

## Aastra Network Access

# Benefits of Dial Access Wholesaling

High density and low cost, the **CVX 1800 Access Switch** helps Splitrock meet growing access demands.

White Paper Dial access wholesaling is rapidly emerging as a new business model between content-based ISPs and Network Service Providers (wholesalers) for providing Internet-based services.

by Nik Harit, Bruce Ford and Rob Holt

### Introduction

Dial access wholesaling is rapidly emerging as a new business model between content-based ISPs and Network Service Providers (wholesalers) for providing Internet-based services. The responsibility for physically terminating the data calls is transferred from the ISP to the wholesaler, which owns and operates shared modem ports, while the ISP still maintains control over its individual customers. This model relieves the ISPs from the operational costs associated with maintaining and upgrading modems and allows them to focus on their core competencies, namely, support for their subscribers and subscriber retention, on-line content, and providing value added services such as web hosting. In addition, the wholesaling model enables local ISPs to provide immediate access to new geographic markets without having to purchase any modems.

Dial access wholesaling is already the dominant model for some of the largest players in the Internet arena, with services available from Network Service Providers such as GTEI, PSINet, UUNet, and AGIS (Internet Service Provider Market Review and Forecast, 1998-2003, IDC, Dec. 1998). In addition to local and regional ISPs subscribing to this model, key content providers include AOL and MSN. AOL's extensive dial access wholesaling contracts are shared between UUNet, GTEI, and Sprint.

Despite the strong growth in high speed access technologies such as cable and xDSL, the residential use of traditional dial up access is expected to increase at a Compound Annual Growth Rate (CAGR) of 16% over the next 4 years. While dial access accounted for 99% of the approximately 22 million strong household

Internet access market in 1997, dial access is forecasted to account for 77% of the 60 million on-line households in 2002 (Sizing Internet Services 1998, Forrester, Jan. 1998). Similar trends are visible in the business market, with the number of road warriors and bring-workhome users growing rapidly. The following sections of this white paper will illustrate the benefits of the dial access wholesaling model for both the wholesaling customer, hereafter referred to as the Data Service Provider (DSP), and the wholesaler. Cost models are developed for the DSP that illustrates the potential cost savings attributed to the modem-wholesaling model. The business opportunity for the wholesaler is also investigated, including the network architecture models.

Terminology:

- **Wholesaler:** A Network Service Provider that provides wholesale access to other ISPs or corporate VPN customers.
- **DSP:** Customer of the dial access wholesale offering, either an ISP or enterprise customer.

## Rationale for Outsourcing Modems

### ISPs

For many ISPs, modems are no longer viewed as a strategic asset that must be managed “in-house.” Instead, a number of ISPs are focusing their investments on services and content and on growing their subscriber base. The majority of ISP revenues are currently derived from monthly access fees from subscribers.

Although the churn in user subscription is typically high, ISPs have been able to ride the wave of immense overall Internet subscriber growth to maintain and grow their own subscriber base. However, dial access is increasingly becoming a commodity item, with similar pricing offered by most ISPs, e.g. \$20 per month. Value added services such as enhanced on-line content, web hosting, and e-commerce applications will become the key determining factors to retain existing subscribers and attract new ones.

ISPs can typically achieve significant cost savings by outsourcing their remote access operations to a wholesaler that can leverage its existing network infrastructure and benefit from an economy of scale advantage. Not only can the cost savings attributed to modem outsourcing be used to invest in services and content, but the ISP has immediate access to a much larger geographic area. ISPs benefit by avoiding the costs of establishing and operating Points of Presence (POPs), and by having the use of a large scale, well-run, and reliable network.

### Enterprises

The issues facing corporate IT departments are very similar to those of ISPs: increased demand from a growing base of end users, service enhancements, and ongoing equipment upgrades. In addition, security considerations are fundamental for enterprises. As organizations become more dependent on electronic mail and network based information, the need to provide remote access

solutions for employees is becoming more important, enabling them to conduct business at various locations at any time of day. Most large enterprises currently provide dial-up access to the corporate data network for a large community of work-at-home and bring-work-home employees, as well as providing national roaming services for the road warrior segment. Many enterprises faced with the high cost of managing their own “in-house” dial access services are looking to reduce their costs by implementing dial Virtual Private Networks (VPNs).

A VPN refers to shared public facilities that provide users with the appearance of being connected to a private network. Dial VPNs are designed to provide remote employees with secure access to the corporate network through outsourced remote access. For wholesalers providing VPN services to enterprises, capabilities such as encryption services (e.g. IPSec), tunneling services (e.g. L2F, L2TP), and Quality of Service (QoS) guarantees are typically required.

Encryption techniques may be used to guarantee the privacy of packets sent over a public IP network. In VPN security, the source and destination of packets are authenticated and their payloads are encrypted. It is the process of encryption and authentication that adds security, and can be used with tunneled, or non-tunneled packets. For wholesalers, encryption is typically included along with a tunneling based solution.

Tunneling refers to the encapsula-

tion of one packet within another, the most common for dial-up applications being PPP within IP. The key benefit of tunneling is that it allows a user's PPP session to extend to the corporate home gateway, permitting the corporation to retain complete control of functions such as IP address assignment, while the modem call terminates at the wholesaler's access switch. The tunnel protocol (e.g. L2F, L2TP) is used to create, maintain, and tear down the tunnel. The remote ends of the tunnel can be the user's PC, or the wholesaler's access switch at one end, and the corporate home gateway which terminates the PPP session and layer 2 tunnel, at the other end. Some enterprises are now using client based tunneling whereby remote users can use any ISP's Internet access service to reach their corporate network. In this case, the client-based tunnel is transparent to the wholesaler's network.

