5 References


Appendix A - Cable Modem Configuration File Details

A1 Unknown Modem Configuration

// MCNS Configuration file for CM-UnknownCfg
NetworkAccess 1
ClassOfService start
ClassId 1
MaxDownstreamRate 10000000
MaxUpstreamRate 25000000
UpstreamChannelPriority 1
MaxUpstreamBurst 254
PrivacyEnable 1
ClassOfService end
MaxCpeAllowed 1
SnmpMib start

// Filters to permit traffic to selected locations, deny access to others through the ethernet-side

// Permit access to Network Services systems

1.3.6.1.3.83.1.6.3.0 EnumSyntax 1
1.3.6.1.3.83.1.6.4.1.3.5 EnumSyntax 2
1.3.6.1.3.83.1.6.4.1.4.5 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.5.5 EnumSyntax 1
1.3.6.1.3.83.1.6.4.1.6.5 Integer 2
1.3.6.1.3.83.1.6.4.1.7.5 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.8.5 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.9.5 IpAddress 10.2.0.2
1.3.6.1.3.83.1.6.4.1.10.5 IpAddress 255.255.255.255
1.3.6.1.3.83.1.6.4.1.11.5 EnumSyntax 256
1.3.6.1.3.83.1.6.4.1.12.5 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.13.5 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.14.5 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.15.5 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.2.5 Integer 1

// Deny access to all other network nodes

1.3.6.1.3.83.1.6.4.1.3.17 EnumSyntax 1
1.3.6.1.3.83.1.6.4.1.4.17 BoundInteger 2
1.3.6.1.3.83.1.6.4.1.5.17 EnumSyntax 2
1.3.6.1.3.83.1.6.4.1.6.17 Integer 2
1.3.6.1.3.83.1.6.4.1.7.17 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.8.17 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.9.17 IpAddress 10.0.0.0
1.3.6.1.3.83.1.6.4.1.10.17 IpAddress 255.0.0.0
1.3.6.1.3.83.1.6.4.1.11.17 EnumSyntax 256
1.3.6.1.3.83.1.6.4.1.12.17 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.13.17 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.14.17 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.15.17 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.2.17 Integer 1

// Permit all packets through the CATV-side interface

1.3.6.1.3.83.1.6.4.1.3.20 EnumSyntax 2

AOL(2)001824
1.3.6.1.3.83.1.6.4.1.4.20 BoundInteger 2
1.3.6.1.3.83.1.6.4.1.5.20 EnumSyntax 3
1.3.6.1.3.83.1.6.4.1.6.20 Integer 2
1.3.6.1.3.83.1.6.4.1.7.20 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.8.20 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.9.20 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.10.20 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.11.20 EnumSyntax 256
1.3.6.1.3.83.1.6.4.1.12.20 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.13.20 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.14.20 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.15.20 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.2.20 Integer 1
SnmpMib end

A2 Provisioning Services Configuration

// MCNS Configuration file for CM-ProvisionTest
NetworkAccess 1
ClassOfService start
ClassId 1
MaxDownstreamRate 10000000
MaxUpstreamRate 2500000
UpstreamChannelPriority 1
MaxUpstreamBurst 254
PrivacyEnable 1
ClassOfService end
MaxCpeAllowed 1
SnmpMib start

// Filters to allow access to provisioning servers & network services

// Permit access to network services

1.3.6.1.3.83.1.6.3.0 EnumSyntax 1
1.3.6.1.3.83.1.6.4.1.3.10 EnumSyntax 2
1.3.6.1.3.83.1.6.4.1.4.10 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.5.10 EnumSyntax 1
1.3.6.1.3.83.1.6.4.1.6.10 Integer 2
1.3.6.1.3.83.1.6.4.1.7.10 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.8.10 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.9.10 IpAddress 10.2.0.2
1.3.6.1.3.83.1.6.4.1.10.10 IpAddress 255.255.255.255
1.3.6.1.3.83.1.6.4.1.11.10 EnumSyntax 256
1.3.6.1.3.83.1.6.4.1.12.10 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.13.10 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.14.10 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.15.10 BoundInteger 512
1.3.6.1.3.83.1.6.4.1.2.10 Integer 1

// Permit access to provisioning service

1.3.6.1.3.83.1.6.4.1.3.15 EnumSyntax 2
1.3.6.1.3.83.1.6.4.1.4.15 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.5.15 EnumSyntax 1
1.3.6.1.3.83.1.6.4.1.6.15 Integer 2
1.3.6.1.3.83.1.6.4.1.7.15 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.8.15 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.9.15 IpAddress 10.2.0.8
1.3.6.1.3.83.1.6.4.1.10.15 IpAddress 255.255.255.255

