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## Related Documents

- [Software Package Management](#)

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## Description

IPsec (IP Security) supports secure (encrypted) communications over IP networks.

## Encryption

After packet is src-natted, but before putting it into interface queue, IPsec policy database is consulted to find out if packet should be encrypted. Security Policy Database (SPD) is a list of rules that have two parts:

- **Packet matching** - packet source/destination, protocol and ports (for TCP and UDP) are compared to values in policy rules, one after another
- **Action** - if rule matches action specified in rule is performed:
  - **accept** - continue with packet as if there was no IPsec
  - **drop** - drop packet
  - **encrypt** - encrypt packet

Each SPD rule can be associated with several Security Associations (SA) that determine packet encryption parameters (key, algorithm, SPI).

Note that packet can only be encrypted if there is usable SA for policy rule. By setting SPD rule security "level" user can control what happens when there is no valid SA for policy rule:

- **use** - if there is no valid SA, send packet unencrypted (like accept rule)
- **acquire** - send packet unencrypted, but ask IKE daemon to establish new SA
- **require** - drop packet, and ask IKE daemon to establish new SA.

## Decryption

When encrypted packet is received for local host (after **dst-nat** and **input** filter), the appropriate SA is looked up to decrypt it (using packet source, destination, security protocol and SPI value). If no SA is found, the packet is dropped. If SA is found, packet is decrypted. Then decrypted packet's fields are compared to policy rule that SA is linked to. If the packet does not match the policy rule it is dropped. If the packet is decrypted fine (or authenticated fine) it is "received once more" - it goes through **dst-nat** and routing (which finds out what to do - either forward or deliver locally) again.

Note that before **forward** and **input** firewall chains, a packet that was not decrypted on local host is compared with SPD reversing its matching rules. If SPD requires encryption (there is valid SA associated with matching SPD rule), the packet is dropped. This is called incoming policy check.

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## Internet Key Exchange

The Internet Key Exchange (IKE) is a protocol that provides authenticated keying material for Internet Security Association and Key Management Protocol (ISAKMP) framework. There are other key exchange schemes that work with ISAKMP, but IKE is the most widely used one. Together they provide means for authentication of hosts and automatic management of security associations (SA).

Most of the time IKE daemon is doing nothing. There are two possible situations when it is activated:

- There is some traffic caught by a policy rule which needs to become encrypted or authenticated, but the policy doesn't have any SAs. The policy notifies IKE daemon about that, and IKE daemon initiates connection to remote host.
- IKE daemon responds to remote connection.

In both cases, peers establish connection and execute 2 phases:

- **Phase 1** - The peers agree upon algorithms they will use in the following IKE messages and authenticate. The keying material used to derive keys for all SAs and to protect following ISAKMP exchanges between hosts is generated also.
- **Phase 2** - The peers establish one or more SAs that will be used by IPsec to encrypt data. All SAs established by IKE daemon will have lifetime values (either limiting time, after which SA will become invalid, or amount of data that can be encrypted by this SA, or both).

There are two lifetime values - soft and hard. When SA reaches it's soft lifetime treshold, the IKE daemon receives a notice and starts another phase 2 exchange to replace this SA with fresh one. If SA reaches hard lifetime, it is discarded.

IKE can optionally provide a Perfect Forward Secrecy (PFS), which is a property of key exchanges, that, in turn, means for IKE that compromising the long term phase 1 key will not allow to easily gain access to all IPsec data that is protected by SAs established through this phase 1. It means an additional keying material is generated for each phase 2.

Generation of keying material is computationally very expensive. *Exempli gratia*, the use of modp8192 group can take several seconds even on very fast computer. It usually takes place once per phase 1 exchange, which happens only once between any host pair and then is kept for long time. PFS adds this expensive operation also to each phase 2 exchange.

## Diffie-Hellman MODP Groups

Diffie-Hellman (DH) key exchange protocol allows two parties without any initial shared secret to create one securely. The following Modular Exponential (MODP) Diffie-Hellman (also known as "Oakley") Groups are supported:

Diffie-Hellman Group	Modulus	Reference
Group 1	768 bits	RFC2409
Group 2	1024 bits	RFC2409
Group 5	1536 bits	RFC3526

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## IKE Traffic

To avoid problems with IKE packets hit some SPD rule and require to encrypt it with not yet established SA (that this packet perhaps is trying to establish), locally originated packets with UDP source port 500 are not processed with SPD. The same way packets with UDP destination port 500 that are to be delivered locally are not processed in incoming policy check.

## Setup Procedure

To get IPsec to work with automatic keying using IKE-ISAKMP you will have to configure **policy**, **peer** and **proposal** (optional) entries.

For manual keying you will have to configure **policy** and **manual-sa** entries.

## Policy Settings

Home menu level: */ip ipsec policy*

### Description

Policy table is needed to determine whether encryption should be applied to a packet.

