Distributed Systems

28. Virtual Private Networks

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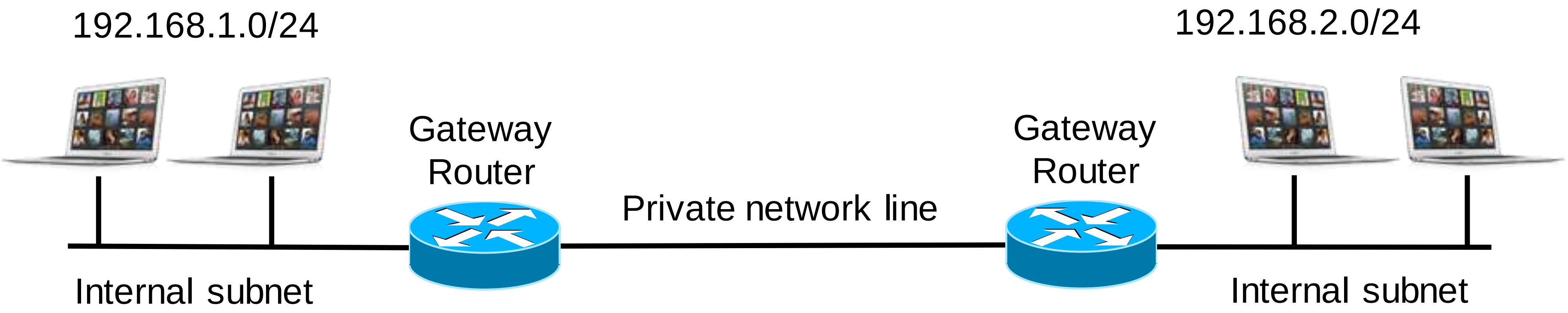
Private networks

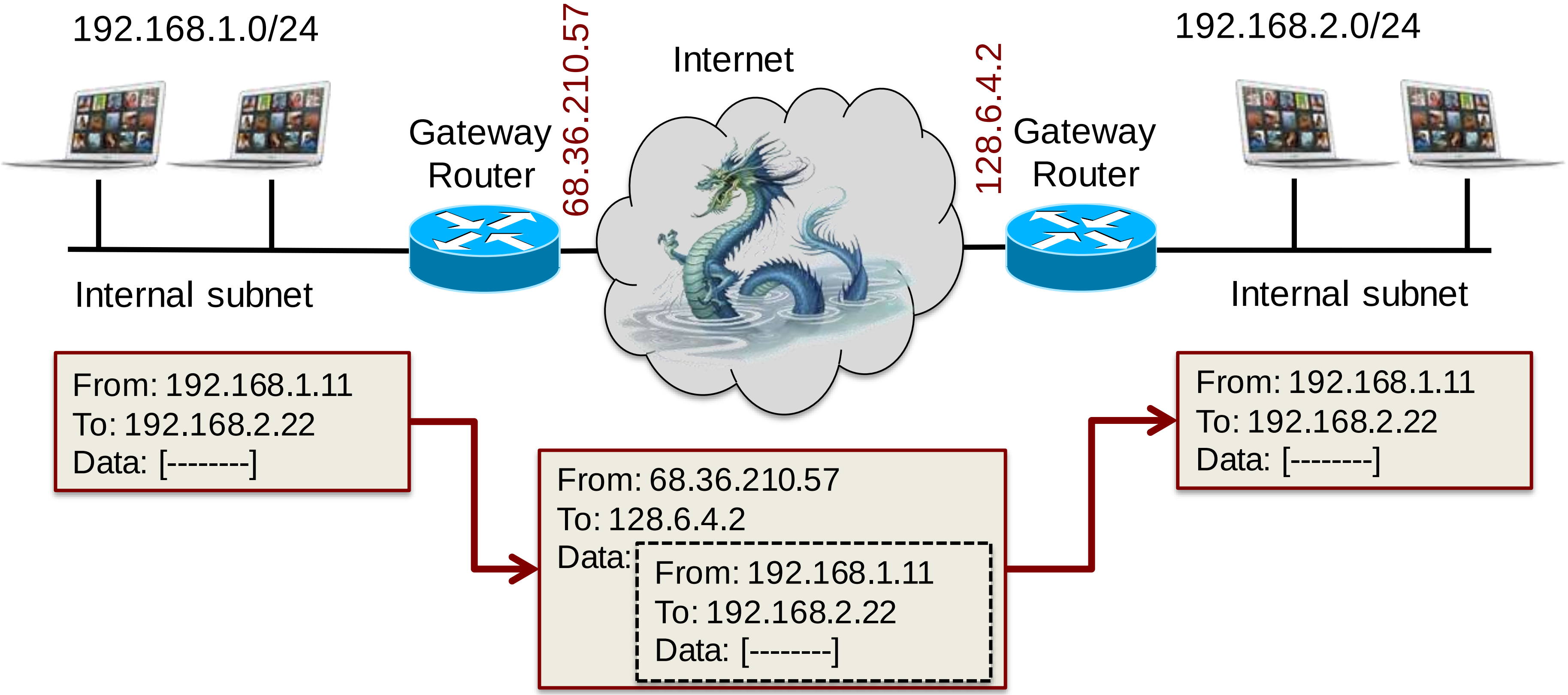
Connect multiple geographically-separated private subnetworks together



