



SoX Virtual Training Workshop

Hands-on Session 1: Essentials of BGP, EBGP, IBGP

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SoX Virtual Training Workshop

- Webpage with PowerPoint presentations:

http://ce.sc.edu/cyberinfra/sox_workshop_2023.html

- Hands-on sessions: to access labs for the hands-on sessions, use the following link:

<https://netlab.cec.sc.edu/>

- Username: email used for registration
- Password: nsf2023

Border Gateway Protocol Lab Series

- Lab experiments
 - Lab 1: Introduction to Mininet
 - Lab 2: Introduction to Free Range Routing (FRR)
 - Lab 3: Introduction to BGP
 - Lab 4: Configure and verify EBGP
 - Lab 5: BGP Authentication
 - Lab 6: Configure BGP with Default Route
 - Lab 7: Using AS_PATH BGP Attribute
 - Lab 8: Configuring IBGP and EBGP Sessions, Local Preference, and MED
 - Lab 8.1: Configuring OSPF, IBGP and EBGP Sessions, Local Preference, and MED
 - Lab 8.2: Configuring IBGP and EBGP Sessions, Local Preference, and MED
 - Lab 9: IBGP, Next Hop and Full Mesh Topology
 - Lab 10: BGP Route Reflection
 - Lab 11: Configuring BGP Local Preference and AS_PATH Prepending
 - Lab 11.1: Configuring BGP Local Preference and AS_PATH Prepending

Organization of the Lab Manuals

Each lab starts with a section *Overview*

- Objectives
- Lab topology
- Lab settings: passwords, device names
- Roadmap: organization of the lab

Section 1

- Background information of the topic being covered (e.g., fundamentals of BGP)
- Section 1 is optional (i.e., the reader can skip this section and move to lab directions)

Section 2... n

- Step-by-step directions

AS, IGP, EGP

- Routers are organized into Autonomous Systems (ASes or ASs)
- What is an AS (RFC 1771)?

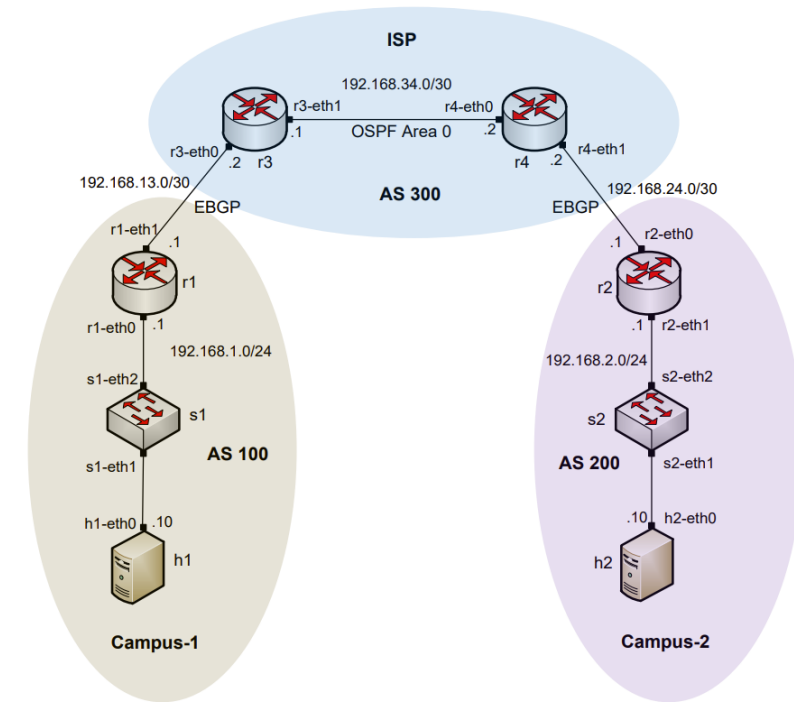
“A set of routers under the single technical administration, using an IGP and common metrics to route packets within the AS, and using an EGP to route packets to other ASs.”

- What is an Interior Gateway Protocol (IGP)?

