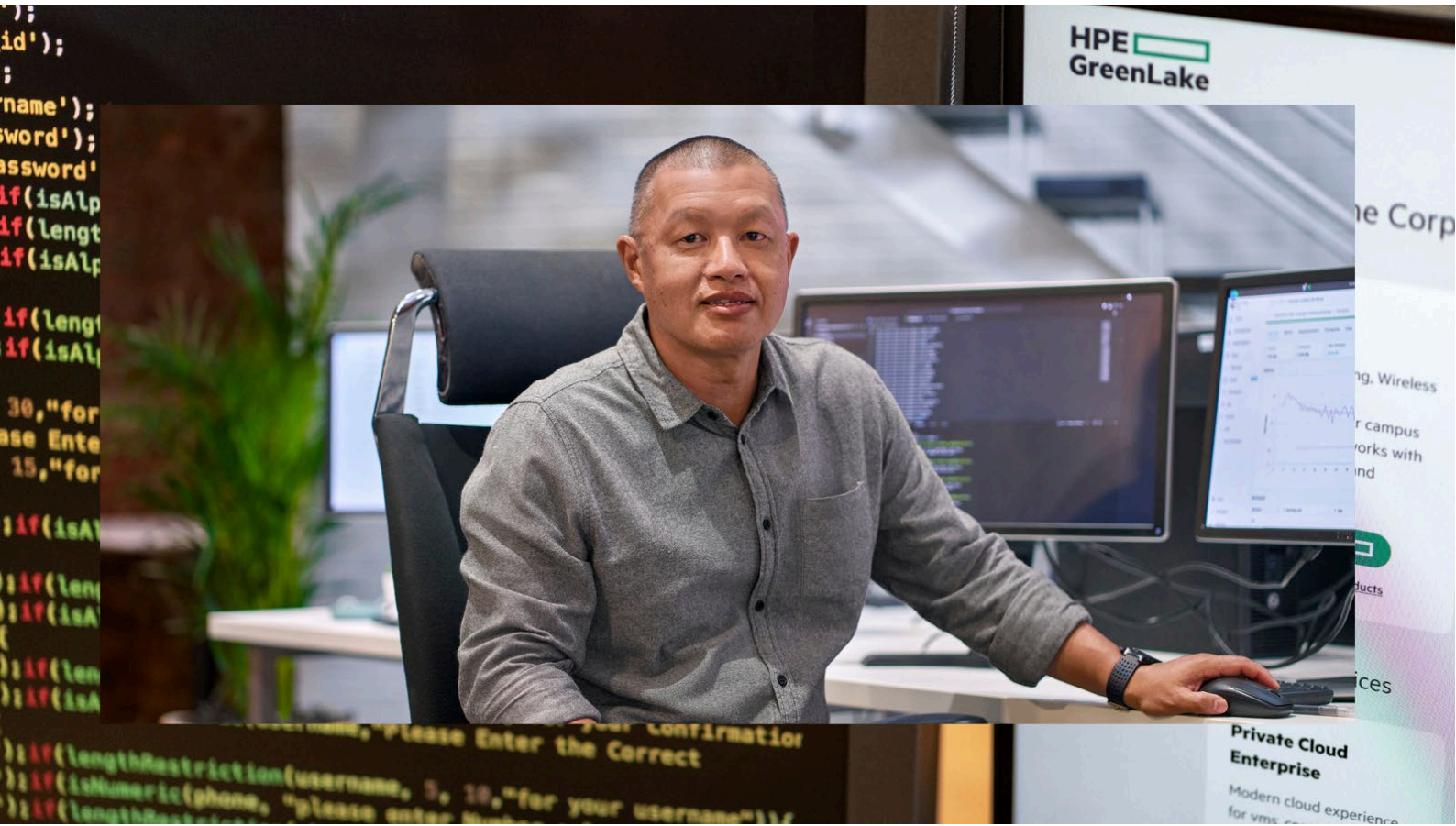
HPE ProLiant Compute

Technical white paper

Server memory population rules for HPE Gen12 servers with 6th Gen Intel Xeon Scalable processors

HPE GreenLake



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Introduction

This paper describes how to populate HPE DDR5 Smart Memory DIMMs in HPE ProLiant Compute Gen12 servers with 6th Gen Intel® Xeon®. HPE Server Memory for HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon support faster data rates, lower latencies, and greater power efficiency than the DIMMs used in previous generations of HPE servers. HPE DDR5 Smart Memory also provides superior performance over third-party memory when used in HPE servers.

HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon and 6th Gen Intel Xeon Scalable processors offer increased memory speed from 4800 to 6400 Mb/s than the HPE ProLiant Compute Gen11 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 Smart Memory DIMMs in HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon.

HPE DDR5 Smart Memory for HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon: Engineered with 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 Compute Gen12 servers with 6th Gen Intel Xeon. DDR5, the most technologically advanced DRAM to date, enables 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.[1] 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 enables the next generation of server workloads by delivering up to a 100% increase in overall memory performance. Comparing to DDR5 4800 in last generation (5th Gen Intel Xeon) servers, DDR5 6400 enables the next generation of server workloads by delivering up to a 35% increase in overall memory performance.[2]

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 support 16 Gb, 24 Gb up to 32 Gb density, and 6400 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 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 the 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 100% increase in the bandwidth with 6400 MT/s as compared to DDR4 which tops out at 3200 MT/s.[3] 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 backward compatibility between DDR5 and DDR4.

Table 2, 3, and 4 provide detailed information about the recently introduced HPE DDR5 Smart Memory for HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon, 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 in mixed rule summary in Table 1.

[1] "HPE DDR5 Smart Memory," Hewlett Packard Enterprise, 2023.
[2] 6400 is about 35% faster than 5600. The actual improvement also depends on platform channel numbers and max speed.
[3] 6400 is double of 3200. The actual improvement also depends on platform channel numbers and max speed.

Populating HPE DDR5 Smart Memory DIMMs in HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon

HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon 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 Compute Gen12 servers with 6th Gen Intel Xeon with HPE DDR5 Smart Memory 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 ProLiant Compute Gen12 servers with 6th Gen Intel Xeon.

Table 1. DIMM population rules for HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon

Category	Population guidelines
Processors and DIMM slots, types, and capacities	1. Install DIMMs only if the corresponding processor is installed. If only one processor is installed in a two-processor system, only the DIMM slots that have processor 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. 2. 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. **Mixed rule:** 3. RDIMM is only mixed with RDIMM. Do not mix RDIMMs and LRDIMMs in the same system. 4. MRDIMM is only mixed with MRDIMM. Do not mix MRDIMMs with RDIMM or LRDIMMs in the same system. 5. Do not mix x4 with x8 within same channel or across a channel. 6. Rank mixing on a channel is not allowed except when all DIMM slots on each channel are fully populated. Like HPE ProLiant DL360 / HPE ProLiant DL380 server, 16 DIMMs for a processor socket is fully populated (2 rank in white slot, 1 rank in black slot). 7. Do not mix 24 Gb die with non-24 Gb die in the same system platform. 8. Do not mix 32 Gb die with non-32 Gb die in the same system platform. 9. Do not mix non-3DS and 3DS in the same system platform. 10. HPE DDR5 Smart Memory DIMMs and HPE NVDIMM-Ns from previous generation servers are not compatible with the current generation. Certain HPE DDR5 Smart Memory features such as memory authentication and enhanced performance may not be supported.

Mixed rule summary of Table 1:

			16 Gb die	**16 Gb die**	**24 Gb die**	**32 Gb die**	**32 Gb die**
			HPE 16 GB 1Rx8 HPE 32 GB 2Rx8	HPE 64 GB 2Rx4	HPE 96 GB 2Rx4	HPE 128 GB 2Rx4	HPE 256 GB 4Rx4 3DS
			RDIMM	RDIMM	RDIMM	RDIMM	3DS RDIMM
16 Gb die	HPE 16 GB 1Rx8 HPE 32 GB 2Rx8	RDIMM	Yes[6]	No[5]	No[7]	No[8]	No[9]
16 Gb die	HPE 64 GB 2Rx4	RDIMM	No[5]	Yes	No[7]	No[8]	No[9]
24 Gb die	HPE 96 GB 2Rx4	RDIMM	No[7]	No[7]	Yes	No[8]	No[4]
32 Gb die	HPE 128 GB 2Rx4	RDIMM	No[8]	No[8]	No[8]	Yes	No[9]
32 Gb die	HPE 256 GB 4Rx4 3DS	3DS RDIMM	No[9]	No[9]	No[9]	No[9]	Yes

