

Sweet Little Lies: Fake Topologies for Flexible Routing



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HotNets

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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

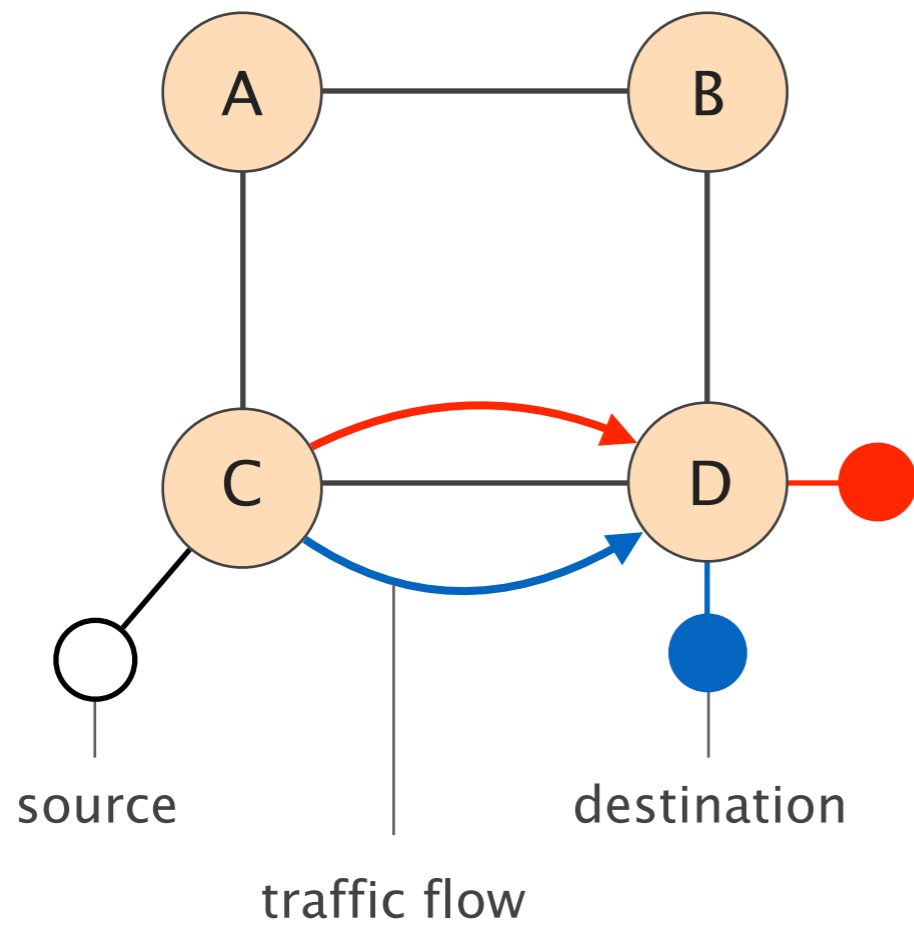
Fibbing



Operators need flexibility for intra-domain routing

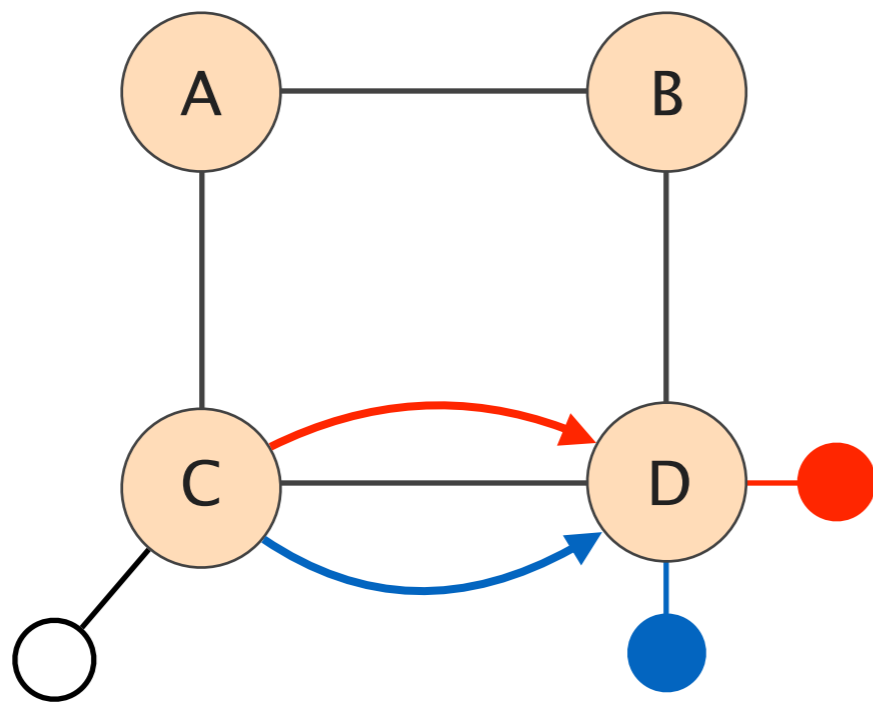
- fine-grained traffic engineering
optimize the available resources
- provision backup paths
quickly and predictably react to failures
- deploy advanced services
e.g., steer traffic through middleboxes

