Bootstrapping the Internet of the Future

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Feb 2012

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Research Question(s)

- What are the necessary architectural components to boot a Virtual Internet?
- Can a Virtual Internet provide more efficient routes between nodes than the current Internet does?

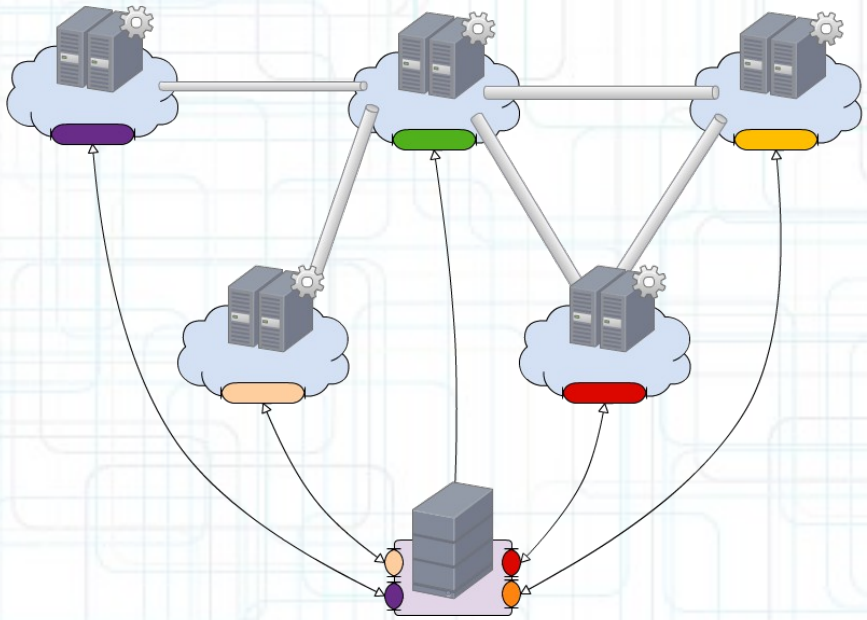
- Computing will be available everywhere any time
- With computing everywhere it is possible to create virtual networks with different optimization

Cloud Infrastructure

- Growing Number of Cloud Providers
  - Amazon
  - Brightbox
  - ...

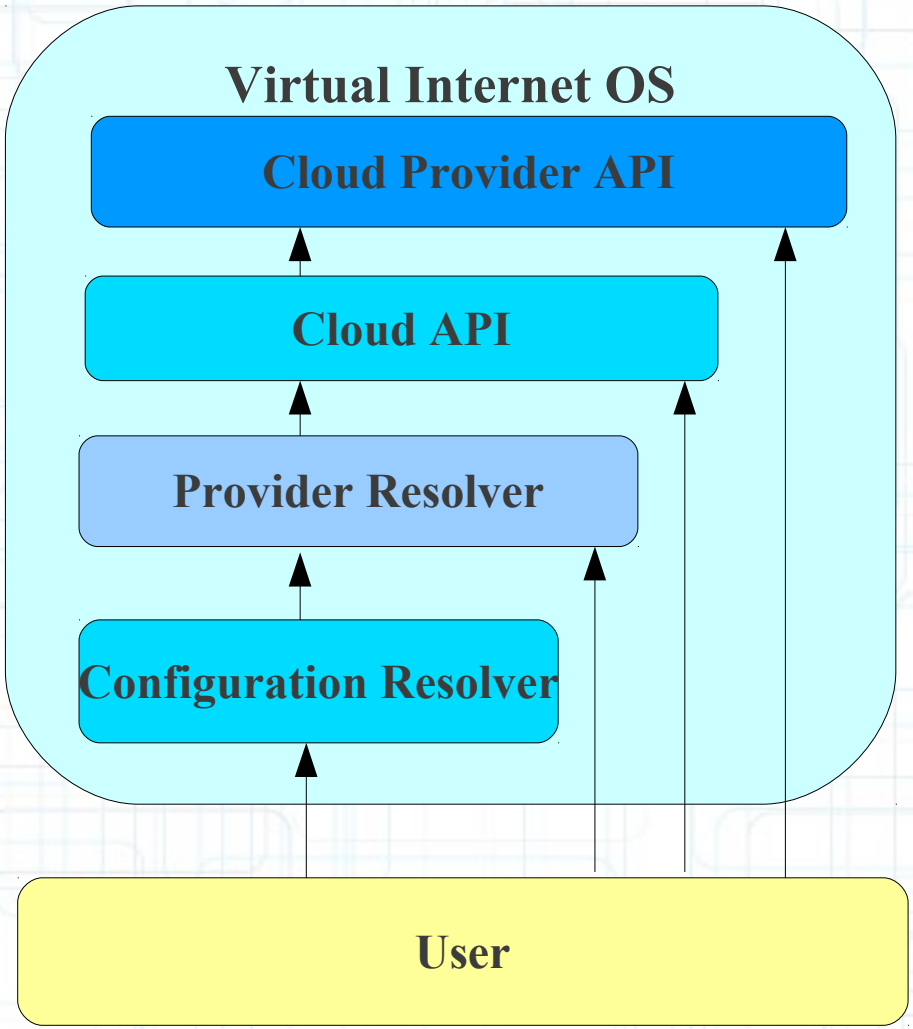
- Clouds Distributer Across the globe:
  - North America
  - Europe
  - Asia
  - ...

