


Dedicated Protection Scheme with Availability Guarantee

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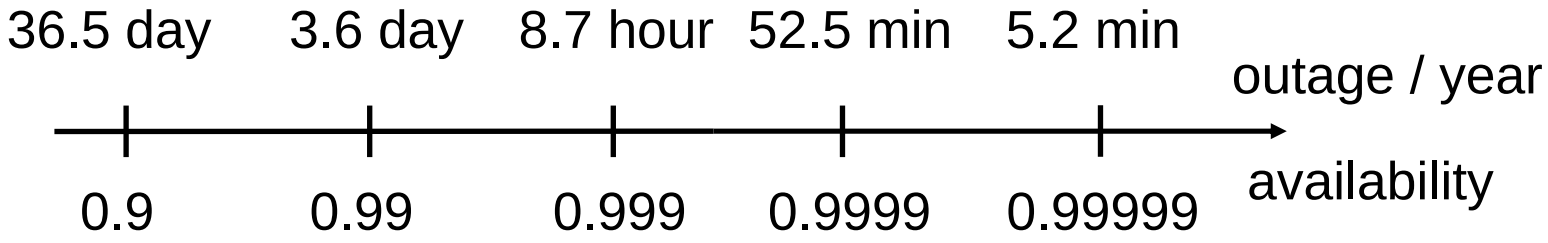
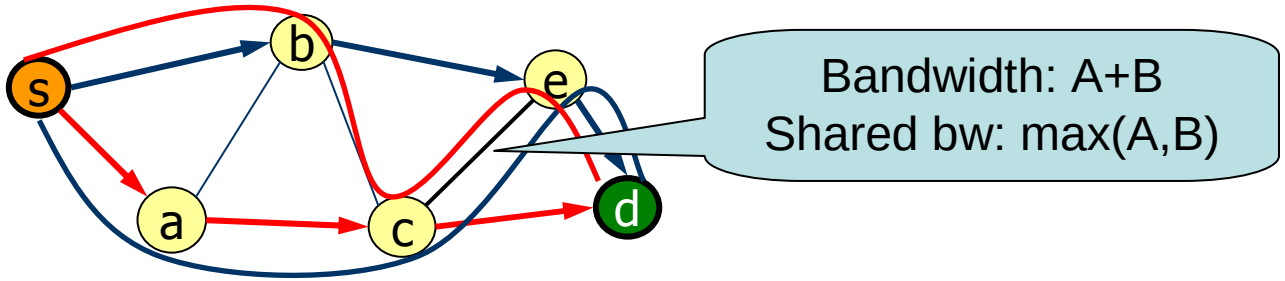
End-to-End Service Availability Guarantee

- Using only one path in the network (called **working path**) for sending user's data may not suffice high availability requirements
- Using more paths (called **protection path(s)**)
  - High availability is reachable
  - Using resources in an economic way

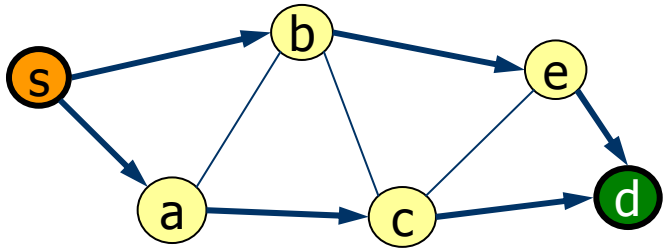


Protection shemes in optical environment

- **Shared Protection** shemes are rarely installed by service providers because of they complexity

