A solution for Synchronization Problem of Interconnected Metro Access and Metro Core Ring Networks

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Plan

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1. Introduction

■ Metropolitan Ring Networks: used to connect the high speed backbone networks with the high speed access networks.

■ Why Ring topologies are used for MAN?
- Construction and maintaining with low cost.
- Bidirectional rings inherently provide fast restoration.
- Statistical multiplexing of data traffic flowing from different nodes over the shared medium.
- Efficient utilization of optical fibers.
- Reduces the infrastructure cost.

■ Necessity for a scalable architecture to support increasing traffic and their different characteristics.

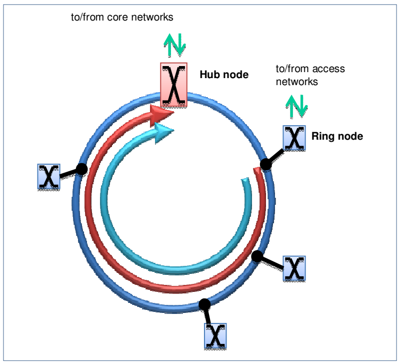
1. Introduction (Cont.)

DBORN (Dual Bus Optical Ring Network)

Characteristics:
- Double Ring Topology.
- Spectral separation (up/down-stream).
- Packets received by Hub node.

Advantages:
- Reduce the cost of building and maintaining the network (use passive components).
- Statistically multiplexed optical packets.
- Simplify the routing protocol.

Disadvantages:
- No fairness between access nodes.
- Fragmentation of bandwidth.
- Positional priority.



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1. Introduction (Cont.)

ECOFRAME (**E**léments de **Co**nvergence pour les **F**uturs **R**éseaux d'**A**ccès et **Mé**tropolitains à haut débit) **(French Research Project)**

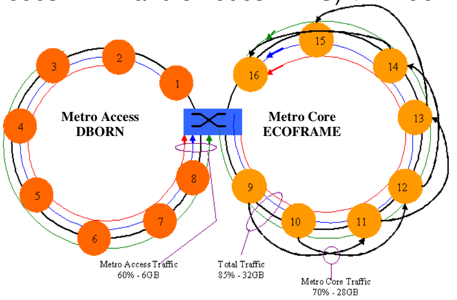
- **Characteristics:**
  - •Synchronous Ring Topology .
  - •Bidirectional ring structure – 2 fibers.
  - •Fixed optical packet size.
  - •Fixed maximun emission rate for each station.
  - •Separately data and control channels.

- **Advantages:**
  - •Synchronous slotted transmission mode.
  - •Fixed-size optical packets.
  - •Transit traffic bypass intermediate nodes transparently.
  - •Using POADM, ring nodes can directly receive and/or transmit data on the ring.

2. Interconnection of Rings

Studied Architecture:

- ▪Two segments: Metro Access (MA - DBORN) and Metro Core (MC - ECROFRAME).
- ▪Interconnection via Hub node.
- ▪16 nodes (8 nodes in MA and 8 nodes in MC) + 1 Hub node



2. Interconnection of Rings (Cont.)

Studied Architecture:

- Two traffic flows:
  - a) the traffic flowing from the MA to the MC through the hub.
  - b) the traffic flow circulating in the MC.

- Mechanisms of creation of new optical packets at HUB:
  - Optical packets coming from different access nodes can be combined together in the electronic domain (O/E/O).
  - Combined with local electronic packets at the hub (O/E/O).
  - Two combinations mentioned, totally according to class of service.
  - Combinated MA packets and MC packets according to their CoS and destination.

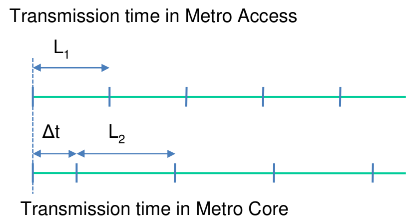
3. Packet creation mechanisms

- **CoS-Upgrade Mechanism (CUM):**
  - Principale: Upgradeting lower priority packet putting into higher priority packet.
  - Improving the filling ratio of the packets.
  - Used for the access nodes and for the hub.
  - Use of static or dynamic timers.
- **Common-Used Timer Mechanism (CUTM):**
  - CUTM has two processes:
  1. Taking optical packet arrived, open it and convert it into electronic packet. After that, the electronic packet will be put to the buffer corresponding to their CoS. If there is a timer running, no new timer is created until this timer has expired.
  2. Electronic packets are selected one after another from the queue in order of priority until the optical packet is full or there is not packet in the queue.
- **Opportunistic Mechanism**

4. Synchronization of Rings

Synchronization Problem:

- The correlation of the variables L1(transmission time of a packet in MA) and L2 (transmission time of a packet in MC).
- The impact of synchronization shift Δt on the network performance.