Consider this network where
a source sends traffic to 2 destinations

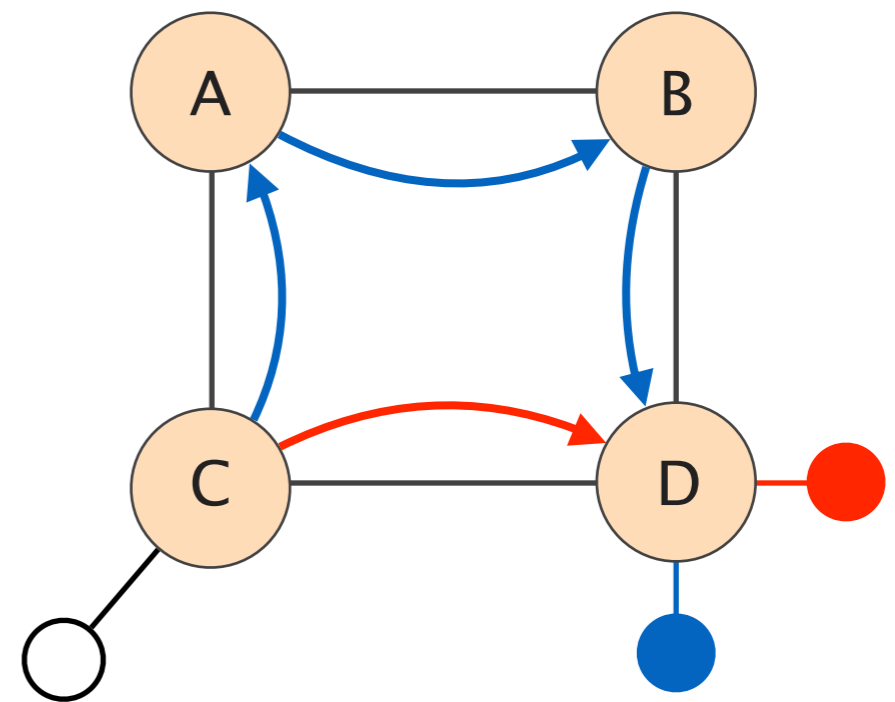


As congestion appears on the (C,D) link,
operators may want to divert the blue flow to A

initial

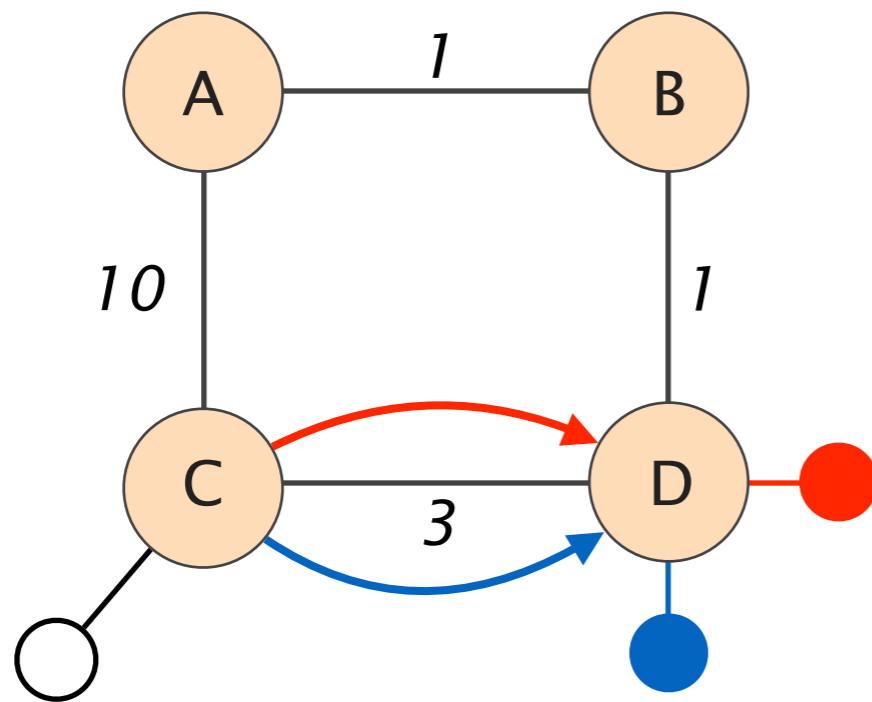


desired

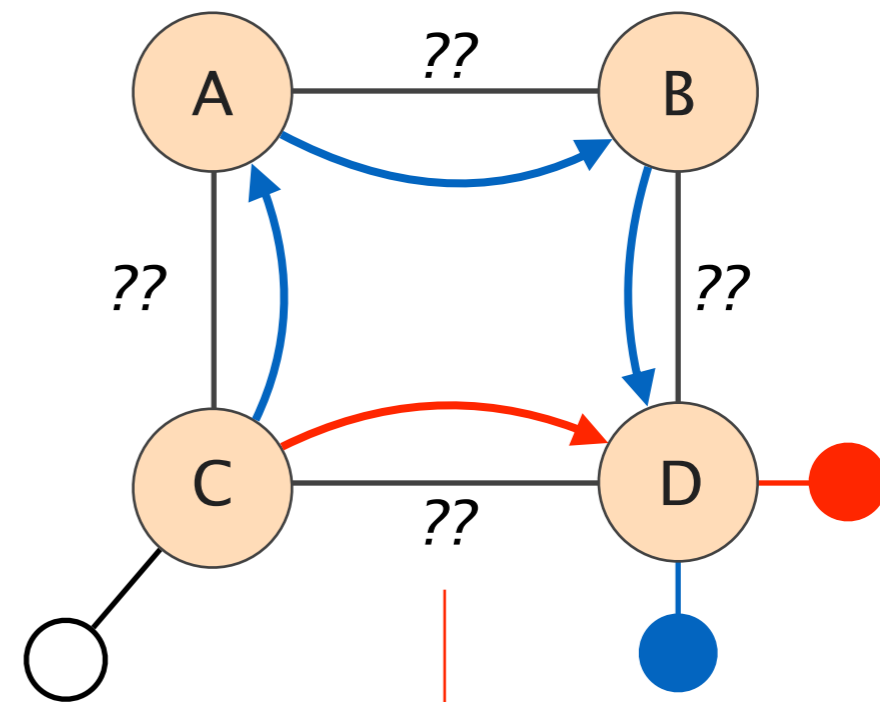


Moving only the orange flow to A is **impossible** with an **IGP** as both destinations are connected to D

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”

