Connection-Oriented Software-Defined Networking

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Roger B. Marks	Voice:	+1 619 393 1913
EthAirNet Associates*	E-mail:	roger@EthAir.net
4040 Montview Blvd		
Denver CO 80207 USA		

  *<http://standards.ieee.org/faqs/affiliationFAQ.html>

Re:
  For P802.16r Project, IEEE 802.16 Session #85

Base Contribution:
  [none]

Purpose:
  To stimulate discussion regarding the implications to the P802.16r project of the integration of a connection-oriented transport like IEEE 802.16 into a software-defined network.

Connection-Oriented Software-Defined Networking (COSDN)

This contribution is a followup to IEEE 802.16-13-0049 ("Integration of IEEE 802.16 and Carrier Ethernet")

- proposed a switch-centric architecture with a switch in the BS
- switch is presumably based on 802.1Q functionality (learning, spanning tree, etc.)

This contribution is a companion to IEEE 802.16-13-0084 ("Integration of IEEE 802.16 with Software-Defined Network Control")

- followup to IEEE 802.16-13-0049, introducing SDN controller to program the switch and link connections, including QoS control, as an alternative to pure 802.1Q behavior.

This contribution takes a broader perspective than IEEE 802.16-13-0084 toward the general issue of Connection-Oriented Software-Defined Networking.

SDN

- SDN controller communicates with switches via control path

- SDN controller controls flow forwarding by managing flow tables

- limited QoS enabled by associating a flow with a customized queue
  - Can schedule packets onto a link
 - Can't control what happens on the link

SDN
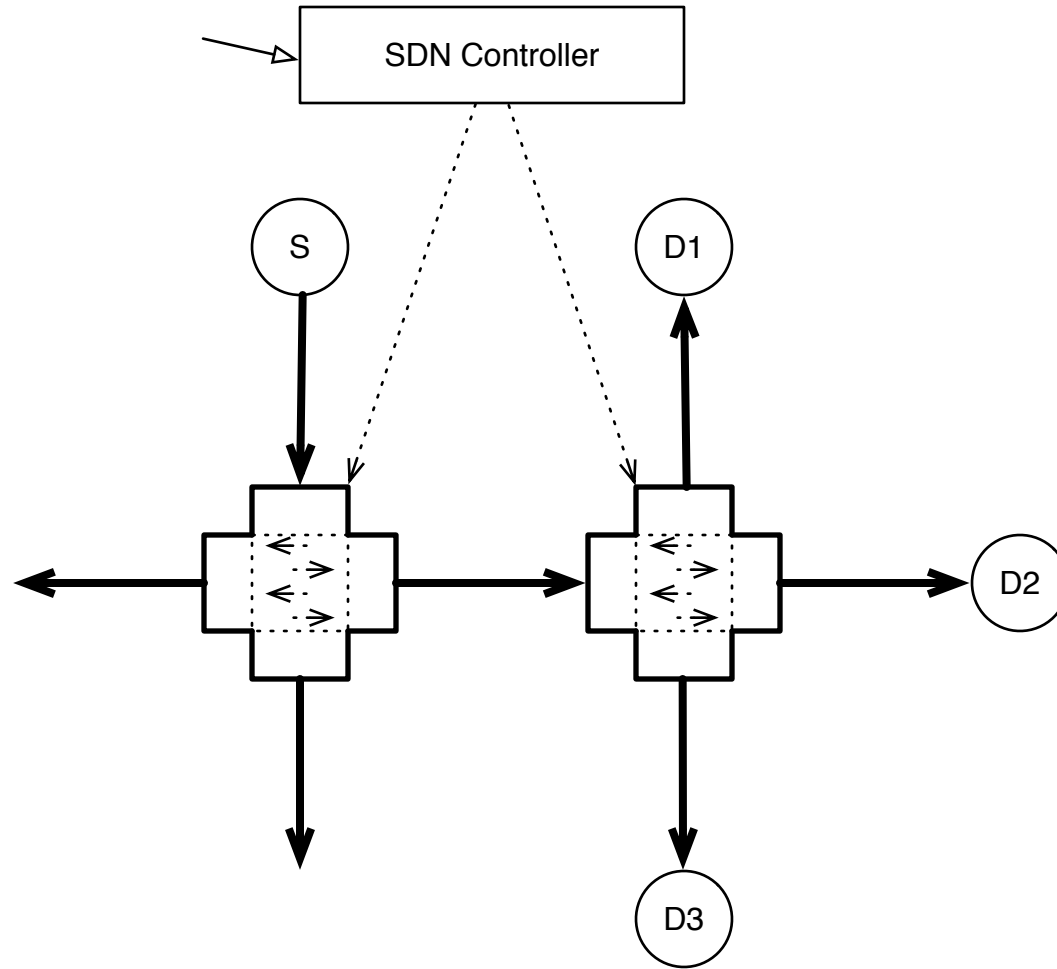
Connection-Oriented SDN (COSDN)

