Abstract

This white paper is intended for server administrators to describe how HPE’s Intelligent System Tuning features are used to improve performance in HPE server environments.
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Features of Intelligent System Tuning

HPE Intelligent System Tuning for HPE ProLiant Gen10 servers consists of the following features:

- **Workload Matching**--Use preconfigured server profiles to maximize application performance.
- **Jitter Smoothing**--Use the Processor Jitter Control setting to level and balance frequency fluctuation (jitter) resulting in lower latency.
- **Core Boosting**--Where supported, use to produce higher performance across more active cores.

**NOTE:**
Core boosting is available only with select HPE ProLiant Gen10 servers, Intel processors, and hardware configurations.

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<th>Core Boosting</th>
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<td>HPE Gen10 server</td>
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<tr>
<td>Intel processor</td>
<td>X</td>
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<td>1.2.4</td>
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</table>

1 Select servers only; requires high-performance heatsinks and fans.
2 Select Intel processors only.
Workload Matching

The default BIOS settings on HPE servers provide a balance between performance and power efficiency. These settings can be adjusted to match specific application workloads.

HPE Gen10 servers offer a UEFI configuration option to help customers tune their BIOS settings by using known workload-based tuning profiles. When matching your Workload Profile setting to your actual deployed workload, you can realize performance gains versus just using the out-of-box BIOS defaults.

For more information about how to tune an HPE Gen10 server using Workload Profiles, see the UEFI Workload-based Performance Tuning Guide for HPE ProLiant Gen10 Servers and HPE Synergy at http://www.hpe.com/support/Workload-UG-en.

Figure 1: Workload profile options in UEFI System Utilities

Increasing performance using Workload Profiles

Use the following system-generated Workload Profiles to increase server performance:

**General Power Efficient Compute**

Applies the most common performance and power management settings. Recommended for users who do not tune BIOS settings to match workloads.
General Peak Frequency Compute
Applies performance and power management settings to achieve the maximum frequency possible for any individual core. Recommended for workloads that benefit from faster compute time.

General Throughput Compute
Applies performance and power management settings to achieve total maximum sustained throughput. Optimized to support NUMA (Non-uniformed Memory Access) awareness.

Virtualization - Power Efficient
Applies performance settings to enable all virtualization options. Manages power settings so that they do not interfere with virtualization. Recommended for virtualization environments.

Virtualization - Max Performance
Applies performance settings to enable all virtualization options. Disables power settings to deliver optimum performance. Recommended for virtualization environments.

Low Latency
Applies reductions to speed and throughput and disables power management to lower overall computational latency. Recommended for RTOS (Real-Time Operating Systems) workloads or other workloads that are latency sensitive.

Mission Critical
Manages advanced memory RAS (reliability, availability, and serviceability) features. This profile is intended to be used by customers who trade off performance for server reliability above the basic server defaults.

Transactional Application Processing
Manages peak frequency and throughput. Recommended for processing environments such as those using OLTP (online transaction processing) applications that require a back-end database.

High Performance Compute (HPC)
Disables power management to optimize sustained available bandwidth and processor compute capacity. Recommended for users running a traditional HPC environment.

Decision Support
This profile is intended for Enterprise Business Database (Business Intelligence) workloads that are focused on operating and/or accessing data warehouses, such as data mining or OLAP (online analytical processing).

Graphic Processing
Power management and virtualization are disabled to optimize the bandwidth between I/O and Memory. Recommended for workloads running on servers that use GPUs (Graphics Processing Units).

I/O Throughput
Disables power management features that impact the links between I/O and memory. Recommended for configurations that depend on maximum throughput between I/O and memory.

Custom
Disables Workload Profiles. Recommended for users who want to set specific BIOS options.
For the past several years, server-class customers have seen processor-based performance increase generation over generation. This increase is due in a large part to increases in core counts and more efficient instruction set architectures. Unlike the preceding decades, the base frequency of the CPU has stayed rather stable with performance improvements coming from increasing core counts and architectural enhancements. However, processor vendors began to realize that not all workloads benefit from increased core counts, so they introduced features that allow some cores to run opportunistically at higher frequencies power headroom is available or other cores are underutilized.

