Considerare la seguente architectura MIPS64:

|  |  |  |
| --- | --- | --- |
| * + Integer ALU: 1 clock cycle   + Data memory: 1 clock cycle   + FP multiplier unit: pipelined 7 stages | * + FP arithmetic unit: pipelined 2 stages   + FP divider unit: not pipelined unit that requires 8 clock cycles   + branch delay slot: 1 clock cycle, and the branch delay slot disabled | * + forwarding enabled   + è possibile completare lo stage EXE di una istruzion in modo out-of-order. |

* Facendo riferimento al frammento di codice riportato, si mostrino le tempistiche relative all’esecuzione ciascuna istruzione e si calcoli il numero totale di clock cycles necessari per eseguire completamente il programma:

for (i = 0; i < 100; i++) {

v5[i] = ((v1[i]/v2[i]) + v3[i]);

v6[i] = ((v3[i]/v4[i]) + v1[i]\*v2[i]);

}

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| .data |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  |  |  |  |  | | | |
| V1: .double “100 values” |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  |  |  |  |  | | | |
| V2: .double “100 values” |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  |  |  |  |  | | | |
| V3: .double “100 values”  …  V5: .double “100 zeros” |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  |  |  |  |  | | | |
| .text |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  |  |  |  |  | | | |
| main: daddui r8, r0, 0x1e | F | D | | E | | M | | W | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  | 5 |  |  |  | | | |
| dadd r9, r0, r0 |  | F | | D | | E | | M | | W | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  | 1 |  |  |  | | | |
| dsll r8, r8, 0x3 |  |  | | F | | D | | E | | M | | W | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  | 1 |  |  |  | | | |
|  |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  |  |  |  |  | | | |
| loop: l.d f1, v1(r9) |  |  | |  | | F | | D | | E | | M | | W | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  | 1 |  |  |  | | | |
| l.d f2, v2(r9) |  |  | |  | |  | | F | | D | | E | | M | | W | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  | 1 |  |  |  | | | |
| sub.d f5, f1, f2 |  |  | |  | |  | |  | | F | | D | | S | | A | | A | | A | | A | | M | | W | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  | 5 |  |  |  | | | |
| l.d f3, v3(r9) |  |  | |  | |  | |  | |  | | F | | S | | D | | E | | M | | W | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  | 0 |  |  |  | | | |
| mul.d f5, f5, f3 |  |  | |  | |  | |  | |  | |  | |  | | F | | D | | S | | S | | X | | X | | X | X | | X | | X | | X | | X | | M | | W | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  | 8 |  |  |  | | | |
| mul.d f6, f5, f3 |  |  | |  | |  | |  | |  | |  | |  | |  | | F | | S | | S | | D | | S | | S | S | | S | | S | | S | | S | | X | | X | | X | | X | | X | | X | | X | | X | | M | | W | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  | 8 |  |  |  | | | |
| l.d f4, v4(r9) |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | F | | S | | S | S | | S | | S | | S | | S | | D | | E | | M | | W | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  | 0 |  |  |  | | | |
| add.d f7, f6, f4 |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | | F | | D | | S | | S | | S | | S | | S | | S | | A | | A | | A | | A | | M | | W | |  | |  | |  | |  | |  | |  | | |  | |  |  | 4 |  |  |  | | | |
| mul.d f7, f7, f2 |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | | F | | S | | S | | S | | S | | S | | S | | D | | S | | S | | S | | X | | X | | X | | X | | X | | X | | X | | X | | | M | | W |  | 8 |  |  |  | | | |
| s.d f5, v5(r9) |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | F | | S | | S | | S | | D | | E | | M | | W | |  | |  | |  | |  | | |  | |  |  | 0 |  |
| s.d f6, v6(r9) |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | F | | D | | E | | M | | W | |  | |  | |  | | |  | |  |  | 0 |  |
| s.d f7, v7(r9) |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | F | | D | | E | | S | | S | | S | | S | | | S | | M | W | 1 |  |
| daddui r9, r9, 0x8 |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | F | | D | | S | | S | | S | | S | | | S | | E | M | W |  |
|  |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | |  |  |  |  |
| Check: bne r9, r8, loop |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | F | | S | | S | | S | | S | | |  | | | | | | |  |  |  |
| halt |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | **F** | |  | |  | | |  | | | | | | |  |  |  |
|  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | |  | | | | | | |  |  |  |
| Total | 7 + 1 \* (1+1+5+8+8+4+8+1+1+2) + 29 \* (2+1+5+8+8+4+8+1+1+2) + 1 = 1207 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Considerando il programma precedente, lo si ottimizzi in modo da eliminare per quanto possibile gli stalli del programma usando le tecniche note come rescheduling e register renaming. Si calcoli il tempo di esecuzione del nuovo programma nella stessa architettura evidenziando il miglioramento ottenuto.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| main: daddui r8, r0, 0x1e | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **5** |
| dadd r9, r0, r0 |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **1** |
| dsll r8, r8, 0x3 |  |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **1** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| loop: l.d f1, v1(r9) |  |  |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **1** |
| l.d f2, v2(r9) |  |  |  |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **1** |
| l.d f3, v3(r9) |  |  |  |  |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **1** |
| sub.d f5, f1, f2 |  |  |  |  |  |  | **F** | **D** | **A** | **A** | **A** | **A** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **4** |
| l.d f4, v4(r9) |  |  |  |  |  |  |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **0** |
| mul.d f5, f5, f3 |  |  |  |  |  |  |  |  | **F** | **D** | **S** | **S** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **8** |
| mul.d f6, f5, f3 |  |  |  |  |  |  |  |  |  | **F** | **S** | **S** | **D** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **8** |
| add.d f7, f6, f4 |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **D** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **A** | **A** | **A** | **A** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **4** |
| mul.d f7, f7, f2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **D** | **S** | **S** | **S** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **M** | **W** |  |  |  |  |  |  |  | **8** |
| s.d f5, v5(r9) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** |  |  |  | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  | **0** |
| s.d f6, v6(r9) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  | **0** |
| s.d f7, v7(r9) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **D** | **E** | **S** | **S** | **S** | **S** | **S** | **M** | **W** |  |  |  |  |  |  | **1** |
| daddui r9, r9, 0x8 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **D** | **S** | **S** | **S** | **S** | **S** | **E** | **M** | **W** |  |  |  |  |  | **1** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Check: bne r9, r8, loop |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **S** | **S** | **S** | **S** | **S** | **S** | **D** | **E** | **M** | **W** |  |  |  | **2** |
| halt |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** |  |  |  |  |  |  |  |
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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Total** | **7+ (1+1+1+4+8+8+4+8+1+1+2) + 29 \* (2+1+1+4+8+8+4+8+1+1+2) + 1 =** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |  |

