QoS in Next-Generation Wireless Multimedia Communications Systems

An IP-Based QoS Architecture for 4G Operator Scenarios

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Abstract

This article describes a global QoS architecture for multimedia traffic in mobile heterogeneous environments. This architecture supports both multiple access networks and multiple service provider scenarios. The architecture is able to provide QoS per user and per service, implementing the notion of a user profile associated with control element functions. An integrated management approach to service and network management in the case of heterogeneous and mobile network access is presented based on cooperative association between QoS brokers and authentication, authorization, accounting, and charging systems. The overall exchange of messages is exemplified for the case of a field test with specific optimizations for voice traffic.

Introduction

Driven by the “anytime, anywhere” concept, new requirements for flexible network access have made their way into the telecommunication community. The present communication paradigm expects a user to be able to access its services independent of its location in a (nearly) completely transparent way. The user terminal should be able to pick the “best” access technology (ad hoc, personal, wired and wireless LAN, and cellular technologies) at its current location, and use this access technology seamlessly (i.e., without noticing) for provision of the desired service.

This homogeneous, high-speed, secure, multi-service, multiple-operator network is being developed in a context commonly referred to as fourth-generation (4G) networks (or, sometimes, as beyond third generation — B3G) [1]. Due to its intrinsic technology heterogeneity, the IPv6 protocol, in particular IPv6, is being targeted as the interconnection layer across the multiple access technologies envisaged. Nevertheless, even with a common network protocol, many problems must be solved. This 4G concept claims to support multiple types of services, from simple network access to complex multimedia virtual reality, and including traditional telecommunications services such as telephony in mobile environments. This implies the development of a network able to associate service agreements with network control constraints, to monitor this usage per service and user, and to provide these services while the user moves (with its terminal changing access technologies). Both convergence of access technologies and unification of multiple protocols — for signaling, quality of service (QoS), security, and authentication, authorization, auditing, and charging (AAAC) — under real operator environments are major research topics nowadays.

One of the important points in this context is the development of a QoS architecture for 4G networks. This architecture should be able to support any type of user service in a secure and auditible way. Both user interfaces and interoperaer interfaces must be clearly defined, and multiple service providers should be able to interoperate under the guidelines of this architecture. This article addresses such a challenge. We present a QoS architecture developed for 4G network environments, able to flexibly support multimedia service provision. This architecture has been further optimized to replicate existing cellular telephony service provision. Voice services are actually one of the most demanding services in terms of network design, imposing hard limits on network performance. Although the use of IP enabled terminals will allow users to access a larger variety of multimedia services, it is of paramount importance that the current voice service environment (channel-based) is able to be replicated in these 4G terminals to convince both users and operators of the advantages of this IP-based approach.

Our QoS architecture has been developed inside a larger networking concept, merging
mobility, QoS, and AAAC issues. This concept is currently being refined inside the IST Moby Dick project [2], and a field trial with real users is now being implemented after an initial test phase in controlled environments. In the next section we briefly describe the 4G network environment envisaged. We describe the overall QoS architecture, while we conceptually present the most relevant elements of this architecture. We detail the signaling flow of end-to-end QoS support in this architecture. Finally, we report our key conclusions.

**AN ALL-IP 4G NETWORK ARCHITECTURE**

The overall 4G architecture underlying this article is IPv6-based, supporting seamless mobility between different access technologies. The target technologies envisaged are Ethernet (802.3) for wired access; Wi-Fi (802.11b) for wireless LAN access; and wideband code-division multiple access (W-CDMA) (the physical layer of the Universal Mobile Telecommunications System, UMTS), for cellular access. Mobility is a key problem in this environment, because seamless intertechnology handovers must be supported. Thus, mobility cannot simply be handled at the physical layer, requiring implementation at the network layer. An IPv6-based mechanism has to be used even for cell handover, and no internal mechanisms for handover, on both the wireless LAN and W-CDMA, should be used.

