Communication Networks II

BMEVITMA310 in English

Tibor Cinkler (**2.**) April 18, 2018

Wednesday 14:15 – 15:45 (I.E.219)

http://opti.tmit.bme.hu/~cinkler/TNS

MPLS (http://opalsoft.net/qos/MPLS.htm)

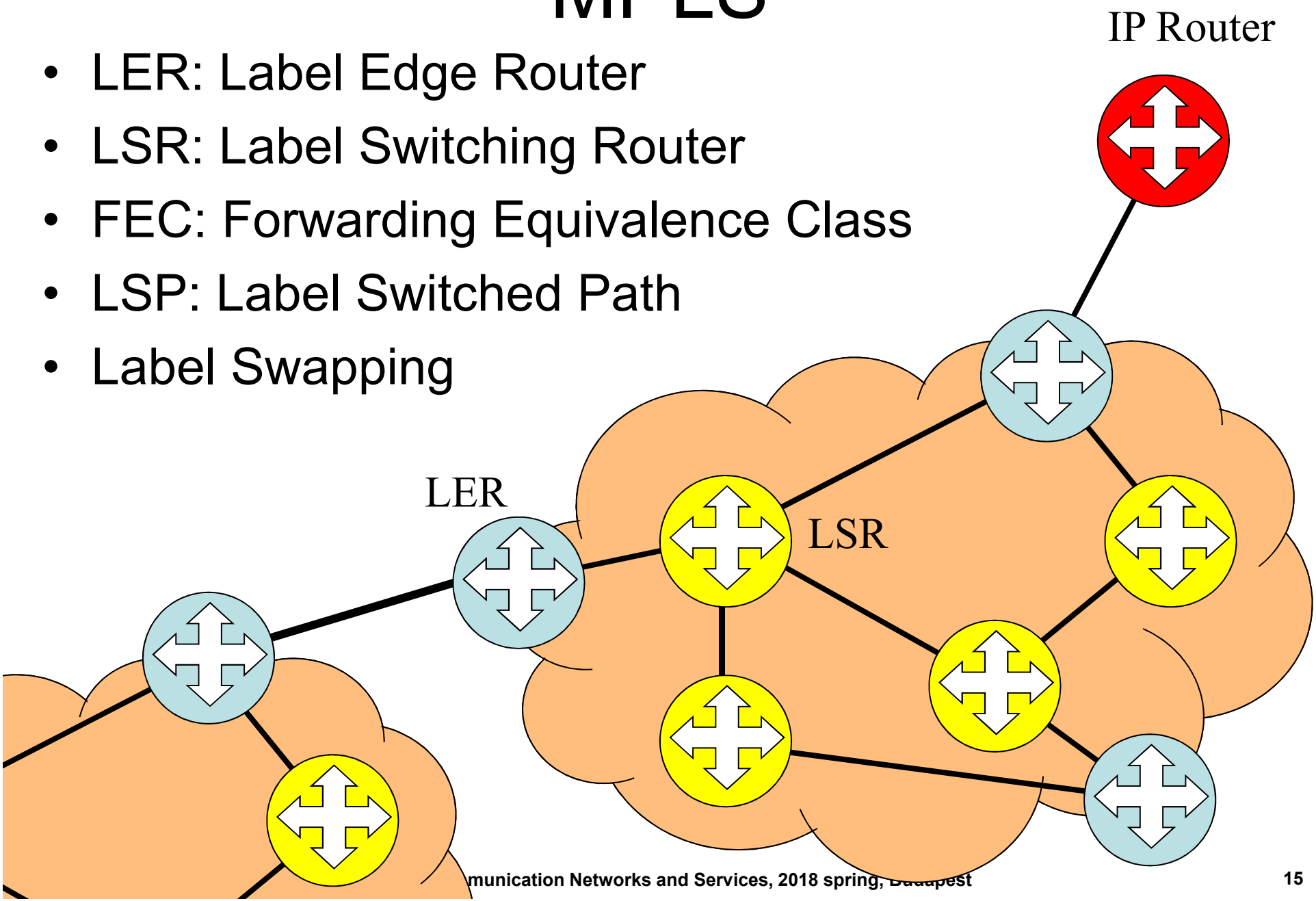
- http://www.cisco.com/c/en/us/about/press/internet-protocol-journal/back-issues/table-contents-10/mpls.html

MultiProtocol Label Switching:

- Unified IP/MPLS control
- Simpler than ATM
- Reduced label space rquirement via FEC (Forwarding Equivalence Class)
- Label Swapping and Stacking
- Not much new compared to ATM ☺
- Topology or Traffic driven
- Some QoS issues still open
- TE and VPN support (Traffic Engineering and Virtual Private Networks)
- IPoMPLS: Peer Model !
  - RSVP-TE
  - CR-LDP

