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TRUST CALCULATION IN ADHOC NETWORKS

M.Dhanalakshmi*, Dr.A.Rajesh**
*Research Scholar, Dept of Computer Science and Engineering, Bharath Institute of Higher Education and Research, Bharath University, Chennai, 600073
**Professor, Dept of Computer Science and Engineering, C.Abdul Hakeem College of Engg and Tech, Melvisharam, Vellore Dt

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Abstract

Ad hoc wireless network (AWN) is a collection of mobile hosts forming a temporary network on the fly, without using any fixed infrastructure. Quality of service (QoS) is the performance level of a service offered by the network to the user. The goal of QoS provisioning is to achieve a more deterministic network behavior, so that information carried by the network can be better delivered and network resources can be better utilized. QoS provisioning is very challenging in adhoc network lack of central coordination, mobility of hosts, dynamically varying network topology, and limited availability of resources. Here we have proposed a framework for providing QoS in Ad hoc network by considering the challenges and requirement. The QoS framework is based on the interaction between the routing protocol and the interaction between the network and the MAC layers. In our frameworks we are using multipath and multi topology routing in order to give better packet delivery ratio.

Introduction

Mobile Ad-hoc NETworks (MANETs) are multi-hop ad-hoc wireless networks in which there are no backbone infrastructure. Each Mobile Node (MN) acts either as a host generating flows or being the destination of flows from other MN or as a router forwarding flows directed to other MN. Due to the unpredictable location and mobility of MNs in MANETs, classical routing protocols used on wired networks are not suitable for MANETs. Protocols defined for ad hoc networks are classified as reactive protocols and proactive protocols. Reactive protocols are characterized by MNs acquiring and maintaining routes on demand, while proactive protocols are characterized by all MNs maintaining routes to all destinations all the time. Examples of reactive protocols are DSR (Dynamic Source Routing), and AODV (Ad hoc On-demand Distance Vector). Examples of proactive protocols are OLSR (Optimized Link State Routing Protocol), and TBRPF (Topology Dissemination Based on Reverse-Path Forwarding). All these protocols have been analyzed and compared in several papers. The main conclusion on these comparisons is that none of them is the best for all environments. Depending on several aspects such as mobility, load of the network, diameter of the network, etc, a protocol may behave better than another.

Quality of Service Mobile in Ad-hoc NET works: For obtaining QoS (Quality of Service) on a MANET, it is not sufficient to provide a basic routing functionality. Other aspects should also be taken into consideration such as bandwidth constraints due generally to a shared media, dynamic topology since MNs are mobile and the topology may change and power consumption due to limited batteries. For wired networks there are two approaches to obtain QoS: an over-provisioning and network traffic engineering. Over-provisioning consists of the network operator offering a huge amount of resources such that the network can accommodate all the demanding applications. Instead, network traffic engineering classifies ongoing connections and treats them according to a set of established rules. Two proposals belonging to this class has been done inside the IETF: Integrated Services (IntServ) and Differentiated Services (DiffServ). IntServ is a reservation-oriented method where users request for the QoS parameters they need. The Resource reSerVation Protocol (RSVP) has been proposed by IETF to setup resource reservations for IntServ. Opposite to IntServ, DiffServ is a reservation-less method. Using DiffServ, service providers offer a set of differentiated classes of QoS to their customers to support various types of applications. IPv4 TOS octet or the IPv6 Traffic Class octet is used to mark a packet to receive a particular QoS class.