A routing protocol used to exchange routing information within an AS (e.g., RIP, OSPF)

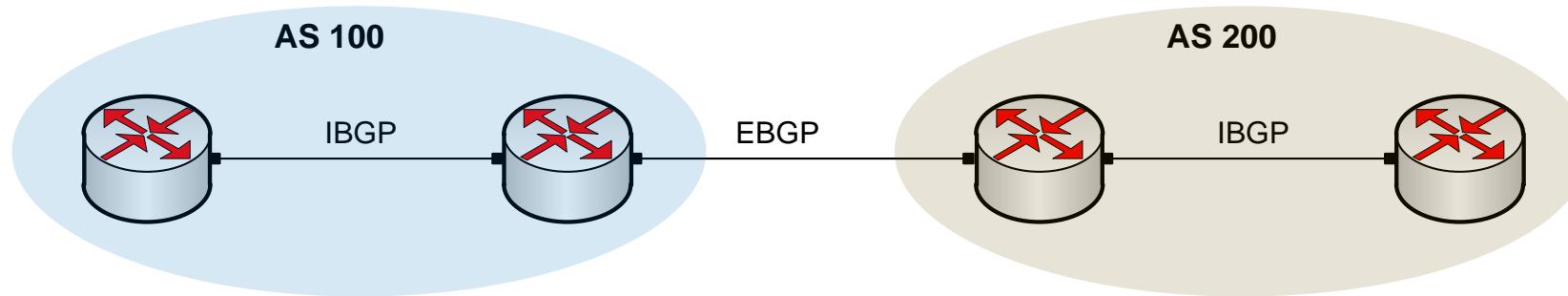
- What is an Exterior Gateway Protocol (EGP)?

A routing protocol used to exchange routing information between AS



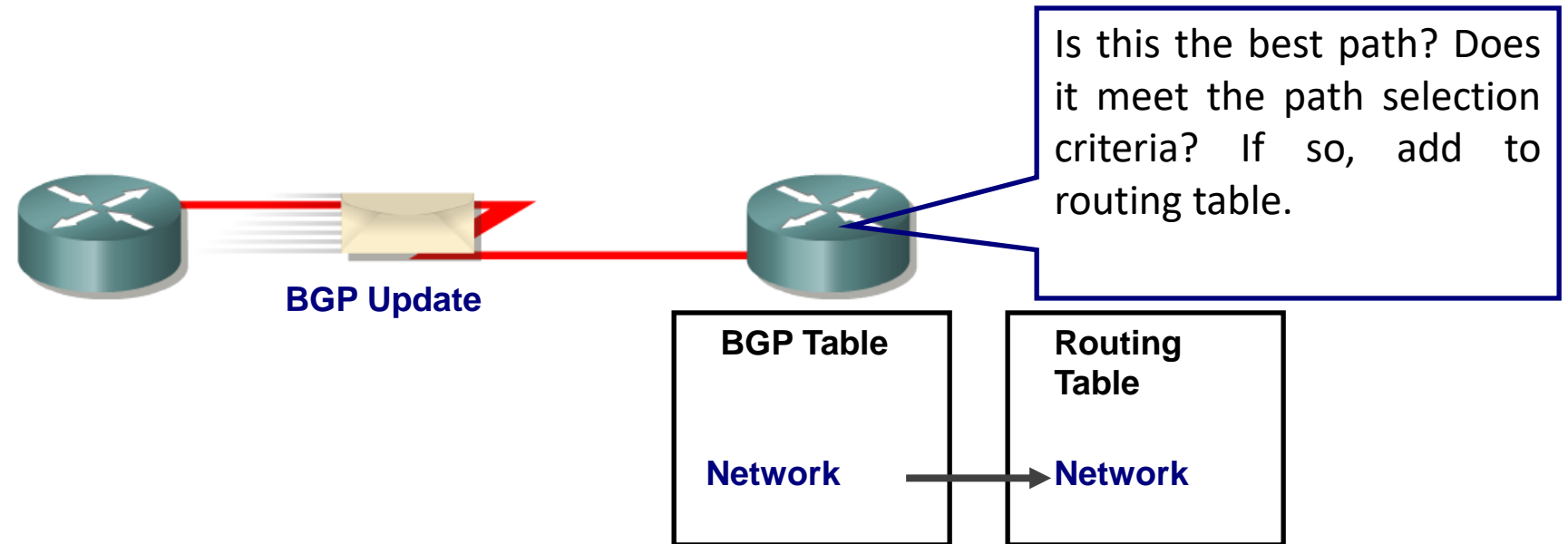
BGP Route Advertisements within an AS

- BGP advertisements from an AS to another is referred to as External BGP (EBGP)
- BGP advertisements within an AS is referred to as internal BGP (IBGP)



