Securing Modern Substations With an Open Standard Network Security Solution

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Presented at the
11th Annual Western Power Delivery Automation Conference
Spokane, Washington
April 7–9, 2009

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***Abstract*—Modern power utility systems deliver information to a wide range of users in near real time and automate several tasks that streamline operations and performance. These new performance advantages often come with an additional cost—cybersecurity. This paper encourages integration and automation professionals to enhance the security of modern power utilities. It examines an open standard, Internet Protocol Security (IPSec), which provides a suite of security protocols for the modern substation owner to secure Internet Protocol (IP) communications. Further, this paper explains the necessary steps to create a secure IPSec remote desktop connection between two computers.**

I. Introduction

Many networking technologies are built on a premise of trust and provide many benefits for operational efficiency. For example, a modern networked substation often allows the remote resolution of problems, preventing a utility from wasting many hours trying to locate a fault. Encroaching on this benefit are new cybersecurity regulations that do not easily align with control system remote diagnostics. Many of the new regulations emerge as a result of work in other sectors, such as information technology (IT). Sometimes, it is appropriate to apply the security principles learned from IT, and at other times, the security principles must be approached with caution. The application of IT security measures and regulations should not negatively impact the reliability nor resiliency of grid operations.

Unfortunately, news reports showing smoking generators and doomsday cyberattacks create a climate of fear, uncertainty, and doubt. These reports can lead to a reaction to increase legislation as a means of promulgating cybersecurity. The appropriate response is to create and implement security policies, plans, training, and procedures. Once these are in place, security technologies, such as those described in this paper, provide a robust ‘security in-depth’ approach to securing critical infrastructure control systems, such as those found in a modern smart grid substation.

II. VLAN: Its Proper Place in a Secure Network Design

A virtual local-area network (VLAN) groups end devices and users into a particular network group or segment, allowing communication to occur only within that group. This provides better management of data traffic and segments network traffic with similar network security requirements, yielding better resiliency during high-traffic communications, even during a cyberattack. Unfortunately, VLANs do not provide security for the data packets, a point which is often misunderstood about VLANs [1].

VLANs do provide a convenient means to move users and/or devices to different broadcast domains. They require only a reconfiguration of the port that is used to connect to the network. For example, you could be working in Engineering Level 1 and need to move to Engineering Level 2. Instead of physically moving the computer or rerouting wires, simply modify the VLAN configuration of the port, changing it from Engineering Level 1 VLAN to Engineering Level 2 VLAN. This flexibility allows you to create logical, rather than physical, groups of users.

If a PC from the Engineering Level 2 VLAN is affected during a cyberattack, isolate the offending PC from network traffic to a separate, less critical segment, causing little or no impact to other network traffic. Conversely, devices or end users can easily be moved to other segments, removing them from the danger of the attack.

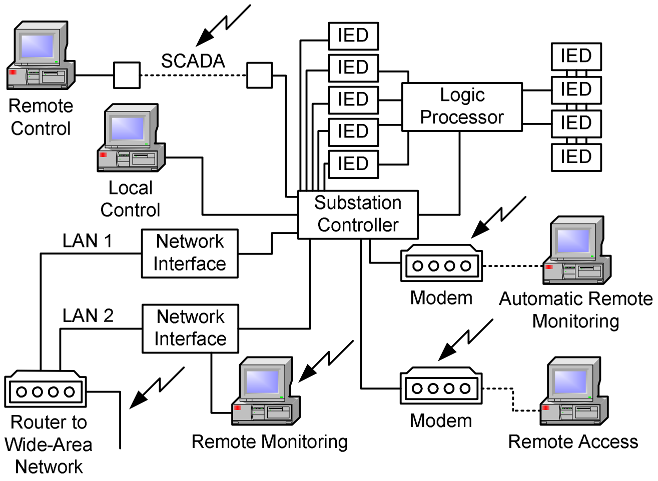


Fig. 1. Example of a VLAN

III. VPN Overview

A virtual private network (VPN) creates a network extension that behaves as if it was part of a larger, enterprise-wide network. As an example, VPNs can allow a user the ability to reach work-related emails from a laptop computer from the convenience of a home network. Unlike a VLAN, a VPN is able to provide a secure network infrastructure. A typical VPN uses existing network infrastructures, including the Internet, to make a connection. If configured properly, the security of the VPN allows the data to maintain confidentiality and integrity. VPNs create secure communications links between remote locations, while providing the same level of security as if the connection were part of a fully trusted network.

There are two types of VPNs: trusted and secured. A trusted VPN allows computers in different locations to be members of a common local-area network (LAN), with access to the network resources located within its constraints. A trusted VPN does not establish privacy. A secured VPN uses cryptographic tunneling protocols to provide security. Confidentiality, sender authentication, and message integrity establish security within a VPN. As mentioned previously, VPNs must be set up correctly in order to ensure information security [2].

By implementing the correct security technologies provided by VPNs, it is possible to prevent unauthorized data transmission to critical infrastructure devices as well as avert the interception of authorized data transmissions, such as passwords, between these critical devices.

Despite their popularity, VPNs have limitations, as is true for many security technologies. Organizations should consider that the use of VPNs requires a solid understanding of network security issues as well as careful installation and configuration to ensure security over a public Internet network. Also, it is important to recognize that the performance, reliability, and resiliency of a public, Internet-based VPN is not under the utility's control. Instead, a VPN that uses the public Internet relies on the service provider and their quality of service. In the recent past, mixing and matching network devices in a VPN resulted in technical issues that would drop communications due to vendor incompatibility.

IV. Using IPSec to Secure Communications

A VPN solution starts with two endpoints on a network and, for our purposes, one endpoint that likely terminates in a substation. Engineers suggest that devices residing within a substation's security perimeter should terminate via an Internet Protocol Security (IPSec) gateway appliance. At present, many substation devices are unable to support a direct VPN termination, so termination occurs as part of an existing inline network infrastructure device, such as a gateway, near the vicinity of the device.

IPSec is a framework protocol to secure data that is traversing an internet communications link. The framework protocol includes tunnel and transport modes as well as the Authentication Header (AH) and Encapsulating Security Payload (ESP) security algorithms.

		Modes	
		Tunnel	Transport
Algorithms	AH	Integrity Authenticity (Data is not confidential) IP header protected Not compatible with NAT, NAT-T maybe	Integrity Authenticity IP address Not compatible with NAT, NAT-T maybe
	ESP	Integrity Authenticity Confidentiality (Encryption) Original IP header protected Considered true VPN	Integrity Authenticity Confidentiality (Encryption) Original IP header not encrypted

Fig. 2. IPSec protocol matrix

Choosing between tunnel mode and transport mode depends on the topology and use of the VPN. For more traditional VPN use, tunnel mode topology creates a gateway-to-gateway or host-to-gateway connection. In this case, host is defined as a computer-to-internet device, and gateway is a network device that connects two Internet communications links. Transport mode authenticates the two network hosts or peers and establishes a secure communications channel. This secure channel ensures that communication between the two computers remains tamper-free and private. In transport mode, the Internet Protocol (IP) header is sent in the open.

Tunnel mode secures traffic routed between two gateways over an untrusted network. A device at one site must communicate to a device at the other site. The traffic passes through the IPSec gateway. Tunnel mode is for site-to-site communications, useful for securing gateway-to-gateway, server-to-gateway, and server-to-server communications.

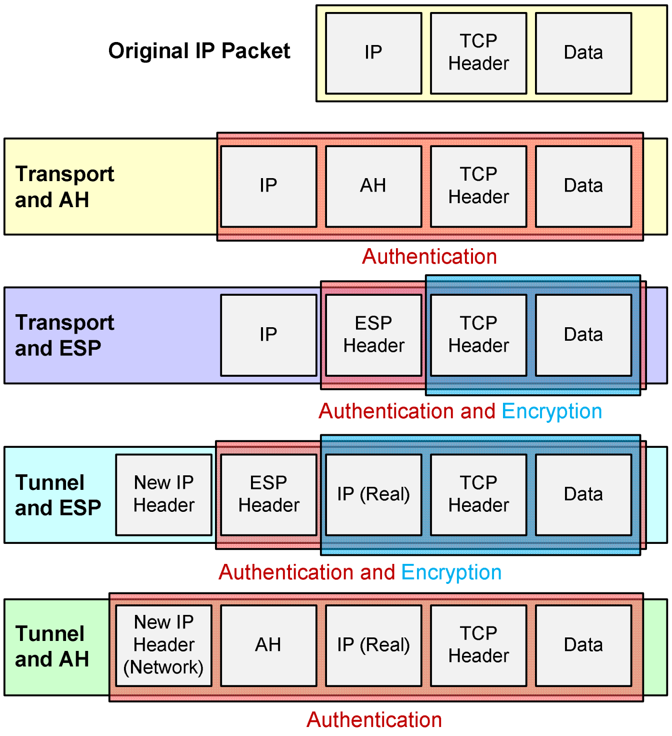


Fig. 3. IPSec datagram differences

Routers enabled with network address translation can cause difficulties with IPSec tunnels because parts of the IP address header change. Also, IPSec operates only on routable protocols, so broadcast and nonroutable messages (e.g., IEC 61850 GOOSE) cannot traverse an IPSec tunnel [3].

Configuring IPSec connections starts with defining a set of security associations (SAs). Each SA is filtered based on source and destination addresses (IPv4 or IPv6), name (user ID or system name), Transport Layer Protocol (Transmission Control Protocol, TCP, or User Datagram Protocol, UDP), and source and destination ports (port number). These SA selectors help determine the eligibility of inbound or outbound traffic for association with a particular SA. IPSec supports very strong cryptographic authentication and encryption of data.

Through the use of SA selectors, it is possible to write access control list entries that force a router to apply the IPSec protocol to very specific TCP/IP traffic profiles. Since IPSec functions at lower layers of the Open Systems Interconnection (OSI) model, there is open exposure to the TCP/UDP header. Therefore, it is possible to filter all network traffic into a set of SAs. This filter controls all traffic that enters or leaves the IPSec device, and no host between the endpoints of the IPSec tunnel can inject malicious packets or analyze the communication. This makes the IPSec VPN operate like a rudimentary firewall, as discussed later in Section V.

