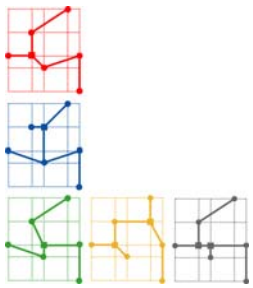
Steiner Min/Max Tree Routing

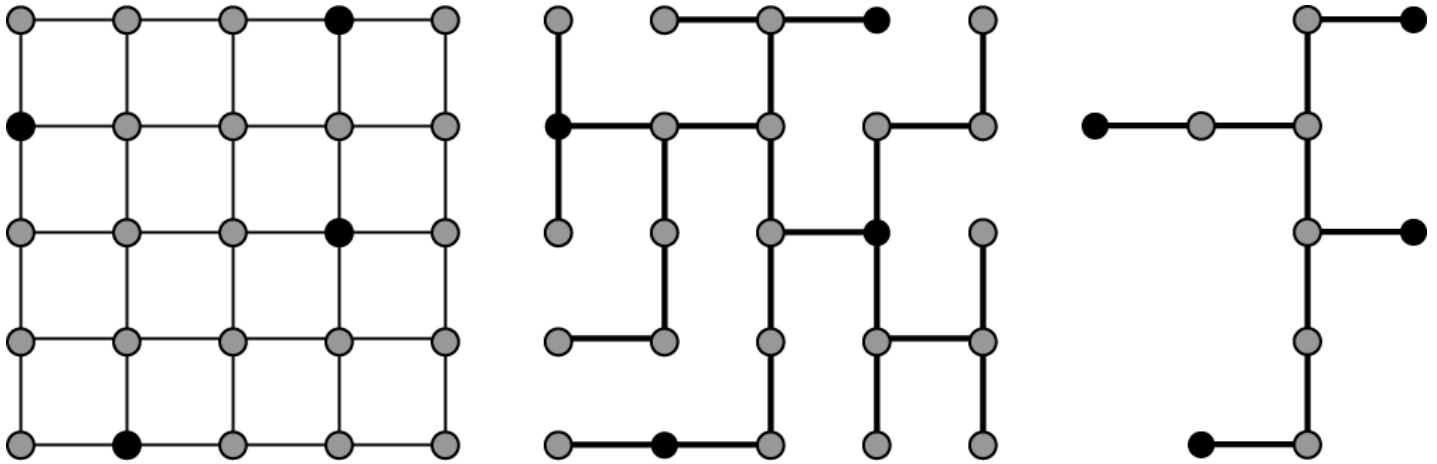
- Route the nets onto 5×5 grid
  - Edge capacity is 3
  - Route nets in the given order
  - Two phases: SMMT-phase (use $c_j = 2.0$) and SP-phase

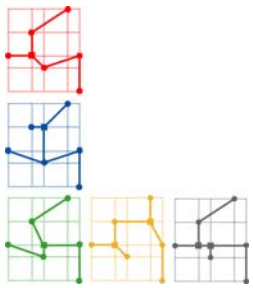
$n_1 = \{(1,0), (0,3), (3,2), (3,4)\}$
$n_2 = \{(0,2), (3,0), (4,3)\}$
$n_3 = \{(1,1), (2,2), (4,0), (4,4)\}$
$n_4 = \{(0,0), (2,1), (1,3), (4,1), (2,4)\}$
$n_5 = \{(2,0), (0,4), (4,2), (3,3)\}$



SMMT-Phase

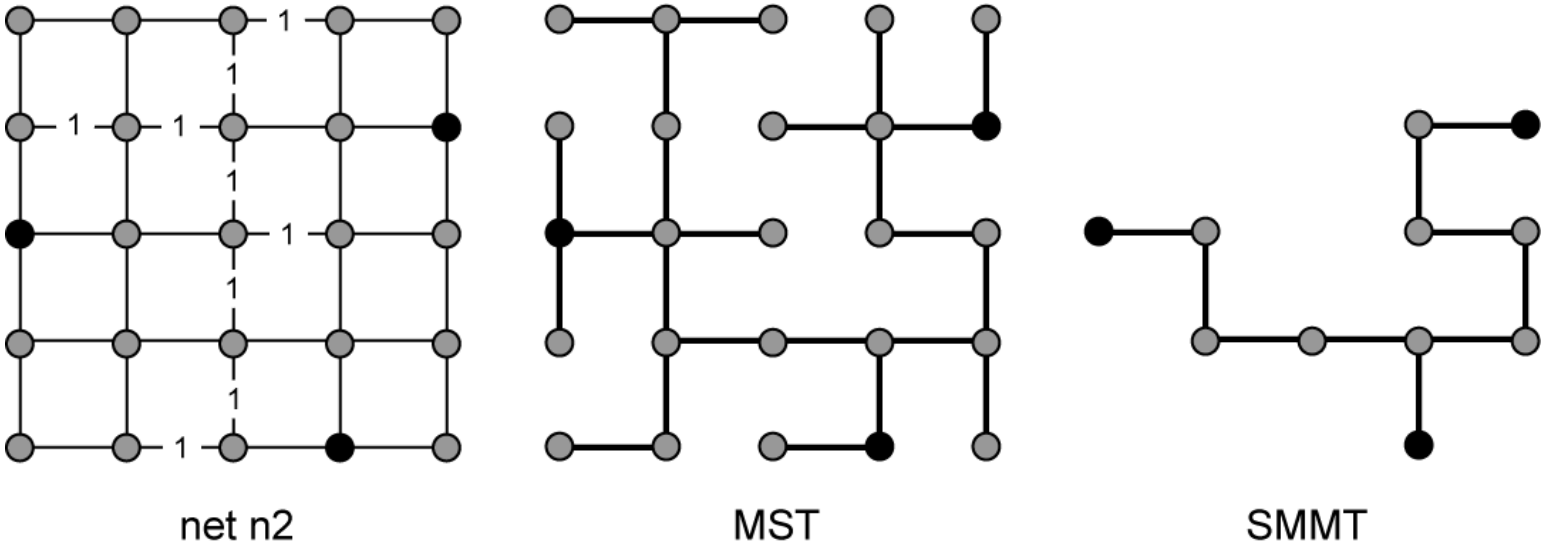
- Route first net
  - Net n_1: HPBB = 7, edge weights = 0 (no edge usage yet)
  - MST is not unique
  - SMMT: max-weight = 0, wirelength = 9 < 2.0 (= c_j) × 7