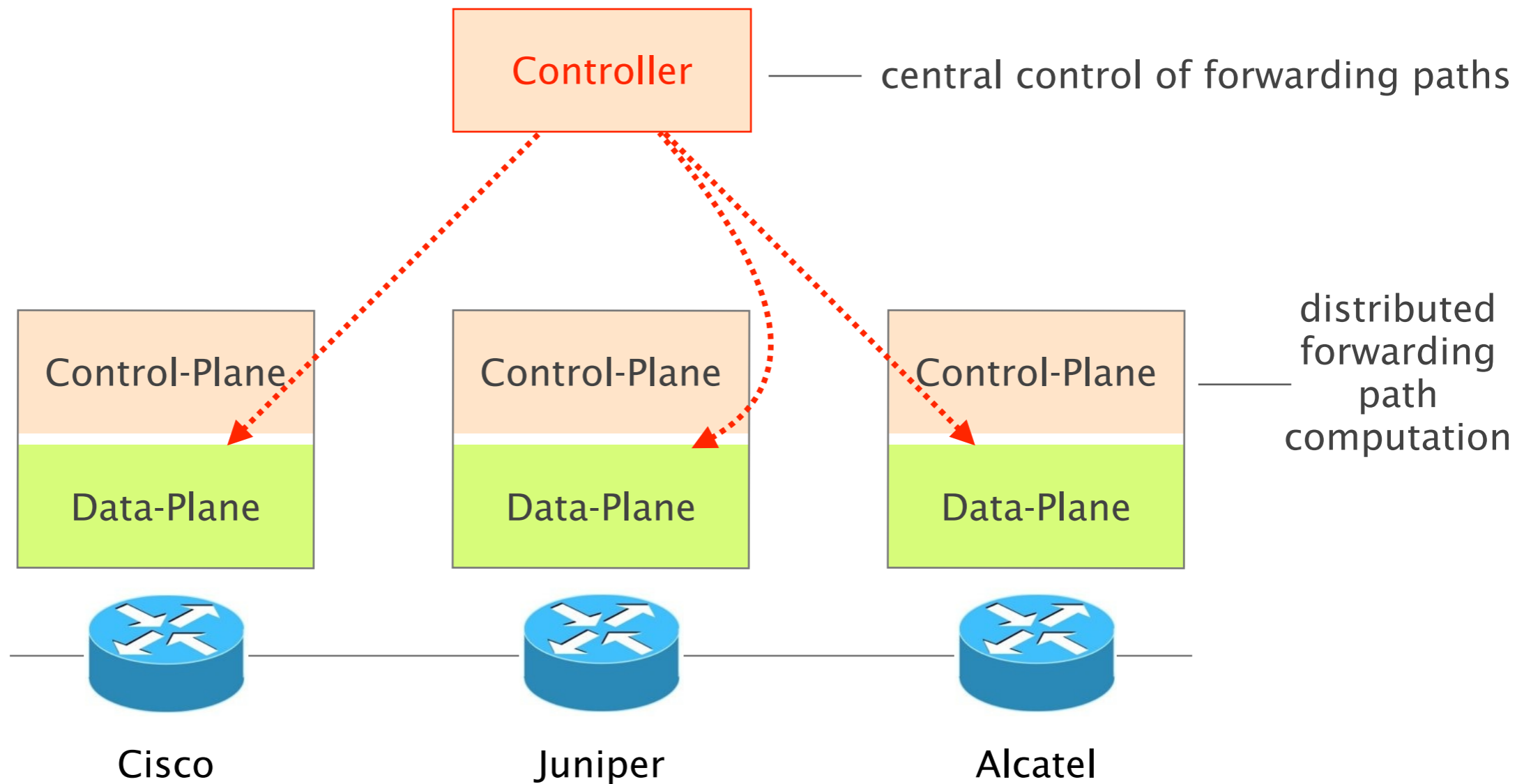
Fibbing achieves flexible routing
in an existing network, “à la SDN”

unmodified routers
(checked in testbed!)

