Nebenläufige Befehlsausführung

Vektorarchitekturen

Flynnsche Klassifikation

1966 Michael J. Flynn

Single	Multiple	
SISD	MISD	Instruction
SIMD	MIMD	Data

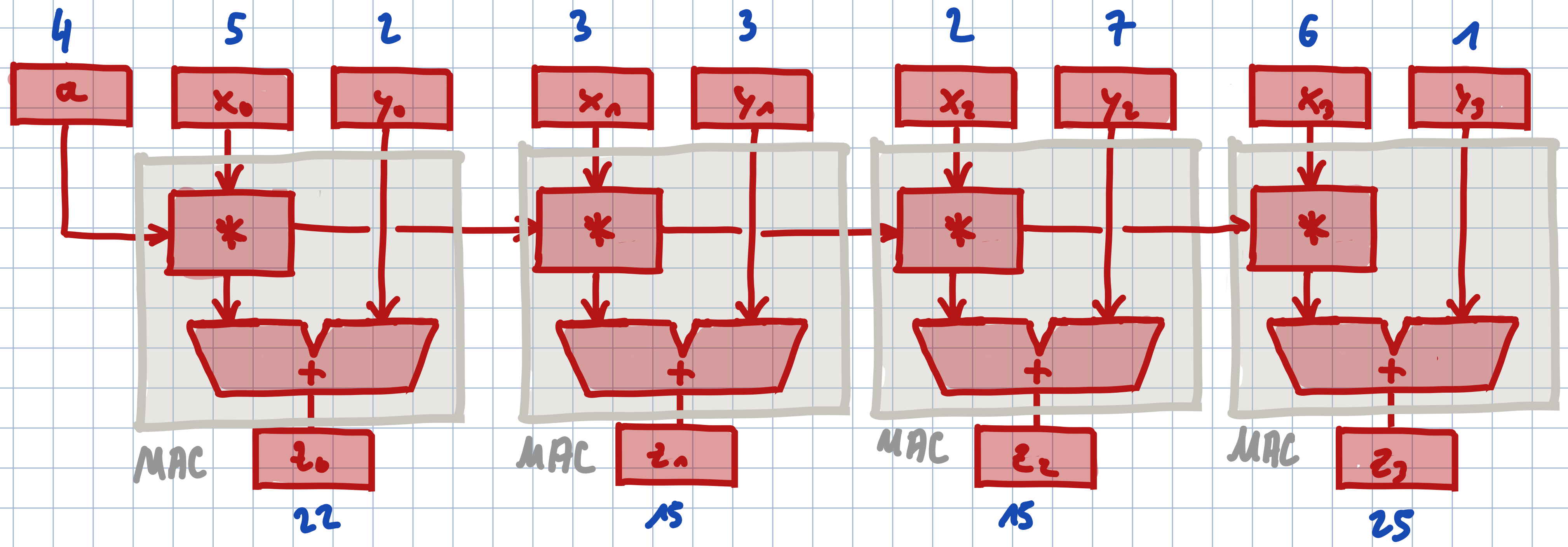
SAXPY :

DAXPY

$$\vec{z} = a\,\vec{x} + \vec{y}$$

Beispiel:

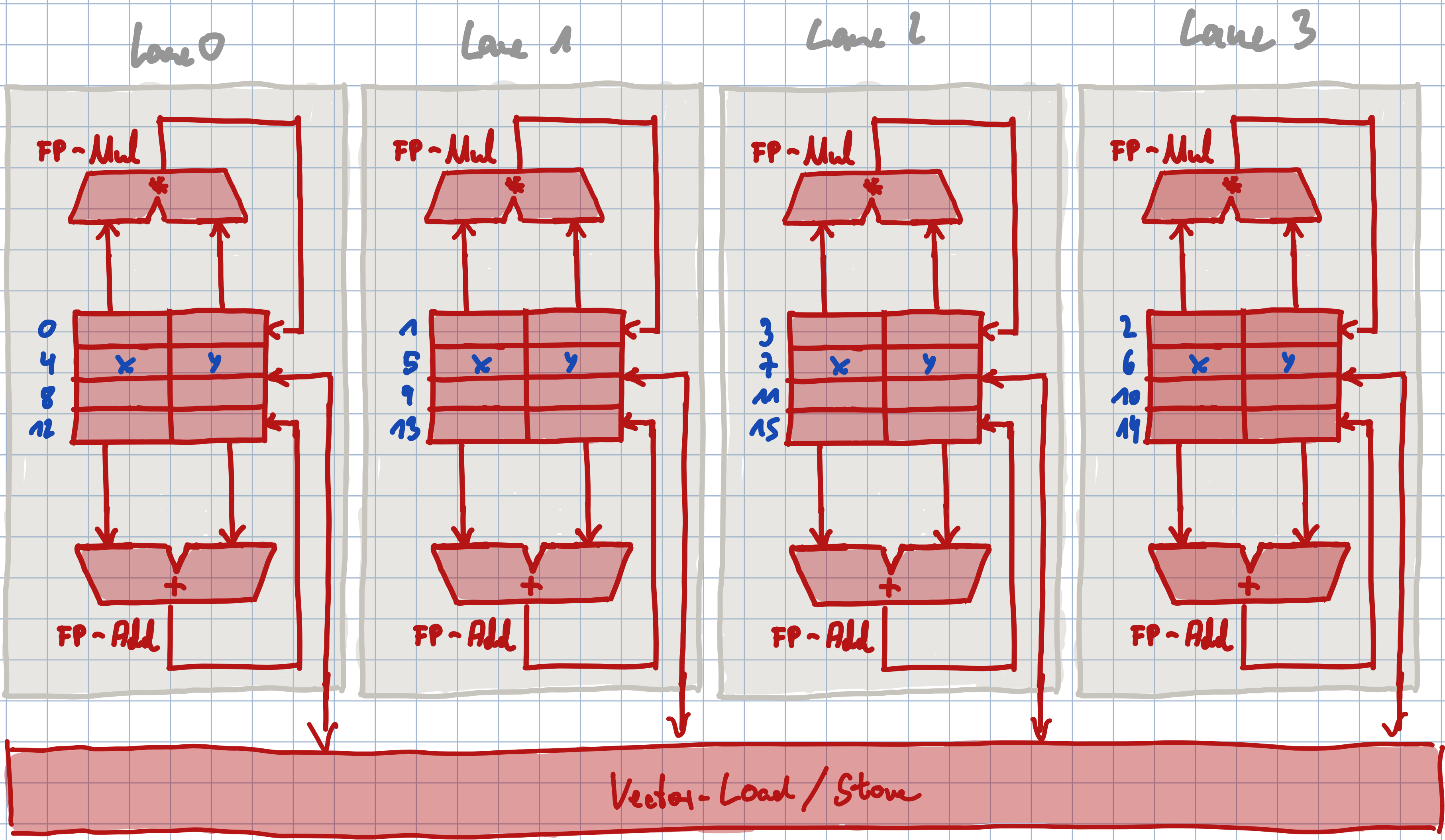
$$4 \cdot \begin{pmatrix} 5 \\ 3 \\ 2 \\ 6 \end{pmatrix} + \begin{pmatrix} 2 \\ 3 \\ 7 \\ 1 \end{pmatrix} = \begin{pmatrix} 20 \\ 12 \\ 8 \\ 24 \end{pmatrix} + \begin{pmatrix} 2 \\ 3 \\ 7 \\ 1 \end{pmatrix} = \begin{pmatrix} 22 \\ 15 \\ 15 \\ 25 \end{pmatrix}$$



