PREMIER REFERENCE SOURCE

Intelligent Quality of Service Technologies and Network Management

Models for Enhancing Communication

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Section 1
Quality of Services

The advent and rise of broadband technologies and new applications and services have led to a complex heterogeneous scenario in which providing Quality of Service (QoS) has become a compelling issue. Furthermore, the competitive condition of the telecommunications environment has caused user's perception of quality to become one of the most differential factors for service providers. Due to this fact, QoS must not only attend to specific technical metrics, but more important, QoS criteria should be defined to assure the level of quality to fulfill the users' requirements. In this new context, the definition of effective user-oriented QoS management models and frameworks has become a matter of contention. This chapter aims to provide readers a comprehensive analysis of the entire significance of a user-centered approach for quality of service management. For this purpose, a review of the most important issues related to the subject is provided.

During the last years Internet evolution demanded for new and richer applications. To fulfill the novel and more complex application requirements, new solutions in many domains were required. One of these domains is the network support, assuring, into some extend, a specific or predictable treatment to traffic; therefore, in this chapter, we present a broad view of the main efforts available on the literature in order to provide Quality of Service (QoS) in both wired networks and wireless sensor networks (WSNs). For this purpose, the authors present: (1) the more relevant QoS architectures and technologies along with some of its recent improvements; (2) the different perspectives that combine some of those architectures and technologies into more complex solutions, in order to achieve stronger QoS and/or performance; (3) the most relevant QoS issues in WSNs environments; and (4) through the comparison of the several solutions, the authors list the advantages and limitations and reveal some relations among the existing QoS solutions.

Currently the Internet offers a point-to-point delivery service, which is based on the "best effort" delivery model. In this model, data will be delivered to its destination as soon as possible, but with no commitment about bandwidth or latency. Using protocols such as the Transmission Control Protocol (TCP), the highest guarantee the network provides is reliable data delivery. This is adequate for traditional data applications like e-mail, web browsing, File Transfer Protocol (FTP) and Telnet, but inadequate for applications requiring timeliness. For example, multimedia conferencing or audio and video streaming applications, which require high bandwidth capacity and are sensitive to delay and delay variation. For these applications to perform adequately, Quality of Services (QoS) must be quantified and managed, and the Internet must be modified to support real-time QoS and controlled end-to-end delays. The efforts to enable end-to-end QoS over the Internet Protocol version 4 (IPv4) networks have led to the development of two different architectures, the Integrated services architecture (Intserv) and the Differentiated services architecture (Diffserv), which although different, support services that go beyond the best effort service. This chapter will present a detailed discussion on these IPv4 quality of services models. First, the Integrated services architecture with its related issues such as the reservation setup protocol will be demonstrated. Second, the Differentiated services architecture with a description of the services they provide will be described. Finally, a comparison between the Best-effort, the Integrated and Differentiated services will be done.

Wireless Sensor Networks (WSNs) have been envisioned as a new and effective means for creating and deploying previously unimaginable applications. These networks generally have the capabilities of observing the physical phenomena, communication, data processing and dissemination. Limited resources of sensor nodes like energy, bandwidth and processing abilities, make these networks excellent candidates for incorporating QoS framework. The possible applications of WSNs are numerous while being diverse in nature which makes analyzing and designing QoS support for each application a non-trivial task. At the same time, these applications require different type of QoS support from the network for optimum performance. A single layer cannot address all these issues, hence, numerous researchers have proposed protocols and architectures for QoS support at different network layers. In this chapter, we identify the generic QoS parameters which are usually supported at different layers of WSNs protocol stack and investigate their importance in different application models. A brief overview of significant research contribution at every network layer is provided. It is worthwhile to mention that same QoS parameter may be supported at multiple layers, hence, adequate selection of suitable mechanism would be application's choice. On the other hand, it is quite possible that a single QoS parameter, such as energy conservation or real-time delivery, can be efficiently supported through interaction of multiple layers. It is difficult, if not impossible to optimize multi layer QoS architecture. Hence, a number of researchers have also proposed the idea of cross layer architecture for providing QoS support for a number of sensor applications, which is also discussed in this chapter. At the end, the authors highlight the open research issues that might be the focus of future research in this area.

Wireless networks such as Bluetooth, WLAN and WiMax have transformed the way we access information and communicate seamlessly whether we are at home, in the office, or on the move on a train, bus or even aircraft. As mobile and embedded computing devices become more omnipresent, it will become increasingly difficult to interconnect them via wires and single-hop wireless links limited by radio transmission range. This has given rise to mobile ad hoc networks (MANET) where far away nodes communicate by requesting intermediate nodes to relay their information in order to reach the destination. MANETs self-organize, self-configure and self-heal themselves. MANETs are being used in many applications ranging from emergency response situations to wireless vehicular ad hoc networks. Many applications of MANETs such as Emergency Response and First Responders have strict Quality of Service (QoS) requirements for their communications systems, making MANET QoS provisioning mechanisms very crucial for supporting multimedia communications such as real-time audio and video. However, QoS provisioning in highly dynamic networks such as MANETs is a very challenging problem compared to QoS provisioning in wireline IP networks. This is due to numerous reasons such as the dynamic network topology, unpredictable communication medium and limited battery power of mobile devices forming the network. This chapter describes the challenges and the current state of the art of QoS protocols and mechanisms in MANETs.

