

# Project 5

*Proxy ARP*

**Deadline: 2020/11/25 (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

## ☐ Reference



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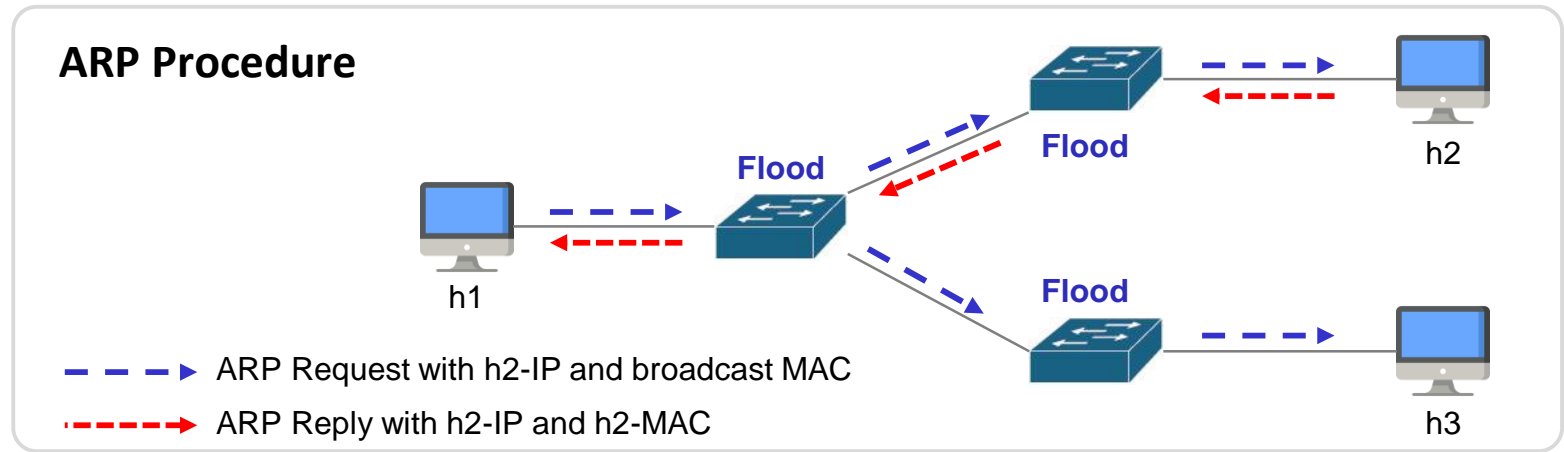
## ☐ Project 5 Requirements

## ☐ Reference



# 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 a ARP table for mapping of IPv4 to MAC address





# ARP Request Packet Frame

- Following table depicts ARP request packet format (Find IPv4 from MAC)

Hardware Type (Ethernet = 1)		Protocol Type (IPv4 = 0x0800)
Hardware Length (Ethernet = 6)	Protocol Length (IPv4 = 4)	Operation Code (ARP request = 1)
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 (Find IPv4 from MAC)

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 not in that network
  - 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:
    - Decrease workload of network devices
    - Prevent issues like broadcast storm





