

Performance Evaluation of Robustness of Inter-layer 3 Networking with ID/Locator Separation Architecture

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Introduction

Conventional Internet

Host mobility and multi-homing is not suitably



Causes severe increase of routing table entries in Default Free Zone

ID/Locator separation architecture※
resolves these technical problems

※A. Jonsson, M. Folke, B. Ahlgren, "The split naming/forwarding network architecture," in *Proc. Swedish National Computer Networking Workshop (SNCNW)*, Sep, 2003.

※D. Farinacci, V. Fuller, D. Meyer, D. Lewis, "Locator/ID Separation Protocol (LISP)," *draft-farinacci-lisp-12.txt*, Mar 2009.

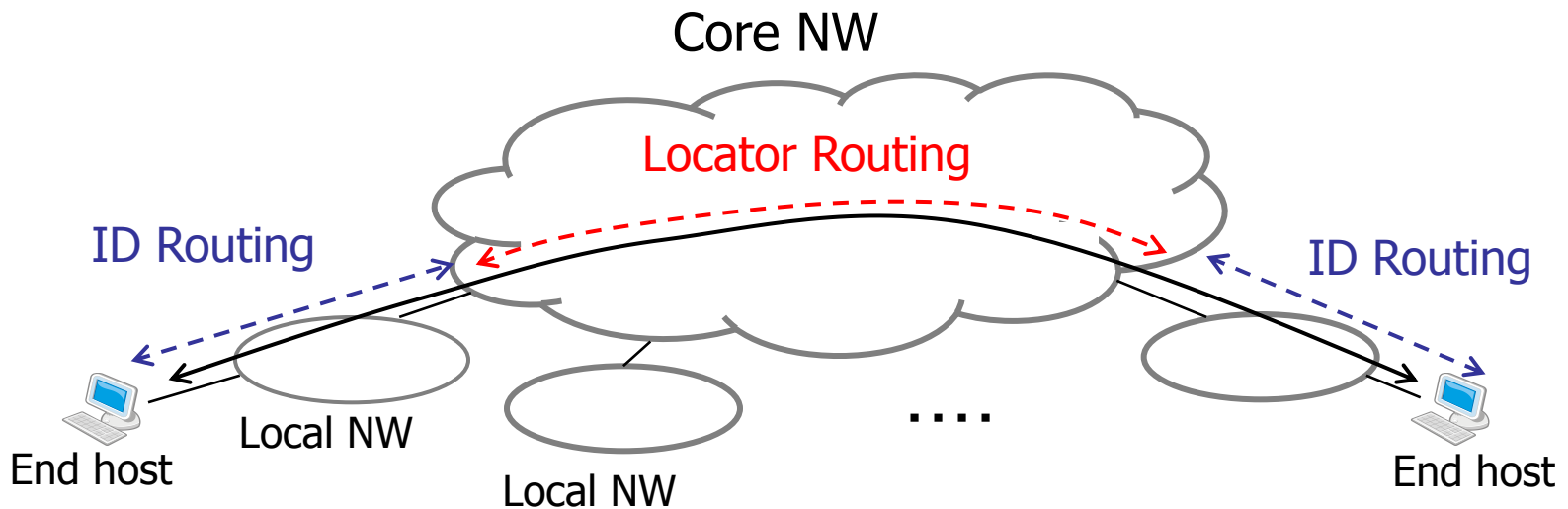
※R. Moskowitz and P. Nikander, "Host Identity Protocol Architecture," *Internet Draft draft-ietf-hip-arch-03*, Aug, 2005.

※J. Abley, M. Bagnulo, "Applicability Statement for the Level 3 Multihoming Shim Protocol (Shim6)," *draft-ietf-shim6-applicability-03*, Jul, 2007.

