Service-Concatenation Routing with Applications to Network Functions Virtualization

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Outline

- Network Function Virtualization (NFV) and ChoiceNet
- Graph Model
- Algorithm
- Results
- Future Work

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NFV

- Decouple Network Service Functionality from underlying Hardware.
- Network Service Orchestration of
  - ❑ Geographically separated services.
  - ❑ Services which are in different Provider domains.

ChoiceNet

- Motivation : Why ChoiceNet?
  - ❑ Innovation at the core network
- What is an Open Marketplace and why do we need it?
  - ❑ Allow economics and technology interaction.
  - ❑ Foster a free and open society
- What do we hope to accomplish?
  - ❑ Provide Choice while selecting network services

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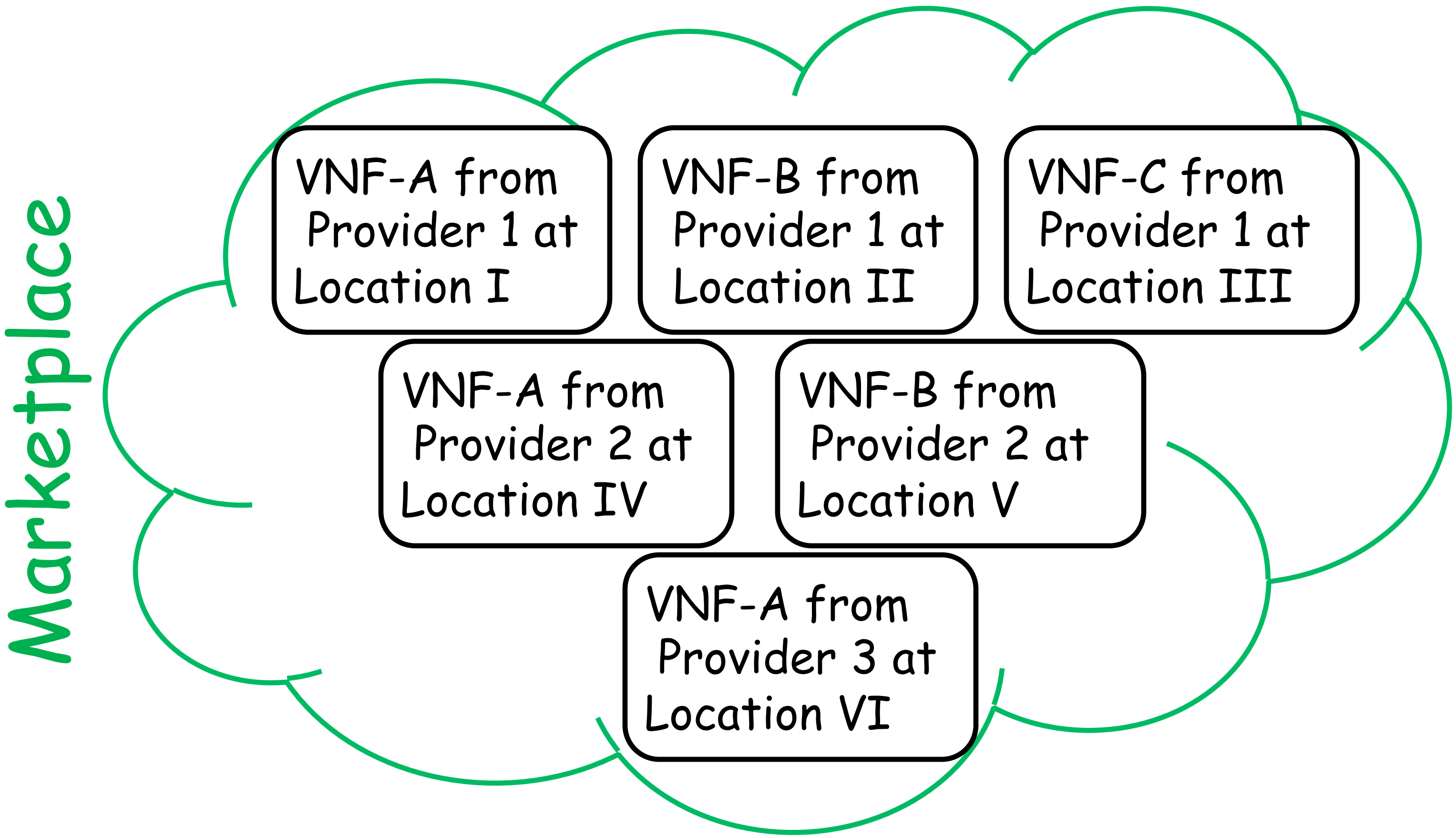
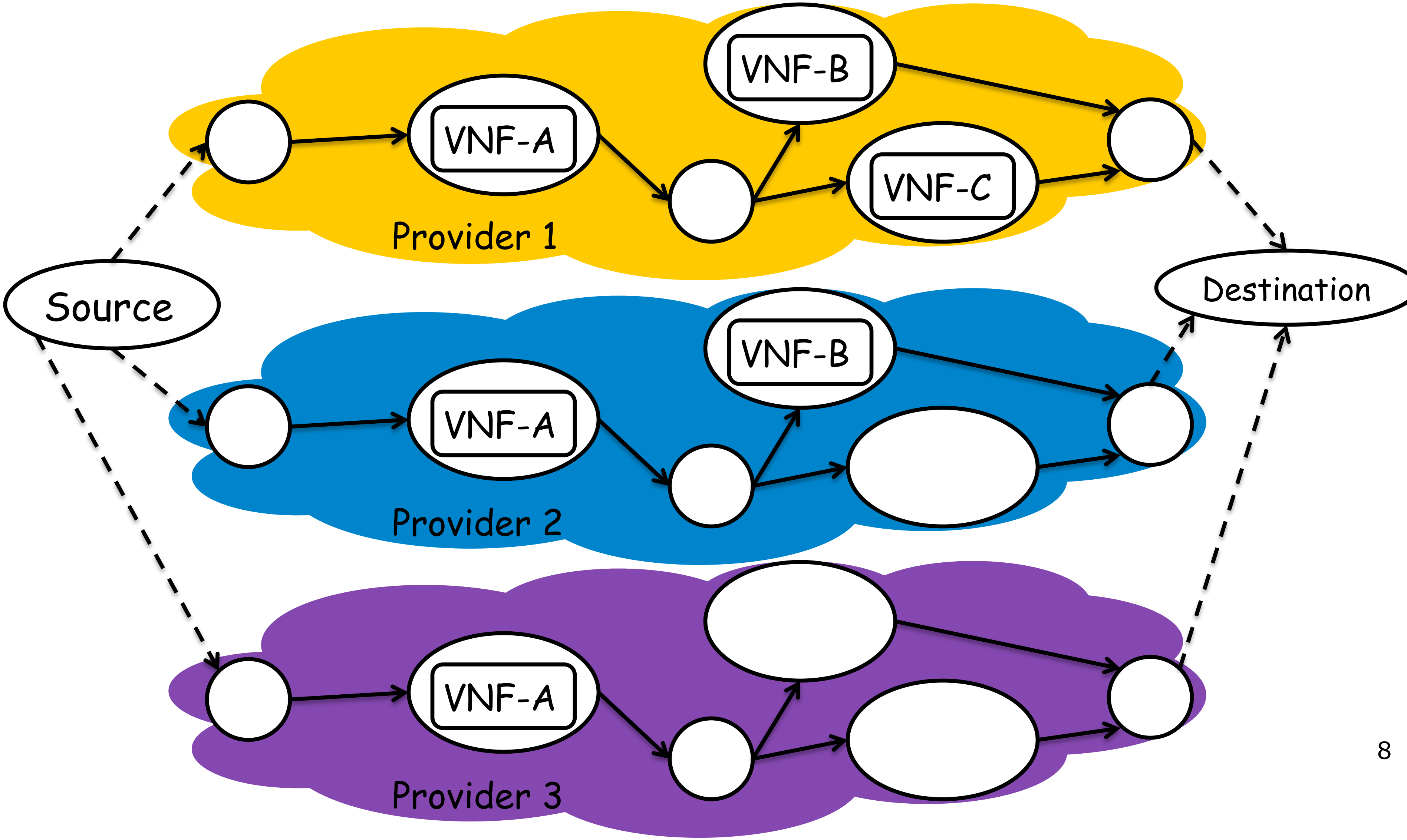
NFV Model in the context of ChoiceNet