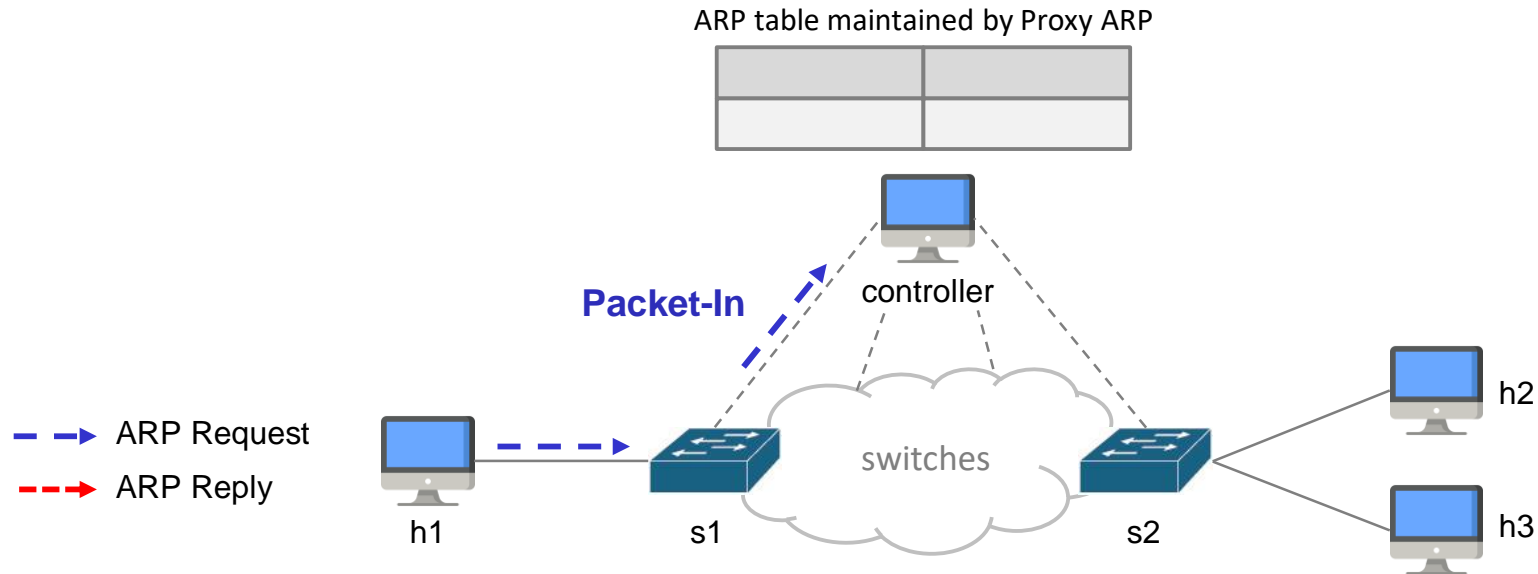
# Workflow of Proxy ARP in SDN

1. Sender sends ARP request
2. Edge switch Packet-Ins the request to controller
3. Proxy ARP learns address mappings of sender
4. Proxy ARP fetches target's MAC from ARP table
  - If mapping not exists
    - a. Flood request packet to edge ports
    - b. Wait for ARP reply from target
    - c. Learn address mapping of target
  - Else, Generate a ARP reply packet
5. Proxy ARP Packet-Outs the ARP reply to sender