MPLS

- LER: Label Edge Router
- LSR: Label Switching Router
- FEC: Forwarding Equivalence Class
- LSP: Label Switched Path
- Label Swapping

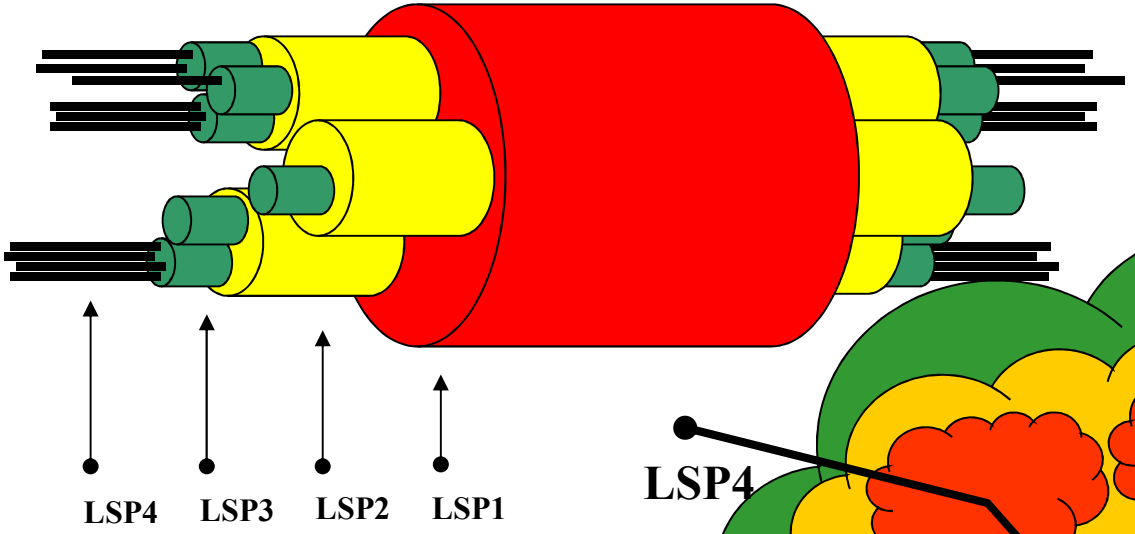


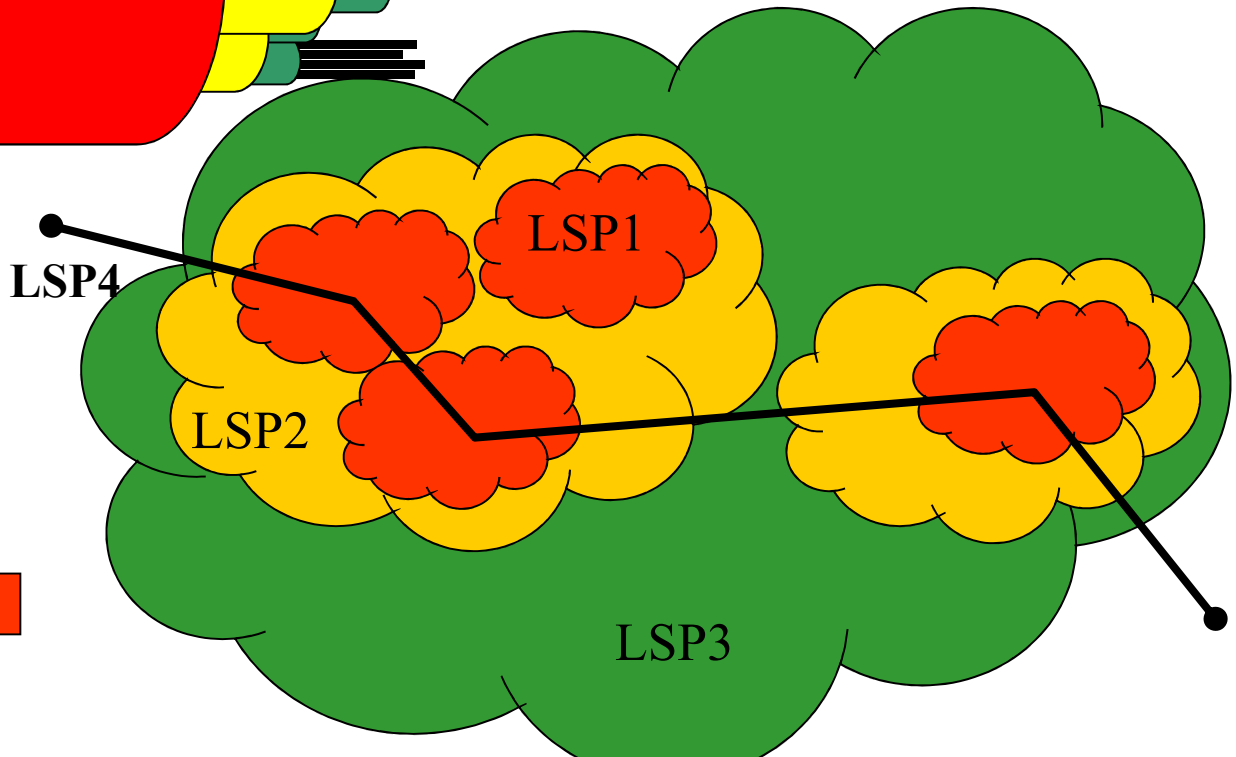
LER and LSR functions

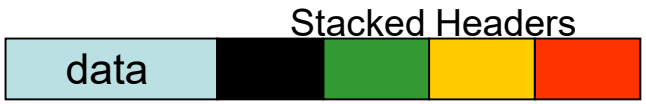
- LER
  - Routing over the MPLS network based on the IP address
  - Seting up the LSP by label distribution to other routers
  - Assigning the label and headre at the ingress
  - Removing the label and header at the egress
- LSR
  - Receiving the label distribution signalling and updating the routing tables
  - Swapping the labels
  - Forwardsing the packets (frames)

Label “Stacking” or “Swapping”?

- Many layers via stacking!
- Hierarchical LSP encapsulation (embedding, nesting)