ID/Locator Separation Architecture

ID/Locator separation architecture

- Split IP address to host ID and Location ID
- Unique ID(host ID) which is independent of location
- Mapping system(**MS**) conversion these addresses

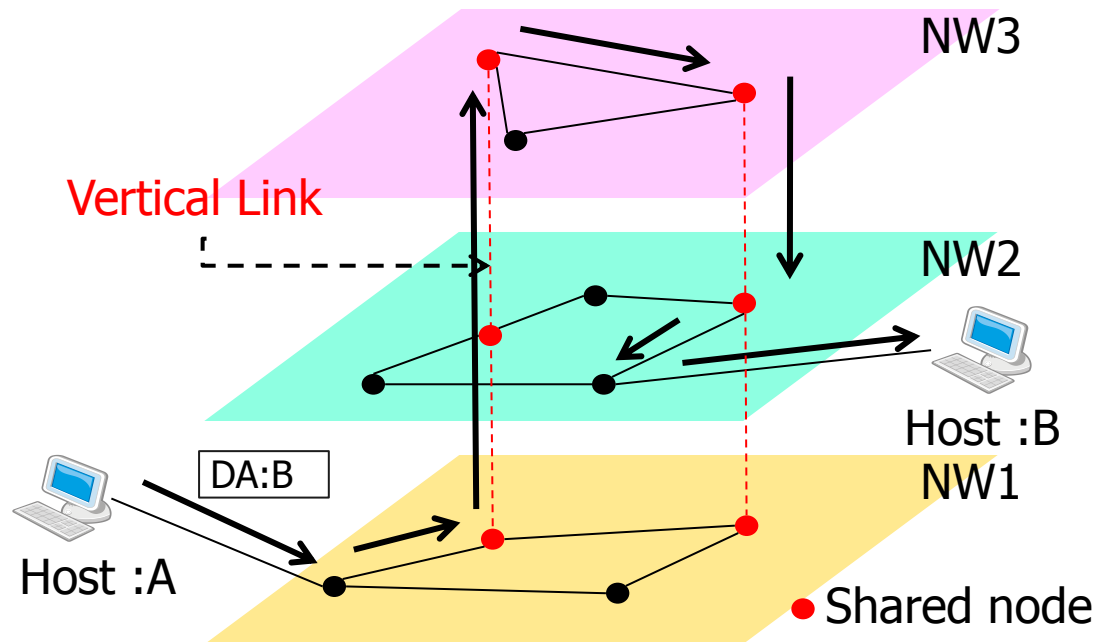


Another benefit of this architecture

Each hosts have unique ID which is independent of NW



Hosts operating different layer 3 protocol can communicate each other (**inter-layer 3 networking**※)



- ※B. Ahlgren, J. Arkko, L. Eggert and J. Rajahalme, "A Node Identity Internetworking Architecture," in *Proc. 9th IEEE Global Internet Symposium*, Apr, 2006.
- ※J. Crowcroft, S. Hand, R. Mortier, T. Roscoe, A. Warfield, "Plutarch: An Argument for Network Pluralism," in *Proc. ACM SIGCOMM Workshop on Future Directions in Network Architecture (FDNA)*, Aug, 2003, pp. 258-266.
- ※S. Schmid, L. Eggert, M. Brunner and J. Quittek, "Towards Autonomous Network Domains," in *Proc. 8th IEEE Global Internet Symposium*, Mar, 2005.
- ※B. Ahlgren, J. Arkko et. al. , "A Node Identity Inter-Networking Architecture," *IEEE 9th Global Internet Workshop*, Apr. 2006.

