

Study on Energy Efficient IPTV Settop Box

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Abstract. The potential exists for substantial energy savings from more efficient set-top boxes (STBs), including digital TV converter boxes, cable boxes, and satellite receivers/tuners. Much of this potential is driven by the scheduled conversion to digital broadcasting in 2007, which will require analog television sets to use some type of set-top box (either a digital converter box, or a digital cable box or satellite tuner that also serves as a converter) to display programming. The growing interest in digital cable and satellite programming and their expanding services also presents an opportunity for new policies and programs to curtail the energy consumption of STBs.

This paper presents findings and savings estimates from research into the rapidly evolving market for STBs. Topics covered include descriptions of various STBs and related technologies; a summary of the STB market; estimates of current and future STB energy use; descriptions of current program activity in the United States and abroad targeting STBs; options for minimum-efficiency standards for STBs; and an analysis of the potential savings from STB standards. Recommendations for mandatory minimum-efficiency standards on STBs are outlined along with suggestions for improving voluntary labeling programs.

Keywords: green settop, power management, active/passive standby

1. Introduction

Set-top boxes receive broadcasting signals from a variety of media—cable, satellite, terrestrial and IP TV broadcasting service providers—and convert them to video and sound signals to send to TVs or AV devices. Today's set-top boxes have multiple functions and higher performance as broadcasting service markets provide higher-quality and a variety of types of content. Now, set-top boxes have begun to have a built-in storage device and to adopt a hybrid operation scheme. For these reasons, the amount of power consumed by set-top boxes is increasing, and this is a problem that should be addressed from the energy efficiency perspective. The improvement of energy efficiency in On mode, when users are watching their TVs is important, but more urgently, the energy efficiency in Standby mode, when users leave their TVs turned on during the times they are not using them, should be addressed because that will give you a definite gain. [1,2,3]

Most of home appliances consume less than 1W when they are in standby mode. This is attributable to government policies of many advanced countries around the world including Korea, and at the same time, to the energy efficiency of parts in electronic alliances have improved due to the progress of IT technology. Nevertheless, the improvement of energy efficiency of set-top boxes has not yet been realized because of technological and broadcasting system operation-related obstacles: a critical part of STBs, SOC (System on Chip) and middleware programs used in broadcasting systems do not support low-power mode. A bigger obstacle is broadcasting service providers, who are reluctant to introducing a low-power scheme for STBs due to possible deterioration of service quality. In most cases, broadcasting service providers purchase a large volume of STBs and lend them to their service subscribers, and this is why the development of standards for STBs has been carried out by broadcasting service providers. Delay of video display and other problems related to system maintenance after the incorporation of standby mode can have direct affects to broadcasting service providers. For this reason, it is important to develop a low-power STB which ensures the existing broadcasting and additional service quality. [4]

This paper describes how to design and develop an STB which will deliver an advantage in use of energy to you. Chapter 2 describes the energy consumption state of STBs and energy use regulations of

countries around the world, which is a major consideration for the development of STB technology. Chapter 3 describes the technical requirements for a low-power STB.[5]

2. Concept of Green STB

STBs are classified into several categories by its signal transmission type: terrestrial, cable, satellite and IP STBs. And again, according to the existence of a CAS (Conditional Access System) in, they are classified into two categories—simple STBs and complex STBs. The former supports free services and the later does paid ones. Other criteria used for classification of STBs are the provision of the HD supporting function, the existence of a storage device, and signal transmission types—single or hybrid. STBs that deliver HD picture quality, have a built-in storage device and support cable and IP TV services as well as conventional terrestrial services will consume more power. It is predicted that these types of STBs will consume a lot more power even in the future as they are required to add new functions and process higher picture quality. In order to provide a clear understanding of the power modes an STB has, let's look at the terms and definitions set forth in Korea's "Regulations on the power saving in standby mode program." [6]

- On Mode: The device is being connected to a power source and is providing main functions such as transferring signals to peripherals.
- Passive Standby Mode: The device has been turned off by signals from the remote, and is still being connected to a power source. The device does not perform main functions but it can be switched to another mode by internal signals or remote control signals.
- Active Standby Mode: The device has been turned off by signals from the remote, and is still being connected to a power source. The device does not perform main functions but it can be switched to another mode by internal signals or remote control signals, or is receiving minimum data sent from a service provider.
- Off Mode: The power switch has been turned off, but the device is still being connected to a power source. The device does perform no function and cannot be switched to another mode by internal or external signals.