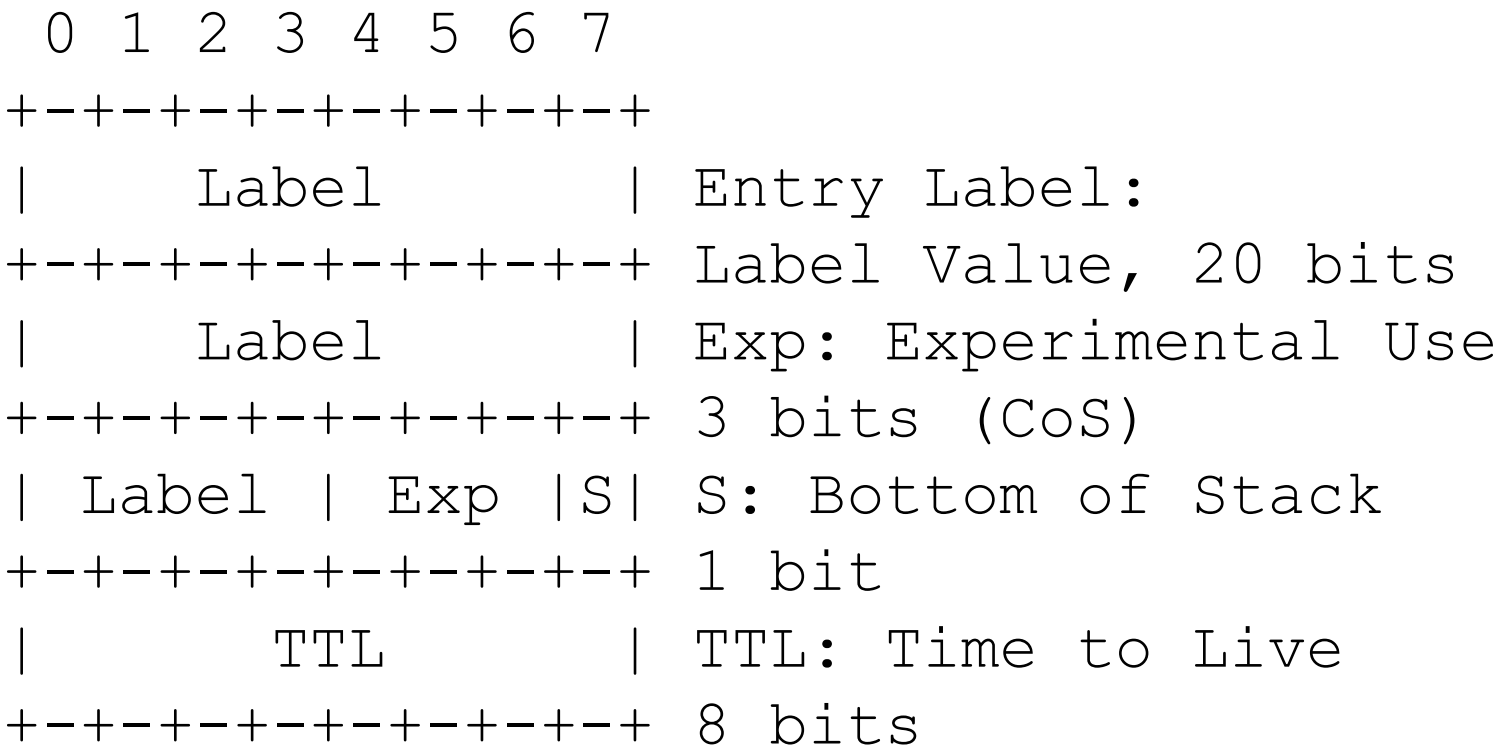






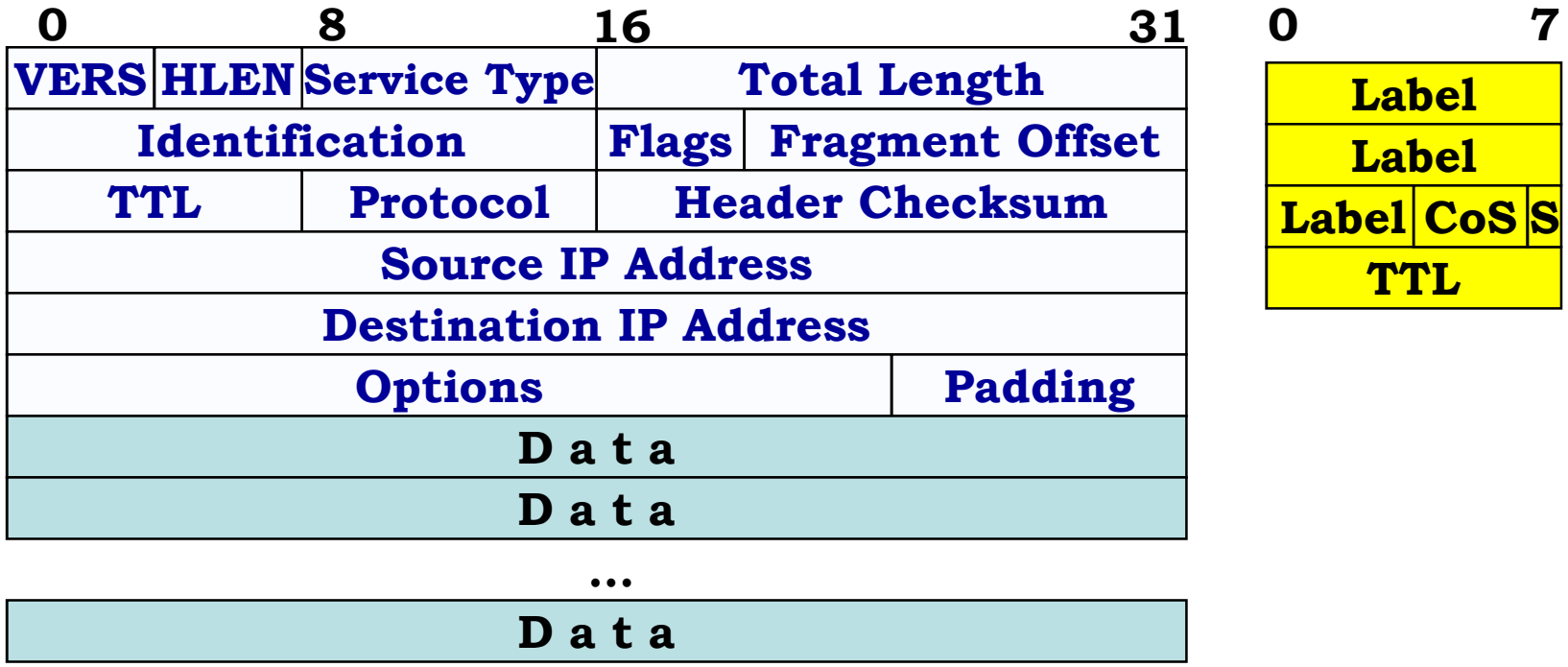
MPLS header

- Header: 32 bit = 4 byte
- Label: 20 bits



