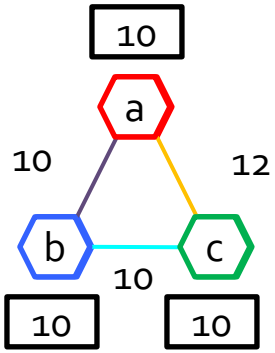
PolyViNE

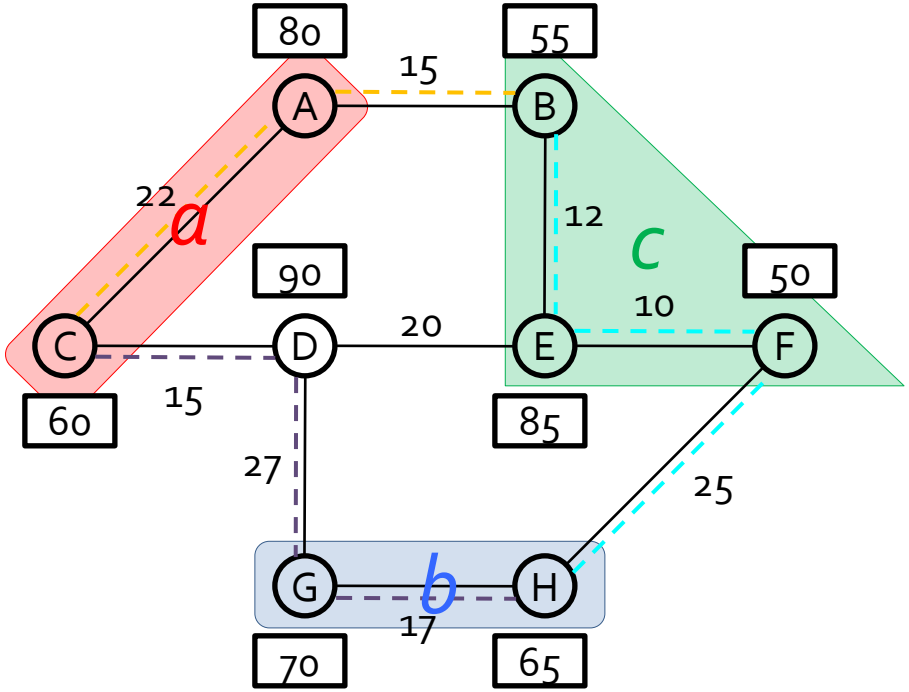
*Poli*cy-based *Vi*rtual *N*etwork *E*mbedding across Multiple Domains

Mosharaf Chowdhury — UC Berkeley
Fady Samuel, Raouf Boutaba — University of Waterloo

