Testing the Usability of the HSPA Wireless Broadband in the Middle East: Jordan and Saudi Arabia as Case Studies

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Abstract

The number of Wireless Internet Broadband users in the Middle East was emerged due to the advances of Mobile technologies. For example, 3.5G (beyond third generation) provides very advanced services such as high wireless internet speed and good quality video/voice telephone calls. In developing countries, this service is still at the initial phase. There are still some obstacles facing people of these countries to use this new service. This paper provides an overview about 3.5G in these countries: Jordan and Saudi Arabia as case studies. It also discusses people's expectations about this service via conducting a questionnaire targeted Internet users. The paper also presents a network assessment experimental test carried out to evaluate the network usability and QoS at selected places of the area where this service is provided. The test was performed on three main network performance metrics: throughput, delay and packet loss. The results showed that the QoS of the network is irregular i.e. it is acceptable at some locations, whereas it is poor at other locations.

Keywords: *Wireless Broadband; 3.5G; HSPA; Network QoS; Network Usability; Jordan; Saudi Arabia.*

1. Introduction

The past decade has brought about many changes in the way people access information. New technologies provided high speed of wireless internet connection. These technologies provided new range of multimedia services such as Video Calls. In this paper we study one of these important technologies which is called HSPA (High Speed Packet Access). At earlier stage, the widely used broadband technology was the DSL (Digital Subscriber Line) which is provided via cables and was playing an important role in connecting people. Recently, HSPA took the lead in broadband connection, not only for the high speed which can be achieved but also for the reason that the whole service is provided wirelessly using the local cellular network [1]. HSPA protocol is one of the Universal Mobile Telecommunications Systems (UMTS) 3G technologies leading the way by providing users with mobile broadband services [2].

This Usability study was performed to test 3.5G UMTS technology using Orange-Jordan and Mobily- Saudi data cards, which utilises HSPA technology in these two developing countries in the Middle East. The test was conducted in different areas of Amman the capital of Jordan and Jeddah the second largest city of Saudi Arabia.

In order to realise the aim of this study, this paper is structured as follows: Section 2 illustrates the Research background. Section 3 discusses the internet in Saudi Arabia. Section 4 discusses the internet in Jordan. Section 5 presents the data collection methodology as well as the outcome of a questionnaire conducted in Jordan. Section 6 illustrates the results of the experimental tests which have been conducted during this project. Finally, section 7 concludes and summarizes the aim, objectives and results of the whole study.

2. Research Background

HSPA is a 3.5G packet air interface protocol which enriches the user experience to a new level of applications, such as video streaming, position location, mobile gaming, and web access. HSPA is designed to provide lower latency with Round Trip Delays of 70 ms, enabling great interactive applications. Theoretically, it allows up to 3.6 Mbps peak data rate for a Category 6 Mobile per user with a classical receiver and up to 14.4 Mbps peak data rate for a Category 10 mobile per user with a special receiver [2].

HSPA offers a new High Speed Downlink Shared Channel (HS-DSCH), commonly used by a number of users. In addition, it introduces the use of adaptive modulation and coding and the use of fast retransmission based on hybrid technique to handle error packets. HSPA also introduces a high speed transmission at the physical layer (2 ms) which is sometimes called Transmission Time Interval (TTI) [2].

Due to the time scheduling aspect of HSPA, Fast Cell Selection (FCS) is used instead of soft handover whilst moving from one cell to another. The mobile device chooses the best cell which provides the best service on the downlink [2,3].

In HSPA the base station determines which device to send data to in the next 2 ms time frame, hence making the most efficient use of the available bandwidth. The base station also determines how much data to send to user devices based on their link account. The HSPA system uses 16 codes, so the base station then determines how many codes to assign to each device within the cell at any given 2 ms time slot, in order to determine the total speed data that should be sent. The base station can assign all the 2 ms time slots and all other 15 codes to a single user device in the cell, and if that device is available within good signal conditions, the maximum data bit rate could be achieved [1,2].

