# IP Security

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The lecture covers chapter 9 “IP Security” in [5]. You should also read section 1 in [3] as a complement to the course literature, to help you grasp the Internet Key Exchange protocol. To check that you have fully understood this chapter, you should solve problems 9.3, 9.6, 9.8 and 9.10.

1. IPsec
   - IP Security
2. Internet Key Exchange
   - IKE

- Lack of security in IP have been discussed since 1994. [1]
- Issue raised by the Internet Architecture Board (IAB).
- Authentication and Encryption features should be included in "Next generation IP".
- The mechanisms were designed for backwards compatibility.

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- Secure remote access.
- Secure tunneling.
- Authentication.

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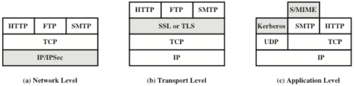
- Besides the apparent security benefits.
- Transparent to applications.
- Depending on deployment, transparent to users.

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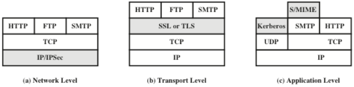


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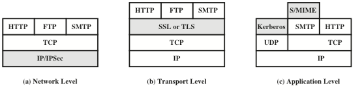


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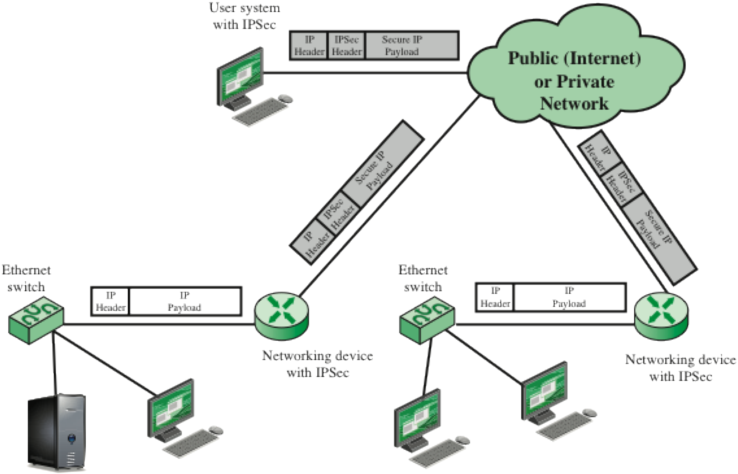


Figur: IPsec deployment scenario [5, Fig. 9-1]

- Access control
- Connectionless integrity
- Data origin Authentication
- Rejection of replayed packets
- Confidentiality
- Limited traffic flow confidentiality

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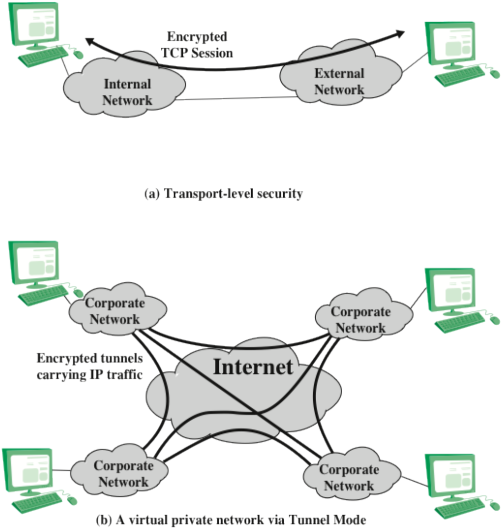
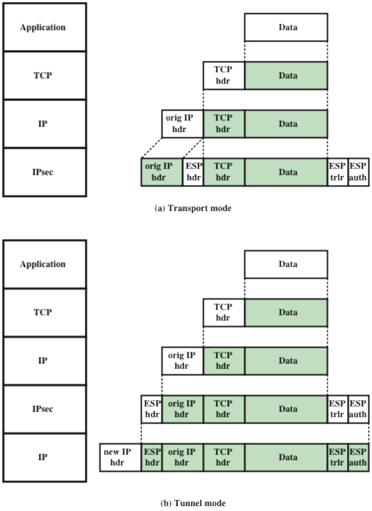
# Transport mode vs. Tunnel mode

