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Understanding and Managing Windows Firewall (Practical Session)

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Outline

- Recap (firewalls in general)
- Understanding Windows Firewall
  - A short history
  - Windows Filtering Platform
  - Windows (Defender) Firewall
- Managing Windows Firewall
  - Via GUI
  - Via `netsh`
  - Via PowerShell

Recap: What is a firewall?

- A firewall is a system (or group thereof) that monitors and/or controls inbound and/or outbound network traffic based on a set of administrator-defined rules (the policy)
  - One of the many definitions

- A typical classification
  - Packet filtering firewall
    - » Makes decisions based on L3/L4 header information
    - » Does not track connection states
  - Stateful firewall
    - » Like a packet filtering firewall, but keeps track of connection states
  - Application-layer firewall
    - » Can understand (some) L7 protocols and make decisions based on L7 contents

A SHORT HISTORY

UNDERSTANDING WINDOWS FIREWALL

Windows Firewall – A short history

- Windows 98 ME and earlier editions
  - No built-in firewall!
  - Users had to find, download, and install one themselves
  - No dedicated Windows APIs for developers
    - » NDIS "hacks", Winsock LSPs, TDI Filter Drivers were necessary

Windows Firewall – A short history

- Windows 2000 and Windows XP until SP2
  - Rudimentary "packet filter firewall"
    - » Can filter only incoming traffic
    - » Can filter only TCP, UDP, and IP by 'Protocol' header
  - Some support for firewall developers
    - » Filter Hook Driver (one per system), Firewall Hook Driver

Windows Firewall – A short history

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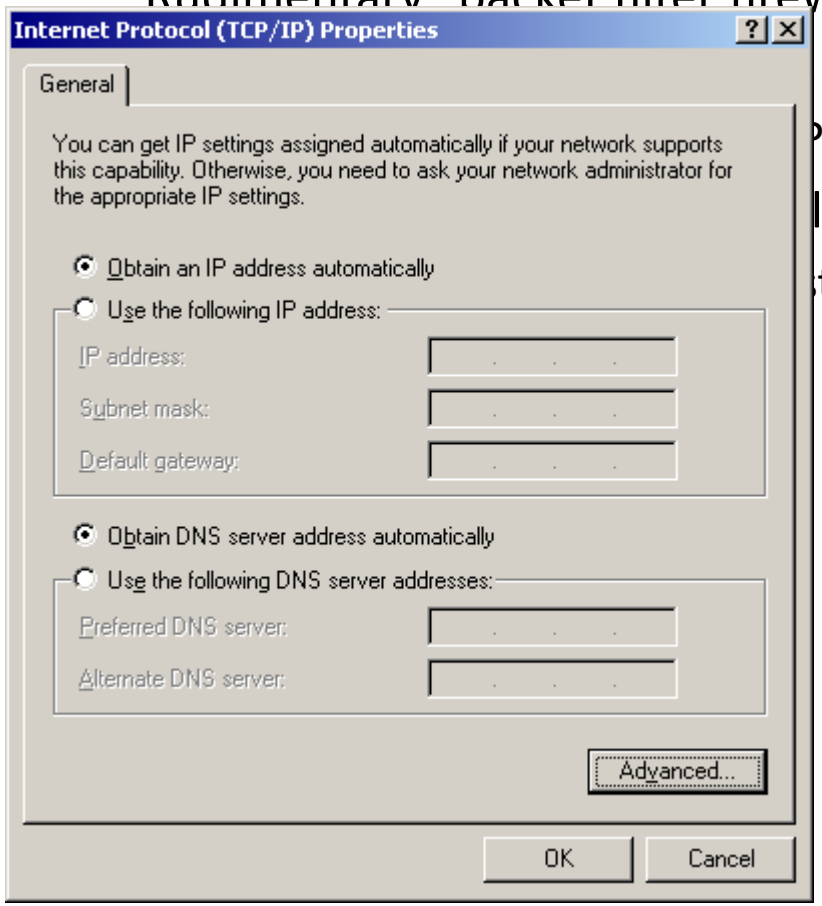
  - Rudimentary "packet filter firewall"



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Windows Firewall – A short history

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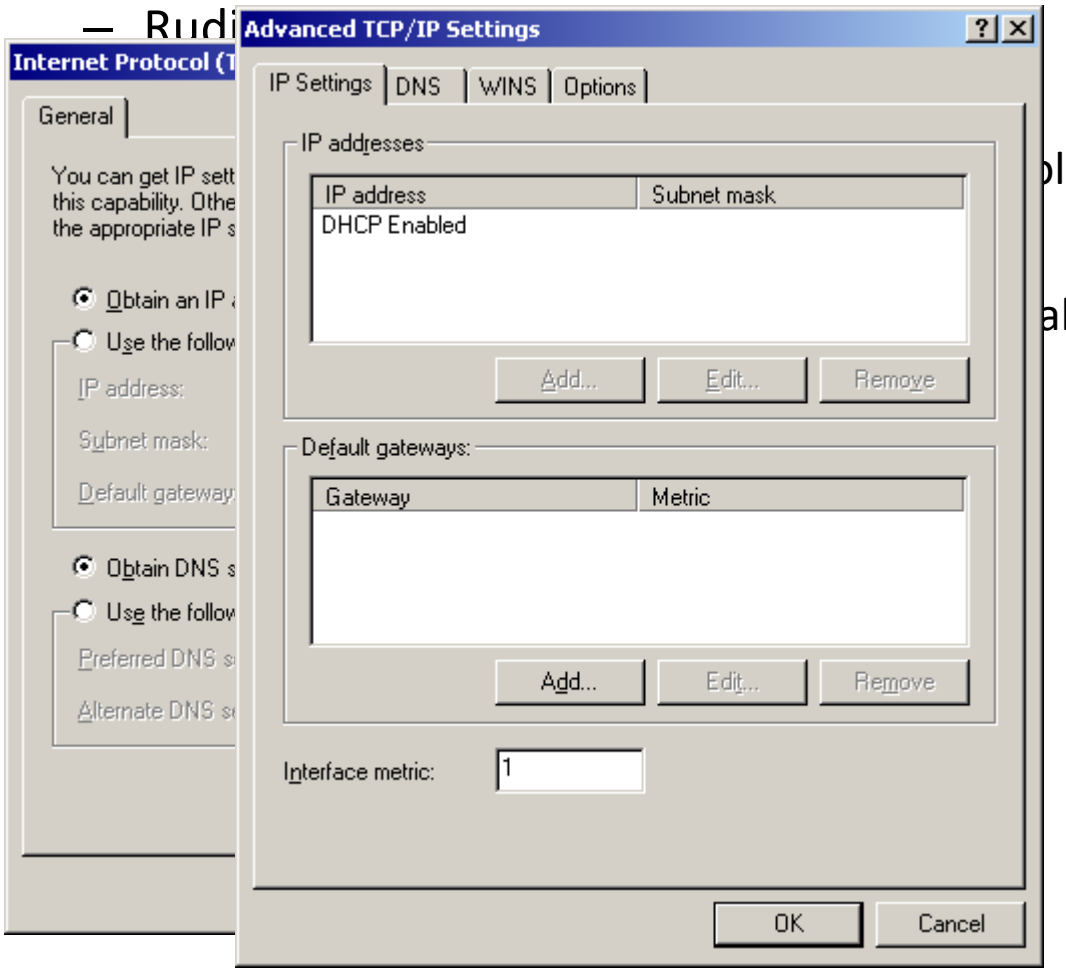

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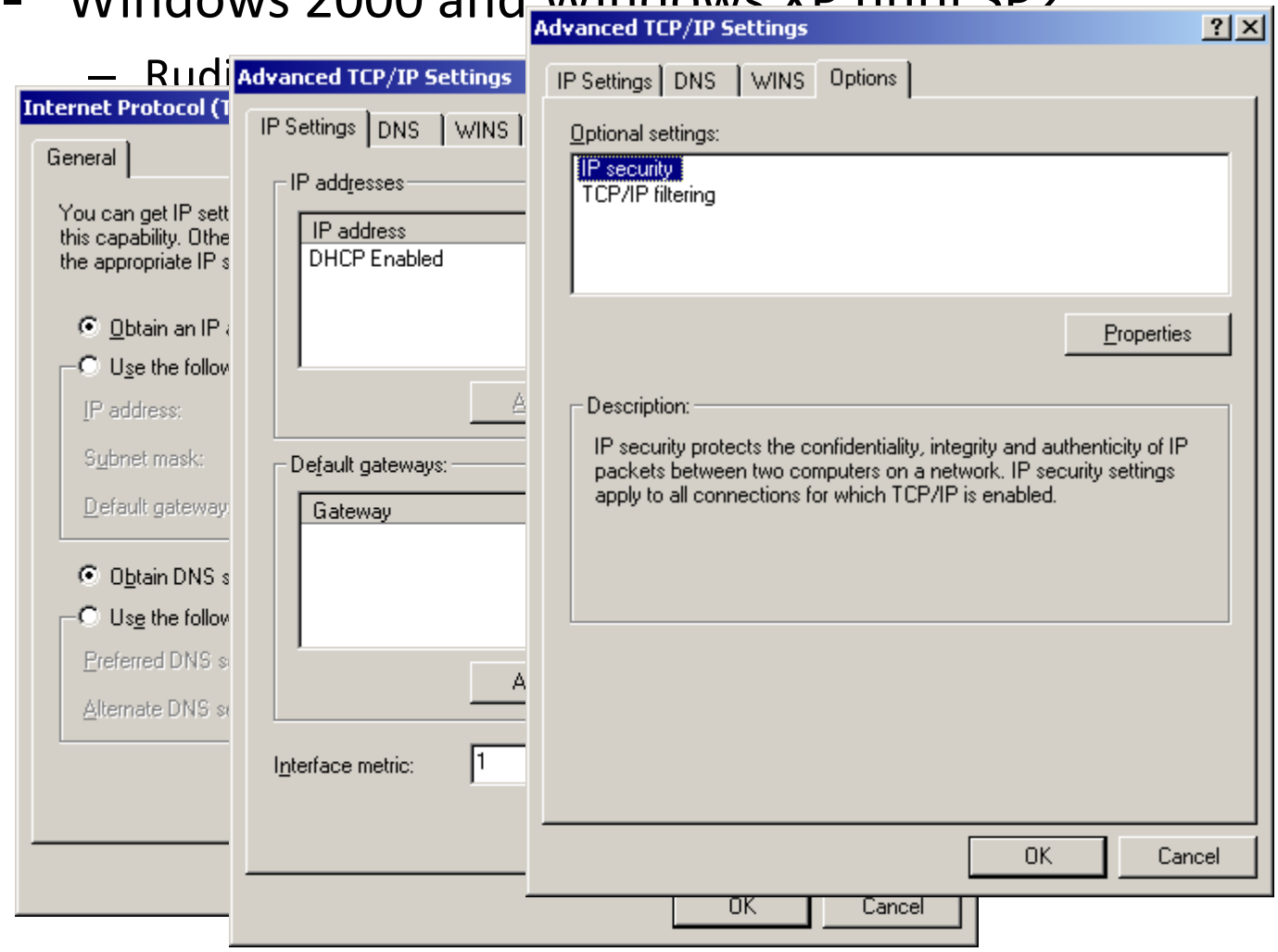

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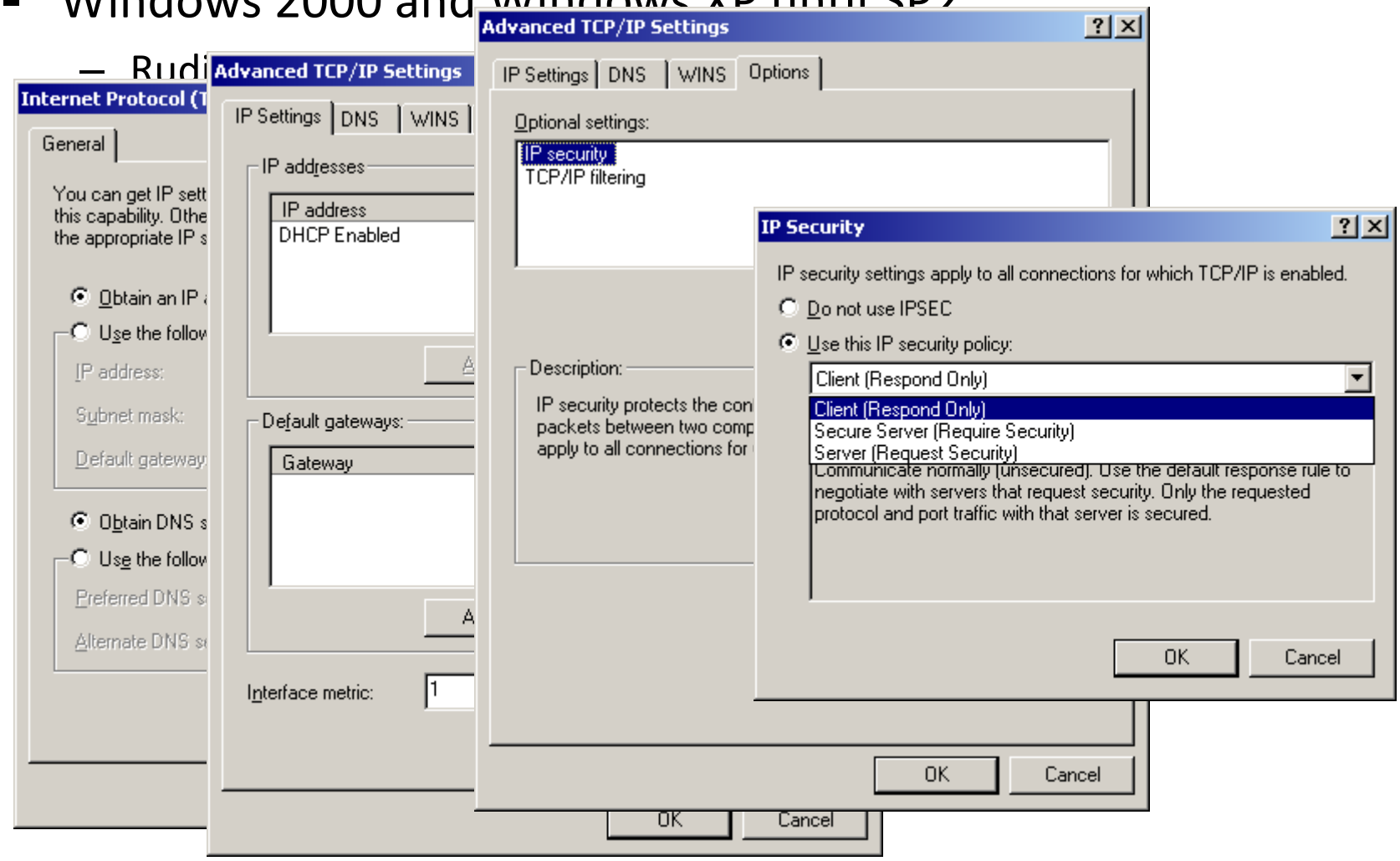

