Everything You Need to Know About Networks and Routers, probably, and hopefully not much more.

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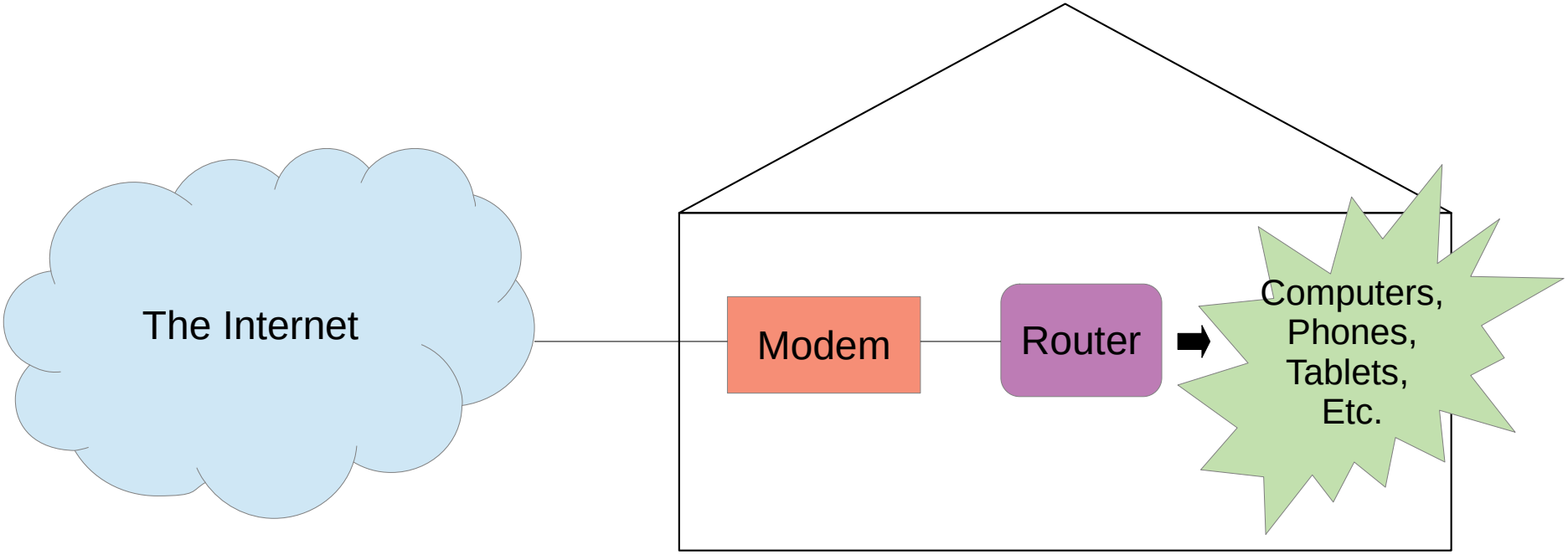
Your Network



- Your Modem and Router may be in a single box (esp. Cable, DSL, and Satellite Modems)
- The Router really “runs the show”

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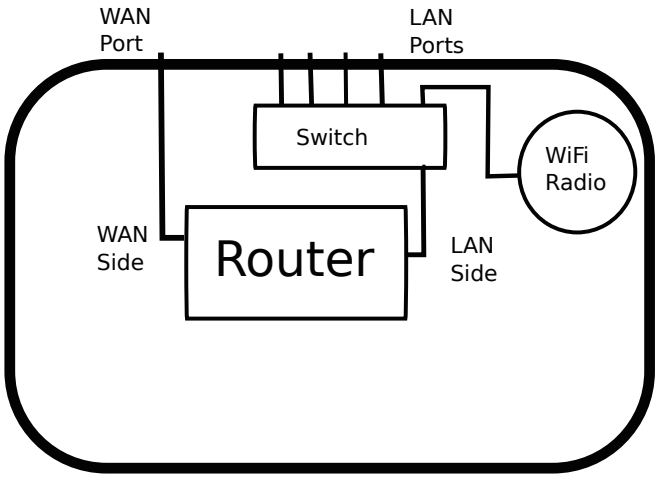
What is a Typical Router?

- Typical Consumer Router is actually 3 things:
  - A Router – connects one network (WAN or Internet side – your ISP's network) to another (LAN side – what you use in your house)
  - A Switch – turns one port on the LAN side into several ports so you can connect multiple devices via Ethernet
  - A WiFi Radio as an Access Point – connected to the LAN side, provides wireless connectivity for devices



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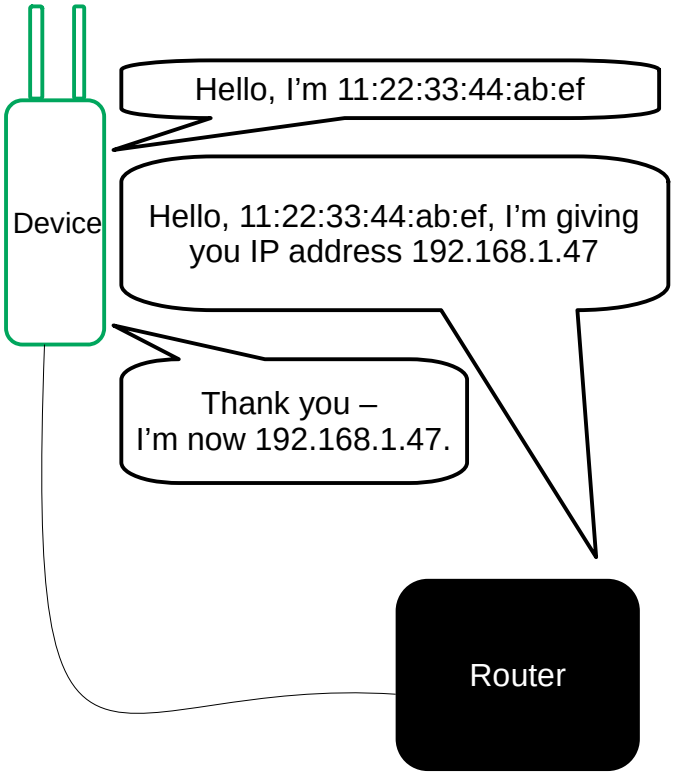
How a Router Works

