Latest Power Management Technologies for Mobile Computing Devices

P. Nagabhushan Reddy, T. Bhaskara Reddy

Abstract--- ***Windows Modern Standby (MS) is the modern Power Management model that enables the Smart phone like power management and responsiveness on laptops, personal computers. Modern standby provides enriched user experience similar to the modern smart phones. The new power management model (Connected standby) allows system to be connected while in standby there by saving the power. With Modern Standby, the system responds quickly, even while in standby, whenever there is a valid wake events.***

Index Terms— Connected Standby, Intel Platform, Personal Computers, Runtime Power Management

I. INTRODUCTION

Billions of users all make use of electronic computers such as PCs, laptops, tablets, 2 in 1s etc for day to day job and activities. These devices have become essential part of our life. Power consumption by these devices has become one of the important aspect for considering buying various devices, as it effects device mobility as well as its impact on environment. The Lower the energy consumed by these devices (especially that are running on Battery), the better the dependence and usability of the device. With the improvement in the Semiconductor technology (from x mm in 1960s to 10nm/7nm at present), more may new form factor devices with various functionality and use cases have come up. Apart from Power and Performance, the other vector that have seen phenomenal growth is Connectivity. The user expects the devices they use to be always connected and desire to have the information ready with in no time. The technology is helping to push the performance up and in parallel engineers across the companies (Semiconductor, Comms, SW, HW, mechanical, thermal etc) are exploring the way to contain the power consumption while still delivering higher performance, responsiveness and instant connectivity. New use cases and applications have come up as the devices become smaller and can function with limited power. There is always need to reduce the energy consumed of these devices, which results in more battery life and also helps save environment. In this paper we will focus on the Traditionally Laptops and PCs support Legacy Standby (S3) feature

II. WHAT IS POWER MANAGEMENT (PM)

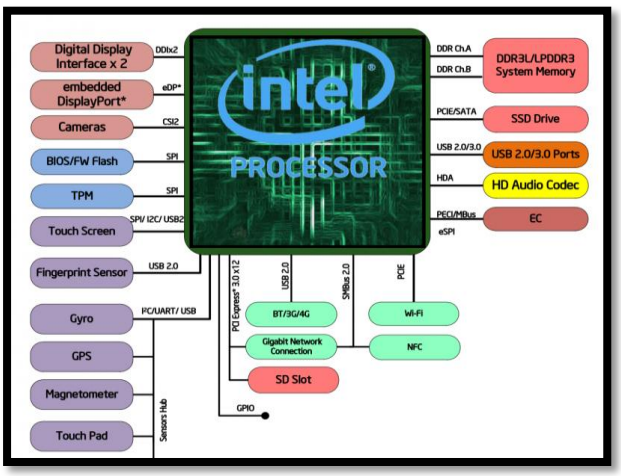
Power Management is an important feature of the electronic devices (for e.g. computers, printers, monitors etc) using which the system/sub-system is turned off or put into low power state when in active. Power Management can be done at various levels in system

- SoC (CPU, Microcontroller, Processor)
- Board Components (PMIC, Display, Memory etc)
- Software (Operating systems, FW, Drivers etc)

Advantages:

- Reduce overall power consumption
- Extended battery life
- Reduce cooling requirements
- Reduce Cost
- Conserve the nature

III. BASIC LAPTOP ARCHITECTURE DIAGRAM



IV. PM WITHIN SOC/MICROCONTROLLER

The IPs within the SoC (System on Chip) need to be turned off when they are idle. It helps to lower the overall power consumption.

- Some of the IPs include: Graphics, IPU (Image Processing Unit), USB, PCIe, Serial peripherals (I2C, SPI, UART) etc
- Power Gating: Mechanism where the power to the IPs are cutoff when they are idle
- P-States (Core Runtime Power Saving States): The P-states are voltage-frequency pairs that set the speed and power utilization of the coprocessor. When the operating voltage of the processor is reduced, the power consumed by the system also goes down. The Power Manager regularly monitors the cycle utilization. If the cycle usage is less than a defined threshold, it increases the P state

Revised Manuscript Received on February 22, 2019.

