Shadow-Fading Environments based routing in MANETs

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Abstract - *Conferring the Quality of Service (QoS) pledges in a mobile ad hoc network (MANET) is onerous by the reason of node motility, rivalry for channel access, a lack of integrated coordination, and the capricious nature of the wireless channel. Two of the most influential components of a system attempting to offer QoS guarantees in the face of the above-mentioned difficulties are QoS-Aware routing (QAR) protocol and an Admission Control (AC) protocol. Early proposed QAR and AC-based solutions have been often outlined and plotted with idealized lower layer models in mind. This paper proposes and evaluates new solutions for improving the performance of QAR and AC protocols in the face of mobility, shadowing, and varying link SINR.*

Key Words: **Multirate mobile ad hoc networks, quality of service aware routing, admission control, shadowing/shadow fading, guaranteed throughput.**

1.INTRODUCTION

The absorbtion in Mobile Ad hoc Networks (MANETs) has grown inordinately over the last 15 years. Much anticipation has been placed in MANETs to form instinctive, potent, and pervasive communications in areas where central infrastructure is limited, lacking or cannot be accessed, or where its use is not desired. This work focuses on MANETs utilizing 802.11 technologies. Two of the most compelling ingredients in a system for QoS are a QoS-aware routing (QAR) and an admission control (AC) protocol. The QAR protocol is intended to see nodes with adequate resources for managing the QoS requested by applications. AC protocol is used to estimate the residual resources of the network and to make accord about whether new application data sessions can or cannot be admitted, given their own QoS constraints, as well as those of previously admitted sessions. The minimum throughput has to be maintained in most practical applications, hence in this work, focus tend to throughput-constrained data sessions. An AC protocol balances the act between admitting too much traffic, promising more resources, such as network capacity than are available, and thereby causing congestion, and blocking too many admission requests, thereby wasting resources that could be allocated to more users. Many previously proposed QAR and AC protocols have been aimed at addressing the above issues. However, in MANETS, the operation of such protocols is hampered by the lack of centralized co-ordination, contention for channel access, node mobility, and the unreliable wireless channel.

2. PROPOSED PROTOCOL

2.1 Staggered Admission Control-backup protocol

An updated version of StAC, termed as StAC-backup, which deed the importance of surrogate or backup routes to a source's destination in order to upgrade the clout of throughput-QoS assurances in the face of route failures. The features of DSR are extended and used. StAC promotes three laps of AC. The first one is on capacity-constrained route discovery, where in each node forwards the flooded route request (RReq) or the route reply (RRep) if and only if it has sufficient residual capacity to support the session. Residual capacity is estimated using the CITR. The session's capacity requirement at a particular node B_{req} is expressed as its requested throughput b_{req} times the protocol overhead weighting factor w_{req} times the contention count c_{cont}. This is expressed as $B_{req}=b_{req}\, w_{req}\, c_{cont}$, where we have,

$$W_{req} = (T_{DIFS}+T_{RTS}+T_{CTS}+T_{ACK}+3T_{SIFS})/\, T_{Data}$$
$$+(T_{bkoff}+T_{MAChdr}+T_{IPhdr}+T_{SRhdr}+T_{Data})\, /\, T_{Data}$$

and the terms denoted by T_x represent the transmission times of the packet or header (hdr). The subscript SRhdr represents the source route header whose length depends on the route length and T_{bkoff} is the minimum amount of time that is always wasted by the 802.11 back-off algorithm before transmissions. $c_{cont} = |N_{cs} \cap R_{prim}|$ where N_{cs}represents the CS neighbor set, and R_{prim} is the set of transmitter/ traffic forwarding nodes on the (potential) primary/current route of the session. The second stage of AC also performs the above test at each node by exchanging session request (SREQ) and session reply (SREP) packets between source and destination nodes along a previously discovered route. If the SREP is received at the source node, the reliability of the route is also tested in the third stage of AC. During this stage, which lasts a few seconds, the session is partially admitted, its packet generation and transmission rate is gradually ramped up and the achievable throughput is tested along the route. Any node detecting a lower than expected throughput at any of the staggered rate stages rejects the session, informing the source node. If the session is not rejected immediately after reaching its desired packet sending rate, it is fully admitted.

