Faces vs. Interfaces

- No Queues (data comes from Content Store)
- No ARP or ES-IS (no layer-3 abstraction to bind to layer-2 address)
- Have to do Suppression (see SRM or NORM) on multi-user broadcast links but can amortise to low cost by content-based prioritisation plus adaptive affinity.

QoS

- In the current Internet, problems that require QoS are highly localized.
- Roughly half the problem is caused by the serial dependencies created by queues.
- The other half is caused the lack of receiver based control of bottleneck links.
- Unlike IP, CCN is local, doesn’t have queues and receivers have complete, fine-grained control.
- But it does aggregate traffic and has face-specific controls on the aggregation.

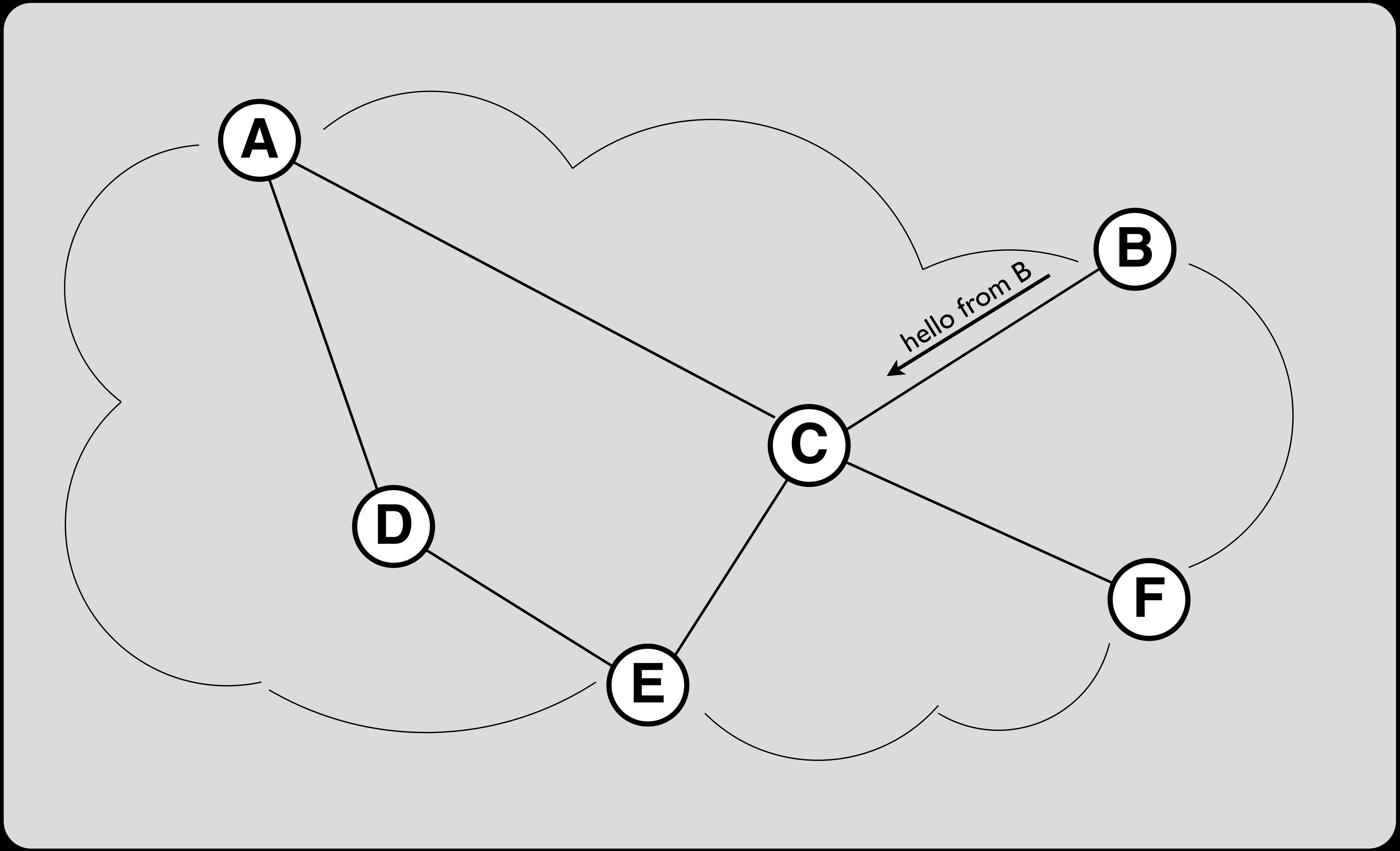
- History and motivation
- Content Model
- Security Model
- Node Model
- Routing
- Transport

- There are many (emerging) ways to do routing, e.g., Small Worlds, Geographic Hyperbolic, Pseudo-potential Gradient, Epidemic percolation.
- In general they’re easier to implement and work better for CCN than for IP:
  - no looping data ⇒ no convergence issues.
  - multi-destination ⇒ state can be approximate (false positives ok).
  - CCN transport model matches routing’s and adds security.

- I’m just going to talk about embedding CCN in existing Internet routing.
    - This is an easy evolutionary path (it allows for immediate, incremental deployment).
    - It offers some intuitions on scaling (same scaling as IP routing).
    - The basics are the same for any routing scheme.