For enterprises implementing VPN solutions, Service Level Agreement (SLA) enforcement becomes paramount. The wholesaler's solution should include customer service management capabilities such as web-based access to provide real time viewing of active service states, as well as the generation of regular customer specific reports. With these features, the enterprise is able to determine whether the SLA-defined performance requirements are being met.

### Out of Territory ISP Expansion Cost Models

Figure 1 shows three possible solutions available to an ISP wishing to expand its territory. The ISP expands to four new locations, with 250 modem ports in each of the four new remote POPs in year 1, and subsequent growth of 20% in the second year. In the non-out-

sourcing model, the ISP incurs the cost of the new equipment required in each of the remote POPs, as well as the associated co-location charges (real estate, power, cooling), equipment management costs, and PRI costs. Inter-POP leased lines are also required to backhaul the dial-up traffic to the main POP, to gain access to centralized servers (e.g. DNS, E-mail, etc.) and the upstream connection to the Internet.

By outsourcing its new modems to a wholesaler, the ISP is alleviated from incurring these costs. The two wholesaling models permit the ISP to expand its territory without

deploying any remote equipment.

- **Internet Direct Model:** The wholesaler provides the IP connectivity to the customer premise as well as the link to the Internet backbone.
- **DSP Direct Model:** The wholesaler provides direct connectivity to the customer premise. Tunneling is often used to achieve this, however other options are available based on the use of dedicated Frame Relay or ATM connections. The DSP provides the link to the Internet backbone. Enterprise customers as well as some ISPs typically use this model.

Figure 1: Remote Access Solution Models

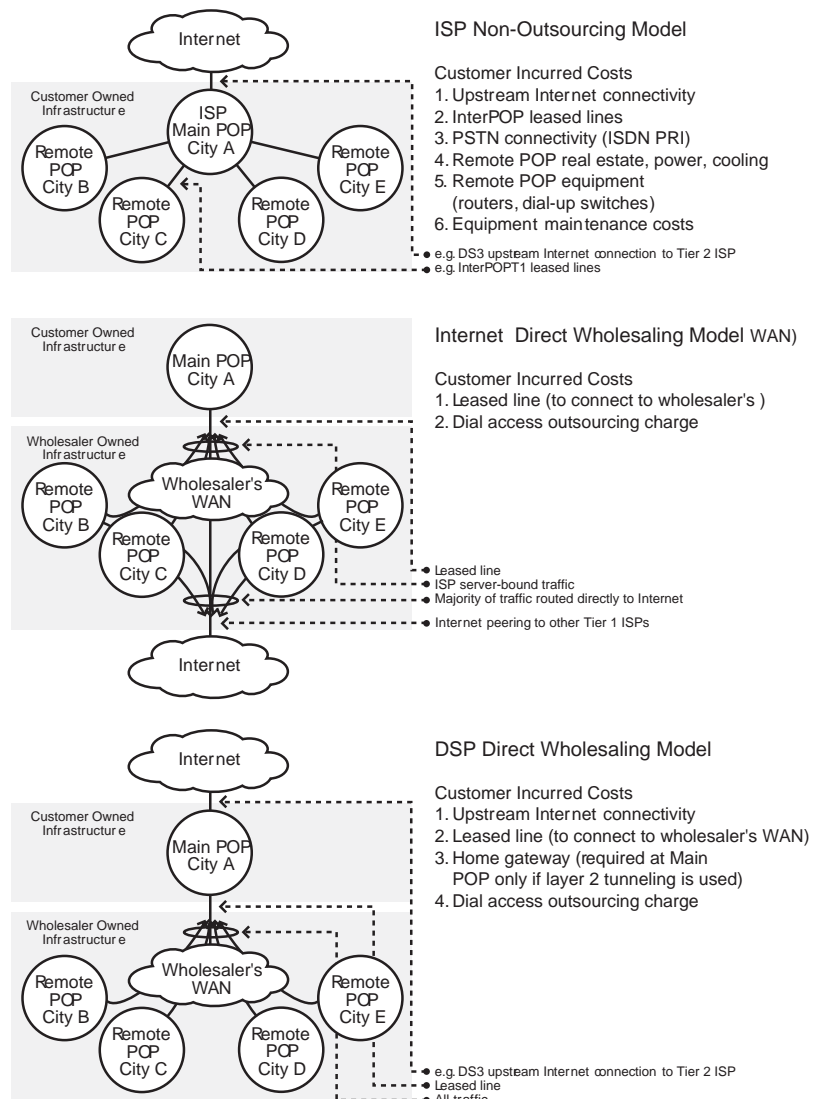


Table 1: Out of Territory ISP Expansion Model Cost Comparison

Out of Territory ISP Expansion Model	Annual per port cost model for 1st year of operation (250 ports in 4 remote POPs)			Annual per port cost model for 2nd year of operation (300 ports in 4 remote POPs)		
	Non-Outsourced	Internet Direct	DSP Direct	Non-Outsourced	Internet Direct	DSP Direct
PRI Charges	\$ 422	\$ -	\$ -	\$ 404	\$ -	\$ -
Leased lines	\$ 81	\$ 6	\$ 75	\$ 66	\$ 5	\$ 71
Equipment capital	\$ 132	\$ -	\$ 25	\$ 235	\$ -	\$ 21
Operations and management	\$ 53	\$ -	\$ 10	\$ 52	\$ -	\$ 8
Co-location	\$ 34	\$ -	\$ -	\$ 28	\$ -	\$ -
Upstream Internet access	\$ 120	\$ -	\$ 120	\$ 120	\$ -	\$ 120
Outsourcing cost	\$ -	\$ 696	\$ 480	\$ -	\$ 696	\$ 480
Total System Cost per Port	\$ 842	\$ 702	\$ 710	\$ 906	\$ 701	\$ 701
% Savings	\$ -	17%	16%	-	23%	23%

In both wholesaling models, the ISP pays a monthly per modem outsourcing charge, as well as the cost of the leased connection to the wholesaler’s network.

