SDN

CS 168 – Spring 2024

What is SDN?

- A way to **manage** networks through a *logically* centralized controller

- What is management?
  - Generally, setting configuration for different protocols
    - So this can look like many different things!
    - Examples:
      - setting routing protocol configuration
      - setting routes directly
      - creating tunnels (encapsulation / decapsulation)
      - ...

Why SDN?

- Network management is complex!
- Often done via ad-hoc scripts (for configuration) or distributed protocols that evolve slowly (ex. BGP)

- Would be nice to say “I want my network to do x” regardless of how the protocols work, etc.

How SDN?

- In general: a controller programs/configures the network according to some code
  - This can look different depending on the context!

- Some examples:
  - Use SDN to program forwarding tables directly (instead of a typical routing protocol)
  - Use SDN to virtualize your network (set up the encap/decap necessary)
  - Use SDN to do traffic engineering (set up the encap/decap and forwarding rules to take custom paths)
  - ...

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Not often used, even though a large part of the initial proposals!

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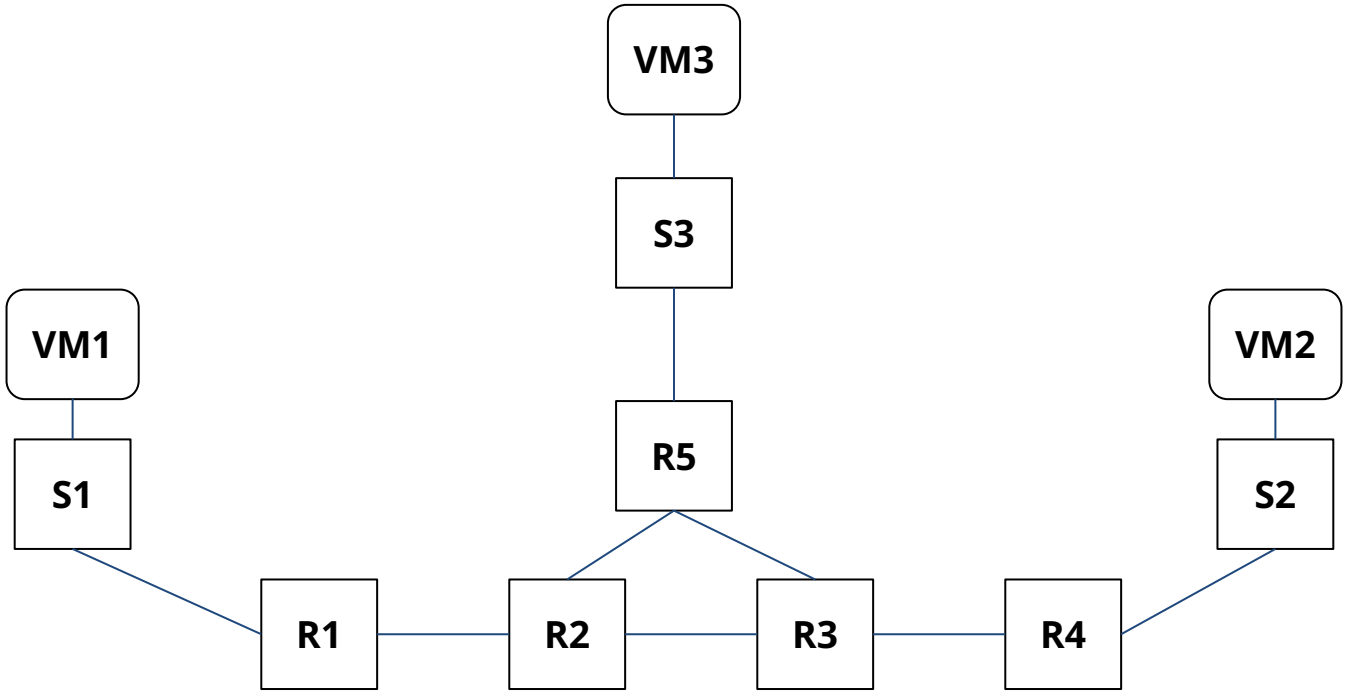
How SDN?

- In a lot of the cases, implement an **overlay** network on top of an **underlay** network
  - Specifics will vary → that's part of the appeal (customization)!

- What is an **overlay?**
  - A subset of the nodes in the underlay network connected together **using the destination-based connectivity achieved in the underlay network**

How SDN? - Network Virtualization

- Fix scalability problems of routing with multitenancy by creating virtual overlay networks



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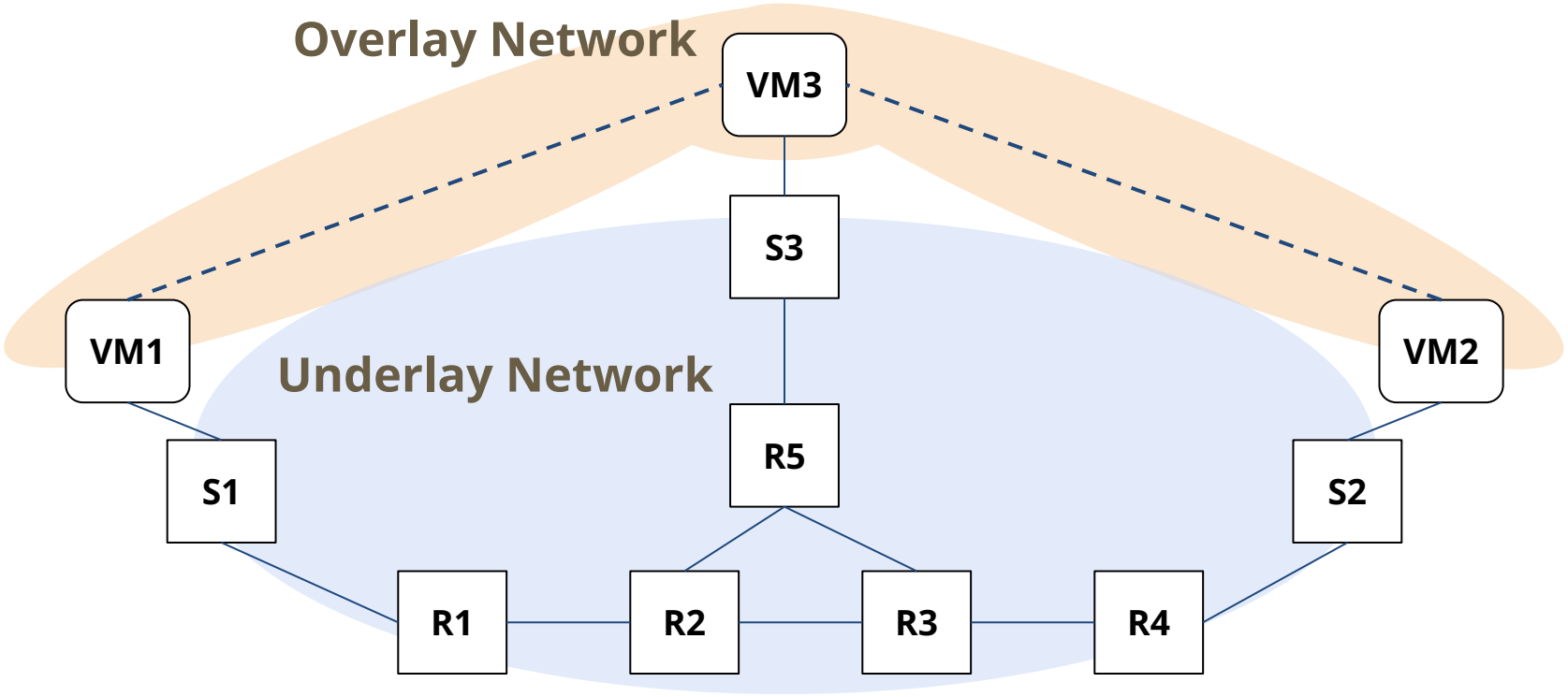

