

Batman-Adv With CentAir

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Introduction

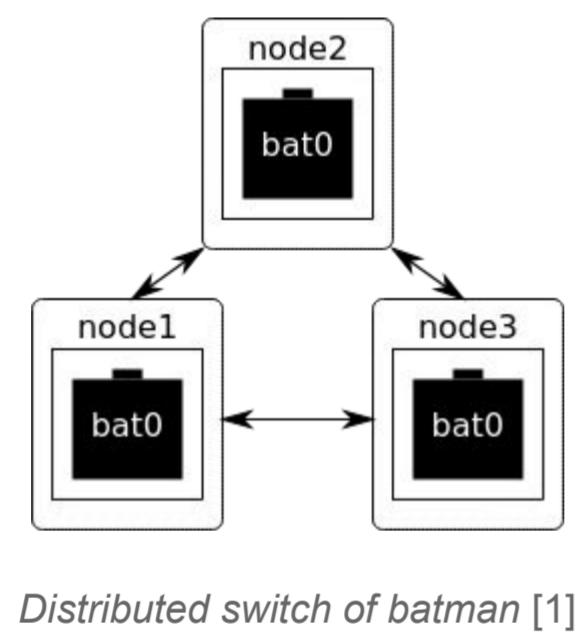
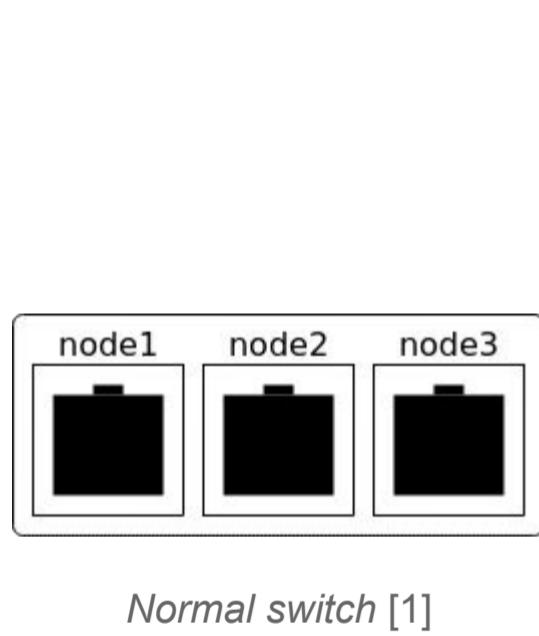
Batman-Adv is a kernel driver for ad-hoc networks where there is no central router to administer communication between nodes. Sometimes Batman's routing algorithm falls short for detecting the loss from collisions. CentAir is a protocol which; according to chosen centrality metric, avoids the paths where collision is likely. In this project, Batman-Adv is enriched with CentAir so that it can avoid central nodes that became bottlenecks.

Methods

Batman-adv module can be observed and configured by a user space program called batctl. With batctl we can even configure intervals of its OGM packets. A batman node broadcasts a special packet named OGM every once while to inform its neighbours about its existence. but this broadcasting have millisecond sensitivity, collisions happen in mere nanoseconds, that's where CentAir comes in to make up for batman's shortcoming.

