Dataflow Model of Computation

(From Dataflow to Multithreading)

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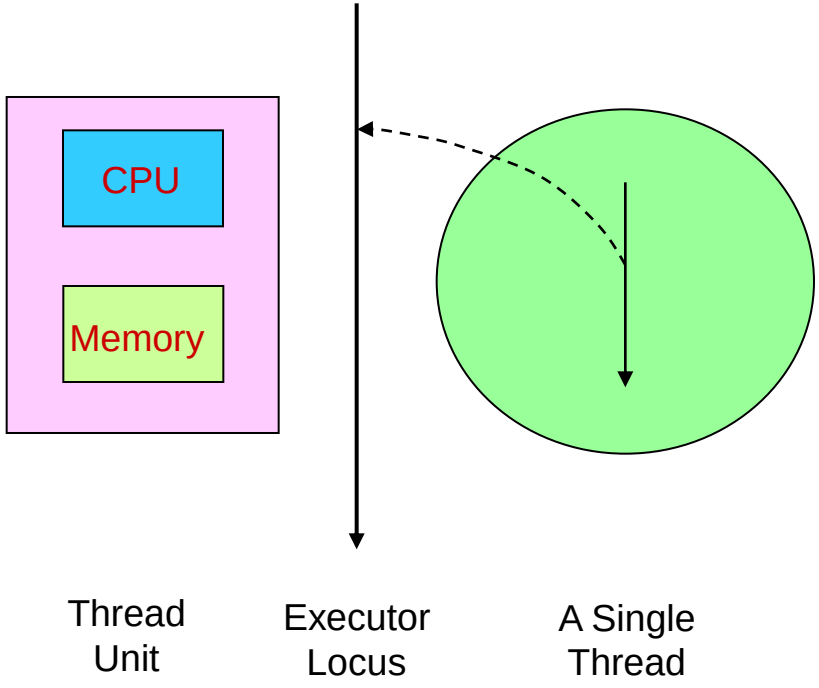
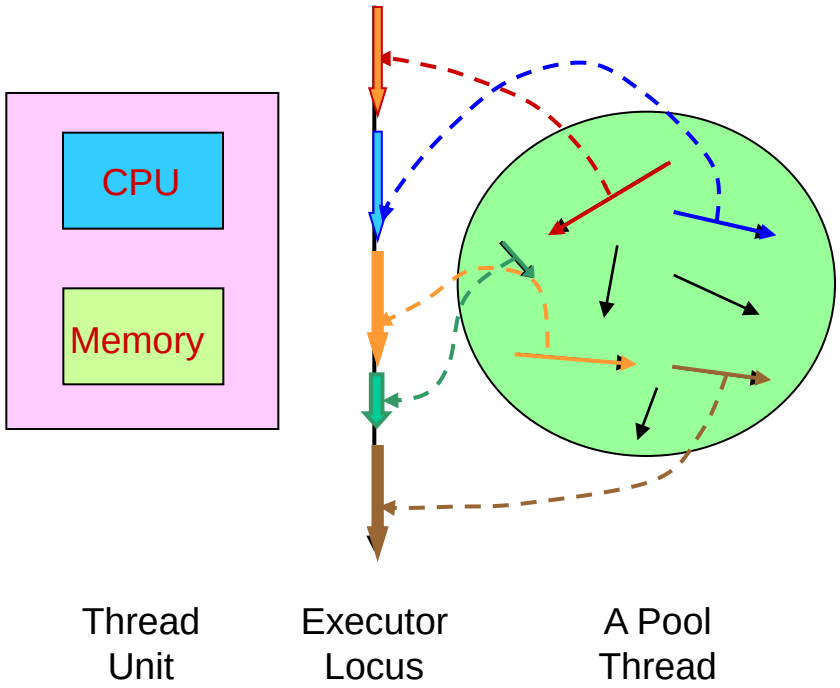