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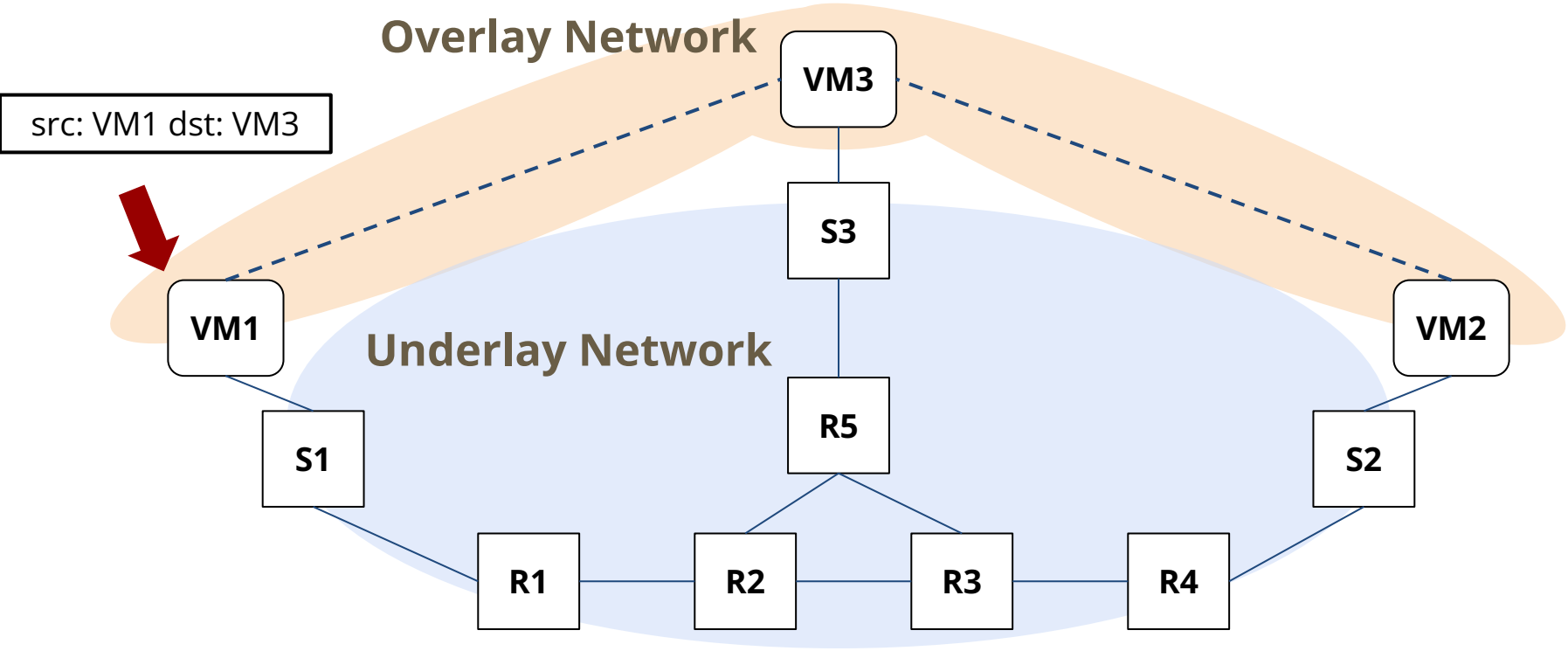

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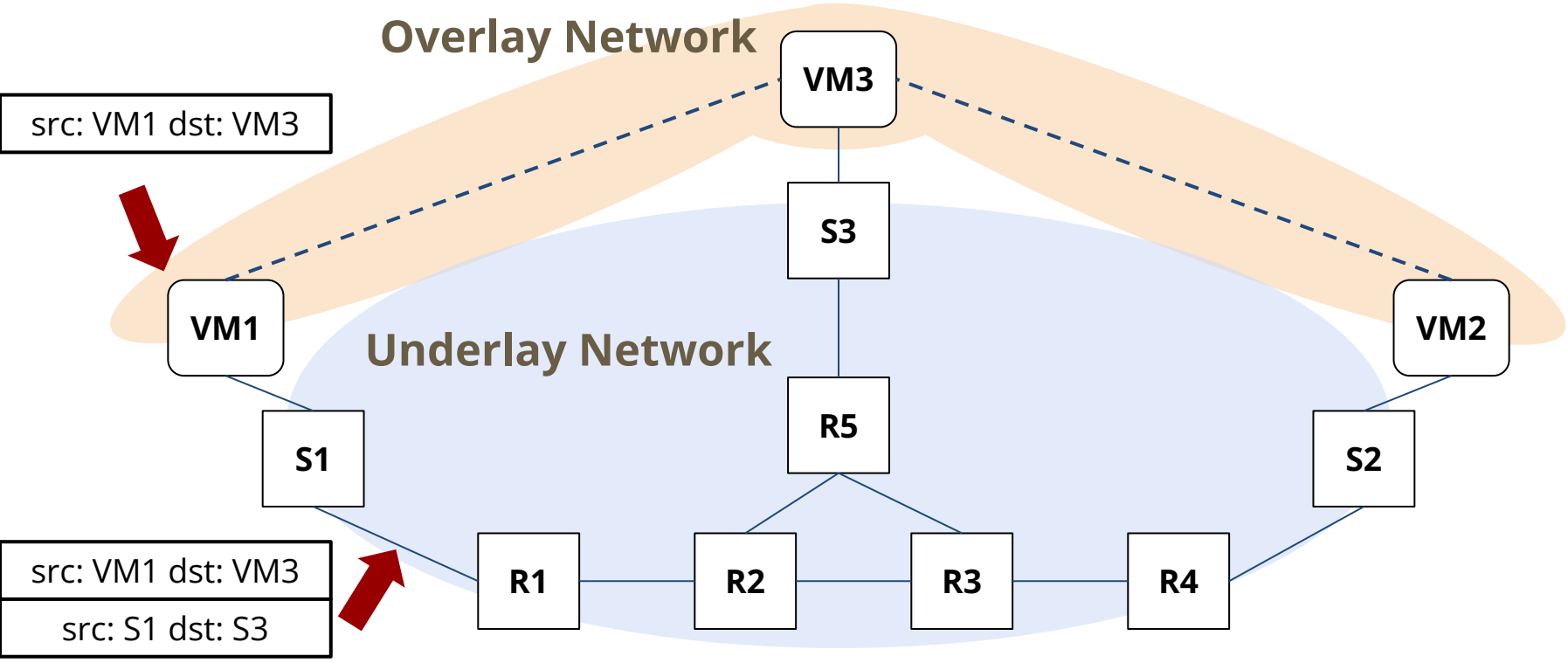