Network function for inter-layer 3 networking

■ Inter-networking routing algorithm

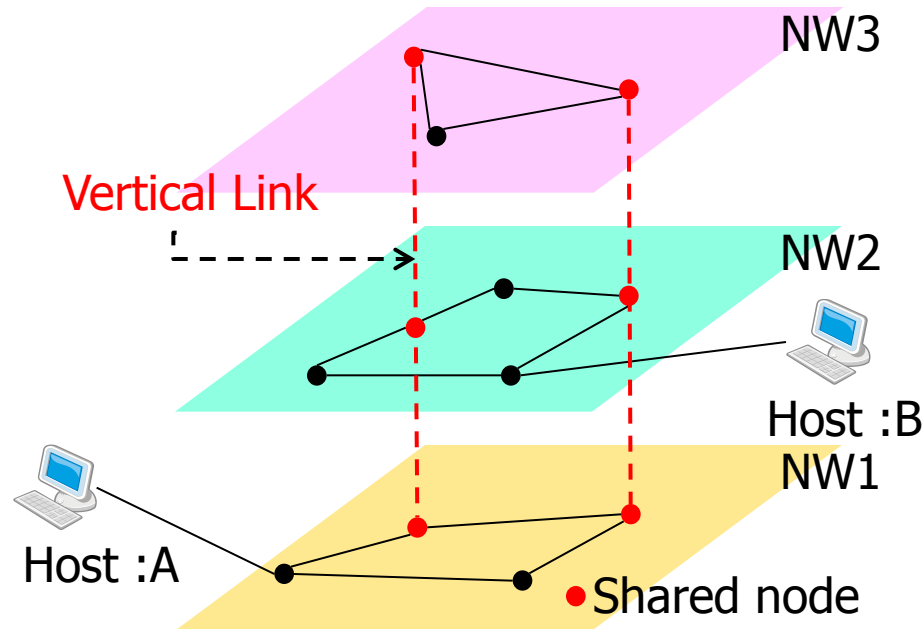
Gives the shortest path on total network protocol planes

■ Share node

Enables transfer to other network protocol plane

■ Vertical Link

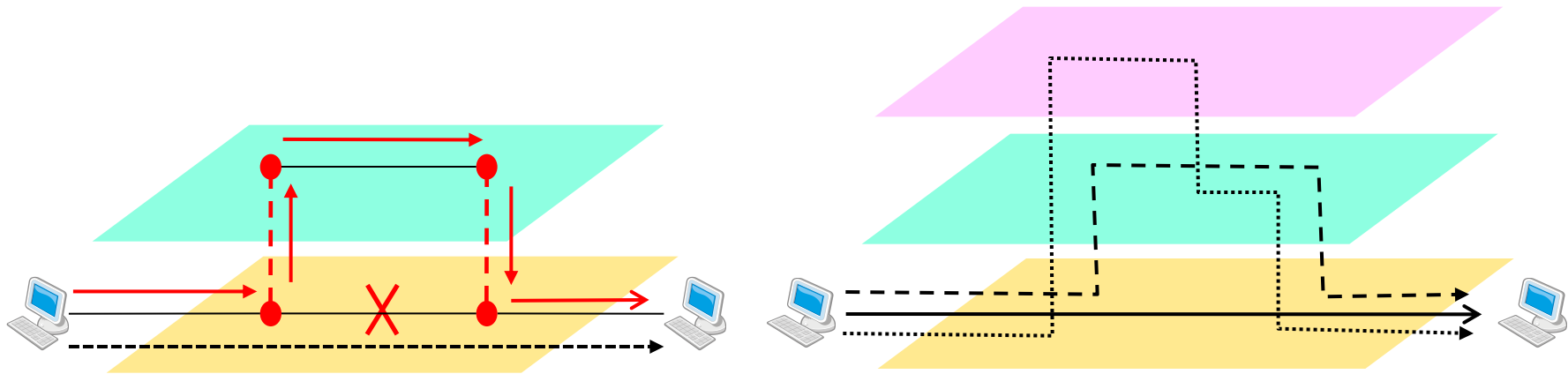
A link between network protocol planes



Advantages of inter-networking routing

Advantages of inter-networking routing

- Communications between different network protocol planes
- Improvement of robustness
- Improvement of shortest path