Virtual network embedding is NP-hard

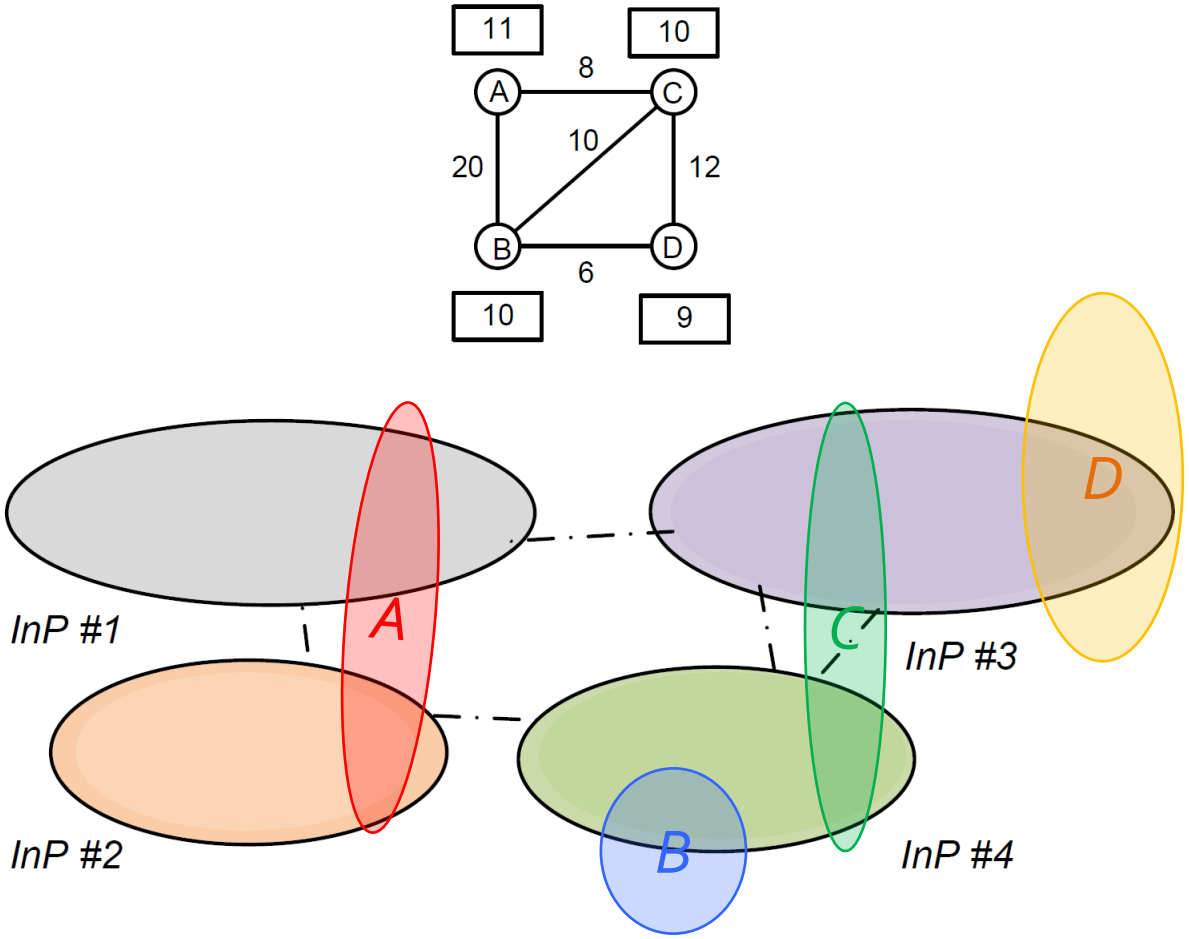


VN Request (SP)



Substrate Network (InP)

Inter-domain ViNE



Bird's-eye-view solution

1. *Partitioning* the VN request into *K* components
2. *Embedding* individual components into *K* substrate networks
3. *Establishing inter-connection* between them

Major challenges

How do InPs and SPs find each other?

How to ensure the best price?

How to share information?

Approaches

1. Full disclosure
   - Publicly available InP information
2. Third-party
   - InP information must be shared with the broker
   - Possibility of monopoly (trust issues)
3. Minimal disclosure
   - No central entity
   - Safest of the three, but the hardest as well

