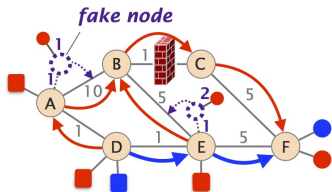# Fibbing: Central Control over Distributed Routing

www.fibbing.net

Olivier Tilmans
UCLouvain

Routing Area Open Meeting
Nov. 15, 2016

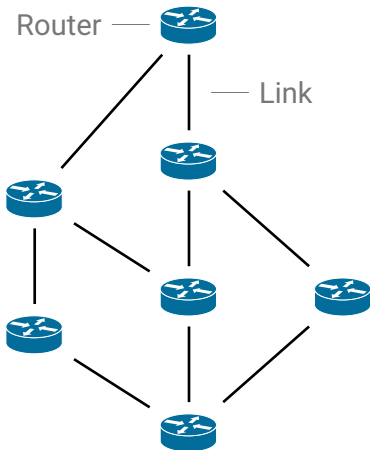Joint work with
S. Vissicchio (UCL), L. Vanbever (ETH Zürich) and J. Rexford (Princeton)
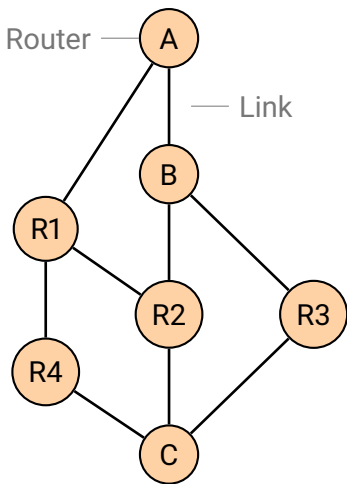
Fibbing
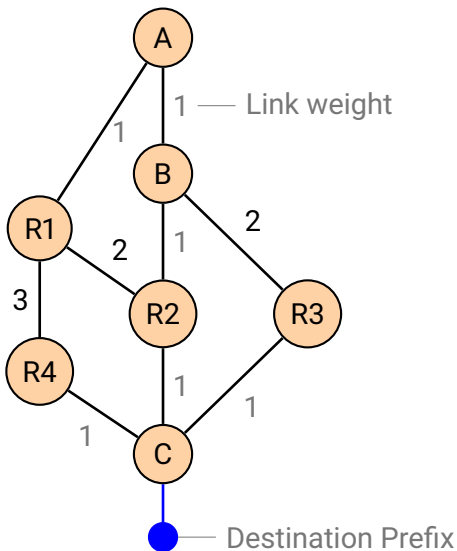
Fibbing

Control routers' FIB, lying to routers

Consider this example network.

Router — Link

Consider this example network.

Router — A

— Link
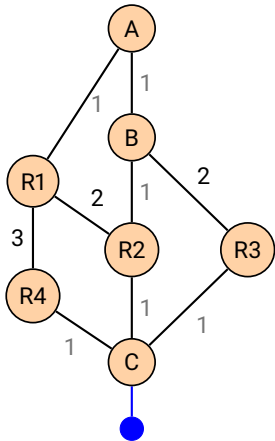
B

R1

R2   R3

R4

C

3

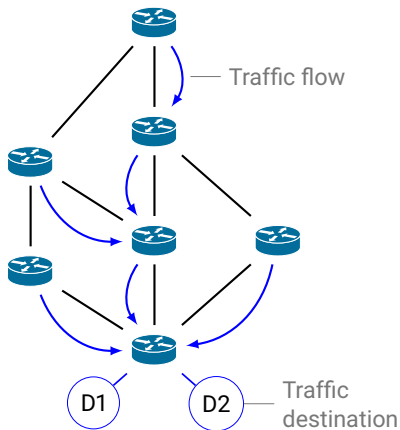**Link-state Interior Gateway Protocols (IGPs) exchange reachability information to infer the topology of the network.**

4

The intra-domain traffic flows along the shortest path on the shared topology.

