

Battery Life Time Extension Method By Using Signalling Interval Control

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Abstract—This paper proposes a battery life time extension method which maximizes the efficiency of a battery by monitoring the available capacity of smartphone battery and by controlling the time interval for the transmission signalling of SNS application. The proposed method extends the battery life time by operating on saving mode which delays the process of sending background traffic if the battery capacity is not enough. So, the proposed method can prevent unnecessary battery consumption. We verify that the proposed method has longer battery life time than the existing one.

Keywords—Battery saving, Battery life time extension, Keep-alive signalling, Signalling interval control, Energy saving mode

I. INTRODUCTION

Recently, the demand for smartphone, which supports mobile internet data service as well as typical voice call, is increasingly accelerated. Accordingly, the mobile application market is rapidly growing with an increase in smartphone user[1].

Smartphones have been experiencing a sensational evolution over the last two decades, starting from simple devices with only voice services to smartphones offering novel services such as mobile Internet, location-aware and map service, SNS(Social Networking Service), real-time services, high data rate connectivity and many more.

However, the increase of smartphone is rapidly increasing the power consumption. Especially, SNS is one of the most popular services for smartphone in mobile application market. Using the SNS can influence on the battery consumption of smartphone[1],[7].

Many studies related to the energy-saving have researched. These studies can be divided into three levels such as device-level technology, equipment-level technology and network-level technology. The device-level technology is a hardware technology such as LSI micro fabrication, optical network node, multi-core cpu, clock gating, power-aware virtual memory and advanced Power Amplifier (PA). The equipment-level technology is a mixed technology of hardware and software such as sleep mode control, Adaptive Link

Rate(ALR)/Dynamic Voltage Scaling(DVS), circuit switching, thermal design, cache server, filtering, sorry server, shaping, compact base transceiver stations (BTSs) and smart antenna technologies. The network-level technology is a software technology related to operating such as energy consumption-based routing/traffic engineering, lightweight protocol, Transmission scheduling, Content Delivery Network(CDN), job scheduling, small-cell design, energy consumption-aware network planning[8]-[11].

The smartphone exchanges a signalling, which called keep-alive message, with the agent server on the network to maintain the user information. So, the background traffic is generated and sent to the agent server even though the smartphone is under idle mode. If several SNS applications are running on the smartphone, the keep-alive messages are frequently exchanged to maintain the user information. This results in much power consumption of the smartphone. The signalling message for SNS does not need to be processed instantly.

In order to reduce the power consumption of the smartphone occurred by frequently signalling message, we propose a battery life time method which maximizes the efficiency of a battery by using controlling the time interval of transmission signalling for SNS application according to the available capacity of smartphone battery.

This paper is structured as follows. In section II, we describe the related work. We describe proposed battery life time extension method in section III. In section IV, we analyze the performance concerning proposed method. Finally, we conclude in section V.

II. RELATED WORK

A. The energy saving method using sleep mode operation

This existing study analytically evaluates the sleep mode operation of the IEEE 802.16e, defined for the energy saving. In the sleep mode, a Mobile Subscriber Station (MSS) sleeps for a sleep window and wakes up at the end of the sleep window in order to check impending download packet(s)

destined to itself. If there is no such a packet, the MSS enlarges the sleep window up to the maximum value and returns to the sleep mode. For the quantitative analysis, this existing study models the sleep mode operation as a semi-Markov chain. Then, the average packet delay and average power consumption are analytically estimated[8].

B. The Reduction of network energy consumption via sleeping and rate-adaptation

This existing study proposes the design and evaluation of two forms of power management schemes that reduce the power consumption of networks. The first form is based on putting network components to sleep during idle times, reducing power consumed when there is no the incoming/outgoing packet. The second form is based on adapting the rate of network operation to the offered utilization of system, reducing the power consumed when actively processing packets. For the real traffic utilization and topologies and using power constants drawn from existing network equipment, it shows that simple schemes for sleeping or rate-adaptation can offer substantial savings[9].

