# An Identifier/Locator Split Architecture for Exploring Path Diversity through Site Multi-homing - A Hybrid Host-Network Cooperative Approach

Subharthi Paul, Raj Jain*, Jianli Pan
Washington University in Saint Louis
Saint Louis, MO 63130
*Presenter: jain@cse.wustl.edu

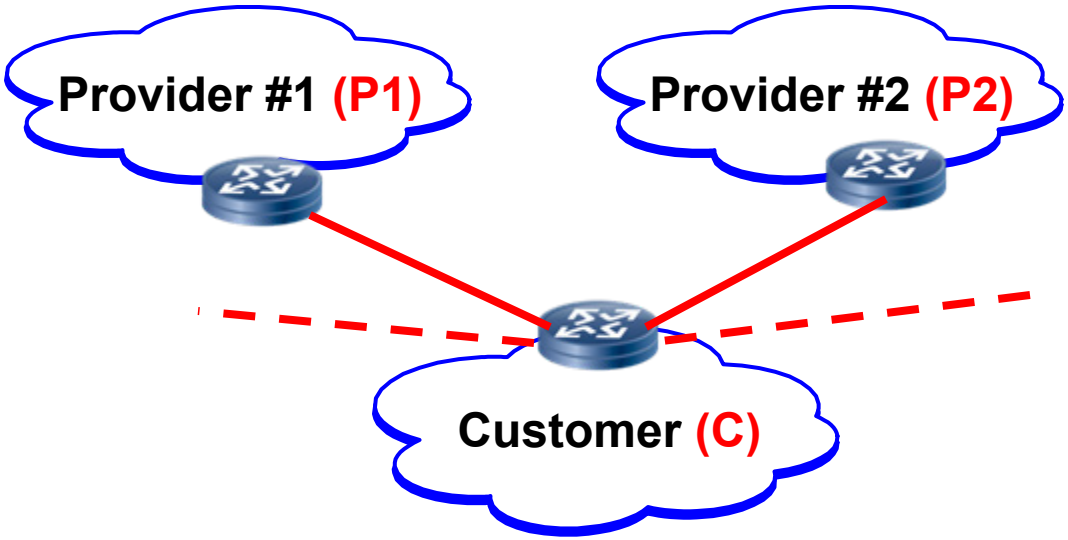
These slides are available on-line at:

http://www.cse.wustl.edu/~jain/papers/multihom.htm


- Stub-site Multihoming: What and why?
- Problems/Weaknesses with current solutions
- Our solution
- Evaluation of Internet Routing Data

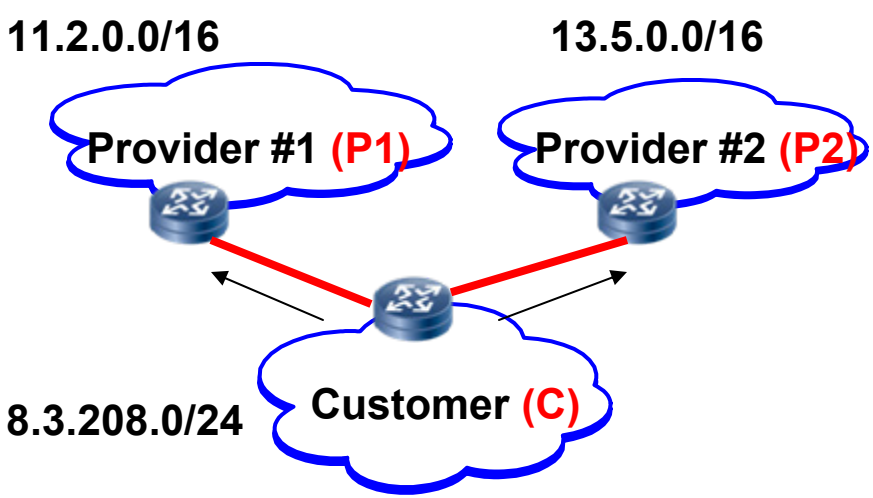
# What is Stub Site Multi-homing?