- Links are connection-oriented and managed
- COSDN controller manages not only switches but also
  - link connections
    - Connection setup, teardown, maintenance
    - packet classification
  - source ports for connection classification
- Links may be unmanaged
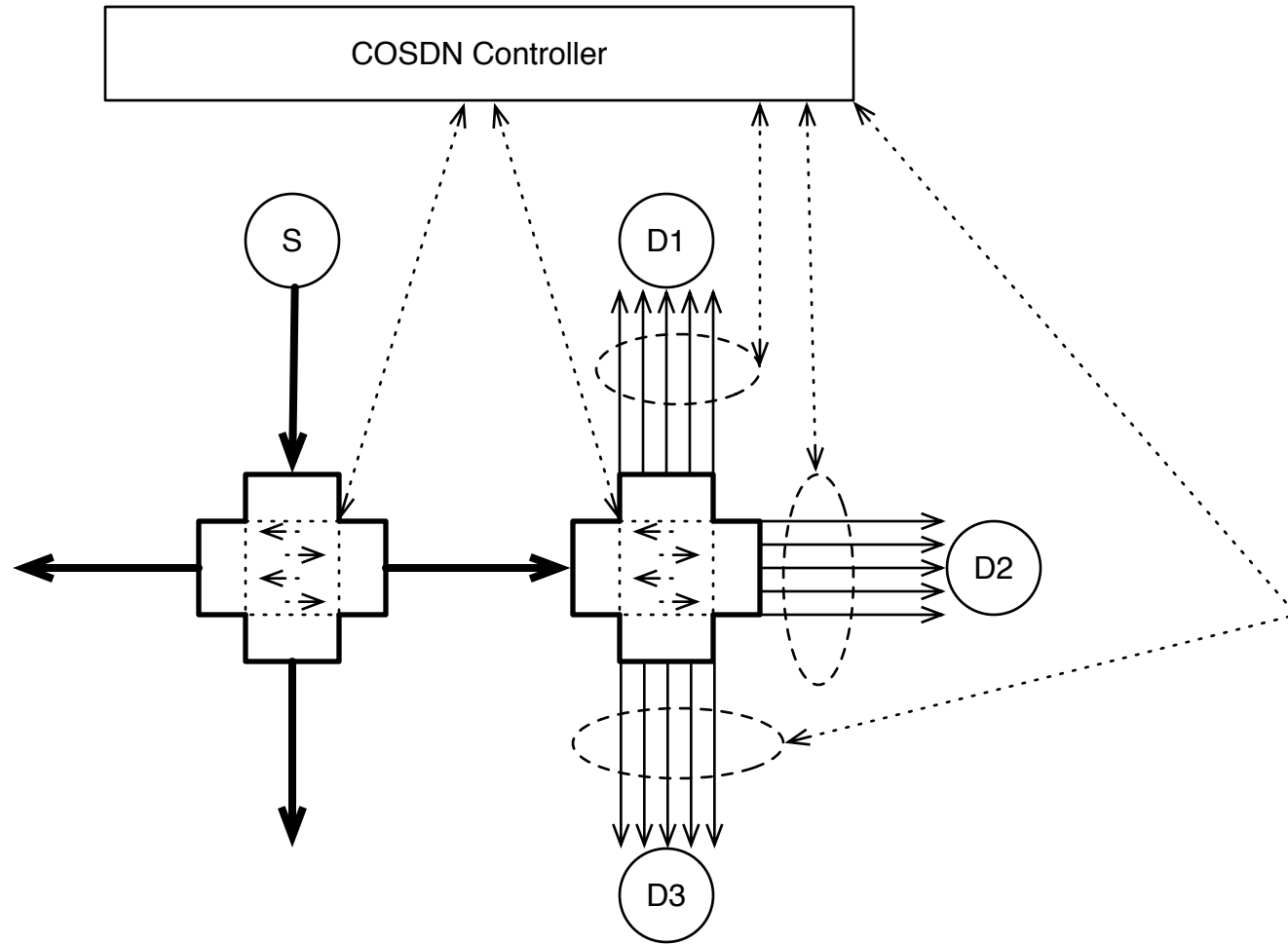 - e.g. they may not be connection-oriented or may support only a single connection

