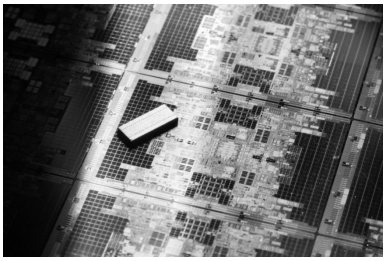
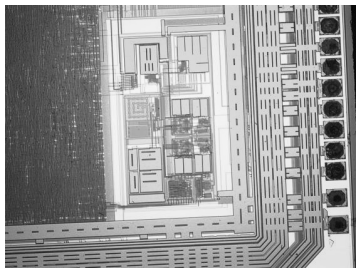



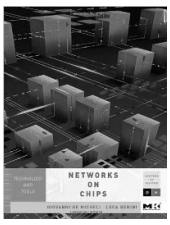
Switching mechanism in multi-core systems

Midia Reshadi, Ph.D

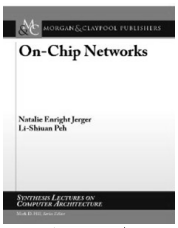
CE Department of
Science and Research Branch of Islamic Azad University

Outline

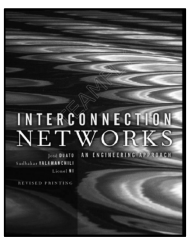
- Router micro architecture
- Switching methods
- References