### Property Description

**action** (*accept | drop | encrypt*; default: **accept**) - specifies what action to undertake with a packet that matches the policy

- **accept** - pass the packet
- **drop** - drop the packet
- **encrypt** - apply transformations specified in this policy and it's SA

**decrypted** (*integer*) - how many incoming packets were decrypted by the policy

**dont-fragment** (*clear | inherit | set*; default: **clear**) - The state of the don't fragment IP header field

- **clear** - clear (unset) the fields, so that packets previously marked as don't fragment got fragmented
- **inherit** - do not change the field
- **set** - set the field, so that each packet matching the rule will not be fragmented

**dst-address** (*IP address | netmask | port*; default: **0.0.0.0/32:any**) - destination IP address

**encrypted** (*integer*) - how many outgoing packets were encrypted by the policy

**in-accepted** (*integer*) - how many incoming packets were passed through by the policy without an attempt to decrypt

**in-dropped** (*integer*) - how many incoming packets were dropped by the policy without an attempt to decrypt

**ipsec-protocols** (*multiple choice: ah | esp*; default: **esp**) - specifies what combination of Authentication Header and Encapsulating Security Payload protocols you want to apply to matched traffic. AH is applied after ESP, and in case of tunnel mode ESP will be applied in tunnel mode and AH - in transport mode

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**level** (*acquire* | *require* | *use*; default: **require**) - specifies what to do if some of the SAs for this policy cannot be found:

- **use** - skip this transform, do not drop packet and do not acquire SA from IKE daemon
- **acquire** - skip this transform, but acquire SA for it from IKE daemon
- **require** - drop packet but acquire SA

**manual-sa** (*name*; default: **none**) - name of manual-sa template that will be used to create SAs for this policy

- **none** - no manual keys are set

**not-decrypted** (*integer*) - how many incoming packets the policy attempted to decrypt. but discarded for any reason

**not-encrypted** (*integer*) - how many outgoing packets the policy attempted to encrypt. but discarded for any reason

**out-accepted** (*integer*) - how many outgoing packets were passed through by the policy without an attempt to encrypt

**out-dropped** (*integer*) - how many outgoing packets were dropped by the policy without an attempt to encrypt

**ph2-state** (*read-only: expired* | *no-phase2* | *established*) - indication of the progress of key establishing

- **expired** - there are some leftovers from previous phase2. In general it is similar to no-phase2
- **no-phase2** - no keys are established at the moment
- **established** - Appropriate SAs are in place and everything should be working fine

**proposal** (*name*; default: **default**) - name of proposal information that will be sent by IKE daemon to establish SAs for this policy

**protocol** (*name* | *integer*; default: **all**) - protocol name or number

**sa-dst-address** (*IP address*; default: **0.0.0.0**) - SA destination IP address

**sa-src-address** (*IP address*; default: **0.0.0.0**) - SA source IP address

**src-address** (*IP address* | *netmask* | *port*; default: **0.0.0.0/32:any**) - source IP address

**tunnel** (yes | no; default: **no**) - specifies whether to use tunnel mode

## Notes

All packets are IPsec encapsulated in tunnel mode, and their new IP header **src-address** and **dst-address** are set to **sa-src-address** and **sa-dst-address** values of this policy. If you do not use tunnel mode (*id est* you use transport mode), then only packets whose source and destination addresses are the same as **sa-src-address** and **sa-dst-address** can be processed by this policy. Transport mode can only work with packets that originate at and are destined for IPsec peers (hosts that established security associations). To encrypt traffic between networks (or a network and a host) you have to use tunnel mode.

It is good to have **dont-fragment** cleared because encrypted packets are always bigger than original and thus they may need fragmentation.

If you are using IKE to establish SAs automatically, then policies on both routers must exactly match each other, *id est* **src-address=1.2.3.0/27** on one router and **dst-address=1.2.3.0/28** on another would not work. Source address values on one router **MUST** be equal to destination address

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values on the other one, and vice versa.

## Example

To add a policy to encrypt all the traffic between two hosts (10.0.0.147 and 10.0.0.148), we need do the following:

```
[admin@Lobo954R] ip ipsec policy> add sa-src-address=10.0.0.147 \  
\... sa-dst-address=10.0.0.148 action=encrypt  
[admin@Lobo954R] ip ipsec policy> print  
Flags: X - disabled, D - dynamic, I - invalid  
0  src-address=10.0.0.147/32:any dst-address=10.0.0.148/32:any protocol=all  
   action=encrypt level=require ipsec-protocols=esp tunnel=no  
   sa-src-address=10.0.0.147 sa-dst-address=10.0.0.148 proposal=default  
   manual-sa=none dont-fragment=clear
```

```
[admin@Lobo954R] ip ipsec policy>
```

to view the policy statistics, do the following:

```
[admin@Lobo954R] ip ipsec policy> print stats  
Flags: X - disabled, D - dynamic, I - invalid  
0  src-address=10.0.0.147/32:any dst-address=10.0.0.148/32:any  
   protocol=all ph2-state=no-phase2 in-accepted=0 in-dropped=0  
   out-accepted=0 out-dropped=0 encrypted=0 not-encrypted=0 decrypted=0  
   not-decrypted=0
```

```
[admin@Lobo954R] ip ipsec policy>
```

## Peers

Home menu level: */ip ipsec peer*

## Description

Peer configuration settings are used to establish connections between IKE daemons (phase 1 configuration). This connection then will be used to negotiate keys and algorithms for SAs.

