



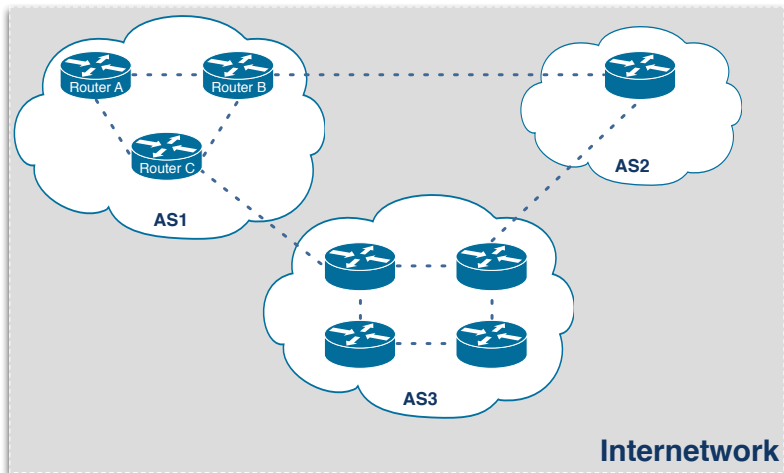
How to Build Complex, Large-Scale Emulated Networks

TridentCom 2010

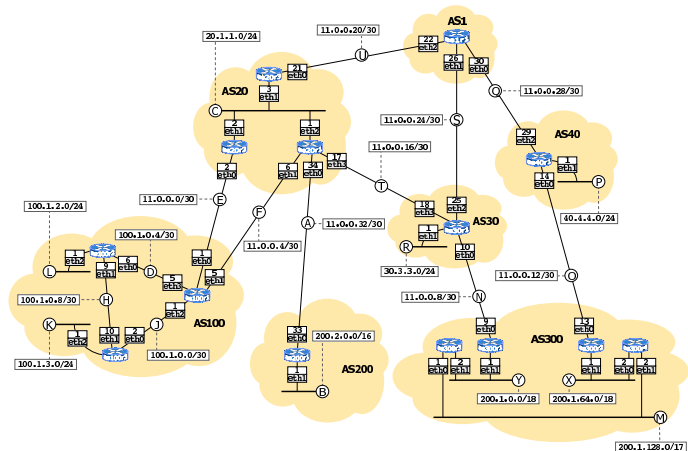
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Data Networks

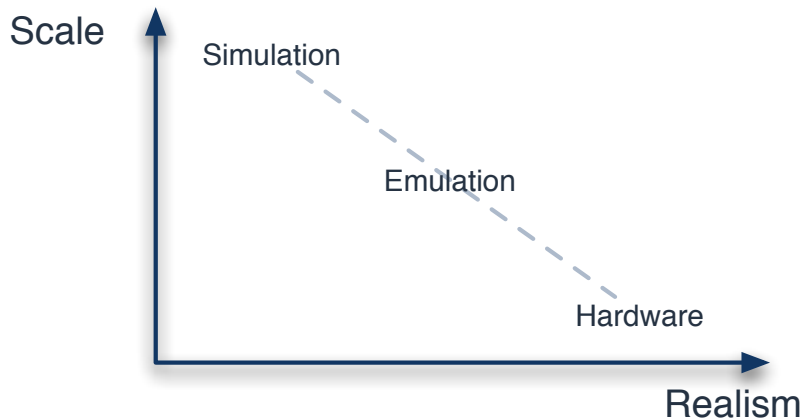
- Routers, Links, Autonomous Systems



Small Internet

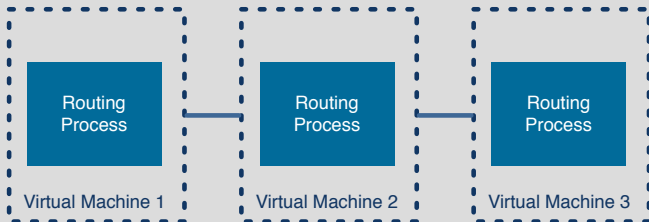


Research Platforms



Emulation

- Virtual routers in software emulate hardware routers
 - Realism, but need configuration

