A Demonstration of Video over an IEEE 802.11 compliant version of the Enhanced-Backpressure algorithm *

Kostas Choumas, Thanasis Korakis, Iordanis Koutsopoulos, and Leandros Tassiulas

Department of Computer and Communication Engineering, University of Thessaly, Greece
Centre for Research and Technology Hellas, CERTH, Greece
{kohoumas,korakis,jordan,leandros}@uth.gr

Abstract. This demo presents a novel routing and scheduling scheme, named Enhanced-Backpressure over WiFi (EBoW), that obviously outperforms the dominant approach of a shortest-path routing (SRCR) combined with the classic CSMA/CA scheduling policy of 802.11 networks. The new scheme combines aspects of load-balancing and shortest-path routing and enhances the CSMA/CA scheduling, maximizing the throughput performance, while keeping low end-to-end delay. We perform a comparative demonstration of video streaming over an ad-hoc 802.11 network, using EBoW and SRCR, where the latter one is a state-of-the-art shortest-path routing algorithm. The new scheme delivers a smooth and jitter-free video playback experience, while the SRCR scheme experiences noticeable jitter and rather frequent distortions. The demo clearly demonstrates the performance superiority of the new implemented scheme, as compared to the other one. The implementation of both schemes relies on the well-known Click framework.

Key words: Backpressure, wireless mesh, multi-path routing, testbed

1 Introduction

The efficiency of a wireless mesh network is directly related to the applied routing and scheduling policy. Backpressure [1] is a throughput optimal scheme that instead of performing explicit path computation from source to destination, it forwards independently packets to less loaded nodes, while it requires TDMA and centralized scheduling. Enhanced-Backpressure (EBP) [1] is an improved version that reduces the average end-to-end delay performance. However, both schemes cannot be implemented on top of WiFi networks, due to the decentralized nature of 802.11 networks. In this paper, we present an 802.11 compliant version of EBP, named Enhanced-Backpressure over WiFi (EBoW) [2], which implements the EBP aspects in a manner that is compatible with WiFi networks. Particularly, we introduce a scheme in which every node attempts to forward packets to less loaded and closer to the destination neighbors, in a similar way that EBP scheme schedules.

The implementation of the novel scheme is based on the Click framework [3], while the NITOS wireless testbed [4] is used for its experimental evaluation. As we mentioned above, we compare EBoW with SRCR [5] in terms of perceived video quality after streaming a video clip over a wireless mesh. We also use a GUI that shows at runtime which route the video stream followed in consecutive moments of time.

2 Enhanced-Backpressure over WiFi

EBoW is an 802.11 compliant routing and scheduling scheme, that attempts load-balancing routing retaining low end-to-end delay, while enhances CSMA/CA scheduling. More specifically, it maintains a set of internal network layer queues at each node, where each queue corresponds to a different destination. When a node receives or generates a packet that needs to be forwarded, it identifies the destination of the packet and pushes it to the corresponding queue. Moreover, each node that has packets in its queues, initiates a procedure to schedule the transmission of a packet. The node computes a weight per each pair of neighbor-destination, which grows when the neighbor is less loaded for this destination or is closer to this. Then the node chooses the maximum weighted pair and transmits a packet of the relative queue to the corresponding neighbor. This algorithm

* This work was supported by European Commission under Marie Curie IRSES grant PIRSES-GA-2010-269132 AGILENet

is the routing policy of the EBoW scheme. On the other hand, in case that every neighbor is more loaded for or in a longer distance to every destination, the node remains inactive and does not schedule transmissions. These requirements constitute the distributed scheduling policy of the EBoW scheme.

3 Demonstation of Video over the new scheme

In this demo, we compare EBoW with SRCR, that is a state-of-the-art shortest-path routing algorithm. SRCR chooses always the shortest route, while EBoW creates parallel routes and therefore balances the traffic load in the network. A ring network (Figure 1) consisting of 5 NITOS nodes has been designed, featuring a 2-hop and a 3-hop path as well, that connect their common source and destination. The physical transmission rate for each node is fixed to 6 Mbps, while their frequency selection is the rarely used (in Greece) 802.11a frequency of 5280 MHz, in order to eliminate outside interference. The well known video of *foreman* is transmitted from source to destination, compressed as H.264 video with constant bitrate equal to 1Mbps. Simultaneously, an Iperf [6] high traffic stream runs from the intermediate node of the 2-hop path to destination, that overflows the intermediate node.

As illustrated in Figure 1, we use an external PC, which runs the VLC [7] client and server to generate and receive respectively the UDP/RTP/H.264 video stream. The server machine of the NITOS testbed is used as the connecting part of the actual network and the external PC. All frames delivered from the PC to the source node, are forwarded to the destination node through the wireless part of the network. Finally, the frames delivered at destination are further delivered back to the external PC. The forwarding procedures are implemented through Socat [8] connections.