Control-Plane

Data-Plane

Traffic flow

Traffic destination
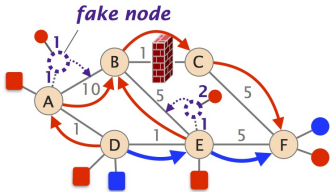
IGPs cause operators to follow a **descriptive** management process.

Fibbing: Central Control over Distributed Routing

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fake node

1. Controlling distributed protocols

2. Fibbing today's networks

3. Case study: On-demand load-balancing

4. Takeaways

Fibbing enables declarative management.

■ Centralizes high level routing decisions.
Operators describe their requirements to a controller.

■ Keeps the route installation distributed.
Each router independently computes its FIB.

■ Leverages the IGP messages as API.
We study *which* message to send.

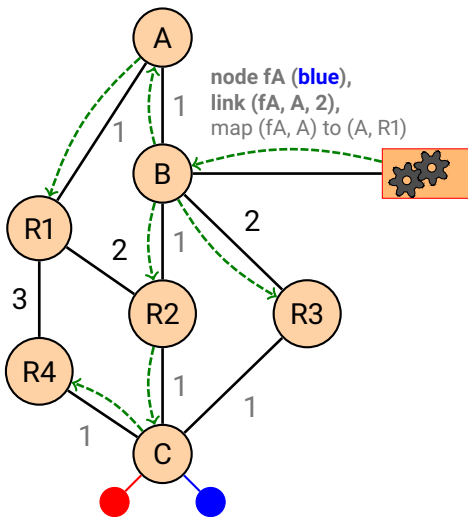# Operators specify paths that must be enforced.

requirements
(A, R1, R2, C, blue)

Fibbing
controller
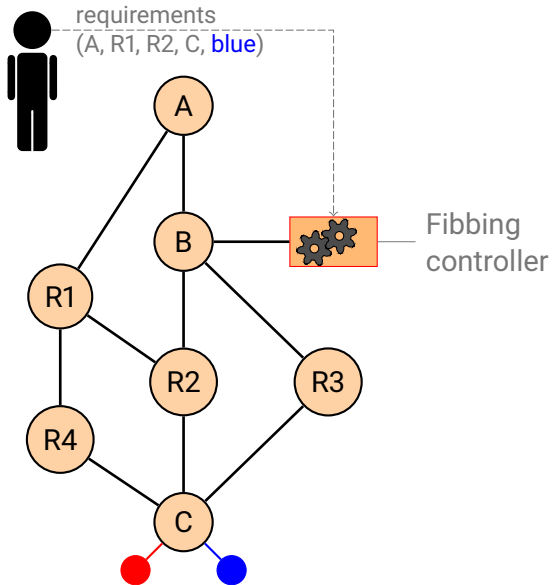
The controller injects one IGP message adding *a fake node and links*.

requirements
(A, R1, R2, C, blue)

node fA (**blue**),
link (fA, A, 2),
map (fA, A) to (A, R1)

IGP adjacency
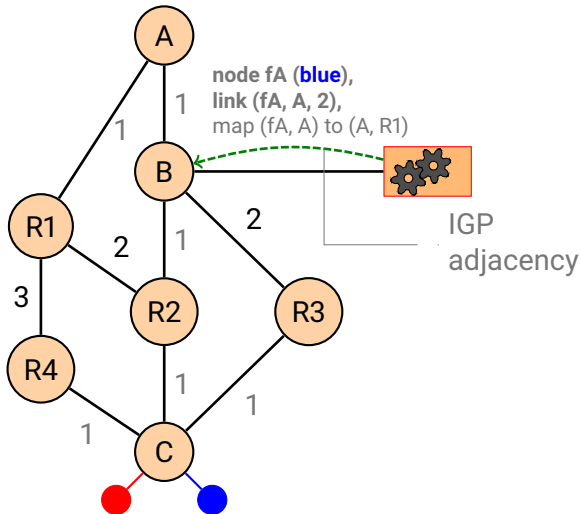
IGP flooding propagates the information.

