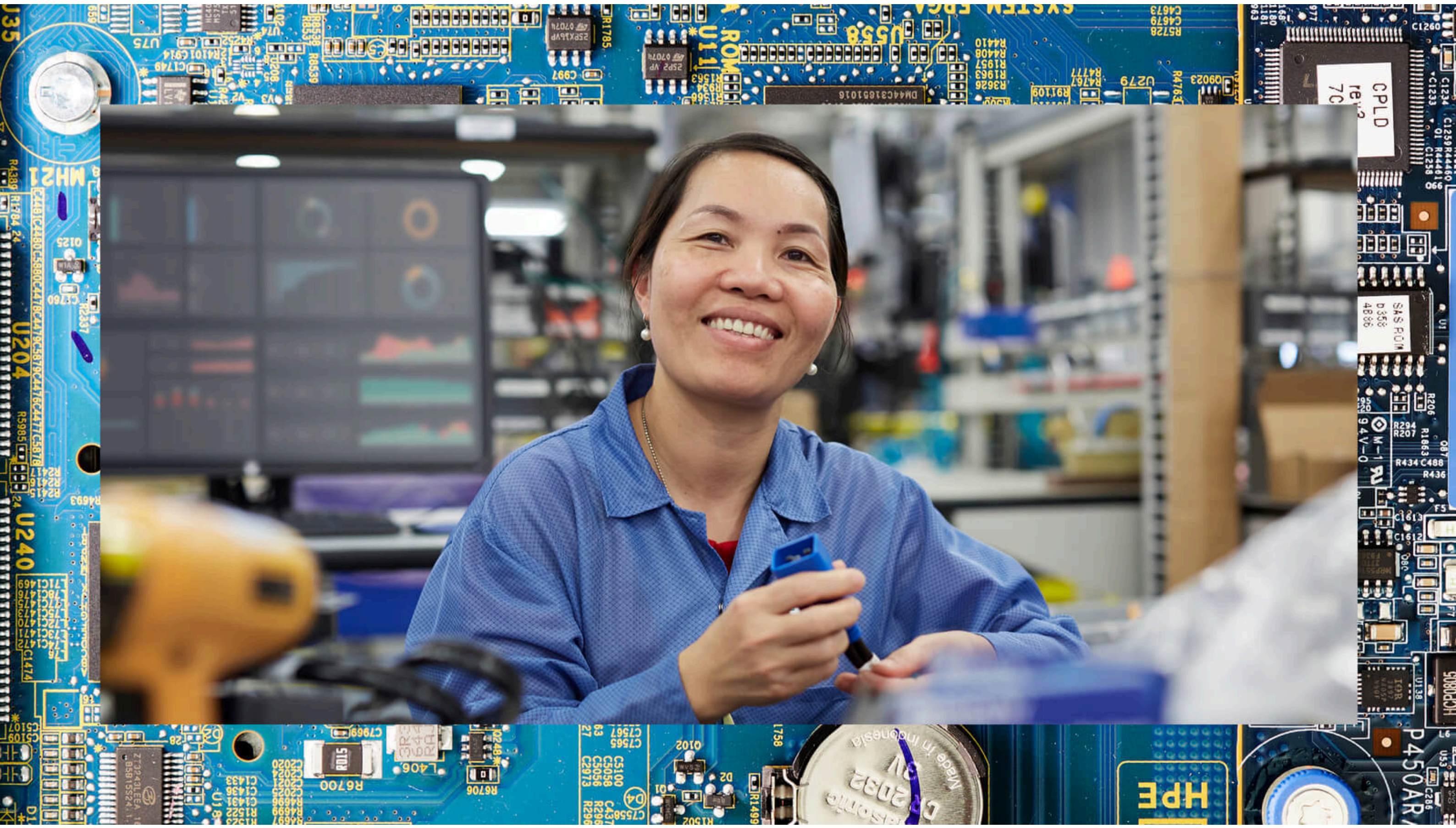
Technical white paper

Server memory population rules for HPE Gen11 servers with 4th Gen Intel Xeon Scalable processors



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Introduction

This paper describes how to populate HPE DDR5 SmartMemory DIMMs in HPE ProLiant Gen11 servers, HPE Synergy Gen11 Compute modules, and HPE Alletra Gen11 Compute modules using 4th Gen Intel® Xeon® Scalable processors. HPE Server Memory for HPE Gen11 servers support faster data rates, lower latencies, and greater power efficiency than the DIMMs used in previous generations of HPE servers. HPE SmartMemory also provides superior performance over third-party memory when used in HPE servers.

HPE Gen11 servers with 4th Gen Intel Xeon Scalable processors offer increased memory speed from 2933/3200 Mb/s to 4800 Mb/s than the HPE Gen10 family of servers.

In addition to describing these improvements, this white paper reviews the rules, best practices, and optimization strategies that should be used when installing HPE DDR5 DIMMs in HPE Gen11 servers.

HPE SmartMemory for HPE ProLiant and HPE Synergy Gen11 servers: Engineered with new DDR5 memory to deliver increased memory performance and reliability

DDR5 Memory technology is the next generational improvement in the DRAM Memory industry and is available now with HPE ProLiant and HPE Synergy Gen11 servers. DDR5, the most technologically advanced DRAM to date, will enable the next generation of server workloads by delivering significant improvements in memory performance versus DDR4. DDR5 doubles memory density while improving reliability at a time when data center system architects seek to supply rapidly growing processor core counts with increased memory bandwidth and capacity. Compared to its predecessor, DDR5 provides higher bandwidth and increased efficiency. The combination of faster speeds, more memory channels and improved efficiency means that DDR5 will enable the next generation of server workloads by delivering up to an 75% increase in overall memory performance.

CPU core counts are growing with every successive new processor generation. DDR4 has reached its limit in terms of memory bandwidth and density. It can only support up to 16 Gb density and 3200 MT/s speed. This is where DDR5 technology offers solutions to meet customer needs for greater memory capacity per core, and bandwidth per core. The major benefit of DDR5 is that it enables improved memory capacity, speed, error correction, and power efficiency compared to DDR4. This helps improve memory performance with all server workloads. Just like with the transition from DDR3 to DDR4, DDR5 can achieve faster speeds, increases effective bandwidth at equivalent data rates, improves bus utilization efficiency for high core count systems, is capable of higher densities, and it consumes less power for equivalent or better performance than DDR4. In short, DDR4 reached its limits and DDR5 has been able to push beyond that threshold.

DDR5 comes with many promises, but one of its most significant selling points is the higher level of bandwidth it can feed to processors with several cores. This is important because memory performance is best approximated as the combination of Throughput (defined as "Bandwidth" x "Efficiency") and Latency. Throughput is also known as "effective bandwidth." DDR5 offers a minimum of 50% increase in the bandwidth with 4800 MT/s as compared to DDR4 which tops out at 3200 MT/s. It also supports a maximum of up to 32 Gb density (in future generations a few years away), compared to 16 Gb in the previous generation. DDR5 also offers 2x the burst length, 2x bank groups, 2x banks, Decision Feedback Equalization, two independent 40-bit channels per DIMM, and optimized power management on DIMM.

While DDR5 memory modules appear similar to DDR4, there are significant changes that make them incompatible with legacy systems. The module key is in a different location to prevent them from being installed into incompatible sockets. The notch in the center of the module acts like a key, aligning with DDR5 sockets to prevent DDR4, DDR3, or other unsupported module types from being installed. There is no backwards compatibility between DDR5 and DDR4.

