

ICCAD-2017 CAD Contest in Net Open Location Finder with Obstacles

Problem Description, Benchmarks, and Results

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Outline

Problem Description

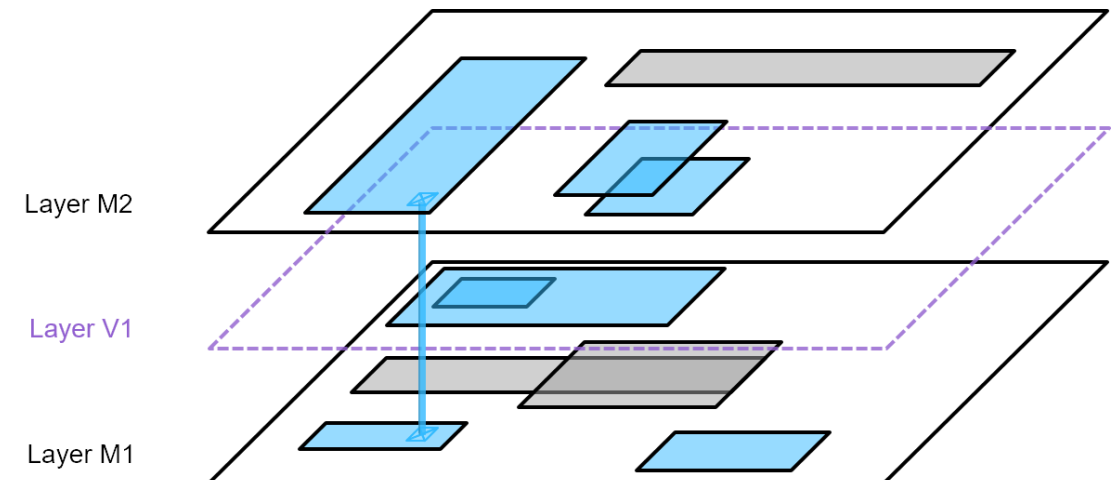
Evaluation Methodology

Benchmarks

Results

Problem Description

- Develop a tool
 - Detect if a net is open after placement & routing (P&R) stage
 - Indicate the (shortest) paths to reconnect existing net shapes to resolve open
 - Obstacle awareness
- Given
 - a set of routed net shapes $\mathbf{R} = \{R_1, R_2, \dots, R_j\}$
 - a set of routed net vias $\mathbf{V} = \{v_1, v_2, \dots, v_k\}$
 - a set of obstacles $\mathbf{O} = \{O_1, O_2, \dots, O_m\}$
 - routing layers $\mathbf{L} = \{M1, V1, M2, V2, \dots, V_{n-1}, M_n\}$
 - design boundary \mathbf{B}
 - minimum spacing \mathbf{S}
 - via cost \mathbf{C}_v



