

Synthese Eingebetteter Systeme

Sommersemester 2011

Übung 4

Michael Engel
Informatik 12
TU Dortmund

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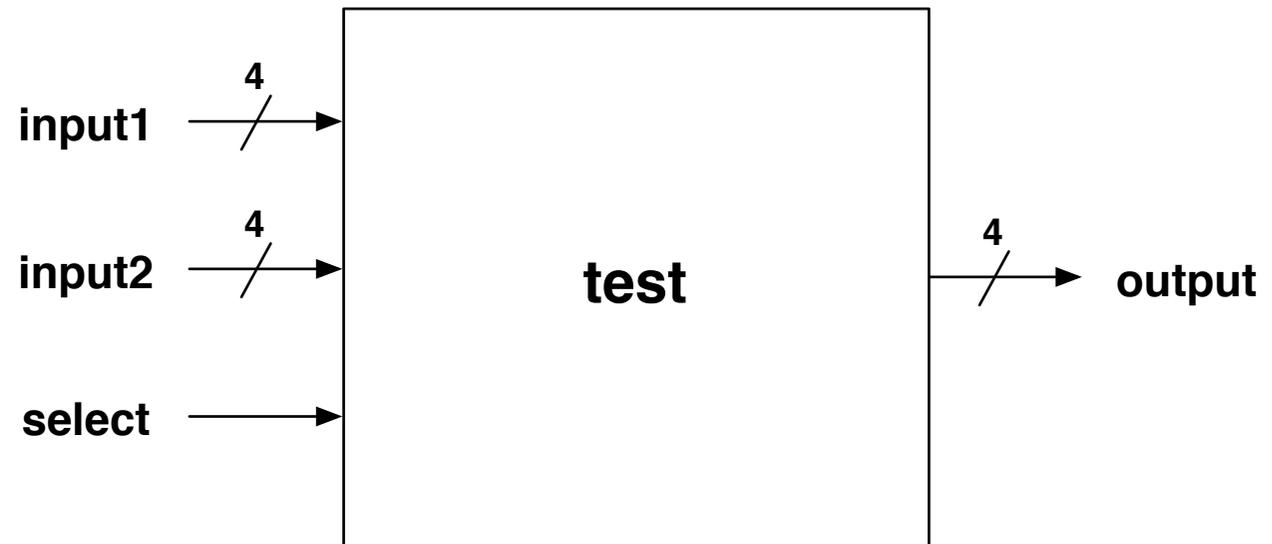
Übung 4

- Hardware-Synthese
- Datenflussgraphen
- Force Directed Scheduling

Hardware-Synthese

- Gegeben: SystemC-Code

```
SC_MODULE(test) {  
    sc_in<sc_uint<4> > input1;  
    sc_in<sc_uint<4> > input2;  
    sc_out<sc_uint<4> > output;  
    sc_in<bool > select;  
    sc_in<bool > select;  
}
```



Hardware-Synthese

- Gegeben: SystemC-Code

```
bool s[4];  
sc_uint<4> q;
```

```
void calc() {
```

```
    int i;
```

Multiplexer

```
    if (select) {
```

```
        for (i=0; i<4; i++) {  
            s[i] = input1.read()[i] & input2.read()[i];  
        }
```

```
    } else {
```

```
        for (i=0; i<4; i++) {  
            s[i] = input1.read()[i] | input2.read()[i];  
        }
```

```
    }
```

```
    q = (s[3] << 3) + (s[2] << 2) + (s[1] << 1) + s[0];
```