In the DSP Direct wholesaling model, the ISP additionally incurs the cost of the connection to the Internet, as well as the cost of a home gateway in the case that layer 2 tunneling is used.

Compared with a non-outsourced remote access solution, the ISP can achieve 17% and 23% savings in the first and second year of operation respectively, using the Internet Direct wholesaling model. The use of the DSP Direct wholesaling model results in 16% (year 1) and 23% (year 2) savings over a non-outsourced solution. Refer to Table 1 for a comparative cost breakdown. In addition, outsourcing permits immediate access to subscribers in the expanded territory. Assuming it takes 3 months to build-up a remote POP infrastructure, the immediate advantage of wholesaling amounts to approximately \$600K in additional revenues in one quarter (assuming 10:1 user to modem ratio, \$20 per subscriber monthly).

*Cost modeling assumptions include:*

- Capital costs are amortized over 2 years in all cases. Capital costs include dial-up ports and routers in the non-outsourcing model,

and the home gateway in the DSP Direct wholesaling model (layer 2 tunneling assumed).

Routers at the main POP are not included, as it is assumed that sufficient packet forwarding capacity already exists.

- PRI charges include both installation and recurring monthly costs.
- Leased line charges include inter-POP leased lines (non-outsourcing model), leased line from main-POP to wholesaler’s WAN (both wholesaling models), and leased lines to the upstream Internet provider (non-outsourcing and DSP Direct wholesaling models).
- Operations and management costs are calculated as 20% of capital annually. Co-location charges are calculated on a per frame basis, and include real estate, power, and cooling.
- Upstream Internet access considers aggregate traffic from all locations, including main POP, assumed to terminate 1,000 dial-up ports. Per port upstream Internet access cost is averaged over all dial-up ports.
- Outsourcing cost for Internet Direct wholesaling model: \$58 per port monthly, includes modem termination as well as Internet access. Outsourcing cost for DSP Direct wholesaling model: \$40 per port monthly, includes modem termination only.

## Business Opportunity for Dial Access Wholesalers

### Introduction

Currently, there exists strong interest in dial access wholesaling from different categories of network providers; specifically, ISPs, CLECs, and ILECs. The wholesaler is assumed to have geographically distributed POPs connected via its reliable, large-scale network. Within the POPs, the wholesaler maintains the equipment required for remote access. This includes connectivity to the public switched network, and the dial access switches. The DSP need only lease a connection from its own premise to the wholesaler’s network, as previously shown in the wholesale models of Figure 1. The DSP effectively increases its addressable market, without having to physically build remote POPs and deploy remote access equipment. End users still dial into their DSP and are unaware of the wholesaler’s involvement.

By offering wholesale dial access, wholesalers serve a greater number of customers using their existing infrastructure, while concentrating on network technology issues without having to focus on content and end-user customer service functions. The wholesaler can establish a high margin new

service targeted at ISPs and enterprises, opening up new revenue generating opportunities by charging these DSPs for Virtual Point of Presence™ (Virtual POP) and enhanced remote access services. A Virtual POP allows a wholesaler to partition its access switches into a series of mutually independent “virtual” access switches. An efficient dial access wholesaling service requires the use of high density remote access switches (Please refer to the white paper entitled “Cost Benefits of High Density Dial Access Products” for more information). Dial access wholesaling also opens up the opportunity for web hosting services, while the DSP maintains control over the content. The wholesaler can also extend services to DSPs to include Internet fax capabilities or enhanced Voice over IP (VoIP) services such as Internet call waiting, generating additional sources of revenue.

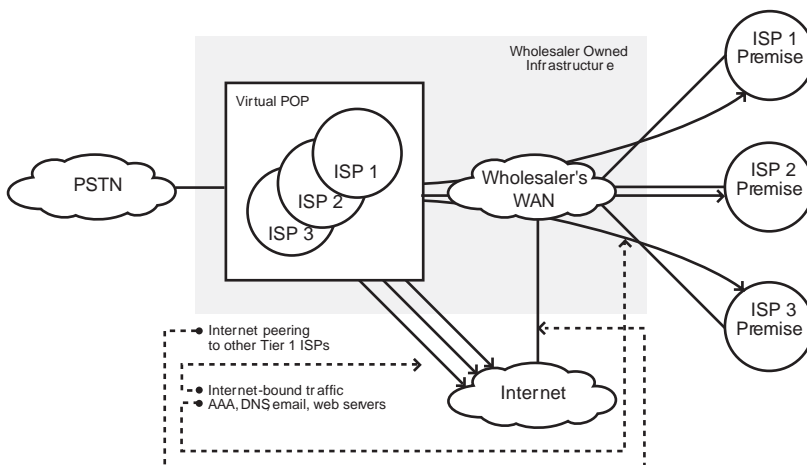
Typically, the network architecture models used by dial access wholesalers can be categorized as either Internet Direct or DSP Direct models. The following section provides a high level overview of each of these models.

### Internet Direct Wholesaling Model

In the Internet Direct wholesaling model (Figure 2), traffic destined for the Internet is routed via the wholesaler’s links, never passing through the DSP’s premise.