P.NagabhushanReddy, Platform Architect, Intel, Bangalore, India(nagabhushan.reddy@intel.com)

Dr.T.Bhaskara Reddy Professor, CS Dept., SK University, Anantapur, AP, India(bhaskarreddy.sku@gmail.com)

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

- C-States (Core Idle Power Saving States): Shutting off the power to the individual CPU cores when they are idle.
- Package C-States: Package C-States is shutting down the rest of other non-core components in the CPU. The package states are mapping to the power states of various components in the CPU like Graphics, PCIe, display, etc.

V. PM AT BOARD LEVEL

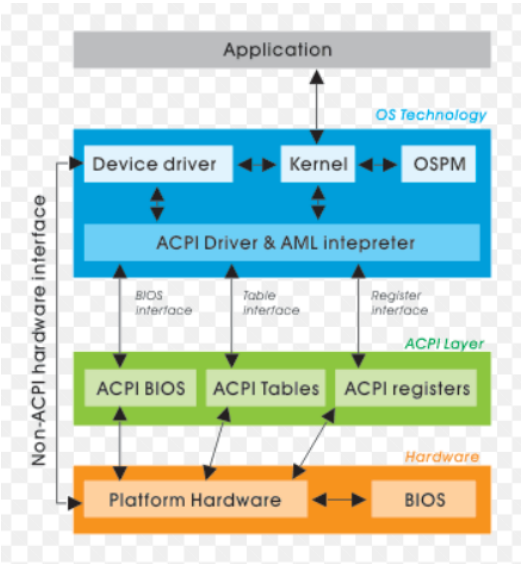
The components on the board will impact the overall Power Management of the system. Some of the important aspects of the board include the following:

- Memory: LP DDR3 Vs DDR3
- Display: Display with PSR feature Vs No PSR
- External PCIe Graphics Card: Supporting L1.2
- SATA SSD: Supporting SATA Slumber

VI. PM AT SOFTWARE LEVEL

The OS, drivers and software plays an important role to control the overall Power Management of the system. Each OS (Windows, Linux, etc) have various kinds of Power Management framework and architecture that provides a comprehensive approach to system and device power management.

The below figure shows the overall components that are part of the Power Management flows.



VII. INTEGRATED POWER MANAGEMENT

The integrated approach to power management—involving the operating system, system hardware, device drivers, and device hardware—results in the following:

More intelligent power management decisions. At each level, the best-informed component directs power usage.

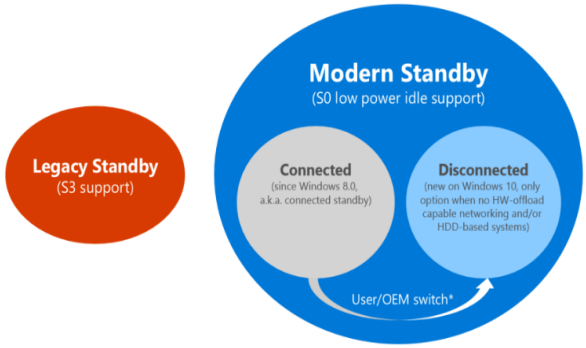
Greater reliability. Better power management decisions reduce the chance of ill-timed shutdowns and loss of data.

VIII. MODERN STANDBY FOR PCS

Modern Standby (MS) enables the smartphone kind of quick responsive capability on the PC and laptops. It provides an instant on/off user experience that users expect to have with their phones. The new power management model (Connected standby) allows system to be connected while in standby there by saving the power.

Some of the key features that are available is Wake of Voice, Wake on Skype, etc which is currently not possible with legacy standby enabled systems.