Table 1. DIMM population rules for HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon (continued)

Category	Population guidelines
CPU SKU/restriction notice	**6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series:** 1. CPU SKU: XCC, HCC, LCC **6th Gen Intel Xeon 6700E-series:** 2. CPU SKU: HDCC 3. MRDIMM is not supported in 6th Gen Intel Xeon 6700E-series. 4. SNC (sub-NUMA cluster) is not supported in 6th Gen Intel Xeon 6700E-series. **6th Gen Intel Xeon 6900P-series:** 5. 1 CPU SKU: UCC 6. Rank mixing is not allowed in 6th Gen Intel Xeon 6900P-series
Performance	1. 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). 2. 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 speed	1. The maximum memory speed is a function of the memory type, memory configuration, and processor model. 2. 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.

Introduction to DIMM slot locations

In general, DIMM population order follows the same logic for all HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon—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 DDR5 Smart Memory 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 Compute DL360 Gen12 / HPE ProLiant Compute DL380 Gen12 / HPE ProLiant Compute ML350 Gen12 Servers with 6th Gen Intel Xeon, which have two sockets and 32 DIMM slots (DL360/ DL380/ ML350 servers). Diagrams for all servers are included in Appendix A.

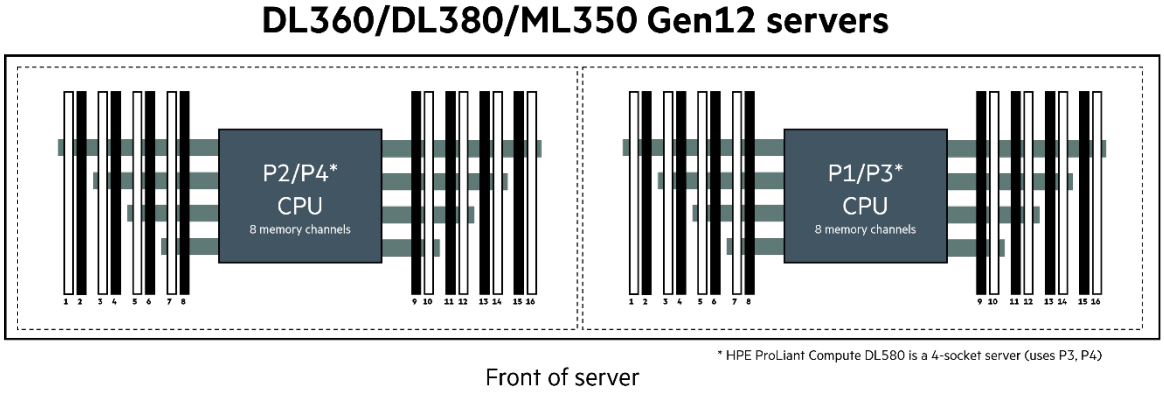

Figure 1. 32 DIMM slot locations in DL360/DL380/ML350 Gen12 servers with 6th Gen Intel Xeon

Population guidelines for HPE DDR5 Smart Memory DIMMs

This section provides generic guidelines for populating HPE DDR5 Smart Memory DIMMs in HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon. See Appendix B for population guidelines for specific HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon.

HPE DDR5 Smart 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 DDR5 Smart Memory DIMMs in HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series (GNR-SP) and Intel Xeon 6700E-series (SRF-SP) with 16 DIMM slots per CPU (for example, DL360/ DL380/ML350 Gen12 servers / HPE ProLiant Compute DL380a Gen12 Servers with 6th Gen Intel Xeon).

Table 3 shows a sample of the population guidelines for HPE DDR5 Smart Memory DIMMs in HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon 6900P-series with 12 DIMM slots per CPU (for example, HPE ProLiant Compute XD230 servers with 6th Gen Intel Xeon).