PolyViNE design choices

Decentralized embedding

- No central entity with knowledge of internal policies

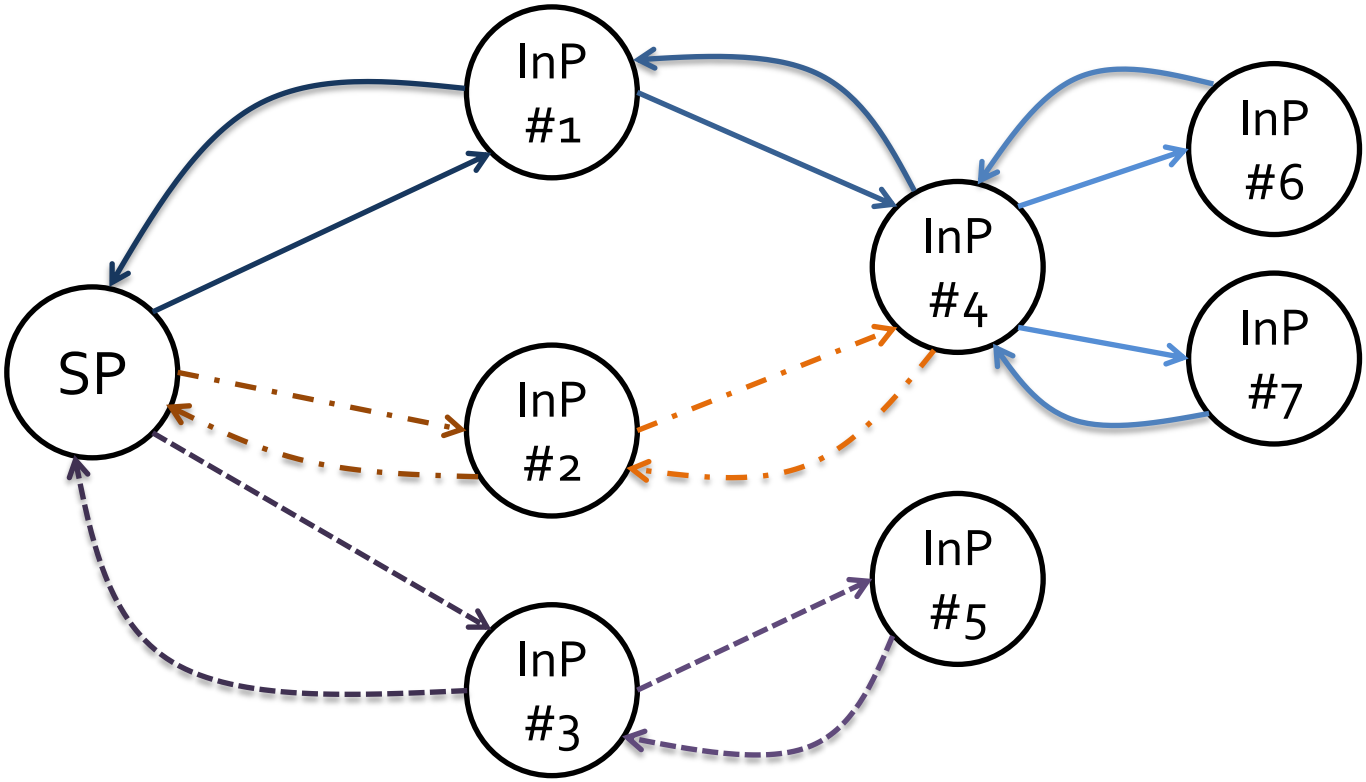
Local autonomy with global competition

- InPs are free to choose individual policies and embedding algorithms
- Competitive pricing at every stage of embedding

