



Project 5

Proxy ARP

Deadline: 2023/11/30 (Thurs) 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



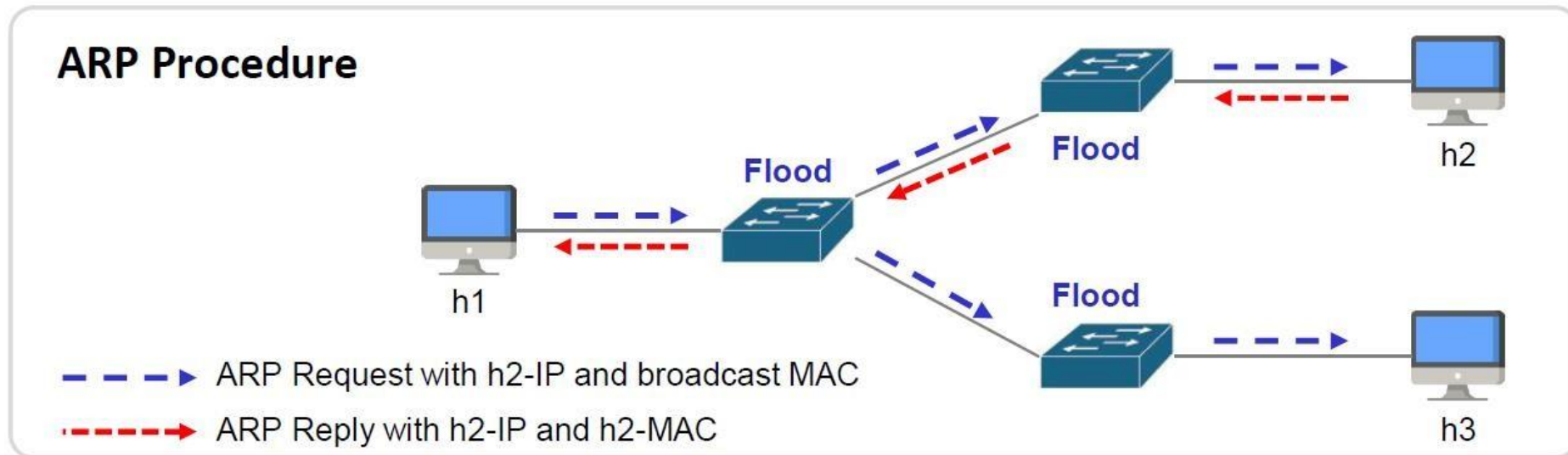
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What is Address Resolution Protocol (ARP)

- 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)		



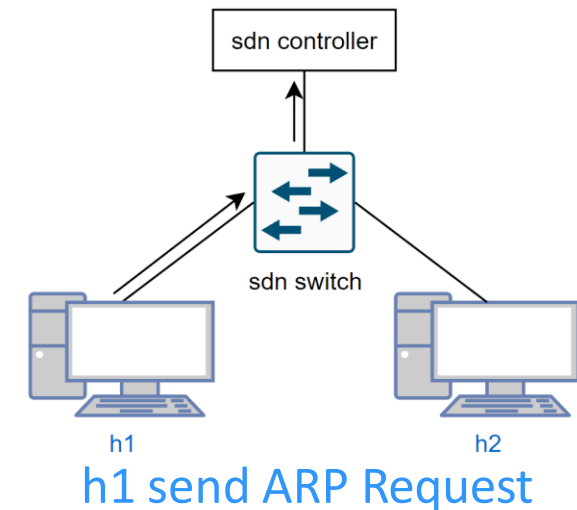
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What is Proxy ARP

