

# Cryptography and Network Security

Third Edition

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# Chapter 16 – IP Security

*If a secret piece of news is divulged by a spy before the time is ripe, he must be put to death, together with the man to whom the secret was told.*

**—The Art of War, Sun Tzu**

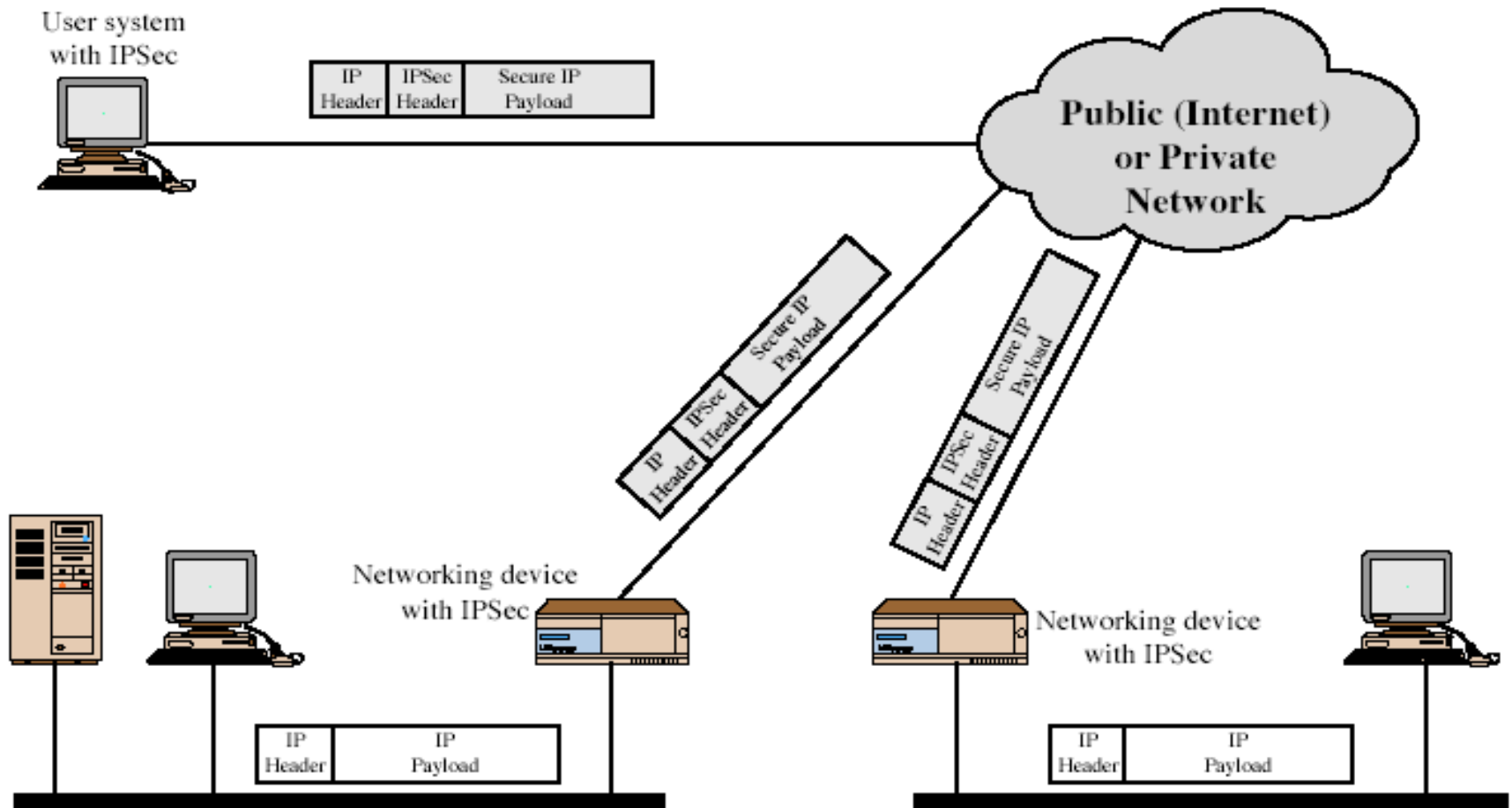
# IP Security

- have considered some application specific security mechanisms
  - eg. S/MIME, PGP, Kerberos, SSL/HTTPS
- however there are security concerns that cut across protocol layers
- would like security implemented by the network for all applications