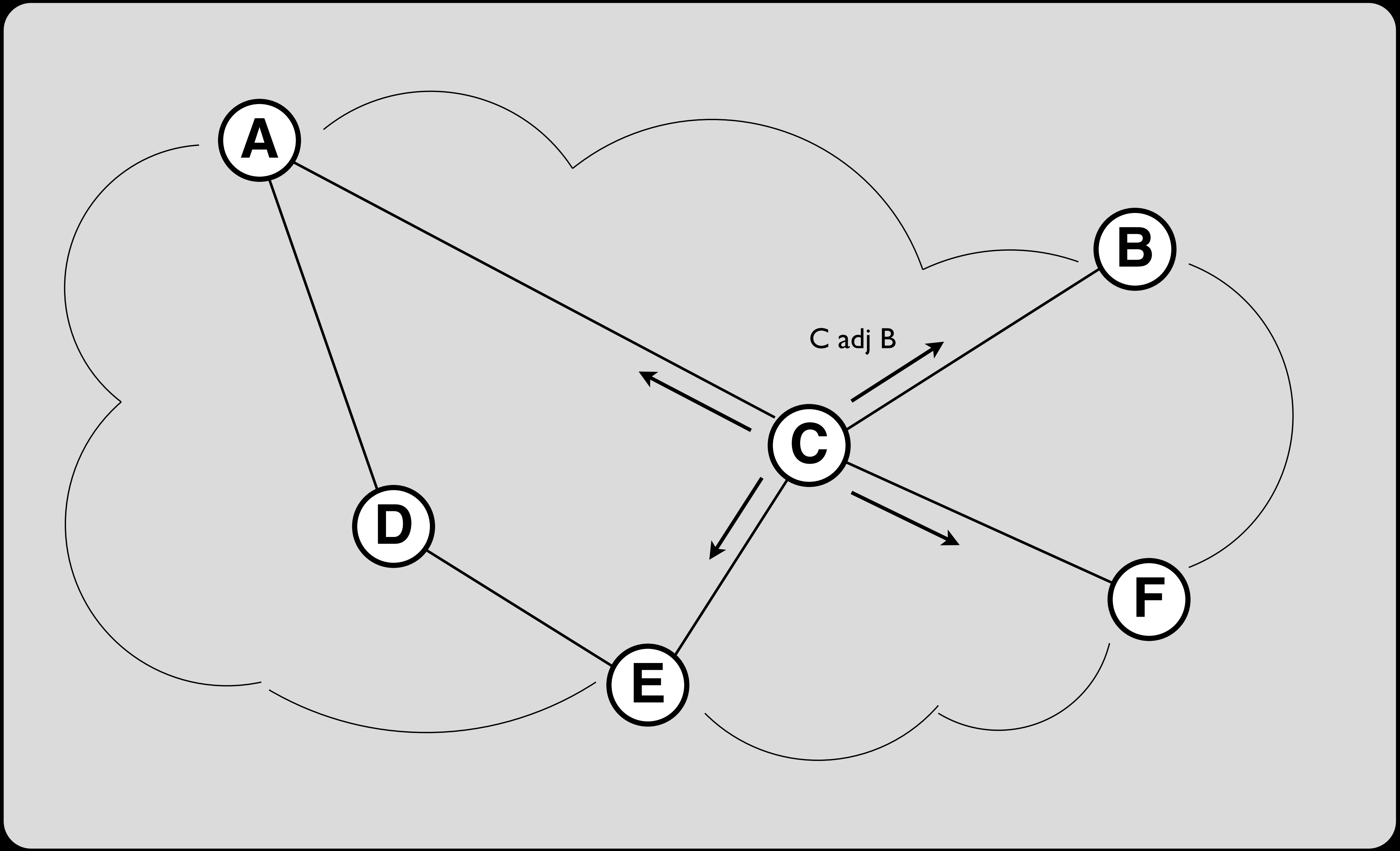
IGP routing

B sends a ‘hello’ out all its links



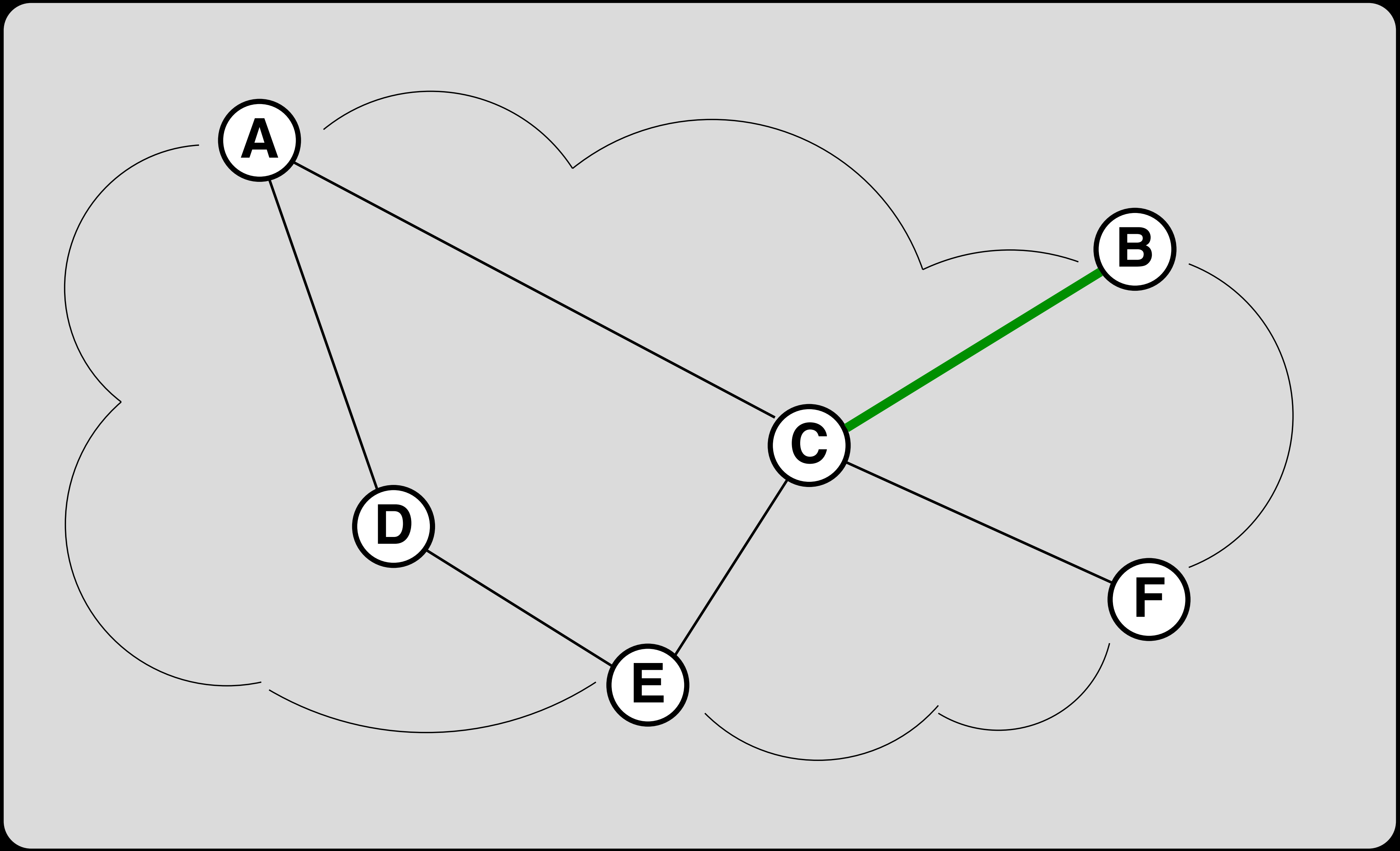
IGP routing

C floods that it’s adjacent to B



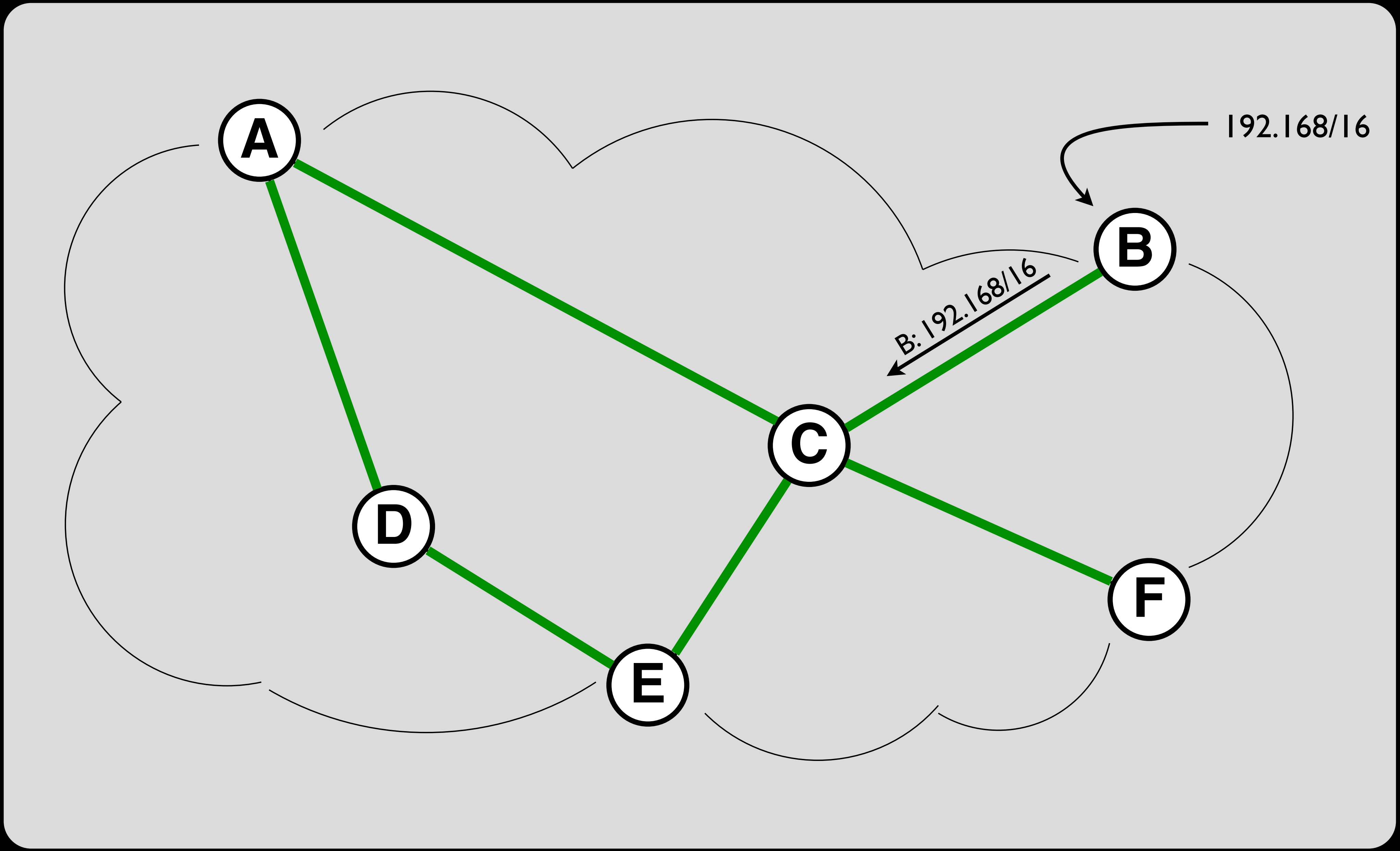
IGP routing

Same thing happens in C→B direction. When ‘B adj C’ announcement flooded, everyone adds B-C link to map.

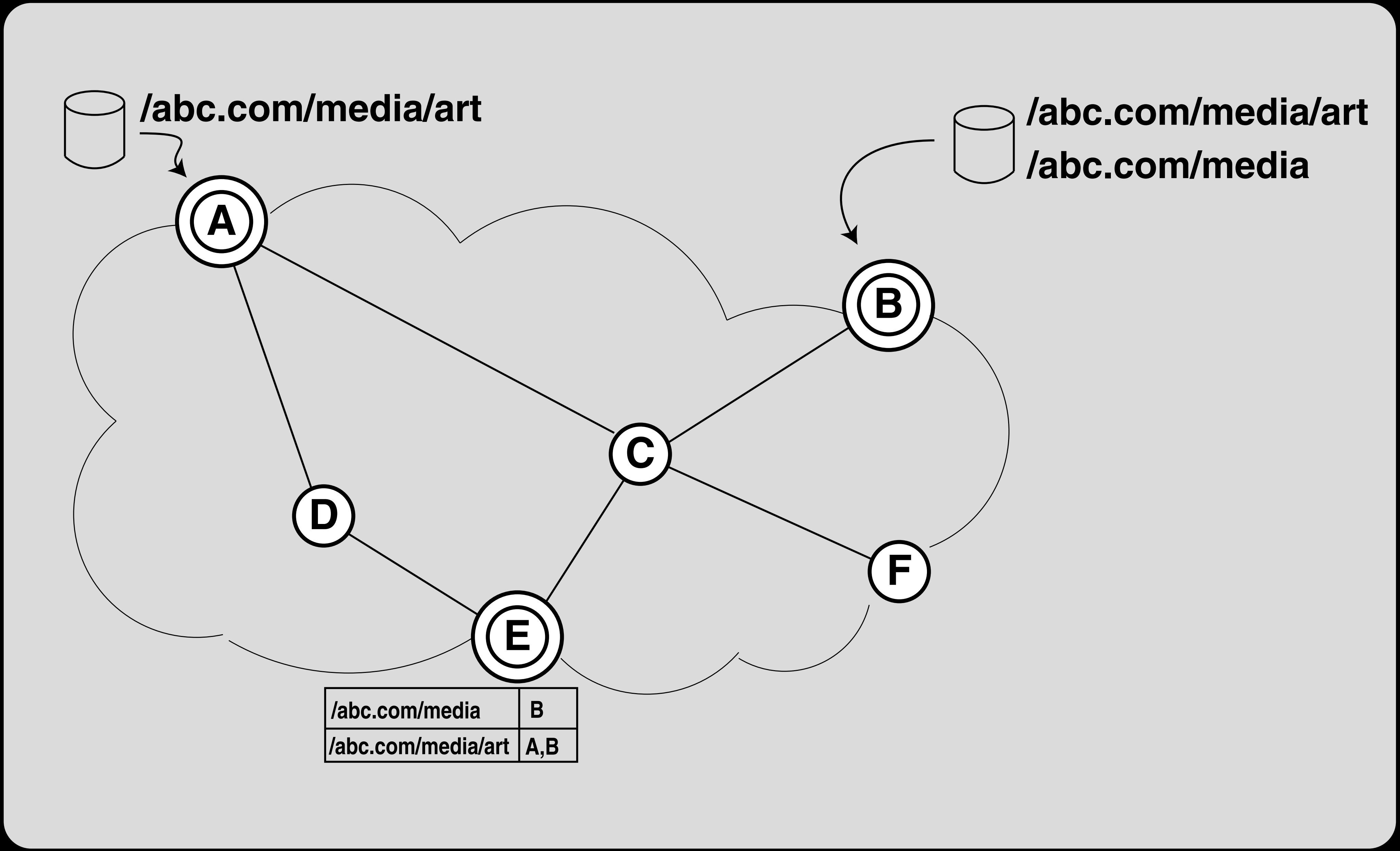


IGP routing

Some ‘external’ (non-IGP) agent injects a ‘prefix announcement’
which B floods to all other IGP nodes

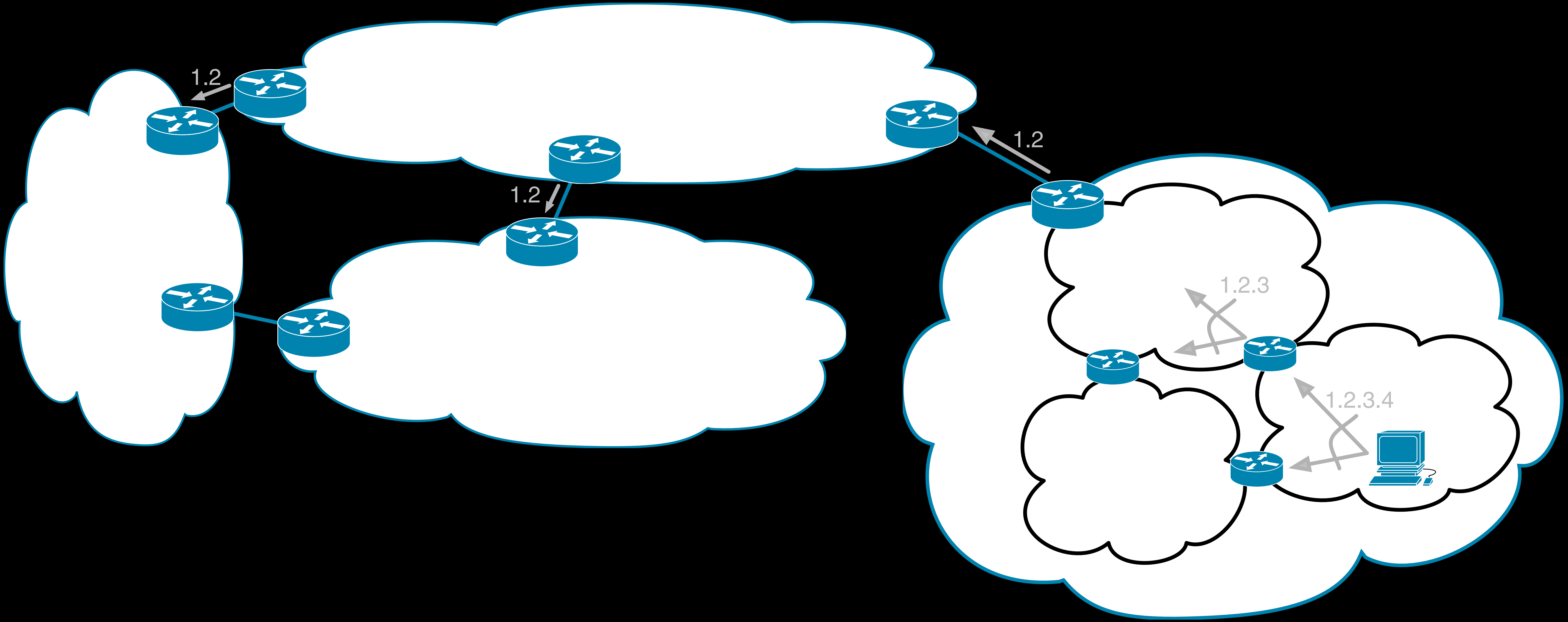


Existing link-state routing protocols can be used, unmodified, to construct a CCN FIB

