

Implement of an Efficient System to Reduce Power Consumption

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Abstract— With the rapid development of current industry, it becomes a more important issue that greenhouse gases are emitted. And many people found the increased of global surface temperature. In Taiwan, the issue also becomes popular, There are many greener electronic products that we can find in marketplace. The Taiwan Power Company implemented the discount measure for encourage energy conservation. Thus, it is a very important issues that conserving energy in our life.

Many people start reducing the usage of energy, however the school have to use a large energy, particularly computer classrooms. There are many computers in a computer classroom and using computer at the same time. But some student may forget to shutdown the computer; it will waste more energy and money. In this paper, we try to implement a technology of WOL and ACPI for "RFID Energy Saving System for Computer Classroom". If RFID get the information of student that he is not in Classroom. The Energy Saving System will let his computer into "Suspend State" or "Shutdown State". Using the RFID Energy Saving System, we found that one computer can save about 100 watt, and more computers can reduce the consumption of more energy.

KEYWORDS— RFID, ENERGY SAVING SYSTEM; ACPI; WOL

I. INTRODUCTION

For decades, due to the rapid warming of the Earth, the world aware of the reduction of greenhouse gas emissions is an important topic. The 141 states formally signed the Kyoto Protocol to slow the warming of the Earth.

RFID (Radio Frequency Identification System) is the most popular recognition technology in the world which is also a considerable number of applications. In Taiwan, RFID has gradually emerged in our lives such as transportation, access control, identification of goods, etc

In this paper, we used the RFID radio frequency identification technology to design an automatic energy-saving system for users to use computer

classroom. When the computer were not in used, the computer will shutdown or suspend automatically. That can save unnecessary waste of energy and reduce carbon dioxide emissions and slow global warming

Chapter 2, we discuss related works the current relevant technology. Chapter 3, we introduce the use of software and hardware equipment. Chapter 4, we present the design of structure and the system process. Chapter 5 and Chapter 6 are the experiment of our system and the conclusions.

II. RELATED WORKS

A. RFID

RFID (Radio Frequency Identification System) [1] [2] [3] [4] [5] is a technology which uses wireless and contactless data transmission with radio frequency for the reader and tag. RFID has three mainly components: Reader, Antenna and Tag, and they are used to read and transmit.

RFID tag has three types, their respectively are active, passive and semi-passive.

- 1) **Passive:** The passive RFID tag doesn't has inside power supply. The inside circuit operated by receiving electromagnetic wave. The electromagnetic wave is sent from reader. When the tag received enough power from the reader, it will wake up the chip in tag and send the message to the reader. This message included tag ID number and other information which was previously saved in EEPROM in tag.
- 2) **Semi-passive:** The semi-passive RFID tag has some energy inside power that can let

the chip stay in active mode. So the outside energy is used in transmitting. If it received an enough power from the reader, it just transmits the message expect wake up the chip.

- 3) **Active:** The active tag has inside power supply itself, these has enough power to send the message periodically. Generally, the active tag has longer distance to transmit and larger memory.

B. WOL(Wake On Lan)

WOL (Wake On Lan) [6] [7] [8] is a technology of network remote wake on LAN. The principle is that when the computer is in shutdown state or standby state, it retains some electric in the power supply unit of the computer. The little electric can let network card retain lowest ability of operation so that the network card can receive the message of network broadcast from outside. Further, WOL can detect and interpret the content of the message. When the network card received the Magic Packet belong to this computer in the network so that it will detect the content of packet. If the Magic Packet is of this network card, the network card can transmit the signal for to power on or wake up the computer. Above the component of Magic Packet contains FFFFFFFF with MAC address repeated 16 times.

C. ACPI

ACPI(Advanced Configuration and Power Interface) [9] [10] is a interface to manage power in operating system which provided by Intel, Microsoft and Toshiba. The specifications of ACPI 2.0, 3.0, and 4.0 were released in August 2000, September 2004, and June 2009 respectively.

