

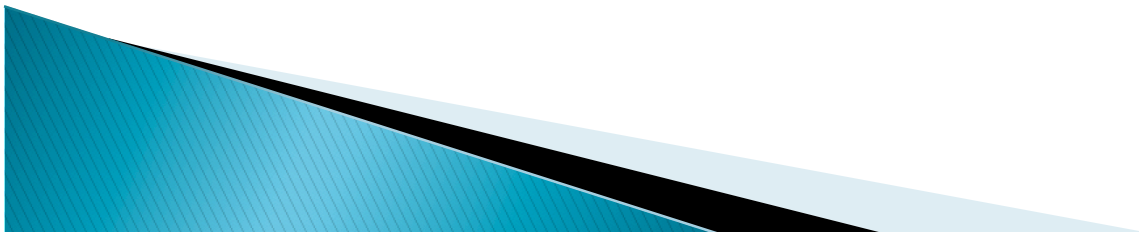
ShadowNet: A Platform for Rapid and Safe Network Evolution

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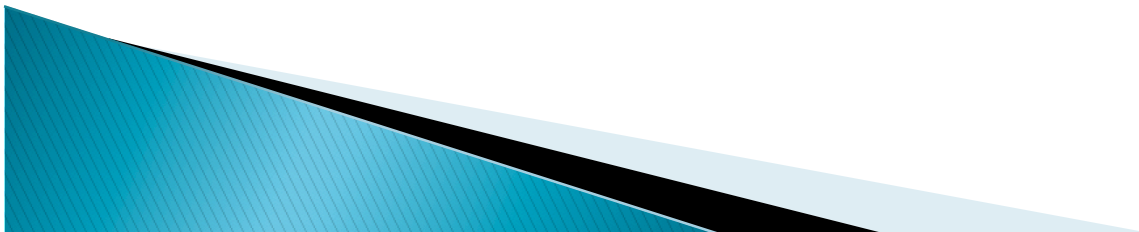
Networks are constantly evolving

- ▶ Growth demand
- ▶ New service technologies
- ▶ New operational tools and procedures



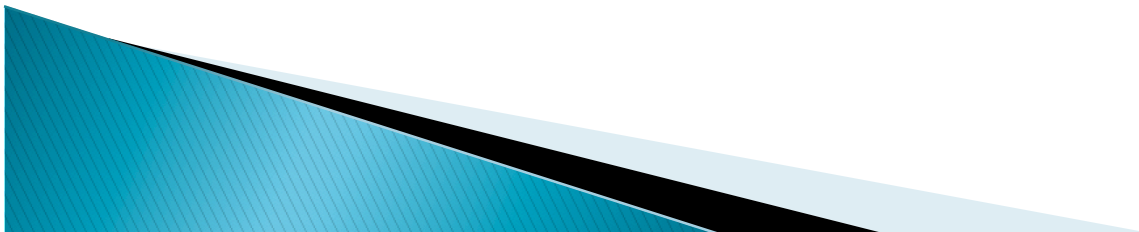
Effecting network change is difficult

- ▶ Any change has potential negative impact
 - Modern networks are shared in nature
 - Number of services increases over time rather than diminishes



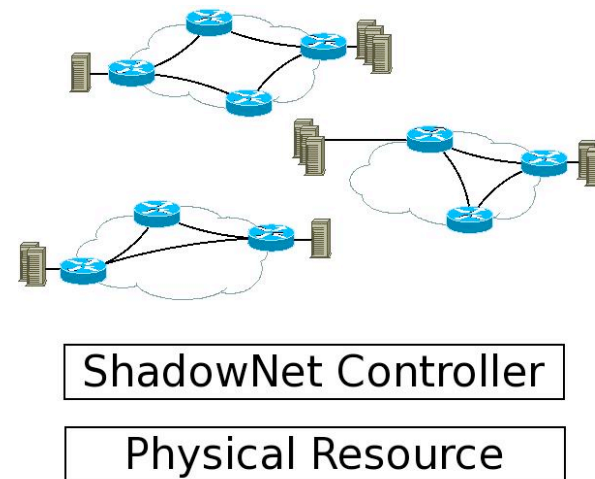
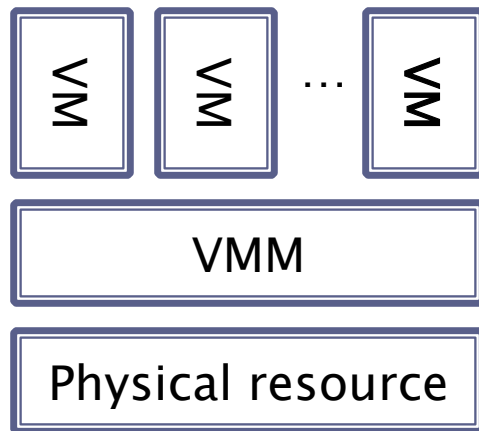
Our proposal: ShadowNet

- ▶ “National footprint” network/platform/testbed for research and network service testing
 - Service testing/trials in a realistic environment
 - Evaluation of new technologies/vendor capabilities
 - Evolution of network support systems
 - Research in operational settings



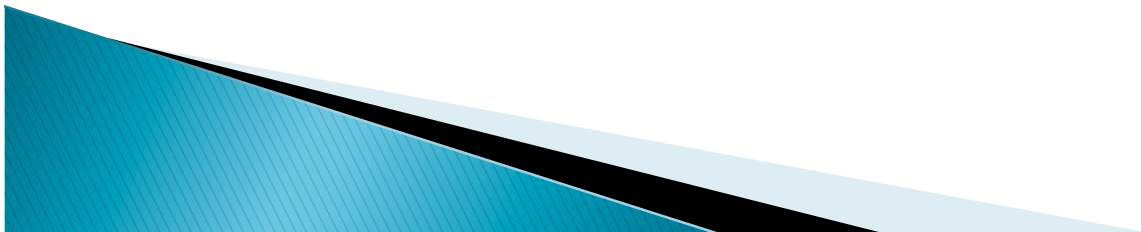
ShadowNet Features

- ▶ Connected to, but separate from production network
- ▶ In between lab and production
- ▶ General-purpose, shareable testbed facility