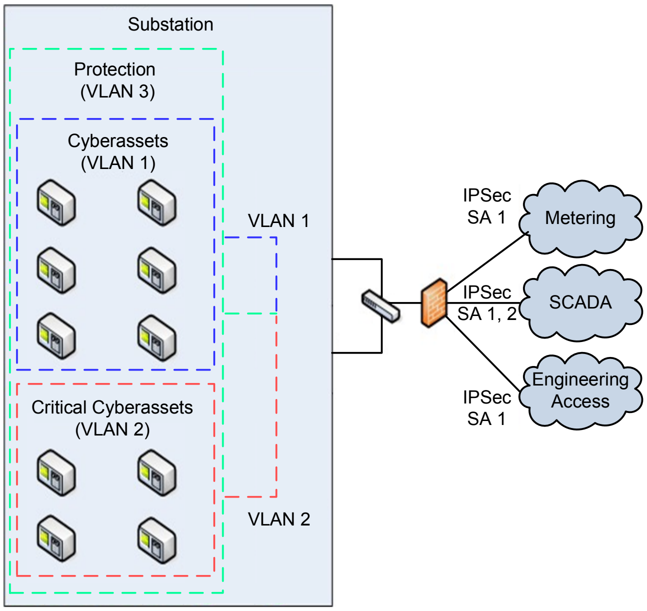


Fig. 4. IPSec VPN operating with a VLAN and a firewall

During a cyberattack, IPSec VPN traffic traveling through a router is filtered so that any frames an attacker forms and attempts to send to a substation computer are dropped. The packets do not pass because the frames fail authentication and/or decryption. An encryption/authentication key must be used to code all data, and the network devices accept or deny this traffic.

IPSec issues arise due to the misconfiguration of the tunnel during setup, which introduces security holes. For example, implementing a traffic filter without any authentication verification on the packets could allow a knowledgeable attacker to send malicious TCP/IP traffic that matches the expected traffic profile. Thus, the rogue traffic survives filtering. A hacker is then able to pose as a legitimate device on the substation network, and malicious traffic can be sent to the substation device by faking or spoofing the IP address.

V. Firewalls as a Security Measure With IPSec VPNs

The last security tool discussed in this paper is the firewall. The name and its function originate from the firewall that can be found in automobiles or applied in the construction of buildings. An automobile's firewall confines fire to the engine compartment, preventing fire from progressing to the driver and passenger areas. The firewall must have holes in it for certain functions, such as steering, throttle control, and braking. Likewise, a network firewall restricts illegitimate traffic from flowing on the network segment but allows legitimate data to proceed. The firewall makes these decisions based on a set of rules. Another firewall feature is the ability to log or document actions, including auditing actions. The rules for a firewall originate from a well-defined security policy.

Typically, a firewall operates between network boundaries, where network communications meet. For example, a firewall would be found where data from the Internet (outsiders) meet the data from a corporate intranet (insiders).

Firewalls are often built into network equipment, such as computers, gateways, or routers, and provide a means to restrict network traffic, such as preventing outsiders from connecting to insiders. Just as there are holes in an automotive firewall, the rules for a substation may allow network holes, or ports, to allow certain TCP/IP network traffic to pass. For example, a firewall may have holes to pass email traffic assigned to Port 25 (Simple Mail Transfer Ptrotocol, SMTP) or Port 110 (Post Office Protocol 3, POP3). These ports in the firewall allow legitimate network traffic to pass but drop illegitimate traffic. Firewall rules that drop data packets often create an alarm or log file that notifies the user and/or administrator of a problem. As with any security tool, a firewall requires an understanding of the network design; unintentionally or inaccurately changing a firewall rule can impede important network traffic.

There are several firewall types: packet filtering, stateful inspection, and application proxy. Packet filtering examines the IP address and/or port and accepts or denies the packet through the firewall. The more popular type of firewall is called stateful inspection (often referred to as a session-based firewall), which bases the rules on the state of a connection or session. It adds slightly more depth to its protection. There are Unix-based firewalls that run off iptables or ipfilters. These work well for a substation environment because they allow for some degree of fine-tuning (e.g., allowing control system packets and rejecting all other traffic). Unix-based firewalls require more time and greater expertise to set up. As the name implies, an application proxy sets up an intermediary hardware path for the data packets. The proxy hardware receives all traffic to and from the destination and filters traffic based on its rule set. One advantage of a proxy firewall is that it hides the true IP addresses from outsider connections.

Firewalls log and document attempts to connect to the network. These log files are an important source of useful information that can be used to prevent illegitimate access to a substation environment.

VI. Creating an IPSec VPN

The appendix of this paper explains how to set up and encrypt the connections between two computers using the Windows® XP operating system with built-in IPSec capabilities. The example provides step-by-step instructions to configure an IPSec VPN between two computers. This example works between two laptops connected via a crossover cable or network hub. In general, the following steps must occur on both computers in order to establish a cryptographically secure communications channel:

- Create a new IPSec policy.
- Create rules within the policy.
- Define how to filter (identify) the traffic to encrypt.
- Select the filters to use.
- Activate the policy.
- Connect to computers using a remote desktop connection.

To begin the process of creating a secure connection between the computers, create a local security policy in both computers. After the IPSec VPN is configured on both computers, verify that only these IPSec-enabled computers can communicate with each other.

When the two computers are connected via a network hub (a network switch will not work in this case), a third computer with a software packet sniffer, such as Wireshark®, allows the user to view the data packets and encrypted data.

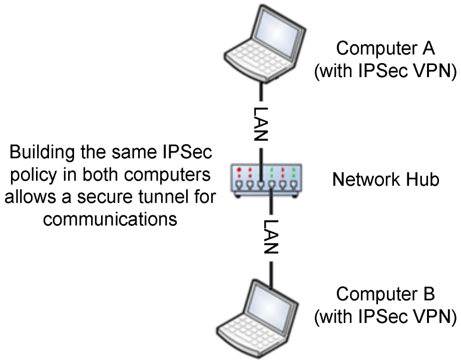

Computer A
(with IPSec VPN)
LAN
Building the same IPSec policy in both computers allows a secure tunnel for communications
Network Hub
LAN
Computer B
(with IPSec VPN)

Fig. 5. Creating an example IPSec VPN

VII. Conclusion

This paper describes several cybersecurity tools to help protect and control data that may need to traverse untrusted network paths located near substation networks. The substation automation professional should be aware of security measures, such as firewalls and VPN IPSec tunnels, that allow for improved secure remote access. Using firewalls and IPSec VPNs helps protect networks from malicious traffic, while VLANs help to provide resiliency.

VIII. Appendix

The following procedures will need to occur on both computers.

A. Configure Windows XP to Accept Remote Desktop Connections

Step 1. Right-click the **My Computer** icon.

Step 2. Select **Properties** on the pop-up menu to open the **System Properties** window.

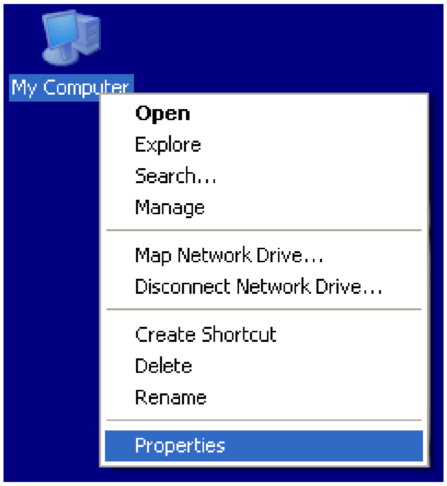
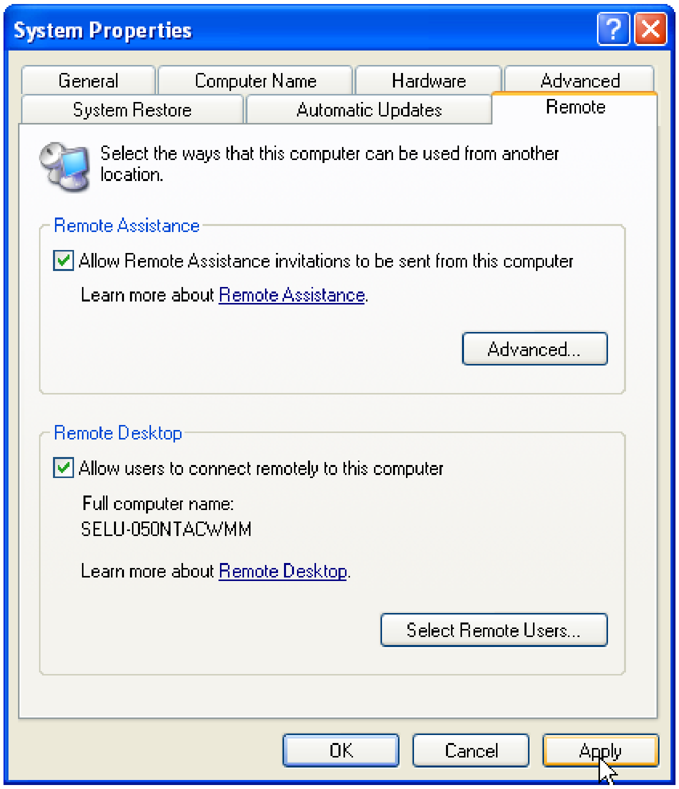


Fig. 6. Right-click on the **My Computer** icon

Step 3. Select the **Remote** tab in the **System Properties** window.

Step 4. In the **Remote Desktop** area of the window, check the **Allow users to connect remotely to this computer** box.



Select the ways that this computer can be used from another location.

Remote Assistance

☑ Allow Remote Assistance invitations to be sent from this computer

Learn more about Remote Assistance.

Remote Desktop

☑ Allow users to connect remotely to this computer

Full computer name:
SELU-050NTACWMM

Learn more about Remote Desktop.

Fig. 7. Check the **Remote Desktop** option in the **System Properties** window

Step 5. Click **Apply**.

Step 6. Click **OK**.

B. Create New User Account

Step 1. Navigate to **Start** > **Settings** > **Control Panel**, and choose **User Accounts**. The **User Accounts** window will open.

Step 2. Click on **Create a new account**.