AOL(2)001825
1.3.6.1.3.83.1.6.4.1.11.15 EnumSyntax 256
1.3.6.1.3.83.1.6.4.1.12.15 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.13.15 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.14.15 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.15.15 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.12.15 Integer 1

// Deny access to other network locations

1.3.6.1.3.83.1.6.4.1.3.16 EnumSyntax 1
1.3.6.1.3.83.1.6.4.1.4.16 BoundInteger 2
1.3.6.1.3.83.1.6.4.1.5.16 EnumSyntax 2
1.3.6.1.3.83.1.6.4.1.6.16 Integer 2
1.3.6.1.3.83.1.6.4.1.7.16 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.8.16 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.9.16 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.10.16 IPAddress 255.0.0.0
1.3.6.1.3.83.1.6.4.1.11.16 EnumSyntax 256
1.3.6.1.3.83.1.6.4.1.12.16 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.13.16 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.14.16 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.15.16 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.12.16 Integer 1

// Allow any packet to pass the CATV-side interface

1.3.6.1.3.83.1.6.4.1.3.20 EnumSyntax 2
1.3.6.1.3.83.1.6.4.1.4.20 BoundInteger 2
1.3.6.1.3.83.1.6.4.1.5.20 EnumSyntax 3
1.3.6.1.3.83.1.6.4.1.6.20 Integer 2
1.3.6.1.3.83.1.6.4.1.7.20 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.8.20 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.9.20 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.10.20 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.11.20 EnumSyntax 256
1.3.6.1.3.83.1.6.4.1.12.20 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.13.20 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.14.20 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.15.20 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.12.20 Integer 1

SnmpMib end
SnmpMib start
1.3.6.1.3.83.1.2.1.2.10 IPAddress 10.2.0.0
1.3.6.1.3.83.1.2.1.3.10 IPAddress 255.255.0.0
1.3.6.1.3.83.1.2.1.4.10 OctetString "private"
1.3.6.1.3.83.1.2.1.5.10 EnumSyntax 3
1.3.6.1.3.83.1.2.1.6.10 OctetString 0xC0
1.3.6.1.3.83.1.2.1.7.10 Integer 1
1.3.6.1.3.83.1.2.1.8.20 IPAddress 10.2.0.0
1.3.6.1.3.83.1.2.1.9.20 IPAddress 255.255.0.0
1.3.6.1.3.83.1.2.1.10.20 OctetString "public"
1.3.6.1.3.83.1.2.1.11.20 EnumSyntax 2
1.3.6.1.3.83.1.2.1.12.20 OctetString 0xC0
1.3.6.1.3.83.1.2.1.13.20 Integer 1
SnmpMib end

A3 Service Provider-Specific Configuration

// MCNS Configuration file for CM-AOLStd
NetworkAccess 1

AOL(2)001826
OfClassOfService start
ClassId 1
MaxDownstreamRate 1000000
MaxUpstreamRate 512000
UpstreamChannelPriority 1
MinUpstreamRate 256000
MaxUpstreamBurst 254
PrivacyEnable 1
OfClassOfService end
MaxCpeAllowed 1

SnmpMib start
1.3.6.1.3.83.1.6.3.0 EnumSyntax 1 // docsDevFilterIpDefault = discard (1)

// Filters to permit traffic to selected locations, deny access to others

// Permit access to Network Services systems
1.3.6.1.3.83.1.6.4.1.3.5 EnumSyntax 2 //
docsDevFilterIpControl = accept (2)
1.3.6.1.3.83.1.6.4.1.4.5 BoundInteger 1 // docsDevFilterIpIfIndex = 1
(ethernet)
1.3.6.1.3.83.1.6.4.1.5.5 EnumSyntax 1 //
docsDevFilterIpDirection = inbound (1)
1.3.6.1.3.83.1.6.4.1.6.5 Integer 2 // docsDevFilterIpBroadcast = false (2)
1.3.6.1.3.83.1.6.4.1.7.5 IpAddress 0.0.0.0 //
docsDevFilterIpAddr/Smask = any
1.3.6.1.3.83.1.6.4.1.8.5 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.9.5 IpAddress 10.2.0.2 //
docsDevFilterIpDAddr/Dmask = [network services]
1.3.6.1.3.83.1.6.4.1.10.5 IpAddress 255.255.255.255
1.3.6.1.3.83.1.6.4.1.11.5 EnumSyntax 256 // docsDevFilterIpProtocol =
any (256)
1.3.6.1.3.83.1.6.4.1.12.5 BoundInteger 1 //
docsDevFilterIpSourcePortLow/High = 1..65535
1.3.6.1.3.83.1.6.4.1.13.5 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.14.5 BoundInteger 1 //
docsDevFilterIpDestPortLow/High = 1..65535
1.3.6.1.3.83.1.6.4.1.15.5 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.12.5 Integer 1 // docsDevFilterIpStatus =
active (1)