Virtual Internet Architecture



- Routers are Virtual Machine
- Connected through Tunnels
- A Controller Manages the Routers

Virtual Internet OS



- Creates an Abstraction for the User
- The user still has access to other layers

Configuration Resolver

- 5 Gb Ram , Japan
- 3 Gb Ram, France
- 8 Gb Ram,

- R1
- R2
- R3

- Resolves Configuration Requirements to Router Names
- If no Router exists with this configuration it creates one
- It can create a Router based on configuration request

Provider Resolver

- R1
- R2
- R3

- Amazon EC2 AP,V1
- Amazon EC2 WA,V2
- Amazon EC2 EA,V1

- Router Names to Virtual Machines
- If no Virtual Machine exists for the Router it creates one

Cloud (Provider) API

- Cloud API
  - Provides a single interface to all the clouds
  - Examples: Ruby cloud,Apache Libcloud, ...
- Cloud Provider API
  - Amazon API
  - ...

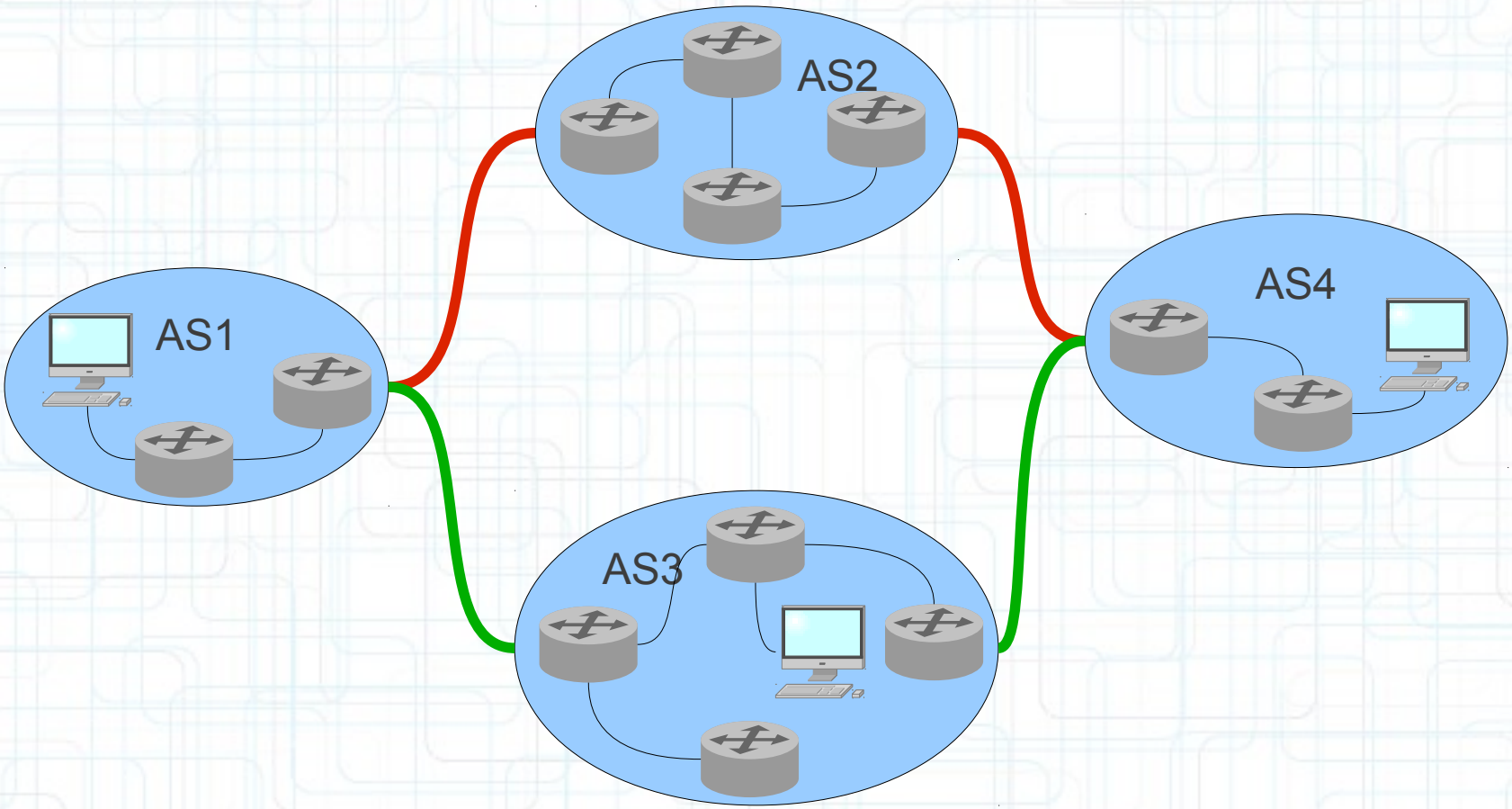
Applications

- Network Evolution
  - Change in the convergence Layer
  - Research cost (Test bed cost)
- Application Specific Optimization
  - Online Gaming
  - Online Surgery!!
  - Avoid faulty or misbehaving paths
- Online changes
  - Measure and change based on while running

What we can't do

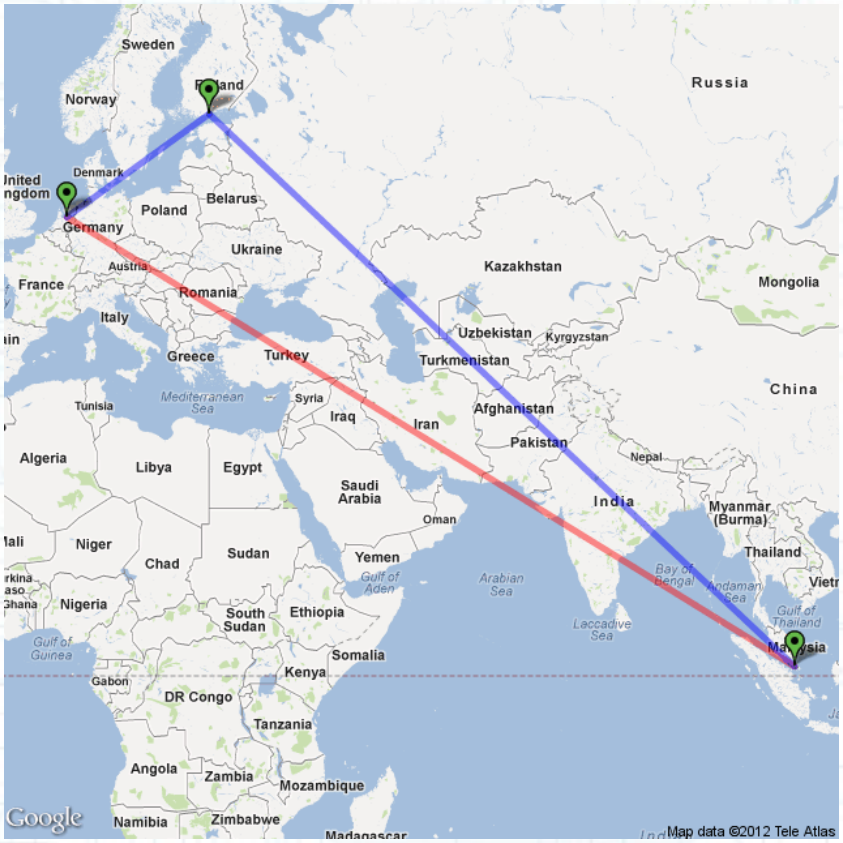
- We can't control the routing of the Internet
  - Paths are mainly economical efficient
  - QoS only sets priority but not path
- We can't relocate our Routers
  - Time consuming
  - Costs a lot

