Necessary
Firewalls are Good

Steven M. Bellovin
smb@research.att.com
908-582-5886
AT&T Bell Laboratories
Murray Hill, NJ 07974
What’s a Firewall

- Barrier between *us* and *them*.
- Limits communication to the outside world.

⇒ The outside world can be another part of the same company.

- Only a very few machines exposed to attack.
Schematic of a Firewall

Inside

Filter

Gateway(s)

DMZ

Filter

Outside
Why Use Firewalls?

- Most hosts have security holes. Proof: Most software is buggy. Therefore, most security software has security bugs.

- Firewalls run much less code, and hence have few bugs (and holes).

- Firewalls can be professionally (and hence better) administered.

- Firewalls run less software, with more logging and monitoring.

- They enforce the partition of a network into separate security domains.

- Without such a partition, a network acts as a giant virtual machine, with an unknown set of privileged and ordinary users.
Should We Fix the Network Protocols?

- Network security is not the problem.

- Firewalls are not a solution to network problems. They are a network response to a host security problem.

- More precisely, they are a response to the dismal state of software engineering; taken as a whole, the profession does not know how to produce software that is secure, correct, and easy to administer.

- Consequently, better network protocols will not obviate the need for firewalls. The best cryptography in the world will not guard against buggy code.

- That said, we need to engineer—and deploy—better security protocols.
Firewall Advantages

*If you don’t need it, get rid of it.*

- No ordinary users, and hence no `/etc/passwd` entries.
- Run as few servers as possible (zap `rlogin`, `finger`, etc.)
- Install conservative software (eliminate `sendmail`, don’t get the latest fancy `ftpd`, etc.)
- Log everything, and monitor the log files.
- Keep copious backups, including a “Day 0” backup.

Ordinary machines cannot be run that way.
Positioning Firewalls

Firewalls protect *administrative* divisions.
Types of Firewalls

- Packet Filters
- Application Gateways
- Circuit Relays

Many firewalls are combinations of these types.
Packet Filters

- Router-based (and hence cheap).
- Individual packets are accepted or rejected; no context is used.
- Filter rules are hard to set up; the primitives are often inadequate, and different rules can interact.
- Packet filters a poor fit for ftp and X11.
- Hard to manage access to RPC-based services.
Sample Rule Set

\textbf{block}: \textit{theirhost} = SPIGOT
\textbf{allow}: \textit{theirhost} = any and
\textit{theirport} = any and
\textit{ourhost} = OUR-GW and
\textit{ourport} = 25.
Incorrect Rule Set

allow: \( \text{theirhost} = \text{any} \) and \( \text{theirport} = 25 \) and \( \text{ourhost} = \text{any} \) and \( \text{ourport} = \text{any} \).

Any remote process on port 25 can call in.
The Right Choice

\[
\text{allow: } \begin{align*}
\text{theirhost} & = \text{any and} \\
\text{theirport} & = 25 \text{ and} \\
\text{ourhost} & = \text{any and} \\
\text{ourport} & = \text{any and} \\
\text{(bitset(ACK)) or } & \text{source = INSIDE).}
\end{align*}
\]

Permit outgoing calls.
Application Gateways

- Gateway machine has custom program for each application.
- Facilities sometimes needed anyway (i.e., mail gateways).
- A good choice for X11 relays or for controlling outbound traffic.
Circuit Relays

- Messages are passed at the TCP level.
- No semantic processing by the gateway.
- Applications must be converted (but this isn’t hard).
- More flexible than application gateway, but can be subverted.
Creating Tunnels

But tunnels are often useful, especially if cryptographically protected.
Single-Router Firewall

The cheapest design, but insecure with some brands of router.
Double-Router Firewall

More secure, but more expensive.
“Belt and Suspenders”

A paranoid solution; the attacker has to go through the gateway, too.

Diagram:
- Router
- GW
- Inside Net 1
- Inside Net 2
- DMZ Nets
- Outside
Providing Inbound Services

- Must allow some incoming traffic (mail, ftp, login, etc.)
- When possible, provide service on gateway machine (i.e., ftp repository).
- Use application gateway for pass-through services.
- High security, such as smart card authentication, desirable.
How Break-ins Can Spread

- Inappropriate .rhosts files.
- Logins via cracked passwords.
- Booby-trapped telnet commands.
Transitive Trust

If A trusts B and B trusts C, then A trusts C, whether it knows it or not.
Living With Firewalls

- Decide on a security policy.
- Decide which services fit that policy.
- Build/configure/tweak your firewall to permit those services.
- Evaluate new services using the same criteria.
- Block all others.