Multilayer Survivable Optical Network Design

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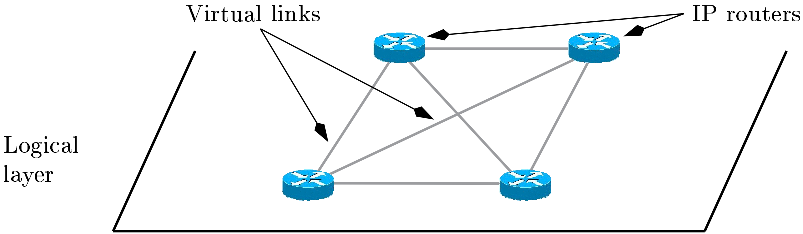
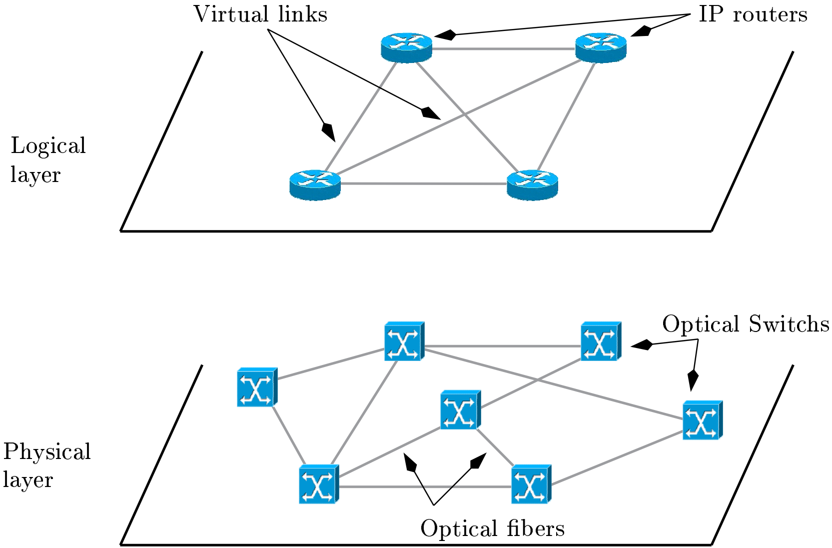
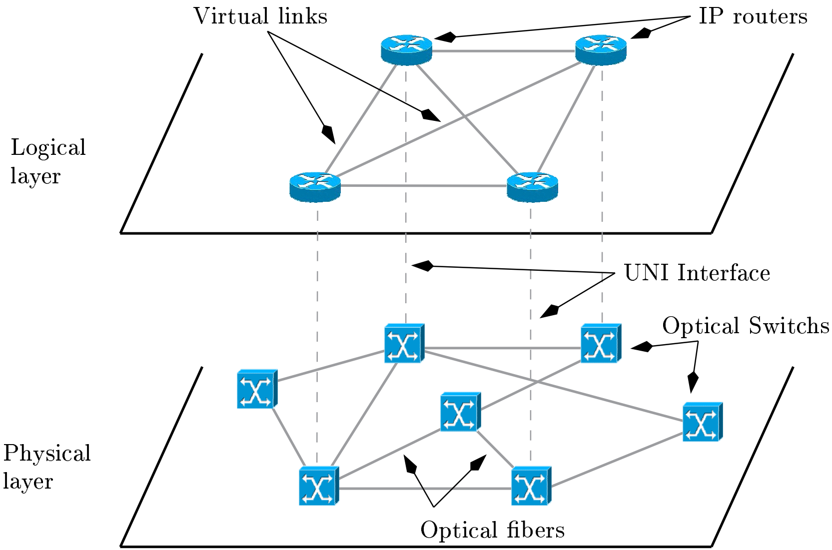

Virtual links
IP routers
Logical layer


Virtual links
IP routers
Logical layer
Optical Switchs
Physical layer
Optical fibers


Virtual links
IP routers
Logical layer
UNI Interface
Optical Switchs
Physical layer
Optical fibers

MSOND

Data

- a bilayer network $(G_1 = (V_1, E_1)$ and $G_2 = (V_2, E_2))$;
- to every router $v_i \in V_1$ corresponds an optical switch $w_i \in V_2$;
- a set K of demands between pairs (O_k, D_k) ;
- for each demand, we know two routing paths L_k^1 et L_k^2 node-disjoint in the higher layer ;
- for each physical edge $e \in E_2$ in the lower layer $\longmapsto$ an installation cost c_e ;
- G_2 complete, infinite capacities on the edges.

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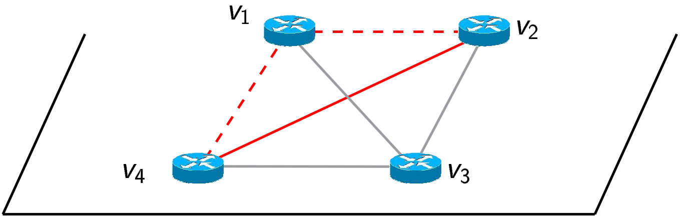
Objective

find for each demand two elementary physical node-disjoint paths respecting the routers order in L_k^1 and L_k^2 such as installation's total cost is minimum.

Example(1)

Logical layer



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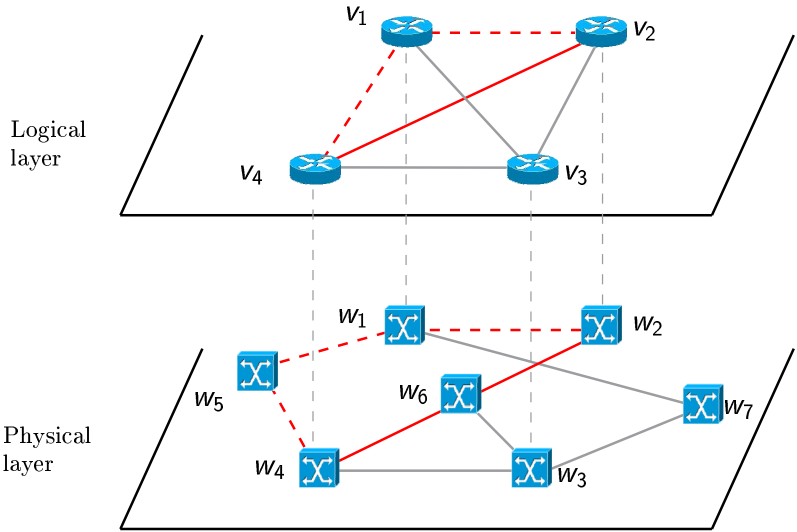
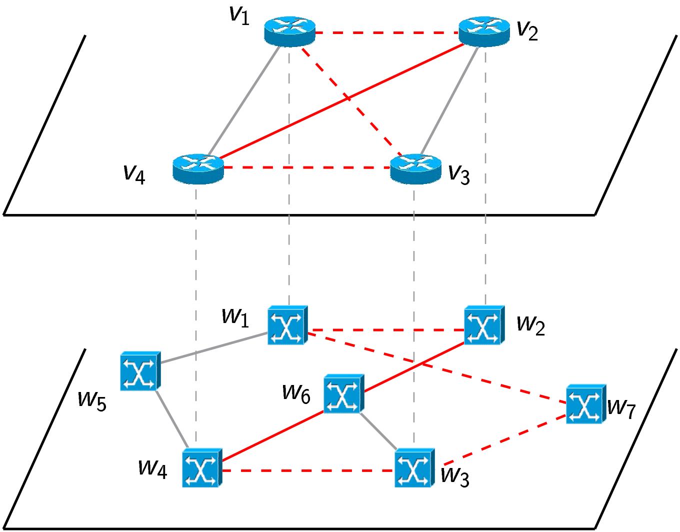


Example(2)

Logical layer



Physical layer

Motivations

1. importance of survivability in the telecommunication context ;

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2. tight relationship with some classical problems and in particular the TSP problem ;

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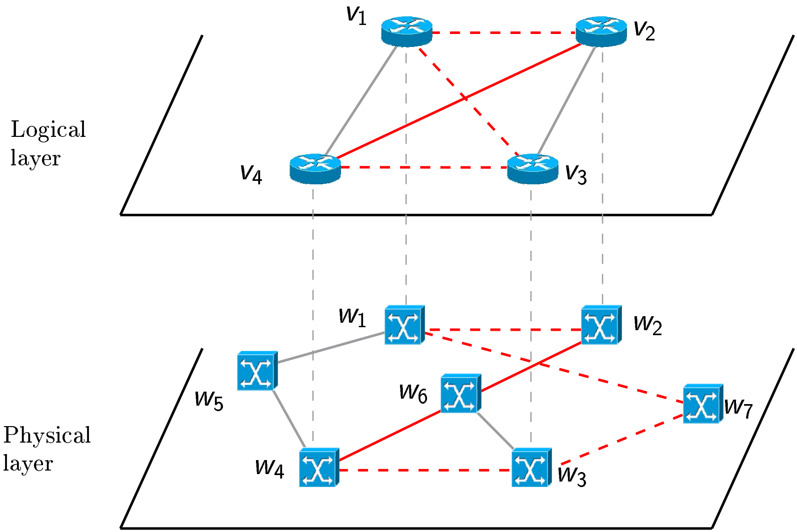