Coarse-Grain thread-
The family home model

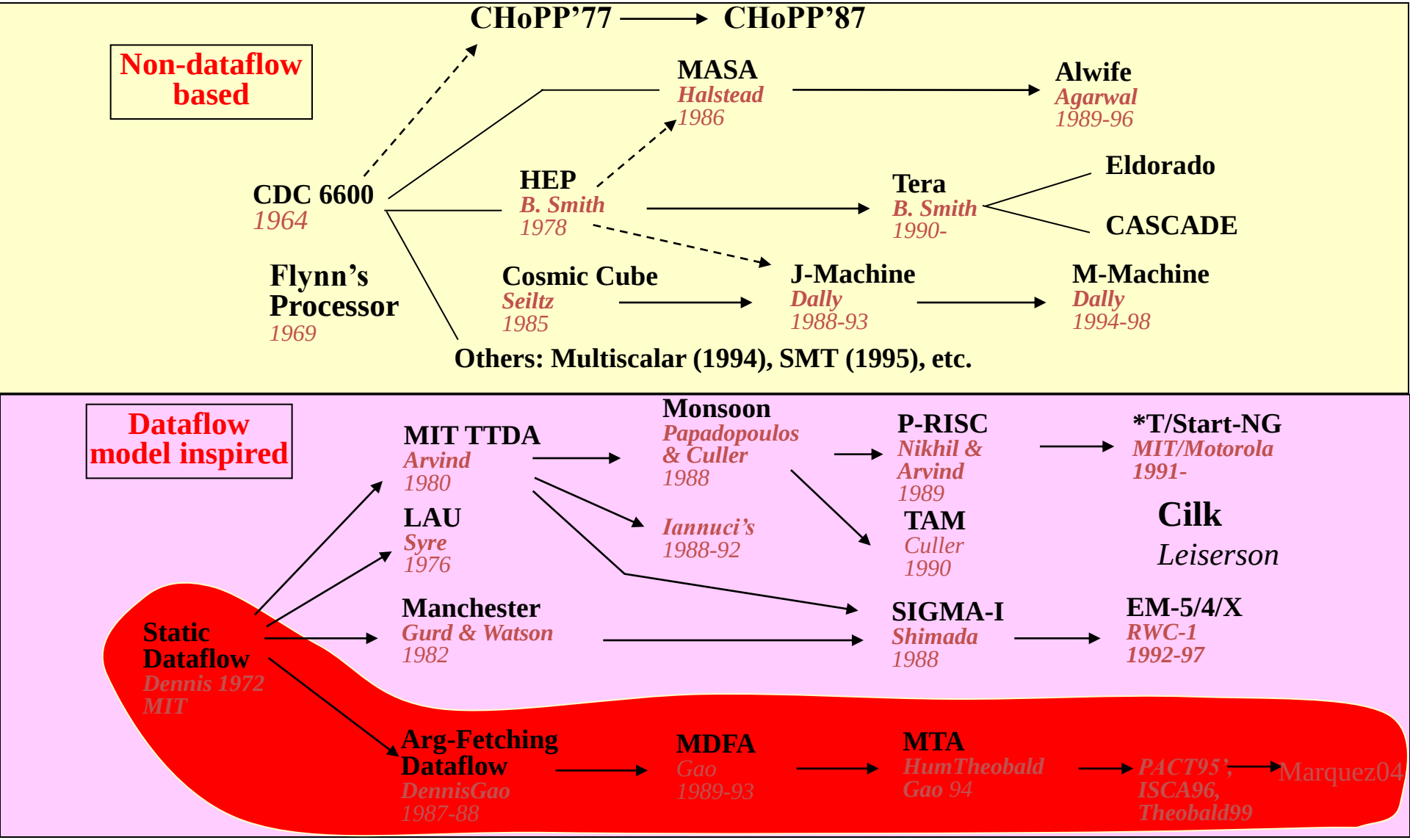


Fine-Grain *non-preemptive* thread-
The "hotel" model

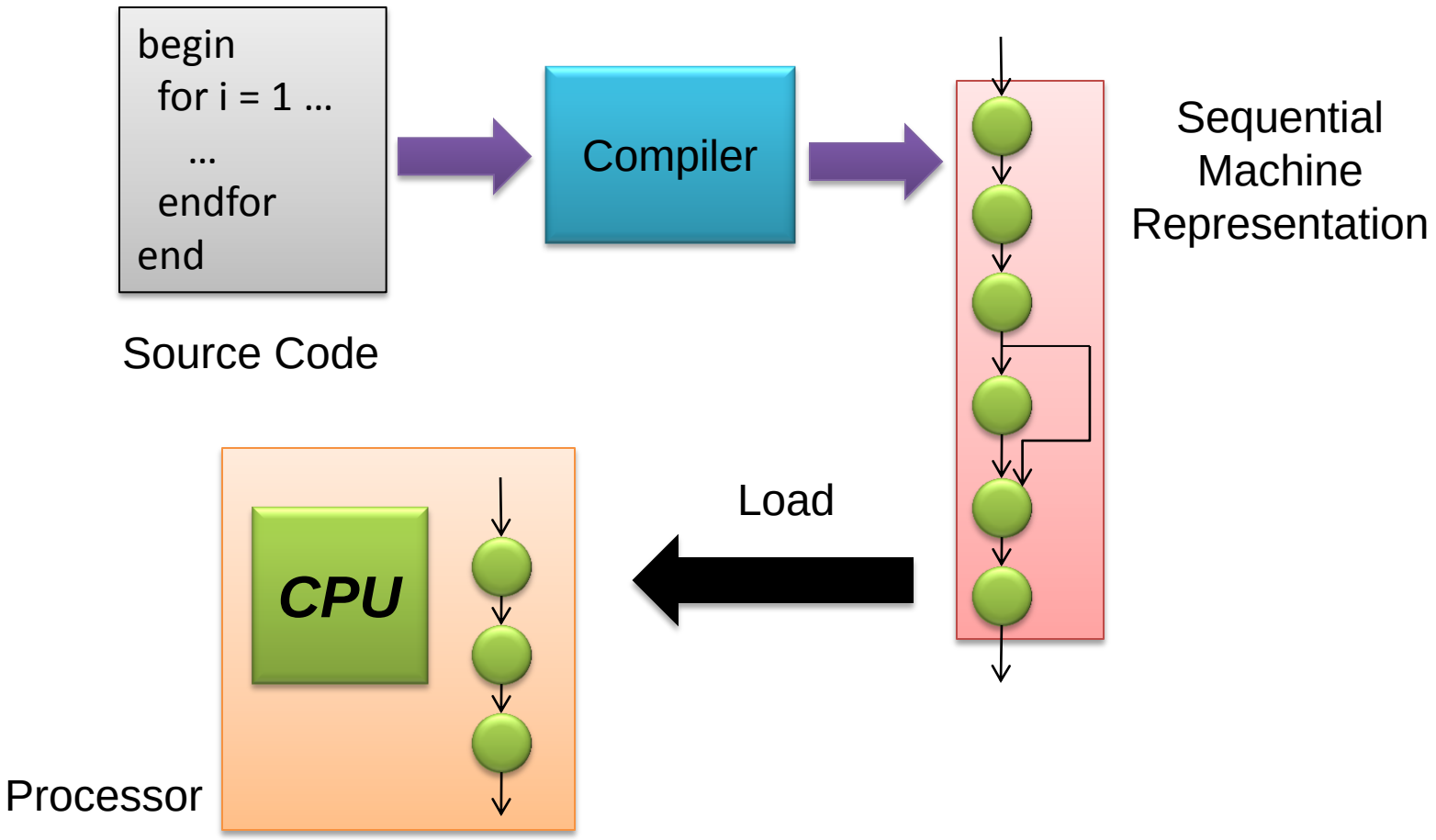