## IP Security

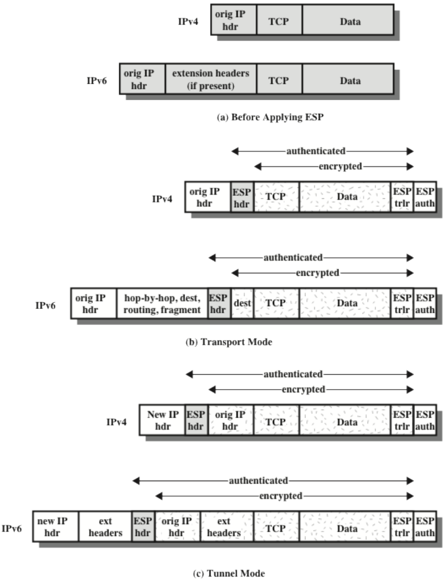



Figur: Transport vs Tunnel mode[5, Fig.9-7]




Figur: Transport vs Tunnel mode[5, Fig. 9-9]

# Transport mode vs. Tunnel mode
## IP Security



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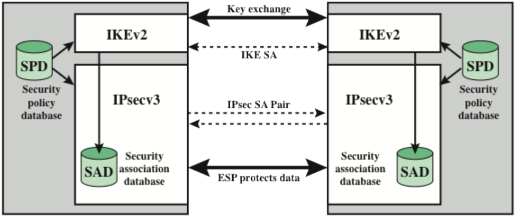
- Each policy is stored in a Security Policy Database.
- Keeps track of what policy to apply to a package based on Security Associations stored in a SAD.




Figur: IPsec architecture [5, Fig. 9-2]

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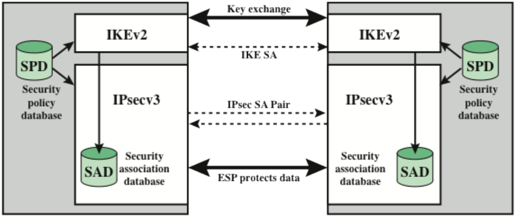


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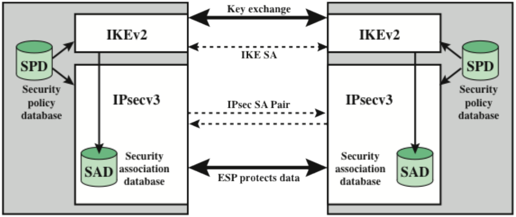


Figur: IPsec architecture [5, Fig. 9-2]

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- Used to identify a certain connection.
- Identified with three parameters
  - Security Parameter Index – A 32 bit value used as an identifier
  - IP destination address
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- Sequence Number Counter
- Sequence Counter Overflow
- Anti-Replay Window
- AH or ESP information - What algorithms to use
- Lifetime
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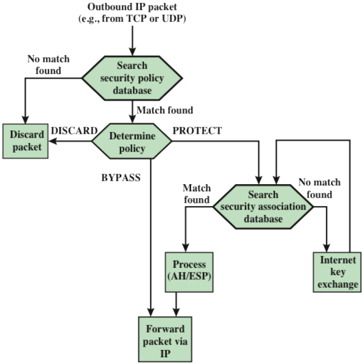
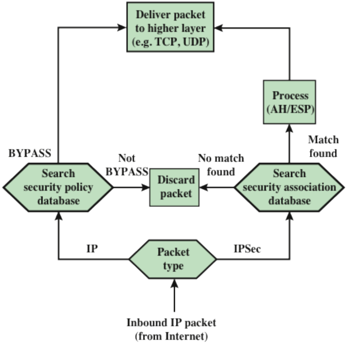



