

A QoS Enhancement Framework for Ubiquitous Network Environments

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Abstract

Quality of Service (QoS) provision is of fundamental concern in high performance data networks. The system's load and capacity evaluation are dependent on prescribed QoS parameters. The Service Level Agreements among telecom operators focus on their provision. In ubiquitous networks, different technologies with varying architectures and design merge together to enable the make before break concept. In such scenarios, QoS parameters are very critical. The paper presents a QoS enhancement framework for ubiquitous networks aimed at evaluating and routing the received network traffic on basis of intelligently evaluated parameters, enabling the network to perform efficiently.

Keywords: *QoS, Ubiquitous, Networks, Intelligence, Priority based selection, Congestion control*

1. Introduction

In today's world of communication, the appearance of ubiquitous networks has created a significant impact on our daily life applications. A ubiquitous network consists of large number of networks with different network architectures and schemas, interconnected for seamless operability using some radio frequency channel. The function of these networks is to process, route or communicate users, using a single several parallel connected networks. The evolution of Multi Protocol Label Switching (MPLS) has enhanced the communication networks and is expected to be widely used in variety of applications.

Basic features supported by these networks are self healing capabilities, short/long range broadcasting communication and omni present services provision [1]. It makes ubiquitous networks different from the wireless adhoc or mesh networks.

1.1 Challenges for Ubiquitous Networks

Many challenges are faced by the ubiquitous networks such as different architectures, traffic routing, QoS management and monitoring etc. However, the traffic pattern induced by the Service Level Agreements (SLAs) help cover-up these issues to a large level. The primary challenge faced by these networks is the lack of conventional agreements among IT / Telecom regulatory authorities which ultimately increase the interoperability issues. The degradation in signal quality and frequency limitations/ infrastructure differences in different regions drop these networks out of the interoperability scenarios. For participation in such network environments, we continuously need handshakes/ handovers of services among networks.

The described challenges call for a need to develop a seamless operability supporting framework for a consistent communication path in ubiquitous application environments.

1.4 Challenges faced by the Ubiquitous Networks Application

Making ubiquitous applications feasible for all types of local/remote applications, the designers aim for provision of simplicity in designing the QoS framework, topology, security and medium of access [4], for achieving a minimum tolerance for congestion handling and Denial of Services (DoS) instances avoidance. The topology term here is used to describe the architectural design of communication between sources and destination nodes. For example if mesh topology is used among the operators, QoS will be delivered at a cost of huge bandwidth utilization, hence making it not feasible for implementation.

Considering other issues are the cases of multi hop network delay factors involved in a framework. The appearance of delay factor requires a complex algorithm, latency and data handling capabilities for each particular network [4]. For coverage factors, a wide range of wireless technologies can support coverage area. Provision of this range allows effective collection, processing and transmission of the data as data drop leads to the losses of huge revenues.

1.5 Data Models of Ubiquitous Applications

The Ubiquitous Networks support many types of applications, with diverse requirement of QoS. The authors in [5] have classified the applications on the bases of data delivery model due to the obvious importance of data delivery mechanism in every ubiquitous application.

Event Driven Applications: give response to their parent networks and occur only in the situation of triggers. Parameters of QoS associated with event driven applications are security, priority, latency and reliability.

Query Driven Applications: respond to the query initiating network and its log is maintained by the QoS scheduler. QoS factors which involved in this case are again low latency and reliability. The only difference between event and query driven application lies on the initiator. In event driven, initiator is source, where as in query driven the initiator is the query initiating network.

Continuous Applications: respond to query generating source network by sending data from source at predetermined data rate. Examples include real-time applications such voice, video and live file transfer. QoS parameters needed here are maximum bandwidth and low latency.

Hybrid Application: is basically the combination of all the above application classes.

2. Current Work

In [8], authors performed a critical study aimed at determining fast handover behaviors for mobile IPv6 users. The study evaluates several QoS parameters on performance computations.

In [9], authors presented an IP-based multi-parametric approach for end to end QoS provision. The model incorporates MPLS properties in the QoS Decision engines which makes it a unique method. The work laid emphasis on dynamic analysis.

In [10], authors presented a research work on the famous DAIDALOS Heterogeneous network architecture project's QoS properties. The study shows that the QoS architecture of DAIDALOS has easy and intelligent administering tools based on priority assignment schemes. The structure is being refined to cope with resources utilization, pricey equipment and heavy processing issues.

