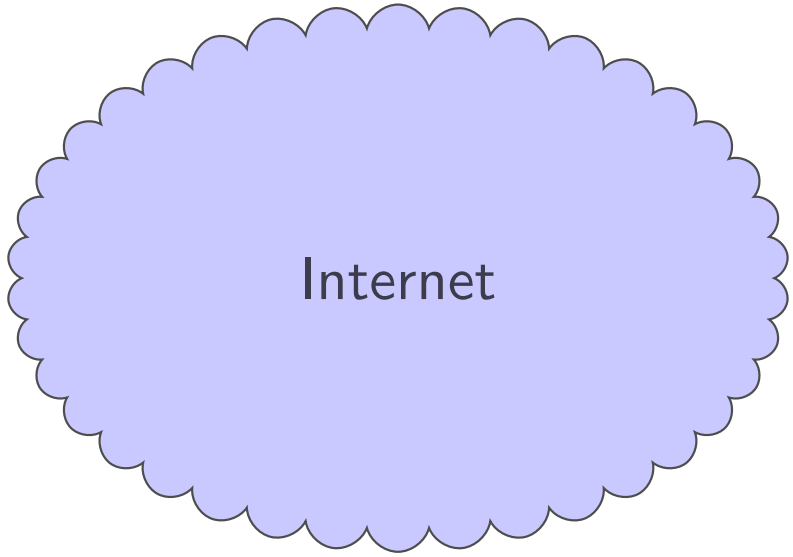
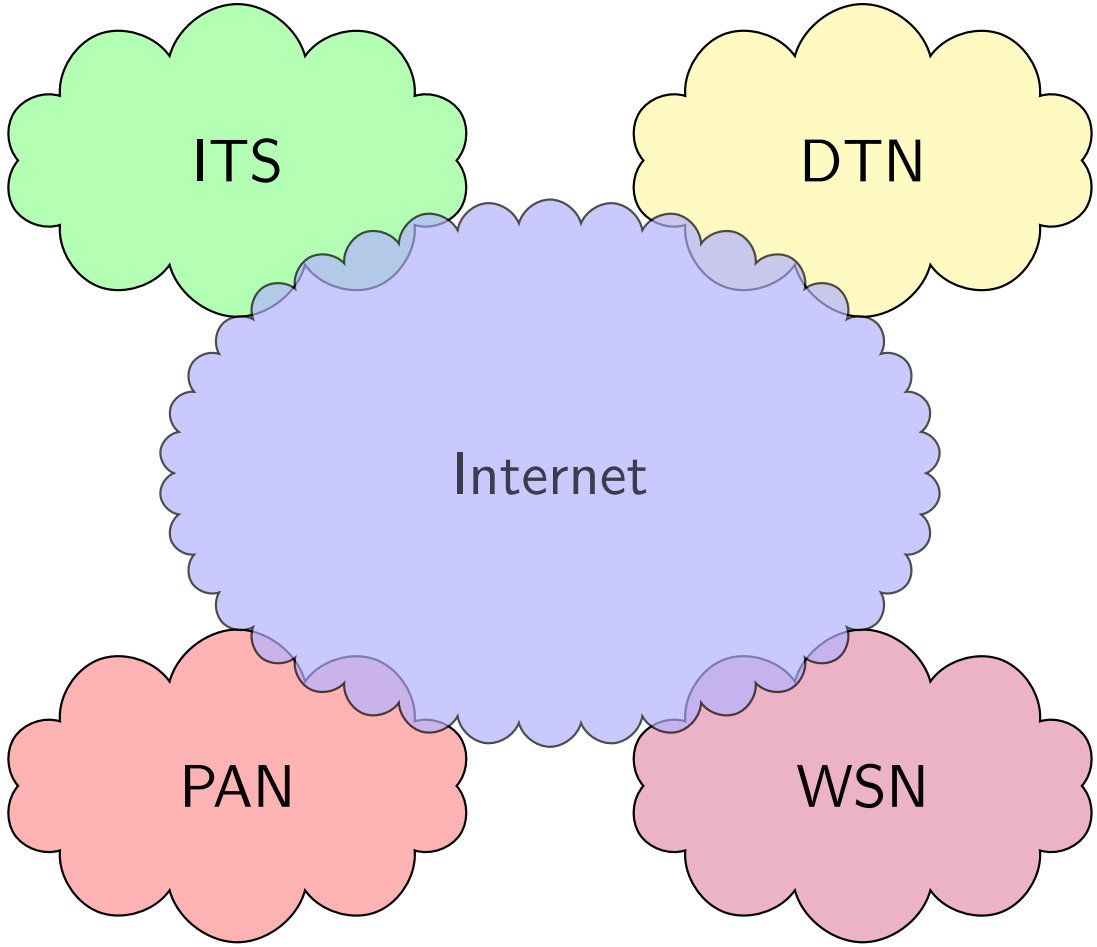
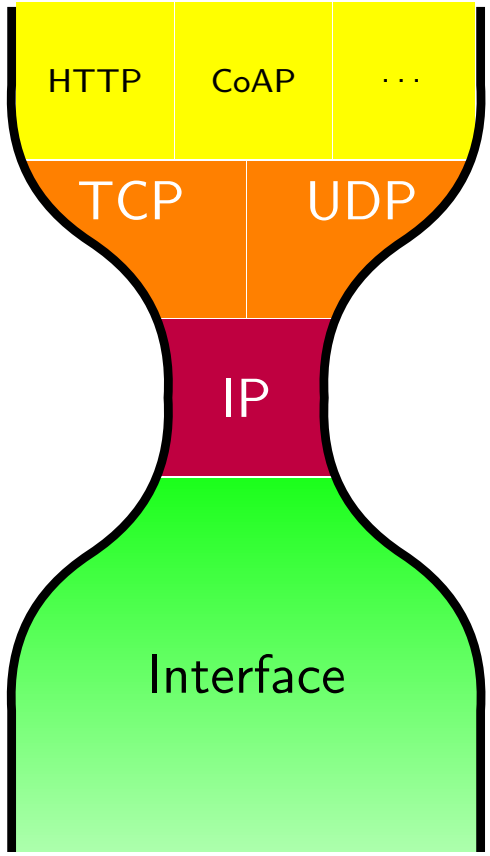
La Frange Polymorphique de l'Internet

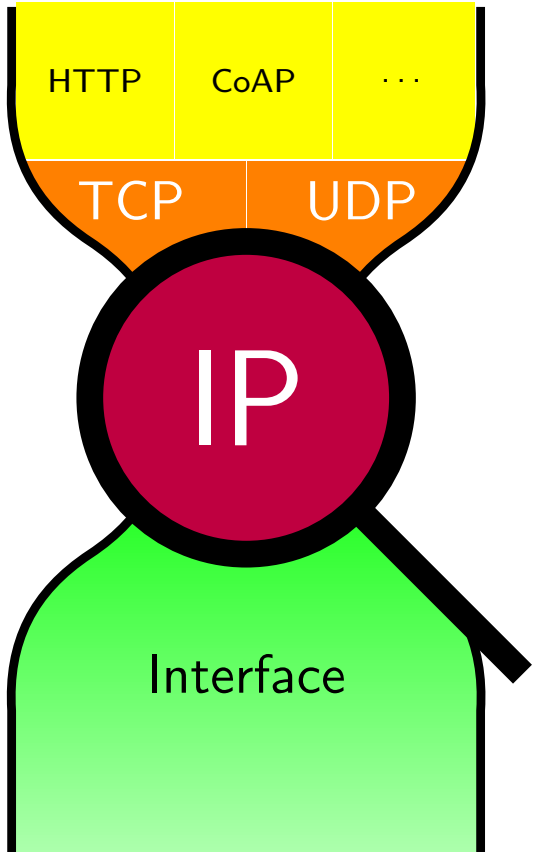
Laurent Toutain, Pascal Thubert

June 26, 2013


Internet


ITS
DTN
Internet
PAN
WSN


HTTP
CoAP
· · ·
TCP
UDP
IP
Interface


HTTP
CoAP
· · ·
TCP
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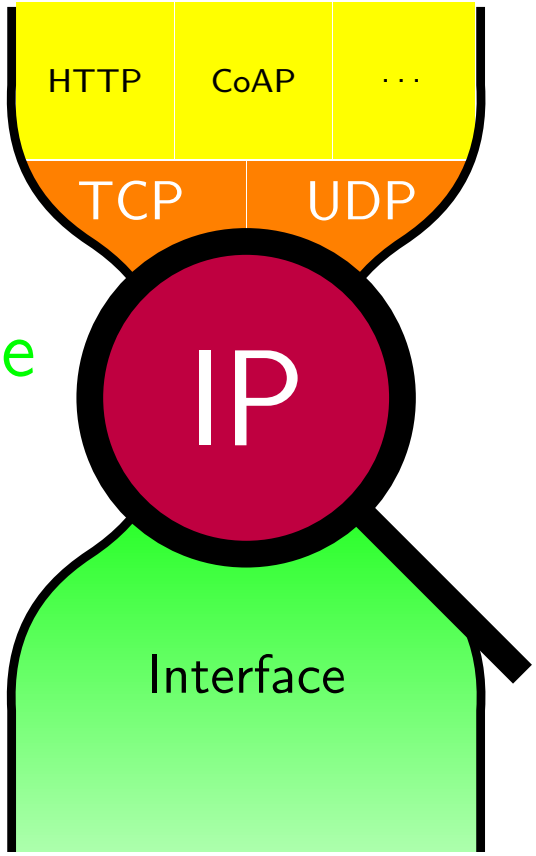
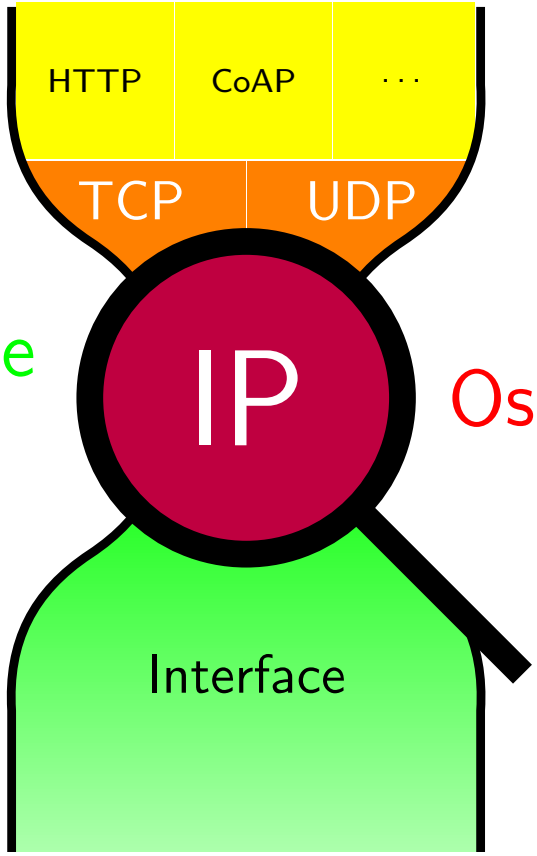
Interface

Common Language Interconnection



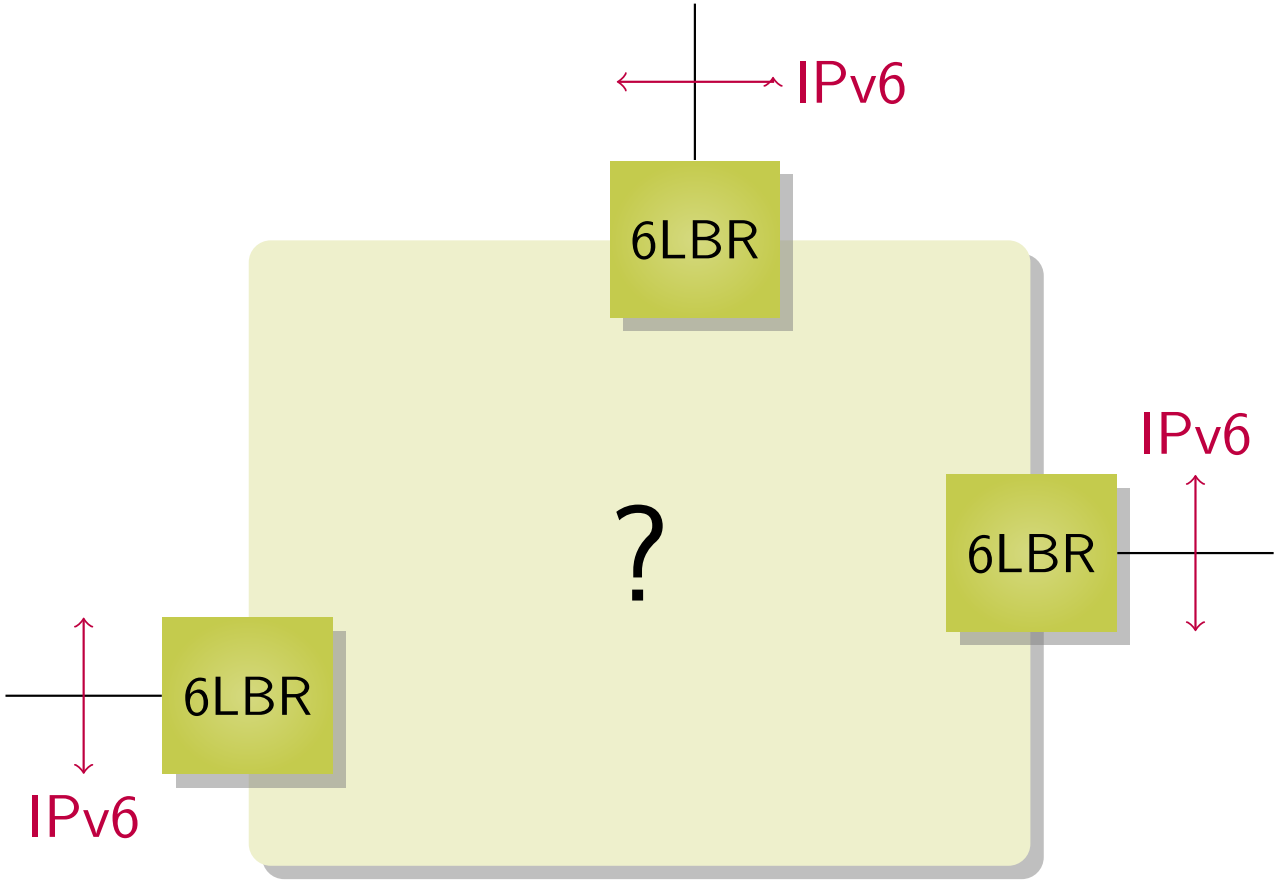
Common Language
Interconnection

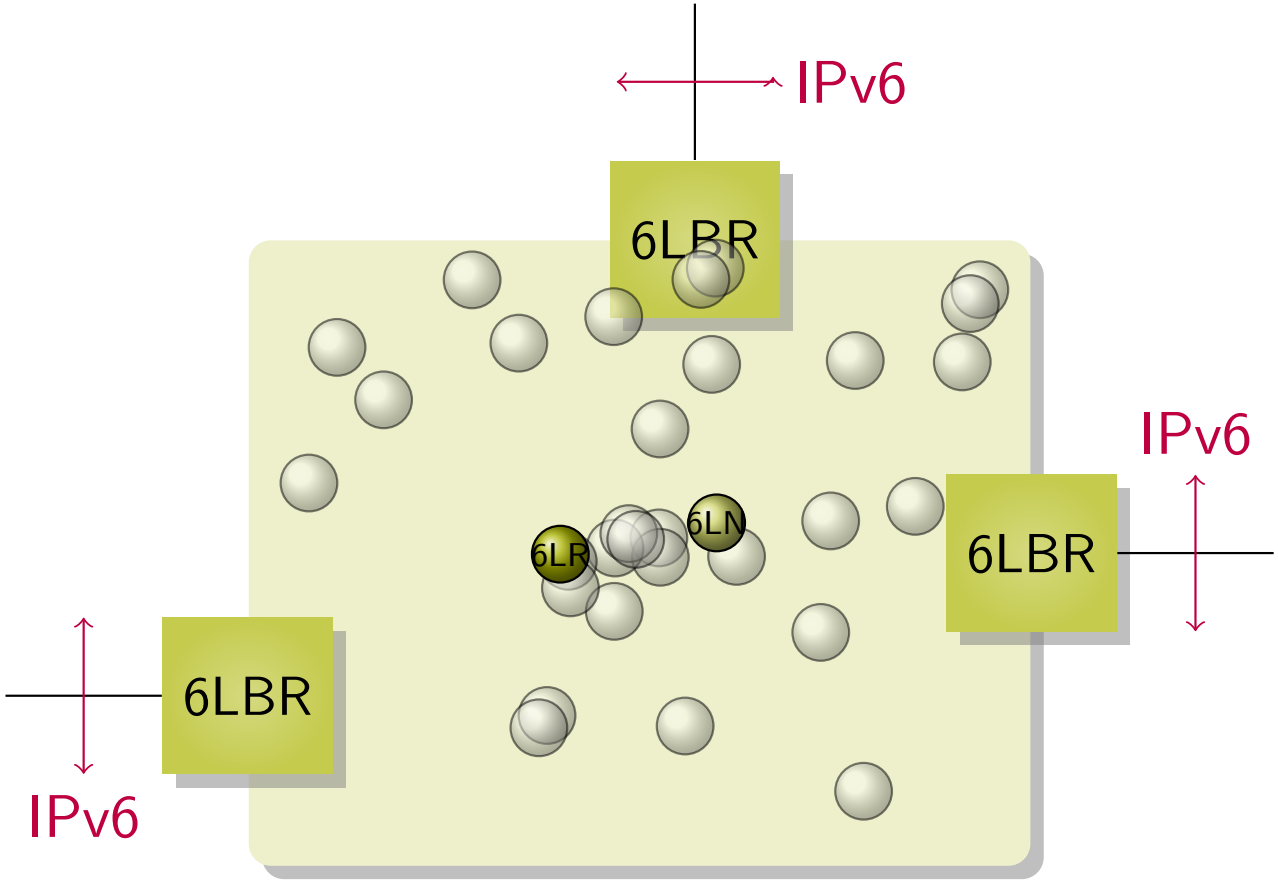


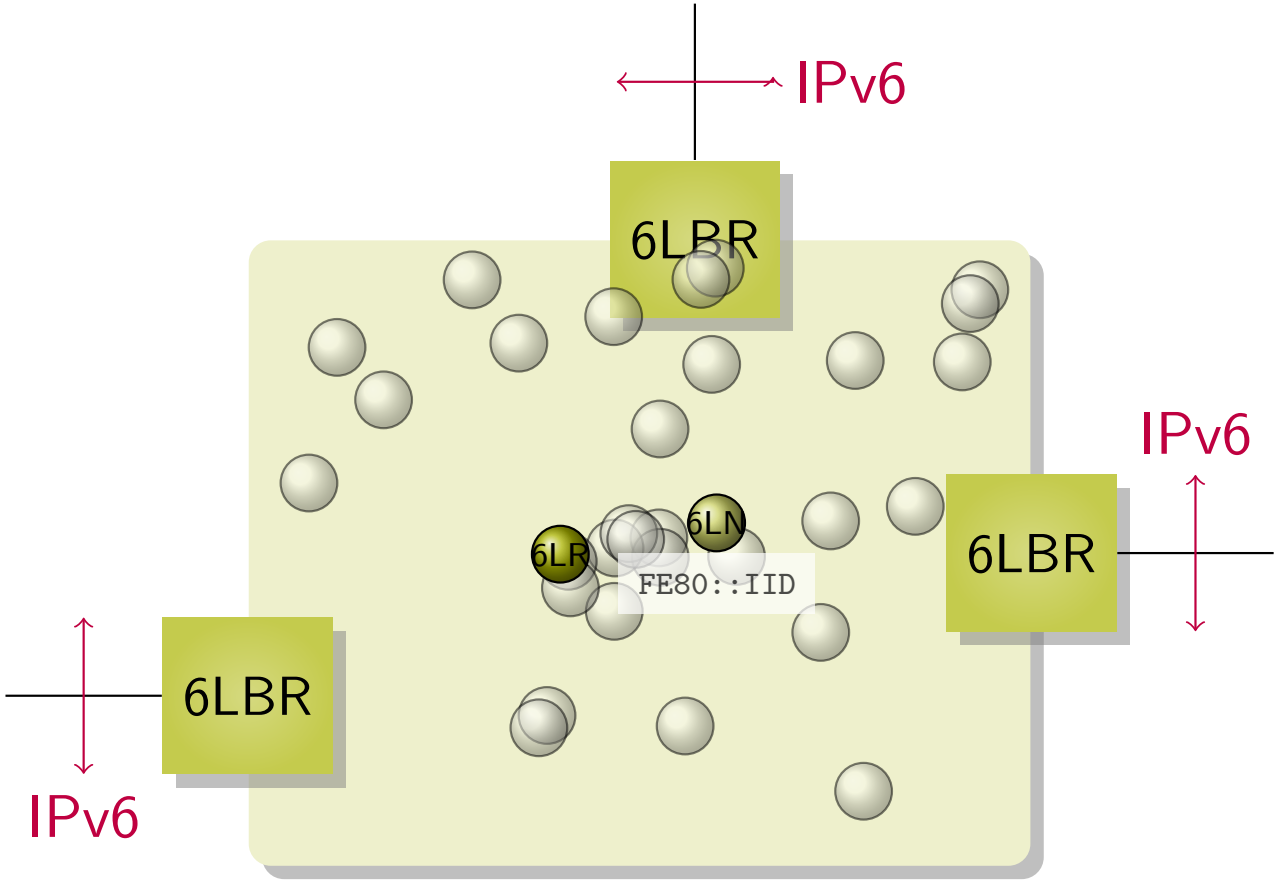
Ossification

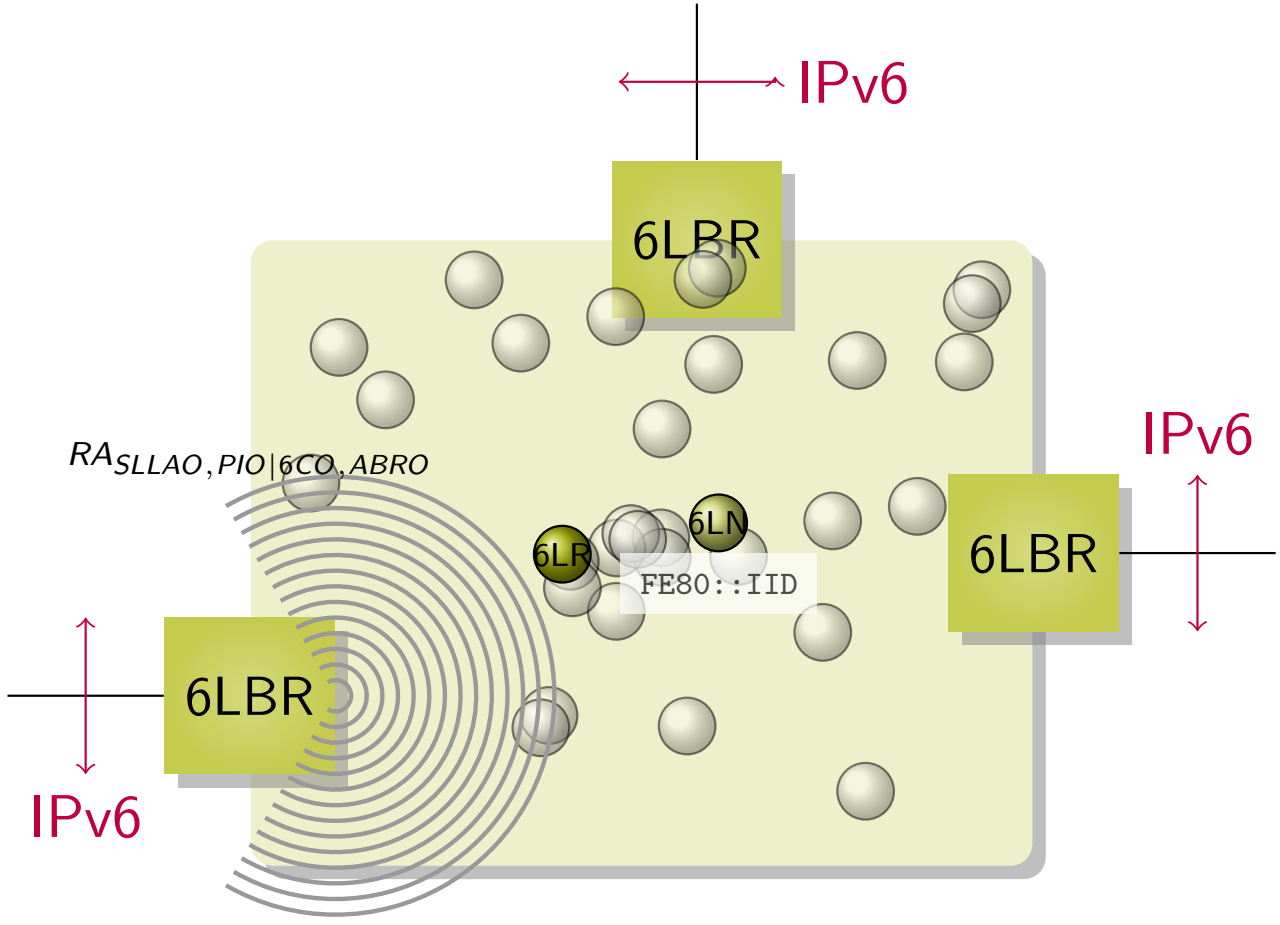
ARESA2 Project

- ANR Verso 2009 project
- Urban Wireless Sensor Networks
  - AMI, Smart Grid, M2M...
- One of the challenges: IPv6
  - Mesh network.
  - Minimize code footprint, minimize energy consumption.

