PolyViNE: **Pol**ic**y**-based **Vi**rtual **N**etwork **E**mbedding Across Multiple Domains

Presented by

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Virtual Network Embedding

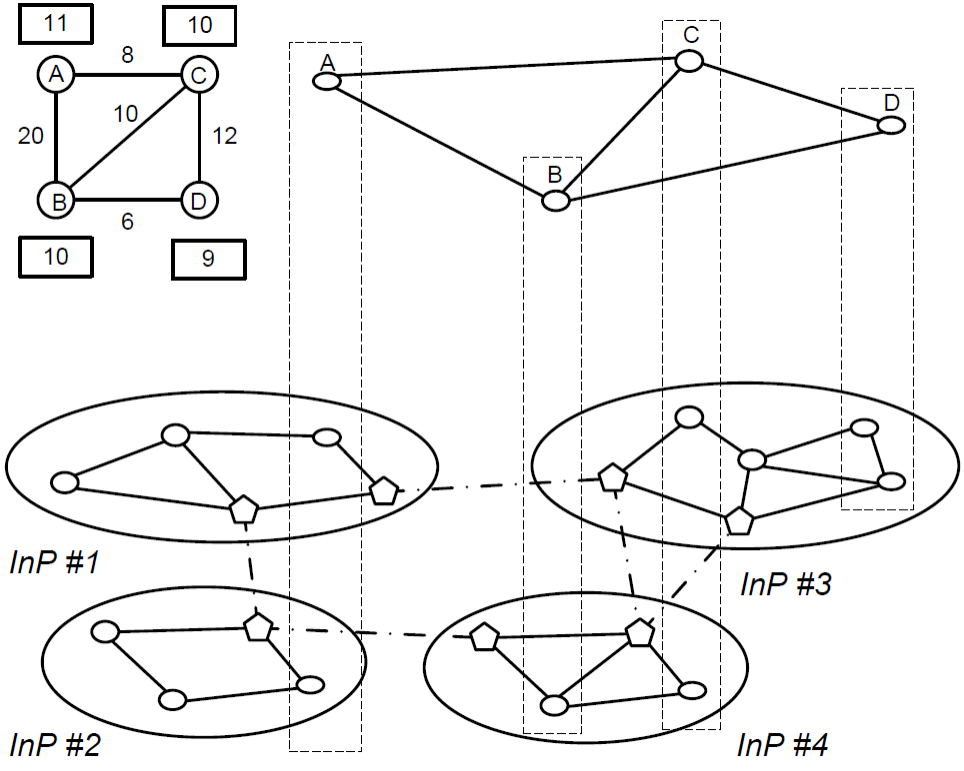
- Mapping of virtual network (VN) requirements onto physical network resources
  - Virtual Node → Physical Node
  - Virtual Link → Physical Path
- The Problem is *NP-hard*
- Existing *heuristics* address the problem in a single infrastructure provider (InP) scenario

