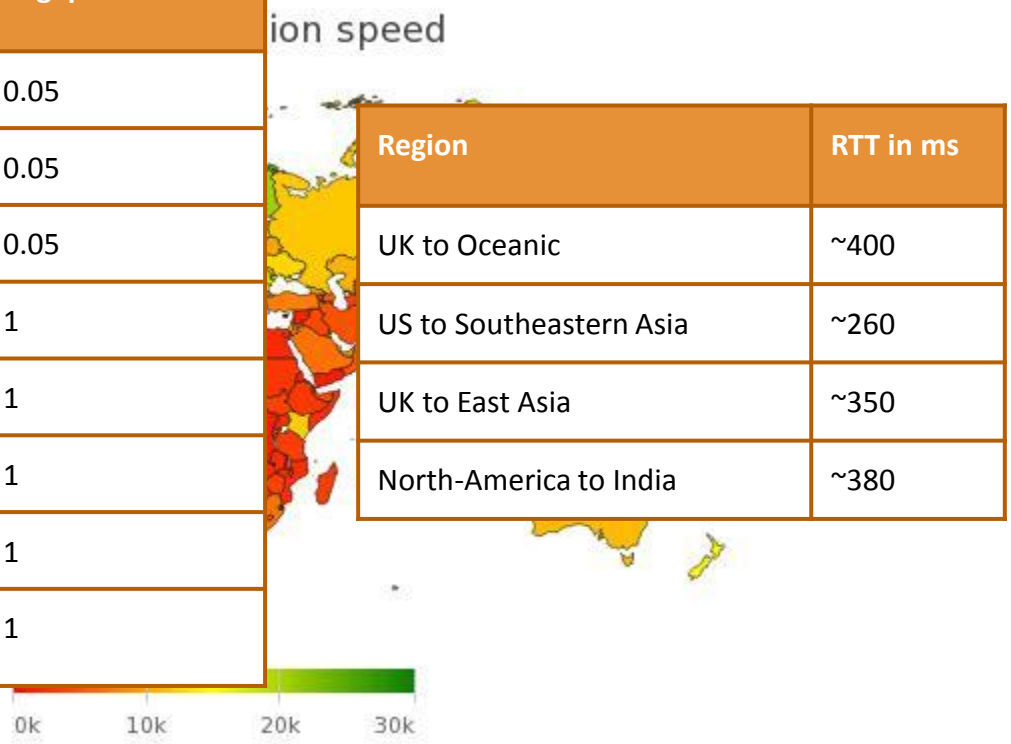
ConfigTron: Tackling network diversity with heterogeneous configurations

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Duke University



Diversity in network conditions

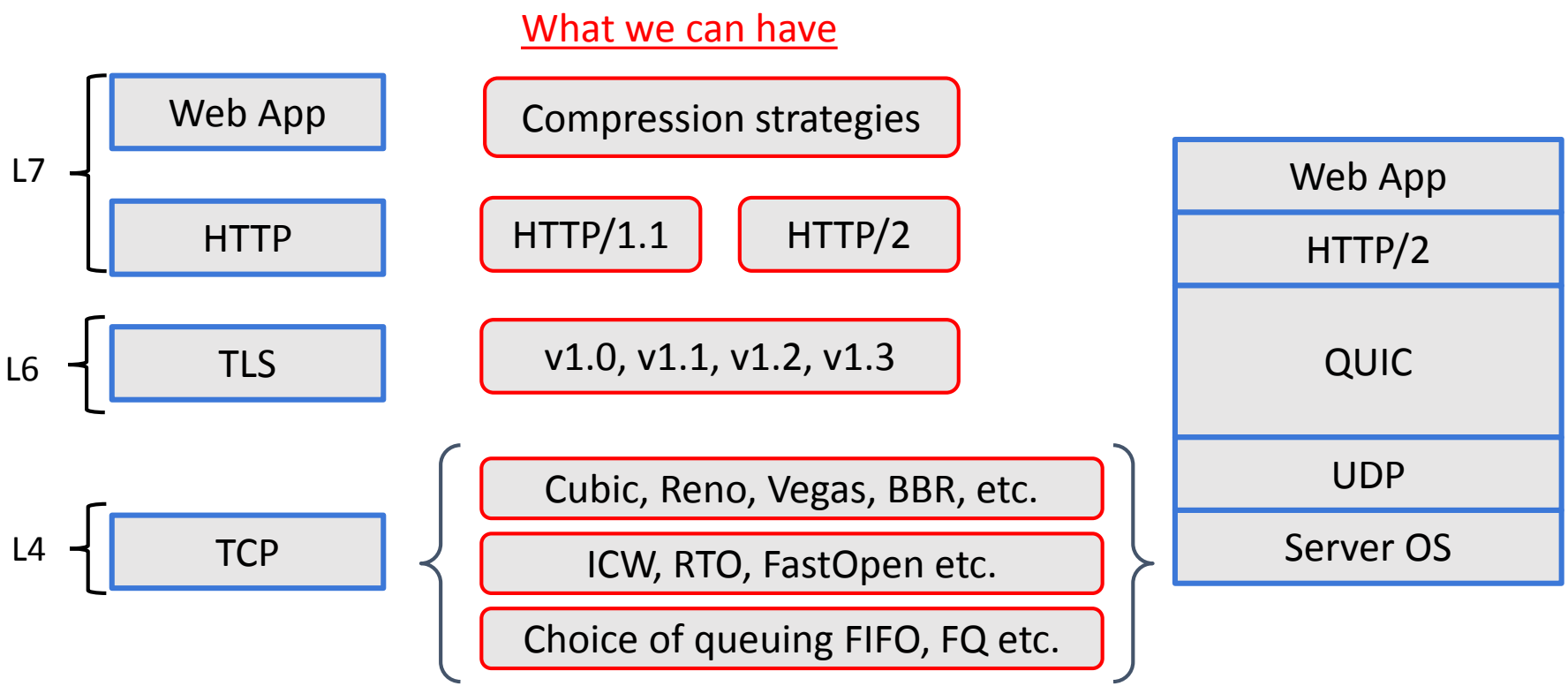
Region	Avg. RTT in ms	Avg. packet loss %
Trans-Atlantic	74	0.05
Europe	11.25	0.05
North America	35	0.05
Intra-Japan	9	1
Trans-Pacific	102.8	1
Asia Pacific	102.6	1
Latin America	135	1
EMEA to Asia Pacific	120.5	1