BGP – Best Path

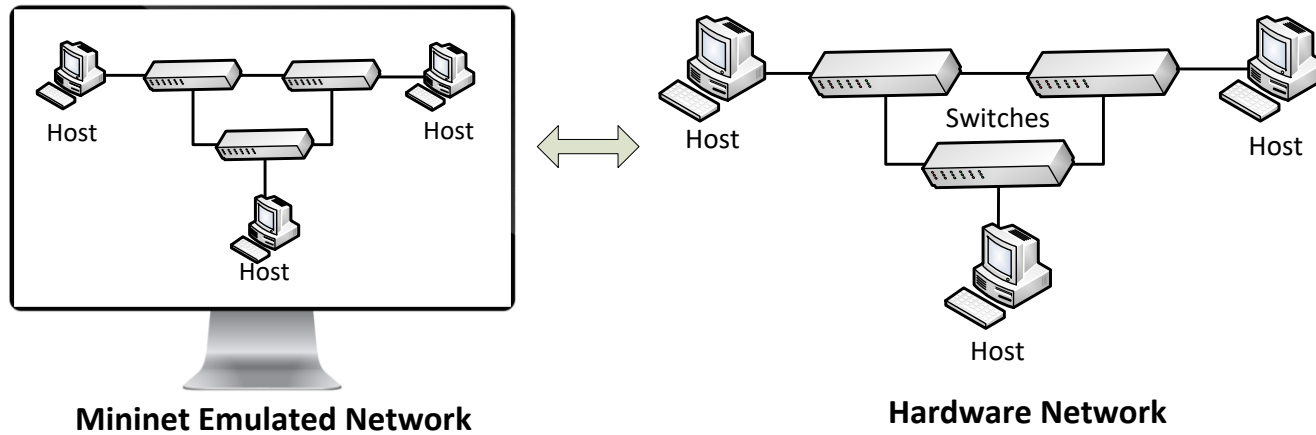
- The main goal is to provide interdomain routing
- BGP selects one path as the best path
- It places the selected path in its routing table and propagates the path to its neighbors



Lab 1: Introduction to Mininet

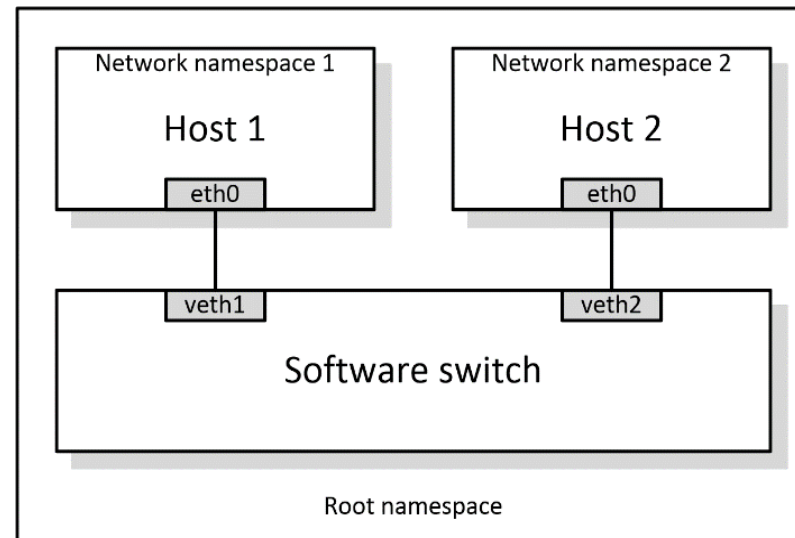
What is Mininet?

- A virtual testbed capable of recreating realistic scenarios
- It enables the development, testing of network protocols
- Inexpensive solution, real protocol stack, reasonably accurate



What is Mininet?