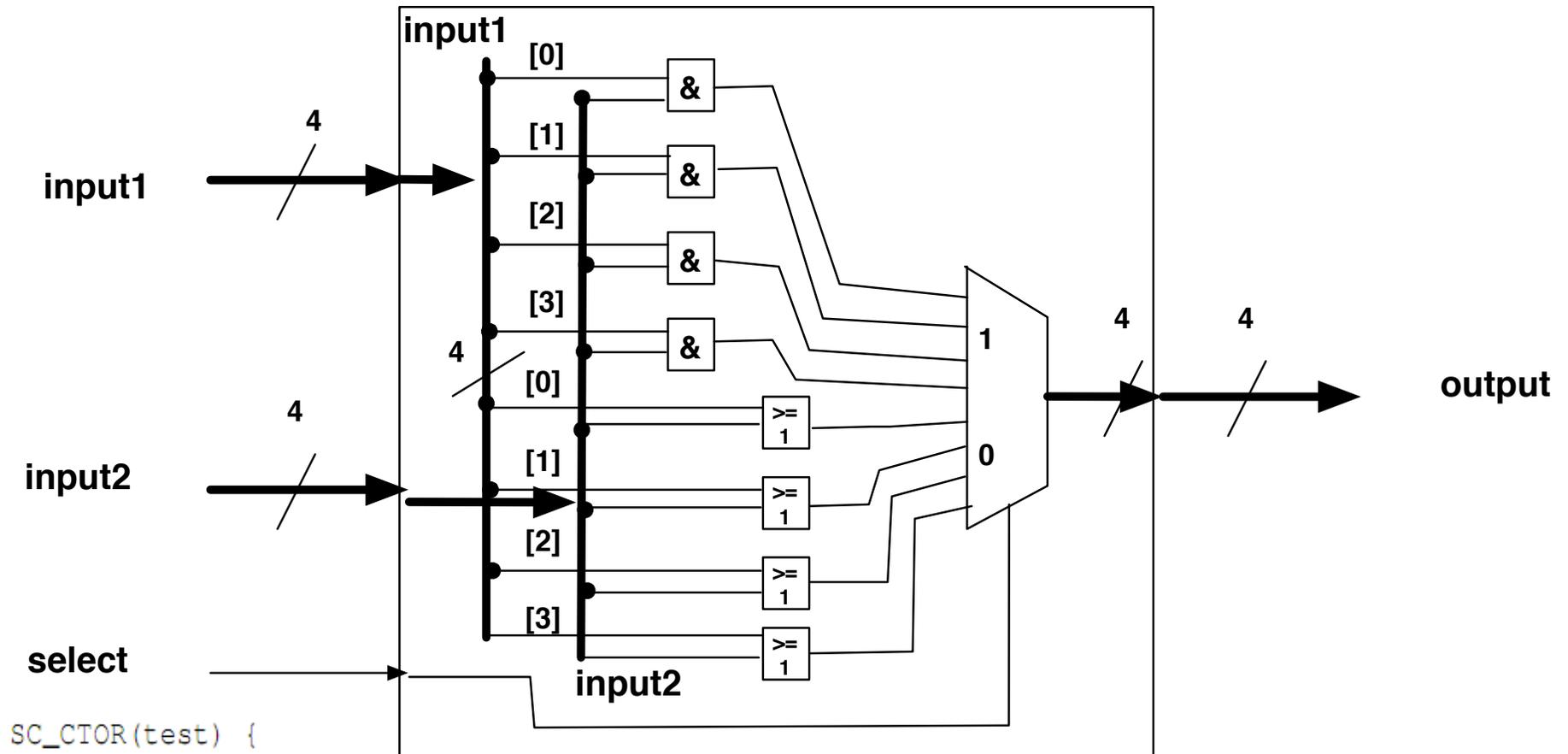
```
    output.write(q);
```

```
}
```

Schleifen
abrollen?!?

~~Oder State Machine?~~

Hardware-Synthese



```
SC_CTOR(test) {  
    SC_METHOD(calc);  
    sensitive << input1 << input2 << select;  
}  
};
```