In the newly proposed protocol, once a session being admitted by StAC has found a suitable route (stage 1, see above) and its CS neighbors have been tested during the

SREQ/SREP exchange (stage 2), a backup route for the session must be found. There are two possible cases. Either more than one route to the destination of the session is already known, or a backup route must be discovered.

2.2 StAC-multirate protocol

This section describes the combination of a rate-switching mechanism with a multirate 802.11 model and proposes a new multirate-aware version of StAC called StAC-multirate. In our implementation, each node stores the rate that was last used for transmission to each of its neighbors with which it has communicated, as well as the numbers of contiguous missed or received ACKs. Since the transmission rate is likely to change multiple times per second, following the fluctuations due to shadowing, it is impractical to report every change to the network layer protocols. Instead, the rate in use by each packet is recorded, and the average rate is calculated in a 1 s sliding window. This average rate is rounded off to the nearest supported rate, which is reported to the routing protocol when it queries that particular link rate. Note that despite the different transmission ranges achieved by the different modulation schemes, the optimal CS range does not vary . Therefore, a fixed CS range is maintained for simulations in this work.

2.3 StAC multirate-backup protocol

The StAC-backup protocol, proposed and the StAC-multirate protocol, described above, can have their features combined into a protocol, we call the StACmultirate- backup protocol.

3. IMPLEMENTATION OF PROPOSED WORK

Simulation Parameters Employed for the Comparative Study of the Proposed AC and QoS Aware Routing Protocols

Parameter	Value
Simulation area size	1660m x 1660m
No. of nodes	100
Node spatial distribution when stationary	Random (uniform distribution)
Node speed when mobile	1-16m/s
Node pause time when mobile	10s
No. of traffic sources	50
Offered load	10 data sessions/source
Session arrival rate	0.68/s
Session desired throughput	75kbps
Session duration	60s
Simulation time	800s
Results averaged over	10 runs
Data packet size	1024 bytes
Traffic source type	Constant bit-rate (CBR)
Propagation model	Constant path loss + shadowing
Path loss exponent	2.7
Shadowing fluctuation frequency	1Hz
Transmission power	100mW
Channel capacity	6Mbps (with BPSK modulation)
Receive Threshold	-85.3dBm
Receive SINR Threshold	4dB (for BPSK)
Average Transmission range	250m
Average Carrier-sensing range	500m
Reserved capacity	10%
MAC protocol	802.11 DCF [24]
Transport protocol	UDP

In this paper the original version of StAC is compared to both StAC-backup and StAC-multirate as well as to the combination of both protocols into a single protocol: StAC-multirate-backup. The popular ns-2 simulation platform8 (version 2.33) was employed for all simulations in this paper.

3.1 PERFORMANCE METRICS

The metrics are concerned with the protocols' capacity utilization efficiency.

3.1.1 Session Admission Ratio (SAR):-The total number of admitted sessions divided by the number of session admission requests. This metric provides a relative measure of a protocol's AC stringency. It also indirectly represents the level of network capacity utilization, since a higher SAR usually translates to a higher network utilization.

3.2.2 Session Rejection Ratio:-

The total number of blocked sessions divided by the number of session admission requests.

3.2.3 Packet Loss Ratio (PLR):-

The fraction of generated application layer data packets that were not delivered to their destination nodes.

4. RESULTS AND DISCUSSION

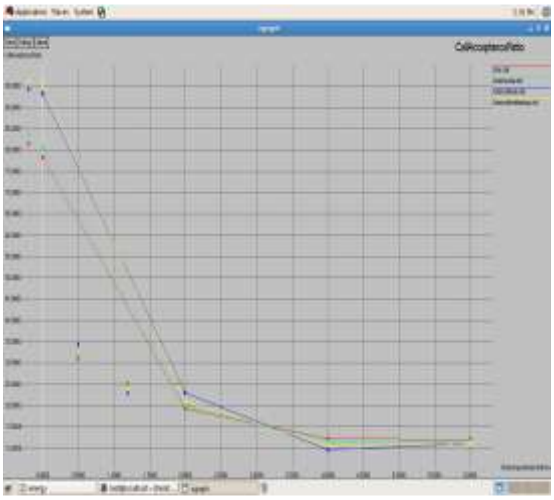

Fig 1: The session admission ratios in a network of static nodes versus the shadowing variation standard deviation. Simulation parameters employed are summarized in Table.

