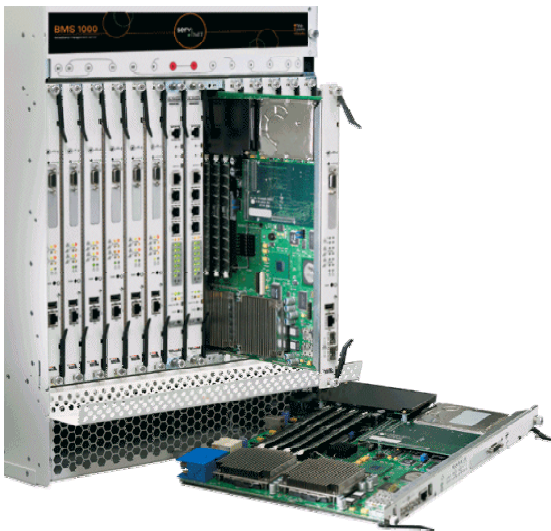


Offloading Point to Point Protocol over Ethernet (PPPoE) from Your Network

ServPoET BMS 200/500/800/1000



Making Broadband Manageable: Be Empowered.

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Fine Point Technologies, Inc. • 139 Centre Street 6th Floor • New York, NY 10013 • USA

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ABSTRACT

PPPoE (Point-to-Point Protocol over Ethernet) is a protocol based on the RFC 2516 and used by many ADSL Internet Service Providers (ISPs) to authenticate and manage broadband subscribers. Essentially PPPoE is PPP, designed for serial communications that have been adapted to an Ethernet network.

A TCP/IP network, and its traffic, has many points of entry and exit for the data packets. New entry points and exits can easily be added, but it is hard to measure the actual traffic at any given point or time.

PPP on the other hand shuttles traffic between two points with no additional entrances or exits along the path. In this mode, it is relatively easy to monitor traffic as there are only two points to measure.

The challenge ISPs face is that they must be able to connect multiple hosts at a remote site through one access point. They also want to access and control the billing systems much like dial-up providers do. PPPoE provides the best solution; it enables the ISP to connect to a network of hosts or entry and exit points, all over a simple bridging access device to a remote access concentrator. With PPPoE traffic monitoring, access control, and billing can be done on a per-user, rather than a per-site, basis as each host utilizes its own PPP stack. Due to these large benefits, PPPoE has become the defacto standard for residential broadband connectivity worldwide.

As broadband service providers entered the ADSL marketplace in force during 1998–2001, the technical challenge to manage subscriber access to the network connection was feasibly handled by using PPPoE (Point-to-Point Protocol over Ethernet) to monitor and terminate subscriber sessions. This afforded both the subscriber and service provider a means of authenticating a user session to the core router without the burden of additional network interface cards or squandering IP (Internet protocol) addresses. Most of the broadband sessions would begin with a log-on function through the use of software such as WinPoET or MacPoET by Fine Point Technologies, and the session terminated when the user disconnected the authenticated link. Network providers wanted an analogous way to control subscriber access, as they had been accustomed to with dial-up modem access, and subscribers needed a secure method to establish their IP link.

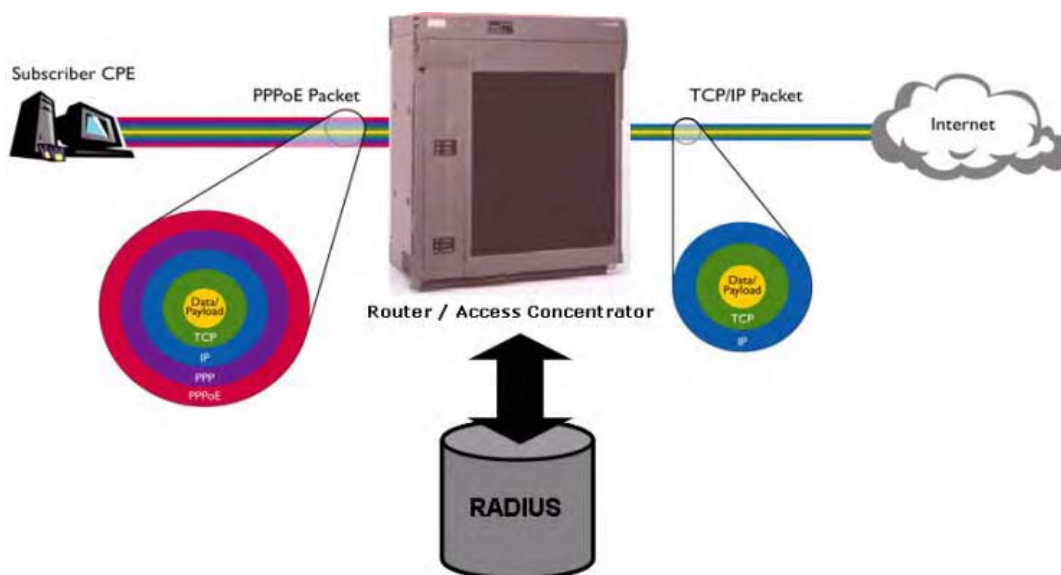
ISSUE WITH TERMINATING PPPoE ON ROUTERS

Let's take a look at how PPPoE operates within a broadband network.