Datenflussgraphen

- Bestimmen Sie die Typen der benötigten Funktionseinheiten

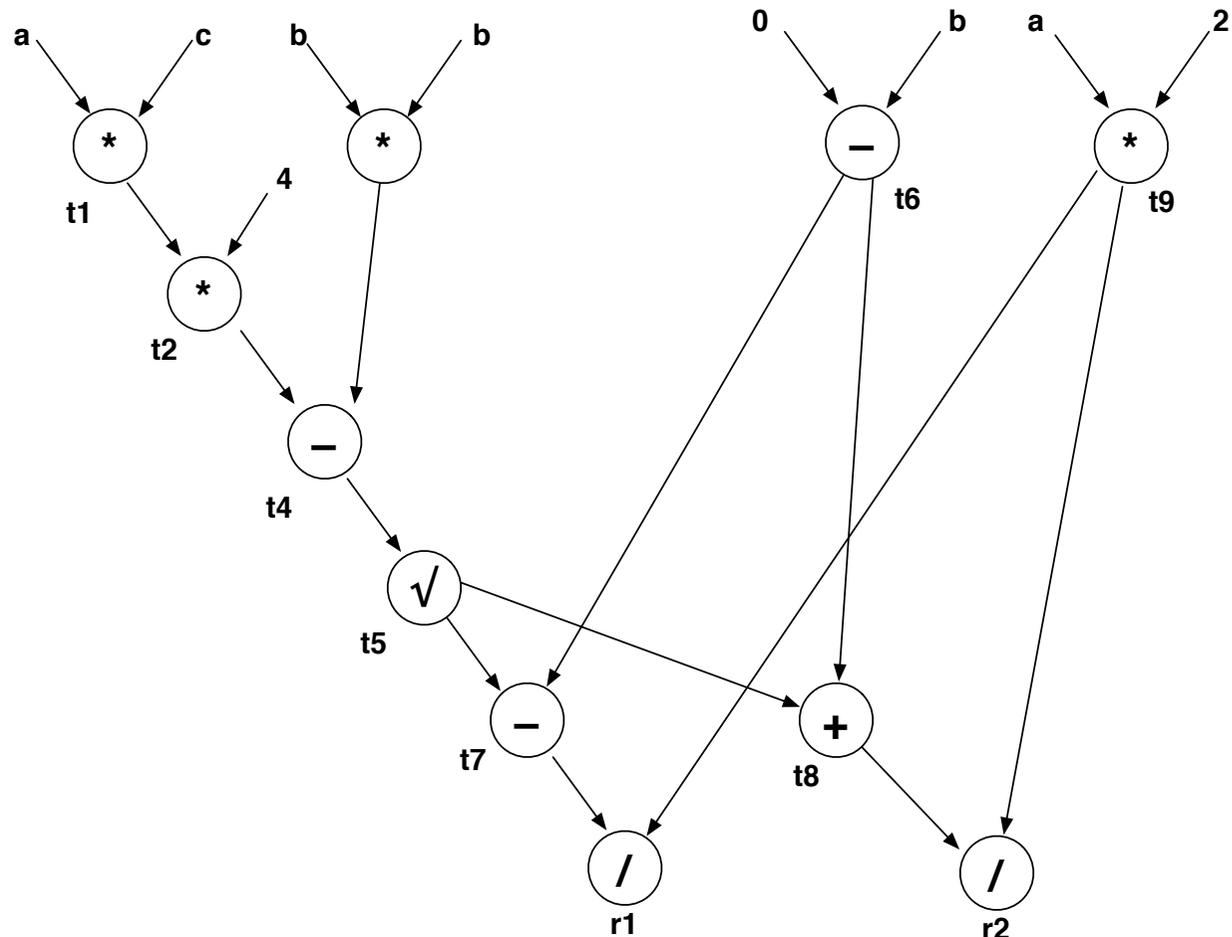
```
t1 = a*c;  
t2 = 4*t1;  
t3 = b*b;  
t4 = t3 - t2;  
t5 = sqrt( t4);  
t6 = -b;  
t7 = t6 - t5;  
t8 = t7 + t5;  
t9 = 2*a;  
r1 = t7/t9;  
r2 = t8/t9;
```

- Multiplizierer (t1, t2, t3, **t9**)
- Addierer (t8)
- Subtrahierer (t4, t6, t7)
- Dividierer (r1, r2)
- Schieberegister (**t9**)