MS will make sure all the wake sources are configured before going to idle state. All other components and IPs will be in their lowest power states (D0 idle or D3 Hot or D3 Cold etc) with Power gating and clock gating enabled, that will help the SoC save lot of power during idle situation. In this condition if the user wakes up the system through one of the wake, the sytems return to the active state very fast (with in 1sec). So the user is getting lower power consumption and very good responsive system.



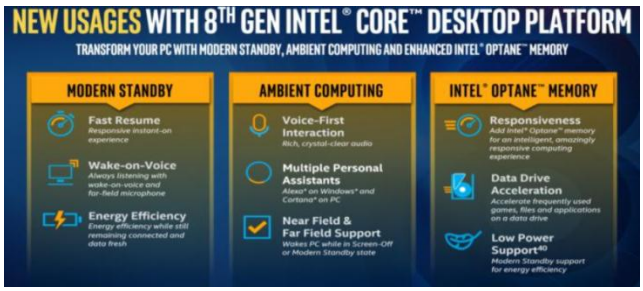
IX. DIFFERENCE BETWEEN CMS AND DMS

Connected Modern Standby (CMS) and Disconnected Modern Standby (DMS) states transitions follow a very similar path. In CMS, the systems is connected to the network in Modern Standby. So if there are any new mails or applications that requires network sync, they are very well connected in the Modern standby.

In DMS, the system will not maintain Network connectivity during the Modern standby.

The OS configures the system as CMS or DMS based on the storage connected to the system. If the system have a fast storage memory (like SSD, NVME etc), the system is configured to CMS as it is capable to handle the fast power transitions (in and out) for any network wake events.

If the system is connected with rotation HDD, it is configured as DMS. This will make sure the network is disconnected while the sytem is in MS to avoid frequent wake to the sytems. This is to ensure the HDD will not be damaged or wore out quickly because of frequent spin-in and spin-outs.



Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

X. MODERN STANDBY-VALIDATION METHODOLOGY

- Connected Modern Standby (CMS) and Disconnected Modern Standby (DMS)
    - Check for SW Drips, HW drips (OS, SW)
    - Check for Low power residency (Hardware) using SoC specific tools
- Verify network connectivity during the standby
- Verify wake through skype for CMS
- Low Power Audio
- Wake on Voice

Testing and validating the operation of a modern standby PC is a critical effort for the system integrator. Modern standby involves all hardware and software components on the system, and requires special attention to the core silicon or System on a Chip (SoC), networking devices (for example, Wi-Fi), and peripheral devices connected to the pins of the SoC chip.

CONCLUSION

Modern standby on Laptops in no doubt is the futuristic Power Management Technologies. The S3 power model is an older standard and is not capable of the instant on that consumers expect from modern devices. Modern Standby is capable of leveraging all the capabilities of a modern chipset and can be integrated across the breadth of tablets and PCs today.

REFERENCES

1. Intel, Microsoft, and Toshiba. Advanced configuration and power interface specification. http://www.intel.com/ial/powermgm/specs.html, 1996.
2. T. Simunic, L. Benini and G. De Micheli, "Power Management of Laptop Hard Disk", Proceedings of DATE, p.736, 2000
3. T. Simunic, L. Benini, and G. D. Micheli. Event-driven power management. In International Symposium on System Synthesis, pages 18–23, 1999.
4. A. V. Ramesh, S. M. Reddy and D. K. Fitzsimmons, "Airplane system design for reliability and quality," 2018 IEEE International Reliability Physics Symposium (IRPS), Burlingame, CA, USA, 2018.
5. https://docs.microsoft.com/en-us/windows-hardware/design/device-experiences/introduction-to-modern-standby-testing
6. Advanced Configuration and Power Interface Specification, Version 5.November 2013.
7. IEEE Standard for Test Access Port and Boundary-Scan Architecture - Redline," in IEEE Std 1149.1-2013 (Revision of IEEE Std 1149.1-2001) - Redline, vol., no., pp.1-899, May 13 2013.
8. https://software.intel.com/en-us/articles/power-management-states-p-states-c-states-and-package-c-states

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication