

White Paper: Broadband Bonding with Truffle

PART I - Single Office Setups

Truffle™ boosting WAN bandwidth and reliability for a single office



The Truffle™ Broadband Bonding Network Appliance enables an SMB (Small and Medium Sized Business) or an enterprise branch-office (see part II) with faster and more reliable Internet access at an affordable cost by combining various Internet connections into a single IP pipe. The return on investment, compared to alternative single ISP service offerings if available, is often only a few months.

Challenge: Lack of Internet Access solutions for SMBs that are fast, reliable and cost effective

Most SMBs currently rely on DSL, T1 or other types of single ISP connections with no diversity. Ironically, many employees may experience slower Internet access at work than their broadband connections at home. With today's high demand on Internet connectivity, single ISP lines are not up to the task in terms of providing enough bandwidth and the required fault-tolerance. Furthermore, sometimes, the data traffic over these lines may be shared with reserved channels for voice over a PBX system, and hence less bandwidth is available for data, as well as the real-time applications such as VOIP or video.

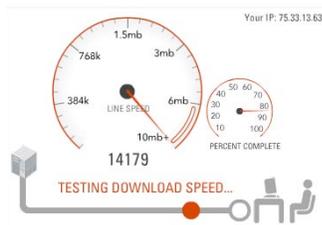
In parallel, the Internet performance requirements of the cloud services that businesses are using have been steadily increasing. As private and public cloud services become essential for businesses of all sizes, so does the Internet services that connect the business to those services in the cloud.

Faster Internet access for the SMB from a single provider may either be unavailable, or too expensive to justify the recurring expense. A single T1 line is already too expensive, and Bonded-T1 service is even more expensive. DS3s or partial DS3s, if available, can have prohibitive costs.

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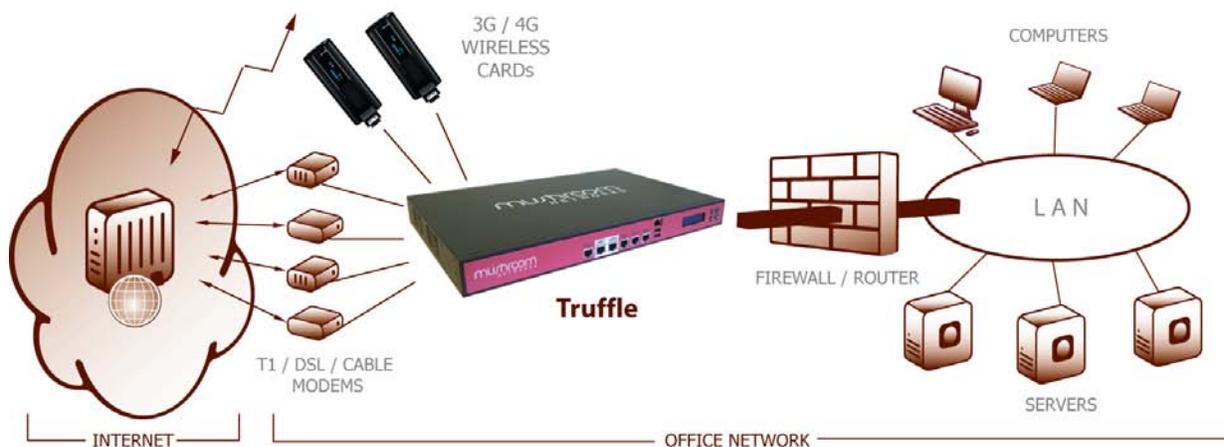
Solution: Broadband Bonding with Truffle™ for fast, reliable & cost effective Internet

Truffle is the only one-sided broadband bonding network appliance that enables SMBs and enterprise branch offices to Broadband Bond™ multiple Internet access lines together as a standalone device. Companies looking for cost effective ways to bring a more reliable and faster Internet WAN pipe, can do so with Truffle™ without requiring any provisioning or coordination from their service providers.



Truffle provides intelligent aggregation of multiple (up to 2,3,4,8 or 12 depending on the Truffle model) Internet access resources, such as DSL lines, T1 lines, cable modem, satellite, etc. This enables file download speeds that reflect of the total bandwidth of all Internet access lines available. The graphic on the right is an actual screenshot of a third party download speed test¹, obtained using the Truffle and three low cost DSL lines . The Truffle is capable of providing download speeds of up to 940 Mbps, depending on the total speed available from all of the available Internet access lines.

