



Interested in learning  
more about security?

# SANS Institute InfoSec Reading Room

This paper is from the SANS Institute Reading Room site. Reposting is not permitted without express written permission.

## Private Internet Exchange: The Fastest Firewall in the World?

There are now numerous amounts of firewalls available in today's market with a wide array of speeds, strengths and weaknesses. The limitations are based on an engineers ability to discern the needs of the client and or model and provide the correct product choice, followed by proper deployment, configuration and management. Without proper implementation, maintenance and follow-up no firewall is invincible.

Copyright SANS Institute  
Author Retains Full Rights



AD

# PRIVATE INTERNET EXCHANGE

## The Fastest Firewall in the World?

### Introduction

There are now numerous amounts of firewalls available in today's market with a wide array of speeds, strengths and weaknesses. The limitations are based on an engineers ability to discern the needs of the client and or model and provide the correct product choice, followed by proper deployment, configuration and management. Without proper implementation, maintenance and follow-up no firewall is invincible.

### Why a Firewall?

Why a firewall? Now that's a good question, The term firewall comes from a device used to protect people from fire. The firewall is a shield of material resistant to fire that is placed between a potential fire and the people it is protecting. The firewall I'm going to discuss has nothing to do with fire or flames, but a wall that is place between the Internet (UN-trusted space) and a company's Intranet (trusted space). Firewalls have been around for many years and have been gaining more popularity as the Internet grows. In simple terms the firewall is a basic computer with more than one network interface card. It will sit between two or more networks with special rules that allow certain traffic to pass to other networks. You can think of a firewall like a gate at a Military base. You have a highly secured entrance with a guard. Before entering the base you first need clearance (authorization), then you need to present identification (authentication) to the guard, and he may allow or deny access to the base, the guard will then log the transaction (accounting) just because you approached the entrance. In the IP world a firewall essentially will act like a security guard at the perimeter of your network. Adhering to a set of rules that are set forth.