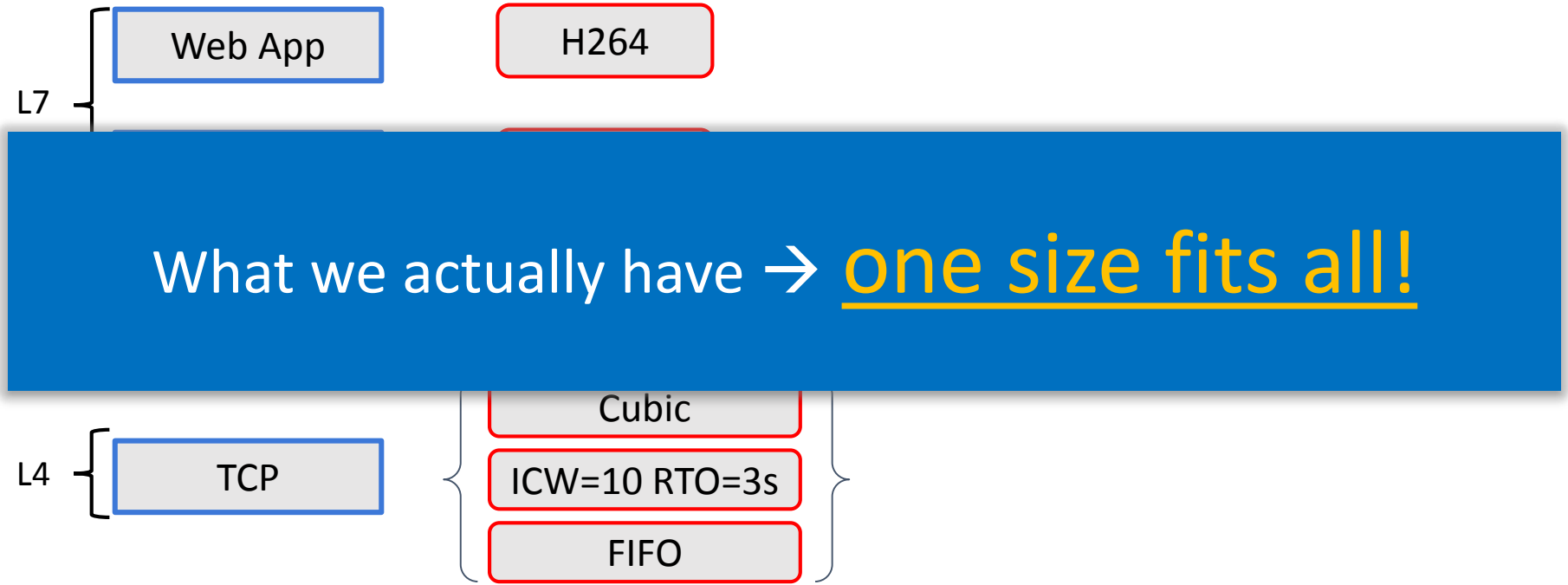
Region	RTT in ms
UK to Oceanic	~400
US to Southeastern Asia	~260
UK to East Asia	~350
North-America to India	~380

http://www.verizonenterprise.com/about/network/latency/#latency

Content serving stack

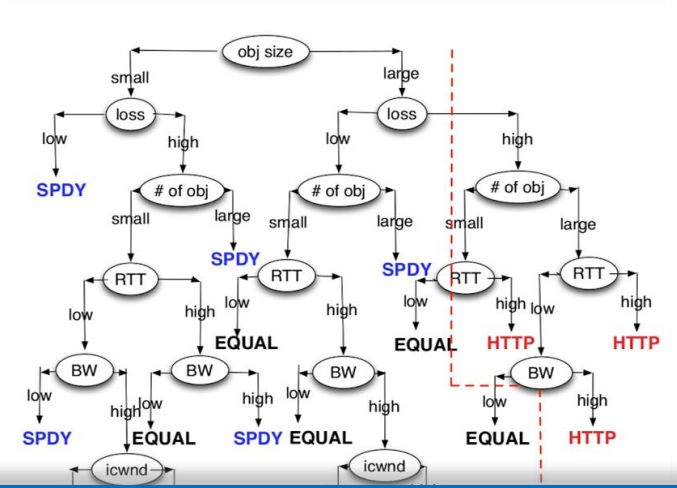


Content serving stack



In the light of divergent network characteristics, is the one-size-fits-all networking stack optimal?

