Lecture 12 - Network Security

CSE497b - Spring 2007

Introduction Computer and Network Security

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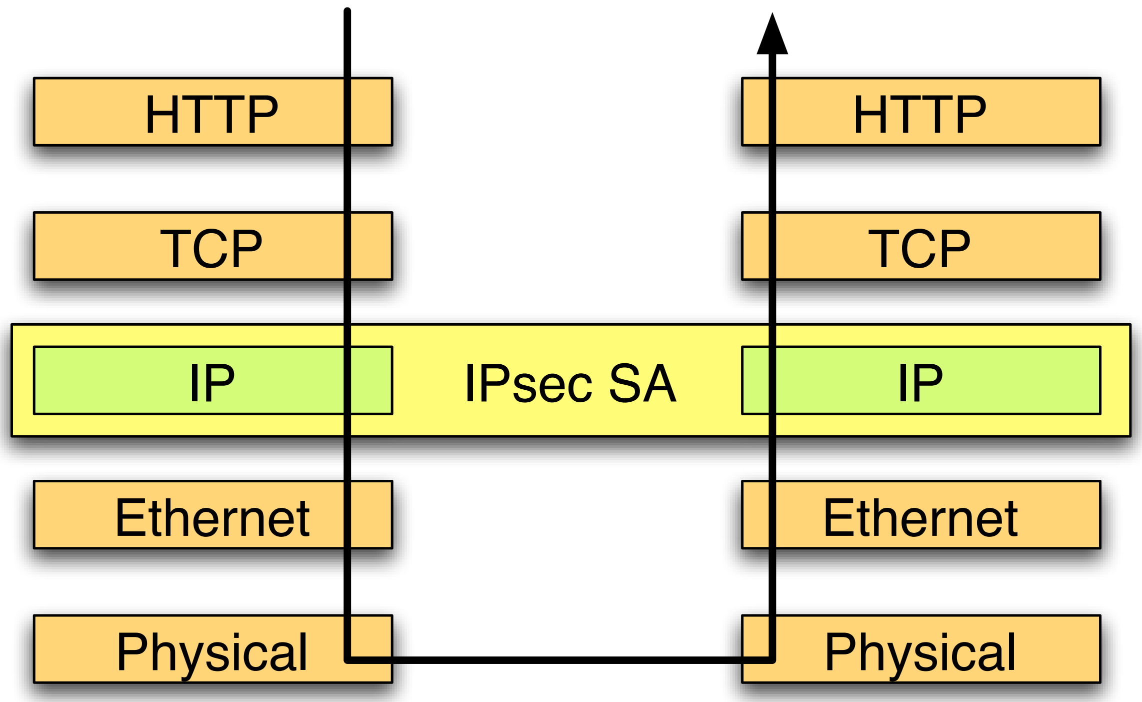
Idea

- Why don’t we just integrate some of these neat crypto tricks directly into the IP protocol stack?

