A proposal for a new MPCP mechanism to achieve higher utilization

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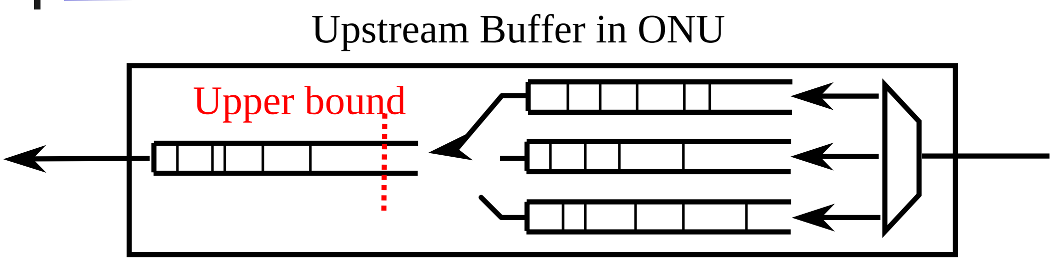
Motivation

• Bandwidth assignment loss deteriorates upstream utilization.
• To solve the problem, introducing queue thresholds (upper bounds) in ONU has been proposed [1, 2].
• We found that carefully managing upper bounds can further enhance upstream efficiency.
• The managing issues of upper bounds, however, have not been sufficiently argued.
• The main purpose of this presentation is to
    • clarify upper-bound handling issues and
    • propose a new MPCP mechanism for achieving higher utilization.

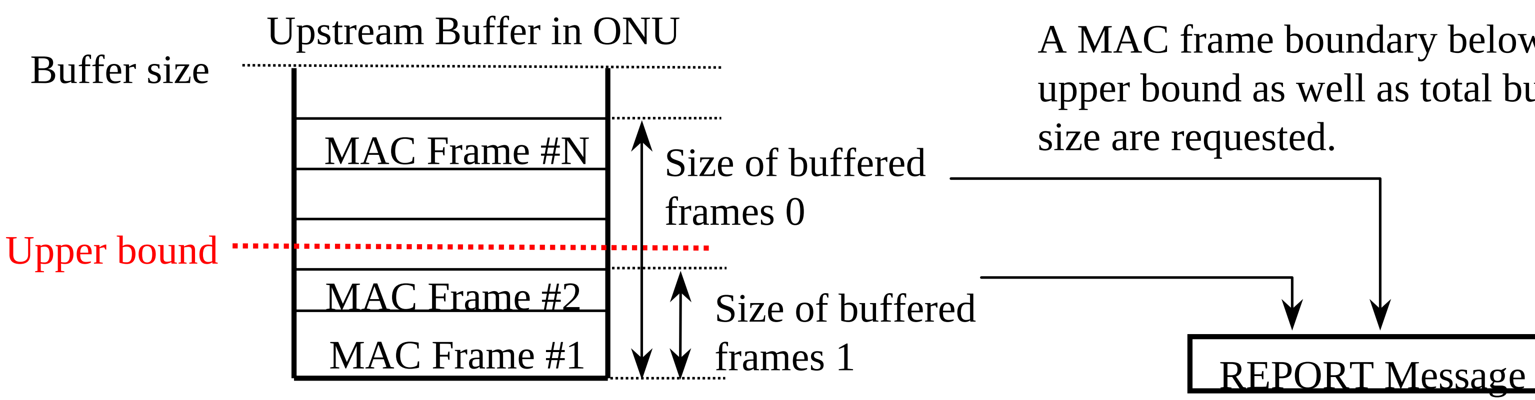
Upper bounds



A MAC frame boundary below upper bound is requested.

(source: Fig. 8 in [1])

A MAC frame boundary below upper bound as well as total buffer size are requested.



(source: [2])

Discussions

Q1) When upper bounds should be set?

- At initial setting by operator (constant upper bound)
- At negotiation of registration process (constant upper bound)
- While operation (variable upper bound)

Q2) How frequently upper bounds should be changed?