The users/terminals may hand over between any of these technologies without breaking their network connection and maintaining their contracted QoS levels [2]. The users can further roam between administrative domains, keeping their contracted services across domains (naturally, pending appropriate agreements between those domains). On the other hand, service providers should be able to keep track of the services being used by their customers, both inside their own network and while roaming. Multiple service providers may be interoperating in the network, and both transport and multimedia content provision is seamlessly supported. For instance, a customer may subscribe to a video server service, and should be able to ignore the complexities of access to that video server: its service operator will interact with the relevant transport operators in order to provide a final solution to its customers. Multiple network functions/subsystems are then identified:

- Physically supporting the mobility of the terminals and multiple technologies
- Guaranteeing planned QoS levels to specific traffic flows
- Supporting interoperator information interchange for multiple-operator service provision
- Realizing appropriate monitoring functions for providing information to the service operator about network and service usage
- Implementing confidentiality of both user traffic and network control information

The whole network, including management functions and applications, was implemented with the IPv6 protocol stack over Linux environments. The implementation relies on the Mobile IP for Linux (MIPL) stack together with the development of Fast Mobile IP [3] extensions. Also developed were all other network and stack entities required to allow mobile terminals to seamlessly operate in this heterogeneous environment: QoS and AAAC subsystems are responsible for serving each user according to the service level agreement (SLA) previously negotiated, operating at the network and service levels respectively; security was also integrated in the network. The software for these entities was developed resorting to a mix of modified existing implementations and newly developed modules [2].

Two distinct entities have to be considered in this architecture: the user, a person or company with an SLA contracted with an operator for a set of services; and the network operator, the entity that owns the administrative network domain, providing the transfer of information across endpoints. Other value-added service (VAS) providers, such as a video-on-demand provider, are entities that are also users of network services, although eventually with specific service agreements with the network operator.

Figure 1 depicts the conceptual network architecture, illustrating some of the handover possibilities in such a network when a user moves. Three administrative domains are shown in the figure, with different types of access technologies. All network resources are managed by the network provider only. Each administrative domain is managed by an AAAC system; at least one network access control entity, the QoS broker (QoSB), is also required per domain. Due to the requirements of full service control by the provider, all handovers are explicitly handled by the management infrastructure (even when they are intratechnology, e.g., between two different access points in 802.11 or two different radio network controllers in W-CDMA) through IPv6-based protocols. In fact, 802.11 nodes are handled in ad hoc mode, and IPv6 protocols are used to handle movement between different cells; similarly, no inherent mobility mechanisms are supported on W-CDMA cells, and the same IPv6 protocols handle movement between W-CDMA cells.

Summarizing, as illustrated in Fig. 1, the key entities in this network architecture are:

- Mobile terminal (MT) — The user terminal from which the user accesses subscribed services. Our network concept supports terminal portability, meaning that a terminal may be shared among several users (although not at the same time). Access is granted to users, not to specific terminals, and an association between the user and the terminal is required when traffic is being generated. This is achieved during an initial registration phase.
- Access router (AR) — The generic MT point of attachment to the network, which takes the name of:
- Radio gateway (RG) — when we have an AR for wireless access (W-CDMA or 802.11).
- QoS broker — The entity responsible for managing one or more ARs/RGs, controlling user access and access rights according to the information provided by the AAAC system.

Mobility cannot simply be handled at the physical layer, requiring implementation at the network layer. An IPv6-based mechanism has to be used even for cell handover, and no internal mechanisms for handover, on both the wireless LAN and W-CDMA, should be used.
• AAAC system — Responsible for service level management (including accounting and charging). In this article, for simplicity, metering entities are considered an integral part of this AAAC system, as well as the overall network management and control.

QUALITY OF SERVICE ARCHITECTURE

The aim of our QoS architecture is to have a structure that leads to a potentially scalable infrastructure, possible to expand to span large areas, maintaining contracted levels of QoS, and ultimately even replacing today’s telecommunications infrastructure. In this context, no specific network services should be imposed by the QoS architecture, although naturally it should be optimized for “typical” network services. On the other hand, no special charging models should be imposed by the user-level AAAC system, and the overall architecture must be able to support very restrictive network resource usage.

With such requirements, network resource control cannot be delegated to the user or user terminal (MT), as it would be impossible to provide all this flexibility to users and still maintain a reliable network. The network (operator) must be able to control every resource, and to grant or deny user/service access, through explicit service admission control (SAC) mechanisms on the network side.

In terms of services, applications that use VoIP, video streaming, Web, email access, and file transfer have completely different requisites, and the network should be able to meet the associated requirements. In this sense, the QoS architecture has to provide different types of network layer services. For this, due to scalability constraints, the QoS architecture relies on a differentiated services (DiffServ) [4] approach, with control mostly performed at the borders of the network, and QoS assurances achieved by the concatenation of multiple managed entities. End-to-end QoS support within this network is then achieved by a set of complementary systems and interactions, providing soft QoS support to users.