- This is called *transport security*

IPsec

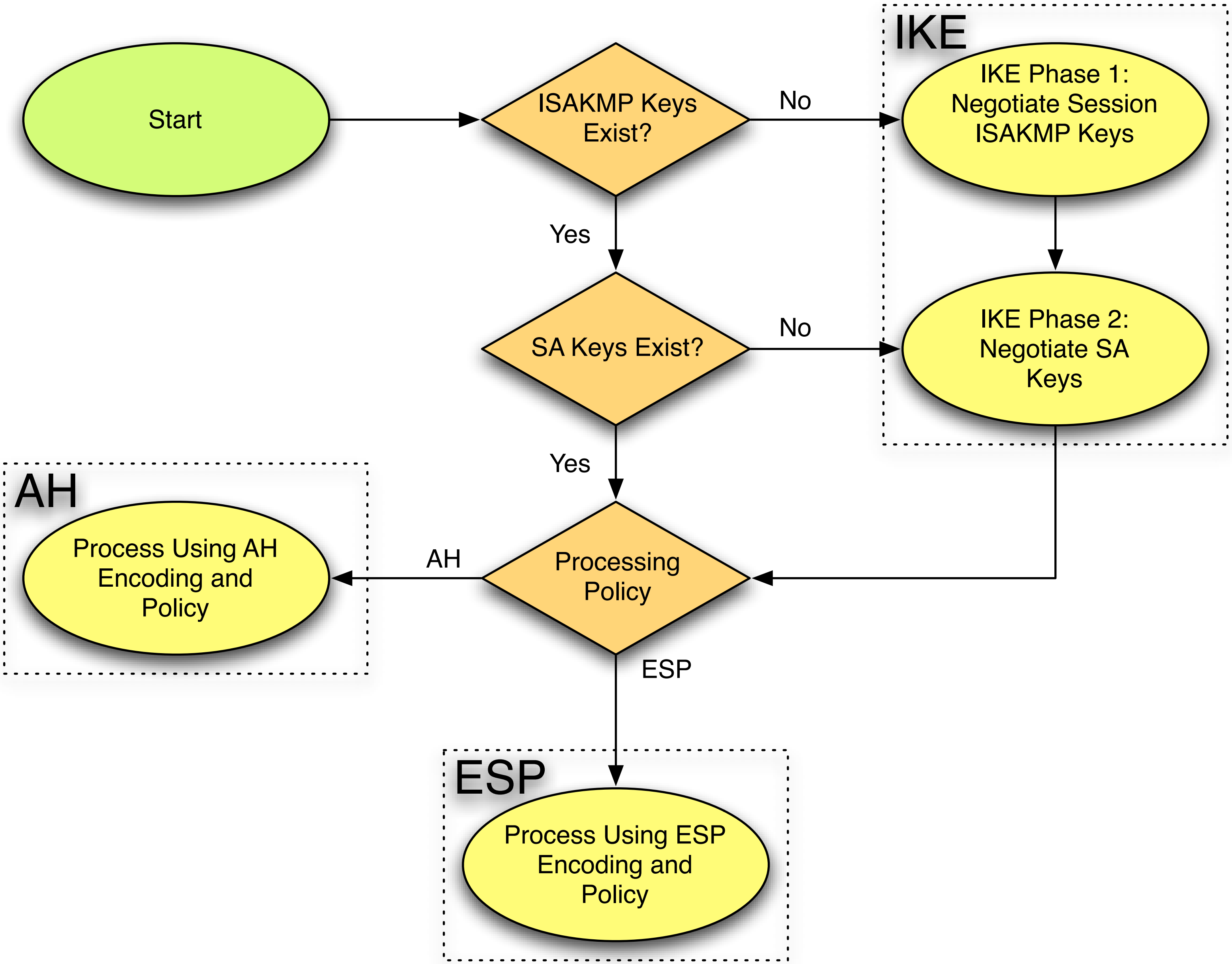
- IP layer security protocol
  - Integrated directly into protocol stack
  - Defined as an extension to the network layer
  - Transparent to the above layers and application
- Provides
  - confidentiality
  - integrity
  - authenticity
  - replay protection
  - DOS protection



Tunnel vs. Transport Mode

- Transport mode
  - default mode of IPsec -- protects transport layer packet
  - end-to-end encapsulation of data
  - useful when both endpoints are configured to use/manage IPsec
- Tunnel mode
  - encapsulates all of the IP data over a new IP level packet
  - useful when the device applying IPsec to the packet is not the originating host, e.g., at a gateway
  - Also known as, "*ip over ip*"
- IPsec provides the mechanism, you provide the policy