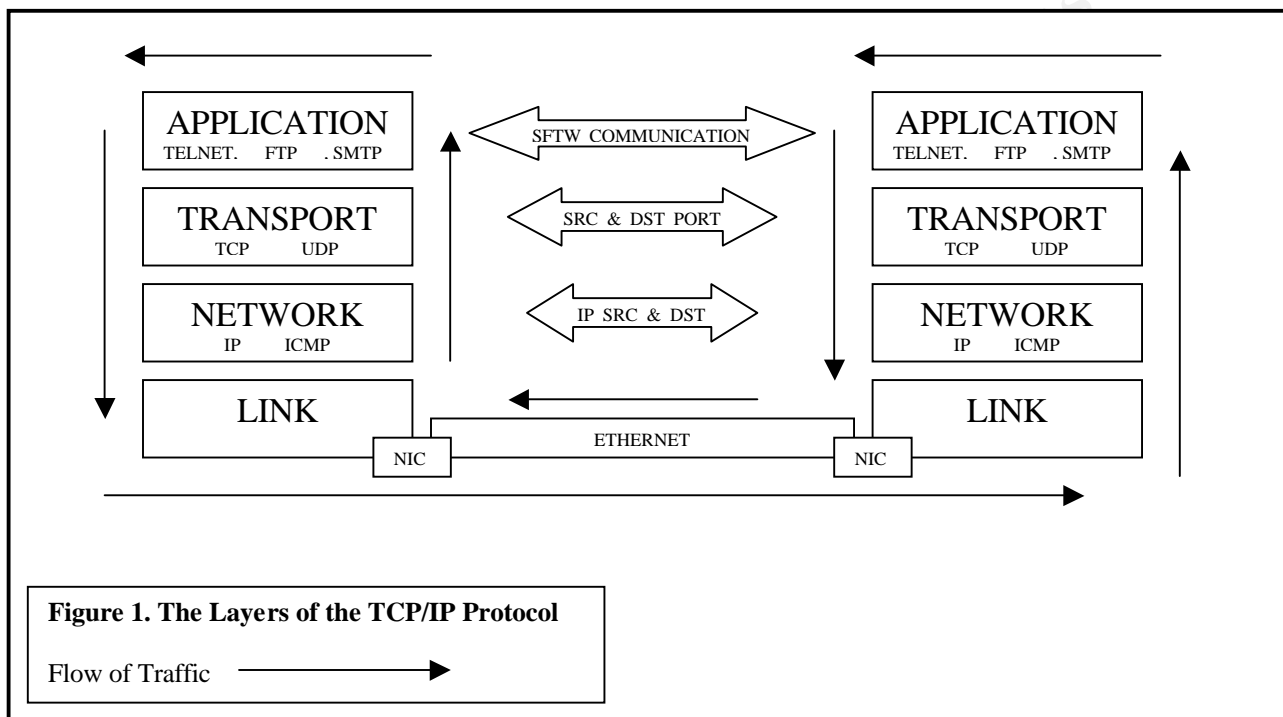
### The History of TCP/IP

Before we can understand how firewalls work, we'll first discuss the origination of the Internet Protocol (IP) and how computers communicate over a switched IP network. TCP/IP was developed by the Defense Advanced Research Projects Agency (DARPA) in 1970. Years later it was introduced to the world through the Berkley Software Distribution (BSD), UNIX included TCP/IP Transmission Control Protocol / Internet Protocol in their O/S and it became the foundation of what the Internet is today.

### TCP/IP the Layers

The TCP/IP model consists of 4 layers; each layer provides a very important duty. The layers of protocols were designed to provide reliability, scalability and communications between heterogeneous networks. The first, the link layer, is responsible for communicating with the actual network hardware (e.g., the Ethernet card). The data that's received off the network wire gets handed off to the network layer. This is where device drivers for different interfaces reside. The second, the network layer, is responsible for figuring out how to get data to its destination. Making no guarantee about whether data will reach its destination, it just decides where the data

should be sent. The third, the transport layer, provides data flows for the application layer. It is at the transport layer where guarantees of reliability may be made. The fourth, the application layer, is where users typically interact with the network. This is where TELNET, FTP, EMAIL, IRC, WEB, etc... reside. Figure 1 has been provided to create a visual understanding of the layers and how a packet travels down through each layer when the packet is transmitted and up each layer when the packets are received at the other end. Packets are the basic unit of transmission on the Internet.



### How do Firewalls Work?

The Firewall sits in between two networks and acts like a gateway to either of the networks. Understanding the function of TCP/IP and how it communicates, traffic can be controlled between these networks. We can find information like the source and the destination of the traffic (network layer), what protocols are being used (transport layer), and what application are communicating (application layer). The Firewall inspects every packet that enters its interface and compares the information against a security policy or rule base. The security policy is a set of rules using TCP/IP properties to accomplish access control over an IP switched packet network.

### Different types of Firewall Technologies

Any device that controls network traffic for security reasons can be called a firewall. There are three major types of firewalls, each using a different strategy to protect network resources. The most basic firewall devices are built on routers. These work in the lower layers of the network

protocol stack by filtering packets (these firewalls are sometimes called screening routers or packet filtering firewalls). A second form of firewalls are Proxy server gateways or application layer firewalls. These work at the upper levels of the protocol stack, and provide proxy services on external networks for internal clients and monitor and control and traffic by looking at certain information inside packets. The third type of firewall uses state-full inspection techniques to compare the bit patterns of the packets to packets already known to be trusted. Firewalls manufactures may use one or a combination of these technologies.

## Commercial Firewalls Available

Several companies have designed and manufactured firewalls for commercial use. There are a number of basic design issues that should be addressed when choosing a firewall for implementation. For the engineer the key is to understand the needs of the client when choosing the best firewall to use. There still does not exist a gold standard firewall that outshines in all areas of protection, implementation and cost effectiveness. However from the pack of available manufacturer firewalls listed below the Cisco Secure PIX has several outstanding qualities that makes it a fierce reliable competitor in the sea of manufactured firewalls.

Firewall Name	Company Name	Web-site URL
Cisco PIX Firewall	<i>Cisco Systems Inc.</i>	<a href="http://www.cisco.com">www.cisco.com</a>
Firewall-1	Checkpoint Technologies	<a href="http://www.checkpoint.com">www.checkpoint.com</a>
Raptor Firewall	Axent Technologies	<a href="http://www.axent.com">www.axent.com</a>
Cyberguard	<i>CyberGuard Corporation</i>	<a href="http://cyberguard.com/">Http://cyberguard.com/</a>
Guardian	NetGuard Inc.	<a href="http://www.ntguard.com/">http://www.ntguard.com/</a>
Netscreen 100	Netscreen Technologies	<a href="http://www.netscreen.com">www.netscreen.com</a>
SideWinder	Secure Computing	<a href="http://www.securecomputing.com">www.securecomputing.com</a>

## The Firewall of choice (The PIX)

### The PIX Background

The PIX firewall was not the brainchild of Cisco Systems. The PIX originally developed by a company called Network Translations Inc., in 1994 did not get acquired by Cisco until the fall of 1995 and has since been flourishing under Cisco's marketing wing. It was originally developed for the dual use as a network translation device and also a firewall.