Coarse-Grain vs. Fine-Grain Multithreading

[Gao: invited talk at Fran Allen's Retirement Workshop, 07/2002]

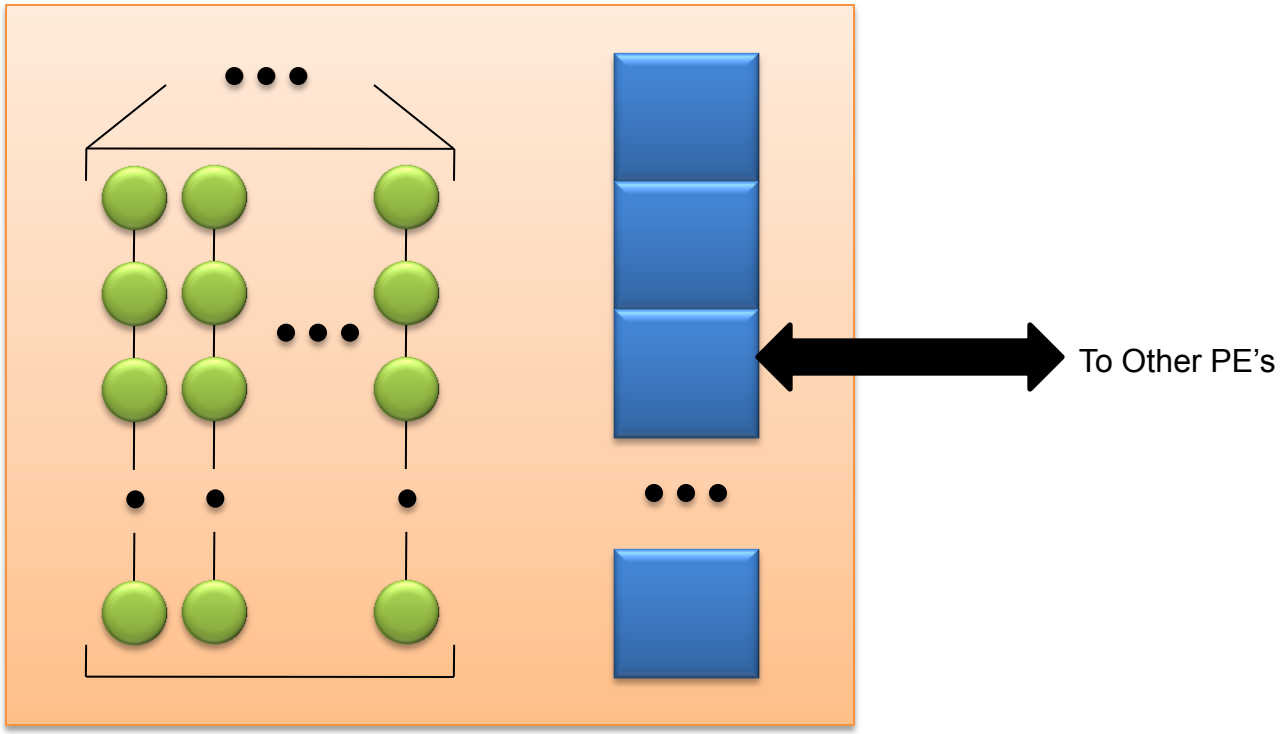
Evolution of Multithreaded Execution and Architecture Models



