Performance Rate for Implementation of Mobile Learning in Network

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***Abstract*— This paper discusses the availability of mobile networks and develops mobile learning software. The measurement Approach is testing from the user experience side to some point where potential users are located. Data clustering is divided into six location of measurement points, with different time sessions; morning, daylight, afternoon, and evening. In each time session, the measurement process is done as much as 10 times test for each the card service packs from Internet Service Providers (ISPs). The measurement process is carried out continuously for 21 days (three weeks), this is done to ensure the availability of mobile networks in the location. The results of measurement and application testing, have given conclusion and contribution, that in of the research explains that although performance levels such as download and upload speed, latency, jitter and packet loss metrics are appropriate, not necessarily the level of network availability is appropriate. Because each parameter is influenced by a certain factor. The average value of network availability measurement experienced an internet connection failure rate on one of ISP 84.046% or as many as 10 to 11 times failed to connect from 70 attempts for internet connection.**

Keywords—quality-of-service; mobile-learning; network; tools; education.

I. INTRODUCTION

Development of information and communication technology (ICT) has affected the learning system [1-5]. The rapid advancement of technology makes the ICT on education has become a necessity. Implementation of ICT can be one indicator of the progress of the school's success. Other than that, also considered to support educators in delivering learning materials making it easier for learners to receive material that is conveyed. Given this, the educators should "aware" of the technology.

To implement the learning process with online learning system, certainly needed a network infrastructure and electronic media which will support the use of online learning [6-8]. Learning with the using of electronic media such as computers and based on online learning known as the electronic learning (e-Learning) and has evolved into a system of mobile learning (m-Learning) using the portable media such as mobile phones, smartphones, Tablet PC, iPhone, portable media devices and other moves that can easily be taken anywhere.

Some of the important capabilities that should be provided by the learning device m-Learning in [9] is the ability to connect to other devices, the ability to present information about learning and the ability to realize the communication between teacher and learner interaction. Learning system using m-Learning in Kalimantan, Indonesia, which is still relatively new makes us study and learn more about the application of the m-Learning system. Related to this issue, the purpose of this study:

- Ensuring network availability, for the application mobile learning with measuring performance quality of service (QoS) the mobile network.
- Development a mobile learning devices (m-Learning), as media tools interaction and communication to support teaching and learning students.

II. RELATED WORK

A. *Architecture System*

Generally, the architectural design in the development of mobile learning system as in "Fig. 1", which is divided into three 3 key elements that must be provided, i.e. an availability of network, smartphone devices, and application software.

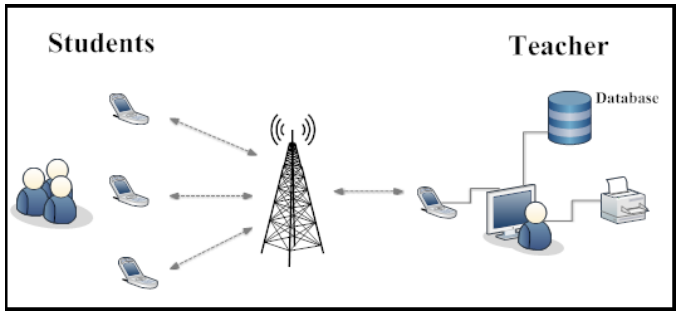

Fig. 1. Network architectures for mobile learning

1) *An availability of mobile network*

One of the research goals is to ensure the availability of the mobile network before implementing the system of mobile learning online. Therefore, the initial stage of the study was the field observation with measuring performance mobile networks to multiple locations as the research object, i.e. a place to stay

prospective users of the system, which in this case is a student residence and lecturer.

Refers to the study [10-11], the architectural design for quality of service measurements mobile network as shown in "Fig. 2", which is divided into three subsystems; mobile client devices, mobile network from internet service provider (ISP), and mobile server.