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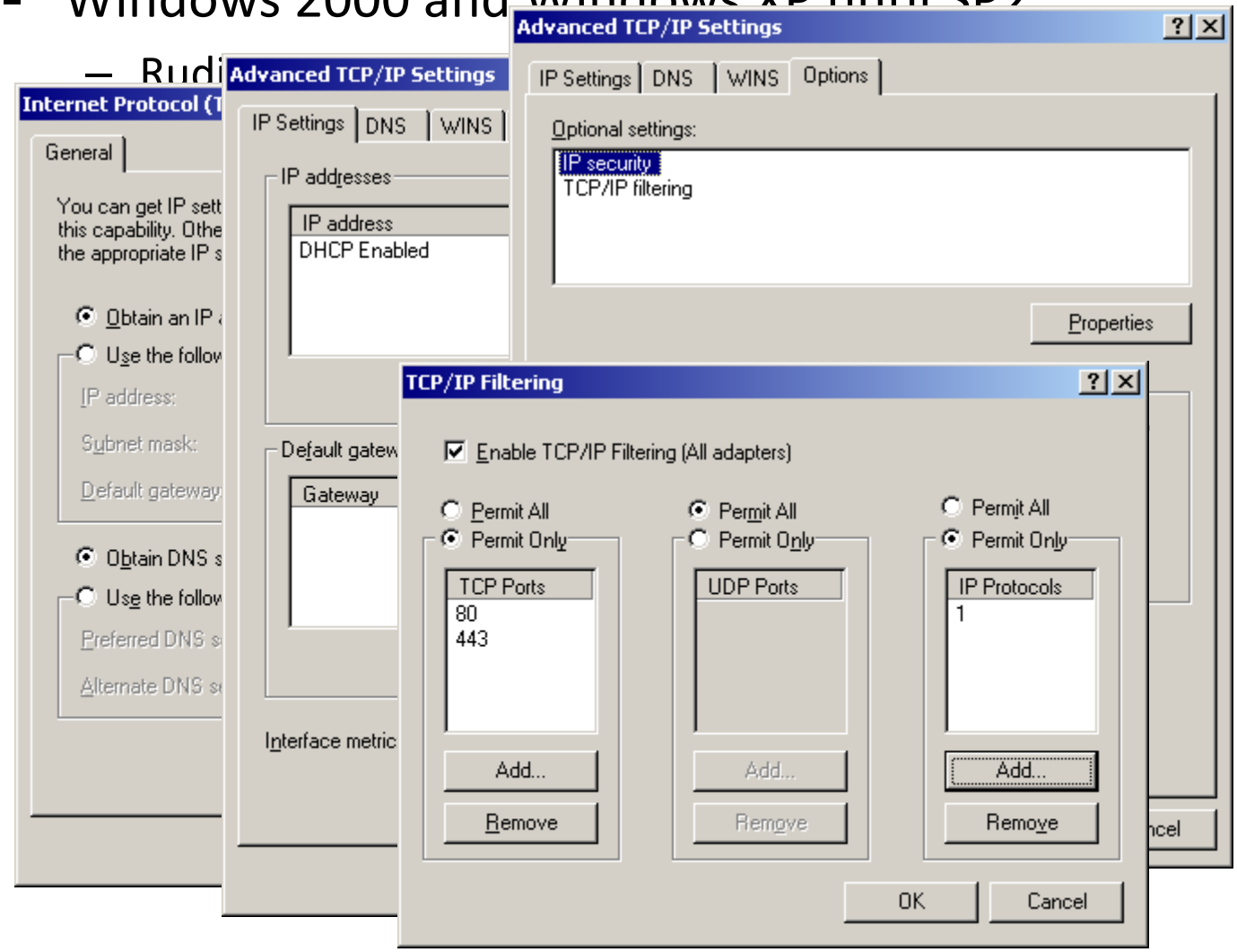
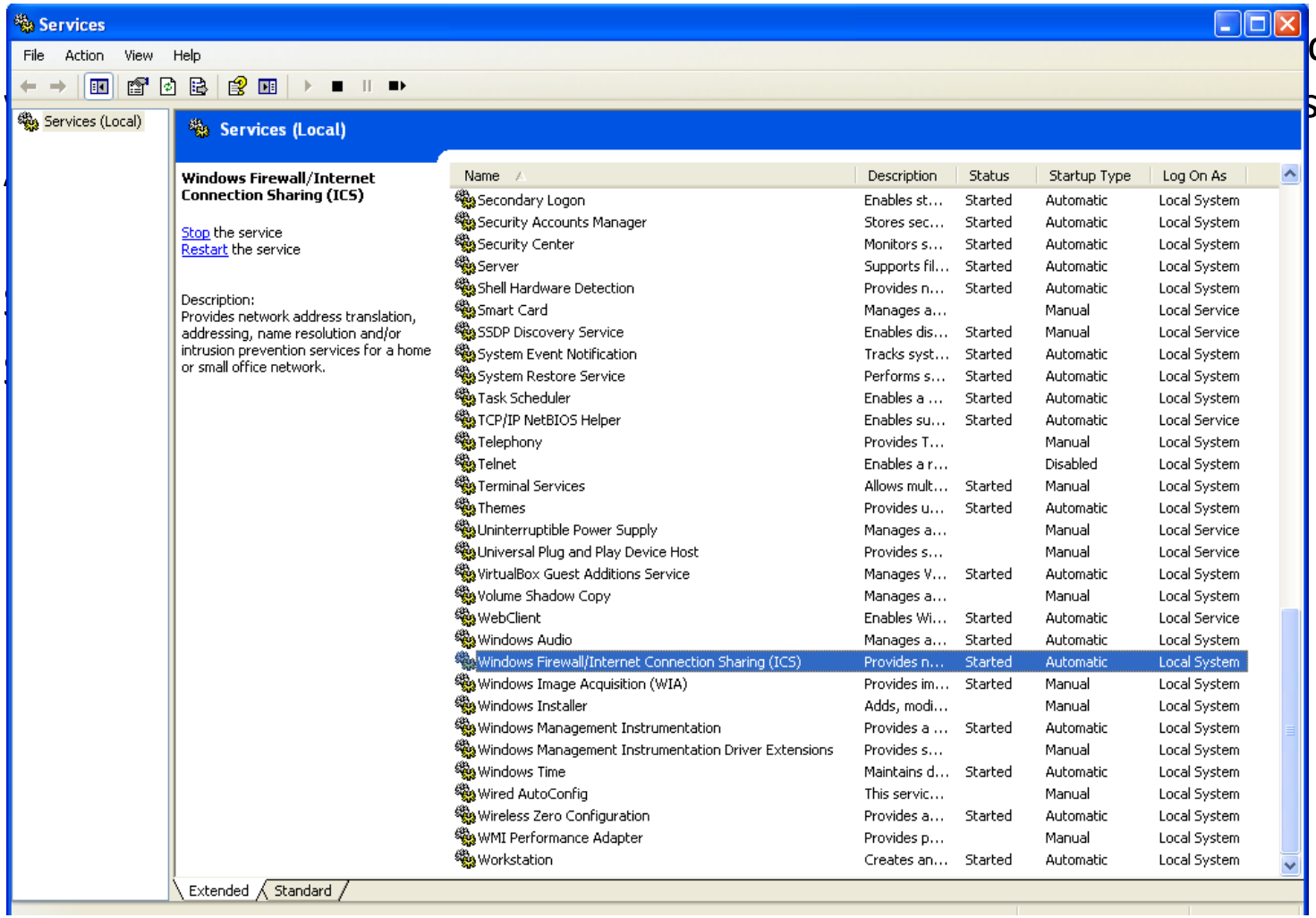


Windows Firewall – A short history

- Windows XP SP2
  - Firewall now runs as a service, and its functionality has been merged with Windows Internet Connection Sharing (ICS), a.k.a. SharedAccess
  - A more user-friendly GUI
    - The old interface is still available
  - Same developer interface as Windows 2000
  - Some more features were added (compared to Windows 2000)
    - Applications can be whitelisted
    - Rule groups
    - Rule scoping
    - Logging
    - Filtering ICMP traffic based on ICMP type
    - NAT (was a stand-alone service in Windows 2000)

Windows Firewall – A short history

- Windows XP SP2



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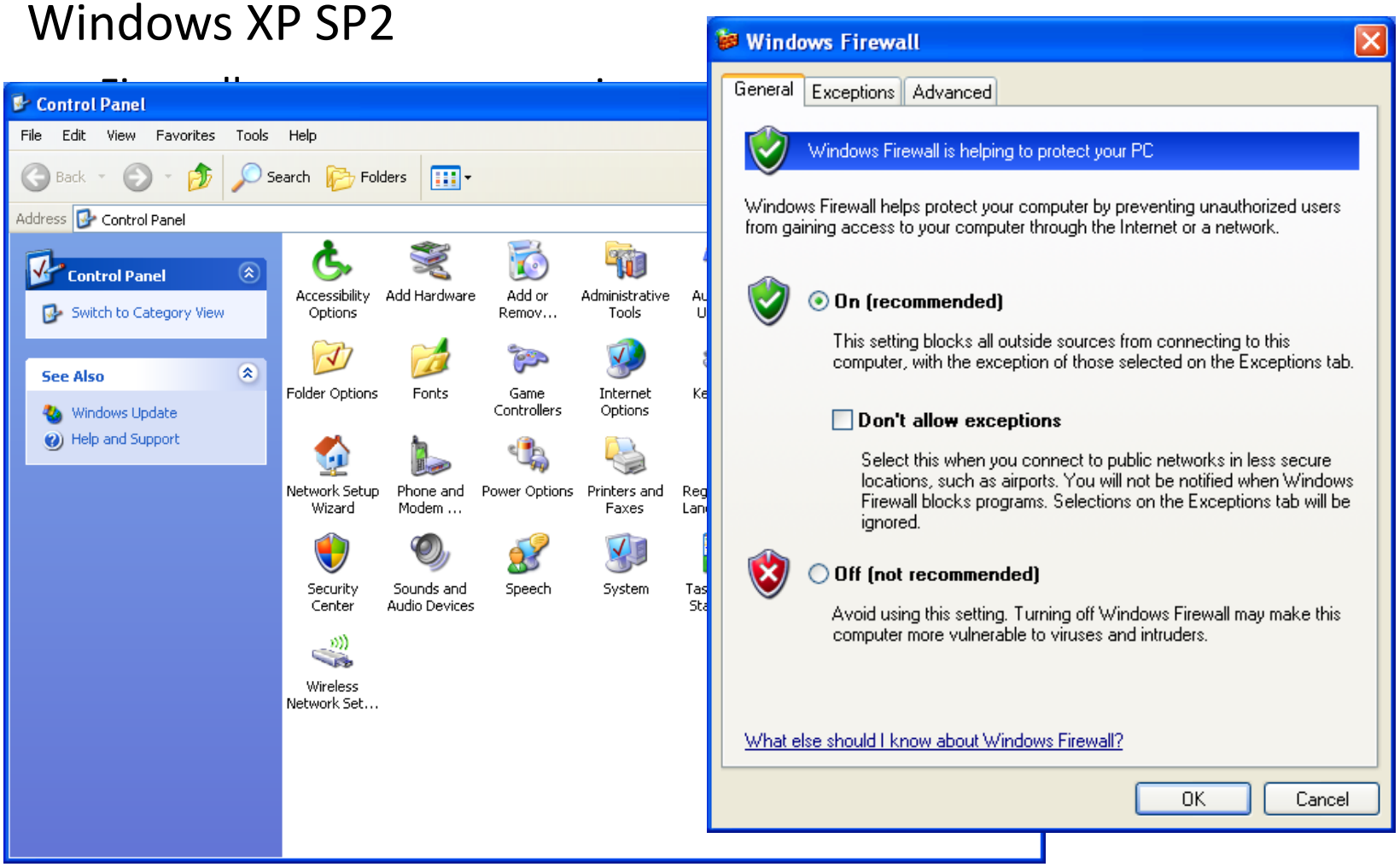

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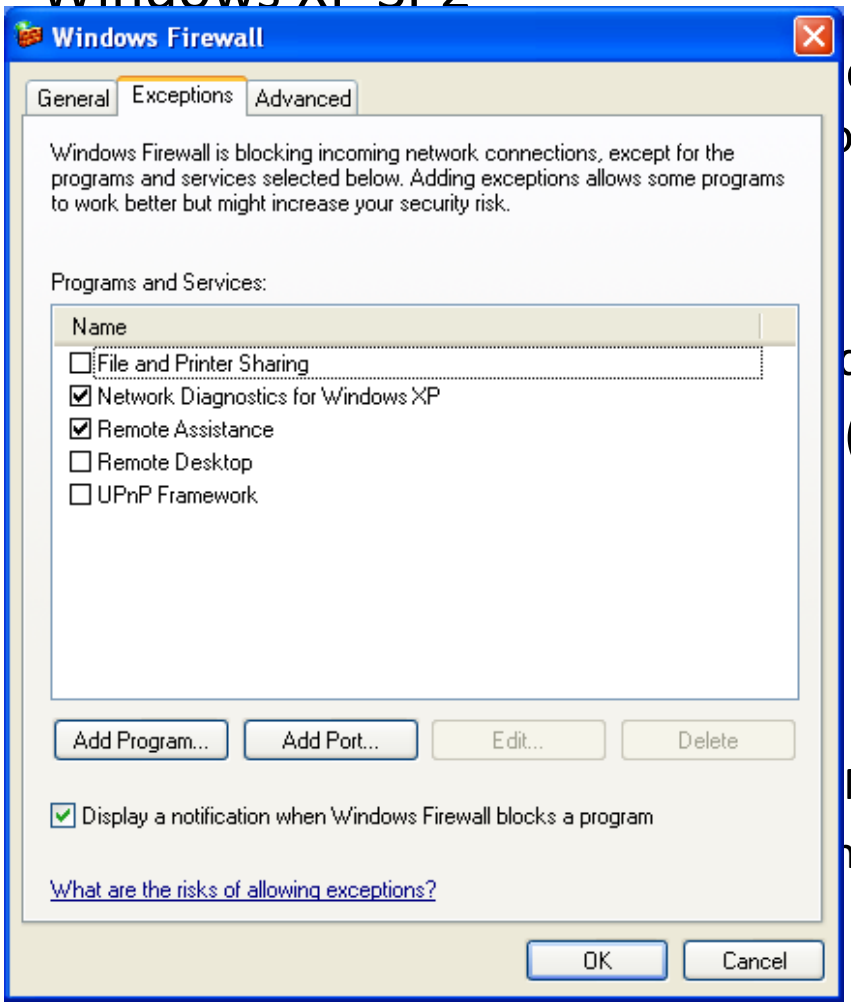

