



Project 5

Proxy ARP

Deadline: 2022/11/23 (WED) 23:55



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



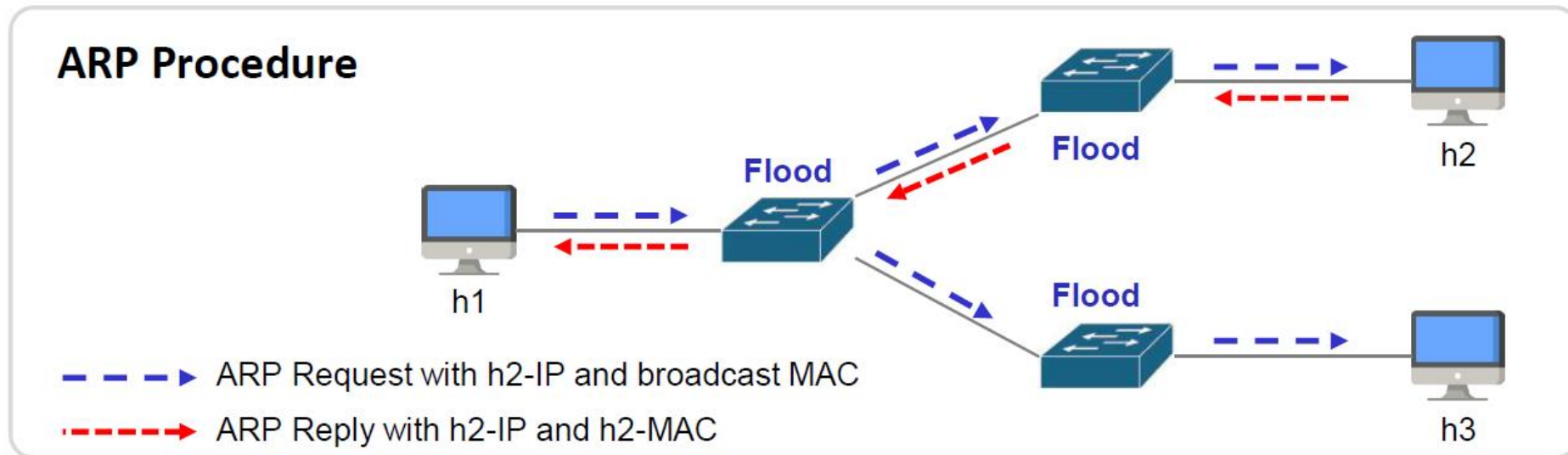
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What is Address Resolution Protocol (ARP)

- 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 address





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 (ARP reply = 1)
Sender Hardware Address (h1-IP)		
Sender Protocol Address (h2-IP)		
Target Hardware Address (00:00:00:00:00:00)		
Target Protocol Address (h1-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 (ARP reply = 2)
Sender Hardware Address (h2-MAC)		
Sender Protocol Address (h2-IP)		
Target Hardware Address (h1-MAC)		
Target Protocol Address (h1-IP)		



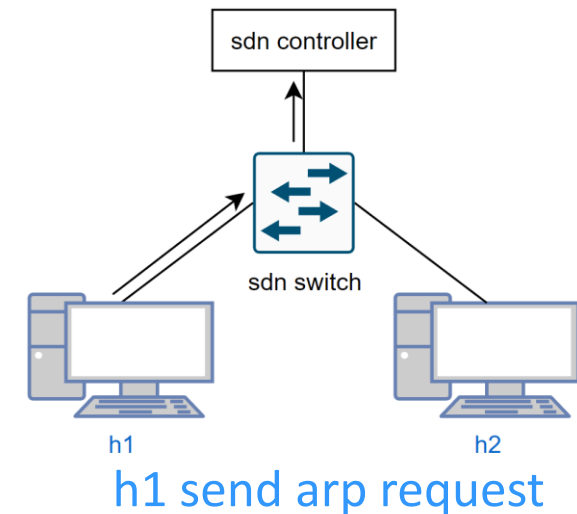
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What is Proxy ARP

- 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 address belongs to the **proxy device**
- In the context of SDN, controller serves as proxy device
 - However, the replied MAC address belongs to the **target host**
 - Benefits:
 - Decreases workload of network devices
 - Prevent issues like broadcast storm