Truffle Functionality: Truffle is a unique stand-alone device, with multiple Ethernet ports. It can operate without any coordination with an ISP, and does not require any new software or reconfiguration on the client devices. Up to 12 of the Ethernet ports on the Truffle device are Wide Area Network (WAN) ports, and plug into DSL modems, cable modems, T1 modems, etc, which provide Internet access. The remaining 2 Ethernet ports of the Truffle are Local Area Network (LAN) ports. The active WAN ports are intelligently aggregated in order to provide high performance Internet access to any device or local network connected to a LAN port of the Truffle.



¹ Speed tests will show accurate results in peered mode. Speed tests sometimes make assumptions that there is only one link and therefore implement algorithms (such as packet-peering etc, instead of a real file transfer) to measure the speed, which provides inaccurate results over bonding devices (sometimes lower, sometimes higher) when Truffle is in standalone operating mode. We recommend real file transfers for accurate speed results.

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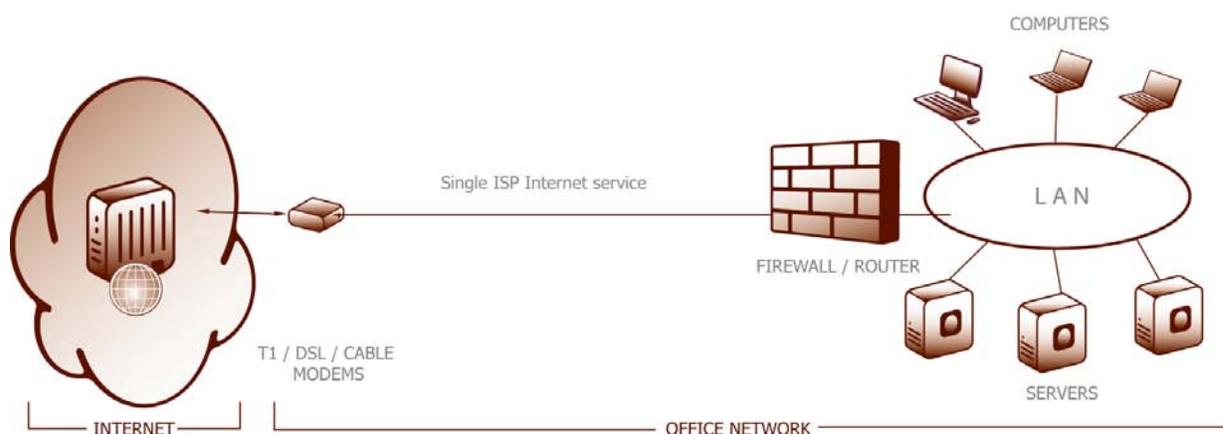
When peered with another Truffle or the optional Broadband Bonding Service (BBS), Truffle will bond all types of traffic in uplink and downlink directions. In standalone operation, i.e. when not peered with another Truffle, all http downlink traffic will be bonded and all other traffic will be intelligently load-balanced.

Truffle has optional router and firewall functionalities built-in. A cellular data card module is also available to add one or two more wireless WAN options for Truffle to provide an unmatched reliability of the various wired connections and the cellular data cards. Quick configuration of the Truffle is done through a web based management interface. Router and firewall functionalities include support for port forwarding, DMZ, blocking of outbound traffic per destination port and/or per source IP address, allowance of inbound traffic per destination IP address or port, a DHCP server, sophisticated QoS functions, traffic monitoring and filtering and visualization of network utilization and traffic graphically.

Often, however, an SMB may have existing networking infrastructure it wants to use, including routers, firewalls, switches, etc. In an optional installation mode for the Truffle called "Pass Through", Truffle can be installed without any modification or reconfiguration of the existing networking hardware and software. This enables Truffle to be installed easily and quickly, with minimal disruption to an already operational network.

In the following, we describe some common use case scenarios for the Truffle.

