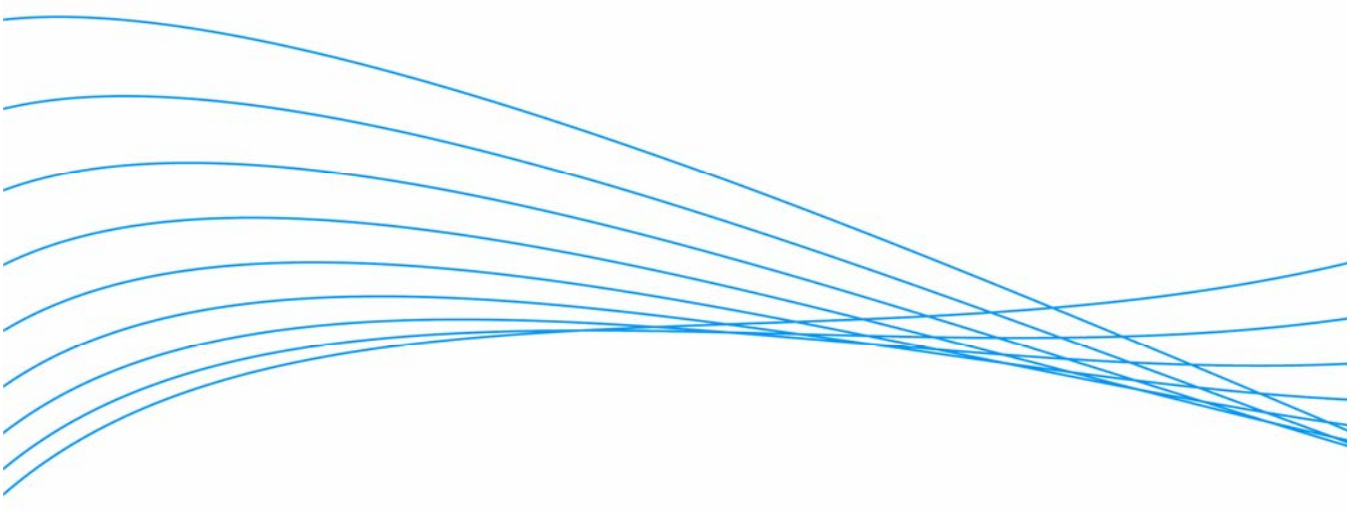
ProCurve Networking by HP

WAN Design Guide

For Advanced Topics

January 2006



Introduction

Fast and reliable data transfer, for many businesses, must continue even when obstacles present themselves. The fleet-footed cross-country runner knows all too well that to meet the objective, win the prize, means adapting and changing in response to obstacles in the path to the finish line. So it is with business: It is often critical that the customer network maintain its ability to function at some level even with disruptions to service. In the previous paper, "ProCurve Networking by HP WAN Design Guide, The Lower Layers," we explored many of the basics for WAN design. In this paper we will handle the additional topic of high availability.

High availability can topically span a wide range of disciplines. Among the most basic considerations are reliability and redundancy of the components, backup availability for power, availability of spare parts and of course the risk assessment to determine if we can justify the cost for coverage. Admittedly we cannot cover all possible considerations in this brief paper. For those that need to understand this more deeply, we have listed reference textbooks in the back of this guide. Points of consideration this guide does not discuss include:

- Defining What is Network Availability
- Understanding the Customer Availability Requirements
- Measuring and Reporting Network Availability
- Other General HA Theory

This paper will cover basic considerations and backup methods for the WAN with particular attention given to the ProCurve Secure Router 7000dl series and its capabilities. There are also some configuration examples along with the discussion of the available technologies.

This guide is for the technical consultant with moderate experience in wide area networking, familiar with the lower four layers of the OSI model, yet who may not be familiar with the ProCurve Secure Router 7000dl series or be an expert in WAN technologies. The consultant focused on LAN networking but with limited experience with WAN is the primary audience for this paper. Even with this audience focus, some aspects of this guide will still be useful for even the most experienced WAN manager, as it contains configuration comparisons between some of the ProCurve and Cisco routers and other relevant information.

High Availability and Redundancy

Executive Summary

The network designer needs to keep in mind aspects of the customer network that need high availability or redundancy. The customer needs a backup plan in the event of failure or scheduled downtime in the network. This plan might take the form of redundant components such as additional routers or, in the WAN world, separate carriers or ISPs. Often the customer requirement will allow the use of redundant physical links. Redundancy touches all layers of the OSI model, but redundant links are typically the most critical to implement in a WAN.

Redundancy can be built into the customer network at Layer 1 and 2 through optional backup modules, primary ISDN modules, MLFR, MLPPP and through different carriers. Layer 3 redundancy methods include designs that use multiple routes between sites. For the client-to-router redundancy, the use of VRRP or XRRP on the routing switches at the distribution layer is recommend so that if the primary routing switch goes down, the clients still have connectivity through the remaining routing switch to gain access to the WAN router.

Often the customer would like to use a different carrier for redundant paths. The Internet can provide such an option. The primary link can be through a private carrier and utilize PPP or Frame Relay. The backup link would be to the ISP. Any interface can be used to gain access to the Internet, and route selection can be controlled through the use of administrative distance parameters with static routes. The backup link is usually less desirable based upon cost or bandwidth of the link.

Overview of Technologies

Backup Methods

We will focus on three basic backup methods for building redundancy in your WAN:

- One option is to use dedicated links to different carriers, with the less desirable link used for backup.
- Another option is a switched link with a persistent backup connection, initiated immediately when the primary connection it monitors fails.
- The third method also uses switched links but establishes a connection differently than the previous method, using ACLs to trigger the establishment of a connection.

Dedicated-Link Backup

The use of dedicated links to different carriers with the less desirable link used for backup can be, though is not always, more expensive than switched-link backup methods. The less desirable link is still connected and available but carries little to no traffic until required after primary failure. A floating static route becomes a better route once the primary route, associated with the primary interface, fails and allows traffic to flow over the backup route and interface.

A common application is that the “less desirable” interface uses an ADSL link into the Internet. The Internet is the “backup” to a primary “leased line” E1, T1 or Frame Relay network. It is “less desirable” because, in this hypothetical situation, ADSL has a lower speed on the upstream side. Other applications are possible, but using the Internet for backup is one of the most common.

In this simple example and attached configurations of Figure 1, we show the branch router has a redundant path to the headquarters router. The DSLAM is simulating a connection to the ISP, and the T1 link from the branch to the center ProCurve Secure Router 7203dl simulates a primary network. The less desirable link is used for backup because in this simulated Internet, we have secured the traffic with an IPSec VPN. For completeness we have also shown a remote home office worker with a client-to-site VPN, but this is not really part of the high availability discussion.

