Advanced VLSI Project – stage 3

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1. Reminder

So far, we have covered the Synthesis stage (converting our RTL into logical cells) and the STA stage (analyzing the timing constraints of our design).

In the current stage (Floorplan) we want to try and plan a head how would we want our chip to be constructed in a general view.

We will introduce several structures, analyze them, way pros and cons and finally – choose the structure we want to continue work with.

2. Setup

As we explained in previous stages of the project, we would like to copy the files for stage 3 from Elad's directory using the command:

```
cp -r /project/advvlsi/users/eladsimanian/ws/bitcoin/stage3 .
```

1. There is an appendix for working with NDM directories in Section 4, but if you get more questions than answers there, just ignore it and continue with the assignment **please**.

3. Stage 3: Floorplan

As we discussed during the lecture, the Floorplan stage is mainly about constructing a general framework for our design.

For example, we want to understand if our block is part of a greater chip and how it should be placed in it – Where should we place the inputs and outputs of our block? Can we design our block in any shape and size we want or are there constraints that we must meet?
In our project the bitcoin block is "stand alone" and therefore those thoughts won't be a factor, but we still want to minimize our chip as we can and think about other aspects of our floorplan.

We want to explore the automatic floorplan ("option 1") being constructed by Fusion Complier with minimal guidance and compare its results with three other options.
The NDM files you received contain three different implementations of floorplan for the bitcoin design. Those NDMs contain an implementation of the Synthesis stage so the stages won't be dependent on one another.
See section "Working with NDM libraries" for additional instructions on the subject.

For your comfort we marked all tasks needed for submission with:
[#P<Part_ID>_Q<Q_ID>] such as **[#P3.1_Q1]**

3.1 Warmup Questions

1. **[#P3.1_Q1]** Why is the floorplan stage important in physical design?
2. **[#P3.1_Q2]** What are some of the factors to consider when creating a floorplan?
3. **[#P3.1_Q3]** Congestion:
   3.1. What is congestion in a floorplan?
   3.2. Why is congestion a concern in floorplanning?

## 3.2 Analyzing floorplan options and comparison

To avoid confusion, scroll to the last page of this pdf file, you will see the questions you need to answer.

Basically, what you need to do:

Option1 + Task X , Option2 + Task X , Option3 + Task X , Option4 (no need task X)

Task X

1. We will introduce four floorplan options and analyze them with several tools:
    1.1. Design reports gathered by using the "collect_reports" proc (create a new directory named "stage3" in your reports's directory).
        Congestion map – Can be found by searching in the Fusion Compiler search engine the phrase "Global Route Congestion" (Reload man if needed):
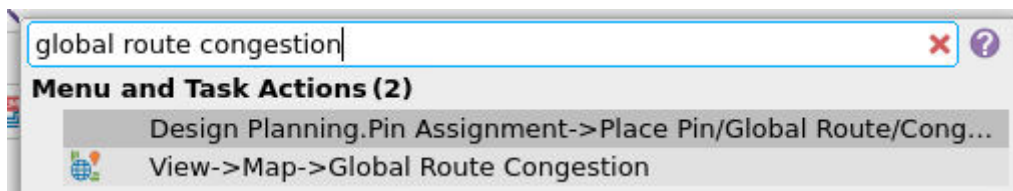

    1.2. Manually analyzing the design.
2. **[#P3.2_Q1]** For each of the three floorplan options submit:
    2.1. Print screen of the layout with and without the congestion map.
        If needed take more than one print screen with a different zoom (F in keyboard might help) and remove from the object's view the objects that aren't necessary for the floorplan.
    2.2. List the major pros and cons of the floorplan option.
    2.3. Suggest how can the floorplan be improved (automatically or manually) and discuss the tradeoffs.
    Option 4 is a theoretical and therefore you need to answer only section 2.2 (pros and cons).

3. **[#P3.2_Q2]**
    This question should be answered only 1 time, after you went through all the options.
    After going through all the floorplan options, choose the best floorplan option from those options and explain your decision.
    Optional: suggest a floorplan of your own!

```
cd /project/advvlsi/users/$user/ws/bitcoin/stage3/workspace/stage3
fc_shell -gui
```

