Contention Resolution for Optical Burst Switching Networks Using Alternative Routing

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Abstract & INTRODUCTION

Dense Wavelength Division Multiplexing (DWDM) technology
- Exploit the huge potential bandwidth
- Without any opto-electro-optic (O/E/O) conversions.

Optical Burst Switching (OBS)
- To build very high capacity routing switches.
- Good solution in high-speed optical Internet backbone.
- Eliminate the electronic bottleneck
  - at switching node without O/E/O conversion
- Guarantee the Class of Service (CoS)
  - without any buffering.

Propose:
- Alternative routing based intra-contention resolution scheme by suggesting a control header packet format
- The blocking probability is significantly reduced.

Additional delay for the alternative path < 10% x Basic offset time
OPTICAL BURST SWITCHING

- OBS composition
  - OBS network
    - Optical core routers and electronic edge routers
  - Each burst
    - Control header packet and a data burst
  - Control header contains
    - Information of the data burst length and offset time
- Packets are
  - Assembled into bursts at the network ingress.
  - Disassembled back into packets at the network egress.

- Two coupled overlay networks
  - A pure optical network transferring data bursts and a hybrid control network transferring control header packets.
  - Control network
    - A packet switched network
    - Controls the routing and scheduling of data bursts in the all optical network
      - based on the control header packet’s information
  - Advantages
    - Mature electronic control technologies
    - Promising optical transport technologies
Fig. 1: three burst switching techniques
- A burst can cut through intermediate routers.

(a) In-Band Terminator (IBT) based burst switching
- Bandwidth is reserved
  - As soon as IBT
  - Followed end of the data burst
- Limitation
  - Be processed all optically
  - Not support optical processing
(b) Tell-And-Go (TAG) based burst switching

Operating steps

1. Source node sends a control packet over the control channel to reserve a bandwidth.
2. Corresponding data burst is transmitted without waiting for the acknowledgement.
3. The source node sends a release packet to the destination.

Ex) Just-In-Time (JIT) protocol

Disadvantage

- Large signaling overhead

(c) Reserve-Fixed-Duration (RFD) based burst switching

- Bandwidth is reserved
  - Fixed time duration at each router
- Information of reservation time
  - Carried by control packet
- Ex) Just-Enough-Time (JET) protocol
  - Eliminates the signaling overhead
  - Improve the resource utilization

Disadvantage

- Complexity increased.
Many challenges to implement the OBS network

- Edge router
  - Burst offset time management, burstification and burst assembly mechanism

- Core router
  - Data burst and control header packet scheduling, protection and restoration mechanism and contention resolution scheme

We focused...

- Contention resolution
  - The core router has no fiber delay line (FDL) and the offset time is fixed at the ingress router.
  - Classify the contention in intermediate core routers.
    - The inter-class contention caused by different class bursts.
    - The intra-class contention caused by same class bursts.
  - To prevent the inter-class contention
    - Additional QoS offset time can be used and high priority bursts can avoid blocking caused by low priority bursts.
    - No published result yet.
ALTERNATIVE ROUTING IN OBS NETWORKS

Our three methods for solving the intra-contention problem in core routers:
1. The wavelength converter
2. FDL
3. The deflection routing

We proposed:

- An alternative routing scheme
  - Combines wavelength converters and the enhanced deflection routing algorithm.

If contention occurs at intermediate core routers, the data burst is blocked.
- Because it can’t change its path.

In our algorithm:
- Every core router has hop by hop routing functions.
- The routing table has two different paths for each destination.
**Operating steps**

- If contention occurs at certain intermediate core router, the hop by hop routing functions are performed.
  - One is routed through the short path and the other is routed through the alternative path obeying certain policy (time critical burst, number of hops, etc.)
- If next node does not encounter any contention, the rerouted data burst will be routed through the shortest path.
- The control packets contain the number of rerouting times
  - Thus if the number of rerouting is over the threshold value, the rerouted bursts are just dropped to prevent looping and early arrival of data bursts.
- Better than deflection routing
“Routing offset time”

- The additional offset time
  - to make up the time by alternative routing.
- Depends on
  - the network size and the header processing time
  - Ingress edge routers decide the offset time
- Prevents the data burst surpasses the control header.
**Message type**
- The header packet type
- Uniquely determines the exact layout of the message.

**QoS**
- Following data burst’s priority.

**Input port and Input wavelength identifier**
- Indicate the incoming data burst’s port and wavelength.

**Offset time**
- The separation time between control header and data burst
  - Consists of the basic offset time and routing offset time.

**Burst length**
- Length of data burst

**Hop count**
- Prevent bursts not to lose their destination router or the looping environment.

**Source address and Destination address**
- Addresses of the source and the destination.

**SIMULATION AND RESULTS**

**Java language**
- To evaluate the performance of blocking probability
  - in the slotted 4x4 Manhattan Street network.

**In fig. 2**
- Assumed
- Nodes
  - 0,3,12,15 nodes – edge routers
  - Others – core routers
- The bursts arrive synchronously.
  - Each time slot is equal to the burst duration.
  - Available wavelength at each node is one.
- Input traffic
  - Exponential distribution and Pareto distribution with Hurst parameter \( H=0.9 \).
Fig. 5 and Fig. 6

- Blocking probability is reduced by 10 and 2 times when offered load is 0.1 and 0.9.
- Self-similar traffic with H=0.9, the proposed alternative routing scheme performs very well.

Fig. 7

- Alternative Path makes the additional delay (additional hop counts) performance.
CONCLUSION

An intra-contention resolution scheme

✓ By introducing additional routing offset time in bufferless intermediate core routers in the OBS network.
✓ Using “Routing offset time”
✓ Effective to significantly reduce the blocking probability for the exponential