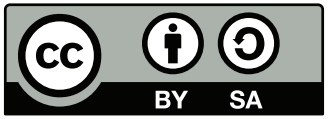
# Network Calculus Tests – Tree Network Configurations

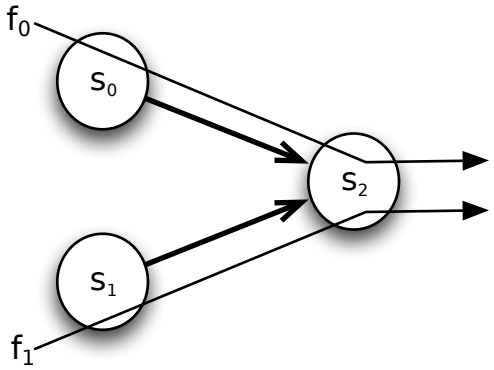


## General Information

- The network calculus analyses documented in this paper were created for the purpose of functional testing the Disco Deterministic Network Calculator (DiscoDNC)[1] – an open-source deterministic network calculus tool developed by the *distributed computer system* / *disco lab* at the University of Kaiserslautern.
- Naming of the individual network configurations depicts the name of the according functional test for the DiscoDNC.
- The nomenclature used in this document is detailed in NetworkCalculus_Nomenclature.pdf.
- Arrival bound computations are equivalent to the `PbooArrivalBound_Output_PerHop.java` class of the DiscoDNC.
- The end-to-end left-over service curve for PBOO arrival bounds can be computed by simply convolving the server-local ones.
- Arrival bounds for `PmooArrivalBound.java` and analyses using them are listed only if results are different to PBOO.

[1] http://disco.cs.uni-kl.de/index.php/projects/disco-dnc

**Tree_1SC_2Flows_1AC_2Paths**




- $\beta_{s_0} = \beta_{s_1} = \beta_{s_2} = \beta_{R_{s_i},T_{s_i}} = \beta_{20,20}$, $i \in \{0, 1, 2\}$
- $\mathcal{F} = \{f_0, f_1\}$
- $\alpha^{f_0} = \alpha^{f_1} = \gamma_{r^{f_j},b^{f_j}} = \gamma_{5,25}$, $j \in \{0, 1\}$

| $\text{arrivalBound}(s_2, \{f_j\}, \mathcal{G}),\ \mathcal{G} = \mathcal{P}(\mathcal{F}) = \alpha_{s_2}^{f_j},\ j \in \{0,1\}$ | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $\alpha_{s_2}^{f_j}$ | | $= \gamma_{5,25}$ | |
| $\alpha_{s_2}^{xf_j}$ | | $= \gamma_{0,0}$ | |
| $\beta_{s_2}^{\text{l.o.}f_j} = \beta_{s_2} \ominus \alpha_{s_2}^{xf_j} = \beta_{R_{s_2}^{\text{l.o.}f_j}, T_{s_2}^{\text{l.o.}f_j}}$ | $=$ | $= \beta_{20,20}$ | |
| $\alpha_{s_2}^{f_j} = \alpha_{s_j}^{f_j} \oslash \beta_{s_j}^{\text{l.o.}f_j} = \gamma_{r_{s_2}^{f_j}, b_{s_2}^{f_j}}$ | $r_{s_2}^{f_j}$ | $= 5$ | |
| | $b_{s_2}^{f_j}$ | $\alpha_{s_j}^{f_j}(T_{s_j}^{\text{l.o.}f_j}) = 5 \cdot 20 + 25 = 125$ | |
| | $=$ | $= \gamma_{5,125}$ | |

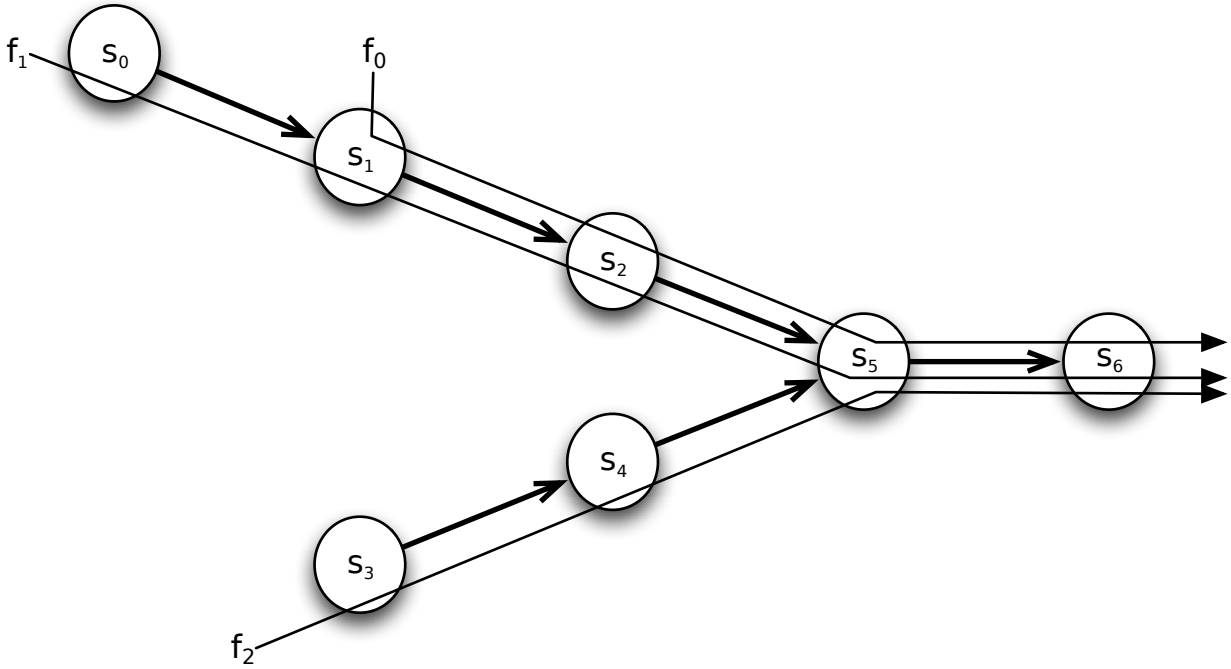
**Flow $f_j$, $j \in \{0,1\}$ (comparable with Tandem_1SC_2Flows_1AC_2Paths)**

| TFA | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $s_j$ | $\alpha_{s_i} = \alpha_{s_j}^{f_j}$ | $= \gamma_{5,25}$ | |
| | $D_{s_j}^{f_j}$ | $\beta_{s_j} = b_{s_J}^{f_j}$<br>$20 \cdot [t-20]^+ = 25$<br>$t = 21\frac{1}{4}$ | FIFO per micro flow<br>$\beta_{s_j} = b_{s_j}^{f_j}$<br>$20 \cdot [t-20]^+ = 25$<br>$t = 21\frac{1}{4}$ |
| | $B_{s_j}^{f_j}$ | $\alpha_{s_j}(T_{s_j}) = 5 \cdot 20 + 25$<br>$= 125$ | |
| $s_2$ | $\alpha_{s_2} = \sum_j \alpha_{s_2}^{f_j}$ | $= \gamma_{5,125} + \gamma_{5,125} = \gamma_{10,250}$ | |
| | $D_{s_2}^{f_j}$ | $\beta_{s_2} = b_{s_1}$<br>$20 \cdot [t-20]^+ = 250$<br>$t = 32\frac{1}{2}$ | $\beta_{s_2} = \alpha_{s_2}$<br>$20 \cdot [t-20]^+ = 10 \cdot t + 250$<br>$t = 65$ |
| | $B_{s_2}^{f_j}$ | $\alpha_{s_2}(T_{s_2}) = 10 \cdot 20 + 250$<br>$= 450$ | |
| $D^{f_j}$ | | $\sum_{k=\{j,2\}} D_{s_k}^{f_j} = 53\frac{3}{4}$ | $\sum_{k=\{j,2\}} D_{s_k}^{f_j} = 86\frac{1}{4}$ |
| $B^{f_j}$ | | $\max_{k=\{j,2\}} b_{s_k}^{f_j} = 450$ | |