# IPSec

- general IP Security mechanisms
- provides
  - authentication
  - confidentiality
  - key management
- applicable to use over LANs, across public & private WANs, & for the Internet

# IPSec Uses



# Benefits of IPSec

- in a firewall/router provides strong security to all traffic crossing the perimeter
- is resistant to bypass
- is below transport layer, hence transparent to applications
- can be transparent to end users
- can provide security for individual users if desired

# IP Security Architecture

- specification is quite complex
- defined in numerous RFC's
  - incl. RFC 2401/2402/2406/2408
  - many others, grouped by category
- mandatory in IPv6, optional in IPv4

# IPSec Services

- Access control
- Connectionless integrity
- Data origin authentication
- Rejection of replayed packets
  - a form of partial sequence integrity
- Confidentiality (encryption)
- Limited traffic flow confidentiality



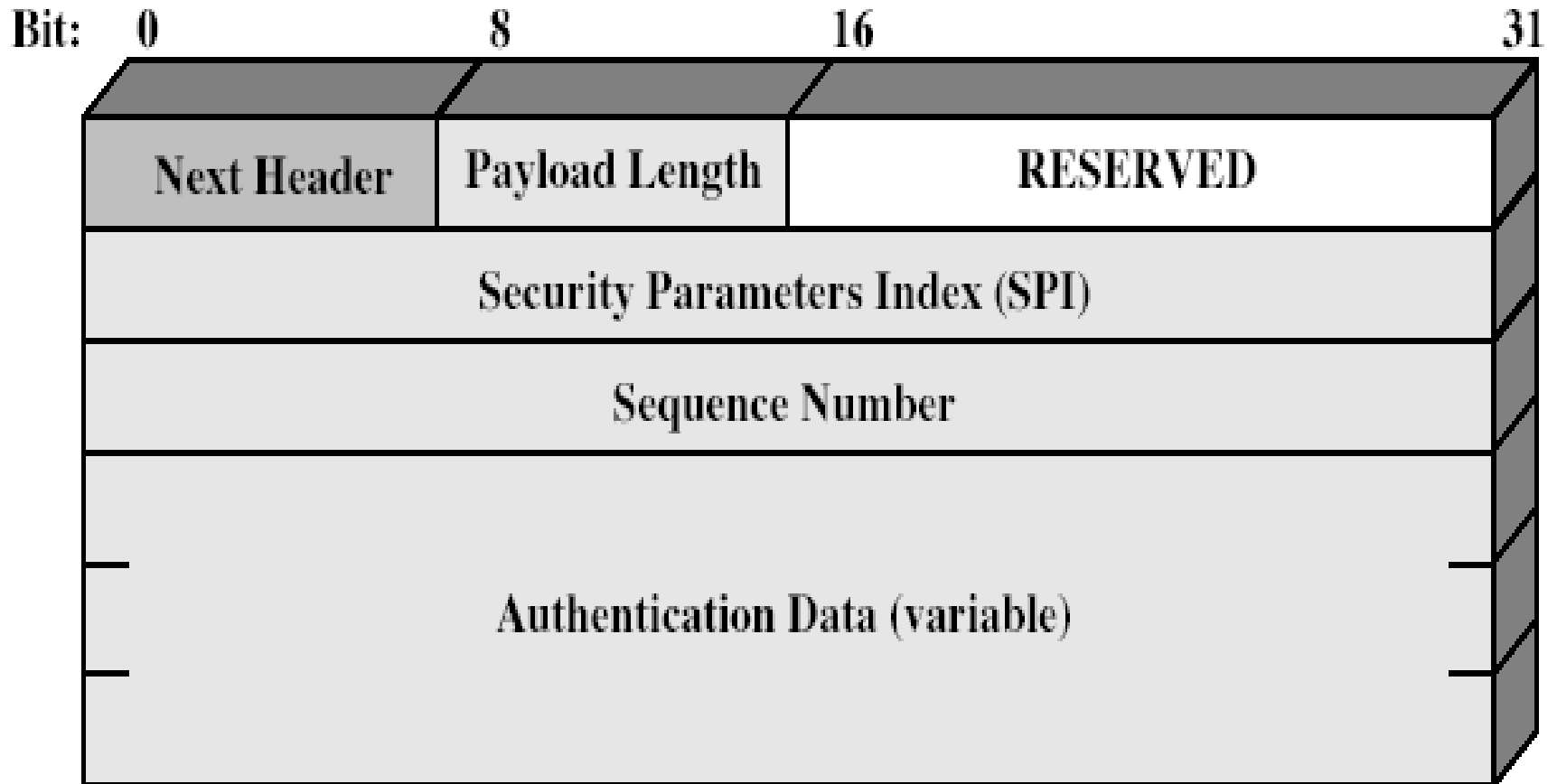
# Security Associations

- a one-way relationship between sender & receiver that affords security for traffic flow
- defined by 3 parameters:
  - Security Parameters Index (SPI)
  - IP Destination Address
  - Security Protocol Identifier
- has a number of other parameters
  - seq no, AH & EH info, lifetime etc
- have a database of Security Associations

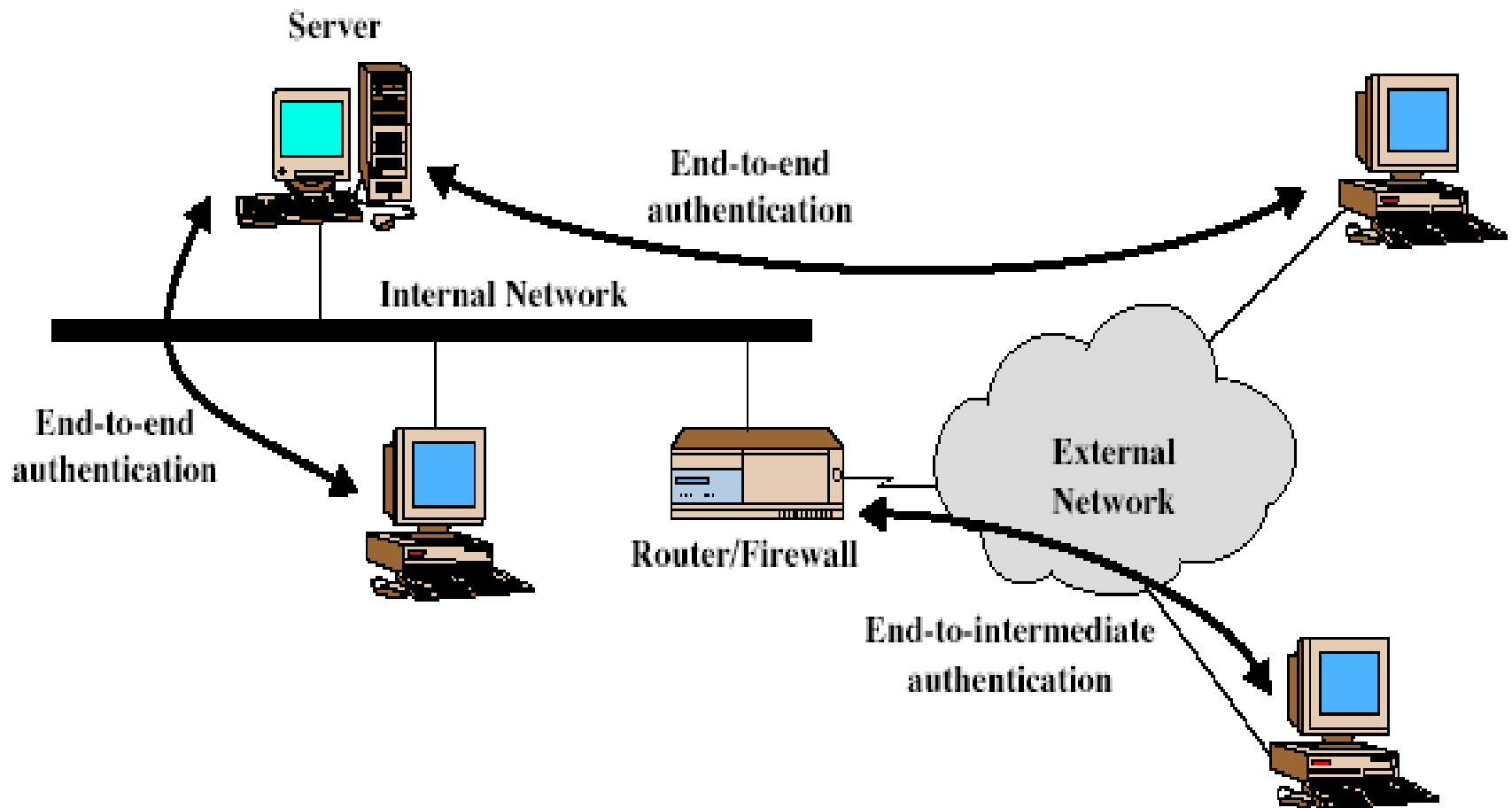
# Authentication Header (AH)

