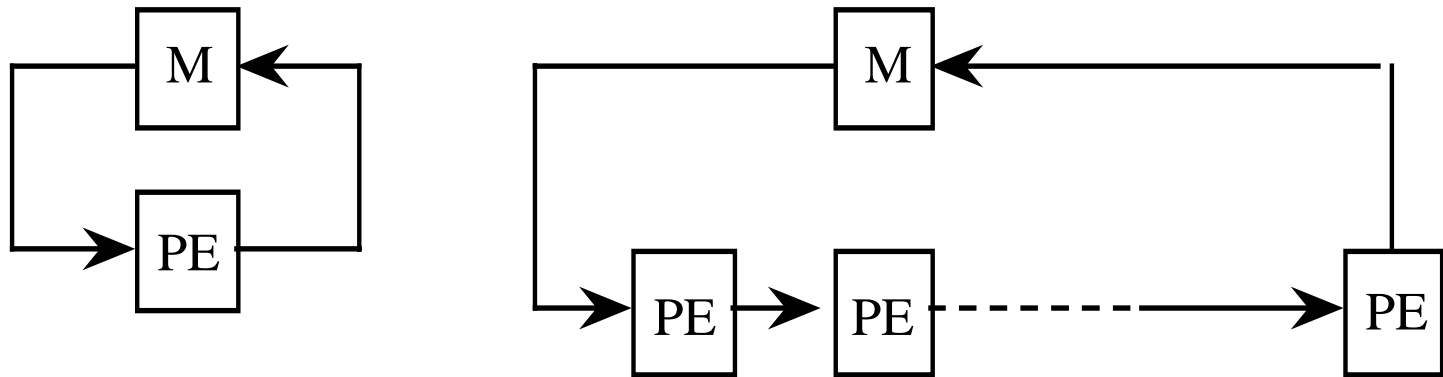


Systolic Architectures

- **Replace single processor with an array of regular processing elements**
- **Orchestrate data flow for high throughput with less memory access**

