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TDM and WDM based FTTX networks

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Abstract

Passive optical network is the primary solution for next generation access networks. It should have the property of low cost, high efficiency and maintain quality of service. A PON be articulated by an Optical Line Termination (OLT) at the communication company's office and a number of Optical Network Units (ONU) close by end users. Usually, up to 32 ONUs can be linked to an OLT. The passive or quiet easily defines the truth that optical transmission has no power requisite or active electronic elements once the signal is going through the network. PON architectures and various dynamic bandwidth allocation algorithms are studied. The major explicit benefit of the PON network is the exclusion of the outdoor active devices. Bandwidth allocation is very essential concern in PON. For a network to be capable it should have a very effectual bandwidth allocation algorithm. In addition, the bandwidth can be ascribed by two modes static or dynamic. The DBA techniques are categorized into two groups with quality of service support and without QoS support. Supporting QoS globally offers a lot of benefits mainly to the real time traffic. The delay and jitter of high priority traffic can be reduced and thus the overall performance is improved. The drawback of the DBA algorithms that do not support QoS is that they do not support the service differentiation needs of the customers. This will cause delay in real time traffic and hence the overall performance of the system will derogate.

Index Terms— DBA algorithms with QoS support, Dynamic Bandwidth Allocation in Passive Optical Network, PON architecture, EPON-Protocol

1. INTRODUCTION

Telecommunications is possibly the fastest growing field of study now a days. It is constantly offering new challenges and opportunities to telecommunications network planners [1].Digital Subscriber Line (DSL) and (CM) Cable Modem networks are the primarily deployed broadband solutions for telecommunication networks. Even though they are improvements over modems, still they are incapable to provide enough bandwidth for on-going services and bandwidth required applications like as online computer games, music and multimedia, video conferencing, online banking, social networking etc. The Optical network is a key in for DSL and CM trouble domains by offering services for users located ahead of 20 km. The Passive Optical Network (PON) is the most capable candidate for an optical network [2]. PON is able to reduce the packet loss and queuing delay in case of congestion and increasing downlink through put by up to 50% in inter-ONU communication without changing the PON hardware [3]. Passive optical network consist of OLT (Line Termination) and many ONU's (Optical Network Units***)*** consisting only the passive components like splitter all the way along from OLT to ONU. For the downstream direction it is like a point-to-multipoint network a passive splitter acts as a 1: N splitter. Downstream direction is like convey system in which information is broadcasted to all ONU the ONU keeps the information relating to it and rejects everything else. But for the upstream direction the network is multipoint-to-point network. Thus all the ONU's shares the solitary medium to correspond with the OLT [4].

1.1Access Networks:

It is that component of a telecommunications network which conjoin subscribers to their immediate service provider. The title access network point out to the network between the local exchange and the subscriber. In a lot of countries this network is still primarily made up of the copper cable based point to point connections .The technology has not changed to a great extent throughout the last many decades even with considerable changes have been introduced in the field of switching and transport.
With the accession of digital technology, the procedure of installation, maintenance has turn into less cumbersome and quality of services has enhanced.

1.1.1 FTT-X Technologies

The three methods which are generally used ,obtain their name from the location of the remote terminal equipment.
(a) Fibre to the Curb (FTTC), in this the terminal equipment is positioned on the curb, from where it would be expedient to serve a appropriate service area. As the distribution would still be copper, appropriate place for the terminal would be one which upgrades the cost, decrease back-feeding, diminish distribution cost and keep safety factors into consideration .
(b) Fibre to the building (FTTB), in which the terminal equipment is positioned within a multi-storeyed building, this conveys higher bandwidth nearer to the subscriber. The distribution part is still copper .
(c) Fibre to the home/Office (FTTH/FTTO), in this method the fibre escalates to the subscriber premises.

1.2 Dynamic Bandwidth Allocation in Passive Optical Network:

As traffic on the individual links in the access networks is quite busy so there is a need of Dynamic Bandwidth Allocation. Because of busy nature, the bandwidth requirements alters rapidly with time. Dynamic bandwidth allocation (DBA) is one of the vital issues in the design of the EPON system. The DBA methods are categorized into two groups; with quality of service (QoS) support and without QoS support as shown in figure1.

