Core network protocols and architectures

Multi-Protocol Label Switching

Data plane

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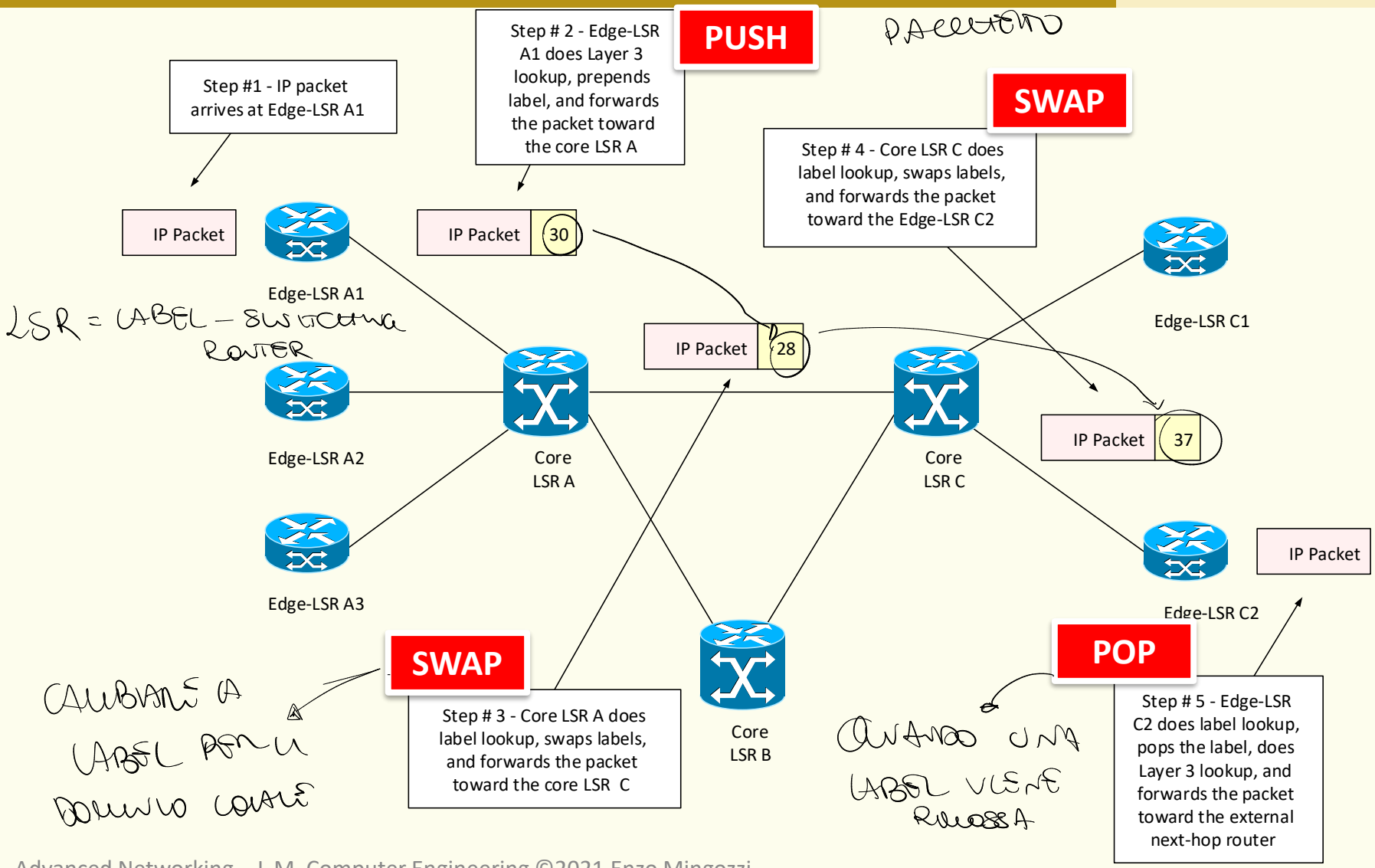
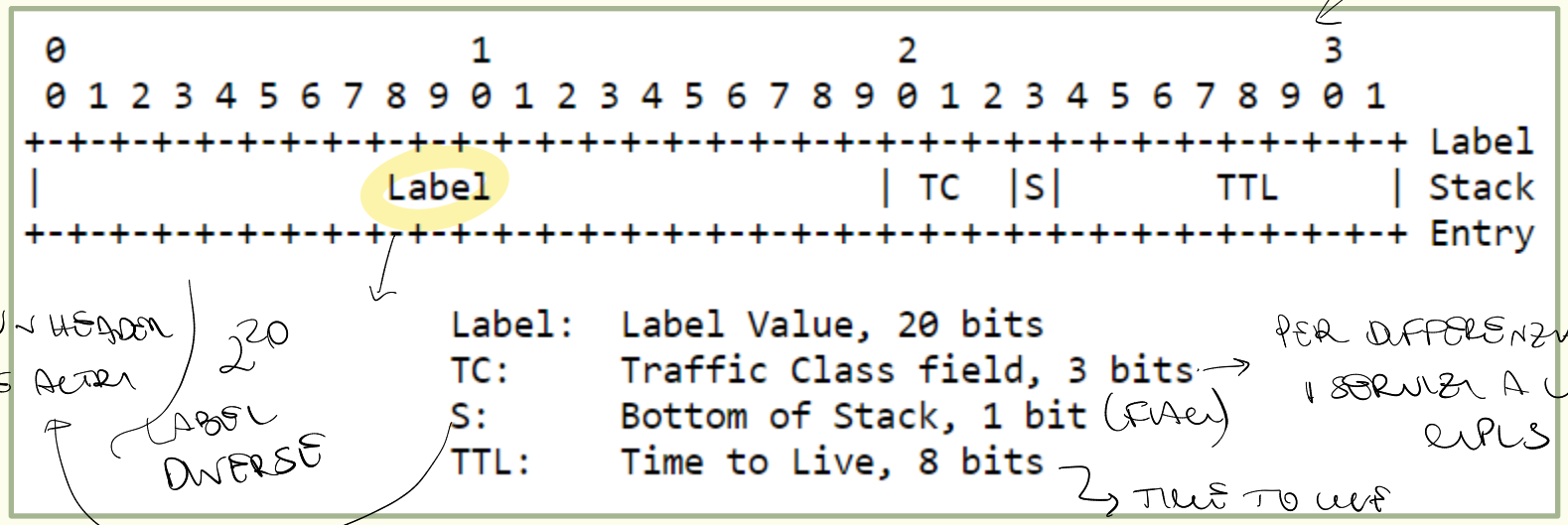
MPLS data plane



MPLS label encoding

- **4** octets, **after** data link layer headers, **before** any network layer header
  - A **Label** is a short, fixed length, locally significant identifier which is used to identify a FEC
  - **TC**: Traffic Class
  - **TTL**: Time-to-Live (IPv4 or IPv6 style)
  - **S**: enables label stacking (more on this later on)