Connection-Oriented SDN
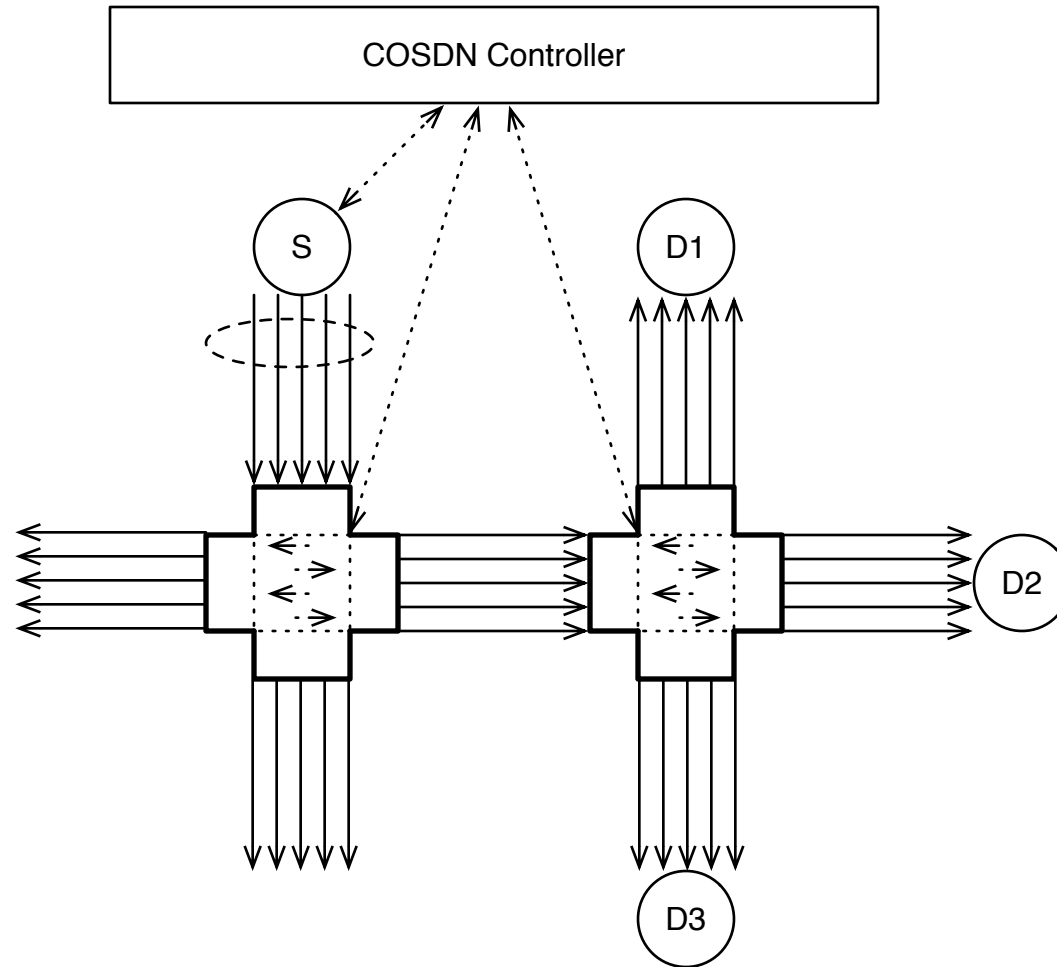
Connection-Oriented SDN
Full Connection Control

