

Problem B: 3D Placement with Macros

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(Synopsys, Inc.)

Q&A

Q1. After reading the document, I have the following questions about Hybrid bonding terminal.

First: Can the position of terminal overlap with that of macros or std cells on the die?

Second: Are all the terminals square? If not, can we rotate the terminal?

Third: If terminals can be placed at any location as long as the spacing between 2 terminals terminal and die boundary is far enough.

A1. Here are the answers for these questions.

First: Yes. Terminal are on the top-most layer of the die while macros and std cells are placed on the bottom metal and device layers. Thus, terminals can overlap with all the cells.

Second: Yes. It would always be square.

Third: Yes.

Q2. I would like to ask the question of Problem B : 3D Placement with Macros (Synopsys, Inc.)

Is the median elapse time mentioned in the runtime factor the median of the times of all participants, or is the median elapse time a fixed value? Thank you for your answer.

A2. The median elapse time is the median runtime result among all participants which have result.

Q3. I would like to ask if Top-Level IOs will be provided for Problem B, since their placement will influence the final placement significantly.

Moreover, is it possible to specify the driving pin of each net?

Potentially, it can help to improve the QoR of the 3D Placer.

Thank you.

A3. There will be no top-level IOs. To simplify the problem, top-level IOs are omitted.

No driver/sink information in this contest.

Q4. For problem B in ICCAD2023, I have the following 7 questions.

1) The <techName> will always be "TA" and "TB" ? Is it possible to be "TC" or other names?

2) Following question 1., does the Top Die always use TA, and the Bottom Die always use TB?

3) Does (<LowerLeftX> , <LowerLeftY>) of DieSize always be (0,0)?

4) Following Question 3., does <rowLength> always equal to <upperRightX> of DieSize?

5) Following Question 3., does <rowHeight> times <repeatCount> always equal to the <upperRightY> of DieSize?

- 6) Do you provide any P&R tools in the contest?
- 7) What is the environment where the evaluator can be executed?

Thank you!

A4. Here are the answers for these questions:

- 1) You can assume the <techName> will always be “TA” and/or “TB”.
- 2) No, Top Die and Bottom Die can be either TA or TB
- 3) Yes, you can have this assumption.
- 4) Yes, you can have this assumption.
- 5) No, <rowHeight> times <repeatCount> would always be less than or equal to the <upperRightY> of DieSize.
- 6) No. we don't provide any P&R tools in the contest.
- 7)The evaluator can be executed on the Linux platform.

Q5. I have the following question about problem B. Could you please advise when the other testcases will be released? Thank you!

A5. More public testcases will be released before May/15.

Q6. I am writing to ask a few questions regarding "Problem B - 3D Placement with Macros."

- 1) I was wondering how you plan to rank each team in the final submission. Will it be based on the sum of the final scores of each case, or are there other scoring functions that will be used?
- 2) I would like to ask if we are allowed to produce coordinates that contain fractional parts in our output file. This information will be very helpful for our team to ensure that our submission meets all the necessary requirements.

Thank you for taking the time to read my email.

A6. Here are the answers for these questions:

- 1) Yes. It would be the summation of the final scores of each case.
- 2) I don't understand this question. All valid results would be with the resolution of integer. That means – Any result with fractional numbers would definitely be a “incorrect” answer of the given case. Don't understand how the result with fractional numbers can help to ensure the submission meets all the necessary requirements given that the result itself is “incorrect”.. Contestants can print necessary debugging messages on console. If the outputted result does not meet the requirements, we can help provide the printed messages on console (<100 lines) for contestants to review.

Q7. For problem B in ICCAD2023, I have the following 1 question.

Does (<startX> <startY>) of TopDieRows and BottomDieRows always be (0,0)?

Thanks.

A7. Yes. You can have this assumption.

Q8. After reading the document, I have the following questions about netlist.

- 1) What does 'TerminalCost<val>' mean? Area or something else?
- 2) In case 1, we observed that the height of the macro cell is larger than the height of the row.
Can the size of the macro cell be larger than the height of the row?
- 3) Following Question 2, If it is possible, does that mean the macro cell can be placed at any position on the die?

Thank you!

A8. Here are the answers for these questions.

- 1) TerminalCost is given from input. Every terminals in the case result will have the same TerminalCost.
- 2) Yes. Macro cell height and width can be any integer value.
- 3) Yes. Macro cell can be placed at any position on the die.

Q9. I am writing to inquire about "Problem B - 3D Placement with Macros" and would like to ask a few questions.

Specifically, in case 3, there seems to be a net named "N61" that is connected to 32618 pins. This appears to be an unusually large net, and its presence may significantly impact the placement procedure. I am curious to know if this is a bug in case 3 or if we are indeed expected to handle such cases.

Thank you for your attention to this matter.

A9. Thanks for pointing this out. We will remove this large net and provide a new version of case3.

Q10. Can you please check that the total Instance area can be placed onto the 2 dies without violating the maximum utility of both die? It seems that this constraint can't be met in case 2. Can you help me make sure that the case is right? Thanks for your help!