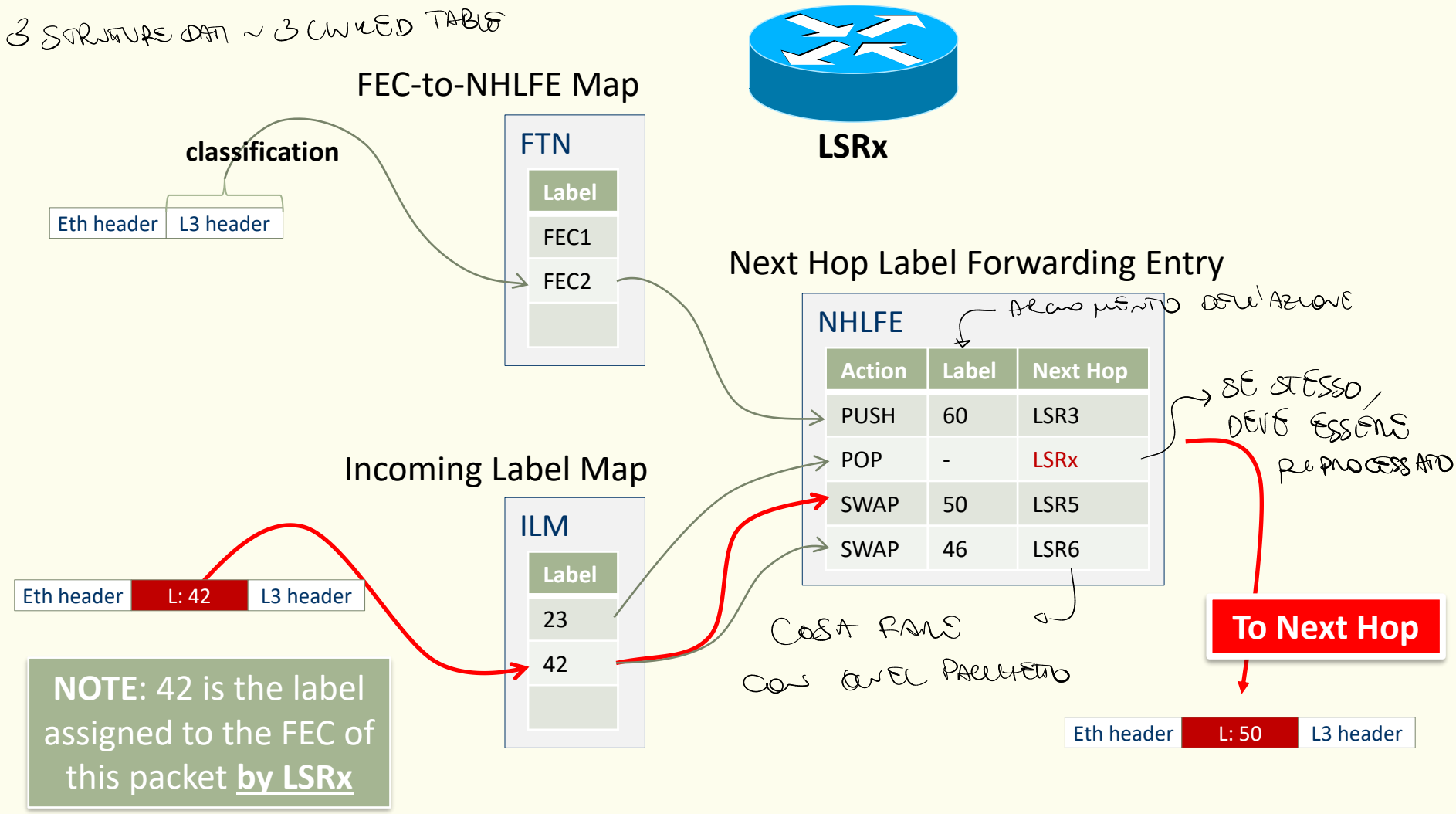
MPLS label encoding

- Ethernet

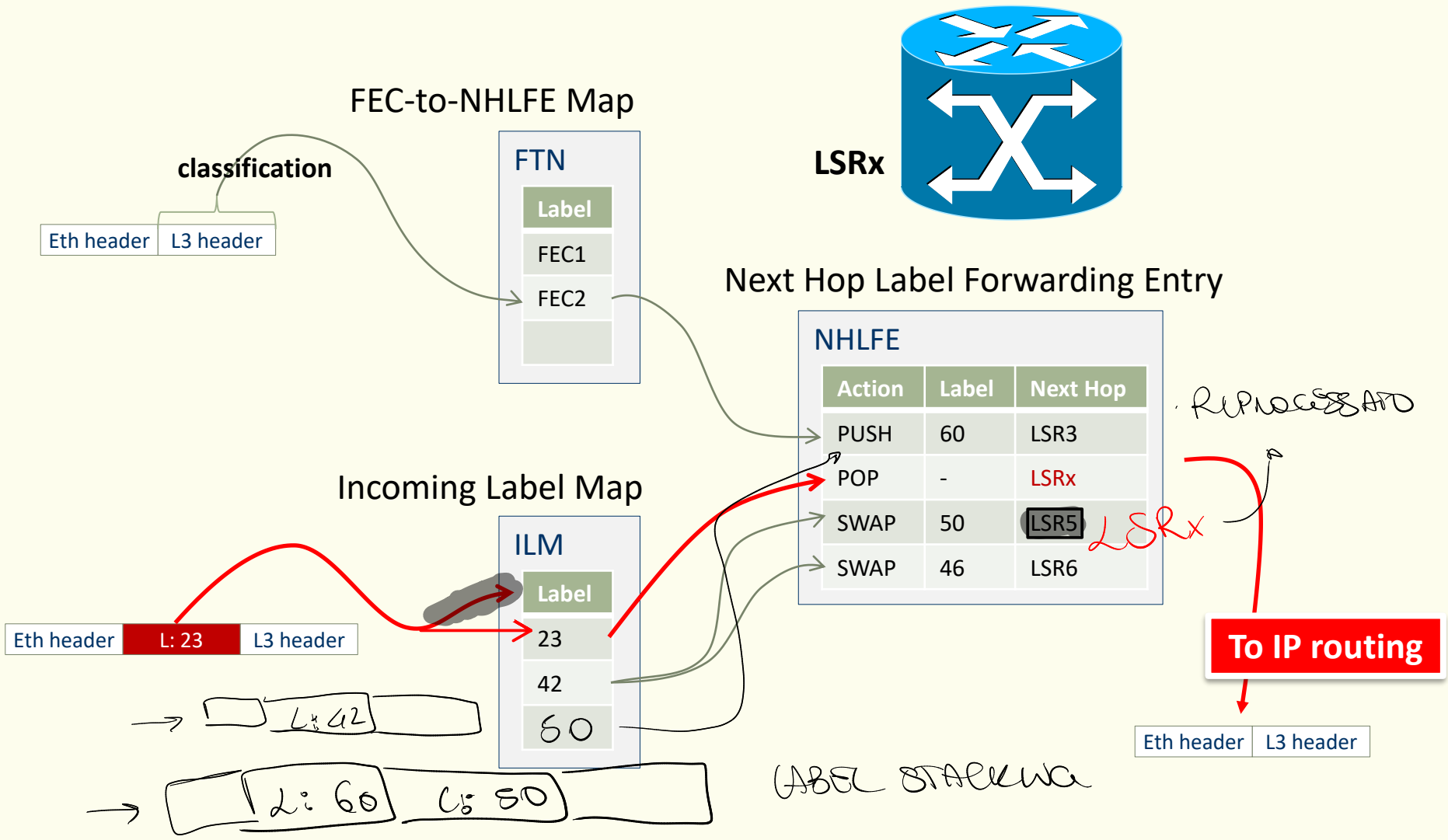
  - Ethertype value 0x8847: MPLS unicast packet
  - Ethertype value 0x8848: MPLS multicast packet
- PPP