Table 15 provides detailed information about the recently introduced HPE DDR5 SmartMemory for HPE ProLiant and HPE Synergy Gen11 servers, including capacity, bandwidth, DIMM type, and part numbers. Note that CPU vendors may reduce memory bandwidth capability based on their respective DIMM population rules. The mixing rules for these DIMMs can be found on Table 16.

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 Gen11 servers with HPE DDR5 DIMMs. Violating these rules may result in reduced memory capacity, performance, or error messages during boot. Table 1 summarizes the overall population rules for HPE Gen11 servers.

Table 1. DIMM population rules for HPE Gen11 servers

Category	Population guidelines
Processors and DIMM slots	Install DIMMs only if the corresponding processor is installed. If only one processor is installed in a 2-processor system, only half of the DIMM slots are available to populate. 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. Rank mixing is not allowed on a channel except for 1 rank and 2 rank combination when all 16 DIMMs for a processor socket is populated (2 rank in white slot, 1 rank in black slot). No x4 mixing with x8 across a socket. If multiple CPUs are populated, split the HPE SmartMemory DIMMs evenly across the CPUs and follow the corresponding CPU rules when populating DIMMs.
Performance	To maximize performance, it is recommended to balance the total memory capacity across all installed processors and load the channels similarly whenever possible (see Appendix B). If the number of DIMMs does not spread evenly across the CPUs, populate as close to evenly as possible. Avoid creating an unbalanced configuration for any CPU.
DIMM types and capacities	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 qualified processors installed on the platform. Do not mix HPE SmartMemory RDIMMs and HPE SmartMemory LRDIMMs in the same system. Rank mixing is not allowed on a channel except for 1 rank and 2 rank combination (2 rank in white slot, 1 rank in black slot), when all 16 DIMMs for a processor socket is populated. The 256 GB 8R 3DS RDIMM can be mixed with 128 GB 4R 3DS RDIMM **only** in 16 DIMMs populated. 256 GB 8R 3DS RDIMM needs to be in white slot while 128 GB 4R 3DS RDIMM needs to be in black slot. No x4 mixing with x8 across a socket. HPE servers based on 3rd Gen Intel Xeon Scalable processors do not support unbuffered DIMMs (UDIMMs).
DIMM speed	The maximum memory speed is a function of the memory type, memory configuration, and processor model. DIMMs of different speeds may be mixed in any order; however, the server will select the lowest common speed among all the DIMMs on all the CPUs. HPE SmartMemory DIMMs and HPE NVDIMM-Ns from previous generation servers are not compatible with the current generation. Certain HPE SmartMemory features such as memory authentication and enhanced performance may not be supported.
Heterogeneous mix	There are no performance implications for mixing sets of different capacity DIMMs at the same operating speed. For example, latency and throughput will not be negatively impacted by installing an equal number of 32 GB 1 rank x4 DDR5-4800 DIMMs (in black slot) and 64 GB 2 rank x4 DDR5-4800 DIMMs (in white slot). Take each DIMM type and create a configuration as if it were a homogeneous configuration.

Introduction to DIMM slot locations

In general, DIMM population order follows the same logic for all HPE Gen11 servers—although physical arrangement may vary from server to server. To populate DIMMs in the correct order and location, see illustrations found in Appendix B for HPE SmartMemory DIMMs available in 128, 256, and 512 GB modules. Each illustration reflects the DIMM slots to use for a given number of DIMMs around a single processor, assuming a common DIMM type.

If multiple processors are installed, split the DIMMs evenly across the processors and follow the corresponding rule when populating DIMMs for each processor (see Figure 1 for an example). For optimal throughput and reduced latency, populate all eight channels of each installed 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 a sample DIMM slot configuration for the HPE ProLiant DL360/DL380/ML350/DL560 Gen11 servers, which have two sockets and 32 DIMM slots (HPE DL360/DL380/ML350) and 64 DIMM slots (HPE DL560). Diagrams for all servers are included in Appendix A.

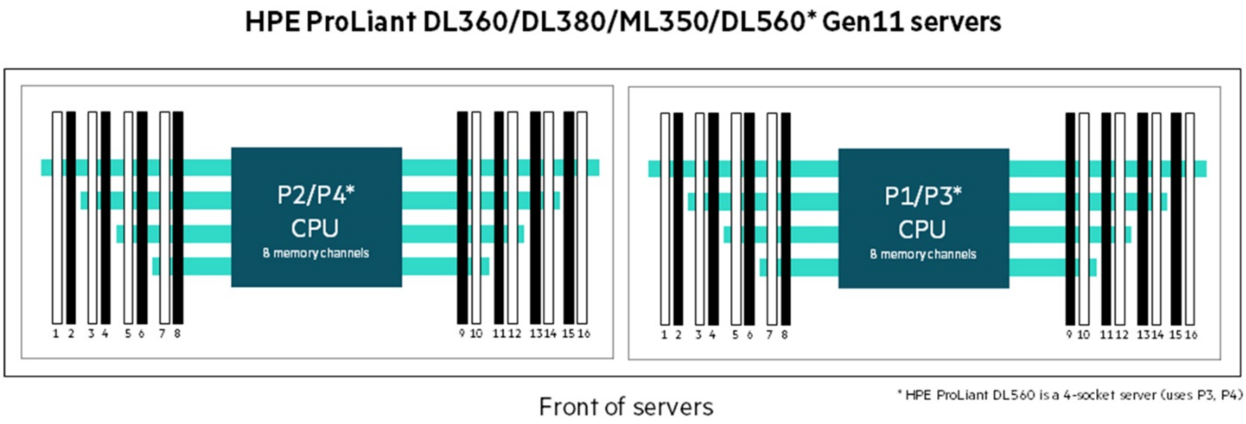


Figure 1. 32 DIMM slot locations in HPE ProLiant DL360/DL380/ML350 and 64 DIMM slot locations in HPE DL560 Gen11 servers

Population guidelines for HPE SmartMemory DIMMs

This section provides generic guidelines for populating HPE SmartMemory DIMMs in HPE Gen11 servers. See Appendix B for population guidelines for specific HPE Gen11 servers.

HPE SmartMemory 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 SmartMemory DIMMs in HPE Gen11 servers with 16 DIMM slots per CPU (for example, HPE ProLiant DL360/DL380/ML350/DL560 Gen11 servers). For a given number of HPE SmartMemory DIMMs per CPU, populate those DIMMs in the corresponding numbered DIMM slots on the corresponding row. Corresponding tables for all servers are included in Appendix B.

Table 2. HPE SmartMemory DIMM population guidelines for HPE Gen11 servers with 16 DIMM slots per CPU

HPE ProLiant Gen11 servers 16 slots per CPU DIMM population order

1 DIMM										10						
2 DIMMs[1]			3							10						
4 DIMMs[1]			3				7			10				14		
6 DIMMs			3		5		7			10				14		16
8 DIMMs[1, 2]	1		3		5		7			10		12		14		16
12 DIMMs	1	2	3		5	6	7			10	11	12		14	15	16
16 DIMMs[1, 2]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

[1] Support Hemi (hemisphere mode)
[2] Support Software Guard Extensions (SGX)

Table 3. HPE SmartMemory DIMM population guidelines for HPE Gen11 servers with 16 DIMM slots per CPU with HBM + 4th Intel® Scalable processors

HPE ProLiant Gen11 servers 16 slots per CPU DIMM population order with HBM + 4th Intel Scalable processors*

0 DIMM																
1 DIMM										10						
2 DIMMs			3							10						
4 DIMMs			3				7			10				14		
8 DIMMs	1		3		5		7			10		12		14		16
16 DIMMs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

* HBM + 4th Intel Scalable processors do not support Hemi (hemisphere mode) and Software Guard Extensions (SGX)

Note
Configurations not listed are not supported and if populated, the server may not boot.

