

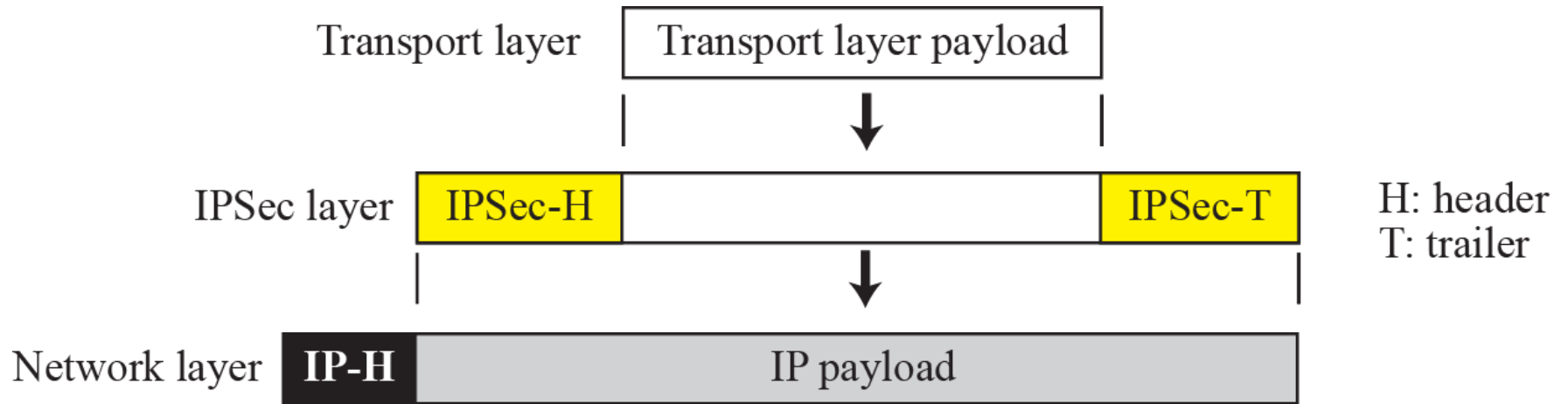
NETWORK LAYER SECURITY

IP Security (IPSec) is a collection of protocols designed by the Internet Engineering Task Force (IETF) to provide security for a packet at the network level. IPSec helps create authenticated and confidential packets for the IP layer.

Topics Discussed in the Section

- ✓ **Two Modes**
- ✓ **Two Security Protocols**
- ✓ **Services Provided by IPSec**
- ✓ **Security Association**
- ✓ **Internet Key Exchange (IKE)**
- ✓ **Virtual Private Network (VPN)**

.1 *IPSec in transport mode*

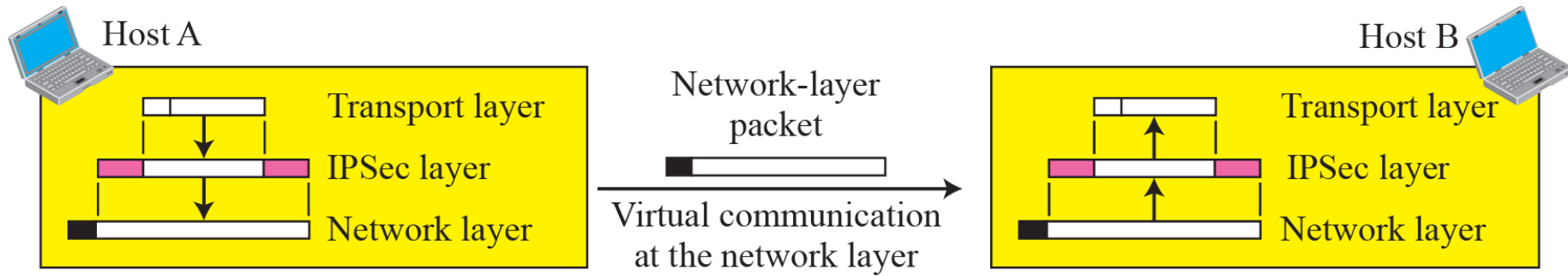




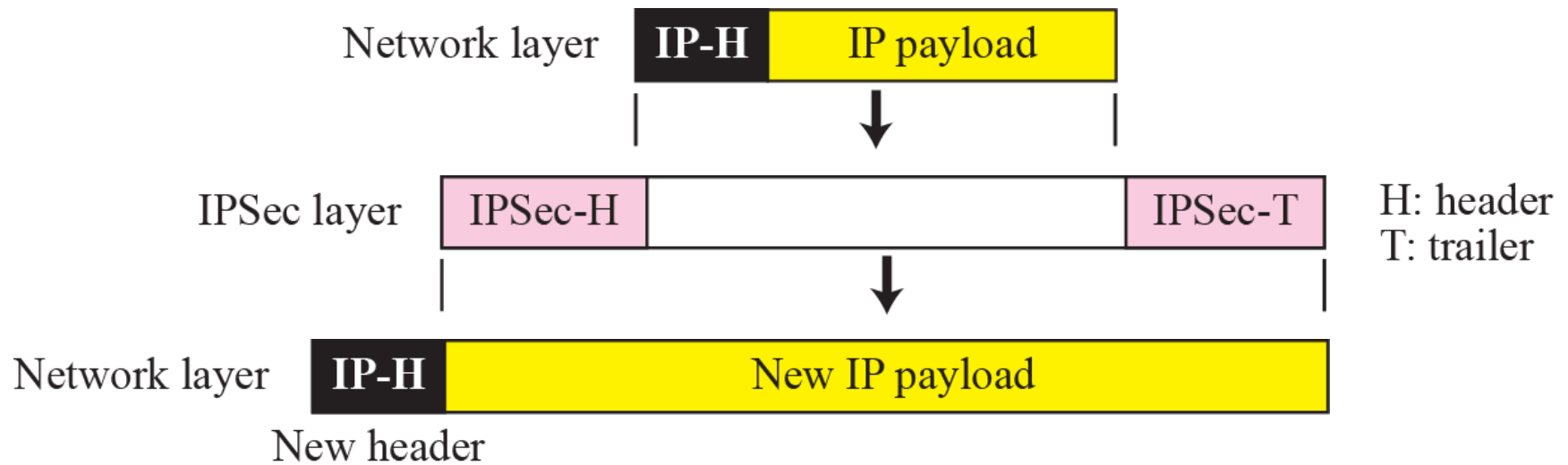
Note

IPSec in transport mode does not protect the IP header; it only protects the information coming from the transport layer.

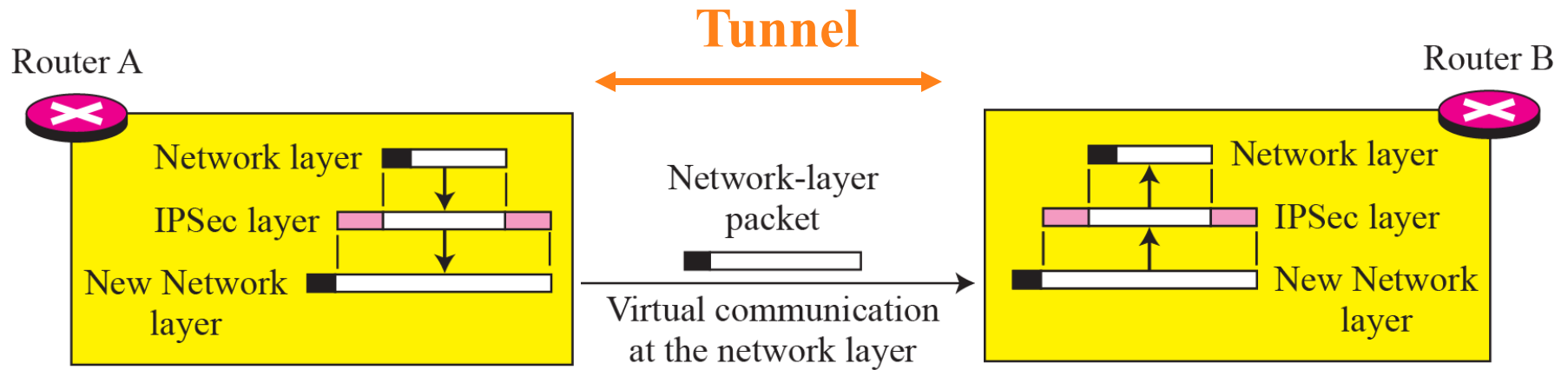
.2 *Transport mode in Action*



.3 *IPSec in tunnel mode*



.4 Tunnel-mode in action

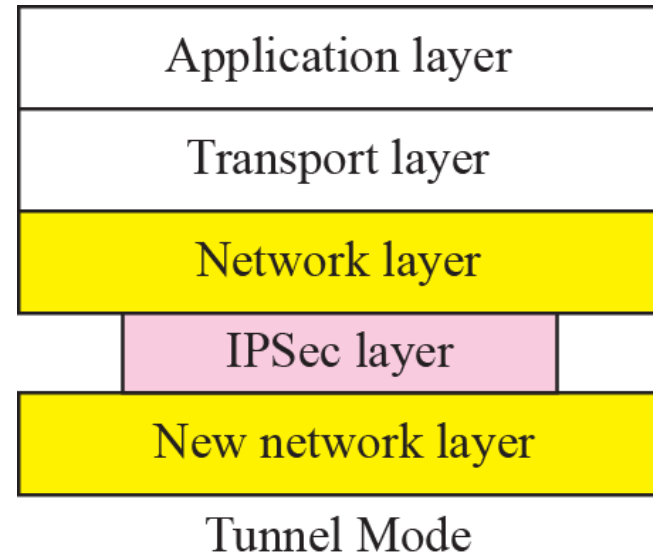
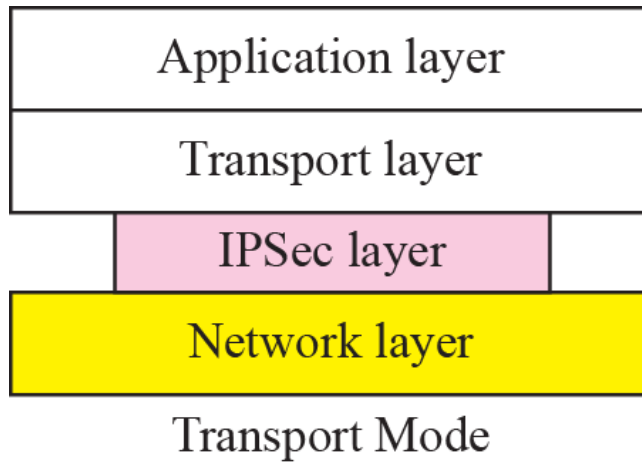