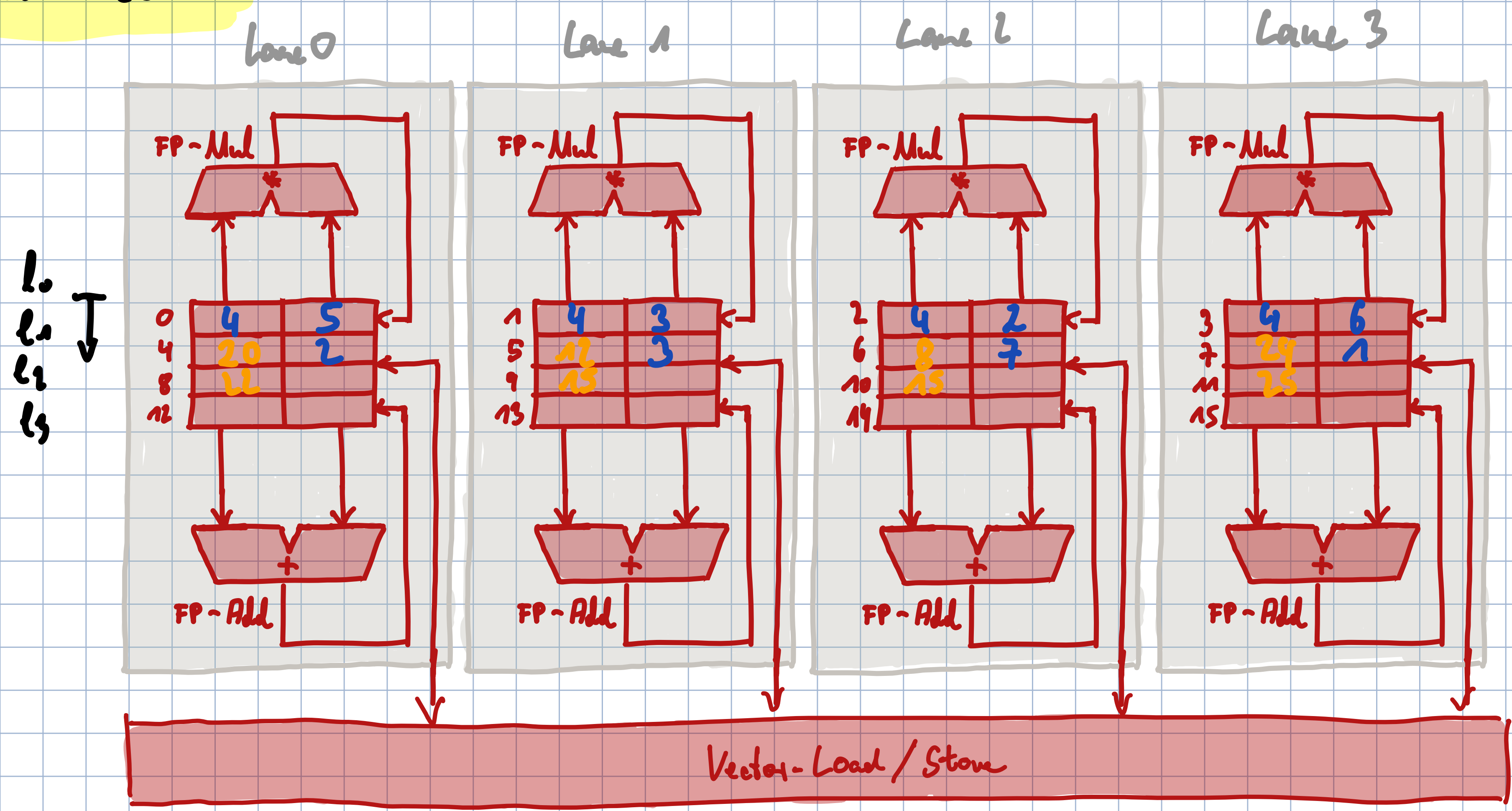
Single Precision A x X Plus Y

Double Precision A x X Plus Y

Vektorrechner

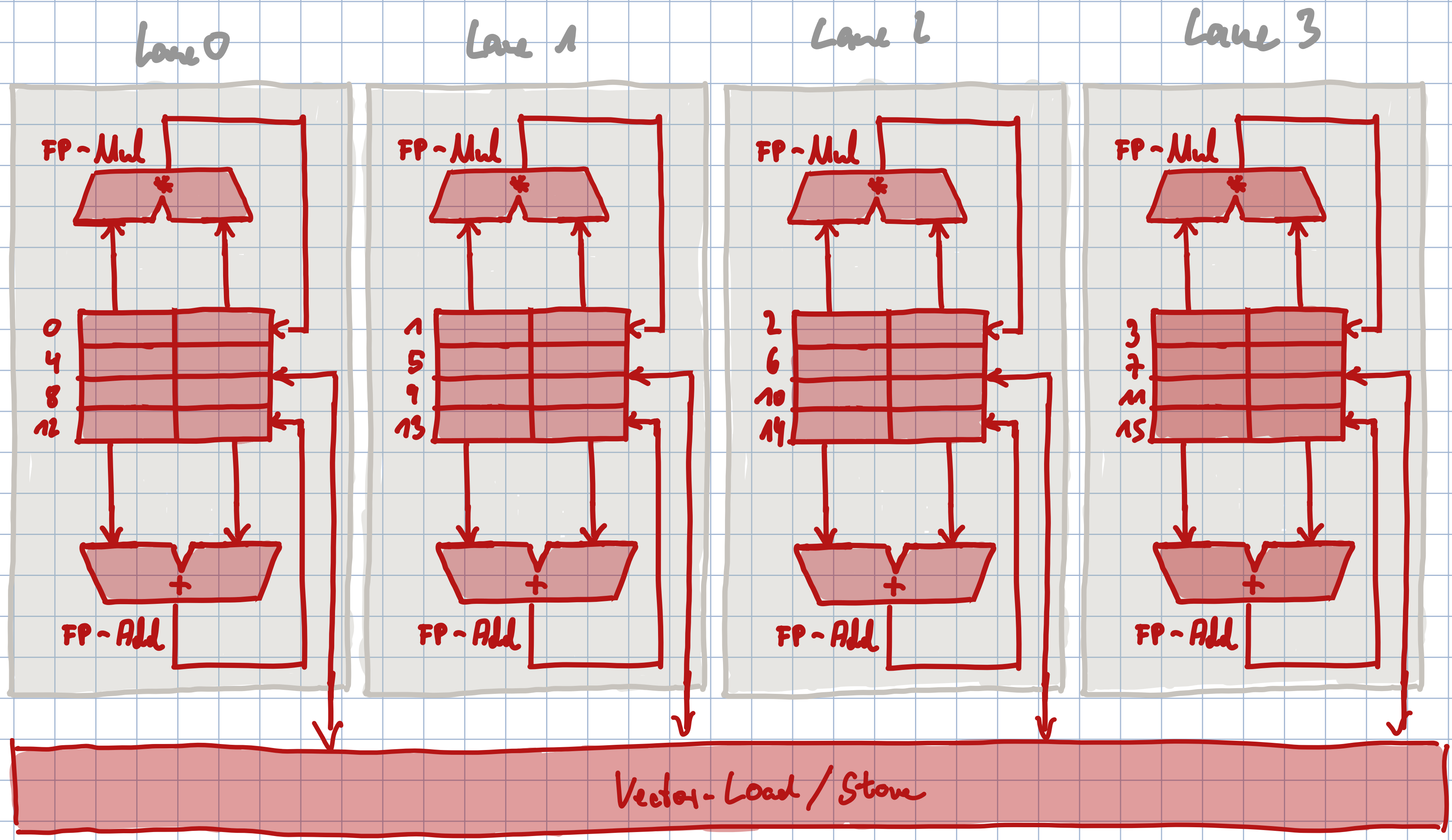


Vektorrechner



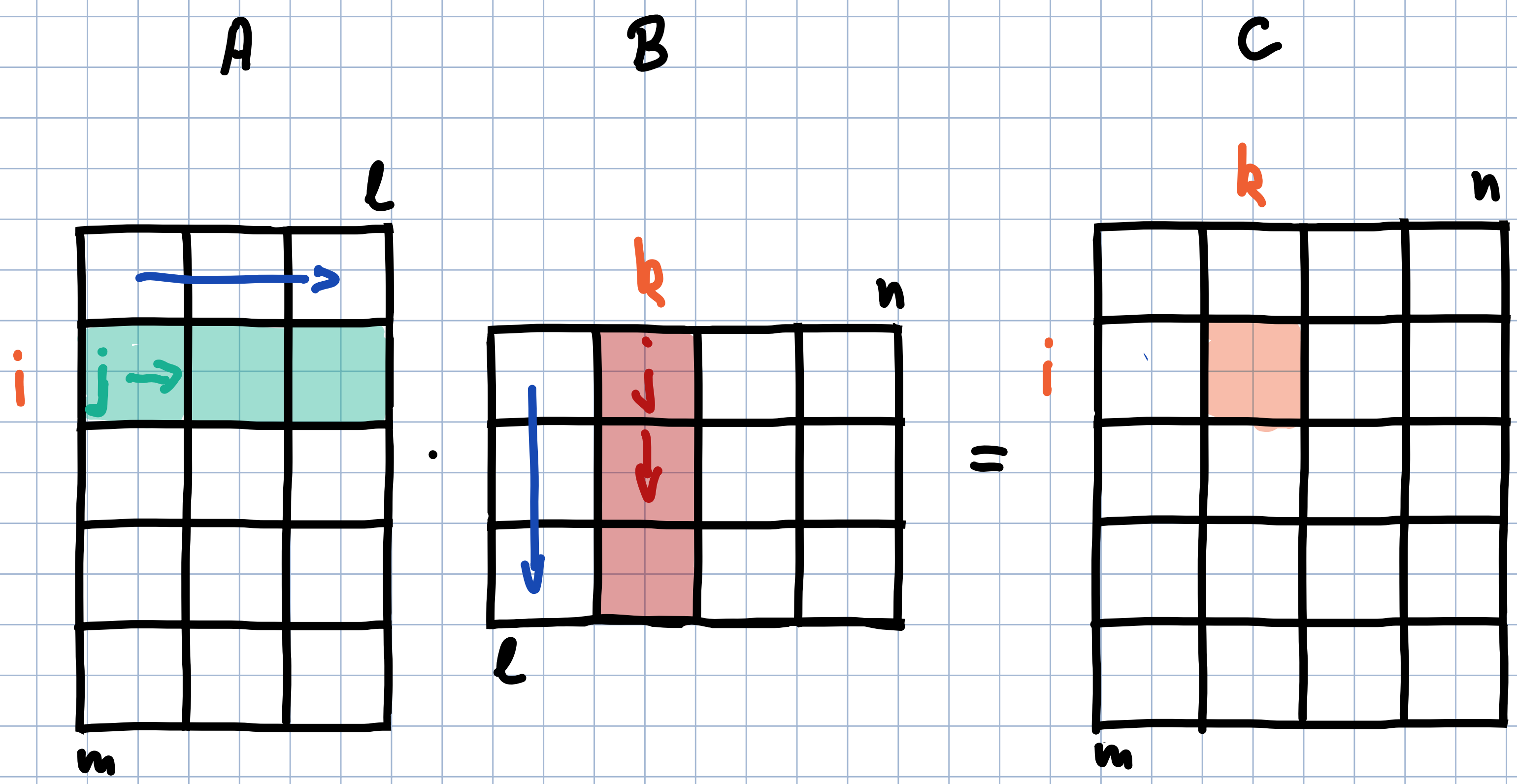
Beispiel:

vload X_0, (4, 4, 4, 4)
vload Y_0, (5, 3, 2, 6)
vload Y_1, (2, 3, 7, 1)
vmul X_1, X_0, Y_0
vadd X_2, X_1, Y_1



Lane 0
Lane 1
Lane 2
Lane 3
FP-Mul
FP-Mul
FP-Mul
FP-Mul
0
4
8
12
1
5
9
13
2
6
10
14
3
7
11
15
FP-Add
FP-Add
FP-Add
FP-Add
Vector-Load / Store