3. Internet in Saudi Arabia

Saudi Arabia is the largest country in the Middle East occupying four-fifths of the Arabian area (see Fig. 1). In south-western Asia, the country is also at the crossroads of three continents: Europe, Asia and Africa. Population growth in Saudi Arabia is recording high rates, grown by an average of 4.3% per annum over the period from 1977 to 2000, rising from 8.060 million in 1977 to 21.5 million in 2000. The factors that contributed to the rise in the population of Saudi Arabia included a marked improvement in the standard of living, health and social conditions. During the last three decades, a large number of non-Saudi labors who participated in the implementation of development programs contributed also to raise these rates [10].

Saudi Arabia and Syria were the slowest states in the region to allow public access to the Internet [11]. The number of internet users in 2000 was around 200,000, while in 2005 it was around 1,500,000 users. The percentage growth between 2000 and 2005 is 650% [11].

Mobily is one of the ISPs in Saudi Arabia [12]. They started providing HSPA service recently. In this study we utilized their network card to test the usability of the 3.5G new technology in the region.

4. Internet in Jordan

Jordan is a developing country located at the Middle East (see the map at Fig. 1). The population of this country is around 5.5 million. Approximately, half of them are based in Amman (the capital) and surrounding area [4]. Jordan was linked to the Internet in 1994. The number of Internet users in 2005 was 457,000 users [11]. Jordan even made the Guinness Book of World Records for the highest concentration of Internet cafés anywhere in the world. There are more than 200 Internet cafés on a single street in Irbid, Jordan [11].

Jordan is one of the countries which have entered recently the world of third generation cellular wireless networking. This service has been provided during the first half of 2010 by Orange Telecom [13]. But the development of this service in Jordan is still at the first stage. Hence, the number of users is still very small relatively [5].

This research aims to compare the people's expectations regarding the 3.5G in the developing countries to the real measurements of this technology which is being provided to them.

Fig. 1 The map of the Middle East where the experiments conducted

5. Data Collection

In order to measure the importance of wireless Internet in developing countries (e.g. Jordan and Saudi Arabia), a group of 100 participants have been selected and asked to fill a questionnaire. This questionnaire was divided into two main parts. The first of which contains questions about the use of Internet in general. The second part contains questions in relation to the people's expectations about the Wireless broadband (e.g. HSPA). The participants were firstly asked a group of questions about the time they spend connecting to the Internet. Then another group of questions have been asked regarding their preferable internet connectivity (Wireless in opposition to Wired). Finally, they have been asked a group of questions concerning the new service itself (HSPA).

Fig. 2 shows the answers of the first question asking: how often do you use the internet in general? The participant's answers showed that most of them (58%) use the internet frequently and 34% use it sometimes and the rest, which is about 8% only, use the Internet rarely. These answers proof that the sample has been selected correctly.
The second question of the first group was asking whether the participants know about this new service or not. As can be seen

in Fig. 3, 85% of them said that they know it whereas only 15% do not. This answer clearly indicates that the sample has been selected correctly and their opinions are having an important effect.

The next question was whether they prefer the Asynchronous Digital Subscriber Line (ADSL), which is the most advanced wired broadband service or 3.5G which is the most advanced wireless broadband service. The answers which are illustrated in Fig. 4 showed that 82% of the sample would like to use the wireless technology whereas 18% only would prefer the wired one. This result gives a clear idea about people's willing to enter the world of 3.5G.

