



# Intel Power Management Technologies for Processor Graphics, Display, and Memory

White Paper

---

*For 2010 - 2011 Desktop and Notebook Platforms*

*August 2010*



INFORMATION IN THIS DOCUMENT IS PROVIDED IN CONNECTION WITH INTEL® PRODUCTS. NO LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT. EXCEPT AS PROVIDED IN INTEL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, INTEL ASSUMES NO LIABILITY WHATSOEVER, AND INTEL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY, RELATING TO SALE AND/OR USE OF INTEL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS OTHERWISE AGREED IN WRITING BY INTEL, THE INTEL PRODUCTS ARE NOT DESIGNED NOR INTENDED FOR ANY APPLICATION IN WHICH THE FAILURE OF THE INTEL PRODUCT COULD CREATE A SITUATION WHERE PERSONAL INJURY OR DEATH MAY OCCUR.

Intel may make changes to specifications and product descriptions at any time, without notice. Designers must not rely on the absence or characteristics of any features or instructions marked "reserved" or "undefined." Intel reserves these for future definition and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to them. The information here is subject to change without notice. Do not finalize a design with this information.

The products described in this document may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are available on request.

Contact your local Intel sales office or your distributor to obtain the latest specifications and before placing your product order.

All products, platforms, dates, and figures specified are preliminary based on current expectations, and are subject to change without notice. All dates specified are target dates, are provided for planning purposes only and are subject to change.

This document contains information on products in the design phase of development. Do not finalize a design with this information. Revised information will be published when the product is available. Verify with your local sales office that you have the latest datasheet before finalizing a design.

Intel and the Intel logo are trademarks of Intel Corporation in the U.S. and other countries.

\*Other names and brands may be claimed as the property of others.

Copyright © 2010, Intel Corporation. All rights reserved.



# Contents

---

1	Introduction .....	5
	1.1 Reference Documents.....	5
2	Power or Efficiency? .....	6
	2.1 Introduction .....	6
	2.2 Power Equation.....	6
	2.3 Memory Power Savings Technology.....	8
	2.3.1 Intel® Smart 2D Display Technology (Intel® S2DDT) .....	8
	2.3.2 Intel® Rapid Memory Power Management (Intel® RMPM) or CxSR ....	8
	2.4 Display Power Savings Technology.....	8
	2.4.1 Intel® Display Refresh Rate Switching (Intel® DRRS) .....	8
	2.4.2 Back light Control Technologies .....	8
	2.5 Graphics Core Power Savings Technologies .....	9
	2.5.1 Intel® Graphics Power Management Technology (Intel® GPMT).....	9
	2.5.2 Intel Graphics Dynamic Frequency.....	9
	2.5.3 Intel® Graphics Render Standby Technology (Intel® GRST), RC6, or RC6+ .....	10
	2.6 Summary.....	10



## *Revision History*

---

<b>Revision Number</b>	<b>Description</b>	<b>Revision Date</b>
-001	Initial release.	August 2010
-002	Formatting edits	August 2010

§



# 1 Introduction

---

The purpose of this document is to discuss the different power management technologies that Intel has developed for Processor Graphics, Display, and Memory

## 1.1 Reference Documents

Document	Document No./Location
<i>Intel® HD Graphics with Dynamic Frequency</i>	<a href="http://www.intel.com/Assets/PDF/whitepaper/323324.pdf">www.intel.com/Assets/PDF/whitepaper/323324.pdf</a>



## 2 Power or Efficiency?

---

### 2.1 Introduction

Want to go fast? If so, you have to give up efficiency. In automobiles the fastest cars on the street also get the worst gas mileage. For computers that use to mean that the fast computers created more noise or generated more heat. What if you could have the best of both worlds? What if you could have high performance and yet not have to sacrifice efficiency? Intel continues to provide you the best of both worlds with their highest performance platforms that don't sacrifice efficiency. Moore's law describes a long-term trend in which the number of transistors on a circuit board has doubled approximately every two years. As computer capabilities grow in areas such as processing, graphics, memory and display technologies, so does the power requirements. If Intel didn't continue to create new technologies to balance that performance with incredible efficiency, notebook computers would not be nearly as easy to carry around nor would you be able to work most of the day on the battery. Intel continues to lead in silicon technologies through investments in R&D and manufacturing technologies. As a result, Intel products are provided with an inherent benefit of both performance increase and power savings, or put another way, the best of both worlds!

