Participatory Networking

Rodrigo Fonseca
trabalho conjunto com Andrew Ferguson, Arjun Guha, Jordan Place, and Shriram Krishnamurthi

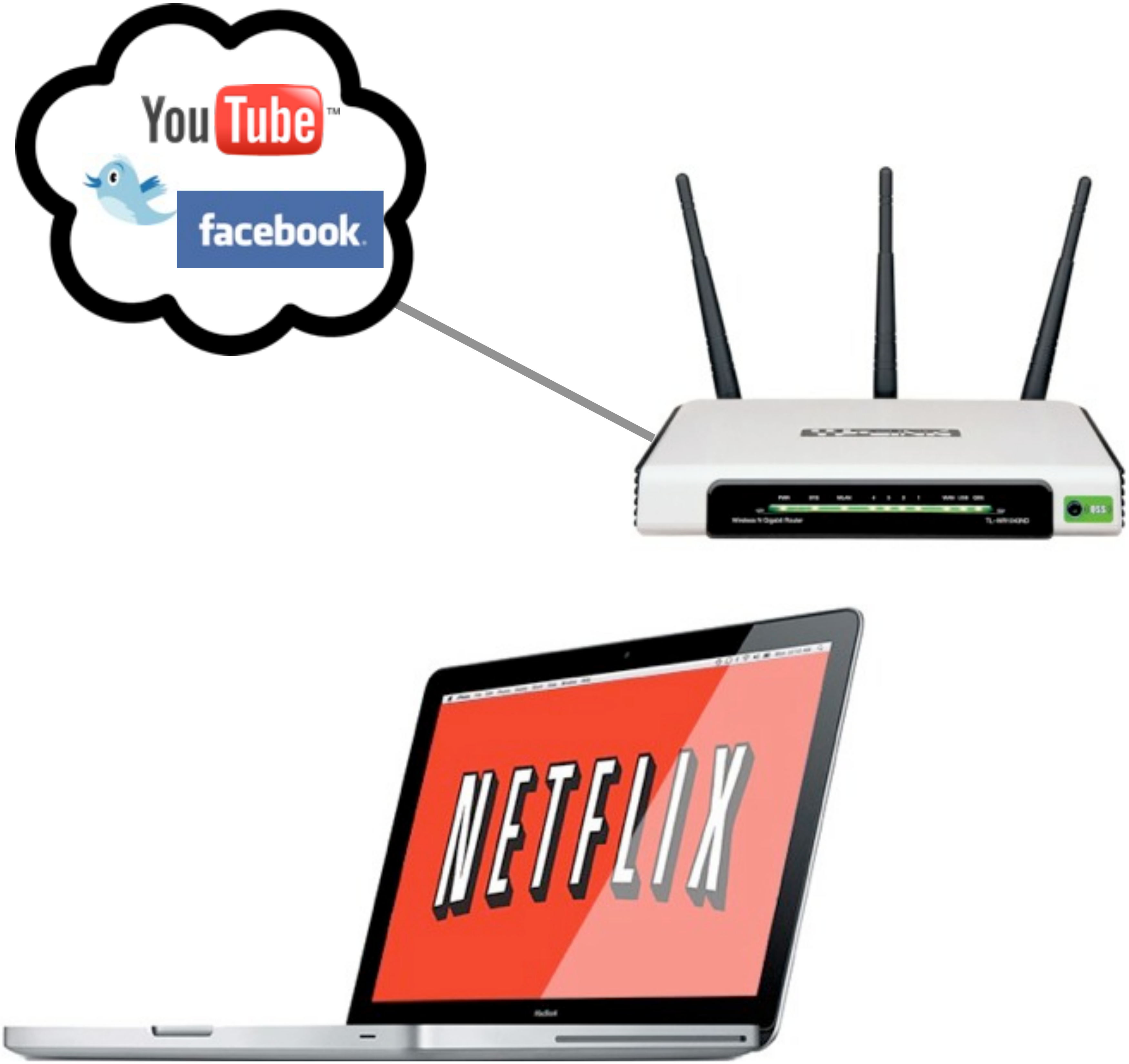
UFMG, 25/5/2012

BROWN

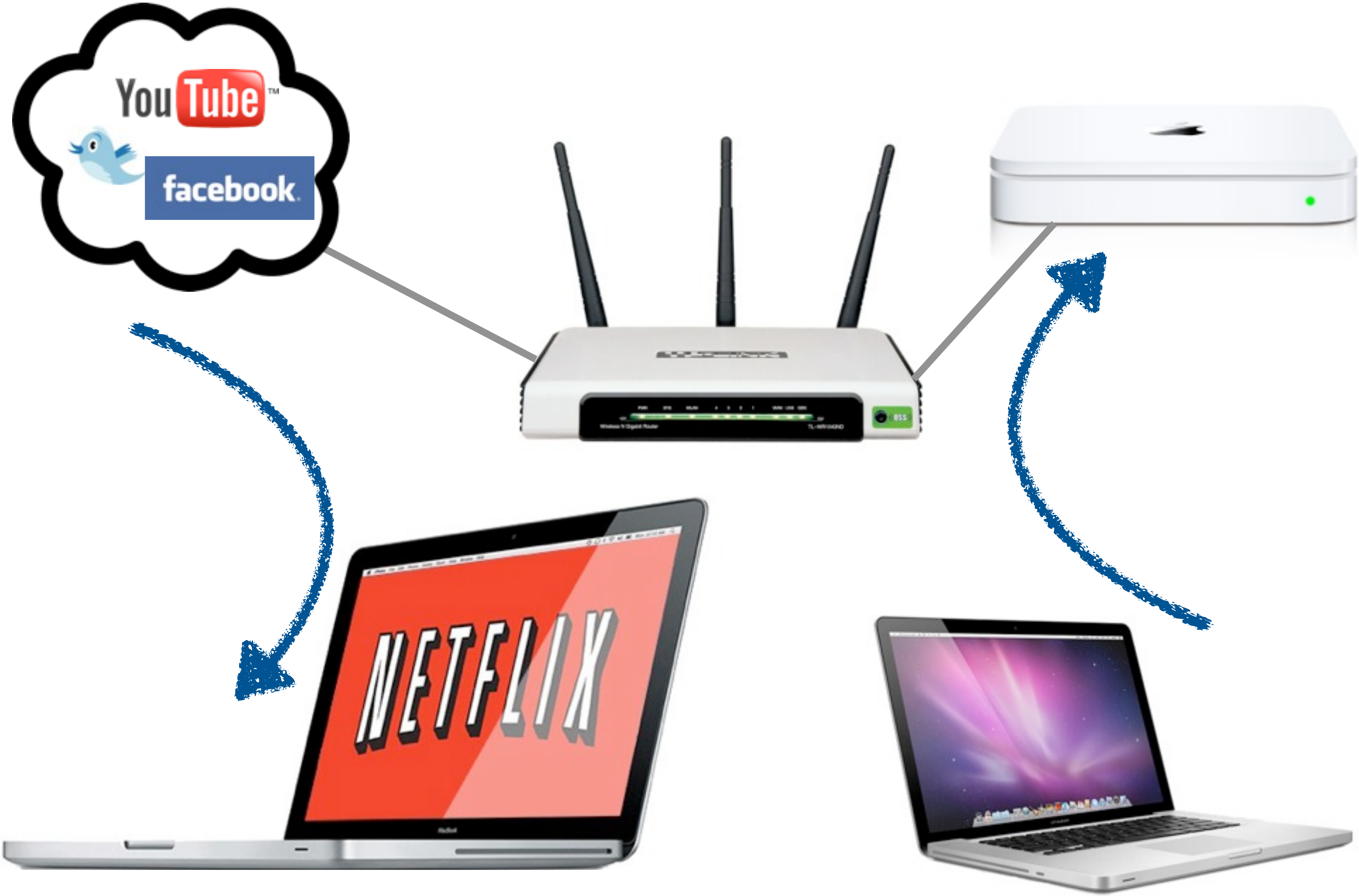
Alguns problemas com o gerenciamento de redes hoje

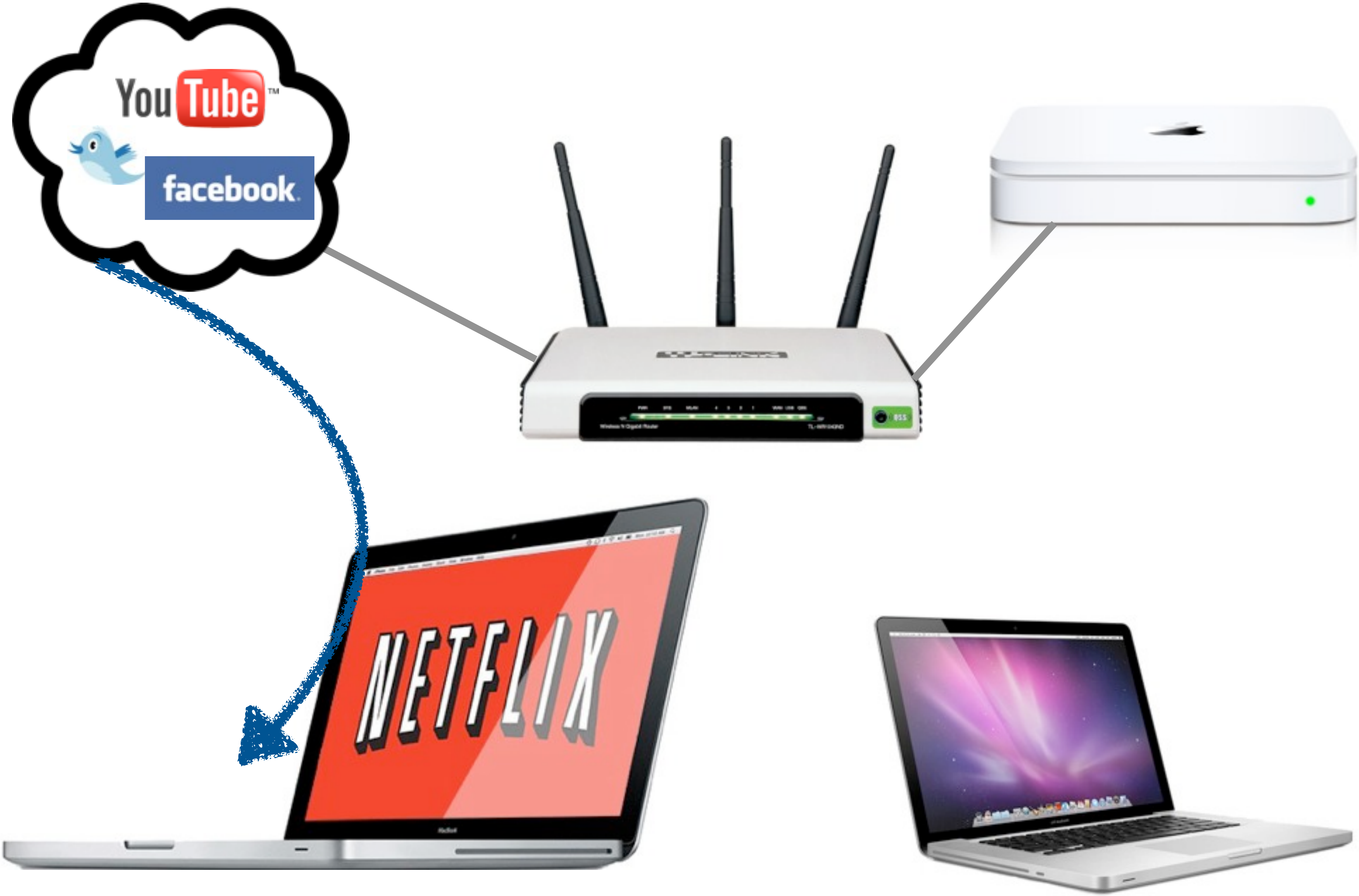
Quatro exemplos

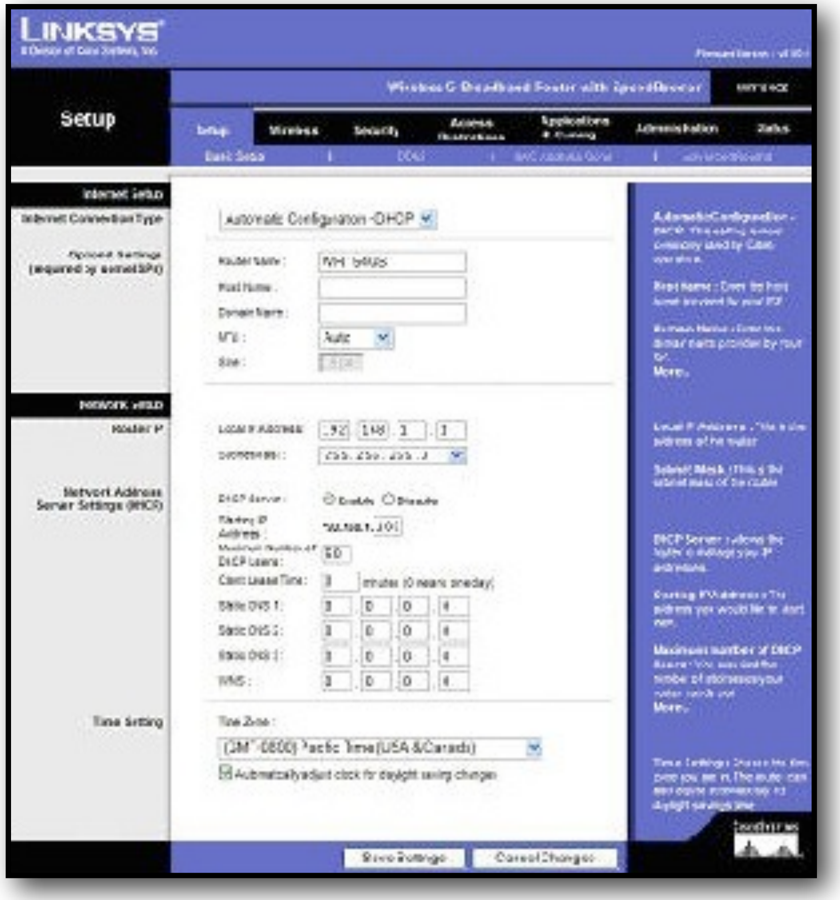
Redes residenciais

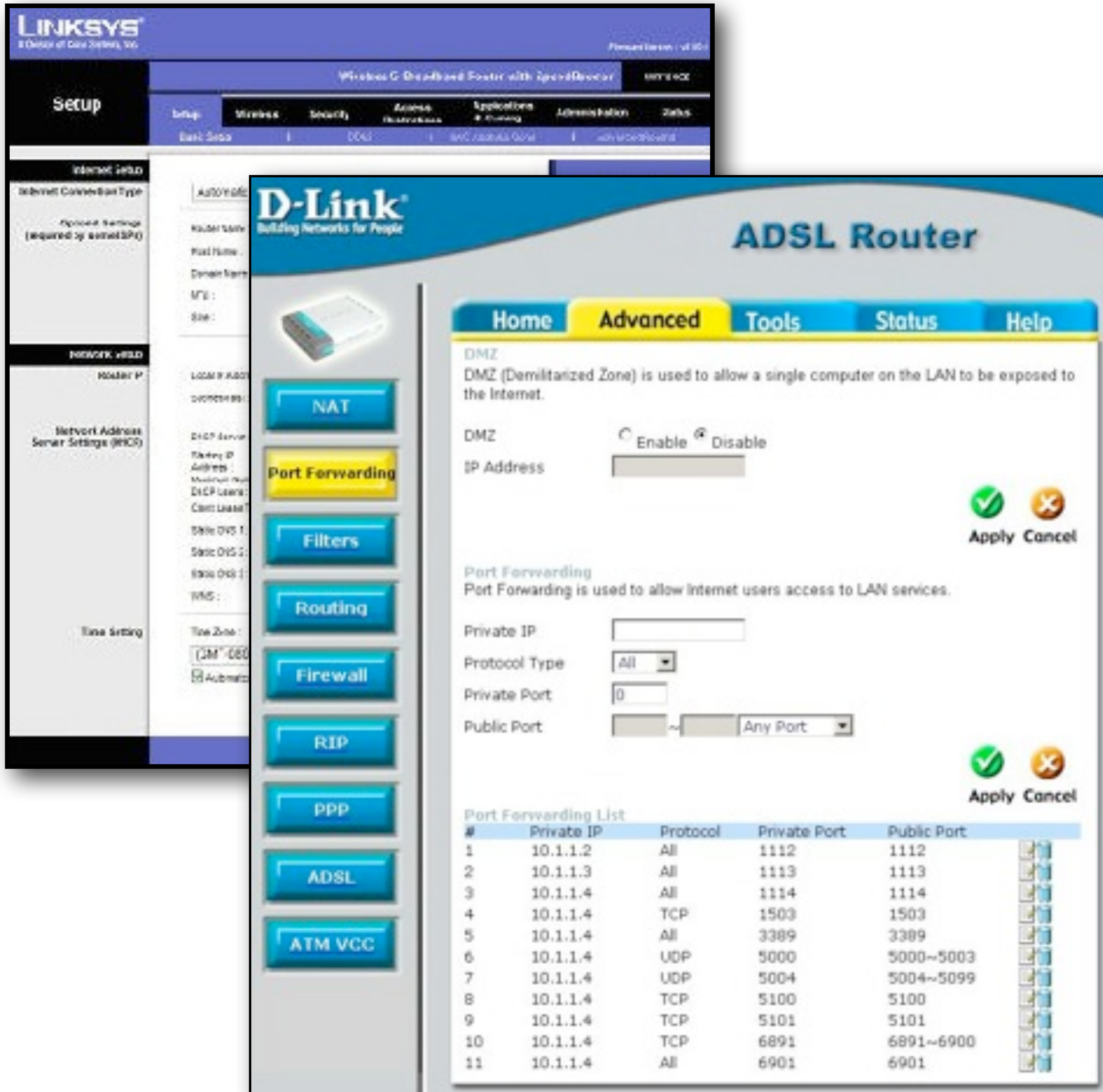

YouTube
facebook
NETFLIX

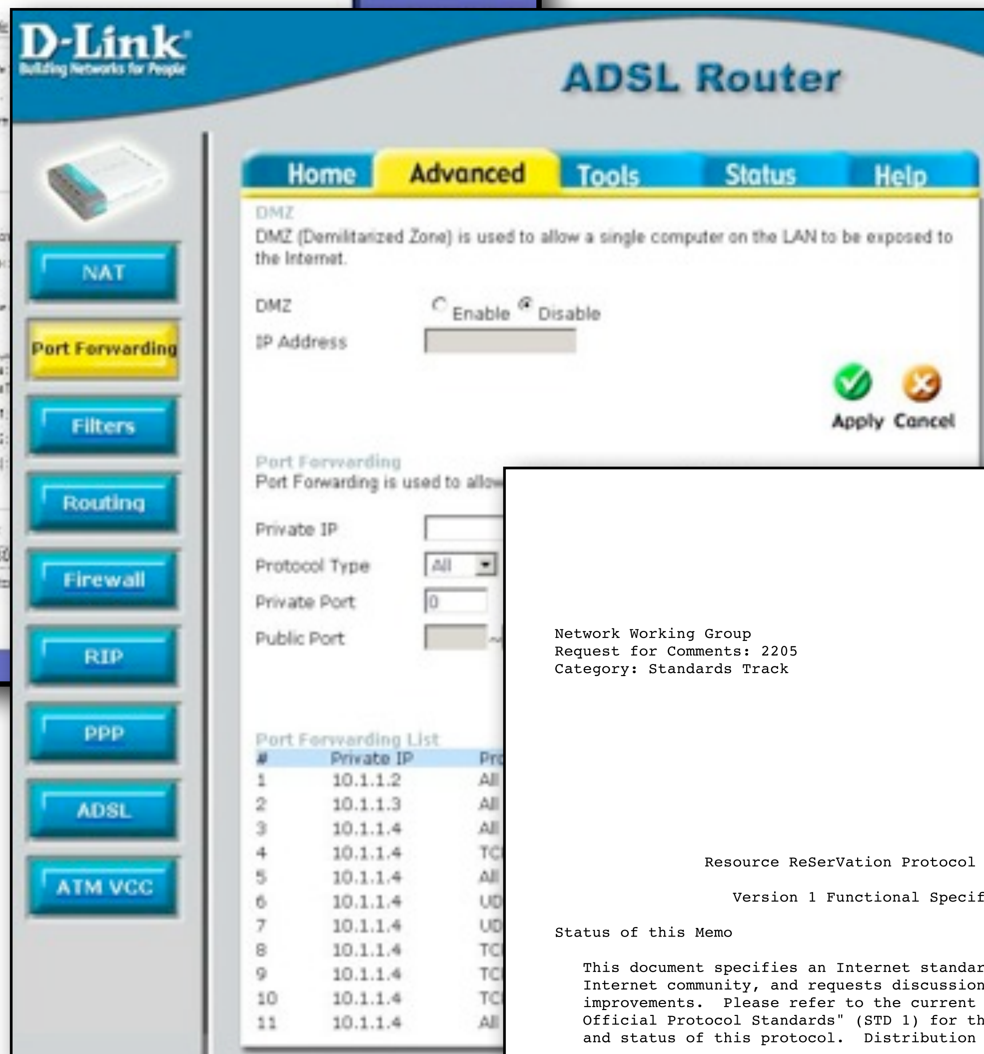

NETFLIX
89%
Buffering
Full Screen
More Episodes
Back to Browsing

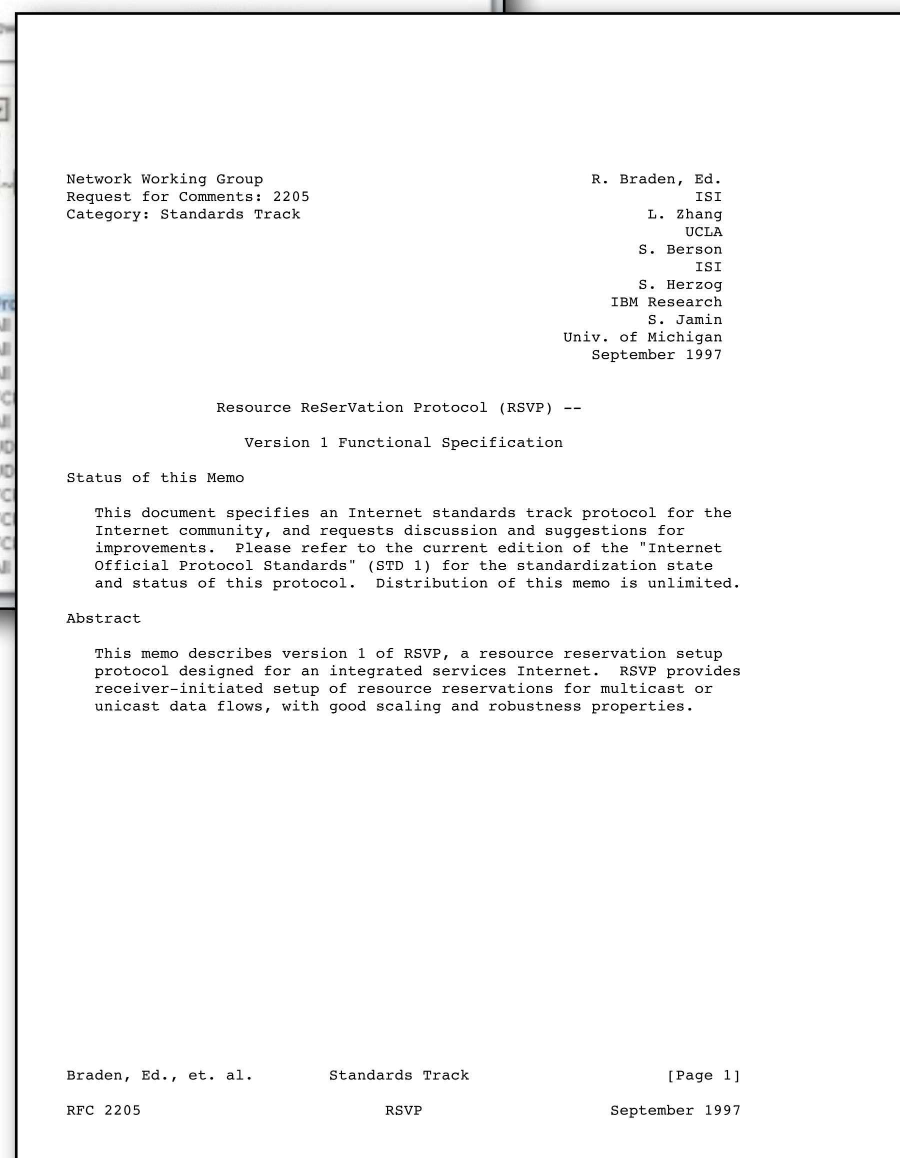

YouTube
facebook
NETFLIX


YouTube
facebook
NETFLIX

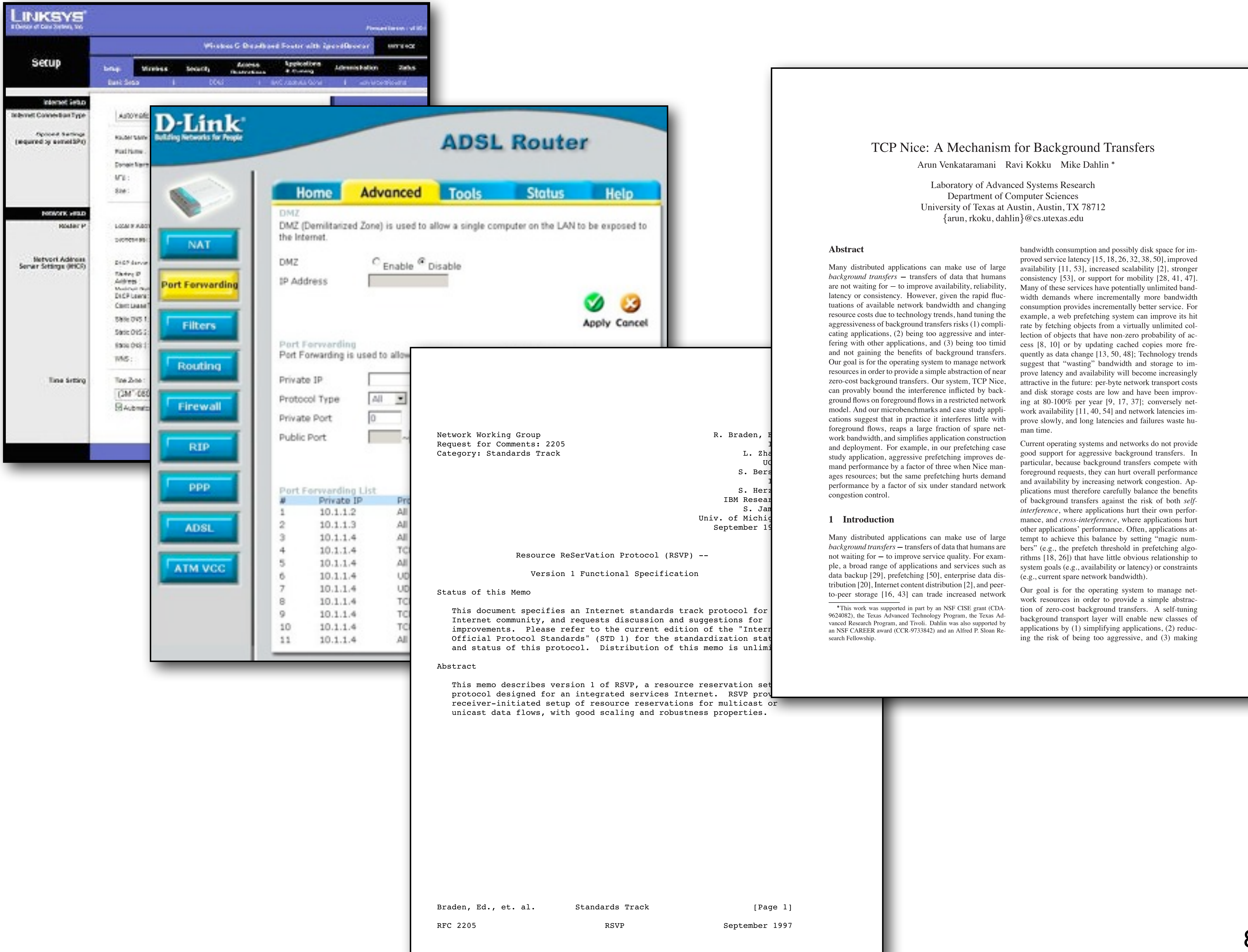

LINKSYS
Setup
Setup
Wireless
Security
Administration
Status
Internet Setup
Internet Connection Type
Automatic Configuration - DHCP
Network Setup
Router IP
Local IP Address:
Network Address Server Settings (DHCP)
Time Setting
Time Zone:
Save Settings
Cancel Changes


LINKSYS
Setup
D-Link
Building Networks for People
ADSL Router
Home
Advanced
Tools
Status
Help
NAT
Port Forwarding
Filters
Routing
Firewall
RIP
PPP
ADSL
ATM VCC
DMZ
DMZ (Demilitarized Zone) is used to allow a single computer on the LAN to be exposed to the Internet.
DMZ
Enable
Disable
IP Address
Apply
Cancel
Port Forwarding
Port Forwarding is used to allow Internet users access to LAN services.
Private IP
Protocol Type
All
Private Port
0
Public Port
Any Port
Apply
Cancel
Port Forwarding List
Private IP Protocol Private Port Public Port
1 10.1.1.2 All 1112 1112
2 10.1.1.3 All 1113 1113
3 10.1.1.4 All 1114 1114
4 10.1.1.4 TCP 1503 1503
5 10.1.1.4 All 3389 3389
6 10.1.1.4 UDP 5000 5000~5003
7 10.1.1.4 UDP 5004 5004~5099
8 10.1.1.4 TCP 5100 5100
9 10.1.1.4 TCP 5101 5101
10 10.1.1.4 TCP 6891 6891~6900
11 10.1.1.4 All 6901 6901





```
Network Working Group                                    R. Braden, Ed.
Request for Comments: 2205                                          ISI
Category: Standards Track                                      L. Zhang
                                                                   UCLA
                                                              S. Berson
                                                                    ISI
                                                              S. Herzog
                                                           IBM Research
                                                               S. Jamin
                                                      Univ. of Michigan
                                                         September 1997

                Resource ReSerVation Protocol (RSVP) --

                   Version 1 Functional Specification

Status of this Memo

   This document specifies an Internet standards track protocol for the
   Internet community, and requests discussion and suggestions for
   improvements.  Please refer to the current edition of the "Internet
   Official Protocol Standards" (STD 1) for the standardization state
   and status of this protocol.  Distribution of this memo is unlimited.

Abstract

   This memo describes version 1 of RSVP, a resource reservation setup
   protocol designed for an integrated services Internet.  RSVP provides
   receiver-initiated setup of resource reservations for multicast or
   unicast data flows, with good scaling and robustness properties.

Braden, Ed., et. al.         Standards Track                    [Page 1]

RFC 2205                          RSVP                    September 1997
```




```
Network Working Group                                        R. Braden,
Request for Comments: 2205
Category: Standards Track                                        L. Zha
                                                                     UC
                                                                S. Bers

                                                                S. Herz
                                                             IBM Resear
                                                                 S. Jam
                                                          Univ. of Michig
                                                            September 19

                Resource ReSerVation Protocol (RSVP) --

                     Version 1 Functional Specification

Status of this Memo

   This document specifies an Internet standards track protocol for
   Internet community, and requests discussion and suggestions for
   improvements.  Please refer to the current edition of the "Intern
   Official Protocol Standards" (STD 1) for the standardization stat
   and status of this protocol.  Distribution of this memo is unlimi

Abstract

   This memo describes version 1 of RSVP, a resource reservation set
   protocol designed for an integrated services Internet.  RSVP prov
   receiver-initiated setup of resource reservations for multicast or
   unicast data flows, with good scaling and robustness properties.

Braden, Ed., et. al.        Standards Track                   [Page 1]

RFC 2205                          RSVP                    September 1997
```

TCP Nice: A Mechanism for Background Transfers

Arun Venkataramani Ravi Kokku Mike Dahlin *

Laboratory of Advanced Systems Research
Department of Computer Sciences
University of Texas at Austin, Austin, TX 78712
{arun, rkoku, dahlin}@cs.utexas.edu

Abstract

Many distributed applications can make use of large *background transfers* — transfers of data that humans are not waiting for — to improve availability, reliability, latency or consistency. However, given the rapid fluctuations of available network bandwidth and changing resource costs due to technology trends, hand tuning the aggressiveness of background transfers risks (1) complicating applications, (2) being too aggressive and interfering with other applications, and (3) being too timid and not gaining the benefits of background transfers. Our goal is for the operating system to manage network resources in order to provide a simple abstraction of near zero-cost background transfers. Our system, TCP Nice, can provably bound the interference inflicted by background flows on foreground flows in a restricted network model. And our microbenchmarks and case study applications suggest that in practice it interferes little with foreground flows, reaps a large fraction of spare network bandwidth, and simplifies application construction and deployment. For example, in our prefetching case study application, aggressive prefetching improves demand performance by a factor of three when Nice manages resources; but the same prefetching hurts demand performance by a factor of six under standard network congestion control.

1 Introduction

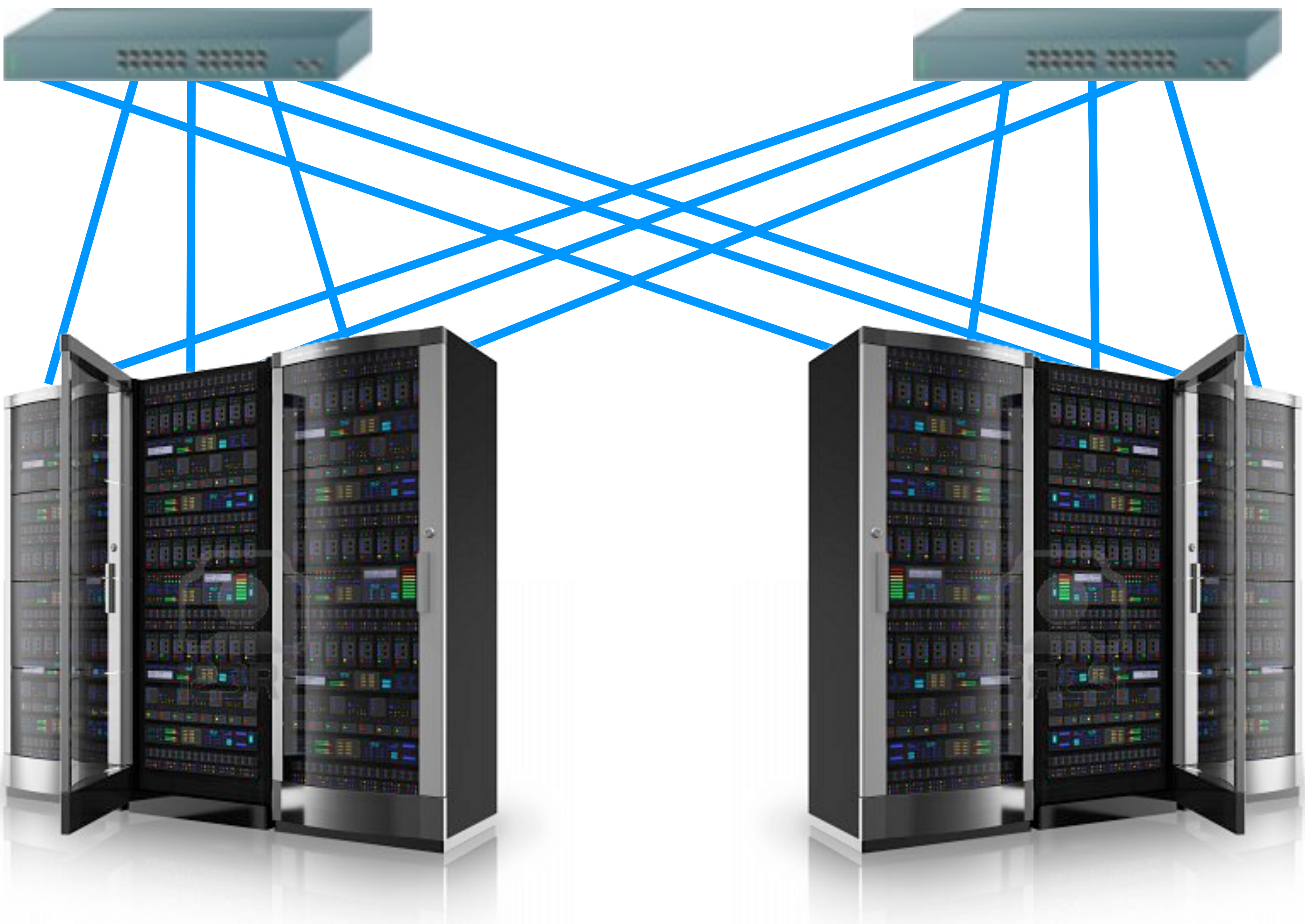
Many distributed applications can make use of large *background transfers* — transfers of data that humans are not waiting for — to improve service quality. For example, a broad range of applications and services such as data backup [29], prefetching [50], enterprise data distribution [20], Internet content distribution [2], and peer-to-peer storage [16, 43] can trade increased network bandwidth consumption and possibly disk space for improved service latency [15, 18, 26, 32, 38, 50], improved availability [11, 53], increased scalability [2], stronger consistency [53], or support for mobility [28, 41, 47]. Many of these services have potentially unlimited bandwidth demands where incrementally more bandwidth consumption provides incrementally better service. For example, a web prefetching system can improve its hit rate by fetching objects from a virtually unlimited collection of objects that have non-zero probability of access [8, 10] or by updating cached copies more frequently as data change [13, 50, 48]; Technology trends suggest that "wasting" bandwidth and storage to improve latency and availability will become increasingly attractive in the future: per-byte network transport costs and disk storage costs are low and have been improving at 80-100% per year [9, 17, 37]; conversely network availability [11, 40, 54] and network latencies improve slowly, and long latencies and failures waste human time.

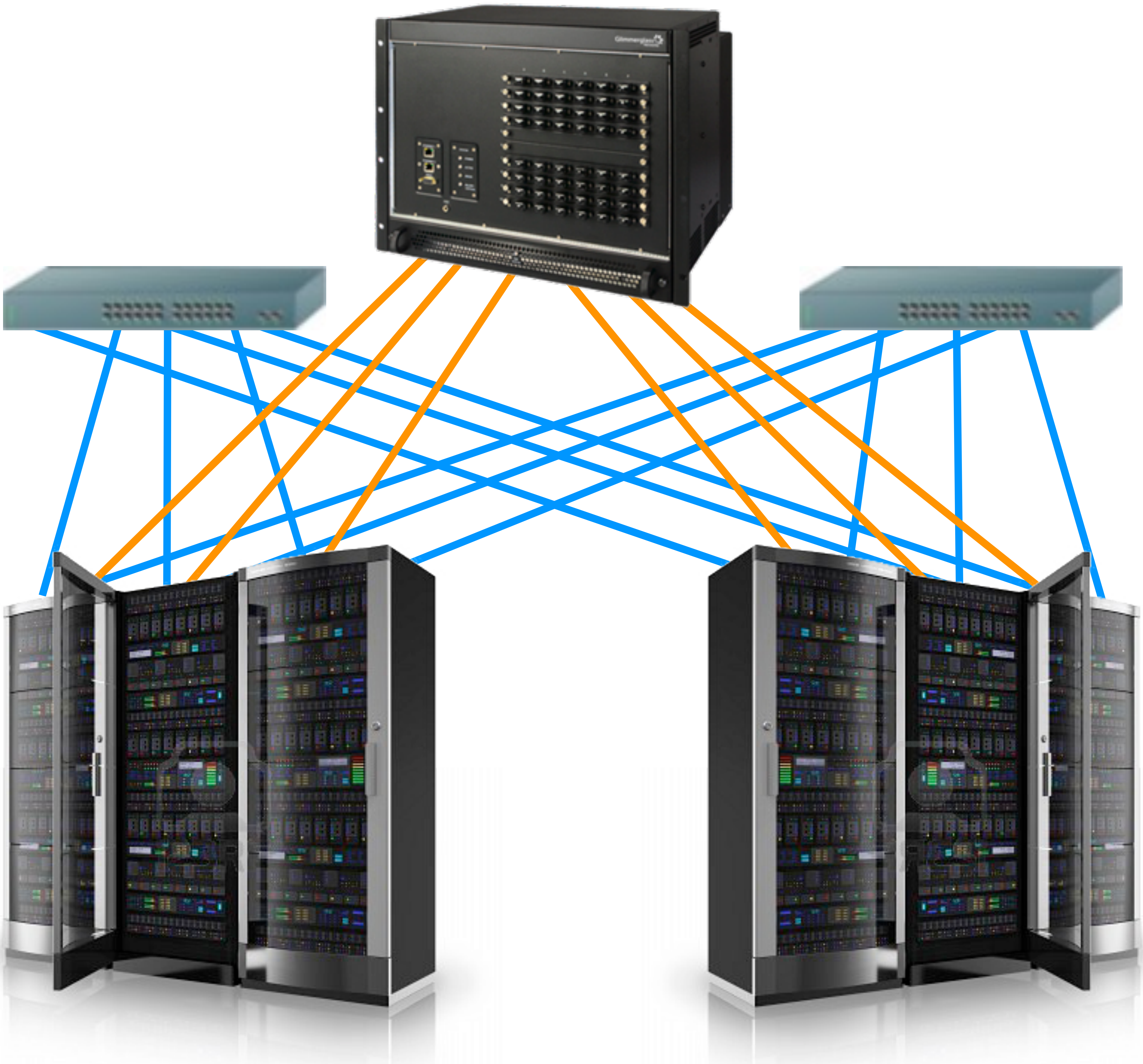
Current operating systems and networks do not provide good support for aggressive background transfers. In particular, because background transfers compete with foreground requests, they can hurt overall performance and availability by increasing network congestion. Applications must therefore carefully balance the benefits of background transfers against the risk of both *self-interference*, where applications hurt their own performance, and *cross-interference*, where applications hurt other applications' performance. Often, applications attempt to achieve this balance by setting "magic numbers" (e.g., the prefetch threshold in prefetching algorithms [18, 26]) that have little obvious relationship to system goals (e.g., availability or latency) or constraints (e.g., current spare network bandwidth).

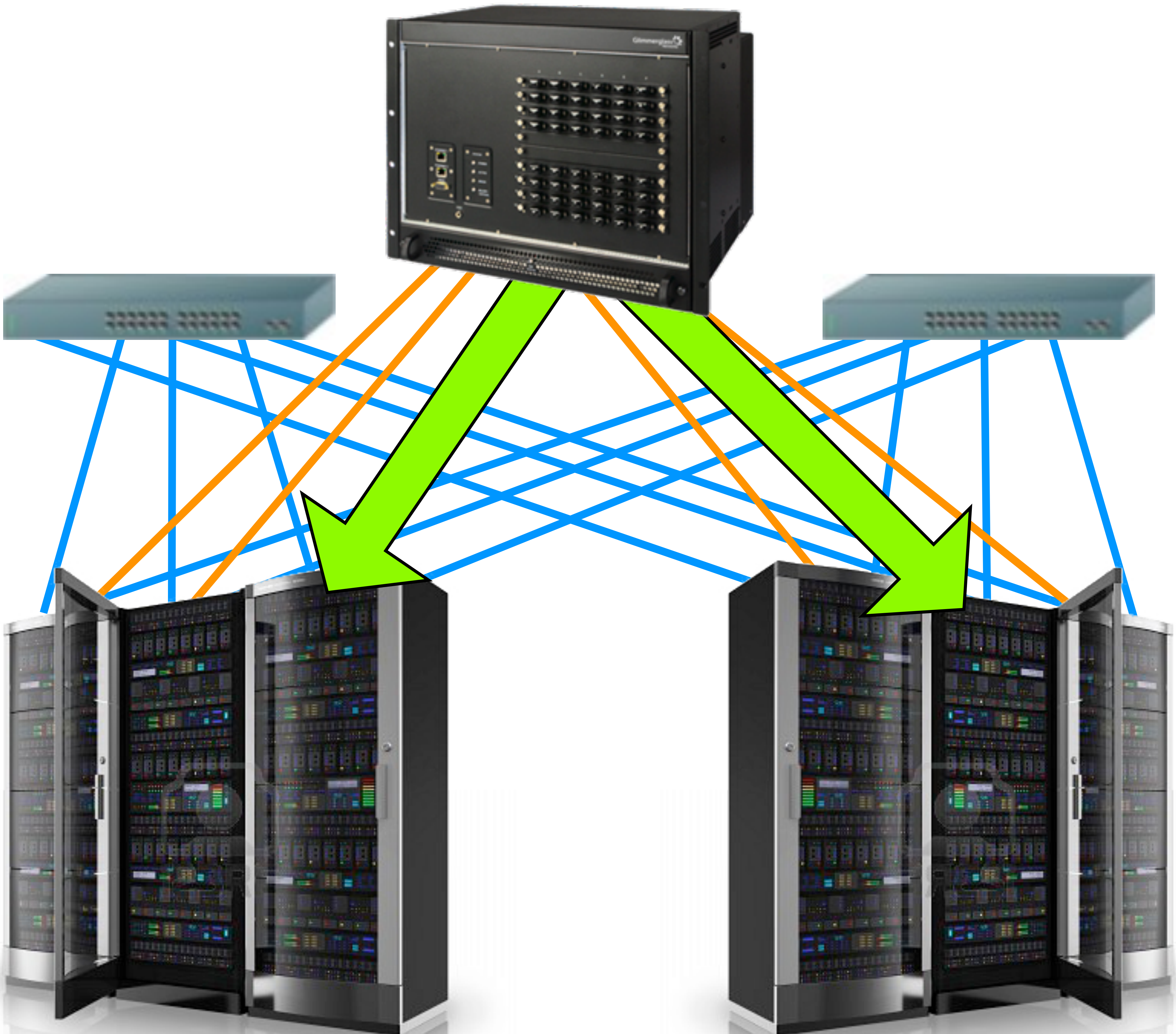
Our goal is for the operating system to manage network resources in order to provide a simple abstraction of zero-cost background transfers. A self-tuning background transport layer will enable new classes of applications by (1) simplifying applications, (2) reducing the risk of being too aggressive, and (3) making

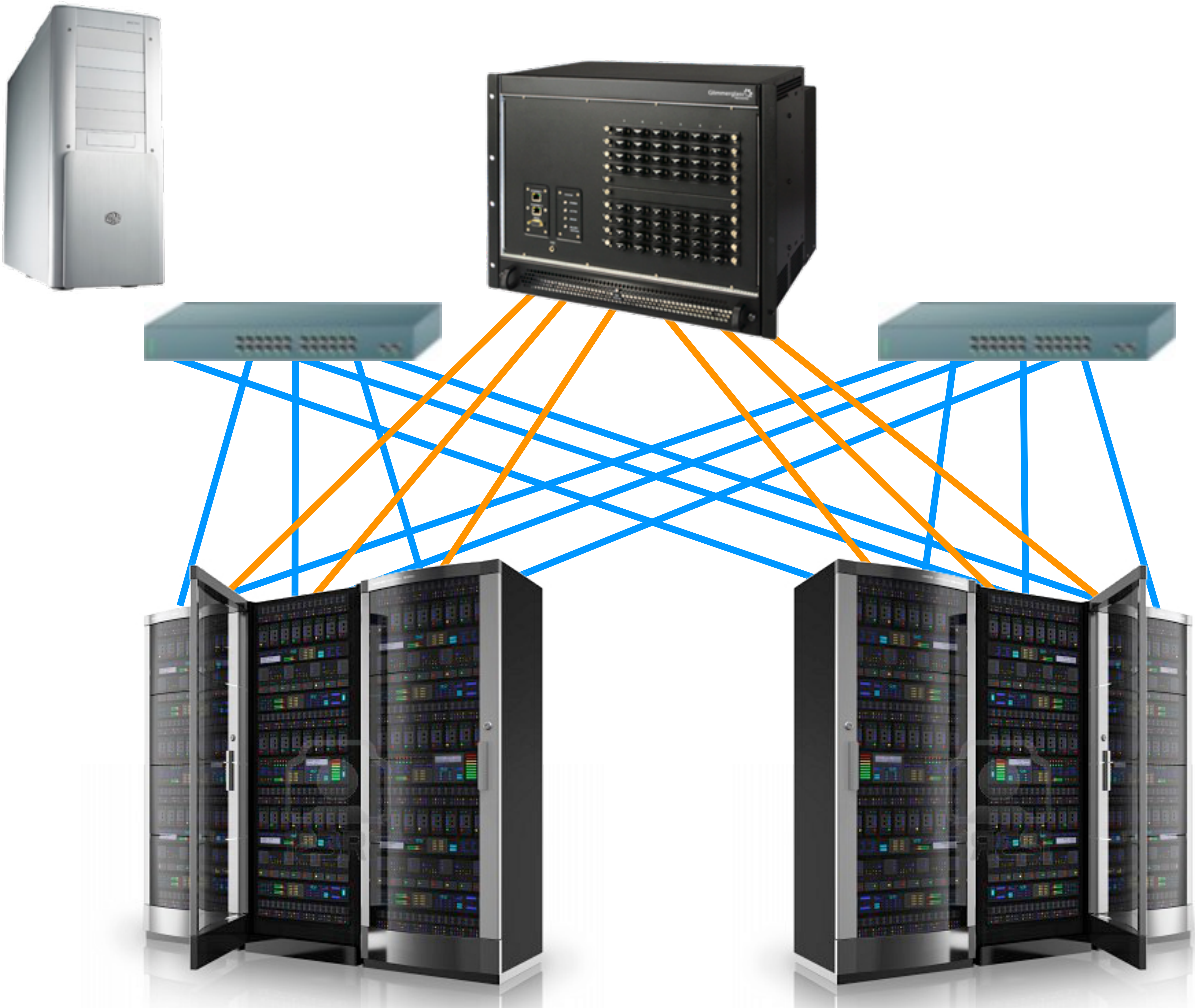
*This work was supported in part by an NSF CISE grant (CDA-9624082), the Texas Advanced Technology Program, the Texas Advanced Research Program, and Tivoli. Dahlin was also supported by an NSF CAREER award (CCR-9733842) and an Alfred P. Sloan Research Fellowship.

