Virtual Private Networks and Secure Protocols

Cryptography

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Topics

- Secure Protocols &Virtual Private Networks
  - VPNs and VPN Architectures
  - HTTPS
  - SSL
  - IPSec
  - Other VPN Technologies

Secure Protocols and VPNs

- Secure communications from multiple services. Including:
  - Authentication (Validate communicators)
  - Key Agreement/Exchange
  - Confidential Communications (Encryption)
  - Integrity
  - Nonrepudiation (Assurance that one party can’t deny the communication.)
- Secure email implements all above services, SSL and IPSec implement all except nonrepudiation.

E-mail

- While many e-mail programs have built in cryptographic protection, you can also install your own cryptographic programs.
  - For example, Microsoft Outlook Express comes with S/MIME (Secure/Multipurpose Internet Mail Extension) support.
    - Because the S/MIME in some mail clients only support 512 bit public keys, some users might want to add PGP, which supports longer public keys.

Virtual Private Network

NIST SP 800-113 defines a Virtual Private Network as:

- A virtual network built on top of existing networks that can provide a secure communications mechanism for data and IP information transmitted between networks.

- Can provide several security services, including:
  - Confidentiality
  - Integrity
  - Authentication
  - Replay protection
  - Access control

Three VPN Architecture Models

- Gateway-to-gateway
  - Protects communications between two specific networks
- Host-to-gateway
  - Protects communications between one or more individual hosts and a specific network belonging to an organization.
- Host-to-host
  - Protects communication between two specific computers.