With the forth coming 2010 - 2011 Desktop and Notebook Platform processors, Intel processor graphics will be on leading edge manufacturing process technology. This provides a consumer with the best possible battery life for a mobile platform as well as an unequaled Energy Star\* rating for desktop systems. The 2010 - 2011 Desktop and Notebook Platform processors will represent the latest installment of Intel processor graphics products to the market place that continues Intel's legacy of providing energy saving processor graphics technologies.

As Intel continues to further reduce the size or lithography of the transistor, power will continue to be reduced. So, one may ask, how is Intel able to do this? The simple answer is that Intel is able to reduce the voltage that our transistors run on. However this is still not obvious with introducing the dreaded power equation.

### 2.2 Power Equation

Power = F (frequency) \* V<sup>2</sup> (Voltage) \* C (capacitance constant of the chip) + Leakage

The frequency and capacitance tend to cancel each other out and become simple multipliers. The voltage term tends to take over as it is squared. So for example, cutting voltage in half from two volts to one volt will have the result of decreasing the power by 400%, or a quarter of the previous power. The final term, leakage, is another matter. Leakage is essentially a constant based upon the simple fact that when a transistor is powered there is an amount of waste (leakage power) created by applying a voltage to a transistor. Leakage will always be a constant battle as long as the transistor is utilized, but Intel is able to reduce the power through innovations to

## ***Power or Efficiency?***



the manufacturing process and with changes within the processor design itself. More on this topic later.

From 2003 to present, Intel has been developing power savings technologies for Intel processor graphics, display, and memory. In the next section we will divide the technologies based upon what part of the processor graphics system they impact. We will also introduce each technology and give a brief tutorial on how the technology works and how the technologies reduce overall power.



## **2.3 Memory Power Savings Technology**

### **2.3.1 Intel® Smart 2D Display Technology (Intel® S2DDT)**

Intel® S2DDT or Frame Buffer Compression (FBC) is primarily a memory power savings technology. That is the major benefit is to the memory power while displaying the processor graphics information to the display. FBC works by compressing the amount of memory used by the display. The technology works for both 2D display operating systems like Windows\* XP and also operating systems that are in 3D like Windows Vista\* and Windows\* 7. The benefit comes from keeping the memory footprint small and having fewer memory pages opened and accessed for refreshing the display. This technology is being extended from mobile platforms to include desktop platforms starting with the 2010 - 2011 Desktop and Notebook Platform processors.

### **2.3.2 Intel® Rapid Memory Power Management (Intel® RMPM) or CxSR**

Intel® RMPM is another memory power savings technology that works while the processor is in lower power states. Intel® RMPM will automatically refresh memory without relying on the processor or processor graphics core to enter higher power states to refresh the memory. Since memory is basically a capacitor it must be refreshed, or the charge renewed, in order to continue to store the data. This technology is available now on Mobile platforms and starting with the 2010 - 2011 Notebook Platform processors - this technology will also be available on 2010 - 2011 Desktop platforms.

## **2.4 Display Power Savings Technology**

One of the major impacts to overall system power is the attached display on mobile platforms. Intel has developed several technologies to manage power and increase battery life.

### **2.4.1 Intel® Display Refresh Rate Switching (Intel® DRRS)**

Intel® DRRS provides a mechanism where the monitor is placed in a slower refresh rate (the rate at which the display is updated). The system is smart enough to know that the user is not displaying either 3D or media like a movie where specific refresh rates are required. The technology is very useful in an environment such as a plane where the user is in battery mode doing E-mail, or other standard office applications. It is also useful where the user may be viewing web pages or social media sites while in battery mode.