- Stub Site: Does not provide "Transit Paths"
- Stub Sites use multi-homing for:
  - Backup Paths
  - Traffic Engineering
  - Path Diversity



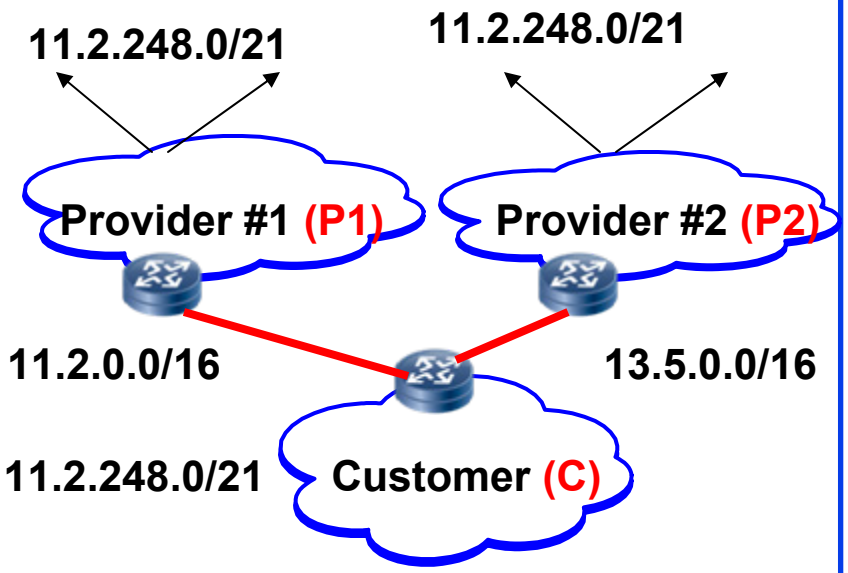
# Stub Site Multi-homing Issues

- Issue 1: Which address to use?




