Server memory population rules for HPE ProLiant Gen11 Servers with Intel Xeon E-2400 processors

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Introduction

This paper describes how to populate HPE DDR5 memory DIMMs in HPE ProLiant Gen11 Servers, using Intel® Xeon® E-2400 processors. HPE Server Memory for HPE Gen11 servers supports faster data rates, lower latencies, and greater power efficiency than the DIMMs used in previous generations of HPE servers. HPE Memory also provides superior performance over third-party memory when used in HPE servers.

HPE ProLiant Gen11 Servers, using Intel Xeon E-2400 processors offer two memory channels with up to two DIMM slots per channel (four DIMM slots per server). The memory speed increases from 3200 MT/s (in the previous generation) to 4400 MT/s.

This white paper reviews the rules, best practices, and optimization strategies that should be used when installing HPE DDR5 DIMMs in HPE ProLiant Gen11 Servers, using Intel Xeon E-2400 processors.

Populating HPE DDR5 DIMMs in HPE Gen11 servers

HPE Gen11 systems support a variety of flexible memory configurations, enabling the system to be configured and run in any valid memory controller configuration. For optimal performance and functionality, you should follow these rules when populating HPE ProLiant Gen11 Servers, using Intel Xeon E-2400 processors. Violating these rules may result in reduced memory capacity, performance, or error messages during boot. Table 1 summarizes the overall population rules.

Table 1. DIMM population rules for HPE ProLiant Gen11 Servers, using Intel Xeon E-2400 processors

<table>
<tr><th>Category</th><th>Population guidelines</th></tr>
<tr><td>General guidelines</td><td>The server supports up to 4800 MT/s ECC unbuffered DIMMs (UDIMMs) and up to 128 GB (4x32 GB).
HPE Memory DIMMs from previous generation servers are not compatible with the current generation.
HPE Memory features such as memory authentication and enhanced performance may not be supported.
Always use HPE qualified DIMMs.</td></tr>
<tr><td>Processors and DIMM slots</td><td>There are two channels per processor with two DIMM slots per channel.
If a memory channel consists of more than one DIMM slot, the white DIMM slot is located furthest from the CPU. White DIMM slots denote the first slot to be populated in a channel. For one DIMM per channel (DPC), populate white DIMM slots only. Memory channel 1 consists of the two DIMMs that are closest to the processor. Memory channel 2 consists of the two DIMMs that are farthest from the processor.
A white DIMM slot indicates the first slot of a channel (2-A, 4-B).
Populate the DIMM on slots in the following sequence: 2-A, 4-B, 1-C, 4-D.</td></tr>
<tr><td>Performance</td><td>To maximize performance, it is recommended to load the channels similarly whenever possible.
Avoid creating an unbalanced configuration for any CPU.
DIMM speed limited is as follows:
<table>
<tr><th>DPCs*</th><th>16 GB 1R x8 DIMM</th><th>32 GB 2R x8 DIMM</th><th>32 GB 2R x8 DIMM) +16 GB 1R x8 DIMM</th></tr>
<tr><td>1 DPC</td><td>4400/4000/3600 MT/s</td><td>4400/4000/3600 MT/s</td><td>N/A</td></tr>
<tr><td>2 DPCs</td><td>4000/3600/3200 MT/s</td><td>3600/3200/2933 MT/s</td><td>2133 MT/s</td></tr>
</table>
* 1 DPC: One DIMM per channel (1, 2 DIMMs); 2 DPCs: Two DIMMs per channel (3, 4 DIMMs)</td></tr>
<tr><td>DIMM types and capacities</td><td>Only ECC UDIMMs are supported on HPE ProLiant Gen11 Servers, using Intel Xeon E-2400 processors. The server does not support non-ECC UDIMMs, RDIMMs, or LRDIMMs.
Capacities available are 16 GB and 32 GB.
The maximum memory capacity is a function of the number of DIMM slots on the platform, the largest DIMM capacity qualified on the platform, and the number and model of installed processors qualified on the platform.</td></tr>
<tr><td>DIMM speed</td><td>The maximum memory speed is a function of the memory type, memory configuration, and processor model. The server will select the lowest common speed among all the DIMMs on all the CPUs.</td></tr>
<tr><td>Homogeneous mix</td><td>Populating both channels with the same DIMMs will generate better memory performance compared to asymmetrical cases. Populating two identical DIMMs in each channel (four identical DIMMs) will generate better memory performance compared to populating just one DPC.
DIMMs within the same channel should be the same. Mixing DIMMs of different types within the same channel may reduce maximum achievable memory performance and is not recommended or supported by Hewlett Packard Enterprise. Mixing DIMMs of different capacities within the same server (in different channels) may have a performance impact and is not recommended nor supported by HPE.</td></tr>
</table>

