Routing and Switching

Dr. Ying-Dar Lin

High Speed Network Lab.

Department of Computer Information Science

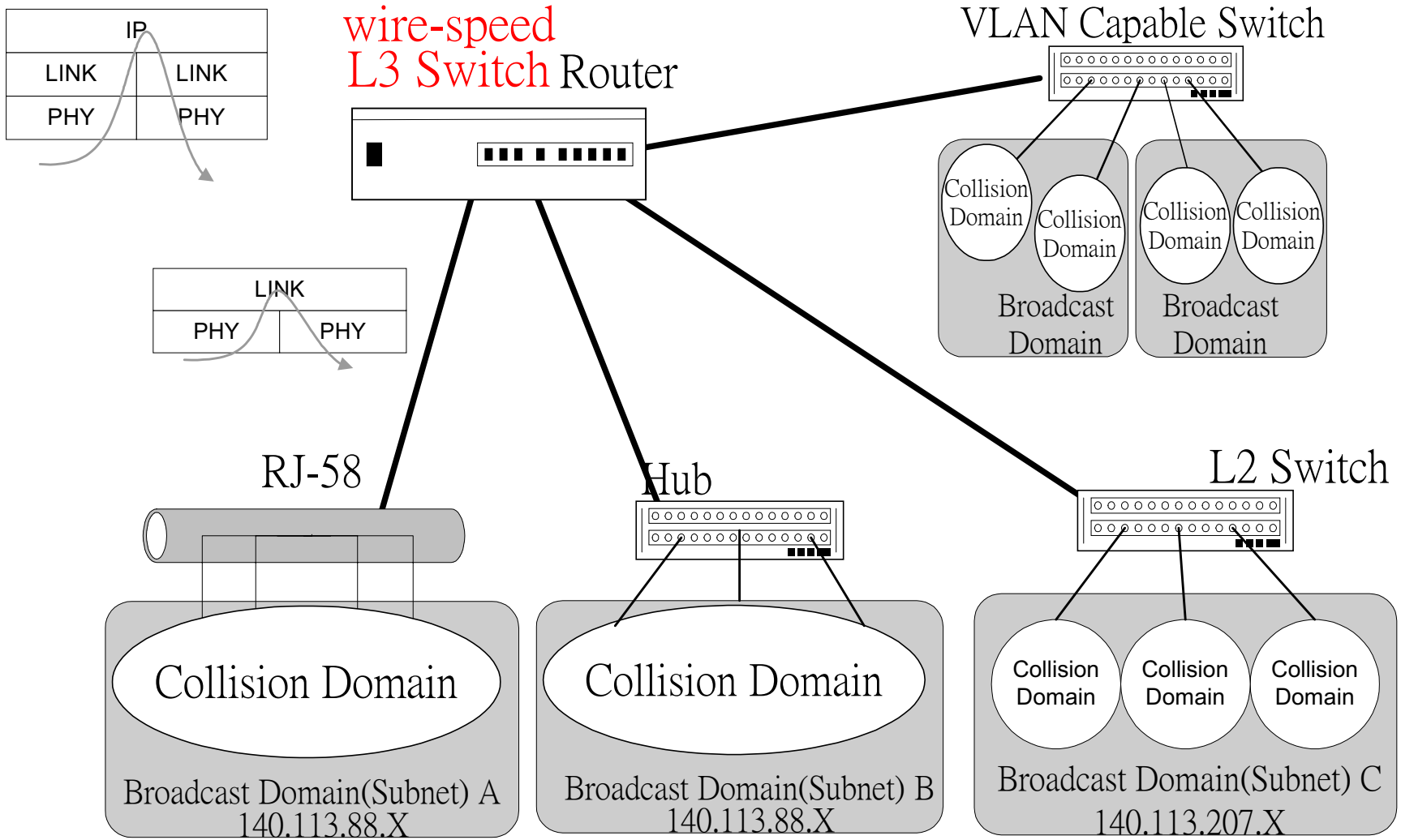
National Chiao Tung University

May 15, 1999

Content

- Wire-Speed Forwarding: LAN to WAN
- Routing v.s Switching
- Stateless v.s Stateful
- Layer 3 Switching Devices
  - Layer 3 switch : stateless
  - MPLS switch : soft-state
  - MPOA switch : hard-state
- Inside the boxes

Wire-speed Forwarding : LAN to WAN



Routing vs Switching

- # of table lookup in a path
  - Routing
    - = hop_count / packet
  - Switching
    - =zero
    - lookup per-port (usually) forwarding cache (or label swapping table, virtual circuit table)

Packet Forwarding : Stateless vs Stateful

Type	Where to lookup ?	Examples
Stateless Routing	Routing table	Traditional software-driven IP router
		Hardware-driven IP router
Soft-state Switching	Forwarding cache (label swapping table or routing table)	IP/MPLS switch
		Software-driven IP switch
Hard-state Switching	Virtual circuit table	MPOA switch

- **Hardware-driven: user-plane through H/W, control-plane through S/W**
- **Software-driven : both through S/W**

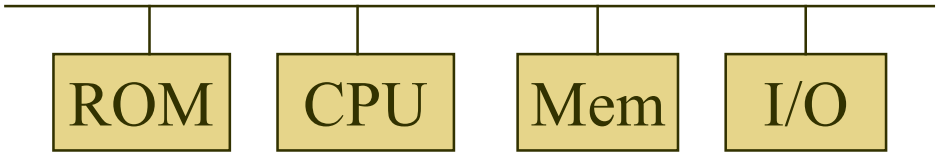
Forwarding & QoS

Forwading \ QoS	No QoS	Soft-state QoS	Hard-state QoS
Stateless Routing	S/W IP router **H/W IP router**	S/W QoS IP router **H/W QoS IP router**	
Soft-state Switching	**IP/MPLS switch** S/W IP switch	**QoS IP/MPLS switch** QoS S/W IP switch	
Hard-state Switching	MPOA switch		MPOA switch

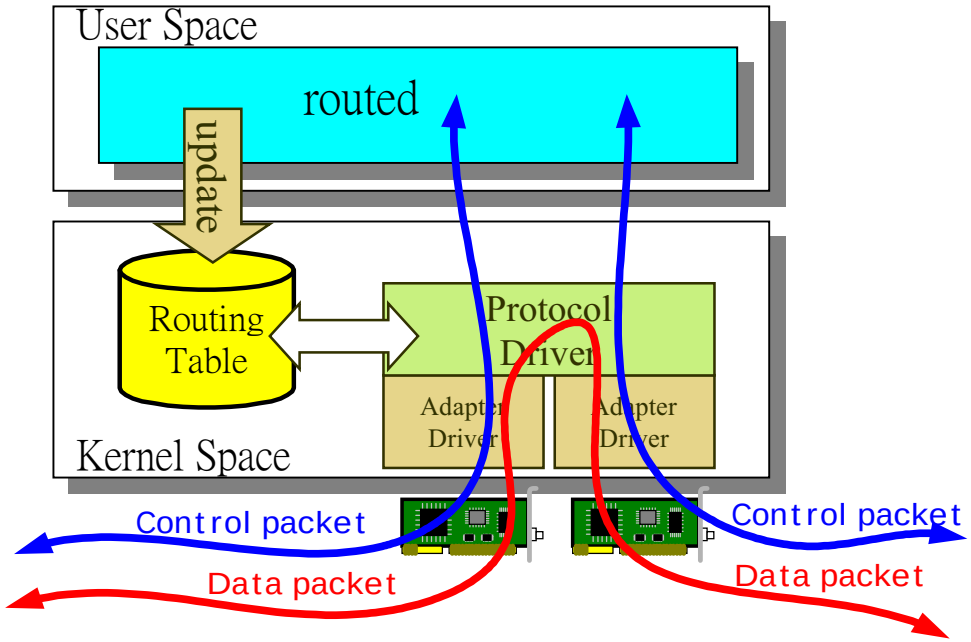
- **H/W : Hardware-driven**
- **S/W : Software-driven**