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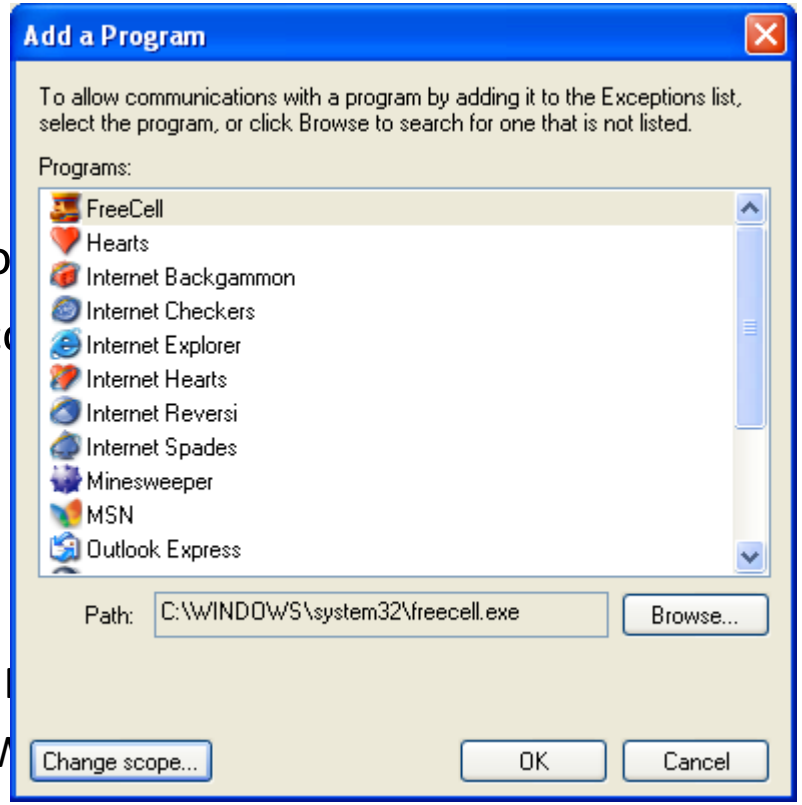

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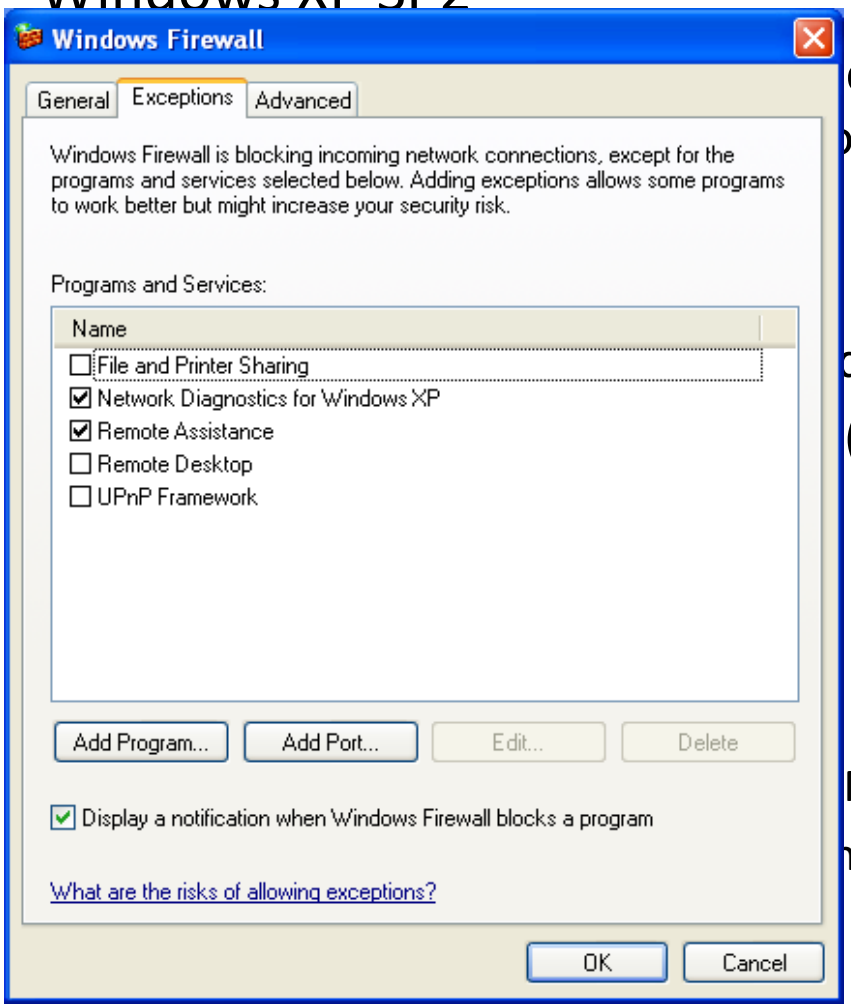

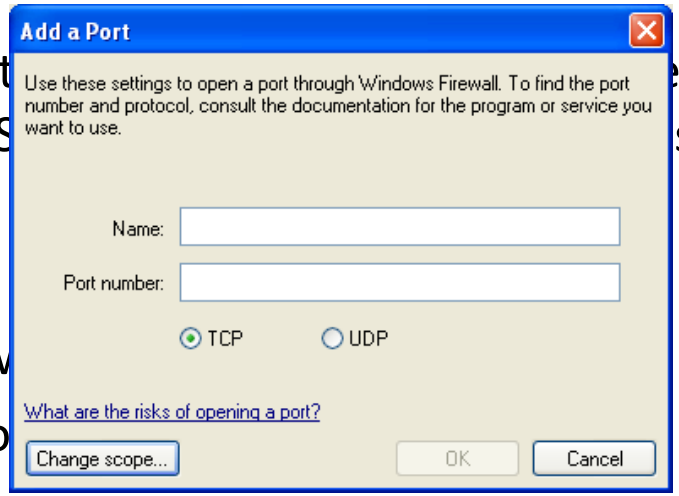

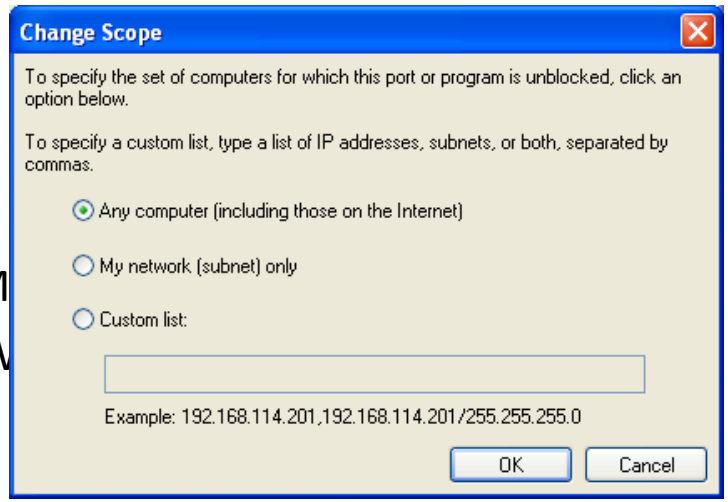

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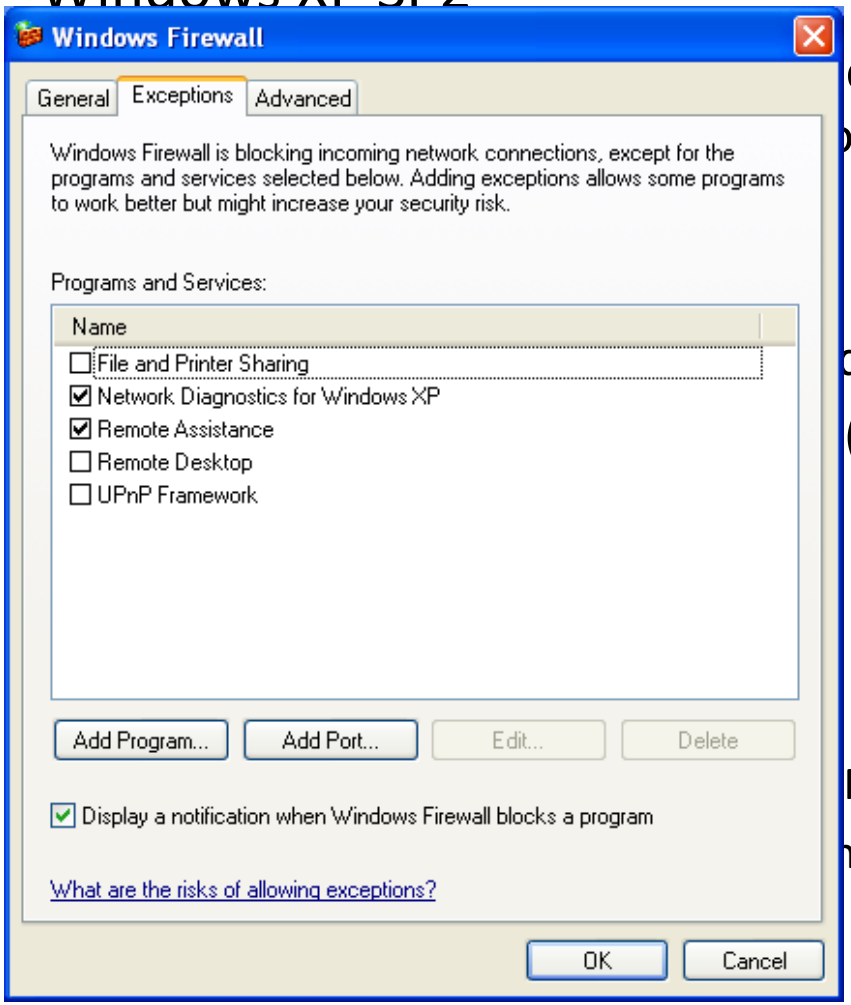

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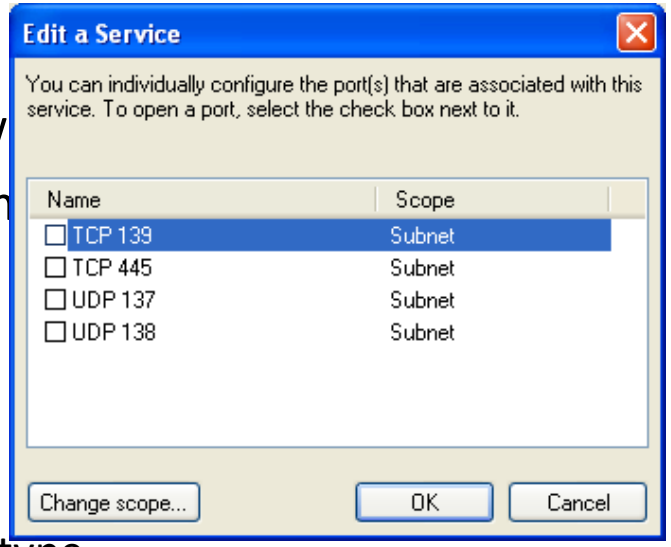

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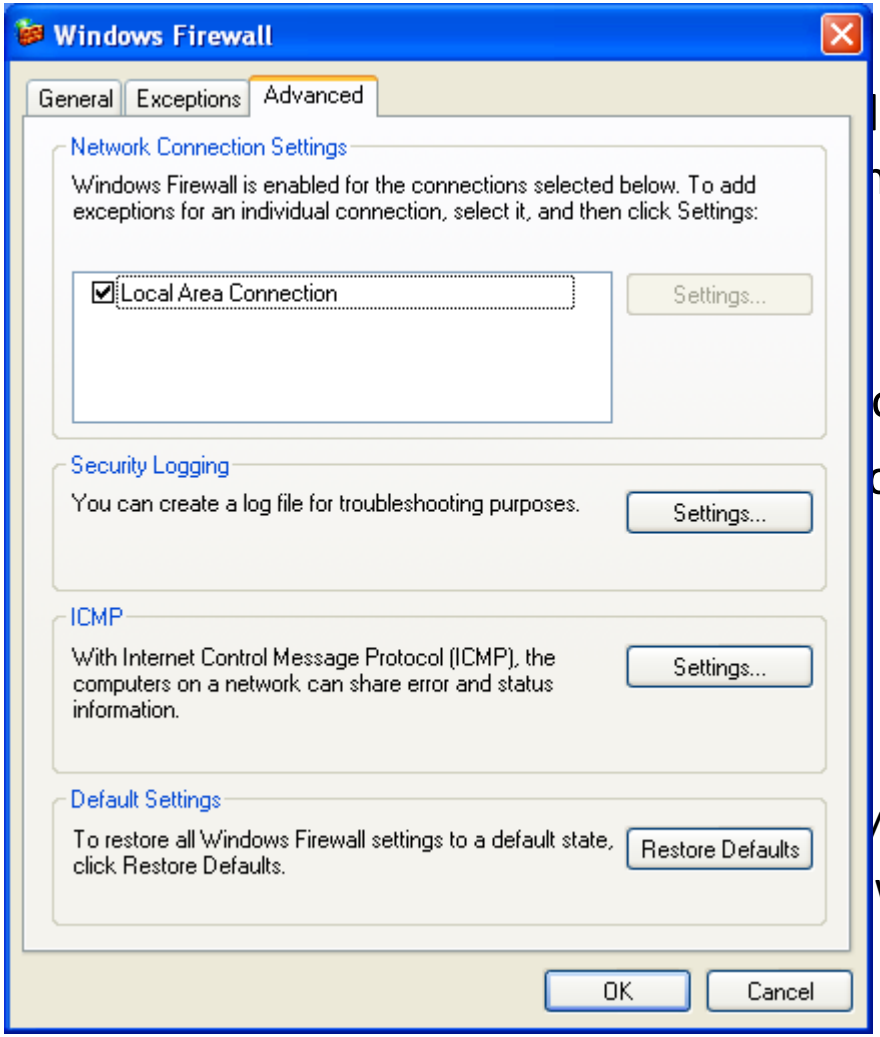
- 

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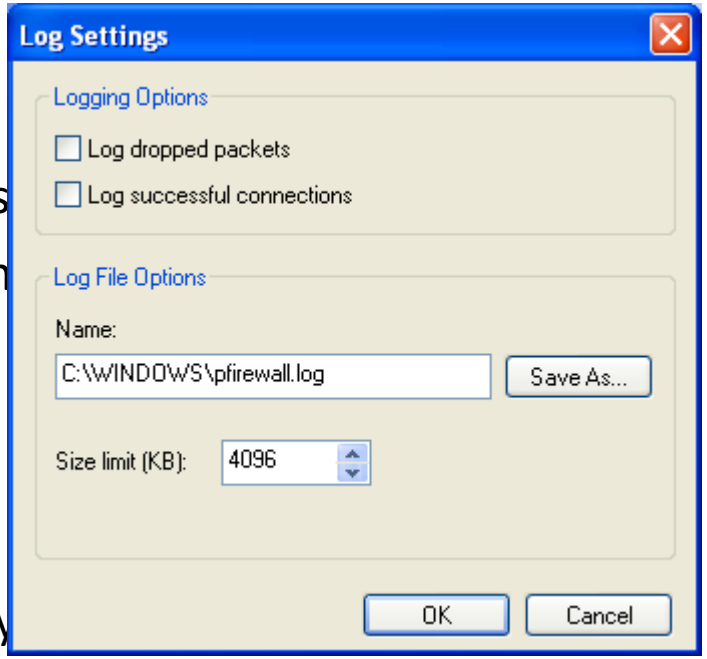