Related works

A number of research have been conducted on required QoS in internet and traditional wireless networks, but current results are not appropriate for MANETs and still quality of service for MANETs is an open problem. Suitable QoS for delivery of real-time communications such as audio/ video creates a number of different technical challenges. In this section, we review several QoS frameworks for MANETs that have been proposed in this area. A framework for QoS is described as a complete system that offers essential services to each user or application. In [15], a flexible QoS model for mobile ad-hoc networks (FQMM) is presented, which is a hybrid service model and based on IntServ and Diffserv model. FQMM combines the reservation procedure for high priority traffic with service differentiation for low-priority traffic. Thus, FQMM provides the ideal QoS for per flow and overcomes the scalability problem by classifying the low-priority traffic into service classes. This protocol addresses the basic problem appeared by QoS frameworks [16]. But it can not solve other problems such as, decision upon traffic classification, allotment of per flow or aggregated service for the given flow, amount of traffic belonging to per flow service, and scheduling or forwarding of the traffic by the intermediate nodes. Reference [17] describes a packet scheduling approach for QoS provisioning in multihop wireless networks. Besides the minimum throughput and delay bounds for each flow, the scheduling disciplines seek to achieve fair and maximum allocation of the shared wireless channel bandwidth. The coordination of the adaptation between the different layers of the network in order to solve the problems introduced by scarce and dynamic network resources is described in [18]. Mobiware effort has investigated the concept of QoS ranges, adaptively, and other mechanisms for providing QoS in wireless environment [19]. More recently, the INSIGNIA protocol combines the idea of QoS ranges with lightweight signaling carried in the data packet headers as an approach to providing QoS in a mobile ad hoc network [20]. This IP-based quality of service framework is designed to be lightweight and highly responsive to changes in the network. Adaptive services support applications that require only a minimum quantitative QoS guarantee (minimum bandwidth) called base quality of service[21]. INSIGNIA is an in-band signaling protocol, integrated with an ad-hoc routing protocol. An in-band signaling system supports fast flow reservation, restoration, and end-to-end adaptation based on the inherent flexibility, robustness and scalability found in IP networks. This soft state reservation scheme used in this framework guarantees that resources are quickly released at the time of path reconfiguration. Network feedback based on link and acceptable throughput measurements were made to support higher layer and soft quality of service. However, these schemes do not consider the inherent characteristics (changing network topology, limited resource availability, and error-prone shared radio channel) of MANETs and drawbacks of integrated services and differentiated services [22]. Therefore, for supporting a combination of real-time (voice or video) and non-real-time services (data or FTP), an accurate model has to be designed to investigate its applicability within the MANETs.

Identifying problems and solutions

In general, the application of MANETs was first proposed for military battlefield and disaster recovery. However, as a result of evolution in multimedia technology and the commercial interest of companies, quality of service in mobile ad-hoc networks has become an area of interest. Because of various requirements of different applications, the services required and the QoS parameters will change for each application. Therefore, quality of service is identified as a set of measurable pre-specified service requirements such as delay, bandwidth, probability of packet loss, and delay variance (jitter) which a network needs to make them available for the end users while transporting a packet stream from a source to its destination. Real time applications need mechanisms that guarantee restricted delay and delay jitter. For instance, the most important delays that affect the end to end delay in packet delivery from one node to another node are: the queuing delay at the source and intermediate nodes, the processing time at the intermediate nodes, the transmission delay, and the propagation duration over multiple hops from the source node to the destination node. Generally in wired networks, QoS parameters are characterized by the requirements of multimedia traffic. But in ad-hoc networks QoS requires new constraints due to highly dynamic network topology and traffic load conditions, time-variant QoS parameters like throughput, latency, low communication bandwidth, limited processing and power capacity than wire-based network.

Moreover, QoS in ad-hoc networks relates not only to the available resources in the network but also to the mobility speed of these resources. This is because mobility of nodes in ad-hoc networks may cause link failures and broken paths. In order to continue a communication therefore, it requires finding a new path. However, delay will occur for establishing a new path, also some of the packets may get lost. In mobile ad-hoc networks, mobile computation devices are usually battery powered. A limited energy budget constraints the computation and communication capacity of each device. Energy resources and computation workloads have different distributions within the network. The main reasons for energy management in ad-hoc networks are limited energy reserve, difficulties in replacing the batteries, lack of central coordination, constrains on the battery source, and selection of optimal transmission power. The hidden terminal problem is inherent mobile ad-hoc networks. This may happen when packets originating from two or more sender nodes which are not within the direct transmission range of each other, crash at a general receiver node. Thus, it requires the retransmission of the packets that may not be adequate for flows. Security issue is an important factor in providing QoS in mobile ad-hoc networks. Communications in wireless environment are not secure due to the broadcasting behaviour of this type of network. Generally, MANETs have fewer resources than fixed networks and they are more influenced by the resource constraints of the nodes. Therefore, it is hard for these networks to support different applications with appropriate QoS requirements.