IPsec Processing

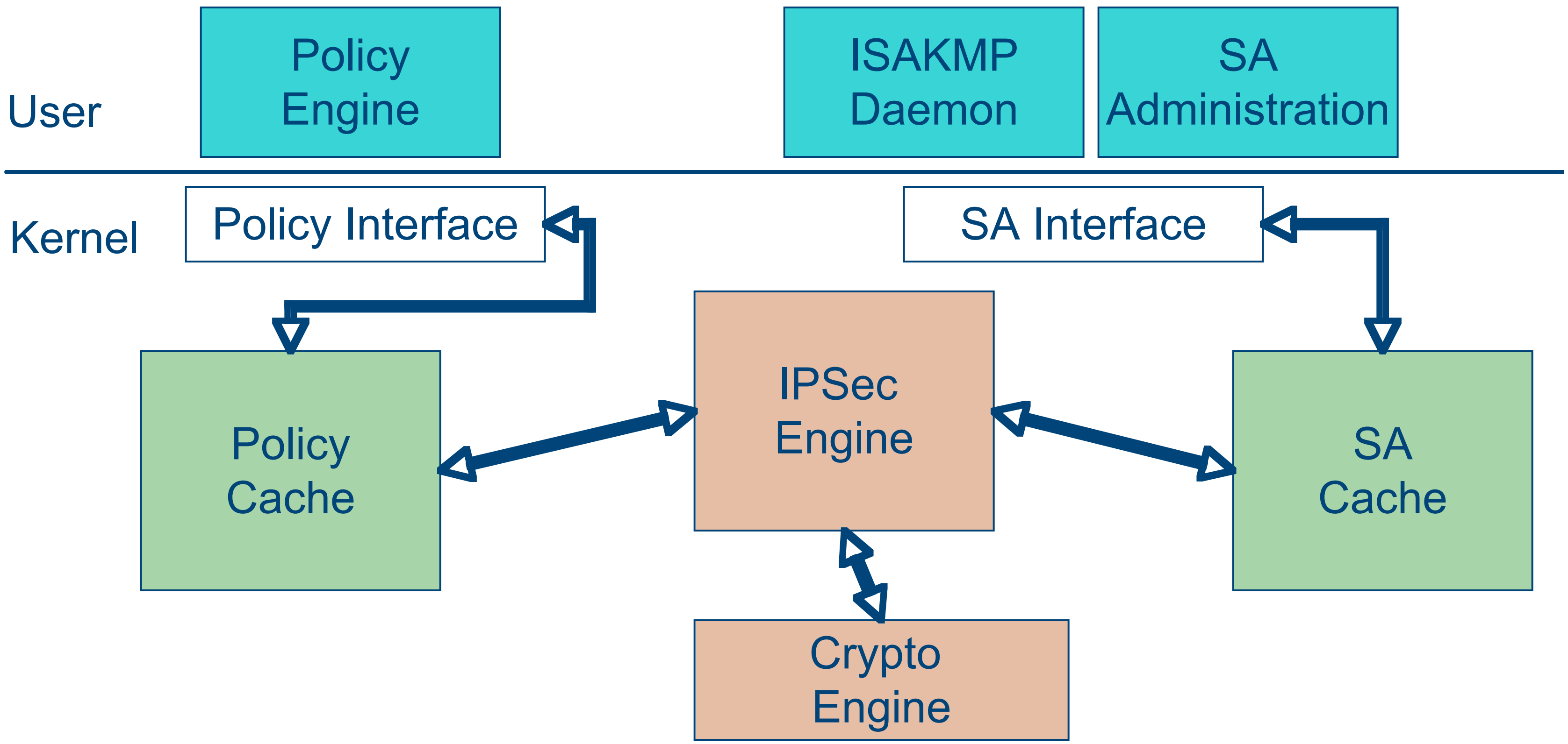


Internet Key Exchange (IKE)

- Built on of ISAKMP framework
- Two phase protocol used to establish parameters and keys for session
  - Phase 1: negotiate parameters, authenticate peers, establish secure channel
    - ISAKMP keys
  - Phase 2: Establish a security association (SA)
    - SA keys used to process user traffic
- The details are unimaginably complex
- The SA defines algorithms, keys, and policy used to secure the session

IPsec Implementation

- User: ISAKMP framework
- Kernel: IPsec processing

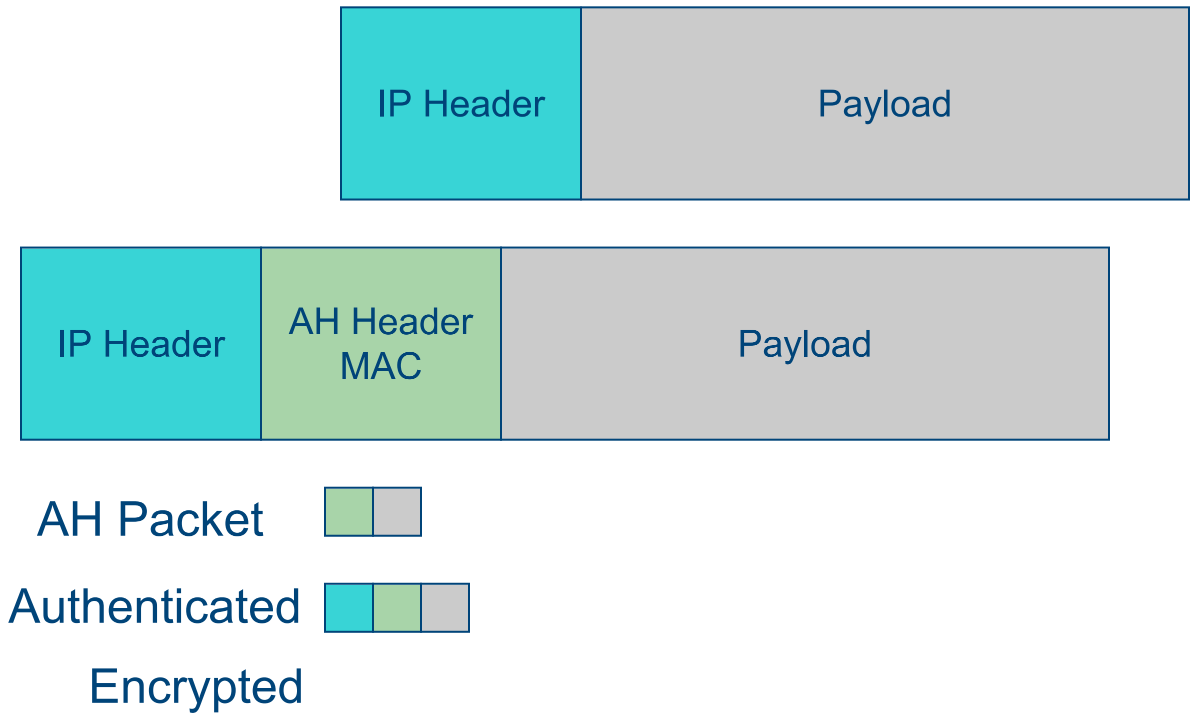


Authentication Header (AH)

