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이동 백홀 네트워크에서 QoS 기능

QoS Functions in Mobile Backhaul Network

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요 약 본 논문은 셀 사이트에서 다양한 트래픽을 수용하기 위한 이동 백홀 네트워크에서 QoS 기능에 관한 것이다. RAN 시스템의 스위칭 기능에 할당된, 이더넷 프레임, IP 패킷, 그리고 ATM 셀과 같은 트래픽은 세그먼트된 후 이동 백홀 네트워크로 전달되기 전에 캡슐화 된다. ISP는 표준의 pseudowire 캡슐화를 통하여 all IP RAN 상에 음성 및 HSPA와 같은 모든 세대의 트래픽을 통합할 수 있다. 이 것들은 다양한 QoS 방법뿐만 아니라 포괄적인 모니터링 및 진단 능력을 통하여 강화될 수 있다. 따라서 본 논문에서는 이와 같은 동작상에서 QoS 기능들이 서로 다른 캡슐 방법에 따라 시뮬레이션 되었다.

Abstract This paper addresses QoS functions in mobile backhaul network to accommodate the diverse traffics in cell site. The traffics assigned to the switching function in RAN system, such as Ethernet frame, IP packet, and ATM cell, are segmented, and then encapsulated to transfer then to the mobile backhaul network. ISP can converge all generation traffics, such as voice, HSPA, over all-IP RAN through standard pseudowire encapsulation. These can be enhanced with diverse QoS methods as well as comprehensive monitoring and diagnostic capabilities. Therefore in this paper, QoS functions under theses operations is simulated according to the encapsulation functions.

Key Words : CES, RAN, Backbaul, TDM, MPLS

Ⅰ. Introduction

As the diverse traffics, such as data, video, and voice, have been increased, and the number of mobile broadband subscribers have also been increased rapidly, Mobile network operators are using IP/Ethernet to catch up with the bandwidth demand. It has integrated the wireless and wire services effectively for the infrastructure of common technologies.

When Base Station(BS) connects to the backhaul network, the bandwidth demand is being increased, and the cost of the available gigabit Ethernet connection is being decreasing. For a long time, Mobile network operators must have paid for much costs to the dedicated TDM (Time Division Multiplexing) lines for many BSs. But they can decrease the cost fairly by transferring TDM signals through CES(Circuit Emulation Service) on IP/Ethernet network[1][2].

RAN(Radio Access Network) system connects BSs

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to the mobile backhaul network through the diverse interfaces, such as T1/E1, Ethernet, and ATM in cell site. The mobile backhaul network supports circuit emulation, MPLS-TP/PBB-TE, time synchronization, protection, QoS(Quality of Service), and OAM. This system can accommodate the diverse BS equipments, and than the diverse traffics through the various transfer paths. So it is important to provide the differentiated QoS for the transport network that transfers the diverse type of traffics[2][3][4].

In almost application services, it is enough to classify the traffics into three or four classes and than treat the classified ones individually. But, in the case of transferring the video or voice traffics sensitive to data loss and jitter, and the multimedia data, such as data, the more sophisticated flow-level QoS is being required in mobile backhaul.

This paper address QoS functions in mobile backhaul network to accommodate the diverse traffics in cell site. And QoS is simulated according to the encapsulation functions.

II. Mobile Backhaul Network

As mobile backhaul network connects Base Station to the BSC(Base Station Controller), it can transfer the required bandwidth of the diverse generation technologies, such as 2G, 3G, 4G, WiMAX, and LTE. PSN(Packet Switched Network) and TDM can be used for mobile backhaul network. Figure 1 shows the backhaul network based on RAN system. RAN system can be used for both cell site gateway and carrier Ethernet service. In cell site gateway, RAN system connects the mobile BS subscribers to the mobile backhaul network through UNI (User-Network interface). In carrier Ethernet service, it connects the mobile BS of several generation to the mobile backhaul network through NNI(Network-Network interface)[2][3].