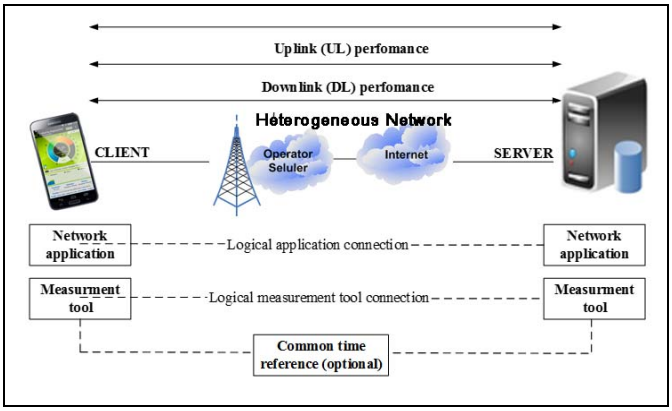

Fig. 2. An architecture for mobile network measurements

a) Mobile client devices: mobile connection quality measurement tools using application 4Gmark [12], is a tool offering a comprehensive and reliable benchmark of the quality of service for smartphones. It allows to test and compare smartphones, networks or places on every technologies 2G (Edge, Gprs), 3G (UMTS, HSDPA, H+, Dual-carrier), 4G (LTE) and Wifi. both applications support for iPhone, iPad, Android devices and Windows Phone [12].

b) Mobile network internet service provider (ISP): is a service provider networks that have a data plan that is the object of research, and is generally used by students and lecturers in the internet connection.

c) Mobile server: is the central access subsystem applications, each process a request or response data transmission will be recorded and stored on the database server.

2) *Smartphones Device*

Mobile devices, the number of internet users and the network connection to use mobile devices in Indonesia is very large and massive [13-15]. Specifically, for students in the University of Mulawarman as potential users, and all students have a smartphone that supports mobile learning system.

3) Application Software of Mobile Learning

For the availability of software applications, we design and development of mobile learning for the data structures course that can support learning students for Undergraduate Degree Programs at the University of Mulawarman.

B. *Quality of Service* (QoS)

According to [16-18] broadband Quality of Service Experience (QOSE) testing standard from LIRNEasia, defines comprehensive set of six performance metrics that should be measured in each experiment, as shown in Table 1.

TABLE I. METRIC QOSE STANDARD OF LIRNEASIA[16-18]

Metric	Method	Benchmarks
download speed (kbps)	file size 1 megabyte; time	
upload speed (kbps)	mb file	
latency: round trip-time	The average of 10 pings (each ping provides 3 sets of results.	<300 ms
jitter (ms)		<50 ms
packet-Loss (in %)		<3%
availability (in %)	Availability = (1 – F/T) x 100%.	>98%

III. METHODOLOGY

The paper uses approach methodology of Research and Development (R & D) [19], with conduct research on an availability of the mobile network for readiness of implementation mobile learning, and to develop a media that will be used as communication tools between students and lecturer interaction in learning.

A. *Methodology for ensure the network availability*

1) Data Sources and Collection Methods

Data source is divided into two, primary and secondary data. Primary data for performance analysis of network availability is a result of measurement quality of service that using mobile network measurement tools, while secondary data is a data packet of internet connection (the card service package featured from ISP), quality of service parameter metric and other references related of research.

The field data collection arranged in 4 session measurement time, i.e. the morning session (07:00 to 11:00), daylight session (12:00 to 15:00), afternoon session (15:00 to 18:00), and the evening session (18:00 to 22:00).

2) Network Availability Testing Methods

According to [16-18] the methodology for broadband QOSE testing is defines a comprehensive set of six performance metrics that should be measured in each experiment, one of which is measuring network availability. In [16-18], explains this measures the number of times we are able to access the Broadband services. If T attempts are made to connect to the Internet, and if F attempts fail, then Availability = (1 – F/T) x 100%.

