Project 5

Proxy ARP

Deadline: 2023/11/30 (Thus) 23:59

Outline

- Introduction to ARP
  - What is ARP
  - ARP Request/Reply Format
- Proxy ARP
  - What is Proxy ARP
  - Workflow of Proxy ARP in SDN
- Project 5 Requirements
- References

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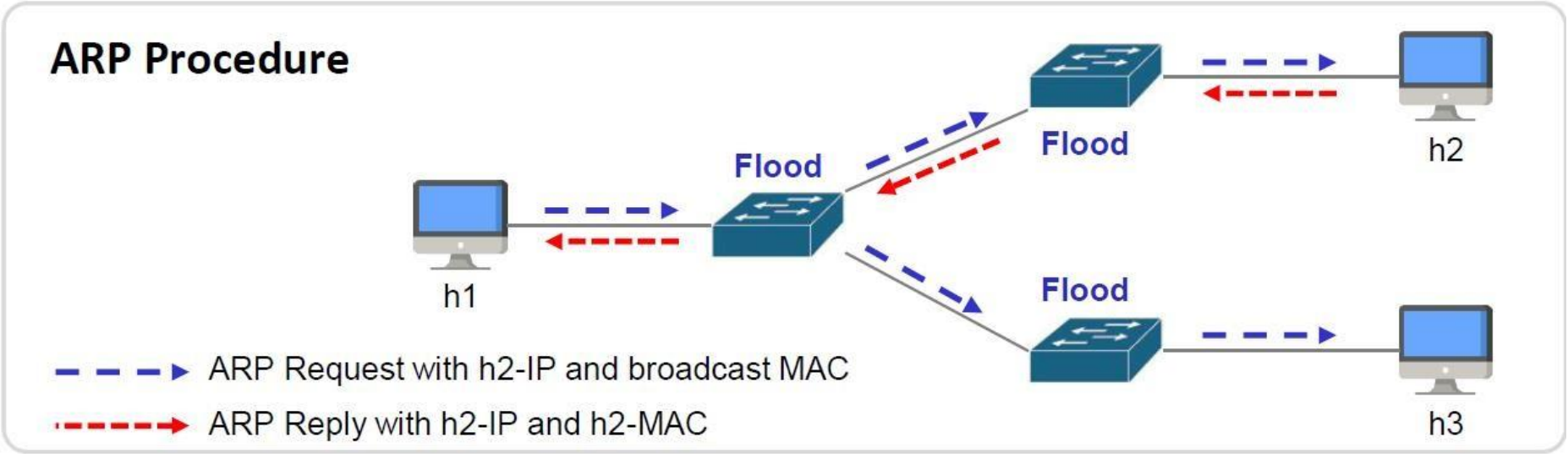
What is Address Resolution Protocol (ARP)

- Used to discover Link Layer address (e.g. MAC) with the given Network Layer address (e.g. IPv4)
- Use flooding to discover devices
  - Destination Ethernet address of ARP Request is broadcast address
- Hosts maintain an ARP table for mapping IP address to MAC



ARP Request Packet Frame

- Following table depicts ARP Request packet format (h1 sends to h2)

Hardware Type (Ethernet = 1)		Protocol Type (IPv4 = 0x0800)
Hardware Length (Ethernet = 6)	Protocol Length (IPv4 = 4)	Operation Code (Request = 0x1)
Sender Hardware Address (h1-MAC)		
Sender Protocol Address (h1-IP)		
Target Hardware Address (**00:00:00:00:00:00**)		
Target Protocol Address (h2-IP)		

ARP Reply Packet Frame

- Following table depicts ARP Reply packet format (h2 reply h1)

Hardware Type (Ethernet = 1)		Protocol Type (IPv4 = 0x0800)
Hardware Length (Ethernet = 6)	Protocol Length (IPv4 = 4)	Operation Code (Reply = 0x2)
Sender Hardware Address (**h2-MAC**)		
Sender Protocol Address (h2-IP)		
Target Hardware Address (h1-MAC)		
Target Protocol Address (h1-IP)		