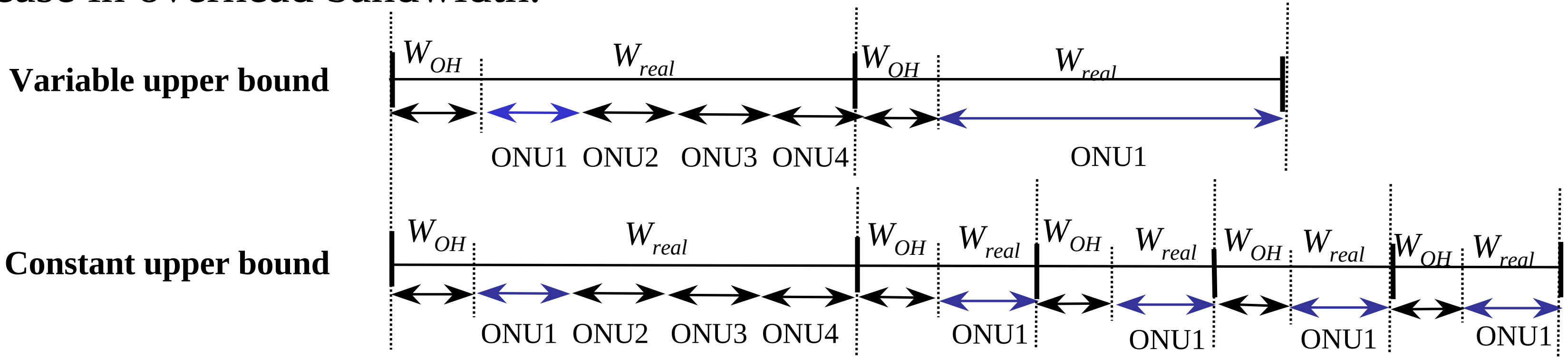
- Ideally in the order of millisecond.

Q3) How to distribute upper bounds from OLT to ONUs?

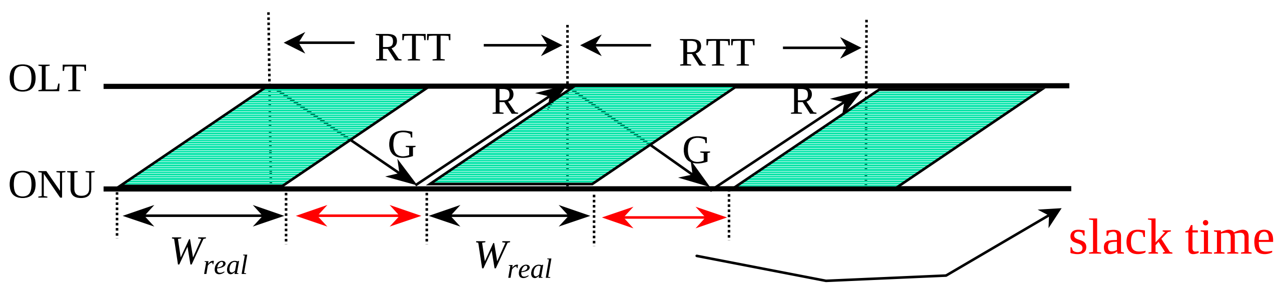
- Currently, no specific method is defined.

Upper bounds: variable or constant

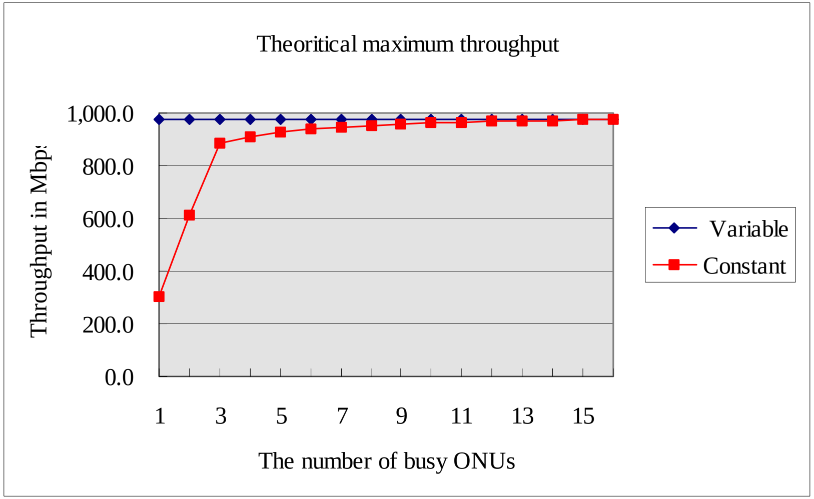
(a) A small number of busy ONUs causes cycle time shrunk, which can lead to an increase in overhead bandwidth.

