Juniper® NETWORKS

Wire Speed. Why wait?

MPLS TUTORIAL
GTER-12
30/maio/2001

Roosevelt Ferreira

Consultant

roosevelt@juniper.net

The MPLS Advantage

Agenda

- MPLS Fundamentals
- Traffic Engineering
- Constraint-Based Routing
- Virtual Private Networks
- Optical Applications for MPLS Signaling (GMPLS/MPλS)
- Questions and Comments

The MPLS Advantage

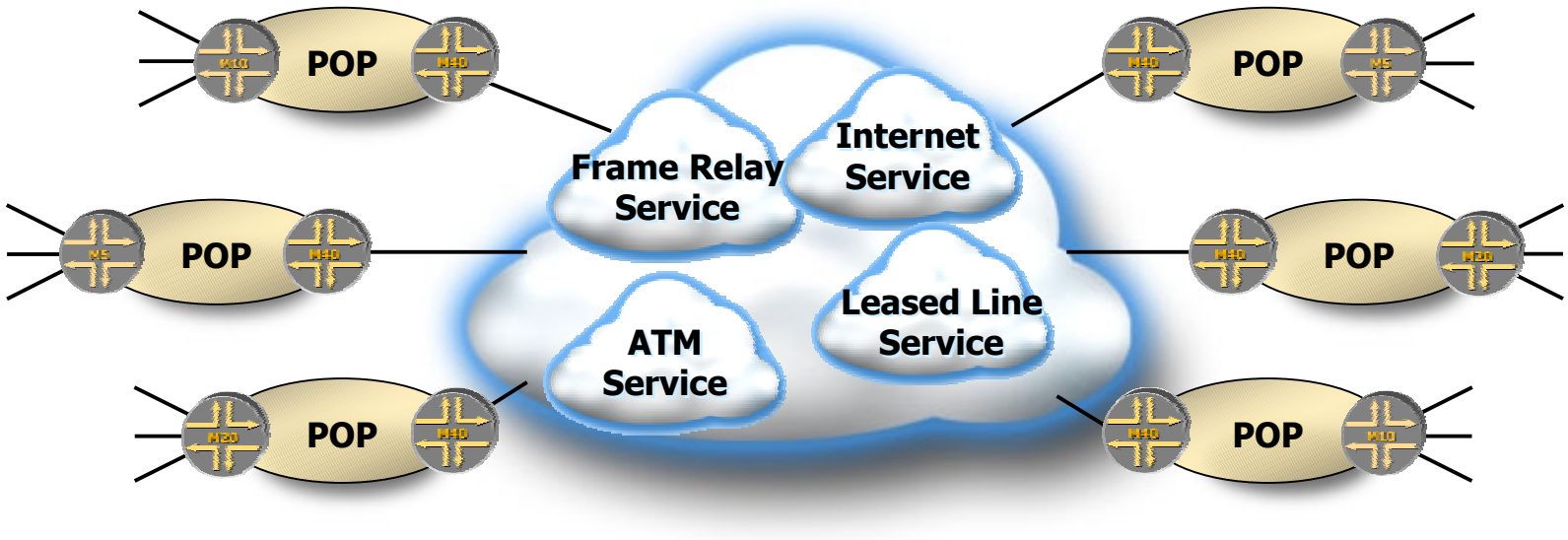
Part I:
MPLS Fundamentals

Agenda: MPLS Fundamentals

- The New Public Network
- MPLS terminology
- MPLS packet forwarding
- LSP path determination
- MPLS signaling protocols
- MPLS routing hierarchy

The New Public Network

What's Happening in New Public Network?



- Rapid growth and migration to IP-based services
- Ubiquitous access to both public & private services
- Internet is the new mass media
- Hot issues - traffic engineering, optical switching, & VPNs
  - But there is always another hot new service
- Provider offerings are currently disjoint

