Realities of IPv6 IPsec Deployment
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Merike Kaeo
merike@doubleshotsecurity.com

Topics Covered

- IPsec standard done but still evolving (that's a good thing)
- Practical Deployment Considerations
- Personal Observations
- Sample Configurations

IPsec Components

- AH (Authentication Header)
  - Authentication is applied to the entire packet, with the mutable fields in the IP header zeroed out
  - If both ESP and AH are applied to a packet, AH follows ESP
  - Standard requires HMAC-MD5-96 and HMAC-SHA1-96….older implementations also support keyed MD5
- ESP (Encapsulating Security Payload)
  - Must encrypt and/or authenticate in each packet
  - Encryption occurs before authentication
  - Authentication is applied to data in the IPsec header as well as the data contained as payload
  - Standard requires DES 56-bit CBC and Triple DES. Can also use RC5, IDEA, Blowfish, CAST, RC4, NULL
- IKE (Internet Key Exchange)
  - Automated SA (Security Association) creation and key management

Relevant Standard(s)

- IETF specific
  - rfc2409: IKEv1
  - rfc4301: IPsec Architecture (updated)
  - rfc4303: IPsec ESP (updated)
  - rfc4306: IKEv2
  - rfc4718: IKEv2 Clarifications
  - rfc4945: IPsec PKI Profile
- IPv6 and IPsec
  - rfc4294: IPv6 Node Requirements
  - Rfc4552: Authentication/Confidentiality for OSPFv3
  - rfc4877: Mobile IPv6 Using IPsec (updated)
  - rfc4891: Using IPsec to secure IPv6-in-IPv4 Tunnels

IPsec Maintenance Working Group

- First Meeting in Dublin IETF (July 2008)
- A charter item specific for IPv6
  - standards-track extension to IKEv2 that provides full IPv6 support for IPsec remote access clients that use configuration payloads. This work will be based on draft-eronen-ipsec-ikev2-ipv6-config. The WG shall solicit help and reviews from the 6MAN WG to ensure that all aspects of IPv6 are properly considered.

Considerations For Using IPsec

- Security Services
  - Data origin authentication
  - Data integrity
  - Replay protection
  - Confidentiality
- Size of network
- How trusted are end hosts – can apriori communication policies be created?
- Vendor support
- What other mechanisms can accomplish similar attack risk mitigation

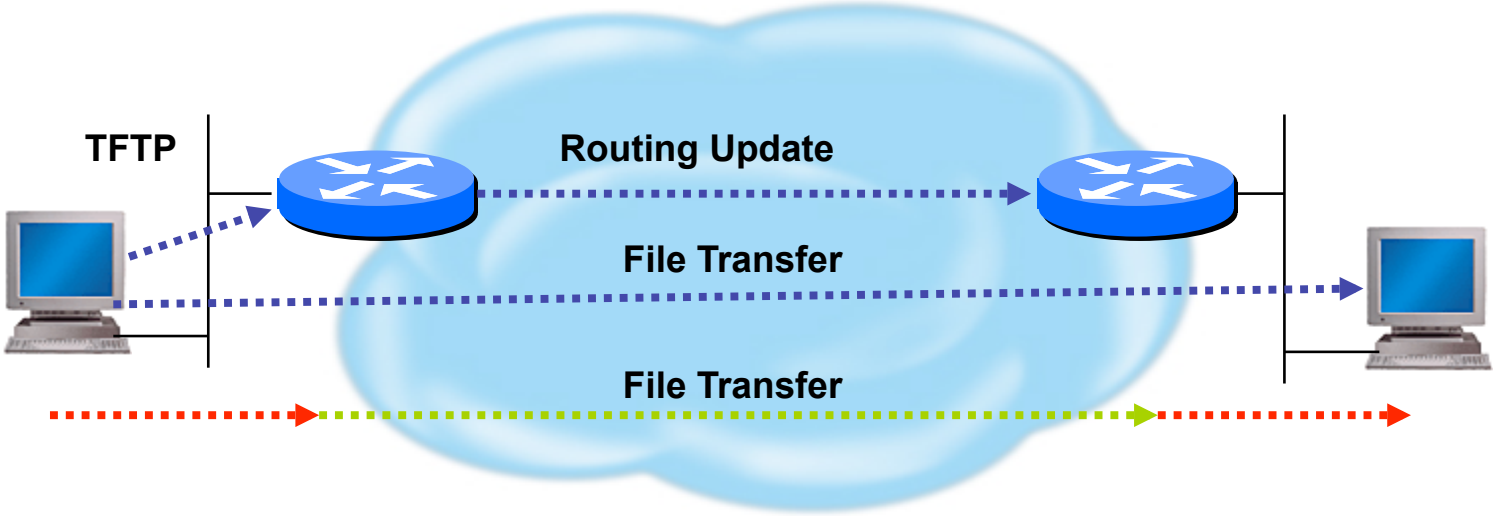
Non-Vendor Specific Deployment Issues

- Historical Perception
  - Configuration nightmare
  - Not interoperable
- Performance Perception
  - Need empirical data
  - Where is the real performance hit?
- Standards Need Cohesion
- IPv6 Certification Entities Need Cohesion

Vendor Specific Deployment Issues

- Lack of interoperable defaults
  - A default does NOT mandate a specific security policy
  - Defaults can be modified by end users
- Configuration complexity
  - Too many knobs
  - Vendor-specific terminology
- Good News: IPv6 support in most current implementations