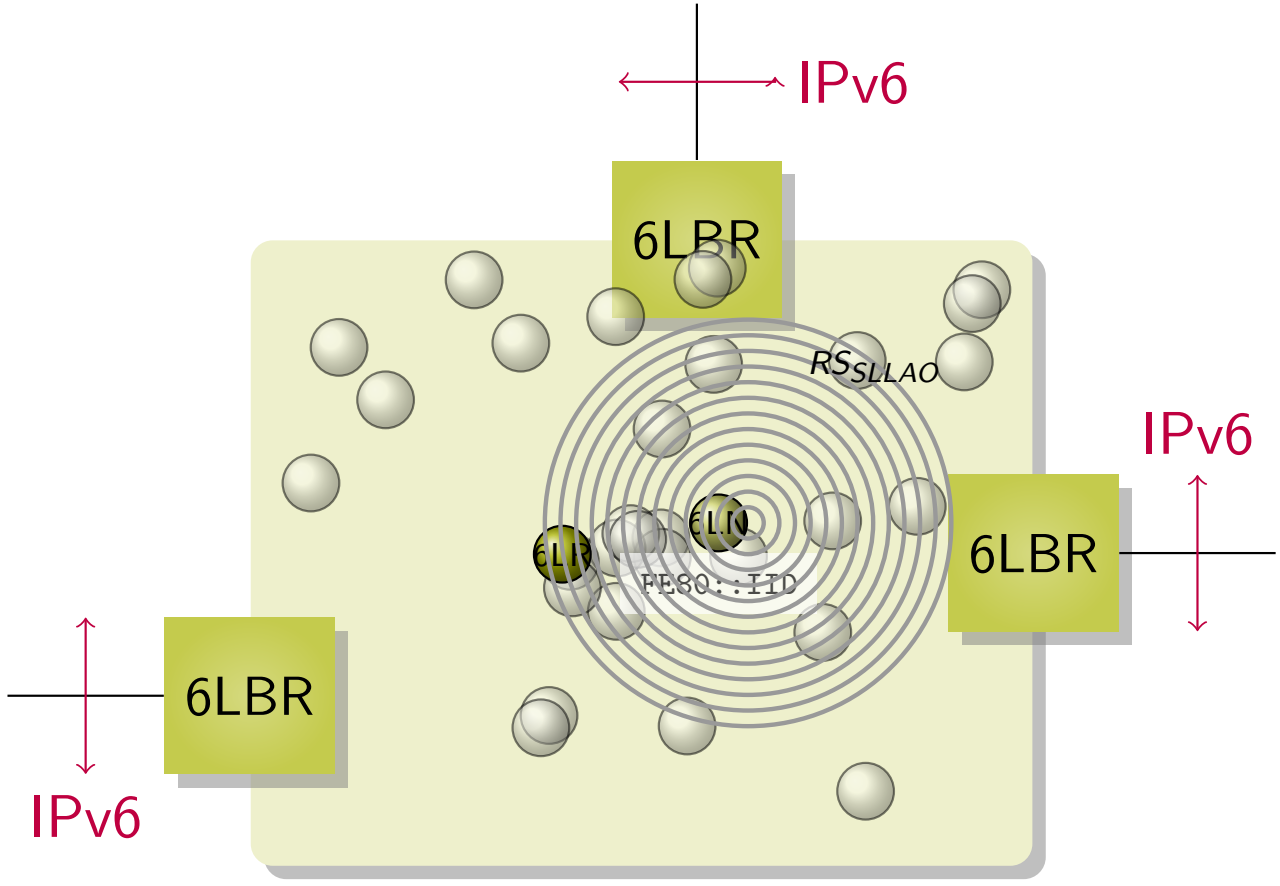

IPv6
6LBR
?
IPv6
6LBR
6LBR
IPv6


IPv6
6LBR
IPv6
6LBR
6LN
6LR
6LBR
IPv6


IPv6
6LBR
IPv6
6LBR
6LN
6LR
FE80::IID
6LBR
IPv6



SLLAO: Source Link-layer Address, **PIO**: Prefix Information, **6CO**: 6LoWPAN Context, **ABRO**: Authoritative Border Router



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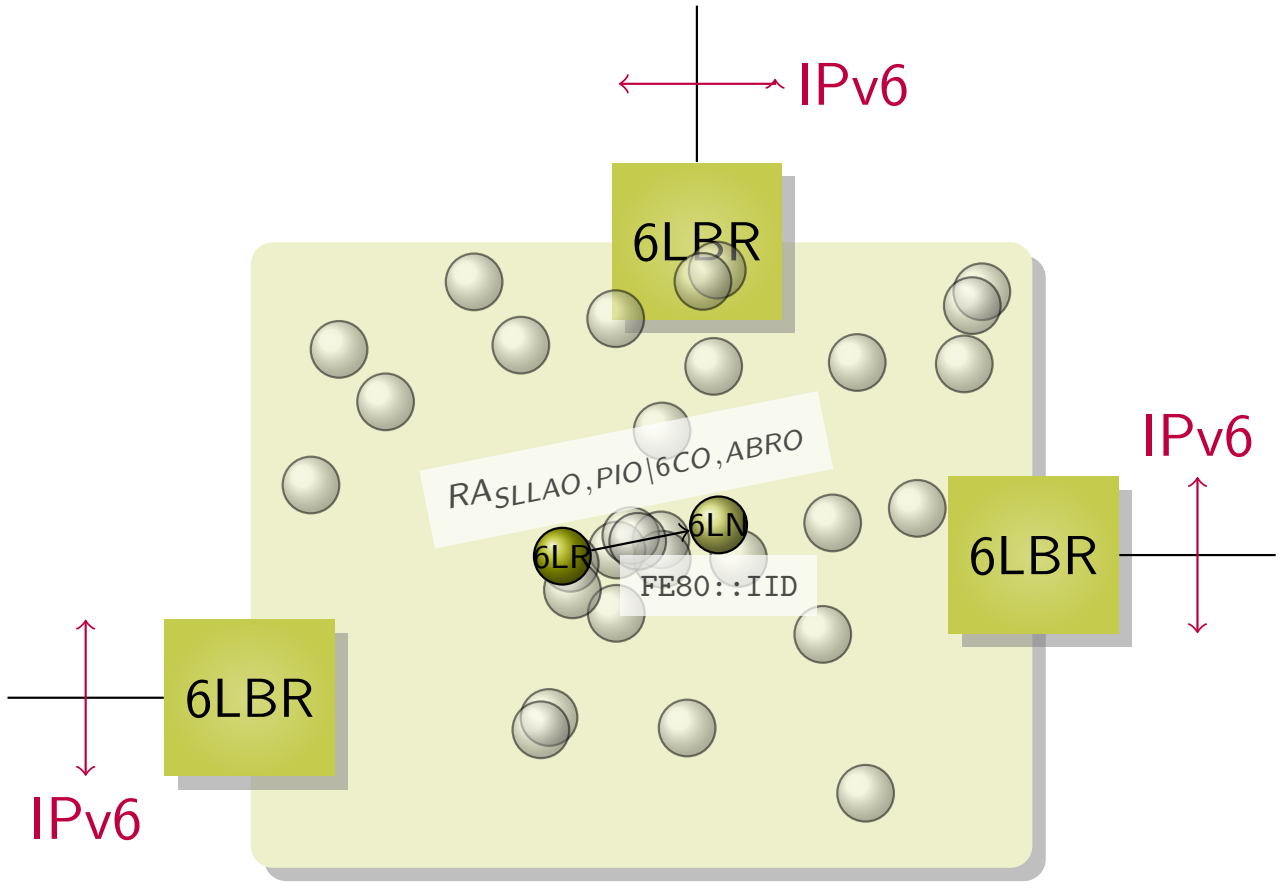

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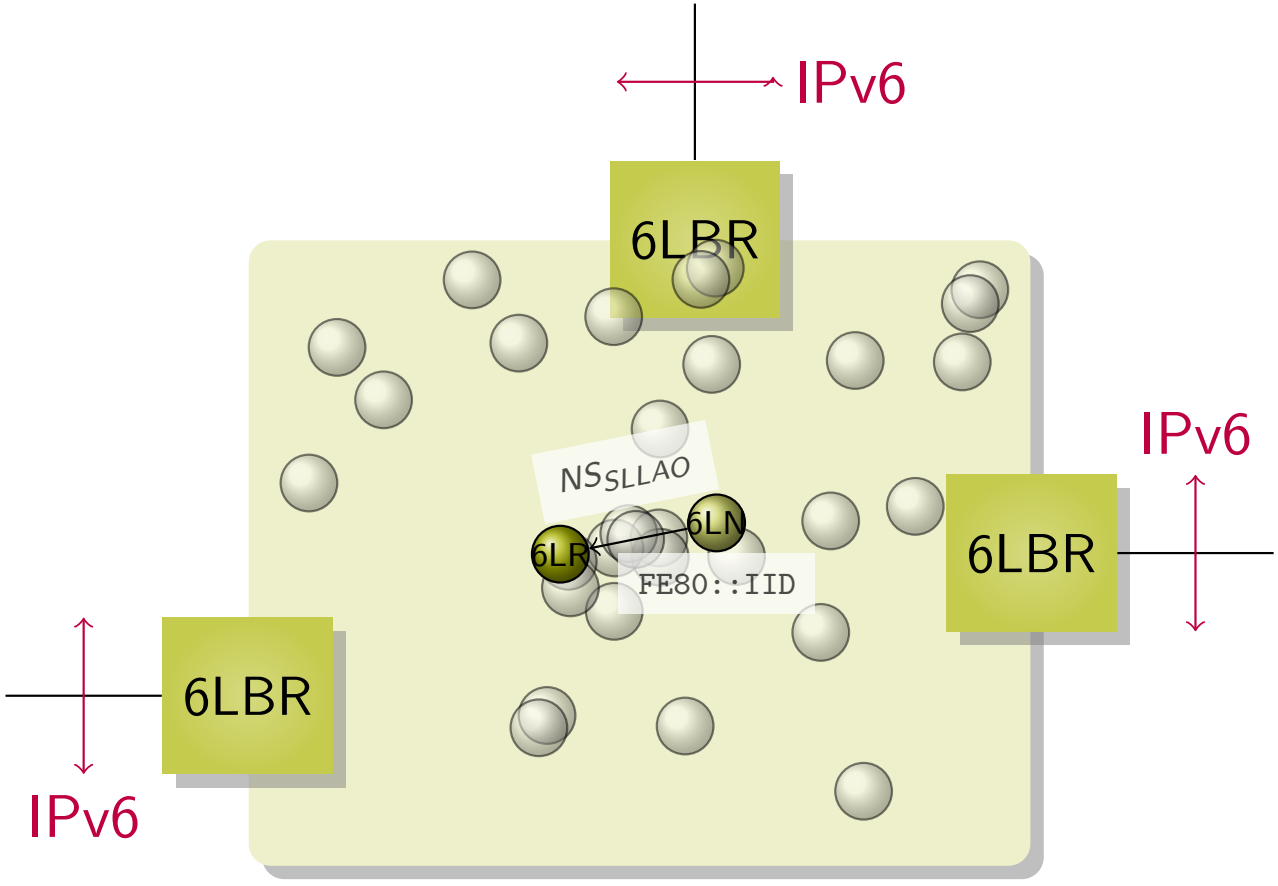
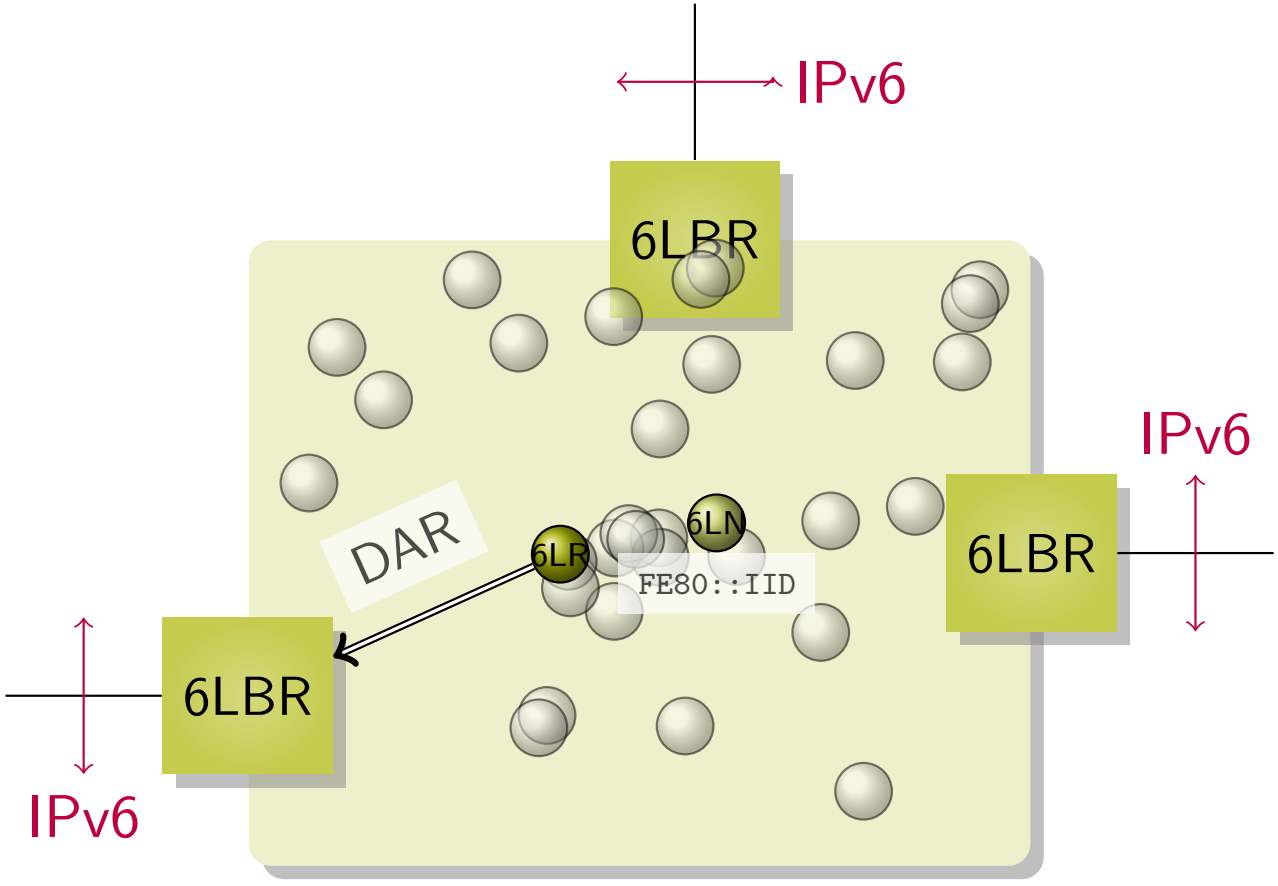
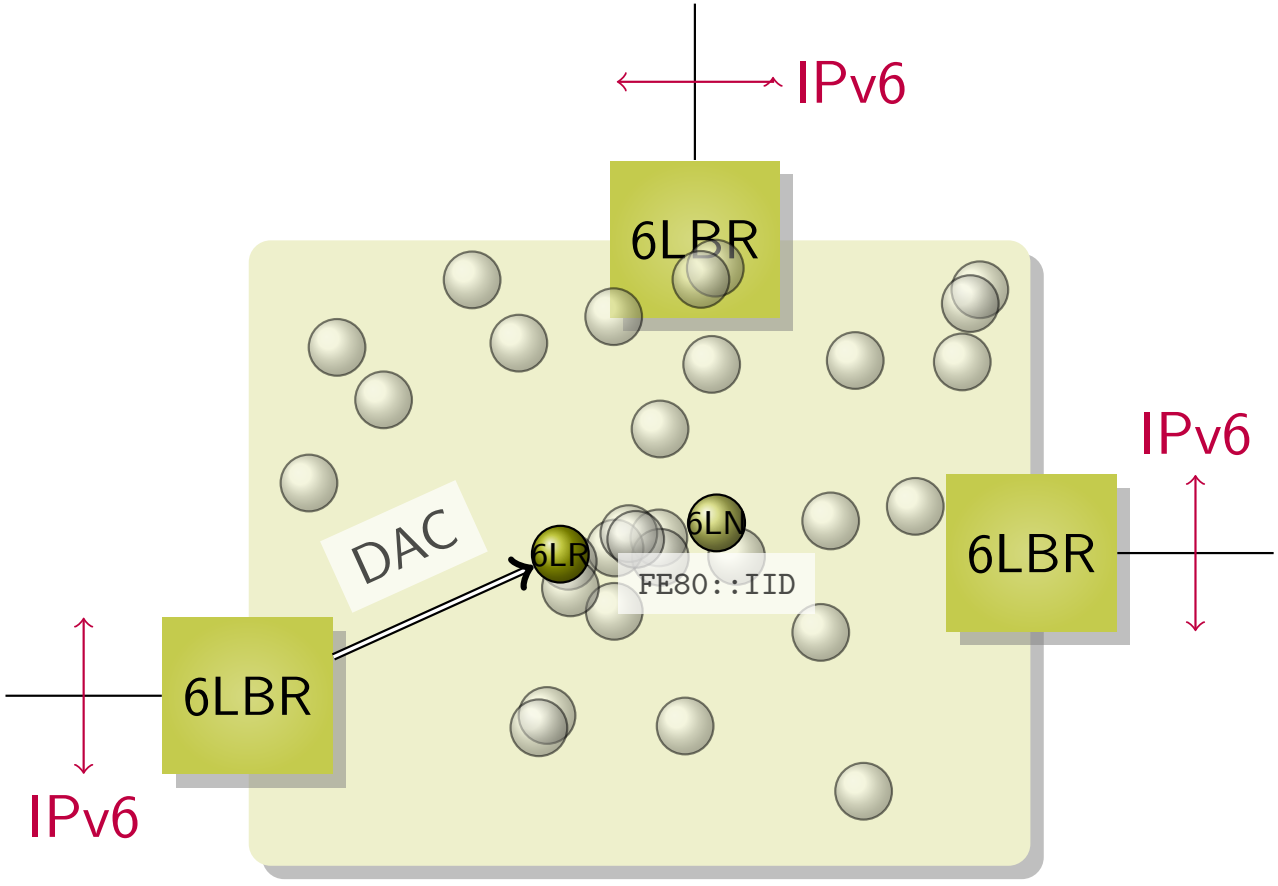
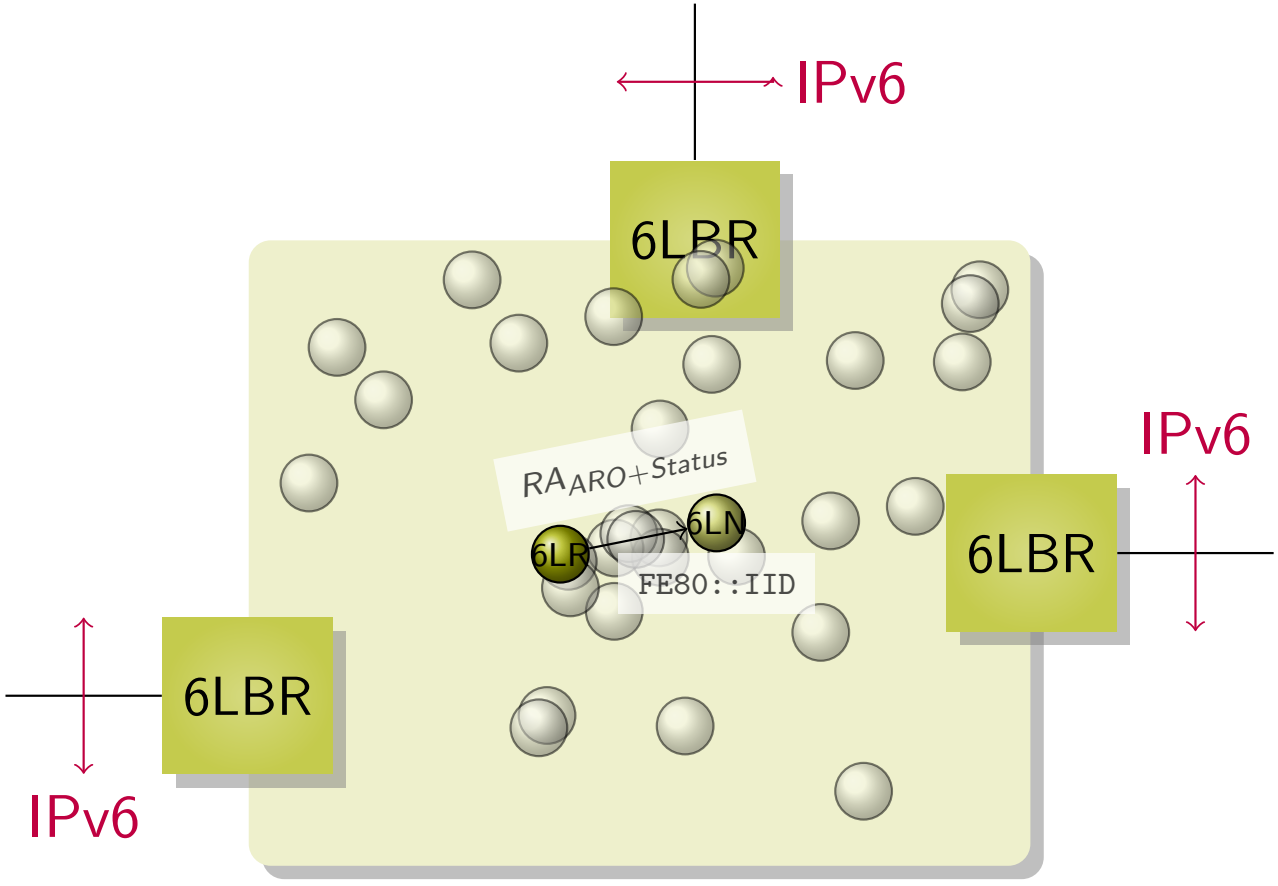

