



A Survey on Bandwidth Aware Routing Protocol

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Abstract—For Mobile Ad-hoc Network (MANET), It is a major challenge to provide QoS guarantee like satisfying bandwidth requirement, minimizing delay, minimizing jitter etc. To meet the bandwidth demand successfully is one of the important issue for multimedia application. This paper presents a survey of some existing routing protocol based on bandwidth estimation looking at their Estimation techniques and their proposed solutions features, which could be very useful for future improvement .

Keywords— Mobile Ad-hoc Network, QoS, AODV, Bandwidth Estimation, Routing Protocol,

I. INTRODUCTION

A wireless ad hoc network is a collection of mobile nodes that dynamically form a temporary network and communicate with each other without any physical networking infrastructure[1]. Each node can serve as both host and router. MANET is best suited for tactical networking application due to its self forming and infrastructure less nature. MANET nodes rely on multihop communication. That is, nodes within each other's transmission range can communicate directly through radio channels, whereas those outside the radio range must rely on intermediate nodes to forward messages toward their destinations. Whenever Mobile nodes want they can move, leave, and join the network whenever they want, and routes need to be updated frequently because of the dynamic network topology[2]. This is illustrated in Figure 1. Suppose, node C wants to communicate with node A. At time t1, the routing path is C→E→A. At time t2 (>t1), node E moves out of range of node C. Because of this, the changed route for node B at time t2 is C→B→A.

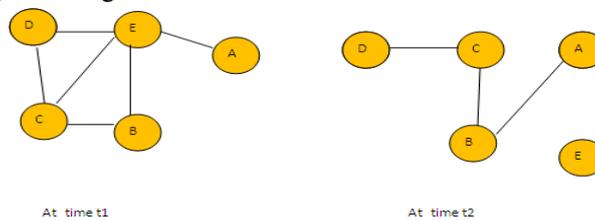


Fig. 1 Node Mobility

II. QoS IN MANETS

A set of service requirements that should be satisfied by the network when routing is performed, is defined as QoS in MANETS[3]. Set of measurable requirements are maximum delay, minimum bandwidth, minimum packet delivery ratio, and maximum jitter. The network has to ensure that the QoS requirements of the data session are satisfied throughout the connection duration by checking all the QoS metrics at the time of connection establishment, and once a connection is accepted. The above-mentioned QoS metrics are used by applications to specify their QoS requirements. QoS requirements can be defined in terms of a set of metrics. For example, a network topology is displaying in which an application at node A has certain bandwidth (BW >= 5 kbps) and delay (D <= 5 ms) requirements. A route (A→F→G→H→E) is selected by QoS-aware routing protocol that satisfies the QoS requirements of the application instead of selecting the shortest path (A→B→D→E). Providing a multiconstrained QoS aims at optimizing multiple QoS metrics while provisioning QoS over MANETS and is, literally, a complex task.

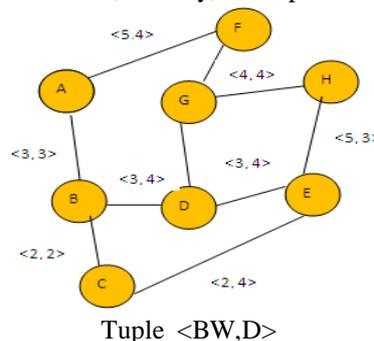


Fig. 1 Bandwidth aware routing

III. BASIC AODV

Perkins and E. Royer [4] proposed Ad hoc On Demand Distance vector Routing (AODV). It is table-based and reactive routing protocols. AODV uses a broadcast route discovery mechanism. AODV relies on dynamically establishing route table entries at intermediate nodes. Each Host works as a router and obtains routes as needed. There is no requirement of periodic routing advertisements. So AODV provides loop free routes even while repairing broken links. This protocol uses bandwidth efficiently by minimizing the network load for control and data traffic is responsive to changes in topology and ensures loop free routing. They maintained most of the advantages of basic distance vector routing mechanism. AODV avoids problems with previous and has the following features:

- The routes are stored only when needed.
- Reduces memory requirements and needless duplications.
- Quick response to link breakage in active routes.

