

Garbage Packet Reuse Method using Protocol Properties for Energy Saving

Seong Gon Choi*, Yong-Woon KIM**

* College of Electrical & Computer Engineering, Chungbuk National University, South Korea

**Electronics and Telecommunications Research Institute, South Korea

sgchoi@cbnu.ac.kr, gkime@etri.re.kr

Abstract— This paper proposes an garbage packet reuse method using L2 protocol properties in Packet Based Network. In general MAC operation, an invalid packet is dropped packet because the packet is not match up to destination address. To save power, the invalid packet is reused as power. We verify amount of power using simply calculation.

Keywords— Power Saving, Garbage Packet, Protocol Property

I. INTRODUCTION

Next Generation network (NGN) is evolving to green network that is high energy efficiency network. Currently IT industry occupies 2% of the world's carbon emissions. Over the next few years, IT industry is expected to growth 10%~15% of the world's carbon emissions. Therefore, depending on rapidly increase of the power consumption in IT sector, energy-saving solutions is actually required [1].

In Wired Network environment, there are many ways for energy-saving on the equipment. Diverse studies are being related with energy-saving such as sleep mode control [2], rate adaptation [3] and so on.

Existing schemes using sleep mode control are going to sleep mode to decrease power consumption when system is idle mode. Sleep mode in part turns the hardware module from “on” to “off” for unused part on the system. So, the method achieved power-saving by low power consumption state [2].

An existing hardware system has been operated something based on maximum performance. Unlike existing hardware system, a scheme using rate adaptation optimizes performance of the hardware according to traffic volume. Due to dynamic adaptive hardware system, rate-adaptive method is able to reduce unnecessary power consumption [3].

Many researches are being studied about valid packets come into system. These existing methods are not considered about invalid packet that is just dropped depending on 802.3 MAC protocol. Energy-saving method for invalid packet is not considered. Therefore energy-saving research on invalid packet is needed because the invalid packet is frequent.

We propose an energy-saving method using L2 protocol properties in Packet Based Network (PBN). To save power, we store invalid packet in the form of power to use efficiently invalid packet that is dropped packet because the packet is not

equal to destination address. However, if packets are valid, the conventional method is used. We verify amount of power and energy using circuit simulation about simple charging circuit.

II. RELATED WORK

Existing paper proposed that ICT energy consumption and ICT-induced energy efficiency are two areas of research that should be integrated. To see the problem in this paper, existing problems take account of one thing independently without considering the two situations. In order to solve this way, author can only obtained by decomposing the ‘ICT monolith’ and look at naturally heterogeneous parts separately. As a result, high energy efficiency can be freed all ICT related to the potential energy savings through limit consumption [1].

An existing paper presents HGESM (Home Gateway Energy Saving Mechanism) which reduces energy consumption in home gateway. The proposed mechanism uses energy saving by switching or keeping processor mode depending on type of service. The type consists of real time service and non-real time service [2].

A previous paper presents the design and assessment of power management schemes that reduce the energy consumption of networks. The first uses adapting the rate of network operation to the offered workload, reducing the energy consumption. The second is based on putting network parts to sleep for idle times, reducing energy consumption in the absence of packets. Using real-world network topologies and traffic workloads, it shows that : (1) even simple strategies for sleeping or rate-adaptation can provide considerable savings without fairly degrading network performance and (2) both forms of solutions are valuable according to the power profile of network equipment and the utilization of the network itself [3].

Nowadays, various studies for saving energy and increasing energy efficiency have been conducted. But there is not present how to reuse unnecessary traffic for the power.

III. PROPOSED METHOD

The proposed method is able to adapt on IP-based network equipment in PBN. However, we use a home gateway for convenience.

Fig. 1 shows the proposed functional hardware architecture of the home gateway. The proposed functional hardware architecture consists of the AMR9 High-Performance CPU core, advanced memory controller, I/O Interfaces, MAC, PHY, power storage and power supply.