IPv6
6LBR
IPv6
NSSLLAO
6LN
6LR
FE80::IID
6LBR
6LBR
IPv6

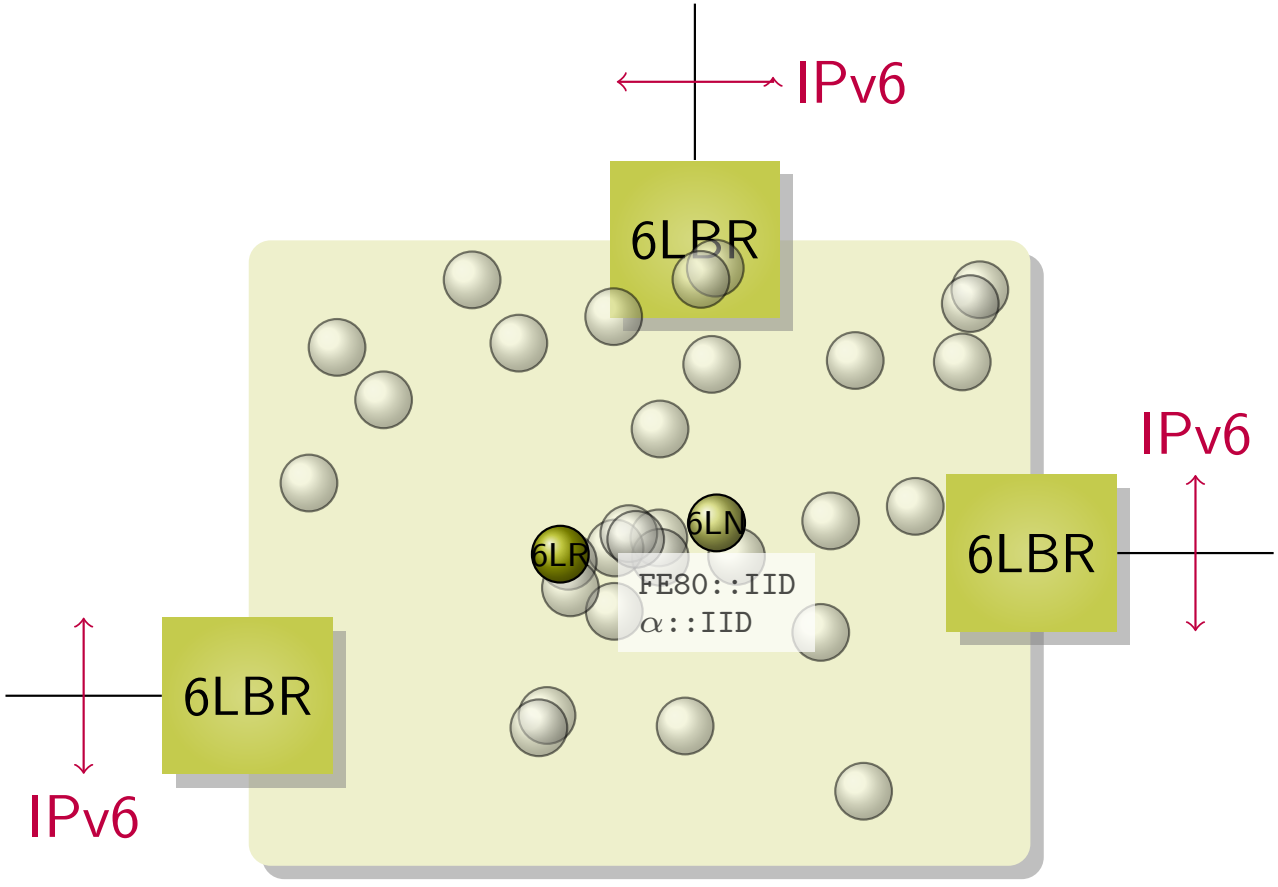


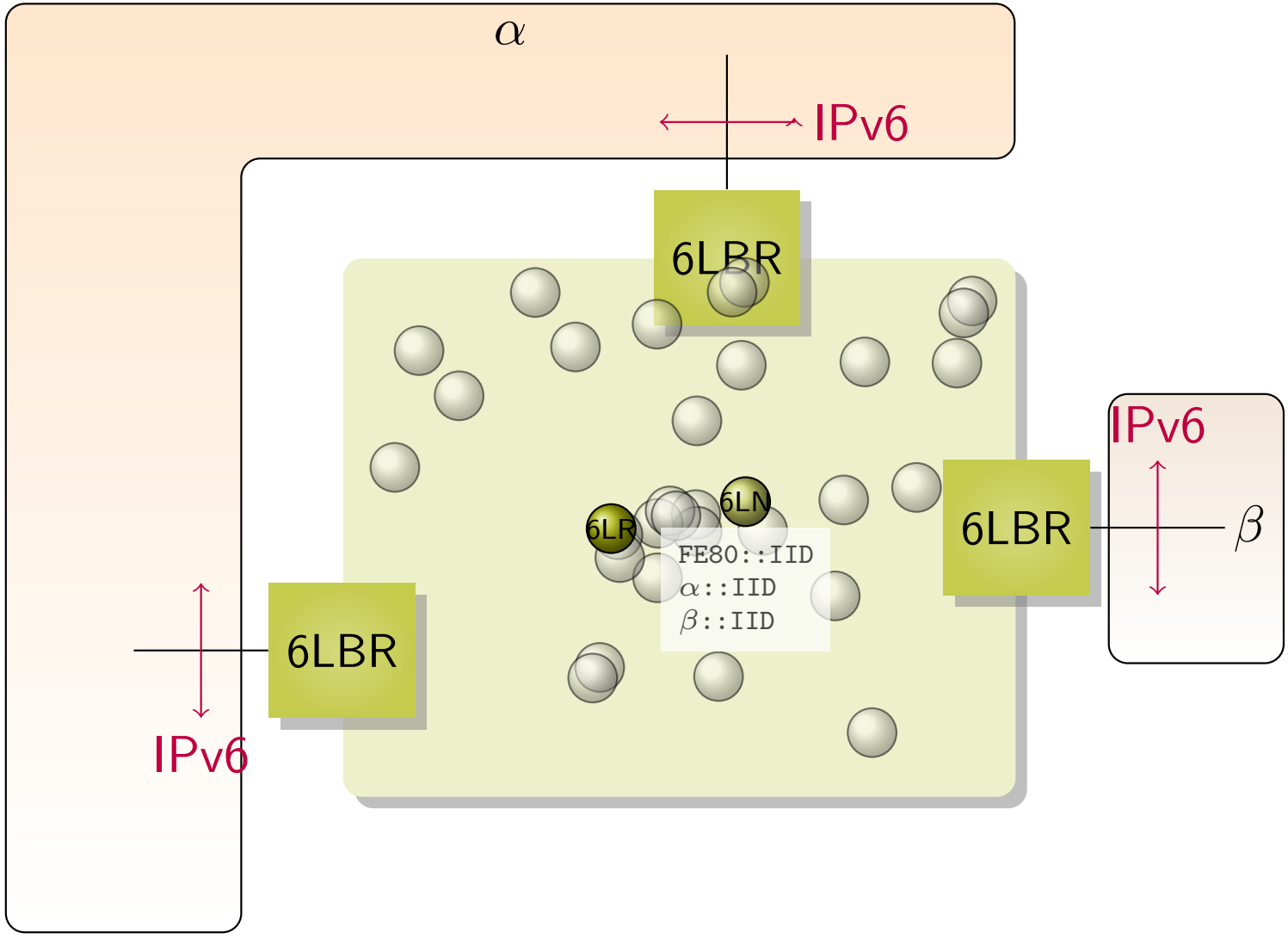
DAR: Duplicate Address Request

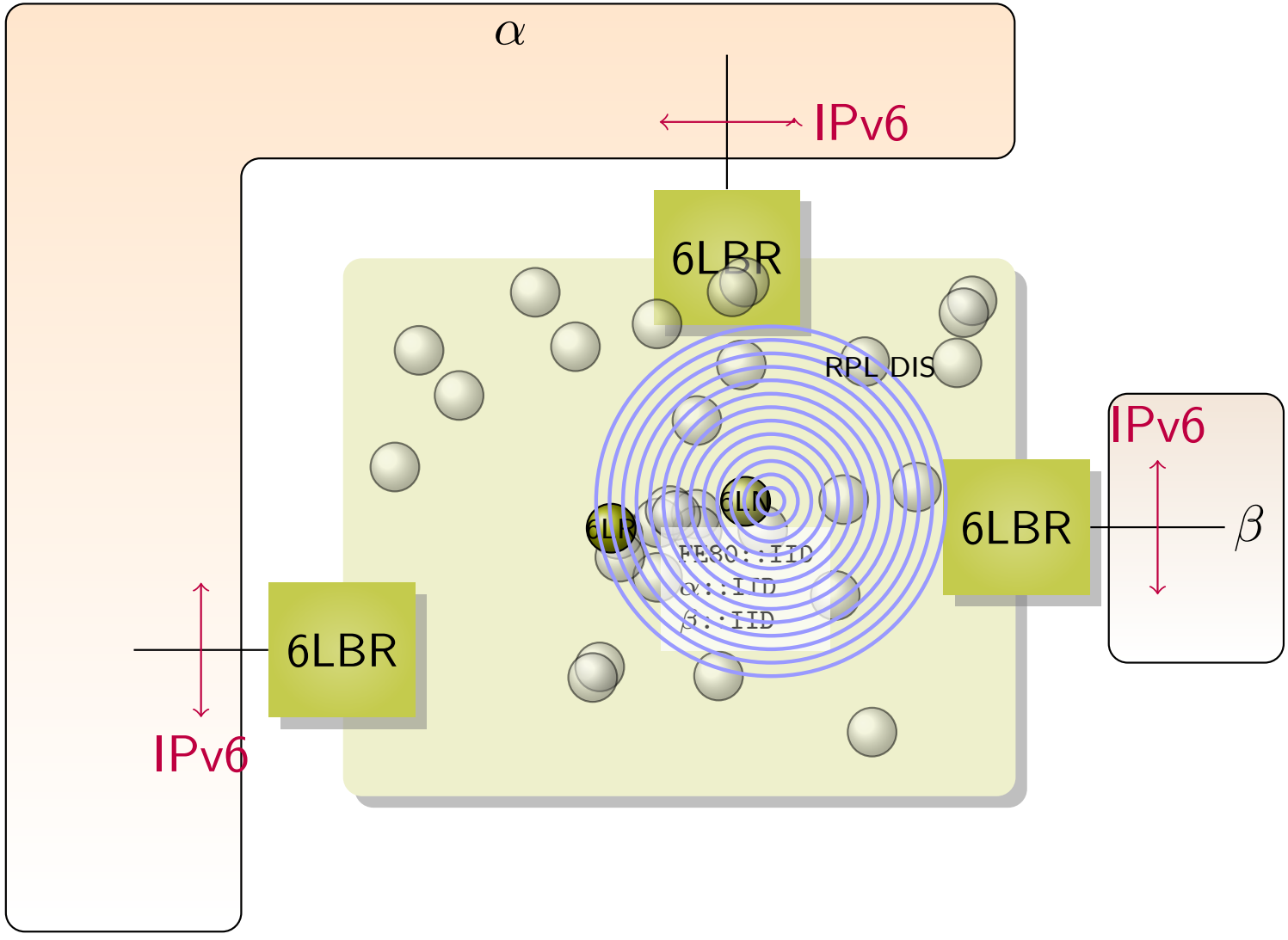


DAC: Duplicate Address Confirmation

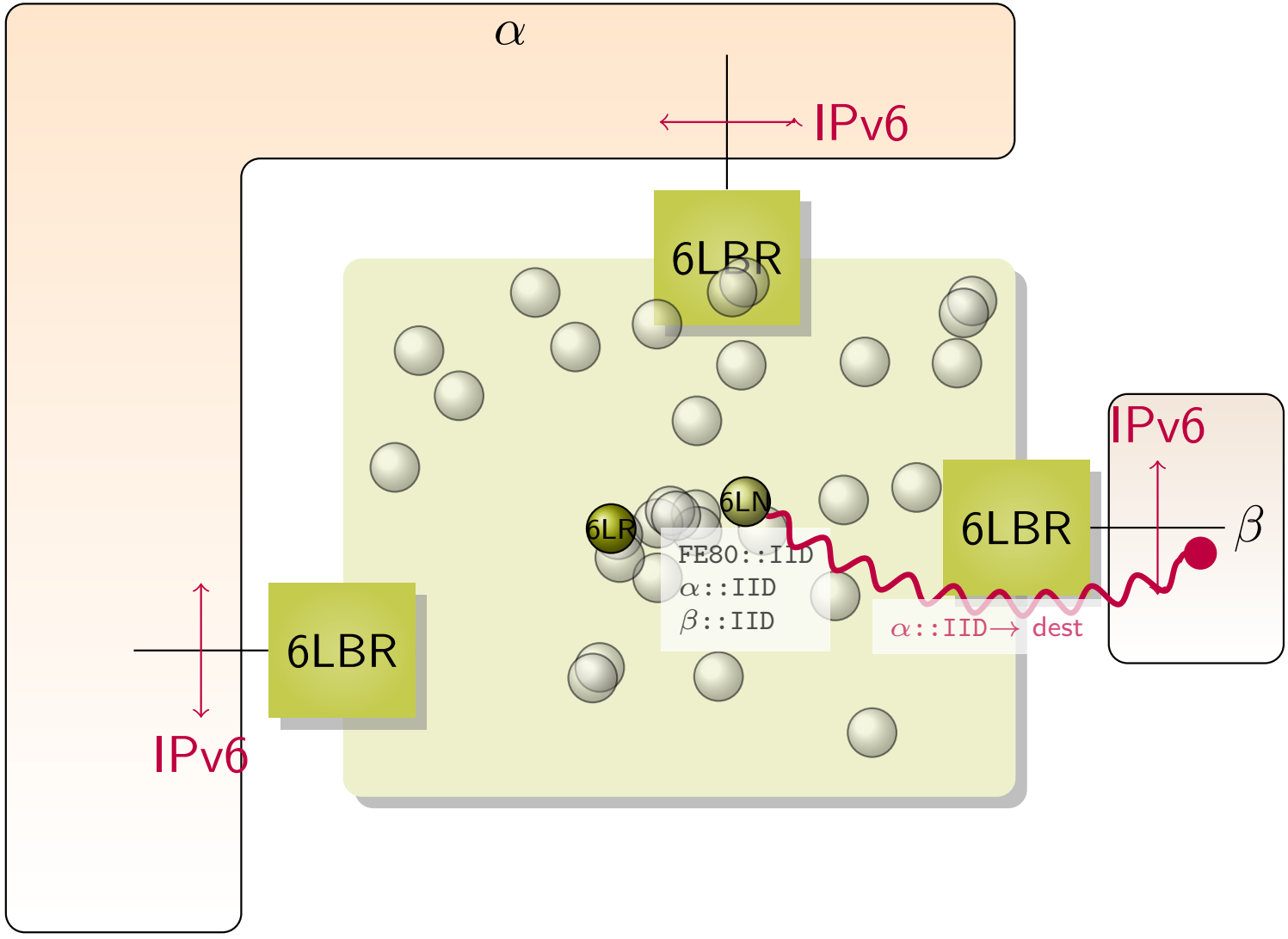

IPv6
6LBR
IPv6
RA ARO+Status
6LN
6LR
FE80::IID
6LBR
6LBR
IPv6

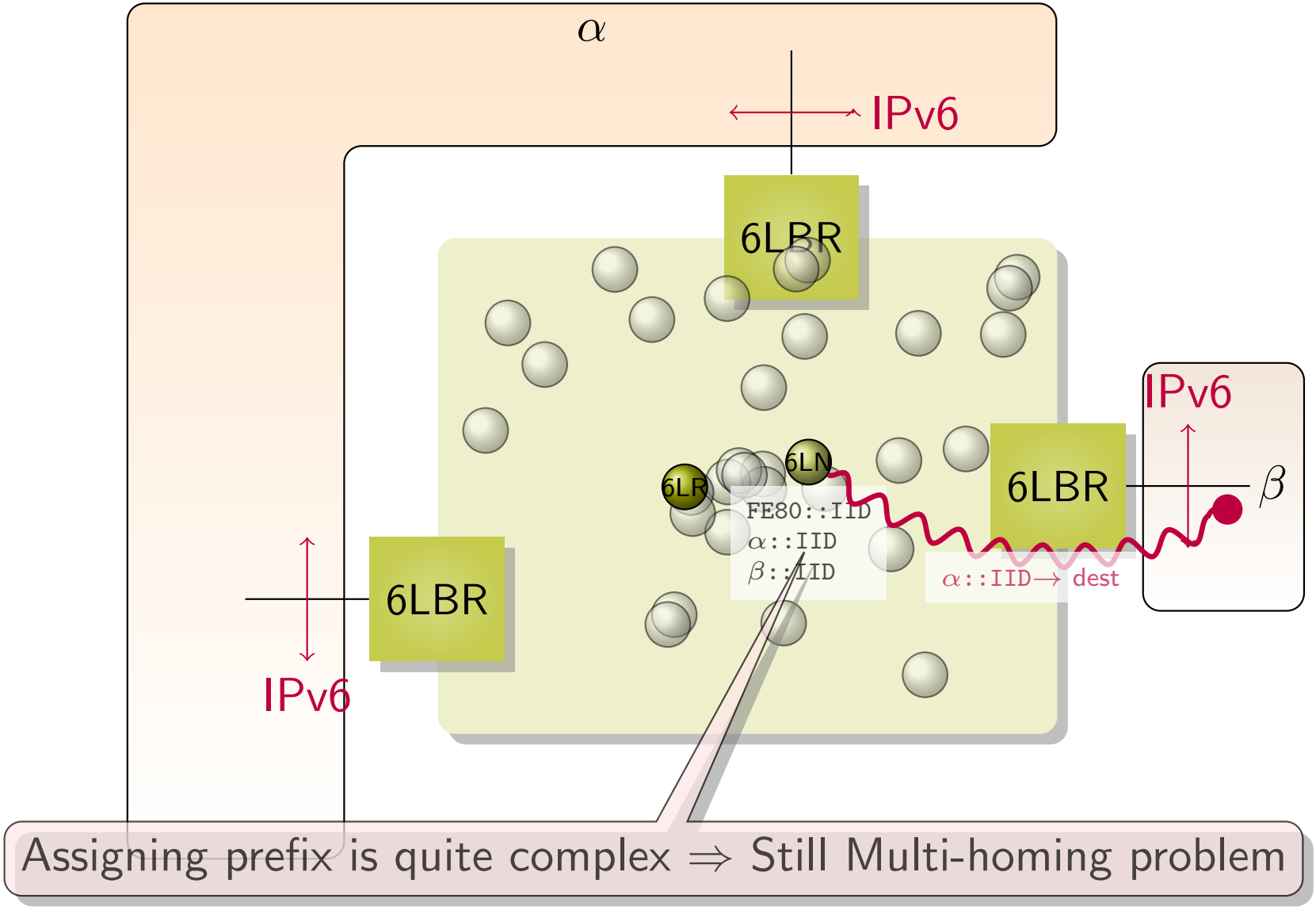

IPv6
6LBR
IPv6
6LBR
6LN
6LR
FE80::IID
α::IID
6LBR
IPv6


α
IPv6
6LBR
6LBR
IPv6
β
6LBR
IPv6
6LN
6LR
FE80::IID
α::IID
β::IID

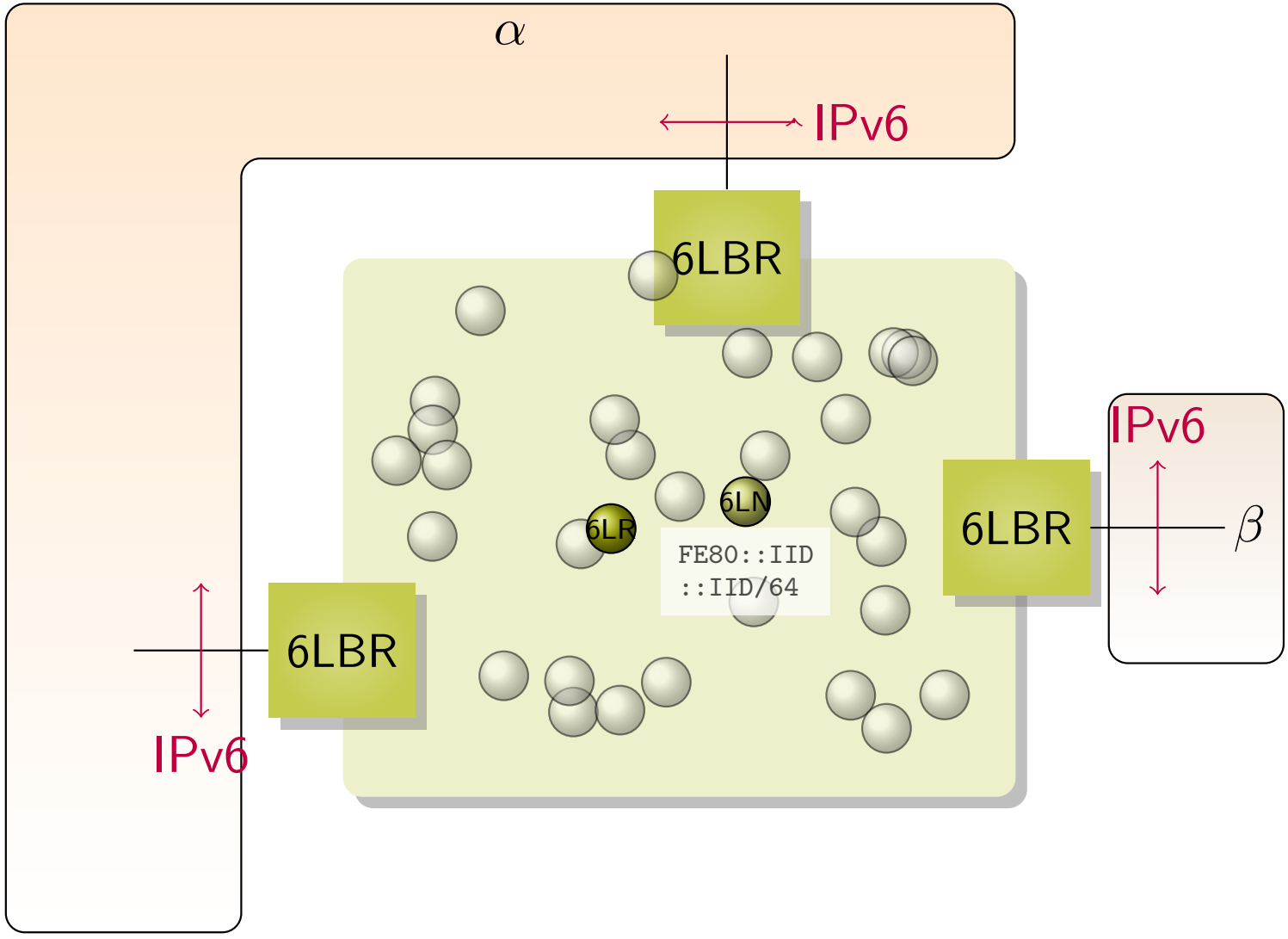


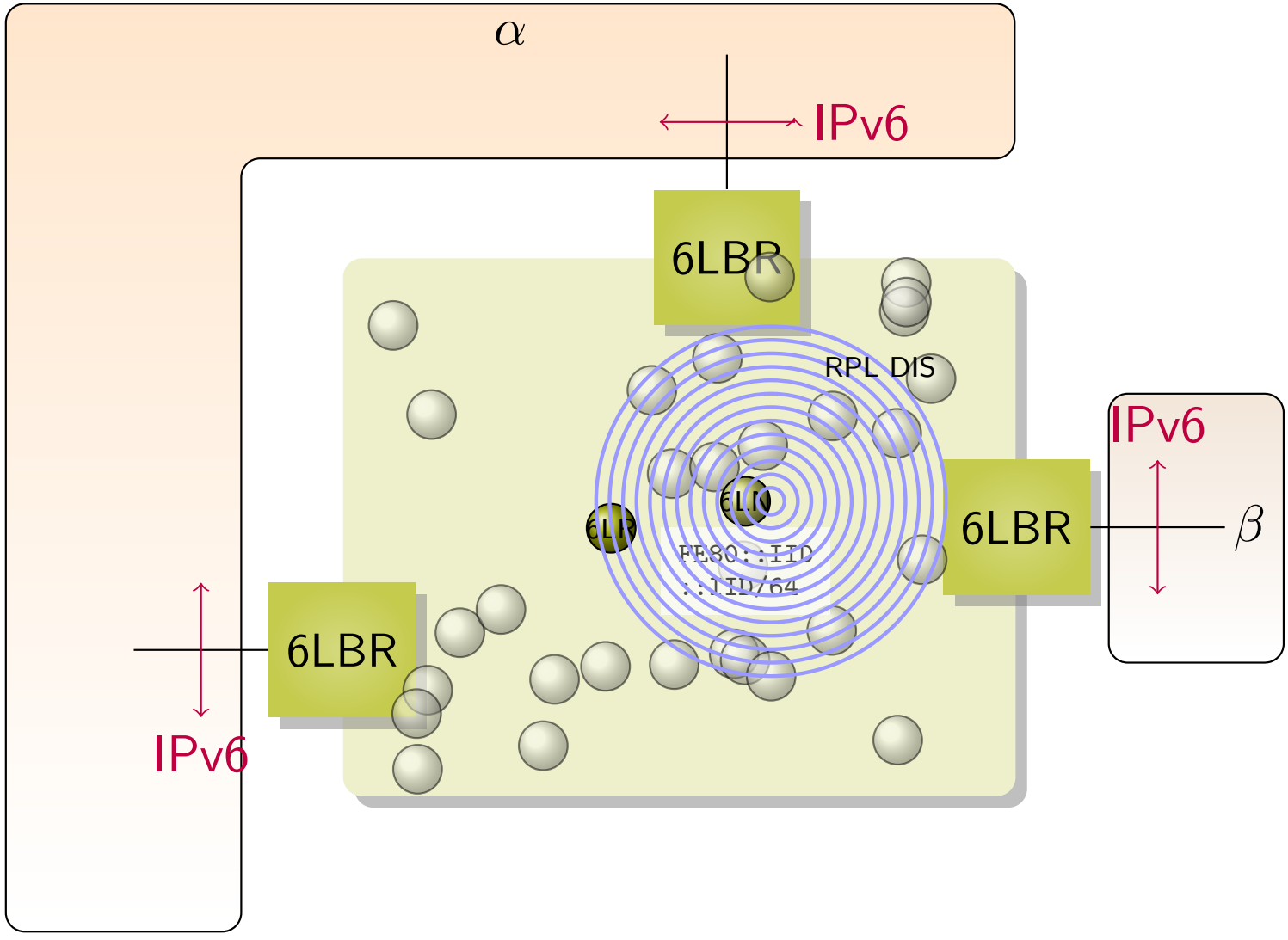
RPL: Routing Protocol for Low power and lossy networks, **DIS**: DODAG (Destination Oriented Directed Acyclic Graph) Information Solicitation