MPLS Primer

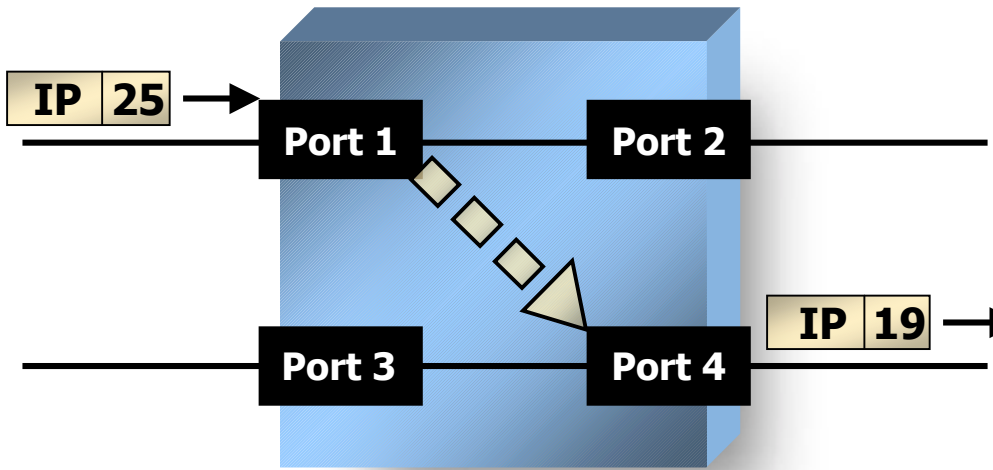
What Is MPLS?

- IETF Working Group chartered in spring 1997
- IETF solution to support multilayer switching:
  - IP Switching (Ipsilon/Nokia)
  - Tag Switching (Cisco)
  - IP Navigator (Cascade/Ascend/Lucent)
  - ARIS (IBM)
- Objectives
  - Enhance performance and scalability of IP routing
  - Facilitate explicit routing and traffic engineering
  - Separate control (routing) from the forwarding mechanism so each can be modified independently
  - Develop a single forwarding algorithm to support a wide range of routing and switching functionality

MPLS Terminology

- **Label**
  - **Short, fixed-length packet identifier**
  - **Unstructured**
  - **Link local significance**
- **Forwarding Equivalence Class (FEC)**
  - **Stream/flow of IP packets:**
    - **Forwarded over the same path**
    - **Treated in the same manner**
    - **Mapped to the same label**