- Authenticity and integrity
  - via HMAC
  - over IP headers and and data
- Advantage: the authenticity of data and IP header information is protected
  - it gets a little complicated with *mutable* fields, which are supposed to be altered by network as packet traverses the network
  - some fields a *immutable*, and are protected
- Confidentiality of data is *not* preserved
- Replay protection via AH sequence numbers
  - note that this replicates some features of TCP (good?)

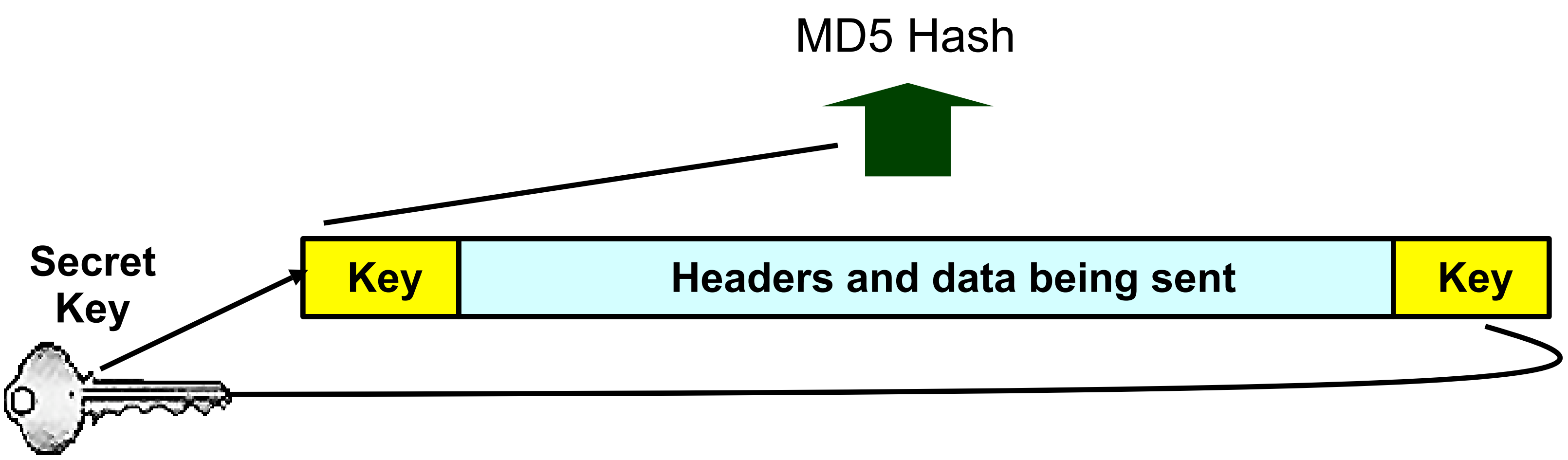
Authentication Header (AH)

- Modifications to the packet format



IPsec Authentication

- SPI: (spy) identifies the security association for this packet
  - Type of crypto checksum, how large it is, and how it is computed
  - Really the policy for the packet
- Authentication data
  - Hash of packet contents include IP header as as specified by SPI
  - Treat transient fields (TTL, header checksum) as zero
- Keyed MD5 Hash is default