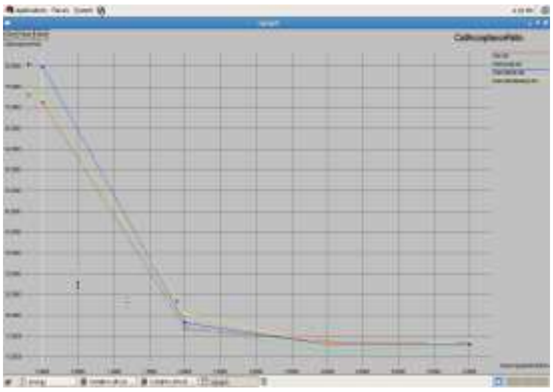

Fig 2: The session admission ratios in a network of mobile nodes versus the shadowing variation standard deviation. Simulation parameters employed are summarized in Table.

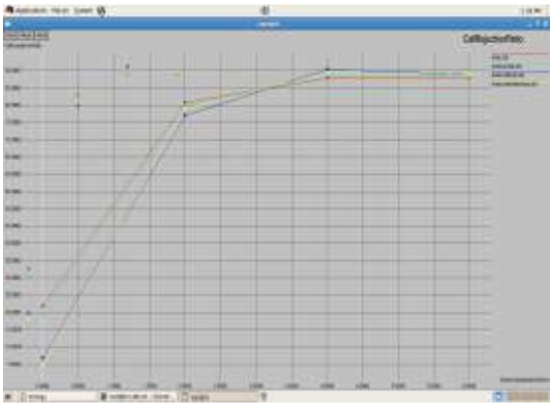

Fig 3: The session rejection ratios in a network of static (left) nodes versus the shadowing variation standard deviation. Simulation parameters employed are summarized in Table.

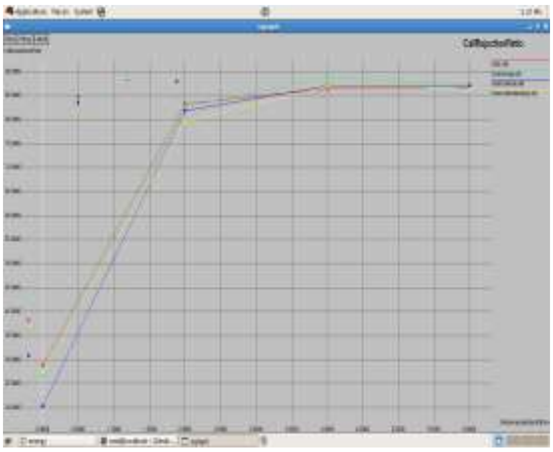

Fig 4: The session rejection ratios in a network of mobile nodes versus the shadowing variation standard deviation. Simulation parameters employed are summarized in Table.

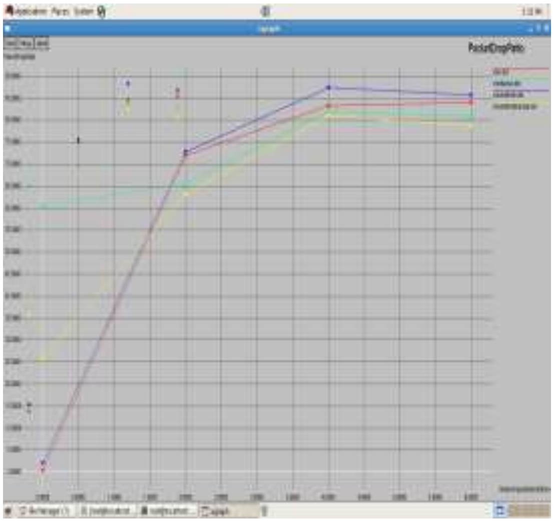

Fig 5: The average data packet loss ratio experienced in a network of static nodes versus the shadowing variation standard deviation. Simulation parameters employed are summarized in Table.

Fig 6: The average data packet loss ratio experienced in a network of static nodes versus the shadowing variation standard deviation. Simulation parameters employed are summarized in Table.

5. CONCLUSIONS

This work have developed the protocols, related to the StAC protocol and evaluated their performance in the face of increasingly severe shadowing attenuation fluctuations. The StAC backup protocol added a feature that attempts to provide a pre-capacity-tested backup route to each active data session. The novelty lay in the method of maintaining the status of backup routes regarding their capacity at data source nodes without incurring any test packet overhead, as well as in the combination with StAC.

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