MPLS Terminology

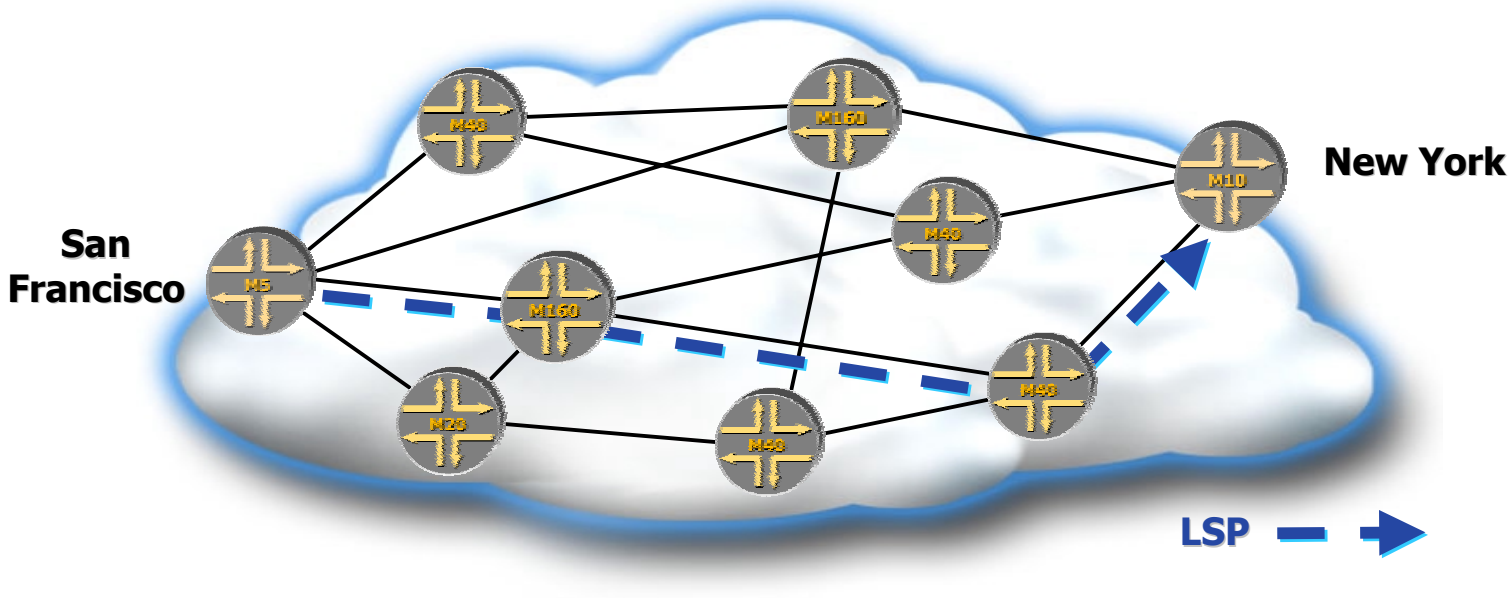


Connection Table

In (port, label)	Out (port, label)	Label Operation
(1, 22)	(2, 17)	Swap
(1, 24)	(3, 17)	Swap
(1, 25)	(4, 19)	Swap
(2, 23)	(3, 12)	Swap

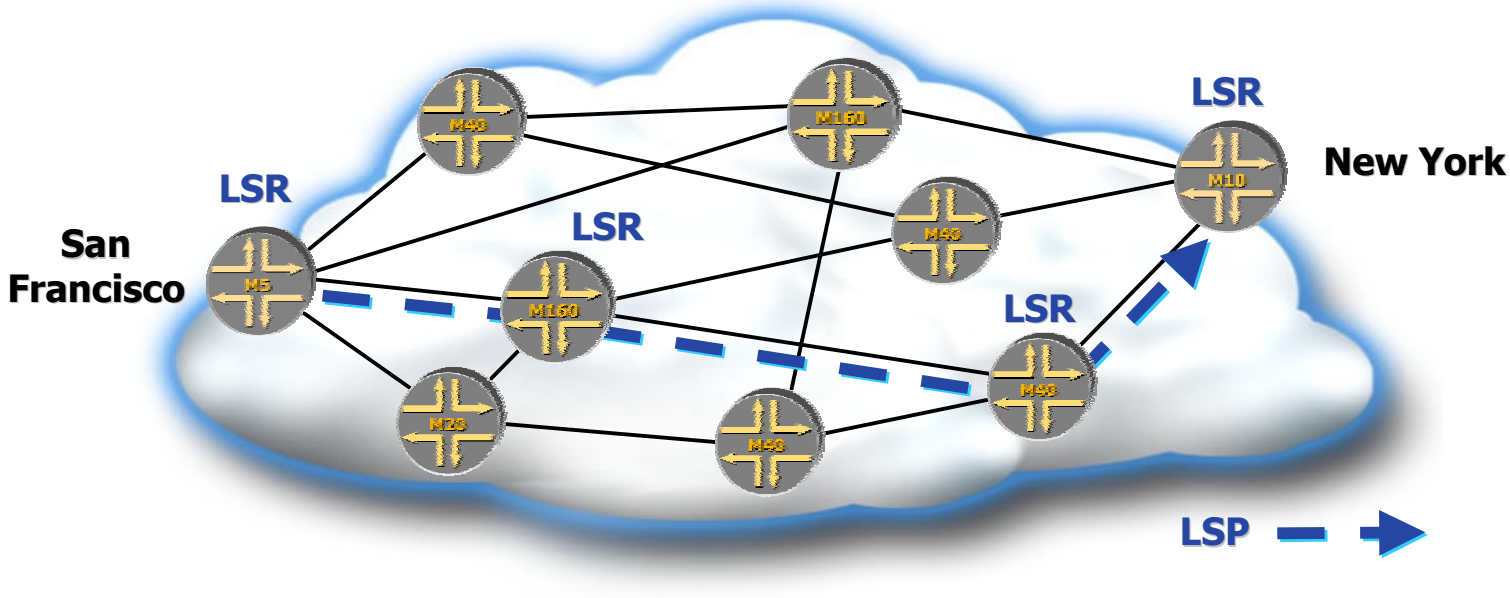
- **Label Swapping**
  - **Connection table maintains mappings**
  - **Exact match lookup**
  - **Input (port, label) determines:**
    - **Label operation**
    - **Output (port, label)**
  - **Same forwarding algorithm used in Frame Relay and ATM**