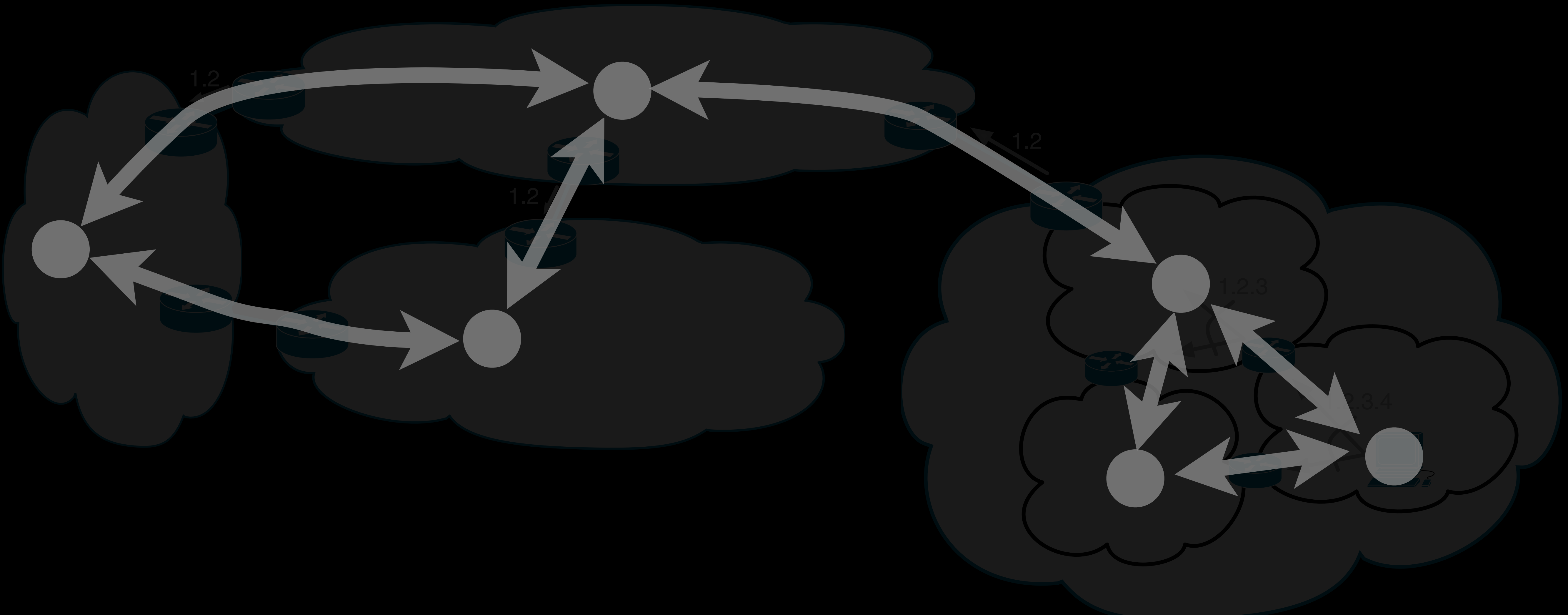


/abc.com/media	B
/abc.com/media/art	A,B

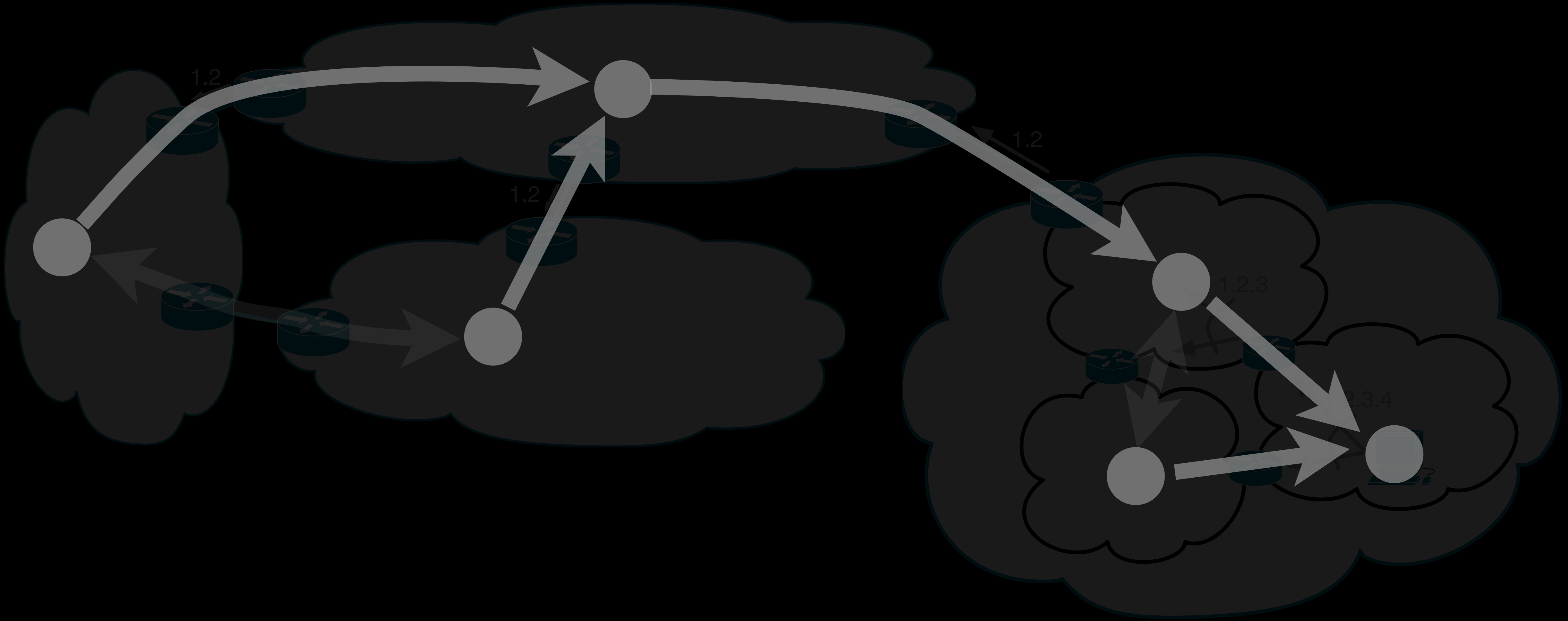
Architectural issues with IP routing



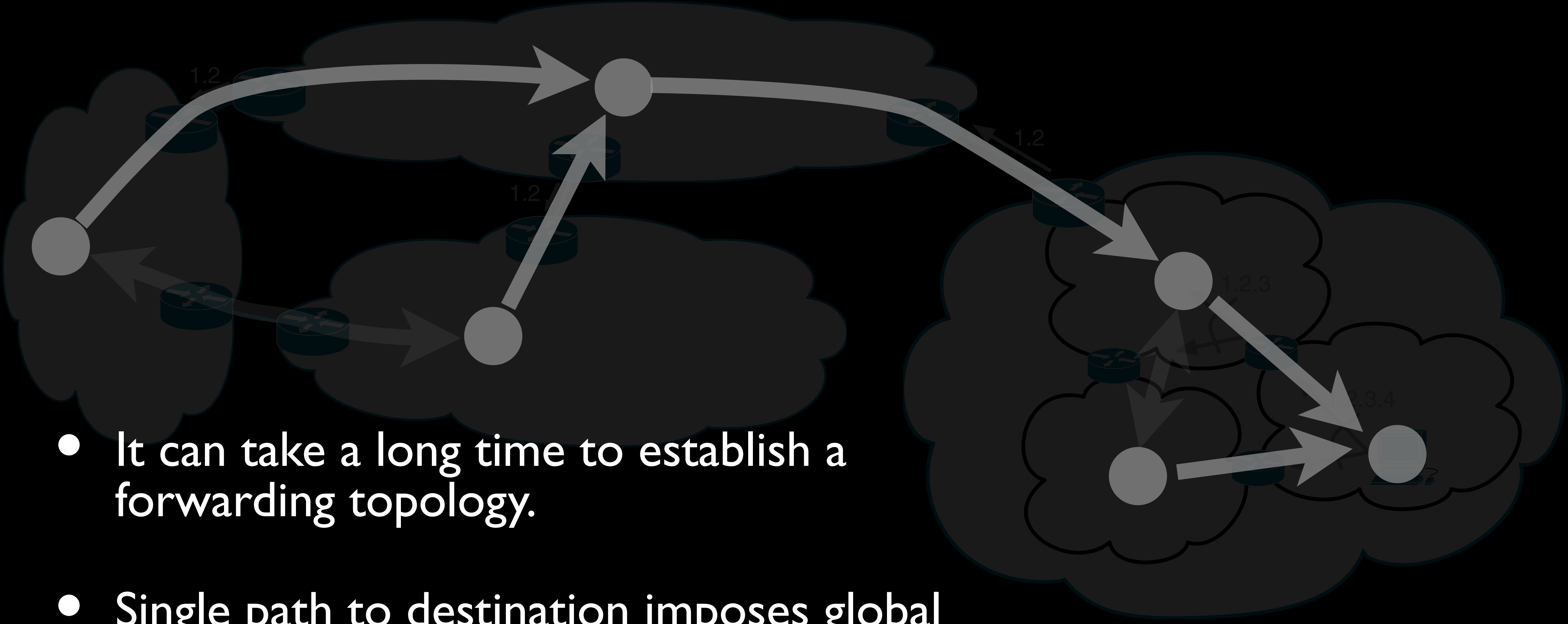
Architectural issues with IP routing



Architectural issues with IP routing



Architectural issues with IP routing



- It can take a long time to establish a forwarding topology.

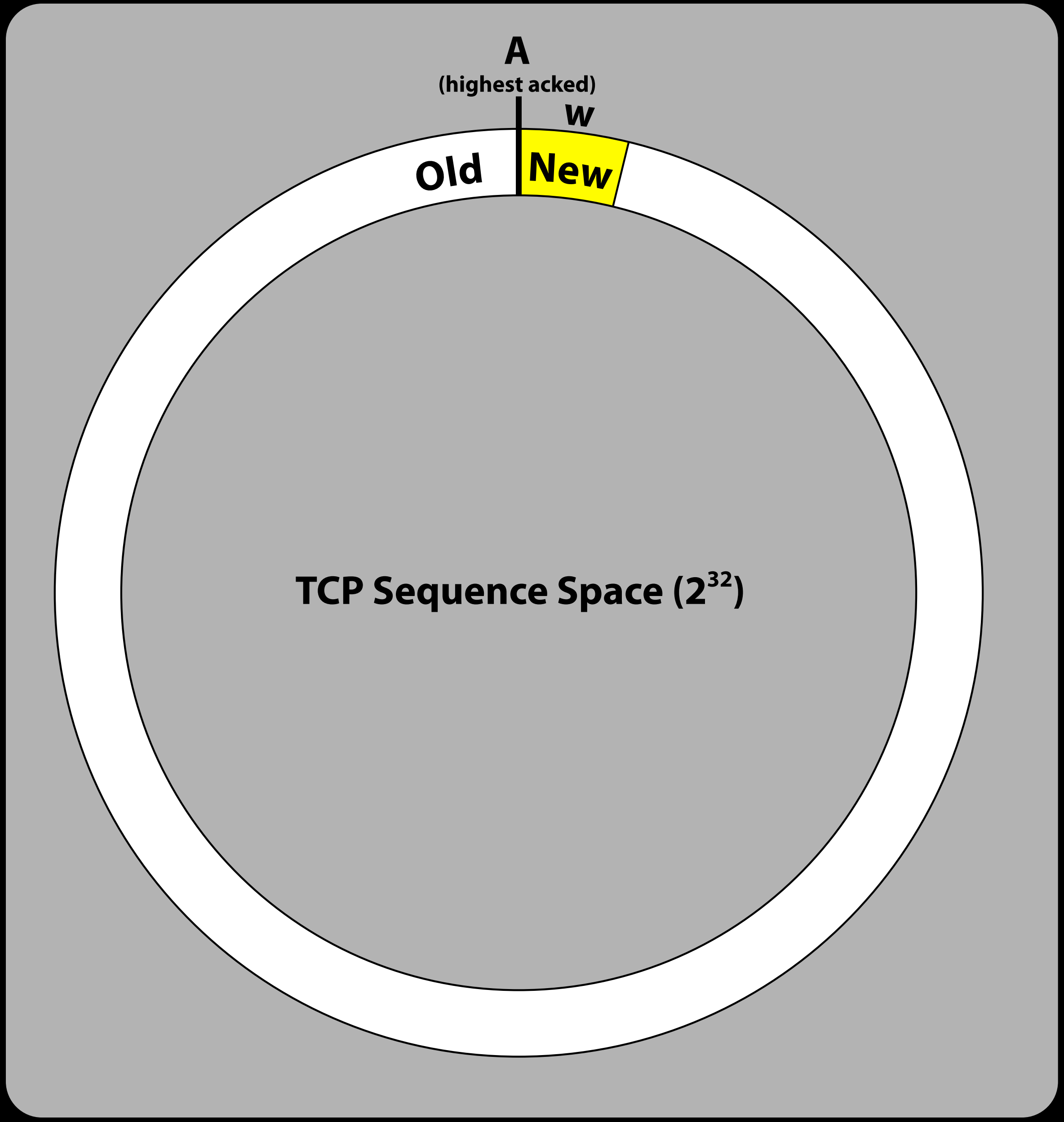
- Single path to destination imposes global constraints on local forwarding decision.

CCN doesn’t need topology

- Content model suppresses duplicates so nothing can loop.
- Data bandwidth use is near theoretical min.
- Topology can reduce interest bandwidth use but factor is small - O(diameter*avg.degree).
- With no topology, interests will always find (dynamic) shortest path to source.
- CCN works well with sloppy topology and performance-based interest re-expression.

- History and motivation
- Content Model
- Security Model
- Node Model
- Routing
- Transport

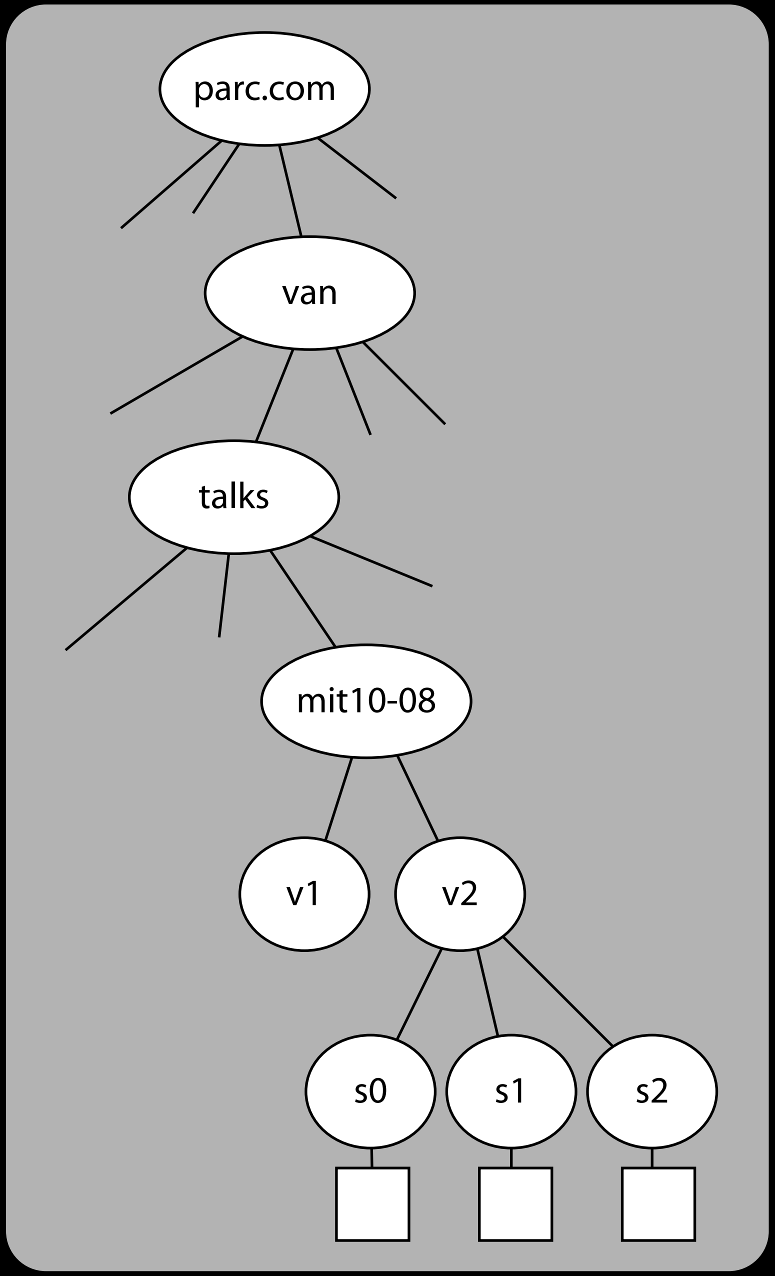
Transport State



Conversation transport state is very compact:

- One dynamic state variable (tcp sequence / ack number) conveys what ends know.
- Additional static variable (tcp window) conveys what they want.

