University of Pennsylvania
Department of Electrical and System Engineering
System-on-a-Chip Architecture

ESE532, Fall 2019   Design and Function Milestone   Wednesday, October 30

Due: Friday, Nov. 8, 5:00PM

Group: Develop functional code. Identify design space options. Writeup (single turn-in for group).

1. Identify major design space axes that could be explored for your implementation.

   - For this milestone, aim for breadth (quantity of options)

   - Each axis description can be 2–3 sentences. Identify challenge being addressed, basic solution opportunity, and continuum. A single point in the design space is not a continuum; except in rare cases, this should capture a range of potential parameter values.

   - Include a simple equation to illustrate ideal benefit (e.g., running N tasks in parallel reduces runtime by a factor of N; $T(N) = T(1)/N$).

   - Cover all operations that must be accelerated including communication among operators.

   - Aim for at least 6 axes per operation. Identify a few associated with how operations interact with each other.

   - Some of this should build on the parallelism opportunities you identified on the previous milestone.

   Example from FFT design discussed in class.

Axis:	P, number of butterfly units.
Challenge:	Improving the throughput of the FFT
Opportunity:	Implement multiple hardware butterfly datapath units.
Continuum:	This can range from 1 to a fully spatial design with $P = \frac{N}{2}\log(N)$ butterfly units.
Equation for Benefit:	$Throughtput(P) = P \times SingleButterflyThroughput$

2. Refine your placeholder implementation into a functional implementation for the project task that can run on a Zynq ARM Cortex A53 processor and produce a valid compressed output stream that works with the supplied decompressor. This does not need to be integrated with I/O. It will compress from SDCard input to SDCard output.

   - The primary goal for this assignment is functionality. As such, you should focus on a simple design that captures the necessary behavior.

   - As a result, this design need not be efficiently synthesizable to hardware.

   - However, you will eventually be optimizing this design and likely exploring HLS mappings to hardware. So, given a choice, you might want to use design constructs and idioms that you know will be more amenable to HLS hardware mappings.

   - Alternately, you should be prepared to rewrite your code later for efficient hardware mappings.

3. Turn in a tar or zip file with your functional code to the designated assignment component in canvas.

4. Turn in a tar or zip file with binaries to support execution of your code to the designated assignment component in canvas.

   (a) The tar (or zip) files should include:
       - `encoder.elf` – binary for your encoder to run on an A53 core on the Ultra96
       - `encoder.bit` – bitstream for the Ultra96 Zynq

   (b) Your encoder should read a file `uncompressed.txt` from the SD Card.

   (c) Your encoder should store the encoded result in `compress.dat` on the SD Card.

5. Document your design.

   (a) Code sources (e.g., URLs) for any open-source code you used as a starting point or as a primary reference

   (b) Current compression ratio and breakdown of contribution from deduplication and from LZW compression; current throughput achieved for full task.

   (c) Overall throughput (Gb/s) of your current implementation.

   (d) Description of all validation performed on your current functional implementation.

   (e) Description of who did what. How did your team collaborate on the design, implementation, and validation?

6. Identify any challenges your group had in collaboration and design integration this week and how you plan to address them for future weeks.

   - This is not a question about technical status – that should be addressed above.

   - This is for teamwork, coordination, collaboration, communication, and workflow issues.

   - These may be things you've overcome by submission but didn't go as smoothly as they should have.

   - In the unlikely case that everything went perfectly, identify the things you did that made it work well. For your future plans, look forward to next week to see if the same techniques are applicable or if there are new challenges that might require different or additional techniques for things to continue to go well.