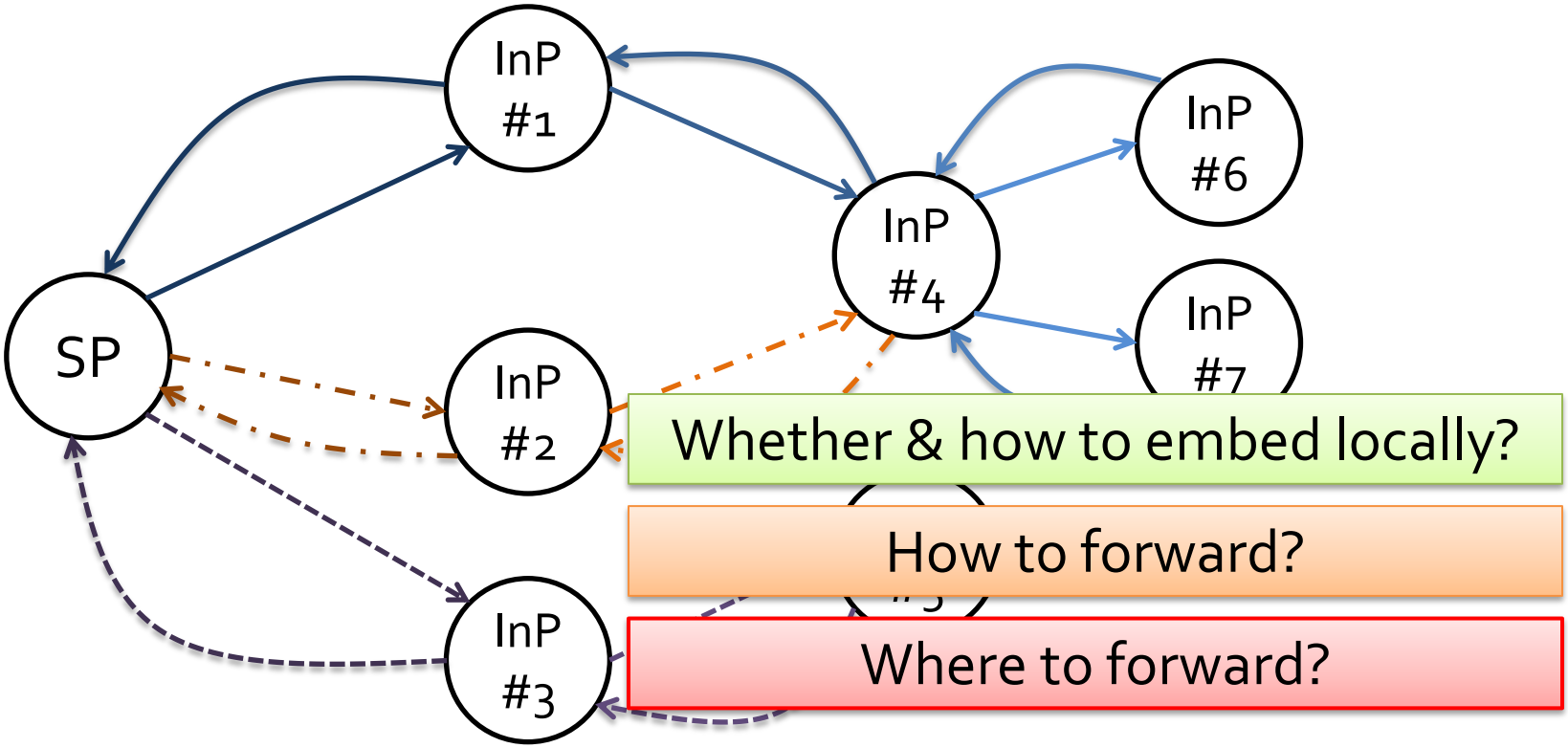
Location assisted embedding

- Guided by the location constraints on virtual nodes and the location information of the substrate nodes

Workflow summary



InP workflow



Location assisted forwarding

Informed request forwarding
- » Minimize flooding
- » Avoid unnecessary random forwarding

Two components
- » Hierarchical addressing scheme (COST)
- » Location awareness protocol (LAP)

COST

Hierarchical addressing scheme

- » Allows prefix aggregation
- » Provides high flexibility in expressing virtual node location constraints
- » Allows InPs to obfuscate topology information

***C**ontinent.c**O**untry.**S**tate.ci**T**y*

- » NA.CA.ON.Toronto: Node in Toronto
- » NA.CA.ON.*: Node anywhere in Ontario

LAP: Location Awareness Protocol

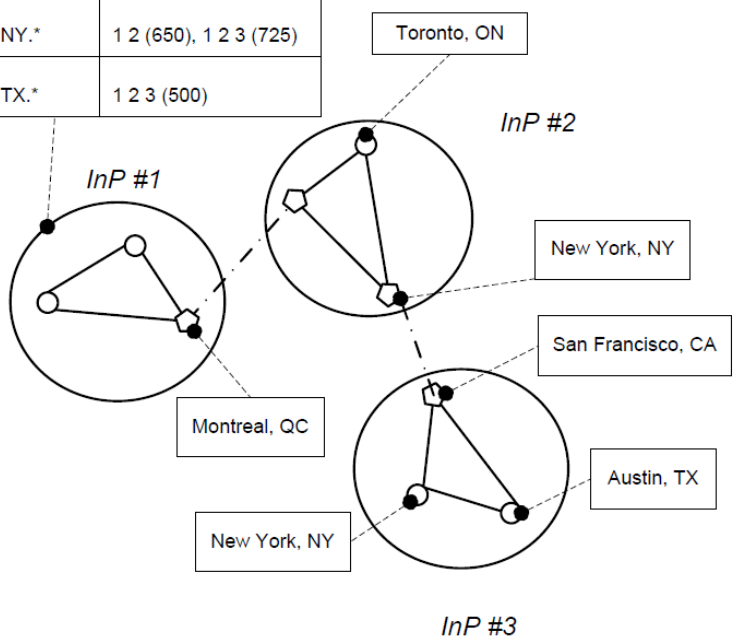
InPs exchange LAP updates to build local policy compliant view of the InP network