# First ARP Request (1/4)

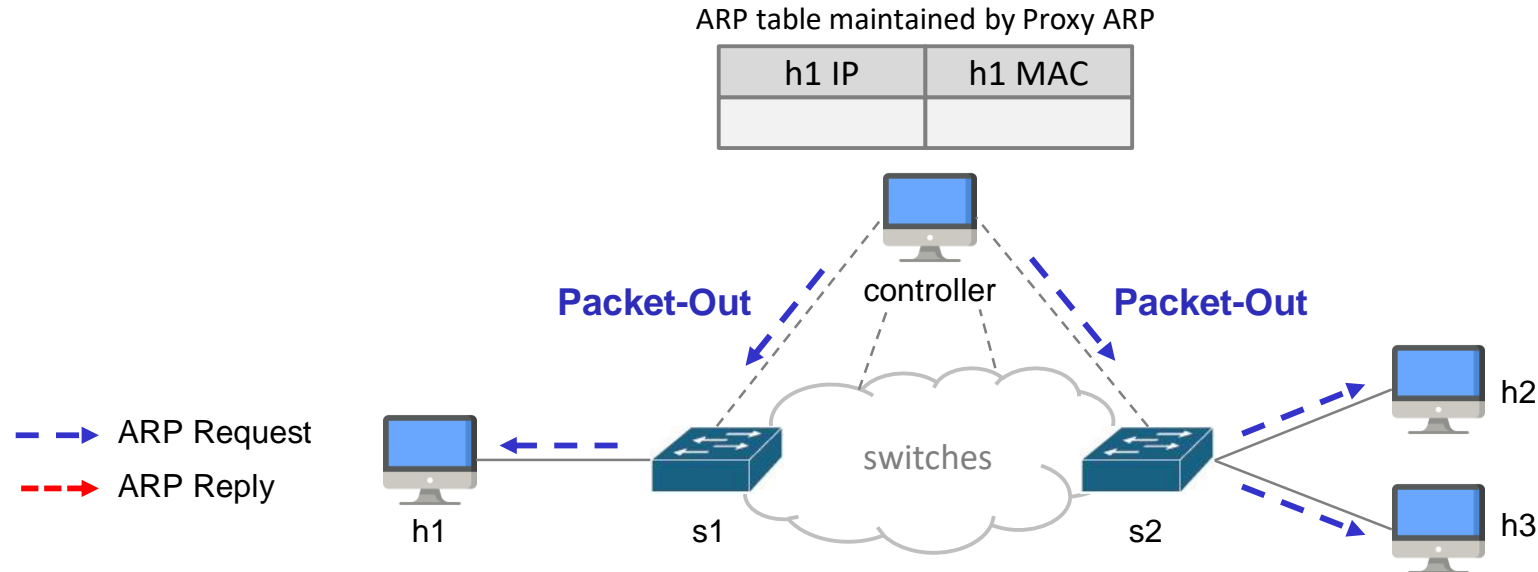
- h1 sends ARP request to h2
- The very first switch (s1) performs Packet-In to controller





# First ARP Request (2/4)

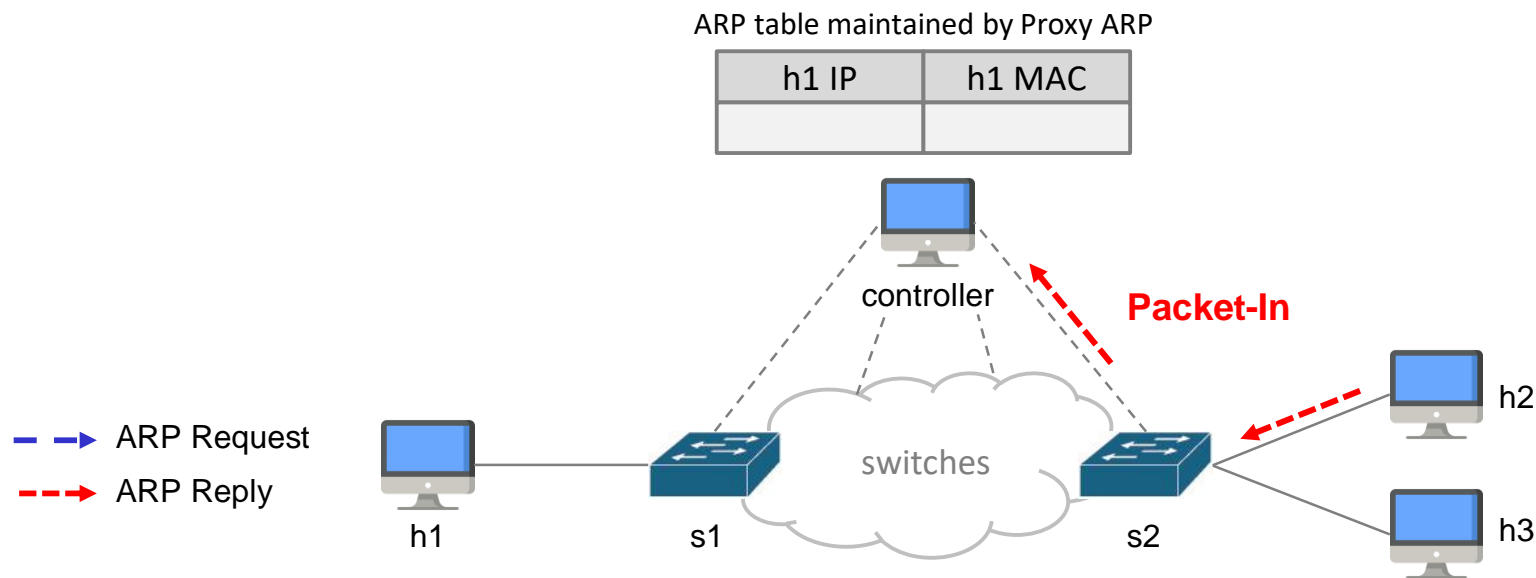
- ❑ Controller learns mapping of IP to MAC address of h1
- ❑ With mapping of h2 absent, controller needs to discover h2
  - By Packet-Outing the ARP request to all edge ports (ports connecting to host)