- Mininet nodes are network namespaces
 - Each node has different / separate virtual interfaces, routing tables
- Nodes use the underlying protocol stack of the host device
- Nodes are connected via virtual Ethernet (veth) links, which behave as Ethernet links



Lab 2: Introduction to FRR

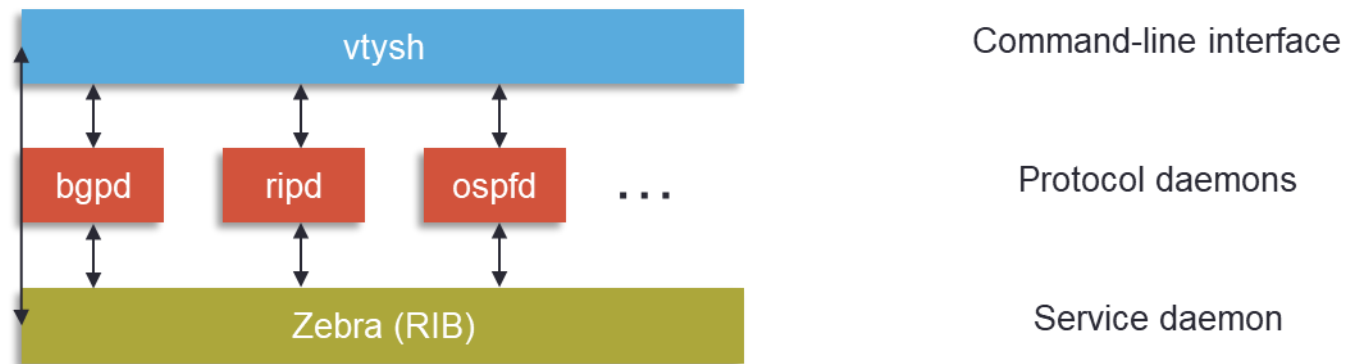
What is FRR?

- FRR is an open source routing protocol stack¹
- It provides similar routing capabilities to other vendors
- It runs natively on Linux and other platforms

¹FRRouting website, <https://frrouting.org>

What is FRR?

- The configuration is similar to other vendors
 - Command-line shell and configuration file
- Protocols are implemented as independent processes
- Zebra is the process that controls the routing information base (RIB)



FRR and Mininet Integration

- Mininet provides network emulation, allowing all network software at any layer to be simply run as is
- The set of commands provided by FRR are inherited and can be run using Mininet's command-line interface

```
Host: r2
root@frr-pc:/etc/routers/r2# zebra
root@frr-pc:/etc/routers/r2# staticd
root@frr-pc:/etc/routers/r2# ripd
root@frr-pc:/etc/routers/r2# ospfd
root@frr-pc:/etc/routers/r2# bgpd
root@frr-pc:/etc/routers/r2# vtysh

Hello, this is FRRouting (version 7.2-dev).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

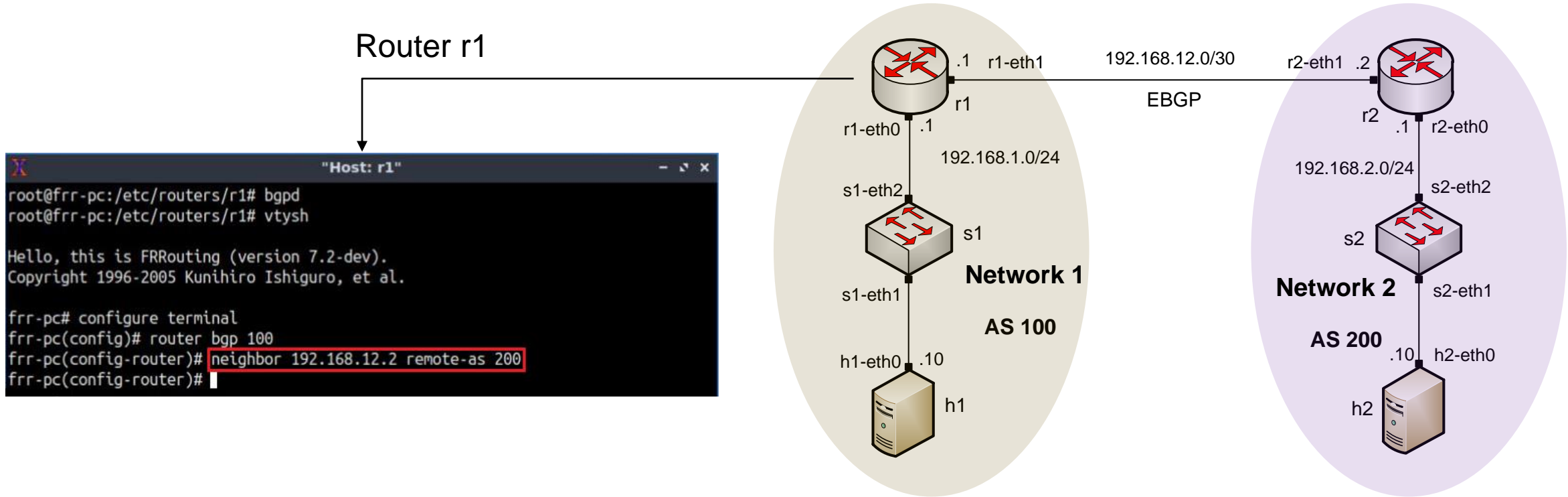
frr-pc#
```