C. A Cooperative Clustering Protocol for Energy Saving of Mobile Devices with WLAN and Bluetooth Interfaces

This existing scheme proposes a novel energy saving approach using the multiradio feature of recent mobile devices equipped with WLAN and Bluetooth interfaces that called Cooperative Networking protocol (CONET), which dynamically reforms clusters according to each node's bandwidth requirement, energy use, and application type. The one of the most widely used wireless communication technologies is a Wireless Local Area Network (WLAN). However, the WLAN has a serious power consumption problem. For settling these problems, proposed method in existing scheme is based on clustering. A cluster is a Bluetooth Personal Area Network (PAN), which consists of one cluster head and several usual nodes. The cluster head acts as a gateway between the PAN and the WLAN, enabling the usual nodes to access the WLAN infrastructure via low-power Bluetooth[10].

The mode control method and the rate-adaptation method are effective to reduce the power consumption. But, it needs to change for a hardware configuration. Unfortunately, it is a very difficult. The CONET does not require modifications of existing wireless infrastructures because clustering is performed independently of WLAN access points. It considers the power consumption using an operational energy-saving method for effective transmission. However, the above mentioned method is not considered for power consumption caused by signalling[8]-[10].

III. PROPOSED BATTERY LIFE TIME EXTENSION METHOD

In this section, we describe proposed battery life time extension method. Before describing the proposed method, first of all, we investigate the features of SNS signalling message. For this end, we analyse the characteristics of the yahoo-messenger at idle mode.

A. The analysis on signalling packets of the SNS application

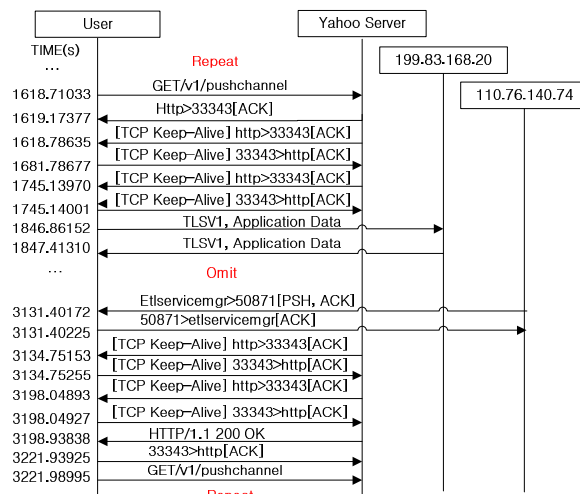


Figure 1. The background traffic of yahoo-messenger at idle mode

Fig. 1 indicates the operation between a terminal and network for SNS application service (Yahoo-Messenger). The procedure and value shown in Fig. 1 and TABLE I came from our own experiment. From experiment, we captured practical background traffic by using ethereal tool and Samsung Galaxy S as the smartphone.

TABLE 1. THE SUMMARY FOR THE EXPERIMENT RESULTS

Traffic	Captured
Total Packets	69
Transmission Packets	38
Total Bytes	8,675
Transmission Bytes	4,805
Average bytes/sec	16.022
Between first and last packet	1603.22892

The smartphone exchanges a signalling with agent server on the network to maintain user information. So, background traffic exists and flows even though the smartphone is under idle mode. Total background traffic, 8,675 bytes, exchanges transmission and reception signalling, 69 times, during specific time interval, 1603.22892 sec. This operation is processed continuously regardless of the remainder of the battery and thus causes unnecessary battery consumption. At this time, users do not recognize a waste of power by the background traffic. So, the battery saving mode operating by checking the available capacity of a battery needs to be considered. Namely, if the remaining capacity is enough, the smartphone works under normal mode. However, if the remaining capacity is not enough, it works under the saving mode for non real time traffic.

B. The mechanism on battery life time extension method

This section presents the proposed method which reduces

battery consumption in a smartphone. The proposed method saves the power by controlling signalling interval for delivering state information of SNS application according to the remainder of smartphone battery. A smartphone monitors the remainder of its battery periodically and then changes its state to battery saving mode if the available capacity is lower than its threshold. At this time, the sending background traffic for non real time service is delayed and processed after some little time.

Fig. 2 shows the flow chart of the proposed method. A smartphone checks the type of service (real time or non real time traffic) when receiving some packets. If the packets are 'Keep Alive Message (KAM)' which is to check whether user logs on or not for SNS, non-real time traffic, the smartphone monitors the remainder of its battery. Also, the smartphone checks whether its battery level is lower or higher than threshold value. If the available battery level is higher than threshold value, the smartphone maintains normal mode. However, if not, the smartphone changes the state for battery saving mode. And then the smartphone determines the time interval for the signalling transmission by using equation (1).