A10. We had verified that case2 is placeable without violating the maximum utility of both dies. The case2 is good without problem.

Q11. I am writing to inquire about "Problem B - 3D Placement with Macros" and would like to ask a few questions. Specifically, in case 4, there are four nets containing more than 10000 pins:

- N27429 has 12937 pins
- N27457 has 12848 pins
- N27488 has 10013 pins
- N27489 has 10013 pins

This appears to be an unusually large net, and its presence may significantly impact the placement procedure. I am curious to know if this is a bug in case 4 or if we are indeed expected to handle such cases.

Thank you for your attention to this matter.

A11. We will revise the case with a new version.

Q12. We are writing to inquire about "Problem B - 3D Placement with Macros" and have a question

regarding the upcoming alpha submission.

We would like to inquire if there will be a hidden case for case1 in the problem.

Thank you for your attention.

A12. There will be hidden cases with the same scale as case2, case3, & case4.

Q13. For problem B in ICCAD2023, I have the following questions.

1) In case4, we found that the y coordinate of the pin positions of all cells is 0.

2) In case4, the width of all cells under TA and TB technologies are the same.

Please help confirm whether case4 is normal.

Thank you!

A13. Thanks for pointing out the issue in Case4. We have uploaded a new Case4 on website.

Q14. In the case 4 of Problem B, we have a question regarding the utilization constraint for both the bottom and top die.

We partition these cells by greedily balancing the area of both dies, but both dies end up exceeding the utilization constraint. The utilization of the two dies is almost equal, with a resulting utilization value of 84%. We are confused as to whether the utilization constraint is too rigid to be met."

Please help confirm whether case 4 is normal. Thank you!

A14. We had validated that the updated case4 indeed has valid solutions which met the given utilization constraint. We would recommend contestants to use the provided evaluator on the contest webpage to check the utilization value of your result.

Q15. For problem B in ICCAD2023, I have the following questions.

1) I noticed that the HPWL calculation method of problem B is calculated separately for the top and bottom dies, the nets are connected through a terminal, and the terminal does not occupy the cell placement area of any dies. Is this a new 3D chip connection technology? Is there any literature available for reference?

I checked some literature on 3D placement, I found that the previous HPWL calculations were calculated by multiple layers together, not separately.

2) The absolute HPWL will heavily depend on the PDK used. Is there any information about PDK?

3) Please confirm whether case4 is normal. Thank you!

A15. Here are the answers for these questions.

1) You can search by "hybrid bonding" as the keyword for academic papers.

2) In each testcase, we have provided the corresponding cell library and site row information of the technology of each die. That would be sufficient enough for this contest.

3) We found the scale of library cell "MC542" between two dies is wrong. We will revise the data of case4 and release the new version soon.

Q16. Please help check the questions about Problem B, thanks.

1) Could we assume all the std cells have the same height in the same die?

2) Is it possible to vertically place two standard cells in the same row?

3) How to define the spacing between two terminals?

A16. Here are the answers for these questions.

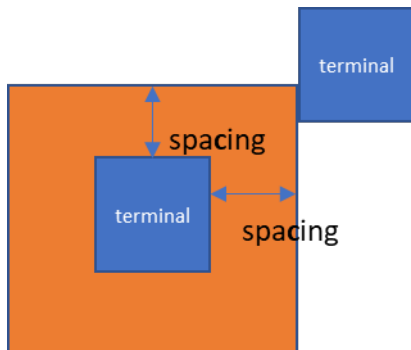
1) Yes. That was stated in the problem description.

“All the std cells would be with single row height of the corresponding technology of the die.”

2) No. This is NOT allowed.

As stated in the problem description: “• All the instances must be without overlap & std cells must be on row”

3) The required spacing between two terminals is illustrated as below figure.



Q17. I would like to inquire about the dataset of Case4. We have found through statistics and experimentation that in order to have a solution that meets utilization requirements for this dataset, the bottom layer can only place at most one macroblock. We are not sure if this rule is correct, or if your solution can have two or more macroblocks that meet utilization requirements. Thanks.

A17. Your observation is correct. Thanks for pointing this out. We found the scale of library cell “MC542” between two dies is wrong. We will revise the data of case4 and release the new version soon.

Q18. We have some questions related to the benchmarks of "Problem B - 3D Placement with Macros." Specifically, we found some irregular nets which contain more than 1000 pins in case 3 and case 4.

The details are listed as follows.

Case3

- Net N62 has 9266 pins.

Case4

- Net N7650 has 2403 pins.
- Net N27369 has 7841 pins.
- Net N27486 has 2792 pins.
- Net N32043 has 1077 pins.

We would like to know whether these nets are part of the power-ground network or the clock tree and whether they should be removed from the test case.

Thank you for your attention to this matter.

A18. We have uploaded the new Case3 and Case4 on the contest website. Thanks.

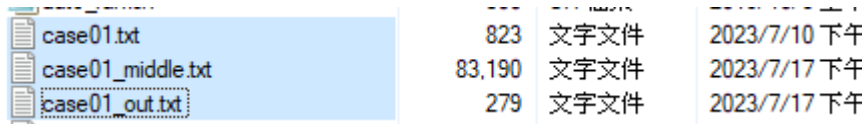
Q19. I would like to ask the question of Problem B :

Is it allowable to add an additional file?