In order to relay this data to the Internet, the data must first be converted to TCP/IP, Transmission Control Protocol/Internet Protocol. When we take a close look at the actual process of “converting” PPPoE to TCP/IP, the benefits of offloading this PPPoE processing will begin to become clear.

The conversion process begins at the subscriber's CPE where the subscriber's connection is delivered to the broadband network via the PPPoE protocol (PPPoE Packets). As we follow the PPPoE packets, they are received by the router, or access concentrator, where the subscriber's sessions is authenticated via the service provider's RADIUS server. Once authenticated, the PPPoE packets are stripped of, first, the Ethernet header, and then the PPP header to be left with the TCP/IP packets which are then routed out onto the Internet.

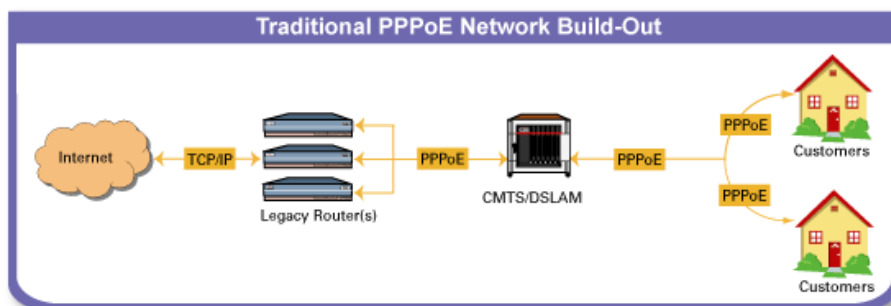
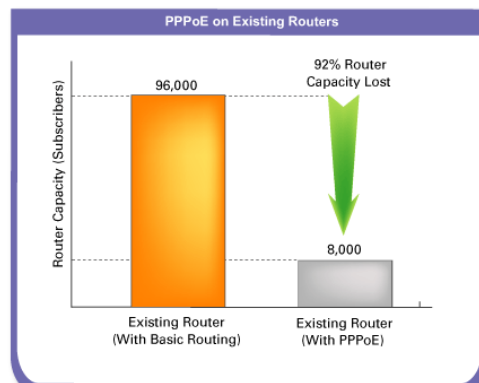
While this may appear simply, the process is rather CPU intensive. Each layer of the each data packet must be “peeled away” to reveal the TCP/IP layers. The process starts when a router receives the PPPoE packet (from the CPE), it must first read and analyze the control information of the Ethernet frame. The router then strips the Ethernet control information from the data frame and passes the frame up to the next layer of the data packet where the next layer is processed. The PPPoE frame is then processed and striped to reveal the PPP data frame. Finally after successful RADIUS authentication, a subscriber session is initiated to permit additional data packets from this authenticated subscriber. Finally, the PPP data frame is striped and the remainder of the data packet (TCP/IP) is routed out to the gateway. This process happens for each and every of the millions of PPPoE data packets that are passed through the router. Also, keep in mind that this operation is then done in reverse (TCP/IP to PPPoE) when the data frame comes from the Internet to the router, destined for the CPE. To make matters worse, this function has to be performed at wire speed to not impact time sensitive applications such as VoIP.



Capacity Intense

This CPU intensive and memory intensive process creates a number of trouble areas for next-generation and legacy routers. In the majority of broadband networks deploying PPPoE, expensive routing equipment, such as Cisco or Redback routers, have been placed in the network to both provide value-add service management, however they are also utilized for routing and PPPoE termination. This severely reduces the capacity of the routing equipment and actually creates a bottleneck in the network.

For example, real world studies have shown that the capacity of a traditional router capable of supporting 96,000 subscribers for routing is reduced to as low as 8,000 subscribers when PPPoE is enabled. This translates to only 8% of the router's originally estimated capacity. Under these circumstances, a service providers starting with no customers that builds out a network planned for five years of capacity would reach 100% capacity in only 4.8 months if PPPoE is implemented.