- 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





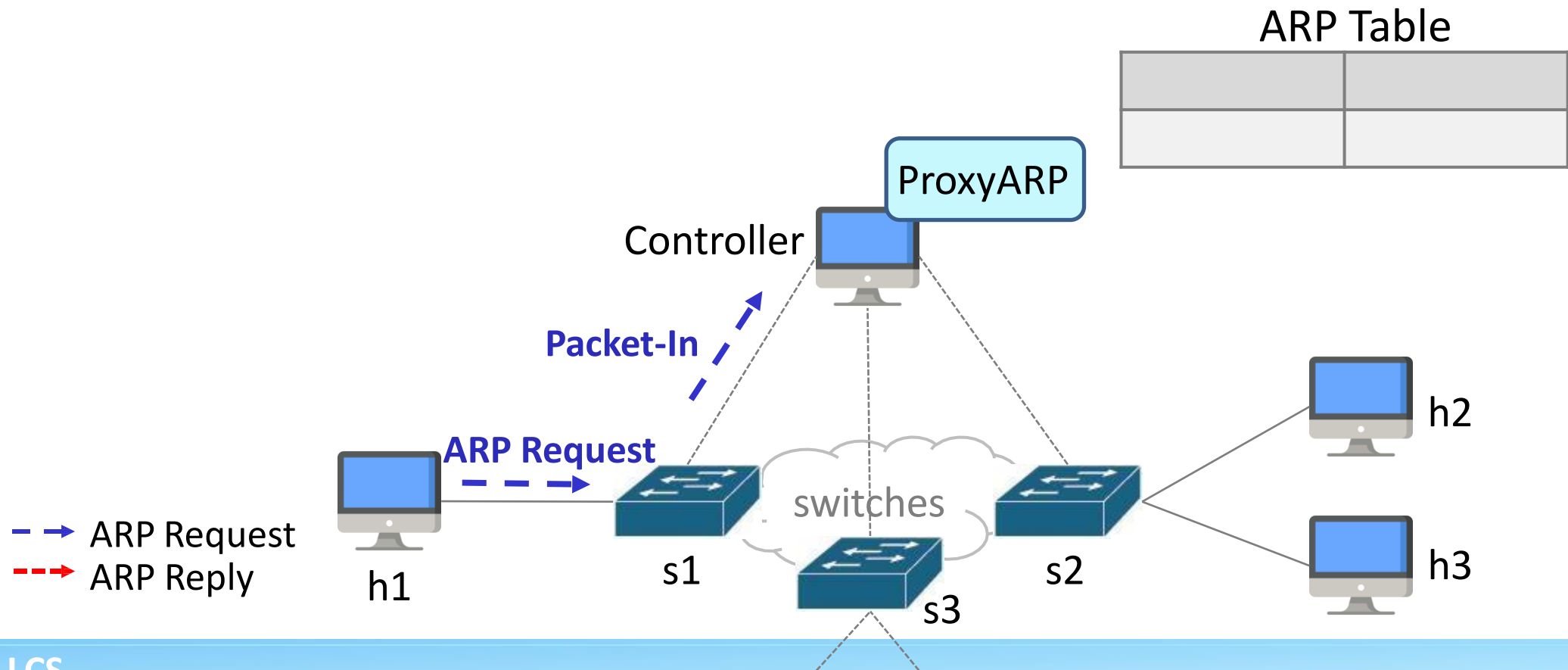
Workflow of Proxy ARP in SDN

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

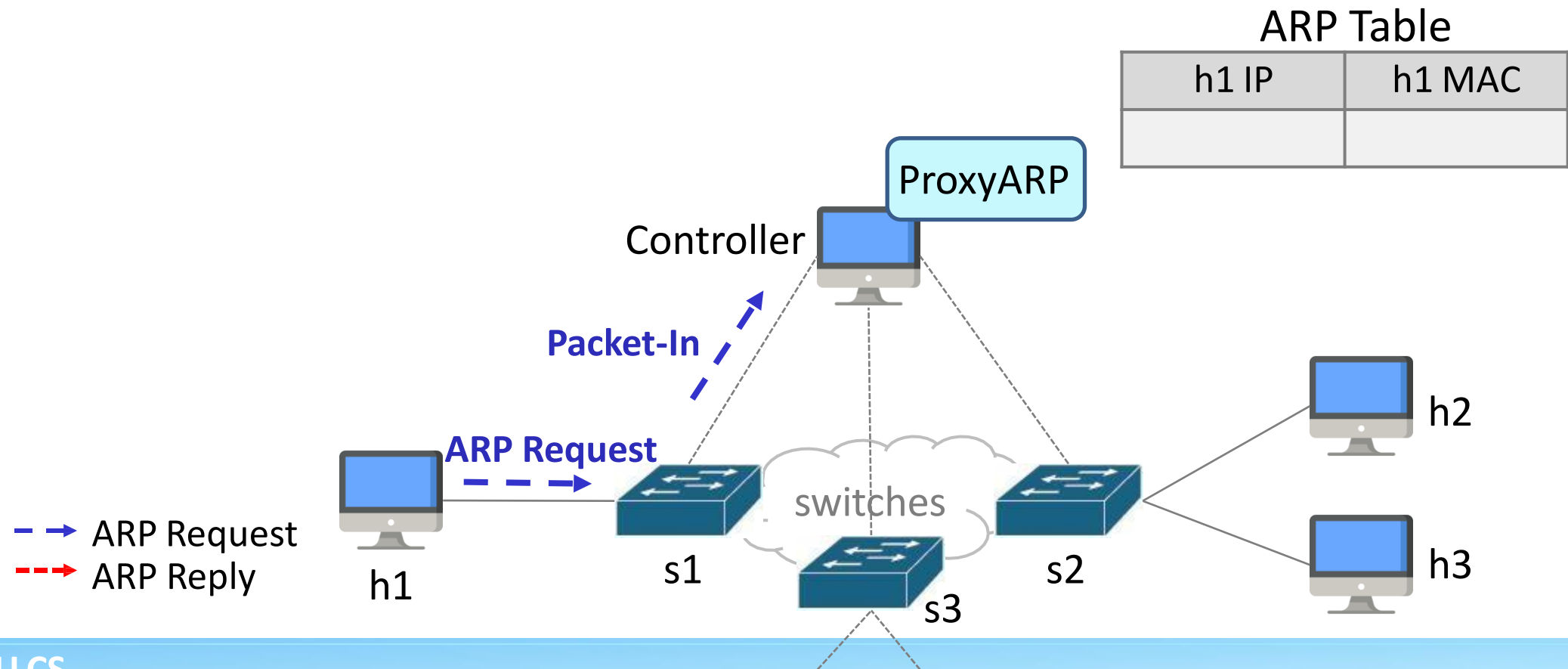
1. h1 sends ARP Request
2. Edge switch Packet-Ins the Request to controller





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)

