

Pursuing a Software-Defined Information-Centric Network

Dimitris Syrivelis

CERTH-ITI and University of Thessaly

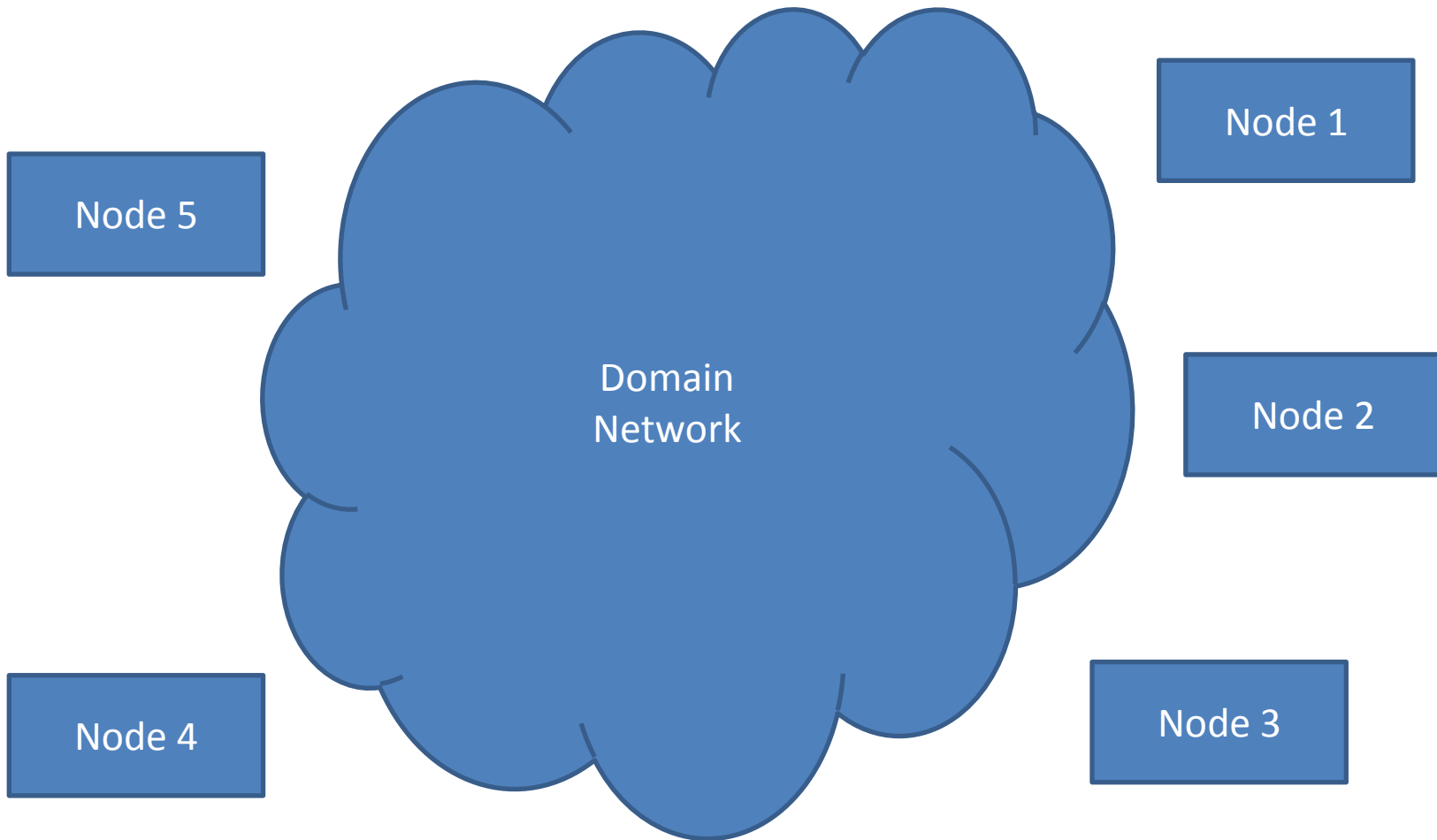
Contents

- An Information – Centric Network Architecture
- An ICN Node Architecture
- Using LIPSIN for packet forwarding
- Designing a LIPSIN switch using Openflow and changes to ICN node architecture
- Benefits of using SDN support

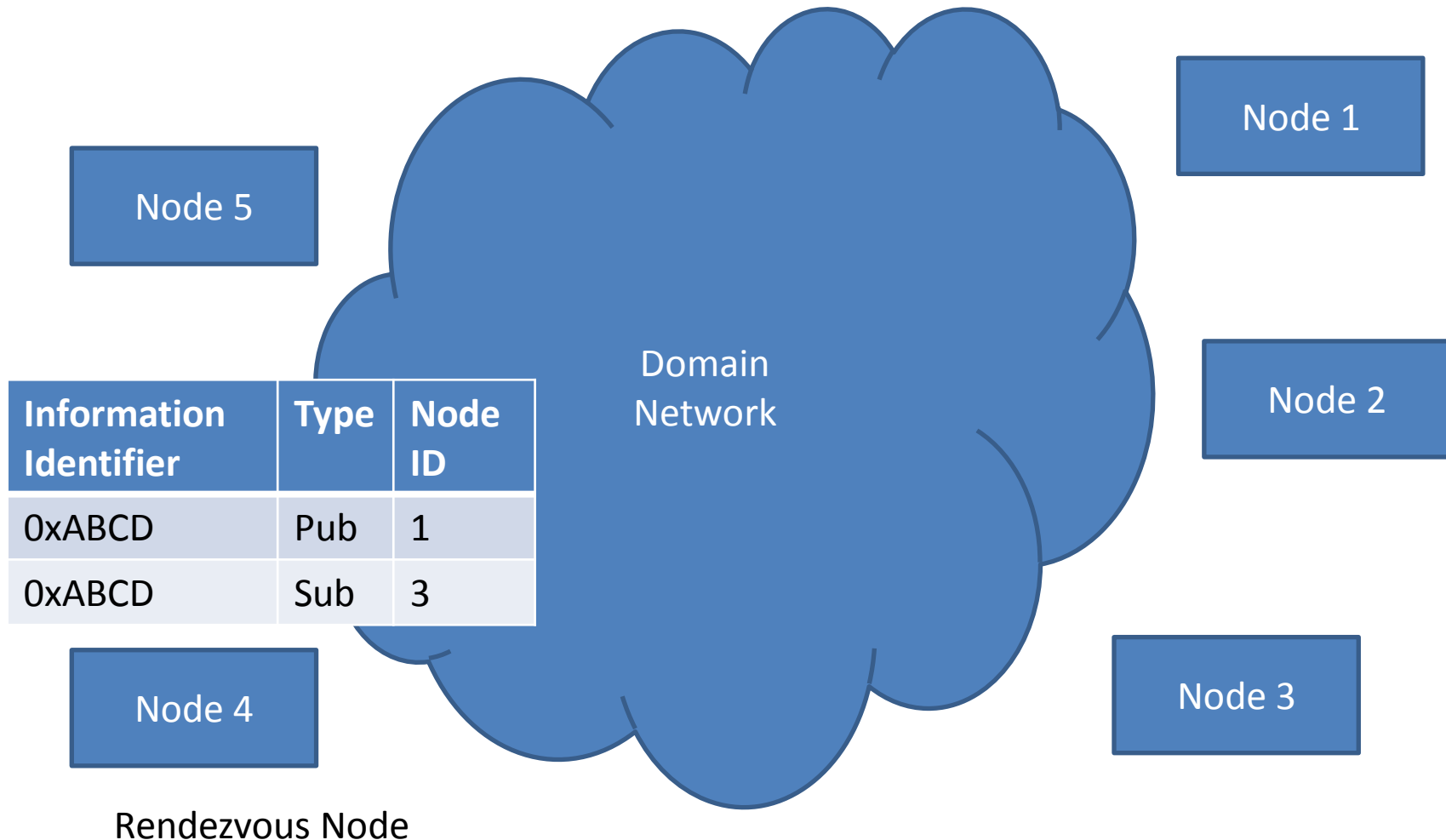
An ICN Network Architecture

- Proposed by FP7 PURSUIT Project
<http://www.fp7-pursuit.eu>
- SDN support developed in FP7 OpenLab project
<http://www.ict-openlab.eu>
- A modular design that supports publish/subscribe semantics with 3 discrete functions:
 - Rendezvous
 - Topology Management
 - Forwarding

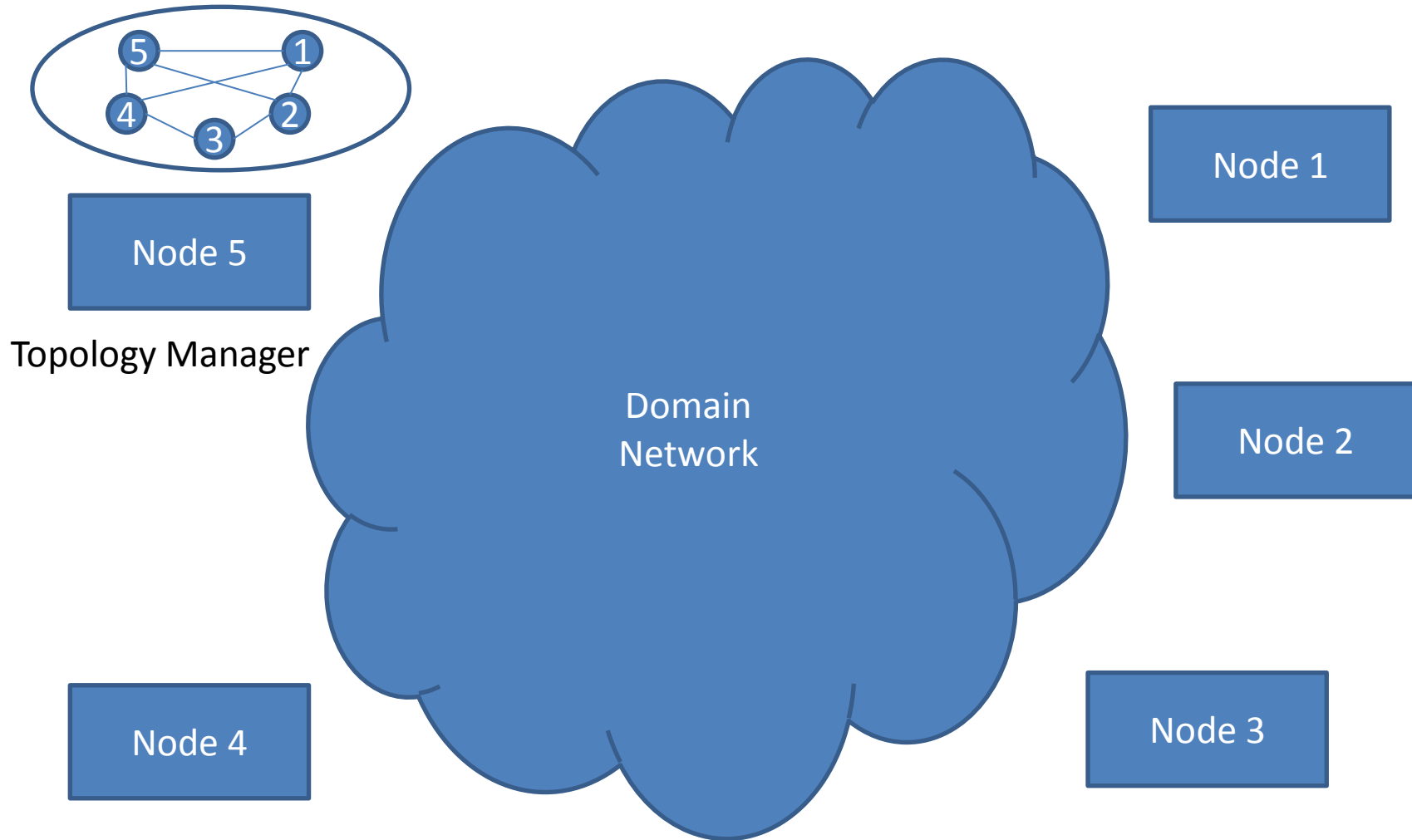
A domain deployment example



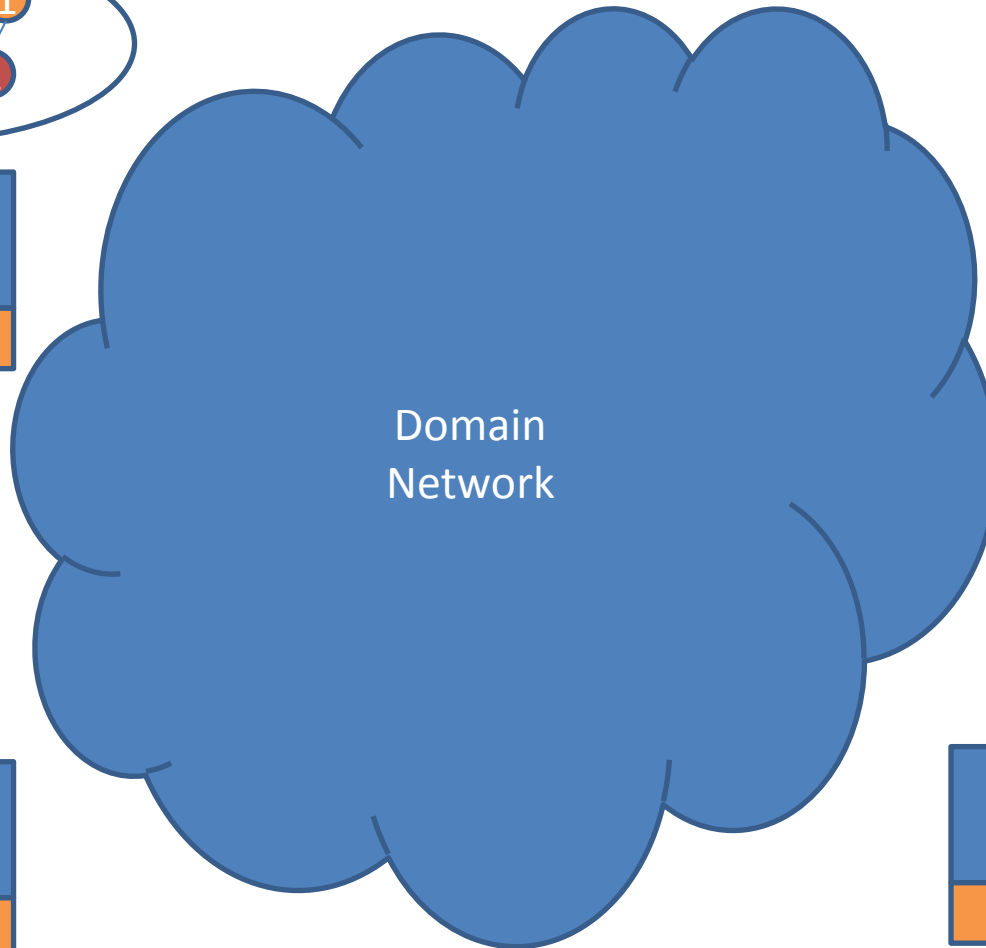
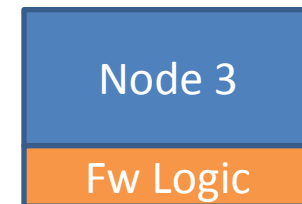
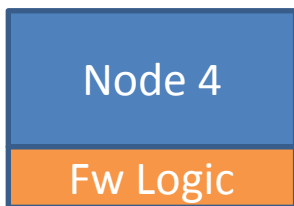
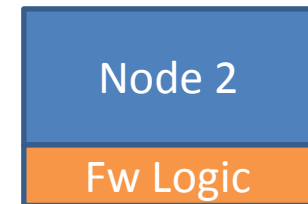
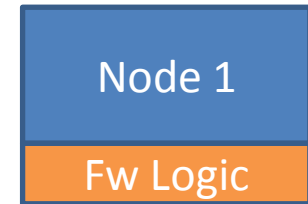
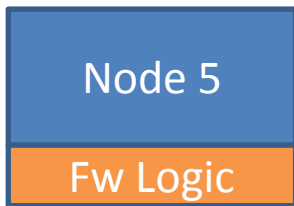
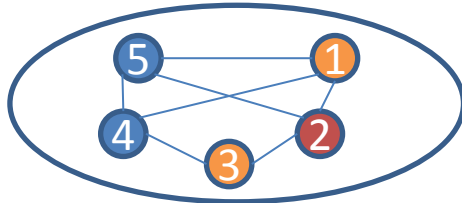
Rendezvous Function



Topology Management Function

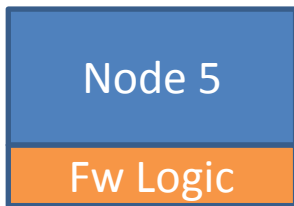
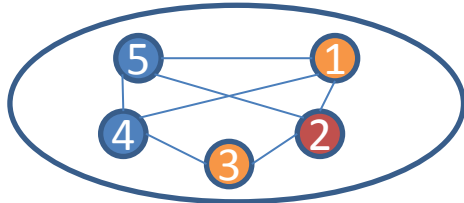


Topology Management/Forwarding

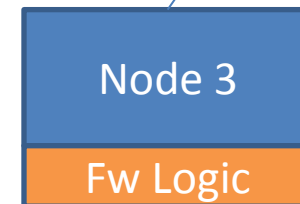
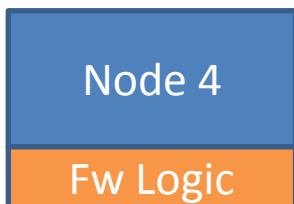
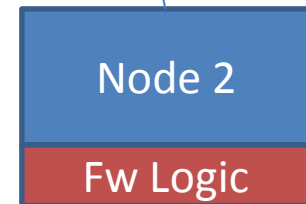
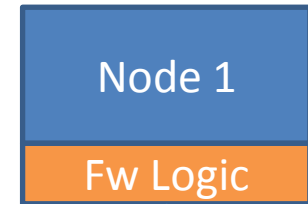
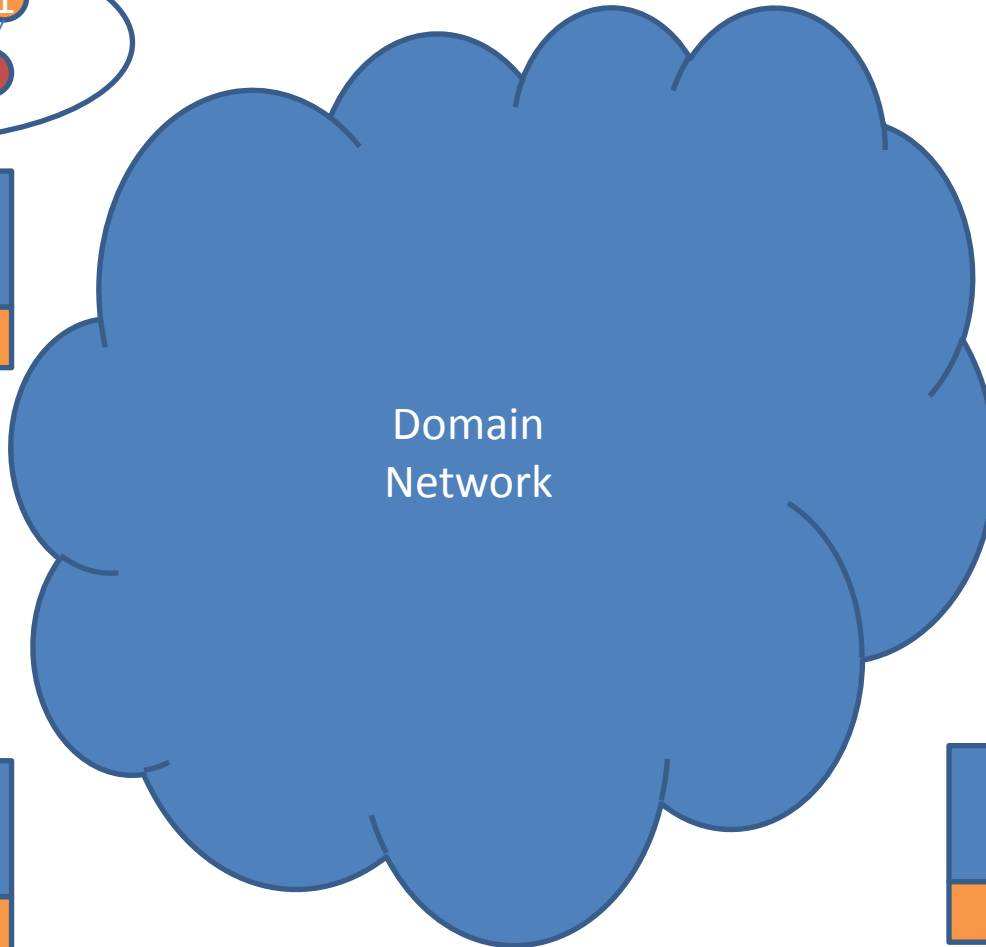


Topology Manager

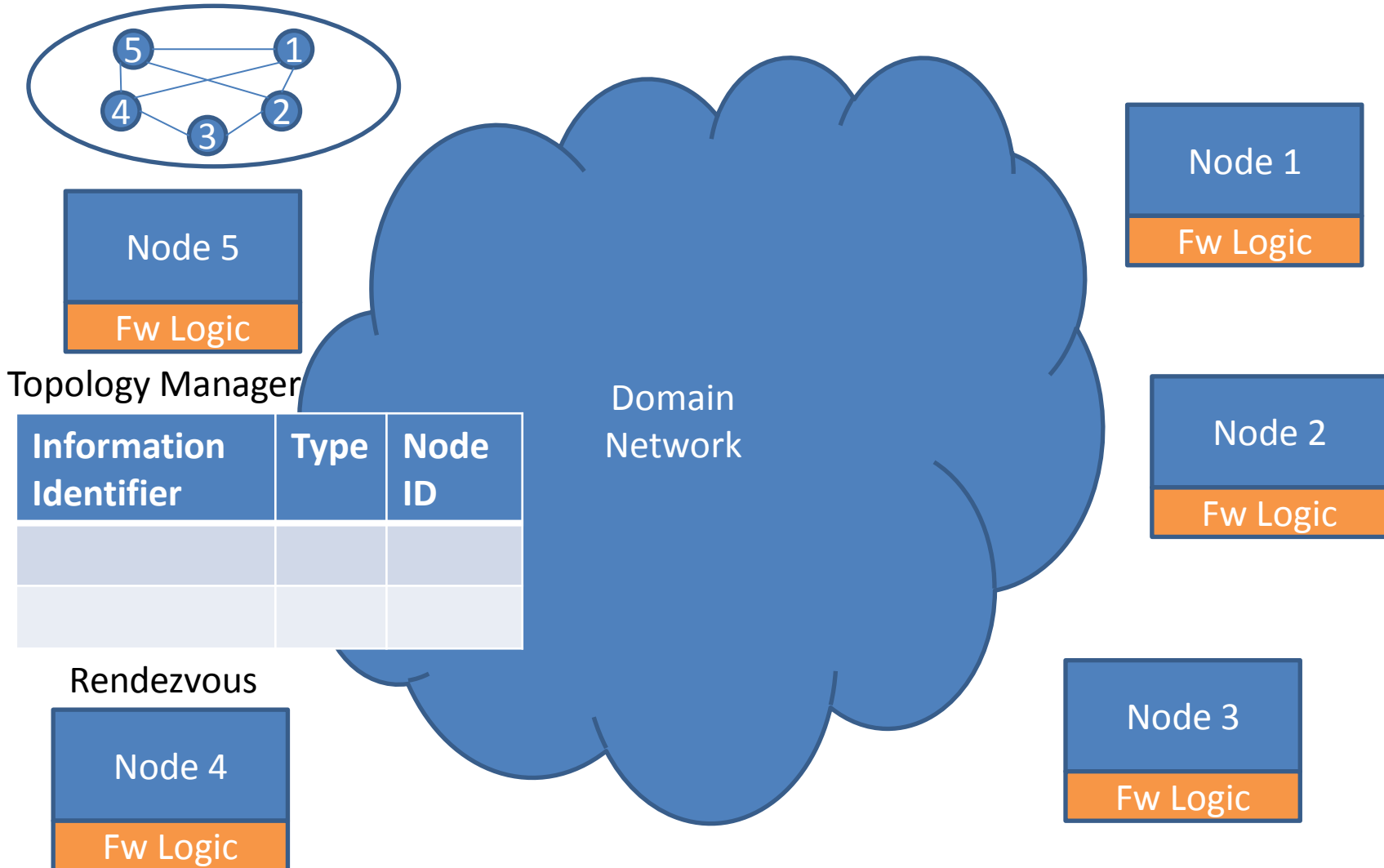
Topology Management/Forwarding



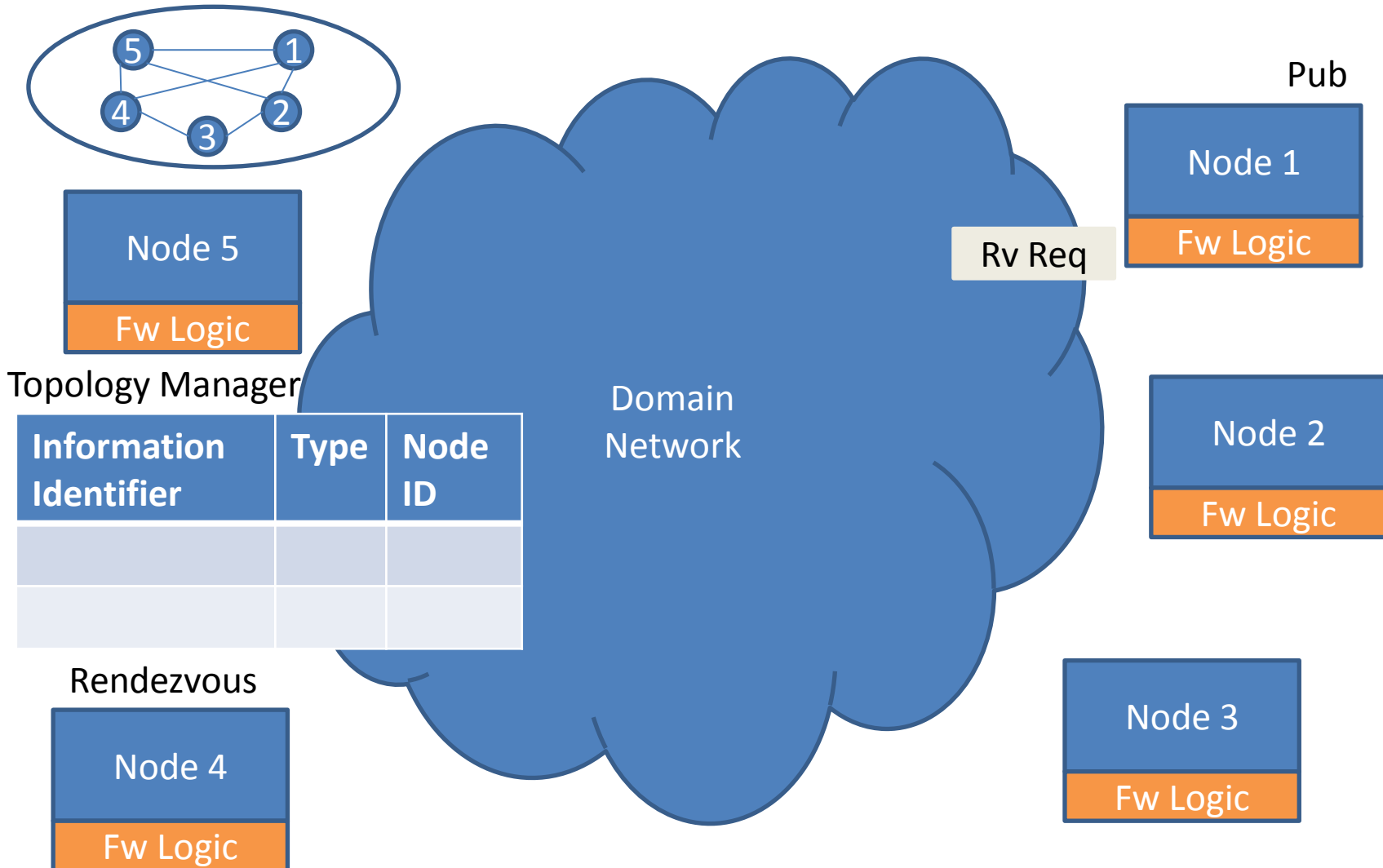
Topology Manager



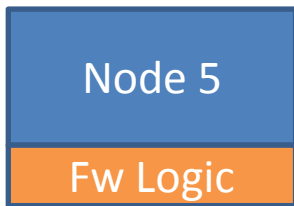
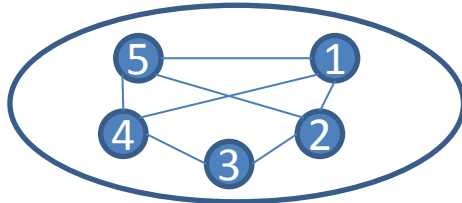
Example System Operation