A large percentage of dial-in traffic is destined for sources on the Internet, in some instances as high as 90%. However, some ISPs such as AOL, and specialized ISPs such as gaming ISPs focus on local content and have less dial-in traffic bound for other sources on the Internet. The wholesaler assumes responsibility

Figure 2: Internet Direct Wholesaling Model



for connectivity to the Internet backbone, and has peering in place to other backbone providers. The traffic routed to the DSP includes end users accessing the DSP’s local servers, such as e-mail, as well as user authentication requiring the DSP’s authentication, authorization, and accounting (AAA) server. With this architecture, the bandwidth required by the DSP to connect to the wholesaler’s network is significantly lower than if the DSP were to provide Internet access itself.

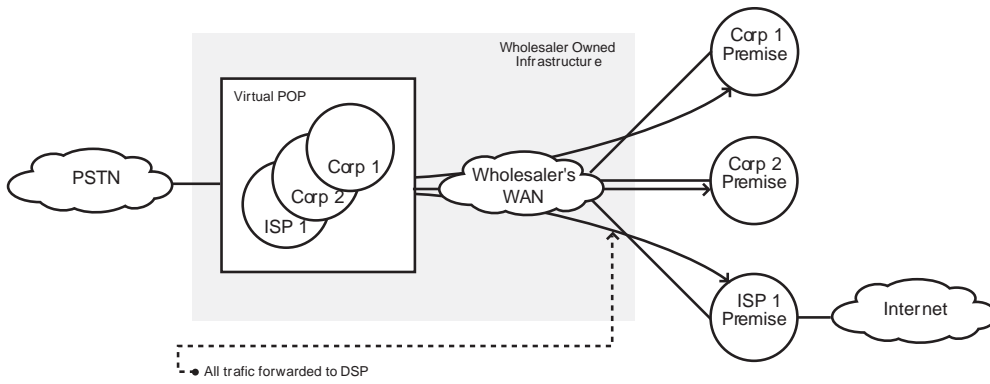
### DSP Direct Wholesaling Model

In the DSP Direct wholesaling model (Figure 3), all the dial-in traffic is routed to the DSP, regardless of the ultimate destination. This architecture is used by corporate customers to access corporate resources such as email, FTP servers, and application servers. Some ISPs, focussed heavily on local content, may also find this model appropriate in order to promote their proprietary content and applications. Although 100% of the traffic is sent to the DSP, the efficiencies gained by packetizing traffic results in the bandwidth required to connect to the wholesaler’s network being much less

than if the customer were to terminate modem dialup traffic itself via PRI.

Different DSP Direct implementations exist in order to forward packets to the appropriate DSP regardless of the destination indicated in the IP header. Tunneling (L2F, L2TP, or layer 3 tunneling) allows the wholesaler’s access switch to forward the dial-in user’s PPP stream to the DSP’s home gateway, allowing the PPP termination, and PPP-related functionality such as authentication and IP address allocation to occur there. A Frame Relay (or ATM) PVC based DSP Direct architecture can be used, where Frame Relay PVCs are dedicated to each DSP. In this case, IP addresses are assigned from IP address pools defined within the access switch Virtual POP, and may be owned by the wholesaler or the DSP. A Switched Virtual Circuit (SVC) based approach can be used as well, although SVC technology is still in its infancy and will require some time to mature. Policy based routing can also be used, where the wholesaler’s routing infrastructure forwards packets based on the source IP address.

Figure 3: DSP DirectWholesaling Model



### IP Addressing

In any dial-in networking configuration, the dial-in client needs an IP address. This IP address must be a unique address in the network in which the dial-in user is connecting. In a corporate dial-in case, the address must be unique within the intranet. For an Internet dial-in user, the address must be globally unique.

Wholesalers are faced with an IP addressing challenge. IP addressing requires that blocks of network addresses be assigned against a physical device, and that the network behind it recognizes that. Wholesaling requires that devices are logically shared. A number of methods exist for wholesalers to resolve the IP addressing issue. These include layer 2 Virtual Private Networks, tunneling, centralized IP address allocation, policybased routing, network address leasing, as well as physically dedicated elements. For more information on these mechanisms, please refer to Appendix B.

A successful wholesaler should be able to support a combination of the above mechanisms. In any case, the wholesaler's network offering must ensure that the dial-in user obtains an IP address (assigned from a specific pool if required), and that traffic is routed as per the specified wholesaling

arrangement (Internet Direct vs. DSP Direct). The wholesaler must ensure that all DSPs are logically isolated from each other, and that the service offered has a sound business case.

### Additional Revenue Streams

In addition to revenues from providing basic modem termination services, additional revenue streams can be generated by offering value added services such as port allocation whereby the wholesaler can maintain a view of all calls and enforce a DSP's total port quota across the network, and overflow quotas which enable DSPs to exceed their base subscribed port limit temporarily and generate addition-

al revenues for these events. These critical forms of control enable the wholesaler to effectively differentiate its customers and services. While maintaining control over its network resources, it allows the wholesaler to cater to its customers' evolving needs.

### Business Cases

Different business models exist depending on the type of wholesaler (ISP, CLEC, ILEC), and the type of DSP customer. In some cases, although the Internet Direct model may be more financially beneficial, some ISPs actively market their own backbone Internet connection as providing added value, differentiating their service offering from other ISPs. While the models presented here separate the Internet Direct and DSP Direct models, in reality wholesalers should be able to cater to DSPs requiring either model. Note that the models presented correspond to different wholesaler types (i.e. ISP, CLEC) each having different network infrastructures, associated costs, and DSP customers. Thus, comparisons should not be made between the results for the individual models.

