

SRP: Simultaneous Routing and Placement for Congestion Refinement



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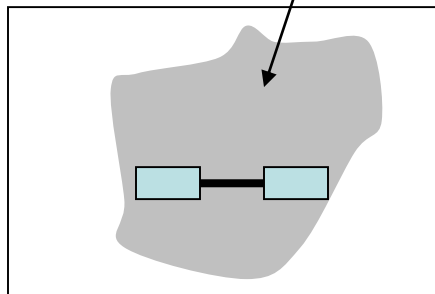
Outline

- Motivation
- Overview of Refinement Process
- Details of Refinement Process
- Experimental Results

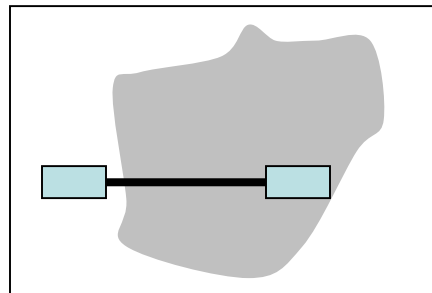
Motivation

- Overflow (routing congestion) is from:
 - Local nets
 - Semi-global nets
 - Global nets

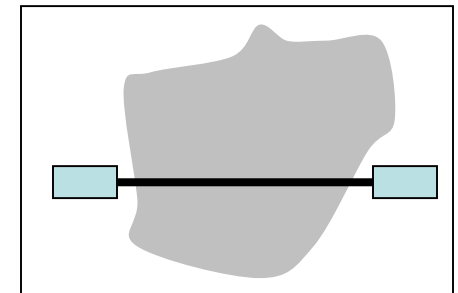
Congested region



(a) Local Net



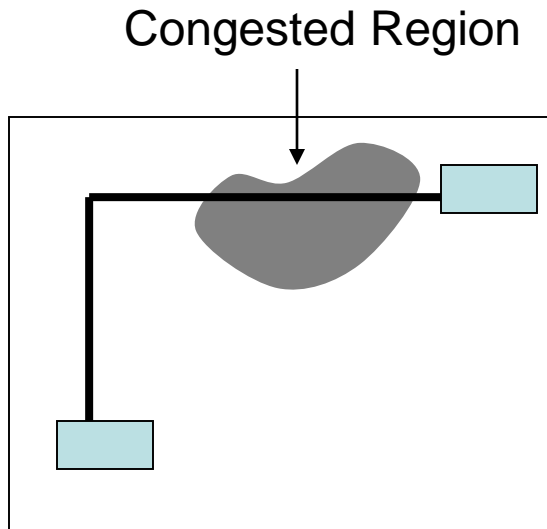
(b) Semi-global Net



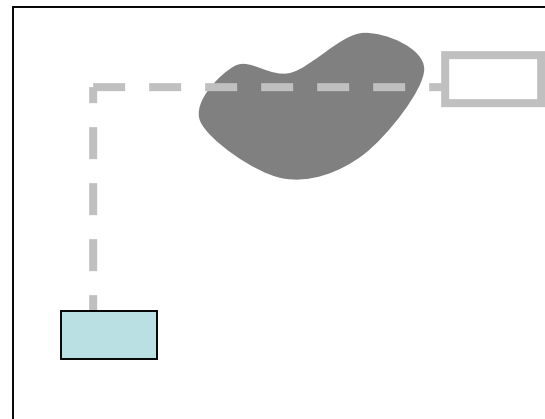
(c) Global Net

Why Use SRP?