Example System Operation



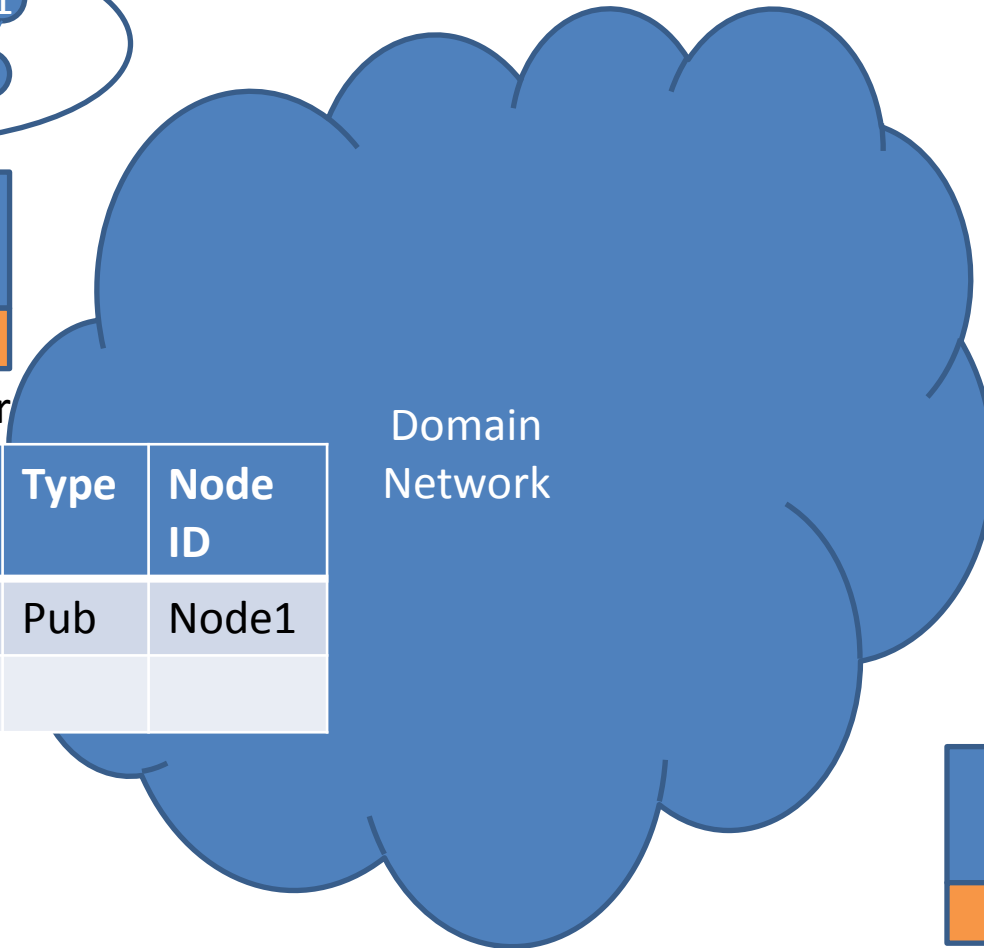
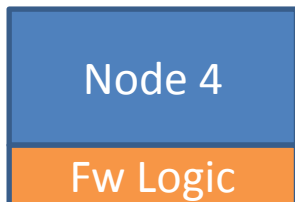
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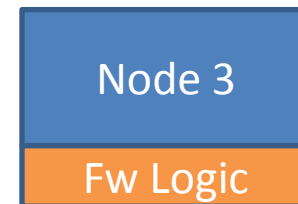
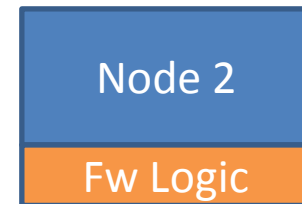
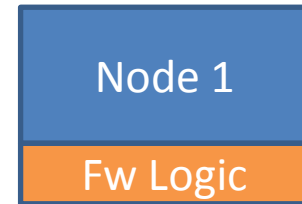
Topology Manager

Information Identifier	Type	Node ID
0xABC1234	Pub	Node1

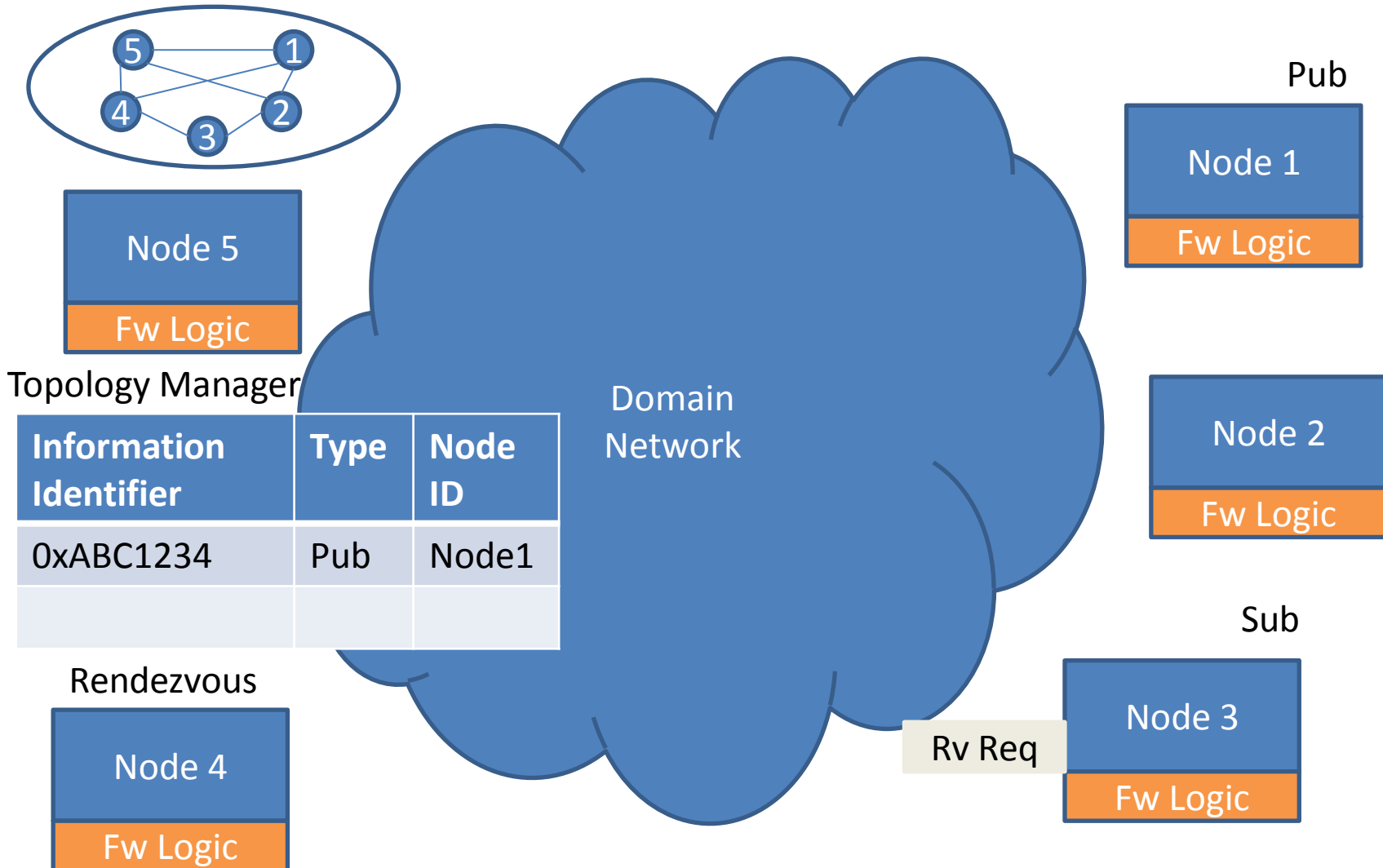
Rendezvous



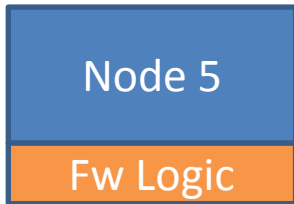
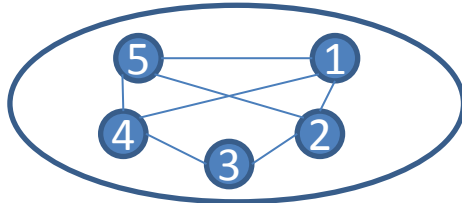
Pub



Example System Operation



Example System Operation

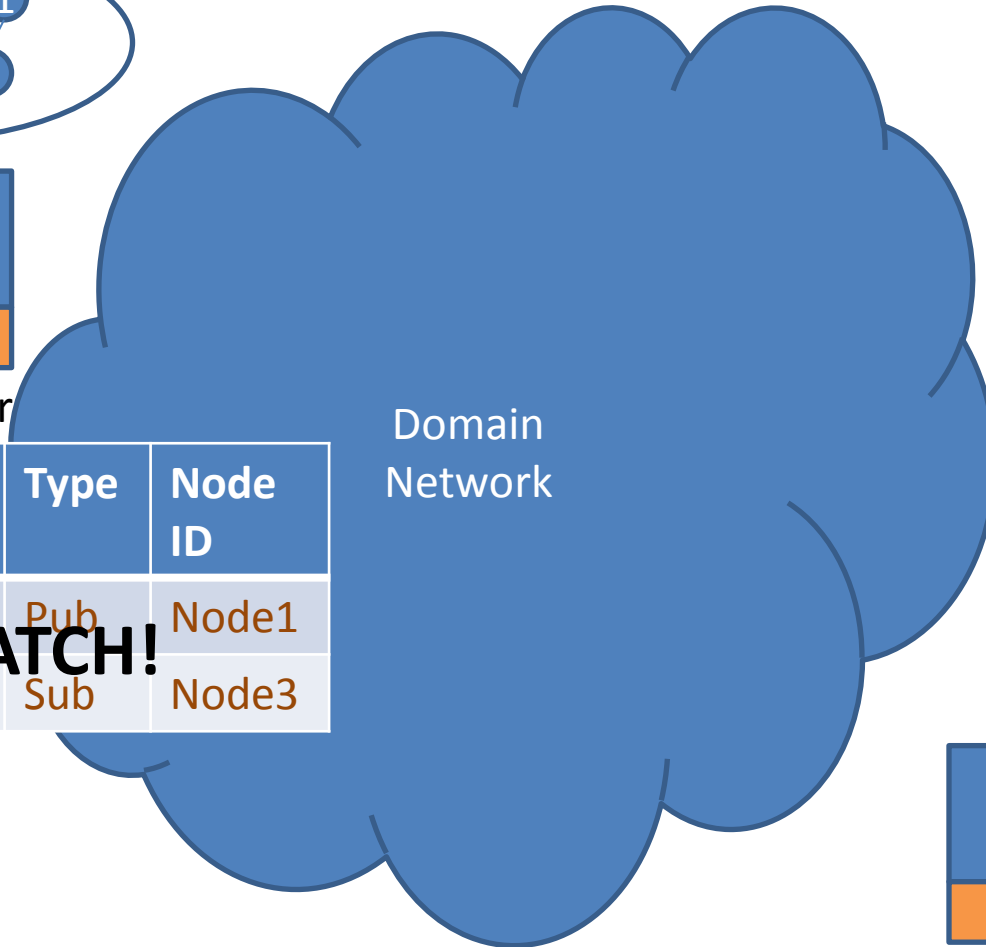
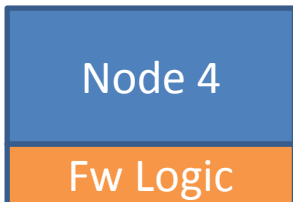


Topology Manager

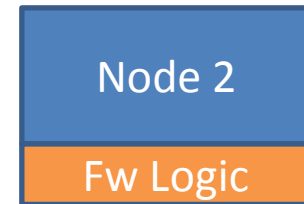
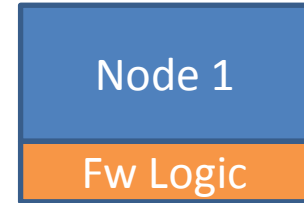
Information Identifier	Type	Node ID
0xABC1234	Pub	Node1
0xABC1234	Sub	Node3

MATCH!

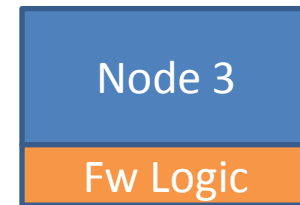
Rendezvous



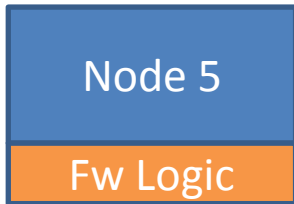
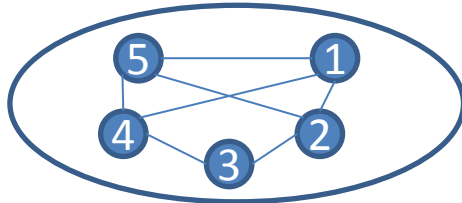
Pub



Sub

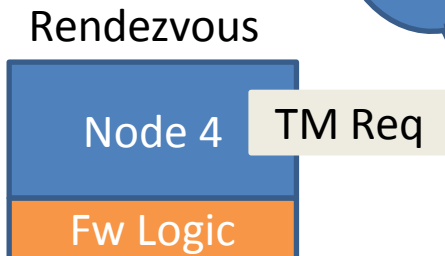
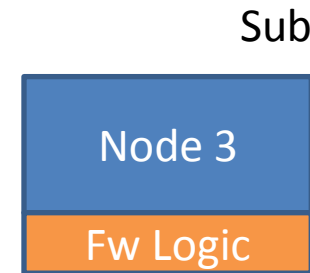
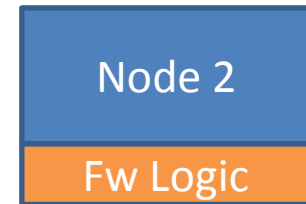
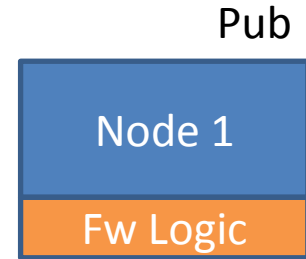
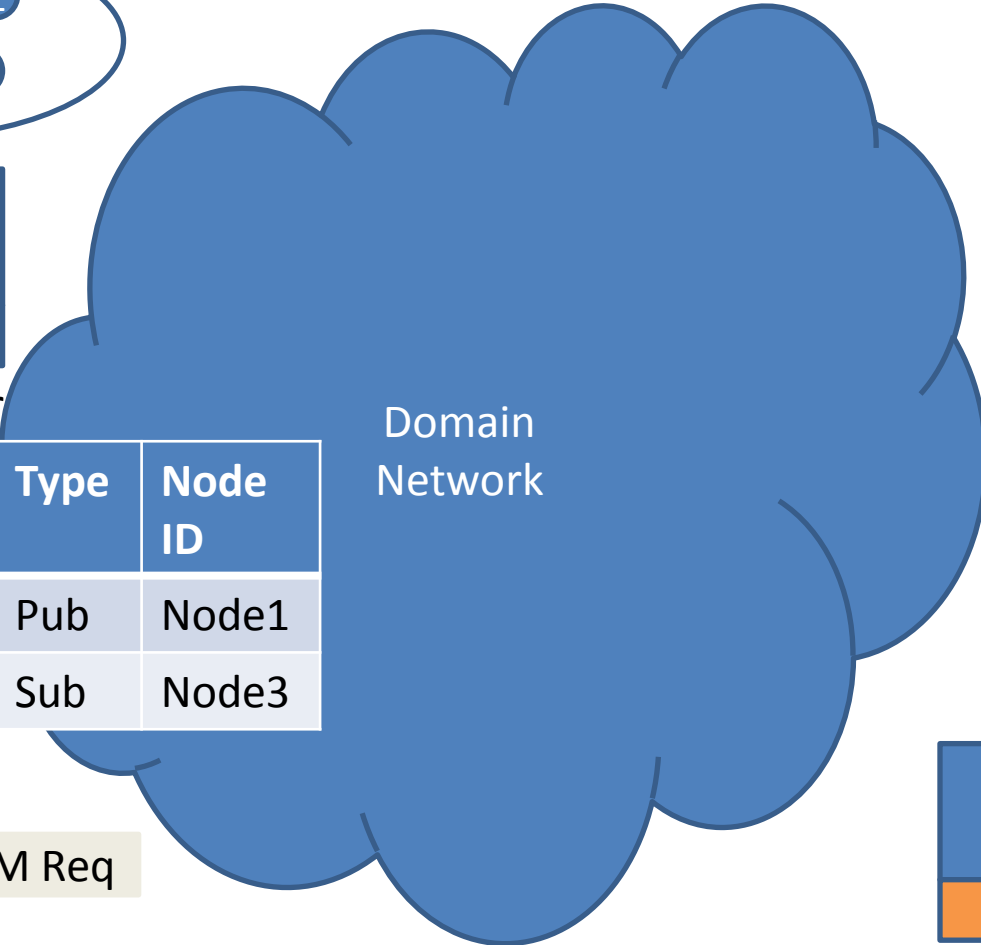


Example System Operation

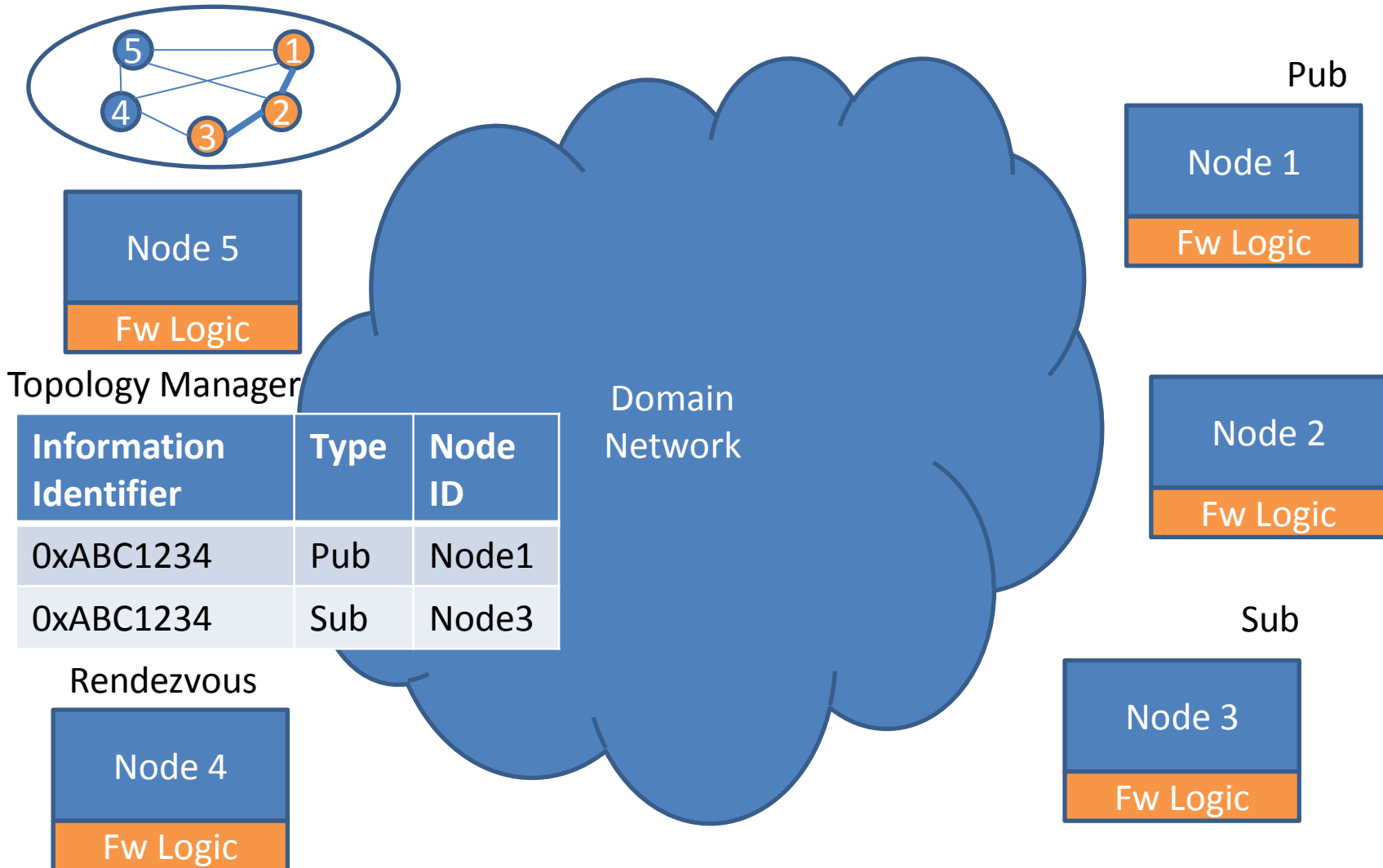


Topology Manager

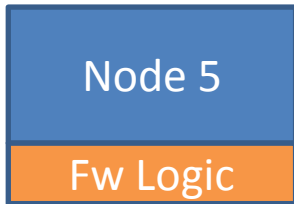
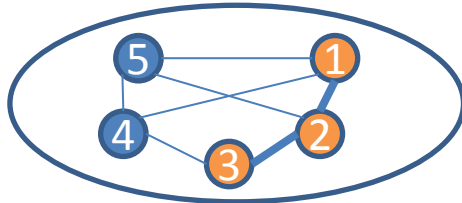
Information Identifier	Type	Node ID
0xABC1234	Pub	Node1
0xABC1234	Sub	Node3