Stateless Software-driven Routing

- **Ex: Traditional IP router**

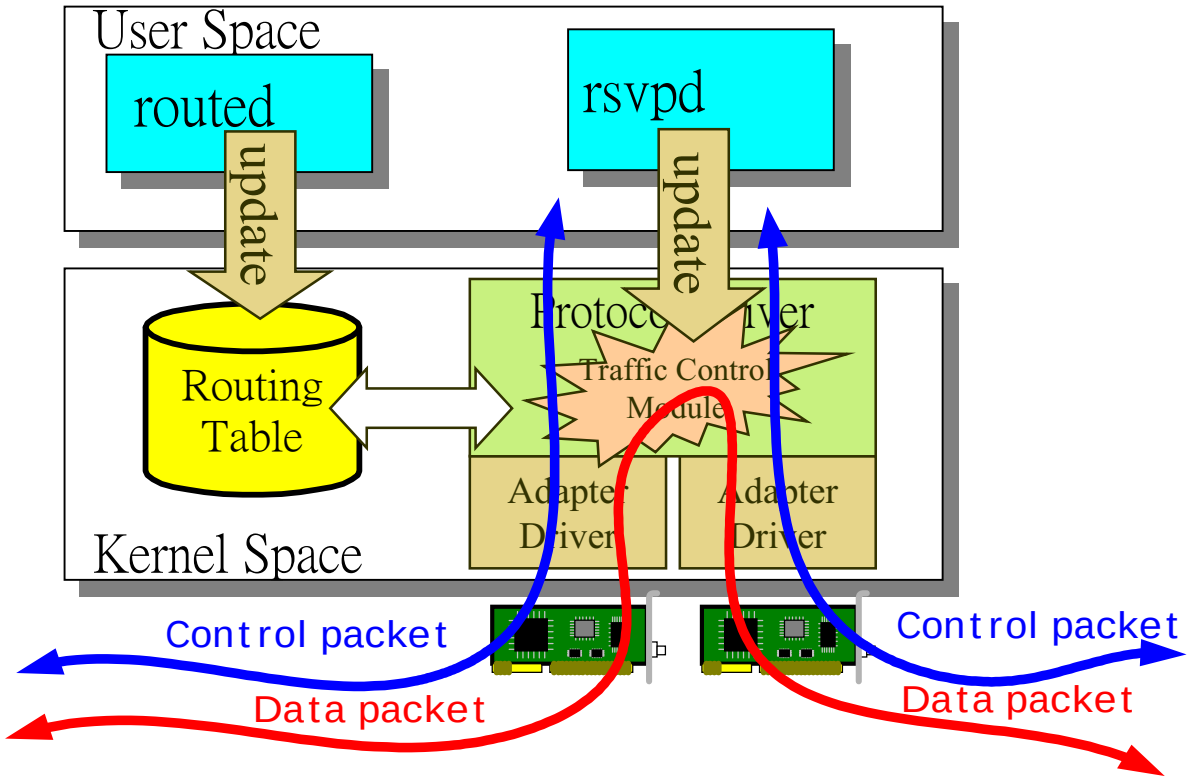


- **Ex: Linux with *routed* daemon**



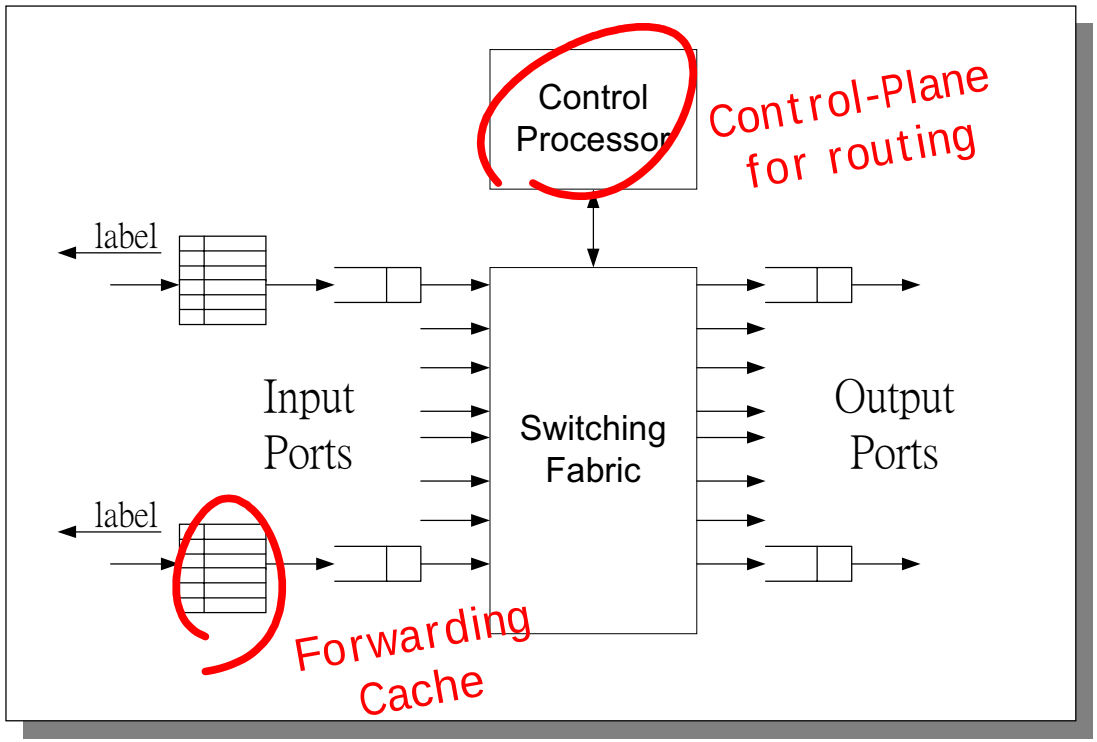
Stateless S/W Routing + Soft-state QoS