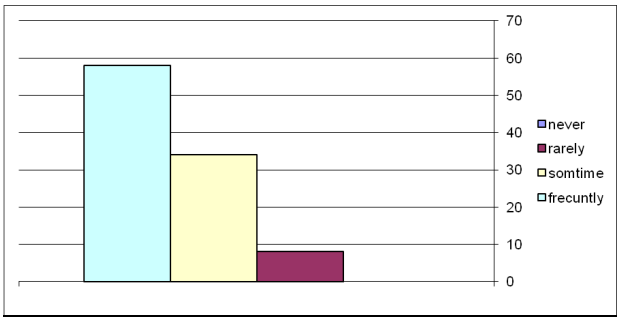

Fig. 2 The Internet Usage

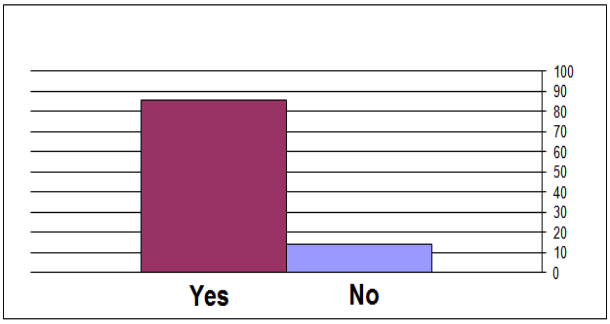

Fig. 3 Number of participants who know 3G+ service

The next part of the questionnaire contains questions about the services provided within the HSPA technology. The participants were asked firstly if they would like to have a wireless connection speed up to 7.2 Mbps. Secondly, they were asked if they would like to make video calls using this new technology. Finally, they were asked if they would like to have better voice call quality. Their answers regarding these three questions are listed in Table 1. As can be seen in the table, 88% of the participants have selected "Yes" for the first question, whereas 12% said "No" for the same question. This result shows that people need to have a broadband Internet on the move while travelling from one place to another.

Besides, 76% of them have selected "Yes" for the second question, where 24% said "No". This result shows that this service will be successful as people would like to use video calls rather than current regular voice calls.

Moreover, 90% of the sample said "Yes" for the third question and 10% of them selected "No". Thus, the majority of people is having problems with the current 2G voice calls and would like to have improved voice calls which can be provided by HSPA [6].

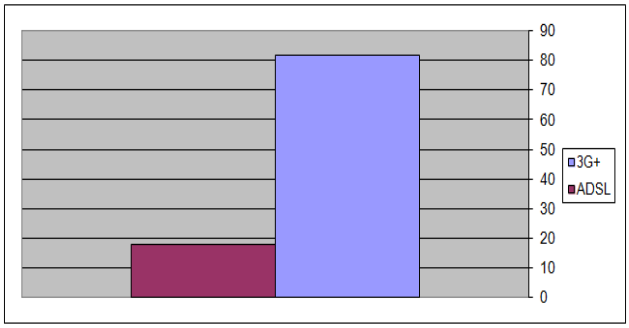

Fig. 4 Preference of 3G+ against ADSL

Table 1: Part two of the questionnaire

Question	Yes	No
Would you like to have a wireless connection speed up to 7.2 Mbps?	88	12
Would you like to make video telephone calls?	76	24
Would you like to have better voice call quality?	90	10

6. Experimental Test.

The second step of this research work is evaluating the performance of the wireless HSPA service in different locations at different times. Therefore, five different places in Amman (Jordan) and Jeddah (Saudi) have been chosen according to how urban the area is. These locations are shown in the map at Fig. 6 and Fig 11.

According to [7], three main issues of wireless network must be tested to evaluate its performance: throughput, delay and packet loss. Consequently, these issues have been tested within this research work many times at each selected location and the average measurement was taken.

The test bed which was utilised during the experimental phase is shown in Fig. 5.A Compaq laptop with Core 2 Due ® processor and a 2GB RAM was connected to a HSPA connector. This connector is the modem which facilitates the Internet access. Data can be sent and received through a cellular (3G) Network. Also, the server which was used to

send/receive data to/from is located at Petra University (Jordan) and King AbdulAziz University (Saudi) was contacted via the Internet.

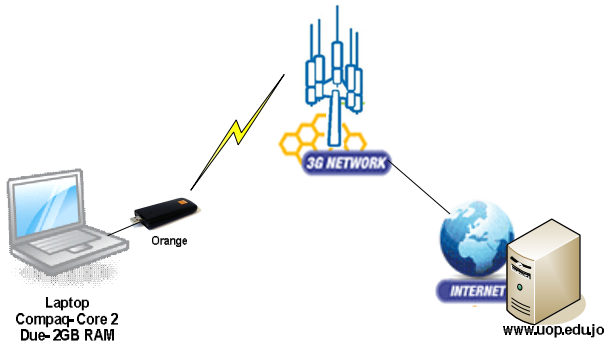

Fig. 5 Setup test of the system

6.1. Experiments in Amman (Jordan)

As can be noticed in Fig 6, the selected positions are located at the western area of Amman. This is because the 3G network is currently available at this area only. Orange™ announced that the whole city will be covered in the near future.