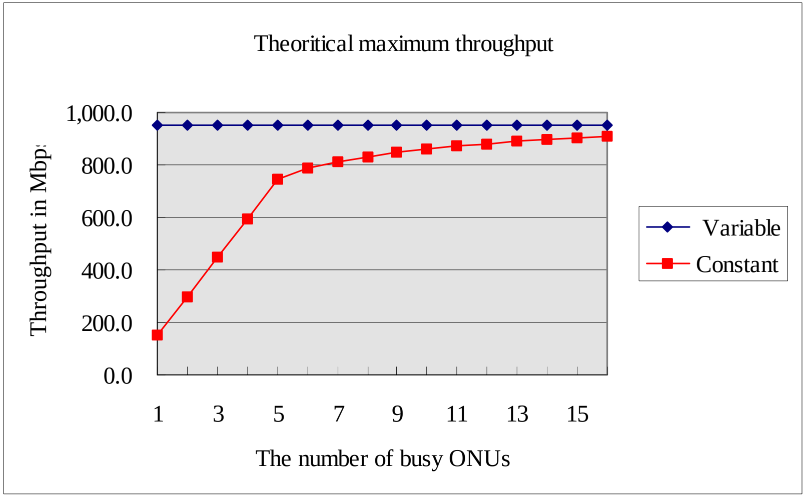


(b) Cycle time cannot be smaller than RTT.



Upper bounds: variable or constant (contd.)