- Device connects to the router
  - Ethernet or WiFi
- Device identifies itself by Media Access Control (MAC) address
  - Unique ID – every device different
- Router responds by providing IP address via DHCP
- DHCP IP address is a “lease” - finite time, renewed before expiration
  - When device does not “renew” lease, IP address is available for different device



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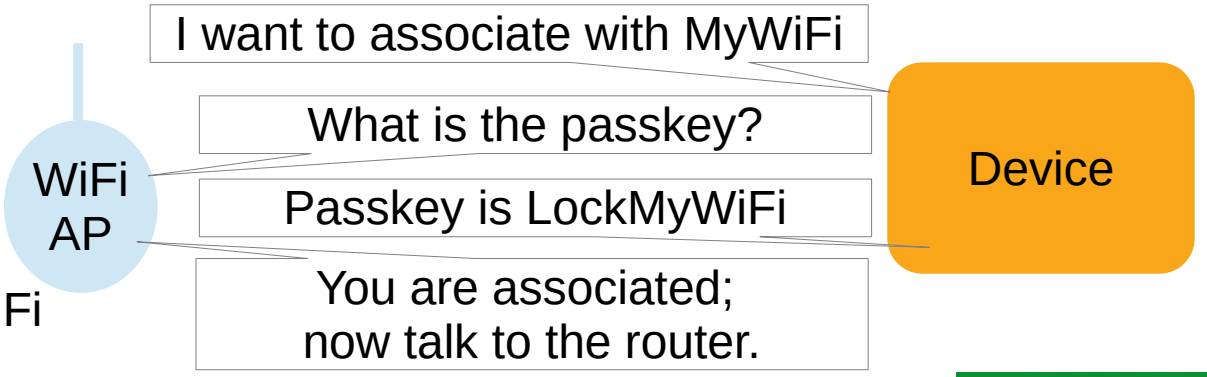
WiFi Steps

- Devices connect to WiFi before they connect to router
  - Device tells access point it wants to associate
    - May get multiple responses if there are several WiFi access points with same SSID – chooses “best”
  - Access point asks for passkey (if encrypted)
  - Device sends passkey
  - If Access Point accepts passkey, opens path so device can talk to router for IP address



SSID: MyWiFi
Passkey: LockMyWiFi

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MAC and IP Addresses

- Every device has a unique MAC address
  - 12 Hexadecimal (base 16) numbers, usually presented in pairs, pairs separated by colons
  - e.g. 0A:BC:DE:F9:87:65
- Each device on a network has an IP address
  - Public IP address: Globally unique IP address – no other device in the world has this IP address
  - Private IP address: Locally unique IP address – no other device on your network has this IP address, but a device on a different network may have the same IP address

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Public vs. Private IP addresses

- Public IP addresses are “visible” on the Internet
- You’ll typically get one public IP address from your ISP; it’s the address on the WAN or Internet port on your router
  - You can see it by going to https://whatismyip.org
- Router creates IP subnet with private IP addresses – NOT visible on the Internet
  - Private IP addresses start with “192.168.” or “10.” or “172.16-32.”

