Project 2
Simple Router

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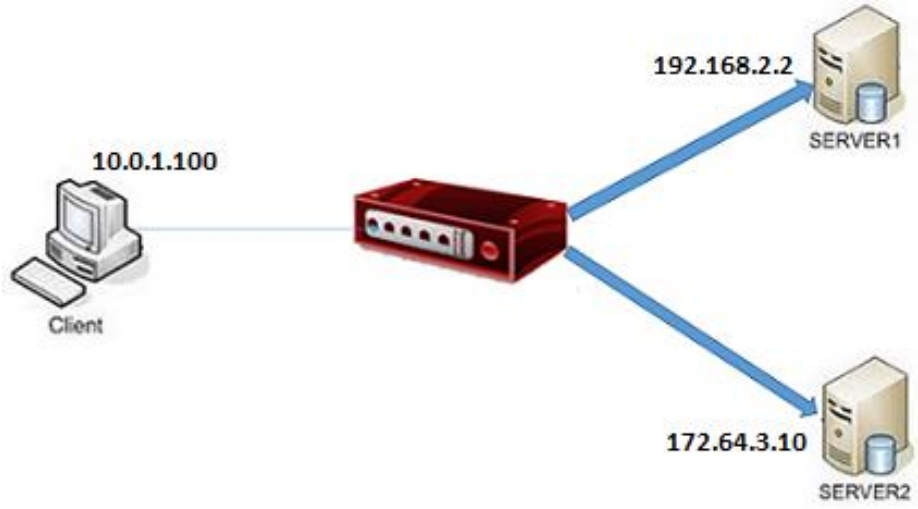
Topology

- The skeleton and dependencies of the project have been setup in a VM for your convenience.

- VM has the network topology and the allows your router implementation to talk with the network topology.



Getting Started

- Load the virtual machine disk image into your VMware machine and login.
- Start Mininet in one terminal and POX controller in another terminal.

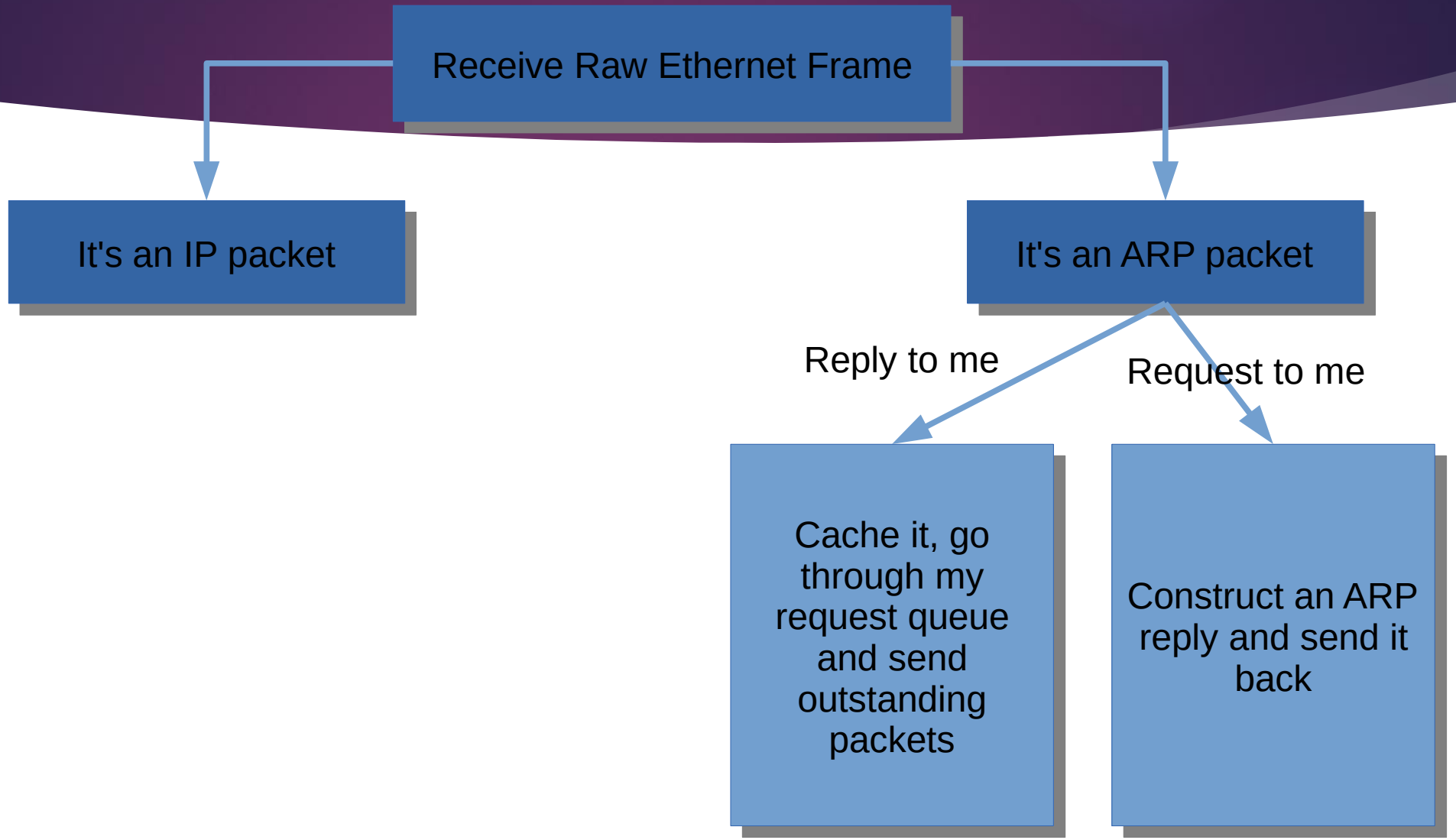
Note: Execute `byobu-enable`. F2 to open new terminal and F3 to switch between terminals.