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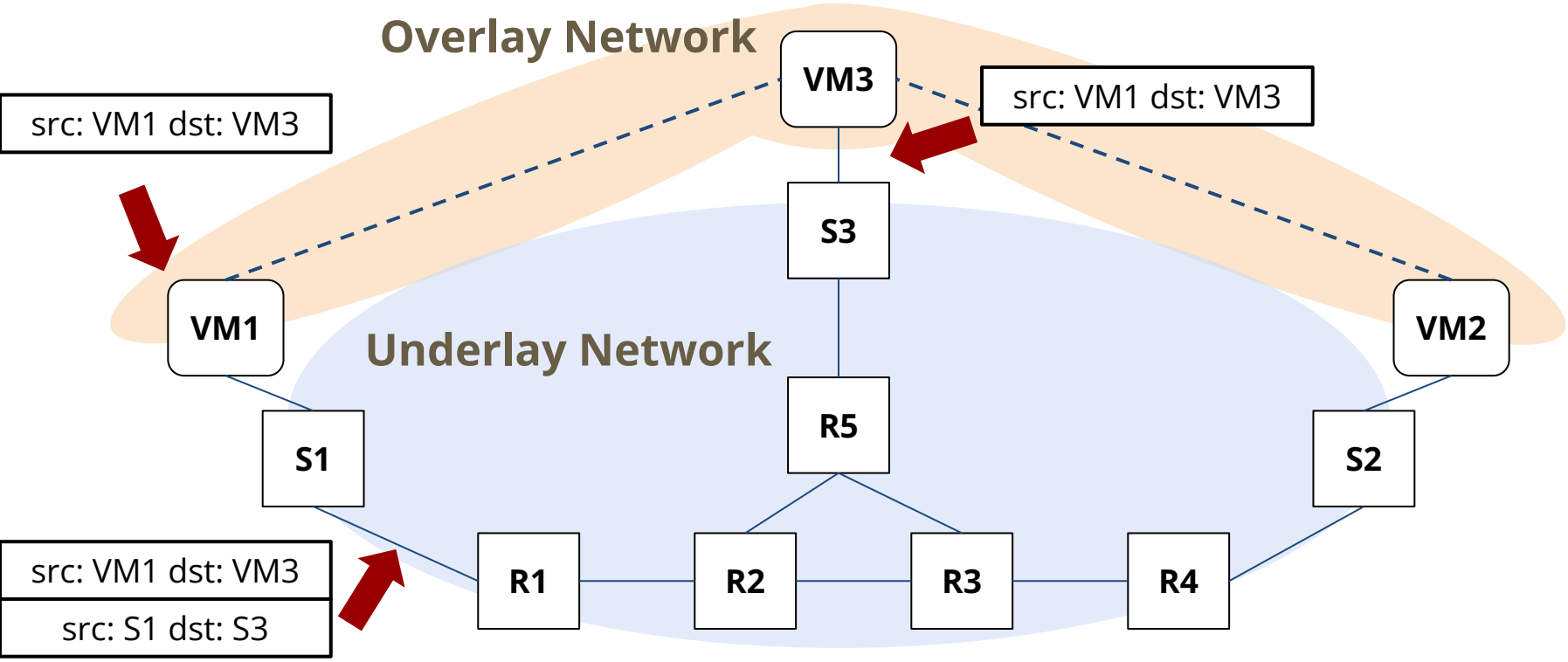
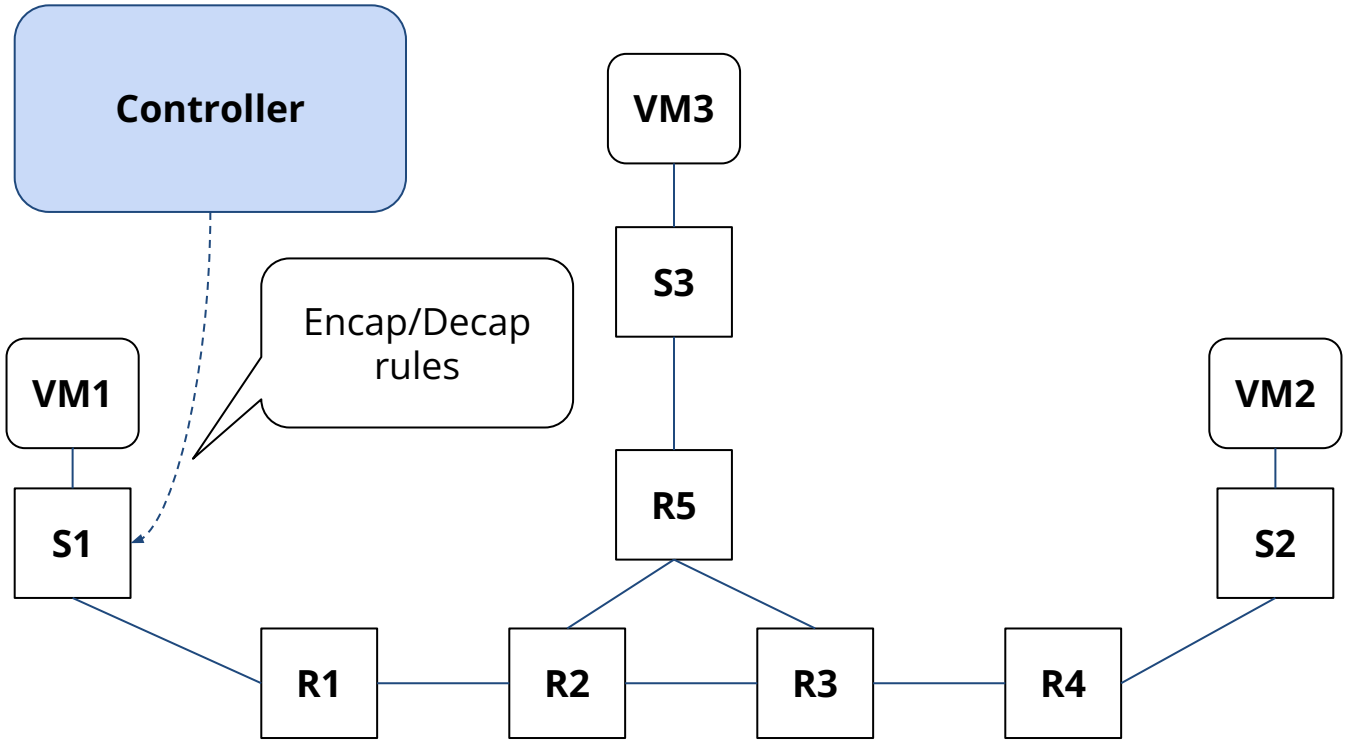


