# PCP Interoperability Test Report
# Apple Airport Extreme
# IETF-89

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v0.1

# Summary

- Apple's Airport Extreme implementation is a feature parity upgrade from NAT-PMP
  - http://www.ietf.org/proceedings/88/slides/slides-88-pcp-5.pdf
- Solid, no major issues
- Some interesting results
- Tests still on-going

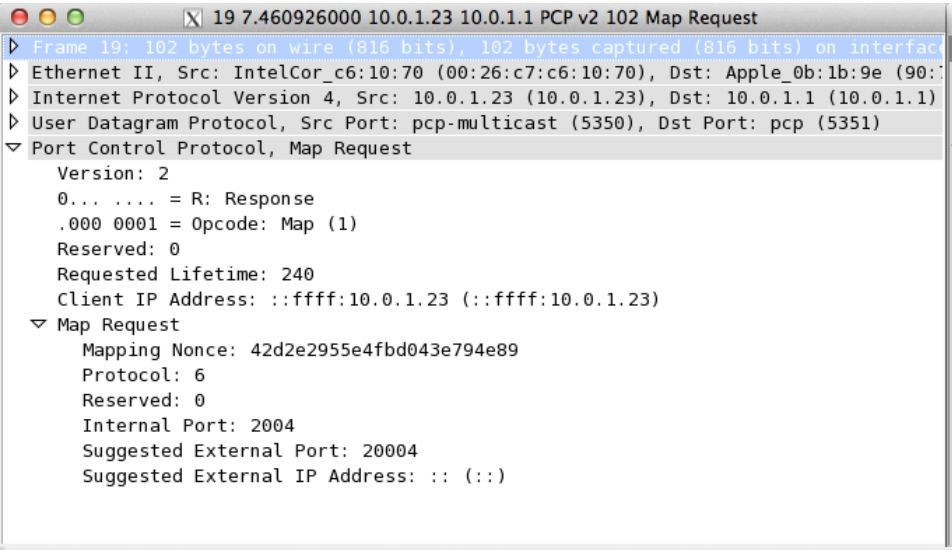
# Logistics

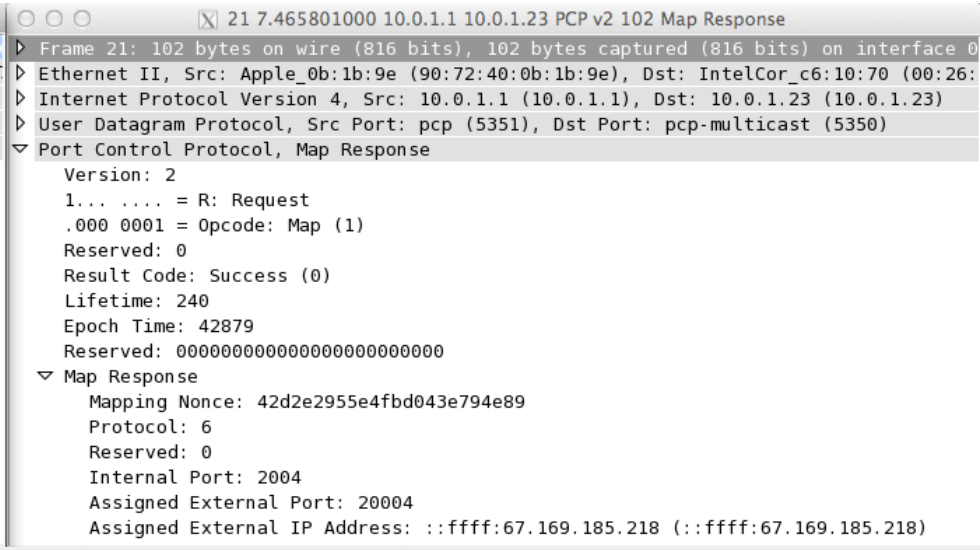
- PCP Client: https://github.com/libpcp/pcp
- PCP Server: http://www.apple.com/airport-extreme/
- Port Scanner: http://www.whatsmyip.org/port-scanner/

