Information Security 11.1

IP Security

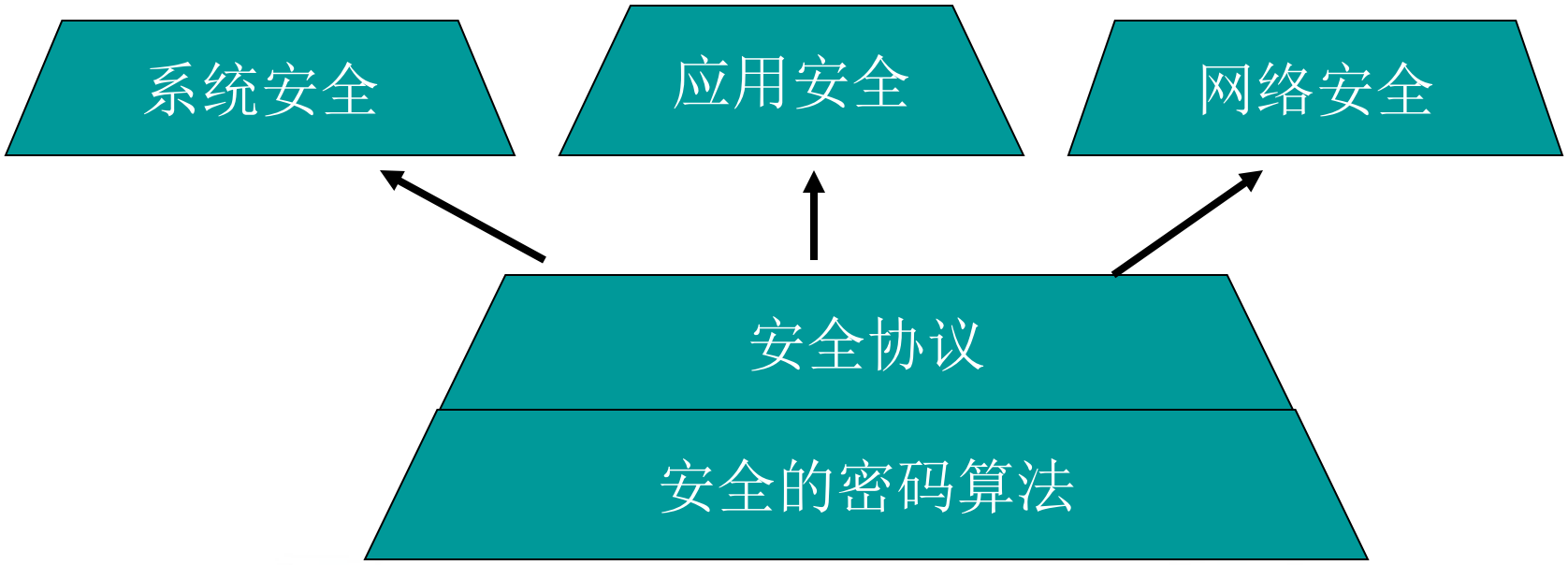
Chapter 16

Review

- Cryptography
- Authentication techniques
- PKI, CA, cert.

Review

- Cryptography
- Authentication techniques
- PKI, CA, cert.