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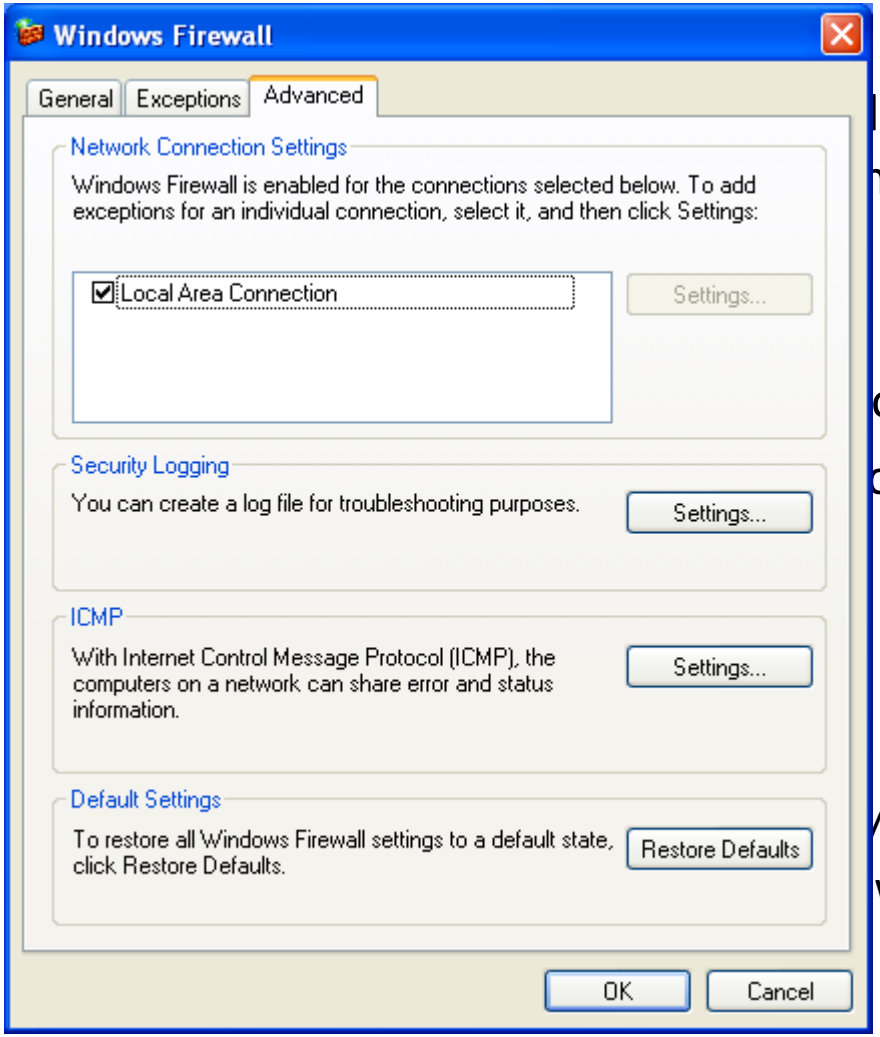
- 

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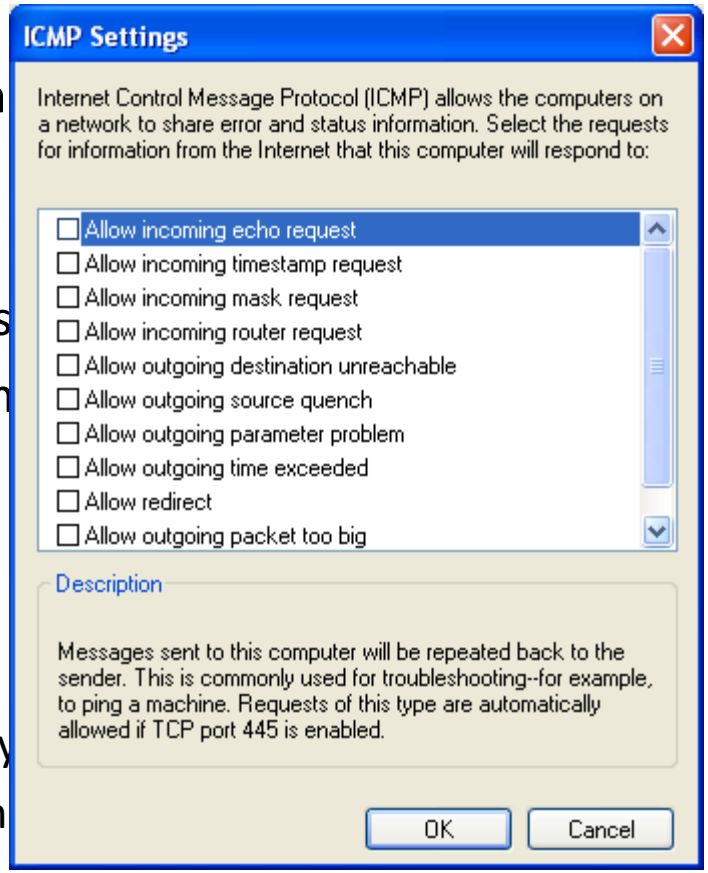

Windows Firewall – A short history

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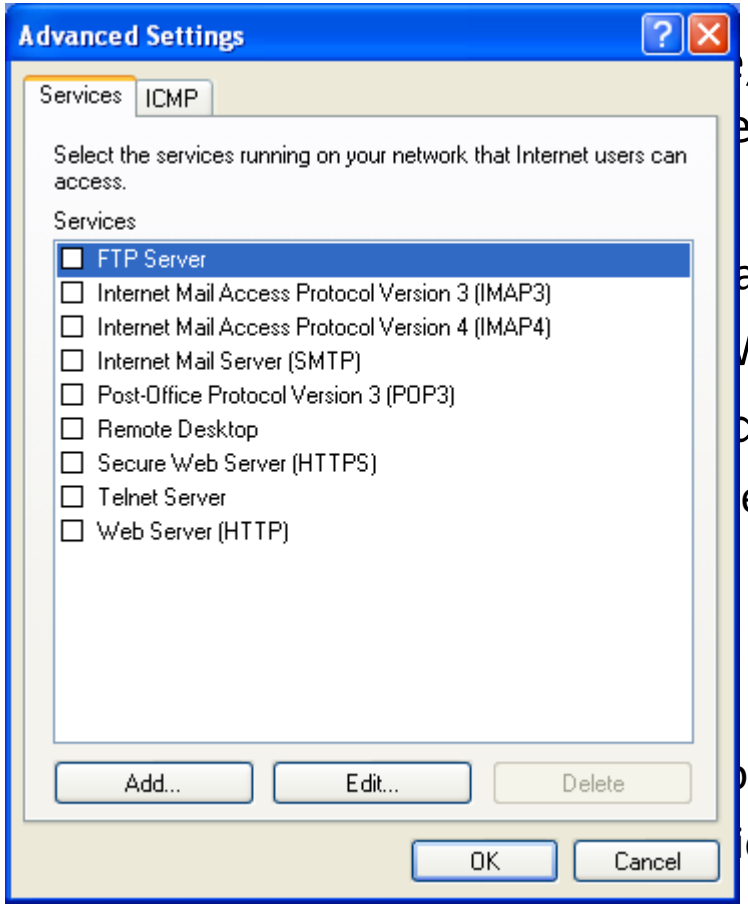

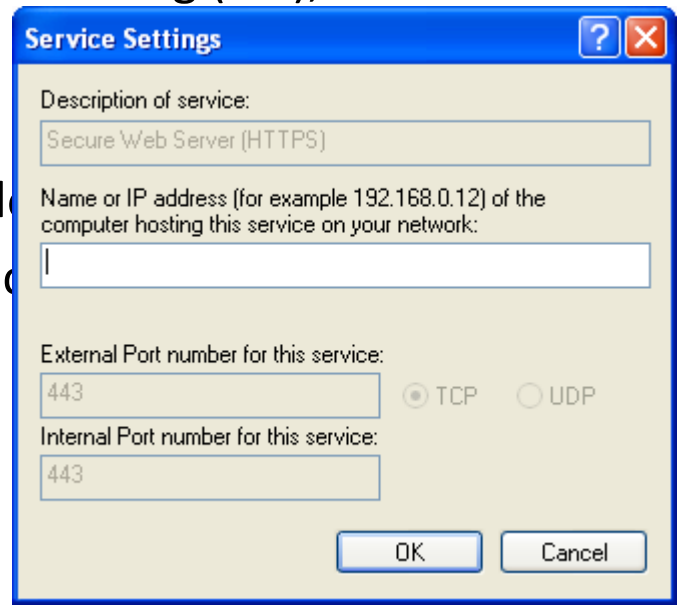

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Windows Firewall – A short history

- Windows XP SP2
  - Basic programmability via `netsh firewall`

```
C:\Documents and Settings\Admin>netsh firewall

The following commands are available:

Commands in this context:
?               - Displays a list of commands.
add             - Adds firewall configuration.
delete          - Deletes firewall configuration.
dump            - Displays a configuration script.
help            - Displays a list of commands.
reset           - Resets firewall configuration to default.
set             - Sets firewall configuration.
show            - Shows firewall configuration.

To view help for a command, type the command, followed by a space, and then type ?.


C:\Documents and Settings\Admin>netsh firewall add

The following commands are available:

Commands in this context:
add allowedprogram - Adds firewall allowed program configuration.
add portopening - Adds firewall port configuration.
```

THE PRESENT

UNDERSTANDING WINDOWS FIREWALL

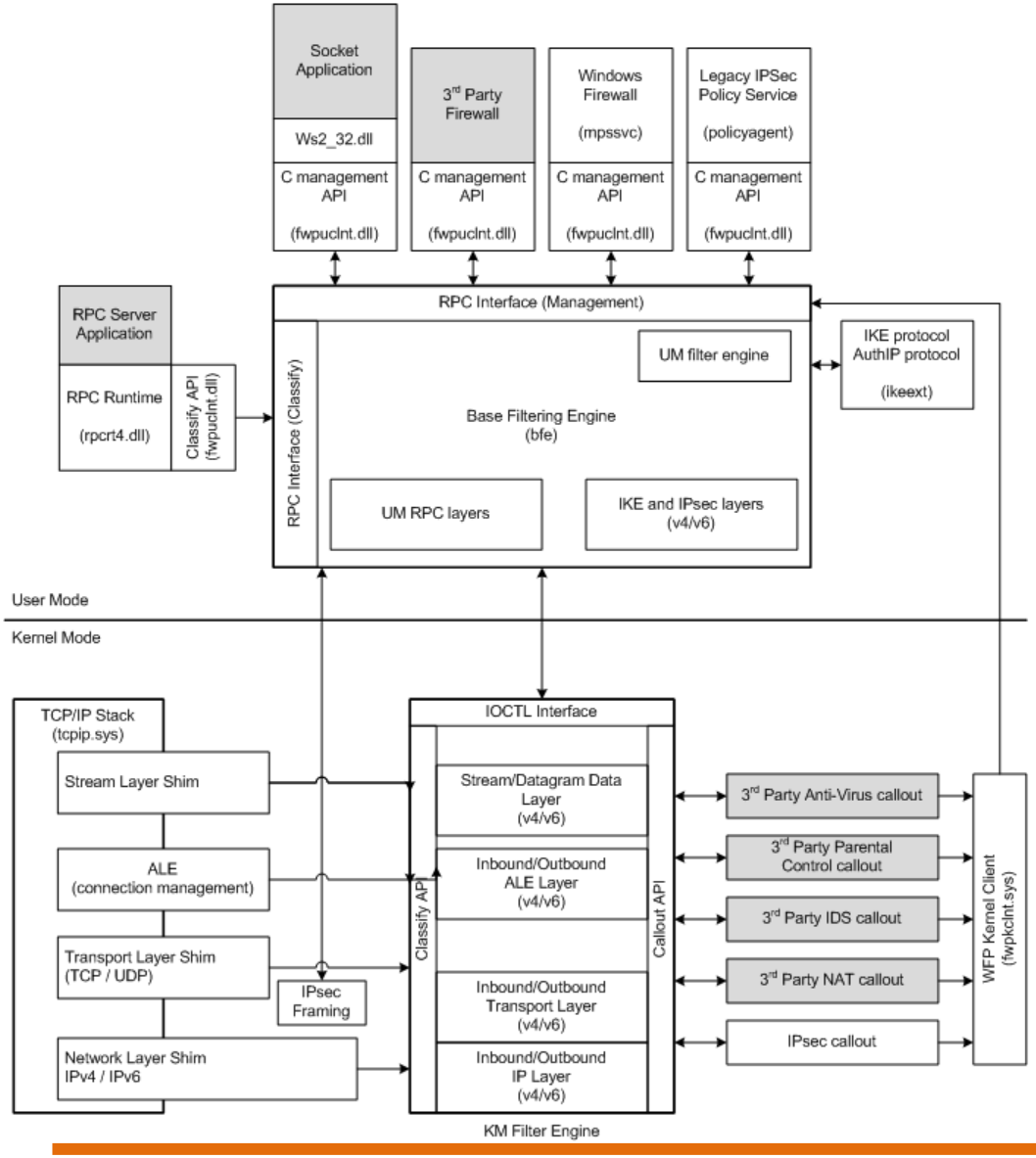
Windows Filtering Platform (WFP)

- Introduced in Windows Vista (and is still used today)
- Completely new architecture for packet filtering/manipulation
  - Supersedes all previous filtering methods
    - » Though many are (were) left available for backwards compatibility
  - Designed to be (more) future-proof
  - Modular and developer-friendly
- Implements state tracking for connections -> stateful firewall
- It is now possible to filter outgoing traffic

- Boot-time security
  - Boot-time filters are applied when tcpip.sys is loaded (kernel-level)
  - These filters drop everything except for DHCP and DNS (and Kerberos/SMB in case of domain-joined computers)
  - (It is possible to install additional boot-time filters if needed)

Windows Filtering Platform (WFP)