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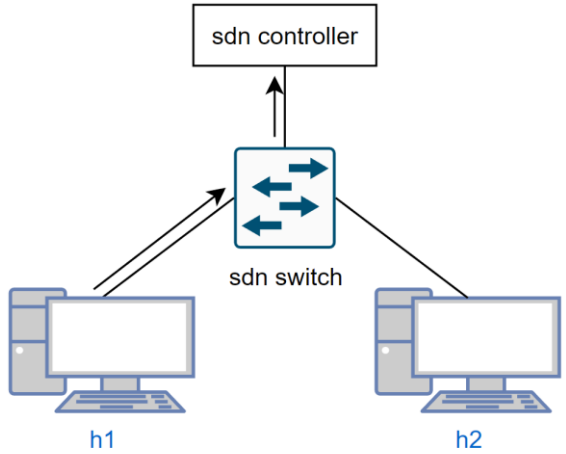
What is Proxy ARP

- A Proxy device answers ARP Requests for IP address on behalf of other devices
  - The Proxy device could be router, firewall, etc.
  - The replied MAC belongs to the **Proxy device**
- In SDNs, controller can serve as Proxy device
  - However, the replied MAC belongs to the **target host**
  - Benefits:
    - Decreases workload of network devices
    - Prevent issues like broadcast storm



h1 send ARP Request

Workflow of Proxy ARP in SDN

1. Sender sends ARP Request
2. Edge switch Packet-Ins the Request to controller
3. Proxy ARP learns IP-MAC mappings of the sender
4. Proxy ARP looks up ARP table (For target IP-MAC mapping)
   - If mapping exist:
     - Fetch target MAC

     5a. Packet-Outs ARP Reply (with target MAC) to the sender
   - Else (mapping not exist):

     5b. Floods ARP Request to edge ports except the port receiving ARP Request

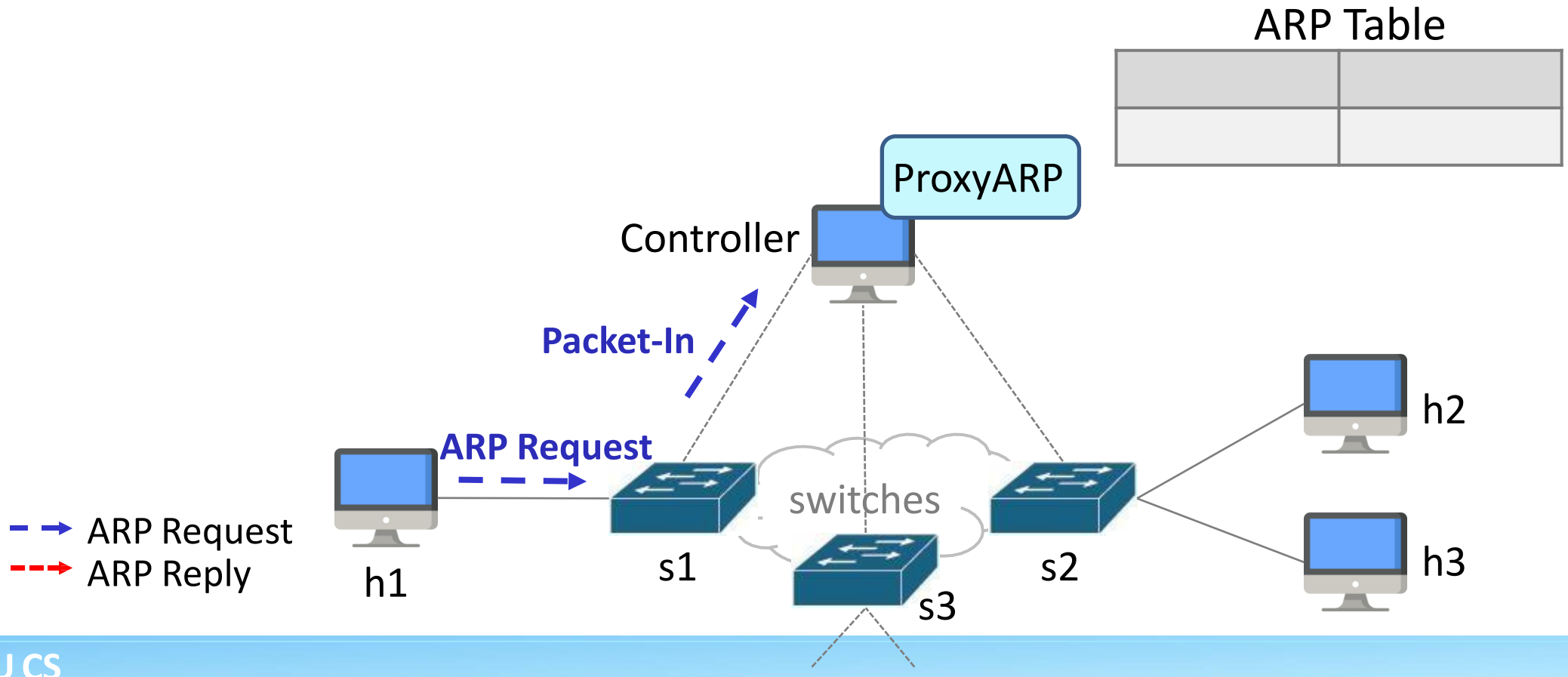
     6. When h2 receives ARP Request, h2 will Reply ARP packet.