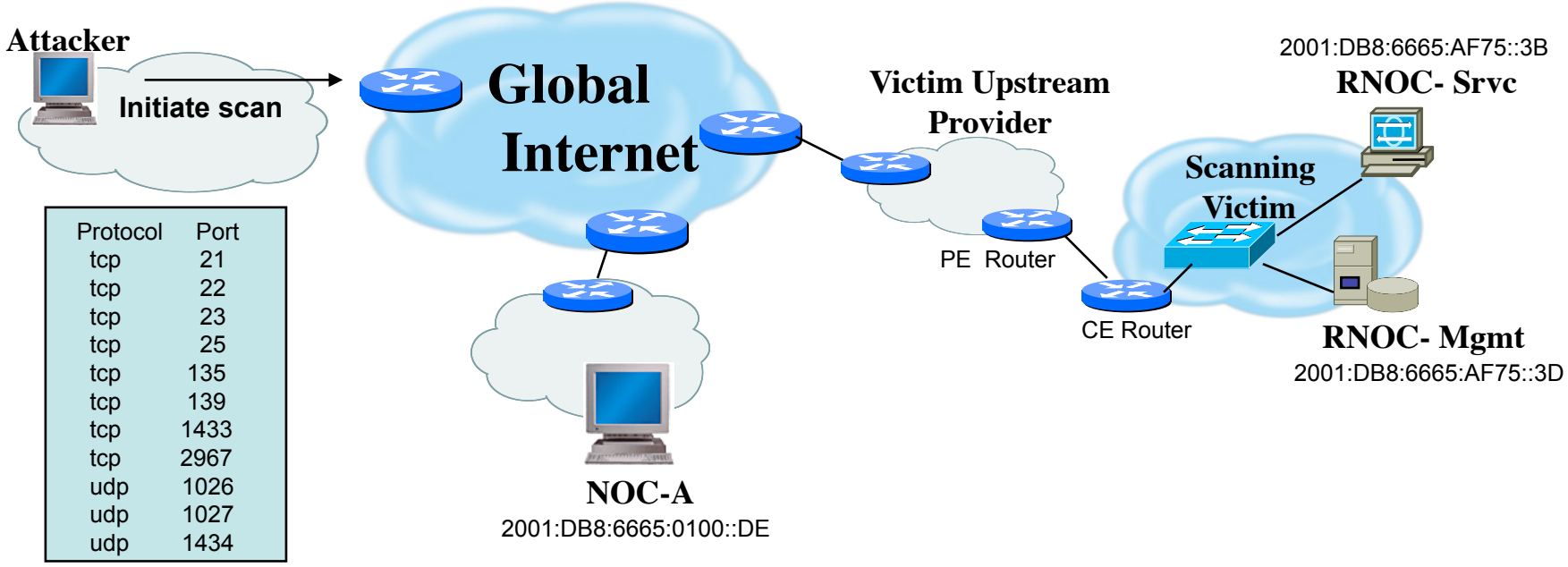
Transport vs Tunnel Mode



Transport Mode: End systems are the initiator and recipient of protected traffic

Tunnel Mode: Gateways act on behalf of hosts to protect traffic

Protecting Against Scanning Attacks



Protocol	Port
tcp	21
tcp	22
tcp	23
tcp	25
tcp	135
tcp	139
tcp	1433
tcp	2967
udp	1026
udp	1027
udp	1434

IPsec Security Policy Database

From	To	Protocol	Dst Port	Policy
2001:DB8:6665:0100::DE	2001:DB8:6665:01C8::3B	TCP / UDP	53 (DNS)	ESP: SHA1, AES-256
2001:DB8:6665:0100::DE	2001:DB8:6665:AF75::3B	TCP	25 (SNMP)	ESP: SHA1, AES-256
2001:DB8:6665:0100::DE	2001:DB8:6665:AF75::3D	UDP	1812/1813 (RADIUS)	ESP: SHA1, AES-128
2001:DB8:6665:0100::DE	2001:DB8:6665:AF75::3D	UDP	514 (Syslog)	ESP: SHA1, 3DES
2001:DB8:6665:0100::DE	2001:DB8:6665:AF75::/48	TCP / UDP	ANY	ESP: SHA1

DOUBLE SHOT SECURITY

IPv6 Architectures using IPsec

- Protect all traffic using IPsec for data origin authentication and integrity
- Add confidentiality as dictated by security policy

Need to dispel myth that using IPsec mandates the demise of network layer defense mechanisms

IPv6 IPsec Concerns

- Are enough people aware that IKEv2 is not backwards compatible with IKEv1?
  - IKEv1 is used in most IPv6 IPsec implementations
  - Will IKEv2 implementations first try IKEv2 and then revert to IKEv1?
- Is IPsec implemented for IPv6?
  - Some implementations ship IPv6 capable devices without IPsec capability….this needs to change
- OSPFv3
  - All vendors 'IF' they implement IPsec used AH
  - Latest standard to describe how to use IPsec says MUST use ESP w/Null encryption and MAY use AH

IPv6 IPsec Concerns (cont)

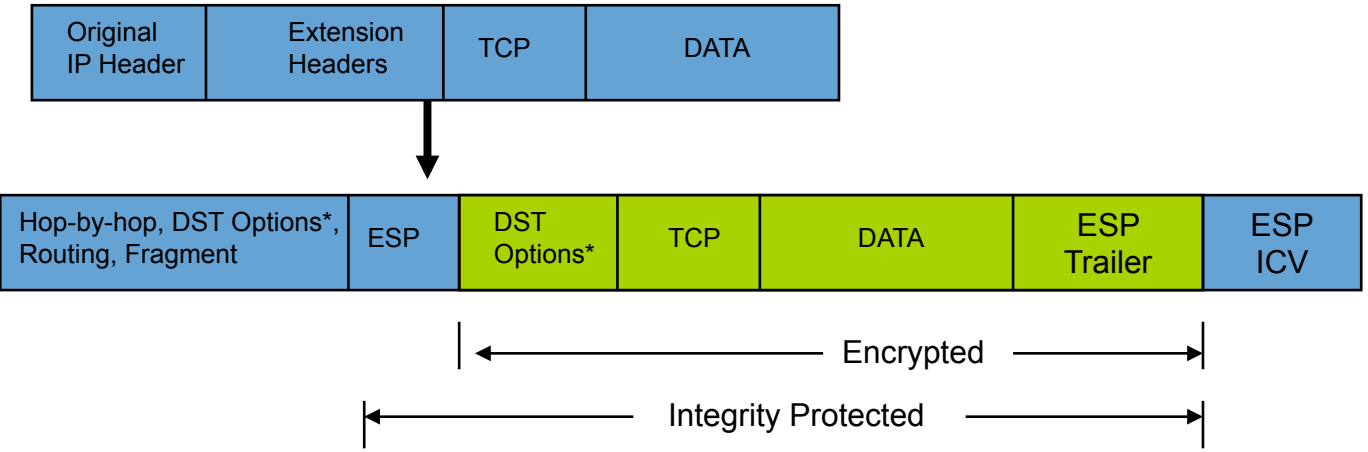
- What is transport mode interoperability status?
  - Will end user authentication be interoperable?
- PKI Issues
  - Which certificates do you trust?
  - How does IKEv1 and/or IKEv2 handle proposals with certificates?
  - Should common trusted roots be shipped by default?
  - Who is following and implementing pki4ipsec-ikecert-profile (rfc4945)
- Have mobility scenarios been tested?
  - Mobility standards rely heavily on IKEv2

Enhancements Needed

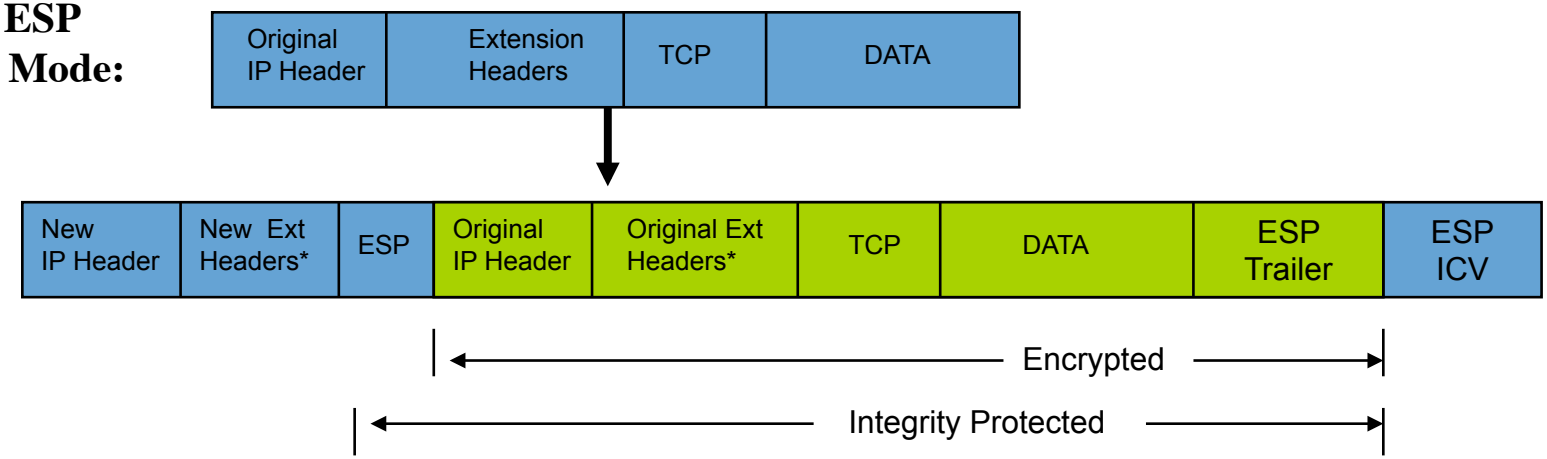
- Standards Modifications
  - Need to take into consideration Stateless Autoconfiguration where Router Advertisement sends network prefix
  - Need to be able to differentiate between encrypted versus integrity protected traffic
- Usability
  - Interoperable defaults
  - Consistent terminology

