Figure 3.



Figure 3. IoT implementation of Madura Tourism Dictionary

TABLE I. MOBILE NETWORKS

Mobile Network	Operator
XL	XL Axiata
Tri	Tri Indonesia
simPATI	Telkomsel
Mentari	Indosat Ooredoo

A. Measurement Tests

We conduct four mobile network measurement tests covering the range of services needed for the IoT implementation of Madura Tourism Dictionary. Table 2 lists the measurement tests and their details.

TABLE II. MEASUREMENT TESTS

Measurement Test	Detail
Signal	Signal bar (maximum 4)
Internet Speed	Upload, Download
Video Streaming	Rate, Score, Bandwidth, Bitrate
Ping Test	www.google.com, www.dydns.com, www.trunoyo.ac.id, www.maduratourism.com

B. Measurement Setup

We conduct all measurements using the Samsung Galaxy J2 mobile phone and Lenovo 310 Windows 10 laptop. The location of the measurement is at the University of Trunoyo Madura in Bangkalan regency. To measure the internet and video streaming speeds, we respectively use the reliable web-based speed checkers, i.e., SpeedSmart (<https://speedsmart.net/>) and StreamTest.net (<http://www.streamtest.net/>). All tests are documented for two type of networks, i.e., 3G (GSM) and 4G (LTE). Measurement tests are conducted five times a day, between 6 AM and 12 AM. The final results are reported as the average performance scores of each metrics.

IV. MEASUREMENT RESULTS DAN DISCUSSION

A. Signal

Figure 4 shows the signal measurement test results. On the 3G network, signals of mobile networks have the same excellent quality, except that of Tri. However, XL gives the best signal on the 4G network.

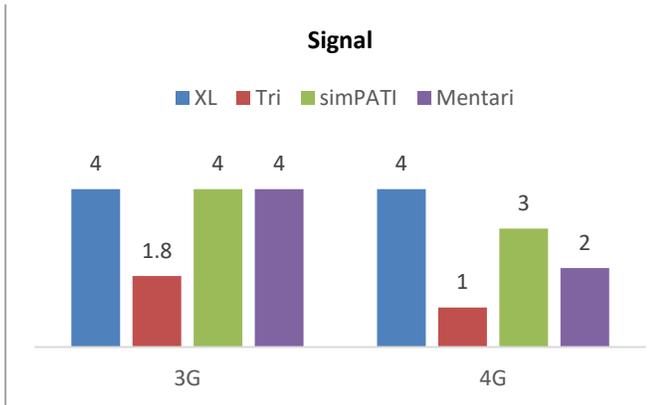


Figure 4. Mobile network signal

B. Internet Speed

Figure 5 shows the results of the upload speed measurement test. On the 3G network, the upload speed of XL and simPATI are considered the same and are faster than the other two mobile networks. However, XL performs the best and much faster than that of simPATI.

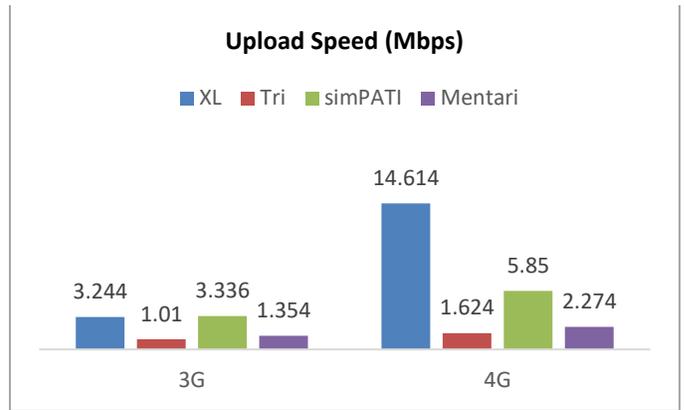


Figure 5. Upload internet speed

The results of the download speed measurement test are shown in Figure 6. On the 3G networks, XL outperforms others with its 2.98Mbps download speed. Meanwhile, simPATI performs better than XL on the 4G network. However, for the IoT implementation of Madura Tourism Dictionary, these results are less significant than those of the upload speed.

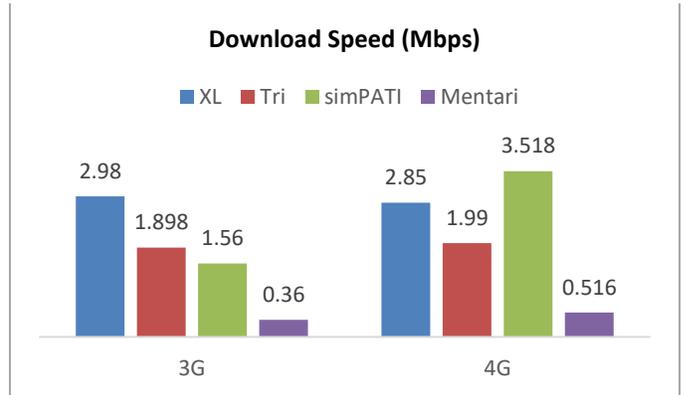


Figure 6. Download internet speed

C. Video Streaming

Regarding the measurement test of video streaming rate, the results of Tri are astounding on both the 3G and 4G networks (Figure 7). Despite its poor signal (Figure 4), it turns out that Tri performs the best in compared to others.