IP Security

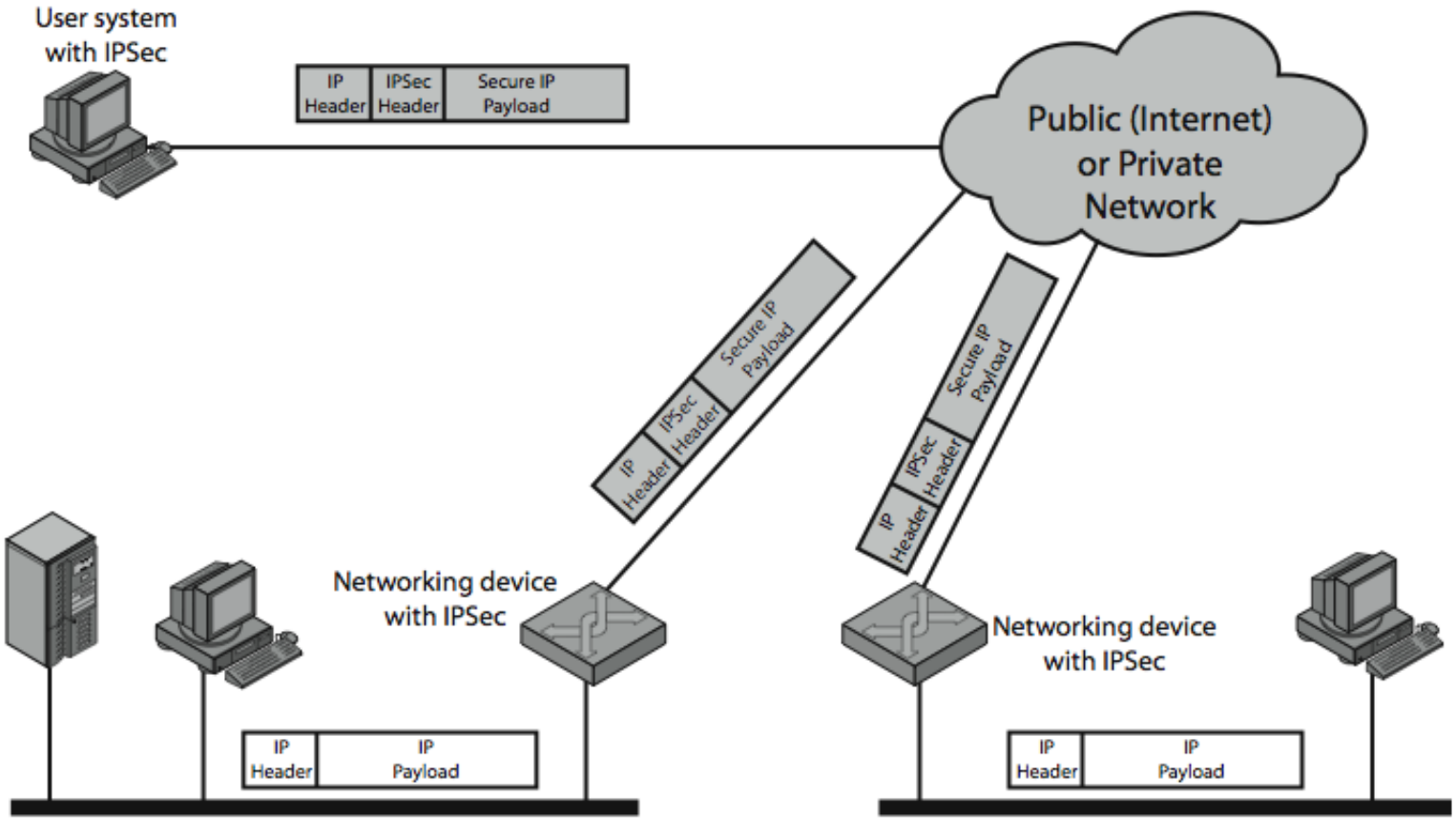
- have a range of application specific security mechanisms
  - eg. S/MIME, PGP, Kerberos, SSL/HTTPS
- however there are security concerns that cut across protocol layers
- would like security implemented by the network for all applications

- *Q: If security mechanisms in app layer have implemented. Security is needed in network level? Or vice versa?*

IPSec

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

IPSec Uses


User system with IPSec
IP Header
IPSec Header
Secure IP Payload
Public (Internet) or Private Network
IP Header
IPSec Header
Secure IP Payload
IP Header
IPSec Header
Secure IP Payload
Networking device with IPSec
Networking device with IPSec
IP Header
IP Payload
IP Header
IP Payload

Benefits of IPSec

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

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
- have two security header extensions:
  - Authentication Header (AH)
  - Encapsulating Security Payload (ESP)