IPv6 IPsec ESP

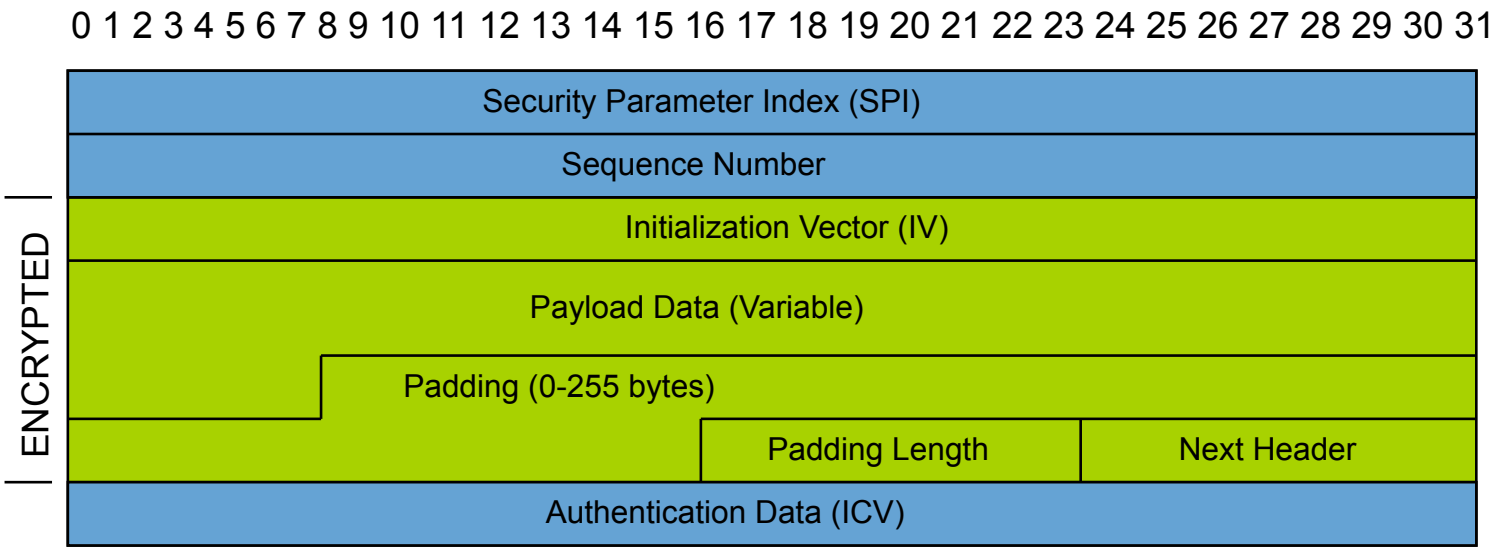
IPv6 ESP Transport Mode:



IPv6 ESP Tunnel Mode:



ESP Header Format



SPI: Arbitrary 32-bit number that specifies SA to the receiving device
Seq #: Start at 1 and must never repeat; receiver may choose to ignore
IV: Used to initialize CBC mode of an encryption algorithm
Payload Data: Encrypted IP header, TCP or UDP header and data
Padding: Used for encryption algorithms which operate in CBC mode
Padding Length: Number of bytes added to the data stream (may be 0)
Next Header: The type of protocol from the original header which appears in the encrypted part of the packet
Auth Data: ICV is a digital signature over the packet and it varies in length depending on the algorithm used (SHA-1, MD5)

Default Issues

Vendor A

IKE Phase 1
- -SHA1
- -RSA-SIG
- -Group 1
- -Lifetime 86400 Sec
- -Main Mode

IKE Phase 2
- -PFS
- -Group 1

Vendor B

IKE Phase 1
- -MD5
- -Pre-Share Key
- -Group 5
- -Lifetime 86400 Sec
- -Main Mode

IKE Phase 2
- -PFS
- -Group 5

Vendor C

IKE Phase 1
- -SHA1
- -Pre-Share Key
- -Group 2
- -Lifetime 86400 Sec
- -Aggressive Mode

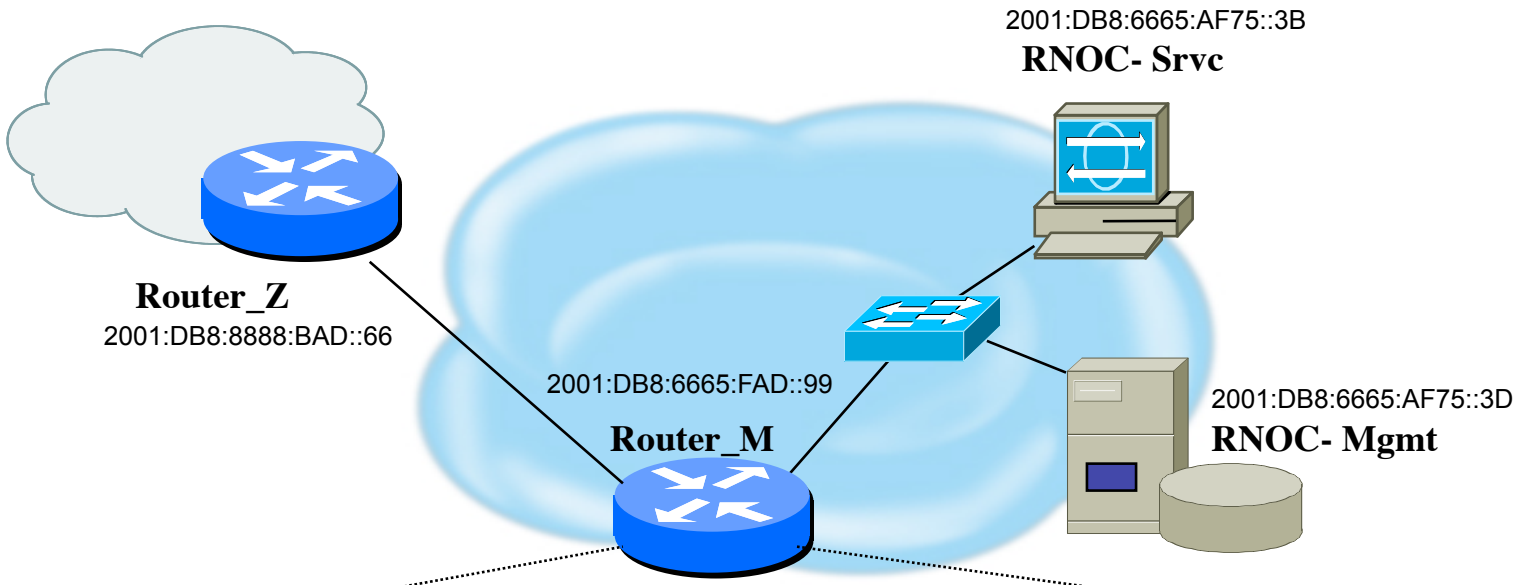
IKE Phase 2
- -PFS
- -Group 2

Terminology Issues

IKE Phase 1	DH Key Length	IKE Phase 2
IKE Phase 1 SA	DH Group	IKE Phase 2 SA
IKE SA	Modp #	IPsec SA
ISAKMP SA	Group #	Quick Mode
Main Mode		

