Towards Certifiable Loop Pipelining Algorithms in Behavioral Synthesis

Disha Puri

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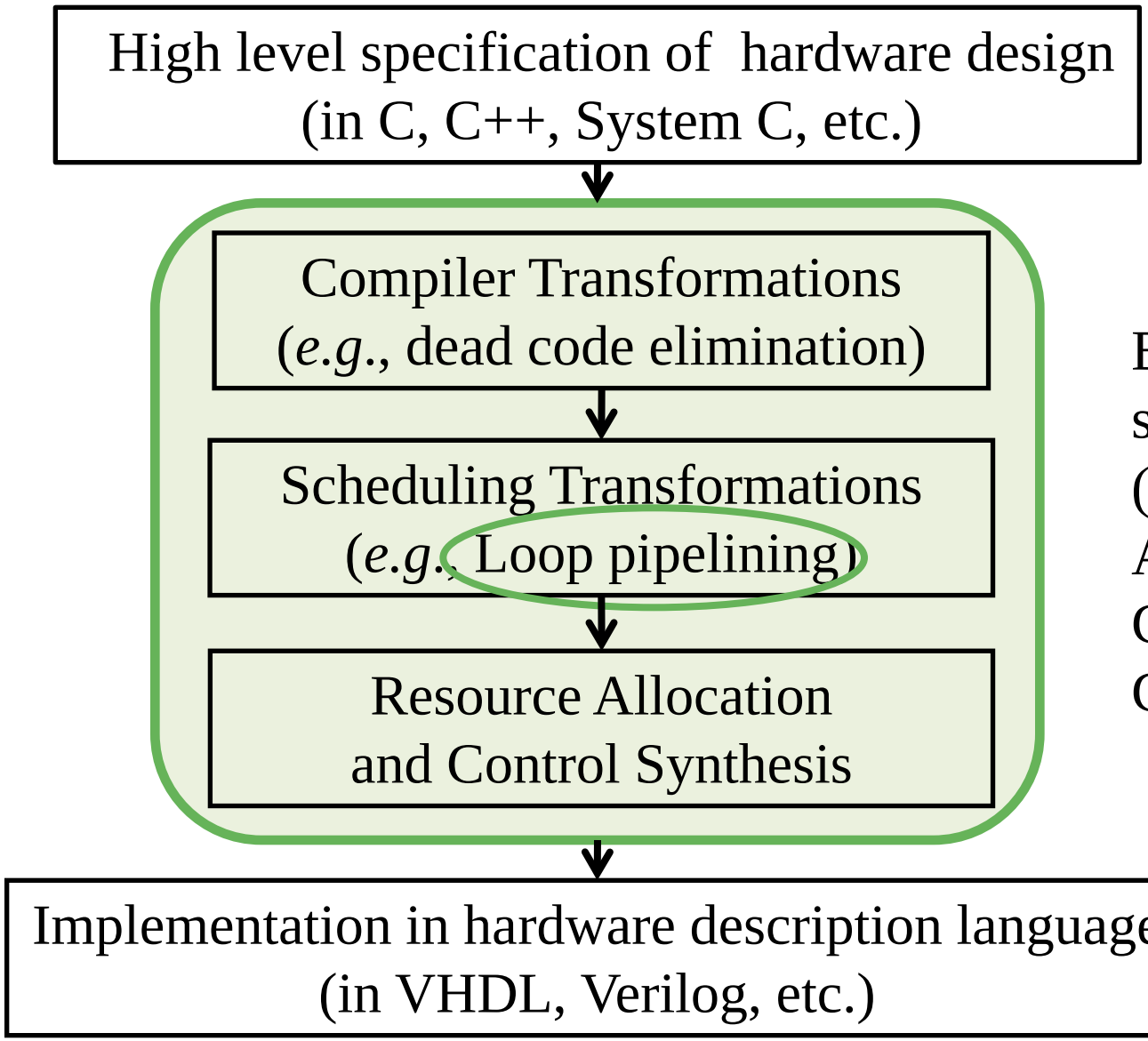
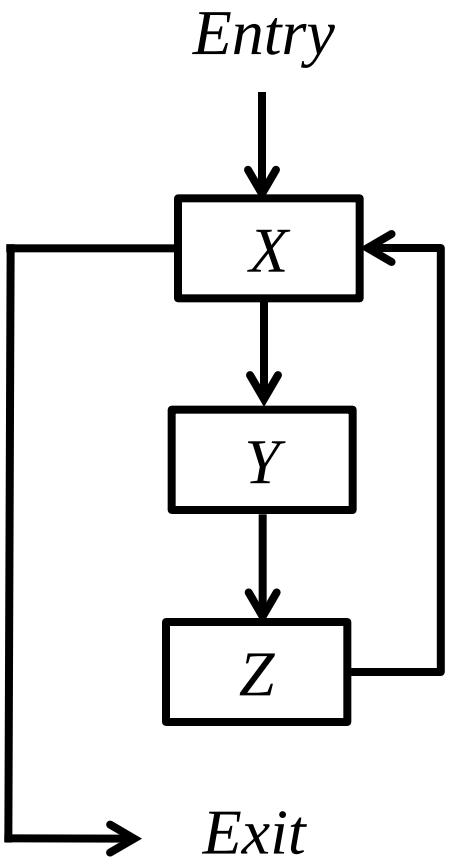
Computer Science Department
Portland State University