6.1.1. Throughput

Throughput can be calculated by dividing Size of downloaded data over the time taken to download it. Therefore, a 4.47 MB file was used to measure the time taken to download it from a server over the internet, and then this time was recorded. The test was also performed at different times and in different locations. HSPA supports 5, 10, and 15 different codes, with the objective of providing users with adoptive bandwidth allocation depending on their needs. This would give a theoretical throughput of up to 14 Mbps (960 Kbps per code) to users, assuming a user has been allocated with all 15 codes [8]. However, this would not be achieved unless there is only one user located just near the base station.

Fig. 7 shows the average measured time taken to download the file at each location. In this situation, the best throughput was experienced at location 4 whereas the poorest was measured at location 3. In general, the test results at locations 1, 2, 4, and 5 were close to the expected values.

6.1.2. Delay

Delay is the time taken for sending information from sender to destination over a wireless network. In order to test this delay, a ping command was used to send ICMP to measure the Round Trip Time (RTT) [9].

In the first scenario, 100 ICMP's were sent while both Uplink and Downlink are idle. This test was conducted by sending packets to a web site (www.uop.edu.jo) using HSPA link at each selected location. Fig. 8 shows the results of this test. The best case was measured at location 3 and location 4, whereas the poorest was experienced at location 1.

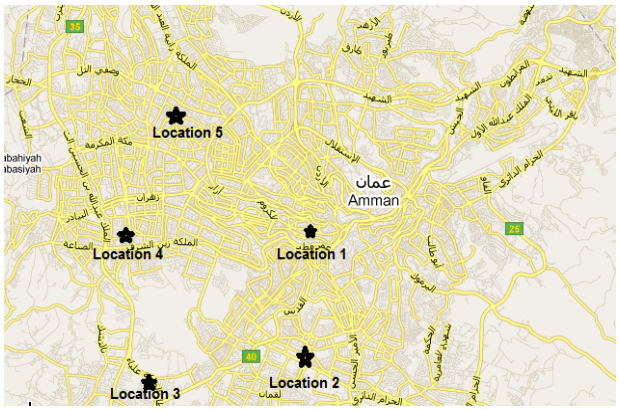

Fig. 6 The five locations of Amman where the experiments took place

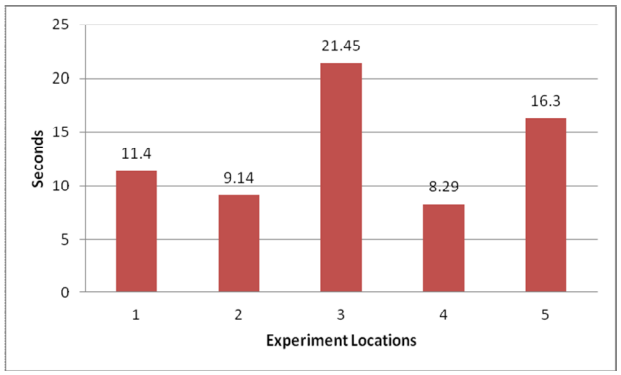

Fig. 7 Average time to download the file measured at each location

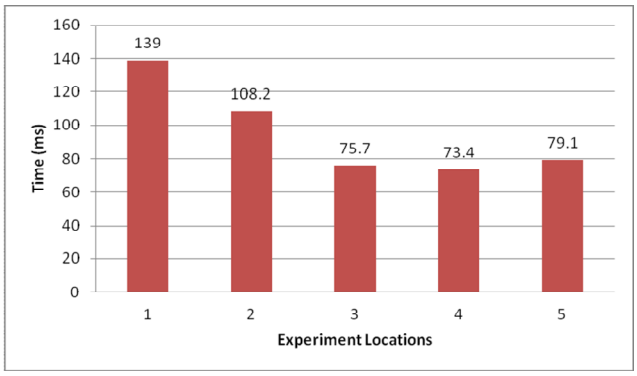

Fig. 8 The average RTT while both Uplink and Downlink are idle at each location

The second scenario of this experimental test is calculating the RTT while the Downlink is busy. This test was performed by pinging the website (www.uop.edu.jo) while downloading data from the same server. The test was repeated many times in different times at each selected location. As can be seen in Fig. 9, the best average RTT was experienced at location 3 whereas the poorest average value was found at location 5.

The third experimental scenario is measuring the RTT while the Uplink is busy. This test was performed by pinging the same website while data is being uploaded to that web server. The test was repeated many times at different times at the selected locations. As can be seen in Fig. 10, the best average RTT was measured at location 3, whereas the poorest was found at location 1 and location 2.