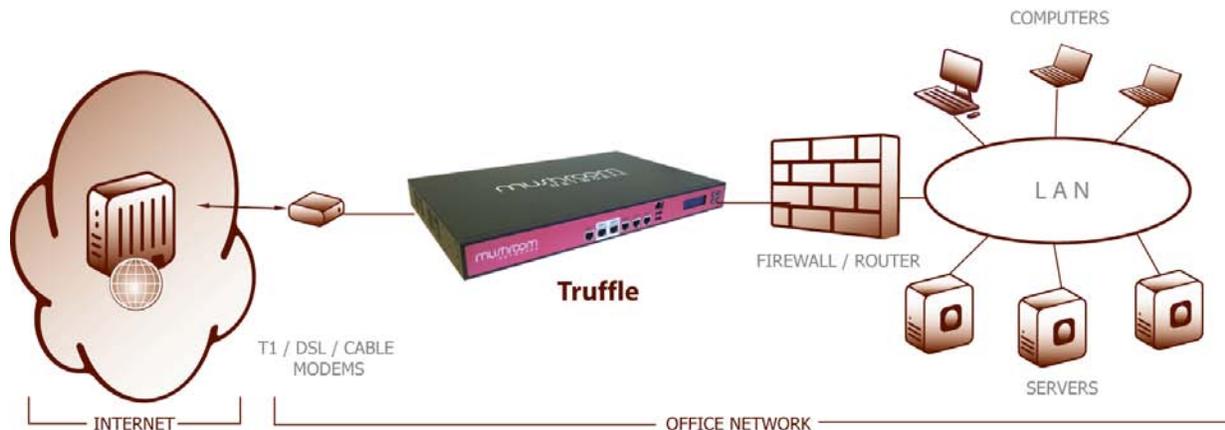
Example Scenario: Speeding up Slow T1 Access



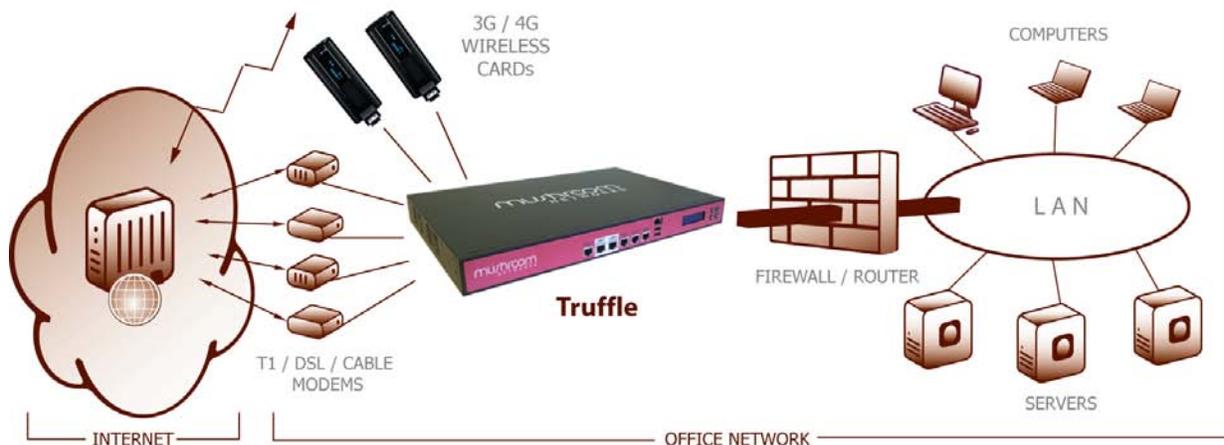
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In this scenario, an SMB uses a T1 access line for Internet access. The T1 line may be used for both data access as well as for providing voice communications through a Private Branch Exchange (PBX) system. Because of this, only a fraction of the bandwidth available from the T1 line may be available for Internet traffic.

Truffle can be installed in-line between the existing T1 modem and the existing firewall/router, without any reconfiguration of hardware or software in the existing network. Configuring the Truffle through the management interface, to specify the IP addresses of the T1 modem and the firewall/router can be completed within a few minutes.



After installation of the Truffle, additional Internet access resources can be added as bandwidth requirements dictate. In the illustration below, 3 more DSL lines and 2 more wireless WAN links are added to the network.