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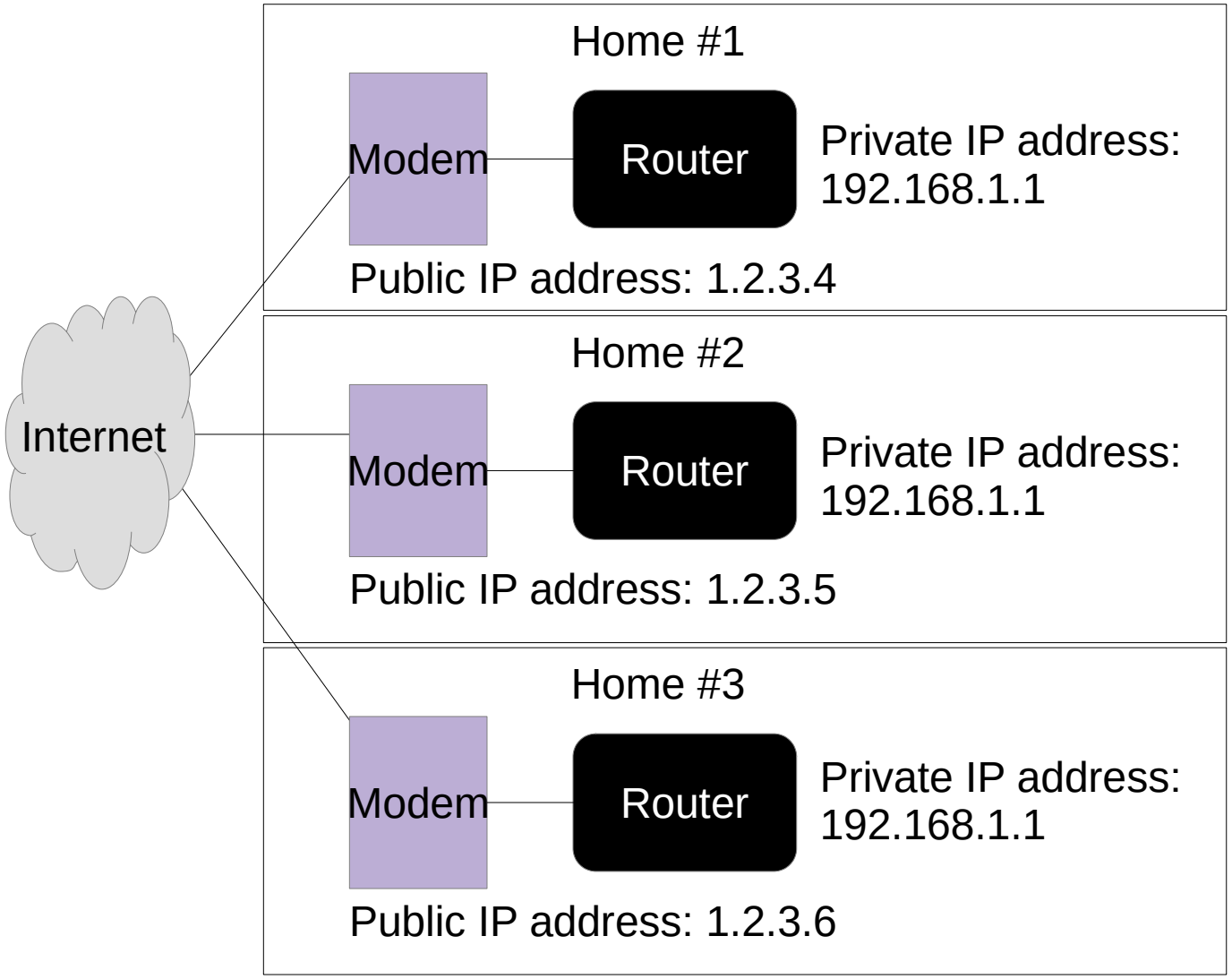
A Neighborhood Example



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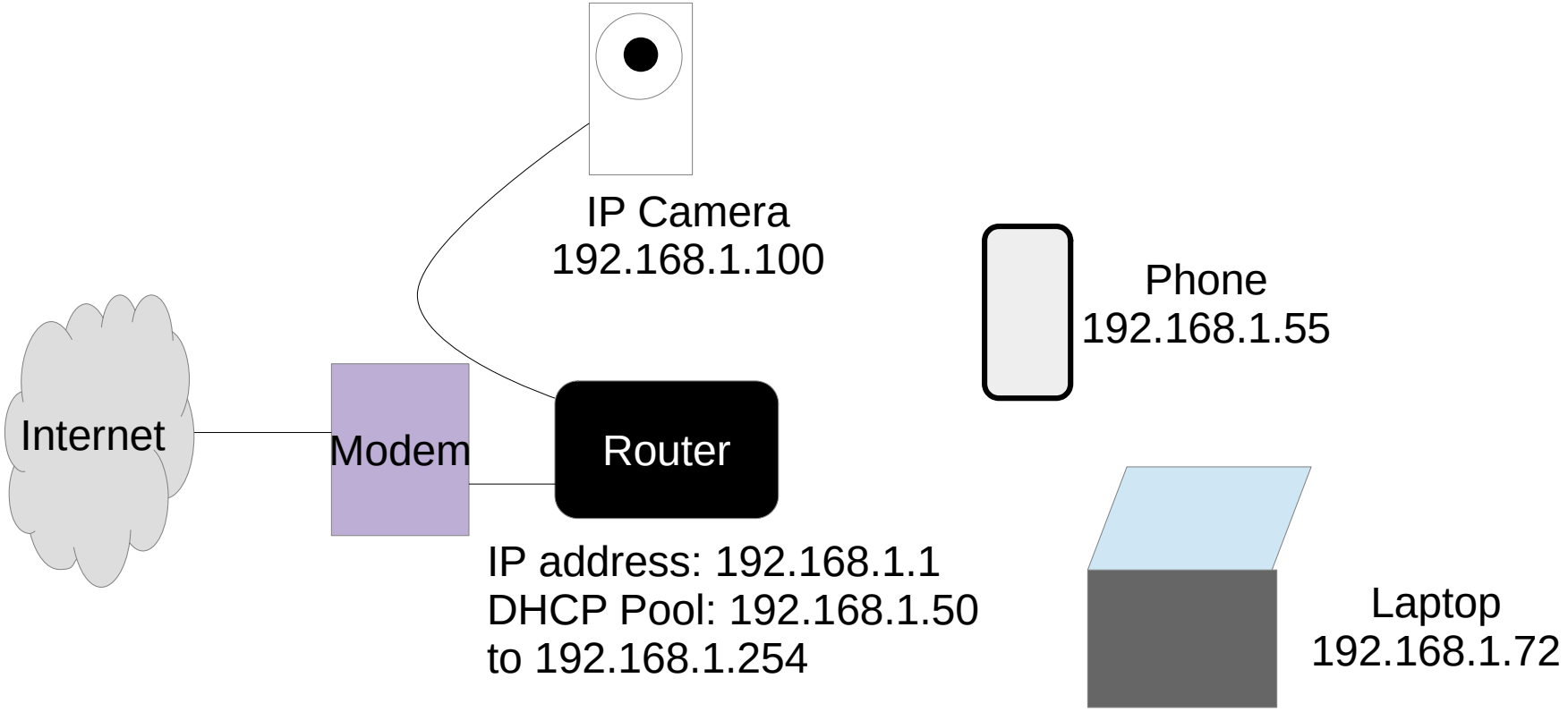
Example Neighborhood

- Note that each house has a different PUBLIC IP address, but the same PRIVATE IP address
  - As long as the Public IP addresses are different, this is OK
- Every network can have the same Private IP addresses (or different ones)

An Example Network



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Example Network

- Router configured with LAN IP 192.168.1.1
- DHCP Pool 192.168.1.50 to 192.168.1.254
- All devices getting IP address via DHCP
- Everything working OK
- However...