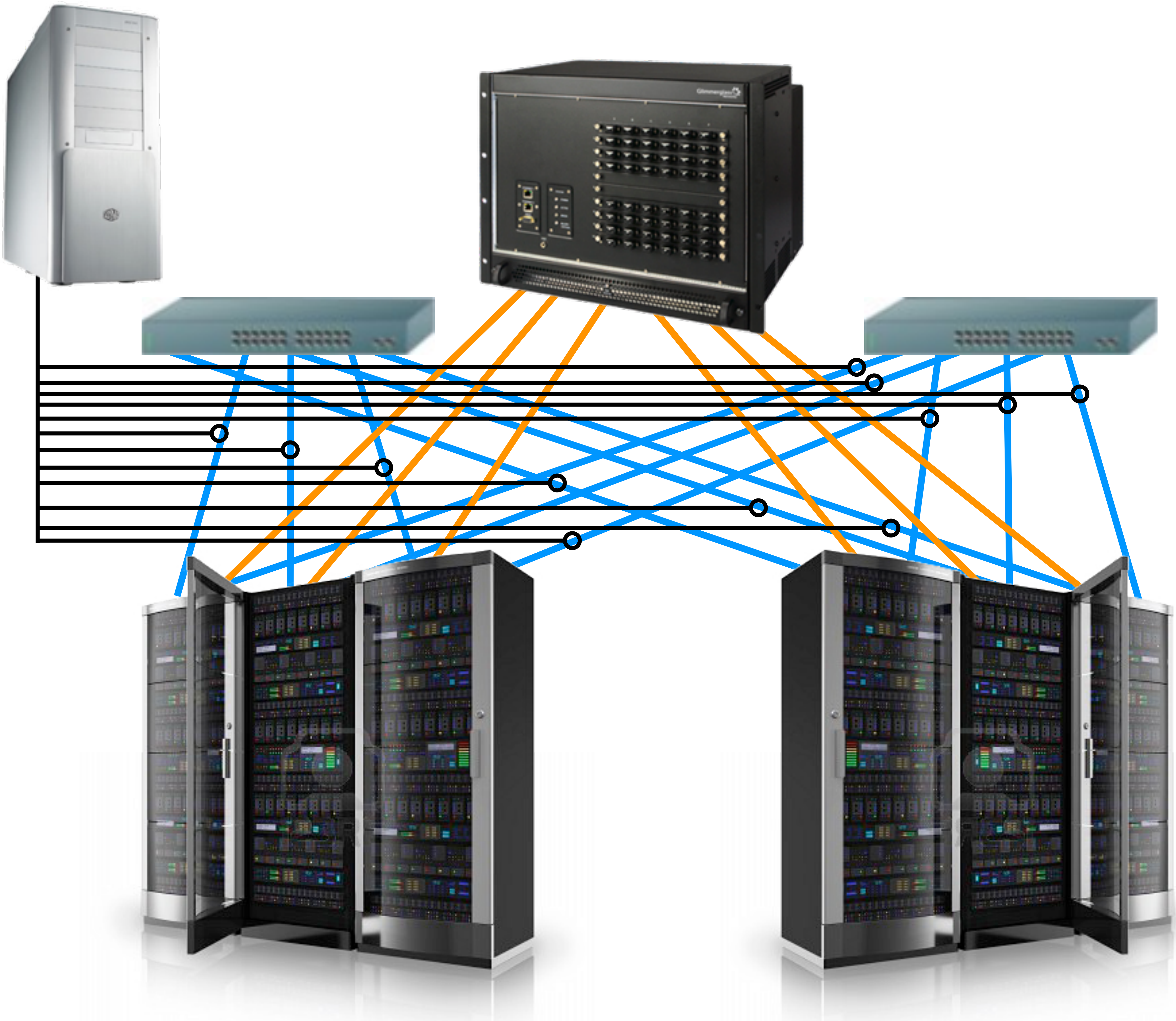
Datacenters:
Processamento em larga escala

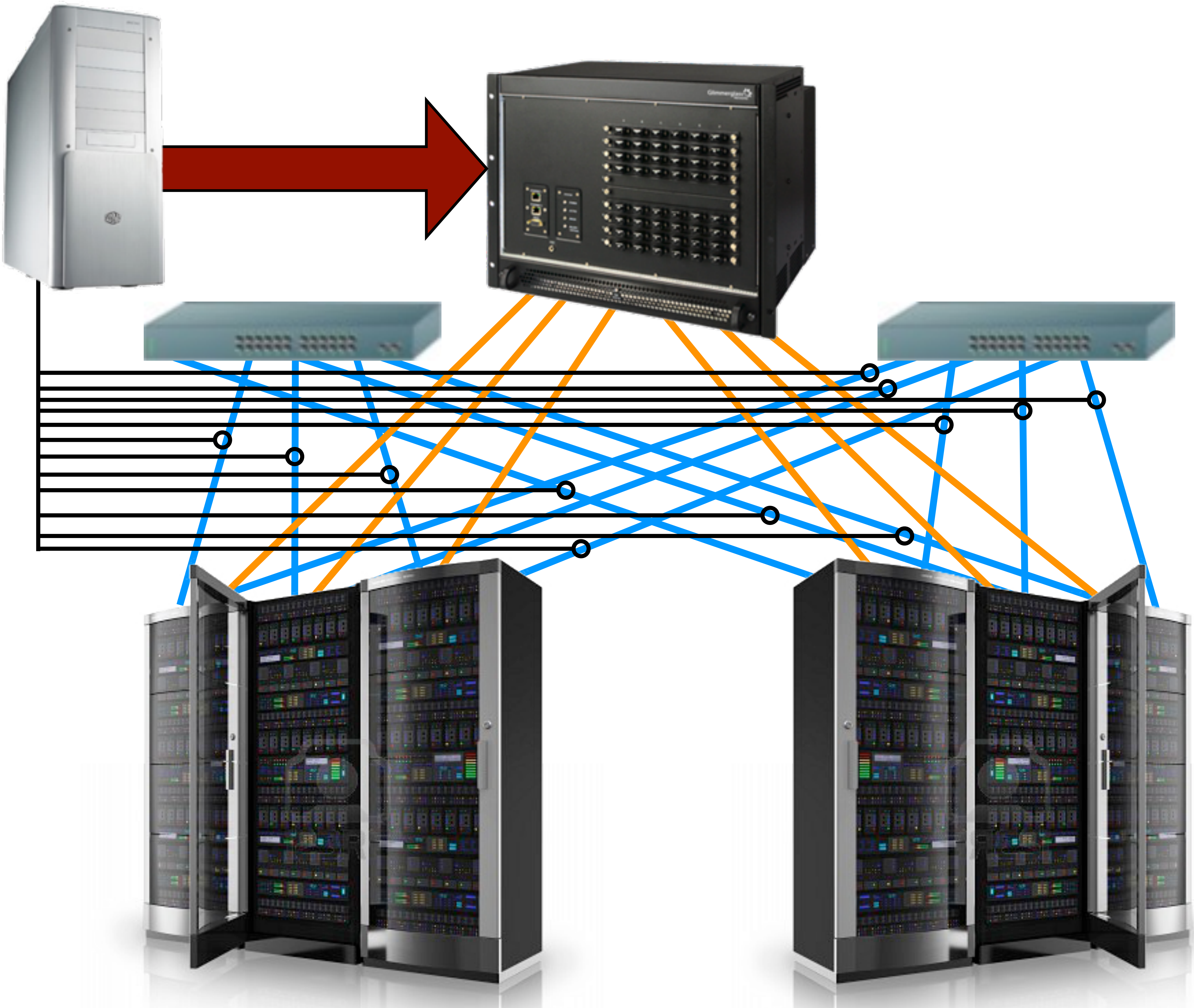





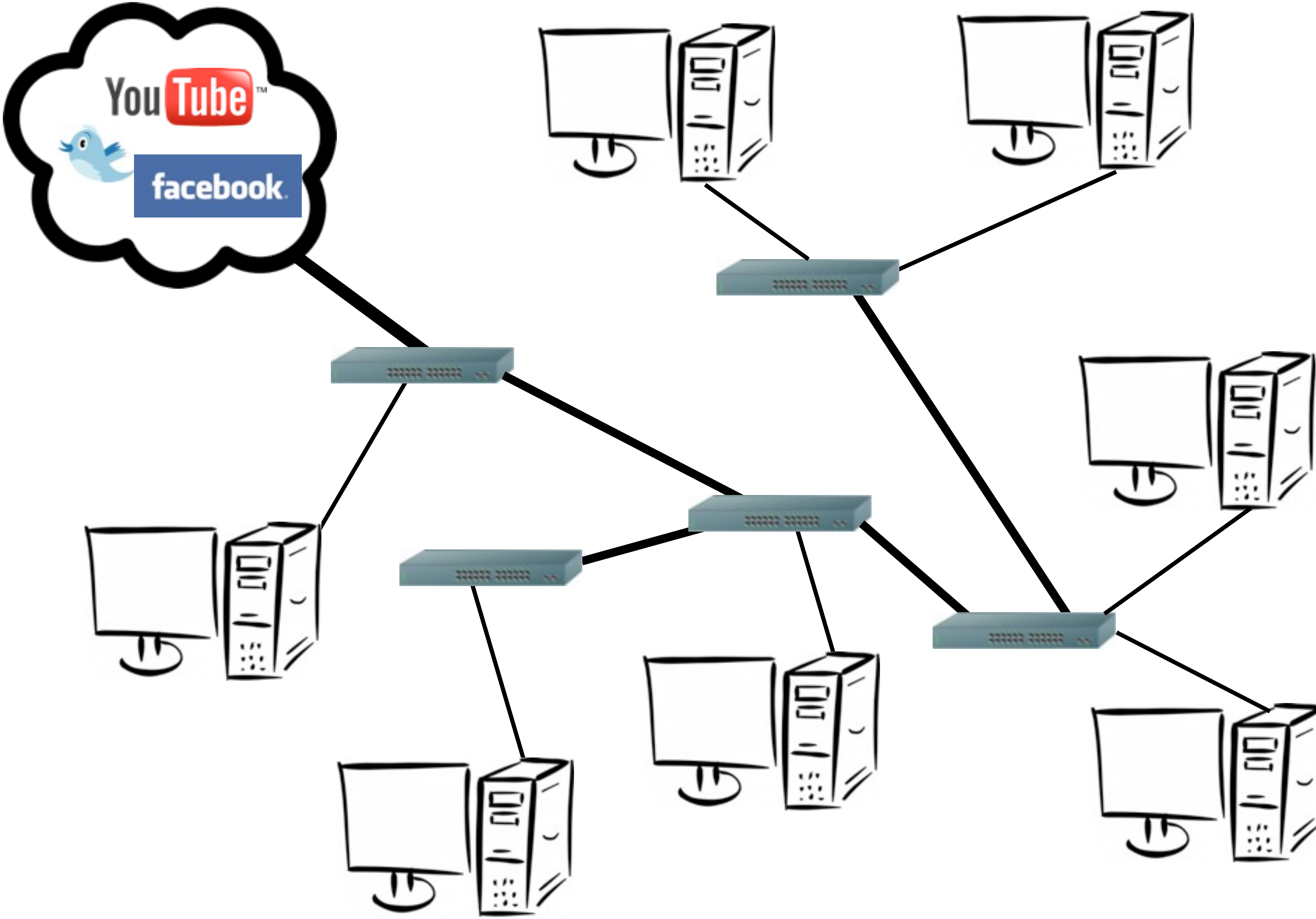


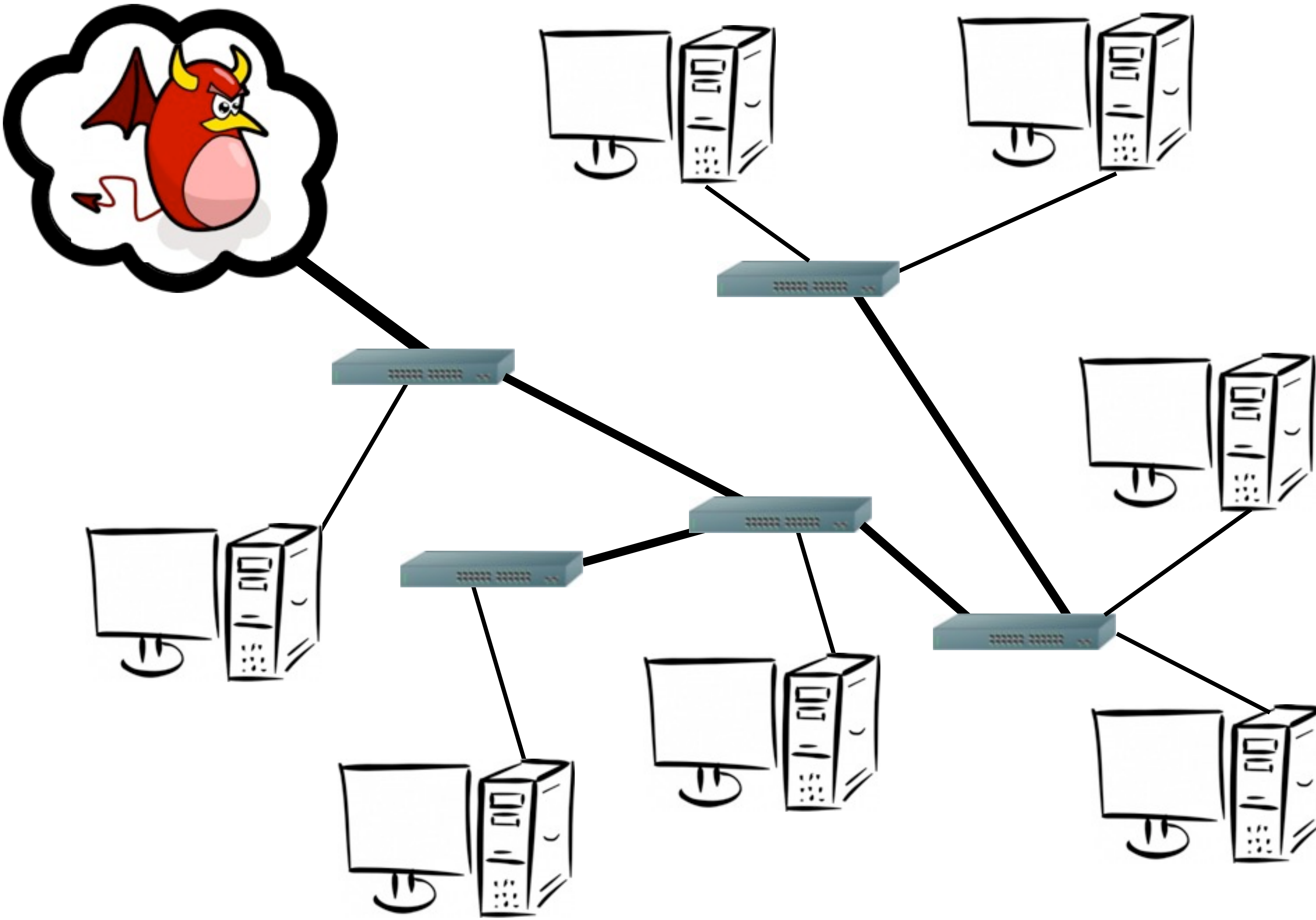


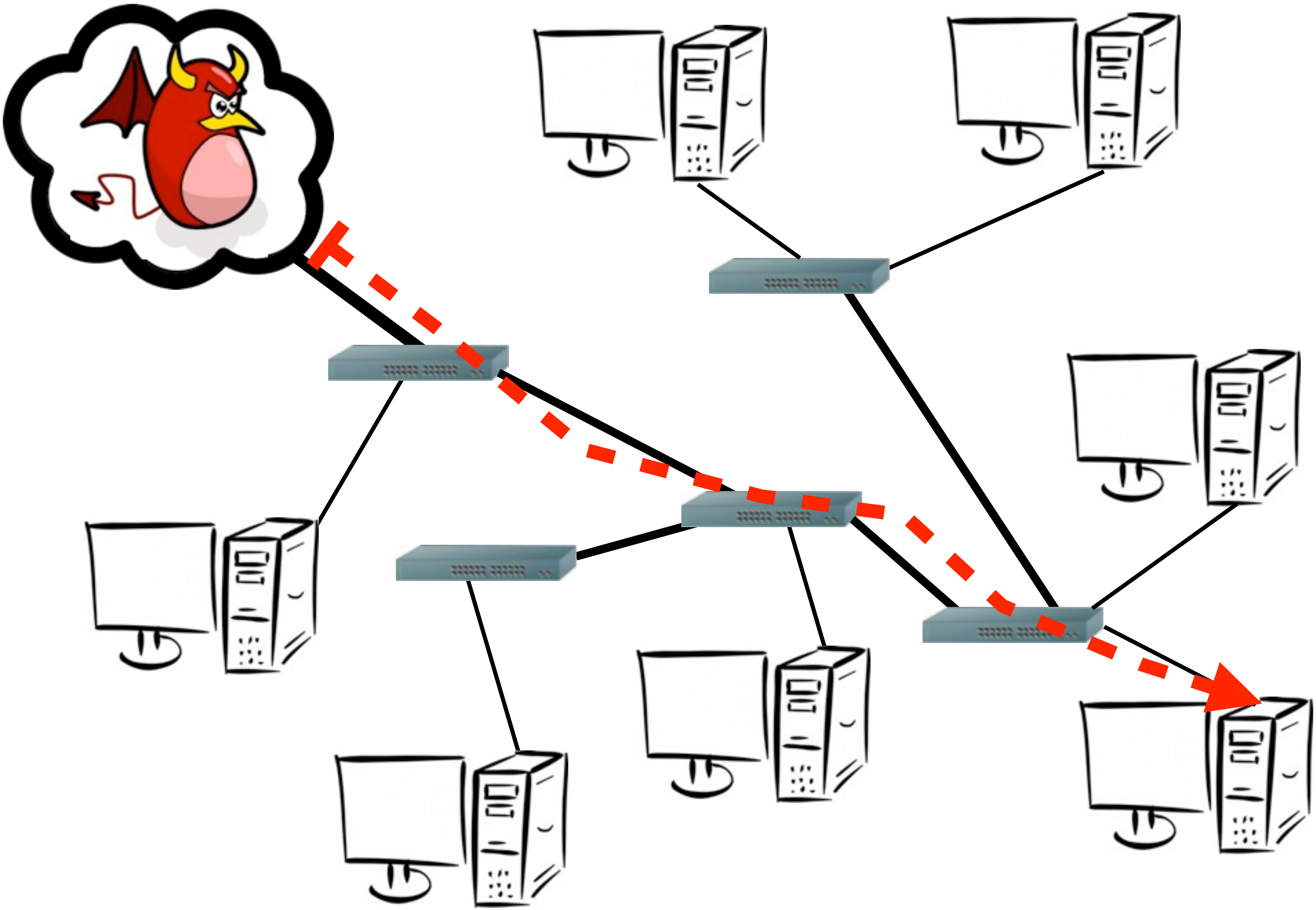


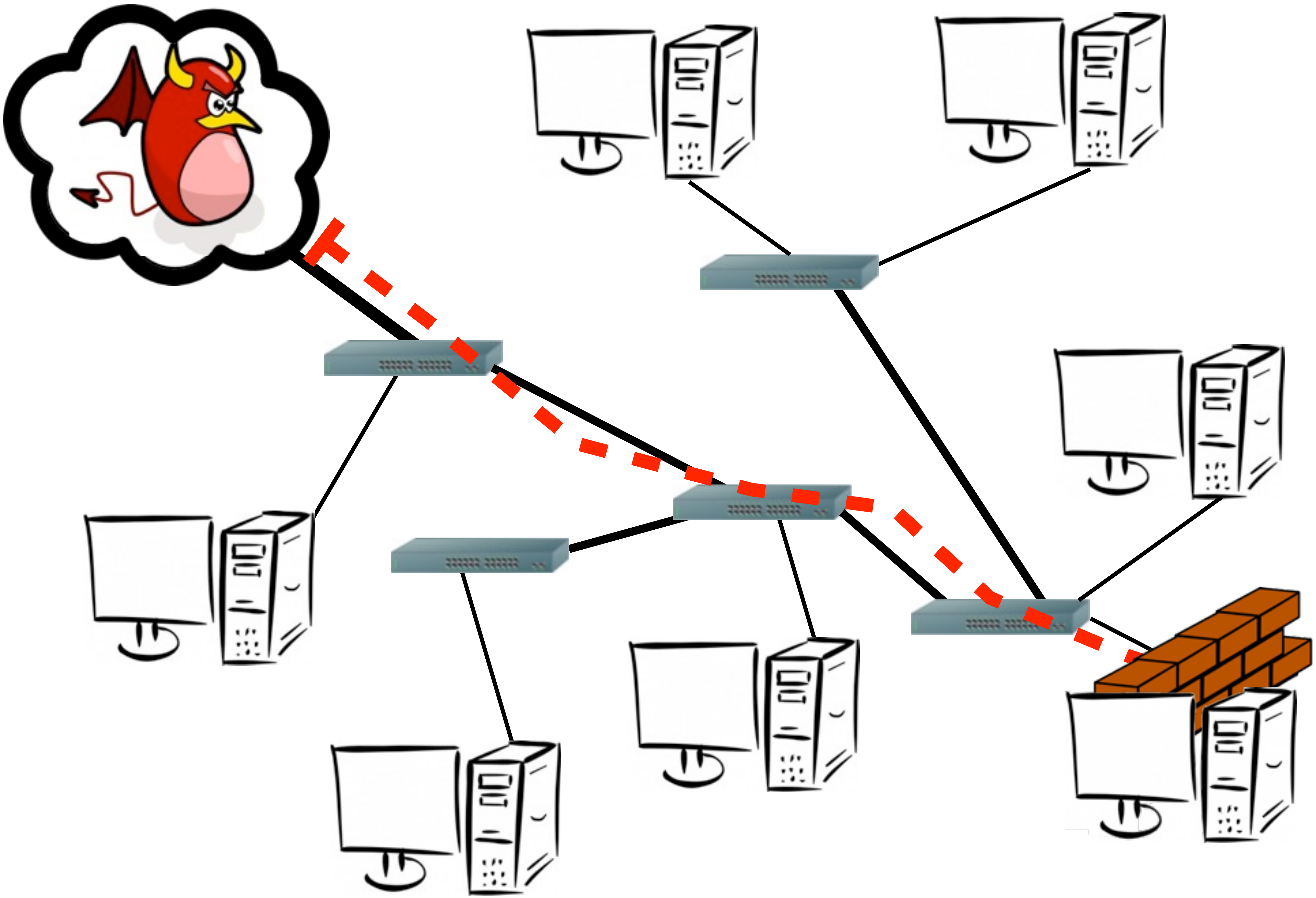


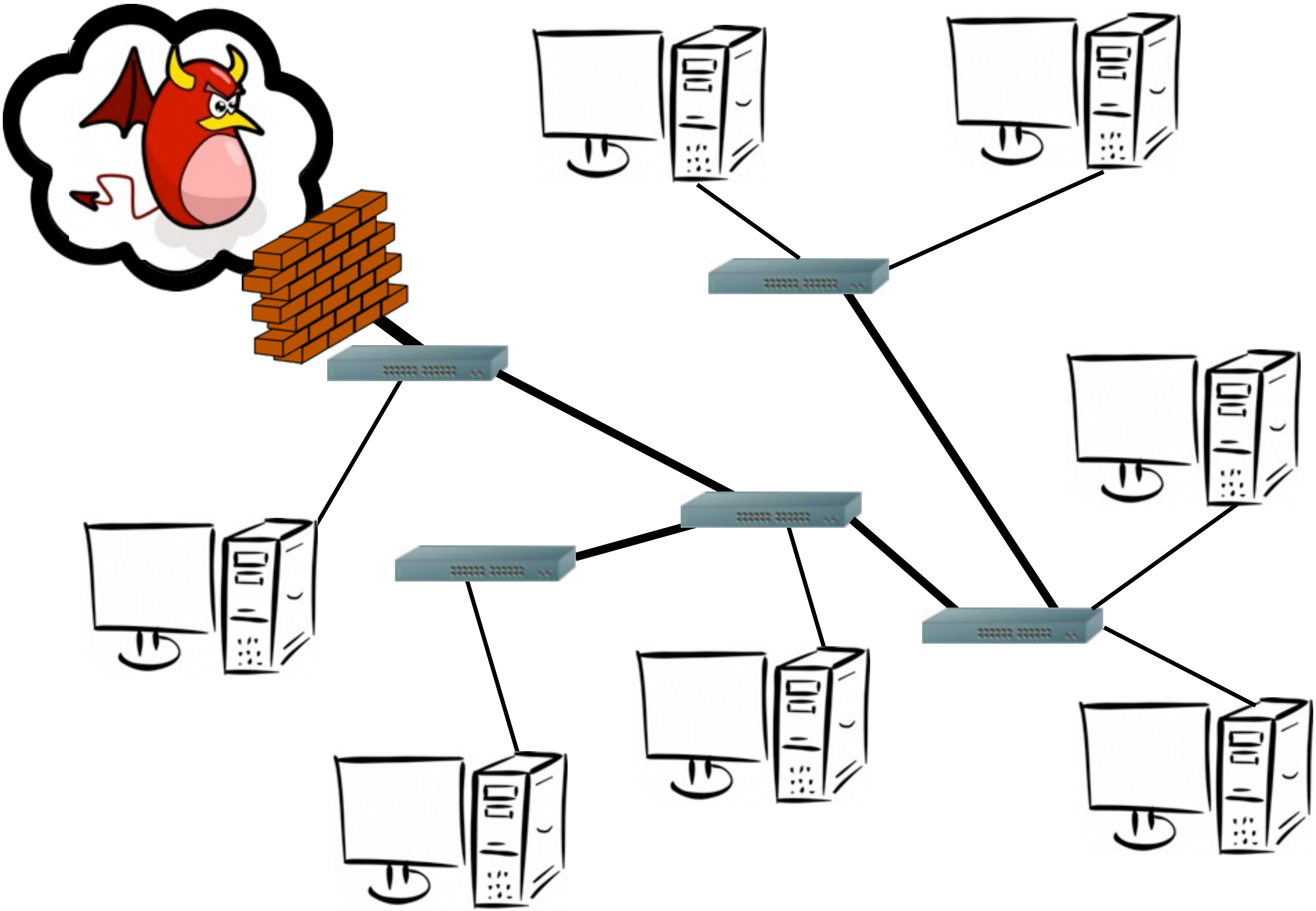
Redes corporativas: Defesa contra ataques


YouTube
facebook



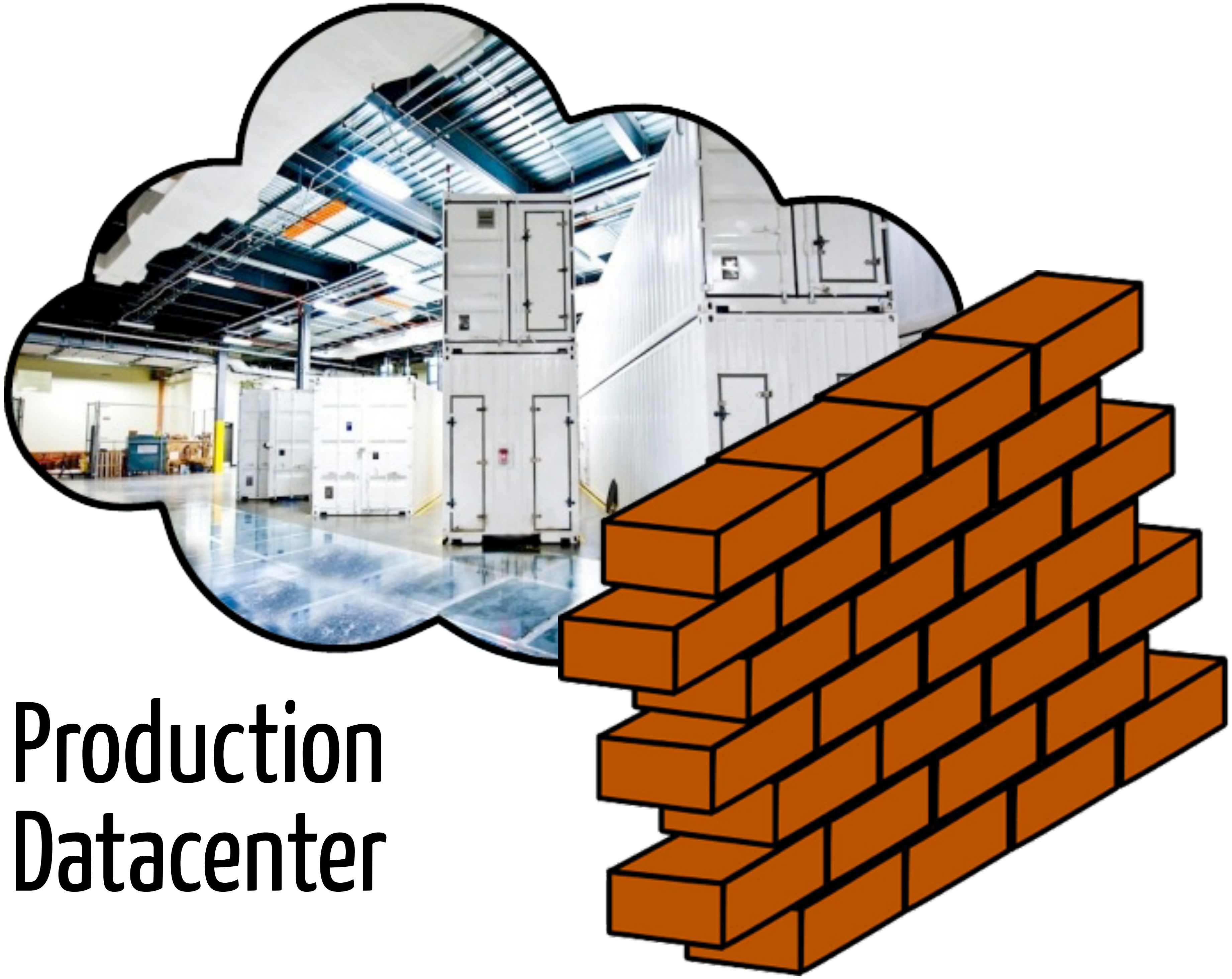






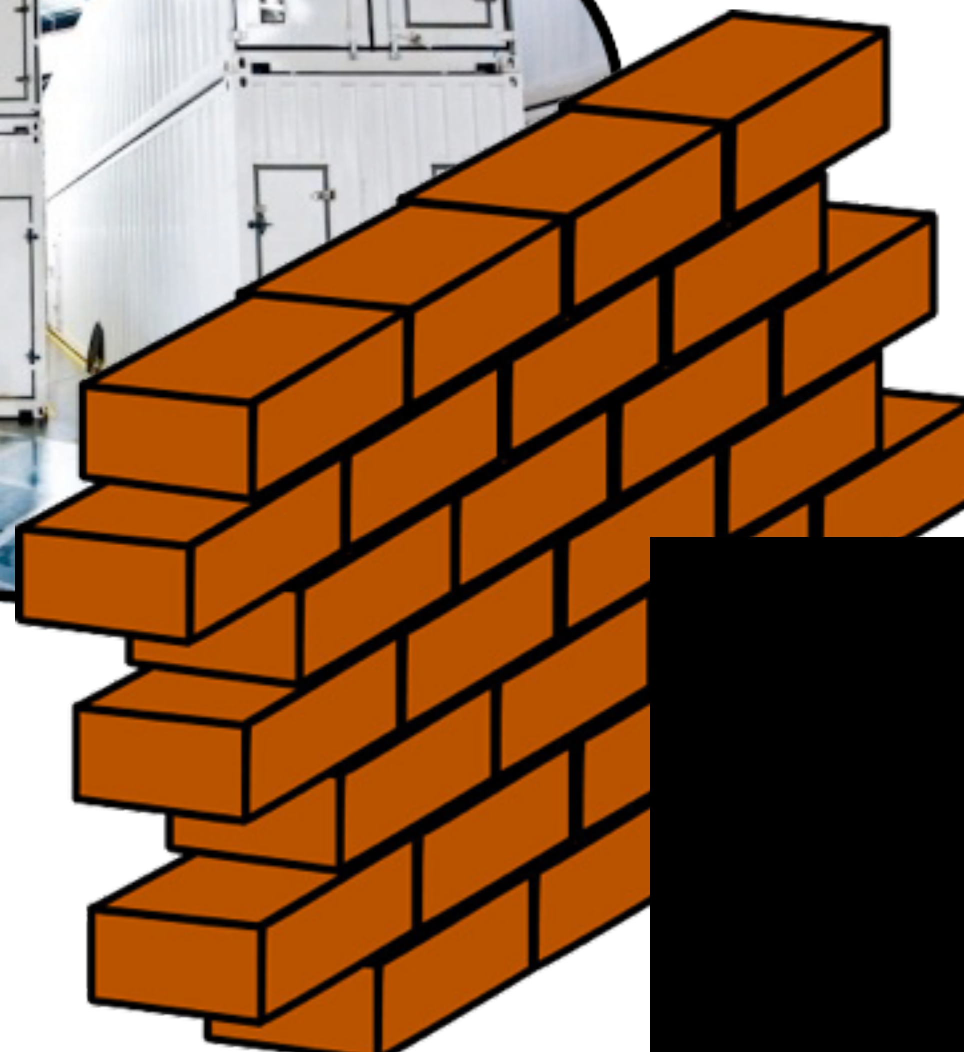
Provedores de cloud:
VMs não confiáveis

Production Datacenter



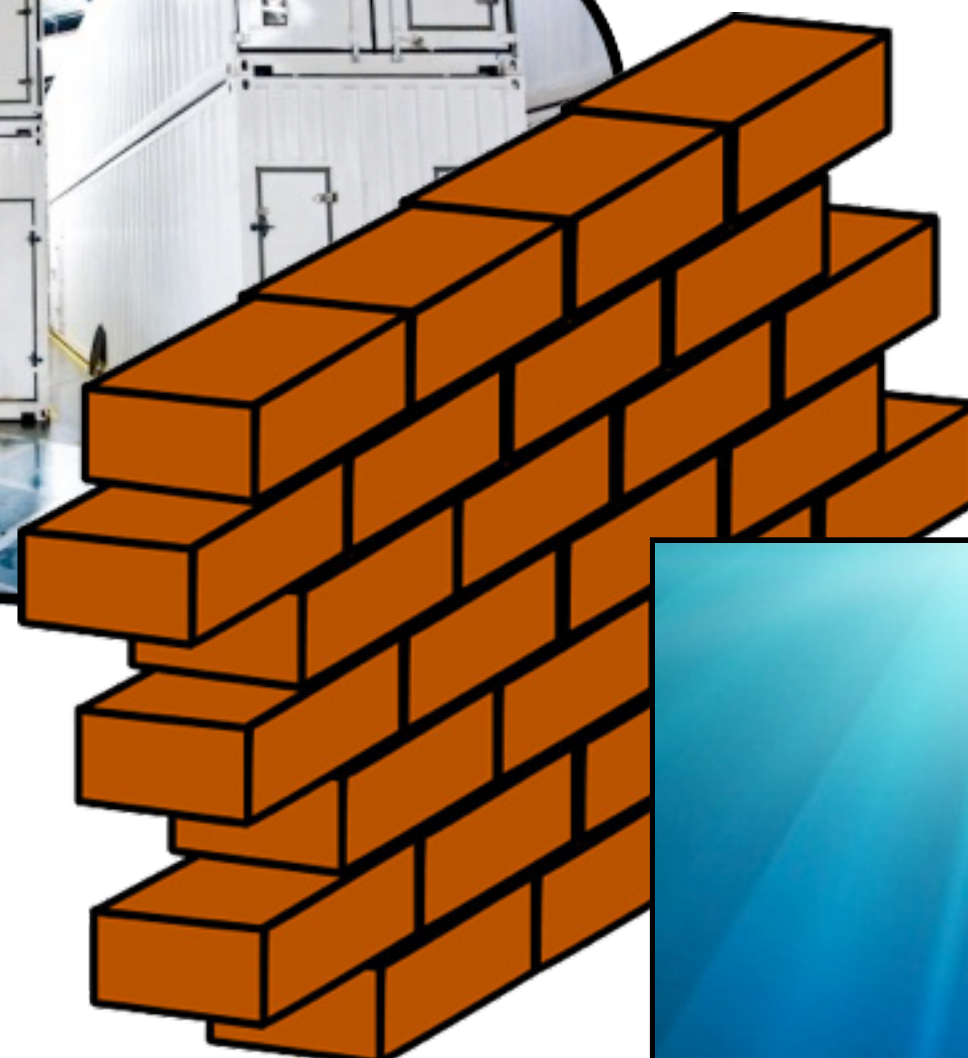
Production Datacenter

Based on "Delusional Boot: Securing Cloud Hypervisors without Massive Re-Engineering" (EuroSys 2012)

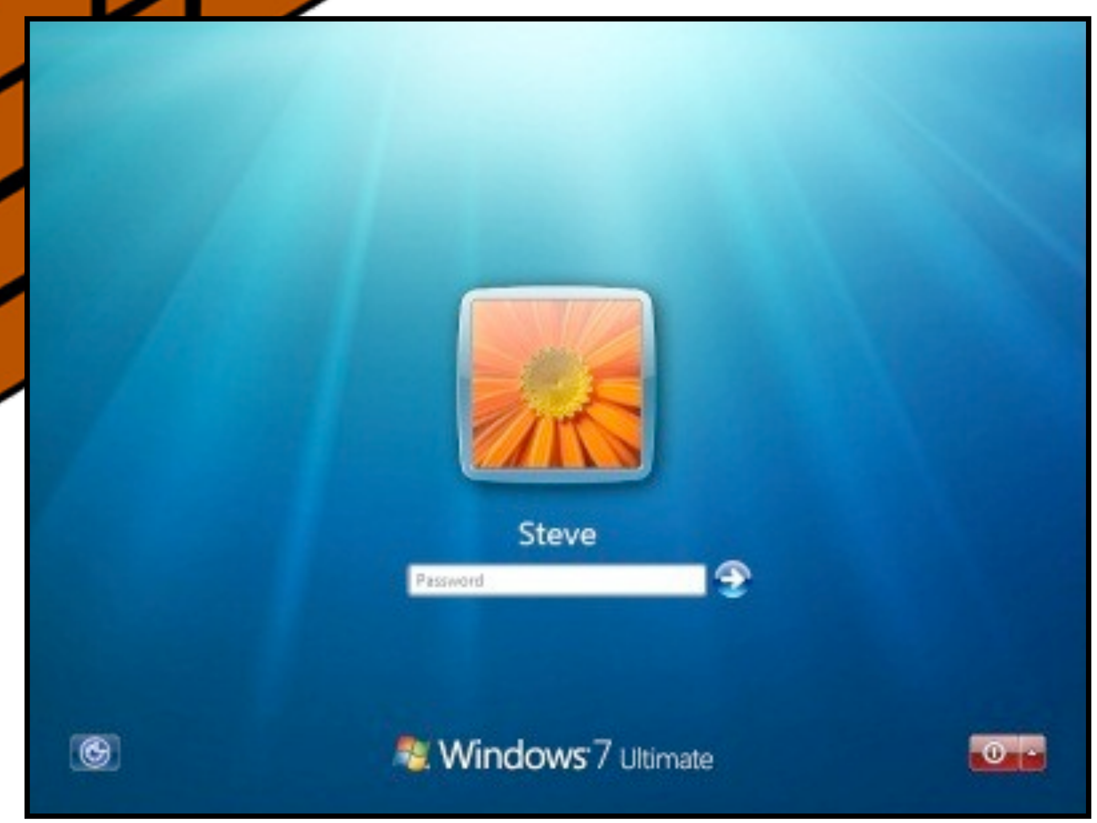


Serviço de Boot

Production Datacenter

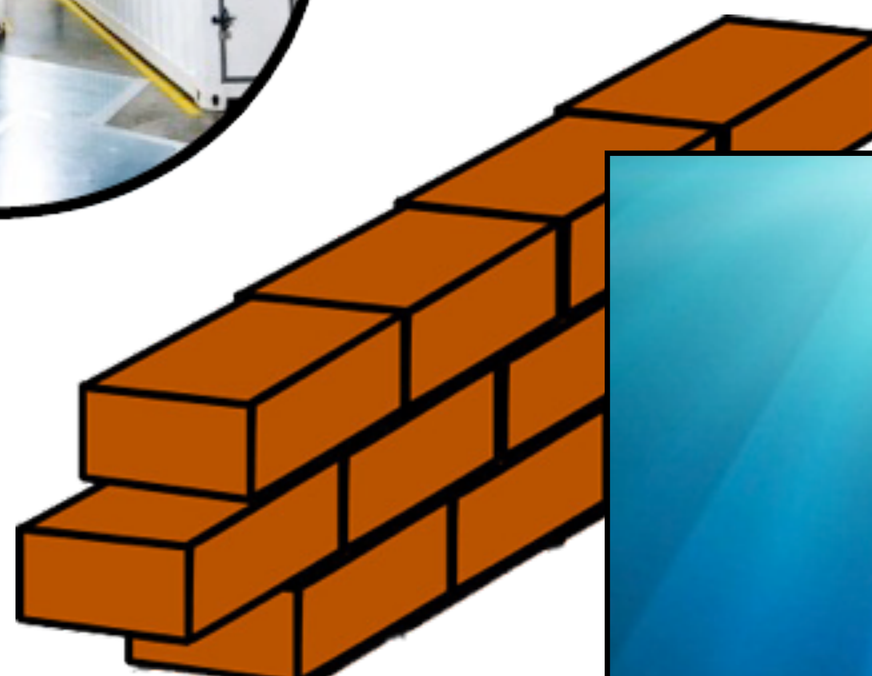


Serviço
de Boot



Production
Datacenter

Based on "Delusional Boot: Securing Cloud Hypervisors without Massive Re-Engineering" (EuroSys 2012)

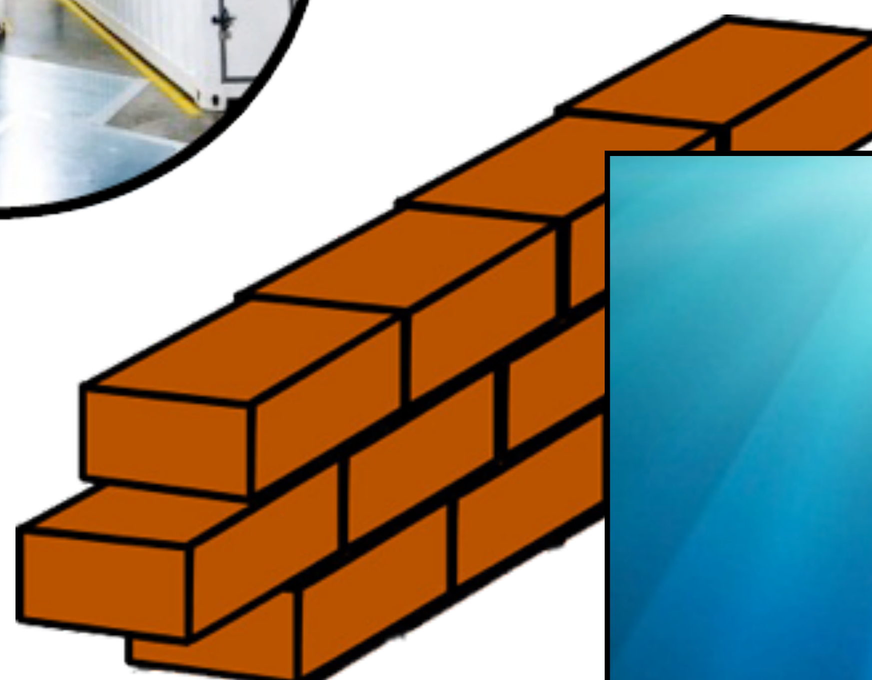


Serviço de Boot

Production Datacenter

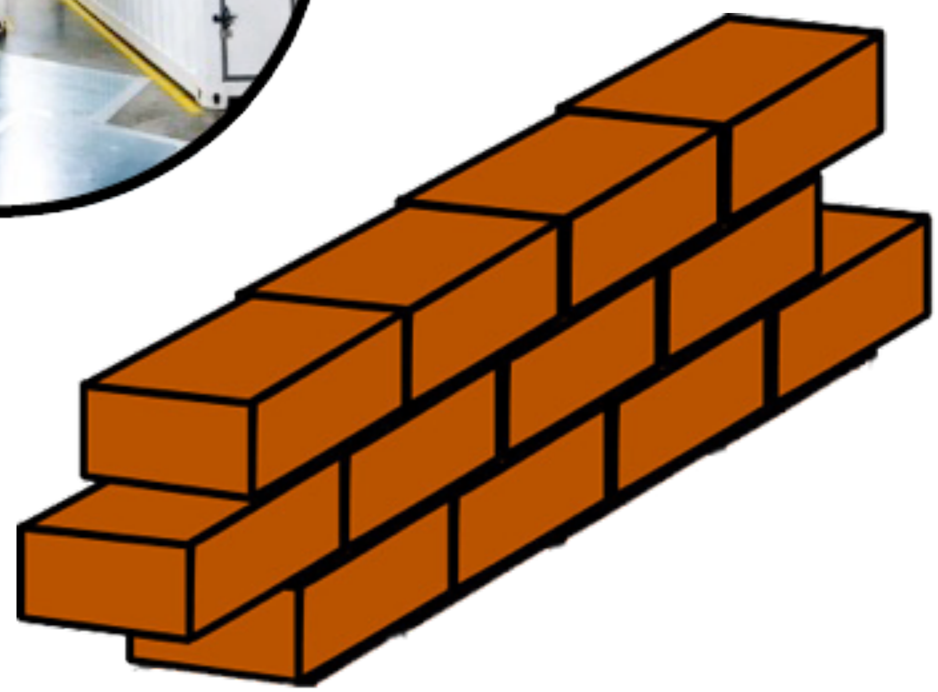
Based on "Delusional Boot: Securing Cloud Hypervisors without Massive Re-Engineering" (EuroSys 2012)

Serviço de Boot



Production Datacenter

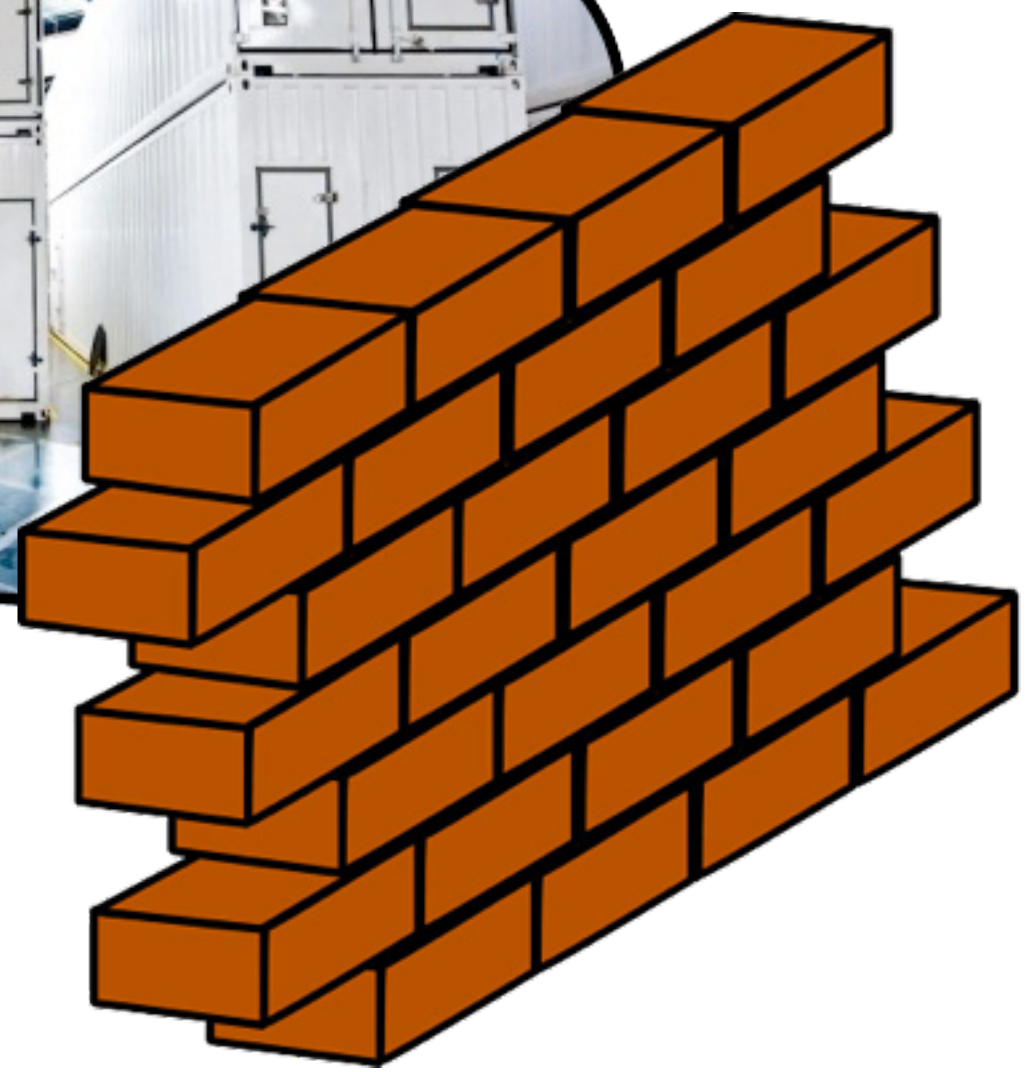
Based on "Delusional Boot: Securing Cloud Hypervisors without Massive Re-Engineering" (EuroSys 2012)



Serviço
de Boot

Production
Datacenter

Based on "Delusional Boot: Securing Cloud Hypervisors without Massive Re-Engineering" (EuroSys 2012)



Serviço
de Boot

Production
Datacenter

Based on “Delusional Boot: Securing Cloud Hypervisors without Massive Re-Engineering” (EuroSys 2012)

Proposta

Participatory Networking

Participatory Networking

Participatory Networking

PANE

Participatory Networking

1. Requests

PANE

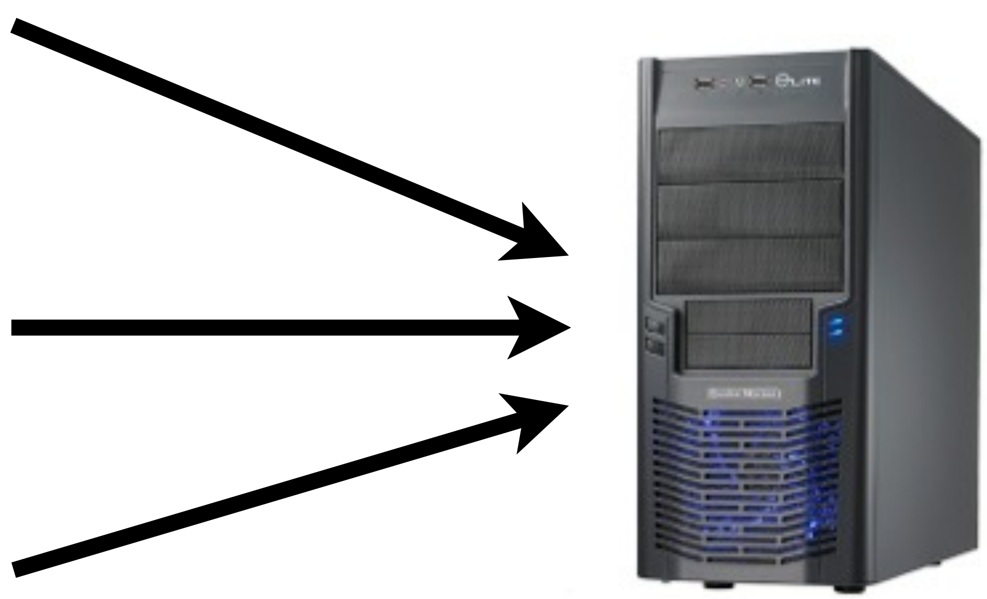
Participatory Networking

1. Requests
2. Hints

PANE

Participatory Networking

1. Requests
2. Hints
3. Queries



PANE

Participatory Networking

Participatory Networking

Seguro?

