

# Sweet Little Lies: Fake Topologies for Flexible Routing



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Joint work with

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**Fibbing**

# Fibbing

control routers' **FIB, lying** to routers

???

Fibbing

control routers' FIB, lying to routers

# We use lies to overcome inflexibilities of traditional networks

traditional networks



# We use lies to work around challenges of OpenFlow-like networks

OpenFlow networks



We use lies to combine the advantages of OpenFlow and of traditional networking

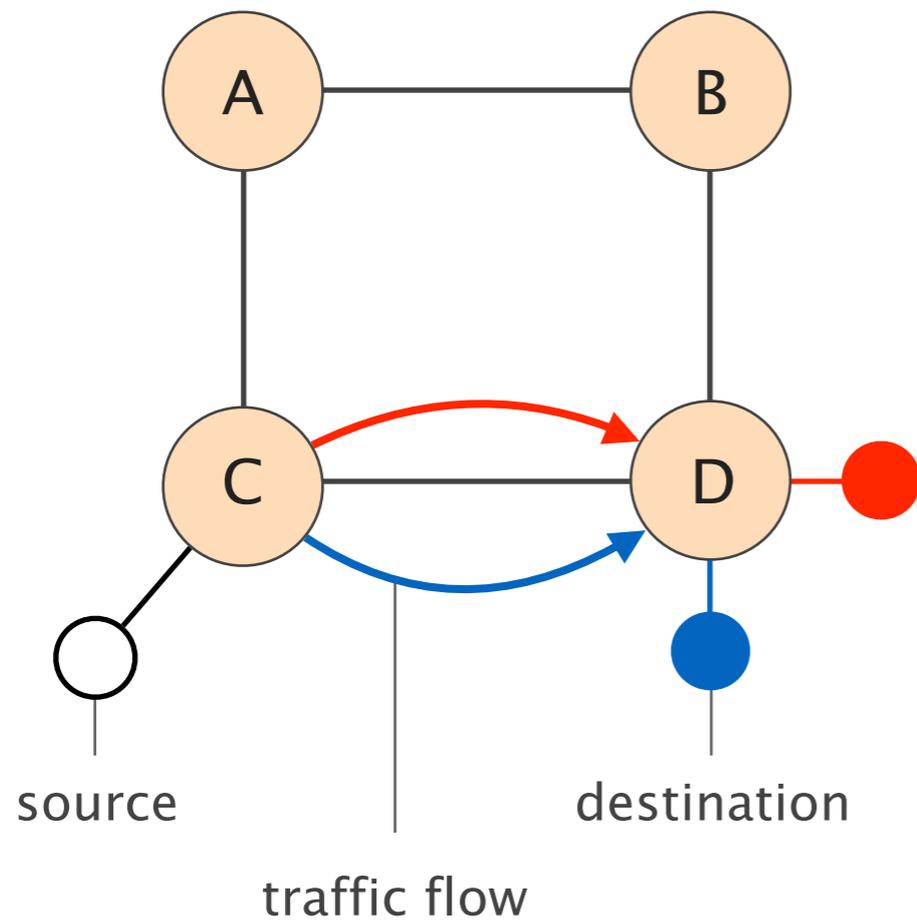
*Fibbing*



# Operators need flexibility for intra-domain routing

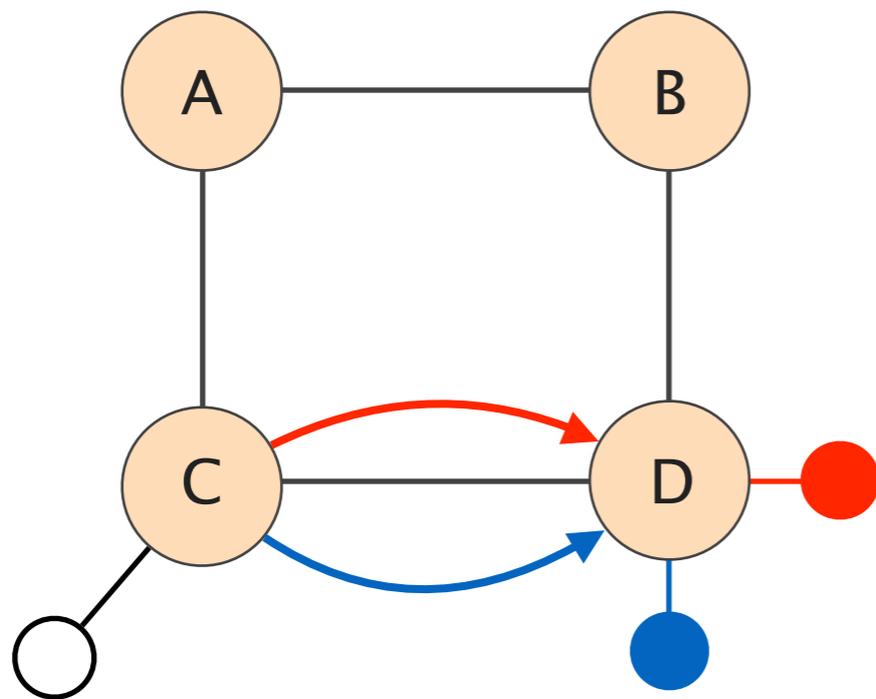
- fine-grained traffic engineering  
optimize the available resources
- provision backup paths  
quickly and predictably react to failures
- deploy advanced services  
*e.g.*, steer traffic through middleboxes