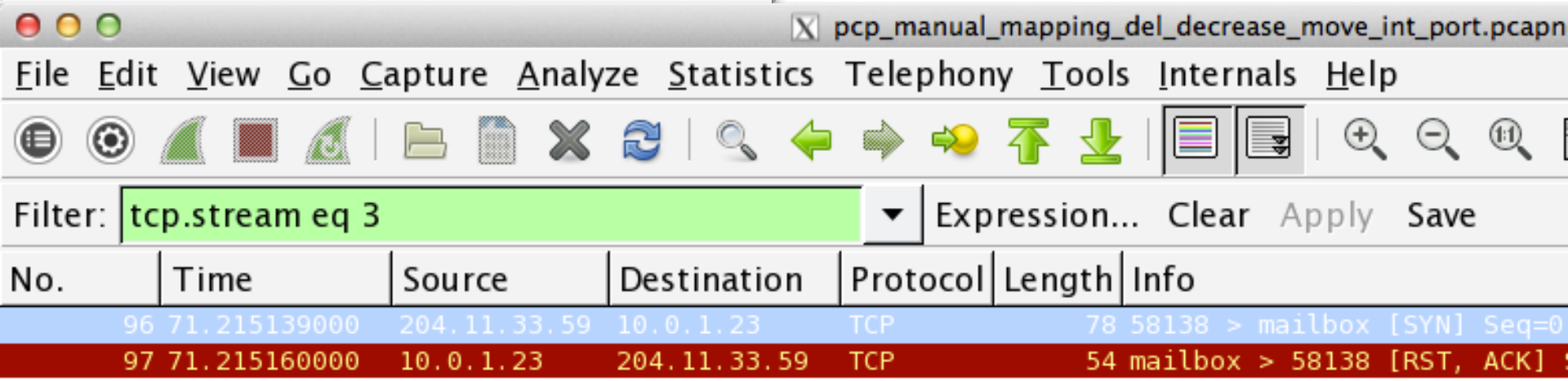
# First Test

- MAP Add
- Outside->In connection
- MAP Delete

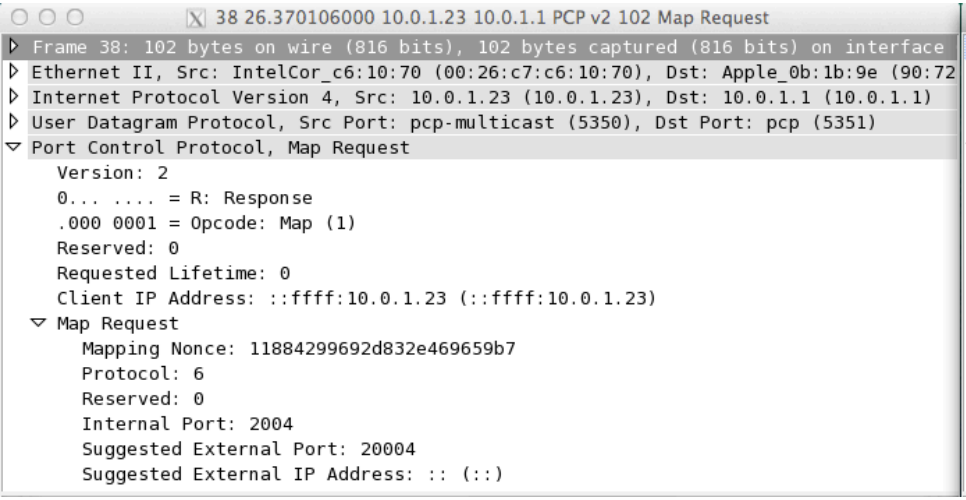
# MAP Add, Out->In Connection

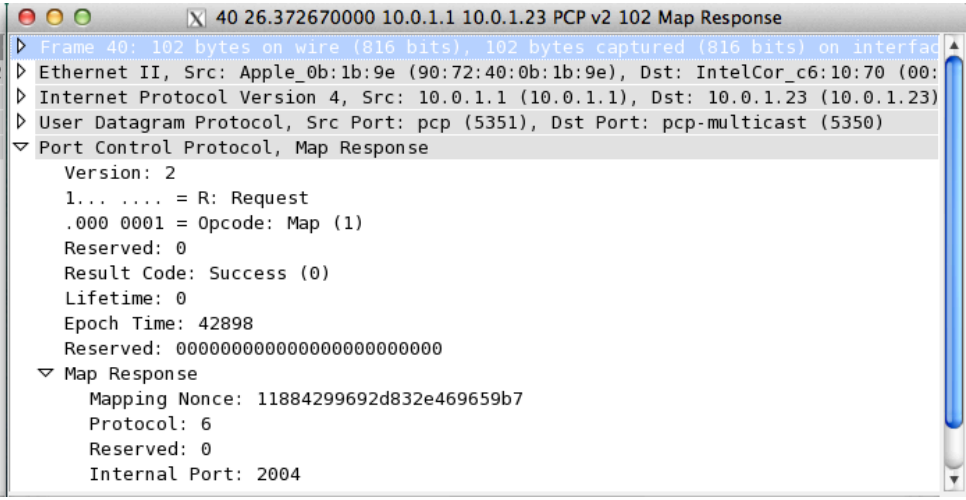


# MAP Delete

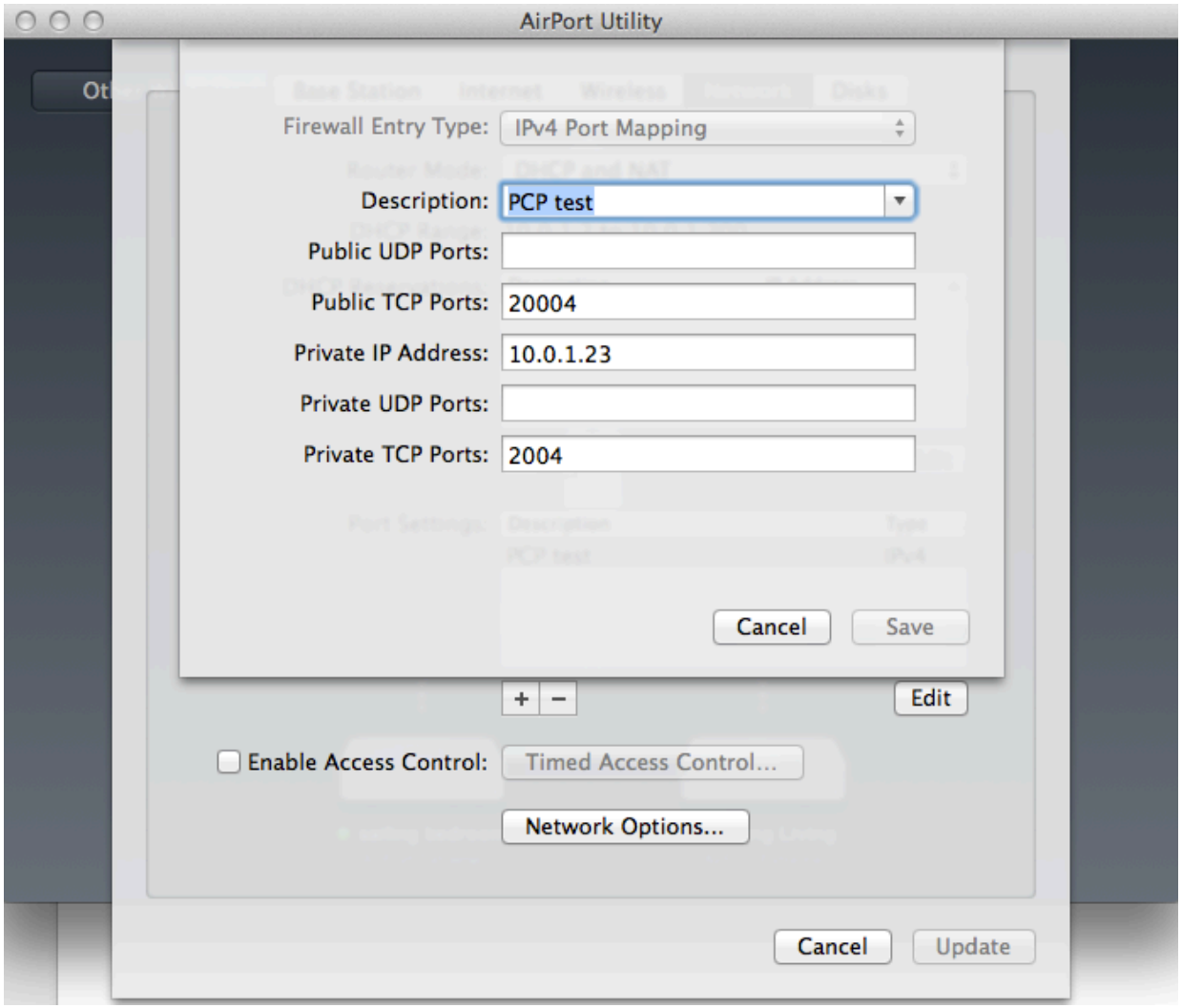

38 26.370106000 10.0.1.23 10.0.1.1 PCP v2 102 Map Request
Frame 38: 102 bytes on wire (816 bits), 102 bytes captured (816 bits) on interface
Ethernet II, Src: IntelCor_c6:10:70 (00:26:c7:c6:10:70), Dst: Apple_0b:1b:9e (90:72
Internet Protocol Version 4, Src: 10.0.1.23 (10.0.1.23), Dst: 10.0.1.1 (10.0.1.1)
User Datagram Protocol, Src Port: pcp-multicast (5350), Dst Port: pcp (5351)
Port Control Protocol, Map Request
Version: 2
0... .... = R: Response
.000 0001 = Opcode: Map (1)
Reserved: 0
Requested Lifetime: 0
Client IP Address: ::ffff:10.0.1.23 (::ffff:10.0.1.23)
Map Request
Mapping Nonce: 11884299692d832e469659b7
Protocol: 6
Reserved: 0
Internal Port: 2004
Suggested External Port: 20004
Suggested External IP Address: :: (::)