Participatory Networking

Seguro? Confiável?

Participatory Networking

Seguro? Confiável? Justo?

Participatory Networking

Seguro?

Confiável?

Justo?

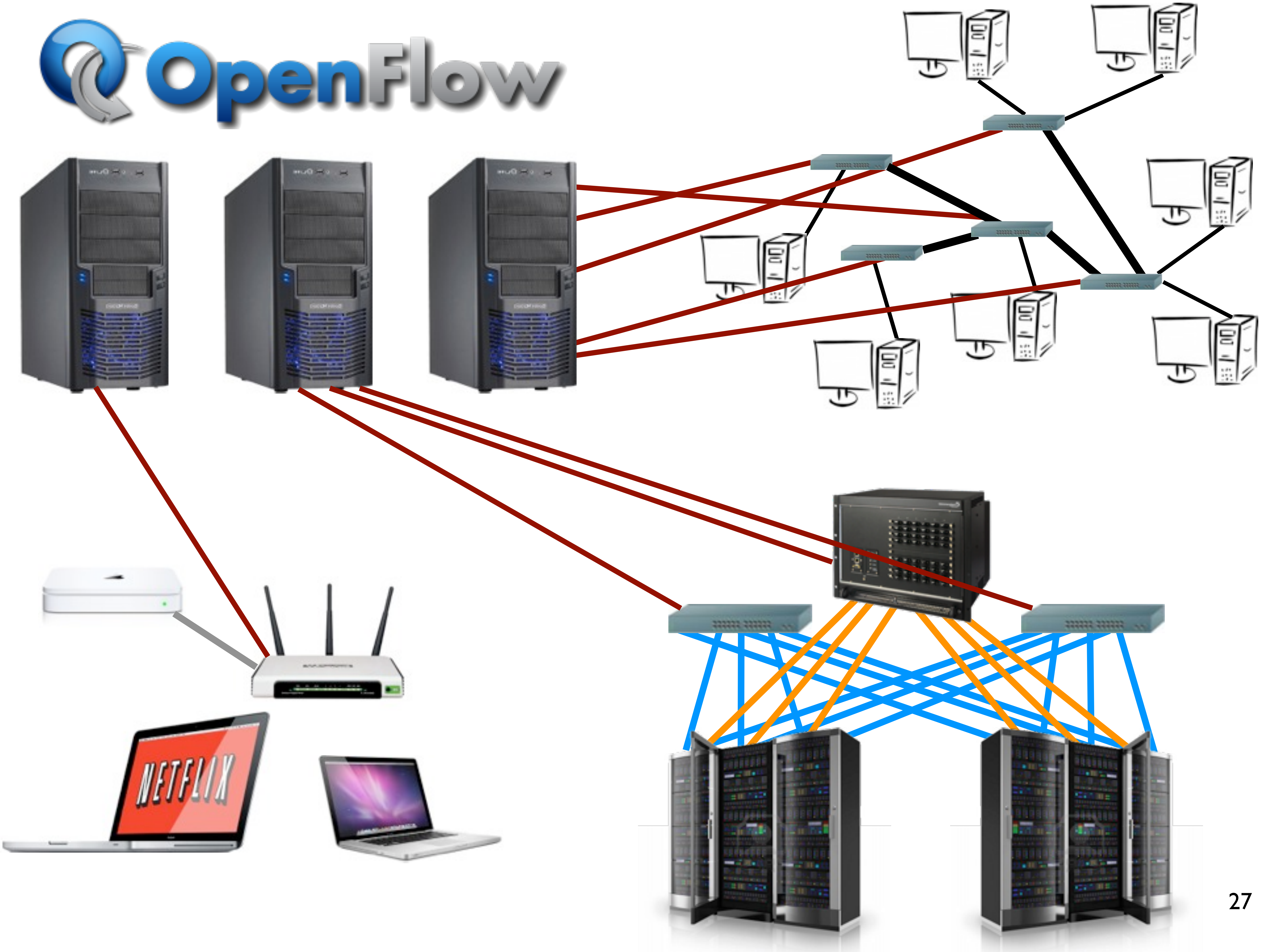
Prático?

Participatory Networking

Seguro? Confiável? Justo?

Prático? Efficiente?

OpenFlow



Participatory Networking

Participatory Networking

- API para usuários de SDNs

Participatory Networking

- API para usuários de SDNs
- Expõe mecanismos existentes

Participatory Networking

- API para usuários de SDNs
  - Expõe mecanismos existentes
- Sem impacto sobre aplicações não modificadas

Roteiro

1. Semântica de delegação de privilégios

Roteiro

1. Semântica de delegação de privilégios
2. Esboço do protocolo

Roteiro

1. Semântica de delegação de privilégios
2. Esboço do protocolo
3. Processamento online de flows

Roteiro

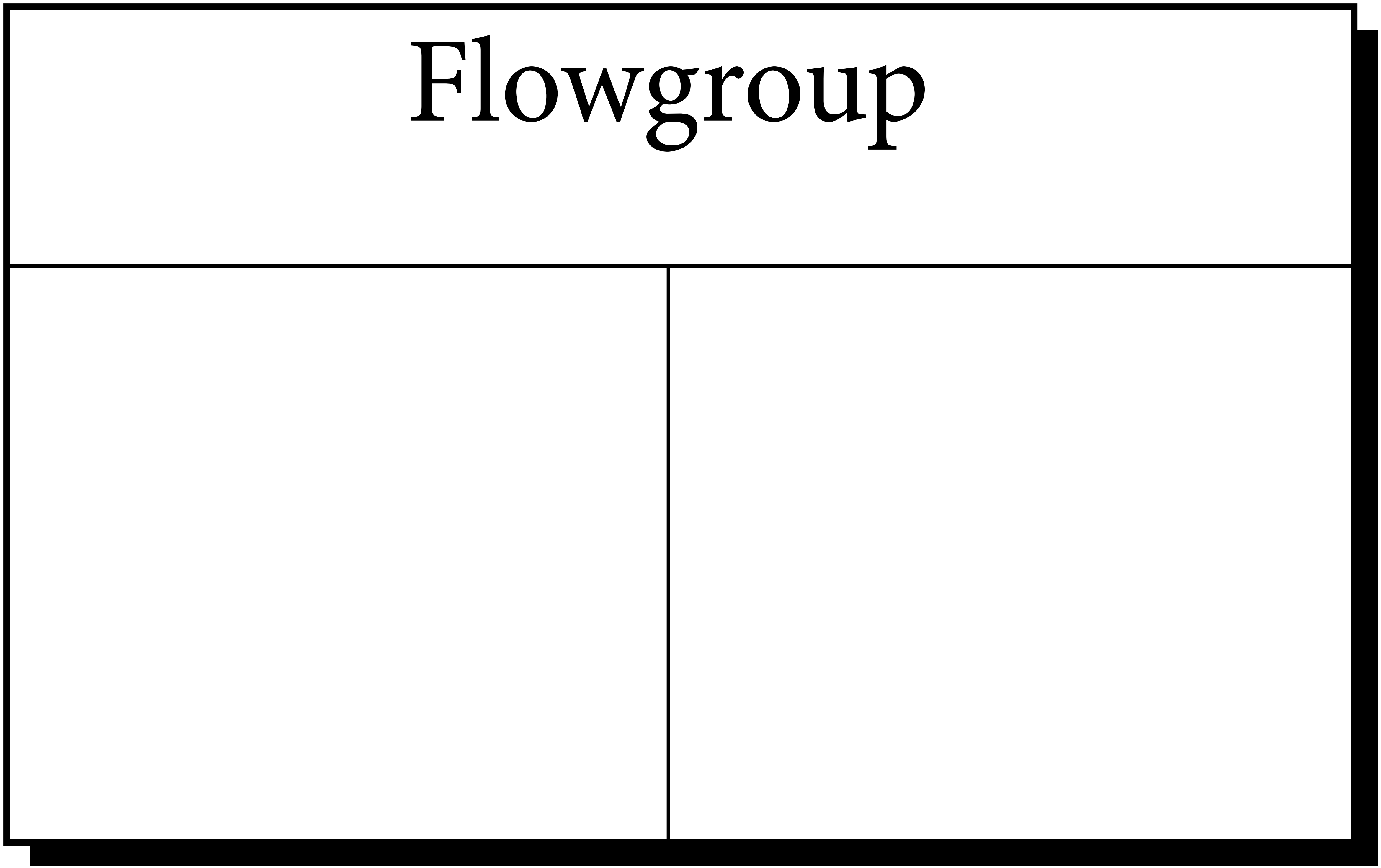
1. Semântica de delegação de privilégios
2. Esboço do protocolo
3. Processamento online de flows
4. Estado atual

Roteiro

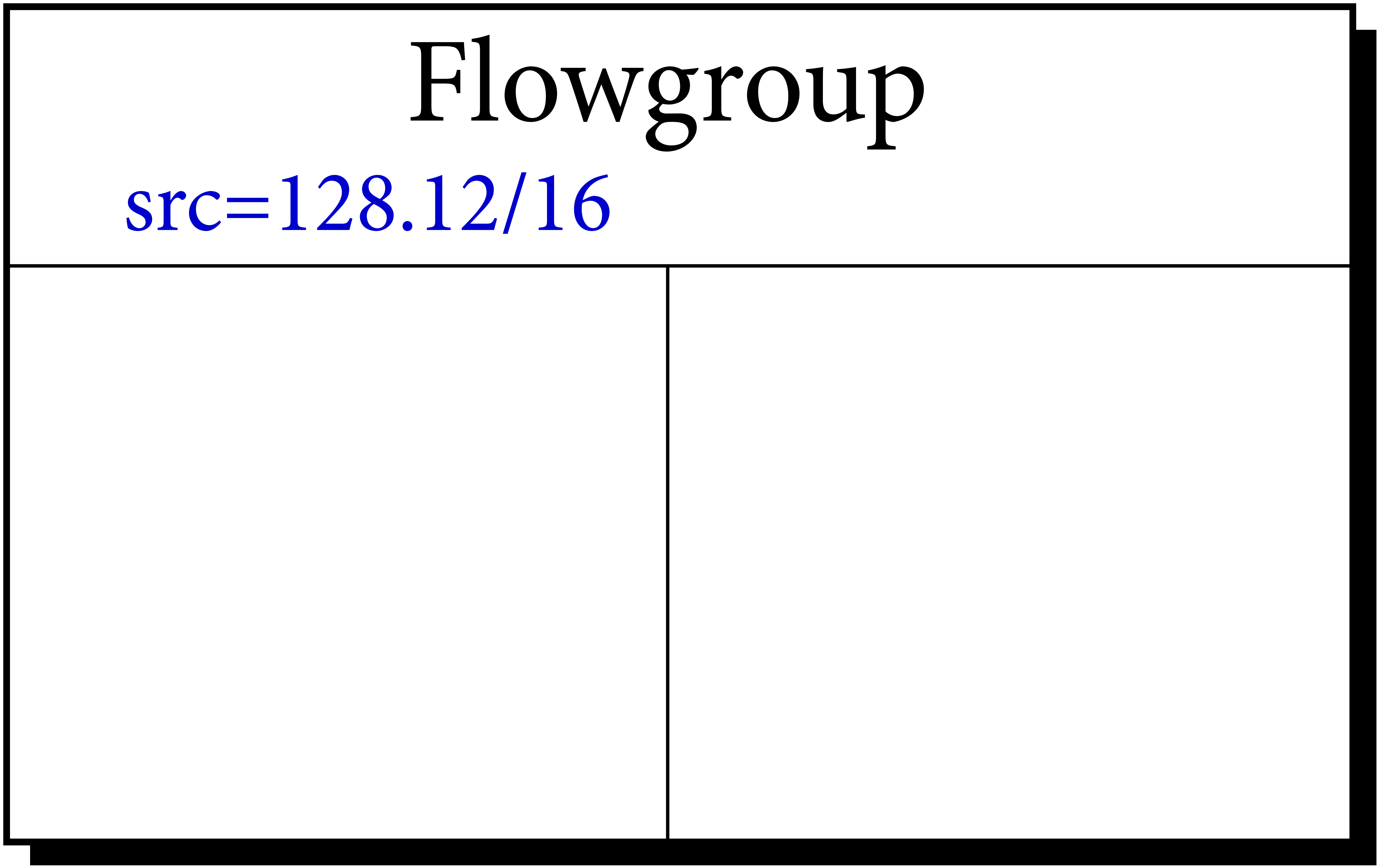
Semantica de Delegação de Privilégios

Shares

Shares



Shares



Shares

Flowgroup

$src=128.12/16 \wedge dst.port \leq 1024$

Shares

Flowgroup

$src=128.12/16 \wedge dst.port \leq 1024$

Privileges

Shares

Flowgroup

$src=128.12/16 \wedge dst.port \leq 1024$

Privileges

deny, allow

Shares

Flowgroup

src=128.12/16 ∧ dst.port ≤1024

Privileges

deny, allow

bandwidth: 5Mb/s

limit: 10Mb/s

Shares

Flowgroup

src=128.12/16 ∧ dst.port ≤1024

Privileges

deny, allow

bandwidth: 5Mb/s

limit: 10Mb/s

hint

query

Shares

<table>
<tr><th colspan="2">Flowgroup
src=128.12/16 ∧ dst.port ≤1024</th></tr>
<tr><td>Speakers</td><td>Privileges
deny, allow
bandwidth: 5Mb/s
limit: 10Mb/s
hint
query</td></tr>
</table>

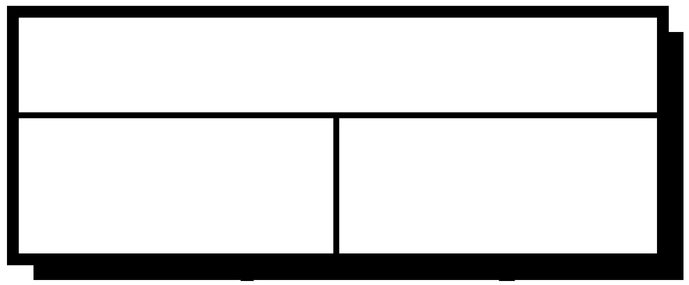
Shares

Flowgroup

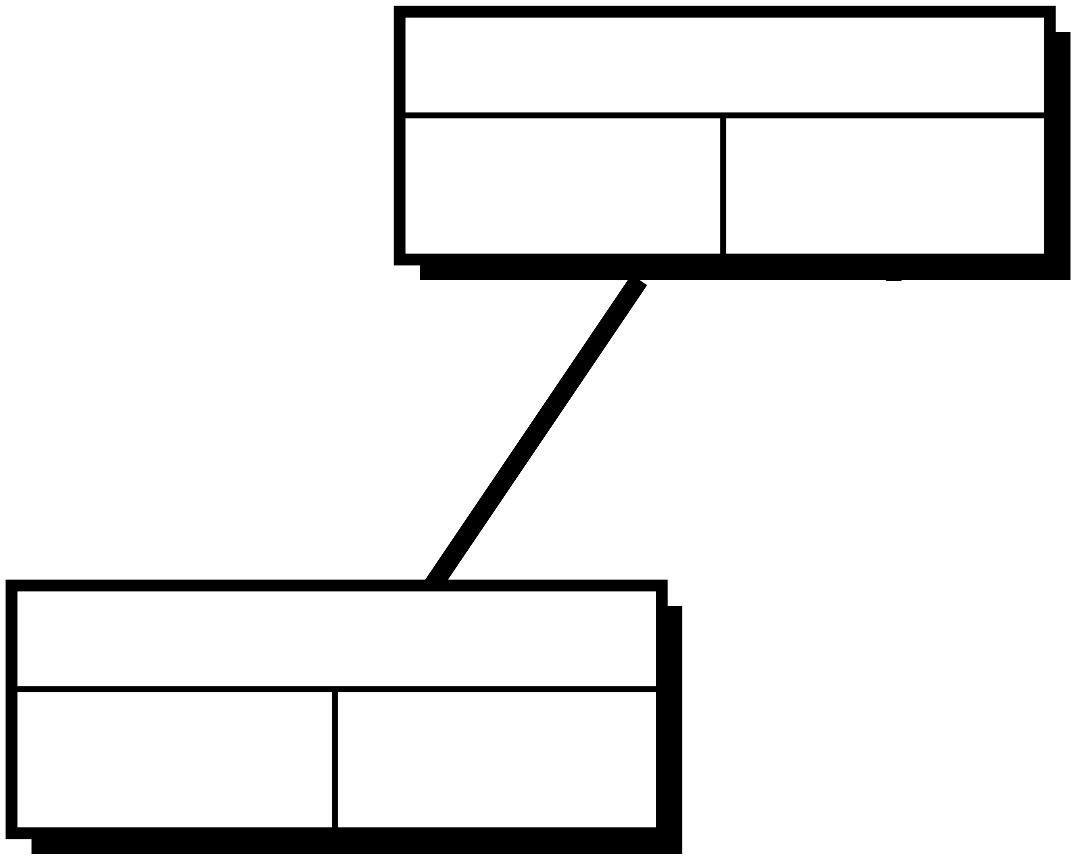
src=128.12/16 ∧ dst.port ≤1024

Speakers	Privileges
Alice Bob	deny, allow bandwidth: 5Mb/s limit: 10Mb/s *hint* *query*

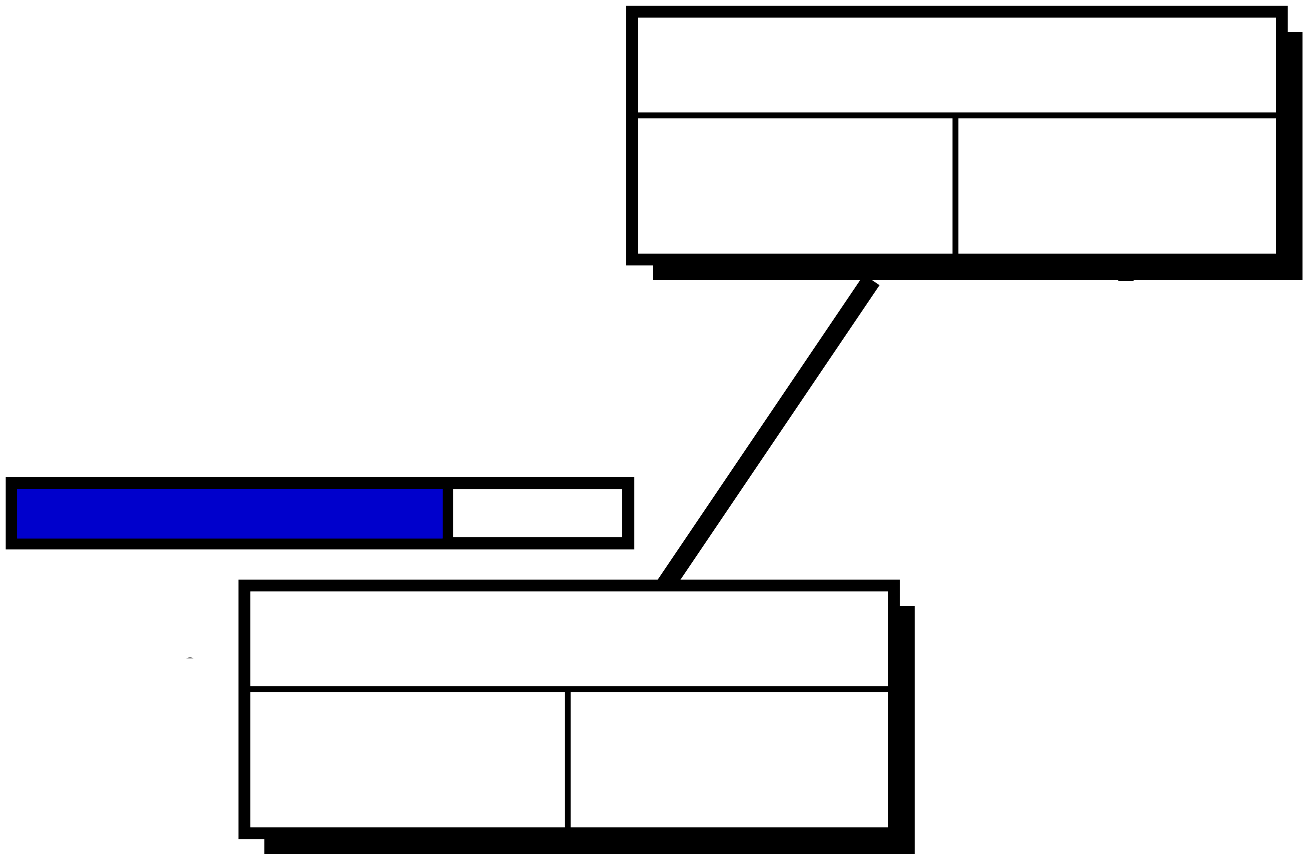
Shares



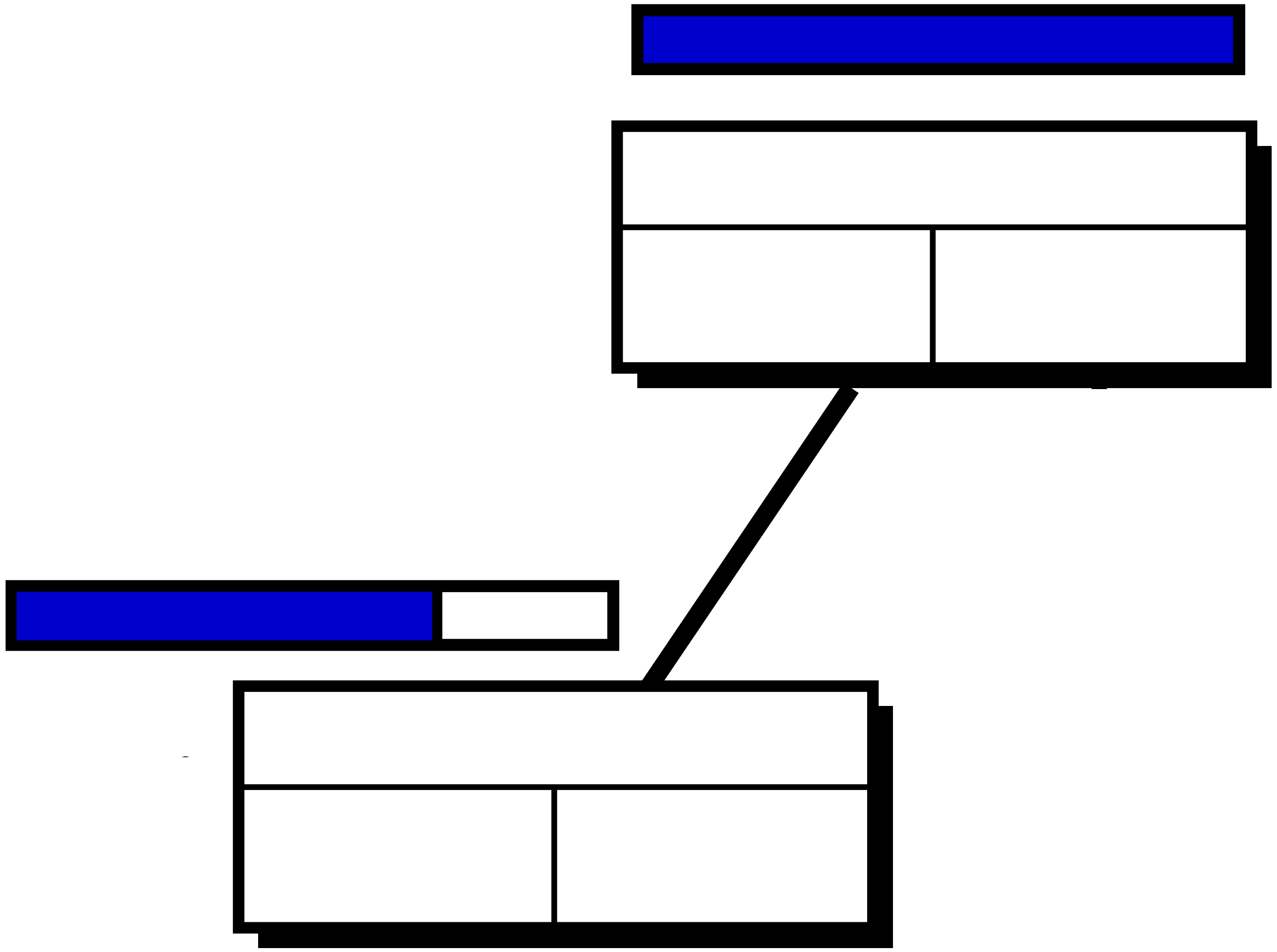
Delegação



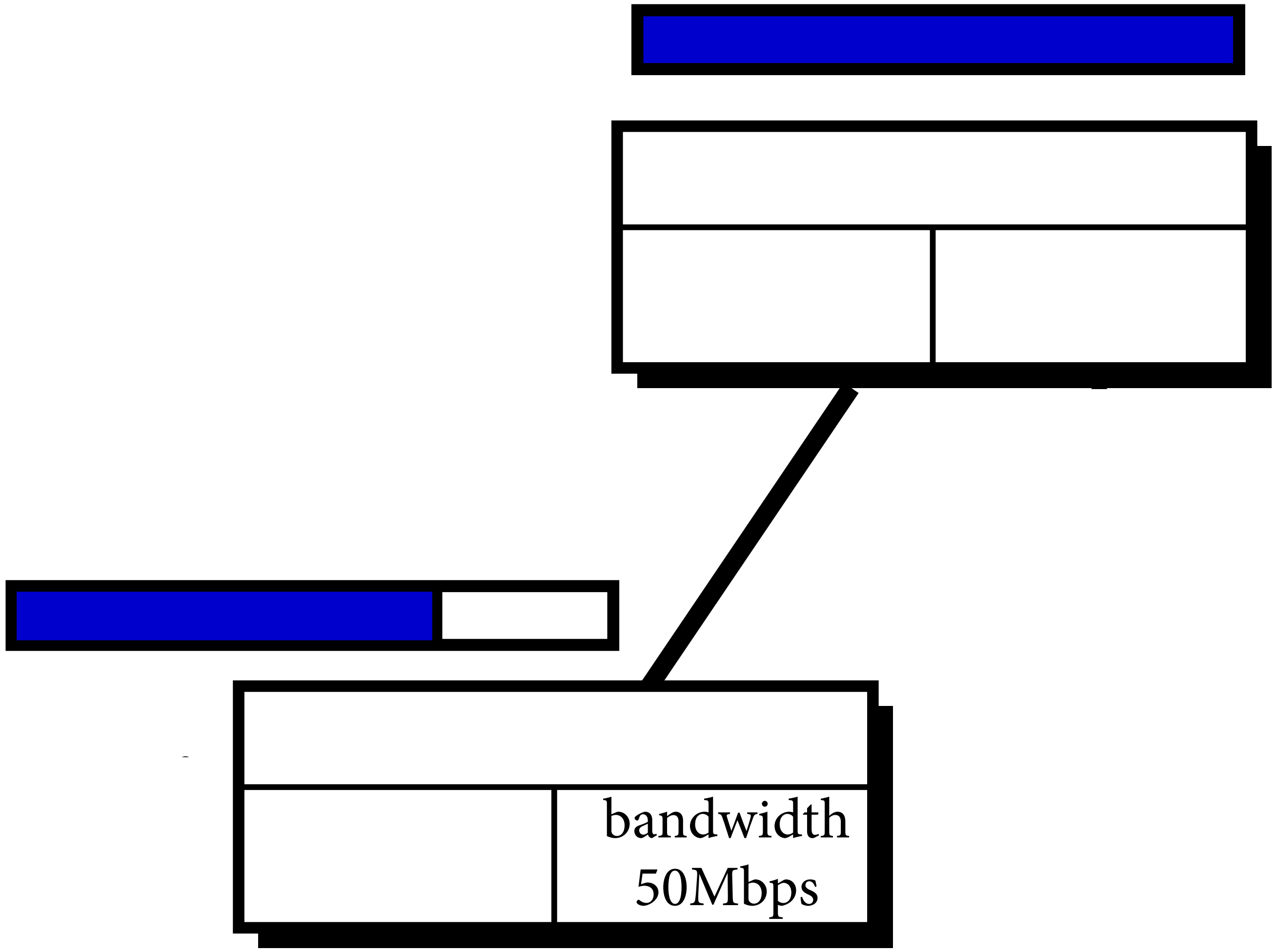
Delegação



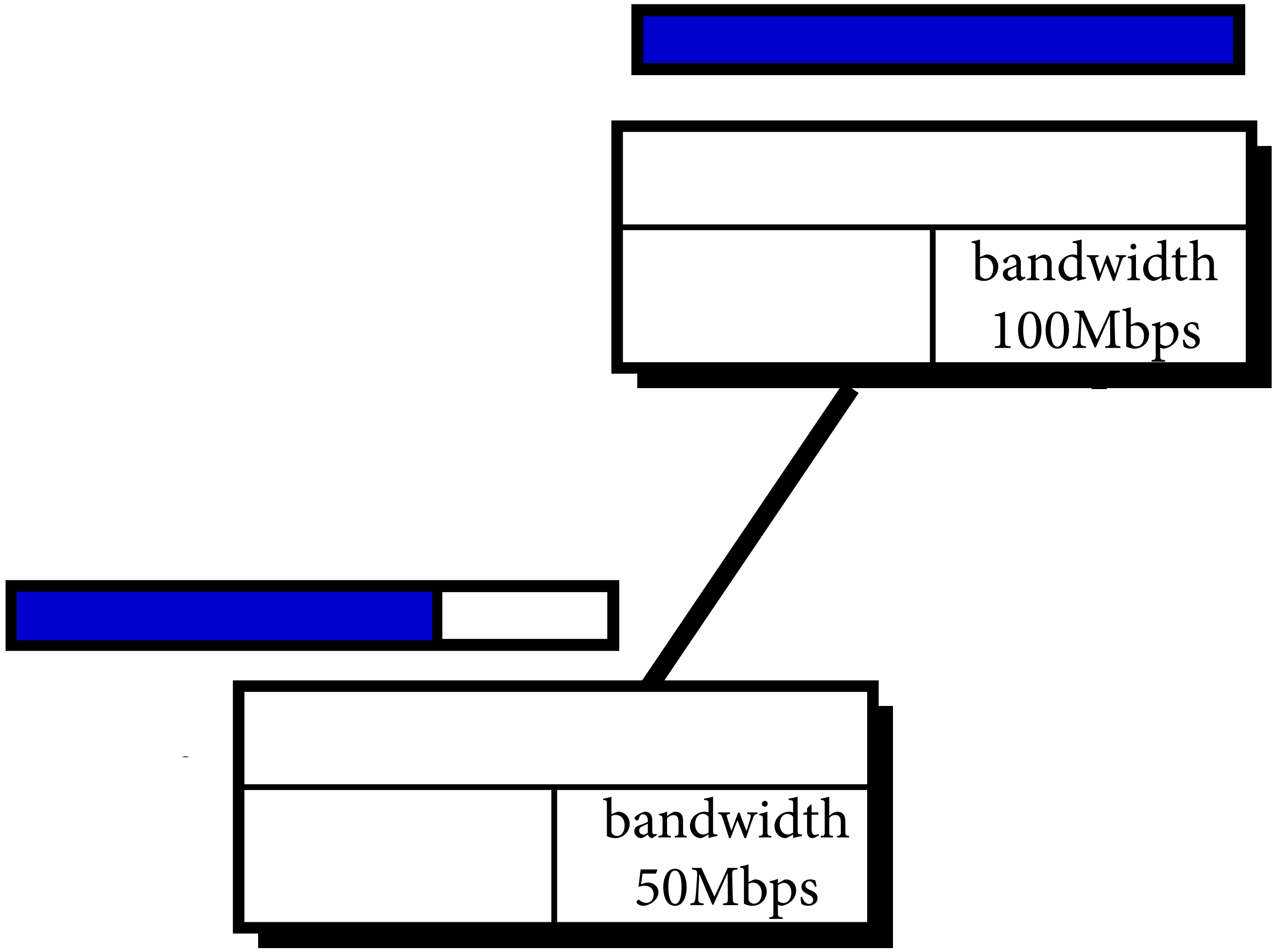
Delegação



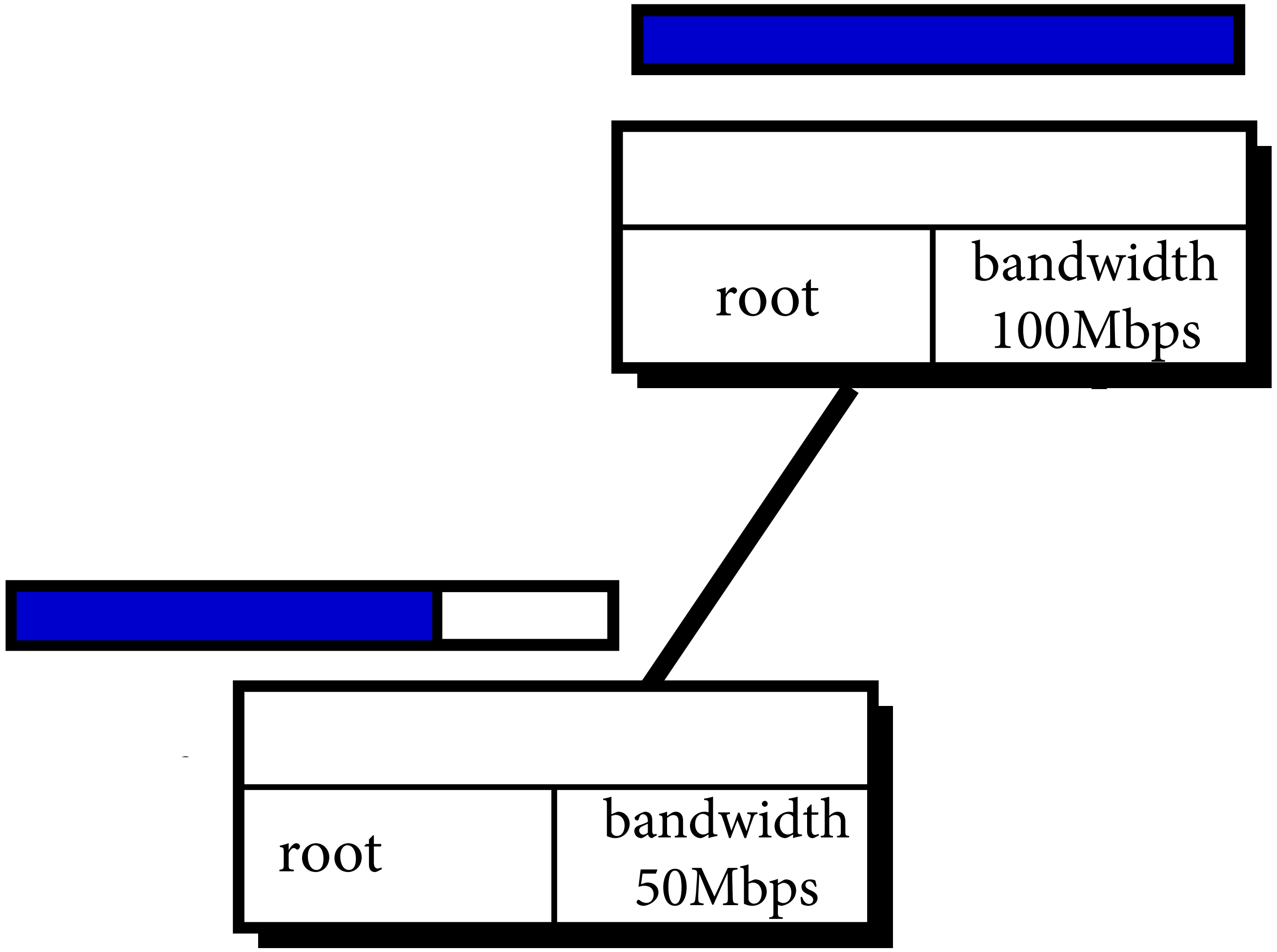
Delegação



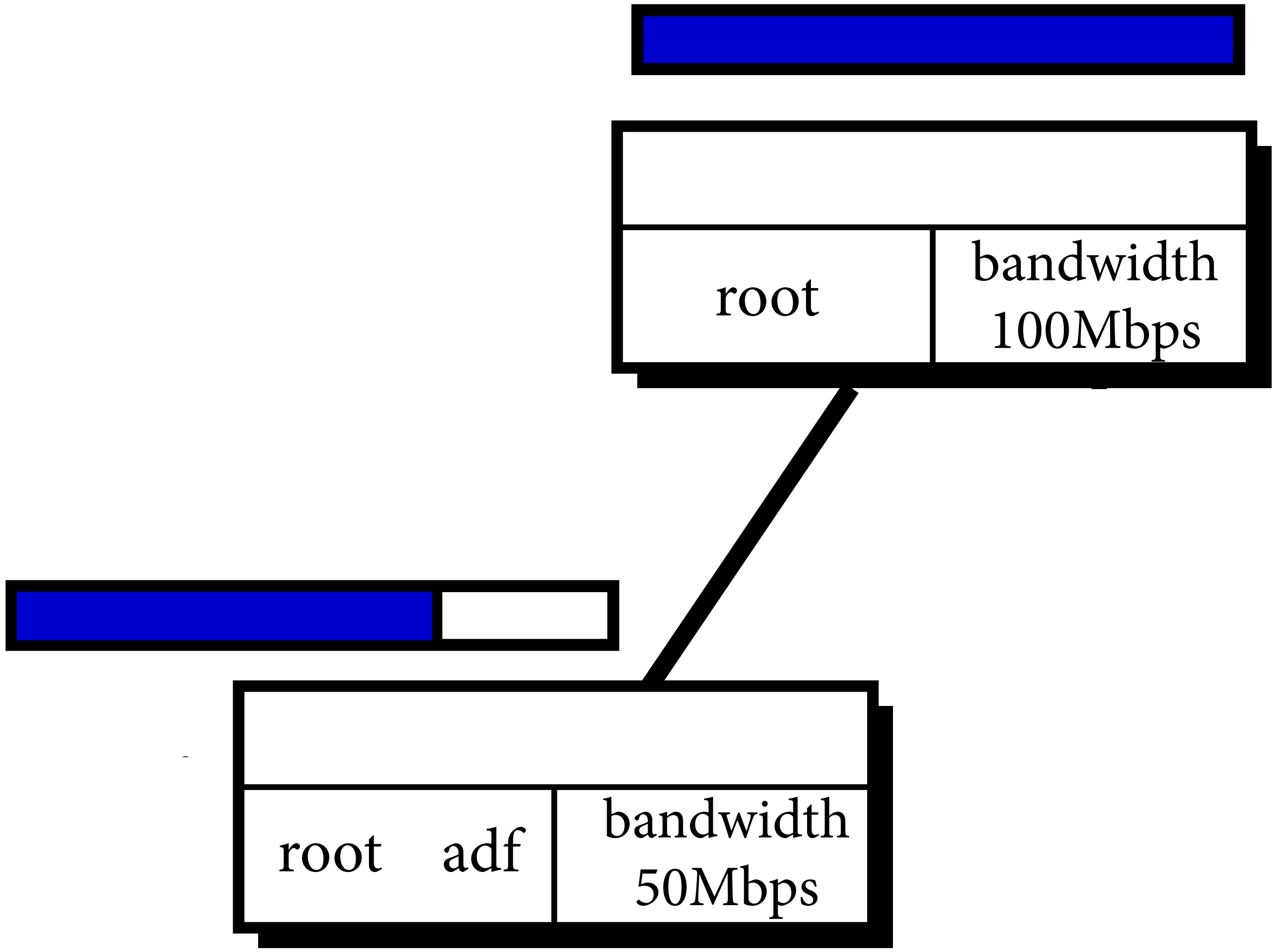
Delegação



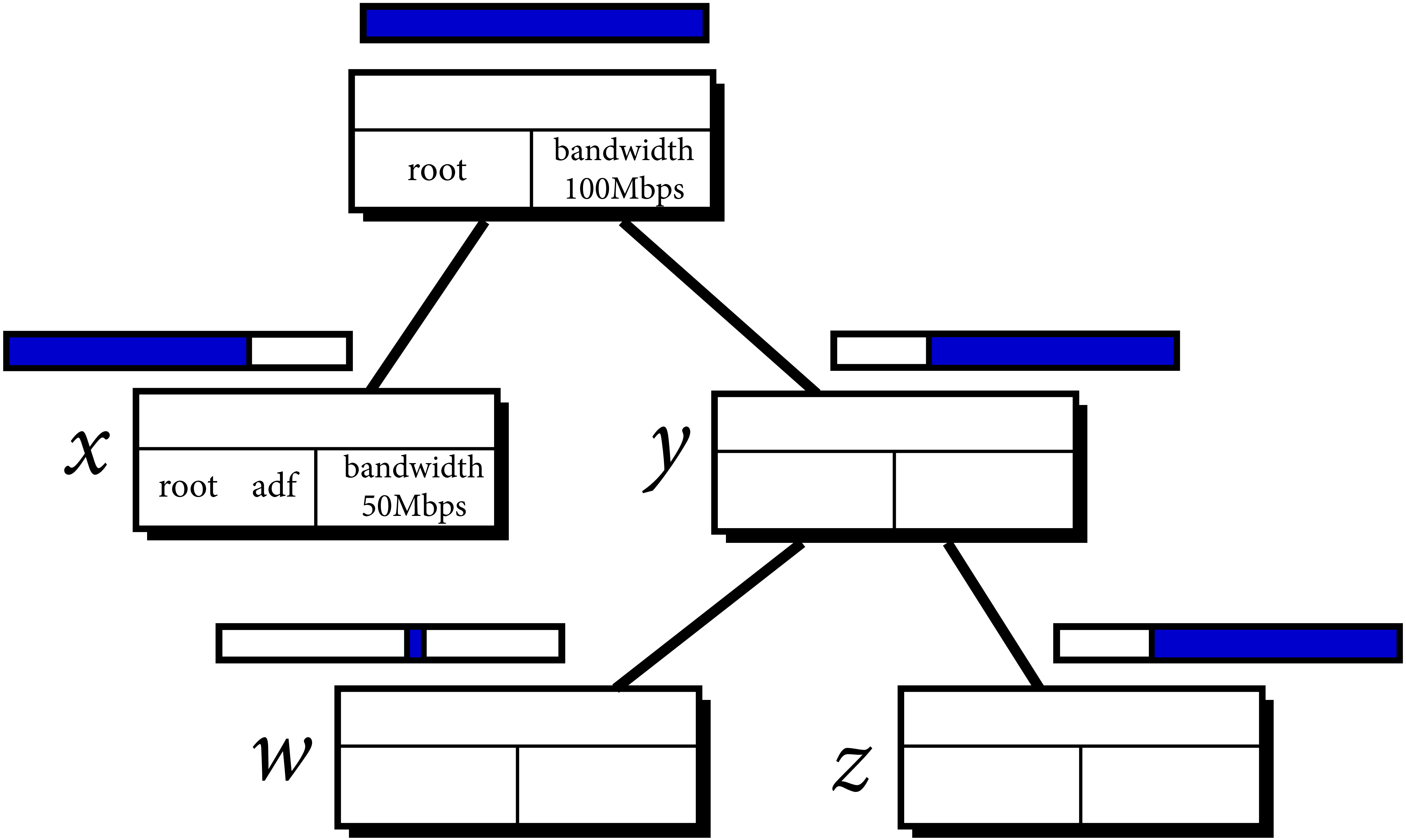
Delegação



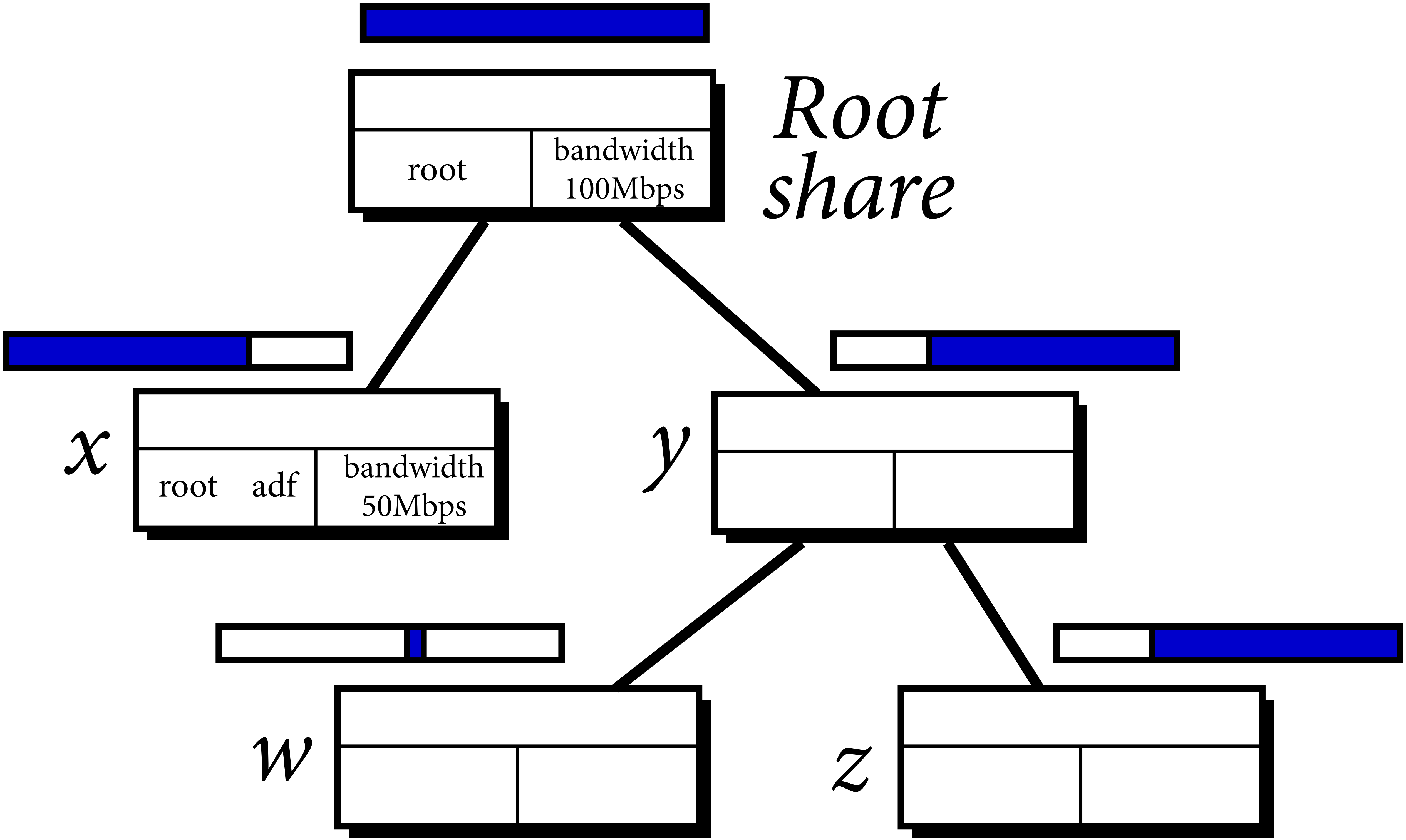
Delegação



Delegação



Delegação


Root
share
root
bandwidth
100Mbps
x
root adf
bandwidth
50Mbps
y
w
z

Delegação

Flowgroup

src=128.12/16 ∧ dst.port ≤1024

Speakers	Privileges
Alice Bob	deny, allow bandwidth: 5Mb/s limit: 10Mb/s *hint* *query*

Contexto Dinâmico

Flowgroup	
src=128.12/16 ∧ dst.port ≤1024	
Speakers	**Privileges**
Alice Bob	deny, allow bandwidth: 5Mb/s limit: 10Mb/s *hint* *query*

PANE

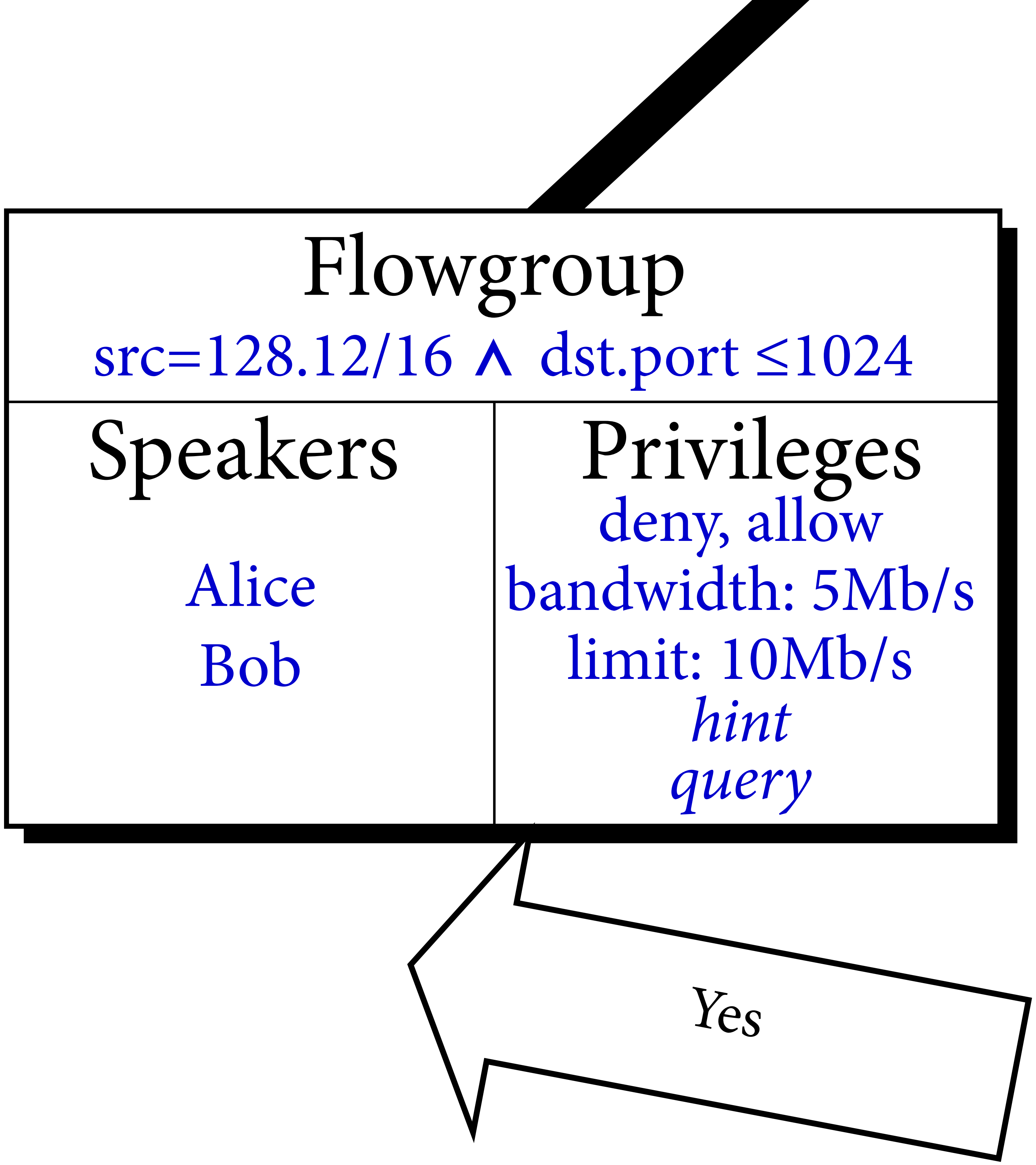
Contexto Dinâmico

Flowgroup	
src=128.12/16 ∧ dst.port ≤1024	
Speakers	Privileges
Alice Bob	deny, allow bandwidth: 5Mb/s limit: 10Mb/s *hint* *query*

Reserve 2 Mbps
from now to +5min?