// Permit access to AOL tunnel server
1.3.6.1.3.83.1.6.4.1.3.10 EnumSyntax 2
1.3.6.1.3.83.1.6.4.1.4.10 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.5.10 EnumSyntax 1
1.3.6.1.3.83.1.6.4.1.6.10 Integer 2
1.3.6.1.3.83.1.6.4.1.7.10 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.8.10 IpAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.9.10 IpAddress 10.3.0.1
1.3.6.1.3.83.1.6.4.1.10.10 IpAddress 255.255.255.255
1.3.6.1.3.83.1.6.4.1.11.10 EnumSyntax 256
1.3.6.1.3.83.1.6.4.1.12.10 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.13.10 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.14.10 BoundInteger 1

AOL(2)001827
1.3.6.1.3.83.1.6.4.1.15.10 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.2.10 Integer 1

// Deny access to all other networks

1.3.6.1.3.83.1.6.4.1.3.15 EnumSyntax 1
1.3.6.1.3.83.1.6.4.1.4.15 BoundInteger 2
1.3.6.1.3.83.1.6.4.1.5.15 EnumSyntax 2
1.3.6.1.3.83.1.6.4.1.6.15 Integer 2
1.3.6.1.3.83.1.6.4.1.7.15 IPAddress 10.0.0.0
1.3.6.1.3.83.1.6.4.1.8.15 IPAddress 255.0.0.0
1.3.6.1.3.83.1.6.4.1.9.15 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.10.15 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.11.15 EnumSyntax 256
1.3.6.1.3.83.1.6.4.1.12.15 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.13.15 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.14.15 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.15.15 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.2.15 Integer 1

// Allow any packet to go through the CATV-side interface

1.3.6.1.3.83.1.6.4.1.3.40 EnumSyntax 2
1.3.6.1.3.83.1.6.4.1.4.40 BoundInteger 2
1.3.6.1.3.83.1.6.4.1.5.40 EnumSyntax 3
1.3.6.1.3.83.1.6.4.1.6.40 Integer 2
1.3.6.1.3.83.1.6.4.1.7.40 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.8.40 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.9.40 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.10.40 IPAddress 0.0.0.0
1.3.6.1.3.83.1.6.4.1.11.40 EnumSyntax 256
1.3.6.1.3.83.1.6.4.1.12.40 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.13.40 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.14.40 BoundInteger 1
1.3.6.1.3.83.1.6.4.1.15.40 BoundInteger 65535
1.3.6.1.3.83.1.6.4.1.2.40 Integer 1

SnmpMib end
Appendix B - Redback Configuration Details

B1 Policy network tests

Figure 13 Redback Policy Network Configuration
Appendix C - Selected Packet Traces

C1 Normal CM DHCP and TFTP Cycle

Packet 1 captured at 10/21/1999 11:28:30 AM; Packet size is 590 (0x24E) bytes
  Relative time: 000:00:46.532
  Delta time: 0.000.000

Ethernet Version II
  Address: 00-10-67-00-34-49 -->00-A0-C9-6F-C6-C2
  Ethernet II Protocol Type: IP

Internet Protocol
  Version (MSB 4 bits): 4
  Header length (LSB 4 bits): 5 (32-bit word)
  Service type: 0x00
    000. .... = 0 - Routine
    ...0 .... = Normal delay
    .... 0... = Normal throughput
    .... ..0.. = Normal reliability
  Total length: 576 (Octets)
  Fragment ID: 0
  Flags summary: 0x00
    0... .... = Reserved
    .0... .... = May be fragmented
    ..0. .... = Last fragment
  Fragment offset (LSB 13 bits): 0 (0x00)
  Time to live: 253 seconds/hops
  IP protocol type: UDP (0x11)
  Checksum: 0xA79C
  IP address 10.12.0.1 -->10.2.0.2
  No option

User Datagram Protocol
  Port Bootp Client --> Bootp Server
  Total length: 556 (Octets)
  Checksum: 0x8670

IP Bootstrap Protocol
  OP Code: 1 (Request)
  Hardware Type: 1 (Ethernet)
  Hardware Address Length: 6
  Hops: 1
  Transaction ID: 1111372823
  Seconds: 0
  Client IP Address: 0.0.0.0
  Your IP Address: 0.0.0.0
  Server IP Address: 0.0.0.0
  Gateway IP Address: 10.12.0.1
  Client Hardware Address: 0000CA1418C70000000000000000000
  Server Host Name
  Boot File Name
  Code: DHCP Message Type, Length: 1, Type: Discover
  Code: DHCP Parameter Request List, Length: 5, Option List:010204032A
  Code: End Option

Data:
0000: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ........................
0010: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ........................
0020: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ........................
0030: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ........................

