# Problem B: 3D Placement with D2D Vertical Connections

Kai-Shun Hu, I-Jye Lin, Yu-Hui Huang, Hao-Yu Chi, and Yi-Hsuan Wu

*(Synopsys, Inc.)*

## Q&A

**Q1.** I have some questions about Problem B and need your help to check it.

Since we need to use the third party library, which provides the form of dynamic library, could the final uploaded package only be a static binary executable file?

Could we use the form of dynamic library compilation link, and provide library and binary finally?

Thank you.

**A1. Yes. That is fine. You can provide multiple files in the same directory and make the dynamic link to the file(s) in the same directory for your executable binary. As long as we can successfully run the binary with all the files you provided in the same directory, that is good.**


**Q2.** Could you please help to check the following questions? Thank you very much.

**1)**. Can lib cells have a horizontal size less than the size of the row?

**2).** If I understand correctly the only connections out of the dies are the terminals on top layers, right?

**3)**. Can pins of lib cells have multiple shapes?

    for example:

    LibCell MC1 5 15 1

    Pin P1 2 11

    Pin P1 15 20

   4). Need your help to advise if the test cases will be released.

**A2. Here are the answers for these questions.**

**1) Yes. That is possible.**

**2) Yes.**

**3) No. To simplify this problem, each pin of lib cells will have one and only one shape.**

**4) will release the 1st test case at round M/Apr.**


**Q3.** I got a question about Problem B:

Will all of the Instances be named after C1, C2, Cn, and the same questions to the libcellname, netname and pinname, will they follow the naming rule: MC1/MC2, ... and P1/P2/... ?

I am wondering whether I can use the number after the character for the index of that object.

However, if the Instance got two naming rules ex: C1 C2 CC1 CC2, there may exist duplicate problems for using the number after the character for the index for that object.

**A3. Yes. You can do this assumption.**

**Q4.** Are there any pads/fixed objects/obstacles?

**A4. No. will not have fixed objects nor obstacles.**


**Q5.** For utilization -- how is the open space to be distributed across the die? Does it need to be relatively uniform? If so, what's the "window size"?

**A5. We just check the die-level utilization. No window concept.**

    **i.e. util% = (total cell area) / (die size)**


**Q6.** How large of designs can we expect?

**A6. Please expect any value in the range of INT32.**


**Q7.** For the indexing of cells and nets -- could this be done starting with zero (rather than 1)? It would make using arrays to hold the data much simpler, esp.

if we can count on things being named C0, C1, C2, ....

**A7. No. We will indexing the cells and nets from 1. You can do whatever the mapping you want inside your program.**


**Q8.** I have a question for ICCAD2022 problem B.

For input File, whether we can trans it to LEF/DEF format ? or you are not using LEF/DEF for the sake of simplification, so we focus on the algorithm? Thank you!

    For exmple,

    NumNets 6

    Net N1 2

    Pin C1/P1

    Pin C2/P2

    ...

    trans to

    DEF,

    NETS 6 ;

    - net1

      ( C1 P1 ) ( C2 P2 )

...

**A8. No. We don't use LEF/DEF for the input file in this contest. We want to make the input file format as simple as possible. So, contestants will not spend much time on file parsing and can focus on the algorithm problem.**

**Q9.** Can we find an open source dataset in this format or use open source tools for conversion, or is this a new format you proposed? Thank you.

**A9. It is the new format we just proposed for this contest.**

**Q10.** We have a question about problem B.

This problem requires outputting the center coordinates of bounding terminals, and the center coordinates are used to calculate hpwl. But we see that the width and height of the bonding terminals in case 1 are not even. Does the answer need to output coordinates with decimals?

In this way, the result of hpwl will also have decimals.

**A10. We want to keep this contest problem with integer scope. Thus, we will update the values of terminal width and height in the testcases to make sure the terminal sizes are always with even numbers. Thanks for pointing this out and please check the new version of case1 on the website.**

**Q11.** As for the cad contest, I would like to know if there is any constraint to use the open-source codes since currently more and more open-source eda programs are available on GitHub.