- Ex: Linux with *rsvpd* & *routed* daemons

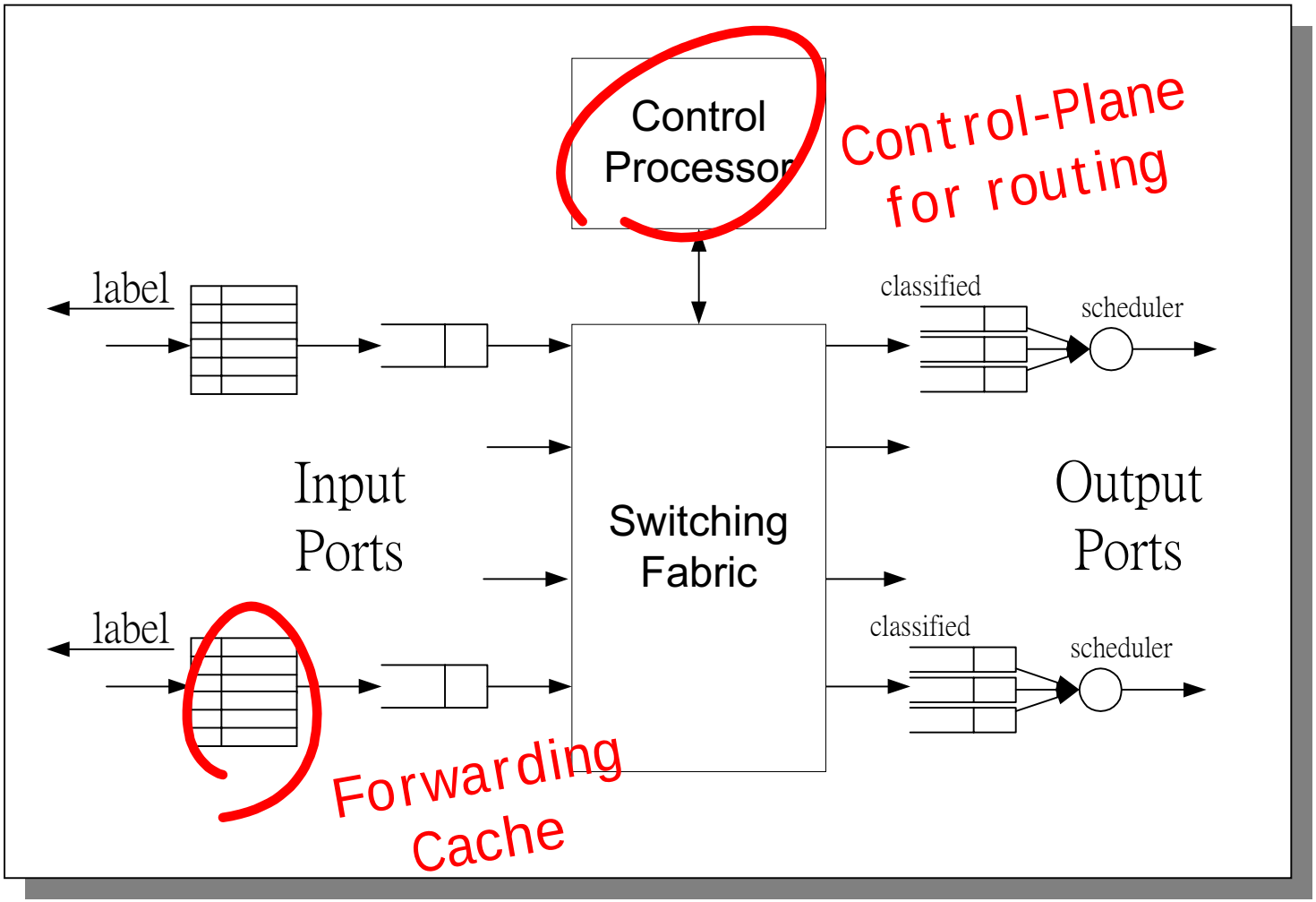


Soft-state H/W Switching

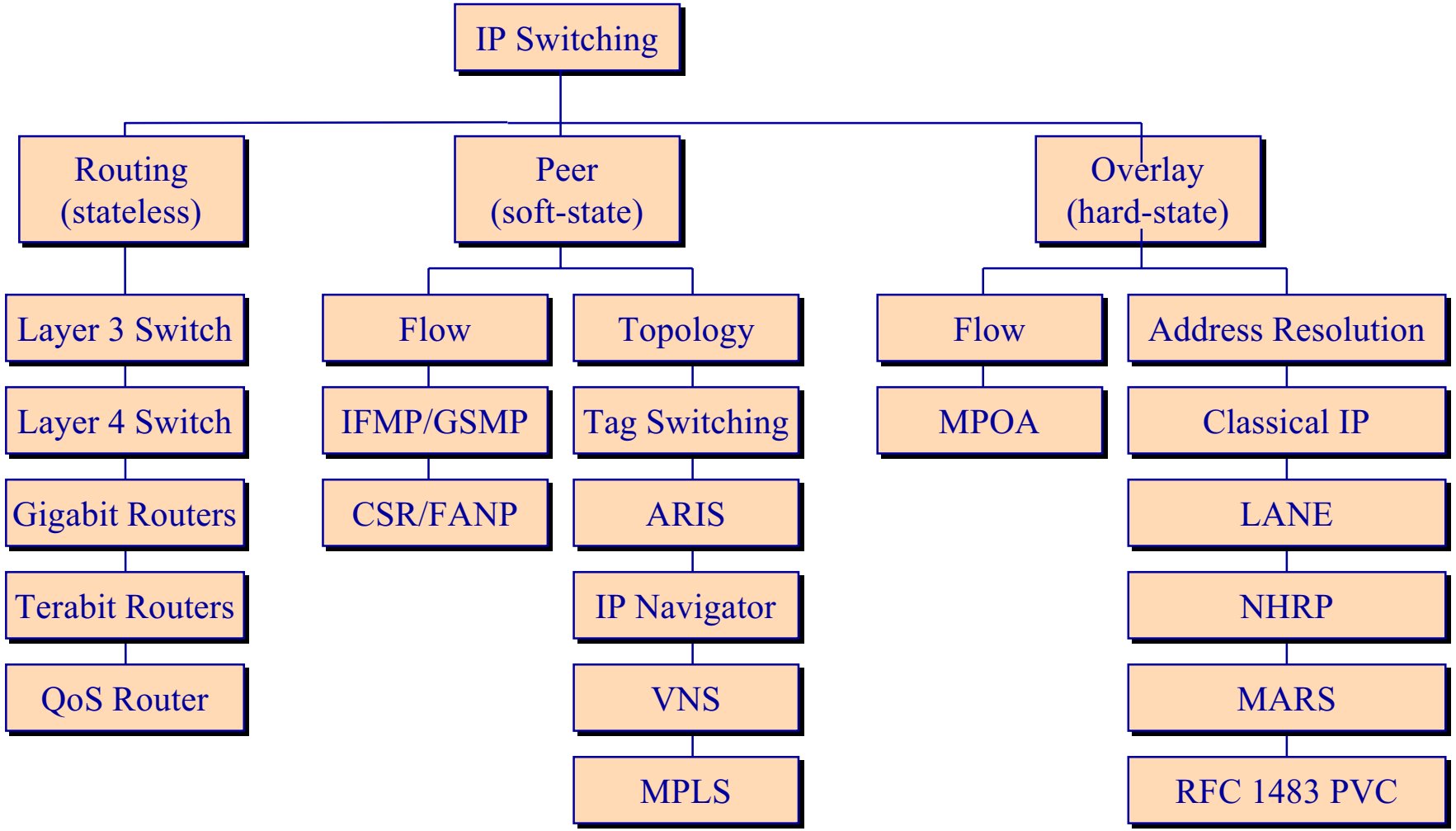
- **Properties:**
  - **Distributed** - Per-port ASIC table lookup
  - **Parallelism** - Switching Fabric