Datenflussgraphen

- Erstellen Sie einen Datenflussgraphen für den angegebenen Code

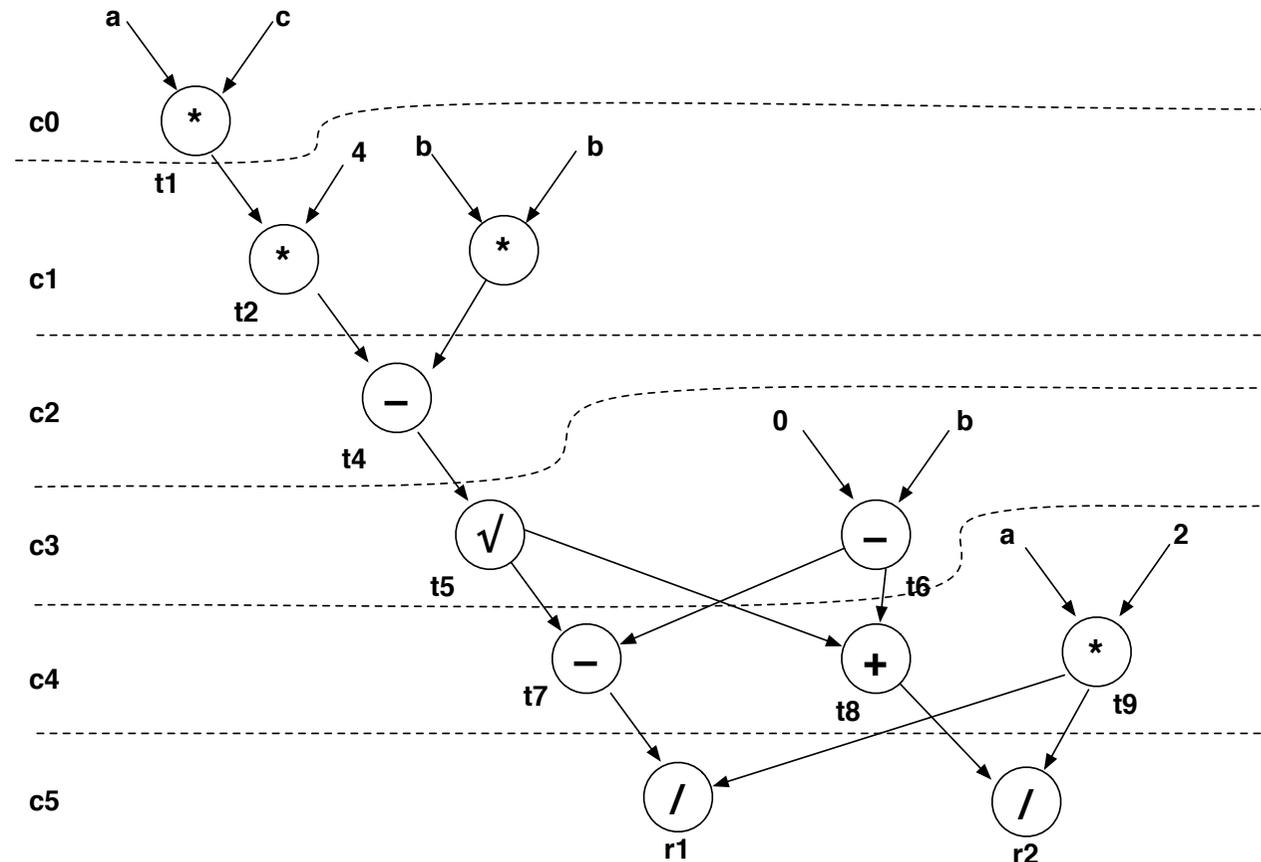
```
t1 = a*c;  
t2 = 4*t1;  
t3 = b*b;  
t4 = t3 - t2;  
t5 = sqrt(t4);  
t6 = -b;  
t7 = t6 - t5;  
t8 = t7 + t5;  
t9 = 2*a;  
r1 = t7/t9;  
r2 = t8/t9;
```