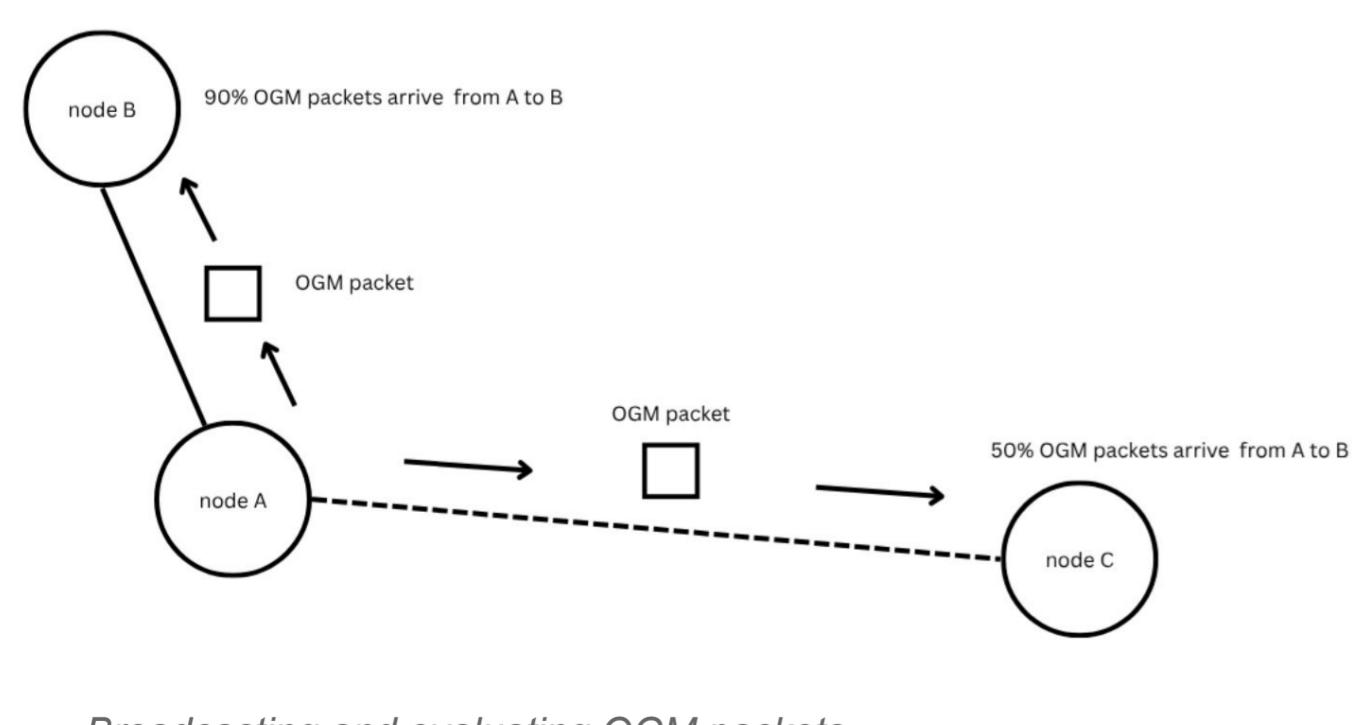
Batman-Adv

- Operates on OSI Layer 2
- Batman network becomes a distributed switch
- Each node becomes a port of this switch