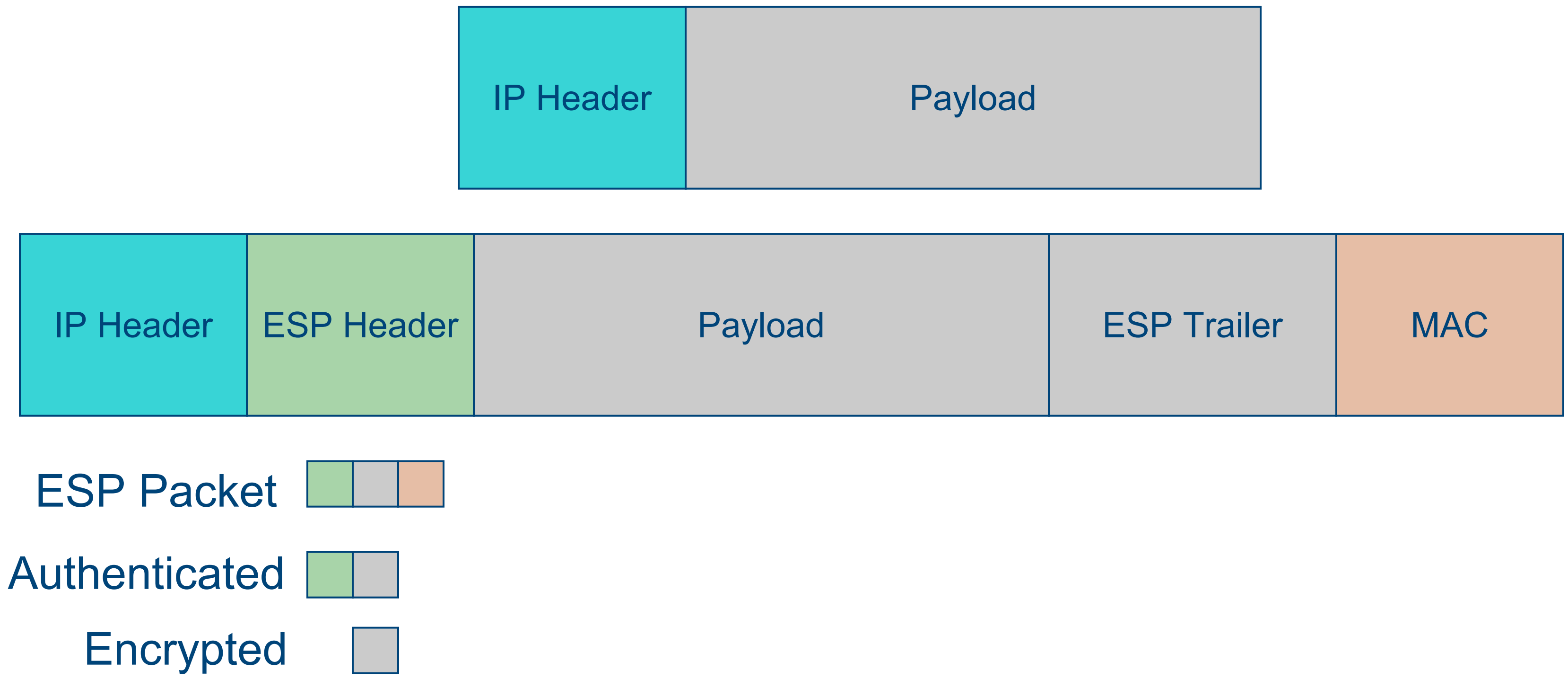


Encapsulating Security Payload (ESP)

- Confidentiality, authenticity and integrity
  - via encryption and HMAC
  - over IP *payload* (data)
- Advantage: the security manipulations are done solely on user data
  - TCP packet is fully secured
  - simplifies processing
- Use “null” encryption to get authenticity/integrity only
- Note that the TCP ports are hidden when encrypted
  - good: better security, less is known about traffic
  - bad: impossible for FW to filter/traffic based on port
- Cost: can require many more resources than AH

Encapsulating Security Payload (ESP)