Are the configurations being used optimal for everyone?



- Verus (NSDI ‘15)
  -TCP versions
- How quick is QUIC? (IEEE ICC ‘16)
  -QUIC vs HTTP2 vs HTTP1.1
- Overclocking the Yahoo!: CDN for faster web page loads. (ACM

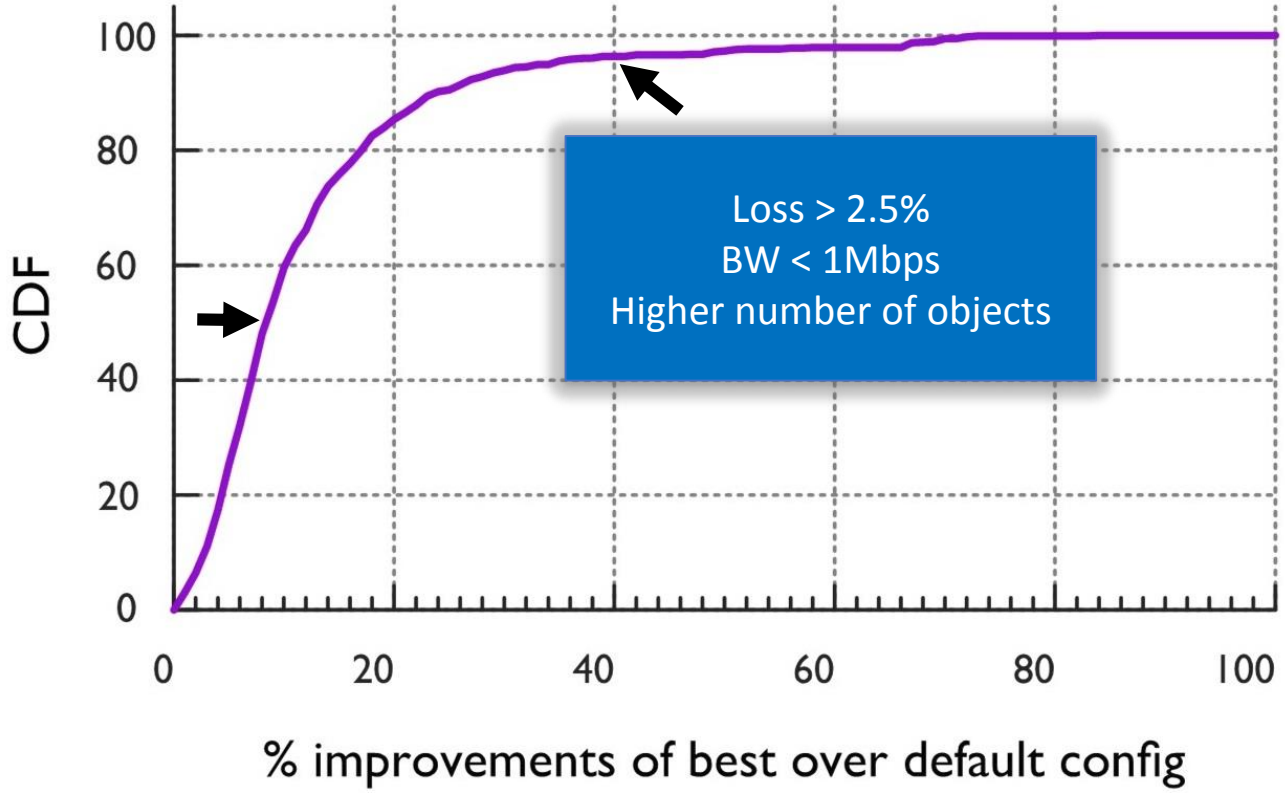
A broader study to understand the impact of reconfiguration across different layers.

Experimental setup

- Controlled website replay
  - MahiMahi
- Network emulation
  - NetEM + TC
- Realistic workloads
  - Alexa top 100