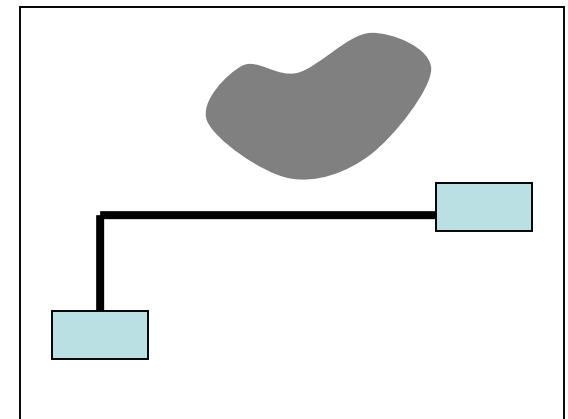
- An example of SRP



(a) A net across a congested region



(b) Rip-up a problematic cell

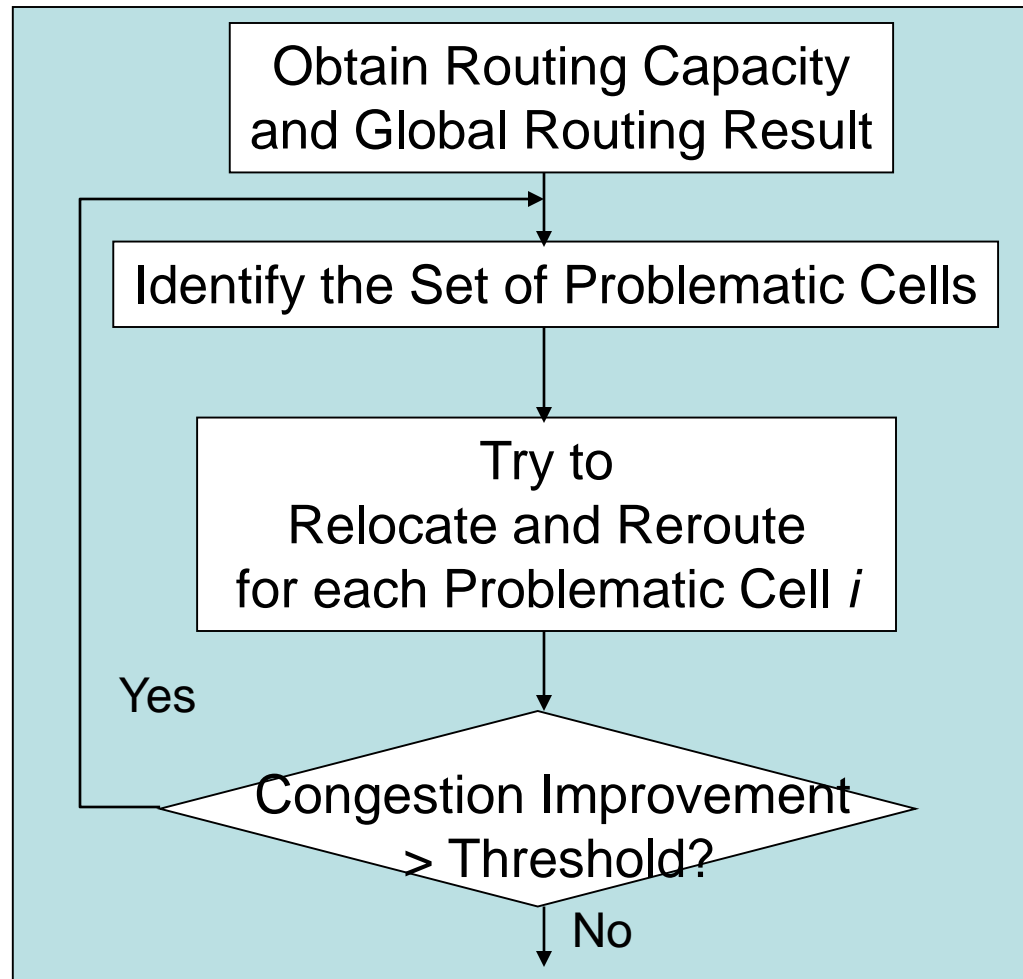


(c) Relocate and Reroute the problematic cell

Outline

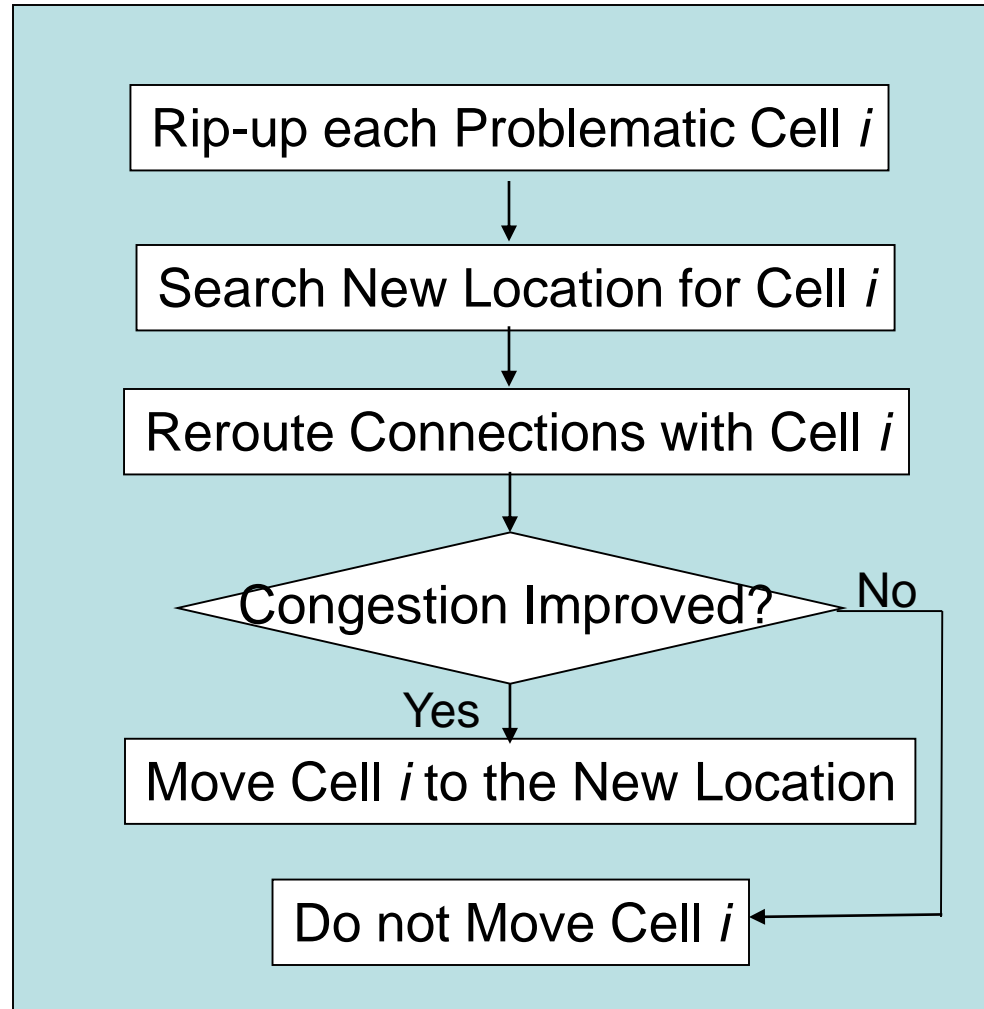
- Motivation
- **Overview of Refinement Process**
- Details of Refinement Process
- Experimental Results

