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Radio Disjoint Multi-Path Routing in MANET

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ABSTRACT

MANET protocols, in general, consider the identification and maintenance of a single routing path between two nodes. There are several research studies that focus on holding multiple routing paths in MANET. These studies mostly focus on the utilization of multiple paths as backup paths due to failures in the main routing path. The main purpose of maintaining these backup paths is to have less frequent route discoveries. The general benefits envisioned by these studies for all MANET protocols are e.g. significantly lower routing overheads and lower transmission delays.

Multi-path routing can also be used to improve communication efficiency and promote quality of service by utilising different paths, simultaneously. Simultaneous use of multiple paths could be used to split packets of a flow or independent flows. This paper discusses an approach to choose multiple paths to be used simultaneously, reducing the effect of interference between nodes as far as possible, which is termed as radio disjoint paths.

Probabilities of finding purely radio disjoint (no nodes in the interfering range of each other) paths are not realistic. However, keeping node disjoint paths with a minimum radio interference helps to avoid performance degradation (e.g. the flow in the middle problem in WLAN) up to some extent. Therefore, use of radio disjoint paths should have an impact on the performance when selected paths are used simultaneously with less or without interference.

In order to measure the interference level of a node, we consider a mechanism to measure the load of a node in terms of two parameters. First to measure the packets transmitted or received by the node itself and second to measure all packets heard from the others in the vicinity. The second measurement directly reflects the interference level of a node. However, the first measurement is also considered to select the less loaded nodes (i.e. paths). During the route discovery process, each node informs about its current load. Using this information, the destination should be able to compute the disjoint paths with less load.

Implementation details of the above algorithm to select the radio disjoint paths in the OPNET simulator and a comparison of results of with and without radio disjoint paths will be discussed in this paper. The following results highlight the performance improvement of simultaneous use of radio disjoint paths. These results were taken by setting 3 independent routing paths consisting of 802.11b WLAN nodes in the OPNET. 3 independent Video Conferencing (VC) sessions start over these three paths simultaneously at the same rate. Initially, these 3 sessions are routed as follows,

- Left Path –> VC session 1
- Middle Path –> VC session 2
- Right Path –> VC session 3

Each path consists of 5 WLAN nodes that are set to ad hoc mode and routes are set manually to take the above paths. Left and Right Paths are fully radio disjoint while the middle path is inside the radio interfering range of both left and right paths. Therefore, VC session 2 suffers the problem of flow in the middle. In order to avoid the flow in the middle problem, later the 2^{nd} VC session is also converted to be used over the left path. For this case, all 3 VC sessions are routed over fully radio disjoint paths (i.e. over left & right paths only) simultaneously. Table 1 shows the end to end delays of each VC sessions that is measured at each originator. It shows that all 3 VC sessions have fewer delays, when using the fully radio disjoint paths even though the load is higher in the left path. Moreover, the 2^{nd} VC session gains higher performance since it avoids the flow in the middle problem by using a fully radio disjoint path. Table 1 shows the flow in the middle problem is clearly visible under heavy load conditions.

Table 1 Average End-to-end Delay under Fully & Partially Radio Disjoint (RD) Paths

Mean Delay (ms)	Partially RD	Fully RD
Session 1	4.3	4.3
Session 2	7	5
Session 3	4	4

Table 2 Average End-to-end Delay with Partially Radio Disjoint Paths with low load and high load

	Low Load			Heavy Load		
VC Session	1	2	3	1	2	3
Mean Delay	3 ms	3 ms	3 ms	4.3 ms	7 ms	4 ms