The Von Neumann-type Processing

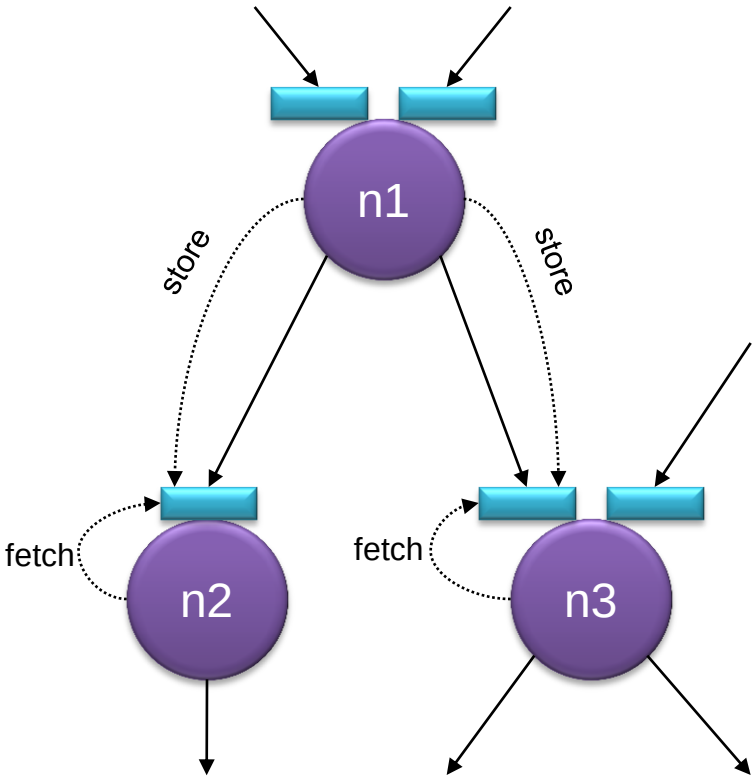


A Multithreaded Architecture

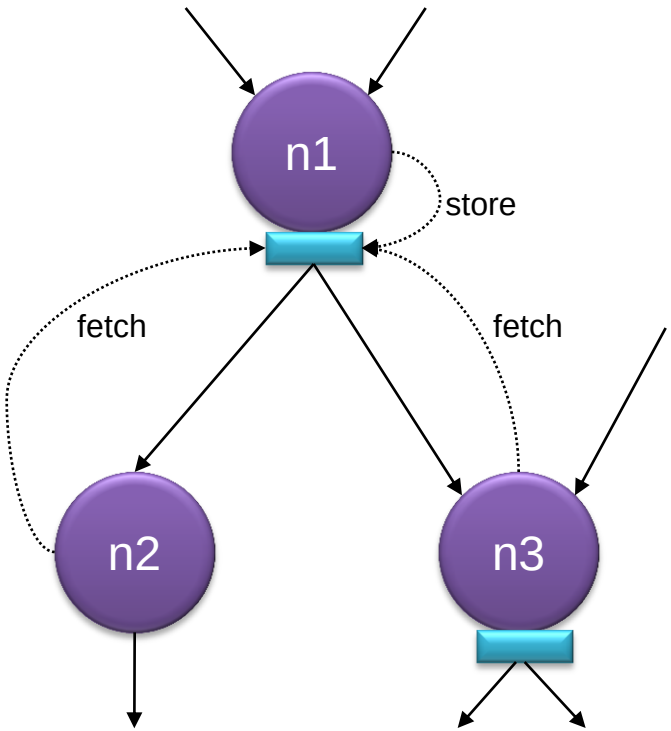


One PE

McGill Data Flow Architecture Model (MDFA)