Behavioral Synthesis

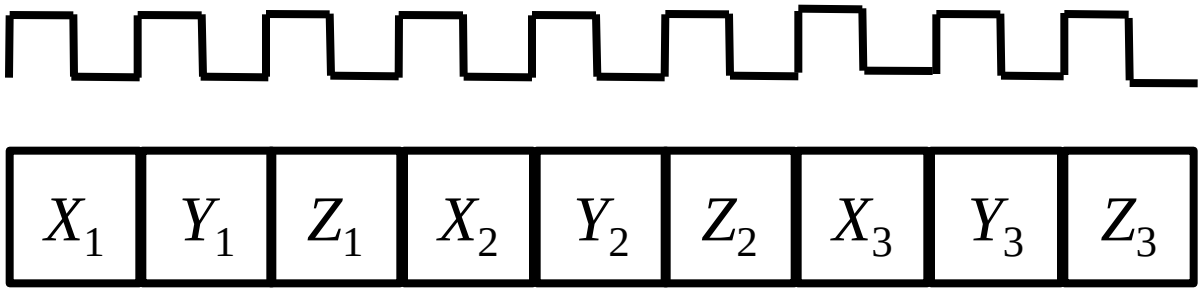


Behavioral synthesis tool (*e.g.*, AutoESL, CtoSilicon, Cynthesizer)

