GRE Tunneling

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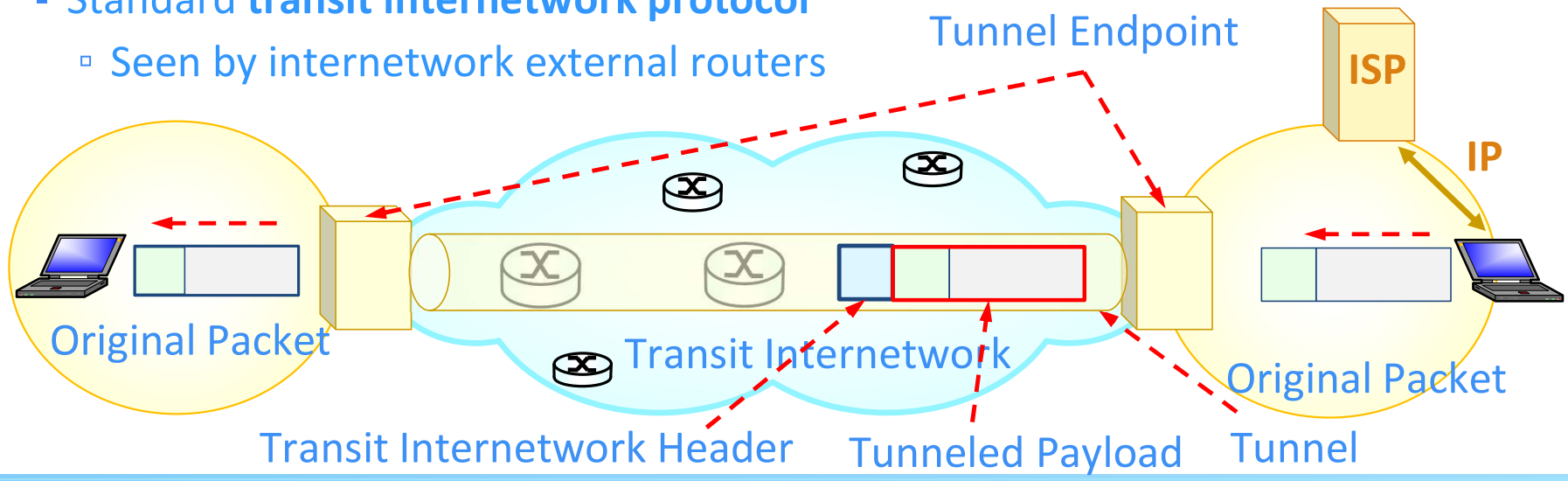
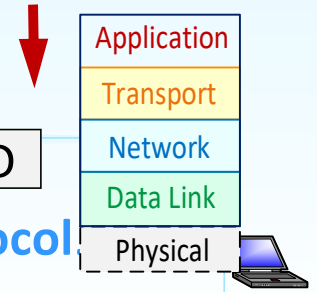
VPN Key Concept – Tunneling

- VPN consists of **a set of point-to-point** connections **tunneled over** the Internet**.**
- **VPN Tunnel Packets:**
  - **Payload**:
    - **Original packets** encapsulated as payload of VPN tunnel packets.
  - **Header**:
    - Standard **transit internetwork protocol**
      - Seen by internetwork external routers

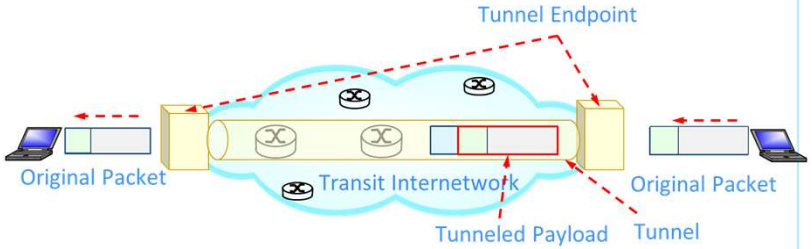


Tunneling vs. Encapsulation



Encapsulation: H_L H_N H_T H_A D

- **Tunneling**
  encapsulates and transports the PDU of one protocol **within another protocol**.
  - Unlike encapsulation, **tunneling** can carry
    - **a lower-layer protocol** PDU or
    - a **same-layer protocol** PDU.