α
IPv6
6LBR
IPv6
β
6LBR
6LN
6LR
FE80::IID
α::IID
β::IID
α::IID→ dest
6LBR
IPv6



Assigning prefix is quite complex ⇒ Still Multi-homing problem


α
IPv6
6LBR
6LN
6LR
FE80::IID
::IID/64
6LBR
IPv6
β
6LBR
IPv6



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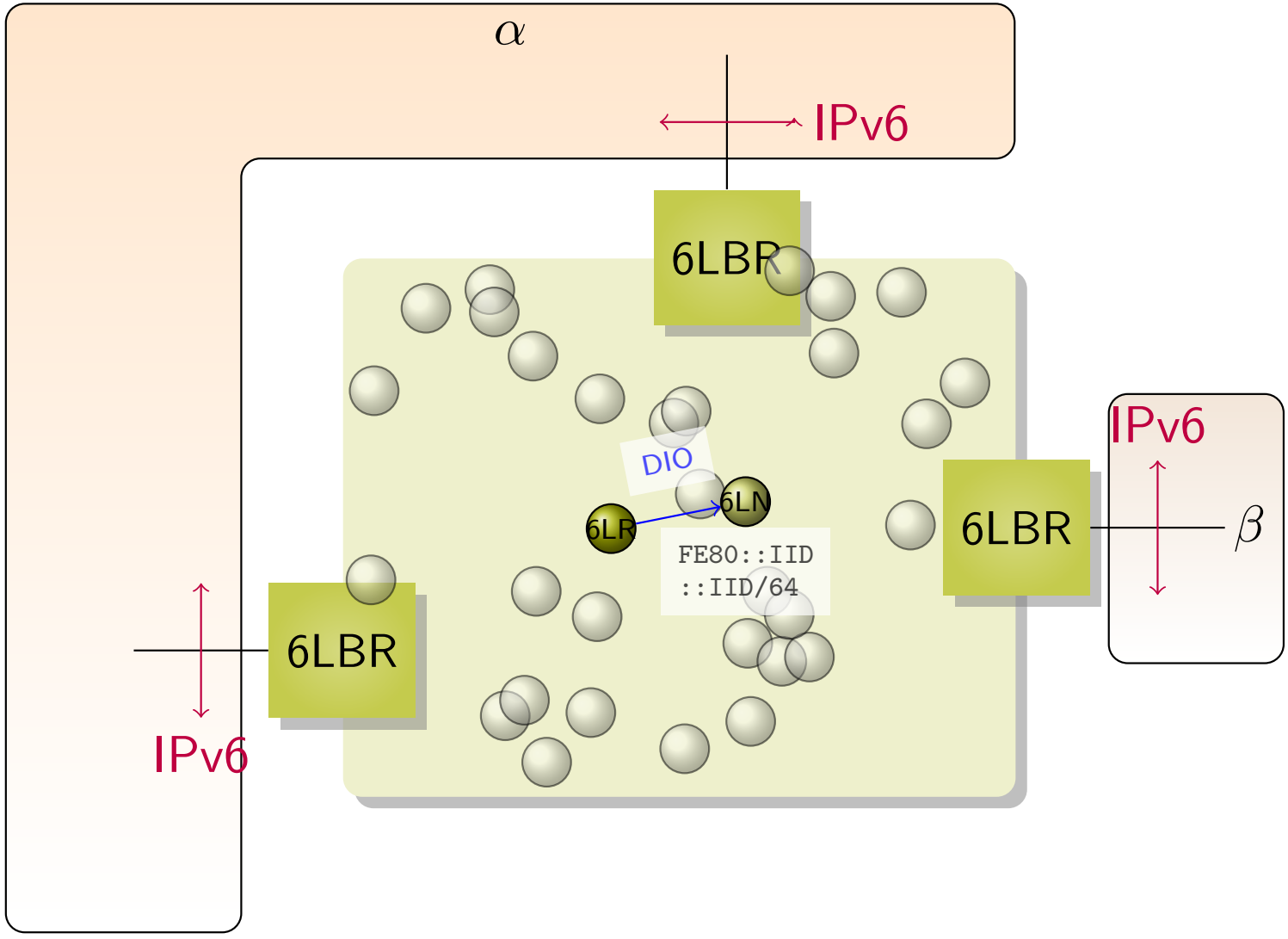
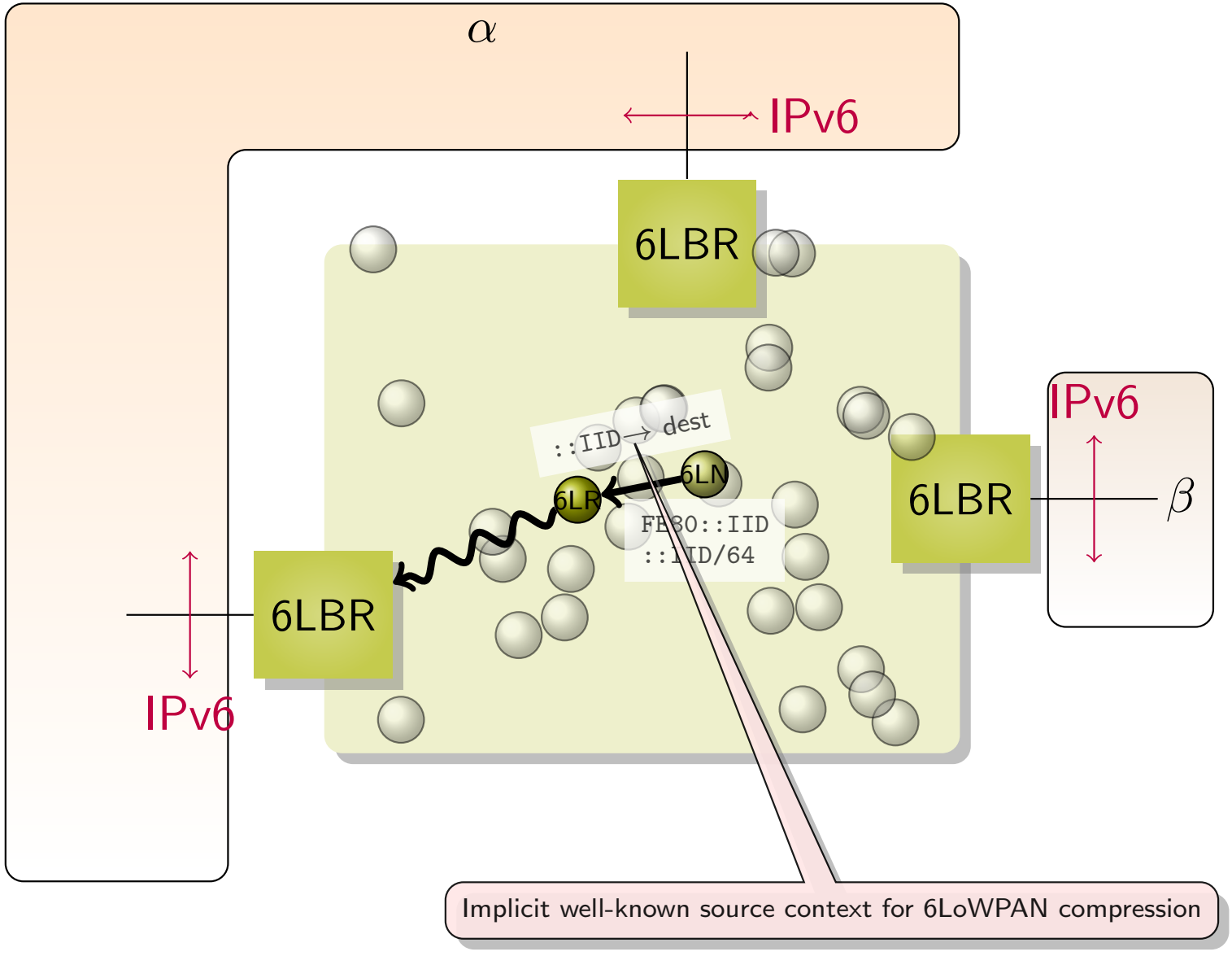
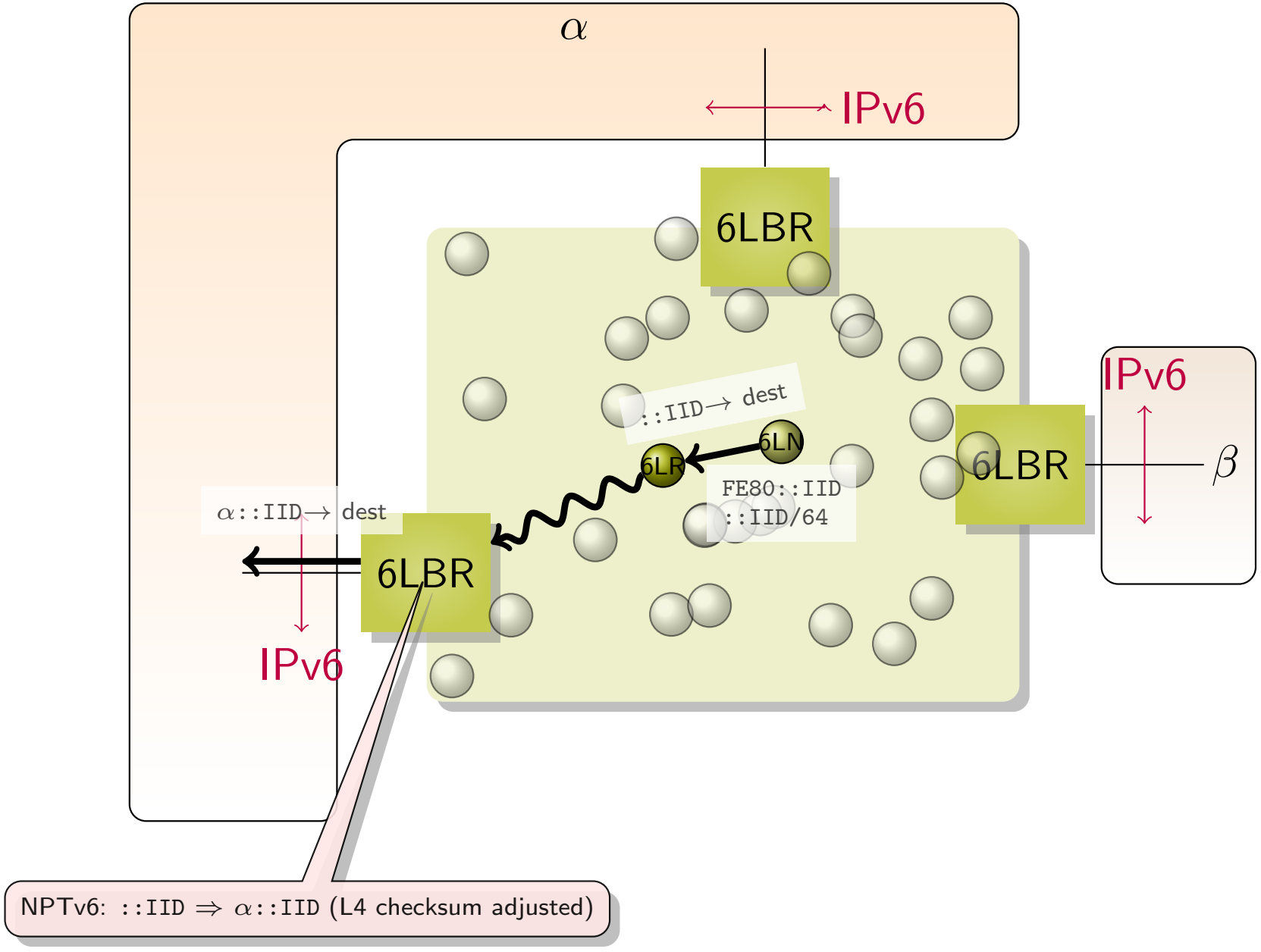
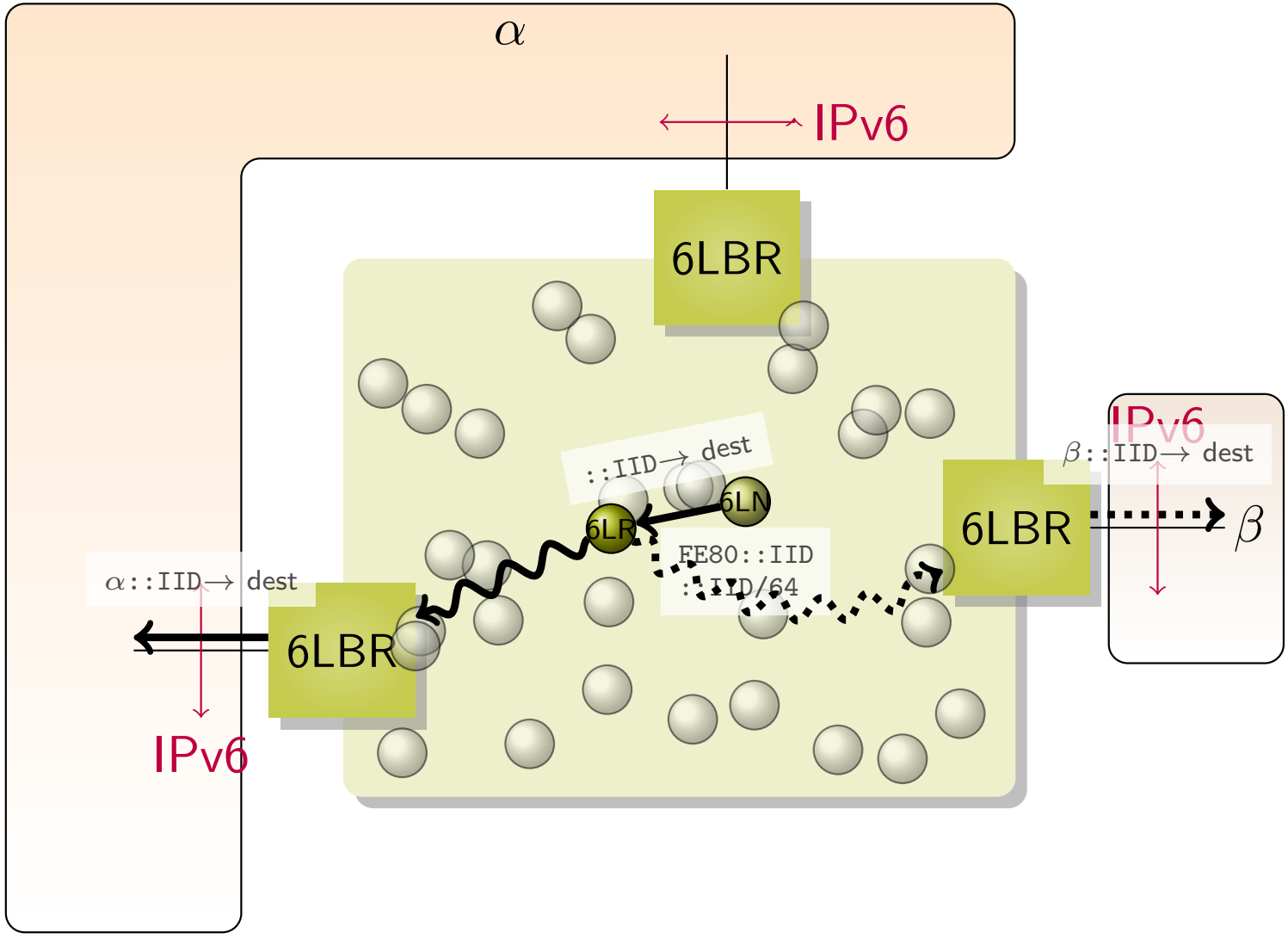
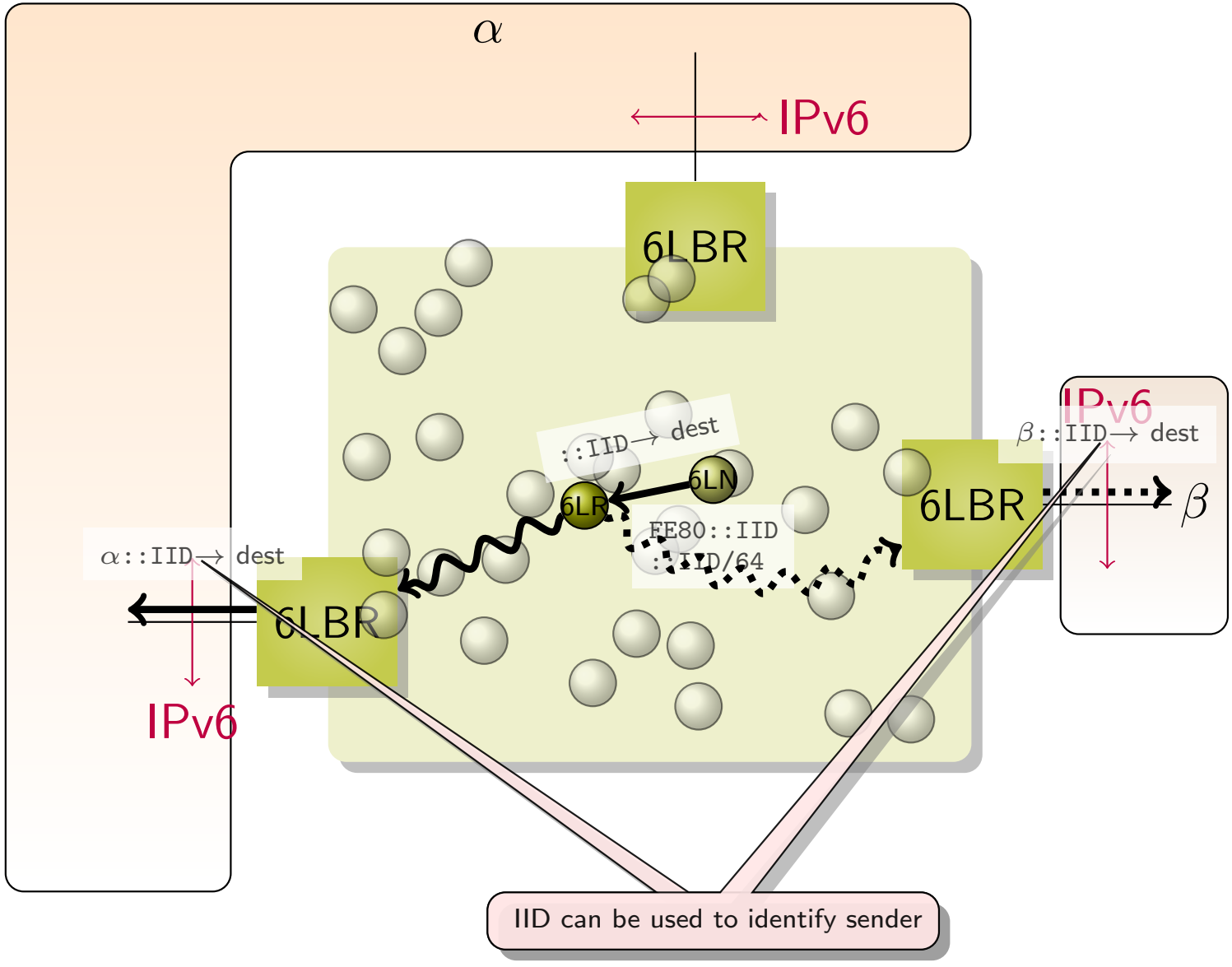

α
IPv6
6LBR
DIO
6LN
6LR
FE80::IID
::IID/64
6LBR
IPv6
β
6LBR
IPv6


α
IPv6
6LBR
::IID
dest
6LN
6LR
FE80::IID
::IID/64
6LBR
IPv6
β
6LBR
IPv6
Implicit well-known source context for 6LoWPAN compression


α
IPv6
6LBR
::IID→ dest
6LN
6LR
FE80::IID
::IID/64
6LBR
IPv6
β
α::IID→ dest
6LBR
IPv6
NPTv6: ::IID ⇒ α::IID (L4 checksum adjusted)


α
IPv6
6LBR
::IID→ dest
6LN
6LR
FE80::IID
::IID/64
6LBR
IPv6
β::IID→ dest
β
α::IID→ dest
6LBR
IPv6

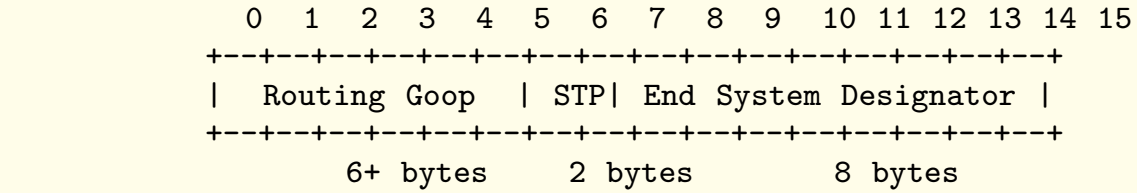

α
IPv6
6LBR
::IID→ dest
6LN
6LR
FE80::IID
::IID/64
6LBR
IPv6
β::IID→ dest
β
α::IID→ dest
6LBR
IPv6
IID can be used to identify sender

Network Working Group
Internet-Draft

Mike O'Dell
UUNET Technologies
1997/02/24 01:32:32GMT

GSE - An Alternate Addressing Architecture for IPv6
<draft-ietf-ipngwg-gseaddr-00.txt>

The 16 byte IPv6 address is split into 3 pieces:



Routing Goop signifies where the Site attaches to the Global Internet. The Site Topology Partition (STP) is Site-private "LAN segment" information. The End System Designator (ESD) specifies an interface on an end-system.

Rewriting IPv6 addresses by Site Border Routers is by far the most controversial, but also most critical part of this proposal. To control the complexity of routing information which must be managed within a Site and to isolate end systems and interior routers from external topology changes, the RG of some addresses is modified by Site Border Routers. Packets exiting a site have the RG for the Site egress point inserted into source addresses, while packets entering a Site have the RG in all destination addresses replaced with a canonical prefix signifying "within this Site" (the "Site-local prefix").

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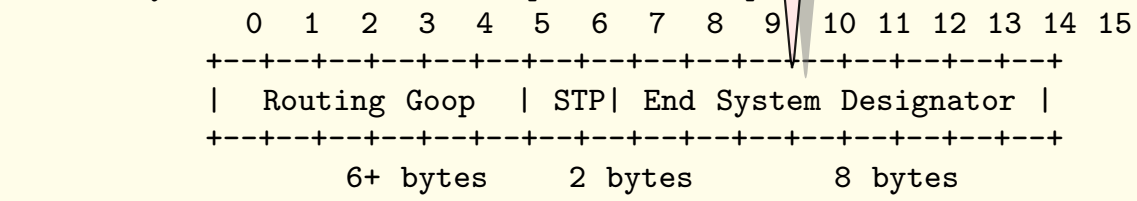

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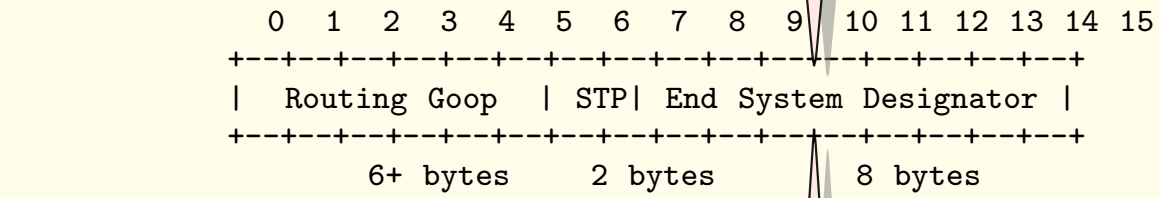

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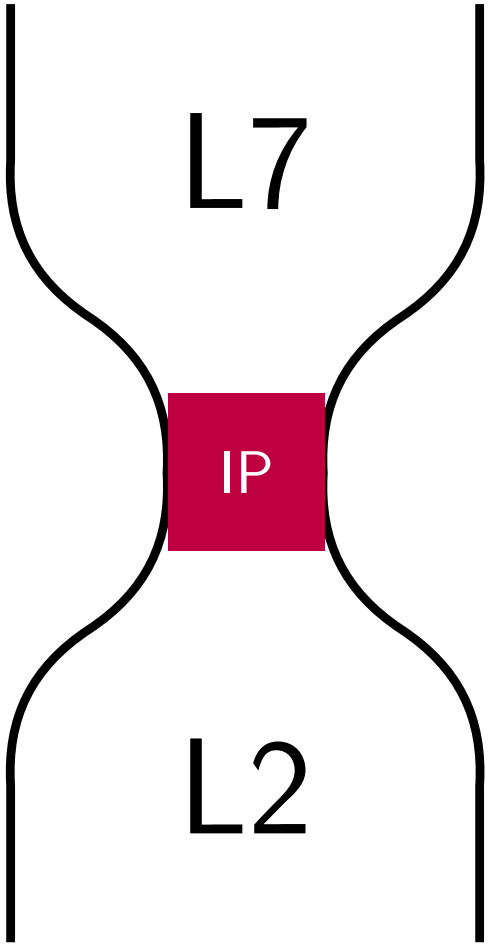
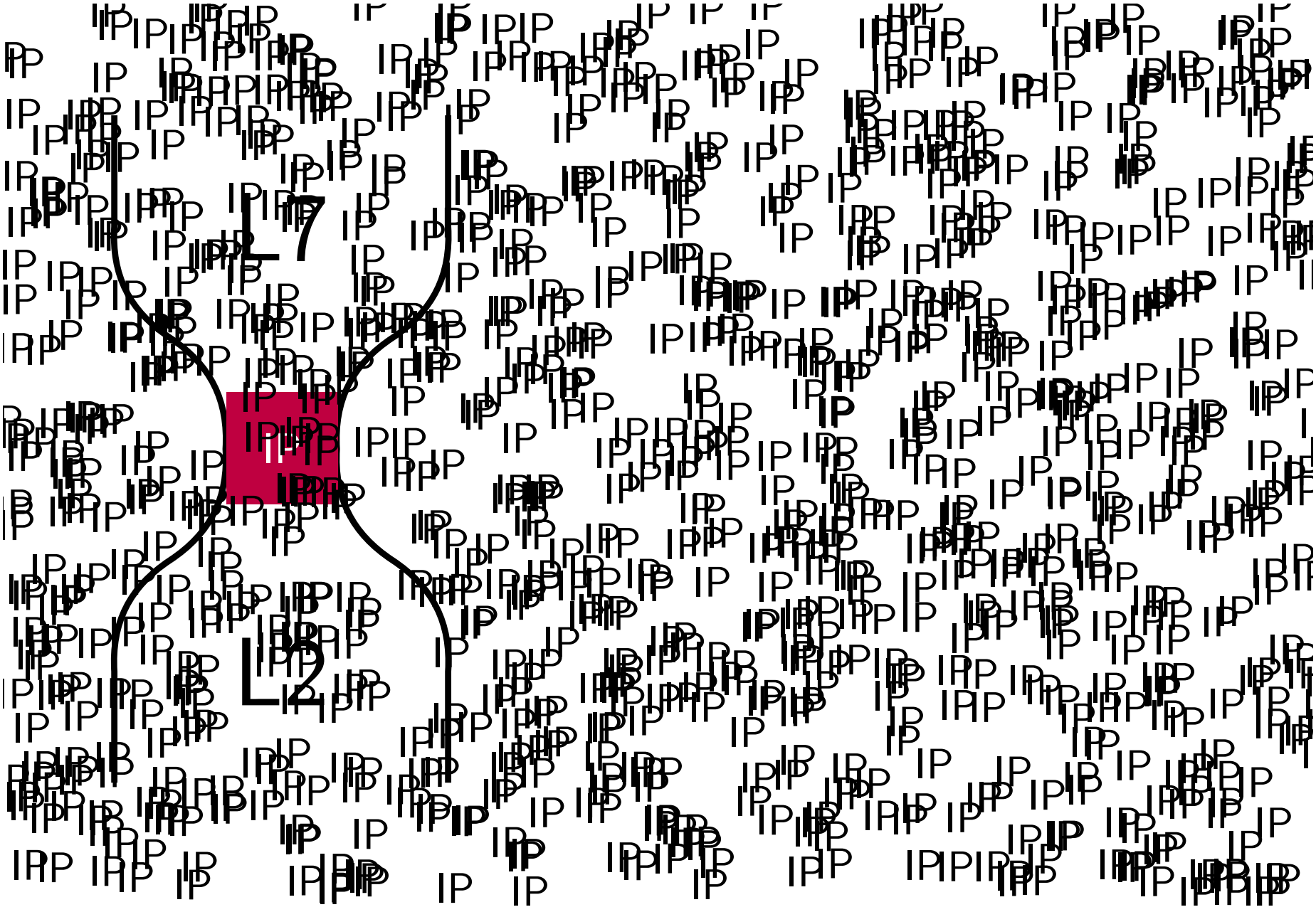
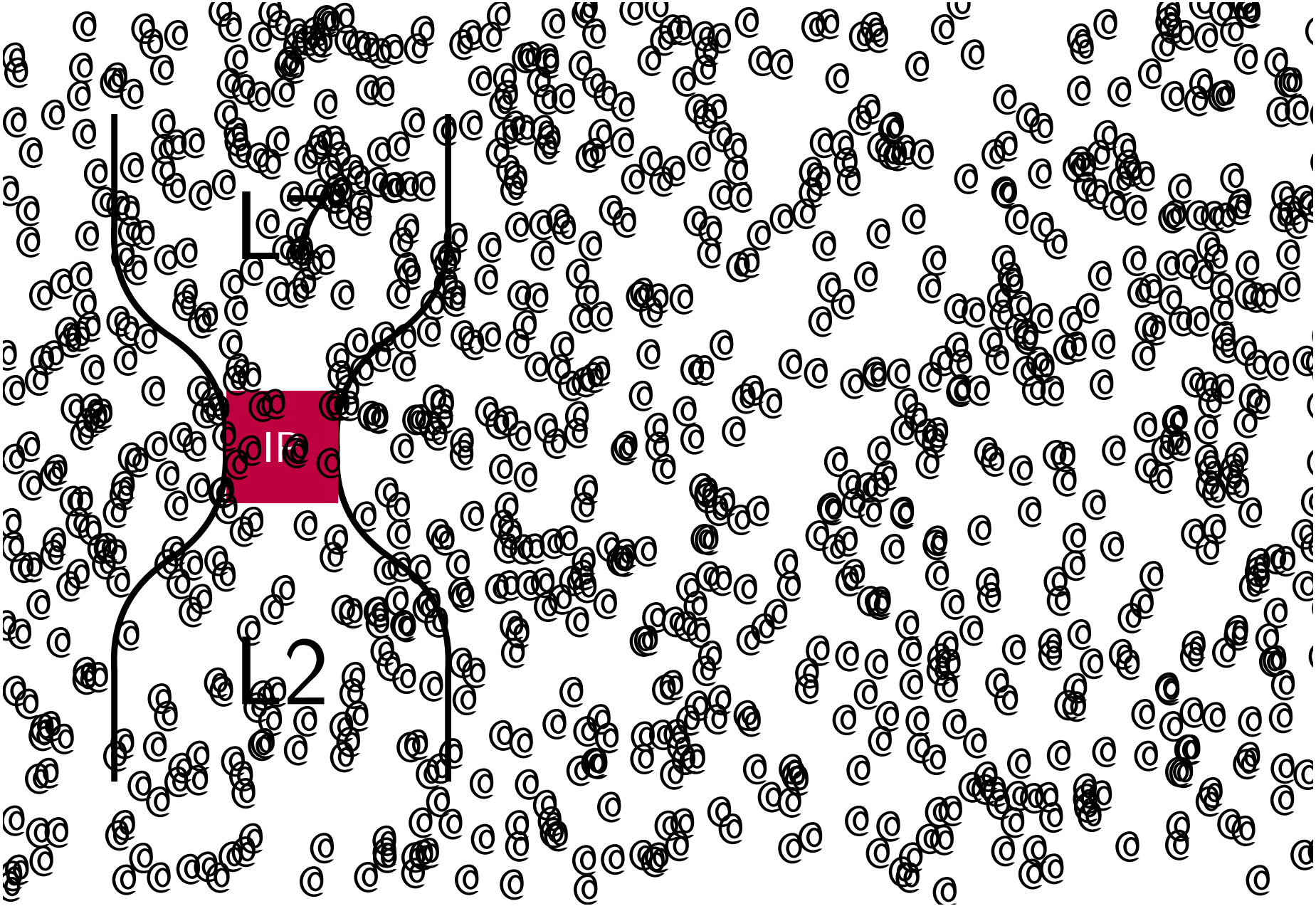
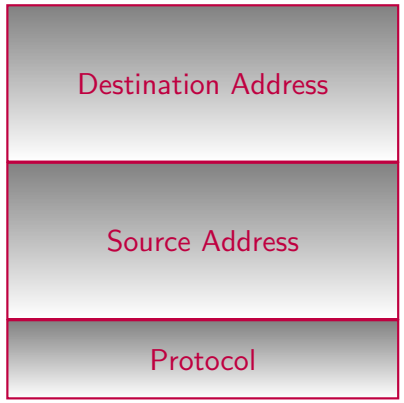
Possible with LoWPAN Network: IID is unique in this area