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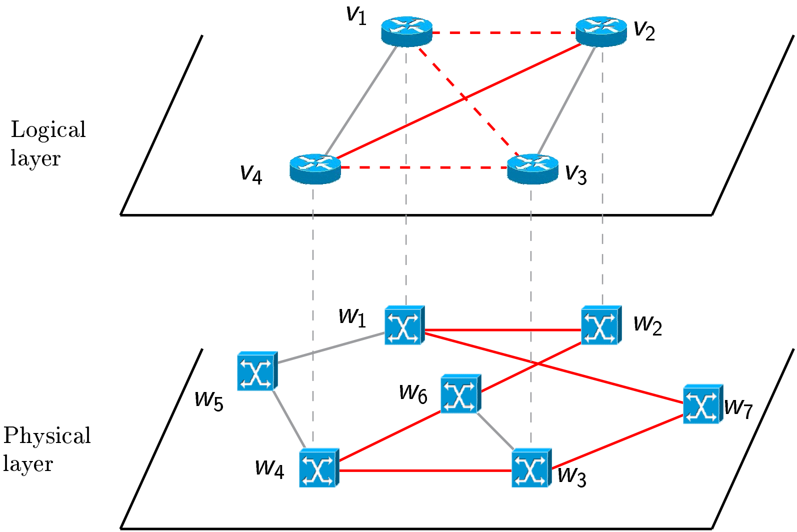
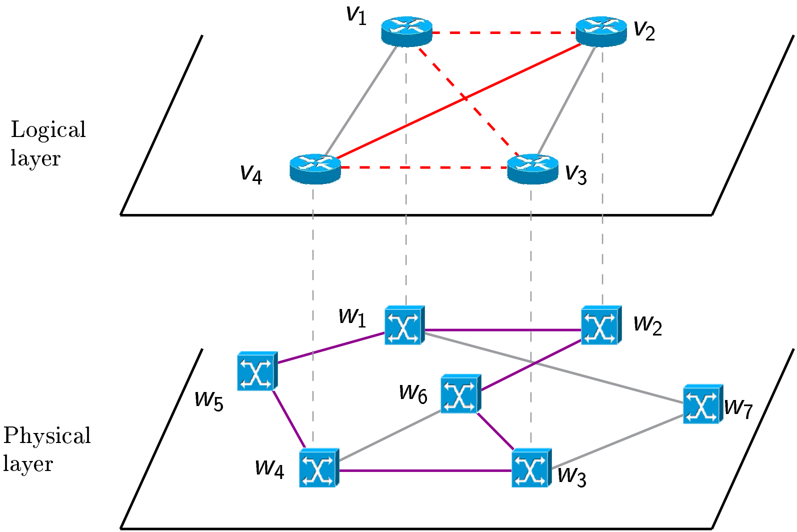


Example(3)



Particularities

1. Elementarity ;
2. Steiner and terminal nodes ;
3. Precedence constraint.

Classical Related Problems (1)

Problem	elementarity	Steiner	Order	Complexity
Shortest Path Problem with specified nodes		x		polynomial (special cases) Bajaj (1971), Ibaraki (1973), Laporte (1984), Volgenant (1987)
Steiner cycle		x		- polynomial (series-parallel graphs, graphical case) Cornuejols and al. (1985)
Steiner TSP	x	x		- complete polyhedral description (series-parallel graphs) Baiou and Mahjoub (2002) - NP-hard Salazar-Gonzalez (2003) - approximation results Steinová (2009)
TSP with precedence constraints Sequential Ordering Problem (Hamiltonian Path with PC)	x		x	NP-hard Balas and al. (1993), Ruland (1997), Gouveia and pesneau (2006), Dumitrescu and al. (2005, 2008), Acheuer and al. (1995, 2000)

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SC-MSOND	x	x	x	complexity ?

Motivations

1. importance of survivability in the telecommunication context ;
2. tight relationship with classical problems and in particular the TSP problem ;
3. NP-hard even for a single commodity (except for some special cases).