MPLS Terminology



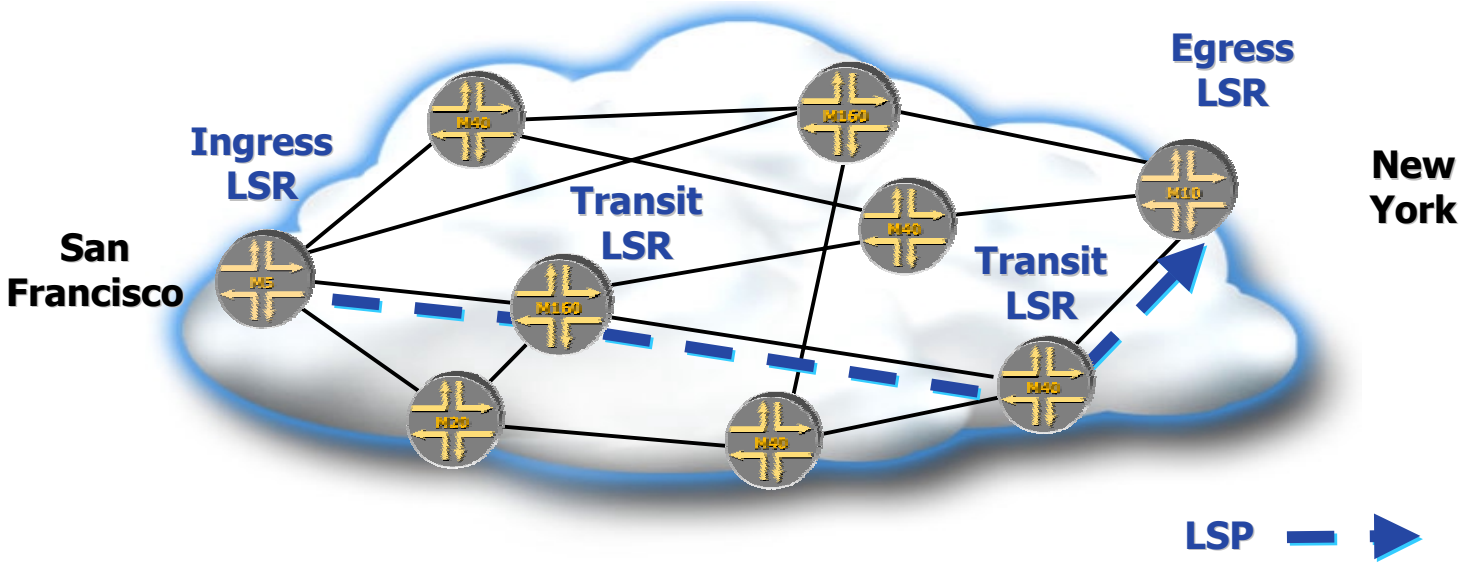
- **Label switched path (LSP)**
  - **Simplex L2 tunnel across a network**
  - **Concatenation of one or more label switched hops**
  - **Analogous to an ATM or Frame Relay PVC**

MPLS Terminology



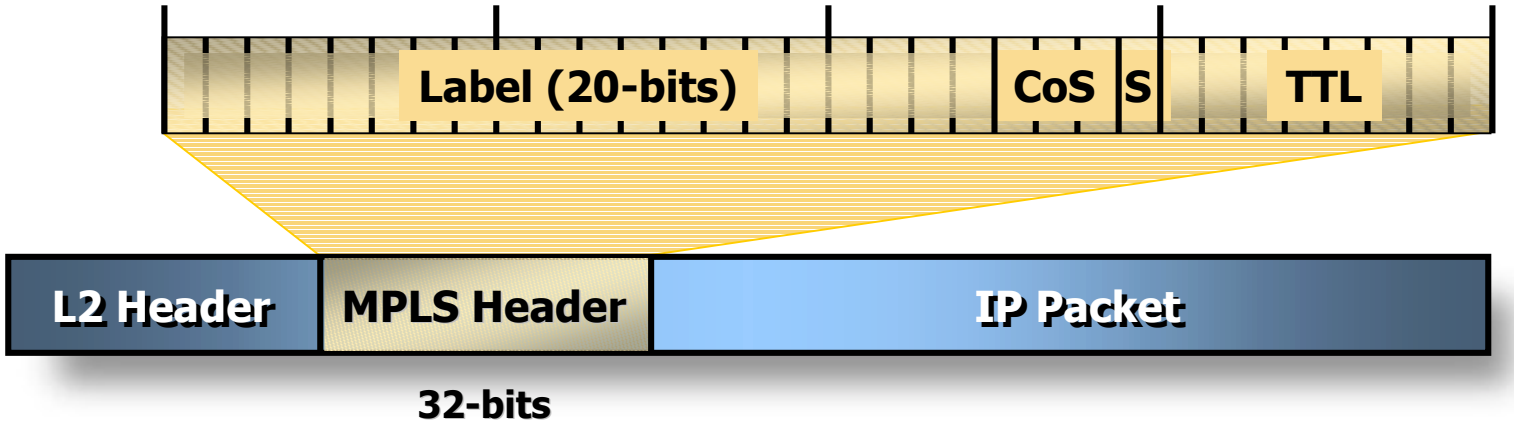
- **Label-Switching Router (LSR)**
  - **Forwards MPLS packets using label-switching**
  - **Capable of forwarding native IP packets**
  - **Executes one or more IP routing protocols**
  - **Participates in MPLS control protocols**

