Rotary Router: An Efficient Architecture for CMP Interconnection Networks

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Overview

• The constraints change on chip
  - Wide links are the norm
  - Local information readily available (neighbors)

• Complex networks...
  - Consume power especially buffering schemes
  - Place area pressure on caches and cores

• Need simplification
  - How do we deal with issues like HOL blocking, adaptive routing and arbitration across a router?
### Router Architecture

- Injection into the ring
  - Routing tag
- Avoid HOL blocking
  - Multiple rotations
- Dual port FIFOs
- No centralized structures
  - Xbars
  - Arbitration

### Input Port

- FIFO buffer and demux
- Local routing tag computation
- Ring selection
  - Distance to port
  - Occupancy
**Output Port**

- Multiplexor + buffers
  - Fair access
- Flow control with neighbor

**Buffer Management**

- Buffer bypass logic when output is available
- Round robin arbitration
- Delay comparable to Adaptive Bubble Router
- Area is buffer bound: comparable/better than traditional routers

Operation

- Arbitration
  - Independent of the # of output ports
  - Local

- Simple FIFO buffer and no HOL blocking

- Router complexity grows linearly in # ports

- Low complexity adaptive routing

Flow Control

- Virtual cut through with neighbors

- Bubble flow control for injection limitation
  - Deadlock freedom relies on bubble flow control

- Occupation based flow control in a ring
  - Levels injection probability across input ports

- Misrouting
  - Multiple ring traversals marks packet for misrouting
  - Take first available port
Deadlock, Liveloop & Starvation

- Bubble flow control ensures progress and deadlock freedom
- Liveloop with very low probability
  - Misrouting is randomized
  - Probability of bubble following cyclic paths is very low
- Starvation is mitigated with adaptive injection rates
  - Ring buffer allocation is unfair between injection ports and router ports
  - Dynamically throttle injection (required bubble count) at router ports

Analysis of Power Behavior

- More activity in the router increases power consumption
  - Superior latency reduces execution time → reduces energy-delay product
- Number of turns are low
  - Multiple flow control protocols smooth out the flows

Performance

Summary

- No virtual channels
- Topology agnostic
- Component complexity independent of node degree
  - However, need to better understand effect of message size, e.g., cache lines