5. Simulation Scenarios

Classes of Service

	CoS 1 – CoS 2 Premium		CoS 3 – CoS 4 Silver		CoS 5 – CoS 6 Bronze		CoS 7 – CoS 8 Best Effort	
% CoS	10.4%	10.4%	13.2%	13.2%	13.2%	13.2%	13.2%	13.2%
Electronic Packet Size (Octet)	810	810	50 500 1500	50 500 1500	50 500 1500	50 500 1500	50 500 1500	50 500 1500
Source	CBR	CBR	MMPP	MMPP	MMPP	MMPP	MMPP	MMPP
Buffer size	1600 KOctets		4000 KOctets		4000 KOctets		8000 KOctets	

5. Simulation Scenarios (Cont.)

Simulation Scenarios

	Scenario 1		Scenario 2		Scenario 3	
	Metro Access	Metro core	Metro Access	Metro core	Metro Access	Metro core
Bit rate	10Gb/s	10Gb/s	10Gb/s	40Gb/s	10Gb/s	40Gb/s
Optical packet size	10µs – 12500 octets	10µs -12500 octets	10µs –12500 octets	5µs – 25000 octets	10µs – 12500 octets	10µs – 50000 octets
Load	35% - 3.5Gb	50% - 5Gb	60% - 6Gb	70% - 28Gb	60% - 6Gb	70% - 28Gb
Node traffic	437.5Mb/s	2.5Gb/s	750Mb/s	14Gb/s	750Mb/s	14Gb/s

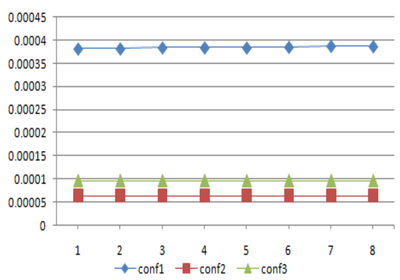
5. Simulation Scenarios (Cont.)

QoS Requirements

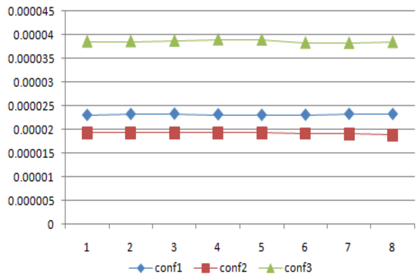
Class of service	Characteristic of service	Service Performance		
		Loss rate	Delay	Jitter
Premium	Telephone or real-time video application	< 0.001%	<5ms	< 1ms
Silver	Applications require less loss and delay	< 0.01%	<5ms	N/S
Bronze	Applications require guaranteed bandwidth	< 0.1%	<15ms	N/S
Best Effort	Applications not requiring guarantees	< 0.5%	<30ms	N/S

6. Numerical Results

Waiting Time in the Hub vs. Node rank (Δt =1µs)



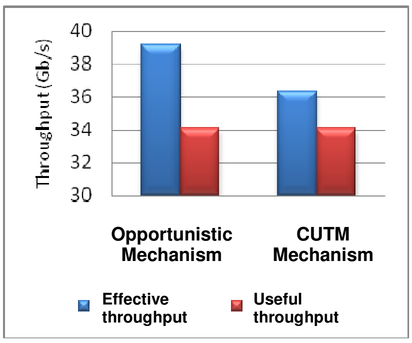
a) CUTM Mechanism



b) Opportunistic Mechanism

6. Numerical Results (Cont.)

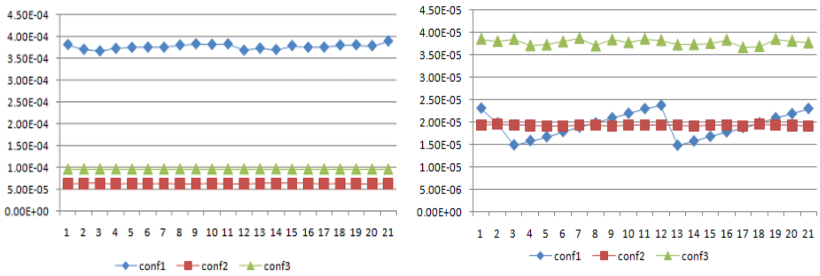
Throughput for Scenario 3



6. Numerical Results (Cont.)

Impact of Δt in varying from 1µs to 21µs (20µs = 2 x L2)

Waiting Time in the Hub vs. Δt



a) CUTM Mechanism b) Opportunistic Mechanism

7. Conclusions

- We have studied and analyzed the performance of interconnected MAN rings (MA and MC).
- Performance comparison of two mechanisms: Opportunistic and CUTM.
- CUTM mechanism solves the problem of synchronization and provides good network utilization.
- CUTM is independent of the correlation between L1&L2, but depends on the core network capacity.
- Performance of opportunistic mechanism does not depend on core network capacity. It uses less network resources.
- There is not a real impact of Δt on the network performance. Variation in waiting time at hub is very small.

Thank You

QUESTIONS?