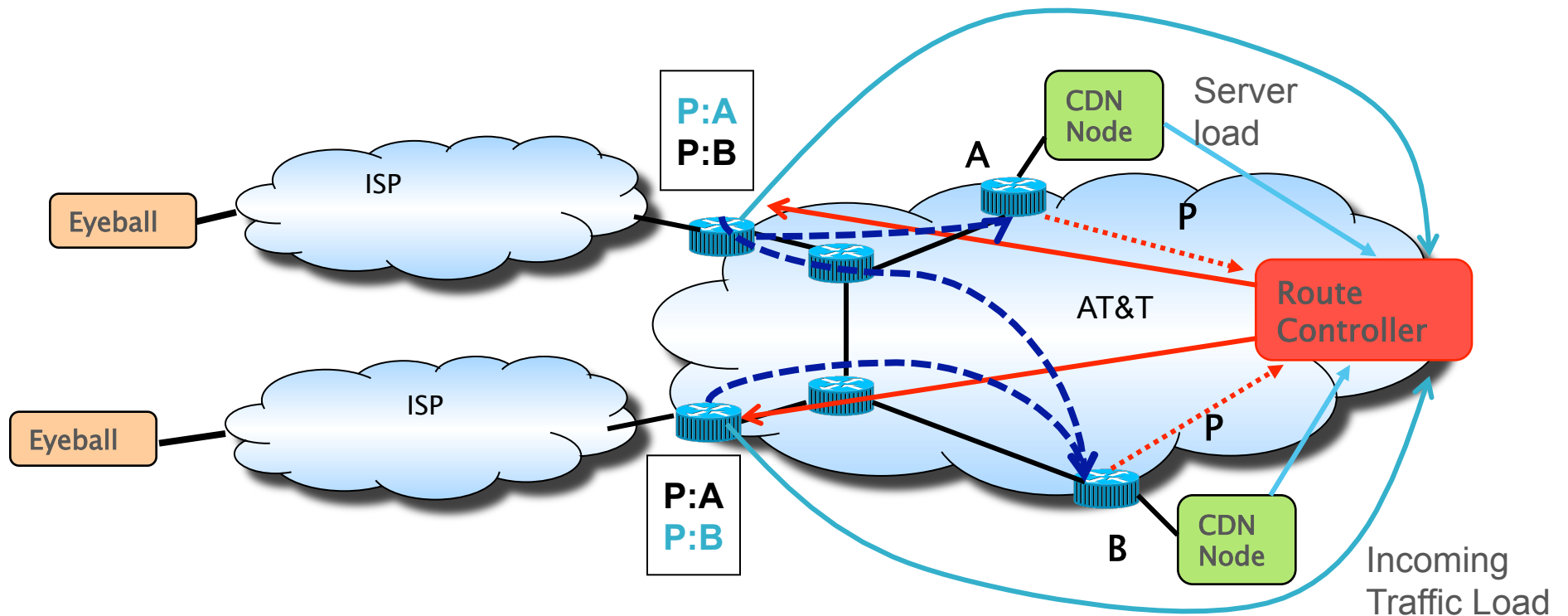


Outline

- ▶ Overview
- ▶ **Motivating example**
- ▶ Architecture
- ▶ Implementation
- ▶ Evaluation
- ▶ Conclusion



