

Core network protocols and architectures

Multi-Protocol Label Switching

Control plane

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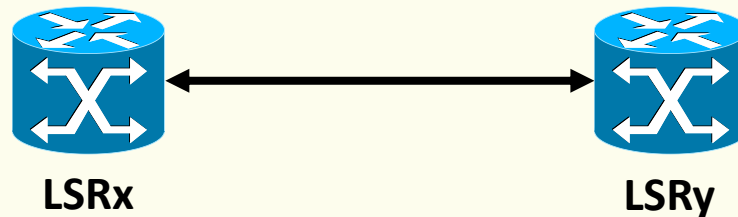
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MPLS control plane

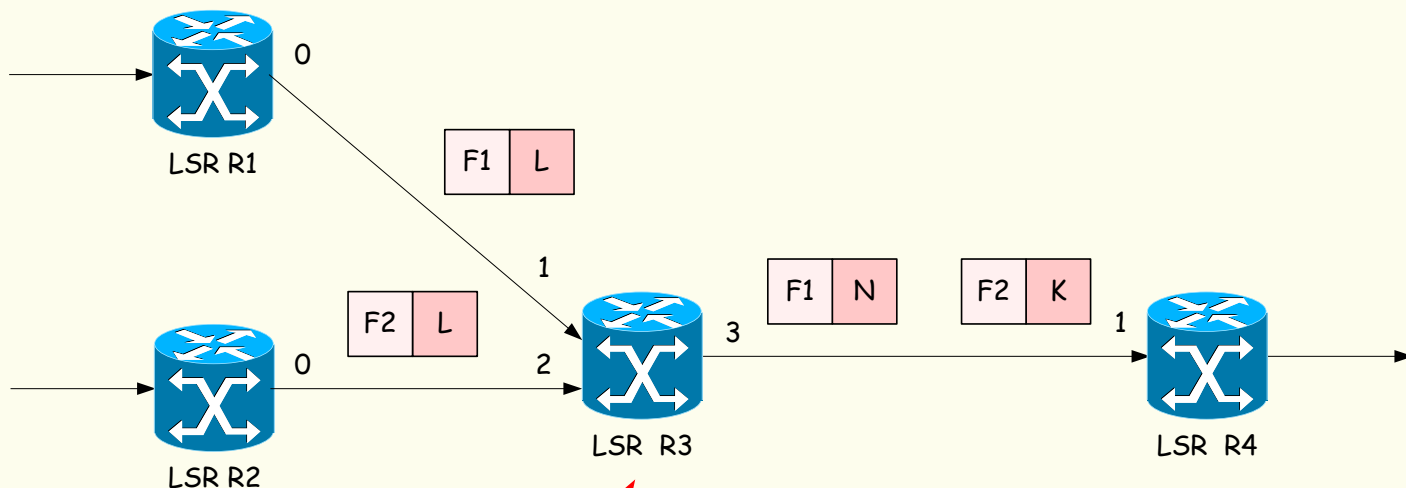
- Procedures at each LSR to
 - **create** bindings between FECs and labels
 - **inform** other LSRs of the bindings it creates
 - **combine** information above to construct and maintain the forwarding table used by the label switching component

FTN		ILM	NHLFE		
Label		Label	Action	Label	Next Hop
FEC1		23	PUSH	60	LSR3
FEC2		42	POP	-	LSRx
			SWAP	50	LSR5
			SWAP	46	LSR6



LSR label scope

- Labels may have "per interface" scope

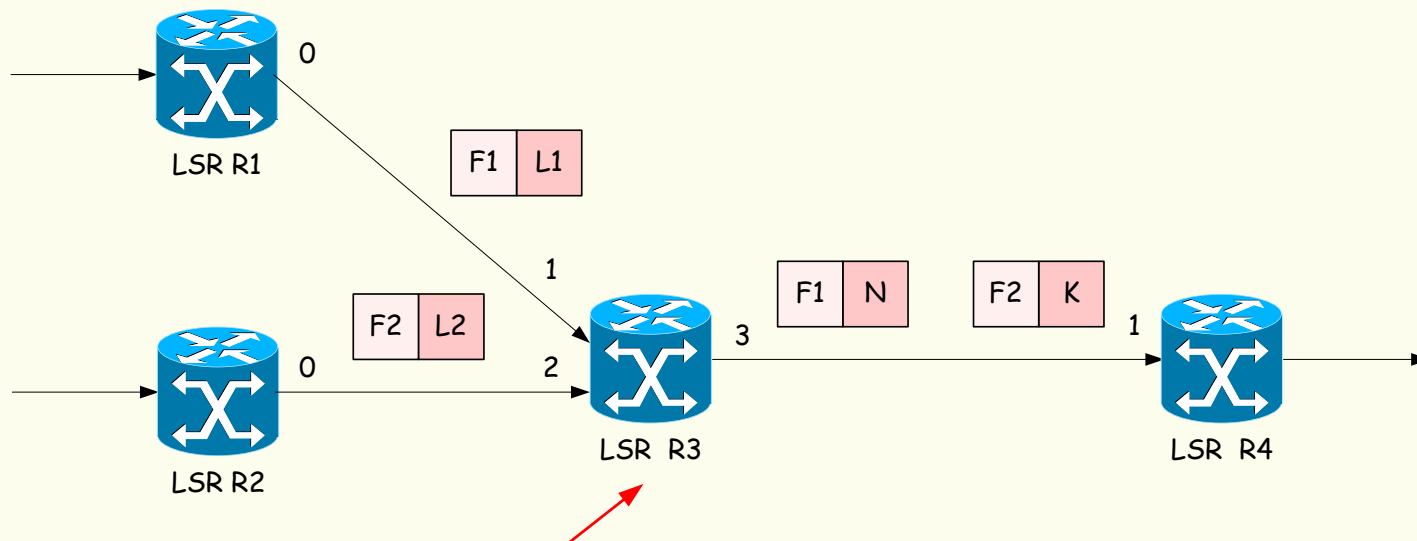


In I/F	In Lab	FEC	Out I/F	Out Lab
1	L	F1	3	N
2	L	F2	3	K
....

LSR3 MUST be able to tell which upstream LSR sent the labeled packet

LSR label scope

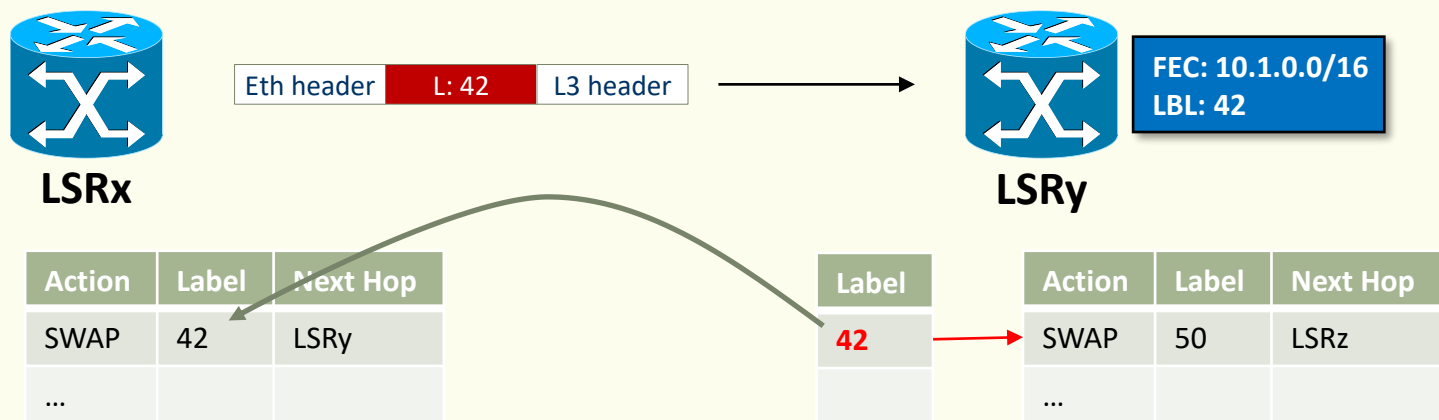
- Otherwise, labels have per-LSR scope



In I/F	In Lab	FEC	Out I/F	Out Lab
1	L1	F1	3	N
2	L2	F2	3	K
....