2006

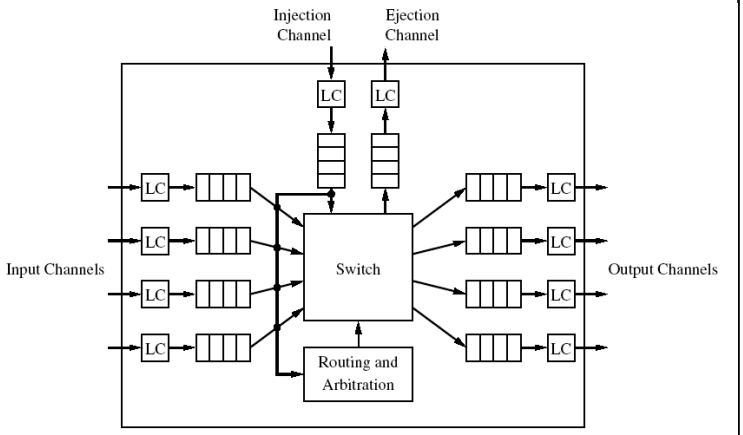


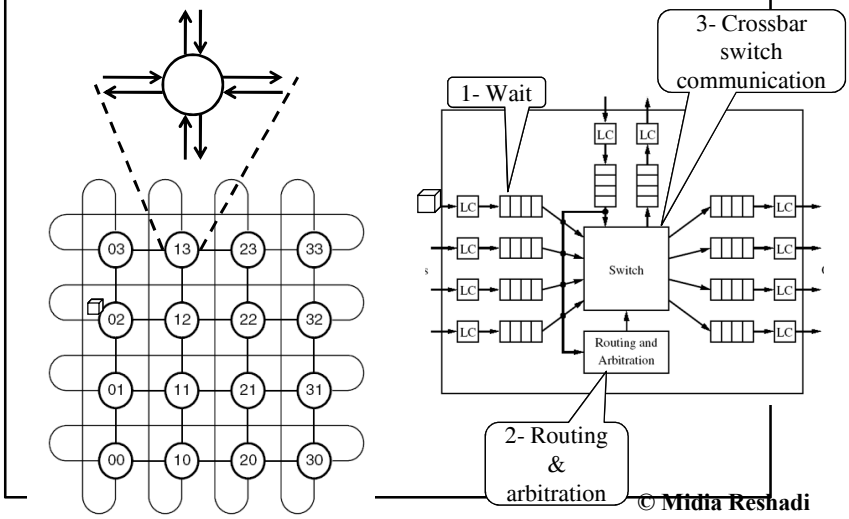
2009



2004

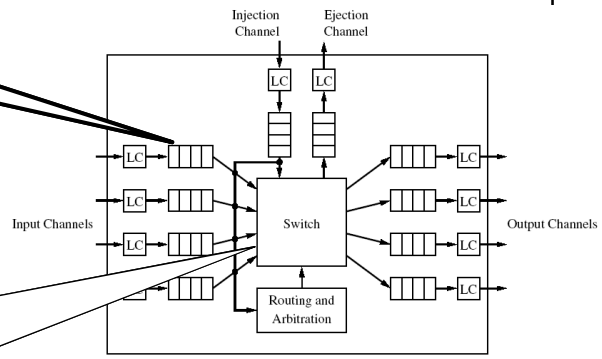
Switch micro-architecture



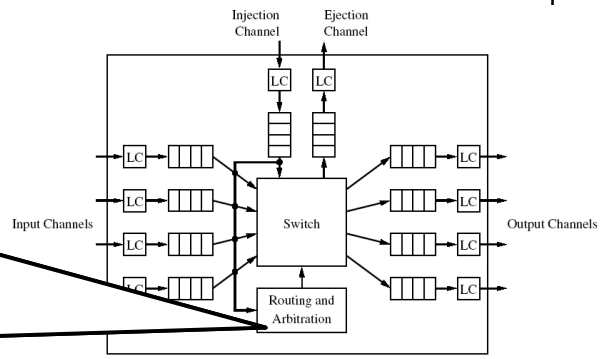


Component

Buffers :
first-in first-out
(FIFO)

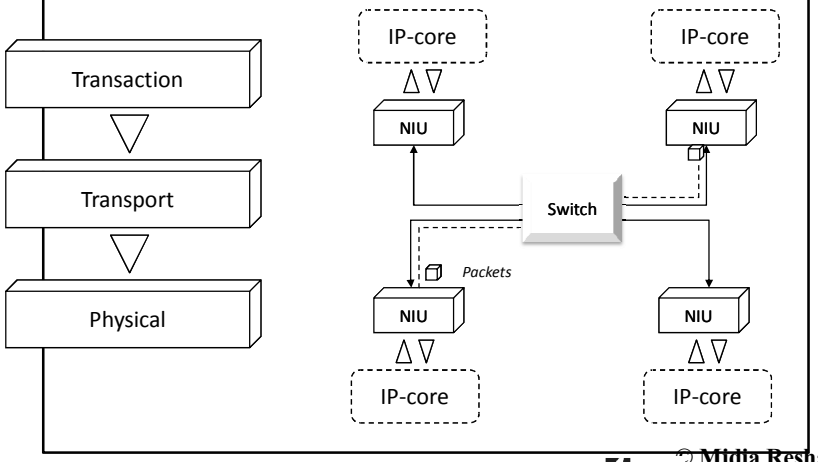


Switch:
connecting router input buffers to router output buffers
High speed-fully connected
Low speed



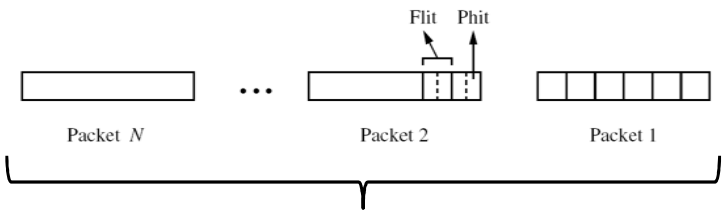
•implementing the routing algorithms,
•selects the output link for an incoming message
•Arbitration: If multiple messages simultaneously request the same output link,

Design layers



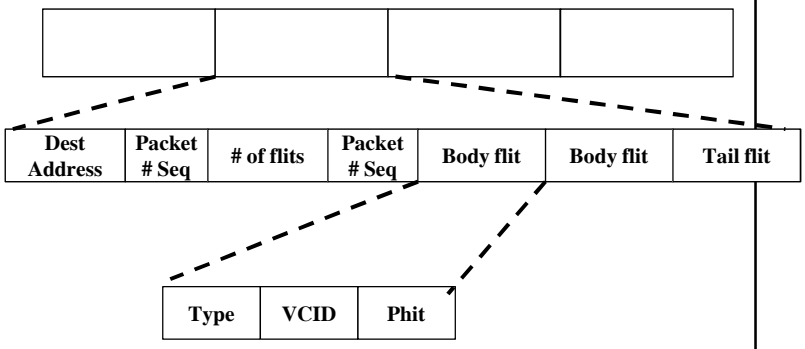
Source: Arteris Company, White paper

Message-packet-flit-phit



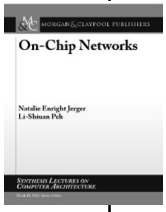
Example:
N packet
6 flit/packet
2 phit/flit