Argument –flow Principle



Argument –fetching Principle

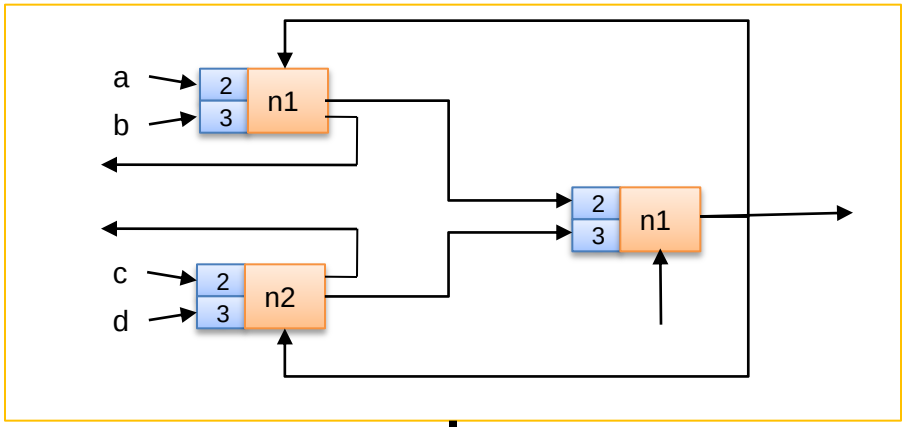
A Dataflow Program Tuple

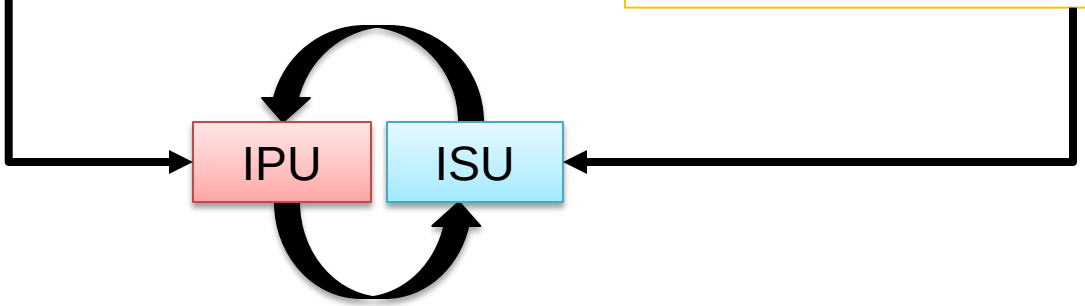
Program Tuple = { P-Code . S-Code }

P-Code

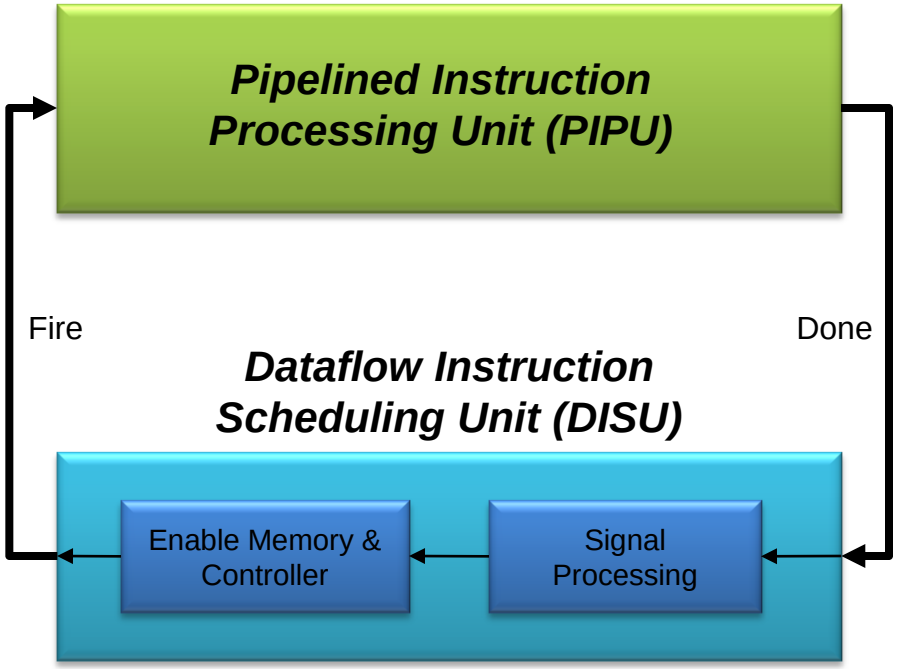
N1: x = a + b;
N2: y = c – d;
N3: z = x * y;

