Introduction

As depicted in [1] routing metrics in wireless mesh networks should satisfy various requirements. In particular the most important characteristics are:

- Route packets through minimum weight paths in terms of certain routing metrics
- Route stability
- Fast convergence
- Efficient calculation of best route
- Loop free routing

B.A.T.M.A.N. routing metric mainly take into account loss probability measured with broadcast messages. Then a number of tricks have been introduced to penalize long route (HOP_PENALITY) and to favour nodes that offer multiple interfaces. This approach has been shown to work quite well, outperforming other mesh network routing protocols [2]. Anyhow a number of improvement can be developed.

I will expose two simple situation in which B.A.T.M.A.N. protocol does not select the best path and then I will describe a possible improvement in order to solve these problems.

Link bit-rate

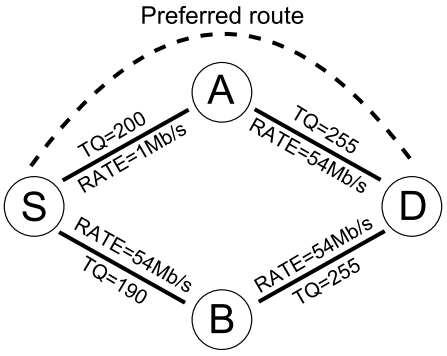

Figure 1: *Routing example with links having different bit-rate.*

The current routing metric does not consider the bit-rate of the link in computing its quality. In other words, in a situation like the one depicted in figure 1 the path with minimum loss rate (but less bit-rate) is chosen albeit the other will

offer an higher throughput.
This can be a very common situation both in case of heterogeneous devices with different characteristic, and also in presence of bad links that cannot work at the maximum bit-rate.

Multi-hop penalisation

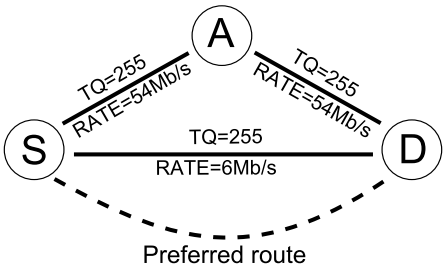

Figure 2: *Routing example showing a situation with two possible path from S to D. One is a slow direct link, the other is a 2-hop path composed of two link with a better bit-rate.*

The current implementation of B.A.T.M.A.N. penalize long route using a coefficient when computing the quality value. This coefficient is called _HOP_PENALITY and its default value is $\frac{245}{255}$.
I will state that this trick can introduce routing decision error that penalize the performance. In fact in a situation like the one depicted in figure 2, B.A.T.M.A.N. will select the slow direct link instead of the 2-hop faster link. This situation is quite probable to happen. In fact the OGM are sent in broadcast at 1 Mb/s (or 6 Mb/s in case of a pure 802.11g network). This measure can lead to use a long direct link that can only work at the minimum bit-rate instead of using a multi-hop link with better performance.

Improvement proposals

The central issue is taking in consideration link bit-rate, in fact this can solve both the described problems improving the overall network performance.
The implementation can be divided into two steps. First OGM structure should be changed in order to add more information about the link. Second a new routing metric that consider the additional information should be developed. In this way, after the first phase, there is the possibility of testing many possible routing metrics, opening an interesting research area that surely will lead to performance improvement.

OGM packet structure

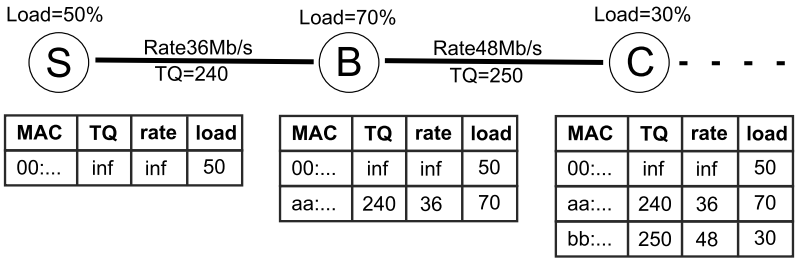

Figure 3: *Path information flooding the network in OGM.*

In each OGM should be written the parameters of each traversed link. In figure 3 can be seen the high level data structure contained in OGM and the flooding mechanism.
In particular the link/node attributes to write in the OGM should be:

- **Loss Rate**: the current metric;
- **Bit-rate**: the bit-rate towards the previous node in the path (infinity for the originator node);
- **Load**: the current load of the node (if available);

In this way the protocol become a sort of "path vector" because each node has the information of all the link toward all the originator nodes. In this way there is also the possibility to use the additional information to find out independent paths, so allowing in the future to implement multipath routing.

Metrics idea

The old loss rate is very useful to cut off vary bad link that shows high loss rate. After this first selection system, the metric should consider the bit-rate of the various path to select the one that offer most bandwidth, at this point load balancing techniques can be used to balance the link load.

References

[1] Y. Yang, J. Wang, and R. Kravets, "Designing routing metrics for mesh networks", In WiMesh, 2005.

[2] Abolhasan M., Hagelstein B., Wang J.C.-P., "Real-world performance of current proactive multi-hop mesh protocols", Communications, 2009. APCC 2009, pp.44-47, 8-10 Oct. 2009