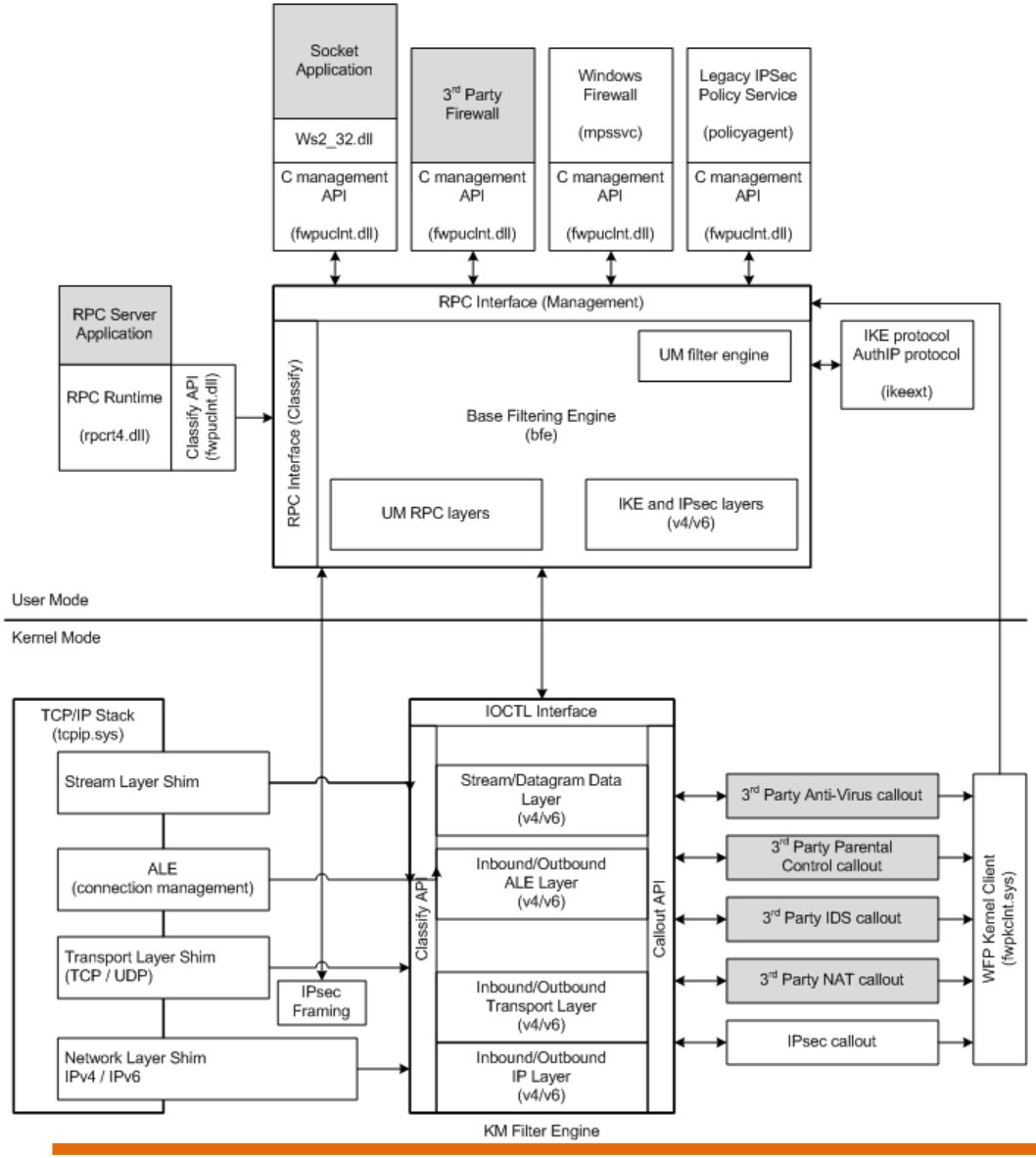
- Filter Engine
  - Two components:
    - » User-mode
    - » Kernel-mode
- Base Filtering Engine
  - User-mode component
  - Disables boot-time filters once started
  - Loads/unloads persistent and run-time filters
  - Stores filter configuration



Source: https://docs.microsoft.com/en-us/windows/desktop/fwp/windows-filtering-platform-architecture-overview

Windows Filtering Platform (WFP)

- Shims
  - Extract information from incoming/outgoing packets
  - Perform classification using the Filter Engine
    - » Filter arbitration (later…)
  - Handle packets according to classification results
    - » Permit
    - » Block
    - » Pass to callout



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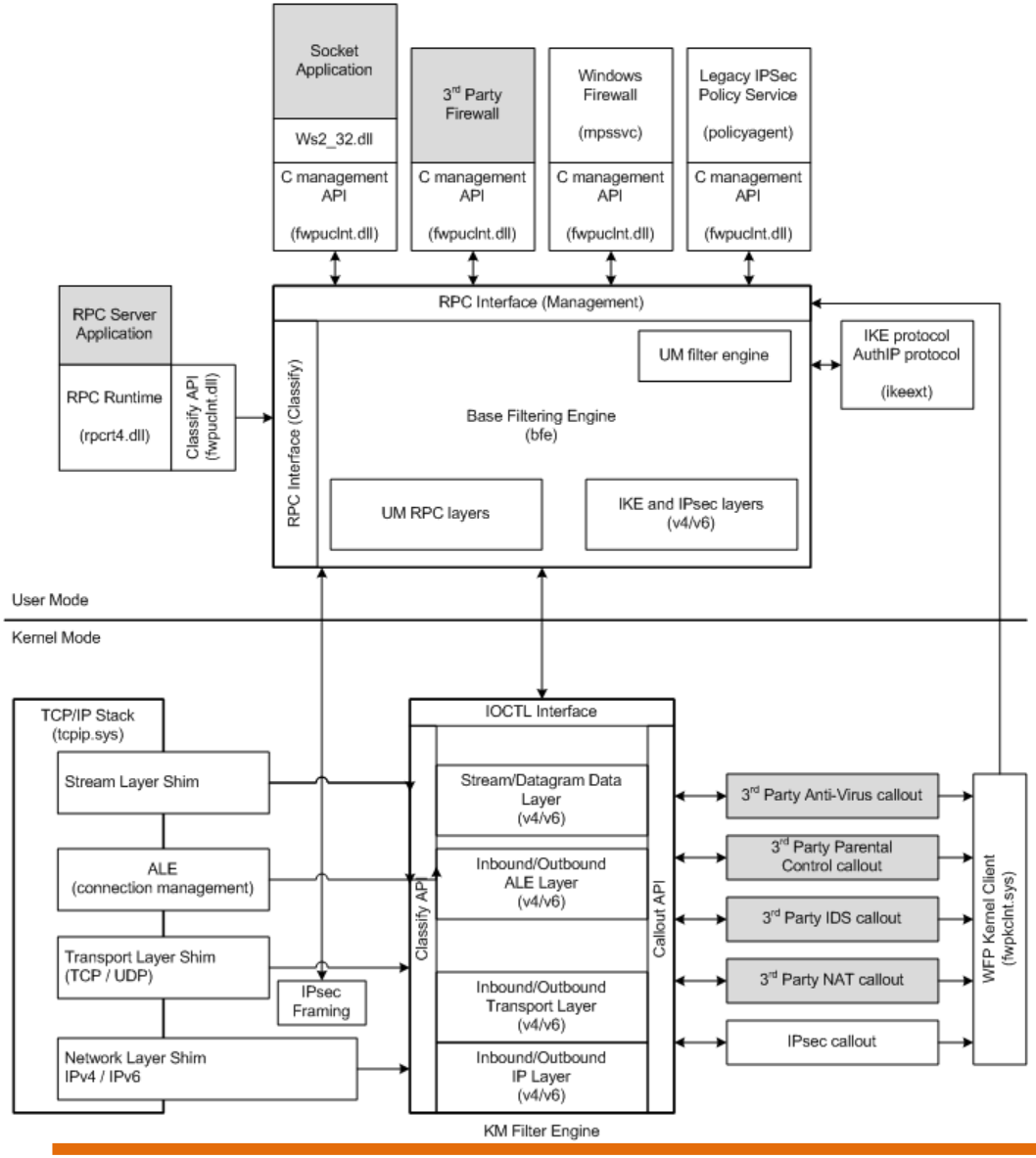
Windows Filtering Platform (WFP)

- Callouts
  - Callbacks that receive the entire packet for analysis or modification
    - » Permit
    - » Block
    - » Continue
    - » Defer
    - » Need more data
    - » Drop connection



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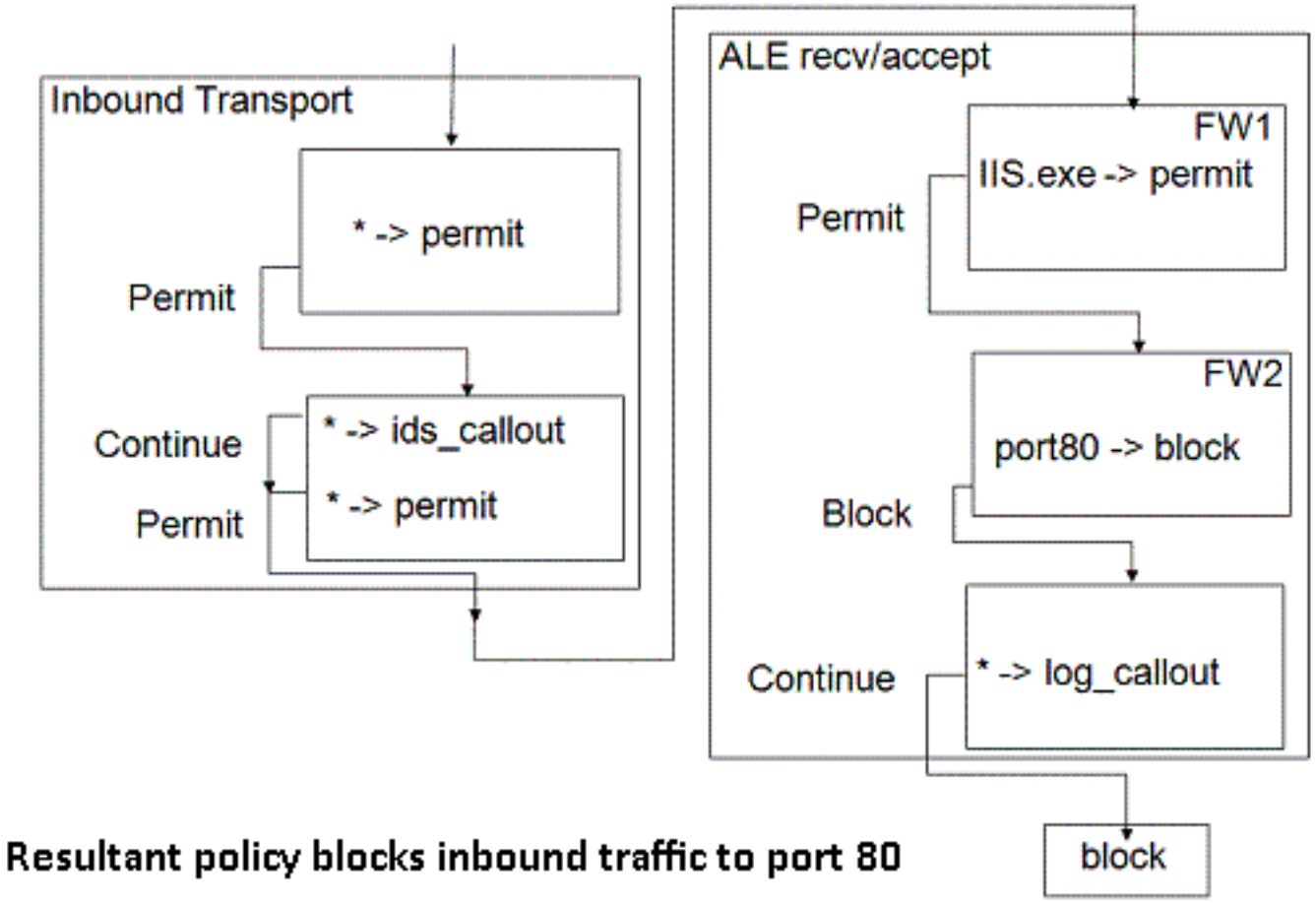
Windows Filtering Platform (WFP)

- Filter arbitration (rules of evaluation)
  - Filters are evaluated in a pre-determined order
  - For each filter layer, sub-layers may be registered
    - » Sub-layers have a priority (weight) value (assigned by the developers)
      - Higher priority = earlier evaluation
  - Sub-layers consist of rules
    - » Rules are also weighted
    - » Block / Permit stops the evaluation within the current sub-layer
    - » The verdict can be flagged as a 'hard' result (hard block, hard permit)
  - Evaluation continues through all the sub-layers, even if a higher priority one determines that the input should be Blocked
    - » Soft permit < Soft block < Hard permit < Hard block ('Veto')
    - » Overriding a hard permit with a hard block generates an audit event
      - But if the hard block comes first, the hard permit is silently ignored
    - » The 'hardness' flag is cleared at the ends of layers

Windows Filtering Platform (WFP)



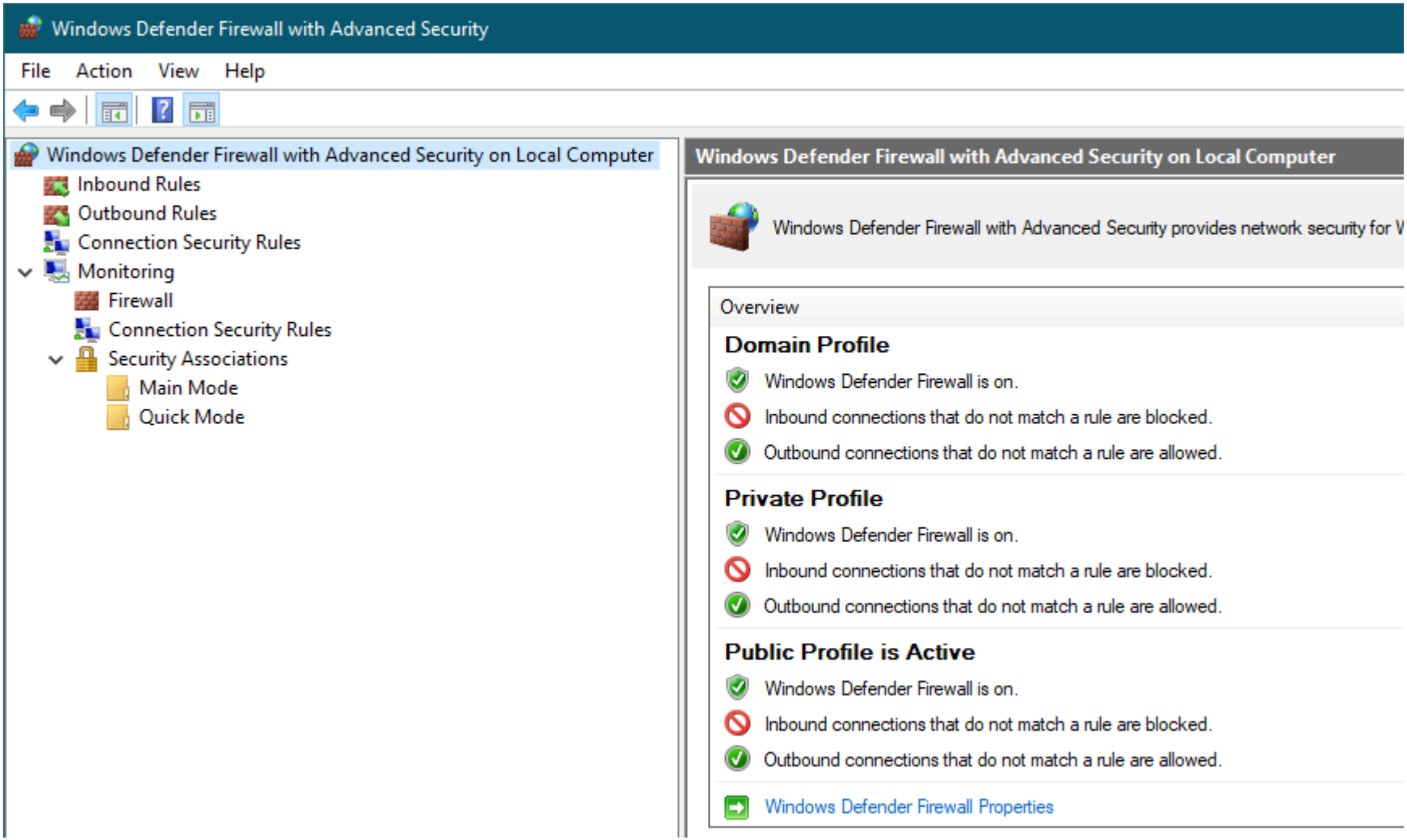
Resultant policy blocks inbound traffic to port 80