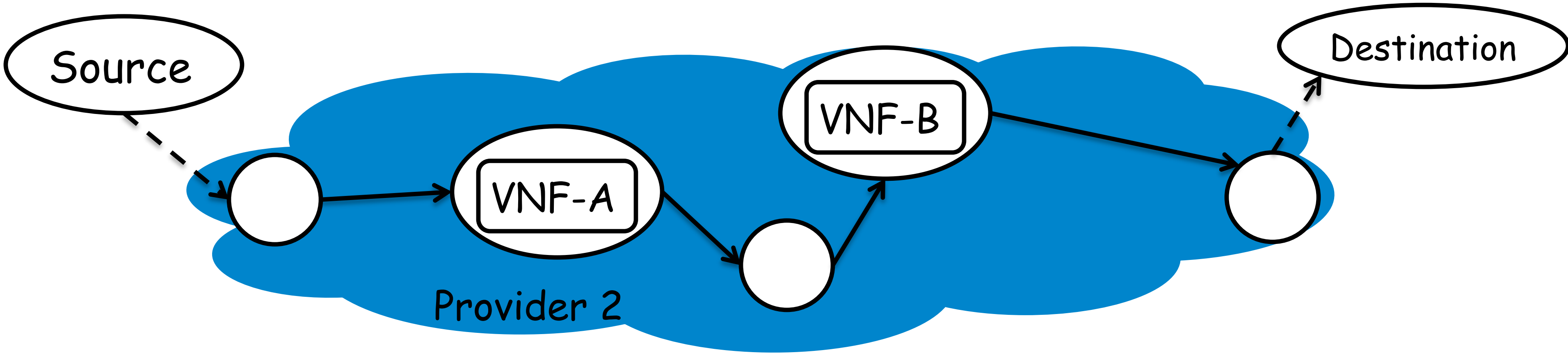
NFV Graph: Example



NFV Graph: Example (continued)

Set I = {I, IV, VI}

Set II = {II, V}



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Problem 5: SPTP Definition

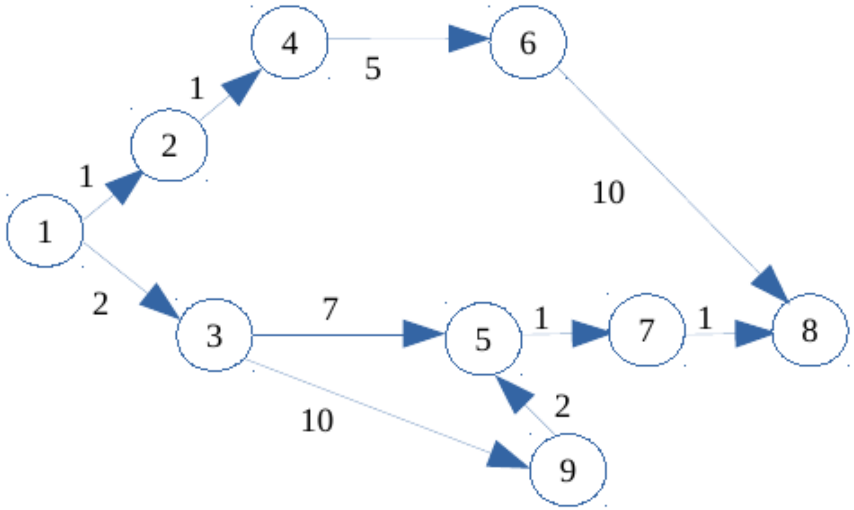
- *Given*
  - *a graph $G = \{N, E\}$ where N is the set of nodes and E is the set of edges,*
  - *a source node s and a destination node d, $s, d \in N$, and*
  - K *non-empty ordered node sets $S_1, S_2, \ldots, S_K$, such that $S_i \subset N$, $i = 1, \ldots, K$,*
- *find the shortest path from s to d under the constraint that the path visit one node $n_i \in S_i$ of every set S_i,*

  $i = 1, \ldots, K$, in the given order, i.e., $n_1, n_2, \ldots, n_K$.