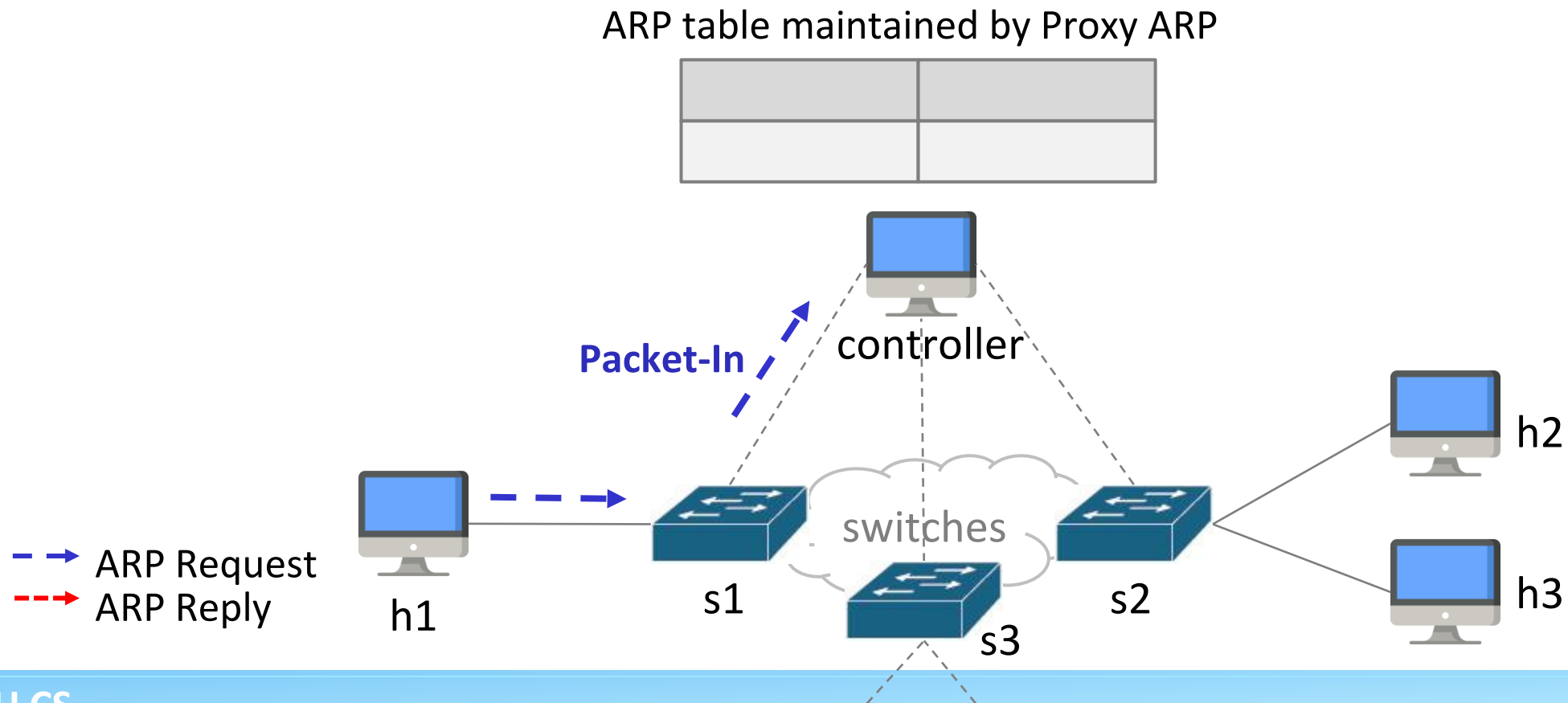
Workflow of Proxy ARP in SDN

1. Sender sends ARP request
2. Edge switch Packet-Ins the request to controller
3. Proxy ARP learns address mappings of the sender
4. Proxy ARP fetches target's MAC from ARP table
 - If mapping not exists:
 - Flood request packet to edge ports except the port receiving ARP request
 - When Proxy ARP receives ARP reply, it records the mapping
 - Else, generate an ARP reply packet
5. Proxy ARP Packet-Outs the ARP reply to the sender(if mapping exists)



First ARP Request (1/4)

- h1 sends ARP request to h2
- The very first switch (s1) performs Packet-In to controller