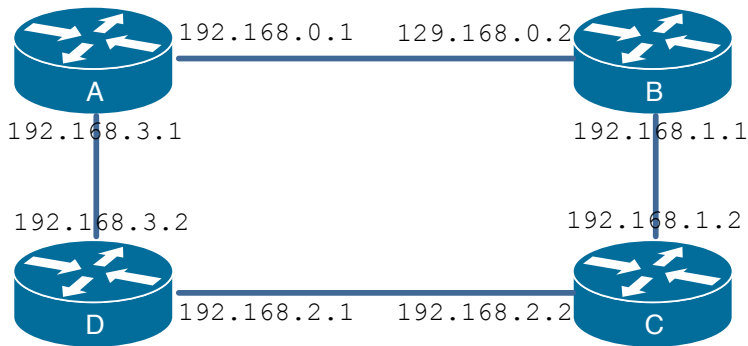


Configuration Problem

- Need to configure large number of devices
 - Many lines of code
 - Low-level configuration language
 - and allocate resources (IPs, AS numbers)
- Repeated trials difficult
 - Limits results
- Time consuming, tedious, doesn't scale to large networks
- Error-prone

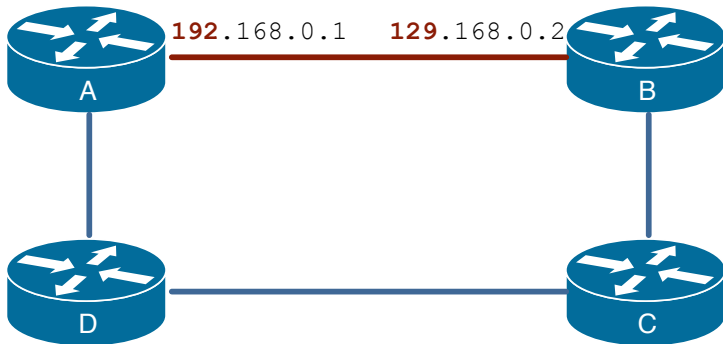
Configuration Errors

- Valid syntax, wrong semantics
 - E.g. link IP addresses



Configuration Errors

- Link from A to B has address wrong
 - Link will not carry traffic



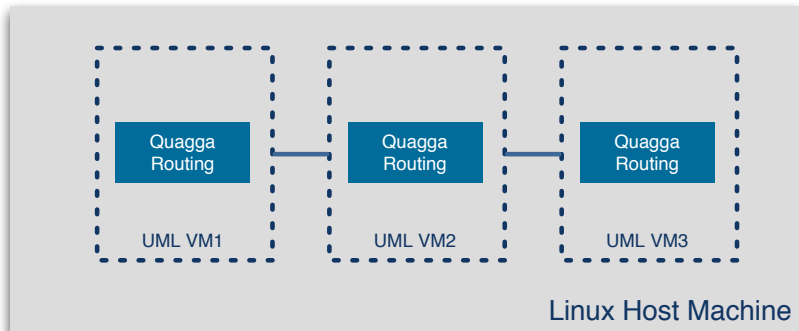
Configuration Errors

- Network automatically routes around problem
 - User may not realise, but results impacted

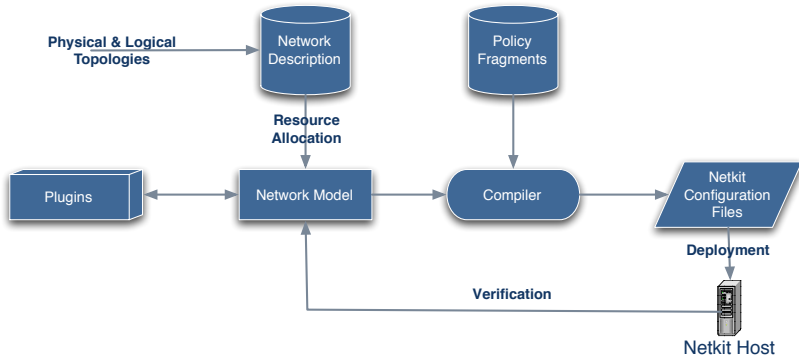


Netkit

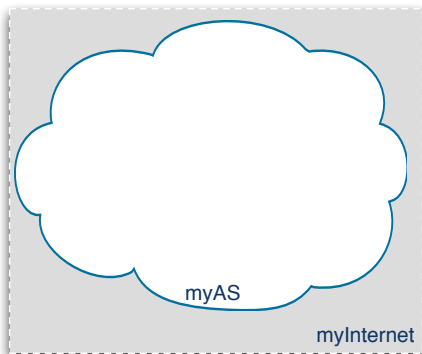
- Quagga real software router
- VM: Virtual machine
- UML: User-mode Linux
- Requires configurations