40 26.372670000 10.0.1.1 10.0.1.23 PCP v2 102 Map Response
Frame 40: 102 bytes on wire (816 bits), 102 bytes captured (816 bits) on interfac
Ethernet II, Src: Apple_0b:1b:9e (90:72:40:0b:1b:9e), Dst: IntelCor_c6:10:70 (00:
Internet Protocol Version 4, Src: 10.0.1.1 (10.0.1.1), Dst: 10.0.1.23 (10.0.1.23)
User Datagram Protocol, Src Port: pcp (5351), Dst Port: pcp-multicast (5350)
Port Control Protocol, Map Response
Version: 2
1... .... = R: Request
.000 0001 = Opcode: Map (1)
Reserved: 0
Result Code: Success (0)
Lifetime: 0
Epoch Time: 42898
Reserved: 000000000000000000000000
Map Response
Mapping Nonce: 11884299692d832e469659b7
Protocol: 6
Reserved: 0
Internal Port: 2004

# Second Test

- Create Manual Mapping
- MAP ADD
  - Same internal port, different external ports. Two external ports pointing to same internal port.
  - Possible when one of them is manual
- Rotate PCP mapping
  - Same external port, another internal port.
  - Not possible, automatically allocates another external port.

# Airport Extreme Configuration



# MAP Add, MAP Rotate

606 437.548341000 10.0.1.23 10.0.1.1 PCP v2 102 Map Request

```
Frame 606: 102 bytes on wire (816 bits), 102 bytes captured (816 bits) on interface
Ethernet II, Src: IntelCor_c6:10:70 (00:26:c7:c6:10:70), Dst: Apple_0b:1b:9e (90:72:
Internet Protocol Version 4, Src: 10.0.1.23 (10.0.1.23), Dst: 10.0.1.1 (10.0.1.1)
User Datagram Protocol, Src Port: pcp-multicast (5350), Dst Port: pcp (5351)
Port Control Protocol, Map Request
   Version: 2
   0... .... = R: Response
   .000 0001 = Opcode: Map (1)
   Reserved: 0
   Requested Lifetime: 240
   Client IP Address: ::ffff:10.0.1.23 (::ffff:10.0.1.23)
  Map Request
     Mapping Nonce: 6739371715d785150834a1d5
     Protocol: 6
     Reserved: 0
     Internal Port: 2004
     Suggested External Port: 20005
     Suggested External IP Address: :: (::)
```

608 437.553520000 10.0.1.1 10.0.1.23 PCP v2 102 Map Response

```
Internet Protocol Version 4, Src: 10.0.1.1 (10.0.1.1), Dst: 10.0.1.23 (10.0.1.23)
User Datagram Protocol, Src Port: pcp (5351), Dst Port: pcp-multicast (5350)
Port Control Protocol, Map Response
   Version: 2
   1... .... = R: Request
   .000 0001 = Opcode: Map (1)
   Reserved: 0
   Result Code: Success (0)
   Lifetime: 240
   Epoch Time: 615
   Reserved: 00000000000000000000000000
  Map Response
     Mapping Nonce: 6739371715d785150834a1d5
     Protocol: 6
     Reserved: 0
     Internal Port: 2004
     Assigned External Port: 20005
     Assigned External IP Address: ::ffff:67.169.185.218 (::ffff:67.169.185.218)
```

822 641.239315000 10.0.1.23 10.0.1.1 PCP v2 102 Map Request

```
Frame 822: 102 bytes on wire (816 bits), 102 bytes captured (816 bits) on interfac
Ethernet II, Src: IntelCor_c6:10:70 (00:26:c7:c6:10:70), Dst: Apple_0b:1b:9e (90:7
Internet Protocol Version 4, Src: 10.0.1.23 (10.0.1.23), Dst: 10.0.1.1 (10.0.1.1)
User Datagram Protocol, Src Port: pcp-multicast (5350), Dst Port: pcp (5351)
Port Control Protocol, Map Request
   Version: 2
   0... .... = R: Response
   .000 0001 = Opcode: Map (1)
   Reserved: 0
   Requested Lifetime: 240
   Client IP Address: ::ffff:10.0.1.23 (::ffff:10.0.1.23)
  Map Request
     Mapping Nonce: 50fa7e906bad535361f64b29
     Protocol: 6
     Reserved: 0
     Internal Port: 2005
     Suggested External Port: 20005
     Suggested External IP Address: :: (::)
```