The other important problems in MANETs when providing QoS are routing, maintenance and variable resource problems

1. Routing problem: It explains how to find a loop-free from the source to the destination in the network that can be able to support a requested level of QoS. Route selection strategies can be based on the power aware, level of the signal strength, link stability, and the shortest path.
2. Maintenance problem: It describes how to make sure that, when network topology changes, new routes that can support existing QoS obligations are available, or can be quickly found.

3. Variable resource problem: It addresses how to react to changes in available resources, either as the result of a route change, or as the result of changes in link characteristics within a given route.

Based on the interaction between the routing protocol and the QoS provisioning mechanism, QoS approaches can be divided into Coupled and Decoupled.

1. In Coupled QoS the routing protocol and the QoS provisioning mechanism directly interact with each other for delivering the required QoS.
2. In Decoupled QoS the QoS provisioning mechanism does not depend on any specific routing protocol with the intention of having required QoS.

In addition, QoS approaches can be categorized as independent and dependent based on the interaction between the routing protocol and the MAC protocol. In independent QoS, the network layer is not dependent on the MAC layer QoS provisioning. While for dependent QoS, it requires the MAC layer to support the routing protocol for QoS provisioning. QoS approaches based on the routing information update mechanism can be classified as table-driven, on-demand, and hybrid.

1. Table-driven (Pro-Active), each node in the network holds a routing table which can support the forwarding packets. The routing tables are called periodically or event-driven and it will be only updated if any change happens in the network. The main disadvantages of table-driven QoS are bandwidth consumption in transmitting routing tables and also saving the table of the routes that are not used in.
2. On-demand (Reactive), there is no any routing table at nodes; thus, the source node has to discover the route by flooding the network with route request packet. In this technique, routes are calculated when they are needed. The main disadvantages of the on-demand approach are delay when the source node trying to find a route and also excessive flooding can be led to the network clogging.
3. Hybrid (Pro-Active/ Reactive), which integrates attributes of the two above approaches. The disadvantage of the hybrid technique depends on the number of active nodes in the network.

QoS Routing in Mobile ad hoc NET works

QoS routing is an essential part of the QoS architecture. Before any connections can be made or any resources reserved, a feasible path between a source-destination pair must be established. QoS routing is a routing mechanism under which paths for flows are determined on the basis of some knowledge of resource availability in the network as well as the QoS requirements of the flows or connections [14]. The objectives of QoS routing are threefold: (1) if one exists, find a feasible path between a source-destination pair (i.e. a path that has sufficient avail-able resources capable of satisfying the QoS require-ments), (2) optimize the use of network throughput and network resources and (3) Adapt to network con-gestion, providing smooth performance degradation to lower-priority traffic. It is important to note that QoS routing and resource reservation (discussed in the Section 4) are separate issues. The QoS routing protocol tries to find a path that has a good chance of meeting the QoS requirements [14]. Designers of QoS routing algorithms for ad hoc networks must consider several design issues: (1)metric selection, (2) QoS state propagation and maintenance and (3) scalability. The QoS routing protocol must also deal with imprecise state information due to node (router) movement and topology changes. Furthermore, a QoS routing scheme for ad hoc networks must balance efficiency and adaptivity, while maintaining low-control-overhead.