L7
IP
L2


L7
IP
L2

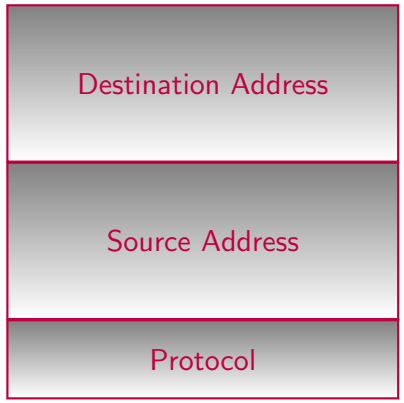

L3
IP
L2

Ethernet

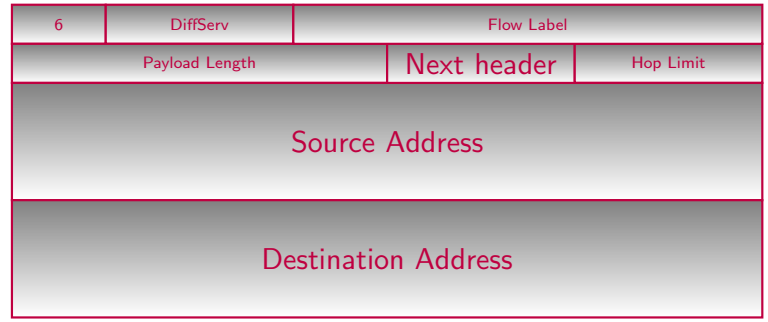


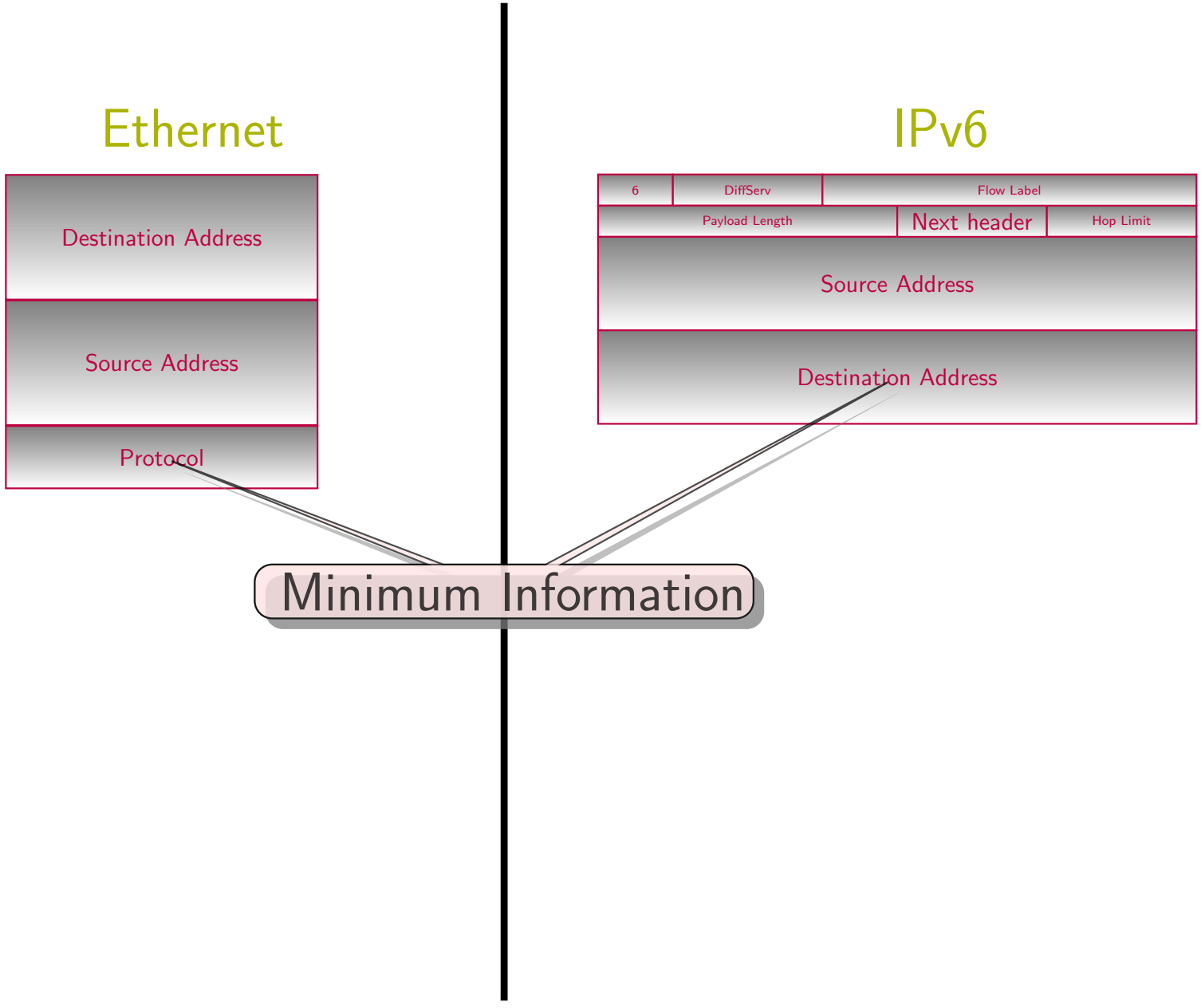
IPv6

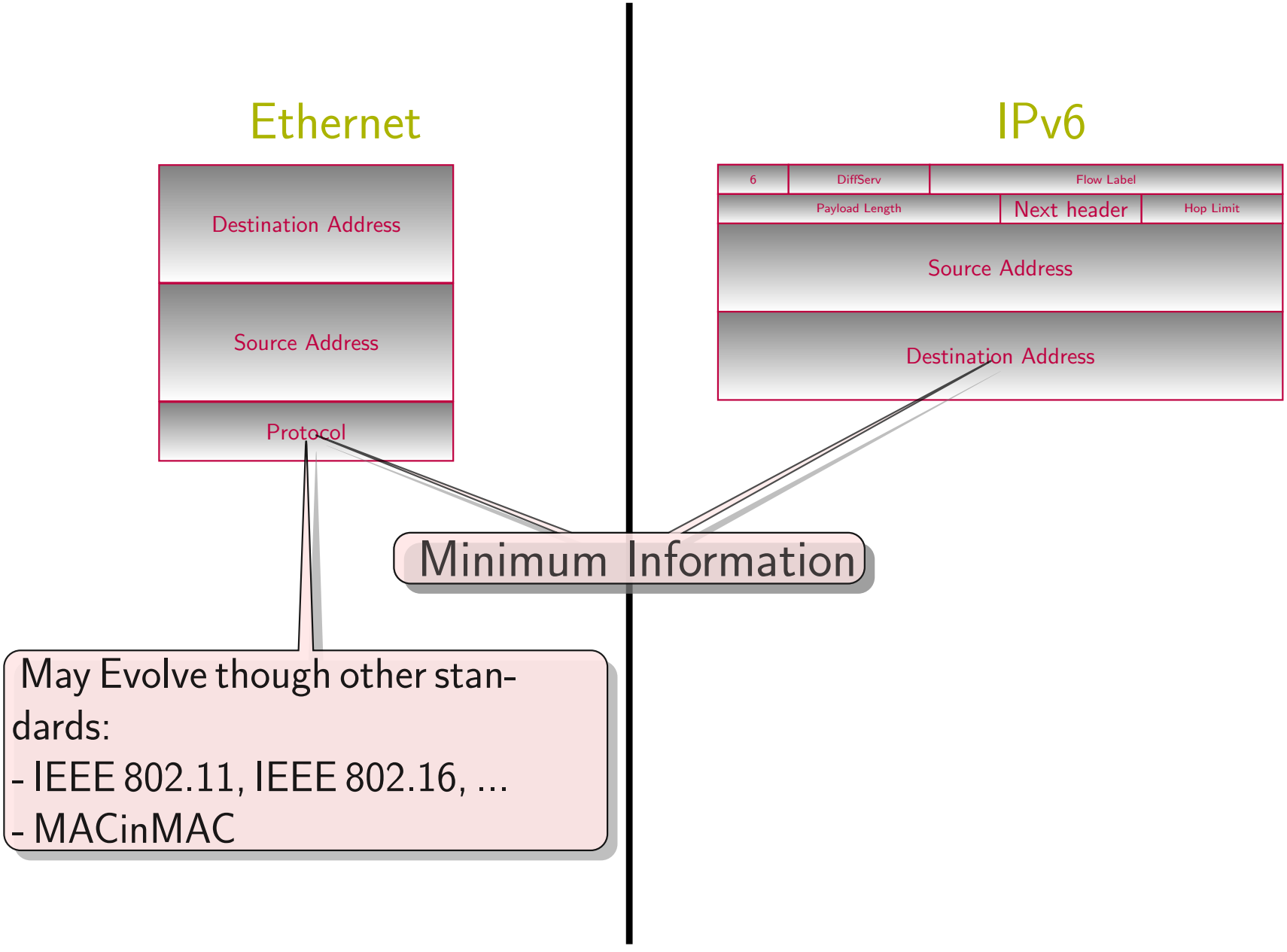
Ethernet

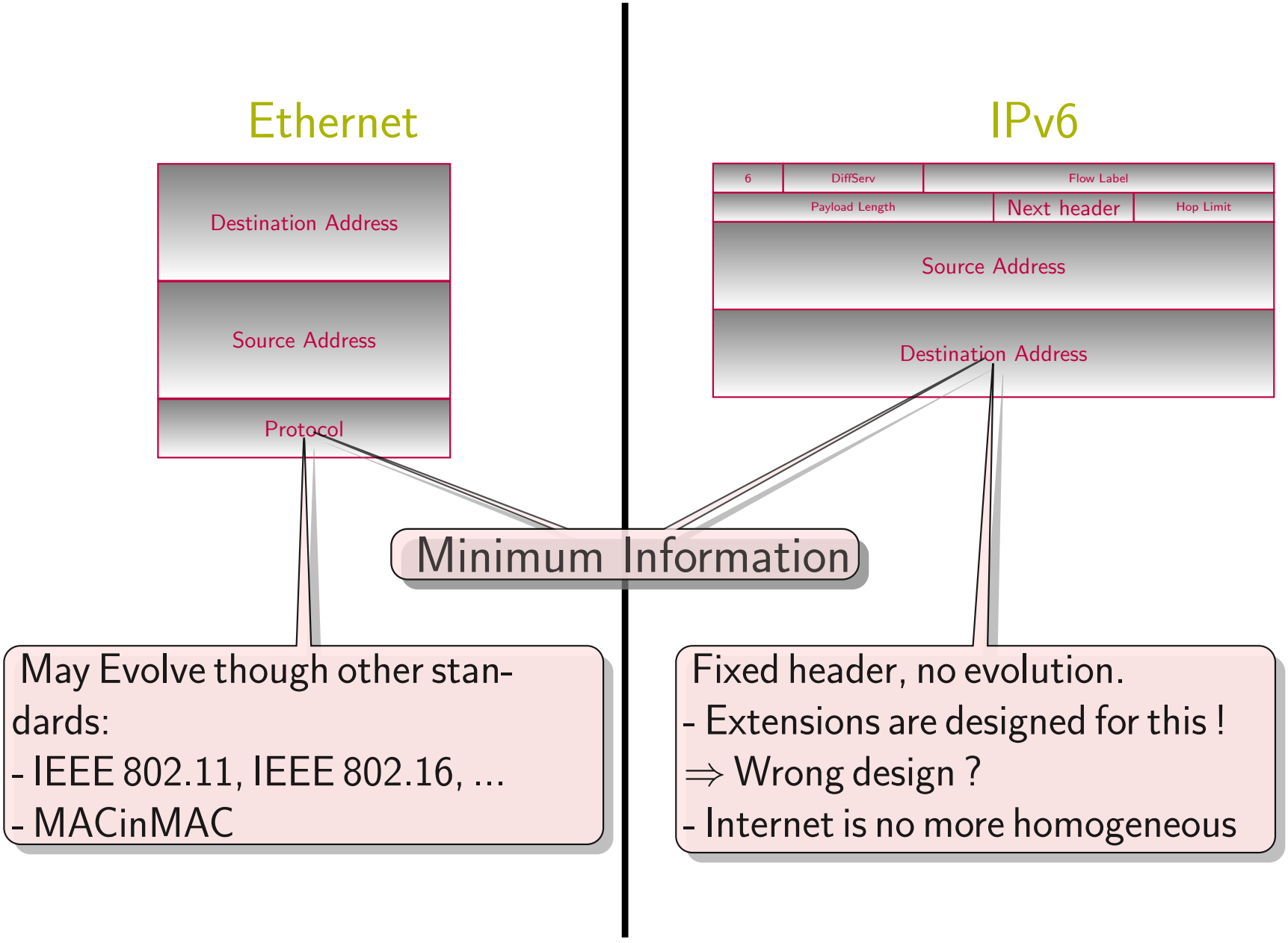


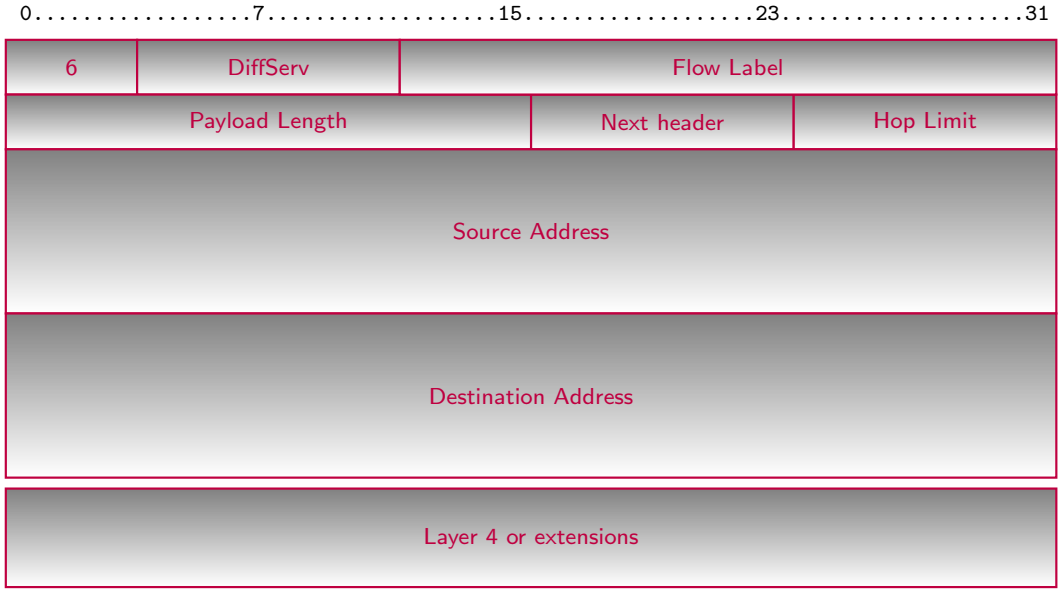
IPv6

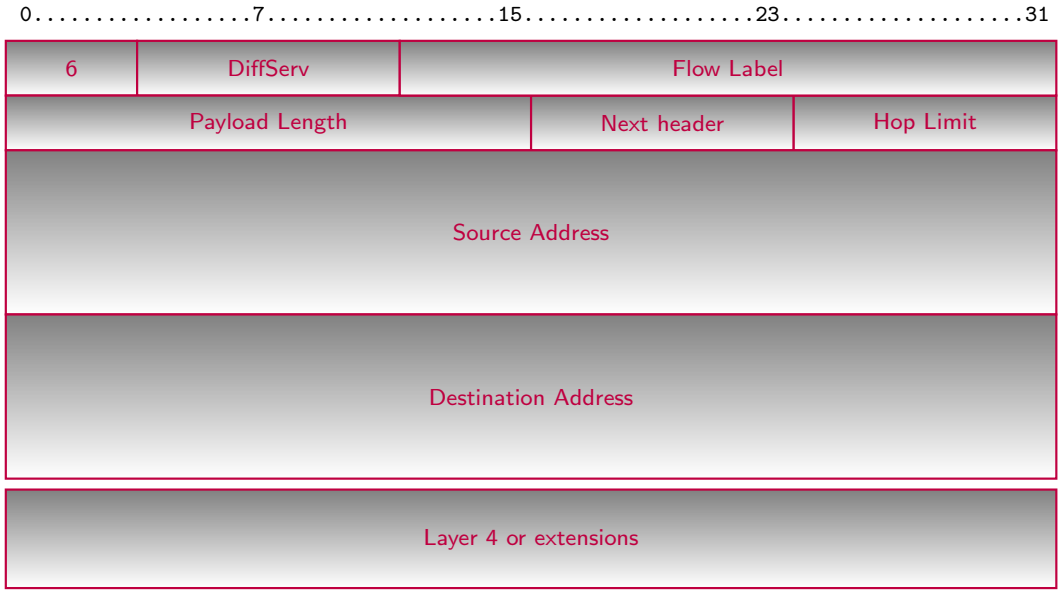


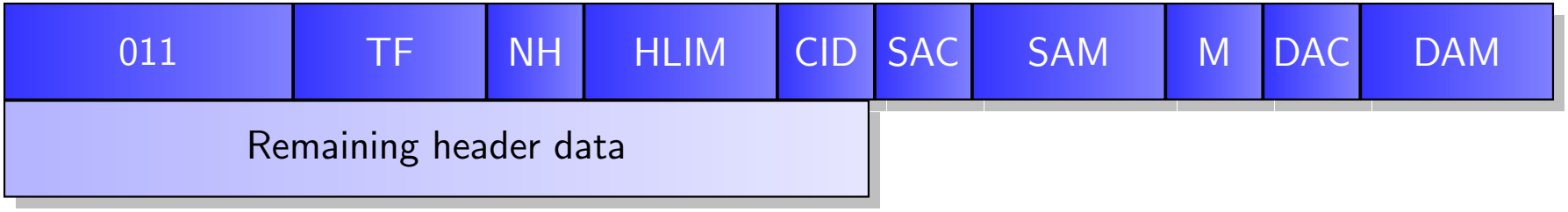

Ethernet
Destination Address
Source Address
Protocol
IPv6
6
DiffServ
Flow Label
Payload Length
Next header
Hop Limit
Source Address
Destination Address
Minimum Information

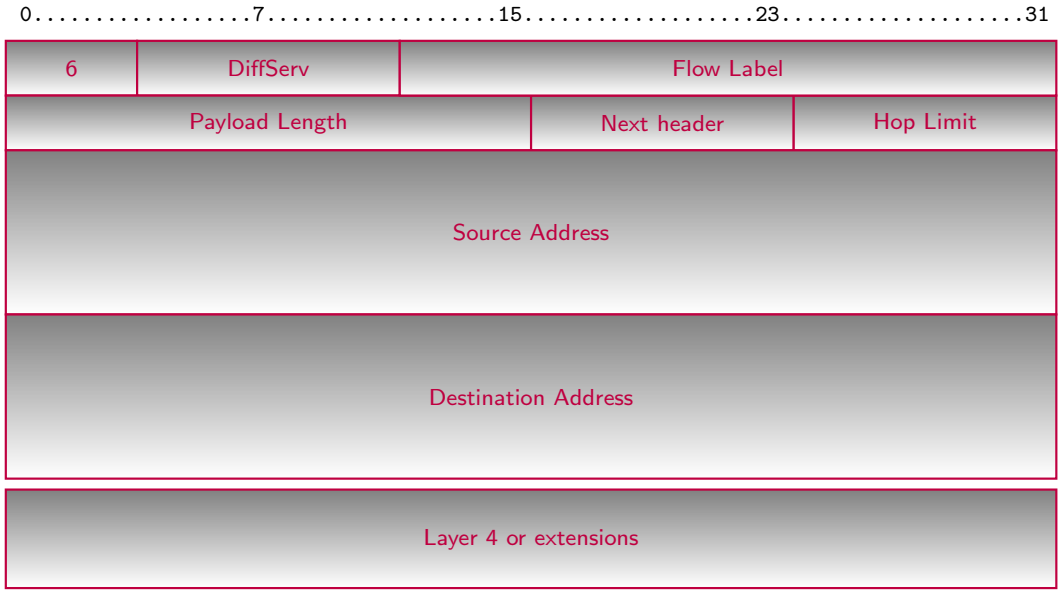

Ethernet
IPv6
Destination Address
Source Address
Protocol
6
DiffServ
Flow Label
Payload Length
Next header
Hop Limit
Source Address
Destination Address
Minimum Information
May Evolve though other standards:
- IEEE 802.11, IEEE 802.16, ...
- MACinMAC

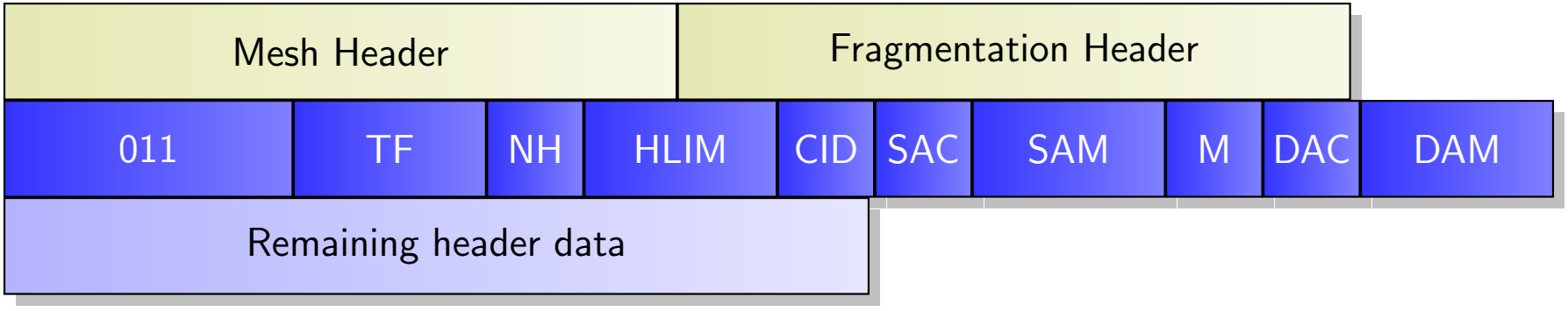

Ethernet
IPv6
Destination Address
Source Address
Protocol
6
DiffServ
Flow Label
Payload Length
Next header
Hop Limit
Source Address
Destination Address
Minimum Information
May Evolve though other standards:
- IEEE 802.11, IEEE 802.16, ...
- MACinMAC
Fixed header, no evolution.
- Extensions are designed for this !
⇒ Wrong design ?
- Internet is no more homogeneous


0.....7.....15.....23.....31
6
DiffServ
Flow Label
Payload Length
Next header
Hop Limit
Source Address
Destination Address
Layer 4 or extensions


0.....7.....15.....23.....31
6
DiffServ
Flow Label
Payload Length
Next header
Hop Limit
Source Address
Destination Address
Layer 4 or extensions

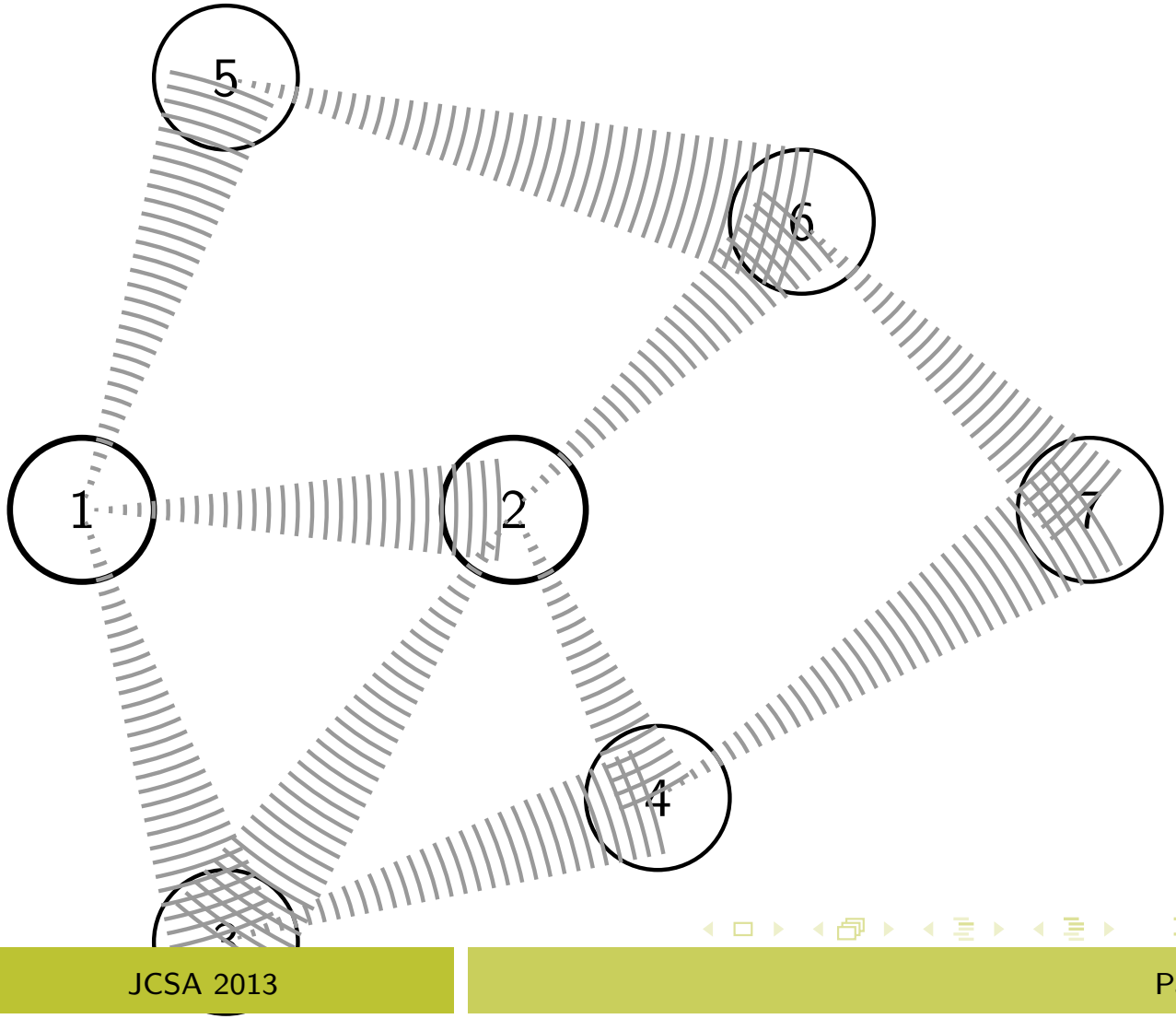

011
TF
NH
HLIM
CID
SAC
SAM
M
DAC
DAM
Remaining header data


0.....7.....15.....23.....31
6
DiffServ
Flow Label
Payload Length
Next header
Hop Limit
Source Address
Destination Address
Layer 4 or extensions


Mesh Header
Fragmentation Header
011
TF
NH
HLIM
CID
SAC
SAM
M
DAC
DAM
Remaining header data

