The Importance of QoS & QoE Management in Wireless Communication System

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Abstract

Now a day, Wireless communication systems are popular due to its wide advantages. In the customer’s point of view, we can say the most of the customer requirements related to communication from one place to another place are fulfilled up to the most extent using these systems. The initiation to these wireless communication systems started to satisfy the minimum requirements of the customers therefore the first generation (1G) mobiles are came into the picture, there after according to customer satisfaction the requirements are increased and therefore the evolution started from 1G and now it is reaching 4G. In this evolution we take care about the quality of service (QoS) and quality of end user experience (QoE) which customer requires is important. By maintaining QoS as well as QoE we can maintain the level of customer satisfaction, so the QoS & QoE management in wireless communication systems is significant particularly in the design part of the system.

Keywords: Quality of service (QoS), Quality of end user experience (QoE), Key performance inductor (KPI), Network management system (NMS).

1. Introduction

In design of any system Quality of Service (QoS) is one of the important issues from both customers and providers Point of view that means customers expect the service of best quality from the system providers and providers want to give best quality of service to the customers from the system. Same in case of wireless communication systems also. All the parameters related to QoS are having different importance for all customers and applications. The contentment level of different customers depends on different QoS parameters. We can define different definitions for QoS and Quality of end user experience (QoE) according to the application as well as satisfaction level of customers. Any way in this paper we try to define the terms from two different perspectives one is technical another one is non-technical perspective. In this paper we defined QoS is the quality provided to the customers which describes ability of the network with an assured service level and QoE is used to describe the perception of end-users on how usable the services are.
To provide better QoE to customers in an efficient manner i.e. with respect to cost as well as with QoS. From this point we understood that QoS & QoE are mutually dependent and to achieve QoE, QoS is the basic building block [1]. Now a day the 3G networks in wireless communication systems are providing services to offer multimedia applications to meet customer requirements. There are many changes occurs in the evolution scenarios from first generation mobile networks to 3G networks. the most popular standards deployed for 1G systems were Advanced Mobile Phone System (AMPS), Total Access Communication Systems (TACS) and Nordic Mobile Telephone (NMT) [2,3].

2. Requirement of QoS & QoE

Before going for the requirement of QoS and QoE, the technical definitions for these two are: QoS is defined as the ability of the network to provide a service at an assured service level & QoE is simply depends on customer satisfaction in terms of usability, accessibility, retain ability and integrity of the service.
QoE, however, is not limited to the technical performance of the network; there are also non-technical aspects, which influence the overall user perception. The fig.2 shows QoE is affected by the technical QoS and non-technical aspects of service. The reliability in service concerns throughput, delay, jitter and loss in data during transmission of data; service availability, security in terms of authentication, coverage area, and service setup time of the related bearer service; service retain ability, in general, characterizes connection losses. ‘QoE’ refers to the personal feelings of the customer about the quality of a service, & expresses using perceptive words like ‘good’, ‘excellent’, ‘poor’ but QoS is a technical perception, It is measured, expressed and understood in terms of networks and network elements. A better network QoS in can result in better QoE. QoS are QoE is only measured using satisfaction level of a customer [1].

### Table I

<table>
<thead>
<tr>
<th>Layer</th>
<th>Application layer</th>
<th>Network layer</th>
<th>Physical layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voice Transmission</td>
<td>• Call rates</td>
<td>• Jitter</td>
<td>• Bit error rate</td>
</tr>
<tr>
<td></td>
<td>• Jitter</td>
<td>• Call handover delay</td>
<td>• Signal to noise ratio</td>
</tr>
<tr>
<td></td>
<td>• Quality of speech</td>
<td>• Call Transfer delay</td>
<td>• Noise figure</td>
</tr>
<tr>
<td></td>
<td>• Accessibility in service</td>
<td>• Accessibility in network</td>
<td>• Path loss</td>
</tr>
<tr>
<td></td>
<td>• Call start-up delay</td>
<td>• Error rate and Loss rate</td>
<td>• Received signal strength</td>
</tr>
<tr>
<td></td>
<td>• Response time</td>
<td>• Traffic handling priority</td>
<td>• Channel capacity</td>
</tr>
<tr>
<td></td>
<td>• Codec delay</td>
<td>• Network allocation</td>
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</table>

The most of QoS parameters are associated to application layer, network layer or physical layer and the QoS parameters for all the layers are not same & the mechanism for different layers are also different. The relationship of QoS parameters in terms of voice, video and data transmission is given in the table I, table II and table III [4-10].
3. **QoS and QoE Management**

The management of QoS and QoE can be classified into four categories: Network planning, QoS provisioning, QoS – QoE monitoring and Optimization.

