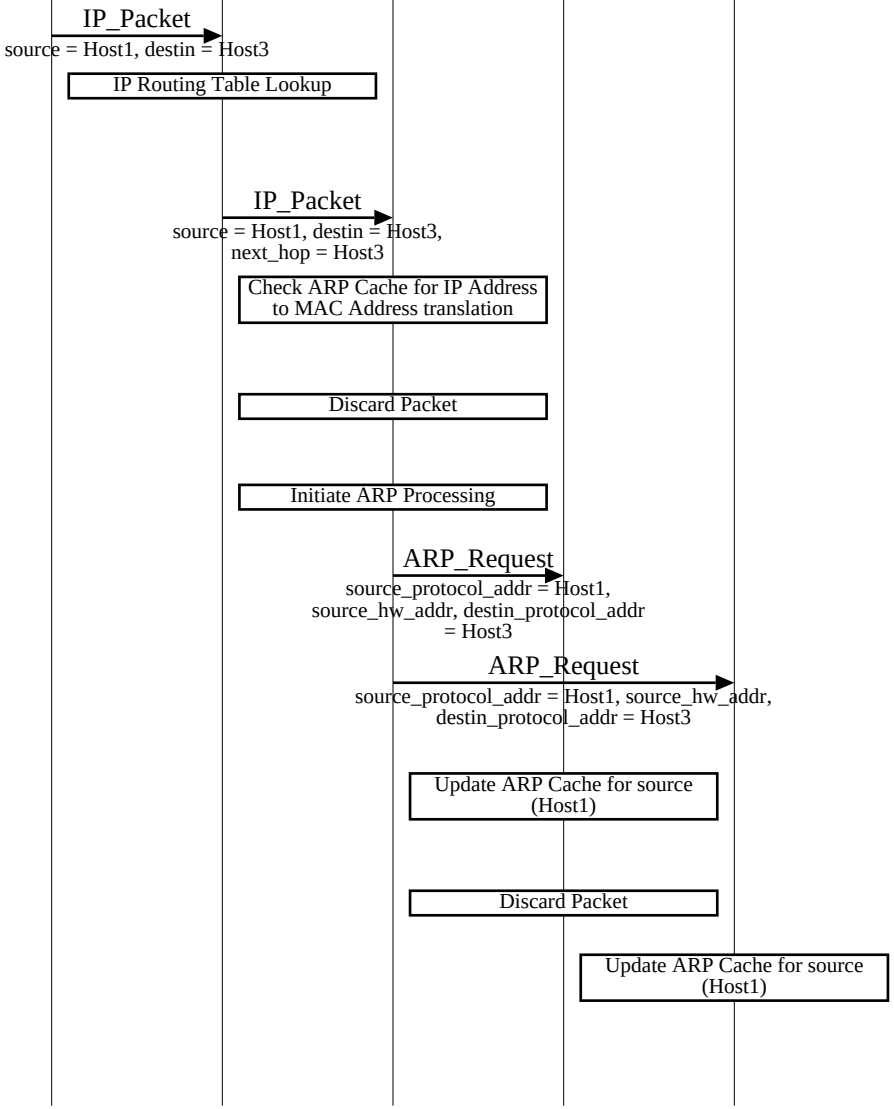
ARP - Address Resolution Protocol (ARP within a Subnet)

Subnet 1					Intranet	Subnet 2	EventHelix.com/EventStudio 1.0
Host1			Host2	Host3	Router	Host4	
Application	IP Stack	LAN Driver 1	LAN Driver 2	LAN Driver 3	Router Driver	LAN Driver 4	03-Feb-02 18:50 (Page 1)

LEG: ARP within a subnet

ARP (Address Resolution Protocol) is responsible for mapping from IP addresses to network specific addressing mechanisms. For example, ARP on Ethernet provides mapping between 32 bit IP addresses and 48 bit MAC addresses. ARP is considered to be a low level protocol and it is generally handled at the device driver level. ARP implementation is dependent on the underlying network technology. Here we will be describing an ARP implementation for Ethernet

Host 1 transmits first packet after booting up



Application sends an IP message destined for Host 3

IP routing software consults the IP routing table to determine the IP address of the next hop. In this case the message is being sent to Host 3 which is directly connected to the same LAN, thus the destination and next hop are the same address (Host 3)

The IP packet is passed to the LAN driver for transport over the Ethernet

LAN driver needs to determine the 48 bit MAC address corresponding to the IP Destination Address (Host3). The ARP Cache is searched to find the MAC address corresponding to the IP address.