An architecture for QoS provision has to consider multiple aspects: QoS provision at both the core and access network, user and session signaling, and integration of mobility and AAAC with user-dependent QoS. We briefly describe our approach to each of these points, adding, when appropriate for clarification, specific examples used in controlled environment trials.

INTEGRATED MANAGEMENT IN MOBILE NETWORKS

The basic management concepts underlying the complexity of service and network management have been defined in the telecommunications management network (TMN) architecture. This architecture is complex and resource consuming, but its layered concepts, separating business, service, networks, and devices, have generally been used as guides in management. Network service provision in 4G networks should similarly be

![Figure 1. General network architecture.](image-url)
based on the separation of service and network support management entities. We define a service layer, with its specific interoperation mechanisms across different administrative domains (and directly mapped on the service provision concept), and a network transport layer, which has its associated interoperation mechanism between network domains. An administrative domain is composed of one (or more) network domains. If a terminal is crossing administrative domains during its movement, this implies that it is also changing its current network service provider. Service definitions are handled inside administrative domains and negotiated across domains, using appropriate frameworks for interoperator service negotiation (e.g. [5, 6]).

Each domain has an entity responsible for handling user service aspects (the AAAC system) and at least one entity handling the network management aspects at the access level (the QoS). The AAAC system is the central point for authentication, authorization, and accounting. When a mobile user enters the network, the AAAC will have to authenticate it (this is done when the network detects that a new terminal wishes to enter the domain, as we will see below). Upon successful authentication, it sends to the QoS the relevant QoS policy information based on the SLA of the user, stored in its profile. The user profile consists of terminal/service pairs ideally suited to implicit DiffServ QoS signaling. From this moment, the AAAC delegates further network-related management associated with this user to the QoS. However, this architecture is flexible enough to allow the implementation of specific services that will require the QoS to question the AAAC system for special services: a special code point will command the QoS to retrieve further instructions from the AAAC system (e.g., for supporting services provided in association with VAS partners).

**QoS on the Core and Access Networks**

In the DiffServ approach, the core is basically managed per aggregate of network services and not by user services, like the access. Core management is then independent of the access, with much larger dynamic requirements. Furthermore, different domains compose the core, one (or more) from each network operator. The packets should cross all these domains before they reach the endpoint, with minimal management intervention. Core network resources are then distributed between several classes of service, according to average traffic levels, to minimize any need of intervention. We assume that the core network is overprovisioned (as it is today); the low cost of upgrading transmission capabilities in the core justifies this existing approach in many network providers.

On the other hand, the access network is managed by the above mentioned QoS, also because of the potential SAC complexity. The QoS provides the interface between the user service view and effective QoS support at the network level. The QoS manages and monitors access network resources, controlling both ARs and RGs in a particular domain of operation for the provision of user services. It also monitors the internetwork edges for incoming and outgoing resource reservations and/or utilization. A QoS is then an entity that makes SAC decisions and does network device configuration according to conditions imposed by the network administration entities (e.g., the AAAC system) with the goal of achieving end-to-end QoS (eventually over different networks). The QoS may also be responsible for managing interdomain communications with neighbor QoSs so that services may be implemented in a coordinated way across various domains.

Typically, there are several QoSs per domain; these are logically close to the actual routers, in order to minimize performance delays (our tests showed that a QoS can realistically handle almost 1000 requests/s, with about 1 ms processing delay per request).

The use of a QoS, responsible for the network optimization view, presents several advantages. First, this distributed environment is able to optimally handle multiple physical layers and network resources, since QoSs can be specifically designed to manage different types of networks. Second, it provides a scalable structure, in terms of both network dimensions and service offerings, as management load is distributed through different elements, both logically and geographically. Third, this is utterly flexible in terms of management options and IP QoS models, since user service issues are hidden from the specific network management aspects.