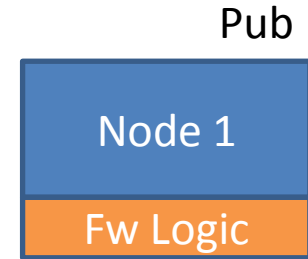
Example System Operation



Example System Operation



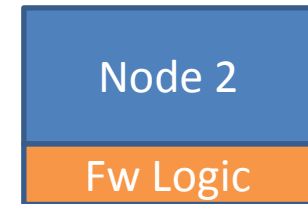
Start Publish Notification



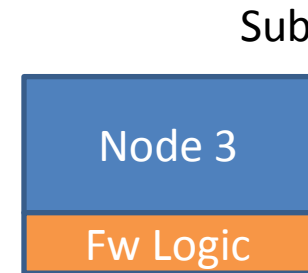
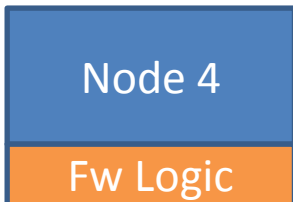
Topology Manager

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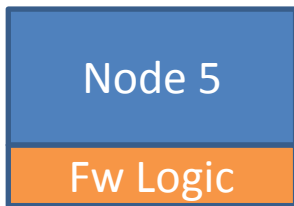
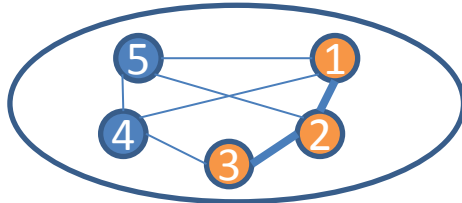
Domain Network



Rendezvous



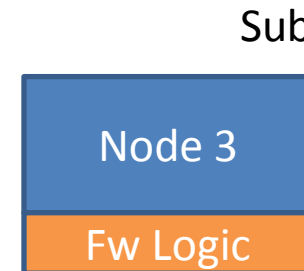
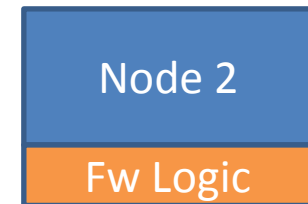
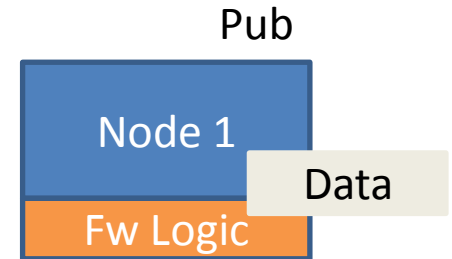
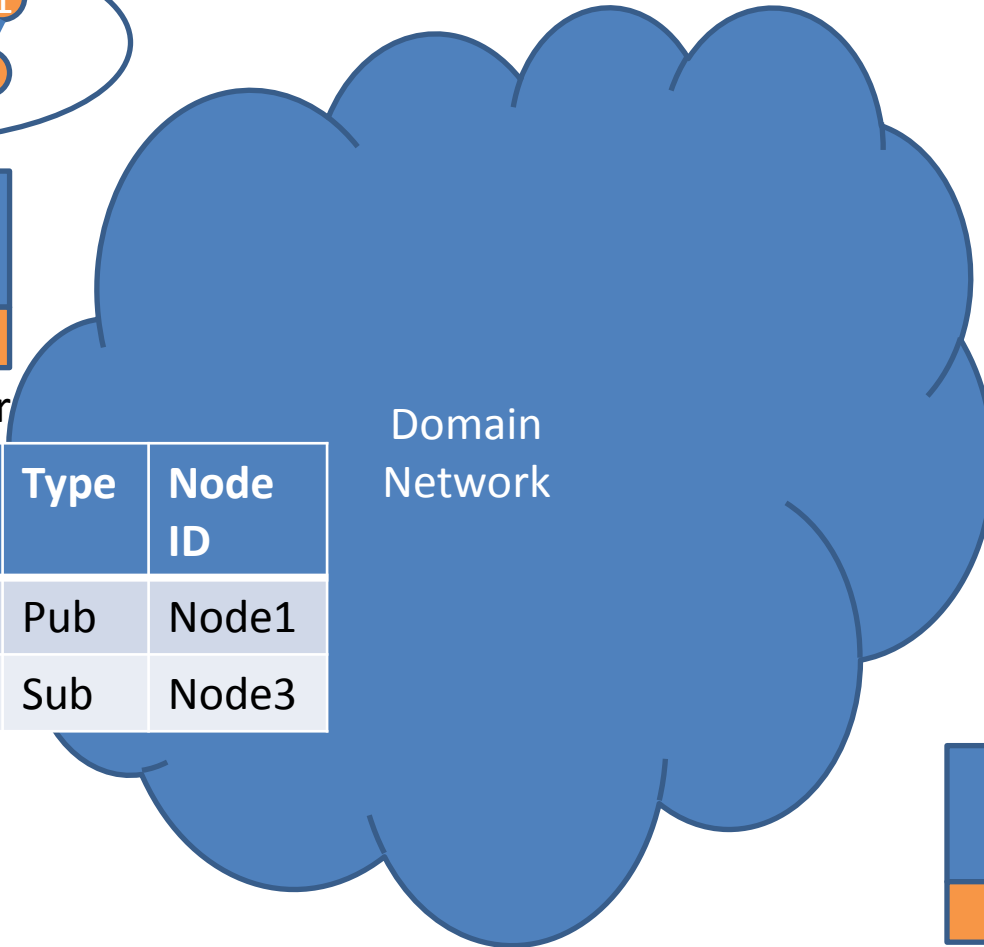
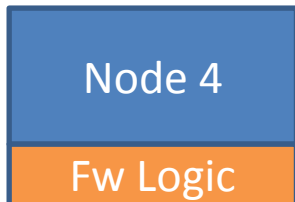
Example System Operation



Topology Manager

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0xABC1234	Sub	Node3

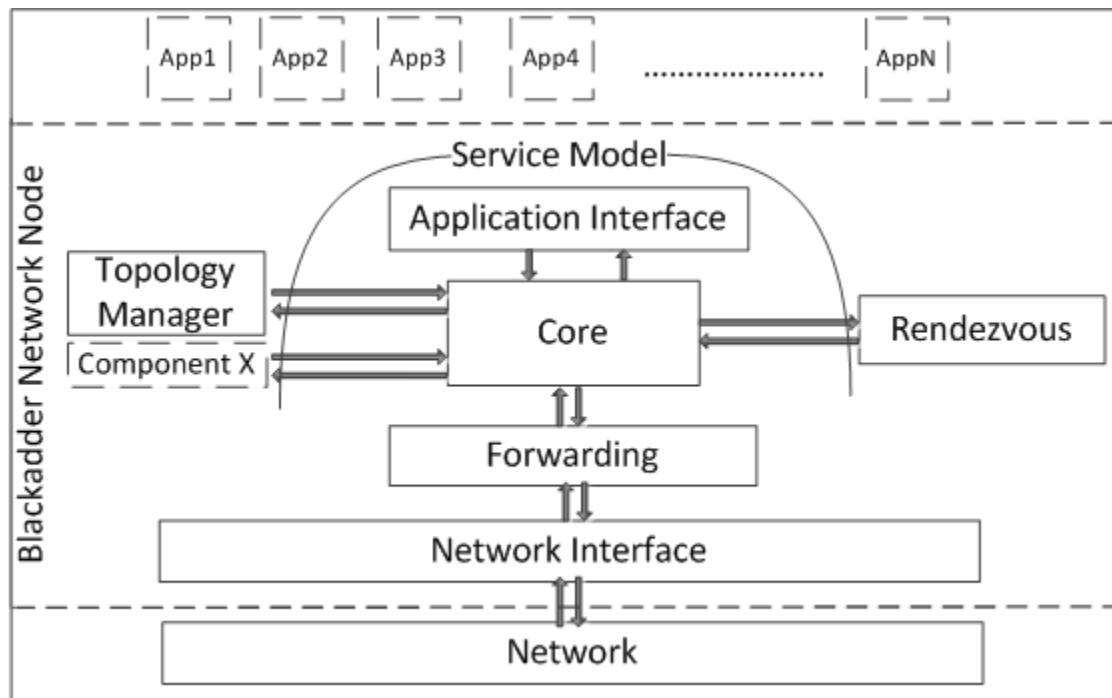
Rendezvous



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An ICN node architecture (BlackAdder prototype)



The service model exports pure publish subscribe semantics, along with synchronization primitives for robust application development

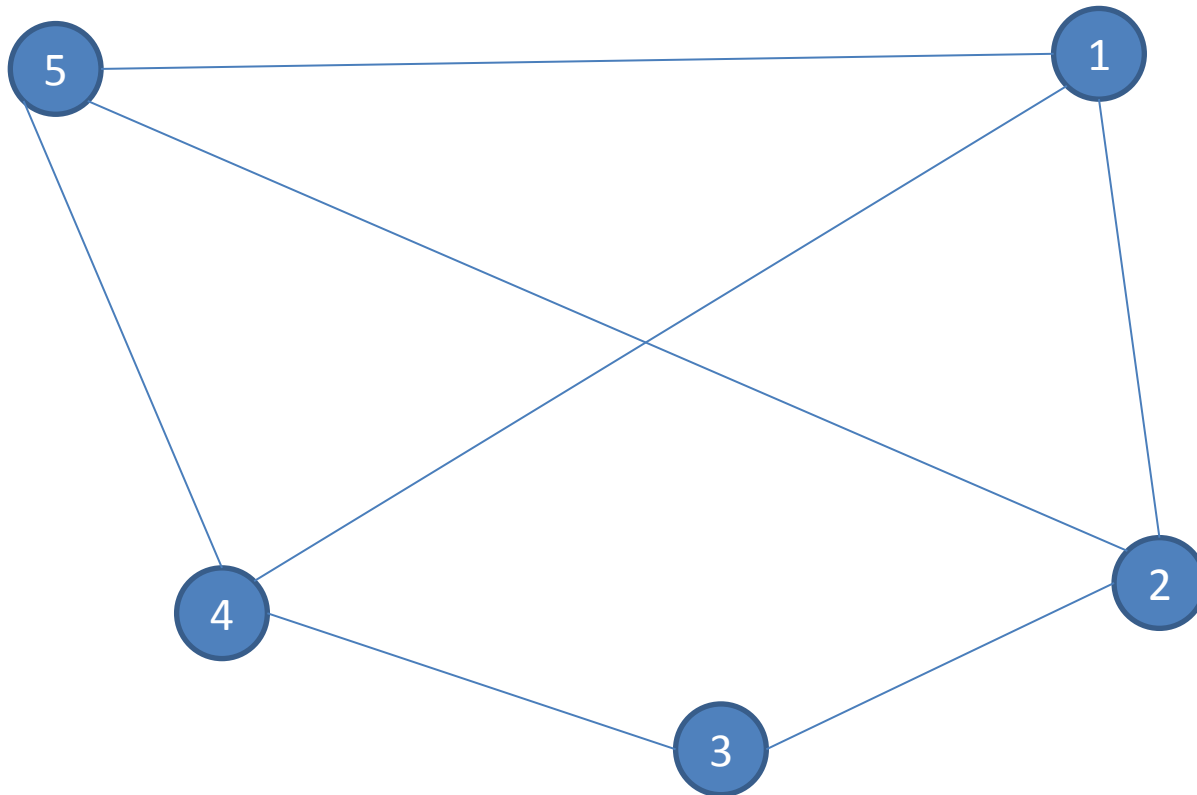
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LIPSIN for packet forwarding

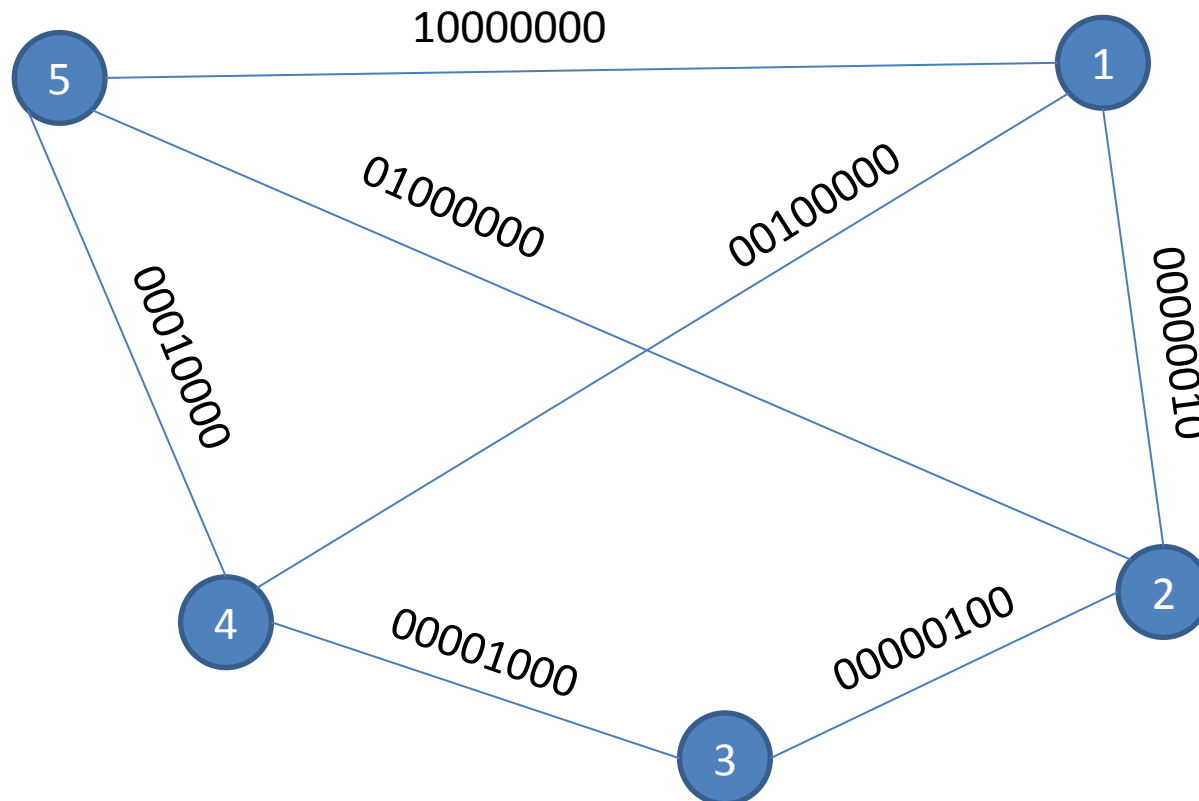
- LIPSIN (Petri Jokela et al.) is a source-based routing system which uses bloom filters to encode routes to one or more destinations (multicast trees).
- LIPSIN encodes physical links by applying bloom filters on a fixed size, few-bytes long, identifier which is prepended on each packet.
- Once routes are encoded into a single forwarding identifier at the source, LIPSIN forwarding achieves line speed.

How LIPSIN works



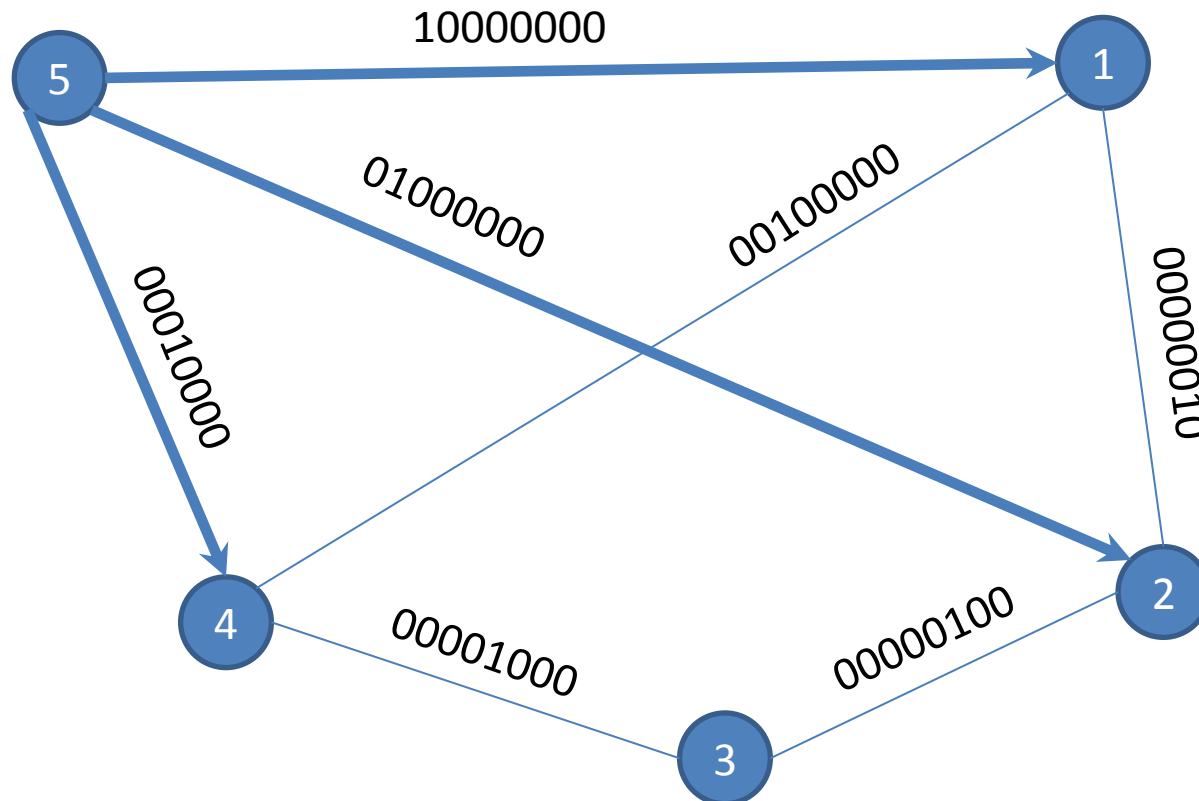
How LIPSIN works

i) Assign fixed length deployment-unique identifiers to all physical links



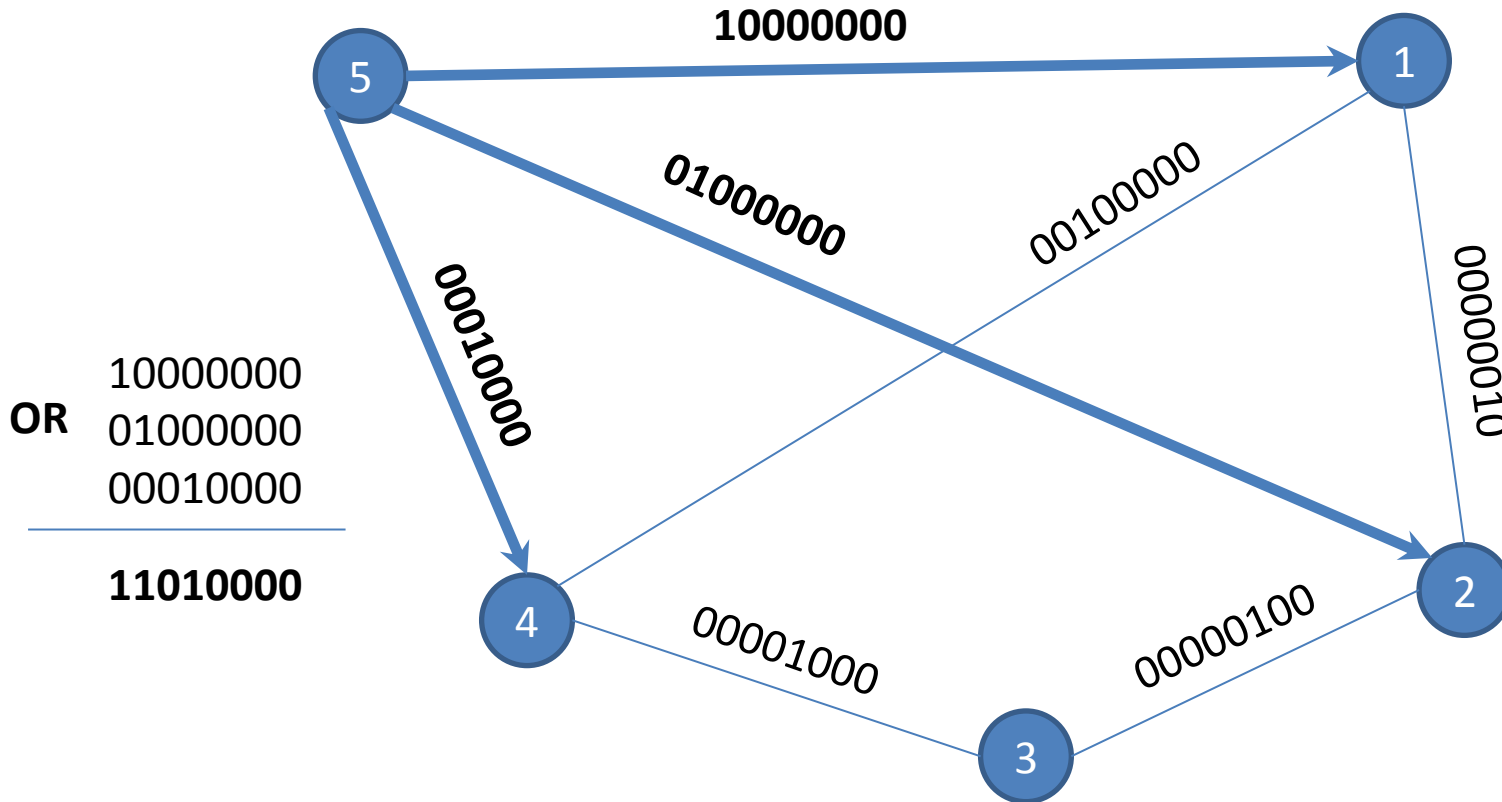
How LIPSIN works

ii) For each set of destinations, you compute the route at the source as follows:



How LIPSIN works

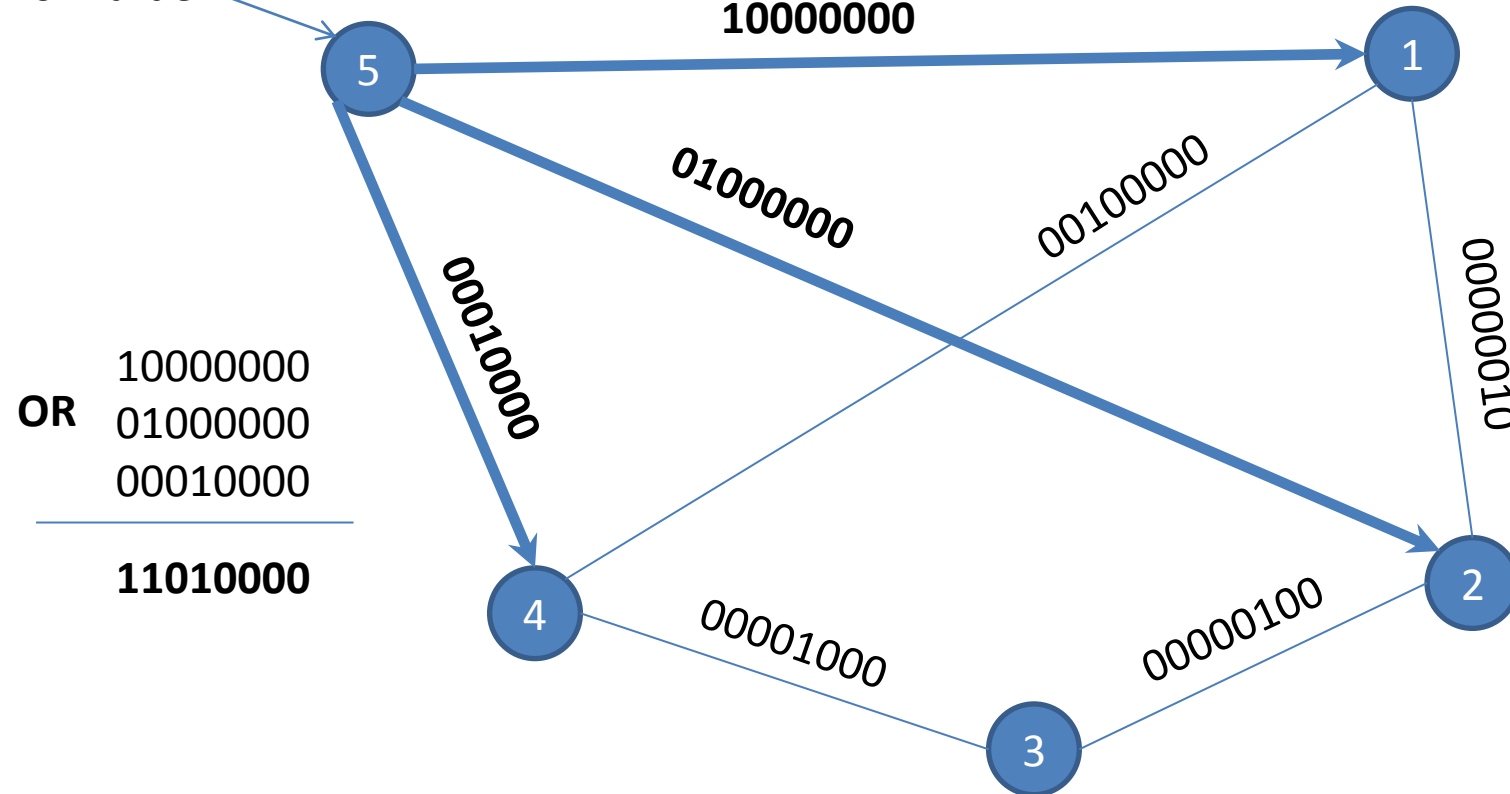
ii) For each set of destinations, you compute the route at the source as follows:



How LIPSIN works

iii) The forwarding identifier can then be used on each forwarder to choose local outgoing links

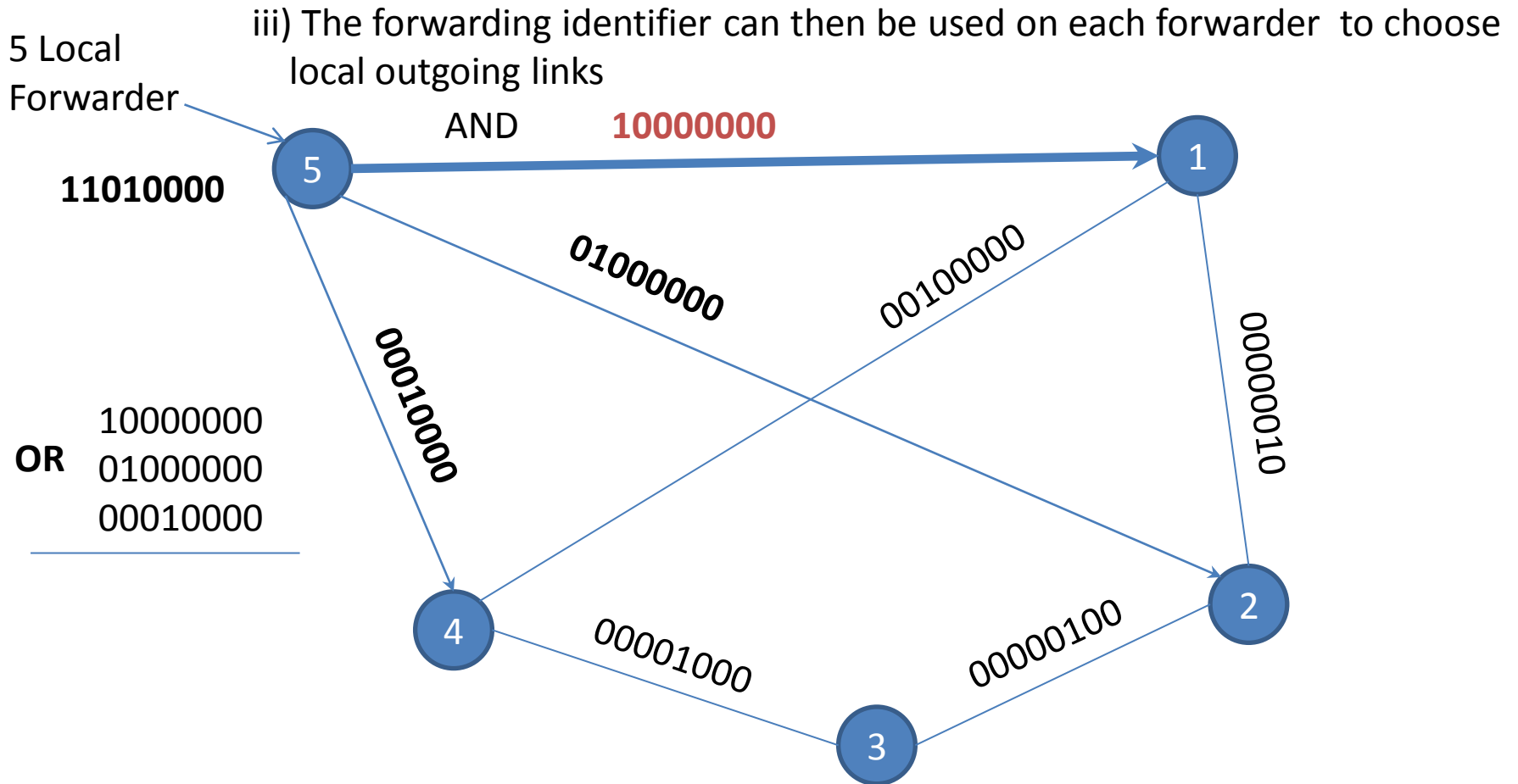
5 Local Forwarder



OR
10000000
01000000
00010000

11010000

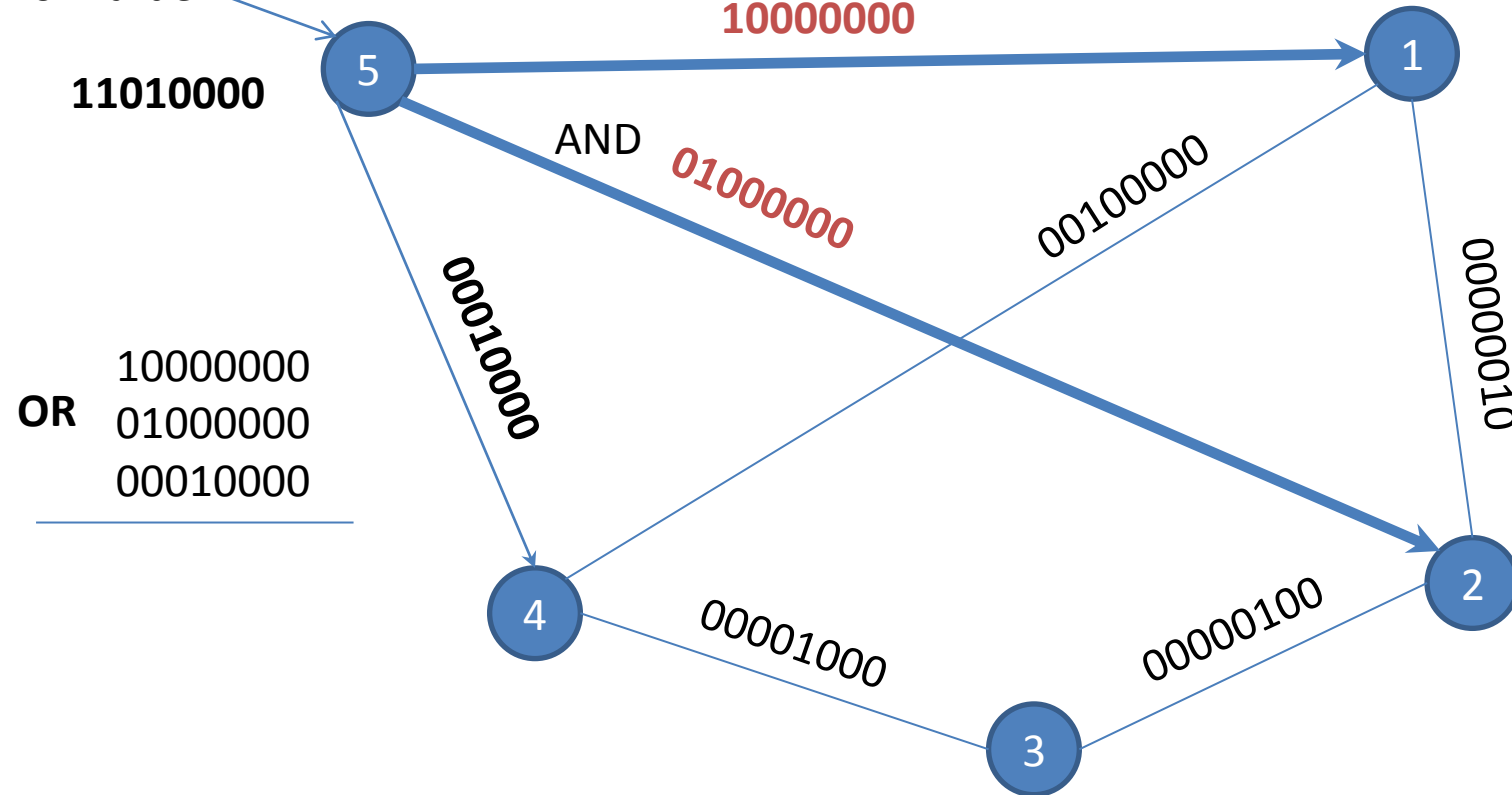
How LIPSIN works



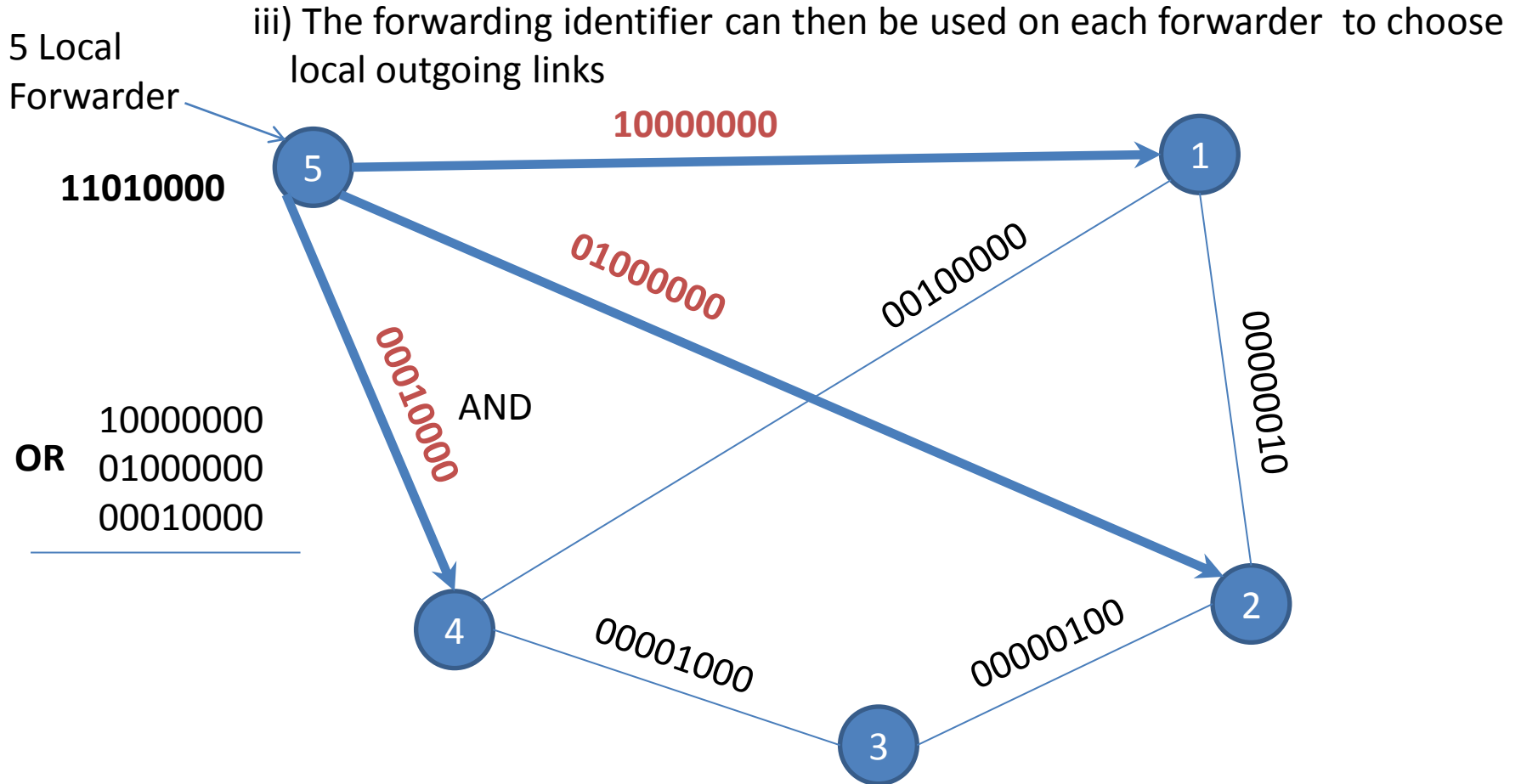
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5 Local Forwarder



How LIPSIN works

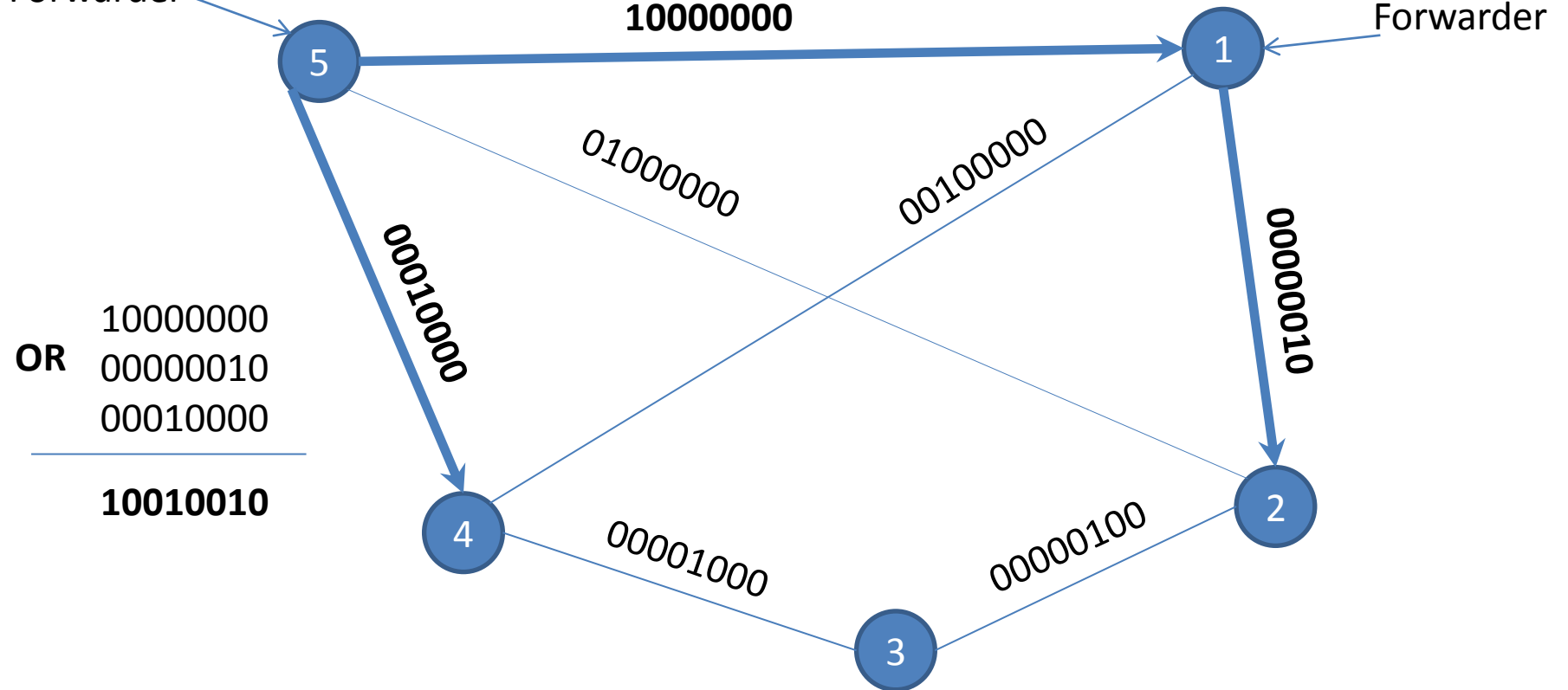


How LIPSIN works

iv) Multihop routing is implemented also by the same operation on the Forwarding identifier on each local forwarder

5 Local Forwarder

1 Local Forwarder

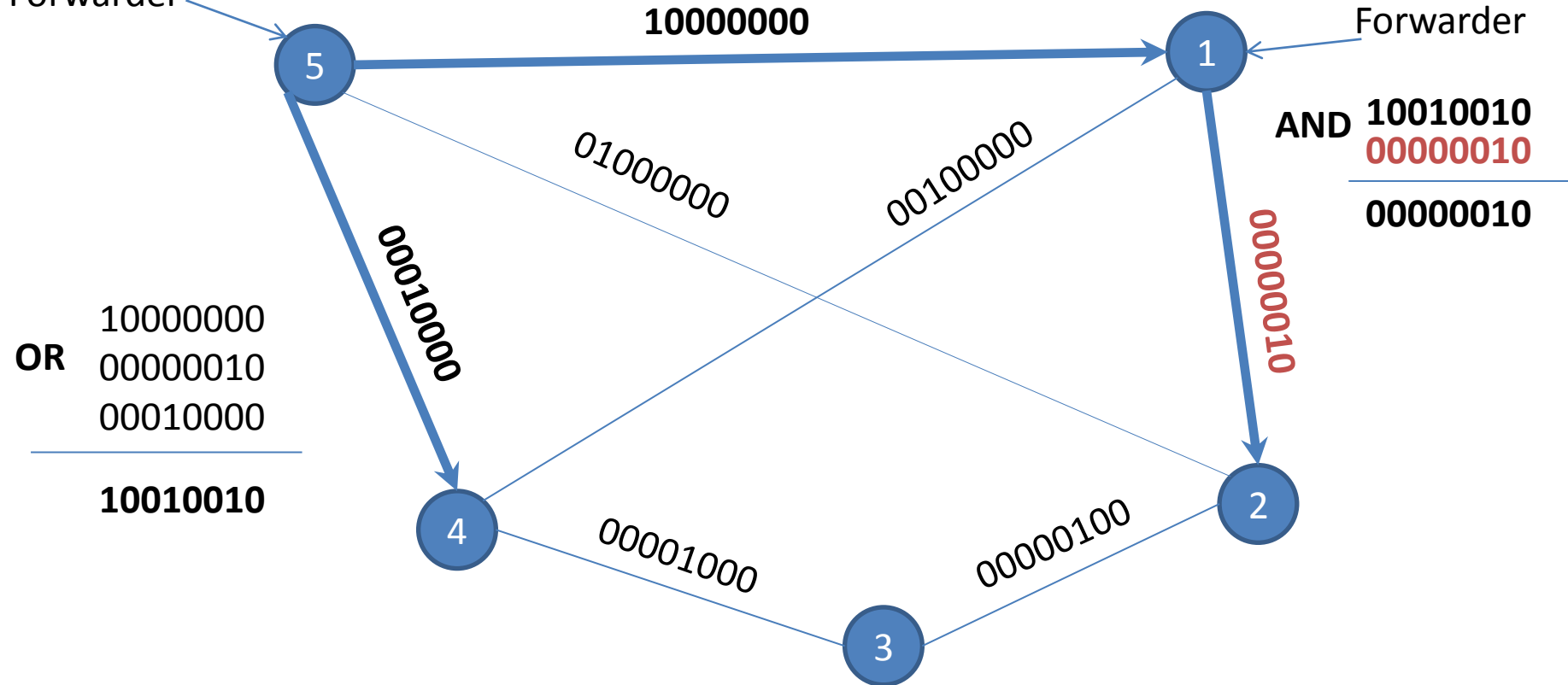


How LIPSIN works

iv) Multihop routing is implemented also by the same operation on the Forwarding identifier on each local forwarder

5 Local Forwarder

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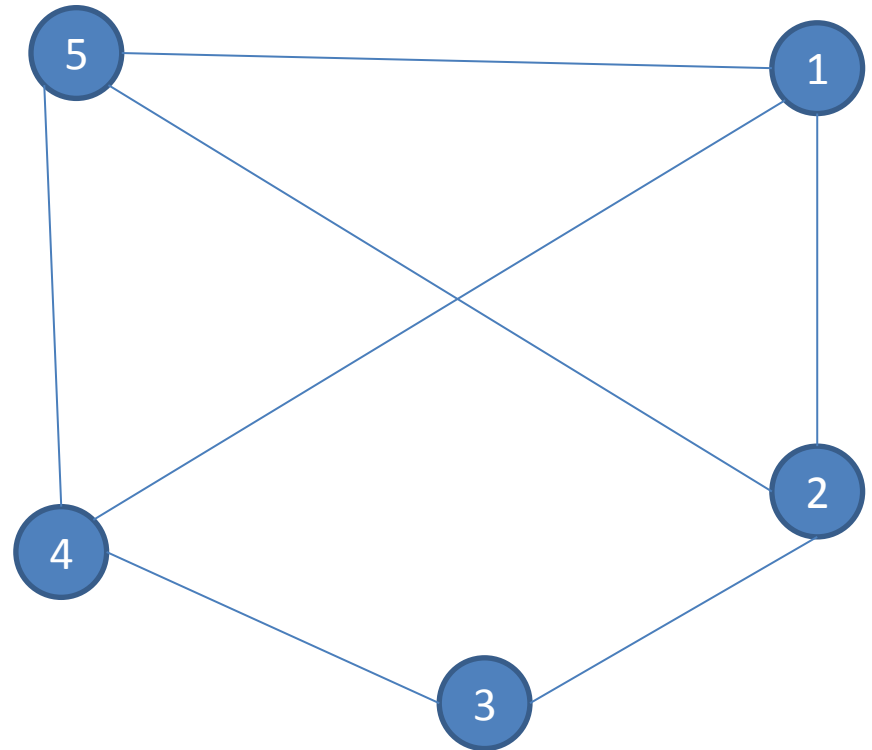
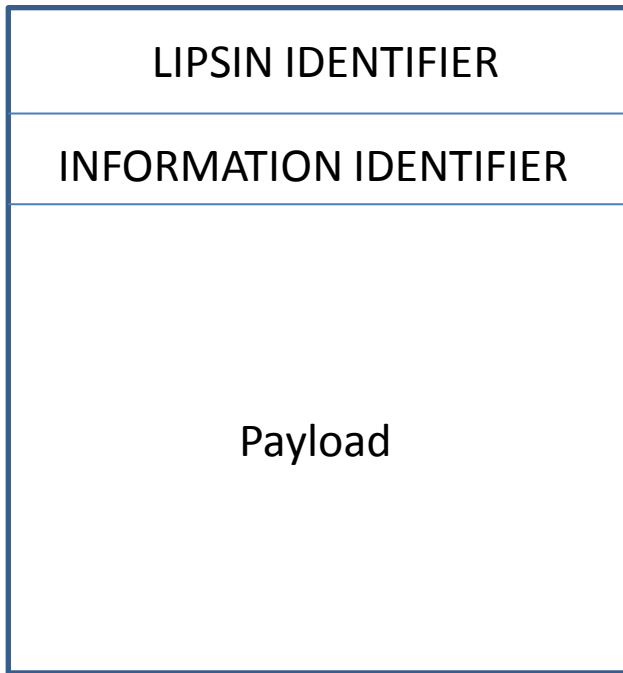


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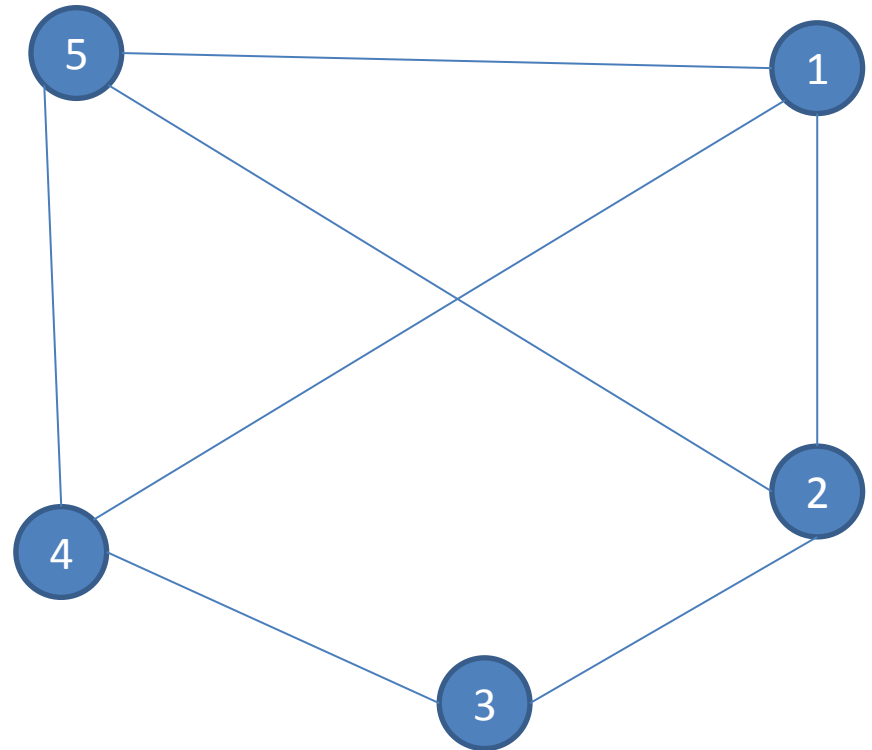
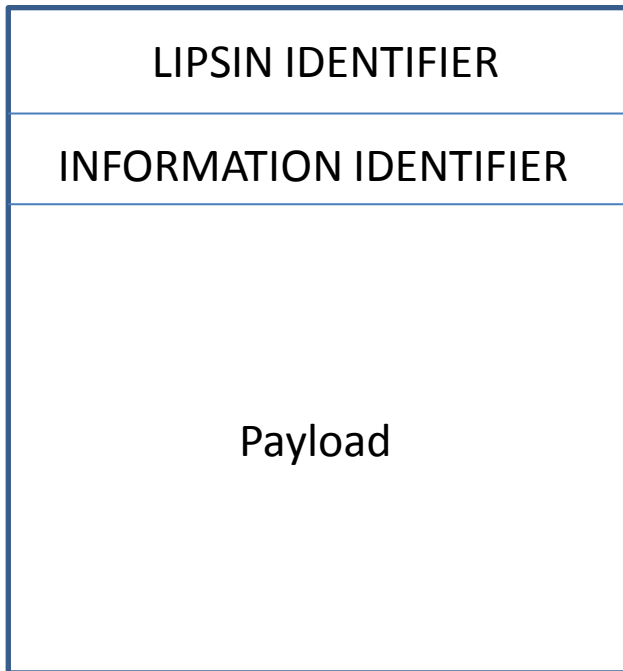
Why using LIPSIN with SDN and not directly information identifiers?