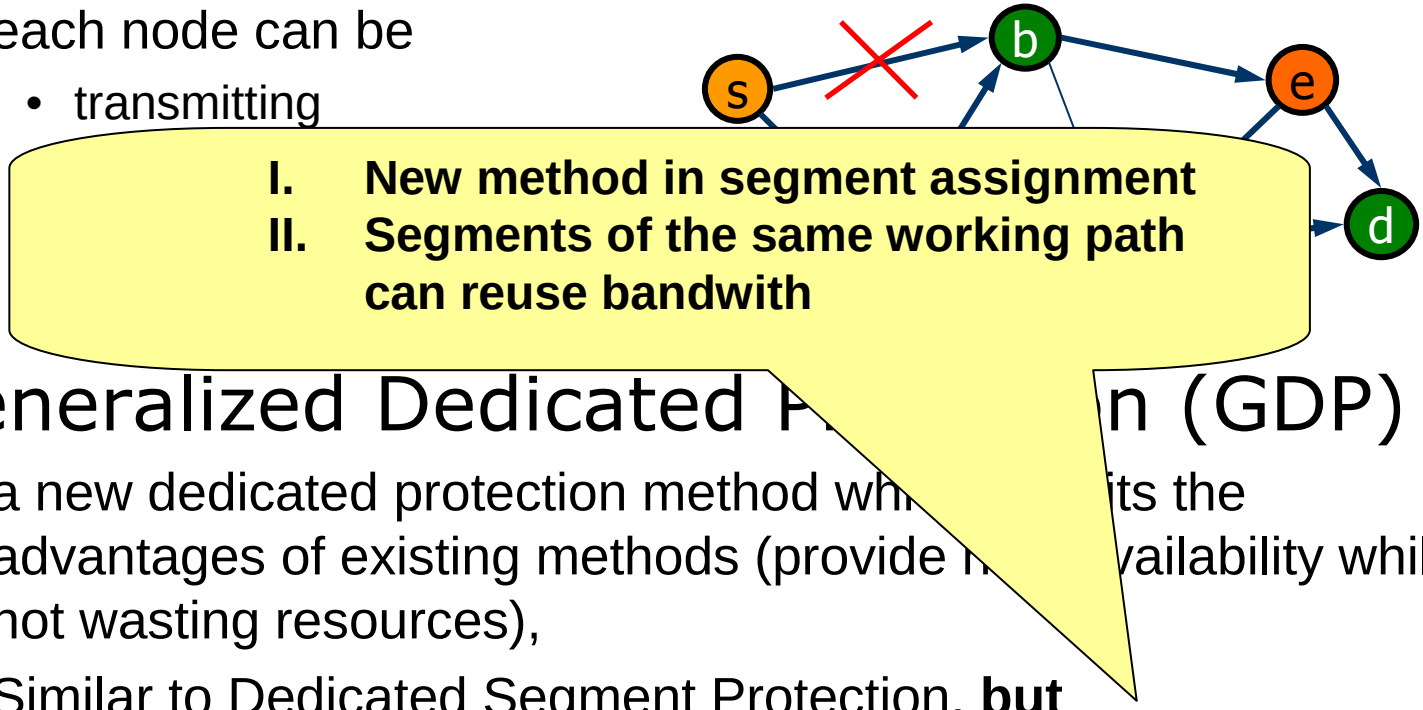


- **Dedicated Path Protection** (DPP, 1+1) shemes are often used because of their simplicity, but they have limited availability guarantee abilities



Protection shemes in optical environment (2)

- **Dedicated Segment Protection** can guarantee a given availability level but wasting resources
  - each node can be
    - transmitting

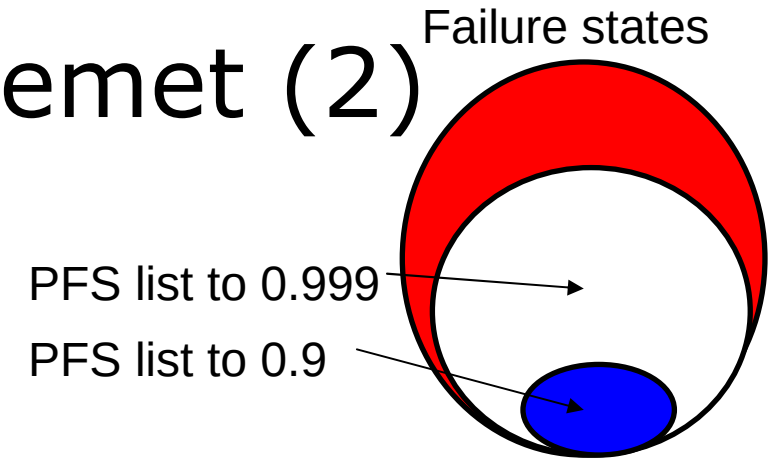


- Generalized Dedicated P n (GDP)
  - a new dedicated protection method wh its the advantages of existing methods (provide h vailability while not wasting resources),
  - Similar to Dedicated Segment Protection, **but**