PANE

Contexto Dinâmico



PANE

Contexto Dinâmico

Flowgroup	
$src=128.12/16 \wedge dst.port \leq 1024$	
Speakers	Privileges
Alice Bob	deny, allow bandwidth: 5Mb/s limit: 10Mb/s *hint* *query*

This traffic will be short and bursty

PANE

Contexto Dinâmico

Flowgroup

src=128.12/16 ∧ dst.port ≤1024

Speakers	Privileges
Alice Bob	deny, allow bandwidth: 5Mb/s limit: 10Mb/s *hint* *query*

OK

PANE

Contexto Dinâmico

Flowgroup	
src=128.12/16 ∧ dst.port ≤1024	
Speakers	**Privileges**
Alice	deny, allow
Bob	bandwidth: 5Mb/s
	limit: 10Mb/s
	hint
	query

How much web traffic in the last hour?

PANE

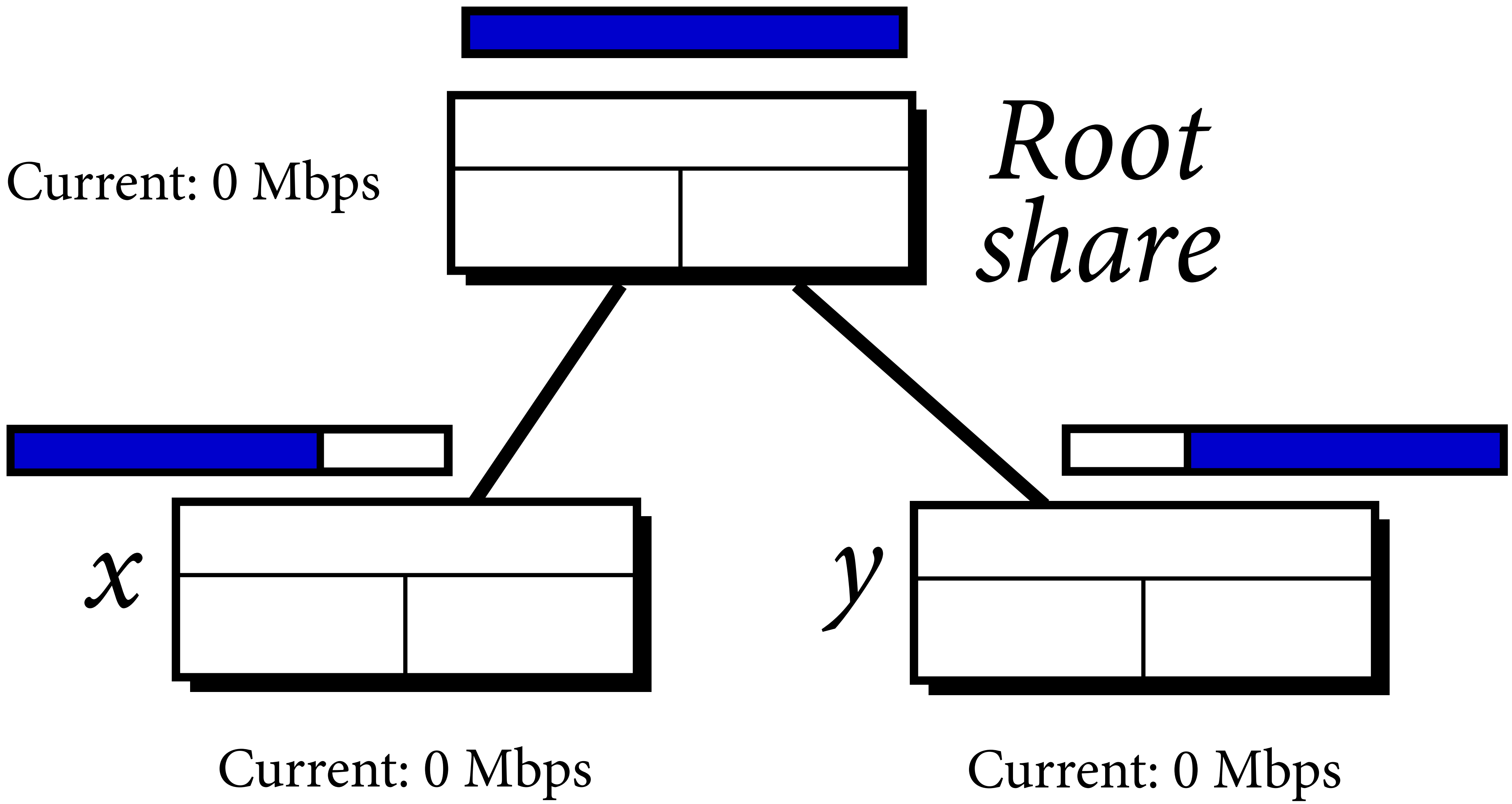
Contexto Dinâmico

Flowgroup	
src=128.12/16 ∧ dst.port ≤1024	
Speakers	**Privileges**
Alice Bob	deny, allow bandwidth: 5Mb/s limit: 10Mb/s *hint* *query*

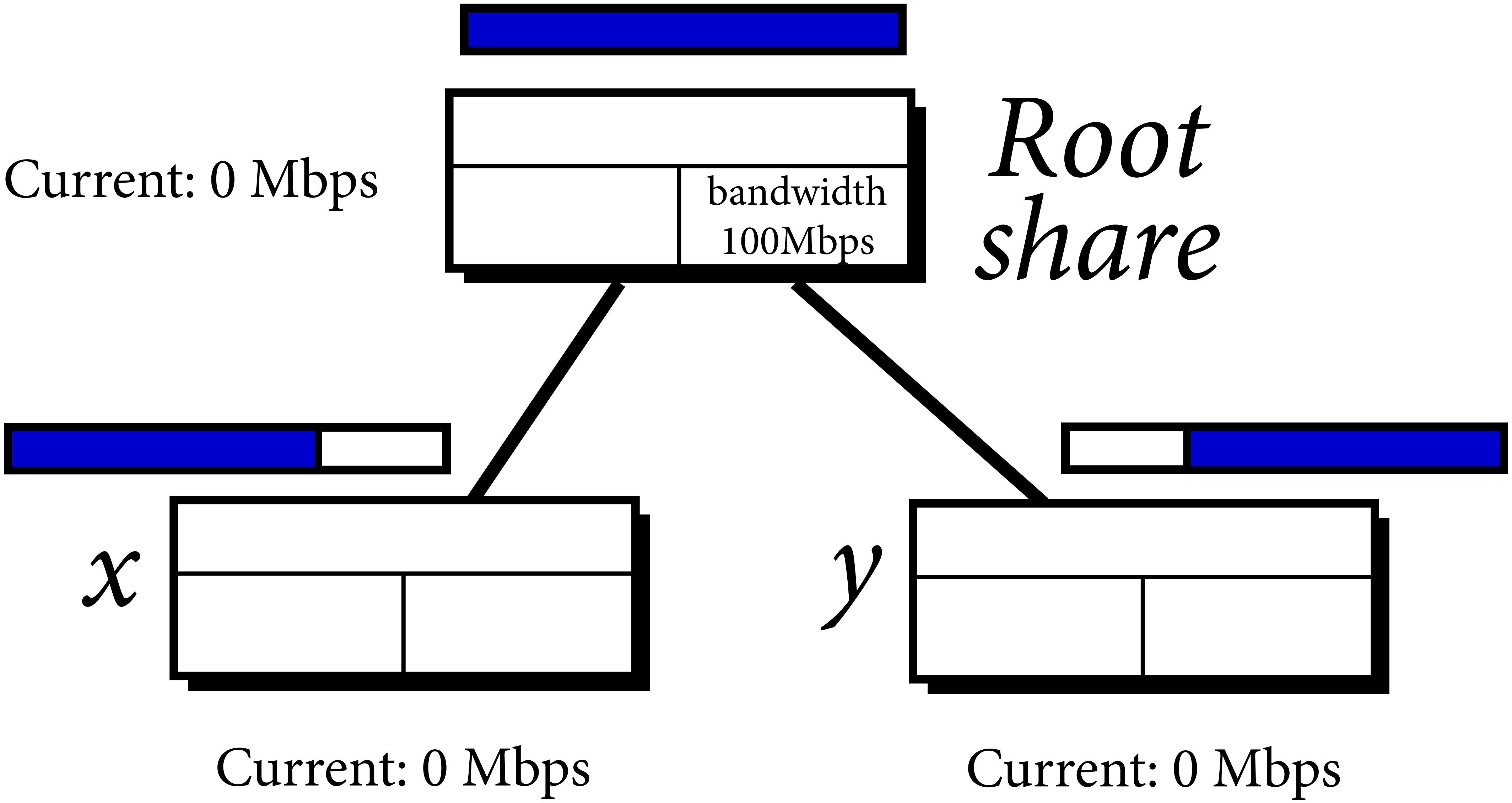
67,560 bytes

PANE

Contexto Dinâmico

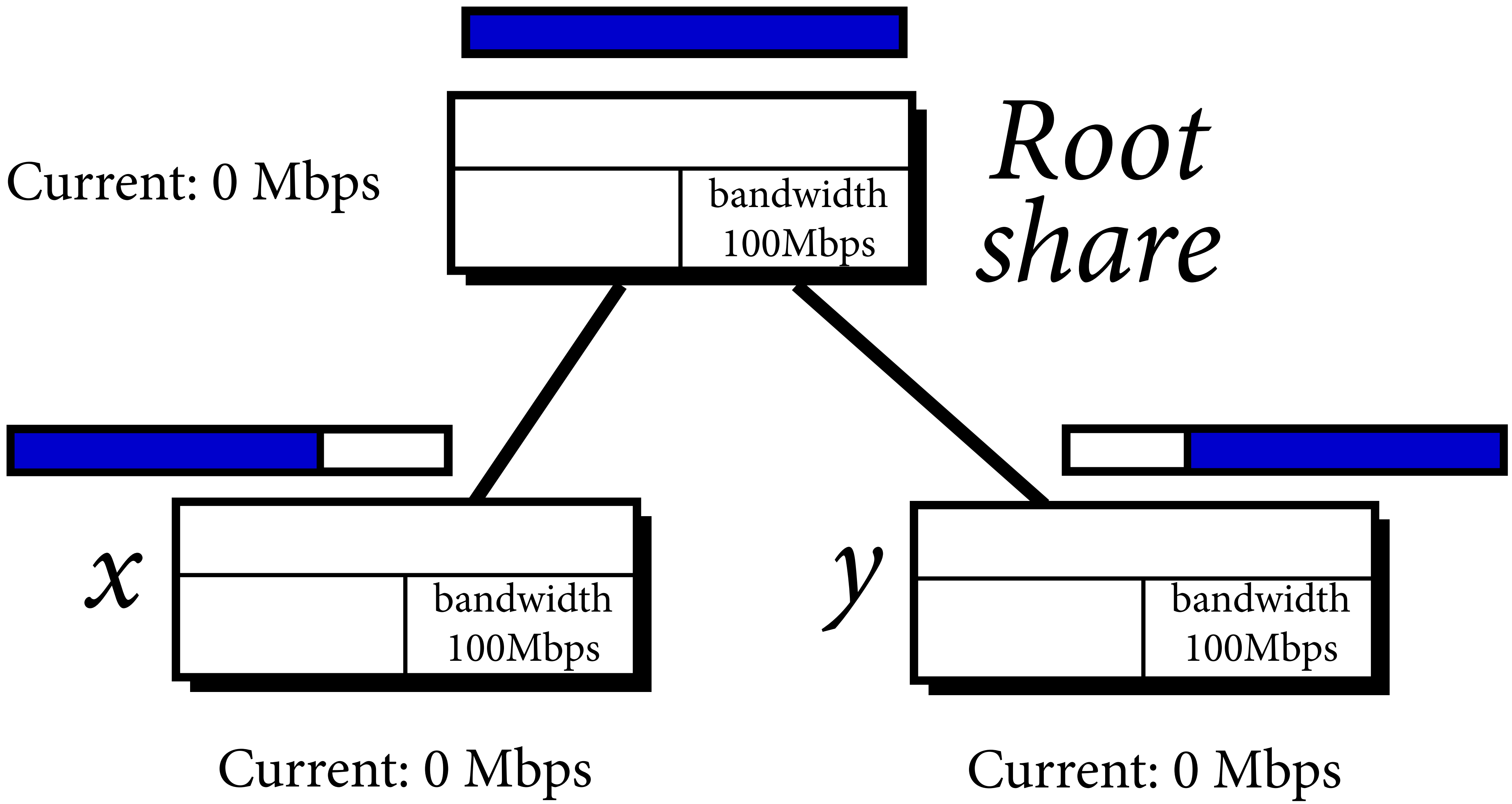


PANE

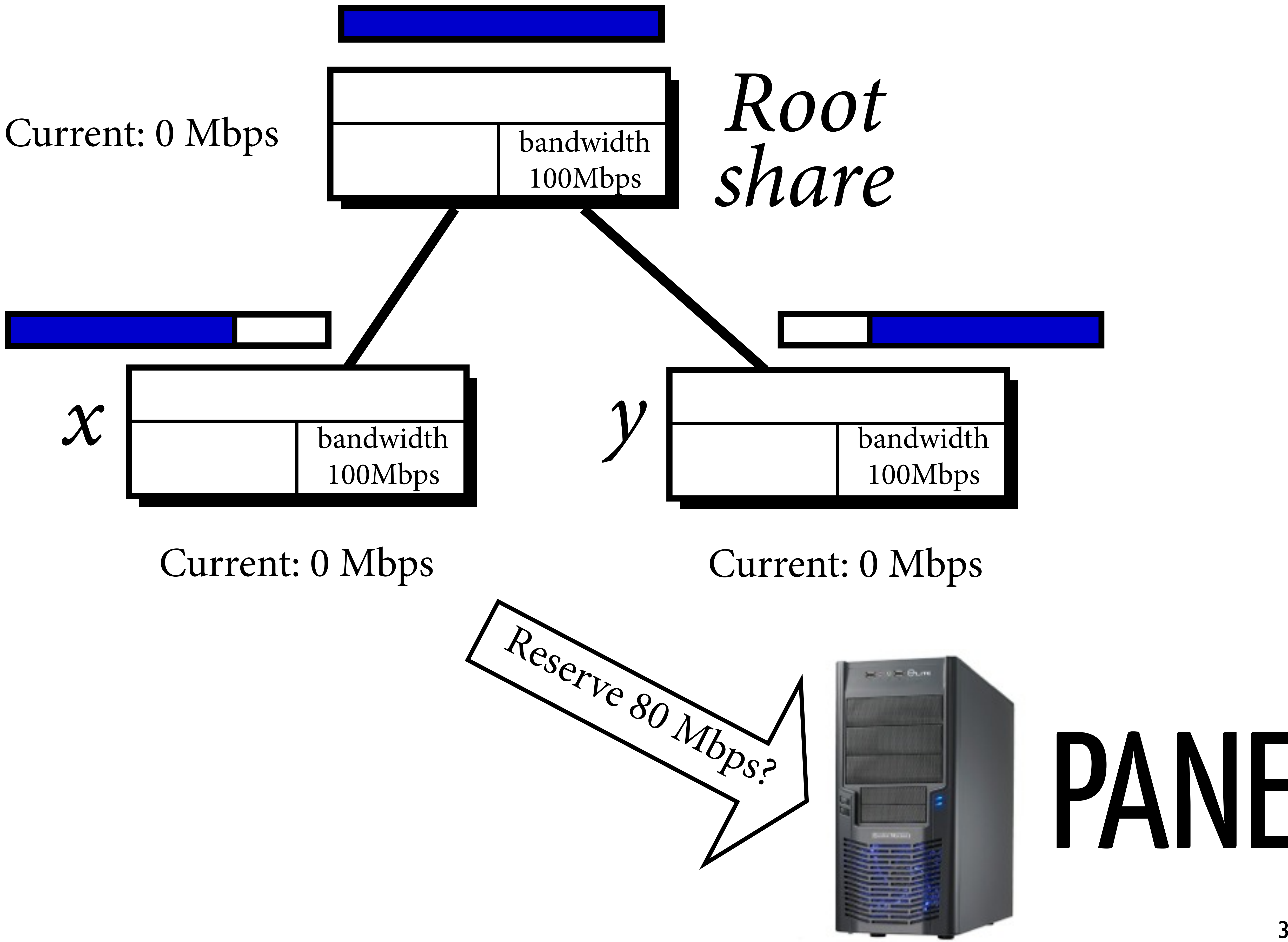


Current: 0 Mbps
bandwidth
100Mbps
Root
share
x
y
Current: 0 Mbps
Current: 0 Mbps

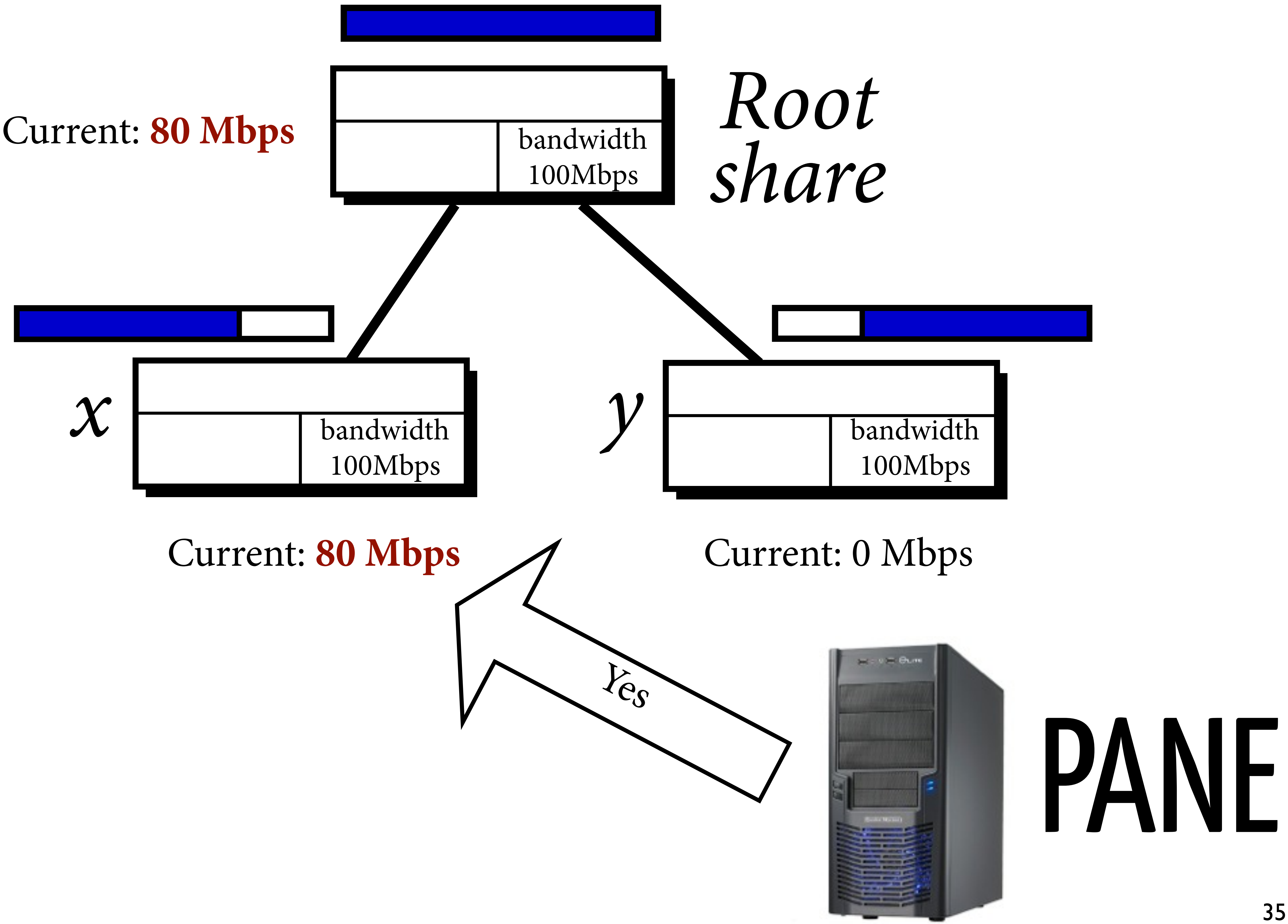
PANE


Current: 0 Mbps
bandwidth
100Mbps
Root
share
x
bandwidth
100Mbps
y
bandwidth
100Mbps
Current: 0 Mbps
Current: 0 Mbps

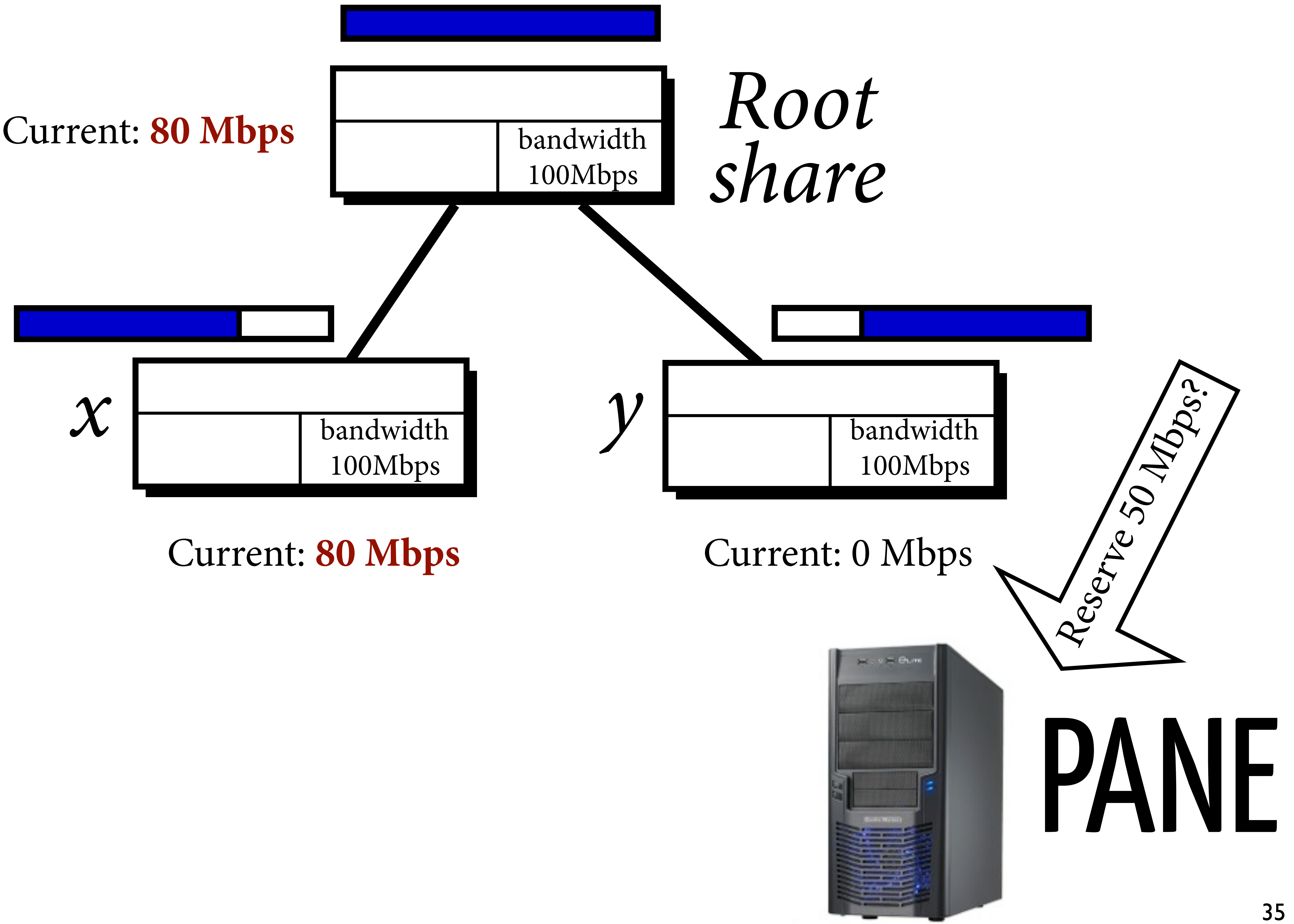
PANE

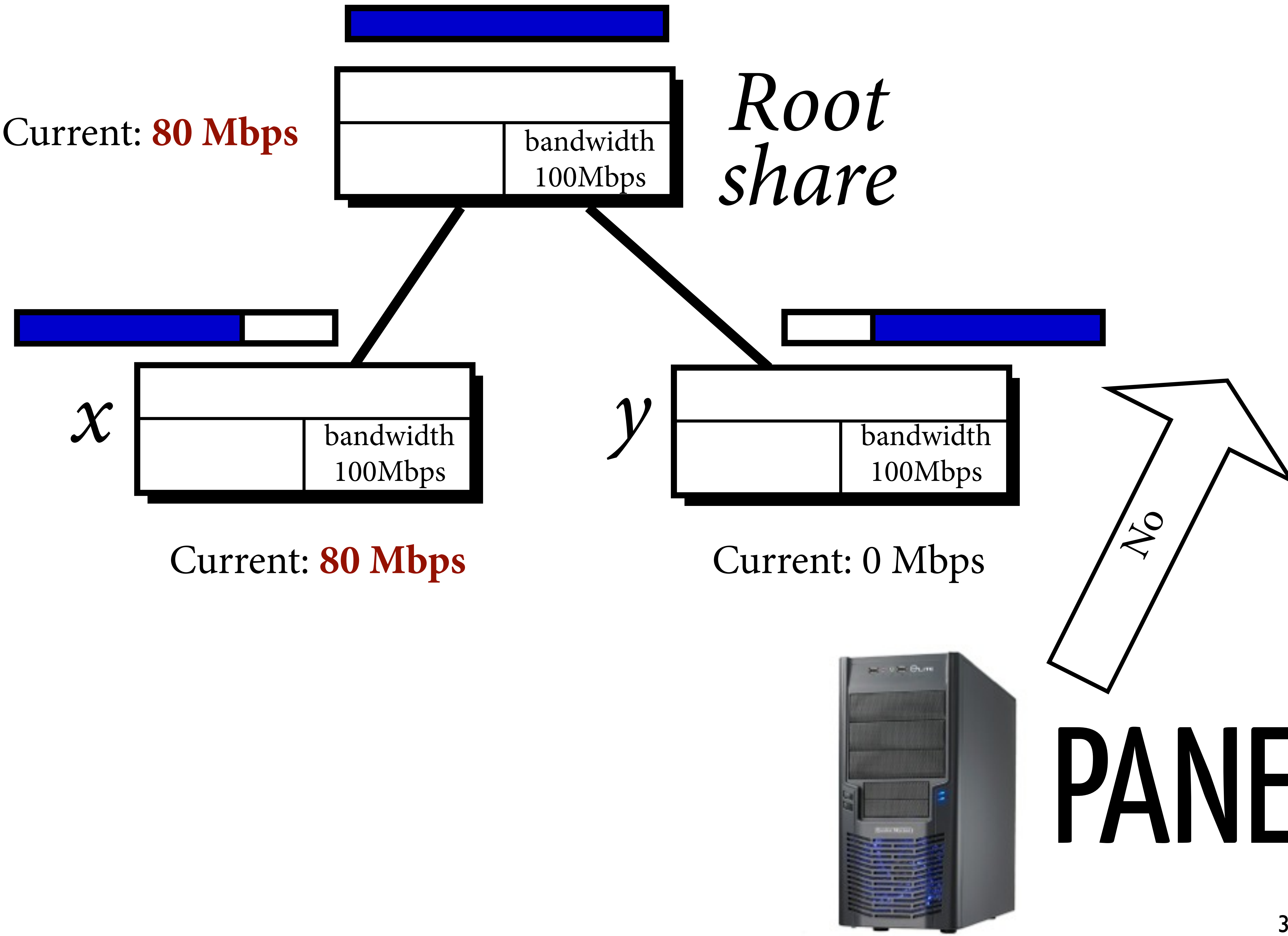


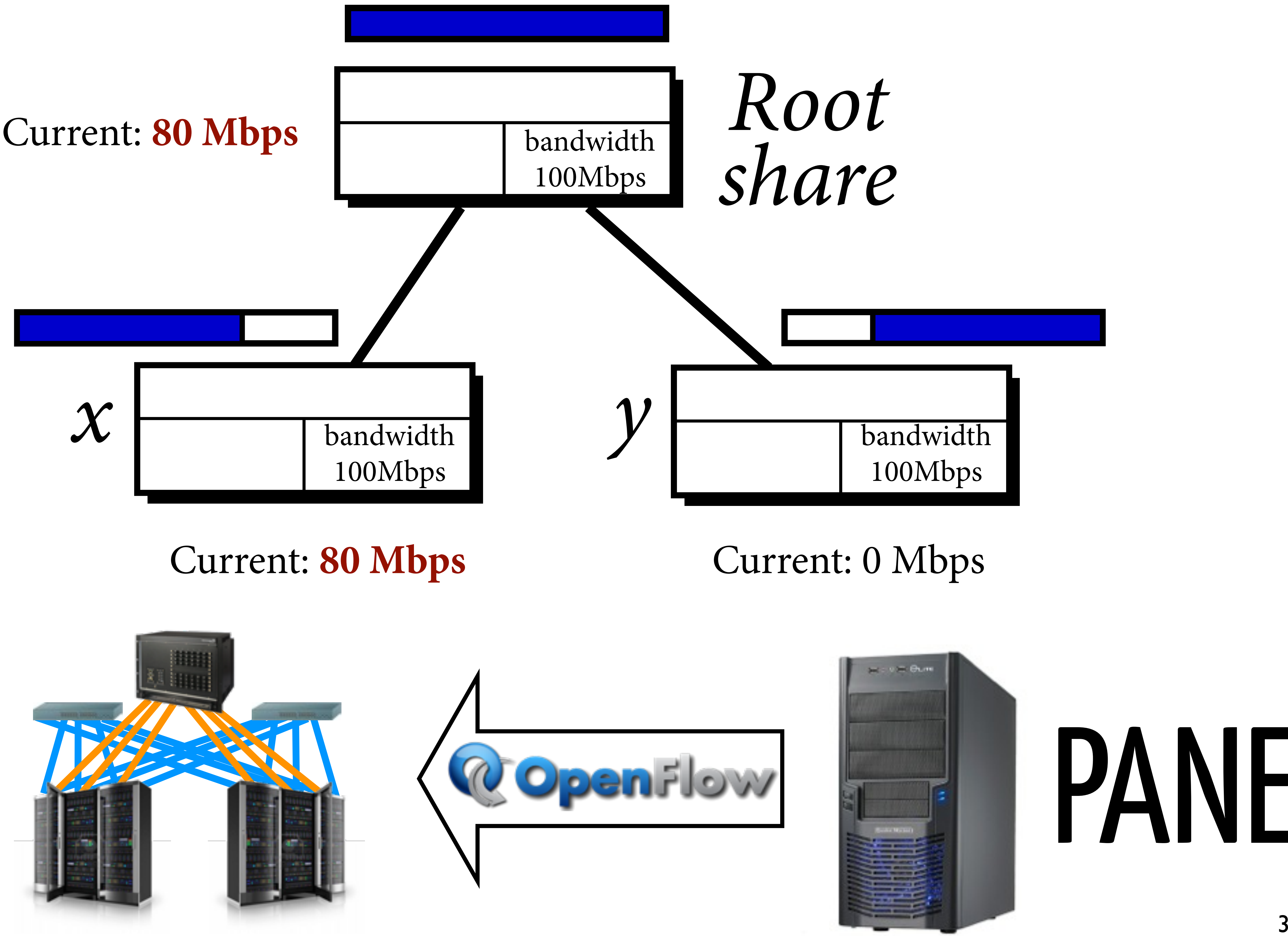
Current: 0 Mbps
bandwidth
100Mbps
Root
share
x
bandwidth
100Mbps
y
bandwidth
100Mbps
Current: 0 Mbps
Current: 0 Mbps
Reserve 80 Mbps?
PANE



Current: **80 Mbps**
bandwidth
100Mbps
Root share
x
bandwidth
100Mbps
y
bandwidth
100Mbps
Current: **80 Mbps**
Current: 0 Mbps
Yes
PANE

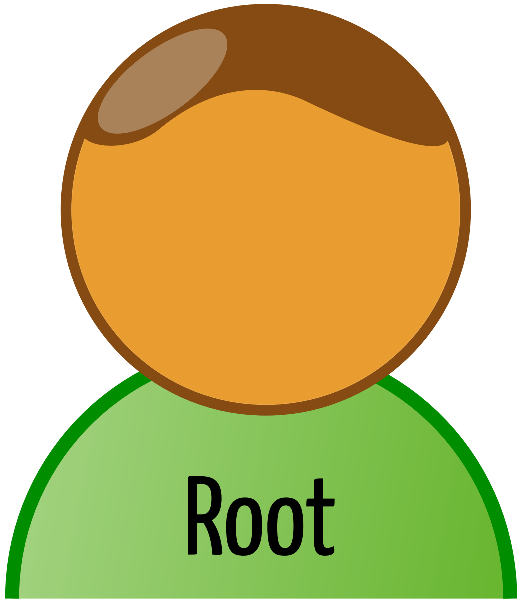

Root share
Current: 80 Mbps
bandwidth 100Mbps
x
bandwidth 100Mbps
Current: 80 Mbps
y
bandwidth 100Mbps
Current: 0 Mbps
Reserve 50 Mbps?
PANE


Root share
Current: 80 Mbps
bandwidth
100Mbps
x
bandwidth
100Mbps
Current: 80 Mbps
y
bandwidth
100Mbps
Current: 0 Mbps
No
PANE

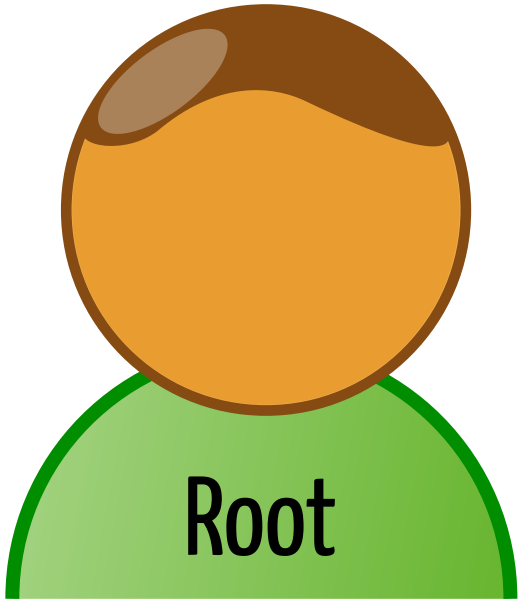

Current: 80 Mbps
bandwidth
100Mbps
Root share
x
bandwidth
100Mbps
y
bandwidth
100Mbps
Current: 80 Mbps
Current: 0 Mbps
OpenFlow
PANE

Esboço do Protocolo

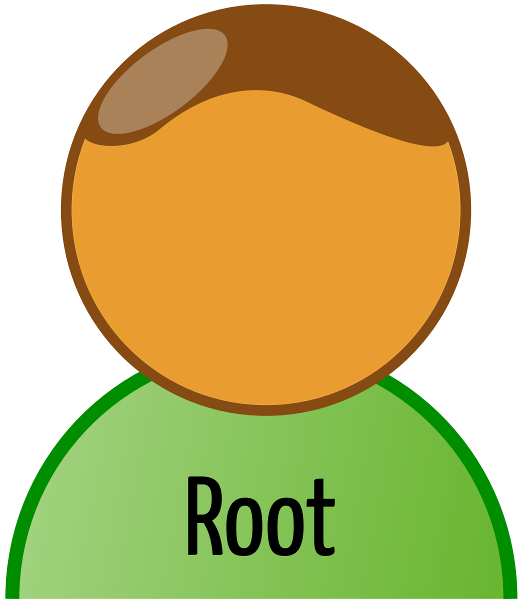
PANE



PANE

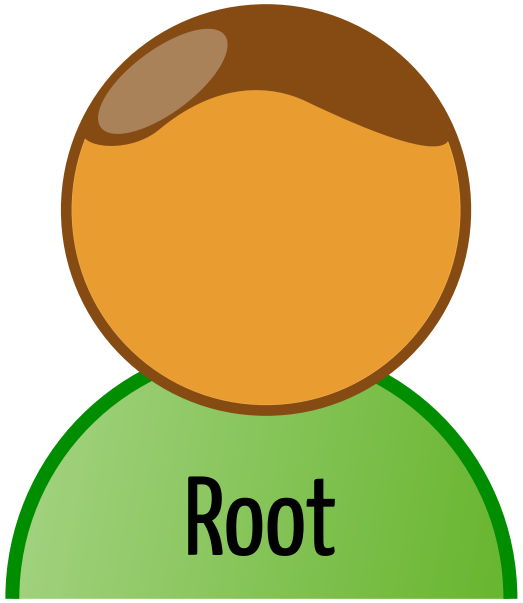


PANE



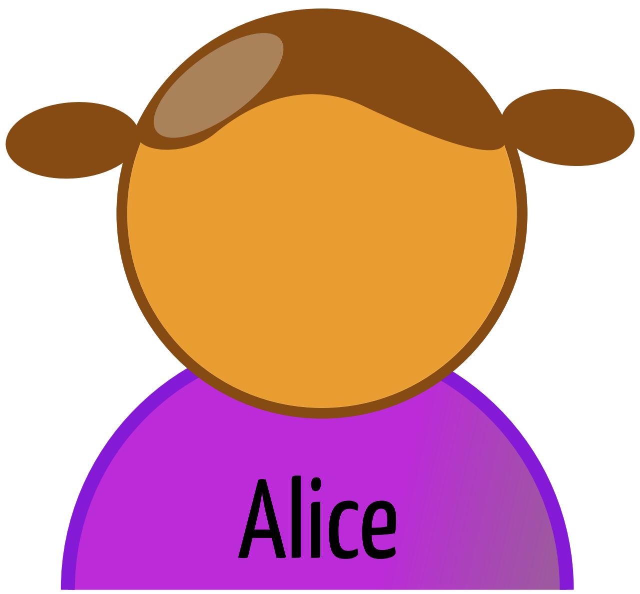
NewShare A for
(user=Alice) [reserve <= 10Mb]
on rootShare.

PANE

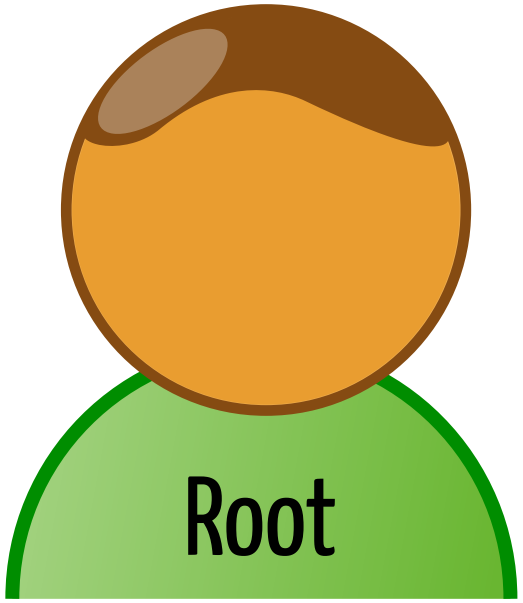



```
NewShare A for
(user=Alice) [reserve <= 10Mb]
on rootShare.
```

OK



PANE

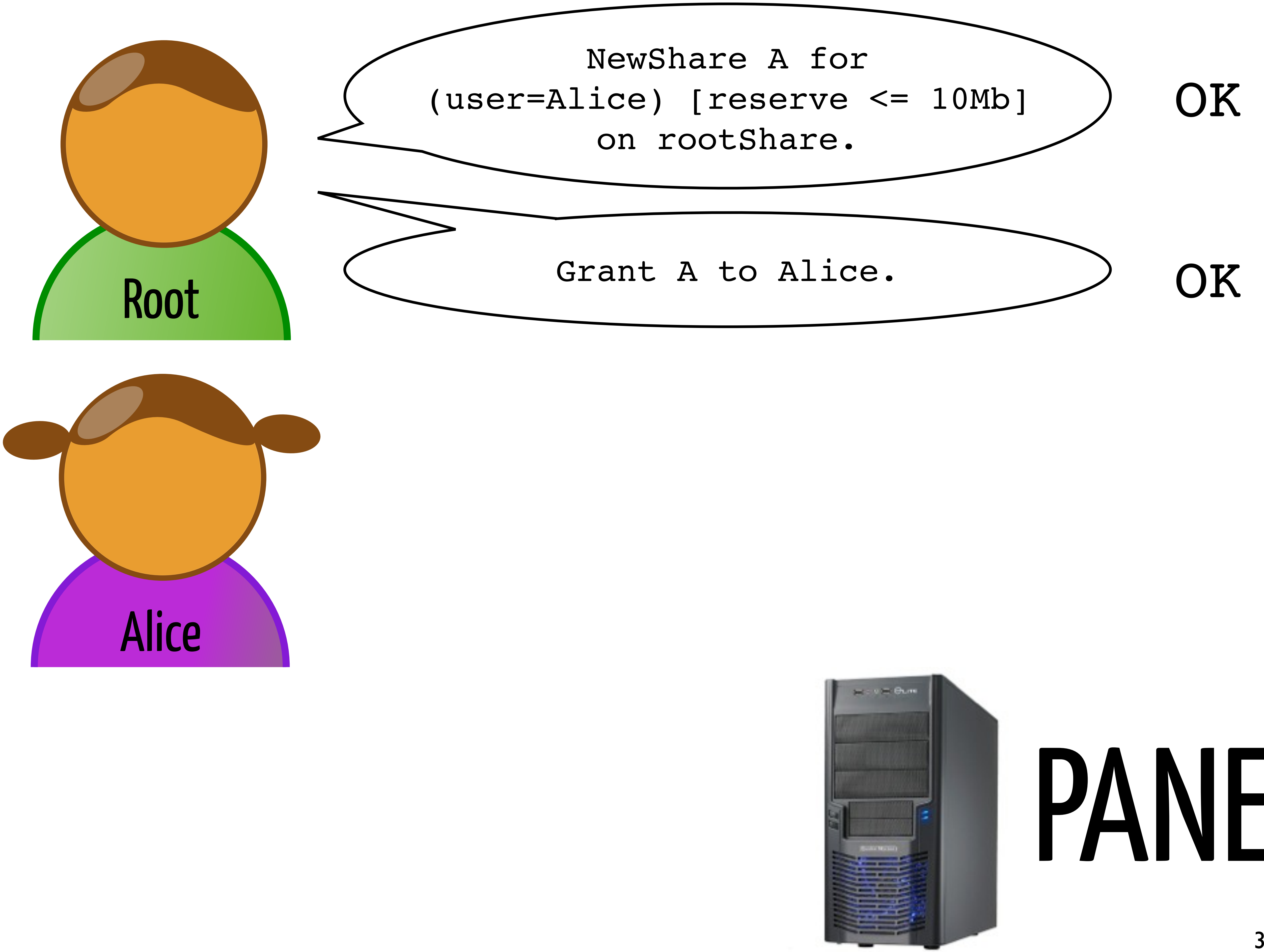


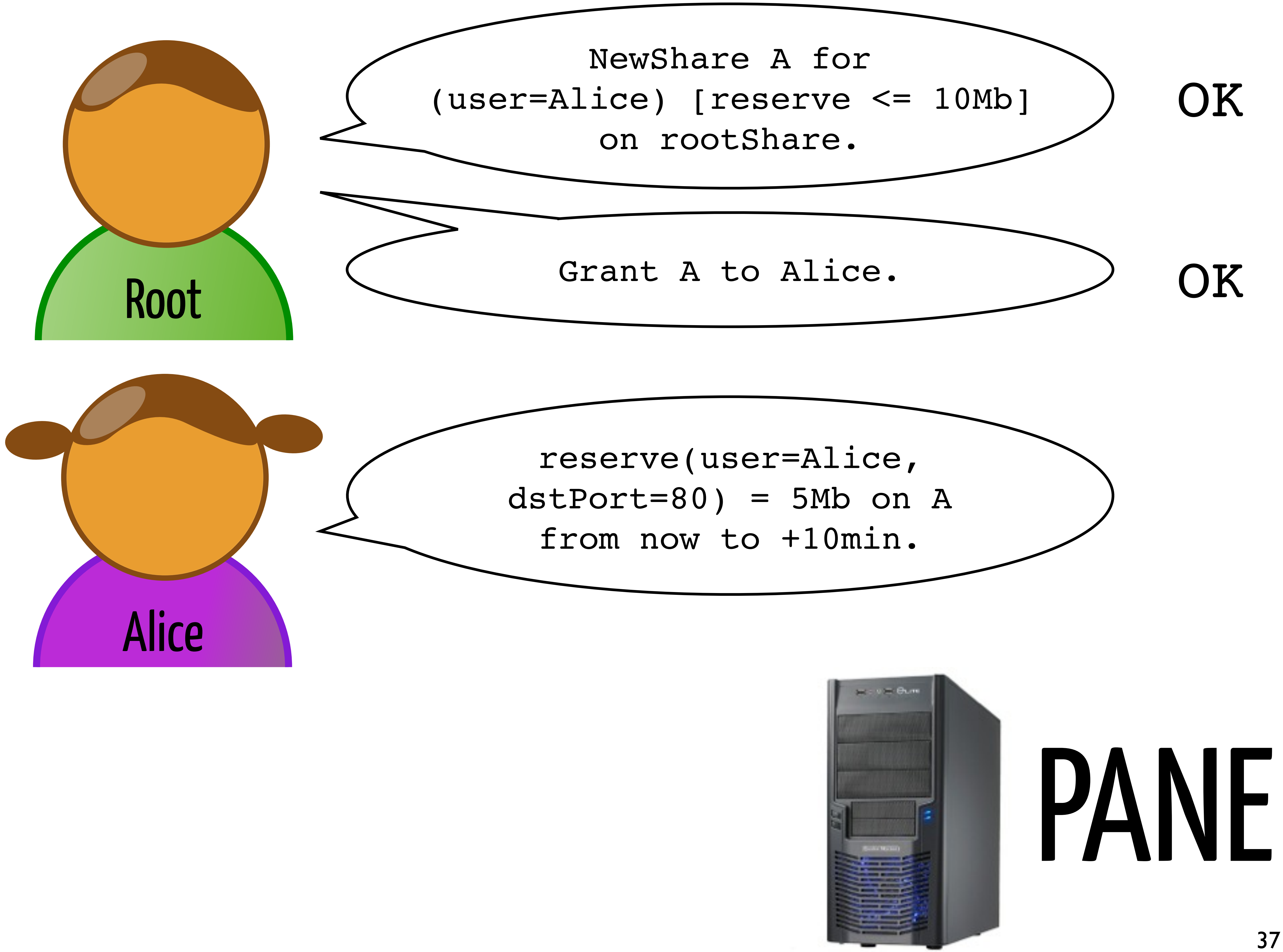
NewShare A for
(user=Alice) [reserve <= 10Mb]
on rootShare.