Although these opportunistic frequency upsides can increase performance, they also introduce an unwanted side effect. Frequency shifting itself introduces computation jitter, or nondeterminism, and undesirable latency. Jitter and the latency associated with it create problems for several customer segments. For example, high-frequency traders, who rely on time-sensitive transactions, cannot tolerate the microseconds of delay that can be added non-deterministically to a trade caused by a frequency shift. These delays over time can cost a trader upwards of millions of dollars. In other environments, servers running RTOS (real-time operating systems) to control critical functionality also cannot tolerate random latencies that happen when opportunistic-frequency features are left enabled.

The current trend for latency-sensitive customers is to disable the features that normally would result in increased application performance because of the associated jitter. A trade executes faster if the processor runs faster, but if it comes at the cost of random delay, the benefit of increased performance is lost.

HPE has introduced Processor Jitter Control in its Gen10 servers to enable customers to achieve both frequency upside and low jitter. This feature allows the customer to remove or reduce jitter caused by opportunistic frequency management, which results in better latency response and higher throughput performance.

NOTE:

- An iLO Advanced or iLO Advanced Premium Security Edition license is required to use this feature.
- Processor Jitter Control is available for Gen10 servers using Intel® Xeon® Scalable Processors. Servers using AMD processors do not support this feature.

Sources of jitter within the processor

The Intel processor introduces jitter in cores at any time they change the operating frequency. Several possible reasons exist for a processor to dynamically change frequencies during run time. Some of the sources that request frequency changes are driven by software, while others are driven by the processor itself.

P-states and power management

P-states are predefined performance states that are made available by the processor for software to control how much performance the processor can deliver so that it can manage the power-performance efficiency of the platform. Performance states are mapped to specific frequencies at which the processor is capable of operating. Power management software instructs the processor to change P-states (frequency) to save power when processor utilization (demand) is low. A processor often offers several different P-states over a range of operating frequencies.

Turbo Boost

Intel’s Turbo Boost allows the processor to run at higher frequencies than the base frequency stated in its specification, assuming it follows certain conditions. The conditions include the amount of heat being
dissipated, the temperature of the part, and the number of cores active (enabled and not idle.) When a workload is run on these processors while Turbo Boost is enabled, the processor will opportunistically switch between frequencies in an attempt to achieve the highest possible performance. But as the demands of the workload change, so can the frequencies. When frequencies change, we get frequency jitter as well as a small amount of latency that occurs, which is required to electrically change frequencies.

The net effect of having Turbo Boost enabled is that while the processor attempts to provide the maximum amount of performance within its limits, it typically does so by changing frequency often.

**C-states**

C-states are predefined power-saving states that the processor offers to power management software to use when the operating system idles a processor core. The operating system puts the processor into one of a number of C-states that are made available. The deeper the C-state, the more power that is saved, but at the cost of longer exit latencies to return to the operating state. In an attempt to save power, C-states on Intel processors also lower the frequency of the processor. Upon exiting a C-state, the processor, running at the lowest frequency available to the C-state, must perform an additional frequency shift to return to the previously requested P-state by power management software.

C-states are useful in saving power when the processor is not being used. However, entering and exiting these states introduces a large amount of jitter.

**Power and thermal events**

The processor, in an attempt to run within the constraints of its design, employs the use of frequency throttling to protect itself from thermal or overcurrent conditions.

Frequency throttling controls the amount of stress that the workload can introduce on the host. Higher stress levels result in higher heat and current draw. Several factors can lead to high operating temperature or overcurrent events. Server ambient temperature, air flow, and other factors all play an important role in processor temperature.

An overcurrent event can occur when the processor executes very high-demand, power-hungry workloads that can consume significant resources within the processor itself. Overcurrent can also occur if Turbo Boost is enabled and the processor attempts to maximize the amount of performance when a particularly aggressive workload executes and the power that is consumed is driven very high.

**Advanced Vector Extensions**

Server processors offer Advanced Vector Extensions (AVX) that perform complex math at the cost of utilizing logic, which can drive very high power usage inside the processor itself.

If left unchecked, overcurrent throttling is required when these instructions eventually drive the processor to consume higher power. Instead of reactively throttling, processors typically proactively force cores to run at a lower frequency to limit the chances of extreme power excursions whenever those instructions are executed.

On Intel processors, the use of AVX instructions causes the processor to limit the processor frequency automatically. Because these instructions cause the processor to automatically limit and potentially lower the frequency, their usage often introduces jitter.