Datenflussgraphen

- Bestimmen Sie das ALAP-Schedule

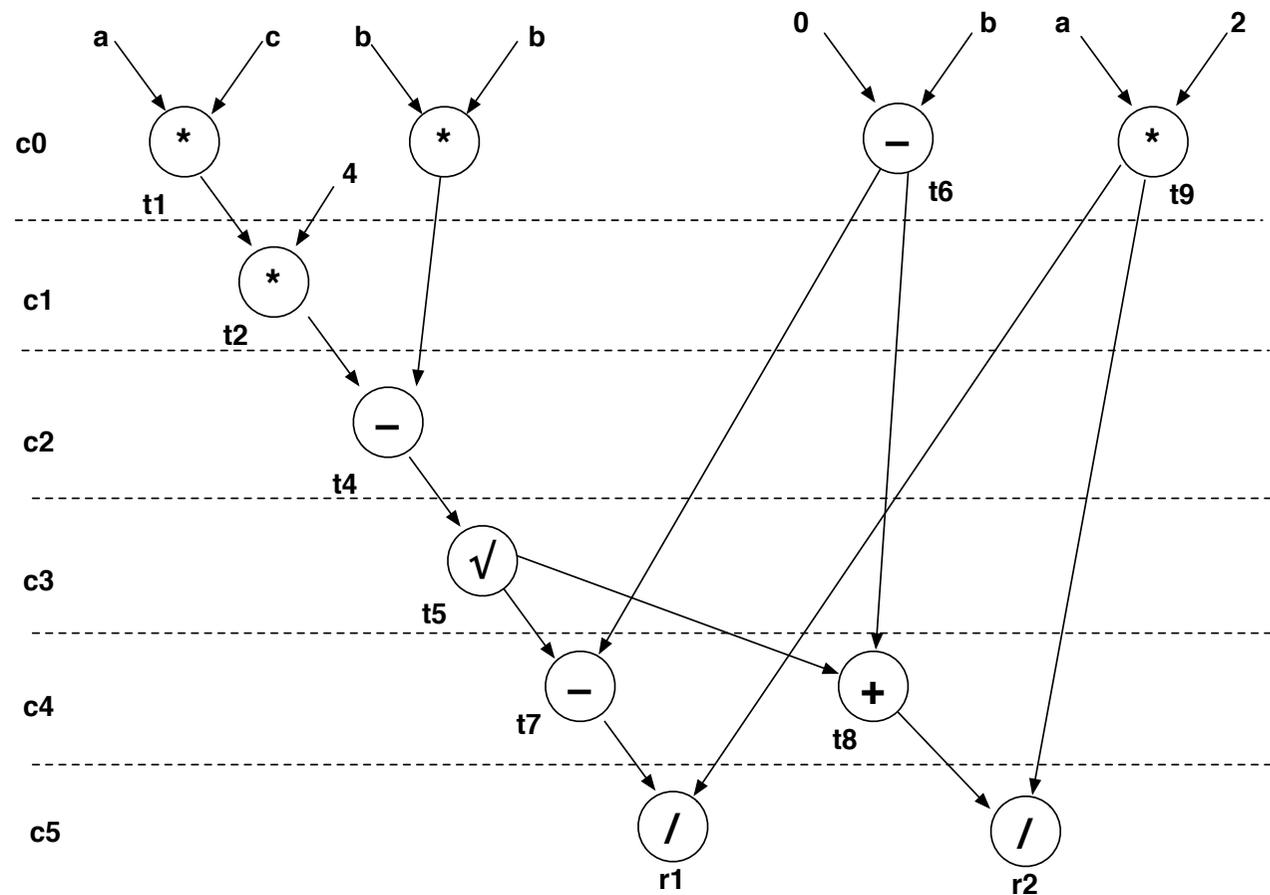
```
t1 = a*c;  
t2 = 4*t1;  
t3 = b*b;  
t4 = t3 - t2;  
t5 = sqrt( t4);  
t6 = -b;  
t7 = t6 - t5;  
t8 = t7 + t5;  
t9 = 2*a;  
r1 = t7/t9;  
r2 = t8/t9;
```