**User and Session Signaling**

In this architecture, each network service is associated with a different DiffServ code point (DSCP). This way, every packet has concisely all information needed for the network entities to correctly forward, account, and differentiate each packet and each service/user. After registering (with the AAAC system), the user signals its intention of using a service by sending packets marked with the DSCP associated with the service. This corresponds to implicit signaling, user-dependent, as the QoS will be aware of the meaning of each DSCP code for each user (although typically there will be no variation in DSCP codes per user). Thus, the QoS has the relevant information for mapping user service requests into network resource requirements. If there are resources available for the service requested, the packets will be forwarded and accounted. If not, the AR signals this occurrence to the user/terminal.

For termination, every network service has an associated timeout. If there are no packets sent or received belonging to that service for this timeout period, the network elements will automatically free the resources and stop accounting usage of the service. So the session concept is here associated with the use of network resources, not explicitly with specific traffic flows.

In addition, our architecture allows a user (or service provider) to explicitly send an unsubscribe service message (or subscribe) using out-of-band signaling. This facility is specially useful for prepaid services: the AAAC can issue commands for the QoS to stop provision of given
Users will subscribe to service level agreements consisting of sets of network services. The operator may have a portfolio of packages composed by different sets of network services, such as “inexpensive service” supported at the network layer through S1 and S4 services; and “exclusive pack,” composed by S1, S2, S3, and S6.

<table>
<thead>
<tr>
<th>Service Name</th>
<th>Class</th>
<th>Relative priority</th>
<th>Service parameters</th>
<th>Typical usage description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIG</td>
<td>AF41</td>
<td>2a</td>
<td>Unspecified</td>
<td>Signaling</td>
</tr>
<tr>
<td>S1</td>
<td>EF</td>
<td>1</td>
<td>Peak BW: 32 kb/s</td>
<td>Real-time services</td>
</tr>
<tr>
<td>S2</td>
<td>AF21</td>
<td>2b</td>
<td>CIR: 256 kb/s</td>
<td>Priority (urgent) data transfer</td>
</tr>
<tr>
<td>S3</td>
<td>AF1*</td>
<td>2c</td>
<td>Three drop precedences (kb/s): AF11 — 64 AF12 — 128 AF13 — 256</td>
<td>Olympic service (better then BE: streaming, ftp, etc.)</td>
</tr>
<tr>
<td>S4</td>
<td>BE</td>
<td>3</td>
<td>Peak bit rate: 32 kb/s</td>
<td>Best effort</td>
</tr>
<tr>
<td>S5</td>
<td>BE</td>
<td>3</td>
<td>Peak bit rate: 64 kb/s</td>
<td>Best effort</td>
</tr>
<tr>
<td>S6</td>
<td>BE</td>
<td>3</td>
<td>Peak bit rate: 256 kb/s</td>
<td>Best effort</td>
</tr>
<tr>
<td>S7</td>
<td></td>
<td>Special service requesting AAAC contact for specific network characteristics (DSCP, BW, etc.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Targeted network services.

services, or a command to the QoSB allowing specific credits (in time or traffic) the QoSB will use to translate into network control commands.

SERVICES

Network Services — Network services are provided by a DiffServ architecture, with each network service implemented with one of the three basic DiffServ types: expedited forwarding (EF), assured forwarding (AF), or best effort (BE), with associated bandwidth (BW) characteristics. Delay, jitter, and loss are other possible parameters to include in the future, but no generalized control mechanisms for these parameters are currently used in IP networks. The services may also be unidirectional or bidirectional. In fact, the QoS architecture is flexible enough to support any type of network service specification, depending on the management complexity (implemented through the interaction of the QoSBS, AAAC systems, and AR) the network provider is willing to support.

Table 1 lists the network services used in our tests, optimized for voice communications and data transfer services, from a network provider point of view (applications run on the test: Web browsing, ftp, Netmeeting, VideoLan, and Quake2). Other possibilities exist: the user may even simply have a contract with a VAS provider, which will then necessarily have a contract with the network provider.

User View — Users will subscribe to SLAs consisting of sets of network services. The operator may have a portfolio of packages composed by different sets of network services, such as “inexpensive service” supported at the network layer through S1 and S4 services (Table 1); and “exclusive pack,” composed of S1, S2, S3, and S6. The reflection of this service pack in terms of network level services is called the network view of the user profile (NVUP), containing the subscribed network-level services and user identification. The user will only be aware of high-level services (e.g., telephony), not their translation into network configuration, which will be done automatically by the QoS architecture entities.

