



National University of Defense Technology

Traversal Packets: Opportunistic Bypass Packets for Deadlock Recovery

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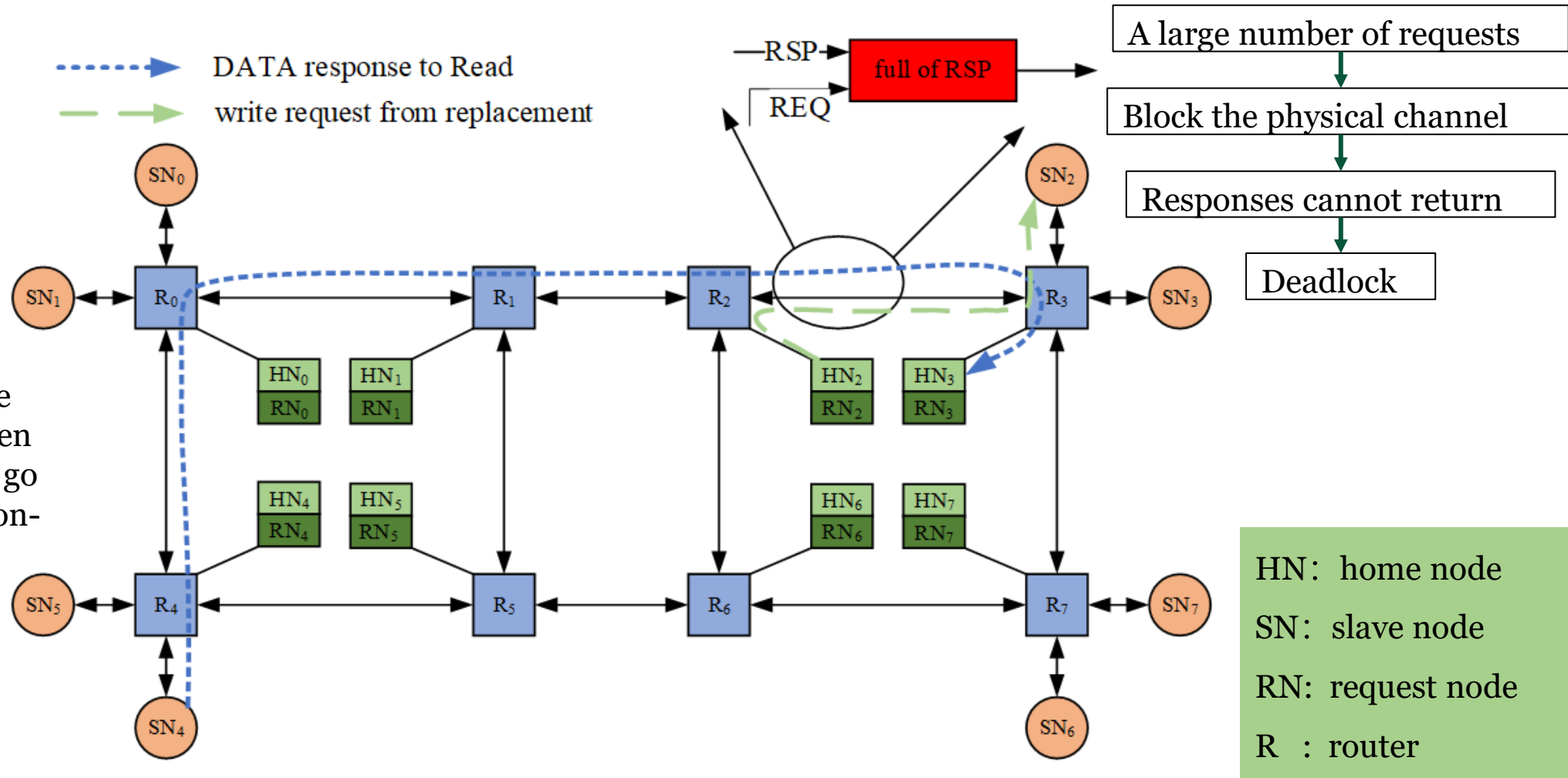
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1. Background

01 A real case:

Due to layout, SN_2 is connected with R_3 . The communication between HN_2 and SN_2 needs to go through the Network-on-chip.