  - MPLS Control Protocol (MPLSCP) defined for initial negotiation
  - PPP protocol field: 0x8281
- L3 protocol identity is implicit (must be inferable from the label value)

MPLS forwarding operation

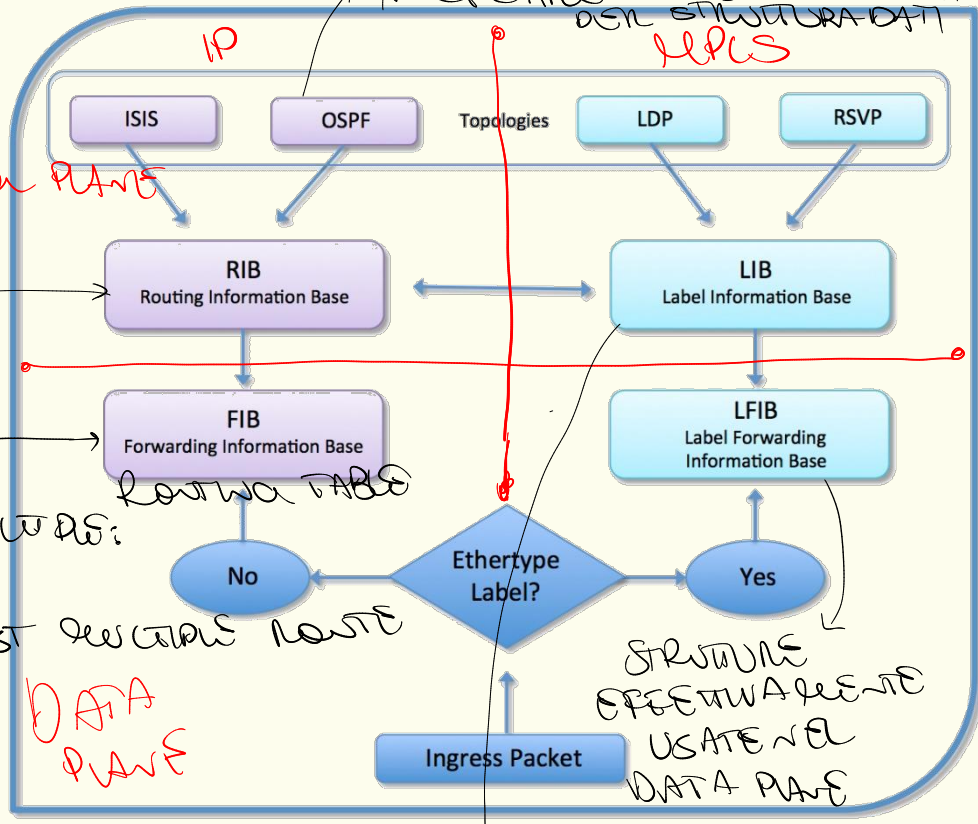


MPLS forwarding operation

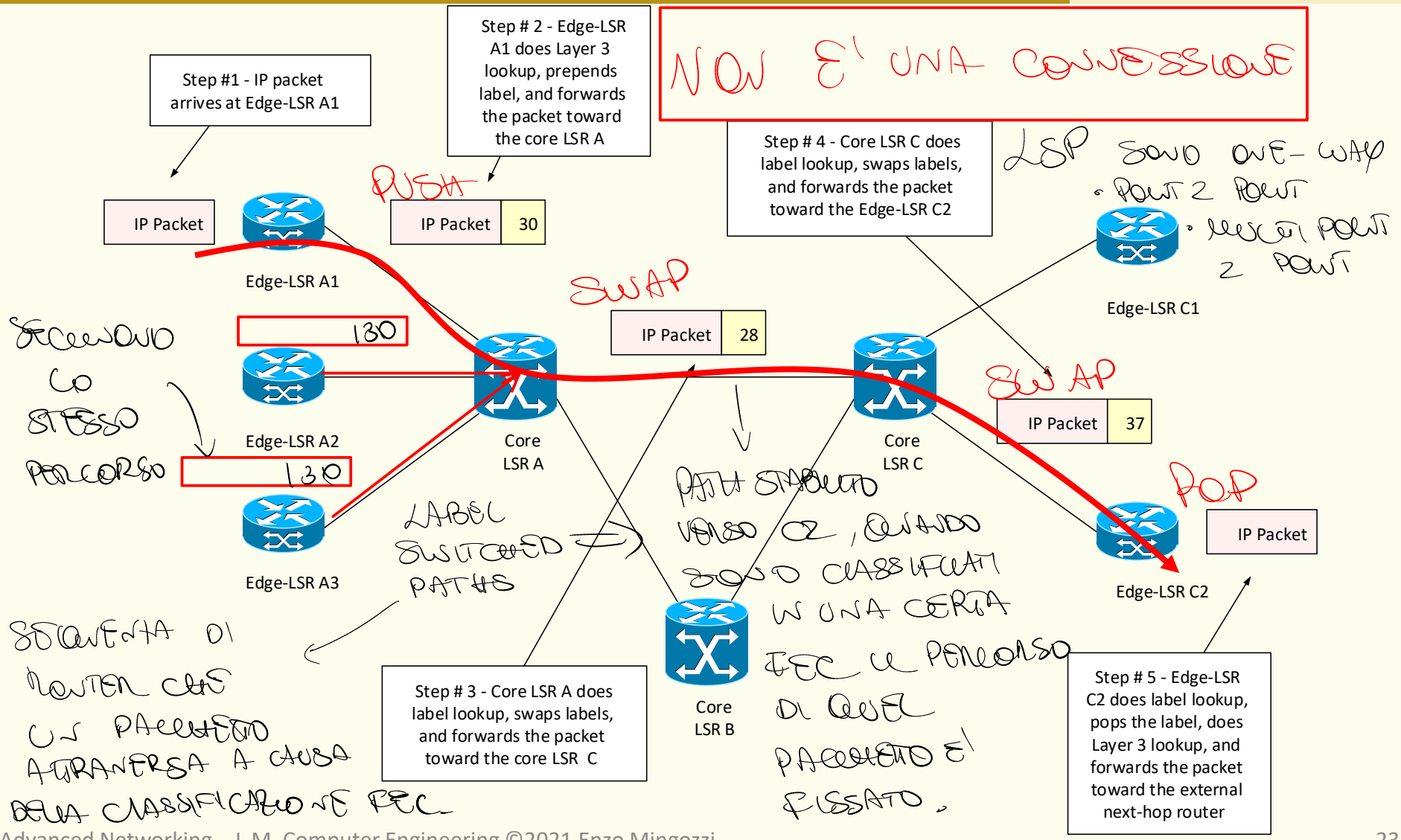


MPLS forwarding

- In concrete implementations, the data plane structures may take different names and/or have different organization
- **Label Forwarding Information Base**

