5 References

[DevMIB] St. Johns, M., ed., Cable Device Management Information Base for DOCSIS compliant Cable Modems and Cable Modem Termination Systems, draft-ietf-ipcdn-cable-device-mib-07.txt, May 1998.

[DocsisV1.0] Data-Over-Cable Service Interface Specifications, Radio Frequency Interface Specification, Cable Television Laboratories, ISP-RFI-I04-980724, July 1998.

[OpenTech] Implementing Open Access Over Cable Systems: A Technical Perspective, Telcordia Technologies, Contract # 41098, Nov 1999.

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 2500000
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
1.3.6.1.3.83.1.6.4.1.2.15 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 10.0.0.0
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
1.3.6.1.3.83.1.6.4.1.2.16 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
1.3.6.1.3.83.1.6.4.1.2.20 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
1.3.6.1.3.83.1.2.1.2.20 IpAddress 10.2.0.0
1.3.6.1.3.83.1.2.1.3.20 IpAddress 255.255.0.0
1.3.6.1.3.83.1.2.1.4.20 OctetString "public"
1.3.6.1.3.83.1.2.1.5.20 EnumSyntax  2
1.3.6.1.3.83.1.2.1.6.20 OctetString 0xC0
1.3.6.1.3.83.1.2.1.7.20 Integer  1
SnmpMib end
```

A3 Service Provider-Specific Configuration

```
// MCNS Configuration file for CM-AOLStd
NetworkAccess 1
```

AOL(2)001826

```
ClassOfService start
ClassId  1
MaxDownstreamRate 1000000
MaxUpstreamRate 512000
UpstreamChannelPriority 1
MinUpstreamRate 256000
MaxUpstreamBurst 254
PrivacyEnable 1
ClassOfService 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      //
docsDevFilterIpSaddr/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
1.3.6.1.3.83.1.6.4.1.2.5 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
```

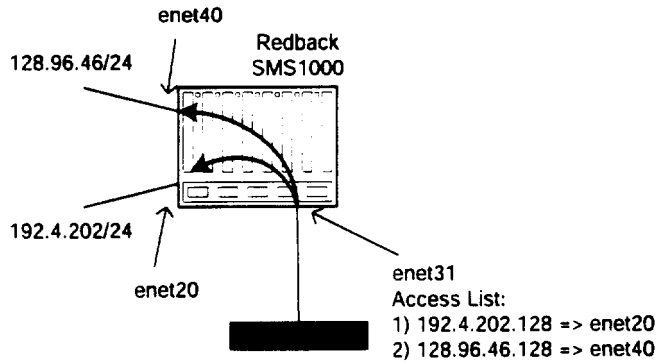
AOL(2)001827

```
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

```
! last updated:  MON OCT 25 15:13:35 1999
no diagnostics
boot system /flash/redback.bin
boot configuration /flash/newcfg.cfg
boot configuration /flash/28-sept.cfg
boot configuration /flash/8-oct.cfg
system contact pedro-jid-wsm
system location cable_lab
context local
 dhcp relay server 10.2.0.2
 interface enet20
  ip address 10.3.0.2 255.255.0.0
  ip arp arpa
 interface enet21
  ip address 10.2.0.1 255.255.0.0
  ip arp arpa
 interface enet30
  ip address 10.8.0.1 255.255.0.0
  ip arp arpa
 interface enet31
  ip address 10.10.0.1 255.255.0.0
  ip arp arpa
 [redacted]
 interface enet40
  ip address 192.4.15.67 255.255.255.0
  ip arp arpa
 operator tac encrypted 1 $1$FBILKq6l$hHoNshDcK.kKCTiBhk6de0
 administrator root encrypted 1 $1$J0zMm0S5$HcQBbNi9f9MnpP4cW43vN/
 ip route 0.0.0.0 0.0.0.0 192.4.15.1 enet40
 ip route 10.9.0.0 255.255.0.0 10.8.0.3 enet30
 ip route 10.12.0.0 255.255.0.0 10.10.0.2 enet31
 ip route 10.14.0.0 255.255.0.0 10.10.0.2 enet31
 ip route 10.15.0.0 255.255.0.0 10.10.0.2 enet31
 ip route 128.96.46.128 255.255.255.128 10.10.0.2 enet31
 ip route 192.4.202.128 255.255.255.128 10.10.0.2 enet31
 [redacted]
 port ethernet 0/0
  shutdown
 port ethernet 2/0
  bind interface enet20 local
 port ethernet 2/1
  bind interface enet21 local
 port ethernet 3/0
  bind interface enet30 local
 port ethernet 3/1
  bind interface enet31 local
 port ethernet 4/0
  bind interface enet40 local
 port ethernet 4/1
 snmp server
 snmp view default system included
 snmp community private read-write
 snmp community public
 line console
 line tty 1
 line tty 2
 line tty 3
 line tty 4
 end
```



