Optimizing Network Selection to Support End-User QOS Requirements for Next Generation Networks

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Summary
Wireless systems in NGN, will integrate different network access technologies, e.g. wireless Local Area Network (WLAN), UMTS Terrestrial Radio Access Network (UTRAN), and WiMax, Moreover, this integrated wireless system, will have to handle diverse types of traffics, such as data traffics (e-mail, web browsing, ftp), voice traffic (VOIP), and multimedia traffics (video conferencing, Online TV, Online Games, ….. etc). This paper focus on providing QoS management, to support end user requirements in mobile environments, one of the most challenging problems here, is the network selection, to choose network from a number of available networks in a heterogeneous system, to serve a connection requested by a mobile user with acceptable level of QoS and good network utilization. We propose an architecture that combines QoS Broker and network Selection. The QoS Broker will monitor the QoS performance in all the time for each wireless network, then the result of this monitoring will be inform of analytical statistics of all the QoS parameters in each network and for each traffic class. The user request for specific service usually depend on available bandwidth and the service QoS parameters, if any network with sufficient traffic bandwidth and QoS parameters, that matches the user request, then the connection to that network will be triggered and the connection will be established with optimum selection for both end-user and network operator.

Key words:
NGN*: Next Generation Networks,* ***ANQoSB****: Access Network QoS Broker.,* ***CNQoSB****: Core Network QoS Broker.* ***MMSP****: Multimedia Services Proxy.* ***PBNMS****: Policy Based Network Management System.*
A4Server*: Authentication Authorization Accounting Auditing Server.* ***MLG****: Multi-layers Gateways.*

1- Introduction

In NGN, the backbone of the overall network architecture will be IP network, supporting different access network technologies; this backbone will be attached with different gateways to integrate different access networks technologies, for that it's highly expected that the future Telecommunication networks, will be converged and support IP packets.
From end-user perspectives side, mobile users should be connected Anytime, Anywhere, for any requested service or application, with the best Quality of Service (QoS). From these perspectives we can imagine that, the centric management for the NGN is complex, and should support end-users mobility, security and QoS requirements.
In near future, mobile users, will be able to connect to different telecommunication applications, ranging from normal voice calls, web browsing and e-mail services, Online streaming data such as TVonline or RadioOnline, Real time video conferencing, interactive network games, ….etc. All these applications need specific Quality of Services requirements, for example voice traffic is sensitive to packets loss, packet delay and jitter, which will result in voice degradation, something similar to voice corruption in cellular phone when the coverage area is low. In NGN, the existence of multiple access networks, will ensure that all applications receive acceptable quality of service (QoS), for example, when network condition changes (suddenly congested), application maybe vertically handoff to another better access technologies ,however Users will be always best connected, and even remain seamlessly connected with the best network while they are roaming between different network technologies, the best connected network depends on application factors- such as personal preferences, device capabilities, application QoS needs, security, available network resources and network coverage [1]
As a survey in related works regarding to seamless end-to-end QoS architecture for NGN, there are many projects and proposals to integrate heterogeneous network technologies, to support the management and monitoring of QoS parameters in centric architecture to offer application session with the best resources in mobile environments', both for inter-domain and intera domain level. In most of these studies, the proposed architecture, depend on network classes definitions for diffServ, each network QoS class ensure edge to edge QoS guarantees, described by parameters as delay, jitter, packet loss and bandwidth availability. [5]
These architectures deploy policies for SLA (Service Level Agreement), it acts like contracts between end user and service providers to specify the SLS (Service Level Specifications) that determine the required resources to be reserved for specific application QoS.