ENTITIES AND PROTOCOLS OF THE QoS ARCHITECTURE

This section summarizes network management protocols used for QoS entities communication. Each of the main entities involved in the QoS process are then concisely described, highlighting their interrelationships. The different signal flows associated with QoS are further described in the next section.

NETWORK MANAGEMENT PROTOCOLS

The network elements have to interact between themselves, and for that they need to have a common language. Two main protocols are used in our network architecture: Common Open Policy Service (COPS) and DIAMETER.

The COPS protocol [7] is able to support policy control in an IP network through simple request and answer messages. COPS is used to exchange information about traffic policy between a policy server (policy decision point, PDP) and different clients (policy enforcement points, PEPs). The PDP is responsible for interpretation of the rules to be implemented in the network and enforced by the PEPs. In our architecture, the interactions between QoSBS (acting as PDPs), edge routers (acting as PEPs), and AAAC systems (also acting as PDPs, but at a higher level) are based on COPS message exchange.

Although the policy concepts associated with QoSBS are adequate for managing network resources, there is also a need for information to be exchanged related with users’ services. In a 4G environment, the user may subscribe to different multimedia service providers. Its relevant contract information has to be conveyed to the management system of the transport network, which should then provide adequate network services to the user. The authentication, authorization, and accounting (AAA) architecture [8], and the DIAMETER protocol [9], are adequate for our 4G reference environment: the DIAMETER protocol was originally defined for the transport of authentication, authorization, and accounting information between AAA clients.
(e.g., a network access server) and AAA servers. At the AAA server an internal database keeps track of user authentication information, such as user names and passwords, authorization information, and information of the service type to be delivered. The DIAMETER protocol is able to transport configuration information back to an AAA client after successful authorization, but can also be used for interoperatation of multiple AAA servers.

QoS Entities at the Network Level

Three different entities interoperate in order to ensure QoS provision at the network level: the mobile terminal (MT), the access router, and the QoS broker. Figure 2 depicts a simplified functional overview of these entities from the point of view of the QoS architecture.

The MT supports an enhanced IPv6 stack, able to perform marking according to user subscribed services; a networking control panel, able to perform AAA registration/deregistration; an MT networking manager that will make the decision to execute handover and attach procedures, based on information configured by the user (network preferences, handover preferences, manual handover request, explicit registration request), usually done automatically at software installation time, and information received from the networking devices (W-CDMA, WLAN, Ethernet drivers); and a radio convergence function that interfaces with the radio layer in compliance with the IP-level QoS requirements.

The AR also comprises an enhanced IPv6 stack with IPSec and DiffServ filtering, implementing basic transport, authentication, and security functionalities, added by QoS-related functions (dropping, shaping, scheduling); a fast handover (FHO) module, implementing fast handover procedures [3] in an MIPL distribution, with added proper QoS-related signaling; an AAA attendant, responsible for all communication with the AAAC system, acting on behalf of the MT to establish initial user registration and basic security functionalities; and a QoS attendant, able to configure QoS policies in the stack and interoperate with context transfer mechanism (similar to the approach of the Internet Engineering Task Force, IETF, seamoby group [10]), to exchange FHO metering data.

The QoS broker has an engine responsible for making all management decisions, and several different interfaces to interoperate with other entities using COPS. The AR interface is used for both letting the AR pool the broker for policies related to the services the attached users are requesting, and configuring the AR with that specific policy. The AAAC interface is used to exchange messages with the AAAC, inform the QoS broker of every new MT/user that attaches to its domain (including the NVUP information for each user), and require specific user and service information. The QoS broker interface is used for exchanging information between QoS brokers in order to provide end-to-end QoS guarantees.

End-to-end QoS Support

These entities can support end-to-end QoS using the overall concepts previously described. Three distinct situations arise in the QoS architecture:

- **Registration** — An MT/user may only start using network resources after authentication and authorization, as in today’s networks.
- **Authorization** — The user has to be authorized to use specific services.
- **Handover** — This is when the user needs to have its existing resources transferred from one AR to another when moving.

Registration

The registration process (Fig. 3) is initiated after a care-of address (CoA) is acquired by the MT via stateless auto-configuration, using unique layer 2 identifiers [11] to create the interface identifier part of the IPv6 address. However, getting a CoA does not entitle the user to consume resources, besides registration messages and emergency calls. The MT has to start the authentication process by sending user authentication information (message 1, Fig. 3) to the AR, in order to later be allowed to use network resources. The request is then forwarded to the AAAC system (message 2). Upon successful authentication, the AAAC system dumps the NVUP to the QoS broker (3b), performing the required association between user and MT, and informs the MT via the AR (3a+4).