DIMM slot locations in HPE ProLiant DL20/ML30 Gen11 Servers

This section illustrates the physical location of the DIMM slots for HPE Gen11 servers using Intel Xeon E-2400 processors. HPE ProLiant DL20 and HPE ProLiant ML30 Gen11 Servers have four DIMM slots per CPU.

HPE ProLiant DL20/ML30 Gen11 Servers

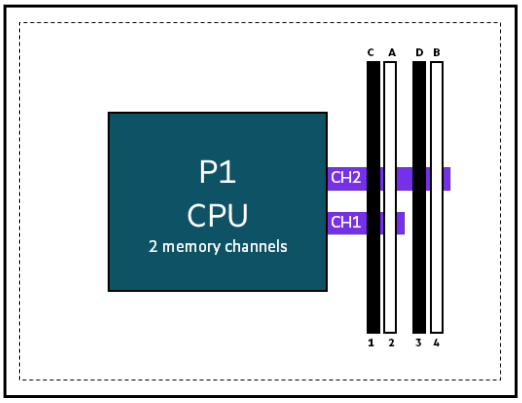

Figure 1. Four DIMM slot locations in HPE ProLiant DL20/ML30 Gen11 Servers

Memory population guidelines for HPE ProLiant DL20/ML30 Gen11 Servers

This section illustrates which DIMM slots to use when populating HPE Memory DIMMs in HPE ProLiant Gen11 Servers, using Intel Xeon E-2400 processors, notably the HPE ProLiant DL20 and ML30 Gen11 Servers. The illustration reflects the DIMM slots to use for a given number of DIMMs around a single processor, given a common DIMM type. Unbalanced configurations are noted with an asterisk. In these configurations, memory performance may be inconsistent or reduced compared to a balanced configuration.

In cases of a heterogeneous mix, take each DIMM type and create a configuration as if it were a homogeneous configuration. Depending on the per-channel rules, populate the DIMMs with the highest rank count in white DIMM slots in each channel and then populate the other DIMMs in the black DIMM slots in each channel.

For optimal throughput and reduced latency, populate both channels of the CPU identically. The first DIMM slots for each channel have white connectors, and the second DIMM slots, if any, have black connectors. Figure 1 shows the DIMM slot locations for the HPE ProLiant DL20 and HPE ProLiant ML30 Gen11 Servers, which have one CPU socket and four DIMM slots.

HPE Memory DIMMs may be populated in many permutations that are allowed but may not provide optimal performance. The system ROM reports a message during the power-on self-test if the population is not supported or is not balanced.

Table 2 shows a sample of the population guidelines for HPE Memory DIMMs in HPE ProLiant DL20 and ML30 Gen11 Servers with four DIMM slots per CPU. For a given number of HPE Memory DIMMs per CPU, populate those DIMMs in the corresponding numbered DIMM slots on the corresponding row.

Table 2. HPE Memory DIMM population guidelines for HPE ProLiant DL20/ML30 Gen11 Servers with four DIMM slots per CPU

DIMMs	Slot 1	Slot 2	Slot 3	Slot 4
1 DIMM	N/A	1	N/A	N/A
2 DIMMs	N/A	1	N/A	2
3 DIMMs*	3	1	N/A	2
4 DIMMs	3	1	4	2

* Unbalanced configuration may have a performance impact.