Improve of Robustness

Efficient shortest path



Aim of the paper

Previous work

Improvement of shortest path in inter-layer 3 networking has been evaluated※

Aim of the paper

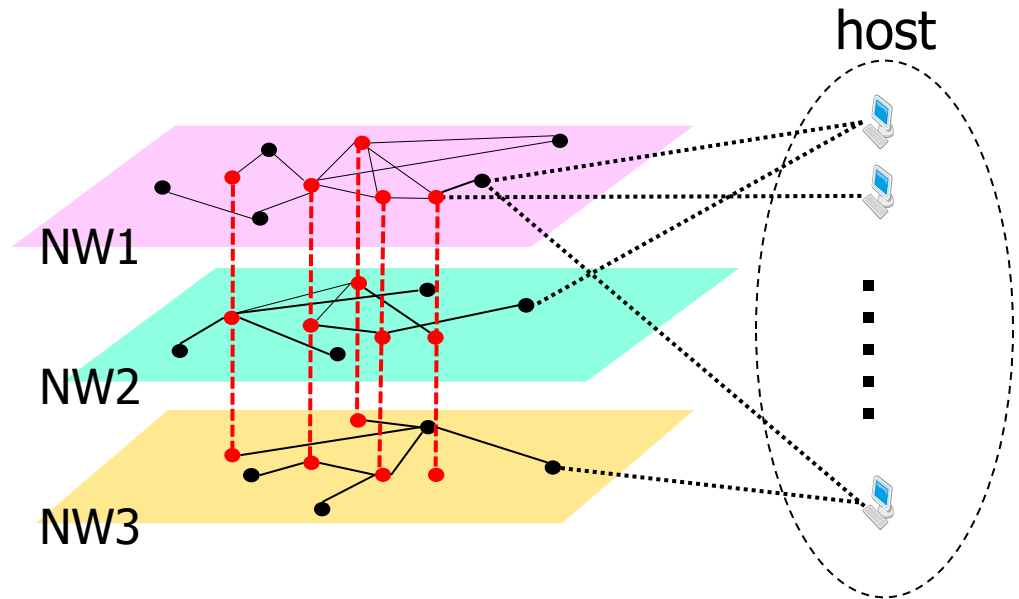
Evaluation of robustness brought by inter-layer 3 networking
Especially, robustness against link failure is evaluated

Evaluation

Inter-layer 3 networking with increase of shared nodes

Simulation model

- Network planes : 3
- Node : 100
- Host : 100
- Shared node : 5
- Multi-homing rate : 0.5



■ Random(Waxman) model

■ BA(Barabashi-Albert) model

■ Homogeneous

... Shared node has large outdegree in each network

■ Heterogeneous

... Shared node characteristics are independent in each network



Performance metrics for robustness

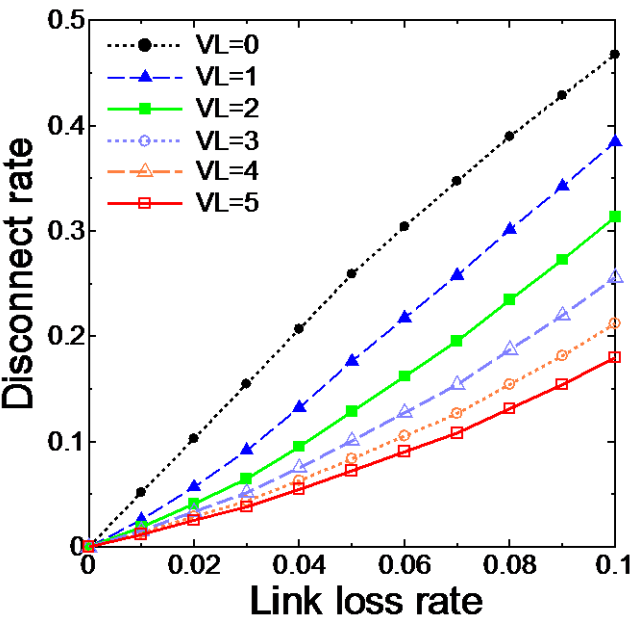
■ $Disconnect_rate_p = 1 - \frac{P_p}{Path}$

{ P_p : number of reachable paths with link failure p
 $Path$: number of total paths

