Safe Early Output Logic

An Improved QDI Logic System
Overview

☆ DIMS
  ☆ What we have now
☆ Early Output
  ☆ What we want
☆ Guarding
  ☆ How we get it
☆ “Backward safe” guarding
  ☆ How we make it (even) better
What is a Token

**Petri nets**
- An event
- Discrete movement
- Occupies a single place

**Async Four Phase**
- Area between events
  - Specially & Temporally
- Rising & falling edges
- Separated

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DIMS vs Early Output Logic

Size: 48 transistors
Delay: 4 inversions

Size: 12 transistors
Delay: 2 inversions
Early Output cases

Average: 80%
1 in 5 times down to 60%
DIMS

★ No output until all inputs present
★ Output not released until all inputs released
Early Output

- Output generated as early as possible
- State of inputs cannot be determined by the state of the output
Validity

- Input latches generate validities
- Result only acknowledged once valid
Simple Guarding

★ State of stage inputs can be determined from the Validity
★ Input low and Outputs low does not mean stage is reset
★ Not sensing internal wires
★ Not QDI
Forward Safe Guarding

Ensure all wire pairs are cycled up and down

QDI

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Behaviour

☆ Viewpoint of a single output
☆ Many inputs
Behaviour

☆ All or nothing
☆ Synchronises inputs together
Short Tokens

☆ High throughput
☆ Few stalls

Stall!
Long Tokens

- Block stages
- Spreads
- Induces other long tokens
Backward Safe Guarding

Ensure all wire pairs are cycled up and down

QDI

Acknowledge parts

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Behaviour

★ Acknowledge ASAP
Behaviour

☆ Late Islands
Behaviour

☆ Late Arrival
Behaviour

★ Trimming
Conclusion

★ Early output QDI system
★ Improved guarding
★ Localised handshakes
★ Static Anti-Tokens
★ Desynchronisation of inputs
★ Unnecessary speculative should not operations ruin performance