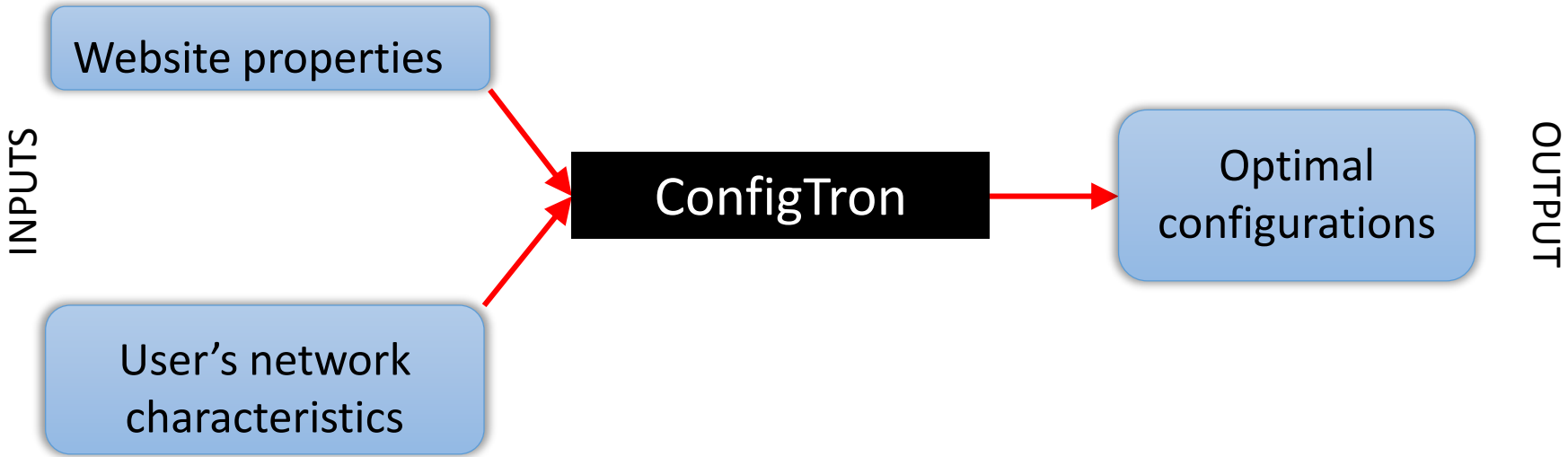
Dimensions	Values
Network	• RTT • Bandwidth • Loss rate
TCP/IP stack	• TCP ICW • Congestion control • Slow_start_after_idle • Low_latency • Auto_corking • Packet scheduling
Web App	• HTTP protocol
Website	• Web object size • # of objects

Reconfiguration improves performance!

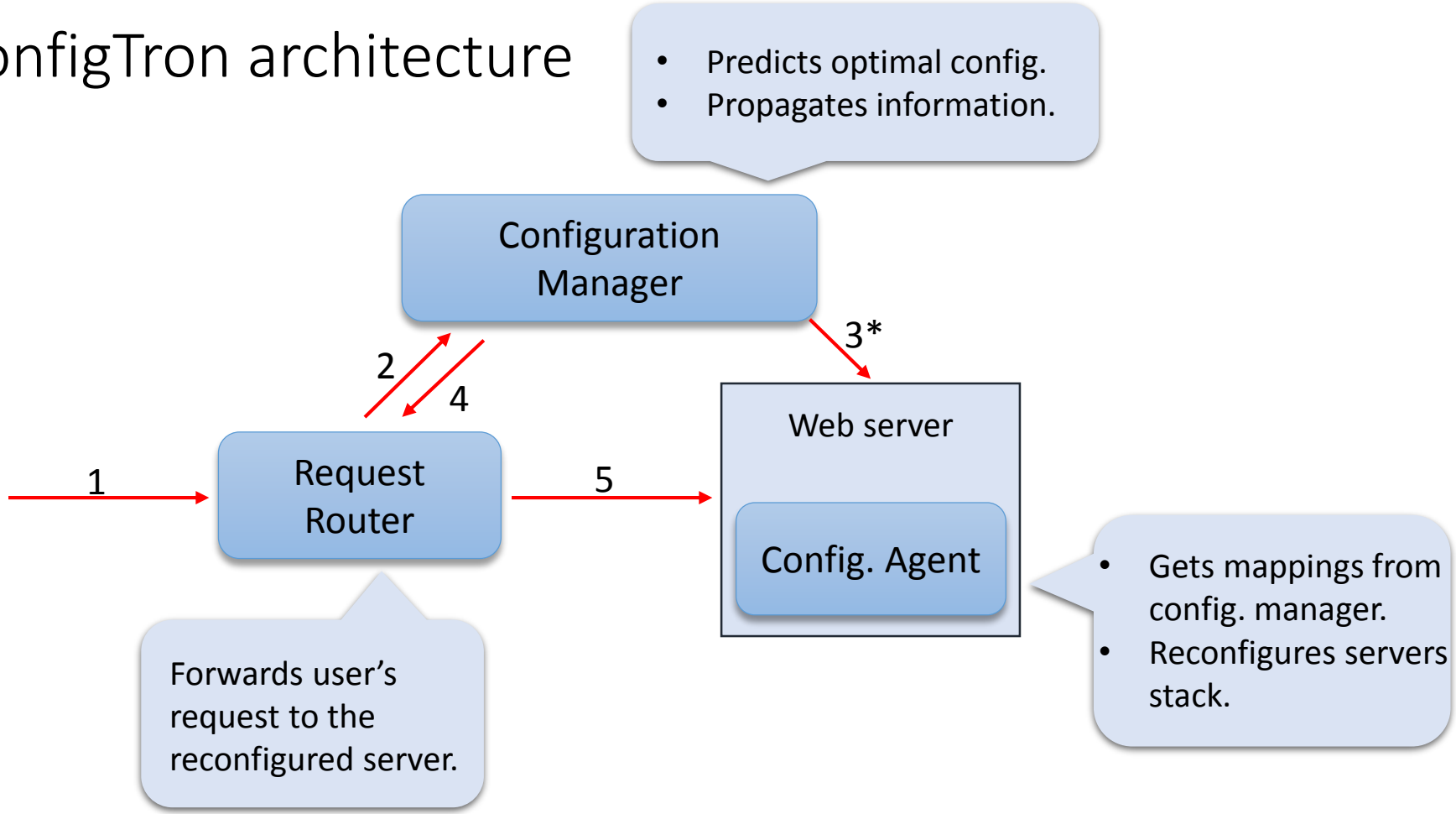


Given the benefits of reconfiguration, how can we use network conditions reconfigure on the go?