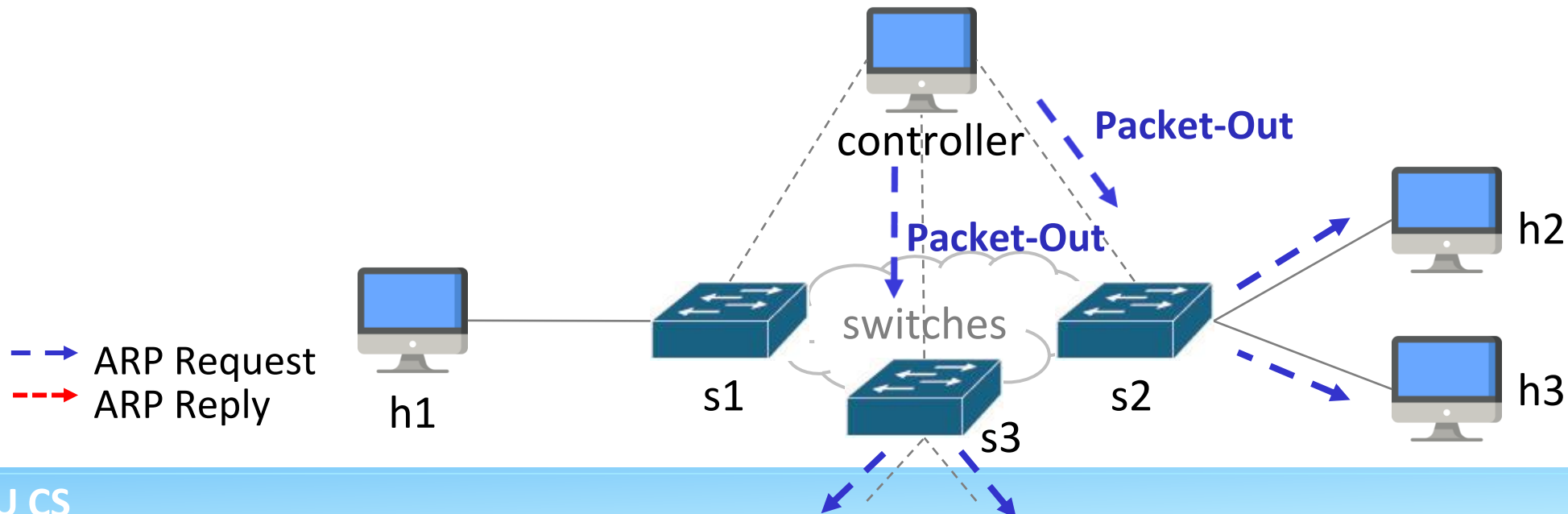


First ARP Request (2/4)

- Controller learns mapping of IP to MAC address of h1
- With mapping of h2 absent, controller needs to discover h2
 - By Packet-Outing the ARP request to all edge ports (ports connecting to host) other than h1's

