مجلة العلوم البحتة والتطبيقية
Journal of Pure & Applied Sciences
www.Suj.sebhau.edu.ly ISSN 2521-9200
Received 15/06/2018 Revised 19/12/2018 Published online 15/01/2019

Study and design new model for Quality of Service Measurements in Mobile Networks sector

*Ali Abudraa , Nassir Abuhamoud
School of Communication and Computer Engineering, Sebha University, Libya
*Corresponding author: Ali.abudraa@sebhau.edu.ly

Abstract In mobile networks, performance evaluation is an important part in modeling and designing effective schemes to utilize the limited resource. In the past, performance evaluation was carried out either under restricted assumption on some time variables such as exponential assumption or via simulations. In This paper discusses different schemes for providing Quality of Service (QoS) in cellular networks. Each scheme has its own algorithm to provide QoS and every scheme has its advantages and disadvantages. We have also dealt about an important aspect of QoS which is the Individual QoS (iQoS). iQoS measures the satisfaction rate per user and it is measured individually at each and every user terminal. Voice traffic is very delay sensitive and data traffic is loss sensitive. QoS schemes which try to incorporate both voice and data have to take into consideration this issue.

Keywords: Performance, Evaluation, Mobile, Telecommunications, Network, Quality, Service, Call, Ratio.

دراسة وتصميم نموذج جديد لقياس جودة أداء شبكات الهاتف المحمول

*علي محمد أبودراع و ناصر أبوهامود
قسم الهندسة الإلكترونية والحاسوب–كلية العلوم الهندسية والتقنية– جامعة سبها، ليبيا
*للمراسلة: Ali.abudraa@sebhau.edu.ly

الملخص في شبكات الهاتف المحمول، يعتبر تقييم الأداء جزءاً مهماً ورئيسيا في وضع السياسات العامة للشركات ورسم الخطط الفعالة للاستفادة من الموارد المحدودة. في الماضي، تم تنفيذ تقييم الأداء إما في إطار قياس بعض قراءات الشبكة وحساب سرعة الاستجابة والتحمل في أوقات الذروة أو عن طريق المحاكاة. ولاكن نتيجة لتطور الخدمات وزيادة تعقيد التقنيات المستخدمة أصبحت الوسائل القديمة غير ذات جدوة حقيقية لانها لاتعبر ولا تستكشف الخدمة المقدمة من وجهة نظر المستخدمين.هنا نناقش مخططات مختلفة لقياس جودة الخدمة (QoS) في الشبكات الخلوية. كل نموذج لديه خوارزمية خاصة بها لقياس جودة الخدمة ولكل نموذج مزاياه وعيوبه. كما تناولنا جانباً مهماً من جودة الخدمة (QoS) وهو جودة الخدمة الفردية (iQoS) او ما يعرف بتجربة المستخدم، حيث يقاس معدل الرضا التقني لكل مستخدم ويتم قياسه بشكل فردي في كل محطة طرفية للمستخدم. سرعة وجودة حركة مرور البيانات الصوتية. حيث سيتم في نهاية الورقة الوصول الى النموذج النظري المناسب لتقييم شبكة الليبيانا بالمنطقة الجنوبية ومن ثمة وضع المنهجية للجانب العملي التطبيقي لقياس جودة الخدمة.

الكلمات المفتاحية: الأداء، التقييم، الهاتف المحمول، الاتصالات، الشبكة، الجودة، الخدمة، الاتصال، النسبة.

Introduction

Increased failure to access and engage communication channels, increased low calls and poor quality of public service are some of the continuing problems faced by cellular networks. The quality of the telecommunications service remains a major concern worldwide in the mobile communications industry.