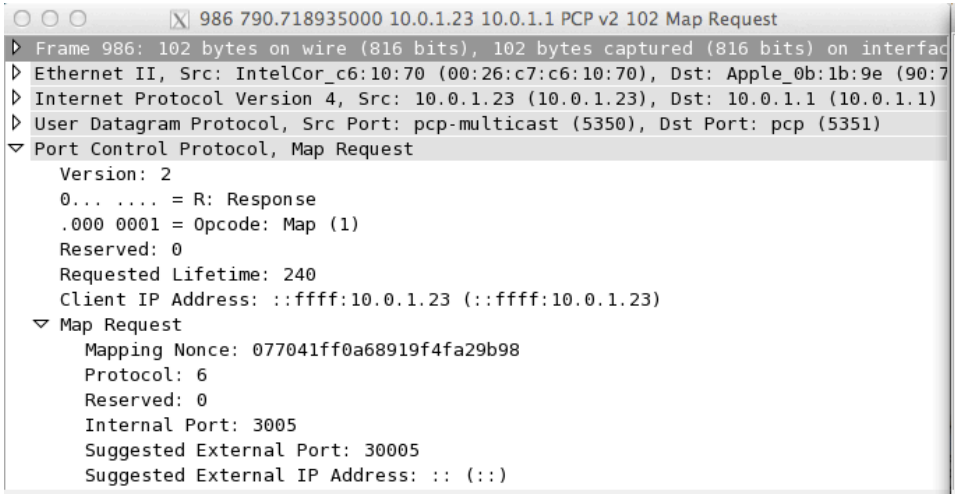
824 641.249547000 10.0.1.1 10.0.1.23 PCP v2 102 Map Response

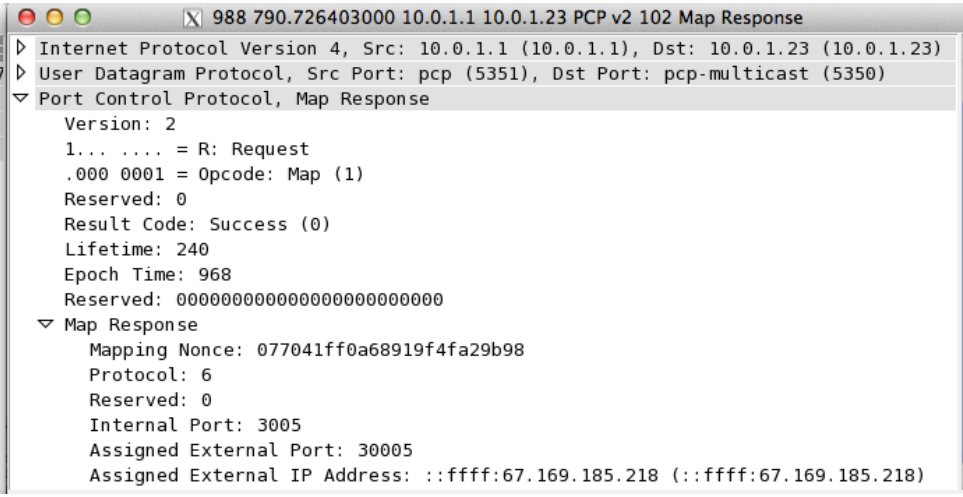
```
Internet Protocol Version 4, Src: 10.0.1.1 (10.0.1.1), Dst: 10.0.1.23 (10.0.1.23)
User Datagram Protocol, Src Port: pcp (5351), Dst Port: pcp-multicast (5350)
Port Control Protocol, Map Response
   Version: 2
   1... .... = R: Request
   .000 0001 = Opcode: Map (1)
   Reserved: 0
   Result Code: Success (0)
   Lifetime: 240
   Epoch Time: 819
   Reserved: 00000000000000000000000000
  Map Response
     Mapping Nonce: 50fa7e906bad535361f64b29
     Protocol: 6
     Reserved: 0
     Internal Port: 2005
     Assigned External Port: 32769
     Assigned External IP Address: ::ffff:67.169.185.218 (::ffff:67.169.185.218)
```