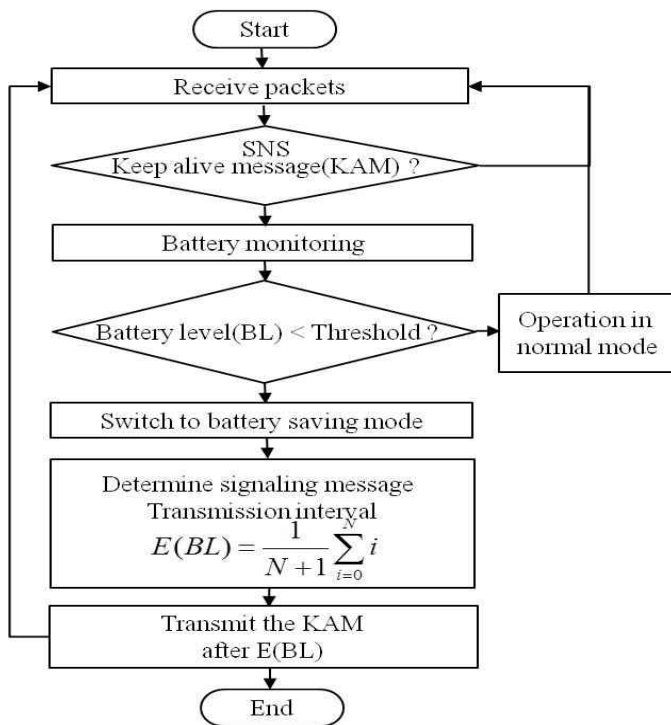


Figure 2. The flow chart of the proposed method

The KAM signalings are delayed during $E(BL)$ time and then processed after the time. Equation (1) is based on the existing expected backoff equation [2]-[3]. The Collision (C) in the existing equation is replaced by BL (Battery Level) that is calculated as in the TABLE 2.

$$E(c) = \frac{1}{N+1} \sum_{i=0}^N i, (N = 2^c - 1) \quad (1)$$

TABLE 2. THE CALCULATED VALUE OF BL

Battery Level(%)	Collision(number)	E(BL)
100	0	0
50	3	3.5
40	4	7
30	5	15.5
20	6	31.5
10	7	63.5

IV. PERFORMANCE ANALYSIS

In this section, we analyze the performance of the proposed method. The Fig. 3 and Fig. 4 present the power consumption consumed by the Keep Alive Message(KAM) of the SNS applications on the smartphone in the normal and battery saving mode when the smartphone uses the IEEE 802.11g(data rate : 24Mbps) and the UMTS(data rate : 384kMbps) as the technology of the network interface, respectively.

In order to calculate the power consumption, we assume as follows.

- Assumption 1 : The smartphone has ten SNS applications.
- Assumption 2 : After three hundred minutes, the battery status of terminal is 50%.
- Assumption 3 : When the battery status is 50%, a smartphone operates to the battery saving mode.

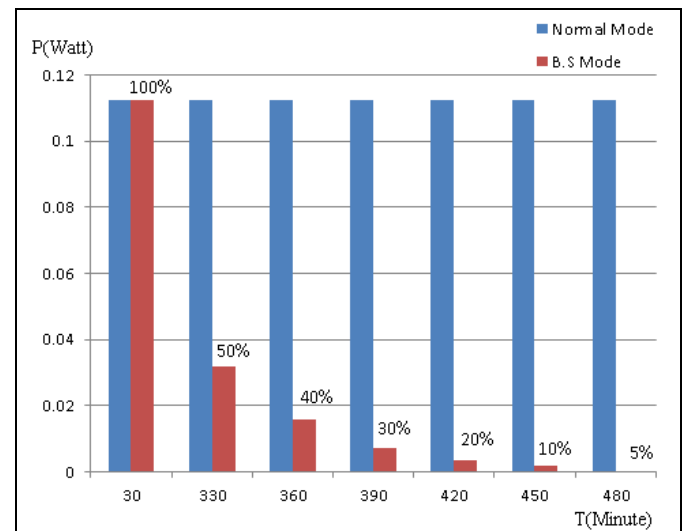


Figure 3. The distribution of power consumption using the 802.11g(data rate: 22Mbps)

In five hours-thirty minutes, the smartphone operates to the battery saving mode. When the smartphone operates to the battery saving mode, the transmission period of the SNS application is lengthened. Because of this, the power consumption for transmitting the KAM is reduced. Consequently, the battery life of the smartphone is extended.