6LoWPAN: Route Over

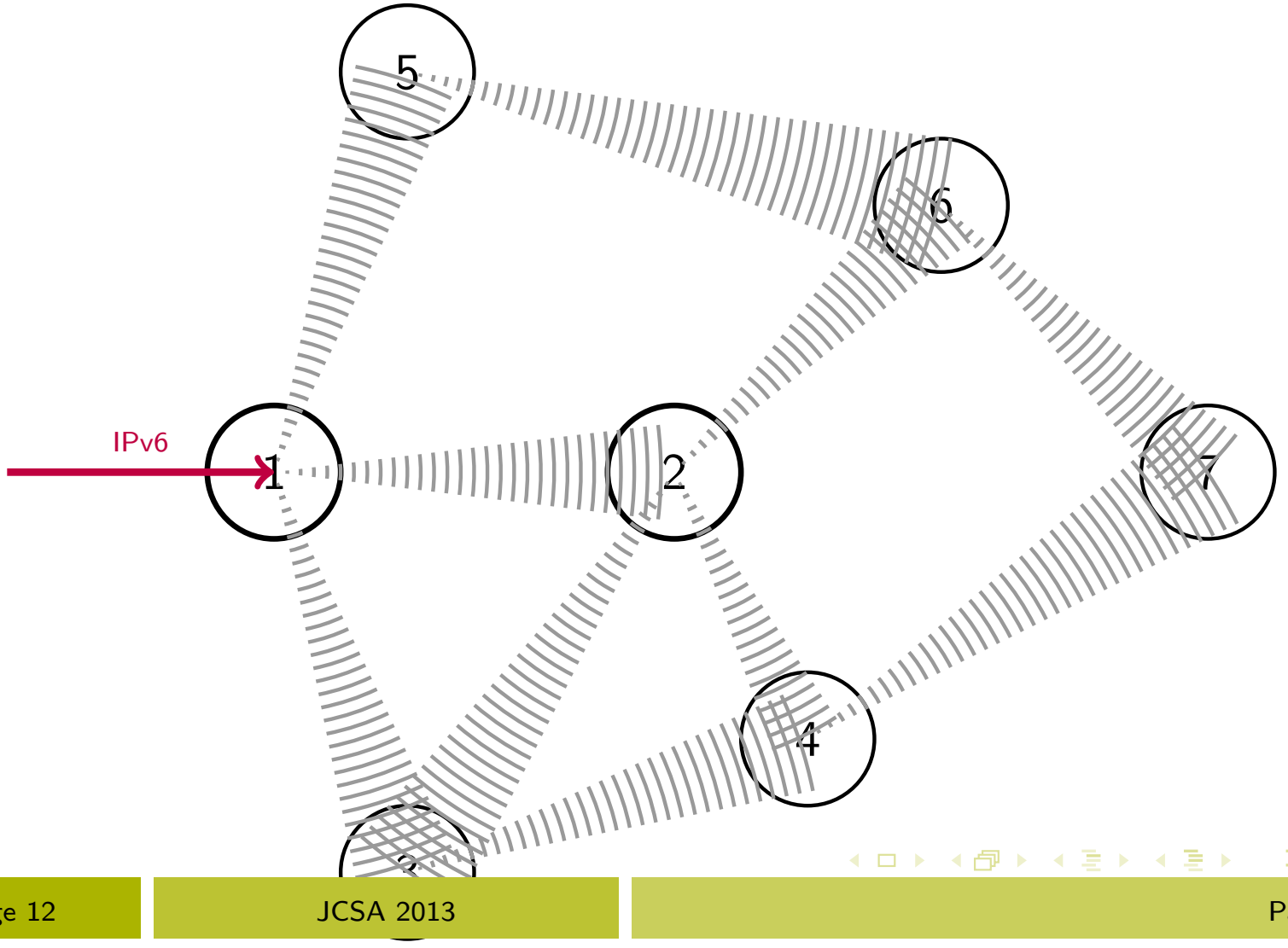
Breaking the Hourglass



TELECOM Bretagne

6LoWPAN: Route Over

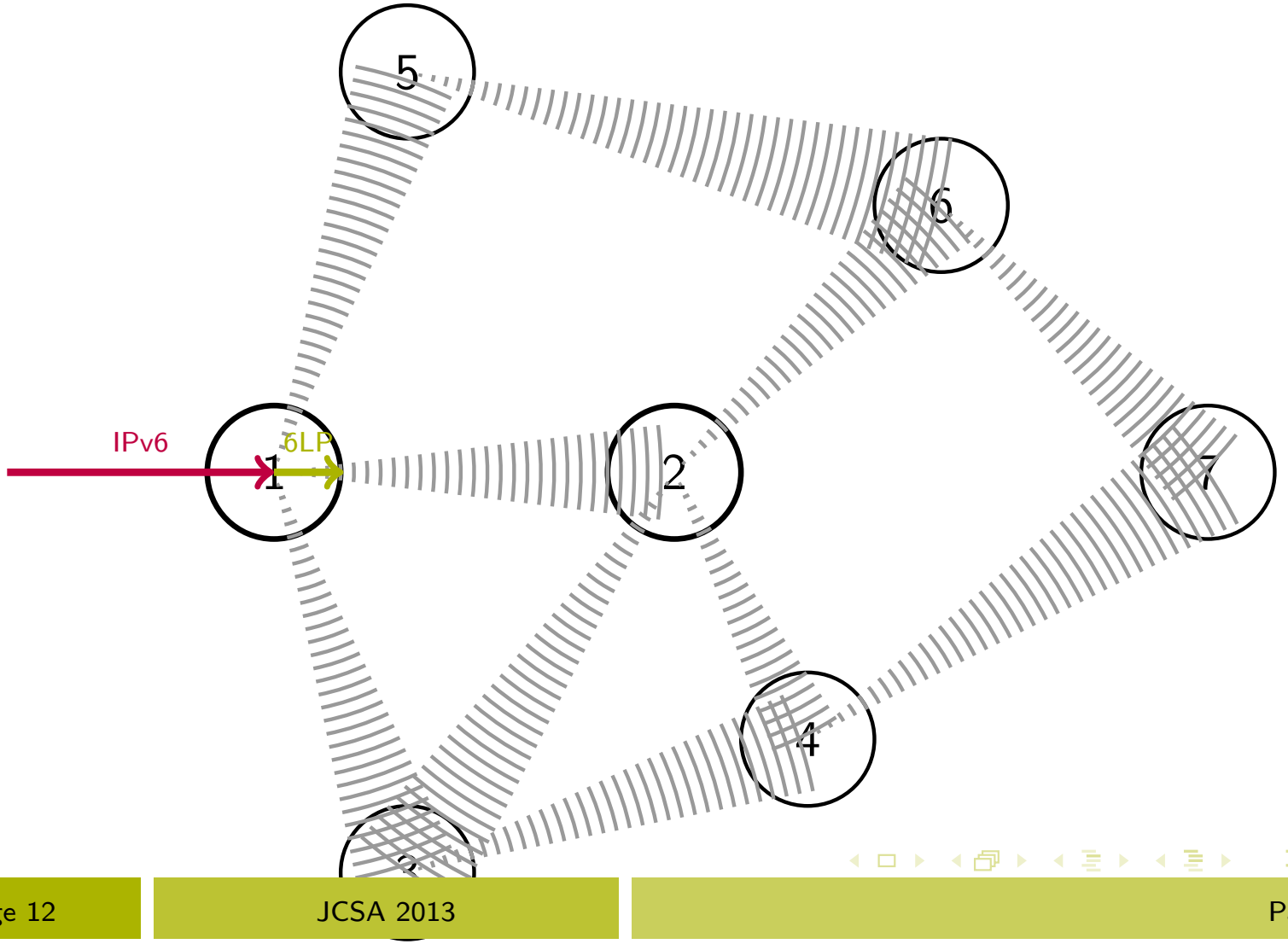
Breaking the Hourglass



TELECOM Bretagne

6LoWPAN: Route Over

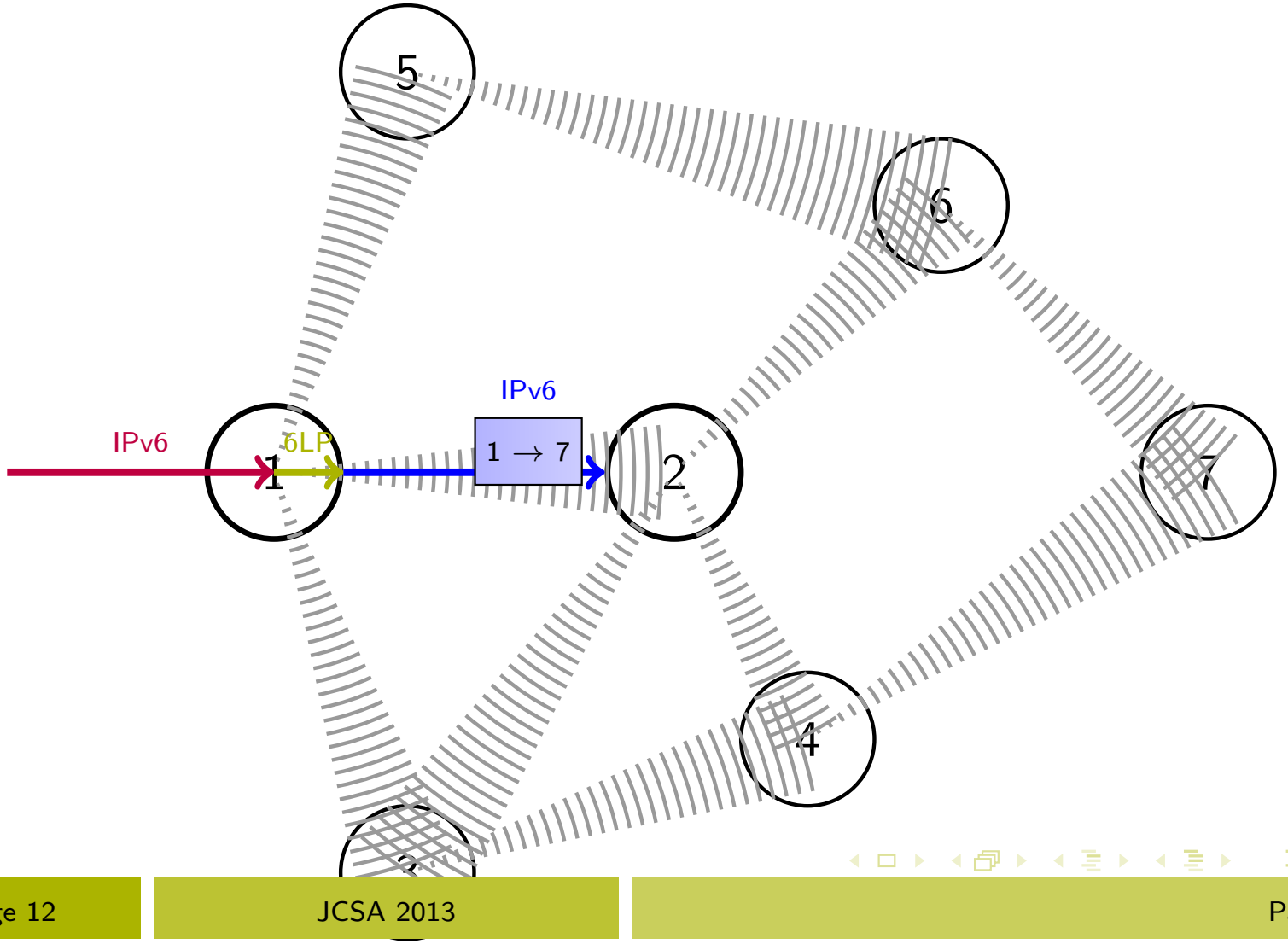
Breaking the Hourglass



TELECOM Bretagne

6LoWPAN: Route Over

Breaking the Hourglass



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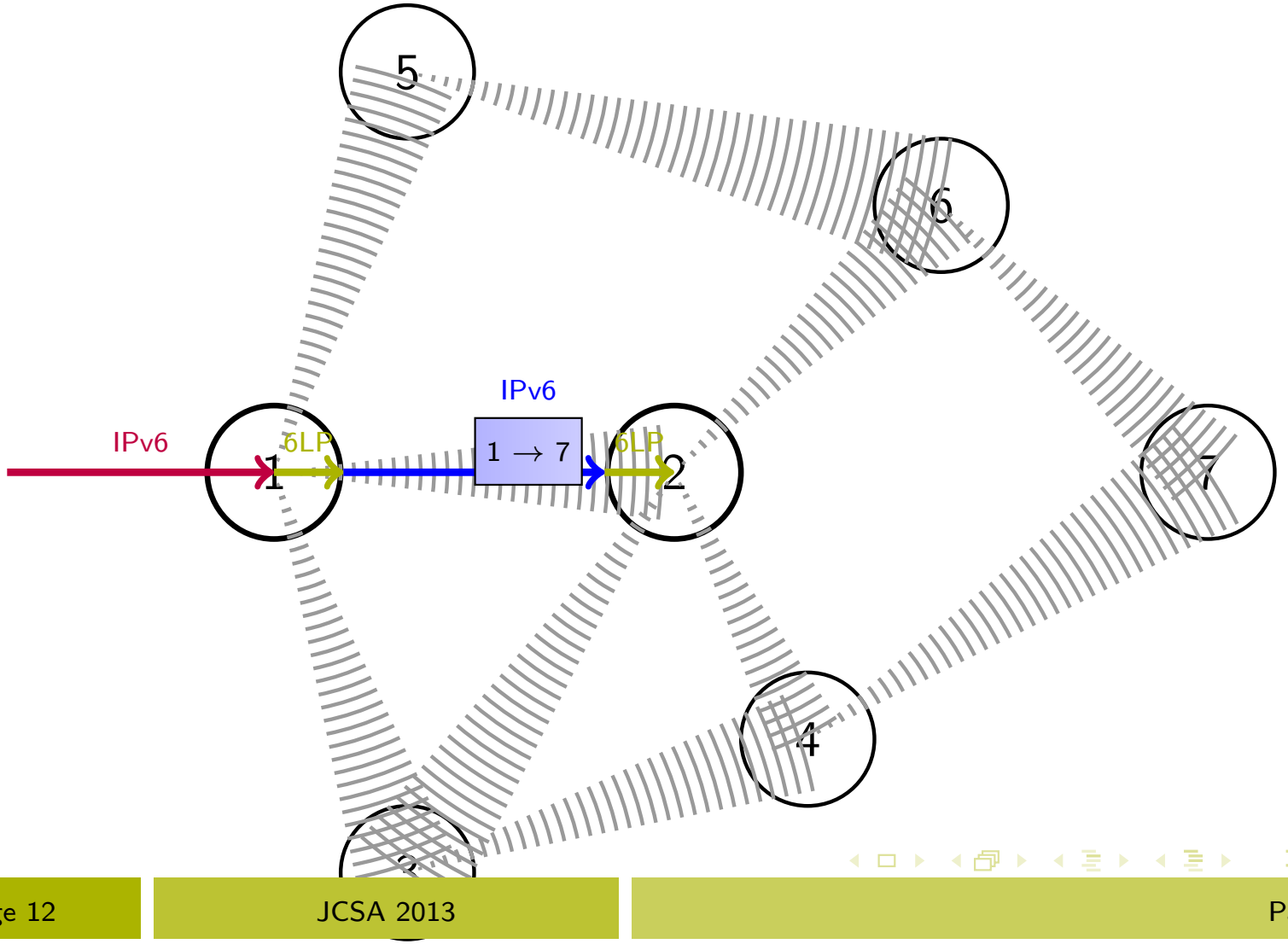
6LoWPAN: Route Over

Breaking the Hourglass



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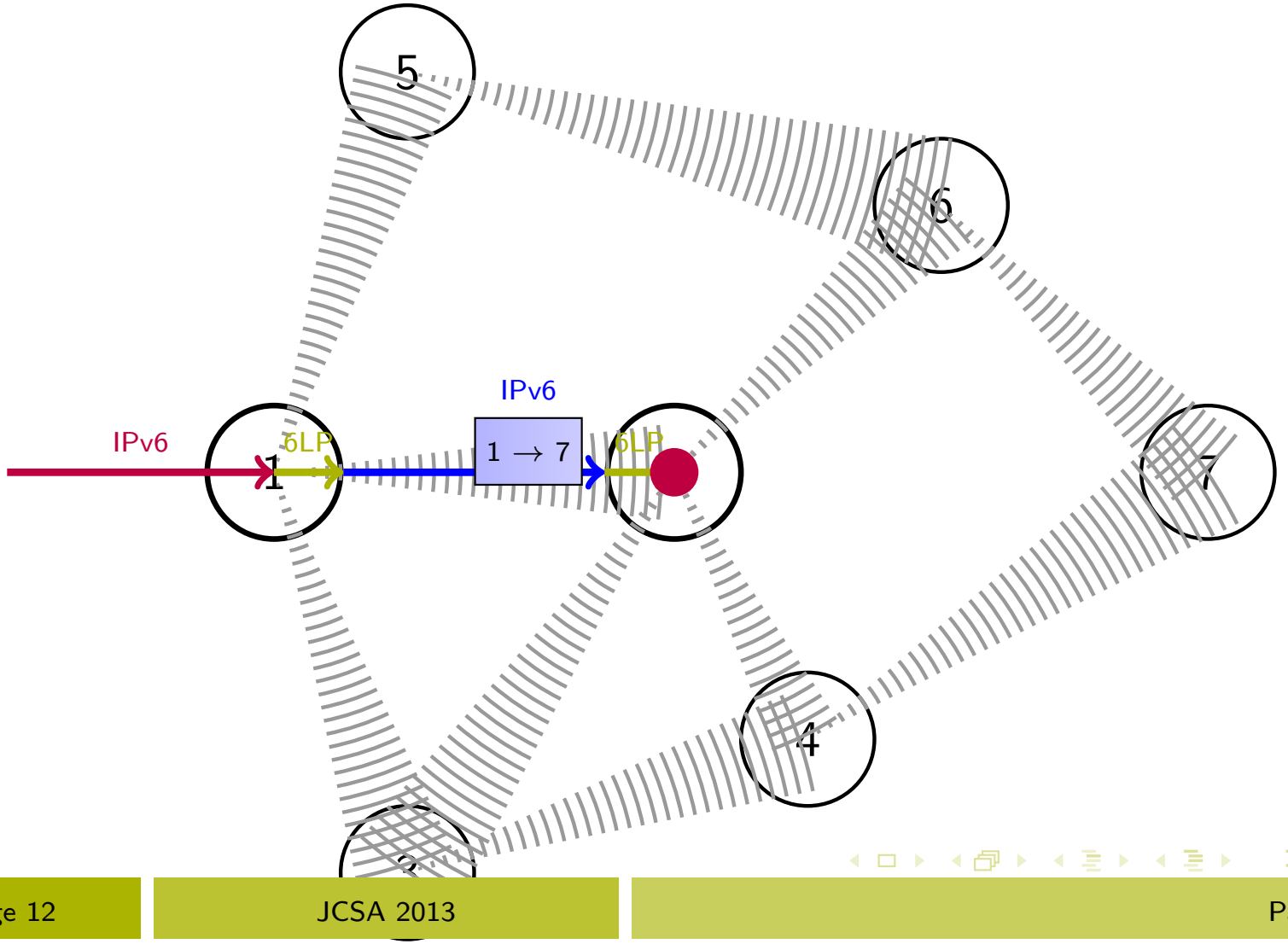
6LoWPAN: Route Over

Breaking the Hourglass



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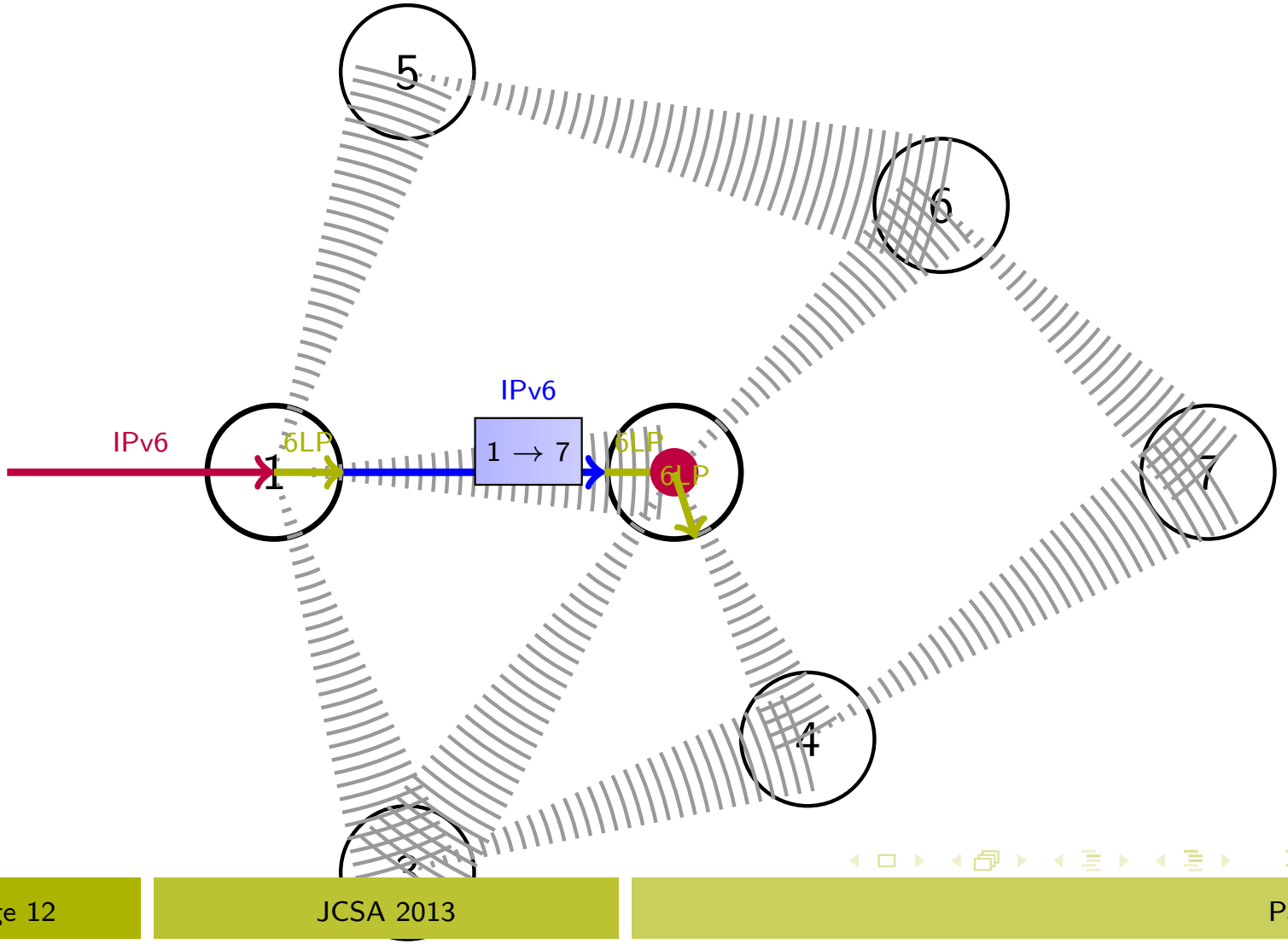
6LoWPAN: Route Over