Figure 4: ISP Wholesaler Internet Direct Model Network Infrastructure

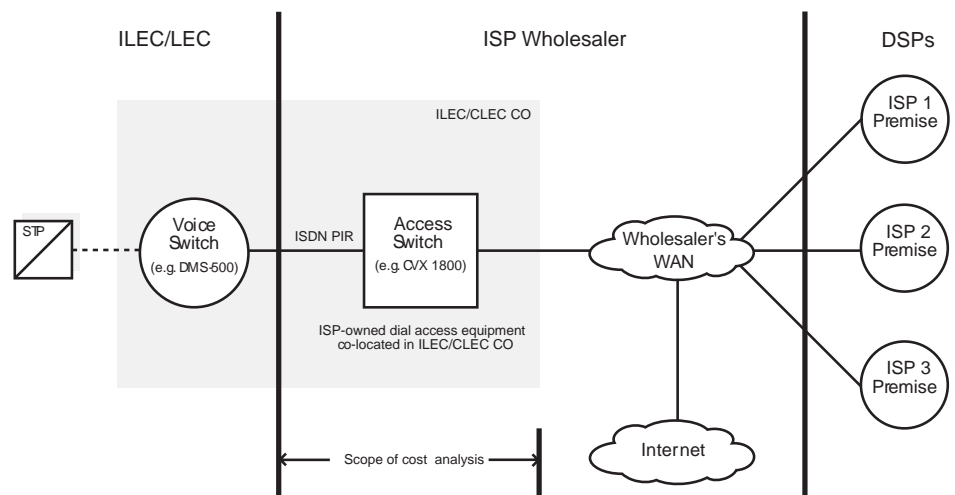
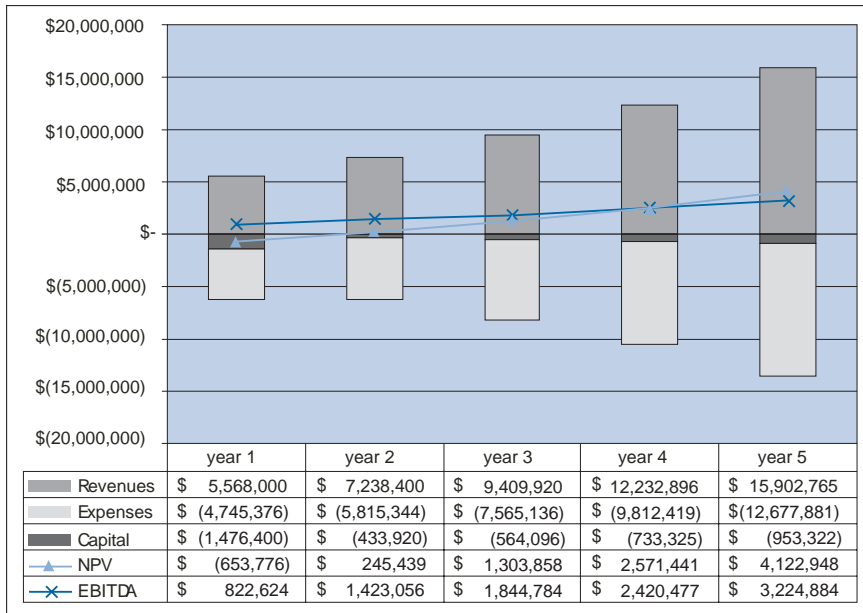


Figure 5: ISP Wholesaler Internet Direct Model Cash Flow and Cost Breakdown

Yearly Cash Flow Summary



lowing business cases exemplify the opportunity for a dial access wholesaler. Figure 4 illustrates the network infrastructure for an ISP wholesaler providing Internet Direct dial access to outsourcing customers. Figure 5 shows the 5 year cash flow for a the ISP wholesaler Internet Direct model. The wholesaler starts with 8,000 modem ports in year 1, with an annual growth of 30%. The 5 year NPV is \$4.1 million, with a payback of just over one and three-quarter years.

The wholesaler's Return on Investment (ROI) is 14.8% over 5 years. Refer to Figure 5 for a cost breakdown in year 2 (representative of the costs involved in steady growth phase).

Cost modeling assumptions include:

- Wholesaling revenues of \$58 per port monthly. Priced \$18 more than DSP Direct mode to take Internet access into consideration. Revenues from value added services not included.
- Capital expenses include access switches, policy manager, and network management platform.
- The overall PSTN interface costs form the largest cost element for the ISP wholesaler since these costs include both PRI monthly charges (\$700) and PRI installation charges (\$1,200).
- Co-location charges and equipment maintenance costs are calculated on a per frame basis.
- SG&A calculated as 20% of revenues.
- Wholesaler data network costs (routers, transport equipment, fiber) are not included, as it is assumed the existing infrastructure has sufficient capacity.