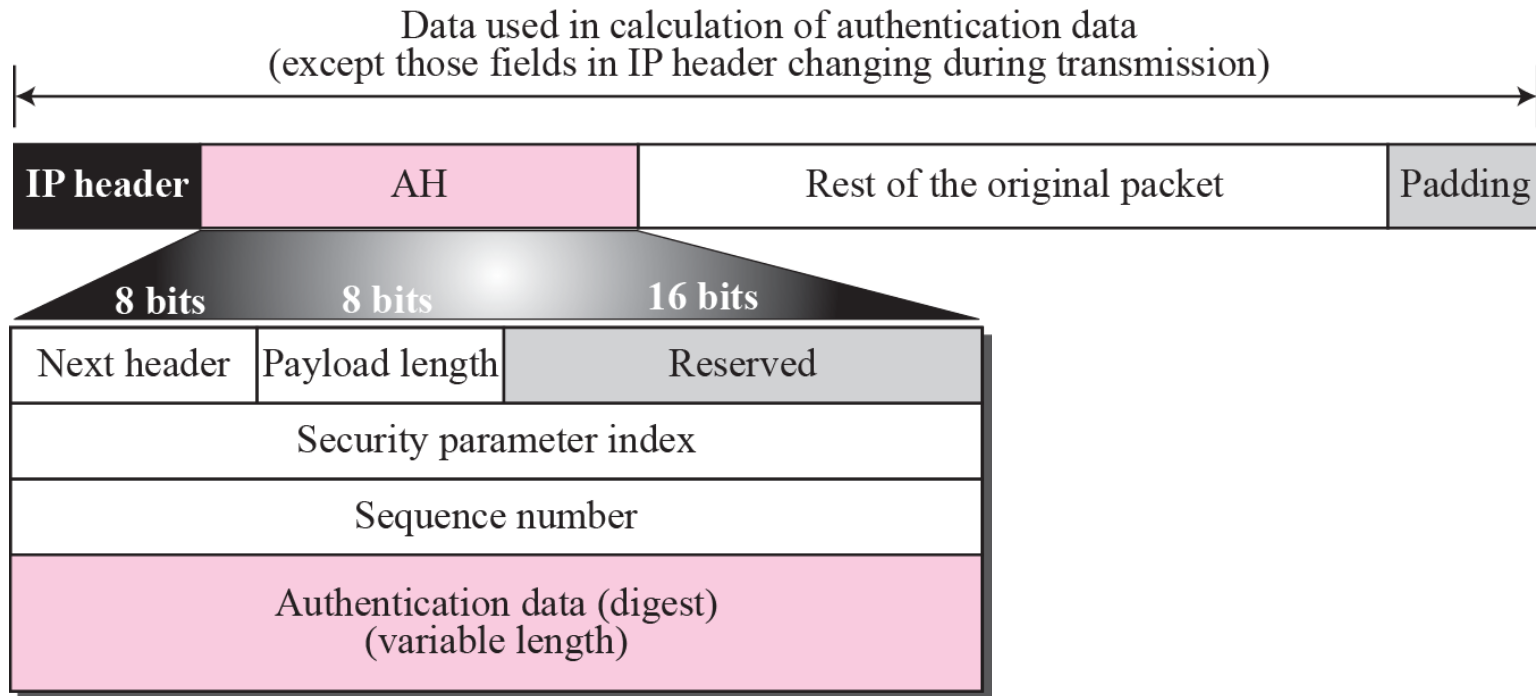
Note

IPSec in tunnel mode protects the original IP header.

.5 *Transport mode versus tunnel mode*



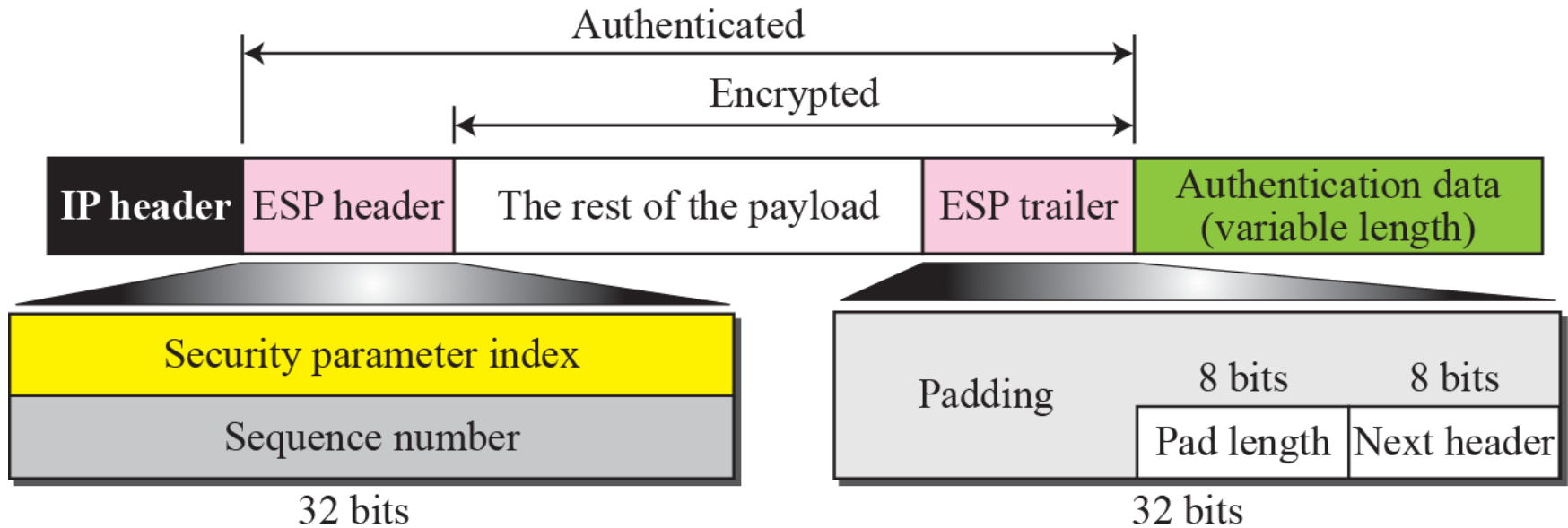
.6 Authentication Header (AH) protocol



Note

The AH protocol provides source authentication and data integrity, but not privacy.

.7 Encapsulating Security Payload (ESP)





Note

***ESP provides source authentication,
data integrity, and privacy.***

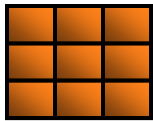
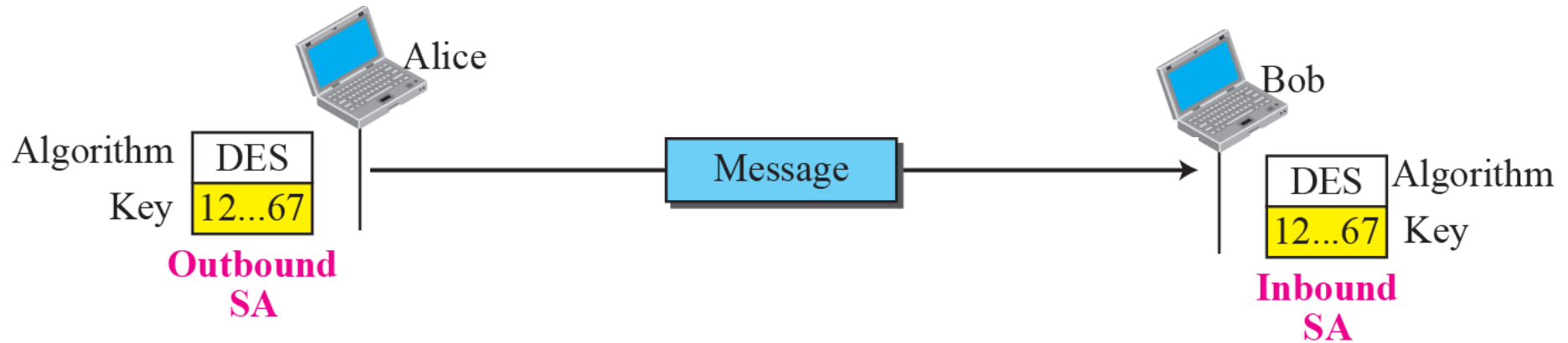


Table 30.1 *IPSec services*

<i>Services</i>	<i>AH</i>	<i>ESP</i>
Access control	Yes	Yes
Message authentication (message integrity)	Yes	Yes
Entity authentication (data source authentication)	Yes	Yes
Confidentiality	No	Yes
Replay attack protection	Yes	Yes

.8 Simple SA



Index	SN	OF	ARW	AH/ESP	LT	Mode	MTU
< SPI, DA, P >							
< SPI, DA, P >							
< SPI, DA, P >							
< SPI, DA, P >							

Security Association Database

Legend:

SPI: Security Parameter Index

DA: Destination Address

AH/ESP: Information for either one

P: Protocol

Mode: IPsec Mode Flag

SN: Sequence Number

OF: Overflow Flag

ARW: Anti-Replay Window

LT: Lifetime

MTU: Path MTU

Index	Policy
< SA, DA, Name, P, SPort, DPort >	
< SA, DA, Name, P, SPort, DPort >	
< SA, DA, Name, P, SPort, DPort >	
< SA, DA, Name, P, SPort, DPort >	

Legend:

SA: Source Address

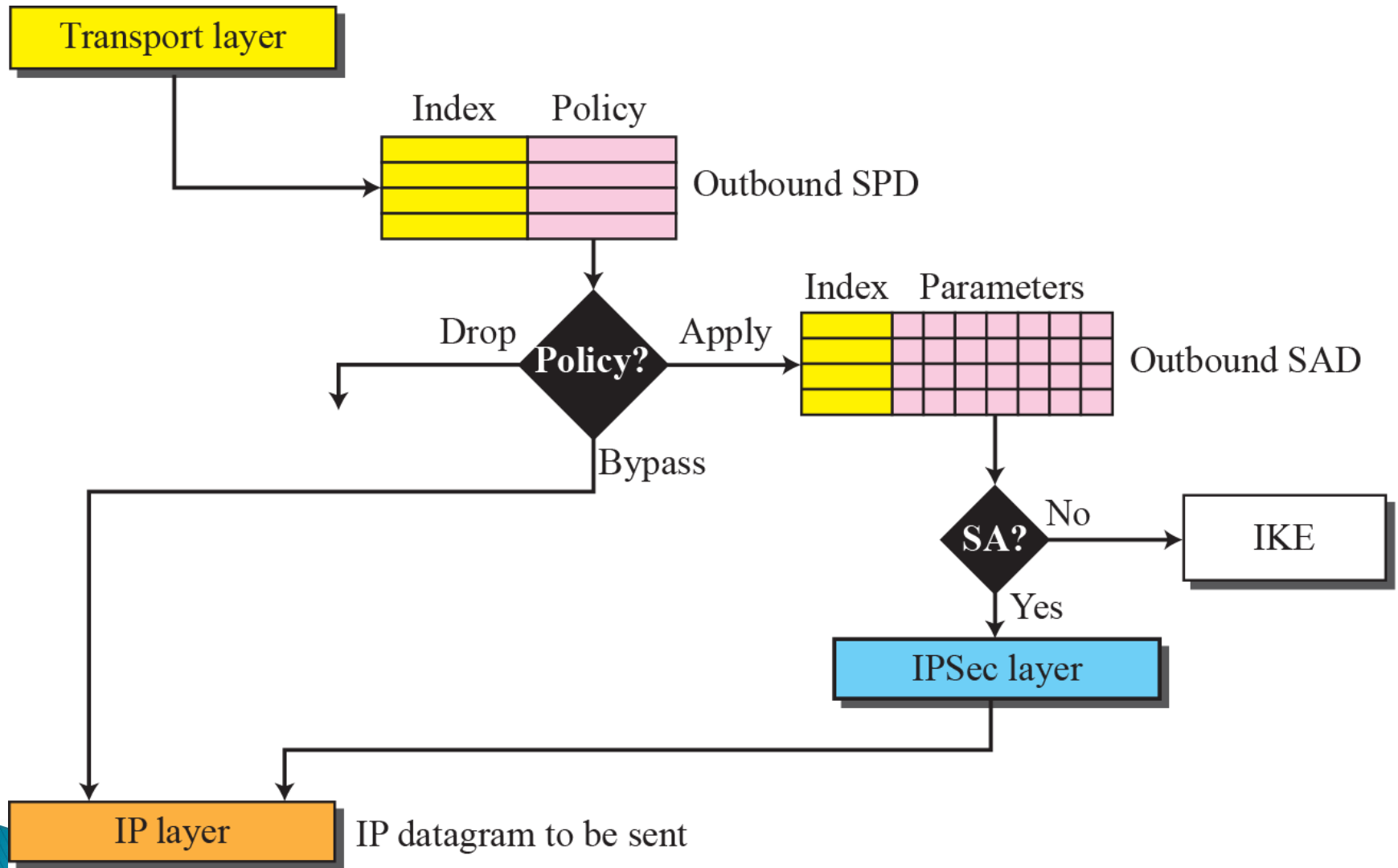
SPort: Source Port

DA: Destination Address

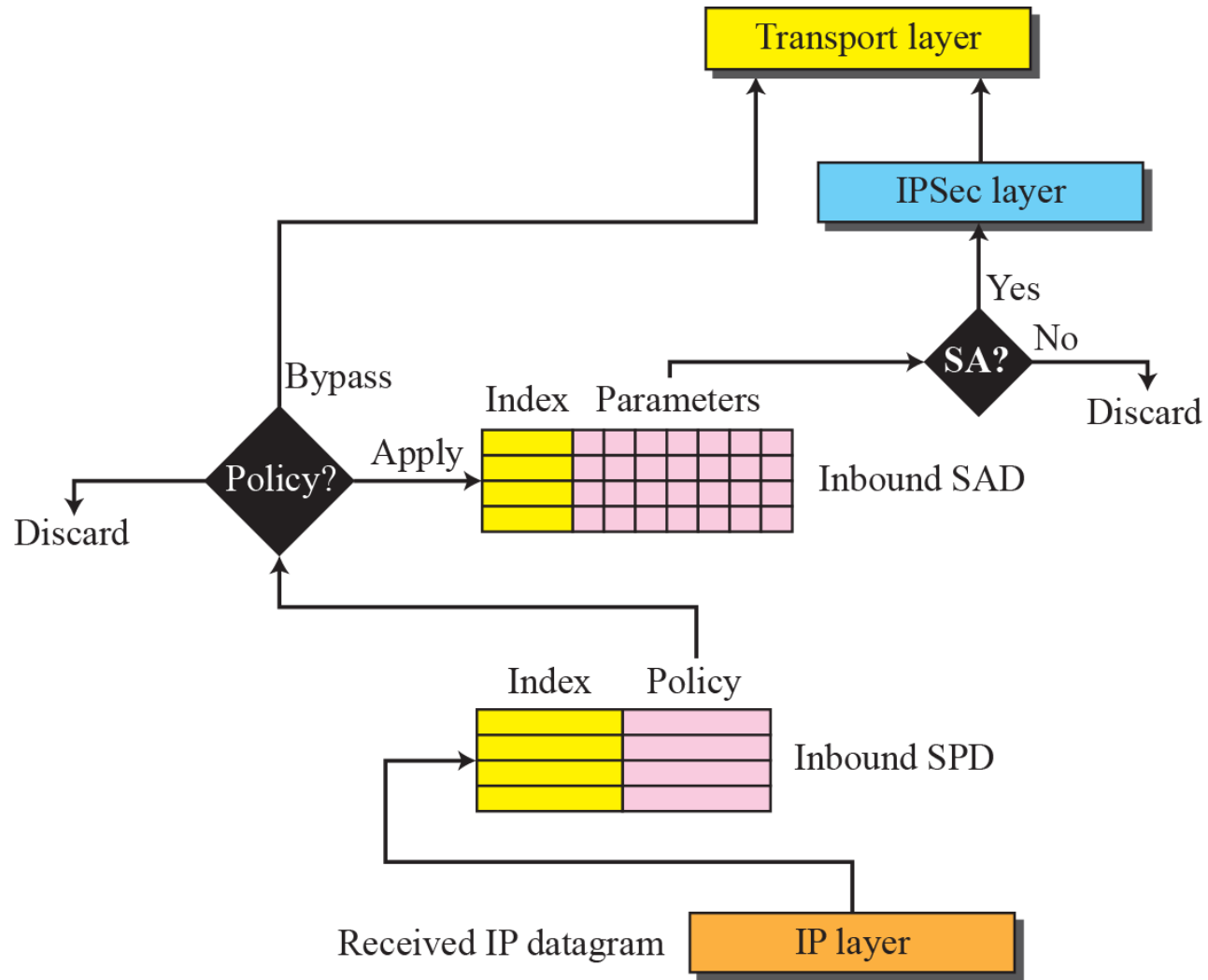
DPort: Destination Port

P: Protocol

.11 Outbound processing



.12 Inbound processing

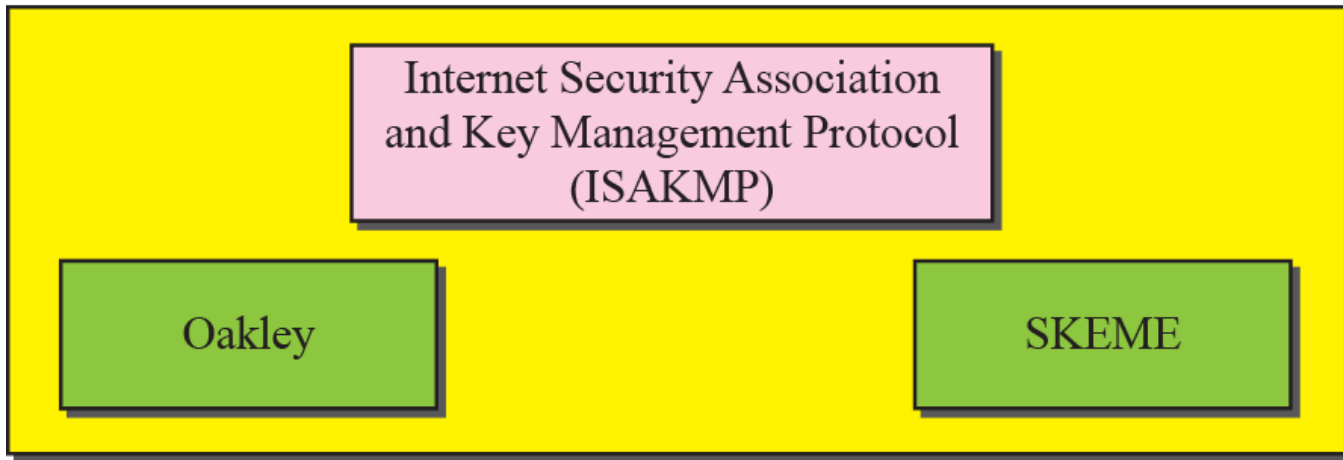




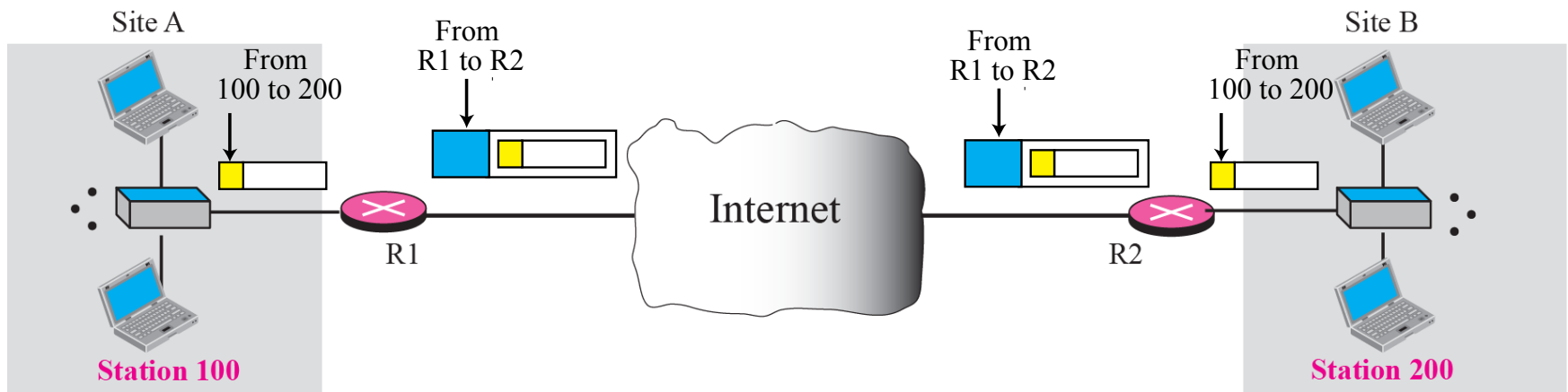
Note

IKE creates SAs for IPSec.