Then open from the script editor your (not Elad's) relevant scripts (from the script folder) like you did in stage 1, for example:
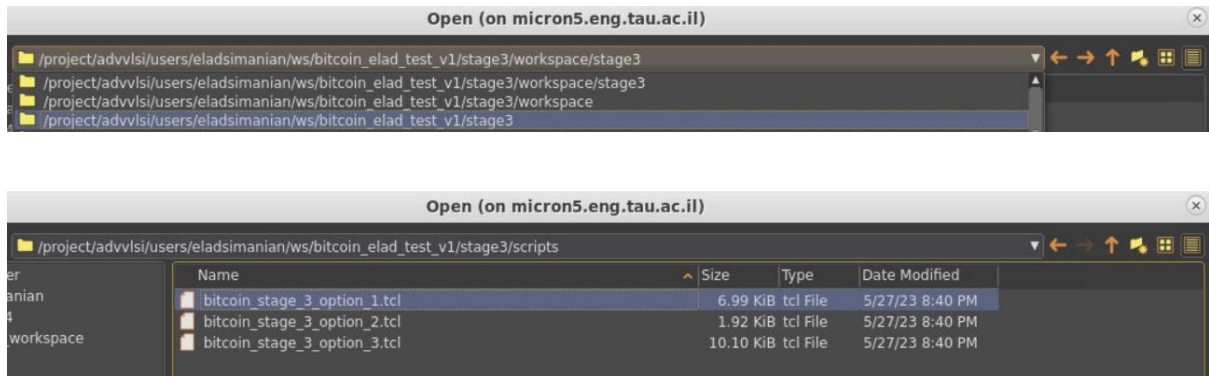
3.2.1 Option 1: Automatic floorplan

Mark the "selected" box, **and by using the script:**

1. Open the NDM lib "bitcoin_stage_3_option_1". This lib contains a similar snapshot of our design from stage 1 (Synthesis).
2. Read the relevant tcl script located at the directory and answer:
    2.1. Explain how the parameters core_utilization and side_ratio in set_auto_floorplan_constraints procedure effect the automatic floorplan.
    2.2. What metals are we using for the power grid?
3. Run the commands one-by-one and answer the questions at "Task X" with this floorplan option.
4. close_block
5. close_lib

3.2.2 Option 2: Re-organized the location of the SRAMs into a matrix shape (fixed spaces)

Open the relevant script from the script editor, **and by using the script:**

1. Open the NDM lib "bitcoin_stage_3_option_2". This lib is an extension of the design from stage 1 (Synthesis) which contains a re-organization of the SRAMs in our design. The SRAMs are organized in the shape of a matrix with fixed spaces between them.
2. Answer the questions at "Task X" with this floorplan option.
3. close_block
4. close_lib

3.2.3 Option 3: Re-organized the location of the SRAMs into a matrix shape (unfixed spaces)

Open the relevant script from the script editor, **and by using the script:**

1. Open the NDM lib "bitcoin_stage_3_option_3". This lib is a copy of the NDM "bitcoin_stage_3_option_2".
2. In the directory you can find the script to construct this structure, make sure you understand its input and output:
   2.1. What does the function do?
   2.2. How can we set the input arguments to get a floorplan like option 2?
3. Run the "create_macro_arrays" procedure with different input arguments to understand better its functionality and its effect on the final floorplan. Then, decide on the best configuration and write it down in your report. Explain your decision.
   Note: the script doesn't validate its input, you must understand its functionality and use it correctly.
4. Answer the questions at "Task X" with this floorplan option, list the input arguments and explain.
5. close_block
6. close_lib

3.2.4 Option 4: Divide and conquer

1. In this section we will discuss a **theoretical option** for our floorplan.
2. The general idea: We will construct at the bit_coin level the 16 bit_top instances in a 4x4 fashion. The 4 bit_top instances in each row are abutted together. The 2nd row is created by Flipping the 1st row along the x-axis and then abutting it with the 1st row. Similarly, we created the 3rd and 4th rows.
   Space was left in the middle for top-level cells placement.

   Shown below:
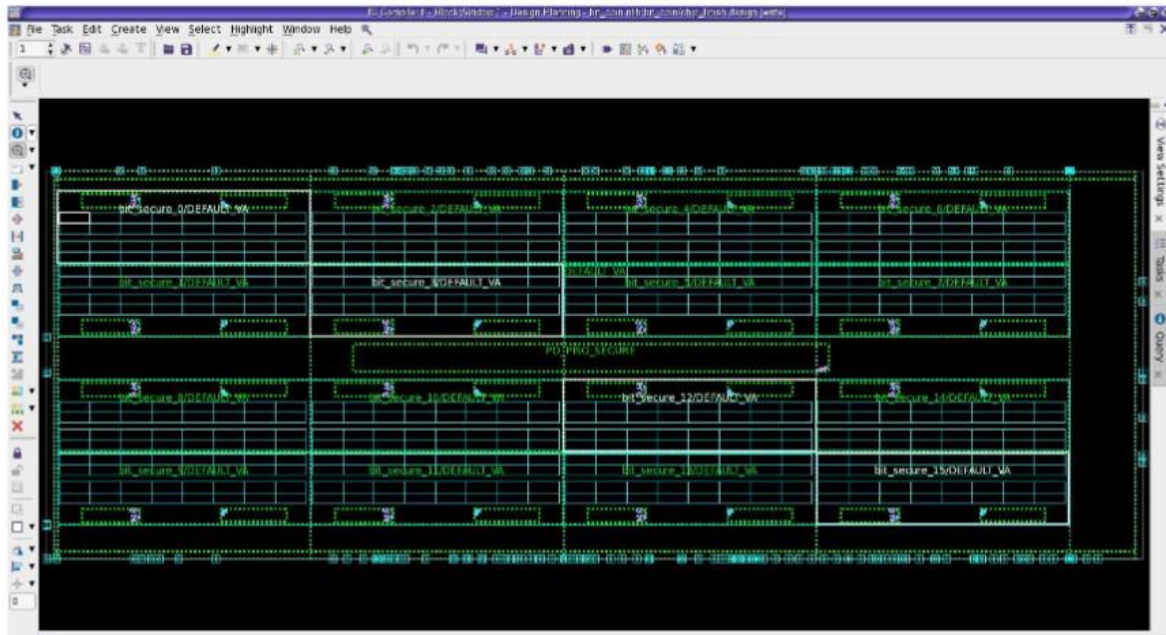
3. No need to go back to "Task X", just explain the pros and cons of this option.