Lab 3: Introduction to BGP

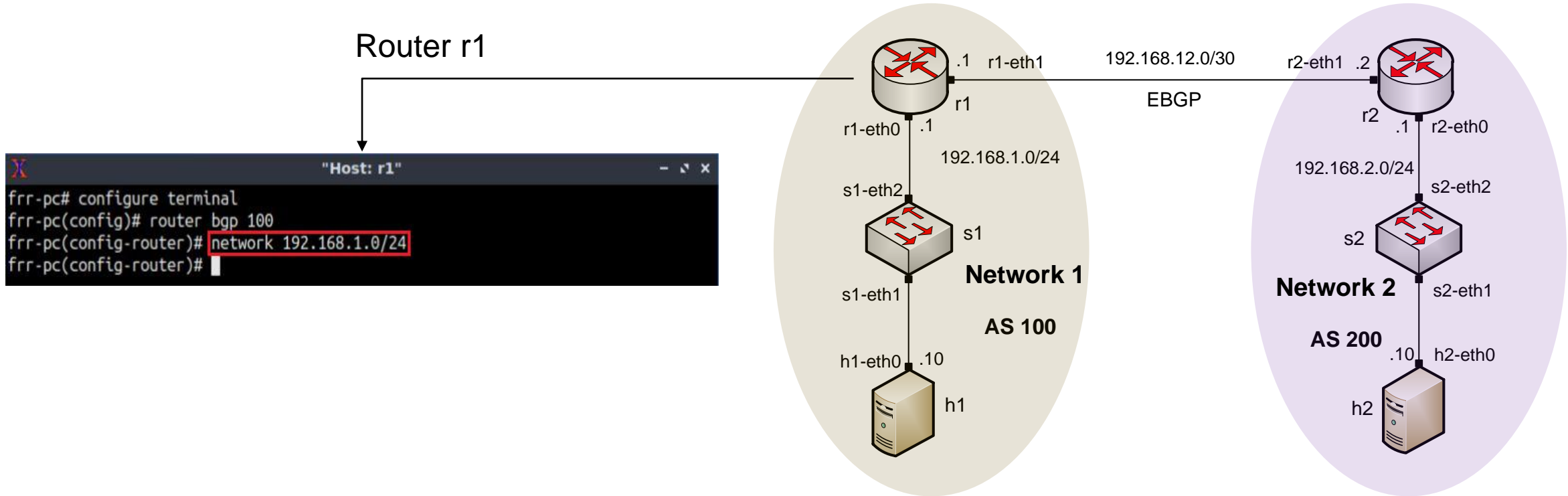
Lab Topology

- Establish BGP neighborhood



Lab Topology

- Advertise a network in BGP



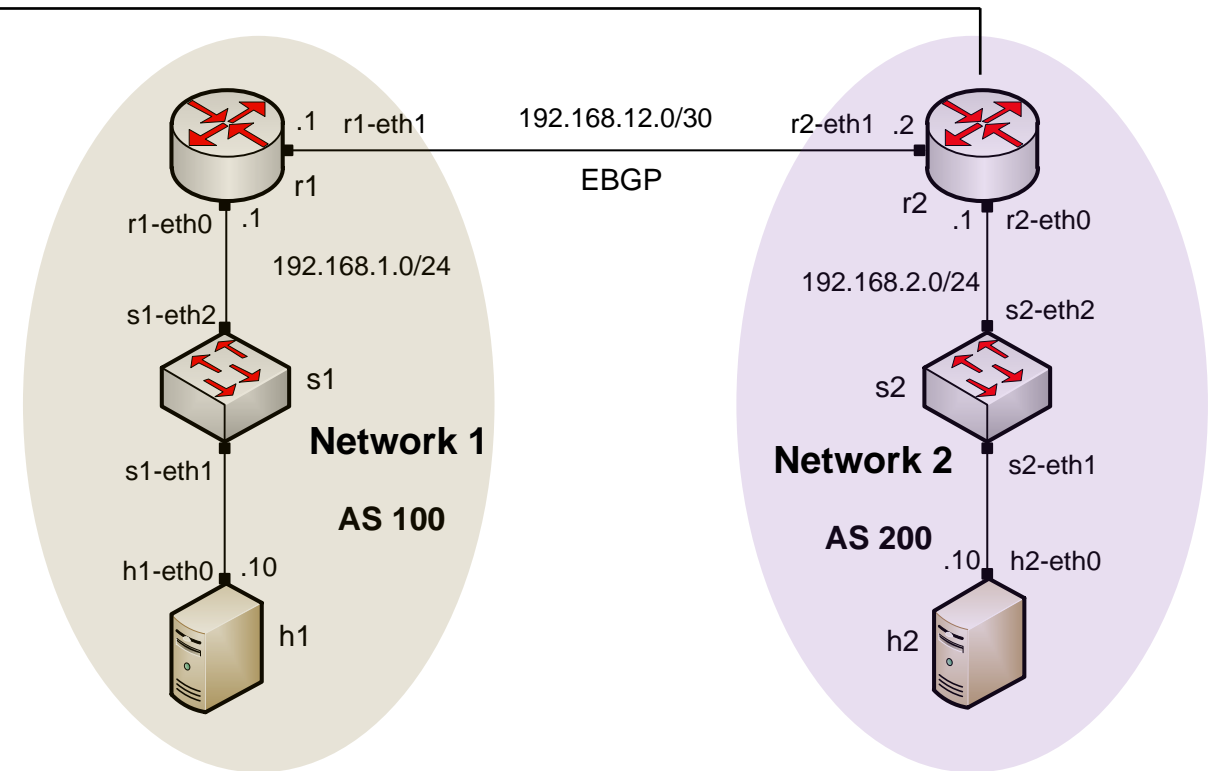
Lab Topology

- Routing table: lists the routes learned from different routing protocols

Router r2

```
Host: r2
frr-pc# show ip route
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, D - SHARP,
       F - PBR, f - OpenFabric,
       > - selected route, * - FIB route, q - queued route, r - rejected route

B>* 192.168.1.0/24 [20/0] via 192.168.12.1, r2-eth1, 00:00:52
C>* 192.168.2.0/24 is directly connected, r2-eth0, 00:18:36
C>* 192.168.12.0/30 is directly connected, r2-eth1, 00:18:02
frr-pc#
```



Lab Topology

- BGP table: it lists the routes learned from BGP routing protocol

Router r2

```
"Host: r2"
frr-pc# show ip bgp
BGP table version is 2, local router ID is 192.168.12.2, vrf id 0
Default local pref 100, local AS 200
Status codes: s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, r RIB-failure, S Stale, R Removed
Nexthop codes: @Nnn nexthop's vrf id, < announce-nh-self
Origin codes:  i - IGP, e - EGP, ? - incomplete

   Network        Next Hop           Metric LocPrf Weight Path
*> 192.168.1.0/24  192.168.12.1       0         0   100  i
*> 192.168.2.0/24  0.0.0.0            0         0  32768  i

Displayed 2 routes and 2 total paths
frr-pc#
```