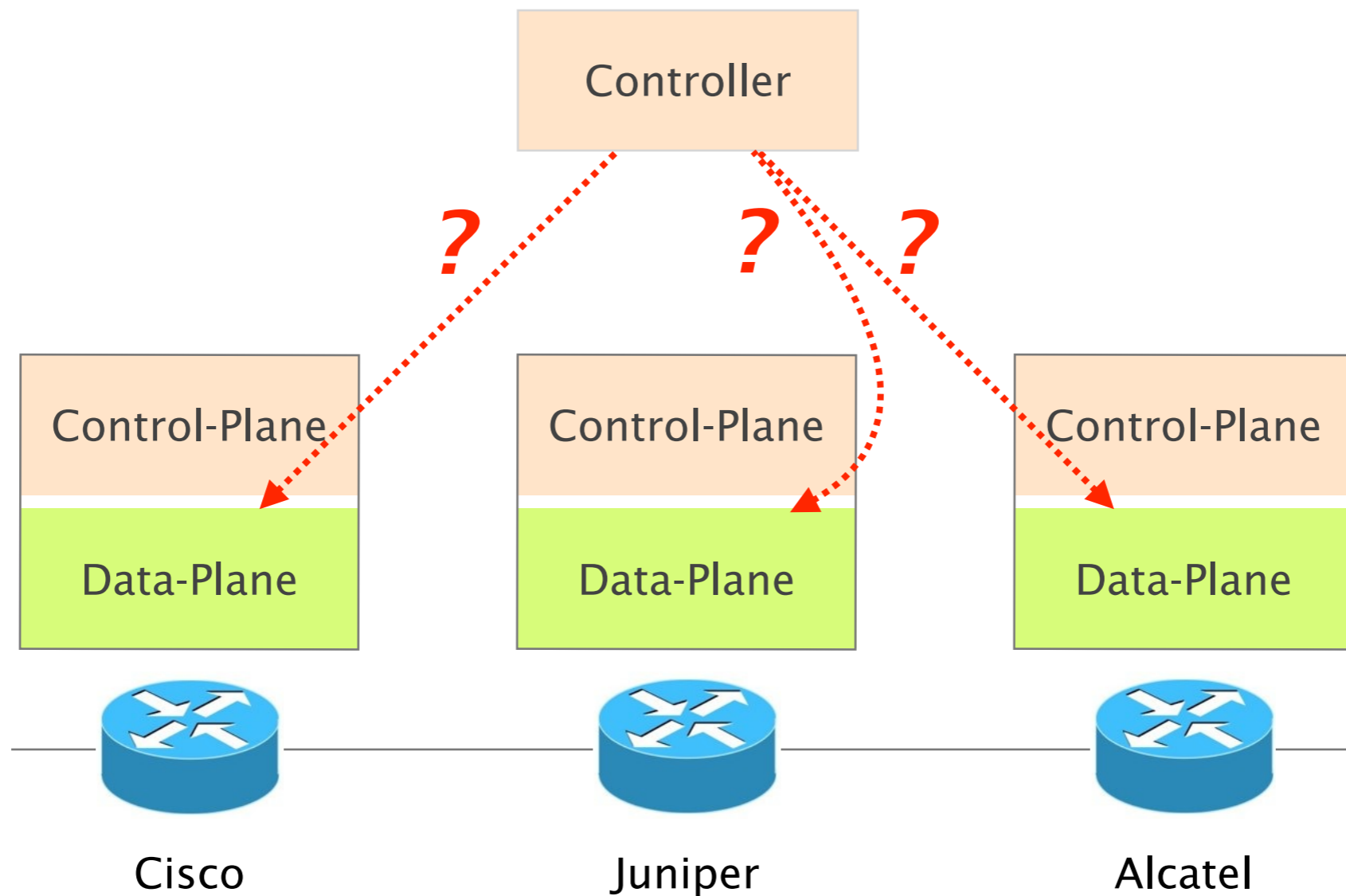
Fibbing achieves flexible routing
in an existing network, “à la SDN”

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?



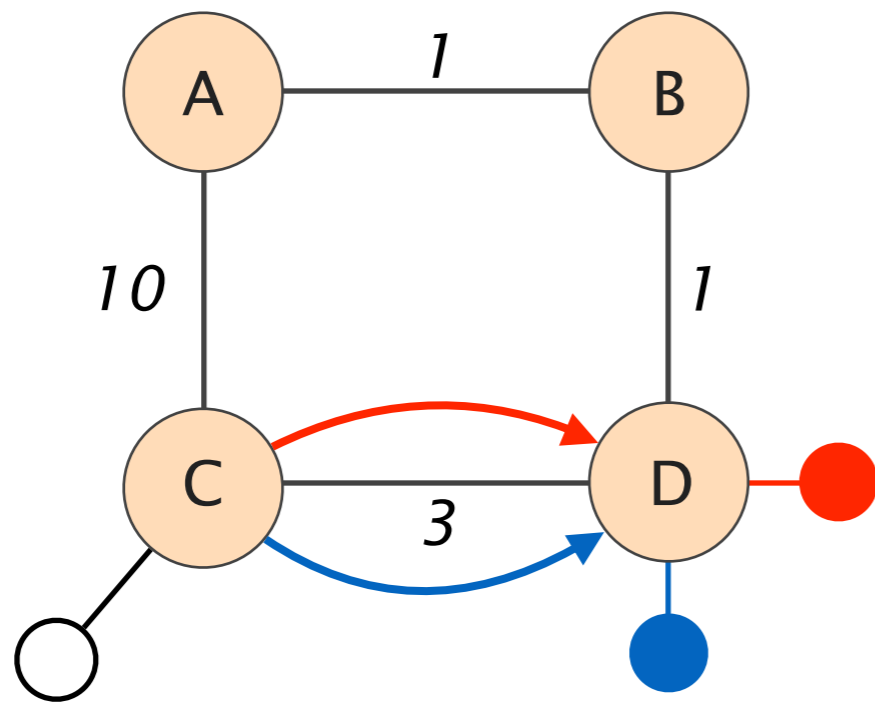
Fibbing achieves **flexible routing**
in an existing network, “à la SDN”

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

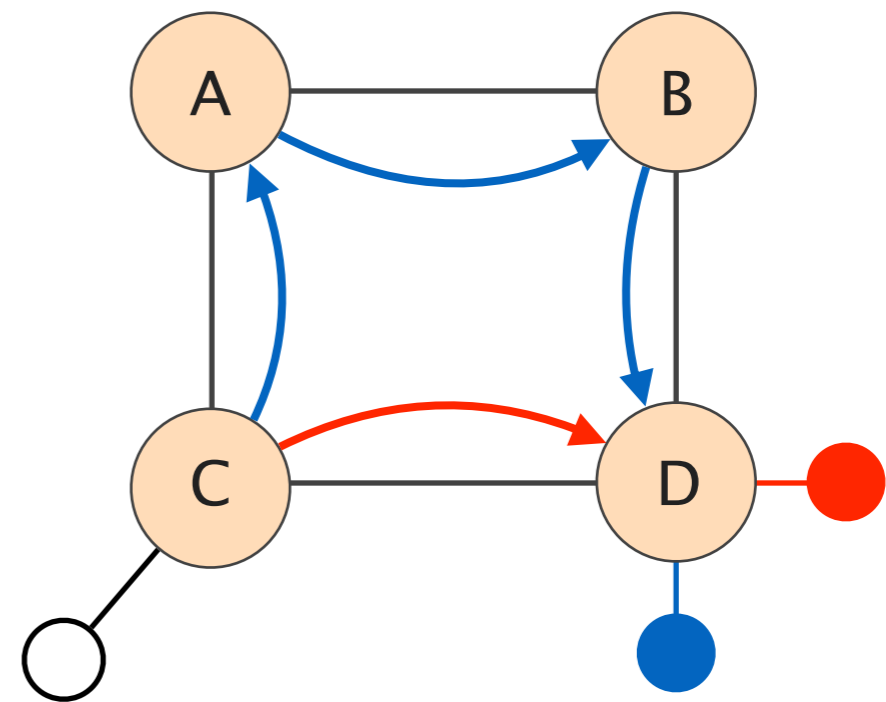
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As congestion appears on the (C,D) link, operators may want to divert the blue flow to A