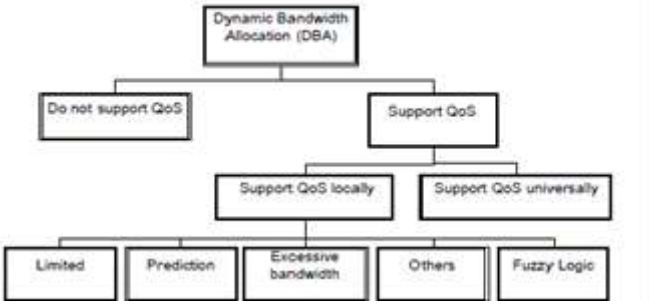

Fig.1. DBA Taxonomy

1.2.1 DBA algorithms without QoS support:

The first DBA algorithm for EPON is Interleaved Polling with Adaptive Cycle Time (IPACT). In (IPACT), the OLT polls ONUs and grants the bandwidth to each ONU in a round-robin fashion according to the ONU's bandwidth demand. Each ONU is served once per round-robin polling cycle. The length of the polling cycle is not fixed where it adapts to the bandwidth requirements of the ONUs.

1.2.2 DBA algorithms with QoS support:

Using one LLID per ONU method DBA with Multiple Services algorithm that combines limited scheduling in inter ONU allocation with non-strict priority scheduling in intra ONU allocation. Non-strict priority scheduling conveys only the previously reported packets, even though additional top-priority packets reach after the last REPORT was sent [5].

The shortcoming of the DBA algorithms that do not support QoS is that they do not support the service differentiation needs of the subscribers. This causes delay in real time traffic and thus, the overall performance of the system degrades [5].in order to provide end-to-end QoS and elude bandwidth wastage as well as data collision crucial efficient solutions for bandwidth allocation is dmandatory. Different ways for multiple accesses to the upstream shared bandwidth for EPONs are showed in Fig.2 and specified as follows.

•Wavelength Division Multiplexing (WDM)
•Contention-Based Media Access
•Time-Sharing Access
•Decentralized-Based Dynamic Slot Assignment
•OLT-Based Static Allocation (SBA) Scheme
•OLT-Based Dynamic Allocation (DBA) Scheme
•DBA, Non-Prediction Scheme
•DBA, Prediction-Oriented Scheme [2]

1.3 PON architecture:

A PON generally has a physical tree structure, where one optical line terminal (OLT) located at the central office of the service provider attached to several optical network units (ONUs) in the field. The OLT is associated to the ONUs with a feeder fiber that is consequently split using a 1 : *N* optical splitter/combiner to allow the ONUs to share the optical fiber.
There are two alternative PON architectures: the TDM-PON and the WDM-PON that are illustrated in Fig. 3(a) and (b), respectively. In the TDM-PON scenario, a single wavelength is used to join all the users to the CO and a different time slot is allocated to each user [6]

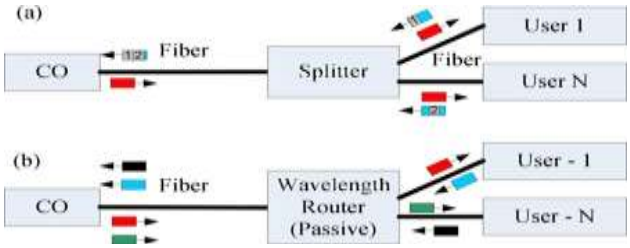

Fig.2. PON architecture: (a) TDM-PON and (b) WDM-PON [6].

(TDM PON) Time Division Multiplexed Passive Optical Network was actualized using P2MP (Point-to-Multipoint) network architecture. The TDM PON cannot exist with the requirements of future network growth with respect to accumulated bandwidth and the acceptable power budget. Furthermore, it is able to assist only a small number of users with small speed and for short distances. WDM in a PON assent one to support higher bandwidth while each wavelength is dedicated to a single subscriber. The WDM PON offers other advantages just as easiness of management and upgradability, sturdy network security, high flexibility with data and protocol transparency [7].