**A11. It is fine to use open-source code.**

**Q12.** 1. In the input file, what is the meaningfor **<repeatCount>** in **TopDieRows** and **BottomDieRows**?

**A12.** <repeatCount> **means the number of rows that would be created from the** <startY> **location with the step of** <rowHeight> **by repeating** <repeatCount> **times.**

**Q13.** Does **<rowHeight>** times **<repeatCount>** always equal to the **<upperRightY>** of **DieSize**?

**A13. No.** <rowHeight> **times** <repeatCount> **would always be less than or equal to the** <upperRightY> **of DieSize.**

**Q14.** Will there be more than two technologies? And also for each Die, can we choose different technologies to use? (Take Problem_B_case1 for example, **<rowHeight>** of **TopDieRows** is 10, and **<rowHeight>** of **BottomDieRows** is 15. Does this means that I can use both Tech TA (<libCellSizeY> 10) and TB (<libCellSizeY> 15) for the bottom die but just TA (<libCellSizeY> 10) for the top die?)

**A14. There would be at most 2 technologies.**

**No. You can only use the specified technology in TopDieTech and BottomDieTech from the input file for top die and bottom die respectively.**

**Q15.** For Problem B, can I use Python scripts, say, pybind11 environment with dynamic libraries.

**A15. Please try your program on the testing machine provided by this contest. As long as your program can be run successfully on the testing machine, that is good.**

**Q16.** We have a question about problem B. Would it be a situation that one pin connects to multiple nets? Thank you.

   For example

   Net N1 2

   Pin C1/P1    //same pin

   Pin C2/P1

   Net N2 2

   Pin C1/P1    //same pin

   Pin C3/P4

**A16. It would NOT happen.**


**Q17.** We are unsure if we understand it right for problem B, could you help checking the following questions?

**1)** The terminals and the cells are placed in different layers, so the overlapping of a terminal and a cell on x or y coordinate is allowed, right?

e.g. the size of terminal T1 is 20\*20, the size of cell C1 is 10\*10, and we place T1 at (10, 10), C1 at (5, 5), is this legal (suppose not violating other constraints)?

**2)** Under the spacing constraint, the only cost for placing a terminal is that it would be included in calculating the HPWL of the belonging net for both dies, right?

**A17. Here are the answers for these questions.**

**1) Yes. The example is a legal case.**

**2) Yes.**


**Q18.** Could you please help to advise if we could assume the bottom-left point of the die area is (0,0) in all cases? Thank you.

**A18. Yes. You can make this assumption.**


**Q19.** We have a question for problem B, please help us.

From the previous Q&A13, it is mentioned that <rowHeight>\*<repeatCount> may be less than <upperRightY>. But in the problem description file, the bottom-left point of the die would be (0, 0), and the given placement rows would start from (0, 0) and "cover the entire die".

Wouldn't it cause conflict (if <rowHeight>\*<repeatCount> is less than <upperRightY>, then there exists some space of the die not covered by placement rows)? Or is there something we misunderstood? Thank you very much!

**A19. <rowHeight> times <repeatCount> would always be less than or equal to the <upperRightY> of DieSize. The height of the "uncovered portion" would be less than <rowHeight>.**

**That means if the row can be created completed inside DieSize, the row will be existed. Indeed, there might be a small portion at the top edge of the die which does not have placement row. But, the height of that region must be less than <rowHeight>.**

**Q20.** I have some questions for ICCAD 2022 Problem B:

**1)** Will it be guaranteed that if there exists a standard cell library in TA, then there must exist a standard cell library in TB if there exist two techs?

**2)** Will it be ensured that there exists at least one solution for case4 to partition the instances into two dies with valid max utilities that satisfy the MAX_UTILITY constraints?

**3)** If there exists an Instance called C5, can I assume that there must exist C1 C2 C3 C4 in the netlist? Same as the naming rule for pinName, and netName, will they follow this rule?

Thanks for your reply!

**A20. Here are the answers for these questions.**

**1) Yes. That is guaranteed.**

**2) Yes. The valid solutions do exist for all cases. You can use the released evaluator binary to check your result.**

**3) Not quite sure your question. But we can guarantee followings.**

    **If numInstances x , then the instances are named as C1 ~ Cx.**

    **If netNum y, then the nets are named as asN1 ~ Ny.**

    **For a LibCell pinCount = z, then the pins are named as P1~Pz.**

**Q21**. I have some questions regarding problem B.

**1)** A19 in the Q&A states that "The height of the 'uncovered portion' would be less than <rowHeight>." However, both dies in case 4 seem to violate the statement. Can you look into it?