Internet Key Exchange (IKE)



.14 *Virtual private network*



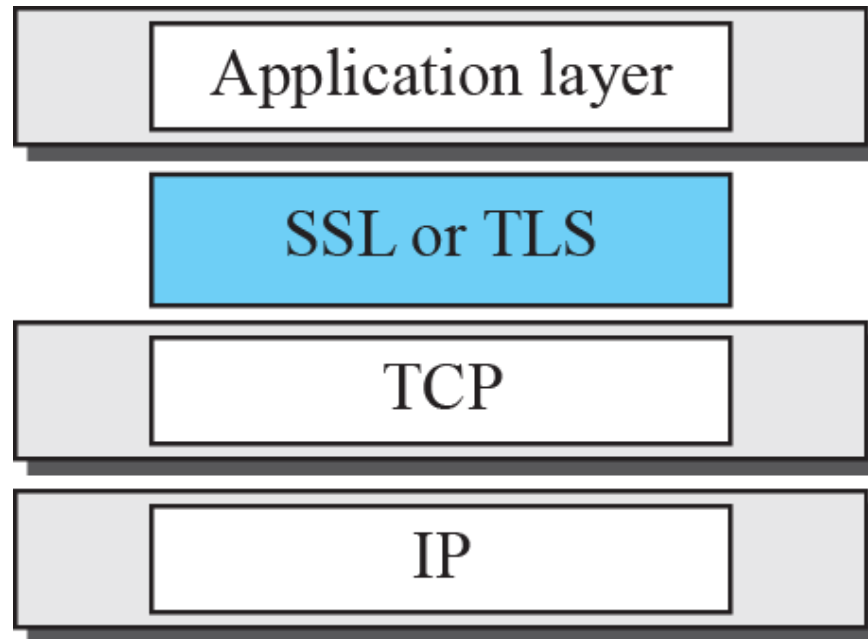
30-2 TRANSPORT LAYER SECURITY

Two protocols are dominant today for providing security at the transport layer: the Secure Sockets Layer (SSL) protocol and the Transport Layer Security (TLS) protocol. The latter is actually an IETF version of the former. We discuss SSL in this section; TLS is very similar. .15 shows the position of SSL and TLS in the Internet model.

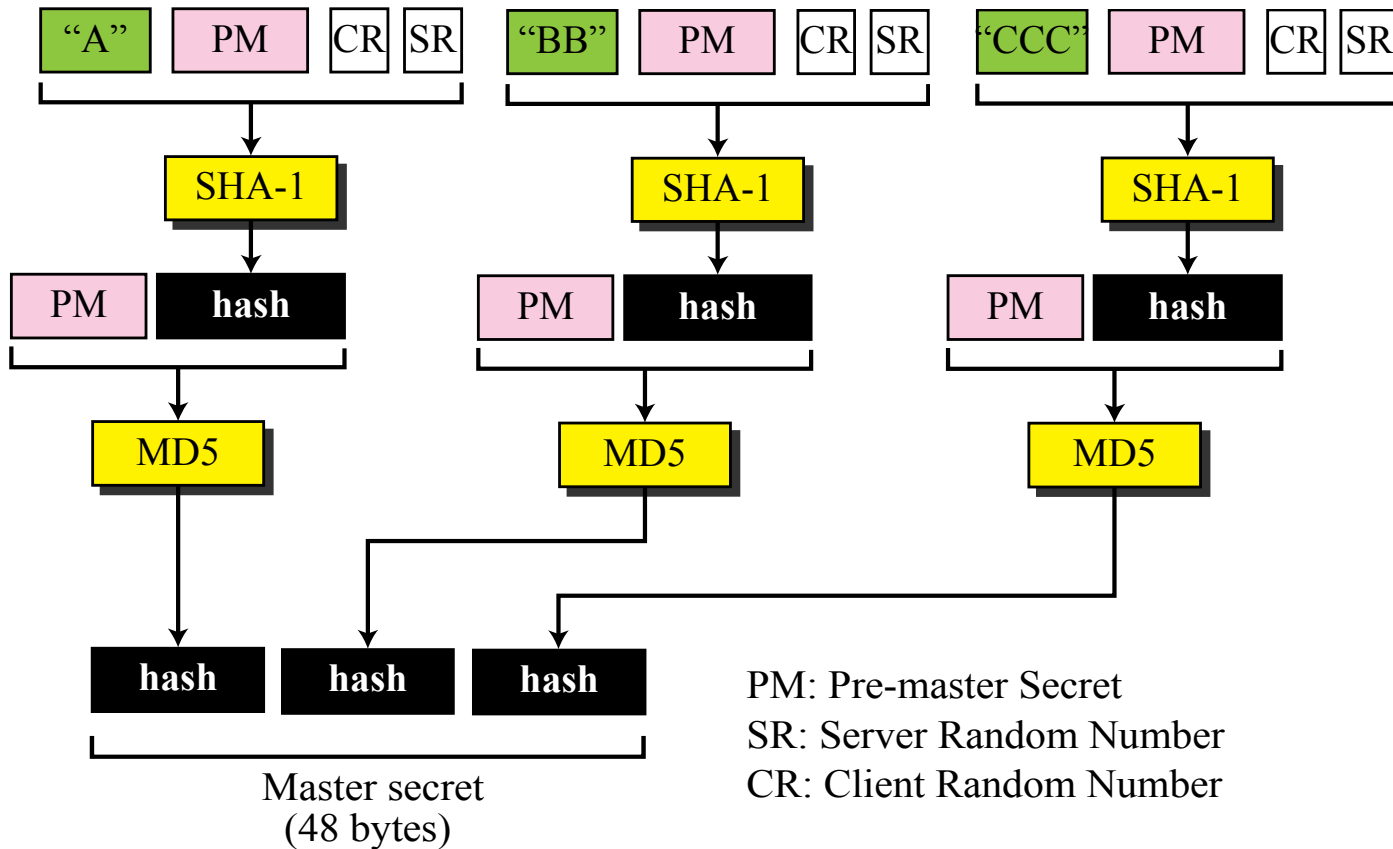
Topics Discussed in the Section

- ✓ **SSL Architecture**
- ✓ **Four Protocols**

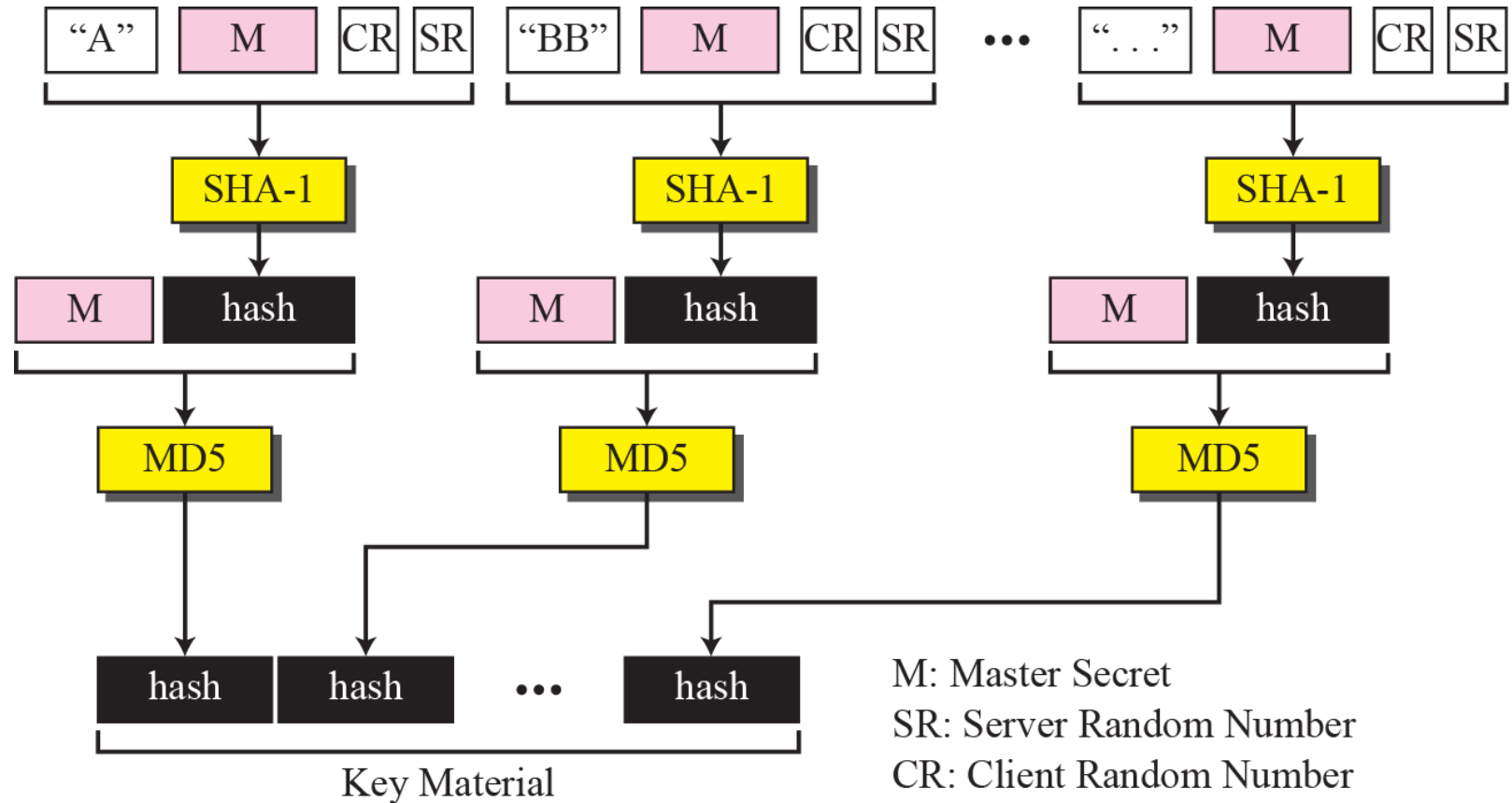
.15 *Location of SSL and TLS in the Internet mode*