# First ARP Request (3/4)

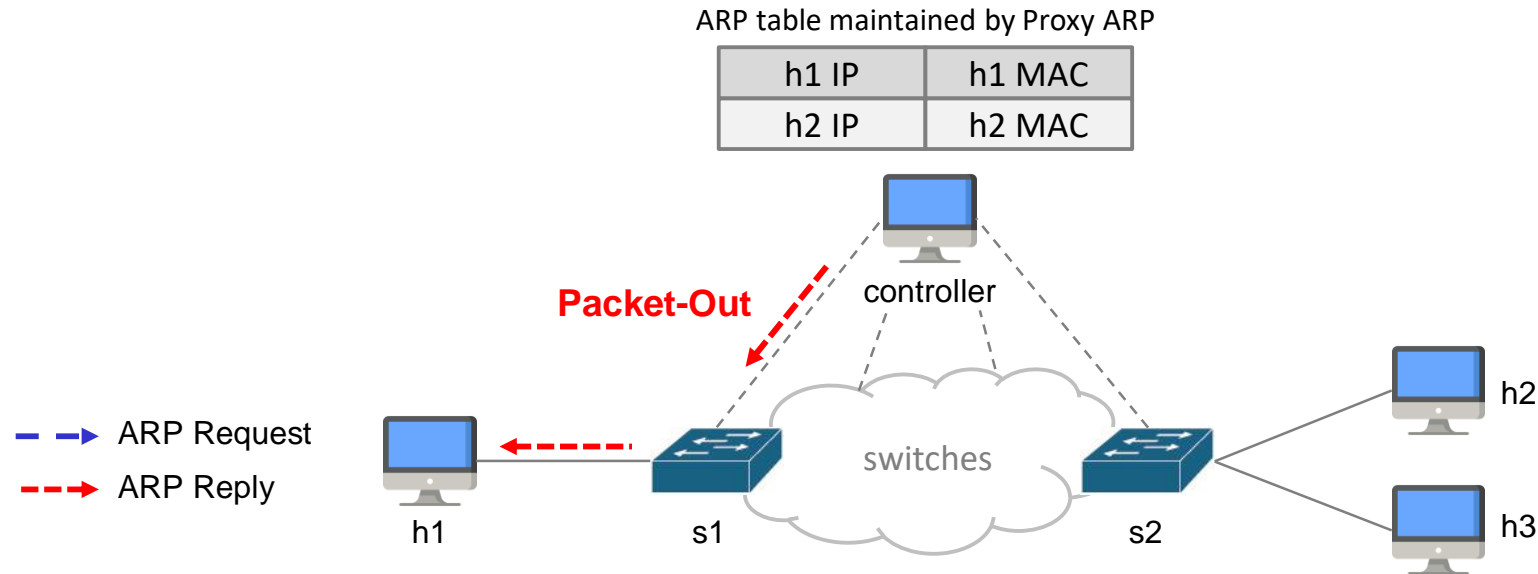
- All hosts receive ARP requests, but only h2 will send ARP reply
- Again, the very first switch (s2) performs Packet-In to controller