IP and MPLS Headers

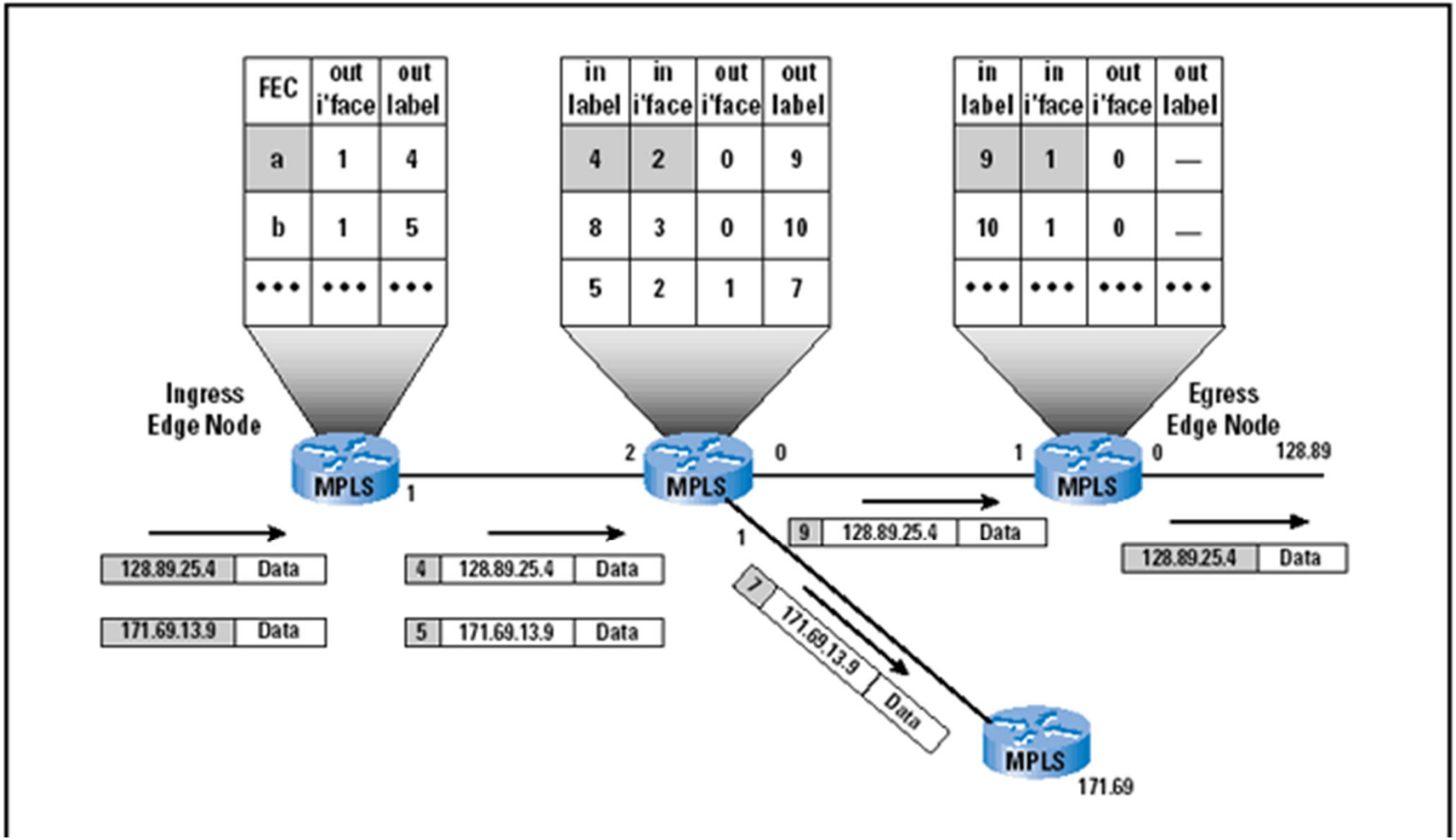
- Routing and Forwarding



MPLS forwarding

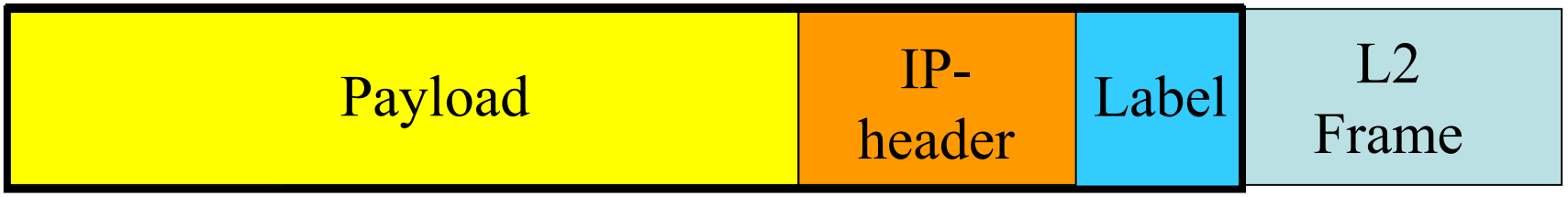
- http://www.cisco.com/c/en/us/about/press/internet-protocol-journal/back-issues/table-contents-10/mpls.html

Figure 2: MPLS Packet Forwarding



IP over MPLS over Ethernet?