Label assignment and distribution

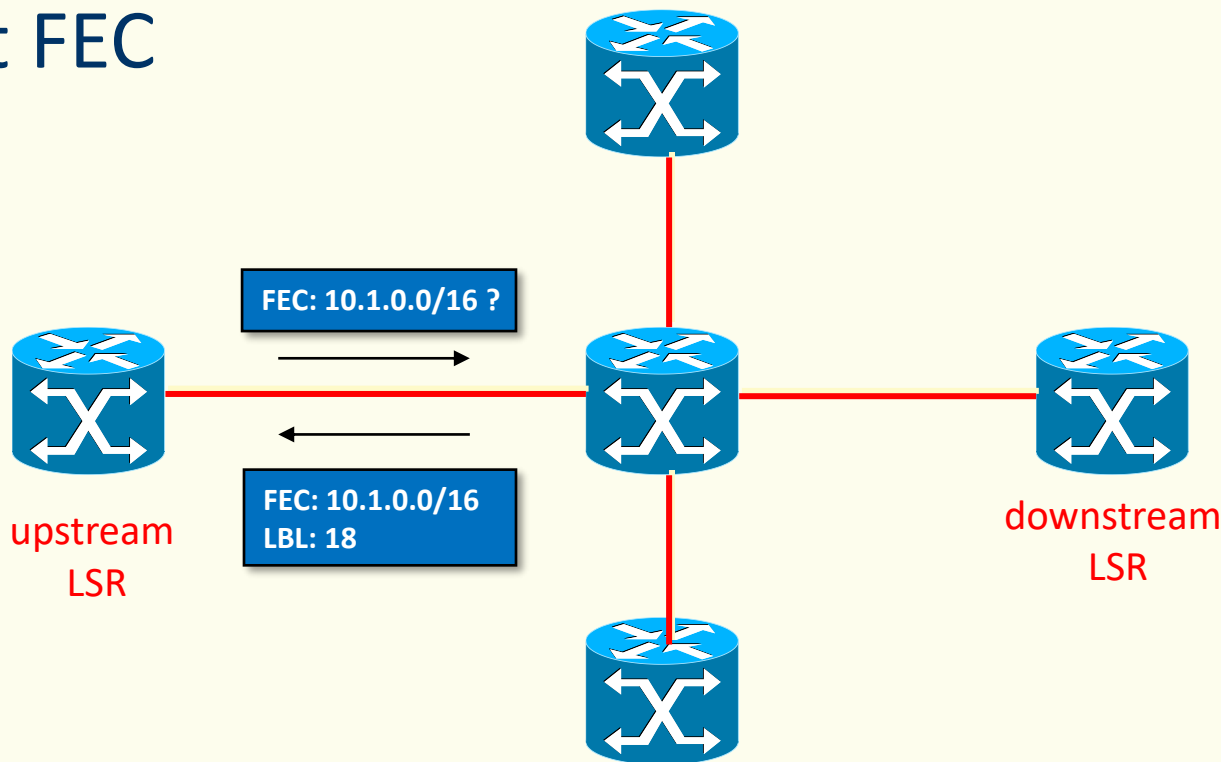
- Labels are "downstream-assigned"
 - The binding of a FEC F to a label L is taken by the LSR which is **downstream** with respect to that binding



- A label distribution protocol is then needed

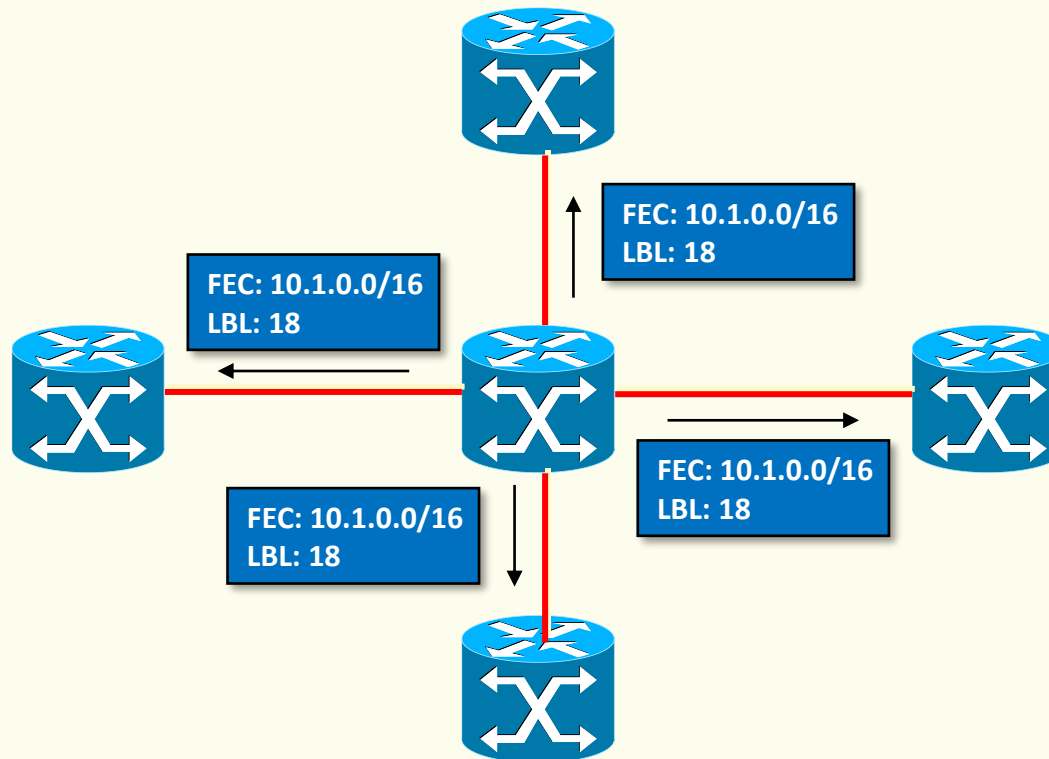
Downstream-on-demand

- An LSR is allowed to explicitly request, from its next hop for a particular FEC, a label binding for that FEC