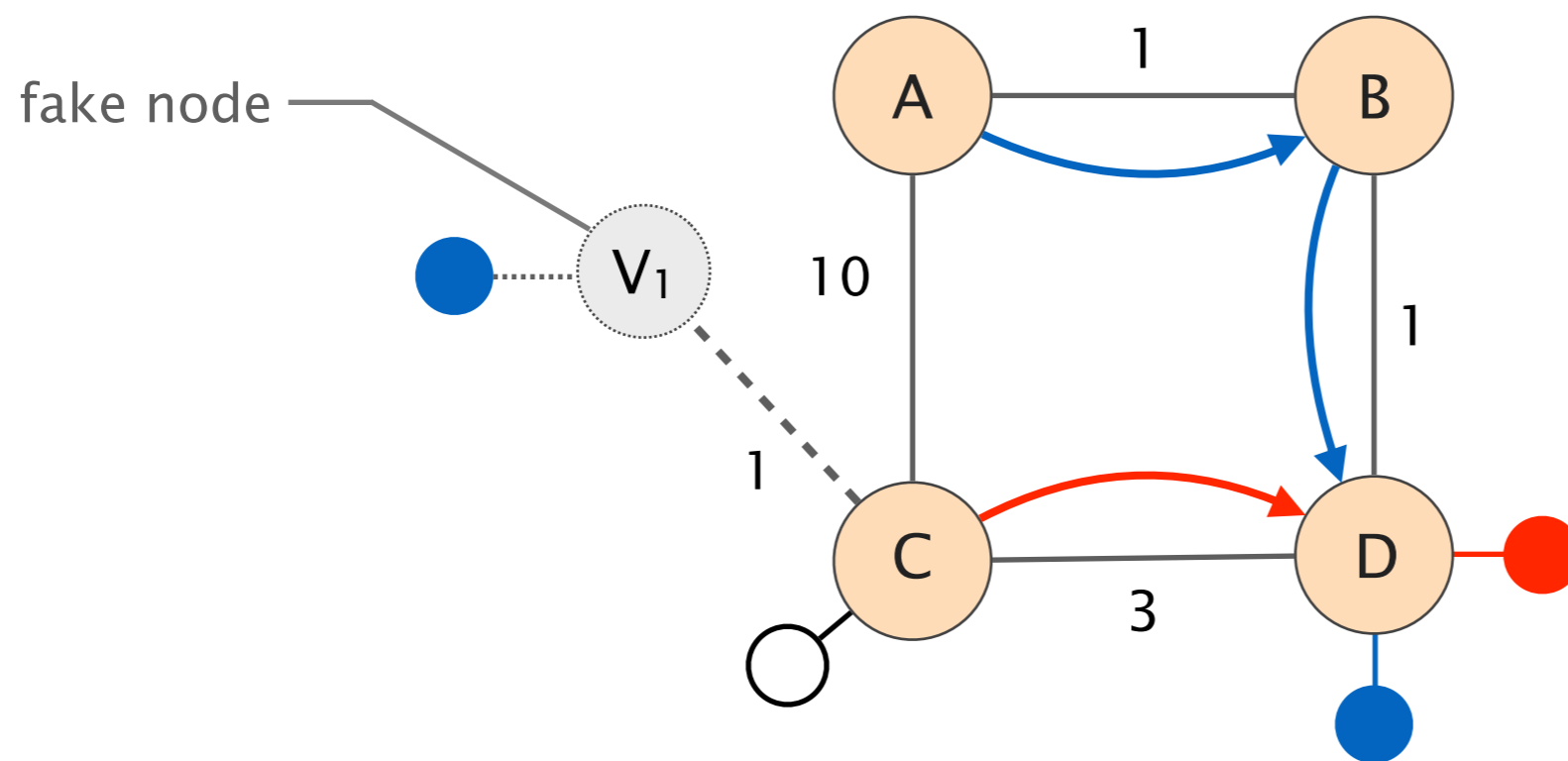
initial



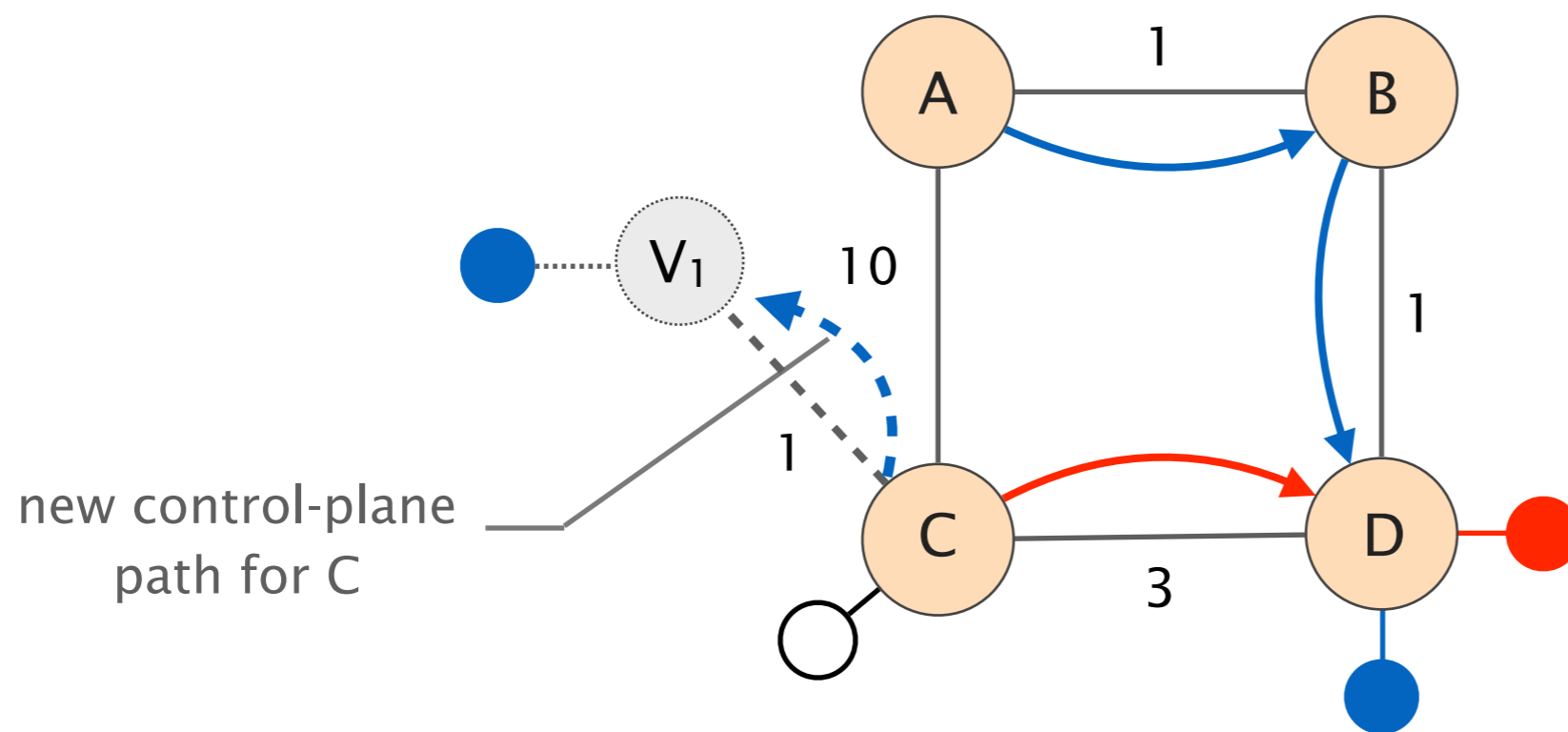
desired