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The management for and monitoring of each class QoS is a central manner for Core and Access level networks. [5].
In this paper, we propose to integrate QoS management architecture with dynamic access selector, allowing the end user to be always best connected for the best access network technologies, this to support end-users applications setup requirements, even while his roaming between different access networks, applications sessions should be supported continuously with soft handoff and without performance degrading.
Our proposal combine the end-to-end QoS architecture for 4G scenarios applied in daidalos project [6] with a multi-link architecture to support central dynamic network selection. It is clear that this combination will result in architecture, supporting dynamic network selection, with the QoS best suiting the end user requirements, dynamically and in roaming environments.
When the end user request a service, the request will be forwarded to the QoS Broker in the core network, the QoS broker will determine the best available network resources for the requested service, the decision of best network will be then forwarded to a multi-link gateway (in the core network). The ML gateway acting as a main gateway to other gateways connected to the backbone network to allow the convergence of multi-access network. At the end the ML gateway will route the IP packets, to the gateway which will attach the end-user with the most suitable network.

2- Related work

Several studies and significant research work carried out for providing QoS management solutions in IP base networks, also many existing research projects, for providing end-to end QoS delivery and management for NGN, such as (Moby Dick, TEQUILA, CADENUS, AQUILA, MESCAL, ENTHERONE, DIADLOUS) [4], from all these proposed QoS architecture, we can come out with a criteria to evaluate QoS management architectures to integrate heterogeneous access networks as the following points:-

1. The QoS architecture should manage and monitor the QoS requirements both at intra-domain and inter-domain administration level, that's means at the level of access networks as well as core networks.
2. This architecture should be a solution, providing an integrated and complete view of how to deliver QoS across multiple heterogeneous domains at large and scalable domains.
3. From the view of service offering, the solution, should take into account any business related aspects, and should consider different services stake holders such as service provider, content provider, network provider, and end customer, so the solution design should support the whole service business chain.
4. The solution should be optimized and not evolving a significant amount of signaling processes at end customer request.
5. The QoS resource reservation and traffic monitoring should be supported dynamically in real time situation, allowing automatic reconfiguration and resource adjustment for best network resource allocation and reservations, to obtain the end user satisfaction and network operator maximum benefits.

3- Proposed End to End QoS Architecture, with network selection capability

As survey in the current QoS management architecture for NGN, we found that mostly these QoS architecture is lack of centric module for network selection, and dynamic reconfiguration to connect the end user (for any given time) for best network from a multiple of heterogeneous network to satisfy end user QoS requirements, we propose a centric solution QoS architecture, able to monitor network resources, reserve resources for any QoS service or application triggered by the end user, and also with the ability to select the best access network among a multiple heterogeneous network.

QoS architecture's elements

Several access networks are connected with the core network, the core network is Multi-link gateways (MLG) connecting with each other to form the core network, access networks are connected with Access routers and each administrative domain is connected to other domains by Edge Router (ER)[2].
We can explain the elements and the behavior and function of each element as the following:-

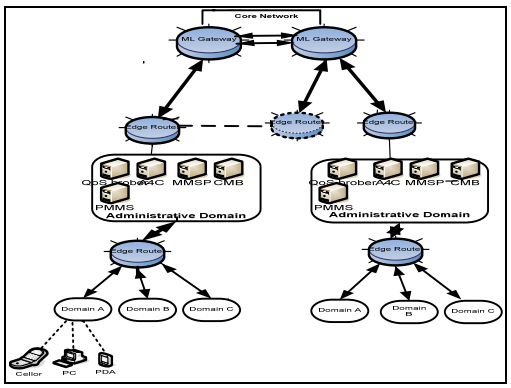

Figure 1:- QoS network architecture

- In each access network, mobile terminals (Laptops, PC, and PDA) are connected to the network through access routers, each mobile terminal able to request QoS resources to the network in implicit or explicit way.
- The QoS Broker is the module, which perform admission control and manage network resources among available networks (with maybe different access technologies), to optimize operators income, the QoS broker in the core network (CNQoSB), manages the core resources in term of aggregates communicating with other administrative domains to avoid networks congestions and utilize the network backbone operations.
- The basic QoS is provided intrinsically by access network, but also more advanced services are supported by a service provision platform (SPP) in the core network.
- In AN, service proxies for multimedia services (MMSP), deployed for efficient service provision and controlling for multimedia session, both the QoS broker in the access network (ANQoSB) and MMSP can provide adequate level of QoS to multimedia stream, during the knowledge of active services and a available network resources.
- At the domain level, the QoS definitions, are provided by a Policy Based Network Management System (PBNMS), and then proxied by the ANQoBs to the ARs in different AN. For authentication and accounting, an A4C server is also present is each domain.