ARP table maintained by Proxy ARP

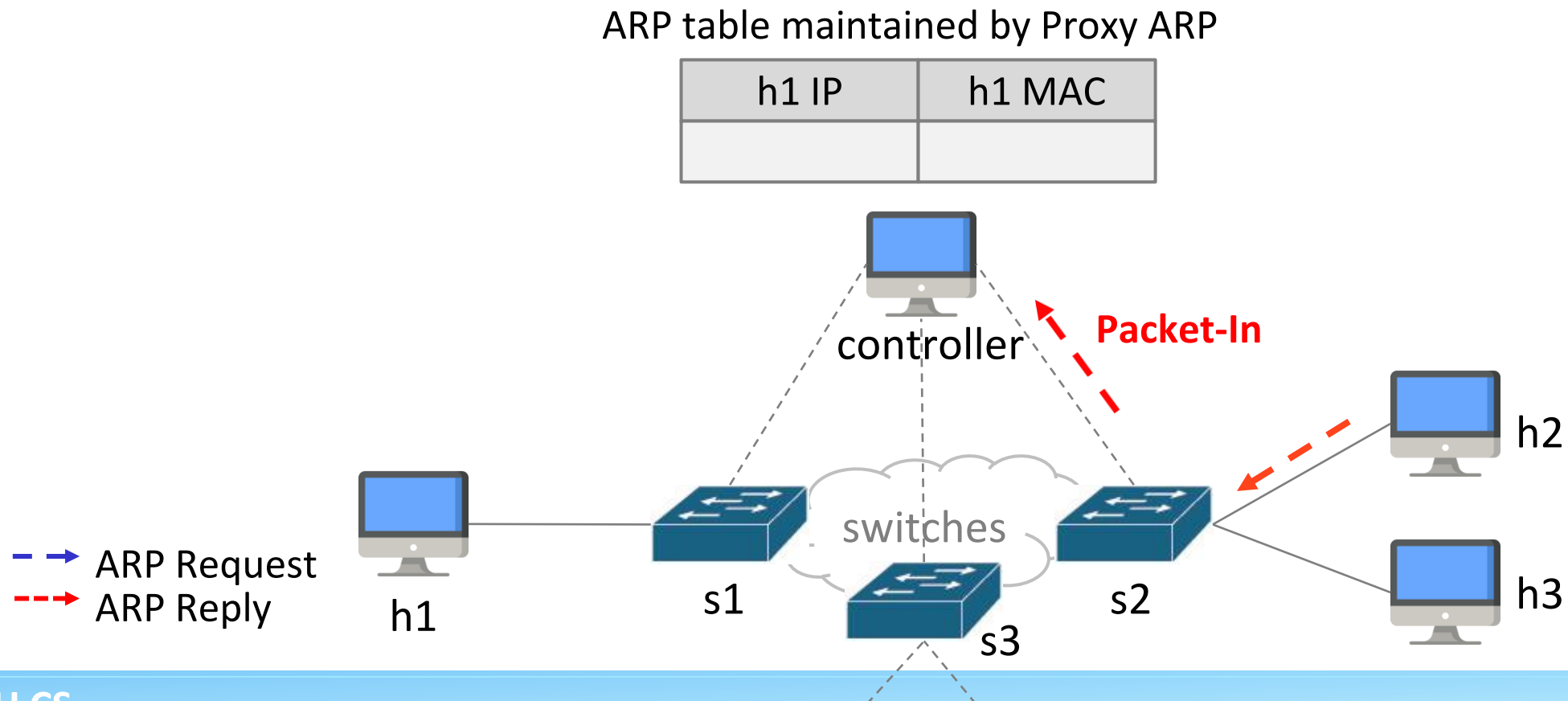
h1 IP	h1 MAC





First ARP Request (3/4)

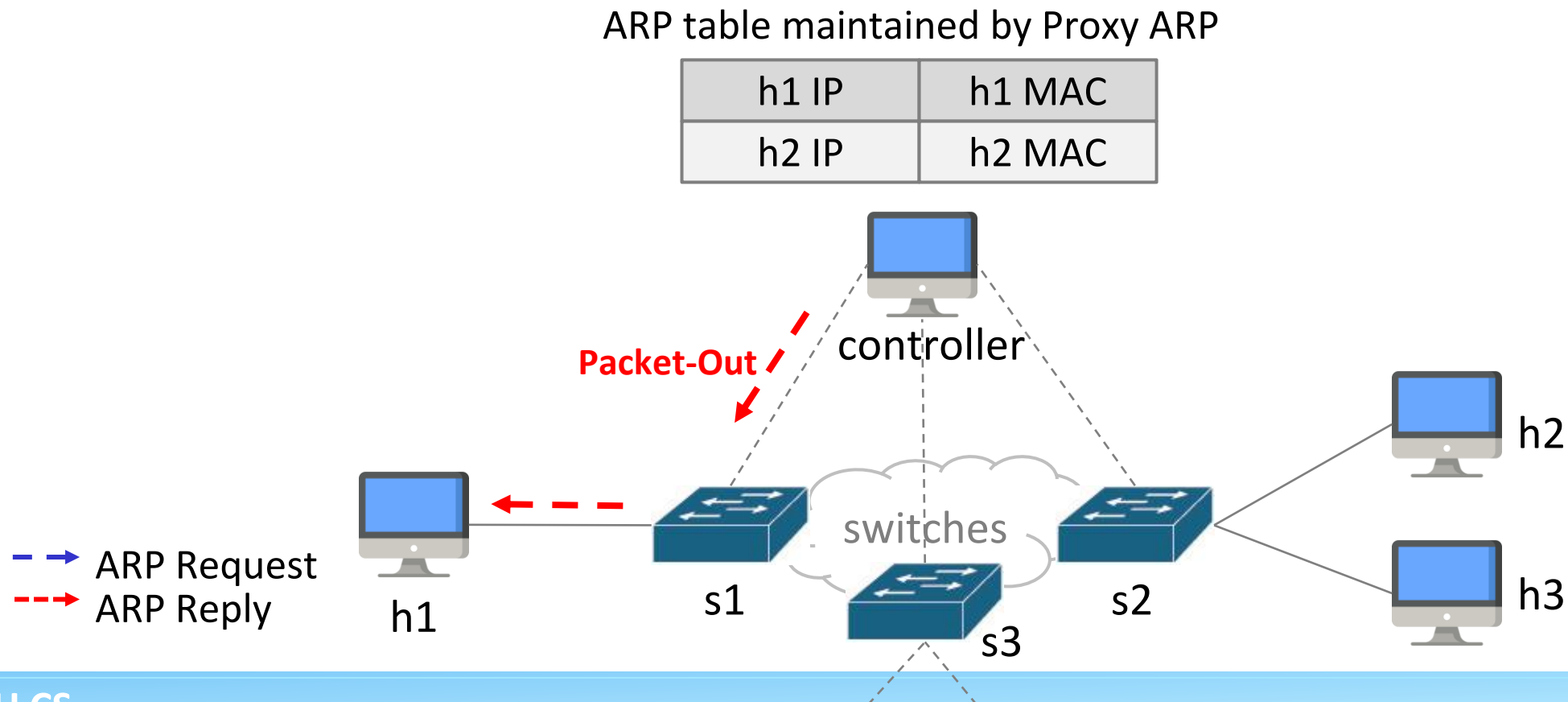
- All other hosts receive ARP requests, but only h2 will send ARP reply
- Again, the very first switch (s2) performs Packet-In to controller