TABLE II. APPLICATION QOS METRICS

Metric	Parameter quality of service and measurement object					
Browsing test	Time (s)	Weight (kb)	Website: visualgo.net	Performance rate (PR) (%)	Availability (%)	Reference module
Streaming test	Location	Resolution: 240p 360p	Initial loading (s)	Performance rate (PR) (%)	Data used (kb)	Visual module
Speed test	Download (kbps)	Upload (kbps)	Latency (ms)	Jitter (ms)	Packet loss (%)	App

The mobile learning app contains multimedia teaching materials, presenting and combining various applications such as text, sound, images, animation, audio, video, and etc. Therefore, sufficient networking is required to implement the application. The metric, parameter quality of service, and measurement object presented in Table 2.

B. Methodology for Mobile Learning Application

1. Software Analysis and Design

Analysis and design software for development of mobile learning system using object-oriented Unified Modeling Language (UML) [24]. Furthermore, the use case diagram design presented in "Fig. 3" for students.

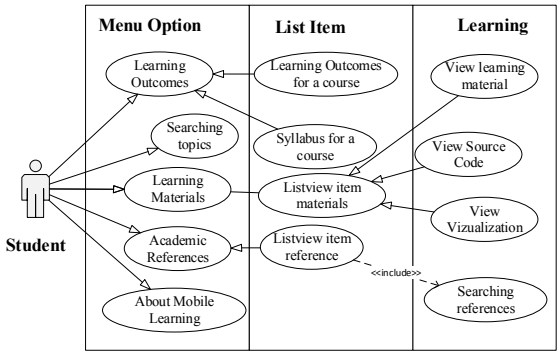

Fig. 3. Use case diagram for students

2. Framework Architecture for Mobile Learning System

In general, the framework architectural design and teaching materials to be presented in the mobile learning applications are shown in "Fig. 4".

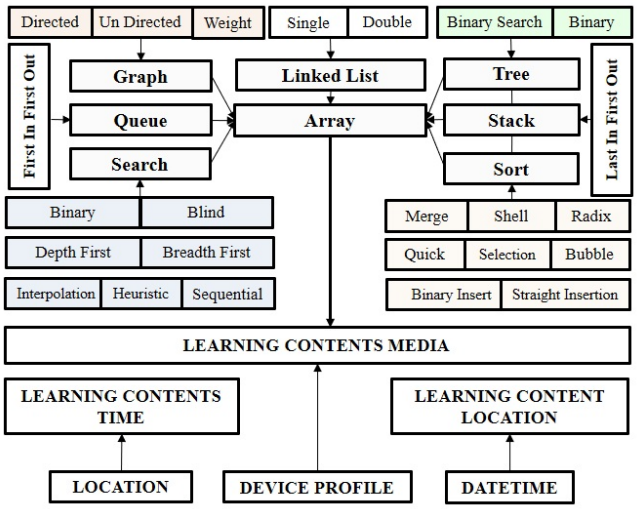

Fig. 4. framework architecture material teaching of data structures course

Mobile learning media contains teaching materials based on the syllabus of the Data Structure course. Teaching materials are visualized in the form of text, images, and moving animations. The media content created includes the teaching material as shown in "Fig. 4", which comprise the subject matter; Array, Queue, Stack, Graph, Tree, Sort, Search, and Linked List.

The mobile learning app which can be installed on Android system was one of the ultimate production of this study. It is conceived as a learning system with a base on mobile Android, utilizing smartphone a student's for learning, and organizing the students' learning process anytime and anywhere. In general, hierarchical information about the content of the material teaching on the mobile learning can be seen in the framework diagram in "Fig. 4".

IV. RESULT AND DISCUSSION

A. Result

1) Testing Session and Measurement

The Measurement Approach is testing from the user experience side to some point where potential users are located. Data clustering is divided into six location of measurement points, with different time sessions; morning, daylight, afternoon, and evening. In each time session, the measurement process is done as much as 10 times test for each the card service packs from ISP. We are using data service packs from ISP A and ISP B alternately in one session. The measurement process is carried out continuously for 21 days (three weeks), this is done to ensure the availability of mobile networks in the location.