BATMAN's OGM Packets

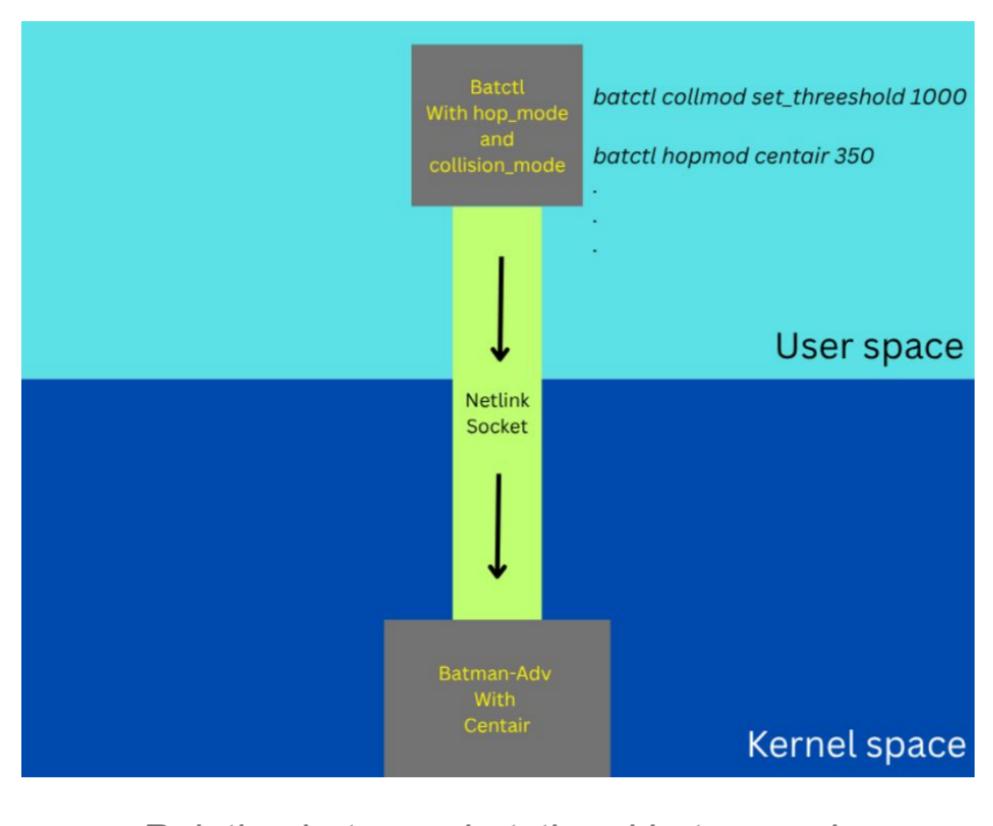
OGM packet stands for originator message, a batman node broadcast this packet every once while so that neighbours can be aware of it. Every batman node keeps a sliding window for every node in the network by tracking OGM packets' sequence numbers. This is how batman calculates quality of links between other nodes. Not just theirs but when they receive they can broadcast other batman nodes' OGM packets too, for each other.



Broadcasting and evaluating OGM packets

Batctl

Batctl is a user space program which can interact with the batman module itself which reside in kernel space. They interact with each other via netlink sockets.