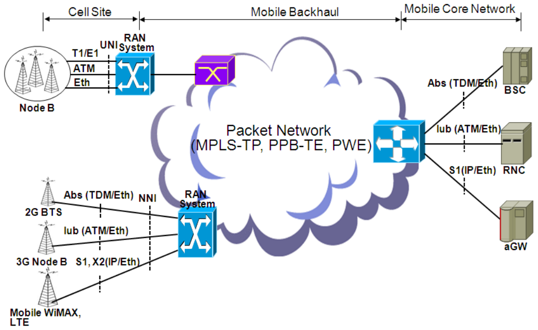

그림 1. 이동 백홀 네트워크
Fig. 1. Mobile Backhaul Network

III. RAN Transmission System

IP network has been developed through powerful scalability, compatibility, and interworking. The existing communication network limited by transfer mode and service type is inefficient in the characteristics which IP have. Also, it has many problems in sharing the new network and managing the interworking. When upgrading the existing communication network and extending the applications, it is difficult to install the redundant network and take full advantage of the resources[4][5].

PWE3(Pseudowire Emulation Edge-to-Edge) is the layer 2 VPN that provides the tunnel to emulate the diverse services, such as TDM, ATM, and Ethernet on PSN. This protocol connects the existing network to PSN to share the resources and extend the network. So, it is end-to-end L2 carrier technology and also point-to-point L2 VPN[9].

Figure 2 shows PWE3. TDM traffic is segmented, adapted, and then encapsulated by TDM signal in the ingress of PSN. The operation in the egress of PSN is opposite to one in the ingress of PSN. Adaptation is the mechanism that changes the payload for the proper reconstruction in the egress of PSN. TDM signal and timing can be reconstructed by using the proper adaptation method, and then the packet loss is tolerated to some extent because of it. Encapsulation is the process that arranges the adapted payload in the packet configuration required by PSN technology[9][10][11].

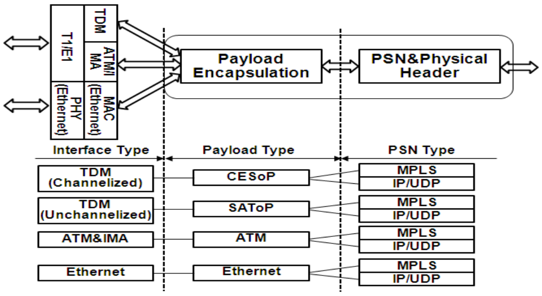

그림 2. PWE3
Fig. 2. PWE3

Mobile backhaul network has to be able to transfer 2G, 3G, 4G, and LTE services. In general, mobile communication connection provides 384kbps. UMTS and HSDPA has already provided 1.8~14.4Mbps for downlink, and LTE provides 200Mbps for the downlink, and up to 100Mbps for the uplink. So to catch up with this growing access link rate, the mobile backhaul network with the more high capacity has to be installed using Ethernet technology because it is not enough to support that the growing access link rate by extending E1 or T1 TDM links physically for transfer[1][5][9].

Figure 3 shows the architecture of RAN system. RAN system connects the mobile base stations to mobile backhaul networks through the diverse interfaces in cell site, such as T1/E1, Ethernet, and ATM. So mobile backhaul network has to support circuit emulation, MPLS-TP, PBB-TE, time synchronization, protection, QoS, and OAM.

If RAN system packets receive the packets from cell site, it classifies the packets into the specific flows based on the classification policy. The classified packets are assigned and then segmented to each switching function, such as Ethernet, IP, and ATM, and then encapsulated to be transferred to the mobile communication backhaul network. Before transferring to the mobile communication backhaul network, QoS functions are assigned to the encapsulated traffics[1][5][6].

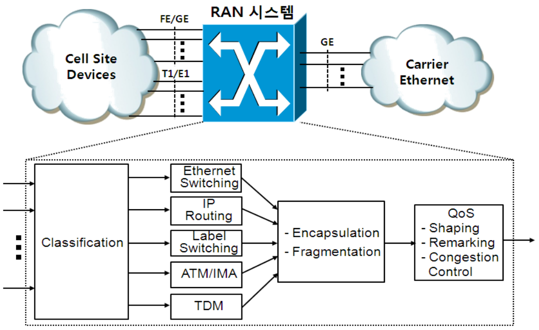

그림 3. RAN 시스템 구조
Fig. 3. RAN system architecture

Figure 4 shows QoS model for RAN System. When RAN system receives the packets from cell site, it classified them into the flows according to classification method. The classified packets are assigned to the switching functions, such as Ethernet switching, IP routing, label switching. The traffics assigned to the switching function, such as Ethernet frame, IP packet, and ATM cell, are segmented, and then encapsulated to transfer then to the mobile backhaul network. And RAN system supports QoS functions, such as shaping, marking/remarking, and congestion control[12][13].