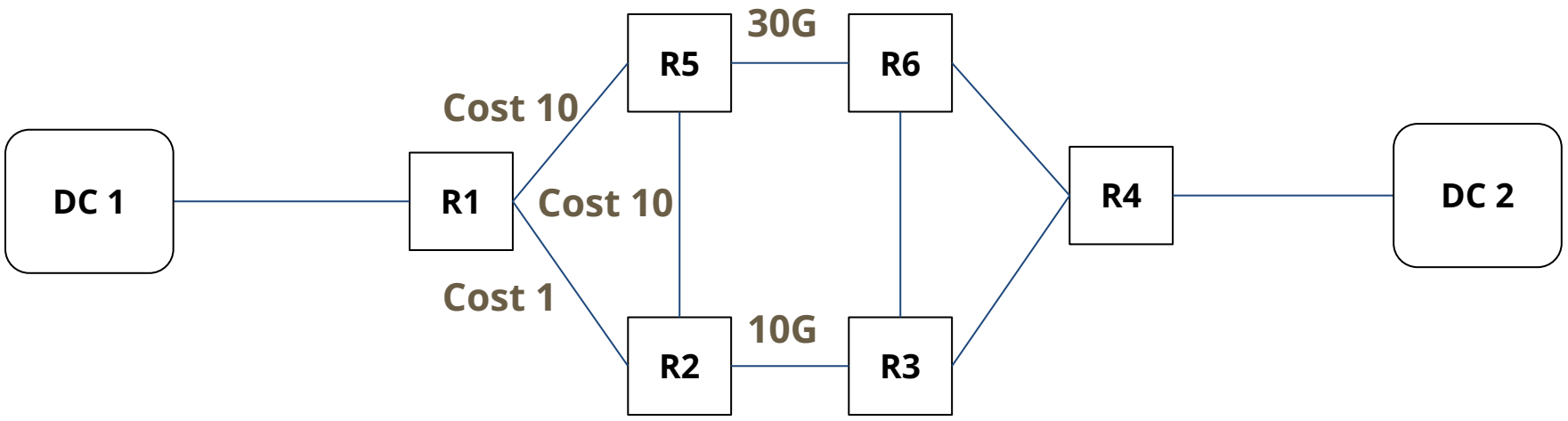
How SDN?

- Where did all this configuration to set up these overlays/underlays come from?
  - The **SDN controller**



How SDN? - Traffic Engineering

- Use labels in header to customize the path that traffic takes
  - But the existing network only does destination-based forwarding!
  - Exploit that to create new paths



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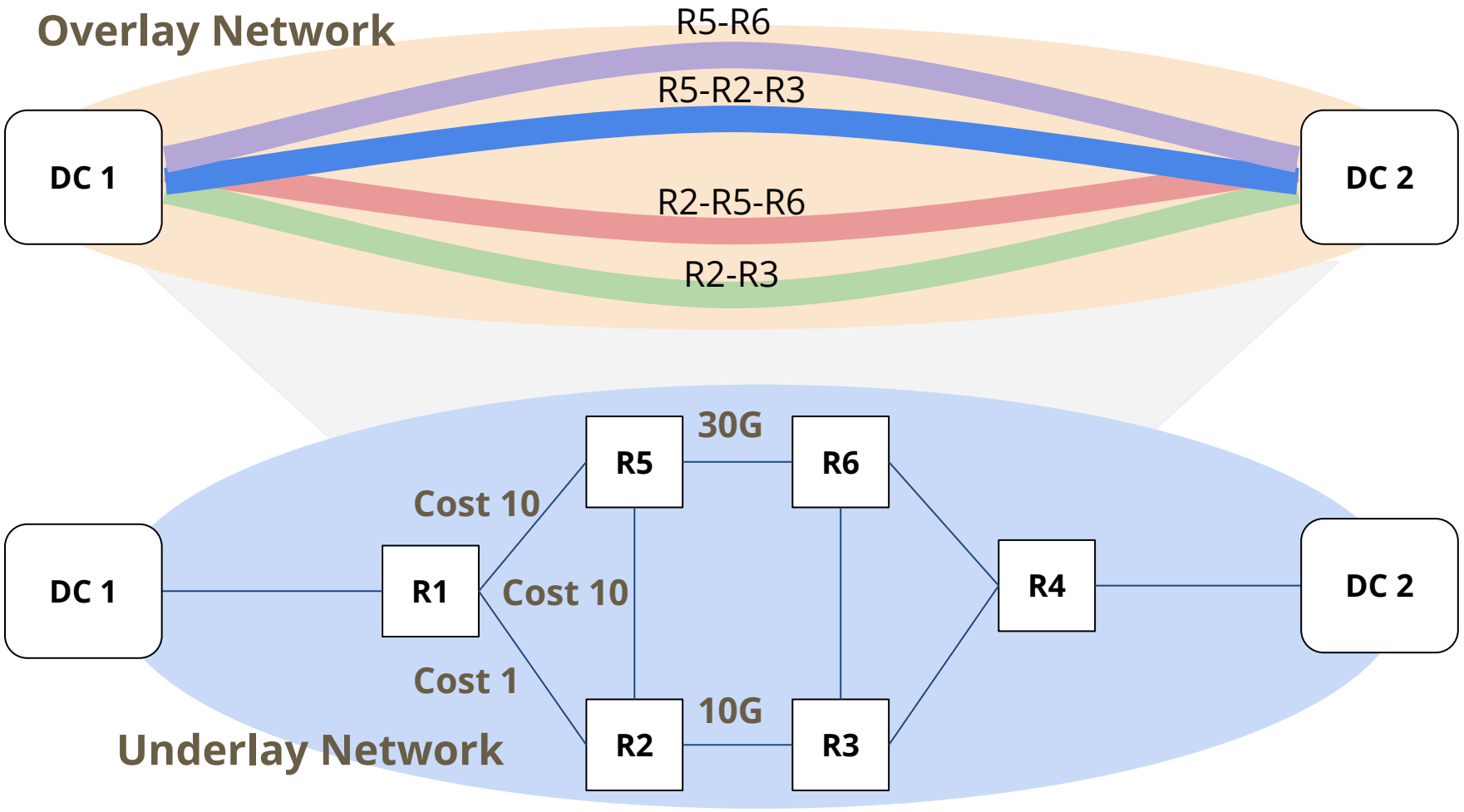