Soft-state H/W switching + Soft-state QoS

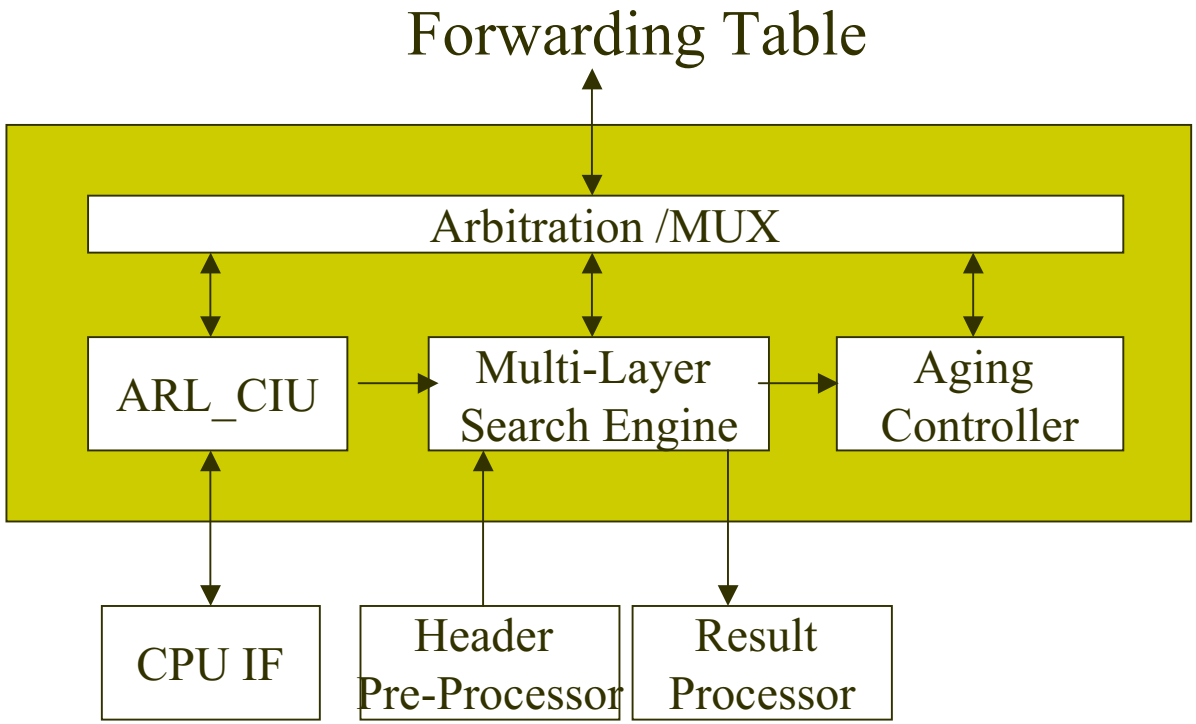


Layer 3 Switching Devices



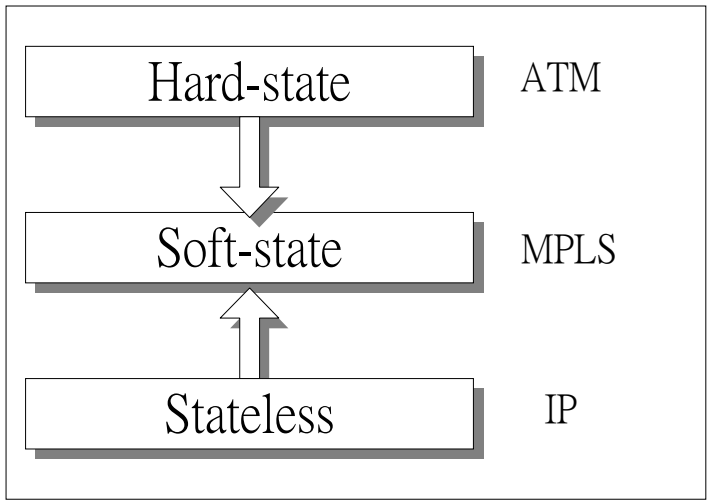
Layer-3 Switch Router

- Stateless Hardware-driven IP Router
- ASIC technology