requirements
(A, R1, R2, C, blue)

node fA (blue),
link (fA, A, 2),
map (fA, A) to (A, R1)

The Fibbing message *augments* the topology.

requirements
(A, R1, R2, C, blue)

node fA (**blue**),
link (fA, A, 2),
map (fA, A) to (A, R1)
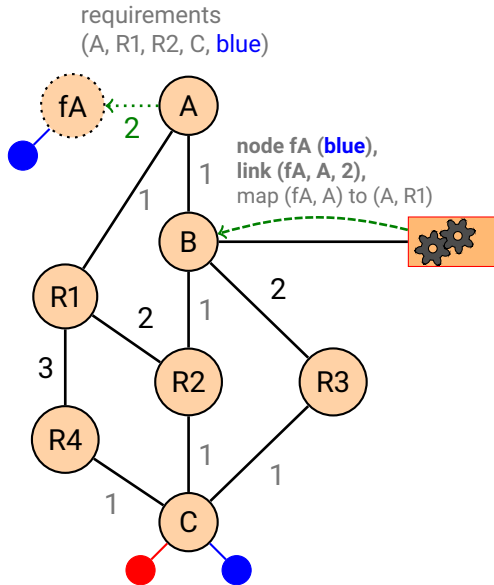
Augmented topologies translate into new control-plane paths.

requirements
(A, R1, R2, C, blue)

node fA (blue),
link (fA, A, 2),
map (fA, A) to (A, R1)

Augmented topologies translate into new data-plane paths.
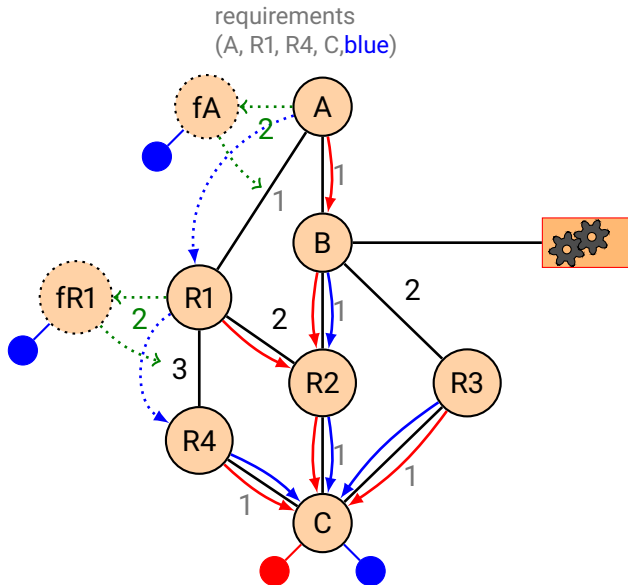
Control-Plane

Data-Plane
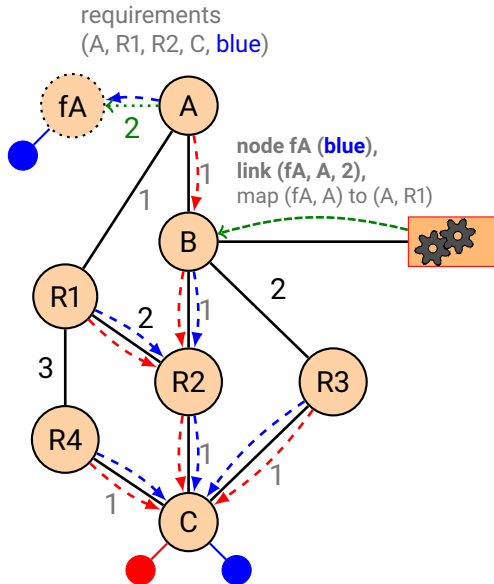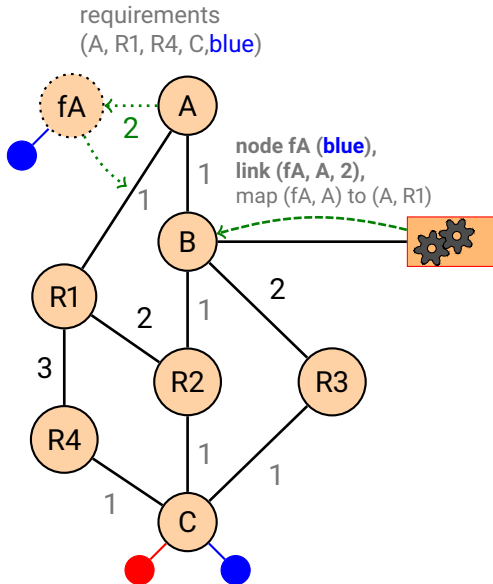
Chaining multiple fake nodes enables to program complex paths.