**Use Provider-Independent address**

***Advertise 8.3.208/24 into the Global routing through P1 and P2***

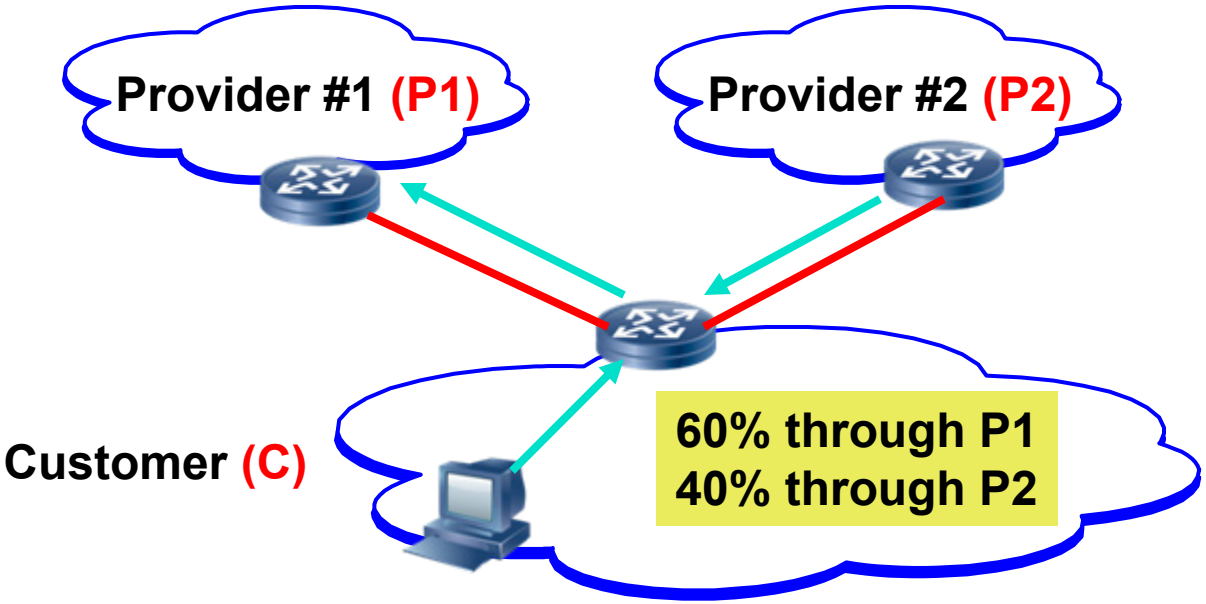



**Use one Provider-Assigned Address**

***P1 and P2 both Advertise 11.2.248.0 /21 into the Global routing***

# Multihoming Issues (Cont)

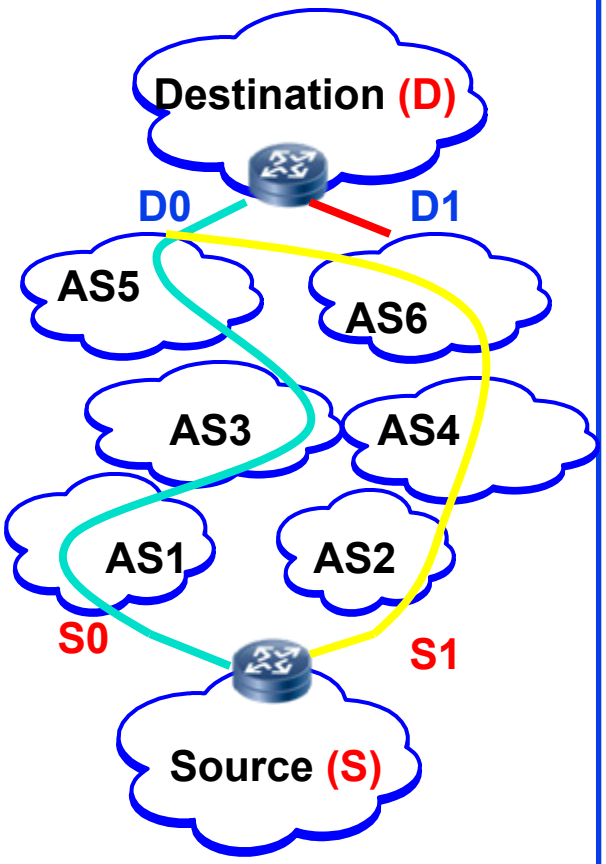
- Issue 2: How to control incoming traffic?
  (Traffic Engineering)




- Solution: Border routers over-write source addresses in the outgoing packets. TE-proxy switches flows not packets.