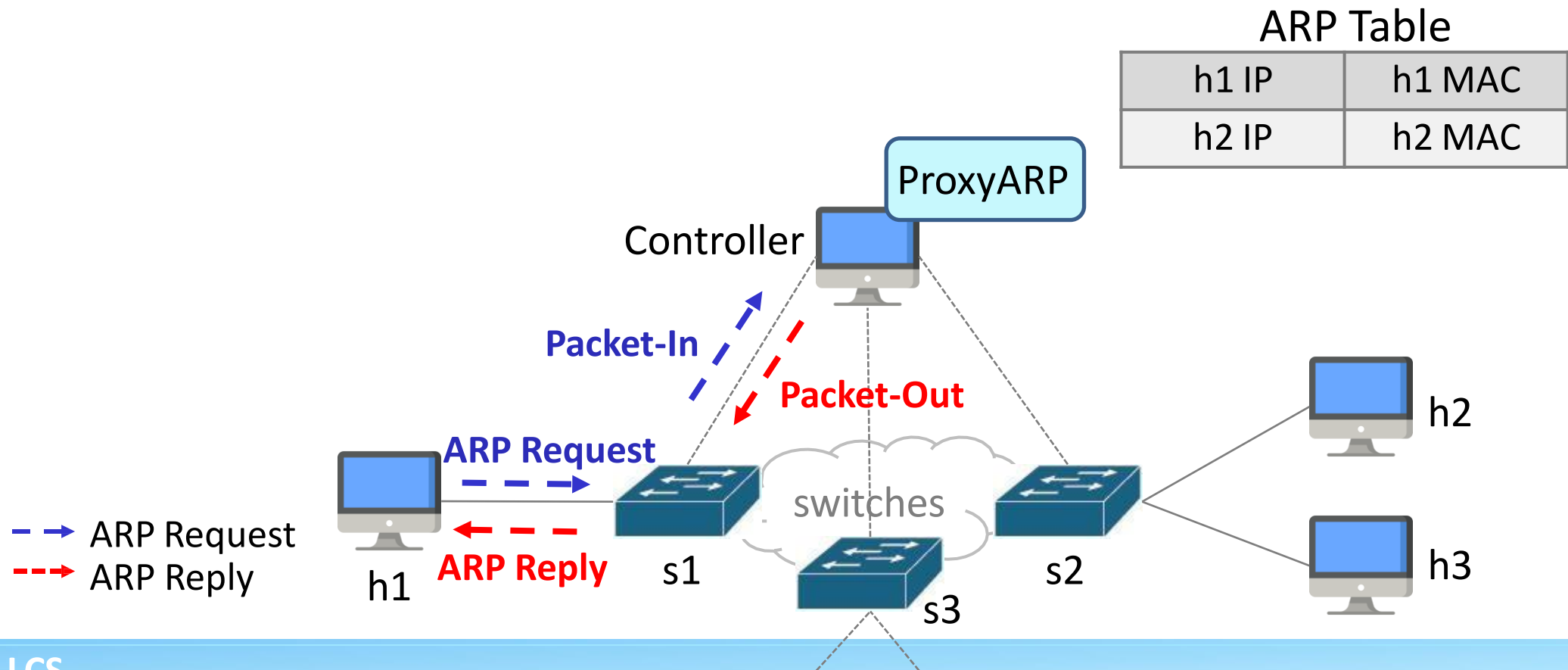




If mapping exist

- Fetch target MAC

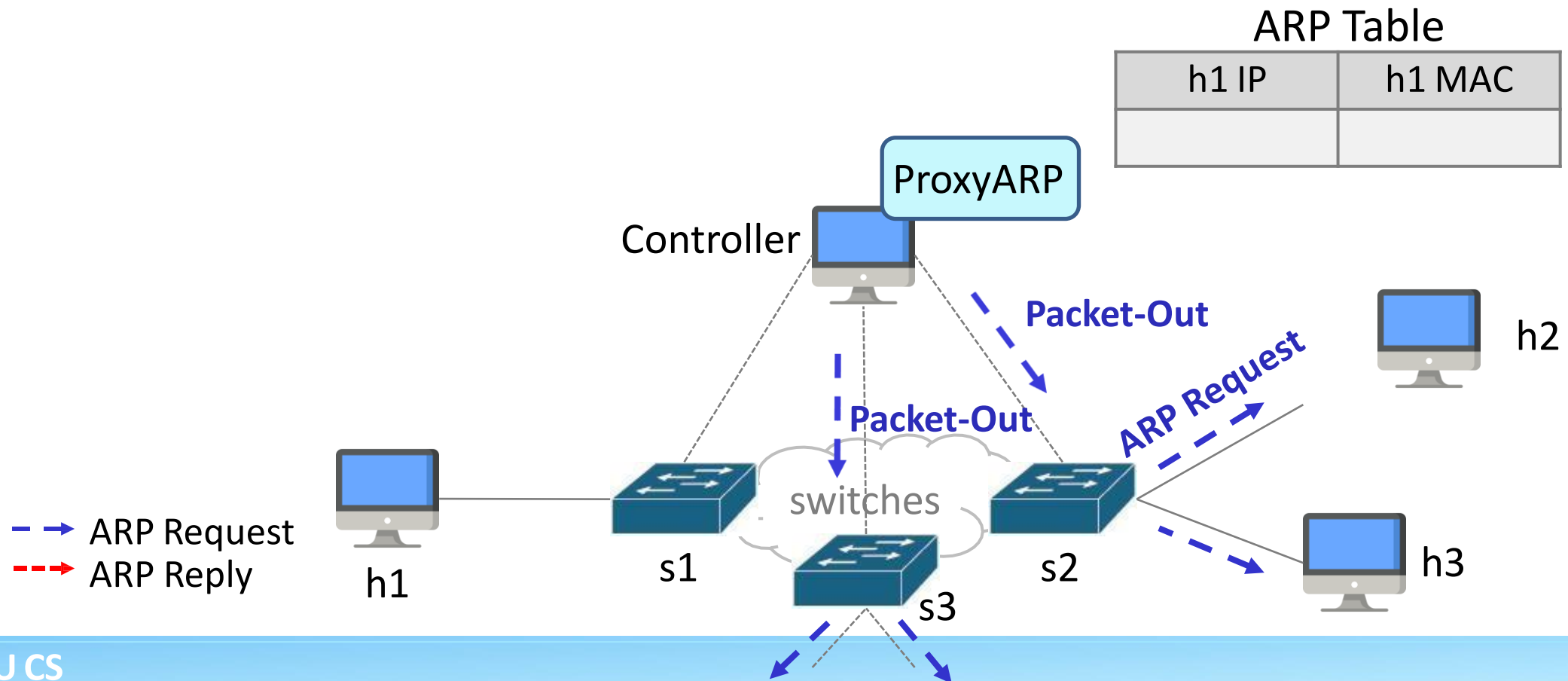
5a. Proxy ARP simply generates and Packet-Outs ARP Reply (with target MAC) to the sender