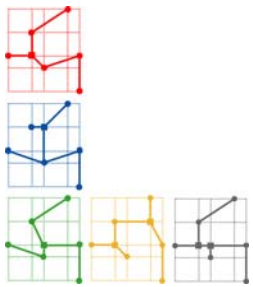




SMMT-Phase

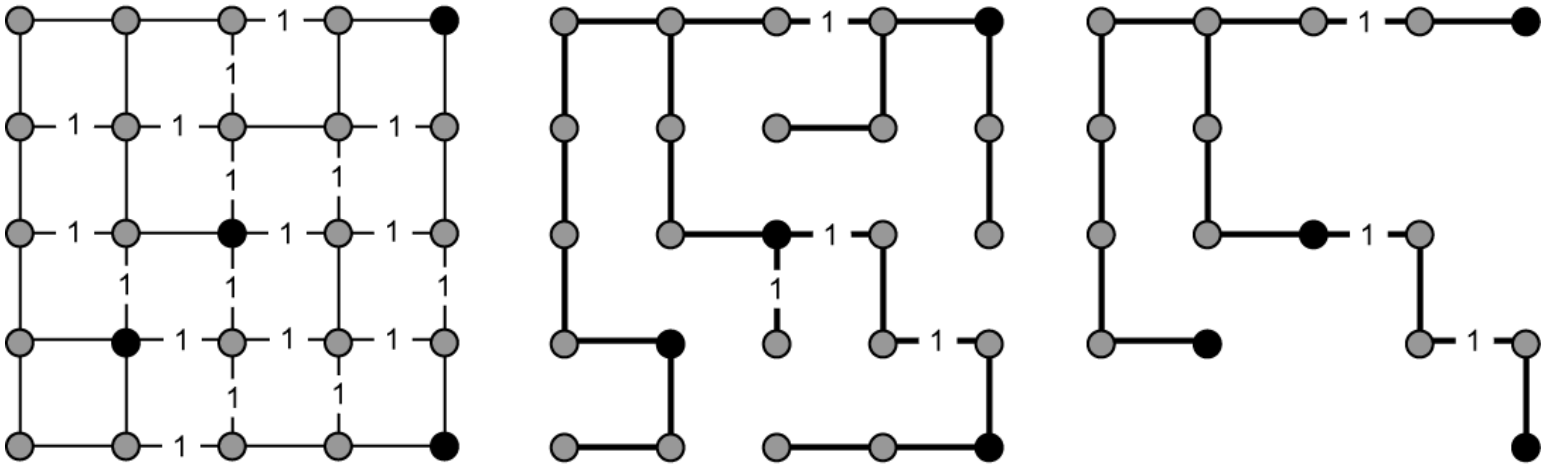
- Route second net
  - Net n_2: HPBB = 7, edge weights reflect routing of n_1
  - SMMT: max-weight = 0, wirelength = 10 < 2.0 × 7