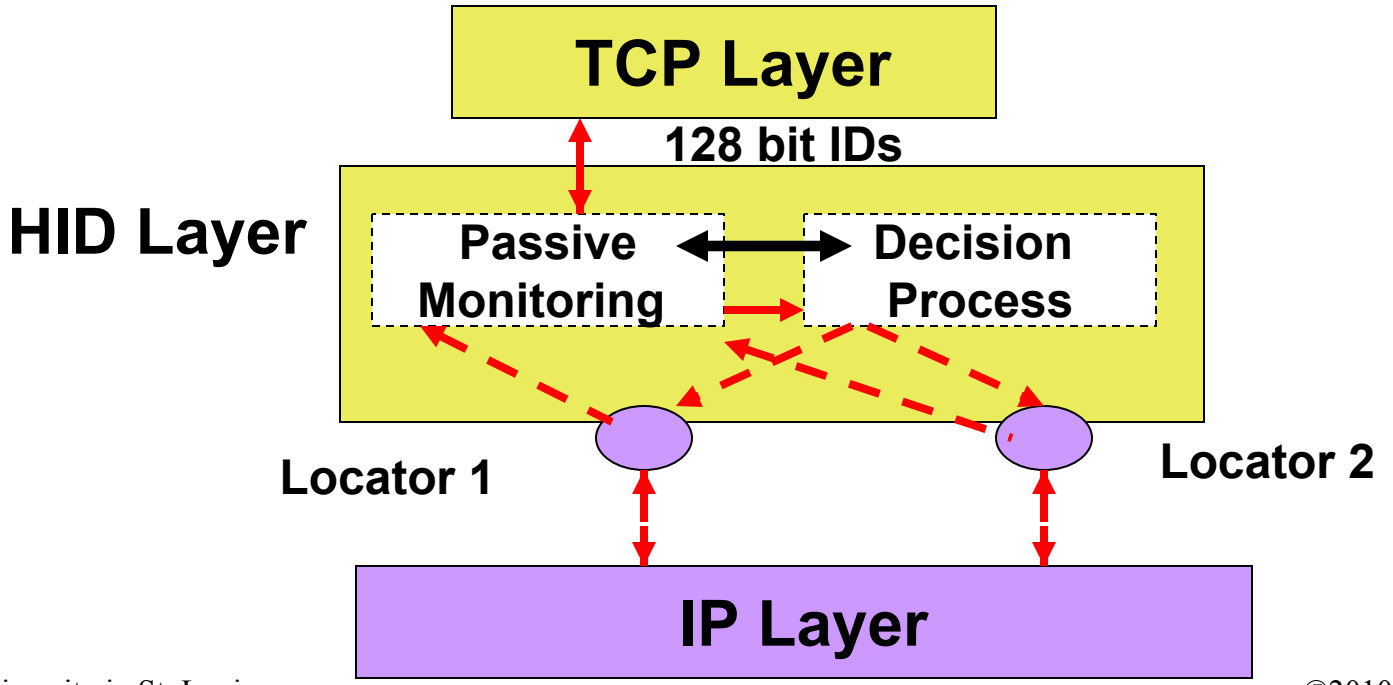
# Multihoming Issues (Cont)

- Issue 3: How to ensure that the two paths are different?
  - Border routers are not aware of end-to-end path problems
  - Hosts have "hints" about path problems but no control over "path switching"



# ID/Locator Split

- Each host is given a 128 bit IPv6-like Identifier (ID)
- TCP-like upper layer protocols bind to this ID
- IDs are mapped to "Locators" (IPv4 or IPv6) by HID sub layer
- In a multi-homed site, each host has multiple locators