MPLS Terminology



- Ingress LSR ("head-end LSR")
  - Examines inbound IP packets and assigns them to an FEC
  - Generates MPLS header and assigns initial label
- Transit LSR
  - Forwards MPLS packets using label swapping
- Egress LSR ("tail-end LSR")
  - Removes the MPLS header

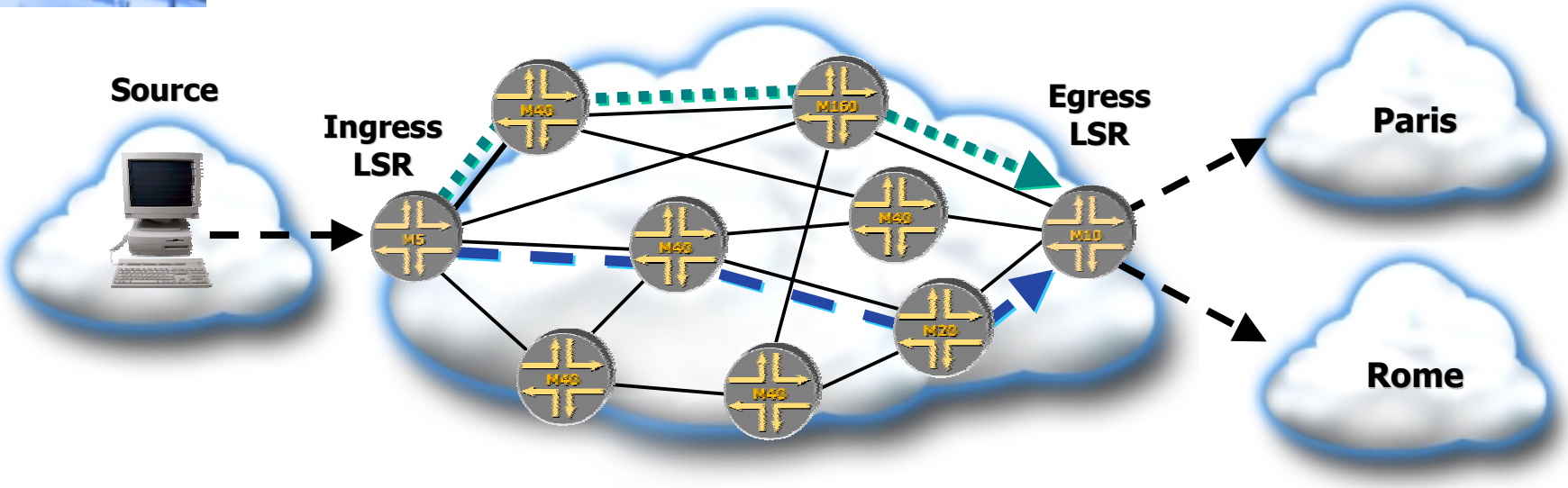
MPLS Header



- Fields
  - Label
  - Experimental (CoS)
  - Stacking bit
  - Time to live
- IP packet is encapsulated by ingress LSR
- IP packet is de-encapsulated by egress LSR