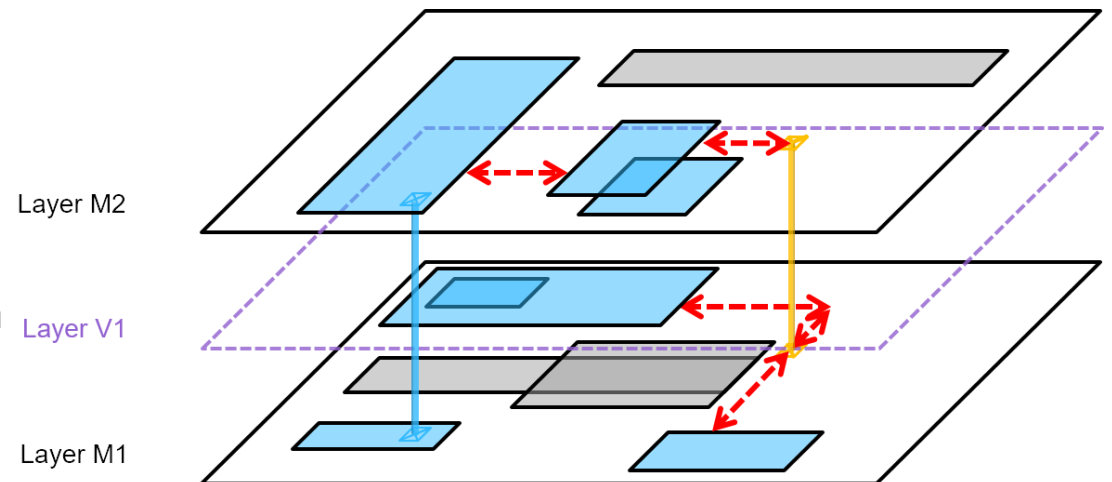
Problem Description

- Output

- a set of paths $\mathbf{p} = \{p_1, p_2, \dots, p_i\}$ to connect all \mathbf{R} and \mathbf{V} together
- each path p_i can be a H-line, a V-line, or a via

- Challenges

- Large amount of existing routing shapes
- Geometries not Points
- Multi-layer
- Runtime
 - Seek for fast solution to solve a large net open problem
 - Multi-threading is encouraged
 - 4-core machine provided



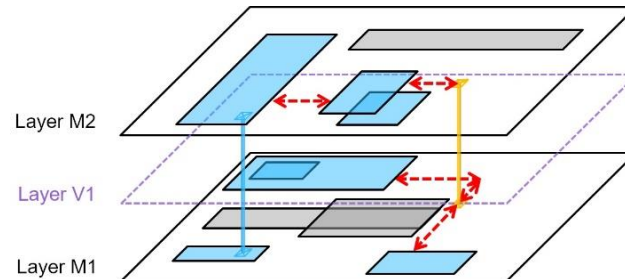
Evaluation Methodology

- Overall cost

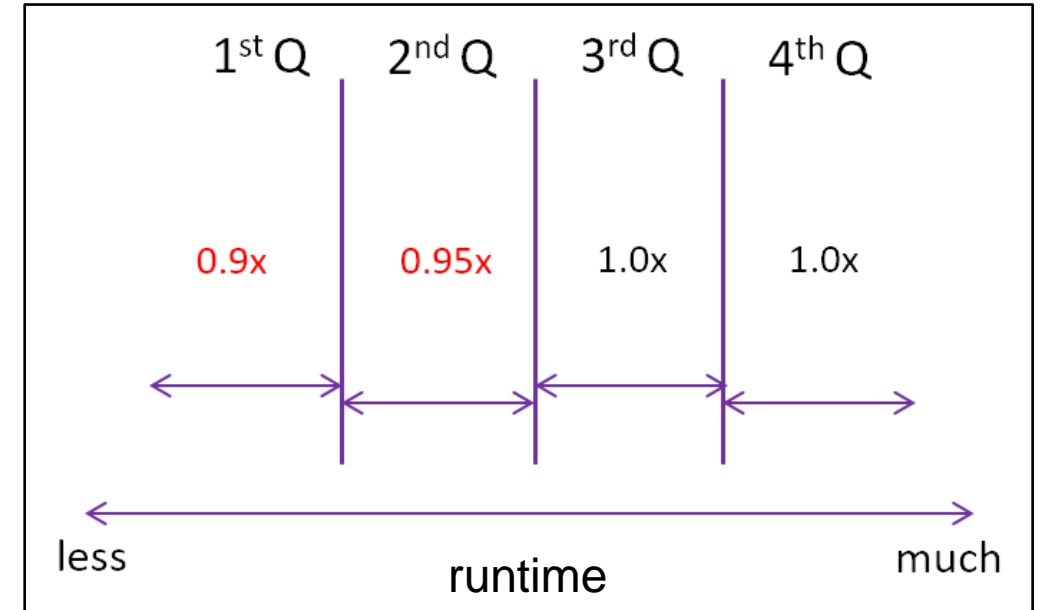
$$\begin{aligned} \text{disjoint cost } C_d &= 2 \times (\#components - 1) \times (boundary\Delta X \\ &\quad + boundary\Delta Y \\ &\quad + \#ViaLayers \times C_v) \end{aligned} \quad (1)$$

$$\text{overall cost} = \sum_{q=1}^t Cost(p_q) + C_d \quad (2)$$

- if p_q is a line, $Cost(p_q)$ = length of this line
- if p_q is a via, $Cost(p_q) = C_v$