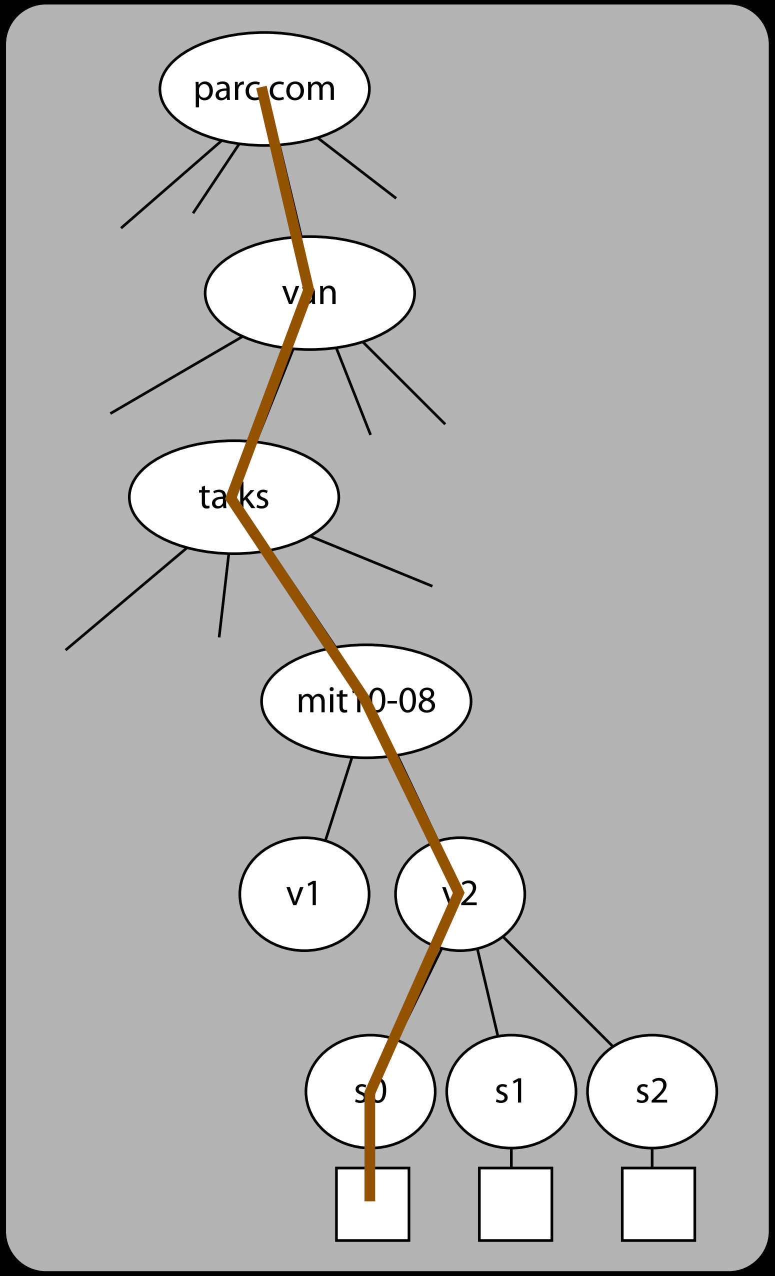
Annotated path in CCN name tree serves as transport state



Conventions:

- name tree child nodes are lexically ordered
- <next> assumed if no relationship specified

Annotated path in CCN name tree serves as transport state



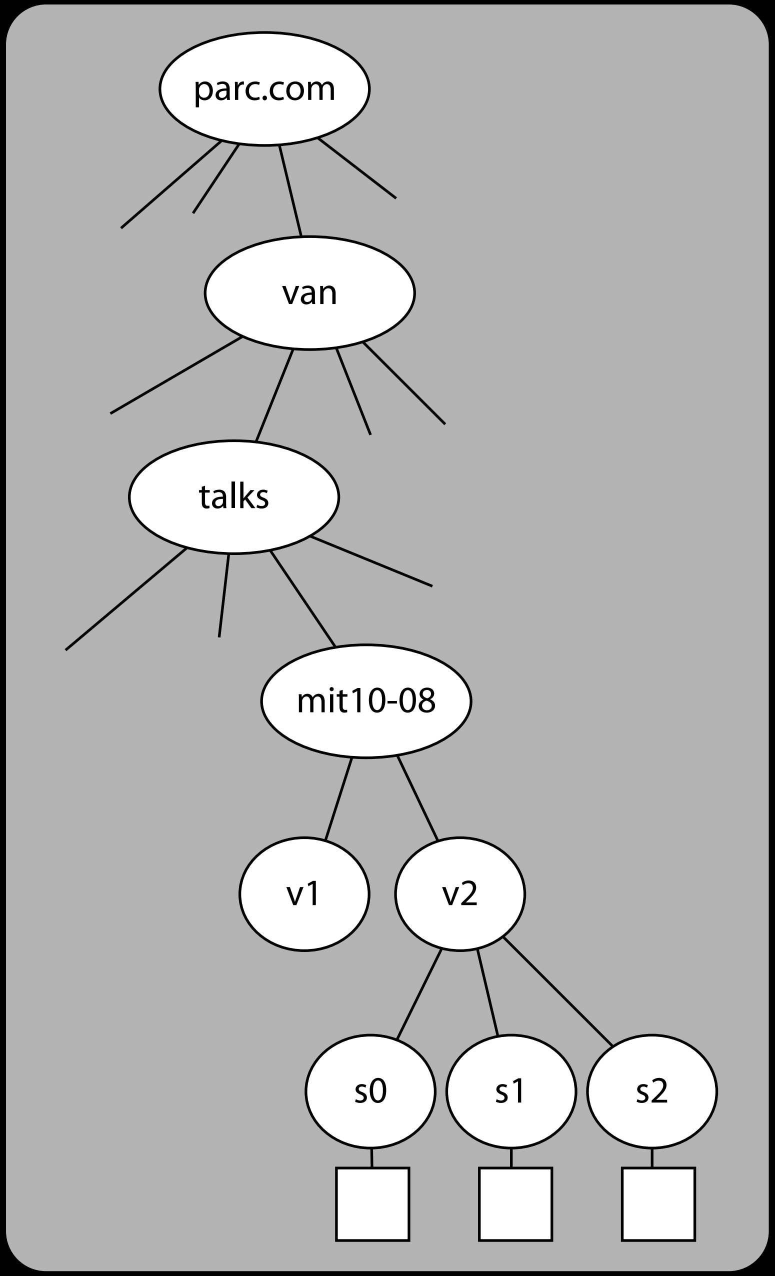
Most recent version of slides for this talk:

parc.com/van/talks/mit10-08 <rightmost child>

Conventions:

- name tree child nodes are lexically ordered
- <next> assumed if no relationship specified

Annotated path in CCN name tree serves as transport state



Most recent version of slides for this talk:

parc.com/van/talks/mit10-08 <rightmost child>

Newest version after v2:

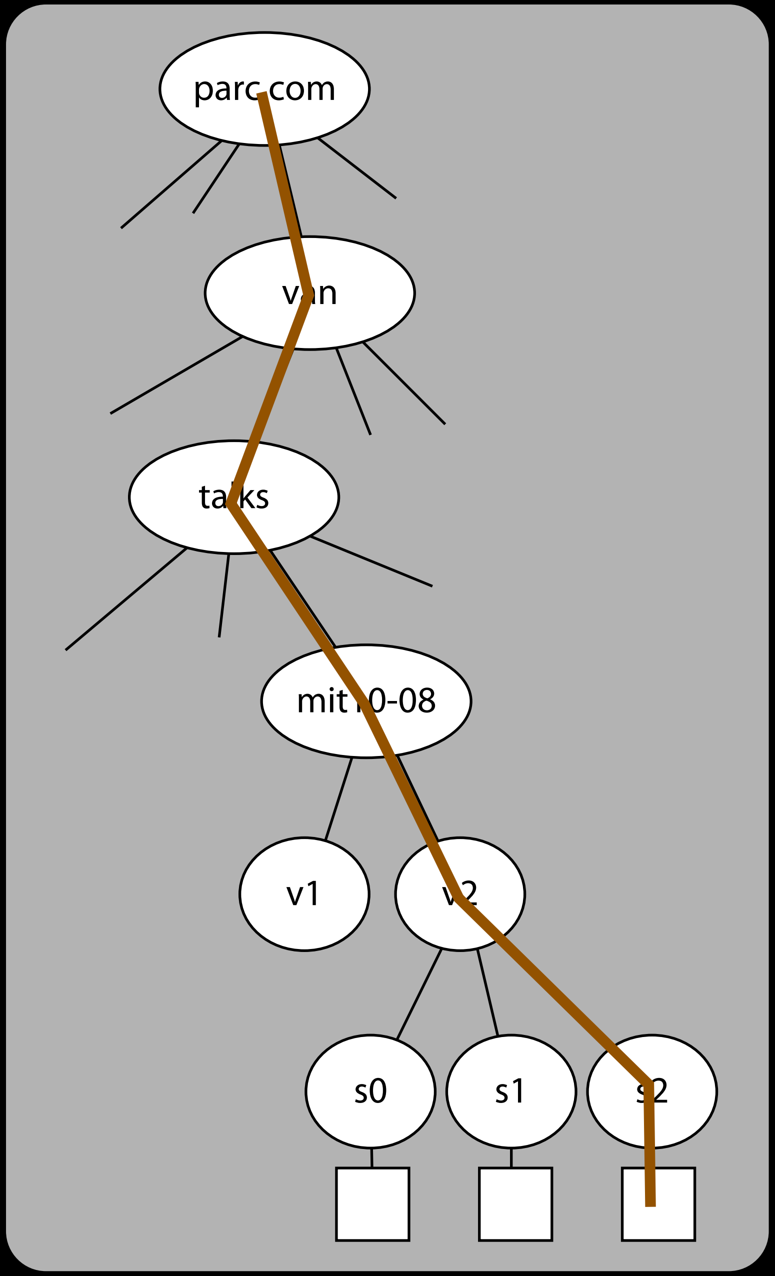
parc.com/van/talks/mit10-08/v2 <rightmost sibling>

(fails since there is no newer version)

Conventions:

- name tree child nodes are lexically ordered
- <next> assumed if no relationship specified

Annotated path in CCN name tree serves as transport state



Most recent version of slides for this talk:

parc.com/van/talks/mit10-08 <rightmost child>

Newest version after v2:

parc.com/van/talks/mit10-08/v2 <rightmost sibling>

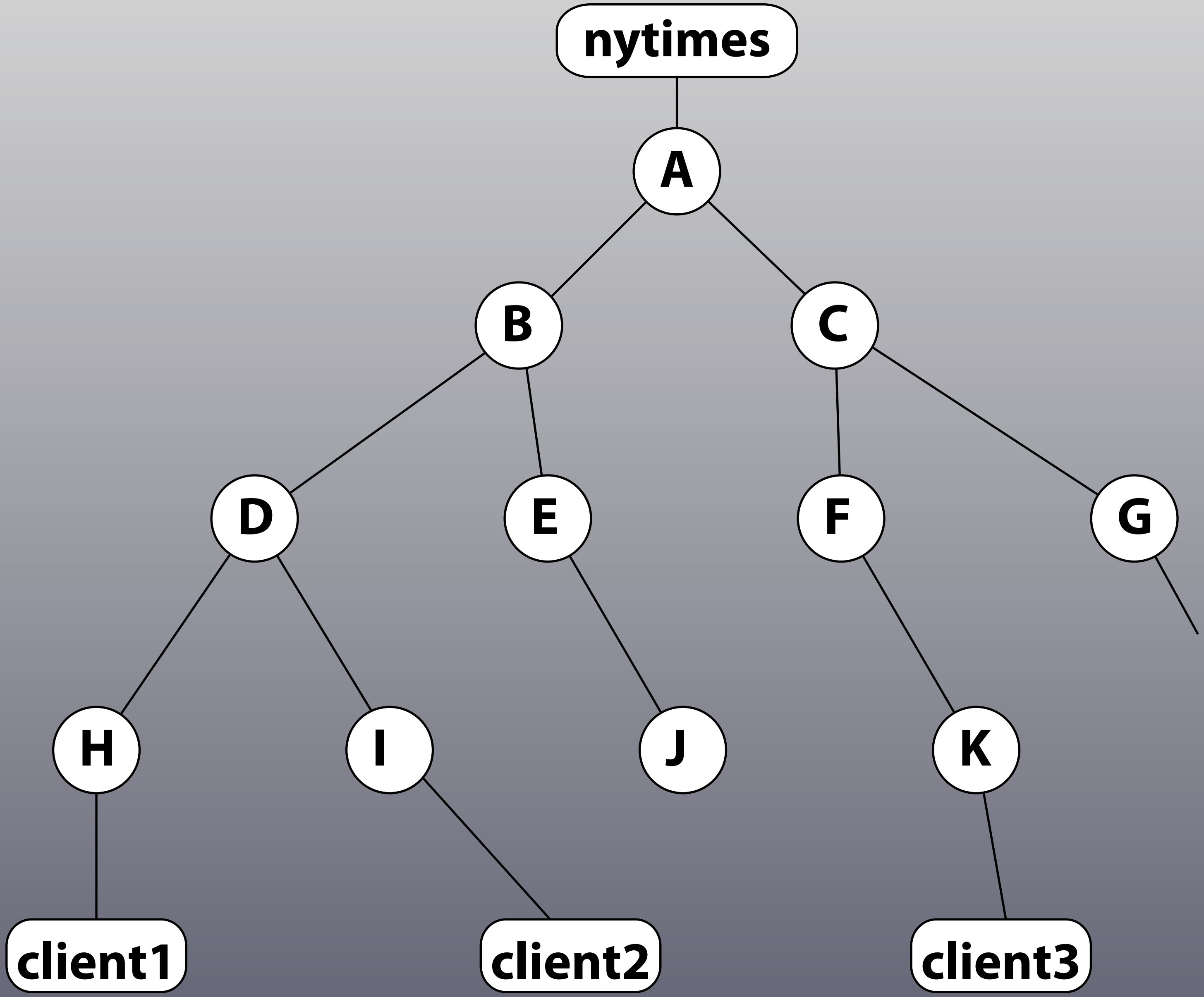
(fails since there is no newer version)

