



Lab 5: halfMac with Software Control

Chris Hunter & Patrick Murphy

Rice University

WARP Project

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1 Introduction

In the previous lab, WARP nodes had no concept of addresses. The “MAC” was little more than software that directly transferred packets from Ethernet to the wireless PHY and vice versa. In this lab, we will implement a “true” medium-access layer to control nodes in the topology shown in Figure 1.

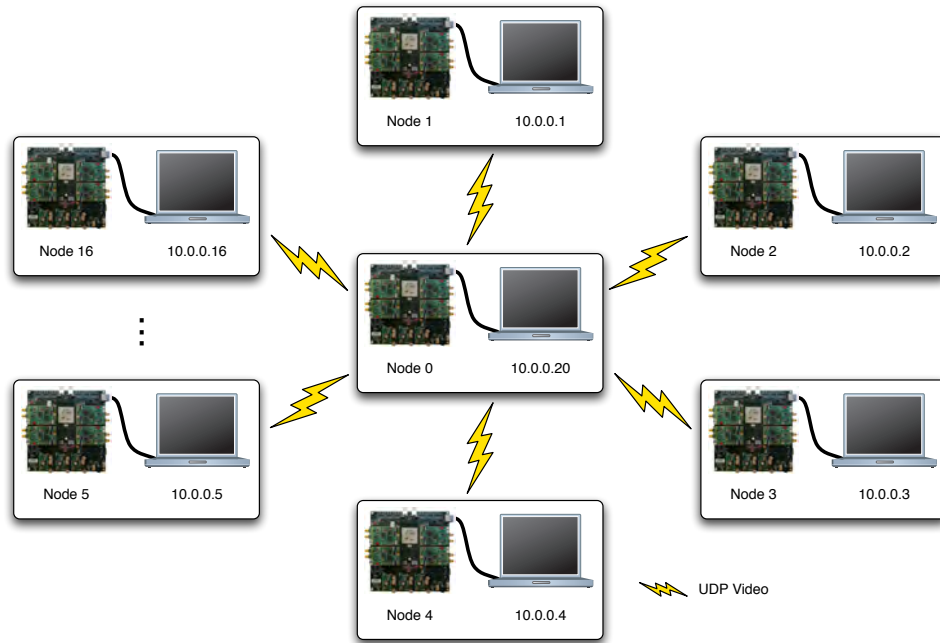


Figure 1: Lab Topology

In this experiment, a central transmitter will stream UDP video to each of the participants’ PCs. Each wireless node has a unique MAC address, allowing the node to process only its own packets. For the purpose of this lab, the local MAC addresses are set using the DIP switch on each WARP FPGA board; each node is already configured with a different DIP switch value.

The central node implements an ARP table, mapping WARP MAC addresses to the attached PC’s IP address. This node also implements a modified version of a CSMA MAC. The central node’s MAC expects to receive an ACK for each packet it sends. It will re-transmit unacknowledged packets 8 times before dropping the packet entirely.

Note: All files are stored in C:\workshop\. This location will be referred to as .\ for the rest of the lab.

In this lab, you need to implement code which realizes the following behavior:

- Check the destination address of each received wireless packet. If it is addressed to your node, send an ACK to node 0 and send the packet via Ethernet.
- If a packet is received via Ethernet, the MAC should send it wirelessly to node 0. You do not need to implement the backoff/retransmit state machine.

This behavior is illustrated in Figure 2.