     7. Edge switch Packet-Ins the Reply to controller

     8. Proxy ARP learns IP-MAC mapping from h2

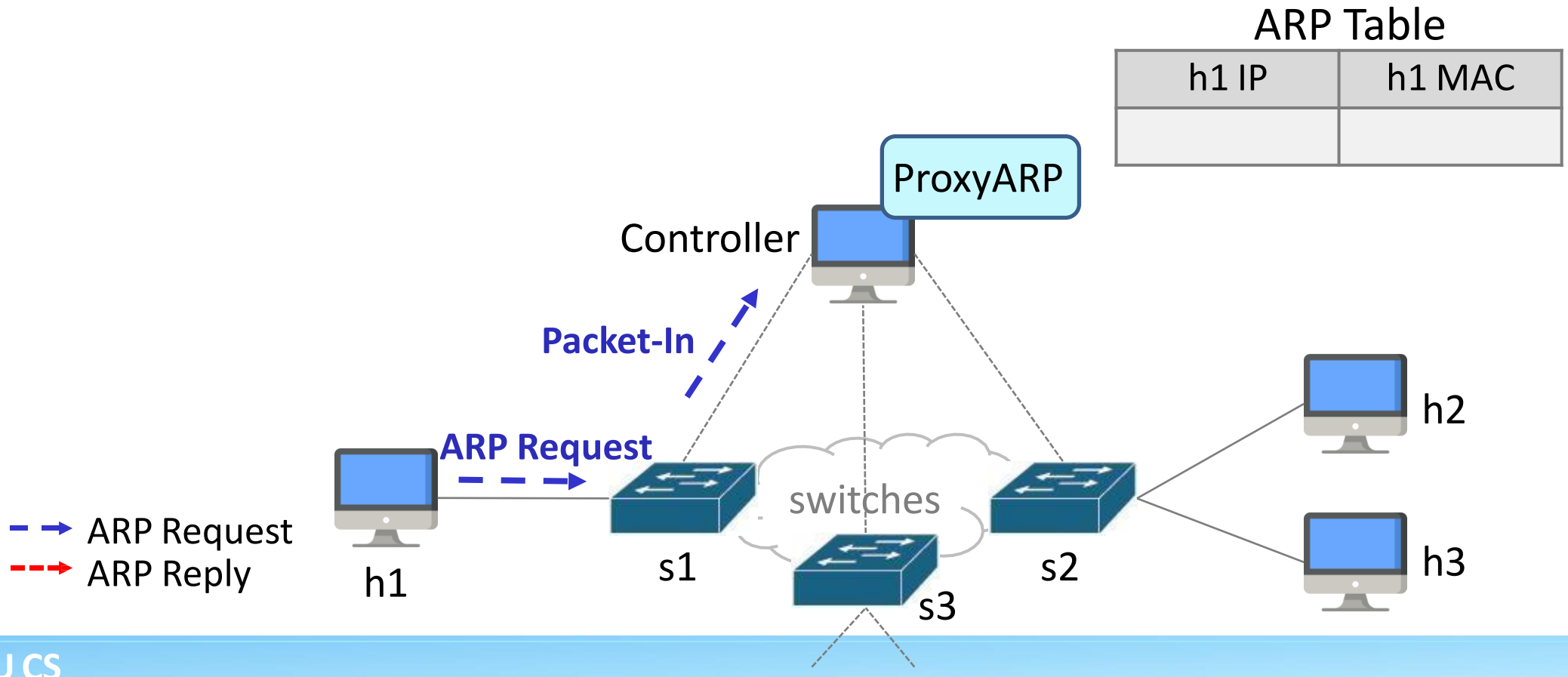
First ARP Request

1. h1 sends ARP Request