ACPI regulate a computer of compatible with the following states:

- 1) **S0(Working State):** The operating system and application are all executed.
- 2) **S1(Sleeping State):** In this state, no system context is lost. The state saves fewest energy.
- 3) **S2(Sleeping State):** This state is similar to the S1 sleeping state except that the CPU and system cache context is lost.
- 4) **S3(Sleeping State):** In the state, all system context(CPU, cache, and chip set context) is

lost except system memory. It is also called standby mode in Windows.

- 5) **S4(Sleeping State):** The S4 sleeping state is the lowest power, longest wake latency sleeping state supported by ACPI. In order to reduce power to a minimum, it is assumed that the hardware platform has powered off all devices. It is also called hibernation mode in Windows.
- 6) **S5(Soft-Off State):** The S5 state is similar to the S4 state except that the OS does not save any context. The system is in the "soft" off state and requires a complete boot when it wakes.

III. RELATED SOFTWARE AND HARDWARE INTRODUCTION

A. Hardware Introduction

The following is this paper hardware device list of require:

- 1) Active RFID reader
- 2) Active RFID tag
- 3) Several computers
- 4) Cisco 2950 24 port switch
- 5) Power monitor

B. Software Introduction

Figure 1 is we invented active RFID power consumption management system that can read the signal of RFID tag. When a user leave classroom temporarily, the system will command the user's computer go into standby state. When all user leave classroom, all computer will be shutdown.

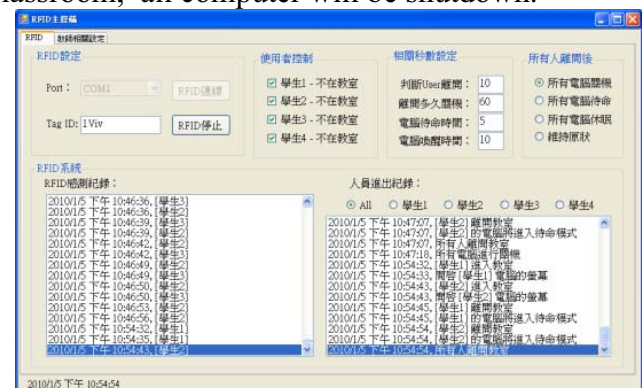


Figure 1. Main control system

IV. PRACTICE DESCRIPTION

A. System Architecture

In this paper, the system architecture is such as following the Figure 2. We use Ethernet Internet to

connect server (RFID host, we call it master) and client (computer of student) by Cisco 2950 switch. Server connects an active RFID reader to receive the signal from tags. Client is installed the control software our designed for receiving the host commands from server. It can let those computer go into standby mode or shutdown.

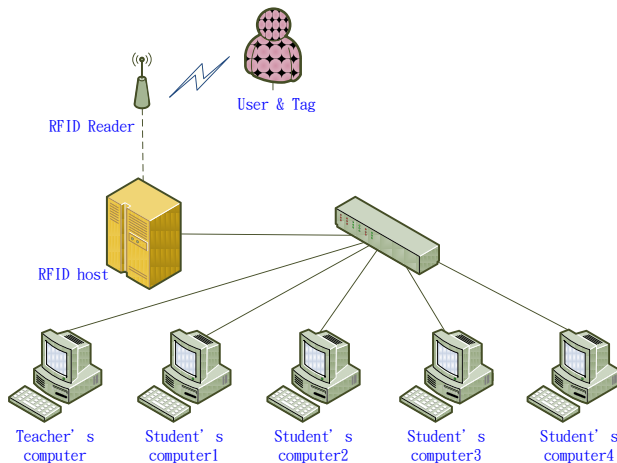


Figure 2. Structure of the System

B. System Operation Flow

The following ClassStates and Userstate represent the classroom's and every user's state:

There are two states for ClassState:

- 1) **START**: It represents the initial state that there is no student in the classroom.
- 2) **IN**: It represents students in the classroom.

There are four states for UserState:

- 1) **START**: It represents that the student entered the classroom or the computer of the student were shutdown already.
- 2) **IN**: It represents that the students is in the classroom.
- 3) **OUT**: It represents that the student leaved the classroom temporarily.
- 4) **SLEEP**: It represents this student temporarily leaved the classroom and his computer has been into standby mode.