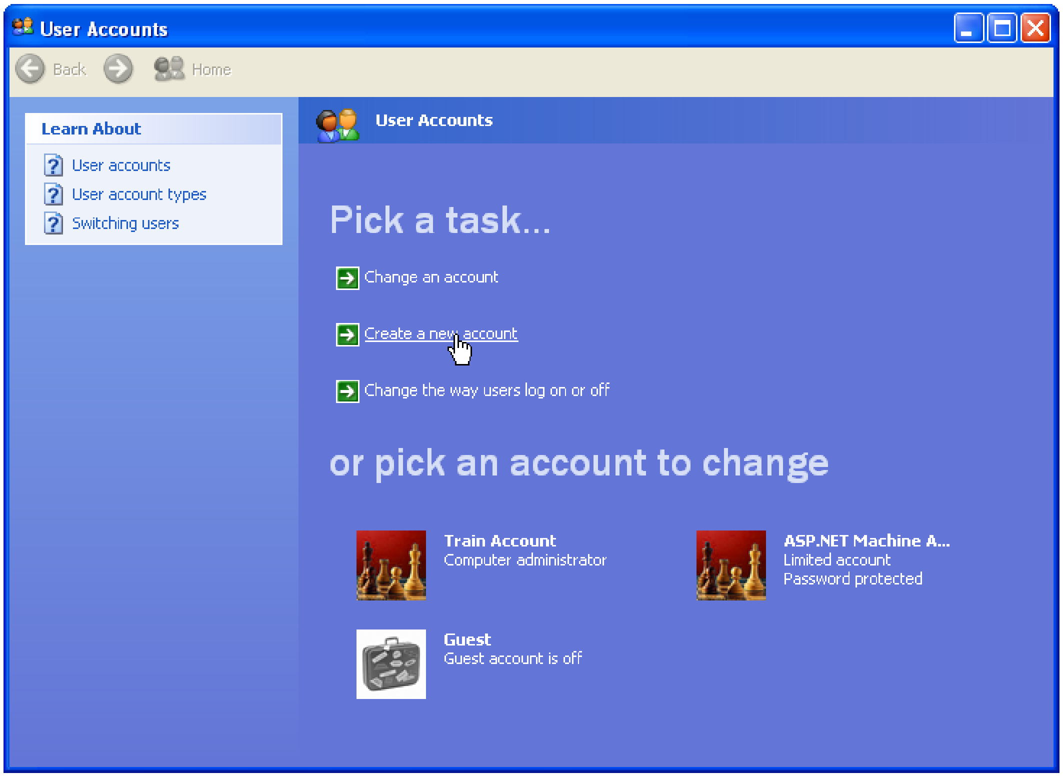
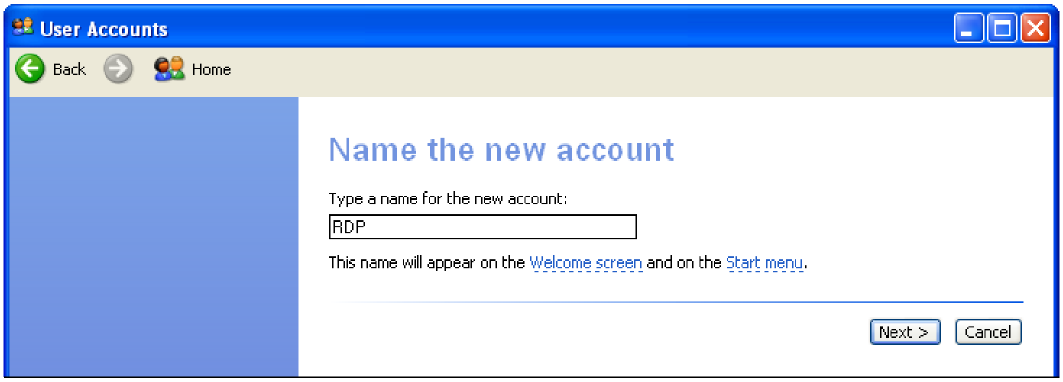


Fig. 8. Select **Create a new account** in the **User Accounts** window

Step 3. Type **RDP** for the new account name in the area provided. Click **Next**.



Name the new account

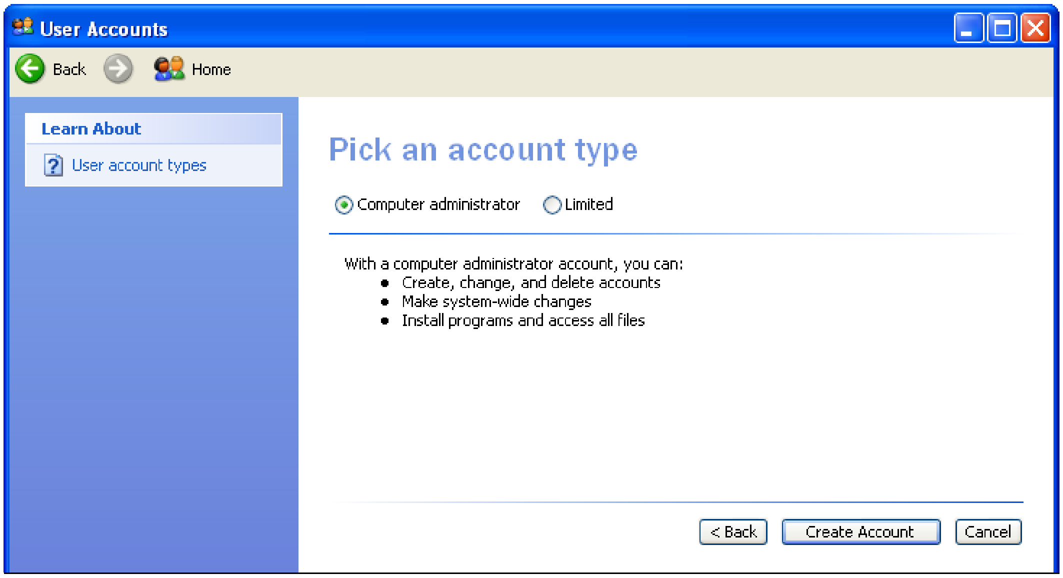
Type a name for the new account:

RDP

This name will appear on the Welcome screen and on the Start menu.

Fig. 9. Name the new account

Step 4. Select **Computer administrator** as the account type. Click the **Create Account** button.



Pick an account type

● Computer administrator ○ Limited

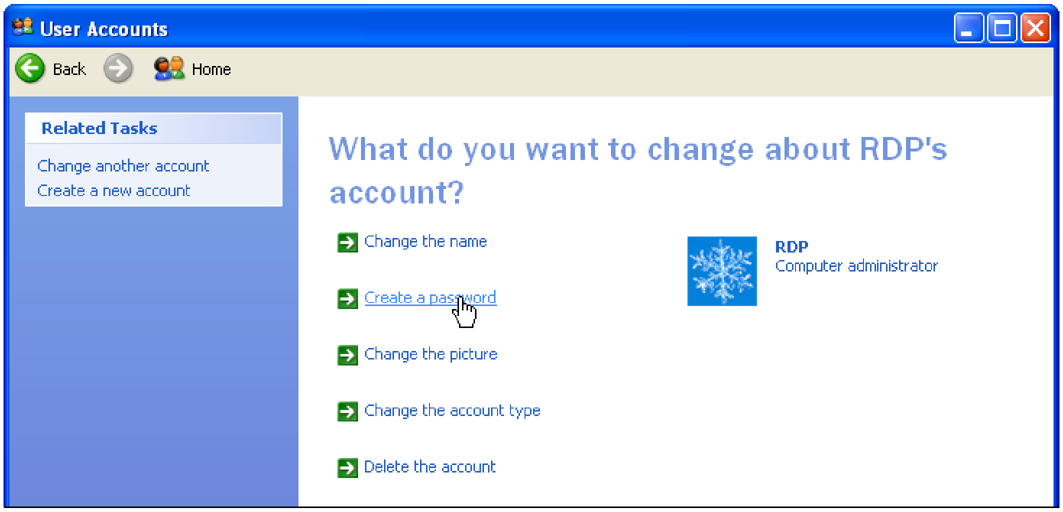
With a computer administrator account, you can:

- Create, change, and delete accounts
- Make system-wide changes
- Install programs and access all files

Fig. 10. Select **Computer administrator**

Step 5. Select the **RDP** user account that was just created.

Step 6. Select **Create a password**.

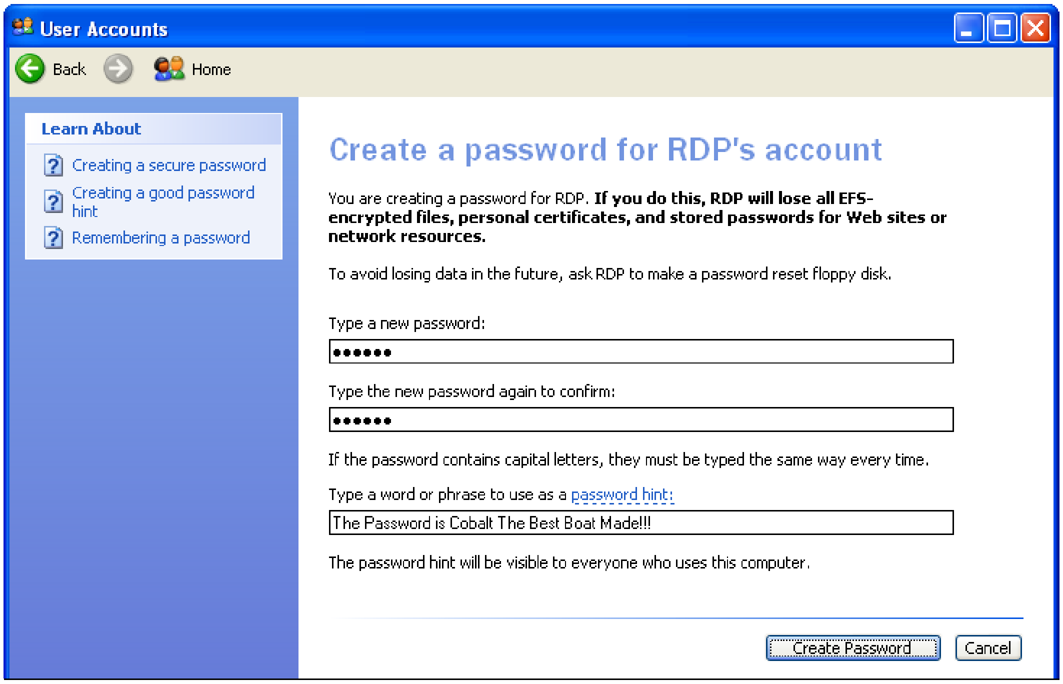


What do you want to change about RDP's account?

RDP
Computer administrator

Fig. 11. Click on **Create a password**

Step 7. In the **Type a new password** text box, enter **Cobalt!123**, and then type the new password again to confirm. If desired, enter a password hint in the area provided. Click **Create Password**.



Create a password for RDP's account

You are creating a password for RDP. **If you do this, RDP will lose all EFS-encrypted files, personal certificates, and stored passwords for Web sites or network resources.**

To avoid losing data in the future, ask RDP to make a password reset floppy disk.

Type a new password:
••••••

Type the new password again to confirm:
••••••

If the password contains capital letters, they must be typed the same way every time.

Type a word or phrase to use as a password hint:
The Password is Cobalt The Best Boat Made!!!

The password hint will be visible to everyone who uses this computer.

Fig. 12. Create a password

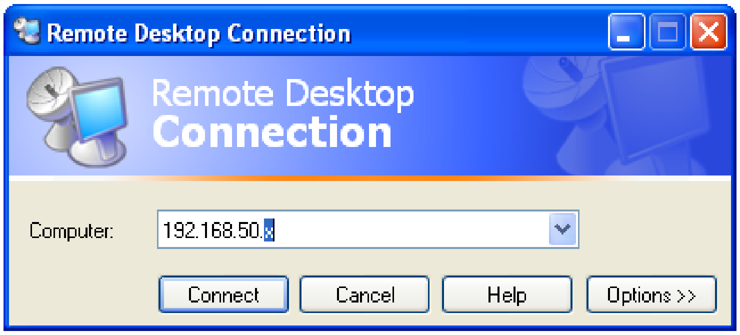
Step 8. Close the **User Accounts** window.

C. Establish Remote Desktop Connection to Second Computer

If you are using a hub to connect two computers, ensure your local hub **Normal/Uplink** switch is in the **Normal** position.

Step 1. Double-click the **Remote Desktop** icon on your desktop.

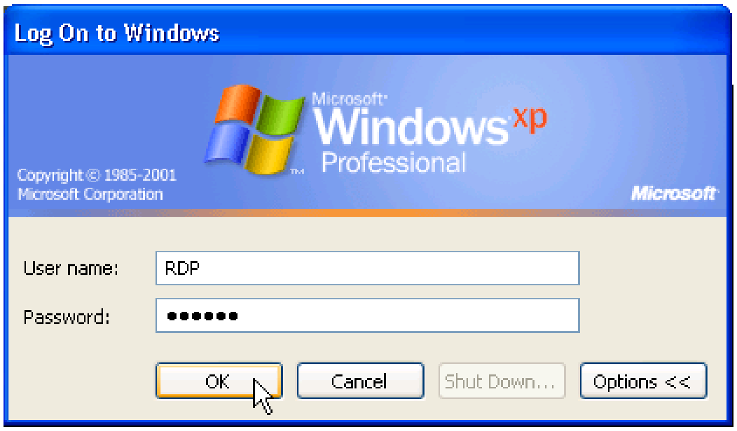
Step 2. In the **Remote Desktop Connection** window, type the IP address. This will take control of the second computer.



Computer: 192.168.50.x

Fig. 13. Type the IP address in the **Remote Desktop Connection** window

Step 3. Log in to the second computer using the RDP account that was previously created.

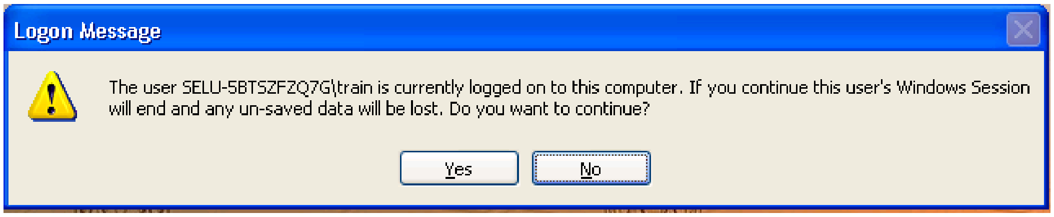

Log On to Windows
Microsoft Windows xp Professional
Copyright © 1985-2001 Microsoft Corporation
Microsoft
OK
Cancel
Shut Down...
Options <<

User name: RDP

Password: ●●●●●●

Fig. 14. Log in to second computer

Step 4. Log in to the second computer by clicking **Yes** in the **Logon Message** window. The first computer is now logged out, and you are operating the second computer.



The user SELU-5BTSZFZQ7G\train is currently logged on to this computer. If you continue this user's Windows Session will end and any un-saved data will be lost. Do you want to continue?

Fig. 15. Click **Yes** in the **Logon Message** window

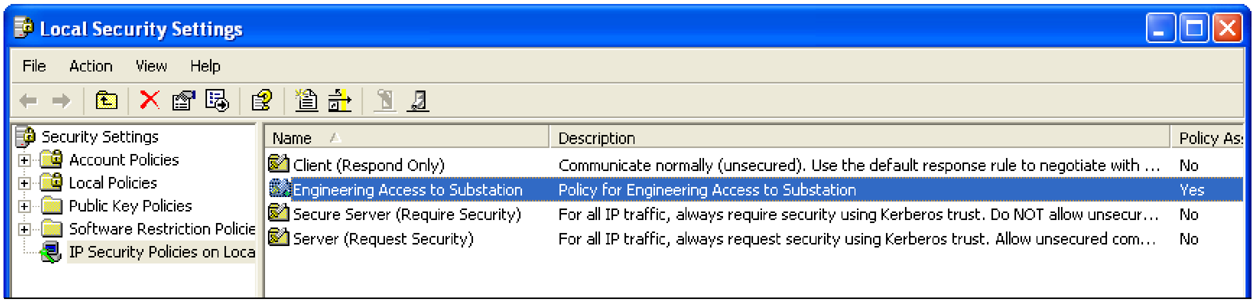
Step 5. Select **Log Off RDP** on the **Start** menu.

Step 6. Click **Log Off** in the **Log Off** window.

Step 7. On the second computer, repeat Step 1 through Step 6.

D. Create a Remote Desktop Security Policy

Step 1. Select **Local Security Policy** from **Start** > **Settings** > **Control Panel** > **Administrative Tools**. The **Local Security Settings** window will open.



Name	Description	Policy As:
Client (Respond Only)	Communicate normally (unsecured). Use the default response rule to negotiate with ...	No
Engineering Access to Substation	Policy for Engineering Access to Substation	Yes
Secure Server (Require Security)	For all IP traffic, always require security using Kerberos trust. Do NOT allow unsecur...	No
Server (Request Security)	For all IP traffic, always request security using Kerberos trust. Allow unsecured com...	No

Fig. 16. **Local Security Settings** window

Step 2. Click the **Create an IP Security policy** icon in the **Local Security Settings** window.

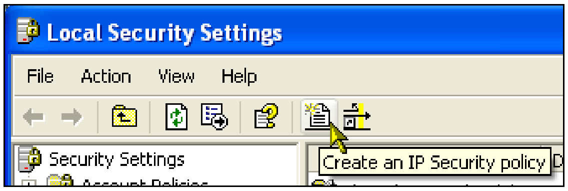
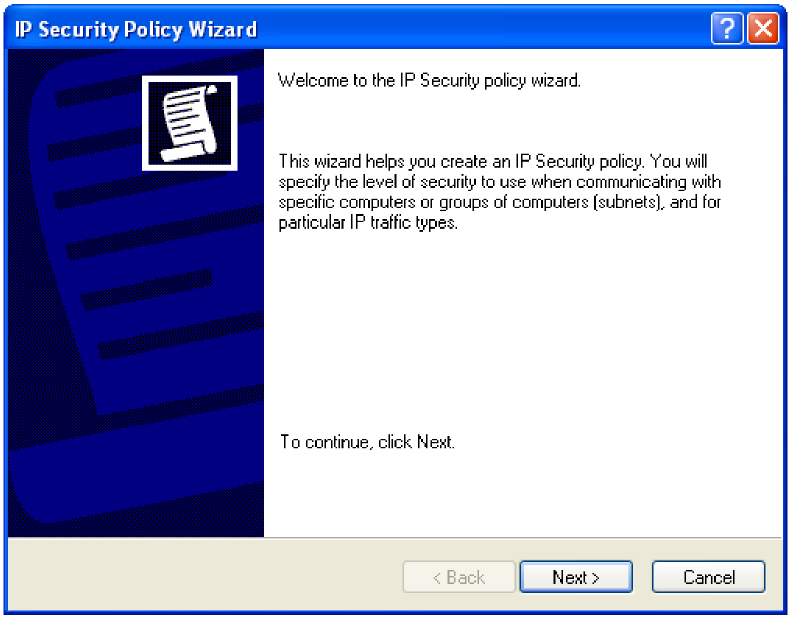


Fig. 17. Click on the **IP Security policy** icon

Step 3. Click **Next**.



IP Security Policy Wizard

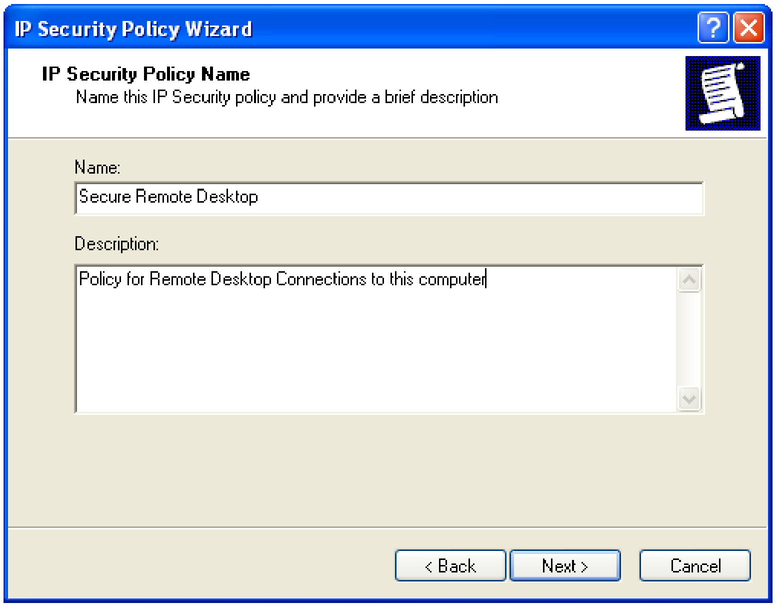
Welcome to the IP Security policy wizard.

This wizard helps you create an IP Security policy. You will specify the level of security to use when communicating with specific computers or groups of computers (subnets), and for particular IP traffic types.

To continue, click Next.

Fig. 18. **IP Security Policy Wizard** window

Step 4. Type a name for this security policy in the area provided. If desired, type a description for the policy. Click **Next**.