Configuration complexity increased with vendor specific configuration terms

Potentially Easy Configuration



Syslog server 2001:DB8:6665:AF75::3D authenticate esp-null sha1 pre-share ‘secret4syslog’

TFTP server 2001:DB8:6665:AF75::3D authenticate esp-null aes128 pre-share ‘secret4tftp’

BGP peer 2001:DB8:8888:BAD::66 authenticate esp-null aes128 pre-share ‘secret4AS#XXX’

DOUBLE SHOT SECURITY

Interoperable Defaults For SAs

- Security Association groups elements of a conversation together
  - ESP encryption algorithm and key(s)
  - Cryptographic synchronization
  - SA lifetime
  - SA source address
  - Mode (transport or tunnel)

How Do We Communicate Securely ?

Do we want integrity protection of data ?
Do we want to keep data confidential ?
Which algorithms do we use ?
What are the key lengths ?
When do we want to create new keys ?
Are we providing security end-to-end ?

IPv6 IPsec WishList

- Common Terminology
- Interoperable Defaults
  - RFC 4308 was a good start but needs to be updated
- Interoperability Tests
  - Both transport and tunnel mode
  - Mobility scenarios
- API Standards
- Repeatable performance data

Pretty Good IPsec Policy

- IKE Phase 1 (aka ISAKMP SA or IKE SA or Main Mode)
  - 3DES (AES-192 if both ends support it)
  - Lifetime (480 min = 28800 sec)
  - SHA-1
  - DH Group 14 (aka MODP# 14)
- IKE Phase 2 (aka IPsec SA or Quick Mode)
  - 3DES (AES-192 if both ends support it)
  - Lifetime (60 min = 3600 sec)
  - SHA-1
  - PFS 2
  - DH Group 14 (aka MODP# 14)

Routers: Configuring IPsec

- For IPv6, consider using transport mode between routers and syslog servers, tftp servers, snmp servers, etc.
- Document for Cisco IPv6 IPsec configuration:
  - http://www.lseltd.com/univercd/cc/td/doc/product/software/ios123/123cgcr/ipv6_c/v6_ipsec.pdf
- Document for Juniper IPsec configuration:
  - http://www.pacificbroadband.com/techpubs/software/junos/junos83/feature-guide-83/html/fg-ipsec13.html#1139838

Cisco: Configuring IPsec

STEP 1 *Configure the IKE Phase 1 Policy (ISAKMP Policy)*

Cisco literature refers to IKE Phase 1 as the ISAKMP policy.
It is configured using the command:

crypto isakmp policy *priority*

Multiple policies can be configured and the priority number, which ranges from 1 to 10,000, denotes the order of preference that a given policy will be negotiated with an ISAKMP peer. The lower value has the higher priority. Once in the ISAKMP configuration mode, the following parameters can be specified are:

Encryption Algorithm
Hash Algorithm
Authentication Method
Group Lifetime

Cisco: Configuring IPsec

STEP 2 *Set the ISAKMP Identity*

The ISAKMP identity specifies how the IKE Phase 1 peer is identified, which can be either by IP address or host name.
The command to use is:

crypto isakmp *identity* {*IP address* | *hostname*}

By default, a peer's ISAKMP identity is the peer's IP address.
If you decide to change the default just keep in mind that it is best to always be consistent across your entire IPsec-protected network in the way you choose to define a peer's identity.

Cisco: Configuring IPsec

STEP 3 *Configure the IPsec AH and ESP Parameters*

The AH and ESP parameters are configured with the following commands:

crypto ipsec transform-set *transform-set-name* <transform 1> <transform 2> mode [tunnel | transport]
crypto ipsec security-association lifetime seconds *seconds*

STEP 4 *Configure the IPsec Traffic Selectors*

The traffic selectors are configured by defining extended access-lists. The *permit* keyword causes all IP traffic that matches the specified conditions to be protected by IPsec

Cisco: Configuring IPsec

STEP 5 *Configure the IKE Phase 2 (IPsec SA) Policy*

This step sets up a crypto map which specifies all the necessary parameters to negotiate the IPsec SA policy. The following commands are required:

crypto map *crypto-map-name seq-num* ipsec-isakmp
match address *access-list-id*
set peer [*IP address* | *hostname*]
set transform-set *transform-set-name*
set security-association lifetime seconds *seconds*
set pfs [group1 | group 2]

Cisco: Configuring IPsec

STEP 6 *Apply the IPsec Policy to an Interface*

The configured crypto map is then applied to the appropriate interface using the crypto map *crypto-map-name* command.
It is possible to apply the same crypto map to multiple interfaces.
This case would require the use of the command:

crypto map *crypto-map-name* local-address *interface-id*

Using this command, the identifying interface will be used as the local address for IPsec traffic originating from or destined to those interfaces sharing the same crypto map. A loopback interface should be used as the identifying interface.

Unix IPsec IKE Daemons

- Racoon2 (IKEv1 and IKEv2 and KINK)
  - http://www.racoon2.wide.ad.jp/w/
- Ipsec-tools (IKEv1)
  - port of KAME's IPsec utilities to the Linux-2.6 IPsec implementation; it supports NetBSD and FreeBSD as well
  - http://ipsec-tools.sourceforge.net/
- Strongswan (IKEv1 and IKEv2)
  - http://www.strongswan.org/
- Openikev2 (IKEv2)
  - http://openikev2.sourceforge.net/

LINUX and MACOSX machines

- Type command ‘ *man racoon* ’
  - Read how to set-up racoon, the name for this particular IKE software
- Type command ‘ *man setkey* ’
  - This command is used to set up the SA database
- The following files are located in ***/etc/raccoon***:
  - ***psk.txt*** – file which contains the shared secrets
  - ***raccoon.conf*** – file which configures IKE phase 1 and IKE phase 2 parameters

Set Up Security Policy Database

- Create a file named '***ipsec.conf***' which will be used with *setkey* to establish the correct security associations. The file should have the following information:
  - `flush;`
  - `spdflush;`
  - `spdadd 2001:DB8:6665:AF75::3D/128 2001:DB8:8888:BAD::66/128 any -P out ipsec esp/transport//require ;`
  - `spdadd 2001:DB8:8888:BAD::66/128 2001:DB8:6665:AF75::3D/128 any -P in ipsec esp/transport//require ;`

Creating SA Database

- Test to see what happens when you try and create an SA database:
- Type the following:
  - `setkey -f /etc/racoon/ipsec.conf`
- Use the '`setkey -P -D`' command to see if appropriate entries have been created

Pre-Shared Key Configuration

- Edit the psk.txt file to add the peer IP address and the pre-shared secret key:
  - `# file for pre-shared keys used for IKE authentication`
  - `# format is:  'identifier' 'key'`
  - `# For example:`
  - `#  10.1.1.1            flibbertigibbet`
  - `#  www.example.com      12345`
  - `#  foo@www.example.com  micropachycephalosaurus`
  - `<peer IPv6 address>     <shared secret>`
- Since the psk.txt file contains sensitive information make sure that the file is appropriately protected:
  - `chmod 600 /etc/raccoon/psk.txt`