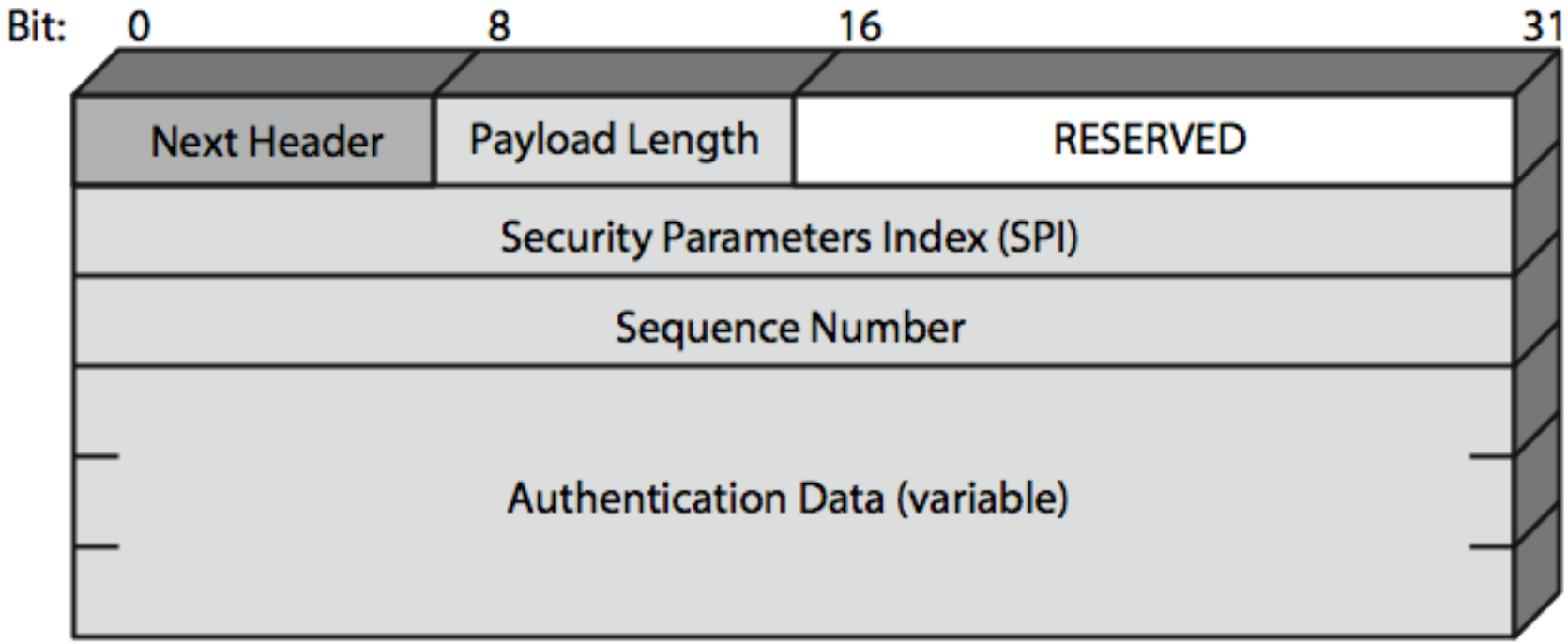
IPSec Services

	AH	ESP (encryption only)	ESP (encryption plus authentication)
Access control	✔	✔	✔
Connectionless integrity	✔		✔
Data origin authentication	✔		✔
Rejection of replayed packets	✔	✔	✔
Confidentiality		✔	✔
Limited traffic flow confidentiality		✔	✔

Authentication Header (AH)

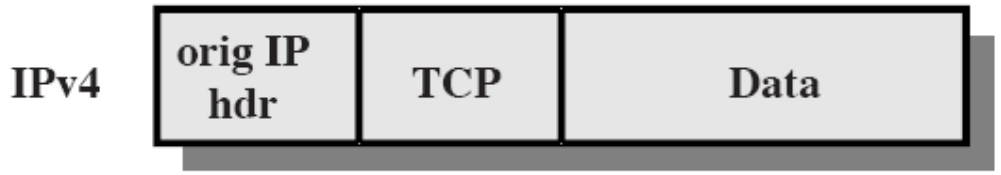
- provides support for data integrity & authentication of IP packets
  - end system/router can authenticate user/app
  - prevents address spoofing / replay attacks by tracking sequence numbers
- based on use of a MAC
  - HMAC-MD5-96 or HMAC-SHA-1-96
- parties must share a secret key