<table>
<tr><th colspan="3">SFA</th><th>FIFO_MUX</th><th>ARB_MUX</th></tr>
<tr><td rowspan="2">$s_j$</td><td colspan="2">$\alpha_{s_j}^{xf_j}$</td><td colspan="2">$= \gamma_{0,0}$</td></tr>
<tr><td colspan="2">$\beta_{s_j}^{\text{l.o.}f_j} = \beta_{s_j} \ominus \alpha_{s_j}^{xf_j} = \beta_{s_j}$</td><td colspan="2">$= \beta_{20,20}$</td></tr>
<tr><td rowspan="4">$s_2$</td><td colspan="2">$\alpha_{s_2}^{xf_j} = \alpha_{s_2}^{f_j}$</td><td colspan="2">$= \gamma_{5,125}$</td></tr>
<tr><td rowspan="3">$\beta_{s_2}^{\text{l.o.}f_j} = \beta_{s_2} \ominus \alpha_{s_2}^{xf_j} = \beta_{R_{s_2}^{\text{l.o.}f_j}, T_{s_2}^{\text{l.o.}f_j}}$</td><td>$R_{s_2}^{\text{l.o.}f_j}$</td><td colspan="2">$[R_{s_2} - r_{s_2}^{xf_j}]^+ = 15$</td></tr>
<tr><td>$T_{s_2}^{\text{l.o.}f_j}$</td><td>$\beta_{s_2} = b_{s_2}^{xf_j}$<br>$20 \cdot [t-20]^+ = 125$<br>$t = 26\frac{1}{4}$</td><td>$\beta_{s_2} = \alpha_{s_2}^{xf_j}$<br>$20 \cdot [t-20]^+ = 5 \cdot t + 125$<br>$t = 35$</td></tr>
<tr><td>$=$</td><td>$= \beta_{15,26\frac{1}{4}}$</td><td>$= \beta_{15,35}$</td></tr>
<tr><td colspan="3">$\beta_{\text{e2e}}^{\text{l.o.}f_j} = \beta_{R_{\text{e2e}}^{\text{l.o.}f_j}, T_{\text{e2e}}^{\text{l.o.}f_j}}$</td><td>$\bigotimes_{k=\{j,2\}} \beta_{s_k}^{\text{l.o.}f_j} = \beta_{15,46\frac{1}{4}}$</td><td>$\bigotimes_{k=\{j,2\}} \beta_{s_k}^{\text{l.o.}f_j} = \beta_{15,55}$</td></tr>
<tr><td colspan="3">$D^{f_j}$</td><td>$\beta_{\text{e2e}}^{\text{l.o.}f_j} = b^{f_j}$<br>$15 \cdot [t - 46\frac{1}{4}]^+ = 25$<br>$t = 47\frac{11}{12}$</td><td>$\beta_{\text{e2e}}^{\text{l.o.}f_j} = b^{f_j}$<br>$15 \cdot [t-55]^+ = 25$<br>$t = 56\frac{2}{3}$</td></tr>
<tr><td colspan="3">$B^{f_j}$</td><td>$\alpha^{f_j}(T_{\text{e2e}}^{\text{l.o.}f_j}) = 5 \cdot 46\frac{1}{4} + 25$<br>$= 256\frac{1}{4}$</td><td>$\alpha^{f_j}(T_{\text{e2e}}^{\text{l.o.}f_j}) = 5 \cdot 55 + 25$<br>$= 300$</td></tr>
</table>

| PMOO | | ARB_MUX |
|---|---|---|
| $s_j$ | $\alpha_{s_j}^{x' f_j}$ | $= \gamma_{0,0}$ |
| | $\alpha_{s_j}^{x f_j}$ | $= \gamma_{0,0}$ |
| $s_2$ | $\alpha_{s_2}^{x' f_0}$ | $= \gamma_{5,125}$ |
| | $\alpha_{s_2}^{x f_0}$ | $= \gamma_{5,125}$ |
| $\beta_{\text{e2e}}^{\text{l.o.}f_j} = \beta_{R_{\text{e2e}}^{\text{l.o.}f_j}, T_{\text{e2e}}^{\text{l.o.}f_j}}$ | $R_{\text{e2e}}^{\text{l.o.}f_j} = \bigwedge_{k\in\{j,2\}} \left(R_{s_k} - r_{s_k}^{x f_j}\right)$ | $= (20-0) \wedge (20-5)$<br>$= 15$ |
| | $T_{\text{e2e}}^{\text{l.o.}f_j} = \sum_{k\in\{j,2\}} T_{s_k} + \frac{\sum_{k\in\{j,2\}} \left(b_{s_k}^{x' f_j} + r_{s_k}^{x f_j} \cdot T_{s_k}\right)}{R_{\text{e2e}}^{\text{l.o.}f_0}}$ | $= 20 + 20 + \frac{0 + 0 \cdot 20 + 125 + 5 \cdot 20}{15}$<br>$= 40 + \frac{225}{15}$<br>$= 55$ |
| | $=$ | $= \beta_{15,55}$ |
| $D^{f_j}$ | | $\beta_{\text{e2e}}^{\text{l.o.}f_j} = b^{f_j}$<br>$15 \cdot [t-55]^+ = 25$<br>$t = 56\frac{2}{3}$ |
| $B^{f_j}$ | | $\alpha^{f_j}(T_{\text{e2e}}^{\text{l.o.}f_j}) = 5 \cdot 55 + 25$<br>$= 300$ |

**Tree_1SC_3Flows_1AC_3Paths**




- $\beta_{s_0} = \beta_{s_1} = \beta_{s_2} = \beta_{R_{s_i},T_{s_i}} = \beta_{20,20}$, $i \in \{0,1,2\}$
- $\mathcal{F} = \{f_0, f_1, f_2\}$
- $\alpha^{f_0} = \alpha^{f_1} = \alpha^{f_2} = \gamma_{r^{f_j},b^{f_j}} = \gamma_{5,25}$, $j \in \{0,1,2\}$

| $\text{arrivalBound}(s_1, \{f_1\}, \mathcal{G}),\ \mathcal{G} \in \mathcal{P}(\mathcal{F}) = \alpha_{s_1}^{f_1}$ | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $\alpha_{s_0}^{f_1}$ | | $= \gamma_{5,25}$ | |
| $\alpha_{s_0}^{xf_1}$ | | $= \gamma_{0,0}$ | |
| $\beta_{s_0}^{\text{l.o.}f_1} = \beta_{s_0} \ominus \alpha_{s_0}^{xf_1} = \beta_{R_{s_0}^{\text{l.o.}f_1}, T_{s_0}^{\text{l.o.}f_1}}$ | $=$ | $= \beta_{20,20}$ | |
| $\alpha_{s_1}^{f_1} = \alpha_{s_0}^{f_1} \oslash \beta_{s_0}^{\text{l.o.}f_1} = \gamma_{r_{s_1}^{f_1}, b_{s_1}^{f_1}}$ | $r_{s_1}^{f_1}$ | $= 5$ | |
| | $b_{s_1}^{f_1}$ | $\alpha_{s_0}^{f_1}(T_{s_0}^{\text{l.o.}f_1}) = 5 \cdot 20 + 25 = 125$ | |
| | $=$ | $= \gamma_{5,125}$ | |

| $\text{arrivalBound}(s_2, \{f_1\}, \{f_0\}) = \alpha_{s_2}^{f_1}$ | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $\alpha_{s_1}^{f_1}$ | | $= \gamma_{5,125}$ | |
| $\alpha_{s_1}^{xf_1}$ | | $= \gamma_{0,0}$ | |
| $\beta_{s_1}^{\text{l.o.}f_1} = \beta_{s_1} \ominus \alpha_{s_1}^{xf_1} = \beta_{R_{s_1}^{\text{l.o.}f_1}, T_{s_1}^{\text{l.o.}f_1}}$ | $=$ | $= \beta_{20,20}$ | |
| $\alpha_{s_2}^{f_1} = \alpha_{s_1}^{f_1} \oslash \beta_{s_1}^{\text{l.o.}f_1} = \gamma_{r_{s_2}^{f_1}, b_{s_2}^{f_1}}$ | $r_{s_2}^{f_1}$ | $= 5$ | |
| | $b_{s_2}^{f_1}$ | $\alpha_{s_1}^{f_1}(T_{s_1}^{\text{l.o.}f_1}) = 5 \cdot 20 + 125 = 225$ | |
| | $=$ | $= \gamma_{5,225}$ | |

| $\text{arrivalBound}(s_5, \{f_1\}, \{f_0\}) = \alpha_{s_5}^{f_1}$ | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $\alpha_{s_2}^{f_1}$ | | $= \gamma_{5,225}$ | |
| $\alpha_{s_2}^{xf_1}$ | | $= \gamma_{0,0}$ | |
| $\beta_{s_2}^{\text{l.o.}f_1} = \beta_{s_2} \ominus \alpha_{s_2}^{xf_1} = \beta_{R_{s_2}^{\text{l.o.}f_1}, T_{s_2}^{\text{l.o.}f_1}}$ | $=$ | $= \beta_{20,20}$ | |
| $\alpha_{s_5}^{f_1} = \alpha_{s_2}^{f_1} \oslash \beta_{s_2}^{\text{l.o.}f_1} = \gamma_{r_{s_5}^{f_1}, b_{s_5}^{f_1}}$ | $r_{s_5}^{f_1}$ | $= 5$ | |
| | $b_{s_5}^{f_1}$ | $\alpha_{s_2}^{f_1}(T_{s_2}^{\text{l.o.}f_1}) = 5 \cdot 20 + 225 = 325$ | |
| | $=$ | $= \gamma_{5,325}$ | |

| $\text{arrivalBound}(s_4, \{f_2\}, \mathcal{G}),\ \mathcal{G} \in \mathcal{P}(\mathcal{F}) = \alpha_{s_4}^{f_2}$ | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $\alpha_{s_3}^{f_2}$ | | $= \gamma_{5,25}$ | |
| $\alpha_{s_3}^{xf_2}$ | | $= \gamma_{0,0}$ | |
| $\beta_{s_3}^{\text{l.o.}f_2} = \beta_{s_3} \ominus \alpha_{s_3}^{xf_2} = \beta_{R_{s_3}^{\text{l.o.}f_2}, T_{s_3}^{\text{l.o.}f_2}}$ | $=$ | $= \beta_{20,20}$ | |
| $\alpha_{s_4}^{f_2} = \alpha_{s_3}^{f_2} \oslash \beta_{s_3}^{\text{l.o.}f_2} = \gamma_{r_{s_4}^{f_2}, b_{s_4}^{f_2}}$ | $r_{s_4}^{f_2}$ | $= 5$ | |
| | $b_{s_4}^{f_2}$ | $\alpha_{s_3}^{f_2}(T_{s_3}^{\text{l.o.}f_2}) = 5 \cdot 20 + 25 = 125$ | |
| | $=$ | $= \gamma_{5,125}$ | |