Gateway to Gateway VPN

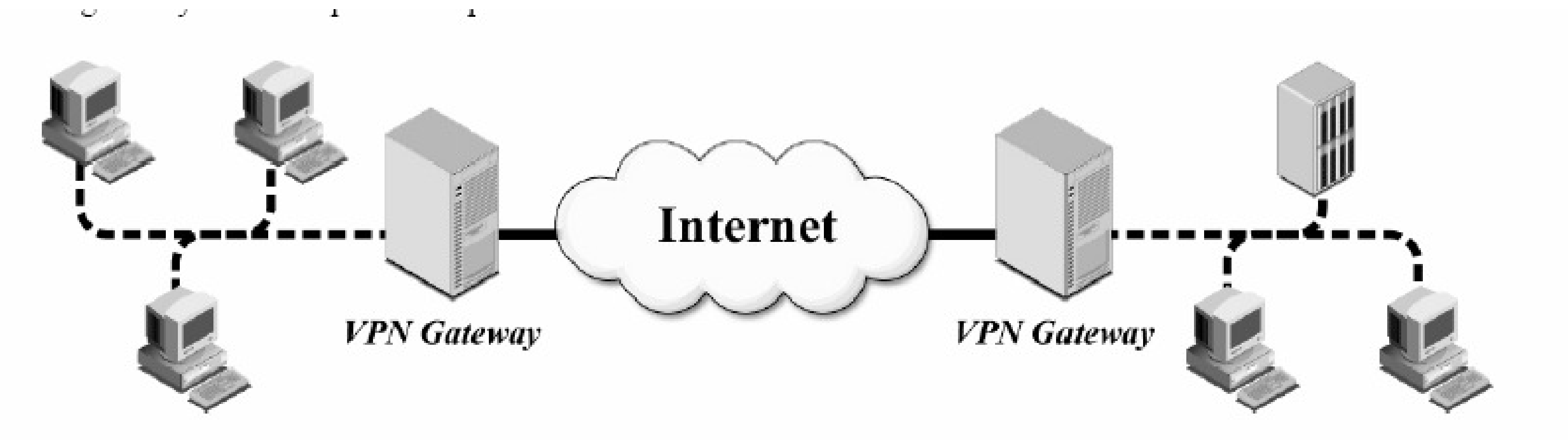


Figure 2-2. Gateway-to-Gateway Architecture Example

- *This, and following two images from NIST SP 800-77*

Host to Gatway VPN

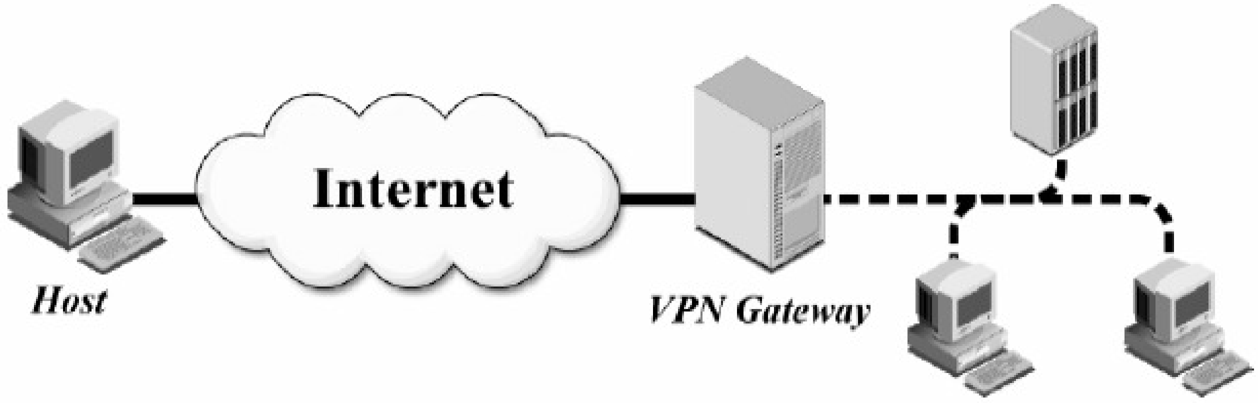