- IP-in-IP Tunnel

Ethernet Header	Outer IP Header	Inner IP Header	Inner IP Payload

- **Generic Route Encapsulation** (GRE) Tunnel [RFC 2890]

Ethernet Header	Outer IP Header	GRE Header	Inner IP Header	Inner IP Payload

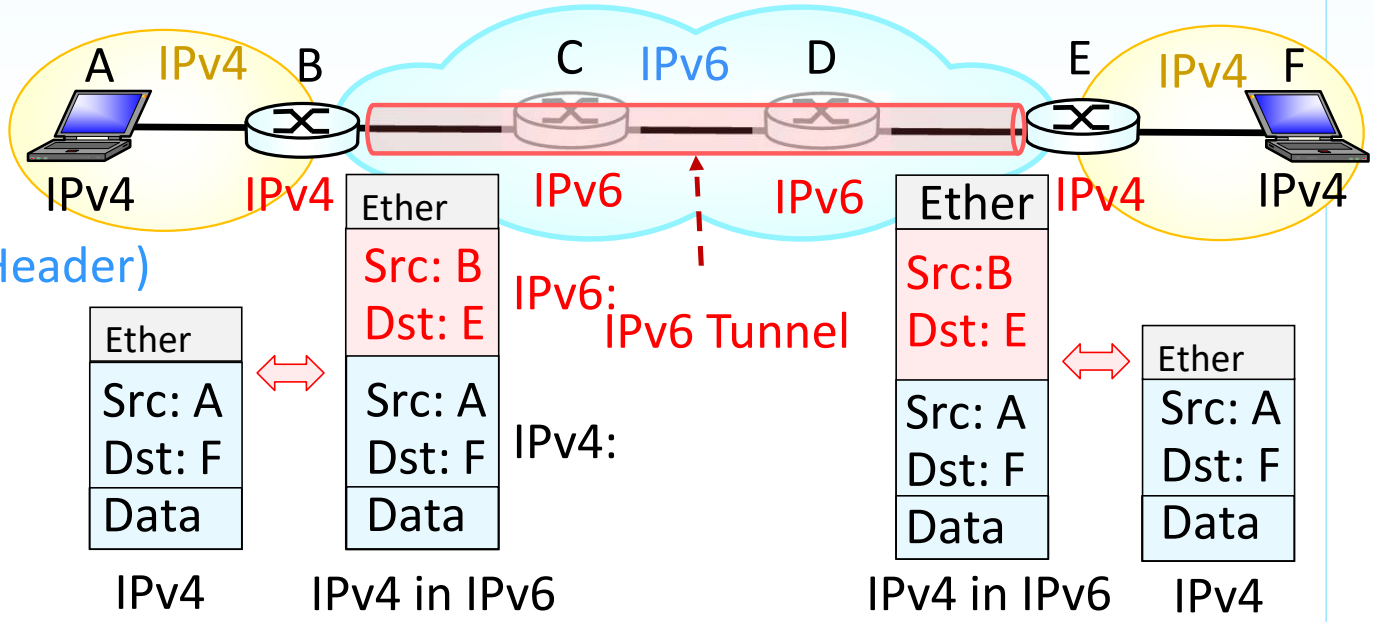
- **Virtual Extensible LAN** (VXLAN) Tunnel

Inner Ethernet Header

Ethernet Header	Outer IP Header	UDP Header	VXLAN Header	Ethernet Header	Inner IP Header	Inner IP Payload

Tunneling Use Case 1 – Heterogeneous Networking

- Provides a network service that the underlying network does not support or provide directly
- E.g., IPv6 Tunnel for IPv4 Networking
  - Protocol Value (Next Header) in IPv6 header:
    - IPv4: 0x04
    - TCP: 0x06
    - IPv6: 0x41

