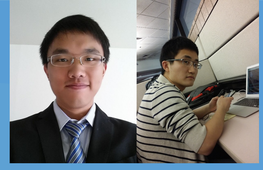
Fault-Tolerant Adaptive Routing Algorithm for Network-on-chip

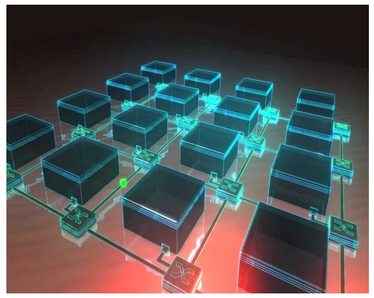


EECS 578 Fall 2015 - Final Project

Group Cohever: Tan Bie, Yang Jiao, Rong Xu, Zixin Wang

Introduction & Overview

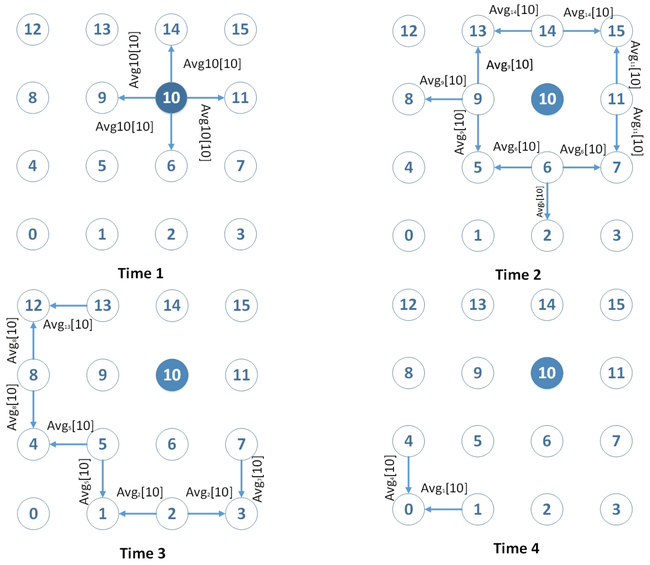
- Some adaptive algorithms are based on local-congestion state such as: Regional Congestion Awareness(RCA)
- Some algorithms don't have deadlock avoidance or deadlock recovery mechanism
- Some adaptive algorithms cannot work correctly on NoC with faults such as: Destination-based Adaptive Routing(DAR).



A better algorithm in need

- Global-Congestion Adaptive (GCA) Routing Algorithm
- Distributed delay measurement for global congestion state
- Equipped with Runtime fault tolerant mechanism to handle permanent link failures
- Deadlock-free Routing by Escaped Virtual Channel & Up/Down restriction
- Verified & Simulated on BookSim simulation
- Hardware Implementation on RTL to check the overhead

Global-Congestion Adaptive Routing



Hardware Implementation

•Port Pre-Selection

-one-hot port representation, 10 bits needed for each destination

•Delay Measurement and Propagation

-two 6-bit local delay for every destination node

•Adapt Split Ratio

-one 5-bit split ratio for every destination in network

Algorithm	Storage Overhead
Baseline DAR	4.5%
Fault-Tolerant GCA	6.1%

- Forward Reconfiguration Flag

-5-bit reconfiguration flag for every possible destination node

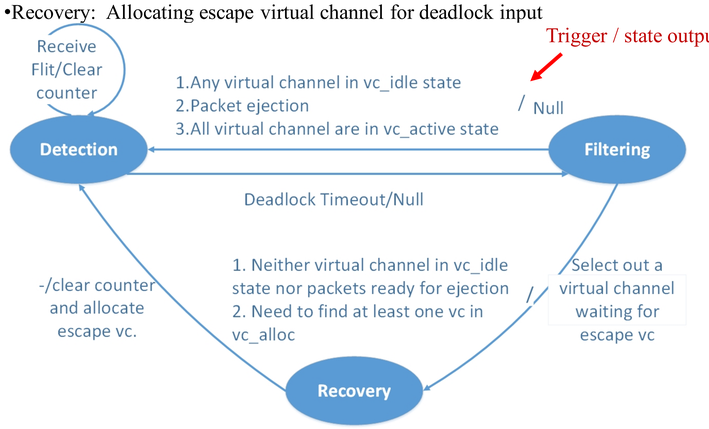
Deadlock Recovery Mechanism

• Deadlock recovery phases

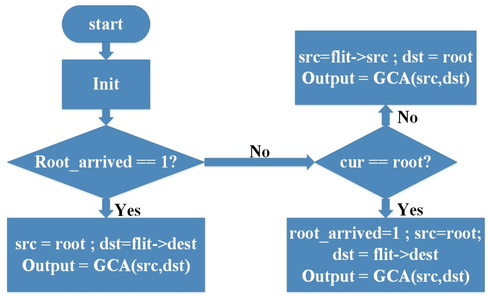
•Detection: Timeout → send deadlock recovery requests