### The Operating System

The PIX's operating system is a proprietary, Non-UNIX, secure, real time embedded system, and entirely less than three megabytes in size. This means that the PIX OS is specialized where it's sole purpose is dedicated building translations and filtering packets through a designed rule base. Most other firewalls still require UNIX or Windows NT operation systems. Thus, these systems where not designed with the sole purpose for firewall use in mind.

## The Hardware

The PIX is a solid state firewall this means there are no moving parts, well except one “the fan,” that cools the power supply and the rest of the PIX’s components. The PIX IOS (Integrated Operating System) runs on an i386 platform an industry standard for PC market. The PC 100 motherboard is usually equipped with a Pentium II 350MHz, 16 MB of flash, 128MB of RAM and three PCI expansion slots for additional NICs or the VPN accelerator card. All this powerful hardware is encased in a nineteen-inch rackable gray shell.

## Access Control (packet filtering) and State-full Inspection (ASA)

Other key features of the PIX firewall is its strength of security when used with Cisco router access control lists for packet filtering. The nucleus of the PIX firewall is the Adaptive Security Algorithm (ASA) which is less complex but more robust than the standard packet filtering system. ASA offers state-full connection oriented security while tracing the source and destination address, TCP sequences as well as additional TCP flags and information which is then stored within a table of inbound and outbound packets ultimately controlled by the security policy applied. Only transmissions that match the administrators defined table will be allowed freeway access through the firewall.

## Not A Router

Note the PIX firewall is NOT a router. This device does not route traffic yet it passes information determined by predefined static translation rules from one security level to another, due to it’s unique sub-system the software can communicate directly with it’s hardware. The PIX provides a bridge like layer I connection that filters layers II and III for access control. This feature explains the PIX Firewall’s speed and ability to handle information at 370 MB / sec.

## Running at the SPEED OF LIGHT

As the Internet grows and prospers the users needs are becoming a lot more demanding and important, the need for speed is increasing every day. Currently large company’s infrastructures demand fast connections to the Internet and they need not only a firewall that can handle line speeds, but can handle the speeds in a secure fashion. One of the PIX’s greatest features is its speed and the amount of simultaneous connections it can handle without jeopardizing security.

## PIX Speed Specifications

Model	Throughput	Simultaneous Sessions
PIX 535	1 Gbps	500,000
PIX 525	370 Mbps	280,000
PIX 520	370 Mbps	250,000
PIX 515	120 Mbps	125,000
PIX 506	10 Mbps	XXXXX

## **Failover/Hot-Standby**

The PIX offers an failover option for approximately \$5000 this results in a continuous hot standby. Other commercial competitors will offer similar failover capabilities however cost for the additional firewall is the same as the primary firewall thus doubling the cost. The PIX Failover is achieved with a secondary PIX and a specialized serial (failover) cable which will allow configuration and failover information to pass from one PIX to another. "Heartbeats" are transferred back and forth through the failover and Ethernet cables to allow for the state of the PIX to be continuously monitored. With the PIX, implementation is simple and quick. Only one PIX firewall needs to be configured for failover, once that is done, the failover cable is connected, failover is turned on for the primary unit. All configuration information will sync to the secondary unit and then will provide a HOT standby firewall.

## **Back up and Restores**

One of the most crucial parts of any computer device is the backing up and restoration of its information. Simplicity and speed are also very important. The PIX firewall is one of the fastest on the market, just like a Cisco router. Not only for backing up and restoring its config, but loading its Operation System. The config can be backed up or restored in three different ways because the configuration is kept in a flat ASCII text format.

- Copy and Pasted into a text editor
- Transferred directly to a floppy
- Via a TFTP server

If an older PIX fails a brand new PIX (cold standby) with no config can be set up in minutes. The config can fit on a floppy the maximum PIX config at this time is about 340KB.

## **The PIX – Why A Firewall Appliance is the Way to Go?**

- Compact
- Plug and Play
- Dedicated Device
- Single vendor for H/W and S/W

## **Conclusion**

The role of security and protecting networks with Firewalls are evolving at ridiculous speeds. Everyday new Firewall technologies are being developed and introduced to the industry to meet market demands. Companies are interested in security devices that can handle data transmissions at wire speeds that will plug and play right into their network, with easy to use GUI's which allows ease of management. The Private Internet eXchange (PIX) happens to meet the current demands of the market. The real question will be how long will the PIX maintain its ability to satisfy the security industry's quest for the fastest firewall in the wall?

