Message Switching Layer

Outline

- Network and Router Model
- Basic Concepts
- Basic Switching Techniques
  - circuit-switching
  - packet-switching
  - virtual cut-through switching
  - wormhole switching
- Virtual Channels
- Hybrid Switching Techniques

Network and Router Model

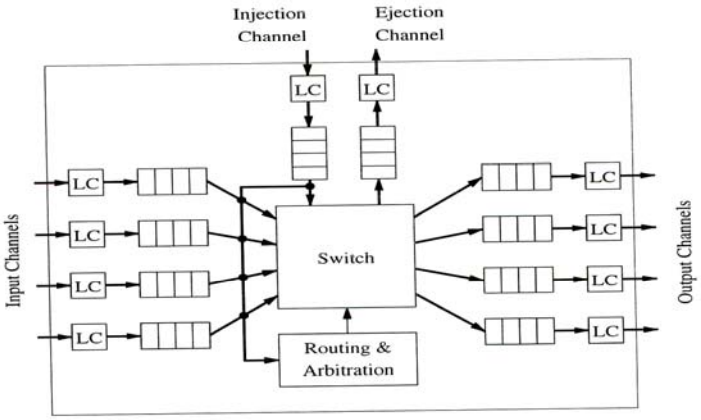

Figure 2.1: Generic router model

Basic Concepts

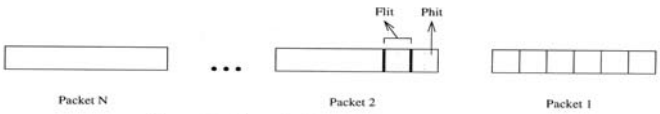

Figure 2.2: Alternative flow control units in a message

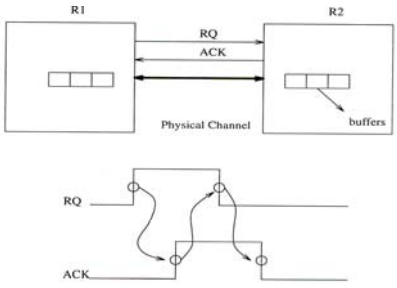

Figure 2.3: An example of asynchronous physical channel flow control

Synchronous Flow Control

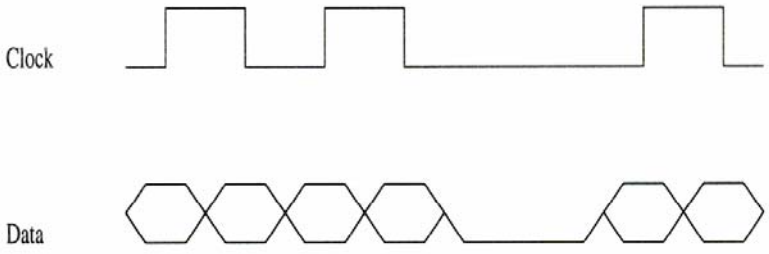

Figure 2.4: An example of synchronous physical channel flow control

Basic Switching Techniques

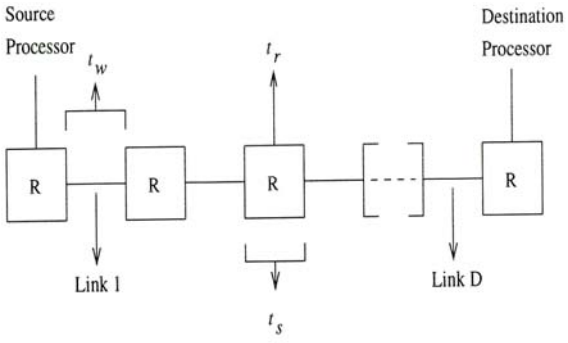

Figure 2.5: View of the network path for computing the no load latency

Packet Switching

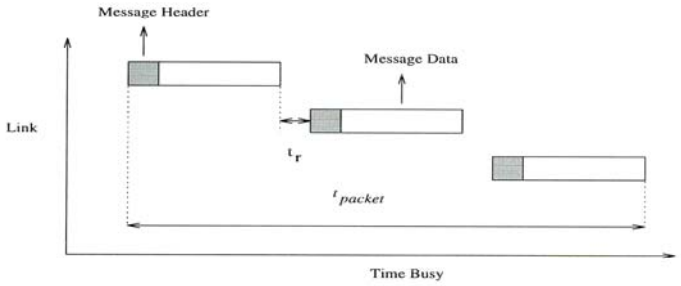

Figure 2.8: Time space diagram of a packet switched message

$$t_{packet} = D * \left(t_r + (t_s + t_w) * \left\lceil \frac{L+W}{W} \right\rceil\right)$$

Circuit Switching

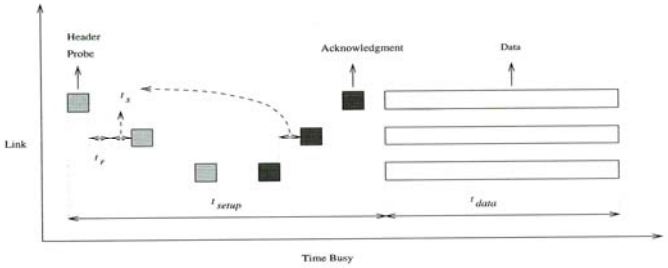

Figure 2.6: Time space diagram of a circuit switched message

$$t_{circuit} = t_{setup} + t_{data} \text{ where}$$
$$t_{setup} = D * (t_r + 2 * (t_s + t_w))$$
$$t_{data} = \frac{1}{B} * \left\lceil \frac{L}{W} \right\rceil$$