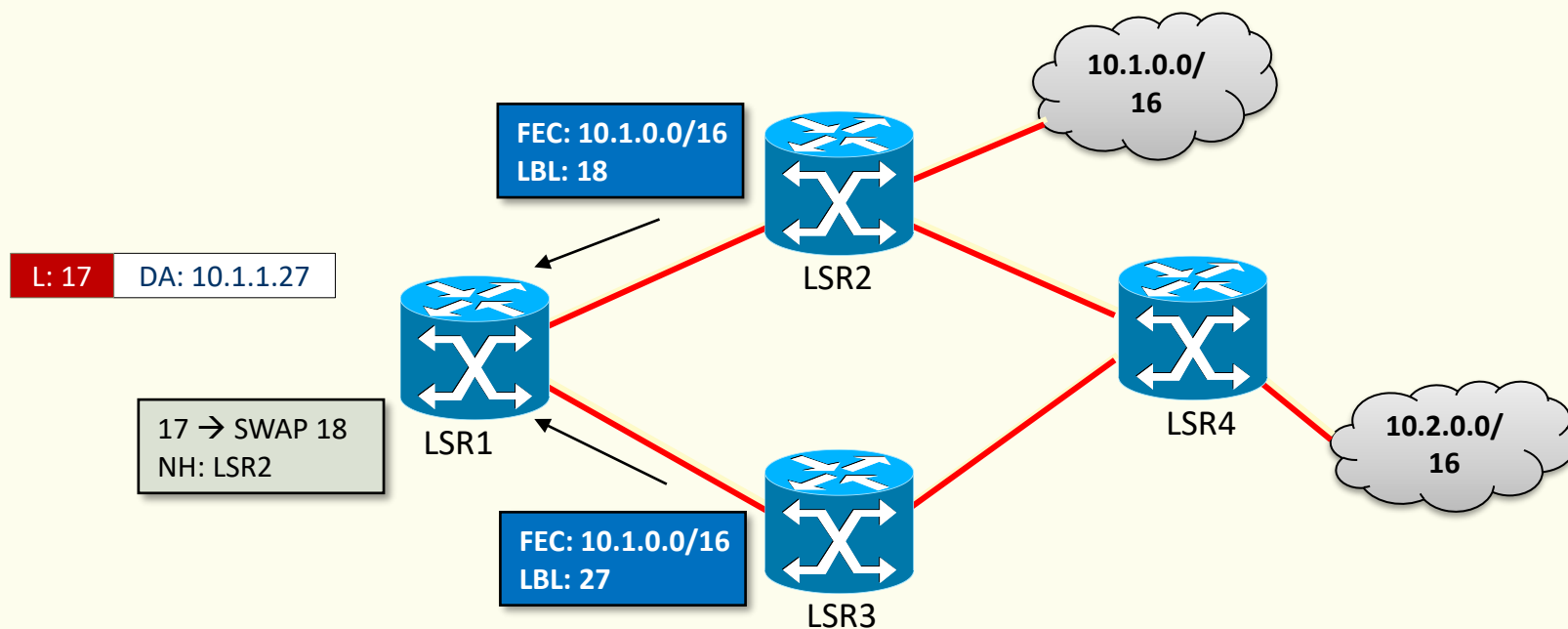
Unsolicited downstream

- An LSR is allowed to distribute bindings to LSRs that have not explicitly requested them



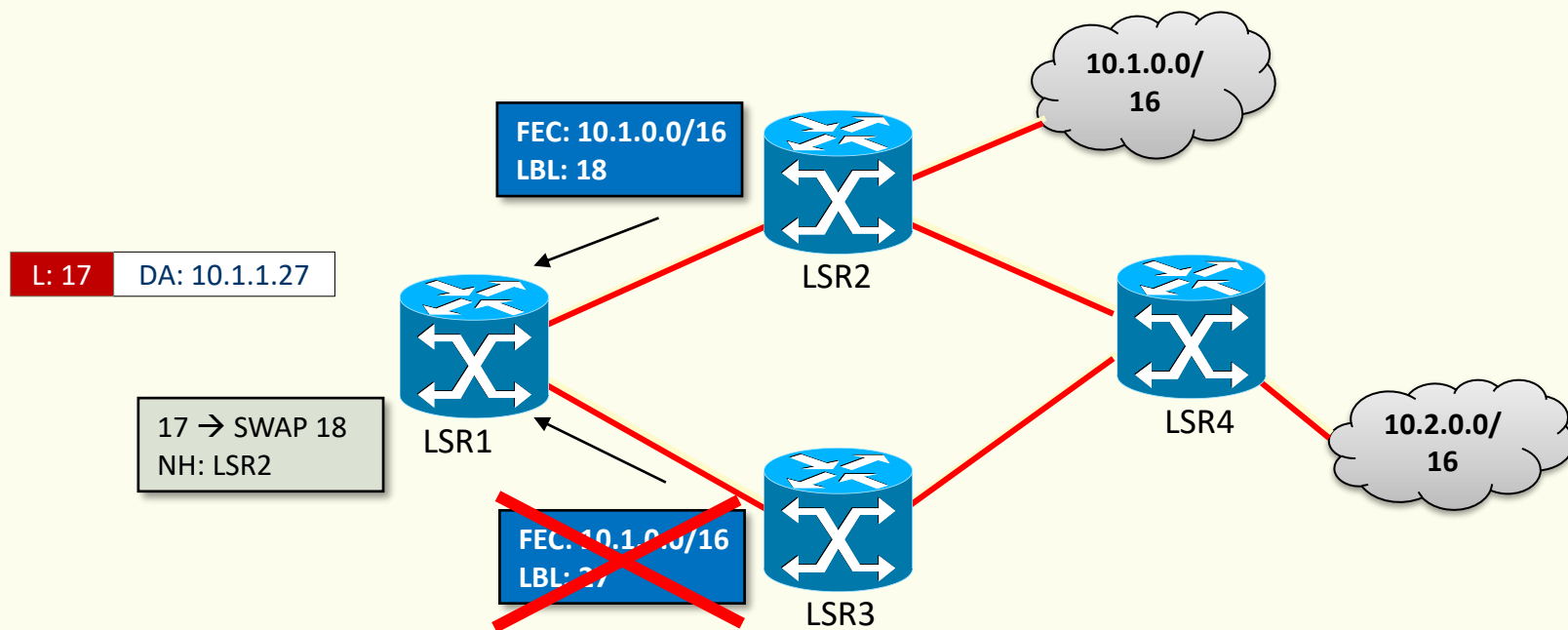
Label retention modes

- Liberal label retention mode



Label retention modes

- Conservative label retention mode



LSP setup control

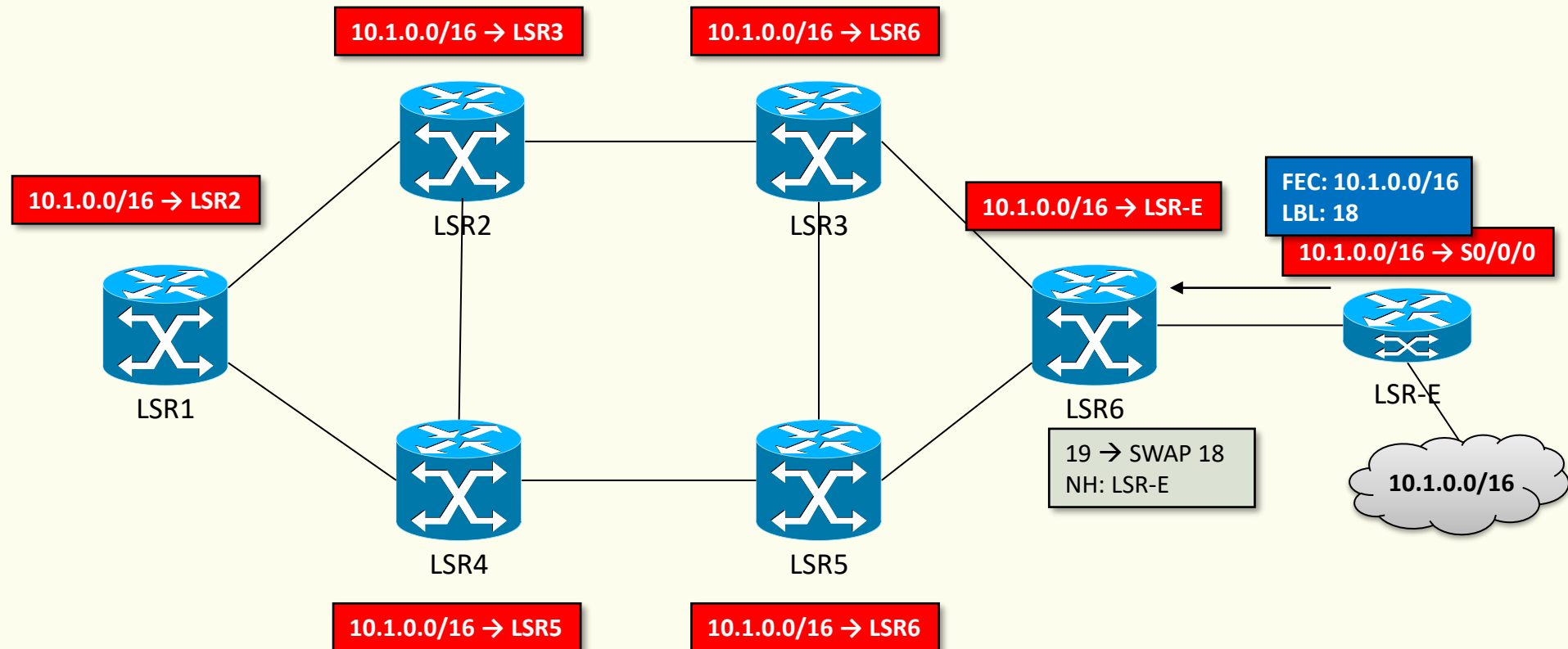
- **FEC-to-label bindings** are only distributed for the purpose of establishing label-switched paths
- **Which FEC to advertise a binding for?**
 - The choice of FEC determines which LSPs are set up
- **When to advertise this binding?**
 - This determines who has control over the LSP setup
- Two modes of operation: **ordered** control vs. **independent** control