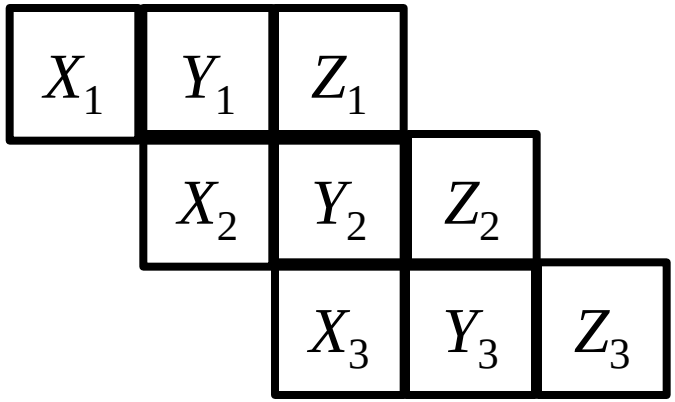
Motivation behind Loop Pipelining



Sequential Execution



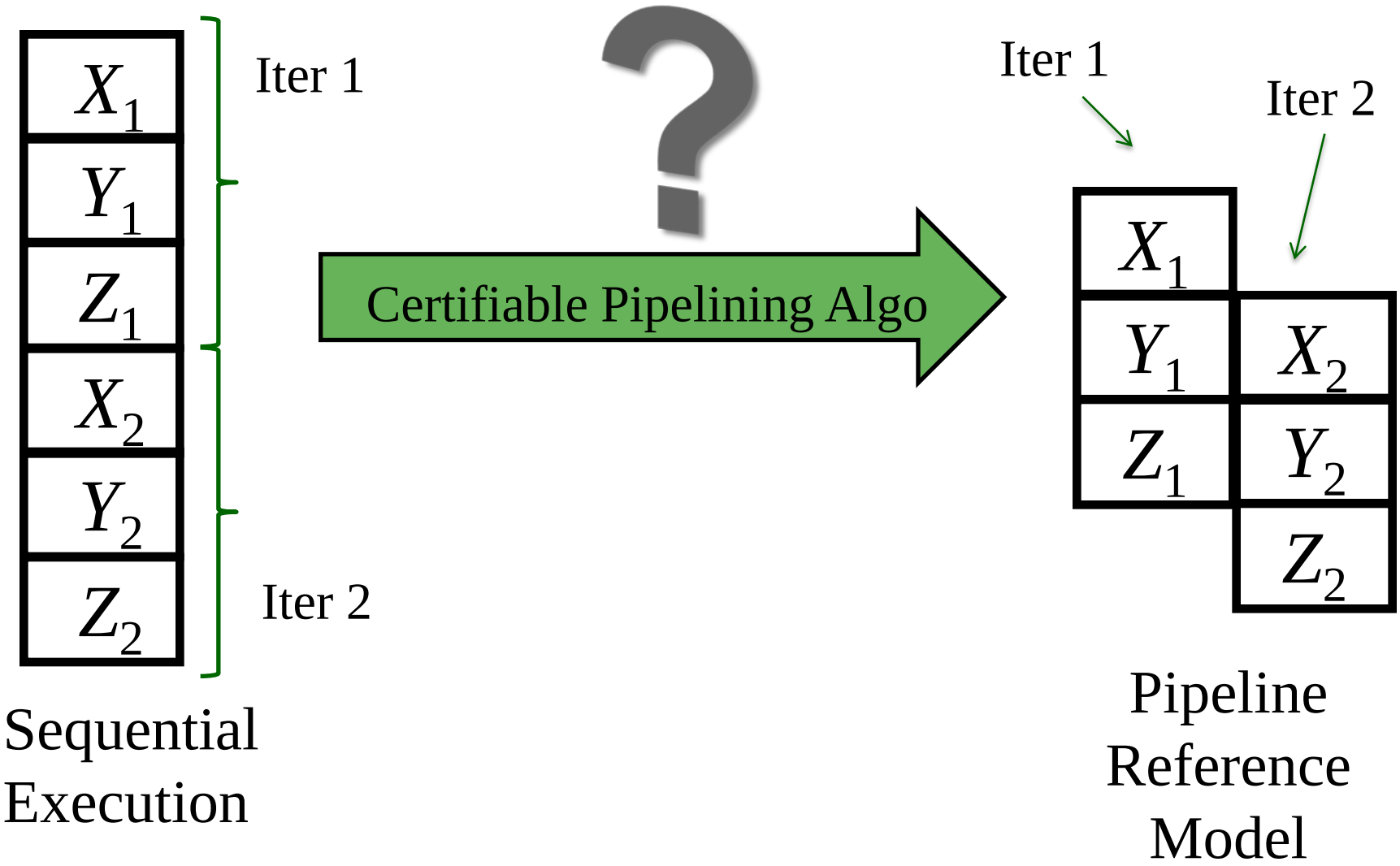
