CS6250 Computer Networks

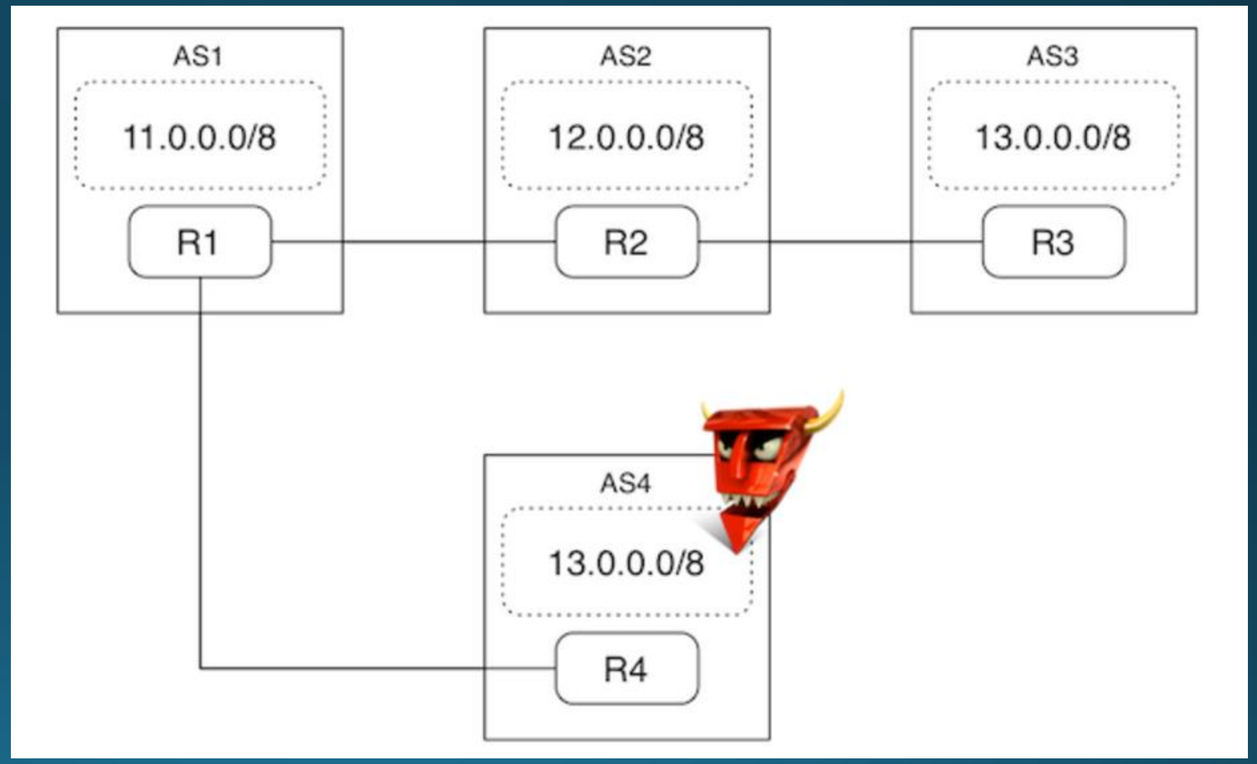
BGP Hijacking Project

Introduction

- In this project, using an interactive Mininet demo, we will explore some of the vulnerabilities of Border Gateway Protocol (BGP)
- BGP is vulnerable to abuse and manipulation through a class of attacks called BGP hijacking attacks
- A malicious Autonomous System (AS) can mount these attacks through false BGP announcements from a rogue AS, causing victim ASes to route their traffic bound for another AS through the malicious AS
- This attack succeeds because the false advertisement exploits BGP routing behavior by advertising a shorter path to reach a particular prefix, which causes victim Autonomous Systems to attempt to use the newly advertised (and seemingly better!) route
- We use FRR for BGP and zebra, refer to the FRR docs for configuring a BGP router with FRR. The FRR docs for zebra can also be useful.