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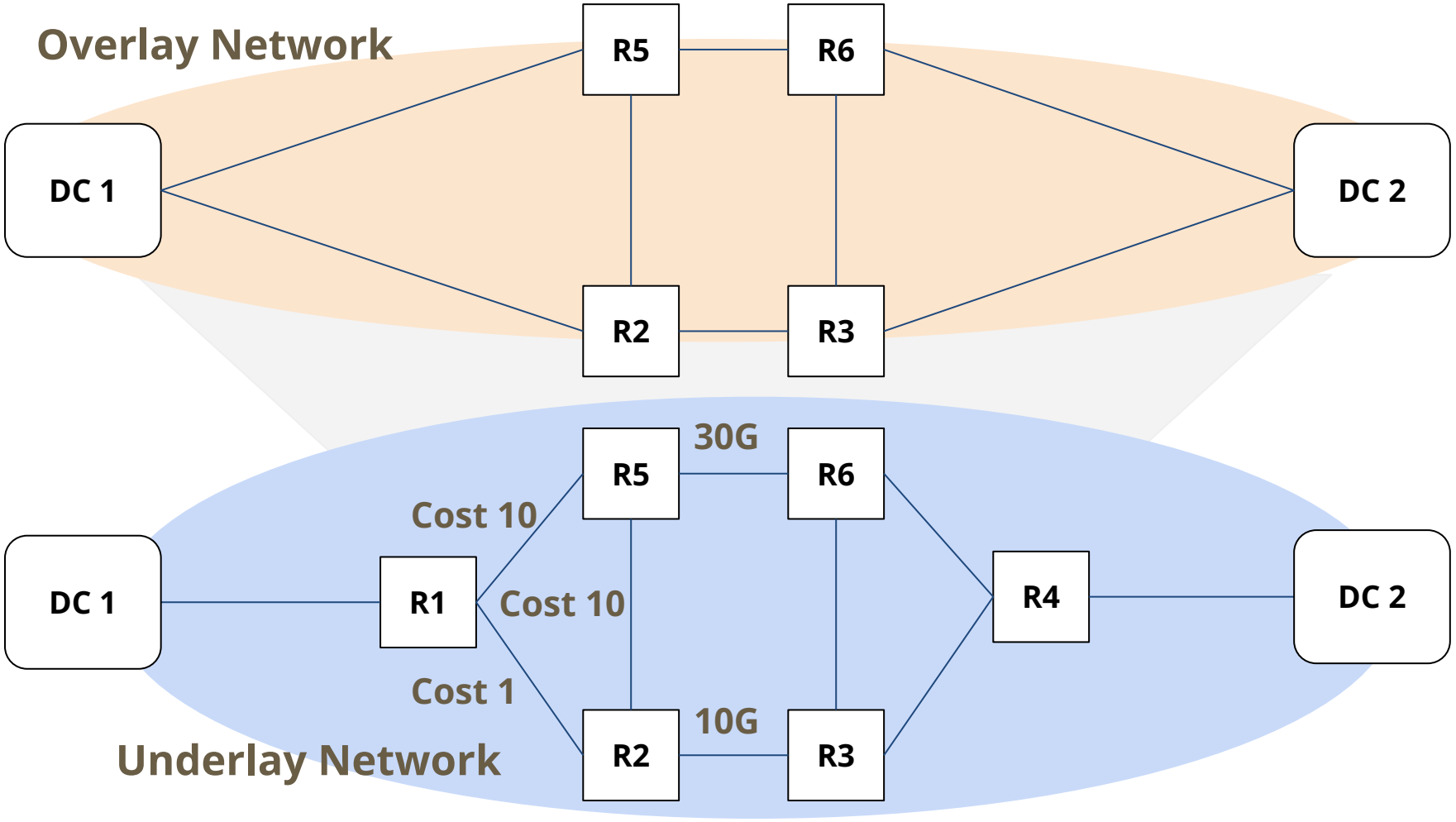