- Runtime bonus



Benchmarks

- Public cases

Name	#Layers	#RoutedShapes	#Obstacles	#Components
case1	3	1503	414	113
case2	5	4518	4773	1602
case3	8	97146	79012	18438
caseA	8	104492	69491	21137

- Hidden cases

Name	#Layers	#RoutedShapes	#Obstacles	#Components
case4	3	1941	421	216
case5	5	4450	4762	1663
case6	8	94100	77969	31163
caseB	8	97019	81852	32045

Results

• Alpha

	case1	case2	case3	caseA	case4	case5	case6	caseB	
Team	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	sum of Cost
Top1	5615.5	112608.0	1757681.0	-	11179.6	69936.2	3272724.0	-	-
Top2	10354.0	283169.7	8603366.4	-	16574.4	405935.1	11516518.8	-	-
Top3	5852.0	91617.1	1682141.4	-	1418378.0	39835263.2	3644879.4	-	-
Top4	222898.5	13639418.1	2771104479.8	-	307918.8	15119409.6	3504707256.4	-	-
Top5	1263615.0	80939003.0	6513229278.1	-	2462976.0	79419405.0	14062146000.6	-	-
Top6	5346.0	79032.6	21578259186.0	-	10374.0	53983.8	28059542442.0	-	-

• Beta

	case1	case2	case3	caseA	case4	case5	case6	caseB	
Team	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	sum of Cost
Top1	3373.5	65532.0	774949.2	1243805.6	8730.9	23102.0	1451527.2	4800562.2	8371582.5
Top2	3501.9	62834.4	793566.9	1221963.3	9336.6	26946.0	1589137.2	4920687.0	8627973.3
Top3	3589.0	67766.0	743067.2	1231049.0	9831.0	22772.0	1529955.1	5137222.9	8745252.1
Top4	3945.4	71829.5	883606.0	1358057.0	10544.0	29694.2	1746400.0	5485610.0	9589686.0
Top5	5346.0	79032.6	1308958.2	1588569.3	9828.0	53983.8	2529135.0	5509345.5	11084198.4
Top6	4803.2	83946.8	1120525.0	1679905.0	11668.9	42489.7	2394072.2	6340824.4	11678235.1