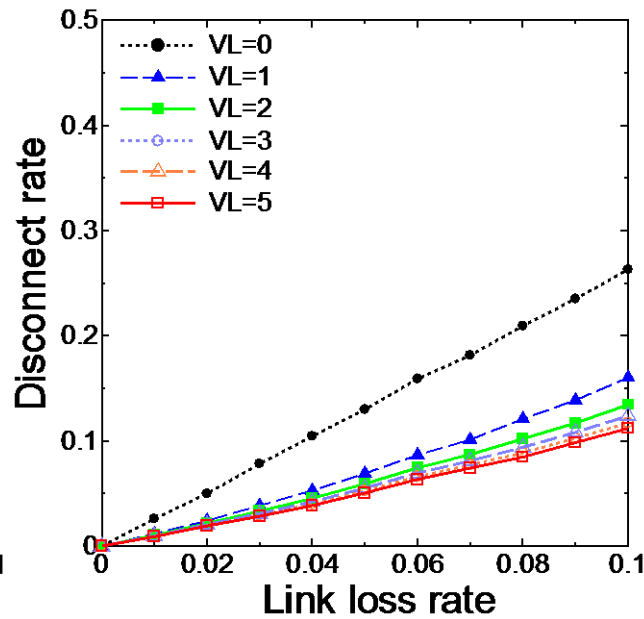
■ $Increase_in_path_cost(i, j)_p = C_{p(i,j)} - C_{(i,j)}$

{ $C_{p(i,j)}$: hop-count of node pair (i, j) with link failure p
 $C_{(i,j)}$: hop-count of node pair (i, j) with no link failure