S-Code





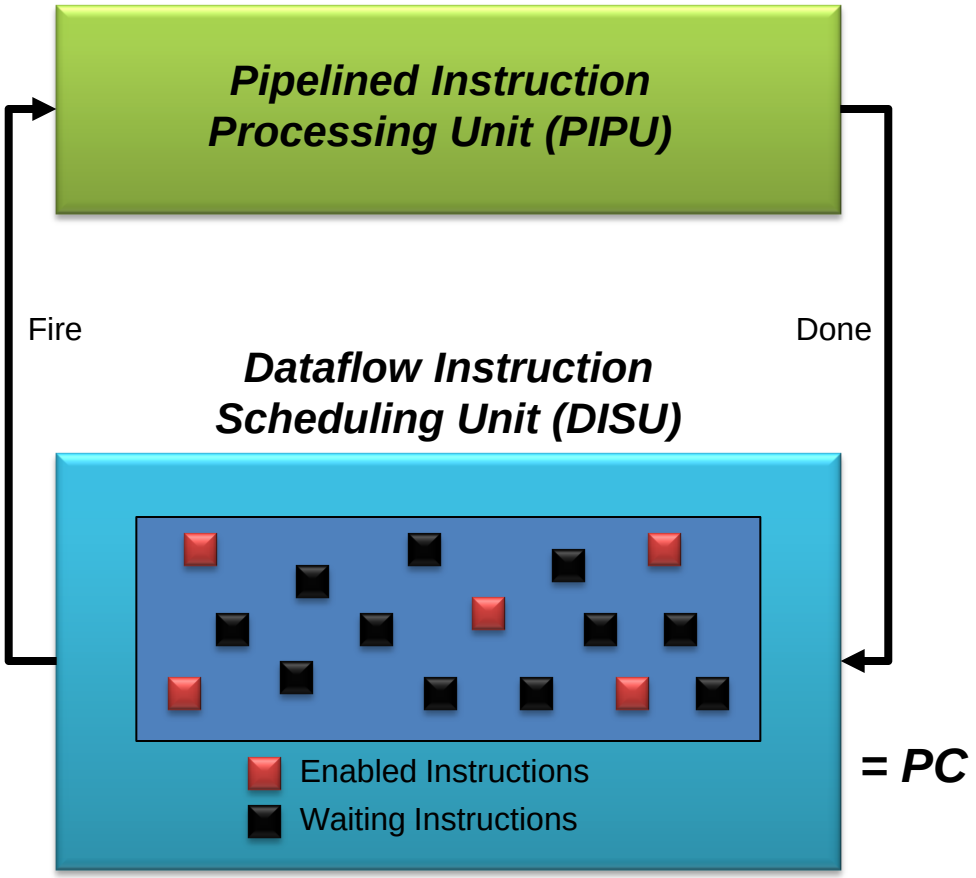
The McGill Dataflow Architecture Model



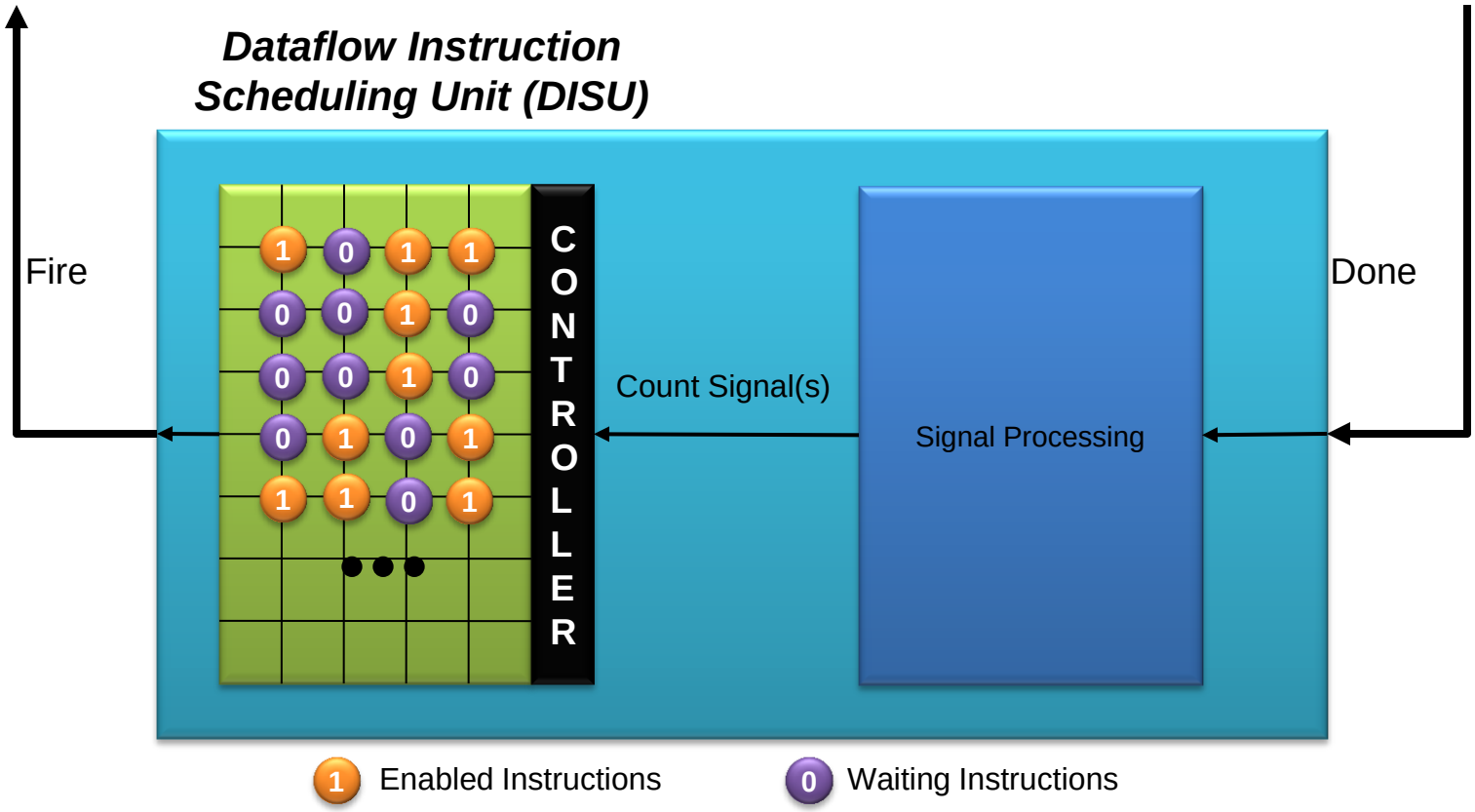
The McGill Dataflow Architecture Model

Important Features