As shown in Table 2, memory should be installed as indicated based on the total number of DIMMs being installed per CPU. For example:

- If only one HPE Memory DIMM is installed, it should be located in slot 2.
- If two HPE Memory DIMMs are being installed, they should be installed in DIMM slots 2 and 4. Since these slots are in different channels, this configuration results in one DIMM per channel (1 DPC).
- If three HPE Memory DIMMs are being installed, they should be installed in DIMM slots 2, 4, and 1. This is an unbalanced configuration and not recommended.
- If four HPE Memory DIMMs are being installed, they should be installed in DIMM slots 2, 4, 1, and 3. Since slots 2 and 4 are in a different channel than slots 1 and 3, this configuration results in two DIMMs per channel (2 DPC).

Table 3. HPE Memory DIMM population order for HPE ProLiant DL20/ML30 Gen11 Servers with four DIMM slots per CPU

	Population order; start with A first, B second, C third, D fourth	
Channel	**Slot**	**Population order**
CH2	4	B (second)
CH2	3	D (fourth)
CH1	2	A (first)
CH1	1	C (third)

Memory interleaving

Memory interleaving is a technique used to maximize memory performance by spreading memory addresses evenly across memory devices. Interleaved memory results in a contiguous memory region across multiple devices with sequential accesses using each memory device in turn, instead of using the same one repeatedly. The result is higher memory throughput due to the reduced wait times for memory banks to become available for desired operations between reads and writes.

Memory interleaving techniques for HPE ProLiant DL20/ML30 Gen11 Servers include the following:

Rank interleaving

This technique interleaves across ranks within a memory channel. When configured correctly, sequential reads within the channel will be interleaved across ranks. This enhances channel throughput by increasing the utilization on the channel. Rank interleaving is a lower priority than channel interleaving when creating an interleave region, and a 1-DPC region across two channels will be a higher priority than a 2-DIMM region within a channel.

Channel interleaving

This technique interleaves across memory channels. When configured correctly, sequential reads will be interleaved across memory channels. Channel bandwidth will be accumulated across the interleaved channels. The UEFI System Utilities User Guide for HPE ProLiant Gen11 servers, and HPE Synergy goes into detail regarding setting up memory for interleaving.

Understanding unbalanced DIMM configurations

Unbalanced configurations may not provide optimal performance. This is because memory performance may be inconsistent and reduced compared to balanced configurations. Applications that rely heavily on throughput will be most impacted by an unbalanced configuration. Other applications that rely more on memory capacity and less on throughput will have far lesser impact by such a configuration.

Optimal memory performance is achieved when the system is configured with a fully homogeneous and balanced DIMM configuration. Unbalanced DIMM configurations are those in which the installed memory is not distributed evenly across the memory channels or the CPU. HPE discourages unbalanced configurations because they will always have lower performance than similar balanced configurations. There are two types of unbalanced configurations, each with its own performance implications.

Memory configurations that are unbalanced across channels

The primary effect of memory configurations that are unbalanced across channels is a reduction in the number of channels that can be interleaved. Interleaving fewer channels results in a decrease in memory throughput in those regions that span fewer memory channels. Peak performance is achieved when the interleave region can span both channels per CPU. As noted in Table 4, there is only one unbalanced configuration listed. There are two interleave regions in this configuration. One can interleave across all channels on the processor, thus achieving peak performance in the region. However, the second region can only interleave reads across four channels as a second DIMM is not installed on the other channels. Depending on where memory is allocated, the application will experience different memory performances from run to run. The best case would be peak performance and the worst case would be 50% of peak performance.

Table 4. Impact of unbalanced configurations on memory throughput

Number of interleaved channels per processor			Throughput compared to peak	
DIMMs	**Large group (white slot)**	**Small group (black slot)**	**Weighted channel performance in %***	**Worse channel performance in %****
1	1	N/A	50%	N/A
2	2	N/A	100%	N/A
3*	2	1	100%	50%
4	2	2	100%	100%

* Unbalanced
** Worse channel interleaving and frequency performance in % compared to the peak

Unbalanced configurations are tagged with an asterisk. In these cases, there will be multiple interleave regions of different sizes. Each region will exhibit different performance characteristics. When running a benchmark sensitive to throughput (such as STREAM), the benchmark program may measure the throughput of any of the different interleave groups and report confusing results.