Like the foregoing definitions, STBs have On, Standby, and Off modes, and there are two types of standby modes: Active Standby and Passive Standby. Similar definitions for STBs are found in terms provided by EnergyStar and CoC.

To get more detailed information, let us compare STBs and other home appliances in the amount of annually consumed power. Typical STBs used for a cable or satellite TV consume 150KWh annually, which is larger compared with a washing machine (115KWh), and smaller with a 32" CRT TV (200KWh). STBs with the function of DVR consume an annual average of 200KWh. HD STBs with the function of DVR do 350KWh, which is larger than that consumed by a PC (260KWh) (Source: Annual Energy Use of Common Household Appliances, NRDC-2008) [1]. As you can see from the statistics, as an STB has multiple functions and supports more sophisticated specifications, the amount of its annual power consumption sharply increases.

It suggests that there is no significant difference in the amount of power consumption between Active mode and Off/Standby mode. The reason why Standby mode has not been available until now—unlike other electronic appliances—despite their higher energy consumption is that broadcasting service providers have worried about the potential possibility of lower service quality. Broadcasting service providers send updated information to TVs even when users are not watching them so that firmware, middleware or applications are upgraded in almost real time. Another possible problem is that when users turn on an STB later again, video sent from a broadcasting service provider could not be immediately displayed on the screen, and at this time a certain video delay can occur. Without solving the problem of potential service quality deterioration, it will be meaningless to introduce Standby mode only for the purpose of energy saving.

Nevertheless, many advanced countries including Korea have made efforts to understand the power consumption state of STBs and have prepared and implemented laws and regulations to reduce power

consumption. A classic example is energy efficiency standards that are suggested by the U.S.' Energy Star and Europe's CoC.

<Table 1> U.S.' Energy Star energy efficiency standards for STBs

	Annual Energy Allowance (kWh/year)
Effective Date	2011/01
Cable	50
Satellite	56
IP	36
Terrestrial	22
Thin-Client/Remote	22

3. Green STB Design

Prior to the development of a low power STB, an analysis on component technology should be first carried out. We studied critical parts and detailed technologies required for an STB and figured out what kinds of requirements are needed to yield higher energy efficiency. Critical parts which an STB has in it can be classified into two categories: hardware and software. Critical hardware parts are an Soc, tuner, demodulator, network interfaces and AV output parts, while from the software perspective broadcasting middleware, OS supporting it and applications are critical.

What should be done first for an STB to support standby mode is realizing the function of power control for a key part, SoC. Imported SoCs, which has dominated the Korean market, support only two modes: On and Off. Other types of modes are not available. Most SoC have two internal blocks—the processor core block and the media processing one. The process core block should support various power modes, and a top priority should be put on controlling power supply to the internal blocks. For SoC-based systems, power supply should be controlled for each individual block. In other words, the system should be designed in the way that even if SoC enters into low power mode, users should be able to make inputs and broadcasting information should be able to be received.

From the software perspective, the OS' kernel should support a power supply control module and a user interface should be provided so that users can enjoy this function. In addition, how to control power supply to middleware-related parts should be explored for power control for broadcasting servers and the reception of information on program updates. For PCs, power control specifications ACPI are applied to hardware and operating systems, but for STBs, there are no applicable specifications that take broadcasting communication technology into consideration. Therefore, the preparation of specifications for STB power control should be first carried out. Technical requirements for a low power STB are like the following:

- SoC supporting low power standby mode
- Power control for the individual blocks of the hardware system in an STB
- UPS with a high energy efficiency
- OS and firmware that support the power modes of SoC
- Middleware controlling power supply to an STB
- User interface

Another consideration is the development of hardware and software technology that will make it possible to minimize the possibility of occurrence of delay during On to Standby transition. The next chapter describes how to design and develop an STB with standby mode.

4. Conclusion

This paper presents findings and savings estimates from research into the rapidly evolving market for STBs. Topics covered include descriptions of various STBs and related technologies; a summary of the STB market; estimates of current and future STB energy use; descriptions of current program activity in the United States and abroad targeting STBs; options for minimum-efficiency standards for STBs; and an analysis of the potential savings from STB standards. Recommendations for mandatory minimum-efficiency standards on STBs are outlined along with suggestions for improving voluntary labeling programs.

5. Acknowledgements

This work was supported by the Energy Efficiency & Resources of the Korea Institute of Energy Technology Evaluation and Planning(KETEP) grant funded by the Korea government Ministry of Knowledge Economy(2010T100200175)

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