IP Address to MAC address translation could not be found in the ARP cache so this packet will be discarded. (Assuming that higher layers will recover from this lost packet)

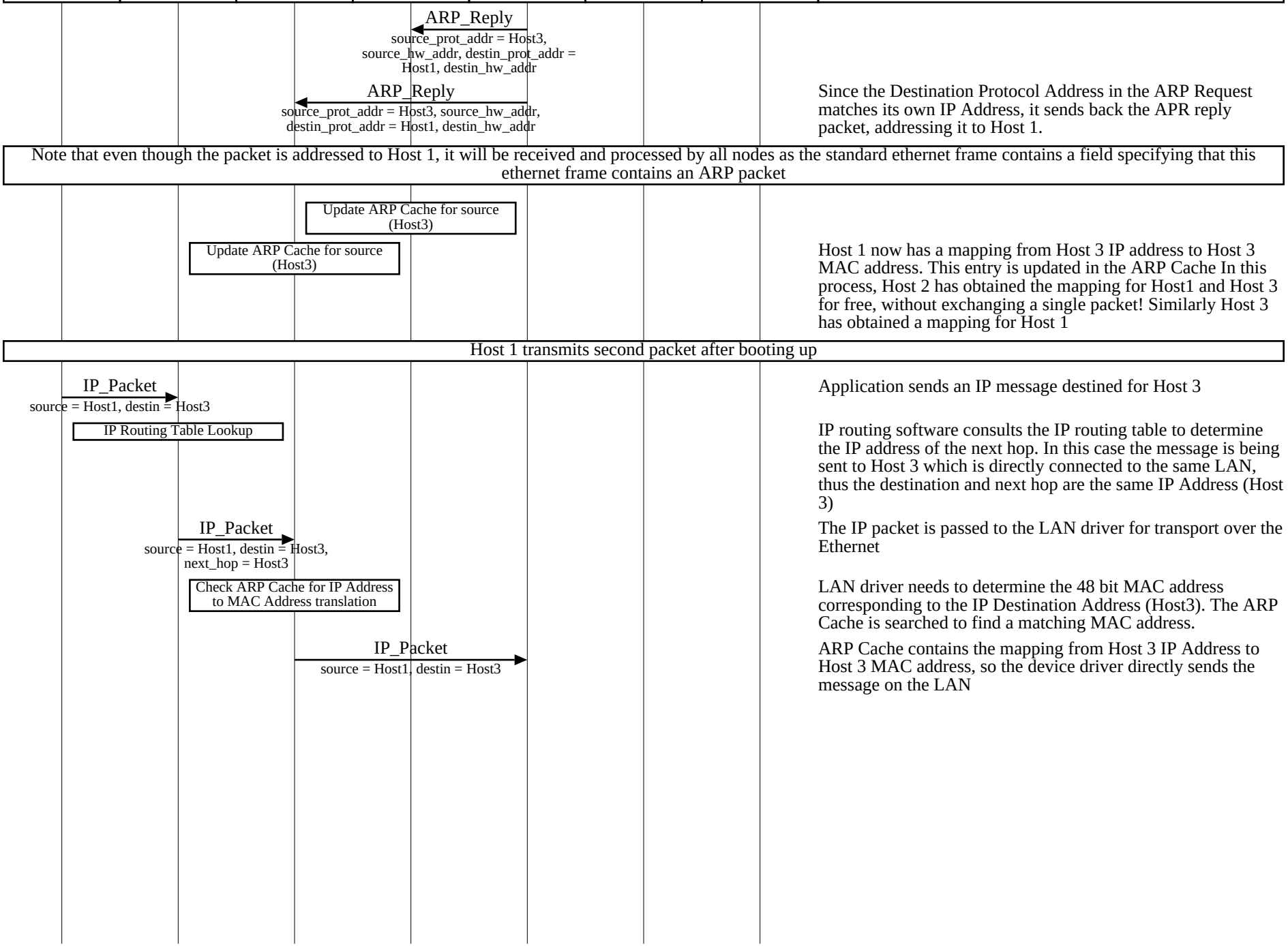
The Address Resolution Protocol (ARP) will be used to determine the MAC address corresponding to the IP address

ARP sends out the ARP Request packet as a ethernet broadcast. All machines on the ethernet receive the message as the ethernet frame indicates that this is an ARP packet. (Here, the broadcast is shown as multiple messages)

Host 2 processes the ARP Request packet. It checks its ARP cache to determine if it has a mapping between the source protocol address and the source hardware address (Host1 in this case). If a mapping is not found, the ARP cache is updated