Ordered control



- Unsolicited downstream

ROUTING TABLE (IGP)

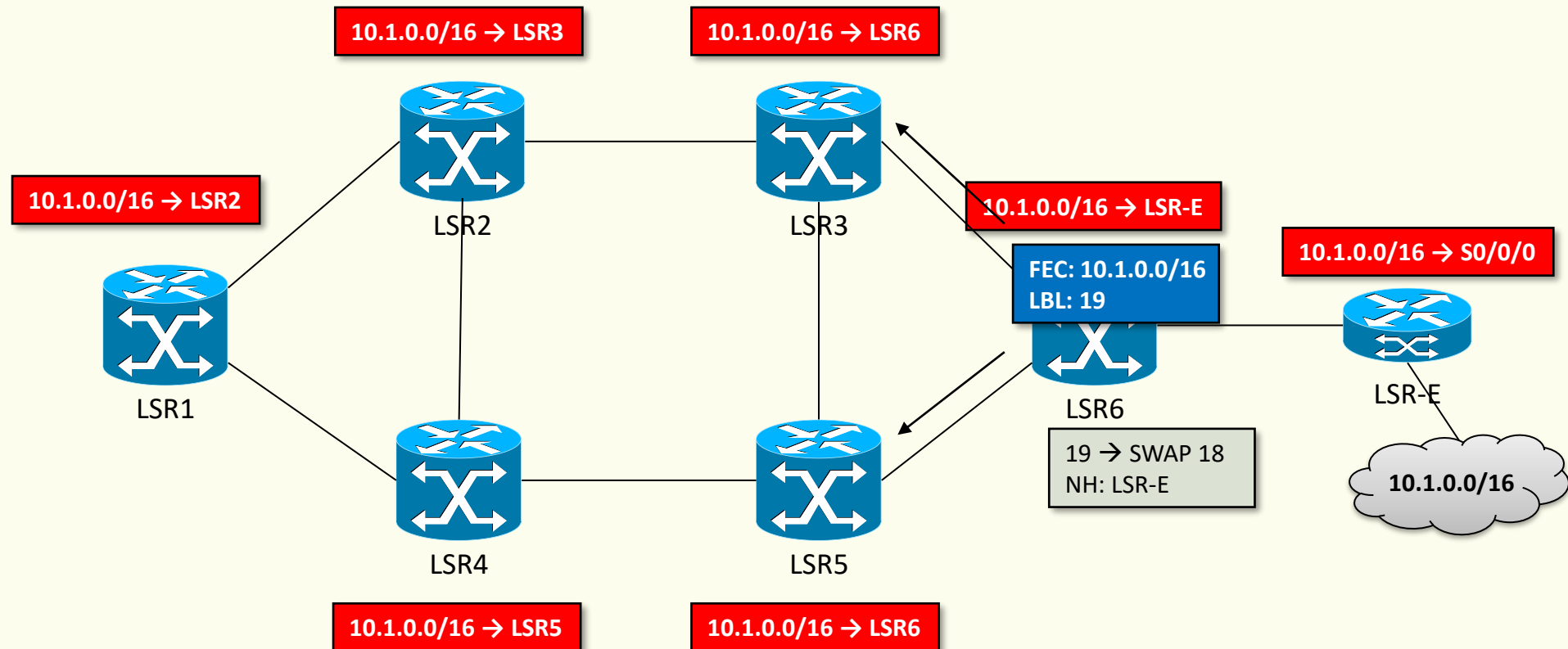


Ordered control



ROUTING TABLE (IGP)

- Unsolicited downstream

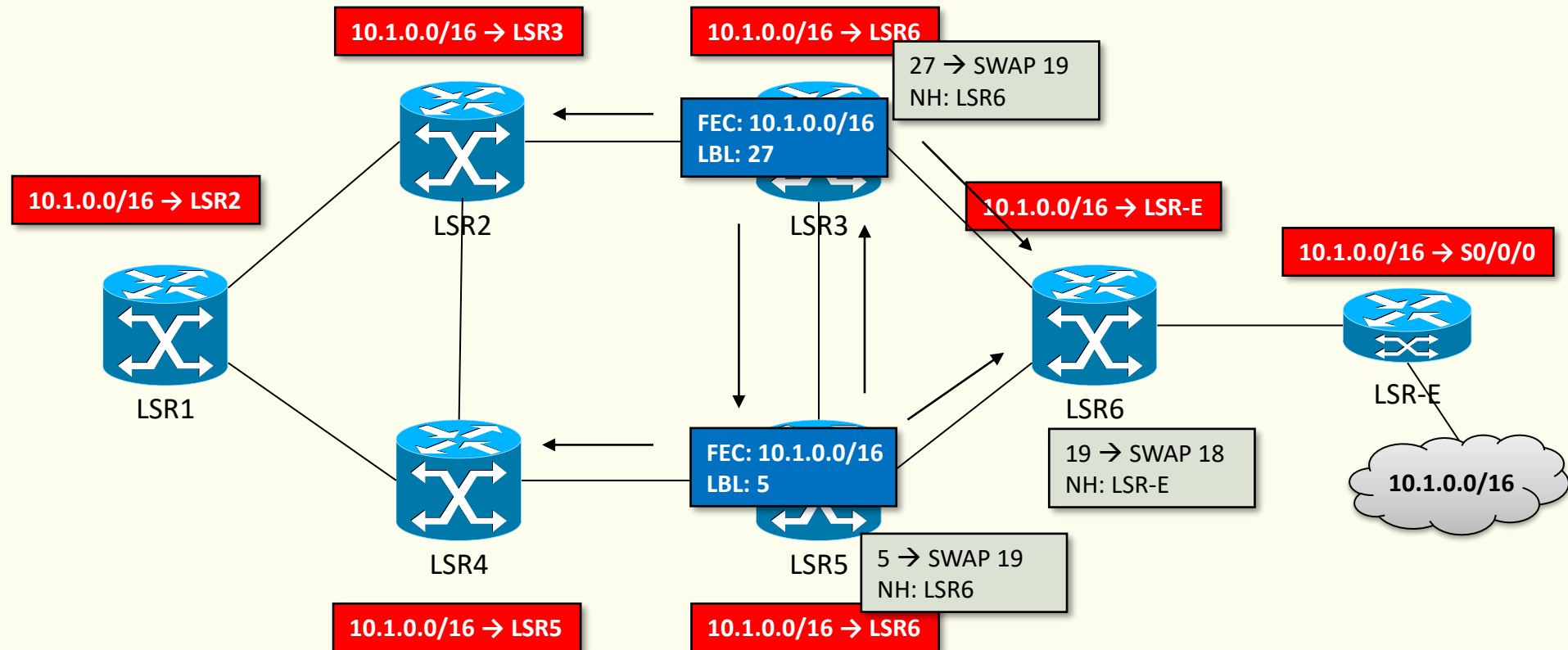


Ordered control



- Unsolicited downstream

ROUTING TABLE (IGP)

