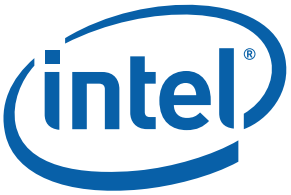

# Intel® Data Direct I/O (Intel® DDIO): Frequently Asked Questions

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*March 2012*

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# Revision History

| Date | Revision | Description |
|---|---|---|
| March 2012 | 1.0 | Initial release |

Q1: What is Intel® Data Direct I/O?

A1: Intel® Data Direct I/O (Intel® DDIO) is a feature to be introduced on the Intel® E5 Xeon® processors. Intel's LAN Access Division (LAD) worked for the incorporation of Intel DDIO into the Xeon E5 processor because of its benefits for LAN I/O in terms of performance and system power consumption. With Intel DDIO, Intel's Ethernet server NICs and controllers talk directly to the processor cache without a detour via system memory. Intel DDIO makes the processor cache the primary destination and source of I/O data rather than main memory. By avoiding system memory, Intel DDIO reduces latency, increases system I/O bandwidth, and reduces power consumption due to memory reads and writes.

Q2: How does Intel DDIO relate to Intel Integrated I/O and PCI Express* 3.0?

A2: Integrated I/O is the new Intel Xeon processor E5 I/O architecture in which the PCI Express interface is integrated onto the processor itself rather than an I/O hub or south bridge. The Intel Xeon processor E5 Integrated I/O implements the PCI Express 3.0 specification and also incorporates Intel DDIO.

Q3: What applications benefit from Intel DDIO?

A3: Applications that reach, or nearly reach, the I/O bandwidth, as is common in telecomm, can have a 2x or more increase with Intel Xeon processor E5-based servers over the previous Intel Xeon processor 5600-based architecture because memory bandwidth is now no longer a constraint. With more common data center applications that do not reach the I/O bandwidth, the performance benefit will be relatively minor in general, but they will see a power consumption savings of up to seven watts per two-port NIC. Applications that are sensitive to latency, such as UDP-based financial trading, will see a reduction in latency on the order of ~10-15% due to Intel DDIO. In the lab, we've increased the I/O data rates to find the absolute limits of the Intel Xeon E5 platform and achieved I/O data rates of 250 Gbps, which is three times the maximum ever seen with the previous generation Intel Xeon processor 5600 servers. The previous generation is limited when the memory bandwidth maximum is reached. But with Intel DDIO, much of that memory activity is eliminated, removing the bottleneck and using the full capabilities of the Intel Xeon processors, resulting in dramatic improvement in the capabilities of the Intel Xeon processor E5-based platforms in managing I/O. With Intel DDIO, your Intel Xeon processor E5 server or workstation has the bandwidth headroom to handle even the most extreme I/O loads.

Q4: What do I need to do to enable Intel DDIO?

A4: Intel DDIO is enabled by default in all Intel Xeon processor E5-based servers.

Q5: What enabling is required in the IHV ecosystem to take advantage of Intel DDIO?

A5: All IHV adapters will benefit from Intel DDIO, though Intel's Ethernet NICs and controllers, with their stateless architecture, will benefit most from this system improvement. No hardware needs to change in any adapter or server platform. And Intel DDIO is invisible to software: no driver, firmware, application, or system software changes are required to get the benefits of Intel DDIO.

Q6: In the Intel Xeon processor E5-based servers architecture, I/O can be "local" when a NIC is attached to the processor using its I/O or "remote" when the I/O has to travel over a QPI link to connect with the processor using it. Does Intel DDIO work on both local and remote sockets?



A6: With Intel Xeon processor E5-based servers, Intel DDIO accelerates only the local socket. Overall system I/O performance will improve, but not every thread will see the benefit. Remote socket acceleration will be implemented in a future processor. Applications with critical I/O performance requirements can be pinned to local sockets.

Q7: Do Intel NICs and Ethernet controllers perform better than the competition with Intel DDIO?

A7: Intel's high-speed stateless architecture with intelligent offloads takes advantage of host-based processing whenever that makes sense. Intel has designed Ethernet controllers to take advantage of Intel DDIO. Intel DDIO accelerates the interaction between host and adapters, so, yes, Intel's Ethernet does take more advantage of Intel DDIO and thus performs better.

Q8: Above you've said that no driver changes are required for an adapter to take advantage of Intel DDIO. Though not "required," can drivers be tuned for better Intel DDIO performance?

A8: While Intel DDIO is enabled by default and does not require enabling, getting the maximum benefit from Intel DDIO can be obtained by software tuning, depending on the implementation. We have no further comment on software tuning at this time.

Q9: I understand that Intel DDIO data only gets written to main memory when it's evicted from the cache. But doesn't all data eventually get evicted from the cache? And if so, doesn't Intel DDIO just defer memory accesses?

A9: Consider a L2 forwarding example. The buffers are kept small and well-controlled so no pressure is put on the cache. This was the only app running. Think of a CPU writing and rewriting the same memory location with new calculations. That location will always have the most recent copy. With Intel DDIO for output/egress, the CPU is simply rewriting the same locations in the L3 cache output buffer for L2 forwarding. The cache is always current, hence coherency is maintained and nothing need ever get written back to memory. The same holds true for input/ingress. The most recent data will be in the input L3 cache buffer. When I/O input overwrites a location, it is doing so with the most recent data.

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