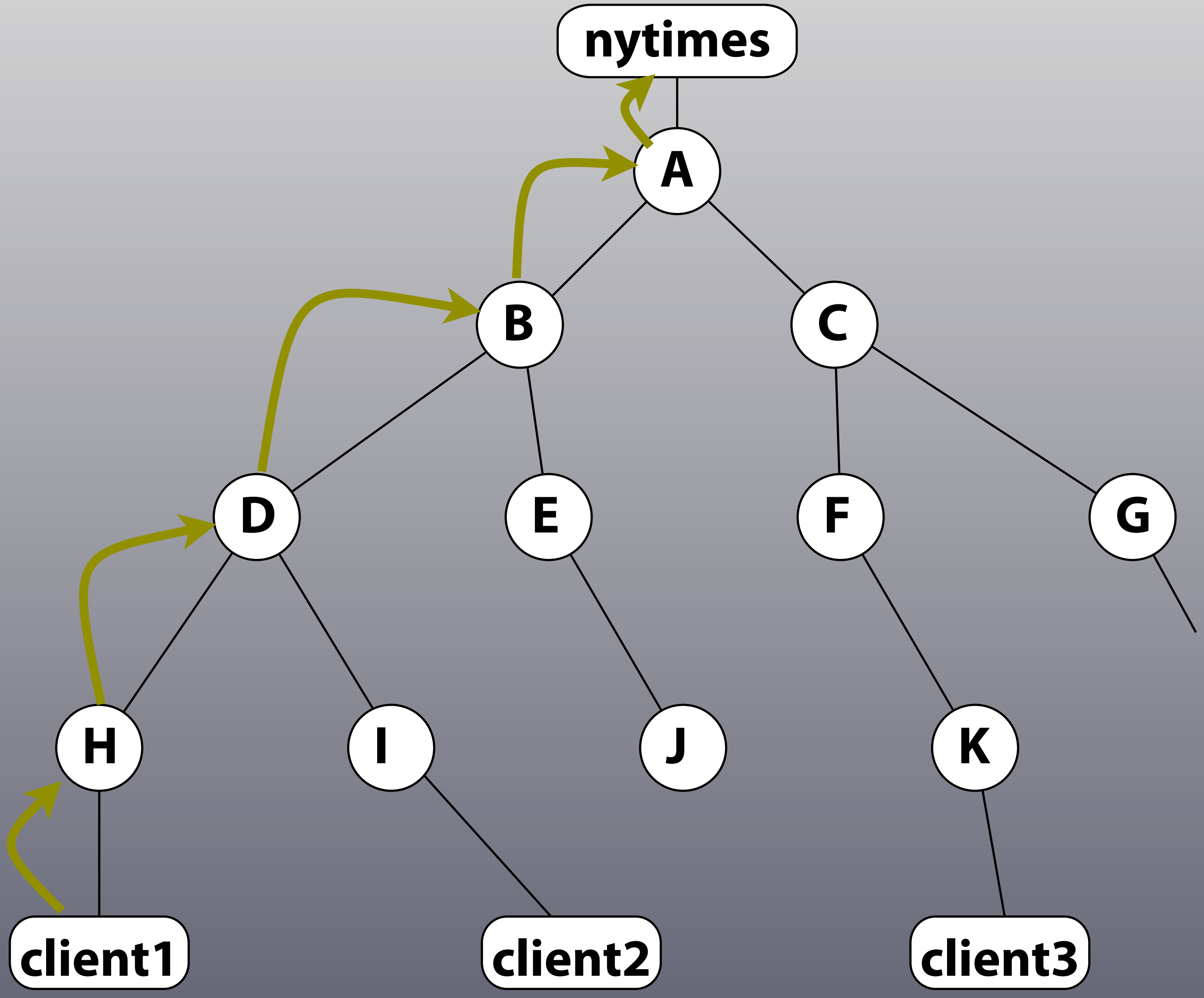
Next available chunk after s1:

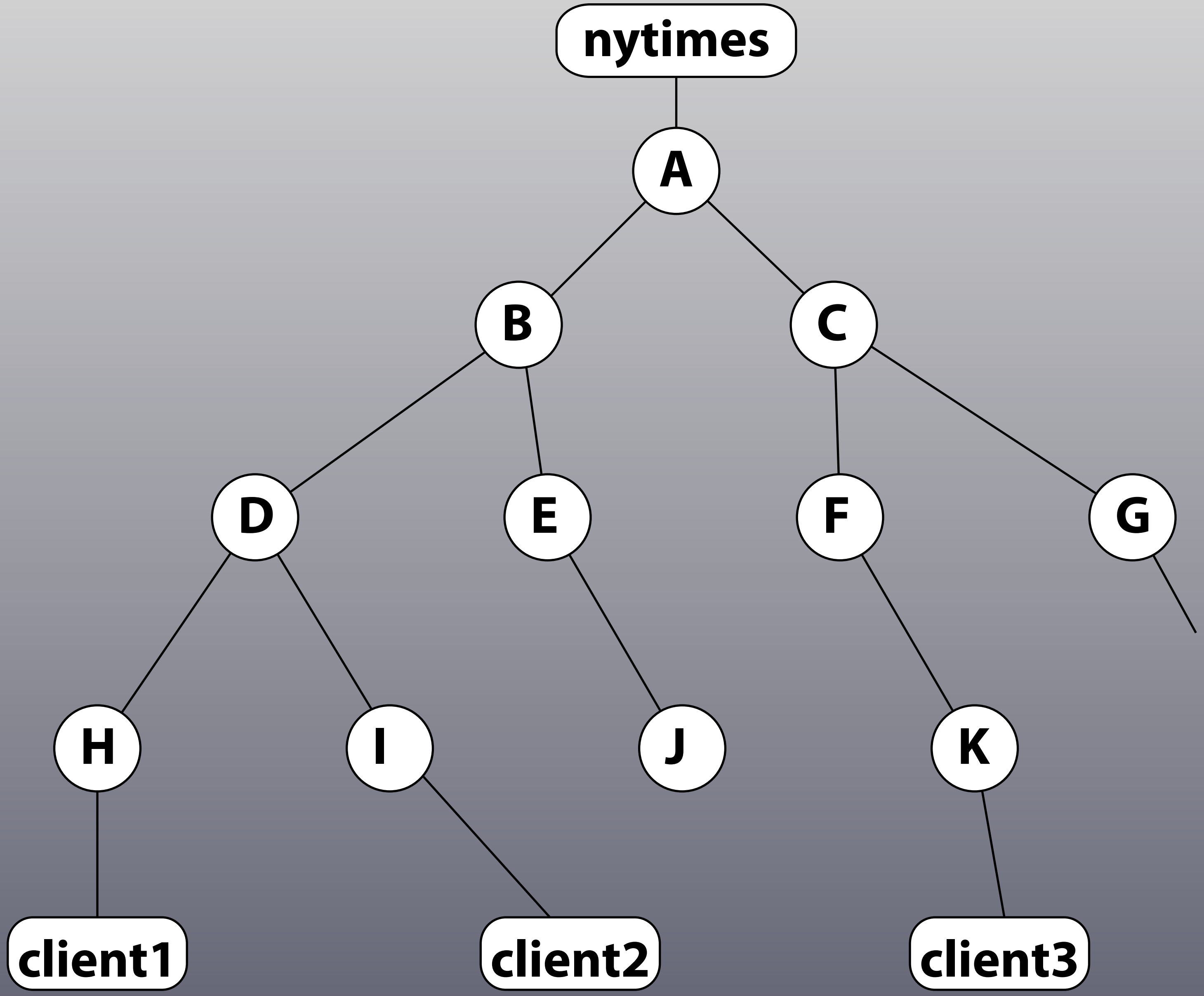
parc.com/van/talks/mit10-08/v2/s1

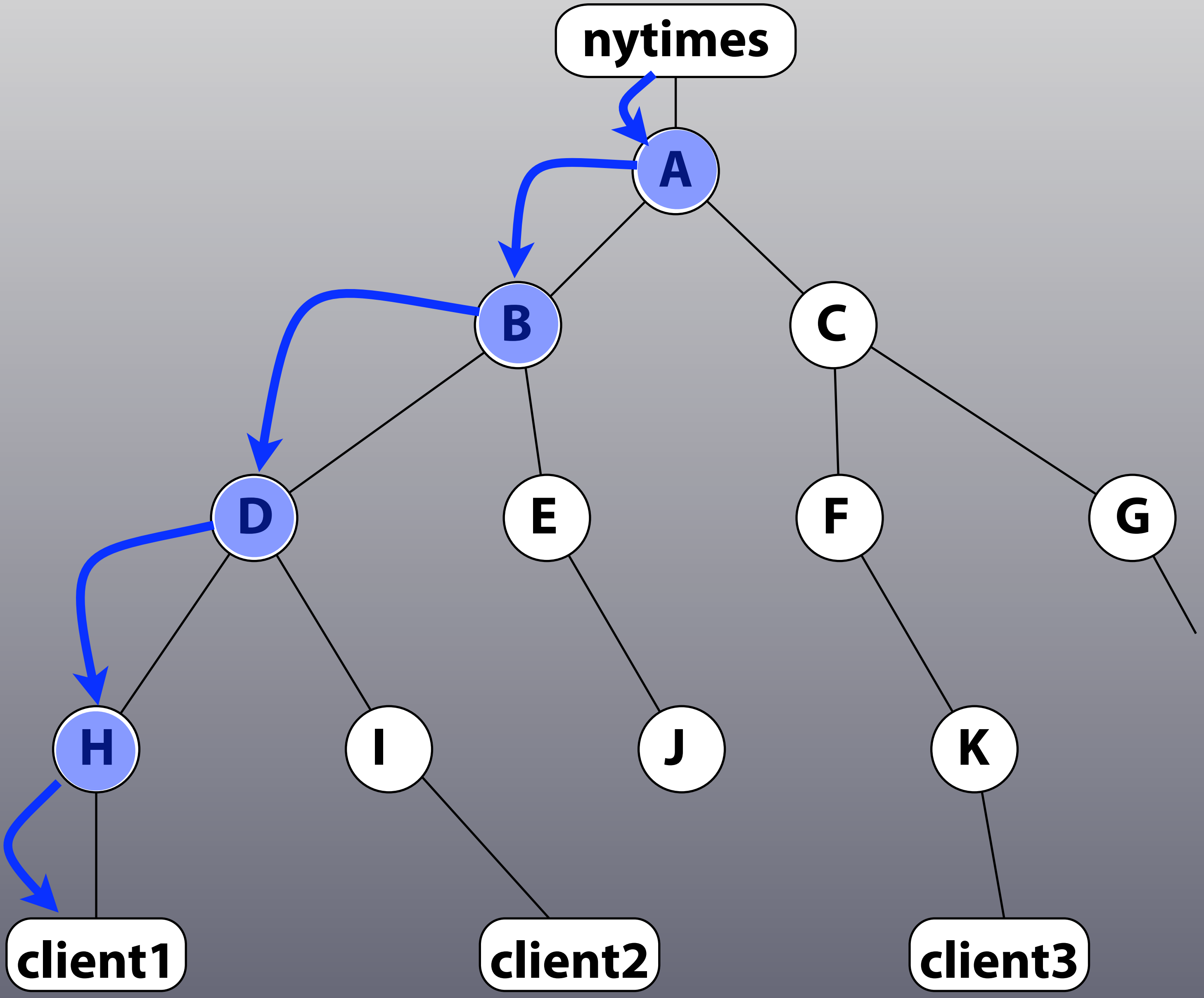
Conventions:

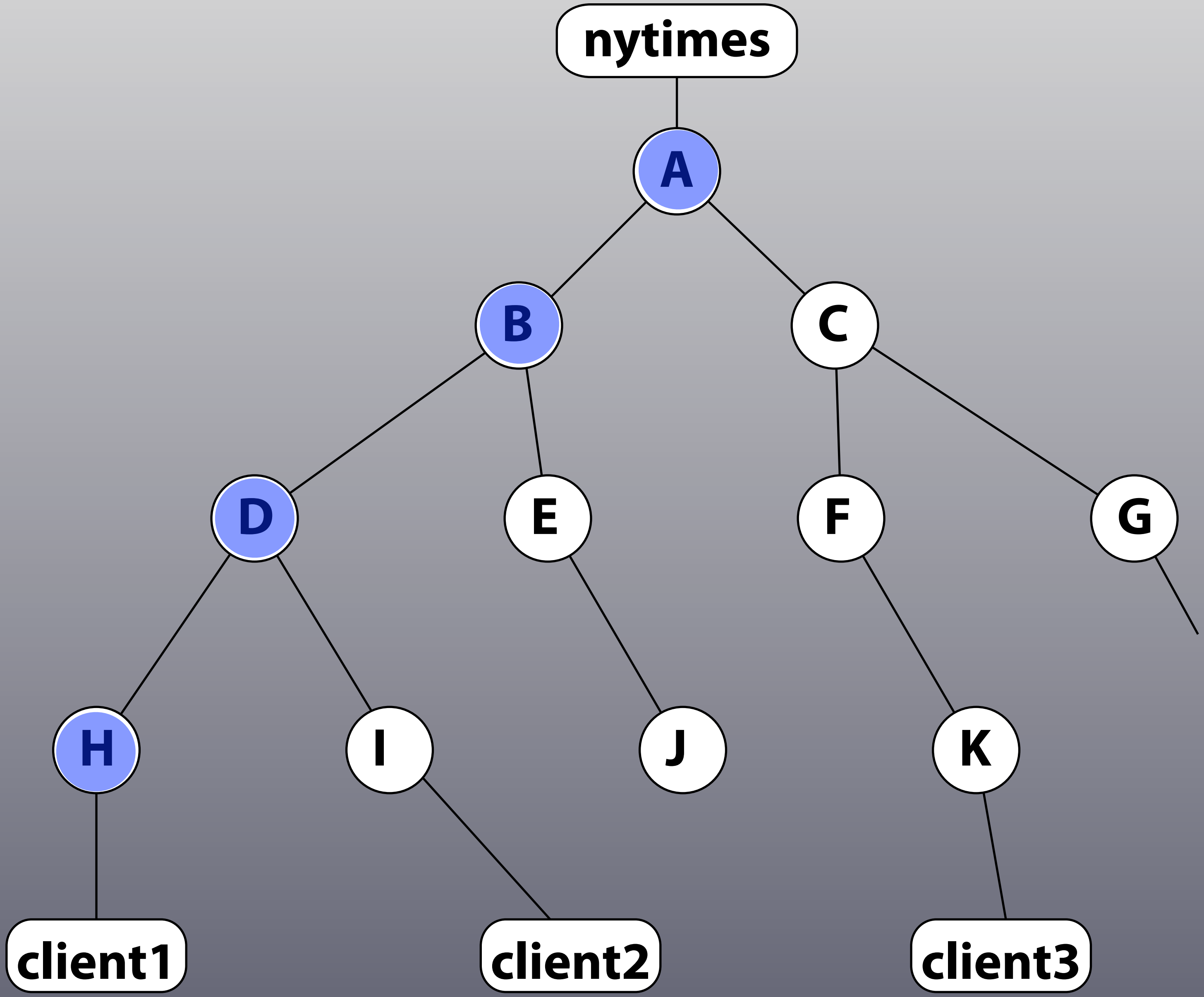
- name tree child nodes are lexically ordered
- <next> assumed if no relationship specified