End-to-end VN Embedding

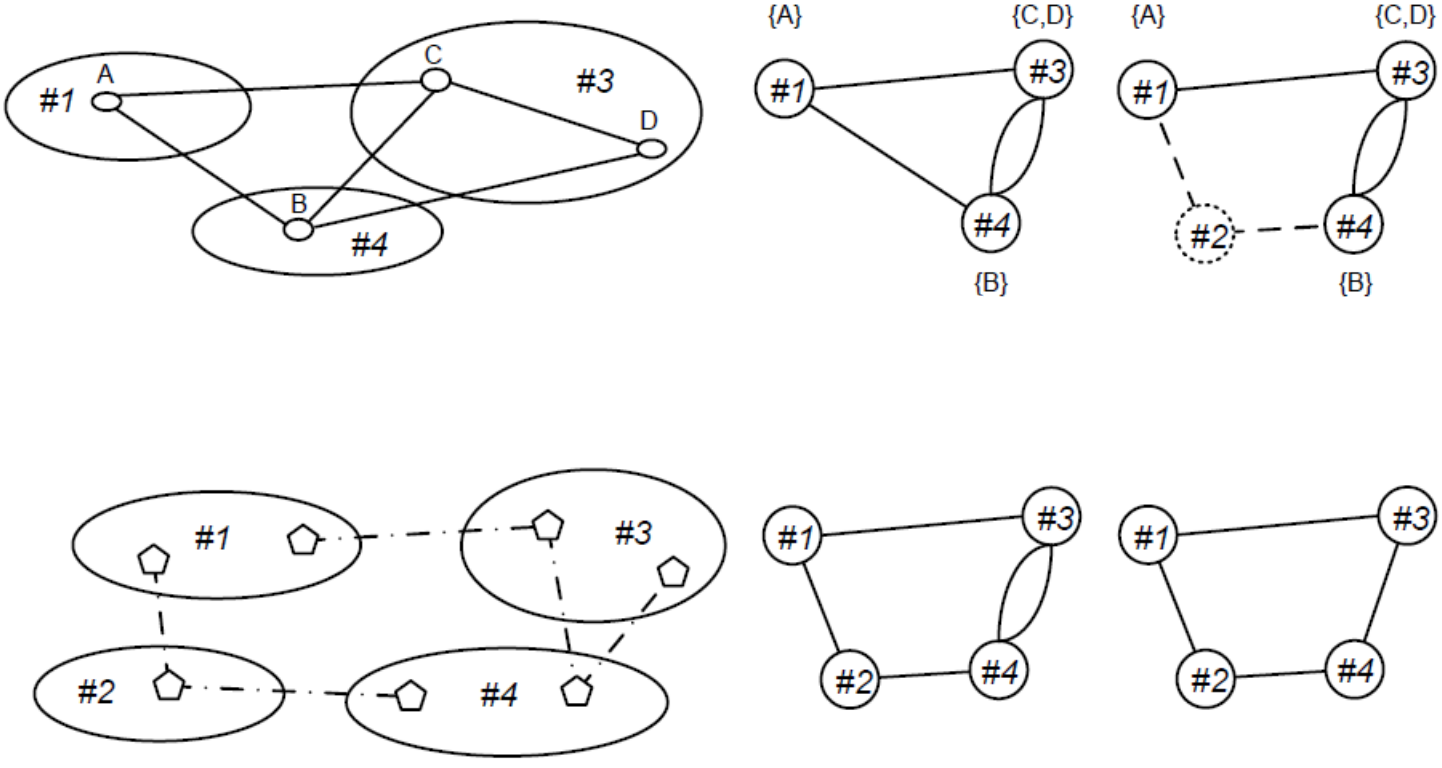
- End-to-end VN embedding is *NP-harder*
- Interactions between multiple InPs
  - Coordination
  - Collaboration

- Major challenges
  - Framework for resource trading for rapid VN instantiation and *fair value*
  - Tussles between parties with contrasting utility functions (between InPs, between SPs and InPs etc.)
  - Privacy concerns of the InPs

End-to-end VN Embedding (2)



End-to-end VN Embedding (3)