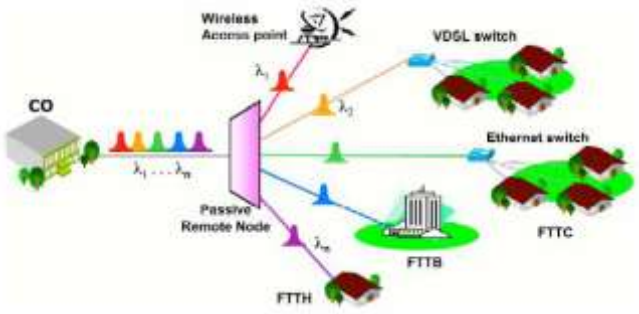

Fig.3. WDM-PON supports multiple services [8]

Figure 3 illustrates the general construction for WDM-PON. As can be seen in the figure, WDM-PON can be assumed as general-purpose construction that can deliver multiple applications for multiple users [8].

1.4 EPON-Protocol:

Multi-Point Control Protocol (MPCP) was expanded by the IEEE 802.03ah task force to maintain time slot allocation for multiple ONUs in EPONs. MPCP used two crucial control messages: REPORT and GATE to achieve the bandwidth allocation process. It also uses DISCOVERY messages which contain three sub-messages namely: REGISTER_REQ, REGISTER and REGISTER_ACK these are correspondingly used to help a new ONU connect the EPON environment [2].

LITERATURE SURVEY

Er. S. Sharma et al.(2013) explained a proficient PDF based DBA algorithm which uses the last recent polling table used for the current allotment of the bandwidth among the ONU's vigorously. This idea early allocates the bandwidth to the ONU's requesting bandwidth less than minimum guaranteed bandwidth and ONU's demanding bandwidth greater than minimum guaranteed whose PDF in the last polling table is more than threshold value. It allocates excess bandwidth of lightly loaded ONU's to the wholly loaded ONU's. This algorithm uses the early assignment concept thus incorporates the inactive period. Through simulation experiments, it is shown that the proposed algorithm can

significantly improve the network presentation in terms of queue length, bandwidth utilization and packet delay under high traffic load .

N. Moradpoor et al. (2008) this paper includes a full implementation of a sample EPON environment assuming the standard messages, protocols and structures as well as the modeling, simulation and performance analysis of the preferred bandwidth allocation algorithms. This work presents detailed network architecture for the EPON environment and its most difficult issues for the first time. Simulation results reveals that the suggested test-bed provides smooth insertion of the different bandwidth allocation algorithms for EPON and can be selected as the standard model for more research and investigations.

Pei Hsien Wei et al. (2013) An proficient dynamic bandwidth allocation (DBA) algorithm for multiclass services called MSDBA is proposed for next-generation (TDM) time division multiplexing passive optical networks with network coding (NC-PON).
Numerical analyses and simulations for performance estimate are accomplished in 10 Gbps Ethernet passive optical networks (10G EPON), which is a standardized solution for next-generation EPON. Valuation results show that compared with the existing two DBA algorithms deployed in TDM NC-PON, MSDBA not only demonstrates better presentation in delay and QoS support for all classes of services but also attains the maximum end-to-end wait fairness between coded and uncoded lower-class services and guarantees the end-to-end holdup bound and fixed polling order of high-class services by compromising their end-to-end delay fairness for compromise.

Fong-Ke Shen et al.(2014) author proposed a Ethernet Passive Optical Network (EPON) is constituted by Ethernet in the First Mile (EFM), with data encapsulated in Ethernet frames. But the lack of bandwidth allocation and guarantee will be the fatal problem of EPON. They proposed a dynamic allocation with bandwidth guaranteed (DABG) method which based on fix slot time and dynamic repartition surplus bandwidth to support bandwidth guaranteed for every Optical Network Unit (ONU). They then analyzed the performance under varying offered loads to verify average packet delay, bandwidth satisfaction, and queue size utilization.

Nurul Asyikin Mohd Radzia et al.(2014) introduces the elementary concepts on EPONs, its protocol and its bandwidth allocation. We also collect and classify the research works in order to supply the state-of-art of the DBA algorithms. The advantages and disadvantages of every classification is provided. The classifications present insightful presentations of the prior work on EPONs which will help the researches to choose the most accurate algorithm as according to the needs.