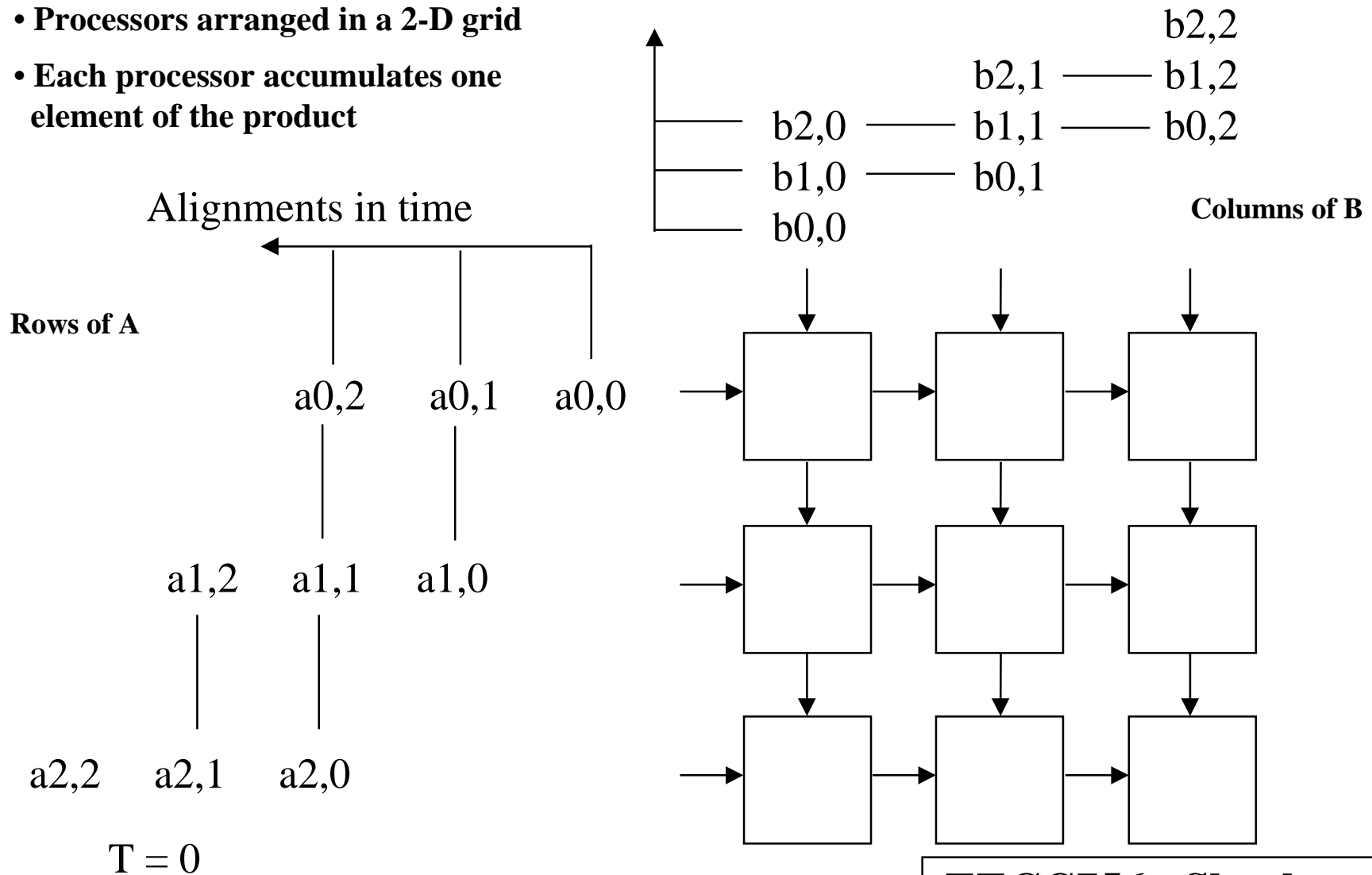


- **Different from pipelining**
 - **Nonlinear array structure, multidirection data flow, each PE may have (small) local instruction and data memory**
- **Different from SIMD: each PE may do something different**
- **Initial motivation: VLSI enables inexpensive special-purpose chips**