Generates Netkit configurations

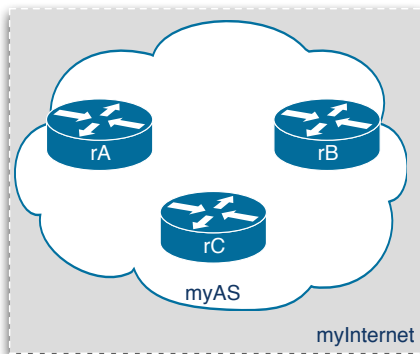


AutoNetkit: Creating Networks



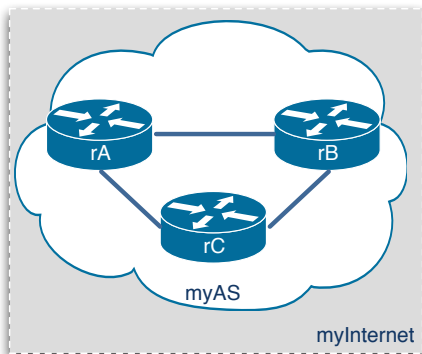
```
myInternet = Internetnetwork()  
myAS = myInternet.addAS(1234)
```

AutoNetkit: Adding Routers



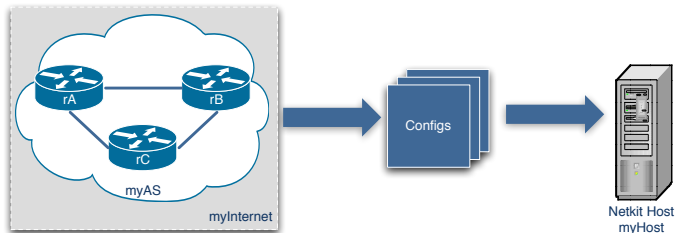
```
rA = myAS.addRouter("Router_A")  
rB = myAS.addRouter("Router_B")  
rC = myAS.addRouter("Router_C")
```

AutoNetkit: Adding Links



```
myAS.addLink(rA, rB)  
myAS.addLink(rA, rC)  
myAS.addLink(rB, rC)
```

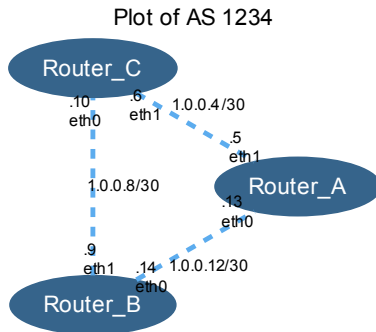
AutoNetkit: Configuring and Deploying



```
myInternet.compile()  
myInternet.addRouting()  
myNk = Netkit("myHost", "sknight")  
myNk.deploy(myInternet)
```

Verification

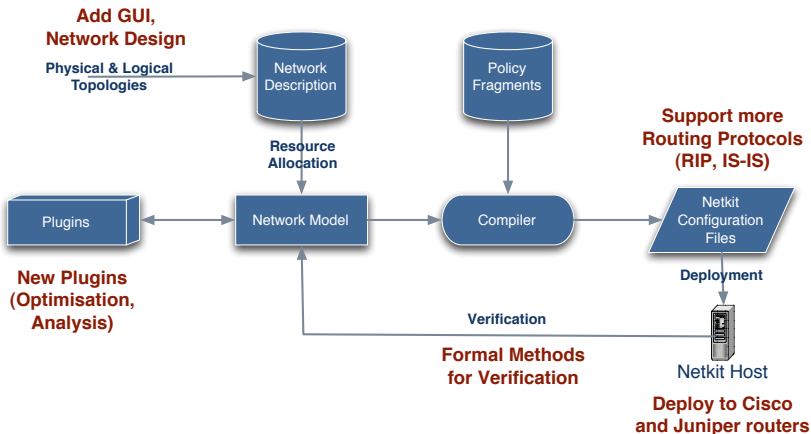
- Measurement: automated traceroute tests
 - Tests both paths and end-to-end connectivity
- Topology plots



Performance

- Comparison: Created a 200 node test network
 - Using BGP, OSPF, DNS
- Manual Configuration
 - 2 days to write configurations
 - thousands of lines of low-level router configuration code
 - another day to test by running traceroutes
- AutoNetkit
 - 1 hour to write high-level AutoNetkit code
 - hundreds of lines of descriptive code
 - automatic testing: `myInternet.runTraceroutes()`

Future Work



Conclusion

- AutoNetkit
 - Tool to simplify configure of complex, large-scale emulated networks
 - Enables low-cost research of ISP size networks
- Questions?