I. Segment assignemet

- Our segment assignemet is built on **failure dependencies** contrary with most of the existing methods
  - wrong router drags down some of the neighboring routers sending faulty packages
  - in case of conduit cut a great number of connections has failed at the same time
- A **long list** of network failures worked out by the service provider is given
- A **failure state (FS)** represents the current state of the network after one failure occured

I. Segment assignemet (2)



- A failure state contains the
  - failed network elements
  - stationary probability P(x)
    - In reality: measurements, a failure list is available
    - In paper: generating based on independent failure events
- A FS selected to protect a given availability level is a Protection Failure State (PFS)
  - when a connection protects a PFS, the P(x) of the PFS can be added to it's availability
- For each provided availability class a **global list of PFS** is generated

II. Generalized Dedicated Protection Routing Problem (GDP-RP)

- ***Given:***
  - ***G(V,E)*** representing the GMPLS network topology, where forall **e**$\in$***E*** a c_e cost function is given
  - Source ***s*** and destination ***d*** node of the connection
  - C_g PFS list. Forall $PFS_a \in C_g$ a $G_a(V,E_a)$ subgraph is given, where E_a denotes the edges PFS_a NOT contains
- **Find:**
  - A ***H(V,E')*** subgraph in ***G(V,E)***, that forall $G_a(V,E_a)$ PFS_a graph contains path between ***s*** and ***d***
    - In this case the connection is available in all PFS state in C_g, which means the connection availability is at least ***g***

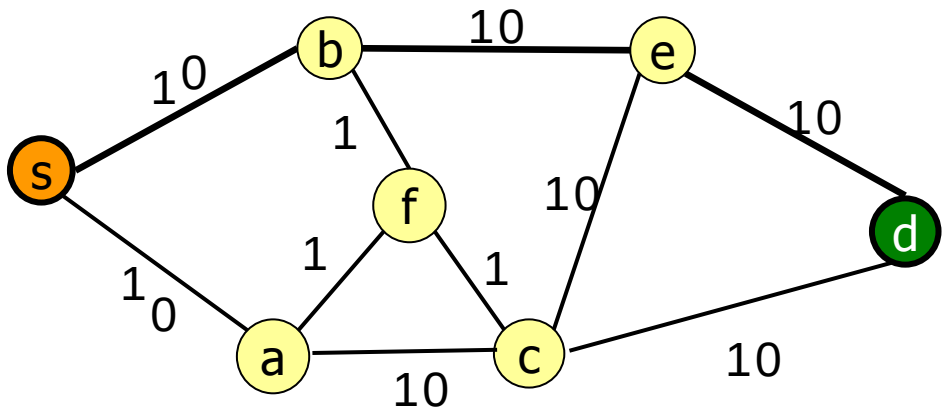
II. GDP-RP Dijkstra heuristic

- The problem is NP hard
  - if the number of sub-graphs are part of the input
- A simple heuristic using shortest path search provides a decent performance

