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Security Implications of Virtual Private Networks

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In order to understand Virtual Private Networks (or VPN's) better I built one using the Internet Security Protocol (or IPSec) VPN support that ships with Windows 2000. Based on the Microsoft experience, I will describe what an IPSec VPN is. I will also explore some of the security implications of using Virtual Private Networks (or VPN's).

What is a VPN?

A simple VPN is a "virtual" tunnel between two machines. All network traffic between these machines passes through this "virtual" tunnel. Because encryption is done at the Network layer, VPN support must be provided in the network stack. I used Microsoft Windows 2000 to construct an IPSec VPN. See Appendix B for an example of an IPSec VPN packet built by Windows 2000. Notice that the packet is not TCP or UDP and there is no indication what the packet may originally have started as.

Wide Area Network vendors market VPN services. With these services I have to trust the vendor to keep my data safe. The vendor may or may not use cryptographic methods to do this. This is not the VPN discussed in this paper.

Current Web browsers support encrypted conversations (HTTPS). This is not a VPN. It is application layer encryption. This kind application layer encrypted packet (SSL) is of type TCP, (with destination port 443 for HTTPS) and only the application payload is encrypted.

How is it built?

Windows 2000, Checkpoint 2000 and Cisco Routers can uses the IKE protocol to construct an IPSec VPN. See references [1,2] for a detailed description of the process.

When the tunnel is first created, both machines must authenticate each other. Windows 2000 provides 3 choices of authentication method: shared secret, certificate, and Kerberos. Kerberos authentication is not useful over the Internet. I used a shared secret for my testing but certificates are the best choice to ensure the authenticity of each machine in the VPN.

After authentication the machines negotiate what encryption algorithm to use, what secret to use with the encryption algorithm, what data integrity algorithm to use, what network traffic to pass through the tunnel etc.

After successful negotiation network traffic between the machines will flow through the constructed VPN.

Why is it useful?

VPN's are typically used to provide secure communication between systems across the Internet. Company to company or branch-office to head-office secured communications are common examples. VPN technology is becoming more inexpensive and high speed

Internet access is also becoming both more prevalent and inexpensive. This contributes to VPN's becoming a cost-effective alternative to private networks and also an effective way to provide high speed network access from home to the office.

A VPN can be used to ensure the identity of the participating machines (authentication and non-repudiation). It effectively prevents data modification and session hijacking. The VPN can prevent eavesdropping if the data is encrypted. Unlike application level network encryption like SSL a VPN is not application specific. All data between machines participating in a VPN can be protected.

It is not generally possible to guarantee that a particular security technique or tool is 100% foolproof. There is no guarantee that there isn't a way to circumvent or crack an IPSec VPN. However, a lot of effort has gone into the IPSec design and most security compromises will not be a result of a direct attack on the VPN.

What are the security implications of using VPN's?

VPN's do not remove the requirement for proper security practices. When we connect company A to company B using VPN technology the systems at company B can access systems at company A. If company B has compromised systems the VPN can allow free access to company A resources. This is not a new exposure. When companies connect their networks together through a private line, most if not all of the same exposures exist. With inexpensive VPN technology however, we have the capability of building many more exposures. Microsoft Windows 2000 can be configured to talk over a VPN to some machines and to talk in the clear to others. This is a typical home office situation. Unwanted parasites like Back Orifice [6,7] can allow a hacker real-time unrestricted access to the corporate network. We can limit the possible attack points to machines participating in the VPN if all the machines only accept VPN network traffic. In practice this is not practical.

VPN's do not provide fine-grained access control mechanisms. A major VPN strength is that it can provide all the same services as the local LAN. Applications cannot usually tell if the user is VPN based or not. A VPN can be configured so that only certain networks segments are accessible or only certain protocols flow over the VPN. Network controls usually cannot restrict access to resources by user. Application proxies like the iPlanet application server can but they cannot provide access to all applications.