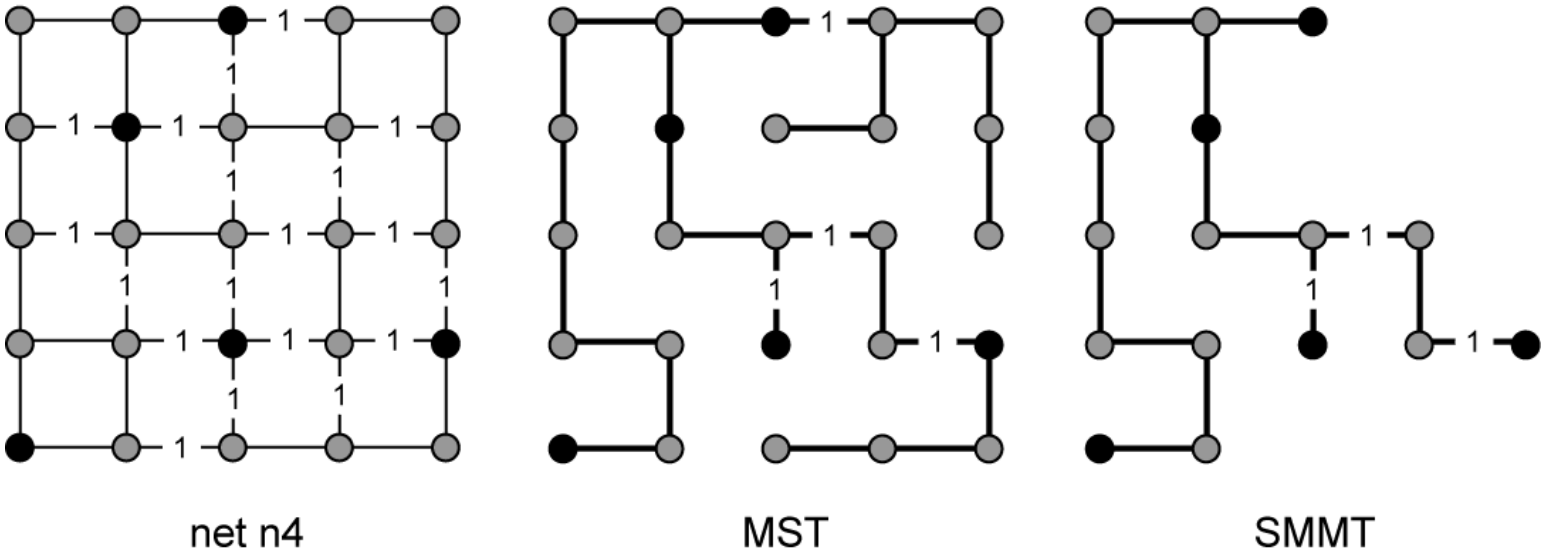
SMMT-Phase

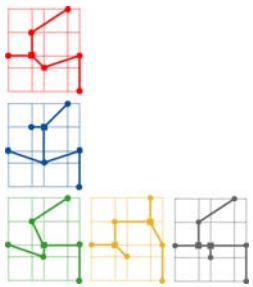
- Route third net
  - Net n_3: HPBB = 7, edge weights reflect routing of n_1 and n_2
  - SMMT: max-weight = 1, wirelength = 15 > 2.0 × 7 !!
  - So we reject this SMMT (routing failed)



SMMT-Phase

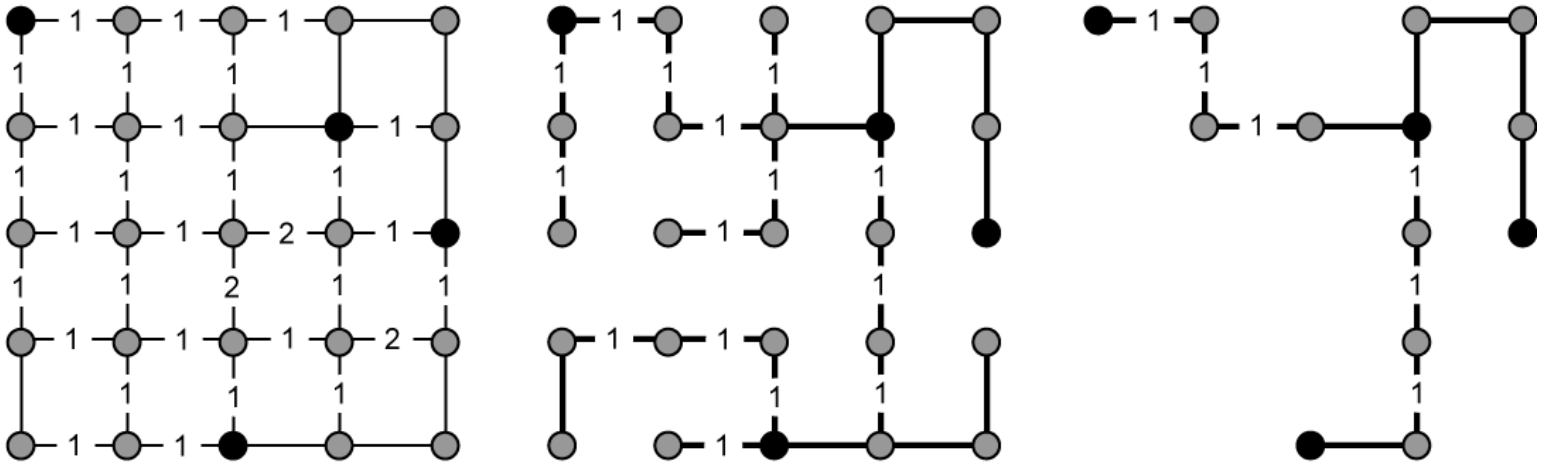
- Route fourth net
  - Net n_4: HPBB = 8, edge weights reflect routing of n_1 and n_2
  - SMMT: max-weight = 1, wirelength = 15 < 2.0 × 8