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 two HPE SmartMemory DIMMs are being installed per CPU, they should be installed in DIMM slots 3 and 10.
- If six HPE SmartMemory DIMMs are being installed per CPU, they should be installed in DIMM slots 3, 5, 7, 10, 14, and 16.

Unbalanced configurations not listed 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 be far less impacted by such a configuration.

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 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 utilization on the channel. Rank interleaving is a lower priority than channel interleaving when creating an interleave region, and a 1-DPC region across three channels will be 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 Gen10, HPE ProLiant Gen11 Servers, and HPE Synergy goes into detail regarding setting up memory for interleaving. Table 4 shows Impact of all balanced configurations on memory throughput. If you look at 12 DIMMs configuration, there are two interleave regions in this configuration. One can interleave across all eight channels on the processor, thus achieving peak performance in the region. The second region, however, can only interleave reads across four channels as a second DIMM is not installed in the other channels. Depending on where memory is allocated, the application will experience different memory performance from run to run. Best case would be peak performance and worst case would be 50% of peak performance.

Memory controller interleaving

4th Gen Intel Xeon Scalable processors have four memory controllers per CPU, each one supporting two channels. The channels selected for channel interleaving are based on matching channels in the memory controllers and across memory controllers.

Node interleaving

This technique interleaves across sockets and is not optimal for modern software and operating systems that understand non-uniform memory access (NUMA) system architectures. Node interleaving is not supported while HPE NVDIMM-Ns are present. Non-NUMA operating environments, however, may see improved performance by enabling node interleaving.

Understanding unbalanced DIMM configurations

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 CPUs. 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 all eight channels per CPU. If you look at Figure 3, there are two DIMMs balanced populated in slot 3 and slot 10, Unbalanced DIMM populated in slot 7. There are two interleave regions in this configuration. DIMMs on slot 3 and slot 10 can interleave across memory controller on the processor, thus achieving peak performance in the region. However, the second region, slot 7, cannot interleave with any others. Depending on where memory is allocated, the application will experience different memory performance from run to run. Best case would be peak performance and 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	12.50%	12.50%
2	2	N/A	25%	25%
4	4	N/A	50%	50%
6	6	N/A	75%	75%
8	8	N/A	100%	100%
12	8	4	100%	50%
16	8	8	100%	100%

* Best channel interleaving and frequency performance in % compared to the peak.
** 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.

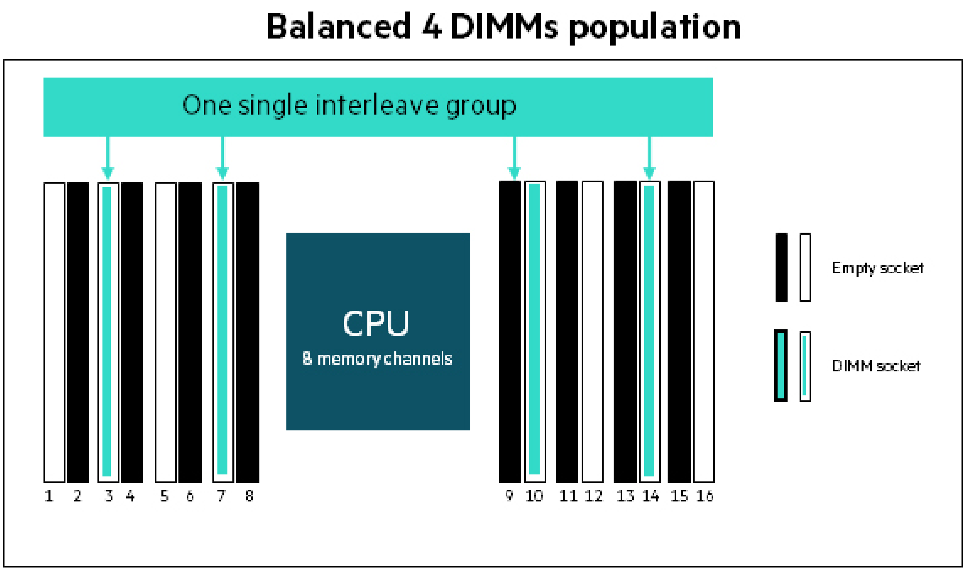


Figure 2. Example of memory that has balanced population

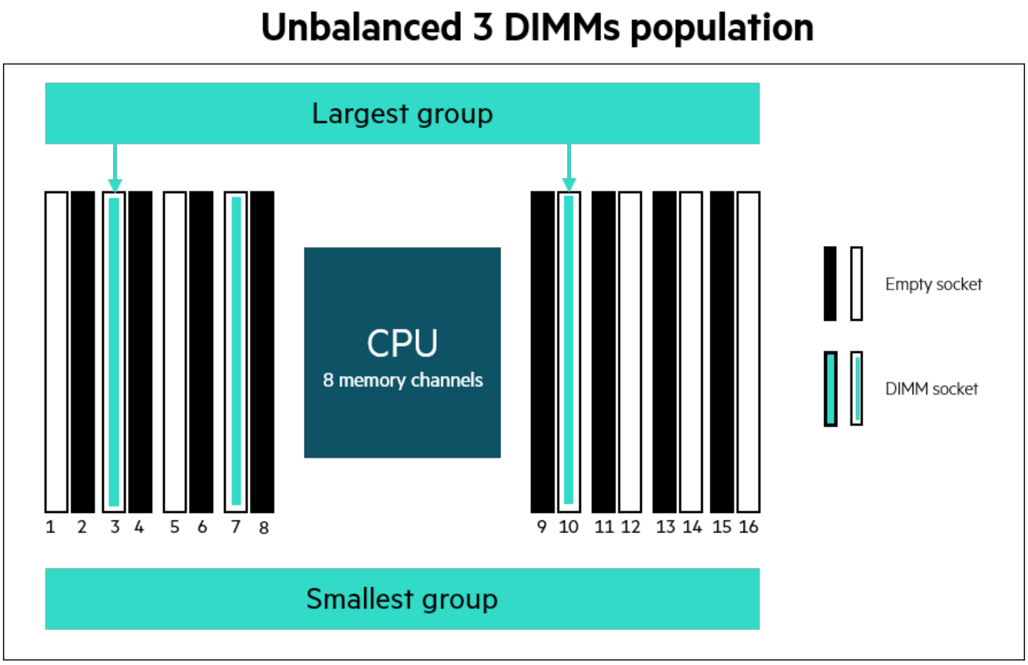


Figure 3. Example of memory that has unbalanced population

Figures 2 and 3 show an example of balance and unbalanced population memory configurations. Figure 2 shows a balanced configuration with 4 DIMMs and all 4 DIMMs are in the same interleave region. Figure 3 shows unbalanced configuration with 3 DIMMs. In this case, there are two interleave regions each with different performance characteristics.

Memory configurations that are unbalanced across processors

Figure 2 shows a memory configuration that is unbalanced across processors. The CPU 1 threads operating on the larger memory capacity of CPU 1 may have adequate local memory with relatively low latencies and high throughput. The CPU 2 threads operating on the smaller memory capacity of CPU 2 may consume all available memory on CPU 2 and request remote memory from CPU 1. The longer latencies and limited throughput of cross-CPU communications associated with the remote memory will result in reduced performance of those threads. In practice, this may result in non-uniform performance characteristics for software program threads, depending on which processor runs them.

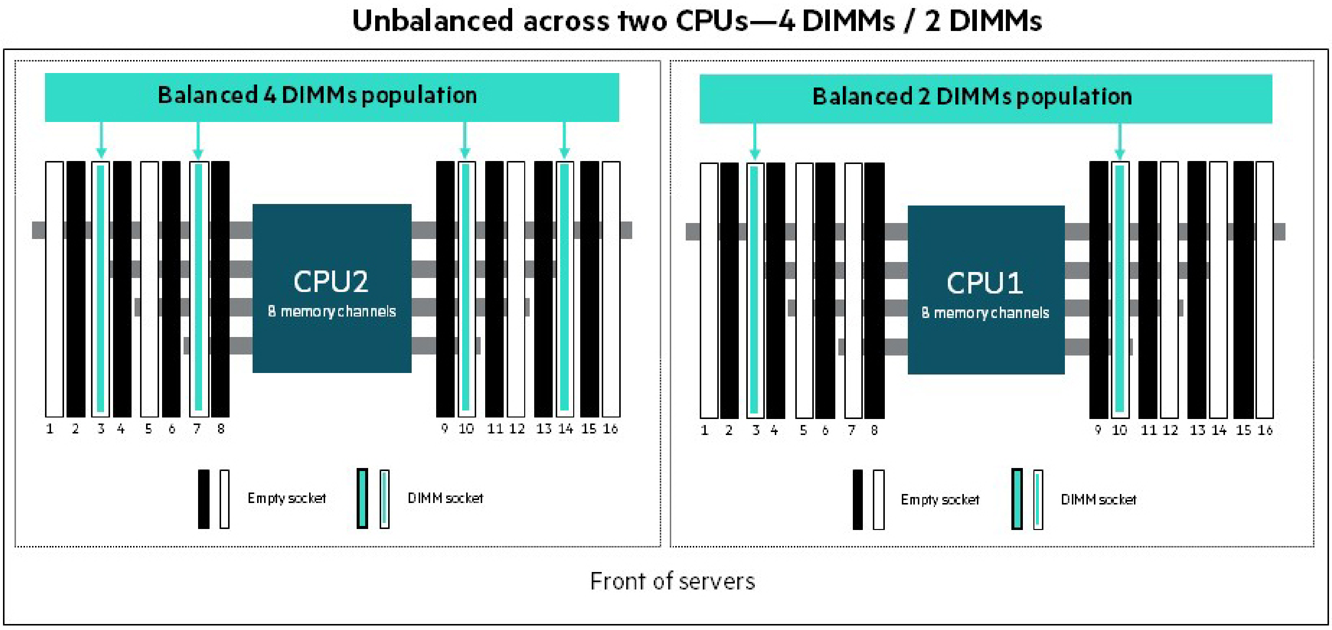


Figure 4. Example of memory that is unbalanced across processors

Figure 4 shows an example of unbalanced memory configurations across processors. In this example, the first processor has four DIMMs while the second CPU only has two DIMMs installed. Both CPU configurations are balanced, but the imbalance is from CPU to CPU.

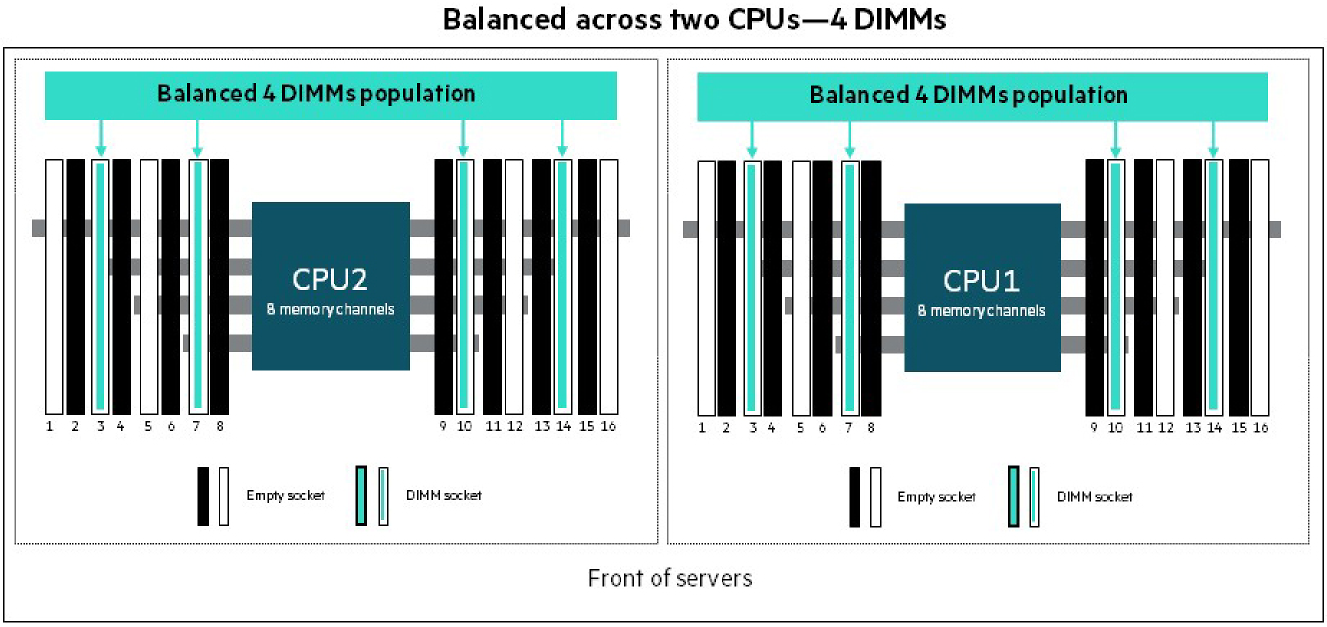


Figure 5. Example of a memory configuration that is balanced across processors

Figure 5 shows an example of a configuration that is balanced across processors. In this example, both processors have four DIMMs installed.

Message of unsupported configurations

For system configuration

If the system is in a validated configuration, there is no error log.

If the system is in an unsupported (not validated) configuration, there is an informational error log as mentioned in the following:

- The DIMM population on one or more processors results in a memory configuration that is not validated. This may result in nonoptimal memory performance or other unexpected behavior.

If a DIMM failure kicks the system into an unsupported (not validated) configuration, there is an informational error log as mentioned in the following:

- A memory error has resulted in one or more DIMMs being mapped out resulting in a memory configuration that is not validated. This may result in nonoptimal memory performance or other unexpected behavior.

If a RDIMM and LRDIMM mixed failure kicks the system into an unsupported (not validated) configuration, there is an informational error log as mentioned in the following:

- Unsupported DIMM configuration detected: Mixed DIMM configuration is not supported in this system. The system can only have one DIMM type (such as RDIMM or LRDIMM) installed at a time—system halted (major code:%3, minor code:%4).