Execution order before pipelining



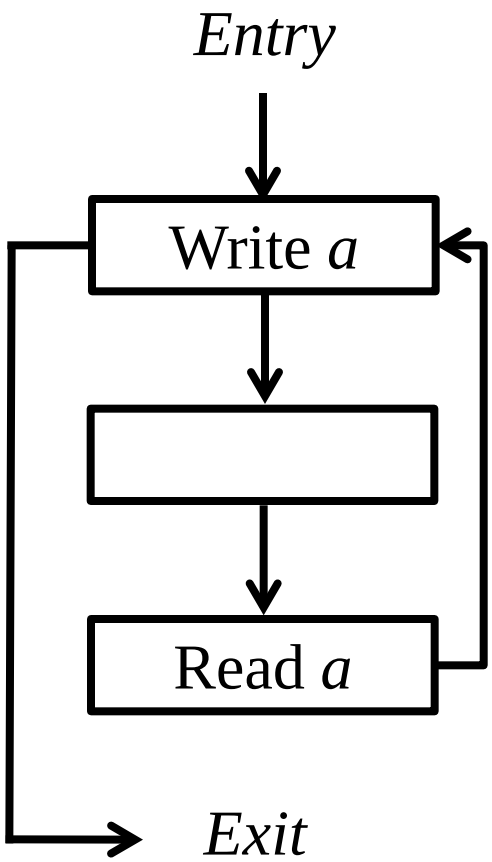
Execution order after pipelining

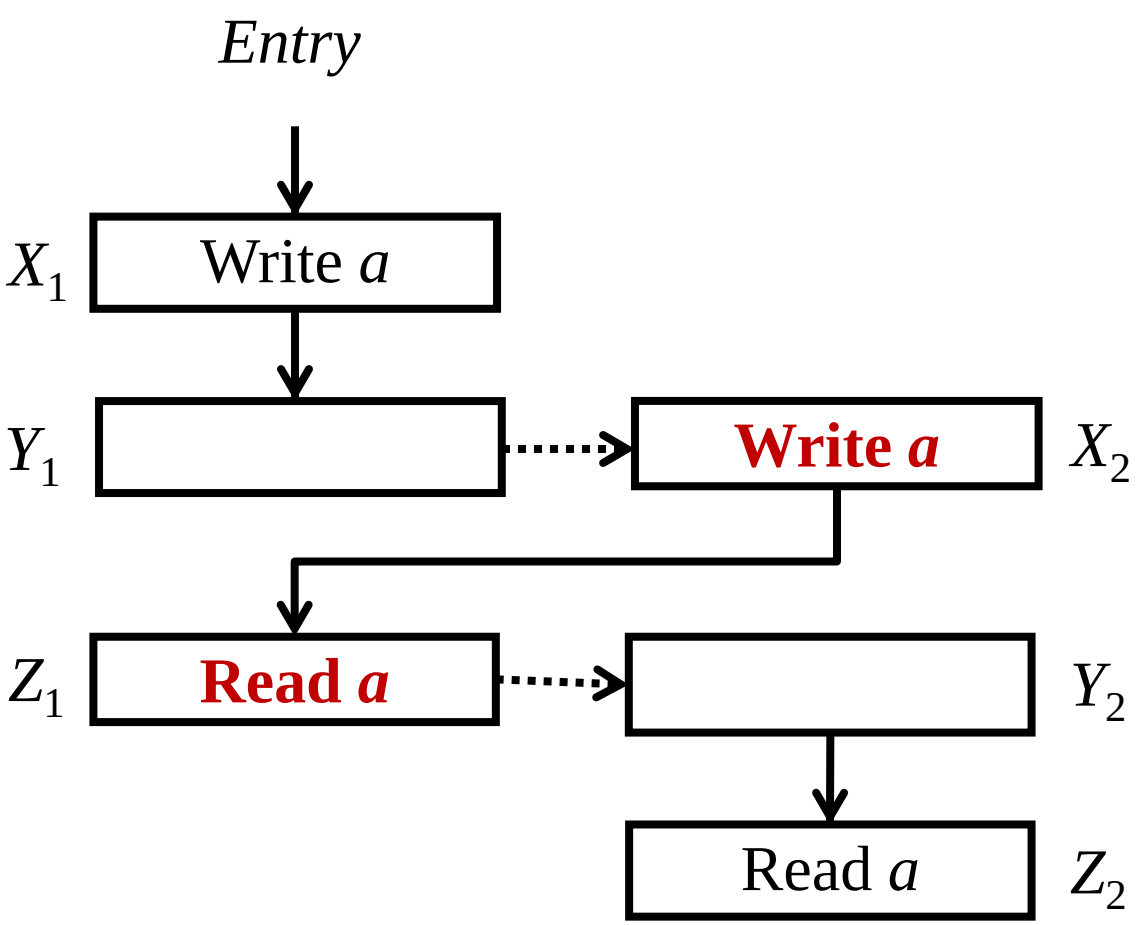
“ Pipeline interval is 1”