In wireless cellular networks, call connection premature termination (call dropping) is possible due to an unsuccessful handoff when the user moves out the current cell coverage while the target cell does not have resource to serve the call connection [14,15,16]. In order to reduce such forced call termination, call arrivals (new calls and handoff calls) have to be treated differently, which leads to the call admission control (CAC) and resource management in wireless cellular networks. Various priority-based CAC schemes have been proposed [14] in the literature, they can be classified into two broad categories: (1). Guard Channel (GC) Schemes: Some channels are reserved for handoff calls. Three different schemes can be identified. The first scheme, the cutoff priority scheme, is to reserve a portion of channel for handoff calls, whenever a channel is released, it is returned to the common poll of channels [11,12]. The second scheme, the fractional GC schemes is to admit a new call with certain probability (which depends on the number of busy channels). This scheme was first proposed in. [9] and shown to be more general than the cutoff priority scheme. The last scheme is to divide all channels allocated to a cell into two groups, one is for the common use for all calls while the other is for handoff calls only (the rigid division-based CAC scheme [48]). (2). Queueing Priority (QP) Schemes: In this scheme, calls are accepted whenever there are free channels. When all channels are busy, either new calls are queued while handoff calls are blocked [16], or new calls are blocked while handoff calls are blocked [17], or all arriving calls are queued with certain rearrangements in the queue [14]. Various combinations of the above schemes are possible depending on specific applications [14]. Performance evaluation of these schemes are important in choosing the appropriate parameters.

Moreover, under a specific CAC scheme, the call connection performance is also crucial to meet the design requirements. With the given call blocking probabilities, we need to find the call dropping probability (for the premature call termination), handoff probability, handoff rate, and actual call holding times. It is desirable that all these quantities can be computed under more general assumptions.

Another important problem in wireless mobile networks is mobility management. In order to effectively deliver a call connection service to a mobile user, the location of a called mobile user must be determined within a certain time limit (before the service is blocked). When the call connection is in progress while the mobile is moving, the network has to follow the mobile users and allocate enough resource to provide seamless continuing service without user awareness that in fact the network facility (such as base station) is changing. Mobility management is used to track the mobile users that move from place to place in the coverage of a wireless network or in the coverage of multiple communications networks working together to fulfill the grand vision of ubiquitous communications. Thus, mobility management is a key component for the effective operations of wireless networks to deliver wireless services [1]. In wireless cellular systems, two operations are usually used to carry out the mobility management: location update and terminal paging. Location update is a process for a mobile user to inform the network where it is, while terminal paging is a process that the network attempts to locate a mobile user in the area it was last reported, which is called uncertainty area. Both processes will invoke signaling traffic in the signaling networks. The more frequent the location update, the higher the signaling traffic for location updates, while the smaller the uncertainty area, hence the lower the signaling traffic for terminal paging. On the other hand, the less frequent the location update, the lower the signaling traffic for the location updates, while the larger the uncertainty area, hence the higher the signaling traffic for terminal paging. Hence, there is a tradeoff between the location update and terminal paging. How to balance these two kinds of signaling traffic is important for the mobility management? To come up with an optimal design for mobility management, we need to quantify the total signaling traffic analytically so that optimization can be carried out.

To obtain analytical results for performance evaluation in wireless cellular networks, and even in general communications networks, time variables are usually assumed to be independent and exponentially distributed. For example, in the study of call blocking performance for the traditional cellular networks and PCS networks, the following assumptions are commonly used in order to obtain some analytical results: the interval time of cell traffic, the call holding time, and the channel holding time are all assumed to be exponentially distributed [9]. However, field data and simulation study showed that exponential assumption is not appropriate. In References [8], it has been shown that the channel holding time is not exponentially distributed for many wireless and cellular systems. In Reference [13], under certain assumptions, we showed that channel-holding time is exponentially distributed if and only if the cell residence time is exponentially distributed, where the cell residence time is the time a mobile user stays in a typical cell. The study for common-channel signaling (CCS) networks [11] demonstrated that the call holding time could not be accurately modeled by exponential distribution and showed that the mixed-type probability distribution model is much more appropriate. In Reference [7], the authors showed that the cell traffic is smooth (which implies that the interval-times for the cell traffic cannot be modeled by Poisson process). Thus, it is imperative for us to seek more general distribution models for the time variables needed to carry out more effective performance evaluation.

