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Security: Background information

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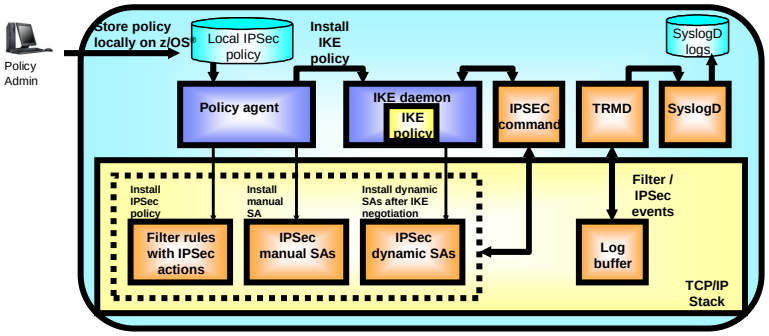
Integrated IP security infrastructure in z/OS V1R7

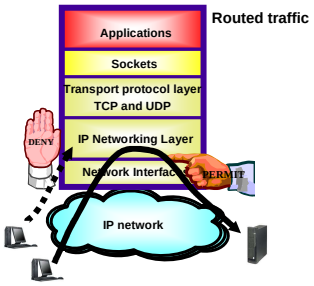


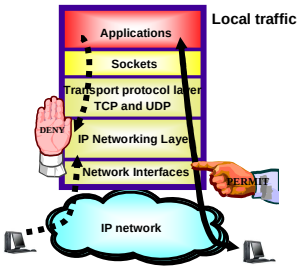
- **Integrated IP security in z/OS V1R7 covers:**
  - IP filtering
  - Virtual private networks based on IPSec
  - IPv4 only

- **Configuration support**
  - Optimized for z/OS host-to-host and z/OS host-to-gateway (z/OS gateway still supported)
  - NAT IP address traversal support
- **Simplified infrastructure**
  - Eliminates need for FW Technologies daemons
  - Policy agent reads and manages IPSec and IKE policy
- **Simplified configuration**
  - New configuration GUI for both new and expert users
  - Direct file edit into local configuration file
  - Reduced definition, more "wildcarding"
- **Improved serviceability**
  - Improved messages and traces
- **Default filters part of TCP profile**
  - More granular control before policy is loaded
- **Administrative controls**
  - pasearch, new IPSec command

Basics of IP filtering

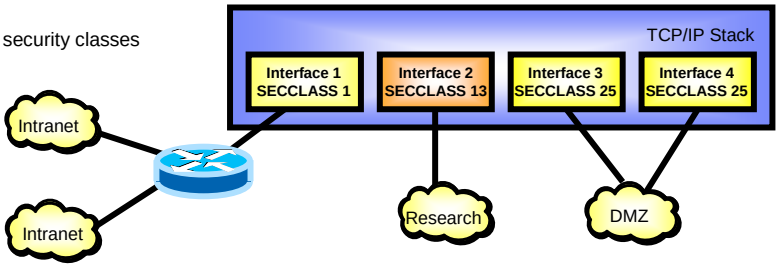
- **Packet filtering at IP layer**
  - Filter rules defined to match on inbound and outbound packets based on:
    - Packet information
    - Network attributes
    - Time of day
  - Used to control
    - Traffic being routed
    - Access at destination host
  - Possible actions
    - 1. Permit
    - 2. Deny
    - 3a. Permit with manual IPSec
    - 3b. Permit with dynamic IPSec
    - Log (in combination with others)





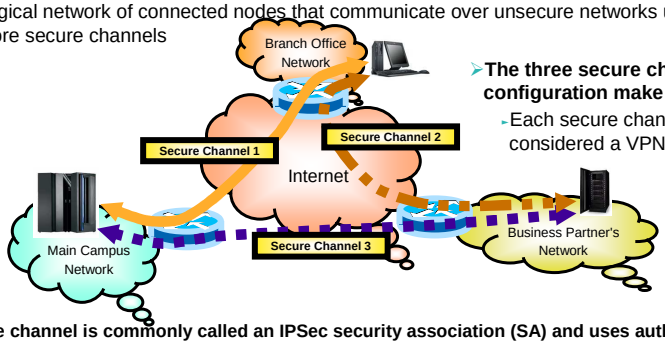
Interface security class (SECCLASS)

