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Mohamed Maher

Ethernet passive optical networks erformance optimization.An extensive comparative study for DBA algorithms

Passive Optical Network

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EPON performance optimization: An extensive comparative study for DBA algorithms

Mohamed Ahmed Maher Awad

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ABSTRACT

Dynamic bandwidth allocation in Ethernet passive optical networks (EPON) presents a key issue for providing efficient and fair utilization of the EPON upstream bandwidth while supporting the quality of service QoS requirements of different traffic classes. Rare literatures have addressed a qualitative and quantitative comparison of large numbers of DBA algorithms based on their performance indicators.

This thesis provides a detailed comparison and a classification study for a large number of DBA algorithms with respect to time delay and throughput as performance indicators. The study shows that IPACT WITH CBR, UDBA, IPACT with two stages and CPBA are the optimum DBA algorithms regarding both time delay and throughput at highly loaded scenarios.

These algorithms are enrolled in a parametric optimization process targeting performance enhancement at highly loaded scenarios this increasing upstream line rates, changing distance between the OLT (Optical Line Terminal) and ONU (Optical Network Unit), increasing size of an Ethernet packet and changing maximum cycle time to 1 ms and altering guard time value).

This process reduces time delay around 3.5% for IPACT WITH CBR, 1.725% for UDBA, 1.167% for IPACT with two stages and (1.167% for CPBA. Also, the optimization increases the throughput by 1.3% for IPACT WITH CBR, 1.795% in UDBA, 2.5% for IPACT with two stages and 1.684% for CPBA.

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LIST of SYMBOLS

$\mathring{A}$	Amount of bit rate for ONU to OLT (Mb/s)
B^M	Minimum guaranteed bandwidth
B_{req}	Requested bandwidth
B_{excess}	Excessive bandwidth
B_{eth}	Ethernet overhead in bits
B_{req}	REPORT/GATE message size in bits
$b_{i,c}^{fix}$	Fixed bandwidth
$b_{i,c}^{min}$	Minimum guaranteed bandwidth
$b_{i,c}^{max}$	Maximum bandwidth limitation
$D_i^{ONU}(t)$	Measure of maximum time (delay time)
Đ	Distance between OLT and ONUs (km)
D_{GRANT}	Delay for GRANT
D_{IPACT}	Delay in IPACT
D_{POLL}	Delay for POLL
D_{QUEUE}	Delay for QUEUE
$\acute{E}$	Ethernet overhead (bits)
Gci	Total window size granted
N	Number of ONUs
Nci	Number of ONUs in class *i*
P	Packet size (bits)
R_{bps}	Transmission speed of the EPON
$\check{R}$	Request message size (bits)
R_T	Total upstream bandwidth.
Ri	Requested window size of class *i*
R_U	Upstream data rate in bits per second
T_{cycle}	cycle time
T_g	Guard intervals
TCm	Max cycling time (ms)
W	Windows size for report message (Byte)
W_{max}	Maximum data transmission window size in packets
$\prod_i^{ONU}$	Payoff amount that ONU_i declares as its request for the bandwidth
α	Weight factor
β	Function of parametric bid
β	Buffer size (M byte)
λ_s	Separate wavelength

LIST of ABBREVIATIONS

AAL	ATM Adaptation Layer
AF	Assured Forwarding
ATM	Asynchronous Transfer Mode
AWG	Arrayed Waveguide Grating
BE	Best Effort
BG	Bandwidth Guaranteed
CAC	Call Admission Control
CM	Cable Modem
CO	Central Office
CoS	Class-Of-Service
CPBA-SLA	Cyclic-Polling-Based DBA Scheme with Service Level Agreement
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
DBA	Dynamic Bandwidth Allocation
DPoE	DOCSIS Provisioning of EPON
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
EDA	Even Distribution Algorithm
E-DSA	EPON Dynamic Scheduling Algorithm
EF	Expedited Forwarding
EPONs	Ethernet Passive Optical Networks
FCE	Fuzzy Credit Estimator
FPS	Full Priority Scheduling
FSAN	Full Service Access Network
FTTB	Fiber To The Building
FTTC	Fiber To The Curb
FTTH	Fiber To The Home
FUDLC	Fuzzy Unstable Degree List Controller
GEM	GPON Encapsulation Method
GPON	Gigabit-capable Passive Optical Networks
HFC	Hybrid Fiber Coaxial
IEEE	Institute of Electrical and Electronics Engineers
IFG	Inter-Frame Gap
IP	Internet Protocol
IPACT	Interleaved Polling with Adaptive Cycle Time