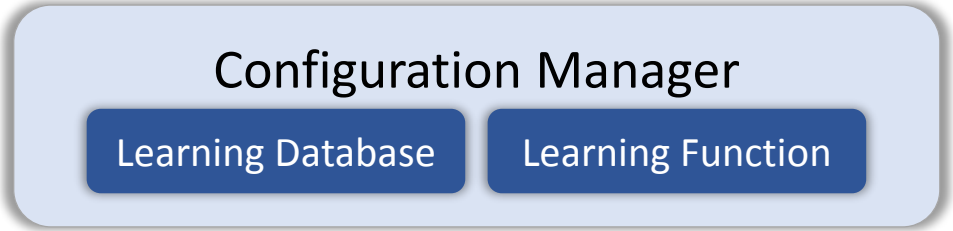
ConfigTron optimizes web performance by systematically reconfiguring web servers in a principled manner.

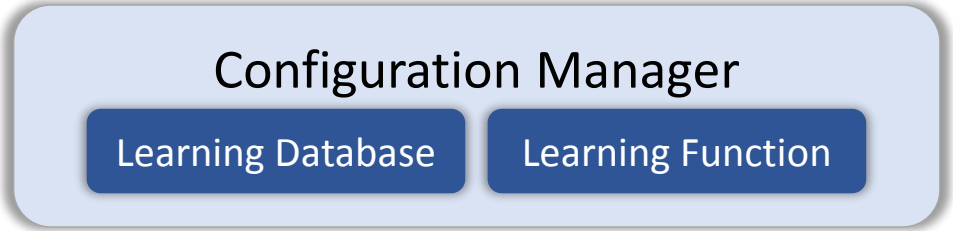


ConfigTron architecture



* Not required for every request.


Configuration Manager
Learning Database
Learning Function



Learning Database

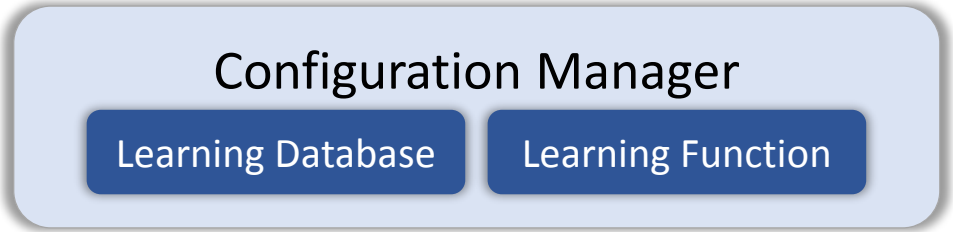
- Generates data related to performance of different configurations.

Synthetic data:

- Mahimahi based web emulation
- Pros
  - Can be generated offline.
- Cons
  - Requires lots of resources.
  - Requires lots of execution time.

Real world data:

- A/B tests
- Pros
  - Dynamic.
  - Adjusts with time.
- Cons
  - Impacts real users.
  - Needs mechanism for selection of real users. (Kraken OSDI ‘16)

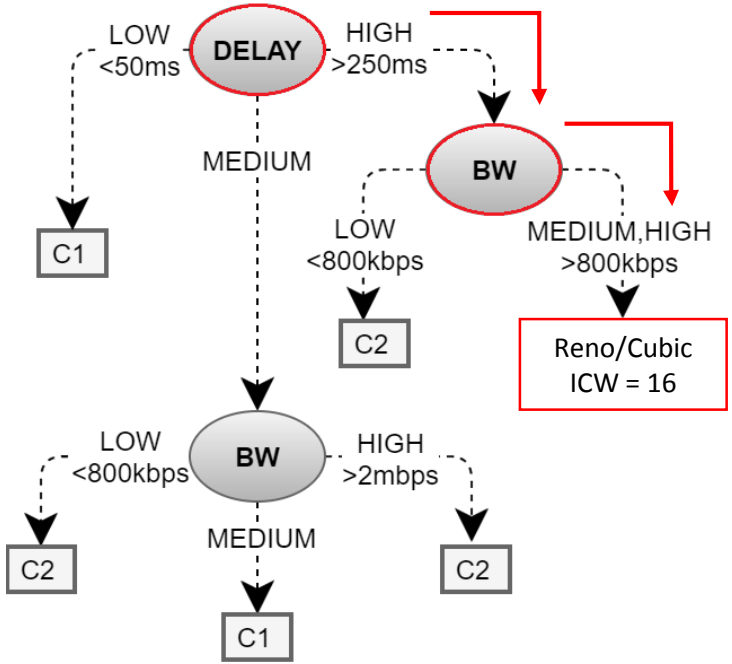


Learning Function

- Aggregates data from learning database to predict optimal configurations.
- Requires a learning algorithm to learn mappings from network conditions to configurations.
- Machine Learning (Decision trees, SVM), Deep Learning (Reinforcement learning), Statistical (Markov process)

Decision Trees

- One decision tree per website category.