- **Can be assigned only to non-virtual interfaces**
- **Defined in the TCP/IP profile**
  - LINK statement (SECCLASS parameter)
  - IPCONFIG DYNAMICXCF statement (SECCLASS parameter)
- **Value 1 to 255 (default is 255)**
  - Value is just a classification identifier; it has no inherent meaning
    - Can be referred to in the filter rules
- **Packets inherit the security class of the interface they traverse**
- **A more flexible and expandable mechanism than the traditional firewall's "secure" vs. "non-secure" interface types**
  - 254 interface security classes instead of two



IPSec Virtual Private Network (VPN) overview

- **Virtual Private Network**
  - Logical network of connected nodes that communicate over unsecure networks using one or more secure channels



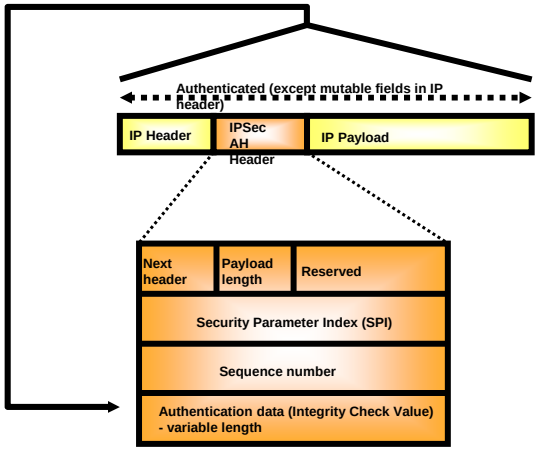
- **The three secure channels in this sample configuration make up a VPN**
  - Each secure channel in itself can be considered a VPN
- **A secure channel is commonly called an IPSec security association (SA) and uses authentication and/or encryption**
  - The term "tunnel" is also sometimes used in this context, but it is ambiguous and can be confused with tunnel vs. transport mode
- **A secure channel provides point-to-point security**
- **Integrated IPSec utilizes IP security protocols defined by the IPSec working group**
  - RFC 2402 - IP Authentication Header (AH) protocol
    - Data authentication
    - IP header authentication
    - Data origin authentication
  - RFC 2406 - IP Encapsulating Security Payload (ESP)
    - Data authentication
    - Data origin authentication
    - Data privacy

IPSec VPN concepts - encapsulation mode

- **Indicates how to construct an IPSec packet**
- **Two modes**
  - Transport mode
    - Inserts AH and/or ESP headers between original IP header and protected data
  - Tunnel mode
    - Creates a new IP header with an AH and/or ESP header
    - AH/ESP header followed by original IP header and protected data
- **If one or both security endpoints are acting as a gateway**
  - Tunnel mode must be selected
- **If neither security endpoint is acting as a gateway**
  - Tunnel or transport may be selected
  - Usually transport mode is used in this case
    - No need for extra cost of adding a new IP header in this case
- **The counterpart to encapsulation is decapsulation**

IPSec VPN concepts - Authentication Header (AH) protocol

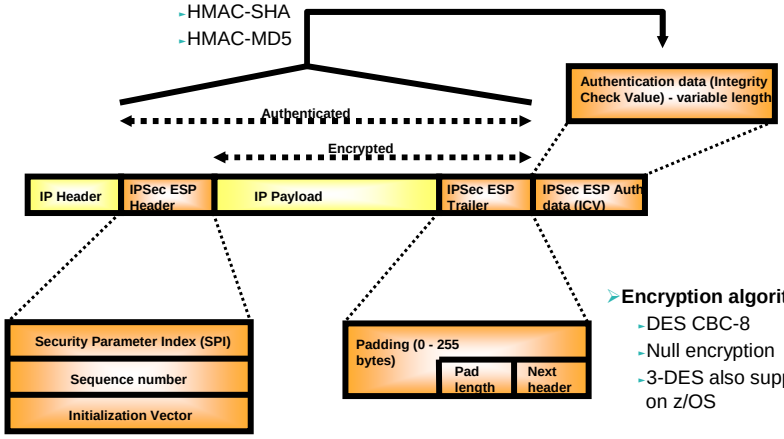
- **Authentication algorithms**
  - HMAC-SHA
  - HMAC-MD5