**2)** Can we make the assumption that each cell will connect to at least one net, and each net will connect to at least two different cells?

Thank you!

**A21. Here are the answers for these questions.**

**1) Thanks for pointing this out. Please check the updated version of the case4 on the website.**

**2) Yes. You can make that assumption**

**Q22.** I'm wondering if the top layer is all for bonding terminals so that I won't need to preserve any routing resource.

For example: for case2, we can have 50x40=2000 terminals at most, these terminals are all available. Thank you.

**A22. Yes, you are right. Case2 can have 50x40=2000 terminals at most. All these terminals are available.**

**Q23.** I have a problem about the evaluator in problem B.

According to description of problemB description:

Evaluation score = HPWL of top die + HPWL of bottom die

We found that the Evaluation score is really different with our calculation.

*We use a simple case (only 2 cell place in same layer and cell type are same),

when hpwl is a line ex: (5,5) (10,5), the evaluation score is not 5 .

We also try to find the calculating rule of the Evaluator, but it's very hard to speculate.

Could you please help to give us some suggestions?

**A23. We found that indeed a bug in our evaluator. We have updated the evaluator. Please download the new version of the evaluator from CAD Contest Web site.**

**Q24.** I want to ask about how the evaluator computes HPWL.

Since that we've summed up each rectangle's half parameter but got different answers with the evaluator.

Here is a brief test about it：

We copy-pasted every property in **case1.txt,** but only left InstanceC1,C2 and Net1.

NumInstances 2

Inst C1 MC1

Inst C2 MC3

NumNets 1

Net N1 2

Pin C1/P1

Pin C2/P2

Our output is as below：

**TopDiePlacement 0**

**BottomDiePlacement 2**

**Inst C1 0 15**

**Inst C2 7 15**

**NumTerminals 0**

In this case, HPWL

Pin C1/P1 is at (2,26) , Pin C2/P2 is at (10,18)

HPWL should be 8+8 =**16**

But the evaluator said it's **34.**

Could you please help us figure out the problem? Thanks a lot!

**A24. We found that indeed a bug in our evaluator. We have updated the evaluator. Please download the new version of the evaluator from CAD Contest Web site.**

**Q25.** We have a question for ICCAD 2022 problem B.

Could we assume that, for each cell, we can traverse all the other cells via the netlist? (It means the graph is a connected graph)

It means that the example below will not happen,

CellList = C1, C2, C3, C4, C5

Net N1 C1 C2 C3

Net N2 C4 C5

Could we have this assumption? Thanks for your help!

**A25. It depends on the netlist and we do not guarantee this. Please do not make this single connected graph assumption.**

**Q26.** Can I get all the test cases of Alpha Test after the completion of the Alpha Test?

**A26. No. You already can find all the public cases on the CAD Contest website. For the hidden cases, we will release those cases after the end of the contest this year.**

**Q27.** Can I submit shell scripts in the final submission?

**A27. We will execute your program in this following way. You can have your shell scripts being included inside that "YOUR_PROGRAM_NAME" executable file. As long as we can successfully execute your "YOUR_PROGRAM_NAME" file in the CAD Contest evaluation machine in this following way, that would be good.**

**./YOUR_PROGRAM_NAME <input_file.txt> <output_file.txt>**

**Q28.** Do the **hybrid bounding terminals** be placed on the top die and cannot overlap with the top die cells?

**A28. Hybrid bounding terminals can be overlapped with top die cells.**

**Hybrid bounding terminals are on the top-most layer of the die while cells are placed on the lowest layer. Cells and hybrid bounding terminals are on different layers. Thus, can be overlapped.**

**Q29.** (As previous QA28) Thanks for your reply.

So I can understand as there has two layer for each die(top die and bottom die).For each die is like: (terminal layer, cell layer). Is this correct?    Thank you.

**A29. Yes, your understanding is correct.**

**Q30.** I was getting an error with the 5-25 evaluator for my output on case 4. I modified the utilization limits so that the area use should be legal, but am getting some other sort of error on this benchmark. My modified input file, the placement, and the output of the evaluator are here:

https://www.cs.binghamton.edu/~pmadden/cadb1006.tgz

The evaluator reports:

---

iccad_evaluator_0525: src/Parser/Parser.cxx:150: void

Parser::checkInstNumandRow

(): Assertion `assertInputError && "inst not legal"' failed.