Challenges in reconfiguring today's stack

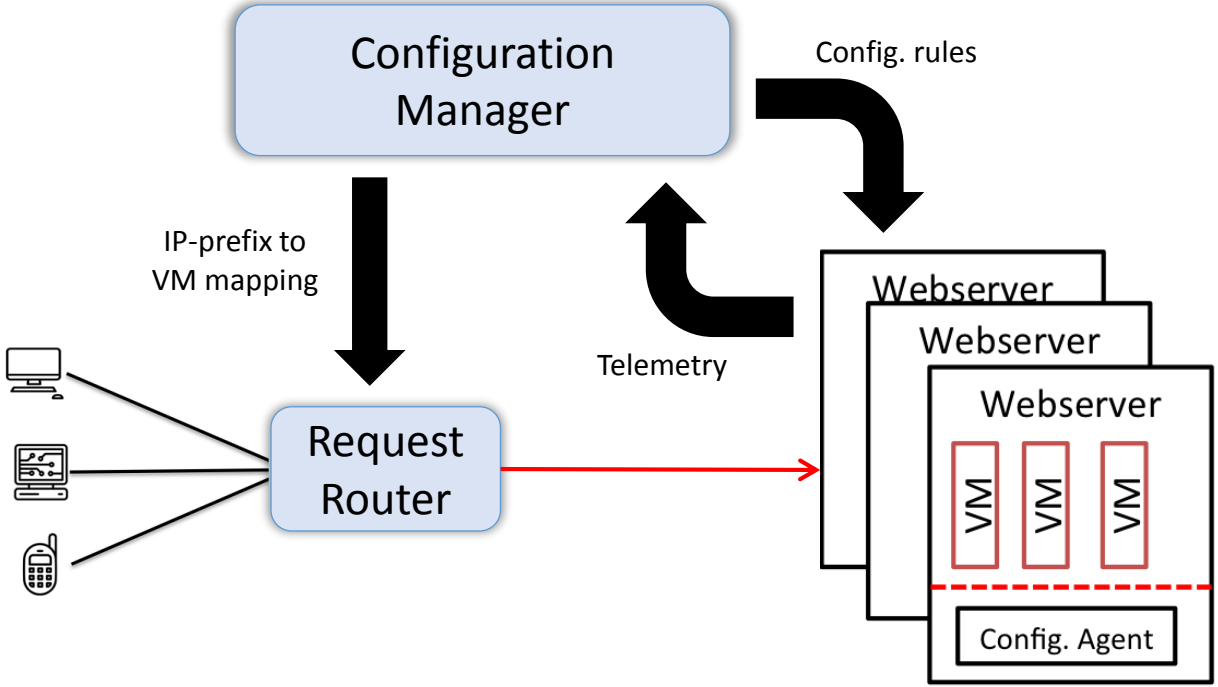
Dimensions	Values	Configuration Granularity
TCP/IP stack	TCP ICW	Per connection (IP tables)
	Congestion control	Per connection (setsockopt)
	Auto_corking	
	Low_latency	Kernel wide (proc interface)
	Slow_start_after_idle	

- TLS and HTTP layers are more flexible due to user space.
- Challenges:

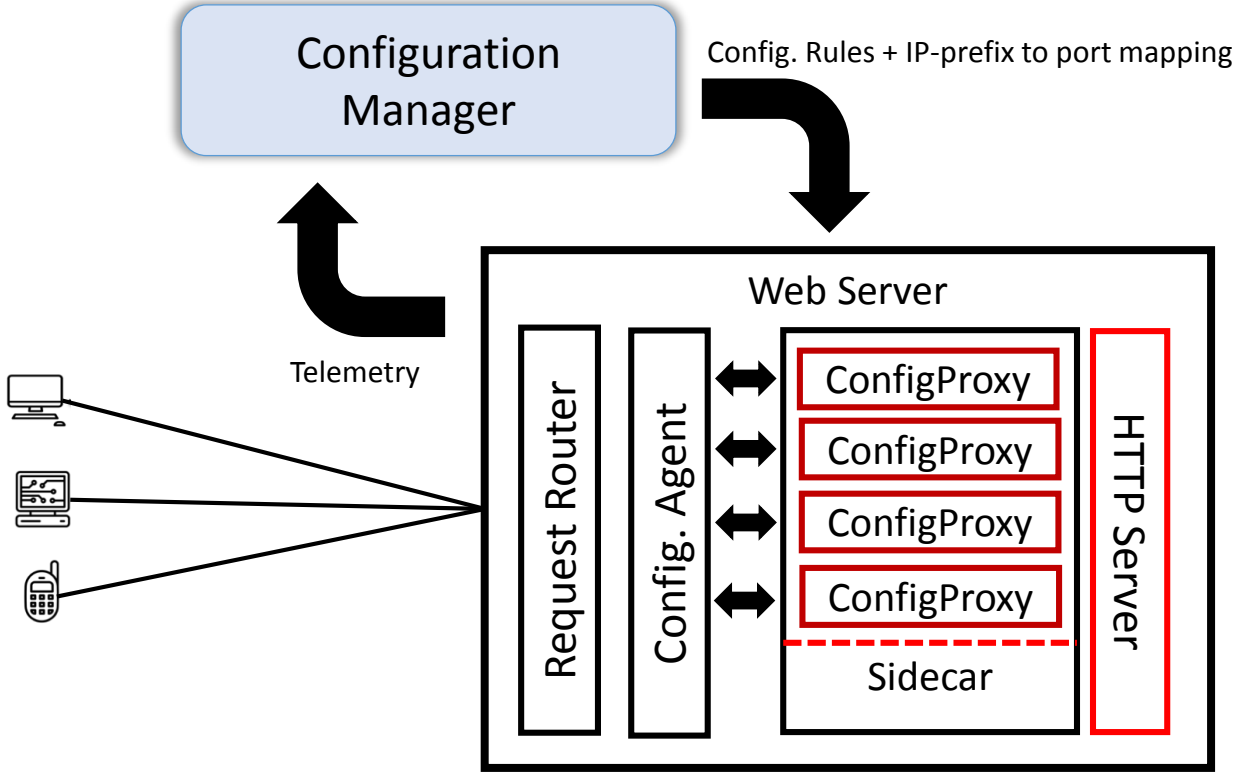
- Requires rewriting chunks of kernel.