- **If transport mode, then "Payload" contains the original transport header and original data**
- **If tunnel mode, then "Payload" contains the original IP header, original transport header, and original data**

IPSec VPN concepts - Encapsulating Security Payload (ESP) protocol

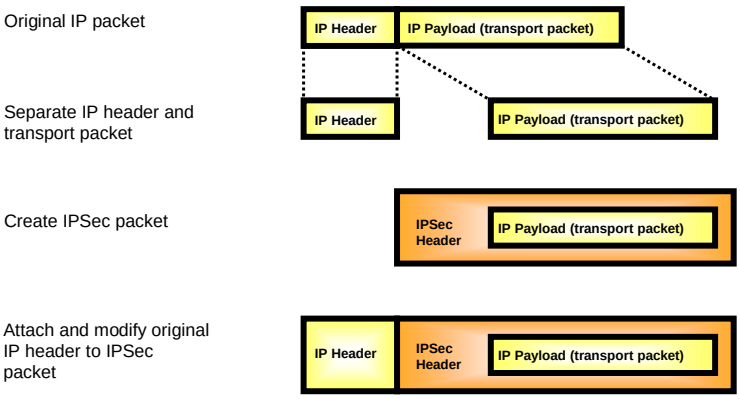
- **Authentication algorithms**
  - HMAC-SHA
  - HMAC-MD5



- **Encryption algorithms**
  - DES CBC-8
  - Null encryption
  - 3-DES also supported on z/OS

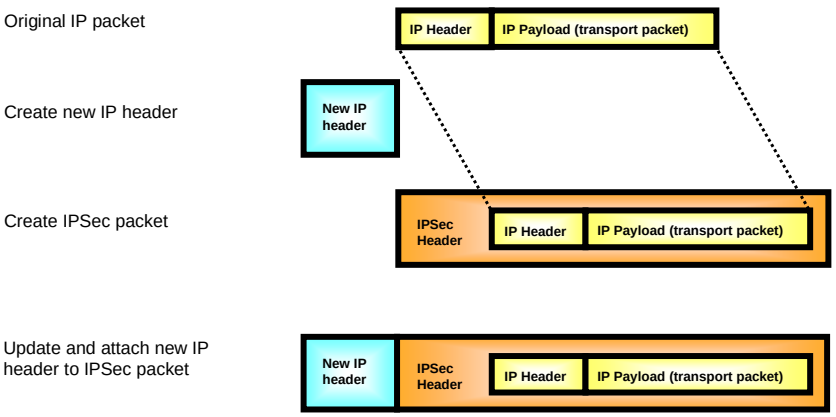
- **If transport mode, then "Payload" contains the original transport header and original data (possibly encrypted)**
- **If tunnel mode, then "Payload" contains original IP header, original transport header, and original data**
  - "Payload" can be encrypted

IPSec VPN concepts - creating an IPSec packet using transport mode



Transport mode is typically used between two hosts that establish an IPSec VPN end-to-end between them.

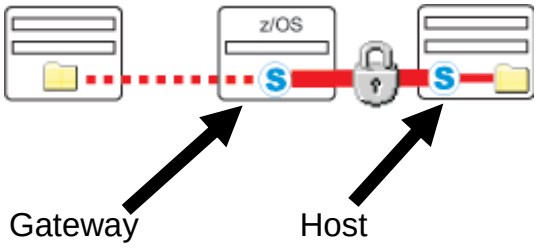
IPSec VPN concepts - creating an IPSec packet using tunnel mode

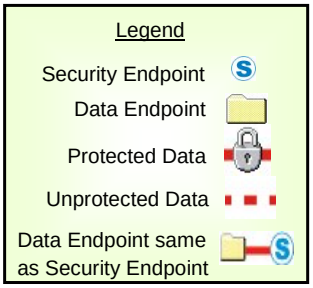


Tunnel mode is used if at least one of the two IPSec VPN endpoints is a gateway.