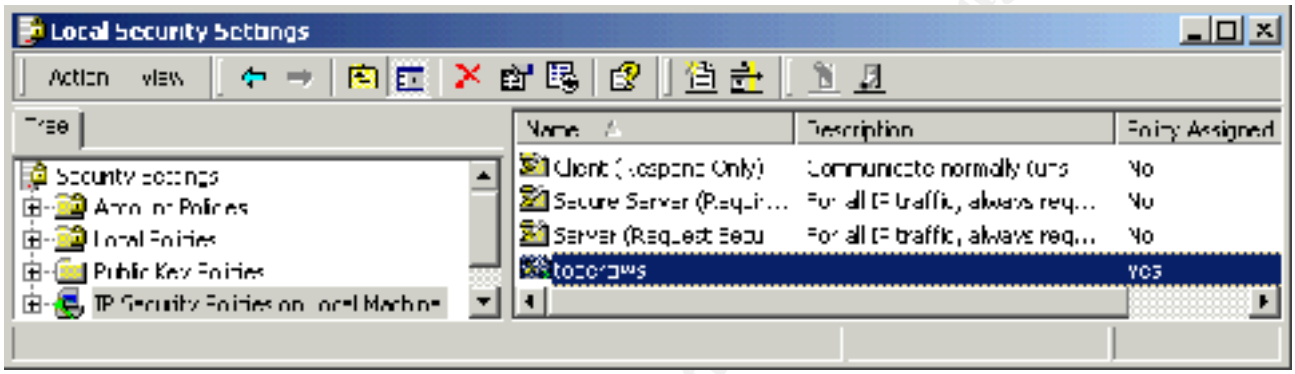
Conclusion

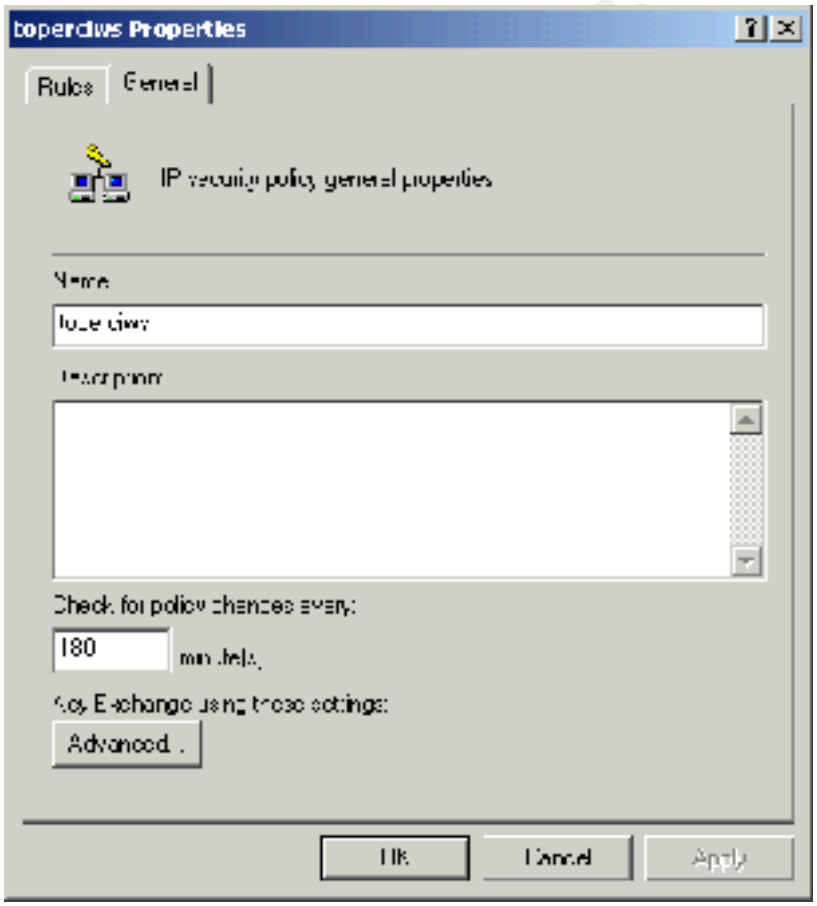
VPN's are an effective way to create secure communication channels across the Internet or between sensitive systems within a company's internal network. With the inclusion of VPN support in Microsoft 2000, Cisco routers, Checkpoint 2000, and a host of other systems, the deployment of VPN's is going to become more commonplace. Without proper security design, these VPN's could add many more unwanted entrances to corporate networks. Use VPN's where appropriate but ensure security issues including machine configuration, policy and user security awareness have been considered.