Algorithms Classification for SPTP

- Path Tour Decomposition
  - ❑ All Pair Shortest Path (APSP)
  - ❑ Multiple Pair Shortest Path (MPSP)
  - ❑ Single Source Shortest Path (SSSP)
- Layered Graph Model
- Depth First Tour Search (DFTS) (Our Algorithm)

DFTS: Example



Suppose s = 1, d = 8, S_1 = {4,5,9}, and S_2 = {6,7}

Iteration	F_1	F_2	F_3
1	{1}	{}	{}
2	{1,2}	{}	{}
3	{1,2,3}	{}	{}
4	{1,2,3,**4**}	{4}	{}
5	{1,2,3,**4**}	{4,**6**}	{6}
6	{1,2,3,**4**,**5**}	{4,**6**,5}	{6}
7	{1,2,3,**4**,**5**}	{4,**6**,5,**7**}	{6,7}
All nodes in S_2 have been explored before nodes in S_1. So we stop exploring nodes in F_1 and F_2.			
8	NA	NA	{6,7,**8**}
Shortest tour path found: 1, 3, 5, 7, 8 with cost 11.			

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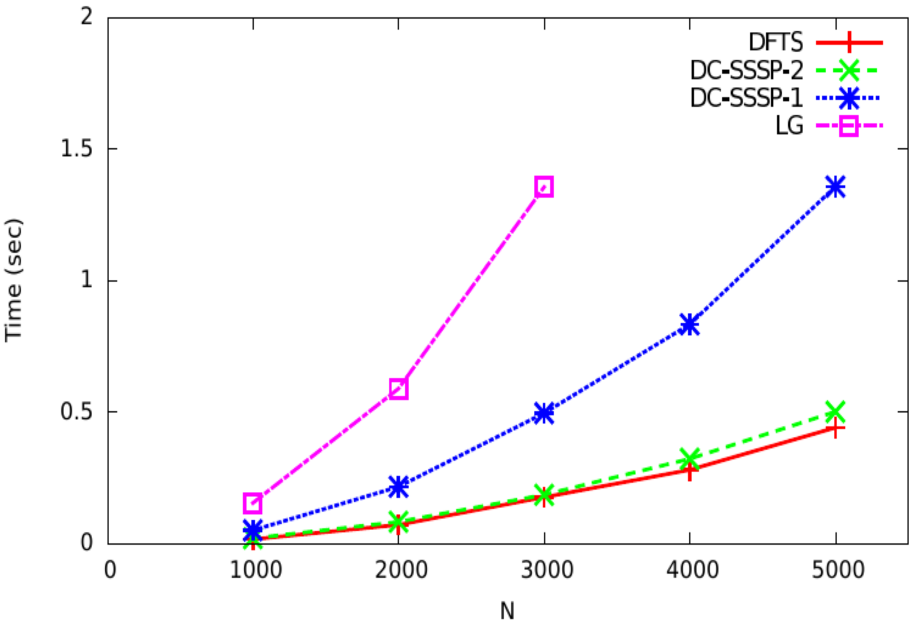
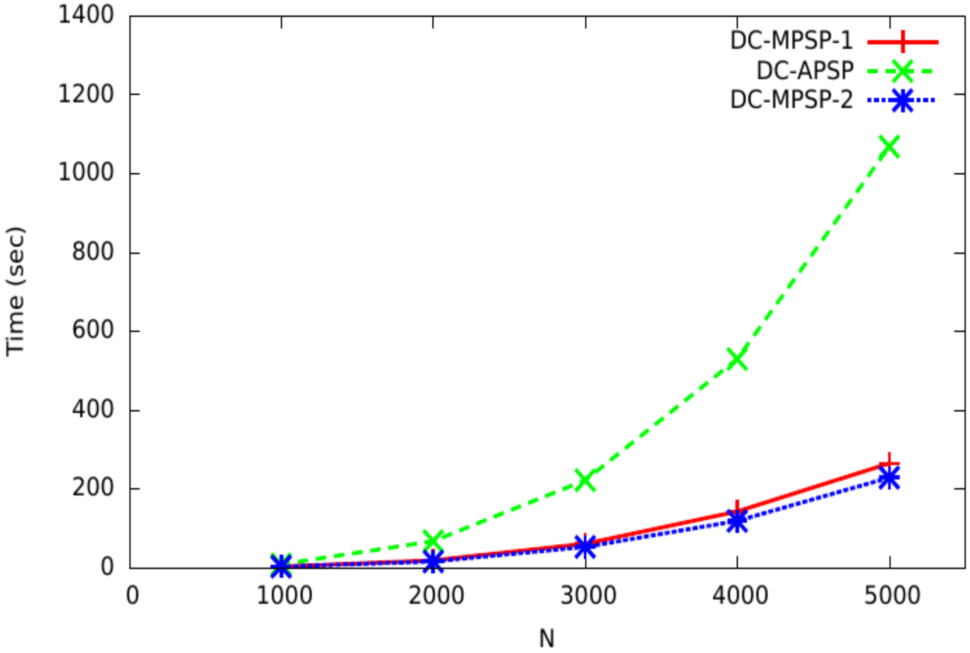
SPTP: Notation