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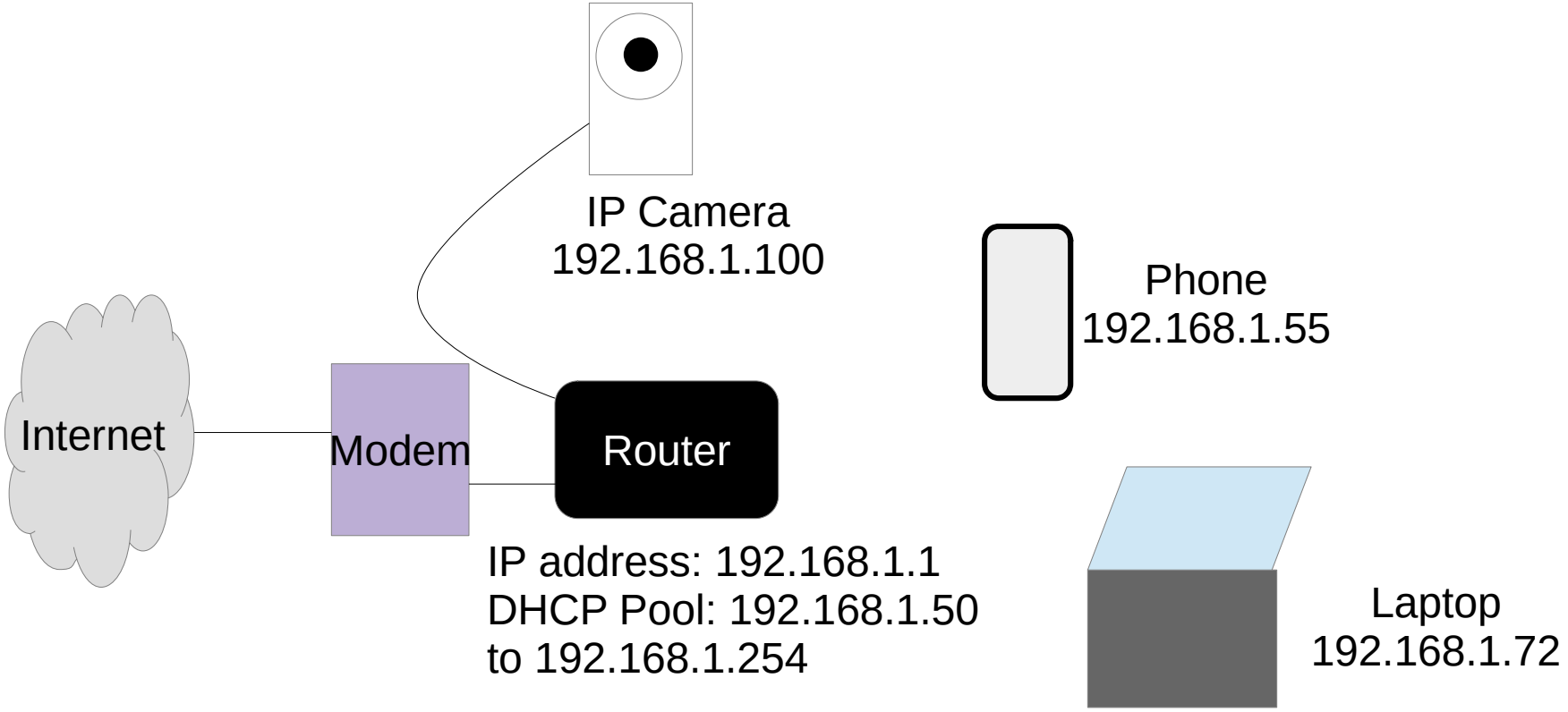
Example Network

What if IP Camera has Static IP address?



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Example Network

- Static IP address: an IP address configured to the device instead of being assigned by the router via DHCP
- DHCP Pool 192.168.1.50 to 192.168.1.254, so Camera address of 192.168.1.100 is WITHIN the DHCP Pool
- Everything working OK – for now
- However, friend comes by and connects phone to WiFi and network crashes
  - Router assigns it 192.168.1.100, then two devices have same IP address
  - IP address conflict causes router to “freeze”