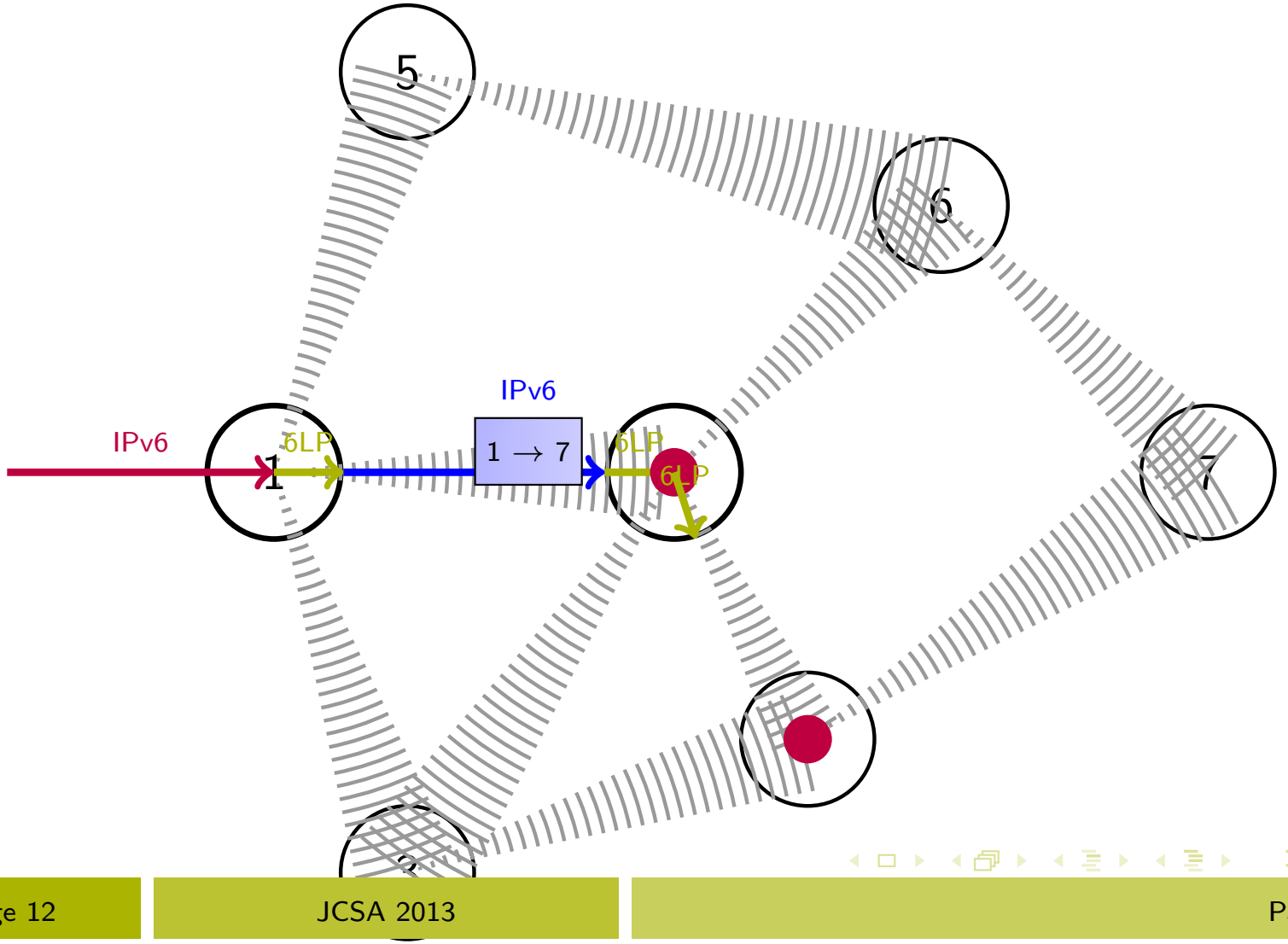
Breaking the Hourglass



TELECOM Bretagne

6LoWPAN: Route Over

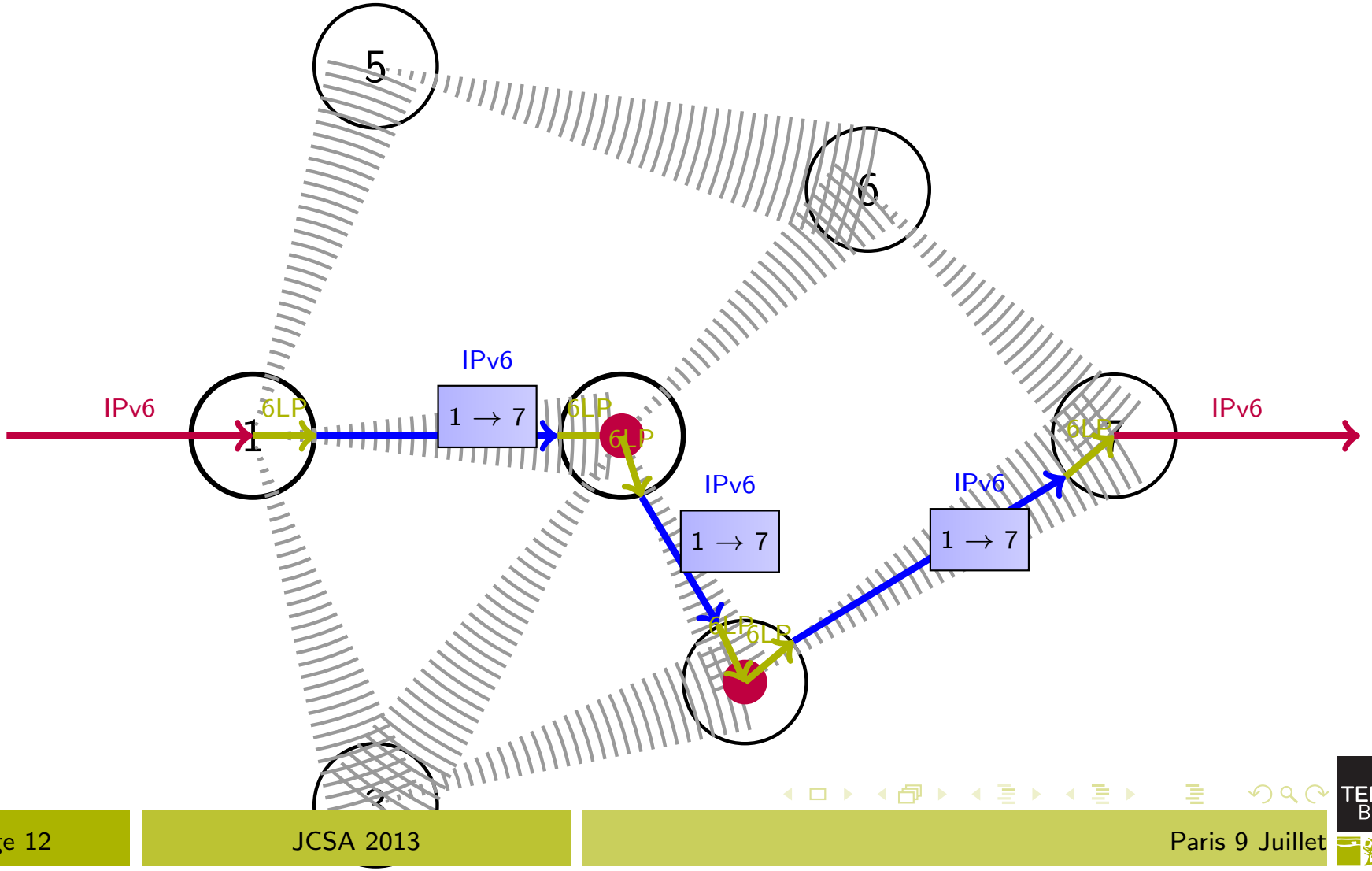
Breaking the Hourglass



TELECOM Bretagne

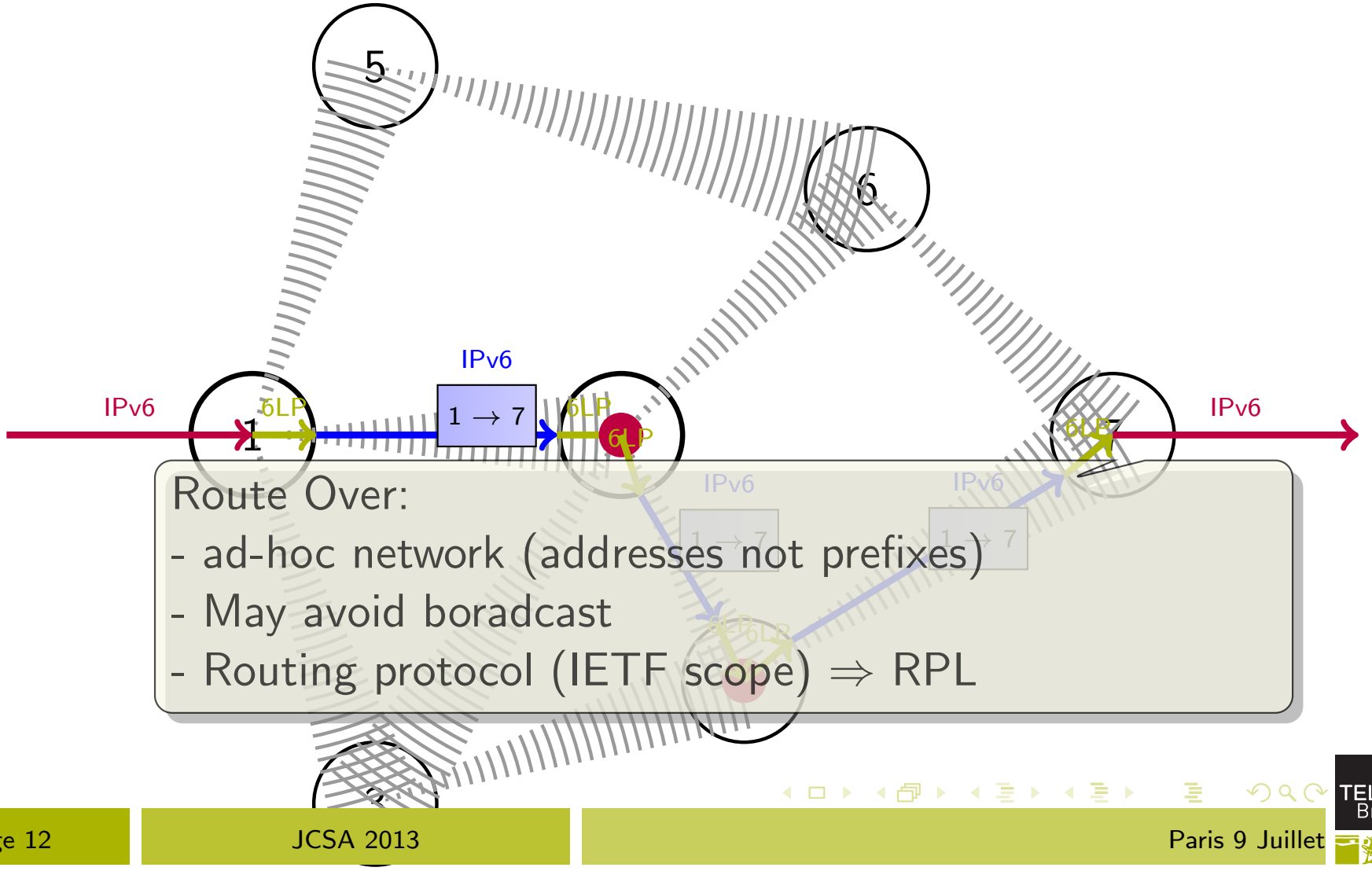
6LoWPAN: Route Over

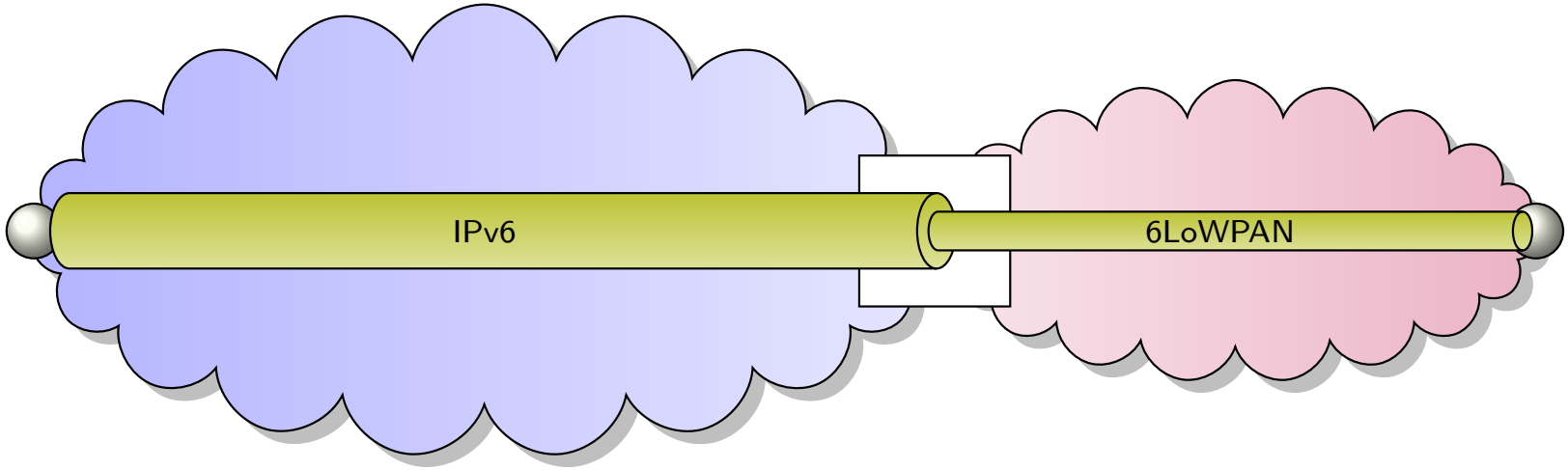
Breaking the Hourglass

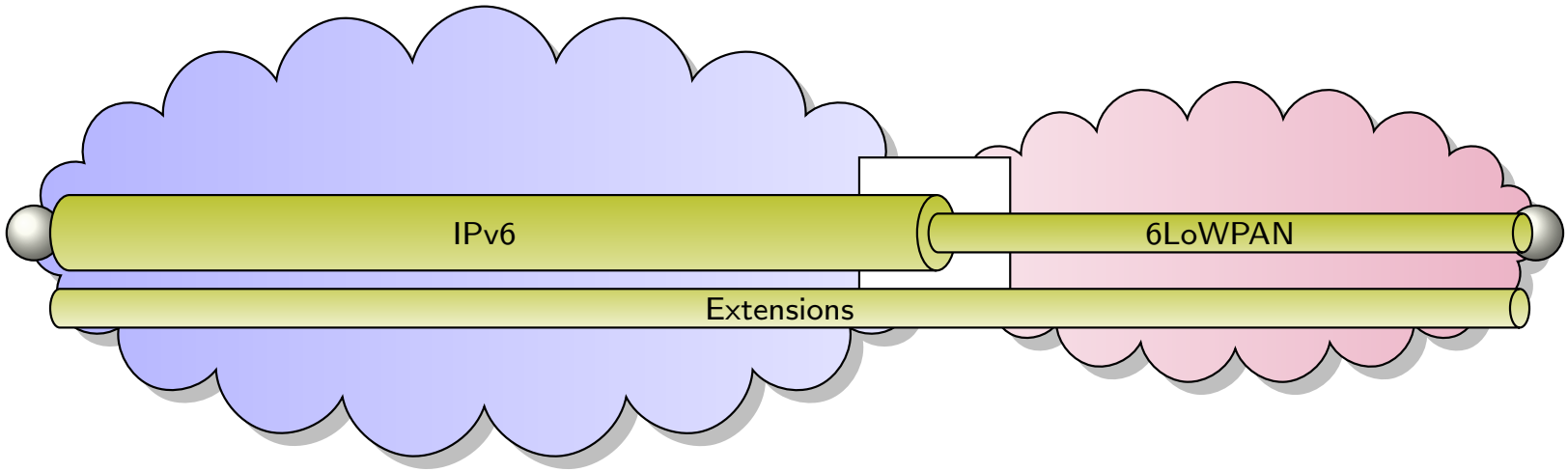


TELECOM Bretagne

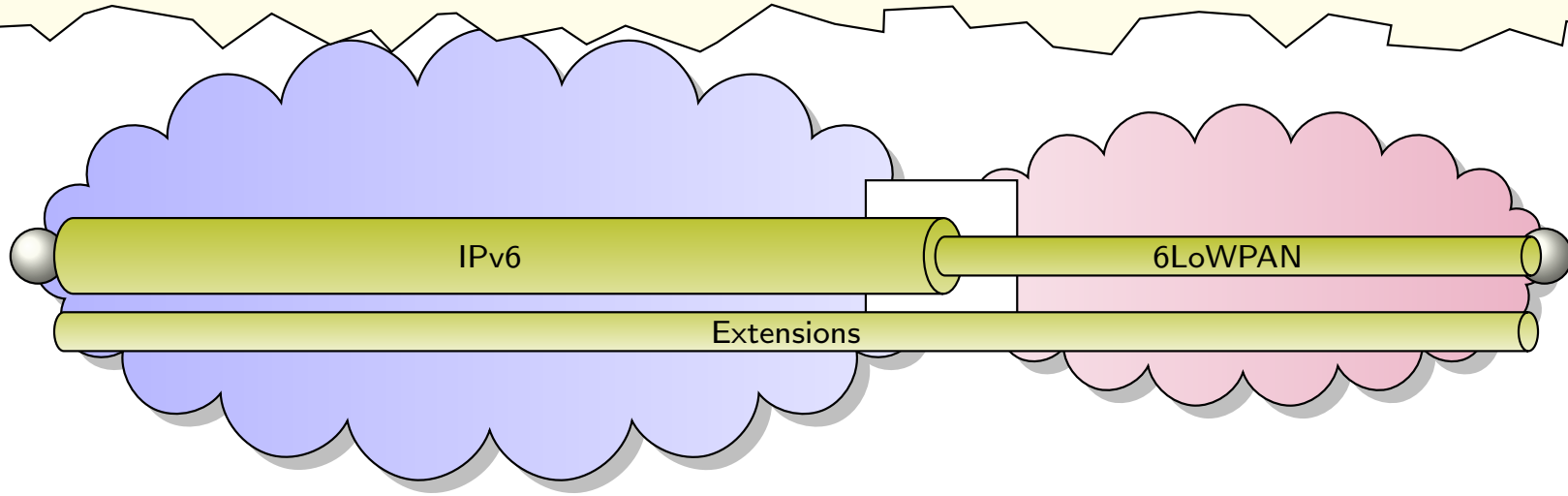
6LoWPAN: Route Over



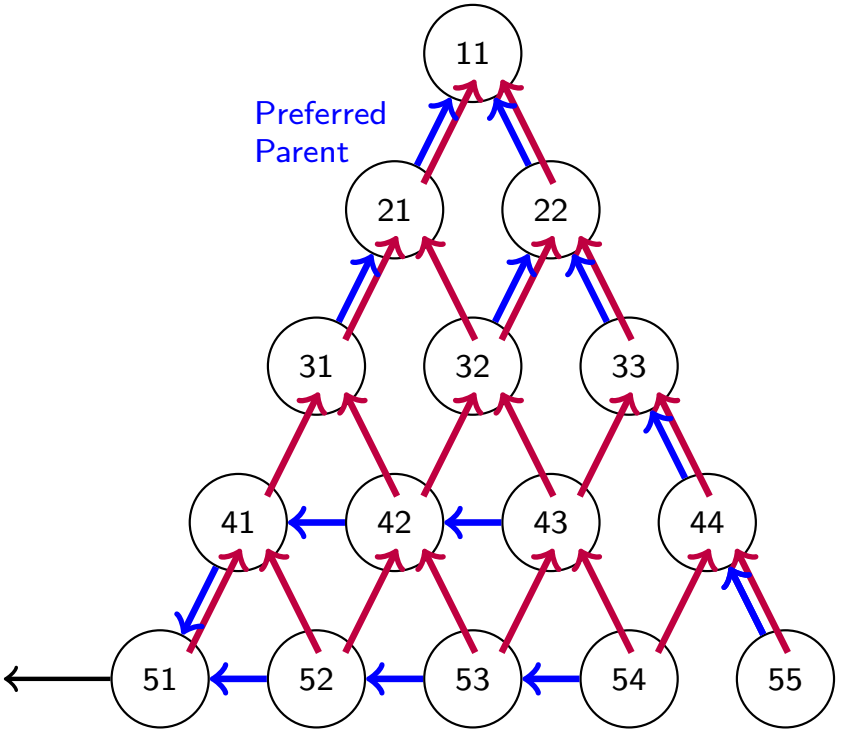

IPv6
6LoWPAN


IPv6
6LoWPAN
Extensions

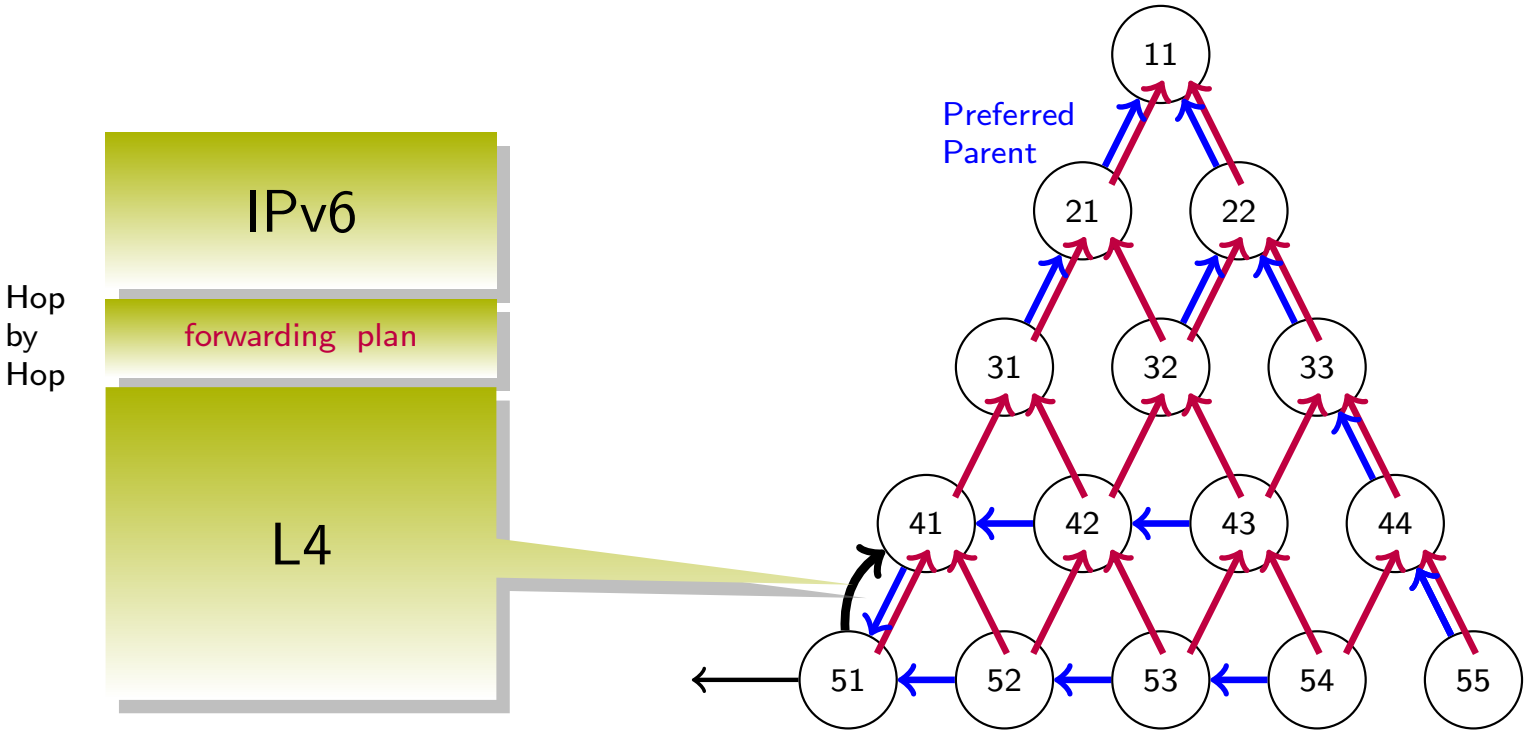
RFC 2460: With one exception, extension headers are not examined or processed by any node along a packet's delivery path , until the packet reaches the node (or each of the set of nodes, in the case of multicast) identified in the Destination Address field of the IPv6 header.