What’s a tunnel?

Tunnel = Packet encapsulation

Treat an entire IP datagram as payload on the public network



192.168.1.0/24

Gateway Router

68.36.210.57

Internet

128.6.4.2

Gateway Router

192.168.2.0/24

Internal subnet

Internal subnet

From: 192.168.1.11
To: 192.168.2.22
Data: [--------]

From: 68.36.210.57
To: 128.6.4.2
Data: From: 192.168.1.11
To: 192.168.2.22
Data: [--------]

From: 192.168.1.11
To: 192.168.2.22
Data: [--------]

Tunnel mode vs. transport mode

- Tunnel mode
  - Communication between gateways
  - Or a host-to-gateway
  - Entire datagram is encapsulated

- Transport mode
  - Communication between hosts
  - IP header is not modified

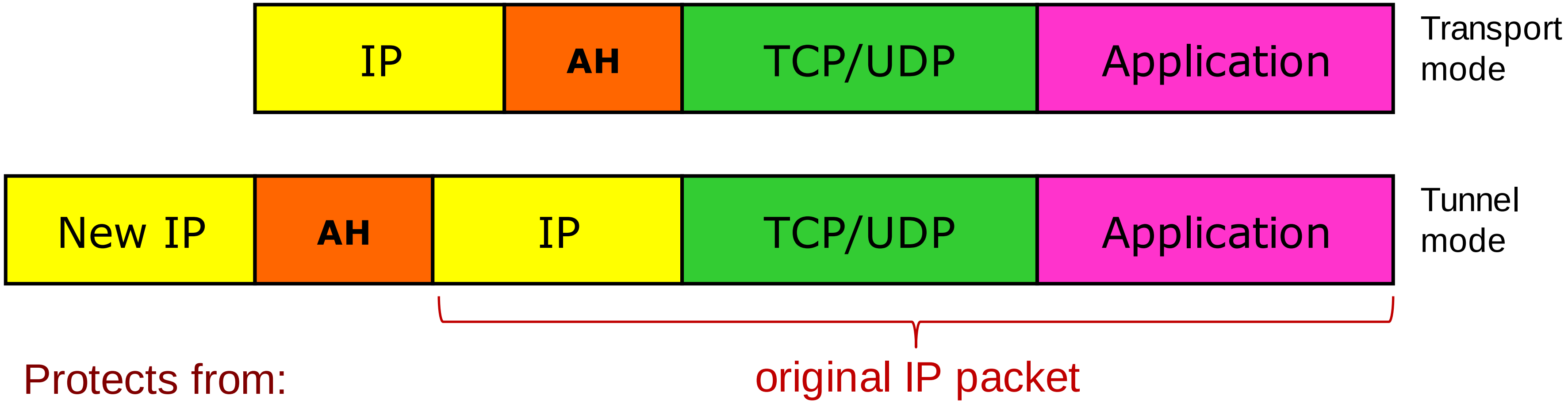
IPsec

- Internet Protocol Security
- End-to-end solution at the IP layer
- Two protocols:
  - IPsec Authentication Header Protocol (AH)
  - IPsec Encapsulating Security Payload (ESP)