Theodore Rokkas et al. (2012) a system-of-systems (SoS) technique for wave length division multiplexing (WDM) and time-division multiplexing (TDM), (FTTH) fiber-to-the-home telecommunication networks is described. Cost evolution curves for individual systems as well for complete FTTH WDM and TDM networks are presented. The study can be exploited for a fast and accurate analysis of FTTH operation outlay in dense urban, urban, and suburban areas from the techno economic point of view, which is of paramount significance for telecom operators, apparatus vendors, regulators, and policy makers. The impact of delaying the deployments or adopting various rollout strategies is also investigated and presented. The SoS emergent behavior is further revealed using exploratory modeling. The results disclose that in all cases, the WDM solution is more expensive than TDM. The total cost for suburban region is almost six times higher than in dense urban areas and four times than urban areas.

Jisha V. S.et al. (2015) (TDM) Time Division Multiplexing and Wavelength Division Multiplexing (WDM) are the most popular multiplexing methods, all of these multiplexing methods has its own pros and cons. Time division multiplex is able to serve only a small number of users with low speed, however, for reasonable prices. On the other hand, wavelength division multiplex can supply a high number of contestants but its price is much higher. In light of these different properties, there is an effort to make a Hybrid WDM/TDM network that would have positive characteristics of both of these multiplexes and at the similar time would meet the characteristics of the Passive Optical Network (PON). Hybrid WDM/TDM PON have been replicated using NRZ, RZ and Manchester coding for various bit rates, input power and fiber lengths. The entire topology design was achieved using the OptiSystem version 12 software**.**

Nik Shahidah Afifi et al.(2008) (WDM-PON)Wavelength Division Multiplexed Passive Optical Network is generally an extreme efficient future proof optical transport technology used in evaluate and Metro transport networks. It enables highly efficient use of the outside fiber plant by supplying point-to-point optical connectivity to multiple remote locations through a single feeder string. little parameters such as bit rate, power transmit**,** and fiber length should be considered because it will impact the system performance. Therefore, the purpose of this paper is to identify the best length and suitable bit rate in WDM-PON construction for star architecture with 64 end users. This project is focusing on one design parameter beside two performance parameters; distance vs. (BER) bit error rate and distance vs. power received at various bit rates. The simulation results are formed using Optisystem 6.0. From the experimental results, the performance of WDM-PON can be impacted by various parameters.

Deepak Malik et al.(2011) evaluated and compared the performance gains by using independent multicast data streams on a time-division-multiplexed and wavelength-division-multiplexed passive optical network in a 32 users. Simulation work revealed that performance gains of around 25km in terms of system reach and up to 10Gbps in term of data carrying capacity per user could be attained.

Nitish Verma et al.(2011) evaluated the performance of the FTTH Gigabit Ethernet Passive Optical Network (GEPON) system with triple play services such as video broadcast at 1550 nm and voice over IP and high speed internet at 1490 nm with 1:32 splitting is evaluated using FEC technique. By using the FEC (Forward Error Correction) technique the transmission distance of fiber was increased from 20 Km to 30 Km and data rate was increased from 1.25 Gb/s to 2.50 Gb/s. The performance characteristics like bit error rate, quality factor, dispersion, optical power and eye diagrams were studied by simulating different systems.

S. Rajalakshmi et al. (2011) analysed and estimated the performance achieved by TDM PON and WDM PON using Different Coding Schemes by the use of 16 users in Optical Network Unit (ONU) receiver side. Simulation work estimated the gain performance achieved up to 10Gbps in terms of data capacity per ONU and distance at 100 km in terms of system reach at the downstream direction in the receiver side.

Yinghui Qiu et al. (2012) proposed a new DBA algorithm to support QoS and to achieve higher performance. This algorithm

could avoid bandwidth wastage result from dynamically allocation from differentiated services and unused bandwidth.

Rakesh Goyal et al.(2012) analyzed the performance and feasibility of a hybrid wavelength division multiplexing time division multiplexing passive optical network (WDM/TDM) PON system with 128 optical networks units (ONUs). In the proposed network, the triple play services (video, voice and data) were successfully transmitted to a distance of 28 km to all ONUs.

Anurag Sharma et al.(2016) investigated the performance of Fiber-To-The-Home (FTTH) triple play Gigabit Ethernet Passive Optical Network(GEPON) using different modulation formats, varying data rates, number of users and link lengths. First of all the architecture was investigated for different modulation formats and analyzed that CRZ-DPSK gives better response because using this format as we increase the number of users, the system response becomes better at increasing data rates.