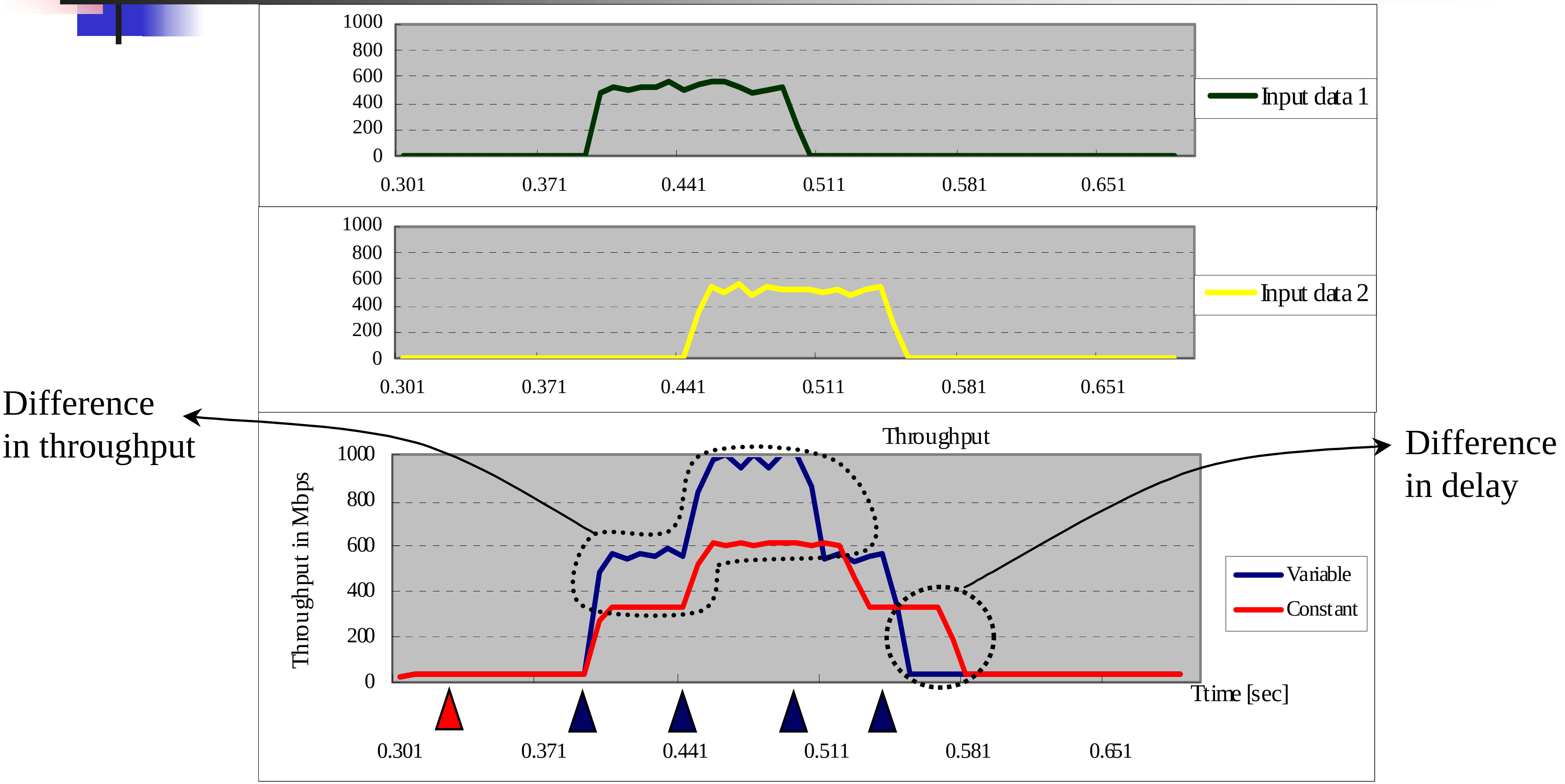




Guard time = 1.0 usec
Maximum cycle time = 1.0 msec
RTT = 200usec
Line rate = 1,000Mbps
Length of report message = 64Byte
Max number of ONUs = 16

Guard time = 1.0 usec
Maximum cycle time = 1.0 msec
RTT = 200usec
Line rate = 1,000Mbps
Length of report message = 64Byte
Max number of ONUs = 32