IPsec VPN concepts - security endpoint

- **The endpoints of an IPSec secure channel**
  - Where IPSec protection is applied
- **Endpoint roles**
  - Host
    - Local data endpoint and secure channel endpoint are the same IP address
  - Gateway (or Security Gateway)
    - Local data endpoint and secure channel endpoint are different IP addresses





IPsec VPN concepts - encapsulation mode rules

- **Must use tunnel mode:**

Gateway to Gateway

Gateway to Host

Host to Gateway

- **May use tunnel or transport mode:**

Host to Host

Legend

Security Endpoint

Data Endpoint

Protected Data

Unprotected Data

Data Endpoint same as Security Endpoint

IPsec VPN concepts - security associations (SAs)

- **IPSec secure channel endpoints must agree on how to protect traffic**
  - Security protocol
    - AH
    - ESP
  - Algorithms to be used by the security protocols
    - Encryption Algorithm
      - DES or Triple DES
    - Authentication Algorithm
      - HMAC_MD5 or HMAC_SHA
  - Cryptographic keys
  - Encapsulation mode
    - Tunnel
    - Transport
  - Lifetime/lifesize (for dynamic SAs)
- **This agreement is known as a "security association" - or for short, an SA**

IPSec VPN concepts - more about IPSec security associations (SAs)

- **Used to protect IP traffic**

- **Unidirectional**
  - Need one for inbound and another for outbound - each IPSec secure channel endpoint consists of two SAs
    - Generally symmetrical with regards to algorithms used
    - Cryptographic keys will be different
  - A pair of matching SAs are on z/OS referred to as a "Tunnel ID" - in a sense identifying the secure channel

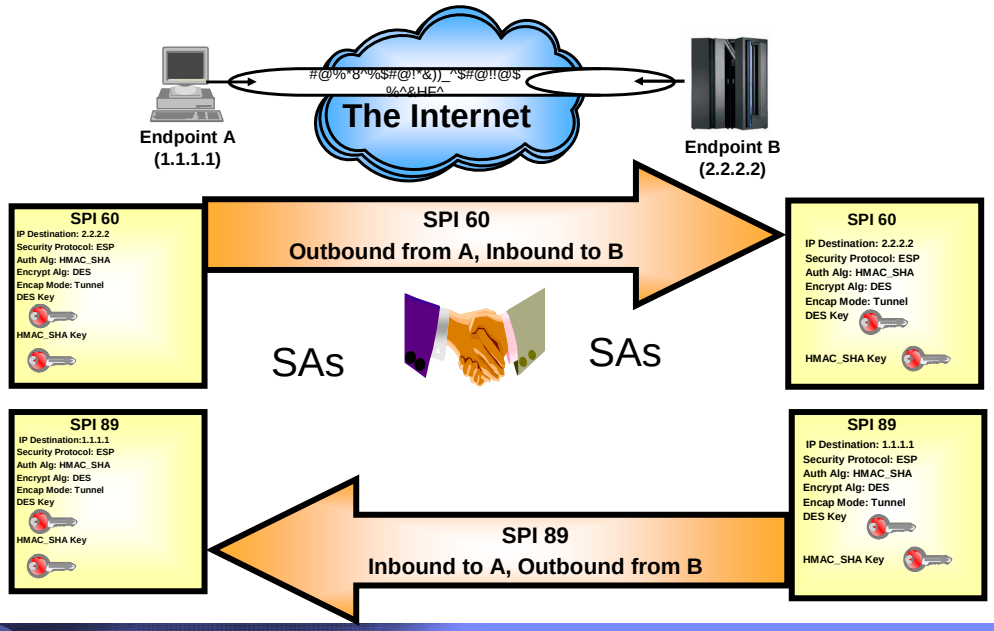
- **An SA is identified by:**
  - A Security Parameter Index (SPI)
    - The SPI is a 32-bit value
    - SPI numbers in themselves may not be unique on a given IPSec node
    - The SPI is carried in the IPSec headers
  - IPSec protocol
  - Destination IP address information

- **Manually defined SAs**
  - Statically defined in the Security Policy Database (SPD - Pagent IPSec config file)

- **Dynamically defined SAs**
  - Negotiated using the Internet Key Exchange protocol
  - Acceptable values (policy) defined in the SPD (Pagent IPSec config file)

- **Security Association Database (SAD)**
  - The collection of all SAs known to the stack