QoS classes

Each network QoS ensures certain edge-to-edge QoS guarantees described by parameters as delay, jitter, and packet loss and bandwidth availability. Mainly, we will consider 4 network service classes: conversational, transactional, streaming and best efforts traffic, these services defined as a subset of service classes from ITU-TY [5]. The network service is described by two parameters, first the service QoS class (the class here is specified by a set of QoS parameters), second the bandwidth to be reserved. The definition of the service class is conformant with DiffServ network architecture. There should be a mapping mechanism to map the OoS Parameters to network QoS parameters, this mapping can be done in the QoS client, Advanced Routing mechanism (ARM) or in the MMSP, depending in the signaling strategy used.

3- Function and behavior of the proposed system architecture

We can predict the behavior of the proposed architecture for the QoS management and network selection as the following steps:-

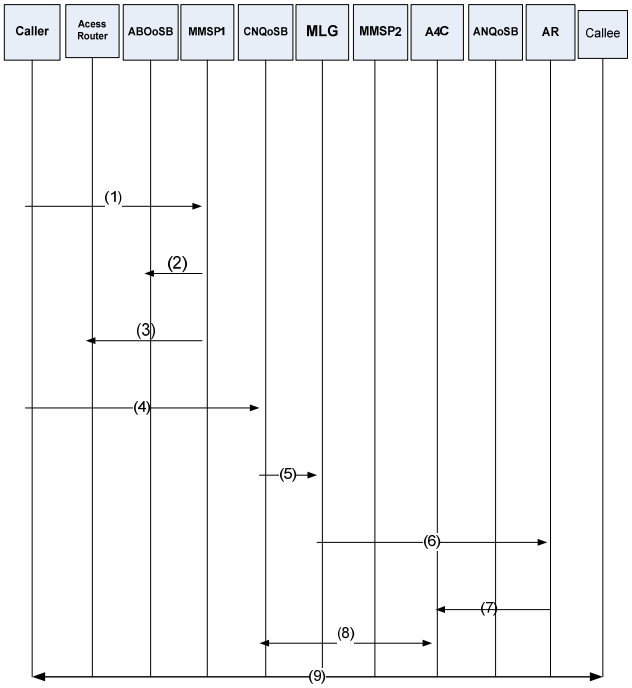

Figure 2:- Multimedia service setup

Step 1:- An approach trigger QoS multimedia request from the MT side.
Step2:- MMSP (from the caller side) will queries ANQoSB in the direct connected AN.
Step3:- The ANQoSB will forward the request to the AR, which proxy this request to the CNQoSB.
Step4:- Since the CNQoSB has information about overall network resources and network QoS parameters, the CNQoS will decide which network will be the most suitable for the caller request.
Step5:- The CNQoSB will encapsulate the request (the request to connect the end user with the most suitable network) to Multi-link layer Gateway (MLG).
Step6:- the MLG will decapsulate the forwarded packet and construct the inner packet, then routing the packet to Access Router, in the most suitable access network for the user request.
Step7:- if AC4 server (in the domain with the most suitable network for the caller request), authenticate the caller request, then multimedia session will be established between the caller and the callee side,

connecting the triggered QoS request with the best connected network.
Step8:- The QoS Broker from the access network connected to the caller side now will negotiate with the QoS broker in the access network from the callee side, about the QoS requirement to setup the service between them.
Step9:- the communication session between the caller and callee will be setup with the QoS required for the triggered service or application between both of them.

4- Theoretical analysis and architecture advantages

Building an all IP packet architecture with differentiated services, has many challenges should be addressed, and proper solution should be introduced for each problem, [7] in this section we will investigate and analyze how the presented architecture can contribute for these problems in one good overall solution.