Figure 2-3. Host-to-Gateway Architecture Example

Host to Host VPN

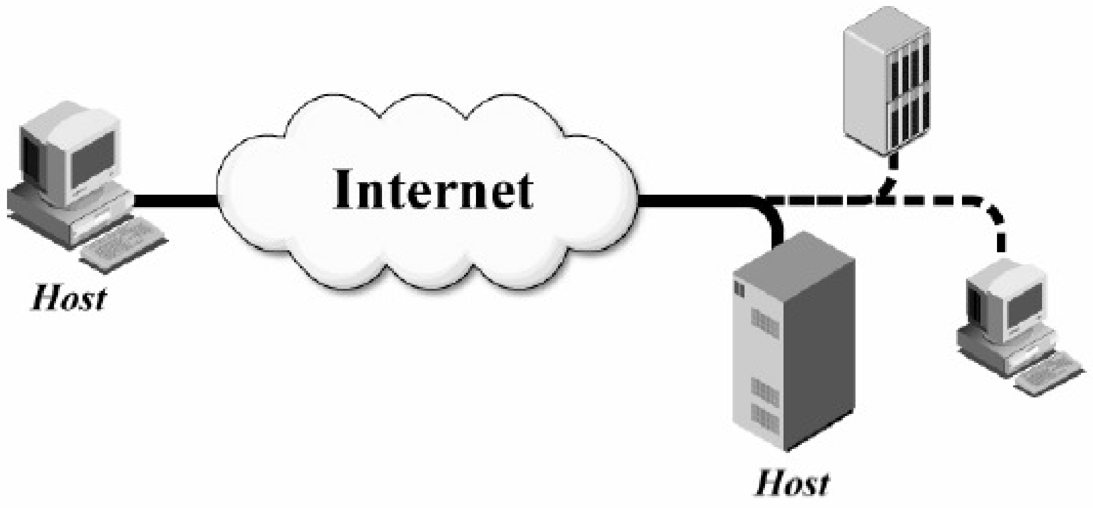


Figure 2-4. Host-to-Host Architecture Example

VPN Comparison

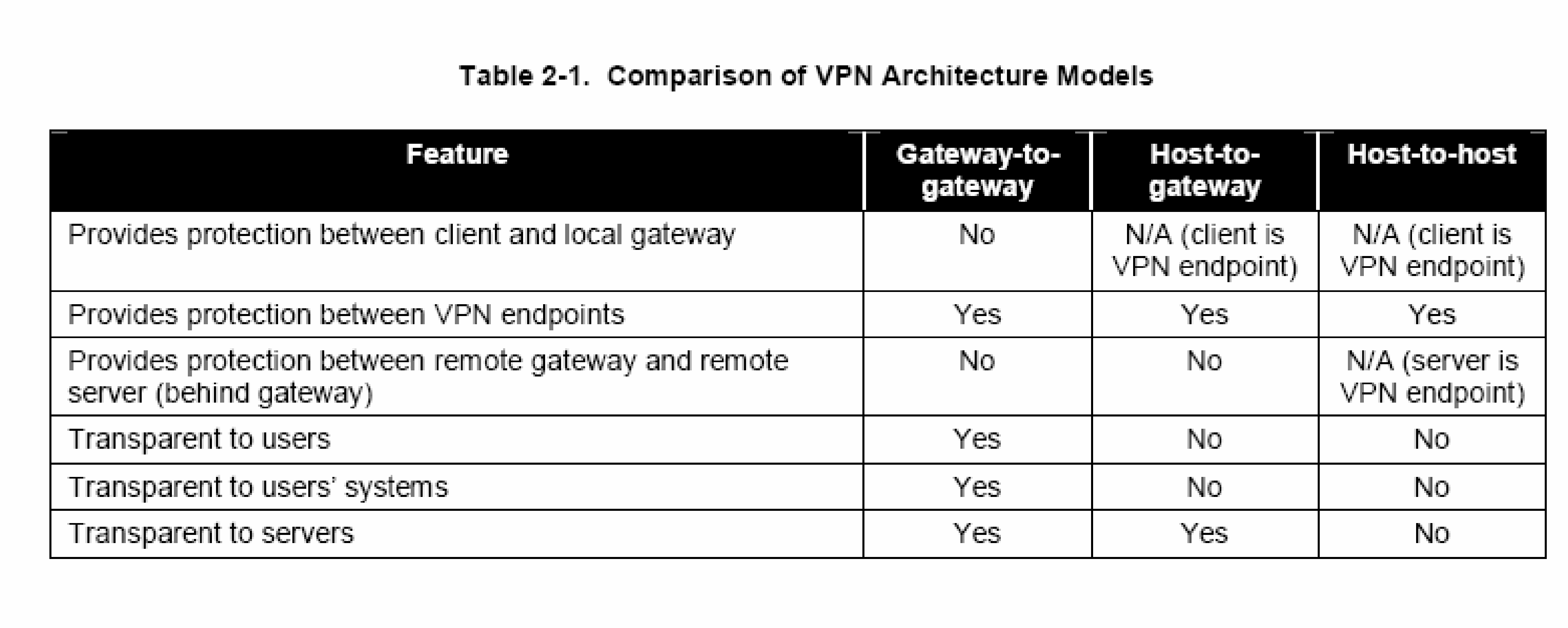
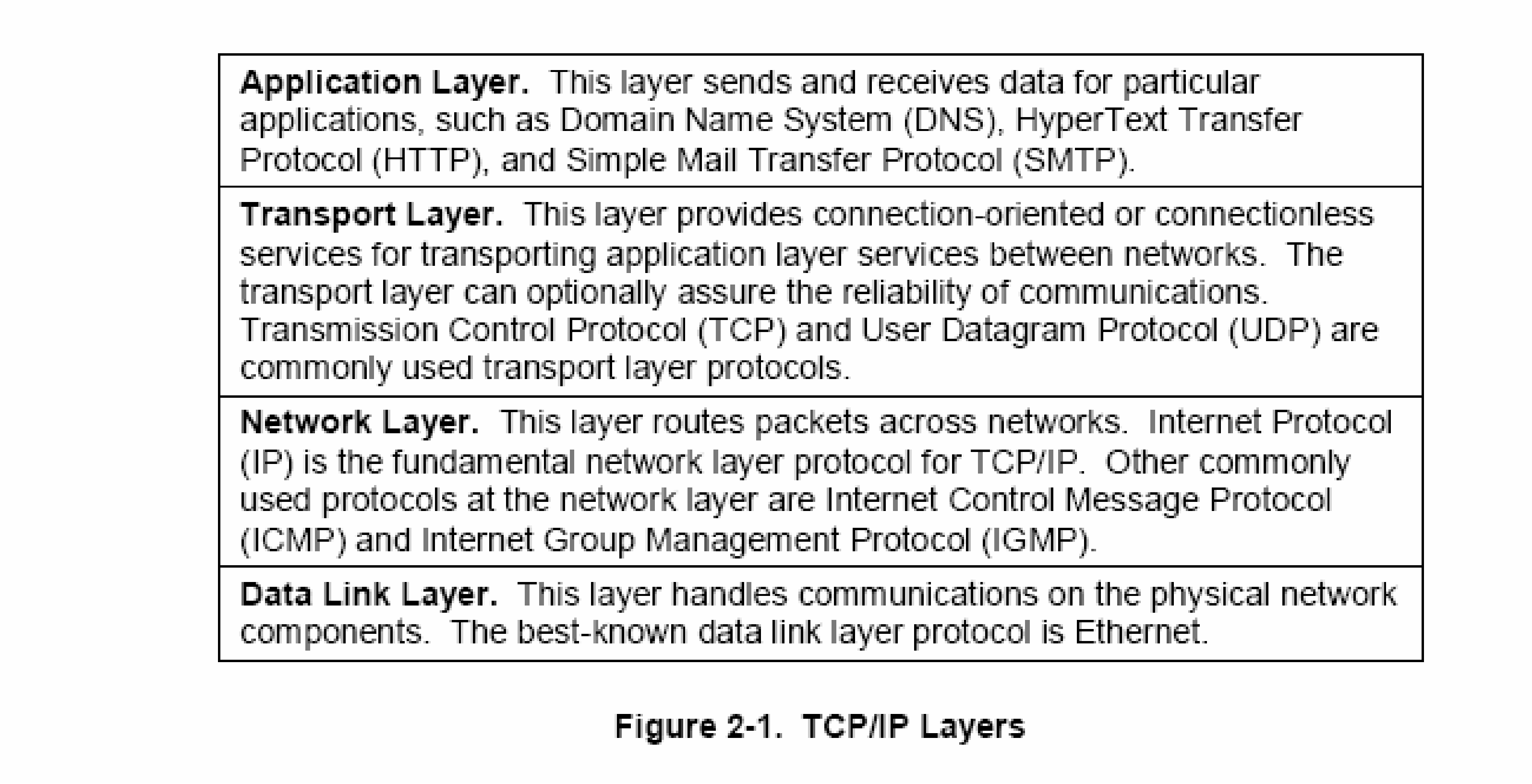