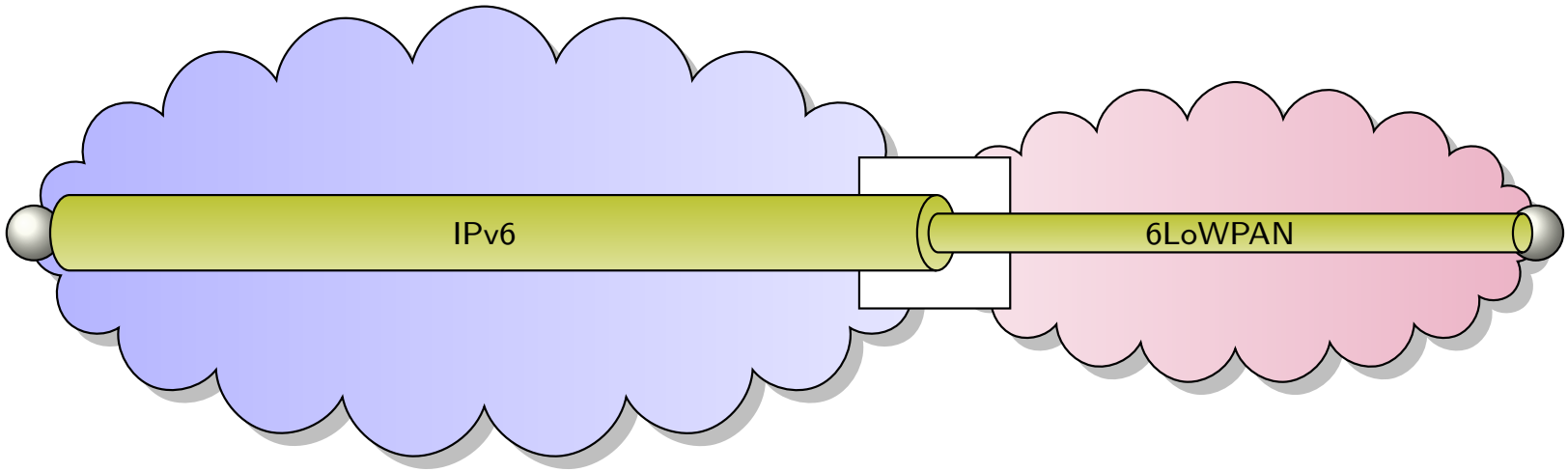


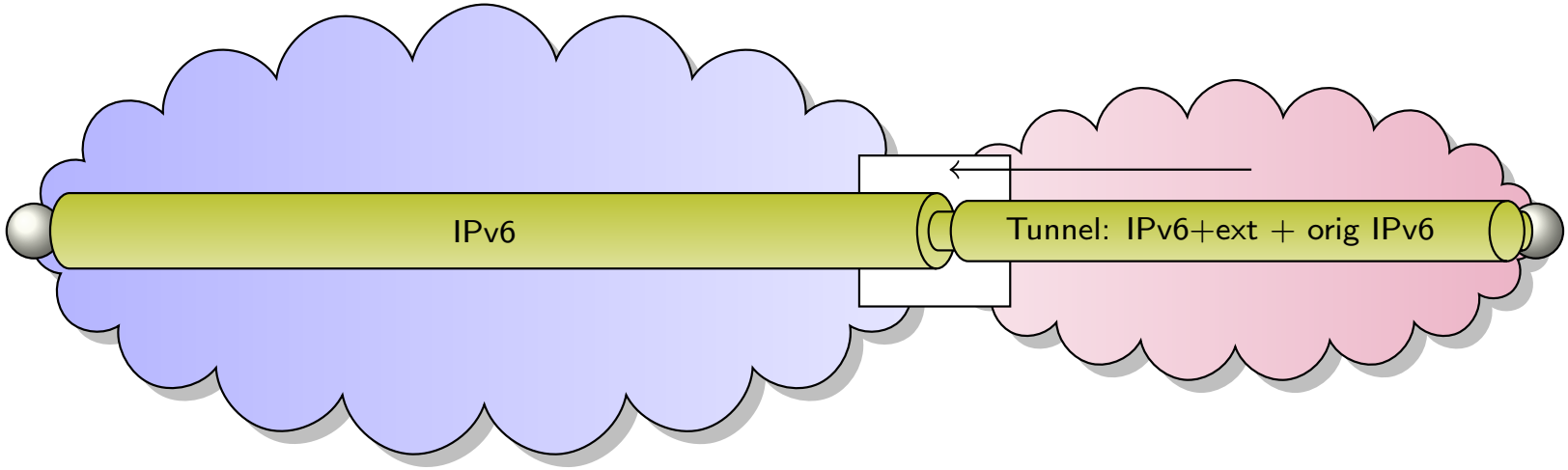
Upward traffic: DoDAG

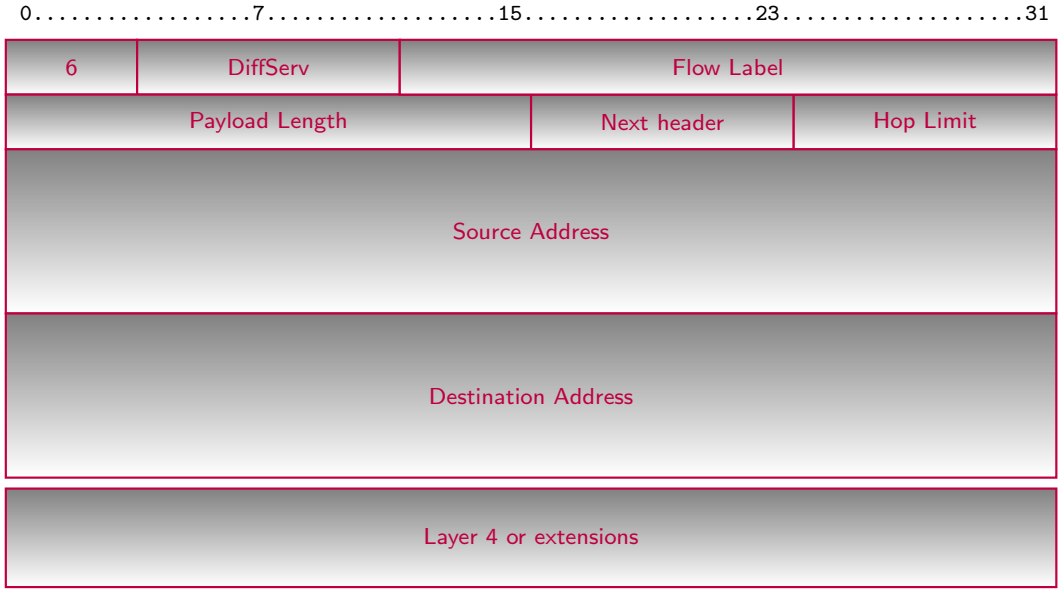


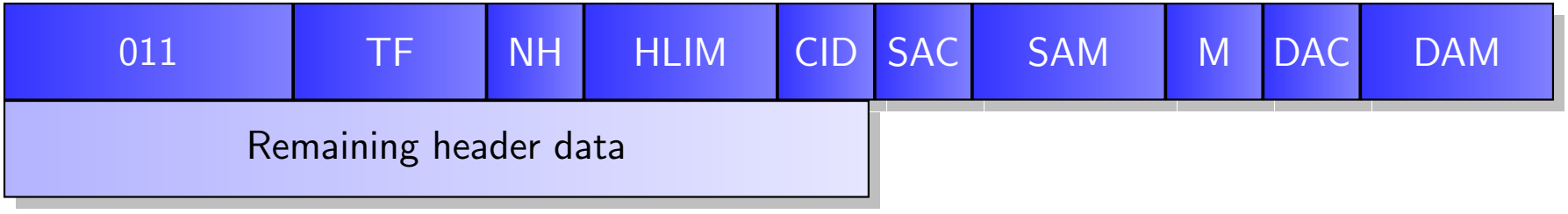
Upward traffic: DoDAG

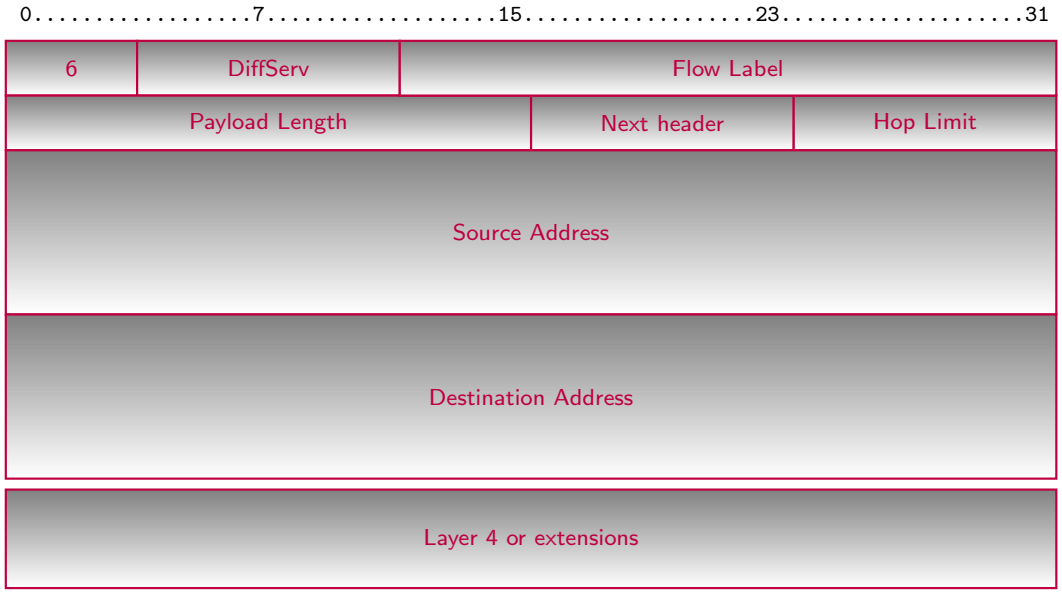



IPv6
6LoWPAN


IPv6
Tunnel: IPv6+ext + orig IPv6


0.....7.....15.....23.....31
6
DiffServ
Flow Label
Payload Length
Next header
Hop Limit
Source Address
Destination Address
Layer 4 or extensions


011
TF
NH
HLIM
CID
SAC
SAM
M
DAC
DAM
Remaining header data


0.....7.....15.....23.....31
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DiffServ
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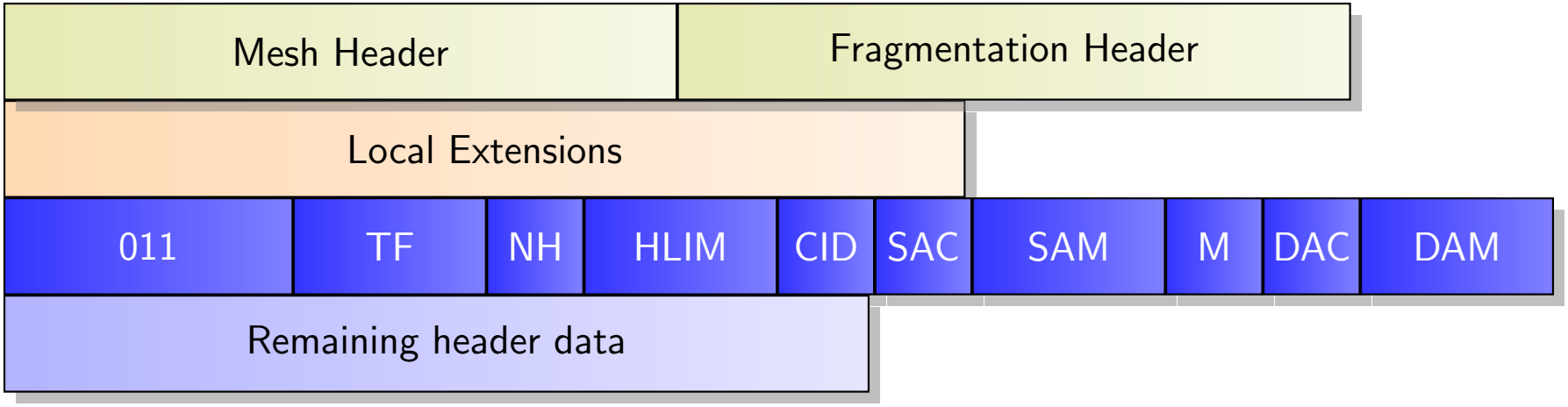
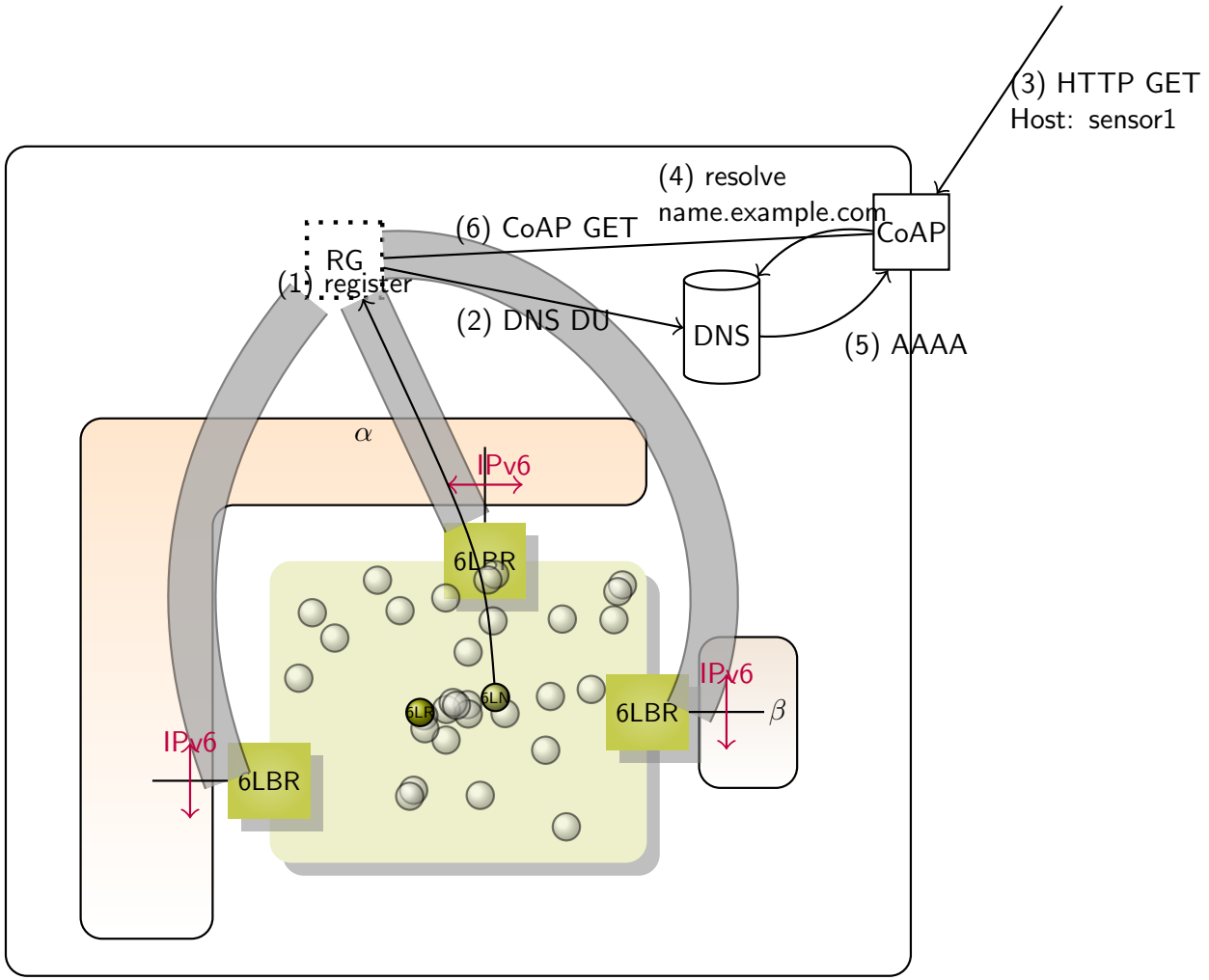
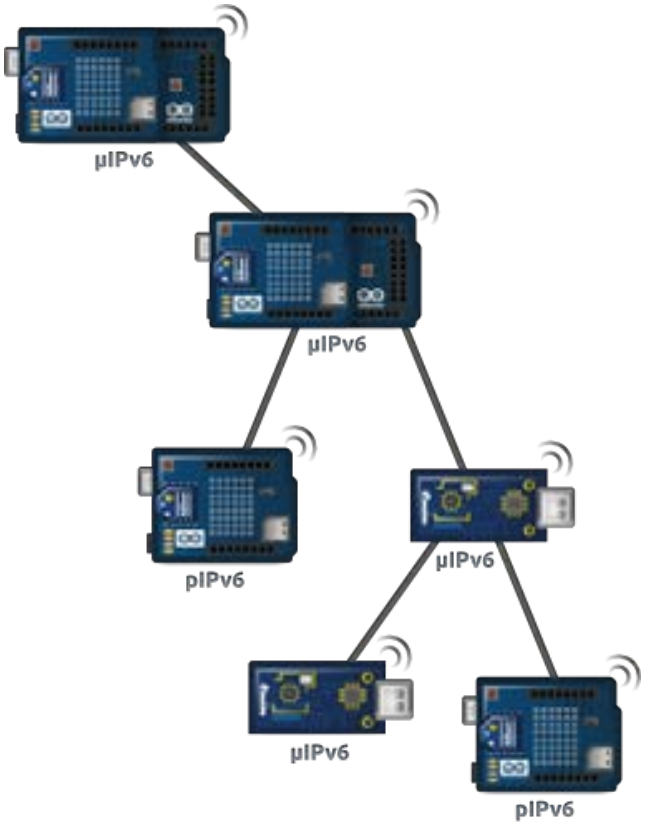
Layer 4 or extensions


Mesh Header
Fragmentation Header
Local Extensions
011
TF
NH
HLIM
CID
SAC
SAM
M
DAC
DAM
Remaining header data

DNS: CoAP Mode

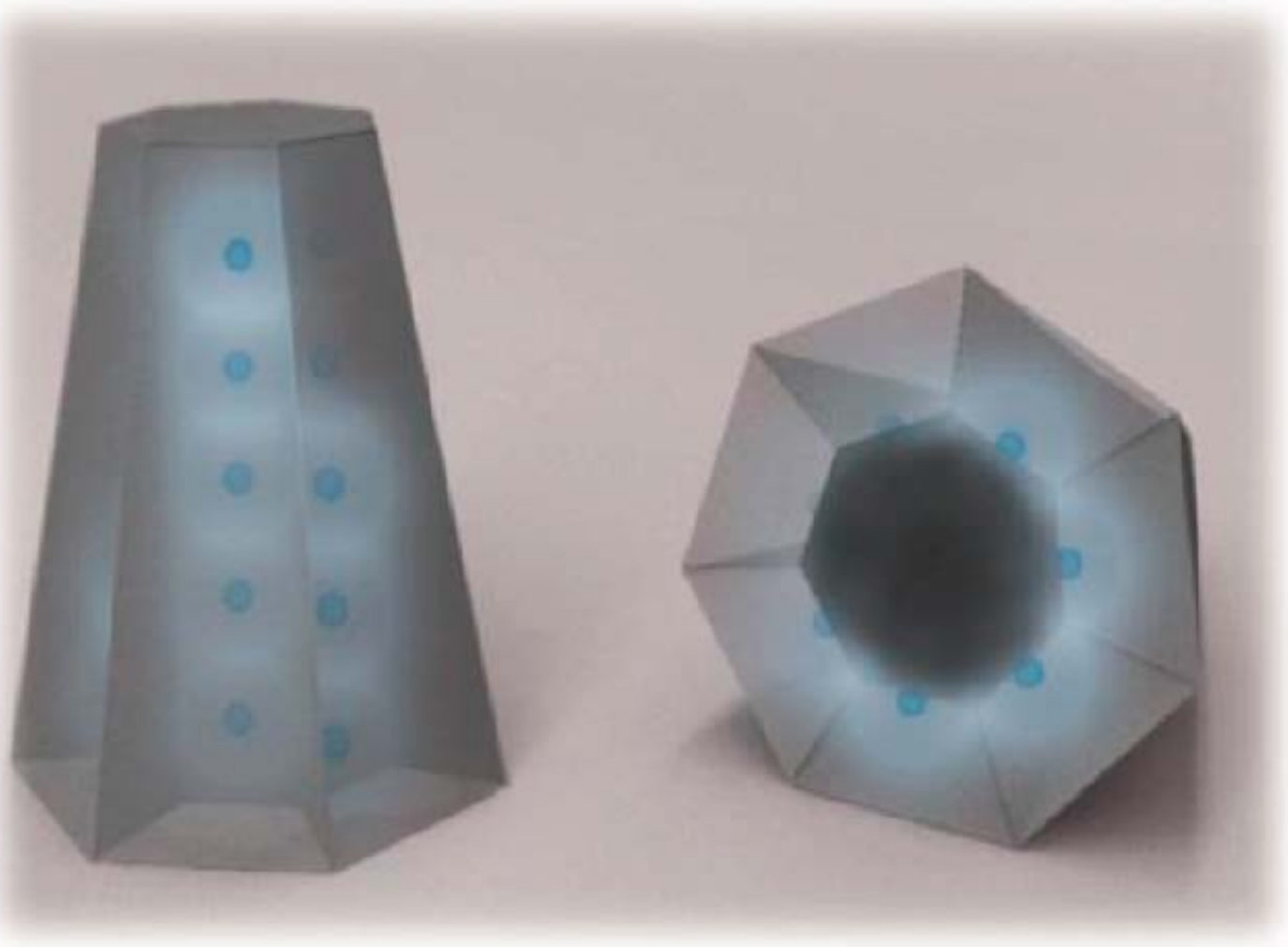


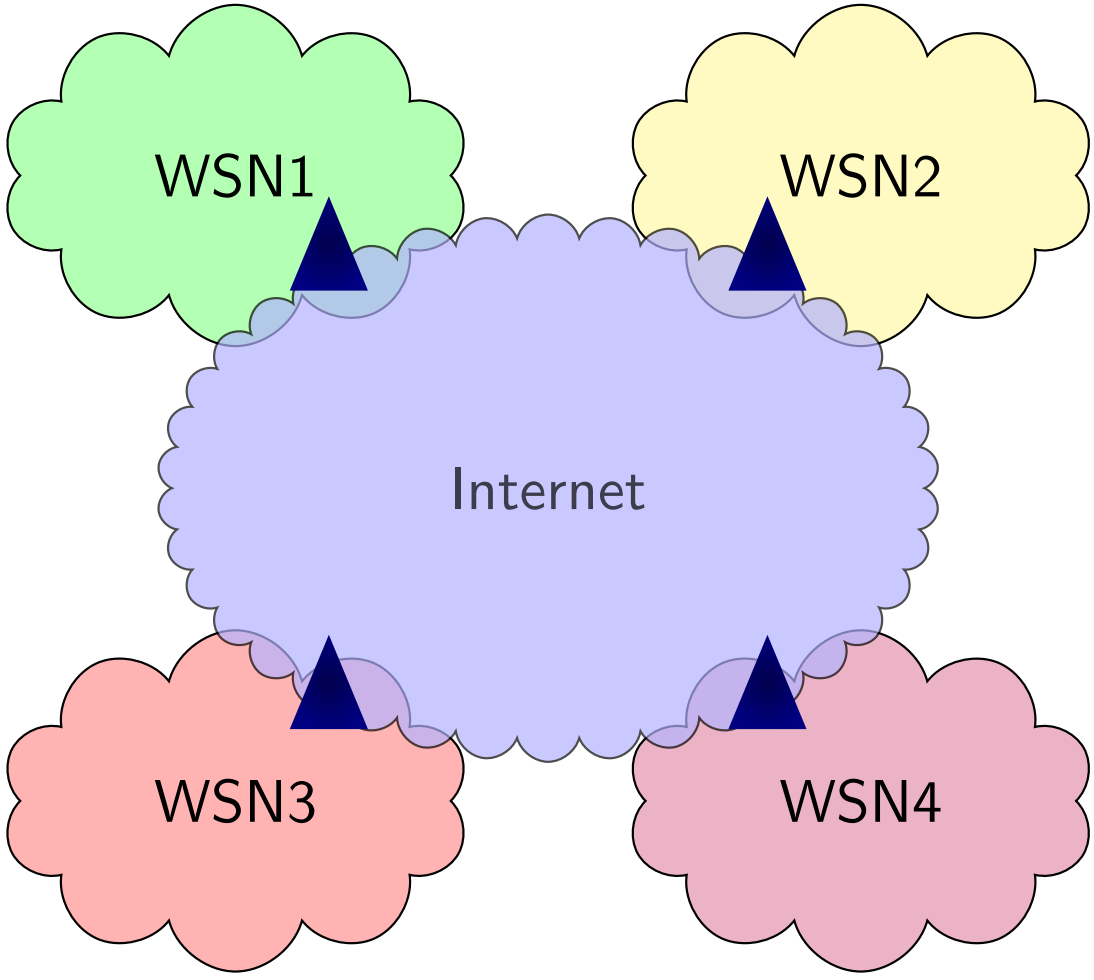


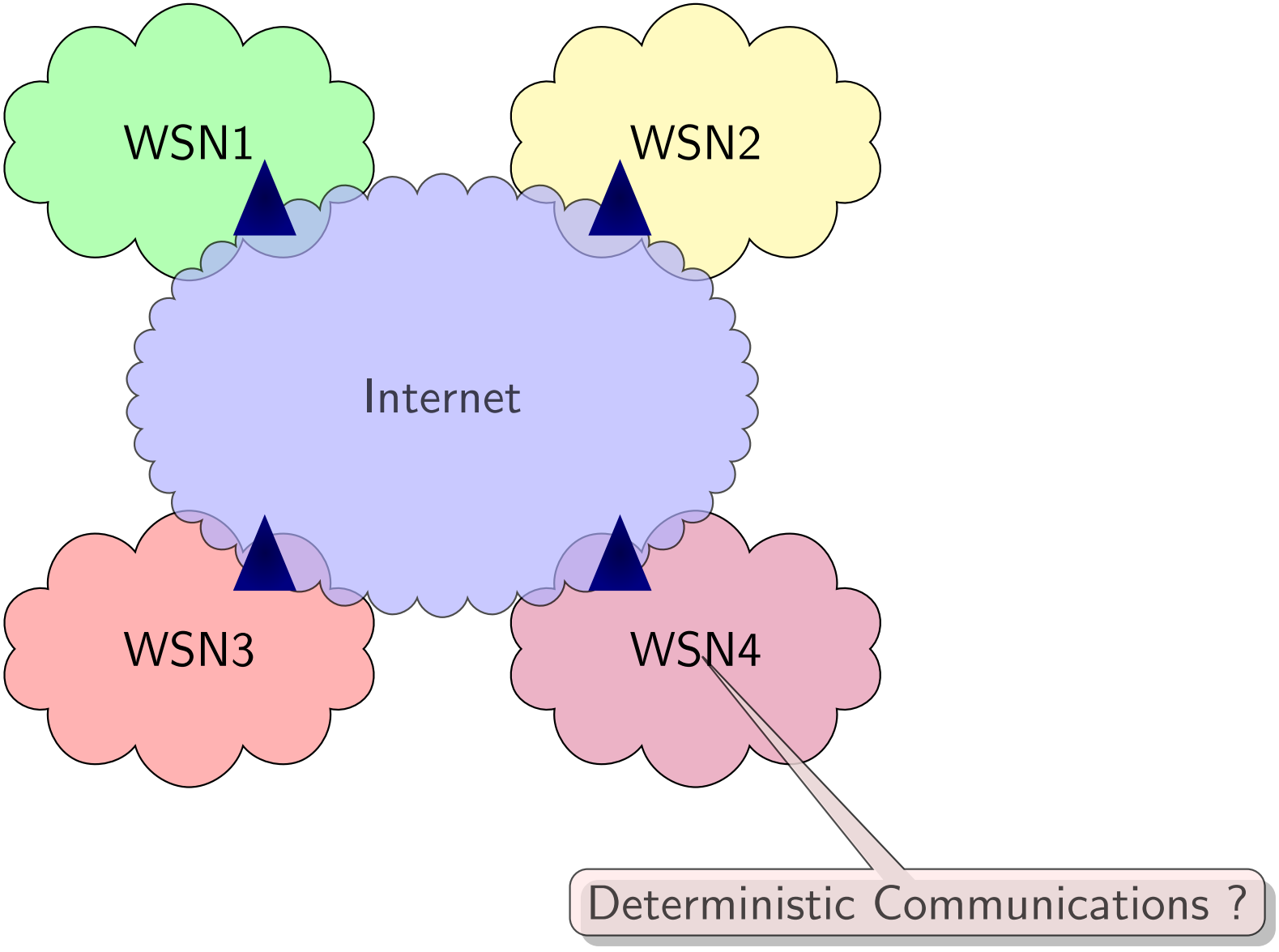
Heterogeneous wireless sensor network

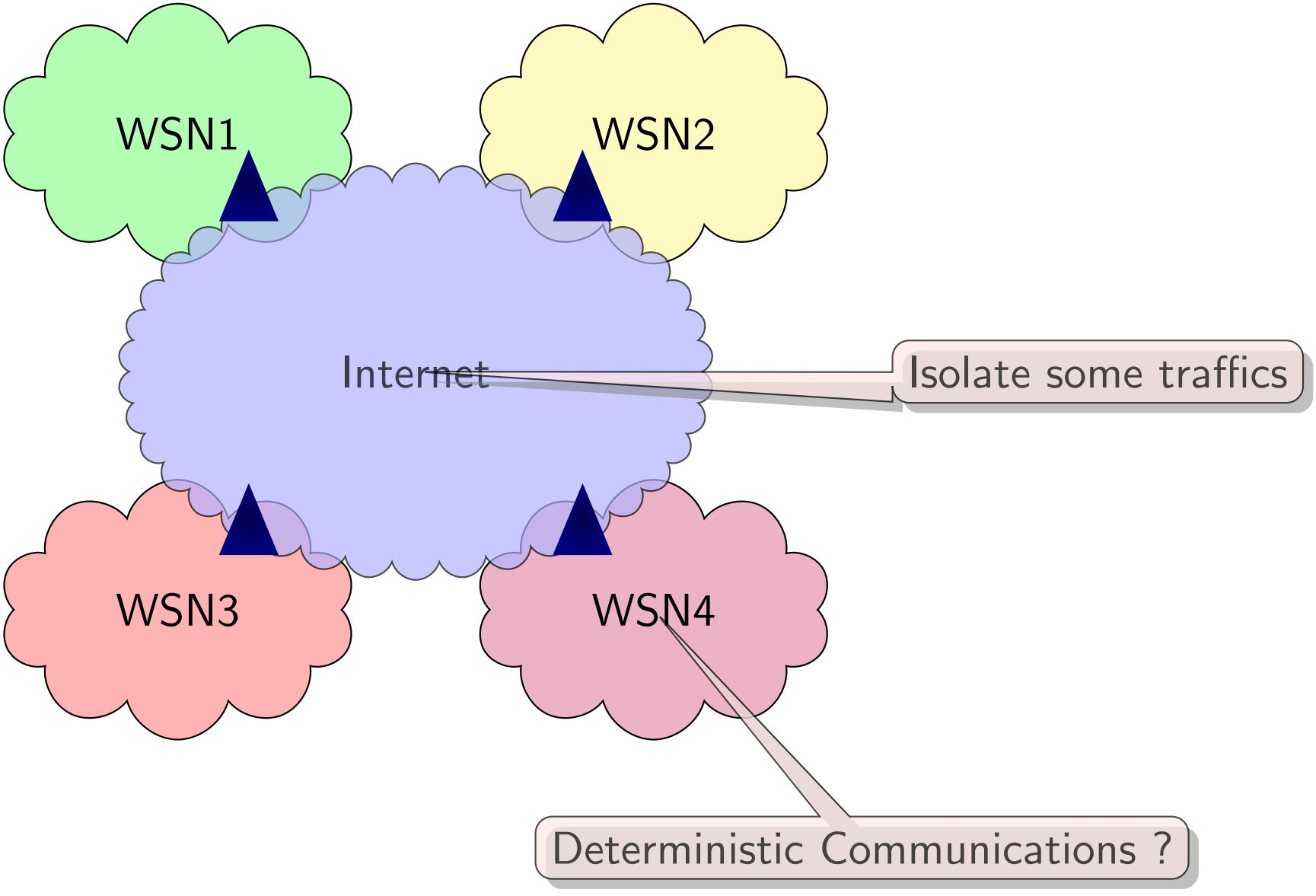
see

https://github.com/telecombretagne/Arduino-IPv6Stack




WSN1
WSN2
Internet
WSN3
WSN4


WSN1
WSN2
Internet
WSN3
WSN4
Deterministic Communications ?


WSN1
WSN2
Internet
Isolate some traffics
WSN3
WSN4
Deterministic Communications ?