Appendix A: Setting up a Windows 2000 VPN

The following is a quick introduction to setting up a VPN on Windows 2000. See [5] for more detailed instructions and a description of the various Windows 2000 VPN debugging tools.

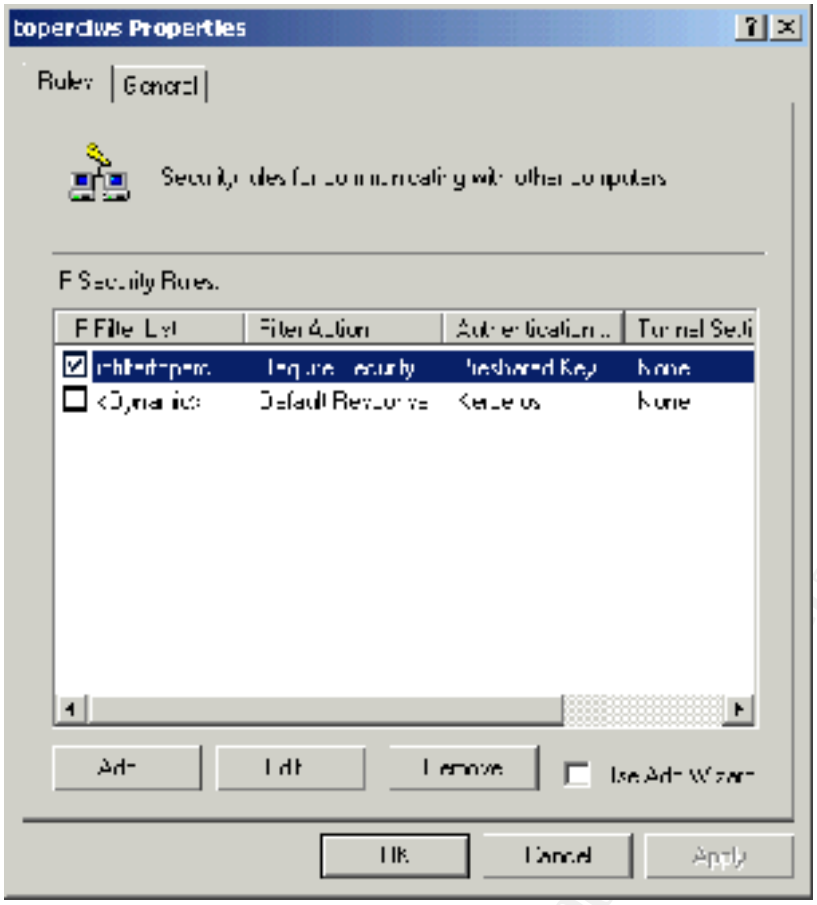
The administrative tool used on Windows 2000 to create and edit IPSec security policies can be accessed by "file -> run -> secpol.msc".