Overview



The Main Flow of SRP

Overview



Relocate and Reroute for each Problematic Cell *i*

Outline

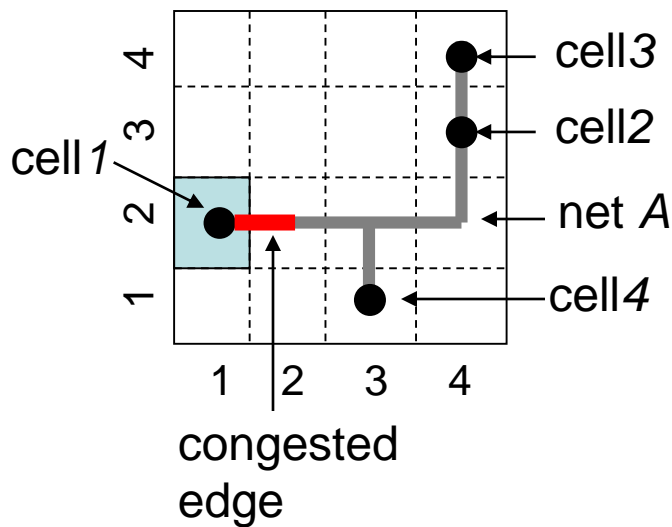
- Motivation
- Overview of Refinement Process
- **Details of Refinement Process**
 - Identify Problematic Cell
 - Rip-up Problematic Cell
 - Search New Location
 - Reroute
- Experimental Results

Problematic Cell Identification

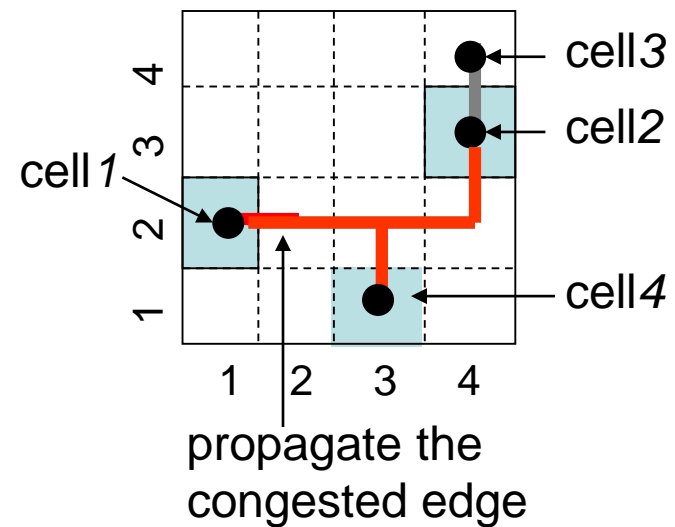
- Not only the cells in congested tiles, but also the cells whose connections across congested tiles
- Greatly solve the congestion from
 - Local nets
 - Semi-global nets
 - Global nets

Problematic Cell Identification

- An example



(a)

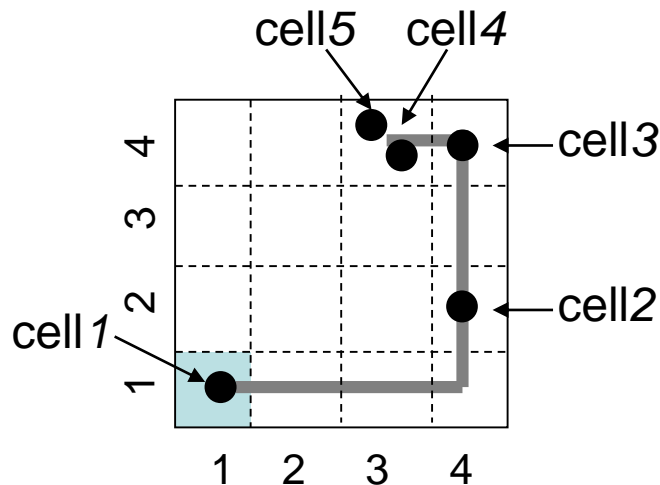


(b)