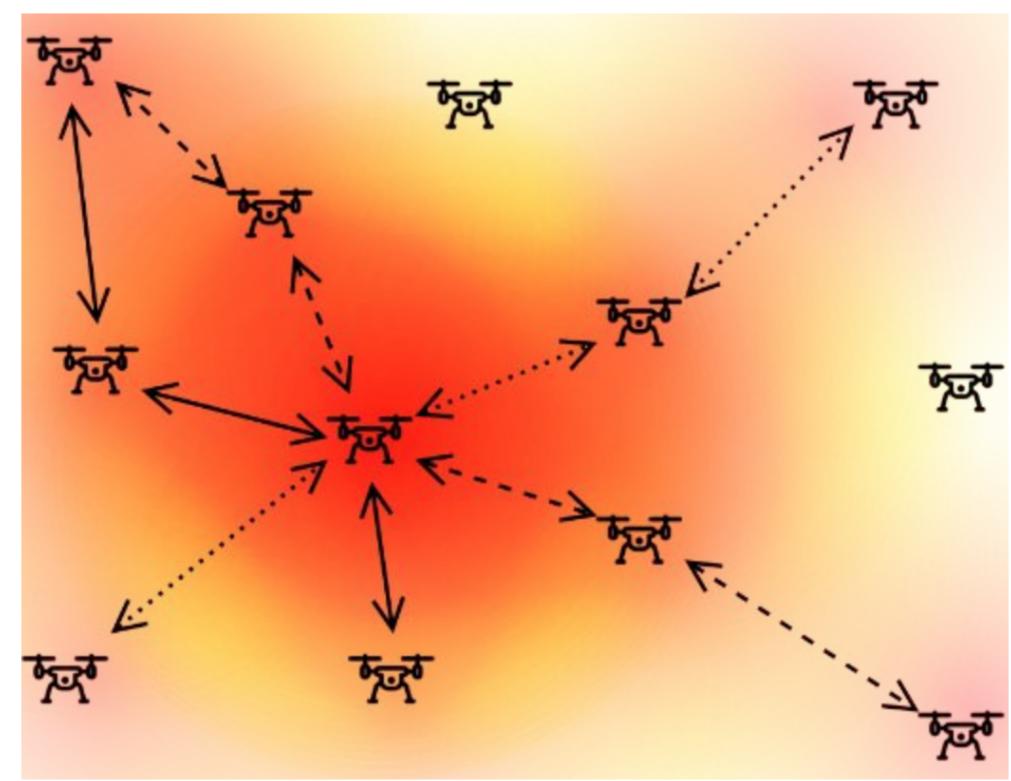


Relation between batctl and batman-adv

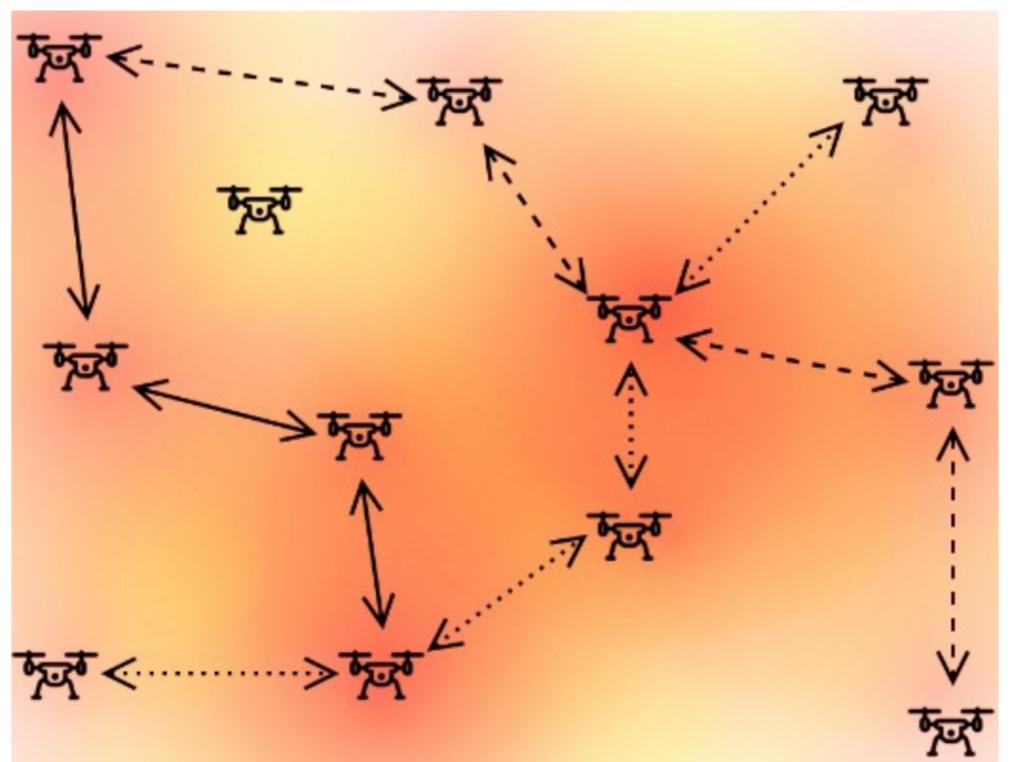
CentAir

User can put all network in two hop mode with batctl: uniform and CentAir mode. In uniform mode all nodes have the same hop penalty. This mode tries to minimize number of nodes between source and destination. In CentAir [2] hop penalty is proportional with number of neighbors. A node can broadcast a number and hop penalty is calculated according to equation below:

$$\text{Hop penalty} = (\text{broadcasted number}) * (\text{number of neighbors} / \text{number of routers})$$