Example: Anycast CDN



Testbed requirements

ShadowNet

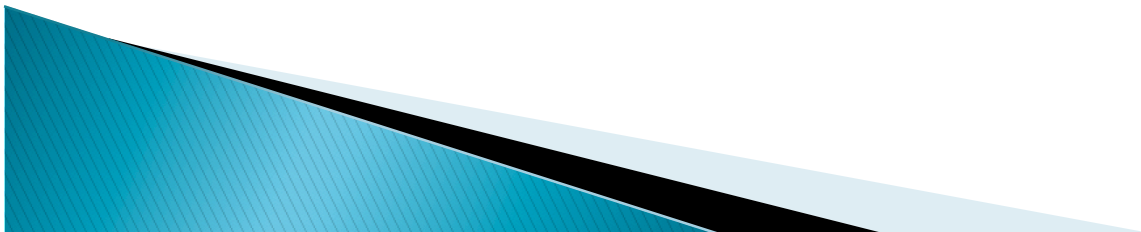
EmuLab

PlanetLab

VINI

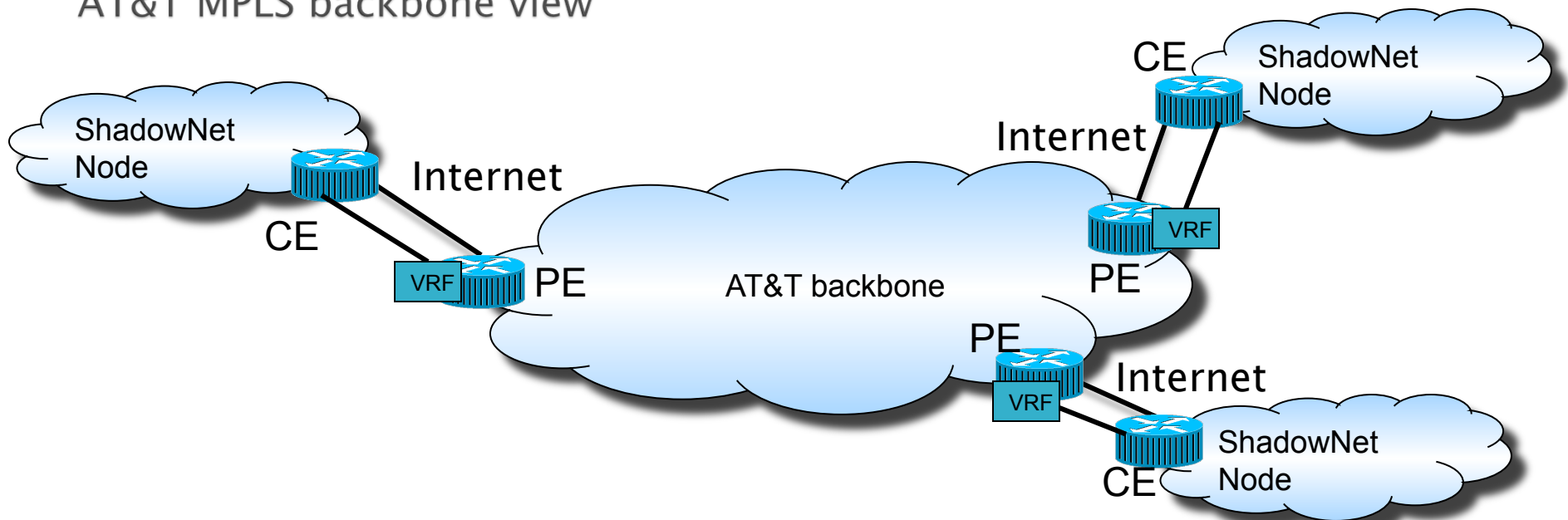
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ShadowNet Building Blocks: Backbone