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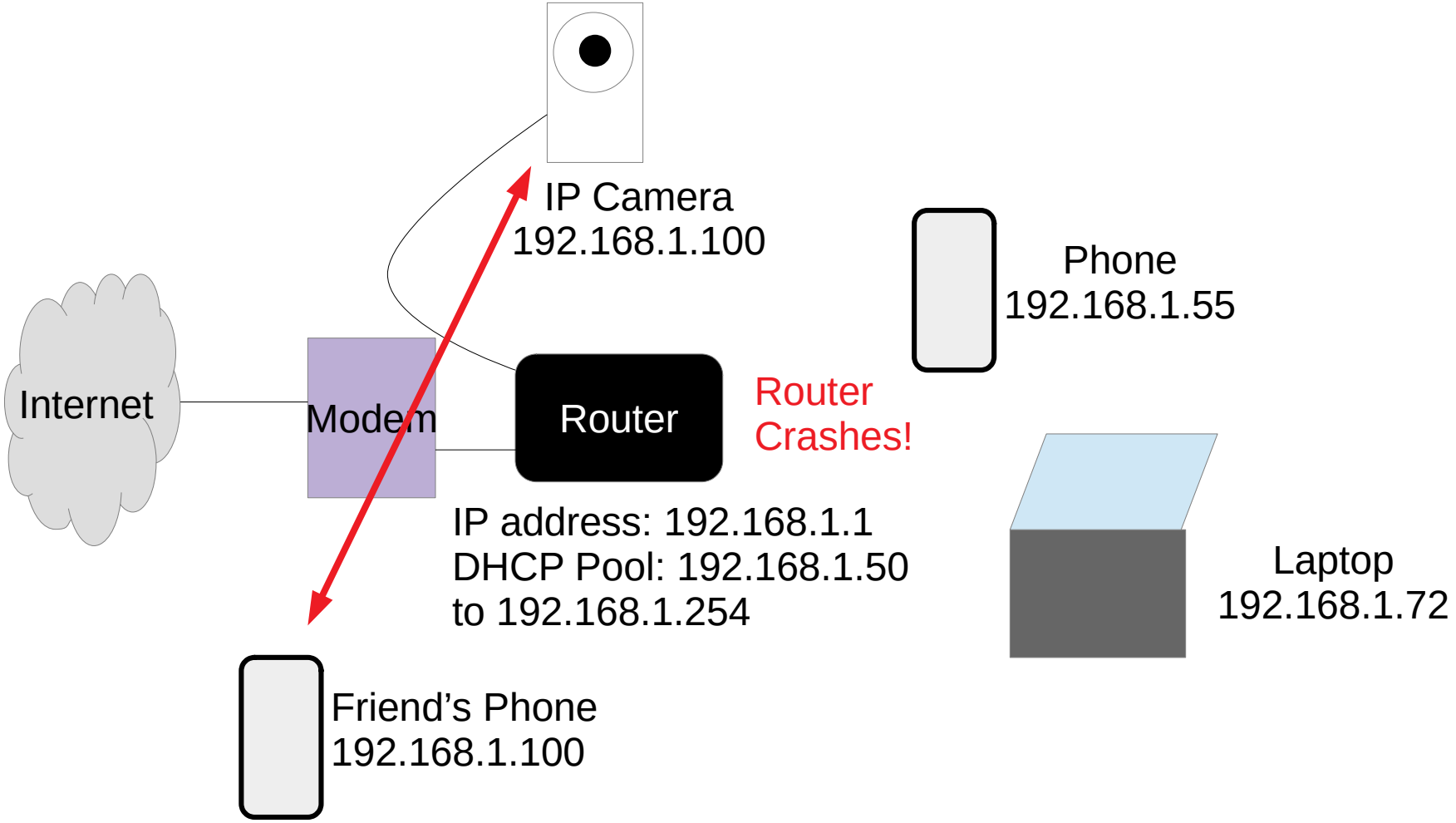
Example Network

What if IP Camera has Static IP address?



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Why Use Static Address?

- If you want to use a device remotely, via the Internet, device needs to have a constant address
  - Router will change addresses of devices with DHCP addresses
- “Port Forwarding” allows you to access device from the Internet
- If possible, use DHCP Reservations instead of assigning Static IP addresses!
  - Not always possible...

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How to Fix

- Make sure ANY static IP address is OUTSIDE the DHCP pool
  - Some routers set entire subnet – e.g. 192.168.1.2 to 192.168.1.254 – as DHCP
- Reconfigure DHCP pool if necessary
- Since DHCP pool is 192.168.1.50 to 192.168.1.254, set address to an address lower than 192.168.1.50
  - e.g. 192.168.1.2