### **2.4.2 Back light Control Technologies**

Intel has enabled several Back Light Control (BLC) technologies to reduce power consumption. One of the easiest is the ability to turn the back light down and this has



been enabled within most operating system power schemes. Intel felt that this was not enough, so Intel developed two other complementary technologies.

### **2.4.2.1 Intel® Automatic Display Brightness**

Since display brightness is not only an issue for battery life, but also an issue in really bright or dark environments, Intel has enabled the ability for an ambient light sensor to be an intelligent input to the processor graphics system. Based upon inputs from this sensor the Intel Graphics driver will automatically adjust the display to provide the best user experience.

### **2.4.2.2 Intel® Display Power Savings Technology (Intel® DPST)**

Intel® DPST is available when either the simple BLC or Intel Automatic Display Brightness is being used when in battery mode. With Intel DPST technology the display brightness can be reduced even more as Intel DPST changes the chroma values of each pixel to still provide a readable screen image when the back light is turned down to save display power.

## **2.5 Graphics Core Power Savings Technologies**

Intel also has several power savings technologies when either the system is in use, at rest, or put to sleep. We will be discussing these next.

### **2.5.1 Intel® Graphics Power Management Technology (Intel® GPMT)**

Intel® GPMT is enabled when the system is in battery mode. This technology has the capability to both adjust voltage and frequency of the graphics cores. As you may recall from the power equation previously discussed, these are the two items that we can control to adjust power dissipation. The only other item, capacitance, is mainly based on die size and process technology. The purpose of this Intel GPMT is to adjust the voltage and frequency down when on battery and there is not an application demand. When there is an application demand the frequency and voltage will be adjusted back up to some nominal level. This leads us to the next technology that is very similar to Intel GPMT.

### **2.5.2 Intel Graphics Dynamic Frequency**

Dynamic Frequency is otherwise known as Graphics Turbo. The technology was first introduced on Intel's mobile platforms based on the Intel 5 series-M chipset and has now been expanded to include 2010 -2011 Desktop processors. This technology works a lot like Intel GPMT in that it is responsible for changing both the voltage and frequency of the graphics core (please see previous Whitepaper: [www.intel.com/Assets/PDF/whitepaper/323324.pdf](http://www.intel.com/Assets/PDF/whitepaper/323324.pdf)). The exception is that this technology is able to increase the frequency of the part beyond the nominal operating frequency for short periods of time based upon application demand and the amount of activity the processor cores are being used. When Intel Graphics Dynamic Frequency is enabled; Intel GPMT is disabled starting with 2010 -2011 Desktop and Notebook Platform processors.



### 2.5.3 **Intel<sup>®</sup> Graphics Render Standby Technology (Intel<sup>®</sup> GRST), RC6, or RC6+**

The final power savings technology from Intel happens while the system is asleep. This is another technology where the voltage is adjusted down. For RC6 the voltage is adjusted very low, or very close to zero. So let's say we adjust the voltage 1.3V to 0.4 V with everything being equal we have reduced power by over 1000 percent (this is done by dividing the  $V^2$  terms ( $1.3^2 / 0.4^2$ )). Intel will be introducing this technology for desktop based processors starting with the 2010 -2011 Desktop and Notebook Platform processors. Previously it was only available on mobile platforms.

## 2.6 **Summary**

Intel has been the leader in process technology and, innovations and technologies that create both speed and efficiency. This provides Intel with the ability to provide the marketplace with low power products that also deliver the world's best processor performance. Intel also develops technologies to further reduce power for individual components. Intel has developed technologies to reduce display, memory, and graphics core power for our processor graphics products. In addition to these technologies, Intel has also taken technologies that were only available on mobile platforms and extended these technologies to desktop platforms.

§