MPLS and Internet Traffic Engineering

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Outline

- Introduction
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- LDP
- Traffic Engineering
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  - OMP
  - Metric Manipulation
  - Constraint-based Routing
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    - Traffic Engineering Extensions
    - Multi-area Traffic Engineering
    - RSVP-TE and CR-LDP

Introduction

- Many proprietary solutions for the fast IP traffic delivery were emerged in 1996
  - IP switching (Ipsilon)
  - Tag Switching (Cisco)
  - Cell Switching Router (Toshiba)
  - Aggregate Route-based IP Switching (IBM)
- These solutions are all based on the concept of switching
- The IETF created the MPLS working group in order to have a standard for the switching technology

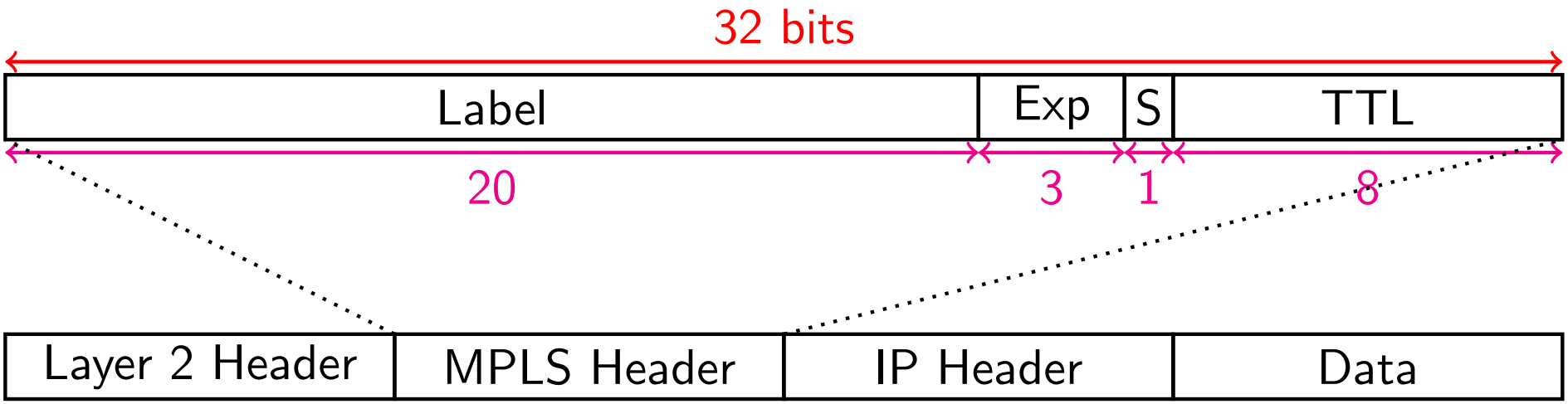
MPLS

- It stands for MultiProtocol Label Switching
- It is working between Layer 2 and Layer 3
- It is a Layer 2.5 networking protocol
- Traditional IP Forwarding
  - Each router performs an IP lookup, determines a next-hop based on its routing table, and forwards the packet to that next-hop.
  - The process is repeated by each router onn the path, each making its own independent routing decisions, until the final destination is reached.
- MPLS replaces IP Forwarding by Label Switching

