Design Technologies for Integrated Systems, EPFL

Project **Deadline: 13/12/2018**

Problem Description

This project aims at training you on the use of open source logic synthesis tools. The main purpose is to build an optimization flow for size minimization, by exploiting different data structures.

Support

Open source tools are described during the lecture on November 22:

1) Yosys (*https://github.com/YosysHQ/yosys*)

2) abc (*https://github.com/berkeley-abc/abc*)

3) CirKit (*https://github.com/msoeken/cirkit*)

If you have your own laptop, you can choose one of the following options to access the tools. Otherwise you must use option 3.

1. Use docker for the precompiled binaries

After installing docker, copy *dtis.tar.gz* from dtis20@selsrv1:∼/

```
$ scp -r dtis20@selsrv1:~/dtis.tar.gz /your/path
```

the password is *.dtis$18*

Once done you can do the following:

```
$ docker load -i dtis.tar.gz
$ docker run -it dtis
```

All the tools can then be run from the *tools* directory.

```
$ cd tools
$ ./yosys
$./abc
$./cirkit
```

After exiting the docker container, you can resume it with:

```
$ docker start <container_id>
$ docker exec -it <container_id> bash
```

where the container_id can be retrieved from

```
$ docker ps
```

2. Install the tools on your machine cloning them from Github

3. Use singularities on lsisrv8

This is the only option you have if you are using a laptop provided by the lab. Access the server:

```
$ ssh yourgaspar@lsisrv8
$ cd /files/singularity
$ singularity shell /files/singularity/ubuntu18.img/
```

To access the tools:

```
$ cd /tools
$ ./yosys
$ ./abc
$ ./cirkit
```

To access the benchmark

```
$ cd /benchmarks
```

Benchmarks

We consider six benchmarks, which can be found on Moodle, in the benchmarks directory in the Docker image or in the singularity. Some benchmarks have sequential components, which can be turned into combinational ones by calling '*proc*' in Yosys, and by calling '*comb*' in ABC. The benchmark *softusb_navre_simple* has a memory element, which can be made combinational by using the '*memory*' command in Yosys.

Task

Optimize **the size** of all the benchmarks. For each Verilog file:

1) Read the benchmark using Yosys and transform it into a BLIF format file.

2) Using abc, read the BLIF and optimize it using the available optimization commands. The commands are described in the abc tool documentation (*https://people.eecs.berkeley.edu/∼alanmi/abc/*). Many of the commands implement multi-level optimization techniques seen during the lectures. Generate an output file.

3) Read the output file you obtained using CirKit and optimize it using the available commands. A list of all commands can be found by calling '*help*', the help of each command can be printed by calling the command with the '*-h*' flag. Write a Verilog file that contains only majority and inverter operations (MIG).

4) Submit the final Verilog files using Moodle.

Table 1: Size and depth for not-optimized benchmarks.

Benchmark	I/O	Size	Depth
aes_5cycle_2stage_simple	909/650	57932	52
cordic_9_8_simple	250/256	3565	16
elliptic_curve_group_simple	8226/7684	103668	30
MAX10_simple	16/56	268	7
sddac_simple	65/47	701	27
softusb_navre_simple	382/390	8633	60

Without any optimization step we obtained MIGs with size and depth as reported in Table 1.

Table 2: Size and depth for optimized benchmarks.

Benchmark	I/O	Size	Depth
aes_5cycle_2stage_simple	909/650	40712	51
cordic_9_8_simple	250/256	1460	14
elliptic_curve_group_simple	8226/7684	69285	24
MAX10_simple	16/56	132	5
sddac_simple	65/47	288	41
softusb_navre_simple	382/390	5542	40

Performing size optimization we obtained MIGs with size and depth as reported in Table 2. These results are just indicative, you can beat them!

Rules for Submission and Grading

You should submit on Moodle:

- a compressed folder containing all your output Verilog files.
- a PDF file (max 1 page) describing your flow. If you perform some optimization, specify the commands you used.

This project accounts for the 15% of your final mark. The project is graded over 100 points.

- 20/100 points will be granted if you manage to obtain the results in **Table 1** (assuming a good report).
- 100/100 points will be given to the submission with the best result in terms of size (assuming a good report). If two or more submissions have the same size, the depth will be considered. The other grades will be adjusted consequently.