Abort

---

Can you let me know what the evaluator doesn't like? Thank you.

**A30. The assertion was due to Inst C220695 did not align to the row.**

**We have updated the evaluator to prevent the assertion, but print a message only for the bad result.**

**Please check the contest website to get the updated evaluator for this problem.**


**Q31.** Our team observed that in case 1 to case 4, if there are 2 technologies, then the cells' area of one technology is greater than the other one. We want to ask is that, is it any possible that some cells' area in tech A is bigger, while other cells' area in tech B is bigger, or the cell's area in tech A(or B) is always greater than the other one?

**A31. Yes. You can assume the cell area in tech A(or B) is always equal or greater than other one.**


**Q32.** We are provided a TSRI machine to submit the files for alpha and beta test submission. We want to ask if in the final test, the program will be executed on this machine, or by the additional machine?

**A32. Yes. We will use TSRI machine for all the evaluation.**


**Q33.** Can we build up some libraries or update cmake beforehand for problem B?

**A33. We will execute your program in this following way. You can make your executable "YOUR_PROGRAM_NAME" as a wrapper to include your pre-steps and real binary execution inside this wrapper.**

**As long as we can successfully execute your "YOUR_PROGRAM_NAME" file in the TSRI machine in this following way, that would be good.**

**/YOUR_PROGRAM_NAME <input_file.txt> <output_file.txt>**


**Q34.** In the specification, it says "The hidden cases will be in the same scale as public cases". Does it mean that the largest public case will be the largest among all testcases?

I'm not sure how much runtime for public case4 can guarantee a valid runtime of 1 hour for hidden cases.

Could you help check this? Thank you.

**A34. The largest hidden case would be with similar size as public case4. The runtime depends on your algorithm. We are not able to comment.**

**Q35.** We found that the die size of the case3 does not match the row height repeat count. In case3, die size is 19192 but row height(115) * repeat count (166) = 19090 does not match. But " The given rows would start from (0, 0) and cover the entire die." is mentioned in ProblemB. Could you help check on this? Thank you.
**A35. I think this question has already been answered in Q13.**
**That there might end up with a small gap at the top-most edge of the design which the height of the gap would always be smaller than rowHeight.**

**Q36.** We have some questions about the final evaluation on problem B.
1) Will runtime be part of the evaluation criteria? Or there is no effect on the evaluation as long as the runtime is under one hour?
2) Assume no violation of the given constraints, will the final evaluation be the sum of the score on all cases (as "Total Score" shown in the result of beta submission)? or will there be a weighted score on each case (e.g. case 1:10%, case 2:20%....)?
**A36. Here are the answers for these questions.**
**1) No. runtime is not in the evaluation score but just a condition. As long as the runtime is within 1 hour, that is fine for each case.**
**2) Yes. Final score is the sum of the score on all cases.**

**Q37.** The <techName> will always be "TA" and "TB" ? Is it possible to be "TC" or other names?
**A37. You can assume the <techName> will always be "TA" and/or "TB". That is fine.**

**Q38.** We have some questions about test cases and final ranking rules:
1) For the final test, are there any other test cases besides case1-4 (containing hidden cases)? If so, what is the approximate size?
2) We noticed that the results from different cases are of different magnitudes, so what is the final ranking rules? Total scores, total weighted scores, or rank each case individually?
**A36. Here are the answers for these questions.**
**1) there will be no other new cases.**
**2) Total scores, as answered in QA36.2).**

**Q39.** The report results show "TIME_OUT", is that really mean timeout? Or it possible be segmentation fault?
**A39. If the case is segmentation fault, we will report NO_OUTPUT.**

**Q40.** We have a question about problem B. Can we include the evaluator provided from Problem B in our final submission and execute it in our program?

**A40. Yes. If you want to include and execute the provided evaluator in your program, that is fine. That will still count in your program runtime.**


**Q41.** 1. We have a question for ICCAD 2022 problem B

Could we use a third party library that needs a license only usable for one username? We would like to know whether the final submission will be run and evaluated on using our username.

Or could you please give us suggestions about how we could solve this problem?   Thanks.

**A41. No. evaluation will not use contestant's username. You should use the library without license restriction. Please note, the evaluation machine would have the same hardware and software environment setting as the contestant machine. But, it is a different machine.**

**Please make sure your program is portable and don't have any dependency to your local directory.**


**Q42.** Could you please advise if it is possible to use the innovus software in the system to achieve the placement of standard cells? Thank you.