In [11] authors presented a model based on OSI pattern, aimed at providing mobility in ubiquitous network environments for service users to manage their usage criteria themselves using different coverage plans.

In [12], authors proposed an end to end QoS management architecture, which was implemented and tested. The proposed model results in guaranteeing QoS in dual mode and accesses them simultaneously. The model monitors the load balancing performance.

In [13], authors proposed a QoS Optimization method for Next Generation Networks with reconfigurable network resources plan for optimized usage. The framework performs flexible handover and a high organized resource management for QoS maintenance.

In [14], authors presented architecture for enabling QoS in Wireless Mesh Networks (WMNs) and outlined the issues/ drawbacks in WMNs in term of QoS scenarios. The highlighted flaws in WMN standards recommended congestion controlling measures.

In [15], authors proposed a plan, to grant resource supervision options in a ubiquitous network framework. The concept amalgamates the SLA policies with implemented policies to highlight the issues in ubiquitous network. The complications in user controlled bandwidth reservation will smoothen when policies implementation at operator level will be made transparent.

In [16], authors proposed a solution for achieving QoS through Collision Avoidance (CA) in ubiquitous networks. The solution uses protocols for reduction/ termination of collisions.

In [17], authors proposed a middleware for mobility management and QoS integration. The circumstances provided in the proposed framework assist users to maintain QoS and seamless mobility.

In [18], authors conducted a brief study for assessment of mobility management issues in ubiquitous environments. The calculations were made for Personal ubiquitous environment's mobility management issues via simulations. A descriptive over view of proposed framework was provided for data transmission rates.

In [19], authors developed a schema, meant for ubiquitous networks. In the described schema, a network used its neighboring network's information to create triggers, which were vital in making a handover before downing of an active connection. The handover schema can easily overcome handoff issues and communication breaks in a ubiquitous network. The proposed design was enhanced for time estimation issues.

In [20], authors presented a design of handover method using Y-Comm framework, which was aimed at exploring the reactive policies of handovers using Cambridge wireless test bed. The work conducted various simulations.

In [21], authors presented a model for choosing a connection from available networks using handoffs. The model can opt for a network with uninterrupted detail requests. The model's proposed handover mechanism is very flexible.

In [22], authors performed a research project that provides ubiquitous network performance policies proposed to achieve desired QoS limits. The traffic inspection method is unique as the router buffer slots are used for QoS enhancement. The derived simulation results are being refined to implement the technology in industry.

In [23], authors conducted a study, aimed at analyzing various QoS parameters in ubiquitous networks. The study analyzed a total of 13 research QoS frameworks, models and technologies used for ubiquitous network environments.

3. Problem Statement

There is a dire need of developing a framework, which can deliver timely, accurate and reliable delivery of ubiquitous network applications. The solution to this issue is the answer to

this big issue. The major issue in a ubiquitous network is that we have to select a particular network from the pool of networks, which must accord requirements of user and application.

Although none of the wireless technologies can satisfy the diverse requirements of users such as low delay, high bandwidth, long range and low cost [2].

It means that there is a need of an optimal mechanism, which while monitoring the availability of network, can recognize the need of handover, whenever required by the application. Generally, the vertical hand off between two networks depend on the application based QoS, signal strength, bit error rates, coverage area [3].

The research work will propose and validate a QoS framework for ubiquitous wireless networks, and will analyze their comparative performance in making optimal decisions in network selection.

4. Proposed Framework

The framework addresses QoS issues in ubiquitous network environment. The proposed QoS framework is aimed at selecting the most suitable network among the available ones. The decision is not only based on QoS parameters of available networks but it also depends on QoS specific criteria for applications.

This comprehensive QoS framework maps requirements to the desired performance attributes of the ubiquitous applications. The emphasis is laid on the use of computational intelligence to customize the generic network selection criteria in order to achieve optimal application specific performance.

4.1 Approach Used for Network Selection

The research makes use of a novel approach for selection of network, which uses computational intelligence for selecting optimal network for every application. The diversity of wireless networks connected to the serving network/ host introduces a huge number of parameters to be taken into consideration while selecting a particular network to transit the traffic through. The approach provides the concept of weighted link sets which realize a many-to-one mapping between several networks and their counterparts. This makes the network source adequate in focusing the entire network domain.

4.2 Decision Methodology

The decision methodology used in designing this approach makes use of Analytic Hierarchy Process (AHP). Multiplication between each network nodule value and its corresponding application provided weights are calculated. The final decision of network selection is based on union operation of all these calculated values. Network having the maximum calculated value is considered to be the final selection.