| $\text{arrivalBound}(s_5, \{f_2\}, \mathcal{G}), \mathcal{G} \in \mathcal{P}(\mathcal{F}) = \alpha_{s_5}^{f_2}$ | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $\alpha_{s_4}^{f_2}$ | | $= \gamma_{5,125}$ | |
| $\alpha_{s_4}^{xf_2}$ | | $= \gamma_{0,0}$ | |
| $\beta_{s_4}^{\text{l.o.}f_2} = \beta_{s_4} \ominus \alpha_{s_4}^{xf_2} = \beta_{R_{s_4}^{\text{l.o.}f_2}, T_{s_4}^{\text{l.o.}f_2}}$ | $=$ | $= \beta_{20,20}$ | |
| $\alpha_{s_5}^{f_2} = \alpha_{s_4}^{f_2} \oslash \beta_{s_4}^{\text{l.o.}f_2} = \gamma_{r_{s_5}^{f_2}, b_{s_5}^{f_2}}$ | $r_{s_5}^{f_2}$ | $= 5$ | |
| | $b_{s_5}^{f_2}$ | $\alpha_{s_4}^{f_2}(T_{s_4}^{\text{l.o.}f_2}) = 5 \cdot 20 + 125 = 225$ | |
| | $=$ | $= \gamma_{5,225}$ | |

| $\text{arrivalBound}(s_6, \{f_1, f_2\}, \{f_0\}) = \alpha_{s_6}^{\{f_1,f_2\}}$ | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $\alpha_{s_5}^{\{f_1,f_2\}}$ | | $= \gamma_{10,550}$ | |
| $\alpha_{s_5}^{x\{f_1,f_2\}}$ | | $= \gamma_{0,0}$ | |
| $\beta_{s_5}^{\text{l.o.}\{f_1,f_2\}} = \beta_{s_5} \ominus \alpha_{s_5}^{x\{f_1,f_2\}} = \beta_{R_{s_5}^{\text{l.o.}\{f_1,f_2\}}, T_{s_5}^{\text{l.o.}\{f_1,f_2\}}}$ | $=$ | $= \beta_{20,20}$ | |
| $\alpha_{s_6}^{\{f_1,f_2\}} = \alpha_{s_5}^{\{f_1,f_2\}} \oslash \beta_{s_5}^{\text{l.o.}\{f_1,f_2\}} = \gamma_{r_{s_6}^{\{f_1,f_2\}}, b_{s_6}^{\{f_1,f_2\}}}$ | $r_{s_6}^{\{f_1,f_2\}}$ | $= 10$ | |
| | $b_{s_6}^{\{f_1,f_2\}}$ | $\alpha_{s_5}^{\{f_1,f_2\}}(T_{s_5}^{\text{l.o.}\{f_1,f_2\}}) = 10 \cdot 20 + 550 = 750$ | |
| | $=$ | $= \gamma_{10,750}$ | |

| $\text{arrivalBound}(s_2, \{f_0, f_1\}, \mathcal{G}), \mathcal{G} \in \mathcal{P}(\{f_2\}) = \alpha_{s_2}^{\{f_0,f_1\}}$ | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $\alpha_{s_1}^{\{f_0,f_1\}}$ | | $= \gamma_{10,150}$ | |
| $\alpha_{s_1}^{x\{f_0,f_1\}}$ | | $= \gamma_{0,0}$ | |
| $\beta_{s_1}^{\text{l.o.}\{f_0,f_1\}} = \beta_{s_1} \ominus \alpha_{s_1}^{x\{f_0,f_1\}} = \beta_{R_{s_1}^{\text{l.o.}\{f_0,f_1\}}, T_{s_1}^{\text{l.o.}\{f_0,f_1\}}}$ | $=$ | $= \beta_{20,20}$ | |
| $\alpha_{s_2}^{\{f_0,f_1\}} = \alpha_{s_1}^{\{f_0,f_1\}} \oslash \beta_{s_1}^{\text{l.o.}\{f_0,f_1\}} = \gamma_{r_{s_2}^{\{f_0,f_1\}}, b_{s_2}^{\{f_0,f_1\}}}$ | $r_{s_2}^{\{f_0,f_1\}}$ | $= 10$ | |
| | $b_{s_2}^{\{f_0,f_1\}}$ | $\alpha_{s_1}^{\{f_0,f_1\}}(T_{s_1}^{\text{l.o.}\{f_0,f_1\}}) = 10 \cdot 20 + 150 = 350$ | |
| | $=$ | $= \gamma_{10,350}$ | |

| $\text{arrivalBound}(s_5, \{f_0, f_1\}, \mathcal{G}),\ \mathcal{G} \in \mathcal{P}(\{f_2\}) = \alpha_{s_5}^{\{f_0,f_1\}}$ | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $\alpha_{s_2}^{\{f_0,f_1\}}$ | | $= \gamma_{10,350}$ | |
| $\alpha_{s_2}^{x\{f_0,f_1\}}$ | | $= \gamma_{0,0}$ | |
| $\beta_{s_2}^{\text{l.o.}\{f_0,f_1\}} = \beta_{s_2} \ominus \alpha_{s_2}^{x\{f_0,f_1\}} = \beta_{R_{s_2}^{\text{l.o.}\{f_0,f_1\}}, T_{s_2}^{\text{l.o.}\{f_0,f_1\}}}$ | $=$ | $= \beta_{20,20}$ | |
| $\alpha_{s_5}^{\{f_0,f_1\}} = \alpha_{s_2}^{\{f_0,f_1\}} \oslash \beta_{s_2}^{\text{l.o.}\{f_0,f_1\}} = \gamma_{r_{s_5}^{\{f_0,f_1\}}, b_{s_5}^{\{f_0,f_1\}}}$ | $r_{s_5}^{\{f_0,f_1\}}$ | $= 10$ | |
| | $b_{s_5}^{\{f_0,f_1\}}$ | $\alpha_{s_2}^{\{f_0,f_1\}}(T_{s_2}^{\text{l.o.}\{f_0,f_1\}}) = 10 \cdot 20 + 350 = 550$ | |
| | $=$ | $= \gamma_{10,550}$ | |

| $\text{arrivalBound}(s_6, \{f_0, f_1, f_2\}, \{\}) = \alpha_{s_6}^{\{f_0,f_1,f_2\}}$ | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $\alpha_{s_5}^{\{f_0,f_1,f_2\}}$ | | $= \gamma_{10,775}$ | |
| $\alpha_{s_5}^{x\{f_0,f_1,f_2\}}$ | | $= \gamma_{0,0}$ | |
| $\beta_{s_5}^{\text{l.o.}\{f_0,f_1,f_2\}} = \beta_{s_5} \ominus \alpha_{s_5}^{x\{f_0,f_1,f_2\}} = \beta_{R_{s_5}^{\text{l.o.}\{f_0,f_1,f_2\}}, T_{s_5}^{\text{l.o.}\{f_0,f_1,f_2\}}}$ | $=$ | $= \beta_{20,20}$ | |
| $\alpha_{s_6}^{\{f_0,f_1,f_2\}} = \alpha_{s_5}^{\{f_0,f_1,f_2\}} \oslash \beta_{s_5}^{\text{l.o.}\{f_0,f_1,f_2\}} = \gamma_{r_{s_6}^{\{f_0,f_1,f_2\}}, b_{s_6}^{\{f_0,f_1,f_2\}}}$ | $r_{s_6}^{\{f_0,f_1,f_2\}}$ | $= 15$ | |
| | $b_{s_6}^{\{f_0,f_1,f_2\}}$ | $\alpha_{s_5}^{\{f_0,f_1,f_2\}}(T_{s_5}^{\text{l.o.}\{f_0,f_1,f_2\}}) = 15 \cdot 20 + 775 = 1075$ | |
| | $=$ | $= \gamma_{15,1075}$ | |

**Flow $f_0$**

| TFA | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $s_1$ | $\alpha_{s_1} = \alpha_{s_1}^{f_0} + \alpha_{s_1}^{f_1}$ | $= \gamma_{5,25} + \gamma_{5,125} = \gamma_{10,150}$ | |
| | $D_{s_1}^{f_0}$ | $\beta_{s_1} = b_{s_1}$<br>$20 \cdot [t-20]^+ = 150$<br>$t = 27\frac{1}{2}$ | $\beta_{s_1} = \alpha_{s_1}$<br>$20 \cdot [t-20]^+ = 10 \cdot t + 150$<br>$t = 55$ |
| | $B_{s_1}^{f_0}$ | $\alpha_{s_1}(T_{s_1}) = 10 \cdot 20 + 150$<br>$= 350$ | |
| $s_2$ | $\alpha_{s_2} = \alpha_{s_2}^{\{f_0,f_1\}}$ | $= \gamma_{10,350}$ | |
| | $D_{s_2}^{f_0}$ | $\beta_{s_2} = b_{s_2}$<br>$20 \cdot [t-20]^+ = 350$<br>$t = 37\frac{1}{2}$ | $\beta_{s_2} = \alpha_{s_2}$<br>$20 \cdot [t-20]^+ = 10 \cdot t + 350$<br>$t = 75$ |
| | $B_{s_2}^{f_0}$ | $\alpha_{s_2}(T_{s_2}) = 10 \cdot 20 + 350$<br>$= 550$ | |
| $s_5$ | $\alpha_{s_5} = \alpha_{s_5}^{\{f_0,f_1\}} + \alpha_{s_5}^{f_2}$ | $= \gamma_{10,550} + \gamma_{5,225} = \gamma_{15,775}$ | |
| | $D_{s_5}^{f_0}$ | $\beta_{s_5} = b_{s_5}$<br>$20 \cdot [t-20]^+ = 775$<br>$t = 58\frac{3}{4}$ | $\beta_{s_5} = \alpha_{s_5}$<br>$20 \cdot [t-20]^+ = 15 \cdot t + 775$<br>$t = 235$ |
| | $B_{s_5}^{f_0}$ | $\alpha_{s_5}(T_{s_5}) = 15 \cdot 20 + 775$<br>$= 1075$ | |
| $s_6$ | $\alpha_{s_6} = \alpha_{s_6}^{\{f_0,f_1,f_2\}}$ | $= \gamma_{15,1075}$ | |
| | $D_{s_6}^{f_0}$ | $\beta_{s_6} = b_{s_6}$<br>$20 \cdot [t-20]^+ = 1075$<br>$t = 73\frac{3}{4}$ | $\beta_{s_6} = \alpha_{s_6}$<br>$20 \cdot [t-20]^+ = 15 \cdot t + 1075$<br>$t = 295$ |
| | $B_{s_6}^{f_0}$ | $\alpha_{s_6}(T_{s_6}) = 15 \cdot 20 + 1075$<br>$= 1375$ | |
| $D^{f_0}$ | | $\sum_{k=\{1,2,5,6\}} D_{s_k}^{f_0} = 27\frac{1}{2} + 37\frac{1}{2} + 58\frac{3}{4} + 73\frac{3}{4} = 197\frac{1}{2}$ | $\sum_{k=\{1,2,5,6\}} D_{s_k}^{f_0} = 55 + 75 + 235 + 295 = 660$ |
| $B^{f_0}$ | | $\max_{k=\{1,2,5,6\}} B_{s_k}^{f_0} = 1375$ | |