Beispiel: Matrixmultiplikation

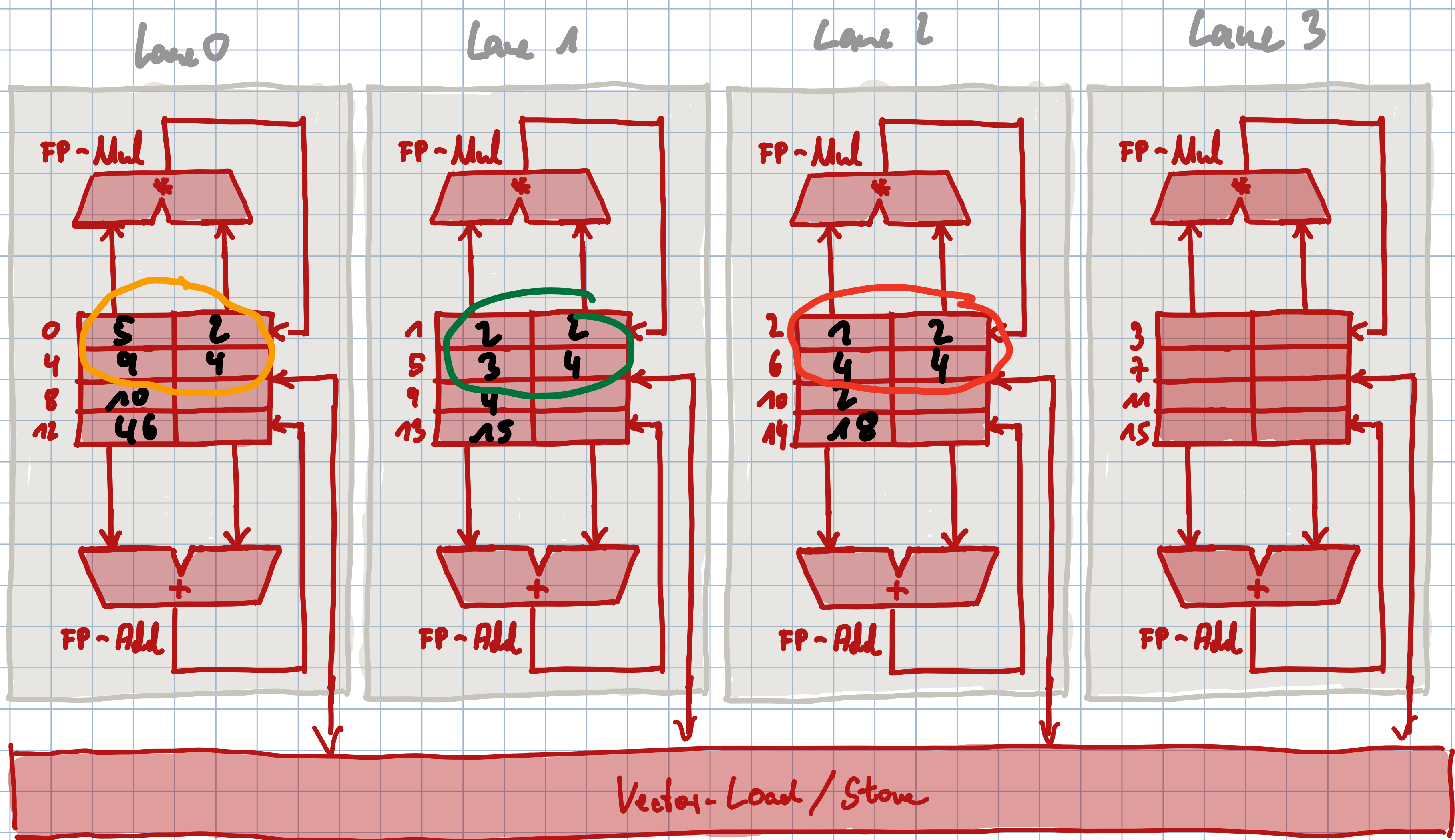


$$c_{ik} = \sum_{j=1}^{l} a_{ij} \cdot b_{jk}$$

Matrixmultiplikation

$$c_{ik} = \sum_{j=1}^{2} a_{ij} \cdot b_{jk}$$

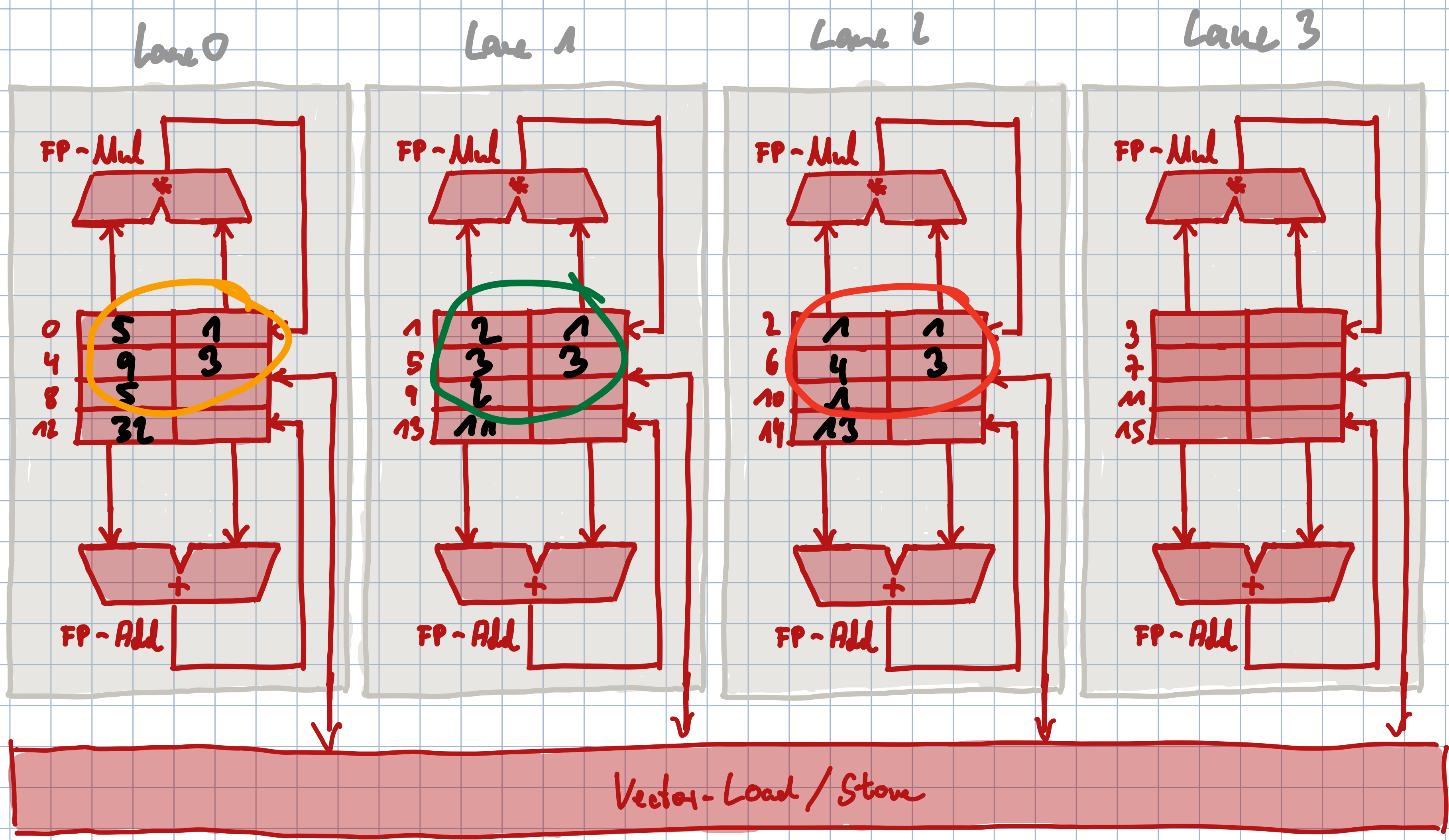
$$\begin{pmatrix}5 & 9\\ 2 & 3\\ 1 & 4\end{pmatrix} \cdot \begin{pmatrix}2 & 1\\ 4 & 3\end{pmatrix} = \begin{pmatrix}5\cdot2+9\cdot4 & 5\cdot1+9\cdot3\\ 2\cdot2+3\cdot4 & 2\cdot1+3\cdot3\\ 1\cdot2+4\cdot4 & 1\cdot1+4\cdot3\end{pmatrix} = \begin{pmatrix}46 & 32\\ 15 & 11\\ 20 & 13\end{pmatrix}$$