**Jitter and latency**

Jitter and latency are directly related. Jitter induced by processor frequency changes introduces changes in latency as observed by a workload. When a processor executes a change in frequency, it goes through a process that causes thread execution to stop entirely before the processor is capable of running at the new chosen frequency. This process occurs regardless of whether the processor will shift to a faster or slower frequency. The amount of time that the processor is stopped can vary, but is typically between 10 microseconds and 15 microseconds. For a workload that depends on processor execution, a change in frequency will then always introduce an additional 10-15 microseconds of latency.
Because frequency shifts are often asynchronous to application tasks running on the server, these latencies are random and thus non-deterministic from an application standpoint. Also, it is important to note that a processor that varies its frequency also creates a non-deterministic level of performance for the running applications. Software will execute slower as the frequency is lowered and vice versa. The difference in frequency itself also means that there is a variable amount of latency involved when an application depends on a certain amount of execution time.

Latency introduced by frequency changes can be illustrated by measuring latency when the processor is configured to allow for frequency shifts (for example, when Turbo Boost is enabled.) The following figure illustrates how latency spikes in the 10-15 microsecond range occur when the processor is allowed to shift frequency.

![Latency events caused by changes in processor frequency](image)

**Figure 2: Latency from frequency shifts**

### Configuring Processor Jitter Control

The Processor Jitter Control feature uses the platform firmware within HPE ProLiant Gen10 servers with Intel Xeon Scalable Processors to reduce or remove processor jitter (jitter smoothing). Use the UEFI System Utilities or the iLO RESTful API interface to configure auto-tune or manual mode or to disable the feature.

**NOTE:**

Jitter Control requires HPE Power Regulator to be set to any mode other than OS Control. BIOS does not automatically modify the Power Regulator setting when Jitter Control is enabled because if Jitter Control is disabled during run-time, the system switches back to the behavior of the Power Regulator setting.
**Auto-tuned mode**

When Processor Jitter Control is configured to run in auto-tuned mode, HPE Server firmware disables the impact of power management and dynamically makes adjustments to the processor during run time to eliminate the occurrence of frequency shift induced jitter. The result of running in auto-tuned mode is that the processor will eventually run at the highest frequency that can be achieved where the processor stops making frequency changes to stay within its thermal, power, and core usage constraints. Auto-tuned mode lowers the frequency upon detection of frequency changes caused by the following sources:

- C-state transitions
- AVX induced transitions
- Turbo transitions (due to power, thermal, and core usage)
- Thermal throttling

**NOTE:**

- When selecting auto-tuned mode through UEFI System Utilities, C-state settings are also set to disabled. Most operating systems rely on BIOS reporting of supported C-states through the Advanced Configuration and Power Interface (ACPI). However, certain Linux distributions that load the intel_idle driver will ignore the ACPI reporting of C-state support. For Auto-tuned to function properly, the intel_idle driver must be disabled by adding `intel_idle.max_cstate=0` in the kernel boot command parameters.
- Jitter control equally affects all cores on all processors.

**Manual-mode**

When Processor Jitter Control is configured to run in Manual-mode, the processor is configured to run no faster than a user selectable frequency. In this mode, firmware does not lower the user-selected upper frequency limit dynamically even if processor frequency changes are detected. Manual-mode is useful for users who want to manually tune for jitter reduction by setting a maximum operational frequency. Unlike in auto-tune mode, if a frequency change occurs below the programmed frequency, the server will not reduce the operating frequency permanently and the processor is allowed to return to the user-selected maximum frequency when the limiting constraints no longer exist.

**Configuring Processor Jitter Control through UEFI System Utilities**

**NOTE:**

An iLO Advanced license or higher is required to use Processor Jitter Control.

Processor Jitter Control configuration options are located in UEFI System Utilities, which you access by pressing F9 during POST. When the System Utilities screen opens, click System Configuration > BIOS/Platform Configuration (RBSU) > Power and Performance Options > Advanced Performance Tuning Options. The two options Processor Jitter Control and Processor Jitter Control Frequency are available when the server supports jitter control and an iLO Advanced License or higher is installed.
The Processor Jitter Control option in UEFI System Utilities (v1.10) has three modes: Disabled, Auto-tuned, or Manual-mode. Selecting Auto-tuned or Manual-mode also allows you to edit the Processor Jitter Control Frequency input option, which allows you to select the target frequency for manual-tuned mode or the starting maximum frequency for auto-tuned mode. Frequency is entered in units of MHz and the system firmware rounds up to the nearest frequency interval allowed by the processor. For example, Intel Xeon Scalable Processors support frequency programming in intervals of 100 MHz. If a user inputs 2,050 MHz, the resulting frequency will be 2,100 MHz if supported by the installed processor.