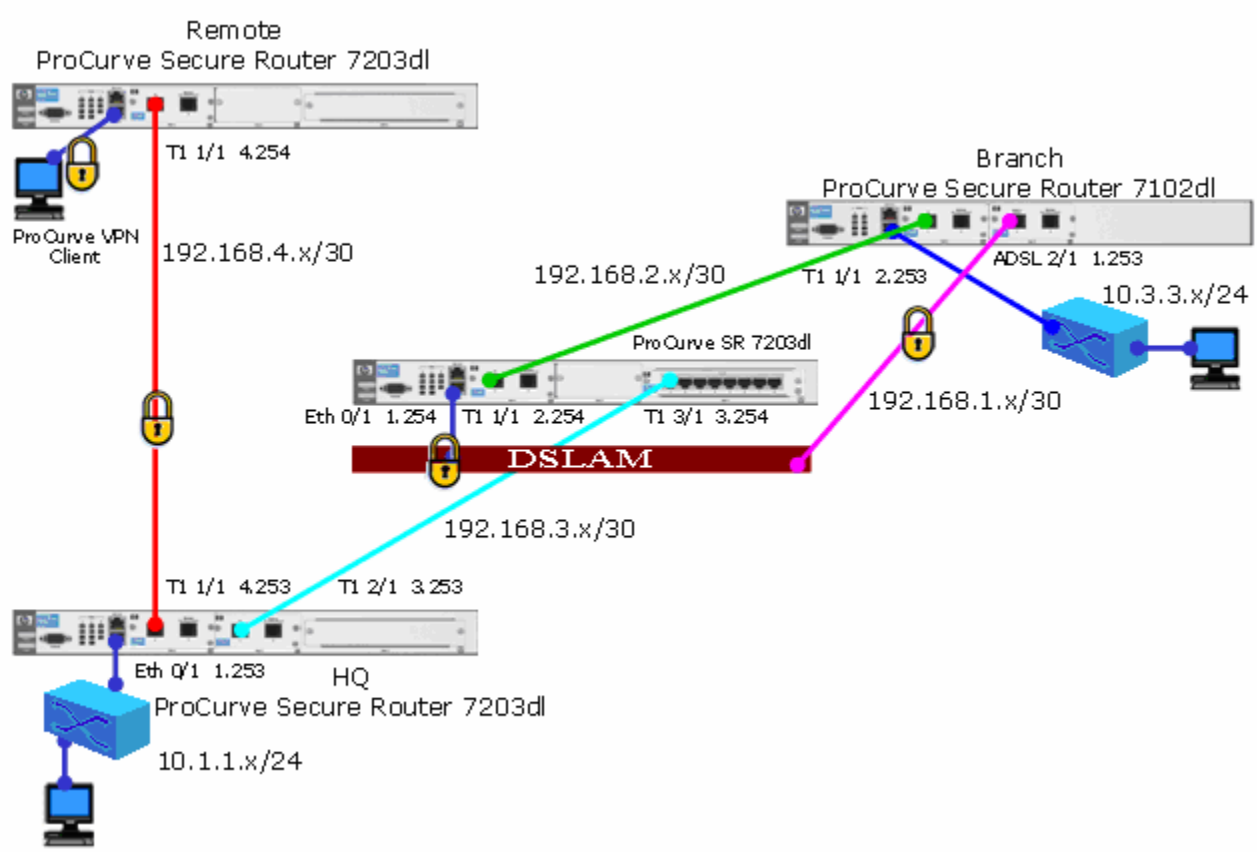


Figure 1: Example of a Dedicated-Link Backup with Internet and VPNs

Notice the branch configuration in Figure 1. Two default routes are set up, but the one exiting the less desirable ADSL interface to our simulated Internet has an Administrative Distance of "3". The route most used out of the branch will be through 192.168.2.1 until there is a failure, then the best route will be through 192.168.1.1. Because 192.168.1.1 has an AD higher than the primary link it will not be used until the primary fails. This technique is also used in other backup methods but is clearly seen in this example that does not utilize dial connections.

ProCurve Secure Router 7203dl (Branch)

```
!
!
hostname "branch"
.
(some CLI output not shown)
.

!
ip crypto
!
crypto ike policy 100
  initiate main
  respond anymode
  local-id fqdn procurve.com
  peer 192.168.1.254
  attribute 1
    encryption 3des
    hash md5
    authentication pre-share
!
crypto ike remote-id fqdn procurve.com
preshared-key pnb ike-policy 100
crypto map VPN 10 no-mode-config no-
xauth
```

```
crypto ike remote-id address
192.168.1.254 preshared-key pnb ike-
policy 100 crypto map VPN 10 no-mode-
config no-xauth
!
crypto ipsec transform-set esp-3des-
esp-md5-hmac esp-3des esp-md5-hmac
  mode tunnel
!
crypto map VPN 10 ipsec-ike
  description ISP
  match address VPN-10-vpn-selectors
  set peer 192.168.1.254
  set transform-set esp-3des-esp-md5-
hmac
  ike-policy 100
!
!
!
interface eth 0/1
  ip address  10.3.3.253
255.255.255.0
  no shutdown
!
!
interface t1 1/1
  clock source internal
  tdm-group 1 timeslots 1-24 speed 64
  no shutdown
!
interface adsl 2/1
  training-mode multi-mode
  no shutdown
!
!
interface atm 1 point-to-point
  no shutdown
  bind 1 adsl 2/1 atm 1
!
interface atm 1.1 point-to-point
  no shutdown
  pvc 0/33
  atm routed-bridged ip   ip address
192.168.1.253  255.255.255.252
  bandwidth 512
  crypto map VPN
!
interface ppp 1
  ip address  192.168.2.253
255.255.255.252
  no shutdown
  bind 2 t1 1/1 1 ppp 1
!
!
ip access-list extended VPN-10-vpn-
selectors
  permit ip 10.3.3.0 0.0.0.255
10.1.1.0 0.0.0.255
!
!
ip route 0.0.0.0 0.0.0.0 192.168.2.254
ip route 0.0.0.0 0.0.0.0 192.168.1.254
3 *
.
(some CLI output not shown)
.
```