Mahmoud M. Al-Quzwini et al.(2014) presented a step by step design and field implementation of a protected GPON FTTH access network serving 1000 users. The basic components of the network are presented and the contribution of each component to the architecture of the FTTH network is addressed. The design incorporates Class B protection, to provide redundancy in the feeder and GPON port, the practical implementation of a protected FTTH network is highly emphasized.

Ref. No.	Year	Tech/Method used	Findings
1	2013	efficient PDF based DBA algorithm	significantly improve the network performance in terms of packet delay, queue length, and bandwidth consumption under high traffic load
2	2008	implementation of a sample EPON environment	Gives standard model for smooth insertion of the different bandwidth allocation algorithms for EPON
3	2013	DBA algorithm for multiclass services called MSDBA	demonstrates better performance in delay and QoS support for all classes of services, also achieves the maximum end-to-end delay fairness between coded and uncoded lower-class services
4	2014	dynamic allocation with bandwidth guaranteed (DABG) method which based on fix slot time and dynamic repartition surplus bandwidth to support bandwidth guaranteed for every Optical Network Unit (ONU).	analyzed the performance under varying offered loads to verify average packet delay, bandwidth satisfaction, and queue size utilization
5	2014	fundamental concepts on EPONs, its protocol and its bandwidth allocation	The classifications provide perceptive presentations of the prior work on EPONs which will help to choose the most suitable algorithm as according to the needs.
6	2012	system-of-systems (SoS) approach for wavelengthdivision multiplexing (WDM) and time-division multiplexing (TDM) fiber-to-the-home (FTTH) telecommunication networks	the WDM solution is more expensive than TDM. The total price for suburban areas is almost six times higher than in dense urban areas and four times than urban areas
7	2015	Hybrid Time Division Multiplexing (TDM) and Wavelength Division Multiplexing (WDM)	would have positive properties of both of these multiplexes and at the same time would meet the characteristics of the Passive Optical Network (PON)
8	2008	Wavelength Division Multiplexed Passive Optical Network (WDM-PON)	Wavelength Division Multiplexed (WDM) in Passive Optical network (pon) allow one to support much higher bandwidth
9	2011	Time Division Multiplexing (TDM) and Wavelength Division Multiplexing (WDM)	performance gains of around 25km in terms of system reach and up to 10Gbps could be attained
10	2011	Forward Error Correction(FEC)	the transmission distance of fiber was increased from 20 Km to 30 Km and data rate was increased from 1.25 Gb/s to 2.50 Gb/s
11	2011	WDM and TDM PON using different coding schemes	Estimated the gain performance achieved up to 10Gbps in terms of data capacity per ONU and distance at 100 km
12	2012	a new DBA algorithm to support QOS	Avoid bandwidth wastage result from dynamically allocation from differentiated services and unused bandwidth.

13	2012	Hybrid WDM/TDM PON	triple play services (video, voice and data) were successfully transmitted to a distance of 28 km to all ONUs.
14	2016	Fiber-To-The-Home (FTTH) triple play Gigabit Ethernet Passive Optical Network(GEPON)	investigated for different modulation formats and analyzed that CRZ-DPSK gives better response
15	2014	GPON FTTH access network serving 1000 users	incorporates Class B protection, to provide redundancy in the feeder and GPON port

Conclusion

Based on MPCP PDF-polling bandwidth allocation algorithm for EPONs displayed that under moderate traffic load, the algorithm can appreciably enhance the network performance in sense of queue length, packet delay and Bandwidth utilization. An proficient DBA algorithm for multiclass service called MSDBA in next-generation TDM PONs with NC exhibit better scheduling delay, queuing delay, and end-to-end delay presentation and better QoS assist for differentiated classes of services in almost all cases evaluated and replicated, no matter the number of total ONUs, coded ONUs, and the ratio of bandwidth assigned to coded and uncoded ONUs vary. The maximum end-to end delay equality between coded and uncoded lower class services in MSDBA can be attained because of suitable scheduling schemes, while the end-to-end delay bound at more loads and fixed polling array of high-class services in MSDBA are guaranteed by compromise their end-to-end delay fairness for cooperation. Hybrid WDM/TDM PON offers a great potential and a very attractive solution for the future next generation access network. WDM-PON can provide more bandwidth over longer distances by assigning rawer optical bandwidth to each user, and by escalating the link loss budget of each wavelength, making it less responsive to the optical losses incurred at each optical splitter. This is the reason why WDM-PON is one of the promising technologies today because it is economic, easily upgraded, secured, and lastly it is convenient in testing and troubleshooting. It can be concluded that very classification has their pros and cons and can be implemented in different situations according to need.