Consider this network where  
a source sends traffic to 2 destinations

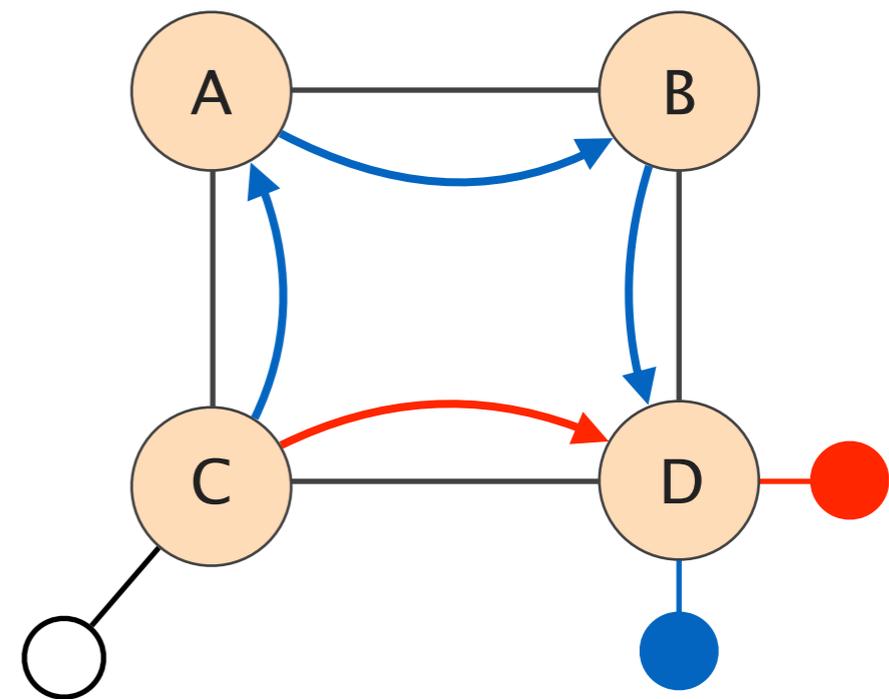


As congestion appears on the (C,D) link,  
operators may want to divert the blue flow to A

initial

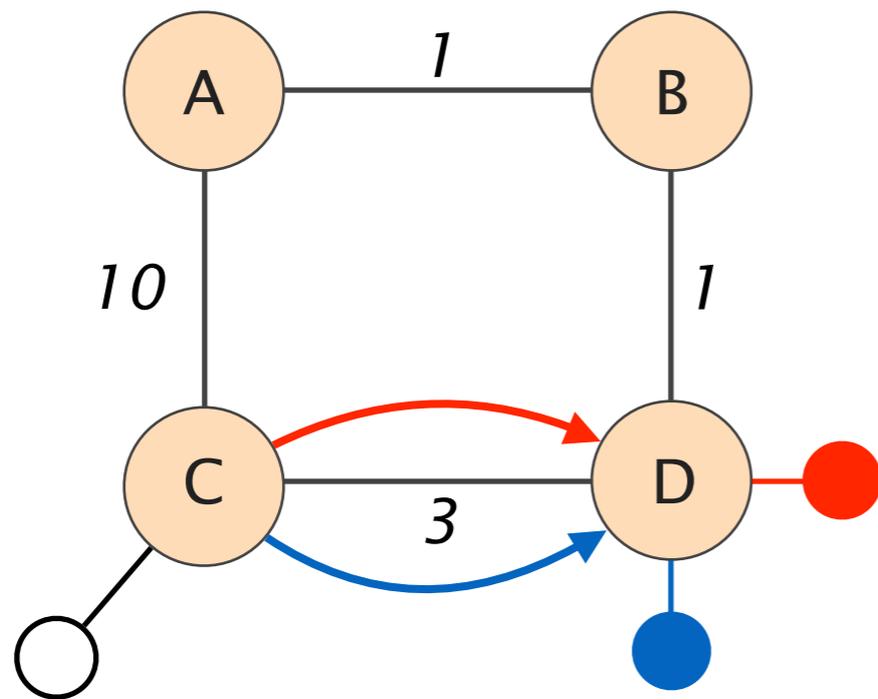


desired

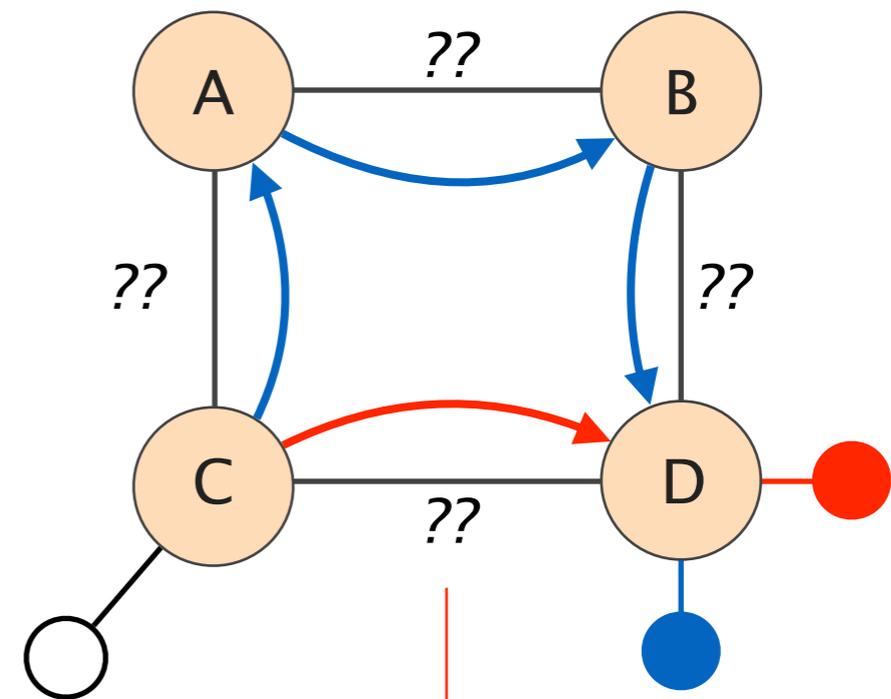


Moving only the orange flow to A is **impossible** with an **IGP** as both destinations are connected to D

initial



desired



*impossible by  
reweighing the IGP links*

Currently, operators have two ways  
to improve flexibility

- virtual circuit based solutions (MPLS)
- SDN based solutions (OpenFlow)

# Both solutions comes at a significant cost

- virtual circuit based solutions (MPLS)

*control- and data-plane overhead*

- SDN based solutions (OpenFlow)

*deployment costs, new challenges of a novel paradigm*

Fibbing achieves flexible routing  
in an existing network, “à la SDN”