What we can do



- Control Endpoints
- Create Virtual Machines

Example



- Internet: 335.18 ms

  27.15 % Improved

- V-Internet:244.17

- Internet Path(14):

  [AS65534]

  [AS38895](2)

  [AS23730](2)

  [AS10026/AS1221]

  [AS10026](4)

  [AS4589]

  [AS12871](3)

- V-Internet Path(15):

  [AS65534]

  [AS38895](2)

  [AS23730](2)

  [AS2914](3)

  [AS3292]

  [AS2914]

  [AS3292]

  [AS1200]

  [AS12871](3)

Test Setup - NLNOGRING

- RING nodes: 75
- ASs: 72
- Countries: 21

Amazon EC2

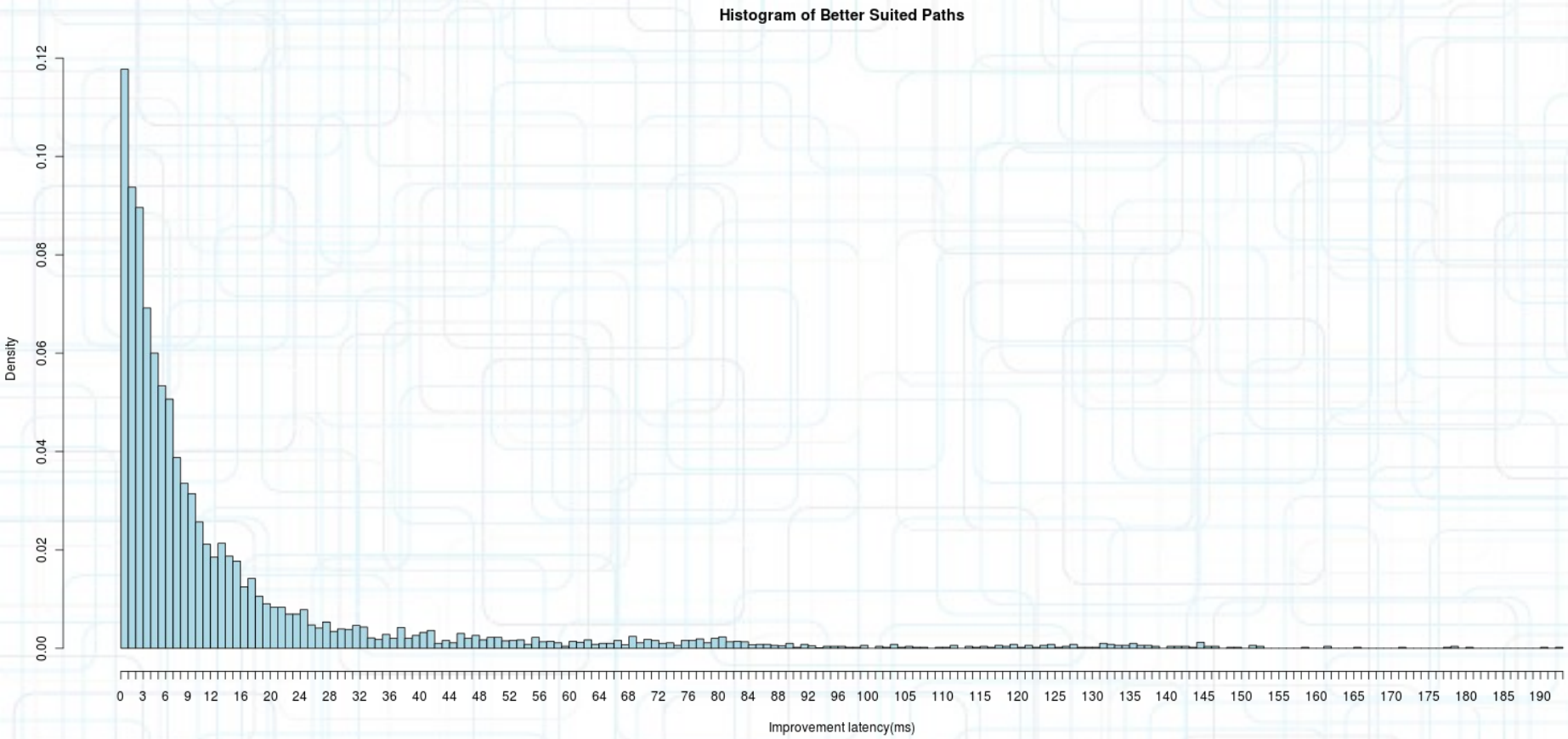
- Singapore
- Tokyo
- Europe(Ireland)
- North California
- Oregon
- Virginia
- Sao Paulo