When the amount of the smartphone battery is 100% and 50%, the smartphone consumes approximately 0.11(W/bit) and 0.03(W/bit) for transmitting the KAM of the SNS applications, respectively because the delay time calculated by

the equation (1) extends the KAM transmission period of the SNS applications. We uses the TABLE 1 and 1.1617×10^{-7} (w/bit)[5] for calculating the power consumption consumed by the Keep Alive Message(KAM) of the SNS applications on the smartphone.

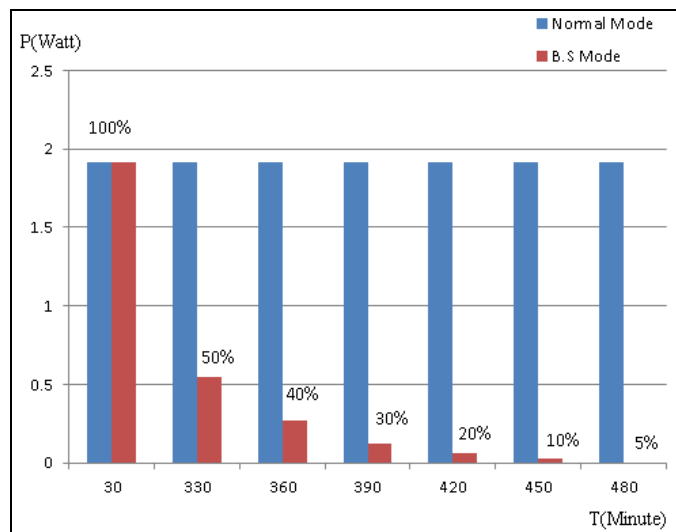


Figure 4. The distribution of Power consumption using the UMTS (data rate: 384kbps)

As the same method mentioned above, the power consumption of the smartphone is calculated. As shown in the Fig. 4, in the UMTS, the smartphone consumes much transmission power than the IEEE 802.11g because the distance between the UE(User Equipment, or smartphone) and the BS(Base Station) is far.

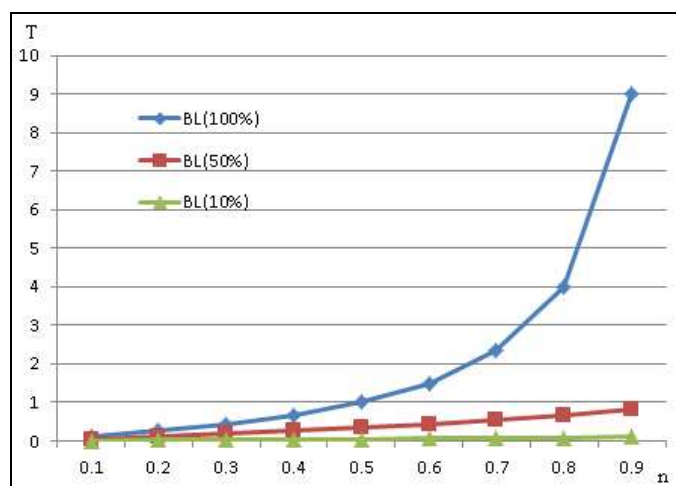


Figure 5. The quantity of traffic received in terminal

The Fig. 5 presents the average power consumption consumed by the Keep Alive Message(KAM) of the SNS applications on the smartphone. For simplifying the average power consumption, we used the M/M/1 queuing model. In the Fig.5, the n is the number of SNS application owned by the smartphone and the T is the KAM transmission rate of the SNS application.

When the number of the SNS application and the KAM transmission frequency are increasing, the power consumption of the smartphone also is increasing. However, in the battery saving mode of the smartphone, the power of the smartphone is slowly decreased because the smartphone can adjust the KAM transmission period of the SNS applications according to the battery status(or level).

V. CONCLUSIONS

This paper proposes a battery life time extension method which maximizes the efficiency of a battery by using controlling the time interval of transmission signalling for SNS application according to the available capacity of smartphone battery. The proposed method extends the battery life time by operating on saving mode which delays the process of sending background traffic if the battery capacity is not enough. So, the proposed method can prevent unnecessary battery consumption. As a result, we verify that the proposed method has longer battery life time than the existing one.

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