## Property Description

**address** (*IP address | netmask | port*; default: **0.0.0.0/32:500**) - address prefix. If remote peer's address matches this prefix, then this peer configuration is used while authenticating and establishing phase 1. If several peer's addresses matches several configuration entries, the most specific one (i.e. the one with largest netmask) will be used

**dh-group** (*multiple choice: modp768 | modp1024 | modp1536*; default: **esp**) - Diffie-Hellman MODP group (cipher strength)

**enc-algorithm** (*multiple choice: des | 3des | aes-128 | aes-192 | aes-256*; default: **3des**) - encryption algorithm. Algorithms are named in strength increasing order

**exchange-mode** (*multiple choice: main | aggressive | base*; default: **main**) - different ISAKMP phase 1 exchange modes according to RFC 2408. DO not use other modes then main unless you know what you are doing

**generate-policy** (yes | no; default: **no**) - allow this peer to establish SA for non-existing policies. Such policies are created dynamically for the lifetime of SA. This way it is possible, for example, to create IPsec secured L2TP tunnels, or any other setup where remote peer's IP address is not known at configuration time

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**hash-algorithm** (*multiple choice: md5 | sha*; default: **md5**) - hashing algorithm. SHA (Secure Hash Algorithm) is stronger, but slower

**lifebytes** (*integer*; default: **0**) - phase 1 lifetime: specifies how much bytes can be transferred before SA is discarded

- **0** - SA expiration will not be due to byte count excess

**lifetime** (*time*; default: **1d**) - phase 1 lifetime: specifies how long the SA will be valid; SA will be discarded after this time

**proposal-check** (*multiple choice: claim | exact | obey | strict*; default: **strict**) - phase 2 lifetime check logic:

- **claim** - take shortest of proposed and configured lifetimes and notify initiator about it
- **exact** - require lifetimes to be the same
- **obey** - accept whatever is sent by an initiator
- **strict** - If proposed lifetime IS longer than default then reject proposal otherwise accept proposed lifetime

**secret** (*text*; default: **""**) - secret string. If it starts with '0x', it is parsed as a hexadecimal value

**send-initial-contact** (yes | no; default: **yes**) - specifies whether to send initial IKE information or wait for remote side

## Notes

AES (Advanced Encryption Standard) encryption algorithms are much faster than DES, so it is recommended to use this algorithm class whenever possible. But, AES's speed is also its drawback as it potentially can be cracked faster, so use AES-256 when you need security or AES-128 when speed is also important.

Both peers **MUST** have the same encryption and authentication algorithms, DH group and exchange mode. Some legacy hardware may support only DES and MD5.

You should set **generate-policy** flag to **yes** only for trusted peers, because there is no verification done for the established policy. To protect yourself against possible unwanted events, add policies with **action=accept** for all networks you don't want to be encrypted at the top of policy list. Since dynamic policies are added at the bottom of the list, they will not be able to override your configuration.

## Example

To define new peer configuration for **10.0.0.147** peer with **secret=gwejimezyfopmekun**:

```
[admin@Lobo954R] ip ipsec peer>add address=10.0.0.147/32 \  
\... secret=gwejimezyfopmekun  
[admin@Lobo954R] ip ipsec peer> print  
Flags: X - disabled  
0 address=10.0.0.147/32:500 secret="gwejimezyfopmekun" generate-policy=no  
exchange-mode=main send-initial-contact=yes proposal-check=obey  
hash-algorithm=md5 enc-algorithm=3des dh-group=modp1024 lifetime=1d  
lifebytes=0  
  
[admin@Lobo954R] ip ipsec peer>
```

## Remote Peer Statistics

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Home menu level: */ip ipsec remote-peers*

## Description

This submenu provides you with various statistics about remote peers that currently have established phase 1 connections with this router. Note that if peer doesn't show up here, it doesn't mean that no IPsec traffic is being exchanged with it. For example, manually configured SAs will not show up here.

## Property Description

**established** (*read-only: text*) - shows date and time when phase 1 was established with the peer

**local-address** (*read-only: IP address*) - local ISAKMP SA address

**ph2-active** (*read-only: integer*) - how many phase 2 negotiations with this peer are currently taking place

**ph2-total** (*read-only: integer*) - how many phase 2 negotiations with this peer took place

**remote-address** (*read-only: IP address*) - peer's IP address

**side** (*multiple choice, read-only: initiator | responder*) - shows which side initiated the connection

- **initiator** - phase 1 negotiation was started by this router
- **responder** - phase 1 negotiation was started by peer

**state** (*read-only: text*) - state of phase 1 negotiation with the peer

- **established** - normal working state

## Example

To see currently established SAs:

```
[admin@Lobo954R] ip ipsec> remote-peers print
 0 local-address=10.0.0.148 remote-address=10.0.0.147 state=established
   side=initiator established=jan/25/2003 03:34:45 ph2-active=0 ph2-total=1
[admin@Lobo954R] ip ipsec>
```

## Installed SAs

Home menu level: */ip ipsec installed-sa*

## Description

This facility provides information about installed security associations including the keys

## Property Description

**add-lifetime** (*read-only: time*) - soft/hard expiration time counted from installation of SA

**auth-algorithm** (*multiple choice, read-only: none | md5 | sha1*) - authentication algorithm used in SA

**auth-key** (*read-only: text*) - authentication key presented in form of hex string

**current-addtime** (*read-only: text*) - time when this SA was installed

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**current-bytes** (*read-only: integer*) - amount of data processed by this SA's crypto algorithms

**current-usetime** (*read-only: text*) - time when this SA was first used

**direction** (*multiple choice, read-only: in | out*) - SA direction

**dst-address** (*read-only: IP address*) - destination address of SA taken from respective policy

**enc-algorithm** (*multiple choice, read-only: none | des | 3des | aes*) - encryption algorithm used in SA

**enc-key** (*read-only: text*) - encryption key presented in form of hex string (not applicable to AH SAs)

**lifebytes** (*read-only: integer*) - soft/hard expiration threshold for amount of processed data

**replay** (*read-only: integer*) - size of replay window presented in bytes. This window protects the receiver against replay attacks by rejecting old or duplicate packets.