5. Discussion

The proposed framework consists of a sequence of steps adopted for helping in route/network selection of a network among a number of available networks. In brief, the proposed module calculates the accumulative weights of individual networks and opts to respond for the suitable network. The proposed framework consists of following components/ modules;

5.1 QoS Performance Evaluator: The QoS Performance Evaluator is an evaluating and monitoring module which provides information related to the condition and availability of wireless networks to Resource Association Module. The information provided by this module

consists of selected network parameters e.g. Latency, Bandwidth, Application Priority, Coverage area etc. All these parameters are later passed on to the Resource Association Module.

5.1.1 Connectivity Archive: Connectivity Archive is a module containing the historical data of previously selected networks. Indirectly, this module is used to give strength to the decision factors. While observing the information provided by this Connectivity Archive, the pros and cons of previous decisions are considered. These pros and cons help in drawing an analysis graph between current decision and historical decision. The resultant of this analysis graph is the final decision of network selection.

5.1.2 Network Selection Criteria: The Network Selection Criteria is dependent on information access/group policies of an organization and vary from environment to environments. They can be engineered as per requirement and have variations as per requirement/ service level agreements.

5.1.3 User Set Parameters: The parameters defined by a user vary from person to person, place to place and environment to environment. The parameters defined by the user are the initiating factor to a network QoS performance metrics. Occasion based parameters and nomad entrant based parameters are not considered when QoS policies are formulated for users.

5.1.4 Application Based Module: This module defines, parameters related to each specific application type. The parameters related them can be set as per network requirement e.g bandwidth requirement, security, application priority, coverage area etc. The value of this parameter differentiates and prefers for network selection choices.

5.2 Resource Association Module: The major module of the QoS framework is the Resource Allocation Module. It helps in required network route selection and works on the basis of AHP Function Initiator and Optimized Parameters, discussed below in detail:

5.2.1 AHP Function Initiator (AFI): This module is used to convert the input criteria, injected by network module, into normalized values of fuzzy sets ranging from [0 1] by using a QoS Broker's selected Gaussian Function.

5.2.2 Optimized Parameters Component: This module is used to give weightage to user defined parameters such as Application Type and QoS criterion. This tool makes ranking or standards for comparison and synthesizes. Decision of AHP is highly dependable on the quantitative scoring. This scoring plays a vital role in the selection of best option among the available once, which can fulfill the required criteria.

The judgment will start from the top of hierarchy containing a Type and QoS. Later on this hierarchy is further subdivided and is considered as alternatives rules for decision making. Ranking procedure or comparison of these parameters starts by defining a number of scales. The QoS numeric scale defines that how one parameter is more important or dominant or at

equal level as compared to other parameters. Here the judgment scale used for pair wise comparison is as follow [6, 7] and it totally depend on human based thinking.

- 1 = equally likely to be important.
- 3 = weakly less impact factor of one over the other.
- 5= strongly influence the other parameter.

5.3 QoS Decision Element

The Decision Element works on the outputs of AHP Function Initiator (AFI) and the Optimized Parameters Component (OPC). The output is fed to the QoS Broker. This helps in maintaining the optimized QoS parameters values more accurate.

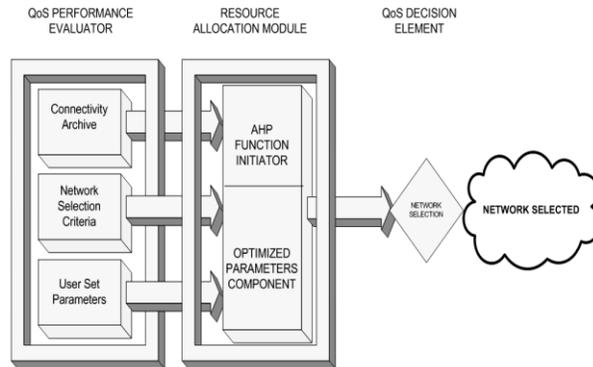


Figure 2. Process Schema (App. Priority)

5.2 Location of Proposed Framework

The proposed framework is proposed to be a QoS sensing element and is suited for acting in a Distributed Admission Control (DACME) or a QoS Decision Engine of a network. The figure displays the diagram of a DACME agent.