**Configuring Processor Jitter Control through the iLO RESTful API**

**NOTE:**

- An iLO Advanced license or higher is required to use Processor Jitter Control.
- The following minimum firmware versions are required for run-time RESTful API support:
  - iLO Firmware version 1.15
  - System ROM (UEFI BIOS) version 1.20
  - HPE Innovation Engine Firmware 1.2.4

iLO 5 server management provides intelligent remote control automation using the RESTful API, which integrates server management components and full compute power. You can use the RESTful API to manage the complete life cycle of HPE Gen10 servers through Redfish API conformance.
You can use the iLO 5 RESTful API to configure Processor Jitter Control during run-time operation of the server. Using a RESTful Interface Tool such as ilorest, Processor Jitter control can be switched between Disabled, Auto-tuned, or Manual-tuned without requiring a server reboot. The RESTful API allows this change in configuration to be applied from a tool running on the server locally or remotely. Additionally, when in Auto-mode, the RESTful API can be used to determine which frequency the server has settled at for jitter-free operation.

The properties that are provided by the iLO RESTful API that pertain to run-time Processor Jitter Control are located under the URI /redfish/v1/systems/1. The Processor Jitter Control property is at {"Oem":{"Hpe":{"ProcessorJitterControl"}}}) and contains the following two configurable properties FrequencyLimitMHz and Mode. The following are examples of how to configure Processor Jitter Control using the RESTful API:

- To configure Processor Jitter Control for Auto-mode to use the default frequency, the following properties are modified:
  
  ```json
  {"Oem":{"Hpe":{"ProcessorJitterControl":{"FrequencyLimitMHz": 0,"Mode": "Auto"}}}}
  ```

- To configure Processor Jitter Control for Manual-mode using 2.6 GHz:
  
  ```json
  {"Oem":{"Hpe":{"ProcessorJitterControl":{"FrequencyLimitMHz": 2600,"Mode": "Manual"}}}}
  ```

- To disable Processor Jitter Control:
  
  ```json
  {"Oem":{"Hpe":{"ProcessorJitterControl":{"Mode": "Disabled"}}}}
  ```


**NOTE:**
CONREP is not a supported utility for performing dynamic updates during run time.

### Increasing performance with Processor Jitter Control

Jitter control can be used to tune for best performance in workloads that are traditionally sensitive to changes in latency, as well as in workloads that are impacted by excessive amounts of frequency shifting.

Users that traditionally tune servers for low latency and follow the HPE technical white paper Configuring and tuning HPE ProLiant Servers for low-latency applications are familiar with the practice of disabling P-state power management, C-states, and Turbo mode to eliminate jitter caused by frequency shifting by the processor. However, a significant amount of performance can be gained by leaving Turbo Boost enabled and also enabling Processor Jitter Control.

**NOTE:**
The Configuring and tuning HPE ProLiant Servers for low-latency applications technical white paper is available on the following website:


Although the frequencies above the base frequency of the processor and up to the maximum Turbo Boost mode frequency are not guaranteed, a workload is not likely to encounter limiting constraints if the processor is limited to a specific frequency within the Turbo Boost frequency range. Processor Jitter Control, when configured for Auto-mode, finds the frequency dynamically for any workload and environment in which the server is deployed. If the resulting Auto-tuned frequency is higher than the base frequency, gains in performance are achieved over the conservative practice of disabling Turbo Boost. The following image
demonstrates the gains that can be achieved using Processor Jitter Control with an HPE ProLiant DL360 Gen10 with Intel Xeon Platinum 8180 Scalable Processor.

Figure 4: Results of using Processor Jitter Control

When utilizing Processor Jitter Control, a workload may even surpass the performance seen by enabling Turbo Boost alone. If a workload drives the processor to a state where Turbo is constantly making frequency shifts to maximize performance, but cannot stay at the higher frequencies for a substantial time period, then the gains by attempting to run at higher frequencies are nullified, and, in some cases, performance may be reduced. When using the HPE ProLiant DL360 Gen10 with an Intel Xeon Platinum 8180 Scalable Processor running a server-side Java workload, it is possible to see gains beyond using Turbo Boost alone.