Goal: A Certifiable Loop Pipelining Algo



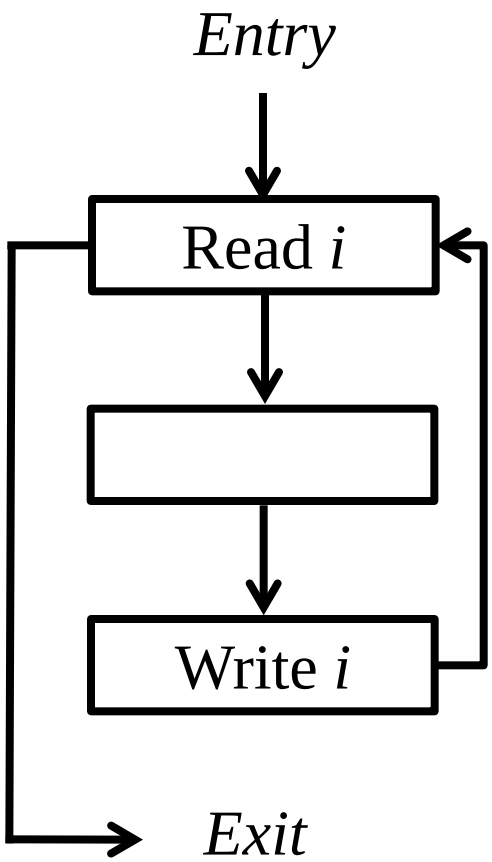
Challenges in Loop Pipelining # 1

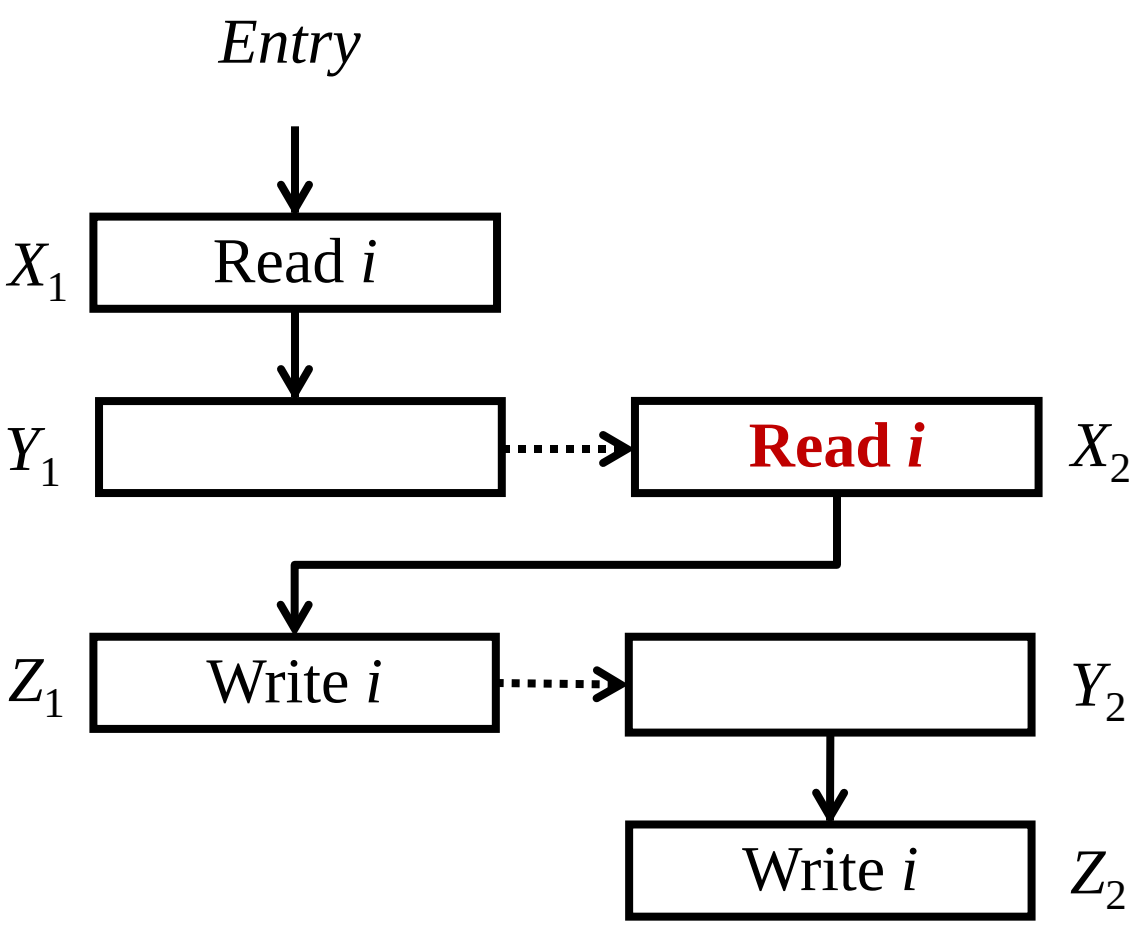




Problem: *a* will be overwritten by X_2 before being read by Z_1

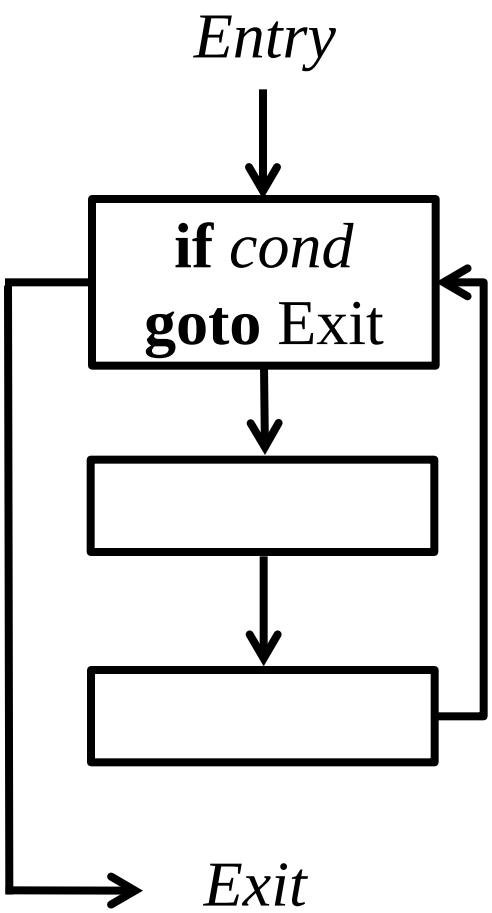
Challenges in Loop Pipelining # 2