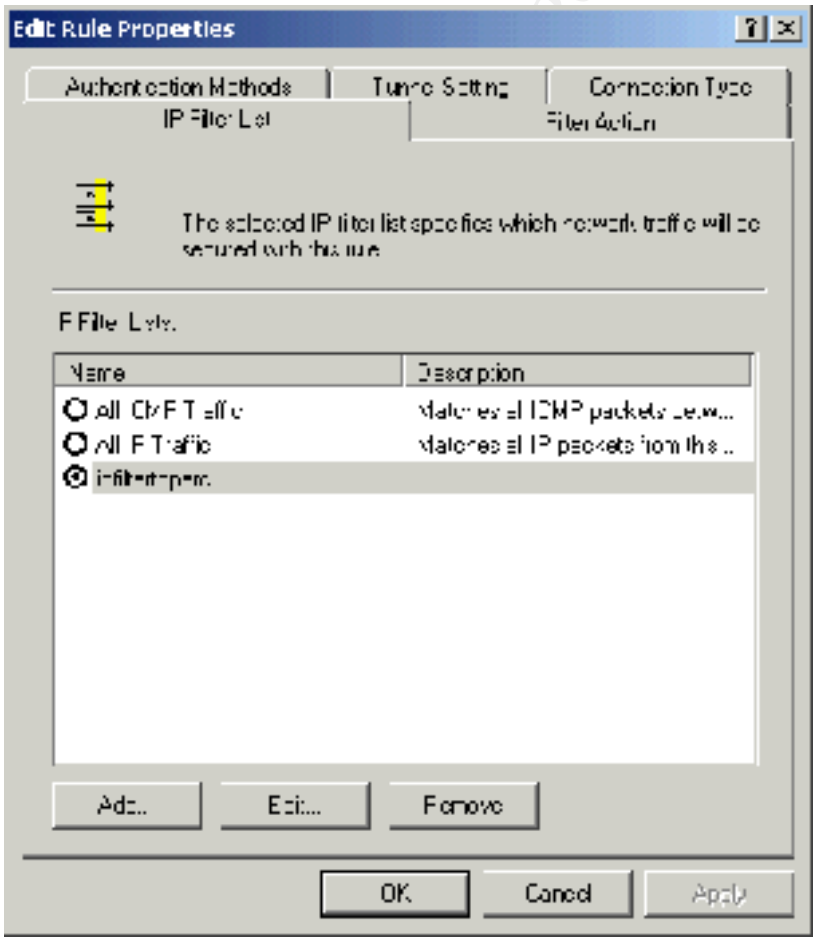


Right click on the security policy on the window above to assign and un-assign the policy. The policy is only active when assigned.

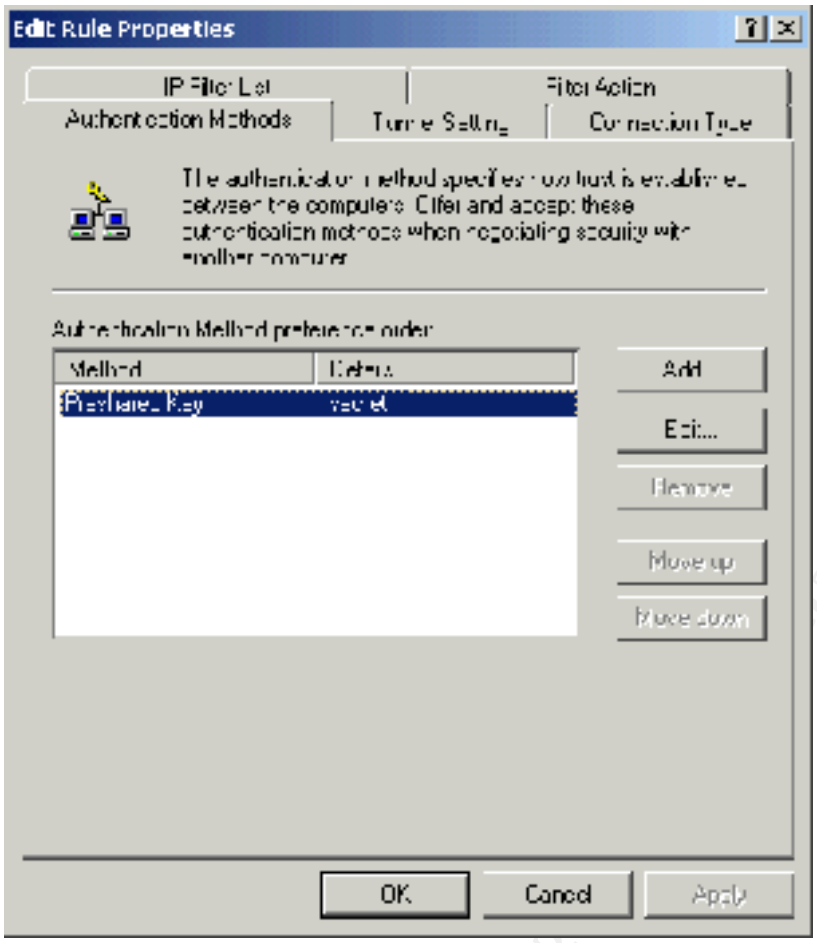
Double Click on the security policy to obtain the "properties" window for the "toperciws" security policy as seen on the left.