For a given number of HPE DDR5 Smart Memory 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 DDR5 Smart Memory DIMM/MRDIMM population guidelines for HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series with 16 DIMM slots per CPU

Intel Xeon 6700E-series (SRF-SP)	Intel Xeon 6700P-series and Intel Xeon 6500P-series (GNR-SP)	DIMM population MRDIMM is not supported in 6th Gen Intel Xeon 6700E-series (SRF-SP)																
SRF-SP (Intel® default)	GNR-SP (Intel default)	1 DIMM[1]										10						
SRF-SP (HPE request)	GNR-SP (HPE request)	2 DIMMs[1]						7				10						
SRF-SP (HPE request)	GNR-SP (Intel default)	4 DIMMs[1]			3			7				10				14		
SRF-SP (Intel default)	GNR-SP (Intel default)	8 DIMMs	1		3		5		7			10		12		14		16
Not supported	GNR-SP (Intel default)	12 DIMMs[1]	1		3	4	5		7	8	9	10		12	13	14		16
GNR-SP (Intel default)	GNR-SP (Intel default)	16 DIMMs[1]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

[1]Does not support MRDIMM. MRDIMM only supports with eight DIMMs.

Table 3. HPE DDR5 Smart Memory DIMM/MRDIMM population guidelines for HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon 6900P-series with 12 DIMM slots per CPU

Intel Xeon 6900P-series (GNR-AP)	DIMM population Rank mixing is not allowed in 6th Gen Intel Xeon 6900P-series												
GNR-AP (Intel default)	1 DIMM[1]						7						
GNR-AP (Intel default)	12 DIMMs	1	2	3	4	5	6	7	8	9	10	11	12

[1]Does not support MRDIMM. MRDIMM only supports with 12 DIMMs.

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 four HPE DDR5 Smart Memory DIMMs are being installed per CPU, they should be installed in DIMM slots 3, 7, 10, and 14.
- If eight HPE DDR5 Smart Memory DIMMs are being installed per CPU, they should be installed in DIMM slots 1, 3, 5, 7, 10, 12, 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 access using each memory device in turn, instead of using the same device 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 Compute Gen12 servers goes into detail regarding setting up memory for interleaving. Tables 4 and 5 show the impact of all balanced configurations on memory throughput. If you look at the 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 on the other channels.

Depending on where the memory is allocated, the application will experience different memory performance from run to run. The best case would be peak performance and the worst case would be 50% of peak performance.

Memory controller interleaving

6th 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.

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. Hewlett Packard Enterprise discourages unbalanced configurations because they will always have lower performance than similar balanced configurations. There are two types of unbalanced configurations, each with their own performance implications.

Table 4. Impact of unbalanced configurations on memory throughput on 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series

			Number of interleaved channels per processor sor		Throughput compared to peak	
Intel Xeon 6700E-series (SRF-SP)	**Intel Xeon 6500P-series (GNR-SP)**	**DIMMs**	**Large group (white slot)**	**Small group (black slot)**	**Weighted channel performance in %***	**Worse channel performance in %****
SRF-SP	GNR-SP	1	1	n/a	12.5%	12.5%
SRF-SP	GNR-SP	2	2	n/a	25%	25%
SRF-SP	GNR-SP	4	4	n/a	50%	50%
SRF-SP	GNR-SP	8	8	n/a	100%	100%
Not supported	GNR-SP	12	8	4	100%	50%
SRF-SP	GNR-SP	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

Table 5. Impact of unbalanced configurations on memory throughput on 6th Gen Intel Xeon 6900P-series

		Number of interleaved channels per processor		Throughput compared to peak	
Intel Xeon 6900P-series (GNR-AP)	**DIMMs**	**Large group (white slot)**	**Small group (black slot)**	**Weighted channel performance in %***	**Worse channel performance in %****
GNR-AP	1	1	n/a	8.3%	8.3%
GNR-AP	12	12	n/a	100%	100%

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

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

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 nonuniform performance characteristics for software program threads, depending on which processor runs them.