Remember to choose and explain your final option for the best floorplan! [#P3.2_Q2]

4. Working with NDM libraries

Be sure to notice that you are now in stage 3 not 1, this is just a general explanation.

1. In this stage of the project (and the next stages) we are working on a given NDM library and blocks that were already implemented for us.

2. Here, we will discuss some useful commands in Fusion Compiler to guide you:

   2.1. list_libs – shows a list of all current libraries open in the context. Can be useful for getting the name of a library you wish to open.

   ```
   list_libs
   ```

   2.2. open_lib – open a new library from the file system

   ```
   open_lib bitcoin_stage_1.dlib
   ```

   2.3. list_blocks – show a list of all current blocks in the library opened in the current context. Can be useful for getting the name of a block you wish to open.

   ```
   list_blocks
   ```

   2.4. open_block – open a new library from the file system

   ```
   open_block bitcoin_stage_1.dlib:bitcoin/compile.design
   ```

   After opening a block you will have two instances of Fusion, run current_block to make sure you are working on the block you want to proceed.

   2.5. copy_block – it is good practice to start working on each stage with copying the given block and working on a different one, therefore if something gone wrong we can start over.

   ```
   copy_block -from bitcoin_stage_1.dlib:bitcoin/compile.design -to
   bitcoin_stage_1.dlib:bitcoin/compile_sol.design
   ```

   2.6. current_block – shoe the block you are currently working on

   ```
   current _block
   ```

3. Here is a standard flow – **close fusion_compiler** (exit command) and make sure you are in advvlsi env. Then:

   ```
   fc_shell -gui
   open_lib bitcoin_stage_1.dlib
   open_block bitcoin_stage_1.dlib:bitcoin/compile.design
   copy_block -from bitcoin_stage_1.dlib:bitcoin/compile.design -to
   bitcoin_stage_1.dlib:bitcoin/compile_sol.design
   open_block bitcoin_stage_1.dlib:bitcoin/compile_sol.design
   current_block # Make sure you are working on the desired block
   ```

4. There are many other commands related (for closing, linking, etc.), if needed you can read about them with man command.

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5. Submission

1. If the team approves the design functionality, the team lead, which has the updated work area with all the teams' files working, should submit the assignment as follows.
2. Submit to Moodle a zip:
   Let's say you are group advvlsi_15 then:
   bitcoin_stage3_advvlsi_15.zip

   The zip must include a PDF file:
   bitcoin_stage1_advvlsi_15.pdf

   the pdf should include the following:
   2.1. The stage name and number (Stage 3 – Floorplan)
   2.2. Workarea path, such as: /project/advvlsi/users/$user/ws/bitcoin_project
   2.3. Team's info: members name, id, usernames (in micron servers), tau emails
   2.4. Answers for all questions and tasks marked with "[#P<>Q<>]"

Good Luck.

P.S the next stage will deal with Placement!

Questions only

[#P3.1_Q1] Why is the floorplan stage important in physical design?

[#P3.1_Q2] What are some of the factors to consider when creating a floorplan?

[#P3.1_Q3] Congestion:

- What is congestion in a floorplan?
- Why is congestion a concern in floorplanning?

[#P3.1_Q4] In what situations might a worker need to do manual work to assist an automatic program in floorplanning?

[#P3.2_Q1] For each three floorplan options submit:

- Print screen of the layout with and without the congestion map.
  If needed take more than one print screen with a different zoom and remove from the object's view the objects that aren't necessary for the floorplan.
- List the major pros and cons of the floorplan option.
- Suggest how can the floorplan be improved (automatically or manually) and discuss the tradeoffs.
  Option 4 is a theoretical and therefore you need to answer only section 2.2 (pros and cons).

Also-

> **For Option 1 – question 2.1 and 2.2**
>
> **For Option 2- question 2.1 , 2.2 and 3**

[#P3.2_Q2] After going through all the floorplan options, choose the best floorplan option from those options and explain your decision.
Optional: suggest a floorplan of your own!