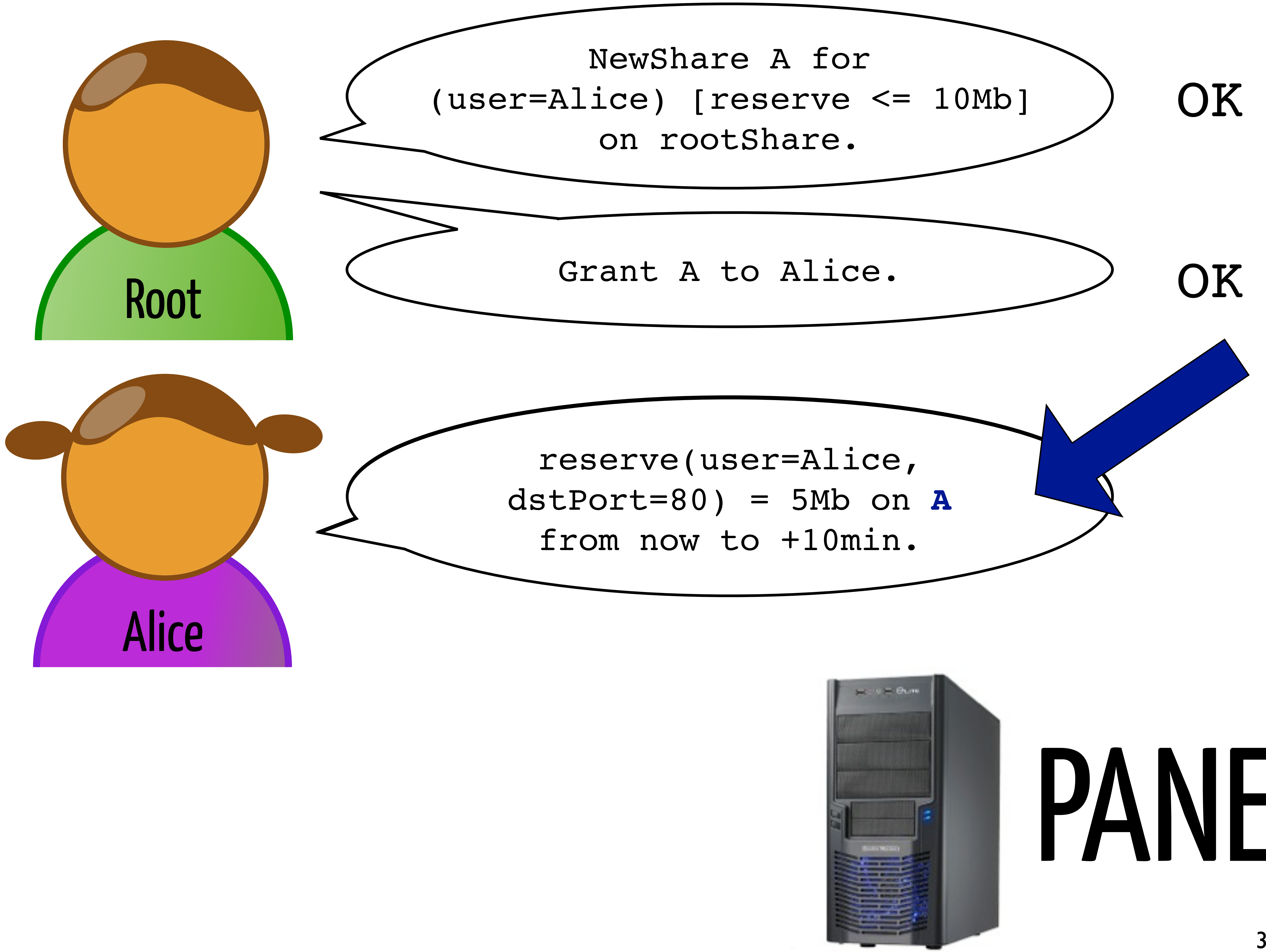
OK

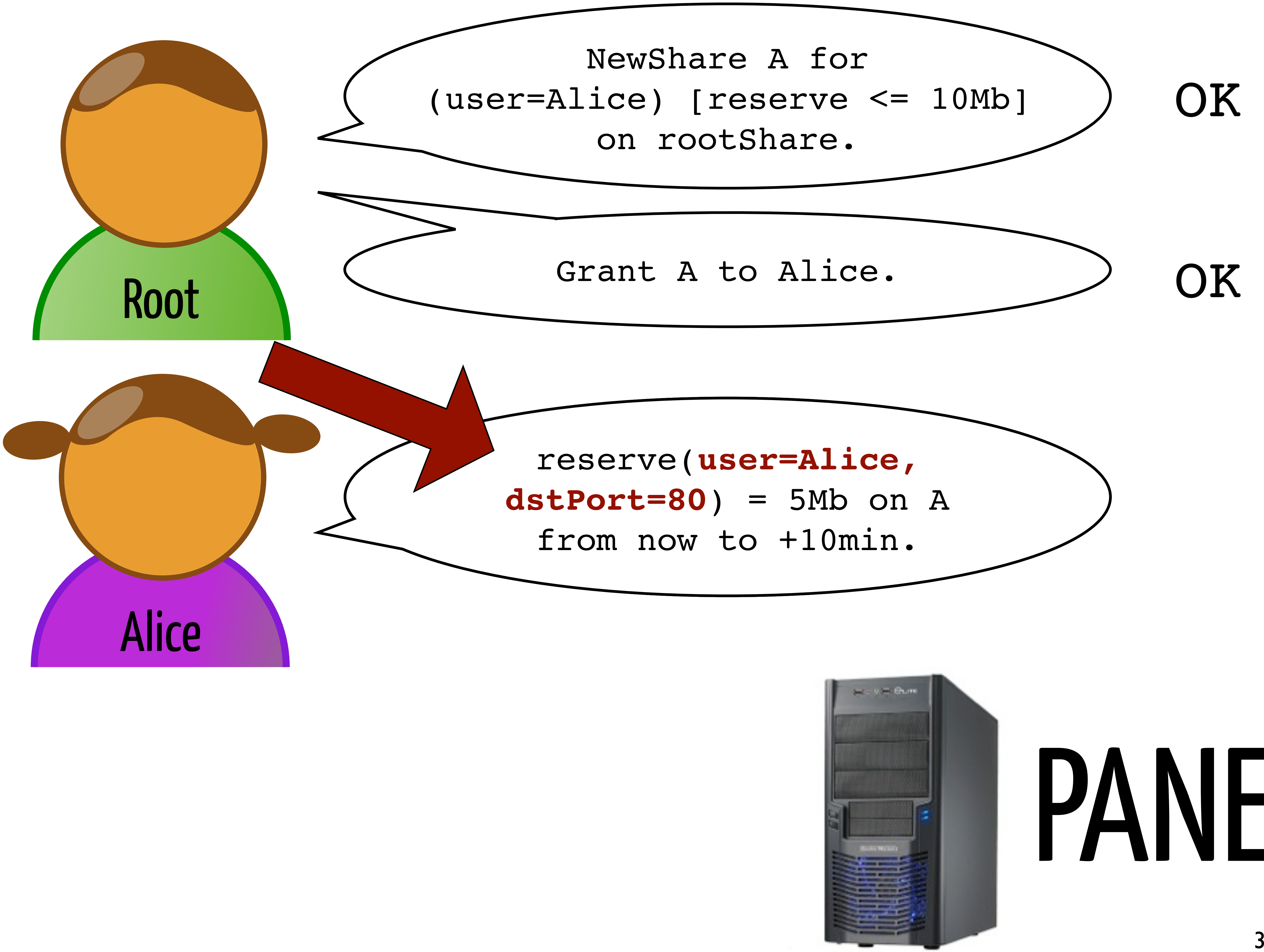
Grant A to Alice.

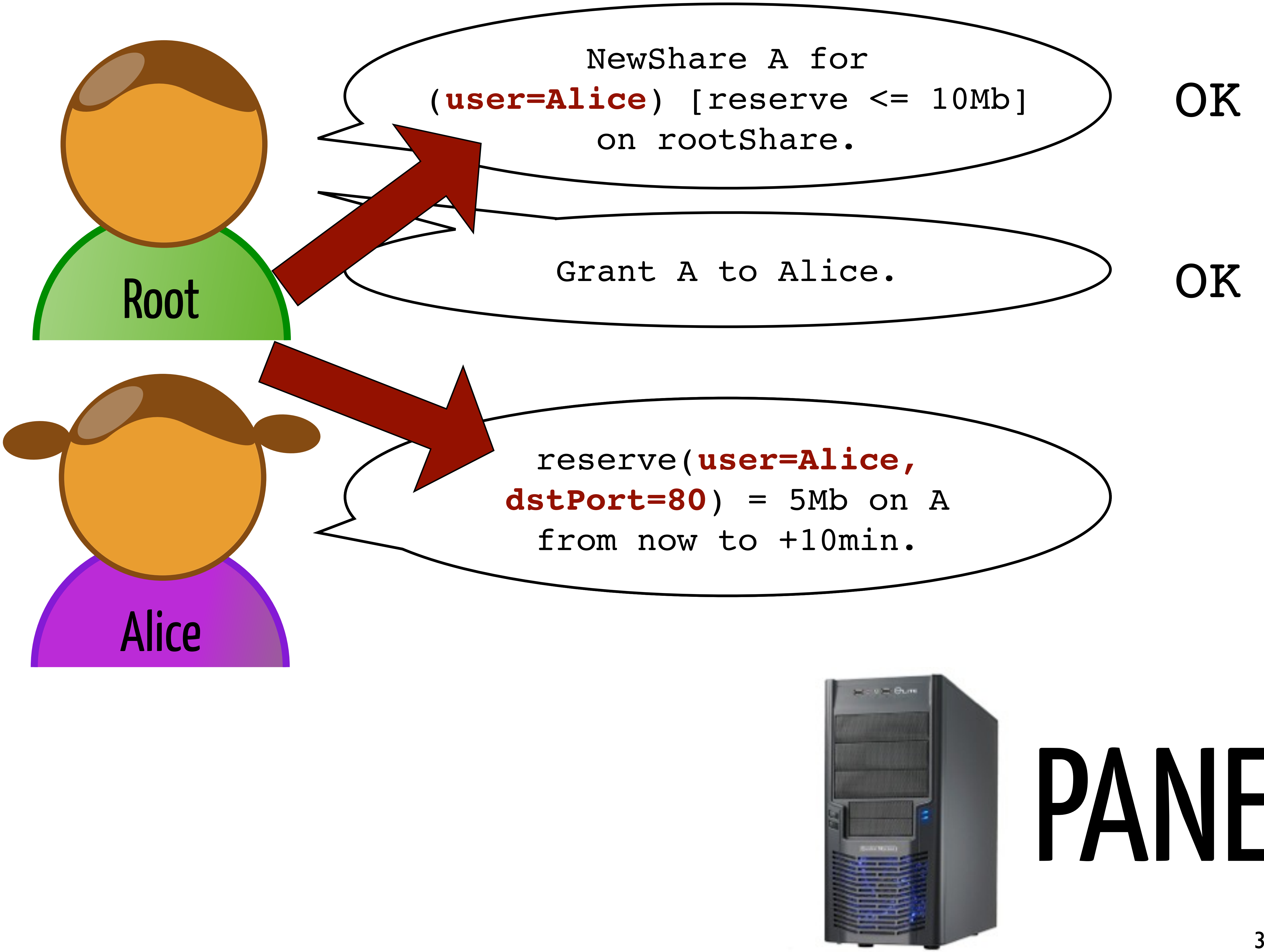
PANE


NewShare A for
(user=Alice) [reserve <= 10Mb]
on rootShare.
OK
Grant A to Alice.
OK
Root
Alice
PANE


Root
NewShare A for (user=Alice) [reserve <= 10Mb] on rootShare.
OK
Grant A to Alice.
OK
Alice
reserve(user=Alice, dstPort=80) = 5Mb on A from now to +10min.
PANE

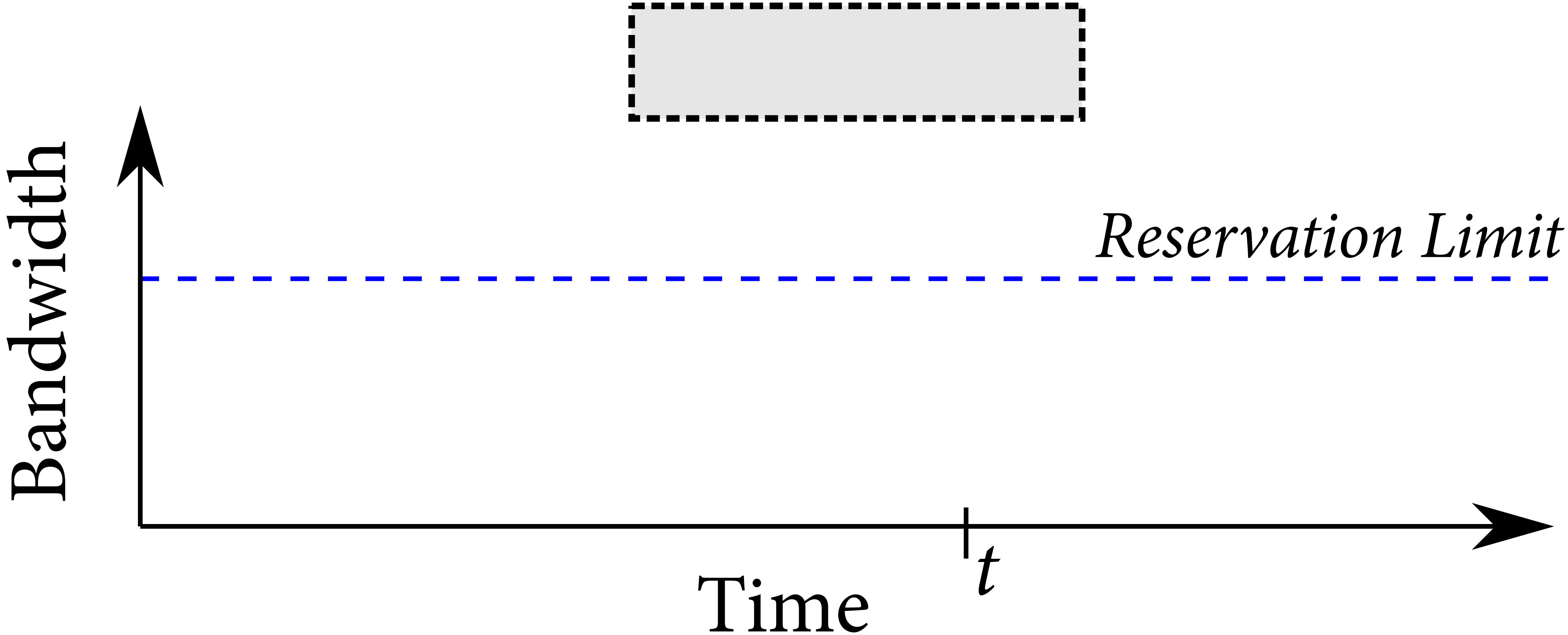

Root
NewShare A for
(user=Alice) [reserve <= 10Mb]
on rootShare.
OK
Grant A to Alice.
OK
Alice
reserve(user=Alice,
dstPort=80) = 5Mb on A
from now to +10min.
PANE


NewShare A for (user=Alice) [reserve <= 10Mb] on rootShare.
OK
Grant A to Alice.
OK
Root
reserve(user=Alice, dstPort=80) = 5Mb on A from now to +10min.
Alice
PANE


Root
Alice
NewShare A for (user=Alice) [reserve <= 10Mb] on rootShare.
OK
Grant A to Alice.
OK
reserve(user=Alice, dstPort=80) = 5Mb on A from now to +10min.
PANE

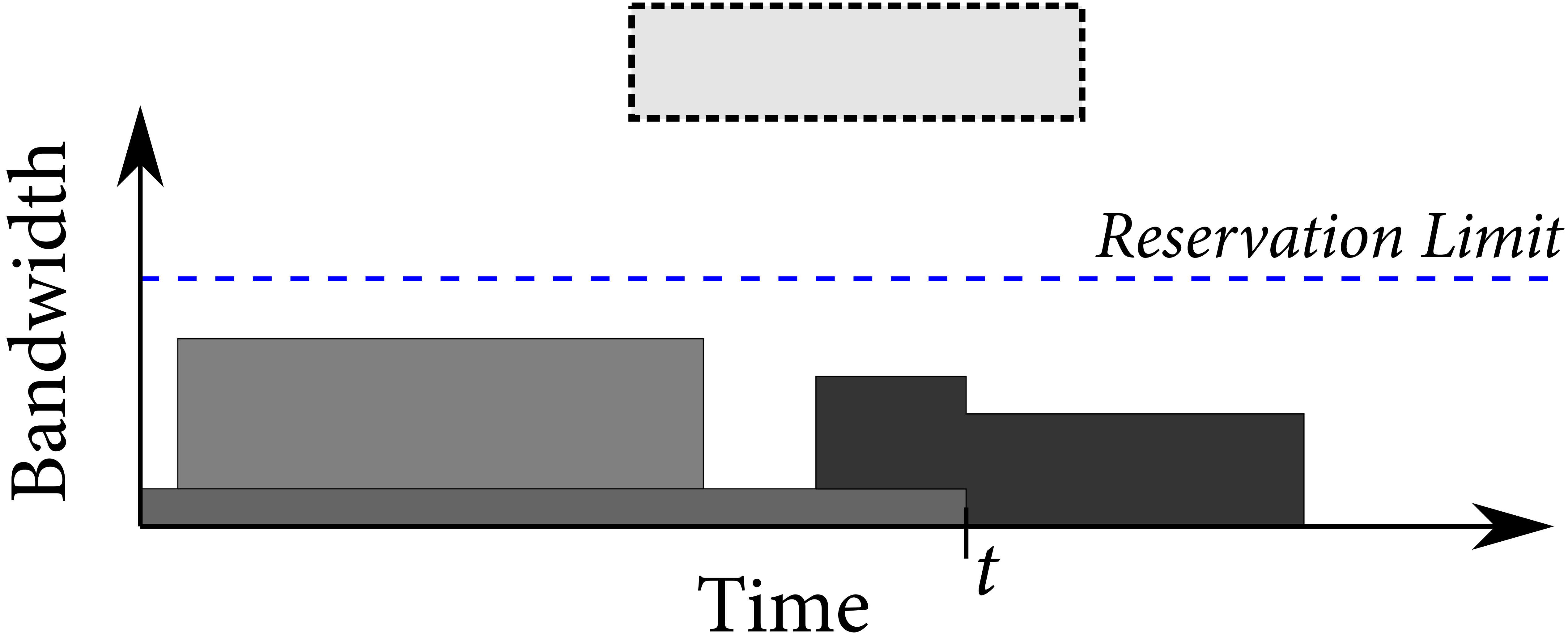
reserve(user=Alice,
dstPort=80) = 5Mb on A
from now to +10min.

PANE



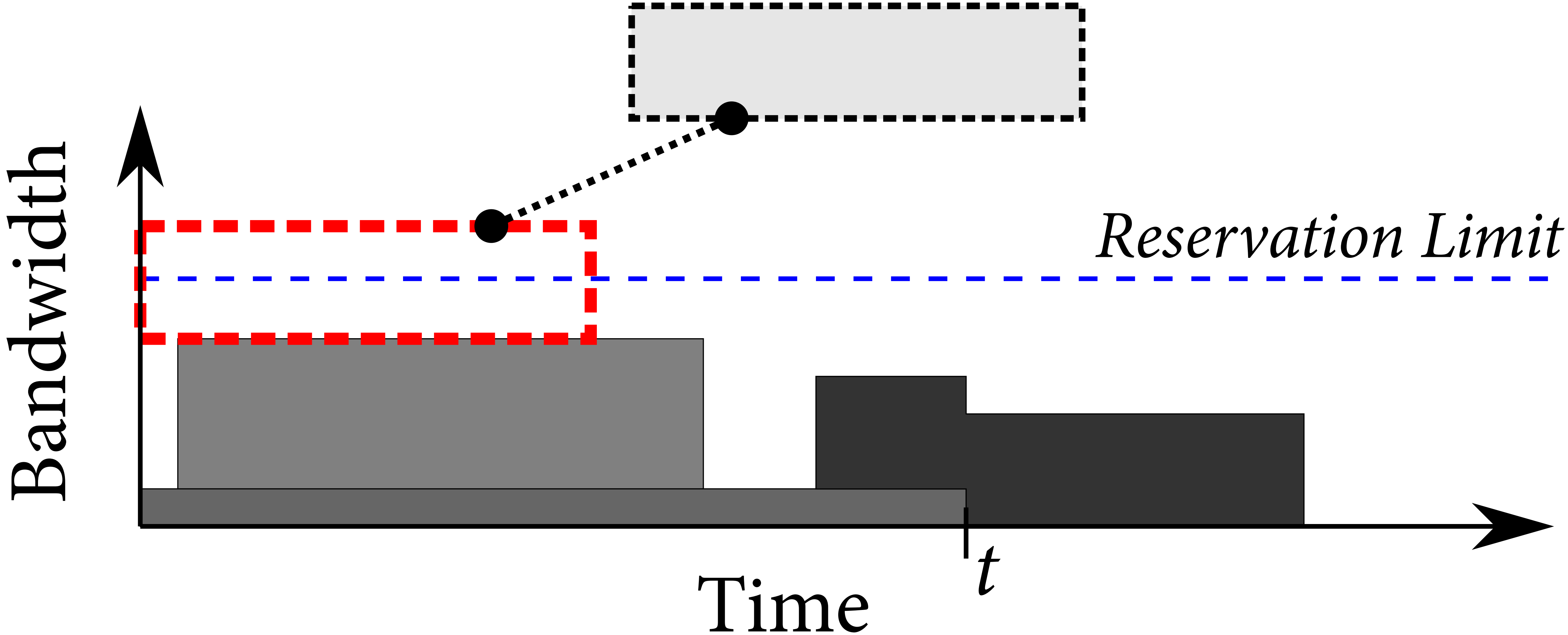

```
reserve(user=Alice,
dstPort=80) = 5Mb on A
from now to +10min.
```

PANE



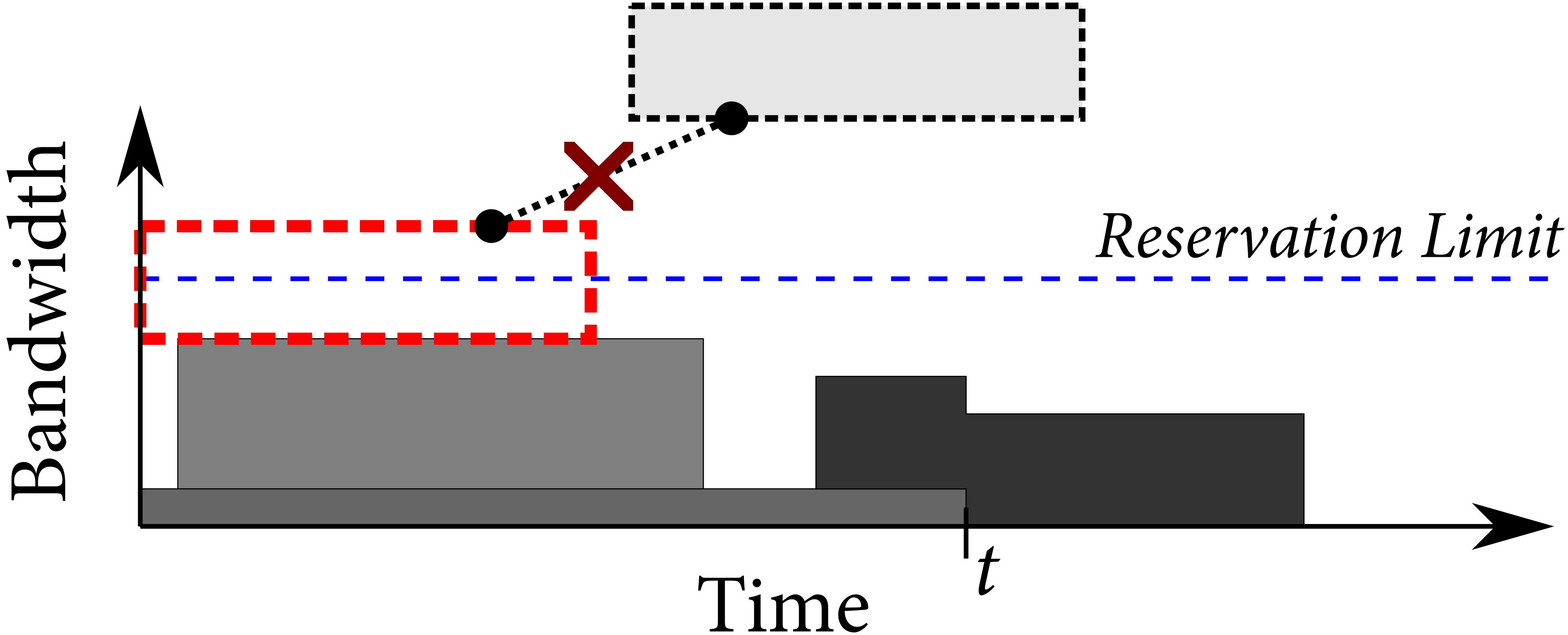
reserve(user=Alice, dstPort=80) = 5Mb on A from now to +10min.

PANE




```
reserve(user=Alice,
dstPort=80) = 5Mb on A
from now to +10min.
```

PANE




```
reserve(user=Alice,
dstPort=80) = 5Mb on A
from now to +10min.
```

PANE


```
reserve(user=Alice,
dstPort=80) = 5Mb on A
from now to +10min.
```

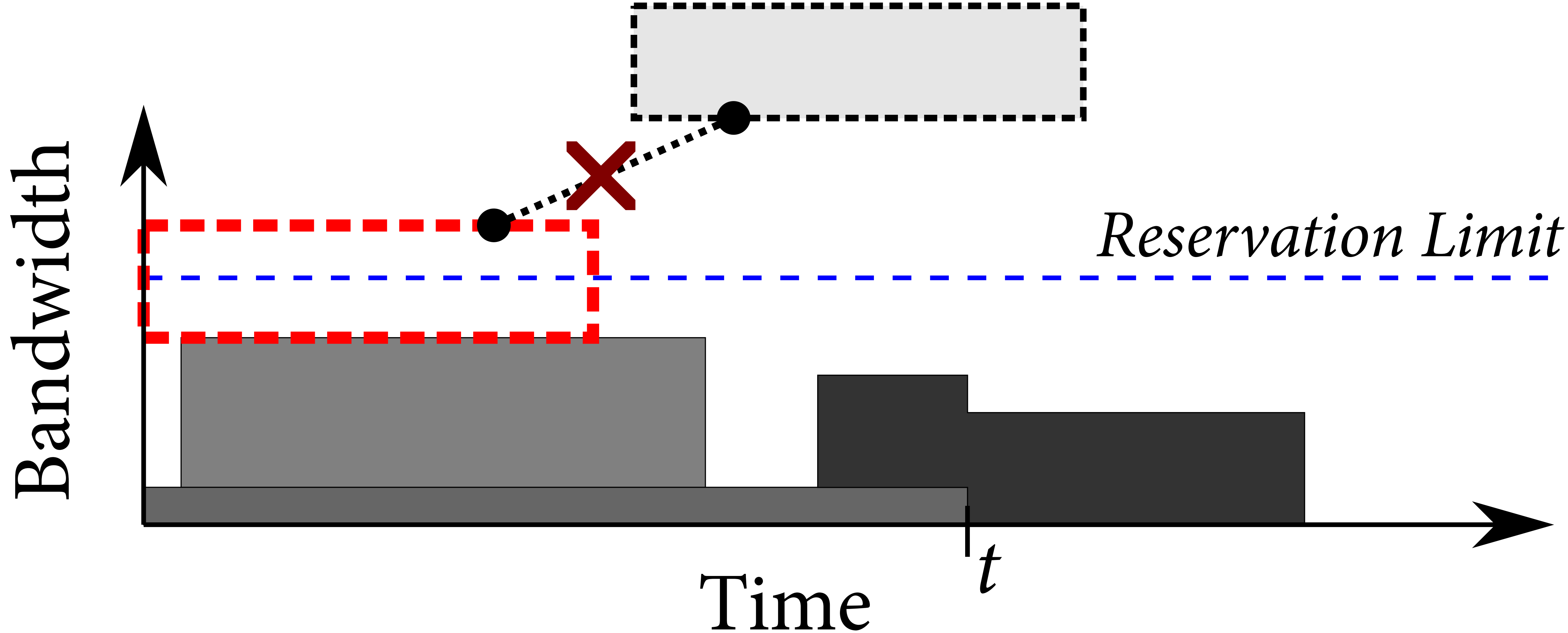
NO

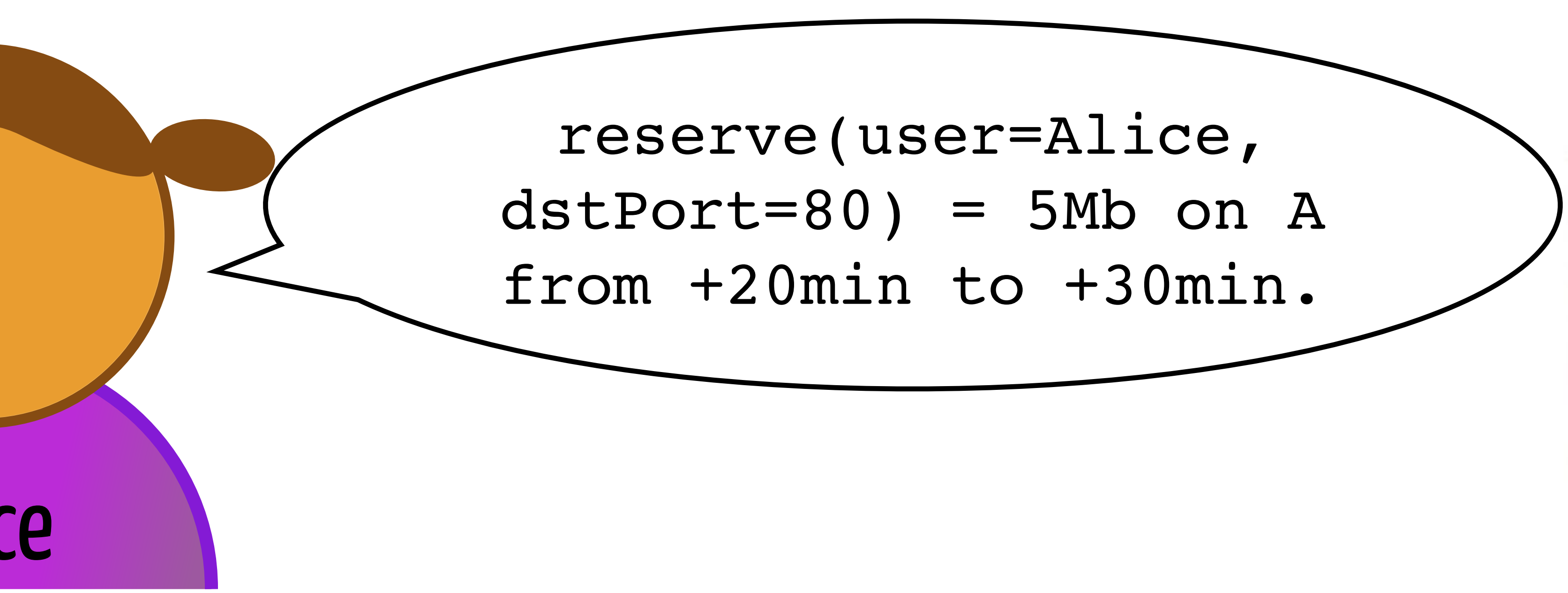
PANE


```
reserve(user=Alice,
dstPort=80) = 5Mb on A
from now to +10min.
```

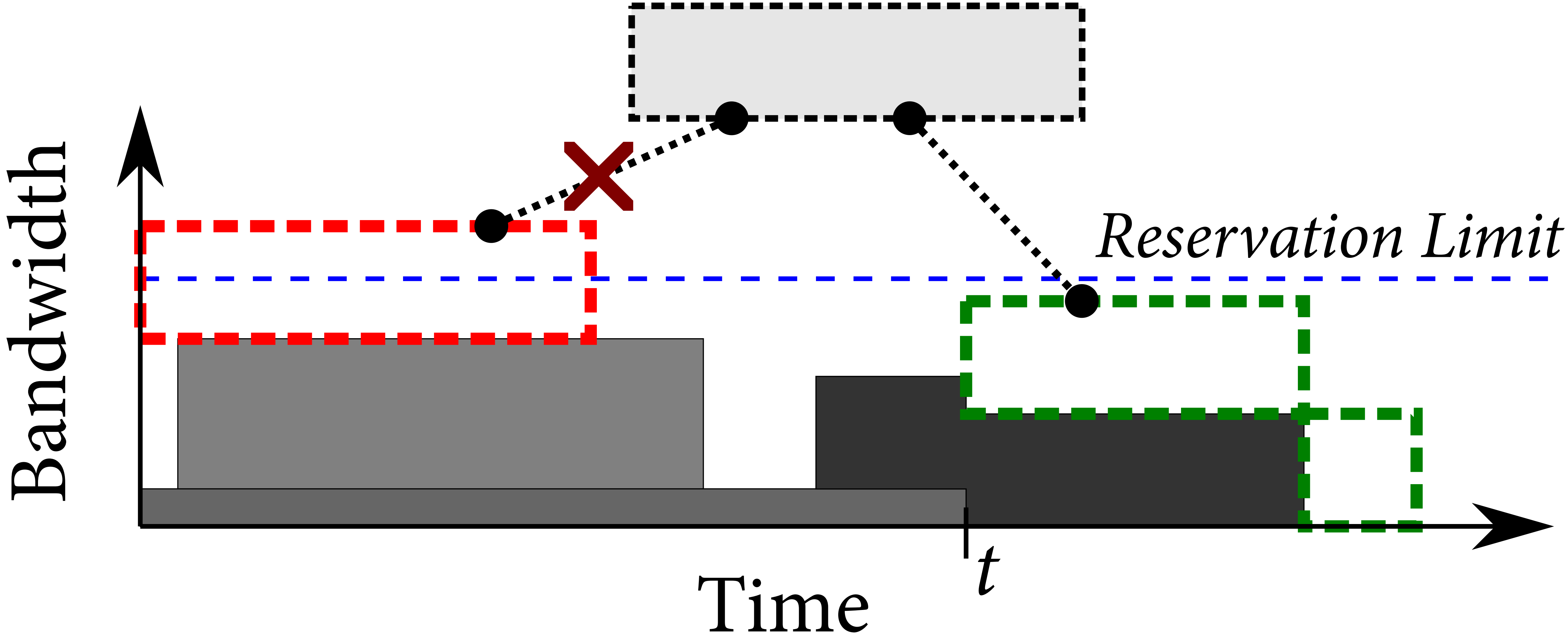
NO

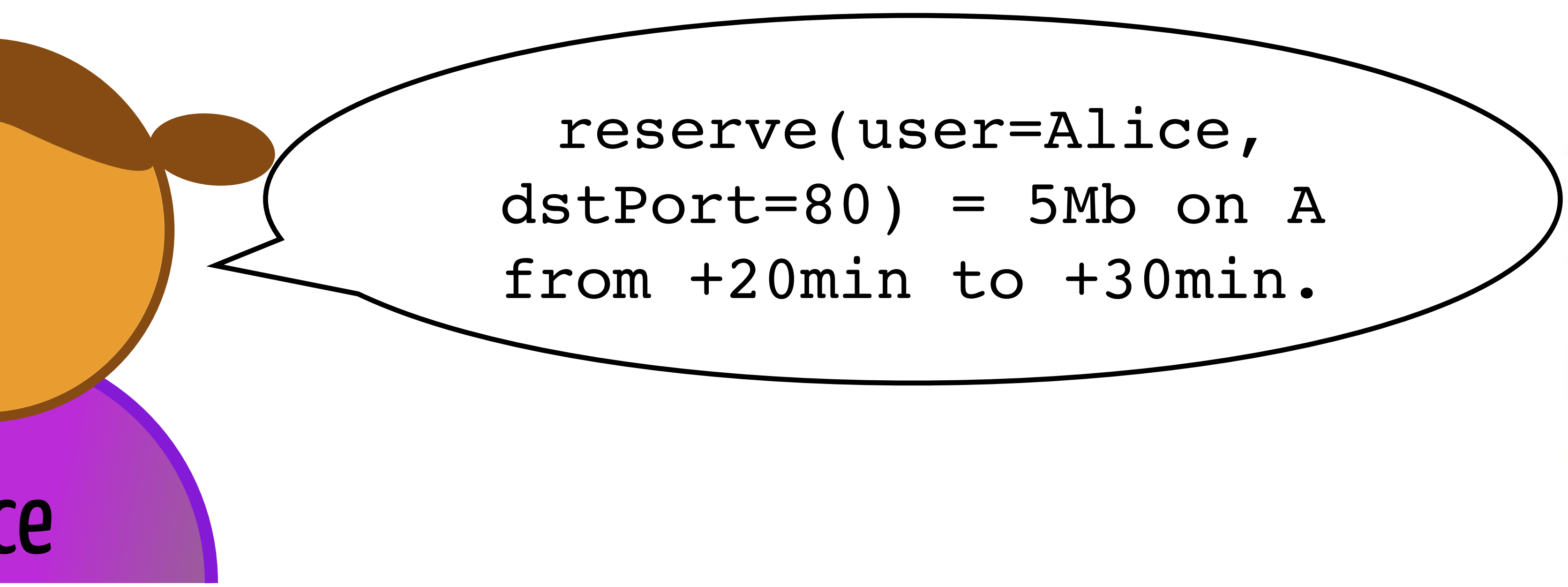
PANE


Bandwidth
Reservation Limit
Time
t

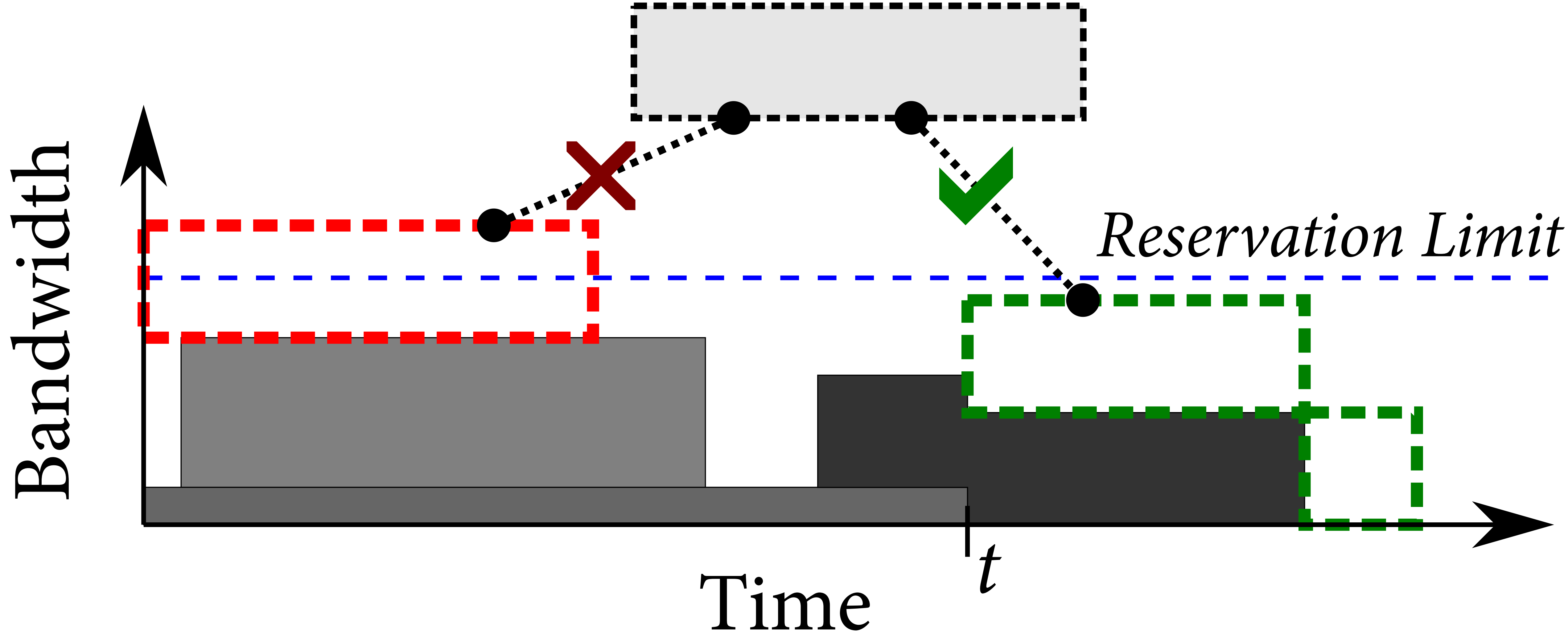

reserve(user=Alice,
dstPort=80) = 5Mb on A
from +20min to +30min.
ce

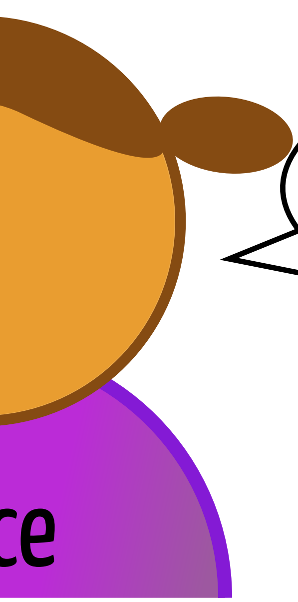
PANE


Bandwidth
Reservation Limit
t
Time


reserve(user=Alice,
dstPort=80) = 5Mb on A
from +20min to +30min.
ce

PANE





reserve(user=Alice,
dstPort=80) = 5Mb on A
from +20min to +30min.