- Modifications to packet format

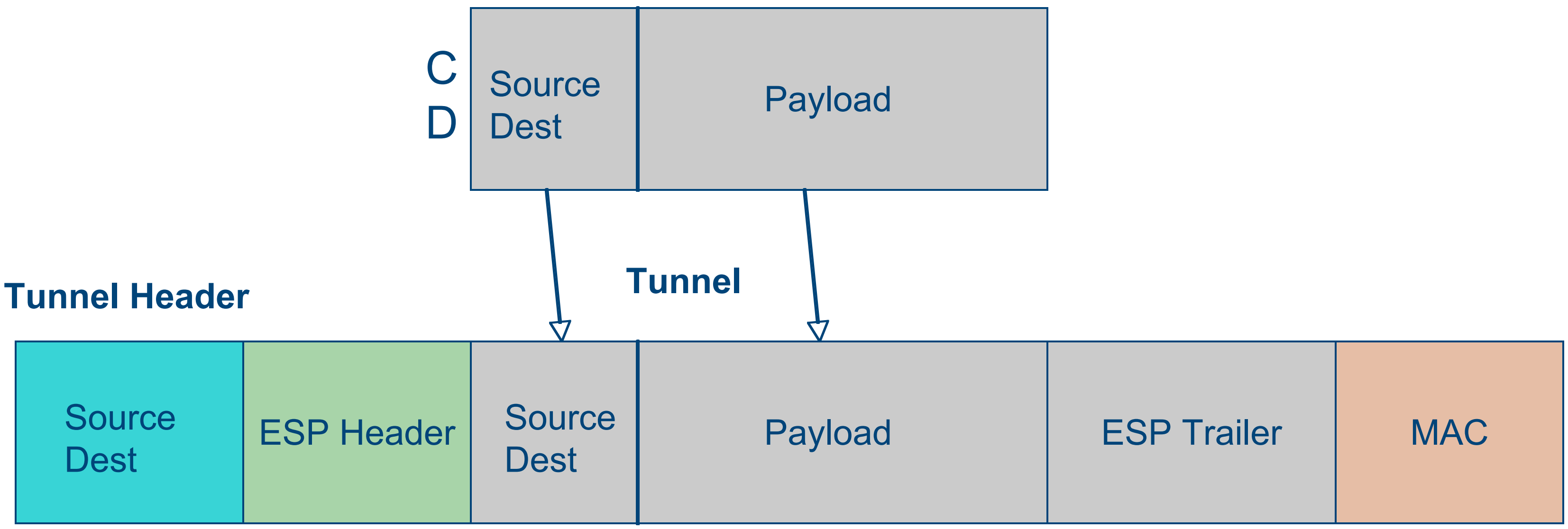


Is AH necessary?

- Some argue that AH is subsumed by ESP
  - Header protection can be achieved by tunnel mode ESP
  - Protection of header has limited utility
- Should we allow firewalls (and eavesdroppers) to look at layer 4 (TCP) information
  - e.g., filter on ports
  - exposes a lot of information
- In practice, the protocol AH is generally not used.