- User space TCP stacks are limited in configuration diversity (eg, only cubic or reno).

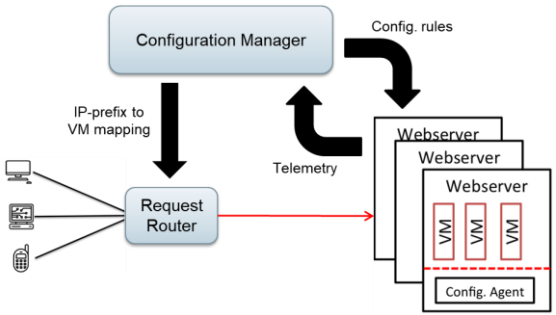
ConfigTron architecture (VM based)



ConfigTron architecture (Socket based)



VM based:



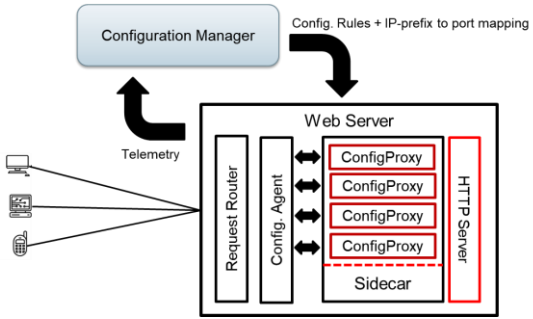
Pros:

- VMs can be reconfigured in isolation.
- Fine-grained control over resource usage.

Cons:

- Higher resource usage.
- Traps resources.
- High startup times. May need to have VMs on standby.

Socket based:



Pros:

- Less resource intensive.
- Can be created on-the-go.

Cons:

- Not all TCP parameters are reconfigurable by setsockopt.

Related work

- Overclocking Yahoo! CDN (ACM SIGCOMM ‘11) looks at configuring TCP at end hosts in a datacenter environment where controller has a view of entire network.

- We are broader in the sense that we are looking at more parameters across different layers.

- OpenTCP (Hot Topics in networks, ACM ‘12.) reconfigures TCP in data center environment whereas Software Defined Transport (ONS ’14) presents a programmable centralized platform to define transport mechanisms in data centers with a central controller. Similarly TROLL (IEEE NetSys ’17) uses central controller for protocol suggestions and makes decisions for network core and edge devices.

- ConfigTron is different since it reconfigures multiple layers in CDN server to optimize web performance, without the presence of a centralized controller.

- No control over end hosts (users) in case of web.

Conclusion

- One-size-fits-all configurations can be sub-optimal for a proportion of users.
- Network diversity can be tackled by heterogeneity in configurations.
- Reconfiguration can improve PLT by as much as 40%.