Table 2-1. Comparison of VPN Architecture Models

Feature	Gateway-to-gateway	Host-to-gateway	Host-to-host
Provides protection between client and local gateway	No	N/A (client is VPN endpoint)	N/A (client is VPN endpoint)
Provides protection between VPN endpoints	Yes	Yes	Yes
Provides protection between remote gateway and remote server (behind gateway)	No	No	N/A (server is VPN endpoint)
Transparent to users	Yes	No	No
Transparent to users' systems	Yes	No	No
Transparent to servers	Yes	Yes	No

TCP/IP Layer Review



Application Layer. This layer sends and receives data for particular applications, such as Domain Name System (DNS), HyperText Transfer Protocol (HTTP), and Simple Mail Transfer Protocol (SMTP).

Transport Layer. This layer provides connection-oriented or connectionless services for transporting application layer services between networks. The transport layer can optionally assure the reliability of communications. Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) are commonly used transport layer protocols.

Network Layer. This layer routes packets across networks. Internet Protocol (IP) is the fundamental network layer protocol for TCP/IP. Other commonly used protocols at the network layer are Internet Control Message Protocol (ICMP) and Internet Group Management Protocol (IGMP).

Data Link Layer. This layer handles communications on the physical network components. The best-known data link layer protocol is Ethernet.

Figure 2-1. TCP/IP Layers

Secure Protocols by TCP Layer

- HTTPS, SSH – Application level security
- SSL/TLS – Security at the transport level.
- IPSEC – Security at the network level.
- PPTP, WEP – Security at the data link layer.
- Link encryption – Security at the data link and physical levels.

SSL/TLS

- SSL is a data communication protocol that implements three cryptographic services
  - Authentication
  - Confidentiality
  - Message integrity.
- By default, authenticates server to client.
  - Does not provide MIM attack protection
- Developed by Netscape ('94) to secure Internet transactions .

SSL/TLS

- SSL evolving into TLS
  - IETF open standard.
    - Only minor differences between SSL V3 and TLS V1
  - Can use a variety of technologies including:
    - 3DES or RC4
    - MD5 or SHA1
    - RSA and Diffie Hellman and X.509 certificates for authentication.
- Provides secure key exchange an Internet browser and an Internet server.
- Does not offer nonrepudiation.