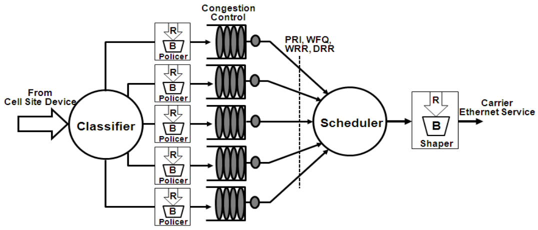

그림 4. RAN 시스템 QoS 모델
Fig. 4. QoS model for RAN System

Ⅳ. QoS characteristics of RAN System

RAN system has to be equipped with QoS functions to accommodate the diverse traffics in cell site. And QoS is simulated according to the encapsulation methods. Figure 5 shows simulation model for QoS functions of RAN system. The background traffics is to add the load to the system. Load will be increased by 10 percents. Under this background traffics, CES and ATM traffics will be entered into this system, and then the round trip time will be simulated for each load after encapsulating these traffics into IP/UDP. MPLS, and MEF E-Line. In this simulation, the size of the background traffics and ATM one are 128bytes and 1,920kbytes respectively. RAN (switching functions) is one shown in figure 4.

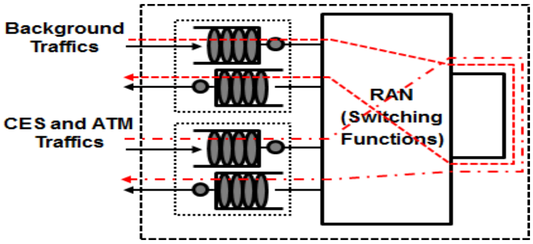

그림 5 시뮬레이션 모델
Fig. 5. Model for simulation

Figure 7 shows the RTT (Round Trip Time) for the packets that have the overheads due to the IP/UDP encapsulation. The overhead include 14 bytes Ethernet head, 20bytes IP header, and 8 bytes UDP header. RTT value is measured for each packet size under the background load.

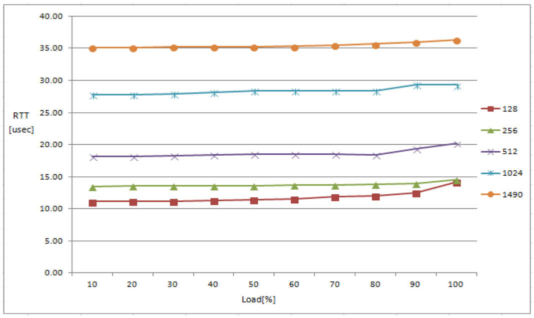

그림 6. IP/UDP에 대한 왕복 시간
Fig. 6. Round Trip Time for IP/UDP

Figure 8 shows the RTT for the packets that have the overheads due to the MPLS encapsulation.

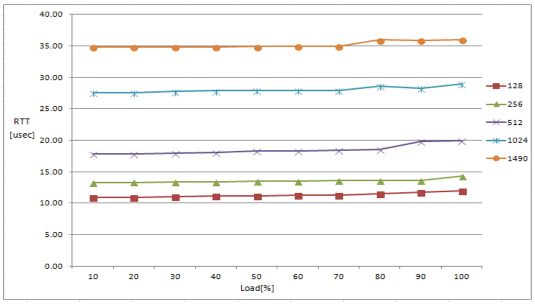

그림 7. MPLS에 대한 왕복 시간
Fig. 7. Round Trip Time for MPLS

The overhead include 14 bytes Ethernet head, 4bytes MPLS outer label, and 4bytes MPLS inner label. if PSN and PW label were to be added, MPLS encapsulation adds 8 bytes to ATM cell. In this case, MPLS increases the requirement of bandwidth, but the bandwidth efficiency can be increased through the cell concatenation. If a single ATM cell is encapsulated with MPLS, the more overhead is occurred than plain ATM transport. In the case of concatenating multiple ATM cells, the overhead of MPLS can be compensated.