# Chaining multiple fake nodes enables to program complex paths.

requirements
(A, R1, R4, C, blue)

node fR1 (blue),
link (fR1, R1, 2),
map (fR1, r1) to (R1, R4)

Chaining multiple fake nodes enables to program complex paths.

requirements
(A, R1, R4, C, blue)
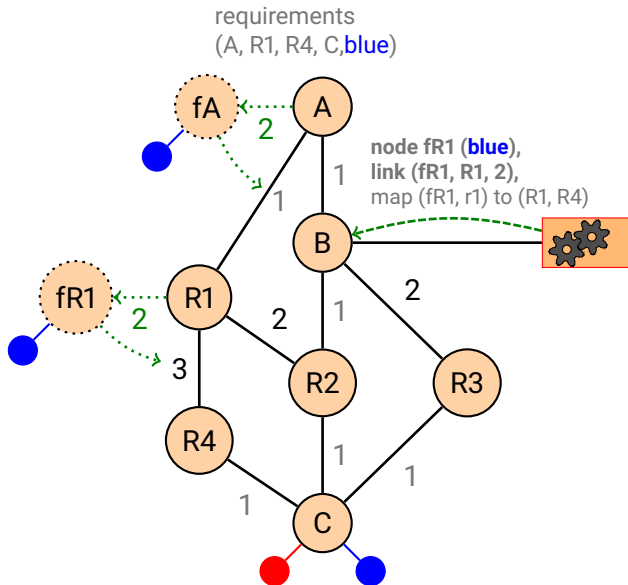
Augmented topologies can be reduced to optimize the number of fake nodes.

Naive augmentation

requirements
(A, R1, R4, C,blue)

Reduced augmentation

requirements
(A, R1, R4, C,blue)
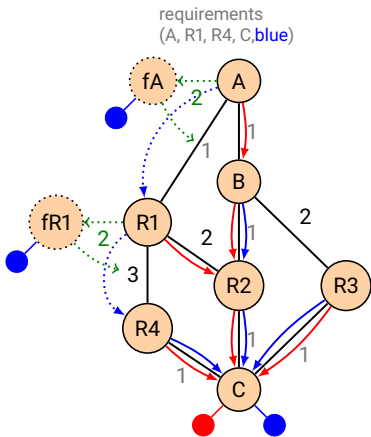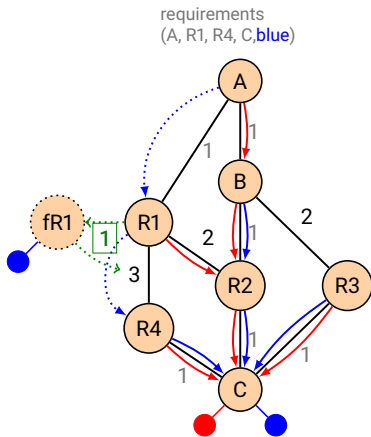
Fibbing preserves the scalability of IGPs.

■ We can compute augmented topologies in $\mathcal{O}(ms)$
   Ensures quick reaction to changes

■ We can *reduce* augmented topologies in $\mathcal{O}(s)$
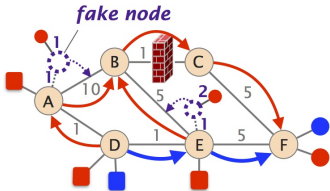   Ensures limited control-plane overhead

Fibbing leverages the robustness of IGPs.