- Labeled IP packet with e.g., Ethernet Frameing
- MPLS label between
  - the IP header and
  - the Ethernet header

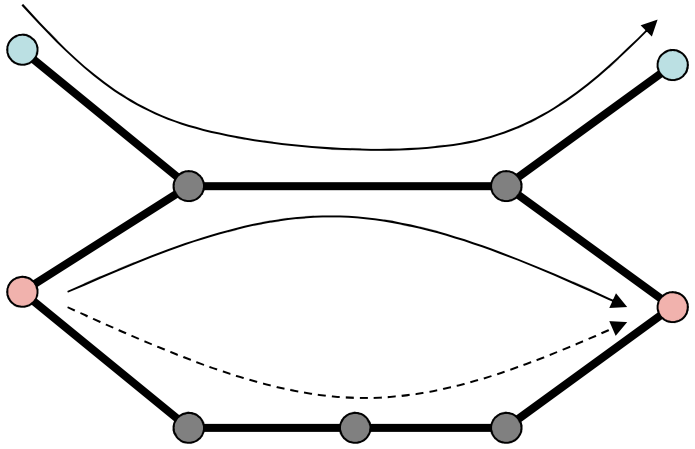


Label distribution mechanisms

- LSP setup
- LSR forwarding tables
- Different Label Distribution protocols:
  - **a Border Gateway Protocol (BGP)**
    - between different Internet AS-es
    - **MPLS extension**
  - **Resource reSerVation Protocol (RSVP)**
    - signalling where label distribution is assigned to RSVP flows
    - **RSVP-TE extension**
  - **Label Distribution Protocol (LDP),** defined by IETF for this purpose only
    - **CR-LDP**

MPLS TE

- IP: shortest path = least-hop path
- MPLS: Arbitrary path can be chosen
  - Alternative paths – load sharing
  - Explicit Route or Hop-by-Hop Routing
    - Loose
    - Strict



MPLS FRR
(Fast Re-Route)
Protection

MPLS QoS: CR-LDP Traffic Parameters slides 1-9 QoS in MPLS

U	F	Traf. Param. TLV	Length
Flags		Frequency	Reserved	Weight
Peak Data Rate (PDR)			
Peak Burst Size (PBS)			
Committed Data Rate (CDR)			
Committed Burst Size (CBS)			
Excess Burst Size (EBS)			

32 bit fields are short IEEE floating point numbers

Any parameter may be used or not used by selecting appropriate values

Flags control "negotiability" of parameters

Frequency constrains the variable delay that may be introduced

Weight of the CRLSP in the "relative share"

Peak rate (PDR+PBS) maximum rate at which traffic should be sent to the CRLSP

Committed rate (CDR+CBS) the rate that the MPLS domain commits to be available to the CRLSP

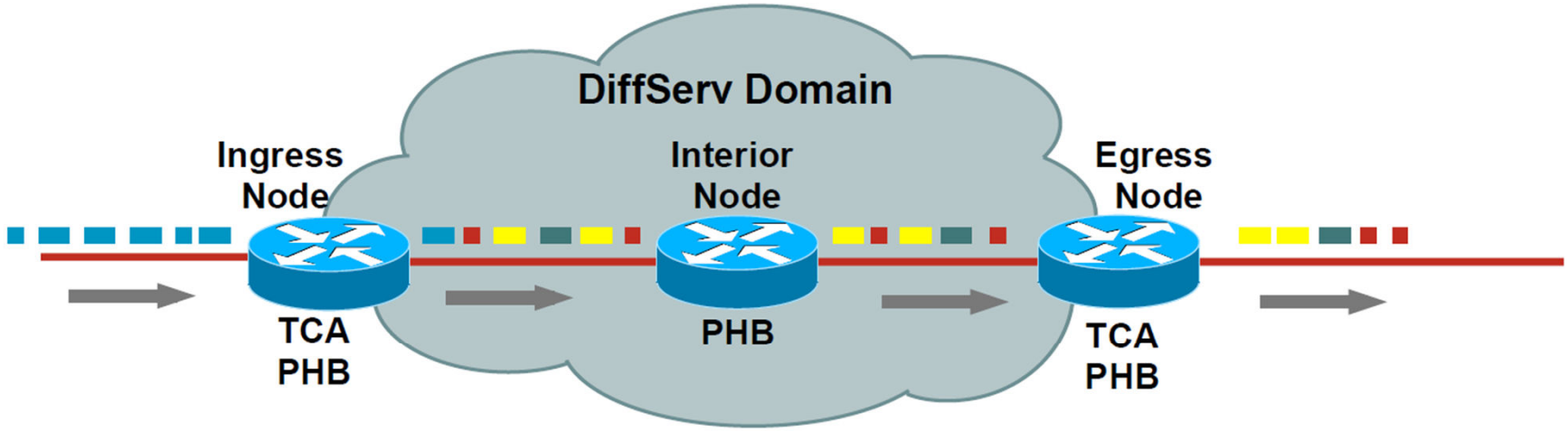
Excess Burst Size (EBS) to measure the extent by which the traffic sent on a CRLSP exceeds the committed rate