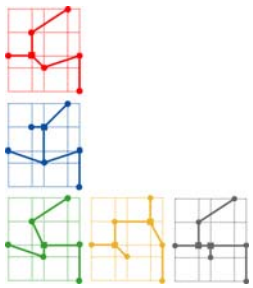




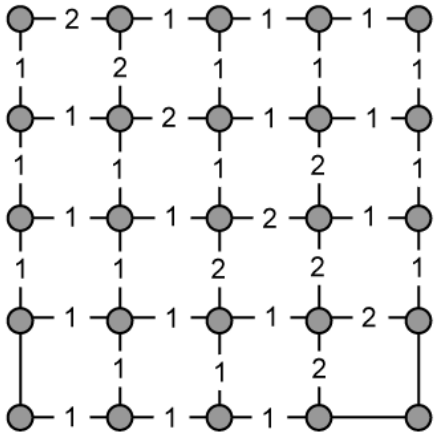
SMMT-Phase

- Route fifth net
  - Net n_5: HPBB = 8, edge weights reflect routing of n_1, n_2, n_4
  - SMMT: max-weight = 1, wirelength = 12 < 2.0 × 8

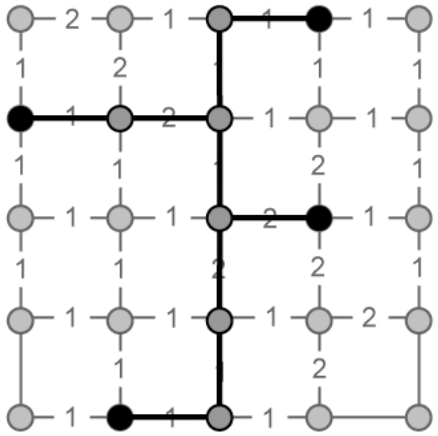




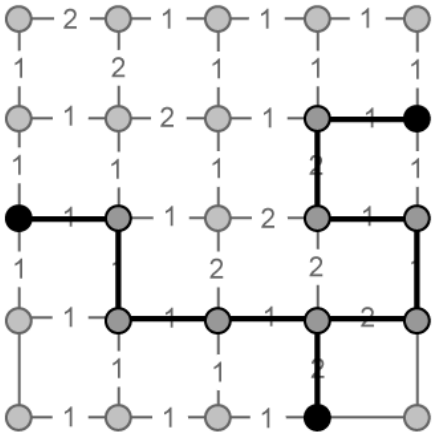
Summary of SMMT-Phase



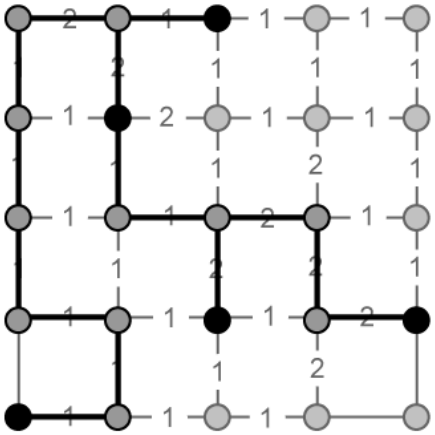
final routing graph



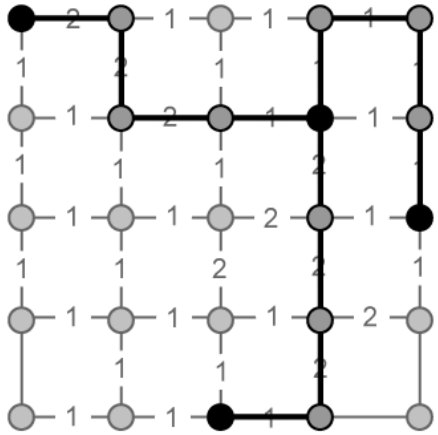
SMMT(n1)



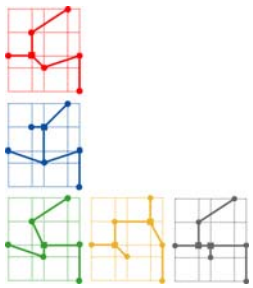
SMMT(n2)



SMMT(n4)

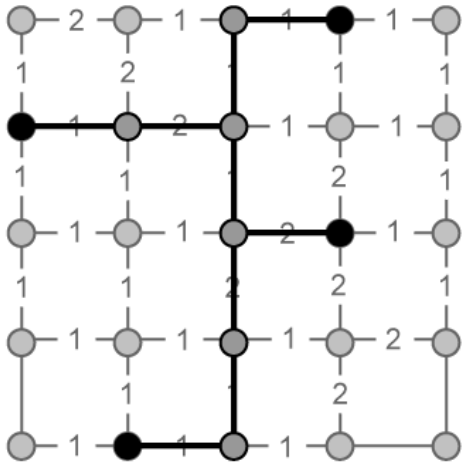


SMMT(n5)