### 3.1. Network planning

The initial planning provides an estimate of the required number of radio, transmission and core network elements and the capacity of related interfaces & capacity and coverage are analyzed for each relevant part of the network and interfaces between the entities in communication. This requires real traffic estimates and a network topology for each analyzed area, the utilization of accurate models for signal and user data transmission, and the actual network element’s characteristics, functionalities and parameters [1]. The well-planned network is the base for a radio platform. The Issues like the location of sites has a major impact on the distribution of the radio signal that means indirectly on call quality. The faults rectification is also very important in planning. Along with the above considerations the frequency planning & parameterization are also important for network performance. If we do not have a good frequency plan it leads to interference (co-channel) in signal transmission. Parameterization, standard parameters have been used in network performance. Each cell operates under unique conditions and requires customization of parameter values to provide optimum network performance. Automation can be applied to all the tasks shown in Fig. 3 with a view to attracting network performance and at the same time reducing the man-effort required to carry out the task. This means that through the application of automation to these tasks, the data transfer cost can be reduced [11, 21].

![Automation Tasks](https://via.placeholder.com/150)

**Figure 3. Network planning tasks**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Application layer</th>
<th>Network layer</th>
<th>Physical layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td>• Call rates&lt;br&gt;• Packet loss rate &amp; Error rate&lt;br&gt;• throughput&lt;br&gt;• End-End one way delay&lt;br&gt;• Jitter&lt;br&gt;• Web browsing one way delay&lt;br&gt;• Service accessibility</td>
<td>• Call handover delay&lt;br&gt;• Maximum bit rate&lt;br&gt;• Accessibility in network&lt;br&gt;• Error rate (frames per second) and Loss rate&lt;br&gt;• Network allocation / Priority</td>
<td>• Frame error rate&lt;br&gt;• Signal to noise ratio&lt;br&gt;• Noise figure&lt;br&gt;• Path loss&lt;br&gt;• Received data signal strength&lt;br&gt;• Channel capacity</td>
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### 3.2. QoS provisioning

It is a process which spreads QoS in networks and mobile terminals. QoS provisioning can be classified in three categories: Radio, core and transport (IP and data link layer) QoS provisioning, Service QoS provisioning and Terminal QoS provisioning [11, 12].

#### 3.2.1. Radio, core and transport QoS provisioning

It configures QoS mechanisms inside the network & describes the network element functionalities that need to be configured and
maintained with parameter settings and QoS policies. The main objective of radio, core and transport (IP layer and DLL) QoS provisioning is to ensure that QoS differentiation mechanisms are provisioned at all network layers. Second objective of radio, core and transport QoS provisioning is to deploy QoS mapping between layers. One can view QoS provisioning as configuring bit pipes that will treat differently. It is hence not enough to only configure pipes at different layers. A proper mapping between the bit pipes at different layers must also be provisioned [13, 14].

3.2.2. Service QoS provisioning

Maps services onto bearer QoS attributes Implementation of 3GPP QoS provides means to operators to change from ‘best-effort’ radio network planning, provisioning, optimization and monitoring to a more service oriented approach. This section briefly describes how a particular subset of QoS parameters (bearer service attributes) may be used by the network administrator to manage QoS differentiation when providing a wide range of value-added IP connectivity services to end-users. The proposed methodology allows operators to logically divide their network into ‘pipes’ offering different service performance characteristics – for example, in terms of throughput. Individual service applications can then be mapped onto these different Pipes according to corresponding performance requirements [16].

3.2.3. Mobile terminal QoS provisioning

Once QoS is provisioned at the HLR and at various network elements, the next question is how an application on a mobile device knows which APN and hence associated QoS to use and, for an application on QoS-aware devices, what QoS to ask for. Applications are typically designed to handle a different bit rate or bandwidth. However, what QoS to request for a specific application depends partly on user subscription. It would be too great a hurdle to require end-users to manually configure QoS for different applications on mobile devices. The best way is to provision QoS over the air – for example, at service subscription time. Though there are many proprietary ways to configure devices and applications over the air, the trend is toward Open Mobile Alliance (OMA) device management standardization. They are described in the following sections [15].