Pipeline can be kept fully utilized provided that the program has sufficient parallelism



The Scheduling Memory (Enable)



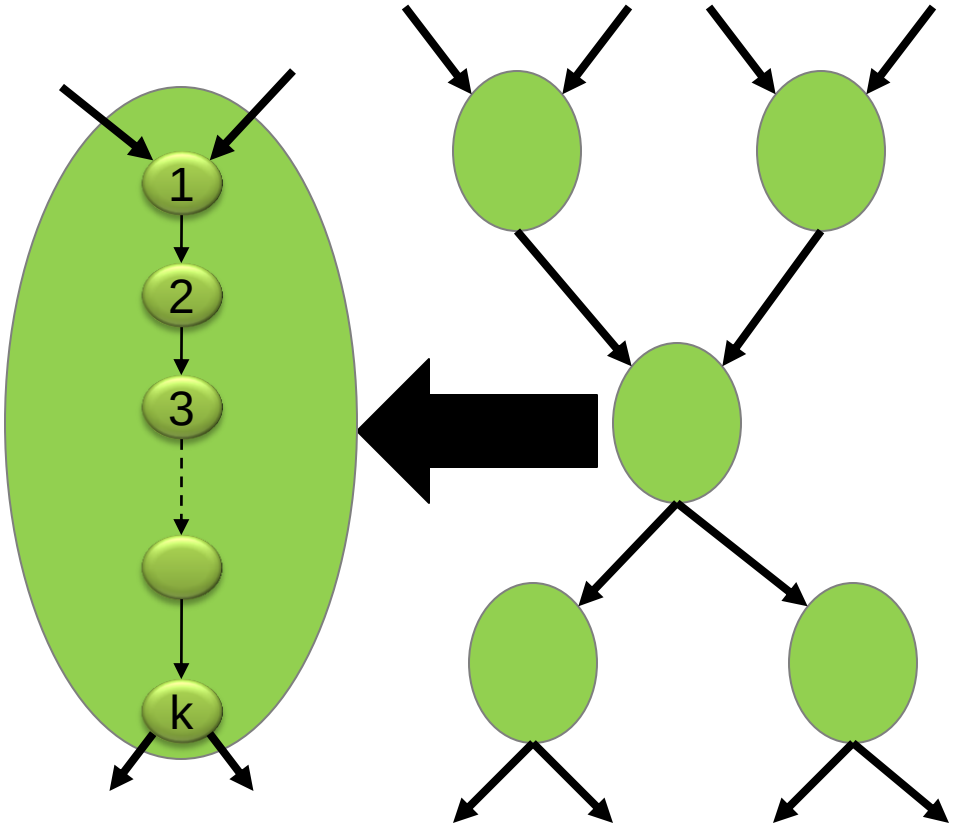
Advantages of the McGill Dataflow Architecture Model