A Core-Extraction Distributed ad hoc Routing Algorithm

The Core-Extraction Distributed ad hoc Routing Algorithm (CEDAR) [1] has been proposed as a QoS routing algorithm for small to medium size mobile ad hoc networks, consisting of tens to hundreds of nodes. CEDAR includes three key components: (1) core extraction, (2) link state propagation and (3) route computation. CEDAR proposes the use of core-based routing mechanisms for two primary reasons. First, because of the bandwidth and power constraints, reducing the number of nodes participating in route maintenance (i.e. state propagation and path restoration) is expected to increase network performance and increase network scalability. Second, because of the hidden terminal and exposed terminal problems, local broadcast may be highly unreliable in mobile ad hoc networks. Using only a subset of nodes should reduce the negative effects of local broadcast. Core extraction. The core of the network is extracted by approximating a minimum dominating set (MDS) of the ad hoc network using only local computation and local state information. The MDS is the minimum subset of nodes, such that every node in the network is in the MDS (i.e. is a core node) or is a neighbor of a node in the MDS. Each node in the core then establishes a unicast virtual link with other core nodes a distance of three or less away from it in the ad hoc network. Each node that is not in the core chooses a core neighbor as its dominator. The core nodes are responsible for collecting local topology information and performing routing on behalf of the nodes in their respective domain (or immediate neighborhood). Typically, routing proto-cols in ad hoc networks use a broadcast approach to determine routes by using a flooding-based algorithm. The flooding of route request (RREQ), how-ever, has been shown to be very unreliable because of the hidden and exposed terminal problems [8, 22]. To help reduce the effects of these problems, CEDAR uses a unicast mechanism, the core broad-cast, in which a core node tunnels the route request to each of its core neighbors. CEDAR uses the core broadcast mechanism to find a route from the dominator of the source to the dominator of the destination. Link state propagation. QoS routing in CEDAR is achieved by propagating the bandwidth availability information of stable links in the core subgraph. When a link, (a,b), experiences a significant change (i.e. changes by some threshold value) in available bandwidth, a and b must inform their respective dominators. The dominators are responsible for propagating state information via slow-moving increase waves and fast-moving decrease waves (i.e. messages) to all other core nodes via the core broadcast mechanism. The basic philosophy is that the information about stable links with large available bandwidths can be made known to nodes far away in the network, while information about dynamic links or low bandwidth links should remain local.

Route computation. CEDAR is an on-demand source routing algorithm and has three key phases. The first phase consists of locating the destination node and establishing a core path to the destination. The second phase consists of finding a stable route using the core path, established in phase one, as a directional guide. Using only local information about each stable link, CEDAR iteratively tries to find a par-tial route from the source to the domain of the furthest possible intermediate node in the core path, which can satisfy the requested bandwidth. Eventually, either the shortest widest admissible route will be established or a failure is reported. The final phase involves two cooperative mechanisms that dynamically restores or re-computes the QoS-based route upon link failures or topology changes in the network. Upon the failure of a link, CEDAR initially attempts to re compute an admissible route at the point of failure. As a long-term solution, source-initiated re computation is used.

Ticket-Based Probing

A distributed (i.e. hop-by-hop) multi path QoS rout-ing scheme for ad hoc networks called ticket-based probing is proposed in [9]. Imprecise state information can be tolerated and multiple paths are searched simultaneously to find the most feasible path. Similar to CEDAR, ticket-based probing does not use a flooding-based route discovery technique. Instead of randomly selecting the many potential routes to search for an admissible route, ticket-based prob-ing attempts to search only the best possible routes. Ticket-based probing is proposed as a general QoS routing approach for MANETs and can handle different QoS constraints (i.e. bandwidth, delay, packet loss and jitter). Ticket-based QoS routing solutions for the bandwidth and delay-constrained routing problems were presented in [9]. In this paper, we present only the general ticket-based probing scheme. The basic goal of the ticket-based probing scheme is to utilize tickets to limit the number of paths searched during route discovery. A ticket is the per-mission to search a single path. When a source wishes to discover an admissible route to a destination, it issues a probe (routing message) to the destination. A probe is required to carry at least one ticket, but may consist of more (i.e. connection request with tighter requirements are issued more tickets). At an intermediate node, a probe with more than one ticket is allowed to split into multiple ones, each search-ing a different downstream sub-path. Hence, when an intermediate node receives a probe, it decides, on the basis of its available state information, whether the received probe should be split and to which neighbors the probe(s) should be forwarded. In the case of route failures, ticket-based probing utilizes three mechanisms: path re routing, three-level path redundancy and path repairing. Re routing requires that the source node be informed of a path failure. After which, the source initiates the ticket-based algorithm to locate another admissible route. The path redundancy scheme establishes multiple routes for the same connection. For the highest level of redundancy, resources are reserved along multiple paths and every packet is routed along each path. In the second level of redundancy, resources are reserved along multiple paths; however, only one is used as the primary path while the others serve as backup. In the third level of redundancy, multiple paths are selected, but resources are only reserved on the primary path. The path-repairing mechanism tries avoid the cost of re routing by attempting to repair the route at the point of failure.