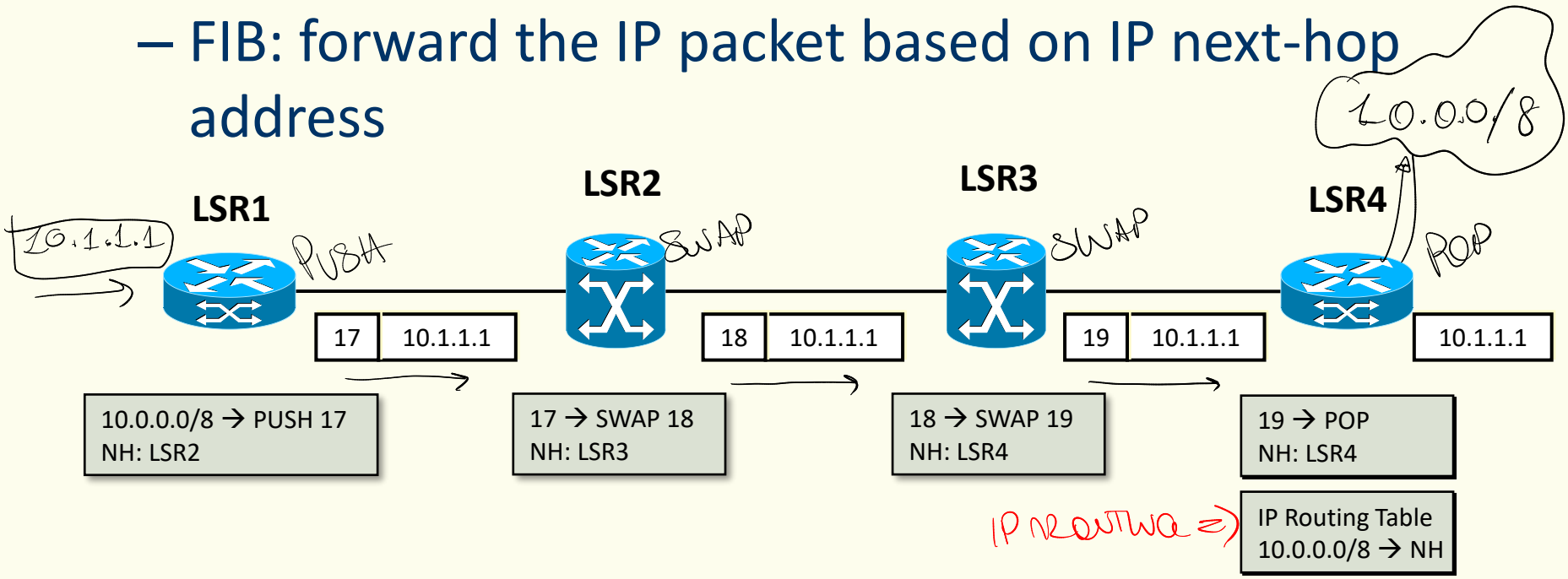


Label Switched Path (LSP)



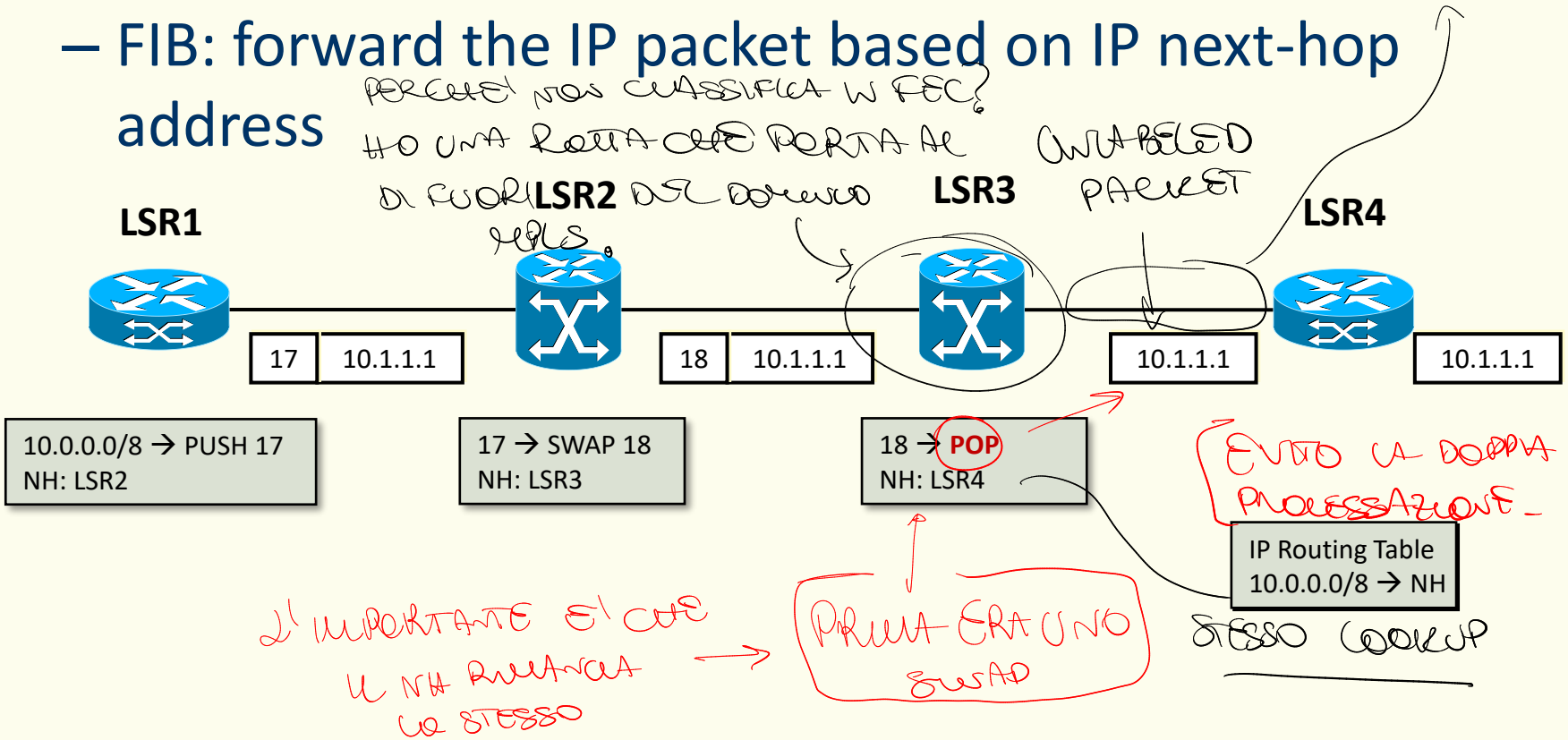
Penultimate Hop Popping

- Double lookup at LSP egress
  - LFIB: remove the label
  - FIB: forward the IP packet based on IP next-hop address



Penultimate Hop Popping (PHP)

- Single lookup at LSP egress
  - ~~LFIB: remove the label~~
  - FIB: forward the IP packet based on IP next-hop address