Figur: IPsec outbound packages [5, Fig. 9-3]

# Process inbound packages


Figur: IPsec inbound packages [5, Fig. 9-4]

## Replay attack

"An attack in which a valid data transmission is maliciously or fraudulently repeated, either by the originator or by a third party who intercepts the data and retransmits it" [4, page. 249]

- Each SA stores a sequence number counter, that initially is set to 0
- Anti-replay don't allow this counter to exceed $2^{32} - 1$
- if counter is exceeded, a new SA is negotiated.
- Use an anti-replay window to compensate for IPs unreliable and connectionless design.

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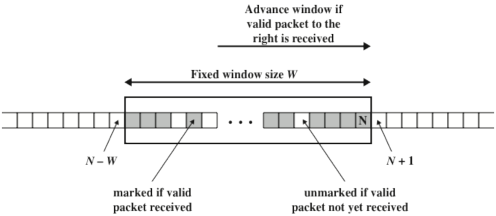


Figur: Anti-Replay window [5, Fig. 9-6]

- A need to combine multiple IPsec services for the same flow.
- Bundles a sequence of SAs
- Each SA might be terminated at a different or the same endpoint.
- Two types of bundles
  - Transport adjacency – Applies multiple security protocols without tunneling.
  - Iterated tunneling – Each security protocol is nested through tunneling.
  - Or a combination of above

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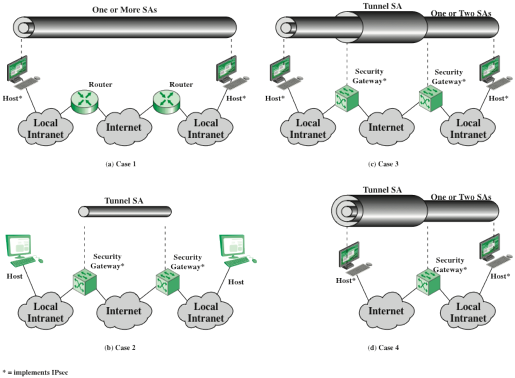


Figur: Combining Security Associations[5, Fig. 9-10]

## Overview

1. IPsec
   - IP Security
2. Internet Key Exchange
   - IKE

IETF established standard that handles the determination and distribution of the secret keys.

## Key management

- Manual
- Automated
  - Oakley – Key exchange protocol based on Diffie-Hellman
  - Internet Security Association and Key Management Protocol (ISAKMP) – A framework for key management. (Same principal as EAP)
  - IKEv2 have implemented a way to use EAP for authentication[2]

- For each IPsec two-way communication, usually four keys need to be created.
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## Weaknesses in Diffie-Hellman

- Doesn't provide any identity information
- Susceptible to a man-in-the-middle attack
- Computationally intensive – clogging attacks.

## IKE Key Determination

- Use cookies to counter clogging attacks
- Allows the parties to negotiate the groups to be used for the DH key exchange to increase security.
- Introduce nonces to counter replay attacks.
- Adds authentication to the key-exchange.

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# IKE Message Exchange II
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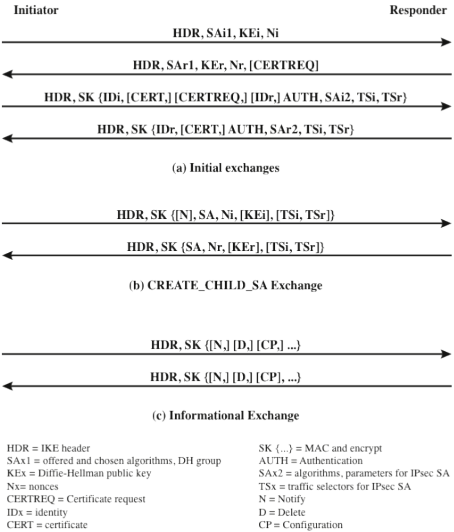


Figur: IKEv2 Exchanges [5]

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