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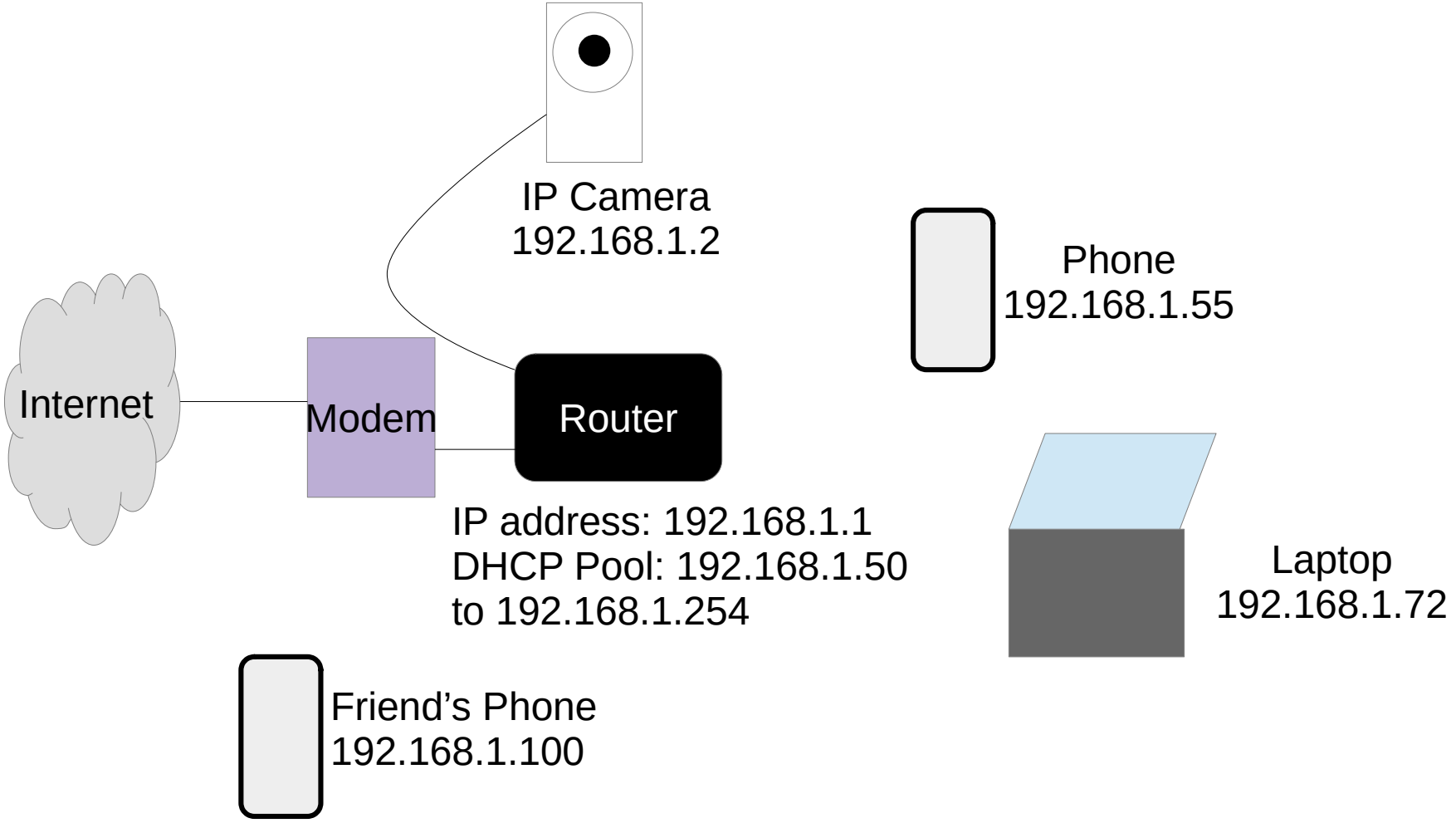
Example Network

Now everything works again...



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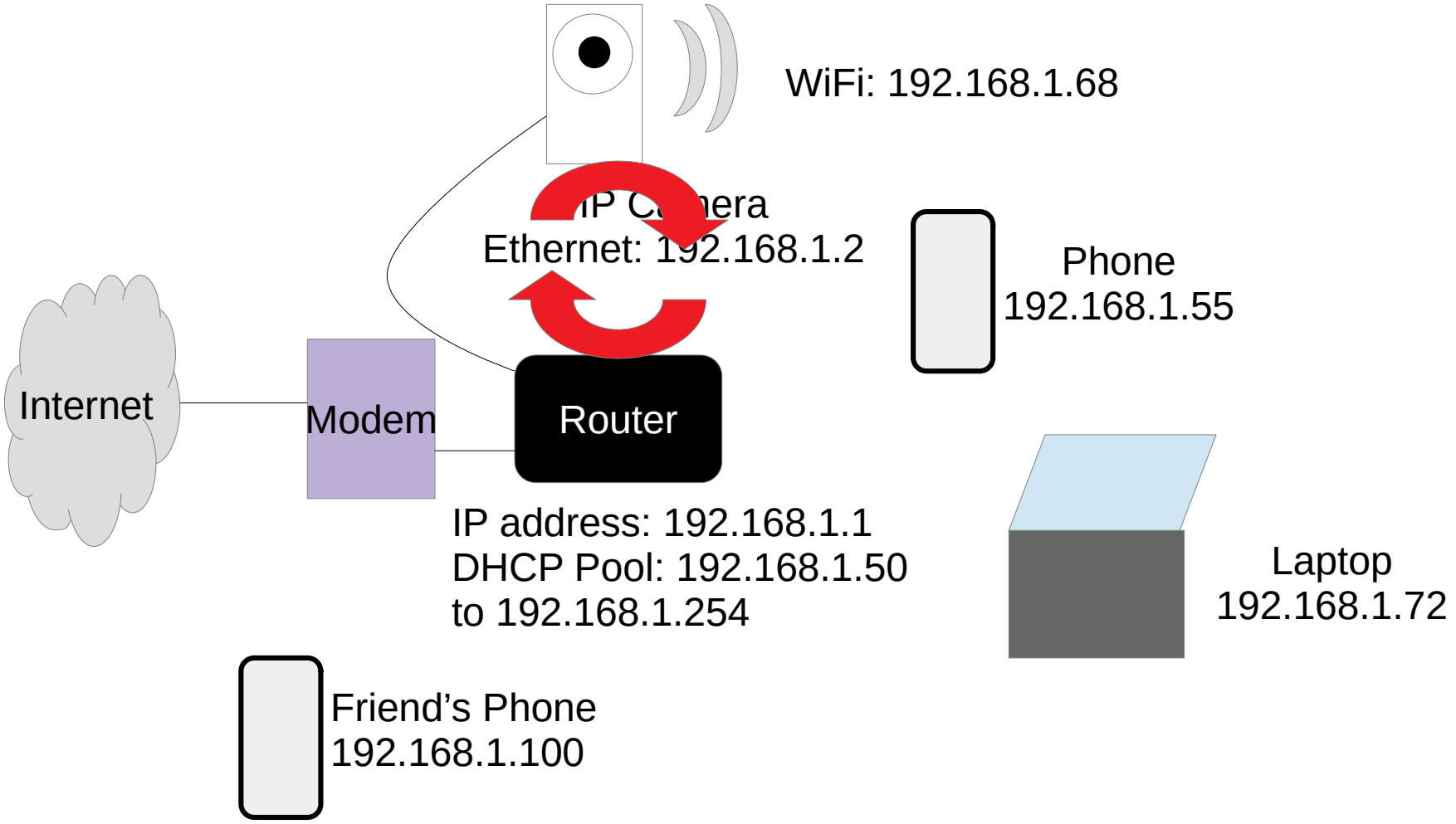
Another Common Problem: Network Loop