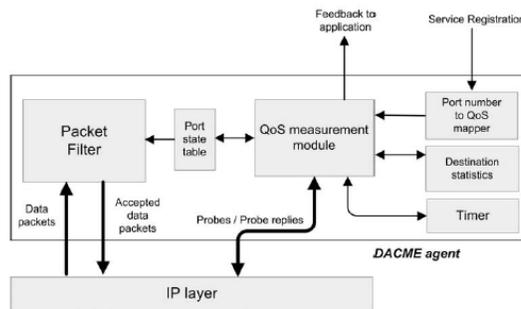


Figure 3. A DACME Agent from [24]

The described process layout can be easily depicted in the following data model.

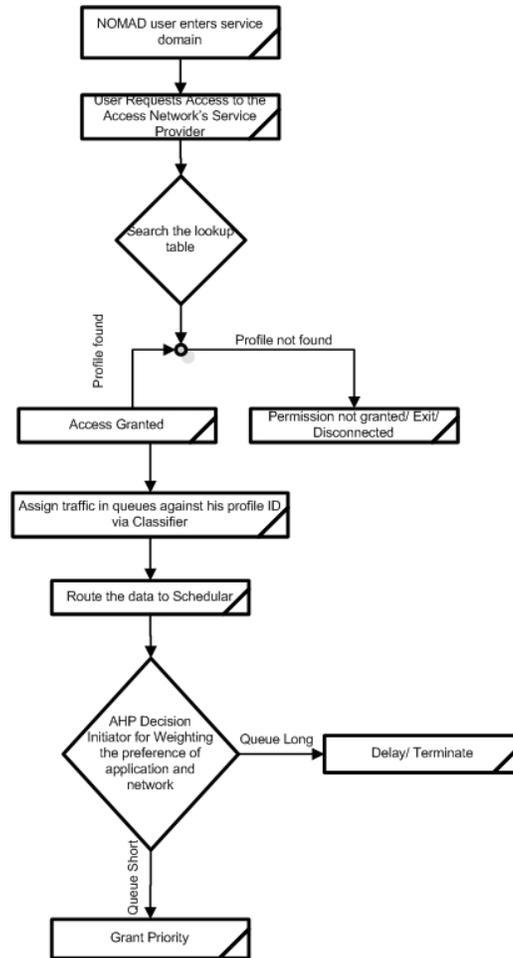


Figure 4. Process Model

6. Validation

For checking the performance measure of work, the desired numbers of network were used for measuring delay, jitter, latency and congestion. According to the authors in [10] ubiquitous devices provide support for many different types of applications.

Each application type has a requirement of diverse QoS parameters. These applications get triggered in the presence of favorable conditions (desired parameters). In the discussed scenario, the query triggers the applications to respond on prescribed weights and ranks for responding to data on a prescribed scheme. In the calculation of network selection for this application, different types of QoS parameters are required both from user as well as from network. The advantage of using the AHP is that one can easily express both quantitative and qualitative data. Later on these values develop symmetry among the parameters.

The simulation was performed using MATLAB. The AHP matrices regarding each network responded to their requests. The end user viewed an invited for selection of available networks option. Upon selection, user is required to input the number of networks requesting a network service as shown below in Figure 5.

