**ECE – 6100**

**Tomasulo Algorithm Pipelined Processor**

**PROJECT REPORT**

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**Assumptions / Limitations:**

In any clock cycle, results from previous clock cycle that were added to result buses would be updated to schedule queue and register file. Thus, in every clock entire result bus is free to be updated by the FUs.

Hence, I am assuming that maximum R is equal to K0+K1+K2 because in any clock cycle at-most all the FUs will need to update the result bus.

I am assuming that we get the best IPC when R, K0, K1 and K2 are maximum i.e. 6,2,2,2. We can then change F=4 and 8 to check the best case IPC.

I observed that when K0 or K1 or K2 is reduced to 1 for the same R and F, we get a significant drop in IPC. Hence, it will be observed that K0=K1=K2=2 would be the used case.

Dispatch queue size is assumed to be infinite which will not be the case in actual system. It was observed that average dispatch queue size was > 25,000 which is very high. Thus, in an actual system observed IPC would be way less that what is observed in this project.

We keep dead entries in schedule queue even though they have been fired which I don’t think is required. This increases the schedule queue size and imposes the restriction that schedule queue size be twice the number of FUs because FUs can update result bus which will then delete the entries from schedule queue only in next cycle and we need to have extra instructions in schedule queue which can be put in FU.

We are assuming that every FU gives a latency of 1 which may not be the case in actual system. And if FU is pipelined then it can demand a higher schedule queue size which has not been considered.

**Experiment Methodology:**

To decide on the configuration for a trace, I am following the below steps:

1. Set R=6, K0=K1=K2=2. Check with F=4 and 8 to get the best case IPC.
2. Set F=value from (1) and R=5. Check if IPC obtained by reducing either K0 or K1 or K2 to 1 achieves 95% best case IPC.
3. Fix F, K0, K1 and K2 from (2). Now get least R to get 95% of IPC from (1).

In step2 we choose R=5 because there are only 5 FUs in the test. Thus, R=6 should not result in better IPC compared to R=5.

**GCC:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **R** | **K0** | **K1** | **K2** | **F** | **Trace** | **IPC** |
| 6 | 2 | 2 | 2 | 4 | gcc | 2.42207 |
| 6 | 2 | 2 | 2 | 8 | gcc | 2.42207 |

IPCmax = 2.42207

Thus, target IPC > 0.95\*IPCmax > 2.3009

Set R=5, F=4.

1. With K1=K2=2 and K0=1
2. With K0=K2=2 and K1=1
3. With K0=K1=2 and K2=1

From the graph we can observe that when either K0 or K1 or K2 is reduced to 1 we get IPC < 2.3009. Thus, we need to set K0=K1=K2=2.

Set K=0=K1=K2=2 and F=4. Vary R.

Thus, K0=K1=K2=2, R=3 and F=4 is the configuration needed that gives IPC of 2.36675

**GOMBK:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **R** | **K0** | **K1** | **K2** | **F** | **Trace** | **IPC** |
| 6 | 2 | 2 | 2 | 4 | gobmk | 2.36446 |
| 6 | 2 | 2 | 2 | 8 | gobmk | 2.36446 |

IPCmax = 2.36446

Thus, target IPC > 0.95\*IPCmax > 2.246237

Set R=5, F=4.

1. With K1=K2=2 and K0=1
2. With K0=K2=2 and K1=1
3. With K0=K1=2 and K2=1

From the graph we can observe that when either K0 or K1 or K2 is reduced to 1 we get IPC < 2.246237. Thus, we need to set K0=K1=K2=2.

Set K=0=K1=K2=2 and F=4. Vary R.

Thus, K0=K1=K2=2, R=3 and F=4 is the configuration needed that gives IPC of 2.30463

**HMMER:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **R** | **K0** | **K1** | **K2** | **F** | **Trace** | **IPC** |
| 6 | 2 | 2 | 2 | 4 | hmmer | 2.26685 |
| 6 | 2 | 2 | 2 | 8 | hmmer | 2.26685 |

IPCmax = 2.26685

Thus, target IPC > 0.95\*IPCmax > 2.1535075

Set R=5, F=4.

1. With K1=K2=2 and K0=1
2. With K0=K2=2 and K1=1
3. With K0=K1=2 and K2=1

From the graph we can observe that when either K0 or K1 or K2 is reduced to 1 we get IPC < 2.1535075. Thus, we need to set K0=K1=K2=2.

Set K=0=K1=K2=2 and F=4. Vary R.

Thus, K0=K1=K2=2, R=3 and F=4 is the configuration needed that gives IPC of 2.20639

**MCF:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **R** | **K0** | **K1** | **K2** | **F** | **Trace** | **IPC** |
| 6 | 2 | 2 | 2 | 4 | mcf | 2.36944 |
| 6 | 2 | 2 | 2 | 8 | mcf | 2.36944 |

IPCmax = 2.36944

Thus, target IPC > 0.95\*IPCmax > 2.250968

Set R=5, F=4.

1. With K1=K2=2 and K0=1
2. With K0=K2=2 and K1=1
3. With K0=K1=2 and K2=1

From the graph we can observe that when either K0 or K1 or K2 is reduced to 1 we get IPC < 2.250968. Thus, we need to set K0=K1=K2=2.

Set K=0=K1=K2=2 and F=4. Vary R.

Thus, K0=K1=K2=2, R=3 and F=4 is the configuration needed that gives IPC of 2.3245