COSDN Controller

S

D1

D2

D3
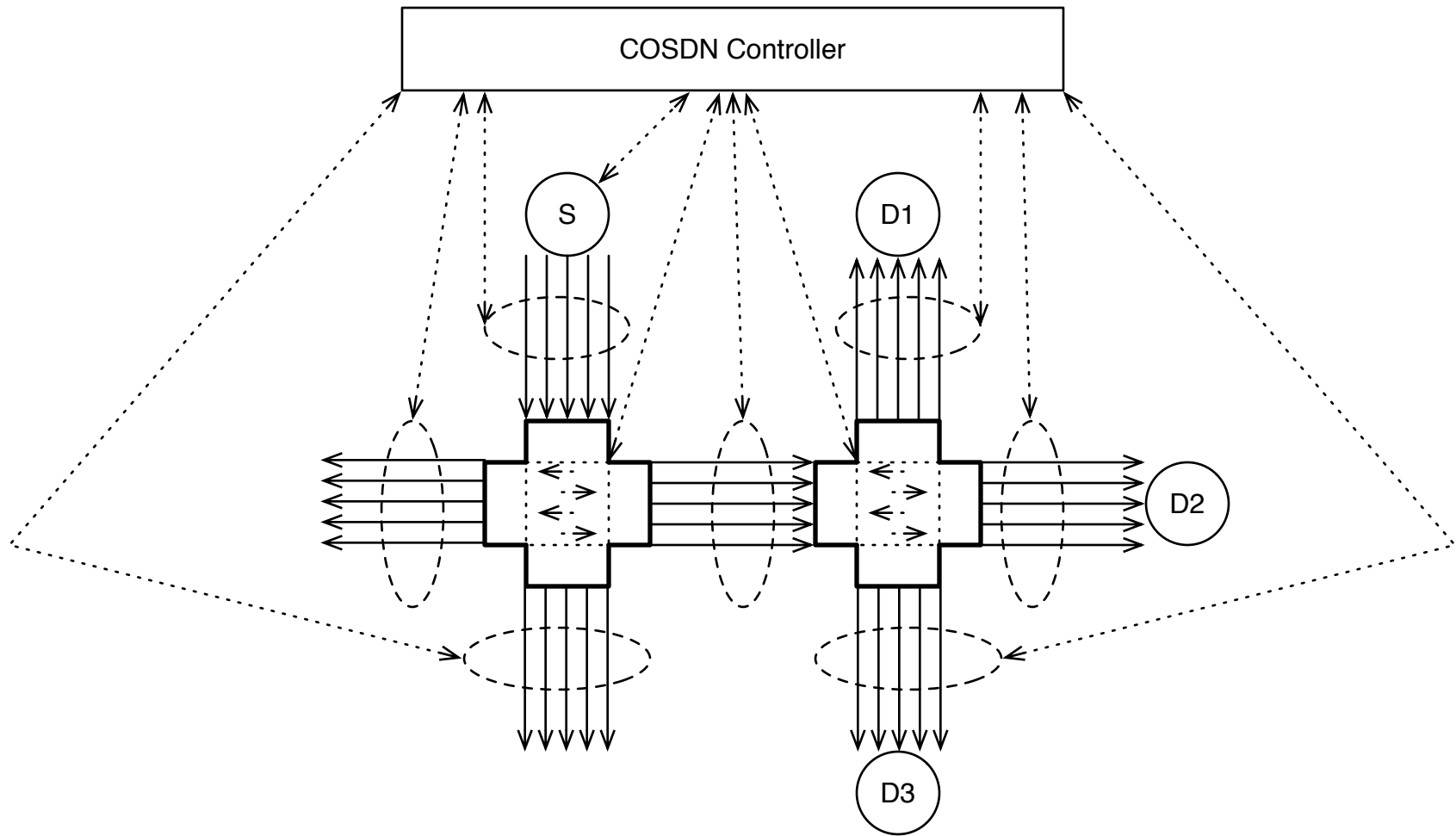
Connection-Oriented SDN
Partial Connection Control

Connection-Oriented SDN with Shared Physical Medium

- Multiple Links may share a physical medium

- This points out a major limitation of queuing only on the link: if the link resource is shared, the entire shared resourced must be managed as a single resource, with scheduling to accommodate connection QoS requirements across all links.

- Example: Point-to-multipoint radio links, as in IEEE 802.16.

- Note: the switch ports are virtual, not physical.