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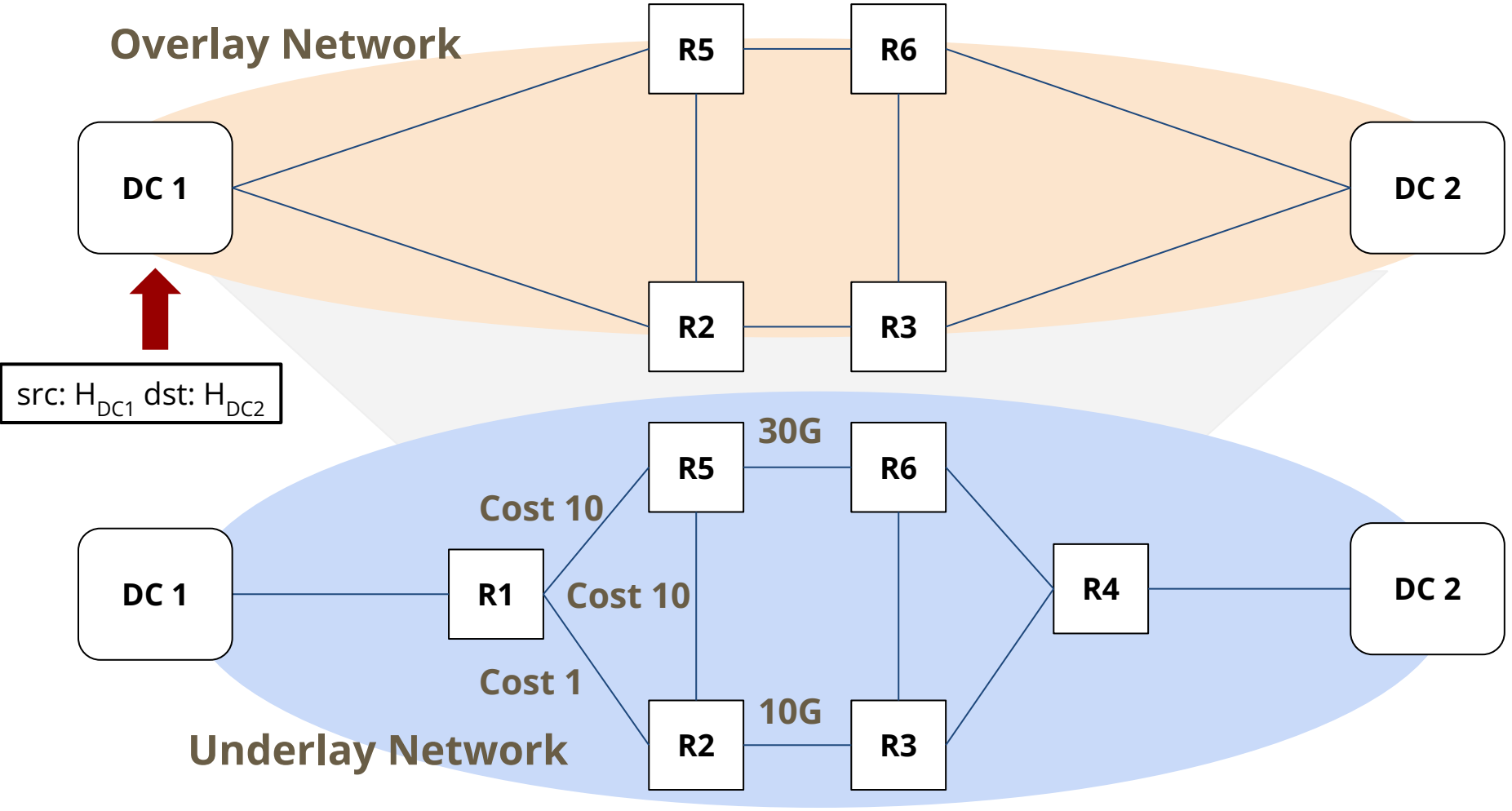

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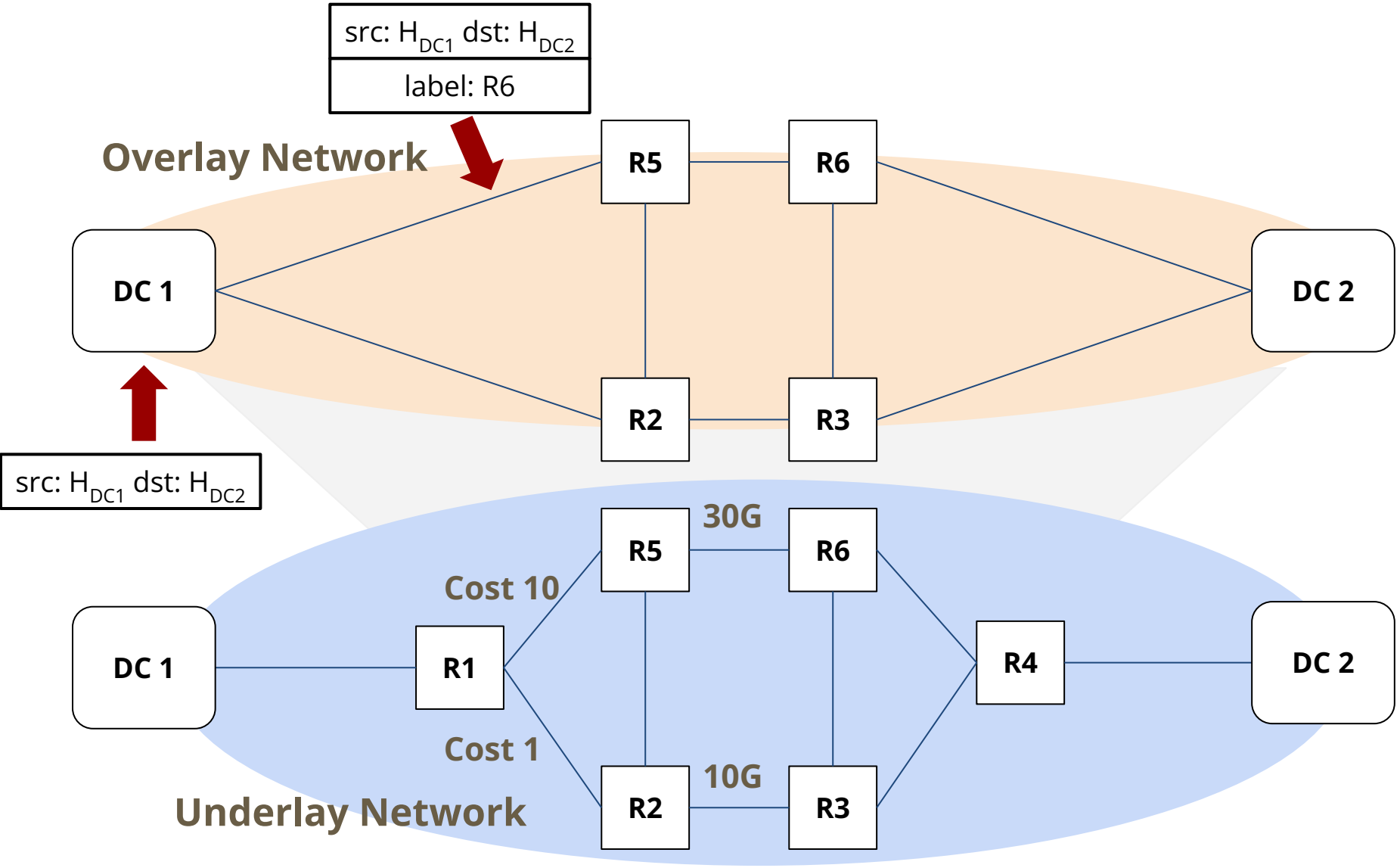