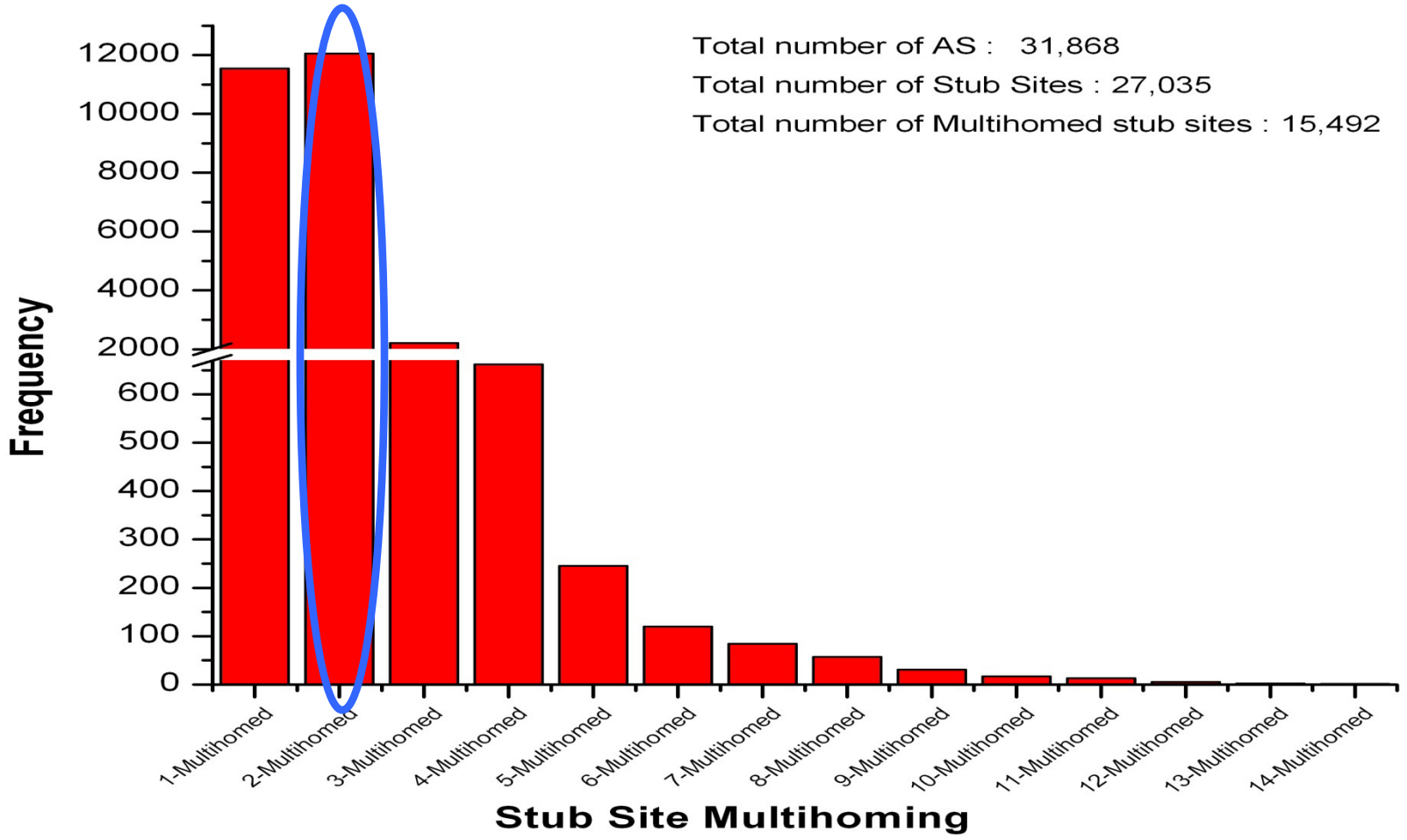
# Our Proposed Scheme

- Border routers do traffic engineering of flows
- At end Hosts:
  - "shim" snoops reliable transport layer packets to get path hints (Passive Monitoring)
  - If it detects a "congestion" or "path failure", it switches its source address
- Source "cannot" switch destination address
  - Destination may switch its "source" address in ACK or return packets
- Additional IP options in the packets help hosts communicate with the border routers so that border routers do not override source's decision in case of path problems

# Feasibility Evaluation

- Address scalability, diversity, and traffic engineering is useful iff:
  - A lot of sites are multi-homed
  - All providers are equally and richly connected
  - Path diversity is feasible
- We analyzed BGP RIB data at *"RouteViews"*
  *~11.2 million routes*

# Multi-Homing in the Internet




- Over 1/3rd of the stub sites are dual-homed.