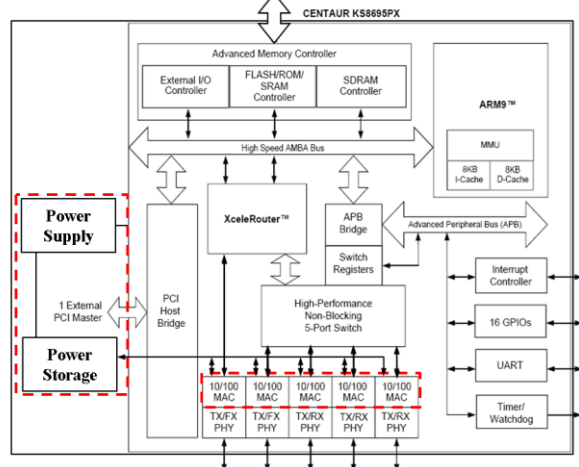


Figure 1. Proposed Functional Hardware Architecture

An algorithm of proposed method is worked at the MAC. The power supply provides power to the home gateway. The power storage is newly added to store power from packet in the proposed method. Its circuit component and storing method remain for further study.

In packet forwarding, according to the specification defined in the MAC Layer, data is translated in binary code. Binary code is transmitted via physical transmission medium through the line coding. For the IEEE 802.3 standard, depending on the transmission medium, Manchester or NRZI line coding method is used. In case of 10base-t line, Manchester line coding is used with the property at least 450mV to maximum 1315mv and current of 4mA.

Receiving packets, packet data from network can be checked with MAC address according to datagram sequence. Case of valid destination, a system processes packet at L2/L3 layer. And then, system is going on next layer processing. Otherwise, case of invalid destination, packet is immediately dropped at L2 Layer.

MAC protocol stack consists of Preamble (7-octets), SFD (1 octet), Destination address (6-octets), Source address (6-octets), Length/Type (2-octets), MAC data (40 to 1500 or 1504 or 1982-octets), Pad (7-octets) and Frame check sequence (7-octets) [4].

We use the invalid packet to energy-saving. Before L2 processing, we sequentially check front 14 octets from preamble to destination address using signature matching in form of signal about L2 packet. If incoming packet is valid, the system processes packet equal to existing method that is 802.3 CSMA/CD MAC protocol.

The system is able to progressively check packet in form of signal, using signature matching method [5].

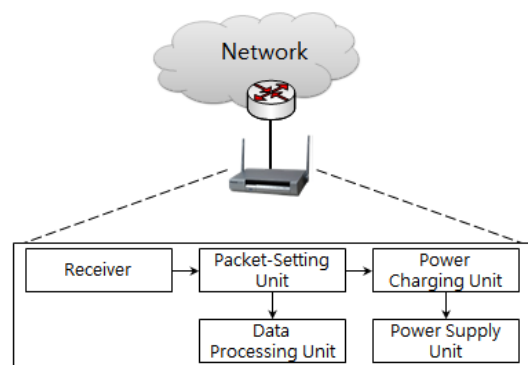


Figure 2. Proposed operation procedure bin network access device

In fig. 2, network access device is connected to the communication network, which includes receiver, packet-setting unit, power charging unit, power supply unit, and data processing unit.

Receiver receives a data packet through the communication network.

Data packet consists of a binary code of the line coding signal.

In other words, binary encoded data packet is converted into electrical signals after line coding, and transmitted through the physical transmission medium. In the IEEE 802.3 standards, line coding is Manchester or NRZI depending on the transmission medium. Data packet is forwarding receiver by using the transmitted signal defined by standard. Packet-setting unit understand destination address by using received data packet from receiver. Packet-setting unit compare the destination address of the data packet and the previous destination address. If it does not match, the previous data packet is set to charge for data packets. Here, previously set the destination address is defined by the user. In addition, previously set in the destination address may be the address of the network access device their own. Here, packet-setting unit understand MAC address by analysing application layer information of data packet from the receiver, and then compare MAC address and previously set in the destination address.

Packet-setting unit check MAC address of the data packet by referring to the application layer information and check whether previously set in MAC address of the data packet from receiver or MAC address of their network access device.

After that, data packet except for the part of the MAC address is set to charge for.

Fig. 3 is a general protocol stack of L2 packet. Data packet is composed of PREAMBLE, SFD, DESTINATION ADDRESS, SOURCE ADDRESS, LENGTH/TYPE, MAC CLIENT DATA, PAD, FRAME CHECK SEQUENCE and EXTENSION.