Impact on Ability to Offer New Digital Services

As next-generation routers are introduced, new services and features, such as Voice over IP (VoIP), become easier to deliver, that is if router capacity is available to offer these services. However, a next-generation router operating at near peak usage, due to PPPoE termination will not have the resources available to support these next-generation services. This forces Internet service providers to invest more capital to purchase more routers to regain the network capacity required for these next-generation services.

As Networks Get Faster, Routers Are Struggling to Keep Up

The performance level of broadband networks has a significant impact on a router's ability to process packets: the faster the network, the more processing work the router has to perform. The growing adoption of high speed broadband services has resulted in more bandwidth throughput; however it is thwarted due to bottlenecks in router CPU power. Every standard Ethernet network transaction requires the processing of a series of TCP/IP and PPPoE parameters that include acknowledgement, error handling, and sliding window for each packet that travels across the wire. As network speeds increase, more of the server's CPU resources are taken up to process network protocols. It is well established that

CPU power of 1 Hz is required to process the TCP overhead associated with transferring data at just 1 bit/sec. With increased bandwidth utilization, a router's CPUs can begin to choke while processing the TCP/IP and PPPoE overhead associated with residential Internet access. Therefore, today's next generation networks require so much TCP/IP and PPPoE processing by the router, that there is little or no CPU capacity left to process the value-add services. For any modern day broadband service provider, this is an unacceptable situation.

Hardware Expense

Router capacity is constrained by the number of subscribers that can be managed at any given time within a specific POP (point of presence). Typical figures of a given POP can be as low as 32,000 and often exceed 103,000 subscribers for particular MSA (metropolitan statistical area) regions. And while router technologies, such as those provided by equipment manufacturers like Cisco and Juniper, are still an obvious choice, the CAPEX costs remain very high in contrast to alternative solutions that modulate subscriber density at a lower CPC (cost per connection) ratio. Traditional CPC values that use router hardware technology as the primary means for session management have been observed to range from \$5.80–\$11.75 per subscriber, with variance given to specific density features of the POP and applied equipment. This notes a cost constraint for adding subscribers to an access point and introduces the question of how to best provision future solutions that effectively lower CPC values.

With the small margins of profit per customer on broadband Internet connections, using expensive next-generation routers to terminate PPPoE dramatically increases the time necessary to recover the cost of installing an average customer. If acceptable network design and implementation would permit a router to operate at maximum capacity this issue would be reduced, however, the life expectancy of the device would then be greatly compromised. Therefore, with a router handling only 75% of expected capacity; the cost per subscriber to route and terminate PPPoE can be as high as \$15 per subscriber.

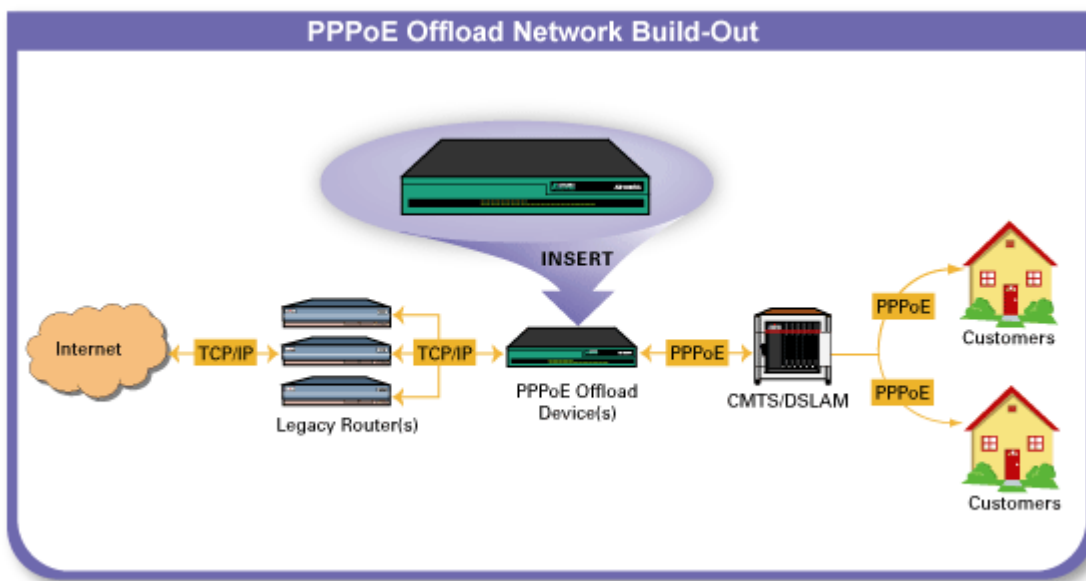
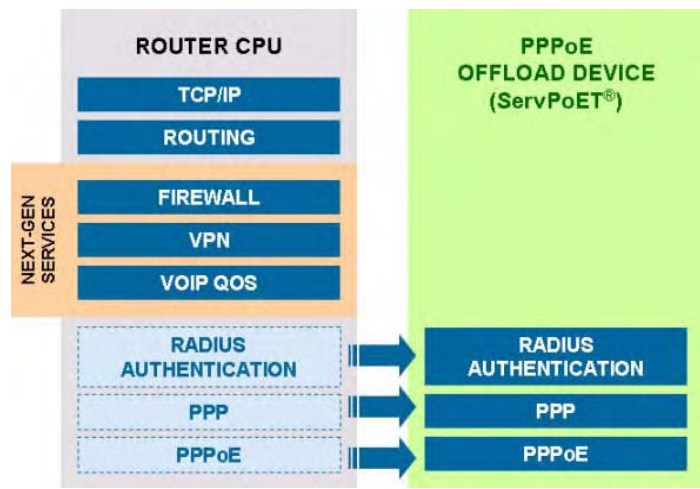
Network Reliability