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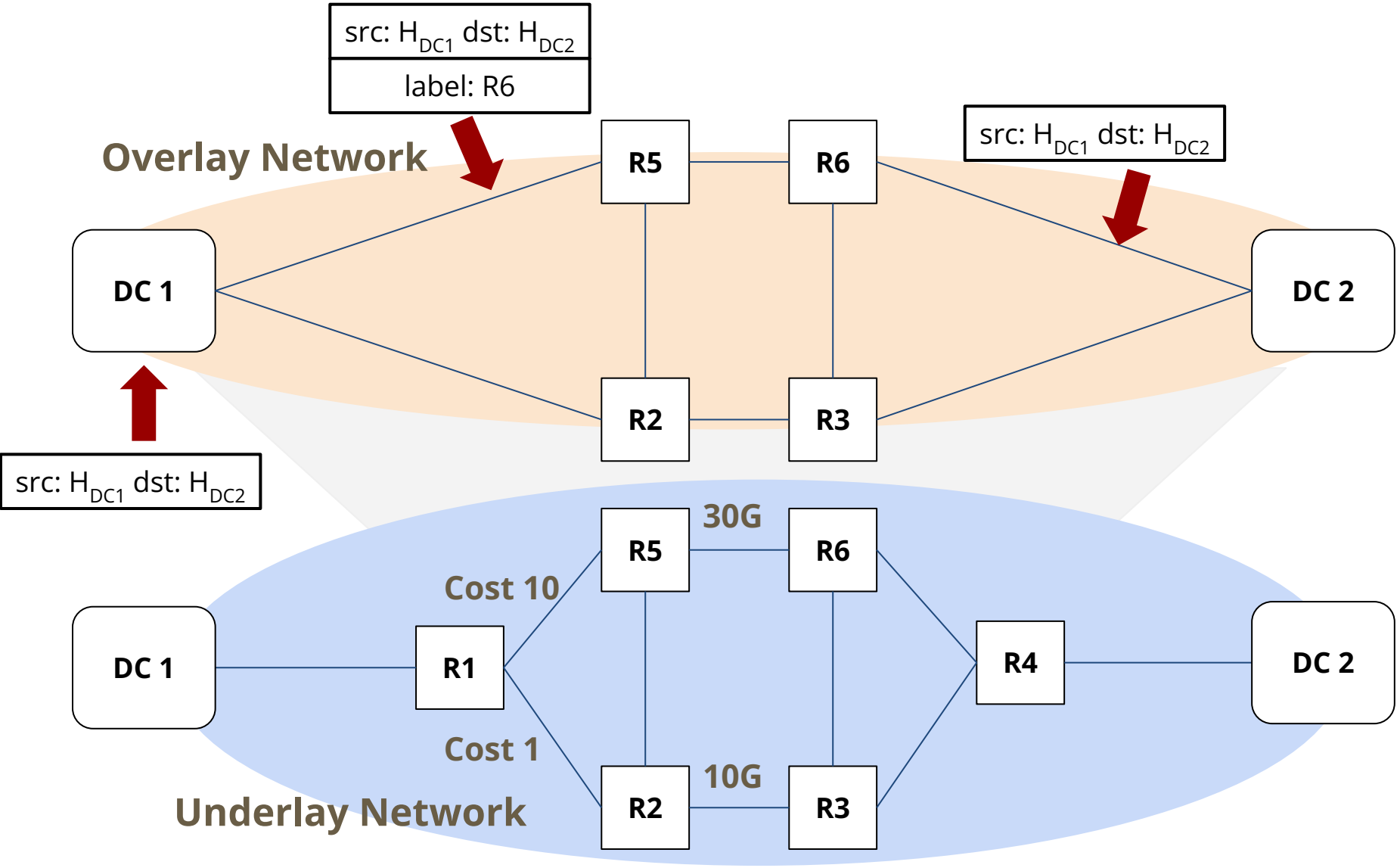

How SDN? - Forwarding

- Directly program forwarding rules into routers instead of using routing protocols
- Requires out-of-band connection with the controller

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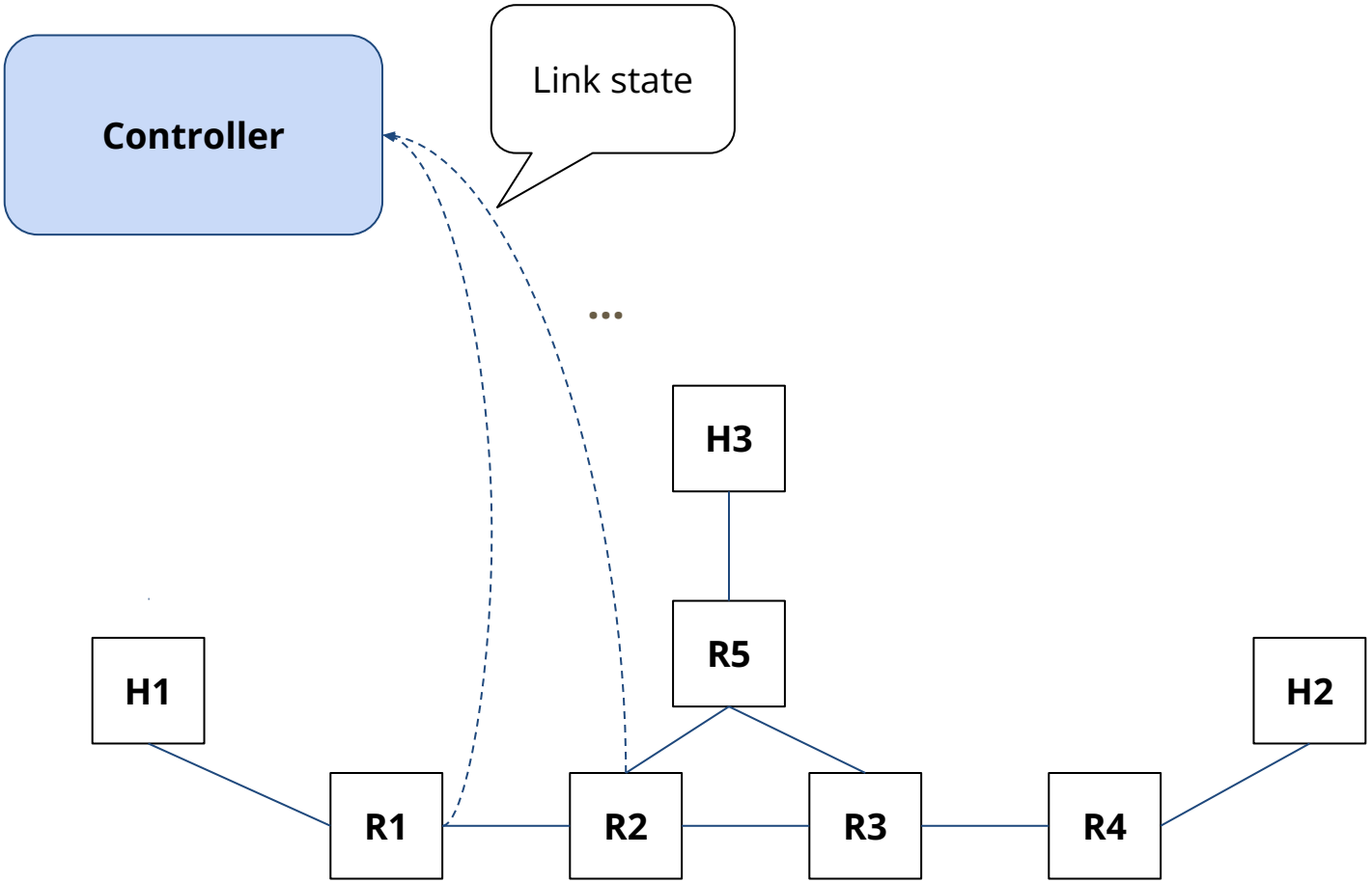