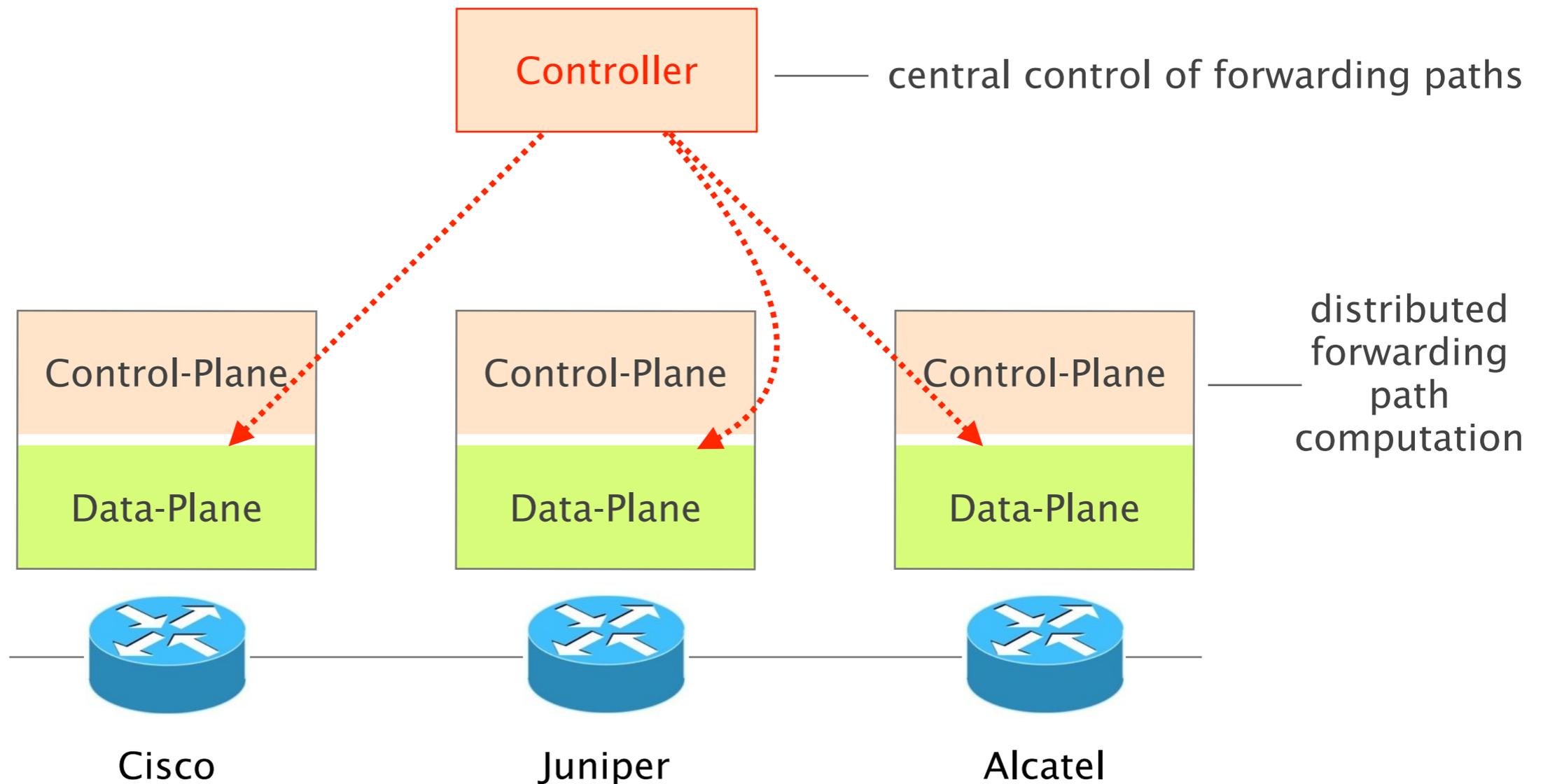
Fibbing achieves flexible routing  
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unmodified routers  
(checked in testbed!)

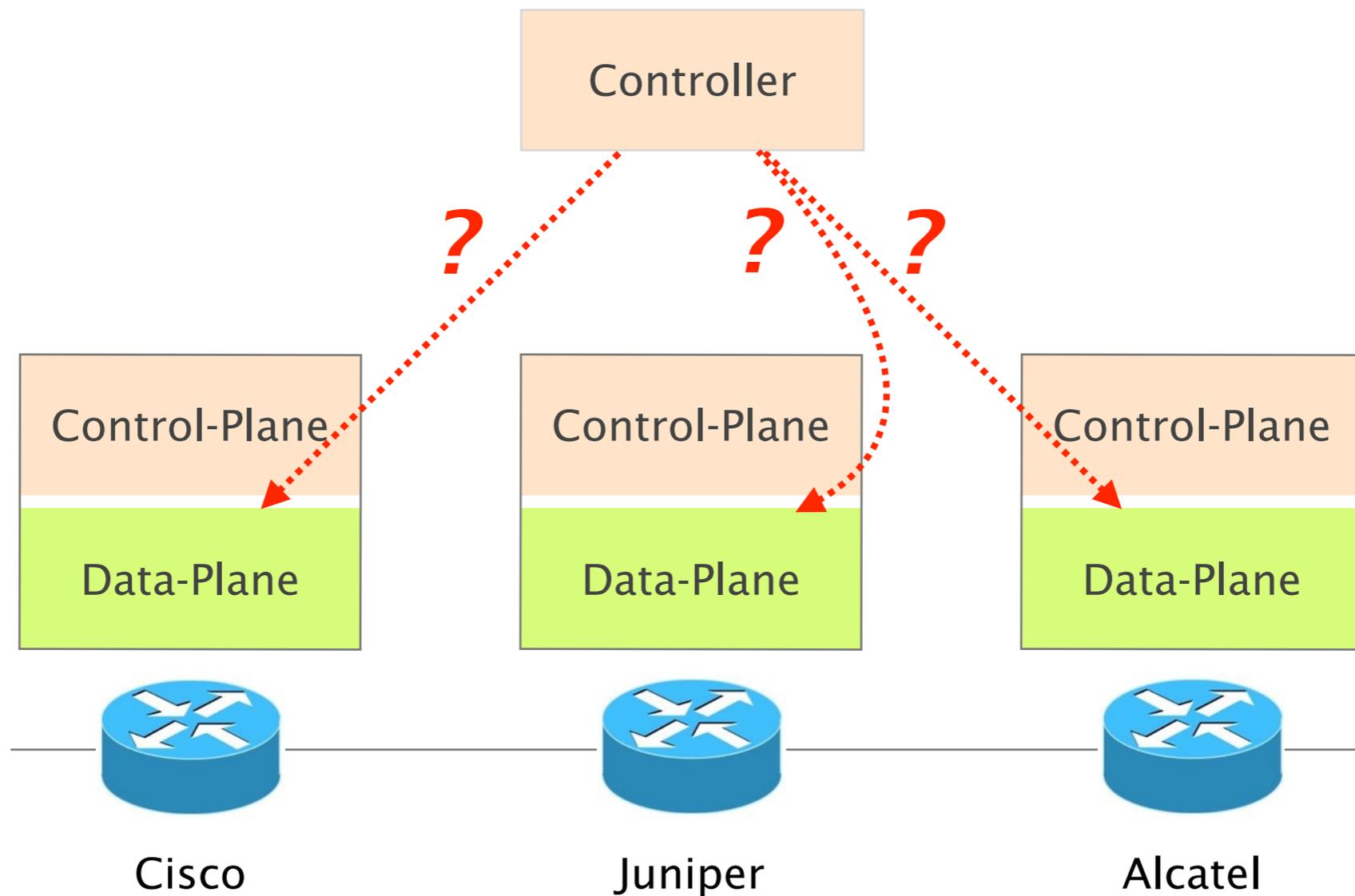
Fibbing achieves flexible routing  
in an existing network, “à la SDN”