Each entry of an InP's LAP database contains a mapping from a COST prefix to a set of paths to InPs with that prefix

Each path has an associated estimated price

LAP

COST Prefix	Path (Cost)
NA.CA.ON.*	1 2 (500)
NA.US.CA.*	1 2 3 (700)
NA.US.NY.*	1 2 (650), 1 2 3 (725)
NA.US.TX.*	1 2 3 (500)



Resource prices can rapidly fluctuate in a dynamic environment

Gossip is too slow to propagate price updates

» Staleness

Use a hybrid of Gossip and Publish/Subscribe

» InPs can get direct and frequent updates

Simulation

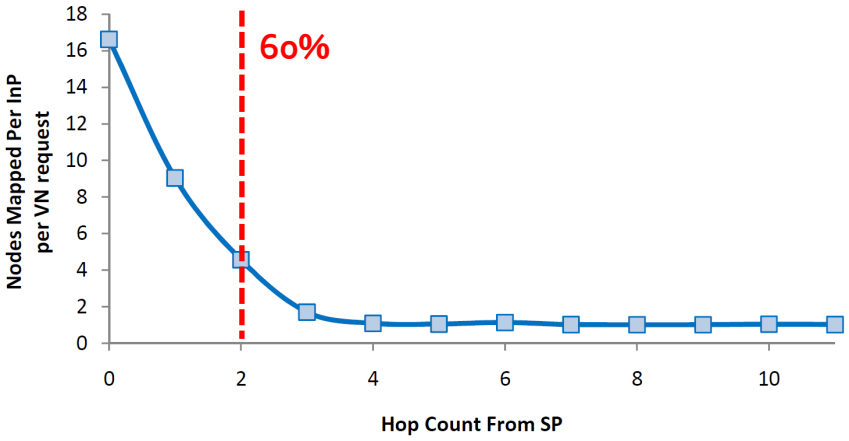
ViNE algorithms are hard to evaluate

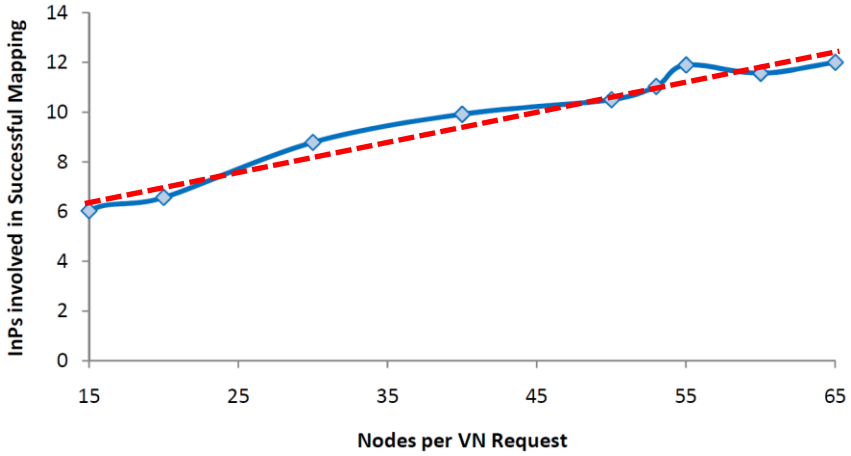
- What would be a representative input dataset?
- Which are the best metrics & how to measure them?
- Only look into simple convergence characteristics

Simulation settings

- Based on settings used in existing intra-domain work
- 100 InPs with random links between them, each with 80-100 nodes and 540-600 links
- Max recursive probe depth set to 12

How many InPs must collaborate?