G_1

G_2

G_3



PFS_1={(s,b)}

PFS_2={(b,e), (c,d)}

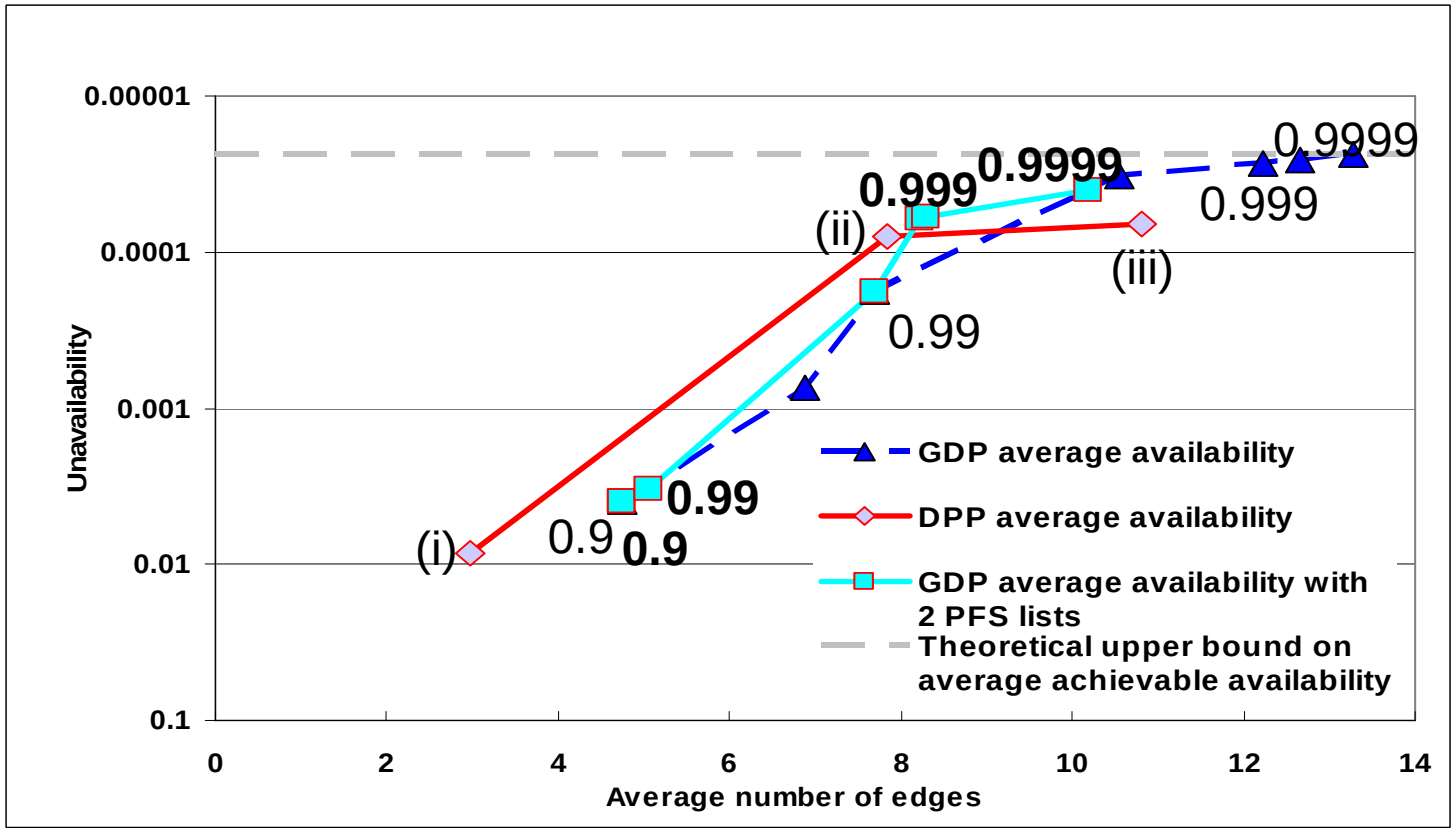
PFS_3={(e,d)}

II. GDP-RP Dijkstra heuristic improvements

- Problems:
  1. The resulted subgraph depends on the order of $G_a (V,E_a)$ PFS graphs
  2. As we use only one PFS list for each service class, some connections recieve much higher availability then they payed
- Solutions
  1. Removing redundant edges (or run the heuristic more times with differrent graph order)
  2. Using more PFS lists per availability class

Simulation results

- 37 nodes,114 directed edges
- 836 PFS in the 0.9999 availability list
- About 100 ms running time in average
- All connection recieves guaranted availability with GDP
- GDP performs even better in **reserved capacity** than 1+1+1 DPP



Conclusions

- Novel failure model based on provider observations on failure dependencies
- Novel framework of survivable routing methods was given
- The goal is to guarantee availability for each connection
  - Reaching the limitation of the topology
- Simple to implement
  - The simplest heuristic method provides a decent performance in backbone topologies