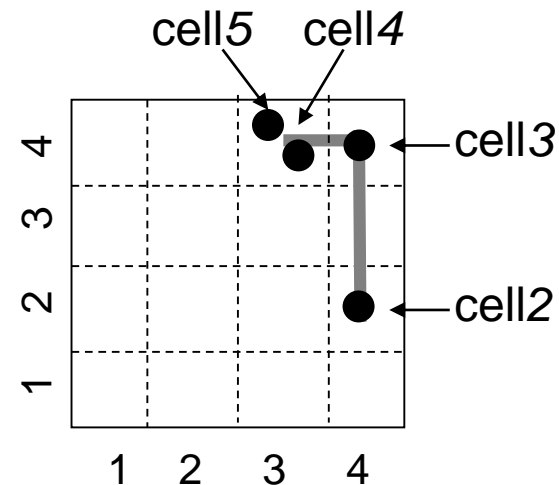
(a) Identify the congested tiles across by routing path; (b) Find the problematic cell 1, cell 2, and cell 4 which are on the congested path

Rip-up Problematic Cell

- Besides removing cell, its connections of each associated nets have to be removed as well.
- There are 3 cases in a net:



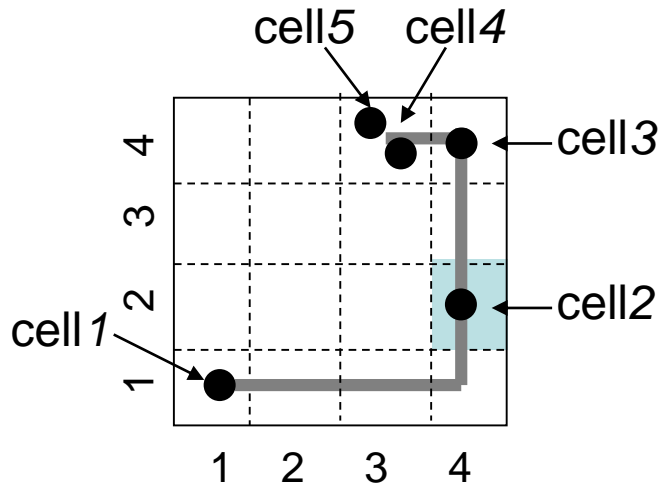
(a)



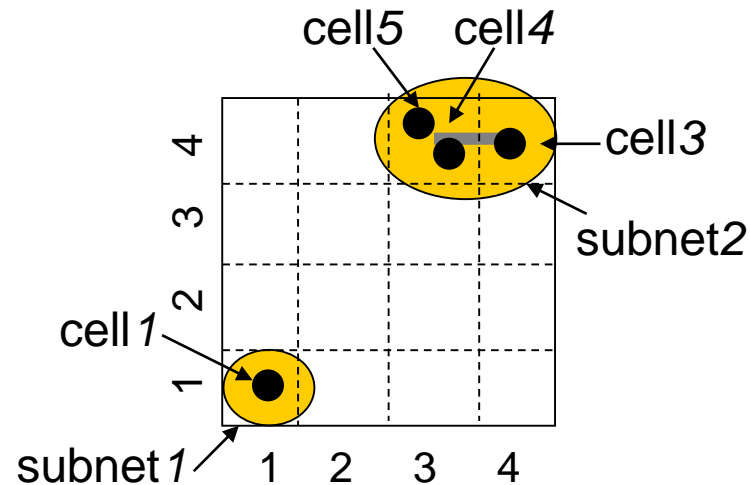
(b)

Case 1: The problematic cell 1's degree is 1 in a net's routing path, then remove its connection with this net directly

Rip-up Problematic Cell



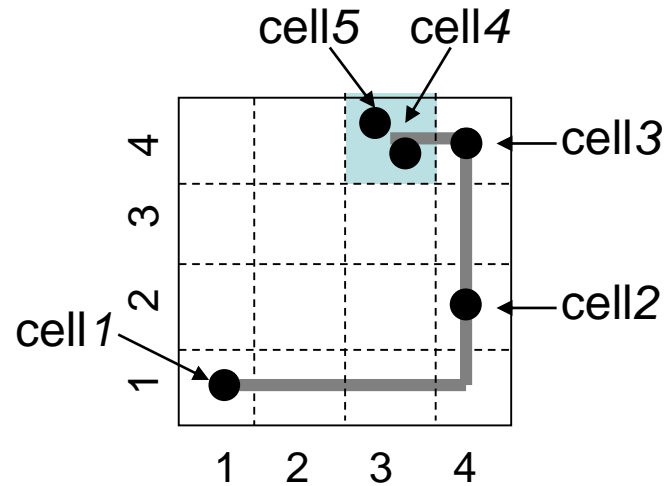
(c)