For DIMM record

If any DIMM/PMem violates the population, there will be an error log record as follows to warn user:

- Unsupported DIMM configuration detected: Processor %1 DIMM %2 violates DIMM population rules (major code:%3, minor code:%4).

If a DIMM/PMem failure results and the DIMM/PMem violates the population, there will be an error log record as follows to warn user:

- Unsupported DIMM configuration detected: Processor %1 DIMM %2 has population violation due to an event that has led to an unsupported configuration (major code:%3, minor code:%4).

Memory population and system settings

HPE Gen11 servers using 4th Gen Intel Xeon Scalable processors support various system settings that influence a wide range of system capabilities. In a couple of cases, these settings introduce a stricter set of population requirements than would otherwise exist for the default system settings. These settings are sub-NUMA clustering in the performance menu and mirrored mode in the memory reliability, accessibility, and serviceability (RAS) menu.

In the case of memory mirroring, only the 8-DIMM and 16-DIMM configurations are supported. See the Memory RAS technologies for HPE ProLiant/HPE Synergy/HPE Blade Gen11 servers with Intel Xeon Scalable processors for more details.

Table 5 shows SNC (Sub-NUMA clustering) and mirror mode support with number of DIMMs populated.

Table 5. SNC (Sub NUMA Clustering)/Mirror mode support table

Number of DIMMs	SNC (Sub NUMA Cluster)/Mirror mode support
1 DIMM	N/A
2 DIMMs	SNC2
4 DIMMs	SNC2, SNC4
6 DIMMs	SNC2
8 DIMMs	SNC2, SNC4, Mirror mode support
12 DIMMs	SNC2, SNC4
16 DIMMs	SNC2, SNC4, Mirror mode support

Conclusion

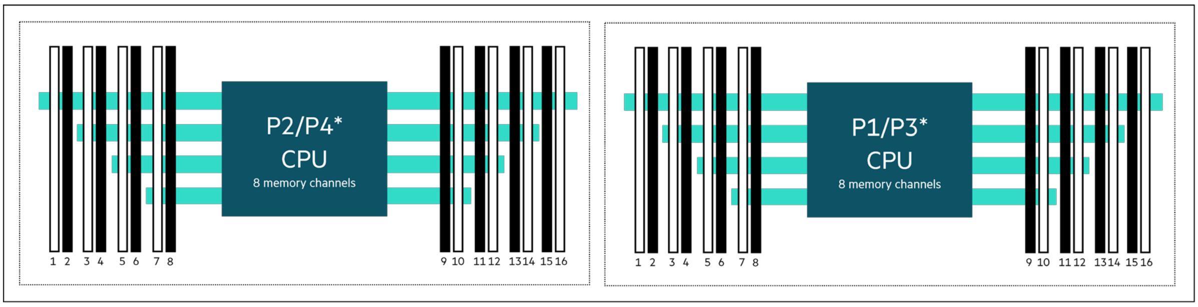
Following the population guidelines maximizes memory performance of HPE SmartMemory DIMMs and HPE PMem in HPE Gen11 servers with 3rd Gen Intel Xeon Scalable processors.

Appendix A—HPE Gen11 DIMM slot locations

This section illustrates the physical location of the DIMM slots for HPE Gen11 servers using 3rd Gen Intel Xeon Scalable processors. HPE servers support 16, 12, or 8 DIMM slots per CPU.

DIMM slot locations in HPE ProLiant DL360/DL380/ML350/DL560* Gen11 servers

HPE ProLiant DL360, DL380, ML350, and DL560* Gen11 servers have 16 DIMM slots per CPU.



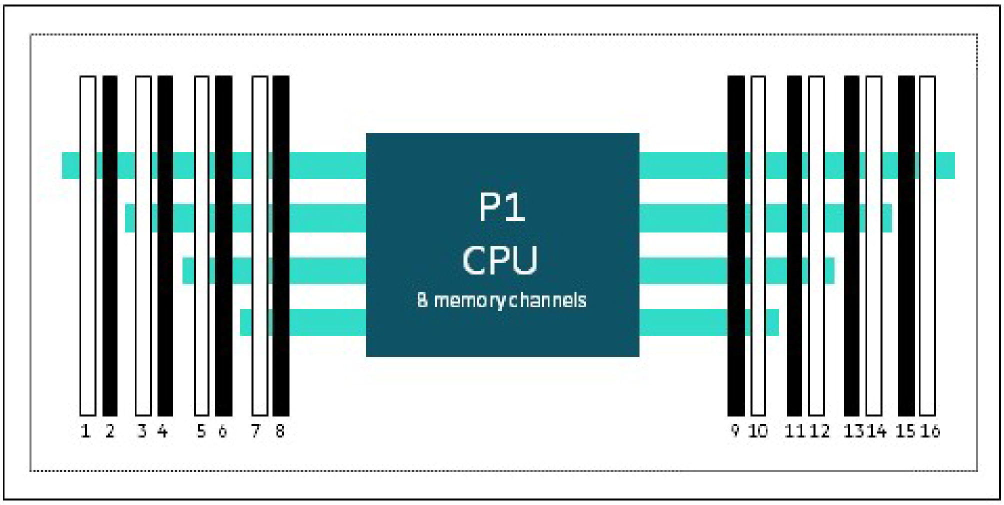
Front of servers

* HPE ProLiant DL560 is a 4-socket server (uses P3, P4).

Figure 6. DIMM slot locations in HPE ProLiant DL360/DL380/ML350/DL560 Gen11 servers

DIMM slot locations in HPE ProLiant DL320/ML110 Gen11 servers

HPE ProLiant DL320 and ML110 Gen11 servers have 16 DIMM slots.



Front of servers

Figure 7. DIMM slot locations in HPE ProLiant DL320/ML110 Gen11 servers

DIMM slot locations in HPE Synergy 480 Gen11 Compute modules

HPE Synergy 480 Gen11 Compute modules have 16 DIMM slots per CPU.