AOL(2)001830
Packet 2 captured at 10/21/1999 11:28:30 AM; Packet size is 342 (0x156) bytes
Relative time: 000:00:46.561
Delta time: 0.028.550
Ethernet Version II
Address: 00-A0-C9-6F-C6-C2 -+-00-10-67-00-34-49
Ethernet II Protocol Type: IP
Internet Protocol
Version (MSB 4 bits): 4
Header length (LSB 4 bits): 5 (32-bit word)
Service type: Preced=Routine, Delay=Normal, Thruput=Normal, Reli=Normal
Flags: May be fragmented, Last fragment, Offset=0 (0x00)
User Datagram Protocol
Port Bootp Server -+- Bootp Server
Total length: 308 (Octets)
Checksum: 0xA660
IP Bootstrap Protocol
OP Code: 2 (Reply)
Hardware Type: 1 (Ethernet)
Hardware Address Length: 6
Hops: 0
Transaction ID: 1111372823
Seconds: 0
Client IP Address: 0.0.0.0
Your IP Address: 10.12.0.66
Server IP Address: 10.2.0.2
Gateway IP Address: 10.12.0.1
Client Hardware Address: 0000CA1418C7000000000000000000000
Server Host Name
Boot File Name: bronze.cm
Code: DHCP Message Type, Length: 1, Type: Offer
Code: Subnet Mask, Length: 4
   Address 255.255.0.0
Code: DHCP Renewal (T1) Time, Length: 4, Value: 1800
Code: DHCP Rebinding (T2) Time, Length: 4, Value: 3150
Code: DHCP IP Address Lease Time, Length: 4, Value: 3600
Code: DHCP Server ID, Length: 4
   Address: 10.2.0.2
Code: Time Offset
Intermediate System to Intermediate System
Protocol ID: 0x04
Header Length: 0
Version/Protocol ID Extension: 0
ID Length: 70
Data: 0000: 02 00 02 03 04 0a 0c 00 01 ff 00 00 00 00 00 | ............
      0010: 00 00

Packet 3 captured at 10/21/1999 11:28:30 AM; Packet size is
590 (0x24e) bytes.
Relative time: 000:00:46.577
Delta time: 0.016.702
Ethernet Version II
Address: 00-10-67-00-34-49 ---->00-A0-C9-6F-C6-C2
Ethernet II Protocol Type: IP
Internet Protocol
Version(MSB 4 bits): 4
Header length(LSB 4 bits): 5 (32-bit word)
Service type: 0x00
 000 .... = 0 - Routine
  ...0 .... = Normal delay
  ....0... = Normal throughput
  ....00.. = Normal reliability
Total length: 576 (Octets)
Fragment ID: 1
Flags summary: 0x00
  0... .... = Reserved
  .0... .... = May be fragmented
  ..0... .... = Last fragment
Fragment offset(LSB 13 bits): 0 (0x00)
Time to live: 253 seconds/hops
IP protocol type: UDP (0x11)
Checksum: 0xA75A
IP address 10.12.0.66 ->10.2.0.2
No option
User Datagram Protocol
Port Bootp Client ----> Bootp Server
Total length: 556 (Octets)
Checksum: 0x321B
IP Bootstrap Protocol
OP Code: 1 (Request)
Hardware Type: 1 (Ethernet)
Hardware Address Length: 6
Hops: 1
Transaction ID: 1111372823
Seconds: 0
Client IP Address: 0.0.0.0
Your IP Address: 0.0.0.0
Server IP Address: 0.0.0.0
Gateway IP Address: 10.12.0.1
Client Hardware Address: 0000CA1418C7000000000000000000000
Server Host Name
Boot File Name
Code: DHCP Message Type, Length: 1, Type: Request
Code: DHCP Requested IP Address, Length: 4
  Address: 10.12.0.66
Code: DHCP Server ID, Length: 4
  Address: 10.2.0.2
Code: End Option
Data: 0000: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ............