- Fast failure detection and recovery

- Survive controller failure

- Support fail-close and fail-open semantics

Fibbing can enforce any set of loop-free paths,
on a per destination basis.

Fibbing: Central Control over Distributed Routing

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fake node

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4. Takeaways

We have a working Fibbing controller prototype.

- The controller maintains an OSPF adjacency to one router

- Topology discovery using the adjacency

- Tested against IOS, NX-OS, JunOS

*The "forwarding address" has one other application.
It enables routers in the Autonomous System's interior to
function as "route servers".*

RFC2328, §2.3—Use of external routing information

If the forwarding address is non-zero, […]
install the AS external path to N, with next hop equal to
the list of next hops to the forwarding address

RFC2328, §16.4—Calculating AS external routes

Fake nodes can be injected using LSA types 5/7.
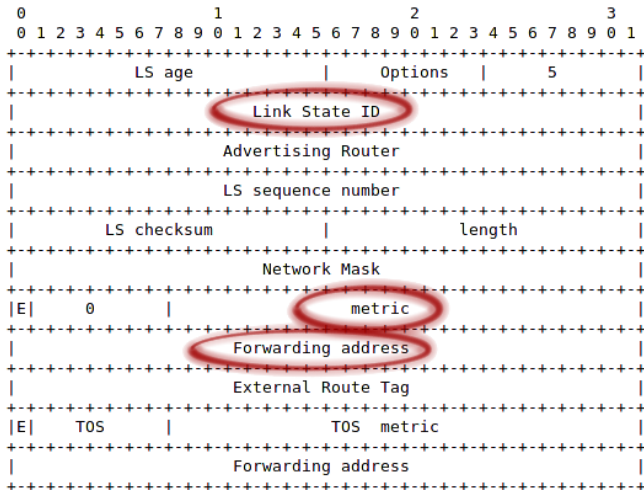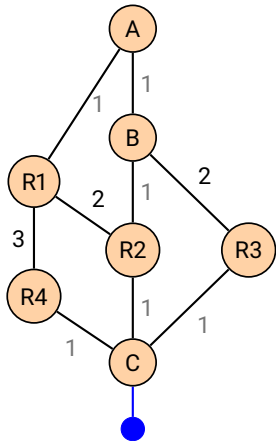

RFC2328, §A.4.5—AS-external-LSAs

Using T5/7 LSAs comes at a price.

- Different expressivity model

- Can only affect prefixes from other T5/T7 LSAs

- Does not exist in IS-IS!

Using T5/7 LSAs has (almost) no overhead on routers and is fast.

- No measurable impact on SPF duration

- 10 000 LSAs eat 14.5 MB of DRAM

- 900 μs to push one fibbed route to the FIB

Fibbing: Central Control over Distributed Routing
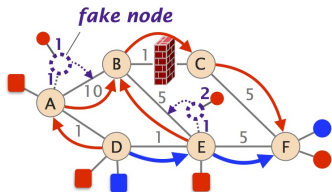
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The initial IGP configuration has a bottleneck towards router C.

Control-Plane

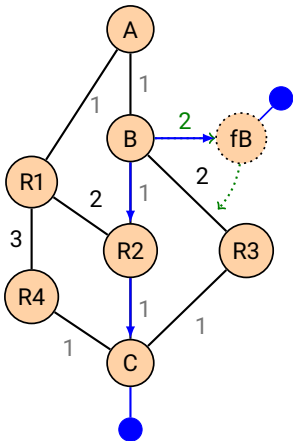# The initial IGP configuration has a bottleneck towards router C.
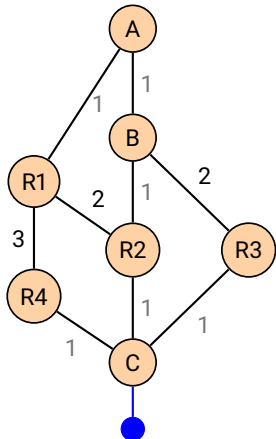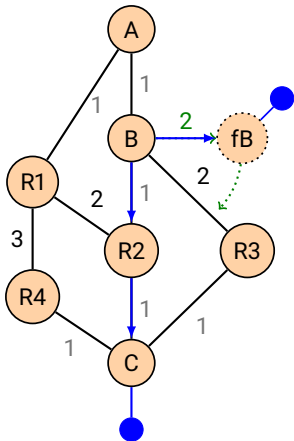
Control-Plane