**spi** (*read-only: integer*) - SPI value of SA, represented in hexadecimal form

**src-address** (*read-only: IP address*) - source address of SA taken from respective policy

**state** (*multiple choice, read-only: larval | mature | dying | dead*) - SA living phase

**use-lifetime** (*read-only: time*) - soft/hard expiration time counted from the first use of SA

## Example

Sample printout looks as follows:

```
[admin@Lobo954R] ip ipsec> installed-sa print
Flags: A - AH, E - ESP, P - pfs, M - manual
 0 E   spi=E727605 direction=in src-address=10.0.0.148
      dst-address=10.0.0.147 auth-algorithm=sha1 enc-algorithm=3des
      replay=4 state=mature
      auth-key="ecc5f4aee1b297739ec88e324d7cfb8594aa6c35"
      enc-key="d6943b8ea582582e449bde085c9471ab0b209783c9eb4bbd"
      add-lifetime=24m/30m use-lifetime=0s/0s lifebytes=0/0
      current-addtime=jan/28/2003 20:55:12
      current-usetime=jan/28/2003 20:55:23 current-bytes=128
 1 E   spi=E15CEE06 direction=out src-address=10.0.0.147
      dst-address=10.0.0.148 auth-algorithm=sha1 enc-algorithm=3des
      replay=4 state=mature
      auth-key="8ac9dc7ecebfe9cd1030ae3b07b32e8e5cb98af"
      enc-key="8a8073a7afd0f74518c10438a0023e64cc660ed69845ca3c"
      add-lifetime=24m/30m use-lifetime=0s/0s lifebytes=0/0
      current-addtime=jan/28/2003 20:55:12
      current-usetime=jan/28/2003 20:55:12 current-bytes=512
[admin@Lobo954R] ip ipsec>
```

## Flushing Installed SA Table

Command name: */ip ipsec installed-sa flush*

### Description

Sometimes after incorrect/incomplete negotiations took place, it is required to flush manually the installed SA table so that SA could be renegotiated. This option is provided by the **flush** command.

### Property Description

**sa-type** (*multiple choice: ah | all | esp; default: all*) - specifies SA types to flush

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- **ah** - delete AH protocol SAs only
- **esp** - delete ESP protocol SAs only
- **all** - delete both ESP and AH protocols SAs

## Example

To flush all the SAs installed:

```
[admin@Lobo954R] ip ipsec installed-sa> flush
[admin@Lobo954R] ip ipsec installed-sa> print
[admin@Lobo954R] ip ipsec installed-sa>
```

## Counters

Home menu level: */ip ipsec counters*

### Property Description

**in-accept** (*read-only: integer*) - shows how many incoming packets were matched by accept policy

**in-accept-isakmp** (*read-only: integer*) - shows how many incoming UDP packets on port 500 were let through without matching a policy

**in-decrypt** (*read-only: integer*) - shows how many incoming packets were successfully decrypted

**in-drop** (*read-only: integer*) - shows how many incoming packets were matched by drop policy (or encrypt policy with level=require that does not have all necessary SAs)

**in-drop-encrypted-expected** (*read-only: integer*) - shows how many incoming packets were matched by encrypt policy and dropped because they were not encrypted

**out-accept** (*read-only: integer*) - shows how many outgoing packets were matched by accept policy (including the default "accept all" case)

**out-accept-isakmp** (*read-only: integer*) - shows how many locally originated UDP packets on source port 500 (which is how ISAKMP packets look) were let through without policy matching

**out-drop** (*read-only: integer*) - shows how many outgoing packets were matched by drop policy (or encrypt policy with level=require that does not have all necessary SAs)