what does it mean?

# The Fibbing controller **program** routers! (bypassing proprietary configuration languages)



The controller uses an *API* that *all* routers understand  
(hint: not OpenFlow)



# Link-state IGPs are actually good for something, to control router behavior

- messages are standardized  
all routers must speak the same language
- behaviors are well-defined and understood  
*e.g.*, shortest-path routing
- implementations are robust and widely-deployed  
nearly all networks out there run OSPF or IS-IS

how?



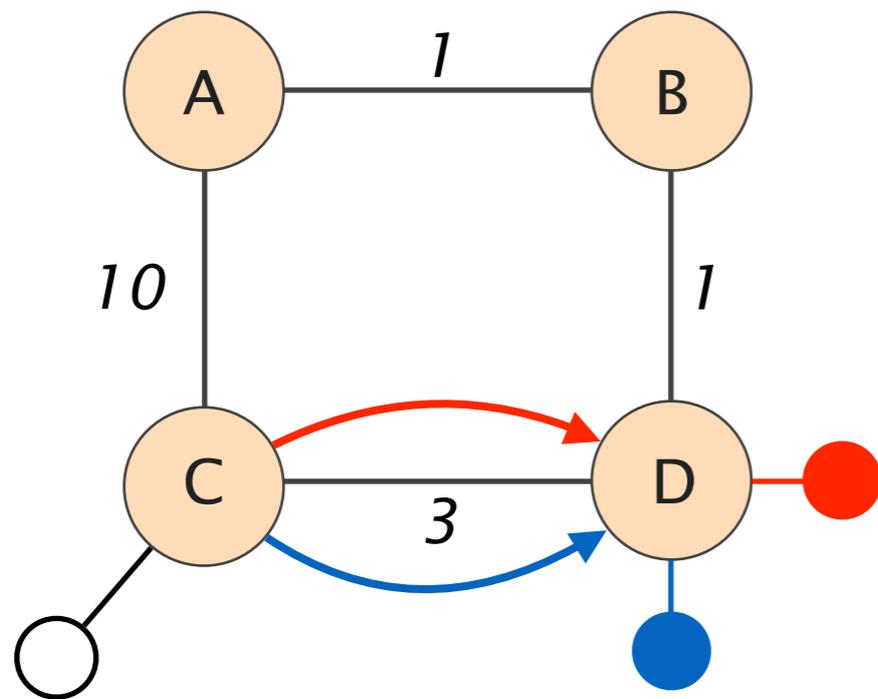
Fibbing achieves **flexible routing**  
in an existing network, “à la SDN”

the controller tricks IGP routers with small lies  
about fake nodes, links and destinations

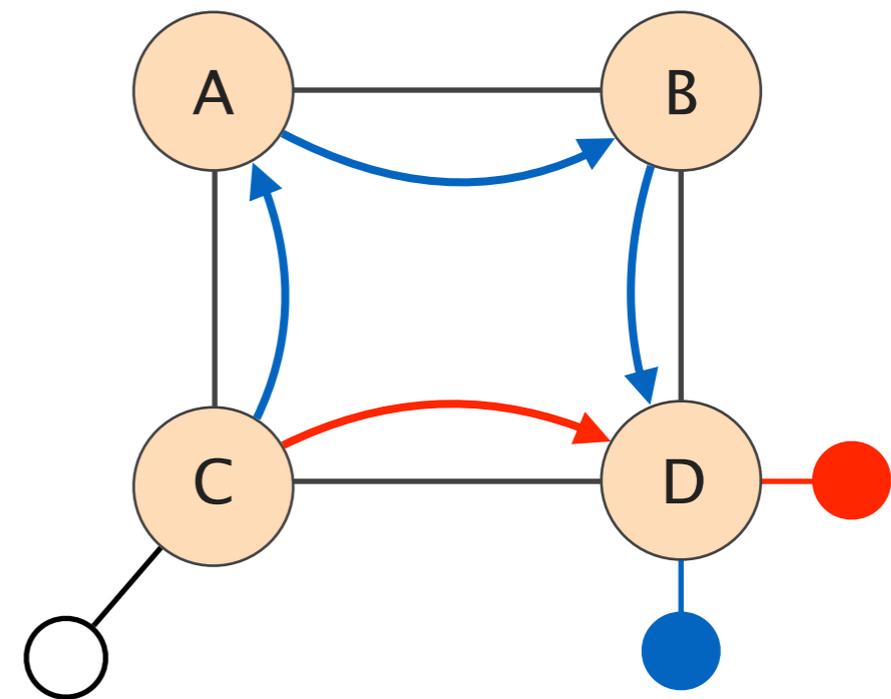
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As congestion appears on the (C,D) link, operators may want to divert the blue flow to A