Example



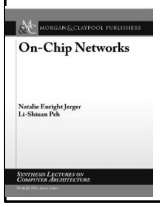
Circuit switching

- Pre-allocation of resources (links)
- Probe (a small set up message) is sent to reserve the links
- Probs reaches the destination
- Acknowledgement message transmitted back
- Source receives the ack
- Source release the message

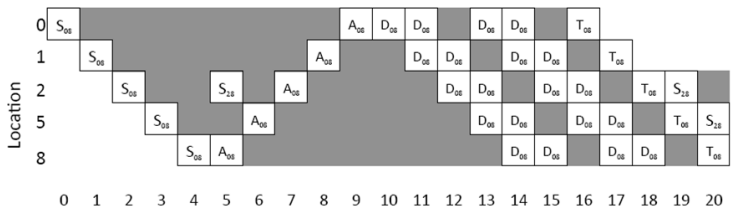


Circuit switching

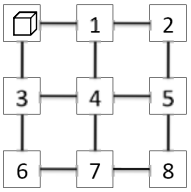
- This switching is sufficient for the large message
- It can be implemented bufferless
- Poor bandwidth utilization



Circuit switching: Example



Source: 0
Destination: 8
S: set up flit
A: Ack flit
D: Data msg
T: Tail flit



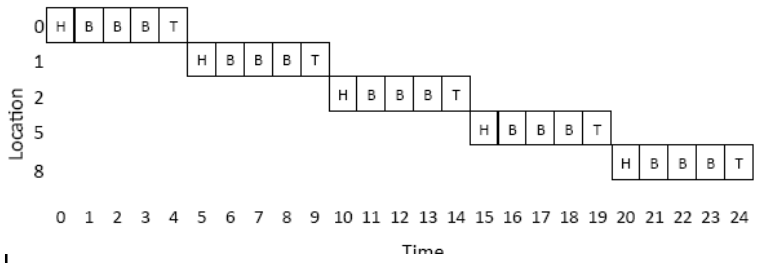
Packet switching

- **Store and forward**
- **Virtual cut through**

Store and forward

- **Store and forward**
  - The main unit=packet
  - Entire packet must be received before forwarding any part of packet
  - Long delay at each hop
  - Unsuitable for on-chip network (delay intensive networks)
  - High buffer size

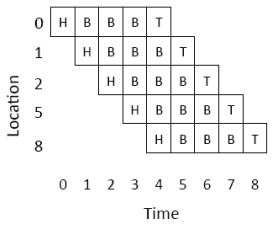
Store and forward



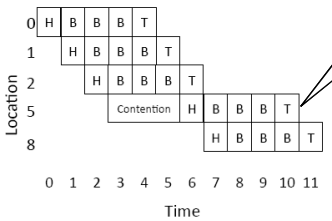
H: header flit
B: Body flit
T:tail flit

Virtual cut-through

- **To reduce the delay packet at each hop**
- **Allows transmission before the entire packet is received**



(a) VCT with no delay



(b) VCT with delay

No flits can proceed until all 5 flit buffers are available.

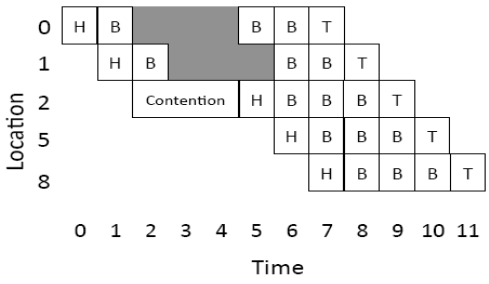
Virtual cut-through

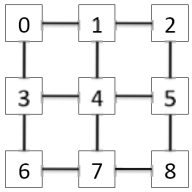
- **Packets move forward *only if* there is enough storage at the next router**
- **In on-chip networks: large packet size (64-128 byte cache lines)**