SFA FIFO_MUX:

$$
\begin{aligned}
\beta_{\text{e2e}}^{\text{l.o.}f_0} &= \left(\beta_{s_1}^{\text{l.o.}xf_0} \ominus \alpha_{s_1}^{xf_0}\right) \otimes \left(\beta_{s_2}^{\text{l.o.}xf_0} \ominus \alpha_{s_2}^{xf_0}\right) \otimes \left(\beta_{s_5}^{\text{l.o.}xf_0} \ominus \alpha_{s_5}^{xf_0}\right) \otimes \left(\beta_{s_6}^{\text{l.o.}xf_0} \ominus \alpha_{s_6}^{xf_0}\right) \\
&= \left(\beta_{s_1}^{\text{l.o.}xf_0} \ominus \alpha_{s_1}^{xf_0}\right) \otimes \left(\beta_{s_2}^{\text{l.o.x}f_0} \ominus \alpha_{s_2}^{xf_0}\right) \otimes \left(\beta_{s_5}^{\text{l.o.}xf_0} \ominus \left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6}^{\text{l.o.}xf_0} \ominus \alpha_{s_6}^{\{f_1,f_2\}}\right) \\
&= \left(\beta_{s_1} \ominus \alpha_{s_1}^{f_1}\right) \otimes \left(\beta_{s_2} \ominus \alpha_{s_2}^{f_1}\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\alpha_{s_5}^{\{f_1,f_2\}} \oslash \beta_{s_5}^{\text{l.o.}\{f_1,f_2\}}\right)\right) \\
&= \left(\beta_{s_1} \ominus \alpha_{s_1}^{f_1}\right) \otimes \left(\beta_{s_2} \ominus \alpha_{s_2}^{f_1}\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right) \oslash \beta_{s_5}^{\text{l.o.}\{f_1,f_2\}}\right)\right) \\
&= \left(\beta_{s_1} \ominus \alpha_{s_1}^{f_1}\right) \otimes \left(\beta_{s_2} \ominus \alpha_{s_2}^{f_1}\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right) \oslash \left(\left(\beta_{s_5} \ominus \alpha_{s_5}^{x\{f_1,f_2\}}\right)\right)\right)\right) \\
&= \left(\beta_{s_1} \ominus \alpha_{s_1}^{f_1}\right) \otimes \left(\beta_{s_2} \ominus \alpha_{s_2}^{f_1}\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right) \oslash \beta_{s_5}\right)\right) \\
&= \left(\beta_{20,20} \ominus \gamma_{5,125}\right) \otimes \left(\beta_{20,20} \ominus \gamma_{5,225}\right) \otimes \left(\beta_{20,20} \ominus \left(\gamma_{5,325} + \gamma_{5,225}\right)\right) \otimes \left(\beta_{20,20} \ominus \left(\left(\gamma_{5,325} + \gamma_{5,225}\right) \oslash \beta_{20,20}\right)\right) \\
&= \left(\beta_{20,20} \ominus \gamma_{5,125}\right) \otimes \left(\beta_{20,20} \ominus \gamma_{5,225}\right) \otimes \left(\beta_{20,20} \ominus \gamma_{10,550}\right) \otimes \left(\beta_{20,20} \ominus \left(\gamma_{10,550} \oslash \beta_{20,20}\right)\right) \\
&= \left(\beta_{20,20} \ominus \gamma_{5,125}\right) \otimes \left(\beta_{20,20} \ominus \gamma_{5,225}\right) \otimes \left(\beta_{20,20} \ominus \gamma_{10,550}\right) \otimes \left(\beta_{20,20} \ominus \gamma_{10,750}\right) \\
&= \beta_{15,26\frac{1}{4}} \otimes \beta_{15,31\frac{1}{4}} \otimes \beta_{10,47\frac{1}{2}} \otimes \beta_{10,57\frac{1}{2}} \\
&= \beta_{10,162\frac{1}{2}}
\end{aligned}
$$

$$
\begin{aligned}
D^{f_0} &= \frac{R_{\text{e2e}}^{\text{l.o.}f_0} \cdot T_{\text{e2e}}^{\text{l.o.}f_0} + b^{f_0}}{R_{\text{e2e}}^{\text{l.o.}f_0}} \\
&= \frac{10 \cdot 162\frac{1}{2} + 25}{10} \\
&= 165
\end{aligned}
$$

$$
\begin{aligned}
B^{f_0} &= \alpha^{f_0}(T_{\text{e2e}}^{\text{l.o.}f_0}) \\
&= 5 \cdot 162\frac{1}{2} + 25 \\
&= 837\frac{1}{2}
\end{aligned}
$$

SFA ARB_MUX:

$$
\begin{aligned}
\beta_{\text{e2e}}^{\text{l.o.}f_0} &= \left(\beta_{s_1}^{\text{l.o.}xf_0} \ominus \alpha_{s_1}^{xf_0}\right) \otimes \left(\beta_{s_2}^{\text{l.o.}xf_0} \ominus \alpha_{s_2}^{xf_0}\right) \otimes \left(\beta_{s_5}^{\text{l.o.}xf_0} \ominus \alpha_{s_5}^{xf_0}\right) \otimes \left(\beta_{s_6}^{\text{l.o.}xf_0} \ominus \alpha_{s_6}^{xf_0}\right) \\
&= \left(\beta_{s_1}^{\text{l.o.}xf_0} \ominus \alpha_{s_1}^{xf_0}\right) \otimes \left(\beta_{s_2}^{\text{l.o.x}f_0} \ominus \alpha_{s_2}^{xf_0}\right) \otimes \left(\beta_{s_5}^{\text{l.o.}xf_0} \ominus \left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6}^{\text{l.o.}xf_0} \ominus \alpha_{s_6}^{\{f_1,f_2\}}\right) \\
&= \left(\beta_{s_1} \ominus \alpha_{s_1}^{f_1}\right) \otimes \left(\beta_{s_2} \ominus \alpha_{s_2}^{f_1}\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\alpha_{s_5}^{\{f_1,f_2\}} \oslash \beta_{s_5}^{\text{l.o.}\{f_1,f_2\}}\right)\right) \\
&= \left(\beta_{s_1} \ominus \alpha_{s_1}^{f_1}\right) \otimes \left(\beta_{s_2} \ominus \alpha_{s_2}^{f_1}\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right) \oslash \beta_{s_5}^{\text{l.o.}\{f_1,f_2\}}\right)\right) \\
&= \left(\beta_{s_1} \ominus \alpha_{s_1}^{f_1}\right) \otimes \left(\beta_{s_2} \ominus \alpha_{s_2}^{f_1}\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right) \oslash \left(\left(\beta_{s_5} \ominus \alpha_{s_5}^{x\{f_1,f_2\}}\right)\right)\right)\right) \\
&= \left(\beta_{s_1} \ominus \alpha_{s_1}^{f_1}\right) \otimes \left(\beta_{s_2} \ominus \alpha_{s_2}^{f_1}\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_1} + \alpha_{s_5}^{f_2}\right) \oslash \beta_{s_5}\right)\right) \\
&= \left(\beta_{20,20} \ominus \gamma_{5,125}\right) \otimes \left(\beta_{20,20} \ominus \gamma_{5,225}\right) \otimes \left(\beta_{20,20} \ominus \left(\gamma_{5,325} + \gamma_{5,225}\right)\right) \otimes \left(\beta_{20,20} \ominus \left(\left(\gamma_{5,325} + \gamma_{5,225}\right) \oslash \beta_{20,20}\right)\right) \\
&= \left(\beta_{20,20} \ominus \gamma_{5,125}\right) \otimes \left(\beta_{20,20} \ominus \gamma_{5,225}\right) \otimes \left(\beta_{20,20} \ominus \gamma_{10,550}\right) \otimes \left(\beta_{20,20} \ominus \left(\gamma_{10,550} \oslash \beta_{20,20}\right)\right) \\
&= \left(\beta_{20,20} \ominus \gamma_{5,125}\right) \otimes \left(\beta_{20,20} \ominus \gamma_{5,225}\right) \otimes \left(\beta_{20,20} \ominus \gamma_{10,550}\right) \otimes \left(\beta_{20,20} \ominus \gamma_{10,750}\right) \\
&= \beta_{15,35} \otimes \beta_{15,41\frac{2}{3}} \otimes \beta_{10,95} \otimes \beta_{10,115} \\
&= \beta_{10,286\frac{2}{3}}
\end{aligned}
$$