Summary

PolyViNE is a policy-based inter-domain VN embedding framework

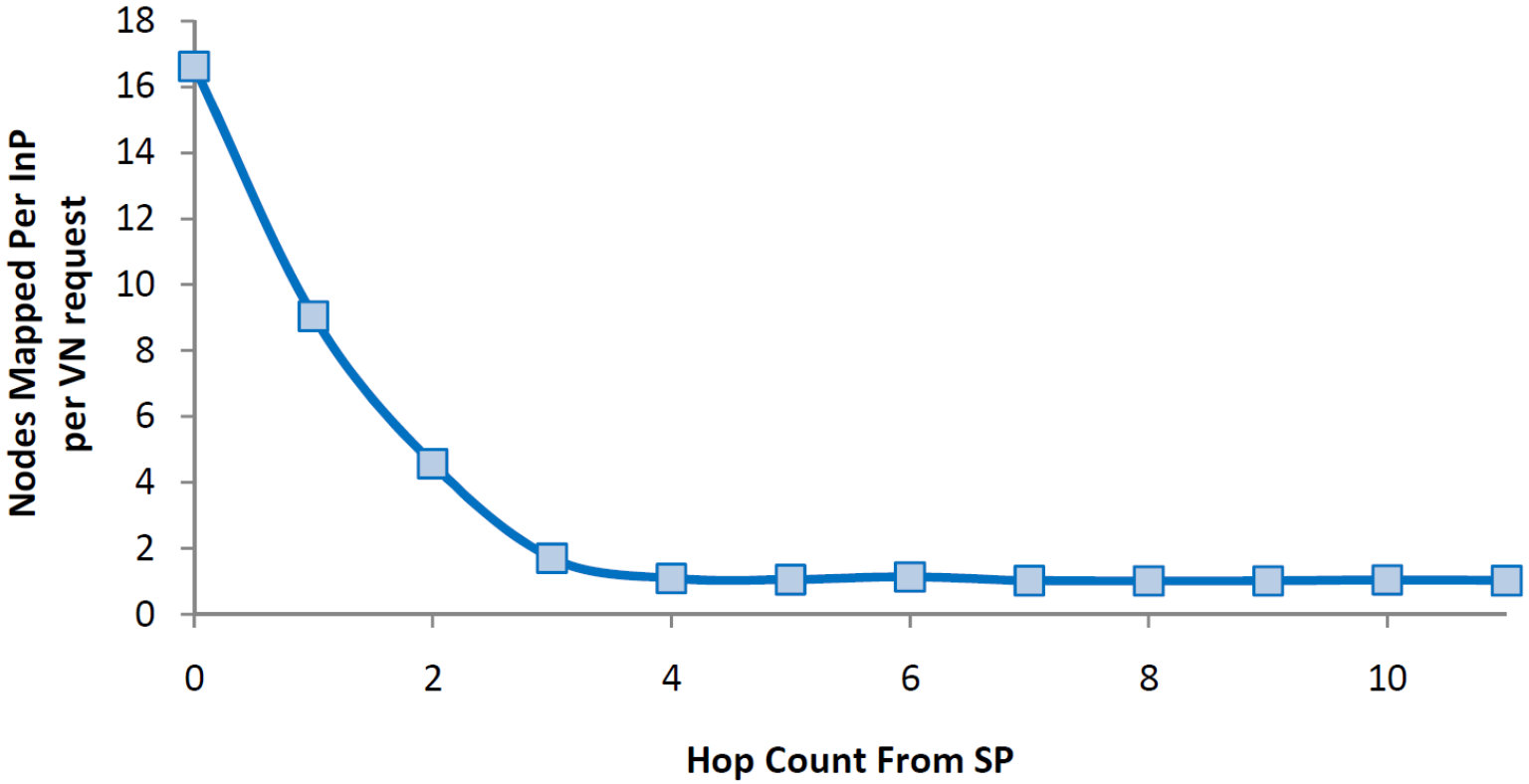
- Local autonomy with global competition
- Decentralized location-assisted embedding using COST and LAP