ICN ethernet frame



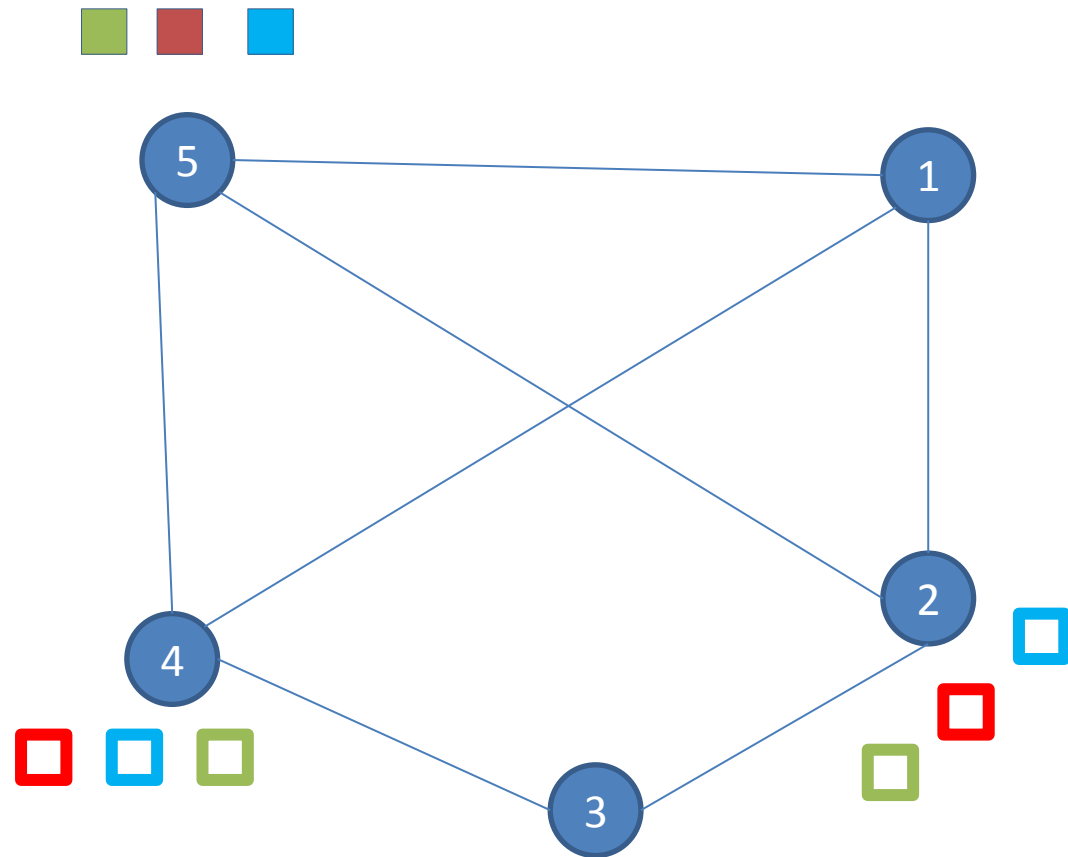
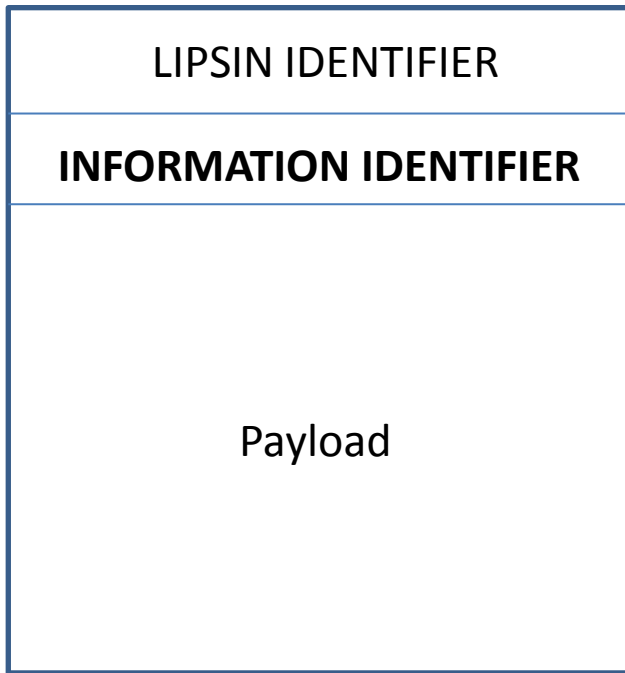
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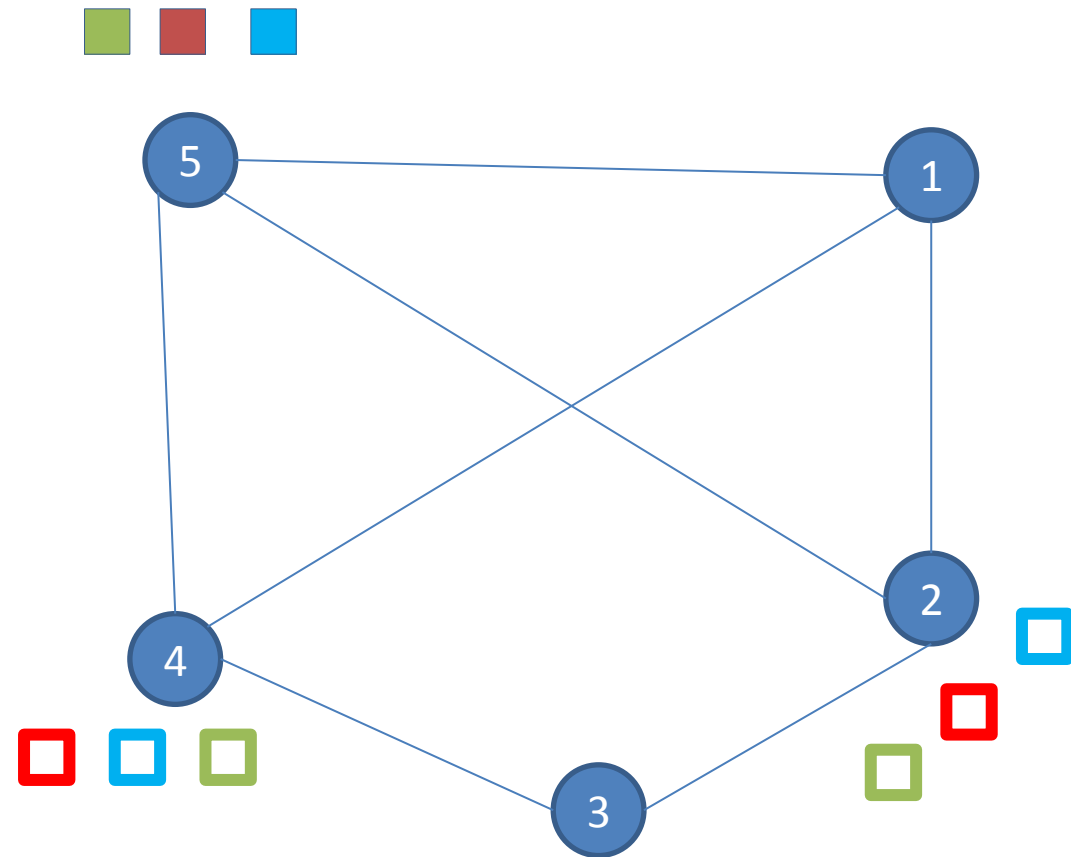
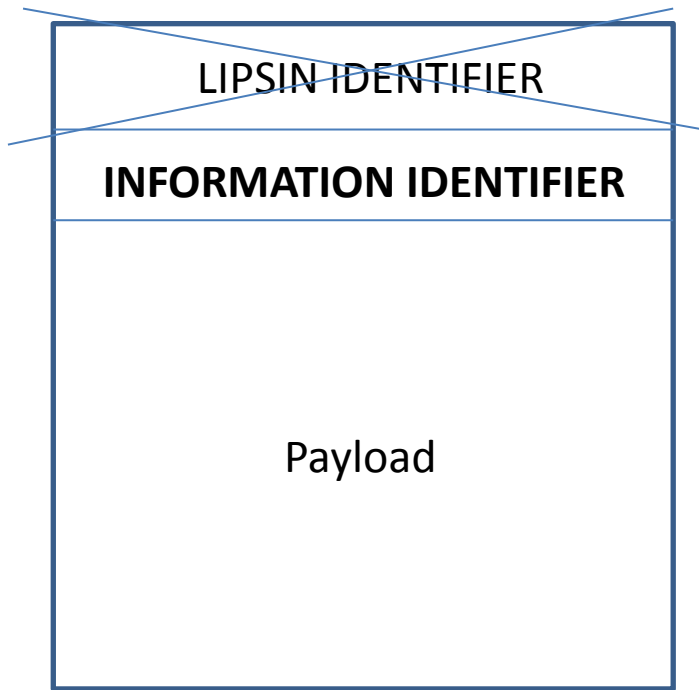
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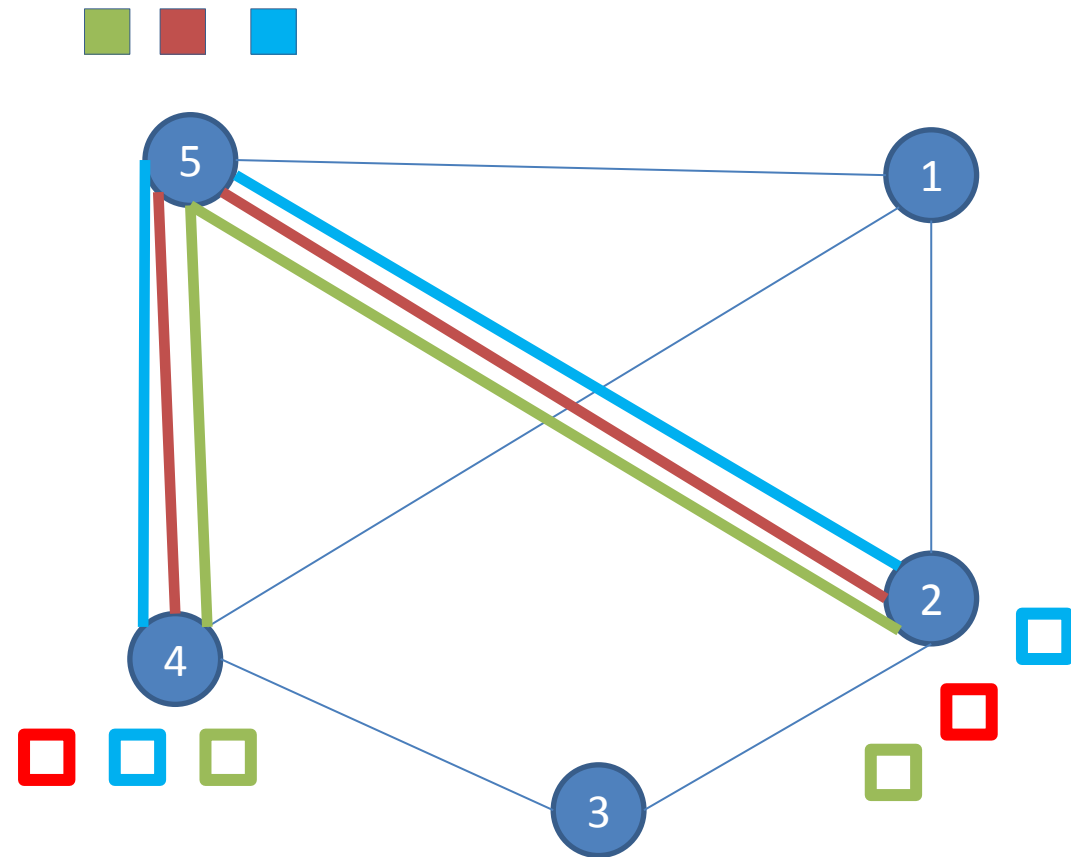
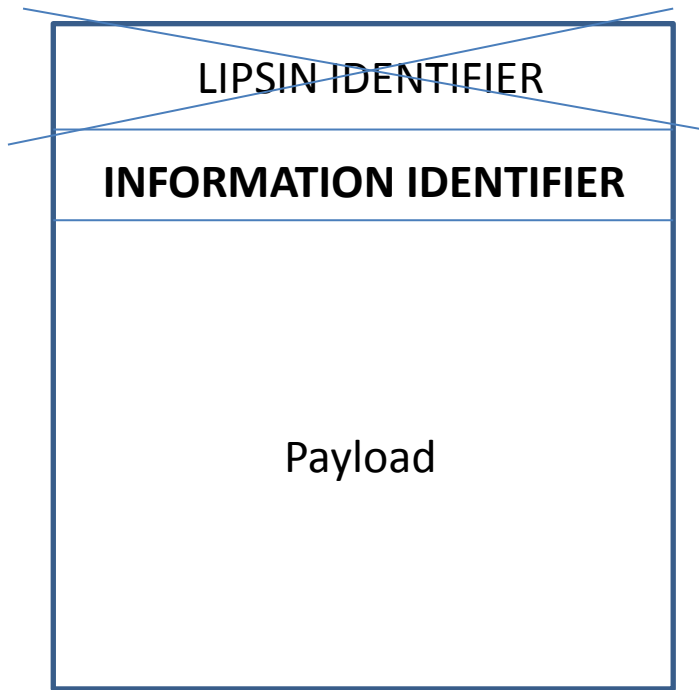
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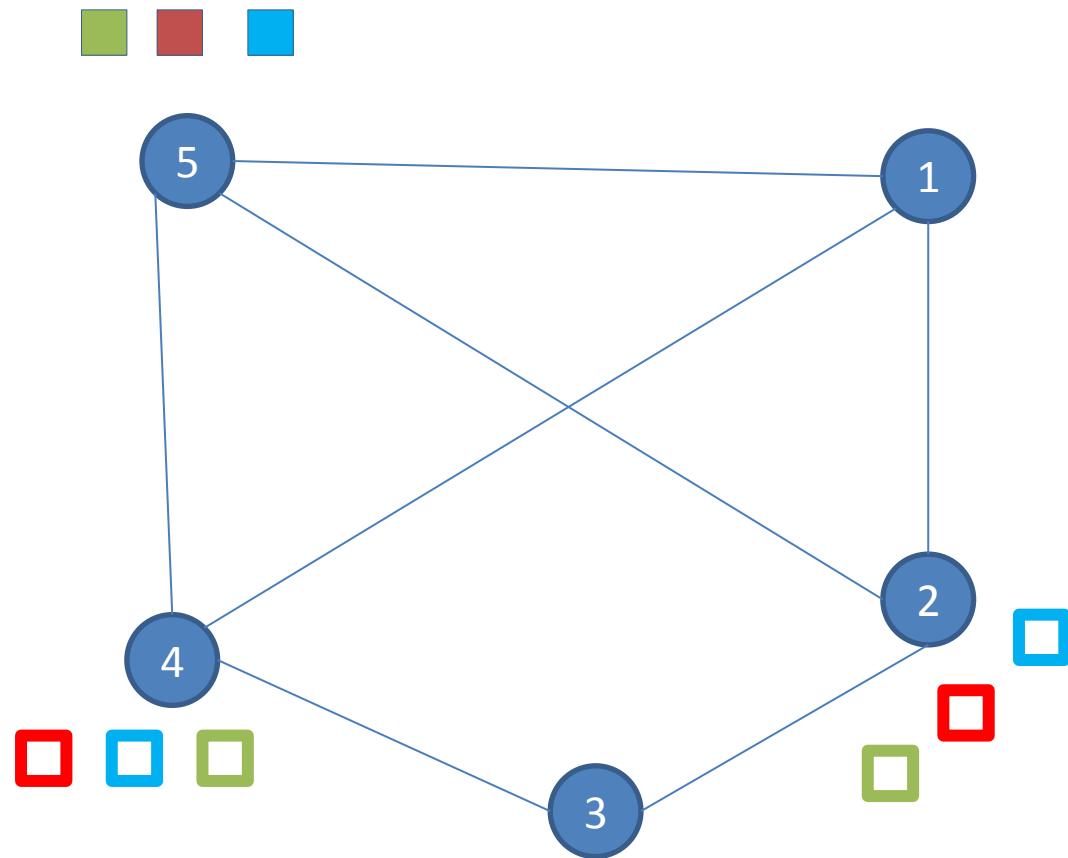
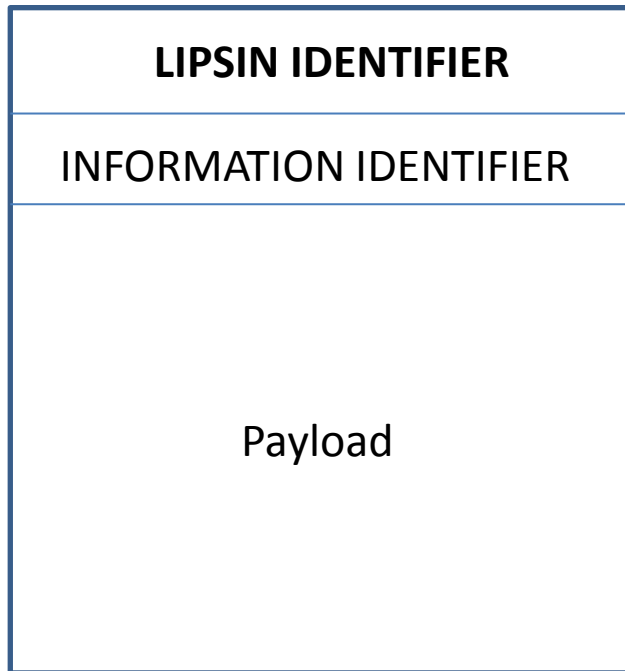
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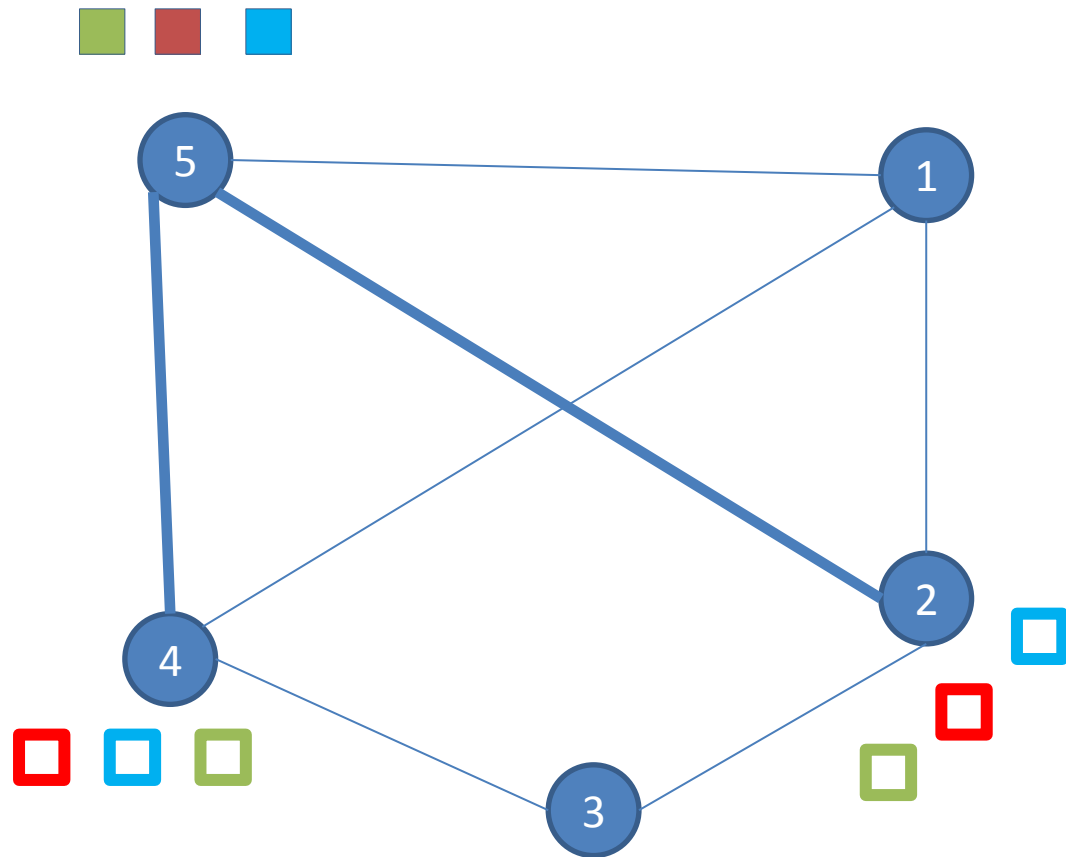
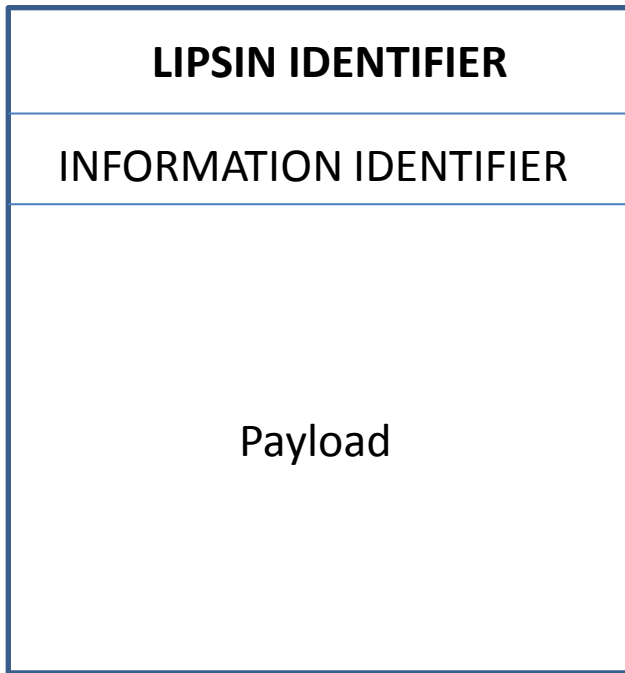
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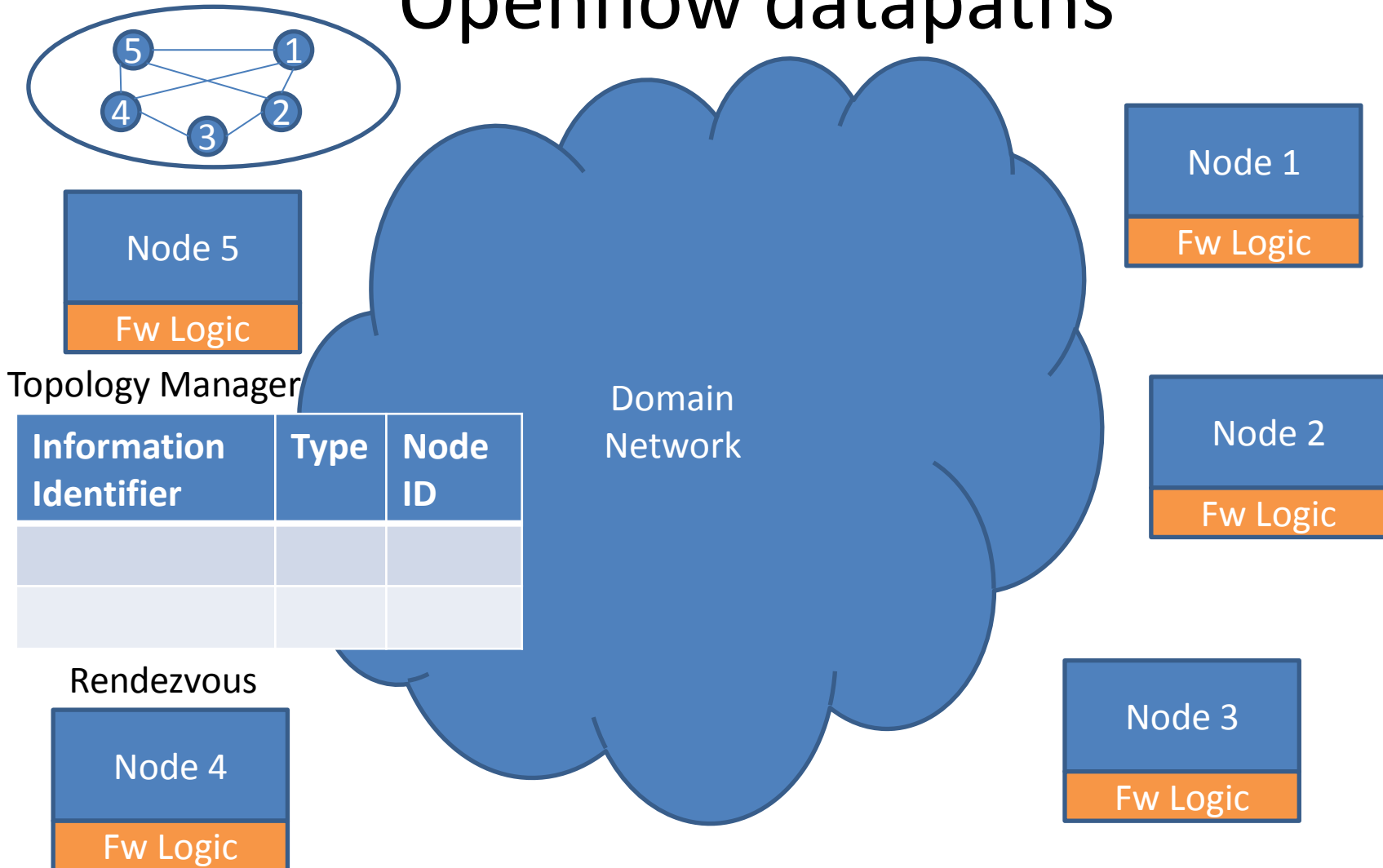


Why using LIPSIN with SDN and not directly information identifiers?