SSL/TLS Handshake

Phases

- Hello
  - Client and server negotiate crypto algorithms, compression methods, and a session ID value
- Server sends certificate
  - Server may request client certificate (rare)
- Key Agreement (Exchange)
- Authentication
  - Client verifies server cert
  - If requested, sends its cert
  - Finished handshake messages
- Bringing up primary crypto
  - Change cipher.
  - Finish handshake.

SSL/TLS Encryption Options

- RC4, 40 bit or 128 bit
- DES – 56 bit
- 3DES – 168 bit
- RC2 – 40 bit
- Utilization depends upon client/server negotiation.
  - Impacted by browser configuration

SSL Rollback Attack

- SSL 3 and TLS 1 are similar and are considered secure
- SSL 2 is vulnerable to a rollback attack
  - SSL 2 uses 40 bit encryption
  - In browsers that offer it as an option, SSL 2 should be manually turned off
  - HIPPA can be interpreted as requiring SSL2 to be turned off in the Windows Registry

IPSec

IETF standard that provides OSI Network Level:

- Confidentiality
- Authentication
- Access control
- Integrity

Supported IPSec communication architectures:

- Host to host
- Network to network
- Host to network

IPSec

- IPSec operations are transparent to the user.
- IPSec automatically protects any electronic communications between itself and another IPsec enabled computer including:
  - Email
  - Web browsing
  - File transfers
- IPSec automatically negotiates cryptographic protections with another IPSec enabled computer that has acceptable credentials.
  - In contrast to SSL, IPSec handshakes take place mostly within a tunnel.

IPSec

IPSec Components

- Internet Key Exchange (IKE)
- Security Association (SA)
- Secure Protocols
  - Authentication Header (AH) provides
    - Integrity
    - Authentication
    - Nonrepudiation.
  - Encapsulation Security Header (ESH) also provides
    - Confidentiality.

IPSec Three Phases

1. Key agreement and authentication
2. Negotiation of VPN parameters
   - Setting up Bulk Exchange Parameters
3. Data Protection

IPSec policy

- Defines a minimum set of communication parameters to be used when securing an IPSec connection.

Internet Key Exchange (IKE)

- Default IPSec key exchange protocol
  - Hybrid of ISAKMP and Oakley methods
  - Allows two IPSec nodes to decide which algorithms they will use for authentication and encryption, as well as how long this will last

Negotiated issues include

  - Authentication method
  - Protocols (ESP or AH)
  - Algorithms
  - Keys

Two IKE Phases

- Phase 1: Key Agreement and Authentication
  - Shared secret keys are established using Diffie-Hellman key agreement.
  - Mostly unencrypted
- Phase 2: Setting up Bulk Encryption Parameters
  - Uses SA-1 (IKE SA) parameters to set up parameters used for bulk data encryption and calculate second set of shared secret keys (i.e. IPSec SA).

IPSec Security Association (SA)

- When a VPN connection is established, the negotiated entries are saved to the Security Association Database.
  - The index value is called the Security Parameter Index or SPI
  - The SPI gets recorded within the header of each IPSec packet

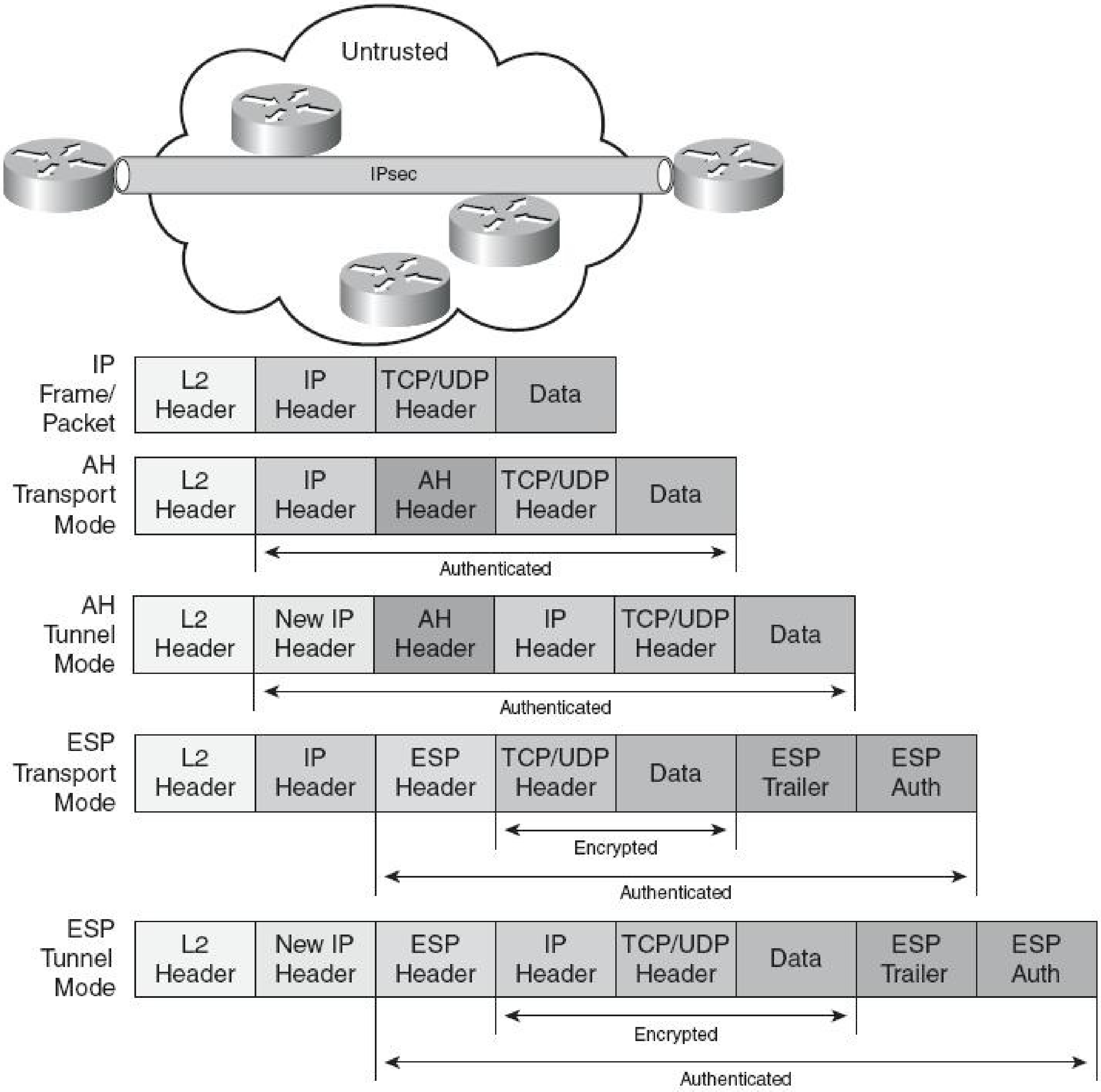
Three Security Association components

- SPI
- Destination IP address
- Security protocol identifier (AH or ESP)

IPSec Protocol Modes

- Transport mode
  - Facilitates communications between two hosts
  - During transport, source and destination IP addresses in plain text.
  - Usually, only authenticates payload
  - Used only netween two end host computers
- Tunnel mode
  - When either end of a security association is a security gateway, the SA must be tunnel mode
  - Encrypts ultimate destination as well as source IP addresses
  - Can be used by any IPSec-enabled computer but must be used when either end SA is a gateway.

Figure 12-2 *AH and ESP Headers*



Management Control

- A security policy is a rule that is programmed into the IPSec implementation that tells it how to process different datagrams received by the device.
    - For example, security policies are used to decide if a particular packet needs to be processed by IPSec or not; those that do not bypass AH and ESP entirely.
    - If security is required, the security policy provides general guidelines for how it should be provided, and if necessary, links to more specific detail.
- Security policies for a device are stored in the

IPSec Issues

- AH breaks many NAT implementations
- IKE expect source and destination ports to be UDP 500
- Because of encryption, may be difficult to troubleshoot

Other VPN Technologies

- PPTP supports authenticaion and confidentiality between a client and a gateway or between two gateways without using public keys.
- L2TP a combinatino of PPTP and L2F.

SET

- Secure Electronic Transaction
  - Because it uses certificates, considered a PKI application
  - Level 7 protocol
    - Developed by a consortium including Cybercash, MasterCard and Visa.
- Provides confidentiality for purchases by encrypting the payment information.
- Covers end to end transactions.

Questions?

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