$$
\begin{aligned}
D^{f_0} &= \frac{R_{\text{e2e}}^{\text{l.o.}f_0} \cdot T_{\text{e2e}}^{\text{l.o.}f_0} + b^{f_0}}{R_{\text{e2e}}^{\text{l.o.}f_0}} \\
&= \frac{10 \cdot 286\frac{2}{3} + 25}{10} \\
&= 289\frac{1}{6}
\end{aligned}
$$

$$
\begin{aligned}
B^{f_0} &= \alpha^{f_0}(T_{\text{e2e}}^{\text{l.o.}f_0}) \\
&= 5 \cdot 286\frac{2}{3} + 25 \\
&= 1458\frac{1}{3}
\end{aligned}
$$

| PMOO | | ARB_MUX |
|---|---|---|
| $s_1$ | $\alpha_{s_1}^{x'f_0}$ | $= \gamma_{5,125}$ |
| | $\alpha_{s_1}^{xf_0}$ | $= \gamma_{5,125}$ |
| $s_2$ | $\alpha_{s_2}^{x'f_0}$ | $= \gamma_{0,0}$ |
| | $\alpha_{s_2}^{xf_0}$ | $= \gamma_{5,125}$ |
| $s_5$ | $\alpha_{s_5}^{x'f_0}$ | $= \gamma_{5,225}$ |
| | $\alpha_{s_5}^{xf_0}$ | $= \gamma_{10,xxx}$ |
| $s_6$ | $\alpha_{s_6}^{x'f_0}$ | $= \gamma_{0,0}$ |
| | $\alpha_{s_6}^{xf_0}$ | $= \gamma_{10,xxx}$ |
| $\beta_{\text{e2e}}^{\text{l.o.}f_0} = \beta_{R_{\text{e2e}}^{\text{l.o.}f_0}, T_{\text{e2e}}^{\text{l.o.}f_0}}$ | $R_{\text{e2e}}^{\text{l.o.}f_0} = \bigwedge_{i\in\{1,2,5,6\}} \left(R_{s_i} - r_{s_i}^{xf_0}\right)$ | $= (20-5) \wedge (20-5) \wedge (20-10) \wedge (20-10)$<br>$= 10$ |
| | $T_{\text{e2e}}^{\text{l.o.}f_0} = \sum_{i\in\{1,2,5,6\}} T_{s_i} + \frac{\sum_{i\in\{1,2,5,6\}} \left(b_{s_i}^{x'f_0} + r_{s_i}^{xf_0} \cdot T_{s_i}\right)}{R_{\text{e2e}}^{\text{l.o.}f_0}}$ | $= 80 + \frac{125 + 5\cdot 20 + 0 + 5\cdot 20 + 225 + 10\cdot 20 + 0 + 10\cdot 20}{10}$<br>$= 80 + \frac{950}{10}$<br>$= 175$ |
| | $=$ | $= \beta_{10,185}$ |
| $D^{f_0}$ | | $\beta_{\text{e2e}}^{\text{l.o.}f_0} = b^{f_0}$<br>$10 \cdot [t-175]^+ = 25$<br>$t = 177\frac{1}{2}$ |
| $B^{f_0}$ | | $\alpha^{f_0}(T_{\text{e2e}}^{\text{l.o.}f_0}) = 5\cdot 175 + 25$<br>$= 900$ |

**Flow $f_1$**

| TFA | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $s_0$ | $\alpha_{s_1} = \alpha_{s_1}^{f_1}$ | $= \gamma_{5,25}$ | |
| | $D_{s_0}^{f_1}$ | $\beta_{s_0} = b_{s_0}$<br>$20 \cdot [t-20]^+ = 25$<br>$t = 21\frac{1}{4}$ | FIFO per micro flow<br>$\beta_{s_0} = b_{s_0}$<br>$20 \cdot [t-20]^+ = 25$<br>$t = 21\frac{1}{4}$ |
| | $B_{s_0}^{f_1}$ | $\alpha_{s_0}(T_{s_0}) = 5 \cdot 20 + 25$<br>$= 125$ | |
| $s_1$ | $\alpha_{s_1} = \alpha_{s_1}^{f_0} + \alpha_{s_1}^{f_1}$ | $= \gamma_{5,25} + \gamma_{5,125} = \gamma_{10,150}$ | |
| | $D_{s_1}^{f_1}$ | $= 27\frac{1}{2}$ | $= 55$ |
| | $B_{s_1}^{f_1}$ | $= 350$ | |
| $s_2$ | $\alpha_{s_2} = \alpha_{s_2}^{\{f_0,f_1\}}$ | $= \gamma_{10,350}$ | |
| | $D_{s_2}^{f_1}$ | $= 37\frac{1}{2}$ | $= 75$ |
| | $B_{s_2}^{f_1}$ | $= 550$ | |
| $s_5$ | $\alpha_{s_5} = \alpha_{s_5}^{\{f_0,f_1\}} + \alpha_{s_5}^{f_2}$ | $= \gamma_{5,225} + \gamma_{10,550} = \gamma_{15,775}$ | |
| | $D_{s_5}^{f_1}$ | $= 58\frac{3}{4}$ | $= 235$ |
| | $B_{s_5}^{f_1}$ | $= 1075$ | |
| $s_6$ | $\alpha_{s_6} = \alpha_{s_6}^{\{f_0,f_1,f_2\}}$ | $= \gamma_{15,1075}$ | |
| | $D_{s_6}^{f_1}$ | $= 73\frac{3}{4}$ | $= 295$ |
| | $B_{s_6}^{f_1}$ | $= 1375$ | |
| $D^{f_1}$ | | $= 197\frac{1}{2} + 21\frac{1}{4} = 218\frac{3}{4}$ | $= 660 + 21\frac{1}{4} = 681\frac{1}{4}$ |
| $B^{f_1}$ | | $= 1375$ | |

SFA FIFO_MUX:

$$
\begin{aligned}
\beta_{\text{e2e}}^{\text{l.o.}f_1} &= \left(\beta_{s_0}^{\text{l.o.}xf_1} \ominus \alpha_{s_0}^{xf_1}\right) \otimes \left(\beta_{s_1}^{\text{l.o.}xf_1} \ominus \alpha_{s_1}^{xf_1}\right) \otimes \left(\beta_{s_2}^{\text{l.o.}xf_1} \ominus \alpha_{s_2}^{xf_1}\right) \otimes \left(\beta_{s_5}^{\text{l.o.}xf_1} \ominus \alpha_{s_5}^{xf_1}\right) \otimes \left(\beta_{s_6}^{\text{l.o.}xf_1} \ominus \alpha_{s_6}^{xf_1}\right) \\
&= \left(\beta_{s_0}^{\text{l.o.}xf_1} \ominus \alpha_{s_0}^{xf_1}\right) \otimes \left(\beta_{s_1}^{\text{l.o.}xf_1} \ominus \alpha_{s_1}^{xf_1}\right) \otimes \left(\beta_{s_2}^{\text{l.o.}xf_1} \ominus \left(\alpha_{s_1}^{xf_1} \otimes \oslash \beta_{s_1}^{\text{l.o.}xf_1}\right)\right) \otimes \left(\beta_{s_5}^{\text{l.o.}xf_1} - \alpha_{s_5}^{xf_1}\right) \otimes \left(\beta_{s_6}^{\text{l.o.}xf_1} - \left(\alpha_{s_5}^{xf_1} \oslash \beta_{s_5}^{\text{l.o.}xf_1}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \alpha_{s_5}^{xf_1}\right) \otimes \left(\beta_{s_6} \ominus \left(\alpha_{s_5}^{xf_1} \oslash \beta_{s_5}^{\text{l.o.}xf_1}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_0} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\left(\alpha_{s_5}^{f_0} + \alpha_{s_5}^{f_2}\right) \oslash \beta_{s_5}^{\text{l.o.}\{f_0,f_2\}}\right)\right)\right.\right. \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_0} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_0} + \alpha_{s_5}^{f_2}\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_0} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_0} + \alpha_{s_5}^{f_2}\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_0} + \left(\alpha_{s_4}^{f_2} \oslash \beta_{s_4}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_2 s_5}^{f_0} + \left(\alpha_{s_4}^{f_2} \oslash \beta_{s_4}\right)\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_0} + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_0} + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\left(\alpha_{s_2}^{f_0} \oslash \beta_{s_2}^{\text{l.o.}f_0}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_0} + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\left(\alpha_{s_2}^{f_0} \oslash \beta_{s_2}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\left(\alpha_{s_2}^{f_0} \oslash \beta_{s_2}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \\
&\quad \otimes \left(\beta_{s_5} \ominus \left(\left(\left(\alpha^{f_0} \oslash \beta_{s_1}^{\text{l.o.}f_0}\right) \oslash \beta_{s_2}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right)\right) \oslash \beta_{s_4}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\left(\left(\alpha^{f_0} \oslash \beta_{s_1}^{\text{l.o.}f_0}\right) \oslash \beta_{s_2}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \\
&\quad \otimes \left(\beta_{s_5} \ominus \left(\left(\left(\alpha^{f_0} \oslash \beta_{s_1}\right) \oslash \beta_{s_2}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right)\right) \oslash \beta_{s_4}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\left(\left(\alpha^{f_0} \oslash \beta_{s_1}\right) \oslash \beta_{s_2}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{20,20} \otimes \left(\beta_{20,20} \ominus \gamma_{5,25}\right) \otimes \left(\beta_{20,20} \ominus \left(\gamma_{5,25} \oslash \beta_{20,20}\right)\right) \\
&\quad \otimes \left(\beta_{20,20} \ominus \left(\left(\left(\gamma_{5,25} \oslash \beta_{20,20}\right) \oslash \beta_{20,20}\right) + \left(\left(\gamma_{5,25} \oslash \beta_{20,20}\right) \oslash \beta_{20,20}\right)\right)\right) \otimes \left(\beta_{20,20} \ominus \left(\left(\left(\left(\gamma_{5,25} \oslash \beta_{20,20}\right) \oslash \beta_{20,20}\right) + \left(\left(\gamma_{5,25} \oslash \beta_{20,20}\right) \oslash \beta_{20,20}\right)\right) \oslash \beta_{20,20}\right)\right) \\
&= \beta_{20,20} \otimes \beta_{20,21\frac{1}{4}} \otimes \left(\beta_{20,20} \ominus \gamma_{5,125}\right) \otimes \left(\beta_{20,20} \ominus \left(\left(\gamma_{5,125} \oslash \beta_{20,20}\right) + \left(\gamma_{5,125} \oslash \beta_{20,20}\right)\right)\right) \otimes \left(\beta_{20,20} \ominus \left(\left(\left(\gamma_{5,125} \oslash \beta_{20,20}\right) + \left(\gamma_{5,125} \oslash \beta_{20,20}\right)\right) \oslash \beta_{20,20}\right)\right) \\
&= \beta_{20,20} \otimes \beta_{15,21\frac{1}{4}} \otimes \beta_{15,26\frac{1}{4}} \otimes \left(\beta_{20,20} \ominus \left(\gamma_{5,225} + \gamma_{5,225}\right)\right) \otimes \left(\beta_{20,20} \ominus \left(\left(\gamma_{5,225} + \gamma_{5,225}\right)\right) \oslash \beta_{20,20}\right)\right) \\
&= \beta_{20,20} \otimes \beta_{15,21\frac{1}{4}} \otimes \beta_{15,26\frac{1}{4}} \otimes \beta_{10,42\frac{1}{2}} \otimes \left(\beta_{20,20} \ominus \gamma_{10,450}\right) \otimes \left(\beta_{20,20} \ominus \left(\gamma_{10,450} \oslash \beta_{20,20}\right)\right) \\
&= \beta_{20,20} \otimes \beta_{15,21\frac{1}{4}} \otimes \beta_{15,26\frac{1}{4}} \otimes \beta_{10,42\frac{1}{2}} \otimes \left(\beta_{20,20} \ominus \gamma_{10,550}\right) \\
&= \beta_{20,20} \otimes \beta_{15,21\frac{1}{4}} \otimes \beta_{15,26\frac{1}{4}} \otimes \beta_{10,42\frac{1}{2}} \otimes \beta_{10,52\frac{1}{2}} \\
&= \beta_{10,162\frac{1}{2}}
\end{aligned}
$$