## **Internet References**

*Under the hood of the Internet: An overview of the TCP/IP Protocol Suite*

Jason Yanowitz

[http://www.smeal.psu.edu/misweb/datacomm/tcp\\_ip.html](http://www.smeal.psu.edu/misweb/datacomm/tcp_ip.html)

*Firewall Technologies and Firewall Selection*

Milkyway Networks

<http://www.mikyway.com/libr/mwm-96-0101.html>

*Special Report: Firewalls For All*

<http://www.networkmagazine.com/article/NMG20010521S0007>

*General Firewall Information*

<http://www.cyberangels.org/net-ed/classes/firewall.html>

*Cisco PIX Firewalls*

<http://www.cisco.com/warp/public/cc/pd/fw/sqfw500/>

## **Book References**

Building Internet Firewalls", O'Reilly & Associates

Chapman / Zwicky

Firewalls and Internet Security

Cheswick / Bellovin

© SANS Institute 2001, Author retains full rights



# Upcoming SANS Training

[Click Here for a full list of all Upcoming SANS Events by Location](#)

SANS San Diego 2017	San Diego, CAUS	Oct 30, 2017 - Nov 04, 2017	Live Event
SANS Seattle 2017	Seattle, WAUS	Oct 30, 2017 - Nov 04, 2017	Live Event
SANS Gulf Region 2017	Dubai, AE	Nov 04, 2017 - Nov 16, 2017	Live Event
SANS Milan November 2017	Milan, IT	Nov 06, 2017 - Nov 11, 2017	Live Event
SANS Amsterdam 2017	Amsterdam, NL	Nov 06, 2017 - Nov 11, 2017	Live Event
SANS Miami 2017	Miami, FLUS	Nov 06, 2017 - Nov 11, 2017	Live Event
SANS Paris November 2017	Paris, FR	Nov 13, 2017 - Nov 18, 2017	Live Event
Pen Test Hackfest Summit & Training 2017	Bethesda, MDUS	Nov 13, 2017 - Nov 20, 2017	Live Event
SANS Sydney 2017	Sydney, AU	Nov 13, 2017 - Nov 25, 2017	Live Event
GridEx IV 2017	Online,	Nov 15, 2017 - Nov 16, 2017	Live Event
SANS San Francisco Winter 2017	San Francisco, CAUS	Nov 27, 2017 - Dec 02, 2017	Live Event
SANS London November 2017	London, GB	Nov 27, 2017 - Dec 02, 2017	Live Event
SIEM & Tactical Analytics Summit & Training	Scottsdale, AZUS	Nov 28, 2017 - Dec 05, 2017	Live Event
SANS Khobar 2017	Khobar, SA	Dec 02, 2017 - Dec 07, 2017	Live Event
SANS Austin Winter 2017	Austin, TXUS	Dec 04, 2017 - Dec 09, 2017	Live Event
SANS Munich December 2017	Munich, DE	Dec 04, 2017 - Dec 09, 2017	Live Event
European Security Awareness Summit & Training 2017	London, GB	Dec 04, 2017 - Dec 07, 2017	Live Event
SANS Bangalore 2017	Bangalore, IN	Dec 11, 2017 - Dec 16, 2017	Live Event
SANS Frankfurt 2017	Frankfurt, DE	Dec 11, 2017 - Dec 16, 2017	Live Event
SANS Cyber Defense Initiative 2017	Washington, DCUS	Dec 12, 2017 - Dec 19, 2017	Live Event
SANS Security East 2018	New Orleans, LAUS	Jan 08, 2018 - Jan 13, 2018	Live Event
SANS SEC460: Enterprise Threat Beta	San Diego, CAUS	Jan 08, 2018 - Jan 13, 2018	Live Event
SANS Amsterdam January 2018	Amsterdam, NL	Jan 15, 2018 - Jan 20, 2018	Live Event
Northern VA Winter - Reston 2018	Reston, VAUS	Jan 15, 2018 - Jan 20, 2018	Live Event
SEC599: Defeat Advanced Adversaries	San Francisco, CAUS	Jan 15, 2018 - Jan 20, 2018	Live Event
SANS Berlin 2017	OnlineDE	Oct 23, 2017 - Oct 28, 2017	Live Event
SANS OnDemand	Books & MP3s OnlyUS	Anytime	Self Paced