PANE


```
reserve(user=Alice,
dstPort=80) = 5Mb on A
from now to +10min.
```

NO

```
reserve(user=Alice,
dstPort=80) = 5Mb on A
from +20min to +30min.
```

OK

PANE

`reserve(user=Alice, dstPort=80) = 5Mb on A from now to +10min.`

NO

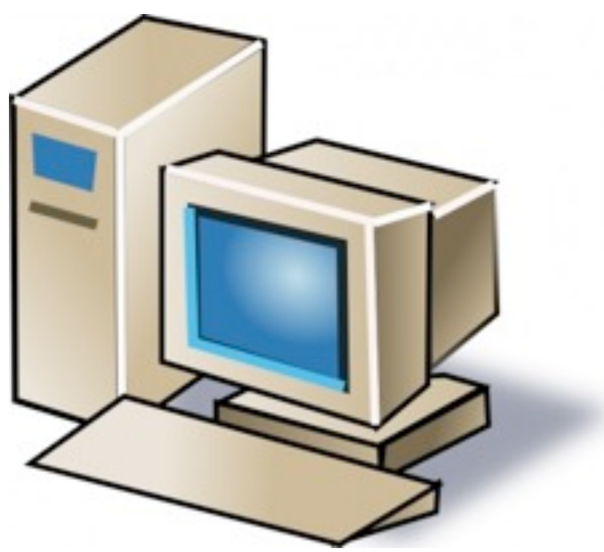
`reserve(user=Alice, dstPort=80) = 5Mb on A from +20min to +30min.`

OK

PANE

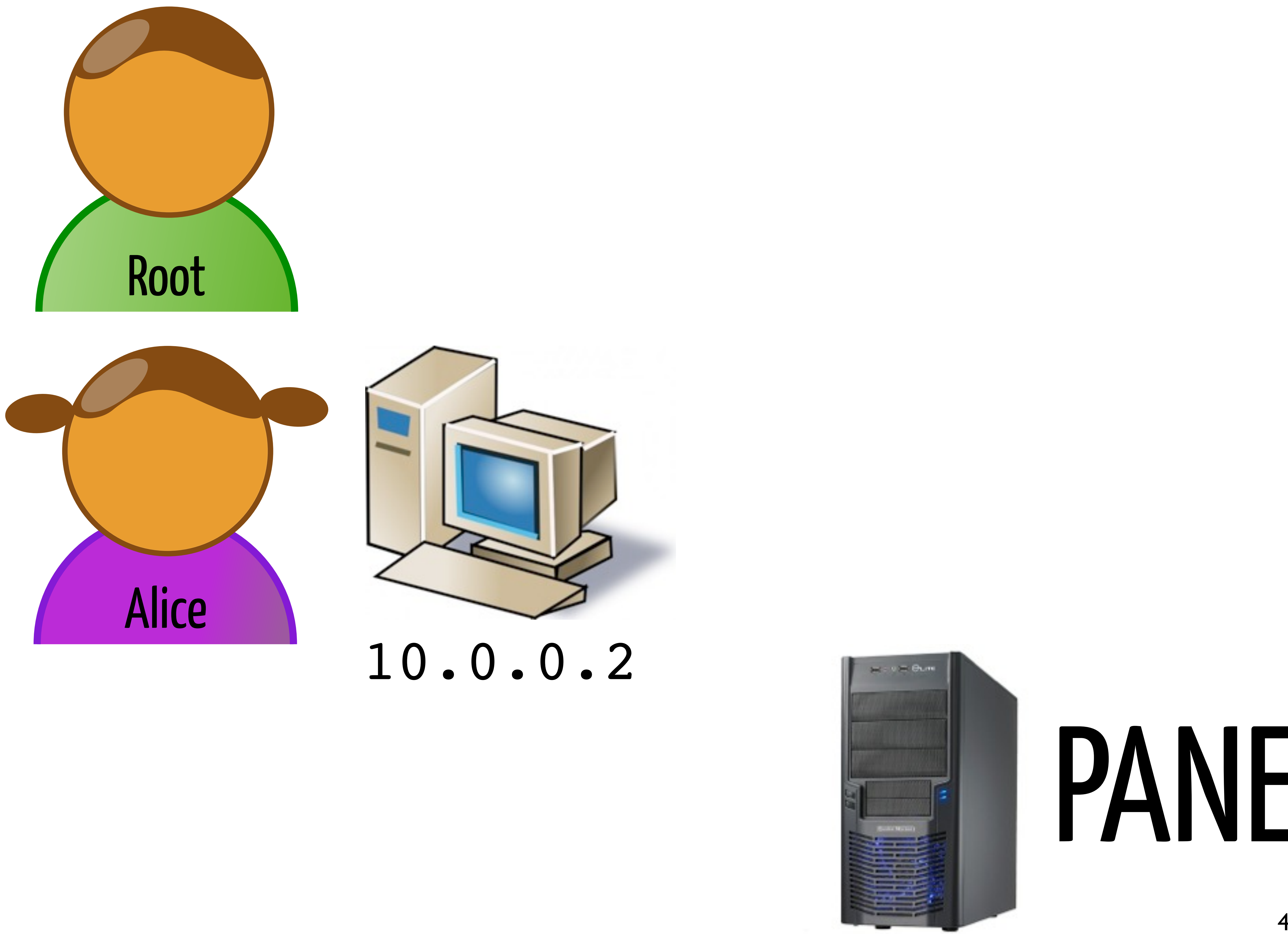
PANE

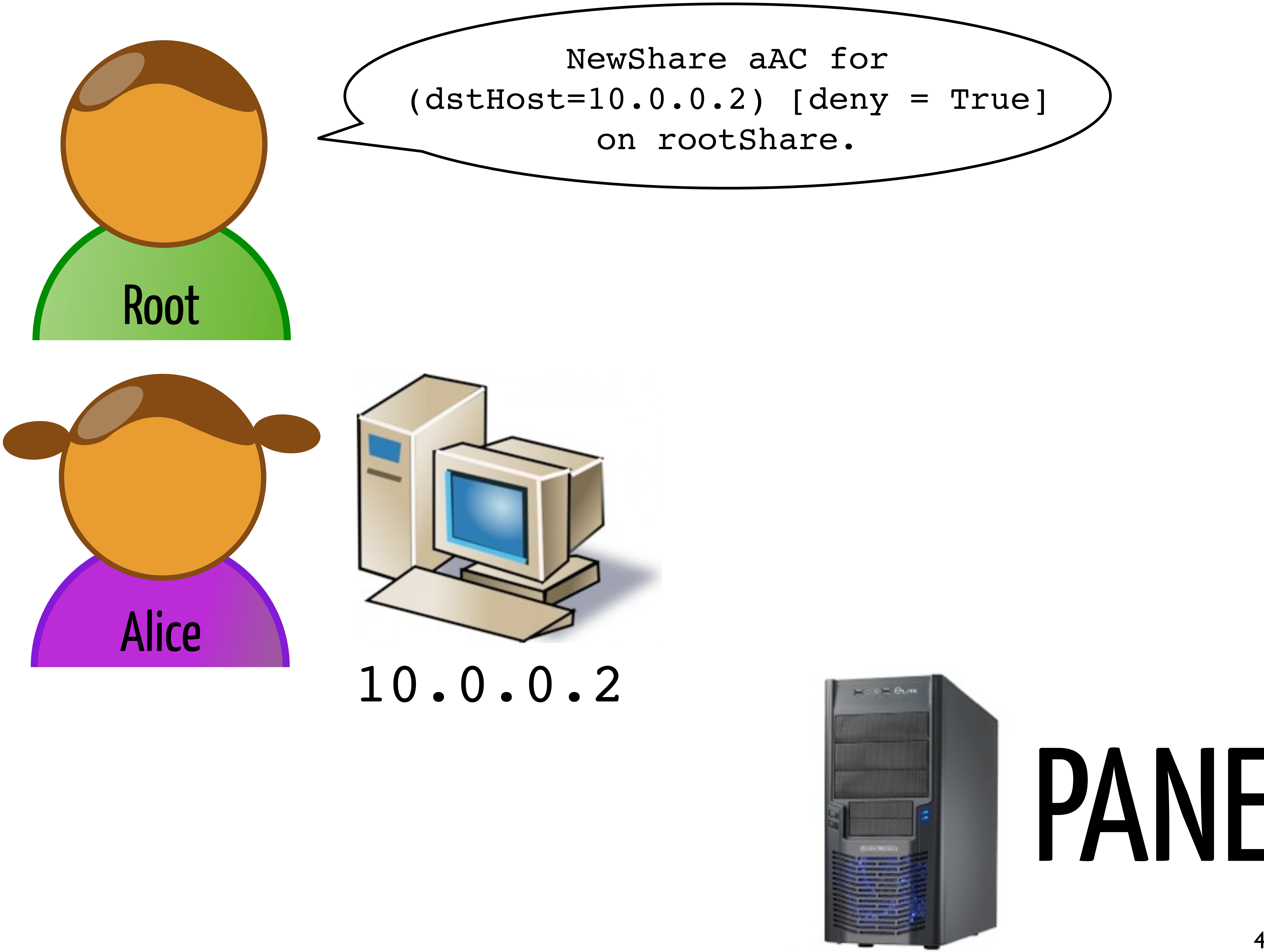
PANE



10.0.0.2

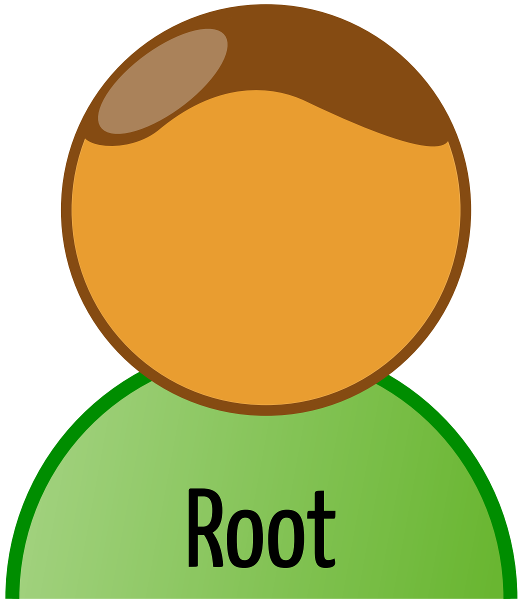
PANE

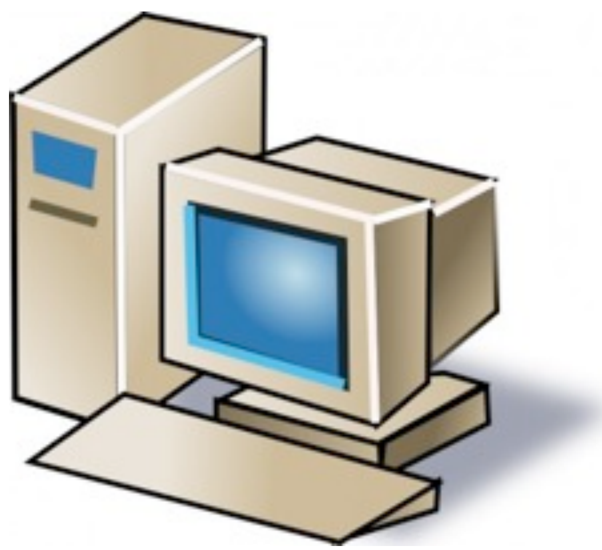

Root
Alice
10.0.0.2
PANE


NewShare aAC for
(dstHost=10.0.0.2) [deny = True]
on rootShare.
Root
Alice
10.0.0.2
PANE

NewShare aAC for
(dstHost=10.0.0.2) [deny = True]
on rootShare.

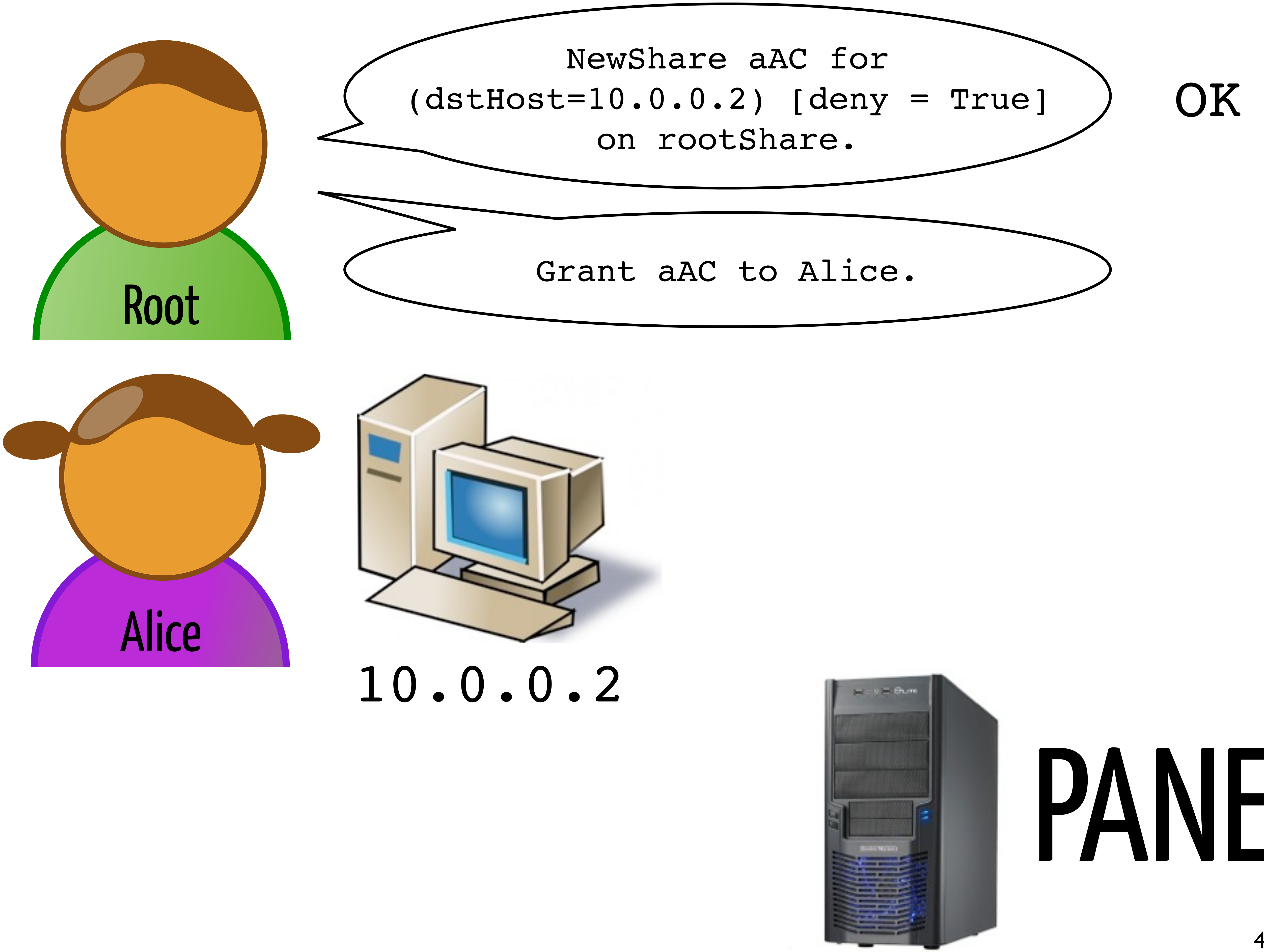
OK

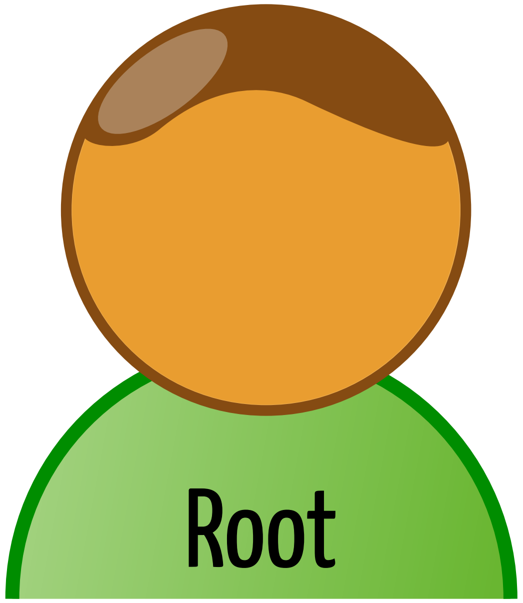




10.0.0.2

PANE


NewShare aAC for
(dstHost=10.0.0.2) [deny = True]
on rootShare.
OK
Grant aAC to Alice.
Root
Alice
10.0.0.2
PANE

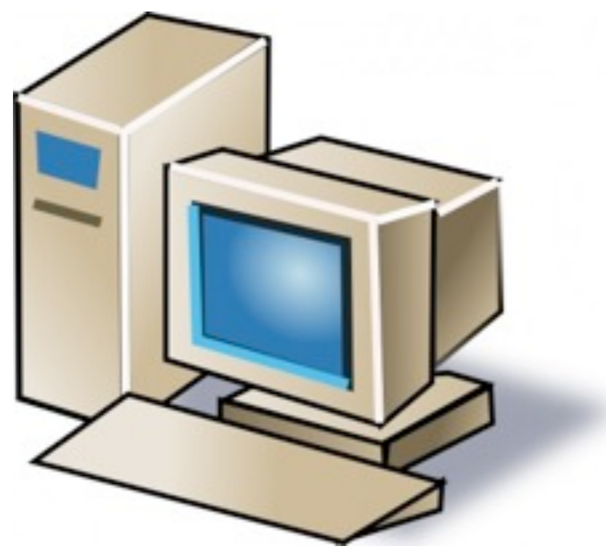


NewShare aAC for
(dstHost=10.0.0.2) [deny = True]
on rootShare.

OK

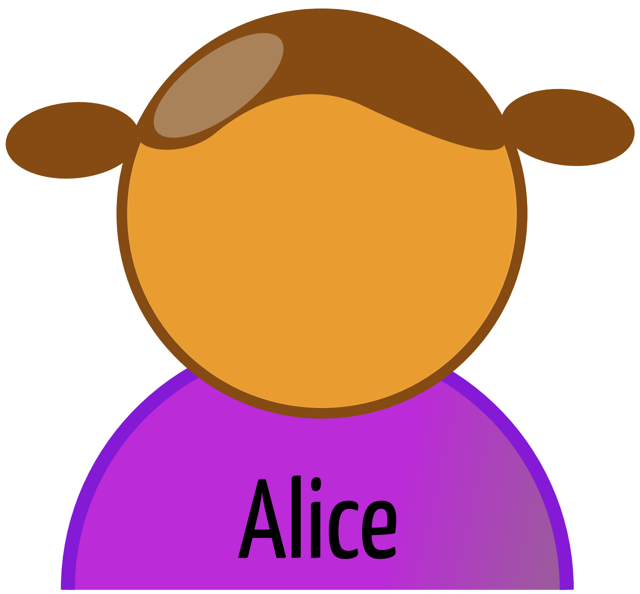
Grant aAC to Alice.

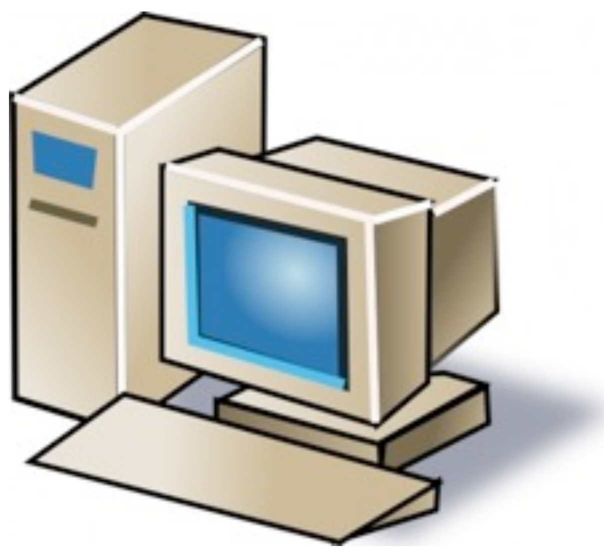
OK



10.0.0.2

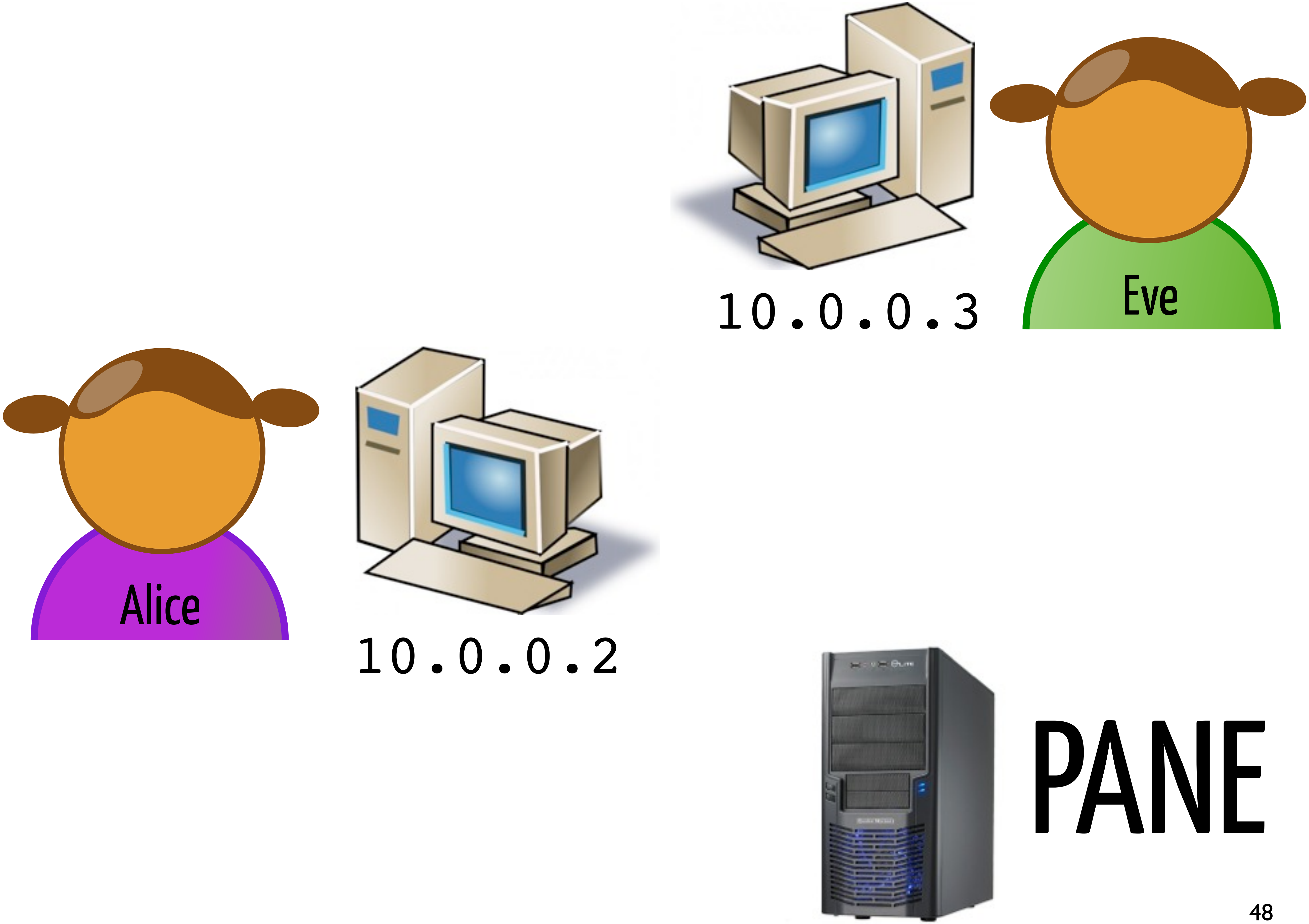
PANE

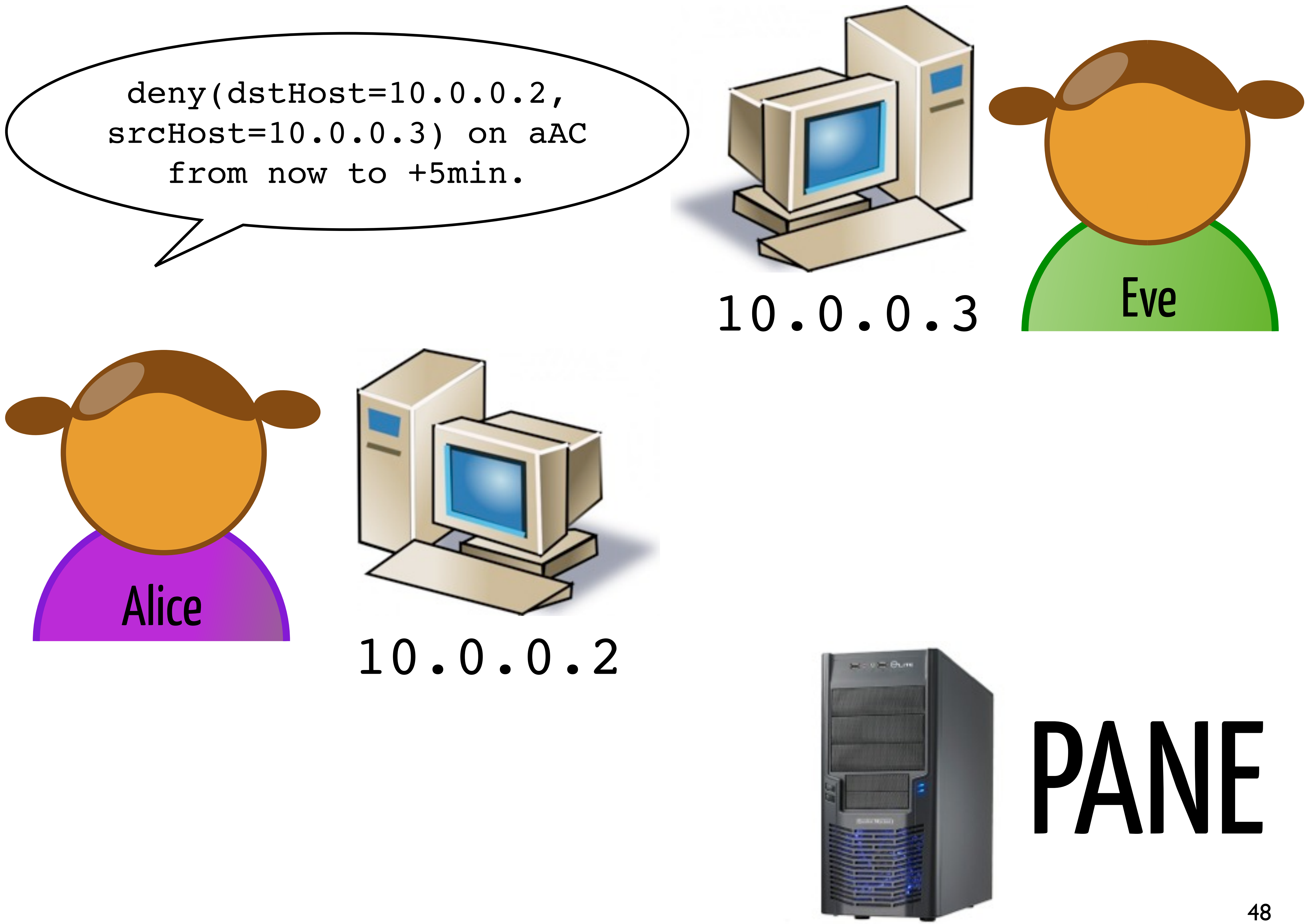


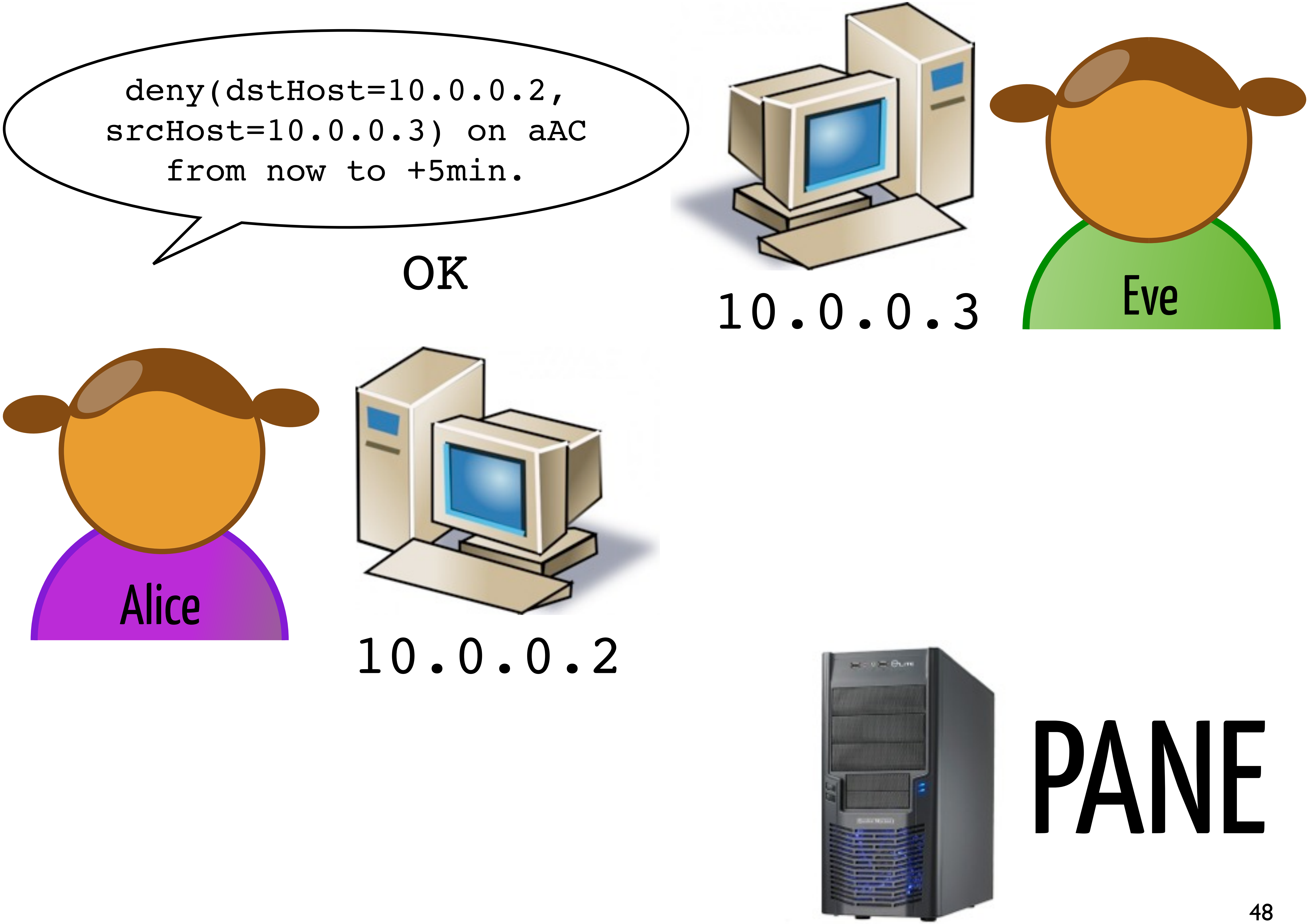


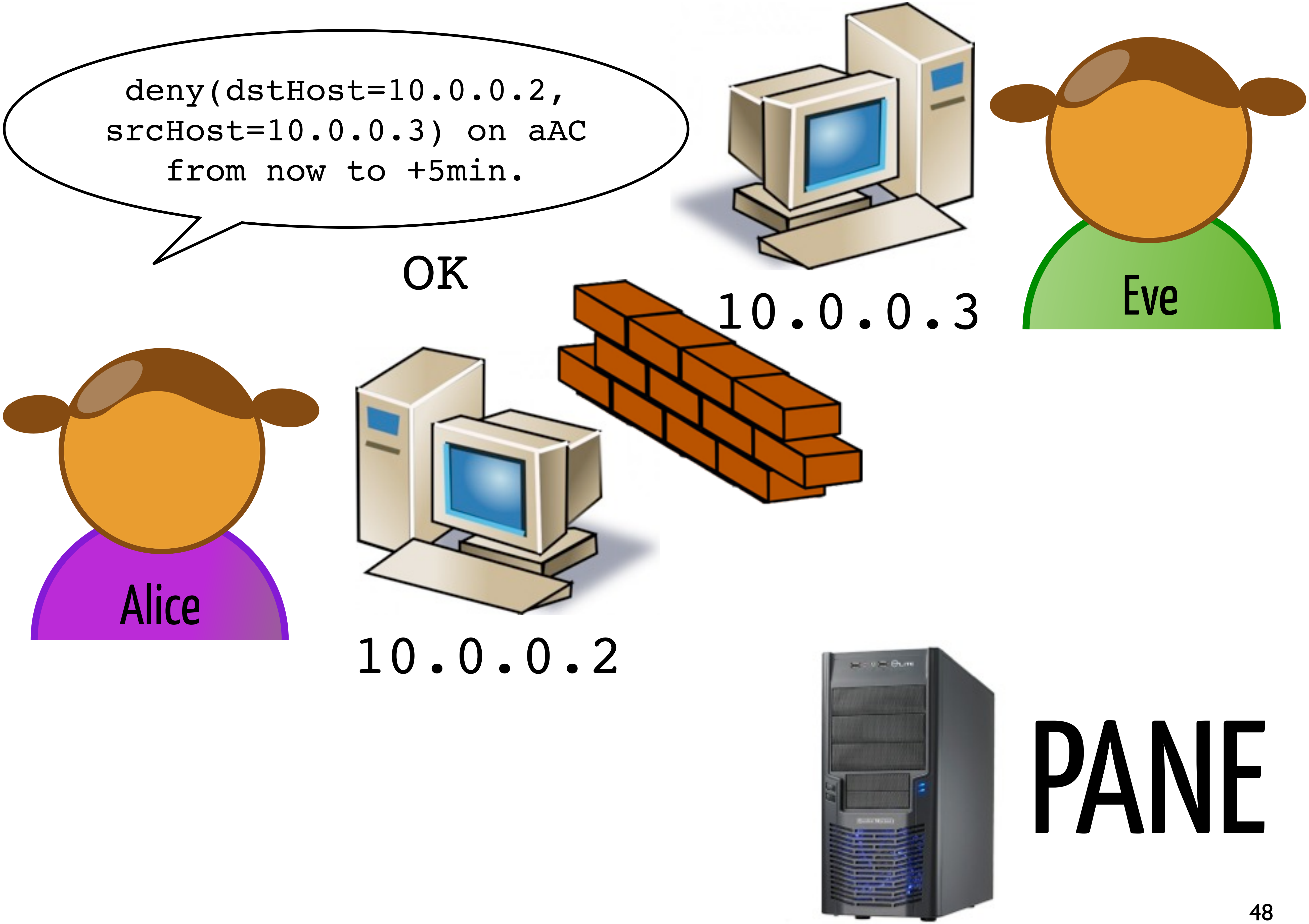
10.0.0.2

PANE

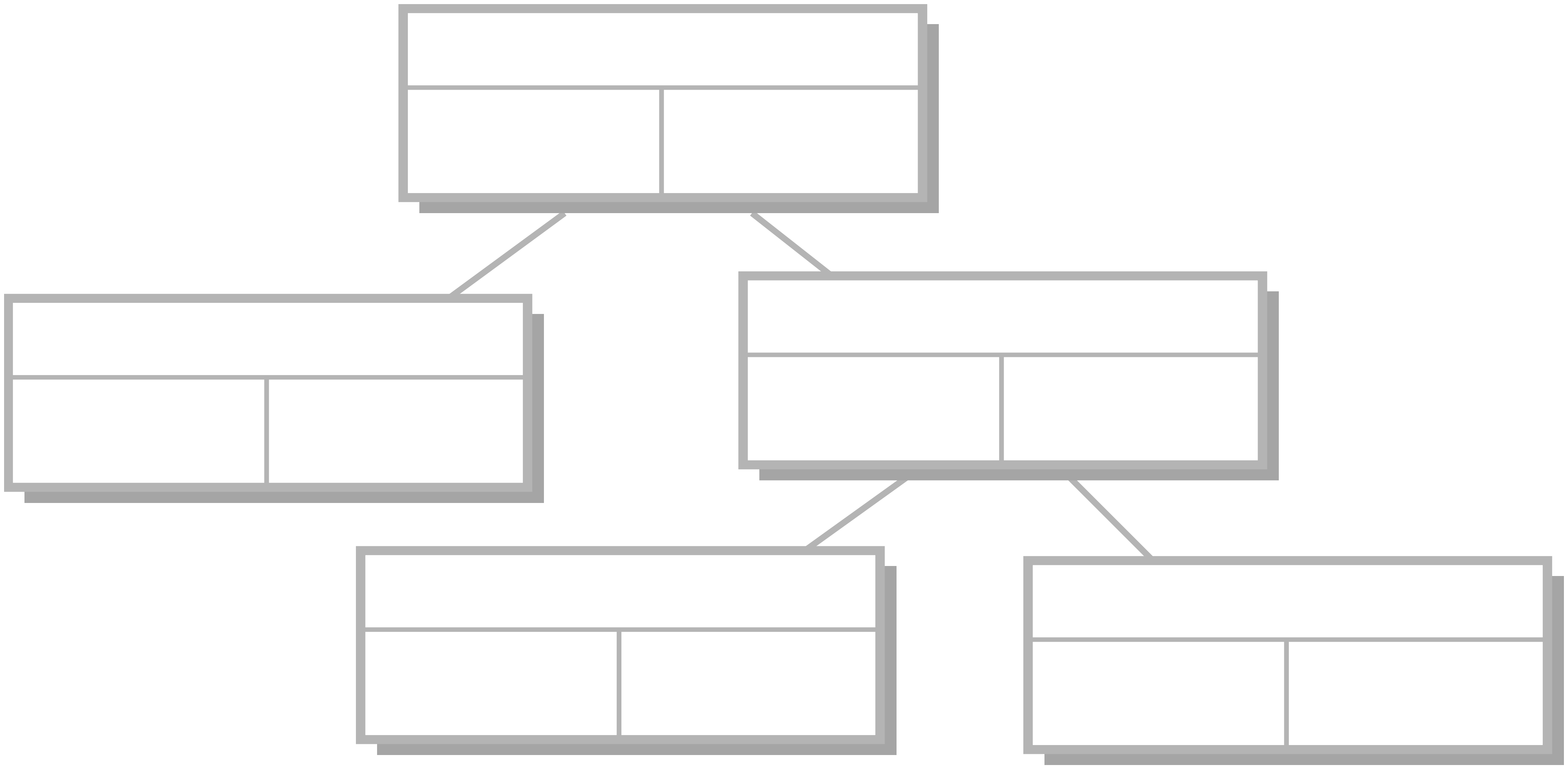

Eve
10.0.0.3
Alice
10.0.0.2
PANE


deny(dstHost=10.0.0.2,
srcHost=10.0.0.3) on aAC
from now to +5min.
10.0.0.3
Eve
Alice
10.0.0.2
PANE

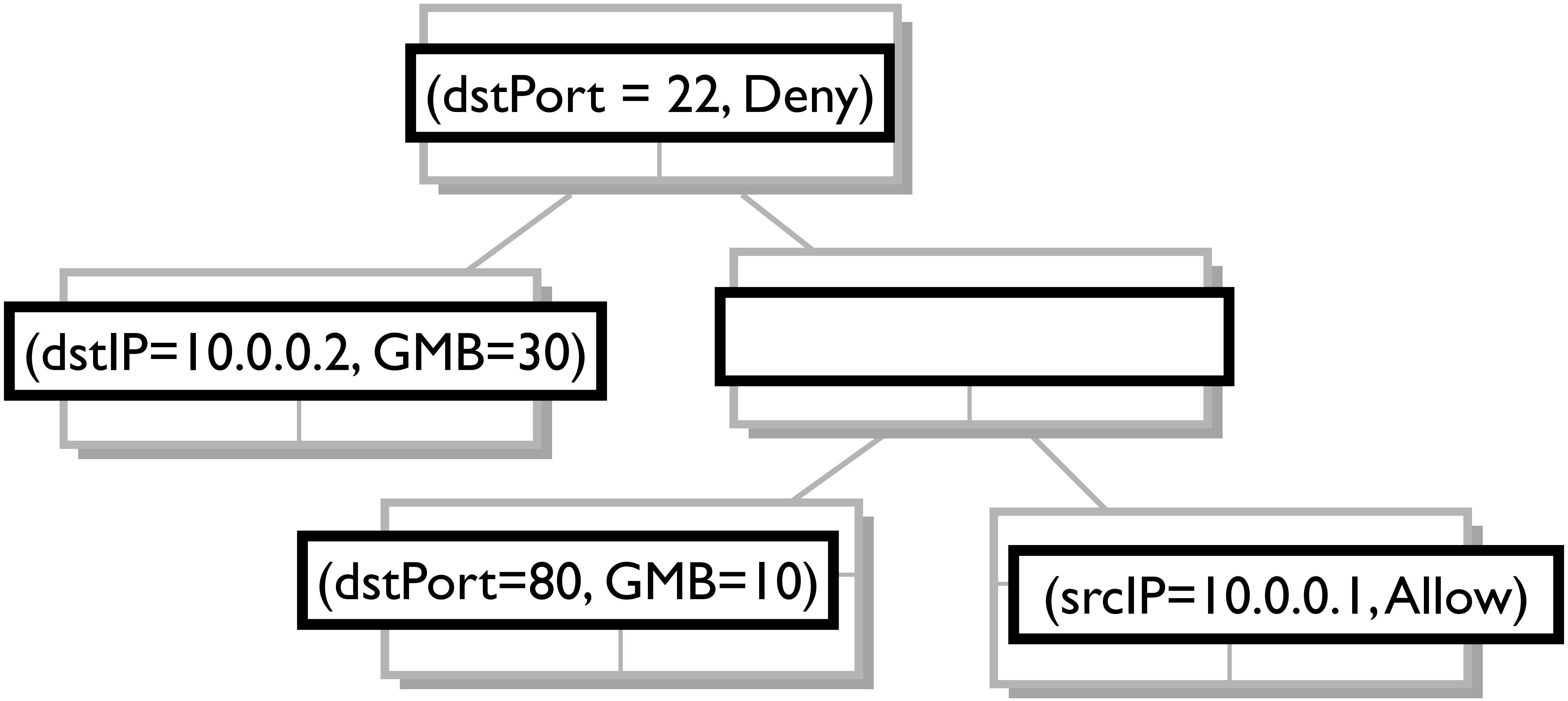

deny(dstHost=10.0.0.2,
srcHost=10.0.0.3) on aAC
from now to +5min.
OK
10.0.0.3
Eve
Alice
10.0.0.2
PANE


deny(dstHost=10.0.0.2,
srcHost=10.0.0.3) on aAC
from now to +5min.
OK
10.0.0.3
Eve
Alice
10.0.0.2
PANE