$$
\begin{aligned}
D^{f_1} &= \frac{R_{\text{e2e}}^{\text{l.o.}f_1} \cdot T_{\text{e2e}}^{\text{l.o.}f_1} + b^{f_1}}{R_{\text{e2e}}^{\text{l.o.}f_1}} \\
&= \frac{10 \cdot 162\frac{1}{2} + 25}{10} \\
&= 165 \\
B^{f_1} &= \alpha^{f_1}\left(T_{\text{e2e}}^{\text{l.o.}f_1}\right) \\
&= 5 \cdot 162\frac{1}{2} + 25 \\
&= 837\frac{1}{2}
\end{aligned}
$$

SFA ARB_MUX:

$$
\begin{aligned}
\beta_{\mathrm{e2e}}^{\mathrm{l.o.}f_1} &= \left(\beta_{s_0}^{\mathrm{l.o.}xf_1} \ominus \alpha_{s_0}^{xf_1}\right) \otimes \left(\beta_{s_1}^{\mathrm{l.o.}xf_1} \ominus \alpha_{s_1}^{xf_1}\right) \otimes \left(\beta_{s_2}^{\mathrm{l.o.}xf_1} \ominus \alpha_{s_2}^{xf_1}\right) \otimes \left(\beta_{s_5}^{\mathrm{l.o.}xf_1} \ominus \alpha_{s_5}^{xf_1}\right) \otimes \left(\beta_{s_6}^{\mathrm{l.o.}xf_1} \ominus \alpha_{s_6}^{xf_1}\right) \\
&= \left(\beta_{s_0}^{\mathrm{l.o.}xf_1} \ominus \alpha_{s_0}^{xf_1}\right) \otimes \left(\beta_{s_1}^{\mathrm{l.o.}xf_1} \ominus \alpha_{s_1}^{xf_1}\right) \otimes \left(\beta_{s_2}^{\mathrm{l.o.}xf_1} \ominus \left(\alpha_{s_1}^{xf_1} \otimes \oslash \beta_{s_1}^{\mathrm{l.o.}xf_1}\right)\right) \otimes \left(\beta_{s_5}^{\mathrm{l.o.}xf_1} - \alpha_{s_5}^{xf_1}\right) \otimes \left(\beta_{s_6}^{\mathrm{l.o.}xf_1} - \left(\alpha_{s_5}^{xf_1} \oslash \beta_{s_5}^{\mathrm{l.o.}xf_1}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \alpha_{s_5}^{xf_1}\right) \otimes \left(\beta_{s_6} \ominus \left(\alpha_{s_5}^{xf_1} \oslash \beta_{s_5}^{\mathrm{l.o.}xf_1}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_0} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\left(\alpha_{s_5}^{f_0} + \alpha_{s_5}^{f_2}\right) \oslash \beta_{s_5}^{\mathrm{l.o.}\{f_0,f_2\}}\right)\right)\right.\right. \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_0} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_0} + \alpha_{s_5}^{f_2}\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_0} + \alpha_{s_5}^{f_2}\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_0} + \alpha_{s_5}^{f_2}\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_0} + \left(\alpha_{s_4}^{f_2} \oslash \beta_{s_4}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_2 s_5}^{f_0} + \left(\alpha_{s_4}^{f_2} \oslash \beta_{s_4}\right)\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_5}^{f_0} + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_0} + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\left(\alpha_{s_2}^{f_0} \oslash \beta_{s_2}^{\mathrm{l.o.}f_0}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_5}^{f_0} + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \otimes \left(\beta_{s_5} \ominus \left(\left(\alpha_{s_2}^{f_0} \oslash \beta_{s_2}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\left(\alpha_{s_2}^{f_0} \oslash \beta_{s_2}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \\
&\quad \otimes \left(\beta_{s_5} \ominus \left(\left(\left(\alpha^{f_0} \oslash \beta_{s_1}^{\mathrm{l.o.}f_0}\right) \oslash \beta_{s_2}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right)\right) \oslash \beta_{s_4}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\left(\left(\alpha^{f_0} \oslash \beta_{s_1}^{\mathrm{l.o.}f_0}\right) \oslash \beta_{s_2}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_0} \otimes \left(\beta_{s_1} \ominus \alpha^{f_0}\right) \otimes \left(\beta_{s_2} \ominus \left(\alpha^{f_0} \oslash \beta_{s_1}\right)\right) \\
&\quad \otimes \left(\beta_{s_5} \ominus \left(\left(\left(\alpha^{f_0} \oslash \beta_{s_1}\right) \oslash \beta_{s_2}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right)\right) \oslash \beta_{s_4}\right)\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\left(\left(\alpha^{f_0} \oslash \beta_{s_1}\right) \oslash \beta_{s_2}\right) + \left(\left(\alpha^{f_2} \oslash \beta_{s_3}\right) \oslash \beta_{s_4}\right)\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{20,20} \otimes \left(\beta_{20,20} \ominus \gamma_{5,25}\right) \otimes \left(\beta_{20,20} \ominus \left(\gamma_{5,25} \oslash \beta_{20,20}\right)\right) \\
&\quad \otimes \left(\beta_{20,20} \ominus \left(\left(\left(\gamma_{5,25} \oslash \beta_{20,20}\right) \oslash \beta_{20,20}\right) + \left(\left(\gamma_{5,25} \oslash \beta_{20,20}\right) \oslash \beta_{20,20}\right)\right)\right) \otimes \left(\beta_{20,20} \ominus \left(\left(\left(\left(\gamma_{5,25} \oslash \beta_{20,20}\right) \oslash \beta_{20,20}\right) + \left(\left(\gamma_{5,25} \oslash \beta_{20,20}\right) \oslash \beta_{20,20}\right)\right) \oslash \beta_{20,20}\right)\right) \\
&= \beta_{20,20} \otimes \beta_{20,28\frac{1}{3}} \otimes \left(\beta_{20,20} \ominus \gamma_{5,125}\right) \otimes \left(\beta_{20,20} \ominus \left(\left(\gamma_{5,125} \oslash \beta_{20,20}\right) + \left(\gamma_{5,125} \oslash \beta_{20,20}\right)\right)\right) \otimes \left(\beta_{20,20} \ominus \left(\left(\left(\gamma_{5,125} \oslash \beta_{20,20}\right) + \left(\gamma_{5,125} \oslash \beta_{20,20}\right)\right) \oslash \beta_{20,20}\right)\right) \\
&= \beta_{20,20} \otimes \beta_{15,28\frac{1}{3}} \otimes \beta_{15,35} \otimes \left(\beta_{20,20} \ominus \left(\gamma_{5,225} + \gamma_{5,225}\right)\right) \otimes \left(\beta_{20,20} \ominus \left(\left(\gamma_{5,225} + \gamma_{5,225}\right) \oslash \beta_{20,20}\right)\right) \\
&= \beta_{20,20} \otimes \beta_{15,28\frac{1}{3}} \otimes \beta_{15,35} \otimes \left(\beta_{20,20} \ominus \gamma_{10,450}\right) \otimes \left(\beta_{20,20} \ominus \left(\gamma_{10,450} \oslash \beta_{20,20}\right)\right) \\
&= \beta_{20,20} \otimes \beta_{15,28\frac{1}{3}} \otimes \beta_{15,35} \otimes \beta_{10,85} \otimes \left(\beta_{20,20} \ominus \gamma_{10,650}\right) \\
&= \beta_{20,20} \otimes \beta_{15,28\frac{1}{3}} \otimes \beta_{15,35} \otimes \beta_{10,85} \otimes \beta_{10,95} \\
&= \beta_{10,273\frac{1}{3}} \\
D^{f_1} &= \frac{R_{\mathrm{e2e}}^{\mathrm{l.o.}f_1} \cdot T_{\mathrm{e2e}}^{\mathrm{l.o.}f_1} + b^{f_1}}{R_{\mathrm{e2e}}^{\mathrm{l.o.}f_1}} \\
&= \frac{10 \cdot 273\frac{1}{3} + 25}{10} \\
&= 275\frac{5}{6} \\
B^{f_1} &= \alpha^{f_1}\left(T_{\mathrm{e2e}}^{\mathrm{l.o.}f_1}\right) \\
&= 5 \cdot 273\frac{1}{3} + 25 \\
&= 1391\frac{2}{3}
\end{aligned}
$$