TABLE III. NETWORK PERFORMANCE QOSE FOR ISP A

Location	Speed (kbps)		Sensitivity to			Availability (%)
	Download	*Upload*	*Latency (ms)*	*Jitter*	*Packet-loss (%)*	
L1	2958	622	69	23,3	0,13	92,86
L2	1270	1032	106	33,7	1,48	72,86
L3	2581	1045	70	58,02	1,02	87,14
L4	1490	1035	108	32,11	1,17	77,14
L5	2960	1628	88	23,82	0,84	88,57
L6	2584	1047	94	18,29	1,33	85,71

TABLE IV. NETWORK PERFORMANCE QOSE FOR ISP B

Location	Speed (kbps)		Sensitivity to			Availability (%)
	Download	*Upload*	*Latency (ms)*	*Jitter*	*Packet-loss (%)*	
L1	3060	866	269	44,03	1,1	81,43
L2	2849	3100	109	15,67	2,4	78,57
L3	1490	743	243	43,22	1,8	75,71
L4	3052	862	130	12,81	3,1	94,29
L5	2844	3095	119	14	0,9	84,29
L6	1482	3052	318	27,56	4,4	71,43

Based on the measurement results presented in Table 3 and Table 4, it is explained that for the parameter values of network service quality metrics generally have been in accordance with existing benchmarks, except on the network availability level

metric that must be with a benchmark >98%, this has not reached the standard presented in Table 1, is still below average, and the average Availability of ISP A is 84.046%, meaning that the range (10/70) to (11/70) has an internet connection failure or 10 to 11 times out of 70 attempts for internet connection.

The frequent occurrence of failures in the internet connection in the measurement location is influenced by the geographical condition of the region in Kalimantan. The number of trees, tall, and bushy. In addition, the current network density of internet access at the measurement site is an area of education which of course the users are very much.

2) Development of Mobile Learning App

Implementation is the realization of an application, In the implementation phase, the application of mobile learning data structures course is run to see how the system was built and worked in practice.

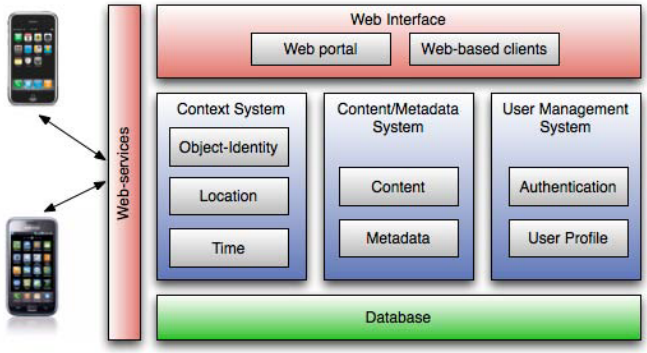

Fig. 5. an overview of the implemented architecture for mobile learning app

"Fig. 5", shows an overview of the implemented architecture for mobile learning app. Three main components can be distinguished: the context system, the content and metadata system, and the user management system. First, the context system is an initial implementation of the Context Metadata and Management of the technical framework presented in this chapter. The context system entails the most basic functionality specified in the technical framework, which allows the specification of context metadata for the learning content in the system. Additionally, it can deliver learning content to the learner on the basis of certain context information provided.

Three types of context information can be distinguished in the architecture: an objectidentity context that identifies objects in the real-world, location context that represents real-world locations, and time-context that identifies the moment a certain resource has been created or last accessed. Second, the content and metadata system manages the learning content that consists of several types of multimedia.