AOL(2)001832
Packet 4 captured at 10/21/1999 11:28:30 AM; Packet size is 342(0x156) bytes
Relative time: 000:00:46.605
Delta time: 0.027.928
Ethernet Version II
Address: 00-A0-C9-6F-C6-C2 -->00-10-67-00-34-49
Ethernet II Protocol Type: IP
Internet Protocol
Version(MSB 4 bits): 4
Header length(LSB 4 bits): 5 (32-bit word)
Service type: 0x00
000. .... = 0 - Routine
...0 .... = Normal delay
.... 0... = Normal throughput
..... ..0. = Normal reliability
Total length: 328 (Octets)
Fragment ID: 47206
Flags summary: 0x00
0... .... = Reserved
..0. ...... = May be fragmented
..0. ..... = Last fragment
Fragment offset(LSB 13 bits): 0 (0x00)
Time to live: 128 seconds/hops
IP protocol type: UDP (0x11)
Checksum: 0x5D2E
IP address 10.2.0.2 -->10.12.0.1
No option
User Datagram Protocol
Port Bootp Server --> Bootp Server
Total length: 308 (Octets)
Checksum: 0x10C4
IP Bootstrap Protocol
OP Code: 2 (Reply)
Hardware Type: 1 (Ethernet)
Hardware Address Length: 6
Hops: 0
Transaction ID: 1111372823
Seconds: 0
Client IP Address: 0.0.0.0
Your IP Address: 10.12.0.66

AOL(2)001833
Server IP Address: 10.2.0.2
Gateway IP Address: 10.12.0.1
Client Hardware Address: 0000C1418C700000000000000000000000
Server Host Name
Boot File Name: bronze.cm
Code: DHCP Message Type, Length: 1, Type: Ack
Code: DHCP Renewal (T1) Time, Length: 4, Value: 1800
Code: DHCP Rebinding (T2) Time, Length: 4, Value: 3150
Code: DHCP IP Address Lease Time, Length: 4, Value: 3600
Code: DHCP Server ID, Length: 4
   Address: 10.2.0.2
Code: Subnet Mask, Length: 4 Address: 255.255.0.0
Code: End Option

Data:
0000: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0010: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

Packet 5 captured at 10/21/1999 11:28:32 AM; Packet size is 60 (0x3c) bytes
   Relative time: 000.00:48.067
   Delta time: 1.461.974
Ethernet Version II
Address: 00-10-67-00-34-49 ----> 00-A0-C9-6F-C6-C2
Ethernet II Protocol Type: IP
Internet Protocol
Version (MSB 4 bits): 4
Header length (LSB 4 bits): 5 (32-bit word)
Service type: 0x00
000. ..... = 0 - Routine
   ..... = Normal delay
   .... = Normal throughput
   .... = Normal reliability
Total length: 32 (Octets)
Fragment ID: 2
Flags summary: 0x00
   0...... = Reserved
   .0..... = May be fragmented
   ..0.... = Last fragment
Fragment offset (LSB 13 bits): 0 (0x00)
Time to live: 253 seconds/hops
IP protocol type: UDP (0x11)
Checksum: 0xA979
IP address 10.12.0.66 ----> 10.2.0.2
No option
User Datagram Protocol
   Port 2048 ----> Time
Total length: 12 (Octets)
Checksum: 0xE35F

Time
Data:
0000: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0010: 00 00

Packet 6 captured at 10/21/1999 11:28:32 AM; Packet size is 46 (0x2e) bytes
   Relative time: 000.00:48.069
   Delta time: 0.001.702
Ethernet Version II
Address: 00-A0-C9-6F-C6-C2 ----> 00-10-67-00-34-49

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Ethernet II Protocol Type: IP
Internet Protocol
Version (MSB 4 bits): 4
Header length (LSB 4 bits): 5 (32-bit word)
Service type: 0x00
0 0 . . . = 0 - Routine
..0 . . = Normal delay
....0 . . = Normal throughput
.... .0 . = Normal reliability
Total length: 32 (Octets)
Fragment ID: 47974
Flags summary: 0x00
0... . . = Reserved
.0... . = May be fragmented
..0 . . = Last fragment
Fragment offset (LSB 13 bits): 0 (0x00)
Time to live: 128 seconds/hops
IP protocol type: UDP (0x11)
Checksum: 0x6B15
IP address 10.2.0.2 -> 10.12.0.66
No option
User Datagram Protocol
Port Time ---> 2048
Total length: 12 (Octets)
Checksum: 0x7805
Time
Data:
0000: bb b9 af a0

Packet 7 captured at 10/21/1999 11:28:32 AM; Packet size is
70 (0x46) bytes
Relative time: 000:00:48.071
Delta time: 0.001.548
Ethernet Version II
Address: 00-10-67-00-34-49 ---> 00-A0-C9-6F-C6-C2
Ethernet II Protocol Type: IP
Internet Protocol
Version (MSB 4 bits): 4
Header length (LSB 4 bits): 5 (32-bit word)
Service type: 0x00
0 0 . . . = 0 - Routine
..0 . . = Normal delay
....0 . . = Normal throughput
.... .0 . = Normal reliability
Total length: 56 (Octets)
Fragment ID: 3
Flags summary: 0x00
0... . . = Reserved
.0... . = May be fragmented
..0 . . = Last fragment
Fragment offset (LSB 13 bits): 0 (0x00)
Time to live: 253 seconds/hops
IP protocol type: UDP (0x11)
Checksum: 0xA960
IP address 10.12.0.66 -> 10.2.0.2
No option
User Datagram Protocol
Port NFS ---> Trivial File Transfer
Total length: 36 (Octets)
Checksum: 0xAC55
Trivial File Transfer Protocol
OP Code: 1 - Read Request
FileName: bronze.cm
Mode: octet
Padding: (10 bytes in highlight area)