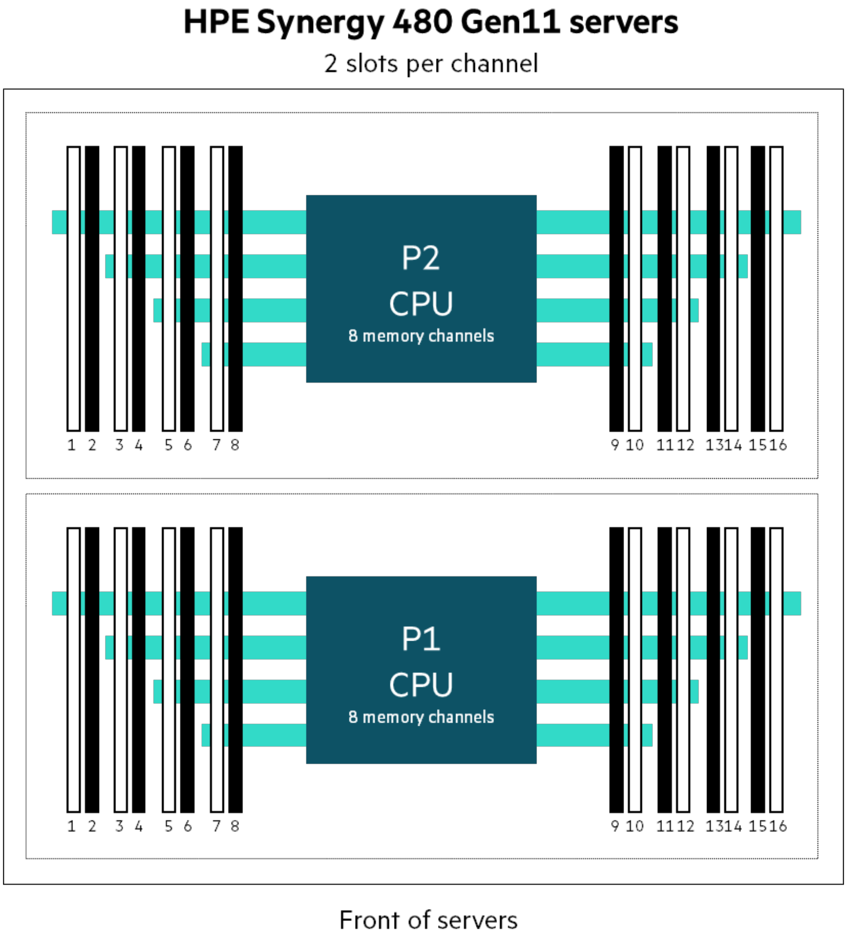


Figure 8. DIMM slot locations for HPE Synergy 480 Gen11 Compute modules (P1 and P2 are rotated.)

DIMM slot locations in HPE Alletra 4120/4110 and HPE ProLiant DL380a Gen11 servers

HPE Alletra 4120/4110 and HPE ProLiant DL380a Gen11 servers have 12 DIMM slots per CPU. Four channels have one DIMM slot, and Four channels have two DIMM slots.

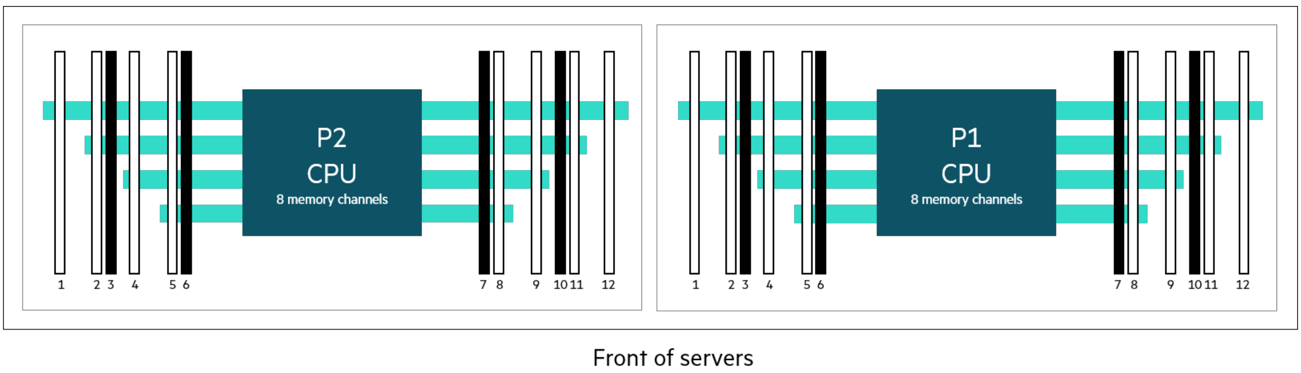


Figure 9. DIMM slot locations in HPE Alletra 4120/4110 and HPE ProLiant DL380a Gen11 servers

DIMM slot locations in HPE DL110 Gen11 servers

HPE DL110 Gen11 servers have eight DIMM slots per CPU.

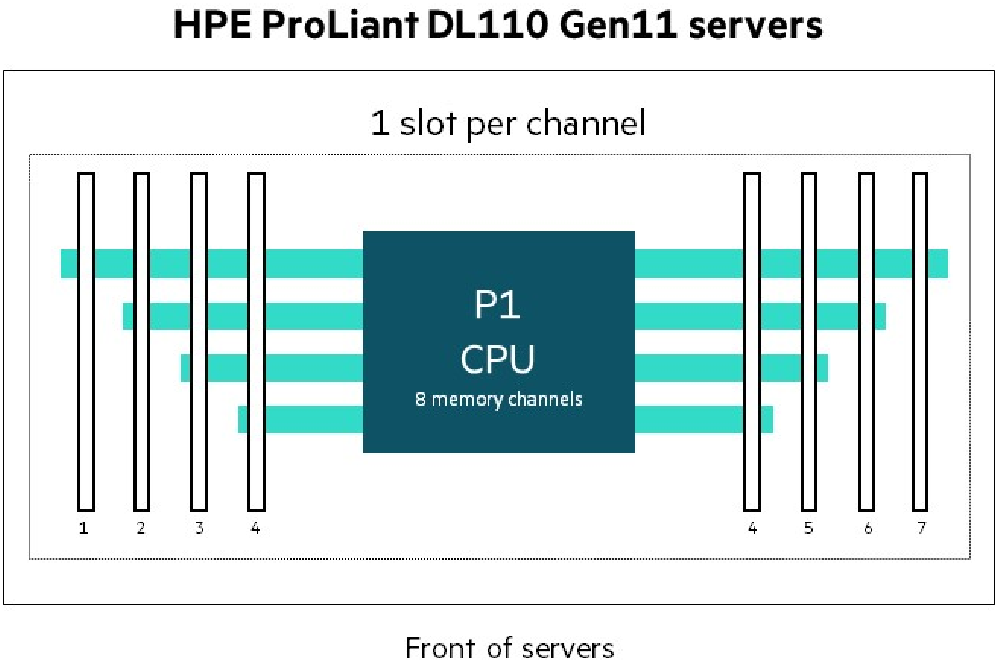


Figure 10. DIMM slot locations in HPE DL110 Gen11 servers (MLB is rotated compared to HPE DL360/DL380)

Appendix B—Population guidelines for HPE SmartMemory DIMMs

This section illustrates which DIMM slots to use when populating memory in HPE Gen11 servers using 3rd Gen Intel Xeon Scalable processors. Each illustration reflects the DIMM slots to use for a given number of DIMMs around a single processor, given a common DIMM type. If multiple processors are installed, split the DIMMs evenly across the processors and follow the corresponding rule when populating DIMMs for each processor. Table 6 represents the bootstrap processor and the population shown will ensure that the first DIMM populated is in the right place. 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 highest rank count in white DIMM slots in each channel, and then populate the other DIMMs in the black DIMM slots in each channel. See the last illustration for an example of a popular mix.

Population guidelines for HPE SmartMemory DIMMs in HPE ProLiant DL360/DL380/ML350/DL560* Gen11 servers

HPE ProLiant DL360/DL380/DL560 Gen11 servers have 16 DIMM slots per CPU.