Figure 5: Results of Processor Jitter Control vs TurboBoost

Jitter control is designed to reduce latency by limiting the causes for frequency changes. While throughput performance metrics are impacted by enabling Jitter Control, the removal of latency spikes is critical for workloads that either cannot tolerate varying latency or have costs associated with changing computational latencies. When using auto-tuned mode, jitter within the 10-15 µsec range caused by frequency changes can be eliminated.
The following figures illustrate the latencies measured by the HPE Timetest tool. Without jitter control and with turbo mode enabled, time test plots show a band of 10-15 µsec latencies that are introduced due to processor frequency changes. After running the same workload with auto-tuned mode, those latencies disappear.

Figure 6: Latency comparison with Processor Jitter Control
Core Boosting technology uses a relaxed and optimized turbo profile that adapts the processor to specific use cases, configurations, and environments. Core Boosting processors take advantage of extra server power and thermal headroom provided by an innovative HPE voltage regulator design and by cooling technologies. Consequently, systems that have Core Boosting processors can alleviate common setbacks and maximize processor computing power.

For example, a processor can have a number of cores and a base frequency at which the cores operate. Processors may also have a turbo mode that operates processor cores at a faster frequency than the base frequency. The turbo mode may use thermal and power capacity headroom opportunistically to operate processor cores at an increased frequency. Turbo mode can increase processor performance while maintaining the same TDP (Thermal Design Power) level.

Some processors are preconfigured with a TDP and a maximum power level. To maintain these parameters safely, the predefined settings are typically fused and locked into the processor. These settings ensure that the processor operates within its standard electrical, thermal, and power design specifications. A turbo profile for a processor is bounded by these constraints using fixed frequency registers and core-to-frequency ratio registers. The power limits can be fused to the TDP level. To maintain the specified TDP level, the CPU turbo frequencies are dictated by the number of active cores that were fused in core-to-frequency ratio register. The turbo frequency profile scales from all cores active to a single core active. Accordingly, the turbo frequency increases as the number of active cores being utilized by lower workload demands or by core parking or disabling technologies.

These fused frequency registers and core-to-frequency ratio registers cap the processor computing capacity at certain levels. On a general-purpose computing processor, however, you can set the turbo profile more conservatively to cover various workloads or a worst-case thermal condition. In other words, the turbo mode might have a one-size-fits-all profile that does not consider the specific configuration or environment in which the processor operates. Accordingly, the processor might not be tuned to use its full operating potential.

**Processor Core Boosting architecture**

The Processor Core Boosting feature uses the platform firmware to provide enhanced Turbo mode performance for select HPE ProLiant Gen10 servers. The platform firmware automatically detects the presence of supported processors and enables Core Boosting by default. You can also configure Core Boost functionality through UEFI System Utilities or the iLO RESTful API.

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**NOTE:**

Core Boosting requires an iLO 5 Advanced license or above.

Core Boosting uses select Intel Xeon Scalable processors with an optimized turbo profile to address key Enterprise use cases, such as high-performance computing, virtualization, and big data. Due to high computing power consumption from Core Boosting processors, high-performance heatsinks and fans are required. The required hardware is included during the CTO process when you order servers with processors that support Core Boosting technology. Currently, Core Boosting SKU is available on the following Gen10 servers:

- HPE ProLiant DL380 Gen10 (16 core)
- HPE Apollo XL230k Gen10 (16 core)

**The Core Boosting turbo profile**

The Core Boosting processor has relaxed the frequency and core-to-frequency ratio registers to optimize processor performance for integer and SSE/AVX-1 operations. Using the Core Boosting settings, the systems
can opportunistically run workloads at higher clock frequencies. The following chart illustrates the benefits of Core Boosting in MIPS (Millions of instructions per second) when compared to an Intel Xeon stock 16-core processor.

The chart shows that Core Boosting enables workloads running on more active cores to do so at a higher frequency compared to turbo, which improves system performance without overclocking, keeping the Intel warranty intact. The reliability specification is also maintained the same as without Core Boosting enabled. Core Boosting also benefits single-threaded applications because its single-core active clock frequency is higher than without Core Boosting, as shown in the following chart.