- provides support for data integrity & authentication of IP packets
  - end system/router can authenticate user/app
  - prevents address spoofing attacks by tracking sequence numbers
- based on use of a MAC
  - HMAC-MD5-96 or HMAC-SHA-1-96
- parties must share a secret key

# Authentication Header



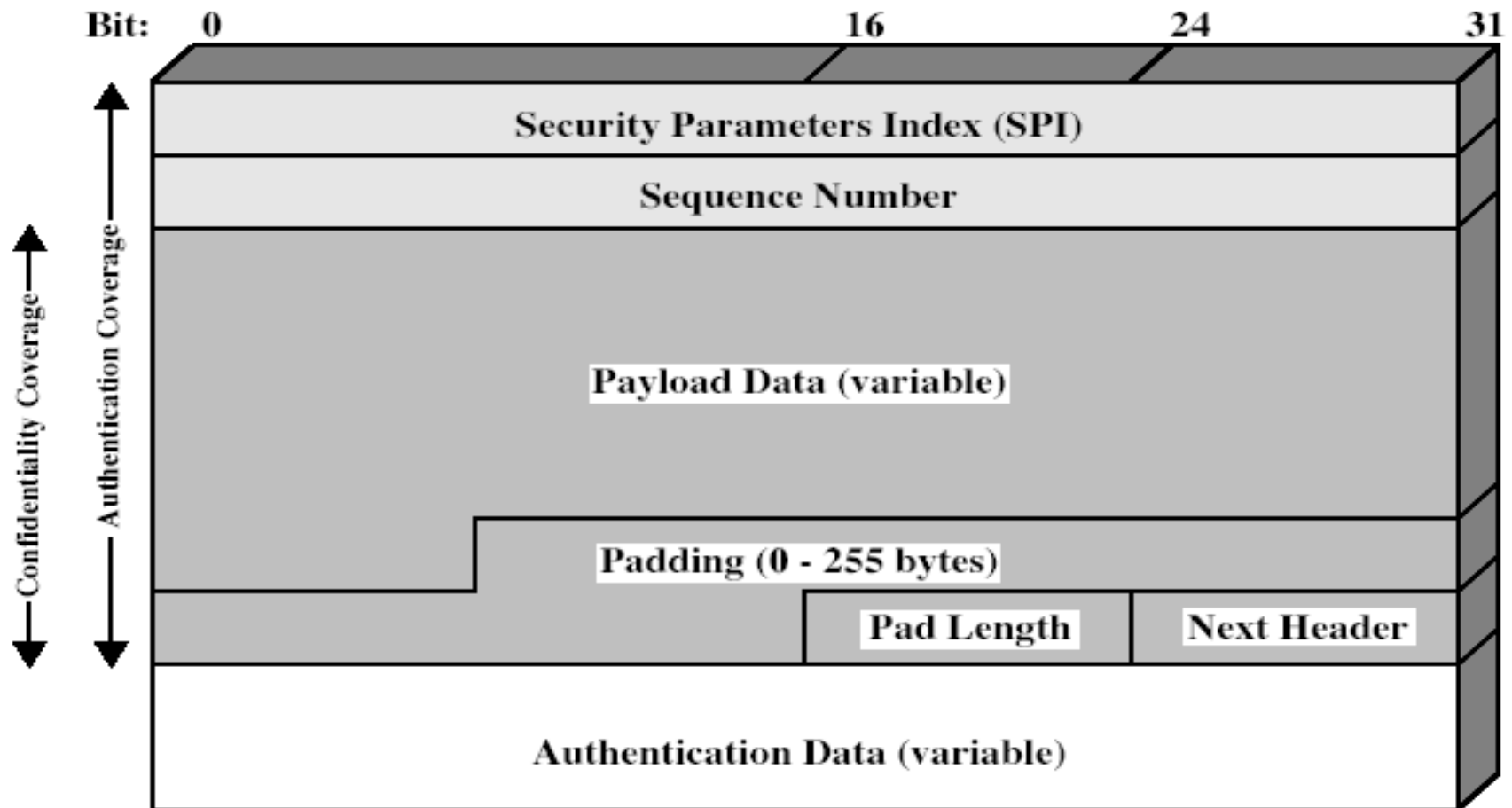
# Transport & Tunnel Modes



# Encapsulating Security Payload (ESP)

- provides message content confidentiality & limited traffic flow confidentiality
- can optionally provide the same authentication services as AH
- supports range of ciphers, modes, padding
  - incl. DES, Triple-DES, RC5, IDEA, CAST etc
  - CBC most common
  - pad to meet blocksize, for traffic flow