IP Security Policy Wizard

IP Security Policy Name

Name this IP Security policy and provide a brief description

Name:

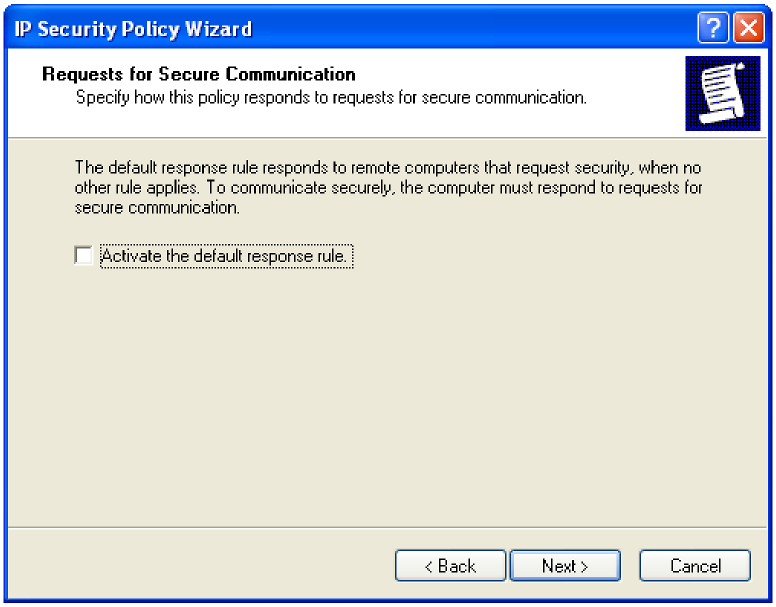
Secure Remote Desktop

Description:

Policy for Remote Desktop Connections to this computer

Fig. 19. Assign **IP Security Policy Name**

Step 5. Remove the check mark from the **Activate the default response rule** box. Click **Next**.



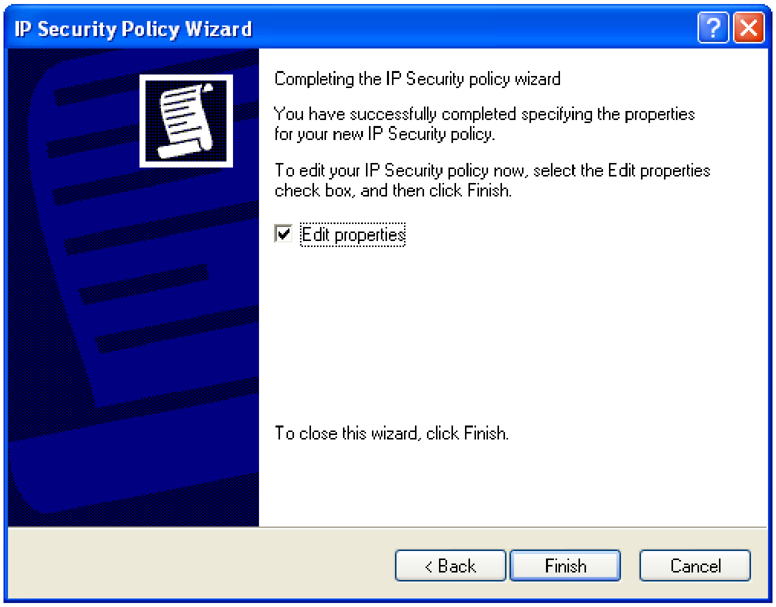
Requests for Secure Communication
Specify how this policy responds to requests for secure communication.

The default response rule responds to remote computers that request security, when no other rule applies. To communicate securely, the computer must respond to requests for secure communication.

□ Activate the default response rule.

Fig. 20. Remove check mark from **Activate the default response rule**

Step 6. Check the box next to **Edit properties**, and click **Finish**. The **Secure Remote Desktop Properties** window will open.



Completing the IP Security policy wizard

You have successfully completed specifying the properties for your new IP Security policy.

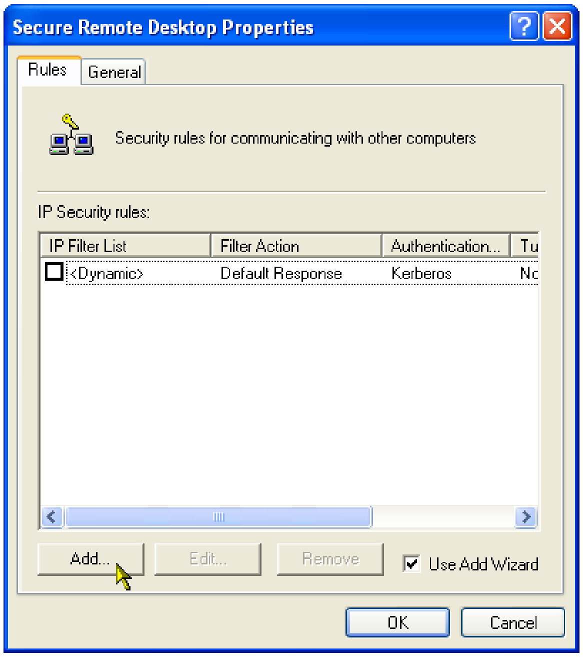
To edit your IP Security policy now, select the Edit properties check box, and then click Finish.

☑ Edit properties

To close this wizard, click Finish.

Fig. 21. Check **Edit properties**

Step 7. Check the **Use Add Wizard** box, and click the **Add** button. The **Security Rule Wizard** window will open.



Secure Remote Desktop Properties

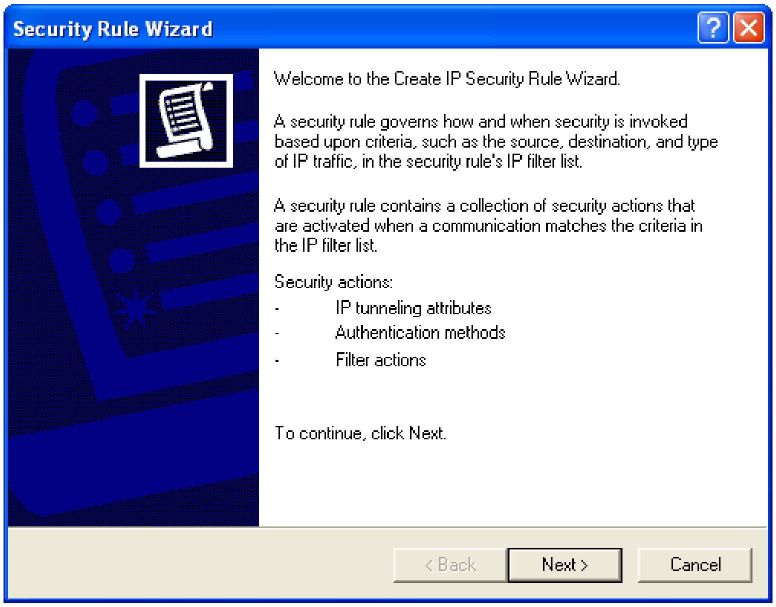
Security rules for communicating with other computers

IP Security rules:

IP Filter List	Filter Action	Authentication...	Tu
□ <Dynamic>	Default Response	Kerberos	Nc

Fig. 22. Rules tab in **Security Remote Desktop Properties** window

Step 8. Click **Next**.



Security Rule Wizard

Welcome to the Create IP Security Rule Wizard.

A security rule governs how and when security is invoked based upon criteria, such as the source, destination, and type of IP traffic, in the security rule's IP filter list.

A security rule contains a collection of security actions that are activated when a communication matches the criteria in the IP filter list.

Security actions:

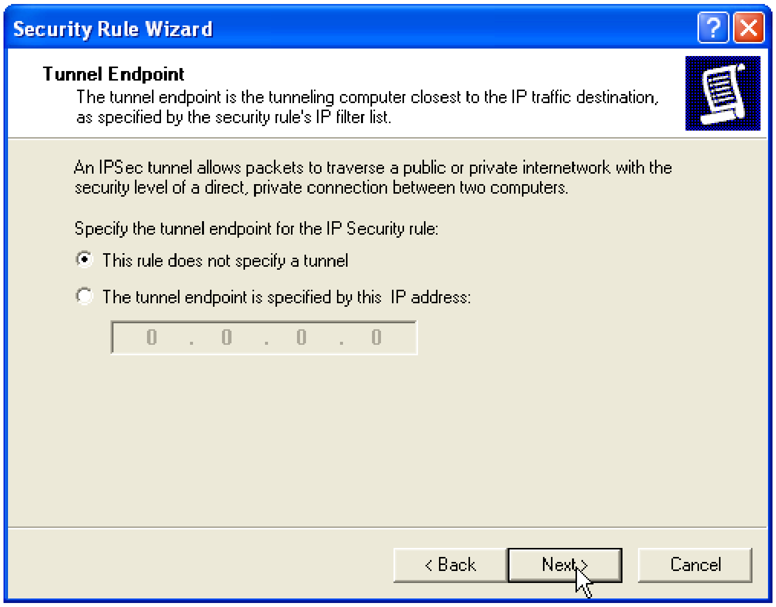
- IP tunneling attributes
- Authentication methods
- Filter actions

To continue, click Next.

Fig. 23. Start **Security Rule Wizard**

Step 9. Select the **This rule does not specify a tunnel** radio button. Click **Next**.

Note: If setting up a secure connection between two computers on a server, select a tunnel, and define the appropriate IP addresses. This also implies that the network interface card (NIC) on both computers would need to use static IP addresses in the network configuration menu. For example, if the NIC card on Computer A is 198.162.1.1, and it is 198.162.1.2 on Computer B, then the tunnel IP address for Computer A is 198.162.1.2, and the tunnel IP address for Computer B is 192.162.1.1.



Tunnel Endpoint

The tunnel endpoint is the tunneling computer closest to the IP traffic destination, as specified by the security rule's IP filter list.

An IPSec tunnel allows packets to traverse a public or private internetwork with the security level of a direct, private connection between two computers.

Specify the tunnel endpoint for the IP Security rule:

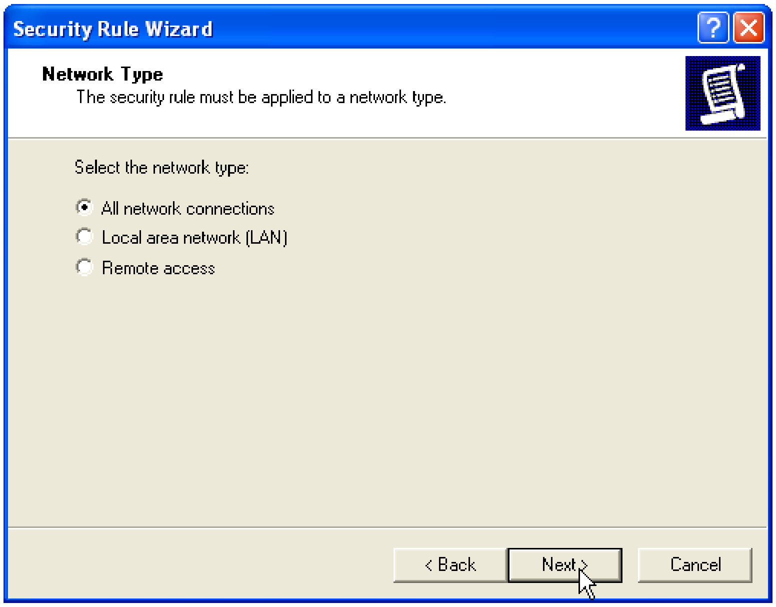
● This rule does not specify a tunnel

○ The tunnel endpoint is specified by this IP address:

0 . 0 . 0 . 0

Fig. 24. Specify tunnel endpoint rule

Step 10. Select the **All network connections** radio button. Click **Next**.