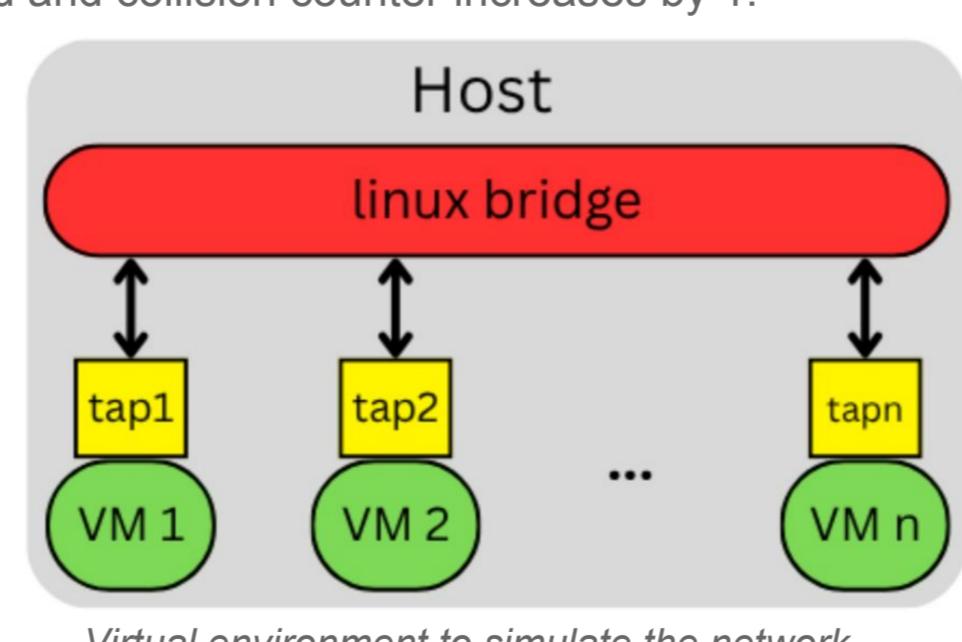
In uniform mode routing prefers least hop between source and destination, thus traffic condense around central nodes [3]



In CentAir mode, because central nodes gets higher penalty, traffic is distributed from central nodes to outer nodes. [3]