Forrás: Loa Andersson, Nortel: MPLS Tutorial, Infocom 2000

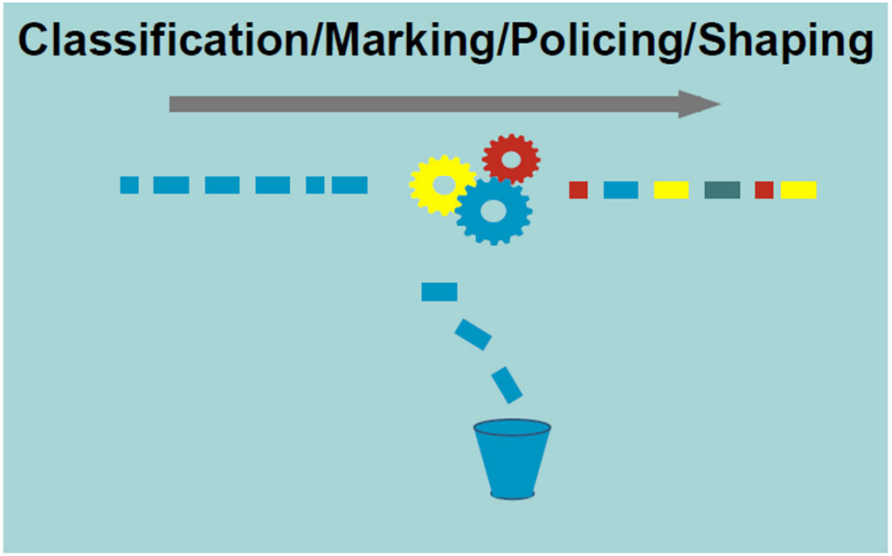
MPLS QoS Architecture

- MPLS does NOT define new QoS architectures
- MPLS QoS uses Differentiated Services (DiffServ) architecture defined for IP QoS
- DiffServ architecture defined in RFC2475
- MPLS support for DiffServ defined in RFC3270