2. Edge switch Packet-Ins the Request to controller



Proxy ARP learns IP-MAC

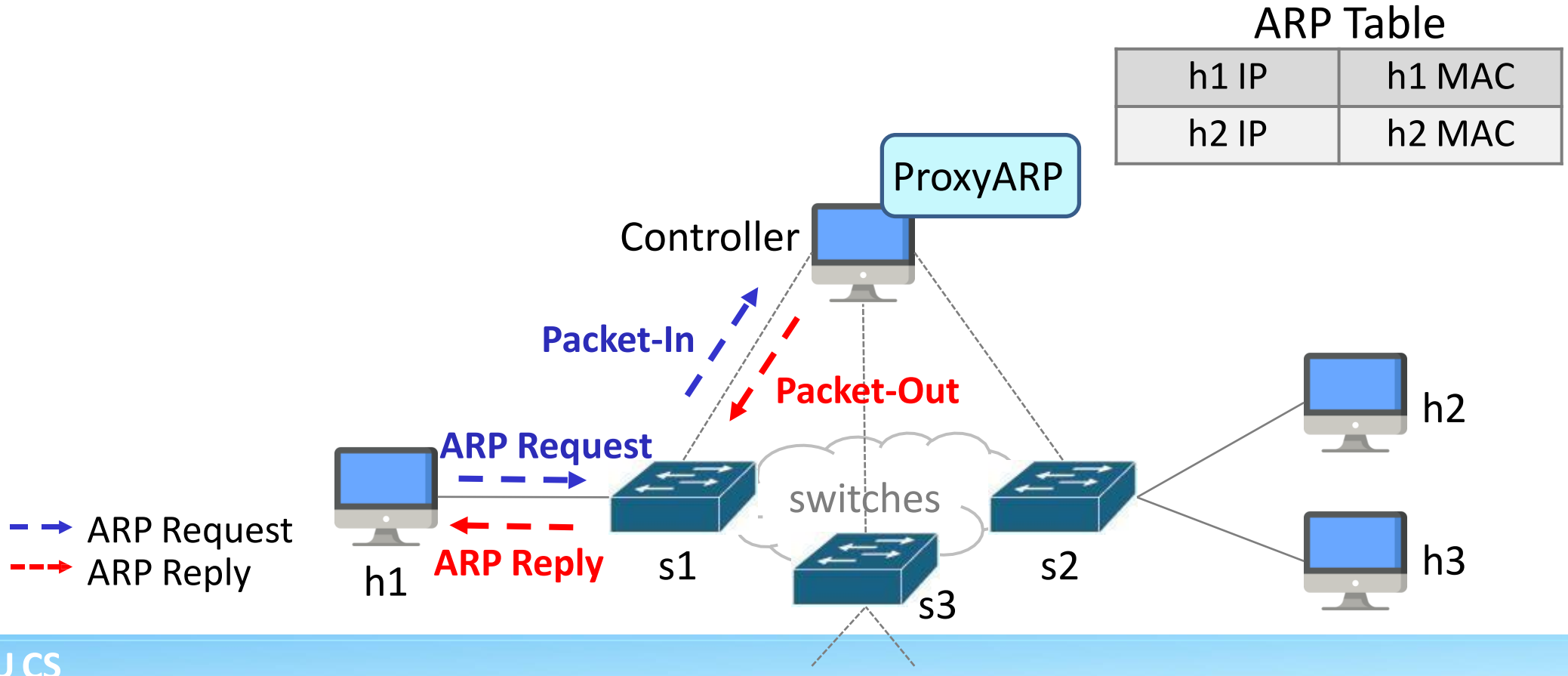
3. Controller learns mapping of IP to MAC of h1
4. Proxy ARP looks up ARP table (For target IP-MAC mapping)