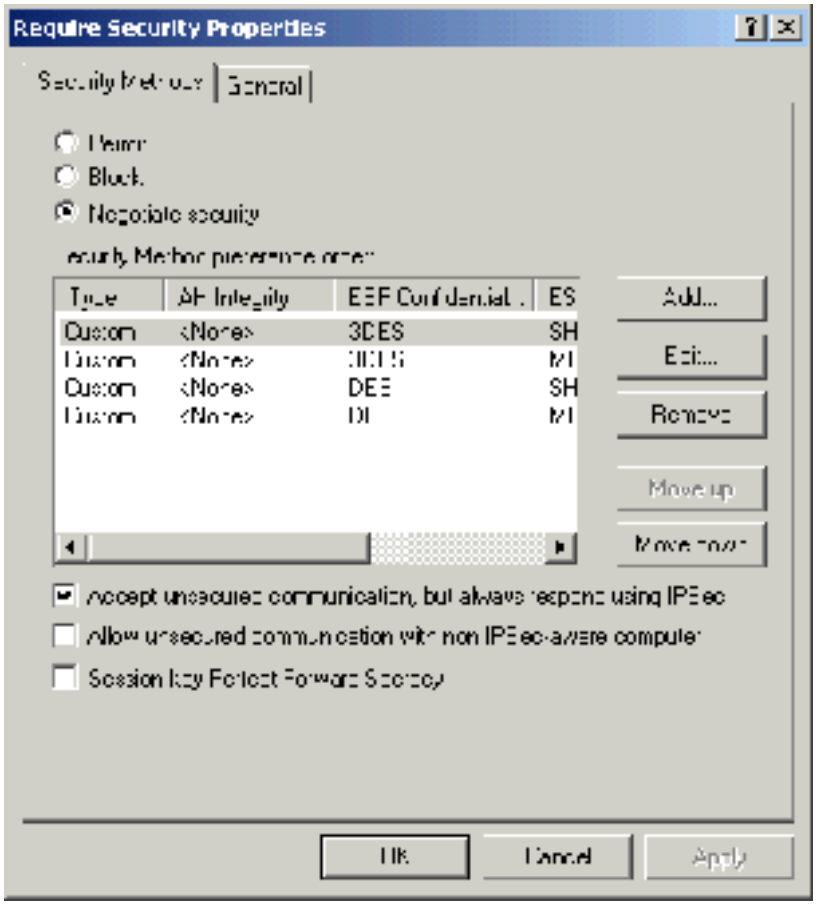
The "rules" tab of the security policy shows which "IP Filter Lists" is in effect. Double Click on a filter list to view or change it.



The "IP Filter List" tab shows the active filter. This filter specifies which networks define the encryption domain or VPN.