Table 6. Population guidelines for HPE SmartMemory DIMMs in HPE ProLiant DL360/DL380/DL560* Gen11 servers

HPE ProLiant DL360/DL380/ML350/DL560 Gen11 servers 16 slots per CPU DIMM population order																
1 DIMM										10						
2 DIMMs[1]			3							10						
4 DIMMs[1]			3				7			10				14		
6 DIMMs			3		5		7			10				14		16
8 DIMMs[1, 2]	1		3		5		7			10		12		14		16
12 DIMMs	1	2	3		5	6	7			10	11	12		14	15	16
16 DIMMs[1, 2]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

* HPE DL560 is a 4-socket server (uses P3, P4)
[1] Support Hemi
[2] Support SGX

Table 7. HPE SmartMemory DIMM population guidelines for HPE Gen11 servers with 16 DIMM slots per CPU with HBM + 4th Intel Scalable processors

HPE ProLiant DL360/DL380/ML350/DL560 Gen11 servers 16 slots per CPU DIMM population order with HBM + 4th Intel Scalable processors*																
0 DIMM																
1 DIMM										10						
2 DIMMs			3							10						
4 DIMMs			3				7			10				14		
8 DIMMs	1		3		5		7			10		12		14		16
16 DIMMs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

* HBM + 4th Intel Scalable processors do not support Hemi (hemisphere mode) and Software Guard Extensions (SGX)

Note

Cells without entries represent configurations not supported, and if populated, the server may result in nonoptimal memory performance or other unexpected behavior.

Population guidelines for HPE SmartMemory DIMMs in HPE ProLiant DL320/ML110 Gen11 servers

HPE ProLiant DL320/ML110 Gen11 servers have 16 DIMM slots.

Table 8. Population guidelines for HPE SmartMemory DIMMs in HPE ProLiant DL320/ML110 Gen11 servers

HPE ProLiant DL320/ML110 Gen11 servers 16 slots DIMM population order																
1 DIMM										10						
2 DIMMs[1]			3							10						
4 DIMMs[1]			3				7			10				14		
6 DIMMs			3		5		7			10				14		16
8 DIMMs[1, 2]	1		3		5		7			10		12		14		16
12 DIMMs	1	2	3		5	6	7			10	11	12		14	15	16
16 DIMMs[1, 2]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

[1] Support Hemi
[2] Support SGX

Table 9. HPE SmartMemory DIMM population guidelines for HPE Gen11 servers with 16 DIMM slots per CPU with HBM + 4th Intel Scalable processors

HPE ProLiant DL320/ML110 Gen11 servers 16 slots DIMM population order with HBM + 4th Intel Scalable processors*																
0 DIMM																
1 DIMM										10						
2 DIMMs			3							10						
4 DIMMs			3				7			10				14		
8 DIMMs	1		3		5		7			10		12		14		16
16 DIMMs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

* HBM + 4th Intel Scalable processors do not support Hemi (hemisphere mode) and Software Guard Extensions (SGX)

Note

Cells without entries represent configurations not supported, and if populated, the server may result in nonoptimal memory performance or other unexpected behavior.

Population guidelines for HPE SmartMemory DIMMs in HPE Synergy 480 Gen11 Compute modules

HPE Synergy 480 Gen11 Compute modules have 16 DIMM slots per CPU.

Table 10. Population guidelines for HPE SmartMemory DIMMs in HPE Synergy 480 modules

HPE Synergy 480 Gen11 servers per CPU DIMM population order

CPU 1

1 DIMM										10						
2 DIMMs[1]			3							10						
4 DIMMs[1]			3				7			10				14		
6 DIMMs[1]			3		5		7			10				14		16
8 DIMMs[2]	1		3		5		7			10		12		14		16
12 DIMMs	1	2	3		5	6	7			10	11	12		14	15	16
16 DIMMs[1, 2]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

CPU 2

1 DIMM							7									
2 DIMMs[1]							7							14		
4 DIMMs[1]			3				7			10				14		
6 DIMMs	1		3				7			10		12		14		
8 DIMMs[1, 2]	1		3		5		7			10		12		14		16
12 DIMMs	1	2	3		5	6	7			10	11	12		14	15	16
16 DIMMs[1, 2]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

[1] Support Hemi
[2] Support SGX

Note

Cells without entries represent configurations not supported, and if populated, the server may result in nonoptimal memory performance or other unexpected behavior.

Population guidelines for HPE SmartMemory DIMMs in HPE Alletra 4120/4110 and HPE ProLiant DL380a Gen11 Compute modules

Table 11. Population guidelines for HPE SmartMemory DIMMs in HPE ProLiant and HPE Alletra 4120/4110 Gen11 servers

HPE Alletra 4120/4110 and HPE DL380a Gen11 servers per CPU DIMM population order												
1 DIMM								8				
2 DIMMs[1]		2						8				
4 DIMMs[1]		2			5			8			11	
6 DIMMs		2		4	5			8			11	12
8 DIMMs[1, 2]	1	2		4	5			8	9		11	12
12 DIMMs	1	2	3	4	5	6	7	8	9	10	11	12

[1] Support Hemi
[2] Support SGX

Table 12. Population guidelines for HPE SmartMemory DIMMs in HPE ProLiant and HPE Alletra 4120/4110 Gen11 servers with HBM + 4th Intel Scalable processors

HPE Alletra 4120/4110 and HPE DL380a Gen11 servers per CPU DIMM population order with HBM + 4th Intel Scalable processors*												
0 DIMM												
1 DIMM								8				
2 DIMMs		2						8				
4 DIMMs		2			5			8			11	
8 DIMMs	1	2		4	5			8	9		11	12

* HBM + 4th Intel Scalable processors do not support Hemi (hemisphere mode) and Software Guard Extensions (SGX)

Note
Cells without entries represent configurations not supported, and if populated, the server may result in nonoptimal memory performance or other unexpected behavior.

Population guidelines for HPE SmartMemory DIMMs in HPE DL110 Gen11 Compute modules

Table 13. Population guidelines for HPE SmartMemory DIMMs in HPE DL110 Gen11 servers

HPE DL110 Gen11 server CPU DIMM population order								
1 DIMM		2						
2 DIMMs[1]		2			5			
4 DIMMs[1]		2		4	5		7	
6 DIMMs		2	3	4	5		7	8
8 DIMMs[1, 2]	1	2	3	4	5	6	7	8

[1] Support Hemi
[2] Support SGX

Table 14. Population guidelines for HPE SmartMemory DIMMs in HPE DL110 Gen11 servers with HBM + 4th Intel Scalable processors

HPE DL110 Gen11 server CPU DIMM population order with HBM + 4th Intel Scalable processors*								
0 DIMM								
1 DIMM		2						
2 DIMMs		2			5			
4 DIMMs		2		4	5		7	
8 DIMMs	1	2	3	4	5	6	7	8

* HBM + 4th Intel Scalable processors do not support Hemi (hemisphere mode) and Software Guard Extensions (SGX)

Note

Cells without entries represent configurations not supported, and if populated, the server may result in nonoptimal memory performance or other unexpected behavior.

Mixed HPE SmartMemory 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, populate the DIMMs with highest rank count in white DIMM slots in each channel, and then populate the other DIMMs in the black DIMM slots with full population. The following illustration shows homogeneous configuration and different rank DIMM mixed configuration.