Demo Network Topology

- The demo creates the network topology shown here, consisting of four Autonomous Systems and their peering relationships.
- AS_4 is the malicious AS that will mount the attack.
- Once again, we will be simulating this network in Mininet, however there are some important distinctions to make from our previous projects.
  - In this set up, each container is not a host, but an entire autonomous system.
  - Each host runs a routing daemon (FRR), communicates with other ASes using BGP (bgpd), and configures its own isolated set of routing entries in the kernel (zebra).
  - Each AS has an IP address, which is the IP address of its border router.
- NOTE: In this topology solid lines indicate peering relationships and the dotted boxes indicate the prefix advertised by that AS



Files in the Demo

- **Please read through all the given files, including the shell scripts**
- bgp.py
  - Main file, defines the topology
- connect.sh
  - Connects the routers' bgpd shells
- run.py
  - Runs the simulation
- start_rogue.sh
  - Starts the rogue AS, begins the BGP hijacking
- stop_rogue.sh
  - Stops the rogue AS, stops the BGP hijacking
- webserver.py
- website.sh
  - Initiates the simulation
- bgpd-R1.conf, bgpd-R2.conf, bgpd-R3.conf, bgpd-R4.conf
  - BGP configuration files for each of the routers
- zebra-R1.conf, zebra-R2.conf, zebra-R3.conf, zebra-R4.conf
  - Zebra is an IP routing manager. It provides kernel routing table updates, interface lookups, and redistribution of routes between different routing protocols.

BGPD Conf. Files

- bgp router-id is not an IP address but is an ID in quad dot notation A.B.C.D, can be anything so long as it is unique. Router ID is not a configuration value, though it may look the same as an interface on the router, the router interface IP is the actual configuration value.
- network: the address of the internal network for each router
- neighbor x.x.x.x remote-as # (the addresses you identified in your network topology)
  - Example: neighbor 10.0.0.1 remote-as 2 means the router in AS-1 is trying to peer with AS-2 at 10.0.0.1
  - 10.0.0.1 would be an interface on the router in AS2
- **"debug bgp as4" tells the software to use 32-bit AS identifiers instead of 16-bit AS identifiers. Don't change it.**
- Leave all router passwords unchanged.

Zebra Conf. Files

- Mininet will add the links in the same order every time. Add your links in ascending router order (R1, R2…) in your zebra conf files to make sure these line up with what's displayed in the links output
- Mininet will use the first available interface to assign links
- Define interfaces and assign IP addresses to the ports

