Optical Burst Switching:

A Novel Paradigm for Optical Networks

Chunming Qiao, Myungsik Yoo and Xijun Zhang

Department of ECE
SUNY at Buffalo
Buffalo, NY 14260
qiao@eng.buffalo.edu
http://www.acsu.buffalo.edu/~qiao

Framework

Scope of the problem: OAM&P in (almost) all-optical networks

- "transparency" feasible in LANs/MANs in the short term and WANs in the long term
- may use O/E and E/O conversions for signal cleanup
- optical cross-connects (OXCs) may still be used

Proposed Approach: Polymorphic Control

- slice an optical network into several *virtual* networks (VONs)
  — each VON may be used to support services of the same class having the same traffic characteristics
- limited resources to be shared and allocated among the VONs
  — fibers, λs, transceivers/node, wavelength converters
- each VON may use different OXCs (some small, others slow)
- each VON to be (re)configured differently
  — scheduled or (quasi)-static lightpaths in Static VONs
  — dynamically established lightpaths in Dynamic VONs
  — optical burst switching in Bursty VONs

Optical Burst Switching

What is OBS?

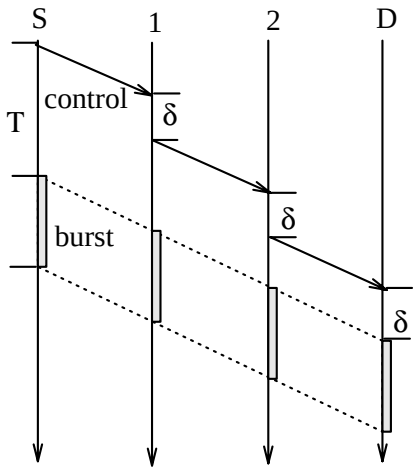
- **one-way reservation: a control/set-up packet on a signaling channel, followed by a data burst (e.g. IP packets)**
  — offset time $\approx$ *total-proc-delay* $\approx$ *hops* $\times$ *proc-delay-per-hop*

Why OBS?

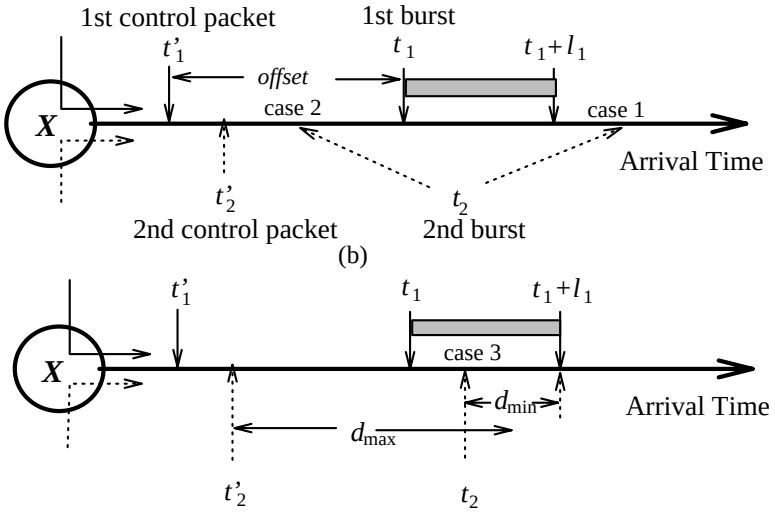
- **for self-similar (bursty) traffic (of Internet esp. WWW)**
- **for high-bandwidth/low latency, short-lived sessions**
- **can take advantage of the (physical) topology of a VON**
- **reduces overhead of higher layer protocols (e.g. IP)**
- **combines the best of coarse-grained circuit (λ-routing) and fine-grained packet/cell switching**

Optical Switching Paradigm	Bandwidth Utilization	Latency (set-up)	Optical Buffer	Proc./Sync. Overhead (per unit data)	Adaptivity (traffic & fault)
Circuit	low	high	not required	low	low
Packet/Cell	high	low	required	high	high
Burst	high	low	not required	low	high

OBS Protocols



(a)