The present day Internet traffic largely caters for the multimedia traffic throwing open new and unthinkable applications such as tele-surgery. The complexity of data transactions increases with a demand for in time and real time data transfers, demanding the limited resources of the network beyond their capabilities. It requires a prioritization of data transfers, controlled dumping of data over the network etc. To make the matter worse, the data from different origin combine together imparting long lasting detrimental features such as self similarity and long range dependency in to the traffic. The multimedia data fortunately is associated with redundancies that may be removed through efficient compression techniques. There exists a provision to control the compression or bitrates based on the availability of resources in the network. The traffic controller or shaper has to optimize the quality of the transferred multimedia data depending up on the state of the network. In this chapter, a novel traffic shaper is introduced considering the adverse properties of the network and counteract with the same.

This chapter presents a multiple constraint optimization algorithm called routing decision system (RDS) that uses the concept of preference functions to address the problem of selecting paths in core networks that satisfy traffic-oriented QoS requirements while simultaneously satisfying network resource-oriented performance goals. The original contribution lies in the use of strong scales employed for constructing a multiple criteria preference function in an affine space. The use of preference functions makes it possible for paths that match both traffic-oriented and resource-oriented goals to be selected by the algorithm. The RDS algorithm is used in conjunction with a heuristic path finding algorithm called Constraint Path Heuristic (CP-H) algorithm which is a novel approach to finding a set of constraint paths between source and destination nodes in a network. The CP-H algorithm finds multiple paths for each metric and then passes all the paths to the RDS algorithm. Simulation results showed that the CP-H/RDS algorithm has a success rate of between 93 and 96% when used in Waxman graph topologies, and is shown to be significantly better than other heuristic based algorithms under strict constraints. In addition, it is shown that the associated execution time of the CP-H/RDS algorithm is slightly higher than other heuristic based algorithms but good enough for use in an online traffic engineering (TE) application. Simulations to assess the performance of CP-H/RDS algorithm in a TE environment show that the algorithms has lower call block rates than other TE algorithms. It is also shown that the CP-H/RDS has a 96% probability of providing at least two distinct feasible backup paths in addition to the main QoS path. A framework for implementing the CP-H/RDS as a routing server is proposed. The routing decision system server (RDSS) framework is novel in that the complexity introduced by QoS awareness remains outside the network.

The Internet relies on the cooperation of competitive network operators that typically administrate their networks unilaterally and autonomously to interconnect people and companies in different locations. Recent work calls for extending this organizational model with augmented interactions between network operators, to provide a higher level of endtoend quality of service and to ease certain aspects of traffic management in backbone networks. This chapter presents the emerging collaborative network management models as well as related technologies. In particular, it describes recent techniques for interdomain traffic engineering and for qualityofservice aware routing. The detailed methods are of great interest for network operators and permit the development of new types of commercial relationships between them, ranging from simple interconnection agreements to collaborative traffic management and automated provisioning.

In this chapter, the authors examine two important network traffic issues: estimation of effective bandwidth and data loss probability in communication networks. They focus on estimation approaches based on network traffic modeling. Initially, the authors review some concepts related to network traffic modeling such as monofractal and multifractal properties. Further, the authors address the issue of estimating the effective bandwidth for network traffic flows. Besides effective bandwidth, the knowledge of the loss probability explicitly allows us to guarantee some QoS parameters required by the traffic flows, for example, by discarding flows with intolerable byte loss rate. In this sense, they present an overview of loss probability estimation methods including an approach that considers multifractal characteristics of network traffic. That is, given the model parameters, the data loss probability for network traffic can be directly computed. The authors conclude that both the multifractal based effective bandwidth and loss probability estimation methods can be powerful tools for really providing QoS to network flows.

Section 3
Integrations of Quality of Service and Network Management Model

In this chapter the authors discuss innovations associated with the transition from the circuit-switched public telephone network to IP packet-switched networks for the provision of voice services by focusing on research findings in the area of quality of service (QoS). To give a meaningful answer on how this transition affects the telecommunications industry, they elaborate on the frequently-cited concept of disruptive innovations, pioneered by Harvard Professor Clayton M. Christensen.

The authors consider distributed mobile networks carrying time-varying heterogeneous traffics. To deal effectively with the mobile and time-varying distributed environment, the deployment of traffic and network performance monitoring techniques is necessary for the identification of traffic changes, network failures, and also for the facilitation of protocol adaptations and topological modifications. Concurrently, the heterogeneous traffic environment necessitates the deployment of hybrid information transport techniques. This chapter discusses the design, analysis, and evaluation of distributed and dynamic techniques which manage the traffic and monitor the network performance effectively, while capturing the dynamics inherent in the mobile heterogeneous environments.