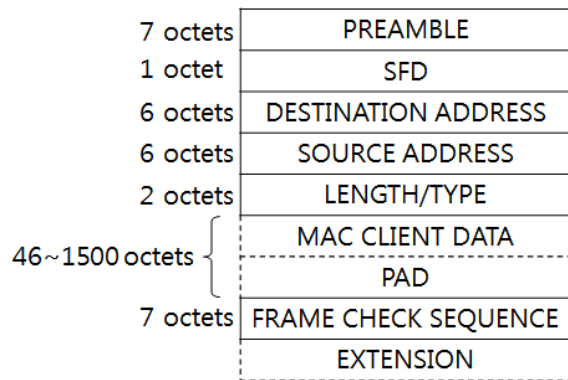


Figure 3. General protocol stack of L2 packet

Packet-setting unit checks PREAMBLE, SFD, DESTINATION ADDRESS and destination MAC address of ADDRESS, after that transmits to Power charging unit for the remaining SOURCE ADDRESS, LENGTH/TYPE, MAC CLIENT DATA, PAD, FRAME CHECK SEQUENCE, EXTENSION.

For example, referring the IEEE 802.3 standard, frame size of data packet from receiver is consists of minimum of 64byte to a maximum of 1518byte and frame size from PREAMBLE to destination MAC address is 14byte. Therefore, if the received MAC address is not destination MAC address, data signal of minimum 50byte from 1504byte except for the 14byte frame destination MAC address check frame transmits power charging unit, and about the potential that corresponds to the size of the power can be recharged.

If the previously set in the destination address and destination address of the received data packet are matched, packet-setting unit transmits data packet to the data processing unit. Data processing unit process the next step by receiving data packet from packet setting unit.

Power c1

+harging unit charges power using electrical signal of charging for data packet received charging for data packet from packet-setting unit.

Power charging unit saves signal due to the potential difference of binary data.

Here, power charging unit consists of power charging circuit. Capacitor of power charging unit is removed when binary data packet is transmitted and during charging time constant through dc ingredients of frequency ingredients.

If physical quantities reached the normal values, the time constant is the time when you reach 62.3% of the normal values. The case of a series RC circuit, the time constant can be expressed as the product of the resistor and capacitor.

- $\tau = R \times C$
- τ : time constant(unit : sec)
- R : resistor (unit : ohm)
- C : capacitor (unit : F)

The capacitor is fully charged, when it would have been five times the time constant of the 5, and 5τ after discharged.

Power supply unit supplies power to their network access device by taking charging power from the external power supply and power charging unit.

There, the network access device can reduce the use of external power by supplying external power and charged power from power charging unit.

Accordingly, there is the effect to reduce the power consumption of the device.

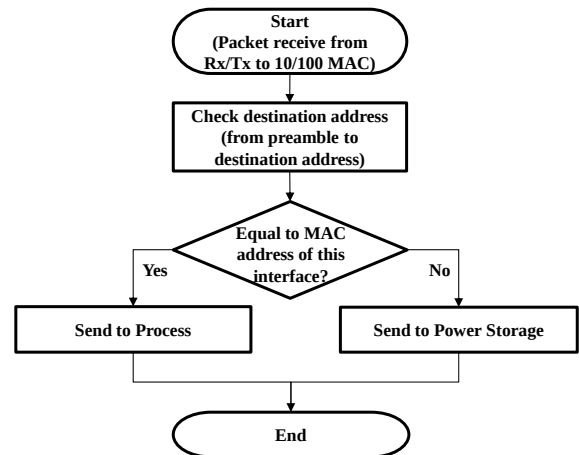


Figure 4. Operation Algorithm for Packet Classification

Fig. 4 shows an algorithm for packet classification. The proposed method is operated at MAC. PHY is received packet from Rx/Tx and forward to MAC, and then it checks addresses of received packet. 14-octets that preamble, SFD and destination address are identified continually. If MAC address is valid, it send packet signal to process. And L2/L3 processing begins. However, if destination address is invalid, it send residual packet signal (minimum 50byte~maximum 1504 byte according to IEEE 802.3 standard) to the power storage. In Power storage, transmitted signal is used to charge. Circuit and charging method of power storage remain for further study.

IV. PERFORMANCE ANALYSIS

Using IEEE 802.3 10base-T specification, we estimate average power-saving amount.10base-T is used to the Manchester line coding that is a form of data communications line code in which each bit of data is signified by at least one voltage level transition.