The PPPoE server is a single point of failure in a network. If this one piece of equipment, which all customers must access to get online, fails, all customers can no longer access the Internet. This results in increased call center traffic and higher operating costs per customer. Multiple PPPoE servers capable of seamless load balancing are the answer to this problem — but traditional and next-generation routers that include PPPoE functionality do not offer native load-balancing technology. Considering the high cost of next-generation routers, the unavailability of built-in load balancing limits the network engineer's options for creating a redundant network capable of 99.999% uptime.

SOLUTION: OFFLOAD PPPoE

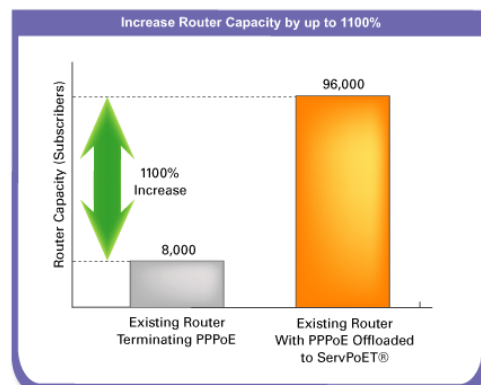
PPPoE offloading technology solves the PPPoE and TCP/IP processing problem by moving the network protocol processing from the router's CPU to a specialized network device optimized for PPPoE processing. Often these devices, such as ServPoET contain technology that is performance enhanced to the specific application in this case, processing PPPoE data packets.

By fully offloading PPPoE and PPP processing to dedicated hardware, ServPoET[®] relieves the router's CPU from managing PPPoE network connection tasks. For example, by preventing PPPoE and PPP protocol processing from reaching the routers, ServPoET[®] reduces CPU interrupts for packet processing as well as trips across the router's memory and backplane busses, all of which are CPU intensive. With the network protocol requirement removed, the routers can process next generation protocols and applications much more quickly than before.



Increased Network capacity

By simply moving the PPPoE and PPP processing from the existing network routers, service providers can increase the available network capacity by a factor of 11. Now the router is no longer a bottleneck, and existing network router resources are optimized for more efficient routing, bandwidth usage and next generation service delivery. The network routers and access concentrators are freed up to route the amount of prospective customers it was built out to handle, regaining its target threshold capacity. With PPPoE support disabled in the router configuration, the full router capacity is now available for the introduction of value-added and next-generation services.



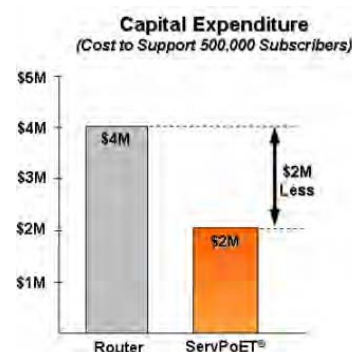
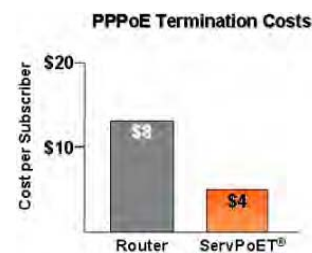
Return on Investment / Total Cost of Ownership

Alternative solutions to core router functions have recently appeared in the marketplace as software and hardware variants, with a dominant trend leaning positively toward NOS-based solutions and a steep curve for architectural standards. One such standard that is gaining developer traction is the PICMG (PCI Industrial Computer Manufacturers Group) reference 3.X platform, or commonly referred to as Advanced Telecom Computing Architecture, or AdvancedTCA™.