# First ARP Request (4/4)

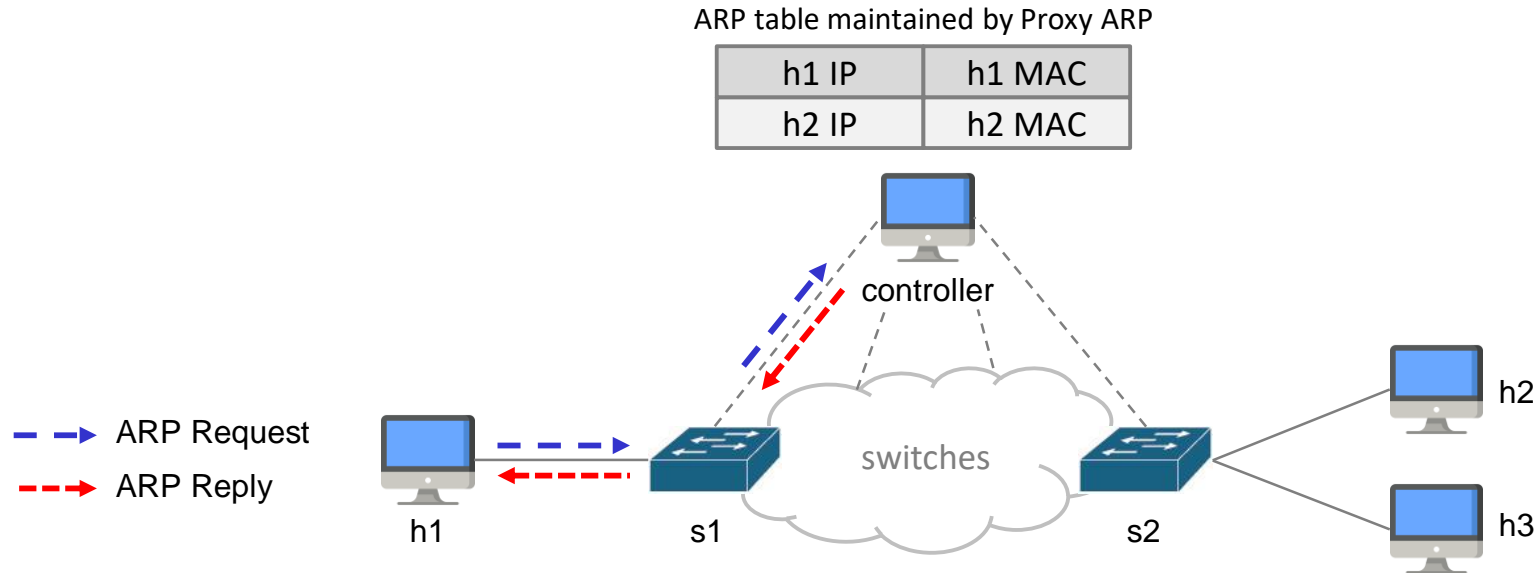
- ❑ Controller learns mapping of requested IP to MAC address of h2
- ❑ Controller Packet-Outs the ARP reply to the switch connected to h1





# 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





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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





# Test Your Application

- ❑ Once you activating your application and Mininet, executeing **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 not be scored
  - `<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
  - ONOS receives ARP reply from host

```
| 209 - nctu.winlab.ProxyArp - 1.0.0.SNAPSHOT | TABLE MISS. Send request to edge ports  
| 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)** topology
  - All hosts are able to **arping** to each other



# Submission



## Files

- All files of your application



## Submission

- Upload “.zip” file to e3
  - Name: **project5\_<studentID>.zip**
- Incorrect naming convention or format will not be scored



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# Reference

## ❑ For fetching network topology status

- <http://api.onosproject.org/2.2.0/apidocs/org/onosproject/net/host/HostService.html>
- <http://api.onosproject.org/2.2.0/apidocs/org/onosproject/net/edge/EdgePortService.html>

## ❑ For packet manipulation

- <http://api.onosproject.org/2.2.0/apidocs/org/onlab/packet/Ethernet.html>
- <http://api.onosproject.org/2.2.0/apidocs/org/onlab/packet/ARP.html>