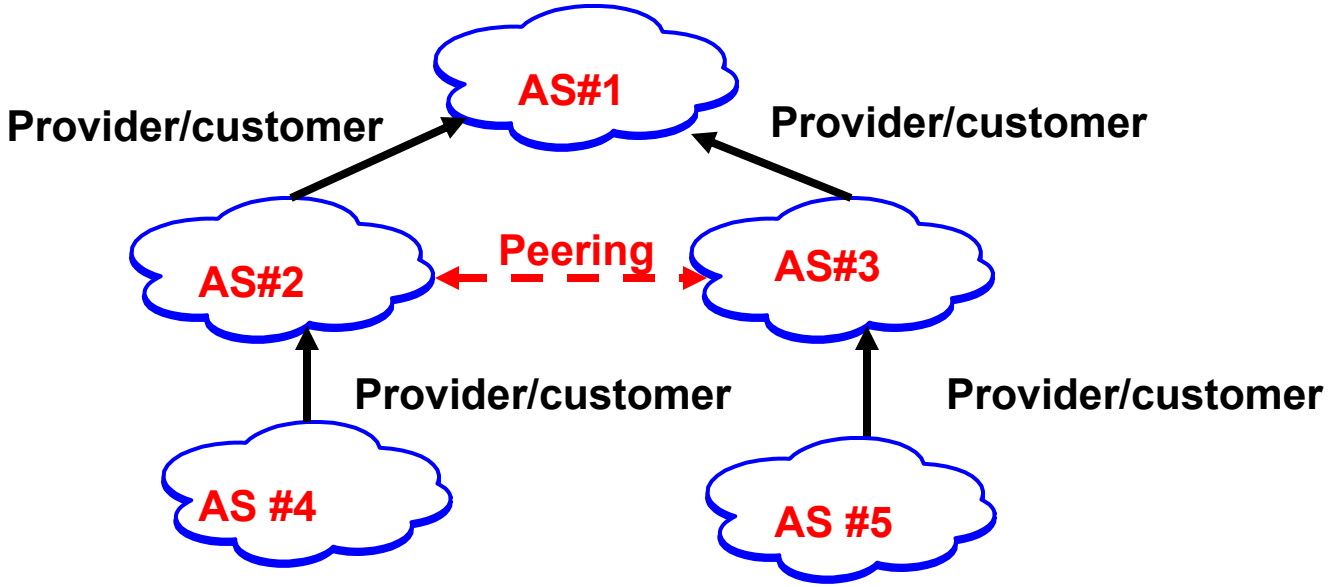
# Address Aggregation

| | |
|---|---|
| **Total 2-Multihomed Stubs** | 12052* |
| **Provider Independent (PI) Address Use** | 7841 |
| **Specific Prefix Advertisement** | 3222 |
| **Use Prefix from Both Providers** | 989 |

*** Numbers in terms of "Number of AS's"**

# Types of AS Relationships

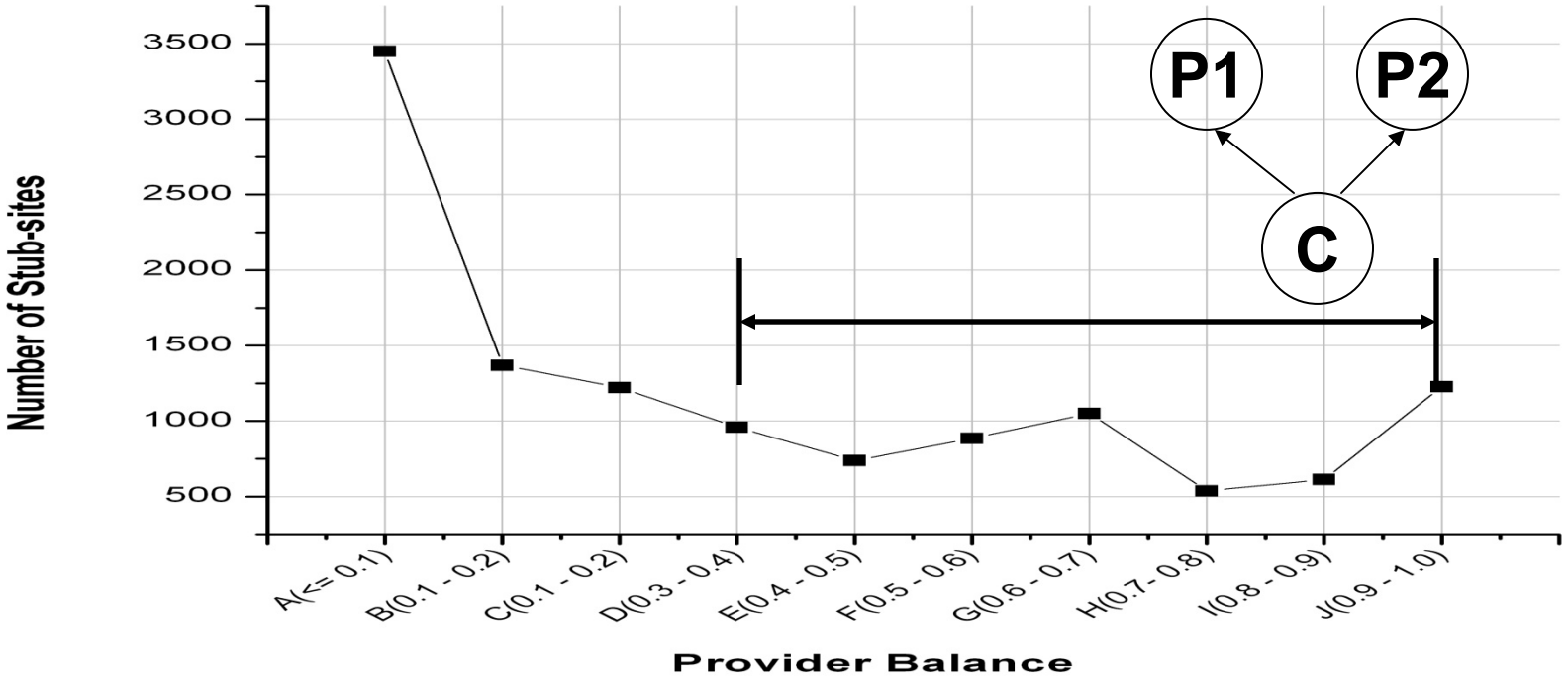
- An AS transports traffic only for those ASs with which it has a provider/customer relationship or peering relationship