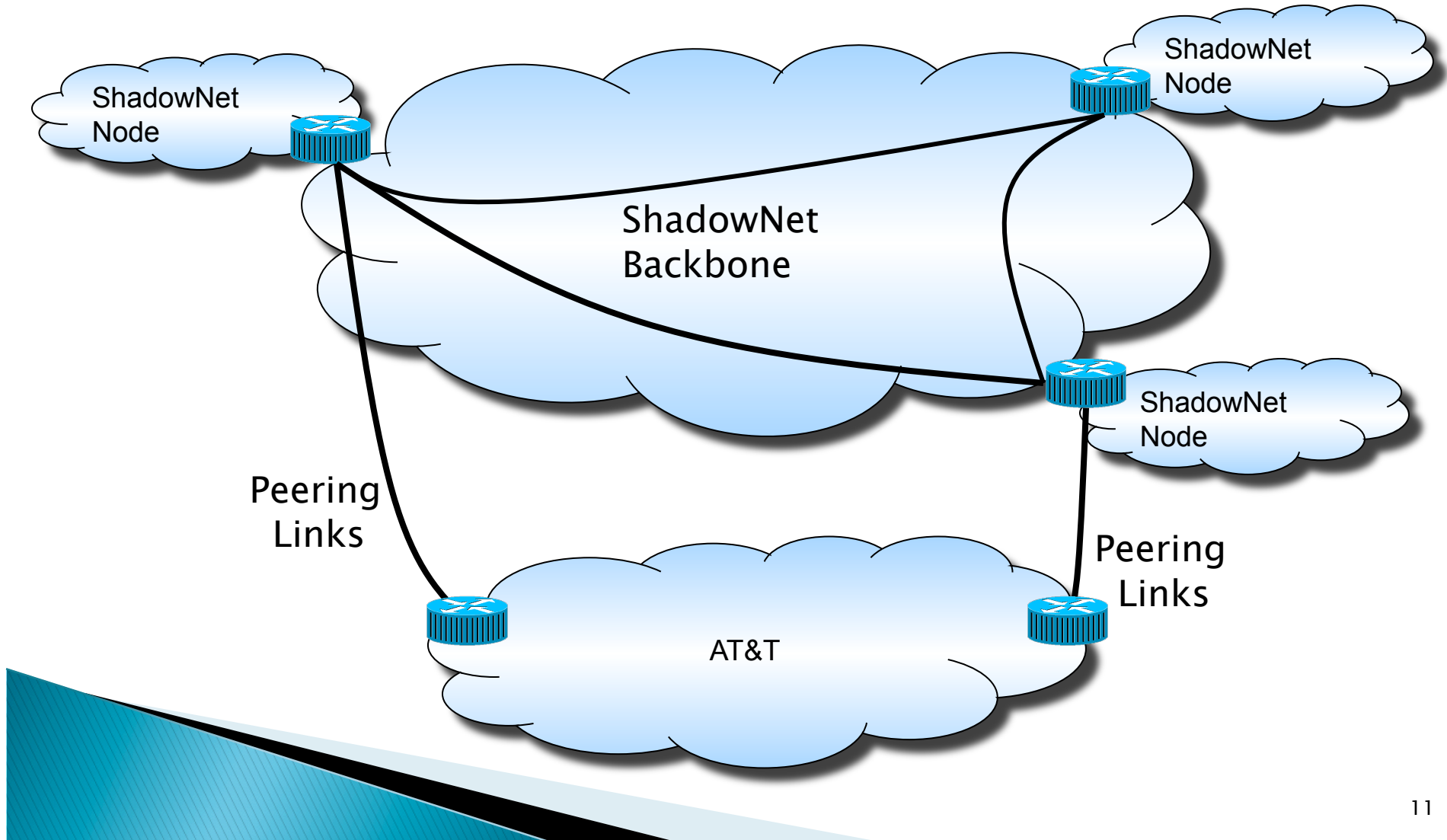
AT&T MPLS backbone view



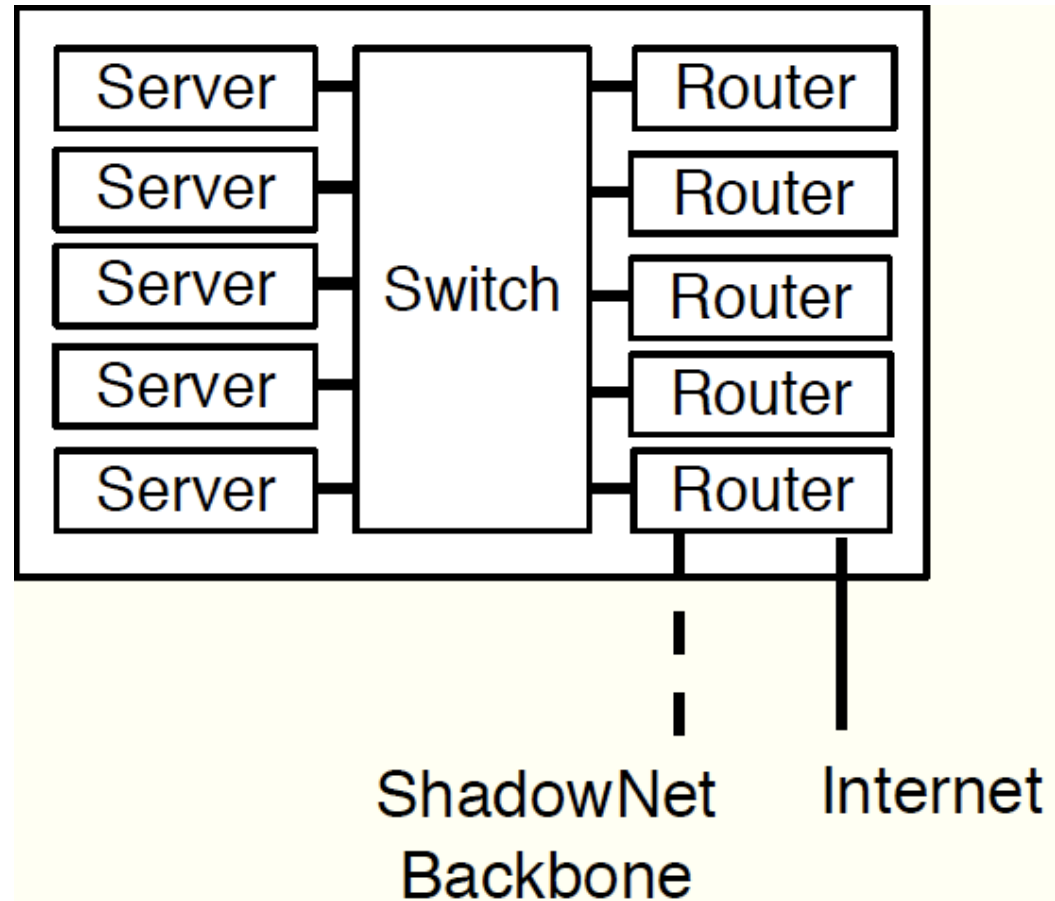
- ▶ From AT&T backbone point of view ShadowNet looks like just another customer
 - VPN service provides dedicated internal connectivity
 - Internet service