Datenflussgraphen

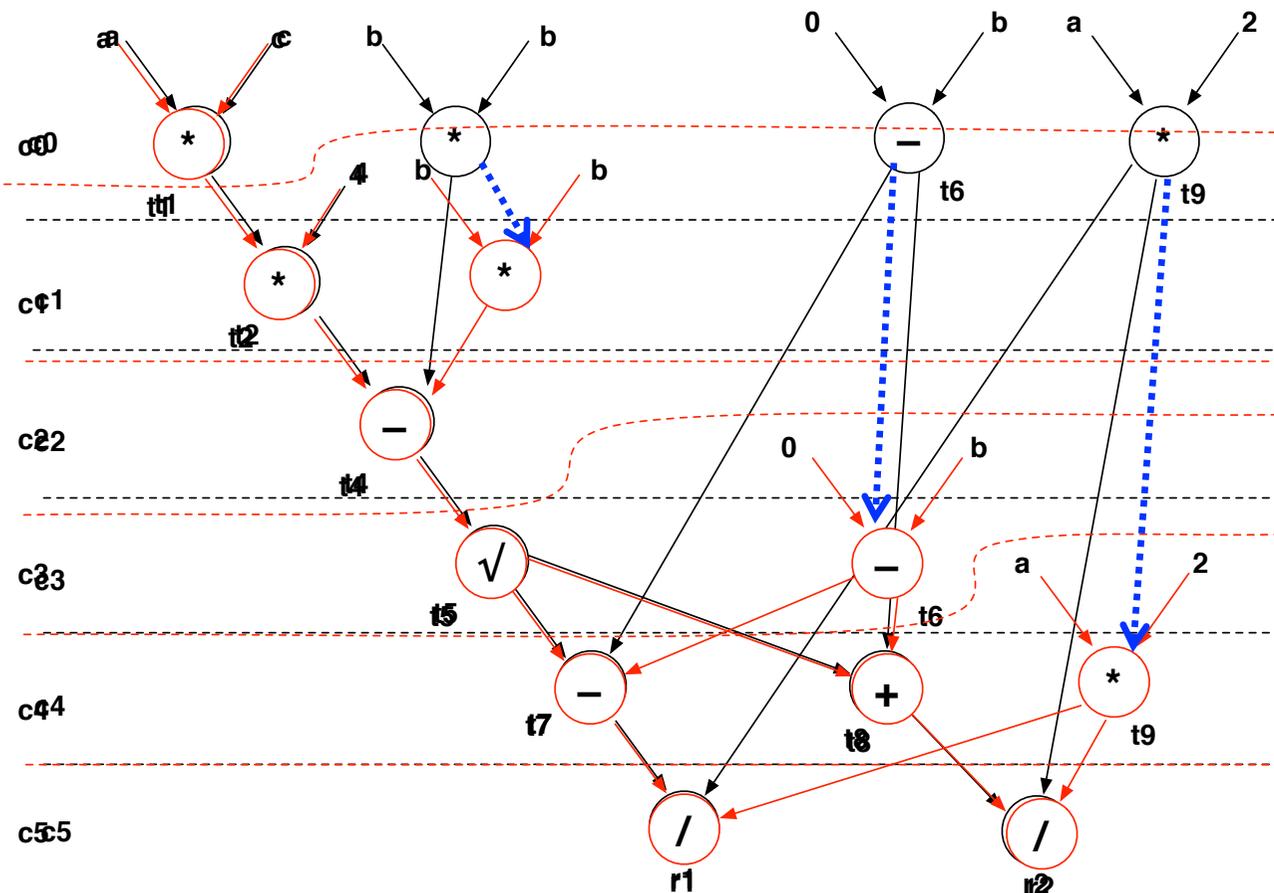
- Bestimmen Sie das ASAP-Schedule

```
t1 = a*c;  
t2 = 4*t1;  
t3 = b*b;  
t4 = t3 - t2;  
t5 = sqrt(t4);  
t6 = -b;  
t7 = t6 - t5;  
t8 = t7 + t5;  
t9 = 2*a;  
r1 = t7/t9;  
r2 = t8/t9;
```