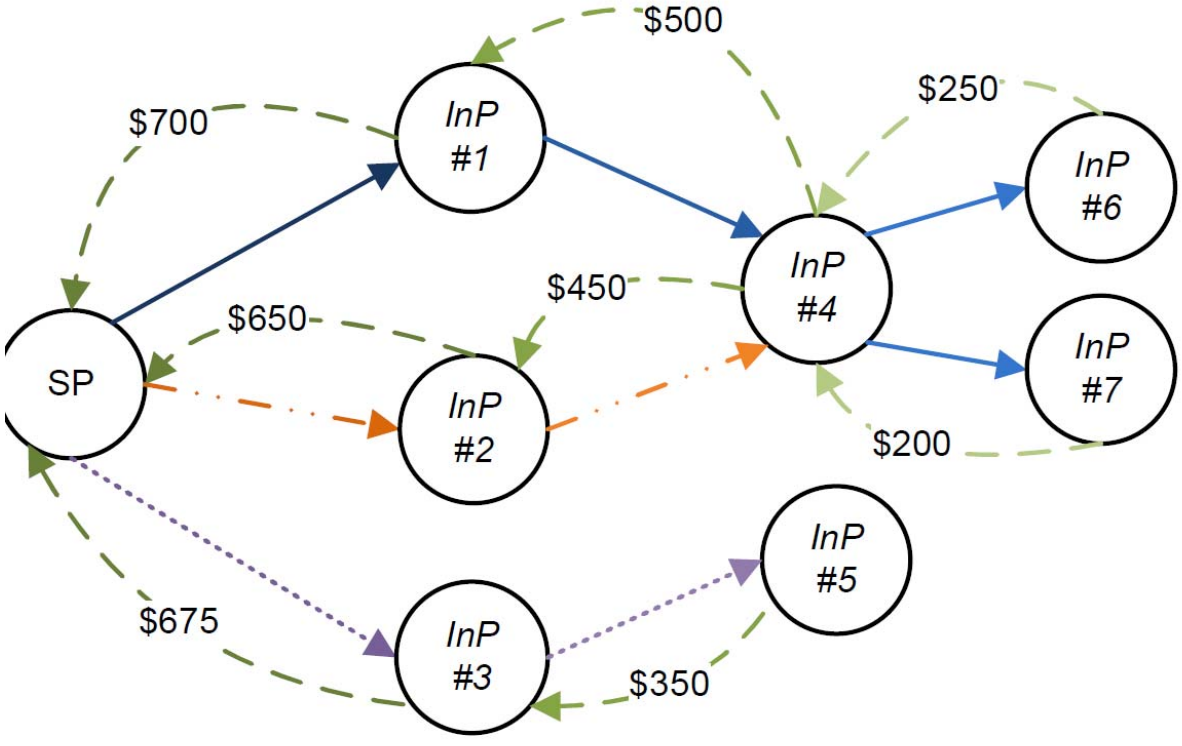
PolyViNE Design Choices

1. Decentralized Embedding
   - Centralized embedding (e.g., broker)
     - Needs to know internal policies and mutual agreements
     - Can create monopoly

2. Local Autonomy with Global Competition
   - InPs are free to choose internal policies, embedding algorithms
   - Competitive pricing at every stage of embedding

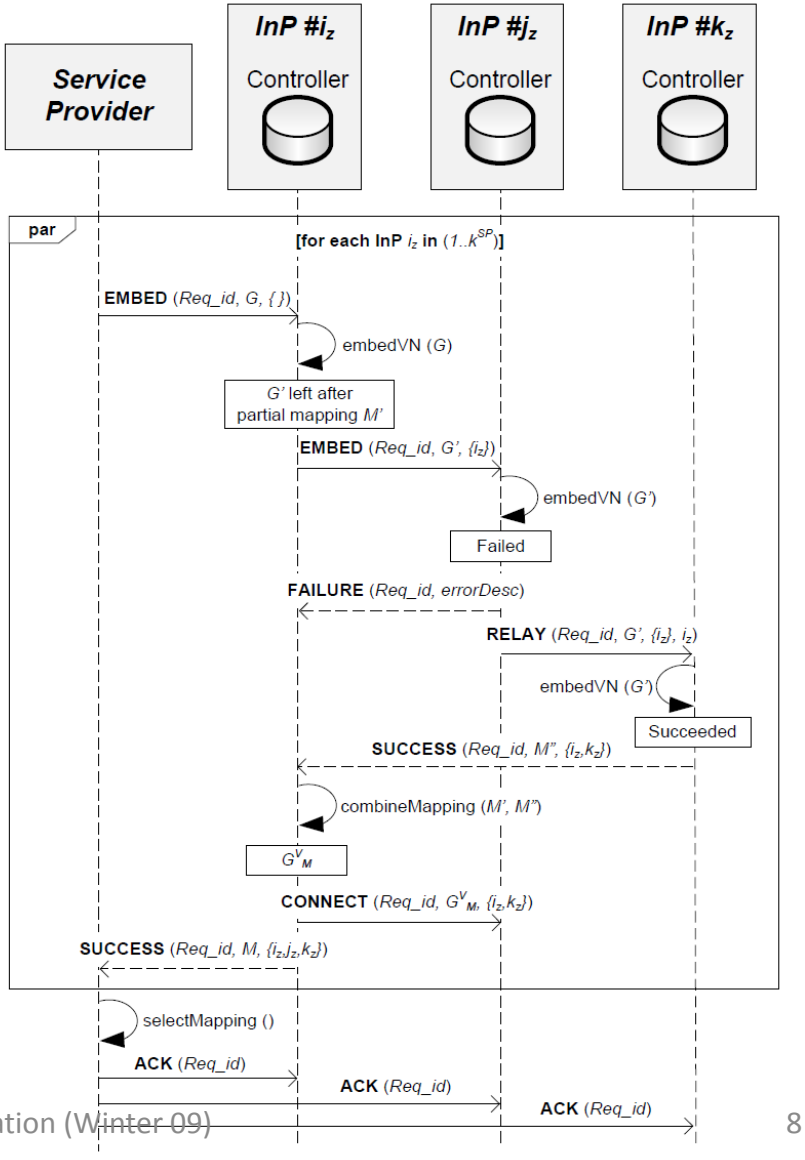
3. Location Assisted Embedding
   - Embedding process is guided by the location constraints on virtual nodes and the location information of the substrate nodes