Authentication Header

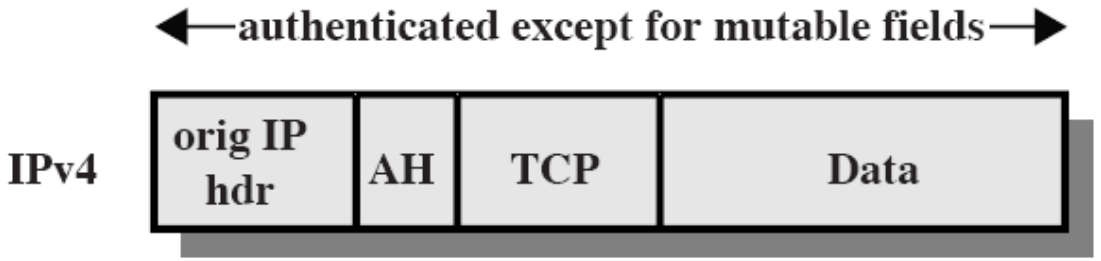


Transport vs Tunnel Modes

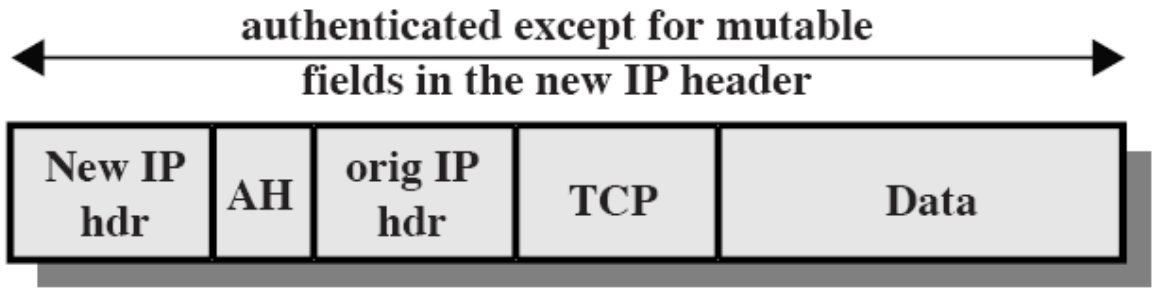
Before Applying AH



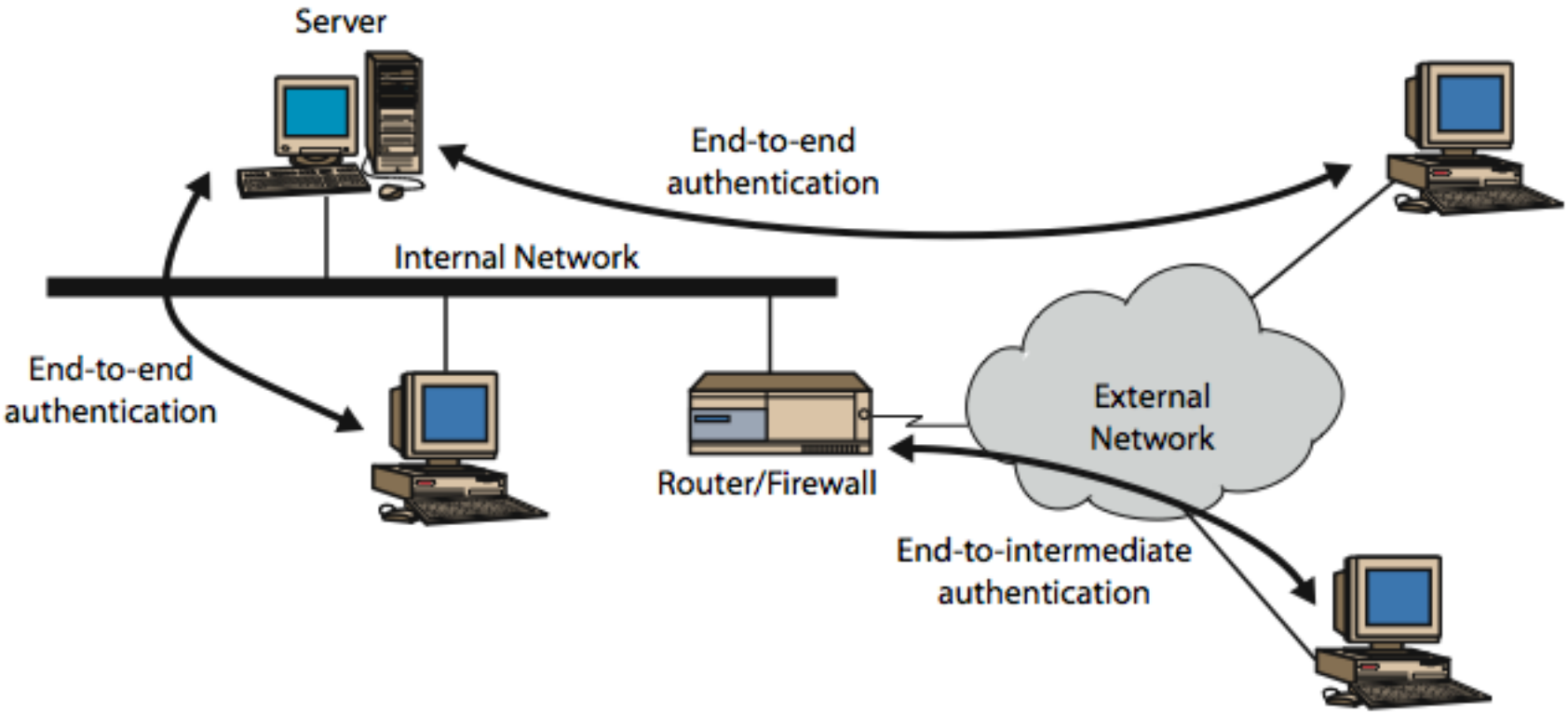
Transport mode



Tunnel mode