Network Type

The security rule must be applied to a network type.

Select the network type:

● All network connections

○ Local area network (LAN)

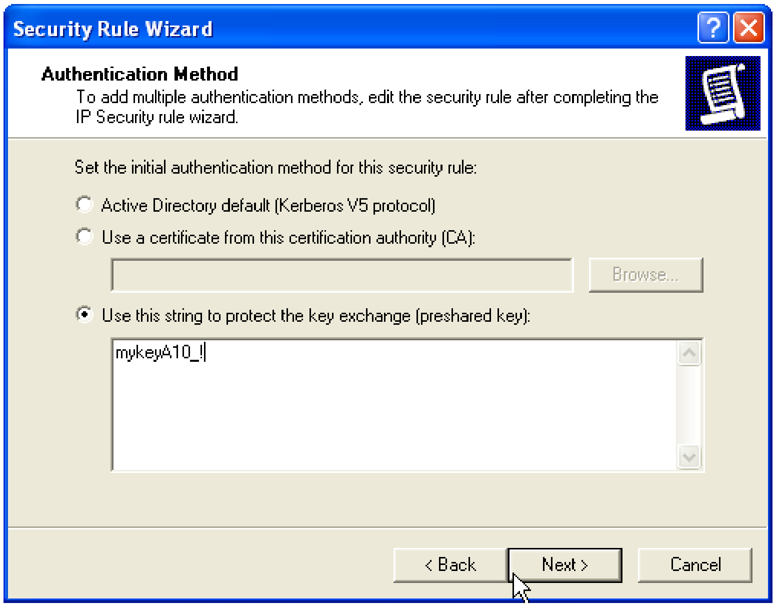
○ Remote access

Fig. 25. Select network type

Step 11. Select the **Use this string to protect the key exchange (preshared key)** radio button.

Step 12. Type **mykeyA10_!** in the text box provided. Click **Next.**

Note: If the encryption keys do not match, the IPSec connection will fail. This results in an authentication failure between the two computers.



Security Rule Wizard

Authentication Method

To add multiple authentication methods, edit the security rule after completing the IP Security rule wizard.

Set the initial authentication method for this security rule:

○ Active Directory default (Kerberos V5 protocol)

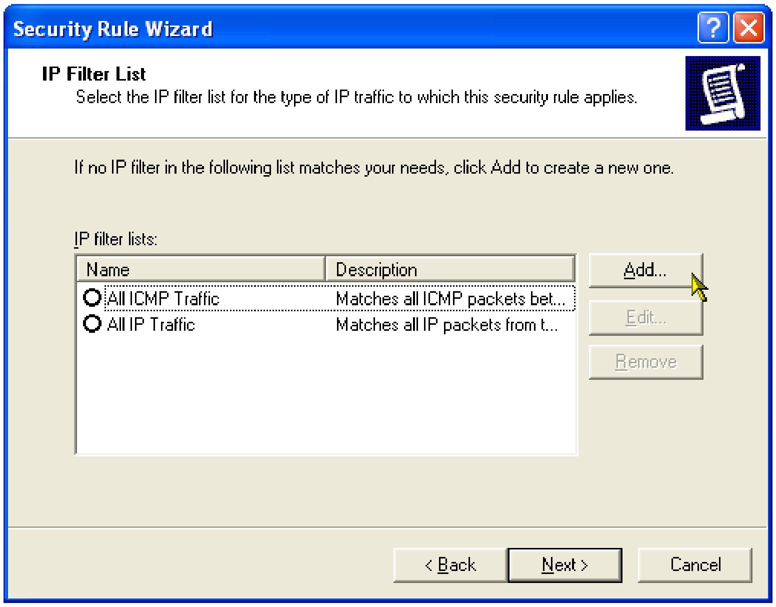
○ Use a certificate from this certification authority (CA):

● Use this string to protect the key exchange (preshared key):

mykeyA10_!

Fig. 26. **Authentication Method** window

Step 13. Ensure that no radio buttons are selected, and then click the **Add** button.



Security Rule Wizard

IP Filter List

Select the IP filter list for the type of IP traffic to which this security rule applies.

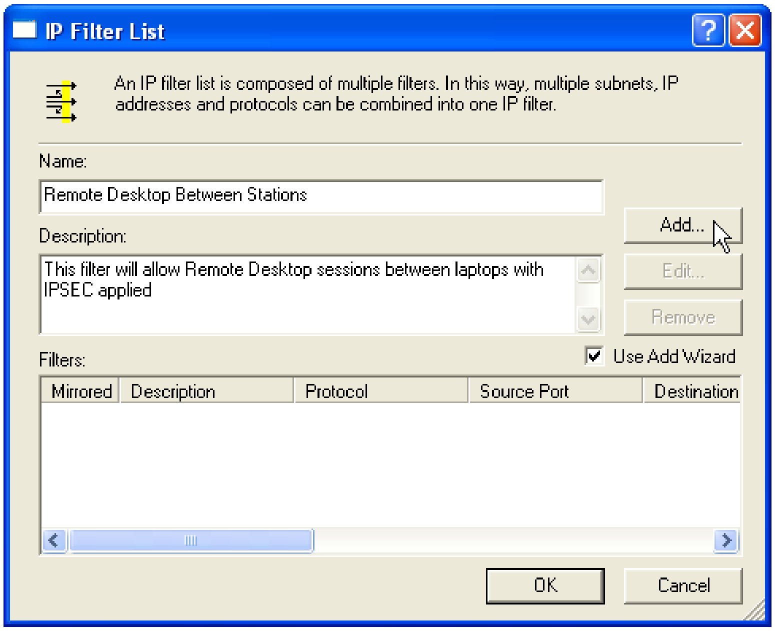
If no IP filter in the following list matches your needs, click Add to create a new one.

IP filter lists:

Name	Description
○ All ICMP Traffic	Matches all ICMP packets bet...
○ All IP Traffic	Matches all IP packets from t...

Fig. 27. **IP Filter List** window

Step 14. Enter the IP filter **Name** and **Description** in the text boxes. Check the **Use Add Wizard** box, and then click **Add**.



IP Filter List

An IP filter list is composed of multiple filters. In this way, multiple subnets, IP addresses and protocols can be combined into one IP filter.

Name:
Remote Desktop Between Stations

Description:
This filter will allow Remote Desktop sessions between laptops with IPSEC applied

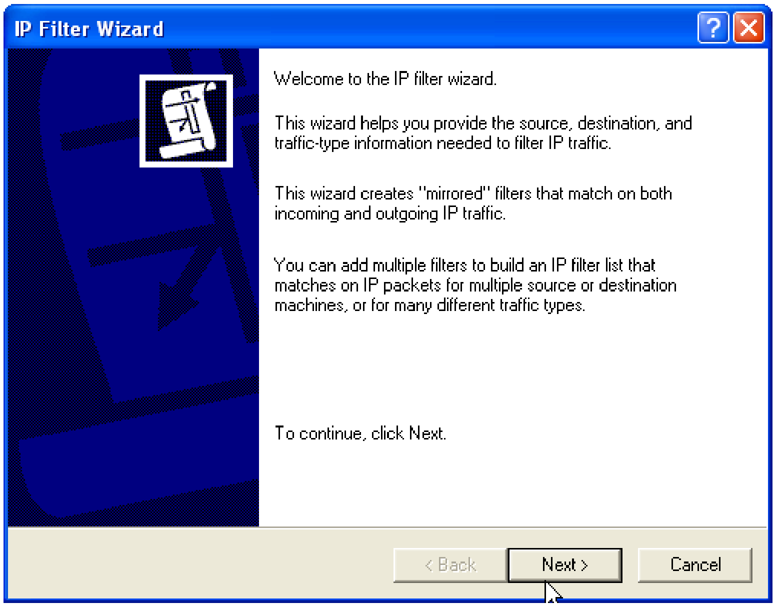
Filters:

☑ Use Add Wizard

Mirrored	Description	Protocol	Source Port	Destination

Fig. 28. Name **IP Filter**

Step 15. Click **Next**.



IP Filter Wizard

Welcome to the IP filter wizard.

This wizard helps you provide the source, destination, and traffic-type information needed to filter IP traffic.

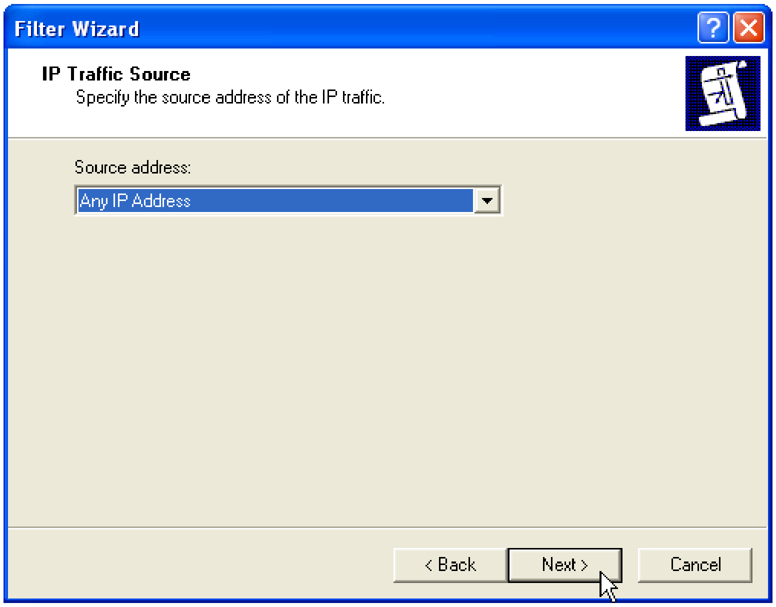
This wizard creates "mirrored" filters that match on both incoming and outgoing IP traffic.

You can add multiple filters to build an IP filter list that matches on IP packets for multiple source or destination machines, or for many different traffic types.

To continue, click Next.

Fig. 29. **IP Filter Wizard** window

Step 16. Identify the attributes of the IP traffic that you want to act on with an IP filter. In the **Source address** drop-down list, select **Any IP Address**. Click **Next**.