* These are default routes used in a “floating static route” configuration

ProCurve Secure Router 7203dl (HQ)

```
!
!
hostname "HQ"
.
(some CLI output not shown)
.
!
ip crypto
!
crypto ike client configuration pool
Mobile_Clients
  ip-range            172.16.1.1
172.16.1.254
!
crypto ike policy 100
  no initiate
  respond anymode
  local-id fqdn procurve.com
  peer any
  client configuration pool
Mobile_Clients
  attribute 1
    encryption 3des
    hash md5
    authentication pre-share
!
crypto ike remote-id fqdn procurve.com
preshared-key procurve ike-policy 100
crypto map VPN 10 no-xauth
!
crypto ipsec transform-set esp-3des-
esp-md5-hmac esp-3des esp-md5-hmac
  mode tunnel
!
crypto map VPN 10 ipsec-ike
  description Mobile_Clients
  match address VPN-10-vpn-selectors
  set transform-set esp-3des-esp-md5-
hmac
  ike-policy 100
  mobile
!
!
!
interface eth 0/1
  ip address  10.1.1.253
255.255.255.0
  no shutdown
!
interface eth 0/2
  no ip address
  shutdown
!
!
!
interface t1 1/1
  tdm-group 1 timeslots 1-24 speed 64
  no shutdown
!
interface t1 2/1
  tdm-group 2 timeslots 1-24 speed 64
  no shutdown
!
interface ppp 1
  ip address  192.168.3.253
255.255.255.252
  no shutdown
  bind 1 t1 1/1 1 ppp 1
!
interface ppp 2
  ip address  192.168.4.253
255.255.255.252
  crypto map VPN
  no shutdown
  bind 2 t1 2/1 2 ppp 2
!
!
ip access-list extended VPN-10-vpn-
selectors
  permit ip any  any
!
!
ip route 0.0.0.0 0.0.0.0 ppp 1
ip route 10.4.1.0 255.255.255.0
192.168.4.254
!
.
```

```
(some CLI output not shown)
.
```

ProCurve Secure Router 7203dl (Remote)

```
!
!
hostname "remote"
.
(some CLI output not shown)
.
interface eth 0/1
  ip address  10.4.1.254
255.255.255.0
  no shutdown
!
interface eth 0/2
  no ip address
  shutdown
!
!
!
interface t1 1/1
  tdm-group 1 timeslots 1-24 speed 64
  no shutdown
!
!
interface ppp 1
  ip address  192.168.4.254
255.255.255.252
  no shutdown
  bind 1 t1 1/1 1 ppp 1
!
!
!
!
!
ip route 10.1.1.0 255.255.255.0
192.168.4.253
!
no ip tftp server
ip http server
no ip http secure-server
no ip snmp agent
no ip ftp agent
!
.
(some CLI output not shown)
.
```

Switched-Link-Persistent Backup

Another option is a switched link with a persistent backup connection. A switched-link-persistent backup is one that switches on as the primary connection fails and stays up until the primary connection is available again. The persistent backup method triggers from the primary interface, physical or logical, status only. Unlike the dedicated link backup method, a switched connection is established by dialing the other router. Once the connection is established, data can flow based upon the status of a floating static route.

For persistent backup connections, you install a backup module in a specific module slot. The corresponding backup line can provide redundancy for any of the WAN connections, physical or logical, on the router. You enable backup for a connection by configuring a backup dial list on the connection's logical interface.

You can define a backup connection for every PVC in a Frame Relay network or ATM connection separately. When doing this you enter the backup commands from the Frame Relay or ATM sub-interface. The analog or ISDN line can provide active backup for only one interface at a time. There is a one-to-one relationship for backing up the primary link. This is because this line makes a point-to-point dial-up connection to the other router; it does not connect to the primary network but bypasses it.

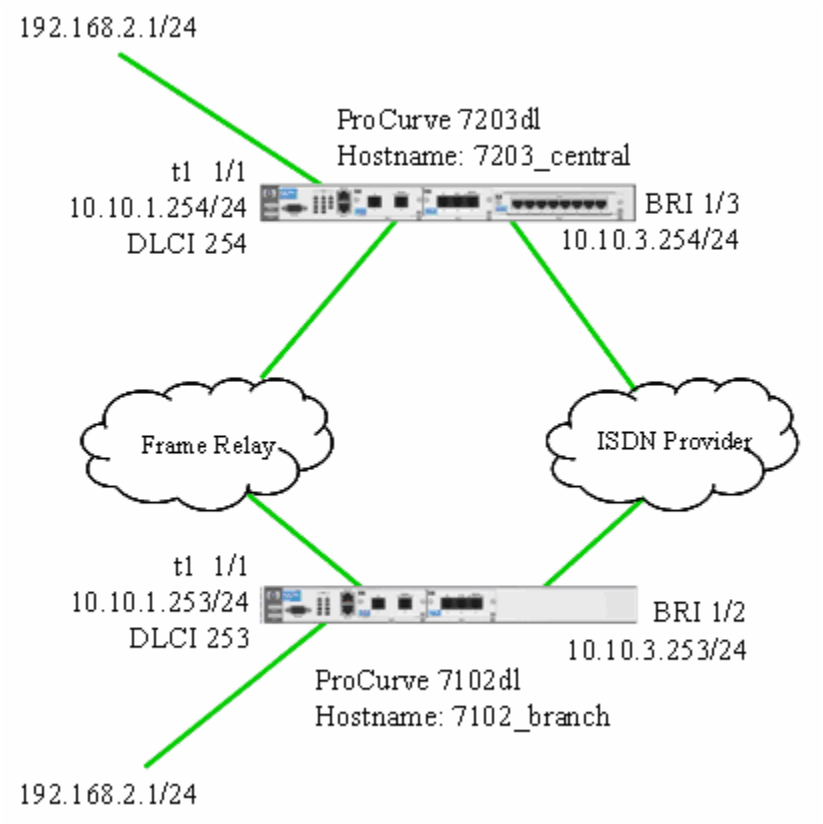


Figure 2: Switched-Link-Persistent Backup Example

Notice the branch configuration in Figure 2. Two default routes are set up, but the one exiting the switched-link-persistent backup module interface has an Administrative Distance of "2". The route most used out of the branch will be through ppp1 (exiting interface) until there is a failure, then the best route will be through ppp2. Because ppp2 has an AD higher than the primary link it will not be used until the primary fails. This technique is also used in other backup methods.