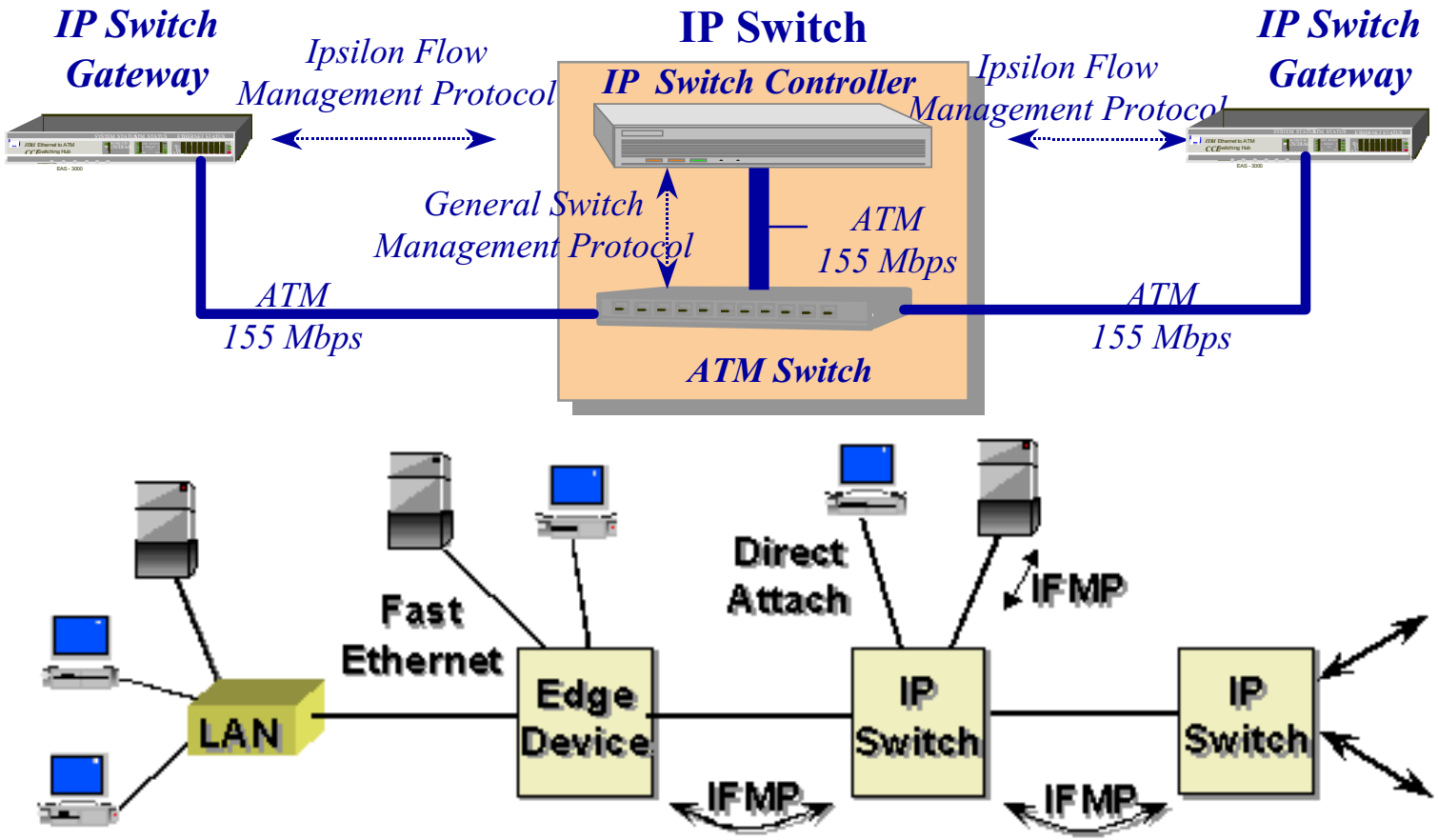
MPLS Switch

- **Soft-State Switch Router**

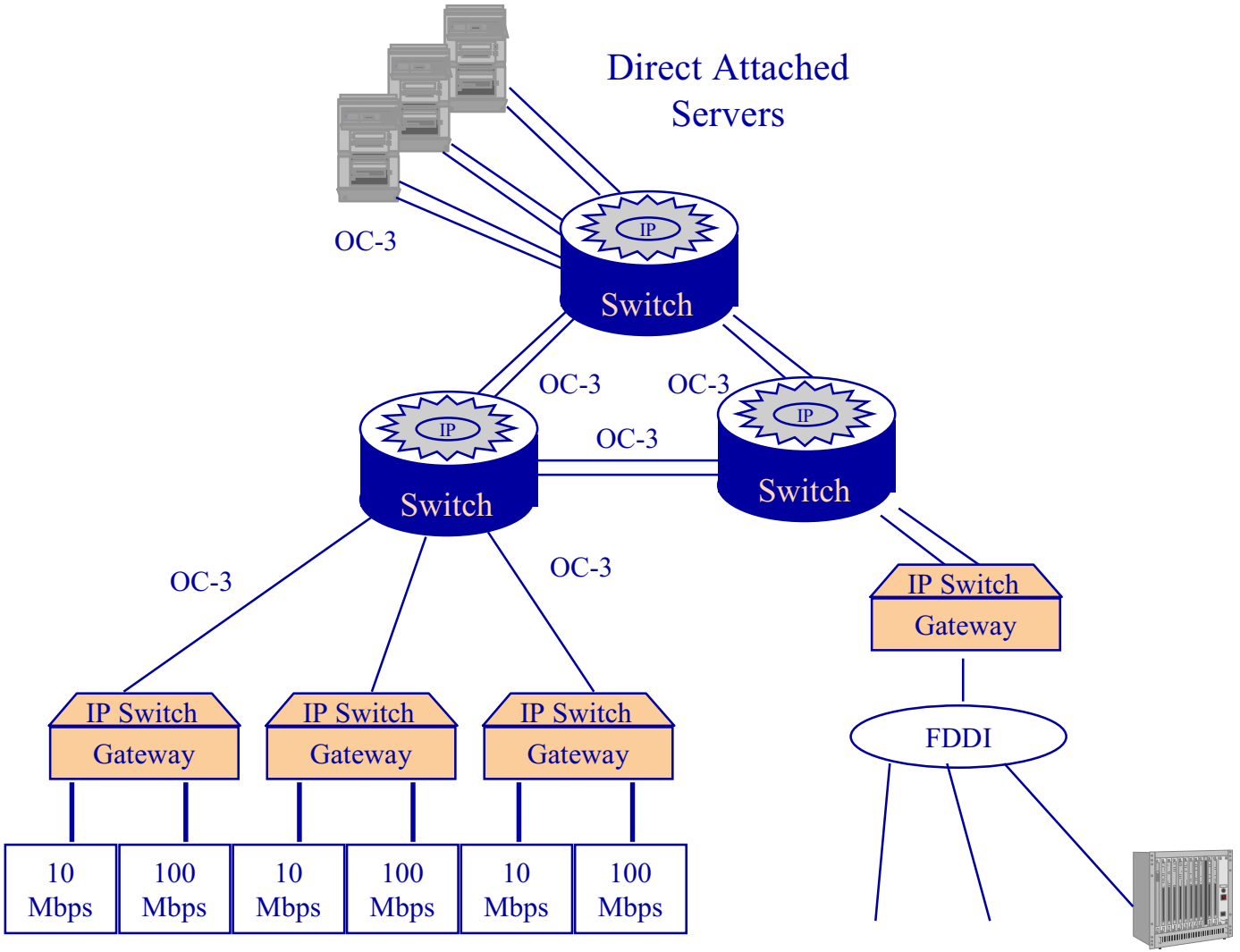


- **Route once, switch many !**
  - Ipsilon's IP switch (flow-based)
  - Cisco's Tag switch (topology-based)
  - MPLS (flexible label granularity)