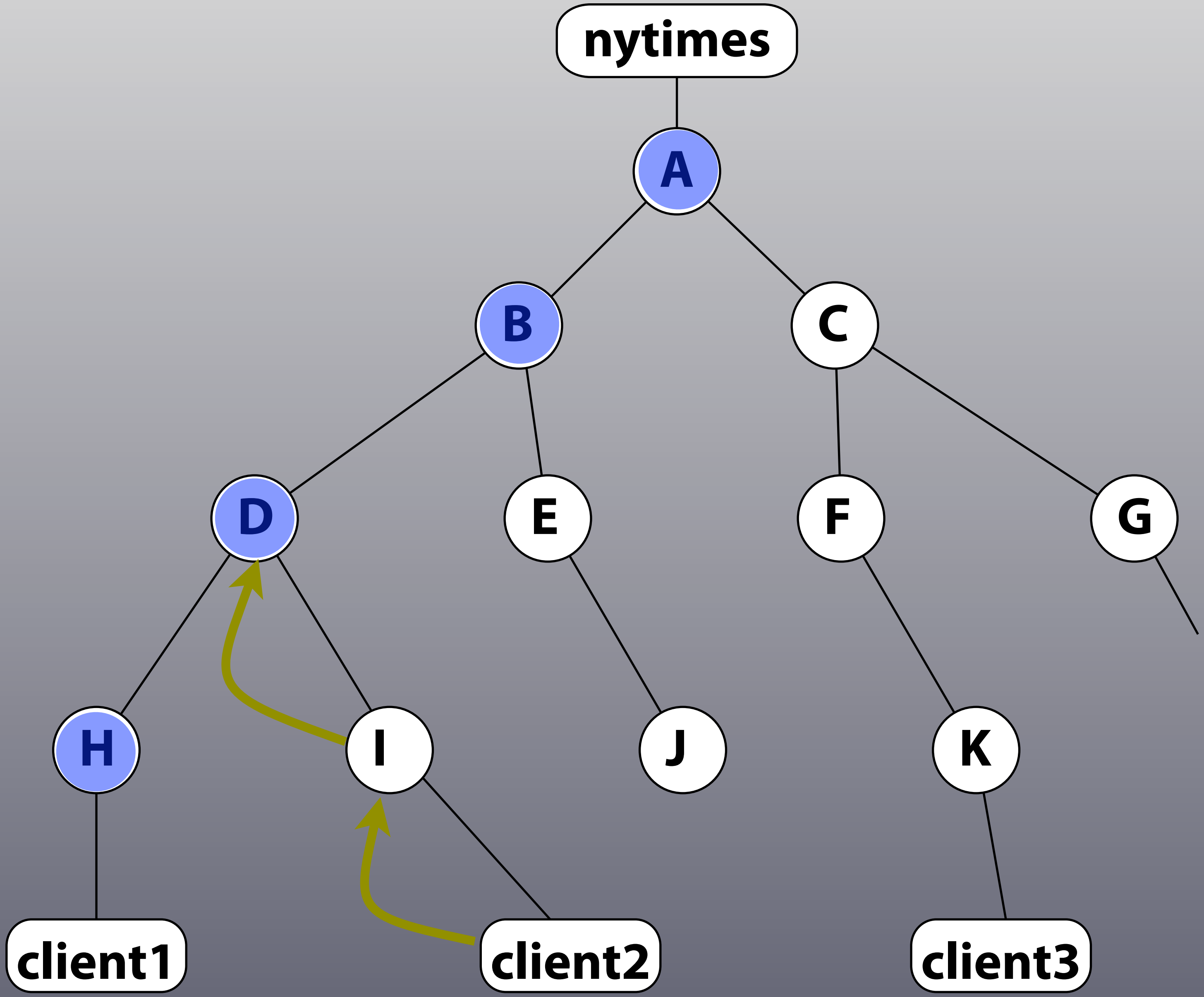

nytimes
A
B
C
D
E
F
G
H
I
J
K
client1
client2
client3

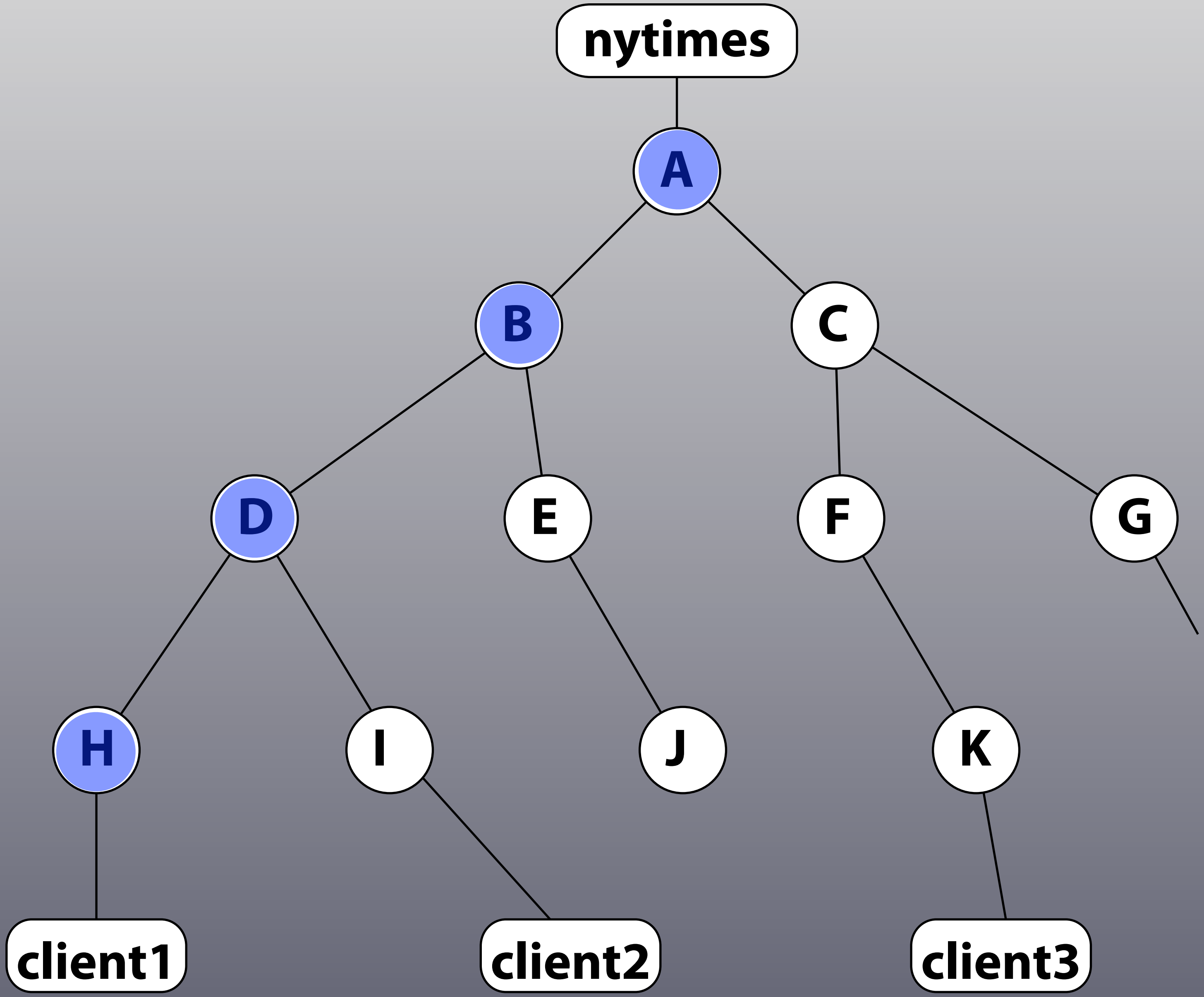

nytimes
A
B
C
D
E
F
G
H
I
J
K
client1
client2
client3

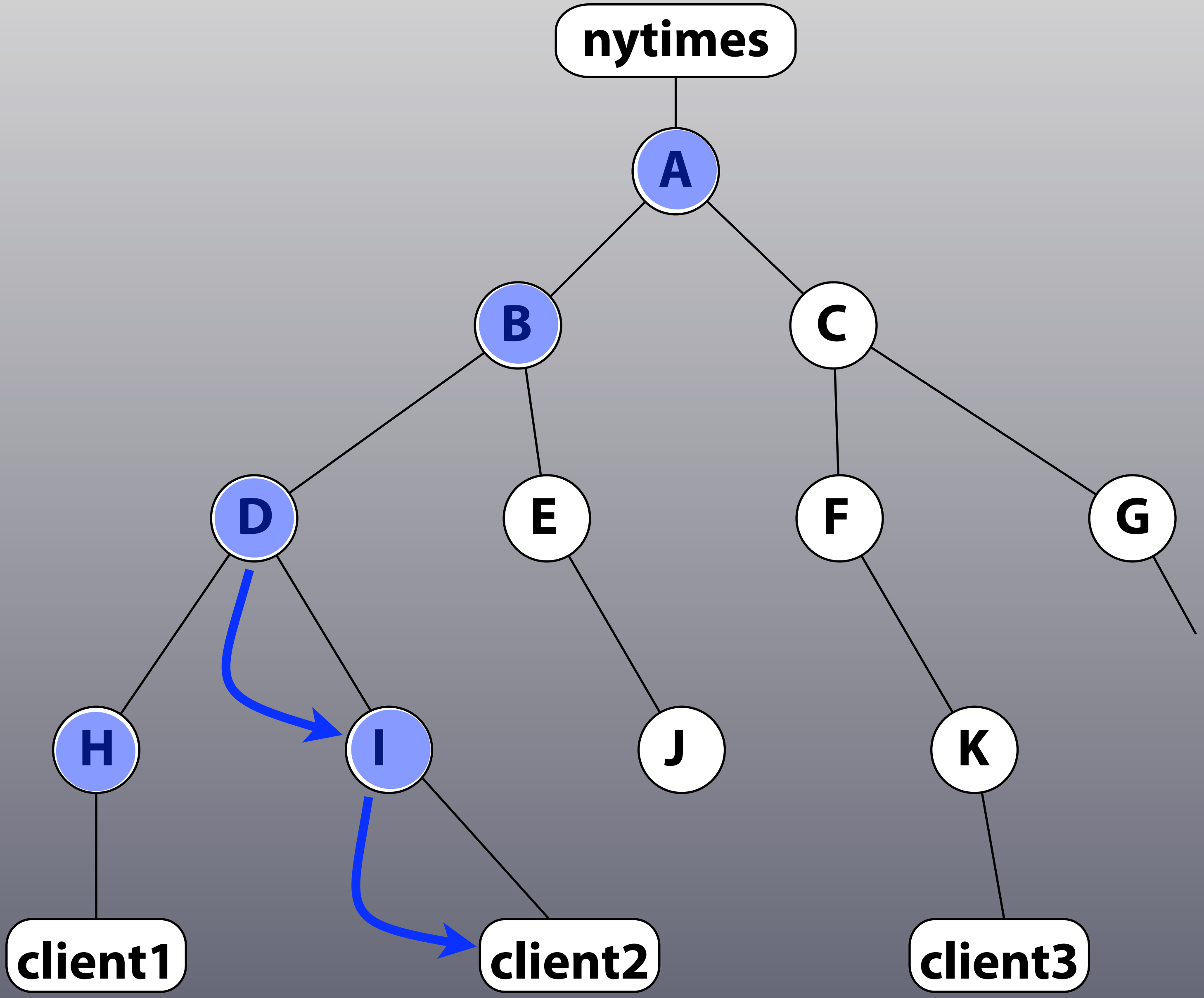

nytimes
A
B
C
D
E
F
G
H
I
J
K
client1
client2
client3

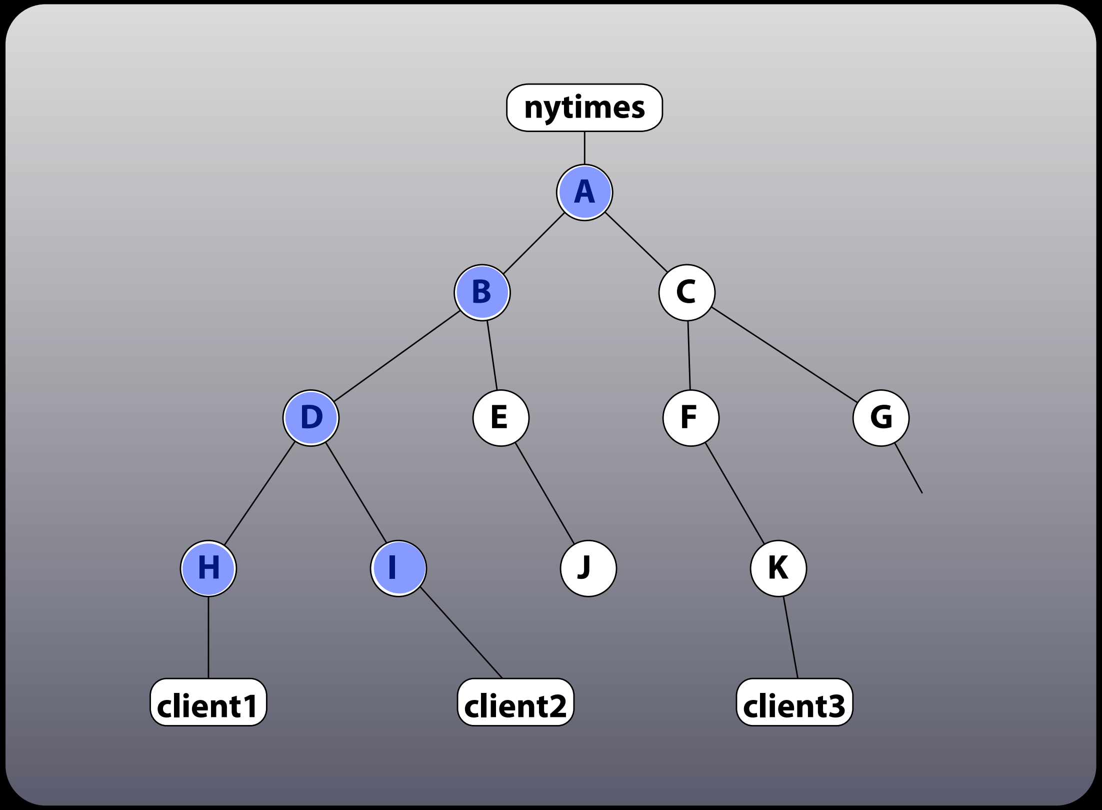

nytimes
A
B
C
D
E
F
G
H
I
J
K
client1
client2
client3


nytimes
A
B
C
D
E
F
G
H
I
J
K
client1
client2
client3


nytimes
A
B
C
D
E
F
G
H
I
J
K
client1
client2
client3

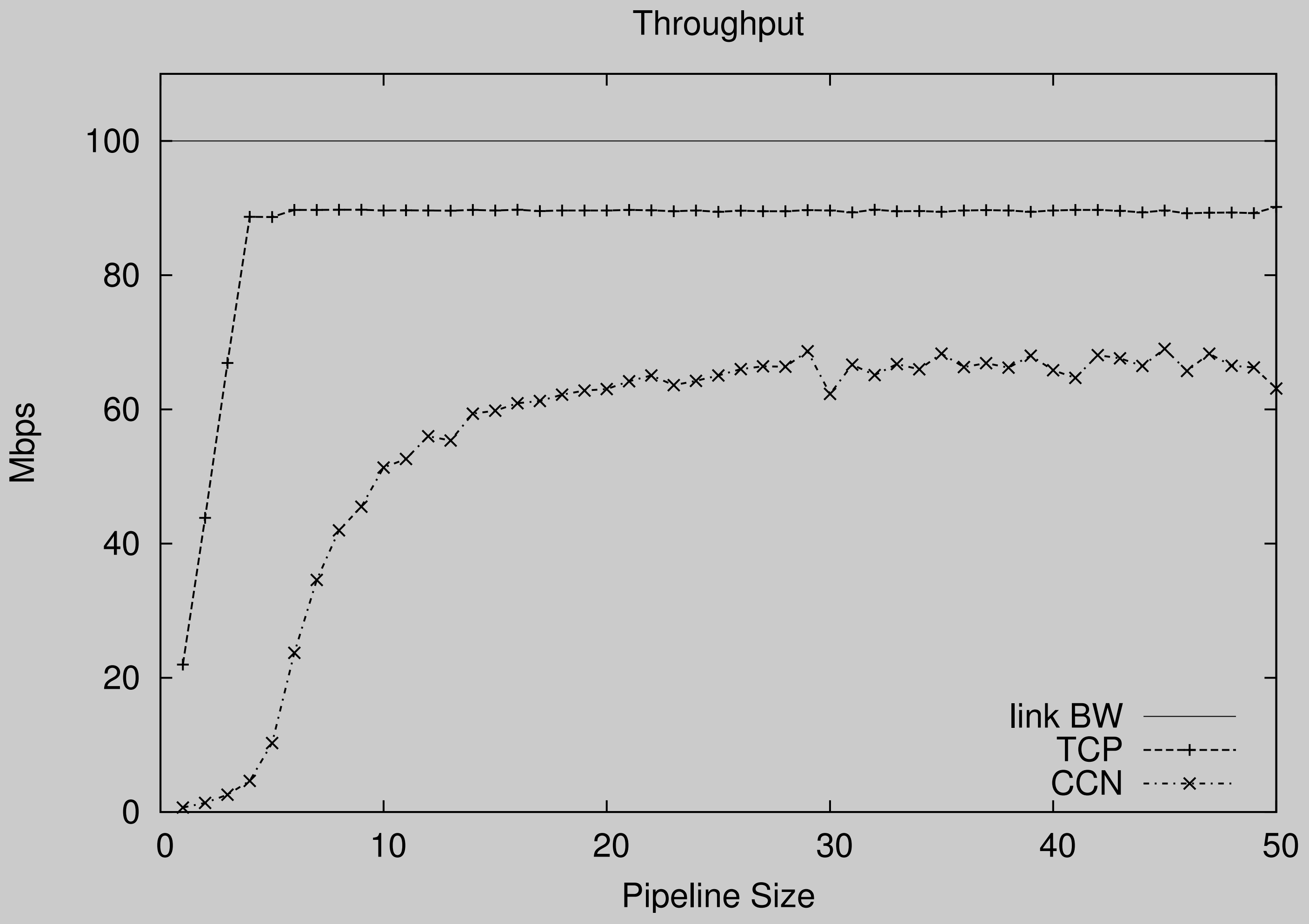

nytimes
A
B
C
D
E
F
G
H
I
J
K
client1
client2
client3


nytimes
A
B
C
D
E
F
G
H
I
J
K
client1
client2
client3

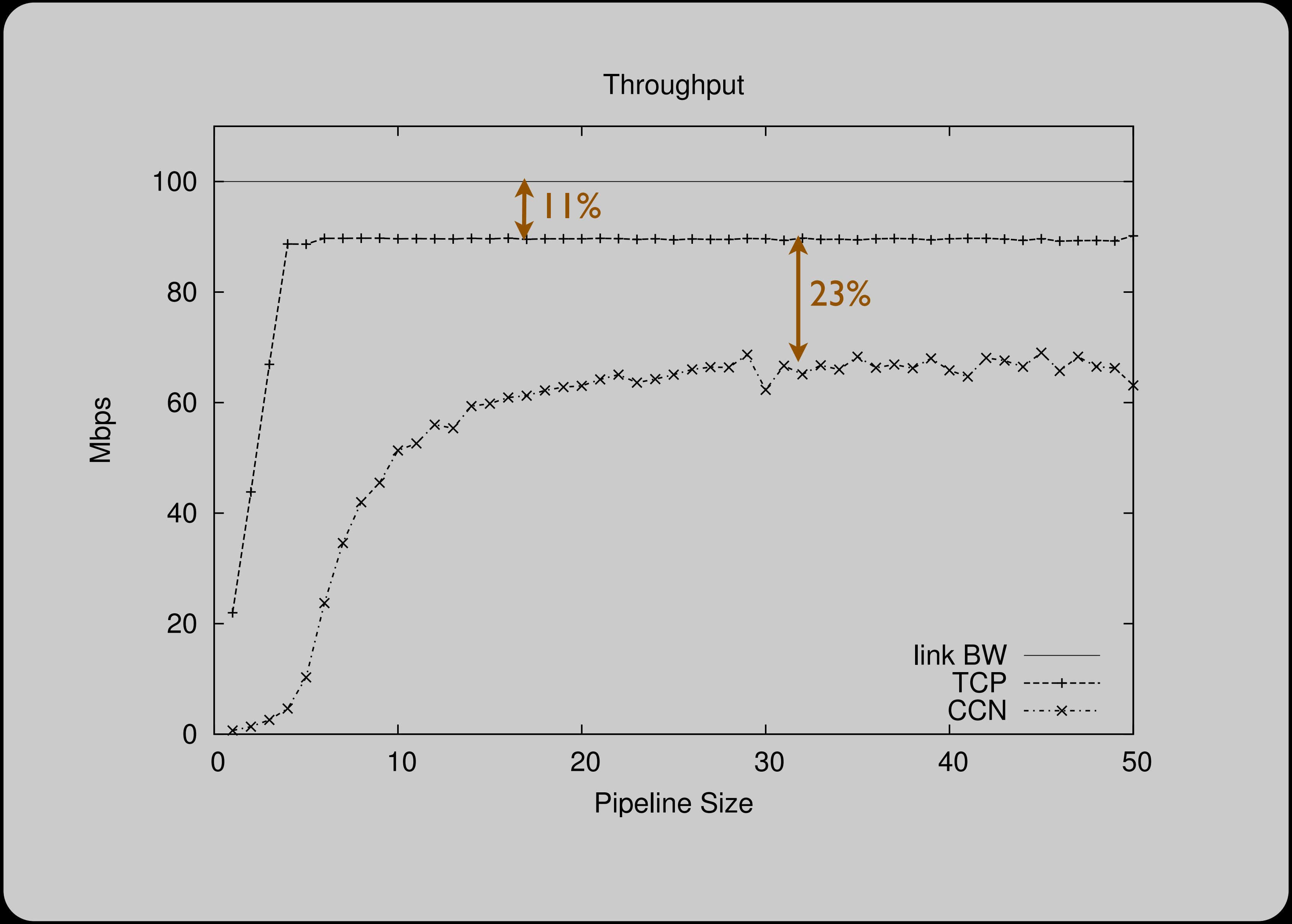


- Content goes only where there's interest.
- It takes at most one trip across any link.
- Average latency is minimized.
- Total bandwidth is minimized.
- There's no routing or control traffic associated with the replicas.

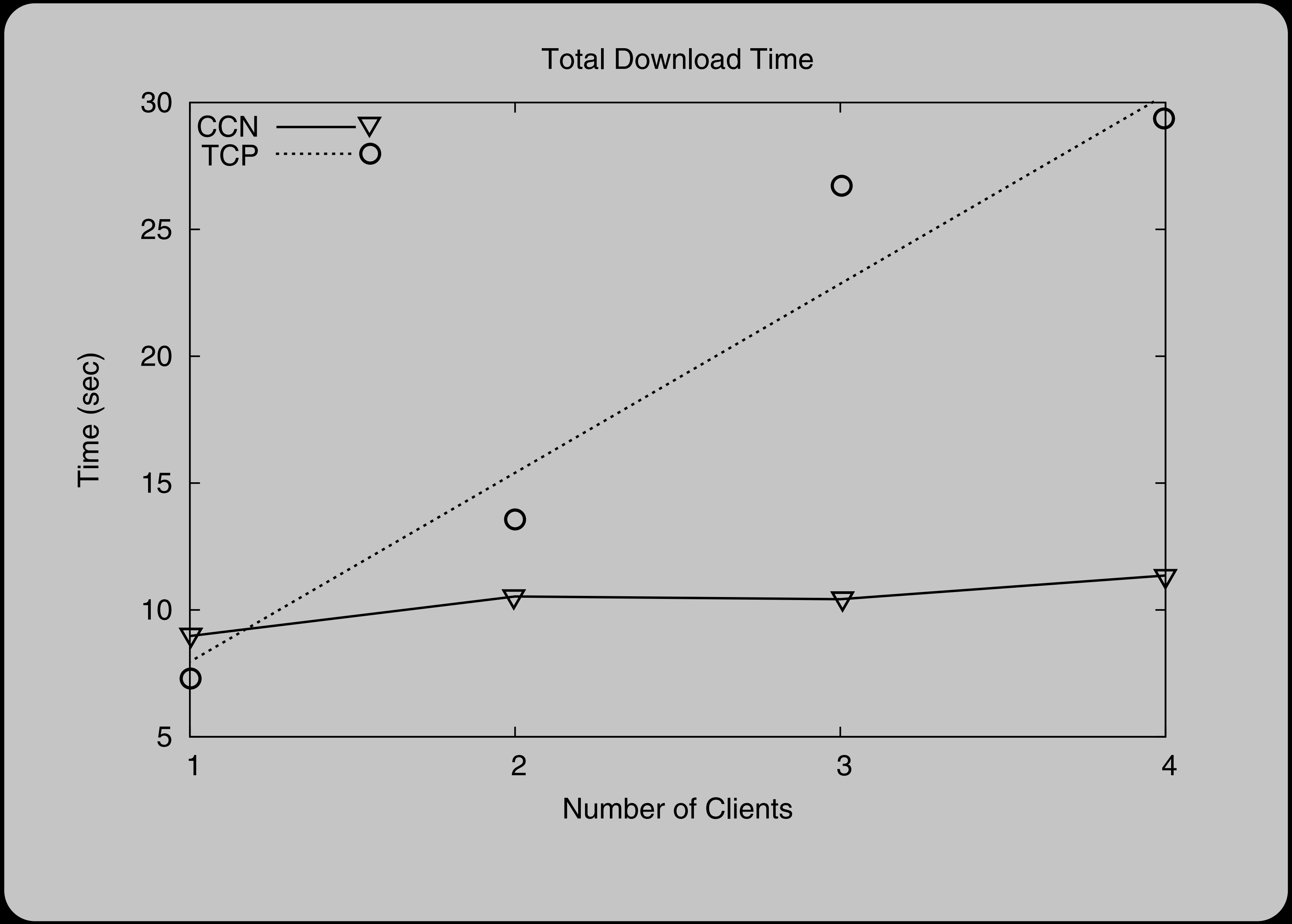
Bulk-data transfer performance comparison



