Custom Topologies with Mininet Python API

Mininet offers some topologies!

Eg: single switch, linear, tree

What if you want to replicate your very own production network?

Create a custom topology!

Low-level API: Nodes and Links

```
h1 = Host( 'h1' )
h2 = Host( 'h2' )
s1 = OVSSwitch( 's1', inNamespace=False )
c0 = Controller( 'c0', inNamespace=False )
Link( h1, s1 )
Link( h2, s1 )
h1.setIP( '10.1/8' )
h2.setIP( '10.2/8' )
c0.start()
s1.start( [ c0 ] )
print h1.cmd( 'ping -c1', h2.IP() )
s1.stop()
c0.stop()
```

Mid-level API: Network Object

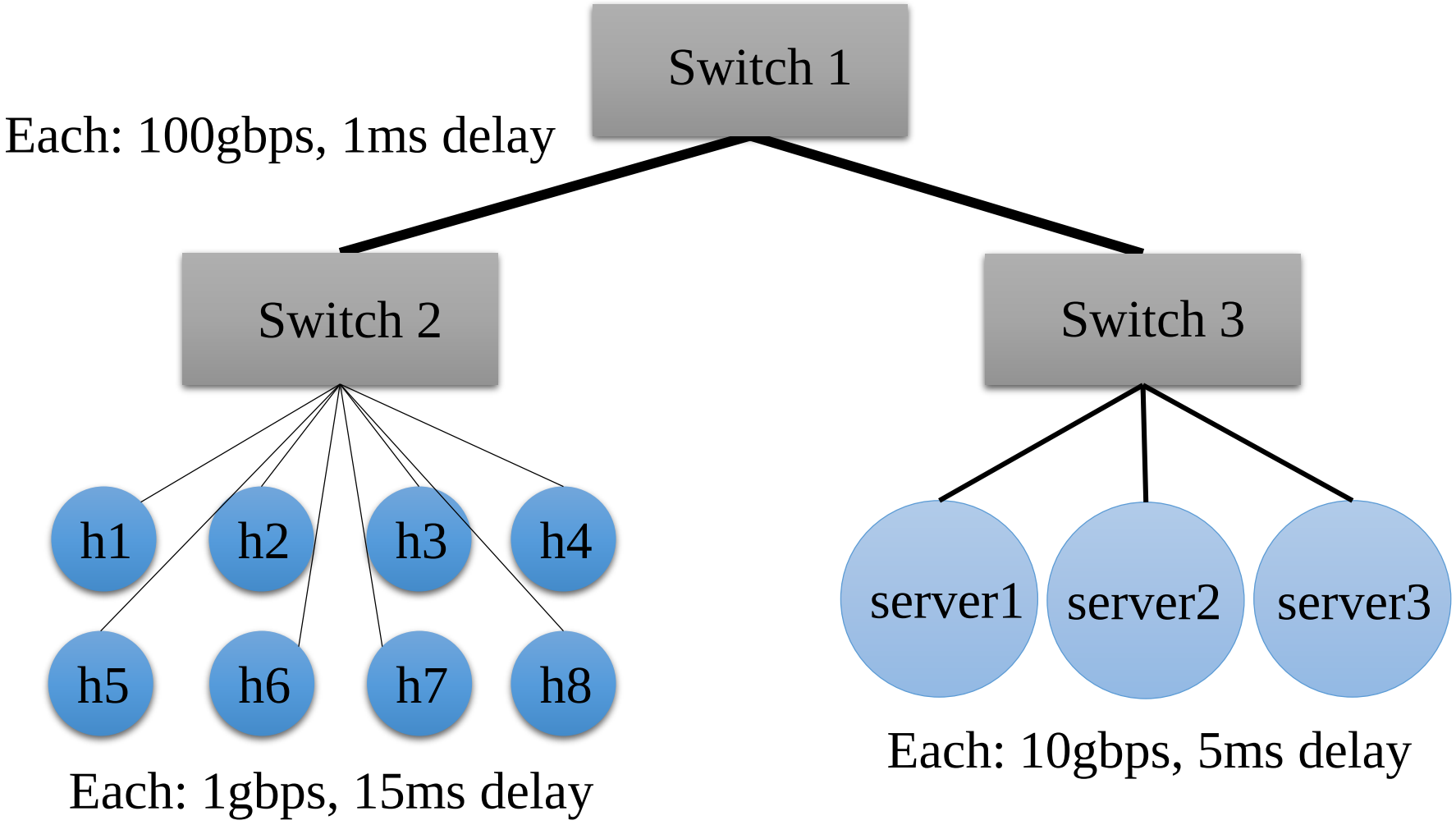
```
net = Mininet()
h1 = net.addHost( 'h1' )
h2 = net.addHost( 'h2' )
s1 = net.addSwitch( 's1' )
c0 = net.addController( 'c0' )
net.addLink( h1, s1 )
net.addLink( h2, s1 )
net.start()
print h1.cmd( 'ping -c1', h2.IP() )
CLI( net )
net.stop()
```