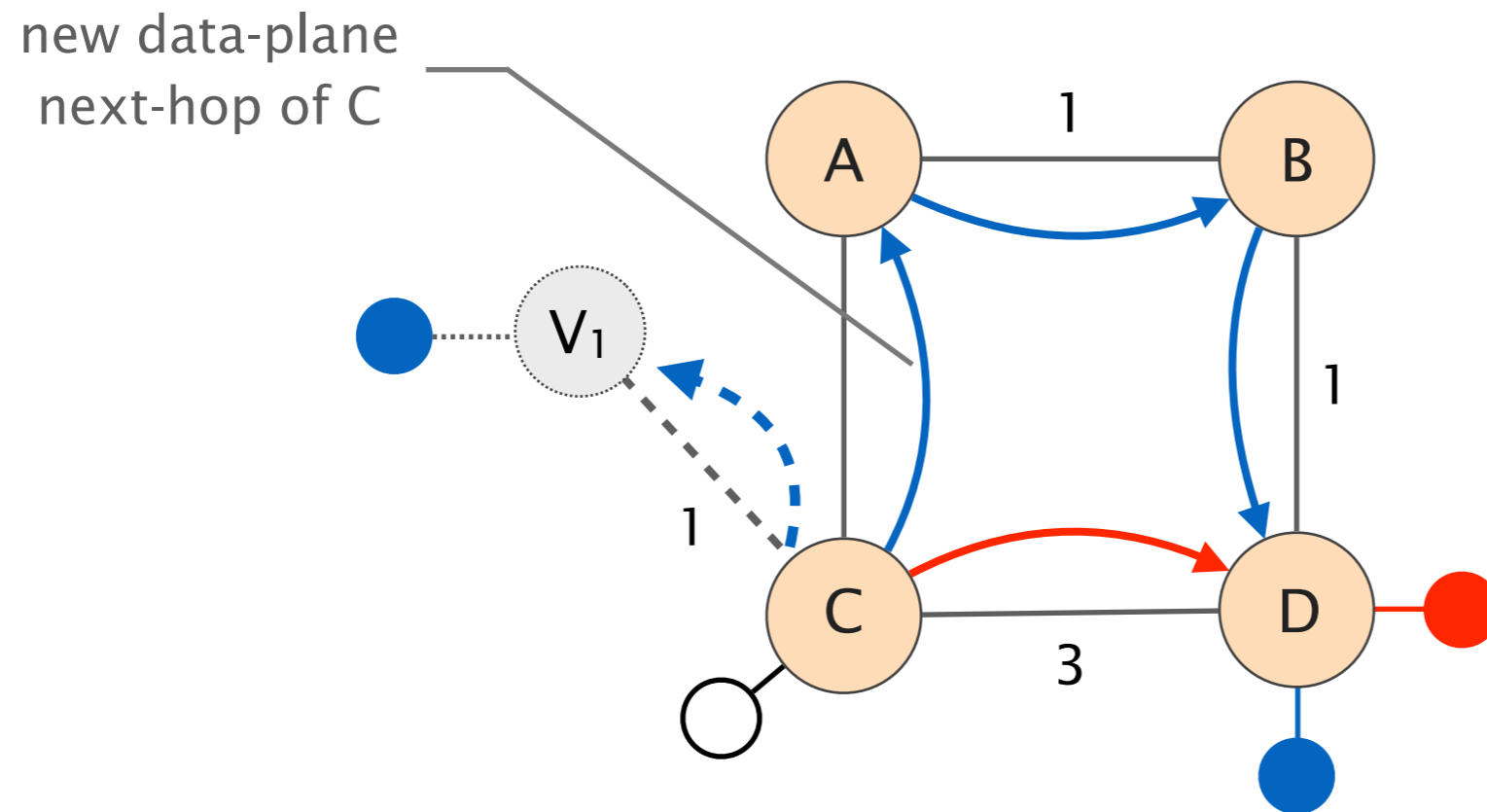
Fibbing can move the orange flow by adding a fake node announcing the blue destination