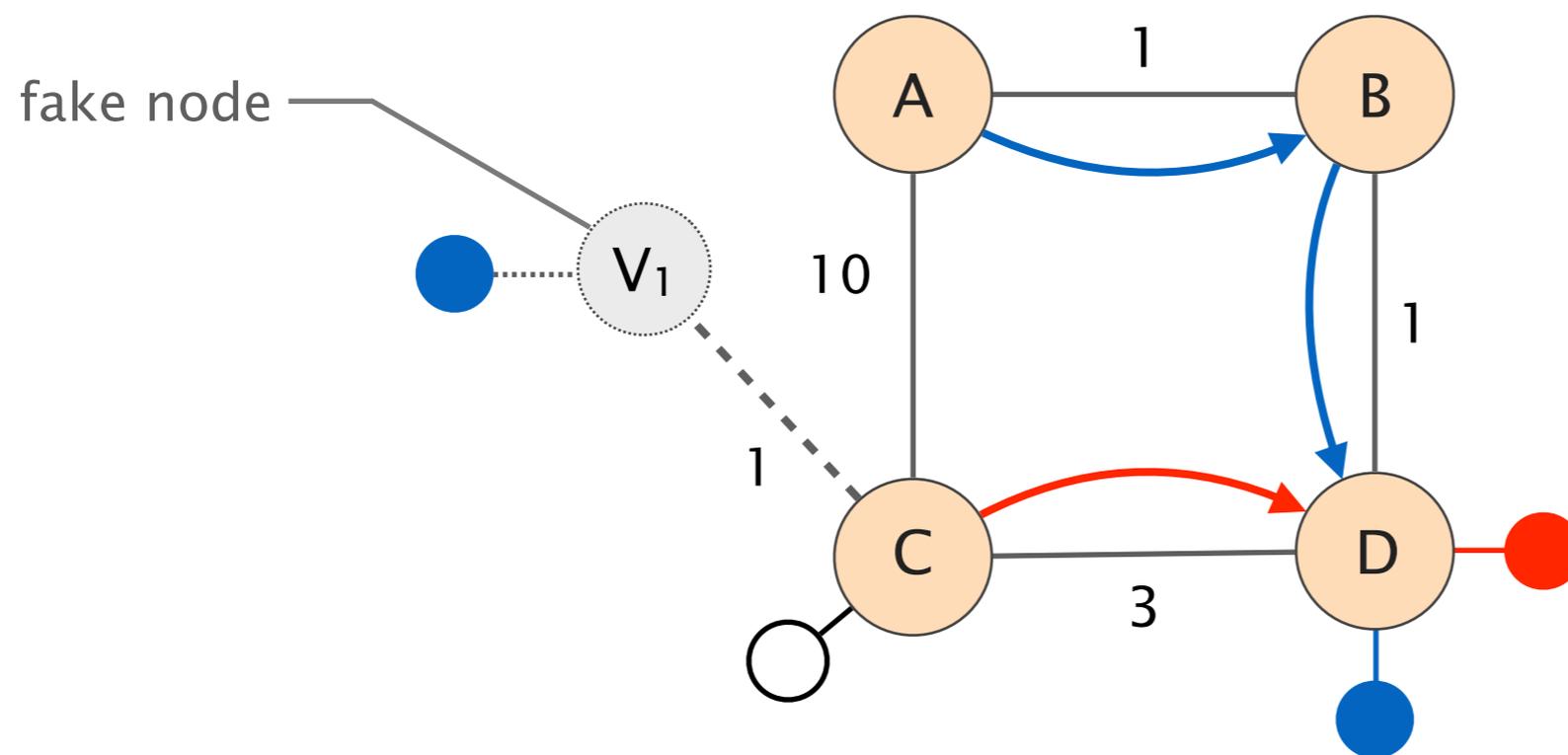
initial



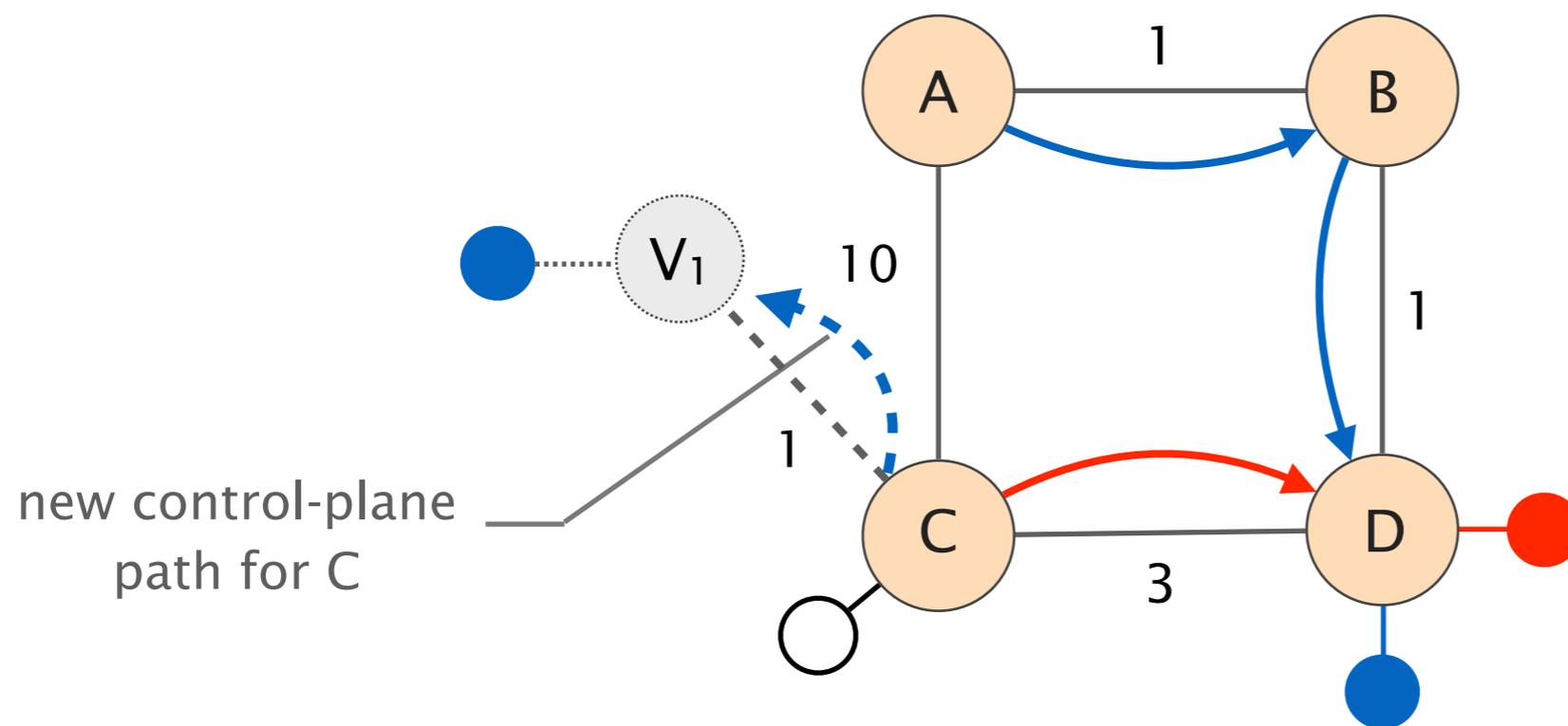
desired