ShadowNet Building Blocks: Backbone

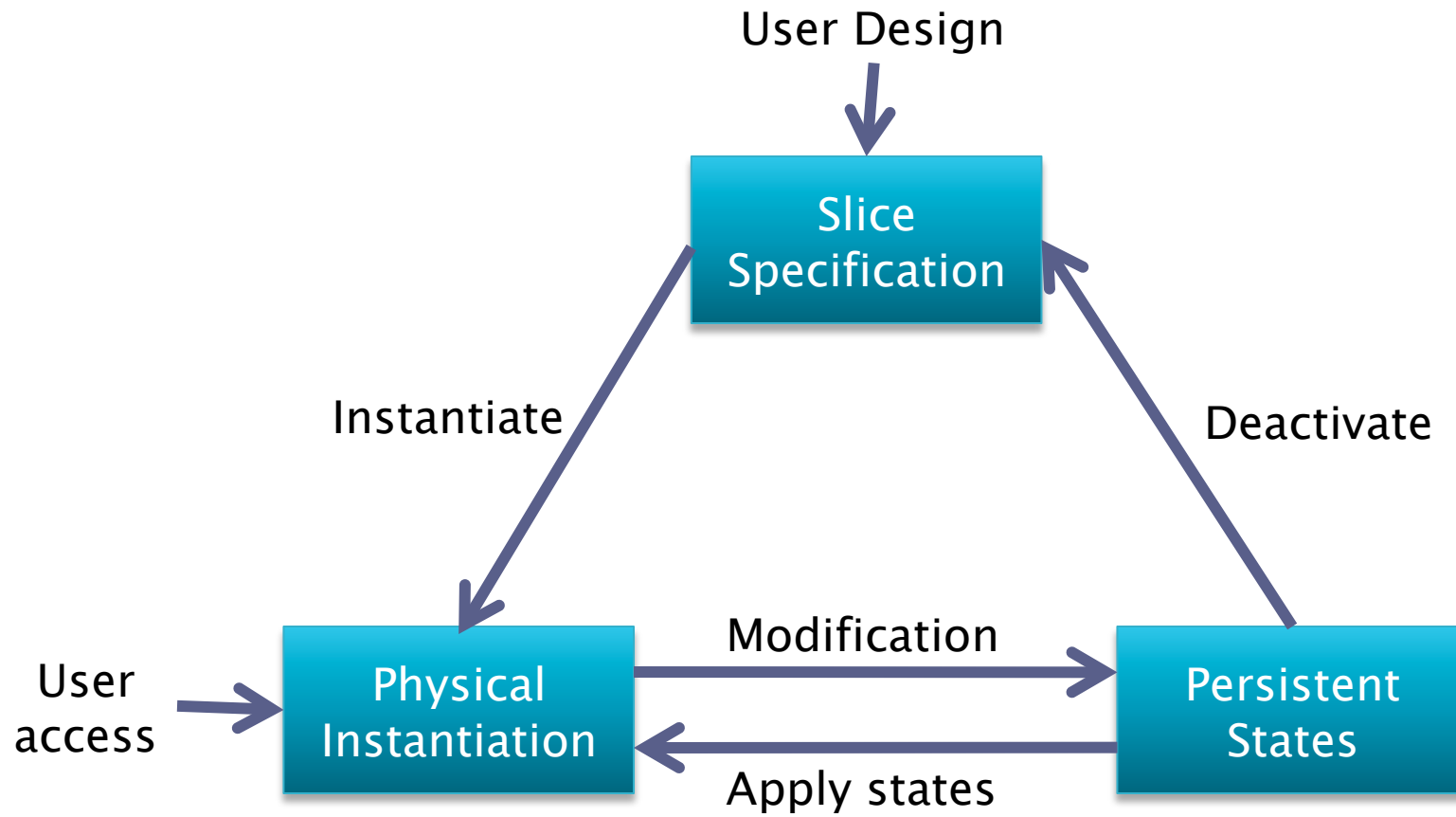
ShadowNet view



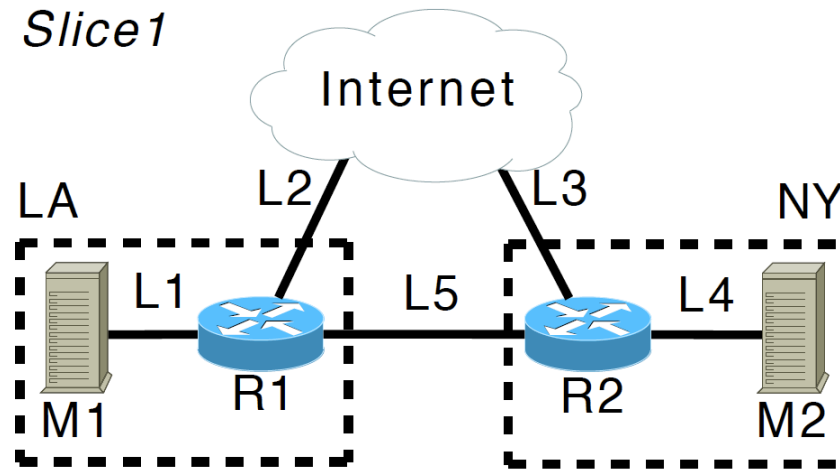
ShadowNet node



Slice – user interaction

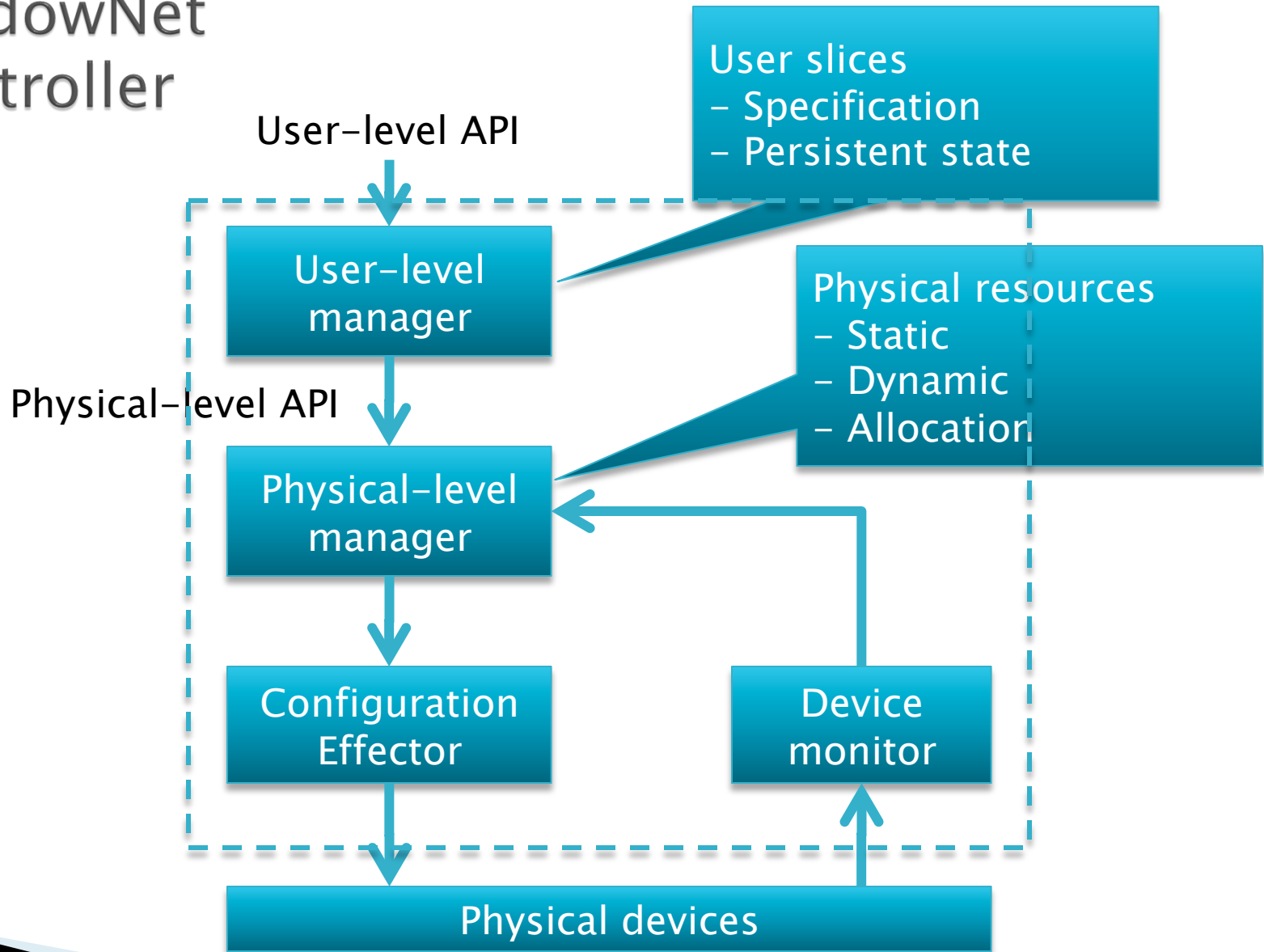


Slice specification example

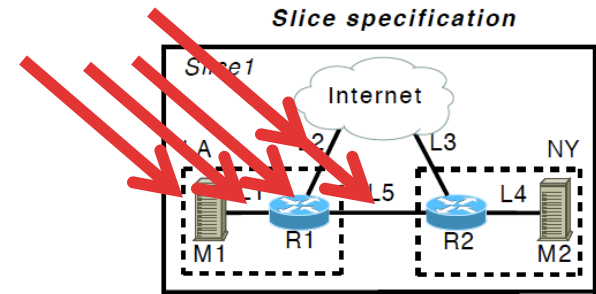


```
$SL = AddUsrSlice();  
$R1 = AddUsrRouter($SL,"LA");  
$M1 = AddUsrMachine($SL,"LA","Debian");  
$L1 = AddUsrLink($M1,$R1); # similar for M2  
$L2 = AddToInternet($R1, "141.212.111.0/24");  
# similar for "NY"
```