Force-Directed Scheduling

- Erzeugung eines Zeitrahmens $R(j)$

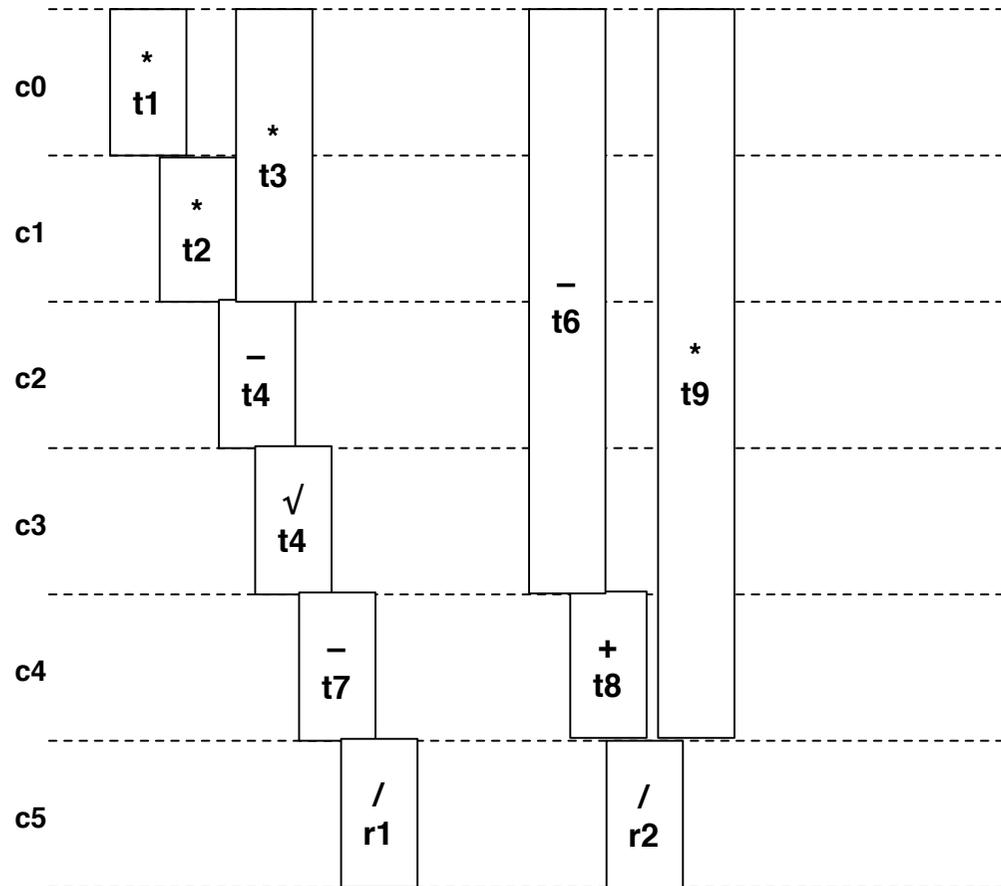


- $t3 = b * b$
in $c0 / c1$
- $t6 = -b$
in $c0 \dots c3$
- $t9 = a * 2$
in $c0 \dots c4$
- Rest:
Fest!