**out-encrypt** (*read-only: integer*) - shows how many outgoing packets were encrypted successfully

## Example

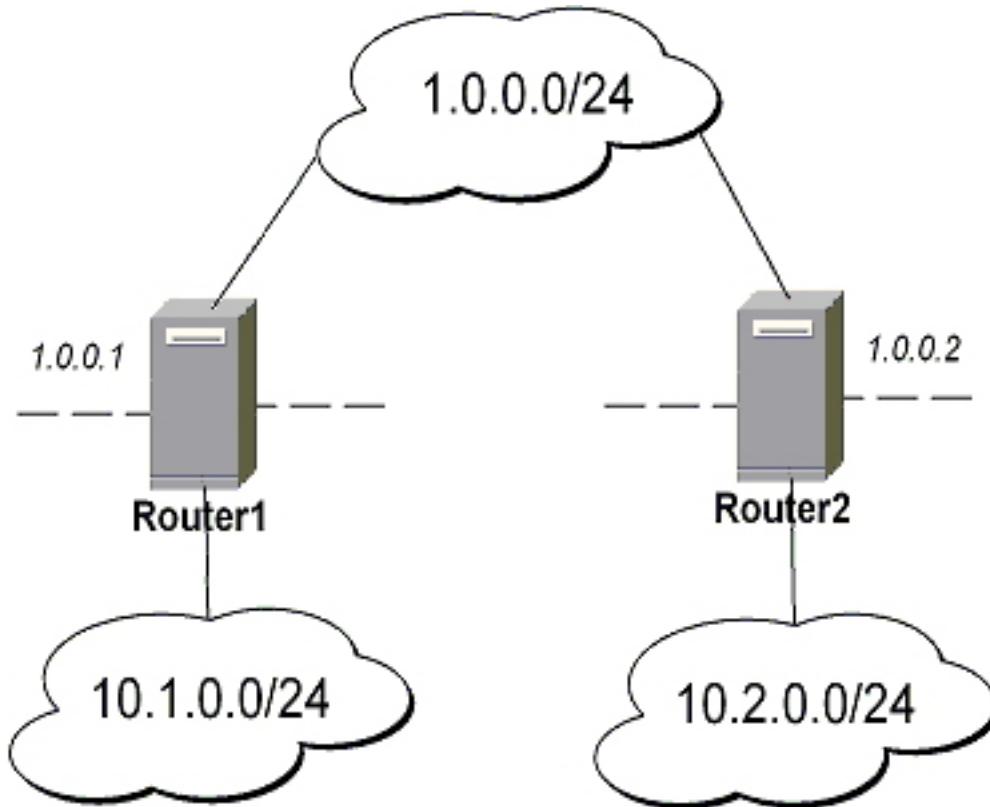
To view current statistics:

```
[admin@Lobo954R] ip ipsec> counters print
      out-accept: 6
out-accept-isakmp: 0
      out-drop: 0
      out-encrypt: 7
        in-accept: 12
in-accept-isakmp: 0
        in-drop: 0
          in-decrypt: 7
in-drop-encrypted-expected: 0
[admin@Lobo954R] ip ipsec>
```

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## General Information

### Lobo to Lobo



- transport mode example using ESP with automatic keying
    - for Lobo1

```
[admin@Lobo954R] > ip ipsec policy add sa-src-address=1.0.0.1 sa-dst-address=1.0.0.2 \  
\... action=encrypt  
[admin@Lobo954R] > ip ipsec peer add address=1.0.0.2 \  
\... secret="gvejimezyfopmekun"
```
    - for Lobo2

```
[admin@Lobo954R] > ip ipsec policy add sa-src-address=1.0.0.2 sa-dst-address=1.0.0.1 \  
\... action=encrypt  
[admin@Lobo954R] > ip ipsec peer add address=1.0.0.1 \  
\... secret="gvejimezyfopmekun"
```
  - transport mode example using ESP with automatic keying and automatic policy generating on Lobo1 and static policy on Lobo2
    - for Lobo1

```
[admin@Lobo954R] > ip ipsec peer add address=1.0.0.0/24 \  
\... secret="gvejimezyfopmekun" generate-policy=yes
```
    - for Lobo2

```
[admin@Lobo954R] > ip ipsec policy add sa-src-address=1.0.0.2 sa-dst-address=1.0.0.1 \  
\... action=encrypt  
[admin@Lobo954R] > ip ipsec peer add address=1.0.0.1 \  
\... secret="gvejimezyfopmekun"
```
-

```
\... secret="gvejimezyfopmekun"
```

- tunnel mode example using AH with manual keying

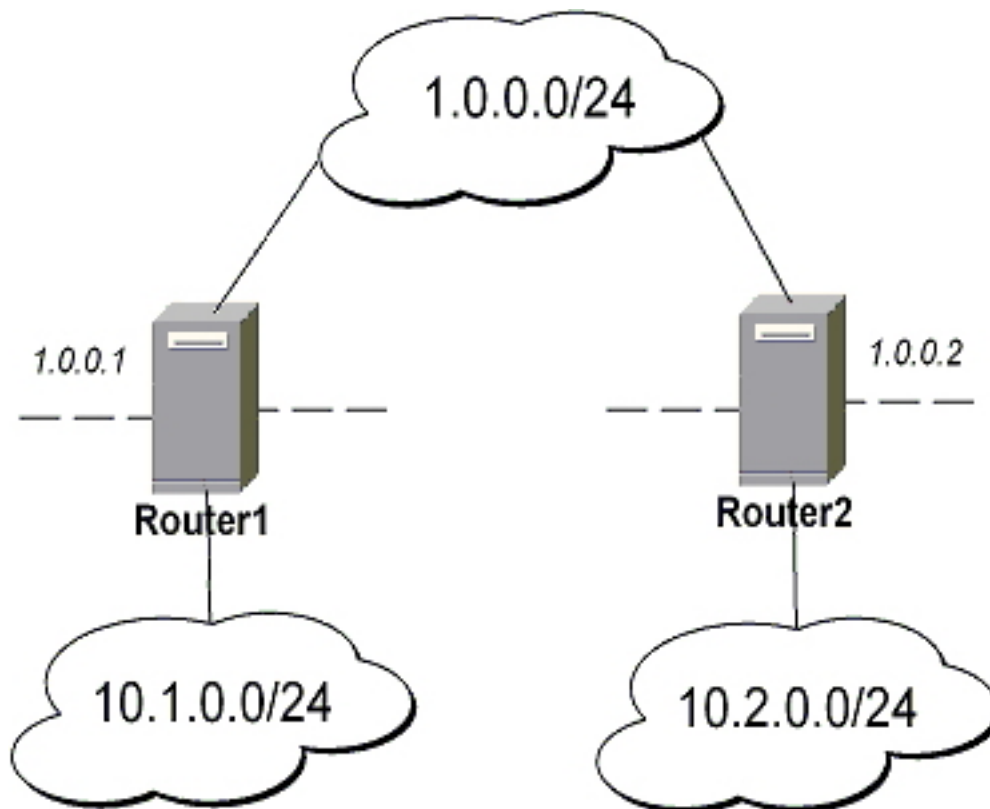
- for **Lobo1**

```
[admin@Lobo954R] > ip ipsec manual-sa add name=ah-sal \  
\... ah-spi=0x101/0x100 ah-key=abcfed  
[admin@Lobo954R] > ip ipsec policy add src-address=10.1.0.0/24 \  
\... dst-address=10.2.0.0/24 action=encrypt ipsec-protocols=ah \  
\... tunnel=yes sa-src=1.0.0.1 sa-dst=1.0.0.2 manual-sa=ah-sal
```