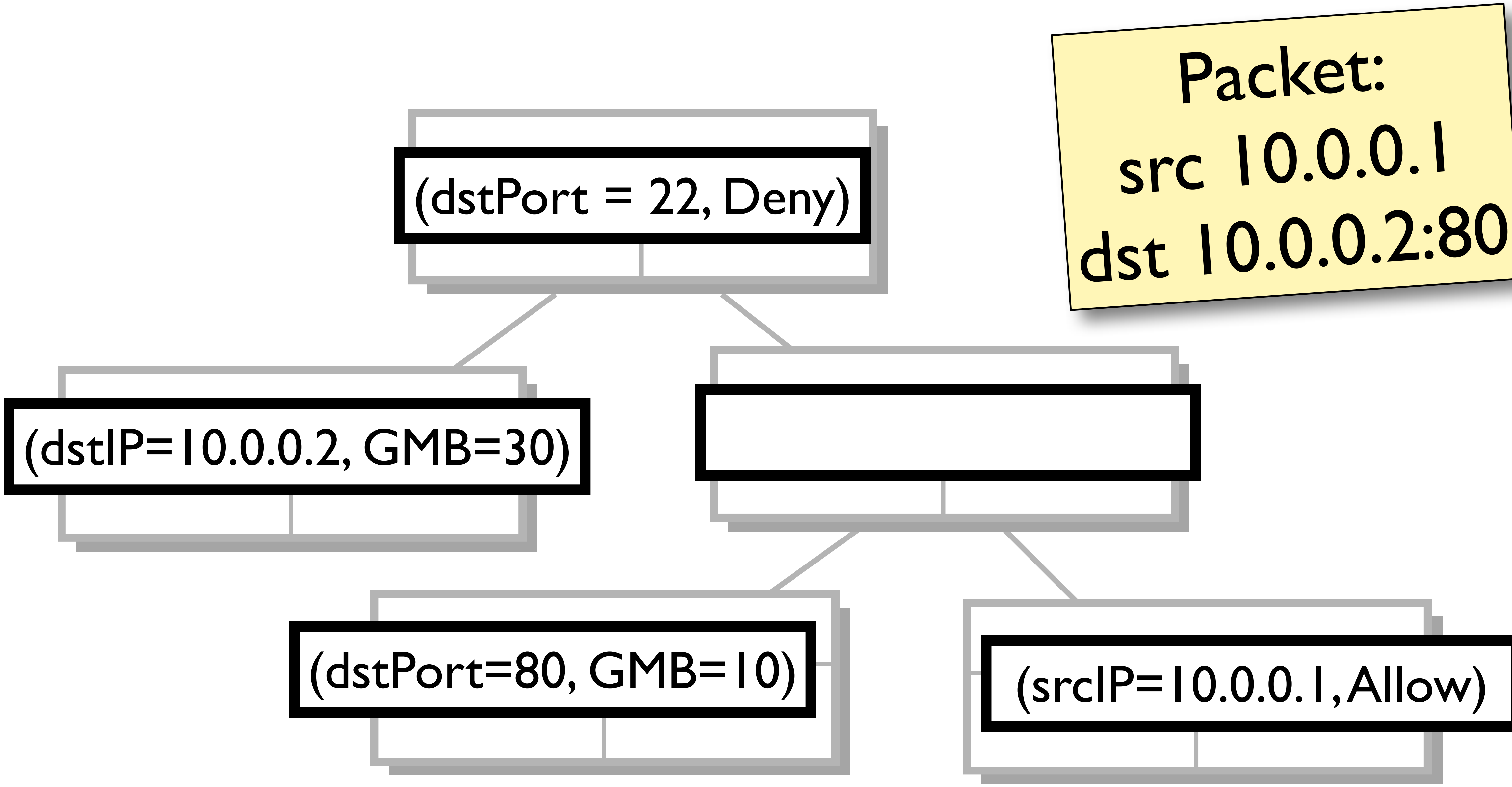
Processamento dinâmico de fluxos



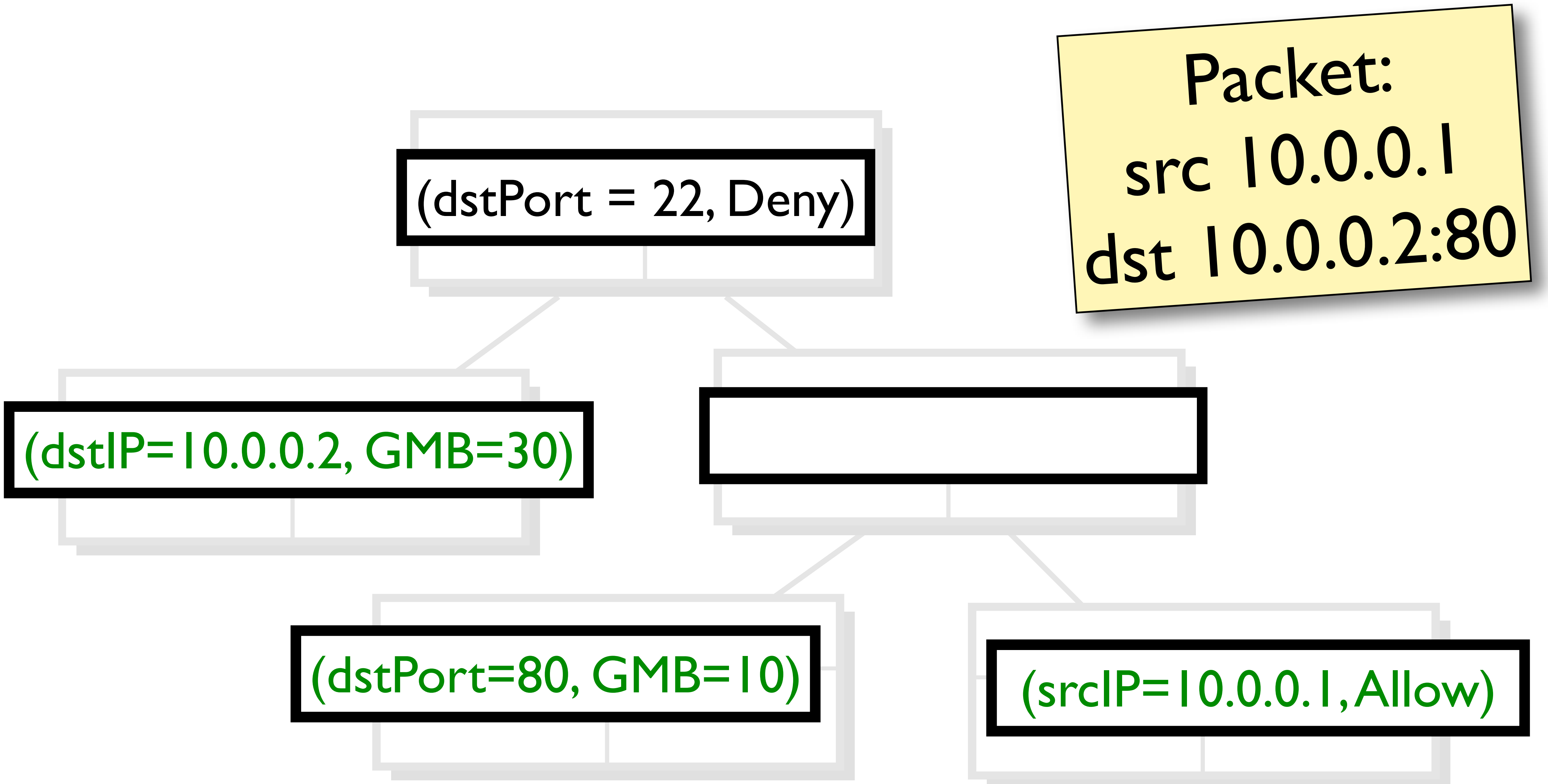
Hierarquia de Políticas



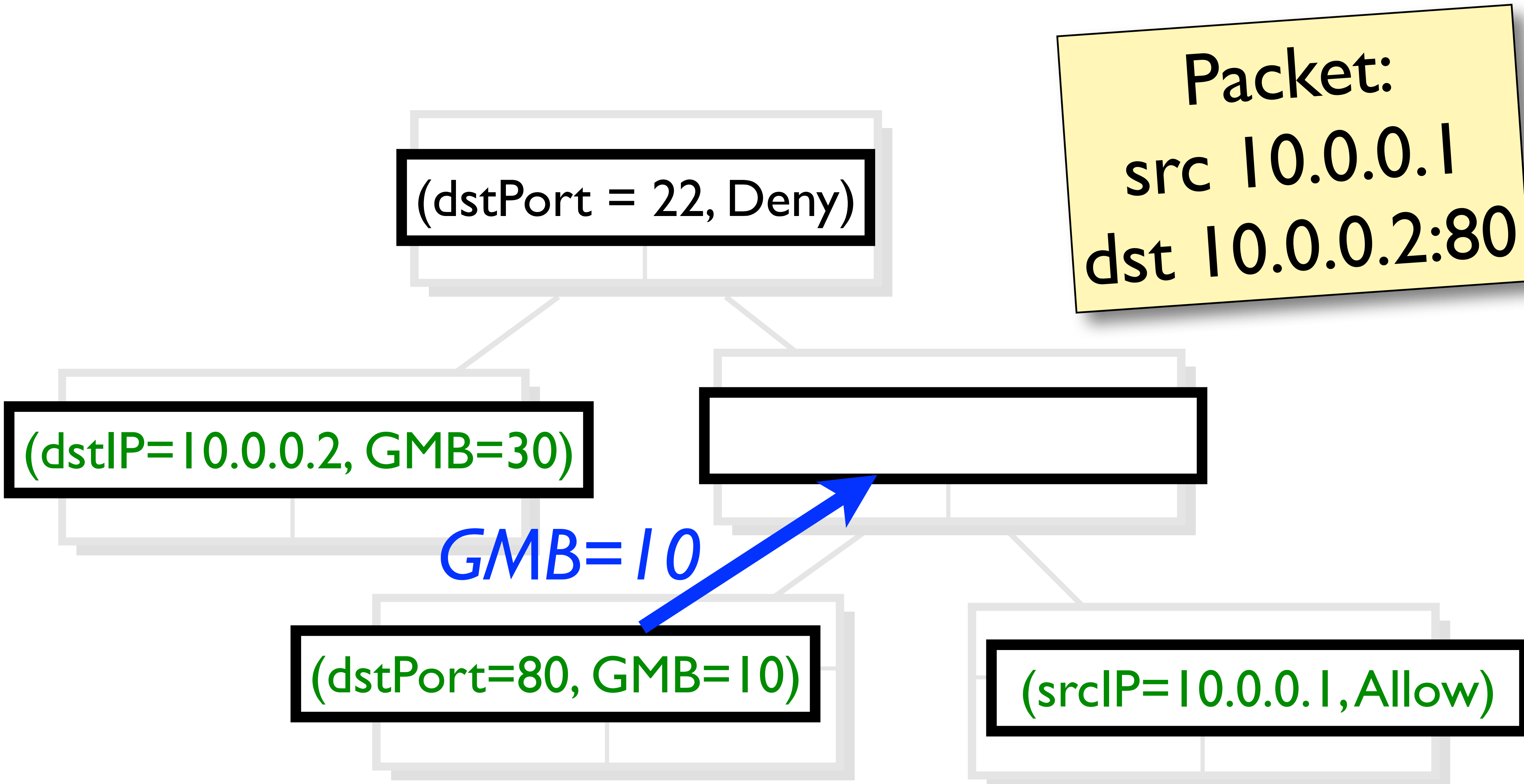
Hierarquia de Políticas



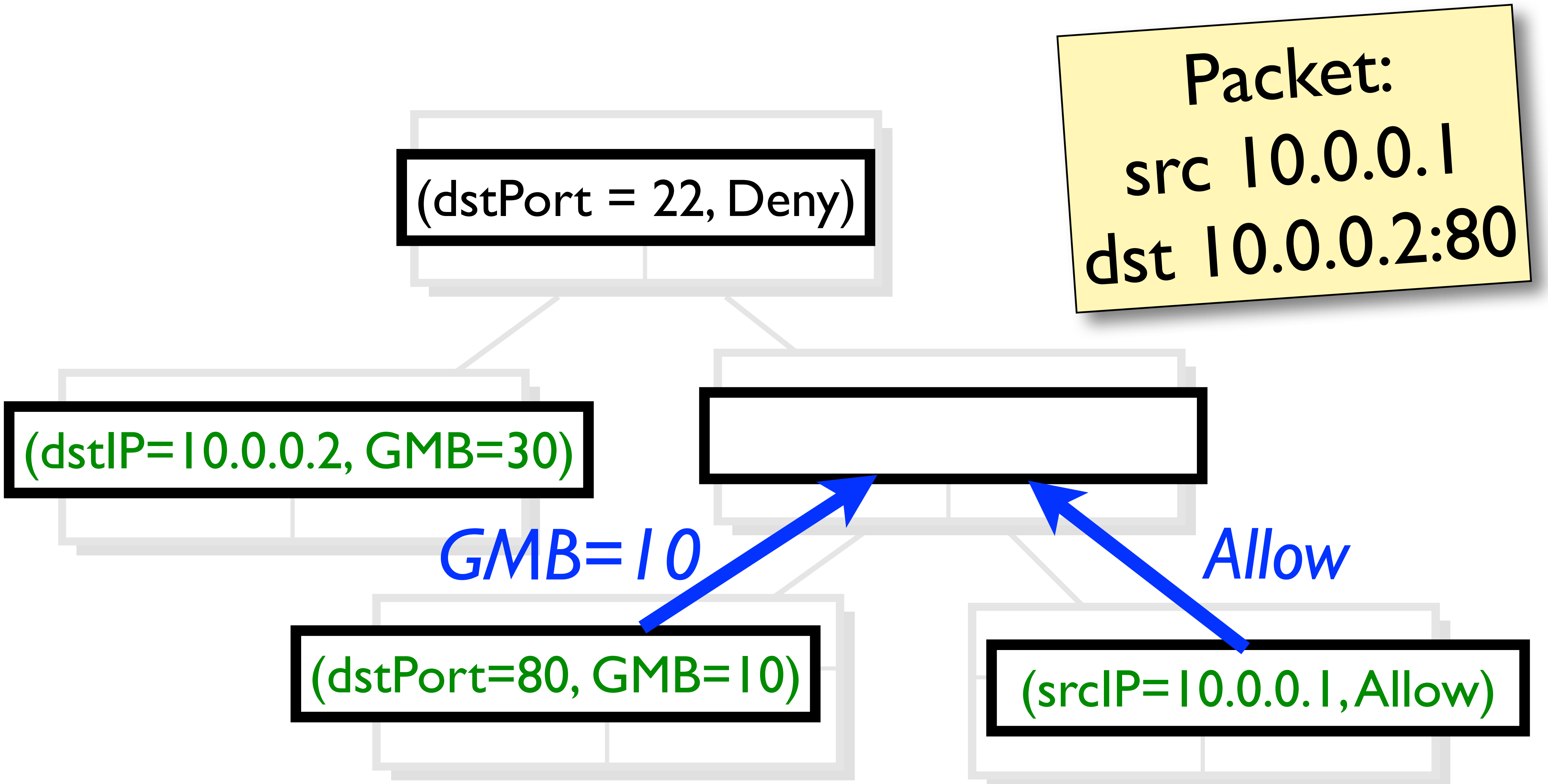
Hierarquia de Políticas



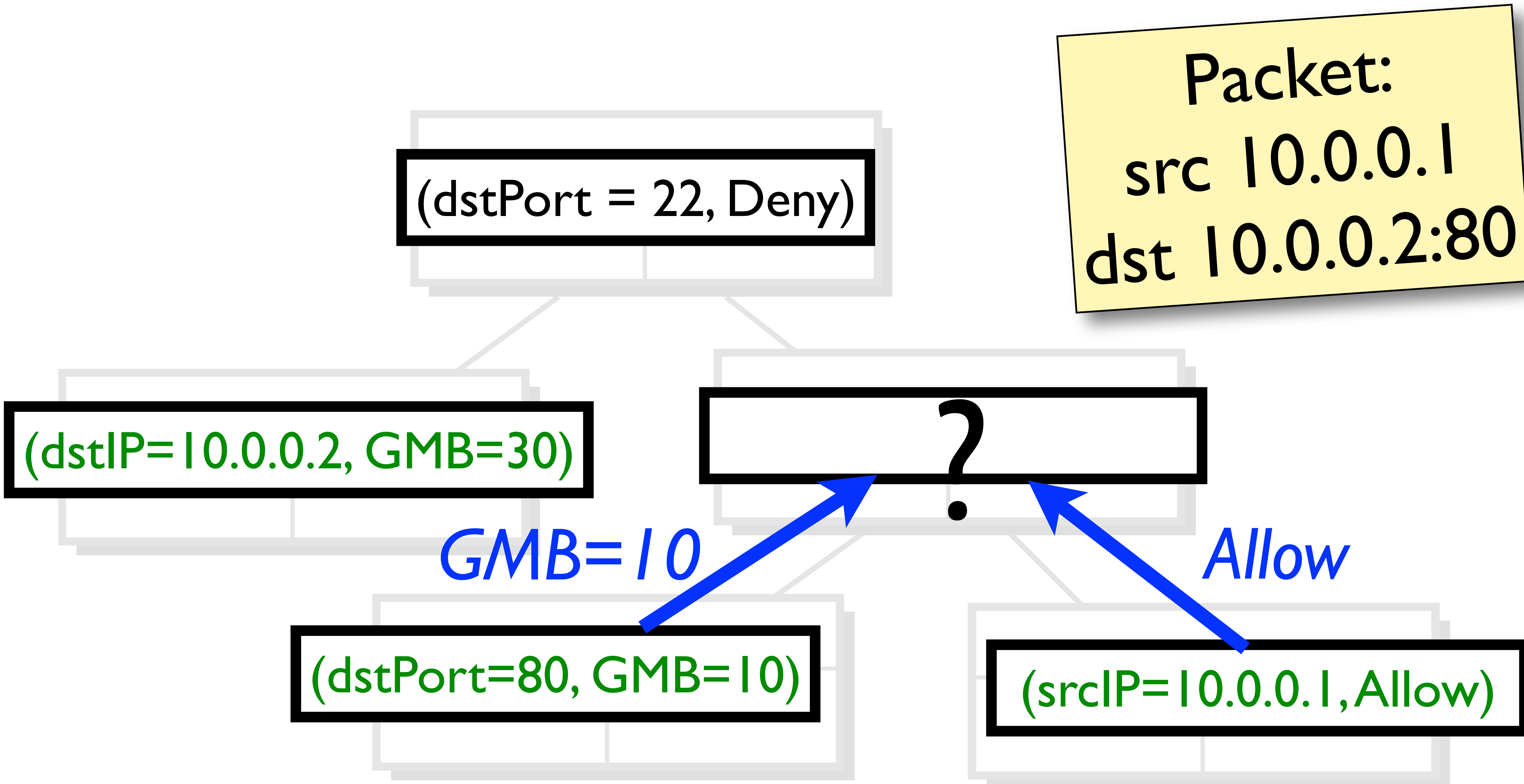
Hierarchical Flow Table (HFT)



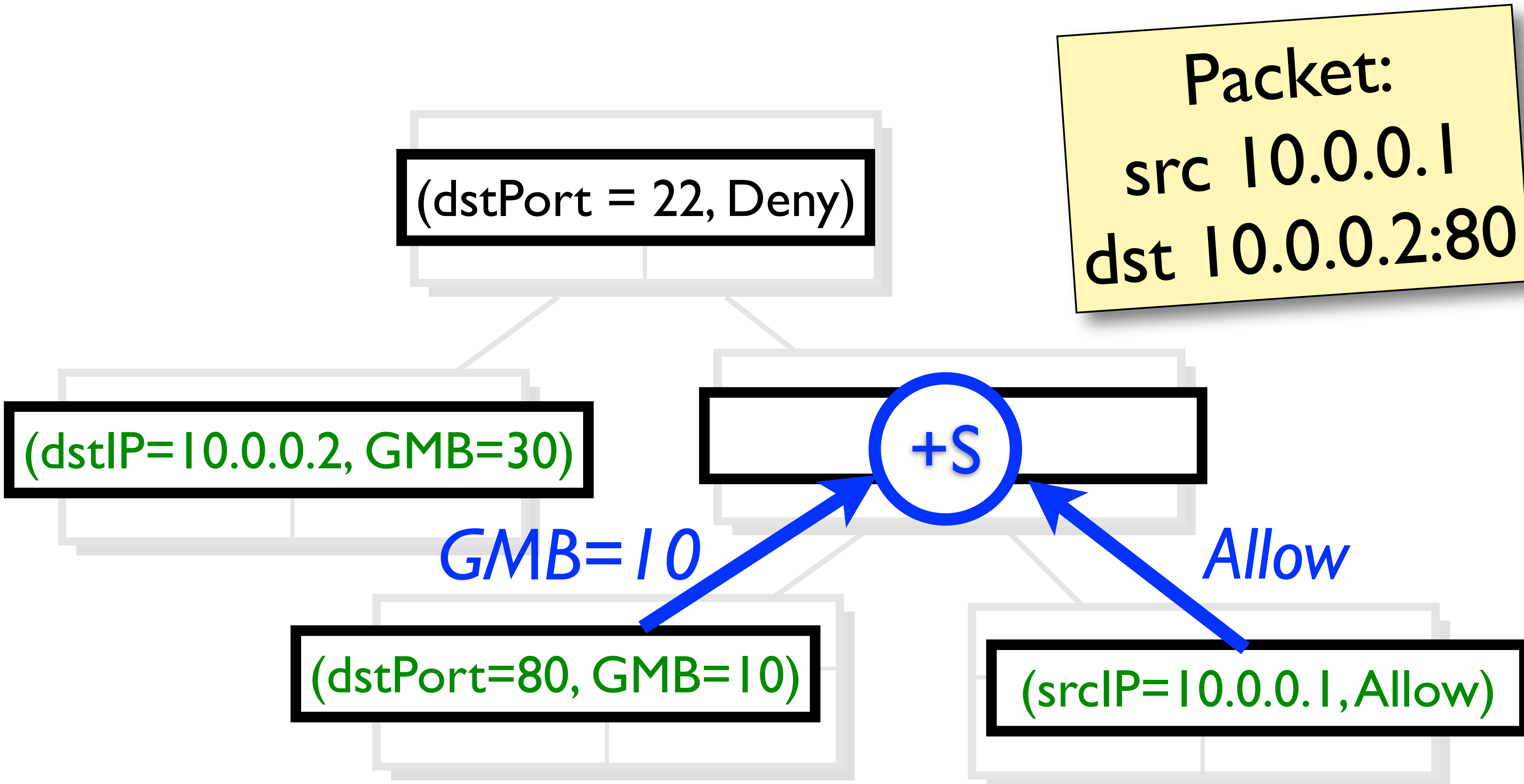
Hierarchical Flow Table (HFT)



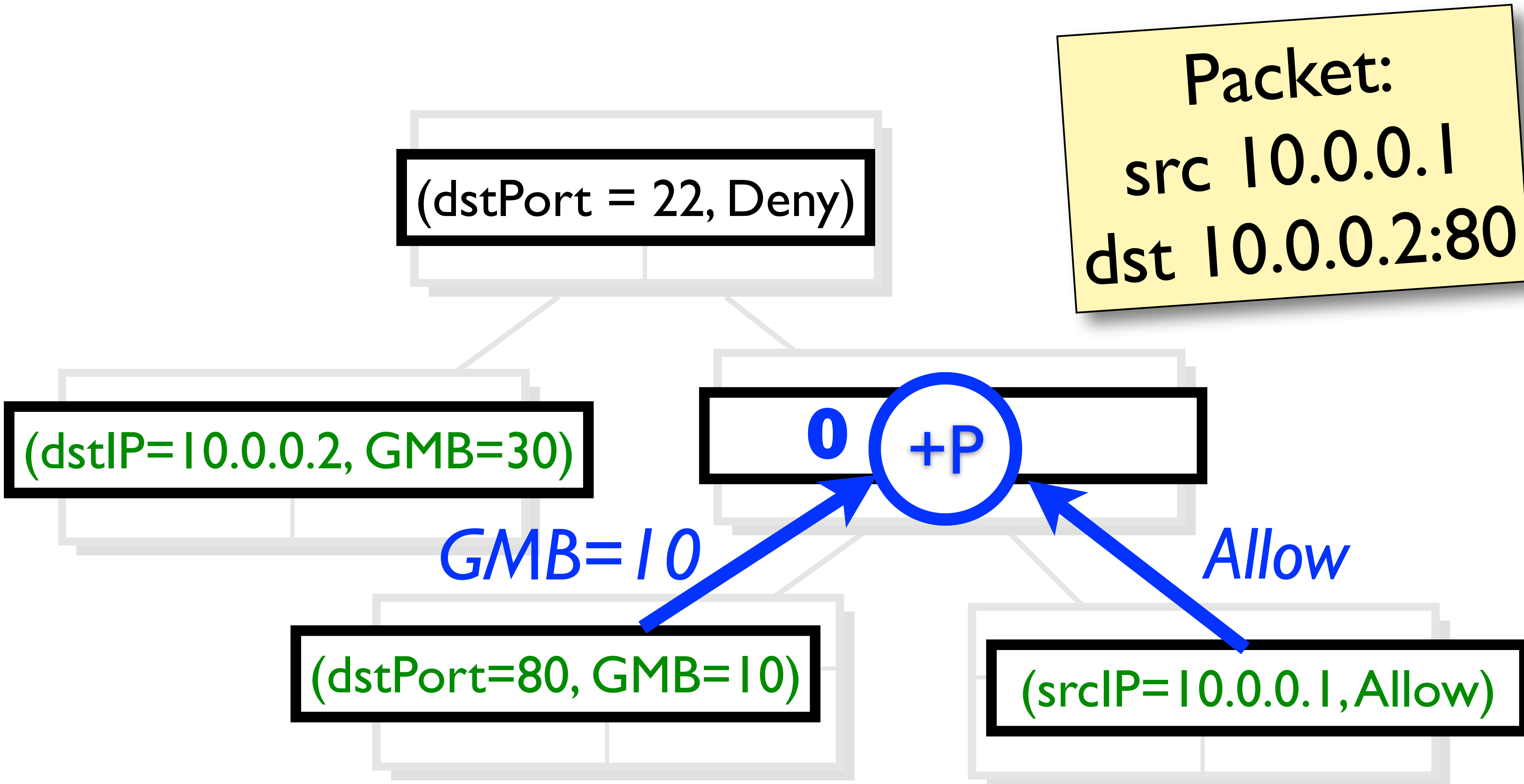
Hierarchical Flow Table (HFT)



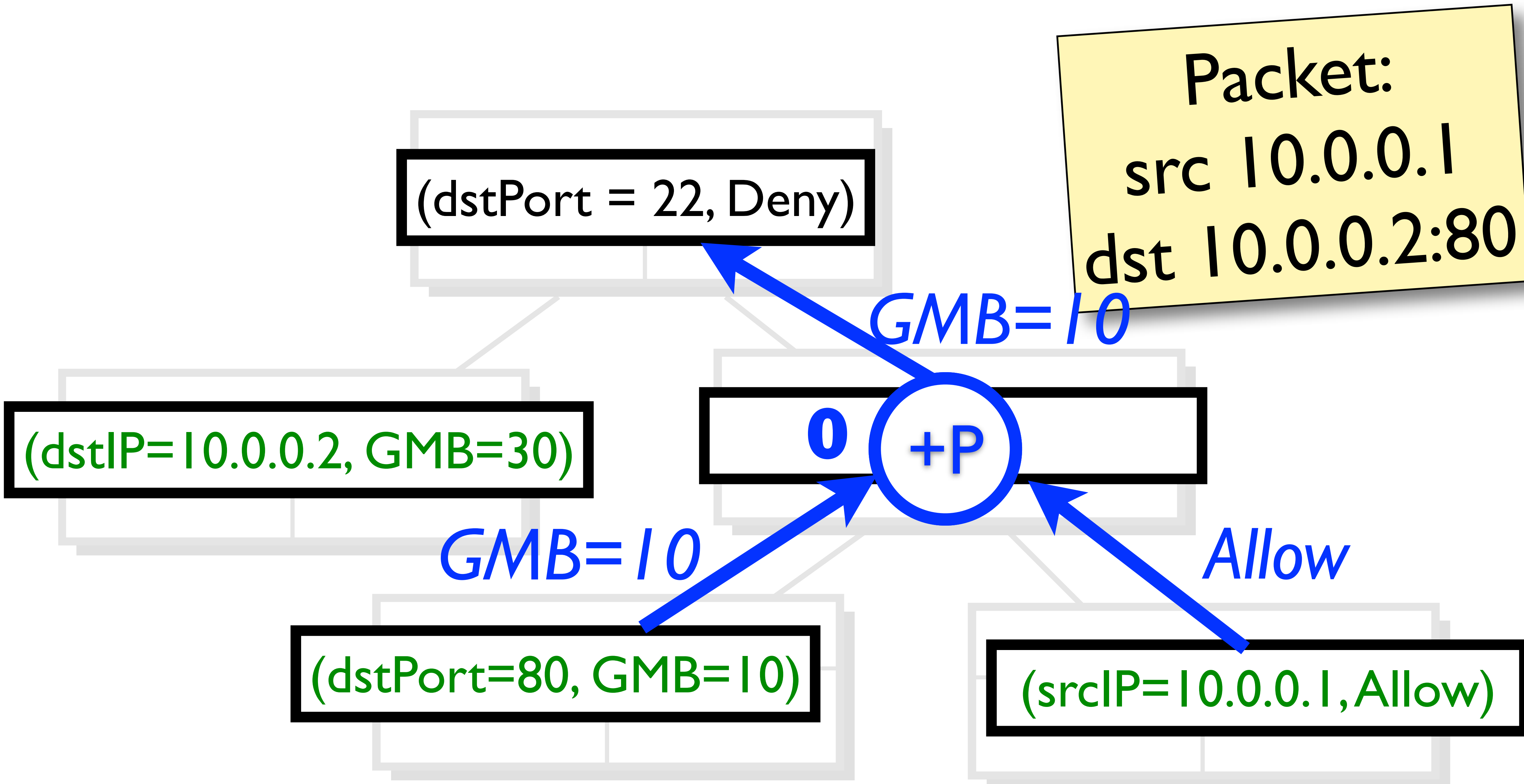
Hierarchical Flow Table (HFT)



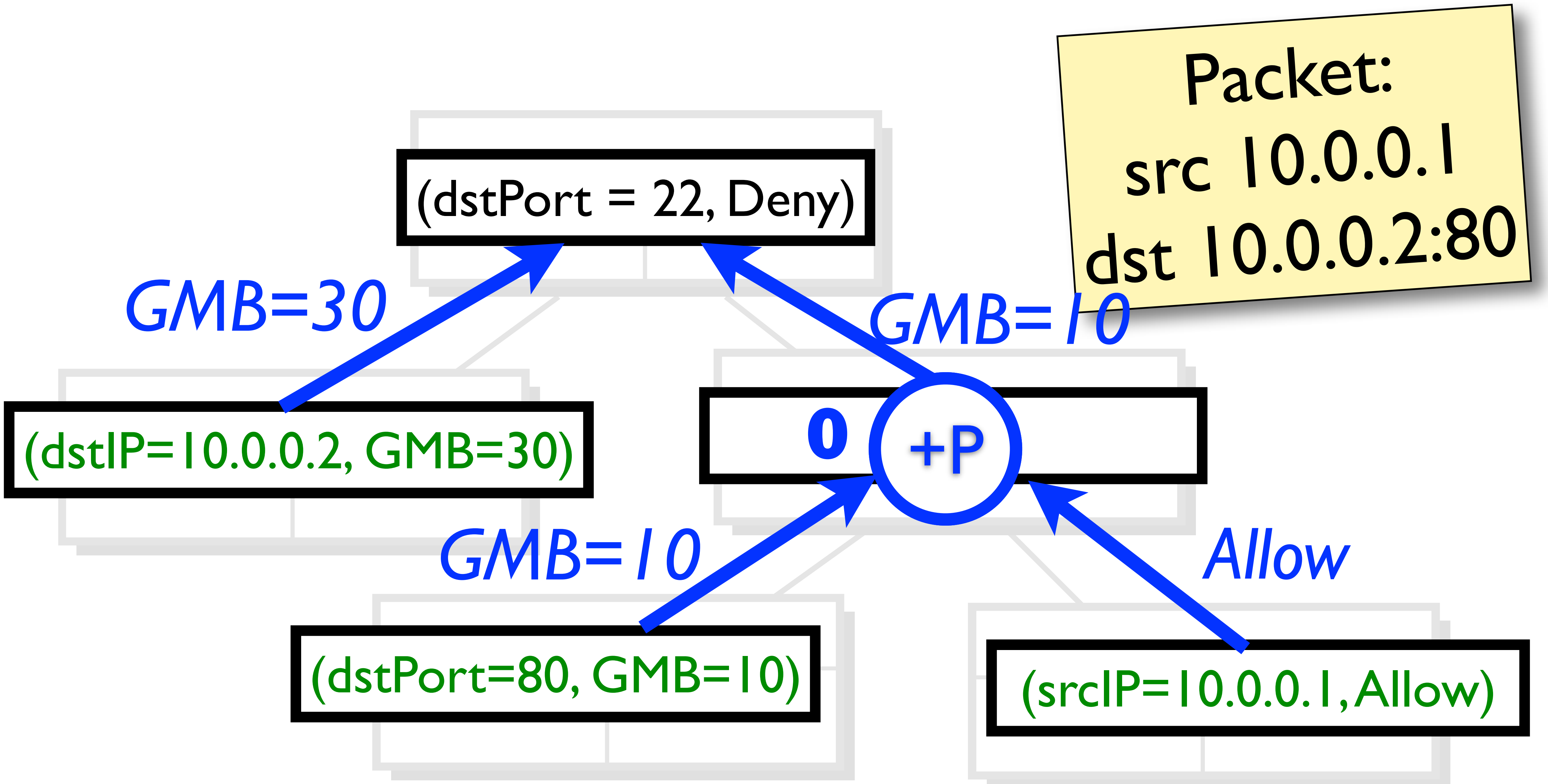
Hierarchical Flow Table (HFT)



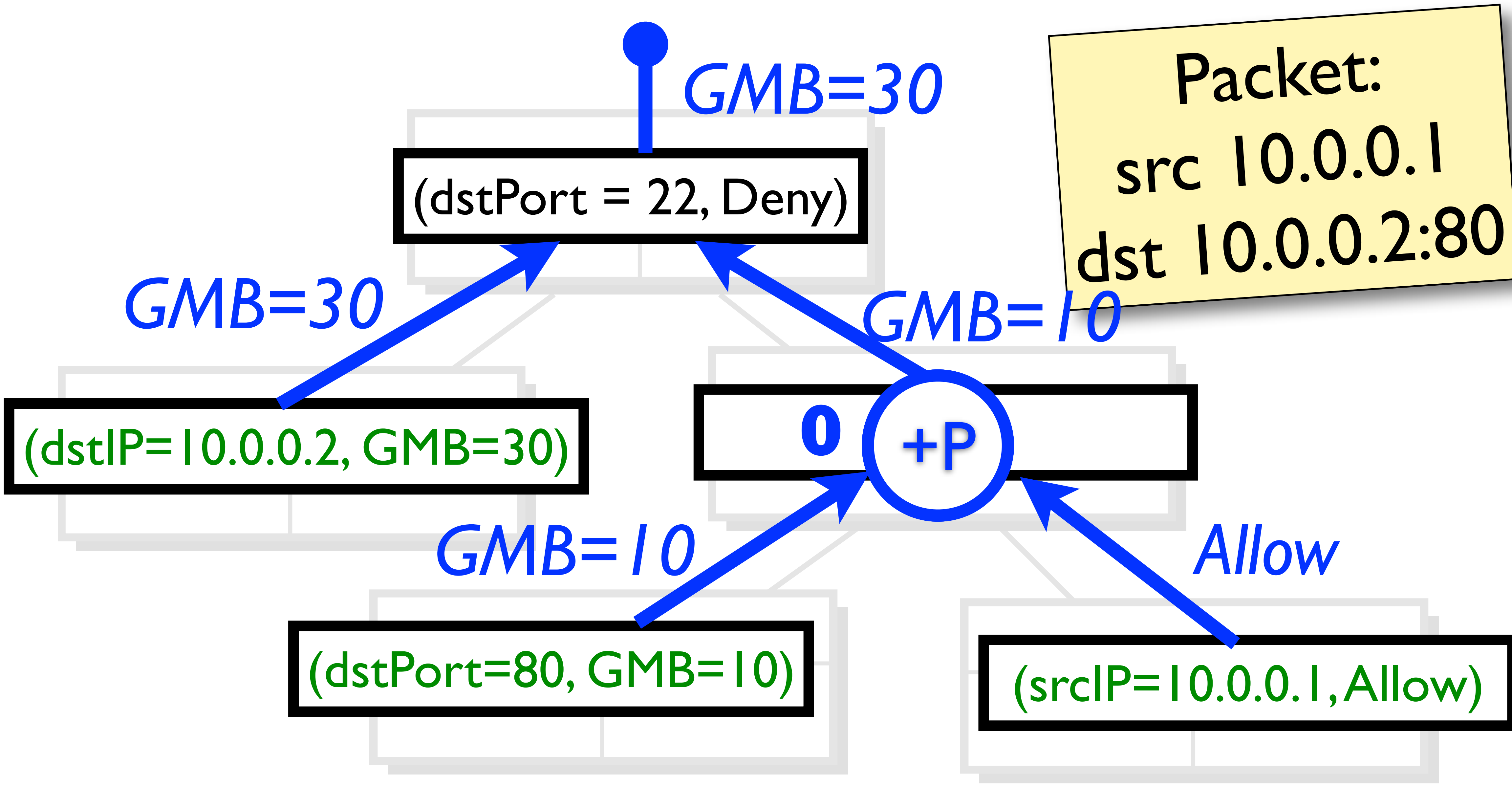
Hierarchical Flow Table (HFT)



Hierarchical Flow Table (HFT)



Hierarchical Flow Table (HFT)



Hierarchical Flow Table (HFT)

Requerimentos

Associativo,
0 *é identidade*

Commutativo

+D *In node*

+S *Sibling*

+P *Parent-Sibling*

Operadores *HFT*

Requerimentos

Em PANE

Associativo,
0 é identidade

Commutativo

+D *In node*

+S *Sibling*

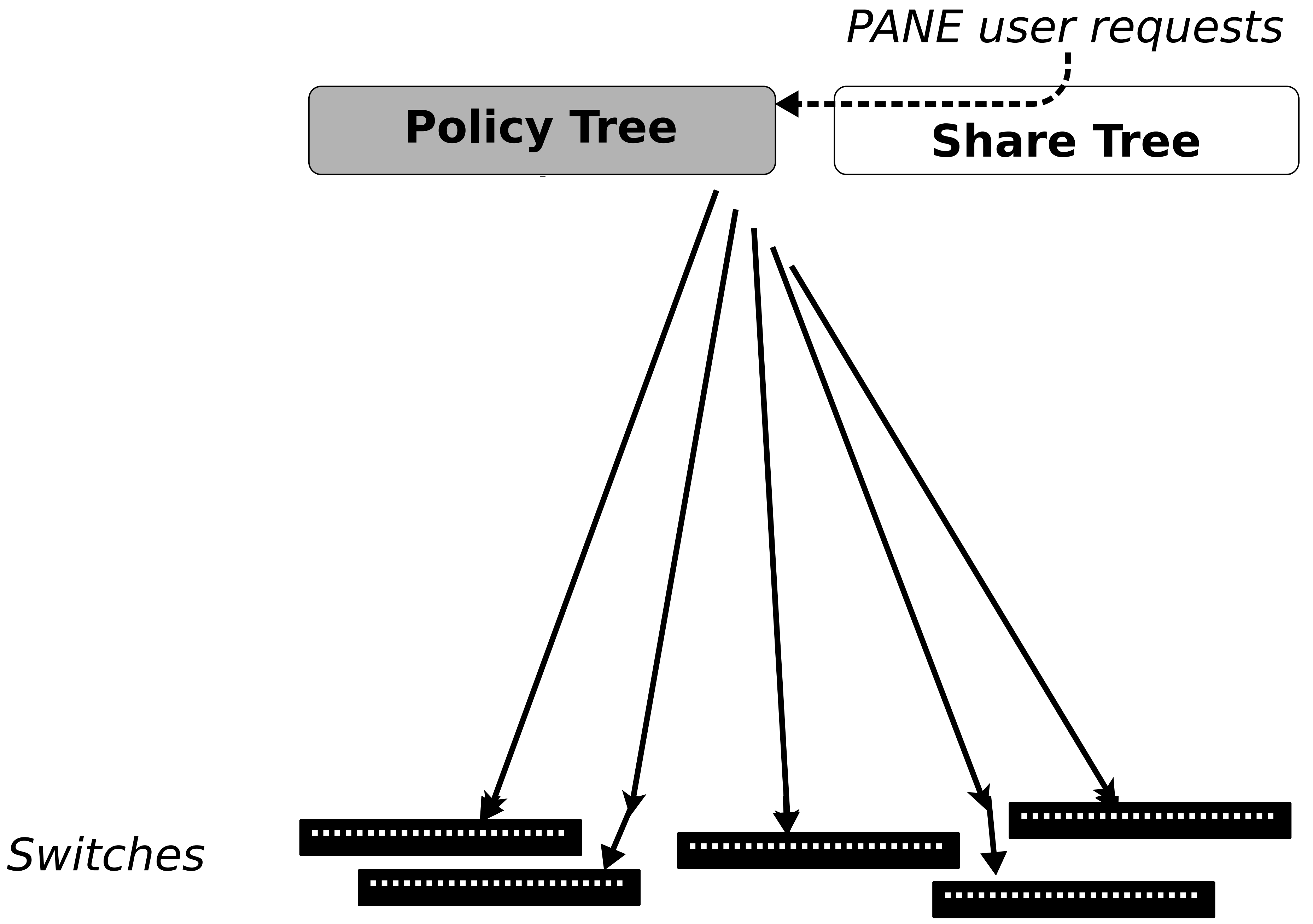
D e S idênticos.
Deny domina Allow.
GMB combina como **max**

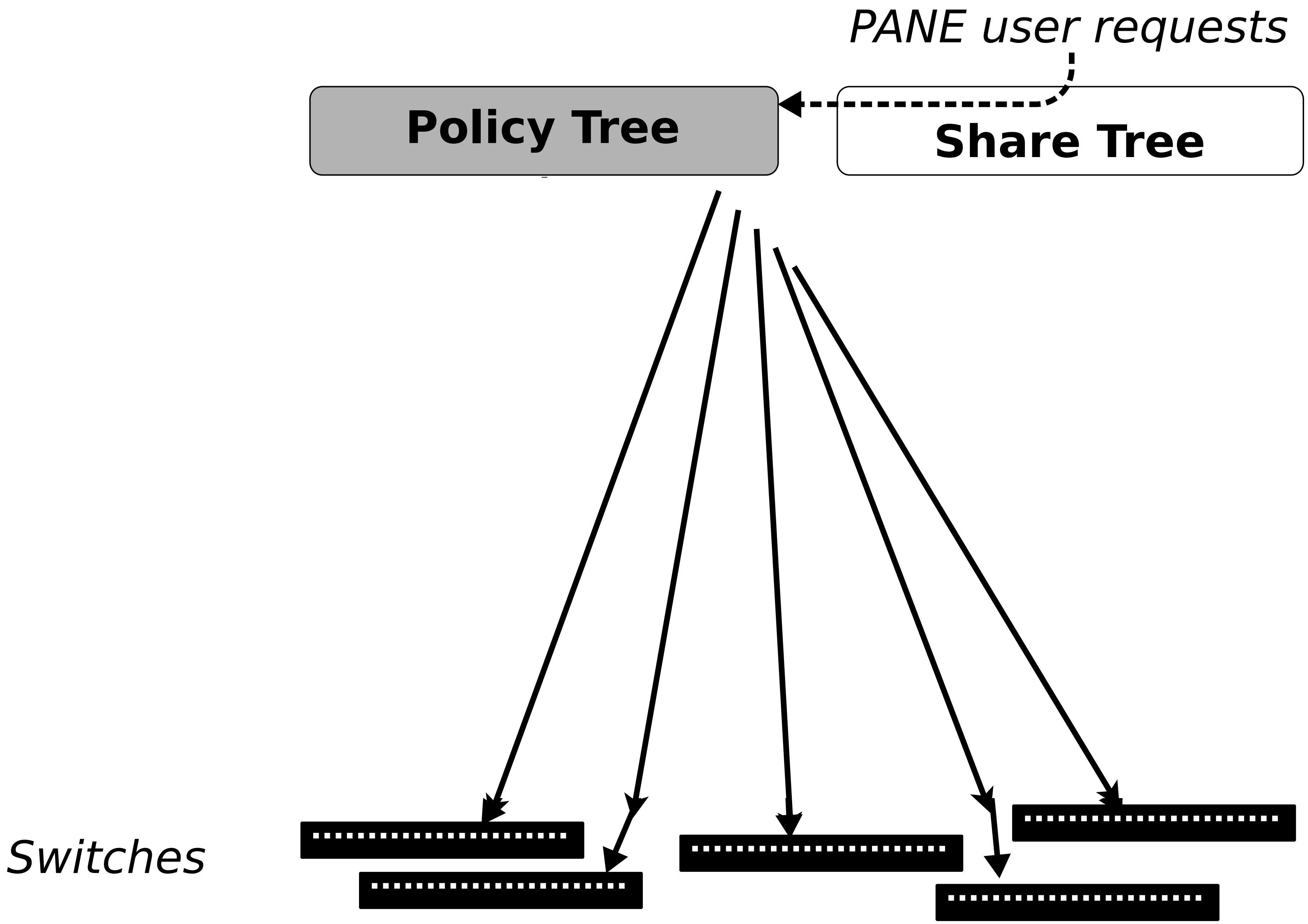
+P *Parent-Sibling*

Filho domina Pai
para Controle de Acesso
GMB combina como **max**

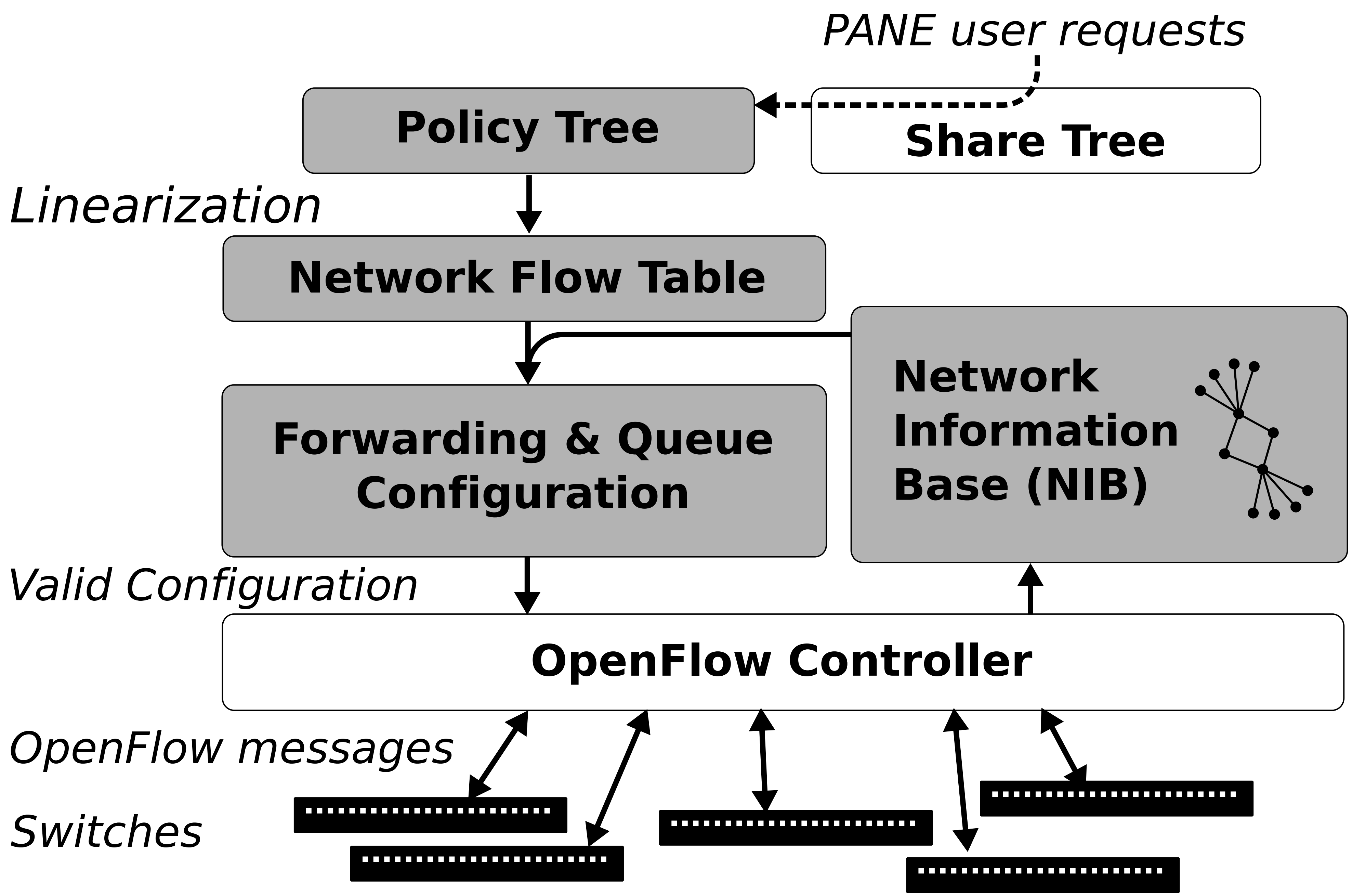
Operadores *HFT*

Há mais um probleminha...


PANE user requests
Policy Tree
Share Tree
Switches

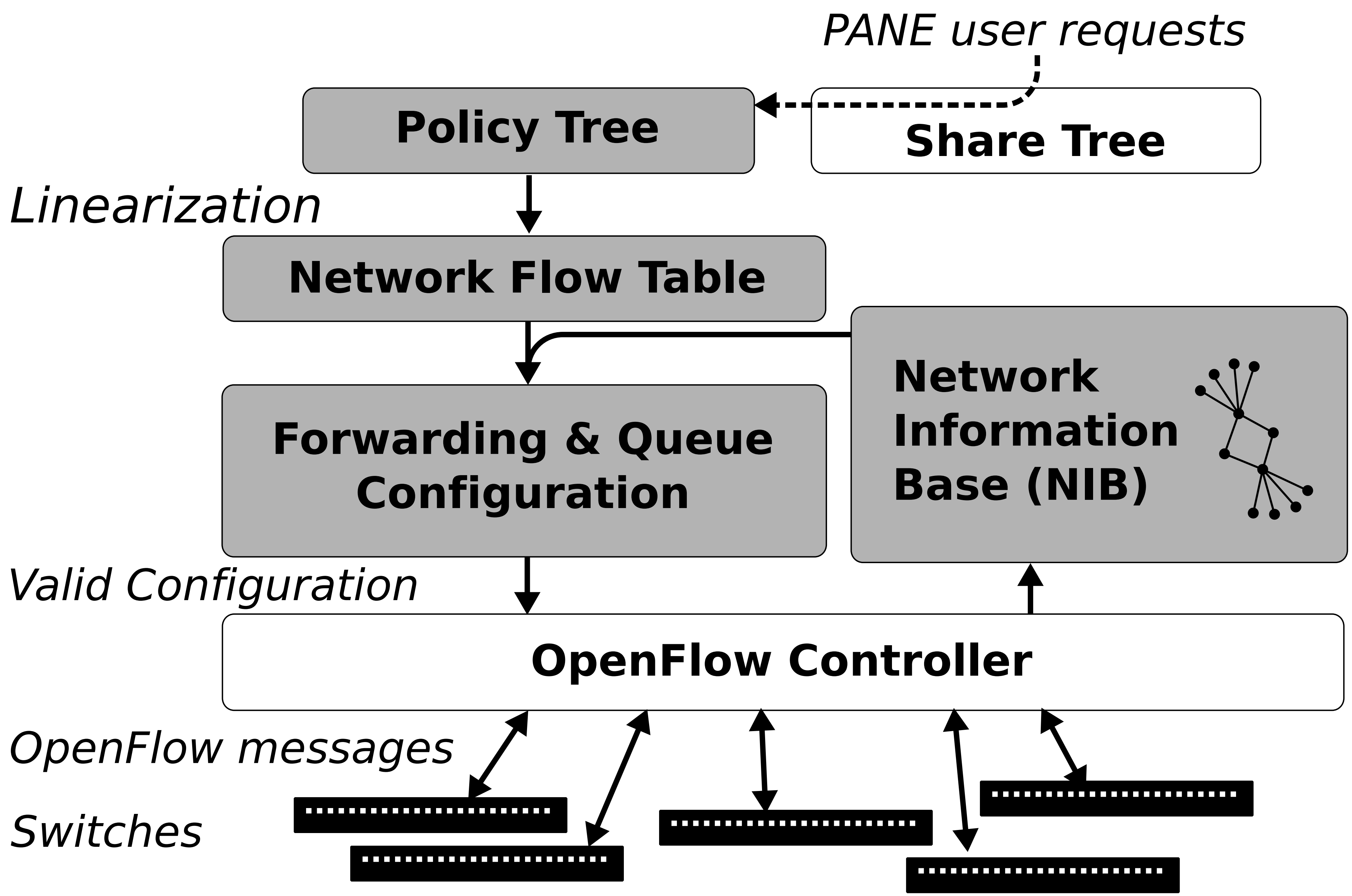


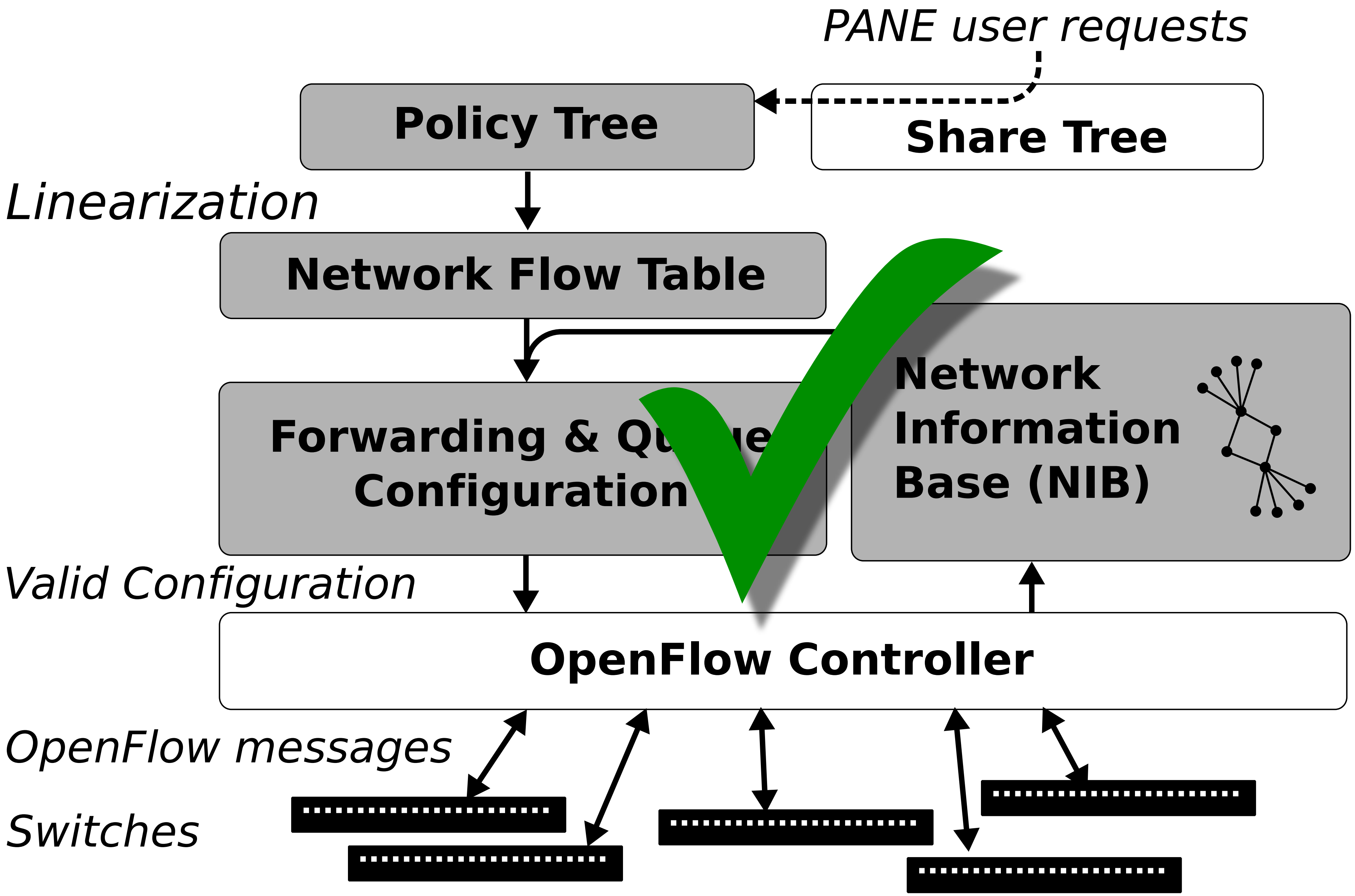
Switches não implementam árvores !

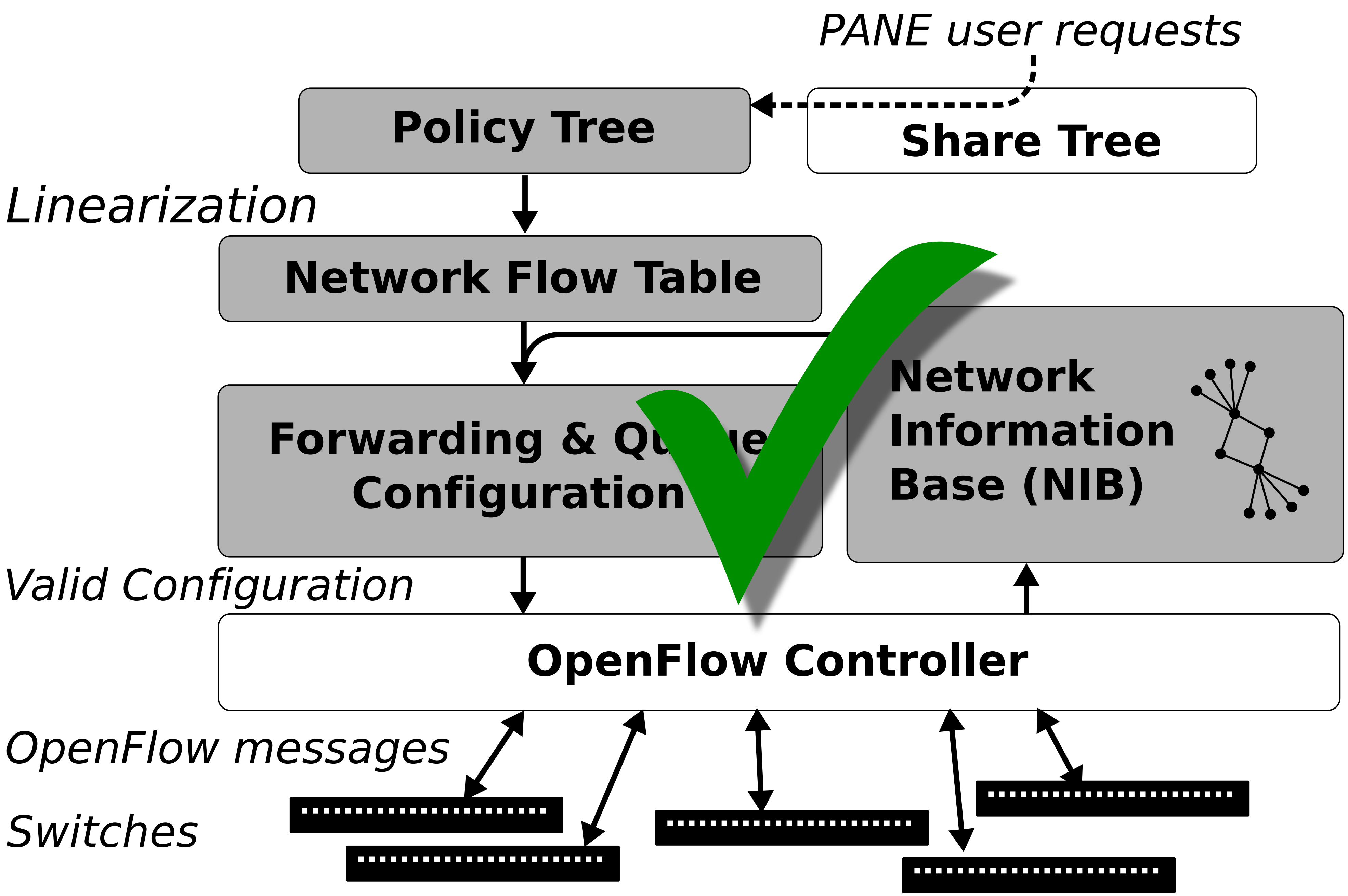


Switches não implementam árvores !