3.3. QoS and QoE monitoring

It is very important for a service provider to measure the QoS and QoE of network accurately and improve it for further in the most effective and cost-efficient way to achieve customer faithfulness and maintain satisfaction. Two approaches to measure QoE are the following [1]: (a) Service level approach using statistical samples of a population of terminals. (b) Network management system (NMS) approach using QoS parameters. The table IV gives better understanding about Service level approach using statistical samples of a population of terminals and Network management system (NMS) approach using QoS parameters [17, 20].

**Table IV**

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Network management system approach</th>
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<tr>
<td>The first relies on a statistical sample of overall network users to measure the QoE for all the users in the network.</td>
<td>The second is a methodology whereby hard QoS performance metrics from various parts of the network are mapped onto user-perceptible QoE performance targets. These QoS measurements are made using an NMS, collecting KPI figures from the network elements and comparing them with the target levels.</td>
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<td></td>
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<tr>
<td>Process</td>
<td>. Identifying the relationship between QoS KPIs and their effect on QoE.</td>
</tr>
<tr>
<td>. Determining the weighting of key applications.</td>
<td>. Measuring QoS KPIs in the network.</td>
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<tr>
<td>. Devising a proper statistical sample and taking KPI measurements accordingly.</td>
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<tr>
<td>. Utilizing handsets.</td>
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<tr>
<td>. Giving an overall QoE score (index) from KPI values</td>
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</table>
3.4. Optimization

The optimization of mobile services faces several challenges and provides operators the opportunity of improving revenue. If continuous optimization process is not there, operators would not be capable of adapting their cellular networks to the evolution of mobile service applications. Cellular network optimization can be seen as a process to improve the overall network quality as experienced by the mobile subscribers and to ensure that the network resources are efficiently utilized [1]. Service & network configuration plans to set-up the network elements and their parameterizations to support operator business functions. These two configurations cannot be separated, because the network is the platform for QoS provisioning & these configurations are the control points for the operator to position the strategy to support its business. Mobile cellular networks have several uncontrollable factors that further challenge optimization. For instance, subscriber behaviour cannot be controlled nor fully predicted. Some customer behaviour phenomena can be foreseen, like big sport events or festivals. In general, subscriber behaviour can only be monitored statistically, but the fluctuation of the traffic generated is an inevitable effect that needs to be taken into account. Network optimization can be easily obtained if we able to

- make frequent and accurate service and network performance measures
- detect, report faulty situations and rectification of faults

There are a number of measurements which provide the information related to details of network to improve service and network performance. Those measurements or metrics are

- If we collect and store the Key performance indicators (KPIs) in the network management system (NMS) are the most relevant source of information to attain statistical optimization. These indicators almost work like an envelope to cover the whole network. The drawbacks with these measures are ; the amount of detail is low, during busy hours, results in patchy information and they naturally do not assess QoE properly.
- Sorting of protocol performance at different interfaces provides detailed information on a part of the network. These protocols facilitate the operator to monitor different interfaces and collect specific performance data. This specific performance data is used for optimization.
- To get the conditions of radio in the mobile station the operators get the data from drive test which provide accurate and actual information. This information is useful for troubleshooting the network. This information can also be used for QoS optimization, but conducting drive tests are expensive and can cover only small areas of the network in the given time period [12,13,15,21]

For optimization process to rectify the most of drawbacks mentioned above we can use Mobile QoS agent (MQA) technology is rather new but extremely promising to collect QoS data. The above-measures are related to take some major decisions inside the optimization process and verifying results of the optimization process [22].

4. Conclusion

This paper summarizes the management of QoS and QoE which are related to wireless communication. The requirement of QoE and QoS along with the QoS parameters with priority order can be helpful for both the operators and users to maximize the network performances and user satisfaction level with the limited resources. During the limited resource condition, QoS requirement can be optimized according to the service type, price, user requirement and priority of QoS parameters. The management of QoS and QoE in wireless communication can be classified into: Network planning, QoS provisioning, QoS – QoE monitoring and Optimization. Hence for proper QoS and QoE management, this QoS parameter characterization will be very helpful.

5. References

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