- for **Lobo2**

```
[admin@Lobo954R] > ip ipsec manual-sa add name=ah-sal \  
\... ah-spi=0x100/0x101 ah-key=abcfed  
[admin@Lobo954R] > ip ipsec policy add src-address=10.2.0.0/24 \  
\... dst-address=10.1.0.0/24 action=encrypt ipsec-protocols=ah \  
\... tunnel=yes sa-src=1.0.0.2 sa-dst=1.0.0.1 manual-sa=ah-sal
```

## IPsec Between two Masquerading Lobos



1. Add accept and masquerading rules in SRC-NAT

- for **Lobo1**

```
[admin@Lobo954R] > ip firewall nat \  
\... add src-address=10.1.0.0/24 dst-address=10.2.0.0/24  
[admin@Lobo954R] > ip firewall nat add out-interface=public \  
\... action=masquerade
```

- for **Lobo2**

```
[admin@Lobo954R] > ip firewall nat \
... add src-address=10.2.0.0/24 dst-address=10.1.0.0/24
[admin@Lobo954R] > ip firewall nat add out-interface=public \
... action=masquerade
```

## 2. configure IPsec

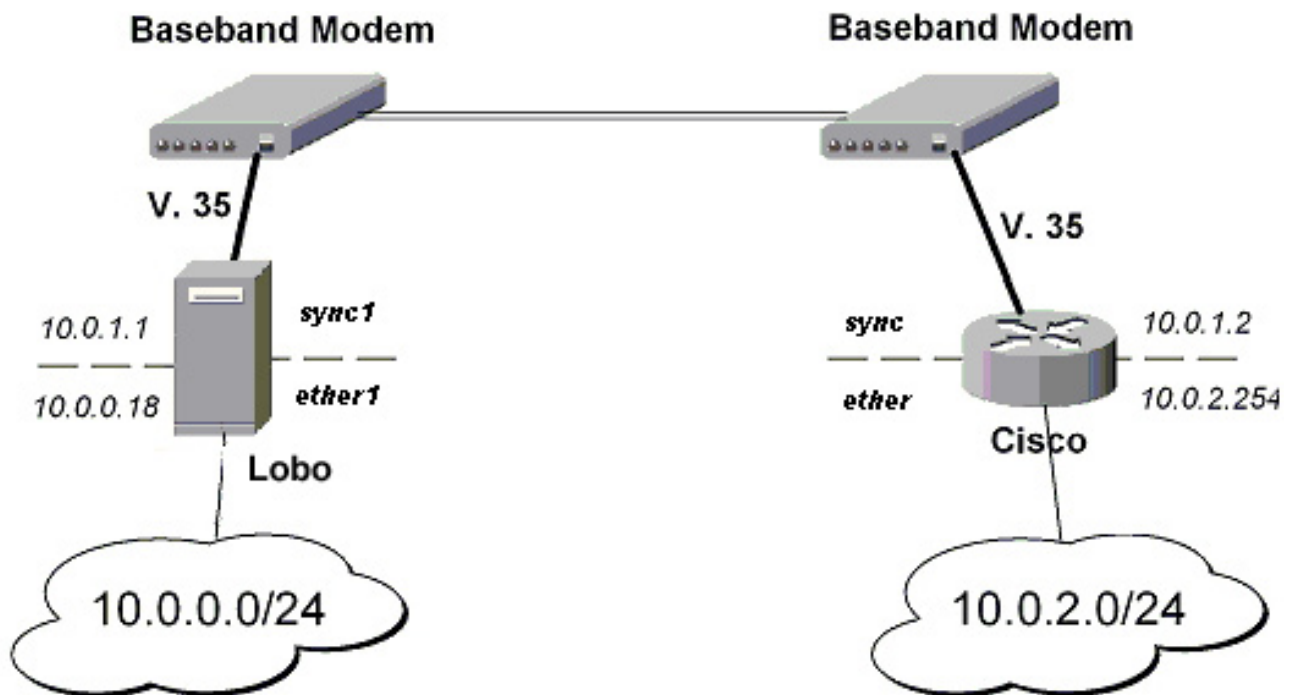
- for **Lobo1**

```
[admin@Lobo954R] > ip ipsec policy add src-address=10.1.0.0/24 \
... dst-address=10.2.0.0/24 action=encrypt tunnel=yes \
... sa-src-address=1.0.0.1 sa-dst-address=1.0.0.2
[admin@Lobo954R] > ip ipsec peer add address=1.0.0.2 \
... exchange-mode=aggressive secret="gvejimezyfopmekun"
```