ShadowNet Controller

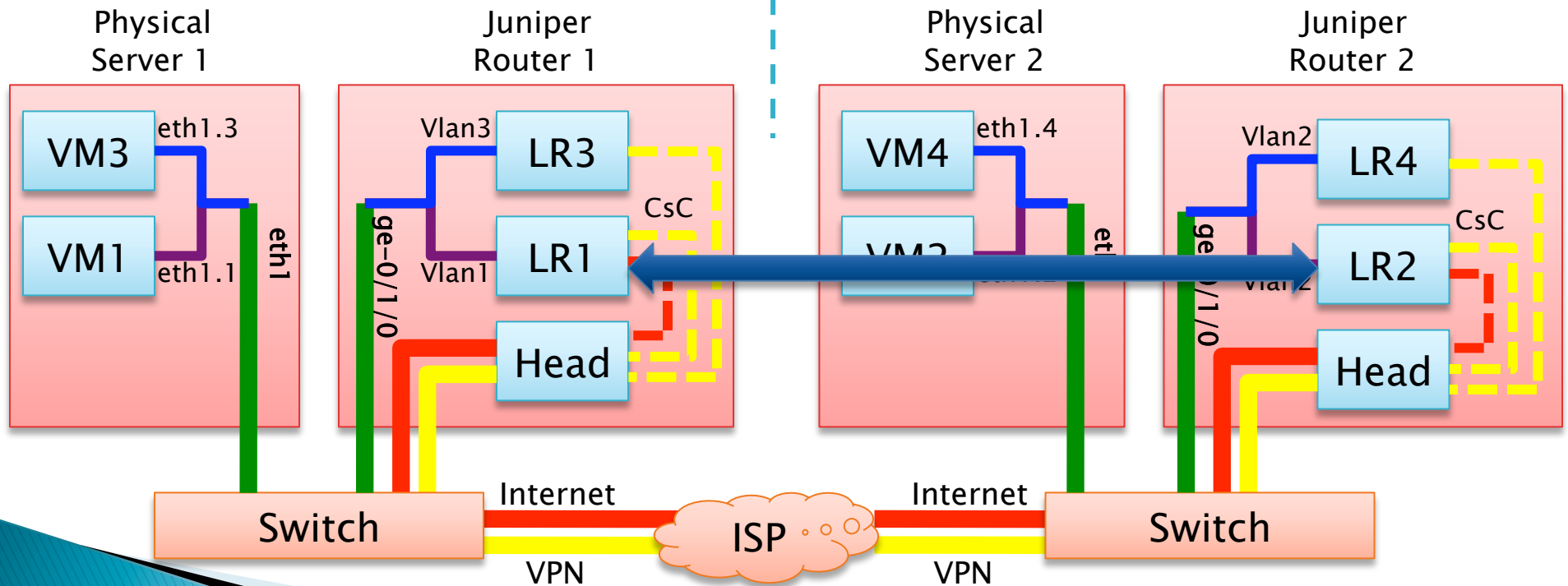


Slice instantiation

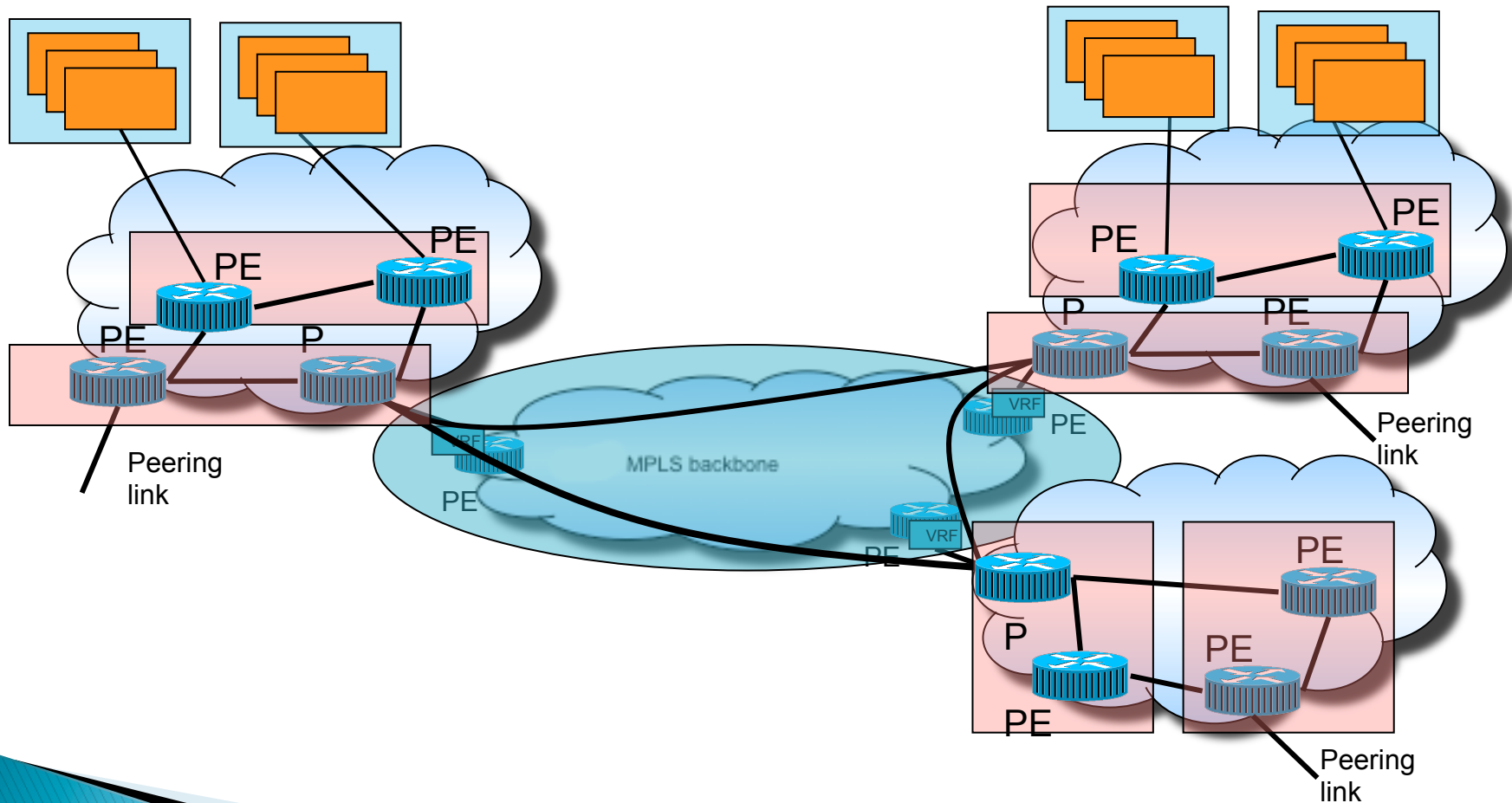


ShadowNet Node 1

ShadowNet Node 2

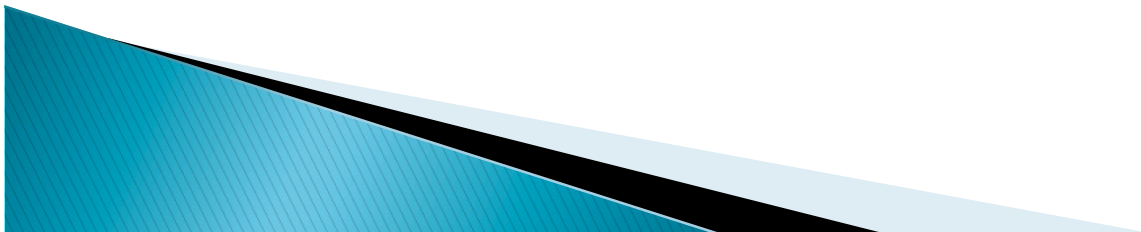


CDN example – Mini ISP with four data centers



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Realization

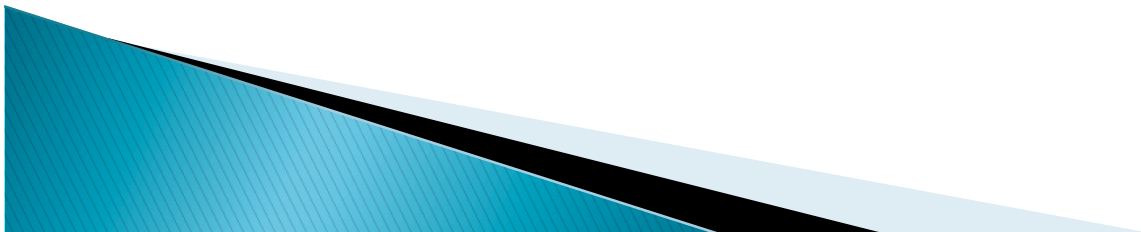
- ▶ Node setup
 - Two Juniper M7i routers, running Junos 9.0
 - One Cisco C2960 switch
 - Four HP DL520 servers, running Debian
- ▶ Backbone
 - Two Cisco 7206 routers, with MPLS/VPN support
- ▶ Four-node wide-area deployment is (still) undergoing!

