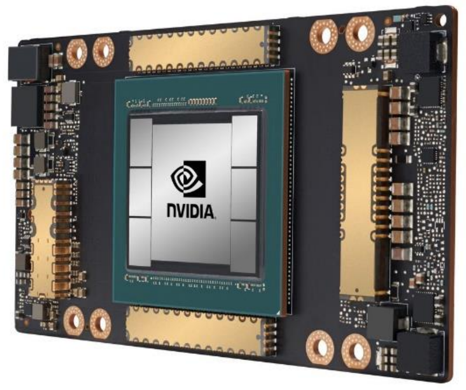
CSCB58: Computer Organization



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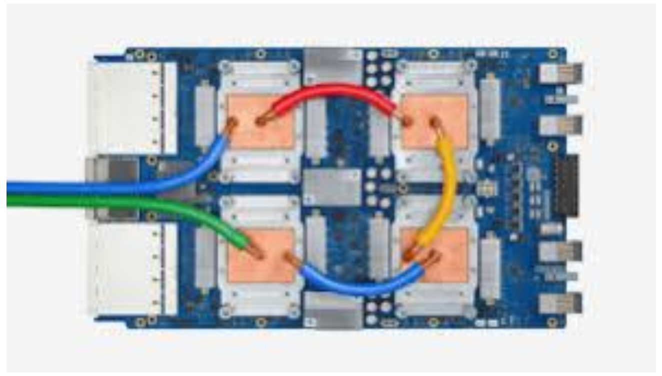


The content of this lecture is adapted from the lectures of Larry Zheng and Steve Engels

CSCB58 Week 12

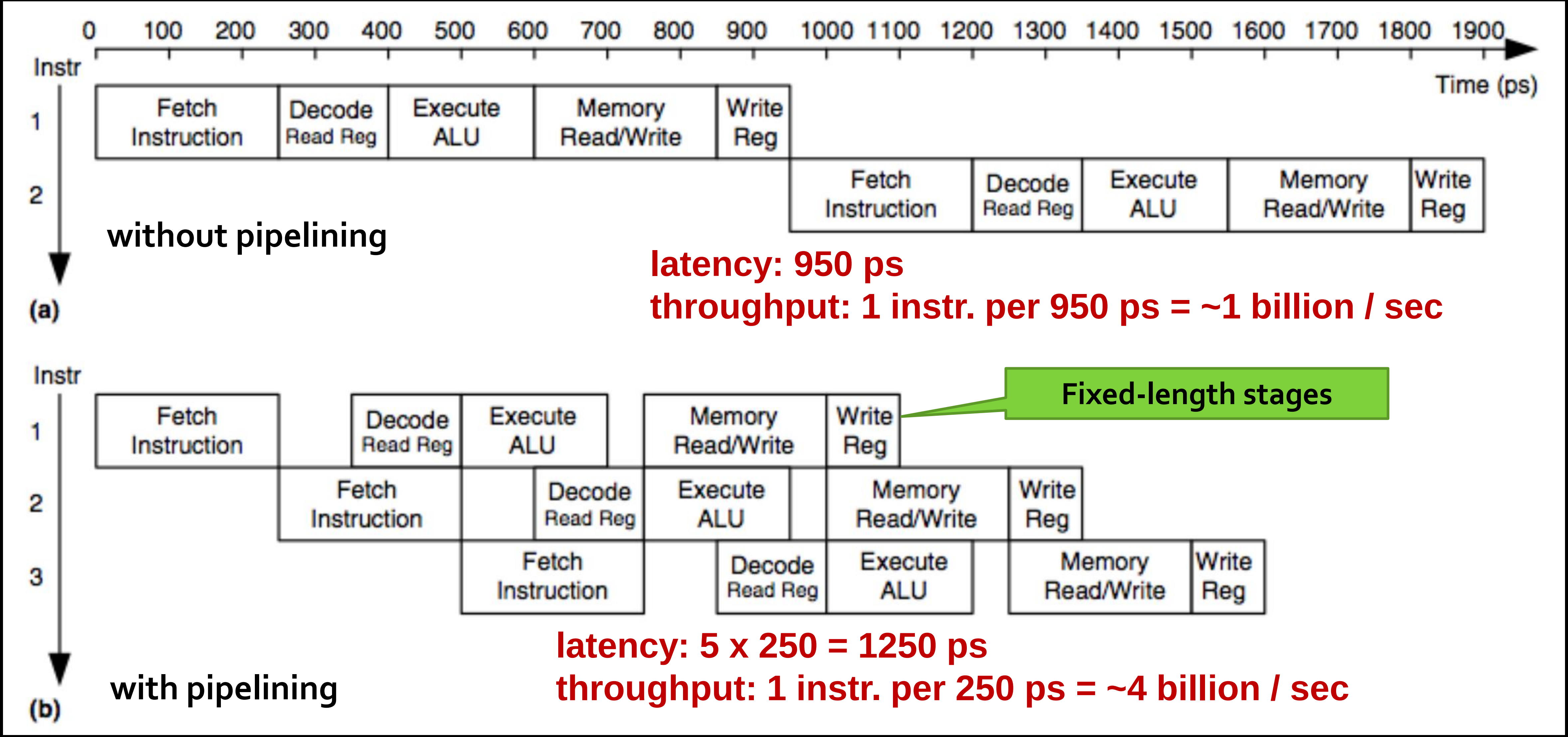
B58 Evaluation

- Please check your e-mail for a link to your evaluations
- Or go to: http://uoft.me/openevals

Execution Stages

- **Fetch**: Updating the PC and locating the instruction to execute.
- **Decode**: Translating the instruction and reading inputs from the register file.
- **Execute** / Address Computation: Using the ALU to compute an operation or calculate an address.
- **Memory Read or Write**: Memory operations must access memory. Non-memory operations skip this.
- **Register Writeback**: The result is written to the register file.

Pipelining the Execution Stages



without pipelining

latency: 950 ps
throughput: 1 instr. per 950 ps = ~1 billion / sec

Fixed-length stages

with pipelining

latency: 5 x 250 = 1250 ps
throughput: 1 instr. per 250 ps = ~4 billion / sec

fibonacci(int n)

```
int fib (int n){
        if (n <= 1)
                return n;
        else
        return fib (n - 1) + fib (n - 2);
}
```

fibonacci(int n)

```
fib:
           bgt $a0, 1, recurse
           move $v0, $a0
           jr $ra$t0, 0($sp)
```

1. Assign register names to variables and determine which is base case and which is recursive.
2. Only one input, n is passed in register $ao. The base case is the "then" clause. The recursive case is the "else" clause.
3. Convert the code for the base case.

Note: codes on the slides are not guaranteed to be correct. You need to be able to find the errors and fix them.

fibonacci(int n)

```
fib:
            bgt $a0, 1, recurse
            move $v0, $a0
            jr $ra$t0, 0($sp)
recurse:
            sub $sp, $sp, 12    # We need to store 3 registers
                                # to stack
            sw $ra, 0($sp)      # $ra is the first register
            sw $a0, 4($sp)      # $a0 is the second register,
                                # we cannot assume $a
                                # registers will not be
                                # overwritten by callee
```

Save callee- and caller-saved registers on the stack.

Note: codes on the slides are not guaranteed to be correct. You need to be able to find the errors and fix them.

fibonacci(int n)

```
fib: …


recurse: …
            addi $a0, $a0, -1 # N-1
            jal fib
            sw $v0, 8($sp)     # store $v0, the third register
                                # to be stored on the stack so
                               # it doesn't get overwritten by
                               # callee
```

Call fib recursively

Note: codes on the slides are not guaranteed to be correct. You need to be able to find the errors and fix them.

fibonacci(int n)

```
fib: …

recurse: …
         …
            lw $a0, 4($sp)     # retrieve original value of N
            addi $a0, $a0, -2 # N-2
            jal fib
```

Call fib recursively again

Note: codes on the slides are not guaranteed to be correct. You need to be able to find the errors and fix them.

fibonacci(int n)

```
fib: …

recurse: …
         …
         …
         lw $t0, 8($sp) # retrieve first function result
         add $v0, $v0, $t0
         lw $ra, 0($sp) # retrieve return address
         addi $sp, $sp, 12
        jr $ra
```

Clean up the stack and return the result.

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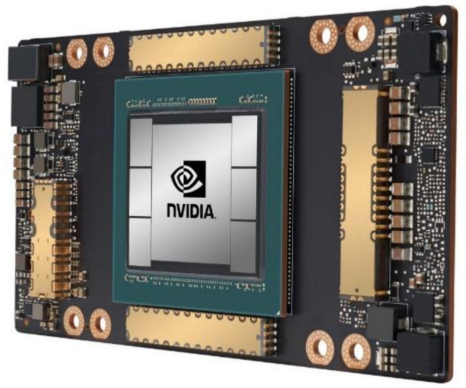

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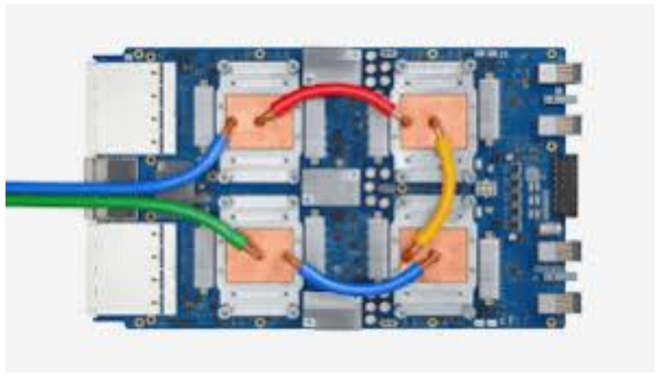

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