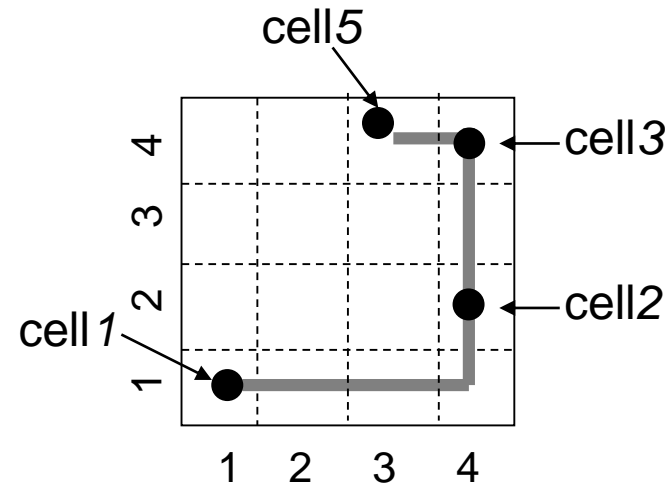
(d)

Case 2: The problematic cell 2's degree is more than 2, the net become two subnets after removing the connections

Rip-up Problematic Cell



(e)

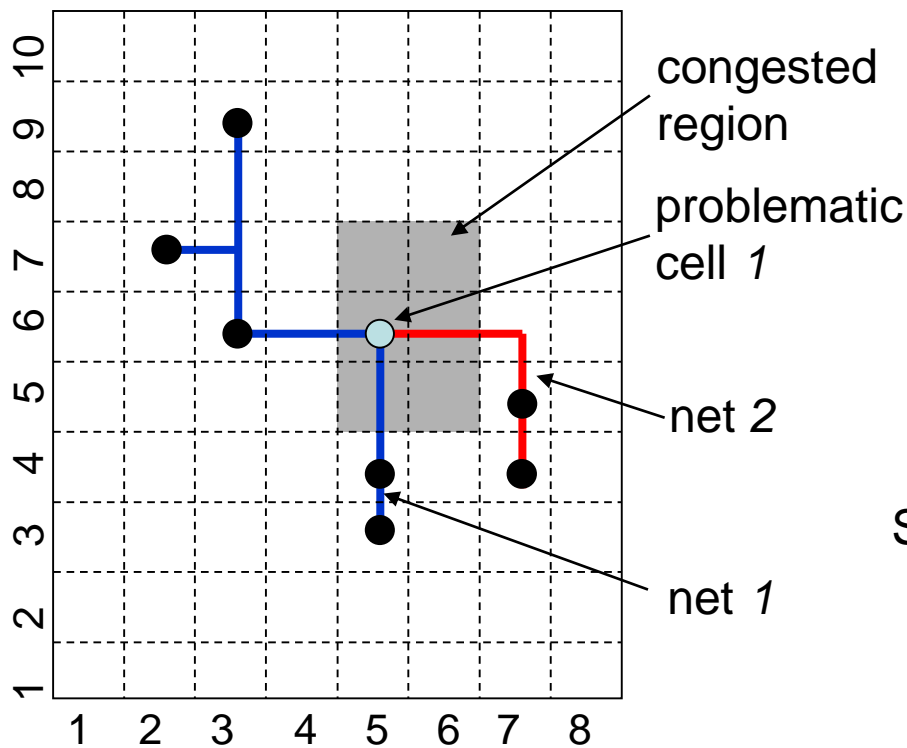


(f)

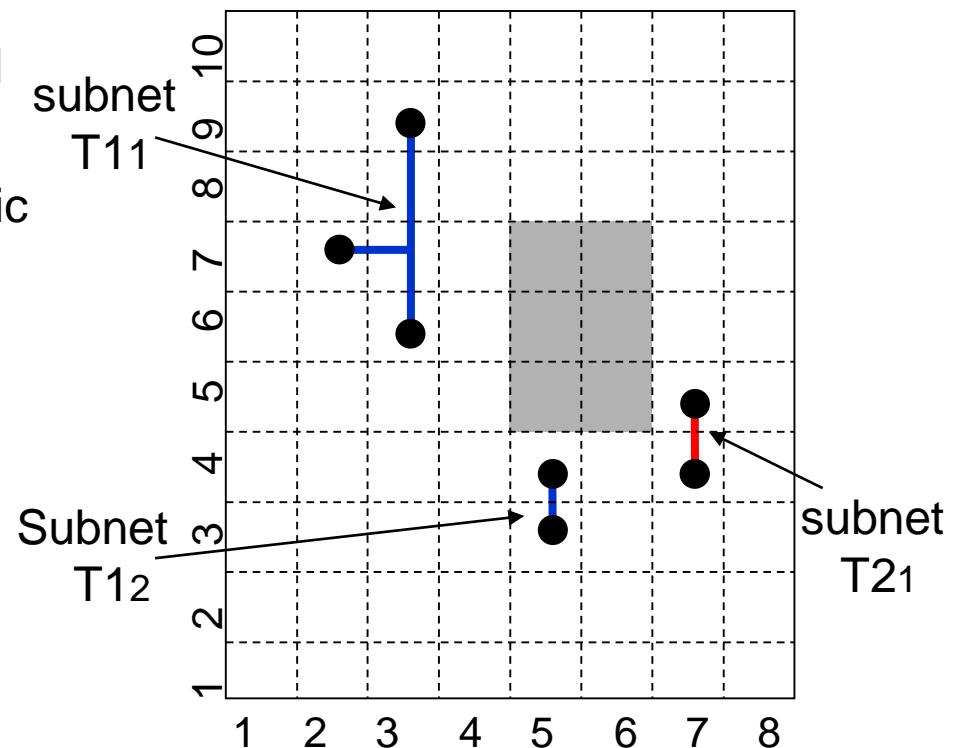
Case 3: The tile containing problematic cell 4 has another cell on the same net, no need to remove the connection