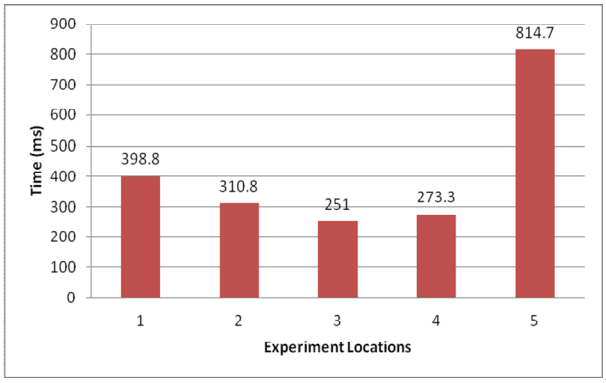

Fig. 9 The Average RTT while downloading data at each location

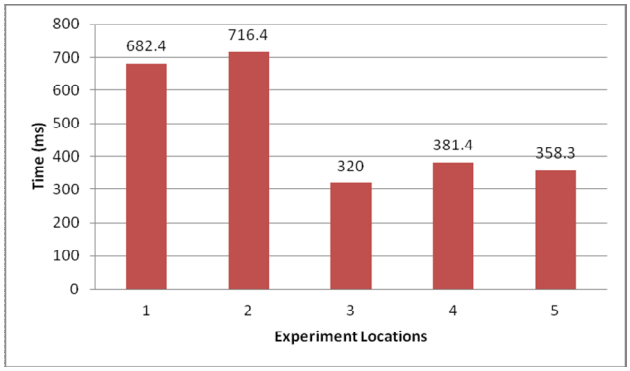

Fig. 10 The average RTT while uploading data at each location

6.1.3. Packet Loss

It is very important to test the packet loss because the more packets the system loses the more re-transmission processes it performs. Likewise, more re-transmission actions carried out will cause more delay in the network. Thus, the test was conducted to monitor the packet loss during different times of day, on different locations and different scenarios. More than 100 packets, in groups of 4, were sent to the website (www.uop.edu.jo), and then all of the packets that did not return were recorded. The test was conducted through two different scenarios: one sending the packets while downloading or uploading a file (busy network), and another without any file being downloaded or uploaded (free network).

The good news is that the average number of the lost packets during these scenarios was very small (only 4.2). These packets where lost while the Downlink was busy, but the average number in all other scenarios was less than 1 packet.

6.2. Experiments in Jeddah (Saudi Arabia)

As can be noticed in Fig 11, the selected positions are located at different areas of Jeddah. This city is located at the western area of Saudi Arabia. It is the second largest city in the country after the capital of Saudi Arabia (Riyadh).

Location 1 is considered to represent a semi urban area. Location 2 is very close to sea with semi urban area. Location 3 has been chosen in an urban district and Location 4 is representing a very crowded urban area. Location 5 is representing very low density areas. It is located outside Jeddah on a highway to Almadinah Almunawwarah City.

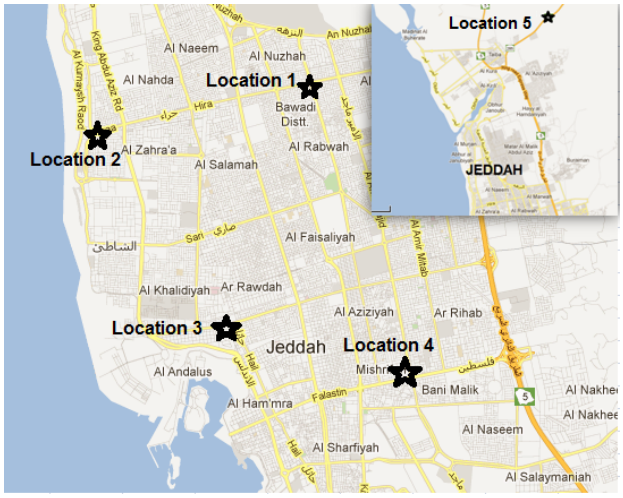

Fig. 11 The five locations of Jeddah where the experiments took place

6.2.1. Throughput

A 2 MB file was used to measure the time taken to download from a server over the internet, and then this time was recorded. The test was performed at different times and in different locations.