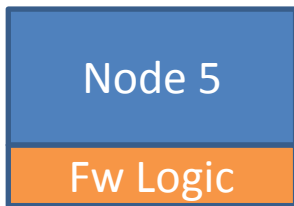
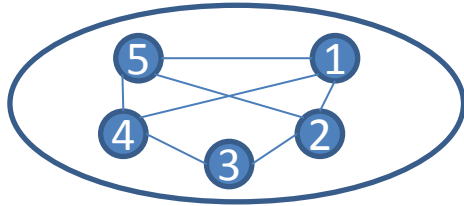
ICN ethernet frame



Modifying LIPSIN functionality for Openflow datapaths



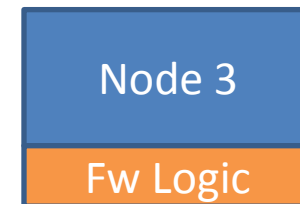
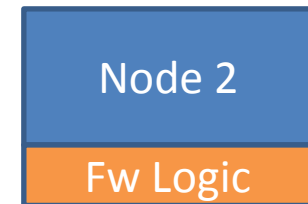
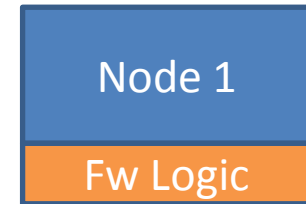
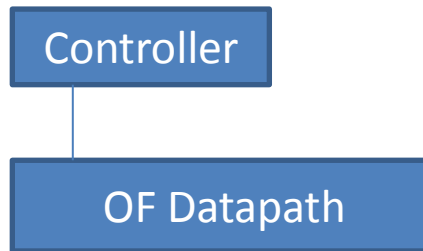
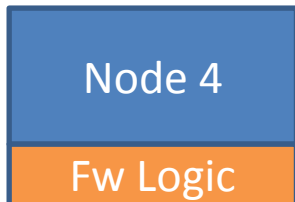
Moving LIPSIN functionality to Openflow datapaths



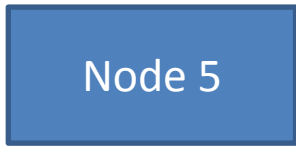
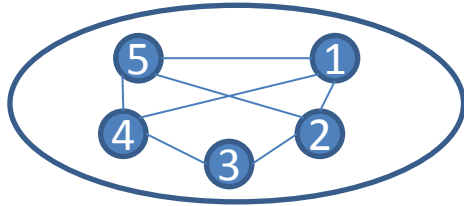
Topology Manager

Information Identifier	Type	Node ID

Rendezvous



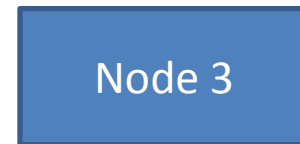
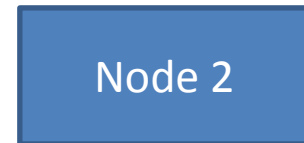
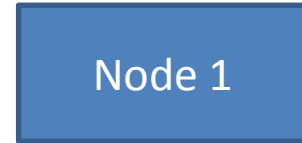
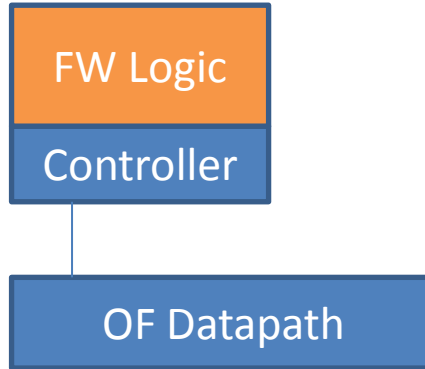
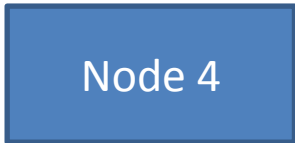
Moving LIPSIN functionality to Openflow datapaths



Topology Manager

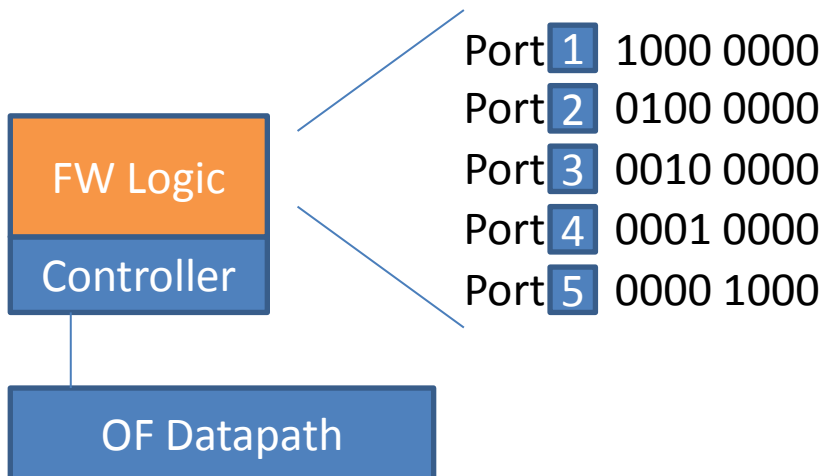
Information Identifier	Type	Node ID

Rendezvous



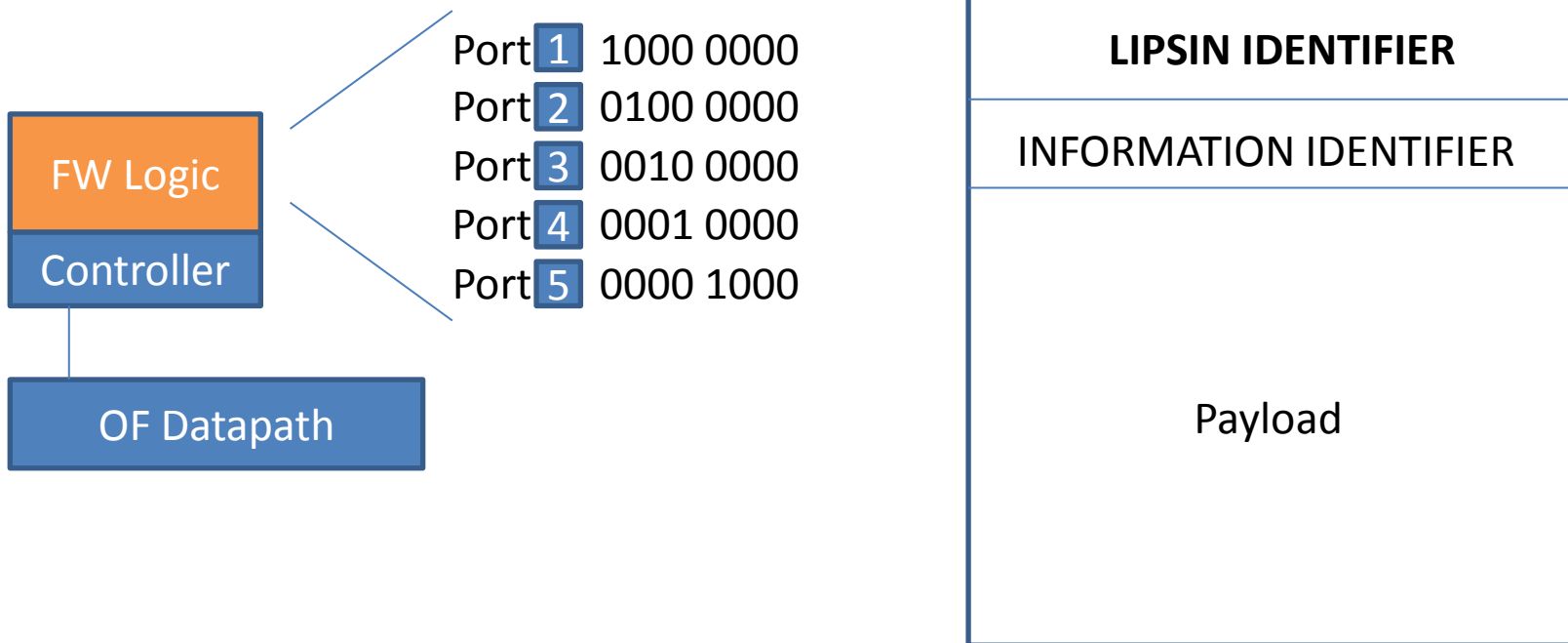
Example for 5-port OpenFlow datapath

Each switch port is assigned a deployment unique Identifier by the Topology Manager which is kept at the local controller



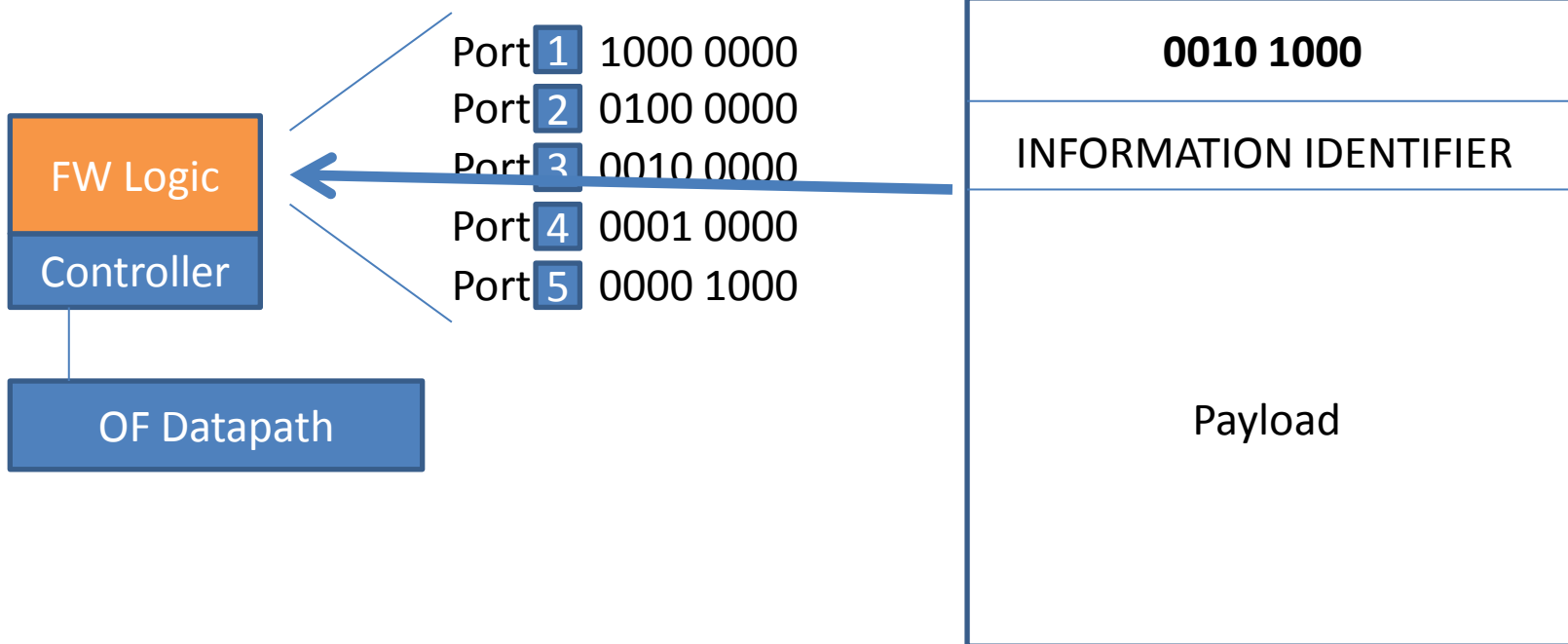
Example for 5-port OpenFlow datapath

Openflow datapath is configured to match forwarding identifiers on each packet with respective delivery ports,



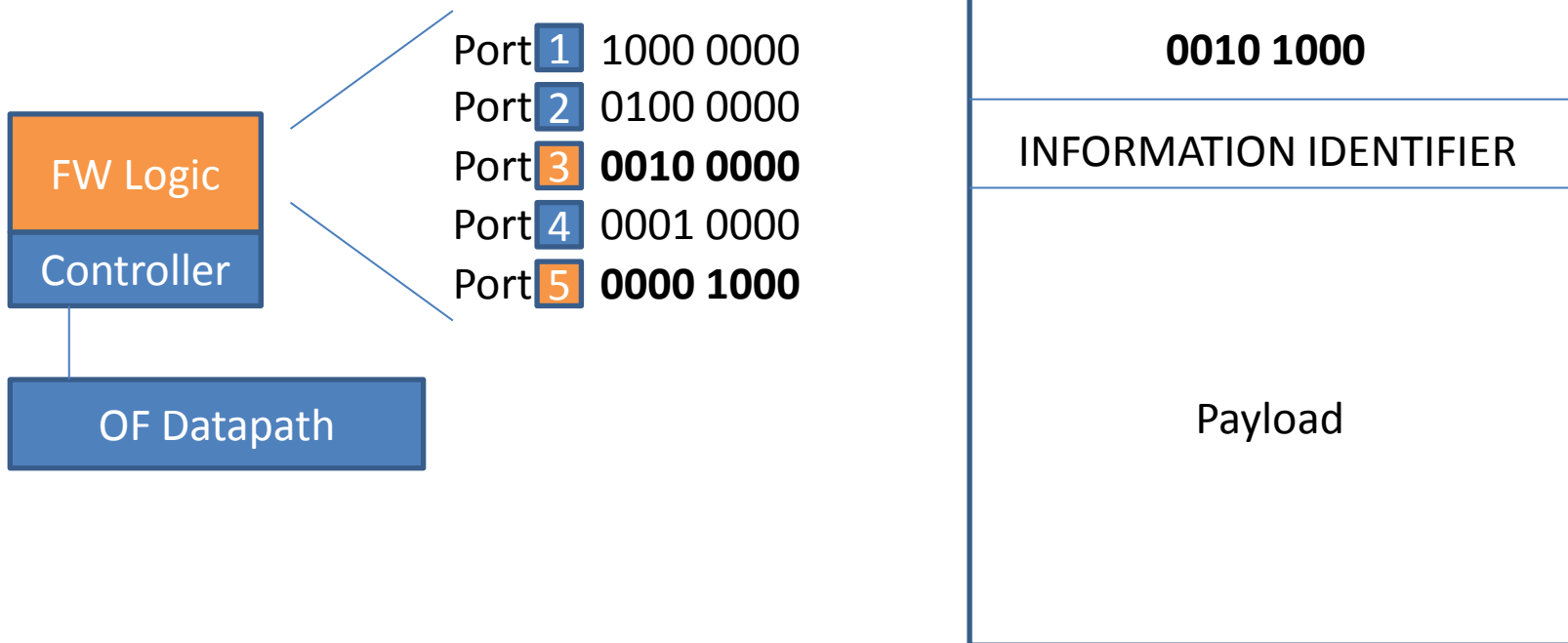
Example for 5-port OpenFlow datapath

Openflow datapath sends to the local controller packets with forwarding identifiers that don't match any entry

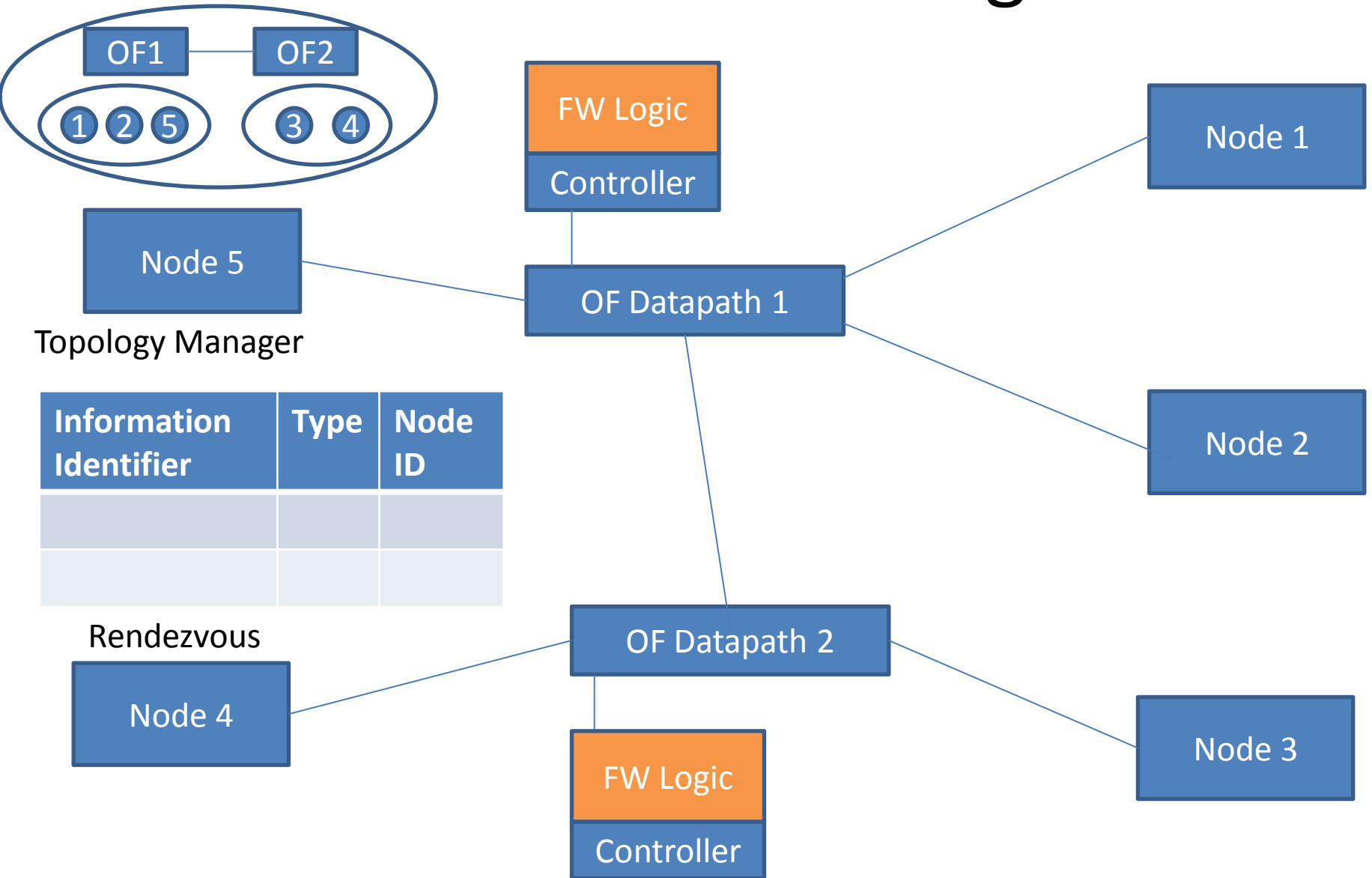


Example for 5-port OpenFlow datapath

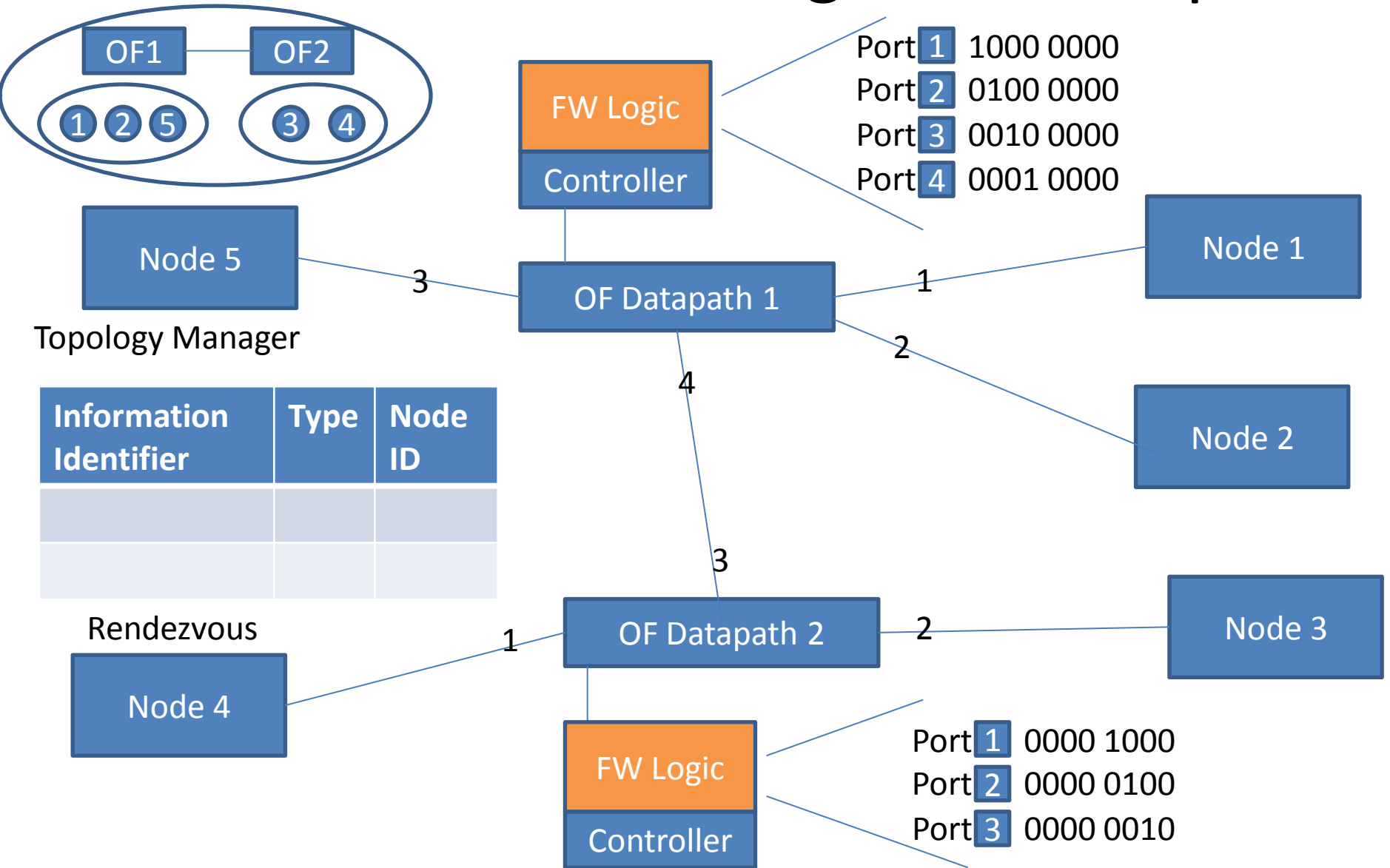
Local openflow controller uses the LIPSIN bloom-filter approach to decode the identifier and find the local datapath ports where the packet should be delivered and installs the rule.