Source: https://docs.microsoft.com/en-us/windows/desktop/fwp/filter-arbitration

Windows Firewall with Advanced Security

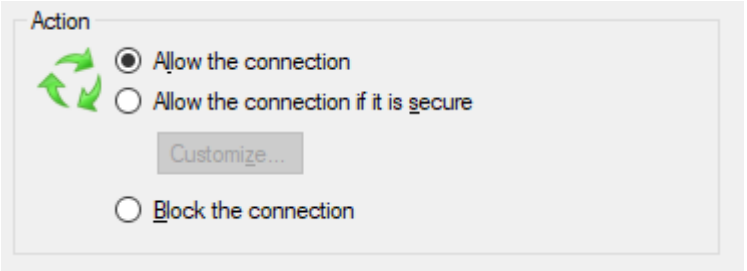
- The built-in firewall in Windows Vista and onwards
  - Renamed to Windows (Defender) Firewall with Advanced Security
- Split in two
  - Internet Connection Sharing (SharedAccess) – NAT functionality
  - Windows Firewall (MpsSvc) – Firewall functionality
    - » Renamed to Windows **Defender** Firewall in Windows 10, update 1709
- Relies on the Windows Filtering Platform
- Programmable
  - `netsh advfirewall`
  - PowerShell (Windows 8/Server 2012 and later versions)

Windows Firewall with Advanced Security

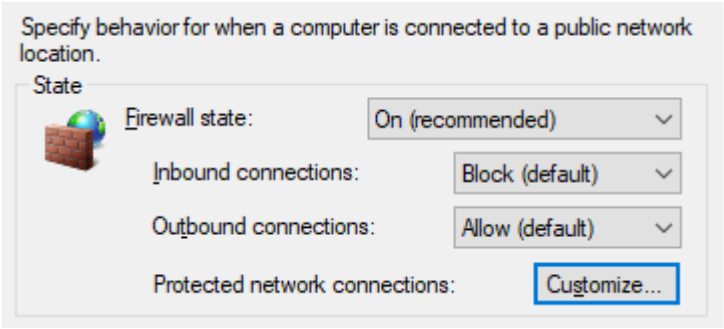


Windows Firewall with Advanced Security

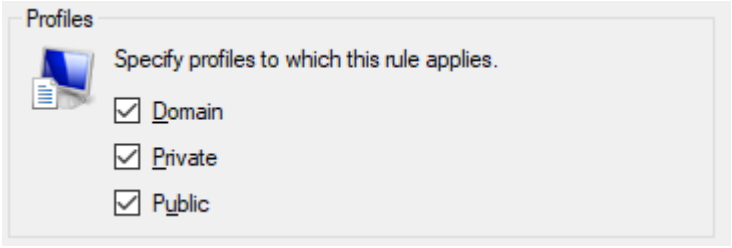
- Two (three) actions: Block and Allow (if secure)
  - Block overrides Allow
  - There is no 'Reject' (like in *iptables*)



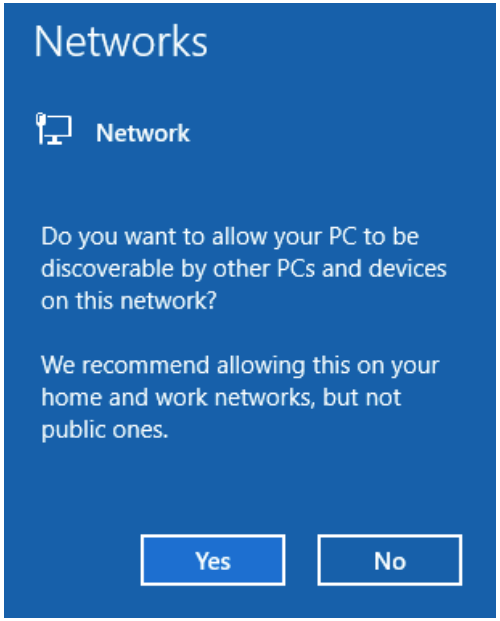
- Direction-based filtering
  - Inbound (default: block)
  - Outbound (default: allow)



Windows Firewall with Advanced Security

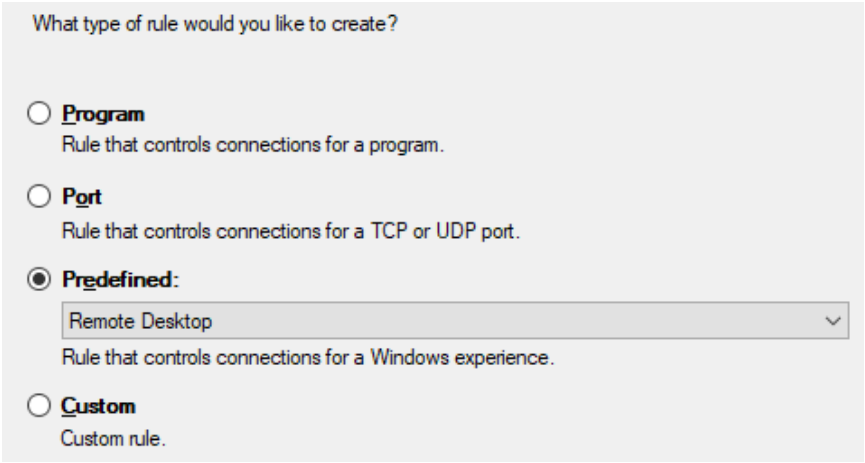


- Profile-based filtering
  - Rules belong to 1..3 profiles
  - Domain: for connections to and from the Active Directory domain network of which this computer is a member of
  - Private: networks the user declared private
    - » Recommended for home or non-domain work networks
  - Public: networks the user declared public
    - » Recommended for untrusted networks, such as hotel or airport WiFi networks



Windows Firewall with Advanced Security

- Predefined rule groups
  - Make it easier to add rules for typical use-cases
  - Good for less tech-savvy users



- Rules can be enabled/disabled
  - Useful for debugging

- It is possible to Export/Import firewall configuration
  - Useful when migrating or for backup before a major reconfiguration

EXAMPLES

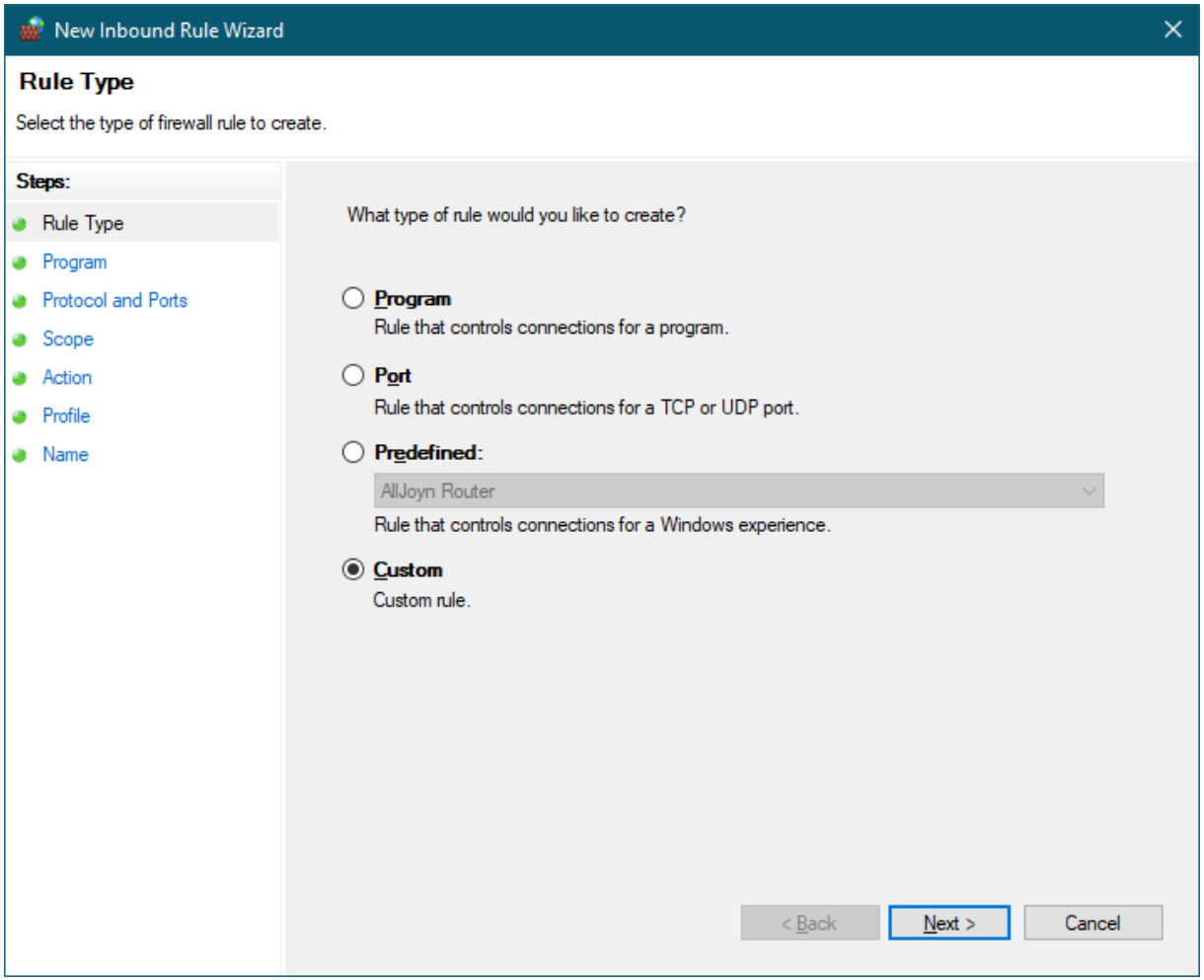
MANAGING WINDOWS FIREWALL

Managing Windows Firewall

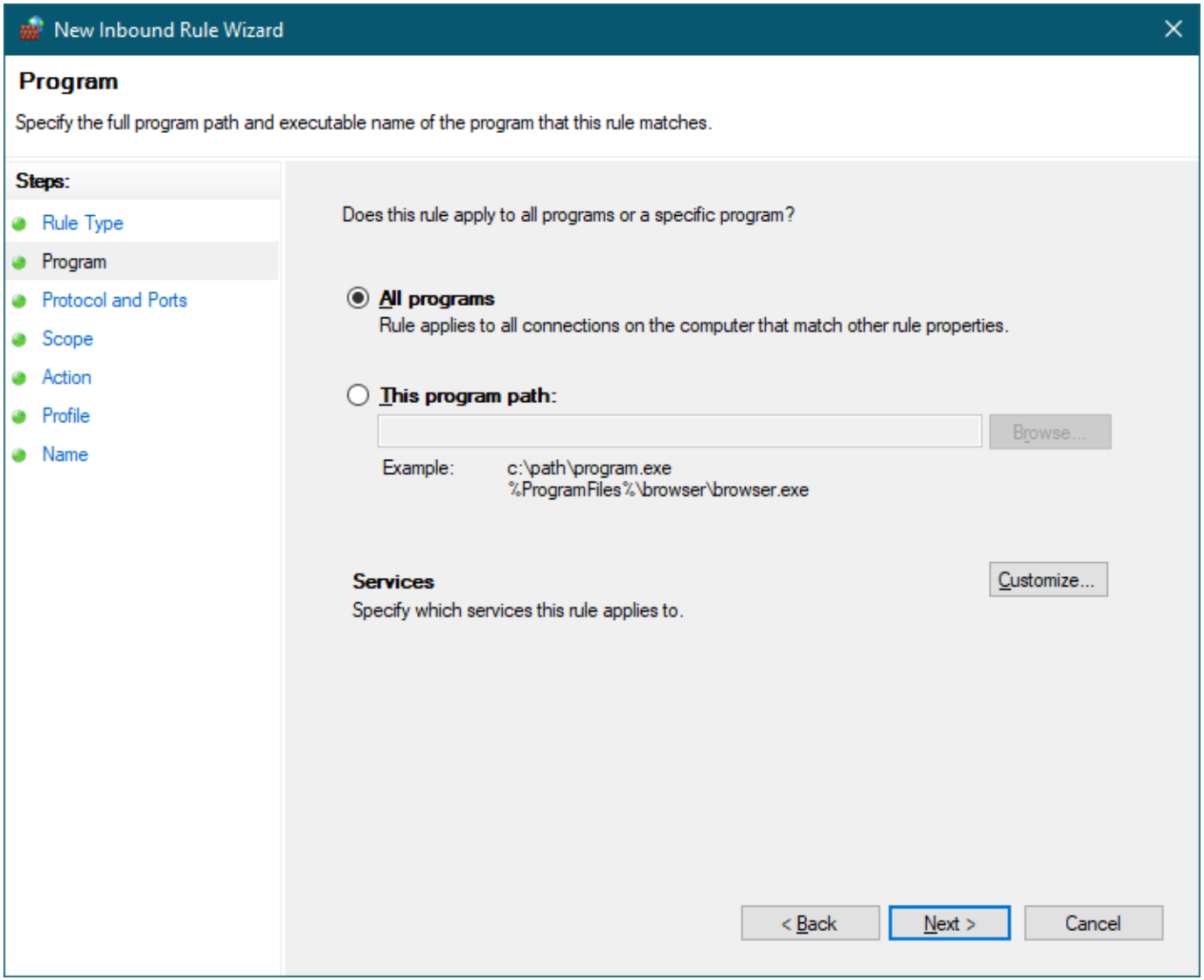
- The practical session begins here
- Further slides are only provided for reference, ~~mainly for those who could not attend~~

Management via the GUI

- Most easily launched via 'wf.msc'