# Encapsulating Security Payload



# Transport vs Tunnel Mode ESP

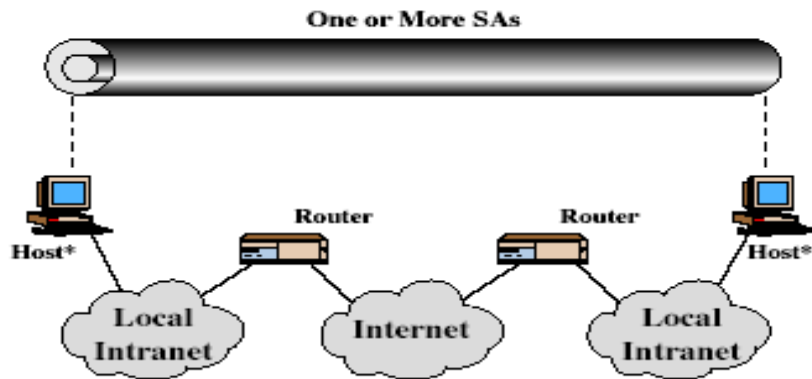
- transport mode is used to encrypt & optionally authenticate IP data
  - data protected but header left in clear
  - can do traffic analysis but is efficient
  - good for ESP host to host traffic
- tunnel mode encrypts entire IP packet
  - add new header for next hop
  - good for VPNs, gateway to gateway security

# Combining Security Associations

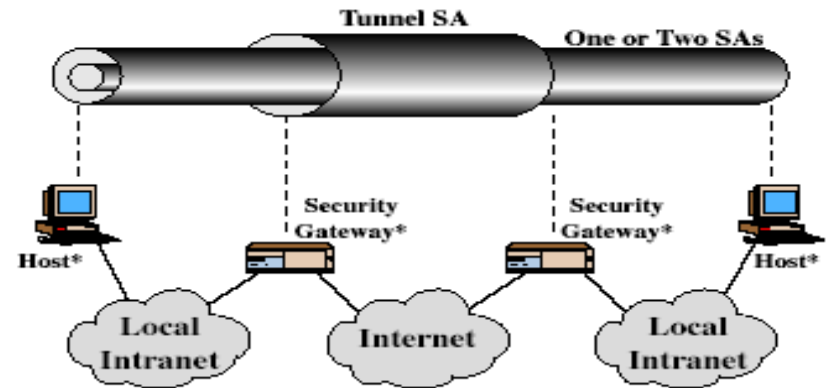
- SA's can implement either AH or ESP
- to implement both need to combine SA's
  - form a security bundle
- have 4 cases (see next)