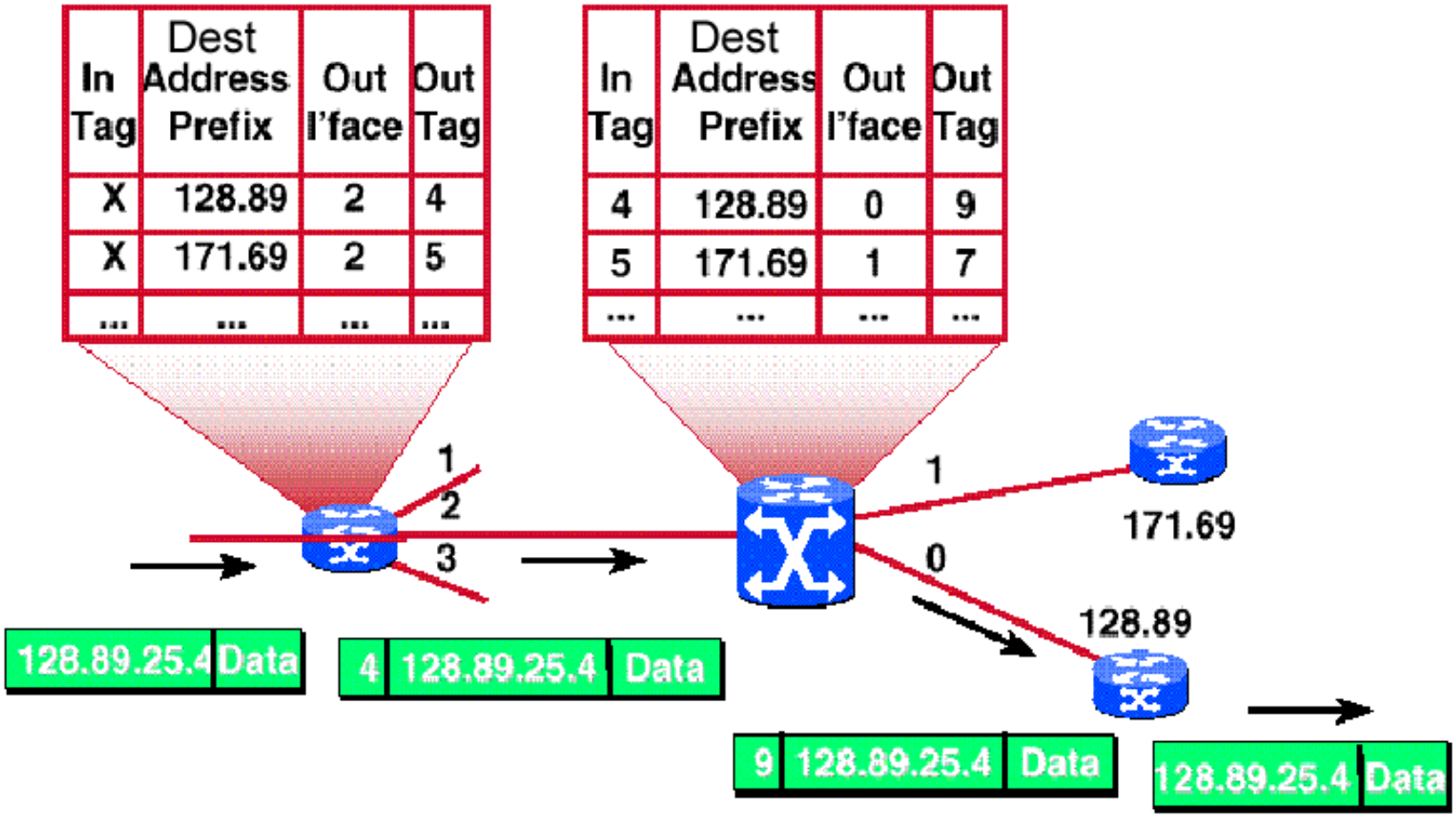
Ipsilon's IP switch (flow-based)



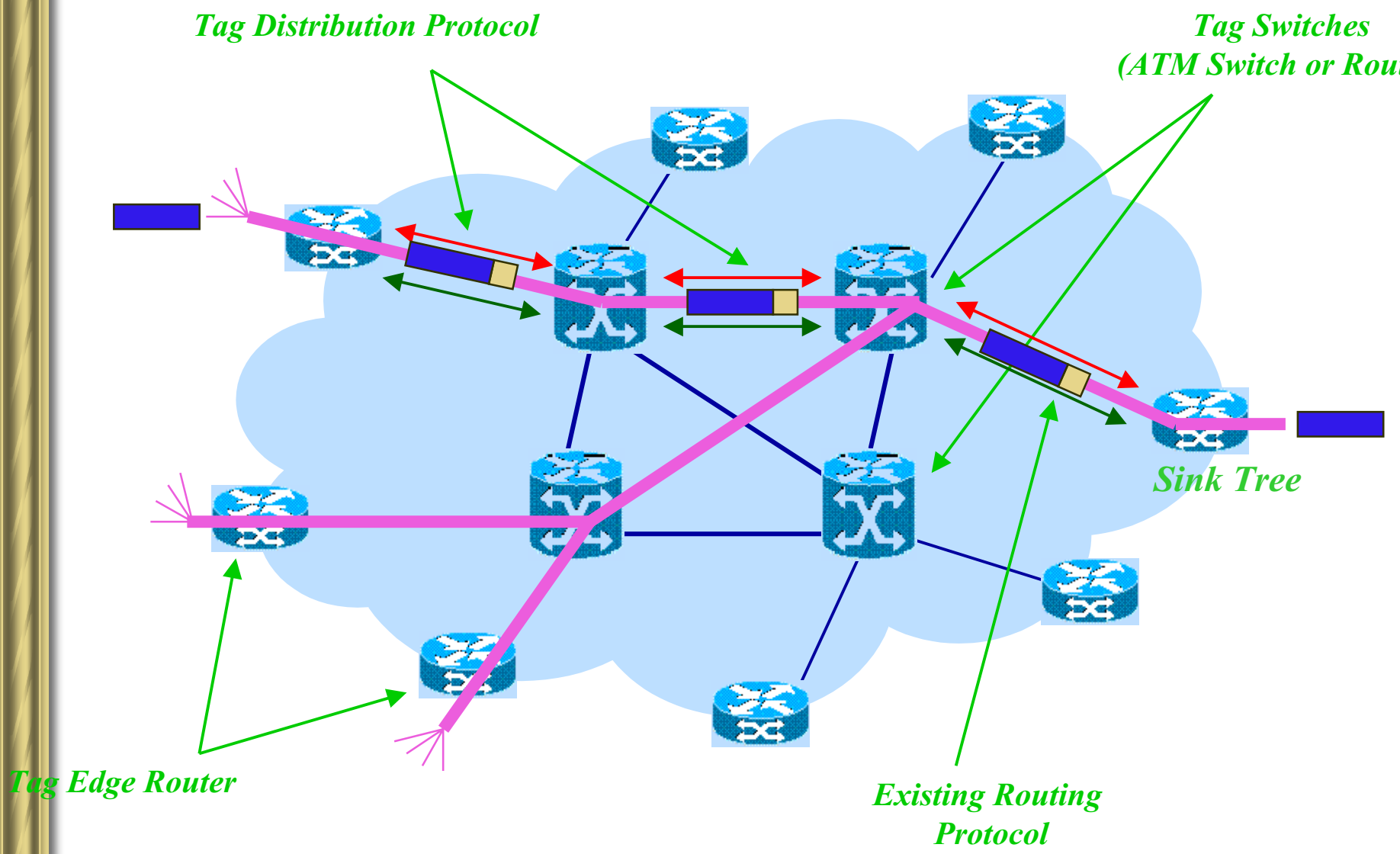
IP Switch - a big picture



Cisco's Tag Switch (topology-based)