Management via the GUI



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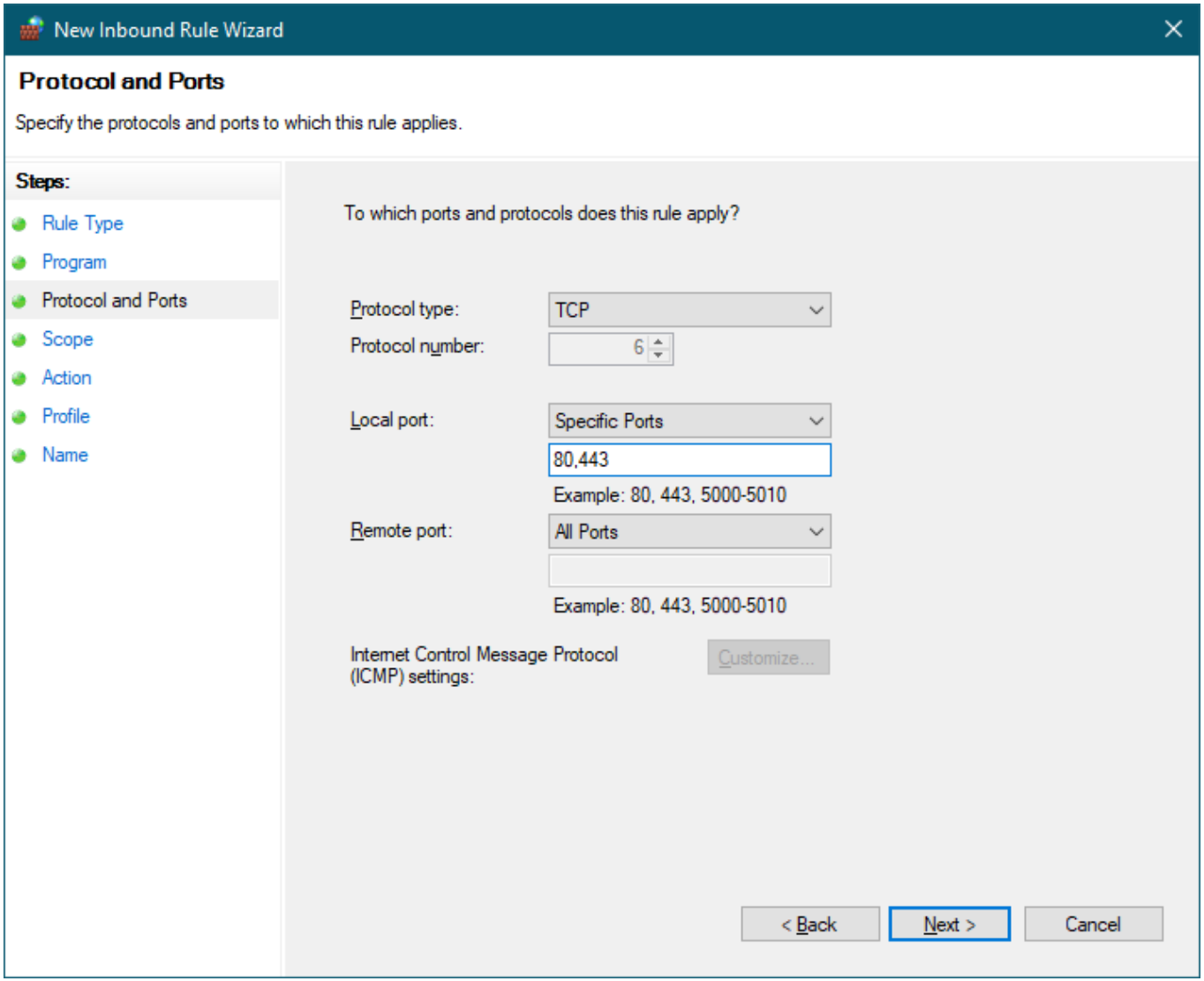

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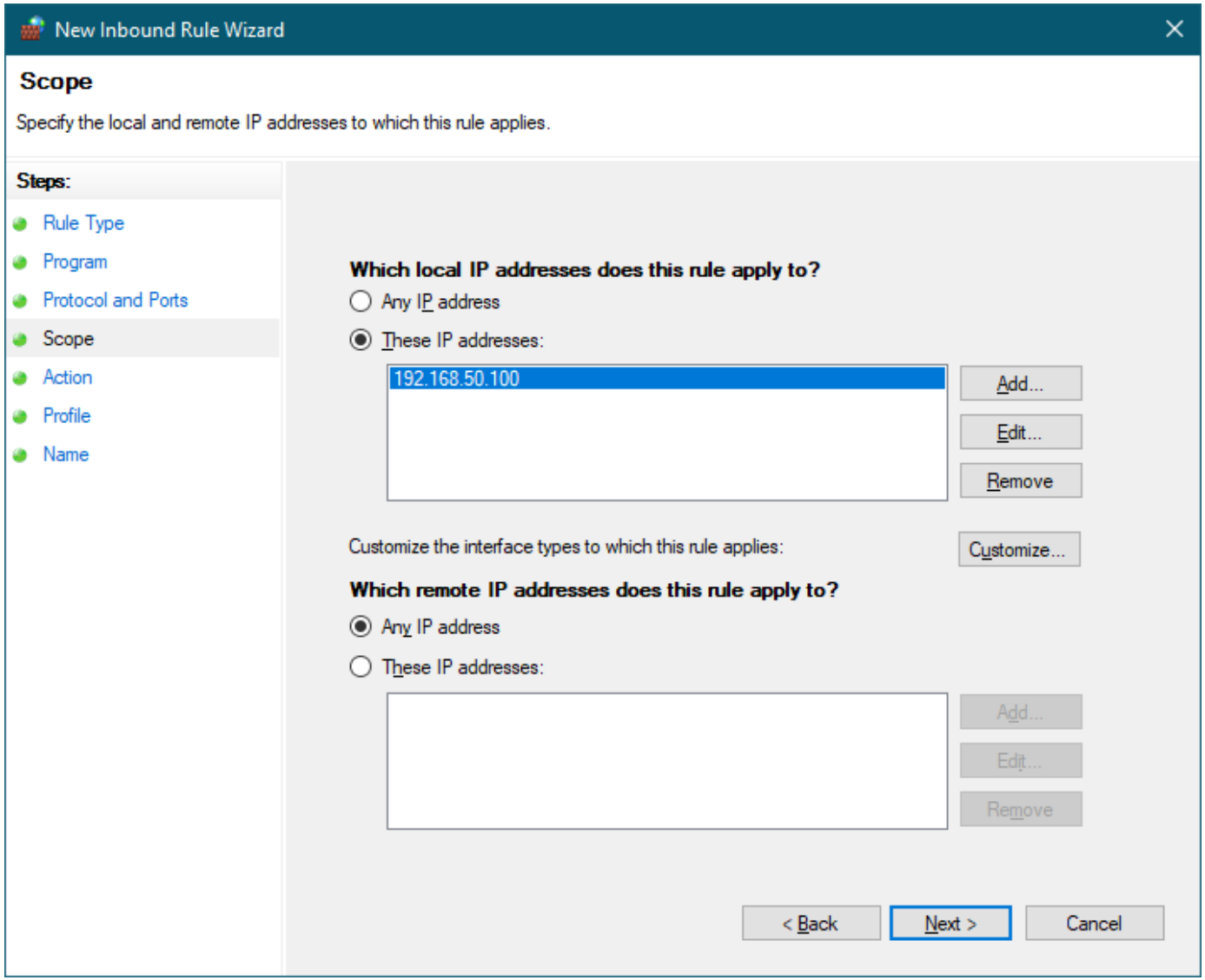

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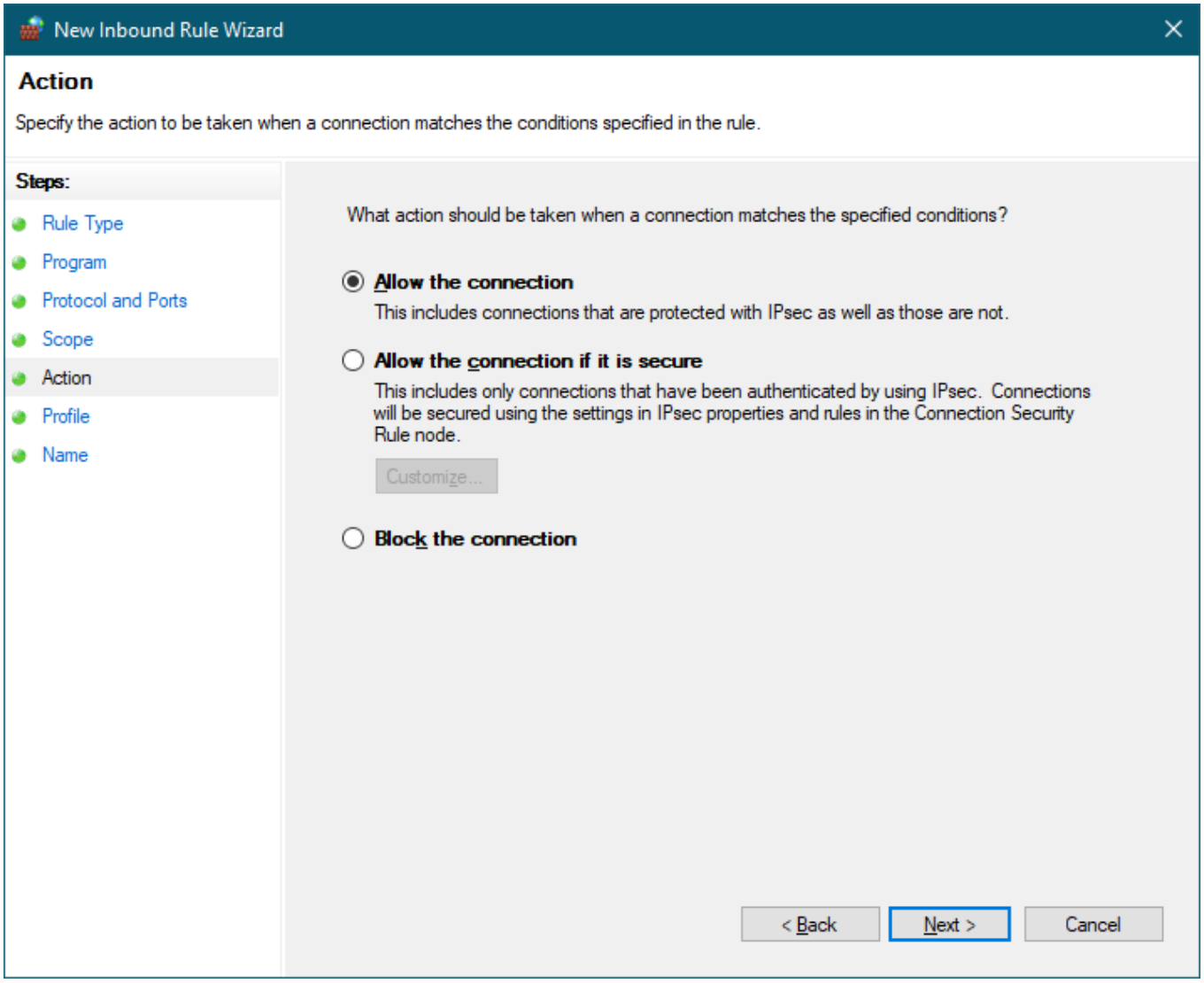

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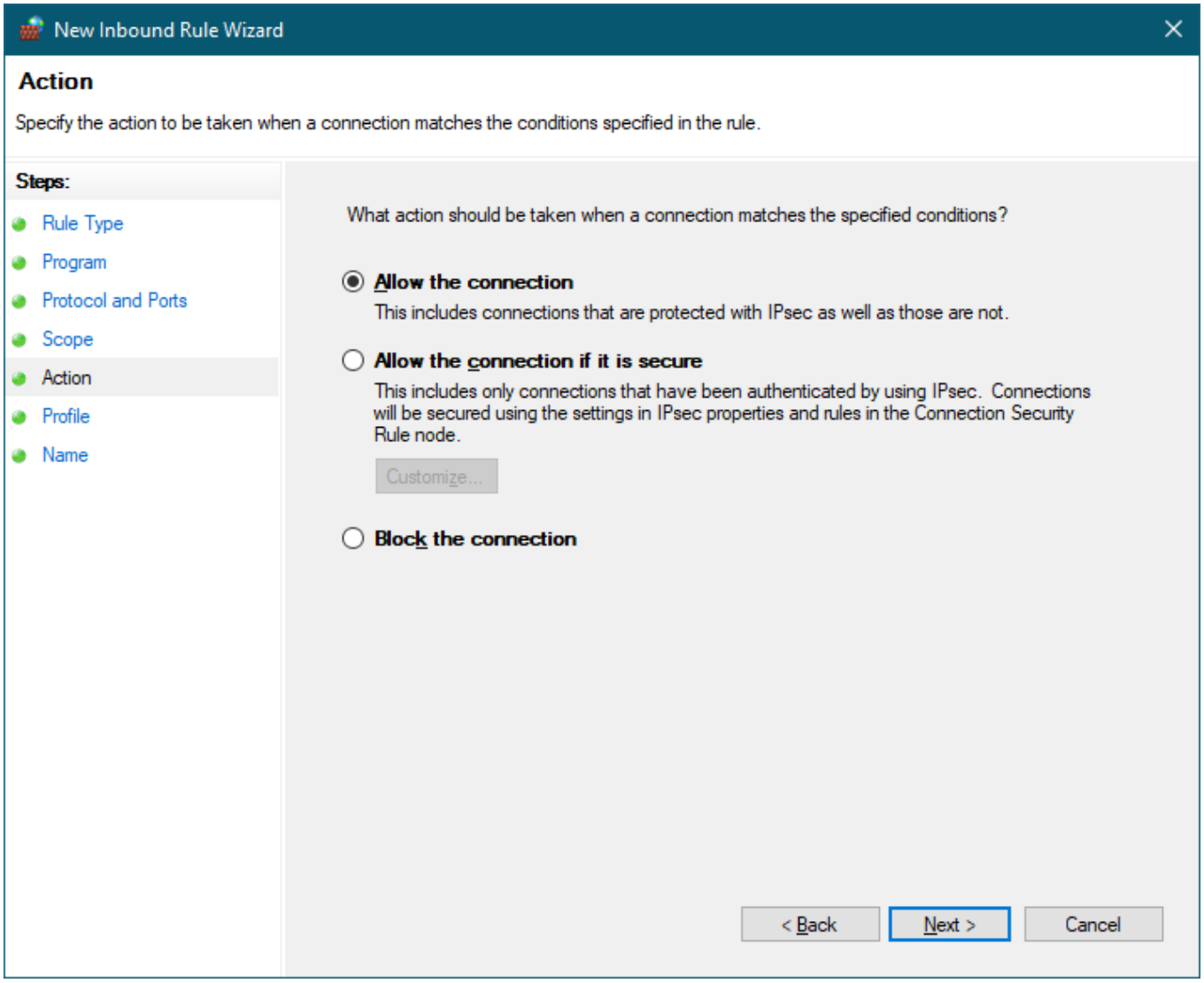