Increasing demands of various multimedia applications over mobile ad-hoc networks (MANETs) requires various quality-of-service (QoS) provisioning solutions in these networks. In these QoS metrics, bandwidth is the most important QoS metric because delay and jitter can be controlled up to some extent by controlling the required bandwidth of a multimedia application.

IV. BANDWIDTH ESTIMATION TECHNIQUES

In MANET, a host's available bandwidth refers to amount of bandwidth available to the node to send packets to the network. Many researchers have proposed different methods for Bandwidth estimation.

A. Perceptive Admission Control (PAC) protocol

I.D. Chakeres and Elizabeth M.B. Royer [5] proposed Perceptive Admission Control (PAC) protocol that monitors the wireless channel and adapts admission control decisions dynamically to enable high network utilization while preventing congestion. They presented simulation results that show that PAC minimizes loss and delay for all admitted flows. For successful packet reception, they referred sender and receiver are separated by at max $R \times R$ and to avoid any possible receiver interference, two senders are separated by at least $2 \times R \times R + R \times ID$. For any node, its PAC based available bandwidth measurement is sufficient to make an admission control decision. Two issues are addressed in PAC 1) shared wireless bandwidth and 2) node mobility. PAC is able to compute its available bandwidth and determine whether a flow can be admitted by sensing all transmissions that may interfere. For calculating the available bandwidth, each source adapts its admitted traffic flows to changing wireless channel use. Using results they show that PAC avoids congestion effectively by limiting the amount of data traffic. So throughput is consistent, packet loss and delay are minimized for all admitted flows. That can be explored multiple priority MAC layers i.e. IEEE 802.11e. PAC can be extended to determine the relative utilization of each priority. PAC can be implemented further in a real system to prove its feasibility. Bandwidth consumption of flows and available resources to a node are not only local concepts but also related to the neighboring nodes in carrier-sensing range.

B. Contention-aware Admission Control Protocol (CACP)

Yaling Yang and Robin Kravets [6] presented an efficient admission control framework—Contention-aware Admission Control Protocol (CACP), that supports QoS in MANET. They focused on MANET based on single-channel MAC layers like IEEE 802.11. CACP provides QoS guarantee in terms of bandwidth allocation. The main goal of CACP is to maintain bandwidth levels for existing flows and to determine whether the available resources can meet the requirements of a new flow. There are two challenges for CACP to achieve this goal.

1) Prediction of Available Bandwidth - The first challenge for CACP is evaluating the available bandwidth in the network so that the bandwidth requirements of all the flows do not exceed the resources in the network. Bandwidth is estimated in two terms

a) Calculation of Local Available Bandwidth- unconsumed bandwidth at a given node is defined as local available bandwidth.

b) Prediction of c-Neighborhood Available Bandwidth- Maximum amount of bandwidth that a node can use for transmitting without depriving the reserved bandwidth of any existing is defined as C-neighborhood available bandwidth. flows in its carrier-sensing range (c-neighborhood)

2) Bandwidth Consumption - The second challenge for CACP is to quantify the bandwidth that a new flow will consume so that it can be decided whether the available bandwidth can satisfy the requirements.

Simulation results showed that by controlling bandwidth allocation, delay and jitter can also be controlled. Their main focus was on the inclusion of information from nodes inside carrier-sensing range and outside transmission range during the admission control process. Using results they showed that CACP effectively manages requests for bandwidth beyond the capabilities of the network, imposing acceptable or even reducing the control message overhead on the network. CACP can be combined further with many existing QoS protocols, such as QoS-aware MAC protocols or end host policing protocols.

C. QoS-aware routing protocol

Lei Chen and Wendi B. Heinzelman [7] proposed a QoS-aware routing protocol that incorporates an admission control scheme and a feedback scheme to meet the QoS requirements. This routing protocol uses bandwidth estimation. There are two phases in QoS routing protocol. The route discovery phase and the bandwidth reservation phase. In the route discovery phase, feasible route is discovered using AODV routing protocol and the

minmax approach to choose the route that is most likely to satisfy the QoS requirement. In the bandwidth reservation phase, according to how many neighbouring hosts' free time slots are blocked by this time the weight of each available time slot is calculated by the hosts in the chosen path. There are two scheme in proposed QoS-aware routing protocol, first one is feedback scheme that provides feedback about the available bandwidth to the application and second one is admission scheme that admits a flow with the requested bandwidth .Knowledge of available bandwidth along the route is required for both schemes.So they focused on exploring different ways to estimate the available bandwidth, incorporating QoS. It is must to know available end to end bandwidth along a route. By estimating the bandwidth QoS can be provided. This can be achieved by finding the minimal residual bandwidth available among the hosts in that route. For bandwidth estimation they used two methods.

