

# FINAL EXAM

TUE 5/16 MRST 132

10:30 - 12.30

- open book/open notes
- 25% of final grade
- off campus students will receive exam by  
postal mail

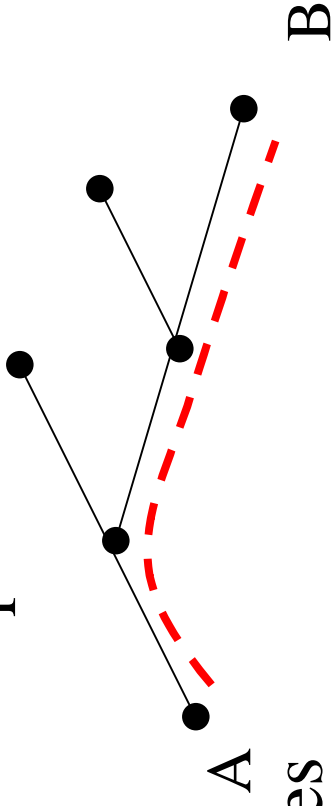
A FLEXIBLE MODEL FOR  
RESOURCE MANAGEMENT  
IN  
VIRTUAL PRIVATE NETWORKS

N.Duffield, P.Goyal ....

Proc. of ACM SIGCOMM'99

## What are Virtual Private Networks?

- Virtual network that allows secure association between end points



- Features
    - security
    - performance isolation
    - guaranteed bandwidth, loss, delay
- =>logically similar to a private leased line.