- N = Number of Nodes in Graph
- Δ = Average Nodal Degree of Graph
- K = Number of sets in the Tour
- M = Number of nodes in each set

Evaluation of various Algorithms for SPTP

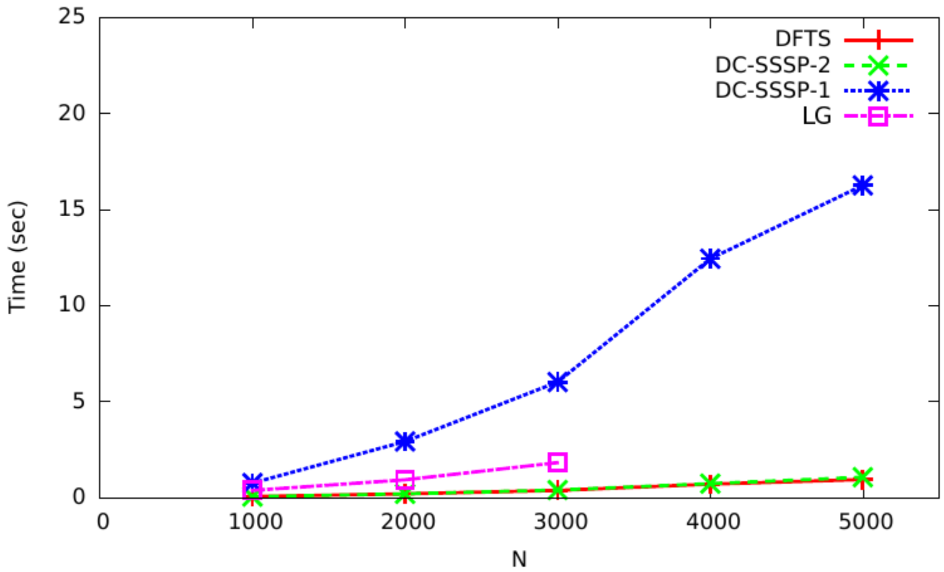
(Δ = 3, K = 2, M = 5)