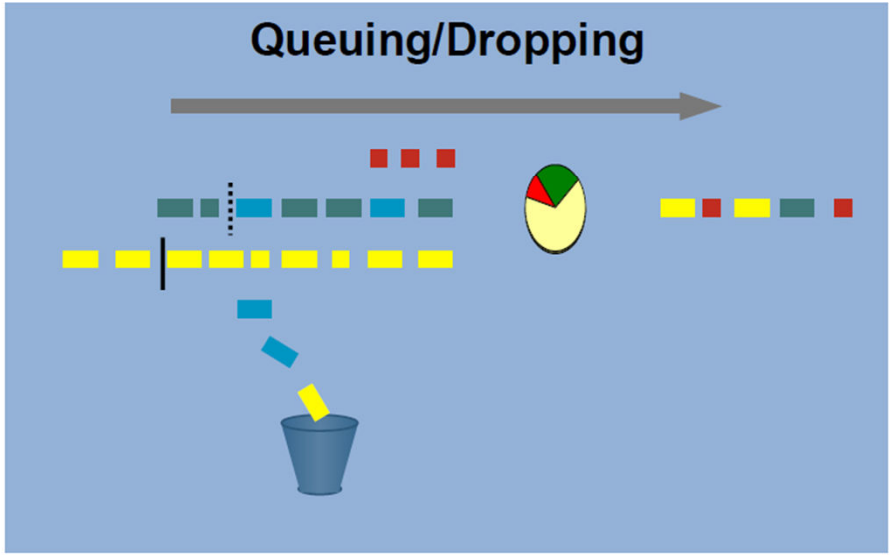
MPLS QoS Architecture



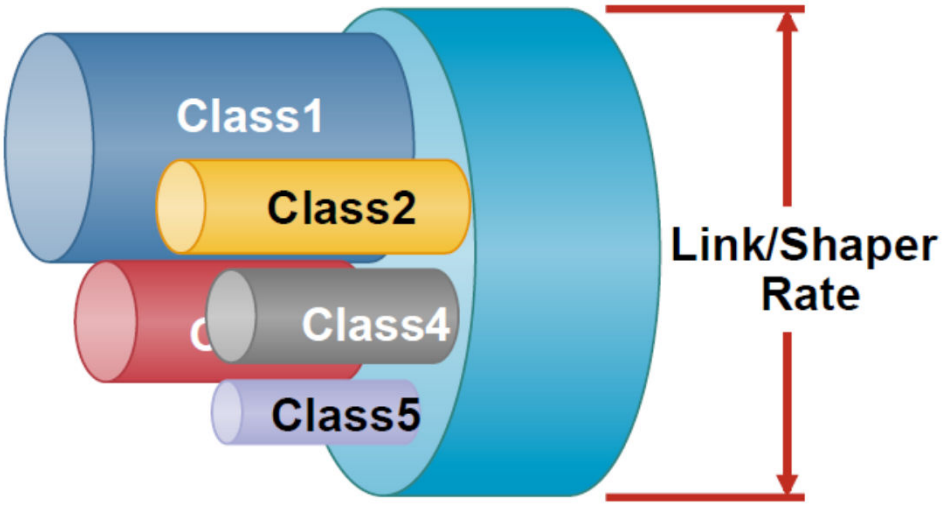
Traffic Conditioning Agreement (TCA)



Per-Hop Behavior (PHB)



SLA: Service Level Agreement



Class	Committed BW	Delay	Jitter	Loss
Real time	X	Low	Low	Low
Interactive	Y	Low	NA	Low
Business	Z	NA	NA	Low
Best Effort	NA	NA	NA	NA

- 3-5 classes typically
- Different traffic and quality requirements

MPLS Conclusion

MultiProtocol Label Switching:

- Unified IP/MPLS control
- Simpler than ATM - Not much new compared to ATM ☺
- Reduced label space rquirement via FEC (Forwarding Equivalence Class)
- Label Swapping and Stacking
- Topology or Traffic driven
- Some QoS issues still open
- TE and VPN support (Traffic Engineering and Virtual Private Networks)
- IPoMPLS: Peer Model !
  - RSVP-TE
  - CR-LDP
- MPLS-TP: MPLS Transport Profile
- GMPLS: Genelazied MPLS

http://www.mplsrc.com/mplsfaq.shtml

Glossary

MPLS	Multi-Protocol Label Switching	Többprotokollos címkekapcsolás
VPN	Virtual Private Network	Virtuális magán hálózat
IP	Internet Protocol	Internet protokoll
ATM	Asynchronous Transfer Mode	Aszinkron átviteli mód
QoS	Quality of Service	Szolgáltatásminőség
LER	Label Edge Router	Címke behelyező (perem) útválasztó
LSR	Label Switching Router	Címke kapcsoló útválasztó
LSP	Label Switched Path	Címke kapcsolt útvonal
FEC	Forwarding Equivalence Class	Továbbítási ekvivalencia osztály
VPI/VCI	Virtual Path Identifier/Virtual Channel Identifier	Virtuális útvonal azonosító/virtuális csatorna azonosító
DLCI	Data Link Connection Identifier	Adat kapcsolat azonosító
CoS	Class of Service	Szolgáltatásosztály
TTL	Time to Live	Élettartam
LFIB	Label Forwarding Information Base	Címketovábbítási információs bázis
NHLFE	Next Hop Label Forwarding Entry	Következő ugrást leíró címketovábbítási elem
ILM	Incoming Label Map	Beérkező címkék térképe
FTN	FEC-to-NHLFE Map	FEC és NHLFE összerendelő táblázat
BGP	Border Gateway Protocol	Határkapu protokoll
RSVP	Resource reSerVation Protocol	Erőforrásfoglalási protokoll
LDP	Label Distribution Protocol	Címketerjesztő protokoll
OXC	Optical Cross Connect	Optikai rendező
GMPLS	Generalised Multi-Protocol Label Switching	Általánosított többprotokollos címkekapcsolás
MPλ S	Multi-Protocol Lambda Switching	Többprotokollos hullámhosszkapcsolás
STM	Synchronous Transport Module	Szinkron átviteli modul