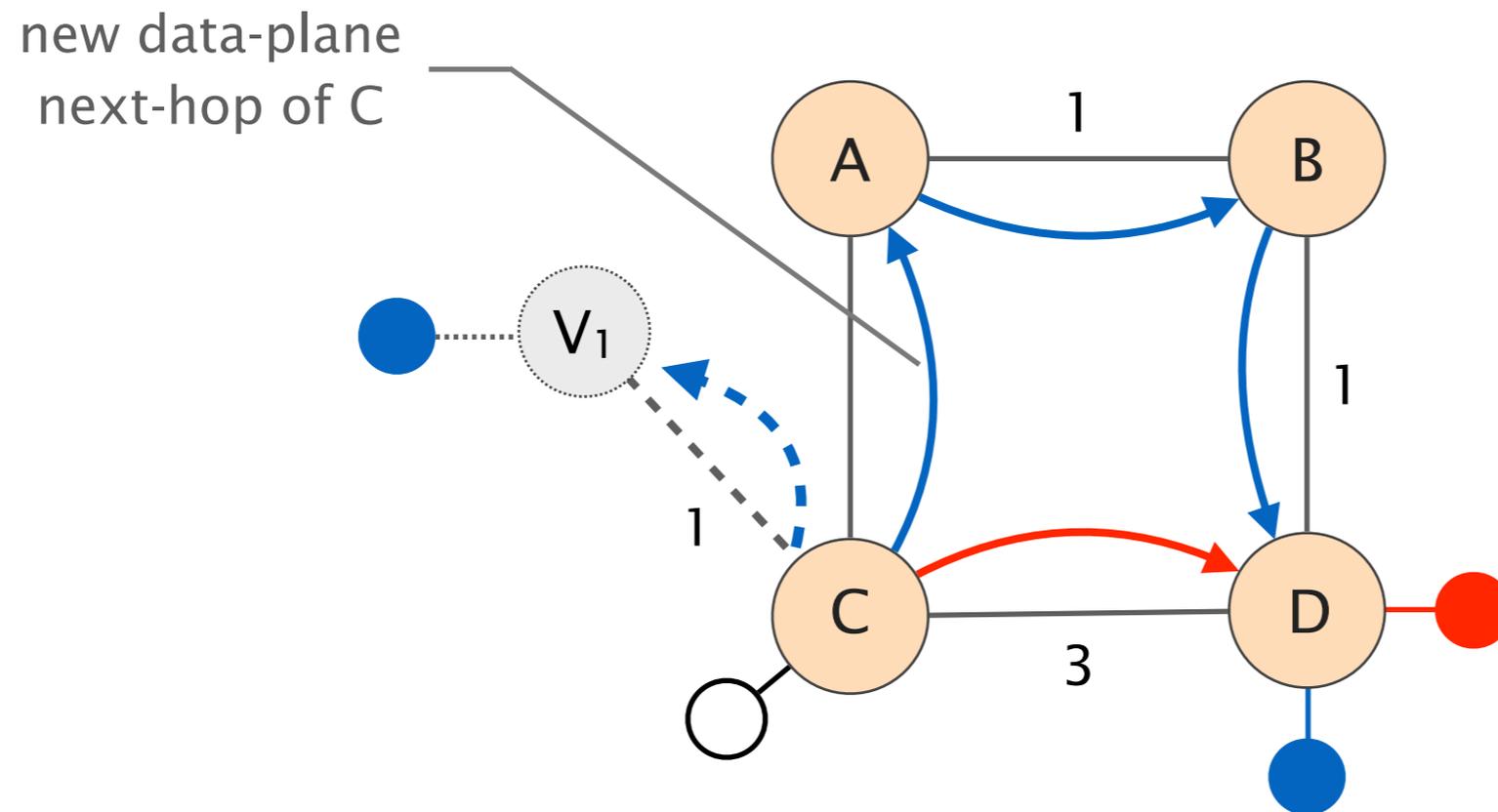
Fibbing can move the orange flow by adding a fake node announcing the blue destination