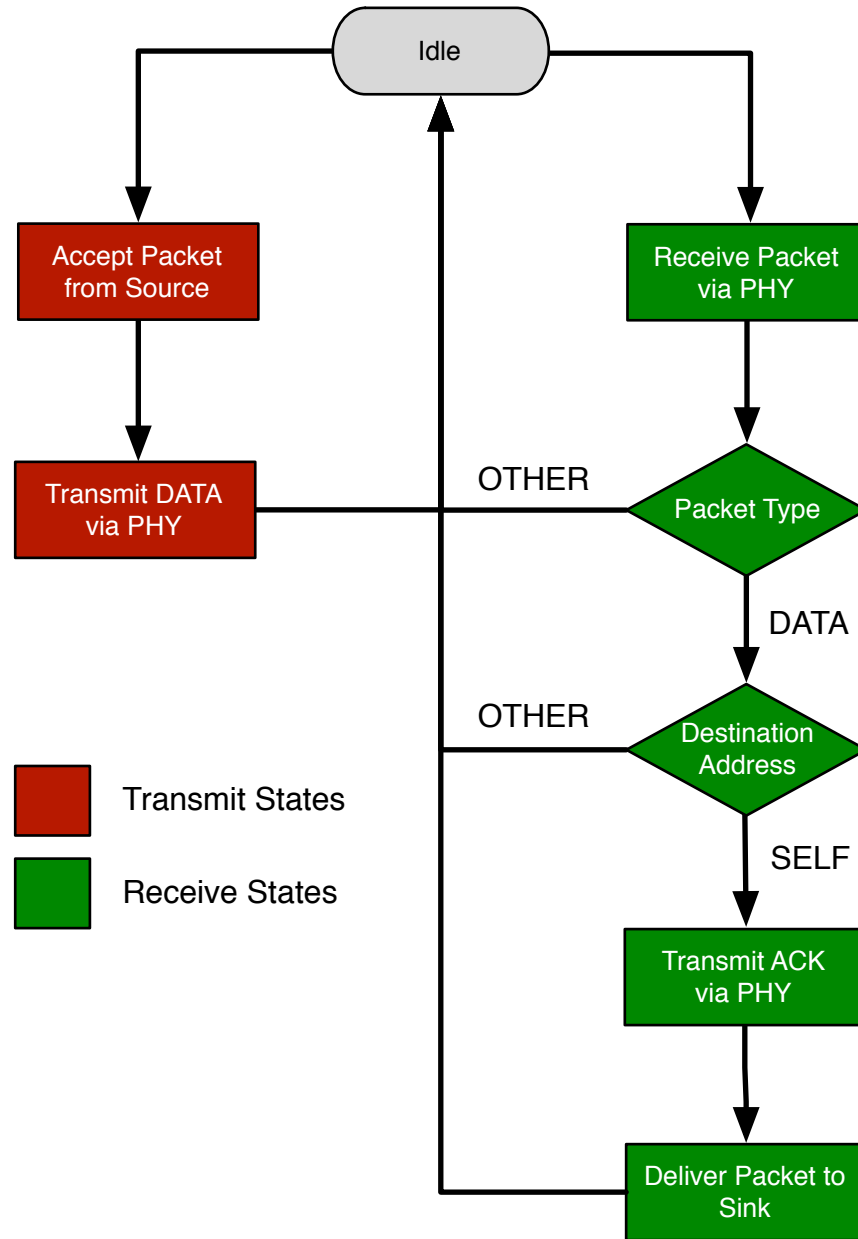


Figure 2: halfMac State Diagram

In effect, your code will be responsible for the receive half of the csmaMac reference design (also available in the XPS project). Hence, the name of this lab exercise is “halfMac.” In this variant, you will use software calls to generate and send acknowledgement packets in response to good data frames.

It is important to note that, while the transmitter has a MAC capable of retransmissions, your MAC implementation will not. Because of the unidirectional nature of UDP, the only Ethernet traffic which will be forwarded to node 0 is an ARP reply to establish the Ethernet MAC address lookup tables on both PCs.

The WARP API will be required throughout this lab exercise. Skeleton code is provided that should compile without user modification.

2 Instructions

1. Open the `.\Labs4to6\system.xmp` associated with this lab
2. Because we will only be dealing with the software project in this lab, we can ignore everything in the “System Assembly View.” Click on the “Applications” tab as shown in the first plot of Figure 3
3. There are two software projects in this tab, as shown in second plot of Figure 3. The “HALF-MAC.SERVER” project is provided for reference only; this is the code which is running on the central wireless node. You are responsible for modifying the “HALFMAC.CLIENT_SW” project. By right-clicking on the projects, you can select which is selected for initialization by checking “Mark to Initialize BRAMs.” In the interest of maintaining the custom network in this lab, please do not download the server project to the board.