- Usually a device connected to the network via two interfaces (e.g. Ethernet and WiFi)
- Device sends messages out on both interfaces, other devices start responding to both interfaces, interfaces start responding to each other, and the network capacity is quickly filled with all these messages
- Router doesn’t actually freeze (usually), network just comes to a halt (may see VERY SLOW data rates or none at all)

Example Network

Example: WiFi camera connected via both Ethernet and WiFi



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Network Loop

- Not always easy to find: network just comes to a sudden halt after some device joins
- Can be caused by any device with more than one network interface
  - IP cameras and printers most common, but even some laptops can cause problems
  - Most modern devices guard against this, e.g. stop sending data via WiFi if Ethernet connected, but not all
- Fix: turn off or disconnect one interface – e.g. turn off WiFi on device connected via Ethernet

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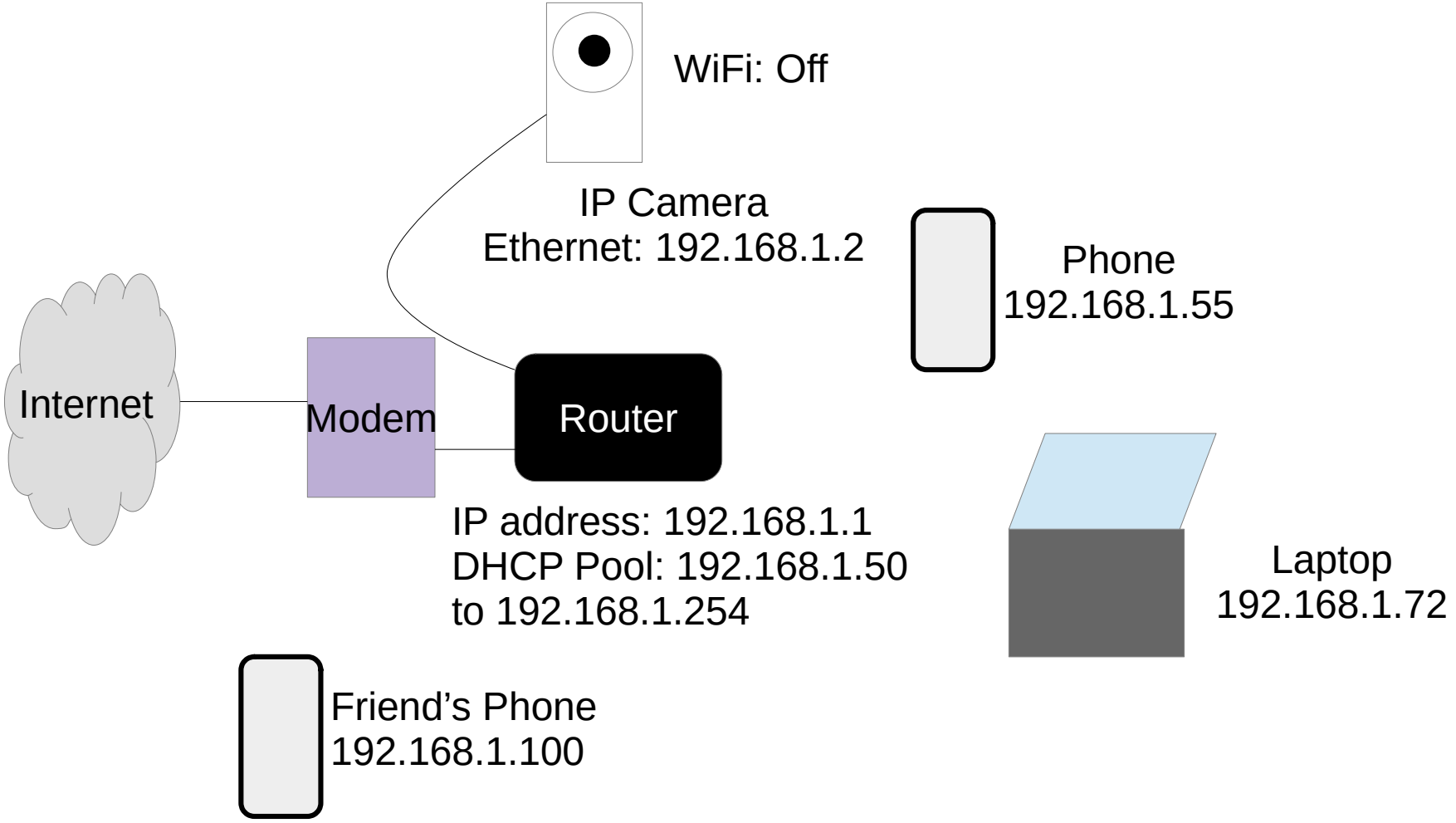
Example Network

Turn off Camera's WiFi – Everything OK



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What Does AyrMesh Do?