| PMOO | | ARB_MUX |
|---|---|---|
| $s_0$ | $\alpha_{s_0}^{x'f_1}$ | $= \gamma_{0,0}$ |
| | $\alpha_{s_0}^{xf_1}$ | $= \gamma_{0,0}$ |
| $s_1$ | $\alpha_{s_1}^{x'f_1}$ | $= \gamma_{5,25}$ |
| | $\alpha_{s_1}^{xf_1}$ | $= \gamma_{5,25}$ |
| $s_2$ | $\alpha_{s_2}^{x'f_1}$ | $= \gamma_{0,0}$ |
| | $\alpha_{s_2}^{xf_1}$ | $= \gamma_{5,125}$ |
| $s_5$ | $\alpha_{s_5}^{x'f_1}$ | $= \gamma_{5,225}$ |
| | $\alpha_{s_5}^{xf_1}$ | $= \gamma_{10,xxx}$ |
| $s_6$ | $\alpha_{s_6}^{x'f_1}$ | $= \gamma_{0,0}$ |
| | $\alpha_{s_6}^{xf_1}$ | $= \gamma_{10,xxx}$ |
| $\beta_{\text{e2e}}^{\text{l.o.}f_1} = \beta_{R_{\text{e2e}}^{\text{l.o.}f_1}, T_{\text{e2e}}^{\text{l.o.}f_1}}$ | $R_{\text{e2e}}^{\text{l.o.}f_1} = \bigwedge_{i\in\{0,1,2,5,6\}} \left(R_{s_i} - r_{s_i}^{xf_1}\right)$ | $= (20-0) \wedge (20-5) \wedge (20-5) \wedge (20-10) \wedge (20-10)$<br>$= 10$ |
| | $T_{\text{e2e}}^{\text{l.o.}f_1} = \sum_{i\in\{0,1,2,5,6\}} T_{s_i} + \frac{\sum_{i\in\{0,1,2,5,6\}} \left(b_{s_i}^{x'f_1} + r_{s_i}^{xf_1} \cdot T_{s_i}\right)}{R_{\text{e2e}}^{\text{l.o.}f_1}}$ | $= 100 + \frac{0+0\cdot 20+25+5\cdot 20+0+5\cdot 20+225+10\cdot 20+0+10\cdot 20}{10}$<br>$= 100 + \frac{850}{10}$<br>$= 185$ |
| | $=$ | $= \beta_{10,185}$ |
| $D^{f_1}$ | | $\beta_{\text{e2e}}^{\text{l.o.}f_1} = b^{f_1}$<br>$10 \cdot [t-185]^+ = 25$<br>$t = 187\frac{1}{2}$ |
| $B^{f_1}$ | | $\alpha^{f_1}(T_{\text{e2e}}^{\text{l.o.}f_1}) = 5\cdot 185 + 25$<br>$= 950$ |

**Flow $f_2$**

| TFA | | FIFO_MUX | ARB_MUX |
|---|---|---|---|
| $s_3$ | $\alpha_{s_3} = \alpha_{s_3}^{f_2}$ | $= \gamma_{5,25}$ | |
| | $D_{s_3}^{f_2}$ | $\beta_{s_3} = b_{s_3}$<br>$20 \cdot [t-20]^+ = 25$<br>$t = 21\frac{1}{4}$ | FIFO per micro flow<br>$\beta_{s_3} = b_{s_3}$<br>$20 \cdot [t-20]^+ = 25$<br>$t = 21\frac{1}{4}$ |
| | $B_{s_3}^{f_2}$ | $\alpha_{s_3}(T_{s_3}) = 5 \cdot 20 + 25$<br>$= 125$ | |
| $s_4$ | $\alpha_{s_4} = \alpha_{s_4}^{f_2}$ | $= \gamma_{5,125}$ | |
| | $D_{s_4}^{f_2}$ | $\beta_{s_4} = b_{s_4}$<br>$20 \cdot [t-20]^+ = 125$<br>$t = 26\frac{1}{4}$ | FIFO per micro flow<br>$\beta_{s_4} = b_{s_4}$<br>$20 \cdot [t-20]^+ = 125$<br>$t = 26\frac{1}{4}$ |
| | $B_{s_4}^{f_2}$ | $\alpha_{s_4}(T_{s_4}) = 5 \cdot 20 + 125$<br>$= 225$ | |
| $s_5$ | $\alpha_{s_5} = \alpha_{s_5}^{\{f_0,f_1\}} + \alpha_{s_5}^{f_2}$ | $= \gamma_{5,225} + \gamma_{10,550} = \gamma_{15,775}$ | |
| | $D_{s_5}^{f_2}$ | $= 58\frac{3}{4}$ | $= 235$ |
| | $B_{s_5}^{f_2}$ | $= 1075$ | |
| $s_6$ | $\alpha_{s_6} = \alpha_{s_6}^{\{f_0,f_1,f_2\}}$ | $= \gamma_{15,1075}$ | |
| | $D_{s_6}^{f_2}$ | $= 73\frac{3}{4}$ | $= 295$ |
| | $B_{s_6}^{f_2}$ | $= 1375$ | |
| $D^{f_2}$ | | $= 180$ | $= 577\frac{1}{2}$ |
| $B^{f_2}$ | | $= 1375$ | |

SFA FIFO_MUX:

$$
\begin{aligned}
\beta_{\text{e2e}}^{\text{l.o.}f_2} &= \left(\beta_{s_3}^{\text{l.o.}xf_2} \ominus \alpha_{s_3}^{xf_2}\right) \otimes \left(\beta_{s_4}^{\text{l.o.}xf_2} \ominus \alpha_{s_4}^{xf_2}\right) \otimes \left(\beta_{s_5}^{\text{l.o.}xf_2} \ominus \alpha_{s_5}^{xf_2}\right) \otimes \left(\beta_{s_6}^{\text{l.o.}xf_2} \ominus \alpha_{s_6}^{xf_2}\right) \\
&= \beta_{s_3} \otimes \beta_{s_4} \otimes \left(\left(\beta_{s_5} \ominus \alpha_{s_5}^{xxf_2}\right) \ominus \alpha_{s_5}^{\{f_0,f_1\}}\right) \otimes \left(\beta_{s_6}^{\text{l.o.}xf_2} \ominus \left(\alpha_{s_5}^{xf_2} \oslash \beta_{s_5}^{\text{l.o.}xf_2}\right)\right) \\
&= \beta_{s_3} \otimes \beta_{s_4} \otimes \left(\beta_{s_5} \ominus \alpha_{s_5}^{\{f_0,f_1\}}\right) \otimes \left(\beta_{s_6} \ominus \left(\alpha_{s_5}^{\{f_0,f_1\}} \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_3} \otimes \beta_{s_4} \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_1}^{\{f_0,f_1\}} \oslash (\beta_{s_1} \otimes \beta_{s_2})\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_1}^{\{f_0,f_1\}} \oslash (\beta_{s_1} \otimes \beta_{s_2})\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_3} \otimes \beta_{s_4} \otimes \left(\beta_{s_5} \ominus \left(\left(\left(\alpha^{f_1} \oslash \beta_{s_0}\right) + \alpha^{f_0}\right) \oslash (\beta_{s_1} \otimes \beta_{s_2})\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\left(\left(\alpha^{f_1} \oslash \beta_{s_0}\right) + \alpha^{f_0}\right) \oslash (\beta_{s_1} \otimes \beta_{s_2})\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{20,20} \otimes \beta_{20,20} \otimes (\beta_{20,20} \ominus (((\gamma_{5,25} \oslash \beta_{20,20}) + \gamma_{5,25}) \oslash (\beta_{20,20} \otimes \beta_{20,20}))) \otimes (\beta_{20,20} \ominus ((((\gamma_{5,25} \oslash \beta_{20,20}) + \gamma_{5,25}) \oslash (\beta_{20,20} \otimes \beta_{20,20})) \oslash \beta_{20,20})) \\
&= \beta_{20,40} \otimes (\beta_{20,20} \ominus (((\gamma_{5,25} \oslash \beta_{20,20}) + \gamma_{5,25}) \oslash \beta_{20,40})) \otimes (\beta_{20,20} \ominus ((((\gamma_{5,25} \oslash \beta_{20,20}) + \gamma_{5,25}) \oslash \beta_{20,40}) \oslash \beta_{20,20})) \\
&= \beta_{20,40} \otimes (\beta_{20,20} \ominus ((\gamma_{5,125} + \gamma_{5,25}) \oslash \beta_{20,40})) \otimes (\beta_{20,20} \ominus (((\gamma_{5,125} + \gamma_{5,25}) \oslash \beta_{20,40}) \oslash \beta_{20,20})) \\
&= \beta_{20,40} \otimes (\beta_{20,20} \ominus (\gamma_{10,150} \oslash \beta_{20,40})) \otimes (\beta_{20,20} \ominus ((\gamma_{10,150} \oslash \beta_{20,40}) \oslash \beta_{20,20})) \\
&= \beta_{20,40} \otimes (\beta_{20,20} \ominus \gamma_{10,550}) \otimes (\beta_{20,20} \ominus (\gamma_{10,550} \oslash \beta_{20,20})) \\
&= \beta_{20,40} \otimes (\beta_{20,20} \ominus \gamma_{10,550}) \otimes (\beta_{20,20} \ominus \gamma_{10,750}) \\
&= \beta_{20,40} \otimes \beta_{10,47\frac{1}{2}} \otimes \beta_{10,55\frac{1}{2}} \\
&= \beta_{10,145}
\end{aligned}
$$