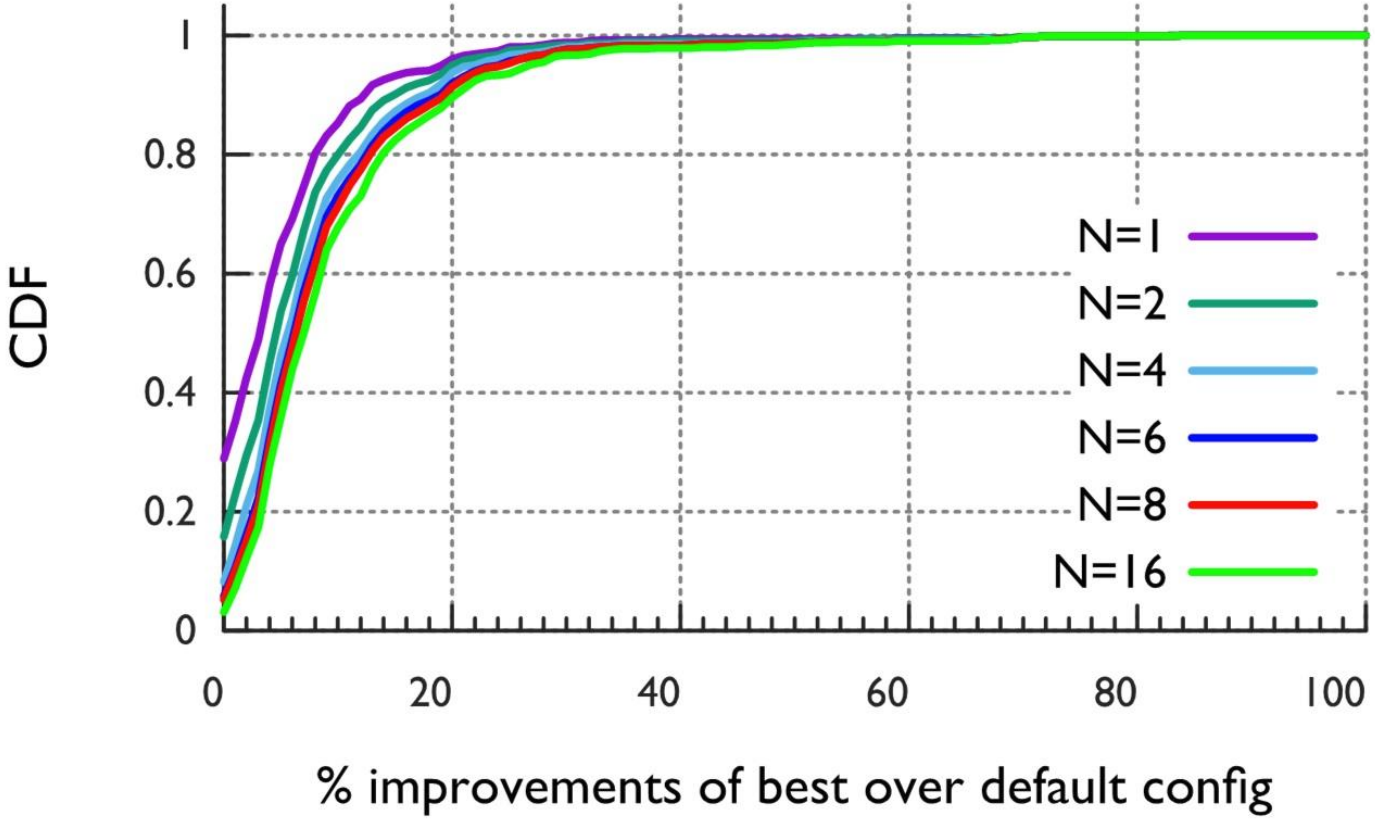
Future work + Discussion

- Inspector Gadget -- infers network stack configuration for web servers by active probing.
- AWS + PlanetLab deployment.
- Extending user-space TCP stacks.
- Network Estimation.

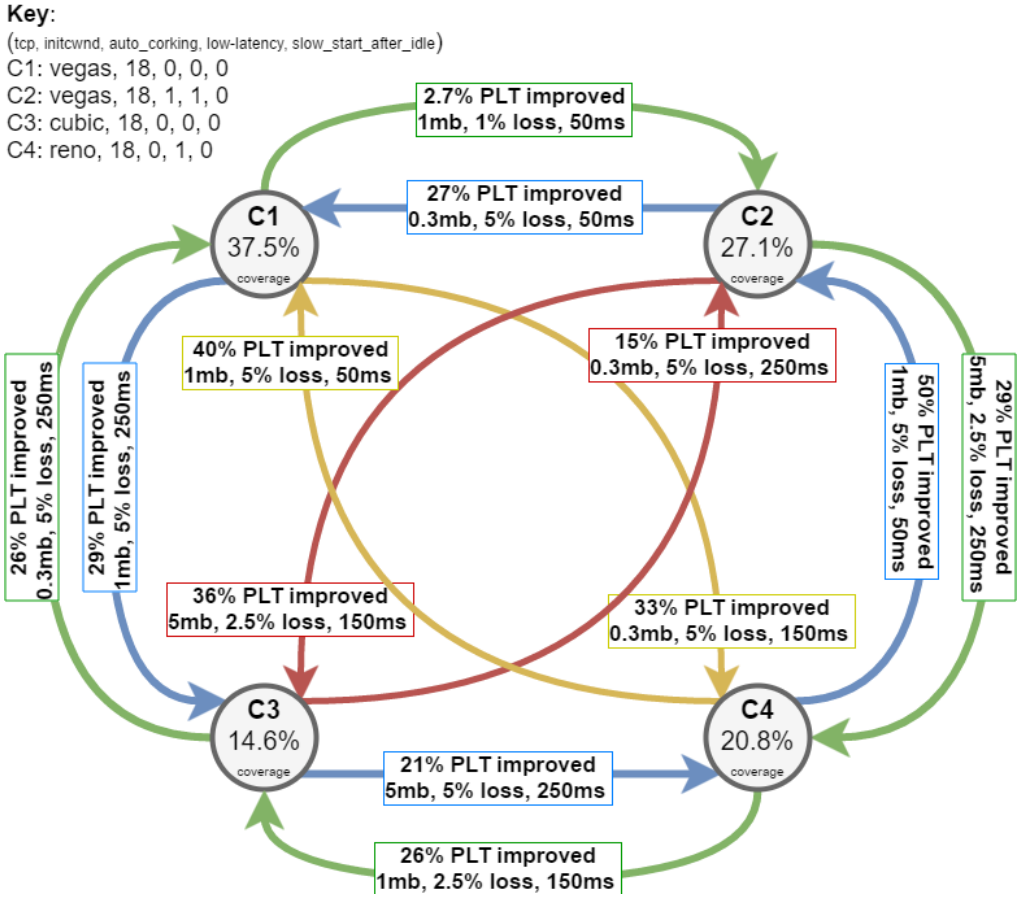
Questions?

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How many configurations are too many?



No configuration is better than others!



- Chen, Yingying, et al. "A provider-side view of web search response time." *ACM SIGCOMM Computer Communication Review* 43.4 (2013): 243-254.

Network coverage wrt number of configurations