- for **Lobo2**

```
[admin@Lobo954R] > ip ipsec policy add src-address=10.2.0.0/24 \
... dst-address=10.1.0.0/24 action=encrypt tunnel=yes \
... sa-src-address=1.0.0.2 sa-dst-address=1.0.0.1
[admin@Lobo954R] > ip ipsec peer add address=1.0.0.1 \
... exchange-mode=aggressive secret="gvejimezyfopmekun"
```

## Lobo to CISCO Router



We will configure IPsec in tunnel mode in order to protect traffic between attached subnets.

1. Add peer (with phase1 configuration parameters), DES and SHA1 will be used to protect IKE traffic

- for **Lobo**

```
[admin@Lobo954R] > ip ipsec peer add address=10.0.1.2 \
... secret="gvejimezyfopmekun" enc-algorithm=des
```

- for **CISCO** router
-

```

! Configure ISAKMP policy (phase1 config, must match configuration
! of "/ip ipsec peer" on RouterOS). Note that DES is default
! encryption algorithm on Cisco. SHA1 is default authentication
! algorithm
crypto isakmp policy 9
  encryption des
  authentication pre-share
  group 2
  hash md5
  exit

! Add preshared key to be used when talking to RouterOS
crypto isakmp key gvejimezyfopmekun address 10.0.1.1 255.255.255.255

```

## 2. Set encryption proposal (phase2 proposal - settings that will be used to encrypt actual data) to use DES to encrypt data

- for **Lobo**

```
[admin@Lobo954R] > ip ipsec proposal set default enc-algorithms=des
```

- for **CISCO** router

```

! Create IPsec transform set - transformations that should be applied to
! traffic - ESP encryption with DES and ESP authentication with SHA1
! This must match "/ip ipsec proposal"
crypto ipsec transform-set myset esp-des esp-sha-hmac
  mode tunnel
  exit

```

## 3. Add policy rule that matches traffic between subnets and requires encryption with ESP in tunnel mode

- for **Lobo**

```
[admin@Lobo954R] > ip ipsec policy add \
\... src-address=10.0.0.0/24 dst-address=10.0.2.0/24 action=encrypt \
\... tunnel=yes sa-src=10.0.1.1 sa-dst=10.0.1.2
```

- for **CISCO** router

```

! Create access list that matches traffic that should be encrypted
access-list 101 permit ip 10.0.2.0 0.0.0.255 10.0.0.0 0.0.0.255
! Create crypto map that will use transform set "myset", use peer 10.0.1.1
! to establish SAs and encapsulate traffic and use access-list 101 to
! match traffic that should be encrypted
crypto map mymap 10 ipsec-isakmp
  set peer 10.0.1.1
  set transform-set myset
  set pfs group2
  match address 101
  exit
! And finally apply crypto map to serial interface:
interface Serial 0
  crypto map mymap
  exit

```

## 4. Testing the IPsec tunnel

- on the **Lobo** we can see installed SAs

```
[admin@Lobo954R] ip ipsec installed-sa> print
Flags: A - AH, E - ESP, P - pfs, M - manual
0 E spi=9437482 direction=out src-address=10.0.1.1
dst-address=10.0.1.2 auth-algorithm=sha1 enc-algorithm=des
replay=4 state=mature
```

---

```

auth-key="9cf2123b8b5add950e3e67b9eac79421d406aa09"
enc-key="ffe7ec65b7a385c3" add-lifetime=24m/30m use-lifetime=0s/0s
lifebytes=0/0 current-addtime=jul/12/2002 16:13:21
current-usetime=jul/12/2002 16:13:21 current-bytes=71896
1 E spi=319317260 direction=in src-address=10.0.1.2
dst-address=10.0.1.1 auth-algorithm=shal enc-algorithm=des
replay=4 state=mature
auth-key="7575f5624914dd312839694db2622a318030bc3b"
enc-key="633593f809c9d6af" add-lifetime=24m/30m use-lifetime=0s/0s
lifebytes=0/0 current-addtime=jul/12/2002 16:13:21
current-usetime=jul/12/2002 16:13:21 current-bytes=0
[admin@Lobo954R] ip ipsec installed-sa>