Deadlock caused by shared response channel

1. Background

02 Deadlock freedom:

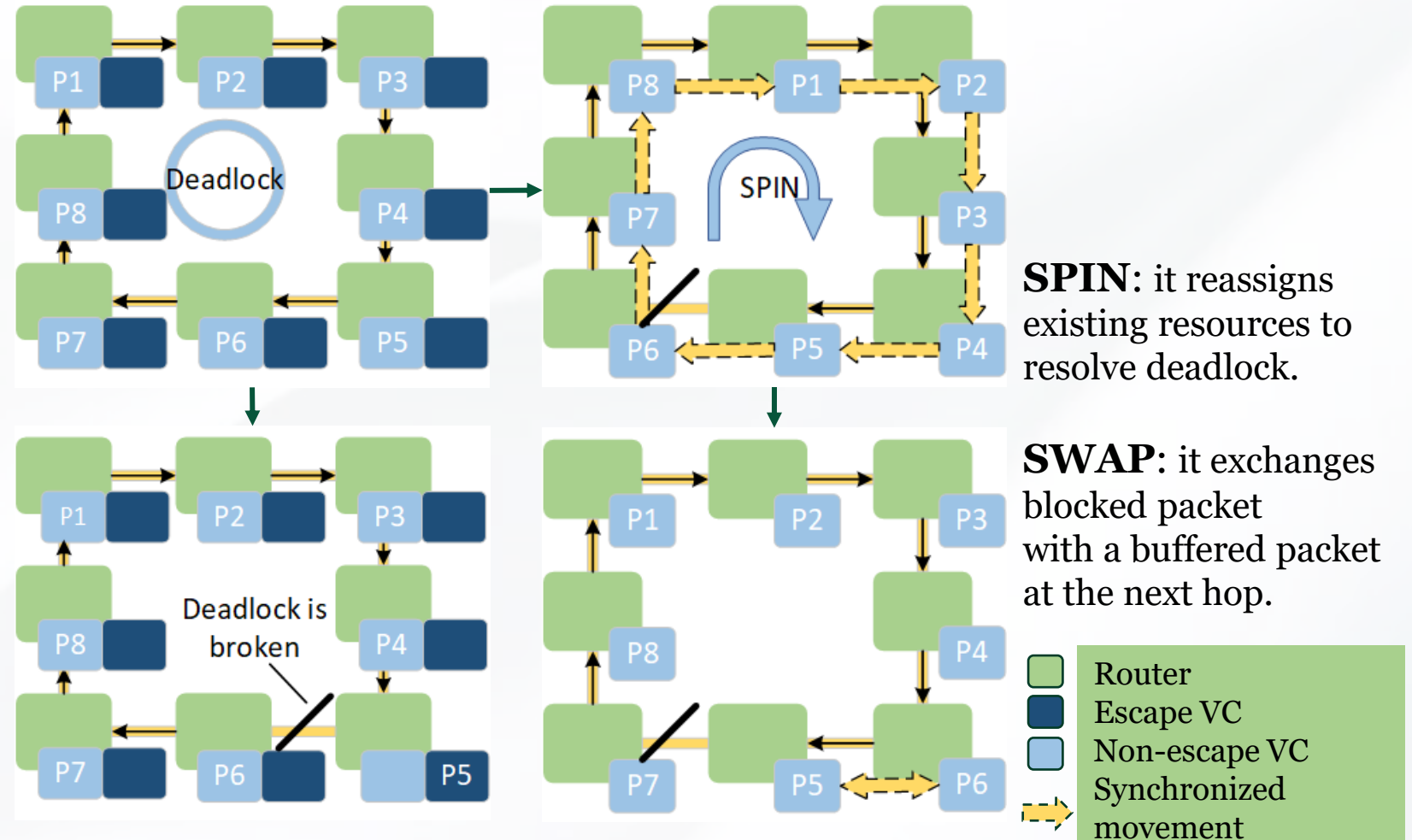
◆ Deadlock avoidance

- turn restriction
- bubble

◆ Deadlock resolution

- deadlock detection
- deadlock recovery

Escape VC: Turn restrictions are applied on Escape VC while Non-escape VC not.