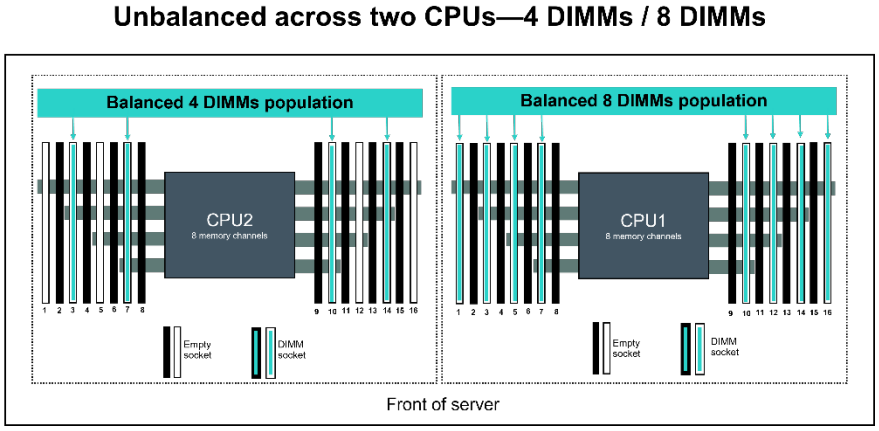

Figure 2. Example of memory that is unbalanced across processors

Figure 2 shows an example of unbalanced memory configurations across processors. In this example, the first processor has eight DIMMs while the second CPU only has four DIMMs installed. Both CPU configurations are balanced, but the imbalance is from CPU to CPU.

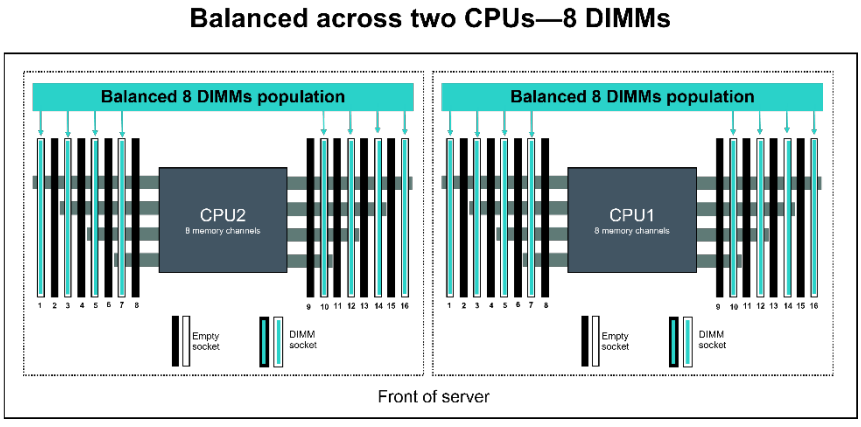

Figure 3. Example of a memory configuration that is balanced across processors

Figure 3 shows an example of a configuration that is balanced across processors. In this example, both processors have eight 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 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 failure results and the DIMM 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 ProLiant Compute Gen12 servers with 6th Gen Intel Xeon using 6th 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 cluster, All to All mode, Hemi mode, Quadra mode 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 Compute Gen12/ HPE Synergy/blade servers with Intel Xeon Scalable processors for more details.

Table 6. HPE DDR5 Smart Memory DIMM/MRDIMM population guidelines for HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series with 16 DIMM slots per CPU

Intel Xeon 6700P-series and Intel Xeon 6500P-series (GNR-SP)	DIMM population	SNC2 (XCC only)	Degrade All2All (XCC/HCC only)	All2All (LCC only)	Hemi (HCC only)	Quad (XCC only)	SGX	Mirror
GNR-SP (Intel default)	1 DIMM[1]	n/a	Yes	Yes	n/a	n/a	n/a	n/a
GNR-SP (HPE request)	2 DIMMs[1]	Yes	n/a	Yes	Yes	n/a	n/a	n/a
GNR-SP (Intel default)	4 DIMMs[1]	Yes	n/a	Yes	Yes	Yes	Yes	n/a
GNR-SP (Intel default)	8 DIMMs	Yes	n/a	Yes	Yes	Yes	Yes	Yes
GNR-SP (Intel default)	12 DIMMs[1]	Yes	n/a	Yes	Yes	Yes	n/a	n/a
GNR-SP (Intel default)	16 DIMMs	Yes	n/a	Yes	Yes	Yes	Yes	Yes

[1] Does not support MRDIMM. MRDIMM only supports with eight DIMMs.