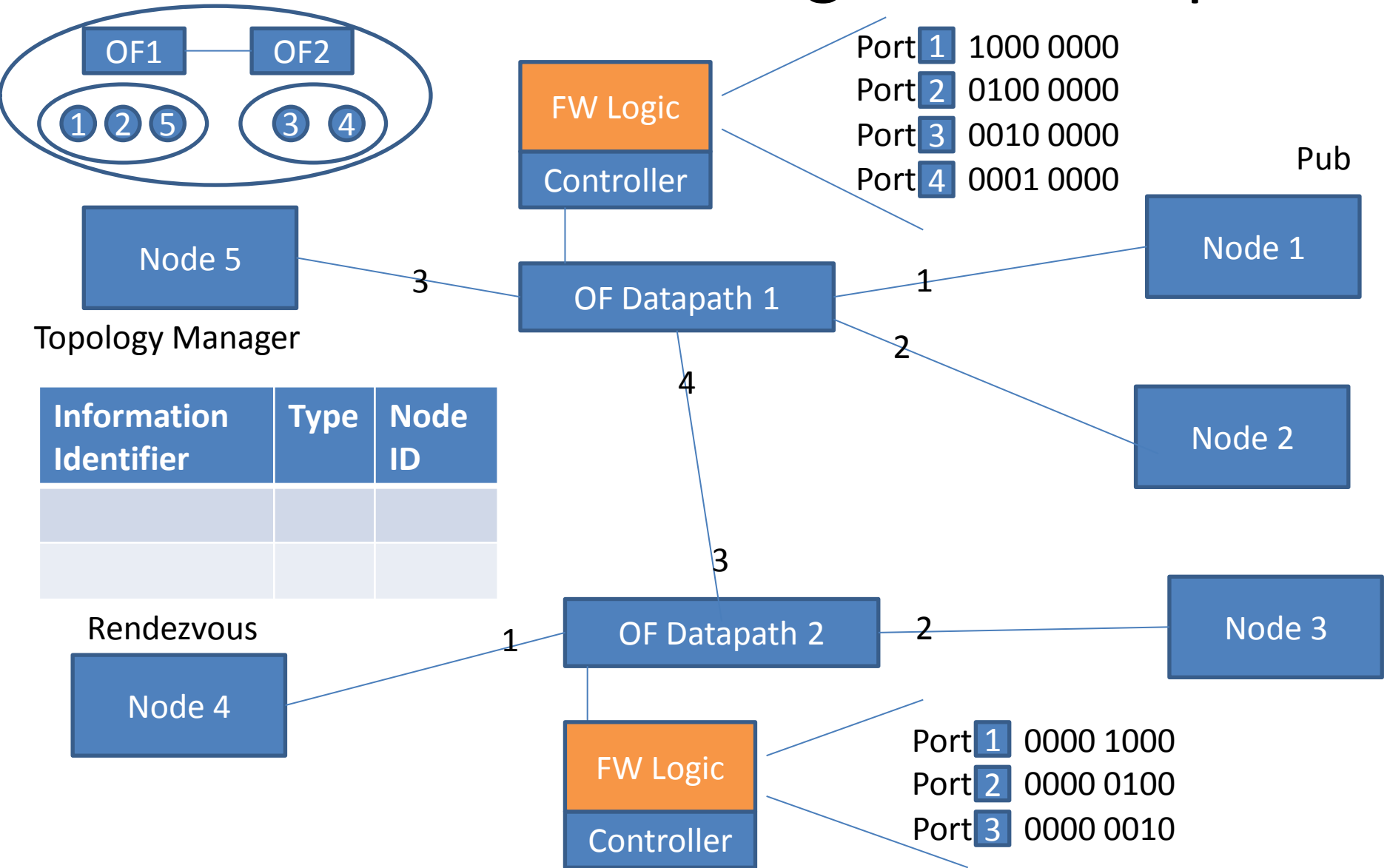
ICN architecture using SDN



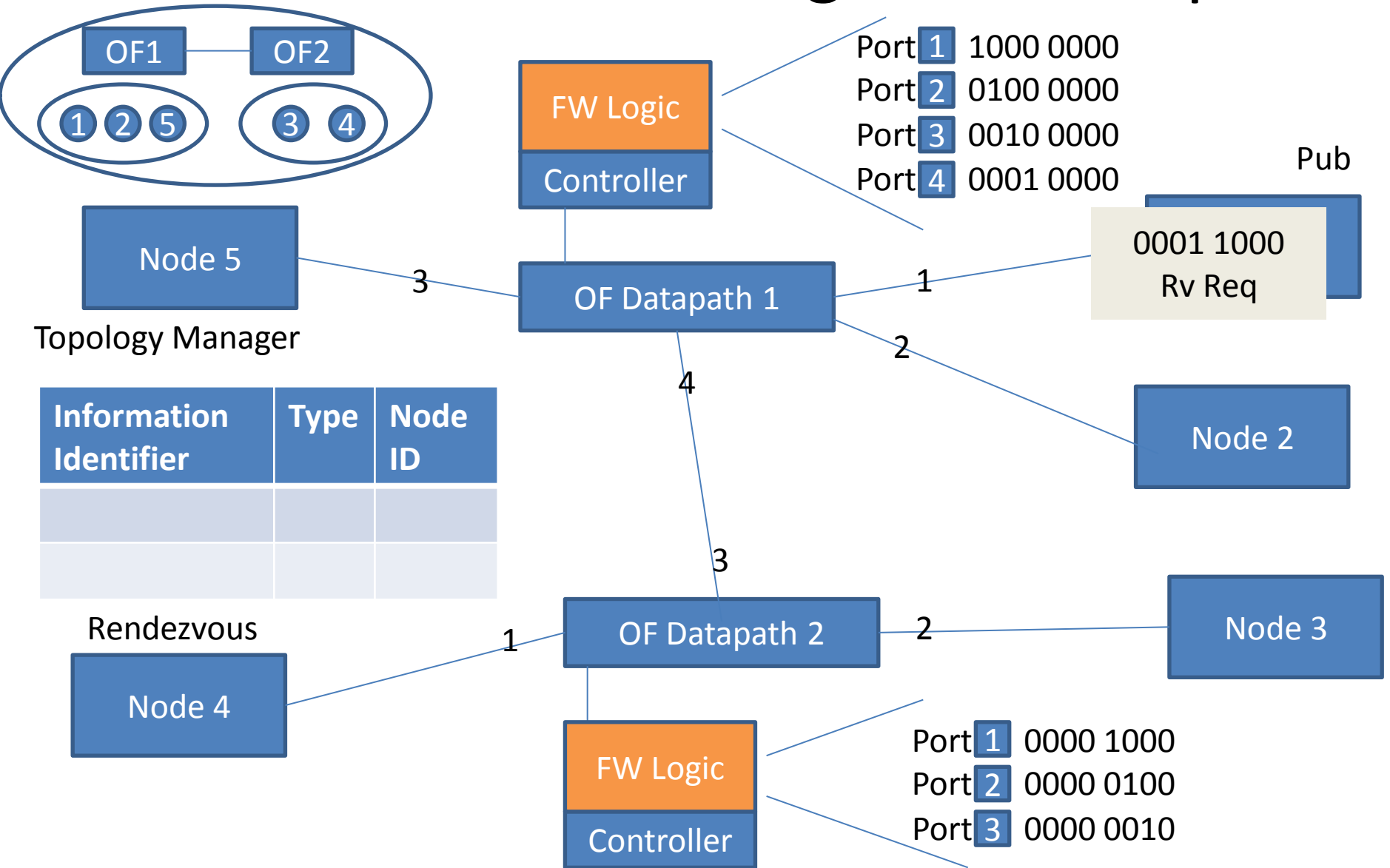
ICN architecture using SDN Example



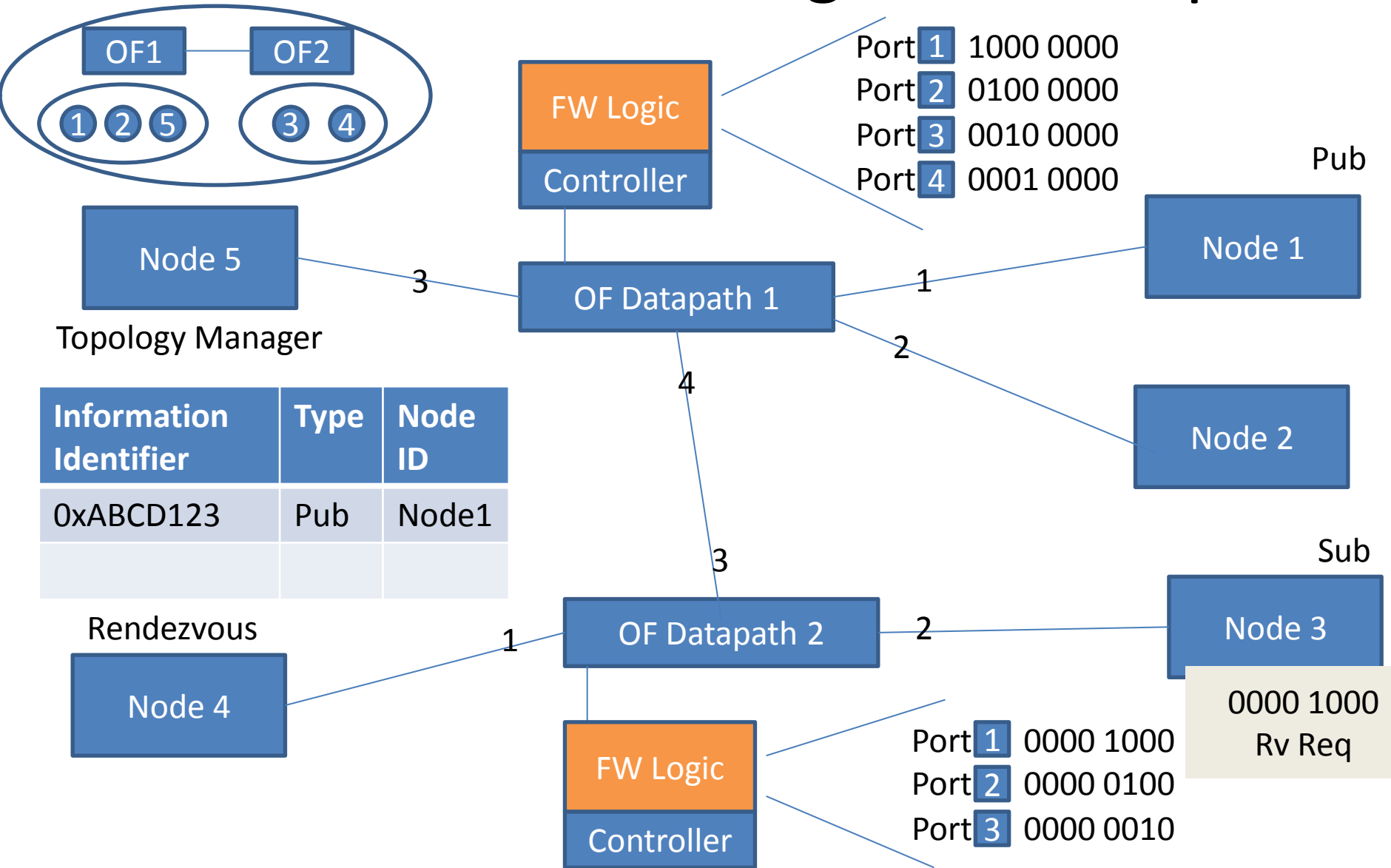
ICN architecture using SDN Example



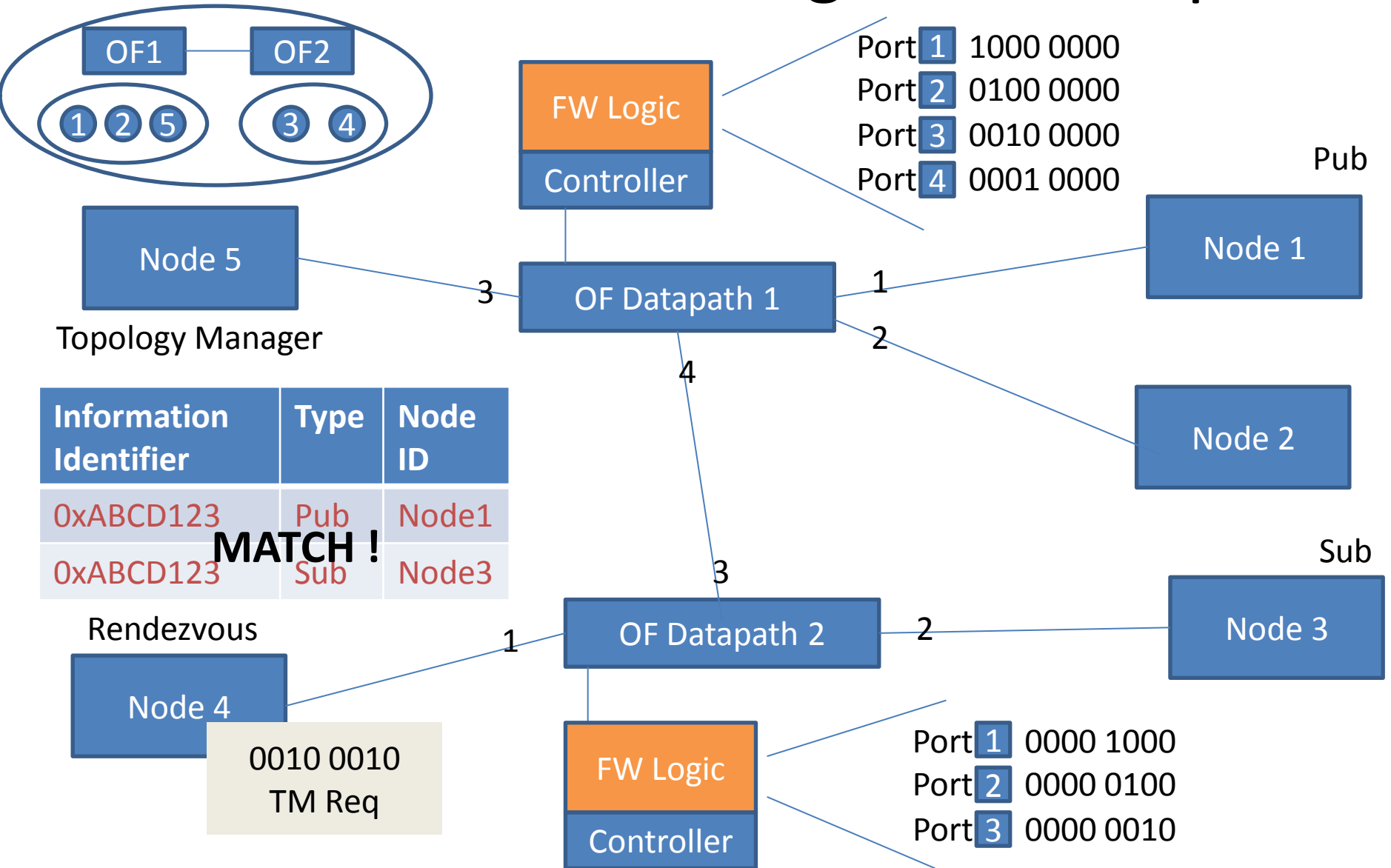
ICN architecture using SDN Example



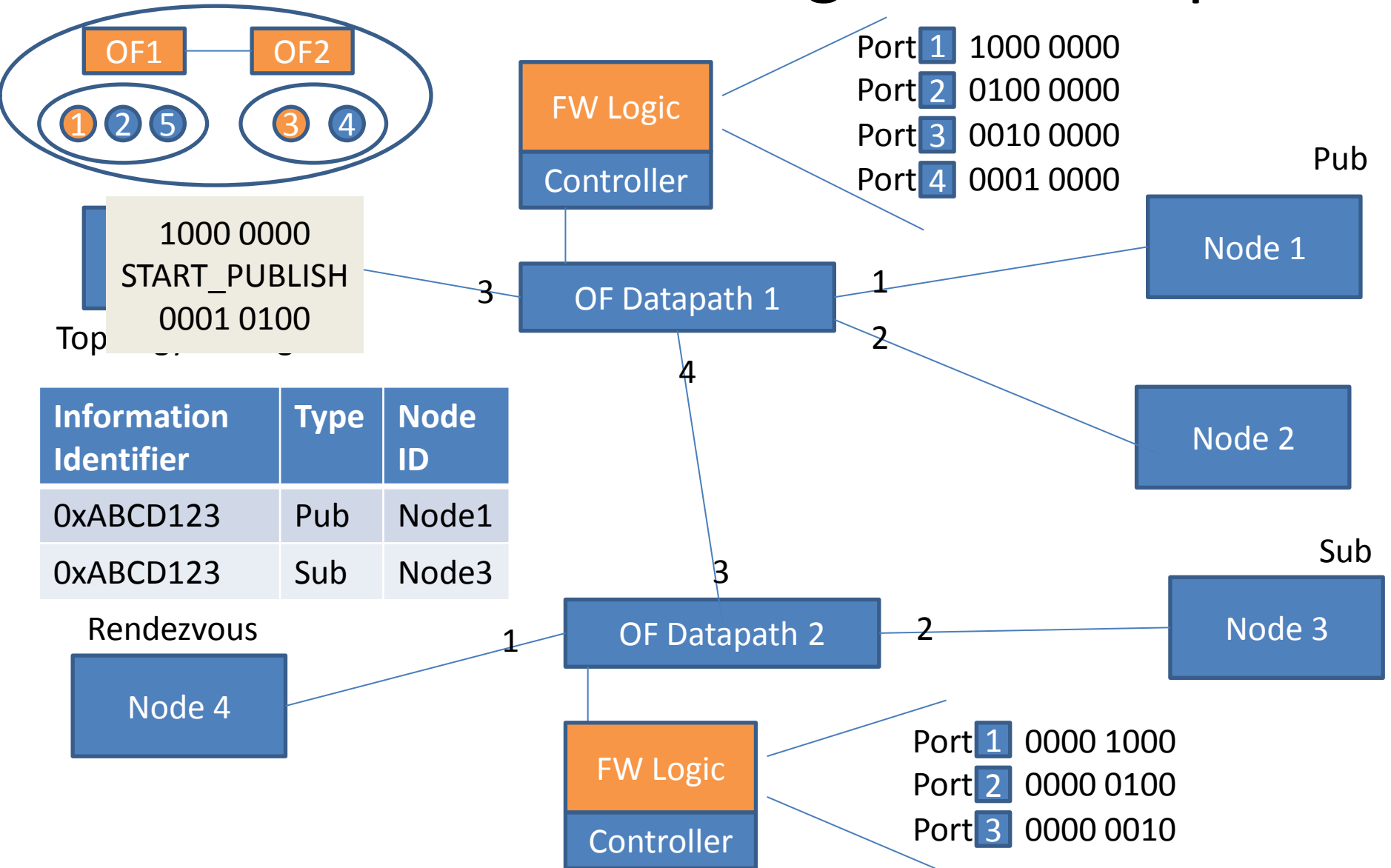
ICN architecture using SDN Example



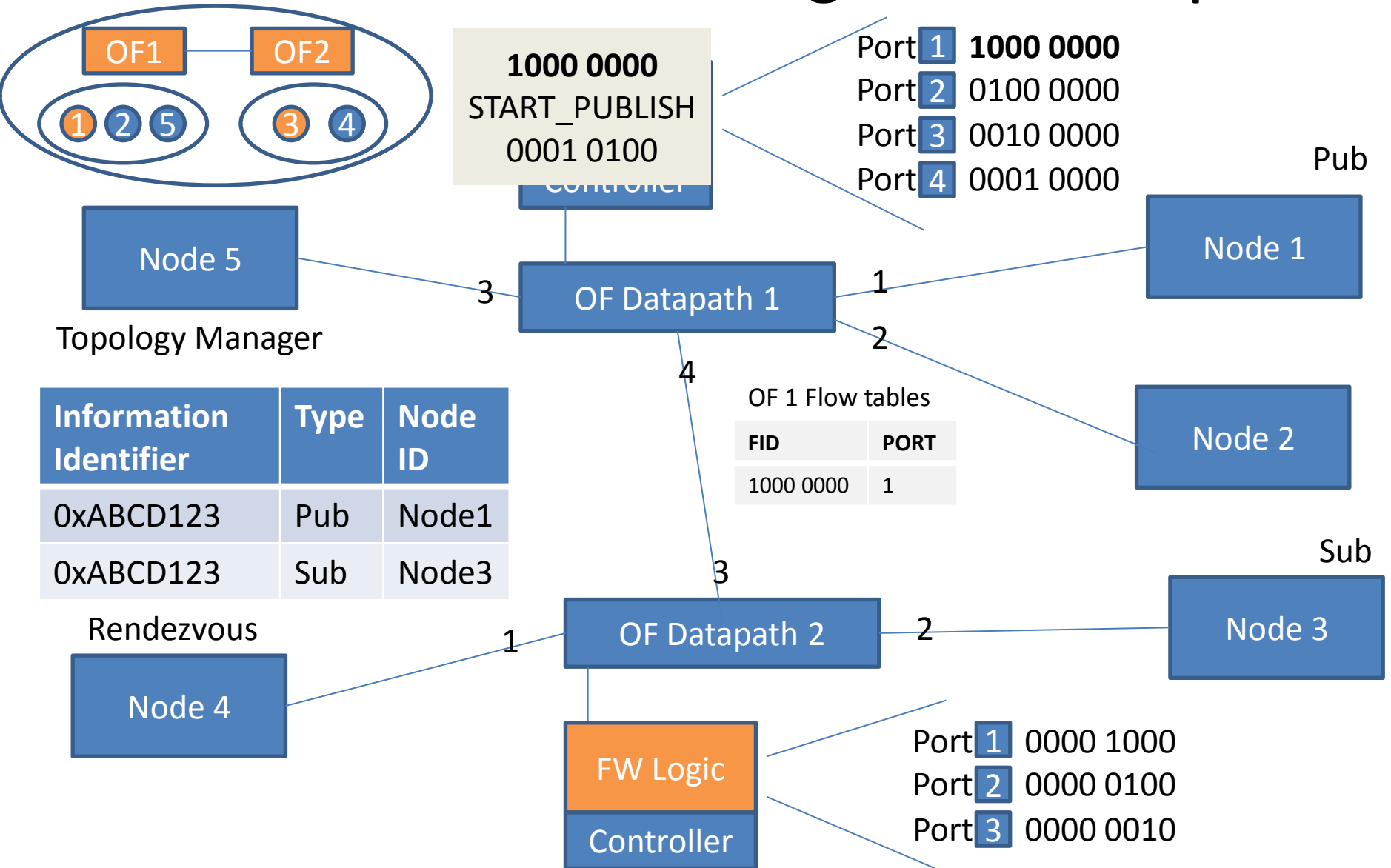
ICN architecture using SDN Example



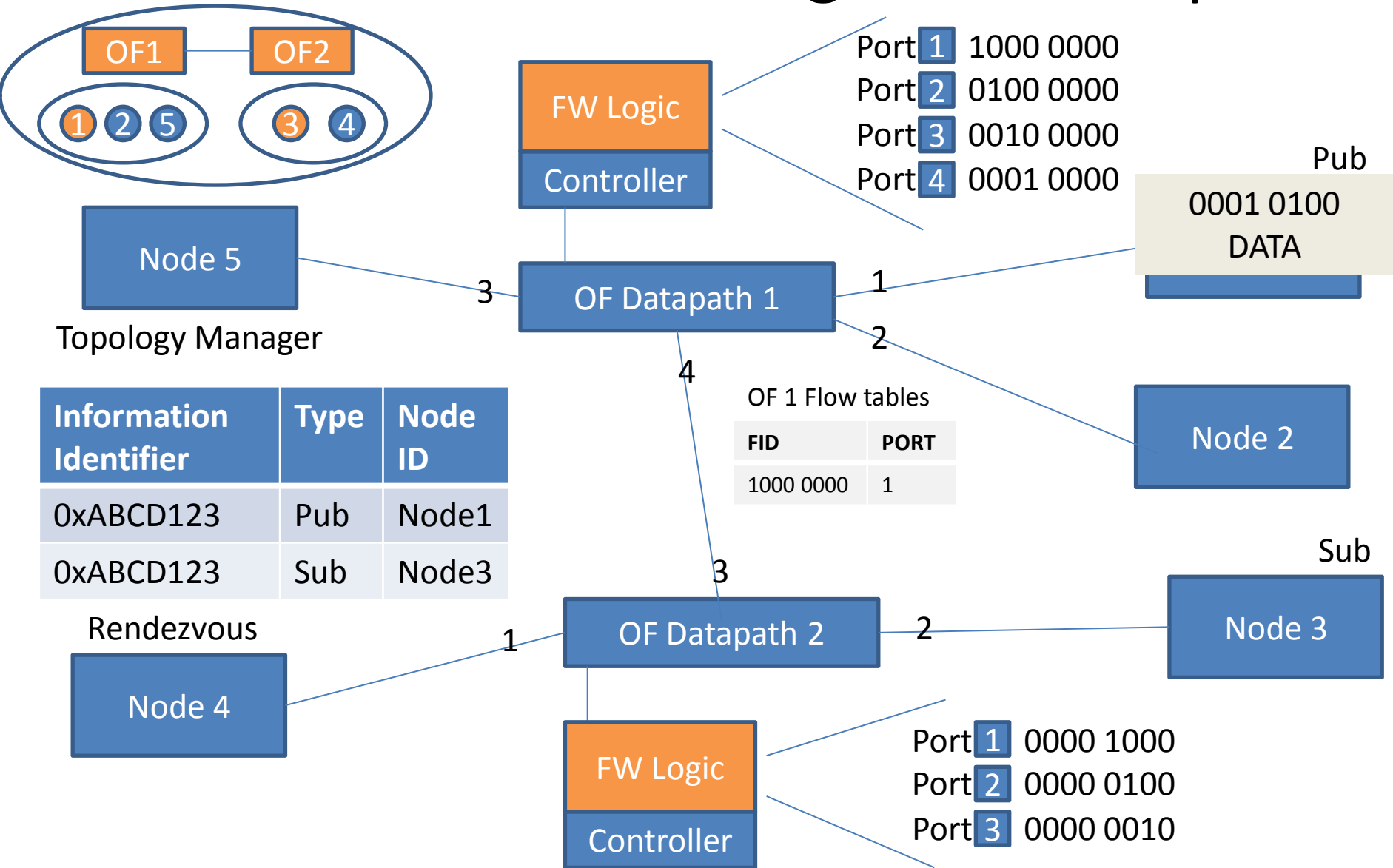
ICN architecture using SDN Example



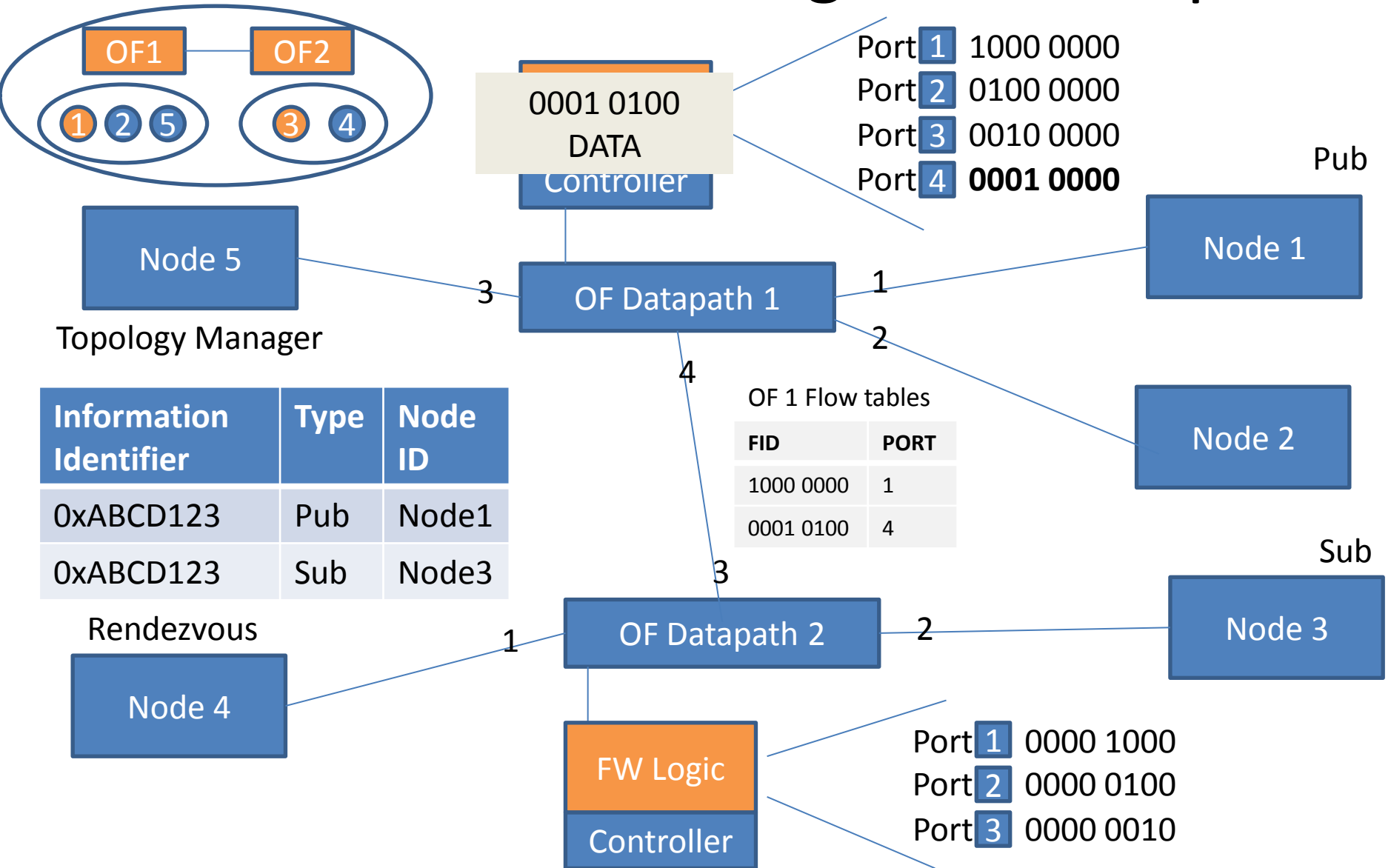
ICN architecture using SDN Example



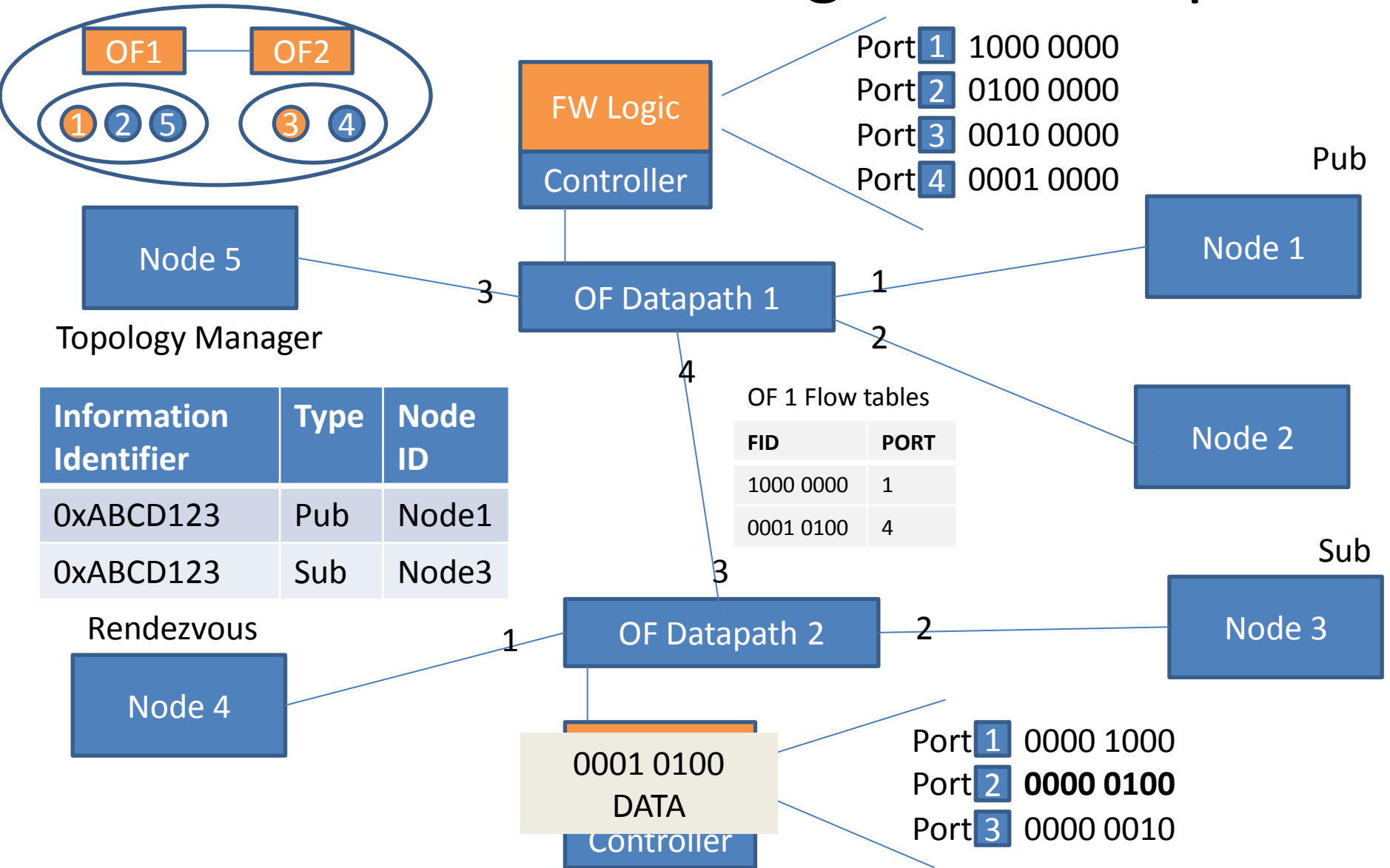
ICN architecture using SDN Example



ICN architecture using SDN Example



ICN architecture using SDN Example

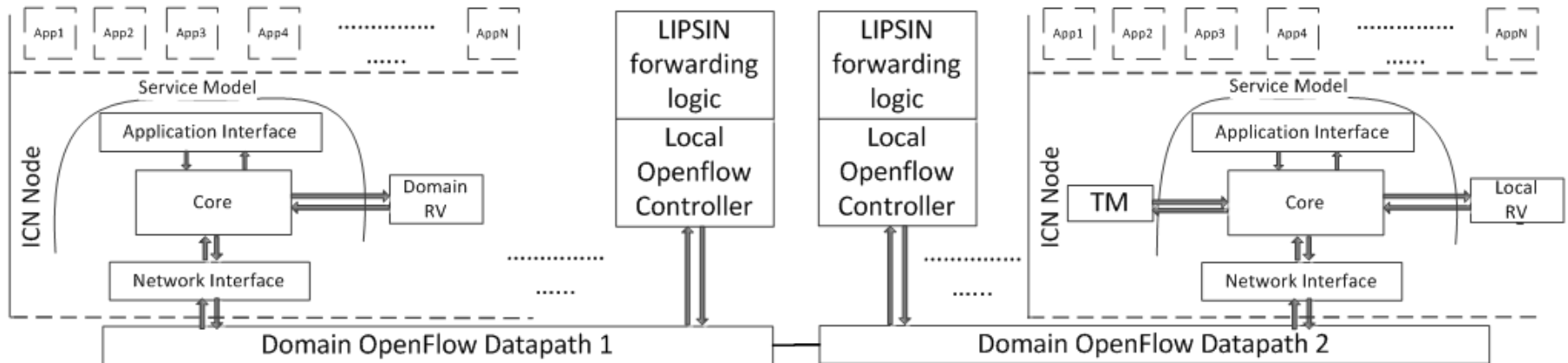


Contents

- An Information – Centric Network Architecture
- An ICN Node Architecture
- Using LIPSIN for packet forwarding
- Designing a LIPSIN switch using Openflow and changes to ICN node architecture
- **Benefits of using SDN support**

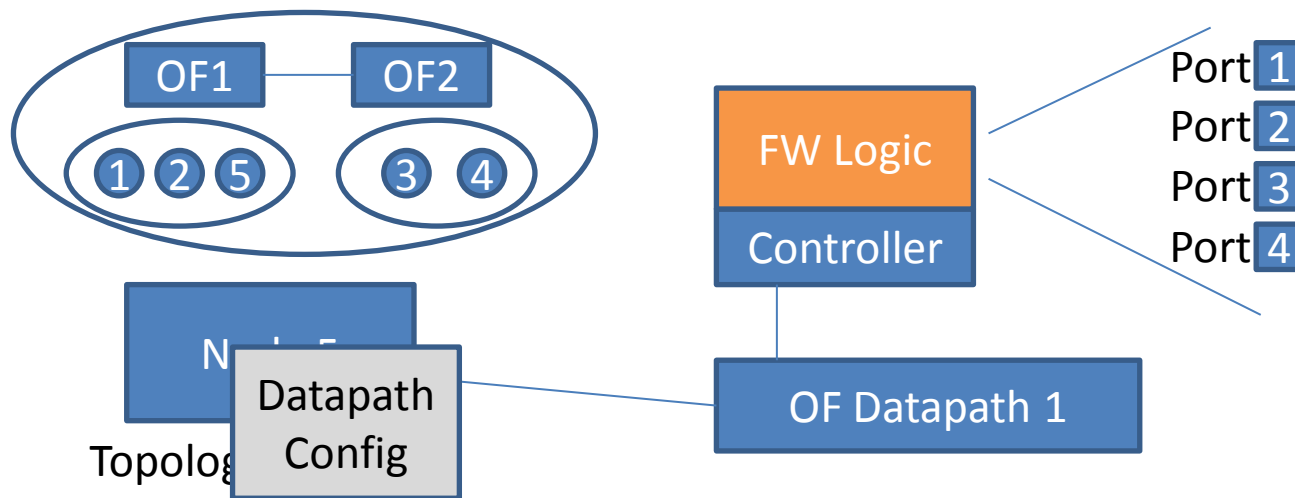
Benefits of using SDN