Bandwidth Routing

A novel QoS routing protocol for QoS support in mobile ad hoc networks is proposed [3] and is based on the destination sequenced distance vector (DSDV) routing scheme [6]. The routing protocol provides QoS support via separate end-to-end band-width calculation and allocation mechanisms, thus called bandwidth routing. The proposed bandwidth routing scheme depends on the use of a CDMA [7] over TDMA [7] medium access scheme in which the wireless channel is time-slotted, the transmission scale is organized as frames (each containing a fixed number of time slots) and a global clock or time-synchronization mechanism is utilized. That is, the entire network is synchronized on a frame and slot basis. The path bandwidth between a source and destination is defined as the number of free or available time slots between them. Bandwidth calculation requires knowledge of the available bandwidth on each link along the path as well as resolving the scheduling of free slots. This problem is NP-complete and thus, requires a heuristic approach. See [3] for details of the bandwidth calculation and slot-assignment algorithms. To support fast rerouting during path failures (e.g. a topological change), the bandwidth routing protocol maintains secondary paths. When the primary path fails, the secondary route is used (i.e. becomes the primary route) and another secondary is discovered.

Quality of Service over AODV

The ad hoc On-Demand Distance Vector Routing Protocol (AODV) [8] has been proposed for best-effort routing in mobile ad hoc networks. When a route to a new destination is needed, the node broadcasts a RREQ packet to find a route to the destination. Each node that participates in the route-acquisition process places in its routing table the reverse route to the source-node. A Route Reply (RREP) packet, which contains the number of hops required to reach the destination node, D, and the most recently seen sequence number for the node D, can be created whenever the RREQ reaches either the destination node, or an intermediate mode with an valid route to the destination.

To provide QoS support, a minimal set of QoS extensions has been specified for the RREQ and RREP messages [4]. Specifically, a mobile host may specify one of two services: A Maximum Delay and Minimum Bandwidth. Before a node can rebroadcast a RREQ or unicast a RREP to the source, it must be capable of meeting the QoS constraints. Upon detecting that the requested QoS can no longer be maintained, a node must send an Internet control message protocol (ICMP) QoS LOST message back to the source. The specific extensions for the routing table and control packets (e.g. RREQ and RREP messages) are outlined in [4].

Conclusions

Multi-hop mobile radio network, also called mobile ad-hoc network is created by a set of mobile nodes on a shared wireless channel. This network is adaptable to the highly dynamic topology resulted from the mobility of network nodes and changing propagation conditions. MANETs are expected to have a significant place in the development of wireless communication systems. Such networks are attractive because they can be rapidly deployed anywhere and anytime without the existence of fixed base stations and system administrators. Hence, mobile ad-hoc networks must be able to provide the required quality of service for the delivery of real-time communications such as audio and video that poses a number of different technical challenges and new definitions. Many ideas regarding QoS inherited from the wire-based networks can be used for MANETs if we consider various constraints due to the dynamic nature, bandwidth restriction, the limited processing, and capabilities of mobile nodes. Thus, for providing efficient quality of service in mobile ad-hoc networks, there is a solid need to create new architectures and services for routine network controls.

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