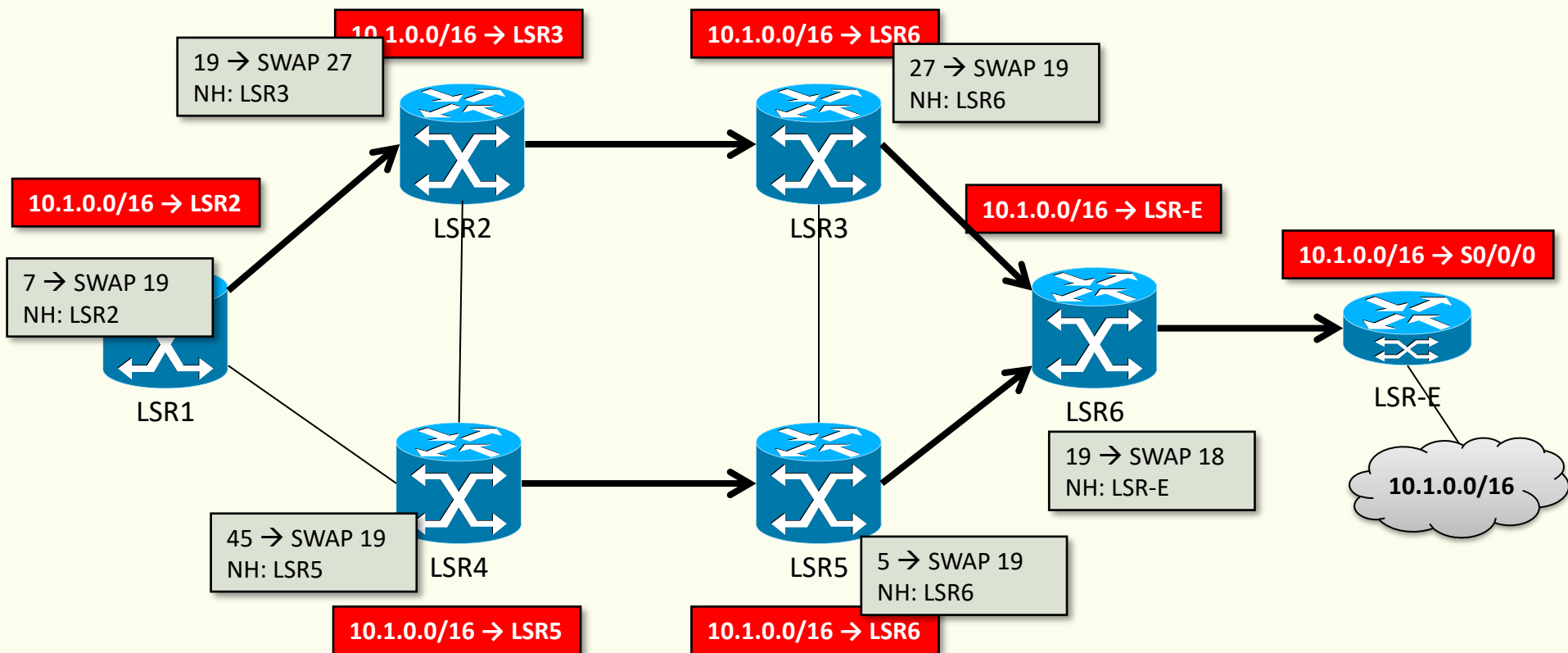


Ordered control



ROUTING TABLE (IGP)

- Unsolicited downstream

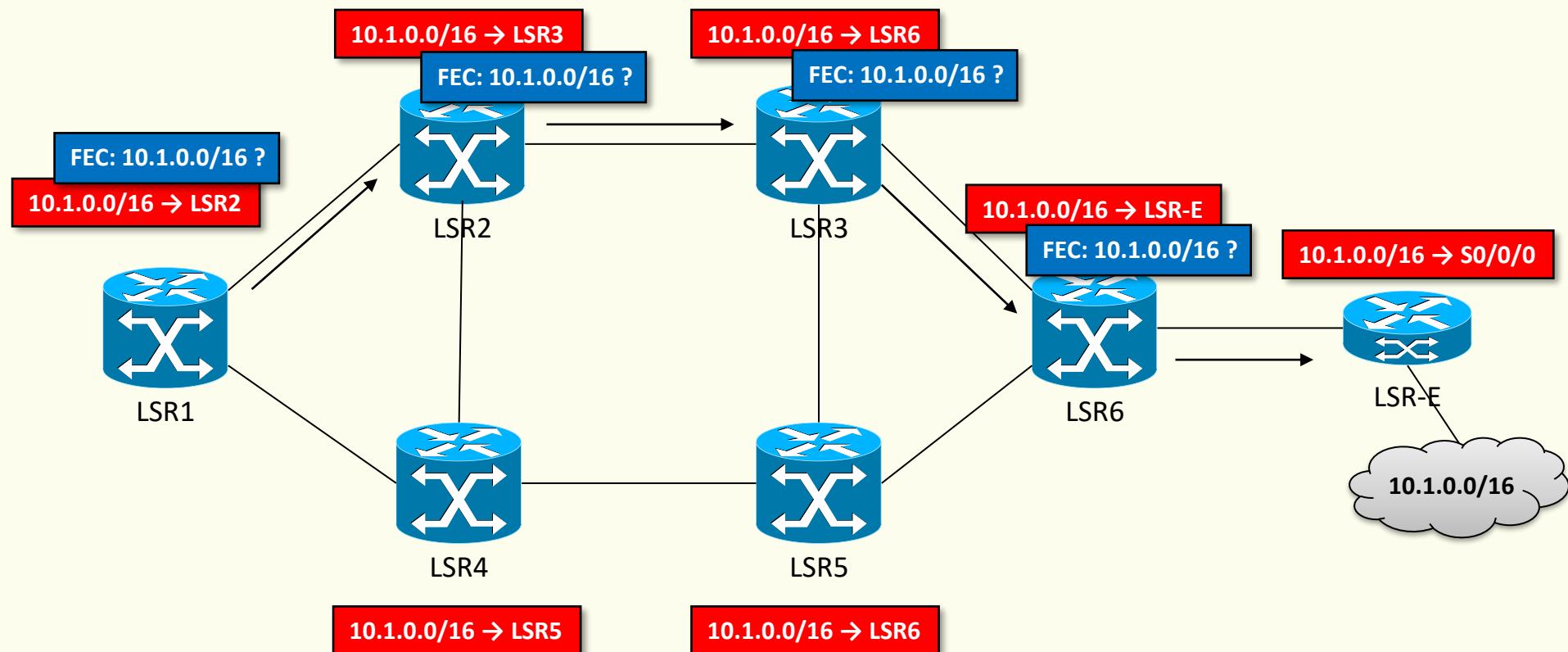


Ordered control



- Downstream on-demand

ROUTING TABLE (IGP)