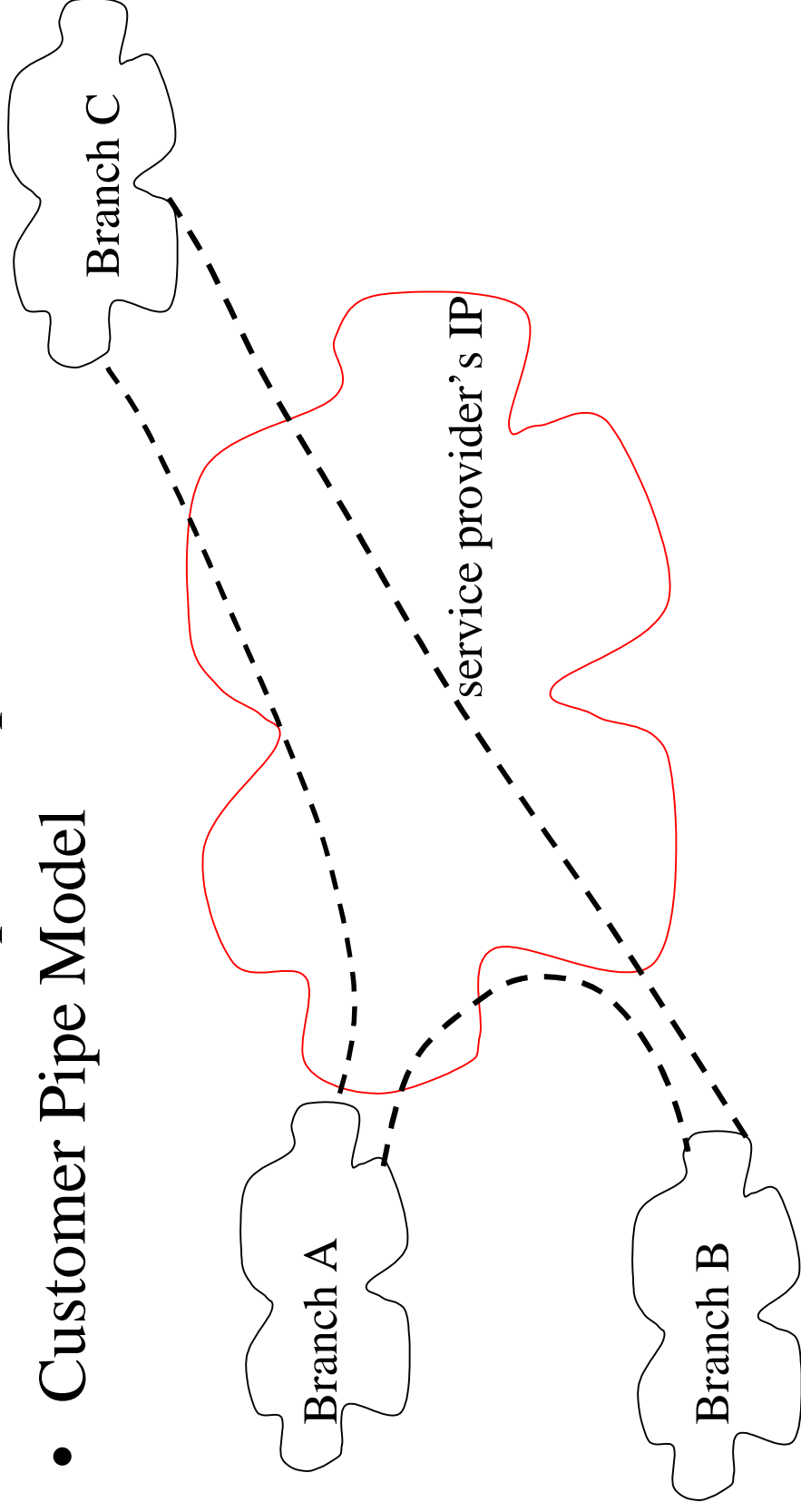
## VPNs for Multiple Endpoints

- Large customers  $\Rightarrow$  multiple end points
- Users are unwilling to specify point-to-point bandwidth matrix.
- No multiplexing gains.

## VPNs with Multiple Endpoints

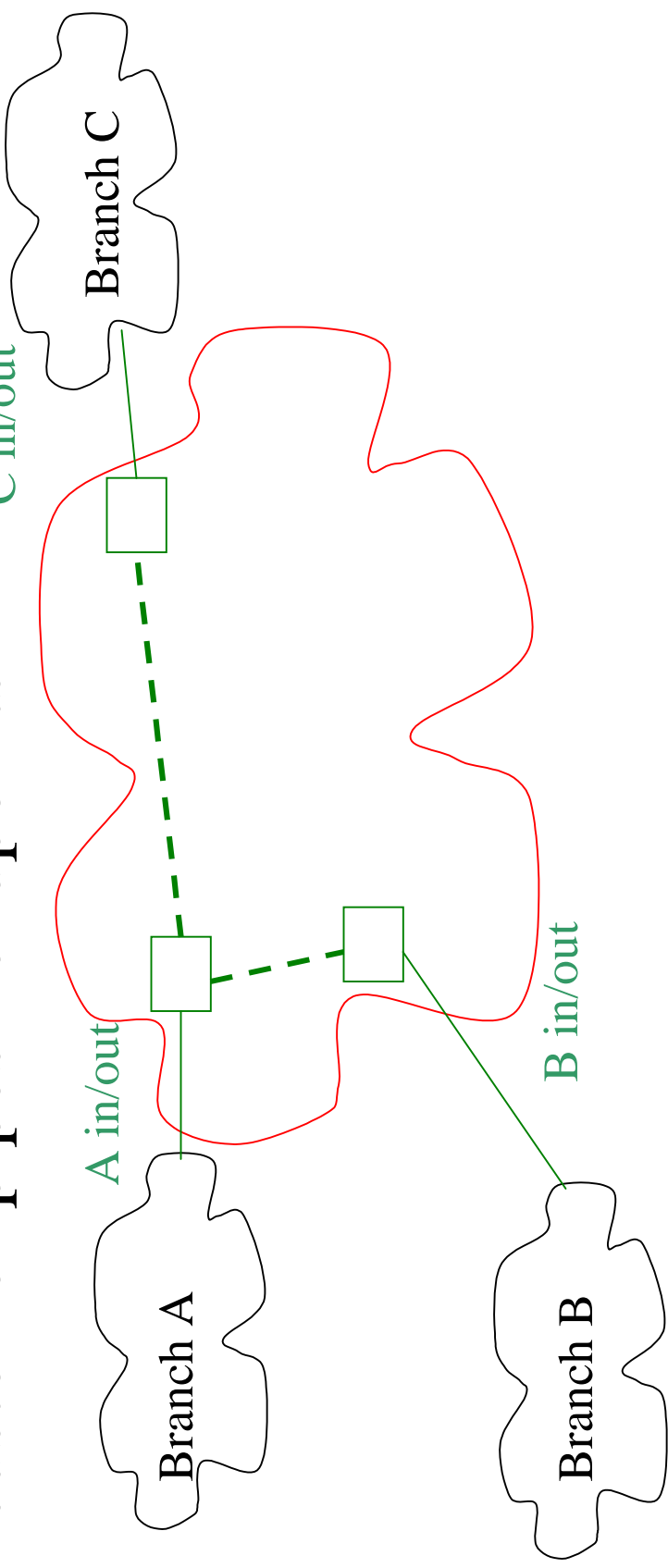
- Organizations with multiple branch offices need VPNs with multiple end points