- AyrMesh is “transparent” to the router – used per the directions, it cannot CAUSE a problem, but it also cannot PREVENT a problem.
  - Anything connected to AyrMesh network appears to the router as if connected via Ethernet to the port that the Gateway Hub or Bridge radio is plugged into
- It’s hard to believe that something connected to the AyrMesh network miles away could be crashing your network… but it can.
- Think of AyrMesh as a long extension of your router
- Hubs work just like router’s own WiFi access point
  - Devices connect to Hubs via WiFi, then Hubs open communications back to router for IP addressing, etc.

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What You Need to Know

- Know how to log in to your router
  - If provided by your ISP, ask them
  - Google the make and model of the router – there are almost always good directions online
- Know what the IP address and DHCP pool is on your router
  - Factory defaults vary
- Learn how to find the “client list” or “DHCP table” on the router – that tells you what devices are getting DHCP addresses (NOT static addressed devices)

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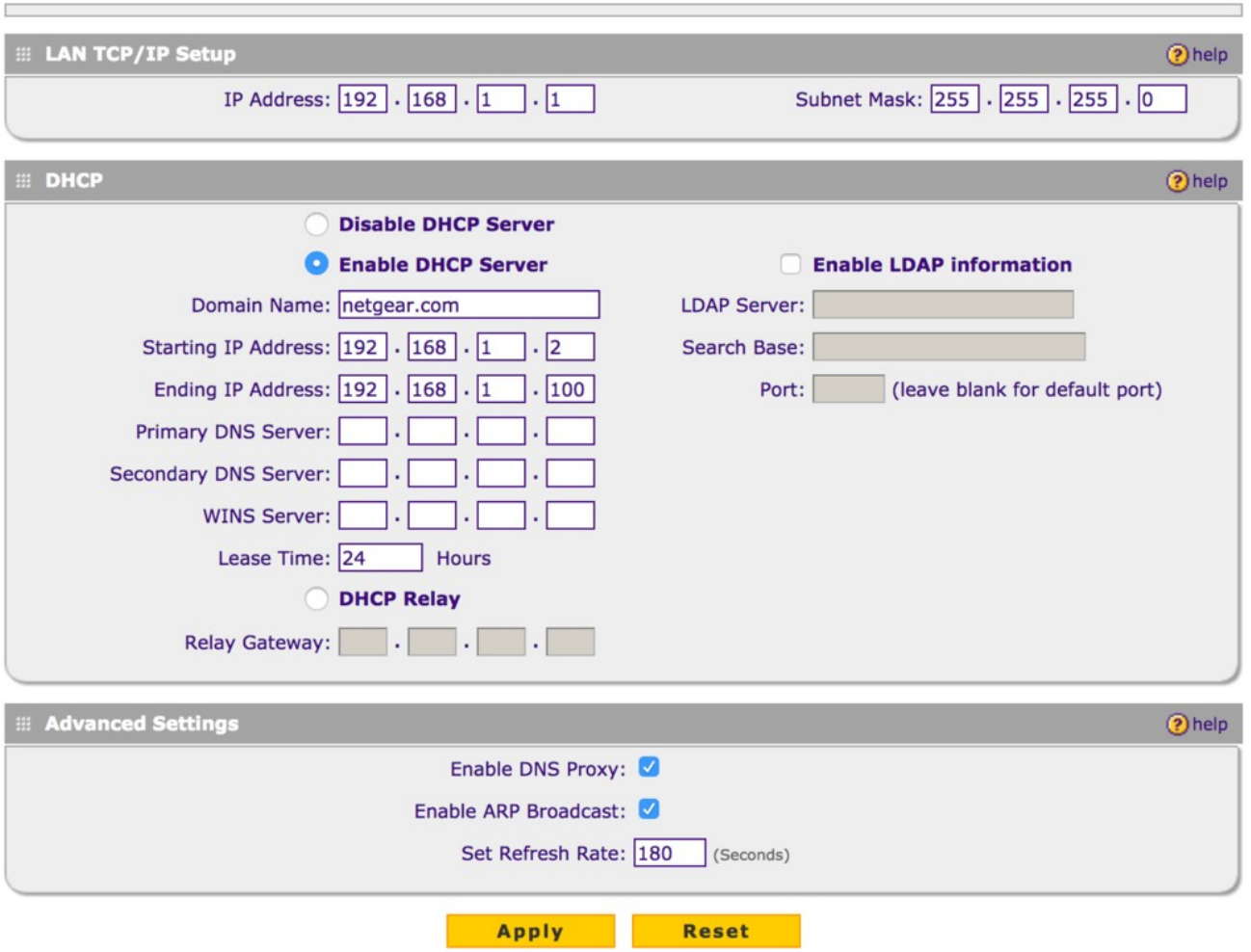
IP address & DHCP Pool

- This NetGear router has an IP address of 192.168.1.1 and a DHCP pool of 192.168.1.2 to 192.168.100
- We recommend a DHCP pool of 192.168.1.50 to 192.168.1.254, so you have 48 free addresses in case you need static IP addresses (192.168.1.2 to 192.168.1.49)



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Conclusions

- Your AyrMesh system is an extension of your router
  - If your router is not working right, neither will your AyrMesh system
- There are a few key things to look at in troubleshooting your router
  - IP address conflicts and network loops in particular
- Make sure your router is configured correctly

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