If mapping not exist

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

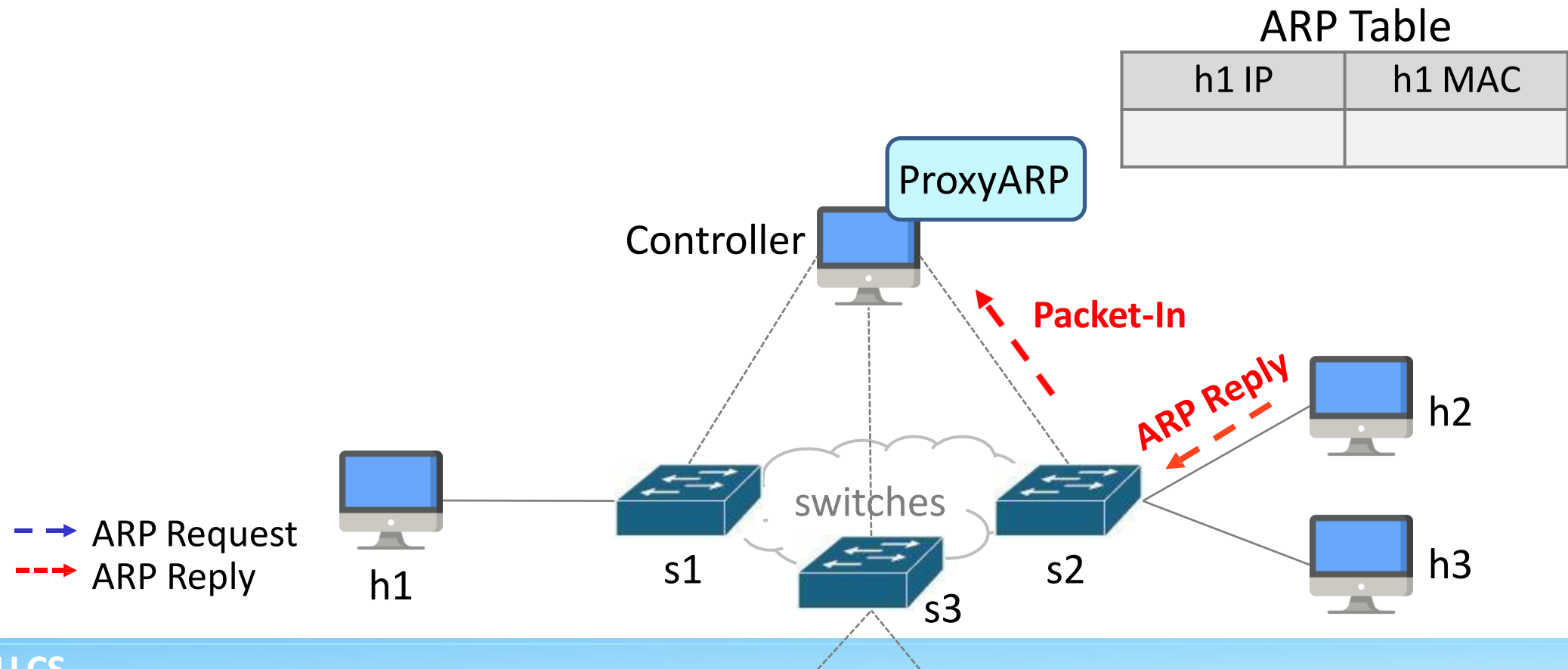




Reply ARP packet

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

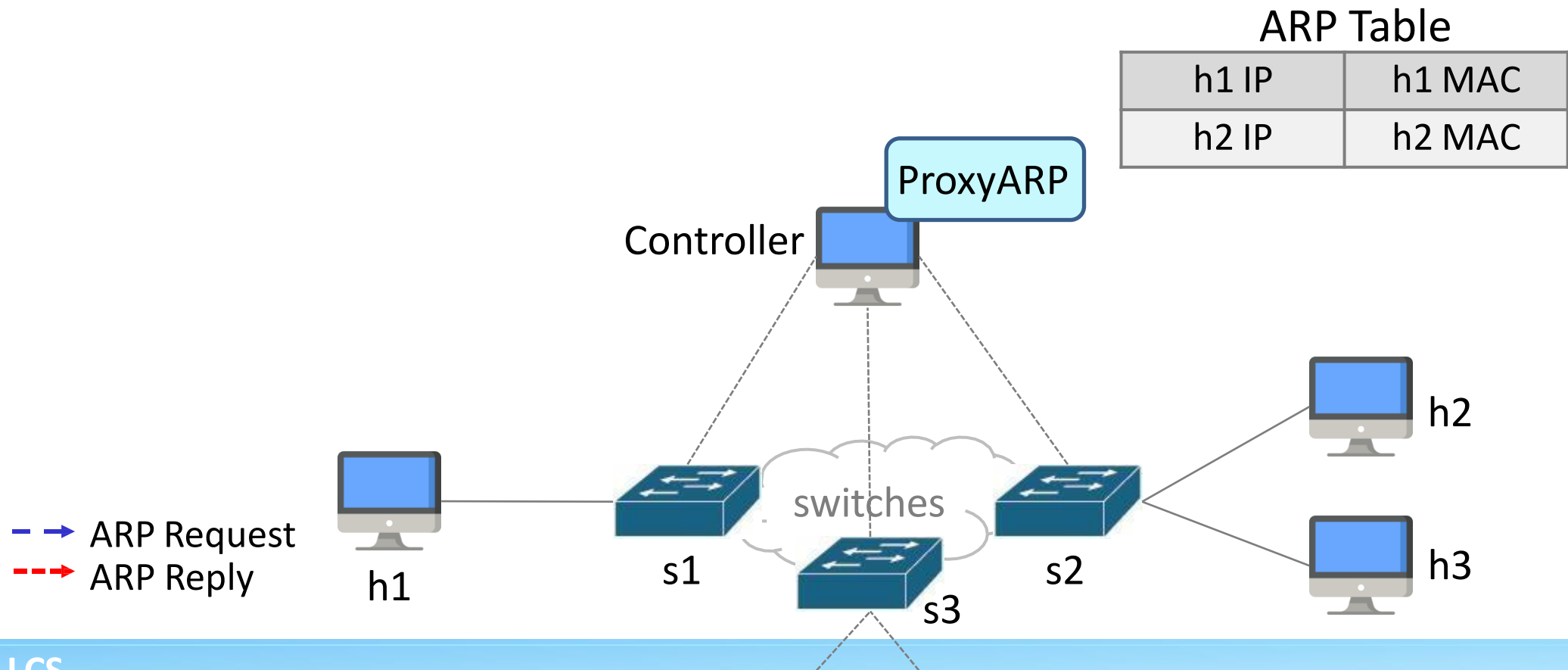
7. Edge switch Packet-Ins the Reply to controller





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:
 $100 \times 60\% + 80 \times 40\% = 92.$



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>