Racoon.conf file

```
# Racoon IKE daemon configuration file.
# See 'man racoon.conf' for a description of the format
      and entries.
path include "/etc/racoon";
path pre_shared_key "/etc/racoon/psk.txt";
path certificate "/etc/racoon/certs";
log debug;
remote anonymous
{
    {
        exchange_mode main;
        lifetime time 480 min;
        proposal {
            encryption_algorithm 3des;
            hash_algorithm sha1;
            authentication_method pre_shared_key;
            dh_group 14;
        }
    }
```

```
sainfo anonymous
{
        pfs_group 2;
        lifetime time 60 min ;
        encryption_algorithm 3des, blowfish
         448, rijndael ;
        authentication_algorithm hmac_sha1,
         hmac_md5 ;
        compression_algorithm deflate ;
}
```

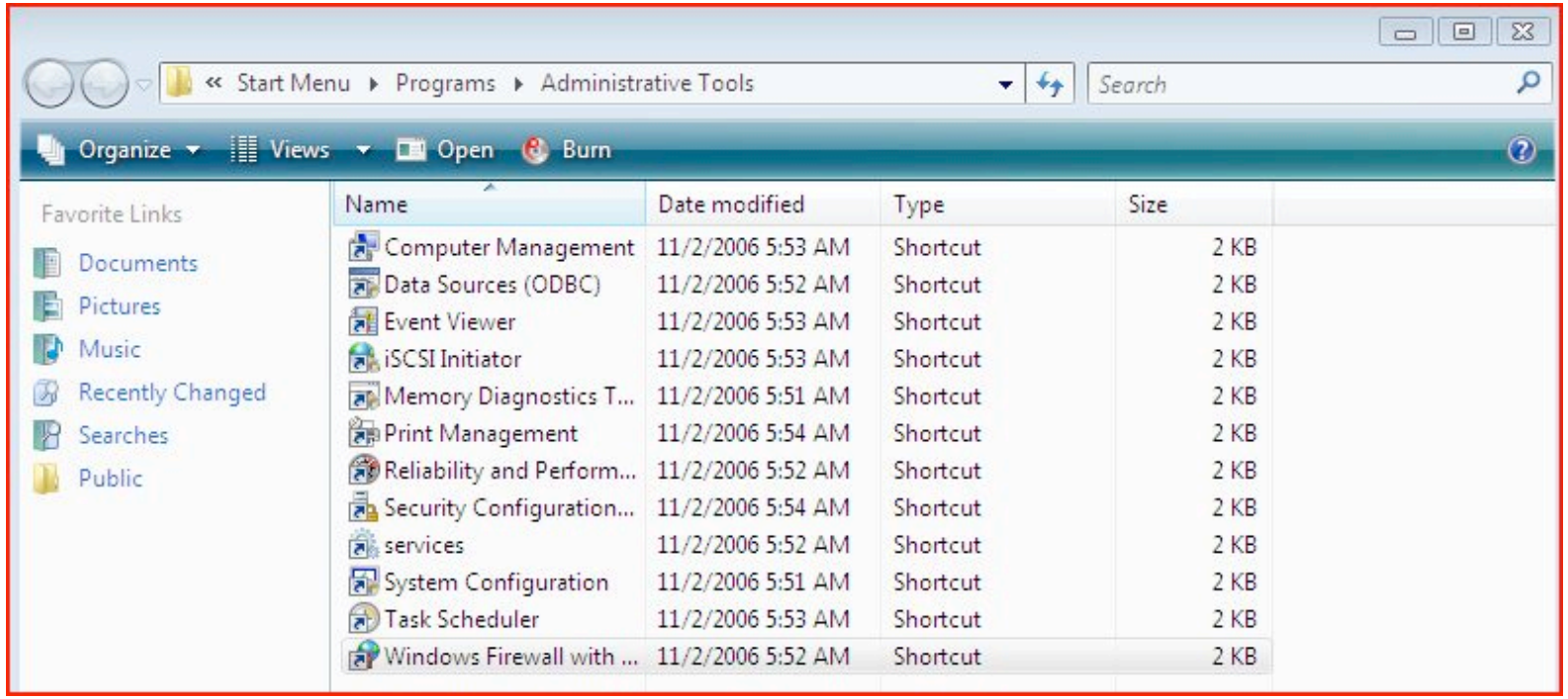
Testing Racoon

- Test racoon with the following command:
  - `racoon -v -f /etc/racoon/racoon.conf -l /etc/racoon/test.log`

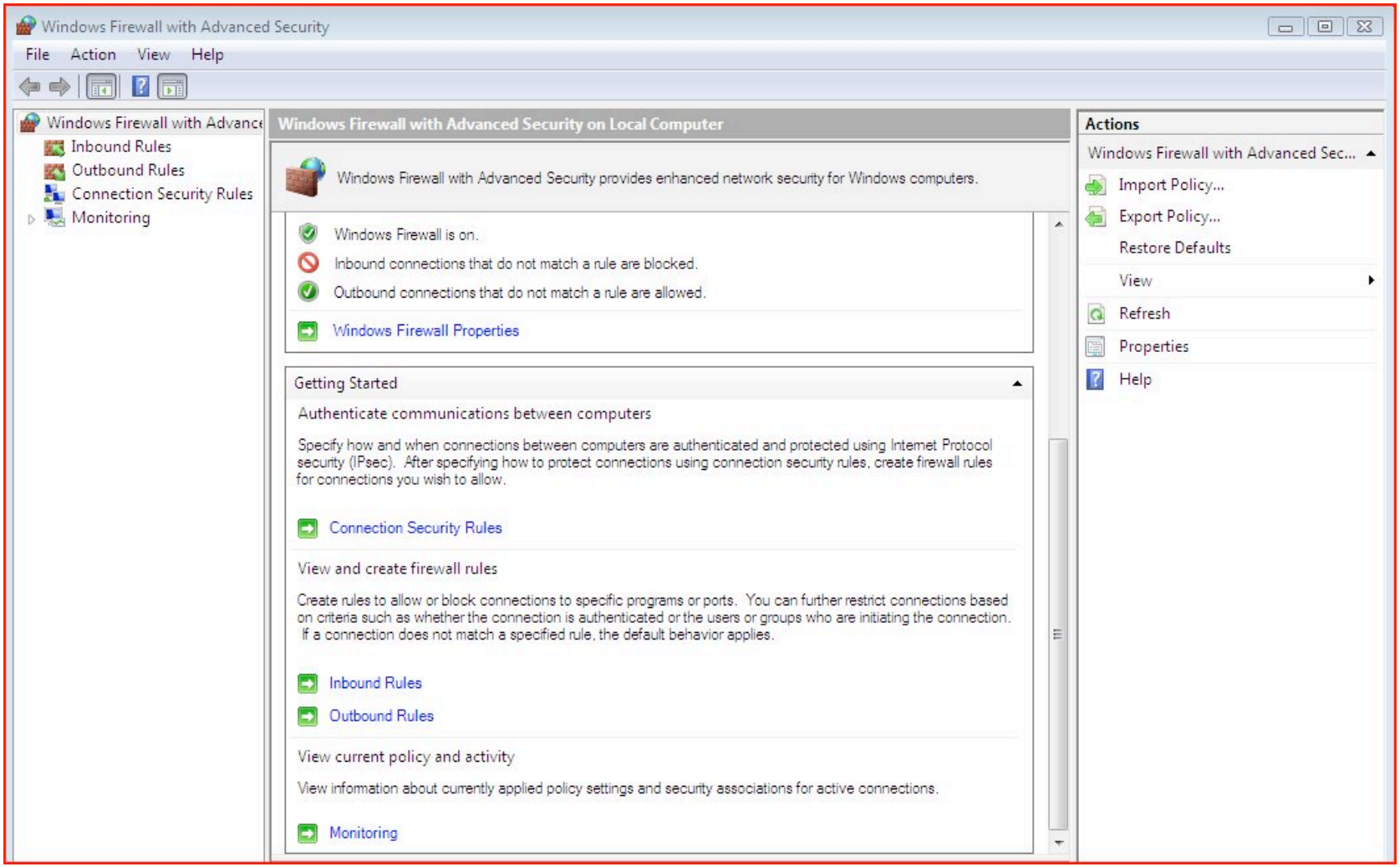
- The '`-l /etc/racoon/test.log`' file is used to write any debug information in the event that there are problems.