Slice specification to physical instantiation

- ▶ Endpoints (Routers/Machines)
 - Logical router (Juniper)
 - Virtual machine (VirtualBox or Xen)
- ▶ Connectivity
 - Linux tap interface/bridge
 - VLAN
 - Carrier-supporting-carrier VPN
 - Layer-2 VPN (pseudo-wire)
 - VPLS (wide-area switch)

Outline

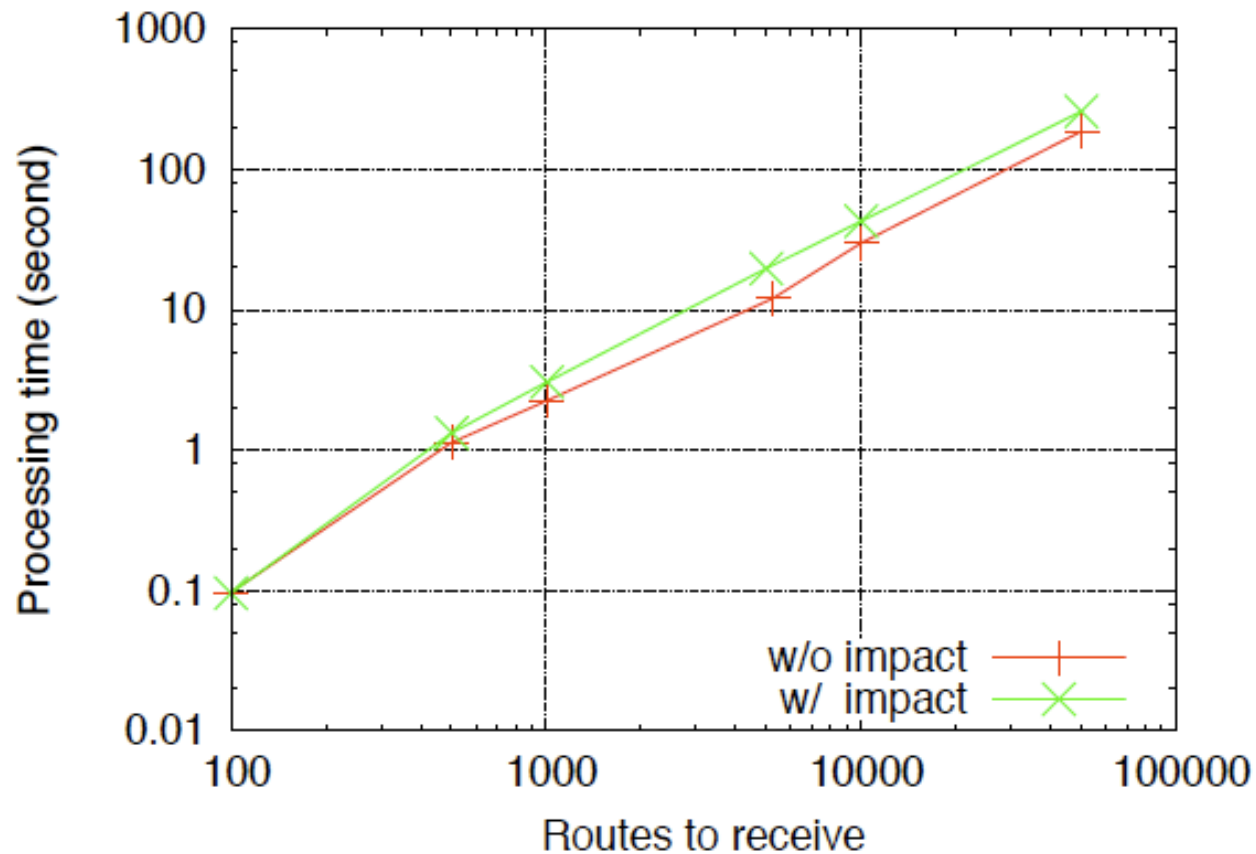
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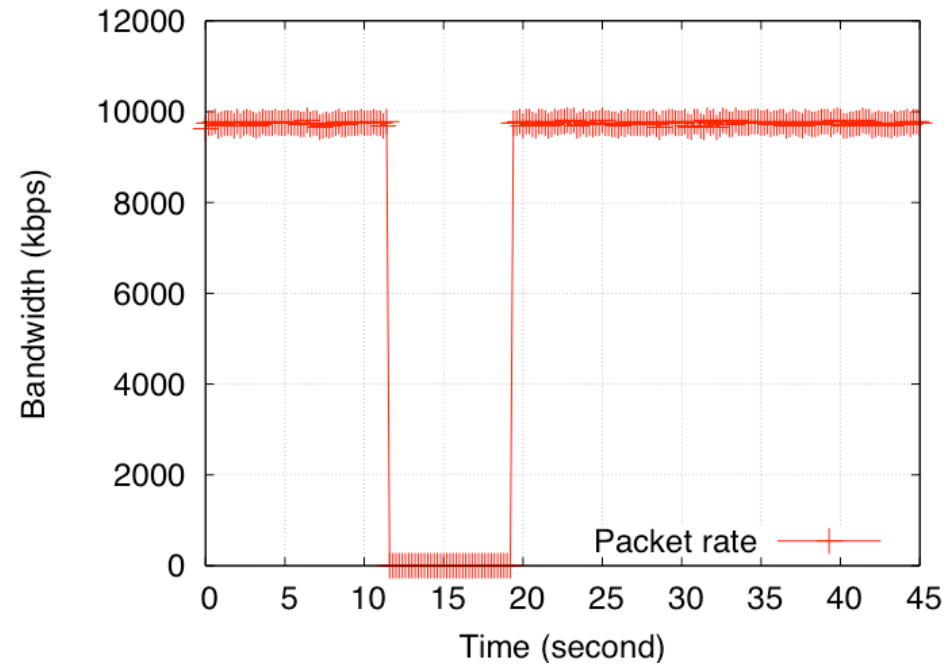
Data plane isolation

bandwidth (Kbps)	packet size	Observed bandwidth	Delta (%)
56	64	55.9	.18
	1500	55.8	.36
384	64	383.8	.05
	1500	386.0	.52
1544	64	1537.2	.44
	1500	1534.8	.60
5000	1500	4992.2	.16
NoLimit	1500	94791.2	NA

Imperfect control plane isolation



Dynamic failure mitigation



Controller monitors health of hardware

- Detect failure
- Dynamically “replace” physical instantiation

Conclusion

- ▶ ShadowNet
 - Production-grade service testing platform
 - In between existing testbeds and production environment
- ▶ Future work
 - Platform for evolving network control/management
 - Sneak into production network management