Packet 8 captured at 10/21/1999 11:28:32 AM; Packet size is 120 (0x78) bytes
Relative time: 000:00:48.088
Delta time: 0.017.648
Ethernet Version II
Address: 00-A0-C9-6F-C6-C2 -->00-10-67-00-34-49
Ethernet II Protocol Type: IP
Internet Protocol
Version (MSB 4 bits): 4
Header length (LSB 4 bits): 5 (32-bit word)
Service type: 0x00
000. .... = 0 - Routine
...0 .... = Normal delay
.... 0... = Normal throughput
..... 0.. = Normal reliability
Total length: 106 (Octets)
Fragment ID: 48230
Flags summary: 0x00
0... .... = Reserved
.0. .... = May be fragmented
..0. .... = Last fragment
Fragment offset (LSB 13 bits): 0 (0x00)
Time to live: 128 seconds/hops
IP protocol type: UDP (0x11)
Checksum: 0x69CB
IP address 10.2.0.2 ->10.12.0.66
No option
User Datagram Protocol
Port Trivial File Transfer --> NFS
Total length: 86 (Octets)
Checksum: 0x98B0
Trivial File Transfer Protocol
OP Code: 3 - Data
Block Number: 1
Data: (74 bytes in highlight area)

Packet 9 captured at 10/21/1999 11:28:32 AM; Packet size is 60 (0x3c) bytes
Relative time: 000:00:48.099
Delta time: 0.010.317
Ethernet Version II
Address: 00-10-67-00-34-49 -->00-A0-C9-6F-C6-C2
Ethernet II Protocol Type: IP
Internet Protocol
Version (MSB 4 bits): 4
Header length (LSB 4 bits): 5 (32-bit word)
Service type: 0x00
000. .... = 0 - Routine
...0 .... = Normal delay
.... 0... = Normal throughput
..... 0.. = Normal reliability
Total length: 32 (Octets)

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---
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Fragment ID: 4
Flags summary: 0x00
  0... .... = Reserved
  .0. .... = May be fragmented
  ..0. .... = Last fragment
Fragment offset (LSB 13 bits): 0 (0x00)
Time to live: 253 seconds/hops
IP protocol type: UDP (0x11)
Checksum: 0xA977
IP address 10.12.0.66 ->10.2.0.2
No option
User Datagram Protocol
Port NFS --> Trivial File Transfer
Total length: 12 (Octets)
Checksum: 0xE339
Trivial File Transfer Protocol
OP Code: 4 - AckKnowledge
Block Number: 1
Padding: (14 bytes in highlight area)