- **Represent algorithms directly by chips connected in regular pattern**

Systolic Array Example:

3x3 Systolic Array Matrix Multiplication

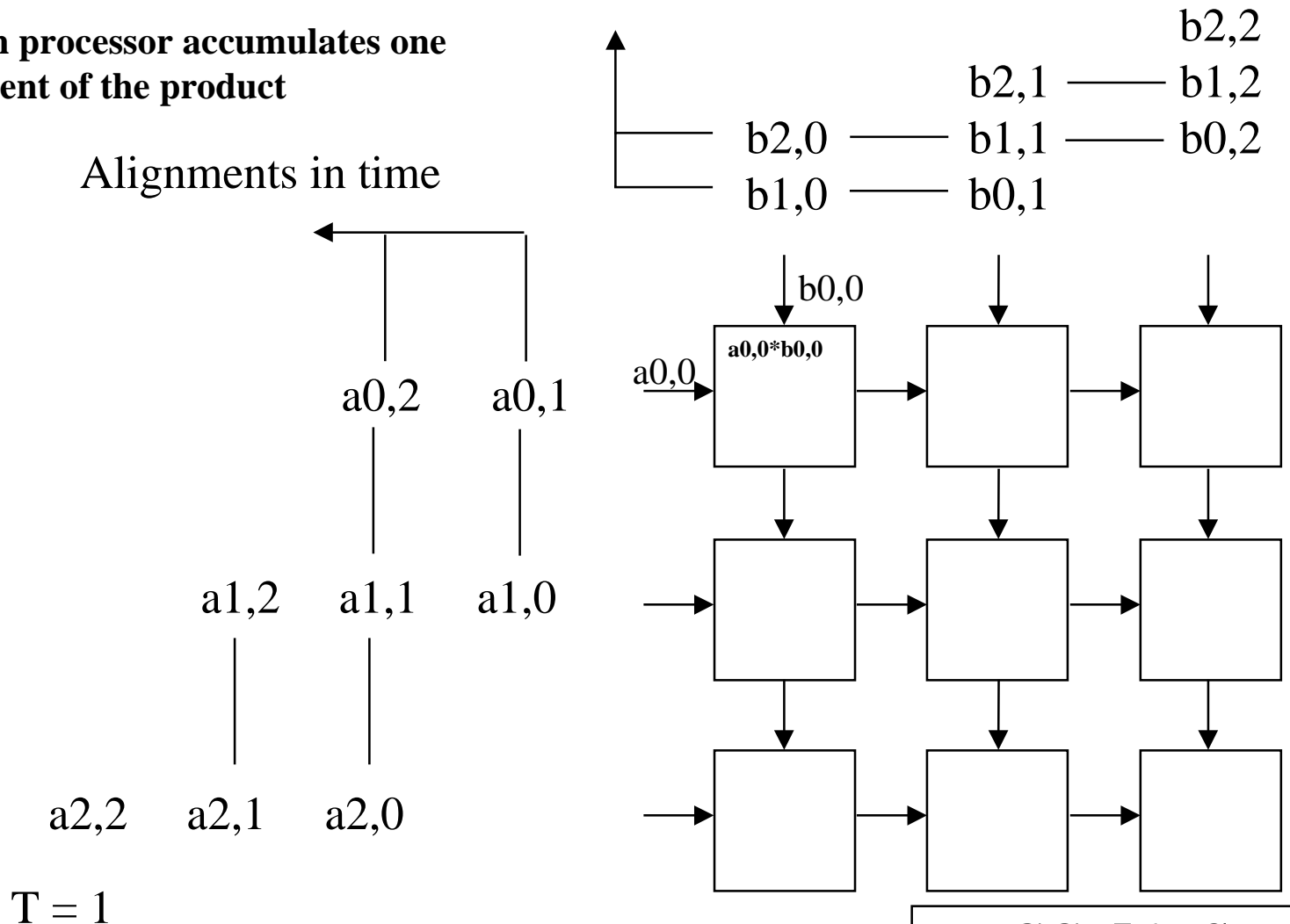
- Processors arranged in a 2-D grid
- Each processor accumulates one element of the product