Rip-up Problematic Cell

- An example



(a)



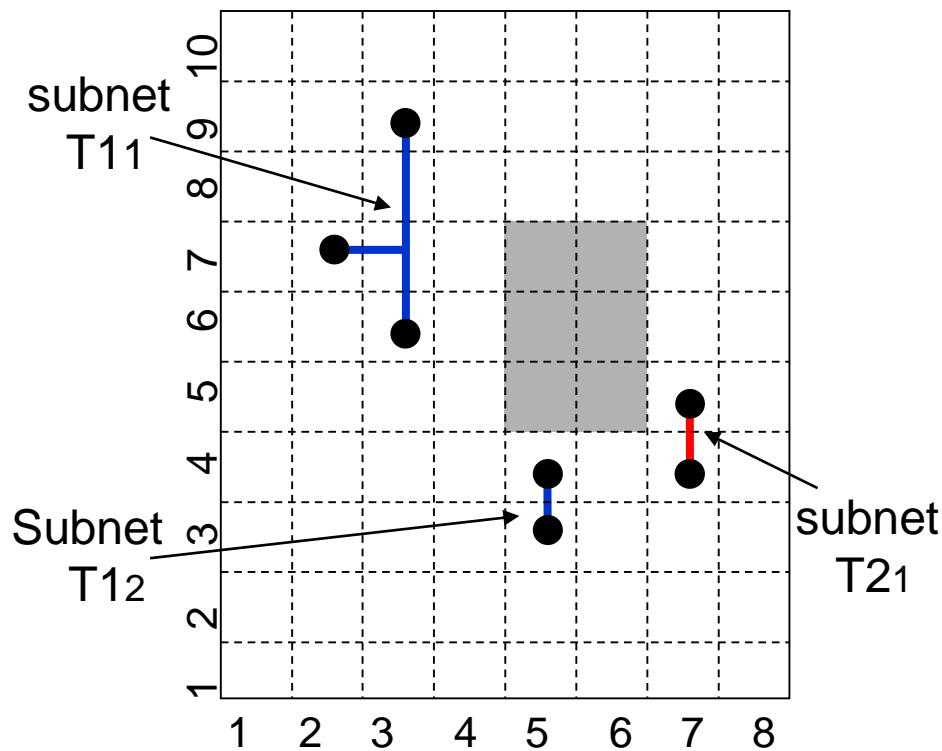
(b)

Search New Location

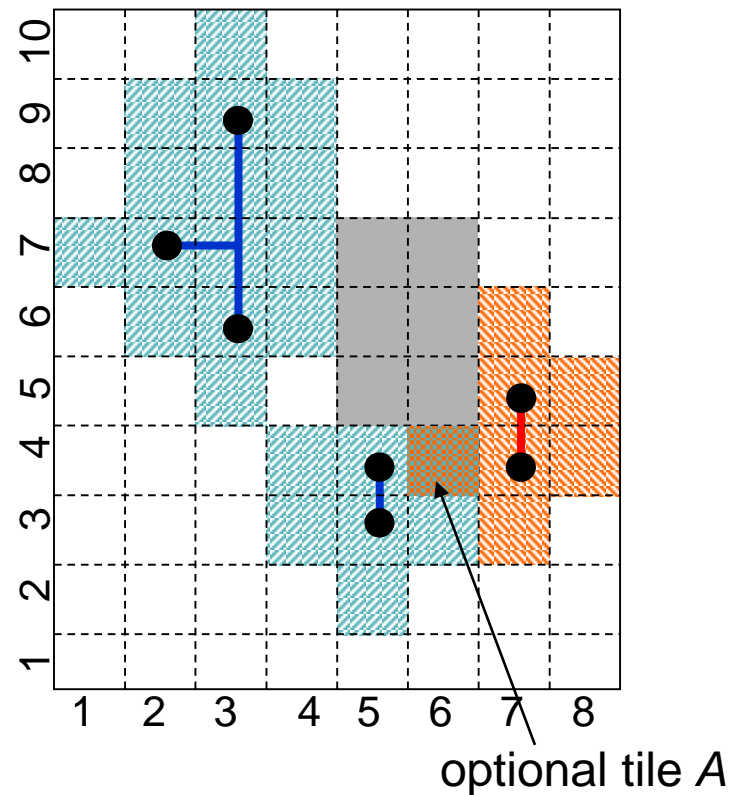
- Multi-source propagation
 - For a net, not only the tiles around the original location, but also the tiles passed by the routing path will be propagated.
 - All associated nets are propagated simultaneously.
 - Optional location: A tile is reached by all associated nets during propagation process.