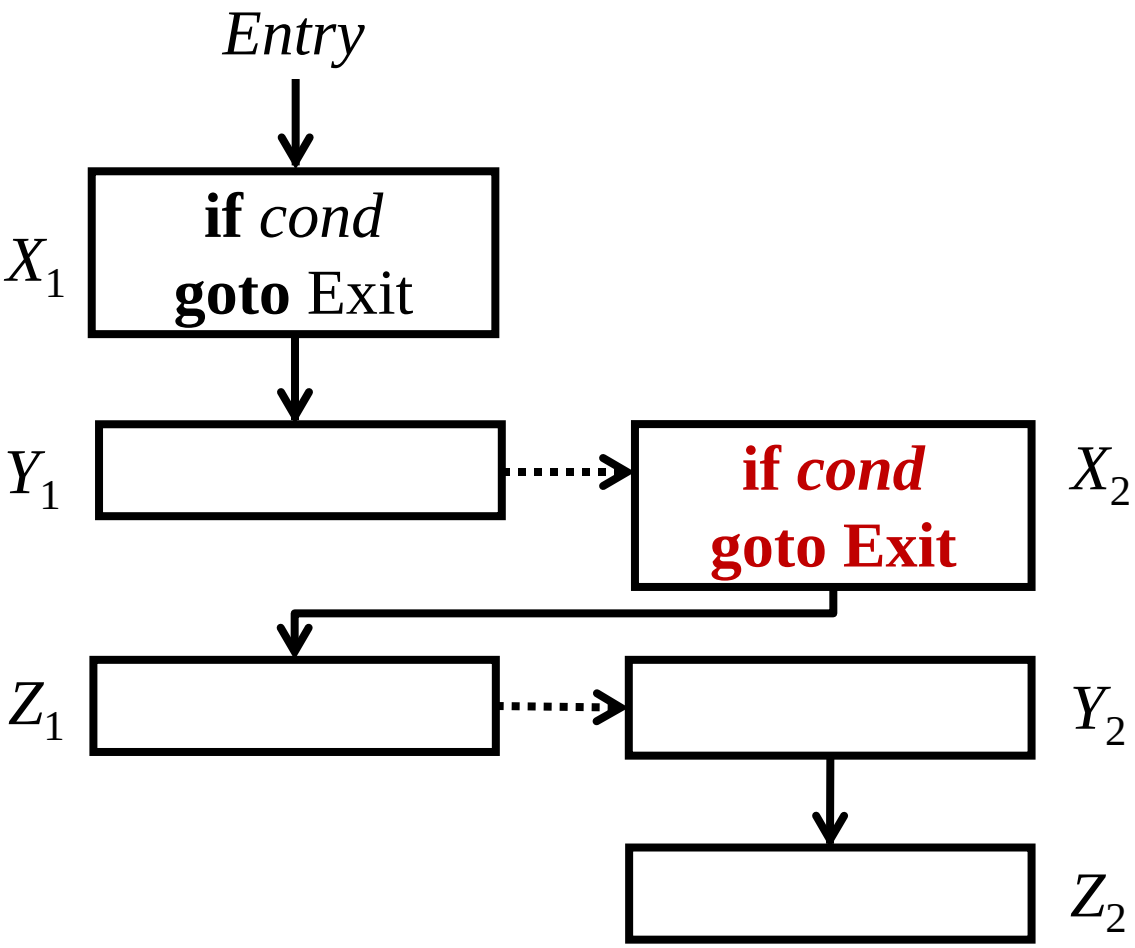




Problem: Attempt to read *i* before it has been written

Challenges in Loop Pipelining # 3





Problem: **If the cond is true, Z_1 is never executed**

Approach

Algorithm:

- Define a **generic framework of pipelining primitives** to handle these challenges
- Develop a **simple pipelining algorithm** using a combination of these primitives to generate reference loop pipelines

Certification:

- Prove using ACL2 theorem prover that these **primitives are correct**
- Prove using ACL2 theorem prover that the **algorithm correctly applies these primitives**.

Thanks!