5 year NPV \$4.1 Million  
 Payback Period 1 3/4 years  
 5 year ROI 14.8%

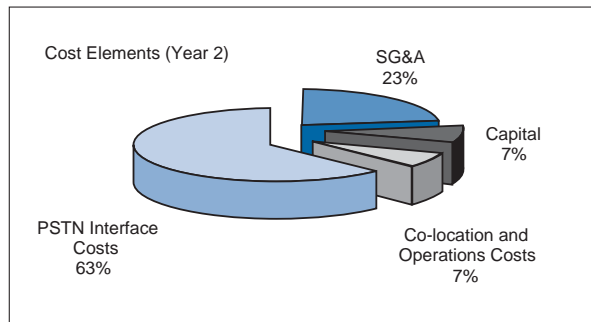


Figure 6: CLEC Wholesaler DSP Direct Model Network Infrastructure

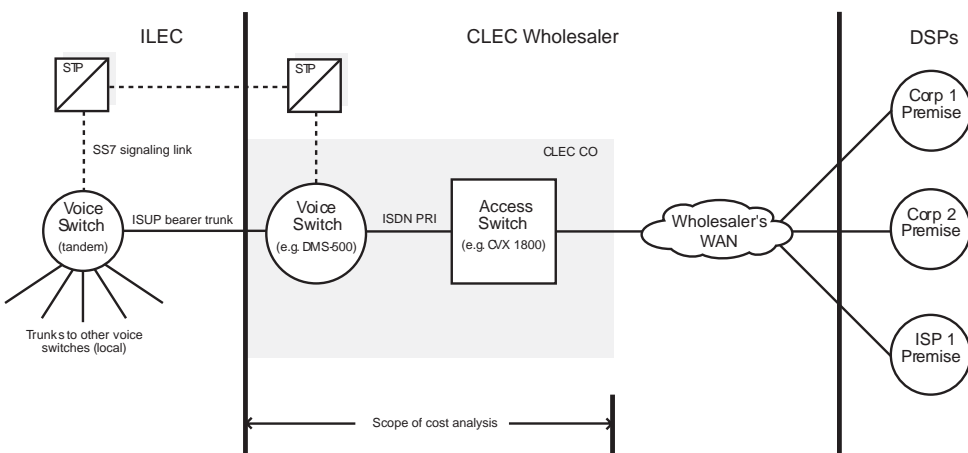


Figure 6 illustrates the network infrastructure for a CLEC wholesaler providing DSP Direct dial access. The CLEC wholesaler initially deploys 8,000 access switch

ports, with an annual growth of 30%. Figure 7 shows the cash flow for the CLEC wholesaler DSP Direct model. The 5-year NPV in this case is \$5.5 million, with a payback of two and a quarter years. The wholesaler's ROI is 32.8% over 5 years. Refer to Figure 7 for a cost breakdown in year 2 (representative of the costs involved in steady growth phase).

*Cost modeling assumptions include:*

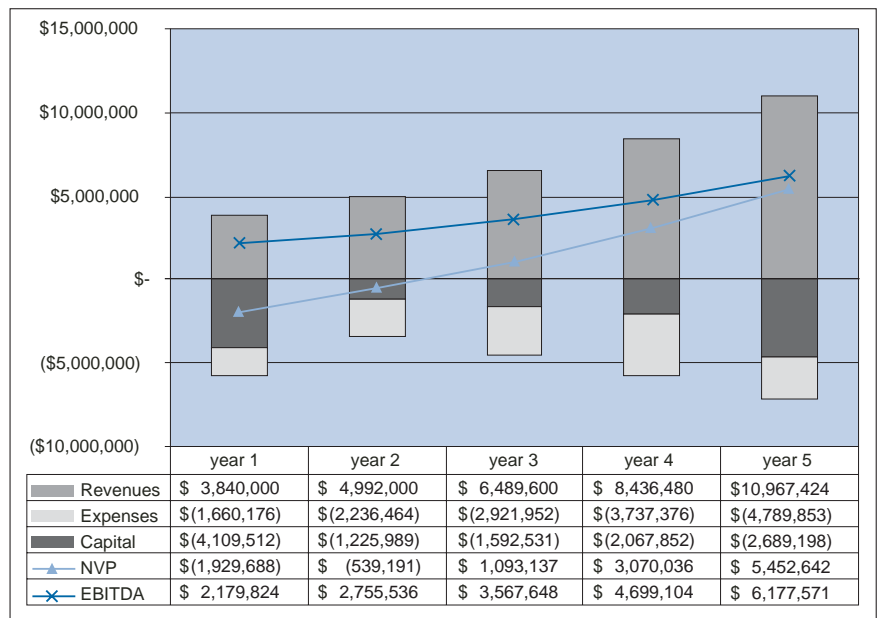
- Wholesaling revenues of \$40 per port monthly. Revenues from value added services not included.
- Dial access capital expenses include access switches, policy manager, and network management platform. PSTN interface capital includes PRI and ISUP ports on voice switches required to handle dial access traffic, and pro rata Add Drop Multiplexer (ADM), and Digital Access and Cross Connect System (DACs).
- Co-location charges and equipment maintenance costs are calculated on a per frame basis. This large cost is primarily due to the large number of voice switching frames required.
- SG&A calculated as 20% of revenues.
- Wholesaler data network costs (routers, transport equipment, fiber) are not included, as it is assumed the existing infrastructure has sufficient capacity.

**Conclusions**

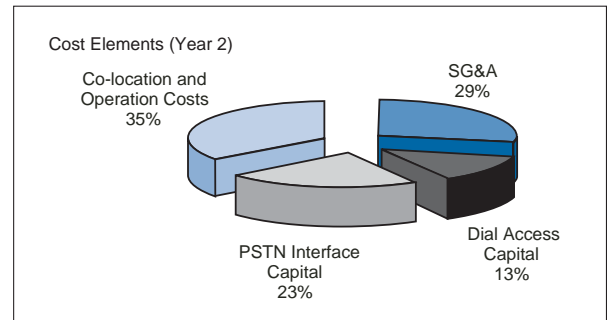
This white paper demonstrated that the business model for dial access wholesaling is strong for both wholesalers and outsourcing ISPs and enterprises. DSPs can realize significant cost savings in the range of 15 to 25 percent by outsourcing to a wholesaler. Different wholesaling models are possible, each having its own benefits. The Internet Direct model

