A headless Raspberry Pi is a great tool because it can run arbitrary code using an assortment of inputs and outputs without requiring a keyboard, mouse, or monitor. But how do you connect to it to upload code and configure it? The answer, of course, is an SSH connection. But there are a few problems that we have to solve before we can use SSH.

The first problem is that campus WiFi blocks SSH access. So our Raspberry Pi computers can connect out to the internet, but we cannot connect in to them. But even if we convince the IT department to allow SSH connections, we still want to use our microprocessors in locations where campus WiFi is unavailable. So, campus WiFi cannot be used for SSH connectivity.

We can solve the first problem by connecting directly to our Raspberry Pi computers over the Ethernet port. However, with a direct wired connection, the device has to live near an ethernet port. The better solution is to configure our Raspberry Pi as a wireless access point for its own ad-hoc wireless network.

Keep in mind that when the Pi is functioning as a wireless access point, it will not be connected to the internet. So it's important that you install any/all software \*before\* you break your original network connection to the campus WiFi. Don't worry; it's possible for the Raspberry Pi to switch between a traditional wireless client and being its own WiFi access point, but it requires you to do a few steps ahead of time (and it's annoying if you have to do it often).

The instructions for this guide are based on a [How-To article by Steve Murch](https://www.stevemurch.com/setting-up-a-raspberry-pi-for-ad-hoc-networking-tech-note/2022/12). Steve does things a bit differently than what we need for class, and he claims that the instructions will only work on the older "Bullet" version of the Raspberry Pi Operating System. But with a few tweaks, I got it all to work on the slightly newer "Bullseye" OS. However, there were significant changes to the "Bookworm" operating system, and a different set of instructions was needed (there should be another document somewhere). Bullet, Bullseye, and Bookworm are all names for the underlying Debian operating system, referring to versions 10, 11, and 12, respectively.

Installing the Ad-Hoc Access Point Software

* Install the Access Point and DNS/DHCP software.  
    
  **ssh@marty:~ $** sudo apt-get install hostapd (Access Point Daemon)  
  **ssh@marty:~ $** sudo apt-get install dnsmasq (for DNS and DHCP)
* Configure the Host Access Point Daemon to run on boot.  
    
  **ssh@marty:~ $** sudo systemctl unmask hostapd (enable the service)  
  **ssh@marty:~ $** sudo systemctl enable hostapd (start automatically on boot)

Configure the Ad-Hoc Access Point

* Start by saving the previous DHCP configuration so that it's simple to restore if you ever want to switch back to being a client on the campus WiFi network.  
    
  **ssh@marty:~ $** sudo cp /etc/dhcpcd.conf /etc/dhcpcd.conf.wifi  
    
  Overwrite the original /etc/dhcpcd.conf file so that the Raspberry Pi uses a static IP address and does \*not\* join the campus WiFi network.  
    
  interface wlan0  
   static ip\_address=192.168.1.1/24 # set our own IP address  
   nohook wpa\_supplicant # disable the WiFi client  
    
  Save a copy of the new DHCP client configuration file so that you can quickly switch between a WiFi client on the campus network and being your own WiFi Access Point. Verify that there are three versions of the file: the current configuration, the saved campus WiFi configuration, and the saved Access Point Daemon configuration:  
    
  **ssh@marty:~ $** sudo cp /etc/dhcpcd.conf /etc/dhcpcd.conf.apd  
  **ssh@marty:~ $** ls /etc/dhcpcd.conf\*  
  /etc/dhcpcd.conf  
  /etc/dhcpcd.conf.apd  
  /etc/dhcpcd.conf.wifi
* Create a route between the Ethernet port and the ad-hoc WiFi network by creating a new file named /etc/sysctl.d/routed-ap.conf with the following contents:  
    
  # Enable routing between networks  
  net.ipv4.ip\_forward=1
* Configure DNS and DHCP services for the clients that connect to your Raspberry Pi's ad-hoc wireless network. Start by saving the previous configuration so that it's simple to restore if you ever want to switch back to being a client on the campus WiFi network.  
    
  **ssh@marty:~ $** sudo cp /etc/dnsmasq.conf /etc/dnsmasq.conf.wifi  
    
  Overwrite the original DNS/DHCP configuration file /etc/dnsmasq.conf so that it only has these lines:  
    
  # Provide DHCP for devices connecting on the wlan0 interface  
  interface=wlan0  
    
  # Hand out 24h DHCP leases for 192.168.1.2/24 to 192.168.1.10/24  
  dhcp-range=192.168.1.2,192.168.1.10,255.255.255.0,24h  
    
  # Setup DNS for domain name and the Raspberry Pi (ourself)  
  domain=headsupflight  
  address=/marty.headsupflight/192.168.1.1  
    
  Save a copy of the new DNS/DHCP configuration file so that you can quickly switch between a WiFi client on the campus network and being your own WiFi Access Point. Verify that there are three versions of the file: the current configuration, the saved campus WiFi configuration, and the saved Access Point Daemon configuration:  
    
  **ssh@marty:~ $** sudo cp /etc/dnsmasq.conf /etc/dnsmasq.conf.apd  
  **ssh@marty:~ $** ls /etc/dnsmasq.conf\*  
  /etc/dnsmasq.conf  
  /etc/dnsmasq.conf.apd  
  /etc/dnsmasq.conf.wifi
* Configure the WiFi AP by creating the /etc/hostapd/hostapd.conf file.  
    
  # Each country has its own restrictions for the wifi band  
  country\_code=US  
    
  # Access point should use the wireless interface  
  interface=wlan0  
    
  # WiFi settings - NOTE: PWD MUST BE 8+ CHARACTERS!  
  ssid=HeadsUpFlight  
  hw\_mode=g  
  channel=7  
  macaddr\_acl=0  
  auth\_algs=1  
  ignore\_broadcast\_ssid=0  
  wpa=2  
  wpa\_passphrase=YourPassword  
  wpa\_key\_mgmt=WPA-PSK  
  wpa\_pairwise=TKIP  
  rsn\_pairwise=CCMP
* Reboot the Pi to use the new WiFi access point.  
    
  **ssh@marty:~ $** sudo reboot

Verify WiFi Access Point

After your Raspberry Pi has rebooted, use another computer to find and connect to its WiFi Access Point. Verify that you can still login via SSH.

If you cannot see the WiFi Access Point or logon, there was probably an error. Connect your Raspberry Pi to a keyboard and monitor and try to start the access point software manually. It will probably give you a hint about the error that is occurring.

**ssh@marty:~ $** sudo hostapd /etc/hostapd/hostapd.conf

Switching between WiFi Client and WiFi Access Point

To configure your Raspberry Pi as a WiFi Client:

**ssh@marty:~ $** sudo systemctl disable hostapd  
**ssh@marty:~ $** sudo systemctl mask hostapd  
**ssh@marty:~ $** sudo cp /etc/dhcpcd.conf.wifi /etc/dhcpcd.conf  
**ssh@marty:~ $** sudo cp /etc/dnsmasq.conf.wifi /etc/dnsmasq.conf  
**ssh@marty:~ $** sudo reboot

To configure your Raspberry Pi as a WiFi Access Point:

**ssh@marty:~ $** sudo systemctl unmask hostapd  
**ssh@marty:~ $** sudo systemctl enable hostapd  
**ssh@marty:~ $** sudo cp /etc/dhcpcd.conf.apd /etc/dhcpcd.conf  
**ssh@marty:~ $** sudo cp /etc/dnsmasq.conf.apd /etc/dnsmasq.conf  
**ssh@marty:~ $** sudo reboot