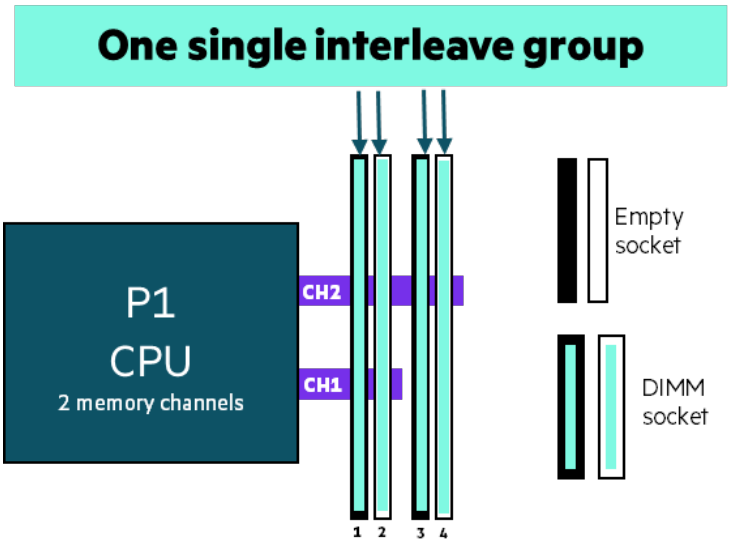

Figure 2. Example of memory that has a balanced population

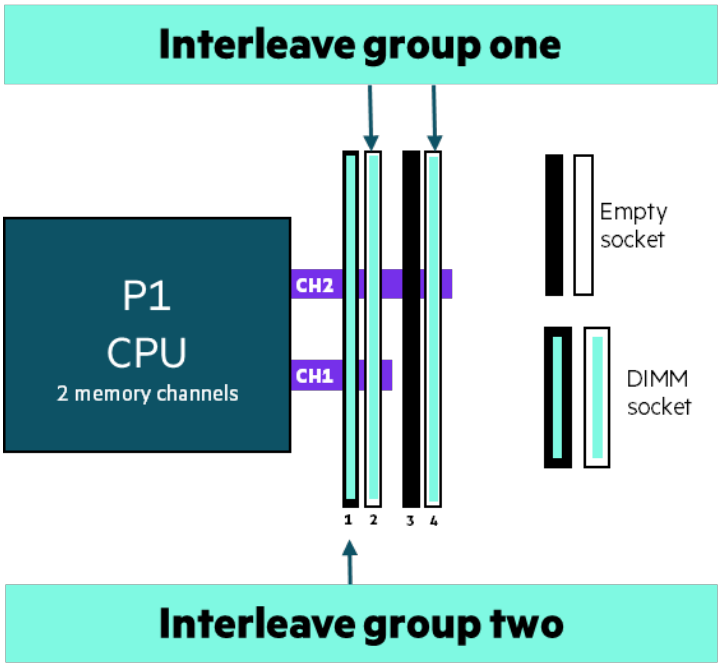

Figure 3. Example of memory that has an unbalanced population

Figures 2 and 3 show an example of balance and unbalanced population memory configurations. Figure 2 shows a balanced configuration with four DIMMs and all four DIMMs are in the same interleave region. Figure 3 shows an unbalanced configuration with three DIMMs. In this case, there are two interleave regions each with different performance characteristics.

Mixed HPE Memory DIMM configurations

In cases of a heterogeneous mix, take each DIMM type and create a configuration as though it were a homogeneous configuration. Depending on the per-channel rules, as shown in the following illustration.