Label Switching

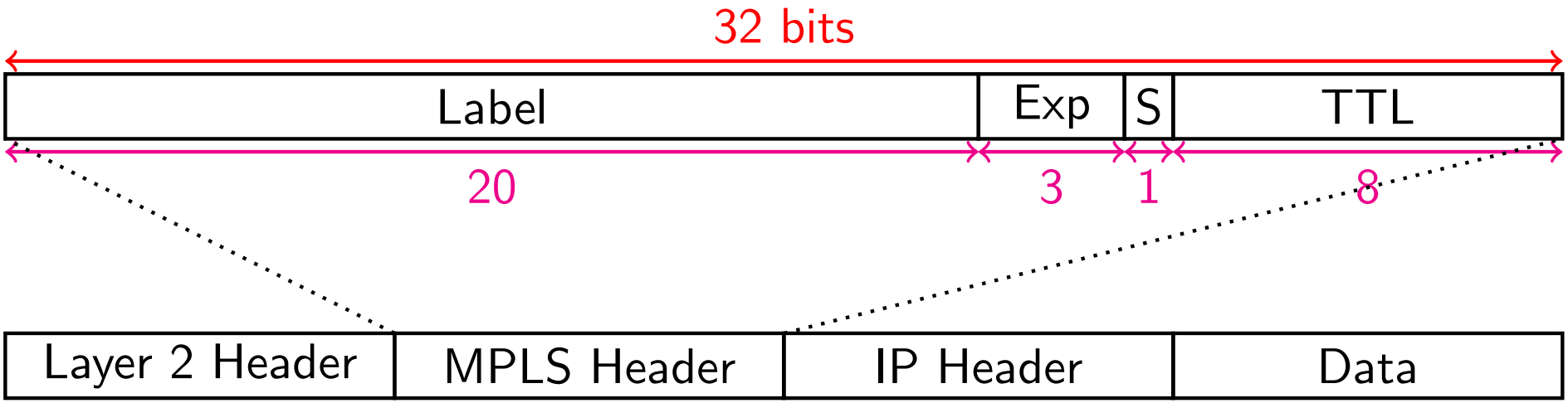
- The first router does a routing lookup, just like before
  - But instead of finding a next-hop, it finds the (FEC) forwarding equivalence class of the packet
  - The router applies a label to the packet in a shim header based on this information
  - Future routers use this label to switch the packet without needing to perform any additional IP lookups
  - When the packet leaves the switching domain, the label is removed
  - And the packet is delivered via normal IP Forwarding

MPLS Shim Header



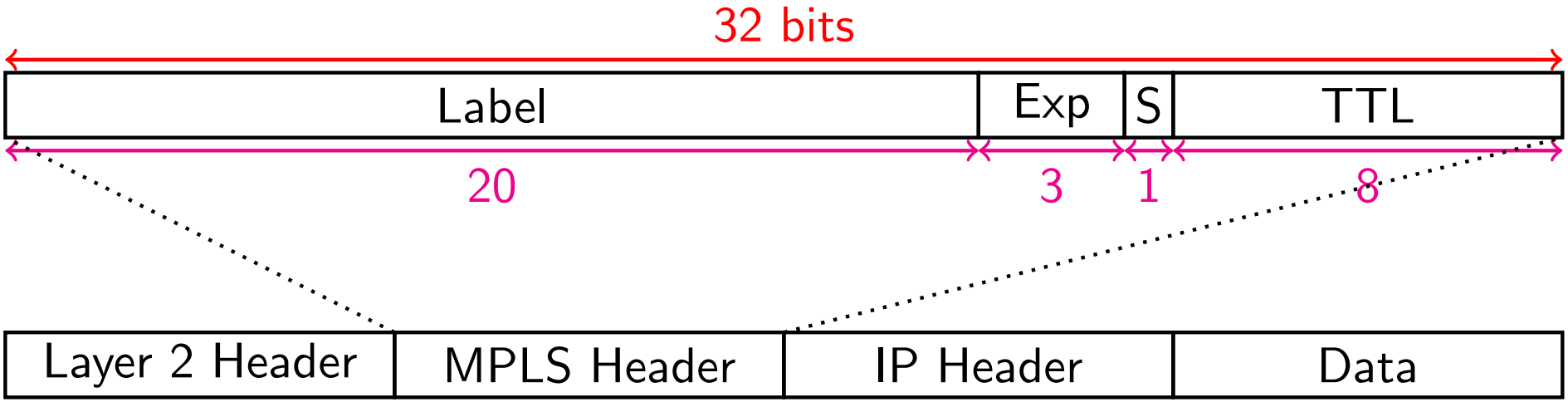
- Label
  - 20 bits
  - Fixed length Identidier
  - Value locally significant to a particular link
  - Assigned manually by the network administrator or automatically using a signaling protocol
  - Used as an index to the swicthing table