Data-Plane
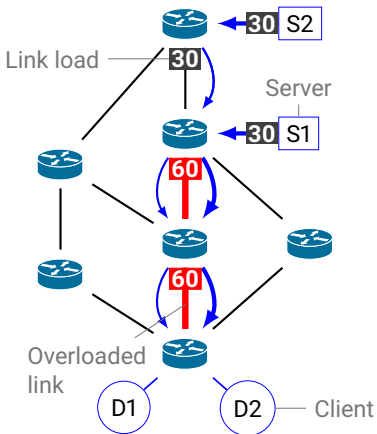
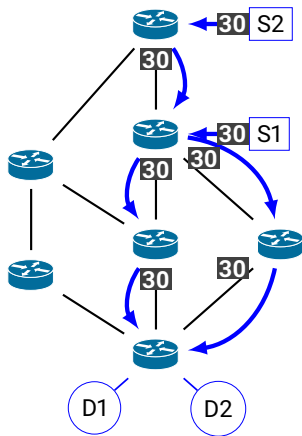# Fibbing can program on-demand ECMP to spread the load.
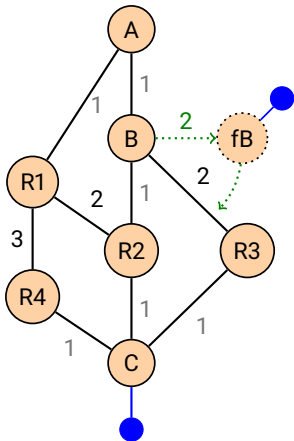
Control-Plane

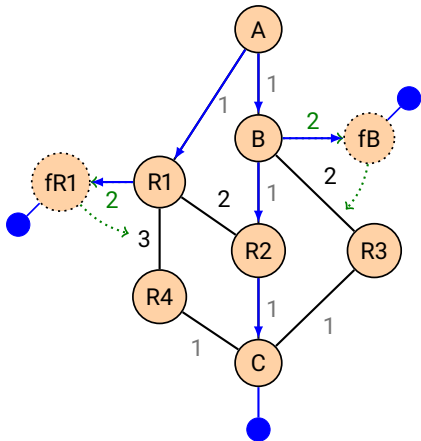**Fibbing can program on-demand ECMP to spread the load.**

Control-Plane

Fibbing can program on-demand ECMP to spread the load.
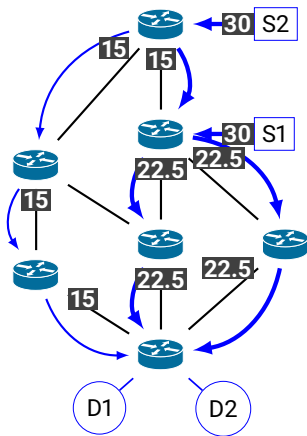
Control-Plane

Data-Plane

Fibbing can program on-demand ECMP to spread the load.