- Customer Pipe Model



# VPNs with the Hose Model

- customer-pipes - endpoints

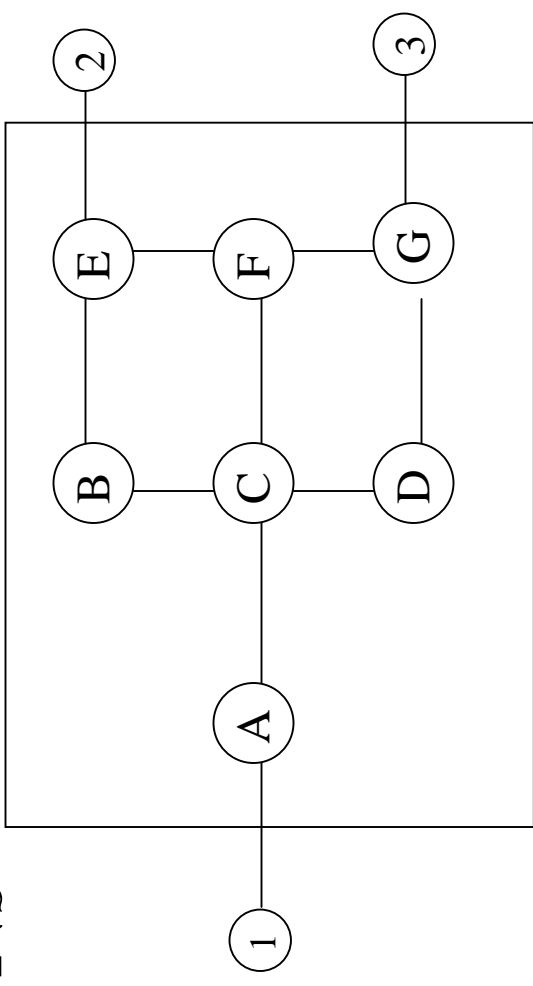


## Hose Model Advantages

- Ease of specification
- Flexibility
- Multiplexing gain
- Characterization
- Statistical Multiplexing gains
- Resizing