First ARP Request (4/4)

- Controller learns mapping of requested IP to MAC address of h2
- Controller Packet-Outs the ARP reply to the switch connected to h1



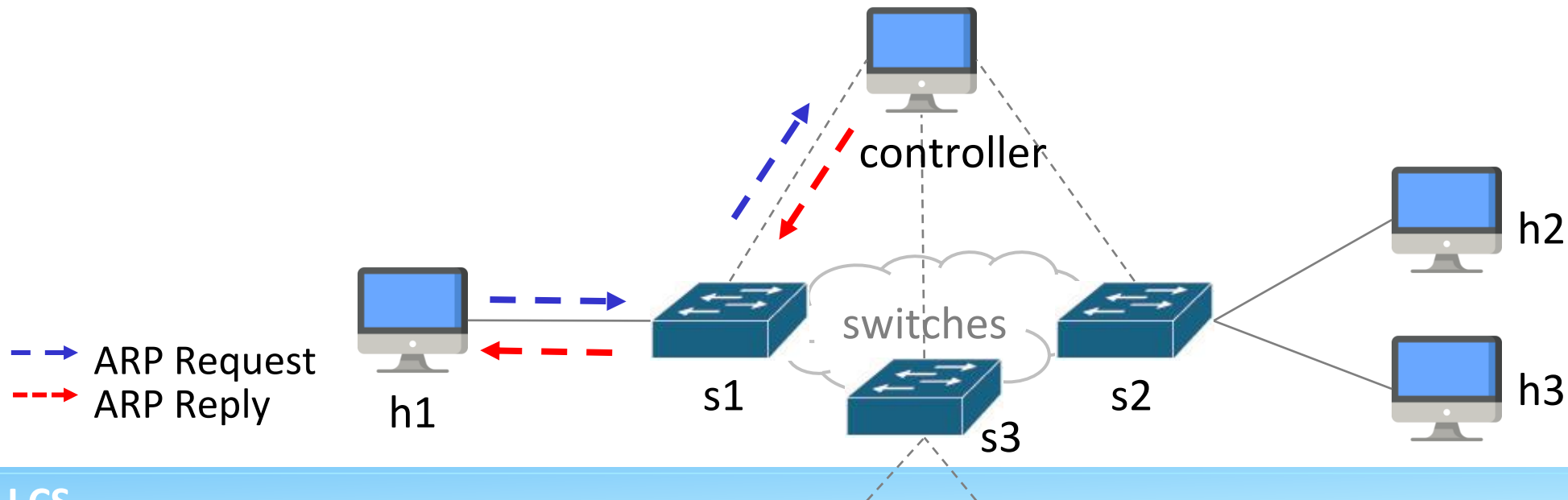


Subsequent ARP Request

- If h1 sends ARP request to h2 again
 - Since controller has learned the address mapping of h2, it just generates and Packet-Out the ARP reply to the ingress port

ARP table maintained by Proxy ARP

h1 IP	h1 MAC
h2 IP	h2 MAC





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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
```



Naming Requirement

- You should follow the Maven project naming format below
- Otherwise, your project will result in 10 points deduction
 - <groupId>: `nctu.winlab`
 - <artifactId>: `ProxyArp`
 - <version>: `<use default> (1.0-SNAPSHOT)`
 - <Package>: `nctu.winlab.ProxyArp`



Project 5 Scoring Criteria

- (10%) Project naming convention
- (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

- Files
 - All files of your application
- Submission
 - Upload “.zip” file to e3
 - Named: **project5_<studentID>.zip**
 - Incorrect naming convention 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-reserved table 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>