References

1. S.Sharma,A.Singhal,"A PDF Based Dynamic Bandwidth Allocation Algorithm Using Last Recent Polling Table", International Journal of Application or Innovation in Engineering and Management, volume 2, Issue 7, pp. 174-180, 2013.

2. N.Moradpoor,G.Parr,S.McClean,B.Scotney,K.Sivalingam,"Sim ulation and Performance Evaluation of Bandwidth Allocation Algorithms for Ethernet Passive Optical Networks (EPONs)", OpnetWork 2010.

3. Pei Hsien Wei, Rentao Gu,"Dynamic bandwidth allocation algorithm for next generation time division multiplexing passive optical networks with network coding",Optical Engineering, Volume 52, Issue 8 August 2013.

4. Fong-KeShen,Fu-Hsiang Tsai,Hao-Dong Zheng,"Dynamic Allocation with Bandwidth Guaranteed over Ethernet PON",IEEE International Symposium on Computer, Consumer and Control, pp. 1119-1122, 2014.

5. Nurul Asyikin Mohd Radzi,Norashidah Md. Din,Mohammed Hayder Al-Mansoori, Sajaa Kh Sadon,"Recent Dynamic Bandwidth Allocation Algorithm Methods in Ethernet Passive Optical Network", International Journal of New Computer Architectures and their Applications, pp. 167-176, 2014.

6. Theodore Rokkas,Ioannis Neokosmidis,Dimitris Katsianis, Dimitris Varoutas, "Cost Analysis of WDM and TDM Fiber-to-the-Home (FTTH) Networks: A System-of-Systems Approach", IEEE Transactions on Systems, Man And Cybernetics Vol. 42, No. 6, pp. 1842-1853, 2012.

7. Jisha V. S. and Sunaina N., "Performance Analysis of Hybrid WDM/TDM PON",International Journal of Engineering Research & Technology Vol. 4 Issue 01, pp. 485- 488, 2015.

8. Nik Shahidah Afifi bt. Md. Taujuddin, Maisara Othman and Zarina Tukiran,"Optimization for the best Performance for Wavelength Division Multiplexed Passive Optical Network", Proceedings of EnCon2008 2nd Engineering Conference on Sustainable Engineering Infrastructures Development & Management , December 2008.

9. Deepak Malik,Ankur Singhal, "Performance Evaluation of Qos for Multicast Streams in Optical Passive Networks", International Journal of Electronics & Communication Technology Vol. 2, Issue 4,pp.220-224, 2011

10. Nitish Verma,Ankur Singhal, "Performance analysis of FTTH Gigabit Ethernet Passive Optical Network (GEPON) system with triple play services" International Journal of Electronics & Communication Technology Vol. 2, Issue 3,pp.154-160, 2011

11. S.Rajalakshmi, Ankit Srivastava, Ashish Pandey, "Performance Analysis of Receivers in WDM for Extended Reach Passive Optical Networks", International Journal of Computer Science Issues, Vol. 9, Issue 2, No 3, pp.217-222, 2012.

12. Yinghui Qiu, "A Dynamic Bandwidth Allocation Algorithm in EPON Networks",Journal of Theoretical and Applied Information Technology, Vol.44, No 2,pp.278-282,2012,

13. Rakesh Goyal,R.S.Kaler, "A novel architecture of hybrid (WDM/TDM) passive optical networks with suitable modulation format",ELSEVIER,Optical Fiber Technology,Issue 18,pp. 518-522, 2012.

14. Anurag Sharma,Hardeep Kumar,Harjitpal Singh , "Performance Analysis of Passive Optical Network based Fiber to the HomeT riple Play Architecture", International Journal for Science, Management and Technology,pp.12-16,2016.

15. Mahmoud M. Al-Quzwini, " Design and Implementation of a Fiber to the Home FTTH Access Network based on GPON",International Journal of Computer Applications,Vol. 92,No 6,pp.30-42,2014.