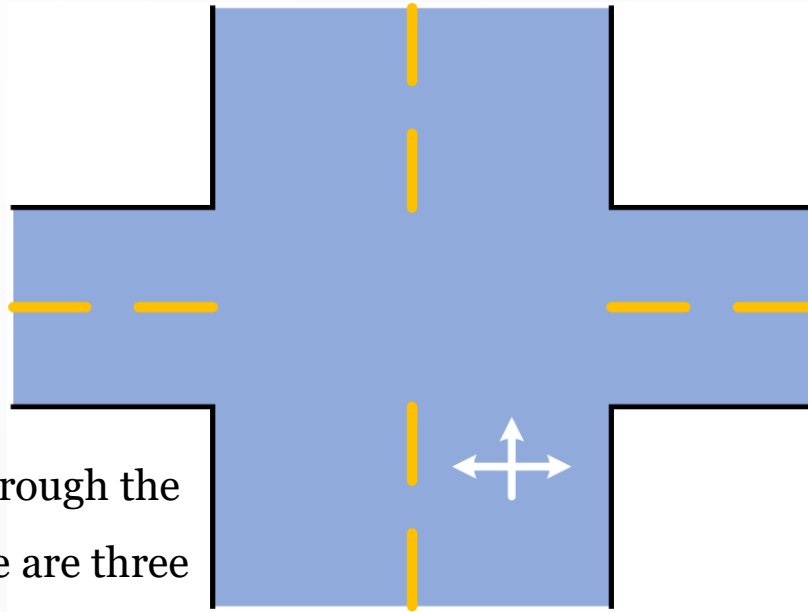


2. Motivation

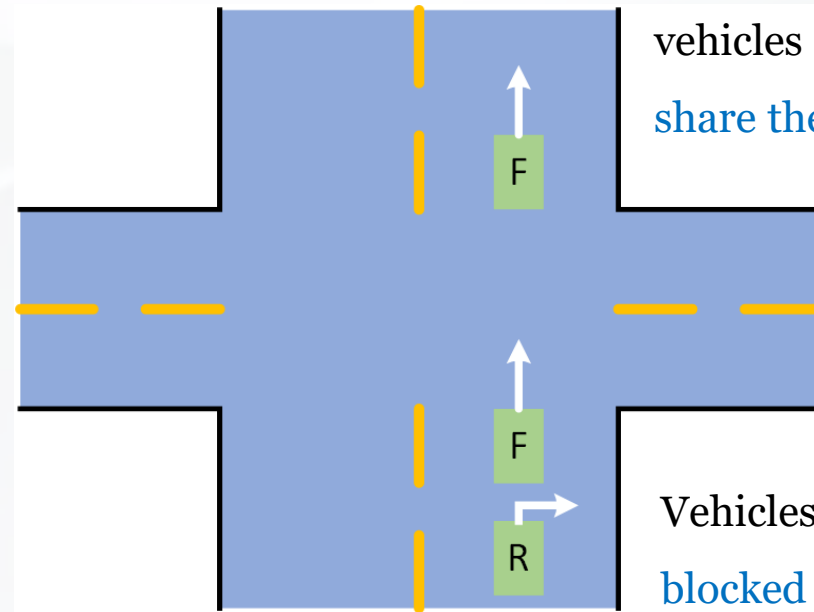
01 Daily-life examples:

When driving through the crossroads, there are three options available:

go straight, turn left or right.