Search New Location

- An example



(a)



(b)

Search New Location

- Choose new location among optional locations
 - The **cost** of an optional location is the **sum of wirelength and overflow** according to the propagation process.
 - The new location is the optional location with minimum cost.

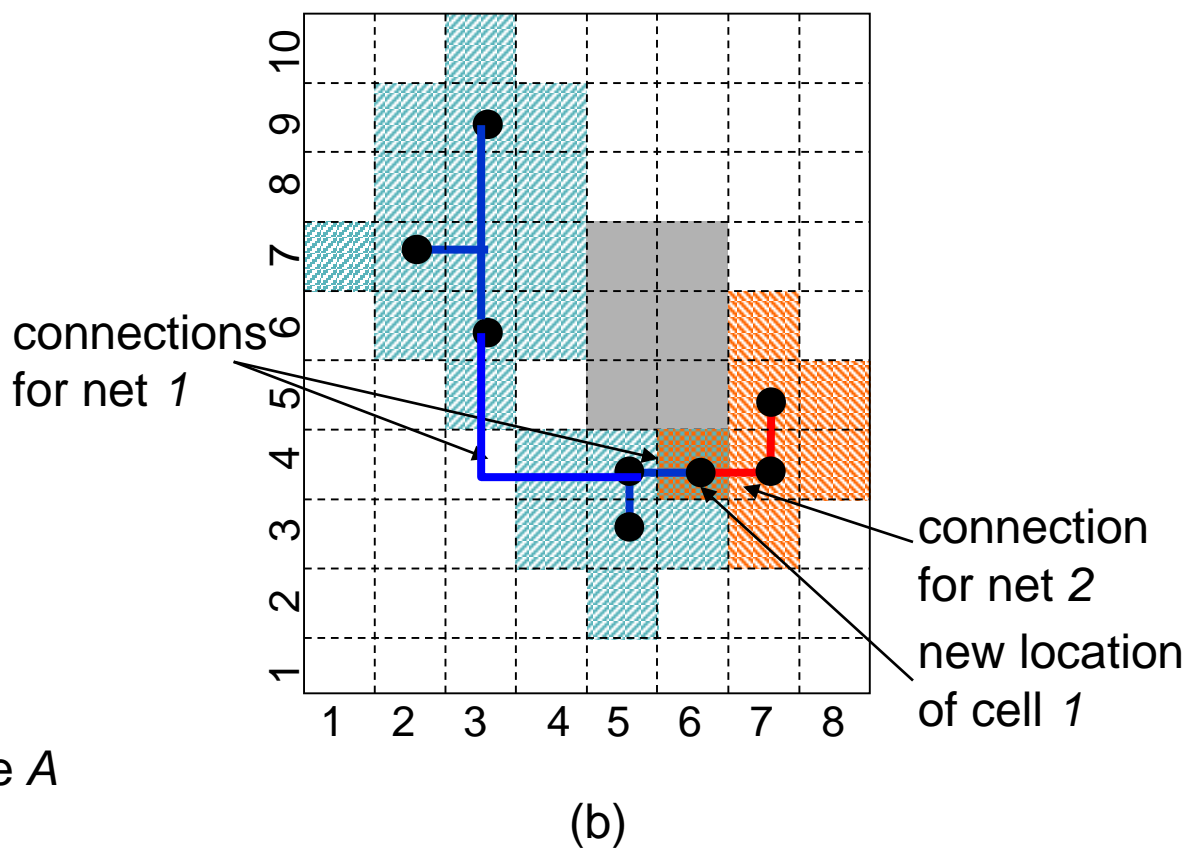
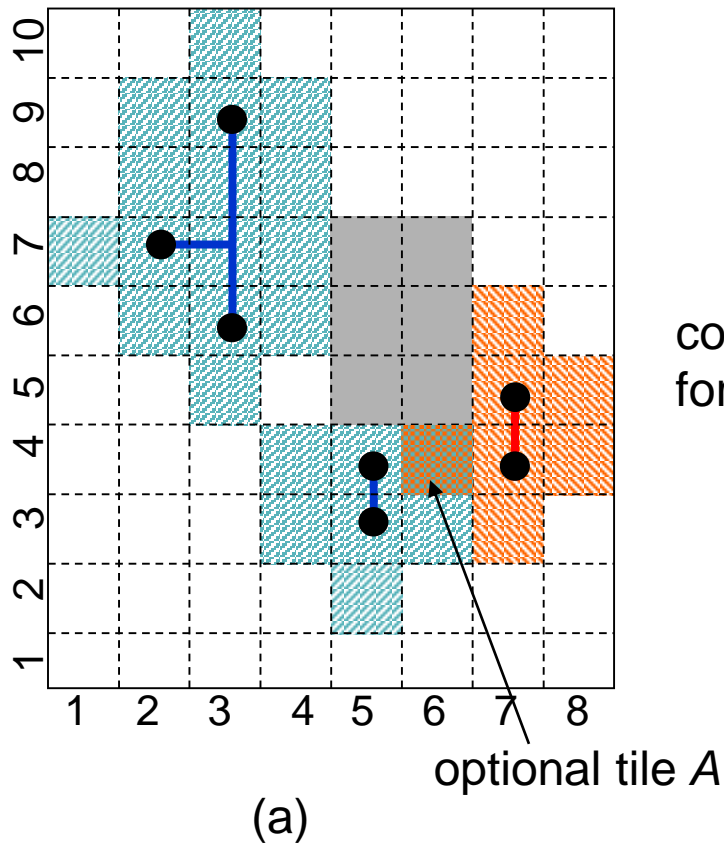
Reroute New Location