IPsec Tunnel Mode

- Encapsulate IP packet



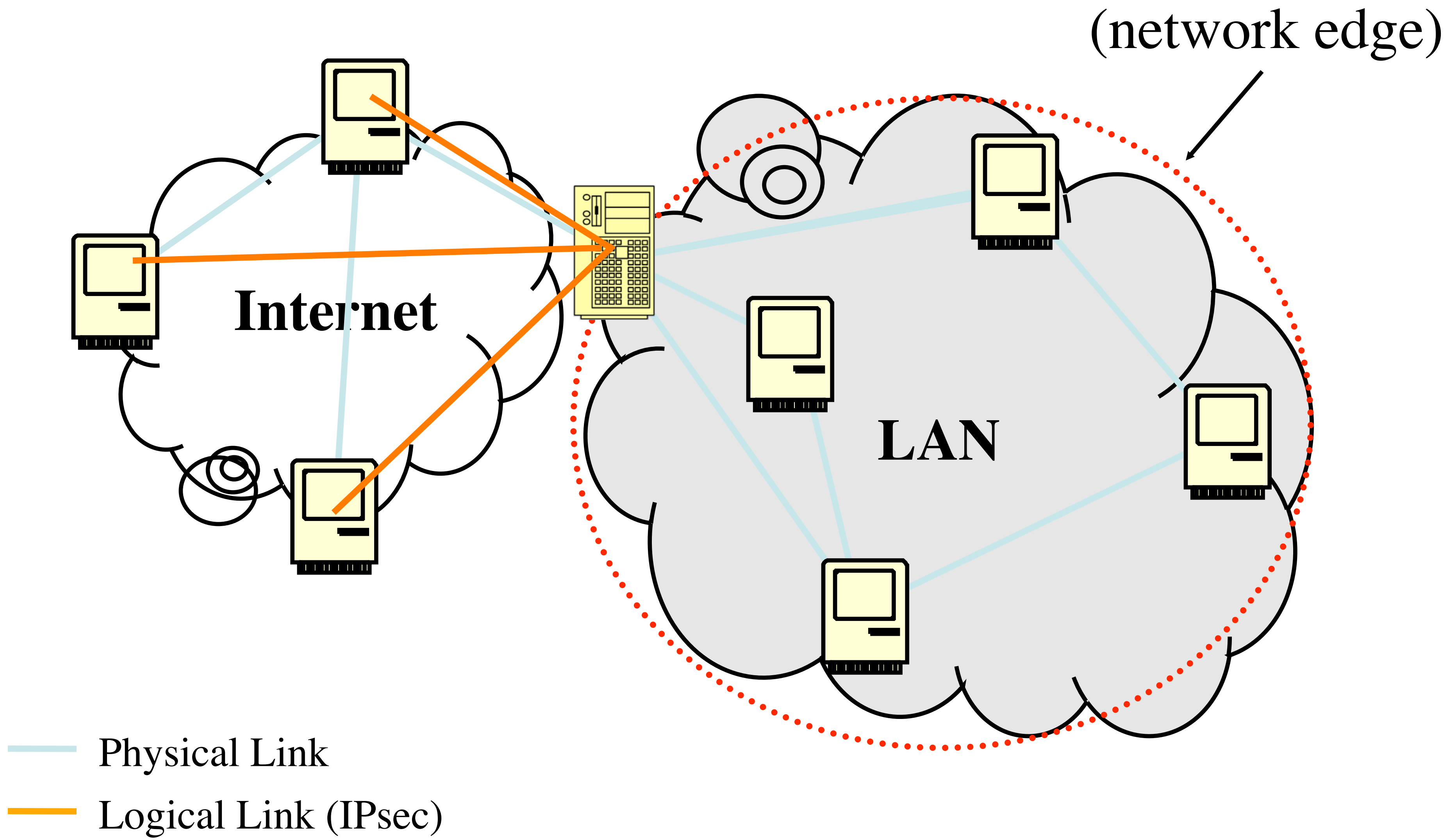
Practical Issues and Limitations

- IPsec implementations
  - Often not compatible (ungh.)
  - Large footprint
    - resource poor devices are in trouble
    - New standards to simplify (e.g, JFK, IKE2)
  - Slow to adopt new technologies
- Issues
  - IPsec tries to be “everything for everybody at all times”
    - Massive, complicated, and unwieldy
  - Policy infrastructure has not emerged
  - Large-scale management tools are limited (e.g., CISCO)
  - Often not used securely (common pre-shared keys)

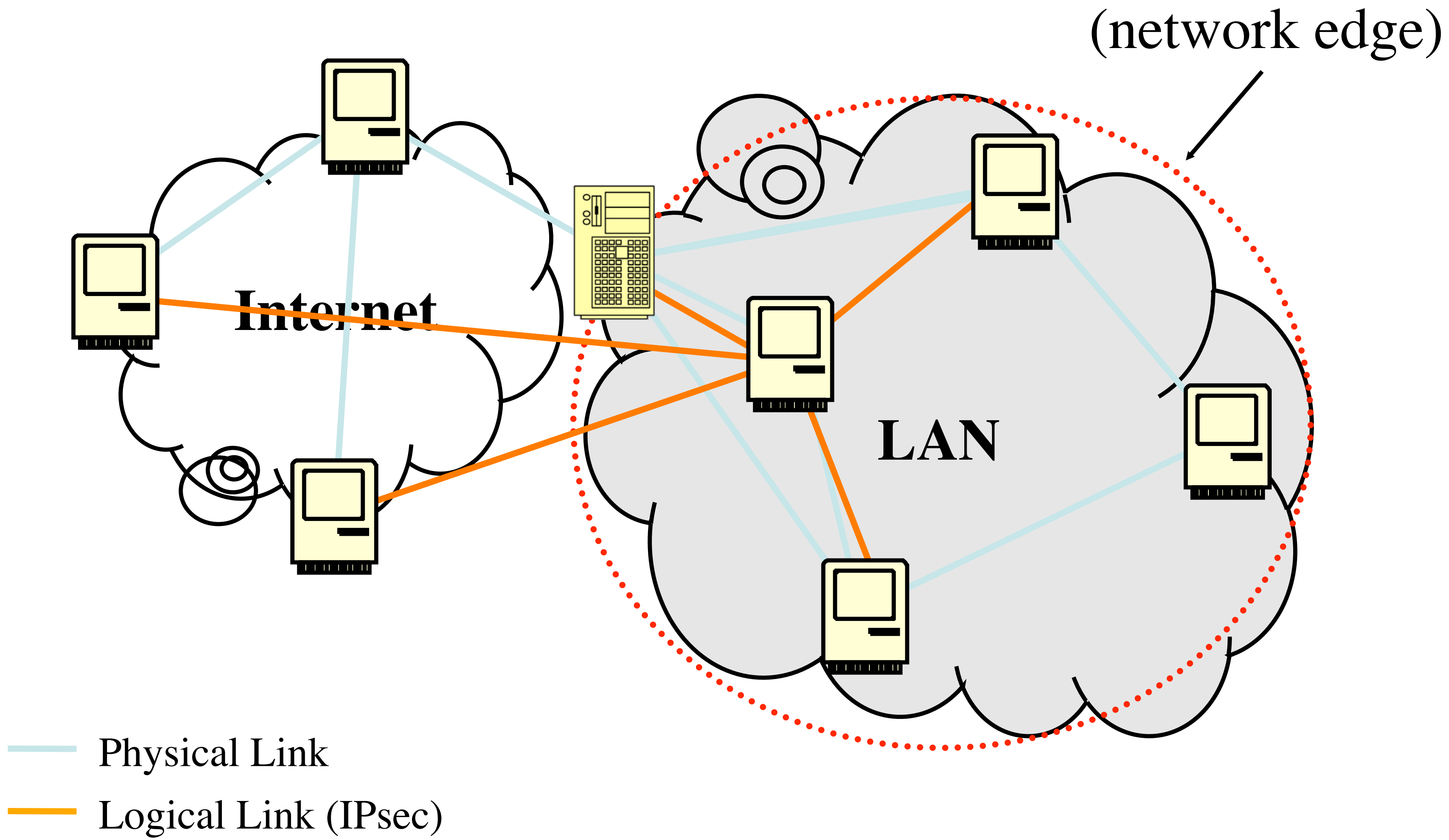
Network Isolation: VPNs

- Idea: I want to create a collection of hosts which operate in a coordinated way
  - E.g., a virtual security perimeter over physical network
  - Hosts work as if they are isolated from malicious hosts
- Solution: Virtual Private Networks
  - Create virtual network topology over physical network
  - Use communications security protocol suites to secure virtual links “tunneling”
  - Manage networks as if they are physically separate
  - Hosts can route traffic to regular networks (split-tunneling)