- Nodes: 17
- Countries: 5

Test Setup Controller Commands

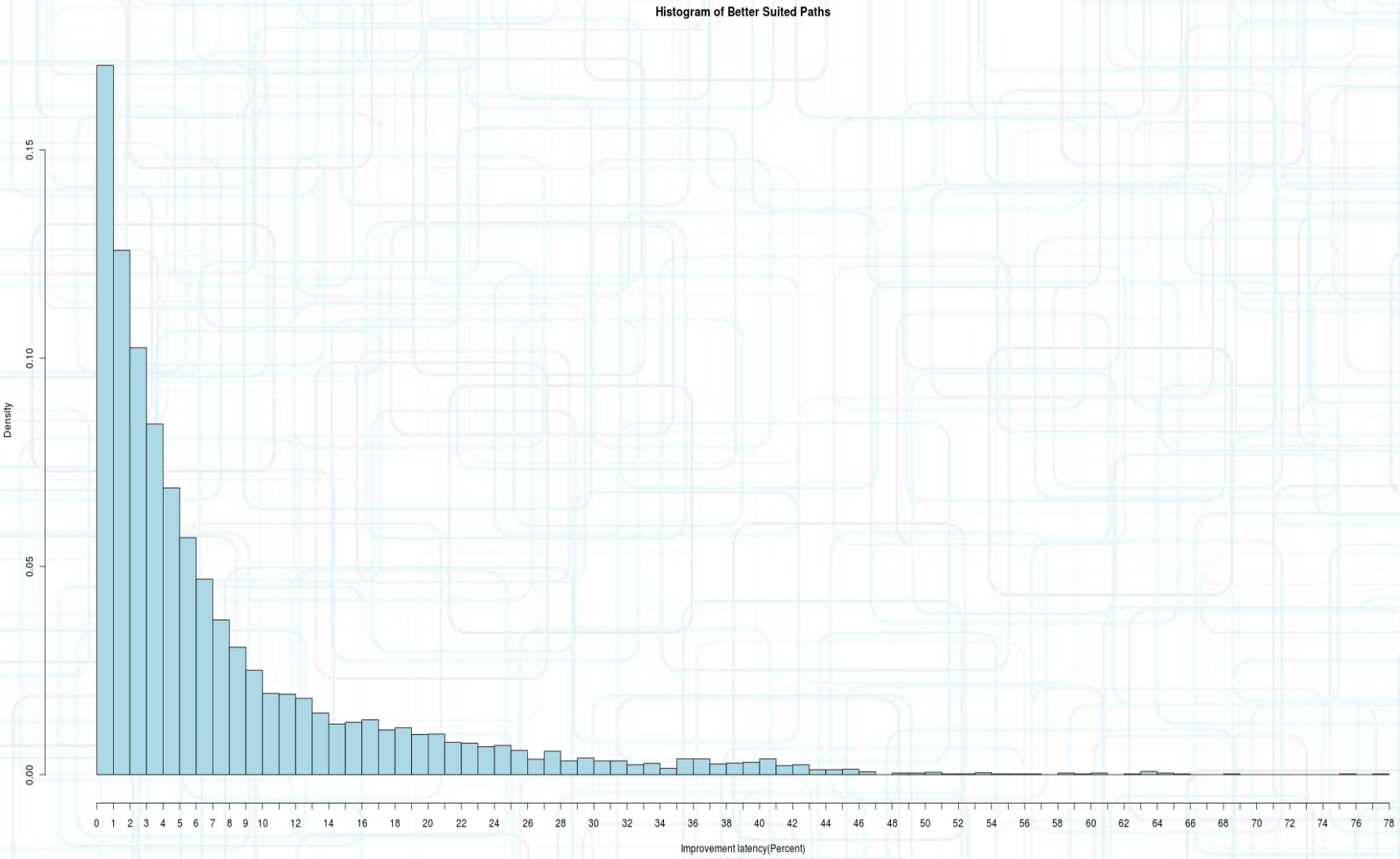
- Deploy
  - Send Setups to VMs
- Install
  - Run Install script on VMs
- Run
  - Run Tests on VMs
- Retrieve
  - Retrieve the results from Vms
- Reset
  - Reset VMs to original state
- Status
  - Show status of Vms (Based on Logs Collected)