Traffic in the city

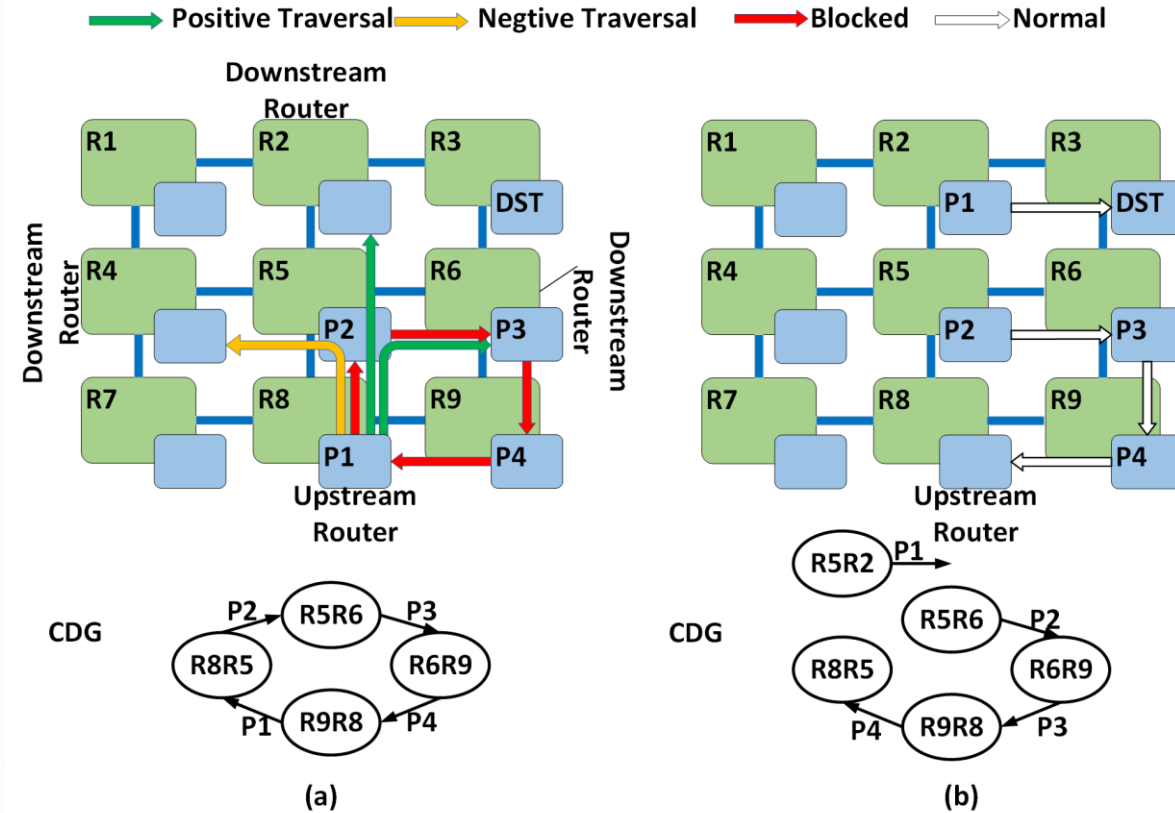


Vehicles that go straight and vehicles that turn right may share the same lane.

Vehicles that turn right are blocked by vehicles that go straight.

2. Motivation

02 Traversal packets:



Definition

A unique kind of packets inside the deadlock cycle.

Feature

The next requested buffer is full, but the subsequent buffer is available.