Distribution models, such as the exponential distribution, the lognormal distribution, the Erlang distribution, the (generalized) Gamma distribution, and Coxian distribution have been used to approximate the distributions of the channel holding times in the past [14, 15]. It is well-known that exponential distribution can be used for one-parameter approximation of the measured data, while the Gamma distribution can be used for two-parameter approximation. Although the exponential and Erlang distribution models have simple good properties for queueing analysis, however, they are not general enough to fit the field data. The (generalized) Gamma and lognormal distributions are more general and has been shown to provide good fits to field data, however, application of these models will lead to the loss of the Markov property required in the queueing analysis [16]. Two new models were proposed for the mobility modeling for wireless cellular networks. One is the so- called Sum of Hyper-exponential (SOHYP) models [6], which has been used to model the channel holding time for cellular systems with mixed plat- forms and various mobility. The other model, called the mixed Erlang model (Hyper-Erlang model as we used in the past) [30], is used to model the cell residence time for wireless cellular networks. It has been demonstrated that the mixed-Erlang models and SOHYP models can approximate any distribution of nonnegative random variables [6]. In fact, both models belong to a more general class of distribution models called phase-type distribution, which has been extensively applied in performance evaluation in computer systems [6]. The popularity of phase-type distribution is because such distribution model leads to tractable queueing analysis using the quasi-birth- death (QBD) process [5]. Due to the generality of phase-type distribution, we can use it to model many time variables in the performance evaluation of wire- less cellular networks. Fang et al. [2] devel- oped a new unifying analytical approach to evaluating the call connection performance under more realistic distribution models for call holding time and cell residence time. Li et al. [4,5] proposed more general Markov correlated arrival process to charac- terize the new calls and handoff calls, and obtained many analytical performance results under general channel holding time distribution such as phase-type distribution. To capture the effect of link unreliability, Zhang et al. [8] and references therein general- ized many aforementioned analytical results recently. The performance of hierarchical cellular systems under generally distributed call holding times and cell residence times were also carried out lately (see References [6]). On a significantly different re- search front, applying the mathematical technique we developed in the past (see Reference [8]), we also analyzed a few mobility management schemes.

1. Models of QoS.

1.1. Service Quality

According to the Nordic model [14], a pioneer work in the area of quality of services, the quality in traditional people-oriented services is estimated from the comparison between the expected and perceived quality. The model conceptualizes perceived service quality by differentiating between the 'what' (what the consumer receives as a result of his interaction with a service provider – technical quality) and 'how' (how they get the outcome resulting from their interactions with the seller – functional quality) components of the buyer-seller interaction (Fig. 1).

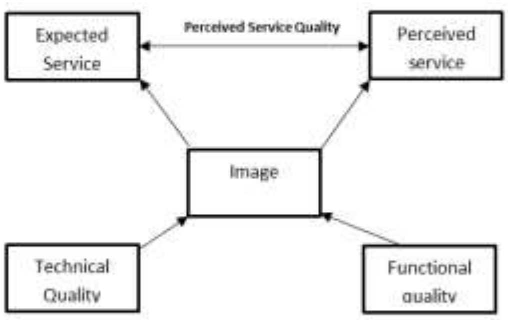

Figure 1: Nordic Model.

Brady and Cronin in [15] combined practice and theory together and justified the importance of developing favorable service among consumers. They developed a hierarchical multidimensional model, adopting at the first level the approach of Rust and Oliver [16], in which the overall quality is composed of three main dimensions: interaction (service delivery), outcome (service product), and physical environment (service environment). As it is depicted in Fig. 2, comparing to the Nordic model, the dimension of environment has been added. For each dimension, the following three sub-dimensions have been suggested:

Interaction quality

- Attitude: friendly service
- Behavior: polite gestures
- Expertise: trained personnel

Physical environment quality

- Ambient conditions: e.g., temperature
- Design: aesthetically attractive spaces
- Social factors: behavior of bystanders

Outcome quality

- Waiting time: accuracy of service (in time)
- Tangibles: the obtained material goods
- Valence: the final impression.

1.2. Quality of Electronic Services

The quality of electronic services (e-services) is defined as the measure according to which an online service is able to meet customer needs efficiently and effectively [17]. Among the studies in the e-services area, the e- SERVQUAL model [7] is noteworthy. Zeithaml et al. developed this model as a specialization on e-services of the SERVQUAL model [18], a widely used measurement scale for service quality. They analyzed why most online companies fail to respond effectively to their customers' requirements. The result of their analysis depicts the reasons for failure as internal business weaknesses and shortages [19]. The authors identified 11 e-service quality dimensions:

- Access (to the website or the company when needed).
- Assurance/trust (customer feels confident dealing with the site).
- Ease of navigation (moving easily and quickly through the website pages).
- Efficiency (site is simple to use, minimal data required as input by the customer).
- Flexibility (in accomplishing an electronic transaction).
- Customization/personalization (based on customer's preferences and purchase histories).
- Price knowledge (concerning total, shipping, and comparative prices).
- Security/privacy (site is safe from intrusion; personal information is protected).
- Site aesthetics (appearance attributes).
- Reliability (correct technical functioning of the site, keeping promises made to the customer).
- Responsiveness (quick response to customer's requirements).