# Implementation scenarios

-Provisioned VPNs



-Dynamically Resized VPNs

-study workload

-resize



AN EXPERIMENTAL STUDY OF  
INTERNET ROUTING CONVERGENCE

C.Labovitz, A Ahuja, A.Bose, F.Jahanian

Proc. Of SIGCOM 2000, Stockholm, Sweden

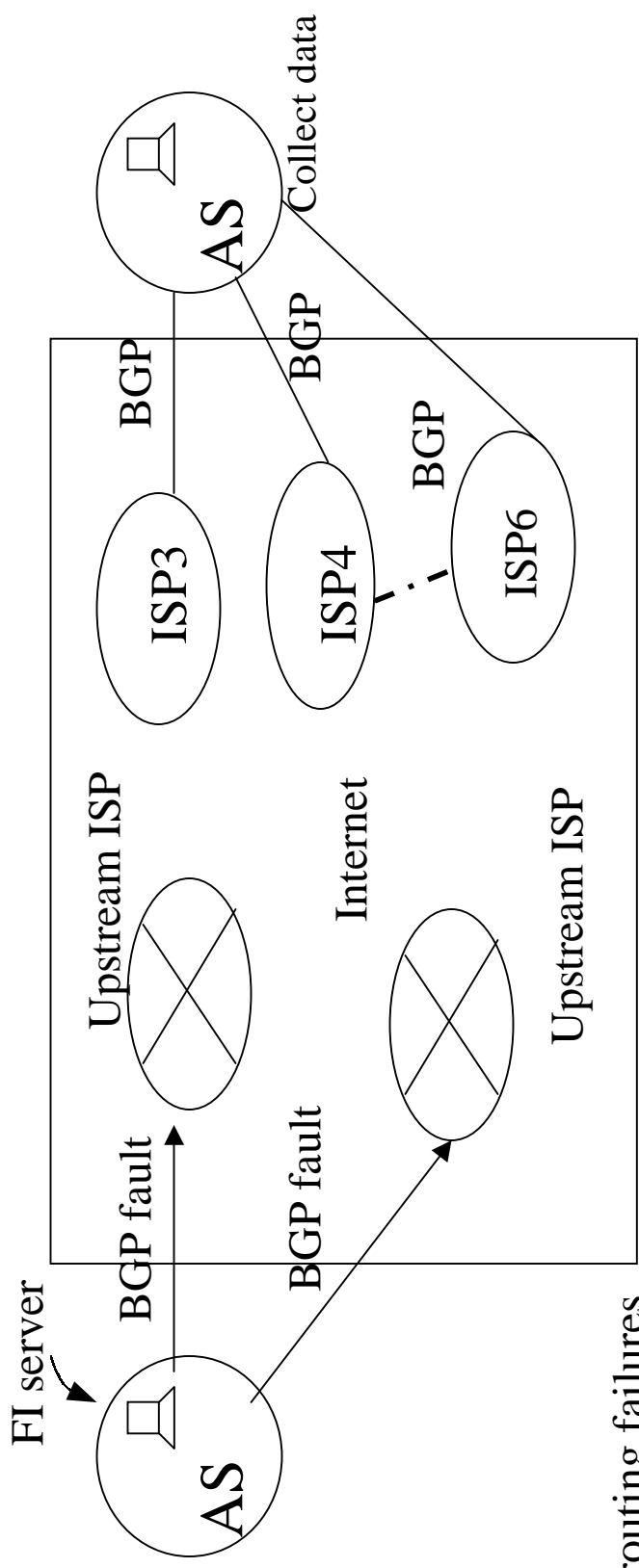
## Motivation

- Study impact of path failures, failovers and repairs on inter-domain routing convergence
- Telephone network: failover takes milliseconds
- Internet: failover takes several minutes
- Why does convergence take this long?

# Methodology

-Fault injection at probe points

-Monitor (passively) major exchange points



Fault = routing failures,  
repairs, multihome  
failures

## Key Results

- BGP uses path vectors => eliminate count to infinite problem. BUT increases possibility of oscillations
- Avg failover time  $\approx 3$  min (15 min in some cases)
- theoretical upper bound on convergence # of states explored  $O(e^{(n-1)!})$ ;  $n = \#AS$
- Lower bound  $\Omega((n-3)*30)$ sec,  $O(n)$  states.
- Reason interactions of protocol timers
- Impact:    loss rate increases by factor of 30,  
                  latency by factor of 4
- Minor implementation changes can reduce bounds