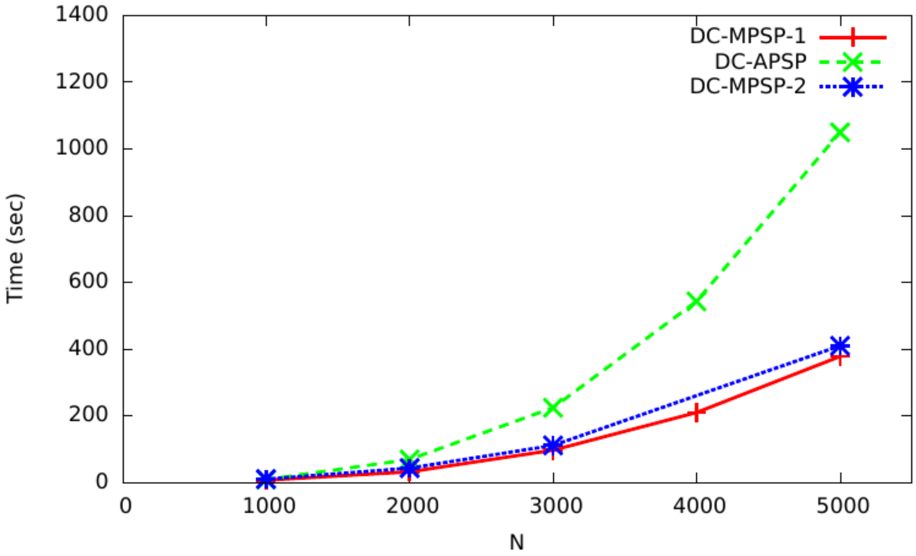




Evaluation of various Algorithms for SPTP

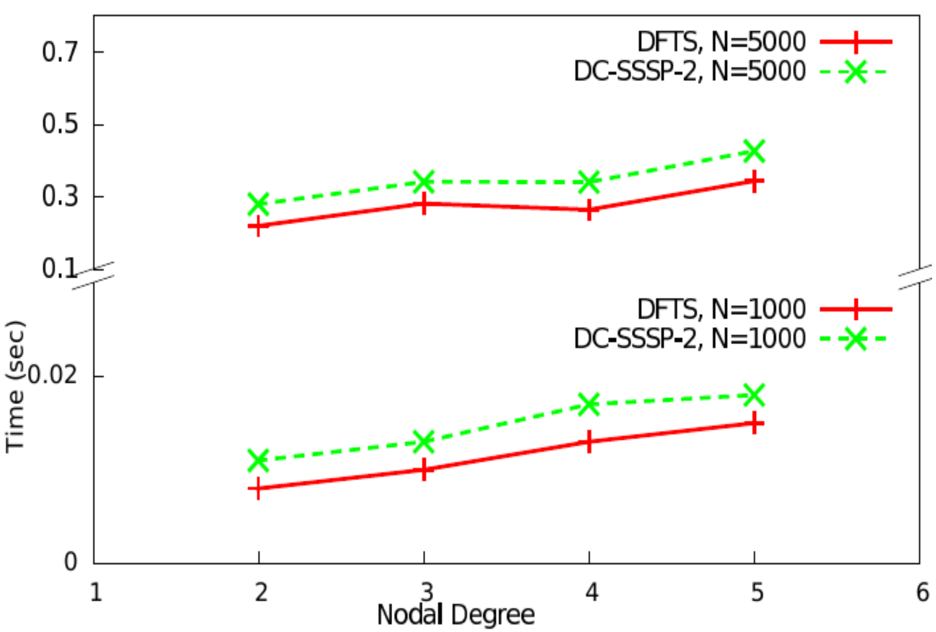
(Δ = 5, K = 4, M = 25)