When Manchester line coding used, plus signals will be half on average for whole pulse signals. L2 packet size is 50byte to 1504byte (that is, including from preamble to destination) except for the checked signal. Therefore, one packet will be able to have plus signal from 200 to 6016.

Pulse signal has a voltage from 450mV to 1315mV on a plus signal. It has a current of 4mA. This AC voltage is

translated into RMS value in which is 318mV to 929m. Therefore, the one signal is able to save the power from 1.272mW to 3.719mW. Its average power is 2.496mW.

KCC(Korea Communications Commission)

Corresponding Author : Seong Gon Choi (sgchoi@cbnu.ac.kr)

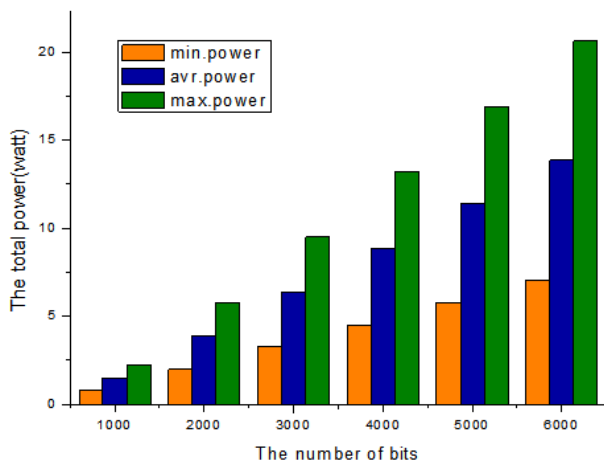


Figure 5. The number of bits vs. the total Power

Fig. 5 shows the total average power for the number of bits in some cases of max.power, min.power and avr.power on one invalid packet. A max.power means the power at maximum value of power on one incoming pulse signal. A min.power means the power at minimum value of power on one incoming pulse signal. An avr.power means the average value between max.power and min.power. The number of bits from 200 to 6016 means the number of signal to save for one packet frame. It shows the values from 0.25W to 22.69W which can be store. Consequently, we will be able to store 11.47W averagely on one invalid L2 packet.

V. CONCLUSIONS

We propose the energy-saving method using L2 protocol properties in Packet Based Network (PBN). To store power, we use an invalid packet in the form of power to use efficiently an invalid packet that is dropped packet since the packet is not equal to destination address. Consequently, we verify the amount of power by using simply calculation. As a result, the proposed method can store averagely 11.47W on one invalid L2 packet. However, it does not take into account charging properties of capacitor. So, the stored power amount of real battery storage circuit is able to differ for simulated amount.

In the future, we will consider the performance evaluation regarding environment and operational method at aspect electronic circuit.

ACKNOWLEDGMENT

This work was partly supported by the IT R&D program of MKE/KEIT [10039160, Research on Core Technologies for Self-Management of Energy Consumption in Wired and Wireless Networks] and the ICT Standardization program of

REFERENCES

- [1] Vlad Coroama and Lorenz M. hilty, "Energy Consumed vs. Energy Saved by ICT –A Closer Look," *EnviroInfo*, 2009.
- [2] Hyeon Yang, Myoung Ju Yu, Dong Geun Yun and Seong Gon Choi, "Energy Saving Mechanism Using Sleep Mode of processor in Home Gateway," *IEEE International Consumer Electronics*, Jan., 2012.
- [3] S.Nedevschi, L.Popa, G.Iannaccone, S.Ratnasamy and D.Wetherall, "Reducing network energy consumption via sleeping and rate-adaptation," *USENIX Symposium on Networked Systems Design and Implementation*, Apr., 2008
- [4] IEEE LAN/MAN Standards Committee, "IEEE 802.3 Part 3: Carrier sense multiple access with Collision Detection(CSMA/CD) Access Method and Physical layer Specification," *IEEE computer Society*, Dec, 2008.
- [5] Min Woo Kim, Wok Seok Choi, Dong Geun Yun, Jong Min Lee and Seong Gon Choi, "A Method on Reducing Processing Time Using signature Matching in a Router," *International Conference on Advanced Communication Technology*, Feb., 2012