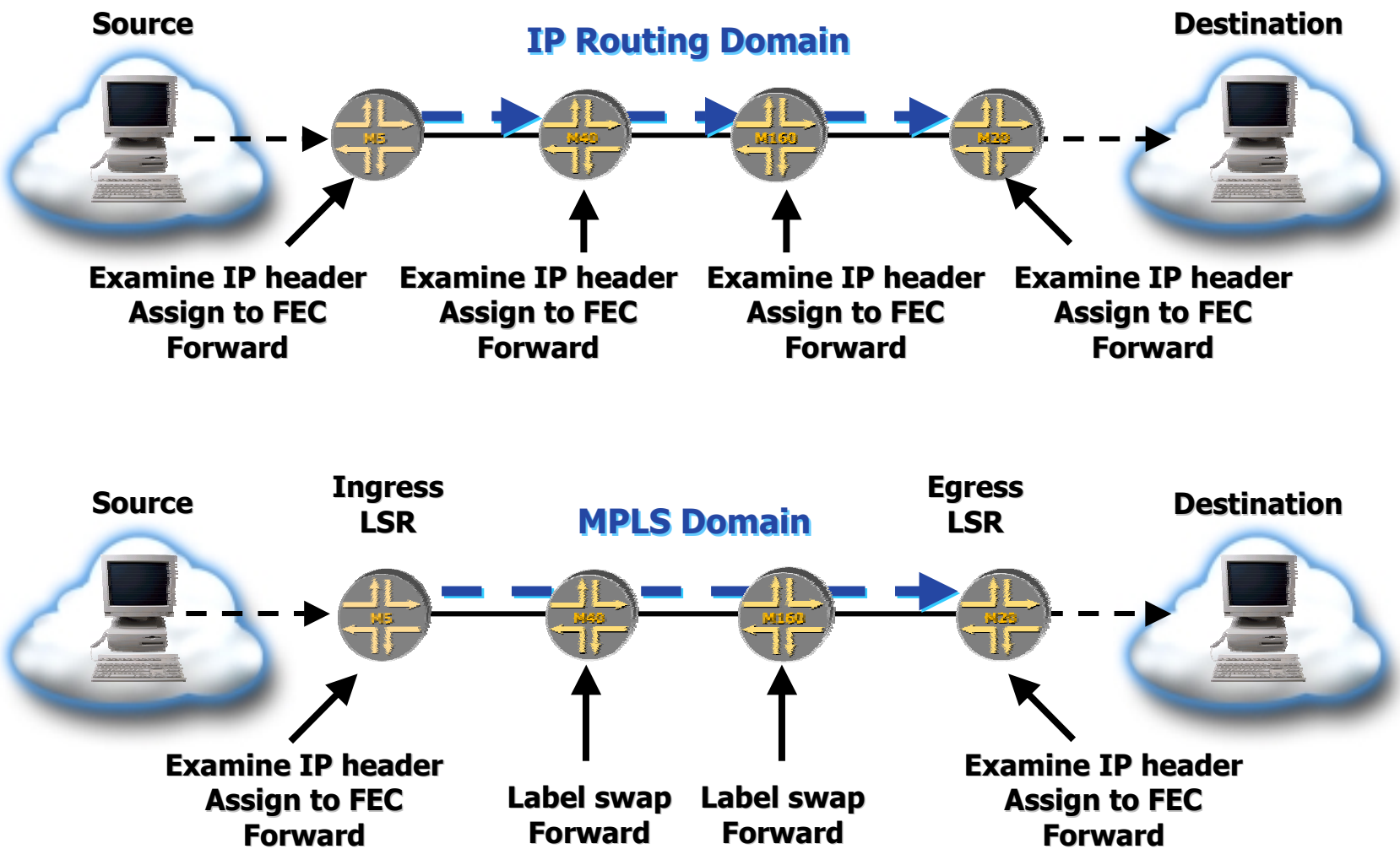
MPLS Packet Forwarding

MPLS Forwarding Model

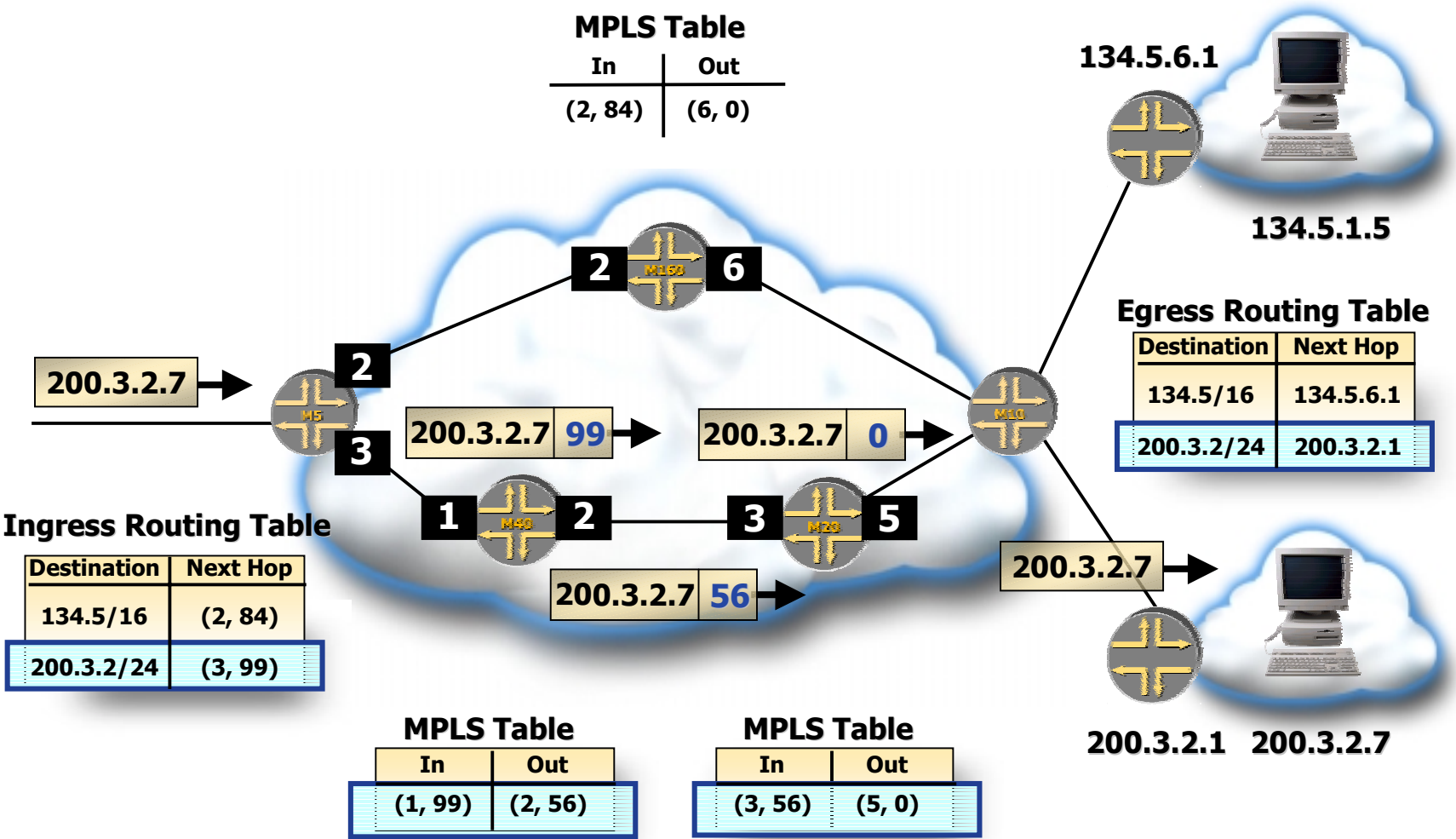


- Ingress LSR determines FEC and assigns a label
  - Forwards Paris traffic on the Green LSP
  - Forwards Rome traffic on the Blue LSP
- Traffic is label swapped at each transit LSR
- Egress LSR
  - Removes MPLS header
  - Forwards packet based on destination address

MPLS Forwarding vs. IP Routing



MPLS Forwarding Example



But There's Much More …

… to MPLS than simple packet forwarding!

- How is the physical path for each LSP determined?
- How is an LSP established?
  - Label distribution and coordination
  - Bandwidth reservation
- How does the ingress LSR map traffic to an LSP?
- Does MPLS support a routing hierarchy?
- Can the LSP physical path calculation be performed online?