Results

• Beta

	case1	case2	case3	caseA	case4	case5	case6	caseB	
Team	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	sum of Cost
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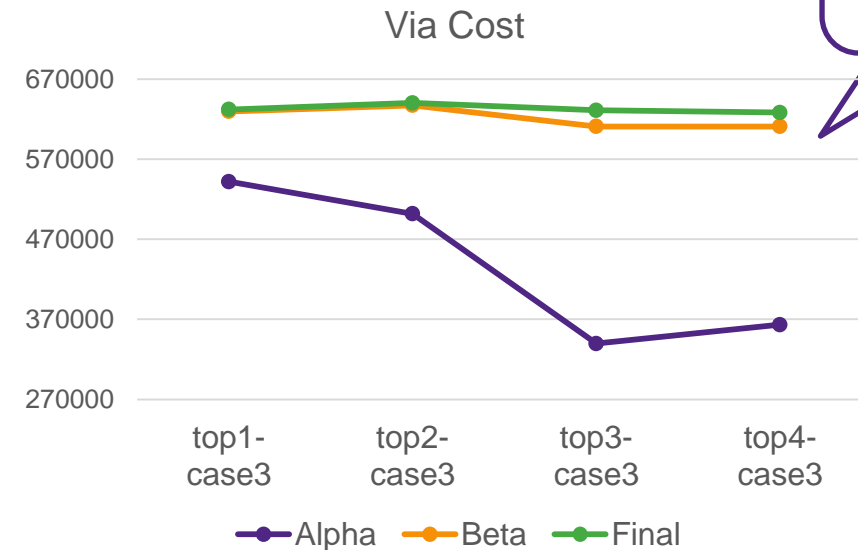
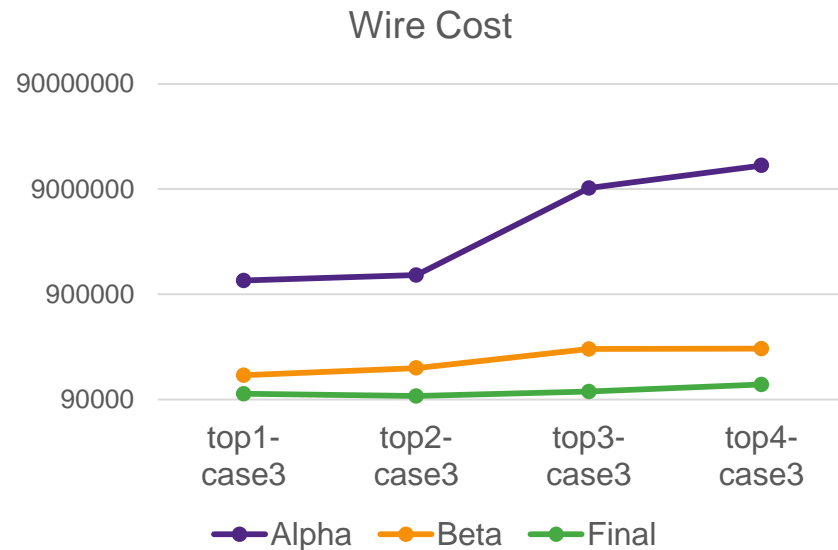
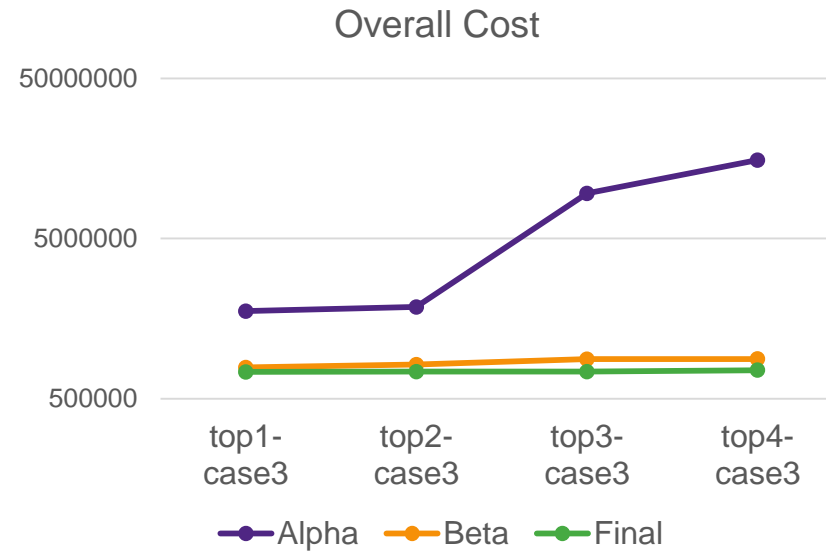
• Final

	case1	case2	case3	caseA	case4	case5	case6	caseB	
Team	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Cost with runtime bonus	Sum of Cost
Top1	3264.3	58868.1	664135.2	1136219.4	8998.2	19053.9	1465547.0	4794177.6	8150263.7
Top2	3238.2	59565.6	692782.2	1153764.9	8756.1	19727.1	1424065.5	4801906.8	8163806.4
Top3	3238.2	64725.0	696948.5	1198014.6	9380.7	19719.2	1387701.9	4792124.7	8171852.8
Top4	3397.2	62118.6	663411.6	1140454.8	9738.0	19771.4	1391601.6	5175015.8	8465509.0
Top5	3424.8	62781.7	691474.5	1217632.1	9305.3	21023.5	1497013.8	5068548.3	8571203.9
Top6	3548.0	65647.0	715172.4	1210209.8	9266.3	21451.0	1485483.7	5065288.9	8576066.9