Function

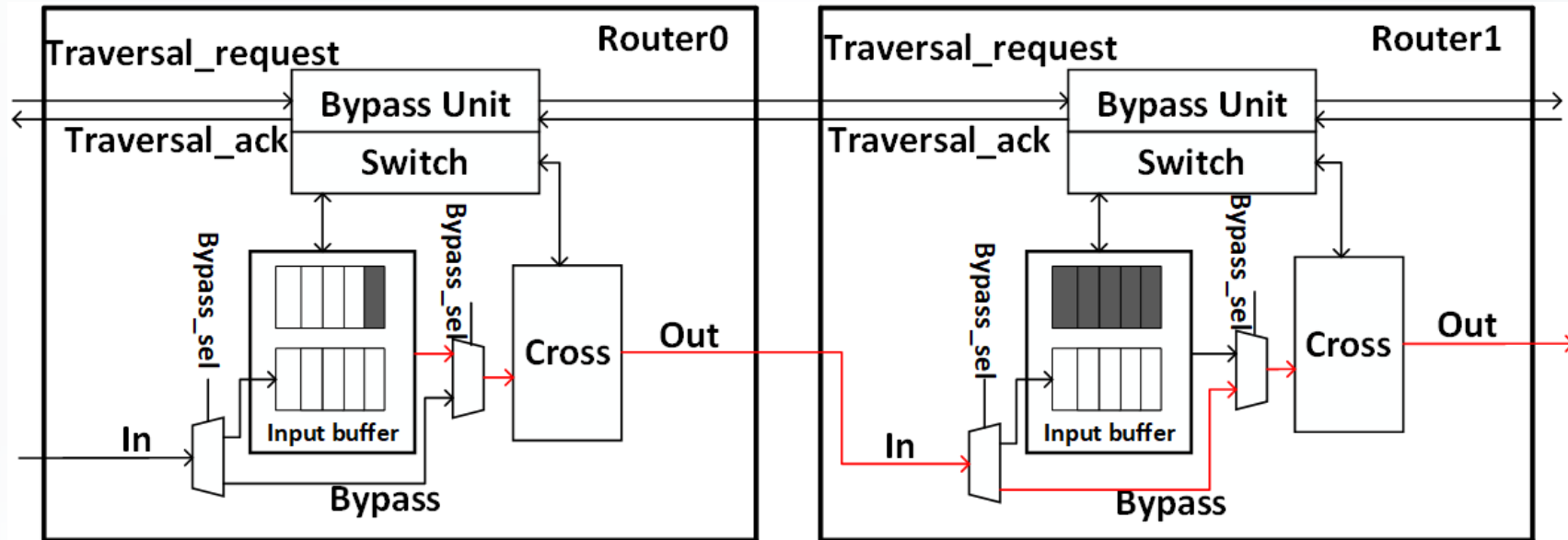
This movement can break the channel dependency chain, which can be used to resolve deadlock and congestion.