Table 5. Mixed memory capacity guidelines for HPE DDR5 Memory DIMMs in HPE ProLiant Gen11 Servers, using Intel Xeon E-2400 processors

Part number	**Description**	**P64336-B21 16 GB 1Rx8 4800 MT/s**		**P64339-B21 32 GB 2Rx8 4800 MT/s**	
Within the same channel		Within the same server	Within the same channel	Within the same server	Within the same channel
P64336-B21	HPE 16 GB 1Rx8 PC5-4800B-E STND Kit	Yes[2, 3]	Yes[2]	Yes[1, 2, 4]	Not recommended or supported[2, 4]
P64339-B21	HPE 32 GB 2Rx8 PC5-4800B-E STND Kit	Yes[1, 2, 4]	Not recommended or supported[2, 4]	Yes[2, 3]	Yes[2]

Server level rules

[1] Mixing DIMMs of different capacities within the same server may have a memory performance impact and is not recommended nor supported by HPE.

Channel level rules

[2] 4400 MT/s is at 1 DPC. 4000 MT/s speed at 2 DPC with 16 GB 1Rx8 in the same channel. 4400 MT/s is at 1 DPC, 3600 MT/s speed at 2 DPC with 32 GB 2Rx8 in the same channel.

[3] Populating both channels with the same DIMMs will generate better memory performance compared to asymmetrical cases.

[4] HPE recommends that DIMMs within the same channel be of the same capacity. Mixing DIMMs of different capacities within the same channel may reduce maximum achievable to 2133 MT/s and impact memory performance.

Table 6. Maximum memory speed and capacity configurations for HPE DDR5 Memory DIMMs in HPE ProLiant Gen11 Servers, using Intel Xeon E-2400 processors

DPCs*	16 GB 1R x8 DIMM	32 GB 2R x8 DIMM	32 GB 2R x8 DIMM +16 GB 1R x8 DIMM
1 DPC	4400/4000/3600 MT/s	4400/4000/3600 MT/s	N/A
2 DPCs	4000/3600/3200 MT/s	3600/3200/2933 MT/s	2133 MT/s

* 1 DPC: One DIMM per channel (1, 2 DIMMs); 2 DPCs: Two DIMM per channel (3, 4 DIMMs)

Speed table

This section provides an overview of HPE DDR5 Memory speeds for HPE ProLiant Gen11 Servers, using Intel Xeon E-2400 processors. The latest generation of HPE DDR5 Memory offers faster data rates, lower latencies, and greater power efficiency than the memory used in previous HPE servers. HPE DDR5 Memory DIMMs also provide superior performance over third-party memory when used in HPE Gen11 servers.

HPE DDR5 Memory DIMMs in HPE ProLiant DL20 and ML30 Gen11 Servers, using Intel Xeon E-2400 processors

Table 7. Unbuffered memory kits

HPE SKU P/N	P64336-B21	P64339-B21
SKU description	HPE 16 GB 1Rx8 PC5-4800B-E STND Kit	HPE 32 GB 2Rx8 PC5-4800B-E STND Kit
DIMM rank	Single rank (1R)	Dual rank (2R)
DIMM capacity	16 GB	32 GB
Voltage	1.2V	1.2V
DRAM depth (bit)	2G	2G
DRAM width (bit)	x8	x8
DRAM density	16 Gb	16 Gb
CAS latency	40-39-39	40-39-39
DIMM native speed (MT/s)	4800	4800
Intel Xeon E-2400 processors officially supported memory native speed (MT/s)[*,5]		
1 DPC	4400	4400
2 DPCs	4000	3600
HPE Server Memory Native Speed (MT/s): Intel Xeon E-2400 processors[*,5]		
1 DPC	4400	4400
2 DPCs	4000	3600

[5] HPE DL20 and ML30 incorporate 2SPC board design that supports four physical DIMM slots, two per channel. 2 DPC is supported when channel is populated with the same DIMM. Symmetric configurations are required for 2SPC within one channel (for example, 1R/1R, 2R/2R).
* The maximum memory speed is a function of the memory type, memory configuration, and processor model.

Conclusion

Following the population guidelines contained within this document maximizes memory performance of HPE Memory DIMMs in HPE ProLiant Gen11 Servers, using Intel Xeon E-2400 processors.

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