- In the third terminal, execute `make clean` followed by `make` in the router directory.
- ./sr
- Go back to the first terminal where mininet is running and execute ping/traceroute commands

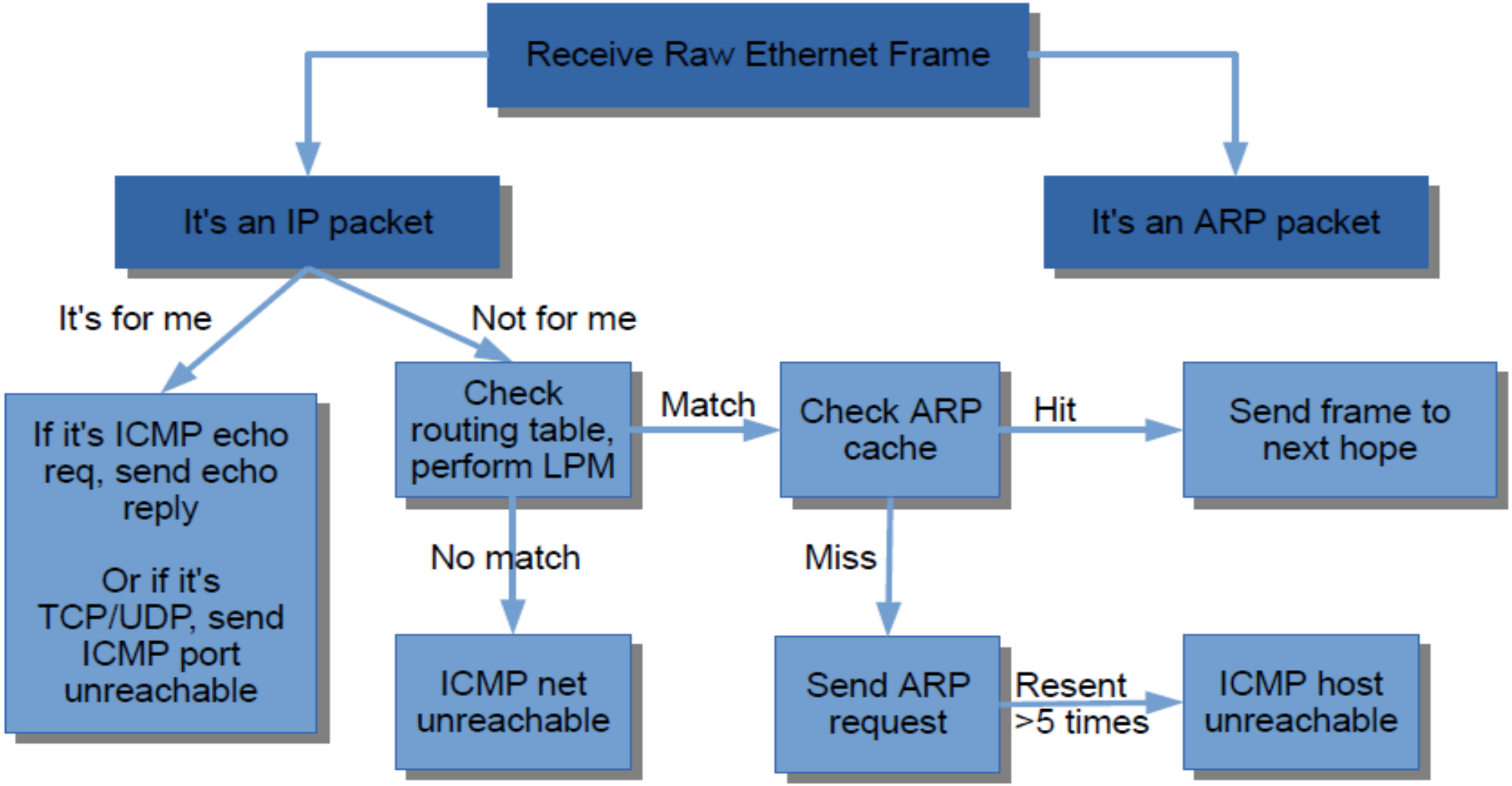
Overview

- Goal: Route Ethernet frames between the client, 10.0.1.100 and the HTTP servers (192.168.2.2 & 172.64.3.10).
- **Routing logic**
  - Handle ARP request and replies and Maintain cache
  - IP forwarding
- See webpage for full requirements

ARP Flow Chart



IP Flow Chart



ICMP Packets

- Echo reply (type 0): Sent in response to an echo request (ping) to one of the router's interfaces.
- Port unreachable (type 3, code 3): Sent if an IP packet containing a UDP or TCP payload is sent to one of the router's interfaces. This is needed for traceroute to work.
- Destination net unreachable (type 3, code 0): Sent when there is no matching entry in routing table when forwarding an IP packet.
- Time exceeded (type 11, code 0)
- Check out the types and header formats at: http://tools.ietf.org/html/rfc792

How to check if the packet is ARP or IP Packet?

- After typecasting 'packet' received by sr_handlepacket() to sr_ethernet_hdr_t*, check ether-type variable.

```
struct sr_ethernet_hdr{

uint8_t  ether_dhost[ETHER_ADDR_LEN];    /* destination ethernet address */
uint8_t  ether_shost[ETHER_ADDR_LEN];    /* source ethernet address */
uint16_t ether_type;                     /* packet type ID */

 } __attribute__ ((packed)) ;

typedef struct sr_ethernet_hdr sr_ethernet_hdr_t;
```

If packet is ARP Type, then

- Verify the length of the packet.
- Use sr_get_interface(sr, interface) [function defined in sr_if.c] to get the interface record. Get the mac address of the destination ip address/interace ip address from the record.
- Check the 'opcode' variable of the ARP header and see if it is arp_op_request or arp_op_reply.