C2 Typical Consumer PC DHCP

Packet 1 captured at 10/28/1999 11:20:04 AM; Packet size is 342 (0x156) bytes
Relative time: 000:00:04.991
Delta time: 0.000.000
ETHER-II: 00-10-67-00-34-49 --> 00-A0-C9-6F-C6-C2
IP: 10.12.0.1 -->10.2.0.2, ID=59259
Service type: Precd=Routine, Delay=Normal, Thruput=Normal, Reli=Normal
Flags: May be fragmented, Last fragment, Offset=0 (0x00)
User Datagram Protocol
Port Bootp Client --> Bootp Server
Total length: 308 (Octets)
Checksum: 0xA8F2
IP Bootstrap Protocol
OP Code: 1 (Request)
Hardware Type: 1 (Ethernet)
Hardware Address Length: 6
Hops: 1
Transaction ID: 1378750256
Seconds: 0
Client IP Address: 0.0.0.0
Your IP Address: 0.0.0.0
Server IP Address: 0.0.0.0
Gateway IP Address: 10.12.0.1
Client Hardware Address: 0004ACD5C86E00000000000000000000
Server Host Name
Boot File Name
Code: DHCP Message Type, Length: 1, Type: Discover
Code: DHCP Client ID, Length: 7, 010004ACD5C86E
Code: DHCP Requested IP Address, Length: 4
  Address: 10.12.0.68
Code: Host Name, Length: 11, Name: pruthie-pc
Code: DHCP Parameter Request List, Length: 8, Option List 0103060F2C2E2F39
Code: End Option
Data:
0000: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
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Packet 2 captured at 10/28/1999 11:20:05 AM; Packet size is 342 (0x156) bytes
Relative time: 000:00:05.017
Delta time: 0.025.486
ETHER-II: 00-A0-C9-6F-C6-C2 => 00-10-67-00-34-49
IP: 10.2.0.2->10.12.0.1, ID=49724
Service type: Precd=Routine,Delay=Normal,Thrput=Normal,Reli=Normal
Flags: May be fragmented,Last fragment,Offset=0 (0x00)
User Datagram Protocol
Port Bootp Server ---> Bootp Server
Total length: 308 (Octets)
Checksum: 0x853F
IP Bootstrap Protocol
OP Code: 2 (Reply)
Hardware Type: 1 (Ethernet)
Hardware Address Length: 6
Hops: 0
Transaction ID: 1378750256
Seconds: 0
Client IP Address: 0.0.0.0
Your IP Address: 10.12.0.68
Server IP Address: 10.2.0.2
Gateway IP Address: 10.12.0.1
Client Hardware Address: 0004ACD5C86E0000000000000000000000
Server Host Name
Boot File Name: bronze.cm
Code: DHCP Message Type, Length: 1, Type: Offer
Code: Subnet Mask, Length: 4, Address: 255.255.0.0
Code: DHCP Renewal (T1) Time, Length: 4, Value: 1800
Code: DHCP Rebinding (T2) Time, Length: 4, Value: 3150
Code: DHCP IP Address Lease Time, Length: 4, Value: 3600
Code: DHCP Server ID, Length: 4, Address: 10.2.0.2
Code: Router, Length: 4, Address: 10.12.0.1
Code: End Option
Packet 3 captured at 10/28/1999 11:20:05 AM; Packet size is 342 (0x156) bytes
Relative time: 000:00:05.032
Delta time: 0.015.260
ETHER-II: 00-10-67-00-34-49 => 00-A0-C9-6F-C6-C2
IP: 10.12.0.1->10.2.0.2, ID=59515
Service type: Precd=Routine,Delay=Normal,Thrput=Normal,Reli=Normal
Flags: May be fragmented,Last fragment,Offset=0 (0x00)
User Datagram Protocol
Port Bootp Client ---> Bootp Server
Total length: 308 (Octets)
Checksum: 0x66EA
IP Bootstrap Protocol
OP Code: 1 (Request)
Hardware Type: 1 (Ethernet)
Hardware Address Length: 6
Hops: 1
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Transaction ID: 1378750256
Seconds: 0
Client IP Address: 0.0.0.0
Your IP Address: 0.0.0.0
Server IP Address: 0.0.0.0
Gateway IP Address: 10.12.0.1
Client Hardware Address: 0004ACD5C86E0000000000000000000
Server Host Name
Boot File Name
Code: DHCP Message Type, Length: 1, Type: Request
Code: DHCP Client ID, Length: 7, 010004ACD5C86E
Code: DHCP Requested IP Address, Length: 4
   Address: 10.12.0.68
Code: DHCP Server ID, Length: 4
   Address: 10.2.0.2
Code: Host Name, Length: 11, Name: pruthie-pc
Code: DHCP Parameter Request List, Length: 8, Option
List0103060F2C2E2F39
   Code: End Option

Data:
0000: 00 00 00 00 00 00 00 00 00 00 00 00
| ................

Packet 4 captured at 10/28/1999 11:20:05 AM; Packet size is
342 (0x156) bytes
Relative time: 000:00:05.062
Delta time: 0.030.240
ETHER-II: 00-A0-C9-6F-C6-C2 == 00-10-67-00-34-49
IP: 10.2.0.2->10.12.0.1, ID=49980
   Service type: Pred=Routine, Delay=Normal, Thruput=Normal, Reli=Normal
   Flags: May be fragmented, Last fragment, Offset=0 (0x00)
User Datagram Protocol
   Port Bootp Server --> Bootp Server
   Total length: 308 (Octets)
   Checksum: 0x823F
IP Bootstrap Protocol
   OP Code: 2 (Reply)
   Hardware Type: 1 (Ethernet)
   Hardware Address Length: 6
   Hops: 0
   Transaction ID: 1378750256
   Seconds: 0
   Client IP Address: 0.0.0.0
   Your IP Address: 10.12.0.68
   Server IP Address: 10.2.0.2
   Gateway IP Address: 10.12.0.1
   Client Hardware Address: 0004ACD5C86E0000000000000000000
   Server Host Name
   Boot File Name: bronze.cm
   Code: DHCP Message Type, Length: 1, Type: Ack
   Code: DHCP Renewal (T1) Time, Length: 4, Value:1800
   Code: DHCP Rebinding (T2) Time, Length: 4, Value:3150
   Code: DHCP IP Address Lease Time, Length: 4, Value:3600
   Code: DHCP Server ID, Length: 4
      Address: 10.2.0.2
   Code: Subnet Mask, Length: 4
      Address255.255.0.0
   Code: Router, Length: 4
      Address: 10.12.0.1
   Code: End Option

Data: 

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Implementing Open Access Over Cable Systems
A Technical Perspective
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1 Executive Summary

This paper describes a variety of methods by which multiple ISPs can serve consumers over the hybrid fiber-coaxial (HFC) facilities of cable operators. The work focuses on the technical and administrative steps that would readily allow multiple ISPs to serve customers on an HFC network using standard DOCSIS equipment. This report is the first of two papers, dealing with requirements, design and analysis. A second paper presents experimental laboratory measurements that validate the concepts presented here using equipment from several vendors in a variety of network configurations.