In addition, this system stores various types of metadata about the learning content. For instance, learning content can be annotated with tags and categories to provide a higher-level organization. Moreover, learners can comment and rate existing learning content. Last, the user management system provides authentication services and stores basic information about the learners in a user profile. Furthermore, this system identifies the learners that created certain learning content. All three main components use a database to store the information used

The information in the mobile learning can be accessed in several ways. On the one hand, a web interface delivers the information in such a way that it can be accessed in a web browser. Depending on the type of client, the information is rendered as a full-featured web page that can be accessed via a web browser on a desktop machine, or as a web page adapted to be viewed on small screens for a web browser on a mobile device. On the other hand, information can be accessed in a client-server setup, via web services (REST and SOAP) with a variety of mobile clients. The different mobile clients that were implemented for the mobile learning architecture will be described in the next section.

The main material contained in the teaching module of mobile learning app includes the material subjects of arrays, pointer, list, stack, queue, tree, sort, search, and graphs. This material is packed in the form of text, images, and animation visually, each teaching material described its presentation in 3 menus, i.e. theory menu, code samples and visualizations of code, it's can be set of values based on an input.

3) Measurement of Network Capabilities in Testing Mobile Learning App

Testing and measurement of mobile learning applications are used directly in the learning of the 2nd-year students of Information and Communication Technology University of Mulawarman. The location point of the test is done randomly in six districts where mobile learning application users live. To ensure the mobile learning system works well, the test is done on the content of teaching materials divided into 3 test sessions, i.e. browser testing, streaming test, and application speed test.

a) Browsing test: Browser testing is done on the reference menu, this menu has been linked in some online sources, and can perform other material searches in various reference sources on the internet online. Fig. 6 is a reference module used as an example to test the browsing capabilities of a mobile learning application.

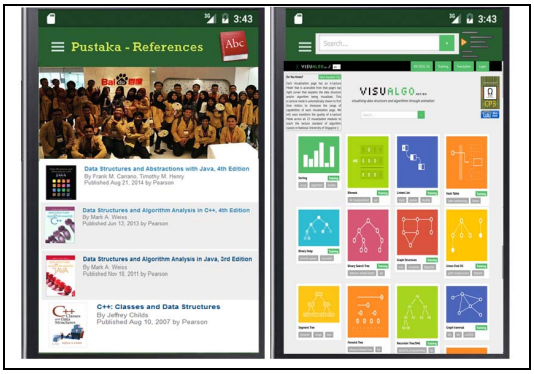

Fig. 6. Screenshots the references module for browser test app

Based on the results of testing browsing sub menu search reference online teaching, with a test on the sample site:

visualgo.net/, and google.co.id, obtained the average value of measurement results as presented in Table 5.

TABLE V. BROWSING TEST FOR SUB-MENU REFERENCES

Location	Google			Availability (%)	Visualgo.net			Availability (%)
	Time (s)	*Weight (kb)*	*PR (%)*		*Time (s)*	*Weight (kb)*	*PR (%)*	
L1	3,21	592	83,75	100	7.64	1053	67,94	90
L2	7.71	645	74,35	100	5.47	1328	70,25	80
L3	5,01	700	93,75	80	8,47	1978	68,86	80
L4	2,98	329	89,92	100	7,39	1115	73,12	90
L5	3,66	127	72,97	90	3,11	1331	63,44	80
L6	4,23	163	90,68	100	6,57	1965	74,96	90

The browsing test on sub menu reference is done repeatedly 10 times, and the frequency of failure to connect an average of 85% or about 1-2 time out in each session.

b) Streaming test*:* Mobile learning app built containing sub-material that is visualized in animated movies. For that test is done based on 2 categories of quality visual resolution, i.e. resolution 240p and 360p. In Fig. 7 is a menu app visual animated code and measured the value of performance rate (PR), initial loading and the amount of data packets used.

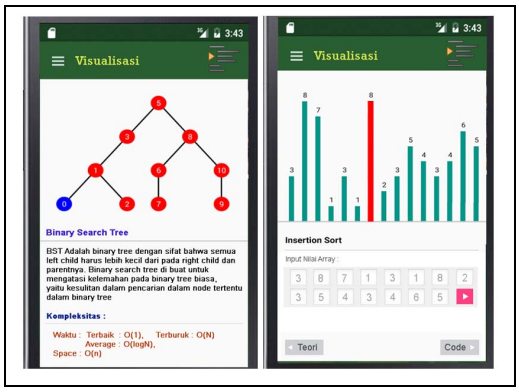

Fig. 7. Screenshots the visualization module for streaming test app

In Table 6 is the result of measurement of network capabilities in the implementation of mobile learning applications for sub-menu material visual running code.