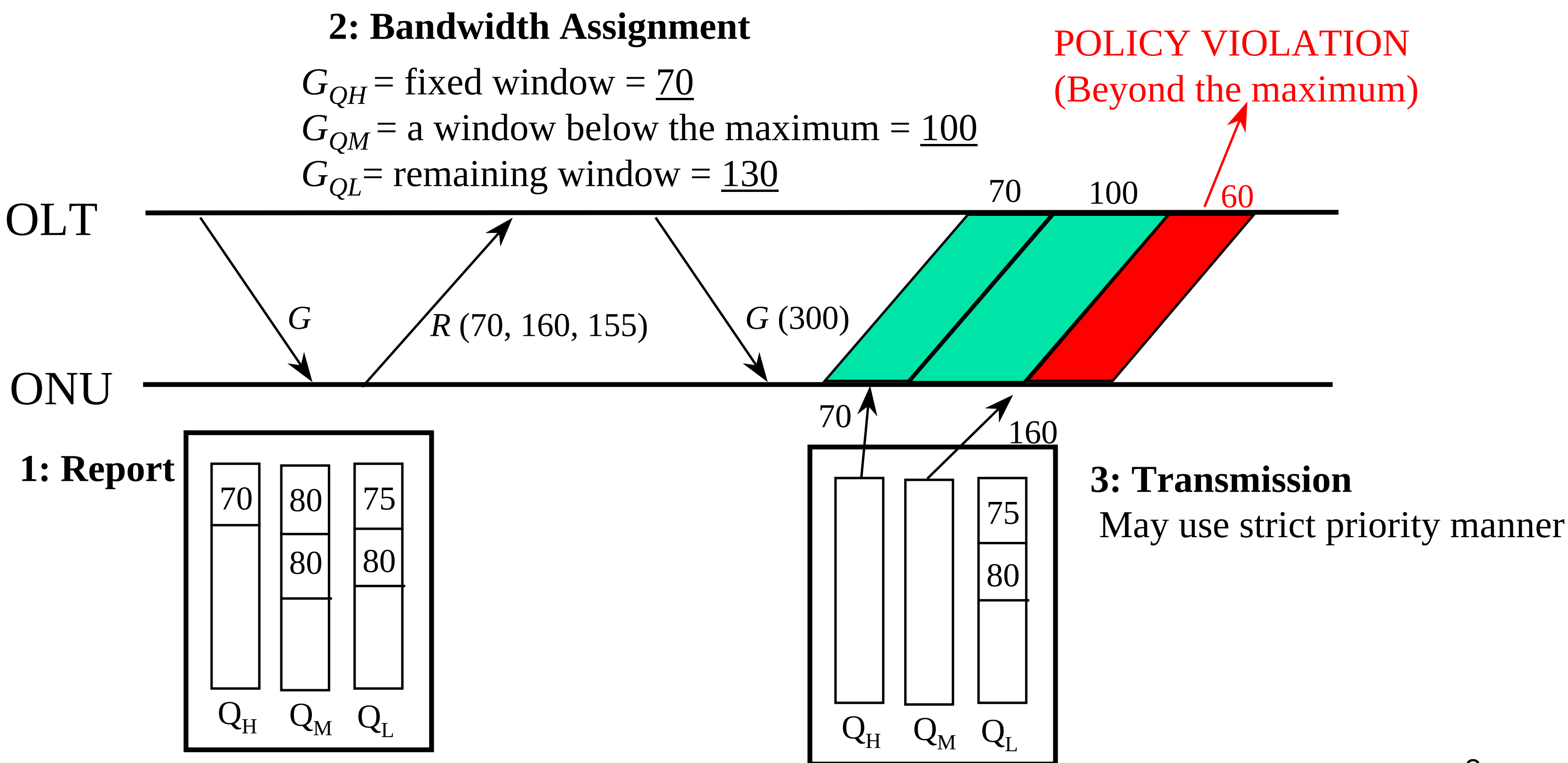
Upper bounds: simulation



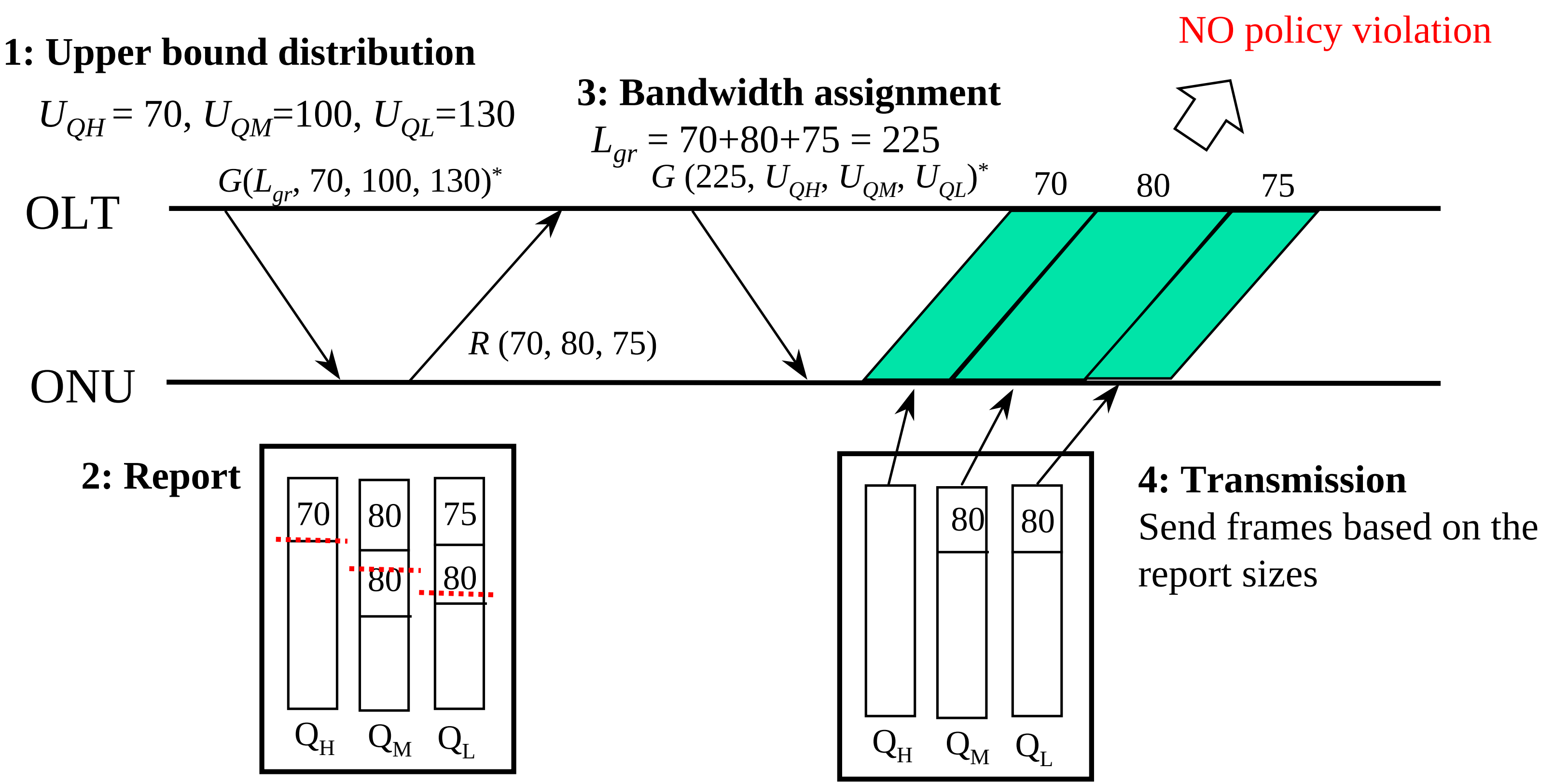
Time when upper bounds are changed

Multiple Queues: problem

Since the gate message specifies the total length granted, if OLT and ONU use different scheduling algorithms, a problem may occur.



Multiple Queues: remedy



* $G(L_{gr}, U_{QH}, U_{QM}, U_{QL})$, where L_{gr} is the grant length, and U_{QH}, U_{QM}, and U_{QL} are upper bounds

Proposed format of the Gate message

Proposal 1

64 octets

Field	Octets
Destination Address	6
Source Address	6
Length/Type = 88-08	2
Opcode = 00-02	2
Timestamp	4
Number of grants/Flags	1
Grant #1 Length	2
Grant #1 Start time	4
Grant #2 Length	0/2
Grant #2 Start time	0/4
Grant #3 Length	0/2
Grant #3 Start time	0/4
Grant #4 Length	0/2
Grant #4 Start time	0/4
Bound bitmap	0/1
Bound #0	0/2
Bound #1	0/2
Bound #2	0/2
Bound #3	0/2
Bound #4	0/2
Bound #5	0/2
Bound #6	0/2
Bound #7	0/2
Pad/Reserved	0/33
FCS	4

Fields defined as Pads/Reserved in draft 1.0

- Two option fields are proposed.
  - **Bound bitmap** indicates which bounds are represented. If this field shows zero, no bound fields appear. This is the same concept of report bitmap in the report message.
  - **Bound #i** represents the upper bound of queue #i. The resolution is 64bits.
- The IDLE sequence counter field is omitted, since this is *normal gate*.

Proposed format of the Gate message (contd.)

Proposal 2

64 octets

Field	Octets
Destination Address	6
Source Address	6
Length/Type = 88-08	2
Opcode = 00-02	2
Timestamp	4
Number of grants/Flags	1