.16 Calculation of maser key from pre-master secret

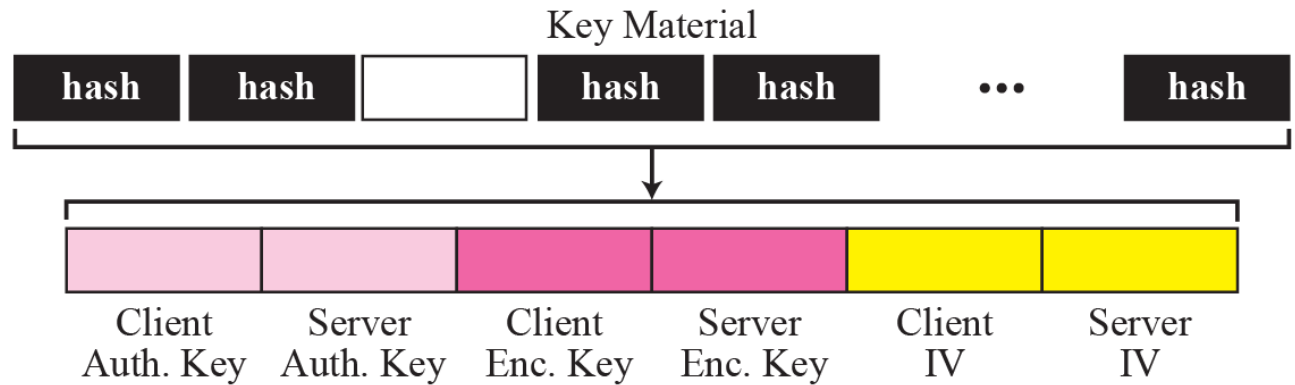


.17 Calculation of the key materials from master secret

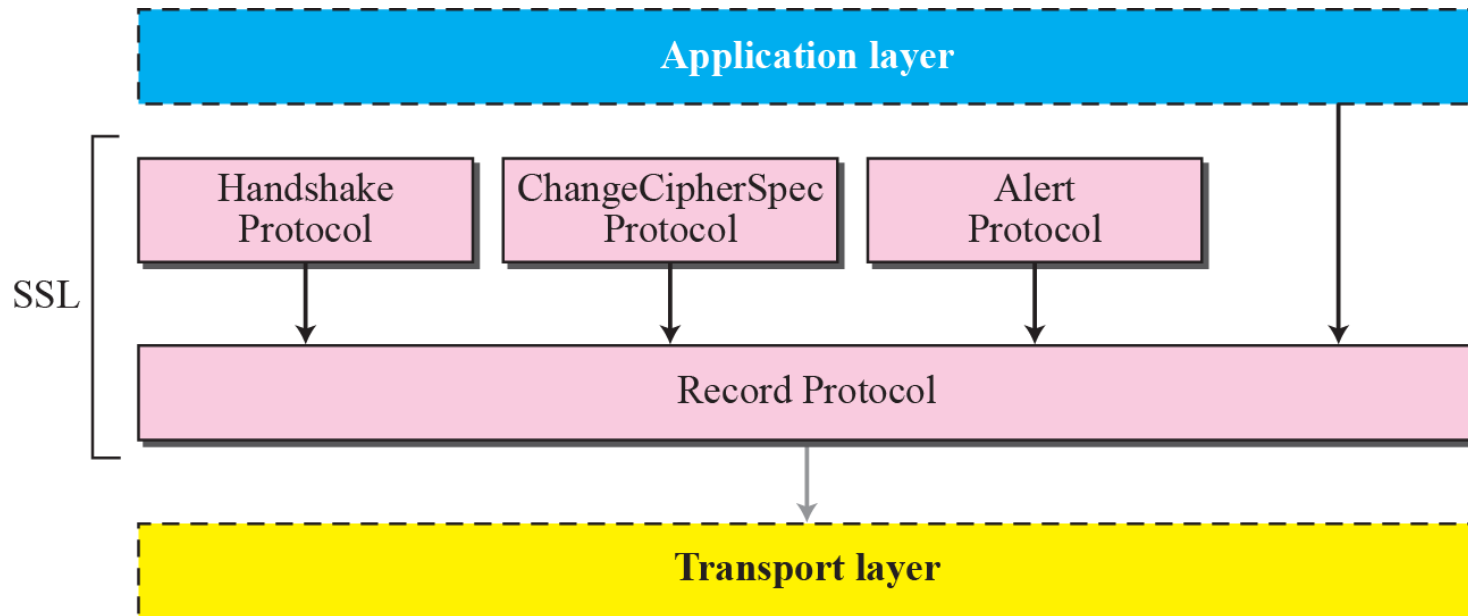


.18 *Extraction of cryptographic secrets from key materials*

Auth. Key: Authentication Key
Enc. Key: Encryption Key
IV: Initialization Vector



.19 *Four SSL protocols*





Note

After Phase I, the client and server know the version of SSL, the cryptographic algorithms, the compression method, and the two random numbers for key generation.

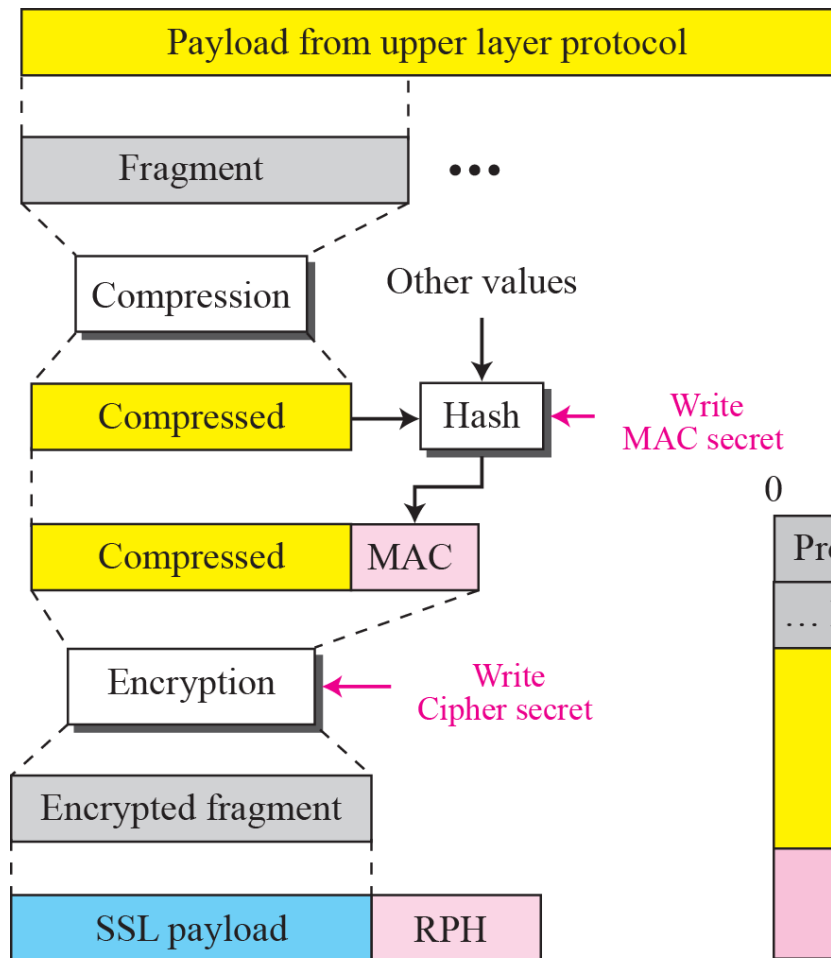
Note

After Phase II, the server is authenticated to the client, and the client knows the public key of the server if required.

Note

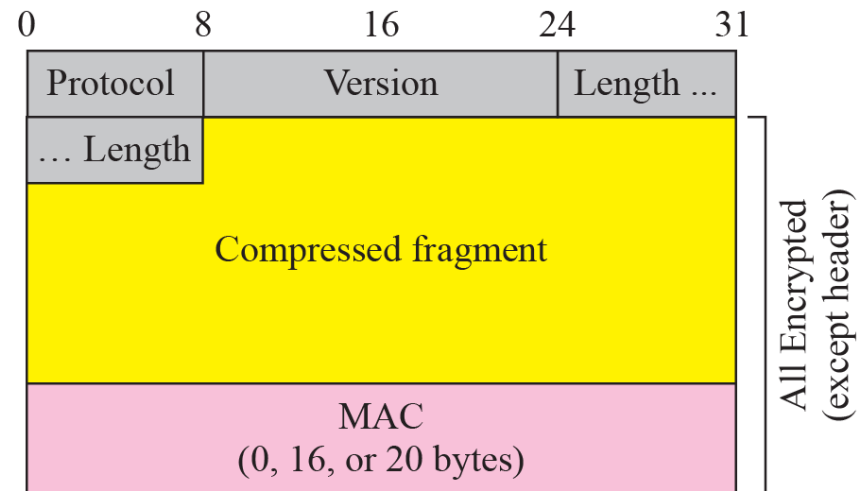
After Phase III, The client is authenticated for the serve, and both the client and the server know the pre-master secret.

.21 Processing done by the record protocol



a. Process

RPH: Record Protocol header



b. Encapsulation

30-3 APPLICATION LAYER SECURITY

This section discusses two protocols providing security services for e-mails: Pretty Good Privacy (PGP) and Secure/Multipurpose Internet Mail Extension (S/MIME).

Topics Discussed in the Section

- ✓ **E-mail Security**
- ✓ **Pretty Good Privacy (PGP)**
- ✓ **Key Rings**
- ✓ **PGP Certificates**
- ✓ **S/MIME**
- ✓ **Applications of S/MIME**

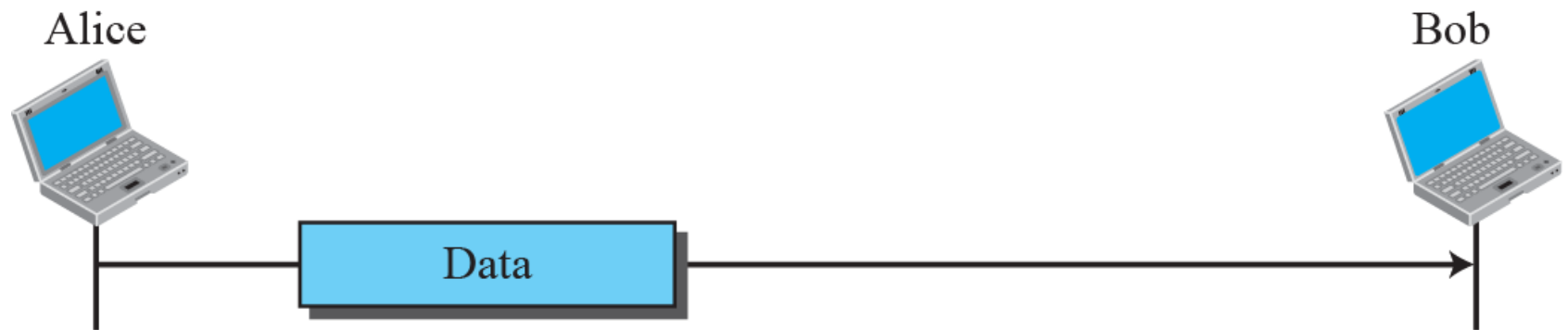
Note

In e-mail security, the sender of the message needs to include the name or identifiers of the algorithms used in the message.