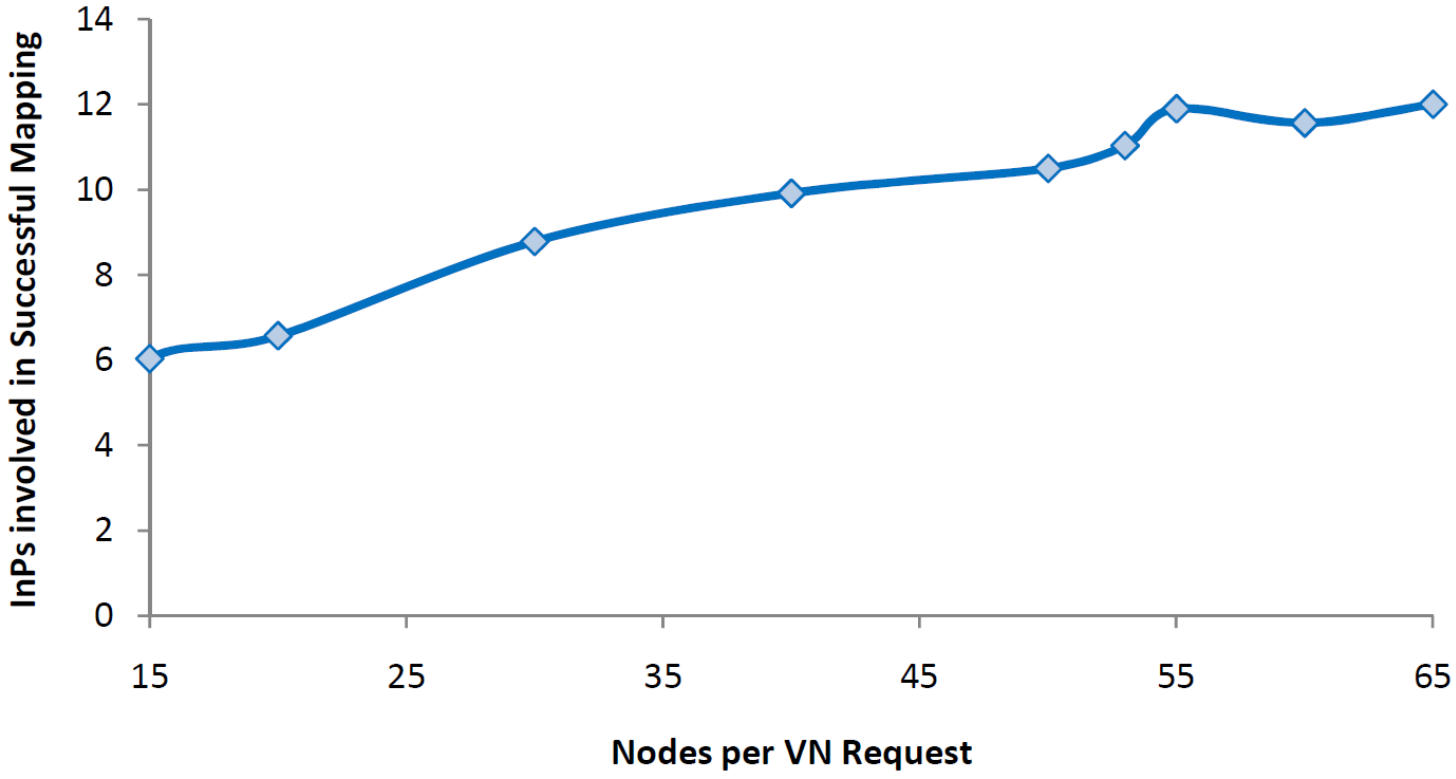
Possible future work (among many)