Improvement in Latency(1)



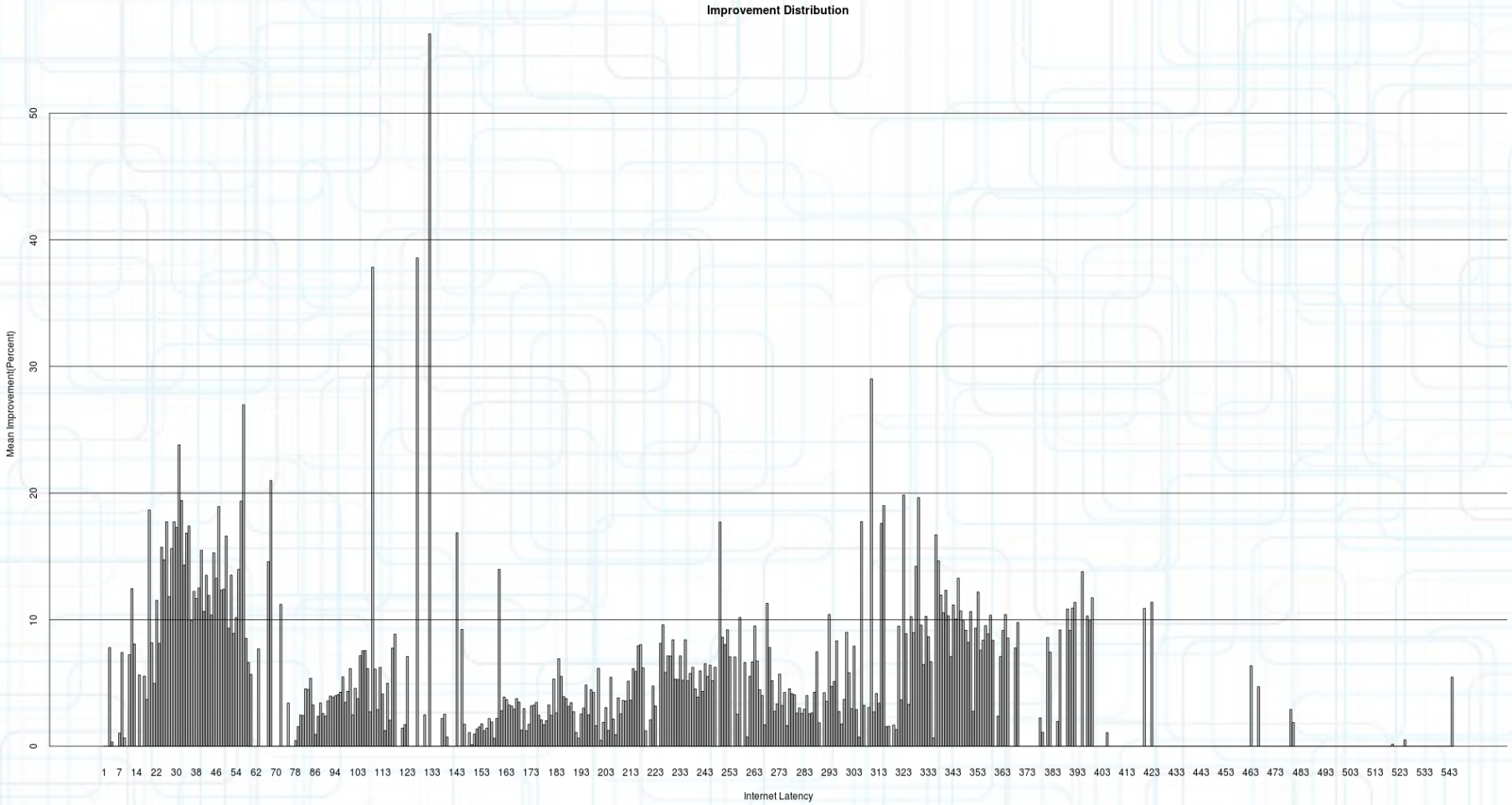
Note:This is only a snapshot in time

Improvement in Latency(2)