- If it is an **ARP Request**, update all the fields of the packet and use sr_send_packet() to send an ARP reply.
- If it is a **Reply,** update ARP cache and ARP queue. Send all the packets in the queue to the destination.

If packet is IP type, then

- Check the length.
- Validate the IP header.
  - Should not be IPv6
  - Check ip_hl
  - Check ip_len
  - Checksum
- Check if it is destined to you, the router.

If the IP packet is destined to you, then

- Check ip_p.
- Router should not handle non-ICMP packets (tcp or udp). Otherwise generate ICMP port unreachable (type 3, code 3).
- If it is ICMP echo request (type 8), then generate ICMP echo reply (type 0).

If the IP packet is not destined to you, then

- Check ip_ttl. If TTL <= 1, send ICMP time exceeded (type 11, code 0).
- Look up next-hop address by doing a LPM on the routing table using the packet's destination address. If it does not exist, send ICMP host unreachable (type 3, code 0).
- If it does exist, then reduce ttl and update checksum.
- From next-hop address, determine outgoing interface and next-hop MAC address
- If necessary, send ARP request to determine MAC address
- Encapsulate IP datagram in Ethernet packet
- Forward packet to outgoing interface

Guidelines

- You will be able to debug your code much faster if you log packets and use gdb.

  After `make`, execute `gdb ./sr`

- Use the Print functions available in sr_utils.c for printing out network header information from your packets .
- Don't get mixed up with endianness: Linux is little endian, network big endian. You could look at the print functions to get a clearer picture.
- Always push your code to the github repo provided after any update is made! Will save you a lot of time, if your VM image gets corrupted.
- Academic integrity policies will be applied by the book.