For example: Our application not only read the file case01.txt and output the file case01_output.txt but also create a middle file case01_middle.txt

for our application to read in the halfway.

As in the picture:



case01.txt	823	文字文件	2023/7/10 下午
case01_middle.txt	83,190	文字文件	2023/7/17 下午
case01_out.txt	279	文字文件	2023/7/17 下午

Thanks for replying!

A19. You can generate any additional files if you need.

We will only check whether you generate the required output file and only use the required output file to evaluate your result.

Q20. For problem B in ICCAD2023, the runtime factor encourages the ideas with faster turnaround-time. But for public cases, there may be certain pre-decision methods that greatly reduce the runtime, which may not fully reflect the performance of the algorithm. How can avoid these situations?

Thank you for your helps.

A20. For this issue, we will compare the runtime and quality of the results between public case and hidden case. If there are a big gap in runtime or quality between public case and hidden case, we would suspect that it is using pre-decision methods on public cases.

And we will do some investigation to judge whether the contestant is cheating on public cases.

Q21. I want to ask a question about the case02.

I notice that the die area of case02 is 23000x19000

But the macros in case02 have the size bigger than 10000x8400.

The case02 requires 6 such super-large macros and they cover the majority of the die area.

Does this kind of super-large macro really exist in the real world? or just for the contest purpose? or just a bug?

Thanks for your help.

A21. Yes, it could be a really exist design in the real world.

Q22. I'm thinking there is a question from ICCAD Problem B which according to the evaluator.

Here is our output of case1 and how did the error happen? We think that we did not violate the rule of "spacing" either between terminals or terminal and die bound, thanks for helping check.

```

TopDiePlacement 6
Inst C3 0 0 R90
Inst C7 12 0 R0
Inst C5 26 0 R0
Inst C8 12 10 R0
Inst C1 19 10 R0
Inst C4 26 10 R0
BottomDiePlacement 2
Inst C6 0 0 R0
Inst C2 18 0 R0
NumTerminals 5
Terminal N1 5 5
Terminal N2 16 5
Terminal N3 27 5
Terminal N4 5 16
Terminal N5 16 16

```

```

[cadb0028@iccad87 3D-Placement-with-Macros]$ ./test/evaluator ./test/cases/1.txt ./test/cases/1.out
=====
Start to check if the placement result is legal.
=====
Check utilization for top die
Done
Check if inst is placed inside top die
Done
Check if inst overlaps with each other
Done
Check utilization for bottom die
Done
Check if inst is placed inside bottom die
Done
Check if inst overlaps with each other
Done
Detected spacing violation between die boundary and terminal (net N1)
Not legal
[cadb0028@iccad87 3D-Placement-with-Macros]$

```

A22. The outputted terminal (x,y) location is the **center** of the hybrid bonding terminal.

In Case1, the terminal spacing is 5 and terminal size is 6 by 6. Therefore, your output of case1 will violate the spacing rule of the terminal and die bound.

Q23. I would like to ask a few questions about Problem B.

1) Do the Macros need to be placed on the row?

2) Do the y coordinate of Macros need to be 0, 1xrow_height, 2xrow_height, 3xrow_height, etc.?

Thanks for your help.

A23. For both (1) and (2). Macro don't need to be placed on the row.

Q24. I have a question about ICCAD Problem B. If some environment variables need to be set before running our program to ensure that the solver we use works properly, such as:

```

export SOLVER_HOME="./solver"
export PATH="{PATH}:{SOLVER_HOME}/binary"
...etc

```

Can we write these variable settings in the README? And could the organizers set these instructions for us before testing? Thank you.

A24. you can use a shell script as the wrapper of your program. Inside the shell script wrapper, you can have all your variable settings and also have the real binary execution at the same wrapper.

Please name the shell script wrapper as the contest required submission name and make it be executable directly.

Q25. As the score scale of some cases, like case 1, is significantly lower than those like case 4, we would like to know how the final score above all cases is calculated.

Does case 1 contribute very little to the final score? Thank you.

A25. Final score is the summation of the score on all cases.

Q26. In TB of case 4, LibCell MC542 is with a sizeX of 8625, and its Pin P1 is with an offsetX of 8637 > 8625. Does it mean there may be some pins outside its inst? Shall we still consider these outside pins?

A26. Please check the updated case3 and case4 on the contest websites.

Q27. We are told that the hidden cases will be on the same scale as public cases. Could you please help to clarify what the same scale will stand for? Does it mean the same die or row size, the same number of Insts or Nets, or the same library of LibCell?

A27. The hidden case will have same number of Insts and Nets as public case.

Notice:

For the macros, macro cell rotation is allowed but NOT mirroring. it can be rotated with 0, 90, 180, & 270 degrees (counterclockwise). However, mirroring is not allowed.

That means, for macros, the orientation of “R0”, “R90”, “R180”, & “R270” are allowed in the output.

The case2 hidden was published on the contest website and we will still have another hidden testcase for the case2.