IPSec VPN concepts - IPSec security association example



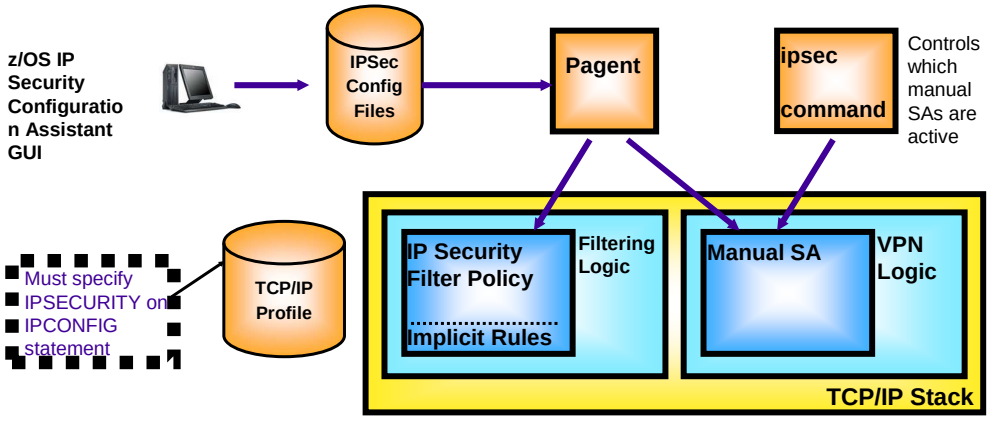
IPSec VPN concepts - manually defined SAs

- **Not commonly used**
  - Do not provide a scalable solution
  - In the long run difficult to manage
- **Require the IPSECURITY option on the IPCONFIG statement**
  - Mutually exclusive with the FIREWALL option
- **Defined in a Pagent IPSec configuration file**
  - Cannot be used when default filter policy is in effect
  - Utilized by filter rules with an action of "ipsec"
  - SA is defined by a manual VPN action
    - Can be generated by the z/OS IP Security Configuration Assistant GUI
- **Use the ipsec command to activate/deactivate manual SAs**
  - Can also be automatically activated when policy is installed
- **Definition of SA attributes require mutual agreement between tunnel endpoint administrators**
  - Cryptographic keys and IPSec Security Protocol parameters must be mutually agreed to between tunnel endpoint administrators
  - Need to decide how to safely exchange keys (physical mail/courier service)
  - Need to decide how to refresh keys
    - Manual SAs must be deactivated and activated when refreshing keys
    - Refreshing keys must be coordinated with the remote tunnel endpoint's administrator
  - Remote endpoint may need to reactivate a manual SA if you locally deactivate the SA and then locally activate the SA.

IPSec VPN concepts - integrated IP Security manual SAs overview

```
IPFilterRule1
IPFilterRule2
   IpGenericFilterAction IPSEC
   IPManVpnAction
```

- Define IP filter conditions here (which packets using manual SAs for encryption)
- Define all encryption info between 2 data endpoints here (cipher suite, spi, keys, method (AH/ESP), Mode (Tunnel/Transport), gateways to use, etc.