```

- on CISCO router

```

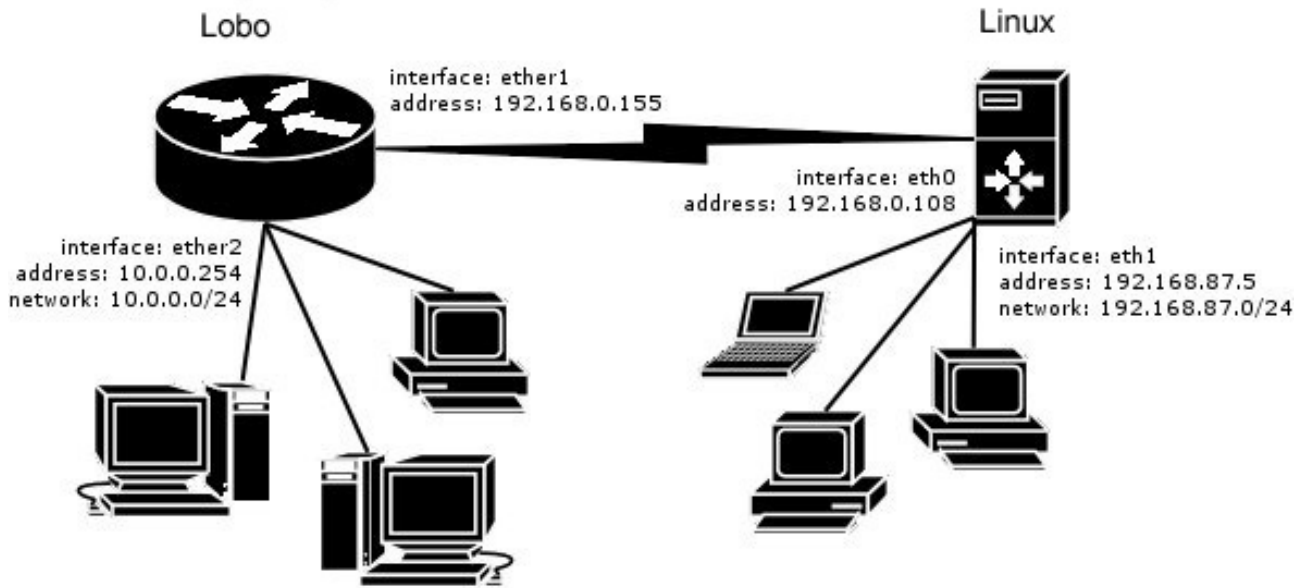
cisco# show interface Serial 0
interface: Serial1
Crypto map tag: mymap, local addr. 10.0.1.2
local ident (addr/mask/prot/port): (10.0.2.0/255.255.255.0/0/0)
remote ident (addr/mask/prot/port): (10.0.0.0/255.255.255.0/0/0)
current_peer: 10.0.1.1
PERMIT, flags={origin_is_acl,}
#pkts encaps: 1810, #pkts encrypt: 1810, #pkts digest 1810
#pkts decaps: 1861, #pkts decrypt: 1861, #pkts verify 1861
#pkts compressed: 0, #pkts decompressed: 0
#pkts not compressed: 0, #pkts compr. failed: 0, #pkts decompress failed: 0
#send errors 0, #recv errors 0
local crypto endpt.: 10.0.1.2, remote crypto endpt.: 10.0.1.1
path mtu 1500, media mtu 1500
current outbound spi: 1308650C
inbound esp sas:
spi: 0x90012A(9437482)
transform: esp-des esp-sha-hmac ,
in use settings ={Tunnel, }
slot: 0, conn id: 2000, flow_id: 1, crypto map: mymap
sa timing: remaining key lifetime (k/sec): (4607891/1034)
IV size: 8 bytes
replay detection support: Y
inbound ah sas:
inbound pcp sas:
outbound esp sas:
spi: 0x1308650C(319317260)
transform: esp-des esp-sha-hmac ,
in use settings ={Tunnel, }
slot: 0, conn id: 2001, flow_id: 2, crypto map: mymap
sa timing: remaining key lifetime (k/sec): (4607893/1034)
IV size: 8 bytes
replay detection support: Y
outbound ah sas:
outbound pcp sas:

```

## Lobo and Linux FreeS/WAN

In the test scenario we have 2 private networks: 10.0.0.0/24 connected to the Lobo and 192.168.87.0/24 connected to Linux. Lobo and Linux are connected together over the "public" network 192.168.0.0/24:

---



- FreeS/WAN configuration:

```
config setup
    interfaces="ipsec0=eth0"
    klipsdebug=none
    plutodebug=all
    plutoload=%search
    plutostart=%search
    uniqueids=yes

conn %default
    keyingtries=0
    disablearrivalcheck=no
    authby=rsasig

conn mt
    left=192.168.0.108
    leftsubnet=192.168.87.0/24
    right=192.168.0.155
    rightsubnet=10.0.0.0/24
    authby=secret
    pfs=no
    auto=add
```

- ipsec.secrets config file:

```
192.168.0.108 192.168.0.155 : PSK "gvejimezyfopmekun"
```

- Lobo configuration:

```
[admin@Lobo954R] > /ip ipsec peer add address=192.168.0.108 \
\... secret="gvejimezyfopmekun" hash-algorithm=md5 enc-algorithm=3des \
\... dh-group=modp1024 lifetime=28800s

[admin@Lobo954R] > /ip ipsec proposal auth-algorithms=md5 \
\... enc-algorithms=3des pfs-group=none

[admin@Lobo954R] > /ip ipsec policy add sa-src-address=192.168.0.155 \
\... sa-dst-address=192.168.0.108 src-address=10.0.0.0/24 \
\... dst-address=192.168.87.0/24 tunnel=yes
```