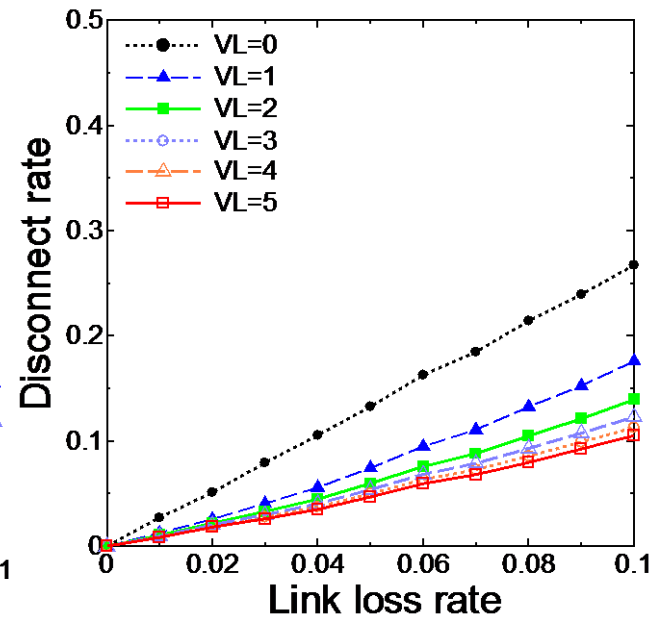
Disconnect rate



(a) Random



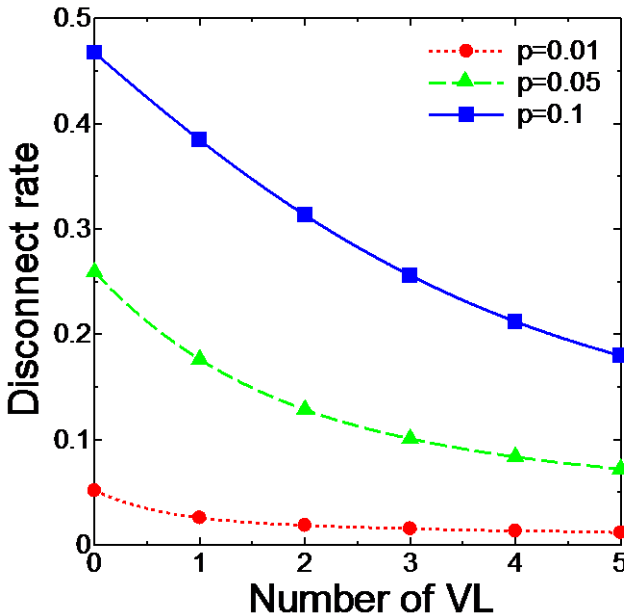
(b) Homogeneous BA



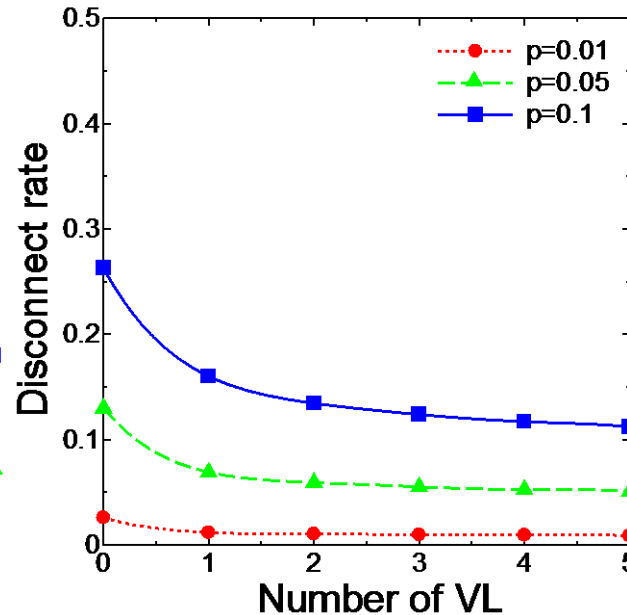
(c) Heterogeneous BA

With increase of vertical links disconnect rate can be improved

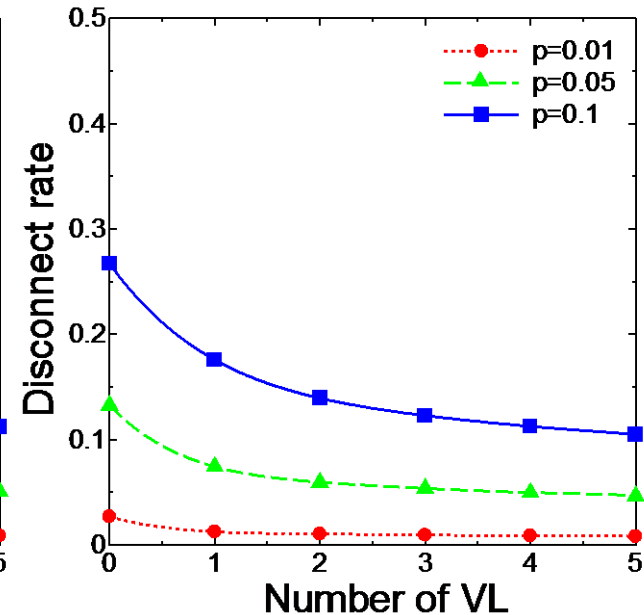
Disconnection rate v.s. the number of vertical links