Simulation

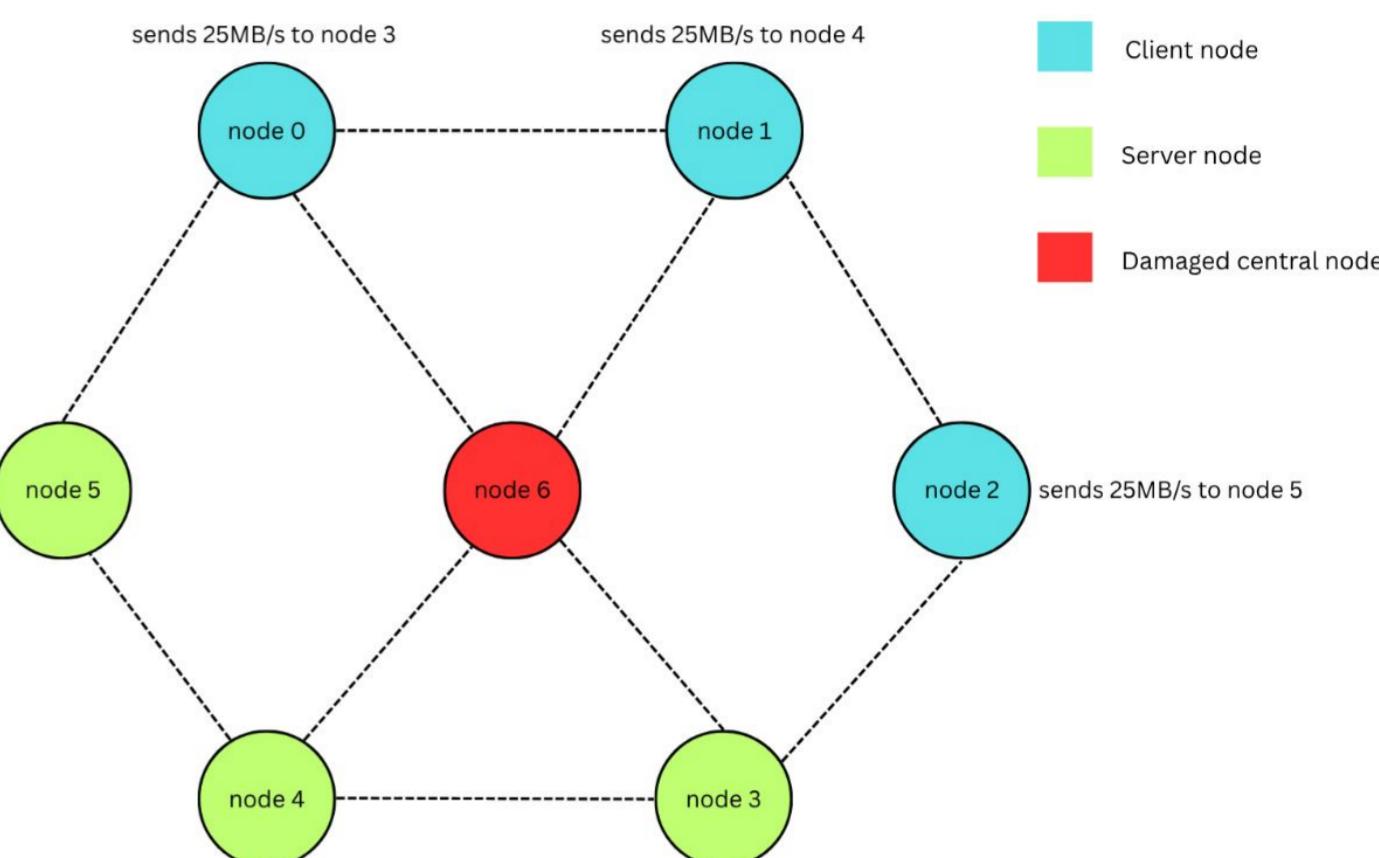
Qemu instances are connected to a linux bridge via tap interfaces. Connection between tap interfaces are defined in nftables subsystem so that multi-hop and damaged links are possible. To simulate collisions, packets that arrive batman driver in a time that is below a threshold after the last packet are dropped and collision counter increases by 1.