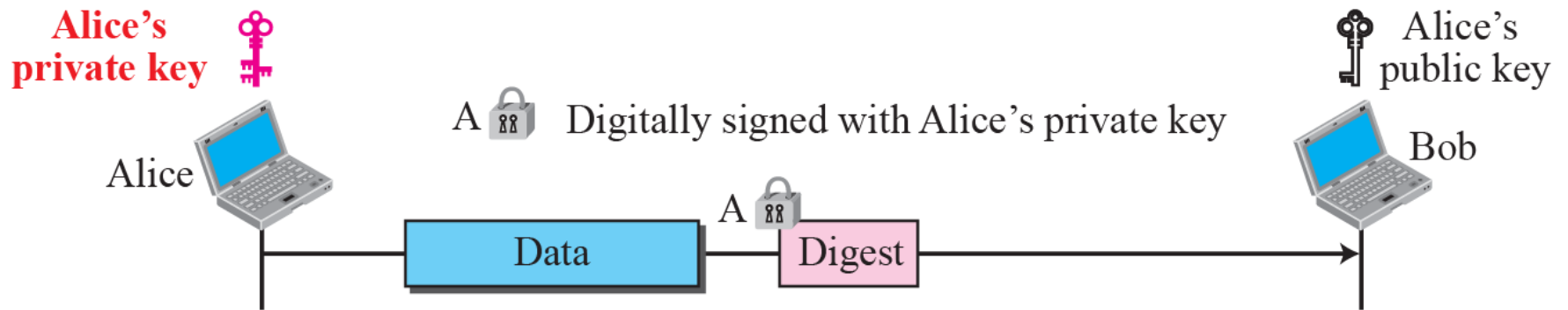


Note

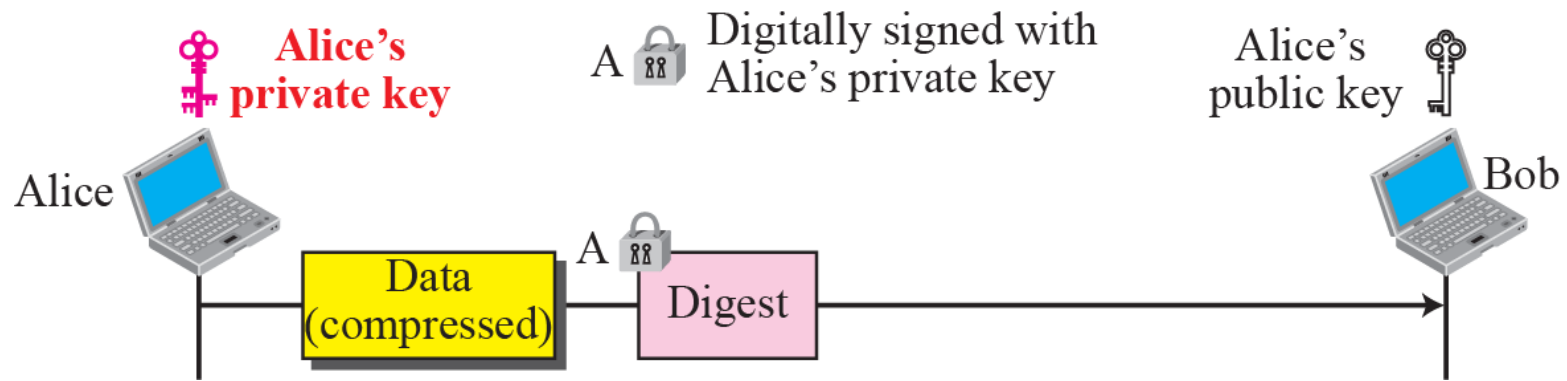
In e-mail security, the encryption/decryption is done using a symmetric-key algorithm, but the secret key to decrypt the message is encrypted with the public key of the receiver and is sent with the message.



.23 *An authenticated message*



.24 *A compressed message*

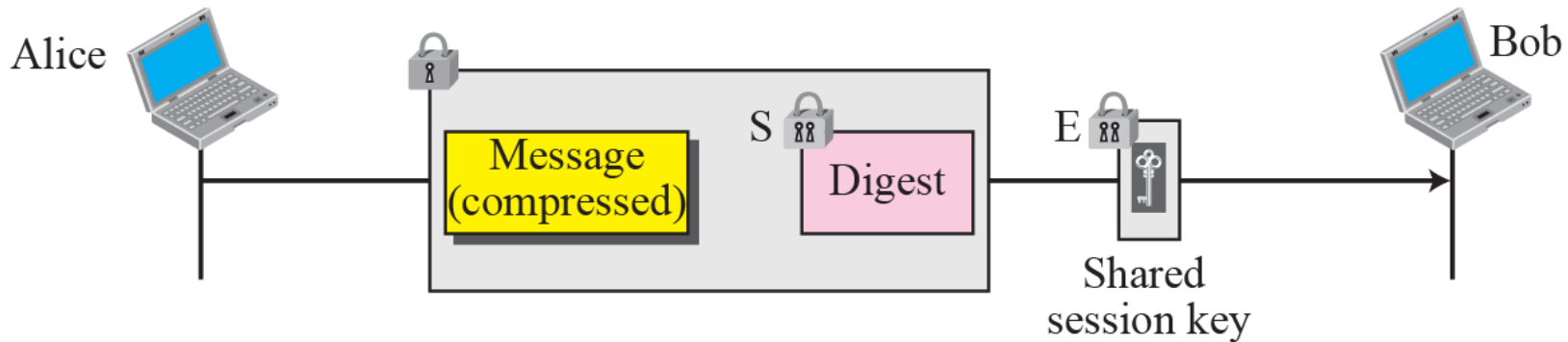


.25 A confidential message

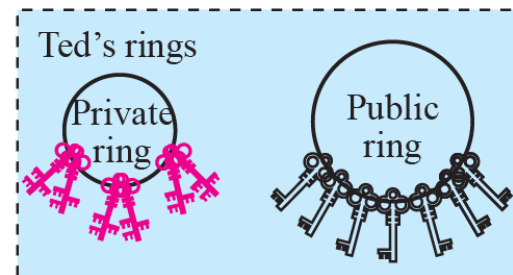
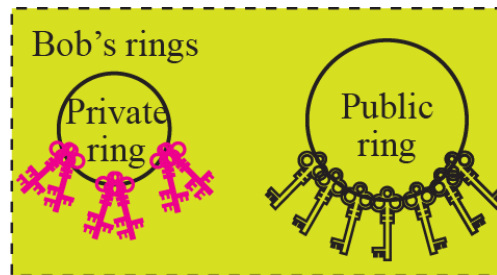
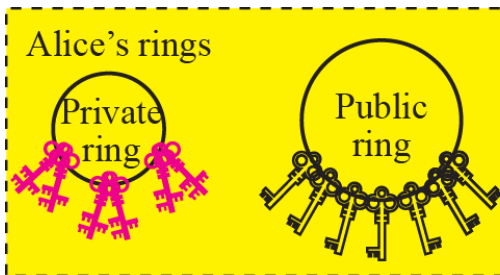
S  Digitally signed with Alice's private key  Encrypted with shared session key
E  Encrypted with Bob's public key

Alice's private key  Bob's public key 

Bob's private key  Alice's public key 

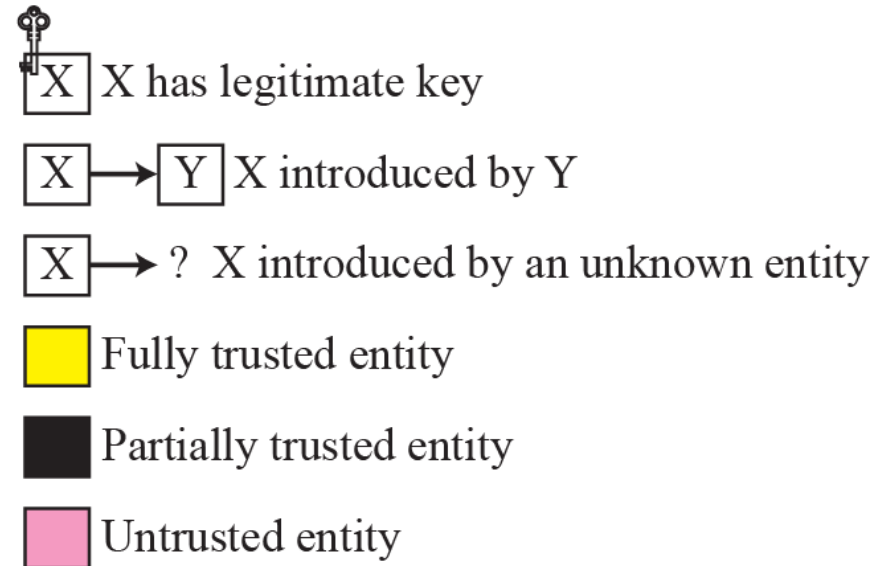
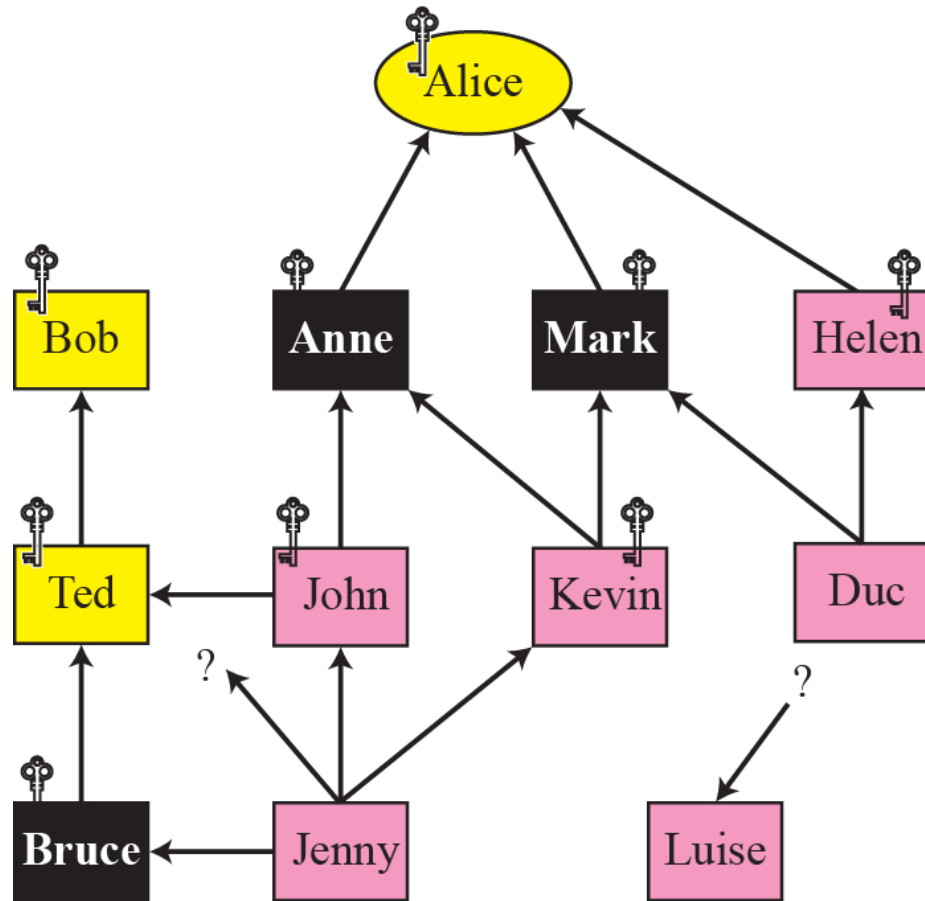