MPLS Shim Header



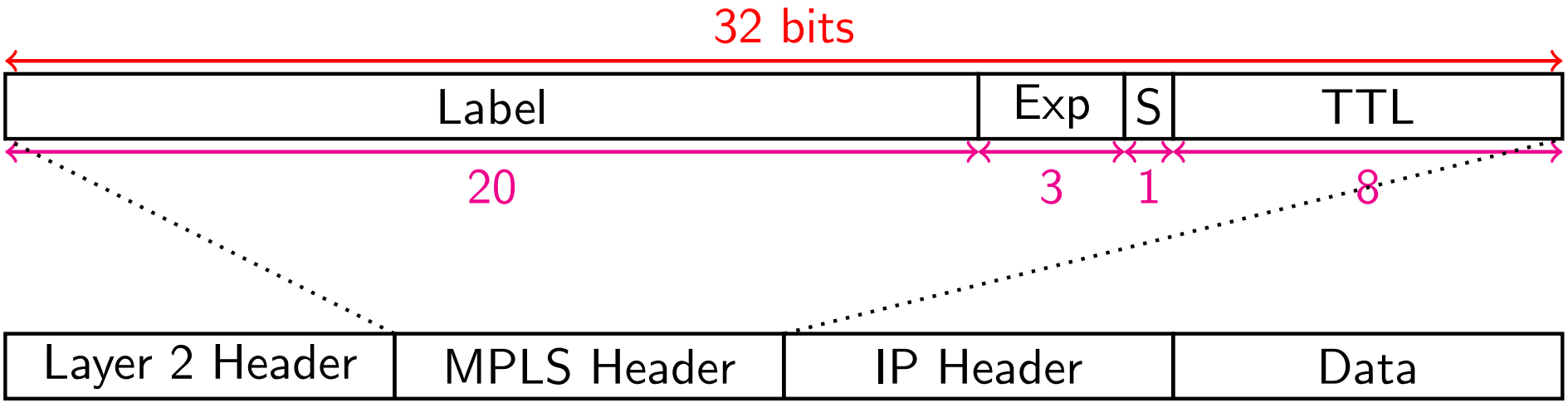
- Exp
  - 3 bits
  - Experimental use
  - May be used as a Class Of Service for DiffServ

MPLS Shim Header



- S
  - 1 bit
  - Stack
  - It indicates the end of the stack
  - The MPLS shim header may contain multiple entries
  - This bit is set to one for the last entry in the label stack

MPLS Shim Header



- TTL
  - 8 bits
  - Time To Live

Terminology

- LSP
  - Label Switched Path
  -
- LSR
  - Label Switch Router
  - MPLS capable router
- FEC
  - Forwarding Equivalence Class
  - A class of packets receiving the same forwarding service
  - Usually IP Prefix
- Ingress LSR
  - Located at the entrance of an MPLS domain
- Egress LSR
  - Located at the exit of an MPLS domain

Label Distribution Protocol

- Label Distribution Mode
  - Downstream on Demand
  - Downstream Unsolicited
- Label Distribution Control Mode
  - Independant
    - Each LSR may advertise label mappings to its neighbors at any time it desires
  - Ordered
    - Each LSR may advertise label mappings to its neighbors only if has received a mapping for the FEC from a downstream LSR or it is the egree LSR for that FEC
- Label Distribution Retention Mode
  - Conservative
    - Advertised label mappings are retained only if they will be used to forward packets
  - Liberal
    - Advertised label mappings are always retained

LDP Messages

- Hello Messages
  - For neighbor discovery
- Notification Message
  - For error notification
- Initialization Message
  - For LDP session establishment
- KeepAlive Message
  - To maintain an LDP session
- Address Message
  - To advertize LSR interface address to an LDP peer
- Address Withdraw Message
  - To withdraw previously advitized interface address

LDP Messages

- Label Mapping Message
  - To advertize a mapping between a FEC and a Label
- Label Request Message
  - To request a mapping between a FEC and a Label
- Label Abort Request Message
  - To abort a request of a mapping between a FEC and a Label
- Label Withdraw Message
  - To withdraw a previously advertized mapping between a FEC and a Label
- Label Release Message
  - To withdraw a previously requested or recieved mapping between a FEC and a Label

Traffic Engineering

- Traffic Engineering is the application of technology and scientific principles to the:
  - measurement,
  - characterization,
  - modeling,
  - and control of Internet traffic

Traffic Engineering Methods

- Overprovisioning
- TE based on Routing Protocols
  - OSPF Equal Cost MuliPath ECMP
  - OSPF Optimized MultiPath OMP
  - OSPF Metric Manipulation
  - Quality of Service OSPF QOSPF
- MPLS Traffic Engineering
  - Constraint-based Routing (online, offline)
    - CSPF
    - OSPF Traffic Engineering Extensions
    - OSPF Multi-Area Traffic Engineering
    - Per-Area Path Computation
    - TE-Summary-LSA
    - Backbone Flooding TE-LSA
    - Dedicated TE Server
    - RSVPTE and CRLDP