Connection-Oriented SDN
Shared Physical Medium
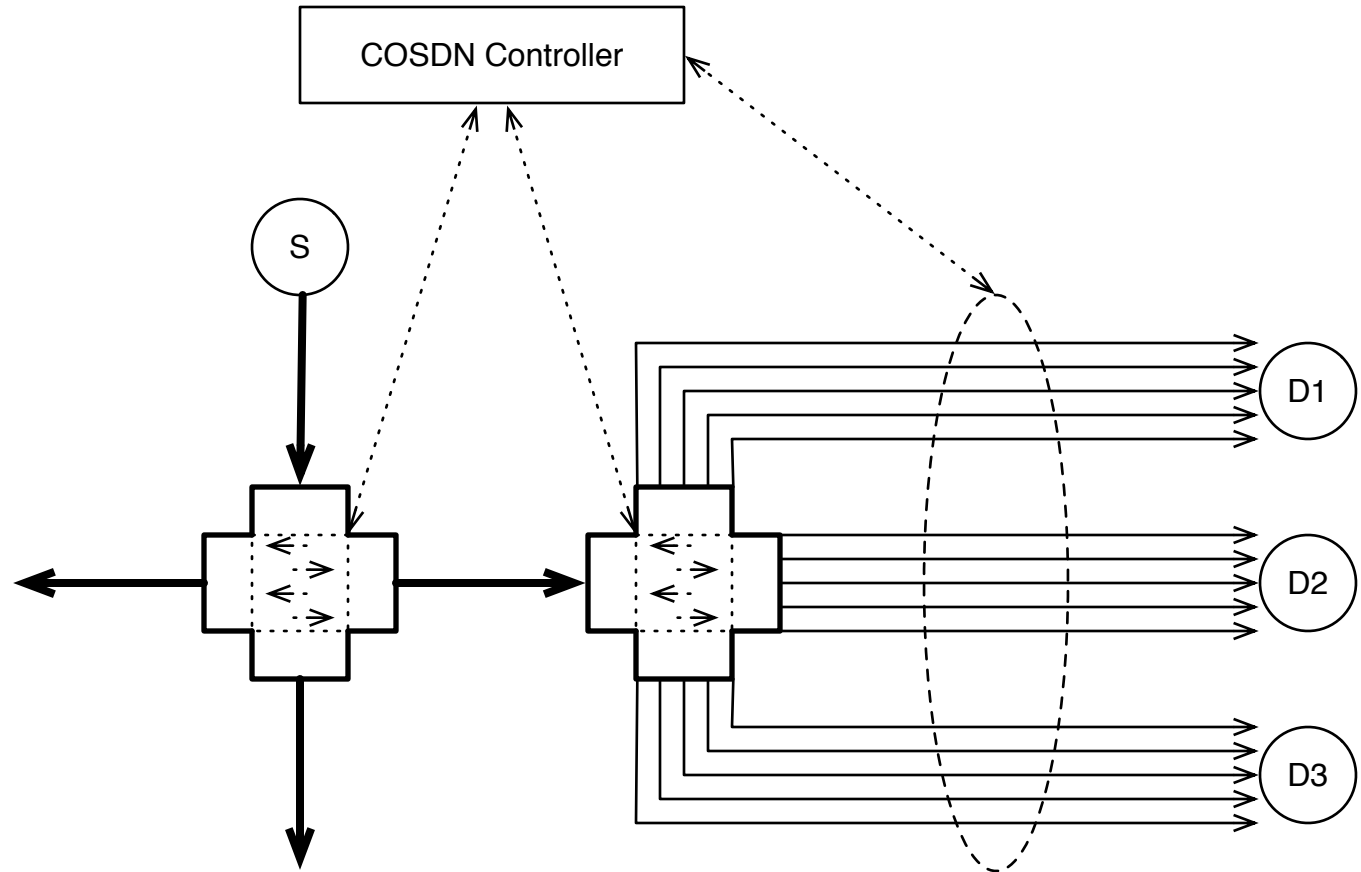
Connection-Oriented SDN with Multiple Physical Media