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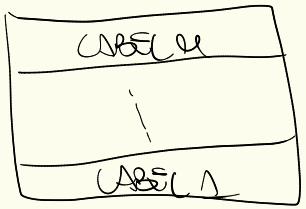
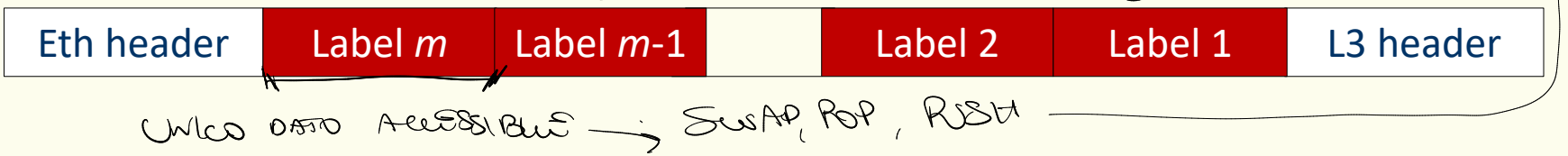
Label stacking

- The MPLS data plane is based on a more general **stack model**
  - A labeled packet carries a number of labels m ≥ 0
  - Labels are organized as a last-in, first out stack
    - Label 1, bottom of stack
    - Label *m*, top of stack
  - Actions in NHLFEs always apply to the top label in the stack

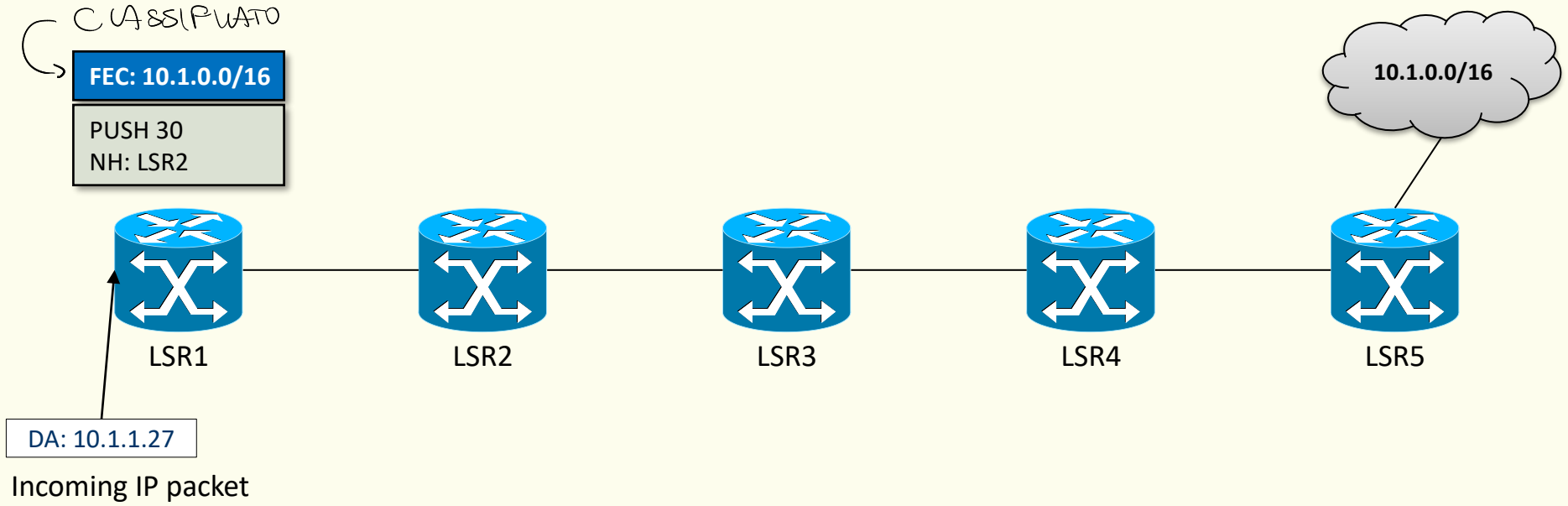




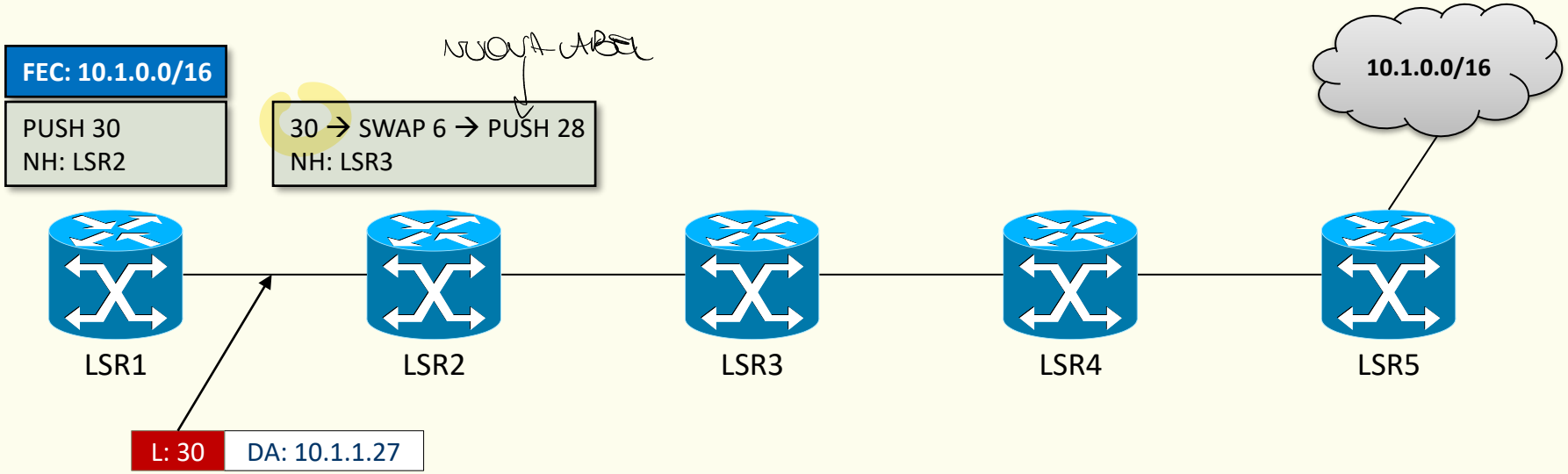
Label stacking and actions

- **SWAP** Lx
  - replace the label at the top of the label stack with a specified label Lx
- **POP**
  - pop the label stack
- **PUSH** Lx
  - push one new label Lx onto the label stack
  - Multiple pushes are allowed