Tag Switch - a big picture

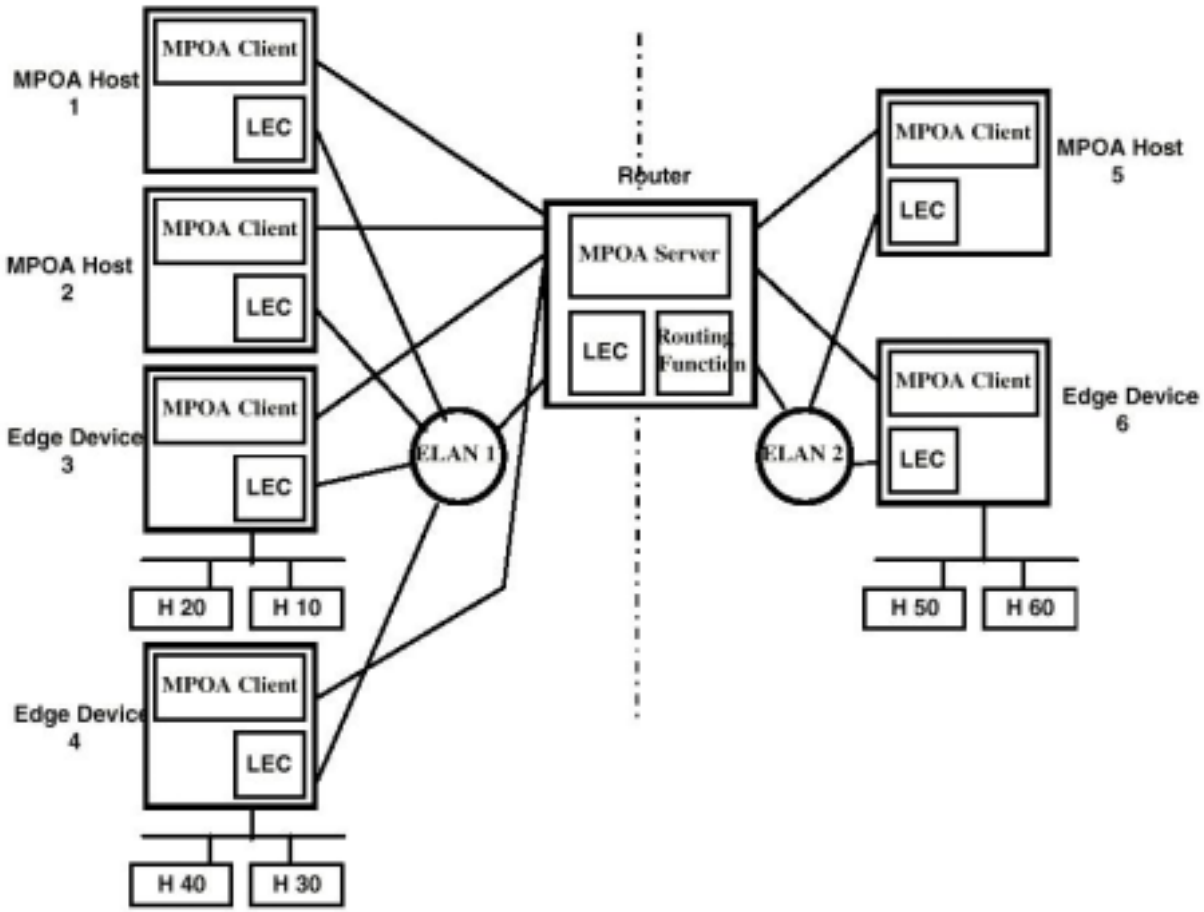


MPLS - Multi-Protocol Label Switching

- Integrates L3 routing with L2 label swapping
- Much the same as Tag Switch
  - Control Protocol distributes route-to-label mappings
  - classify, label and forward at ingress
  - label swap over L2 path to egress
  - remove label and forward at the egress
- With….
  - Flexible granularity
  - Traffic engineering capabilities
    - VPN, explicit route

MPOA switch

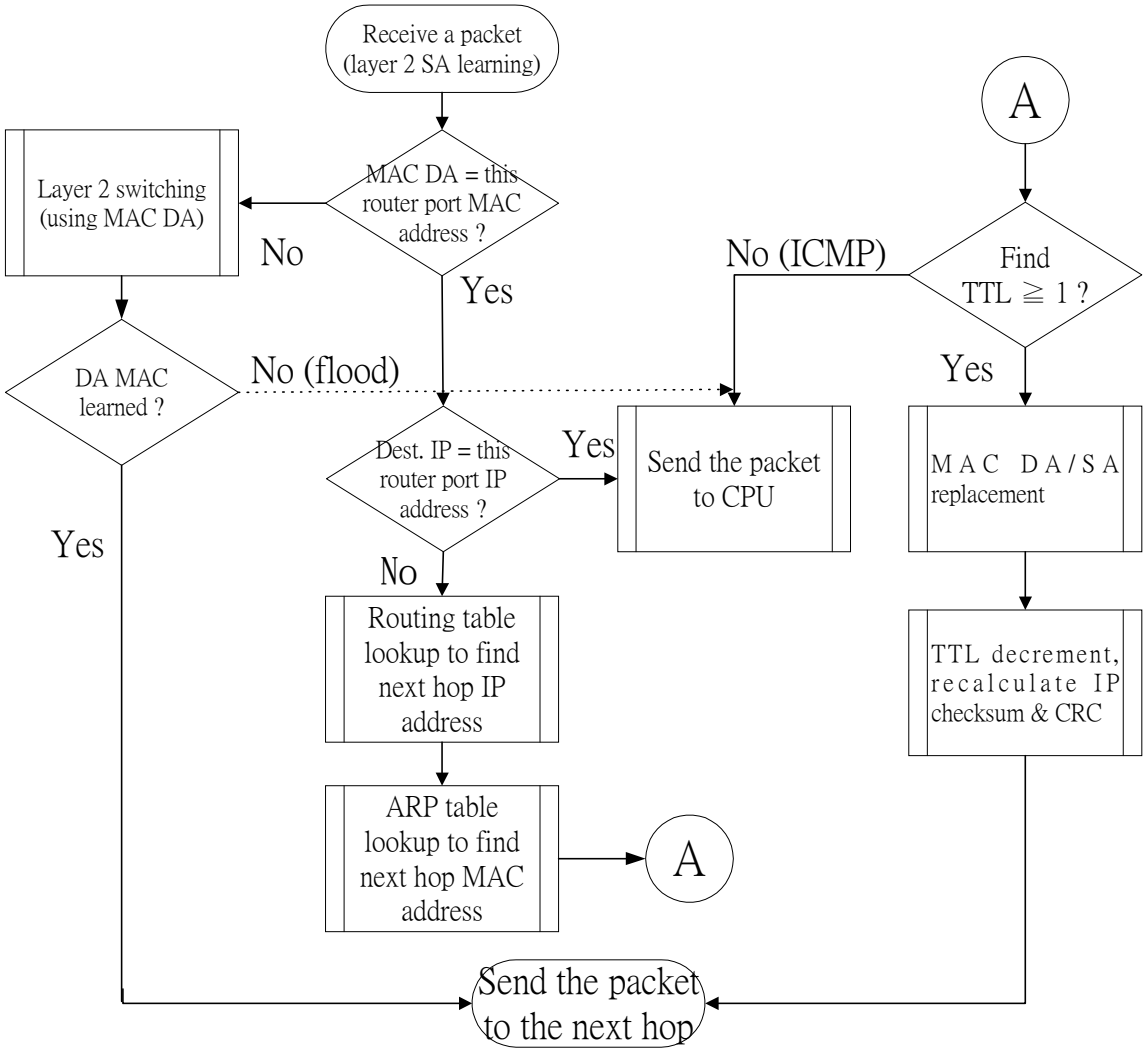
- Hard-state Switch



Inside the Boxes

- When to switch ? When to route ?
- Routing table
- Fast longest prefix match for H/W IP router
- Label Distribution

When to route ? When to switch?