Routes for returned traffic

Figure 13 Redback Policy Network Configuration

AOL(2)001829

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: 0000CA1418C700000000000000000000
      Server Host Name
      Boot File Name
      Code: DHCP Message Type, Length: 1, Type: Discover
      Code: DHCP Parameter Request List, Length: 5, Option
List010204032A
      Code: End Option
Data:
0000: 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 | ................
0020: 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 | ................
```

AOL(2)001830

```
0040: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0050: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0060: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0070: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0080: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0090: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
00a0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
00b0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
00c0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
00d0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
00e0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
00f0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0100: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0110: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0120: 00 00 00 00 00 00 00 00 00                      | .........

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: 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: 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: 0000CA1418C700000000000000000000
      Server Host Name
      Boot File Name: bronze.cm
      Code: DHCP Message Type, Length: 1, Type: Offer
      Code: Subnet Mask, Length: 4      Address255.255.0.0
      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
```

AOL(2)001831

```
      : 80
      Version: 4
Data:
0000: 02 00 02 03 04 0a 0c 00 01 ff 00 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
            .... .0.. = 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: 0000CA1418C700000000000000000000
      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 00 00 | ................
```

AOL(2)001832

```
0010: 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 | ................
0030: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0040: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0050: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0060: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0070: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0080: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0090: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
00a0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
00b0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
00c0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
00d0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
00e0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
00f0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0100: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0110: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0120: 00 00 00 00                                     | ....

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: 0x6D2E
      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: 0000CA1418C700000000000000000000
      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: End Option
Data:
0000: 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                   | ..........

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
            ...0 .... = Normal delay
            .... 0... = Normal throughput
            .... .0.. = 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 | ................
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
```

AOL(2)001834

```
      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)
      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                                          | »¹-

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
            000. .... = 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                                     AOL(2)001835
      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 highligh 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 highligh 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)
```

AOL(2)001836

```
      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 highligh 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,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: 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
List0103060F2C2E2F39
      Code: End Option
Data:
0000: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
```

AOL(2)001837

```
0010: 00 00                                                    | ..

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: 0004ACD5C86E00000000000000000000
      Server Host Name
      Boot File Name: bronze.cm
      Code: DHCP Message Type, Length: 1, Type: Offer
      Code: Subnet Mask, Length: 4      Address255.255.0.0
      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
Data:
0000: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0010: 00 00 00 00                                     | ....

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
```

AOL(2)001838

```
      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: 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: 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: 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: 0004ACD5C86E00000000000000000000
      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:
```

AOL(2)001839

```
0000: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 | ................
0010: 00 00 00 00                                     | ....
```

Telcordia. Technologies

Formerly Bellcore...
Performance from Experience

Telcordia Technologies Document
Contract Number: 41098
Revision 7, 11/30/99 10:20 AM

Implementing Open Access Over Cable Systems

A Technical Perspective

AOL(2)001841

Table of Contents

AOL(2)001842

AOL(2)001843

List of Figures

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.