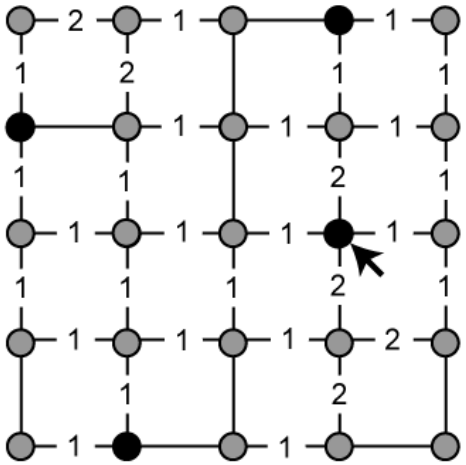


SP-Phase

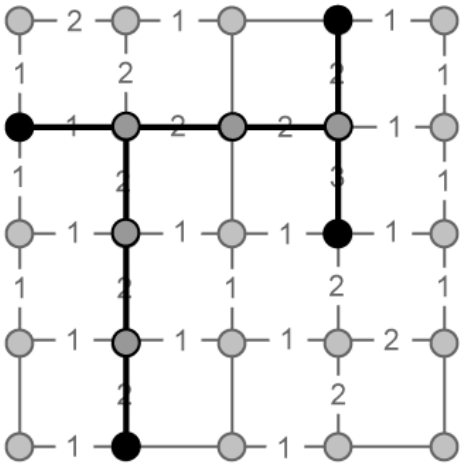
- Reroute first net
  - SMMT(n_1): wirelength = 9
  - Source node s: (3,2) (= arrow), geometric center among terminals
  - Sinks are added to s in this order: (3,4), (0,3), (1,0)
  - SP(n_1): wirelength = 8



SMMT(n1)



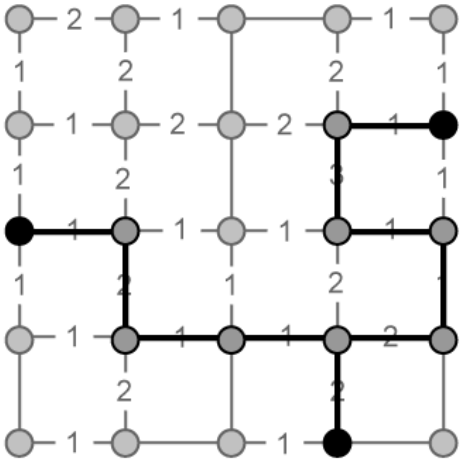
after ripping up SMMT(n1)



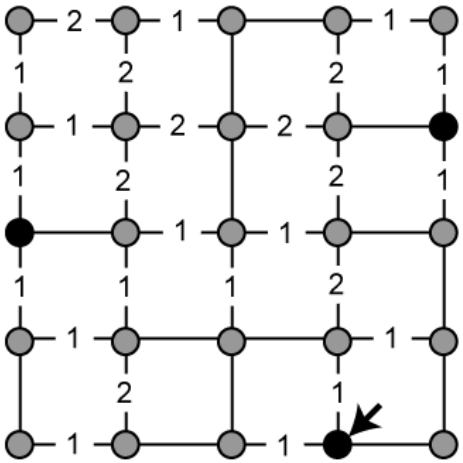
SP(n1)

SP-Phase

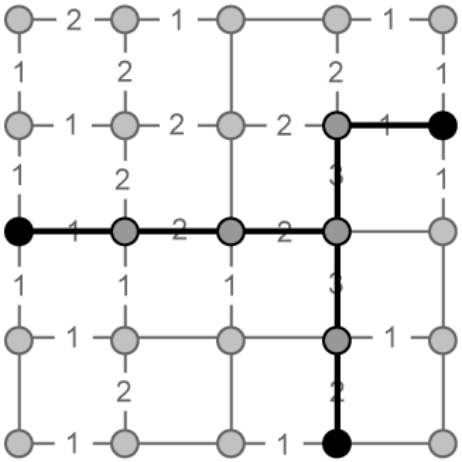
- Reroute second net
  - SMMT(n_2): wirelength = 10
    - Routing graph reflects rerouting of n_1, i.e., SP(n_1)
  - Source node s = (3,0), sinks are added (4,3), (0,2)
  - SP(n_2): wirelength = 7



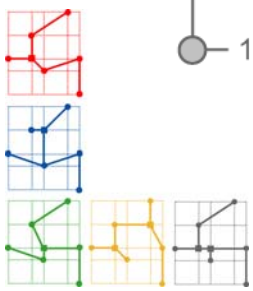
SMMT(n2)



after ripping up SMMT(n2)

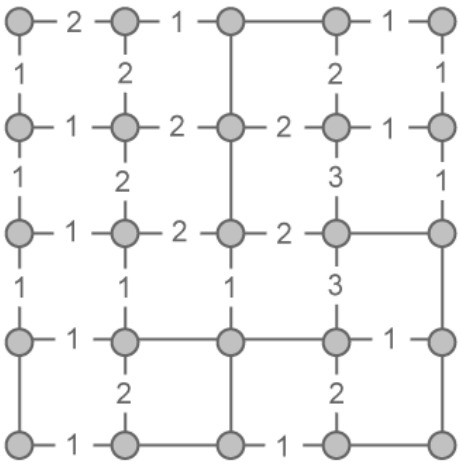


SP(n2)