- ICN node architecture gets simplified and forwarding is carried by the network and is completely decoupled from the nodes.



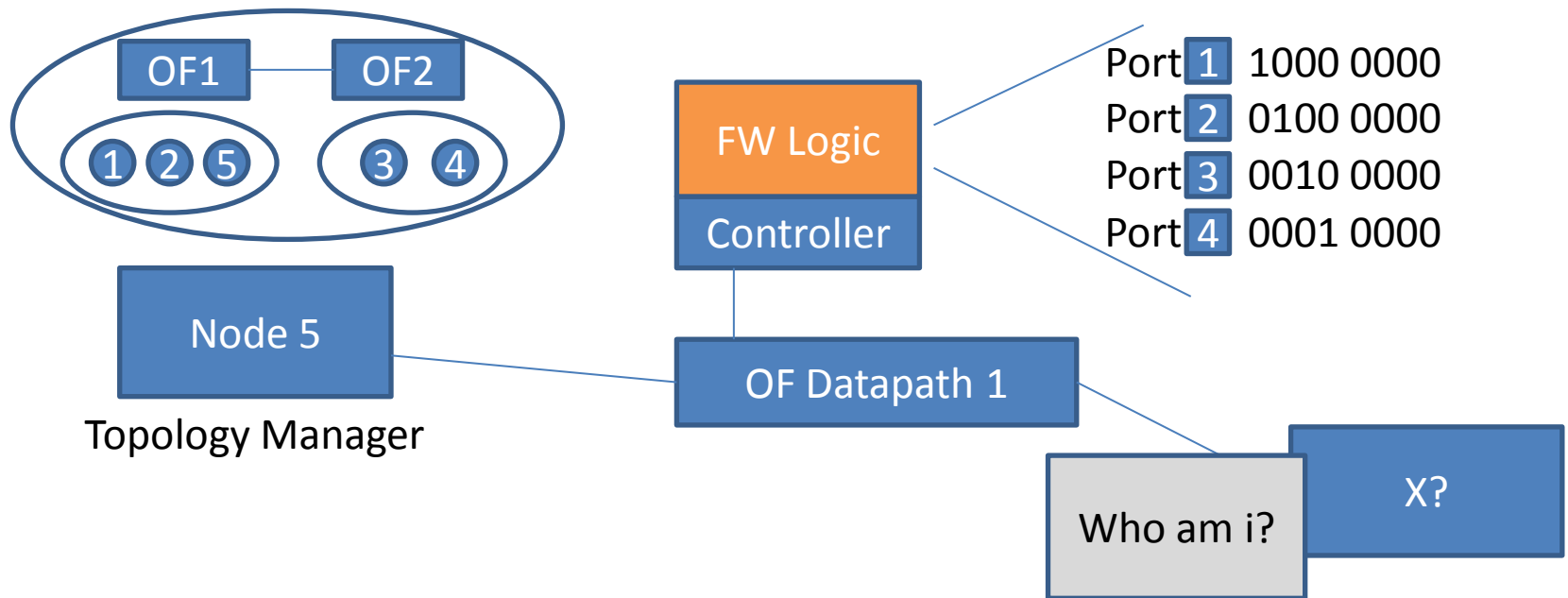
Benefits of using SDN

- Network bootstrap gets very simplified



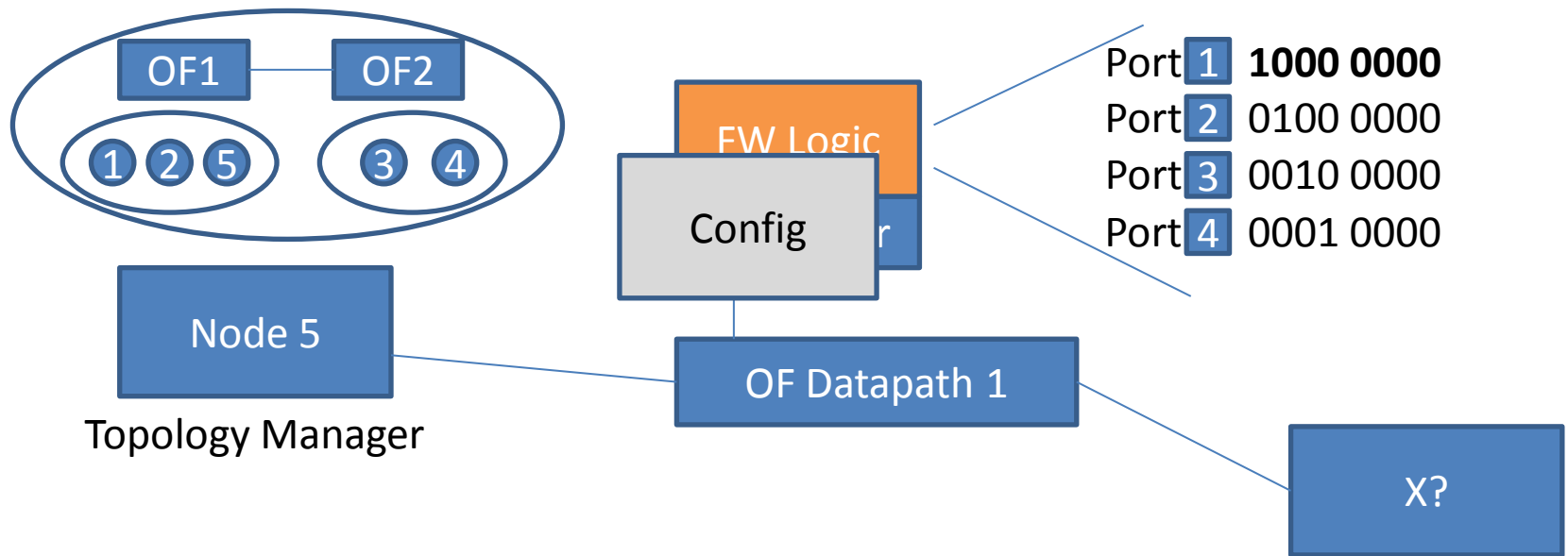
Benefits of using SDN

- Network bootstrap gets very simplified



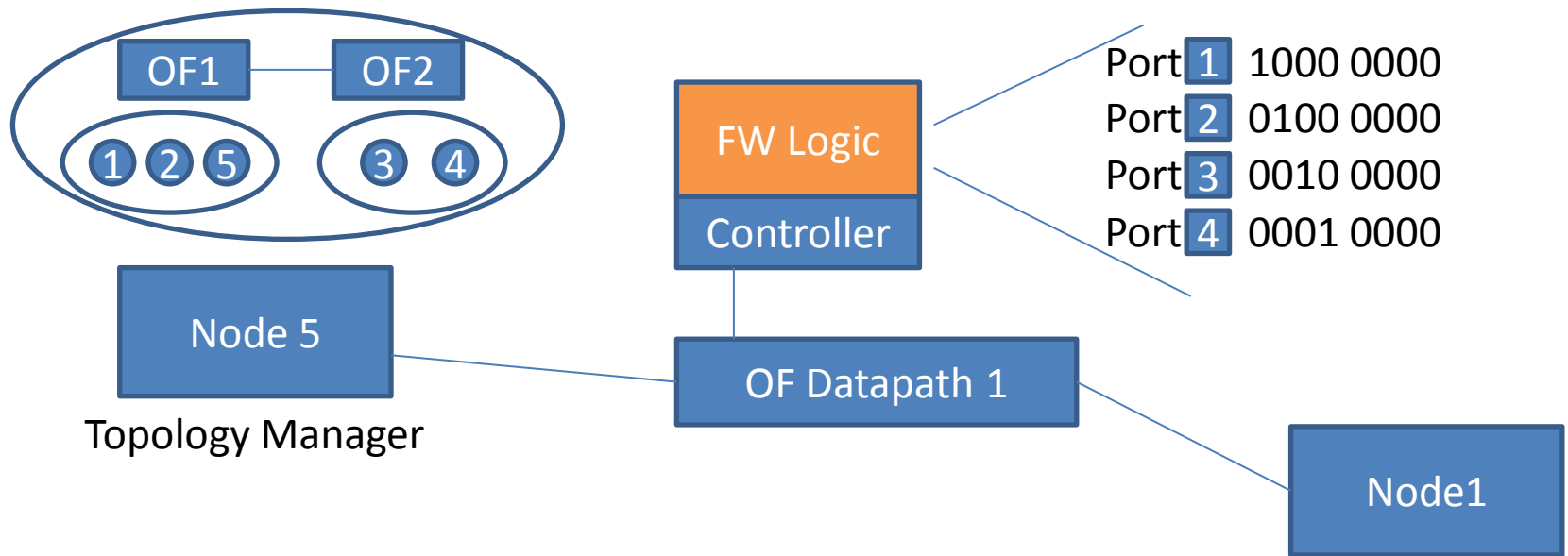
Benefits of using SDN

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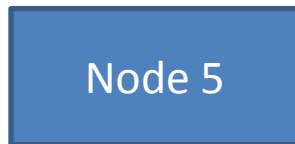
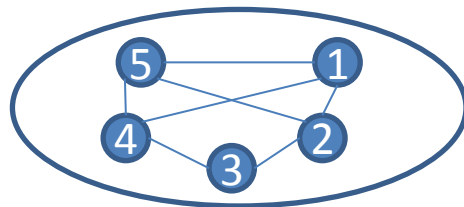
Benefits of using SDN

- Network bootstrap gets very simplified

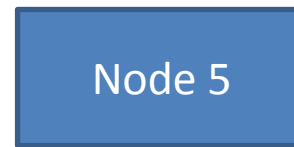
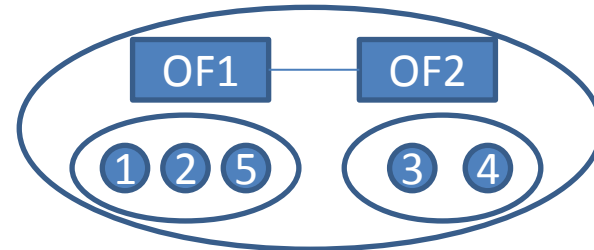


Benefits of using SDN

- Topology Management internal structures get simpler and response is improved



Topology Manager

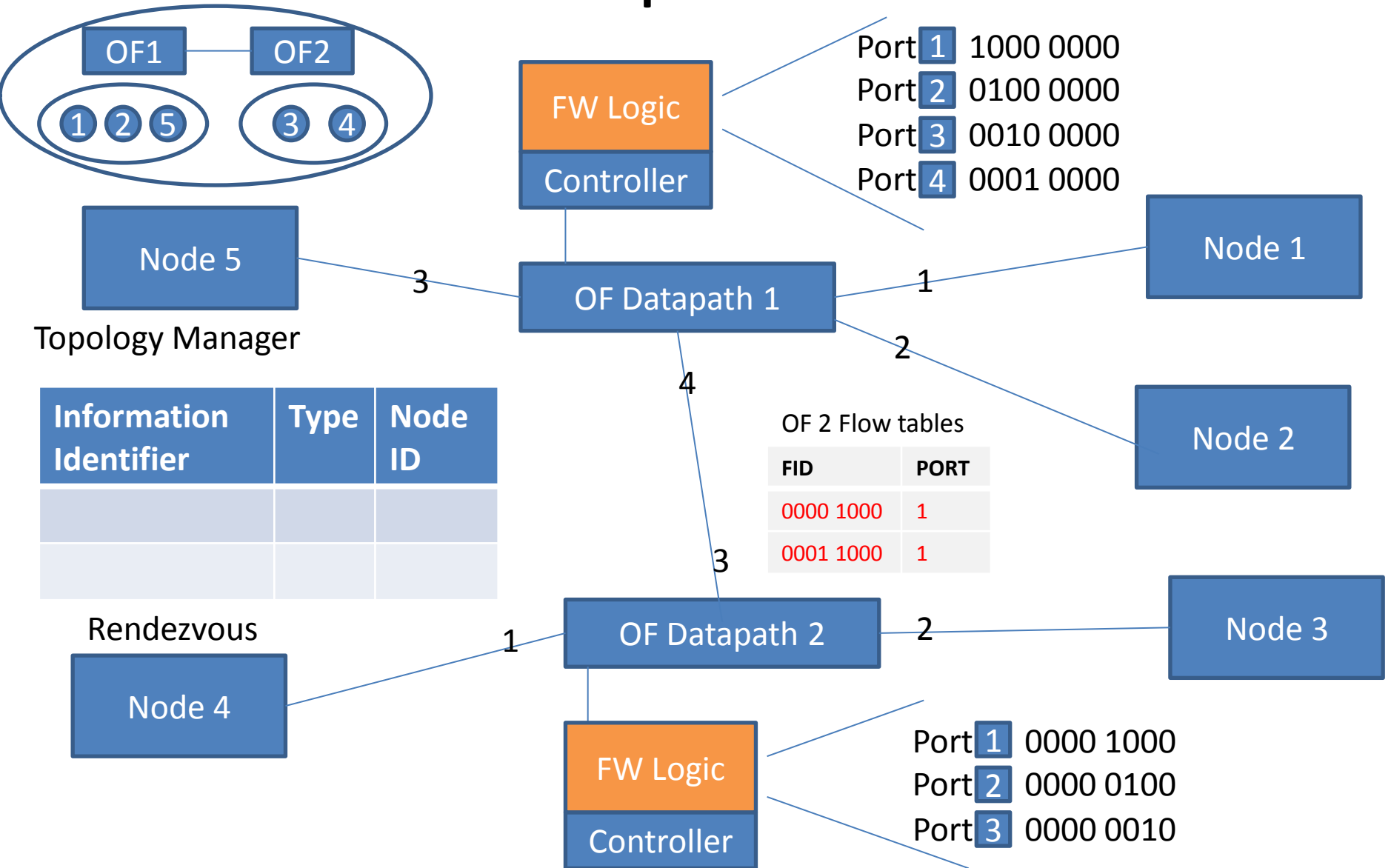


Topology Manager

Future Work

- Use Multi-stage Bloom filters to avoid having different FID labels for the same delivery ports within a datapath

The problem



Future Work

- Future work
 - Use SDN to simplify handover in ICN mobility

Thank You!

Pursuit BlackAdder Prototype:

<https://github.com/fp7-pursuit/blackadder>

Questions ?