Table 15. Memory speed table for 300 series platforms

Registered DIMM (RDIMM)						
HPE SKU P/N	**P43322-B21**	**P43325-B21**	**P43328-B21**	**P43331-B21**	**P43334-B21**	**P43337-B21**
SKU description	HPE 16GB 1Rx8 PC5-4800B-R Smart Kit	HPE 32GB 1Rx4 PC5-4800B-R Smart Kit	HPE 32GB 2Rx8 PC5-4800B-R Smart Kit	HPE 64GB 2Rx4 PC5-4800B-R Smart Kit	HPE 128GB 4Rx4 PC5-4800B-R 3DS Smart Kit	HPE 256GB 8Rx4 PC5-4800B-R 3DS Smart Kit
DIMM rank	Single rank (1R)	Single rank (1R)	Dual rank (2R)	Dual rank (2R)	Quad rank (4R)	Octal rank (8R)
DIMM capacity	**16 GB**	**32 GB**	**32 GB**	**64 GB**	**128 GB**	**256 GB**
Voltage	1.1V	1.1V	1.1V	1.1V	1.1V	1.1V
DRAM depth (bit)	2G	4G	2G	4G	4G	4G
DRAM width (bit)	x8	x4	x8	x4	x4	x4
DRAM density	16 Gb	16 Gb	16 Gb	16 Gb	16 Gb	16 Gb
CAS latency	40-39-39	40-39-39	40-39-39	40-39-39	46-39-39	46-39-39
DIMM native speed (MT/s)	4800	4800	4800	4800	4800	4800
Intel® Xeon® Platinum / Intel® Xeon® Gold 84xx/64xx processors officially supported memory speed MT/s)*						
1 DIMM per channel	4800	4800	4800	4800	4800	4800
2 DIMMs per channel	4400	4400	4400	4400	4400	4400
Intel Xeon Gold 54xx processors officially supported memory speed (MT/s)						
1 DIMM per channel	4400	4400	4400	4400	4400	4400
2 DIMMs per channel	4400	4400	4400	4400	4400	4400
Intel® Xeon® Silver 44xx processors officially supported memory speed (MT/s)						
1 DIMM per channel	4000	4000	4000	4000	4000	4000
2 DIMMs per channel	4000	4000	4000	4000	4000	4000
Intel® Xeon® Bronze 34xx processors officially supported memory speed (MT/s)						
1 DIMM per channel	4000	4000	4000	4000	4000	4000
2 DIMMs per channel	4000	4000	4000	4000	4000	4000
HPE Server Memory Speed (MT/s): Intel Xeon Platinum/Gold 84xx/64xx processors						
1 DIMM per channel	4800	4800	4800	4800	4800	4800
2 DIMMs per channel	4400	4400	4400	4400	4400	4400
HPE Server Memory Speed (MT/s): Intel Xeon Gold 54xx processors*						
1 DIMM per channel	4400	4400	4400	4400	4400	4400
2 DIMMs per channel	4400	4400	4400	4400	4400	4400
HPE Server Memory Speed (MT/s): Intel Xeon Silver 44xx processors*						
1 DIMM per channel	4000	4000	4000	4000	4000	4000
2 DIMMs per channel	4000	4000	4000	4000	4000	4000
HPE Server Memory Speed (MT/s): Intel Xeon Bronze 34xx processors*						
1 DIMM per channel	4000	4000	4000	4000	4000	4000
2 DIMMs per channel	4000	4000	4000	4000	4000	4000

* The maximum memory speed is a function of the memory type, memory configuration, and processor model.

Table 16. Mixed population guidelines for HPE SmartMemory DIMMs

		Intel Sapphire Rapids DDR5					
		P43322-X21	**P43325-X21**	**P43328-X21**	**P43331-X21**	**P43334-X21**	**P43337-X21**
P/N	Description	16 GB 1Rx8	32 GB 1Rx4	32 GB 2Rx8	64 GB 2Rx4	128 GB 4Rx4 2H3DS	256 GB 8Rx4 4H3DS
		4800 MT/s	4800 MT/s	4800 MT/s	4800 MT/s	4800 MT/s	4800 MT/s
		RDIMM	RDIMM	RDIMM	RDIMM	RDIMM	RDIMM
		Within same server	**Within same server**	**Within same server**	**Within same server**	**Within same server**	**Within same server**
P43322-X21	HPE 16GB 1Rx8 PC5-4800B-R Smart Kit	Yes	No[1]	Yes[2]	No[1]	No[3]	No[3]
P43325-X21	HPE 32GB 1Rx4 PC5-4800B-R Smart Kit	No[1]	Yes	No[1]	Yes[2]	No[3]	No[3]
P43328-X21	HPE 32GB 2Rx8 PC5-4800B-R Smart Kit	Yes[2]	No[1]	Yes	No[1]	No[3]	No[3]
P43331-X21	HPE 64GB 2Rx4 PC5-4800B-R Smart Kit	No[1]	Yes[2]	No[1]	Yes	No[3]	No[3]
P43334-X21	HPE 128GB 4Rx4 PC5-4800B-R 3DS Smart Kit	No[3]	No[3]	No[3]	No[3]	Yes	Yes[2]
P43337-X21	HPE 256GB 8Rx4 PC5-4800B-R 3DS Smart Kit	No[3]	No[3]	No[3]	No[3]	Yes[2]	Yes

[1] x4 cannot be mixed with x8.
[2] Ranks can be mixed but only with all 16 DIMMs sockets populated.
[3] Do not mix DIMM module types within a memory channel. All must be RDIMM or 3DS RDIMM module types, with same ECC configuration.

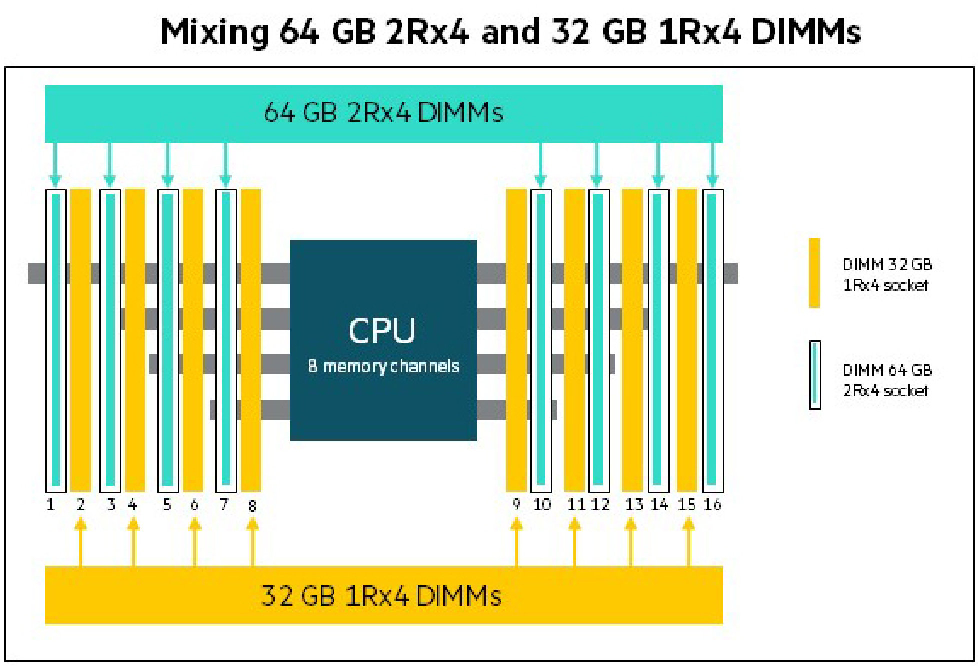


Figure 11. Mixing HPE SmartMemory 64 GB 2Rx4 and 32 GB 1Rx4 mixed configuration

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