Other models worthy of note in this category are the e- S-QUAL and the e-RecS-QUAL scales suggested by Parasuraman et al. in [20]. The authors decreased the number of quality of services to seven:

- Efficiency (accessing and using the site easily and quickly).
- Fulfilment (keeping promises about order delivery and item availability).
- System availability (correct technical functioning of the site).
- Privacy (the site is safe, customer information is protected).
- Responsiveness (effective handling of problems).
- Compensation (the site compensates customers for problems).
- Contact (assistance through telephone or online representatives).

The first four dimensions were said to constitute "core" quality (e-S-QUAL scale), whereas the last three were said to constitute "recovery" quality (e-RecS-QUAL scale).

1.3. Mobile Service Quality

Mobile setting has several particularities that influence service quality. There is, at least, a need for a proper interpretation of the quality dimensions identified in the electronic context. Chae et al. in [1] investigated m-service information quality considering information quality issues, as well as m-commerce characteristics, such as context and mobile devices. They concluded on the following main factors of information quality for wireless Internet services:

Figure 2: Model of Cronin and Brady.

- **Connection quality:** dealing with consumers having access to stable m-services without interruption of connection. It also supports speedy system responses to users' requests.
- **Content quality:** referring to the inherent value and usefulness of the information provided by m- services.
- **Interaction quality**: dealing mainly with the provision of easy and efficient m-services.
- **Contextual quality:** referring to the ubiquitous nature of m-services and personalization issues. However, these four dimensions only focus on the information quality rather than service quality.

2.METHODOLOGY

To properly evaluate QoS of data services in cellular networks, analysts must follow a methodology that considers user-experiences in specific application scenarios. Furthermore, the evaluation methodology must allow users to compare how well networks perform (relative to competitors) in the same geographical region based on predefined evaluation criteria. The evaluation methodology must also allow users to assign priorities to evaluation criteria to customize the results based on particular classes of applications. The creation of such methodology is achieved as follows. First, drive-testing is performed to collect objective measurements associated with identified QoS criteria for data services. Once drive-testing is completed and the data collected, the AHP technique is used to compare multiple networks and determine the network that provides higher QoS based on users' perception of quality. The output provided by the AHP approach can be used as unified measurement of the perceived QoS by users on different networks. In order to determine application-specific priorities, the approach presented here uses the application classes identified in [5], that is: Emergency, Business, and Personal. For each class, the relative importance of each quality evaluation criteria is adjusted in the AHP procedure to reflect the priorities of the services expected. Identify appropriate locations for measurements, taking into account the following:

- **Cover most of the city area**
- **coverage of areas characterized by different levels of congestion during the day**

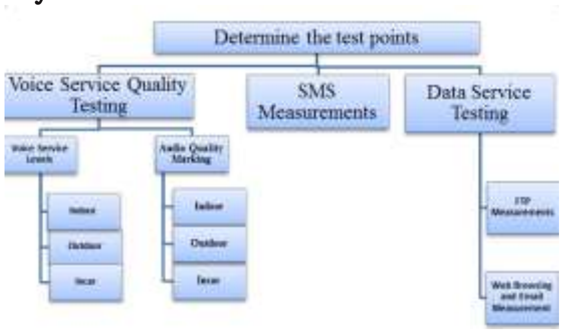

Figure 3. Methodology of evaluate QoS.