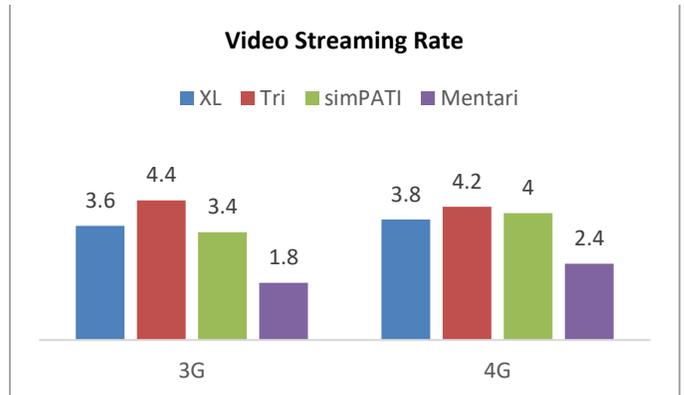


Figure 7. Video streaming rate

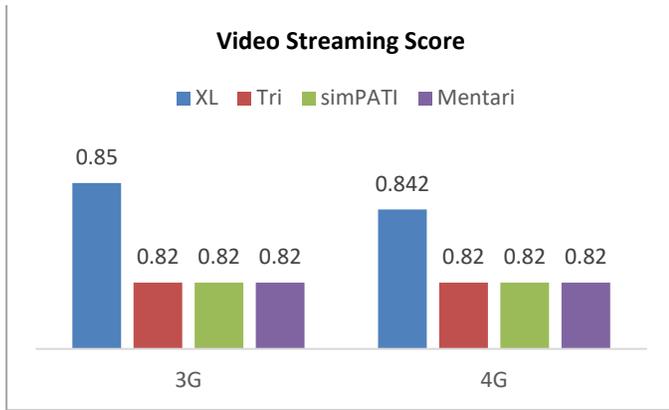


Figure 8. Video streaming score

On the other hand, in general, the results of the video streaming score measurement test show that XL gives the best rating on both 3G and 4G networks (Figure 8). It is to be noted that this test is to investigate how good is the quality of the streaming video.

The streaming video bandwidth and bitrate are used to record the internet speed of the streaming video process. At first glance, we can notice that measurement test results of these two categories are similar, even on both 3G and 4G networks (Figure 9 and Figure 10).

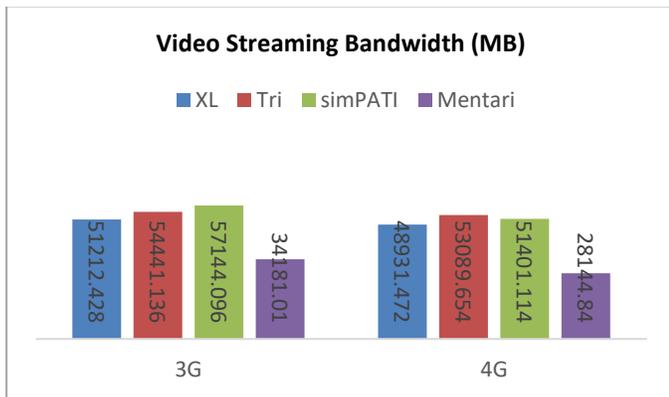


Figure 9. Video streaming bandwidth

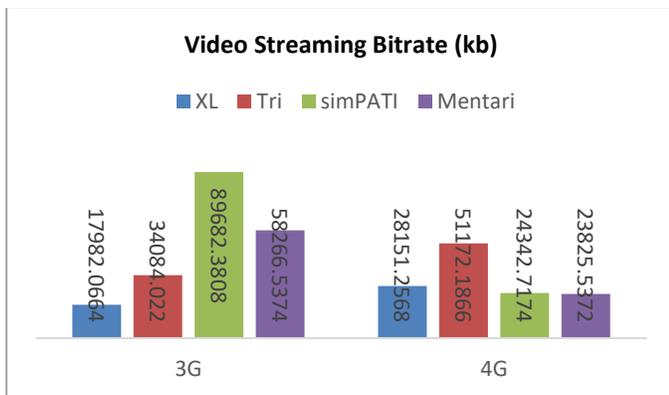


Figure 10. Video streaming bitrate

D. Ping Test

Ping measurement test is to check the response time needed when a device is accessing a host or server. The measurement test results to www.google.com (Figure 11) and www.dydns.com (Figure 12) show that XL has the fastest response time. However, in general, results of (Figure 13) www.trunojoyo.ac.id and www.maduratourism.com (Figure 14) show that Tri operator is the fastest. Note that the later host is that of our Madura Tourism Dictionary application [1].