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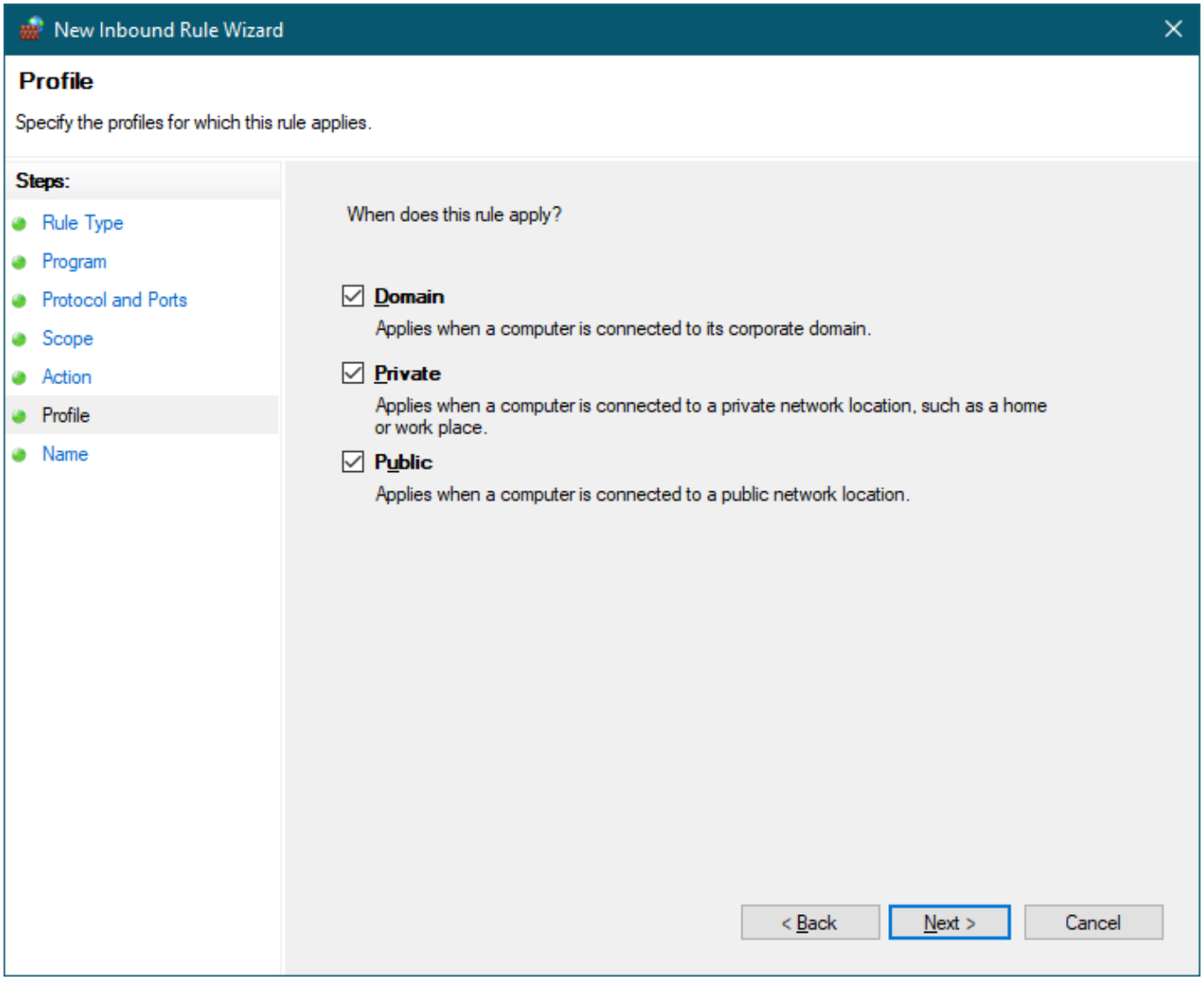

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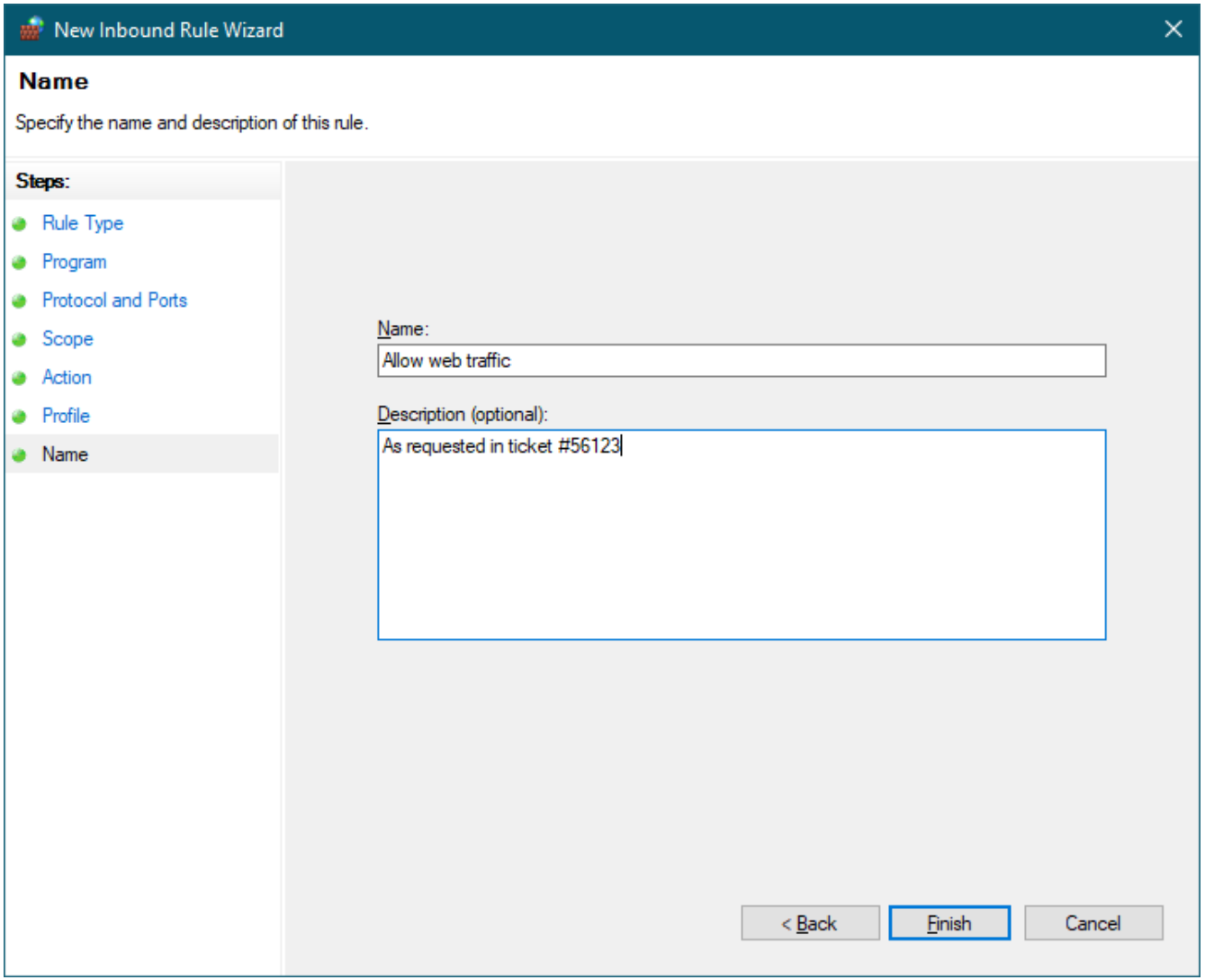

Management via netsh

- `netsh advfirewall firewall add rule name="Allow web traffic in" localport=80,443 protocol=TCP dir=in action=allow`

- `netsh advfirewall firewall show rule name="Allow web traffic in"`

```
Rule Name:                            Allow web traffic in
----------------------------------------------------------------------
Enabled:                              Yes
Direction:                            In
Profiles:                             Domain,Private,Public
Grouping:
LocalIP:                              Any
RemoteIP:                             Any
Protocol:                             TCP
LocalPort:                            80,443
RemotePort:                           Any
Edge traversal:                       No
Action:                               Allow
Ok.
```

- `netsh advfirewall firewall delete rule name="Allow web traffic in"`

Management via Powershell

- `New-NetFirewallRule -DisplayName "Allow web traffic in" -Direction Inbound -Enabled True -Action Allow -Protocol TCP -LocalPort 80,443`

- `Get-NetFirewallRule -DisplayName "Allow web traffic in"`

```
Name                  : {c4a4b5f9-41f3-47e8-8959-8d714e04e3ef}
DisplayName           : Allow web traffic in
Description           :
Group                 :
Enabled               : True
Profile               : Any
Direction             : Inbound
Action                : Allow
EdgeTraversalPolicy   : Block
PrimaryStatus         : OK
Status                : The rule was parsed successfully from the store. (65536)
PolicyStoreSource     : PersistentStore
PolicyStoreSourceType : Local
```

- `Get-NetFirewallRule -DisplayName "Allow web traffic in" | Remove-NetFirewallRule`

TASKS

MANAGING WINDOWS FIREWALL

Tasks

- Set up the virtual machines
  - Create two VMs from the .ova provided
  - Name one of them 'client', the other, 'server'
  - Make sure they're assigned to the same internal network
  - Start the machines
- Set up the client and the server
  - Server
    - » IP address: 10.10.100.200/24
    - » Start the DNS server service: sc start DNS
  - Client
    - » IP address: 10.10.100.1/24
    - » DNS server: 10.10.100.200

Tasks

- Try pinging the server from the client (ping 10.10.100.200 -t)
  - Why isn't it working?
- Check the firewall rules on the server
  - Familiarize yourself with the GUI
  - Enable File and Printer Sharing (Echo Request – ICMPv4-In)
  - What profile is this enabled for?
- Delete all incoming and outgoing firewall rules
- Disable the firewall on the client

Tasks

- Allow some incoming ICMP traffic
  - Only from within the subnet 10.10.100.0/24
  - Only the following ICMP types
    - » Packet Too Big
    - » Destination Unreachable
    - » Source Quench
    - » Echo Request
    - » Time Exceeded
- Can you ping the server now?
- Start pinging the client from the server (use -t)

Tasks

- Set the firewall to block all outgoing traffic (unless allowed)
  - Can you still ping the server?
  - Can you still ping the client?
- Set the firewall to explicitly block all outgoing ICMP traffic
  - Can you still ping the server?
  - Can you still ping the client?
- Key take-away: outgoing packets belonging to an allowed connection are NOT affected by blocking rules
  - How does this compare to allowing such traffic using iptables?

Tasks

- Start pinging the server from itself
  - In one window, use 127.x.y.z
  - In another, use 10.10.100.200
- What's happening?

- Key take-away: traffic to and from loopback addresses and local IP addresses is not filtered by Windows Firewall
  - How does this compare to allowing such traffic using iptables?

Tasks

- Start Lighttpd on the server
- Load http://www.mysite.local on the client
  - It's not working… what could be the problem?
  - Load it on the server… it works!

- Maybe something needs to be permitted through the firewall?
  - Turn on logging to see what's happening
    - » Apparently, UDP 53 is important for some reason…
  - Allow UDP 53
- How about now?
  - Of course, we need TCP 80…
  - Allow TCP 80
- Yey!

Tasks

- Stop Lighttpd
- Start IIS
  - Can you see IIS's welcome page?

- Modify the rule that permits TCP 80 to permit only Lighttpd to accept connections
  - Can you still see IIS's welcome page?

- Stop IIS
- Start Lighttpd
  - Can you see Lighttpd's welcome page?

Tasks

- Attempt to access the C$ admin share on \\10.10.100.200
  - Are you successful?
- Allow SMB access using the premade rules wizard
  - Are you successful now?

Tasks

- On the server, delete the rule that allows incoming DNS traffic
- On the client, try resolving www.mysite.local using *nslookup*

- Using netsh, add a rule that allows incoming DNS traffic
  - `netsh advfirewall firewall add rule name="Allow DNS in" localport=53 protocol=udp dir=in action=allow`
- Was it added successfully?
  - Check it using netsh
    - » `netsh advfirewall firewall show rule dir=in name=all`
  - Check it using the GUI
  - Try nslookup again
- Delete the rule using netsh
  - `netsh advfirewall firewall delete rule name="Allow DNS in"`
  - Try nslookup again

Tasks

- Again, add a rule that allows inbound DNS traffic
  - This time, use Powershell
  - `New-NetFirewallRule -DisplayName "Allow DNS in" -Protocol UDP -LocalPort 53 -Direction Inbound`
- Verify that it was added
  - `Get-NetFirewallRule -DisplayName "Allow DNS in"`
  - Use the GUI
  - Use nslookup
- Delete the rule using Powershell
  - `Get-NetFirewallRule -DisplayName "Allow DNS in" | Remove-NetFirewallRule`

Tasks

- Export the current firewall configuration to *backup.wfw*
- Delete all inbound rules
  - Ooops…
- Restore configuration using the backup

- Optional, if time permits
  - Add a rule using the Local Group Policy Editor and see how it appears, whether you can edit/delete it
  - Observe what you can see in Event Viewer for the Windows Firewall

MISCELLANEOUS

Further Reading

- Kamel Messaoudi: Network traffic filtering technologies for Windows
  https://briolidz.wordpress.com/2011/12/20/network-traffic-filtering-technologies-for-windows/
- NDIS-hooking drivers and legacy Windows systems
  http://omegadroid.co/wanted-knox-void-warranty-0x1/

- About Windows Filtering Platform
  https://docs.microsoft.com/en-us/windows/desktop/fwp/about-windows-filtering-platform
- Filter Arbitration
  https://docs.microsoft.com/en-us/windows/desktop/fwp/filter-arbitration

Windows Firewall with Advanced Security

File Action View Help

Windows Firewall with Advanc
- Inbound Rules
- Outbound Rules
- Connection Security Rules
- Monitoring

Inbound Rules

Name	Group	Profile	Enabled	Action	Override	Program
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.2717\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3182\Agent.exe
Battle.net Update Agent		Private	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.2816\Agent.exe
Battle.net Update Agent		Private	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.2816\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.2816\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3182\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3372\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3372\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3634\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.beta.2638\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.beta.2638\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.beta.2680\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.beta.2680\Agent.exe
Battle.net Update Agent		Private	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3715\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.beta.2581\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.beta.2514\Agent.exe
Battle.net Update Agent		Private	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3715\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.beta.2581\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.2689\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3109\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3023\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3023\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3109\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.2880\Agent.exe
Battle.net Update Agent		Private	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.2880\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.2689\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.2880\Agent.exe
Battle.net Update Agent		Private	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.2880\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3688\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3688\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.beta.2426\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.beta.2426\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3669\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3668\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3634\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3669\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3668\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3689\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3689\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3715\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.beta.2514\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3715\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3147\Agent.exe
Battle.net Update Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.3147\Agent.exe
Blizzard Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.1040\Agent.exe
Blizzard Agent		Public	Yes	Allow	No	C:\ProgramData\Battle.net\Agent\Agent.1040\Agent.exe

Control Questions

- Has Windows always had a built-in firewall?
- Is Windows' firewall a static or a stateful firewall? Why?
- Briefly explain what the Windows Filtering Platform is and how it works. (It is recommended that you draw a sketch.)
- What is the purpose of the Base Filtering Engine?
- What is the purpose of the shims (in the context of the WFP)?
- What is the purpose of the callouts (in the context of the WFP)?

Control Questions

- Name two similarities and two differences between iptables and the modern Windows Firewall.
- What actions (decisions) are there in the modern Windows Firewall for packet handling?
- What profiles are there in the modern Windows Firewall? What is the purpose of each?
- By default, how are incoming and outgoing packets handled by a modern Windows Firewall?

Control Questions

- How does the modern Windows Firewall handle packets that are responses to permitted incoming packets?
- How does the modern Windows Firewall handle packets that are addressed to and from loopback addresses?
- How can the modern Windows Firewall be managed?
- Briefly explain how you would add a new rule to a modern Windows Firewall, using the graphical user interface.