TABLE VI. STREAMING TEST FOR SUB-MENU VISUALIZATION

Location	240p			360p		
	PR (%)	*Initial loading (s)*	*Data used (kb)*	*PR (%)*	*Initial loading (s)*	*Data used (kb)*
L1	81,70	2,297	3610	83,40	2.116	6586
L2	78,50	1,355	3790	60,90	3.403	5625
L3	69,90	2,337	3016	58,88	4.095	5554
L4	77,80	1,705	5623	62,70	2.516	6012
L5	83,62	3,022	3660	75,40	5.466	6620
L6	93,93	3,287	2784	88,20	6.012	6959

c) Speed test app: Speed testing for application performance with metric quality of service parameters, measurement results on Table 7.

TABLE VII. SPEED TEST FOR SUB-MENU VISUALIZATION

Location	Download (Mb/s)		Upload (Mb/s)		Latency (ms)		Jitter	Packet-loss
	Max	*Avrg*	*Max*	*Avrg*	max	min	*(ms)*	(%)
L1	1,5	0,65	0,54	0,47	214	178	275	1,78
L2	5,01	4,49	1,13	0,39	280	139	126	0,27
L3	3,8	3,13	1,84	1,57	227	112	201	0,63
L4	4,11	3,57	0,61	0,24	205	101	167	0,22
L5	7,26	6,34	0,71	0,32	477	256	328	2,4
L6	4,66	2,28	1,29	0,89	172	102	92	0

B. *Discussions*

Difficulties of students in learn of data structures course have encouraged teachers to develop a learning tool that utilizes a smartphone device owned by students to become a media for teaching, a mobile learning media that can be used as a means of presenting lecture materials outside the classroom that can be used anytime and anywhere. The implementation of online mobile learning requires resources capabilities and the availability of mobile networks from the Internet Service Provider is sufficient, and for that, we are doing the measurement and testing of existing network performances.

Based on the results of measurements at 6 points of research location obtained of performance rate that is in accordance with standard parameters broadband QOS LIRNEasia, but, for performance rate of network availability still less than benchmark value that is >98%, only 87.025%, (9/70) 9 times a failure from of 70 times the total internet connection effort made. The failure of internet connection caused by geographical location of Samarinda City which is at altitude 7-25 m, problem of network traffic density, the number of trees around the location also affect the failure of connection to internet.

The research explains that although performance rate such as download and upload speed, latency, jitter, and packet loss metrics are appropriate, not necessarily the level of network availability is appropriate. Because each parameter is influenced by a certain factor.

V. CONCLUSIONS

From the teaching work in these years, we deeply feel that the data structures course is so important for students in the study of computer science and technology. How to turn this course from a difficult and boring course into an interesting course is Becomes an urgent an issue. The Student teaching experience from previous years into an evaluation that this year is much better. This paper has discussed how the implementation of a mobile learning system in the data structures course, various methods and technical approaches used in its development, including measuring and testing network availability.

Based on measurement and implementation of mobile learning application then:

1) The value of network services quality metric parameters such as download and upload speed, latency, jitter and packet-loss values are generally in accordance with performance benchmarks based on QOSE standard of LIRNEASIA, but on the network availability level parameters have not reached the standard.

2) The average value of network availability measurement experienced an internet connection failure rate on one of ISP 84.046% or as many as 10 to 11 times failed to connect from 70 attempts for internet connection.

3) The frequent occurrence of internet connection failure in the measurement site is influenced by the geographical condition of the region in Kalimantan. The number of trees and its hilly terrain.

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