IPsec

Encryption & Authentication

BİL 448/548

Internet Security Protocols

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IPsec

- Cryptographic protection of the IP traffic, transparent to the user
- Main components:
  - Internet Key Exchange (IKE): IPsec key exchange protocol
  - Authentication Header (AH): Authentication of the IP packet (optional)
  - Encapsulating Security Payload (ESP): Encryption/authentication of the IP packet (optional)

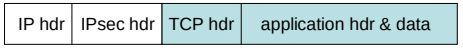
Uses of IPsec

- Can be used to provide user-, host-, or network-level protection (the granularity)
- Protocol modes:
  - Transport mode: Host applies IPsec to transport layer packet
  - Tunnel mode: Gateway applies IPsec to the IP packet of a host from the network (IP in IP tunnel)
- Typical uses:
  - Remote access to network (host-to-gateway)
  - Virtual private networks (gateway-to-gateway)

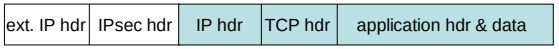
IPsec Coverage

Basic TCP/IP packet:

IPsec – transport mode:



IPsec – tunnel mode:



Some Basics

- Packets are authenticated/encrypted with a session key. Ideally, both parties should contribute to the session key.
- Sequence numbers are needed against packet replay attacks (different from TCP seq.no.).
- Receiver of a packet compares its seq.no. against previous packets in a “sliding window”.
- Session key is reset before seq.no. wraps around.

Security Association & Policy

- *Security Policy Database*
  Specifies what kind of protection should be applied to packets (according to source-destination addresses, port numbers, etc.)
- *“Security Association” (SA)*
  - An IPsec-protected connection
  - Identified by
    - “security parameter index” (SPI)
    - destination IP address
    - protocol identifier (AH or ESP)
  - Specifies the encryption/auth. algorithm, key, etc.

SA Database

Contains the relevant information for each SA:

- AH information (auth. algorithm, key, key lifetime, etc.)
- ESP information (auth./encryption algorithm, key, key lifetime, etc.)
- Sequence number counter
- Anti-replay window (at the destination SA)
- Lifetime of the SA
- Others (protocol mode, path MTU, etc.)

IPsec Packet Processing

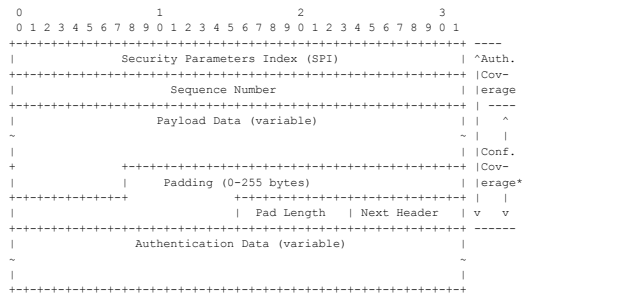
Outbound packets:

- The proper SA is chosen from the security policy database
- From the SA database, the SPI and SA parameters are retrieved
- The IPsec protection is performed; packet passed to IP

Inbound packets:

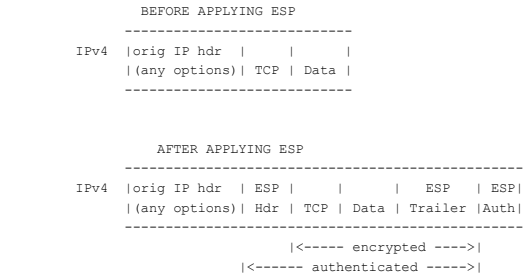
- By the SPI, the SA is found
- IPsec auth./decryption is performed
- Packet passed to upper layer protocol

Encapsulating Security Payload (ESP)

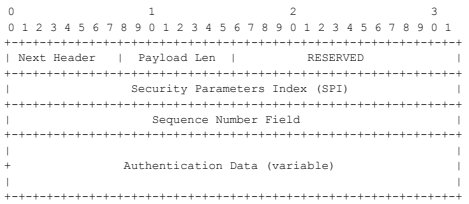


- Encryption: usually a block cipher in CBC mode
- IV is typically included in the payload (not encrypted)

ESP with IPv4

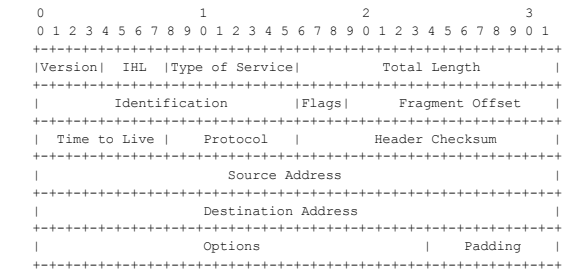


Authentication Header (AH)



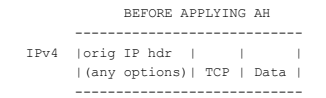
- Auth. alg.: HMAC (with MD5, SHA1, etc.)
  CBC-MAC (3DES, RC5, AES, etc.)
- Authentication covers immutable fields of IP header as well as the payload.

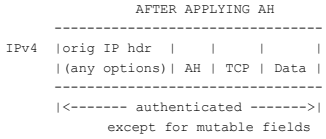
IPv4 Header



Mutable fields (according to AH):
ToS, flags, frag.offset, TTL, checksum

AH with IPv4





AH Controversies

- Authentication is provided by ESP as well (hence, AH is useless)
- Protecting immutable fields doesn't add much
- Destination address may be mutable! (due to NAT)
- Not efficient to compute (MAC at the beginning)