Fig. 12 shows the average measured time taken to download the file at each location. In this situation, the best throughput was experienced at location 4 whereas the poorest was

measured at location 3. In general, the test results at locations 1, 2 and 4 were close to the expected values. At Location 5 no 3G signal could be received. It seems that the service doesn't cover suburban environments.

6.2.2. Delay

In the first scenario, 100 ICMP's were sent while both Uplink and Downlink are idle. This test was conducted by sending packets to a web site (www.kau.edu.sa) using HSPA link at each selected location. Fig. 13 shows the results of this test. The best case was measured at location 1, whereas the poorest was experienced at location 4 and no service was received at location 5.

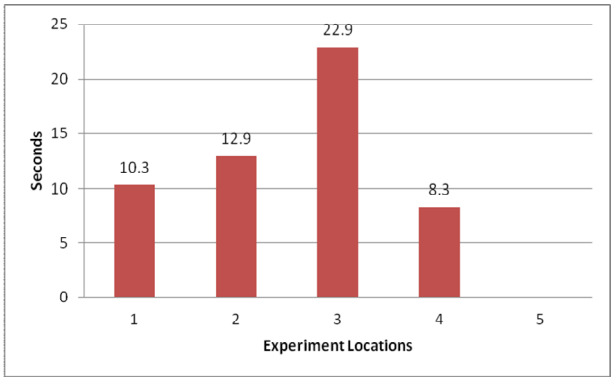

Fig. 12 Average time to download the file measured at each location (Jeddah)

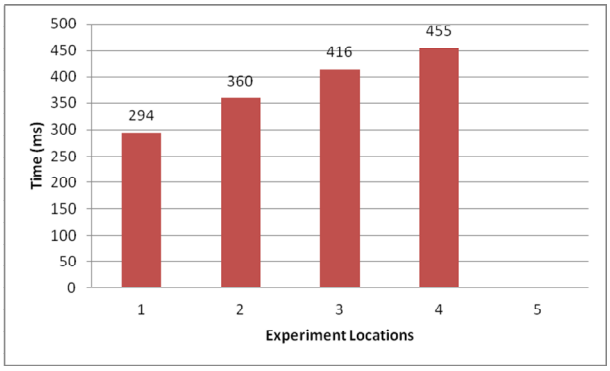

Fig. 13 The average RTT while both Uplink and Downlink are idle at each location (Jeddah)

The second scenario of this experimental test is calculating the RTT while the Downlink is busy. This test was performed by pinging the website (www.kau.edu.sa) while downloading data from the same server. The test was repeated many times in different times at each selected location. As can be seen in Fig. 14, the best average RTT was experienced at location 2 whereas the poorest average value was found at location 4.

The third experimental scenario is measuring the RTT while the Uplink is busy. This test was performed by pinging the same website while data is being uploaded to that web server. The test was repeated many times at different times at the selected locations. As can be seen in Fig. 15, the best average RTT was measured at location 3, whereas the poorest was found at location 4.

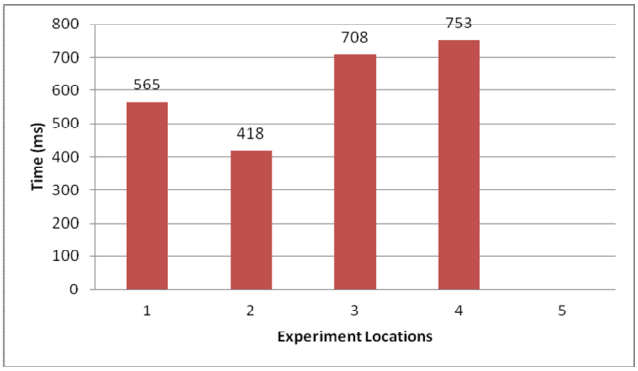

Fig. 14 The Average RTT while downloading data at each location (Jeddah)