.26 Key rings in PGP



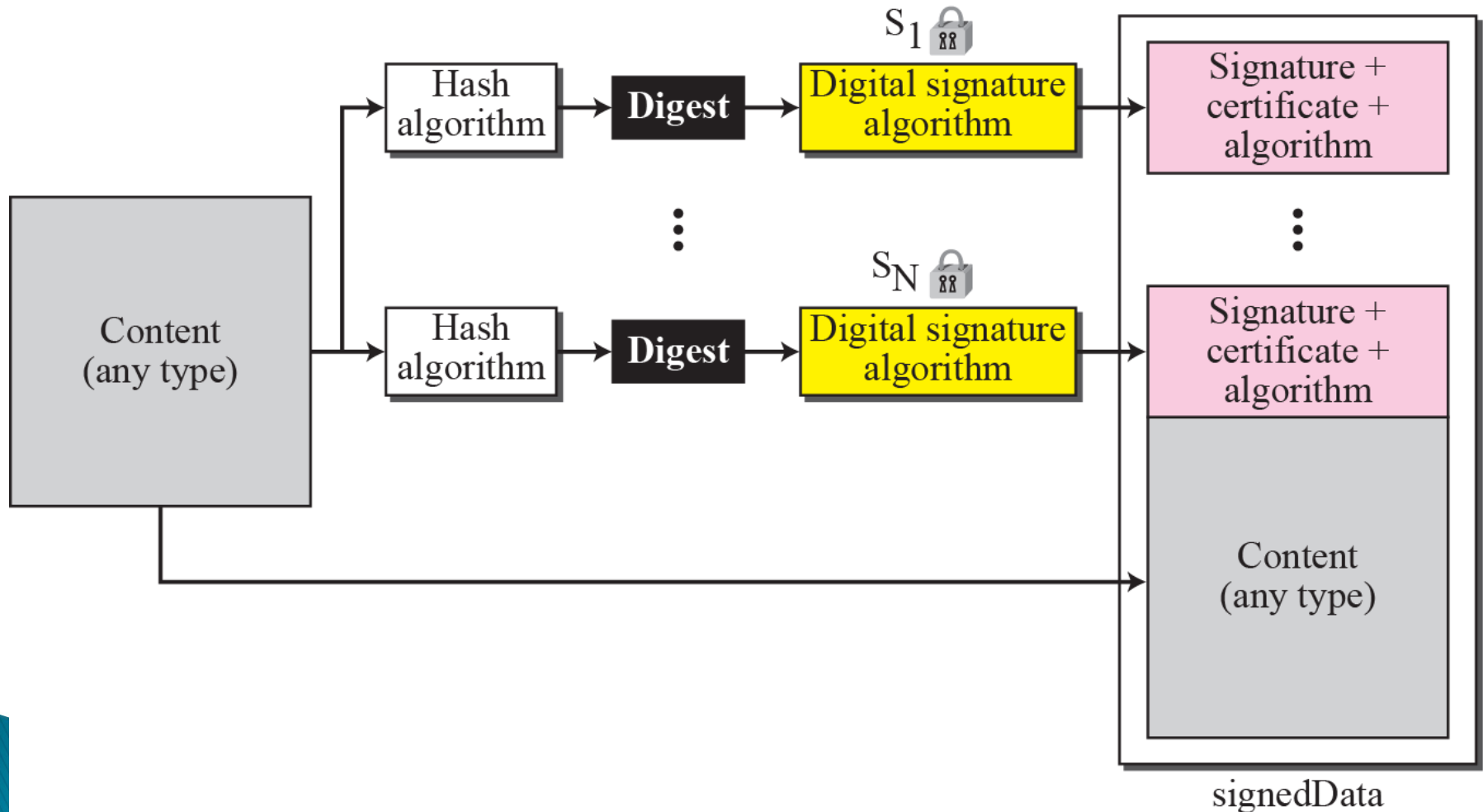
Note

In PGP, there can be multiple paths from fully or partially trusted authorities to any subject.



.28 Signed-data content type

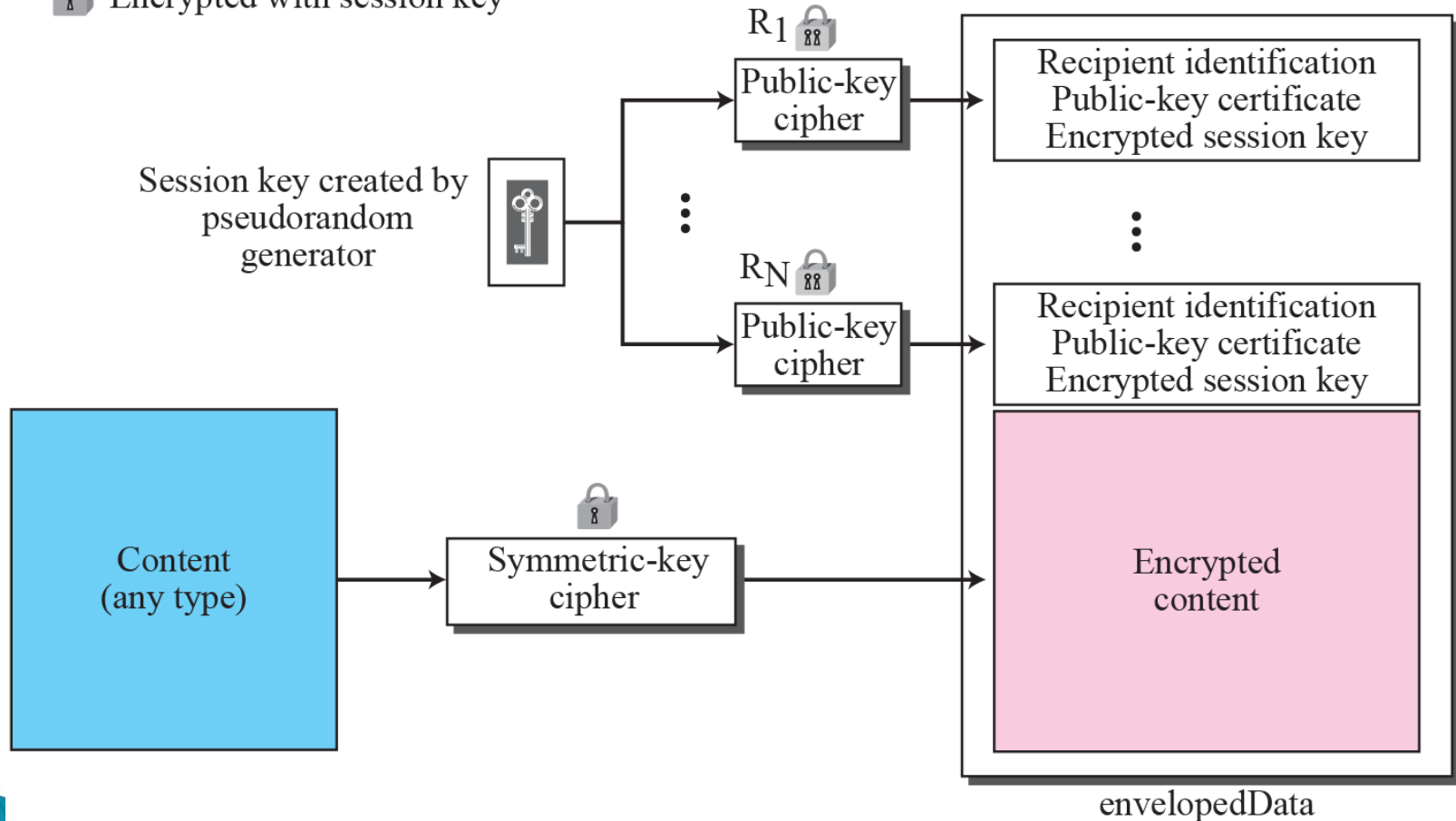
S_1  Signed with private key of signer 1 S_N  Signed with private key of signer N

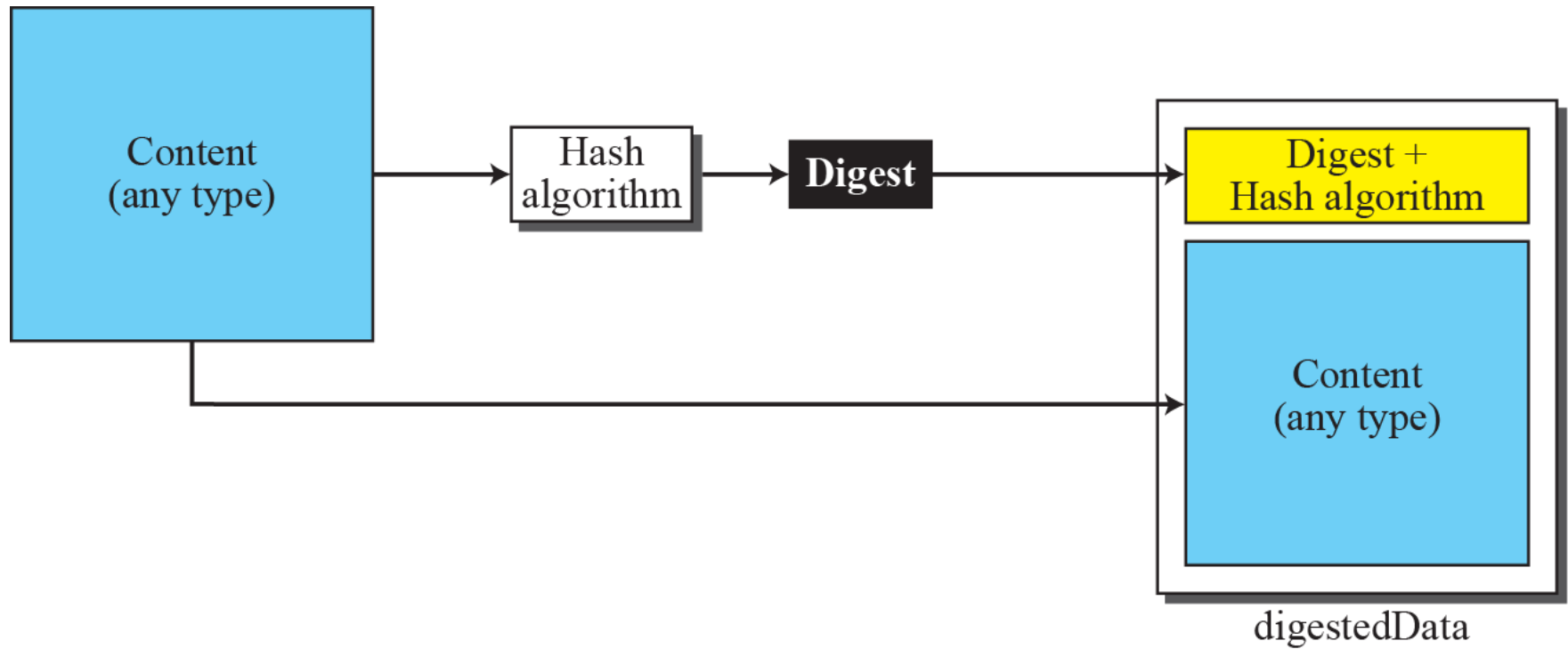


.29 Encrypted-data content type

R_1  Encrypted with public key of recipient 1 R_N  Encrypted with public key of recipient N

 Encrypted with session key





 R_1 

Example 30.1

The following shows an example of an enveloped-data in which a small message is encrypted using triple DES.