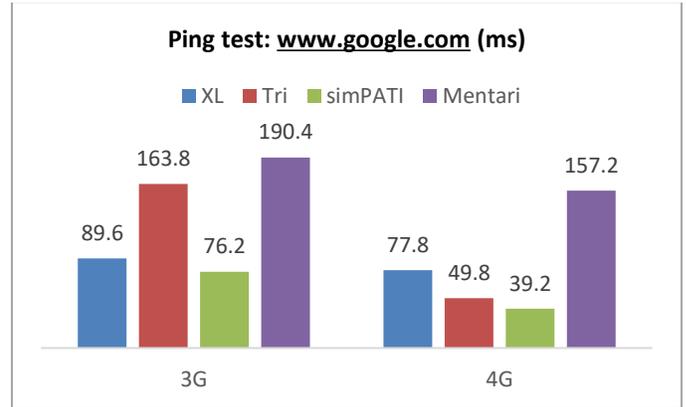


Figure 11. Ping test: www.google.com

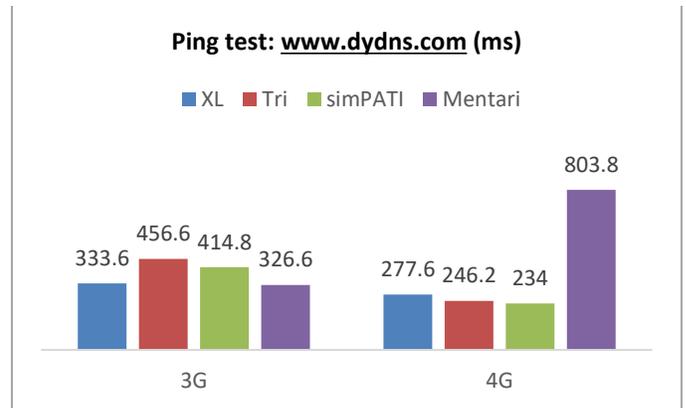


Figure 12. Ping test: www.dydns.com

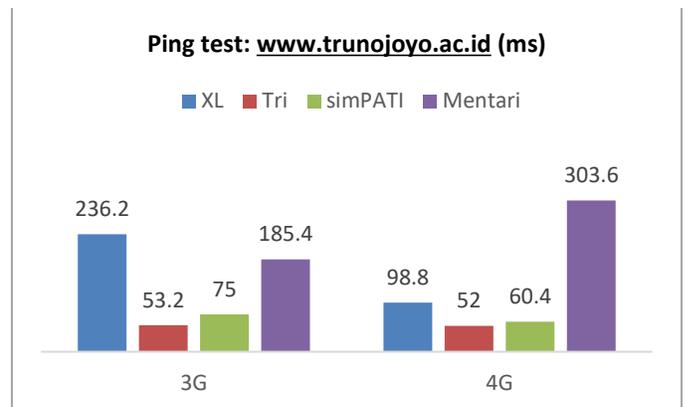


Figure 13. Ping test: www.trunojoyo.ac.id

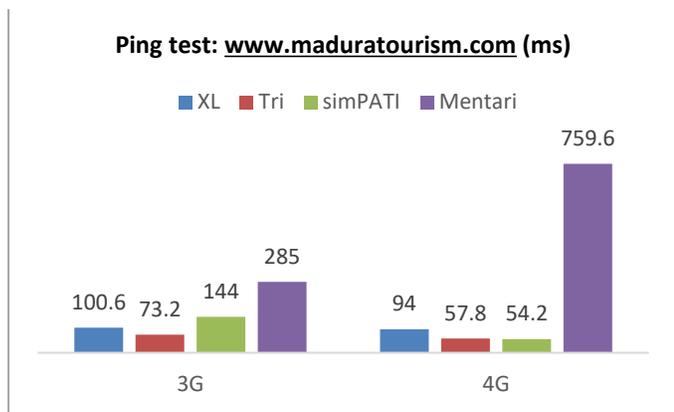


Figure 14. Ping test: www.maduratourism.com

V. DISCUSSION

In this study, we conduct measurement tests to investigate which mobile network performs the best for the IoT implementation of Madura Tourism Dictionary. Out of the four tests (Table II), the most influencing results are those of internet (upload and download) and video streaming speeds. In case, we can notice that XL outperforms others on both 3G and 4G networks in those two terms.

Additionally, it can also be noted that the outperformance of the product of XL Axiata over Telkomsel confirms that the actual quality of each operator varies in a different region. In this case, the best choice of operator used in Madura is XL Axiata.

VI. CONCLUSION

In this paper, we study the quality of four mobile network products of four different operators by comparing the connection speed. Experimental results show that, in the Bangkalan region, XL Axiata operator performs the best in compared to other operators, in terms of internet and video streaming speeds. Therefore, the implementation of IoT in Madura should use XL Axiata as the mobile network operator.

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