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As a result of the Truffle and the additional DSL lines, Internet access for users within the LAN is greatly accelerated. Truffle has 2 operating modes:

1) Standalone mode: In this mode, our Truffle appliances will bond all http downlink traffic. As an example if one were to download a file behind the Truffle device which has 4 ADSL lines plugged in with 6Mbps speed each. Download speed would be around 24Mbps even for that single file download. For all other traffic, our device will implement the "intelligent load-balancing" where the Truffle device will distribute the different Internet sessions, on various WAN links on a session by session basis. Truffle will keep the application semantics in tact, by making sure the sessions from certain applications are kept on the same WAN line, such as banking sites, where a blind load-balancing would break the application.

2) Peered mode: When Truffle is peered with another Truffle Master device over the Internet (let's say a branch office and a headquarter office), the two units create a virtual leased line connection between them over the bonded pipe. In this mode downlink and uplink is bonded for all types of Internet traffic.

Peered mode can also be achieved by the Broadband Bonding Service (BBS). BBS is an optional add-on service and let's the Truffle device peer with one of Mushroom Networks data centers to enable bonding for all types of protocols.

A notable feature of the Truffle is that it allows graceful growth. Up to a total of 12 (2,3,4,8 or 12 WAN links depending on the Truffle model) Internet access lines can be aggregated, and these resources can be added as needed as bandwidth requirements increase. The Internet access lines do not need to be of the same type or even from the same ISP, and indeed no coordination with the ISP is necessary. It may be desirable to use Internet access lines from different carriers, in order to increase overall system reliability.

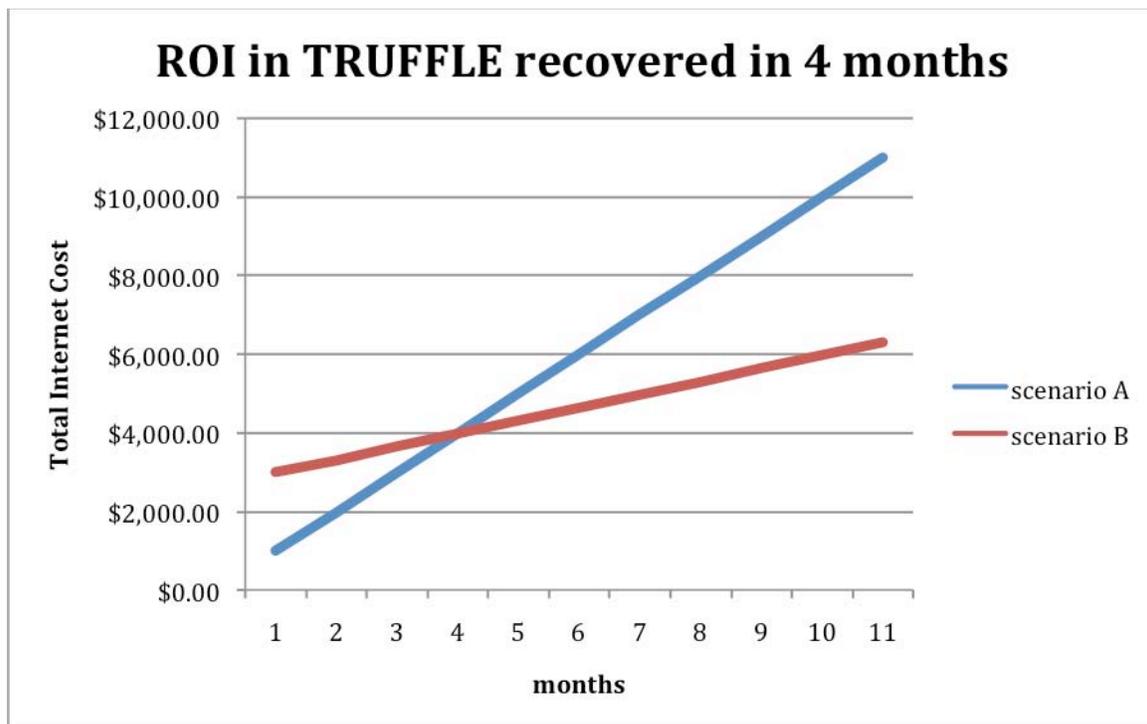
ROI (Return On Investment) analysis: Truffle pays of itself within a few months.

We will compare two scenarios for a small/medium company that has a T1 line (1.5Mbps) and they would like to increase their office connectivity speeds equivalent to a normal residential broadband Internet access (6Mbps or faster).

