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QoS in Mobile Environments

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ABSTRACT

In the near future, wireless networks will certainly run real-time applications with special Quality of Service (QoS) requirements. In this context micro-mobility management schemes such as Fast Handovers over Hierarchical Mobile IPv6 (F-HMIPv6) will be a useful tool to reduce Mobile IPv6 (MIPv6) handover disruption. However, F-HMIPv6 by itself does not support QoS requirements for real-time applications. Therefore, in order to accomplish this goal a novel resource management scheme for the Differentiated Services (DiffServ) QoS model is proposed to be used as an add-on to F-HMIPv6. The new resource management scheme combines the F-HMIPv6 funcionalities with DiffServ QoS model, network congestion control and resource dynamic reallocation mechanisms in order to accommodate different QoS traffic requirements.

In order to assess model performance, as well as its parametrization, a simulation model has been designed and implemented in the Network Simulator version two (NS-2). Simulation results indicate that the solution avoids network congestion and starvation of less priority DiffServ classes.

Moreover, the results also indicate that bandwidth utilization for priority classes increases and the QoS offered to Mobile Node's (MN's) applications, in each DiffServ class, keeps up unchangeable with MN mobility.

The proposed model is simple and easy to implement, takes into account the mobile Internet requirements, and proved to be effective and capable of providing services with high reliable QoS to applications.

INTRODUCTION

During the last years, several network communications challenges have arisen with the growing number of users demanding QoS and mobility simultaneously. In order to satisfy these very demanding customers, the markets are imposing new challenges to wireless networks by demanding heterogeneity in terms of wireless access technologies, new services, suited QoS levels to real-time applications, high usability and improved performance. However, Internet has been designed for providing application's services without quality guarantees. For this reason, in the last years several efforts have been made to endow Internet with QoS support. From the developed efforts had resulted two QoS paradigms: Integrated Services (IntServ) which provides the guaranteed service model, and the DiffServ which provides the predictive service model. Although, as these QoS models have been designed before the existence of mobile Internet they do not take into account the mobility issue. On the other hand, the current standard protocol for mobile Internet - MIPv6, reveals some limitations in scenarios where users are constantly moving to another point of attachment. In this type of scenarios, MIPv6 introduces latency times that are not sustainable for applications with more strict QoS requirements. All things considered reveal the emerging need of adapt the current standard mobility protocol and QoS models to the today mobile user's requirements. For accomplishing this goal the present work proposes enhancements in the mobility management scheme of MIPv6 protocol and in the resource management of DiffServ QoS model. The former was enhanced for micro-mobility scenarios with a specific combination of FMIPv6 (Fast Mobile IPv6) and HMIPv6 (Hierarchical Mobile IPv6) protocols. Whereas, the latter was enhanced for mobile environments with dynamic and adaptive features by using QoS signalization and a distributed resource management. The mobility and resource management has been also coupled in the proposed solution with the objective of optimizing the resource utilization in a environment where the resources are typically scarce. The remainder of this extended abstract is organized in four sections. Next section describes the related work. Third section presents a briefly description of the proposed QoS micro-mobility solution and its extensibility to the global mobility. Fourth section presents the simulation model and some results obtained with the proposed QoS solution. This extended abstract ends by remarking the most important conclusions and with some future research recommendations.

RELATED WORK

Dynamic QoS provisioning architectures can be accomplished by using signaling protocols and admission control policies. The Resource Reservation Protocol (RSVP) is generally the signaling protocol used for request resources to the network, however it is based on static network infrastructures and is not suited for scenarios with mobility, where bandwidth is limited and the operating conditions are non-deterministic. Therefore, in [1] the authors proposed the Mobile RSVP (MRSVP) in order to make advanced reservations at multiple locations where a MN may possibly visit. Thus, when a MN moves to a new location the resources are reserved in advance, but advanced resource reservations has the problem of creating excessive resource reservations resulting in a significant waste of resources and a poor network performance. Other MRSVP derived solutions are Hierarchical MIP (HMRSVP) [2] and Mobility-Aware Resource Reservation Protocol (MARSVP).