- 1) "Listen" Bandwidth Estimation
- 2) "Hello" Bandwidth Estimation

They gave some results that show that QoS aware routing, the packet delivery ratio remains constantly above 90%, and the delay remains lower than 0.17s. they showed that packet delivery ratio is improved in our QoS-aware routing protocol and does not affect the overall end-to-end throughput. This protocol also decreases the packet delay and the energy consumption. This protocol does not have any predictive way to foresee a route break. Because route break causes a performance degradation in mobile topologies. That can be further improved by incorporated some techniques to achieve required level of QoS

D. B-AODV

Xu Zhen, Yang wenzhong [8] presented an algorithm for efficient distributed timeslot assignment. That algorithm used AODV route discovery mechanism to achieve bandwidth-aware QoS routes — B-AODV. In simulation results they showed that packet delivery ratio is increased and end-to-end average packet delay is improved in proposed QoS routing algorithm. Their main focus was to schedule the communication links such a way that any two links in the same timeslots never interfere with each other. The basic working of proposed protocol was that

- A suitable route is selected by Source node for the destination, before starting the transmission. - Delay requirements and bandwidth requirement should be satisfied.
- AODV routing protocol was chosen.
- Assumption was that a connection only uses a single path for transmission. So to provide X bandwidth on a path it is necessary for each node along the path to find at least X slots to transmit to its neighbours.

TABLE I
COMPARISON OF BANDWIDTH AWARE ROUTING PROTOCOLS

Protocol	Local Bandwidth Estimation	Basic Routing Type	Cs-neighbor bandwidth estimation process	Mobility and QoS violation Detection process	Route failure handling method	Other Features
PAC [5]	Channel Idle time Ratio (CITR)	DSR (proactive and source routing)	Passive channel monitoring with low cs-threshold value	Pause effected routes re-routed	Discover fresh routes	Consideration of inter-contention and intra-contention
CACP [6]	Channel Idle time Ratio (CITR)	Source-routing (Combination of AODV and DSR protocols)	Three methods are proposed: passive channel monitoring, querying explicitly and use of higher powered transmission	Data flows are unable to get their requested bandwidth	Pause or reroute the effected sessions and discover new routes	No support to handle mobility and use the cache info if second stage of AC fails
Q-AODV [7]	Channel Idle_time/Busy_time * Weighting_factor	Reactive (i.e., AODV) or hop-by-hop	Using Periodic HELLO packet dissemination process	Once admitted session is not monitored for QoS	Update bandwidth using forced HELLO message initiation	Not checking for intra-contention and also the Mobility issues are not handled properly
B-AODV [8]	TDMA-based timeslot assignment	Channel Idle time Ratio (CITR)	Not application as channel is divided in timeslots	Not handled in the protocol	Re-routing is done if any free time-slot is available	exchange local information of timeslot allocation with its neighbours

V. CONCLUSIONS AND FUTURE SCOPE

In this paper we have compared bandwidth aware routing protocols with various unique features that incorporate QoS metrics in route finding. We focused on various techniques for estimating the available bandwidth. In PAC and CACP protocols bandwidth estimation is based on channel Idle Time Ratio(CITR) whenever in Q-AODV, bandwidth is estimated using $\text{Channel Idle_time/Busy_time} * \text{Weighting_fun}$ and in B-AODV, it is based on TDMA-based timeslot assignment. and discussed bandwidth estimation techniques, routing types, Cs-neighbor bandwidth estimation process, mobility and QoS violation detection process, route failure handling method and other features of these protocols. In the future, to improve end to end throughput we intend to come up with a protocol that incorporate Session Admission Control (SAC) with Cross-layer Communication Module (CLM).

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