Authorization

Figure 3 shows how each network service is authorized (messages 5–8). First, the MT sends a packet (5) (with either real information or just a dummy packet) with the DSCP marked to

In a 4G environment, the user may subscribe to different multimedia service providers. Its relevant contract information has to be conveyed to the management system of the transport network, which should then provide adequate network services to the user.
request a particular service. If the requested packet does not match any policy already set in the AR, the AR issues a request (6) to the QoSB, through the QoS manager (5a). Upon analyzing the request, and based on the specific NVUP and availability of resources, the QoSB sends a service confirmation back to the AR (7). The QoS manager (in the AR) then configures the appropriate policy for that user/MT service (7a) in the AR. After that, any other packet sent from the MT that matches the configured policy will be able to cross the network (8). Nonconformant packets will restart the authorization process once more. At the egress router, another similar authorization process takes place.

**QoS Enabled Handover**

One of the most difficult problems when dealing with IP mobility is ensuring a constant level of QoS. User mobility is here ensured by FHO techniques in conjunction with context transfer between network elements (ARs — old and new — and QoSs). When an MT starts losing signal to the current AR (oldAR, AR1) (message 1, depicted in Fig. 4), it will start a handover procedure to a neighboring AR (newAR, AR2) from which it received a beacon signal with a network prefix advertisement (2). The MT builds its CoA and initiates the handover procedure, sending a handover request to its newAR (3), still through the oldAR. The oldAR forwards this request to both the newAR (known by the network prefix) (4a) and the old QoS (4b). The old QoSB (QoSB1) sends a handover request to the new QoS (QoSB2) (5), indicating the user’s NVUP and the list of services currently being used. This acts as a context transfer from the old QoS to the new QoS. With this information, the new QoS will verify the availability of resources, and send a message to the newAR (6) indicating whether the MT may or may not perform the handover. If the handover is possible, the newAR will be configured with a copy of the policies the oldAR has for that user. If the handover is not possible, multiple operator policies can be supported, according to network usage and user preferences. Meanwhile, the newAR will forward the answer to the oldAR (7), which will then send it to the MT (8). Upon a positive answer, the MT may perform layer 2 handover (9) because all the layer 3 resources are then reserved. During this phase, both ARs are bicasting to minimize packet loss.

**CONCLUSION**

We presented an architecture capable of supporting end-to-end QoS in an infrastructure where mobility and AAAC are also integrated. This QoS architecture is able to support multiservice, multi-operator environments, handling complex multimedia services with per-user differentiation.

The MT, AR, and QoS brokers are the main elements in this QoS architecture for user-oriented service provision. We present the signaling flows and depict the overall QoS concept. The QoSB, AAAC system, and FHO process interact...
with each other for optimum network management efficiency and maximum service flexibility. Their communications is ensured through facilities provided by DIAMETER and COPS protocols. With this approach, very few restrictions are imposed on service offering. We have tried this in controlled environments with voice services, video and audio broadcasts, and videoconferencing applications, always imperceptible to the user. Table 2 shows measured delay achieved in these tests, which were sufficiently small not to affect application behavior, specially due to the bicasting of packets during FHO. This architecture is currently being evolved for large testing in field trials across Madrid and Stuttgart.

This approach suffers from intrinsic DiffServ problems, as each domain has to implement a correspondence between each network service and a DSCP; thus, for interdomain service provision, it is essential a service/DSCP mapping between neighboring domains. Furthermore, an adequate middleware function is required in the MT to optimally mark the packets generated by the applications and issue the proper service requests: the network is not usable with unmodified IP stacks.

Nevertheless, this approach facilitates the deployment of multiple service provision models, as it decouples the notion of service (associated with the user contract) from network management tasks. It also allows for specific optimizations to be made for specific physical layers. In summary, it seems to provide a simple flexible QoS architecture able to support multimedia service provision in future 4G networks.

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We presented an architecture capable of supporting end-to-end QoS in an infrastructure where mobility and AAAC are also integrated. This QoS architecture is able to support multi-service, multi-operator environments, handling complex multimedia services, with per user differentiation.


BIographies

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