Flit-based flow control

- ***To reduce the buffering requirements***
- **WORMHOLE switching**
  - It allocates storage and bandwidth in flit-sized units
  - The flit can depart the current node as soon as there is sufficient buffering for this flit.
- **pros and cons**
  - Need small buffer
  - inefficient use of link bandwidth: why?
    - **when a packet is blocked, all of the physical links held by that packet are left idle**
  - Effective use of buffers
  - *Suffering throughput*:
    - **because other packets queued behind the blocked packet are unable to use the idle physical links.**

- **Wormhole flow control reduces packet latency**
  - by allowing a flit to leave the router as soon as a downstream buffer is available





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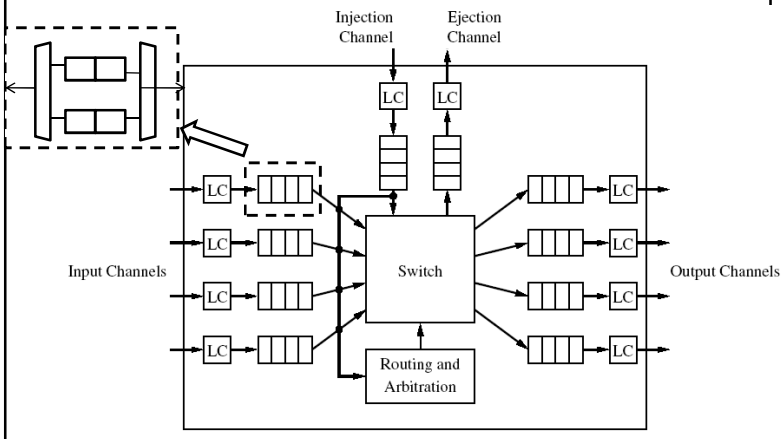
Virtual channels



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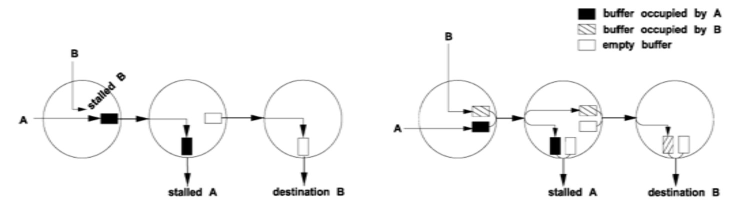
Virtual channels

- **head-of-line blocking in flow control, thus extending throughput.**



HoL Blocking reference


Virtual Channels Planning for Networks-on-Chip

Ting-Chun Huang, Umit Y. Ogras, Radu Marculescu
Carnegie Mellon University

Abstract

1. Introduction

Virtual Channels Planning for Networks-on-Chip
Ting-Chun Huang, Umit Y. Ogras, Radu Marculescu

HoL Blocking

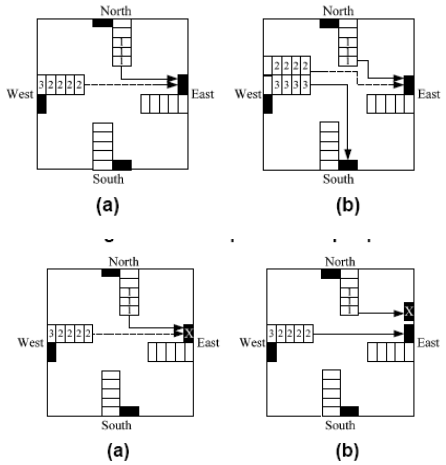
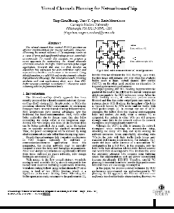