ProCurve Secure Router 7102dl (Branch)

```
hostname "7102_branch"
!
interface eth 0/1
  ip address  192.168.2.1
255.255.255.0
  no shutdown
  no lldp send system-description
  lldp send management-address
!
interface t1 1/1
  tdm-group 1 timeslots 1-24 speed 64
  no shutdown
!
interface bri 1/2
  isdn spid1 91678500110101 7850011
  isdn spid2 91678500120101 7850012
  no shutdown
!
interface ppp 1
  ip address  10.10.1.253
255.255.255.0
  backup call-mode originate
  backup number 7850001 digital-64k 1
2 ppp 2
  no lldp send system-description
  no lldp send system-capabilities
  lldp send management-address
  no shutdown
  bind 1 t1 1/1 1 ppp 1
!
interface ppp 2
  description connect to
branch_central for dial backup
  ip address  10.10.3.253
255.255.255.0
  no lldp send system-description
  lldp send system-capabilities
  no shutdown

ip route 192.168.1.0 255.255.255.0
ppp1 1
ip route 192.168.1.0 255.255.255.0
ppp2 2
!
!
end
```

ProCurve Secure Router 7203dl (Central)

```
hostname "7203_central"
!
interface eth 0/1
  ip address  192.168.1.1
255.255.255.0
  no shutdown
  no lldp send system-description
  lldp send management-address
!
interface t1 1/1
  tdm-group 1 timeslots 1-24 speed 64
  no shutdown
!
interface bri 1/3
  isdn spid1 91678500010101 7850001
  isdn spid2 91678500020101 7850002
  caller-id override always 7850011
  no shutdown
!
interface ppp 1
  ip address  10.10.1.254
255.255.255.0
```

```
  backup call-mode answer-always
  backup number 7850011 digital-64k 1
2 ppp 2
  no lldp send system-description
  lldp send management-address
  no shutdown
  bind 1 t1 1/1 1 ppp 1
!
interface ppp 2
  description connect from remote for
backup
  ip address  10.10.3.254
255.255.255.0
  no lldp send system-description
  no shutdown
!
!
ip route 192.168.2.0 255.255.255.0
ppp1 1
ip route 192.168.2.0 255.255.255.0
ppp2 2
!
!
end
```

Switched-Link-Demand Routing Backup

The third method uses switched links but establishes a connection differently than the switched-link-persistent method. Demand routing does not require a primarily link failure to operate, although this is the way it is used in backup methods. If there are sporadic, or infrequent, transmissions to a remote site, DDR can dial and allow the traffic to flow until complete. As a method for backup, demand routing triggers a call by using an ACL. The ACL sees the traffic because a floating static route has allowed the flow of traffic to the interface. Upon seeing the interesting traffic, the ACL triggers the demand interface.

Demand routing manages the backup connection so that when traffic is sent from the main office to the branch office and the primary interface is unavailable, the demand interface establishes the dial-up connection. Demand routing also ensures that when the dial-up connection is idle for a specified amount of time, the demand interface terminates the call.

Much of the technology can be understood by understanding the basic configuration steps:

- Create an extended access control list (ACL) to define the traffic that will trigger the dial-up connection when the primary interface is unavailable.
- Configure a demand interface.
- Configure the ISDN BRI interface.
- Create a floating static route to the far-end network.

See the ProCurve Secure Router 7000dl Series Management and Configuration manuals, either Basic or Advanced, for further information.

Summary of Major Points

To recap, there are three methods for backing up the primary interface: dedicated-link, switched-link persistent and switched-link-demand routing.

The dedicated-link method can be costly but has the fastest response. The switched-link-persistent backup method considers only the interface status, whether up or down, dials the other side, completes the connection and waits for data to flow based upon the condition set through the “floating static route.” Because the floating static route now has a “better” status in the routing table, the data flows.

The switched-link-demand method considers only the selection defined by the ACL. It could be active with the primary link still up. Some ACL-selected interesting traffic triggers the dial for the remote side. Traffic flows. Normally for backup, a floating static route is used to allow the flow of information. Dial on demand is more granular because an extended ACL can be very specific. The link will not be established upon just any primary link failure but upon primary failure plus interesting traffic. This allows the

customer to allow only the most critical data to use the link. Bonding with dial-on-demand routing can be across more than two channels and interoperates with other vendors, because it uses MLPPP.

Advantages and Disadvantages

Dedicated-Link Backup Method

Advantages	Disadvantages
Potentially Lower Cost	
Can be if using the Internet and VPNs.	ADSL is the most common connection to the Internet and is asymmetrical. Asymmetrical means that business traffic should flow primarily in one direction.
Speed and Efficiency	
This can be costly, but if coupled with ECMP is likely the best solution. When calculating dual dedicated links as a backup method, you may want to consider running your links at only 50% bandwidth. In other words, keep the link at 50% of its full rate. This is so that when one link fails the other can carry all of the traffic without dropping packets.	
Flexibility	
This method can utilize any link technology.	

Switched-Link-Persistent Backup Method

Advantages	Disadvantages
Connection Made Prior to Traffic Flow	
Fewer queuing problems with traffic flow delayed until connection established. Connection established on link failure.	Link established when no routing may be necessary.
	May establish a call and connection when not required, costing money.
Connection Control Timing	
Keeps backup connections disabled during selected times or days. Keeps failed links from forcing a call when one is not required, wasting money.	
Physical and Bandwidth Considerations	
Backup modules do not take slot space from other interfaces needed. Sits on top of a primary ProCurve 7000dl module.	Maximum of 128 Kbps of proprietary ISDN channel bonding per backup connection.
	If using an analog modem for backup, the maximum link speed is 36 Kbps—but may be the only method available in some countries.

Switched-Link-Demand Routing Method

Advantages	Disadvantages
Traffic Flow Triggers Dial to Make Connection	
Very granular selection possible. This is extremely useful when the backup link has less bandwidth than the primary. The ACL selection process can restrict the traffic on the backup link to only the most critical.	No ability to select a time period to disable link as with the switched-link-persistent backup method using backup modules.
Does not require primary interface failure.	
	Queuing may be an issue since the link is not established until there is interesting traffic. By default, the ProCurve Secure Router 7000dl holds 200 packets for 3 seconds. If the number of packets received before the connection is established exceeds 200 packets or if the connection is not established within 3 seconds, the ProCurve Secure Router empties the hold queue. However, emptying the hold queue does not terminate an activation attempt. For configuration information regarding increasing the available queuing, see the ProCurve Secure Router 7000dl Series Advanced Management and Configuration Guide, December 2005 or later, for configuring backup connections.
Physical and Bandwidth Considerations	
Up to 512 Kbps of MLPPP backup capacity when utilized in a ProCurve Secure Router 7203dl.	This capacity only for 7203dl. 7102dl will do up to 256 Kbps while backing up one other interface.
Available only for ISDN modules.	

What to Determine During Planning or for Implementation

- Reference discussion in “ProCurve Networking by HP WAN Design Guide, The Lower Layers” in the ISDN section for lower layer considerations.
- The dual-port ISDN modules have a single TDM clock. That means that you cannot go to two separate service providers with a single module. To utilize two different service providers with the ISDN dual-port modules, use two different modules or an optional backup module.
- Determine your best backup method: dedicated-link, switched-link-persistent or switched-link-demand routing.
- If you use persistent, determine if there are any days you do not want the link to become active.
- If you use switched-link-demand routing, make interesting traffic selection as explicit as possible. If you use standard ACLs, activate them on the port closest to the destination network and on the outbound. If using extended ACLs, activate the ACL as close to the source as possible and on the inbound.
- For implementation purposes consult the Basic Management and Configuration Guide for the ProCurve Secure Router 7000dl Series, December 2005, for information on setting timers for various use models.