(a) Random



(b) Homogeneous BA



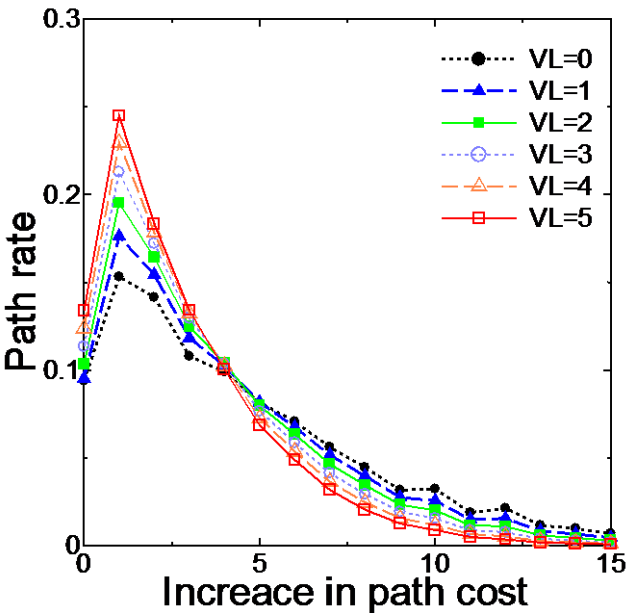
(c) Heterogeneous BA

VL increase from 1 to 2 is generally larger than improvement brought by increase from 4 to 5

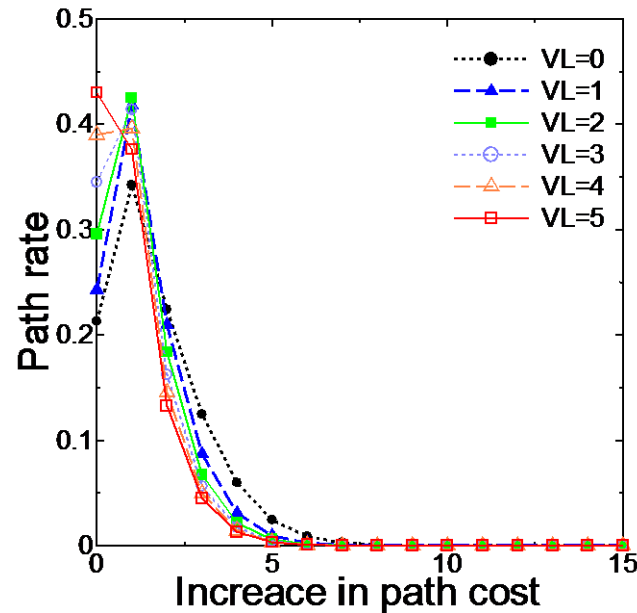


Significant improvement with small number of VL

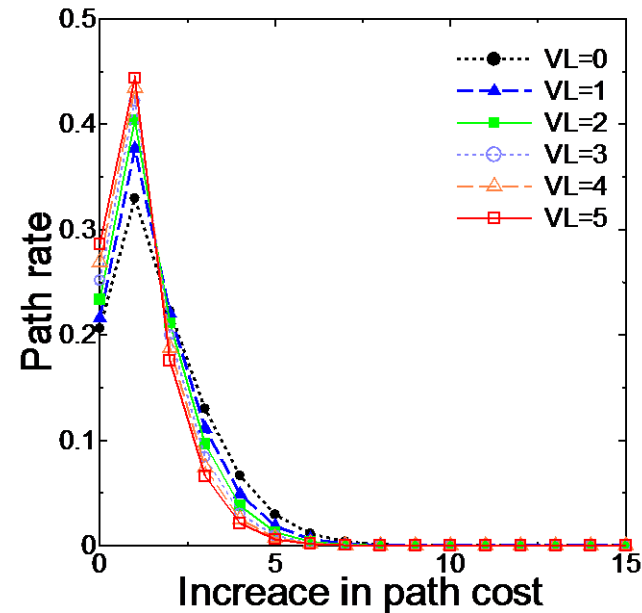
Increase in path cost ($p=0.05$)