SCENARIO A: The IT person considers upgrading to a fractional DS3 or bonded T1 (with multiple T1 lines). The per month subscription for these type of services are anywhere from \$1,000 to \$5,000 per month (we will assume \$1,000 per month). These services sometimes have setup fees (assumed to be zero for this analysis) and/or require long-term commitments. The setup times may also vary from several weeks to months, if the service is available.

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SCENARIO B: The IT person considers bringing in one or two business class DSL lines and Broadband Bond™ those two lines with his T1 line via Truffle. His monthly total subscription fee is \$250 (for T1) plus \$80 (for 2 DSL lines). His one-time investment in the TRUFFLE unit is around \$3,000.



Conclusion:

As the ROI analysis shows, scenario B with where the WAN connectivity is provided with T1 and 2 DSL lines bonded by Truffle recovers the hardware investment within 4 months and continues to save on the operating expenses for the business with 75% savings (\$250 vs \$1,000 in this scenario).

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PART II - Multi Office Setups

Virtual Leased Line (VLL) for high throughput and high reliability Enterprise Branch Office Communications



The Truffle™ Broadband Bonding Network Appliance enables enterprise branch offices to have reliable high performance data connectivity to their main headquarter office datacenters and to the public Internet. Each branch office is enabled with this fast Internet pipe by bonding multiple cost-effective transport technologies such as DSL via Truffle. The Internet lines to be bonded may be from different carriers for ISP diversity to

increase reliability. Additionally, leveraging the high bandwidth connectivity present at the main office of the enterprise, Truffle provides the branch office facility with reliable, high performance Internet access at a fraction of the cost of single provider solutions. In this brief white-paper, we explain how Truffle can save enterprises with branch offices on their monthly Internet access cost, with a return on investment as low as a few months.

Challenge: Data connections between an enterprise headquarters facility and branch offices are unreliable, not fast enough and expensive.

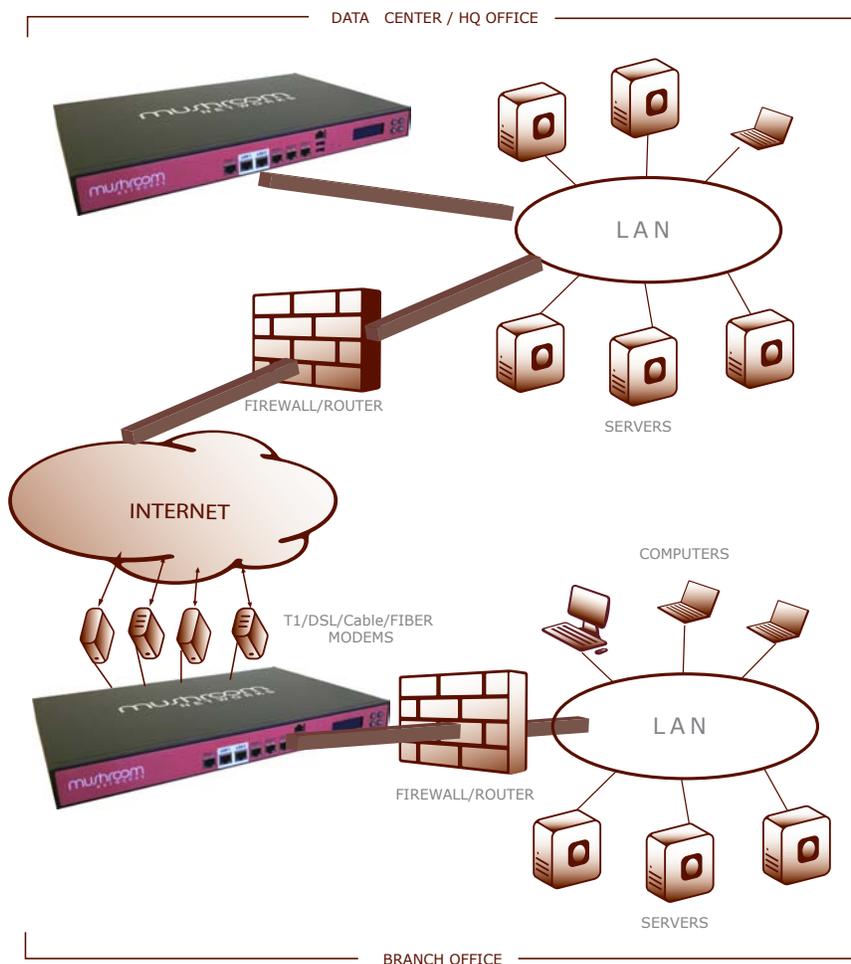
Enterprises that have a headquarter facility such as a main office or data-center and various branch offices need to communicate between all offices as well as with devices and servers on the public Internet. With the proliferation of cloud services based on private and public clouds, as well as services that are heavily dependent on reliable and high-performance applications have saturated the limits of available WAN (Wide Area Network) services. Although it may be economically feasible to provide high bandwidth Internet connectivity to the main office, providing the same speed connections to each branch office is prohibitively expensive since there may be many branch offices and the available Internet services might be limited or costly. Due to security considerations, typically all data communications between offices are transmitted via VPN, sometimes including Internet access, and funneled through the main office facility. Thus, for the data connection between the main office data-centers and the branch office, having a high throughput IP tunnel that is very reliable is critical