Solution Configuration Example

ProCurve Retail is a hypothetical sales-based company headquartered in Berlin that has branch offices in Mannheim, Dublin and Prague. The company’s manufacturing plant, which is located in Mannheim,

requires a high-bandwidth, reliable WAN connection to the Berlin office. The Dublin and Prague offices are remote sales offices that require dedicated connections to the Berlin office and occasional direct connections with the Mannheim office to upload sales information.

To connect the Berlin office to the branch offices outside Germany, the company uses Frame Relay running over E1-carrier lines. The Mannheim and Berlin offices are connected with an Asymmetric Digital Subscriber Line (ADSL) connection, which is less expensive and provides more bandwidth than a dedicated E1 line.

ProCurve Retail uses Integrated Services Digital Network (ISDN) connections to connect the branch offices to each other. ISDN provides a cost-effective WAN connection because the company pays for the connection only when it is needed. An ISDN connection works well because the branch offices exchange information only periodically. For example, the Dublin and Prague offices upload sales information to the Mannheim network once a week, and the Mannheim office then uses this information to forecast manufacturing.

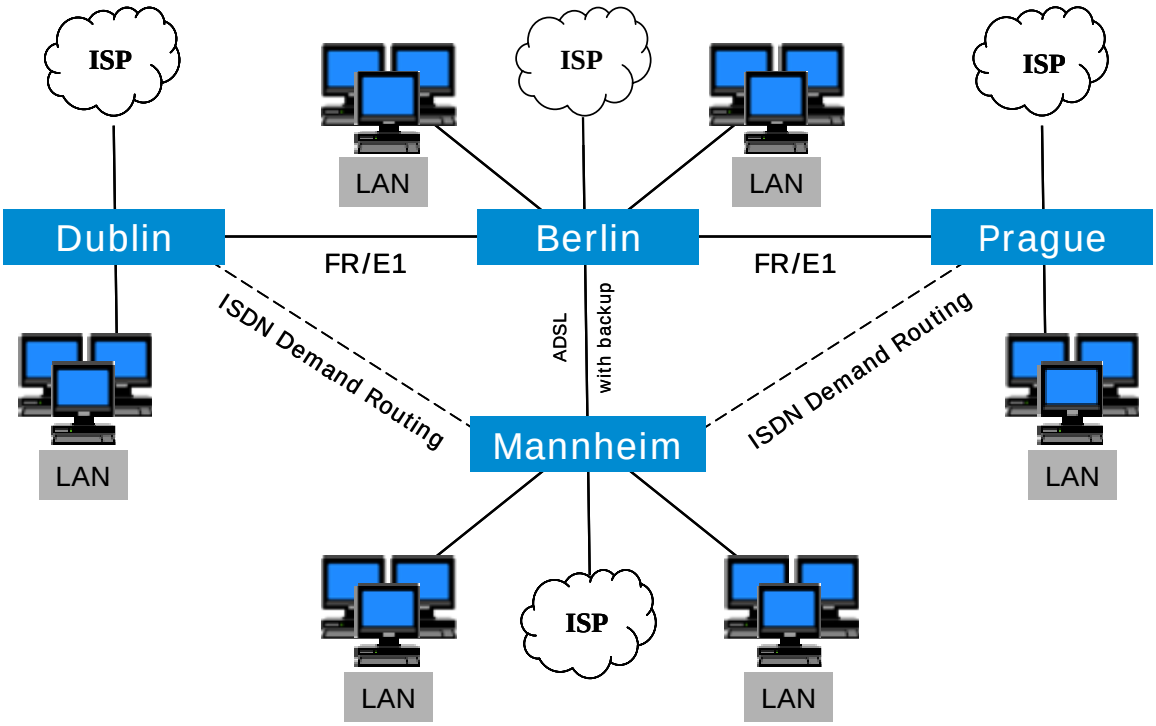


Figure 3: ProCurve Retail Hypothetical Company Network

Because nearly 1,000 employees work at the Berlin office, ProCurve Retail's LAN includes 1,000 workstations, several server farms, and the company's Internet and intranet servers. The company uses ProCurve Networking switches, which have Layer 3 routing capabilities, to provide connectivity and routing at the LAN level. Two core switches connect directly to the two Ethernet ports on the ProCurve Secure Router 7203dl.

This router runs a multilink Frame Relay connection to the branch offices outside of Germany to provide access to the servers and data that the employees require. Berlin also runs a dedicated E1 line using the Point-to-Point Protocol (PPP) for a local connection to the Internet. In fact, all the offices have a PPP connection to a local Internet Service Provider (ISP) for Internet access.

The Berlin headquarters and the Mannheim office are connected through ADSL running PPP over Ethernet (PPPoE). ADSL provides a high-bandwidth connection for a lower cost than an E1-carrier line, particularly since the connection does not cross international boundaries. Because the Berlin and Mannheim networks exchange mission-critical traffic, ProCurve Retail decides to install a backup ISDN BRI S/T module in the Berlin router to provide persistent backup for the ADSL connection.

Some example configurations for the routers depicted in Figure 3 are presented below; they contain some features that are not discussed in this paper. For more information regarding these features, please reference the Advanced Management and Configuration Guide for the ProCurve Secure Router 7000dl Series, December 2005. This is available on the web site www.procurve.com under technical support and manuals. Below are the configuration examples:

ProCurve Secure Router 7203dl (Berlin)

```
!
!
hostname "Berlin"
enable password procurve
!
!
ip subnet-zero
ip classless
ip routing
!
event-history on
no logging forwarding
no logging email
logging email priority-level info
!
no service password-encryption
!
!
ip firewall
no ip firewall alg h323
ip firewall alg sip udp 5060
!
aaa on
!
tacacs-server host 192.168.1.23 key
password
!
aaa authentication login xauth group
tacacs+
!
!
!
no autosynch-mode
no safe-mode
!
!
!
ip crypto
!
crypto ike client configuration pool
RemoteUsers
  ip-range            192.168.126.1
192.168.126.250
  dns-server          10.10.10.10
  netbios-name-server 192.168.3.3
!
crypto ike policy 1
  no initiate
  respond anymode
  peer any
  client authentication server list
xauth
  client configuration pool
RemoteUsers
  attribute 1
    encryption 3des
    hash md5
    authentication pre-share
    group 2
!
crypto ike remote-id any preshared-key
procurve
!
crypto ipsec transform-set MyTrans
esp-3des esp-sha-hmac
  mode tunnel
!
crypto map VPN 10 ipsec-ike
  match address VPNTraffic
  set transform-set MyTrans
```

```
  ike-policy 1
!
!
!
interface loop 1
  ip address  192.168.127.1
255.255.255.0
  no shutdown
!
interface eth 0/1
  ip address  192.168.1.1
255.255.255.0
  ip pim sparse-mode
  no shutdown
!
interface eth 0/2
  ip address  192.168.2.1
255.255.255.0
  ip pim sparse-mode
  no shutdown
!
!
!
interface e1 1/1
  clock source internal
  tdm-group 1 timeslots 1-31 speed 64
  no shutdown
!
interface e1 1/2
  clock source internal
  tdm-group 1 timeslots 1-31 speed 64
  no shutdown
!
interface e1 3/1
  tdm-group 1 timeslots 1-31 speed 64
  no shutdown
!
interface e1 3/2
  shutdown
!
interface e1 3/3
  shutdown
!
interface e1 3/4
  shutdown
!
interface e1 3/5
  shutdown
!
interface e1 3/6
  shutdown
!
interface e1 3/7
  shutdown
!
interface e1 3/8
  shutdown
!
interface adsl 2/1
  snr-margin 6
  training-mode Multi-Mode
  no shutdown
!
!
interface atm 1 point-to-point
  no shutdown
  bind 4 adsl 2/1 atm 1
!
interface atm 1.1 point-to-point
  no shutdown
  pvc 0/33
  description Connection to Mannheim
  atm routed-bridged ip
  no ip address
!
interface bri 2/2
  isdn ldn1 496211111111
  no shutdown
!
!
interface fr 1 point-to-point
  frame-relay lmi-type ansi
  frame-relay multilink
  no shutdown
  bind 2 e1 1/2 1 frame-relay 1
  bind 3 e1 3/1 1 frame-relay 1
!
interface fr 1.1 point-to-point
  frame-relay interface-dlci 103
  description Connection to Dublin
```

```
  ip address  10.1.3.1
255.255.255.252
  ip pim sparse-mode
!
interface fr 1.2 point-to-point
  frame-relay interface-dlci 104
  description Connection to Prague
  ip address  10.1.4.1
255.255.255.252
  ip pim sparse-mode
!
interface ppp 1
  description Connection to ISP
  ip address  10.10.1.1
255.255.255.252
  crypto map VPN
  no shutdown
  bind 1 e1 1/1 1 ppp 1
!
interface ppp 2
  ip address  10.1.2.50  255.255.255.0
  backup number 496215551232 digital-
64k 1 2 ppp 3
  no shutdown
  bind 5 atm 1.1 ppp 2 pppoe-client
!
interface ppp 3
  description Backup to Mannheim
  ip address  10.1.20.1
255.255.255.252
  ppp authentication chap
  username Mannheim password branch
  ppp chap hostname Berlin
  ppp chap password hq
  no shutdown
!
!
interface tunnel 1
  ip address  192.168.191.1
255.255.255.0
  ip pim sparse-mode
  tunnel mode gre
  tunnel source ppp 2
  tunnel destination 10.1.2.200
  mtu 1468
  bandwidth 896
  no shutdown
!
!
!
router ospf
  default-information-originate
  network 192.168.1.0 0.0.0.255 area 0
  network 192.168.2.0 0.0.0.255 area 0
  network 192.168.191.0 0.0.0.255 area
2
  network 10.1.3.0 0.0.0.3 area 3
  network 10.1.4.0 0.0.0.3 area 4
  area 0 range 192.168.0.0
255.255.128.0 advertise
  area 2 stub
  area 3 stub
  area 4 stub
!
!
router pim-sparse
  rp-address 192.168.127.1
!
!
ip access-list extended VPNTraffic
  permit ip 192.168.0.0 0.0.63.255
192.168.126.0 0.0.0.255
!
!
!
ip route 0.0.0.0 0.0.0.0 ppp 1
ip route 192.168.128.0 255.255.255.0
ppp 3 120
ip route 192.168.129.0 255.255.255.0
ppp 3 120
!
ip telnet-server 23
ip ssh-server 22
no ip tftp server
no ip http server
no ip http secure-server
no ip snmp agent
no ip ftp agent
!
!
!
!
```

```
!
!
!
ip sip
ip sip proxy
!
line con 0
!
line telnet 0 4
  no shutdown
line ssh 0 4
  no shutdown
!
!
end
```