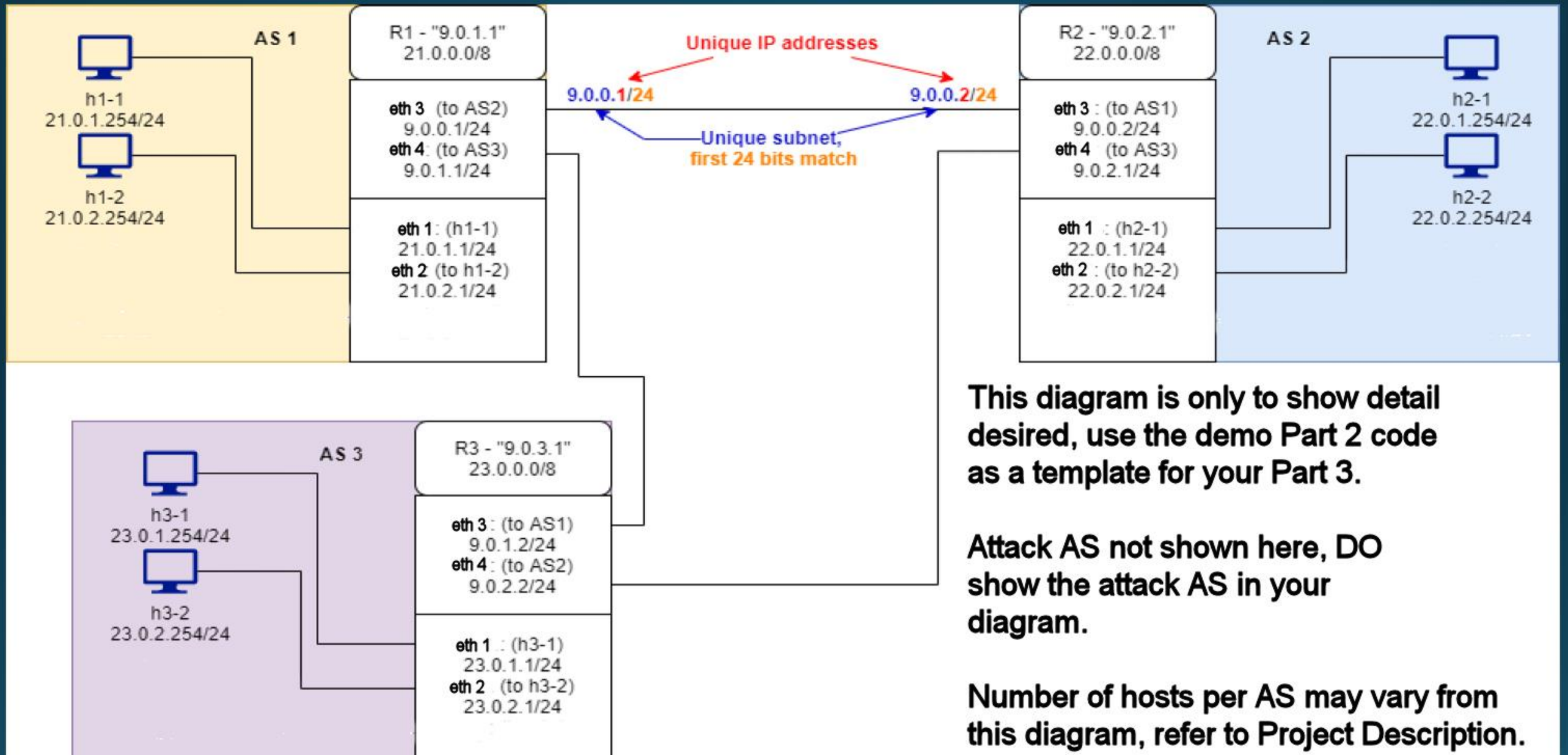
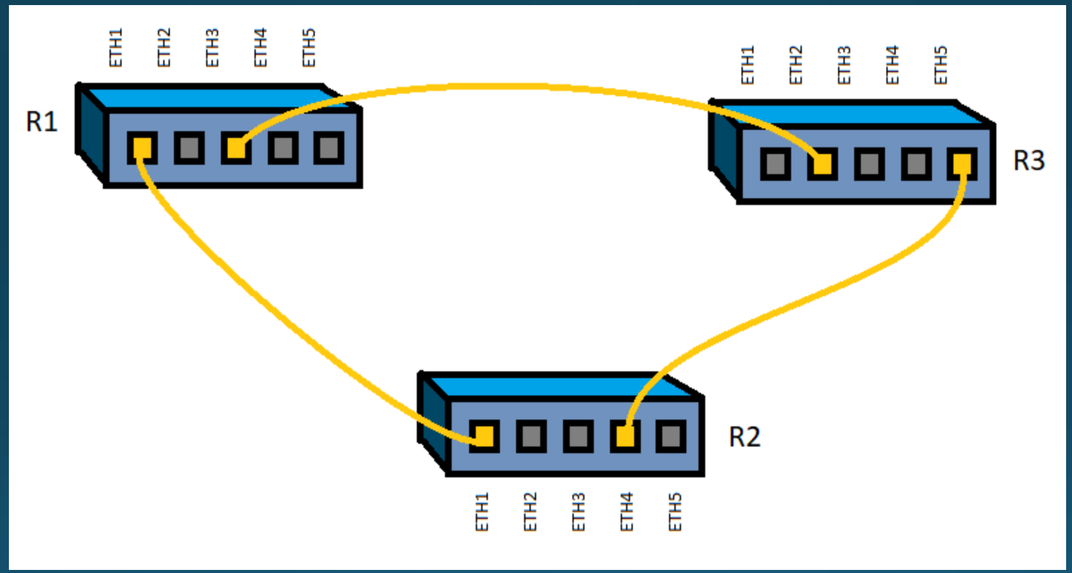

AS 1
h1-1
21.0.1.254/24
h1-2
21.0.2.254/24
R1 - "9.0.1.1"
21.0.0.0/8
eth 3 (to AS2)
9.0.0.1/24
eth 4: (to AS3)
9.0.1.1/24
eth 1: (h1-1)
21.0.1.1/24
eth 2 (to h1-2)
21.0.2.1/24
Unique IP addresses
9.0.0.1/24
9.0.0.2/24
Unique subnet,
first 24 bits match
R2 - "9.0.2.1"
22.0.0.0/8
eth 3 : (to AS1)
9.0.0.2/24
eth 4 (to AS3)
9.0.2.1/24
eth 1 : (h2-1)
22.0.1.1/24
eth 2 : (to h2-2)
22.0.2.1/24
AS 2
h2-1
22.0.1.254/24
h2-2
22.0.2.254/24
AS 3
h3-1
23.0.1.254/24
h3-2
23.0.2.254/24
R3 - "9.0.3.1"
23.0.0.0/8
eth 3 : (to AS1)
9.0.1.2/24
eth 4 : (to AS2)
9.0.2.2/24
eth 1 : (h3-1)
23.0.1.1/24
eth 2 (to h3-2)
23.0.2.1/24
This diagram is only to show detail desired, use the demo Part 2 code as a template for your Part 3.
Attack AS not shown here, DO show the attack AS in your diagram.
Number of hosts per AS may vary from this diagram, refer to Project Description.