A Typical IP Routing Table

- **Typical entry in the routing table**

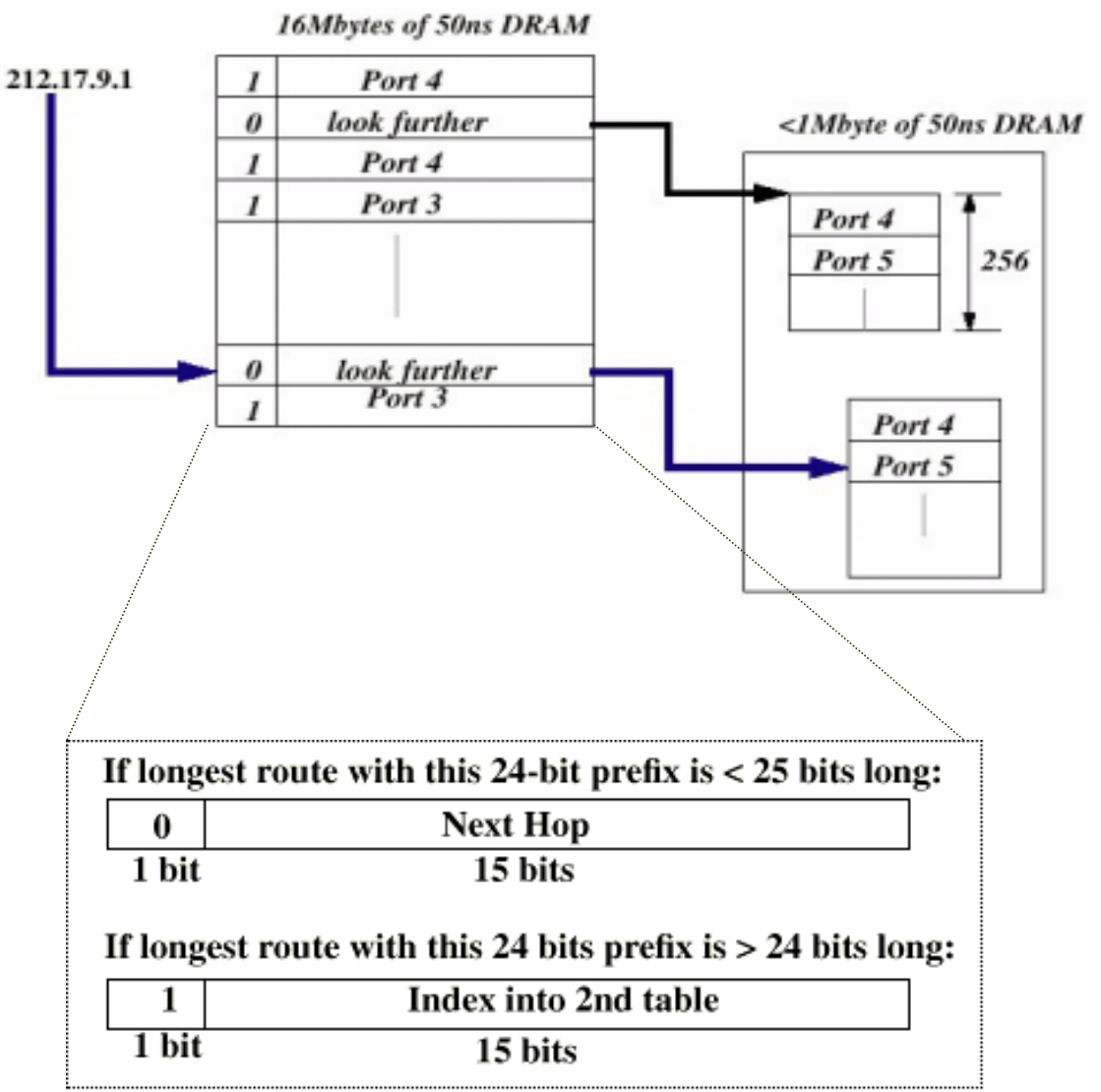
0 31

Network Address for This Route	
Subnet Mask for This Route	
IP Address of the Next Hop	
Distance Metric	Interface Port ID
Sort Key	Time to Live

- **ARP table entry**

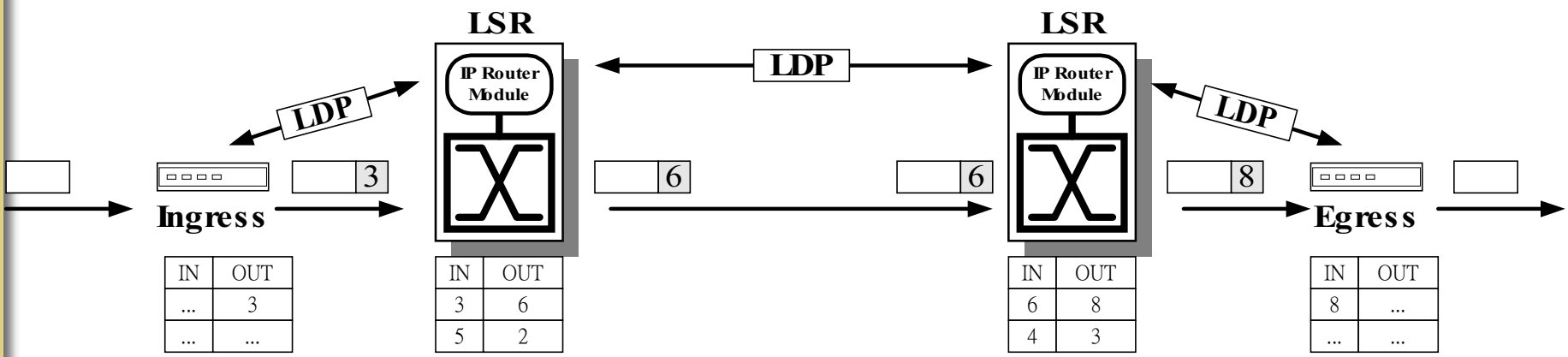
IP Address of the Next Hop or Local Host	
MAC Address [47:16]	
MAC Address [15:0]	Time to Live

Fast Longest Prefix Match for H/W IP router



Label Distribution

- control protocol distributes route-to-label mappings
- classify, label and forward at ingress
- label swap over L2 path to egress
- remove label and forward at the egress



- LDP : Label Distribution Protocol
- LSR : Label Switch Router