Traffic in the Network-on-Chip

3. Method

01 Router bypass:

Skipping intermediate nodes

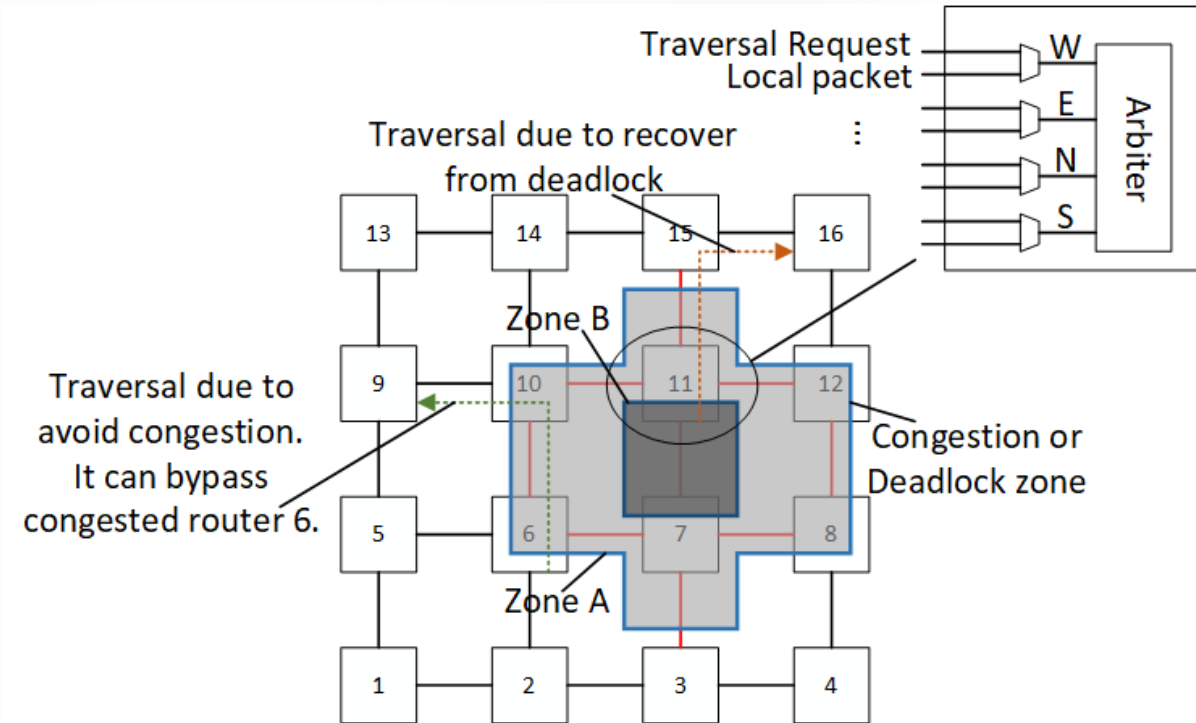


Conditions:

- ◆ The request outport is busy.
- ◆ The downstream router has a free VC.
- ◆ The packet wins arbitration in the next router.

3. Method

02 Conflict:



How to handle conflicts?

Why:

There may be more than one traversal packet competing for the same output.

Where:

The bypass unit is responsible for handling conflicts.

How:

The bypass unit will select a winner and ignore other requests based on the blocked time.

4. Evaluation

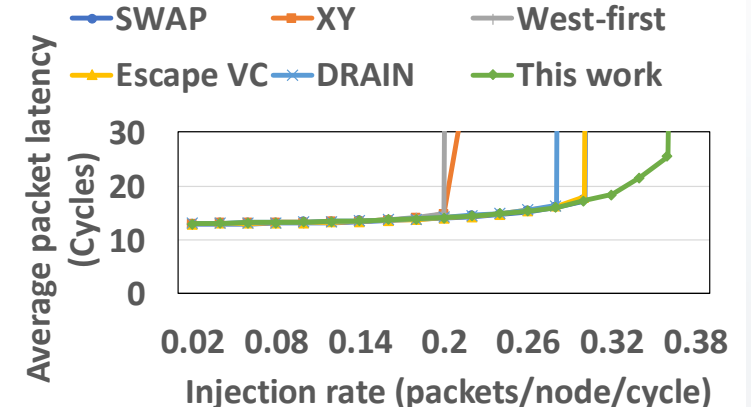
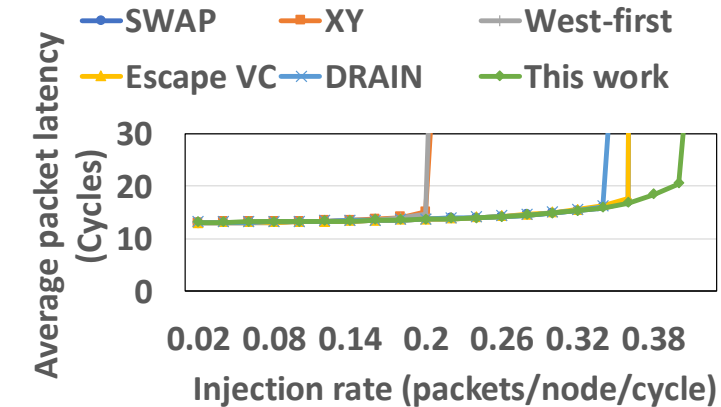
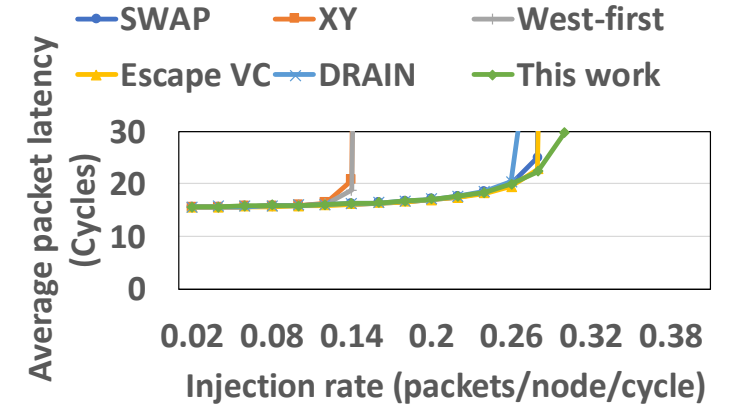
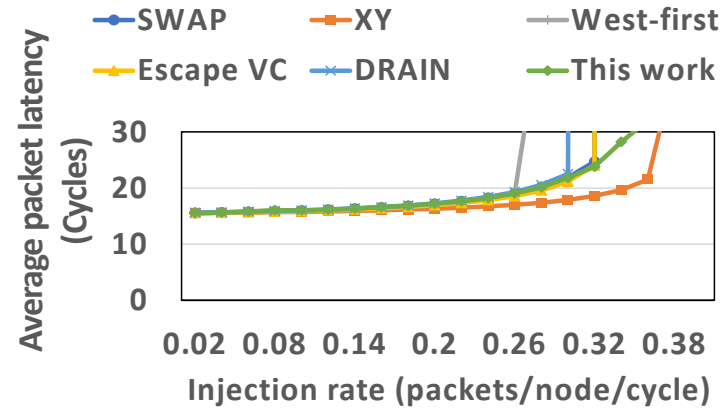
01 Latency and throughput:

Lower or similar latency

Traversal provides lower or approximately equal latency.

Higher saturation throughput

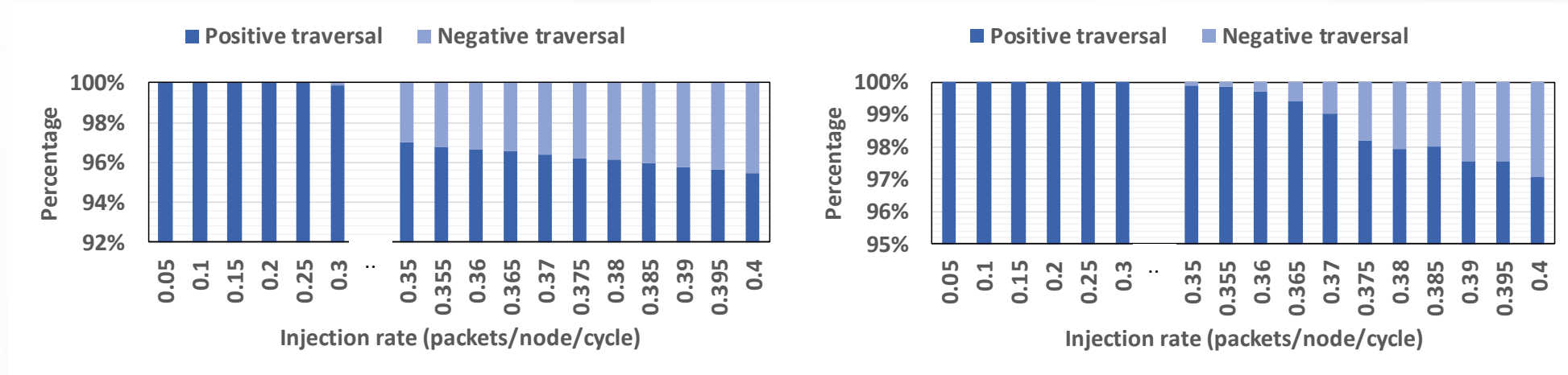
Traversal can provide an obvious improvement on saturation throughput.