Meeting the agreed quality of service in a resource crunched data network is challenging. An intelligent element is required to carry out the activities involved. The inferences drawn with different rules need to be merged. Agents are useful for handling this responsibility in data networks and help in resource sharing. An agent is basically an entity that can be viewed as perceiving its environment through sensors and acting upon its environment through effectors. To handle the network traffic, the agents acquire the traffic status and provide the information on the availability of resources to the source of the traffic. Hence the study on agent communication has become important. Intelligent agents continuously perform the activities including perception of dynamic conditions in the environment, reasoning for interpretation of the perceptions, solve problems, draw inferences and determine actions.

The Internet is an interconnection of multiple networks called domains. Inter-domain routing is ensured by BGP which preserves each domain's independence and announces routes arbitrarily chosen by domains. BGP messages carry no information concerning quality parameters of announced routes. Our goal is to provide domains with information regarding the congestion state of other domains without any changes in BGP. A domain, which is aware of heavily congested domains, can choose a bypass instead of a route exhibiting possible problems with QoS satisfaction. The authors propose a mechanism which sends alert messages in order to notify domains about the congestion state of other domains. The major difficulty consists in avoiding flooding the Internet with signaling messages. Their solution limits the number of alerts by taking advantage of the hierarchical structure of the Internet set by P2C and P2P relationships. Their algorithm is distributed and heuristic because it is a solution to an NP-complete and inapproximable problem. They prove these properties by reducing the Steiner problem in directed acyclic graphs to our problem of alert diffusion. The simulations show that our mechanism significantly diminishes the number of unavailable domains and routes compared to those obtained with BGP routing and with a theoretical centralized mechanism.

Network multimedia applications constitute a large part of Internet traffic and guaranteed delivery of such traffic is a challenge because of their sensitivity to delay, packet loss and higher bandwidth requirement. The need for guaranteed traffic delivery is exacerbated by the increasing delay experienced by traffic propagating through more than one QoS domain. Hence, there is a need for a flexible and a scalable QoS manager that handles and manages the needs of traffic flows throughout multiple IPv6 domains. The IPv6 QoS manager, presented in this paper, uses a combination of the packets' flow ID and the source address (Domain Global Identifier (DGI)), to process and reserve resources inside an IPv6 domain. To ensure inter-domain QoS management, the QoS domain manager should also communicate with other QoS domains' managers to ensure that traffic flows are guaranteed delivery. In this scheme, the IPv6 QoS manager handles QoS requests by either processing them locally if the intended destination is located locally or forwards the request to the neighboring domain's QoS manager. End-to-end QoS is achieved with an integrated admission and management unit. The feasibility of the proposed QoS management scheme is illustrated for both intra- and inter-domain QoS management. The scalability of the QoS management scheme for inter-domain scenarios is illustrated with simulations for traffic flows propagating through two and three domains. Excellent average end-to-end delay results have been achieved when traffic flow propagates through more than one domain. Simulations show that packets belonging to non-conformant flows experience increased delay, and such packets are degraded to lower priority if they exceed their negotiated traffic flow rates. Many pricing schemes have been proposed for QoS-enabled networks. However, integrated pricing and admission control has not been studied in detail. A dynamic pricing model is integrated with the IPv6 QoS manager to study the effects of increasing traffic flows rates on the increased cost of delivering high priority traffic flows. The pricing agent assigns prices dynamically for each traffic flow accepted by the domain manager. Combining the pricing strategy with the QoS manager allows only higher priority traffic packets that are willing to pay more to be processed during congestion. This approach is flexible and scalable as end-to-end pricing is decoupled from packet forwarding and resource reservation decisions. Simulations show that additional revenue is generated as prices change dynamically according to the network congestion status.

In this chapter, the authors present some of the latest developments related to the provisioning of Quality of Service (QoS) in today's networks and the associated network management structures that are or will be deployed to support them. They first give a brief overview of the most important Quality of Service proposals in the areas of Layer 2 (L2) and Layer 3 (L3) QoS provisioning in backbone networks, and we discuss the network management structures and brokers that have been proposed in order to implement these services. As a case study, they describe the pan-european research and academic network, which is supported centrally by GEANT and which encompasses multiple independent NRENs (National Research and Education Networks). In the last few years, GEANT has developed and deployed a number of production and pilot services meant for the delivery of quality network services to the end users across Europe.

Every community in the world expects to have a high value of life. Therefore, budgets are pooling to the local healthcare unit to increase healthcare and medical services to their citizen. One common implementation in the healthcare system is a healthcare network, where all necessary information are transferred to safe patients' lives. Various developments in medical equipments integrate communication circuit to enhance ability to transmit data direct from patients to medical staffs so that their lives can be safe in time. Since the implementation of wireless network is widely spread, this paper proposes