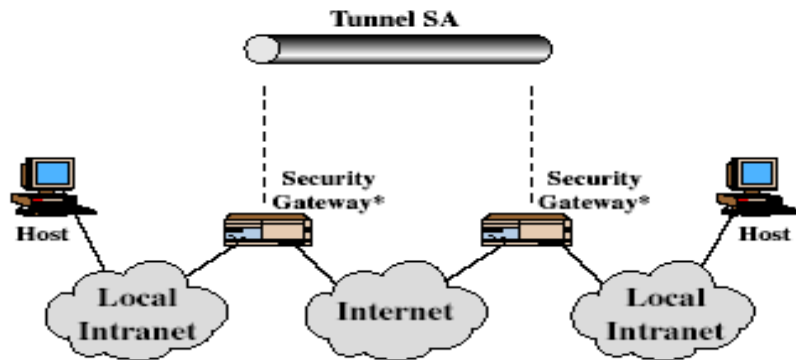
# Combining Security Associations



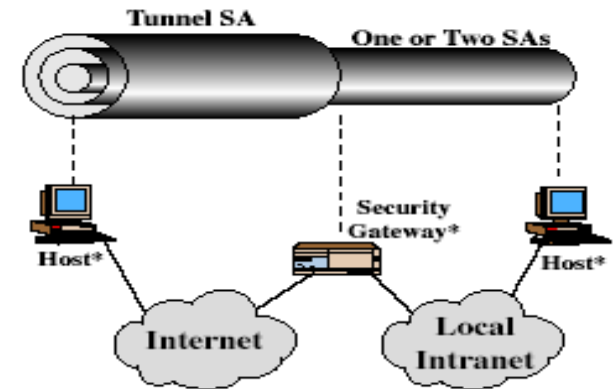
(a) Case 1



(c) Case 3



(b) Case 2



(d) Case 4

# Key Management

- handles key generation & distribution
- typically need 2 pairs of keys
  - 2 per direction for AH & ESP
- manual key management
  - sysadmin manually configures every system
- automated key management
  - automated system for on demand creation of keys for SA's in large systems
  - has Oakley & ISAKMP elements

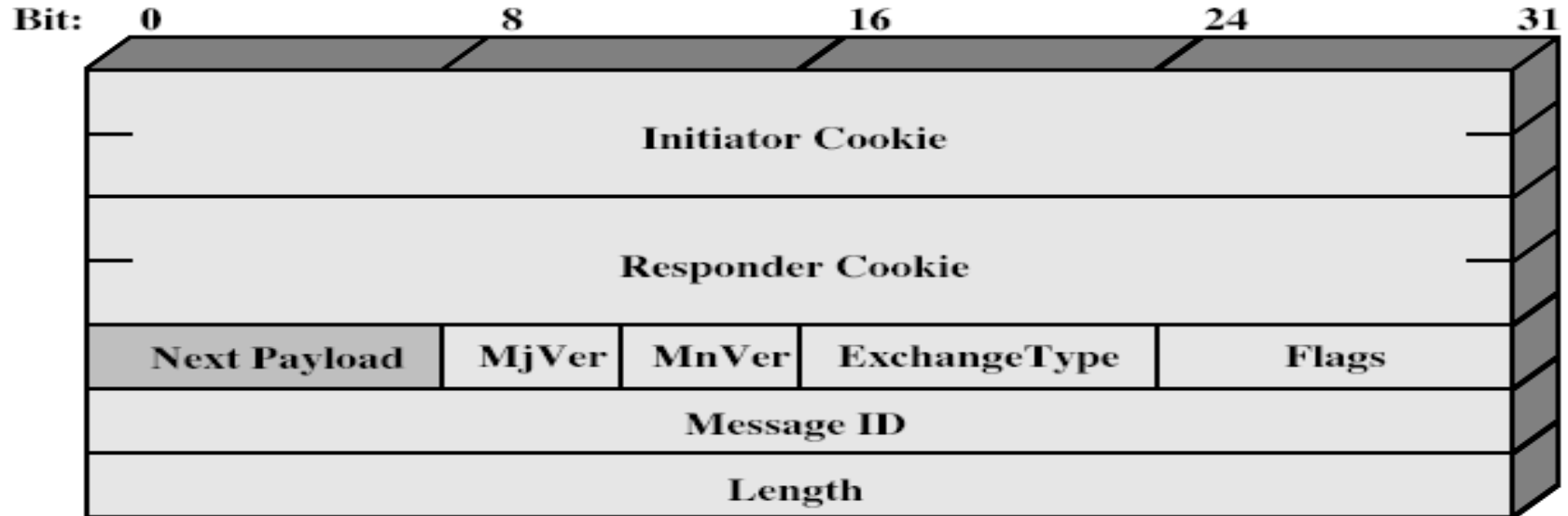
# Oakley

- a key exchange protocol
- based on Diffie-Hellman key exchange
- adds features to address weaknesses
  - cookies, groups (global params), nonces, DH key exchange with authentication
- can use arithmetic in prime fields or elliptic curve fields

# ISAKMP

- Internet Security Association and Key Management Protocol
- provides framework for key management
- defines procedures and packet formats to establish, negotiate, modify, & delete SAs
- independent of key exchange protocol, encryption alg, & authentication method

# ISAKMP



(a) ISAKMP Header



(b) Generic Payload Header

# Summary

- have considered:
  - IPSec security framework
  - AH
  - ESP
  - key management & Oakley/ISAKMP