Virtual Cut-Through Switching

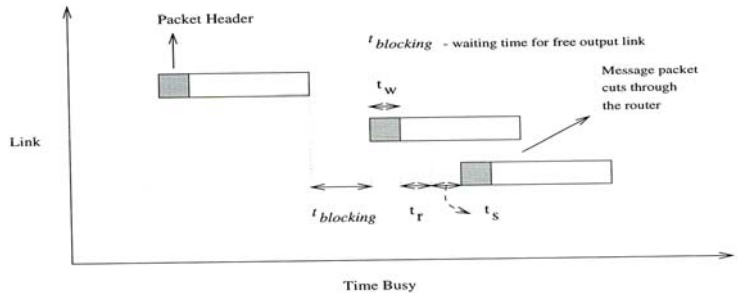

Figure 2.10: Time space diagram of a virtual cut-through switched message

$$t_{vct} = D * (t_r + t_s + t_w) + max(t_s, t_w) * \left\lceil \frac{L}{W} \right\rceil$$

Wormhole Switching

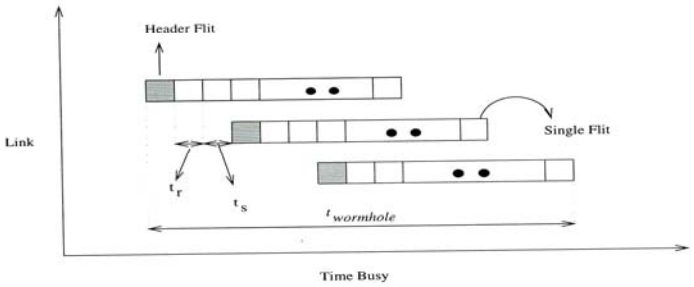

Figure 2.11: Time space diagram of a wormhole switched message

$$t_{wormhole} = D * (t_r + t_s + t_w) + max(t_s, t_w) * \left\lceil \frac{L}{W} \right\rceil$$

Blocking in Wormhole Network

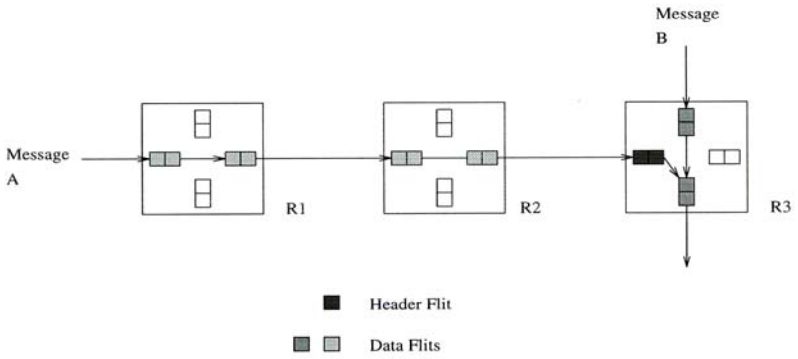

Figure 2.12: An example of a blocked wormhole switched message

Virtual Channels

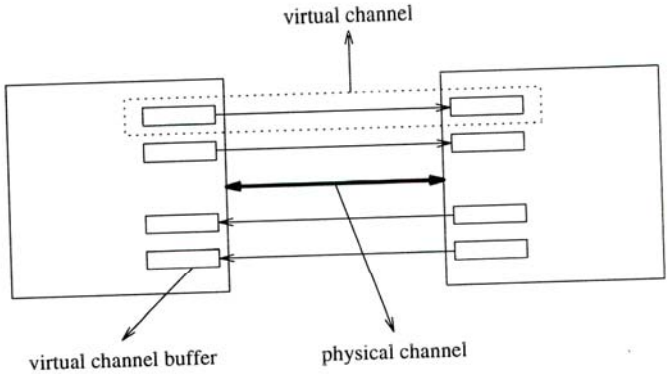

Figure 2.17: Virtual channels

Reduced Contention with VC

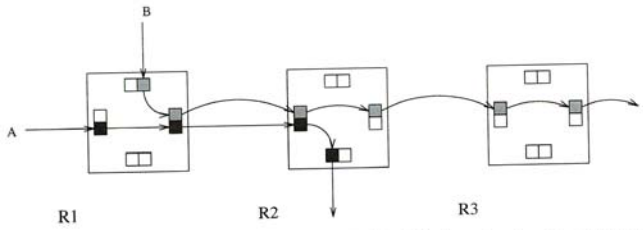

Figure 2.18: An example of the reduction in header blocking delay by using two virtual channels for each physical channel

Hybrid Switching Techniques

- **Buffered Wormhole Switching**
  - **used in IBM SP**
  - **a packet is divided into 8-flit chunks**
  - **a central switch buffer can hold chunks if the packet can not make progress**
  - **wormhole switching**
- **Pipelined Circuit Switching**
  - **circuit-switching for setting up path**
  - **wormhole switching for data transfer**
- **Scouting Switching**
  - **variation of PCS for fault-tolerant routing**