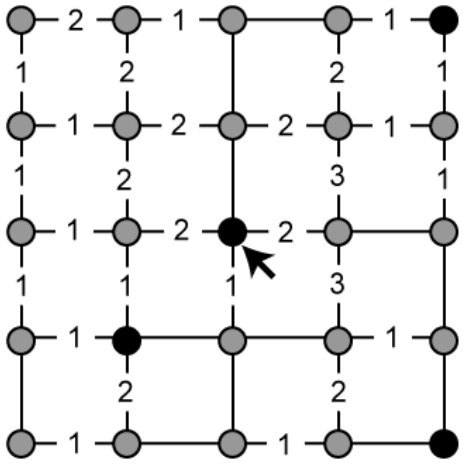


SP-Phase

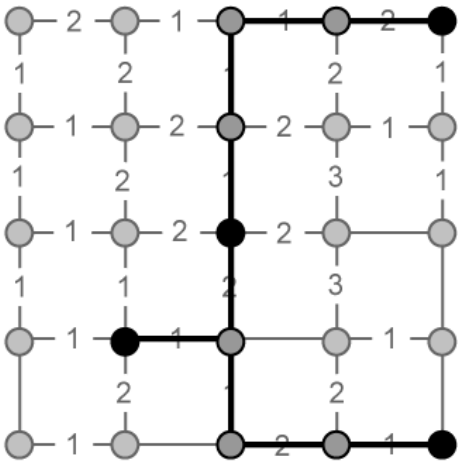
- Reroute third net
  - SMMT(n_3): does not exist due to routing failure
    - Routing graph reflects rerouting of n_1 and n_2
  - Source node s = (2,2), sinks are added (1,1), (4,0), (4,4)
  - SP(n_3): wirelength = 9



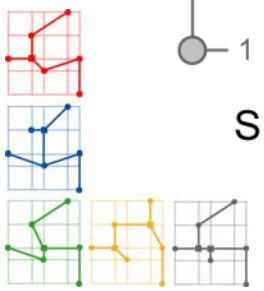
SMMT(n3) = empty



after ripping up SMMT(n3)

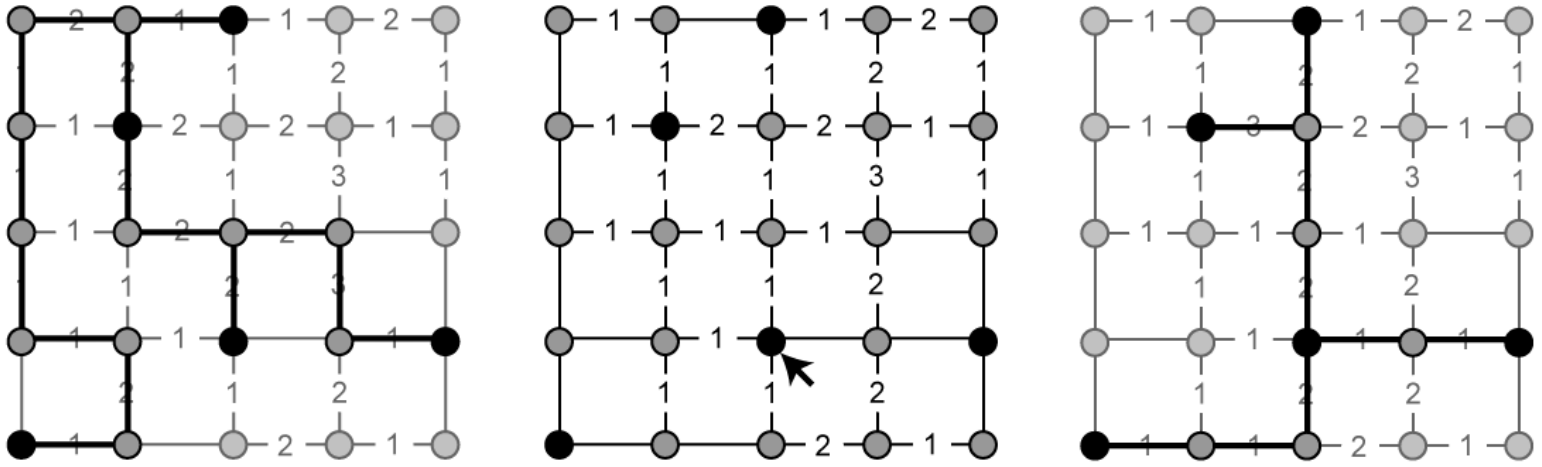


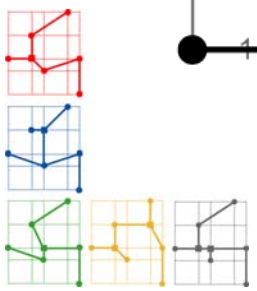
SP(n3)