If the branch office uses a single DSL, T1 or cable modem connection to communicate to the headquarter office, this will provide insufficient throughput and speed, particularly for uploading data from the branch office to the main office. Similarly, a single broadband line at the branch office, will not provide the adequate up-time that the business critical applications demand.

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Solution: Leveraging low cost transport technologies and carrier diversity for fast and reliable connectivity between branch offices and datacenter.

Virtual Leased Line (VLL) enables bonding of multiple Internet access resources such as DSL, Cable or any other IP transport, to provide reliable high throughput data channels. Truffle™ can be installed at the main-office/data-center (master unit) and at a branch office as illustrated below. This architecture will enable a high-speed IP communication framework between the branch office and the headquarters, as well as between the branch offices.



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The two Truffle devices form a transparent high-speed data tunnel between them by combining access resources on each side. To illustrate, suppose the enterprise data-center has a DS3 (or fiber) connection that provides the data-center with a symmetric 45Mbps pipe to the Internet. At the branch office, suppose four ADSL lines are plugged into the WAN ports of the Truffle device installed there. Suppose each of the ADSL lines provides a 6Mbps pipe in the downlink direction and a 768kbps pipe in the uplink direction.

Benefits: High speed connectivity from branches to the headquarters/datacenter.

In this example, the four ADSL lines provide an aggregate capacity of 3Mbps (4 x 768Kbps) in the uplink direction and 24Mbps (4 x 6Mbps) in the downlink direction. These lines are in fact aggregated by the Truffle device, and provide a 3Mbps pipe from the branch office to the main office and a 24Mbps pipe from the main office to the branch office.

Benefits: High Speed general Internet access at the branch office.

If desired, the branch office can use the 24Mbps/3Mbps pipe that connects it to the main office for general Internet access. On the other hand, the Truffle device at the branch office can leverage the 24Mbps aggregate download capacity for HTTP downloads directly rather than being routed through the main office. Thus, the users at the branch office facility can enjoy an Internet access with downloads up to 24Mbps and upload speeds of up to 3Mbps.

Benefits: High 9's reliable WAN connectivity for all branch offices.

The overlay bonding tunnel, VLL, is similar conceptually to a VPN tunnel in the sense that there is a logical connectivity path between the two Truffle points. This provides, Application Armor™, the ability for the VLL tunnel to shield any ISP outages from the applications that are utilizing the bonded VLL tunnel. For the branch office to lose their application session, all of the ISPs that are bonded need to have disconnect events at the same time, which is a very low probability event compared to a single Internet connection disconnecting. VLL can bond various types of Internet connections from any service provider including DSL, Cable, MPLS, T1, E1 or any other IP based Internet connectivity.

Benefits: 75% cost reduction on monthly Internet access fees & quick ROI (Return on Investment).

Compared to using a T1 line or a bonded T1 line, VLL solution provided by Truffle units will save up to 75% on the bandwidth expenditure per month. For example, a typical price for bonded T1 service is \$800 per month. Rather than using bonded T1, which has a throughput of 3Mbps in each direction, the business can use four 6Mbps/768kbps DSL lines with the Truffle bonding solution. This provides the branch office with a faster 24Mbps/3Mbps data connection at a fraction of the cost. A typical price for business DSL is \$50 per month, so the cost of four DSL lines is approximately \$200 per month. This results in a savings of \$600 per month, a 75% savings on monthly fees and therefore paying for the Truffle equipment in less than a few months.