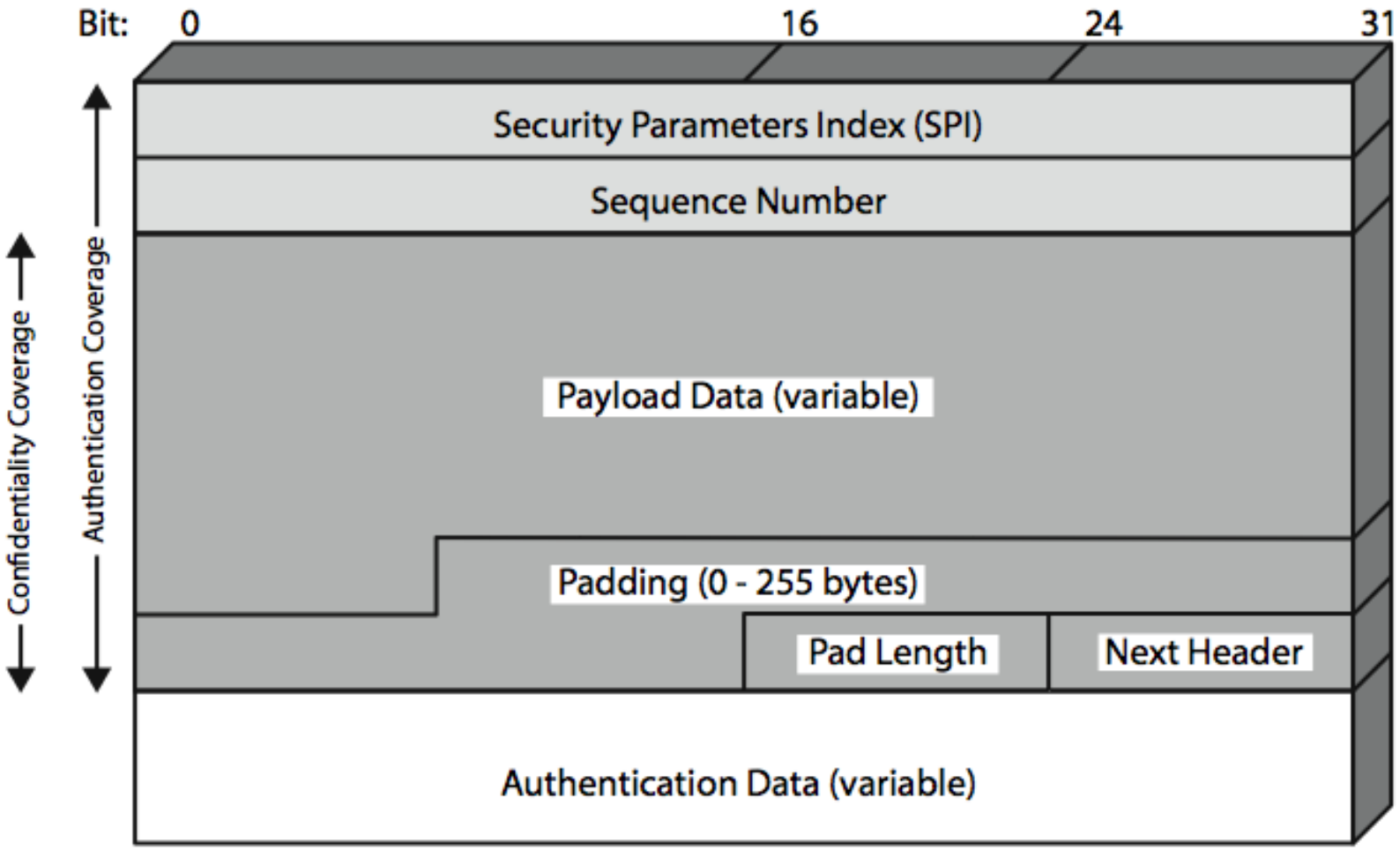
Transport & Tunnel Modes



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 & other modes
  - padding needed to fill blocksize, fields, 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