- Eliminate unnecessary token copying and transmission overhead
- Instruction scheduling is separated from the main datapath of the processor (e.g. *asynchronous, decoupled)*

Von Neumann Threads as Macro Dataflow Nodes

A sequence of instructions is “packed” into a **macro-dataflow node**

Synchronization is done at the macro-node level



Hybrid Evaluation Von Neumann Style Instruction Execution" on the McGill Dataflow Architecture

- Group a "sequence" of dataflow instruction into a "thread" or a macro dataflow node.
- Data-driven synchronization among threads.
- "Von Neumann style sequencing" within a thread.

Advantage:

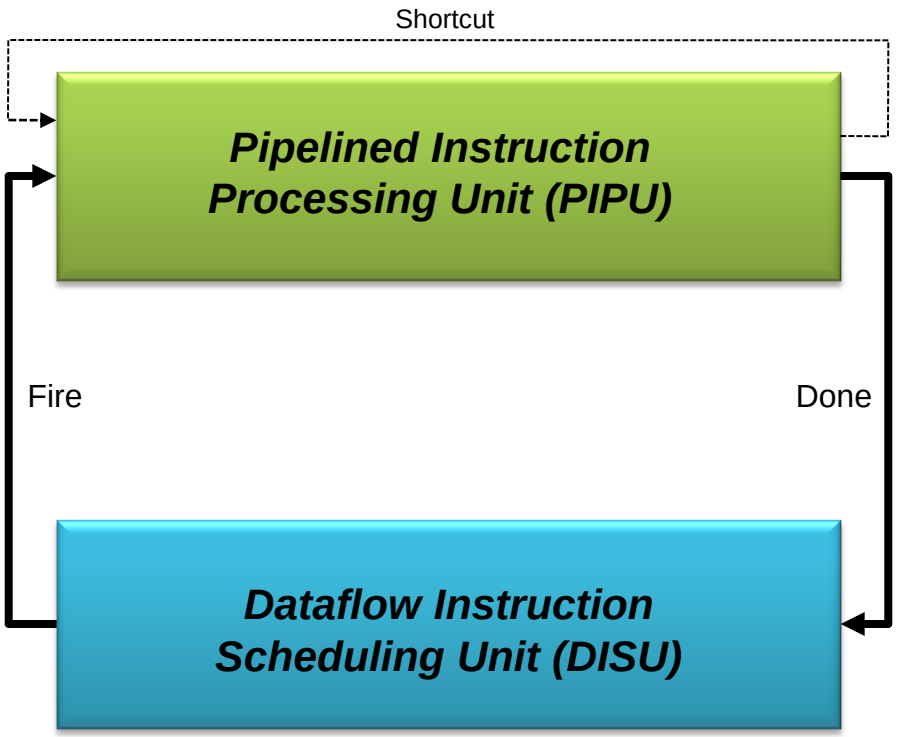
Preserves the parallelism among threads but avoids unnecessary fine-grain synchronization between instructions within a sequential thread.

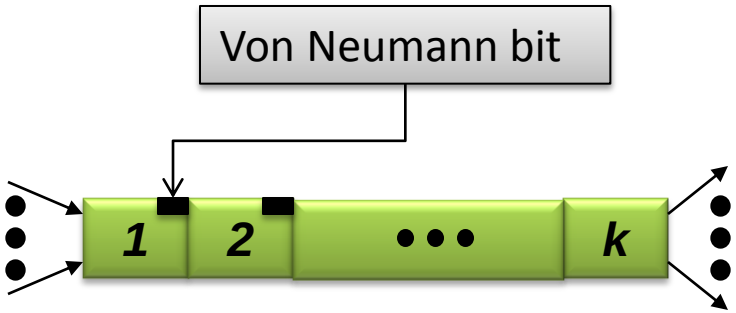
What Do We Get?

- A hybrid architecture model without sacrificing the advantage of fine-grain parallelism!

  (latency-hiding, pipelining support)

A Realization of the Hybrid Evaluation





Case Studies – Dataflow Model Insired Multithreading

- McGill Dataflow Model (1988 - 1993)
- EARTH Model (1993 – mid 2000s)
- The UHPC/Runnemede Model (2010 -)