SP-Phase

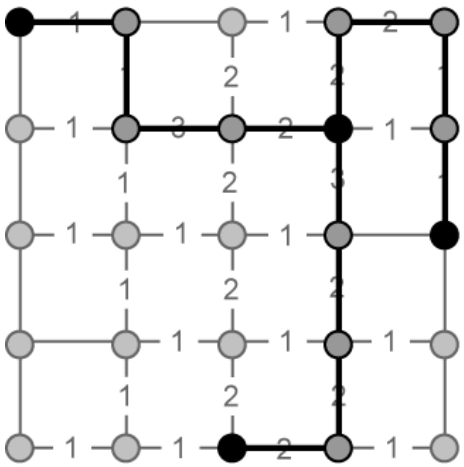
- Reroute fourth net
  - SMMT(n_4): wirelength = 15
    - Routing graph reflects rerouting of n_1, n_2, n_3
  - Source node s = (2,1), sinks are added (4,1), (0,0), (1,3), (2,4)
  - SP(n_4): wirelength = 9



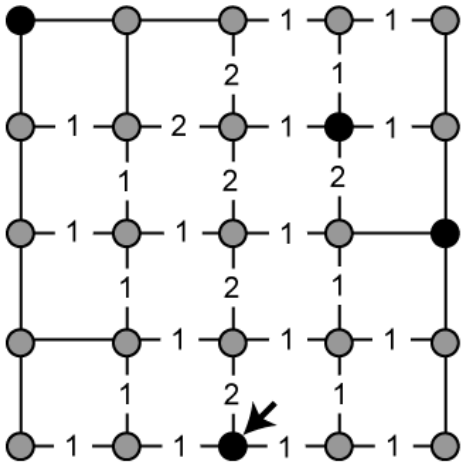


SP-Phase

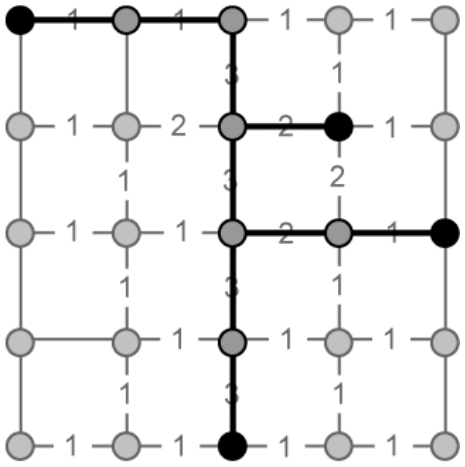
- Reroute fifth net
  - SMMT(n_5): wirelength = 12
    - Routing graph reflects rerouting of n_1, n_2, n_3, n_4
  - Source node s = (2,0), sinks are added (4,2), (3,3), (0,4)
  - SP(n_5): wirelength = 9



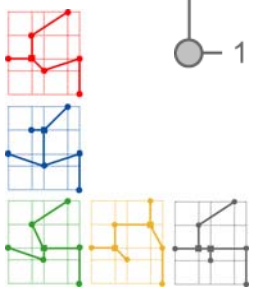
SMMT(n5)



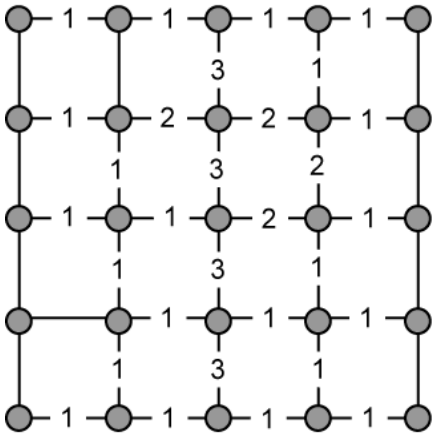
after ripping up SMMT(n5)



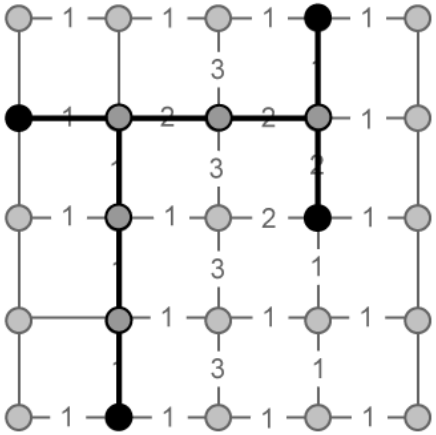
SP(n5)