ProCurve Secure Router 7203dl (Mannheim)

```
!
!
hostname "Mannheim"
enable password procurve
!
!
ip subnet-zero
ip classless
ip routing
!
event-history on
no logging forwarding
no logging email
logging email priority-level info
!
no service password-encryption
!
!
ip firewall
no ip firewall alg h323
ip firewall alg sip udp 5060
!
!
!
!
!
autosynch-mode
no safe-mode
!
!
!
!
!
!
!
!
interface loop 1
  ip address  192.168.135.2
255.255.255.0
  no shutdown
!
interface eth 0/1
  ip address  192.168.128.1
255.255.255.0
  ip pim sparse-mode
  no shutdown
!
interface eth 0/2
  ip address  192.168.129.1
255.255.255.0
  ip pim sparse-mode
  no shutdown
!
!
!
interface e1 3/1
  tdm-group 1 timeslots 1-31 speed 64
  no shutdown
!
interface e1 3/2
  shutdown
!
interface e1 3/3
  shutdown
!
interface e1 3/4
  shutdown
!
interface e1 3/5
  shutdown
!
```

```
interface e1 3/6
  shutdown
!
interface e1 3/7
  shutdown
!
interface e1 3/8
  shutdown
!
interface adsl 2/1
  snr-margin 6
  training-mode Multi-Mode
  shutdown
!
!
interface atm 1 point-to-point
  no shutdown
  bind 2 adsl 2/1 atm 1
!
interface atm 1.1 point-to-point
  no shutdown
  pvc 3/35
  description Connection to Berlin
  atm routed-bridged ip

  no ip address
!
interface bri 2/2
  isdn ldn1 496215551232
  no shutdown
!
interface bri 1/1
  isdn ldn1 496215551212
  no shutdown
interface bri 1/2
  isdn ldn1 496215551222
  no shutdown
!
interface ppp 1
  description Connection to ISP
  ip address  10.20.1.1
255.255.255.252
  no shutdown
  bind 1 e1 3/1 1 ppp 1
!
interface ppp 2
  ip address  10.1.2.200
255.255.255.0
  backup number 496211111111 digital-
64k 1 2 ppp 3
  no shutdown
  bind 3 atm 1.1 ppp 2 pppoe-client
!
interface ppp 3
  description Backup to Berlin
  ip address  10.1.20.2
255.255.255.252
  ppp authentication chap
  username Berlin password hq
  ppp chap hostname Mannheim
  ppp chap password branch
  no shutdown
!
interface demand 1
  resource pool Pool1
  match-interesting list Demand1 out
  match-interesting reverse list
Demand1 in
  connect-sequence 10 dial-string
0035315551213 forced-isdn-64k busyout-
threshold 3
  connect-sequence 20 dial-string
0035315551223 forced-isdn-64k busyout-
threshold 3
  connect-sequence interface-recovery
retry-interval 120 max-retries 0
  description Connection to Dublin
  ip address  10.2.3.1
255.255.255.252
  no shutdown
interface demand 2
  resource pool Pool2
  match-interesting list Demand2 out
  match-interesting reverse list
Demand2 in
  connect-sequence 10 dial-string
004202551214 forced-isdn-64k busyout-
threshold 3
  connect-sequence 20 dial-string
004202551224 forced-isdn-64k busyout-
threshold 3
  connect-sequence interface-recovery
retry-interval 120 max-retries 0
```

```
  description Connection to Prague
  ip address  10.2.4.1
255.255.255.252
  no shutdown
!
!
interface tunnel 1
  ip address  192.168.191.2
255.255.255.0
  tunnel mode gre
  tunnel source ppp 2
  tunnel destination 10.1.2.50
  bandwidth 0
  ip pim sparse-mode
  no shutdown
!
!
isdn-group 1
  resource pool-member Pool1
  connect bri 1/1
!
isdn-group 2
  resource pool-member Pool2
  connect bri 1/2
!
!
router ospf
  network 192.168.128.0 0.0.0.255 area
2
  network 192.168.129.0 0.0.0.255 area
2
  network 192.168.191.0 0.0.0.255 area
2
  area 2 stub
!
!
router pim-sparse
  rp-address 192.168.127.1
!
!
ip access-list extended demand
  permit ip 192.168.2.0 0.0.0.255
192.168.1.0 0.0.0.255
!
ip access-list extended Demand1
  permit ip 192.168.128.0 0.0.0.255
192.168.192.0 0.0.0.255
  permit ip 192.168.129.0 0.0.0.255
192.168.192.0 0.0.0.255
!
ip access-list extended Demand2
  permit ip 192.168.128.0 0.0.0.255
192.168.224.0 0.0.0.255
  permit ip 192.168.129.0 0.0.0.255
192.168.224.0 0.0.0.255
!
!
!
ip route 0.0.0.0 0.0.0.0 ppp 1
ip route 192.168.0.0 255.255.128.0 ppp
3 120
ip route 192.168.192.0 255.255.255.0
demand 1
ip route 192.168.224.0 255.255.255.0
demand 2
!
ip telnet-server 23
ip ssh-server 22
no ip tftp server
no ip http server
no ip http secure-server
no ip snmp agent
no ip ftp agent
!
!
!
!
!
!
!
ip sip
ip sip proxy
!
line con 0
  no login
!
line telnet 0 4
  login
  no shutdown
line ssh 0 4
  login local-userlist
```

```
  no shutdown
!
!
```

```
end
```

ProCurve Secure Router 7203dl (Dublin)

```
!
!
hostname "Dublin"
enable password procurve
!
!
ip subnet-zero
ip classless
ip routing
!
event-history on
no logging forwarding
no logging email
logging email priority-level info
!
no service password-encryption
!
!
ip firewall
no ip firewall alg h323
ip firewall alg sip udp 5060
!
!
!
!
!
autosynch-mode
no safe-mode
!
!
!
!
!
!
!
!
!
interface loop 1
  ip address  192.168.193.3
255.255.255.0
  no shutdown
```

```
!
interface eth 0/1
  ip address  192.168.192.1
255.255.255.0
  ip pim sparse-mode
  no shutdown
!
interface eth 0/2
  no ip address
  shutdown
!
!
!
interface e1 1/1
  clock source internal
  tdm-group 1 timeslots 1-31 speed 64
  no shutdown
!
interface e1 1/2
  clock source internal
  tdm-group 1 timeslots 1-31 speed 64
  no shutdown
!
interface bri 2/1
  isdn ldn1 35315551213
  no shutdown
interface bri 2/2
  isdn ldn1 35315551223
  no shutdown
!
!
interface fr 1 point-to-point
  frame-relay lmi-type ansi
  no shutdown
  bind 2 e1 1/2 1 frame-relay 1
!
interface fr 1.1 point-to-point
  frame-relay interface-dlci 101
  description Connection to Berlin
```

```
  ip address  10.1.3.2
255.255.255.252
  ip pim sparse-mode
!
interface ppp 1
  description Connection to ISP
  ip address  10.30.1.1
255.255.255.252
  no shutdown
  bind 1 e1 1/1 1 ppp 1
!
interface demand 1
  resource pool Pool1
  match-interesting list Demand1 out
  match-interesting reverse list
Demand1 in
  connect-sequence 10 dial-string
00496215551212 forced-isdn-64k
busyout-threshold 4
  connect-sequence interface-recovery
retry-interval 120 max-retries 0
  description Connection to Mannheim
  ip address  10.2.3.2
255.255.255.252
  no shutdown
!
!
isdn-group 1
  resource pool-member Pool1
  connect bri 2/1
  connect bri 2/2
!
!
router ospf
  network 192.168.192.0 0.0.0.255 area
3
  network 10.1.3.0 0.0.0.3 area 3
  area 3 stub
!
!
router pim-sparse
  rp-address 192.168.127.1
!
!
ip access-list extended Demand1
  permit ip 192.168.192.0 0.0.0.255
192.168.128.0 0.0.0.255
  permit ip 192.168.192.0 0.0.0.255
192.168.129.0 0.0.0.255
!
!
!
ip route 0.0.0.0 0.0.0.0 ppp 1
ip route 192.168.128.0 255.255.255.0
demand 1
ip route 192.168.129.0 255.255.255.0
demand 1
!
ip telnet-server 23
ip ssh-server 22
no ip tftp server
no ip http server
no ip http secure-server
no ip snmp agent
no ip ftp agent
!
!
!
!
!
!
!
ip sip
ip sip proxy
!
line con 0
  no login
!
line telnet 0 4
  login
  no shutdown
line ssh 0 4
  login local-userlist
  no shutdown
!
!
end

!
!
hostname "Prague"
enable password procurve
!
```

```
!
ip subnet-zero
ip classless
ip routing
!
event-history on
no logging forwarding
no logging email
logging email priority-level info
!
no service password-encryption
!
!
ip firewall
no ip firewall alg h323
ip firewall alg sip udp 5060
!
!
!
!
!
autosynch-mode
no safe-mode
!
!
!
!
!
!
!
!
interface loop 1
  ip address  192.168.225.4
255.255.255.0
  no shutdown
!
interface eth 0/1
  ip address  192.168.224.1
255.255.255.0
  ip pim sparse-mode
  no shutdown
!
interface eth 0/2
  no ip address
  shutdown
!
!
!
interface e1 1/1
  clock source internal
  tdm-group 1 timeslots 1-31 speed 64
  no shutdown
!
interface e1 1/2
  clock source internal
  tdm-group 1 timeslots 1-31 speed 64
  no shutdown
!
!
interface bri 2/3
  shutdown
!
interface bri 2/1
  isdn ldn1 4202551214
  no shutdown
interface bri 2/2
  isdn ldn1 4202551224
  no shutdown
!
!
interface fr 1 point-to-point
  frame-relay lmi-type ansi
  no shutdown
  bind 2 e1 1/2 1 frame-relay 1
!
interface fr 1.1 point-to-point
  frame-relay interface-dlci 102
  description Connection to Berlin
  ip address  10.1.4.2
255.255.255.252
  ip pim sparse-mode
!
interface ppp 1
  description Connection to ISP
  ip address  10.40.1.1
255.255.255.252
  no shutdown
  bind 1 e1 1/1 1 ppp 1
!
interface demand 1
```

```
  resource pool Pool1
  match-interesting list Demand1 out
  match-interesting reverse list
Demand1 in
  connect-sequence 10 dial-string
00496215551222 forced-isdn-64k
busyout-threshold 0
  connect-sequence interface-recovery
retry-interval 120 max-retries 0
  description Connection to Mannheim
  ip address  10.2.4.2
255.255.255.252
  no shutdown
!
!
isdn-group 1
  resource pool-member Pool1
  connect bri 2/1
  connect bri 2/2
!
!
router ospf
  network 192.168.224.0 0.0.0.255 area
4
  network 10.1.4.0 0.0.0.3 area 4
  area 4 stub
!
!
router pim-sparse
  rp-address 192.168.127.1
!
!
ip access-list extended Demand1
  permit ip 192.168.224.0 0.0.0.255
192.168.128.0 0.0.0.255
  permit ip 192.168.224.0 0.0.0.255
192.168.129.0 0.0.0.255
!
!
!
ip route 0.0.0.0 0.0.0.0 ppp 1
ip route 192.168.128.0 255.255.255.0
demand 1
ip route 192.168.129.0 255.255.255.0
demand 1
!
ip telnet-server 23
ip ssh-server 22
no ip tftp server
no ip http server
no ip http secure-server
no ip snmp agent
no ip ftp agent
!
!
!
!
!
!
!
ip sip
ip sip proxy
!
line con 0
  no login
!
line telnet 0 4
  login
  no shutdown
line ssh 0 4
  login local-userlist
  no shutdown
!
!
end
```