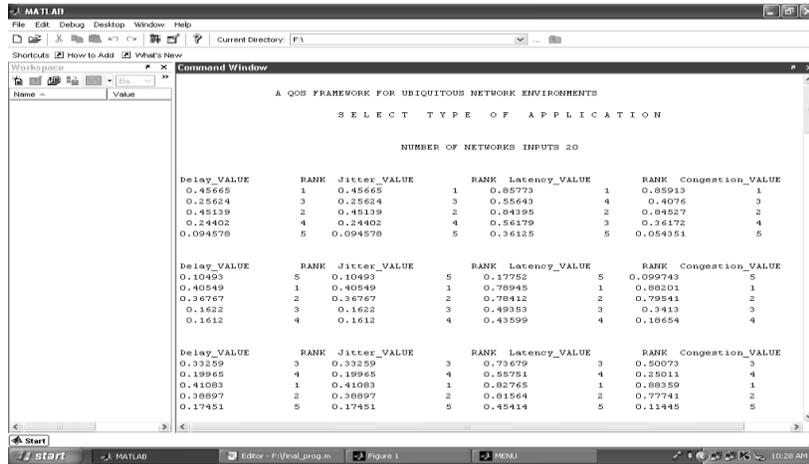


Figure 5. Network Based Weights for Evaluated Parameters

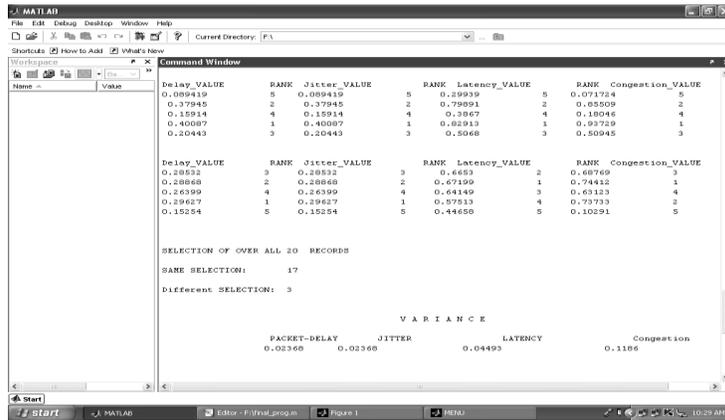


Figure 6. Variance based determination for evaluation of Parameters

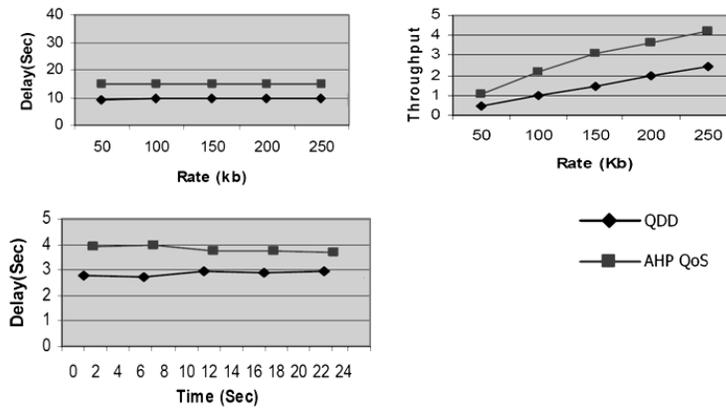


Figure 7. Proposed Framework comparison to QDD Framework

The input number of networks are and their resultant variance are judged on basis of previously set RANKS and AHP values to determine their approach in connecting a serving gateway and hence acknowledges the QoS decision engine, thus making the process fast, organized and efficient as shown in figure 6. In [25], authors proposed a QDD framework for distributed environments which focus QoS driven modeling and transformation for all prescribed system modules for optimized results.

The comparison graph of the proposed model to Quality Driven Delivery (QDD) framework for Rate-Throughput, Rate-Delay and Delay-Time factors is presented in figure 7. Delay is defined as the average end to end delay at destination end for all evaluated data flows. The simulated results demonstrate that on increase of rate of data transmission on a network path, the delay factor for the proposed framework is superior to the QDD as our proposed framework grants priority to bandwidth over user based Value Added Services (Streaming applications, Social networking category). Throughput is the amount of data traffic received at destination side. Similarly it achieves a better throughput for applications. In Time-Delay relationship the initial upward response is achieved due to weighted AHP value of Network based priority assignment. Therefore it stabilizes for prolonged requests.

It is observed that although GPRS shows a large difference in their ranking values and seems to be more accurate in identifying the alternatives as compared to UMTS as large values of error of mean, depicts a large gap between mean decision value and other alternative network values. This large value of standard error of mean basically is the drawback of UMTS, which develop an abnormality and non stability factors in the decision making during ubiquitous activities of users. It fails in making good decision in most of the cases where it cannot make a clear judgment between good and poor QoS attributes.

7. Conclusion and Future Work

For making QoS frameworks practical, different parameters are considered. A number of parameters are input in the proposed framework gateway, both from network as well as from application. These parameters include application type, bandwidth, delay, coverage area, security and priority. Simulation software can be used to conduct these simulations. Results show that more than 80-85% of times the decision made by the framework is accurate, whereas 20% times they made different ranking decisions. It is observed that the reason for selecting different ranking criteria for decision by different algorithms depends on the behavior of the selected network's random behavior. The efficiency and consistency of each algorithm is provoked and more efficient approach for network selection is followed as compared to the others.

In future the consistency and efficiency of the approach can be enhanced by emulation or by importing QoS parameters and behavior directory. Another task on the list is to explore other decision making techniques using a list of extensive QoS parameters such as cost, bit error rate, jitter etc. A data mining on part of the network selector can be constituted so as to deliver the final selection on basis of previous experiences. This approach will make the decision process faster and more efficient. As estimated, the true values will be in hand for making confident and reliable decisions.

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