In spite of the unquestionably enhancements of the proposed QoS solutions for mobility, they are based on deterministic resource reservations for guaranteed service model. These QoS solutions when enforced to mobile wireless networks, will introduce extra signaling overhead due to required QoS renegotiation in new data path when a handover occurs. Consequently, significant scalability problems may arise due to simultaneous QoS and mobility signaling messages caused by handovers that may be excessive in high dynamic mobile networks.

PROPOSED MODEL

The main objective of the proposed model is to define a micro Mobility/QoS-aware network with dynamic QoS funcionalities, adaptive resource management and seamless handovers [3]. Another stated aim is to deal with scalability problems that may arise when handovers are frequent, reducing signaling overhead, processing and state information load.

For overcoming the inefficiency of MIPv6 in micro-mobility scenarios a specific combination of FMIPv6 and HMIPv6 (F-HMIPv6) was applied. The F-HMIPv6 enhances the MIPv6 mobility with seamless handovers and local handovers registrations.

Regarding to QoS architecture the proposed model extends the Resource Management Function (RMF) of DiffServ in the edge routers with a measurement-based admission control mechanism. The RMF comprises the DiffServ QoS mechanisms (policer, congestion avoidance and scheduling) and a measurement-based admission control mechanism (estimator and admission control algorithm) The RMF in the Access Routers (ARs) has an additional element called dynamic allocator to improve the network utilization with an adaptive resource management. Relating to state information overhead, signaling overhead and processing load problems caused by guaranteed service model our approach effort has been to overcome this problems with more relaxed QoS requirements i.e., with the predictive service model of the DiffServ QoS model.

Another objective of the model is designing a micro Mobility/QoS-aware network capable of being easily extended for global mobility. In this scenario the Mobile Anchor Point (MAP) should integrates the functions of ingress router, Bandwidth Broker (BB) and inter-domain signaling entity. The job of BB is to negotiate Service Level Specifications (SLSs) with BBs of neighboring domains in order to provide QoS to the users even in case of inter-domain handovers. The BB translates MN's QoS Context into SLS and then negotiate SLS with its peer BB. The BB of the proposed model only has responsibilities at inter-domain level which include the negotiation of QoS parameters and setting up bilateral agreements with neighboring domains.

SIMULATION MODEL & RESULTS

The deployment of the simulation model has been made in the NS-2 and has provided the following achievements: 1) to choose of the best rate estimator for the model's architecture; 2) the evaluation of the model with and without dynamic allocator in order to assess the influence of this element in the model performance, and; 3) to assay the model performance under different parametrization values in order to choose the best values based on objective criteria.

Accordingly to simulation results, the model has demonstrated to be able to deal with network congestion by limiting the amount of traffic within a class and also to improve resource utilization while maintaining QoS requirements of flows, within their DiffServ classes unchanged.

Further, it also provides a better bandwidth network utilization by reallocating bandwidth to those in need, thus improving resource utilization efficiency in a environment where the resources are scarce. Furthermore, the results show that the model is able to provide the desirable QoS for the handover flows and for the existing flows.

CONCLUSIONS

This research work proposes a model that enables dynamic QoS provisioning to local mobility. Further, the model can also be easily extended to global mobility. The proposed model aims to enhance micro and global mobility with QoS support and seamless handovers. For this purpose two enhancements have been introduced. The first enhancement has been a specific integration of FMIPv6 and HMIPv6 (F-HMIPv6) to improve MIPv6 handover latency. The second enhancement has been the extension of the standard DiffServ resource management with dynamic and adaptive QoS provisioning. The proposed model is simple and easy to implement, takes into account the mobile Internet requirements, and proved to be effective and capable of providing services with high reliable QoS to applications. In future work, we intend to apply optimization functions to adjust the reallocation parameters in order to maximize the resources utilization.

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