Handover auto- configuration with QoS Guarantees:- user mobility between heterogeneous networks is difficult problem, due to sudden degradation of QoS, in our proposed network, fast handover technique is applied when the quability of the radio signal is dropped or going low in the MT connecting to current access router (AR1), the terminal will start handover negotiation to the neighboring AR (AR2), for better signaling without user intervention, this can be achieved by building anew care of address (more applicable for IPv6), and the handover negotiation will start while maintaining the current traffic, the traffic information will be exchangeable between the previous AR and QoS broker from one side and the new AR and QoS broker from the other side, then the new QoS broker will use this traffic information to verify the recourse available and configure the new AR to accept the handover.

Resource reservation for inter - intra domain levels: - we can describe the problem as the following, since different applications generate traffic with different characteristics in terms of data rates, packet loss, level of burstiness, packet delay, so for per domain level, data should be exchanged by mixing the traffic for different application (e.g SNMP, AAAC, VoIP, DNS, etc), in the same time the network operator needs to protect the overall architecture against congestion , so its very important that the aggregate scheduling should be combined to protect the whole network infrastructure against congestion, some of the steps that could be taken avoid congestion and utilize the network operation:-

- Assigning profile to each user and limits the traffic transfer in the ingress routers (ARs) based on each user profile.
- Configure the network recourses to allow for a wide range of services required by different type of users.
- Applying central recourse management for edge- to-edge QoS, by using QoS broker to utilize the network resources , to achieve that the QoS broker should know the demand and the current utilization factors of all links

Intelligent network selection: - the selection of the network will be based on the highest QoS, which is satisfying the end user requirements (profile) and utilizing the heterogeneous connected networks, in a way balancing between the end user requirements and maximizing the profits of network operators for network utilization and congestion avoidance, this will depends on the QoS Brokers at the core and access networks as well as the policies management applied in core and access routers, the intelligent network selection will play important role also in mobile environments, with different networks while the end user roaming, as example: if the end user want to make call, and he is in the range of Wi-Fi spot if the end user profile is configured to allow him to be connected for acceptable level of QoS with the lowest charge, then when he moving from cellular network (UTMS) suddenly entered the Wi-Fi zone, the selection should be automatically , connecting the end user with the Wi-Fi wireless signal, fast and without obvious voice degradation, since in Wi-Fi zone, he can make voice call over VoIP with acceptable level of QoS and almost free of charge.

4- Conclusions

In this Paper, we have presented 4G architecture, combing both QoS reservation and networks selection solutions, in a centric management scheme for both. We have shown a possible implementations step by step to trigger and establish the best QoS connection for multimedia session for best network resources (among heterogeneous network access technologies) offering the best network resources that satisfying end-user QoS applications requirements, the network selection here will be done automatically due to the role of QoS Brokers in ANs and CNs and also due to the structure of Multi-layered Gateways applied in the backbone of the core network as well as Edge Routers and Access Domains Routers connecting different networks technologies and performing the role of network selection.

References

[1] Susana Sargento1, Rui Prior2, Filipe Sousa et al., *End-to-end QoS Architecture for 4G Scenarios*, Universidade de Aveiro, Instituto de Telecomunicações, Portugal.

[2] Guillaume Bichot, Network Science, *A Multi-link architecture for a global wireless Internet connectivity*, Thomson , Corporate Research, 1, Av Belle-Fontaine 35576 Cesson-Sevigne, France

[3] J. Arkko Ericsson B. Adoba Microsoft J. Korhonen TeliaSonera F. Bari Cingular Wireless, *Network Discovery and Selection Problem*, Internet-Draft: Draft-ietf-eap-netsel-problem-06

[4] NGNI Consortium, D2 *QoS Roadmap, Document version 1.0*, Project number IST-2000-26418 NGNI Next Generation Network Initiative.

[5] Mario Marchese, *QoS over Heterogeneous Networks, © 007* John Wiley & Sons, Ltd.

[6] DAIDALOS EU project , (Designing Advanced Interfaces for the Delivery and Administration of Location independent ptimised personal Services, web page : http://labreti.ing.uniroma1.it/daidalos/index.htm, accessed date : 1/10/2007

[7] Janusz Gozdecki1. et al, "*An IP QoS architecture for 4G networks*" , AGH University of Technology,

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