Bulk-data transfer performance comparison



Shared-content performance comparison



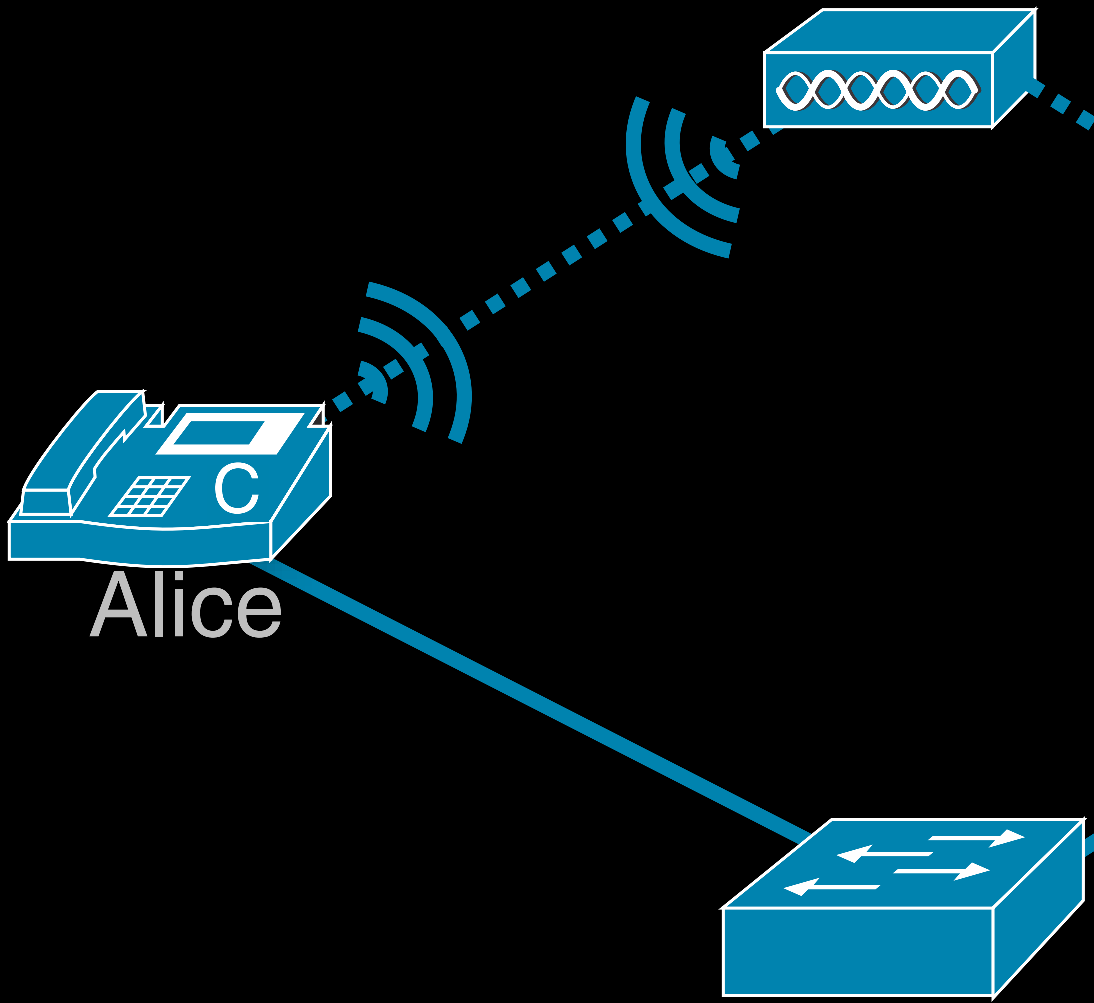
Random transport notes

- Unsatisfied interests are timed out. Consumer is responsible for re-expressing interest if they still care (fate-sharing soft-state model).
- Adaptive supression (as in SRM or NORM) avoids response implosions on broadcast faces.
- Basic CCN behaves as an efficient, secure, serverless, scalable distributed pub-sub plus intentional names.

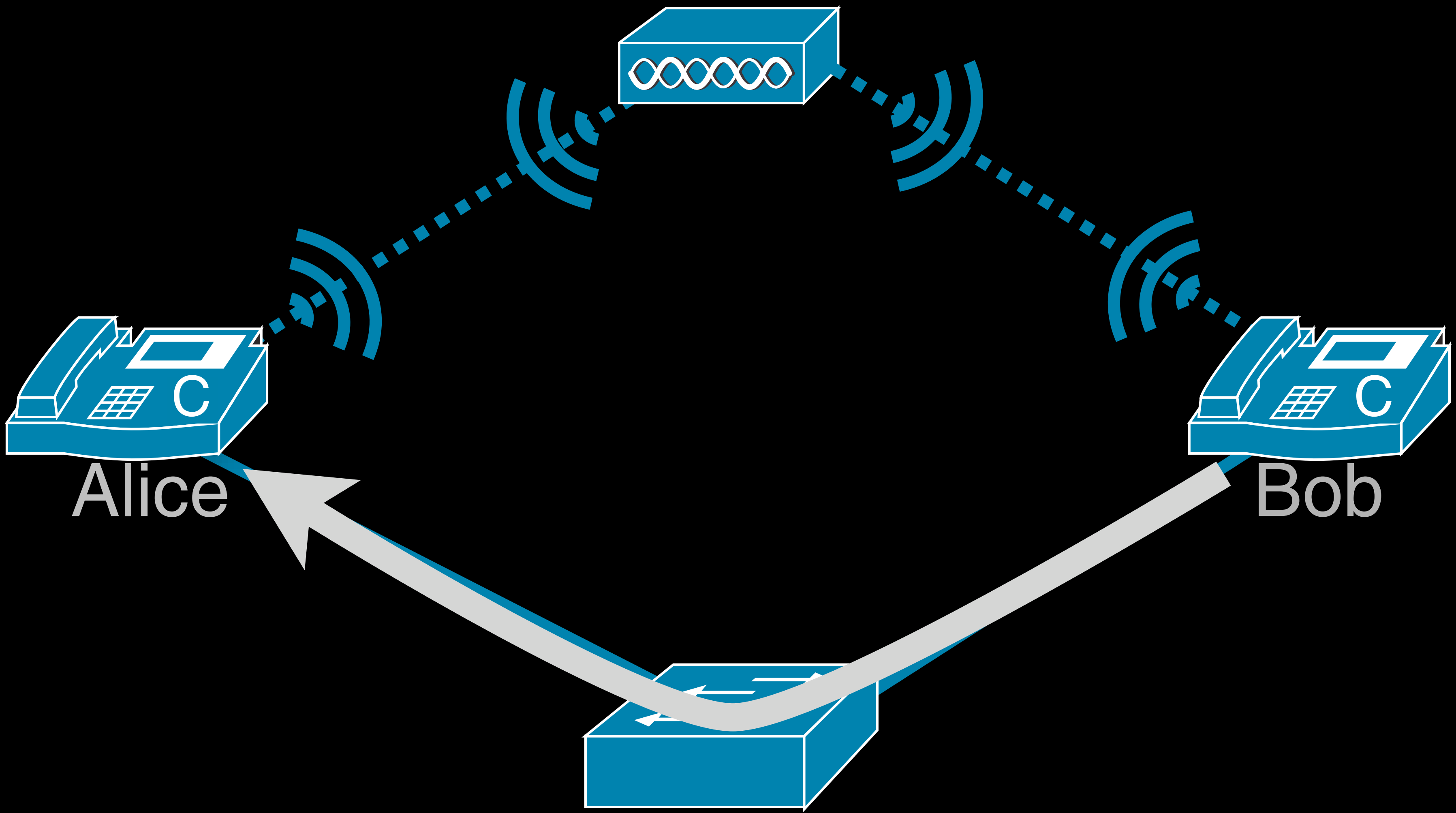
Strategy layer (mobility management)

- If you don’t care who you’re talking to, you don’t care if they change.
- If you can only ask for a few small pieces at a time, it doesn’t matter much if one gets dropped.
- If you can use any and all your links simultaneously, it’s easy for the stack to run experiments.
- If all communication is flow balanced, you know exactly what’s working and how well.

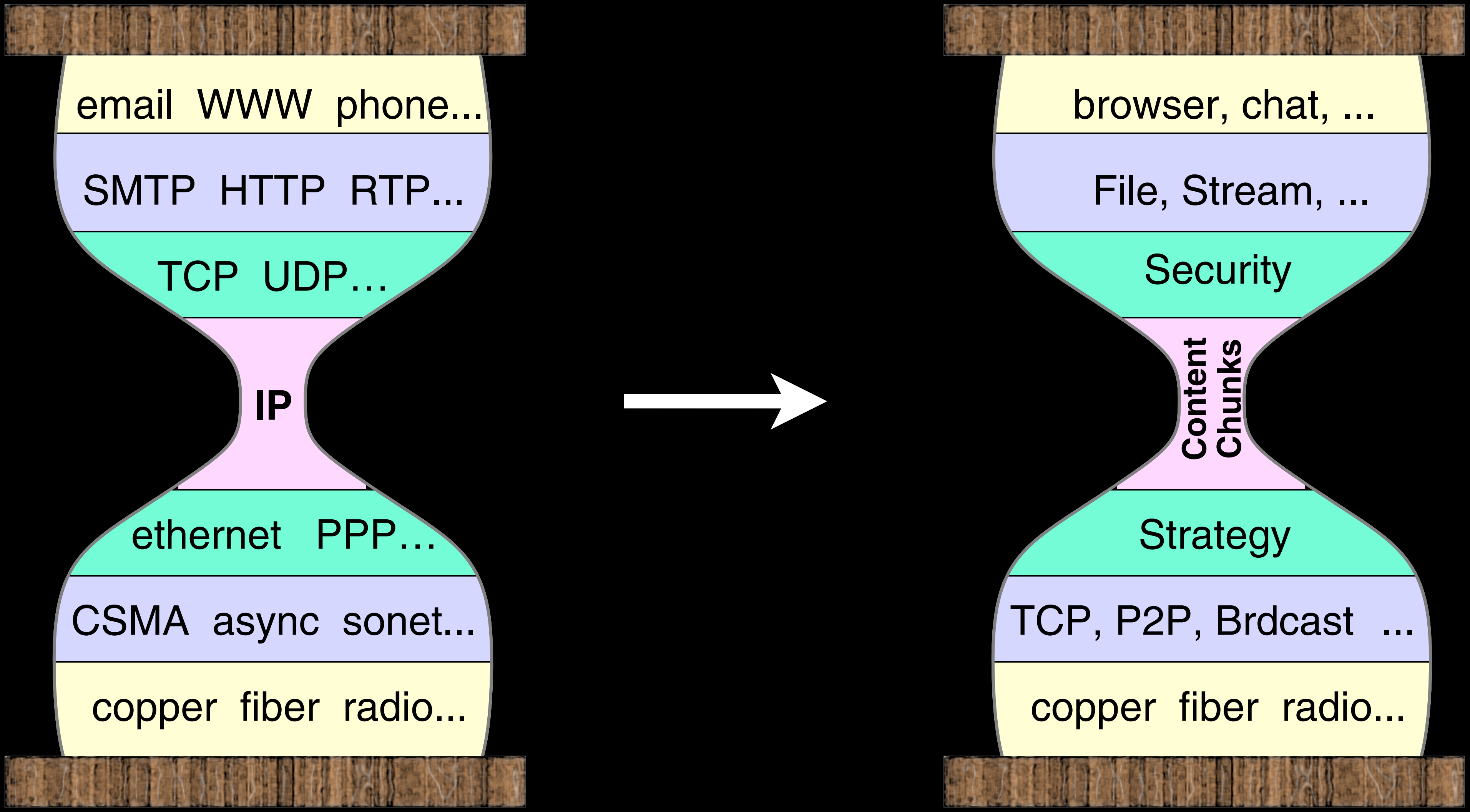
Performance-based interest re-expression



Performance-based interest re-expression



A New Layering



email WWW phone...

SMTP HTTP RTP...

TCP UDP…

IP

ethernet PPP…

CSMA async sonet...

copper fiber radio...

browser, chat, ...

File, Stream, ...

Security

Content Chunks

Strategy

TCP, P2P, Brdcast ...

copper fiber radio...