Vista: Configuring IPsec

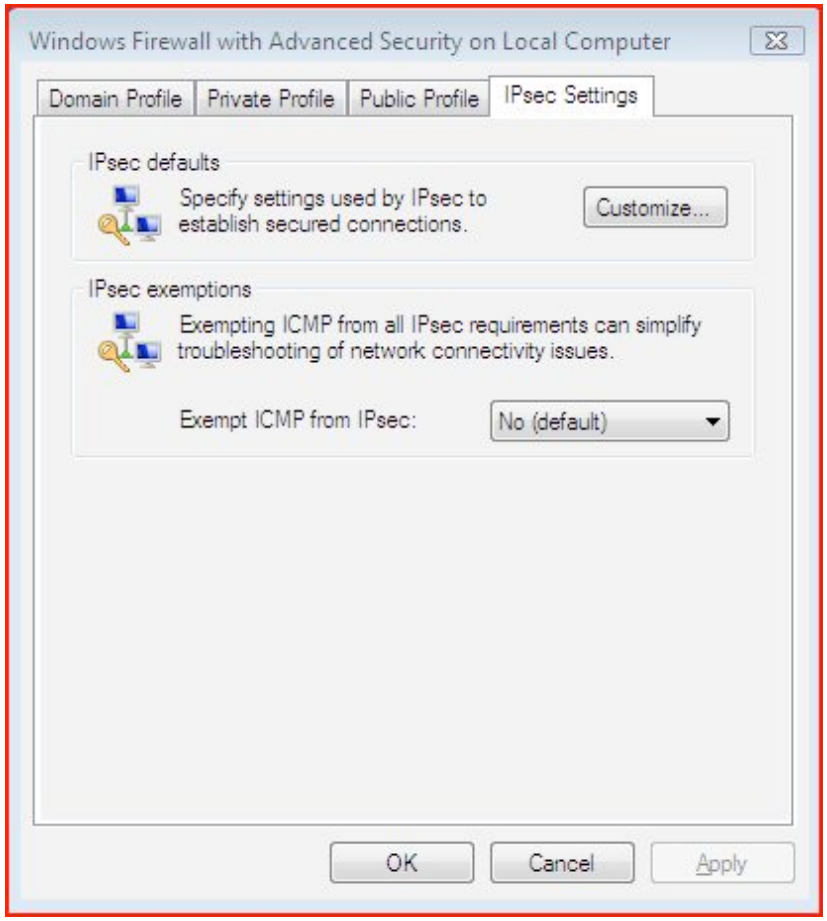
- Defaults work great in a MS-only environment
- Else, need to edit firewall (wf.mmc)