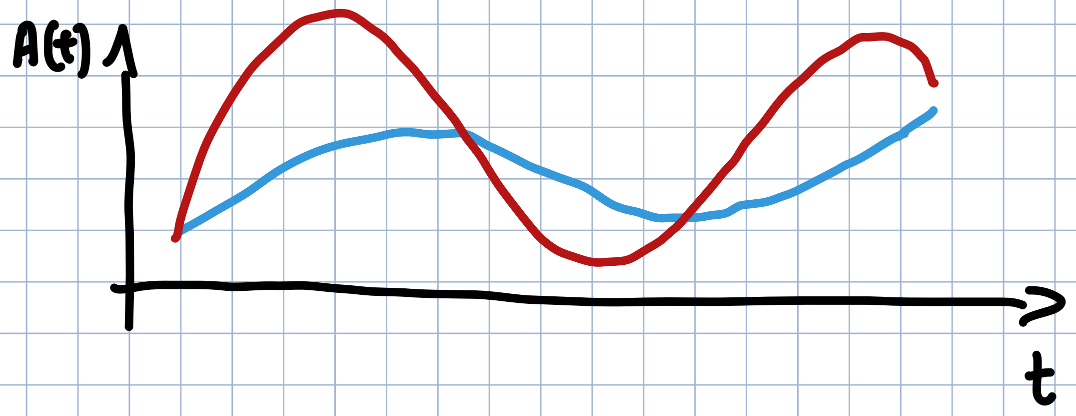
Matrixmultiplikation

$$\boxed{c_{ik} = \sum_{j=1}^{2} a_{ij} \cdot b_{jk}}$$

$$\begin{pmatrix} 5 & 9 \\ 2 & 3 \\ 1 & 4 \end{pmatrix} \cdot \begin{pmatrix} 2 & 1 \\ 4 & 3 \end{pmatrix} = \begin{pmatrix} 5\cdot 2 + 9\cdot 4 & 5\cdot 1 + 9\cdot 3 \\ 2\cdot 2 + 3\cdot 4 & 2\cdot 1 + 3\cdot 3 \\ 1\cdot 2 + 4\cdot 4 & 1\cdot 1 + 4\cdot 3 \end{pmatrix} = \begin{pmatrix} 46 & 32 \\ 15 & 11 \\ 20 & 13 \end{pmatrix}$$



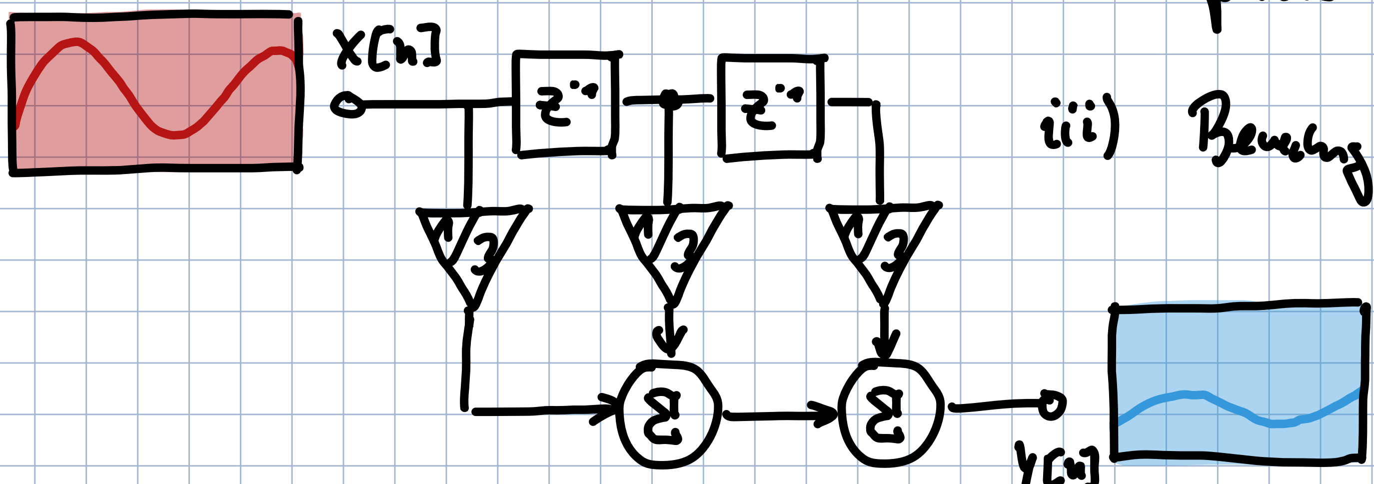
Digitale Signalverarbeitung: Gleitender Mittelwert eines Signals