**A42. Yes. Innovus is available in the CAD Contest machine.**

**Please check the document as "2022 CAD Contest NX Client guideline" provided from the submission announcement mail.**


**Software:innovus**

**source /project/cad/cad50/cadence/CIC/innovus.cshrc**

**source /project/cad/cad50/cadence/CIC/license.csh**

### CAD Tool Source Path Information

| | |
|---|---|
| Software:innovus<br><br>source /project/cad/cad50/cadence/CIC/innovus.cshrc<br><br>source /project/cad/cad50/cadence/CIC/license.csh | Software:VCS<br><br>vG-2012.09-SP1    source /project/cad/cad50/ synopsys<br>/CIC/vcs.cshrc |
| Software:CONFRML CONFRML_21.10.100<br><br>source /project/cad/cad50/cadence/CIC/CONFRML.csh | |
| Software: design compiler 2020.09<br><br>source /project/cad/cad50/synopsys/CIC/synthesis.csh | Software: Nitro-SoC nitroPack-2018.1.R2<br><br>source /project/cad/cad50/mentor/CIC/ Nitro-SoC.csh |
| Software:ncverilog INCISIVE_15.20.075<br><br>source /project/cad/cad50/cadence/CIC/incisiv.cshrc | Software:Synopsys Library Compiler<br><br>source /project/cad/cad50/synopsys/CIC |
| gcc 6.3.1<br><br>/opt/rh/devtoolset-6/root/usr/bin/g++<br><br>/opt/rh/devtoolset-6/root/usr/bin/gcc | |


**Q43.** We have a question about Problem B. We already knew that our final submission will be evaluated by the command line ./binary <input.txt> <output.txt>.

We want to know if the input.txt or output.txt will be under any child directory like the following scenario.

e.g.

1 ./binary case/case1.txt out/out.txt

2 ./binary case/case1.txt out.txt

3 ./binary case1.txt out/out.txt

Or is the input.txt and output.txt are just going to be simply in the current directory.

e.g.

./binary case1.txt out.txt

**A43. input.txt and output.txt are just going to be simply in the current directory.**


**Q44.** Since we have used Innovus, is it permitted that the license must be sourced manually before running the program? Thanks.

**A44. Please try to use a shell script to warp the license sourcing and the binary execution into a single shell script. Thus, we can execute the shell script directly.**

**If that is not doable, please provide a REAMME to indicate how to source the license manually for evaluation.**


**Q45.** We read the QA and saw that we have to make sure no dependencies on our machines, we want to ask that libraries provided such as TCL and TKL will be able to use in the Final submission's machine. Or do we have to do a static link to the libraries. Thank you.

**A45. The machine configuration and available libraries will be the same in contestant machines and evaluation machine. If the TCL and TKL libraries were provided in the contestant machines the same library will be here in evaluation machine.**

**If you can make the static link that would be even safer.**


**Q46.** In the document of problem B, it mentions about the program should be able to be executed like ./$binary_name input.txt output.txt, but I have several executable files, is there any restrictions about the binary name? Or can I add a readme file to indicate which file you should execute? Thanks.

**A46. Not quite understand this question. You should only submit ONE binary. We will use the same binary for evaluating all the public and hidden cases.**

**Using different binaries for evaluating different cases is not allowed…**


**Q47.** According to the previous QA46,

Since in our program, we will execute another binary file, so there will be two binary files. That's why we would like to know if it is acceptable and any restrictions about the binary name. Thank you.

**A47. Yes. That is fine.**

**Please name your main binary as the same as your teamID for final submission. Adding a README in your submission would be even better.**

**Q48.** 1. We have the same situation as QA46 mentioned. In this case, can we use a script to organize these binaries? So it'll be like "./script <input.txt> <output.txt>"

**A48. Yes. "./script <input.txt> <output.txt>" is good.**

**Q49.** I am well aware that the final score is calculated as the sum of the scores of all the cases. If one of the cases is not legal, is the sum of the scores zero? Or does this case(illegal one) have a score of zero and the sum of the scores is calculated by the other cases?

**A49. You will still have score for other legal cases. But, team's final score will be "N/A" and would not be included in the ranking.**