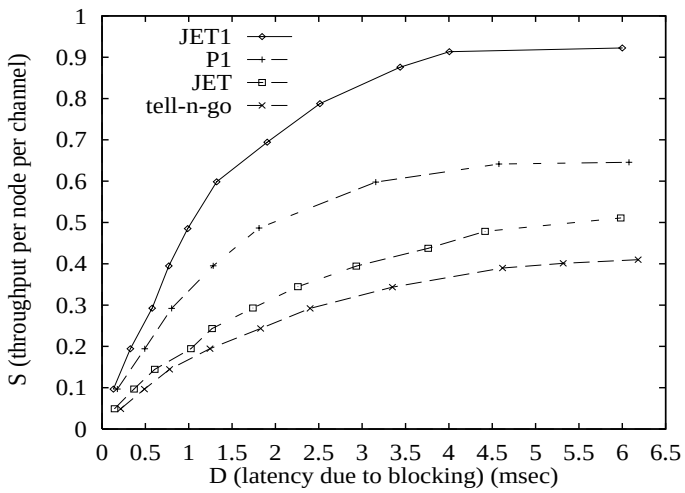
(c)

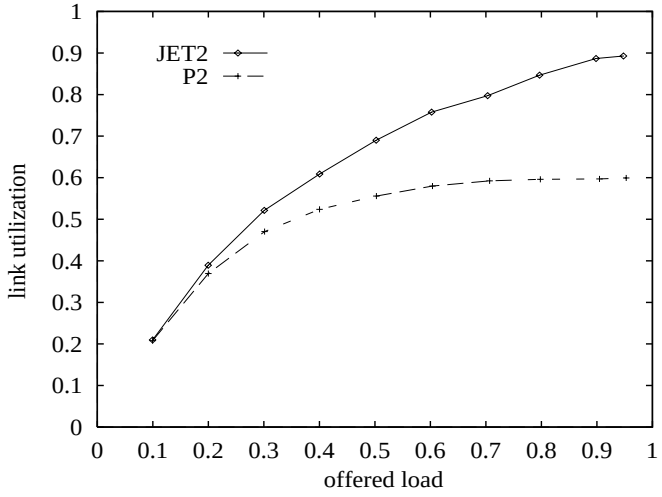
Reduce burst dropping probability

- (b). delayed reservation (DR) for efficient utilization – with non-zero offset time and pre-determined burst lengths
- assign a higher priority (e.g. additional offset time) to longer bursts and/or bursts traveling further
- assign additional offset time for deflection routing
- (c). fiber delay lines (FDLs) and intelligent management

Performance Evaluation

- all JET (Just-Enough-Time) protocols adopt DR
- two cases: reliable (with retransmission) or not





- JET beats tell-n-go (or TNG) – both without FDL
- JET1 beats P1 (a TNG variation) – both with FDLs
- JET2 uses an extra offset time (but no FDLs) and beats P2 (packet-switching)

Remarks

Related Issues in a Bursty-VON

- **interact with other VONs (e.g. traffic migration)**
- **interface with upper layer protocols (e.g. burst (dis)assembly)**
- **OXC addresses, topology update, and routing**
- **support priority routing and multicasting in a B-VON**
- **applicability and benefit of almost-optical networks**
- **performance comparisons of control/switching paradigms**

OBS Publications (http://www.acsu.buffalo.edu/~qiao)

- "A high speed protocol for bursty traffic in optical networks", in SPIE's All-optical Networking Conf, Vol. 3230, Nov'97
- a preliminary version appeared in IEEE/LEOS Summer Topical, Aug'97

Relevant Work on Polymorphic Control Over VONs

- "Polymorphic control for cost-effective design of optical Networks", in NSF/DIMACS Workshop on Multichannel Optical Networks, Mar'98
- "On Scheduling All-to-All Personalized Connections and Cost-Effective Designs in Bidirectional WDM Rings", in SPIE's All-optical Networking Conf., Vol. 2919, Nov'96
- "Efficient Distributed Control Protocols for WDM All-Optical Networks", in IC3N, Sept'97 (a preliminary version appeared in IEEE/LEOS Summer Topical, Aug'96)