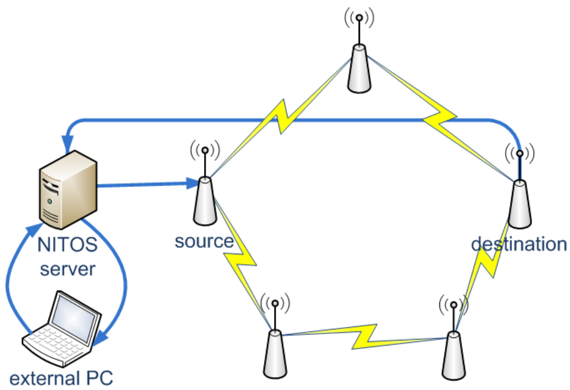


Fig. 1: Ring Network

SRCR forwards the video stream through the shortest two-hop path, although the fact that the intermediate node is overloaded. Because of this phenomenon, the majority of video packets are discarded and the delivered quality to the destination node is not satisfying. On the other hand, the proposed scheme detects the overload node and avoids forwarding towards it. The utilization of the parallel 3-hop is much more efficient in terms of throughput and perceived video quality. Eventually, we are able to compare the quality of the video resulting from transmissions that follow the previous mentioned protocols. In Figure 2, four screen shots are provided that clearly depict the superiority that the EBoW protocol achieves in terms of video quality.

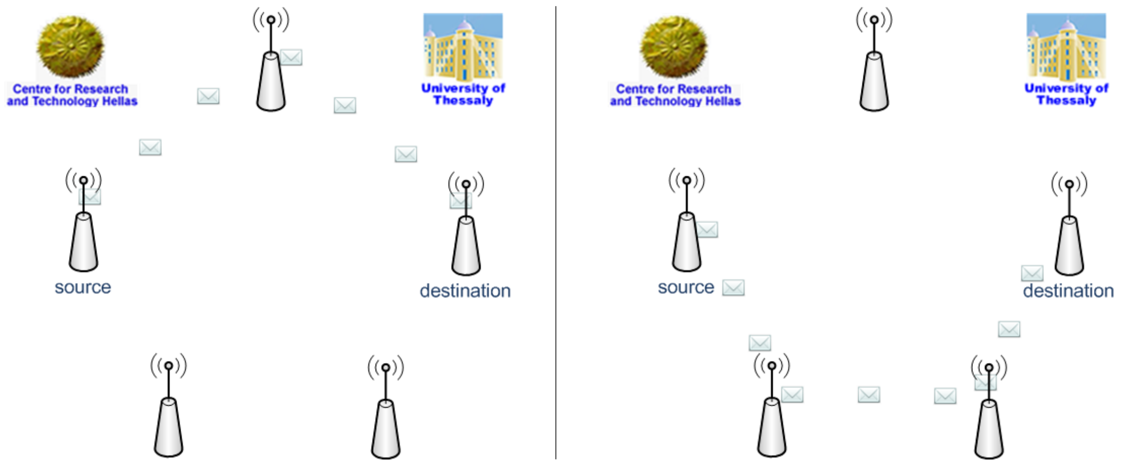
(a) SRCR snapshot (b) EBoW snapshot (c) SRCR snapshot (d) EBoW snapshot

Fig. 2: *foreman* snapshots

Moreover, a Graphical User Interface (GUI) has been developed that gives a depicted representation of the whole topology and its state. GUI shows the path that video stream followed in average the last second. Figure 3 shows two snapshots of the GUI, which indicate that the video stream followed the 2-hop or the 3-hop path respectively. The GUI periodically collects the necessary data using appropriate questions at control TCP socket of Click.

4 Conclusion

In this demo paper we present a novel routing/scheduling scheme that dynamically avoids overloaded paths, creates parallel routes and therefore manages to balance the network traffic load, increasesing in this way its throughput efficiency. We used this scheme to stream a video over a double-path topology, and we observed that it outperforms the state of the art shortest-path routing protocol in terms of throughput and perceived video quality. A future direction is an improved scheduling policy based on prioritization schemes of 802.11, such as those proposed by the 802.11e amendment.



(a) 2-hop forwarding (b) 3-hop forwarding

Fig. 3: GUI snapshots

References

1. L. Georgiadis, M. Neely, and L. Tassiulas. Resource allocation and cross layer control in wireless networks. *Foundations and Trends in Networking*, 1(1):1–149, 2006.
2. K. Choumas, T. Korakis, I. Koutsopoulos, and L. Tassiulas. Implementation and end-to-end throughput evaluation of an ieee 802.11 compliant version of the enhanced-backpressure algorithm. *Submitted for publication*, 2012.
3. R. Morris, E. Kohler, J. Jannotti, and M. F. Kaashoek. The click modular router. *ACM SOSP*.
4. *NITLab: Network Implementation Testbed Laboratory*,`http://nitlab.inf.uth.gr/NITlab/`.
5. J. Bicket, D. Aguayo, S. Biswas, and R. Morris. Architecture and evaluation of an unplanned 802.11b mesh network. *ACM MobiCom*, 2005.
6. *Iperf: The TCP/UDP Bandwidth Measurement Tool*, `http://dast.nlanr.net/Projects/Iperf/`.
7. *VLC: The open source cross-platform multimedia framework*, `http://www.videolan.org/vlc/`.
8. *Socat: Multipurpose relay (SOcket CAT)*, `http://www.dest-unreach.org/socat/doc/socat.html`.