Security Associations

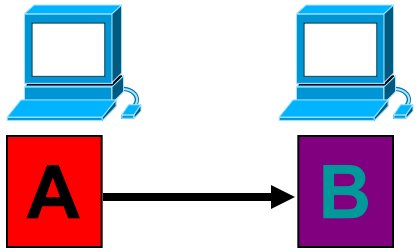
- a one-way relationship between sender & receiver that affords security for traffic flow
- defined by 3 parameters:
  - Security Parameters Index (SPI)
  - IP Destination Address
  - Security Protocol Identifier
- has a number of other parameters
  - seq no, AH & EH info, lifetime etc
- have a database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

Security Parameters Index - SPI

- Can be up to 32 bits large
- The SPI allows the destination to select the correct SA under which the received packet will be processed
  - According to the agreement with the sender
  - The SPI is sent with the packet by the sender
- SPI + Dest IP address + IPSec Protocol (AH or ESP) uniquely identifies a SA

Outbound Processing

Outbound packet (on A)



IP Packet

Is it for IPSec?
If so, which policy entry to select?

SPD (Policy)

SA Database

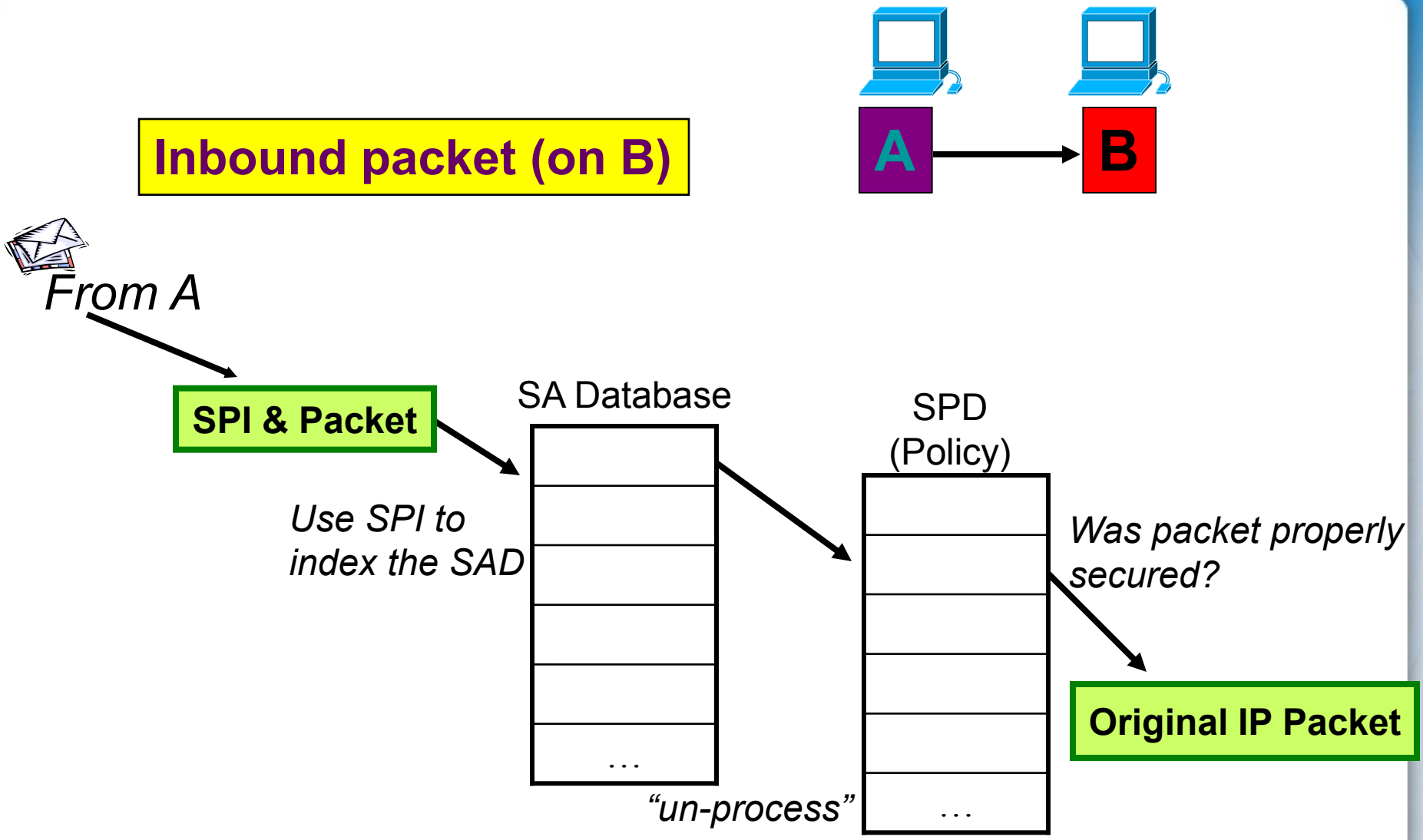
IPSec processing

SPI & IPSec Packet

Determine the SA and its SPI

Send to B

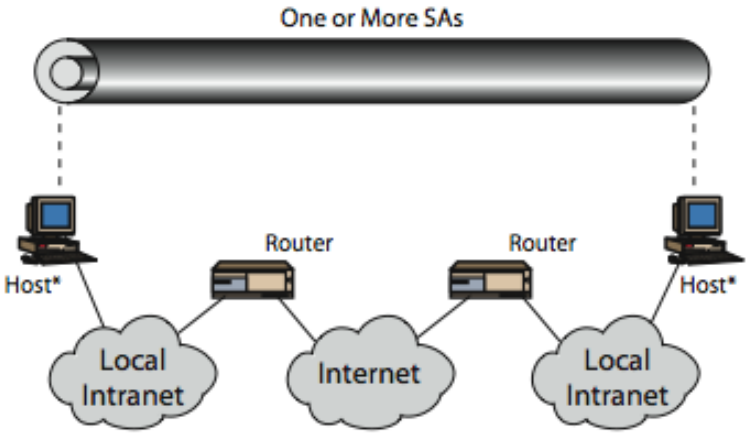
Inbound Processing



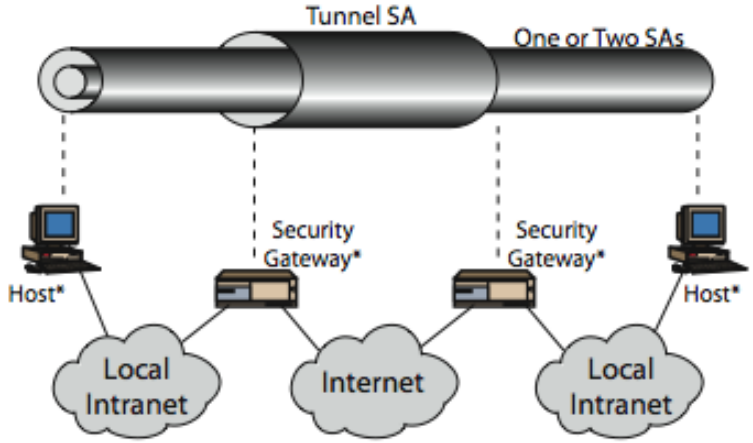
Combining Security Associations

- SA's can implement either AH or ESP
- to implement both need to combine SA's
  - form a security association bundle
  - may terminate at different or same endpoints
  - combined by
    - transport adjacency
    - iterated tunneling
- issue of authentication & encryption order