Label stacking – example



Label stacking – example



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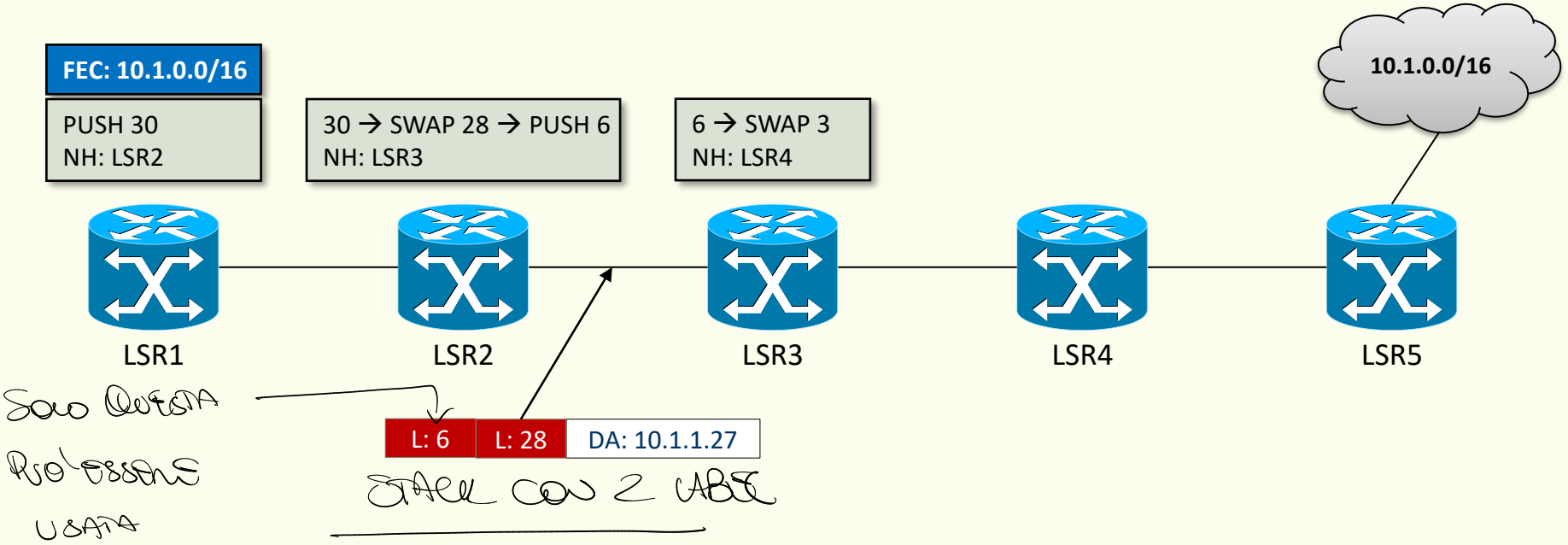

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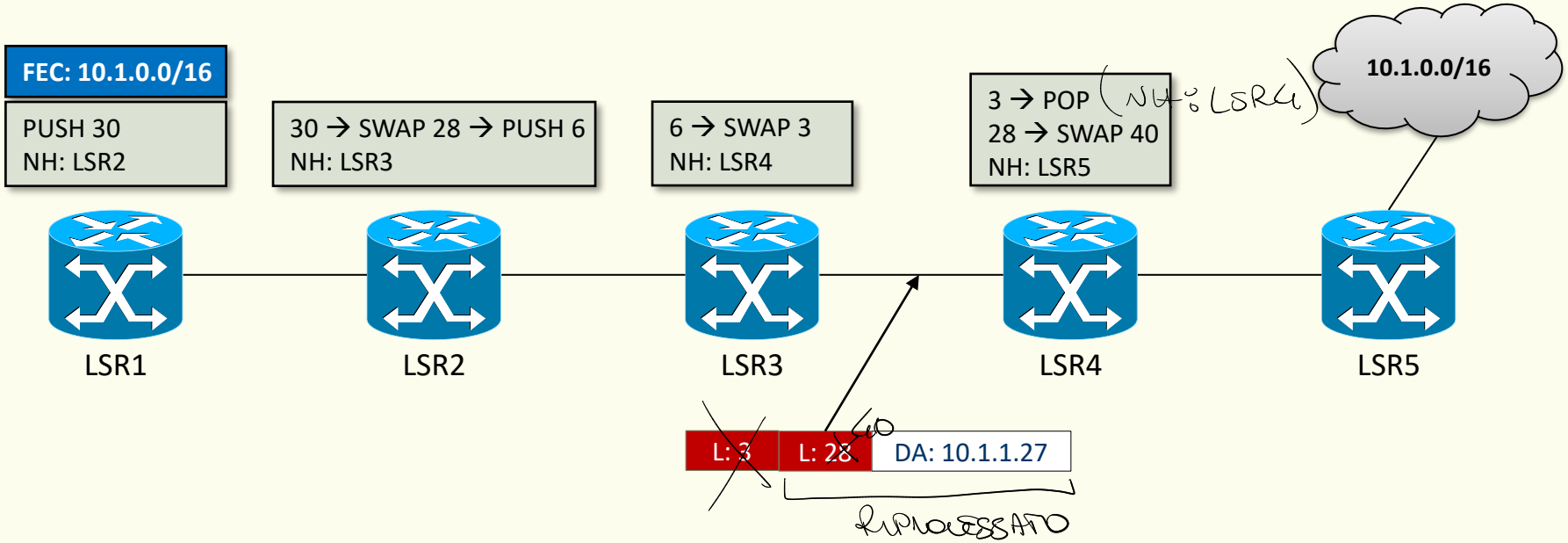