IPsec Authentication Header (AH)

Ensures the integrity & authenticity of IP packets

- Digital signature for the contents of the entire IP packet
- Over unchangeable IP datagram fields (e.g., not TTL or fragmentation)



Protects from:

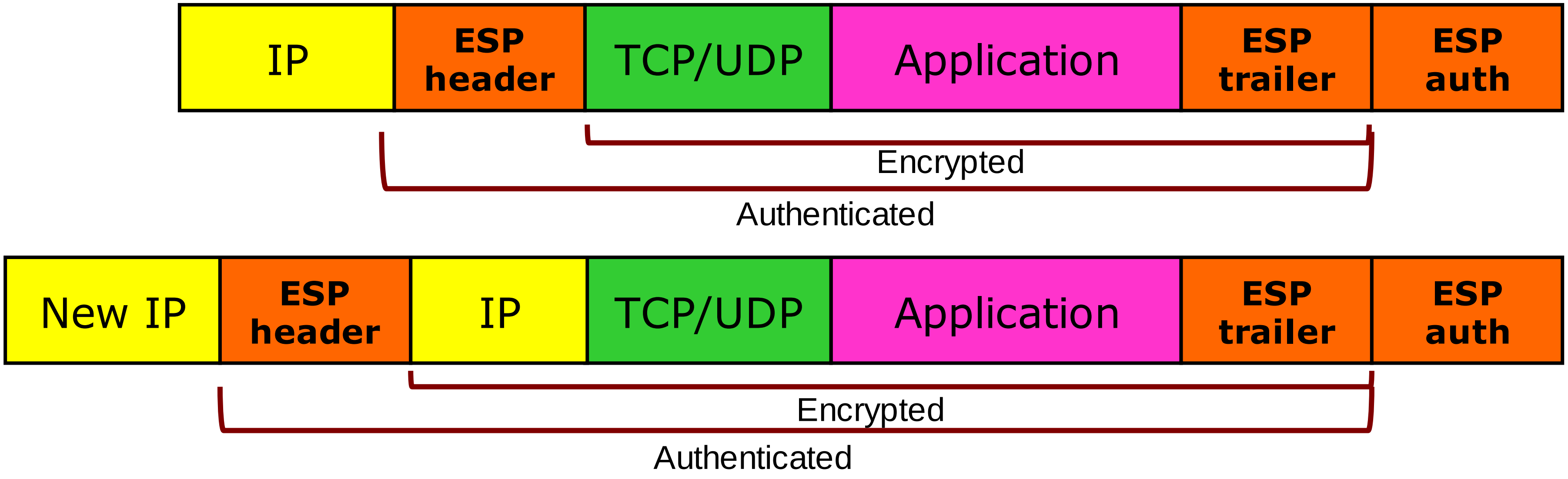
- Tampering
- Forging addresses
- Replay attacks (signed sequence number in AH)

Layered directly on top of IP (protocol 51) - not UDP or TCP

IPsec Encapsulating Security Payload (ESP)

Encrypts entire payload

- Optional authentication of payload + IP header (everything AH does)



Directly on top of IP (protocol 51) - not UDP or TCP

TLS/SSL

- Designed to operate at the transport layer
  - Application-to-application VPN
  - Public key authentication & key exchange; symmetric encryption
  - Provides applications with a socket interface
- SSL VPN
  - Can create host-host, host-to-network, or network-network connections
- SSL-based VPNs (e.g., OpenVPN)
  - authentication: pre-shared keys, certificates
  - Transport: UDP or TCP
  - Multiplex communication stream onto a single TCP or UDP port
  - Transport-layer, so works through proxy servers and NAT environments

The End