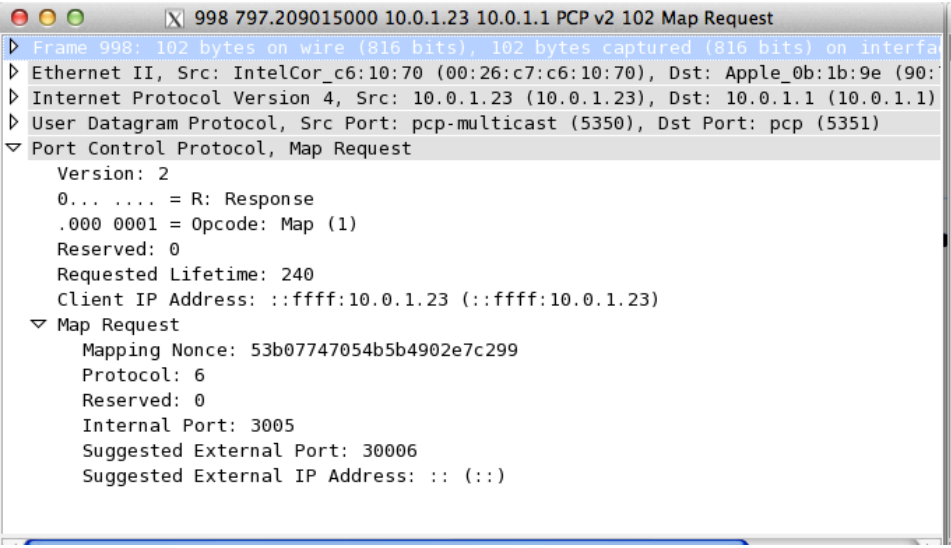
# Third Test

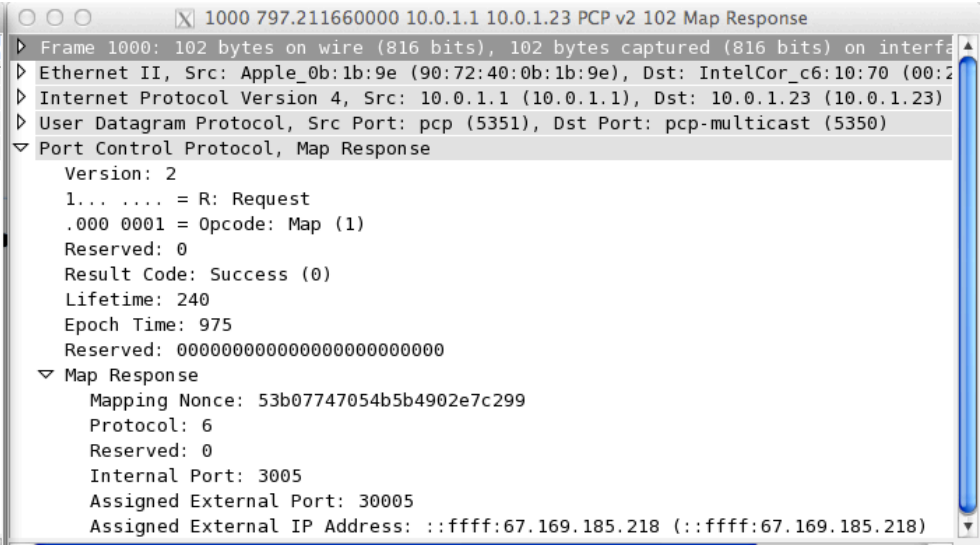
- MAP ADD
  - Same internal port, different external ports. Two external ports pointing to same internal port.
  - **Not** Possible when both mappings are dynamic (PCP)
  - First External 30005-> Internal: 3005 (OK)
  - Then External 30006-> Internal: 3005 (OK, but was assigned 30005 as above)

# Third Test


986 790.718935000 10.0.1.23 10.0.1.1 PCP v2 102 Map Request
Frame 986: 102 bytes on wire (816 bits), 102 bytes captured (816 bits) on interfac
Ethernet II, Src: IntelCor_c6:10:70 (00:26:c7:c6:10:70), Dst: Apple_0b:1b:9e (90:7
Internet Protocol Version 4, Src: 10.0.1.23 (10.0.1.23), Dst: 10.0.1.1 (10.0.1.1)
User Datagram Protocol, Src Port: pcp-multicast (5350), Dst Port: pcp (5351)
Port Control Protocol, Map Request
Version: 2
0... .... = R: Response
.000 0001 = Opcode: Map (1)
Reserved: 0
Requested Lifetime: 240
Client IP Address: ::ffff:10.0.1.23 (::ffff:10.0.1.23)
Map Request
Mapping Nonce: 077041ff0a68919f4fa29b98
Protocol: 6
Reserved: 0
Internal Port: 3005
Suggested External Port: 30005
Suggested External IP Address: :: (::)