If mapping exist

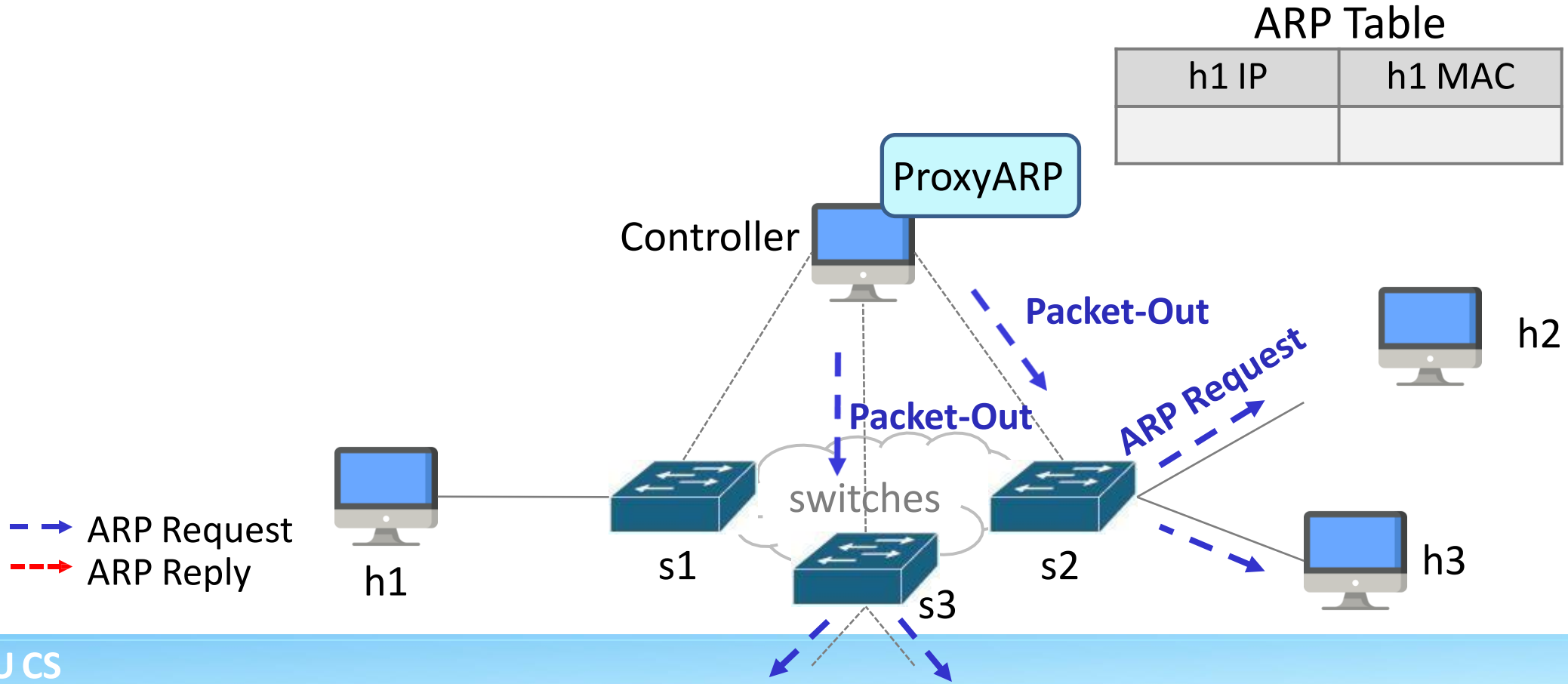
- Fetch target MAC

5a. Proxy ARP simply generates and Packet-Outs ARP Reply (with target MAC) to the sender