i) Abtasten mit Periode T
Zeit- & Wertediskret
Analog/Digitalwandlung

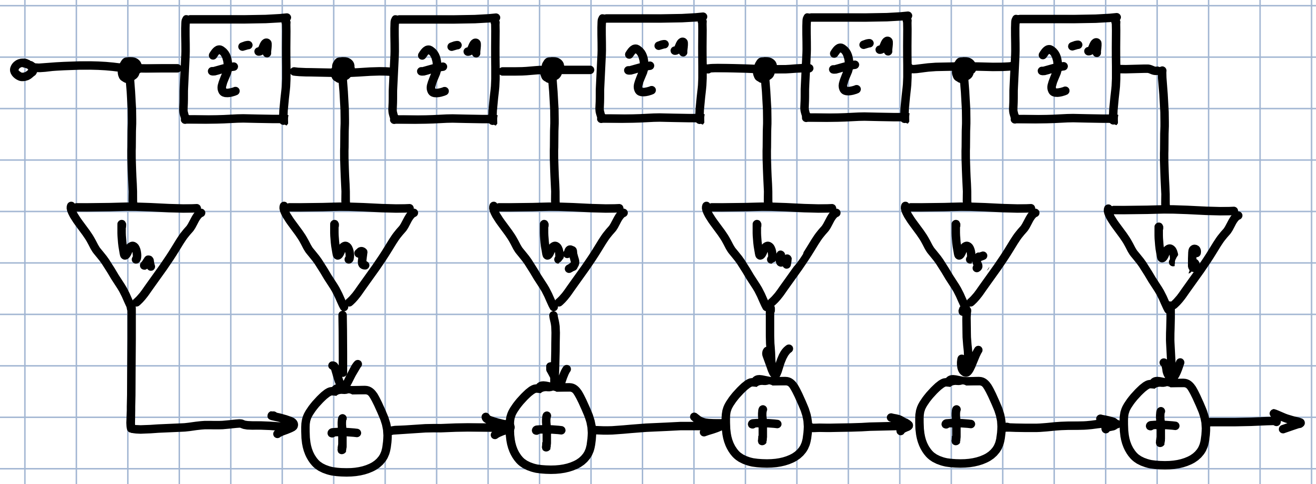
ii) Transversalfilter ohne Speicher (Stabil!)

iii) Berechnung in DSP

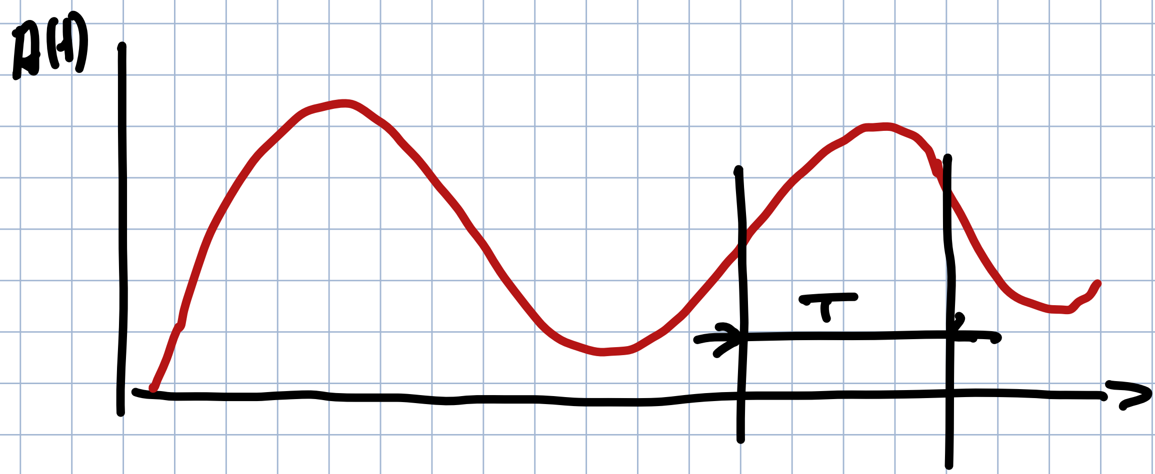


$$h(n) = \frac{1}{3}\delta(t-n) + \frac{1}{3}\delta(t-2n) + \frac{1}{3}\delta(t-3n)$$

Beispiel FIR-Filter (Filter mit endlicher Impulsantwort)
(Finite Impulse Response Filter)