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Similarly, consider the case where a T1 line is used, which typically costs around \$400 per month. Instead, this could be replaced by 2 DSL lines resulting in a savings of approximately \$300 per month.

These calculations do not factor in the added value of high speed general Internet access at the branch office that is enabled by Mushroom Networks' VLL solution. In the example above, a 24Mbps down / 3 Mbps up Internet access service is provided at a cost of \$200 per month. Nor do these calculations take into account that the VLL solution can provide highly reliable service, by combining different types of services from different carriers and providing session continuity for applications even during ISP failures.

Features: Plug and play transparent installation & Advanced Router and Advanced QoS Features.

In situations where the branch office has an existing local network with a single WAN connection, Truffle can be installed without any modification to the existing network, including assignment of IP addresses and the existing firewall configuration. This makes the installation of the VLL solution very easy and quick with minimal down time of an operational network.

Truffle has advanced router features, which can be optionally enabled at no additional cost. A notable feature is the Adaptive Quality of Service features enabling dynamic bandwidth reservation for selected applications and traffic types, that adaptively reserves bandwidth only when that traffic type is detected. One can also limit inbound/outbound traffic to defined bit rates, bind certain traffic types on to specified WAN links, manipulate traffic based on TOS identifier, block certain traffic types. An example use case for this is for VOIP traffic, whereby the VOIP traffic is protected from congestion from other inbound/outbound traffic. Many company network administrators currently provision dedicated access lines that only carry VoIP traffic, to prevent QoS degradation. The VOIP module present on the Truffle enables user defined rate limiting of non-real-time traffic so that real-time traffic, such as VOIP traffic, does not suffer unacceptable QoS degradation due to non-real-time traffic, for example file downloads.

The Truffle includes a full function stateful firewall, which can optionally be enabled. Flows can be defined by source IP address, destination IP address, source port, and destination port, and protocol number, and each such flow can be selectively blocked (outgoing) or selectively unblocked (incoming).

Truffle can be easily configured so that traffic to certain external public IP addresses and ports numbers can be forwarded to local servers and hosts with internal private IP addresses and ports, a feature called port forwarding. A DMZ feature is included so that all incoming traffic not matching certain criteria are sent to a "DMZ" server, to facilitate advanced security.

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Truffle also supports a feature called Interface binding, which allows an operator control to pin down certain types of traffic to a particular interface during normal conditions. This allows the operator maximum flexibility for configuring the Truffle for operation in many application environments.

Truffle can be configured to automatically send out email alarm messages after critical events. Truffle is easily managed through an easy to use web-based graphical user interface, which can either be accessed locally, or remotely, via a password. SNMP support is included (MIB 2, read-only).

Traffic Monitoring module provides applications specific layer7 identifiers of traffic provides pin-point control of your traffic within the network. A graph based traffic monitoring is also available with histograms over seconds, minutes, hours, days, months and years. Scalable design of the Truffle, enables IT personnel to easily and quickly deploy Truffles in large scale. The remote manageability, remote firmware upgrades, configuration backups, CLI scripting options, hot-fail over dual install options enables enterprises with the highest level of uptime with ease.

Conclusion:

Truffle provides a unique fast, high 9s reliable and inexpensive data connectivity between the main-office / data-center of an enterprise with its branch offices, by bonding low cost transport technologies, such as DSL, cable or any other IP based Internet connection. Compared to the alternative of using a single and expensive Internet line, VLL solution reduces WAN expenses for an enterprise around 75% per month. As an added benefit, reliable general Internet access can be provided for the branch office through the Internet connection at the main office.

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About Mushroom Networks, Inc

Mushroom Networks is a San Diego, California-based company with the mission to provide innovative networking solutions. Our products and services are focused on a range of networking solutions for enterprises and small/medium sized businesses in various industries. Our solutions bridge the technology gap to the future by enabling applications today, that are otherwise not possible. Mushroom Networks was founded in 2004 as a spin-off from the University of California at San Diego. Mushroom Networks' products are based on the unique and patented Broadband Bonding® technology developed by our engineering team through extensive research & development.

Mushroom Networks Product & Technology Awards:

