Network Layer Security – Structure and Challenges

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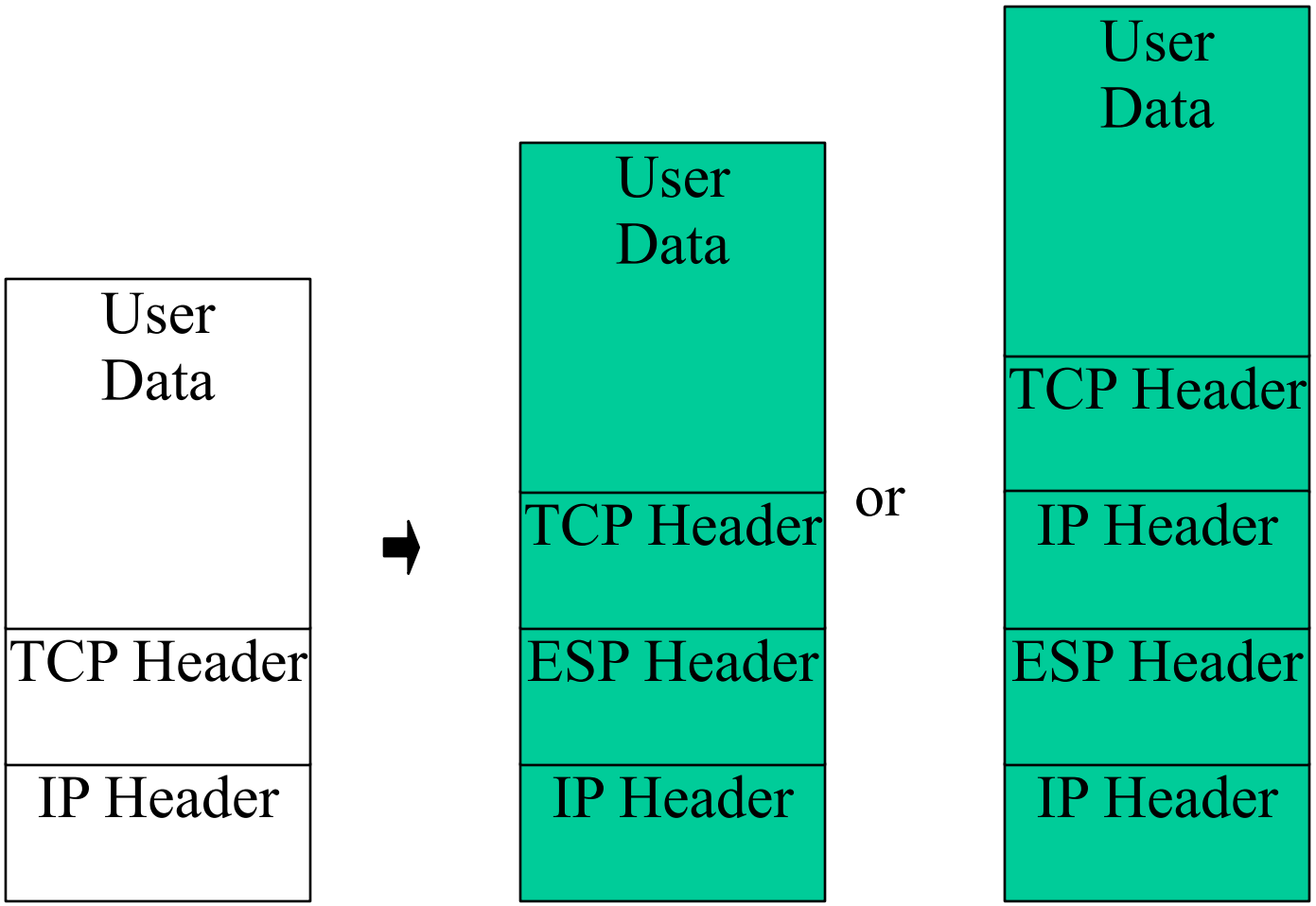
What is Network Layer Security?

- Encrypt (or authenticate) everything above the network layer header.
- Completely transparent to applications.
- TCP- or application-level retransmissions handle deleted or damaged packets.
- Generally must modify protocol stack or kernel; out of reach of application writers or users.

IPSEC Structure

- Nested headers: IP, ESP or AH, maybe another IP, TCP or UDP, then data
- Cryptographic protection can be host-to-host, host-to-firewall, or firewall-to-firewall.
- Option for per-user keying.
- Works with IPv4 and IPv6.


User Data
TCP Header
IP Header
User Data
TCP Header
ESP Header
IP Header
or
User Data
TCP Header
IP Header
ESP Header
IP Header

Authentication Header (AH)

- Uses HMAC algorithm to combine secret key and data via a cryptographic hash function.
- Covers payload and portion of preceding IP header.
- Uses *Security Parameter Index* (SPI) to identify key, algorithm, etc.
- Optionally provides replay protection.

Encapsulating Security Protocol (ESP)

- Carries encrypted packet.
- Uses SPI.
- Provides confidentiality, authentication and integrity protection, and replay protection.

Key Management

- Dynamically negotiate session key between peers.
- Use digital signature algorithm to sign Diffie-Hellman exchange
- Many different flavors.

Uses for IPSEC

- Virtual Private Networks (VPNs)
- “Phone home” for laptops, telecommuters
- General Internet security.

Virtual Private Networks

- Extend boundary of physically-secure network.
- Use cryptography to protect links across public Internet.
- Encrypting gateway (often a firewall) protects all traffic into/out of the network.
- Parties must *know* proper IPSEC gateway.

Open Issues

- Gateway discovery.
- API
- Multicast

IPSEC Gateways

- Often manually configured – doesn't scale.
- DNS-based proposal: KX records, similar to MX records.
- What about complex topologies?
- Pathfinder packets: see who bounces the packet.
  - Do they have the right to? Must be digitally signed by destination.

IPSEC API

- How can an application request cryptographic protection?
- How can an application determine the protection level? The peer's identity?
- How are different cryptographic strengths indicated?
- How is certificate selection done?

Multicast

- What type of multicast? Broadcast? Private conference?
- How can we do key management? Does it scale?
- Who controls group membership? How? Can the membership change dynamically?
- Do we need to be able to revoke keys?

How Can We Secure the Internet?

- Hard to deploy host-to-host IPSEC.
- When can it be used? When should it be used?
- Is it the right mechanism for general Internet security?