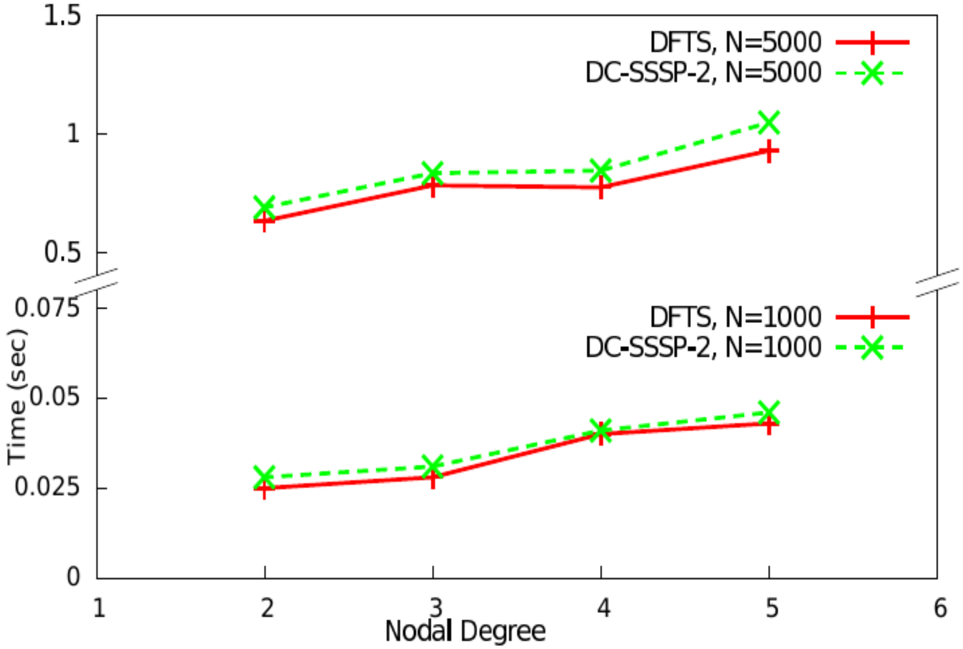




Evaluation of various Algorithms for SPTP

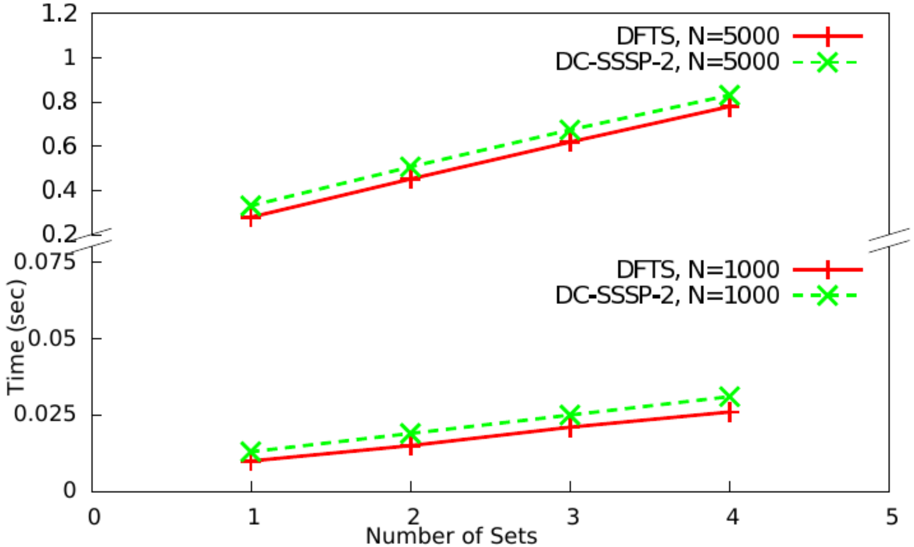
{(K = 1, M = 5), (K = 4, M = 25)}

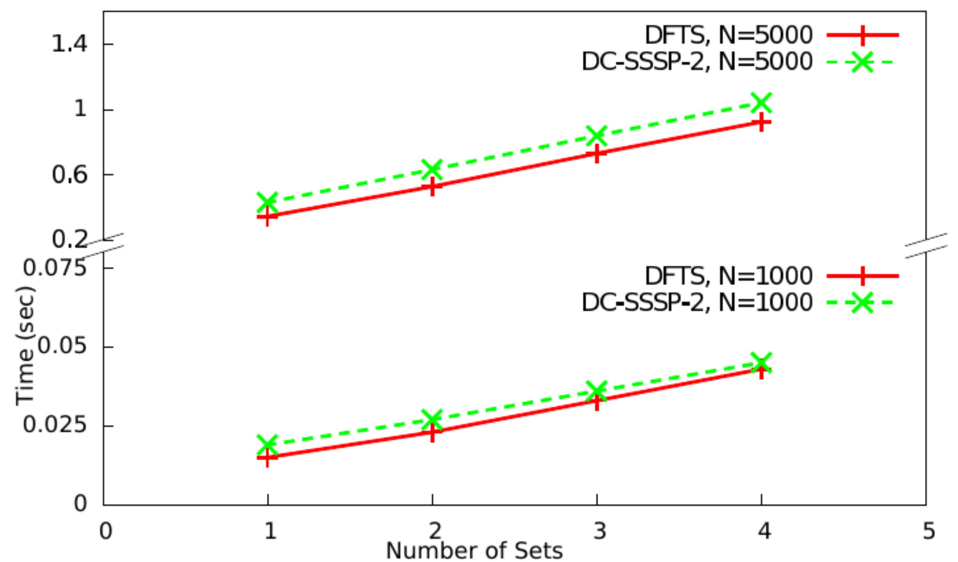




Evaluation of various Algorithms for SPTP

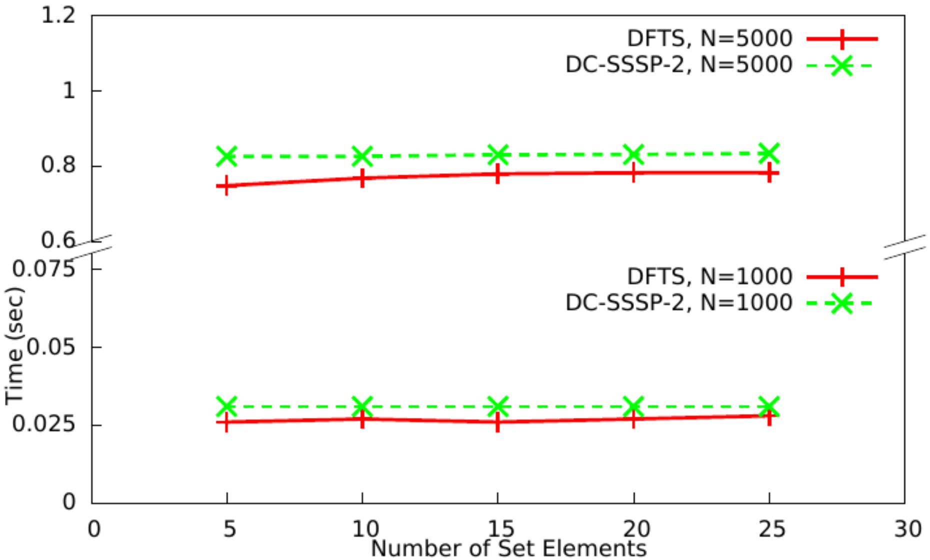
{(Δ = 3, M = 15), (Δ = 5, M = 15)}

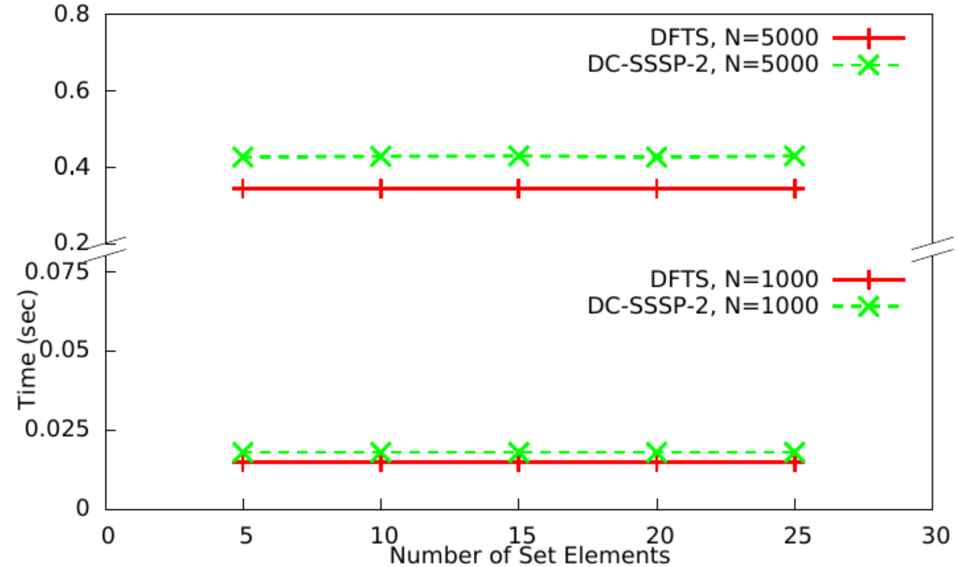




Evaluation of various Algorithms for SPTP

{(Δ = 3, K = 4), (Δ = 5, K = 1)}





SPTP: Summary

- A Generic Decomposition Algorithm
- A novel algorithm which uses DFS
- Application to NFV
- Application to route/trip planning algorithms

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Future Work

- Service Placement
  - ❑ A Planner which works for the Providers
  - ❑ Network Design
  - ❑ Planning based on historical data and expected user demands – Static
  - ❑ Planning based on current user demands – Dynamic
  - ❑ Scale Up or Scale Down

Thank You!