$$\sum_{i=0}^{N} h_i z_i^{-1}$$

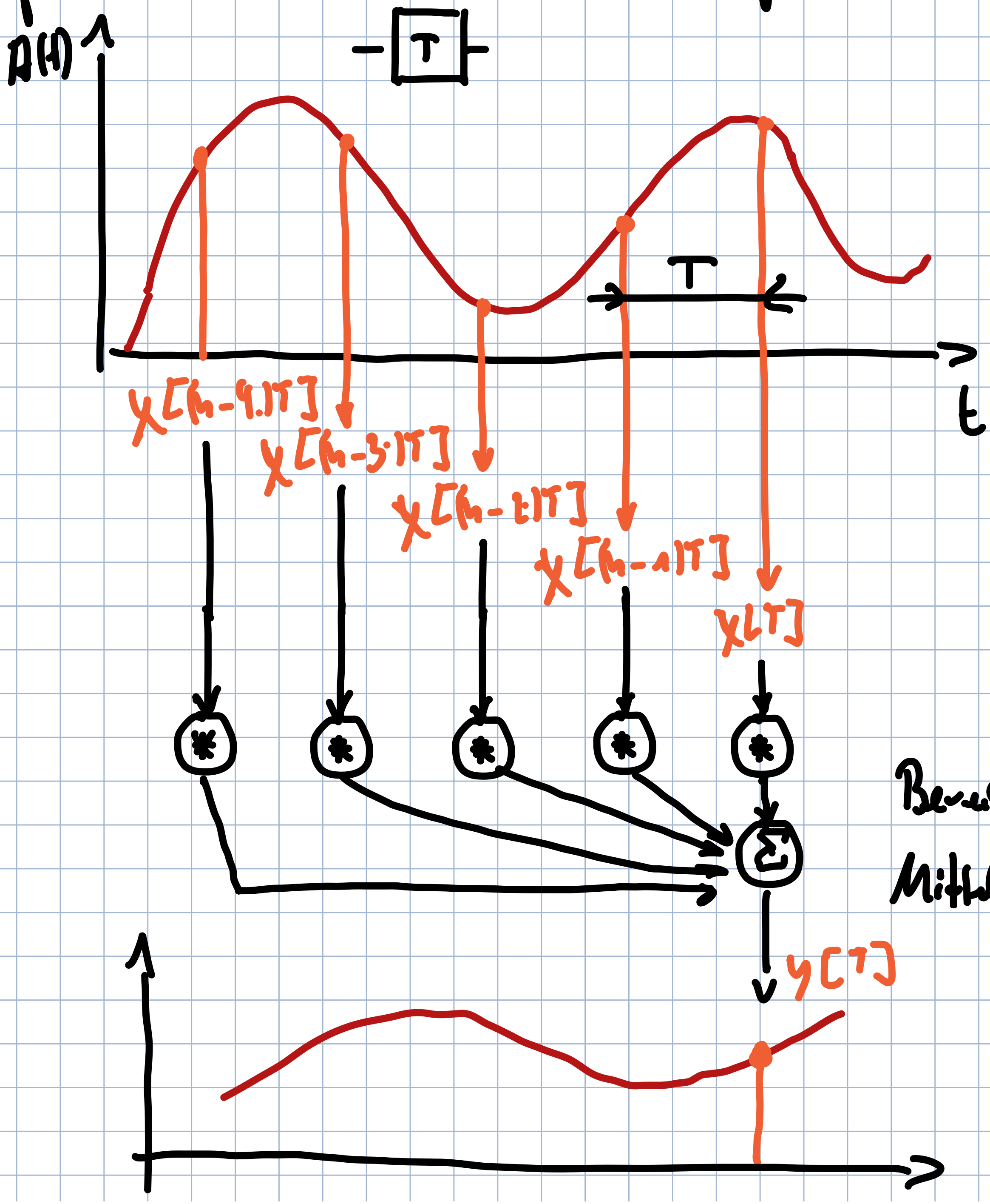


Filtern von Signalen

Abtasten des Signals mit einer Abtastrate $\frac{1}{T}$

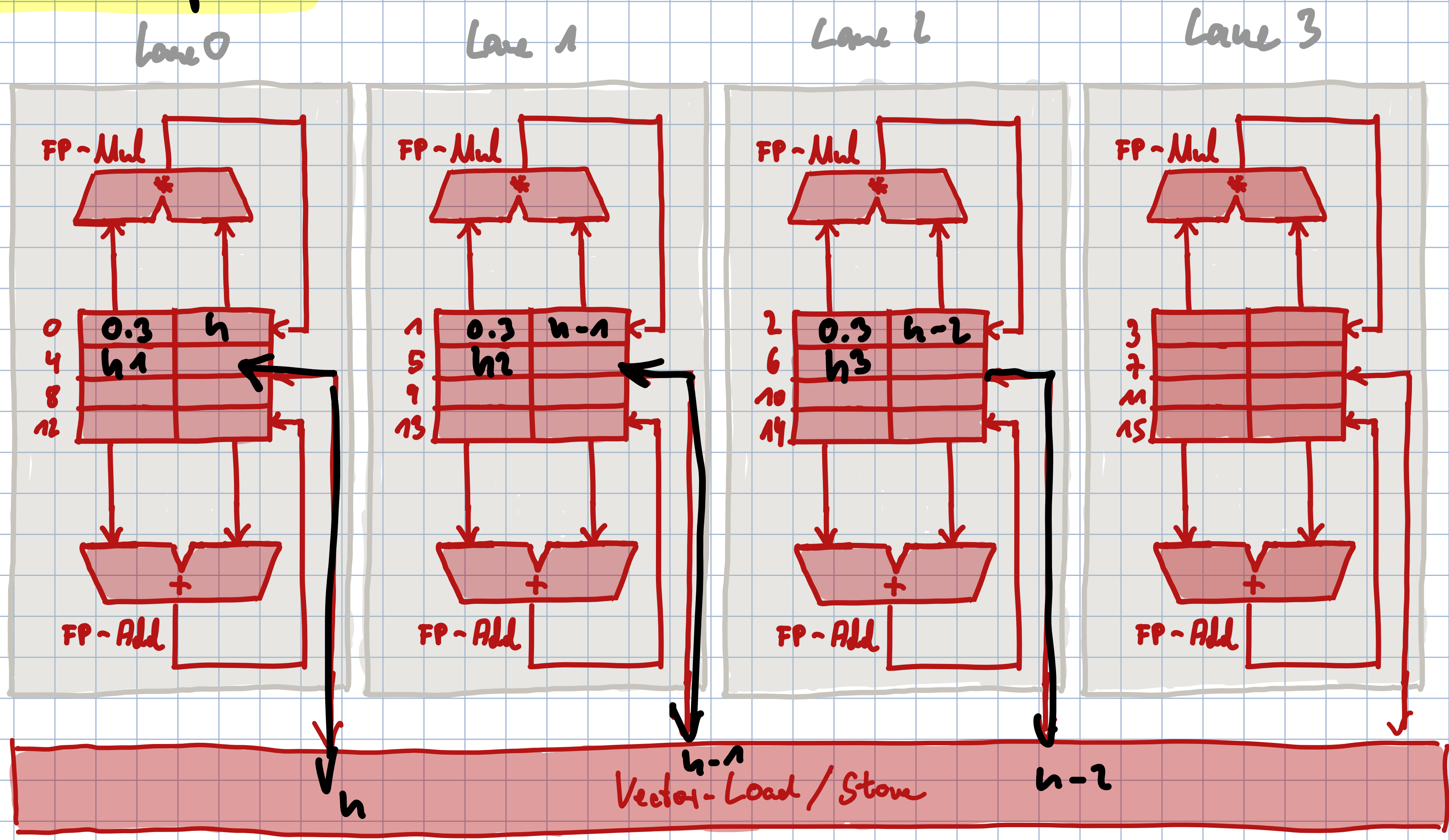
Beispiel FIR-Filter : Transversalfilter

Bsp. Mittelwertglättung



Berechnung eines gleitenden Mittels

Transversalfilter



Crossbar würde Ausführung weiter beschleunigen

Digital Signal Processor : Analog Devices Shark Architecture

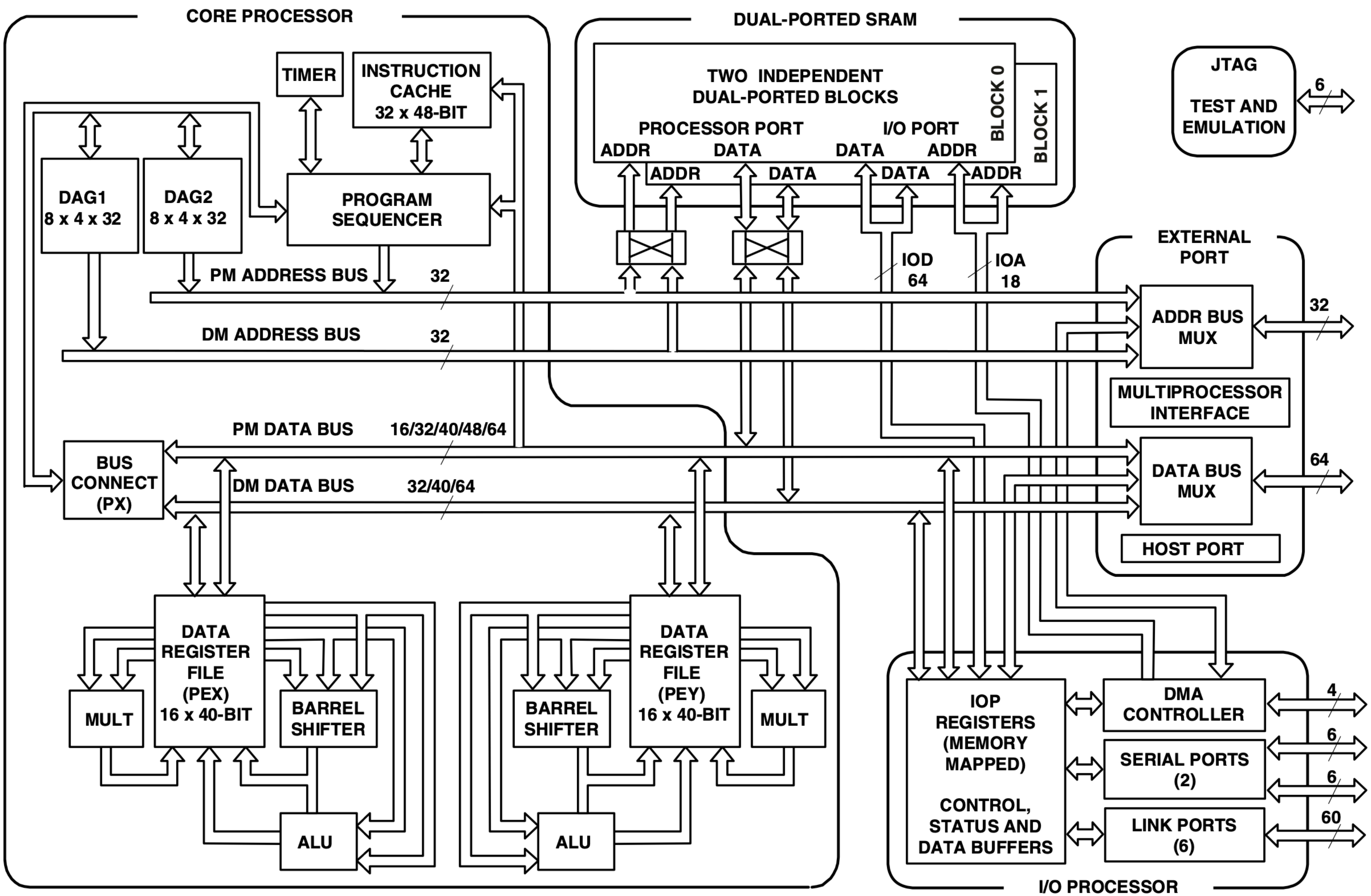
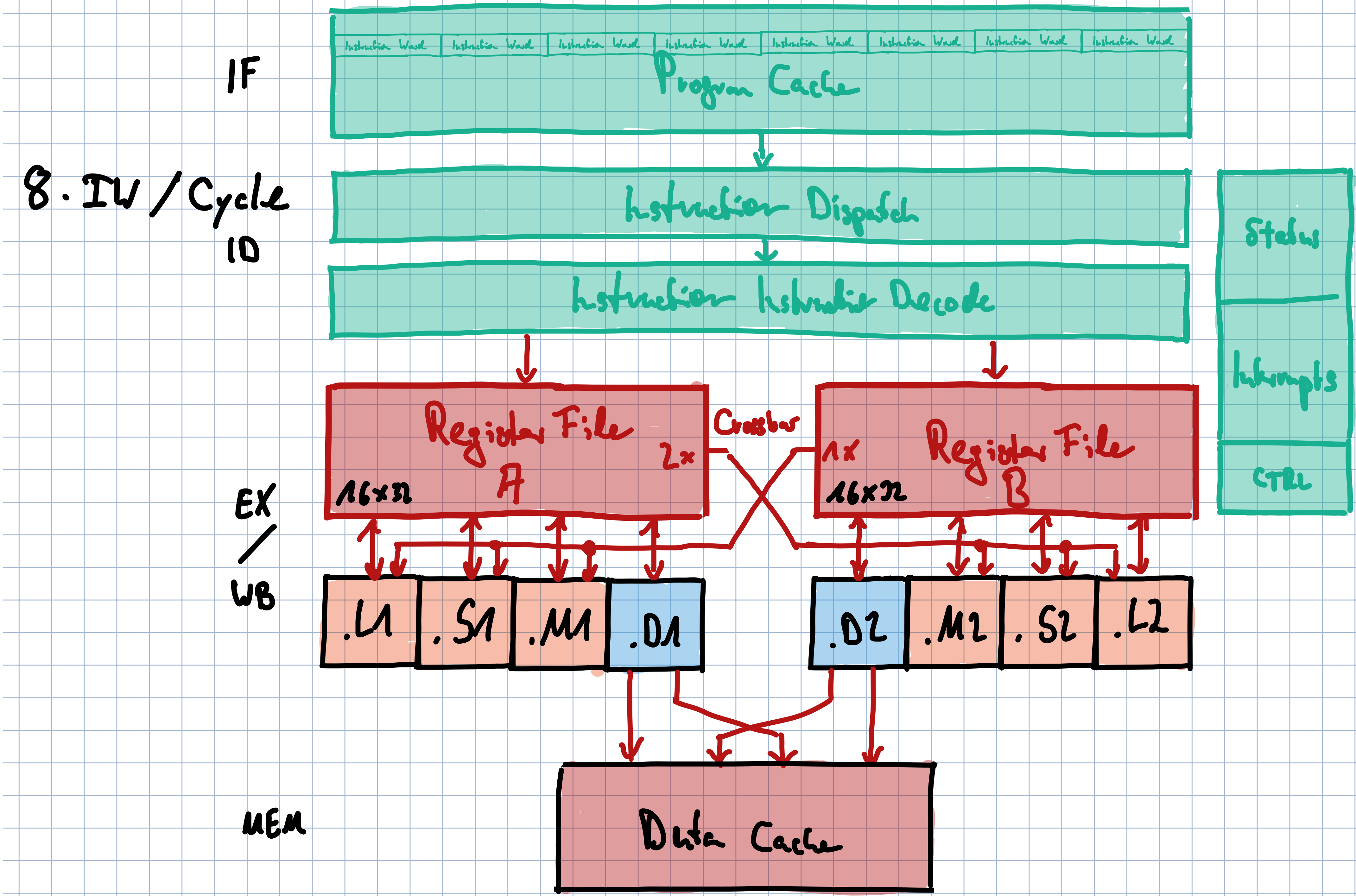


Figure 1. Functional Block Diagram

Texas Instruments DSP TMS 320C67X



Texas Instruments DSP TMS 320C67X : Functional Units

.L = Arithmetic and Logic - Operations

.S = Shift & Square root Operations

Register - Transfers

Single - Precision ⟺ Double Precision

.M = Fixpoint & Floating Point Multiply Unit

.D = Address Calculation & LOAD / STORE

Texas Instruments DSP TMS 320C67X

Befehlsbeispiele:

ADDDP	(unit)	s, t, d	Add Two Double Precision Floating Point Values
			.S1 .S2 .L1 .L2
B	(unit)	label	Branch Using a Displacement
			.S1 .S2
CMPGT	(unit)	s, t, d	Compare Greater Than, Signed Integer
			.L1 .L2