Figure 7: CLEC Wholesaler DSP Direct Model Cash Flow and Cost Breakdown

Yearly Cash Flow Summary



5 year NPV \$5.5 Million  
 Payback Period 2 1/4 years  
 5 year ROI 32.8%



meets the needs of DSPs that do not want to be burdened with access switches or upstream Internet connections. The DSP Direct model caters to DSPs that market their own Internet access as a service differentiating feature, or require that all dial-in traffic be forwarded to their premise. Different wholesaler types (ISP, ILEC, CLEC) will take various approaches in their dial access wholesale offering (e.g. regulatory constraints may prevent some wholesalers from providing direct links to the Internet backbone). The business case for all wholesaler types and wholesaling models is solid, providing substantial revenue streams, returns, and short payback periods. Depending on the wholesaler's anticipated

volume of initial access switch ports and growth rate, these gains can be even more compelling.

Wholesalers need to be able to support both the DSP Direct and Internet Direct architectural models simultaneously, as well as offer a range of different services. An efficient wholesale offering that makes use of high density access switches with Virtual POP capabilities, allows the wholesaler to partition the access switch into a series of mutually independent "virtual" access switches, each with its own authentication method, database, billing system, and management interface. The wholesaler's solution should also offer different options for IP address allocation, as well as dif-

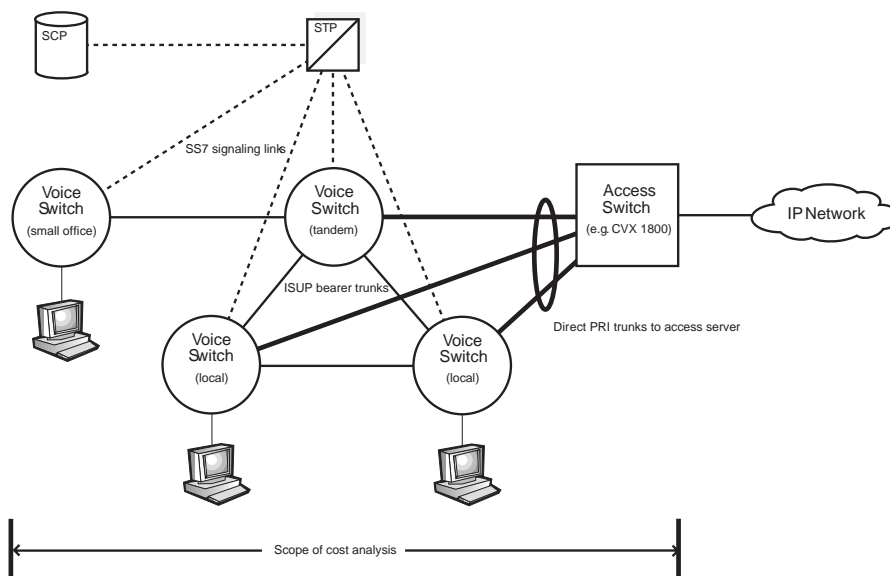
ferent options for forwarding packets to the DSP including tunneling, and encryption capabilities. Along with network policy management capabilities such as network wide port allocation with value-added capabilities such as overflow services and Time-of-Day discrimination, the wholesaler can deliver solutions specifically catered to individual DSPs. Combined, these capabilities result in an effectively implemented wholesaling model that provides a dial access solution that is beneficial to both the wholesaler and the individual DSPs.

## Appendix A: ILEC Wholesaler Model with Direct PRI Links

The ILEC's PSTN network is typically used by ISPs and enterprises to route traffic from their end users to the destination voice switch, where it is terminated on their access switch using PRI trunks. By establishing a dial access wholesale offering to DSPs, in which direct PRI trunks are established from local voice switches directly to the ILEC owned access switches (Figure 8), the ILEC can achieve PSTN cost savings while at the same time generating revenue. ILEC cost savings are realized by the avoidance of operational and capital costs associated with provisioning additional ISUP trunks throughout the PSTN. These costs would otherwise be incurred to handle the rapidly increasing non-voice traffic load.

Figure 9 shows the cash flow for an ILEC wholesaler providing DSP Direct dial access. The ILEC wholesaler is assumed to start with 8,000 ports in year 1, and have an annual growth of 30%. The 5-year NPV in this case is \$6.5 million, with a payback of 26 months. The ILEC wholesaler's

Figure 8: ILEC Wholesaler DSP Direct Model Network Infrastructure



ROI is 41.5% over 5 years. Refer to Figure 9 for a cost breakdown in year 2 (representative of the costs involved in steady growth phase).

*Cost modeling assumptions include:*

- Wholesaling revenues of \$40 per port monthly. Revenues from value added services not included.
- PSTN interface capital includes incremental voice switching costs for handling dial access traffic (e.g. capital costs for ISUP and PRI ports on voice switches). ISUP trunks are assumed to be required for small local offices not connected to the access server via direct PRI trunks.
- Dial access capital expenses include access switches, policy management, and network management platforms.
- Co-location charges and equipment maintenance costs are calculated on a per frame basis. Significant operations costs have also been assumed for setting up local switch translations (e.g. for launching Intelligent Network [IN] queries to the SCP database).
- SG&A calculated at 20% of revenues.
- Wholesaler data network costs (routers, transport equipment,

fiber) are not included, as it is assumed the existing infrastructure has sufficient capacity.