(a) Random



(b) Homogeneous BA

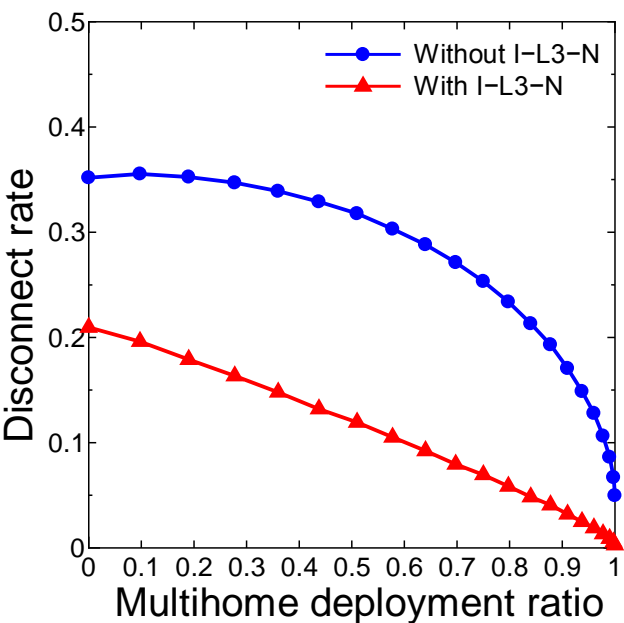


(c) Heterogeneous BA

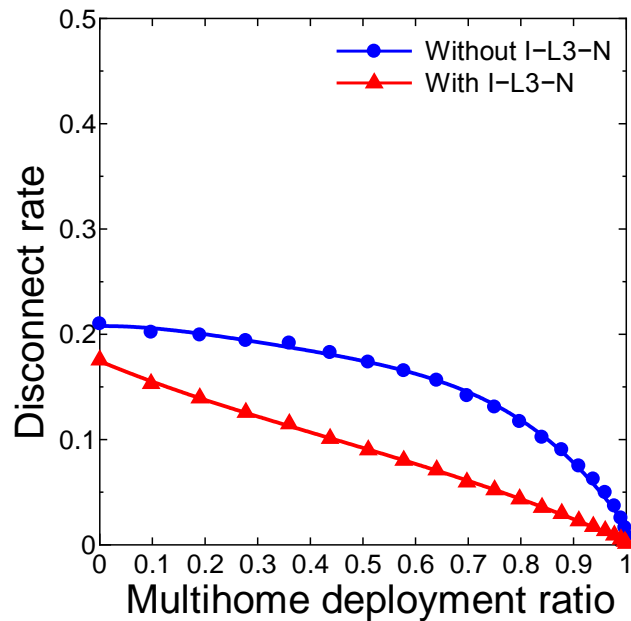
■ Total increase in path cost be reduced by about 5% in VL=1

■ Total increase in path cost be reduced by about 15% in VL=5

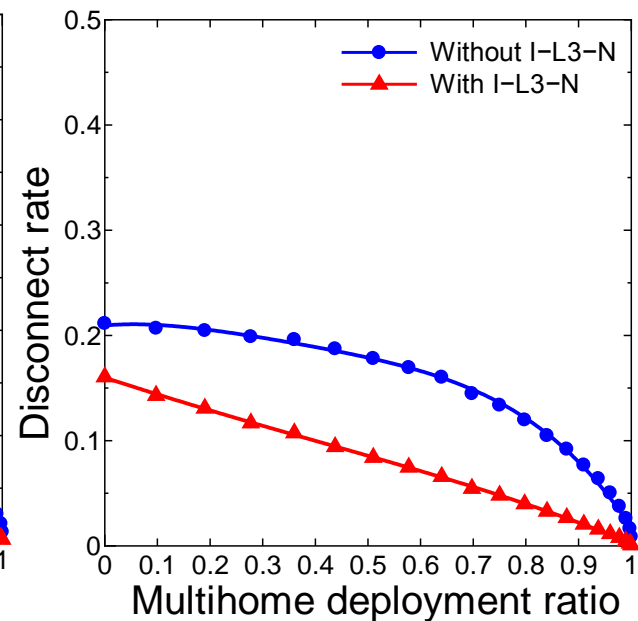
Inter-layer 3 networking and Multi-homing



(a) Random



(b) Homogeneous BA



(c) Heterogeneous BA

Great improvement for robustness even
with small deployment of multi-homing



Conclusion

- Inter-layer 3 networking enhances routing paths including several layer 3 network planes
- Evaluate Robustness brought by inter-layer 3 networking
 - Small number of shared nodes bring significant performance improvement
 - Great improvement even with small deployment of multi-homing