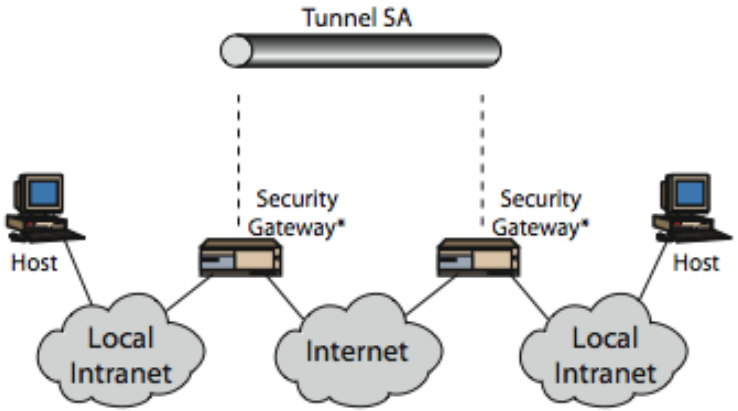
Combining Security Associations



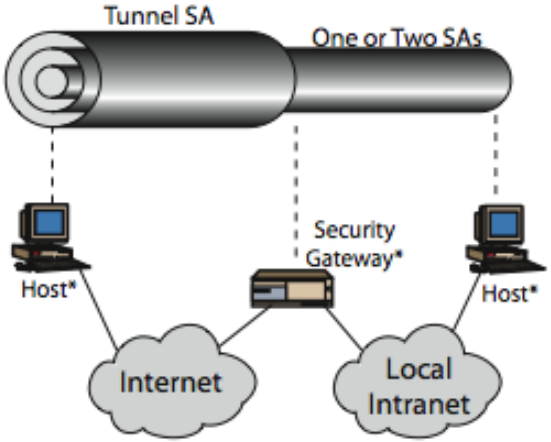
(a) Case 1



(c) Case 3



(b) Case 2



(d) Case 4

Bakup

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

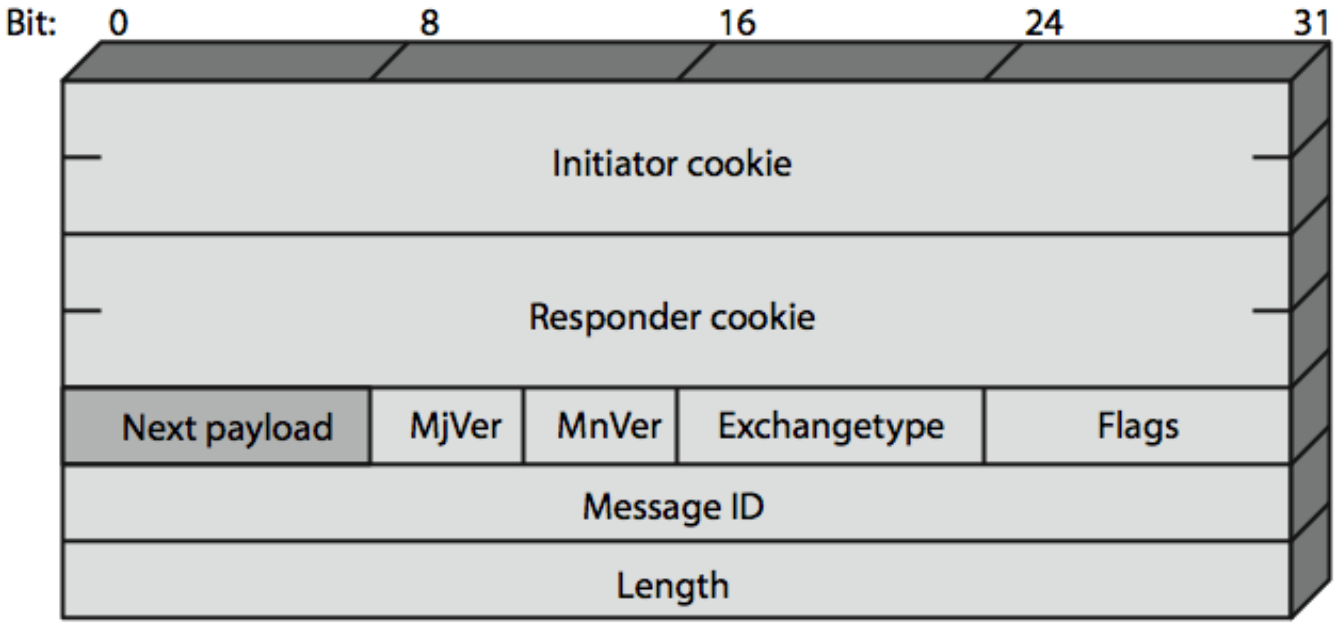
Oakley

- 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

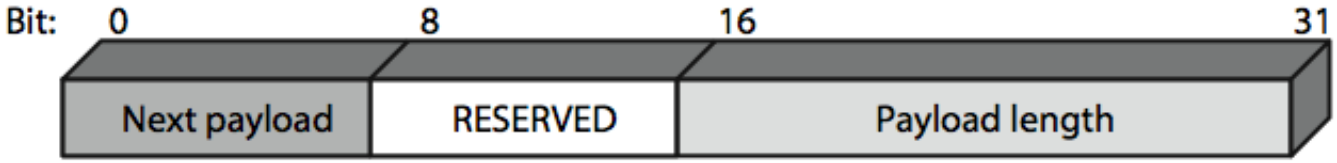
ISAKMP

- 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

ISAKMP Payloads & Exchanges

- have a number of ISAKMP payload types:
  - Security, Proposal, Transform, Key, Identification, Certificate, Certificate, Hash, Signature, Nonce, Notification, Delete
- ISAKMP has framework for 5 types of message exchanges:
  - base, identity protection, authentication only, aggressive, informational

Summary

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