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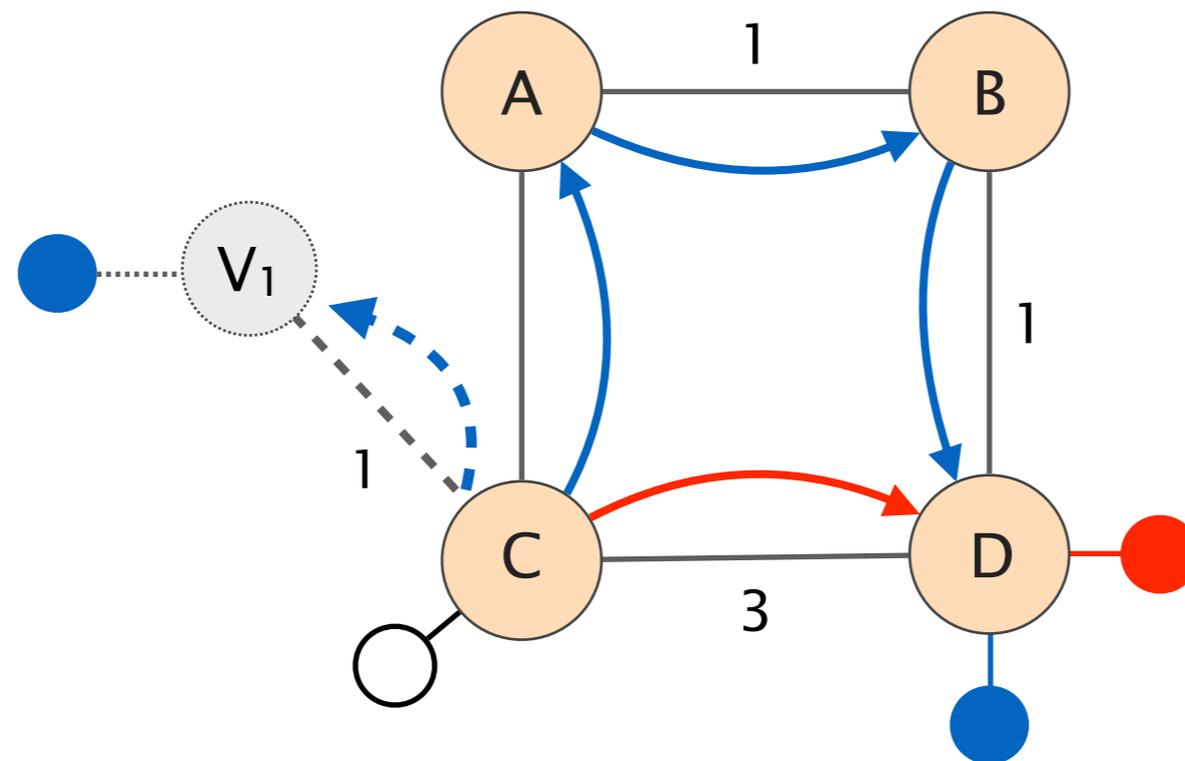


Fibbing can move the orange flow by adding a fake node announcing the blue destination



Fibbing works today!

(tested with off-the-shelf Cisco routers)



Is Fibbing expressive?

Does Fibbing scale?

Is Fibbing expressive?

**Yes!**

Does Fibbing scale?

# Fibbing is expressive

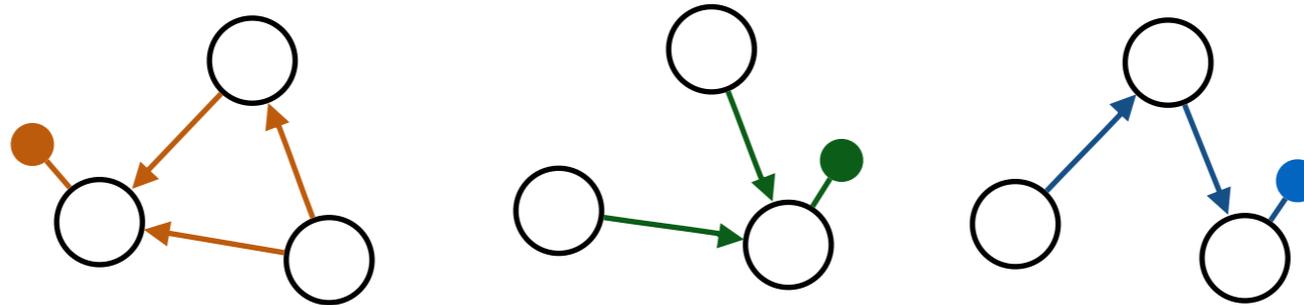
Theorem            Any set of forwarding DAGs can be enforced by Fibbing

# Fibbing is expressive

Theorem

Any set of forwarding DAGs can be enforced by Fibbing

paths to the same destination do not create loops



# Fibbing enables high flexibility

## Theorem

Any set of forwarding DAGs can be enforced by Fibbing

- fine-grained traffic steering to middleboxes
- per-destination load balancing for traffic engineering
- backup paths provisioning

Is Fibbing expressive?

Does Fibbing scale?

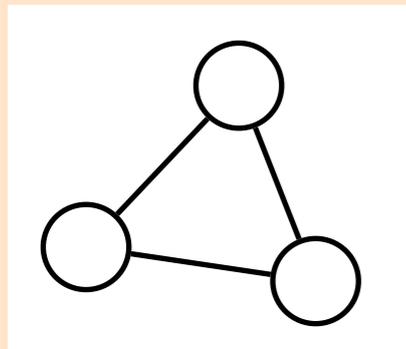
**Yes!**

# Fibbing can scale and quickly react to failures

- computing augmented topologies of limited size  
we have an ILP to strategically place fake nodes
- pre-computing response to failures  
to quickly repair augmented topologies
- applying quickly failure responses  
relying on the effectiveness of IGP for failure reaction