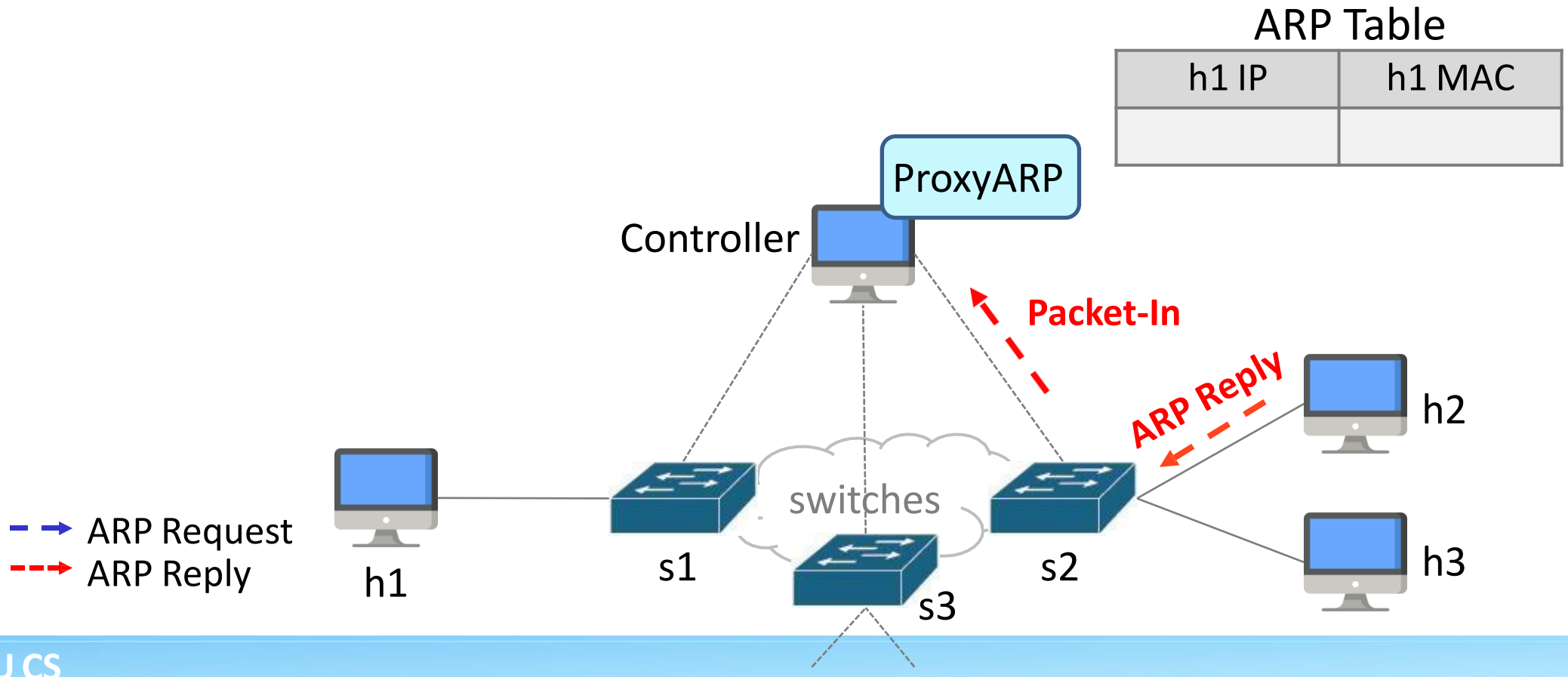
If mapping not exist

- 5b. Floods ARP Request to edge ports except the port receiving ARP Request via Packet-Outs ARP Request