Estado Atual

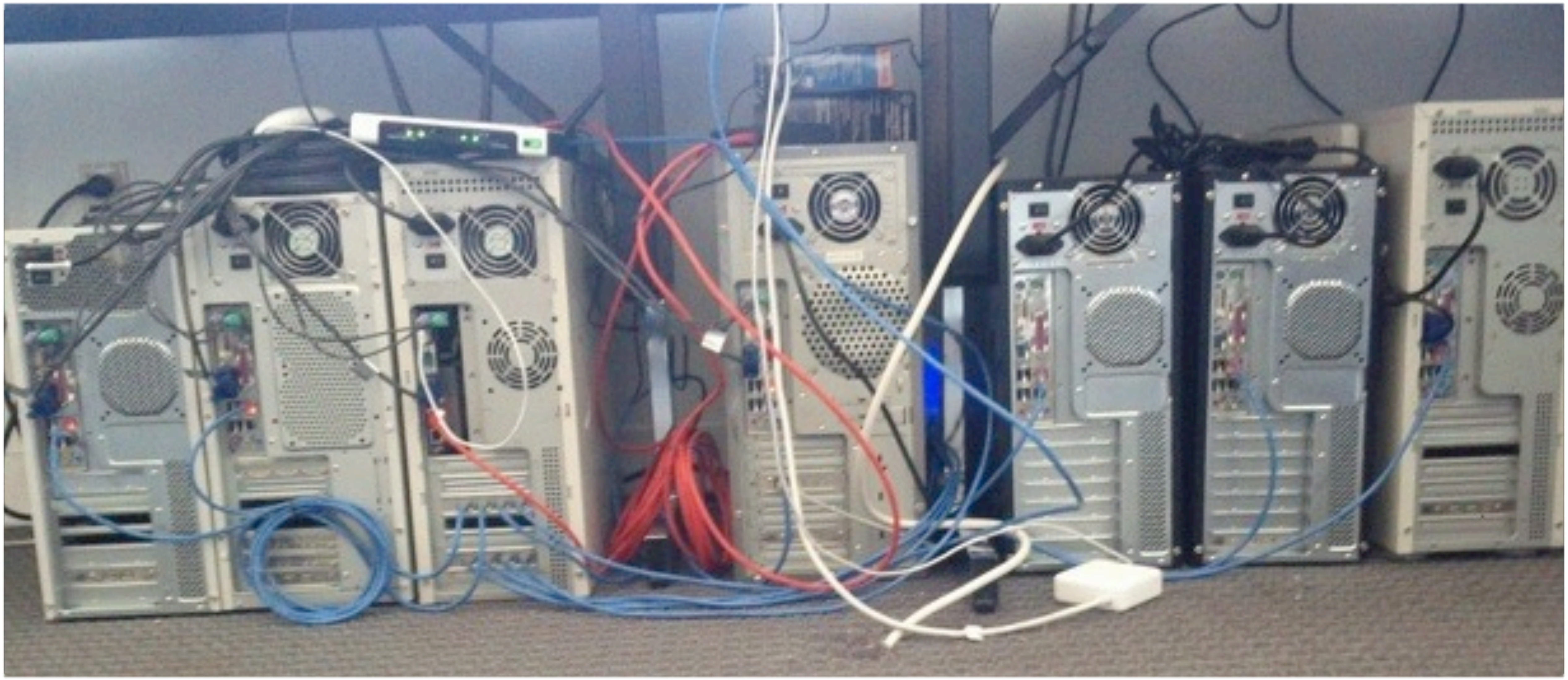

PANE user requests
Policy Tree
Share Tree
Linearization
Network Flow Table
Forwarding & Queue Configuration
Network Information Base (NIB)
Valid Configuration
OpenFlow Controller
OpenFlow messages
Switches


PANE user requests
Policy Tree
Share Tree
Linearization
Network Flow Table
Forwarding & Queue Configuration
Network Information Base (NIB)
Valid Configuration
OpenFlow Controller
OpenFlow messages
Switches



Todos esses componentes implementados com Controle de Acesso and GMB

Código: https://github.com/**brownsys/pane**



Andrew D. Ferguson, Arjun Guha, Jordan Place, Rodrigo Fonseca, and Shriram Krishnamurthi. "**Participatory Networking**". Hot-ICE, April 2012.

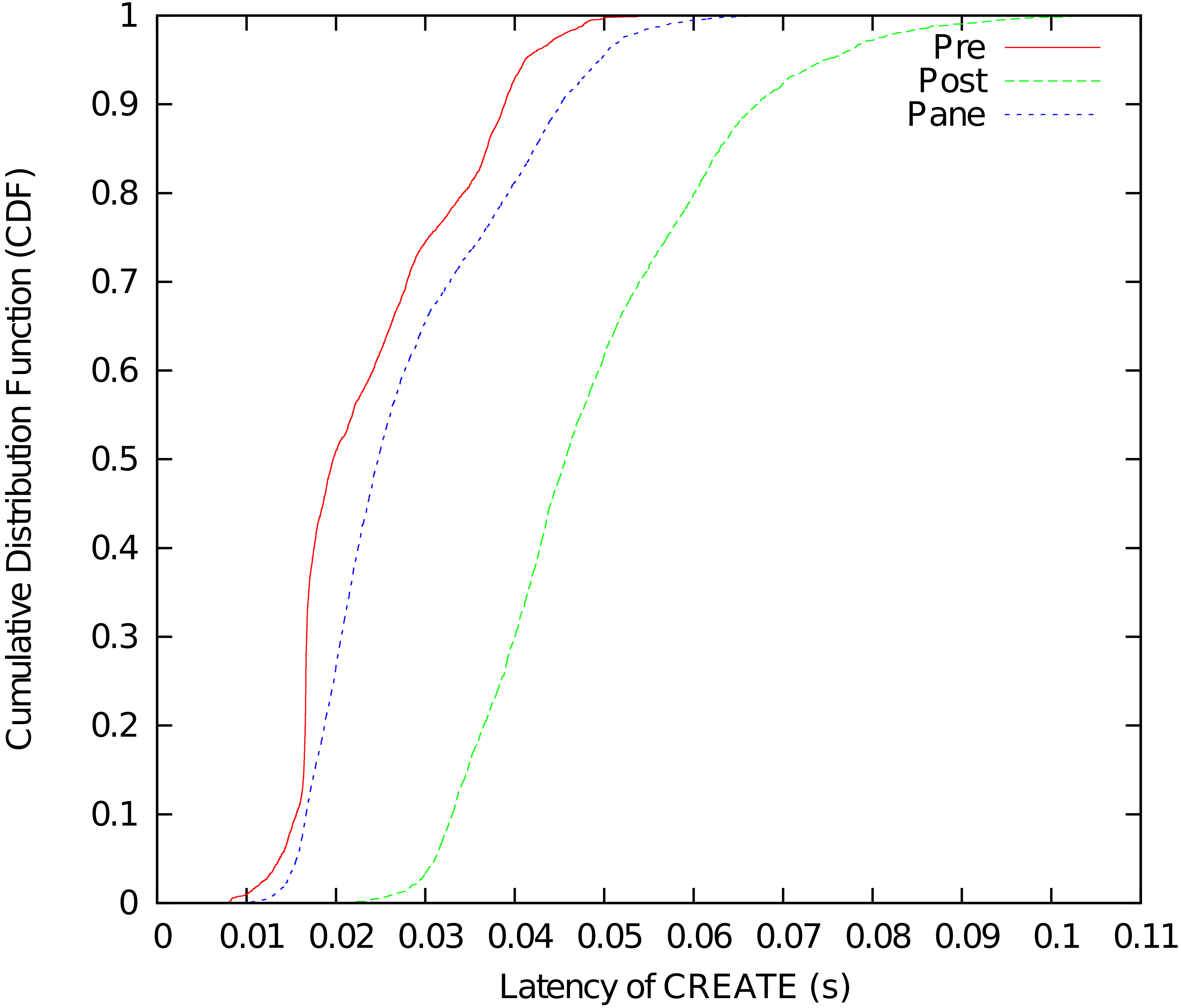
Andrew D. Ferguson, Arjun Guha, Chen Liang, Rodrigo Fonseca, and Shriram Krishnamurthi. "**Hierarchical Policies for Software Defined Networks**". To appear, Hot-SDN, August 2012.

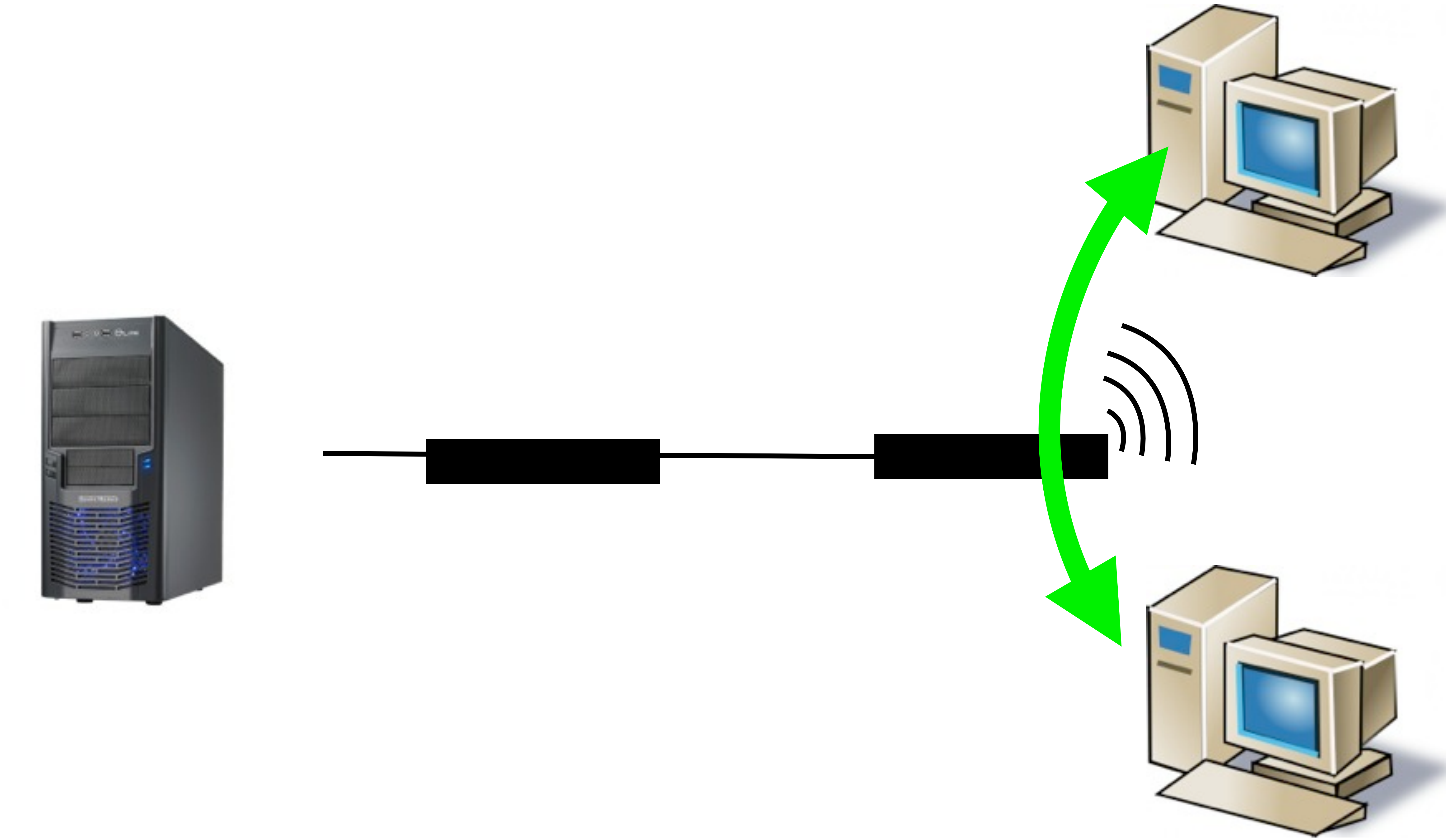
Avaliação Preliminar

Protegendo Zookeeper

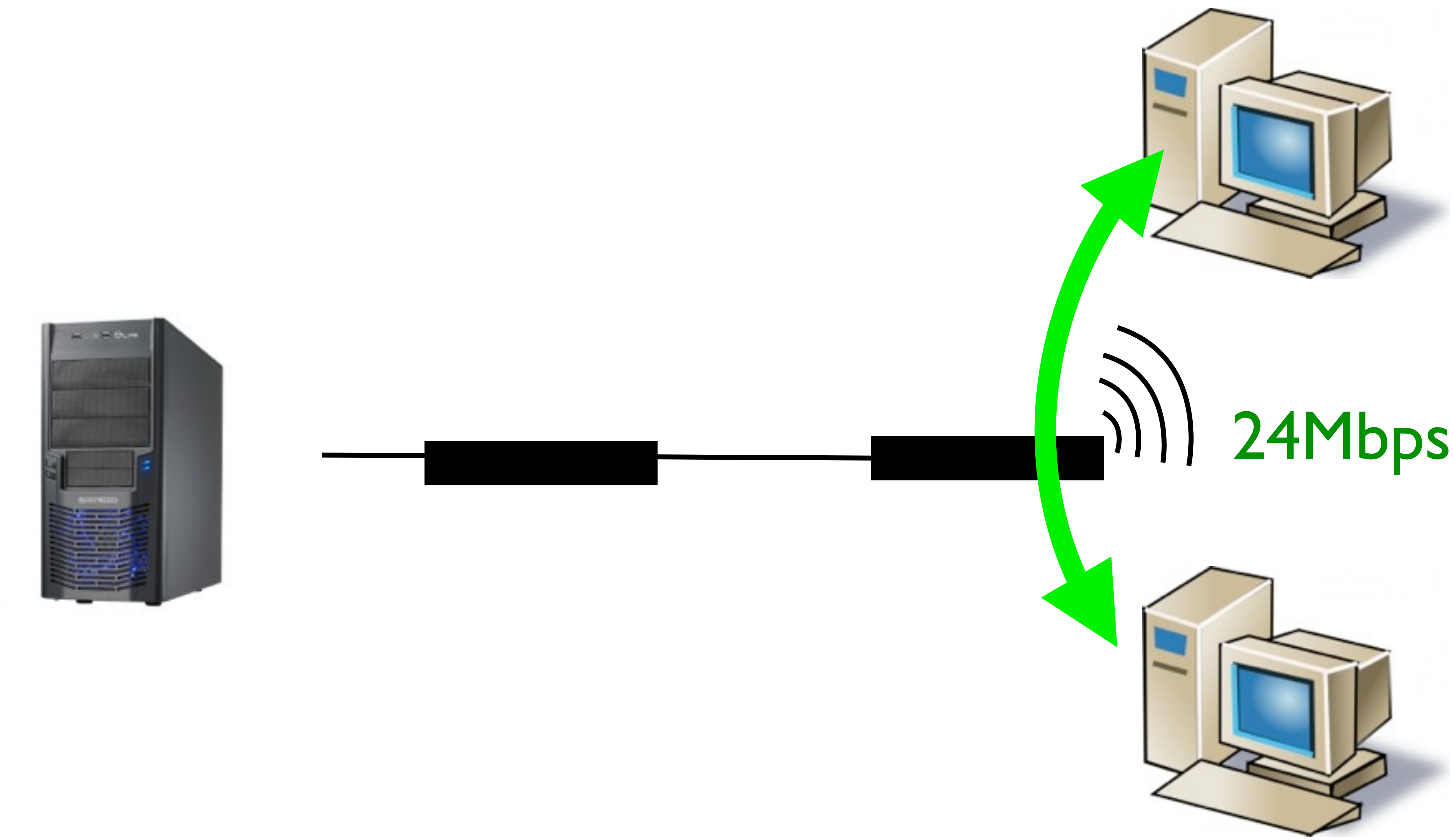
5 servidores Zookeper com PANE
1 cliente
Conectados via 1 OpenVSwitch (3.3Gbps)
iPerf gerando carga em todos os links

Protegendo Zookeeper

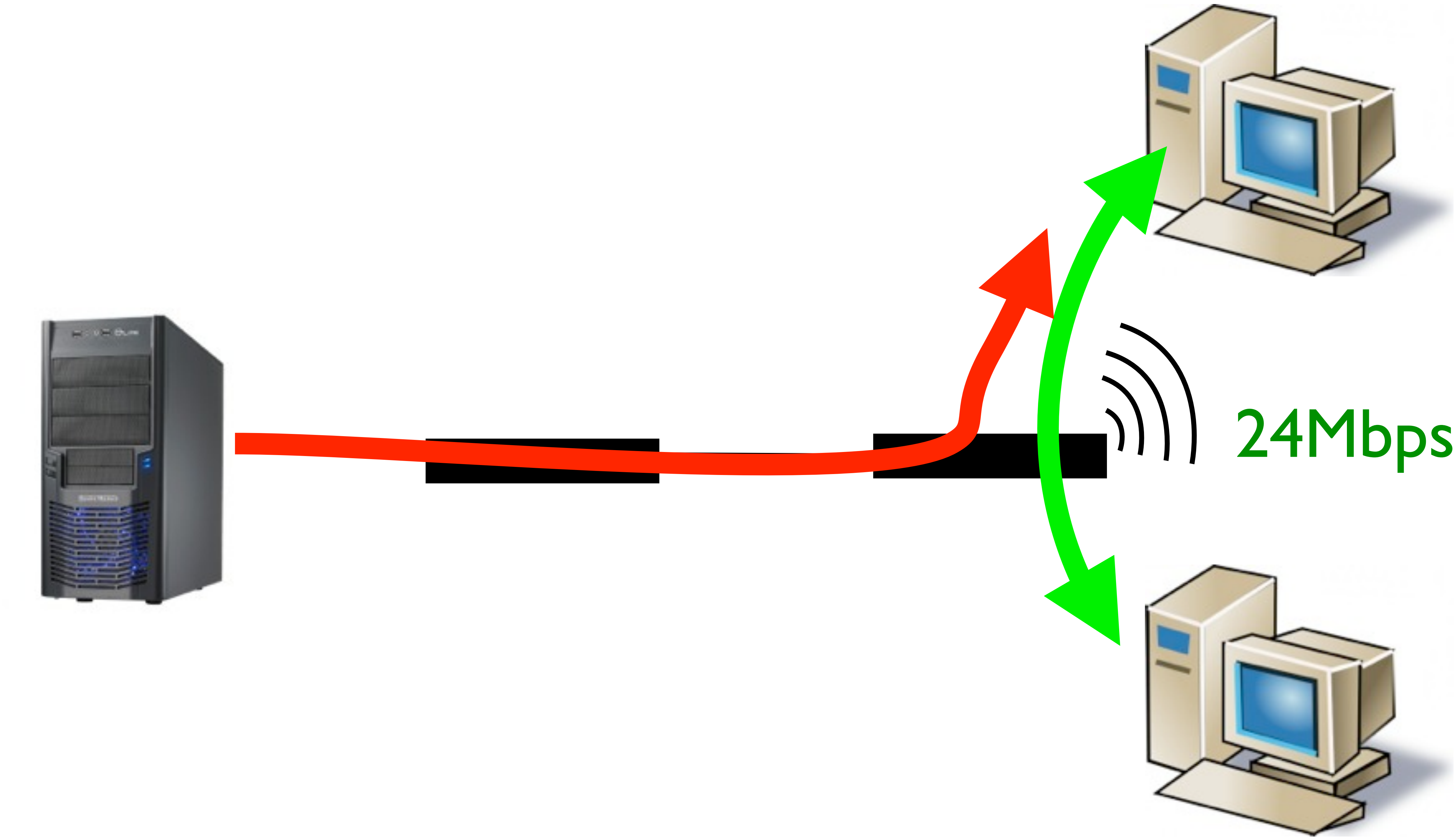

Pre
Post
Pane
Cumulative Distribution Function (CDF)
Latency of CREATE (s)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.11



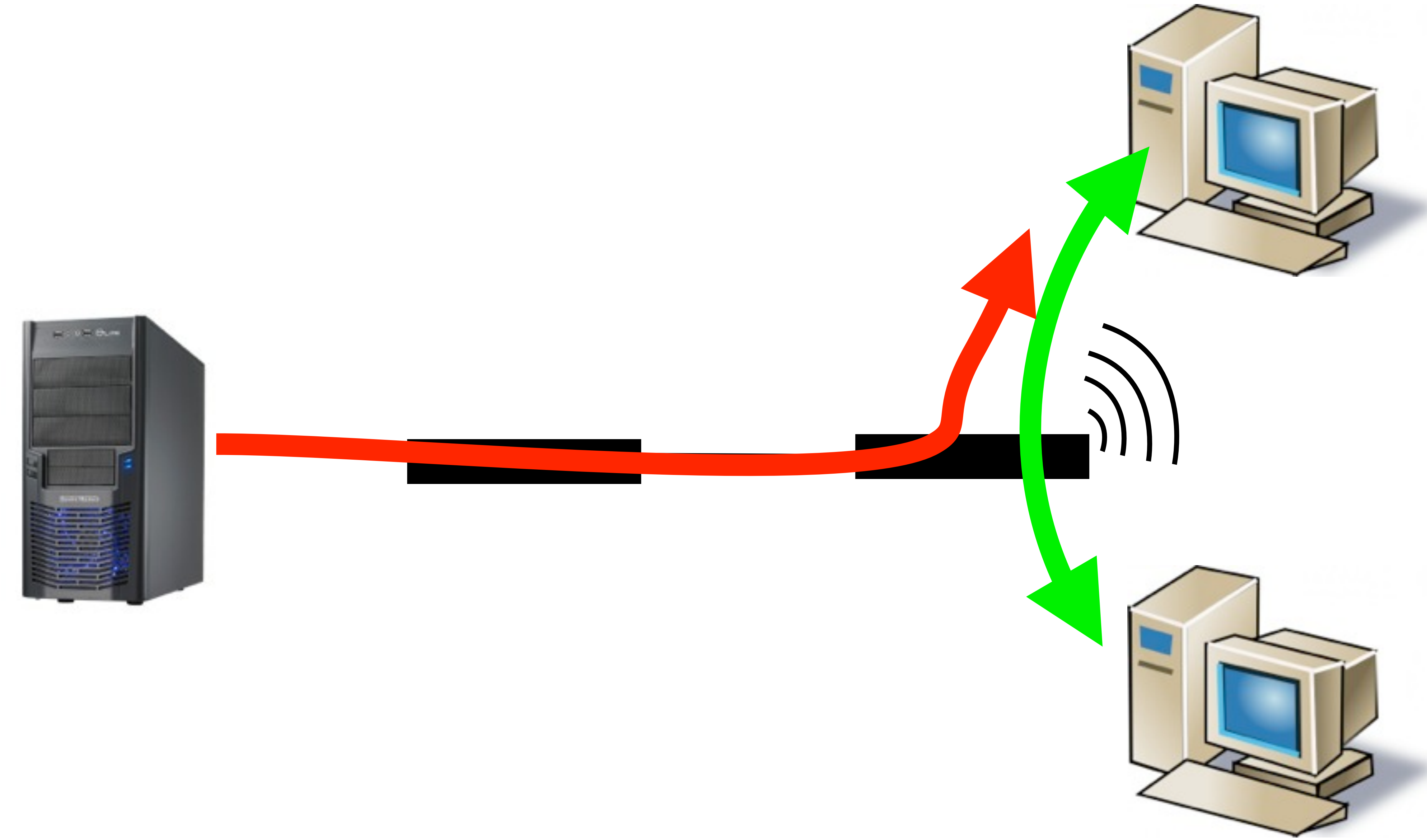
Denial-of-service



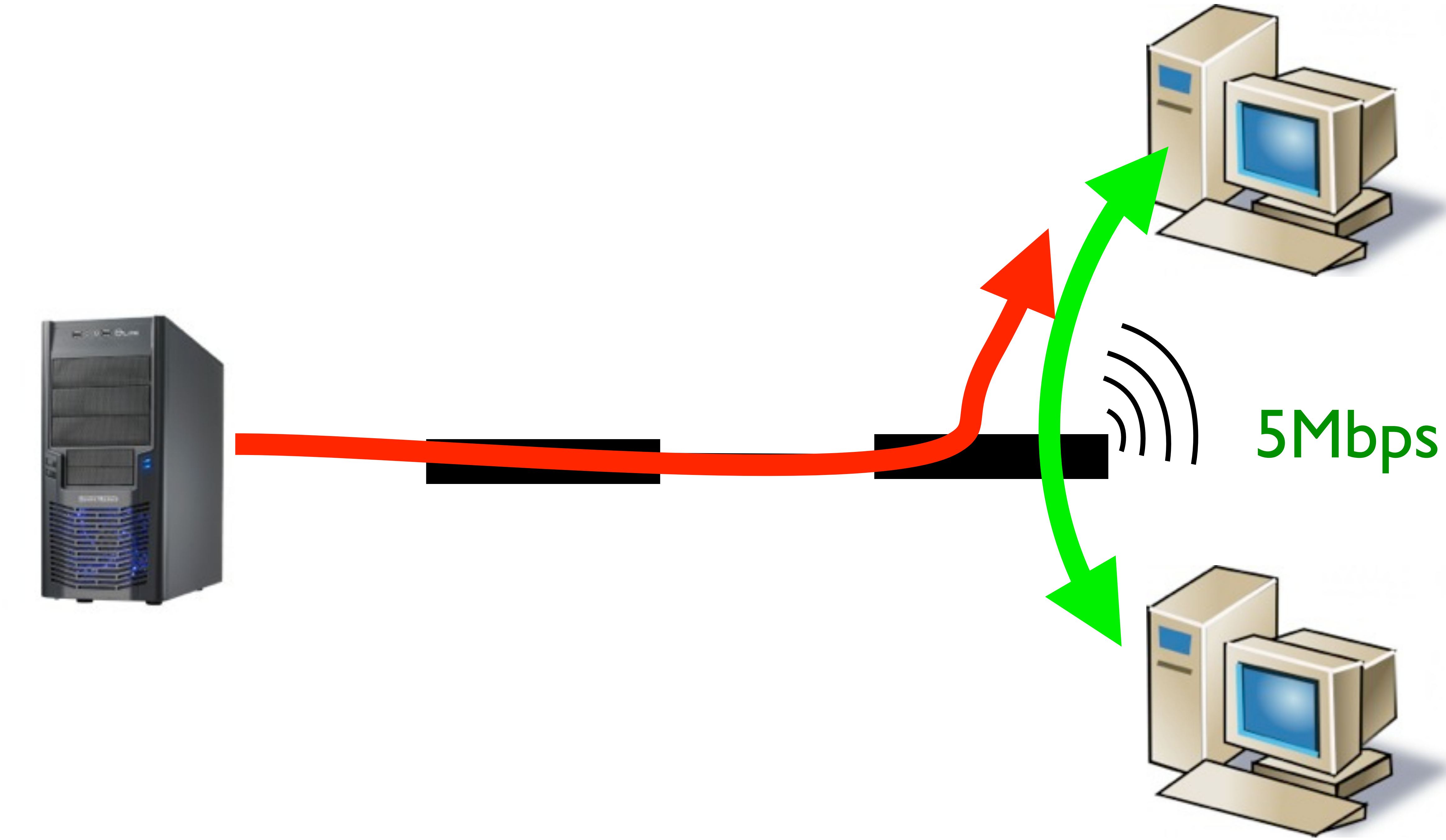
Denial-of-service



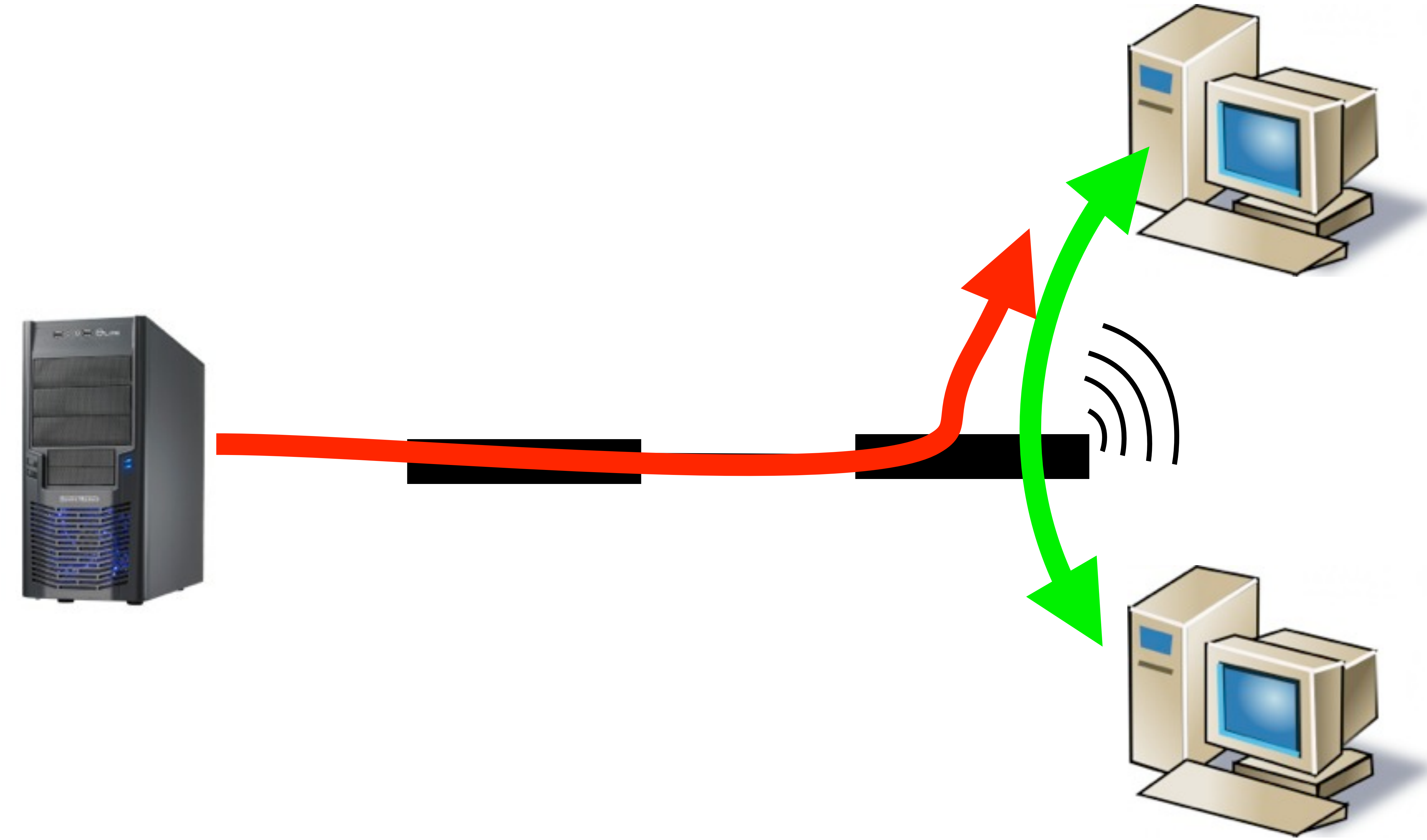
Denial-of-service



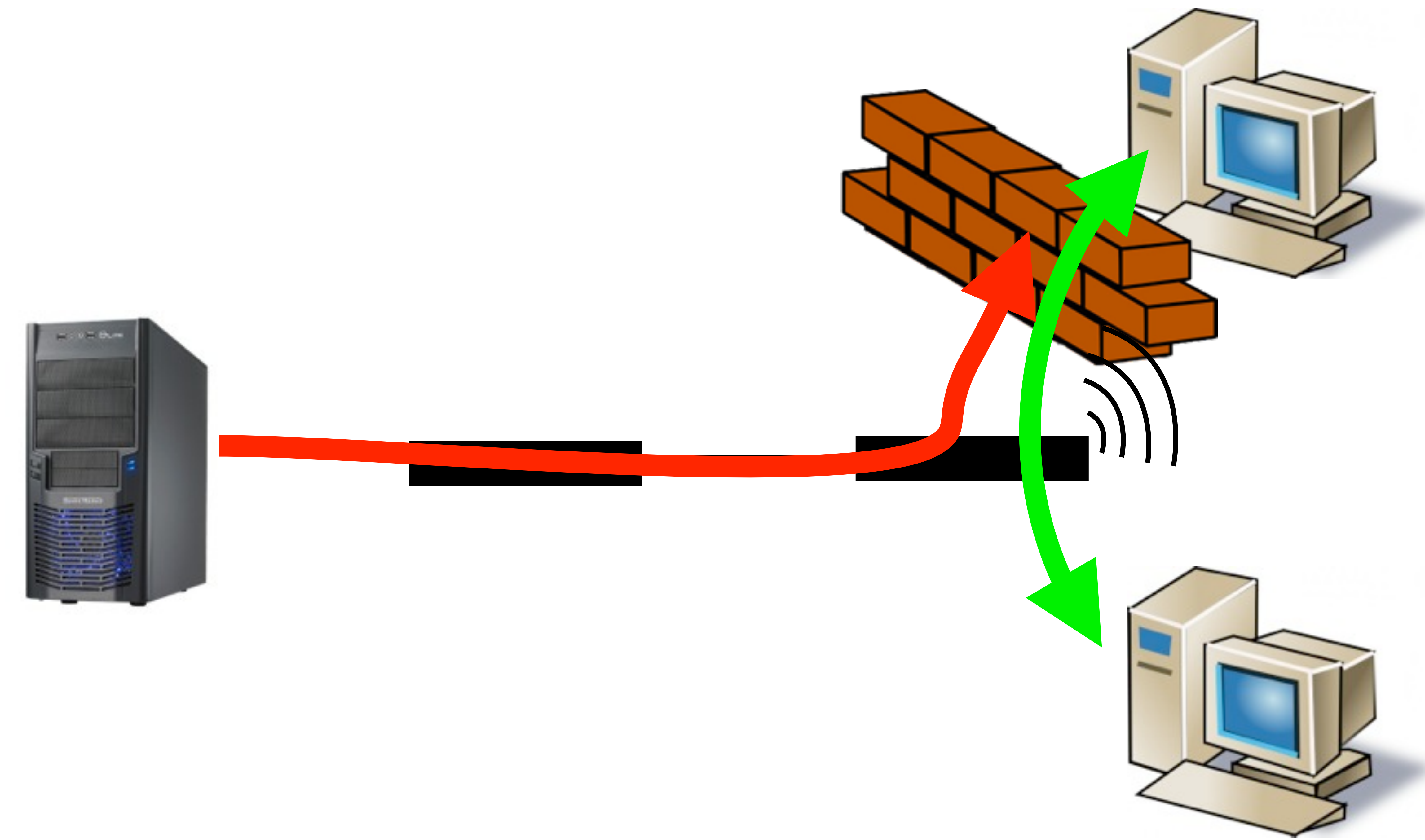
Denial-of-service



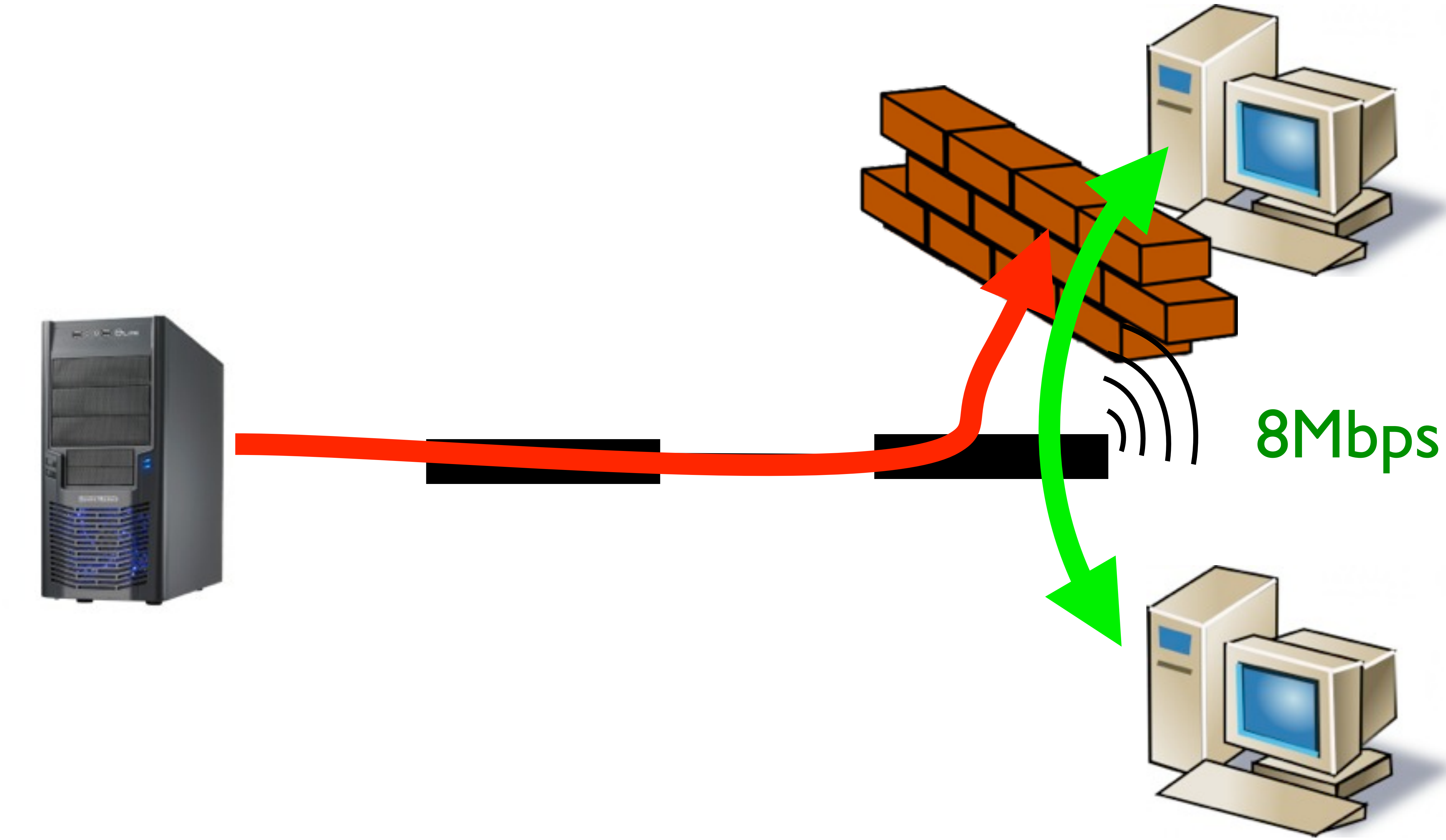
Denial-of-service



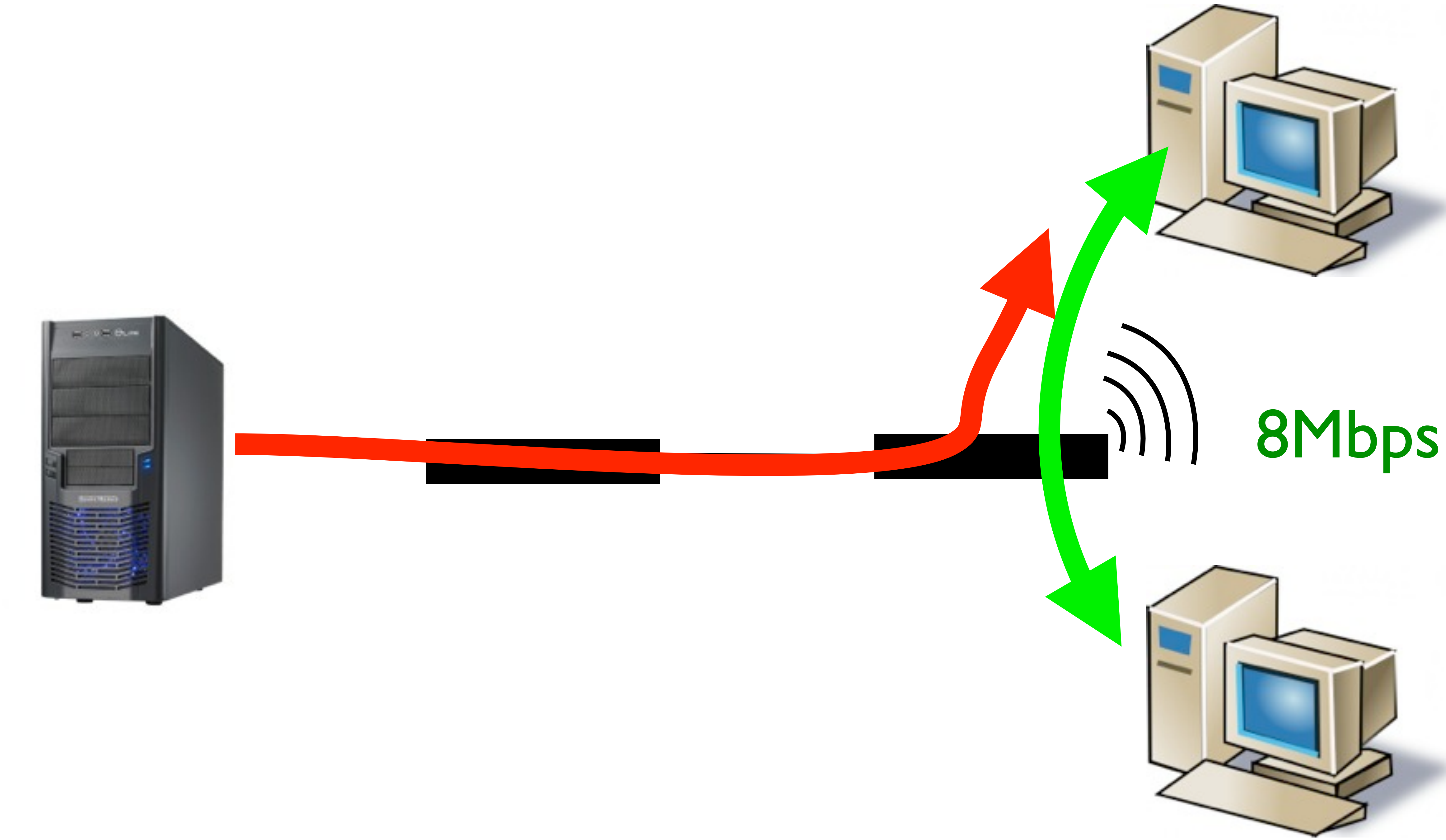
Denial-of-service



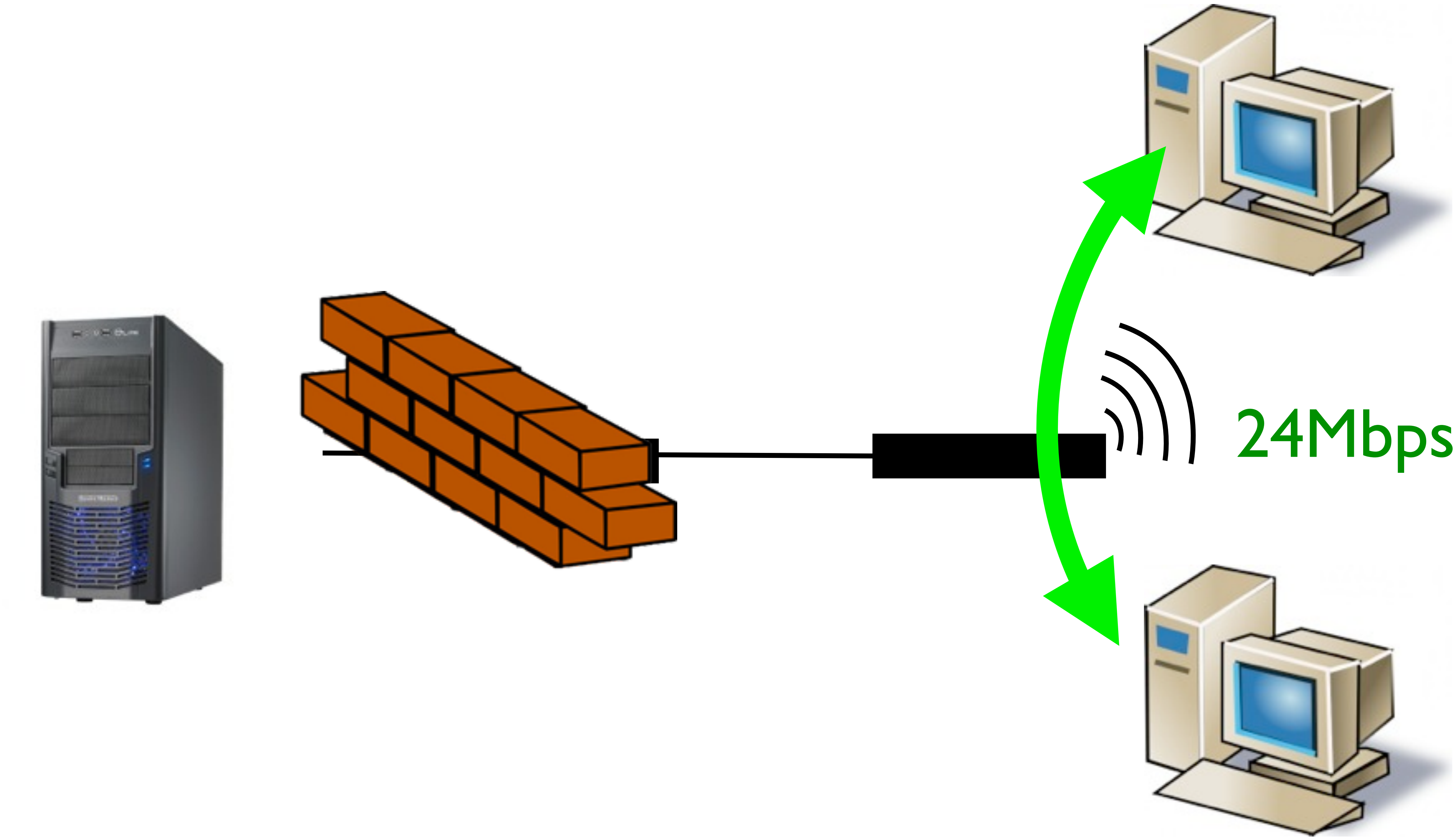
Denial-of-service



Denial-of-service



Denial-of-service



Denial-of-service

Próximos Passos

Implementar mais operadores

Próximos Passos

Implementar mais operadores

Garantia de Latência, Limite de Taxa, Propriedades de Caminhos

Próximos Passos

Implementar mais operadores

Garantia de Latência, Limite de Taxa, Propriedades de Caminhos

Hints

Próximos Passos

Implementar mais operadores

Garantia de Latência, Limite de Taxa, Propriedades de Caminhos

Hints

Queries

Próximos Passos

Implementar mais operadores

Garantia de Latência, Limite de Taxa, Propriedades de Caminhos

Hints

Queries

Sua aplicação?

Próximos Passos

Implementar mais operadores

Garantia de Latência, Limite de Taxa, Propriedades de Caminhos

Hints

Queries

Sua aplicação?

Criar um mercado

Próximos Passos

Implementar mais operadores

Garantia de Latência, Limite de Taxa, Propriedades de Caminhos

Hints

Queries

Sua aplicação?

Criar um mercado

Escalabilidade

Próximos Passos

Conclusion

Informações do usuário podem trazer grandes benefícios para configuração de redes

PANE é nosso primeiro passo para alcançar essa visão

Conclusion

Perguntas?

Rodrigo Fonseca
rfonseca@cs.brown.edu

Andrew Ferguson
adf@cs.brown.edu

Arjun Guha
arjun@cs.brown.edu

Shriram Krishnamurthi
sk@cs.brown.edu