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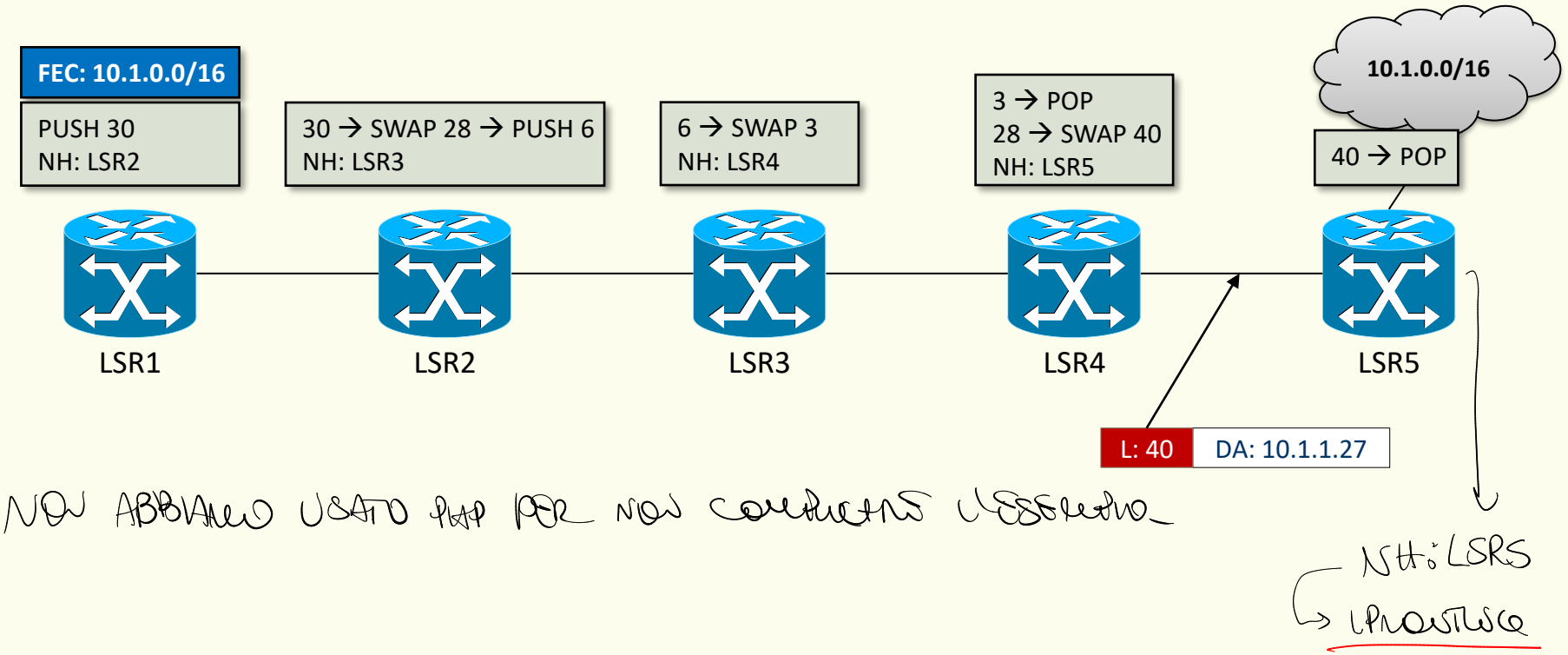
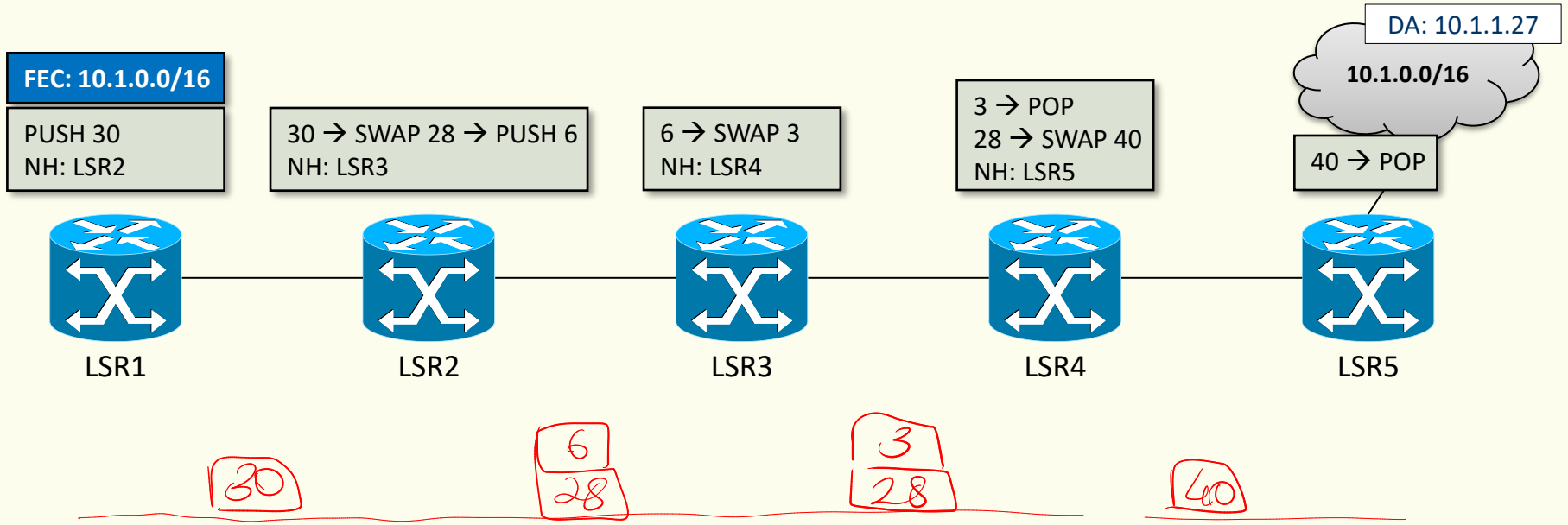
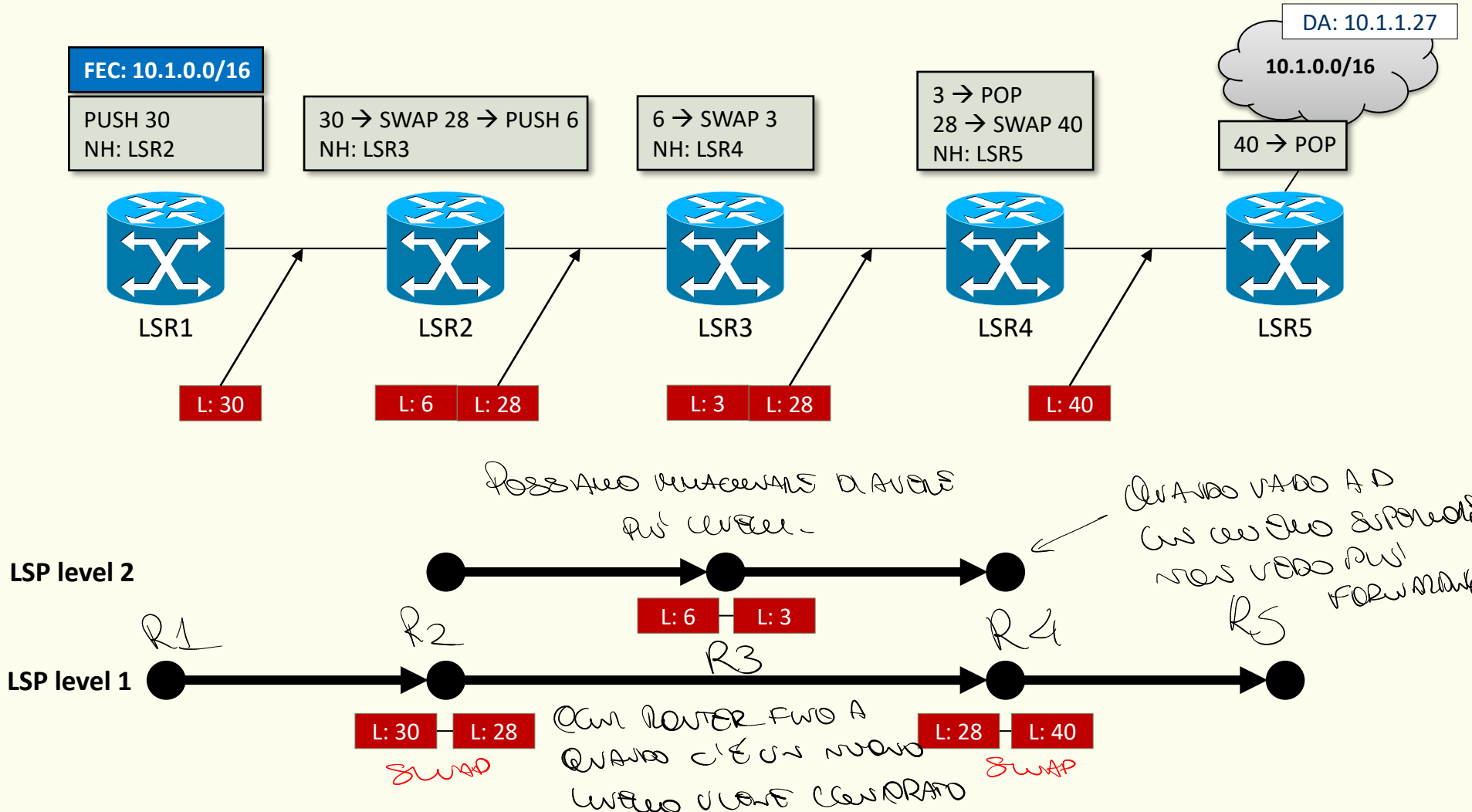