This ARP request does not target Host 2, so it can now discard the packet

Host 3 processes the ARP Request packet. It checks its ARP cache to determine if it has a mapping between the source protocol address and the source hardware address (Host 1 in this case)


ARP_Reply
source_prot_addr = Host3, source_hw_addr, destin_prot_addr = Host1, destin_hw_addr
ARP_Reply
source_prot_addr = Host3, source_hw_addr, destin_prot_addr = Host1, destin_hw_addr
Since the Destination Protocol Address in the ARP Request matches its own IP Address, it sends back the APR reply packet, addressing it to Host 1.
Note that even though the packet is addressed to Host 1, it will be received and processed by all nodes as the standard ethernet frame contains a field specifying that this ethernet frame contains an ARP packet
Update ARP Cache for source (Host3)
Update ARP Cache for source (Host3)
Host 1 now has a mapping from Host 3 IP address to Host 3 MAC address. This entry is updated in the ARP Cache In this process, Host 2 has obtained the mapping for Host1 and Host 3 for free, without exchanging a single packet! Similarly Host 3 has obtained a mapping for Host 1
Host 1 transmits second packet after booting up
IP_Packet
source = Host1, destin = Host3
Application sends an IP message destined for Host 3
IP Routing Table Lookup
IP routing software consults the IP routing table to determine the IP address of the next hop. In this case the message is being sent to Host 3 which is directly connected to the same LAN, thus the destination and next hop are the same IP Address (Host 3)
IP_Packet
source = Host1, destin = Host3, next_hop = Host3
The IP packet is passed to the LAN driver for transport over the Ethernet
Check ARP Cache for IP Address to MAC Address translation
LAN driver needs to determine the 48 bit MAC address corresponding to the IP Destination Address (Host3). The ARP Cache is searched to find a matching MAC address.
IP_Packet
source = Host1, destin = Host3
ARP Cache contains the mapping from Host 3 IP Address to Host 3 MAC address, so the device driver directly sends the message on the LAN

ARP - Address Resolution Protocol (Proxy ARP)

Subnet 1					Intranet	Subnet 2	EventHelix.com/EventStudio 1.0
Host1			Host2	Host3	Router	Host4	
Application	IP Stack	LAN Driver 1	LAN Driver 2	LAN Driver 3	Router Driver	LAN Driver 4	03-Feb-02 18:50 (Page 3)

LEG: ARP across subnets

Using ARP across subnets: ARP should be used only on a single physical network. ARP can also be used (misused?) to handle hosts that are not aware of subnets. Such a host would consider a host with the same network id but a different subnet as belonging to the same physical network. Such a host will use ARP to obtain the MAC address corresponding to the IP address in a different subnet. Implementation of Proxy ARP on the router is designed to handle this situation

In this Scenario, Host1 to Host 3 belong to Subnet 1 while Host4 belongs to Subnet 2. Router connects to both the Subnets and routes packets between them

First packet for Host 4

IP_Packet
source = Host1, destin = Host4

An application generates an IP packet for Host4, a machine on a different subnet

IP_Packet
source = Host1, destin = Host4

Packet for Host 4 is passed to the LAN Driver

ARP_Request
source_protocol_addr = Host1, source_hw_addr, destin_protocol_addr = Host4

Host1 is not aware that Host4 is on a different subnet, it assumes that Host4 is on the same physical network. Thus it sends out an ARP Request for Host4. This broadcast is received by the Router

ARP_Reply
source_protocol_addr = Host4, source_hw_addr = Router_MAC_Addr,
destin_protocol_addr = Host1, destin_hw_addr

Router realizes that Host 1 thinks that Host 4 is on the same physical network. (That's why it is attempting to use ARP). Router recognizes the Host 4 machine as connected to Subnet2. Thus it sends an ARP Reply indicating that its own MAC address should be used to send packets to Host 4

Second packet for Host 4

IP_Packet
source = Host1, destin = Host4

An application generates another IP packet for Host4

IP_Packet
source = Host1, destin = Host4

Packet for Host 4 is passed to the LAN Driver

IP_Packet
source = Host1, destin = Host4, destin_mac_addr = Router

As a result of the ARP reply, the ARP Cache maps Host 4 IP address to Routers MAC address. Thus the packet is forwarded to the Router

IP_Packet
source = Host1, destin = Host4,
destin_mac_addr = Host4_mac_addr

Router routes the packet to Host 4 on a different subnet