Average packet latency

4. Evaluation

02 Positive and negative traversals:

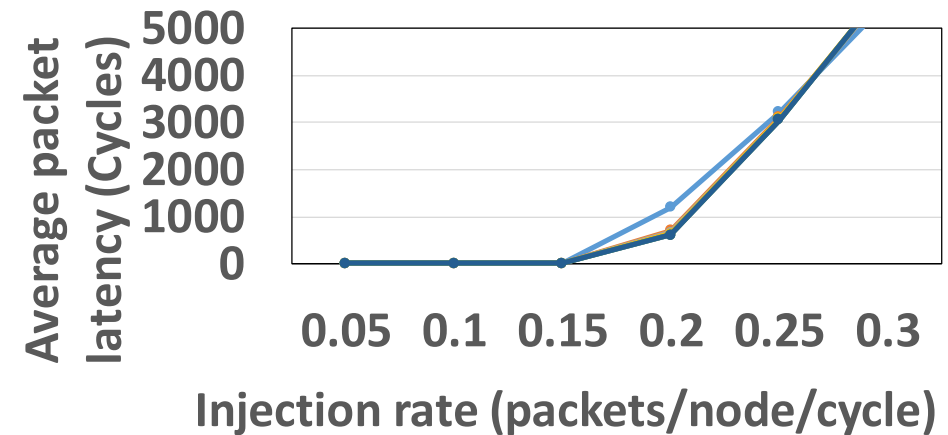
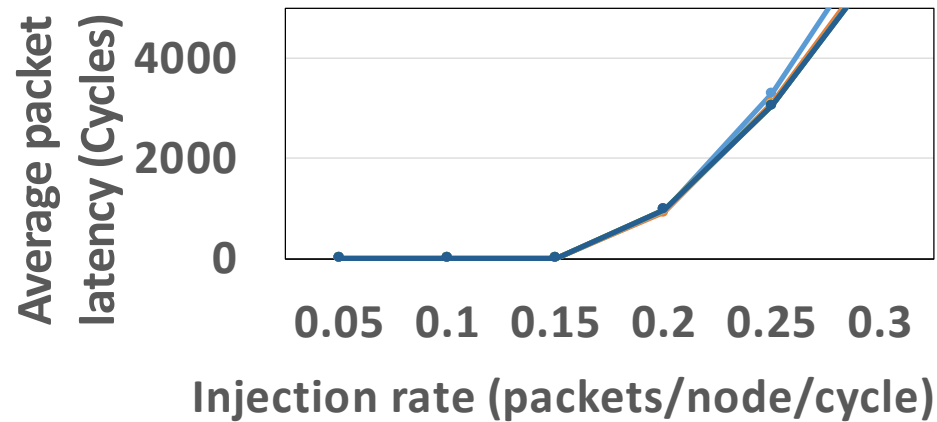


The percentage of positive and negative traversals in total traversals

- ◆ Before the saturation point is reached, the percentage of negative traversal is extremely low.
- ◆ After the saturation point is reached, the percentage of negative traversals exhibits a sharp increment.
- ◆ It is still low when compared with the percentage of positive traversal.

4. Evaluation

03 Sensitivity Study:



How thresholds affect the performance

- ◆ It is the threshold time used to distinguish between congestion and deadlock.
- ◆ Thresholds are set from 32 cycles to 2048 cycles.
- ◆ Average latency is slightly affected by deadlock thresholds.

5. Conclusion

A low-cost and easy-to-implement bypass mechanism.

It does not require extra buffer resources or global coordination,
and is low-cost and scalable.

01

02

Increase the accuracy of deadlock detection.

Some false deadlock judgments caused by congestion can
be eliminated.

Faster deadlock recovery

The leaving of the traversal packets can quickly break the
deadlock cycle, thus recovering from the deadlock.

03

04

Congestion alleviation.

Traversal packets can bypass some congested zones;
thus it is helpful for bandwidth improvement.

Higher throughput.

Throughput improvement of 15% on average.

05

THANKS!