The master detect the RFID tag of the student and then and then according to the UserState of system record to control the user's computer. The following are the operation process of system, pseudo code and flow chart:

- 1) When system start to operate:
ClassState=START, UserState=START.

- 2) When student 1 go into the classroom, the master system will receive the signal from the active tags of the students, and then broadcasts the Magic Packet that fits the student's computer to make the computer start atomically. Therefore, it can help student to save the time of opening computer. At the moment, the ClassState=IN, UserState(1)=IN.
- 3) When the student 1 temporarily leaves classroom in class, the master system does not received the active tag signal of the student1 in a period of time(this paper is set to 10 seconds), then the master system will command this student's computer into sleeping state to reduce the power consumption. At the moment, ClassState=IN, UserState(1)=SLEEP.
- 4) When the student 1 leaves classroom over 30 minutes, the master system will broadcast the Magic Packet that fits the student's computer to command this computer to wake up from sleeping state and command this computer into soft-off state to reduce the power consumption after a few seconds. At the moment, ClassState=IN, UserState(1)=START.
- 5) When all students leave classroom, the master system will wake up all computer which was in sleeping state, and then turn off all computers to reduce the power consumption. At the moment, ClassState=START, UserState(1~n)=START.

```

Set ClassState = START
Set UserState = START
While(True){
    if(Student Arrive){
        Send Magic Packet to boot student's PC
        Set ClassState = IN
        Set UserState = IN
    }
    if(Student Leave){
        Suspend the student's PC
        Set UserState = SLEEP
        if(Abort Program)
            Exit the Program
        if(PC suspend over 30mins){
            Send Magic Packet to resume student's PC
            Shutdown the student's PC
            UserState = START
        }
    }
    if(All Students Leave){
        Send Magic Packet to resume All PC
        Shutdown All PC
        UserState = START
    }
}

```

```

ClassState = START
    }
    }
}

```

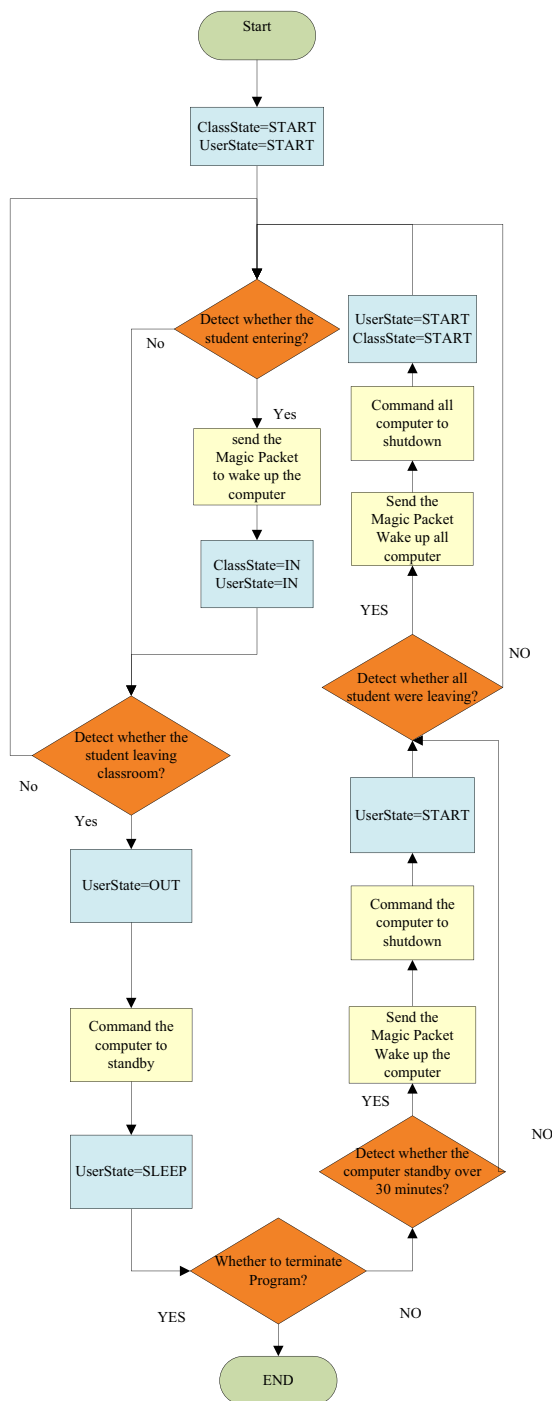


Figure 3. Flowchart of the System

C. Measurement results

This paper tests the power consumption of a teaching PC used or unused our system and the

resume time when computer from sleeping state, soft-off state into working state.