Results

case3

- case3 overall cost w/o runtime bonus

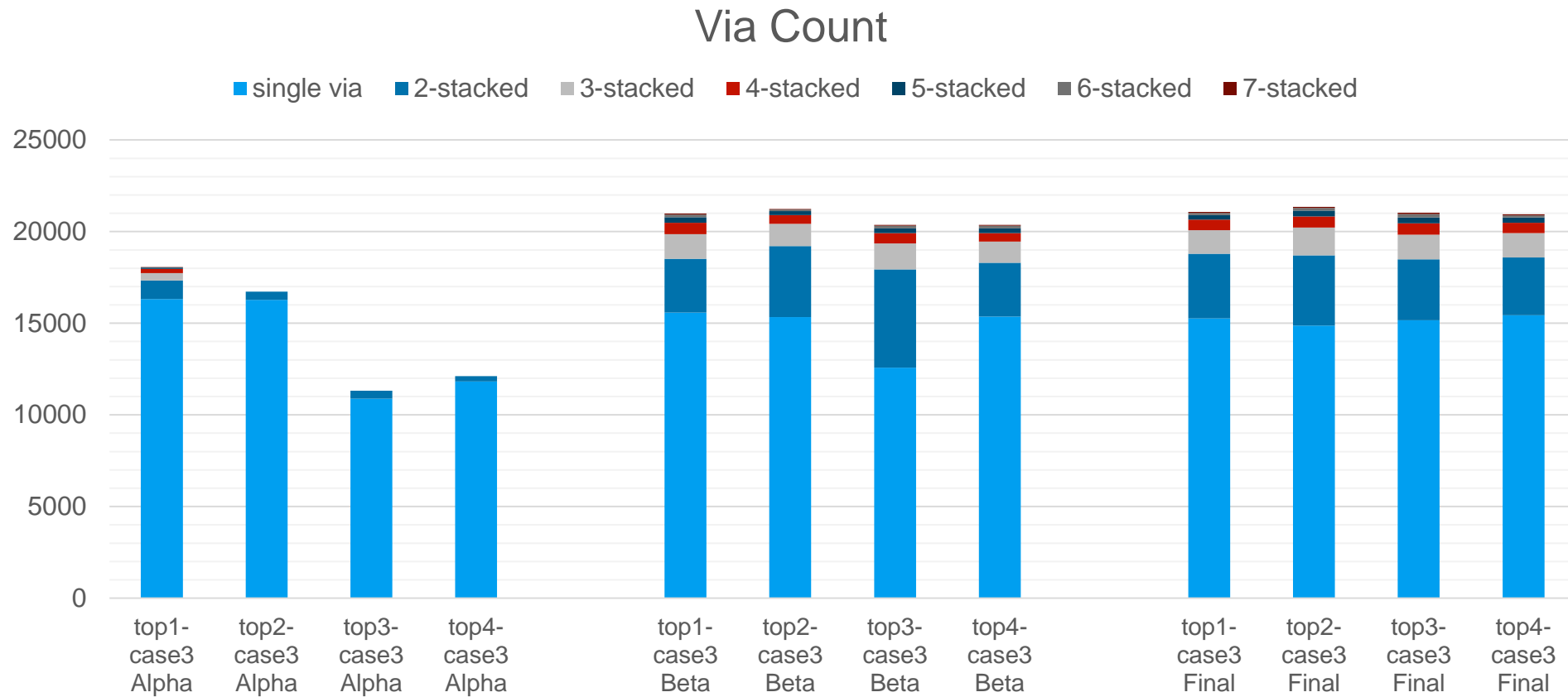


More vias used

Results

case3

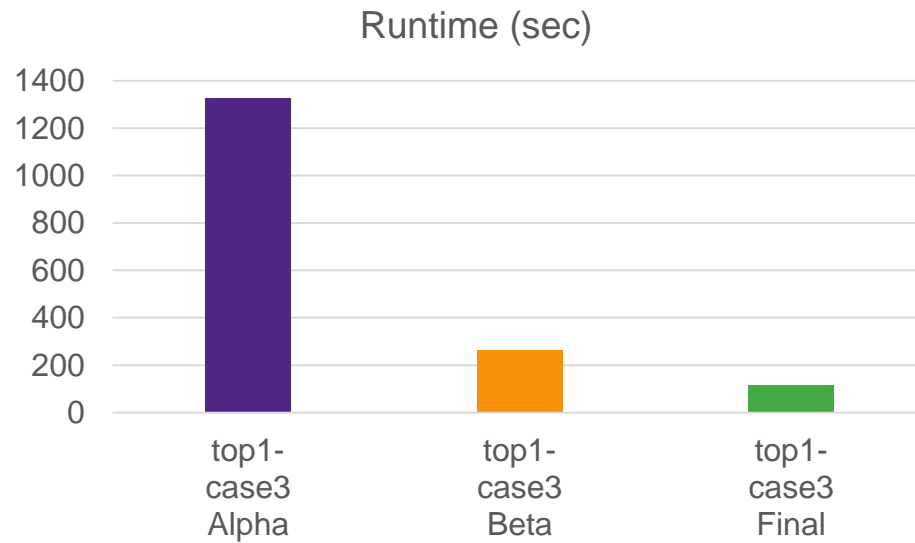
- Vias & stacked via



Results

case3

- Runtime (Elapsed real time)



- CPU time / Elapsed real time

	top1-case3	top2-case3	top3-case3	top4-case3
Alpha	1.00	1.00	1.00	0.97
Beta	0.97	2.56	0.94	1.00
Final	3.01	1.00	0.88	1.65

Award Announcement

Third Place

Team cada009 : SYFisGod

National Taiwan University of Science and Technology

Taiwan

Guan-Qi Fang

Yong Zhong

Yi-Hao Cheng

Prof. Shao-Yun Fang

Second Place

Team cada065 : DoublePai

National Taiwan University

Taiwan

Chia-Cheng Pai

Yu-Cheng Pai

Jing-Syuan Huang

Prof. Yao-Wen Chang, Prof. Chien-Mo James Li

Prof. Jie-Hong Roland Jiang, Prof. Chung-Ping Charlie Chen

First Place

Team cada066 : CCU EDA Route

National Chung Cheng University

Taiwan

Shuo-Hui Wang

Yan-Yu Su

Wei-Liang Wu

Guan-Hong Liou

Prof. Mark Po-Hung Lin

Thank You

Top3 Result

	case1				case2				case3				caseA			
Team	Overall Cost	Runtime (Elapsed real time)	Runtime bonus factor	Cost with runtime bonus	Overall Cost	Runtime (Elapsed real time)	Runtime bonus factor	Cost with runtime bonus	Overall Cost	Runtime (Elapsed real time)	Runtime bonus factor	Cost with runtime bonus	Overall Cost	Runtime (Elapsed real time)	Runtime bonus factor	Cost with runtime bonus