Illustration of Network Connections Between Routers



Note: This is only an illustration of how interfaces are “wired up” to connect routers.

It does not match the previous slide.

Notes on Previous 2 Slides

- Slide 8 (the previous slide):
  - is intended to help you visualize how router interfaces (eth1, eth2, eth3, etc.) represent physical locations where you can plug in a cable.
  - does not have anything to do with the diagram on slide 7.
  - does not have anything to do with the provided demo files.
- Slide 7 (the diagram) is intended to highlight a few key ideas about how IP addresses, subnets, and routers work. It is critical that you understand these concepts in order to successfully complete the project.
- Key Ideas:
  - Only one "cable" or connection per router interface. Again, eth1 means ethernet interface 1 – you can only plug one cable into it.
  - Each assigned IP address needs to be unique. Notice that no two hosts/interfaces have the same IP address.
  - Each interface of a router needs to be on a different subnet. As an example, look at R1: there are 5 interfaces in use and each one of them is on a different subnet. You can tell because they all use a /24 subnet mask, which is 3 octets, and each of the first three octets are different.
  - For two devices to talk to each other, they must be on the same subnet. Notice that for each link, both IP addresses on either side of the link belong to the same subnet. Understand the difference between /8 and /24
  - Each router is advertising a /8 prefix. This is something for BGP. The subnets used between the routers aren't getting advertised this way, which is fine. By advertising the prefix, the other routers will know where to send that traffic. Notice that the hosts may be on smaller subnets (/24), but their prefixes match the /8 prefix advertised by their router.
  - It really doesn't matter what IP address the host has and what IP address its default gateway (the connecting interface on the router) has. Here, it's .254 for the host, and .1 for the gateway. It could be another value. Main thing here is that it's consistently configured for both, and don't use .0 or .255.

Final Tips

- As long as your network responds to the commands like the demo, you will be fine. So, if ping all doesn't work or it hangs, that's fine. It won't be part of the grading.
- Cisco has forums with lots of great information.
- Note, some subnets are reserved, so check that before picking a subnet. Specifically, 1.0.0.x/24 is a bad idea. We recommend in the docs you start with 11.0.0.0/8 for AS1 and increment to 12, 13 and so on.
- Router ID is independent from the IP address(es) of the router (hint: visit that link).

Final Tips - Debugging

- Carefully go through all of bgp config files and understand exactly what each line means. Most will need modification. Go through all files (including the website shell script, for example). Most will need modification.
- For example: Where AS 5 isn't showing up:
  - Double check that your IPs for each router's connecting ethernet link are on the same subnet
  - Double check that your IPs for each router's connecting ethernet link are not on a conflicting subnet on the network.
- Ensure that your zebra files correspond to their peers' bgp files (don't mix up the src and dst ip on the bgp neighbor line).
- Make sure you are assigning valid IP's and gateways in bgp.py for AS 1-5. Check that you have R6 as the rogue.

Some useful Mininet commands

- `mininet> R5 route` (this will give routing table on R5 router, can use for any router just by replacing R5)
- `mininet>R5 ifconfig -a` (will give all interface config of router R5)
- `mininet> R5 ping 13.0.1.254` (will check ping test, since pingall is not reliable for this project, this command can be very handy)
- To test host to host connectivity, for example, use these commands:

  `xterm h1-1` – this will pop up a new xterm window "logged into" `h1-1`

  `ping 13.0.1.254` -- this pings from `h1-1` to `h3-1`

What to turn in, what to share, rubric

- **What to Turn In**
  - For this project you need to turn in a zipped file on folder BGPHijacking/ containing files you. See the project PDF.
- **What you can and cannot share**
  - While discussion of the project in general is always permitted on Edstem, you are not permitted to share your code or configurations that you generated for the graded part.
- See the rubric in the Project Description

Have fun with this

- Good luck !
- Always check Edstem for your questions
- Look at the project-relevant threads, especially the troubleshooting thread