$$
\begin{aligned}
D^{f_1} &= \frac{R_{\text{e2e}}^{\text{l.o.}f_1} \cdot T_{\text{e2e}}^{\text{l.o.}f_1} + b^{f_1}}{R_{\text{e2e}}^{\text{l.o.}f_1}} \\
&= \frac{10 \cdot 145 + 25}{10} \\
&= 147\frac{1}{2}
\end{aligned}
$$

$$
\begin{aligned}
B^{f_1} &= \alpha^{f_1}(T_{\text{e2e}}^{\text{l.o.}f_1}) \\
&= 5 \cdot 145 + 25 \\
&= 750
\end{aligned}
$$

SFA ARB_MUX:

$$
\begin{aligned}
\beta_{\text{e2e}}^{\text{l.o.}f_2} &= \left(\beta_{s_3}^{\text{l.o.}xf_2} \ominus \alpha_{s_3}^{xf_2}\right) \otimes \left(\beta_{s_4}^{\text{l.o.}xf_2} \ominus \alpha_{s_4}^{xf_2}\right) \otimes \left(\beta_{s_5}^{\text{l.o.}xf_2} \ominus \alpha_{s_5}^{xf_2}\right) \otimes \left(\beta_{s_6}^{\text{l.o.}xf_2} \ominus \alpha_{s_6}^{xf_2}\right) \\
&= \beta_{s_3} \otimes \beta_{s_4} \otimes \left(\left(\beta_{s_5} \ominus \alpha_{s_5}^{xxf_2}\right) \ominus \alpha_{s_5}^{\{f_0,f_1\}}\right) \otimes \left(\beta_{s_6}^{\text{l.o.}xf_2} \ominus \left(\alpha_{s_5}^{xf_2} \oslash \beta_{s_5}^{\text{l.o.}xf_2}\right)\right) \\
&= \beta_{s_3} \otimes \beta_{s_4} \otimes \left(\beta_{s_5} \ominus \alpha_{s_5}^{\{f_0,f_1\}}\right) \otimes \left(\beta_{s_6} \ominus \left(\alpha_{s_5}^{\{f_0,f_1\}} \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_3} \otimes \beta_{s_4} \otimes \left(\beta_{s_5} \ominus \left(\alpha_{s_1}^{\{f_0,f_1\}} \oslash (\beta_{s_1} \otimes \beta_{s_2})\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\alpha_{s_1}^{\{f_0,f_1\}} \oslash (\beta_{s_1} \otimes \beta_{s_2})\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{s_3} \otimes \beta_{s_4} \otimes \left(\beta_{s_5} \ominus \left(\left(\left(\alpha^{f_1} \oslash \beta_{s_0}\right) + \alpha^{f_0}\right) \oslash (\beta_{s_1} \otimes \beta_{s_2})\right)\right) \otimes \left(\beta_{s_6} \ominus \left(\left(\left(\left(\alpha^{f_1} \oslash \beta_{s_0}\right) + \alpha^{f_0}\right) \oslash (\beta_{s_1} \otimes \beta_{s_2})\right) \oslash \beta_{s_5}\right)\right) \\
&= \beta_{20,20} \otimes \beta_{20,20} \otimes (\beta_{20,20} \ominus (((\gamma_{5,25} \oslash \beta_{20,20}) + \gamma_{5,25}) \oslash (\beta_{20,20} \otimes \beta_{20,20}))) \otimes (\beta_{20,20} \ominus ((((\gamma_{5,25} \oslash \beta_{20,20}) + \gamma_{5,25}) \oslash (\beta_{20,20} \otimes \beta_{20,20})) \oslash \beta_{20,20})) \\
&= \beta_{20,40} \otimes (\beta_{20,20} \ominus (((\gamma_{5,25} \oslash \beta_{20,20}) + \gamma_{5,25}) \oslash \beta_{20,40})) \otimes (\beta_{20,20} \ominus ((((\gamma_{5,25} \oslash \beta_{20,20}) + \gamma_{5,25}) \oslash \beta_{20,40}) \oslash \beta_{20,20})) \\
&= \beta_{20,40} \otimes (\beta_{20,20} \ominus ((\gamma_{5,125} + \gamma_{5,25}) \oslash \beta_{20,40})) \otimes [\beta_{20,20} - (((\gamma_{5,125} + \gamma_{5,25}) \oslash \beta_{20,40}) \oslash \beta_{20,20})]^{+} \\
&= \beta_{20,40} \otimes (\beta_{20,20} \ominus (\gamma_{10,150} \oslash \beta_{20,40})) \otimes (\beta_{20,20} \ominus ((\gamma_{10,150} \oslash \beta_{20,40}) \oslash \beta_{20,20})) \\
&= \beta_{20,40} \otimes (\beta_{20,20} \ominus \gamma_{10,550}) \otimes (\beta_{20,20} \ominus (\gamma_{10,550} \oslash \beta_{20,20})) \\
&= \beta_{20,40} \otimes (\beta_{20,20} \ominus \gamma_{10,550}) \otimes (\beta_{20,20} \ominus \gamma_{10,750}) \\
&= \beta_{20,40} \otimes \beta_{10,95} \otimes \beta_{10,115} \\
&= \beta_{10,250}
\end{aligned}
$$

$$
\begin{aligned}
D^{f_1} &= \frac{R_{\text{e2e}}^{\text{l.o.}f_1} \cdot T_{\text{e2e}}^{\text{l.o.}f_1} + b^{f_1}}{R_{\text{e2e}}^{\text{l.o.}f_1}} \\
&= \frac{10 \cdot 250 + 25}{10} \\
&= 252\frac{1}{2}
\end{aligned}
$$

$$
\begin{aligned}
B^{f_1} &= \alpha^{f_1}(T_{\text{e2e}}^{\text{l.o.}f_1}) \\
&= 5 \cdot 250 + 25 \\
&= 1275
\end{aligned}
$$

| PMOO | | ARB_MUX |
|---|---|---|
| $s_3$ | $\alpha_{s_3}^{x'f_2}$ | $= \gamma_{0,0}$ |
| | $\alpha_{s_3}^{xf_2}$ | $= \gamma_{0,0}$ |
| $s_4$ | $\alpha_{s_4}^{x'f_2}$ | $= \gamma_{0,0}$ |
| | $\alpha_{s_4}^{xf_2}$ | $= \gamma_{0,0}$ |
| $s_5$ | $\alpha_{s_5}^{x'f_2}$ | $= \gamma_{10,550}$ |
| | $\alpha_{s_5}^{xf_2}$ | $= \gamma_{10,550}$ |
| $s_6$ | $\alpha_{s_6}^{x'f_2}$ | $= \gamma_{0,0}$ |
| | $\alpha_{s_6}^{xf_2}$ | $= \gamma_{10,xxx}$ |
| $\beta_{\text{e2e}}^{\text{l.o.}f_2} = \beta_{R_{\text{e2e}}^{\text{l.o.}f_2}, T_{\text{e2e}}^{\text{l.o.}f_2}}$ | $R_{\text{e2e}}^{\text{l.o.}f_2} = \bigwedge_{i\in\{3,4,5,6\}} \left(R_{s_i} - r_{s_i}^{xf_2}\right)$ | $= (20-0) \wedge (20-0) \wedge (20-10) \wedge (20-10)$<br>$= 10$ |
| | $T_{\text{e2e}}^{\text{l.o.}f_2} = \sum_{i\in\{3,4,5,6\}} T_{s_i} + \frac{\sum_{i\in\{3,4,5,6\}} \left(b_{s_i}^{x'f_2} + r_{s_i}^{xf_2} \cdot T_{s_i}\right)}{R_{\text{e2e}}^{\text{l.o.}f_2}}$ | $= 20+20+20+20+\frac{0+0\cdot 20+0+0\cdot 20+550+10\cdot 20+0+10\cdot 20}{5}$<br>$= 80+\frac{950}{10}$<br>$= 175$ |
| | $=$ | $= \beta_{10,175}$ |
| $D^{f_2}$ | | $\beta_{\text{e2e}}^{\text{l.o.}f_2} = b^{f_2}$<br>$10 \cdot [t-175]^+ = 25$<br>$t = 177\frac{1}{2}$ |
| $B^{f_2}$ | | $\alpha^{f_2}(T_{\text{e2e}}^{\text{l.o.}f_2}) = 5 \cdot 175 + 25$<br>$= 900$ |