Fig.2



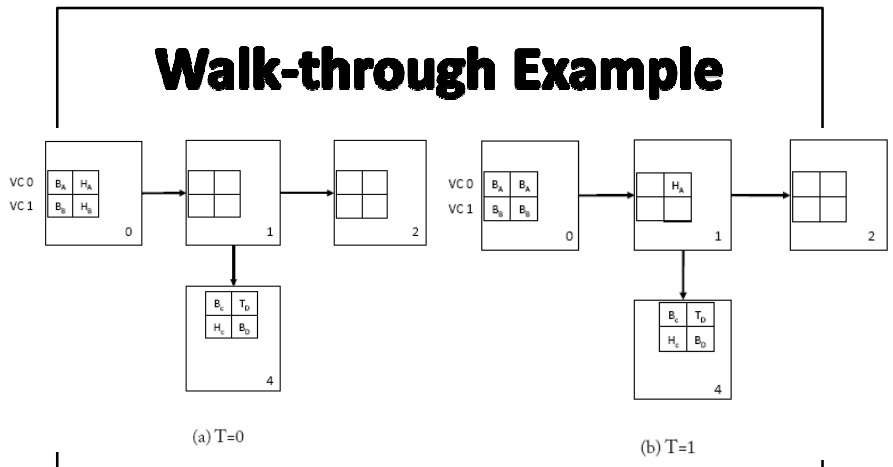
Virtual Channels Planning for Networks-on-Chip
Ting-Chun Huang, Umit Y. Ogras, Radu Marculescu

Fig.3

Virtual channels

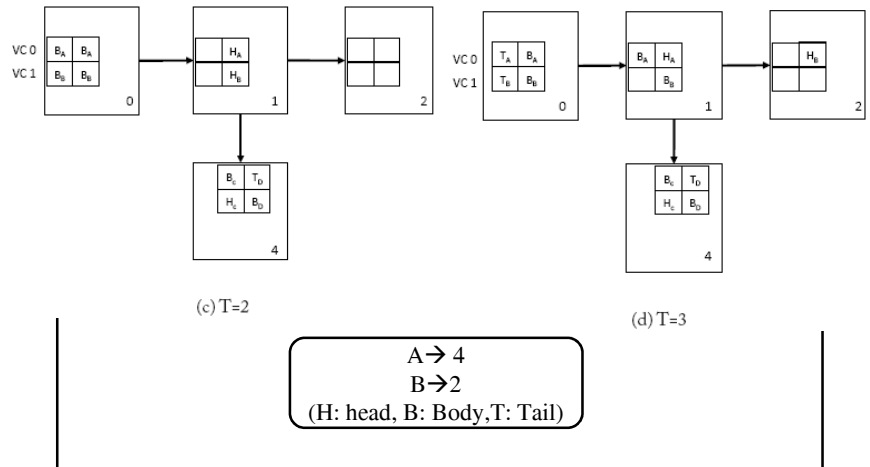
- **VCs can be applied to the:**
  - Circuit switching → virtual circuit switching
  - Packet switching
  - Virtual cut-through switching
  - Wormhole switching

Walk-through Example



A→ 4
B→2
(H: head, B: Body,T: Tail)

Walk-through Example



A→ 4
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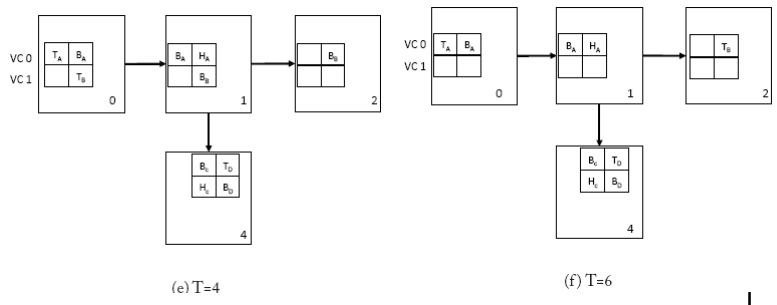
(H: head, B: Body,T: Tail)

Walk-through Example



(e) T=4 (f) T=6

Summary

	Links	Buffers	Comments
Circuit-switching	Messages	N/A (buffer-less)	Requires setup & acknowledgment
Store and Forward	Packet	Packet	Head flit must wait for entire packet before proceeding on next link
Virtual Cut Through	Packet	Packet	Head can begin next link traversal before tail arrives at current node
Wormhole	Packet	Flit	Head of line blocking reduces efficiency of link bandwidth
Virtual Channel	Flit	Flit	Can interleave flits of different packets on links