![Figure 7: Active Cores with Core Boosting](image)

For Intel Xeon v4 or later processors, AVX-2 and AVX-3 technologies were implemented with different turbo profiles than those used for integer or AVX-1/SSE instructions. AVX-2 instructions are 256 bits and AVX-3 are 512 bits, extension of AVX-2. AVX-2 and AVX-3 instructions help accelerate performance but consume more power than non-AVX workloads. However, to maintain processor TDP, their base and turbo clock frequency are noticeably lower. See specifications on the Intel website for more information. For Core Boosting processors, AVX-2 and AVX-3 turbo profiles are maintained in a similar way to comparable Intel Xeon stock parts. However, with higher TDP, Core Boosting processor SKUs still yield higher performance than comparable Intel Xeon stock processors.

### Increasing performance with Core Boosting

Overall, Core Boosting enables higher performance across more processor cores; it can accelerate system performance by running workloads on more active cores at higher clock frequencies than comparable Intel Xeon stock processors. Furthermore, Core Boosting can effectively lower licensing costs for core and processor-based license models, yielding better total cost of ownership when compared to higher core-count Intel Xeon stock processors.

The following table shows SPEC CPU2006 benchmark results among three processors for various configurations: Intel stock 6142 (16 Core) and 6148 (20 Core), and Core Boosting 6143 (16 Core) SKUs.
SPECint_base2006 and SPECfp_base2006's results clearly show Core Boosting advantages on single-threaded applications over Intel Xeon stock processors. On system throughput measurements, the SPECint_rate_base2006 and SPECfp_base2006 numbers show the Core Boosting performance to be superior over the comparable Intel Xeon processor. The competitiveness of Core Boosting performance compared with higher core-count processors is also apparent in the same benchmark results.

**Table 2: SPEC CPU2006 benchmark results**

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<th>6143 vs. 6148</th>
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<td>SPECint_base2006 (single threaded)</td>
<td>6.91%</td>
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<td>SPECfp_base2006 (single threaded)</td>
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<tr>
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<tr>
<td>SPECfp_rate_base2006 (multi-threaded)</td>
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<td>-1.57%</td>
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**Configuring Core Boosting control**

**NOTE:**
An iLO 5 Advanced license or higher is required to use Processor Core Boosting.

Processor Core Boosting technology configuration options are located in UEFI System Utilities under **System Configuration > BIOS/Platform Configuration (RBSU) > Power and Performance Options > Advanced Performance Tuning Options**. The **Core Boosting** option is available when the server is configured with Core Boosting enabled processors and an iLO Advanced License or higher is installed.

The **Core Boosting** option has two modes: **Disabled** and **Enabled**. Selecting **Enabled** allows the server to use the enhanced performance capabilities of the Core Boosting enabled processors. Enabled is the default option when the system detects these processors have been installed in the server. Selecting **Disabled** disables the enhanced performance capabilities. In this case, the processor will have a restricted Turbo frequency profile and lower maximum wattage capabilities.
NOTE:
The Core Boosting options appear only when a core-boosting SKU is installed on the system.

Core Boosting Integrated Management Log and error messages

HPE ProLiant Gen10 servers deployed with processor SKUs supporting Core Boosting generates IML (Integrated Management Log) messages when the platform firmware detects missing licensing requirements or when the functionality has been disabled. The platform firmware issues an error message if an iLO Advanced License or higher is not installed. Resolve the condition by installing an iLO Advanced License or higher on the server.

The platform firmware issues an informational error message when the Core Boosting option has been disabled on a system that is configured with Core Boosting-capable processors. This message is a warning that optimal processor performance is restricted. Resolve the condition by re-enabling the Core Boosting option in the UEFI System Utilities or through the iLO RESTful API.
Websites

Intelligent System Tuning
http://www.hpe.com/info/ist

iLO websites
iLO 5
http://www.hpe.com/support/ilo-docs
iLO licensing
http://www.hpe.com/info/ilo/licensing
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HPE ProLiant Gen8 servers
http://www.hpe.com/info/proliantgen8/docs
HPE ProLiant Gen9 servers
http://www.hpe.com/support/proliantgen9/docs
HPE ProLiant Gen10 servers
http://www.hpe.com/support/proliantgen10/docs

General websites
Hewlett Packard Enterprise Information Library
www.hpe.com/info/EIL
RESTful Interface Tool (GitHub)
https://hewlettpackard.github.io/python-redfish-utility/
Single Point of Connectivity Knowledge (SPOCK) Storage compatibility matrix
www.hpe.com/storage/spock
Storage white papers and analyst reports
www.hpe.com/storage/whitepapers
Support and other resources

Accessing Hewlett Packard Enterprise Support

- For live assistance, go to the Contact Hewlett Packard Enterprise Worldwide website:
  
  http://www.hpe.com/assistance

- To access documentation and support services, go to the Hewlett Packard Enterprise Support Center website:
  
  http://www.hpe.com/support/hpesc

Information to collect

- Technical support registration number (if applicable)
- Product name, model or version, and serial number
- Operating system name and version
- Firmware version
- Error messages
- Product-specific reports and logs
- Add-on products or components
- Third-party products or components

Accessing updates

- Some software products provide a mechanism for accessing software updates through the product interface. Review your product documentation to identify the recommended software update method.