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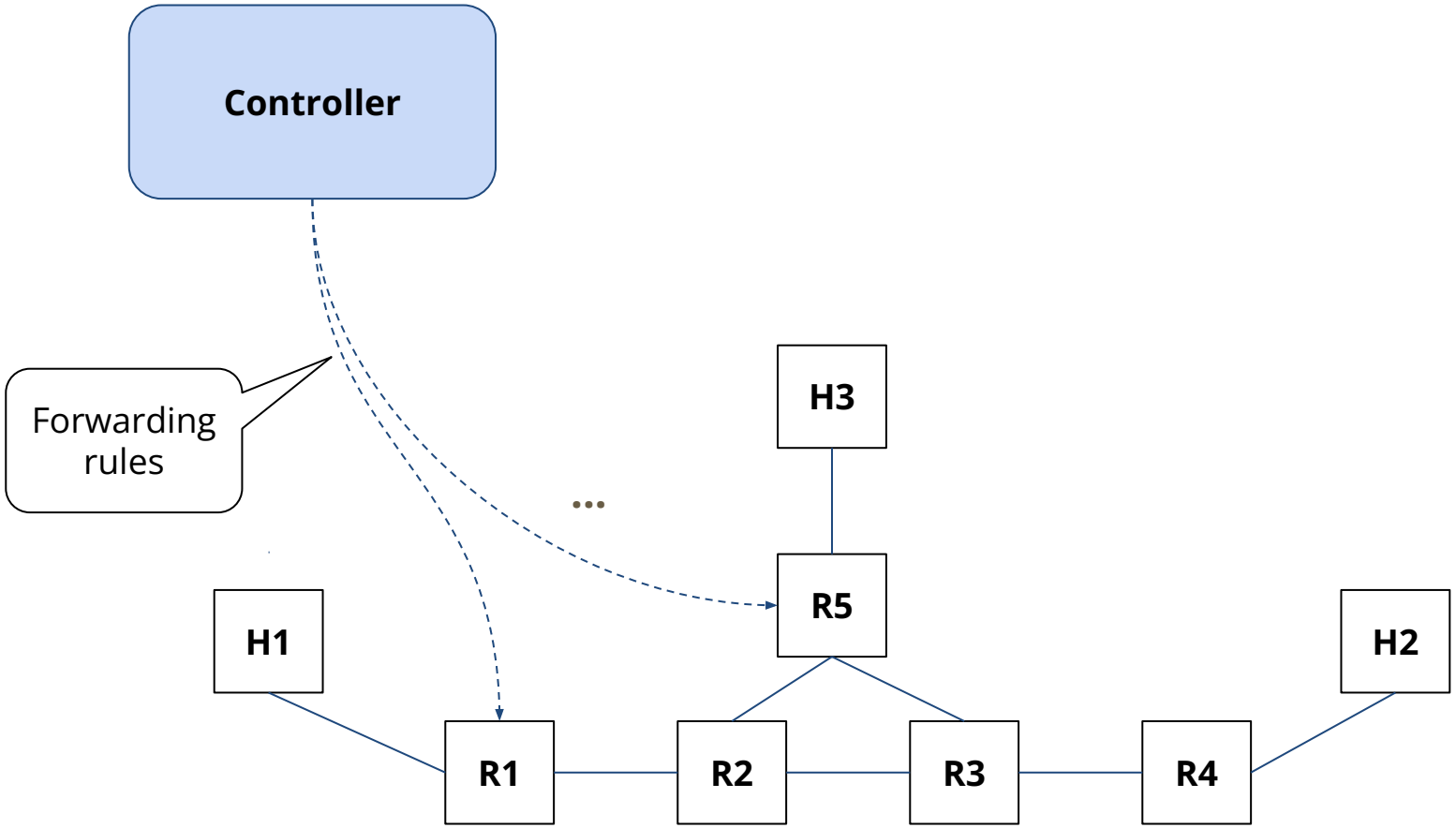

Worksheet - Q1

1 SDN: Overview

You are a chief network engineer at CS168DB, a company that specializes in databases. Currently, your networking infrastructure still relies on hardware switches that converge on routing with various L2/L3 protocols. You have tens of thousands of servers that need to communicate with each other. As the chief network engineer, you are thinking about making the switch to software defined networking.

1. What are your current control plane abstractions?

2. What are the required control plane's abstractions if you make the switch to SDN?

3. What happens when a link goes down in your new SDN setup?

4. Is OpenFlow equivalent to SDN?

Worksheet - Q1

1 SDN: Overview

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1. What are your current control plane abstractions?

   Solution: None!

2. What are the required control plane's abstractions if you make the switch to SDN?

   Solution: There are three. The first is an abstraction of the forwarding model of switches, OpenFlow is an example. The second is an abstraction of network state, in the form of a global network view via a Network Operating System. The third abstraction is an abstraction of the specification for network behavior, which is used to specify the *goals* of an operator on an abstract view of the network.

3. What happens when a link goes down in your new SDN setup?

   Solution: The software switches connected to the link will communicate the topology change to the controller. The controller will then recompute routing state and disseminate that information to the routers.

4. Is OpenFlow equivalent to SDN?

   Solution: No.

Worksheet - Q2