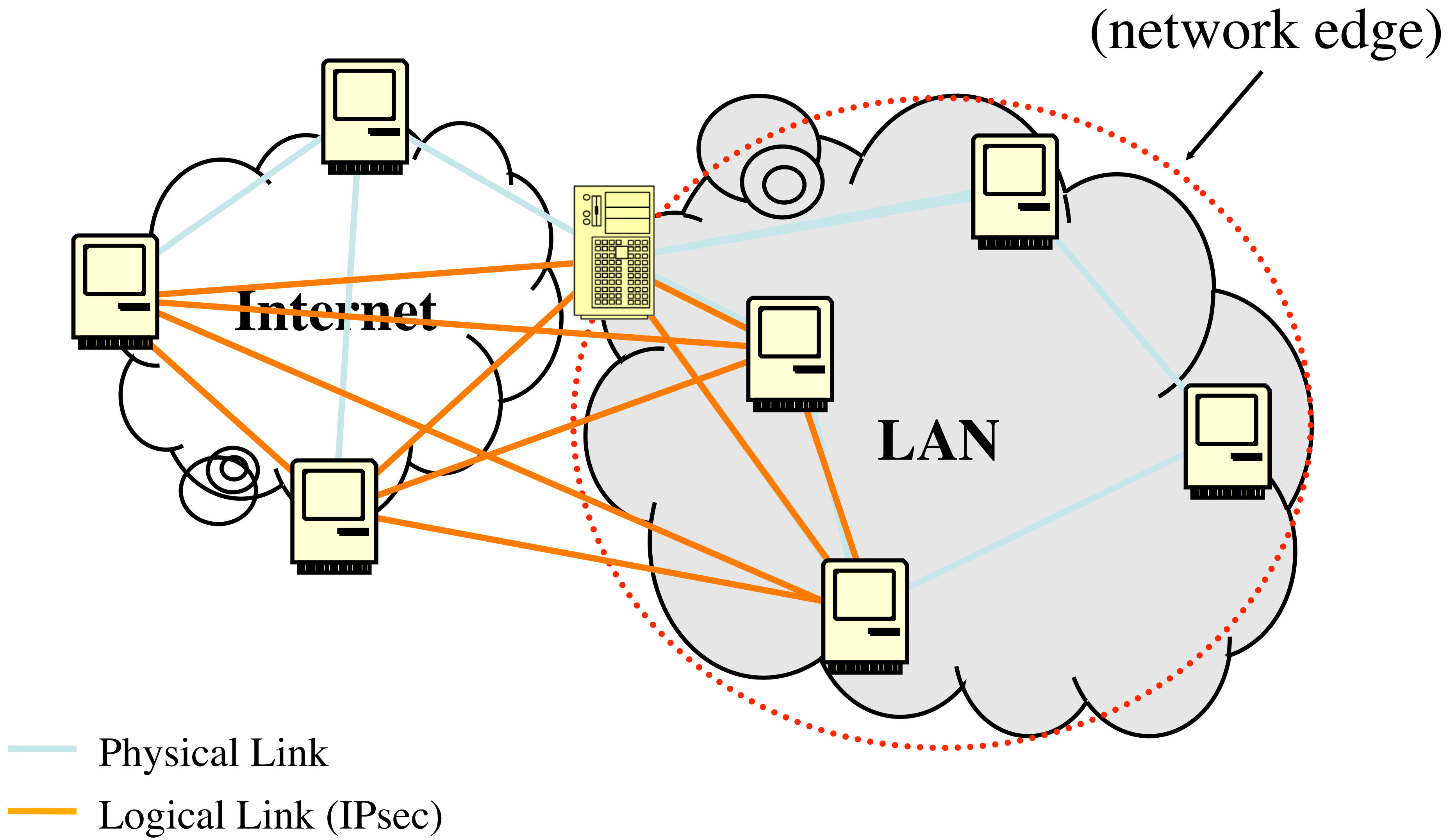
VPN Example: RW/Telecommuter



VPN Example: Hub and Spoke



VPN Example: Mesh



Virtual LANs (VLANs)

- VPNs build with hardware
  - No encryption – none needed
  - “wire based isolation”
  - Switches increasingly support VLANs
  - Allows networks to be reorganized without rewiring
- Example usage: two departments in same hallway
  - Each office is associated with department
  - Configuring the network switch gives physical isolation
  - Note: often used to ensure QoS