Grant #1 Length	2
Grant #1 Start time	4
Grant #2 Length	0/2
Grant #2 Start delay time	0/3
Grant #3 Length	0/2
Grant #3 Start delay time	0/3
Grant #4 Length	0/2
Grant #4 Start delay time	0/3
Bound bitmap	0/1
Bound #0	0/2
Bound #1	0/2
Bound #2	0/2
Bound #3	0/2
Bound #4	0/2
Bound #5	0/2
Bound #6	0/2
Bound #7	0/2
Pad/Reserved	1/33
FCS	4

Fields defined as Pads/Reserved in draft 1.0

- Start time #2, #3, and #4 are now changed to start delay time, which indicates time difference in 16 bits time from the previous start time.
- Grants must be ordered in start time.
- The meanings of bound bitmap and bound are the same as the previous proposal.
- The IDLE sequence counter field is omitted, since this is normal gate.

Summary

- We analyzed the managing issue of upper bounds, which has not been sufficiently argued.
- Through our analysis and computer simulation, having upper bounds changed dynamically can cause higher efficiency.
- In addition, the variable upper bound mechanism shows the validity for overcoming the multiple queue problem.
- In order to distribute upper bounds, two extensions to the Gate message are proposed.

References

[1] G. Kramer, B. Mukherjee, S. Dixit, Y. Ye, and R. Hirth, “Supporting differentiated classes of service in Ethernet passive optical networks,” Journal of Optical Networking August&September 2002, pp. 280-298.

[2] O. Yoshihara, Y. Fujimoto, N. Oota, and N. Miki, “High Performance EPON,” IEEE 802.3ah meeting in November 2001. <http://grouper.ieee.org/groups/802/3/efm/public/nov01/yoshihara_1_1101.pdf>