- Connections need to deliver packets to ports. There are many ways to do so.
- Could separate link connections by physical media.
  - May require a physical switch, not just virtual
- Example: an edge device may support IEEE 802.16 and IEEE 802.11.
  - Provision some connections (e.g., QoS-sensitive ones) over 802.16.
  - Provision other connections (e.g., best-effort) over 802.11.
- Manage all connections in a coordinated fashion using COSDN.
- Enable cross-media handover.
  - Use link aggregation tricks (e.g. IEEE 802.1AX Marker Protocol) to speed transition while maintaining correct packet sequence.
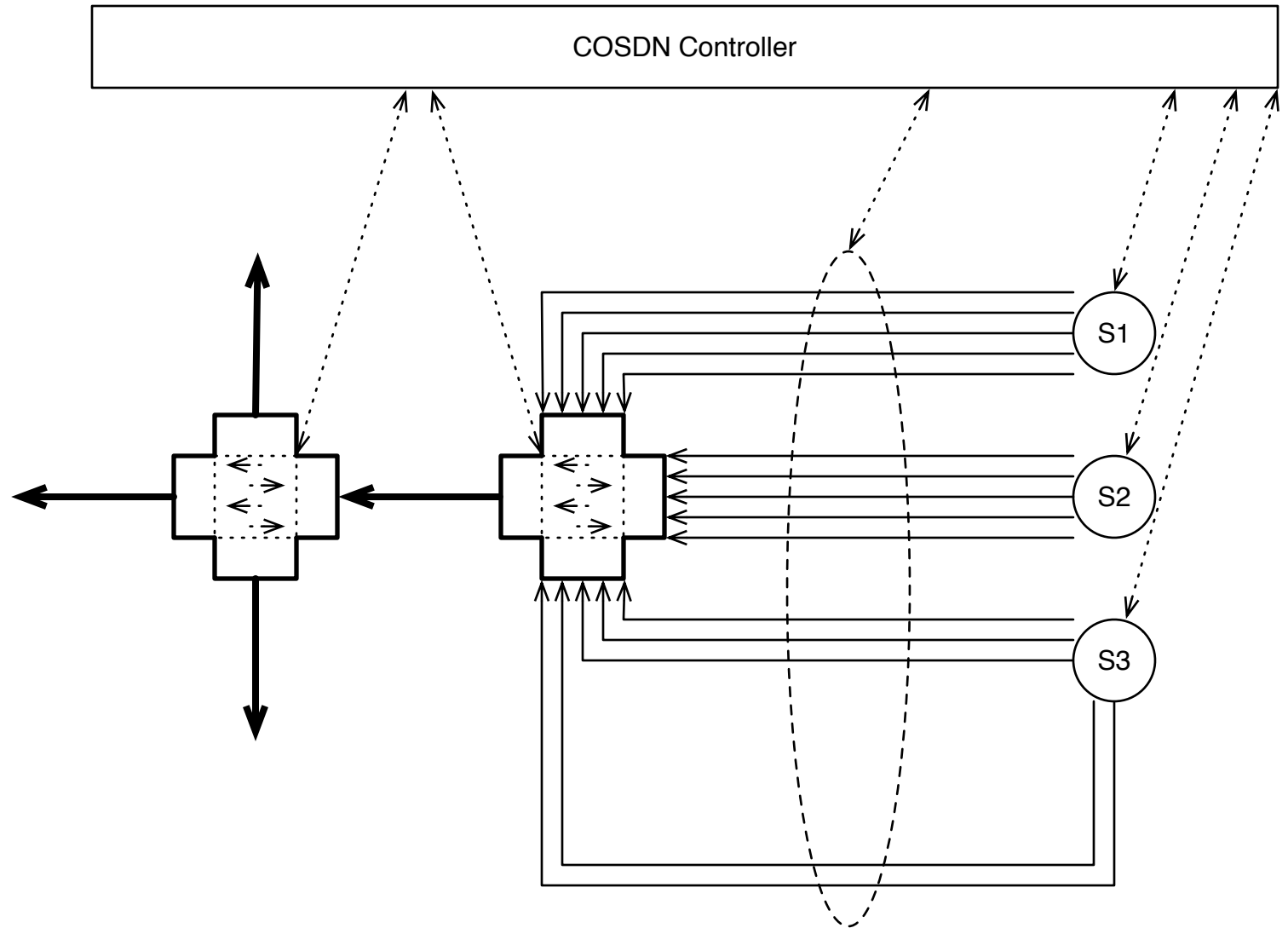
Connection-Oriented SDN
Multiple Physical Media
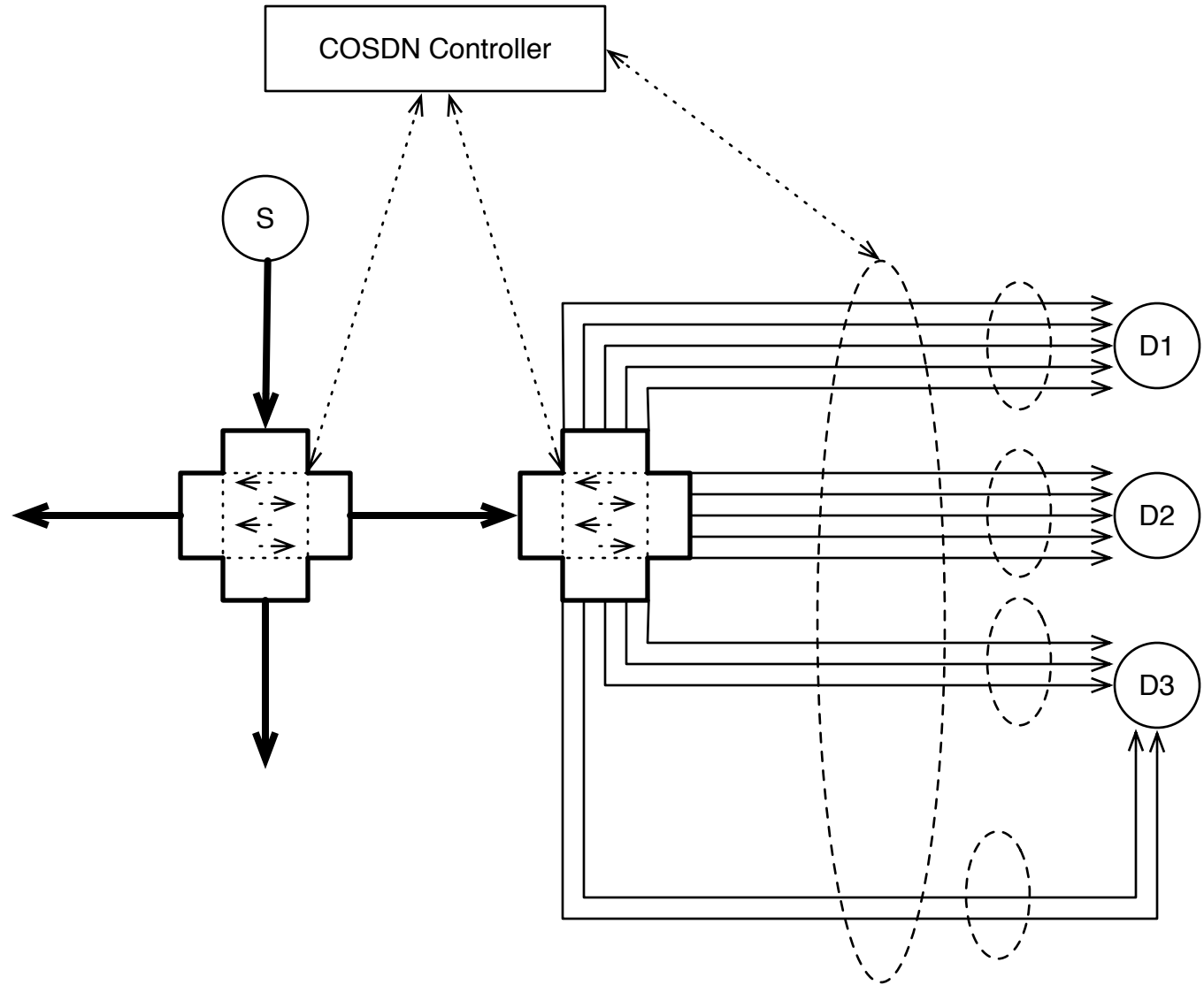
Connection-Oriented SDN with Multiple Physical Media - Uplink

- The previous figures illustrate the "downlink" problem of a point-to-multipoint architecture.

- "Uplink" can be managed in a similar fashion.

- Source packets must be classified and assigned to flows that map to connections appropriate to their QoS requirements.

- COSDN Controller manages connections.

- COSDN Controller configures packet source flow tables
  - Not for switching but for QoS sorting and matching to appropriate connections.

Connection-Oriented SDN
Multiple Physical Media - Uplink

COSDN Controller

S1

S2

S3

Conclusions

- SDN manages switches but not links

- Connection-oriented transport networks, like IEEE 802.16 and others, provide QoS control by managing connections in a manner that is parallel to SDN switch management

- SDN can be extended to COSDN to allow control of the entire port-to-port network flow, including, switches and links.