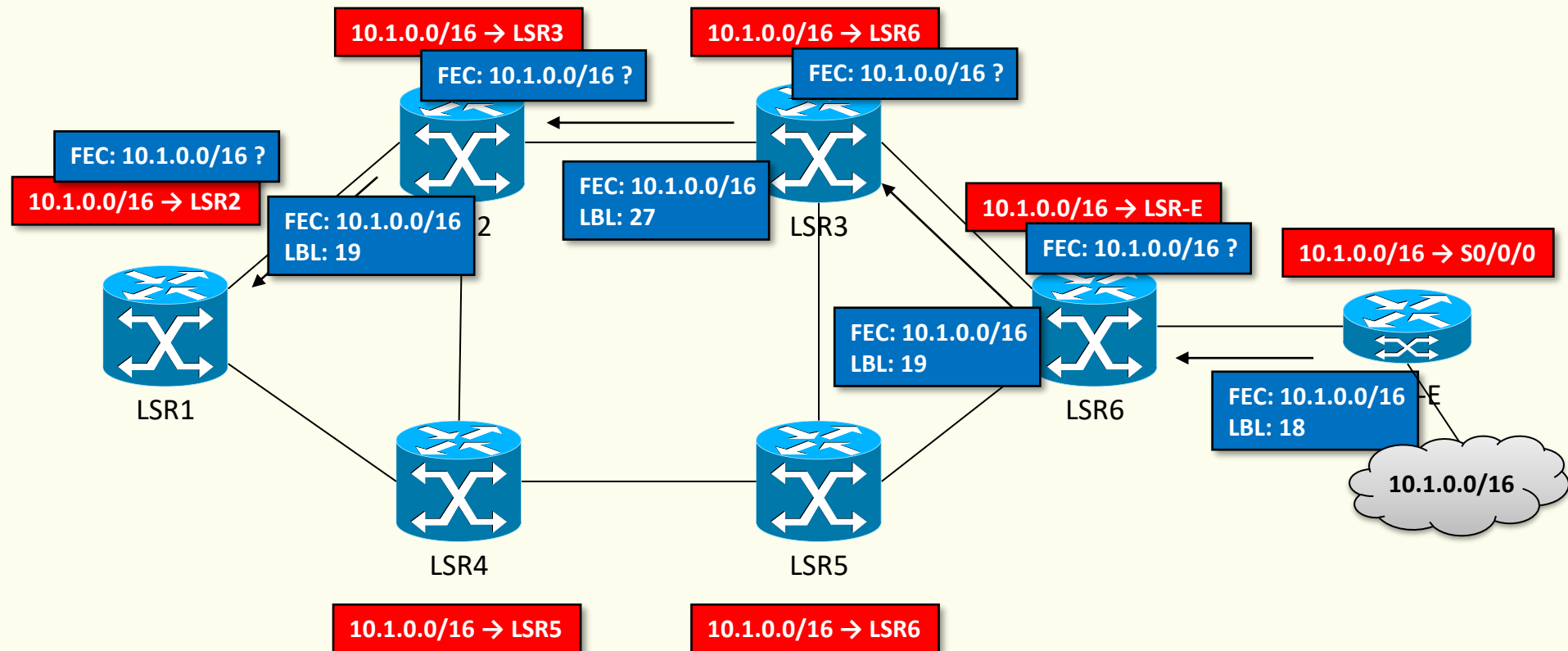


Ordered control



- Downstream on-demand

ROUTING TABLE (IGP)

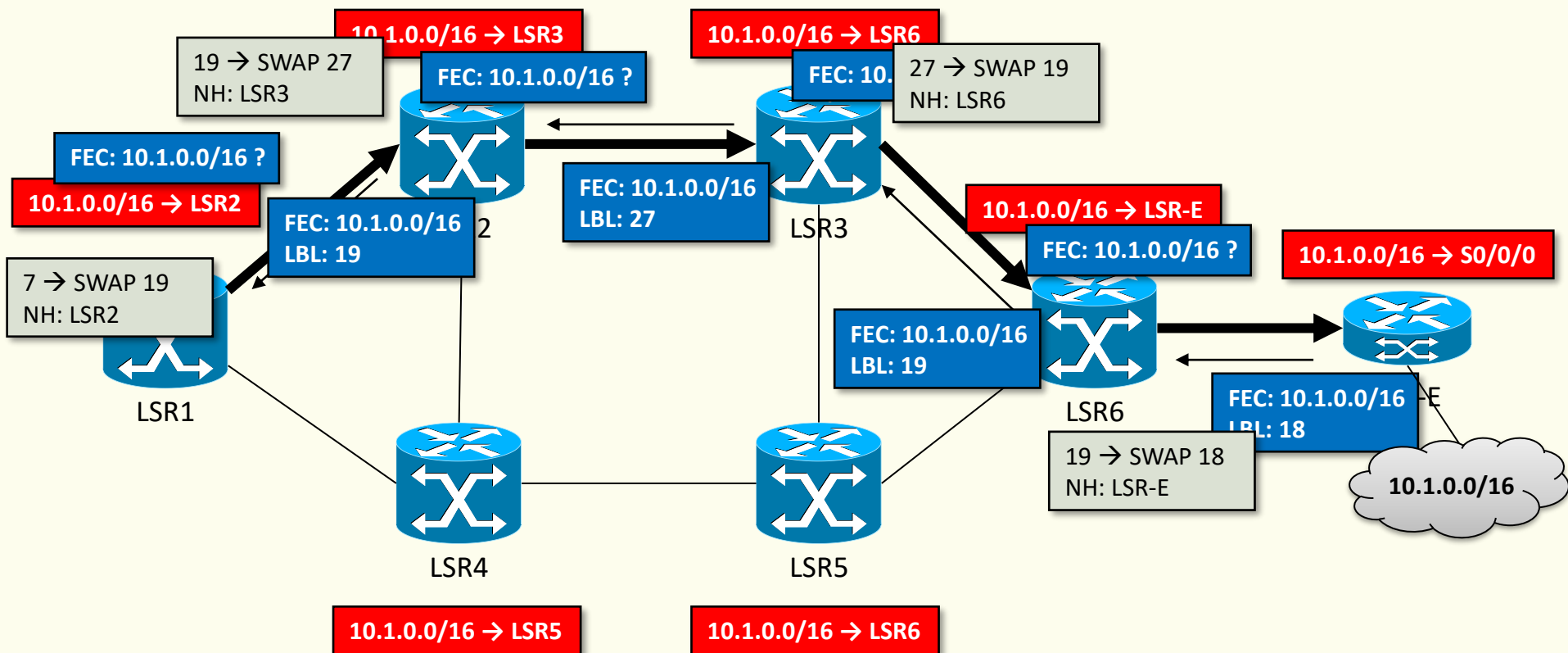


Ordered control



- Downstream on-demand

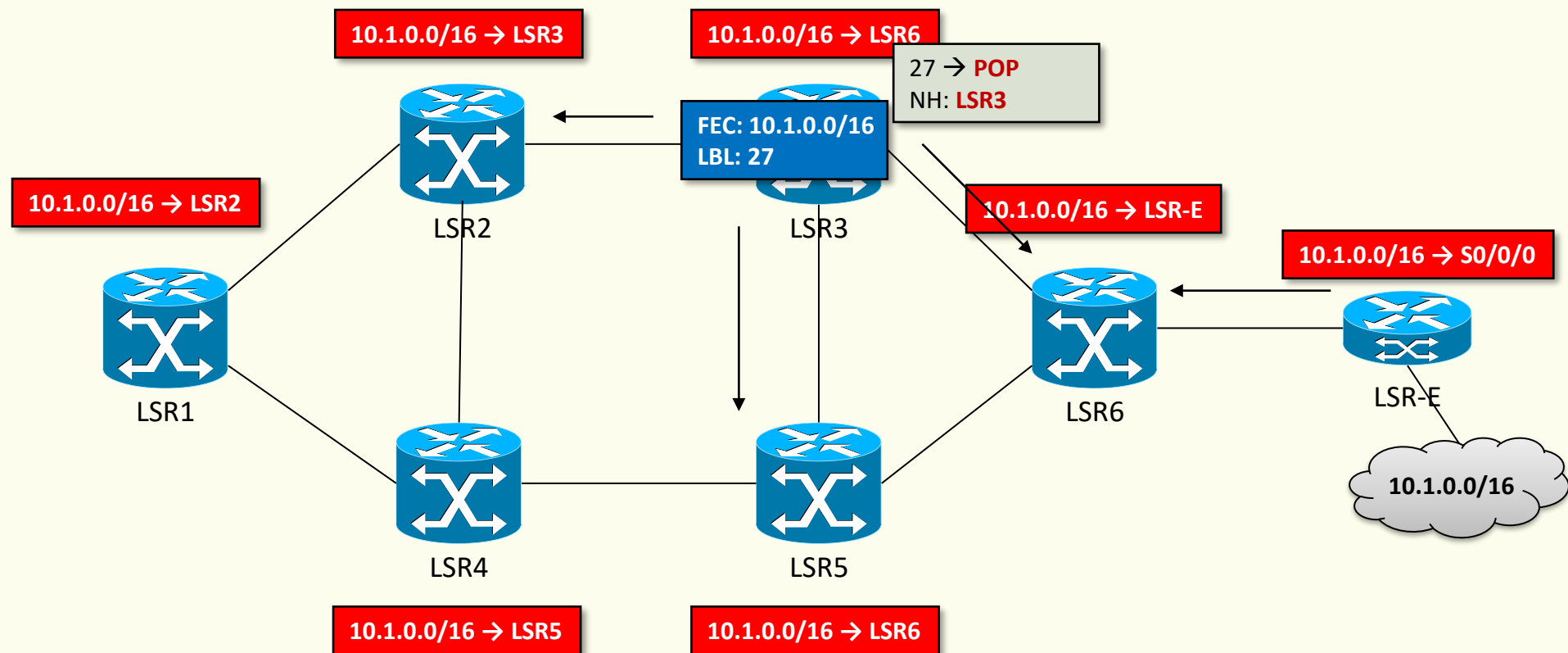
ROUTING TABLE (IGP)