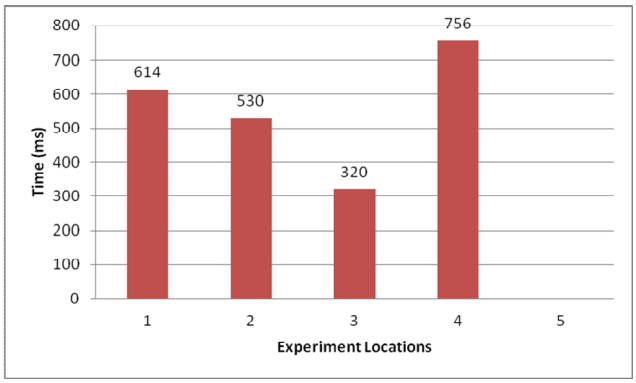

Fig. 15 The average RTT while uploading data at each location (Jeddah)

6.2.3. Packet Loss

During this experimental test, no packet losses have been experienced. This good news is related to the good strength of signal received in locations 1,2,3, and 4.

The outcome of this experimental test shows that the 3.5G network performance provides fluctuated measurements. The QoS is sometimes accepted, whereas at other location or other time of the day it is not. This is because of many reasons: terrain, number of users, weather, etc. As a result, HSPA like any other wireless communication medium is still suffer from such obstacles.

7. Conclusion

In this research work, two main tasks were performed: Questionnaire and real time experiments. The questionnaire methodology and part of the experimental tests have been conducted in Jordan whereas the other part was performed in Saudi Arabia. The outcomes of the questionnaire showed that people of developing countries are willing to use the 3.5G service and are well prepared to enter this world. It showed also that their expectations are very high according to their knowledge about this service. Afterwards, a group of tests was carried out to evaluate the performance of this service and to check if the Network QoS will meet people's expectations or not.

The experimental test results which was conducted in the two countries showed that the QoS of the HSPA network is irregular. Therefore, it would be accepted by users at some locations only. Users might prefer the wired service (DSL) at the locations where the wireless service is poor.

References

[1] M. Jurvansuu, J. Prokkola, M. Hanski and P. Perala. 'HSDPA Performance in Live Networks'. ICC '07. IEEE International Conference on Communications, 2007. Glasgow, UK. Pp. 467 – 471.

[2] M. Necker, A. Weber. 'Impact of Iub Flow Control on HSDPA System Performance'. IEEE 16th International Symposium on Personal, Indoor and Mobile Radio Communications, 2005. PIMRC 2005. Vol. 3 pp. 1703 – 1707.

[3] C. Andersson, 'GRPS and 3G Wireless Applications', Willey, 2001, pg 158.

[4] Jordanian Ministry of Tourism. Web site: http://www.tourism.jo/Home/index.htm. Accessed on 1 Feb. 2011.

[5] F. Qawasmeh and M. Bataineh, 'The Impact of Technological Choices on Competitive Strategy: Orange Jordan as a Case Study'. American Journal of Scientific Research. EuroJournals Publishing, Inc. 2010. ISSN 1450-223X Issue 9 (2010), pp.30-46.

[6] B. Beheshti. 'Study of the technology migration path of the cellular wireless industry from 3G to 3.5G and beyond. Long Island Systems', Applications and Technology, 2005. Print ISBN: 0-7803-8930-1. Pp. 15 – 28.

[7] M. Claypool, R. Kinicki , W. Lee , M. Li , G. Ratner, 'Characterization by measurement of a CDMA 1x EVDO network', Proceedings of the 2nd annual international workshop on Wireless internet, p.2-es, August 02-05, 2006, Boston, Massachusetts.

[8] I. Forkel, H. Klenner, 'High Speed Downlink Packet Access (HSDPA)--a means of increasing downlink capacity in WCDMA cellular networks', Proceedings of the European Wireless Conference, Barcelona, Spain, 2004.

[9] S. Benford, 'Coping with Uncertainty in a Location-Based Game', IEEE Pervasive Computing, September 2003, pp. 34-41.

[10] I. Dincer, B. Al-Rashed, 'Energy analysis of Saudi Arabia', International Journal of Energy Research 26 (3), 263–278.

[11] L. Deborah Wheeler, 'Empowering publics: Information Technology and democratization in the Arab World—Lessons from Internet cafés and beyond', Oxford Internet Institute , Research Report No. 11, July 2006.

[12] Mobily Telecom. Internet web site: http://www.mobily.com.sa. Accessed on: 27/12/2012.

[13] Orange Telecom. http://www.orange.jo. Accessed on: 27/12/2012.

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