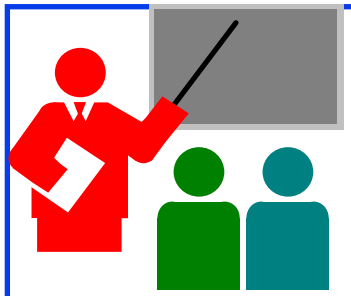

- Provider connectivity = # of non-stub provider/ customer/ peering links
- Higher connectivity is better

# Provider Balance

$$\text{Provider Balance} = \frac{\min(\text{Connectivity of Provider 1}, \text{Connectivity of Provider 2})}{\max(\text{Connectivity of Provider 1}, \text{Connectivity of Provider 2})}$$




- High provider balance ⇒ Path switching is helpful



# Summary

- Multihoming Problems:
  - Global Routing Scalability
  - Inbound Traffic Engineering
  - Leveraging Path diversity
- Id/Locator split with PA locators allows scalability
- Network traffic engineering through source address re-writing
  - Allows inbound traffic control
- Host switches paths based on passive monitoring of reliable transport layer hints
- Co-operative host-network protocol to realize:
  - Host end-to-end performance requirement
  - Network traffic engineering goals

# References


- Subharthi Paul, Raj Jain, Jianli Pan, and Mic Bowman, "A Vision of the Next Generation Internet: A Policy Oriented View," British Computer Society Conference on Visions of Computer Science, Sep 2008, http://www.cse.wustl.edu/~jain/papers/pona.htm
- Jianli Pan, Subharthi Paul, Raj Jain, and Mic Bowman, "MILSA: A Mobility and Multihoming Supporting Identifier-Locator Split Architecture for Naming in the Next Generation Internet,," Globecom 2008, Nov 2008, http://www.cse.wustl.edu/~jain/papers/milsa.htm
- Xiaohu Xu, Dayong Guo, Raj Jain, Jianli Pan, Subharthi Paul, Presented to Routing Research Group (RRG), Internet Research Task Force, Minneapolis, November 21, 2008, http://www.cse.wustl.edu/~jain/irtf/rangi.htm
- L. Gao, "On inferring Autonomous System relationships in the Internet," IEEE/ACM Trans.Networking, vol. 9, no. 6,pp. 733–745, 2001
- L. Subramanian, S. Agarwal, J. Rexford, and R. H. Katz,"Characterizing the Internet hierarchy from multiple vantagepoints," in Proc. IEEE INFOCOM, June 2002.