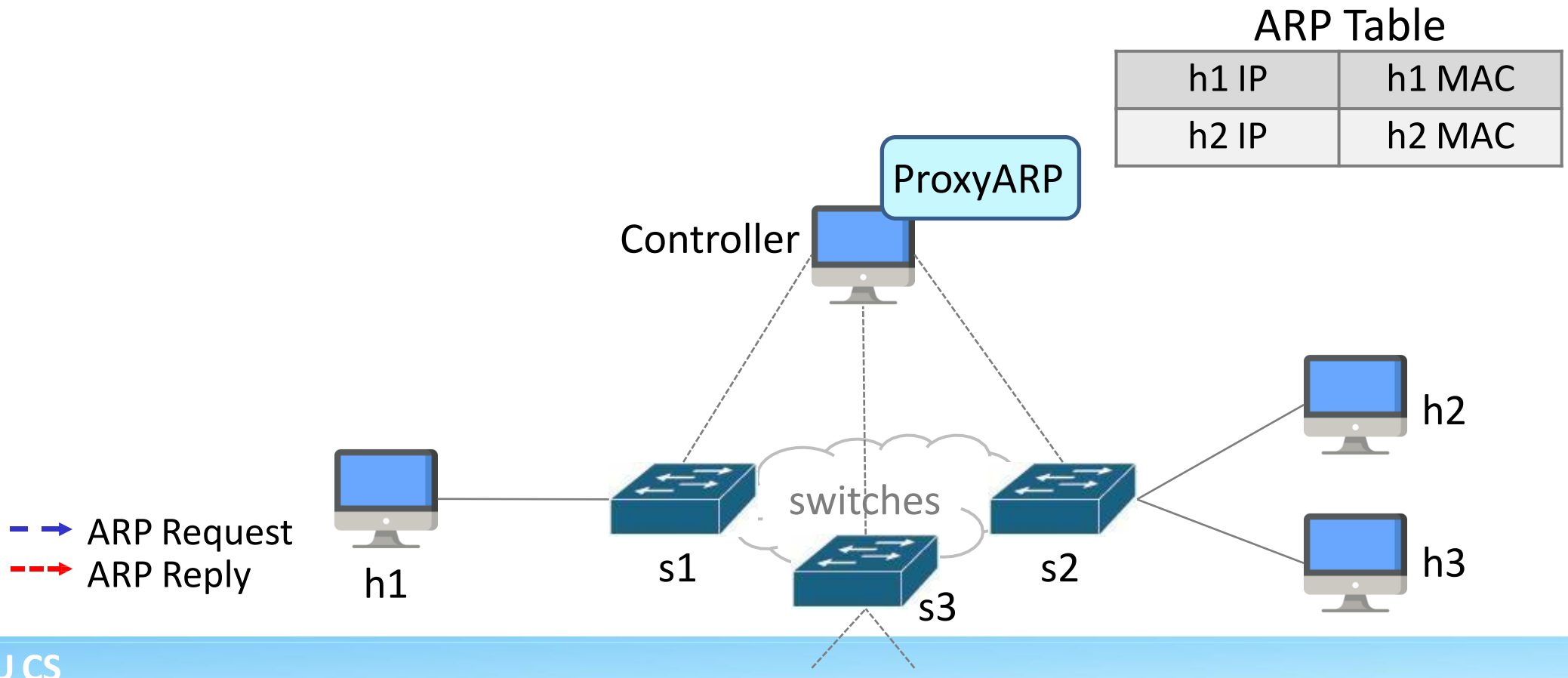
Reply ARP packet

6. When h2 receives ARP Request, h2 will Reply ARP packet.
7. Edge switch Packet-Ins the Reply to controller



Proxy ARP learns IP-MAC

8. Proxy ARP learns IP-MAC from h2



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Project 5 Descriptions

- In this project, you need to implement a Proxy ARP application
- **No** flow rule should be installed by your application
- Your implementation **should comply to workflow** introduced earlier
- Note:
  - The sender should **not** receive the packet-out when table miss
  - When table miss, only packet-out to **edge ports**

Test Your Application

- Once you activate your application and Mininet, execute **`arping`** in Mininet to check ARP functionality

```
mininet> h1 arping h2
```