Considerando il programma precedente, lo si ottimizzi in modo da eliminare per quanto possibile gli stalli del programma usando le tecniche note come rescheduling e register renaming. Si calcoli il tempo di esecuzione del nuovo programma nella stessa architettura evidenziando il miglioramento ottenuto.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| main: daddui r8, r0, 0x1e | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **5** |
| dadd r9, r0, r0 |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **1** |
| dsll r8, r8, 0x3 |  |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **1** |
| l.d f1, v1(r9) |  |  |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **1** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| loop: l.d f2, v2(r9) |  |  |  |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **1** |
| l.d f3, v3(r9) |  |  |  |  |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **1** |
| sub.d f5, f1, f2 |  |  |  |  |  |  | **F** | **D** | **A** | **A** | **A** | **A** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **4** |
| l.d f4, v4(r9) |  |  |  |  |  |  |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **0** |
| mul.d f5, f5, f3 |  |  |  |  |  |  |  |  | **F** | **D** | **S** | **S** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **8** |
| mul.d f6, f5, f3 |  |  |  |  |  |  |  |  |  | **F** | **S** | **S** | **D** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **8** |
| add.d f7, f6, f4 |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **D** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **A** | **A** | **A** | **A** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **4** |
| mul.d f7, f7, f2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **D** | **S** | **S** | **S** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** | **M** | **W** |  |  |  |  |  |  |  | **8** |
| s.d f5, v5(r9) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **S** | **S** | **S** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  |  | **0** |
| s.d f6, v6(r9) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **D** | **E** | **M** | **W** |  |  |  |  |  |  |  |  |  |  |  |  | **0** |
| s.d f7, v7(r9) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **D** | **E** | **S** | **S** | **S** | **S** | **S** | **M** | **W** |  |  |  |  |  |  | **1** |
| daddui r9, r9, 0x8 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **D** | **S** | **S** | **S** | **S** | **S** | **E** | **M** | **W** |  |  |  |  |  | **1** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Check: bne r9, r8, loop |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **S** | **S** | **S** | **S** | **S** | **S** | **D** | **E** | **M** | **W** |  |  |  | **2** |
| l.d f1, v1(r9) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **D** | **E** | **M** | **W** |  |  | **1** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **F** | **D** | **E** | **M** | **W** |  | **1** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Total** | **8+ 30\*(1+1+4+8+8+4+8+1+1+2+1)+1= 1179** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |  |  |