1.4. Voice Service Quality Testing

A-Voice Service Levels:

Voice measurements were performed in three configurations:

- Indoor Pedestrian Indoor in public and private buildings
- Outdoor Pedestrian Outdoor in the busiest outdoor places. 1/3 of the measurements were dynamic, walking from one point to another and 2/3 were static.
- Incar On road links (Incar Road) and within Town borders (Incar Town) Calls included 70% Mobile to Mobile (MTM) own network, 20% MTM cross networks and 10% Mobile to land line

B - Audio Quality Marking

- Testing Area and Sample Size

1.5. SMS Measurements

A measurement consisted of:

- Sending a 26 characters message including an index, and recording time.
- Observing when transmission is acknowledge on the phone and taking note of the time.
- Observing reception of the message on the other phone and taking note of the time; a message not receive after 2 minutes and that has elapse time was marked as failed.
- Opening and checking integrity of the receive message and index matching.

1.6. Data Service Testing

• FTP Measurements

a measurement consisted of:

- Attempting to set up a radio connection before a 1 minute timeout. Connection time is recorded.
- Downloading 5MB file via FTP. Download time of the entire file is recorded (Test of integrity).
- Uploading 1MB file via FTP. Uploading time of the entire file is recorded

In case of error, the software record the error type based on pre-defined error codes such as: FTP server connection error, radio signal drop, data transfer timed out set at 10 minutes etc.

• **Web Browsing and Email Measurement**

Web and Mail measurements are carry out automatically with Mobi.Net © (introduce dearlier).

1.7. Drive Test.

Drive-testing is performed by placing calls, either voice or data, to a cellular network and recording the data from these calls. The calls are automated by test equipment and the data are geographically referenced by using a GPS unit. A typical setup for the drive testing equipment for PS data measurements is presented in Figure 1. As seen, the setup consists of the in-vehicle equipment and appropriate PS data server. The in-vehicle equipment controls data cards (or other data communicating devices), associated with the cellular networks under test. The PS data server is connected to the cellular networks through the Internet cloud. The connectivity between the PS data server and the Internet is accomplished through high bandwidth dedicated lines. This way the performance of the data service is primarily determined by the performance of the cellular side of the network. The in-vehicle equipment controls data devices and it is programmed to execute a sequence of actions. Depending on what needs to be tested, the sequence may include one or multiple data services.

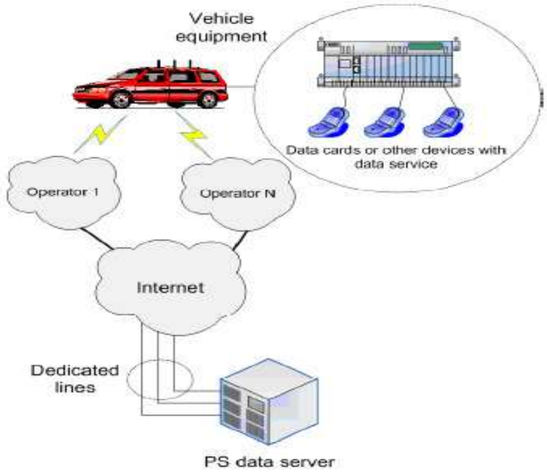

Figure 2. Drive Testing Setup Overview

CONCLUSION

By reviewing the literature, we concluded that the model suggested by Lu et al. in [15] is a contemporary approach, appropriate to define m-service quality. It is based on three core dimensions which were found in many other researchers' work. However, we considered that a few changes need to be made concerning specific sub dimensions. In detail, we added in our model the sub-dimensions of security/privacy and customization/ personalization. Security and privacy issues still have a strong impact on the m-service quality, despite the technological advances in network channels and devices. Communication channel threats are significant network-centric aspects of m-services that need to be considered. Mobile device's instant connectivity and user-friendliness make it an ideal tool for e-crime activities [17]. Besides, malicious users can easily find their unsuspected victims, because security awareness in mobile environment is still in its infancy. We also stressed the importance of customization/personalization upon the delivery of m-service quality. Users prefer to access more personalized and customized services using their mobile devices. The goal of mobile applications should increasingly make their services more personalized and customized towards users. Consequently, personalization and customization should be considered as technologies to enable service differentiation down to the level of the individual [20]. It should also be mentioned, that in our model we omitted the attitude sub-dimension since we believe it should be included in personalized and customized aspects of m-services. Regarding the dimension of outcome quality, we changed the sub- dimension punctuality to reliability, since the second term has a broader meaning and covers the timely accurate aspects of punctuality.