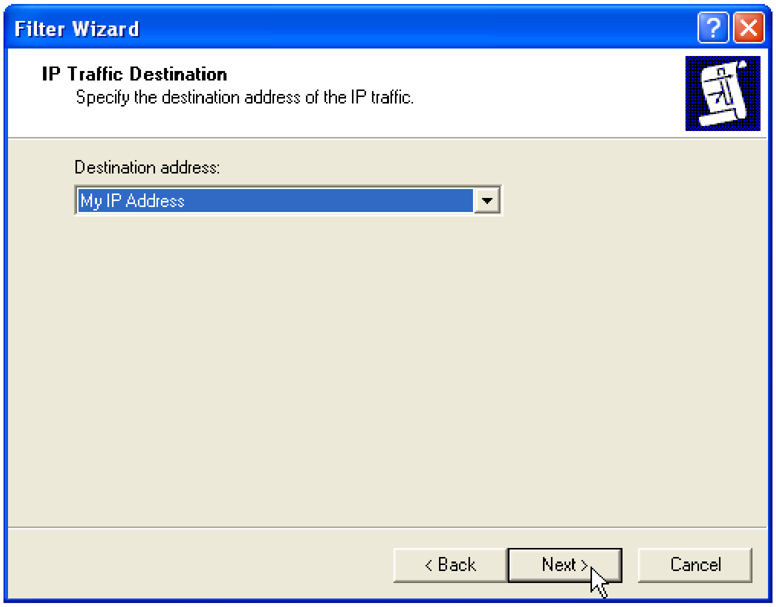


IP Traffic Source
Specify the source address of the IP traffic.

Source address: Any IP Address

Fig. 30. Select **IP Traffic Source**

Step 17. Continue to define the attributes of the IP traffic that you want to act on as the filter is built. In the **Destination address** drop-down list, select **My IP Address**. Click **Next**.

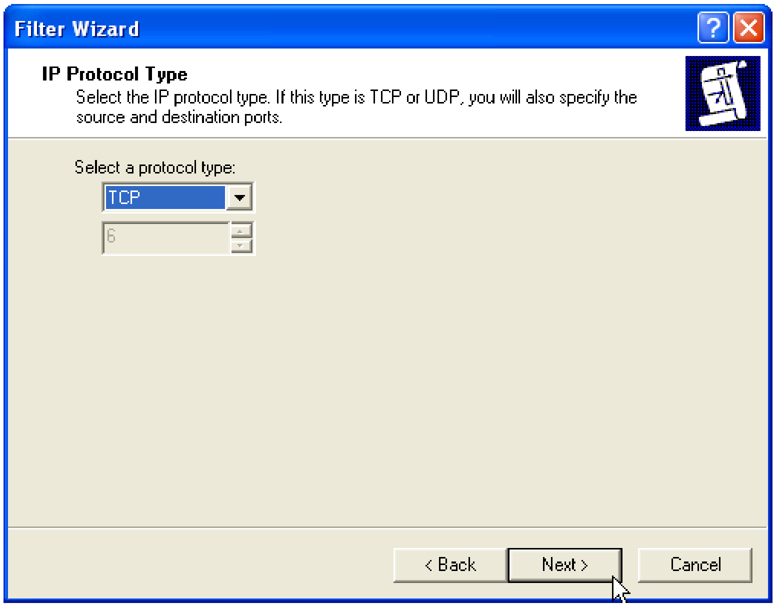


IP Traffic Destination
Specify the destination address of the IP traffic.

Destination address: My IP Address

Fig. 31. Select **IP Traffic Destination**

Step 18. In the **Select a protocol type** drop-down list, select **TCP**. Click **Next**.



Filter Wizard

IP Protocol Type

Select the IP protocol type. If this type is TCP or UDP, you will also specify the source and destination ports.

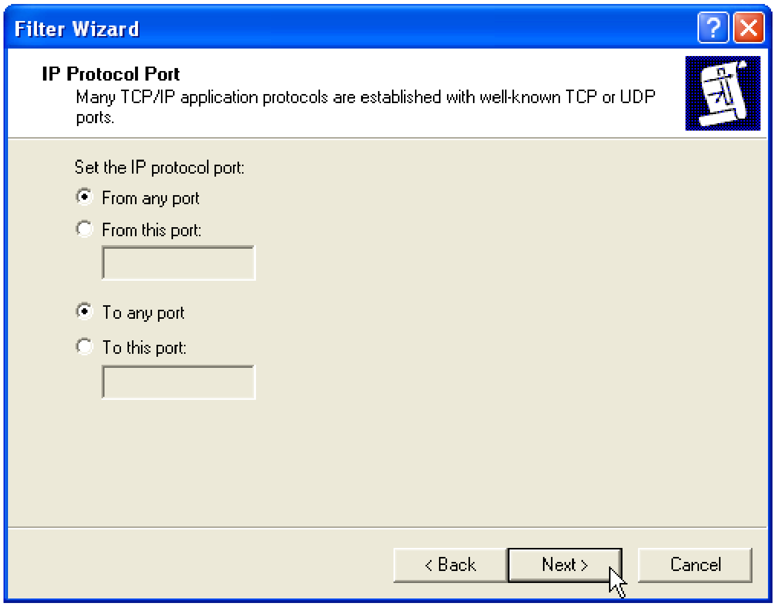
Select a protocol type:

TCP

6

Fig. 32. Select **IP Protocol Type**

Step 19. Select the **From any port** and **To any port** radio buttons. Click **Next**.



Filter Wizard

IP Protocol Port

Many TCP/IP application protocols are established with well-known TCP or UDP ports.

Set the IP protocol port:

● From any port

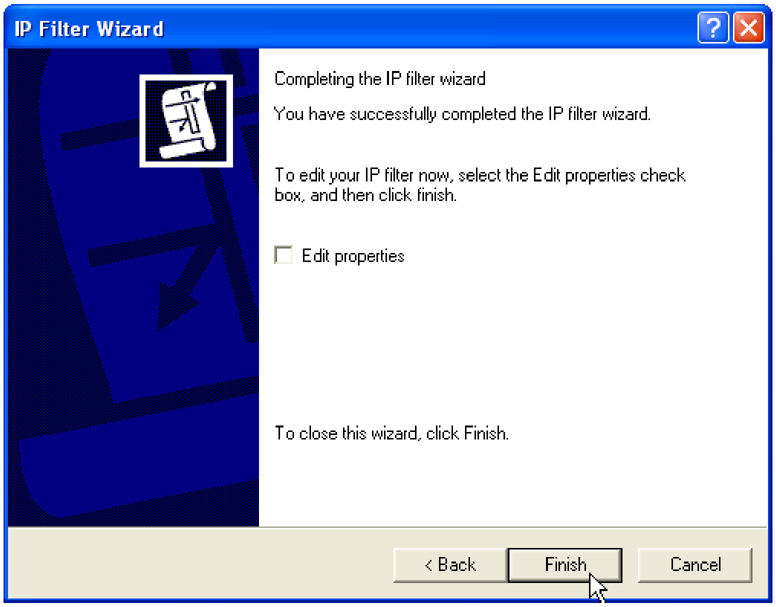
○ From this port:

● To any port

○ To this port:

Fig. 33. Select **IP Protocol Port**

Step 20. Ensure that **Edit properties** is unchecked. Click **Finish**.



Completing the IP filter wizard

You have successfully completed the IP filter wizard.

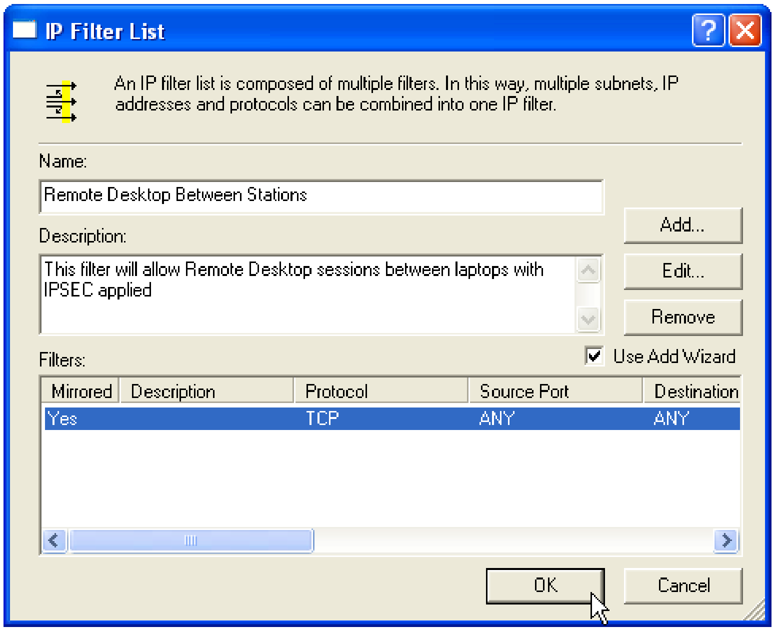
To edit your IP filter now, select the Edit properties check box, and then click finish.

☐ Edit properties

To close this wizard, click Finish.

Fig. 34. Completion screen

Step 21. Click **OK**.



An IP filter list is composed of multiple filters. In this way, multiple subnets, IP addresses and protocols can be combined into one IP filter.

Name:
Remote Desktop Between Stations

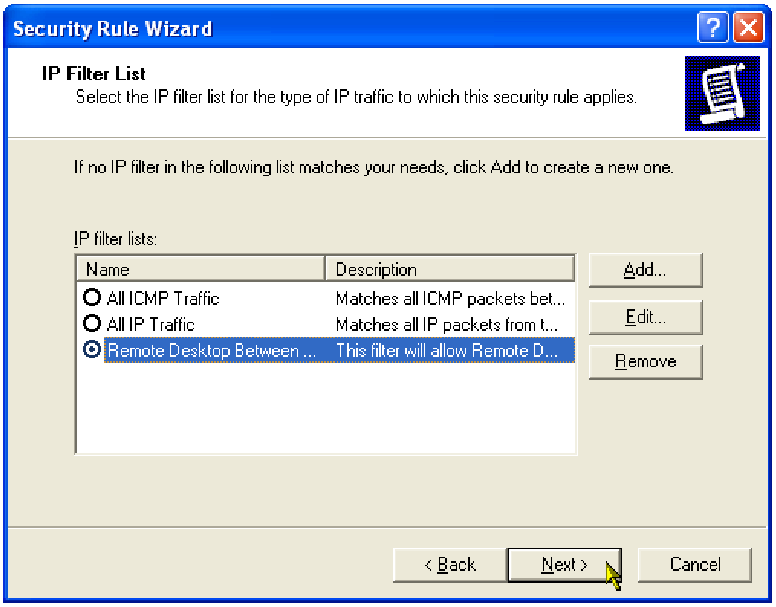
Description:
This filter will allow Remote Desktop sessions between laptops with IPSEC applied

Filters: ☑ Use Add Wizard

Mirrored	Description	Protocol	Source Port	Destination
Yes		TCP	ANY	ANY

Fig. 35. **IP Filter List** window

Step 22. Select the radio button for the new IP filter in the **IP Filter List**. Click **Next**.