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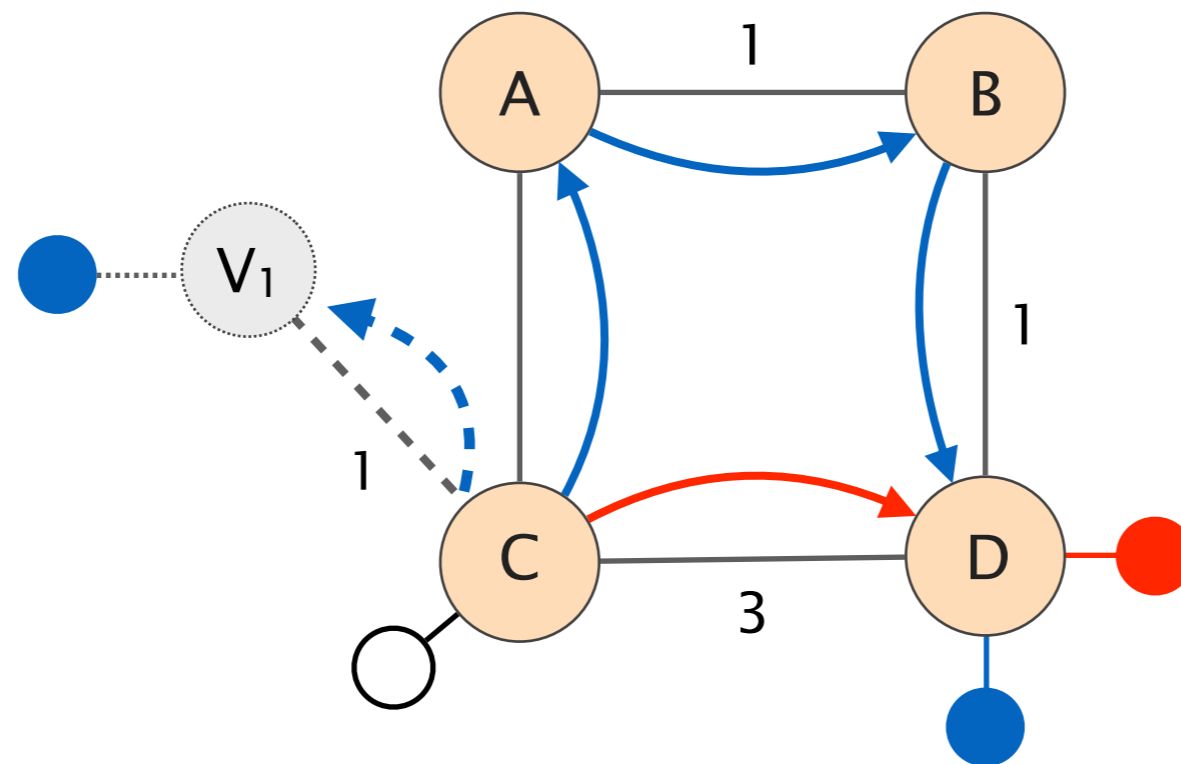


Fibbing can move the orange flow by adding a fake node announcing the blue destination



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

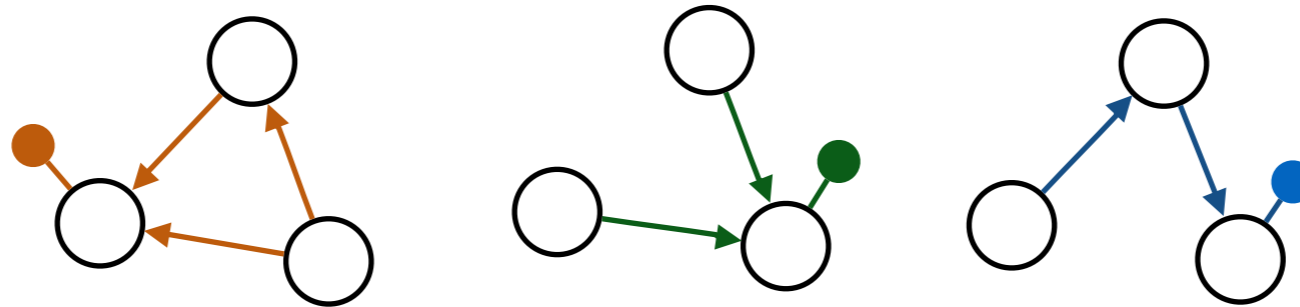
Theorem Any set of forwarding DAGs can be enforced by Fibbing

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?

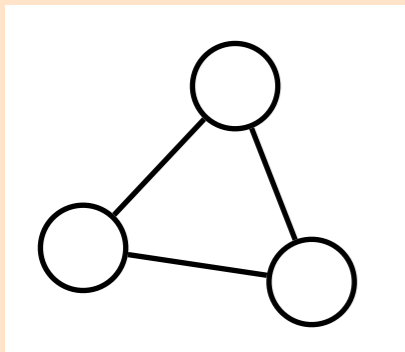
Yes!