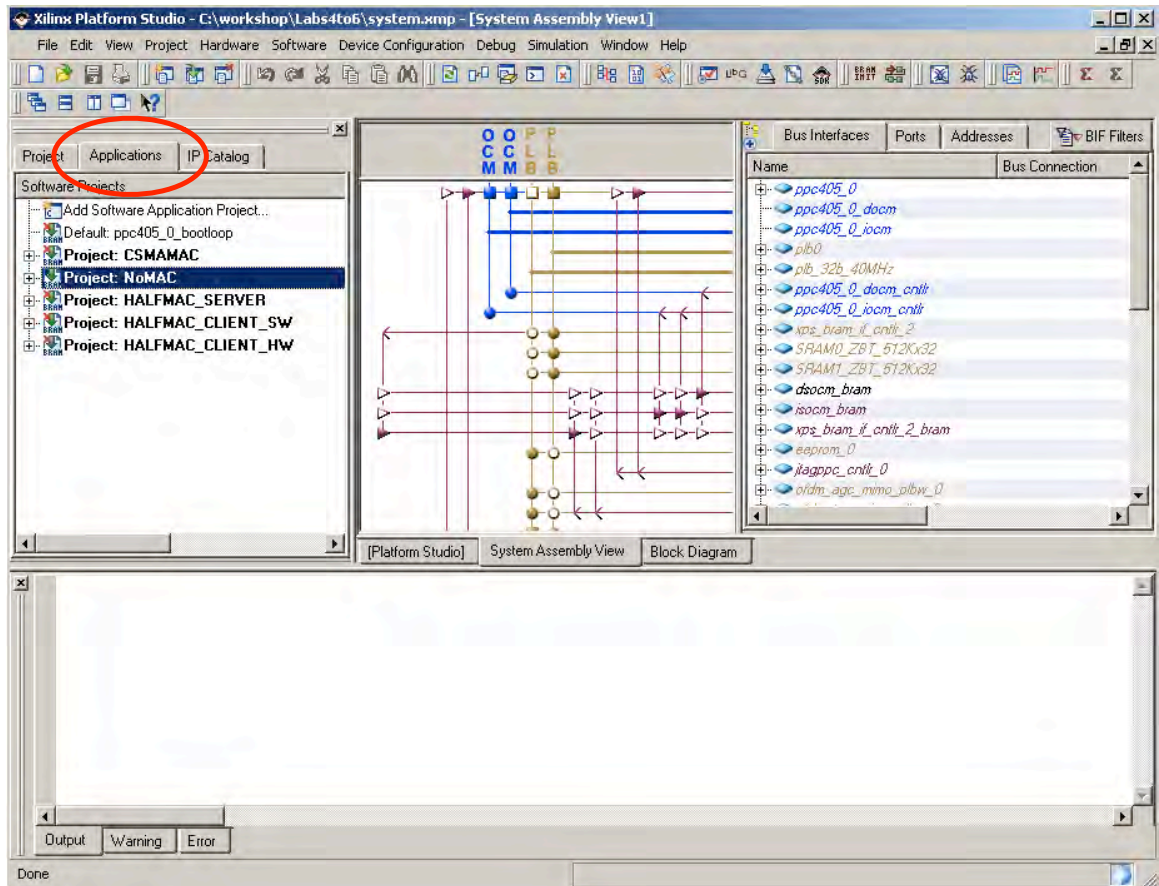


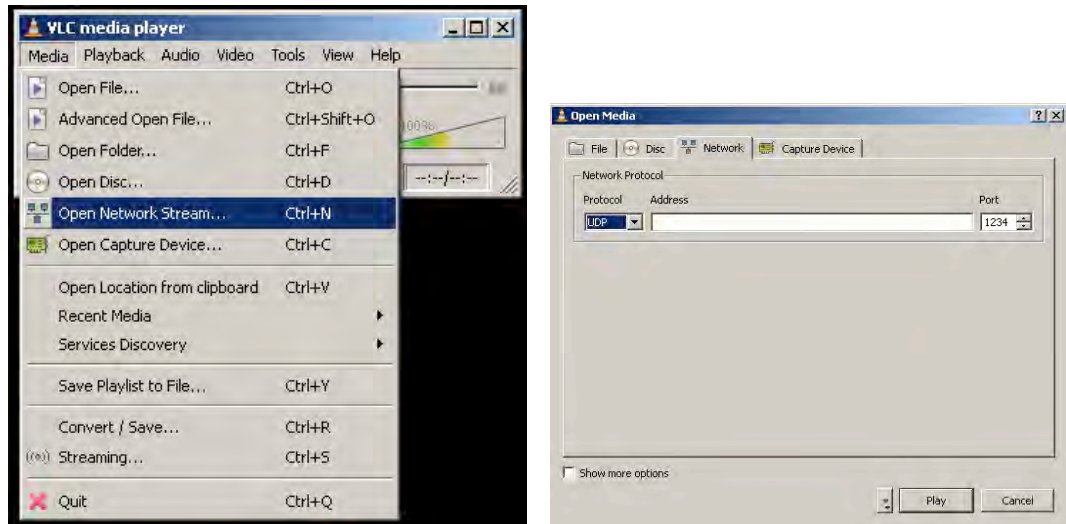
Figure 3: XPS Window

4. Within the “Sources” and “Headers” hierarchies, you will be greeted by a number of files required for the project to build:
 - *halfmac_client_sw.c* - This file is the where all of the user’s modifications will take place. It is the top-level code where the MAC algorithm resides.
 - *warpmac.c* and *warpphy.c* - These file contains all of the MAC development and PHY interface framework. These frameworks provide the user high-level functions for abstracting interactions with the wireless and wired network interfaces.
5. Open the *halfmac_client_sw.c* file and modify the skeleton code to implement the functionality specified in the comments.

3 Testing your MAC

3.1 Video Reception

Launch VLC Media Player, open the network stream as shown in Figure 4, select “UDP” and click “play.” Finally un-mute the computer.



(a) Open the network stream

(b) UDP on port 1234

Figure 4: VLC configuration

3.2 Oscilloscope Measurements

A key metric in MAC performance is the turn-around-time (TAT) in responding to the reception of a wireless packet with the transmission of another wireless packet. In this area (among others), WARP is uniquely capable since wireless processing is local to the board. Using an oscilloscope, trigger on the falling edge of the “RX” signal and observe the rising edge of the “TX.” This will allow you to measure the TAT between data reception and ACK transmission. Please notify a workshop instructor for assistance with the oscilloscopes. Measure the following:

1. TAT between fall of RX to rise of TX: _____
2. TX jitter relative to fall of Rx: _____