REFFERENCES

[1]- Blery E., Batististatos N., Papastratou E., Perifanos L., Remoundaki G. and Retsina M. (2009). Service quality and customer retention in mobile telephony. Journal of Targeting, Measurement and Analysis for Marketing, V: 17, No.1

[2]- Nassir Abuhamoud. Evaluation of L2 Trigger Impact on Fast Mobile IPv6 Handover. International Journal of Innovative Technology and Exploring Engineering (IJITEE). Vol. 04. 2014.

[3]- The Telecommunications Regulatory Authority (Tunisia 2015). Quality of Service REPORT,

[4]- The Telecommunications Regulatory Authority (UAE 2015). Quality of Service REPORT,

[5]- M. Chae, J. Kim, H. Kim and H. Ryu, "Information quality for wireless internet services", Electronic Markets, vol. 12 no. 1, pp. 38-46, 2015.

[6]- A. Seth, H.M. Gupta and K. Momaya, "Quality of service parameters in cellular mobile communication", International Journal of Mobile Communications, vol. 5 no. 1, pp. 68-93, 2007.

[7]- V.A. Zeithaml, L.L. Berry and A. Parasuraman, "The Behavioral Consequences of Service Quality", Journal of Marketing, vol. 60 no. 2, pp. 31-64, 1996.

[8]- A. Aladwani and P . Palvia, "Developing and V alidating an Instrument for Measuring User-Perceived Web Quality", Information and Management, vol. 39 no. 6, pp. 467-476, 2002.

[9]- S.I. Swaid and R.T. Wigand, "Measuring the quality of e-service: Scale development and initial validation", Journal of Electronic Commerce Research, vol. 10, no. 1, pp. 13-28, 2009.

[10]- M. Wolfinbarger and M.C. Gilly, "eTailQ: dimensionalizing, measuring, and predicting etail quality", Journal of Retailing, vol. 79 no. 3, pp. 183-98, 2003.
[11]- N. Abuhamoud, Ems. Geepalla. Using Spatio-Temporal Role Based Access Control for Physical Access Control Specification: Towards Effective Cyber-Physical Systems . International Journal of Innovative Science and Modern Engineering (IJISME), vol. 03. 2015.
[12]- C. Voss, "Rethinking Paradigms of Service: Service in a Virtual Environment", International Journal of Operations & Production Management, vol. 23 no. 1, pp. 88-104, 2003.
[13]- J.E. Francis and L. White, "Value Across Fulfillment-Product Categories of Internet Shopping", Managing Service Quality, vol. 14 no. 2/3, pp. 226-234, 2004.
[14]- J.V. Chen and B.A. Aritejo, "Service quality and customer satisfaction measurement of mobile value-added services: a conceptual review", International Journal of Mobile Communications, vol. 6 no. 2, pp. 165-176, 2008.
[15]- Y. Lu, L. Zhang and B. Wang, "A multidimensional and hierarchical model of mobile service quality", Electronic Commerce Research and Applications, vol. 8, pp. 228-240, 2009.
[16]- N. Abuhamoud, Ems. Geepalla, " , The First Scientific Symposium Of Electrical And Electronic Engineering (EEES) " 2016.
[17]- E.T. Loiacono, R.T. Watson and D.L. Goodhue, "WebQual: An Instrument for Consumer Evaluation of Web Sites", International Journal of Electronic Commerce, vol. 11 no. 3, pp. 51-87, 2007 (WebQual was introduced in Marketing Educators' Conference: Marketing Theory and Applications, vol. 13 pp. 432-437, 2002).
[18]- [C. Grönroos, "A service quality model and its marketing implications", European Journal of Marketing, vol. 18 no. 4, pp. 36-44, 1984.
[19]- M. Brady and J. Cronin, "Some new thoughts on Conceptualizing perceived service quality: a hierarchical approach", Journal of Marketing, vol. 65, pp. 34-49, 2001.
[20]- R. Rust and R.L. Oliver, "Service quality:Insights and managerial implications from the frontier. In: R. Rust and R. L. Oliver (eds), Service Quality: New directions in theory and practice, Sage publications, Thousand Oaks, CA, 1994.
[21]- M. Fassnacht and I. Koese, "Quality of electronic sevices: Conceptualizing and testing a hierarchical model", Journal of Service Research, vol. 9 no. 1, pp. 19-37, 2006.