Top1-cada066	36270	0m0.037s	0.9	3264.3	654090	0m0.597s	0.9	58868.1	737928	0m33.464s	0.9	664135.2	1262466	0m38.305s	0.9	1136219.4
Top2-cada065	35980	0m0.051s	0.9	3238.2	661840	0m0.924s	0.9	59565.6	769758	0m25.407s	0.9	692782.2	1281961	0m23.788s	0.9	1153764.9
Top3-cada009	35980	0m0.075s	0.9	3238.2	647250	0m2.544s	1	64725.0	733630	1m54.595s	0.95	696948.5	1261068	0m51.271s	0.95	1198014.6

	case4				case5				case6				caseB			
Team	Overall Cost	Runtime (Elapsed real time)	Runtime bonus factor	Cost with runtime bonus	Overall Cost	Runtime (Elapsed real time)	Runtime bonus factor	Cost with runtime bonus	Overall Cost	Runtime (Elapsed real time)	Runtime bonus factor	Cost with runtime bonus	Overall Cost	Runtime (Elapsed real time)	Runtime bonus factor	Cost with runtime bonus
Top1-cada066	99980	0m0.050s	0.9	8998.2	211710	0m0.602s	0.9	19053.9	1542681	0m54.164s	0.95	1465547.0	5326864	0m54.166s	0.9	4794177.6
Top2-cada065	97290	0m0.067s	0.9	8756.1	219190	0m0.855s	0.9	19727.1	1582295	0m37.684s	0.9	1424065.5	5335452	0m40.407s	0.9	4801906.8
Top3-cada009	104230	0m0.063s	0.9	9380.7	207570	0m2.866s	0.95	19719.2	1541891	0m42.984s	0.9	1387701.9	5324583	0m34.099s	0.9	4792124.7