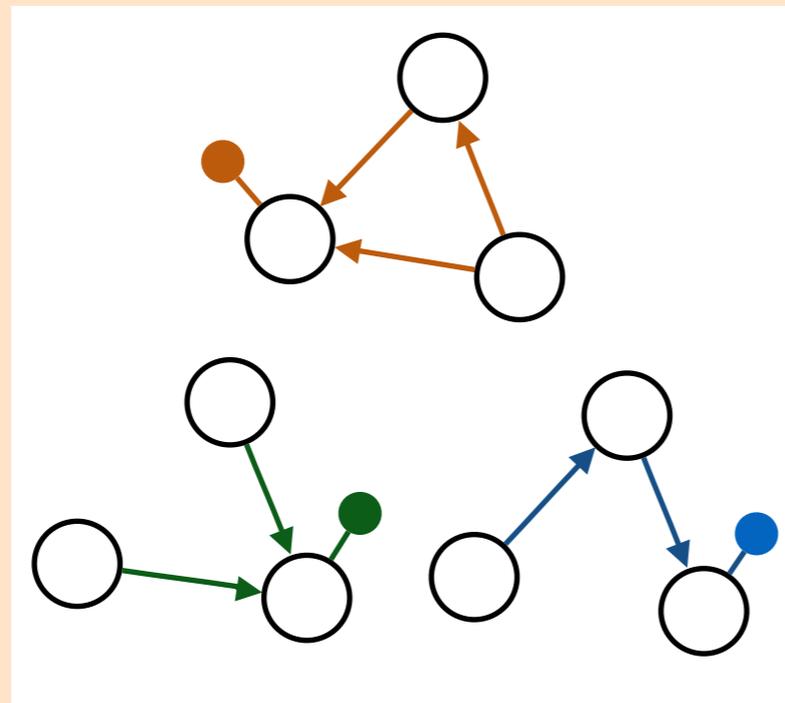
Given a physical topology and a set of path requirements, a linear program computes an optimized virtual topology

physical topology



+

forwarding DAGs



⇒

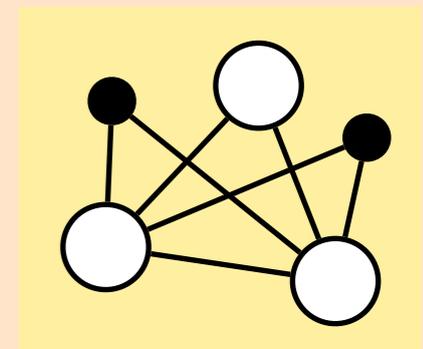
Integer  
Linear Program

Optimizer

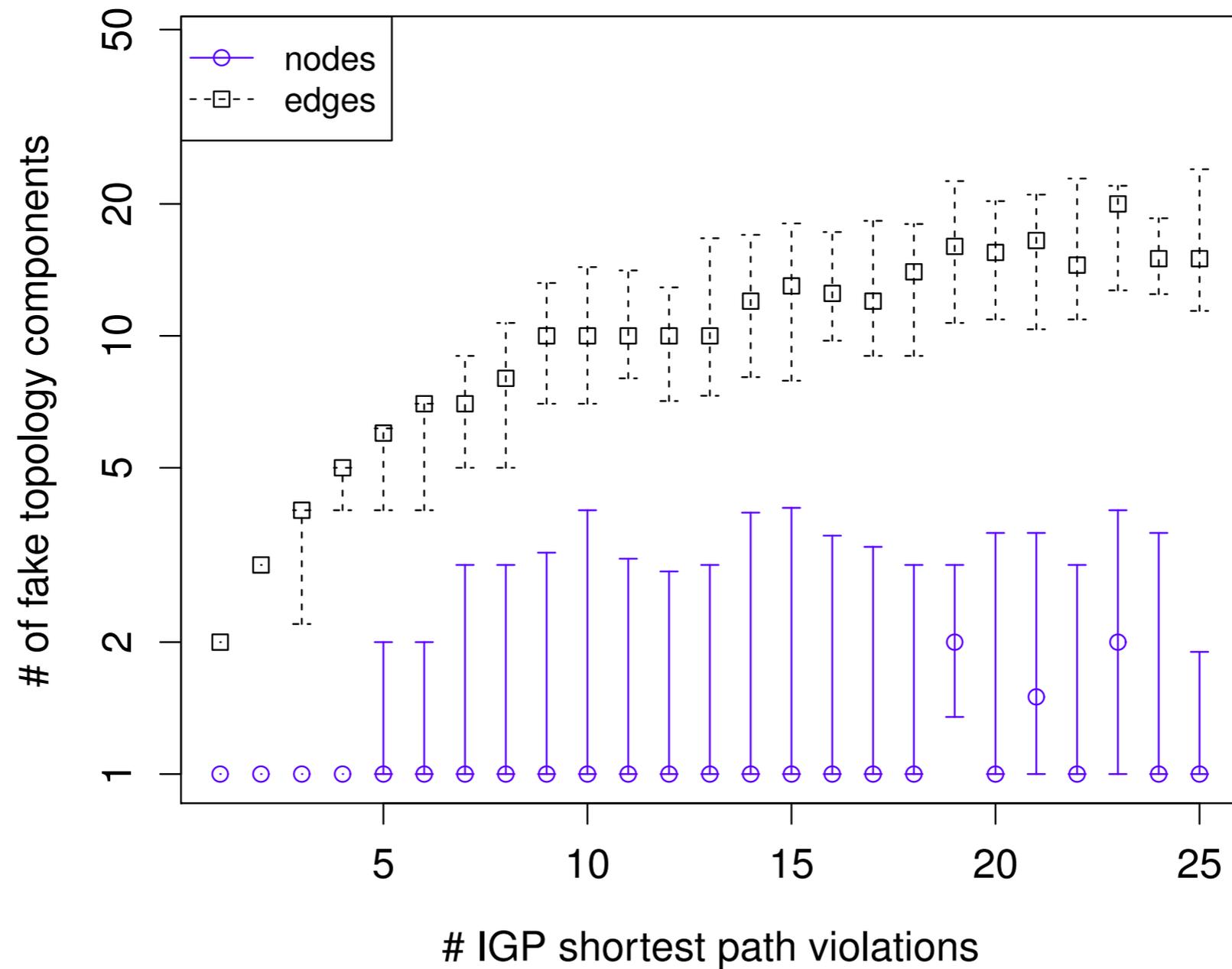
⇒

minimize topology size

augmented  
topology



# Few lies can realize multiple shortest-path deviations (preliminary evaluation on Rocketfuel)



# Fibbing enables flexible routing à la SDN, today!

## Reduce controller concerns

most of the heavy work is still done by the routers

## Maintains operators' mental model

good old protocols running, easier troubleshooting

## Facilitates SDN deployment

unified interface to routers *and* SDN switches

# Sweet Little Lies: Fake Topologies for Flexible Routing



*Tell me lies, tell me sweet little lies*  
— Fleetwood Mac

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