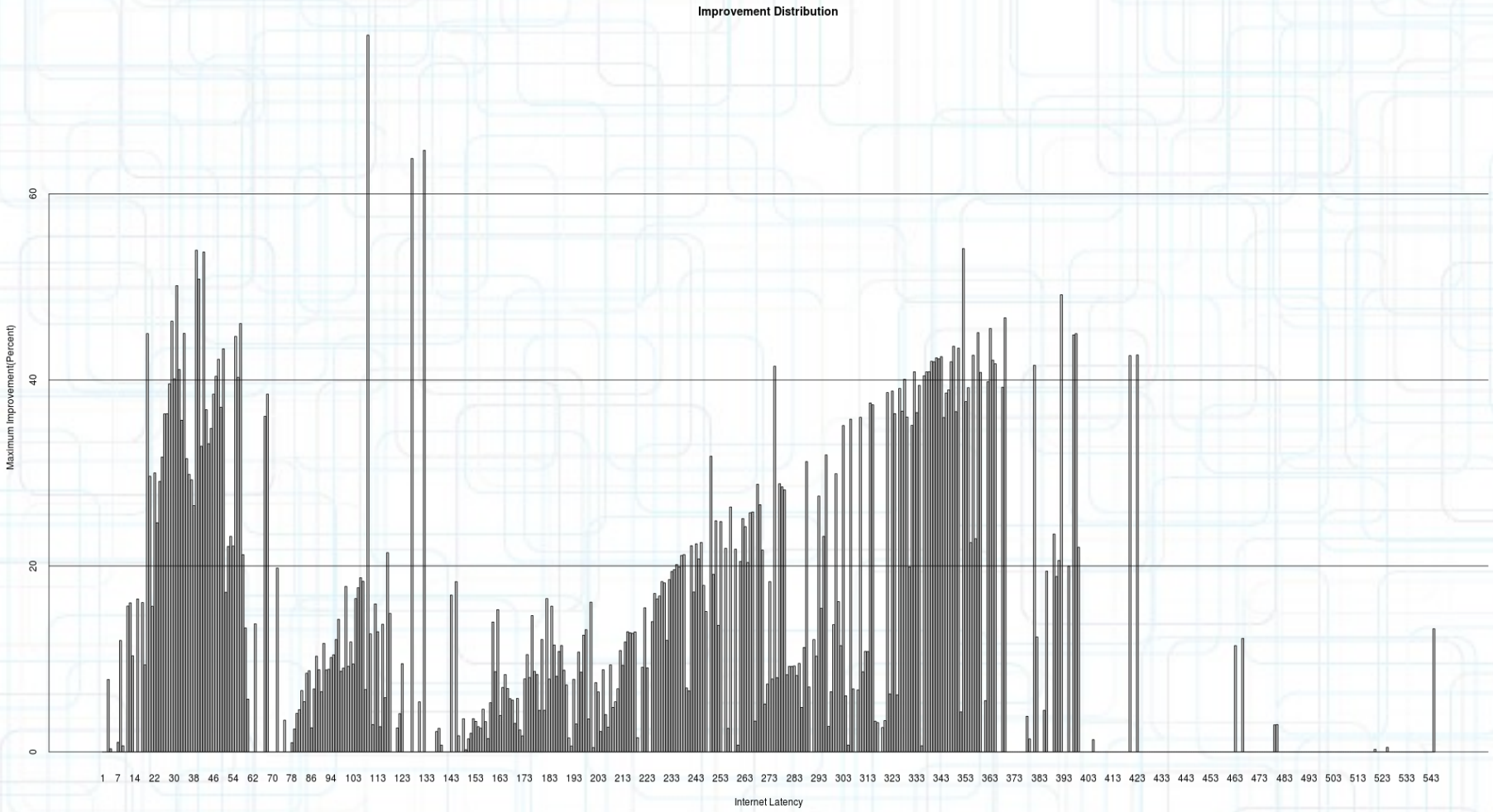
Note:This is only a snapshot in time

Improvement Distribution(1)



Note:This is only a snapshot in time

Improvement Distribution(2)



Note:This is only a snapshot in time

Conclusions

- In 78 % of the cases the Virtual Internet can Provide a more optimal path based on latency than the current Internet paths
- There are cases with more than 50% improvement
- In almost 12% of the cases you only get 1ms improvement but that could be a life saver (Online Surgery)

Future work

- Account stability of the Virtual Internet
- Study on the Internet governance issues of the Virtual Internet
- A paper will be published based on the results of this research

Special Thanks

- Job Snijders that provided access to the NLNOGRING

Questions

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