While presently undergoing ratification by the PICMG standards body, the latest platform enables developers such as Fine Point Technologies the ability to offer a commodity-based platform that scales the subscriber density on a single router from a traditional load of 8,000 connections to a server-consolidated operation of more than 72,000 connections. The significance of the AdvancedTCA™ standard is contained in the architecture's ability to deliver significantly higher throughput, performance, and expansion options as a basis for managing traffic loads and subscriber connections.

PPPoE Offload devices such as ServPoET® are built upon readily available x86 platforms such as this industry accepted AdvancedTCA™. By taking this approach, rather than expensive proprietary hardware, ServPoET® is built upon hardware that is not only more reliable, but a fraction of the cost of proprietary router platforms. Proprietary routers and access concentrators can cost anywhere from \$8 up to \$15 per subscriber adequate capacity. Per subscriber capital expenditure costs becomes an even greater concern as new digital services such as VoIP are deployed within the broadband network.

With profit margins a concern for a competitive broadband market, a lower priced network solution that improves performance and does not sacrifice reliability can dramatically decrease the time to profitability after installing a customer. By substantially increasing subscriber density in a server-based environment, network providers can feasibly expand their infrastructure without the propagation of higher CAPEX investments and load constraints associated with router hardware. In turn, this lowers the CPC to the broadband service provider while affording the auxiliary benefits of sophisticated IP address management and enforcement of SLA (service level agreements) at the subscriber level.



Many of today's network providers have begun to implement tiered service plans for ADSL offerings and find higher ARPU (average revenue per subscriber unit) values through differentiated capacity plans. Of course, the mainstay focus is on managing subscriber access to the network facilities while accounting for usage activity. In the case of ServPoET[®], the result is an eleven fold increase in the life of the network before additional capital must be invested to expand or upgrade it.

Improve Network Mean Time Before Failure (MTBF)

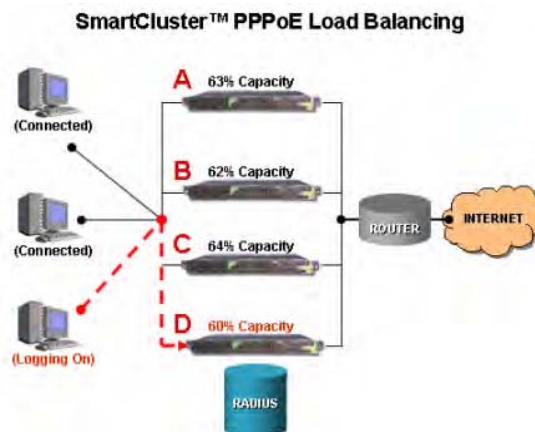
One standard metric for measuring impact of installing a PPPoE offload solution is the PEI (Performance Efficiency Index). The PEI is a measurement of throughput divided by CPU utilization, or effectively, the amount of data transferred for each percentage of CPU power utilized. The higher the PEI, the more data is moved per CPU cycle. The improvement gain by the using a PPPoE offloading solution such as ServPoET[®] results in a higher PEI for the existing routing equipment. Therefore, the life span of the existing router infrastructure is also increased since CPU and memory utilization is drastically decreased, increasing the time before the unit fails and must be taken offline for service.

A Load-Balanced, Redundant Network

One of the benefits of utilizing a PPPoE offload device is that these devices, such as ServPoET[®] leverage PPPoE specific features that are not available in routers or access concentrators. In some cases, these features can offer higher reliability and performance than a router. One such feature in ServPoET[®] empowers service providers to build and support a redundant network for 99.999% uptime and eliminates single points of failure.

Since ServPoET[®] is specifically designed for PPP and PPPoE termination it is engineered to include native clustering technology that enables automatic load balancing of PPPoE network traffic among clustered units for improved service levels.

The ServPoET[®] SmartCluster[™] Technology evenly distributes sessions among cluster members, automatically removing members that fail or become unreachable. New cluster members can be added "hot" to expand an existing cluster for additional capacity and performance, allowing administrators to scale their services with unprecedented time and cost savings.



REGIONAL LOCATIONS WORLDWIDE

United States (Corporate Headquarters)

139 Centre Street, 6th Floor
New York, NY 10013
USA
+1.212.962.7410
info@finepoint.com

United Kingdom

Globix House
1 Olivers Yard
London EC1 Y1HQ
UK
+ 44.2075.264818

France (Europe, Middle East, Africa)

Les Algorithmes, Bât. Aristote A
2000, Route des Lucioles, BP 29
06901 Sophia Antipolis
France
+ 33.1707.18418