- For each associated net i , connect its subnets together by multi-subnet maze routing
 - While the number of subnets > 1
 - Propagate from subnet 1
 - Find a shortest path between subnet 1 and any other subnet j
 - subnet $1 = \text{subnet } 1 \cup \text{subnet } j$

The new location of the current problematic cell is seen as a subnet as well¹⁸

Reroute New Location

- An example



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Experimental Results

Total Normalized Overflow Comparison of SRP

Bench mark	NTUplacer		Ripple		SimPLR		mpl12	
	Input	SRP	Input	SRP	Input	SRP	Input	SRP
sb2	4527	4320	51038	47451	114562	90674	248259	185867
sb3	11744	10182	39068	36295	16191	13689	34903	28891
sb6	4723	4215	7011	6087	2753	2506	4189	3241
sb7	3013	2650	13604	13239	299288	123573	19031	14199
sb9	4893	4648	13592	12479	8389	7420	18812	15380
sb11	2386	2176	2884	2686	21617	15953	13224	11341
sb12	77	59	1975	1718	2878	2524	105472	67374
sb14	410	400	1750	1592	5479	4074	2666	2373
sb16	7410	6359	3831	2850	43027	32677	5498	4308
sb19	1606	1297	4352	3939	3908	2949	21382	18850
Avg.	1.00	-10.99%	1.00	-7.74%	1.00	-42.86%	1.00	-25.69%

The benchmarks and input placement results are from DAC 2012 Contest.
The placement results are evaluated by NCTUgr.

Experimental Results

Routed Wirelength Comparison of SRP (x E6)

Bench mark	NTUplacer		Ripple		SimPLR		mpl12	
	Input	SRP	Input	SRP	Input	SRP	Input	SRP
sb2	17.89	17.89	19.33	19.34	18.77	18.77	21.2	21.22
sb3	10.9	10.9	11.66	11.66	12.57	12.56	12.32	12.32
sb6	10.45	10.45	10.77	10.77	11.18	11.18	12.22	12.22
sb7	12.74	12.74	14.09	14.09	14.34	14.29	14.38	14.38
sb9	7.66	7.66	8.44	8.44	8.26	8.26	9.01	9.01
sb11	10.32	10.32	10.71	10.7	10.55	10.55	12.7	12.69
sb12	10.98	10.98	11.78	11.77	12.19	12.19	10.85	10.86
sb14	6.93	6.93	7.09	7.09	7.47	7.47	8.08	8.08
sb16	7.9	7.9	7.78	7.78	8.13	8.15	8.68	8.68
sb19	4.68	4.68	4.91	4.91	4.94	4.94	5.36	5.36
Avg.	1.00	0.00%	1.00	-0.01%	1.00	-0.04%	1.00	+0.02%

Experimental Results

HPWL Comparison of SRP (x E8)

Benc hmark	NTUplacer		Ripple		SimPLR		mpl12	
	Input	SRP	Input	SRP	Input	SRP	Input	SRP
sb2	6.11	6.12	6.51	6.52	6.29	6.31	7.11	7.13
sb3	3.27	3.28	3.34	3.35	3.63	3.63	3.64	3.65
sb6	3.3	3.31	3.35	3.35	3.5	3.5	3.87	3.87
sb7	3.91	3.91	4.23	4.23	4.29	4.29	4.47	4.48
sb9	2.37	2.37	2.58	2.58	2.54	2.54	2.78	2.78
sb11	3.42	3.42	3.56	3.56	3.47	3.47	4.23	4.23
sb12	3.12	3.12	3.33	3.33	3.55	3.55	3.24	3.26
sb14	2.25	2.25	2.27	2.27	2.38	2.39	2.58	2.58
sb16	2.62	2.62	2.59	2.59	2.67	2.68	2.89	2.89
sb19	1.5	1.5	1.59	1.59	1.58	1.58	1.74	1.74
Avg.	1.00	+0.09%	1.00	+0.06%	1.00	+0.12%	1.00	+0.16%

Experimental Results

Runtime of SRP (sec)

Benchmark	NTUplacer	Ripple	SimPLR	mpl12
sb2	454	1444	1935	1651
sb3	346	974	515	485
sb6	319	467	280	300
sb7	168	381	671	215
sb9	127	342	207	281
sb11	107	200	171	231
sb12	81	365	298	939
sb14	45	66	155	77
sb16	105	144	348	145
sb19	47	148	91	100
Avg.	179.9	453.1	467.1	442.4

Thank you!
Q&A