Figure 8 shows the RTT for the packets that have the overheads due to the MEF(Managed Extensibility Framework) E-Line capsulation. MEF includes the attributes and associated parameters that define the specific Ethernet services. The overhead include 14 bytes Ethernet head, 4bytes outer VLAN tag, and 4bytes inner VLAN tag.

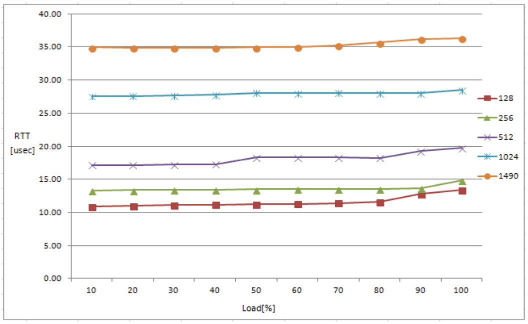

그림 8. MEF E-Line에 대한 왕복 시간
Fig. 8. Round Trip Time for MEF E-Line

Ⅵ. Conclusion

In mobile backhaul network, RAN system connects the mobile communication base stations to the mobile backhaul network through the diverse interfaces such as T1/E1, Ethernet, and ATM in cell site. The mobile backhaul network supports circuit emulation, Time synchronization, protection, QoS, and OAM. So 2G/3G/4G base station equipments can be accommodated through this system and then can transfer the traffics throgh the diverse transfer paths. In this paper, QoS functions in mobile backhaul network to accommodate the diverse traffics in cell site. RAN system supports QoS functions, such as shaping, marking/remarking, and congestion control. Therefore QoS functions under theses operations is simulated according to the encapsulation functions. For the multimedia data sensitive to loss and delay, more sophisticated flow level QoS has to be required.

In near future, the mobile backhaul for LTE will be researched. This will include the backhaul requirements for LTE as specified in LTE specification.

References

[1] Tipmongkolsilp, O, Zaghloul, S, Jukan, A, “The Evolution of Cellular Backhaul Technologies: Current Issues and Future Trends”, Communications Surveys & Tutorials, IEEE, Issue.99, PP1~14, 2010.

[2] Humair Raza, "A Brief Survey of Radio Access Network Backhaul Evolution : Part I ,IEEE Communication Magazine, Vol.49, No.6, PP164~171, June 2011.

[3] Humair Raza, "A Brief Survey of Radio Access Network Backhaul Evolution : Part Ⅱ, IEEE Communication Magazine, Vol.51, No.5, PP170~177, May 2013.

[4] Chia, S., Gasparroni, M., Brick, P., “The next challenge for cellular networks: backhaul“, Microwave Magazine, IEEE Vol.10 , Issue.5, PP54~66, 2009.

[5] NEC Corporation, "Mobile Backhaul Evolution for deploying Mobile Generation Networks (Mobile GEN), White Paper, Feb. 2007.

[6] "Carrier Ethernet Technologies Comparison", Brocade, Feb. 2010.

[7] Ran Avital, "Mobile Backhaul Network Migration -Building an Evolution-Ready Backhaul", Ceragon Network, White Paper, 2007.

[8] Leesutthipornchai, P., Wattanapongsakorn, N., Charnsripinyo, C., “Efficient Design Techniques for Reliable Wireless Backhaul Network", Communications and Information Technologies 2008. ISCIT 2008. PP22~27, 2008.

[9] Huawei Technologies Co., Ltd, “Technical White Paper for PWE3“, httpd://www.huawei.com/products/datacomm/pdf/

[10] RFC4553, “Structure-Agnostic Time Division Multiplexing (SAToP)”, June 2006.

[11] RFC5086, “Structure-aware TDM Circuit Emulation Service over Packet Switched Network (CESoPSN)” July 2005.

[12] Heinanen J. and R. Guerin, A Single Rate Three Color Marker, RFC2697, September 1999.

[13] Heinanen J. and R. Guerin, A Two Rate Three Color Marker, RFC2698, September 1999.

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