High-level API: Topology templates

```
class SingleSwitchTopo( Topo ):
     "Single Switch Topology"
     def __init__( self, count=1):
          Topo.__init__(self)
          hosts = [ self.addHost( 'h%d' % i )
                    for i in range( 1, count + 1 ) ]
          s1 = self.addSwitch( 's1' )
          for h in hosts:
               self.addLink( h, s1 )

topos = {'single' : (lambda: SingleSwitchTopo())}
```

Example Topology – Research Lab



Example Topology – Research Lab

```
#!/usr/bin/python
from mininet.topo import Topo

class ResearchLab( Topo ):
    """Research Lab Topology"""
    def __init__( self ):

        Topo.__init__(self)
        testbedhosts = [ self.addHost( 'h%d' % i ) for i in range( 1, 9) ]
        simservers = [self.addHost( 'sim%d' % i ) for i in range( 1, 4) ]
        s1 = self.addSwitch( 's1' ) # TOR switch
        s2 = self.addSwitch( 's2' ) # Testbed switch
        s3 = self.addSwitch( 's3' ) # Server switch

        for h in testbedhosts:
            self.addLink( h, s2 , bw=1, delay='15ms')

        for srv in simservers:
            self.addLink( srv,s3, bw=10, delay='1ms')

        self.addLink(s2, s1, bw=100)
        self.addLink(s3, s1, bw=100)

topos = {'rlab' : (lambda: ResearchLab())}
```

```
sudo mn
--custom rlab.py
--topo rlab
--link=tc
```

The POX Controller

- Invoke with: ./pox.py [options] <component>

- <options> can be:
  - --verbose : display debugging info
  - --no-openflow: do not automatically listen for OpenFlow connections

- <components> are the real meat!
  - There are some basic components we will use for this class
  - Intention: developers will build their own components

The POX Controller - Components

- Some stock components:
  - py
  - forwarding.hub
  - forwarding.l2_learning
  - forwarding.l2_pairs
  - forwarding…..

  - openflow.webservice
    - Creates a webinterface to interact with OpenFlow

  - openflow.of_01
    - Communicates with OpenFlow 1.0 switches

The POX Controller - Components

- Developing your own components:
  - Not required in this course
  - If you are interested:
    - https://openflow.stanford.edu/display/ONL/POX+Wiki#POXWiki-DevelopingyourownComponents

- In general: POX wiki a good place to look for help
  - https://openflow.stanford.edu/display/ONL/POX+Wiki

POX APIs

- When writing or modifying components (you will do the latter in this course), POX offers some helpful API.
  - E.g.: API for packet handling: **`pox.lib.packet`**

Example: Get L2 source and destination from a packet

```
def _handle_PacketIn(self, event):
        packet = event.parsed # POX is based on events!
        src_of_packet = packet.src #returns an EthAddr
        dst_of_packet = packet.dst #also returns an EthAddr
```

POX APIs

- When writing or modifying components (you will do the latter in this course), POX offers some helpful API.
  - E.g.: API for packet handling: **`pox.lib.packet`**

Example: Get source IP from a packet

```
def _handle_PacketIn(self, event):
        "check if packet is an IP packet"
        packet = event.parsed
        ip = packet.find('ipv4') #check if packet is IP
        if ip is None: #packet is not IP
                return
        print "Source IP: ", ip.srcip
```

POX and Openflow

- Up front: Best to read POX wiki:
  - https://openflow.stanford.edu/display/ONL/POX+Wiki#POXWiki-OpenFlowinPOX
- Usually, switches connect to POX automatically via OpenFlow
  - Exception: `no-openflow` option (see previous slides)
- So – how do we communicate with them?

Coding in POX – Connection Elements

- Upon connecting to POX, a switch is associated with a `Connection` object
- Use that object's `send()` method to send messages to the switch
- `Connection` object will raise events on the corresponding switch
  - Create **event handlers** for events you are interested in

In Practice

- Launch our component.
- Add one event listener for `PacketIn`

```
from pox.core import core
import pox.openflow.libopenflow_01 as of

log = core.getLogger()

def launch ():
    "Starts the Component"
    core.openflow.addListenerByName("PacketIn",
                                    _handle_packetin)

    log.info("Switch running.")
```

In Practice

- Write packet handler (here: flood packet)

```
def _handle_packetin (event):
    “Handle PacketIn“
    packet = event.parsed
    send_packet(event, of.OFPP_ALL) #broadcast

    log.debug("Broadcasting %s.%i -> %s.%i" %
                (packet.src, event.ofp.in_port,
                 packet.dst, of.OFPP_ALL))
```

In Practice

- Write `send_packet` method (simplified)

```
def send_packet (event, dst_port):
    "Instructs switch to send packet via dst_port"
    msg = of.ofp_packet_out(in_port=event.ofp.in_port)
    msg.data = event.ofp.data
    msg.actions.append(of.ofp_action_output(port = dst_port))

    event.connection.send(msg)
```

In Practice

- Code on previous slides implemented a hub behaviour
- Exercise: modify hub behaviour to learning switch behaviour

Exercise!

Time for Exercise 9