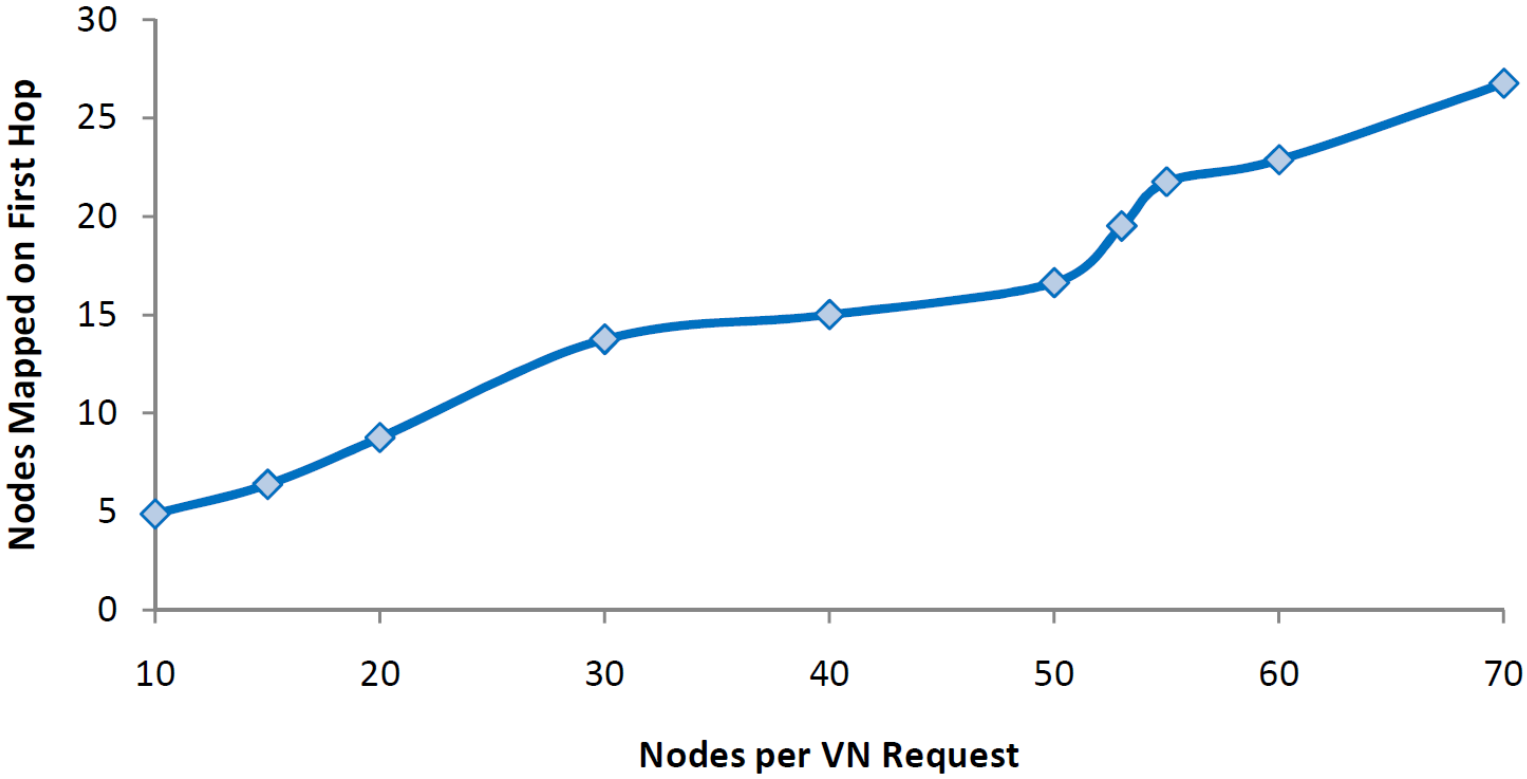
- Interaction between diverse local ViNE algorithm
- Game-theoretic analysis of the proposed scheme

Thanks!

Backup


Nodes Mapped Per InP per VN request
18
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
Hop Count From SP


InPs involved in Successful Mapping
14
12
10
8
6
4
2
0
15
25
35
45
55
65
Nodes per VN Request


Nodes Mapped on First Hop
30
25
20
15
10
5
0
10
20
30
40
50
60
70
Nodes per VN Request