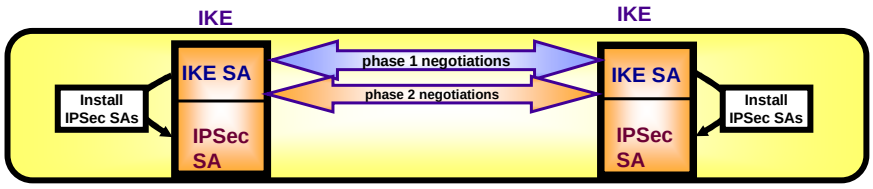


IPSec VPN concepts - dynamically defined SAs

- **Currently state of the art**
  - Scalable
  - Initially requires more configuration than a manual SA
  - In the long run easier to manage
    - Set and forget it
- **Require the IPSECURITY option on the IPCONFIG statement**
  - Mutually exclusive with the FIREWALL option
- **Cannot be used when default filter policy is in effect**
- **Dynamic SAs are negotiated by the IKE daemon**
- **Dynamic IPSec VPN policy defined in a Pagent IPSec configuration file**
  - Can be generated by the z/OS IP Security Configuration Assistant GUI
  - Dynamic IPSec VPN action identifies "acceptable" SA attributes
    - Utilized by filter rules with an action of "ipsec"
  - Key exchange policy defines how to protect dynamic SA negotiations
- **The IKE deamon implements the Internet Key Exchange protocol**
  - Defined in RFC 2409
  - A two phase approach to negotiating dynamic IPSec SAs
- **The IKE daemon obtains its policy from Pagent**
  - Policy information for negotiating IPSec SAs
    - Dynamic IPSec VPN actions
  - Policy for creating a secure channel used to negotiate IPSec SAs
    - Key Exchange Policy
  - Policy for ipsec command activation and autoactivation
    - Local Dynamic IPSec VPN Policy
- **Utilizes UDP ports 500 and 4500 to communicate with remote security endpoints**
  - Negotiating SAs
  - Sending informational messages

IPSec VPN concepts - two phases of IKE negotiations

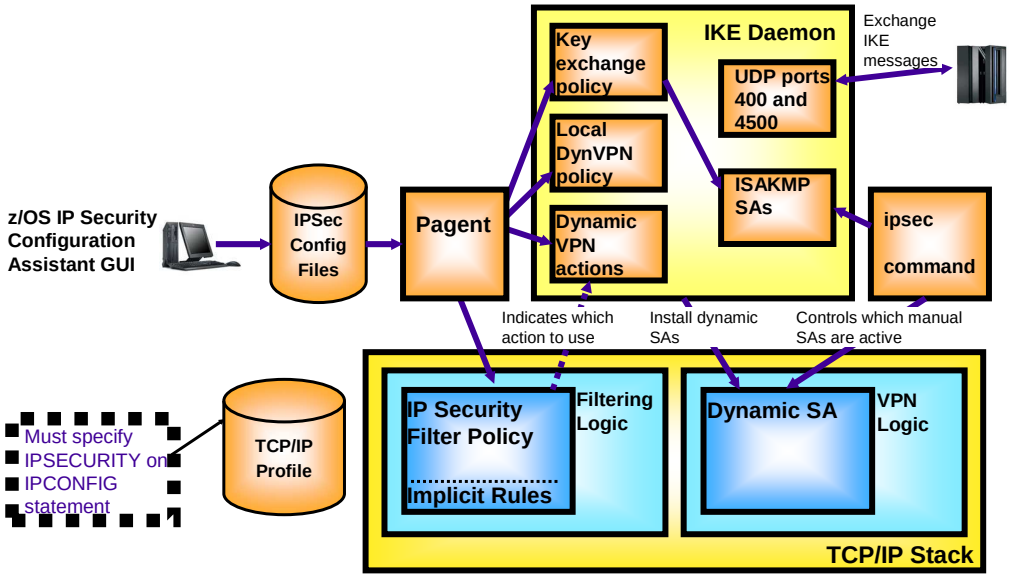
- **Phase 1 negotiation**
  - Creates a secure channel with a remote security endpoint
    - Negotiates an IKE SA
      - Generates cryptographic keys that will be used to protect Phase 2 negotiations and Informational exchanges
      - Authenticates the identity of the parties involved
      - Bidirectional, and not identified via SPIs
  - Requires processor-intensive cryptographic operations
  - Done infrequently
- **Phase 2 negotiation**
  - Negotiates a pair of IPSec SAs with a remote security endpoint
    - Generates cryptographic keys that are used to protect data
      - Authentication keys for use with AH
      - Authentication and/or encryption keys for use with ESP
  - Performed under the protection of an IKE SA
  - Done more frequently than phase 1



IPSec VPN concepts - IKE SAs

- **Used to protect Phase 2 negotiations**
- **Bidirectional**
- **Endpoints must agree on**
  - Encryption algorithm
    - DES/Triple DES
  - Hash Algorithm
    - MD5/SHA1
  - Authentication Method
    - Preshared Key
    - RSA Signature
  - Diffie-Hellman Group
  - Lifetime/Lifesize
- **Policy definition is based on identities exchanged during phase 1**
  - Key Exchange Policy
    - A set of filter rules for IKE

IPSec VPN concepts - integrated IP Security dynamic SAs overview



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