Technology Brief

Intel® Power Management Technologies

Embedded Computing

Balancing Performance and Power Consumption

Power management capabilities give developers control over power consumption

Embedded developers understand the profound impact power consumption has on end-user utility bills, device form factor and attainable performance, as well as battery runtime for mobile devices. A very effective way to manage power consumption is to put the system into a lower power state when the system workload decreases. Intel® processors support a number of power states that enable substantial power savings and design flexibility and are accessible through the industry-standard Advanced Configuration and Power Interface (ACPI).

Defining Power States

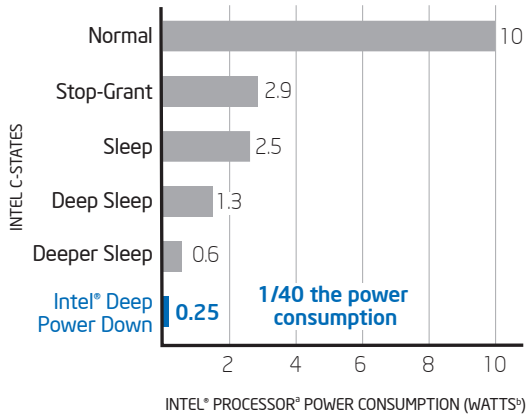
Power states fall into three categories, where the first two define different "sleep" modes and the third defines fully functional operating modes.

- **Global (G-states)/System (S-states):** These states are defined by the ACPI specification and control whether the system is fully on, sleeping with system context saved, in "soft off" or mechanically off.
- **Processor States (C-states):** C-states manage power consumption at the processor core level, as demonstrated by the Intel® Core™2 Duo processor SU9300,[Δ] ranging from 10 W to 0.25 W TDP (thermal design power), as shown in Figure 1.
- **Performance States (P-states):** P-states establish multiple operating points that vary processor frequency and supply voltage.

Intel® Power Management Technologies

In conjunction with power states, the Intel technologies listed in Table 1 enable systems to strike the right balance between computing performance needs and power consumption. They give software developers granular control over the system operation. For mobile applications, like handheld medical devices and ruggedized laptops, some power states save considerable power during periods of low activity and can be used to significantly extend battery runtime.

Developers may also use Enhanced Intel SpeedStep® technology to put a ceiling on the system power consumption. Limiting the maximum power consumption may be useful when an OEM wants to reuse a board design in a more thermally constrained form factor. Software engineers can easily prohibit systems from entering high-performance P-states and satisfy more stringent maximum power consumption requirements.



[a]Intel® Core™2 Duo processor SU9300 in High-Frequency Mode

[b]Thermal Design Power (TDP)

Figure 1. Processor Power Consumption for Different Package C-States

Intel® Power Management Technologies	Capabilities/Benefits
Enhanced Intel SpeedStep® Technology	Allows applications and operating systems software to change the processor supply voltage and frequency. **Benefit:** Enables optimal performance at the lowest power.
Intel® Turbo Boost Technology[1]	Establishes a new P-state (highest performance) by increasing the processor frequency above the base operating frequency when conditions warrant. **Benefit:** Delivers additional processor frequency bins.
Dynamic FSB Frequency Switching	Halves the processor front side bus (FSB) frequency, as directed by application software. **Benefit:** Provides further power savings to P-states.

Table 1. Intel® Power Management Technologies Capabilities and Benefits

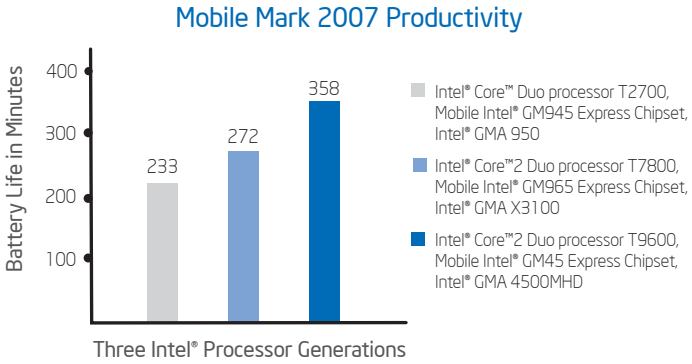


Figure 2. Battery Life for Three Generations of Intel® Platforms

Platform Components	Required Capability
Processor	Enhanced Intel SpeedStep® technology and/or support for power states
Chipset	ACPI-enabled
Voltage Regulator Module (VRM)	Special VRM required for Enhanced Intel SpeedStep technology
Operating Systems	Windows*: 7, Vista,* XP,* XP Embedded
	Linux* Kernels: revision 2.6.21 or higher
	Wind River VxWorks* RTOS: revision 6.2 or higher
BIOS	ACPI-enabled

Table 2. Required Intel® Power Management Technologies Components

Addressing Common Power-Related Challenges

By employing Intel® Power Management Technologies, developers have control over the mix of system performance and power consumption. The technologies address many design challenges, like conserving power, increasing performance and meeting demanding thermal requirements, as described in the next three sections.

Reduce Average Power Consumption

Businesses take overall power consumption seriously because they must pay for electricity to power their equipment and then again to remove the generated heat exhaust from facilities. Application software can cut power consumption when equipment is operating below maximum load by moving to a lower power state or invoking Intel SpeedStep technology and dynamic FSB frequency switching. Further decreasing power consumption, Intel's steady stream of architectural enhancements save power without software intervention, as demonstrated by the battery life improvements over three Intel® platform generations shown in Figure 2.

Crank Up Performance, Conditions Permitting

What if fully loaded systems could overclock the processor to squeeze out a little more performance without the risk of stability issues? This is exactly what Intel® Turbo Boost Technology[1] does – it automatically allows the processor to run faster than the base operating frequency if it's operating below power, current and temperature specification limits. Systems get more performance on demand via an additional processor speed bin, conditions permitting.

Support Many Form Factors with One Platform

The ideal scalable platform has high-performance options for top-end systems and low-power alternatives for space-constrained form factors. Intel platforms with Intel SpeedStep technology satisfy both because designers can run the processor full-board in performance systems or lock in a processor frequency and voltage combination that meets strict power requirements. OEMs can create a family of products with different performance and power consumption objectives using a single platform based on Intel's silicon products.

Deploying Intel® Power Management

Intel Power Management Technologies are enabled by a number of hardware and software components, which are listed in Table 2. Enhanced Intel SpeedStep Technology is supported by specified Intel processors and voltage regulator modules. All technologies require an ACPI-enabled Intel® chipset, BIOS software and operating system.

For more information on Intel® technologies, visit www.intel.com/technology/advanced_comm.

Additional information about Intel® embedded products can be found at www.intel.com/products/embedded/index.htm.

[Δ] Intel processor numbers are not a measure of performance. Processor numbers differentiate features within each processor family, not across different processor families. See www.intel.com/products/processor_number for details.

[1] Intel® Turbo Boost Technology requires a platform with a processor with Intel Turbo Boost Technology capability. Intel Turbo Boost Technology performance varies depending on hardware, software and overall system configuration. Check with your platform manufacturer on whether your system delivers Intel Turbo Boost Technology. For more information, see http://www.intel.com/technology/turboboost.

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