The report demonstrates the technical and administrative viability of an open access policy, whereby the following goals would be achieved: (1) equal opportunity for consumers to choose their service provider; (2) equal opportunity for multiple service providers to reach all consumers with differentiated service offerings; and (3) no cost, service, or performance discrimination against the consumer for exercising its choice of service provider.

The report identifies the respective roles of three separate players in the provision of high-speed Internet access over HFC cable facilities: (1) the cable operator; (2) the access manager; and (3) the ISPs. The cable operator and the ISPs are familiar entities; the access manager is the entity responsible for the management of the shared Internet Protocol networking infrastructure between the end-user and the ISP access point. The access manager and the cable operator could be the same entity, the functional separation being typical of current business practices. The role of the access manager is probably best explained by review of some technical concepts.

The HFC plant is the physical path along which signals pass. In the downstream direction (towards the end-user) the radio frequency (RF) spectrum is divided into many 6 MHz channels, most of which are used to transport the broadcasts of television programs. The multiple channels from the cable company head end, after traveling over the HFC plant, arrive at the customer’s home, whereupon they are delivered to the television set. The design and management of the HFC physical infrastructure is the domain of the cable operator.

Internet access over HFC plant works basically the same way, except that, instead of television programs, it is Internet Protocol (IP) packets that are being delivered to a cable modem (CM) in the home. In the upstream direction (from the end-user) the signals are sent in the RF frequency range between 10 MHz and 40 MHz, and thus two-way IP connectivity is established. At the cable head end a cable modem termination system (CMTS) routes the IP traffic to and from the HFC network to the wide area network. The IP network is a combination of network elements (and associated software) that is overlaid on the physical HFC plant. The access manager is responsible for the deployment and operation of the IP network that has been built over the HFC plant.
The solutions to support multiple ISP over HFC cable broadband networks must account for the following factors: (1) the cable HFC plant is a shared medium, meaning that the traffic from several end-users share the RF spectrum (6 MHz channel down and the return RF); and (2) the IP traffic must be directed appropriately to each one of the multiple ISPs sharing RF spectrum. So when the upstream IP traffic from an end-user's cable reaches the cable head end, the IP packets must be sent to the corresponding ISP depending on the originating customer. Similarly, the IP traffic coming from the Internet at large must be delivered to the correct cable modem.

This report first identifies the technical requirements that must be fulfilled in order to enable multiple ISPs on a broadband HFC cable network. The study then presents several solutions that meet the requirements, corresponding to a variety of possible architectures that are found in the industry. Further, because the cable operator, access manager, and ISPs are each responsible for different aspects of the provision of Internet access, the report describes several approaches to ensuring successful interaction between them.

The study focuses primarily on two technical issues: network architecture, and service definition and provisioning. The report describes three different possible network designs that allow for open access. These include:

- Policy-based routing, this option routes packets to the appropriate ISP using the source IP address as the unique identifier;

- Virtual private networks (VPNs) and IP tunnels, creating virtual dedicated connections over the HFC network between the customer and the ISP. This is a solution appropriate to routed (layer 3) access networks; and

- Point-to-Point Protocol over Ethernet (PPPoE) encapsulation which is a protocol analogous to commonly employed protocols for dial-up. This is a solution appropriate to bridged (layer 2) access networks.

Each of these options has its own unique set of advantages and disadvantages; as such, the appropriateness of each option varies depending on the type of cable system (i.e., large or small, multiple nodes vs. single node), and the networking architecture, being addressed.

Service definition and provisioning involves introducing a new subscriber's hardware (computer, network interface card, and cable modem) and billing and service information to the access manager and the ISP so that the subscriber is able to access the provider of choice. The report describes in technical detail how this could readily be accomplished.

The report provides several implementation examples (one appropriate for a small cable system, one for a bridged network, and one for a routed network), and discusses other management and operational issues (including what topics SLAs should address and ISP access to management.
systems for troubleshooting and problem resolution). Finally, the paper addresses scalability and performance considerations - all of which may be effectively resolved in a manner consistent with open access to the cable platform.