988 790.726403000 10.0.1.1 10.0.1.23 PCP v2 102 Map Response
Internet Protocol Version 4, Src: 10.0.1.1 (10.0.1.1), Dst: 10.0.1.23 (10.0.1.23)
User Datagram Protocol, Src Port: pcp (5351), Dst Port: pcp-multicast (5350)
Port Control Protocol, Map Response
Version: 2
1... .... = R: Request
.000 0001 = Opcode: Map (1)
Reserved: 0
Result Code: Success (0)
Lifetime: 240
Epoch Time: 968
Reserved: 000000000000000000000000
Map Response
Mapping Nonce: 077041ff0a68919f4fa29b98
Protocol: 6
Reserved: 0
Internal Port: 3005
Assigned External Port: 30005
Assigned External IP Address: ::ffff:67.169.185.218 (::ffff:67.169.185.218)


998 797.209015000 10.0.1.23 10.0.1.1 PCP v2 102 Map Request
Frame 998: 102 bytes on wire (816 bits), 102 bytes captured (816 bits) on interfa
Ethernet II, Src: IntelCor_c6:10:70 (00:26:c7:c6:10:70), Dst: Apple_0b:1b:9e (90:
Internet Protocol Version 4, Src: 10.0.1.23 (10.0.1.23), Dst: 10.0.1.1 (10.0.1.1)
User Datagram Protocol, Src Port: pcp-multicast (5350), Dst Port: pcp (5351)
Port Control Protocol, Map Request
Version: 2
0... .... = R: Response
.000 0001 = Opcode: Map (1)
Reserved: 0
Requested Lifetime: 240
Client IP Address: ::ffff:10.0.1.23 (::ffff:10.0.1.23)
Map Request
Mapping Nonce: 53b07747054b5b4902e7c299
Protocol: 6
Reserved: 0
Internal Port: 3005
Suggested External Port: 30006
Suggested External IP Address: :: (::)

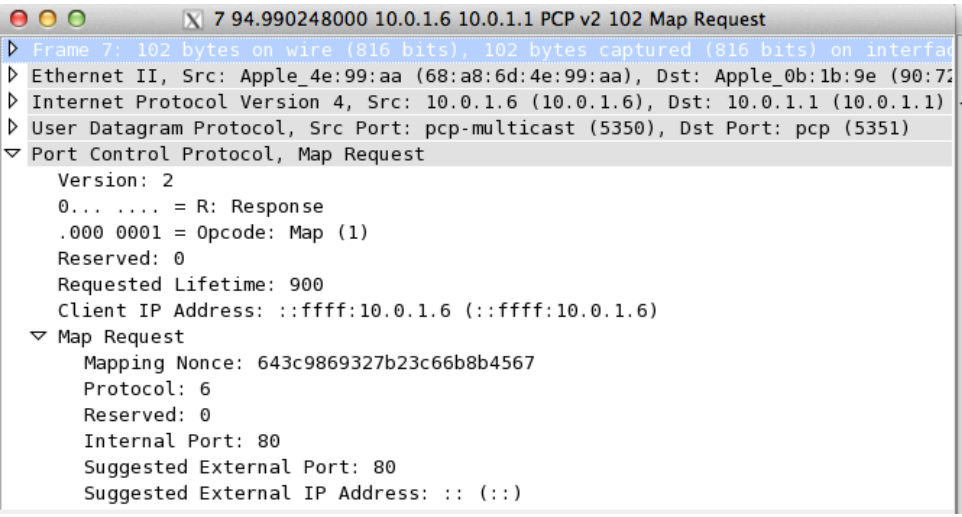

1000 797.211660000 10.0.1.1 10.0.1.23 PCP v2 102 Map Response
Frame 1000: 102 bytes on wire (816 bits), 102 bytes captured (816 bits) on interfa
Ethernet II, Src: Apple_0b:1b:9e (90:72:40:0b:1b:9e), Dst: IntelCor_c6:10:70 (00:2
Internet Protocol Version 4, Src: 10.0.1.1 (10.0.1.1), Dst: 10.0.1.23 (10.0.1.23)
User Datagram Protocol, Src Port: pcp (5351), Dst Port: pcp-multicast (5350)
Port Control Protocol, Map Response
Version: 2
1... .... = R: Request
.000 0001 = Opcode: Map (1)
Reserved: 0
Result Code: Success (0)
Lifetime: 240
Epoch Time: 975
Reserved: 000000000000000000000000
Map Response
Mapping Nonce: 53b07747054b5b4902e7c299
Protocol: 6
Reserved: 0
Internal Port: 3005
Assigned External Port: 30005
Assigned External IP Address: ::ffff:67.169.185.218 (::ffff:67.169.185.218)