Control-Plane

Data-Plane

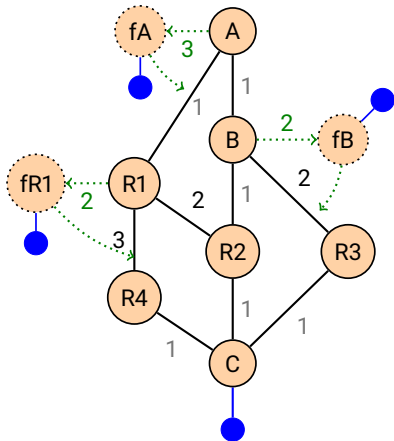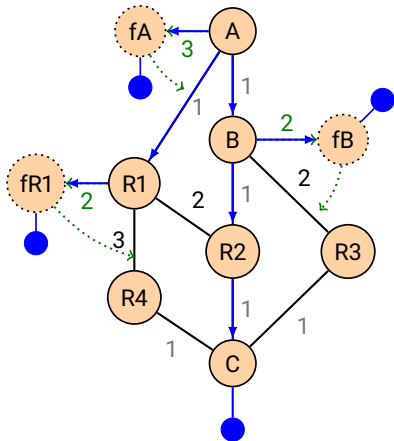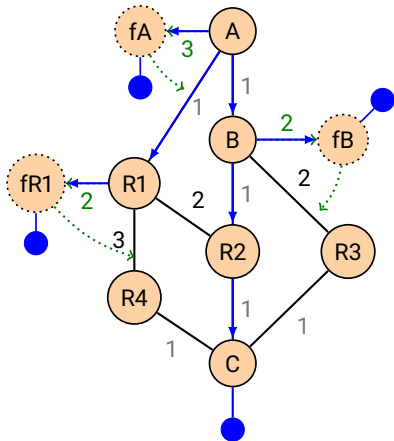# Fibbing controls the splitting ratios across equal-cost paths.

Control-Plane

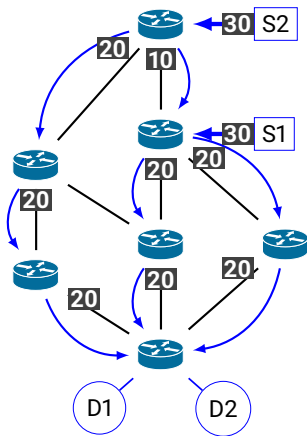# Fibbing controls the splitting ratios across equal-cost paths.

Control-Plane

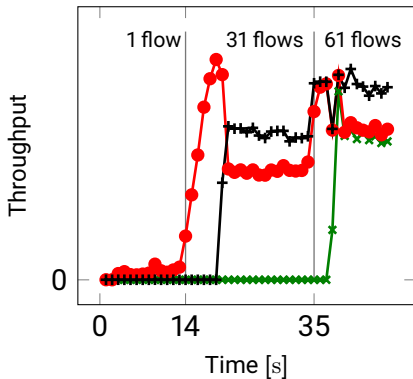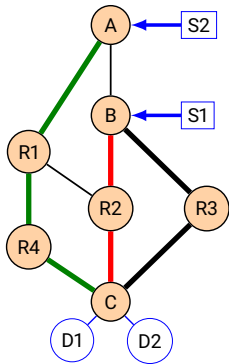# Fibbing controls the splitting ratios across equal-cost paths.
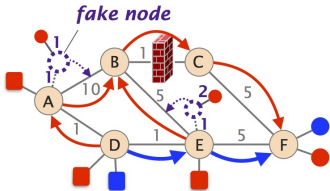
Control-Plane

Data-Plane

The Fibbing controller reacts and adds more paths to spread the load, in real time.

- We initially have 1 flow from S1 to D1.
  - At time $t = 14s$, we start 30 new flows from S1 to D1.
  - At time $t = 35s$, we start 30 flows from S2 to D2.

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Modifying the shared topology is powerful.

- Enables optimal, real-time, TE in the control plane

- Does not impact data-plane

- Gives *some* control over BGP/MPLS-LDP

- Simplifies configurations through exception-based routing

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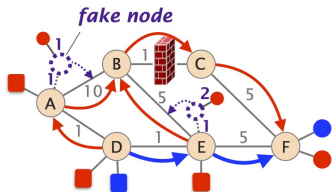
Tell me lies, tell me sweet little lies
— Fleetwood Mac

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