Systolic Array Example:

3x3 Systolic Array Matrix Multiplication

- Processors arranged in a 2-D grid
- Each processor accumulates one element of the product



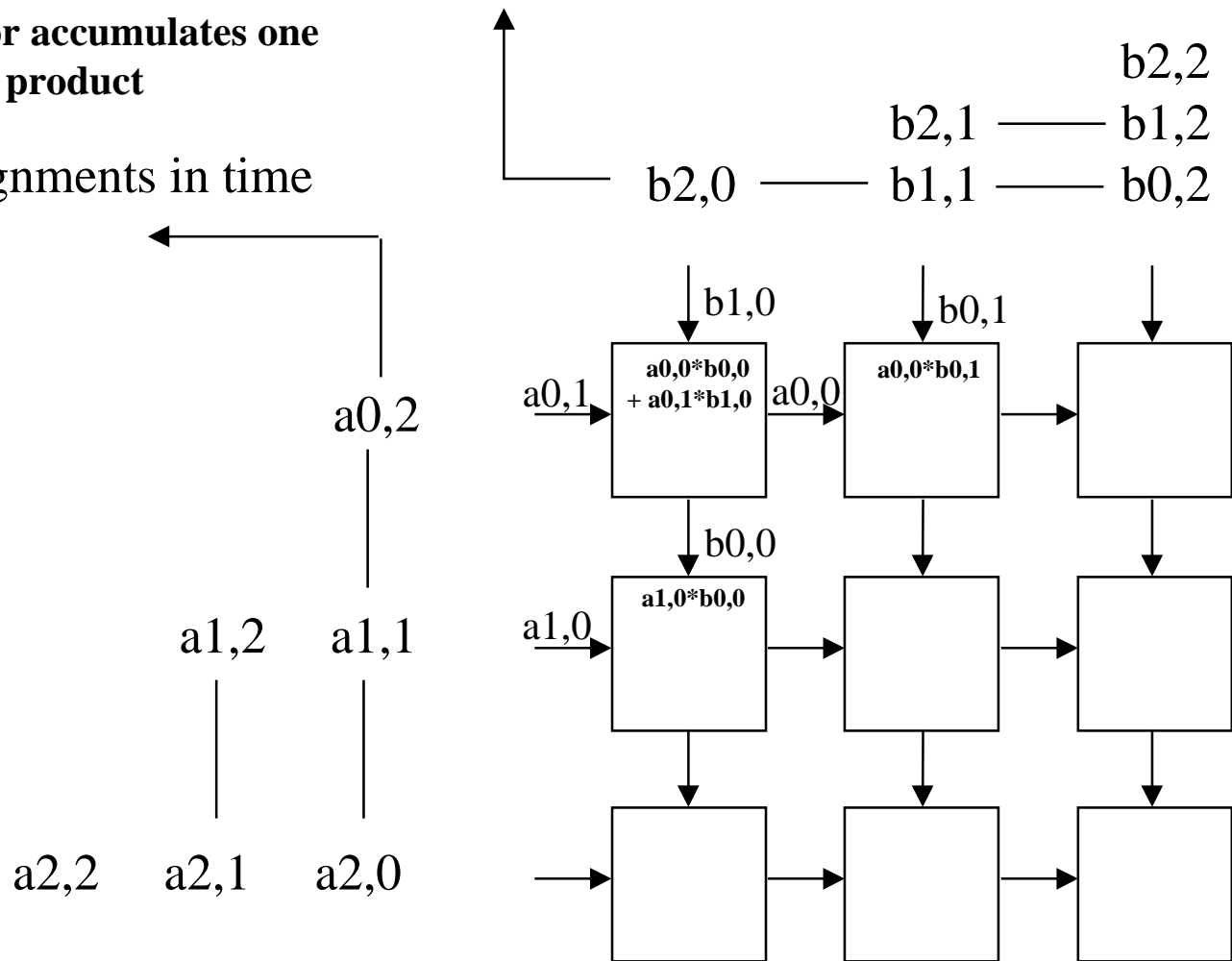
Systolic Array Example:

3x3 Systolic Array Matrix Multiplication

- Processors arranged in a 2-D grid
- Each processor accumulates one element of the product

Alignments in time

$T = 2$

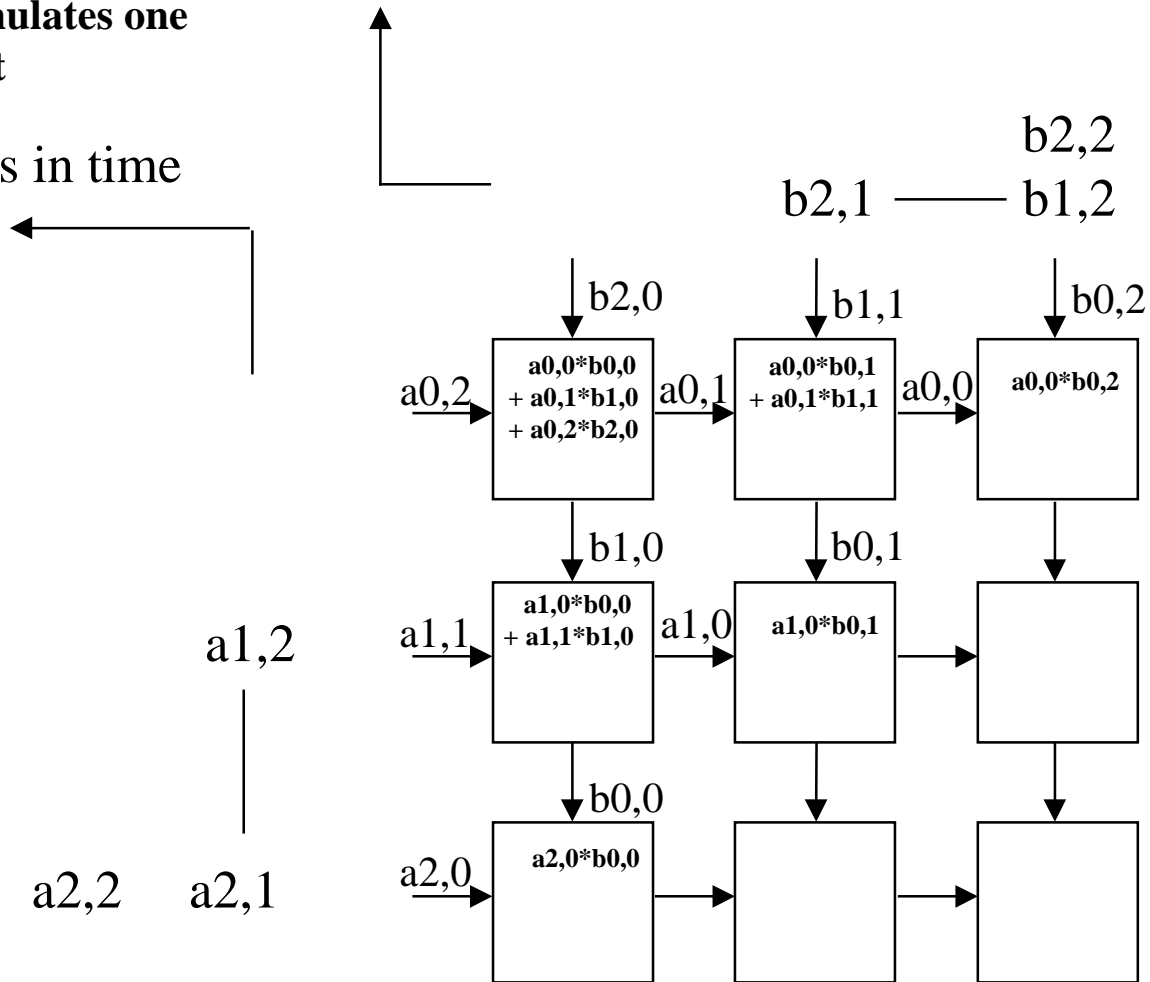


Systolic Array Example:

3x3 Systolic Array Matrix Multiplication

- Processors arranged in a 2-D grid
- Each processor accumulates one element of the product

Alignments in time



T = 3

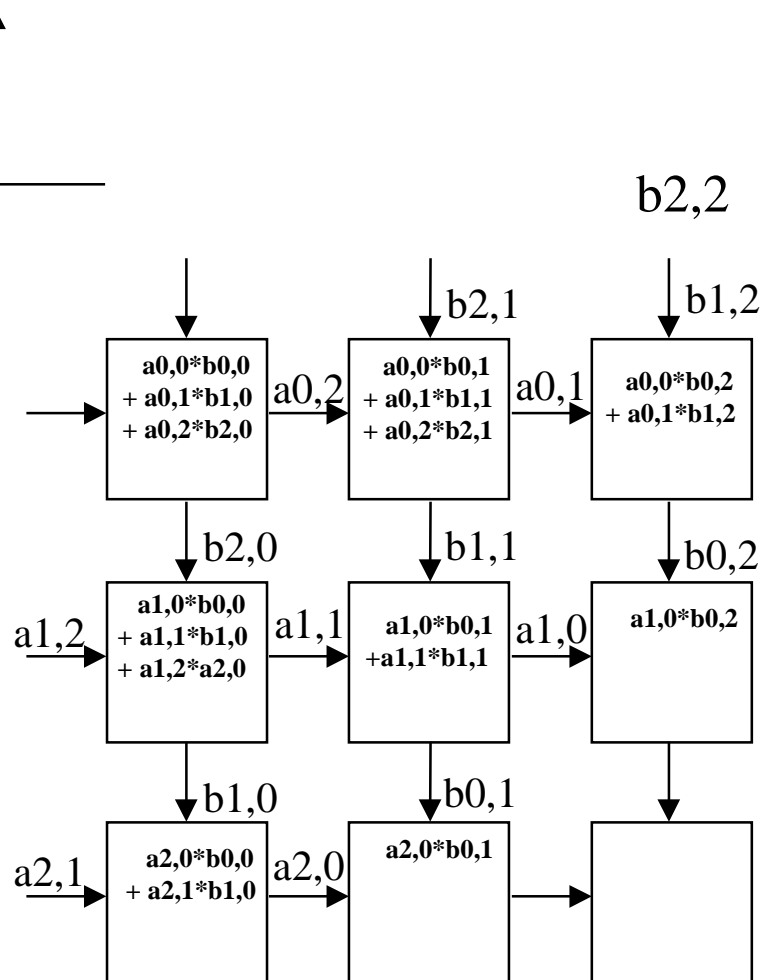
EECC756 - Shaaban

Systolic Array Example:

3x3 Systolic Array Matrix Multiplication

- Processors arranged in a 2-D grid
- Each processor accumulates one element of the product