Content-Type: application/pkcs7-mime; mime-type=enveloped-data

Content-Transfer-Encoding: Radix-64

Content-Description: attachment

name=“report.txt”;

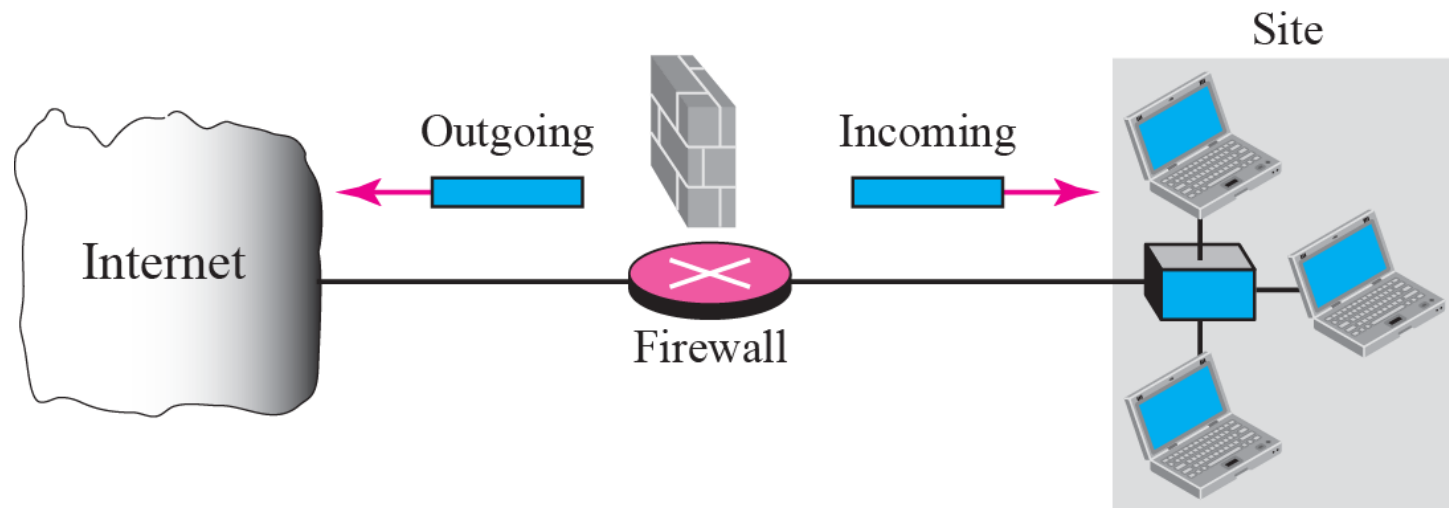
cb32ut67f4bhijHU21oi87eryb0287hmnklsgFDoY8bc659GhIGfH6543mhjkdsaH23YjBnmN
ybmlkzjhgfdyhGe23Kjk34XiuD678Es16se09jy76jHuytTMDcbnmlkjgfFdiuyu678543m0n3h
G34un12P2454Hoi87e2ryb0H2MjN6KuyrlsgFDoY897fk923jlk1301XiuD6gh78EsUyT23y

30-4 FIREWALLS

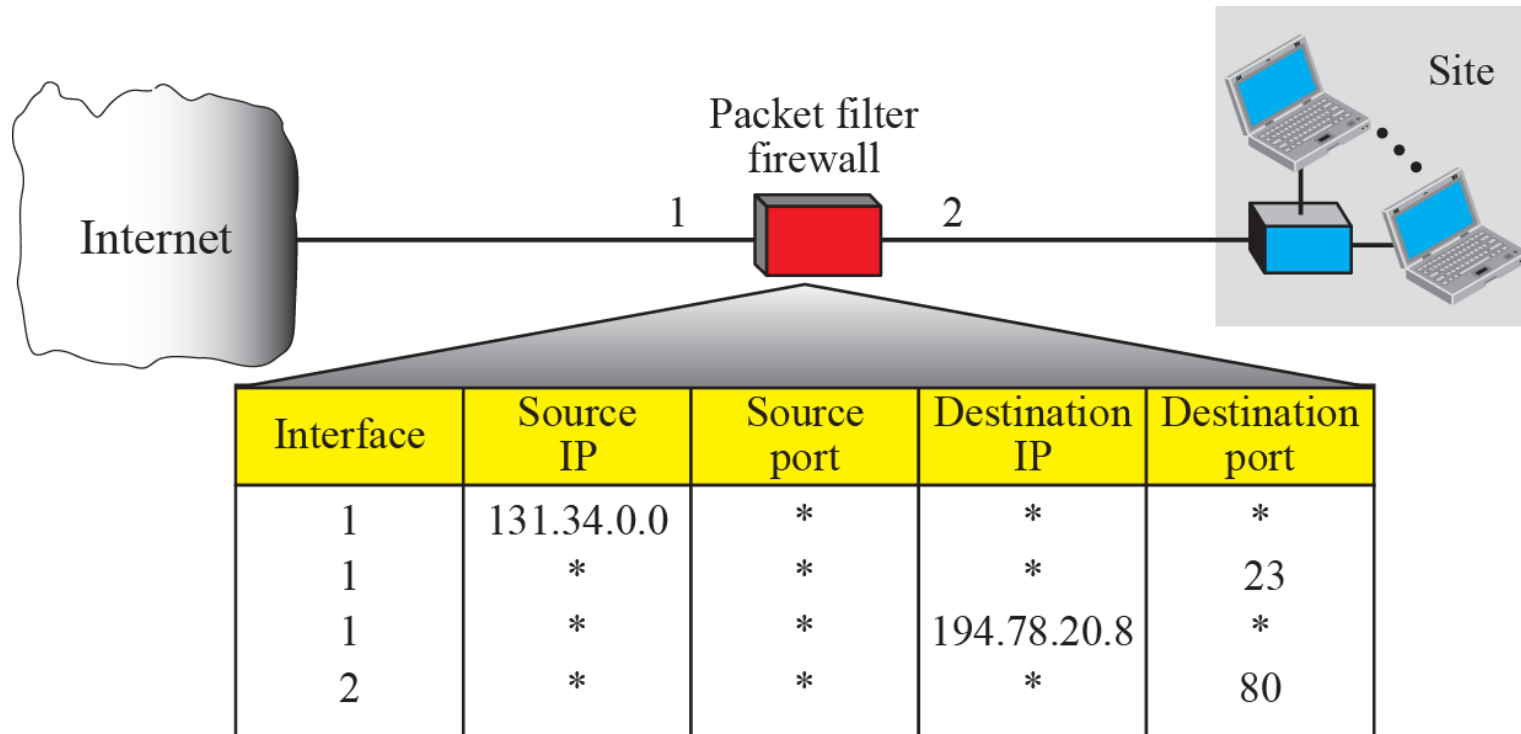
All previous security measures cannot prevent Eve from sending a harmful message to a system. To control access to a system we need firewalls. A firewall is a device (usually a router or a computer) installed between the internal network of an organization and the rest of the Internet. It is designed to forward some packets and filter (not forward) others. .32 shows a firewall.

Topics Discussed in the Section

- ✓ **Packet-Filter Firewall**
- ✓ **Proxy Firewall**

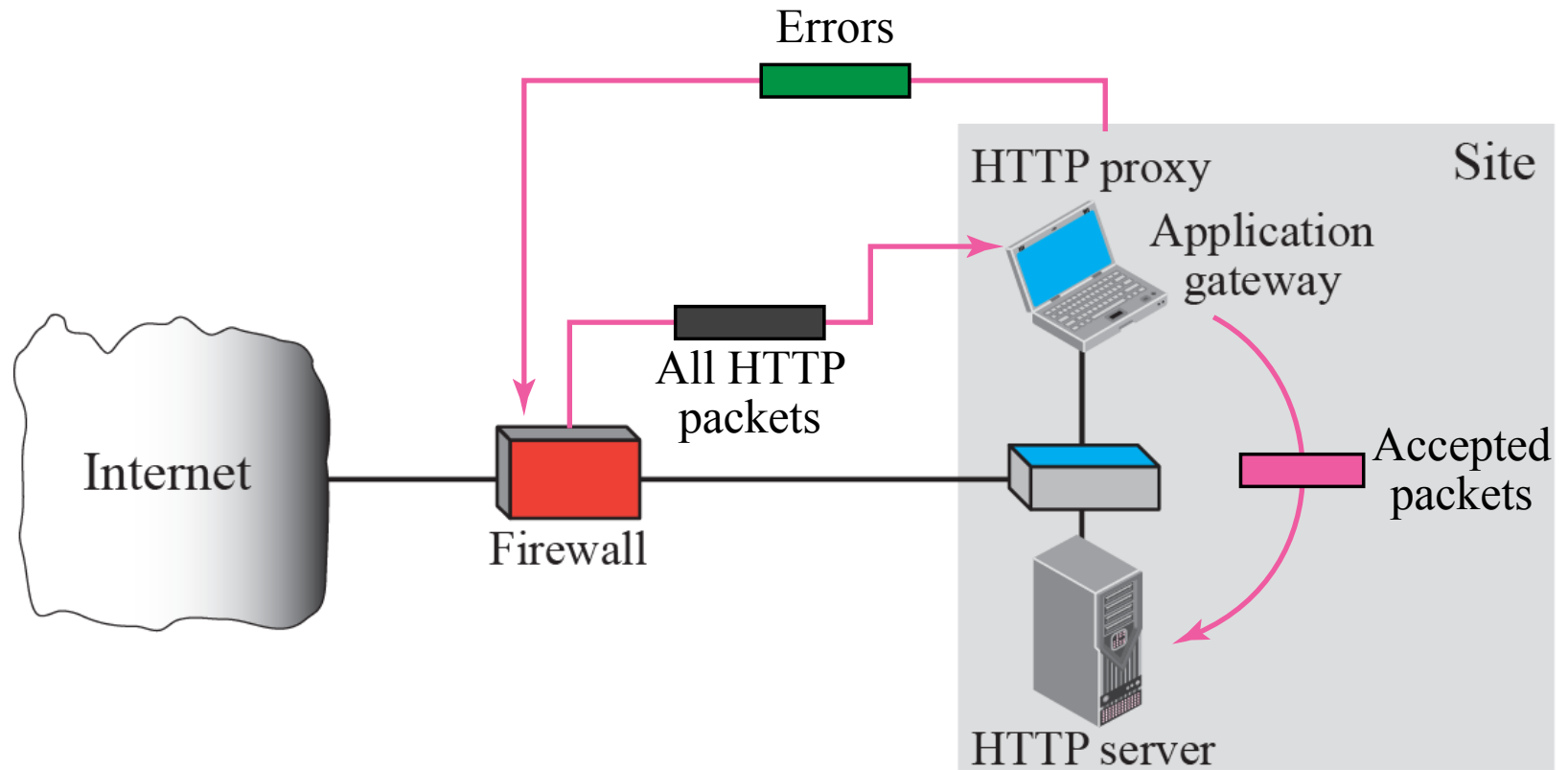


.33 Packet-filter firewall



Note

In PGP, there can be multiple paths from fully or partially trusted authorities to any subject.





Note

A proxy firewall filters at the application layer.