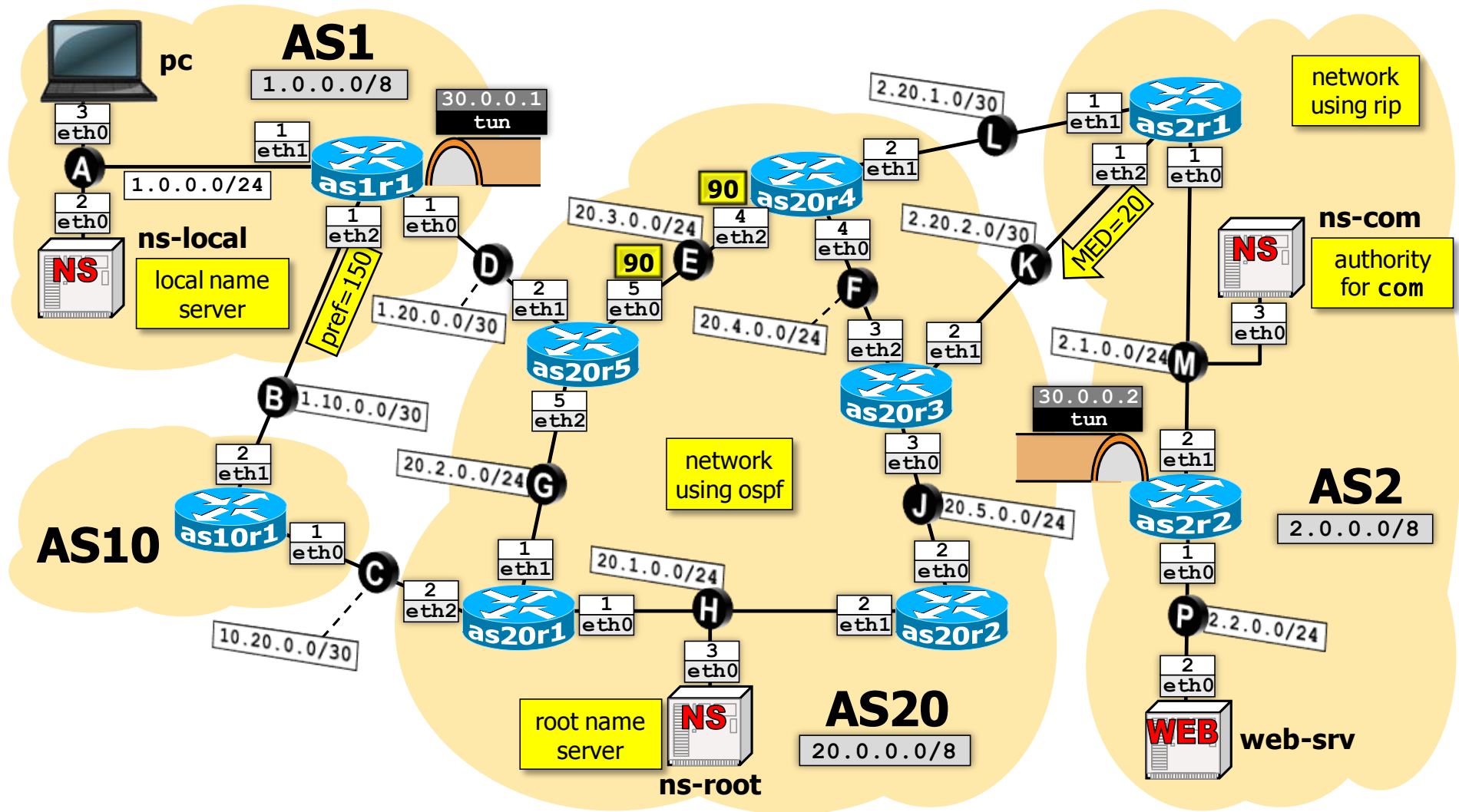




Available time: 120 minutes.



Using Netkit, implement the network depicted in the figure and described below.

- ❑ Remember to set up a default route on all the end systems.
- ❑ Routing within AS2 is implemented by using RIP.
  - `as2r1` injects in RIP all the routes learned via BGP.
- ❑ Routing within AS20 is implemented by using OSPF.
  - All the interfaces belong to area `0.0.0.0`.
  - Border routers inject BGP-learned routes into OSPF (do not worry about redistributing eBGP only: OSPF will automatically take care of this).
  - Some interfaces are assigned the OSPF costs specified in the picture. All the other interfaces have the default cost.
- ❑ Inter-domain routing is implemented by using BGP, which is set up as follows:
  - AS1, AS2, and AS20 also announce their own internal subnets, in gray.
  - All peering LANs are announced in BGP. No routers announce the default route `0.0.0.0/0`.
  - Border routers in AS20 establish iBGP peerings with each other. Pick the IP addresses of network interfaces consistently with OSPF routing in order to establish such peerings.
  - `as1r1` prefers announcements received from AS10, applying to them a local-preference value of 150.
  - `as1r1` applies a community `1:1` to announcements sent to AS10.
  - `as2r1` sets a metric equal to 20 on announcements sent to `as20r3`.
  - `as20r1` prefers received announcements that carry a community value `1:1`.
- ❑ An IP-in-IP tunnel is set up between `as1r1`'s interface `eth0` and `as2r2`'s interface `eth1`.
  - Routing towards the tunnel is set up by using static routes.
  - The tunnel is only used by traffic sent from AS1 towards `2.2.0.0/24`.

#### SETTING AND VERIFYING THE PRESENCE OF A BGP COMMUNITY

In a route-map: `set community communityValue`

On a router that receives updates with communities: `show ip bgp prefix`

#### MATCHING A BGP COMMUNITY

`ip community-list standard CLname permit communityValue`

Then, in a route-map: `match community CLname`

#### SETUP OF AN IP-IN-IP TUNNEL (to be accomplished at both endpoints)

```
ip tunnel add tunnelInterface mode ipip remote remoteIP local localIP ttl 255
ip link set tunnelInterface up
ip address add IPaddress peer remoteTunnelIPaddress dev tunnelInterface
ip route add subnet/netmask [via nextHop] dev tunnelInterface
```

- ❑ A DNS is available on the network, set up as follows:
  - `ns-local` is the local name server for `pc`.
  - `ns-root` is the root name server.
  - `ns-com` is the authority for zone `com`.
  - The only relevant DNS name is `web.com`, which is associated with IP address `2.2.0.2`.
- ❑ `web-srv` is a Web server running apache, which serves a private web page for the “guest” user, accessible by using the URL `http://web.com/~guest/`.

#### Goals:

IP routing must comply with the above requirements. In particular:

- packets from AS1 to `2.2.0.0/24` must be sent through the tunnel and traverse links B, C, H, J, F, L, M;
- packets from AS20 to AS1 must traverse link C.

It must be possible to access the Web page `http://web.com/~guest/` from `pc`.