Independent control

- Unsolicited downstream

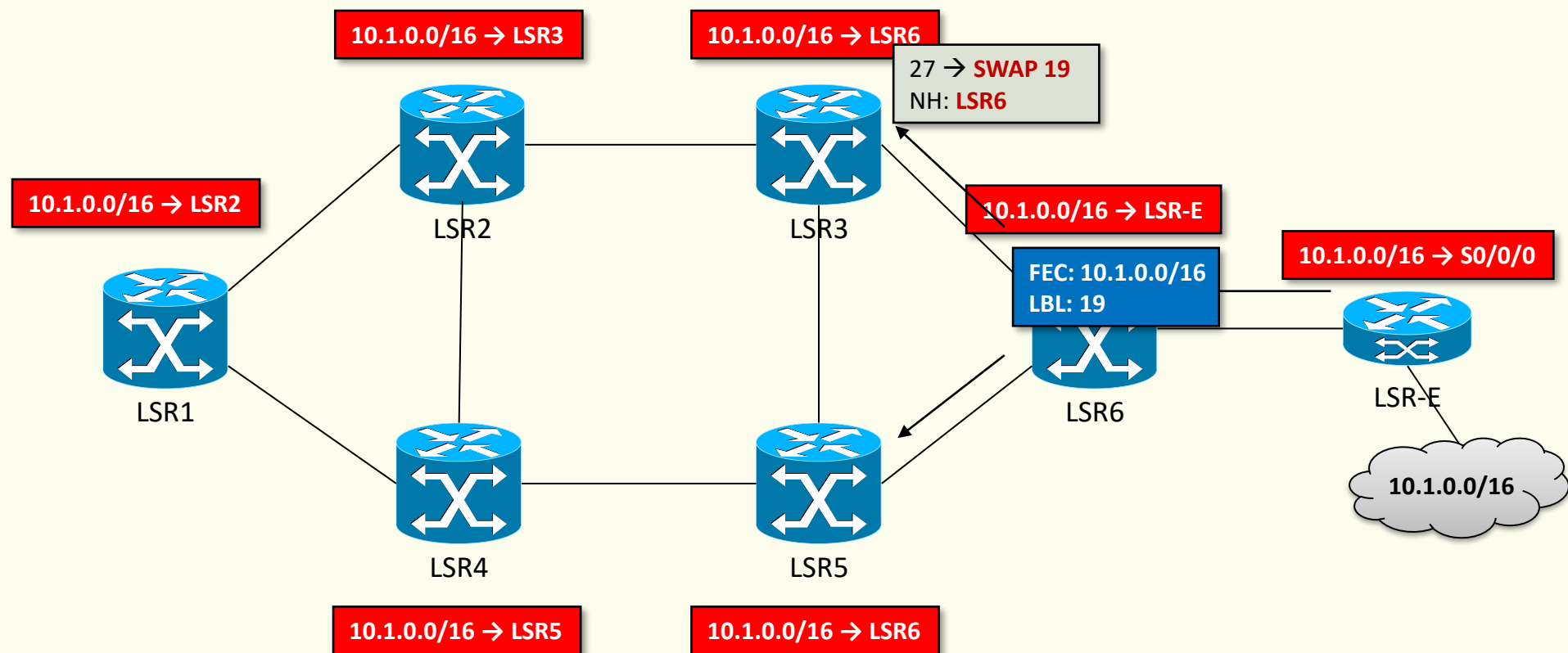
ROUTING TABLE (IGP)



Independent control

- Unsolicited downstream

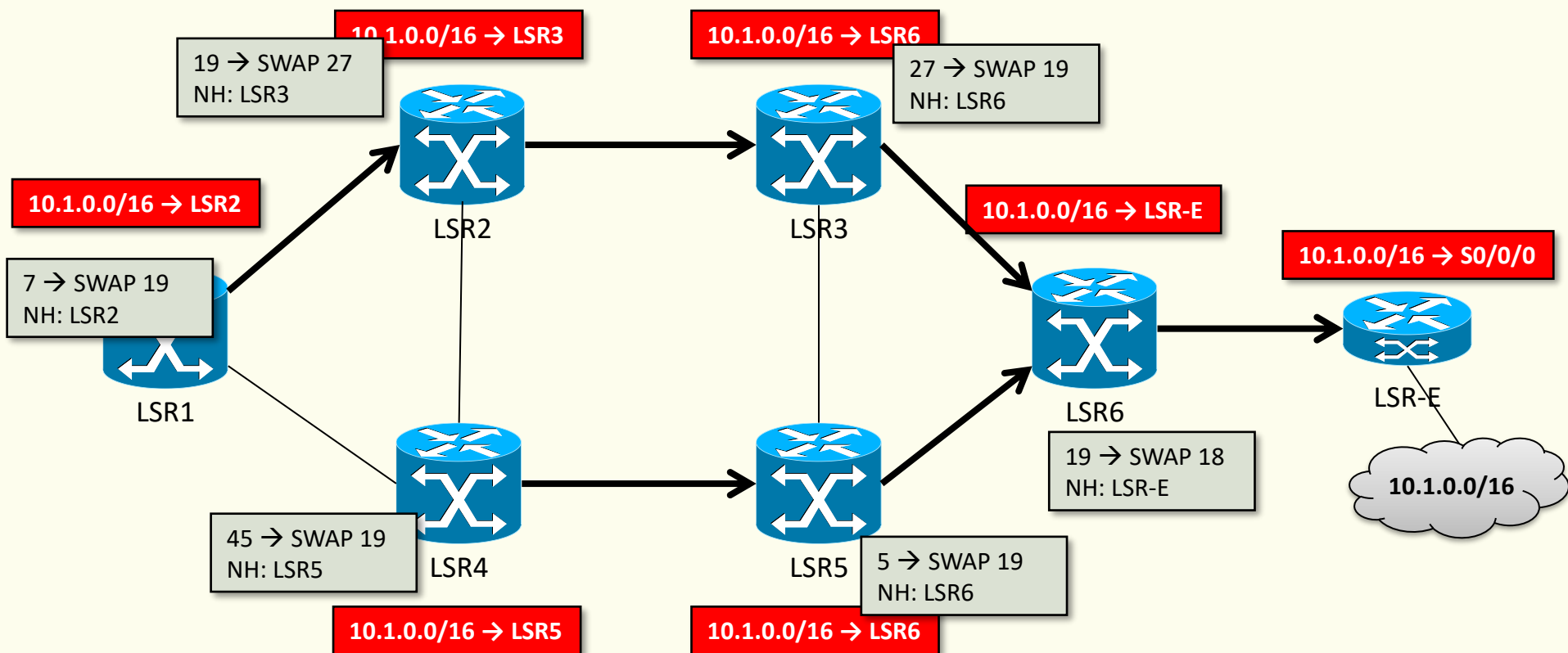
ROUTING TABLE (IGP)