The "Authentication method " tab describes how a VPN is constructed. I used the shared key method (with a poor password) for testing . Kerberos and Certificates are also available methods.



The "Filter Action" tab drills down to the following "Security Properties" window. IPSec negotiation parameters are set here.

Appendix B: VPN Trace

The Following is a Network General sniffer trace of a single encrypted IPSec transport mode (Not Tunneled) packet generated via the setup described in Appendix A. As can be seen, VPN traffic is not TCP or UDP traffic. The VPN settings described above are really in effect.

```
DLC:  ----- DLC Header -----
DLC:
DLC:  Frame 7734 arrived at  07:46:52.0743; frame size is 110 (006E hex) bytes.
DLC:  Destination = Station 00C04F97E6A6
DLC:  Source      = Station 00C04F92F6F3
DLC:  Ethertype   = 0800 (IP)
DLC:
IP: ----- IP Header -----
IP:
IP: Version = 4, header length = 20 bytes
IP: Type of service = 00
IP:       000. .... = routine
IP:       ...0 .... = normal delay
IP:       .... 0... = normal throughput
IP:       .... .0.. = normal reliability
IP: Total length    = 96 bytes
IP: Identification  = 20416
IP: Flags           = 0X
IP:       .0.. .... = may fragment
IP:       ..0. .... = last fragment
IP: Fragment offset = 0 bytes
IP: Time to live    = 128 seconds/hops
IP: Protocol        = 50 (SIPP-ESP)
IP: Header checksum = 02B3 (correct)
IP: Source address      = [10.49.100.24], 4F92F6F3
IP: Destination address = [10.49.111.127], WDCM4C
IP: No options
IP:
ESP: ----- IPv6 ESP -----
ESP:
ESP: Security Association Identifier = 2641496210
ESP: Opaque Transform Data           =
00000001F2F7B41A6B7DD81A211487A56E4B96633FDF5A7652310178B9F6218436CF3921614F88F
E6539D143AC69...

ADDR  HEX                                                ASCII
0000  00 C0 4F 97 E6 A6 00 C0  4F 92 F6 F3 08 00 45 00  ..O.....O.....E.
0010  00 60 4F C0 00 00 80 32  02 B3 0A 31 64 18 0A 31  .`O....2...1d..1
0020  6F 7F 9D 72 08 92 00 00  00 01 F2 F7 B4 1A 6B 7D  o..r..........k}
0030  D8 1A 21 14 87 A5 6E 4B  96 63 3F DF 5A 76 52 31  ..!...nK.c?.ZvR1
0040  01 78 B9 F6 21 84 36 CF  39 21 61 4F 88 FE 65 39  .x..!.6.9!aO..e9
0050  D1 43 AC 69 5D CC 15 FE  53 3C AA 5A 84 27 B6 D9  .C.i]...S<.Z.'..
0060  DD 46 E6 4A 45 9F AD 24  0C 11 F8 A8 EF 2F        .F.JE..$...../
```

References

[1] "IETF Internet Security Protocol Standard". 01 Mar 2000. URL: http://www.ietf.org/html.charters/ipsec-charter.html

[2] Checkpoint Software Technologies Ltd. "Checkpoint Virtual Private Networks" January 2000

[3] Sun-Netscape Alliance. "iPlanet Home Page" URL: http://www.iPlanet.com

[4] Reference Q252735. "How to configure IPSec Tunneling in Windows 2000". 25 Feb 2000. URL: http://support.microsoft.com/support/kb/articles/Q252/7/35.ASP?LN=EN-US&SD=gn&FR=0

[5] "Step-by-Step Guide to Internet Protocol Security (IPSec)". 17 Feb 2000. URL: http://www.microsoft.com/WINDOWS2000/library/planning/security/ipsecsteps.asp

[6] http://www.cyberarmy.com.

[7] http://www.rootshell.com