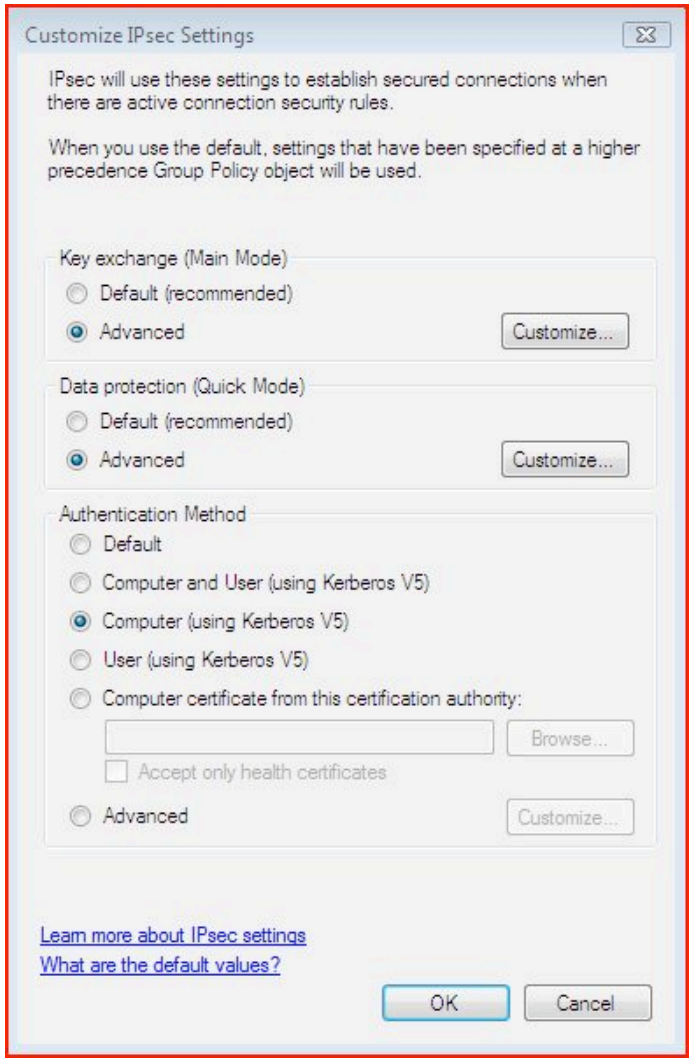


Vista: Configuring IPsec

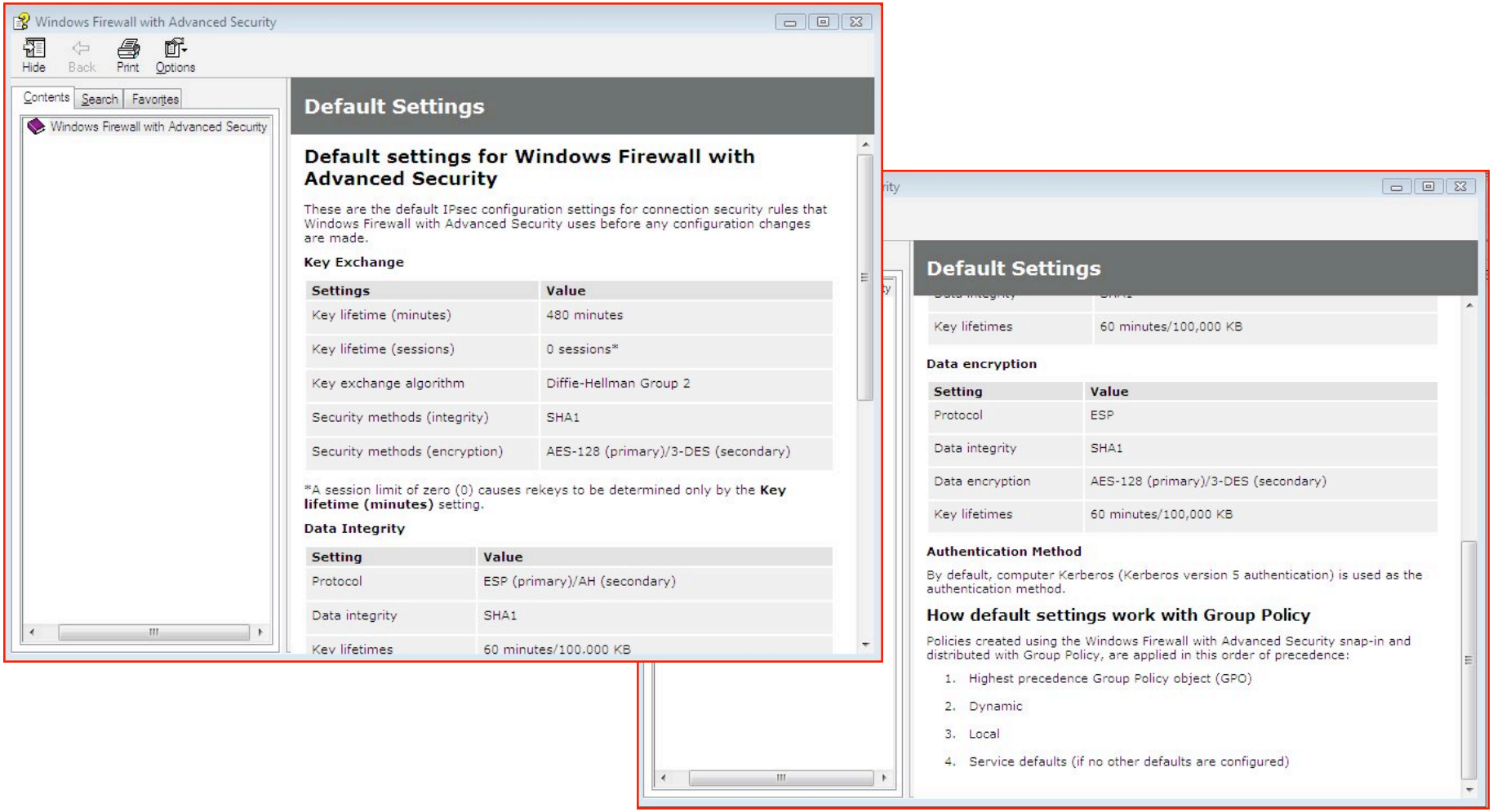


Vista: Customizing IPsec Settings

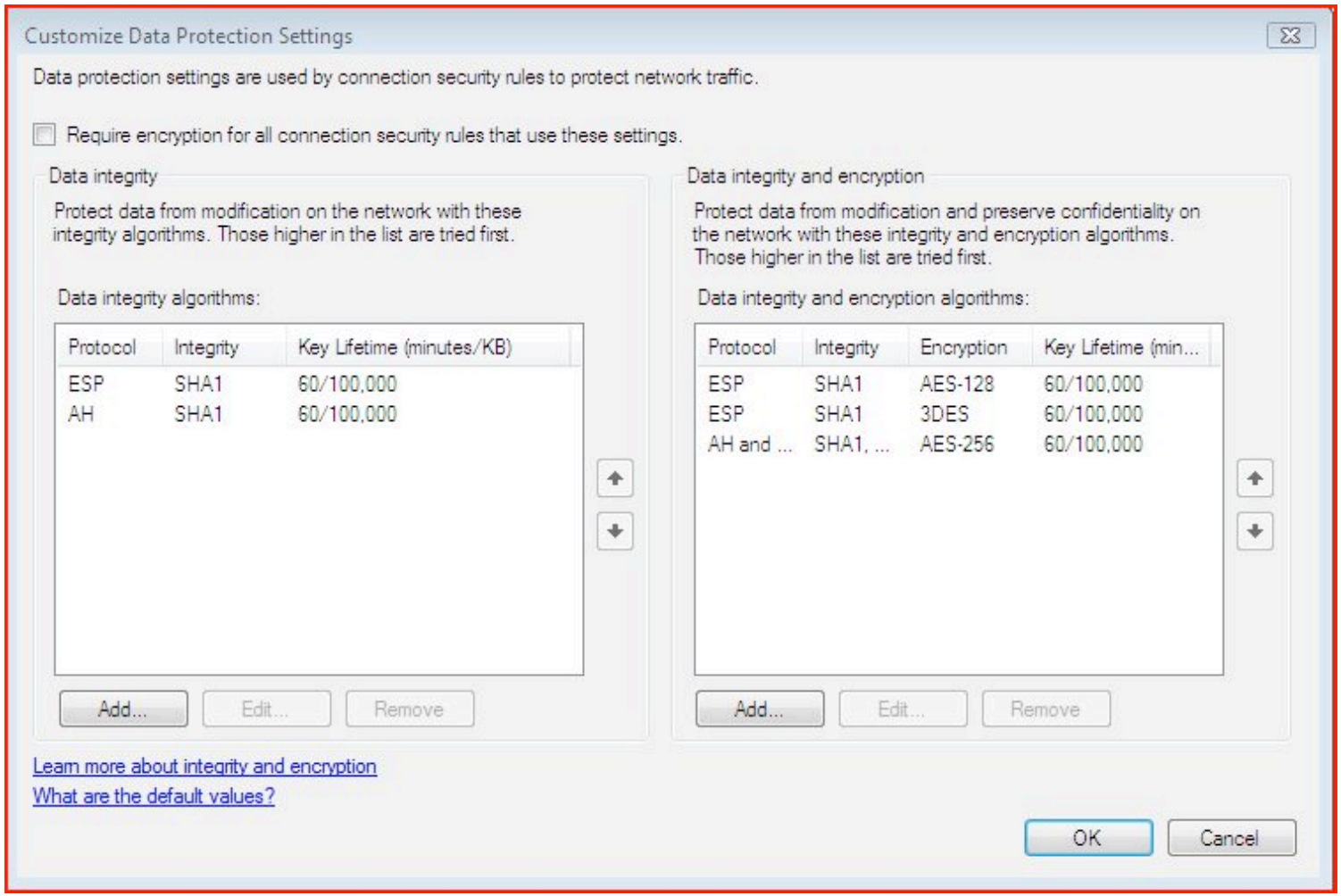




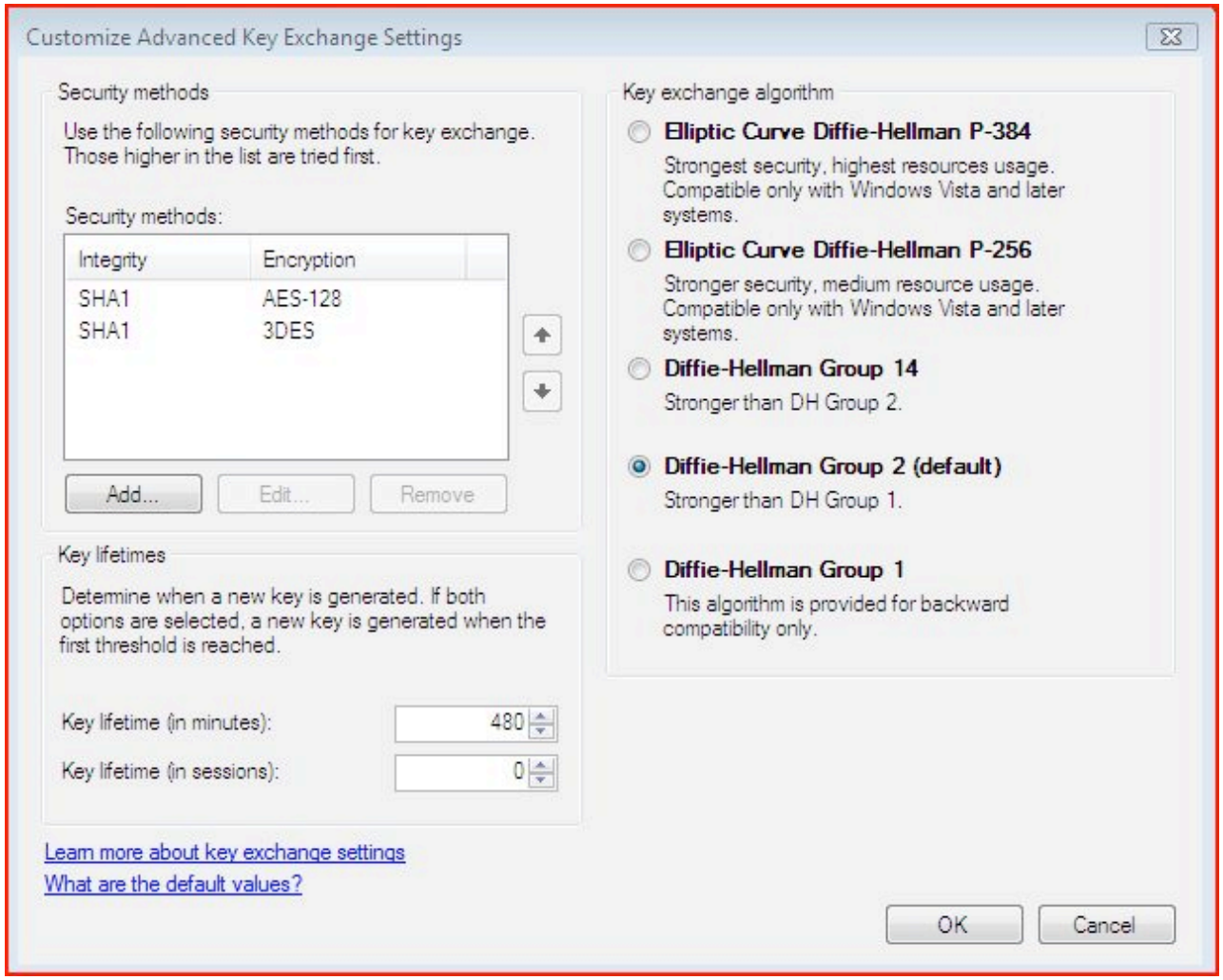
Vista IPsec Defaults



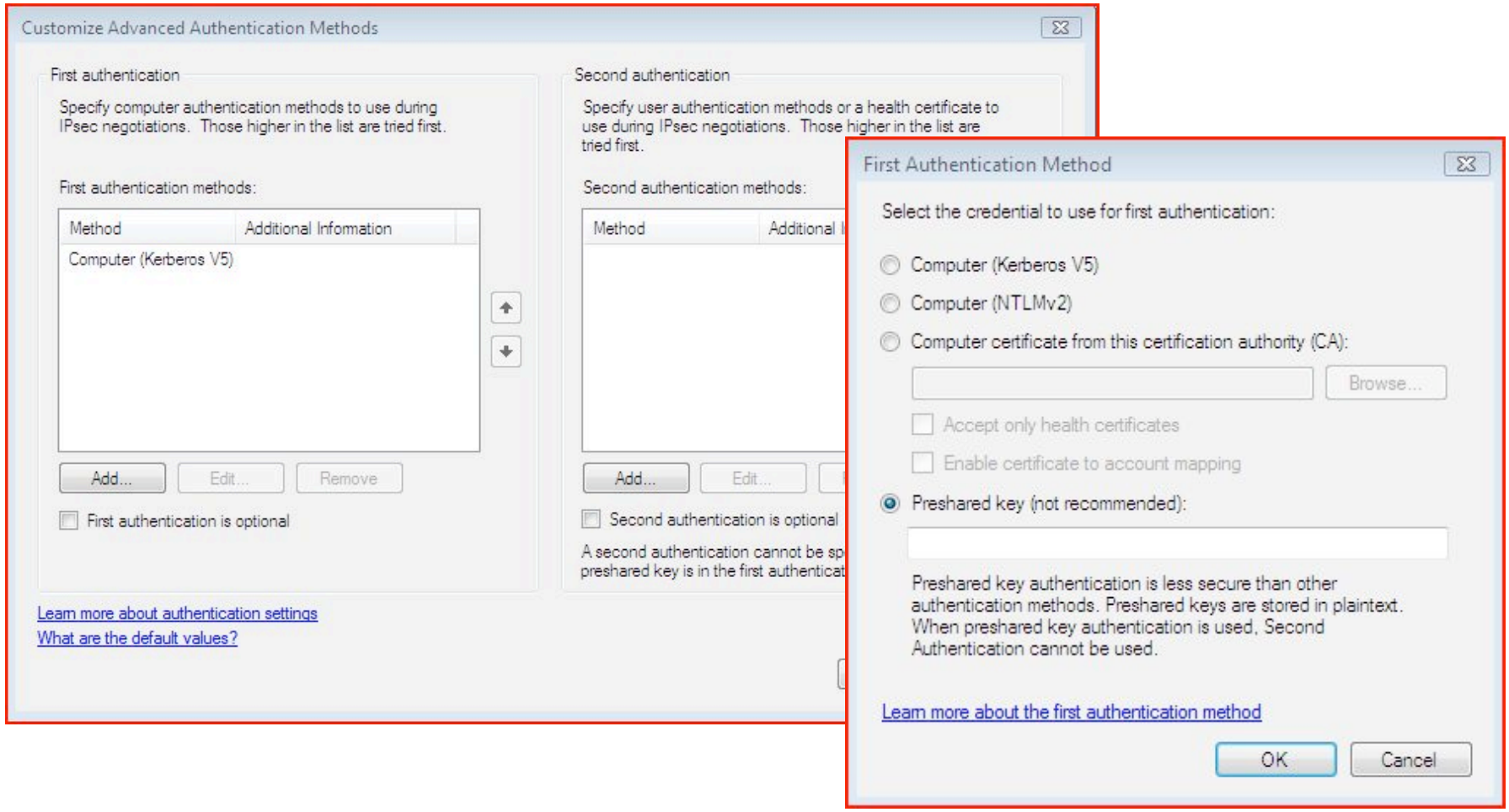
Vista: Customizing Data Protection



Vista: Customizing Key Exchange



Vista: Customizing Authentication



Conclusions

- IPsec is a complex standard but user configurations shouldn't be
- Using IPsec does NOT mean you have to encrypt the data (providing traffic integrity can be useful too)
- Don't leave IPsec out when you are trying to gain experience with IPv6 - time to fix usability issues is NOW