Workflow Summary



PolyViNE Protocol Messages

1. **EMBED** (*Req_id, G, InPSet*)
2. **SUCCESS** (*Req_id, M, InPSet*)
3. **FAILURE** (*Req_id, errorDesc*)
4. **CONNECT** (*Req_id, G^V_M, InPSet*)
5. **RELAY** (*Req_id, G, InPSet, InP#*)
6. **ACK** (*Req id*)



InP Workflow

1. Local Embedding
   - Up to InP's discretion

2. Forwarding
   - How to forward? (Recursive VS Iterative)
   - Where to forward? (DON'T flood blindly)

3. Back-propagation
   - Accumulate prices

Location Aware Forwarding

COST

- ***C**ontinent.c**O**untry.**S**tate.ci**T**y*
- Examples
  - NA.CA.ON.Toronto: Node in Toronto
  - NA.CA.ON.*: Node anywhere in Ontario
- Provides high flexibility in expressing virtual node location constraints
- Allows prefix aggregation

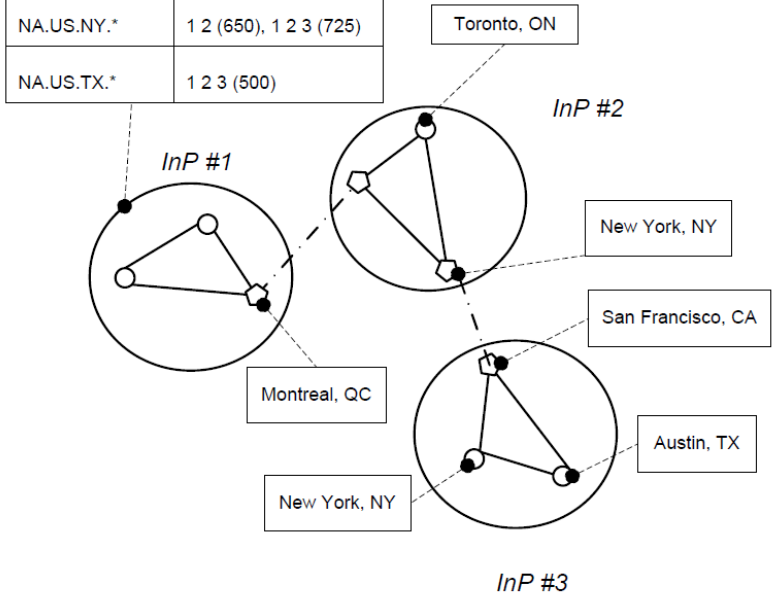
LAP

- **L**ocation **A**wareness **P**rotocol
- Each InP exchanges LAP updates to build its own policy compliant view of the Controller 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 price

Location Aware Forwarding (2)

- 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

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)



Future Work

- Evaluate PolyViNE
  - Scalability
  - Performance
    - Response time
    - Embedding Quality
    - Overheads
- Reputation Management

Summary

- PolyViNE is a policy-based inter-domain VN embedding framework
  - Local autonomy with global competition
  - Decentralized location-assisted embedding

- PolyViNE includes
  - Distributed protocol to coordinate the embedding process
  - Hierarchical location addressing scheme (COST)
  - Location awareness protocol (LAP) for informed forwarding

Questions? || /*Comments*/