- To download product updates:
  
  Hewlett Packard Enterprise Support Center
  
  www.hpe.com/support/hpesc

  Hewlett Packard Enterprise Support Center: Software downloads
  
  www.hpe.com/support/downloads

  Software Depot
  
  www.hpe.com/support/softwaredepot

- To subscribe to eNewsletters and alerts:
  
  www.hpe.com/support/e-updates

- To view and update your entitlements, and to link your contracts and warranties with your profile, go to the Hewlett Packard Enterprise Support Center More Information on Access to Support Materials page:
  
  www.hpe.com/support/AccessToSupportMaterials
IMPORTANT:
Access to some updates might require product entitlement when accessed through the Hewlett Packard Enterprise Support Center. You must have an HPE Passport set up with relevant entitlements.

Customer self repair

Hewlett Packard Enterprise customer self repair (CSR) programs allow you to repair your product. If a CSR part needs to be replaced, it will be shipped directly to you so that you can install it at your convenience. Some parts do not qualify for CSR. Your Hewlett Packard Enterprise authorized service provider will determine whether a repair can be accomplished by CSR.

For more information about CSR, contact your local service provider or go to the CSR website:
http://www.hpe.com/support/selfrepair

Remote support

Remote support is available with supported devices as part of your warranty or contractual support agreement. It provides intelligent event diagnosis, and automatic, secure submission of hardware event notifications to Hewlett Packard Enterprise, which will initiate a fast and accurate resolution based on your product's service level. Hewlett Packard Enterprise strongly recommends that you register your device for remote support.

If your product includes additional remote support details, use search to locate that information.

Remote support and Proactive Care information
HPE Get Connected
www.hpe.com/services/getconnected
HPE Proactive Care services
www.hpe.com/services/proactivecare
HPE Proactive Care service: Supported products list
www.hpe.com/services/proactivecaresupportedproducts
HPE Proactive Care advanced service: Supported products list
www.hpe.com/services/proactivecareadvancedsupportedproducts

Proactive Care customer information
Proactive Care central
www.hpe.com/services/proactivecarecentral
Proactive Care service activation
www.hpe.com/services/proactivecarecentralgetstarted

Warranty information

To view the warranty for your product or to view the Safety and Compliance Information for Server, Storage, Power, Networking, and Rack Products reference document, go to the Enterprise Safety and Compliance website:
www.hpe.com/support/Safety-Compliance-EnterpriseProducts

Additional warranty information
HPE ProLiant and x86 Servers and Options
www.hpe.com/support/ProLiantServers-Warranties
Regulatory information

To view the regulatory information for your product, view the Safety and Compliance Information for Server, Storage, Power, Networking, and Rack Products, available at the Hewlett Packard Enterprise Support Center:

www.hpe.com/support/Safety-Compliance-EnterpriseProducts

Additional regulatory information

Hewlett Packard Enterprise is committed to providing our customers with information about the chemical substances in our products as needed to comply with legal requirements such as REACH (Regulation EC No 1907/2006 of the European Parliament and the Council). A chemical information report for this product can be found at:

www.hpe.com/info/reach

For Hewlett Packard Enterprise product environmental and safety information and compliance data, including RoHS and REACH, see:

www.hpe.com/info/ecodata

For Hewlett Packard Enterprise environmental information, including company programs, product recycling, and energy efficiency, see:

www.hpe.com/info/environment

Documentation feedback

Hewlett Packard Enterprise is committed to providing documentation that meets your needs. To help us improve the documentation, send any errors, suggestions, or comments to Documentation Feedback (docsfeedback@hpe.com). When submitting your feedback, include the document title, part number, edition, and publication date located on the front cover of the document. For online help content, include the product name, product version, help edition, and publication date located on the legal notices page.