Force-Directed Scheduling

- Erzeugung eines Zeitrahmens $R(j)$

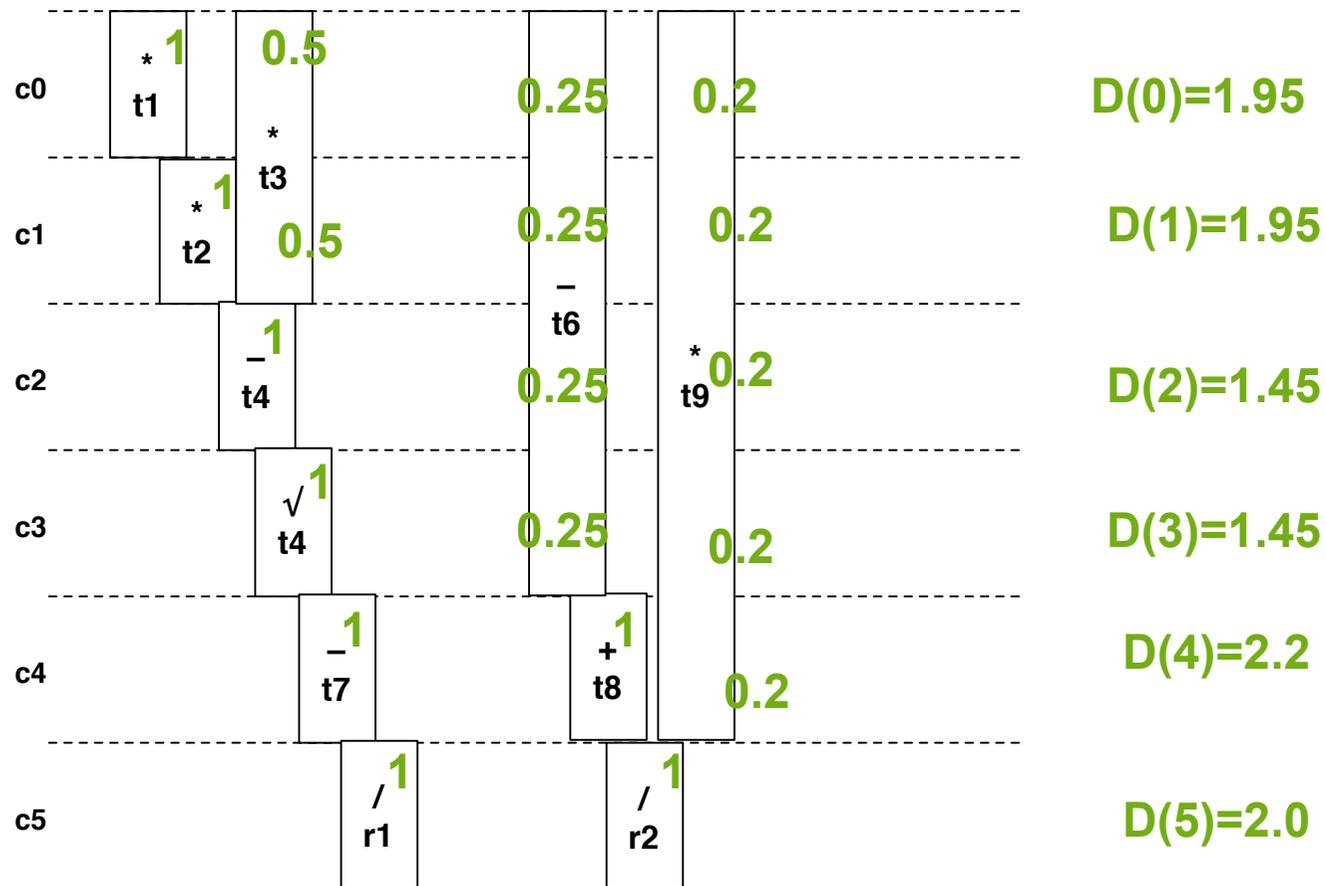
- $t3 = b*b$
in $c0 / c1$
- $t6 = -b$
in $c0...c3$
- $t9 = a*2$
in $c0...c4$
- Rest: Fest



Force-Directed Scheduling

- Erzeugung einer „Wahrscheinlichkeit“ $P(j,i)$ für Zuordnung $j \rightarrow i$
- Verteilung $D(i)$ für jeden Zeitschritt

- $t3 = b * b$
in $c0 / c1$
- $t6 = -b$
in $c0 \dots c3$
- $t9 = a * 2$
in $c0 \dots c4$
- Rest: Fest



Force-Directed Scheduling

- Direkte Kräfte, die entstehen, wenn Operation $t_9 = 2*a$ im ersten Zeitschritt ausgeführt wird

$$SF(j, i) = \sum_{i' \in R(j)} D(i') \Delta P_i(j, i') \quad \Delta P_i(j, i') = \begin{cases} 1 - P(j, i) & \text{falls } i = i' \\ -P(j, i') & \text{sonst} \end{cases}$$

$$R(t_9) = \{0, \dots, 4\}$$

$$D(0) = 1.95$$

$$D(1) = 1.95$$

$$D(2) = 1.45$$

$$D(3) = 1.45$$

$$D(4) = 2.2$$

$$D(5) = 2.0$$

$$P(t_9, i) = 0.2 \text{ (für } i=0..4)$$

$$P(t_9, 5) = 0$$

$$SF(t_9, 1) = D(0) * (1 - 0.2)$$

$$+ D(1) * (-0.2)$$

$$+ D(2) * (-0.2)$$

$$+ D(3) * (-0.2)$$

$$+ D(4) * (-0.2)$$

$$= 1.95 * 0.8$$

$$+ 1.95 * (-0.2)$$

$$+ 1.45 * (-0.2)$$

$$+ 1.45 * (-0.2)$$

$$+ 2.2 * (-0.2)$$

$$= \underline{\underline{0.19}}$$

Fragen?

- *Fragen!*