- Correct result would look like:

```
mininet> h1 arping h2 -c 3
ARPING 10.0.0.2 from 10.0.0.1 h1-eth0
Unicast reply from 10.0.0.2 [D6:B5:82:B5:23:0E]  15.850ms
Unicast reply from 10.0.0.2 [D6:B5:82:B5:23:0E]  4.267ms
Unicast reply from 10.0.0.2 [D6:B5:82:B5:23:0E]  4.370ms
Sent 3 probes (1 broadcast(s))
Received 3 response(s)
mininet>
```

Restriction

- ONOS application activation
  - You are only allowed to activate **your *ProxyARP*** and the following ONOS applications:

```
brian@root > apps -a -s
*   6 org.onosproject.drivers                2.2.0    Default Drivers
*   7 org.onosproject.optical-model          2.2.0    Optical Network Model
*  39 org.onosproject.gui2                   2.2.0    ONOS GUI2
*  52 org.onosproject.openflow-base          2.2.0    OpenFlow Base Provider
*  84 org.onosproject.hostprovider           2.2.0    Host Location Provider
*  85 org.onosproject.lldpprovider           2.2.0    LLDP Link Provider
*  86 org.onosproject.openflow               2.2.0    OpenFlow Provider Suite
* 192 nctu.winlab.ProxyArp                   1.0.SNAPSHOT ONOS OSGi bundle archetype
```

Project 5 Scoring Criteria

- **(10%)** Project naming convention
  - <groupId>: nctu.winlab
  - <artifactId>: ProxyArp
  - <version>: <use default> (1.0-SNAPSHOT)
  - <Package>: nctu.winlab.ProxyArp
- **(30%)** Print messages in following events:
  - ARP table miss

```
| 209 - nctu.winlab.ProxyArp - 1.0.0.SNAPSHOT | TABLE MISS. Send request to edge ports
```

  - ONOS receives ARP Reply from host

```
| 209 - nctu.winlab.ProxyArp - 1.0.0.SNAPSHOT | RECV REPLY. Requested MAC = 06:4F:F1:84:A5:EA
```

  - ARP table hit

```
| 209 - nctu.winlab.ProxyArp - 1.0.0.SNAPSHOT | TABLE HIT.  Requested MAC = 06:4F:F1:84:A5:EA
```

- **(60%)** Work properly at least in tree (depth=3, fanout=3) topology
  - All hosts are able to **arping** to each other

Submission Naming Convention

- Rename your Proxy ARP app directory as **project5_<student ID>**
- Compress the directory into a **zip** file named as **project5_<student ID>**
- Upload your zip file to E3
- Wrong file name or format will result in 10 points deduction
- 20% deduction for late submission in one week
  - Won't accept submissions over one week

Demo

- TA will open a demo time-reservation sheet one week before demo
- The dates will be chosen after the deadline
- Demo questions will appear at the start of the demo
- The score of demo will occupy 40% total score of this project
  - For Example:
    - You earn 100% of the credits for submission
    - You earn 80% of the credits for demo
    - Then your total score of this project will be:

      100 x 60% + 80 x 40% = 92.

About help!

- For any project problem, ask at e3 forum
  - Ask at the e3 forum
  - TAs will help to clarify project contents instead of giving answers!
  - Please describe your questions with sufficient context,
    - e.g. Environment setup, Input/Output, Screenshots, …
- For personal problem mail to **sdnta@win.cs.nctu.edu.tw**
  - You have special problem and you can't meet the deadline
  - You got weird score with project
- No Fixed TA hour

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References

- For fetching network topology status
  - http://api.onosproject.org/2.7.0/apidocs/org/onosproject/net/host/HostService.html
  - http://api.onosproject.org/2.7.0/apidocs/org/onosproject/net/edge/EdgePortService.html
- For packet manipulation
  - http://api.onosproject.org/2.7.0/apidocs/org/onlab/packet/Ethernet.html
  - http://api.onosproject.org/2.7.0/apidocs/org/onlab/packet/ARP.html