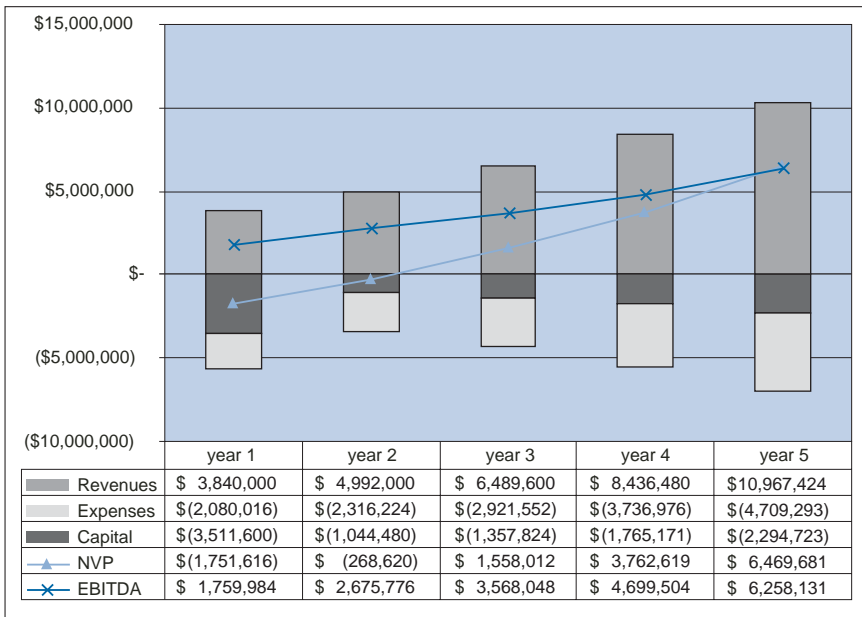
## Appendix B: IP Addressing Mechanisms

While supporting their own dial-in pools (i.e. non-outsourced model), ISPs and corporations simply provision pools against each access switch, whereby segments of the overall address space to be allocated to dial-in users is associated with physical network elements. This makes address pool summarization possible, where the entire ISP or corporate network is aware that a specific segment of network addresses belongs to a specific physical device. This type of a solution scales from less than a dozen addresses to many thousands of addresses.

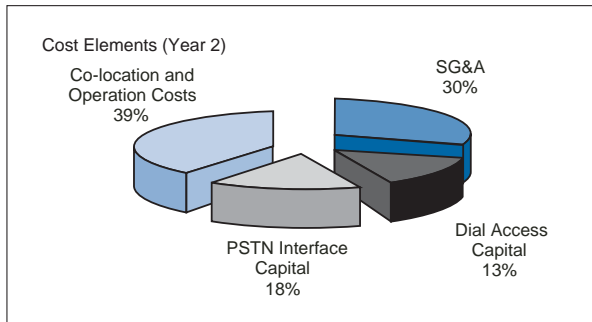
For a wholesaler, being able to support the same address management methodology would require DSP-dedicated physical access, as well as the network behind it (i.e. dedicated routers, network links, etc.). However, wholesaler needs to be able to operate in a more logically shared manner, sharing common physical

Figure 9: ILEC Wholesaler DSP Direct Model Cash Flow and Cost Breakdown

Yearly Cash Flow Summary



5 year NPV \$6.5 Million  
 Payback Period 26 months  
 5 year ROI 41.5%



network resources among different DSPs (while creating a logical isolation among the different DSPs). Unfortunately, business requirements seem orthogonal to what IP networking dictates (i.e. blocks of network addresses assigned against a physical device). Successful wholesalers are overcoming the IP addressing challenge in a number of ways:

• **Layer 2 Virtual Private**

**Networks:** From each access switch a Permanent Virtual Connection (PVC) is extended to the DSP. While this can result in logical segmentation, it can also result in a proliferation of PVCs, which become laborious to administer with increases in

network size and complexity.

- **Tunneling:** Tunneling encapsulates the dial-in user’s traffic such that the destination of the original packet is made transparent to the wholesaler’s IP transit network. Examples of such tunneling protocols include BayDVS, RFC 2003, GRE Tunneling, and IPSec Tunneling Mode. Many tunneling protocols also allow the transfer of assigned IP address from the DSP, or forward the link layer protocol (e.g. PPP) such that IP network negotiations (such as IP address assignment) occur at the DSP site (examples of layer 2 tunneling include Layer 2 Forwarding – L2F; and Layer 2 Tunneling Protocol – L2TP).

• **Centralized IP Address**

**Allocation:** Wholesalers are looking to network intelligence to logically manage and distribute IP addresses in a similar fashion to how next generation DHCP products manage IP addresses in a corporate intranet.

• **Policy-Based Routing:**

Wholesalers allow network addresses to be assigned by the DSP indiscriminately, while the transit IP network routes packets based on the source address in the dial-in user to DSP direction, and triggered routing updates to inform the transit IP address elements current IP address assignments. These solutions tend to have scalability limitations, as each dial-in user occupies a routing table entry in each of the wholesaler’s IP routers.

• **Network Address Leasing:**

Wholesalers can lease its own address pools to DSPs. Alternatively, the wholesaler can require that DSPs provide the wholesaler with enough IP address pool capacity to cover the requested number of wholesaled ports, where the wholesaler would then apply this new address pool to its “global” pool where it can be assigned to any of its wholesaling customers. The assumption here is that the DSP does not perceive value in assigning addresses from a specific address pool. Note that this can cause complications to the DSP if access lists have been employed to restrict access for some users to resources based on assigned IP address.

- **Physically Dedicated Elements:** In some cases, the size of an important DSP justifies the dedication of network elements.

In most cases, a successful wholesaler will have the expertise and quality networking equipment to support a combination of the above.

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