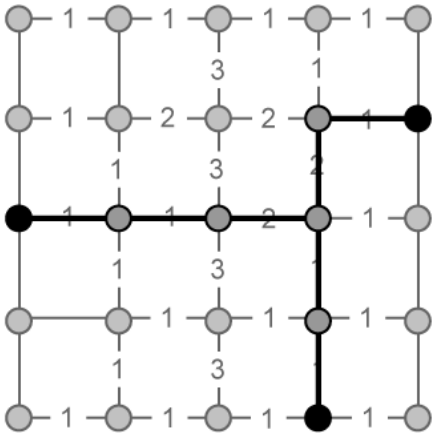
Summary of SP-Phase



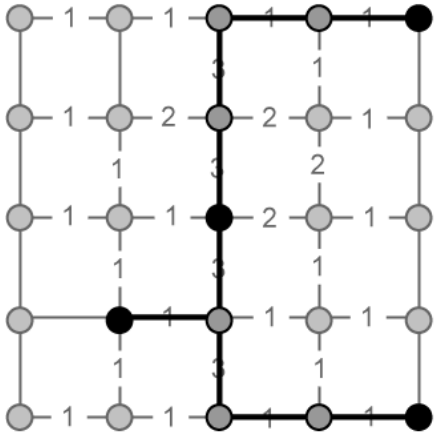
final routing graph



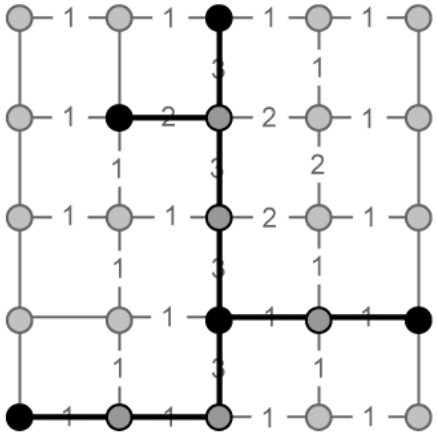
SP(n1)



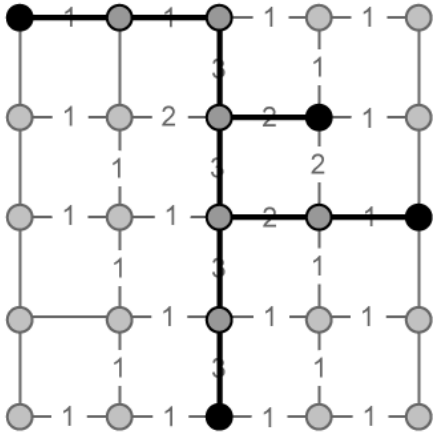
SP(n2)



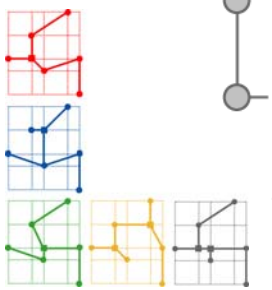
SP(n3)



SP(n4)

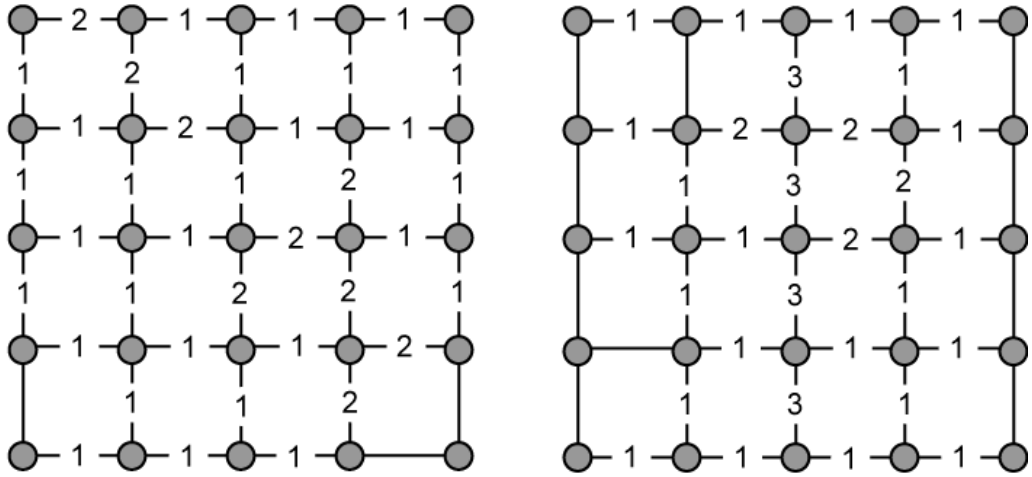


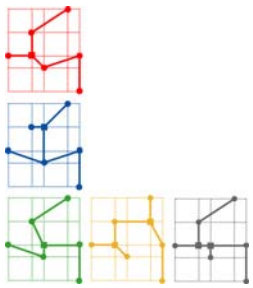
SP(n5)



SMMT vs SP

- SMMT promotes
  - Even usage of the edges (= less congestion)
    - Not a fair comparison since n_3 is missing in SMMT
    - Still SMMT tends to minimize congestion





SMMT vs SP (cont)

- SP promotes
  - Shorter wirelength, higher weight (= more congestion)
  - Congestion vs wirelength tradeoff exists

	SMMT phase		SP phase	
net	max e-wgt	wirelength	max e-wgt	wirelength
n_1	2	9	2	8
n_2	2	10	2	7
n_3	routing failed		3	9
n_4	2	15	3	9
n_5	2	12	3	9