Label stacking – example

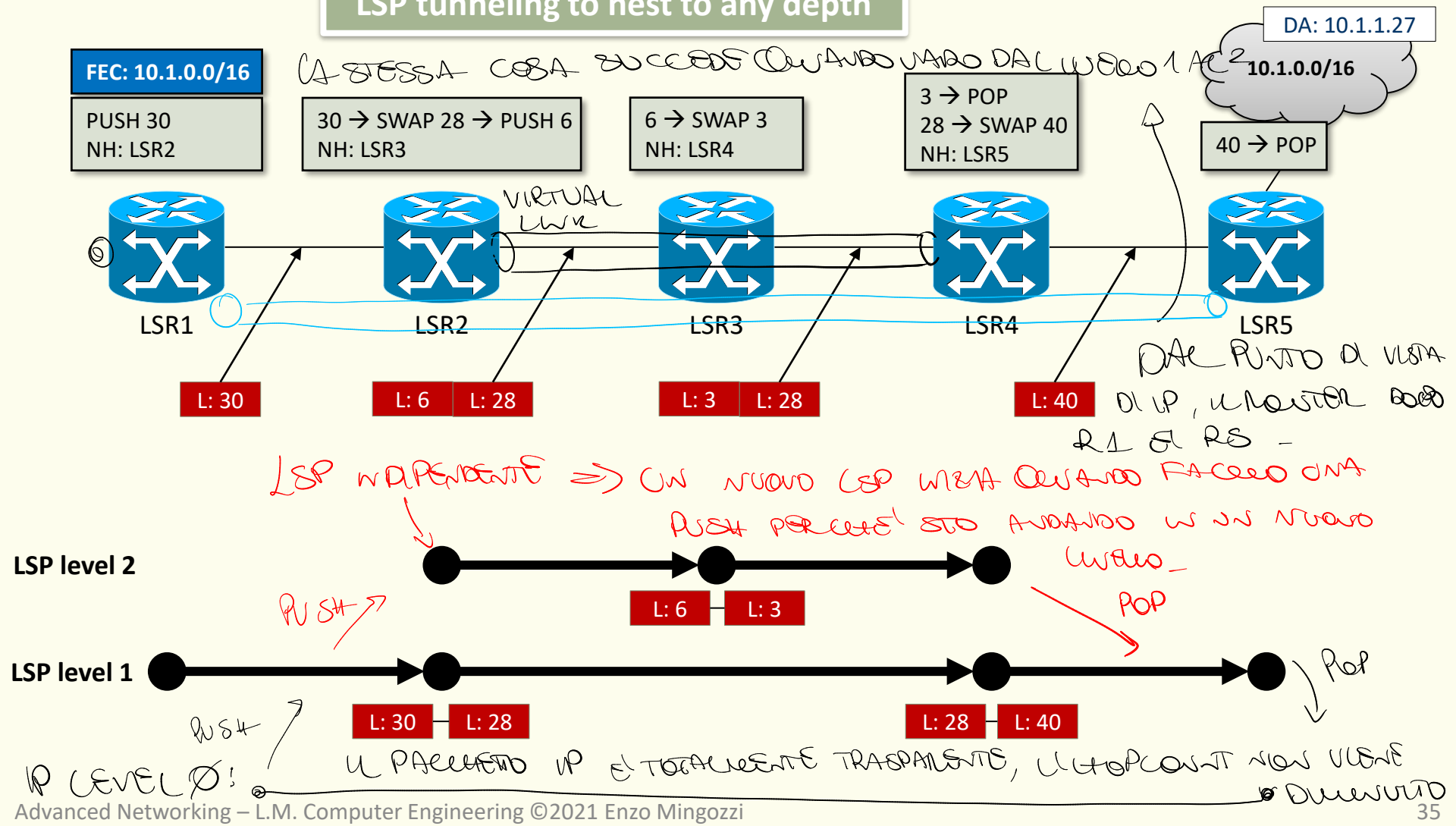


Label stacking – example

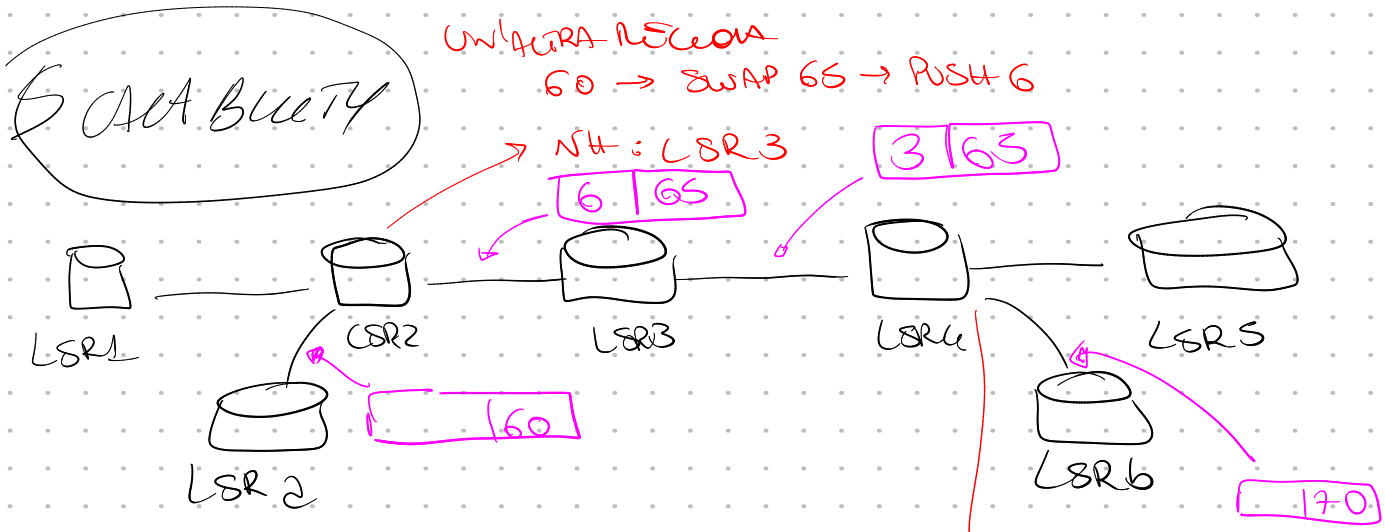


Label stacking – example

The label stack mechanism allows LSP tunneling to nest to any depth



A COSA CI SERVONO QUESTI "TUNNEL"? AD ESEMPIO TRA R2 E R6.



ABBIAMO UN LSP LIVELLO 1 DIVERSO "TUNNELLATO" ATTRAVERSO UN LSP DI LIVELLO 2 VIRTUALE.

UN'ALTRA REGOLA
65 → SWAP 70
NH: LSR5

POTREI FARLO ANCHE SENZA LIVELLI, MA AVREI BISOGNO DI ALTRE LABEL DIVERSE.

SE HO 1000 LSP DIVERSI CHE CONDIVIDONO UNA STESSA PORZIONE DI PERCORSO NON HO BISOGNO DI 1000 LABEL DIVERSE, NE BASTA UNA.

MANUTENIBILITÀ

FEATURE DI IMPORTANZA