1) Two hour power consumption test:

Figure 4 is a power consumption test between "used our system" and "unused our system". At the moment of 20 minutes, we can see that the computer immediately enter sleeping state after the system detect that the student leaves the seat and at the moment of 50 minutes the computer will enter soft-off state automatically. Therefore, it will only consume 50WH electricity after two hours. However, as the figure 4 depicts that the computer without using our system takes 265WH electricity. In addition, when the computer is in soft-off state, the system still need to provide motherboard and network card et al. some basic power to supply for computer to wake by LAN or keyboard. Therefore, in the soft-off state still has power consumption.

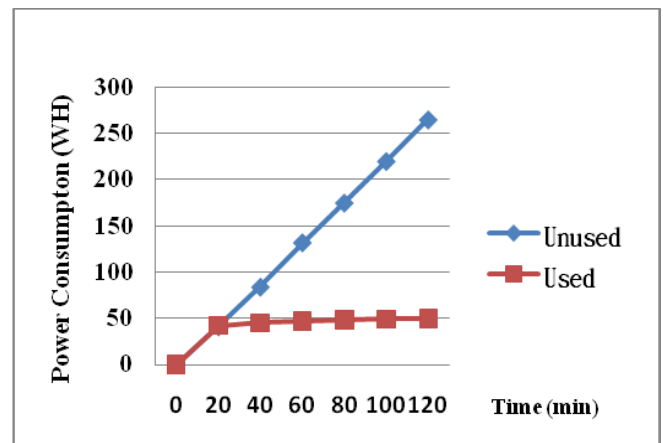


Figure 4. Compare of Power Consumption

2) Reply time test:

Figure 5 is a resume time test from sleeping state and soft-off state back to working state. According to results of Figure 5, from sleeping state back to working state only needs 5 or 6 seconds. However, computer from the soft-off state back to working state needs more than 50 seconds. There are large gap between the two state.

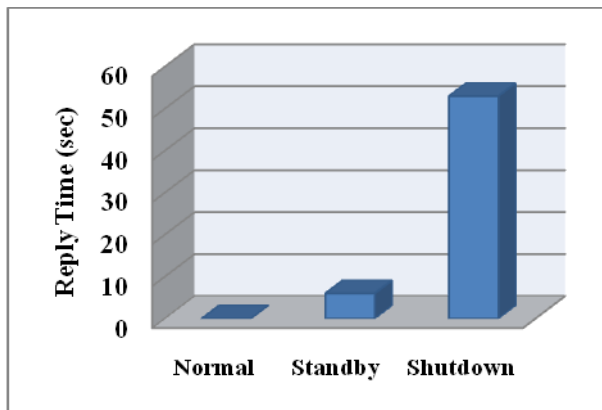


Figure 5. Compare of Resume Time

V. RESULT

According to the results, we can know that computer does not into state of standby or shut down mode, so that can saving more than 200WH by 2 hours that mean we can save 80% of the electricity. Further, the response time of computer in standby state only need less than 10 seconds but from the shutdown state of the open computer, it takes nearly a minute. Therefore, if it is not a long time without using the computer, then you may put your computer on state of standby.

VI. CONCLUSION

In this paper, we successfully design a computer classroom of the energy-saving system by actively RFID. Further, we used some computer to implement the experiment environment. In our experiment, we compare the power consumption between the general system and our energy-saving system. From the experiment result can prove this solution can save a lot of energy, correspondingly, we also saving the much expense of electricity, if this system can extensively popularize each computer classroom and lab, not only You can implement Energy Efficiency and Carbon Reduction, but also reduce the considerable electricity charges and carbon dioxide emissions and slow warming of the Earth.

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