Independent control

- Unsolicited downstream

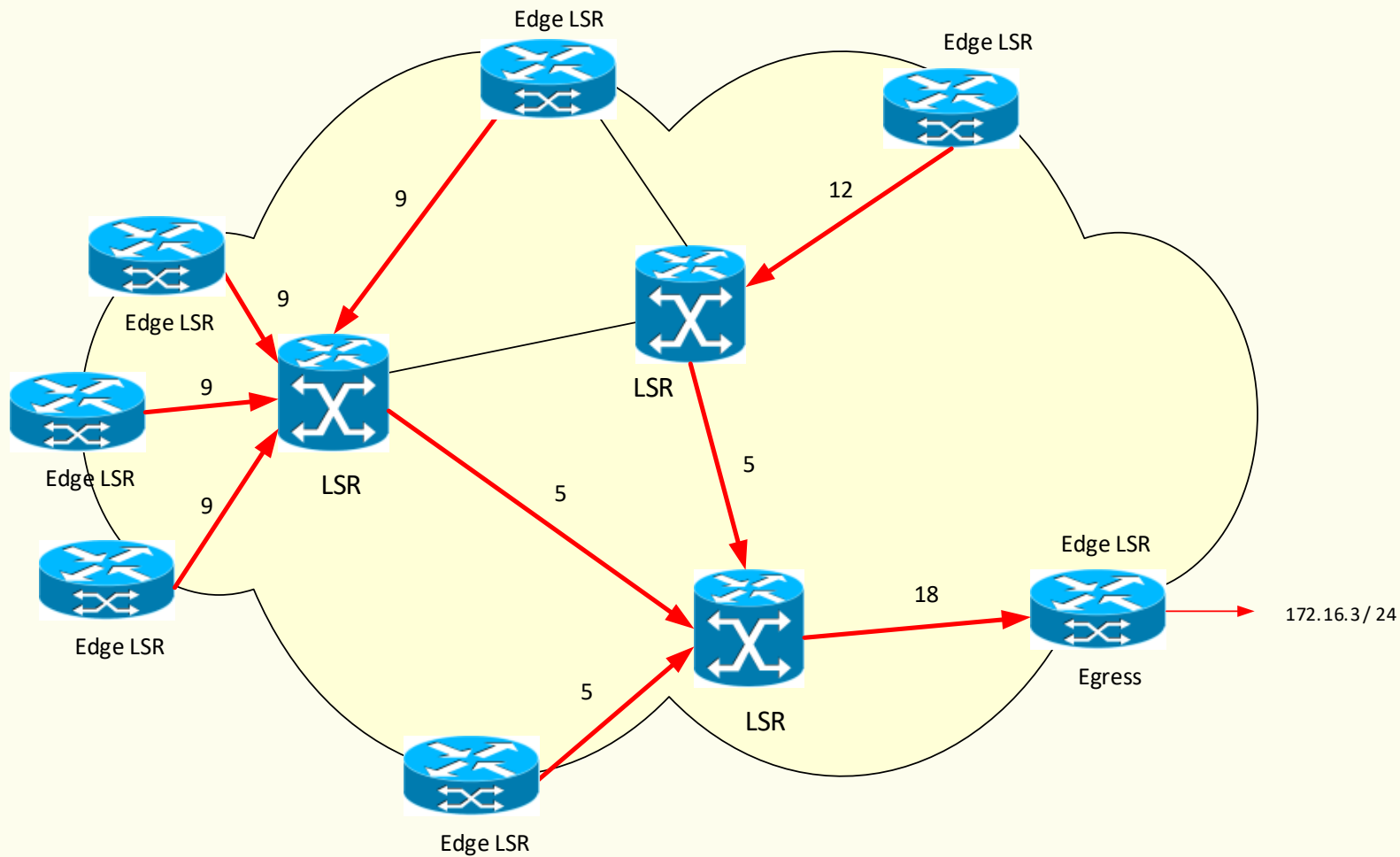
ROUTING TABLE (IGP)



LSP setup control

- Which FEC to advertise a binding for?
- When to advertise this binding?
- **Ordered control**
 - Egress (or Ingress) LSRs have control over which LSP are setup
 - Default behaviour: FEC mapping to the LSR loopback address
- **Independent control**
 - All routers advertise FECs independently (but it should be in a consistent manner)
 - Default behaviour: FEC mapping for all prefixes in the routing table

Aggregation (MP2P)

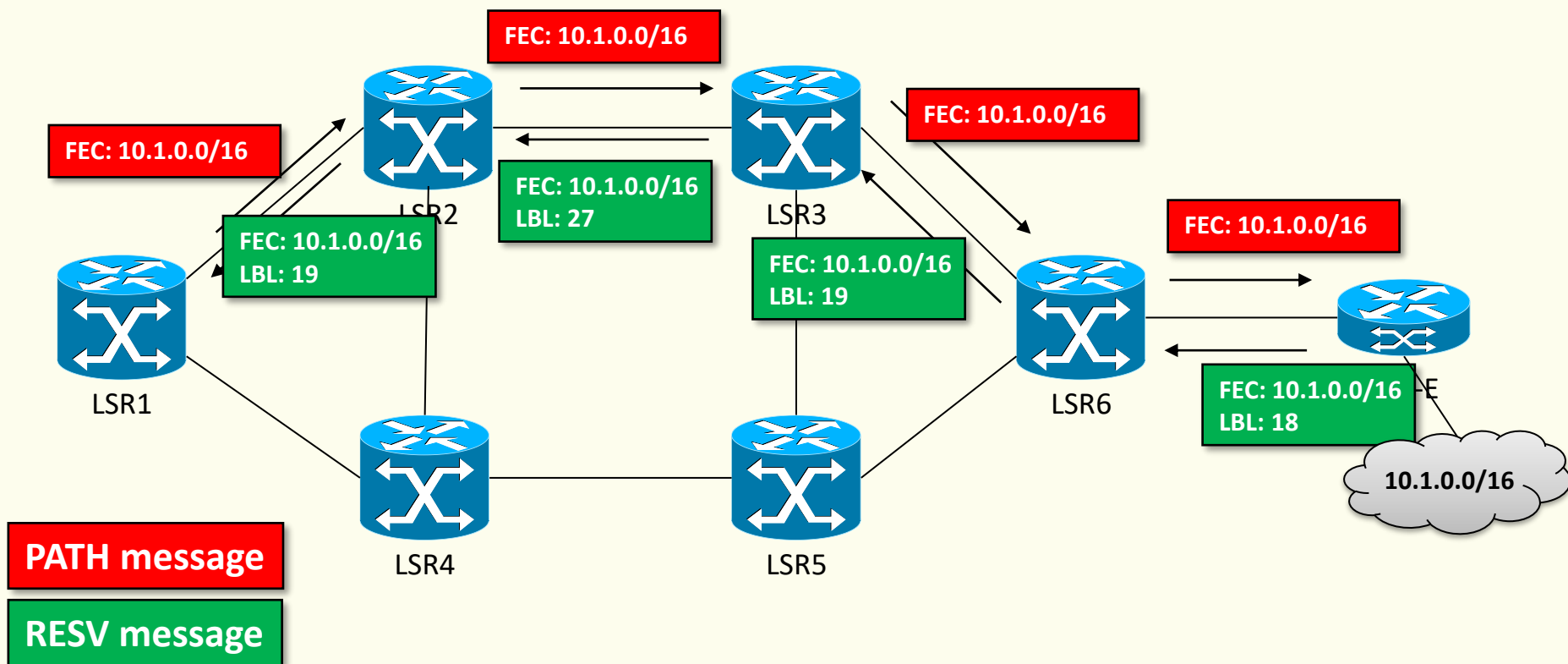


LDP - Label Distribution Protocol

- Specifically designed for label distribution
- Relies on an IGP for all routing-related decisions
 - LSR A that receives a mapping for label L for FEC F from its LDP peer LSR B will use label L for forwarding if and only if B is on the IGP shortest path for destination F from A's point of view
- Major functions (with related messages)
 - Neighbour discovery (UDP)
 - Session establishment and maintenance (TCP)
 - Label advertisement
 - Notification

RSVP for label distribution

- Ordered control with downstream on-demand



References

- I. Minei and J. Lucek, **MPLS-Enabled Applications: Emerging Developments and New Technologies**, 3rd Edition, Wiley, Dec. 2010
- RFCs
 - **RFC3031**, Multiprotocol Label Switching Architecture, Jan. 2001
 - **RFC3032**, MPLS Label Stack Encoding, Jan. 2001
 - **RFC5036**, LDP Specification, Oct. 2007