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

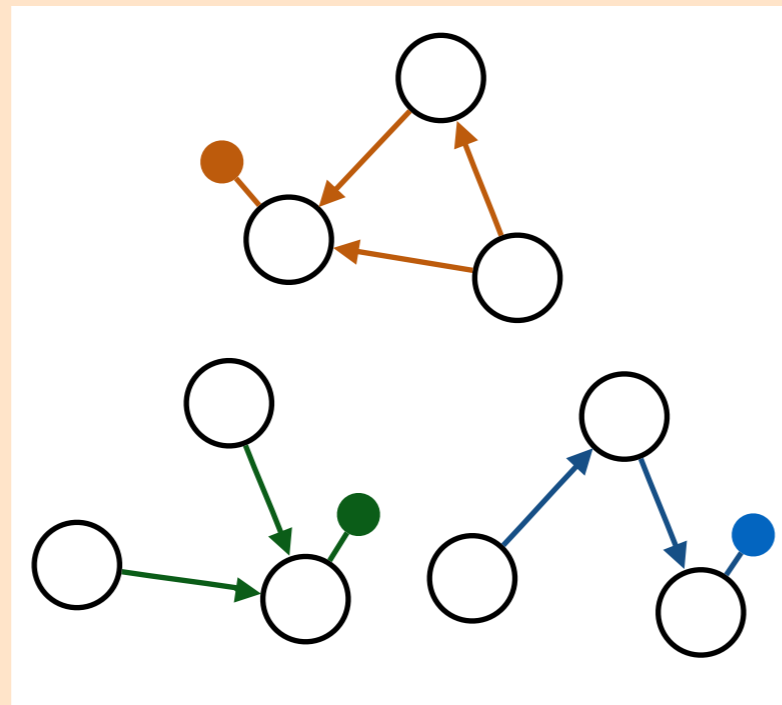
Given a physical topology and a set of path requirements, a linear program computes an optimized virtual topology

physical topology



+

forwarding DAGs



⇒

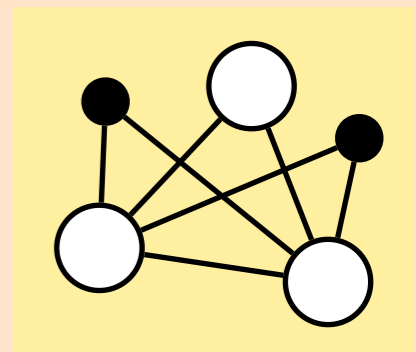
Integer
Linear Program

Optimizer

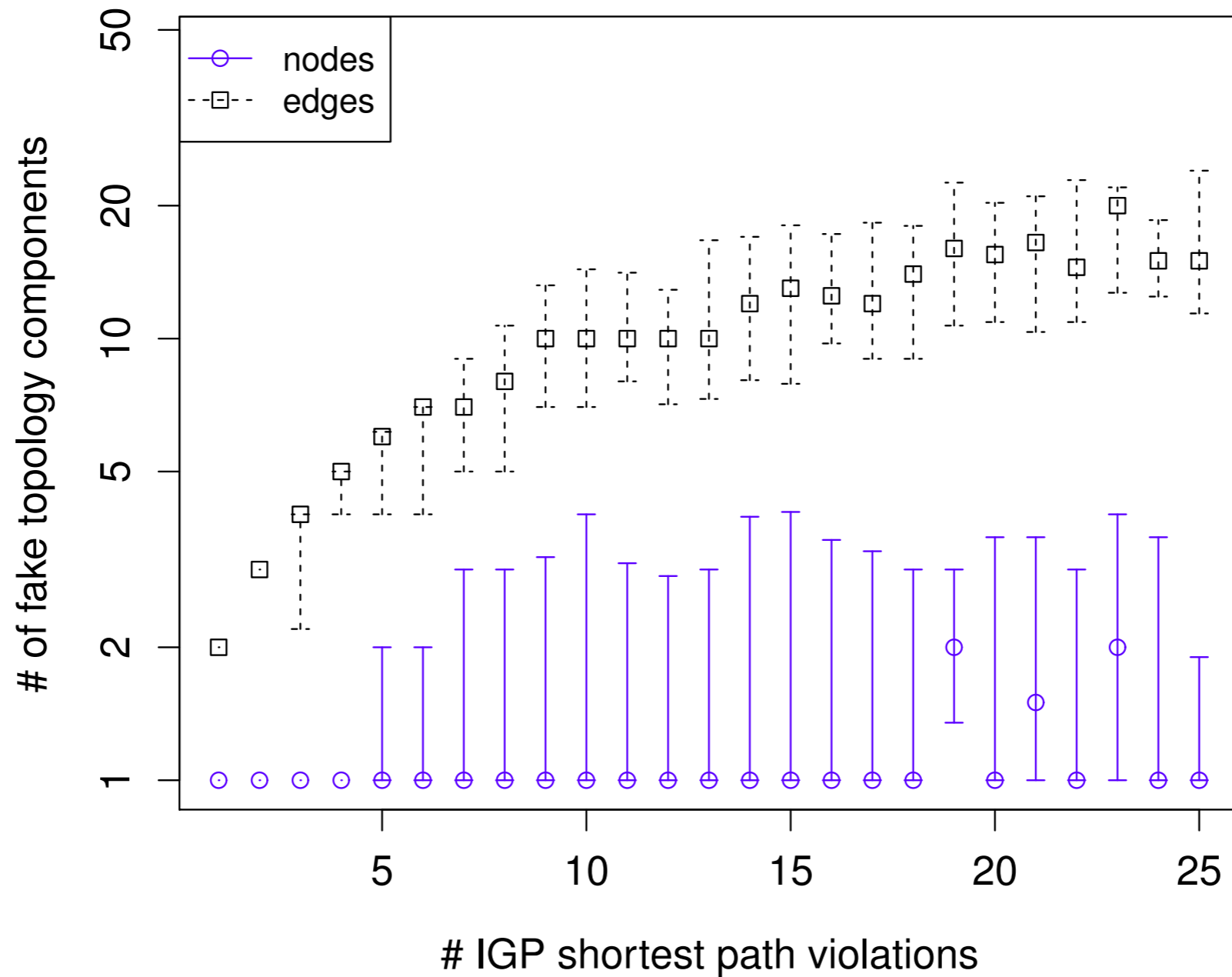
⇒

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

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

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