•Filtering: Filtering false positive cases

•Recovery: Allocating escape virtual channel for deadlock input



•Deadlock free algorithm: up/down algorithm

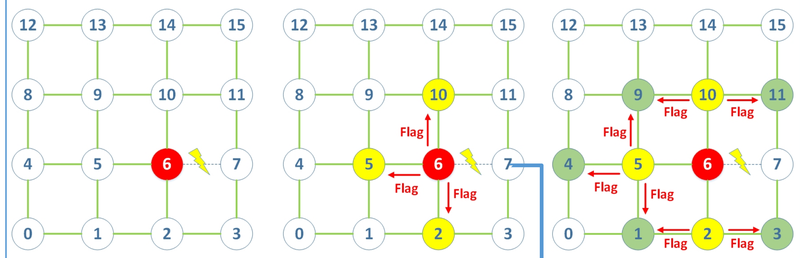


•When the deadlock happens, the escape virtual channel will begin to work based on up/down algorithm.

•Up/down algorithm has two stages

- From current router to root
- From root to destination

Runtime Fault Tolerant Reconfiguration



Dest	W	N	E	S
Ratio	1->0	0->0.6	0->0.4	0
Flag Received?	No	Yes	Yes	No

•Upon link failures are detected, routing table reconfiguration is triggered.

•The faulty router works as a root, sending reconfiguration flag to neighbors

•Upon receiving the flag, the router start to reconfigure the stored routing table and forward the flag to neighbors

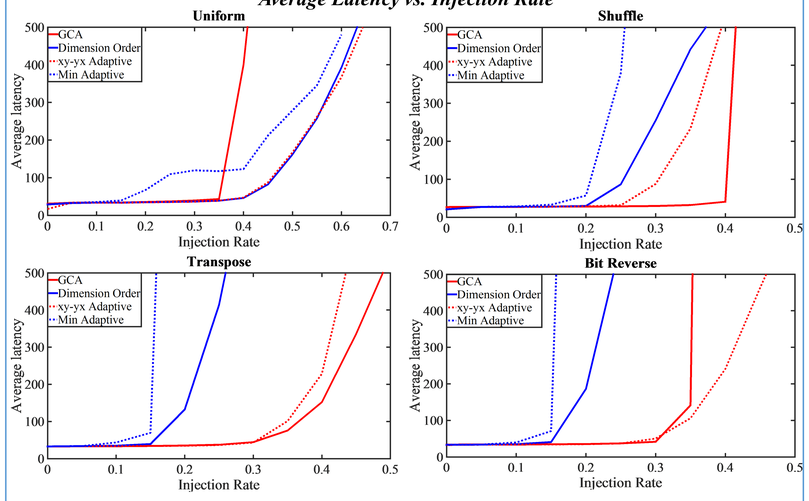
•When the process done, every node in the network update a safe path leading to the faulty router

•Congestion state also propagate with flag forwarding

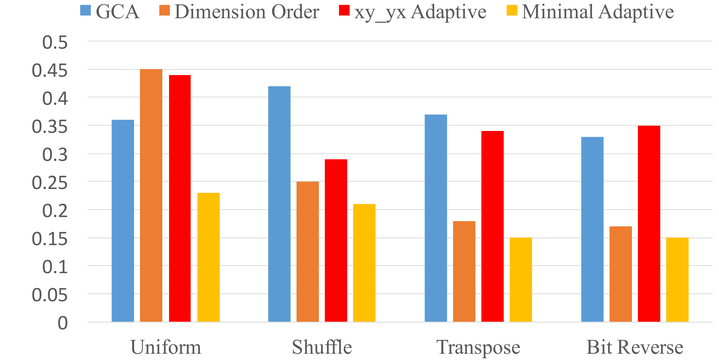
•Traffic split radio update based on whether reconfiguration flag is received

Results

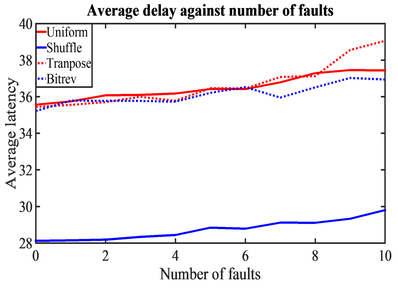
Average Latency vs. Injection Rate



Saturation Throughput Comparison



Average delay against number of faults



	This work	RCA	O1TURN	GAL	ForEVeR
Algorithm	Adaptive	Adaptive	Oblivious	Adaptive	-
Fault tolerant?	Yes	No	No	No	Yes
Throughout in different traffic pattern without faults					
Uniform	0.36	0.35	0.36	0.32	0.34
Shuffle	0.42	-	-	-	-
Transpose	0.37	0.33	0.21	0.27	-
Bit-comp	0.22	0.21	0.22	0.16	-

Comparison between our project and other published NoC routing algorithms

Conclusion

•GCA has the good features below:

- Rely on global congestion state
- Deadlock-free
- Good fault tolerance with low sensitivity to the fault number

•GCA has good saturation throughput compared to other algorithms in network without faults.

•GCA has good injection rate especially for uniform, shuffle and transpose traffic pattern.