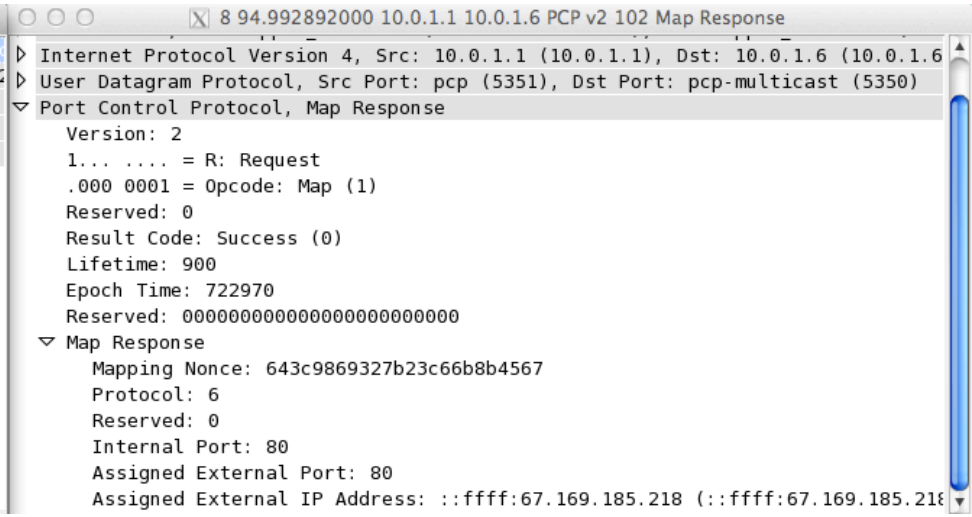
# Test 4-5

- PREFER_FAILURE Option (not supported)
- PEER Opcode (unsupported, Wireshark complains PCP response malformed)

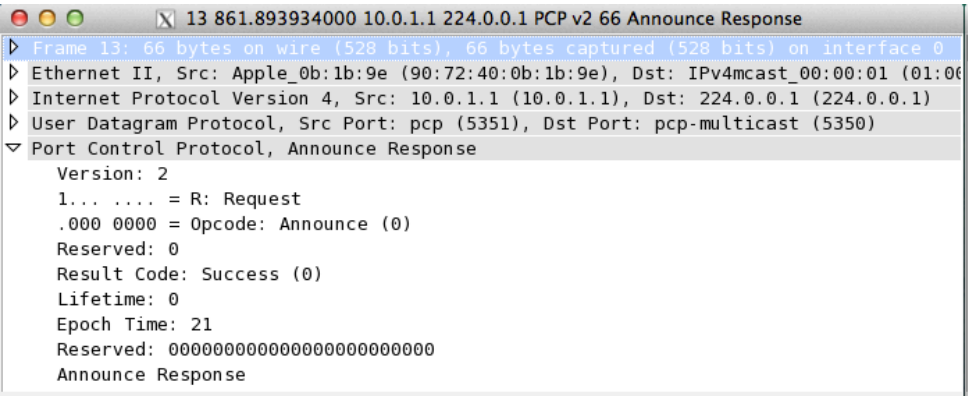
# Test 6

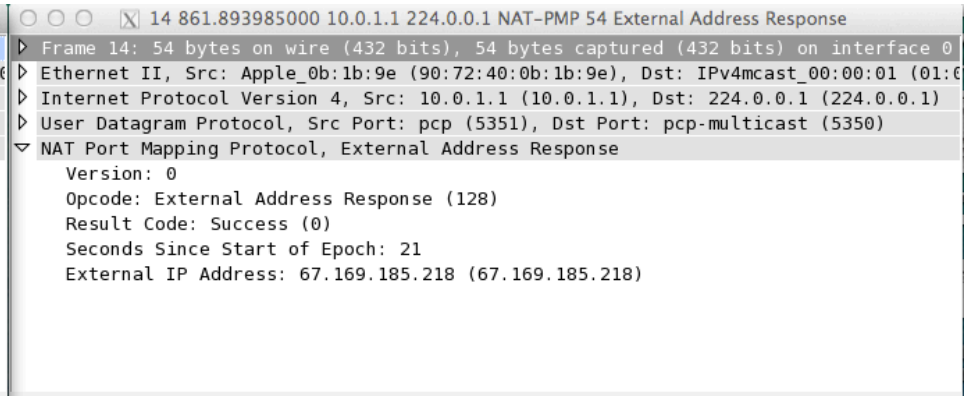
- Port 80 (OK, had to sudo)



# Test 7 - Announce




Both PCP and NAT-PMP Announce messages on reboot

# Test 8

- Shorten Lifetime
- Allowed. Very good for testing, otherwise need to keep guessing how many seconds really need between tests until mapping expires.