Security Rule Wizard

IP Filter List

Select the IP filter list for the type of IP traffic to which this security rule applies.

If no IP filter in the following list matches your needs, click Add to create a new one.

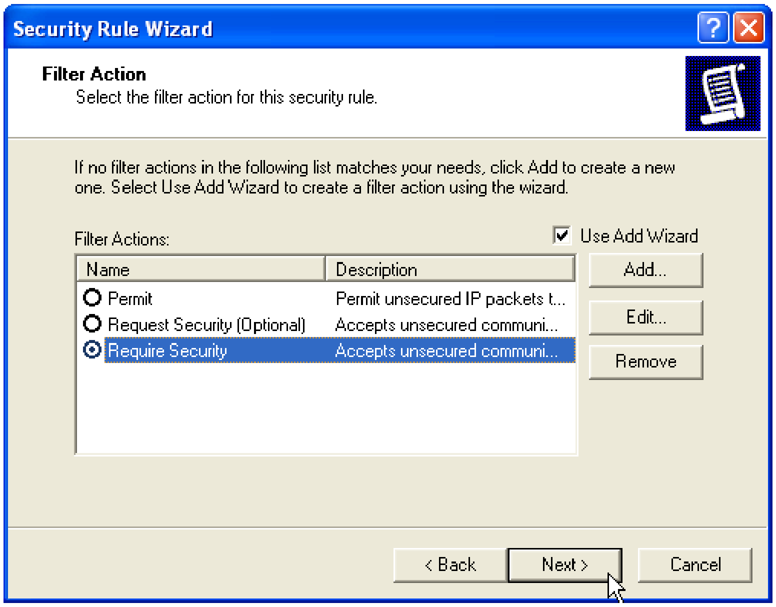
IP filter lists:

Name	Description
○ All ICMP Traffic	Matches all ICMP packets bet...
○ All IP Traffic	Matches all IP packets from t...
● Remote Desktop Between ...	This filter will allow Remote D...

Fig. 36. Select appropriate radio button

Step 23. Select the **Require Security** radio button. Click **Next**.

Note: The **Require Security** action insists that all communications be encrypted, while **Request Security** is more lenient and would allow connections to hosts that do not support your encryption requirements.



Security Rule Wizard

Filter Action

Select the filter action for this security rule.

If no filter actions in the following list matches your needs, click Add to create a new one. Select Use Add Wizard to create a filter action using the wizard.

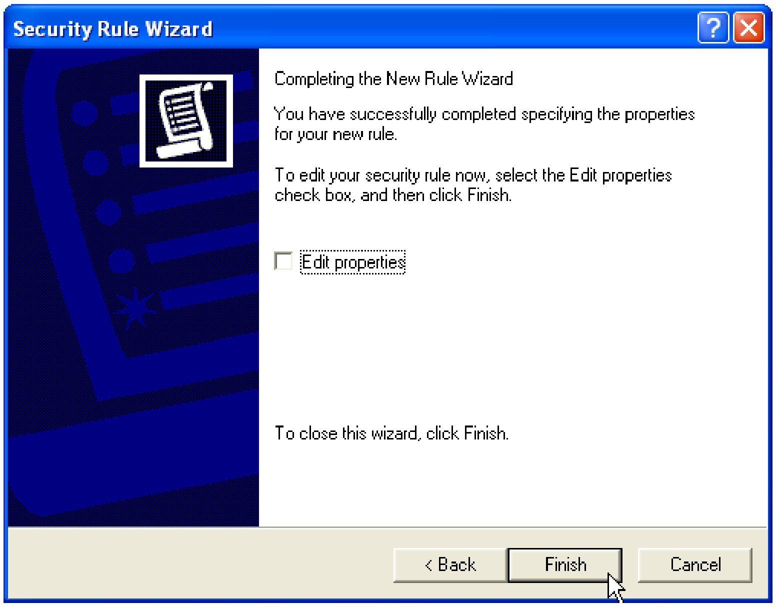
Filter Actions:

☑ Use Add Wizard

Name	Description
○ Permit	Permit unsecured IP packets t...
○ Request Security (Optional)	Accepts unsecured communi...
● Require Security	Accepts unsecured communi...

Fig. 37. **Filter Action** screen

Step 24. Ensure that **Edit properties** is unchecked. Click **Finish**.



Completing the New Rule Wizard

You have successfully completed specifying the properties for your new rule.

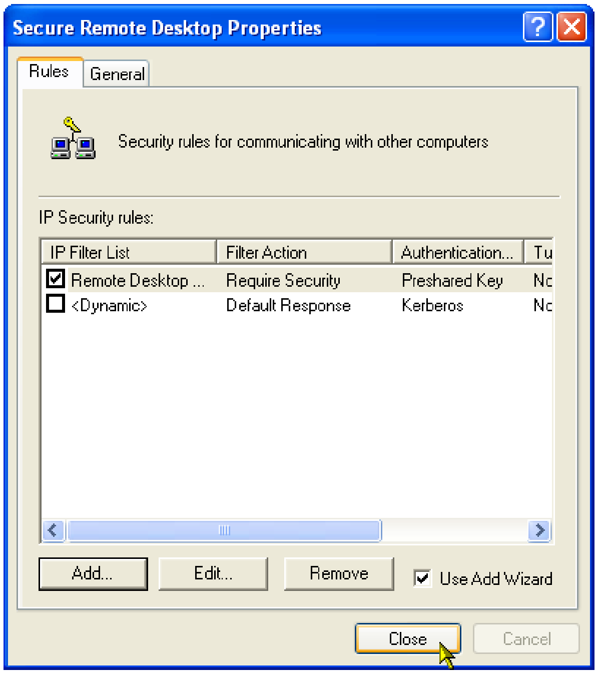
To edit your security rule now, select the Edit properties check box, and then click Finish.

□ Edit properties

To close this wizard, click Finish.

Fig. 38. Completion screen

Step 25. Check the **Remote Desktop** box. Click **Close**.



Security rules for communicating with other computers

IP Security rules:

IP Filter List	Filter Action	Authentication...	Tu
☑ Remote Desktop ...	Require Security	Preshared Key	Nc
□ <Dynamic>	Default Response	Kerberos	Nc

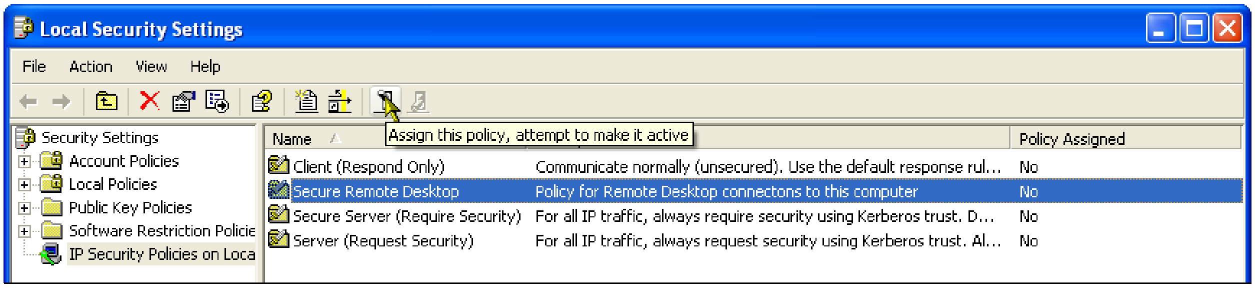
☑ Use Add Wizard

Fig. 39. Rules tab of **Secure Remote Desktop Properties** window

E. Test Remote Desktop Security

Step 1. Select the newly created policy in the **Local Security Settings** window.

Step 2. Click the **Toggle Switch** on the menu to enable the policy.



Name		Policy Assigned
Client (Respond Only)	Communicate normally (unsecured). Use the default response rul...	No
Secure Remote Desktop	Policy for Remote Desktop connectons to this computer	No
Secure Server (Require Security)	For all IP traffic, always require security using Kerberos trust. D...	No
Server (Request Security)	For all IP traffic, always request security using Kerberos trust. Al...	No

Fig. 40. **Local Security Settings** window

Step 3. Attempt to establish a remote desktop connection to the second computer.

Step 4. Attempt to establish a remote desktop connection from the second computer to the laptop.

Step 5. Enable the security policy on the second computer.

Step 6. Attempt to establish a remote desktop connection to the second computer.

Depending on the remote desktop connection to the laptop and the second computer, you should be unable to establish remote desktop connections when only one of the computers has the security policy enabled. Once both computers have enabled their security policy, they can establish cryptographically secure remote desktop connections. Because both computers use the same preshared key in your security policy, you can connect.

IX. References

[1] P. Oman, E. O. Schweitzer, III, and D. Frincke, “Concerns About Intrusions Into Remotely Accessible Substation Controllers and SCADA Systems,” proceedings of the 55th Annual Georgia Tech Protective Relaying Conference, Atlanta, GA, 2001.

[2] P. Oman, A. Risley, J. Roberts, and E. O. Schweitzer, III, “Attack and Defend Tools for Remotely Accessible Control and Protection Equipment in Electric Power Systems,” proceedings of the 56th Annual Georgia Tech Protective Relaying Conference, Atlanta, GA, 2002.

[3] *IEEE Guide for Electric Power Substation Physical and Electronic Security*, IEEE Standard 1402-2000, April 2000.

X. Biography

Dwight Anderson received his BS in electrical engineering from Steven’s Institute of Technology. He is now the security product manager for Schweitzer Engineering Laboratories, Inc. (SEL) in Pullman, Washington. Prior to joining SEL in 2005, he worked 20 years for Hewlett-Packard as an aerospace and defense business development manager and systems engineer, working on projects ranging from electronic warfare countermeasures to SCADA system programming. He recently became a member of the FBI InfraGard forum, regarding the exchange of information related to critical infrastructure protection. He holds the Global Security Essentials Certification (GSEC) from Global Information Assurance Certification (GIAC) and is a Certified Information Systems Security Professional (CISSP).

20090206 • TP6365-01