Alignments in time



$T = 4$

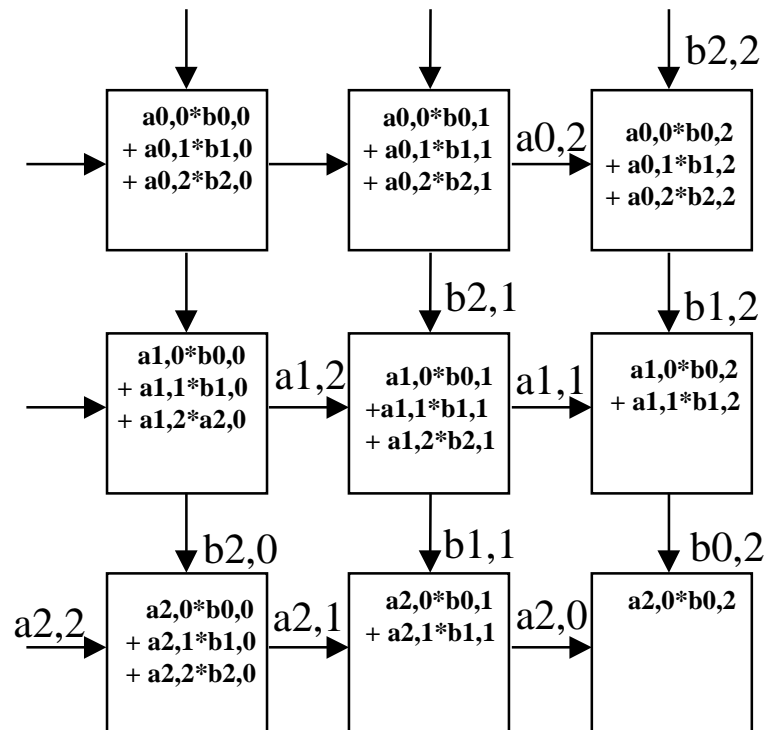
EECC756 - Shaaban

Systolic Array Example:

3x3 Systolic Array Matrix Multiplication

- Processors arranged in a 2-D grid
- Each processor accumulates one element of the product

Alignments in time



$T = 5$

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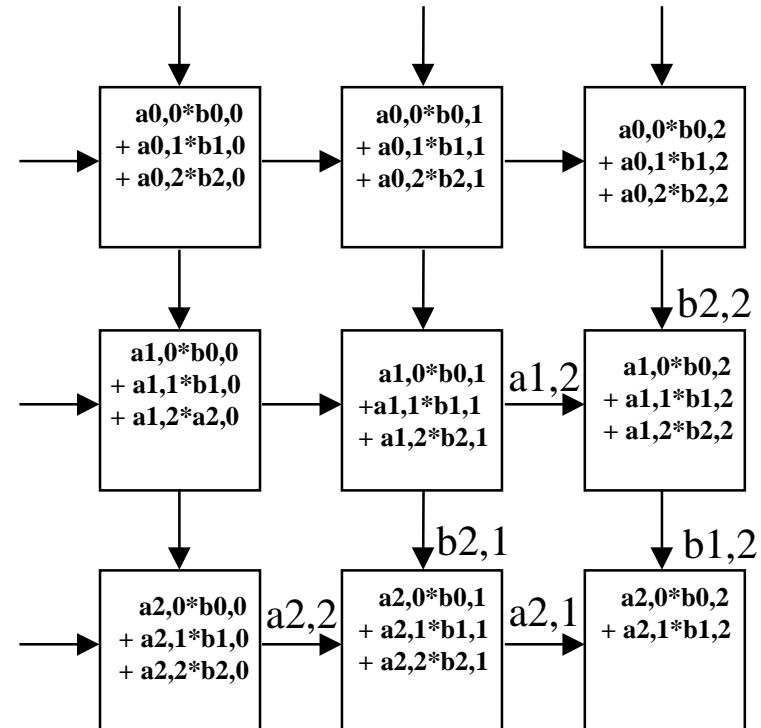
Example source: <http://www.cs.hmc.edu/courses/2001/spring/cs156/>

Systolic Array Example:

3x3 Systolic Array Matrix Multiplication

- Processors arranged in a 2-D grid
- Each processor accumulates one element of the product

Alignments in time



$T = 6$

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Example source: <http://www.cs.hmc.edu/courses/2001/spring/cs156/>

Systolic Array Example:

3x3 Systolic Array Matrix Multiplication

- Processors arranged in a 2-D grid
- Each processor accumulates one element of the product

Alignments in time

Done

$T = 7$