Appendix A – Additional Topics for the Future

The following topics are currently beyond the scope of this paper or simply have not yet been written. Nevertheless, we mention them here as an overview so the designer can make better decisions regarding these topics and be reminded that these are aspects to consider after the basic design is met.

IP Multicast

The ProCurve Secure Router 7000dl series allows for two different methods to handle multicasts in the customer network:

- Stub Network Multicast Forwarding
- Multicast Forwarding with PIM-SM

From a branch office perspective there is often little requirement for extensive routing of multicasts. There is often, however, a requirement to forward multicasts through the router to the central site. The ProCurve Secure Router 7000dl series uses a multicast route helper to allow forwarding of multicasts from a stub network.

Sometimes the customer network is more extensive, with multiple hops between sites or some meshed design. This may require a greater level of sophistication through the use of a multicast routing protocol. A multicast routing protocol will allow the network to take advantage of best-path decisions in a more complicated network. The ProCurve Secure Router 7000dl series allows for this with Protocol Independent Multicast-Sparse Mode, or PIM-SM.

Working with whatever unicast routing protocols the routers implement, PIM-SM allows routers in a PIM domain to construct a shared, unidirectional tree for each multicast group active in the network. The shared tree is rooted at what is called a "rendezvous point" (RP) router, which is the router responsible for drawing multicast traffic from a new source to receivers in the associated group.

See the following ProCurve Secure Router 7000dl series documentation dated after December 2005 for further information:

- Either the Basic or Advanced Management and Configuration Guides
- SROS Command Line Interface Reference Guide

Security, Access Control Lists and Virtual Private Networks

Security, which includes many more facets than simply firewalls and access policies, should be considered during the design phase. This is especially critical if the routers will connect to a public network such as the Internet.

See the following ProCurve Secure Router 7000dl series documentation dated after December 2005 for further information:

- The Basic or Advanced Management and Configuration Guides
- SROS Command Line Interface Reference Guide

Quality of Service

Quality of service should be considered as a part of the overall network solution including both WAN and LAN. An end-to-end QoS discussion is currently beyond the scope of this paper. Please see the following ProCurve Secure Router 7000dl series documentation dated after December 2005 for further information:

- The Advanced Management and Configuration Guide
- The Paper "Understanding SROS Priority Queuing, Class-Based WFQ and QoS Maps" located at: www.procurve.com; follow the links to "Technical Support" and "Product Manuals" for the ProCurve Secure Router 7000dl series.
- SROS Command Line Interface Reference Guide

- Other solution design guides on the topic of convergence at the http://www.procurve.com Web site.

Appendix B – References

These are ranked in order of this paper's preference regarding WAN design on advanced topics:

1. *High Availability Networking with Cisco* by Vincent C. Jones; ISBN: 0201704552
    a. This book discusses HA with Cisco but admittedly Cisco has routing for IPX and other protocols that not every customer will need, so it is understandable to write a text to address all the issues of these protocols. The author readily admits much of this information is useful for those using other routers such as ProCurve routers.
    b. Great text covering many factors for HA design that cannot possibly fit into a paper such as this one.
2. *Clusters for High Availability: A Primer of HP Solutions* by Peter Weygant; ISBN: 0130893552
    a. Admittedly this 2001 text has a focus on server clusters. Nevertheless it does have many of the basic topics covered that are generic to any HA design, covers some networking considerations, will get the network designer considering the customer applications and is relatively easy reading.
3. *Advanced Management and Configuration Guide for the ProCurve Secure Router 7000dl Series*, December 2005.
    a. The Advanced Management and Configuration Guide guide, along with the basic guide, has many configuration examples with systematic instructions. Other new topics include a discussion about policy-based routing in the dynamic routing section of the advanced guide and a section on Protocol Independent Multicast Sparse Mode, PIM-SM.

To find out more about ProCurve Networking products and solutions, visit our Web site at

www.procurve.com

4AA0-0717ENW, 1/2006