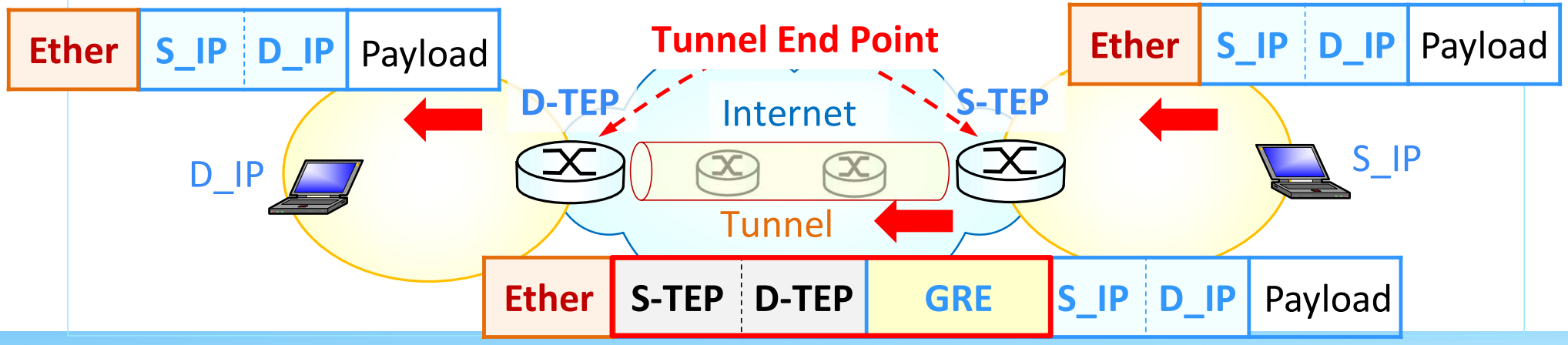


- IPv6 datagrams carry IPv4 packets as payloads among IPv6 routers
  - Logical view: B ↔ E (Two IPv4 routers directly connected)
  - Physically: B ↔ C ↔ D ↔ E (Indirect connection)

Tunneling Use Case 2 – Security Enhancement

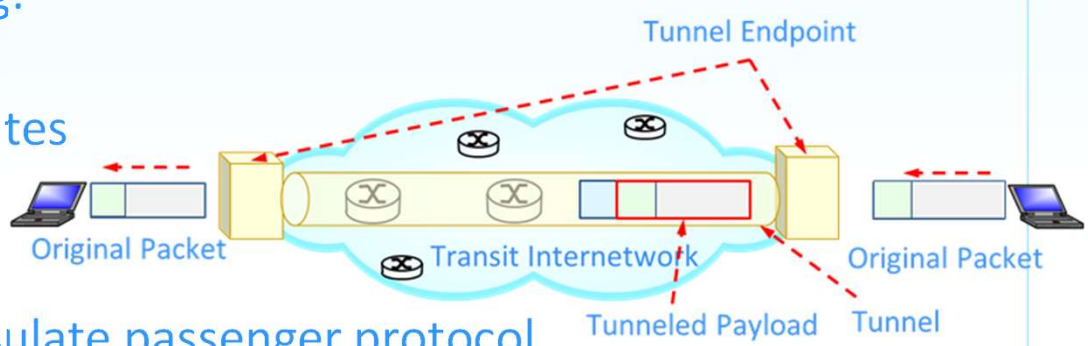
- **Generic Routing Encapsulation** (GRE): RFC 2784 and updated by RFC 2890
  - A **GRE header** between the **inner** and **outer** IP headers

    - **Virtual Tunnel: Tunnel IP Header + GRE Packet Header**
      - **IP** as a transport protocol