Virtual environment to simulate the network

The Tested Network

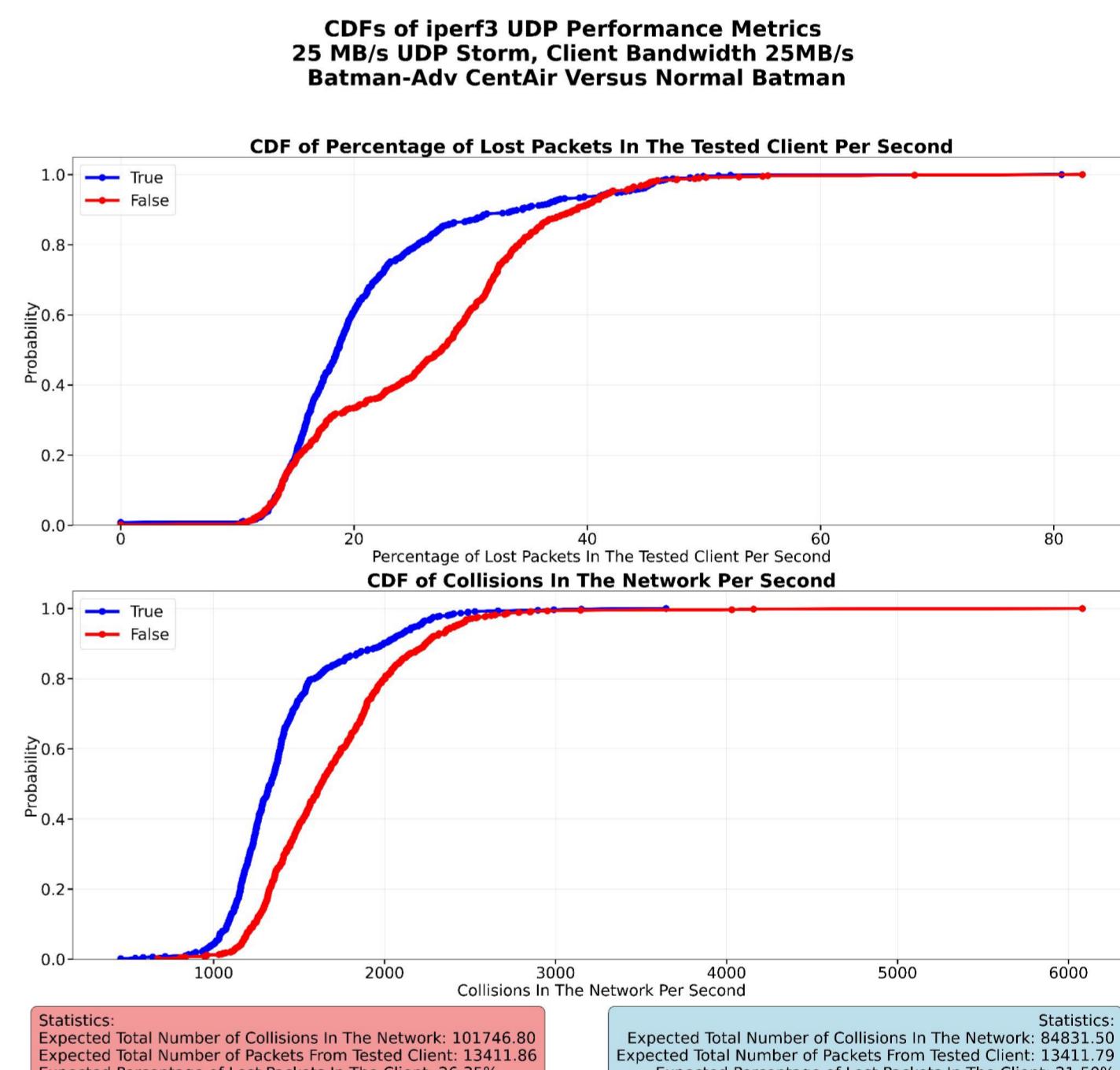
There are 3 client nodes and 3 server nodes, clients send server nodes UDP packets in bandwidth of 25 MB/s. A test lasts for one minute. Central router is slightly damaged, so it is more susceptible to collisions.



Topology of The Tested Network

Results

One half of the tests was running vanilla Batman-Adv, other half was running Batman-Adv with CentAir. In the tests; jitter, throughput, lost packet count, and collision numbers were compared. Actual differences between two networks were in the **number of collisions in the network** and **percentage of lost packets in the client**. According to results; Batman with CentAir reduces number of collisions in the network **by 16.62%** and lost packets **by 4.85%**.



Conclusion

This project aimed to enhance the Batman-Adv's routing algorithm where sometimes because of millisecond sensitivity of its discovery packets, it may fail to detect packet loss caused by collisions, adapt the network and sway the traffic away from the dangerous nodes in time. Especially, batman is vulnerable to collisions during bursty traffic and with damaged central nodes which can be susceptible to become bottlenecks under the heavy load. An admin can observe the network and decide to act upon it by putting the network CentAir mode, as aggressive as he/she desire.

References

1. "B.A.T.M.A.N. Advanced," Open Mesh. [Online]. Available: <https://www.open-mesh.org/doc/batman-adv/Wiki.html>.
2. T. T. Sari and G. Seçinti, "Using Centrality Based Topology Control for FANET Survivability Against Jamming," Computer Networks, vol. 242, pp. 110250, 2024.
3. T. T. Sari and G. Seçinti, "CentAir: Centrality Based Cross Layer Routing for Software-Defined Aerial Networks," in 2022 IEEE 19th Annual Consumer Communications & Networking Conference (CCNC), Las Vegas, NV, USA, 2022, pp. 741-742.