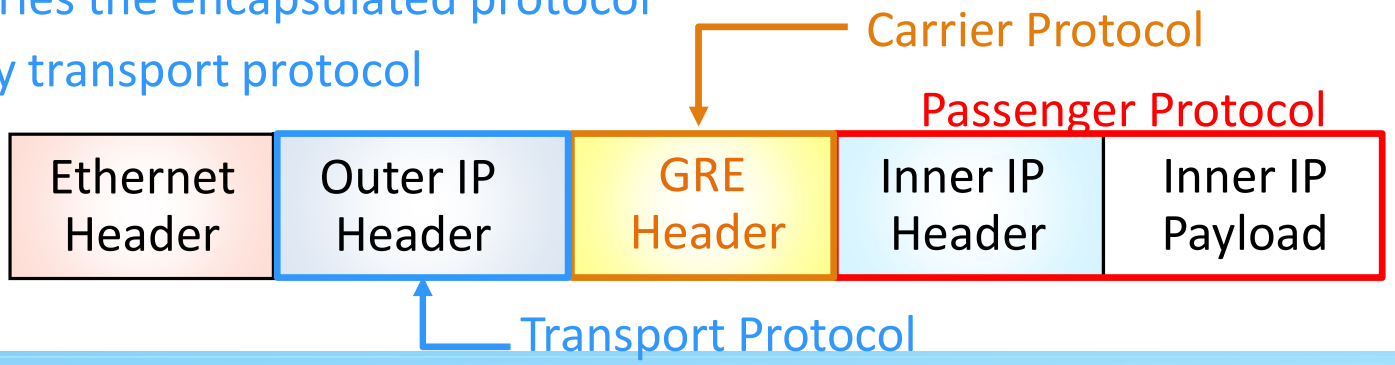


Main Components of Tunneling

- Three Main Components of Tunneling:
  - Passenger protocol
    Protocol that the tunnel encapsulates
    - e.g., IPv4, Ethernet,
  - Carrier protocol
    Protocol the tunnel uses to encapsulate passenger protocol
    - GRE, IP-in-IP, MultiProtocol Label Switching (MPLS).
  - Transport protocol
    Protocol that carries the encapsulated protocol
    - IP is the primary transport protocol



- E.g., GRE Tunnel



- Reference: Cisco

Types of Generic Routing Encapsulation (GRE)

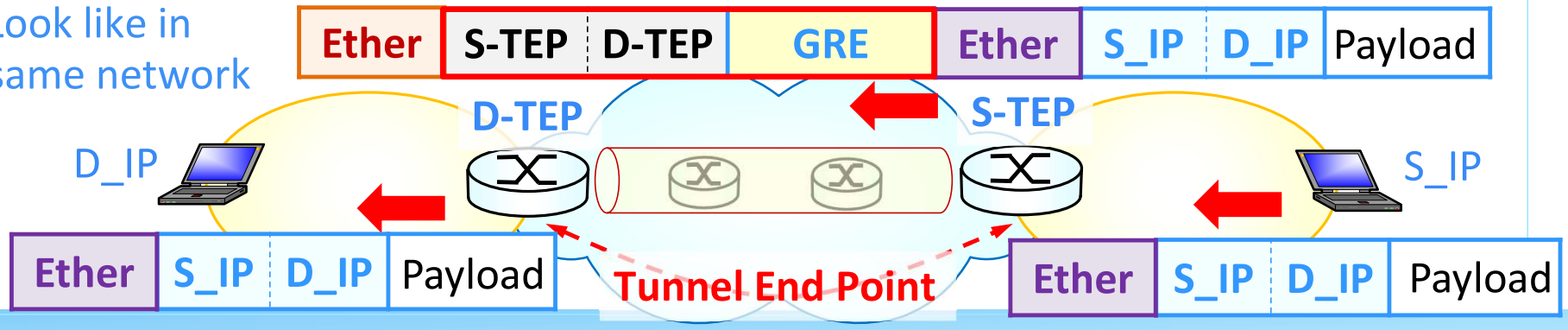
- **GRETUN**: Generic Routing Encapsulation Tunnel
  adds an additional GRE header between the inner and outer IP headers.

Ethernet Header	Outer IP Header	GRE Header	Inner IP Header	Inner IP Payload

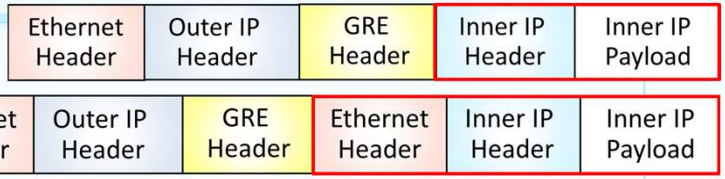
- **GRETAP**: Generic Routing Encapsulation **Terminal Access Point**
  encapsulates Layer 3 protocol with a valid Ethernet type,

Ethernet Header	Outer IP Header	GRE Header	Ethernet Header	Inner IP Header	Inner IP Payload

  - Look like in same network



Generic Routing Encapsulation (GRE) [RFC 2890]



- Enhanced GRE Header (for PPTP defined in RFC 2637):
  - A new **Acknowledgment Number** field,
    - Indicating GRE packets have arrived at the remote end.
      - Can be used to determine the transmission rate

0						8		16	24	31
C	R	K	S	s	Recur	A	Flags	Ver	**Protocol**	
Checksum									Reserved	
Key Payload Length									Key Call ID	
Sequence Number (Optional)										
Acknowledgment Number (Optional)										

- **Protocol: Ethertype** of encapsulated protocol (IP: 0x0800, PPP: 0x880B, …)
- (Optional) **Checksum, Key, Sequence Number**