Table 7. HPE DDR5 Smart Memory DIMM population guidelines for HPE ProLiant Compute Gen12 servers with 6th Intel Xeon 6700E-series with 16 DIMM slots per CPU

Intel Xeon 6700E-series	DIMM population SNC (sub-NUMA cluster) is not supported in 6th Gen Intel Xeon 6700E-series.	Degrade All2All	Hemi	SGX	Mirror
SRF-SP (Intel default)	1 DIMM	V	n/a	n/a	n/a
SRF-SP (HPE request)	2 DIMMs	n/a	V	n/a	n/a
SRF-SP (HPE request)	4 DIMMs	n/a	V	V	n/a
SRF-SP (Intel default)	8 DIMMs	n/a	V	V	V
GNR-SP (Intel default)	16 DIMMs	n/a	V	V	V

Table 8. HPE DDR5 Smart Memory DIMM/MRDIMM population guidelines for HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon 6900P-series with 12 DIMM slots per CPU

Intel Xeon 6900P-series	DIMM population	SNC3	All2All	Hex	Mirror
GNR-AP (Intel default)	1 DIMM[1]	n/a	V	n/a	n/a
GNR-AP (Intel default)	12 DIMMs	V	n/a	V	V

[1] Does not support MRDIMM. MRDIMM only supports with eight DIMMs.

Conclusion

Following the population guidelines help maximize memory performance of HPE DDR5 Smart Memory DIMMs and HPE Persistent Memory in HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon and 6th Gen Intel Xeon Scalable processors.

Appendix A—HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon DIMM slot locations

This section illustrates the physical location of the DIMM slots for HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon using 3rd Gen Intel Xeon Scalable processors. HPE servers support 16, 12, or 8 DIMM slots per CPU.

DIMM slot locations in DL360/DL380/ML350 Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series/ Intel Xeon 6700E-series

DL360, DL380, and ML350 Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series/ Intel Xeon 6700E-series have 16 DIMM slots per CPU, total 32 DIMM slots in a server.

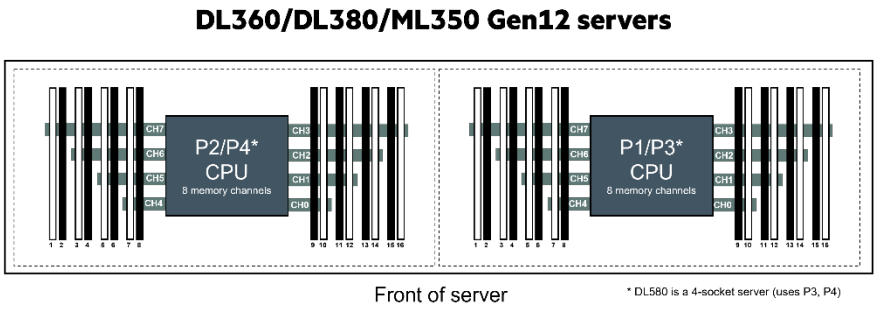

Figure 4. DIMM slot locations in DL360/DL380/ML350 Gen12 servers with 6th Gen Intel Xeon

DIMM slot locations in DL380a Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series / Intel Xeon 6700E-series

DL380a Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series/ Intel Xeon 6700E-series have 16 DIMM slots per CPU, total 32 DIMM slots in a server.

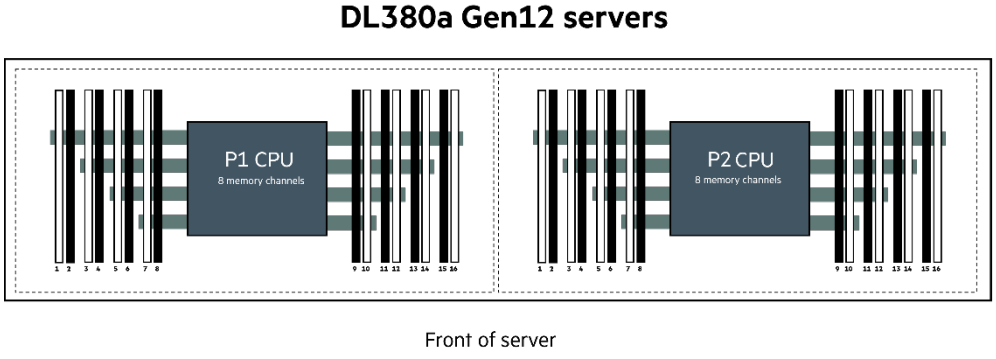

Figure 5. DIMM slot locations in DL380a Gen12 servers with 6th Gen Intel Xeon

DIMM slot locations in HPE Synergy 480 Gen12 Servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series / Intel Xeon 6700E-series compute modules

480 Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series / Intel Xeon 6700E-series compute modules have 16 DIMM slots per CPU, total 32 DIMM slots in a server.

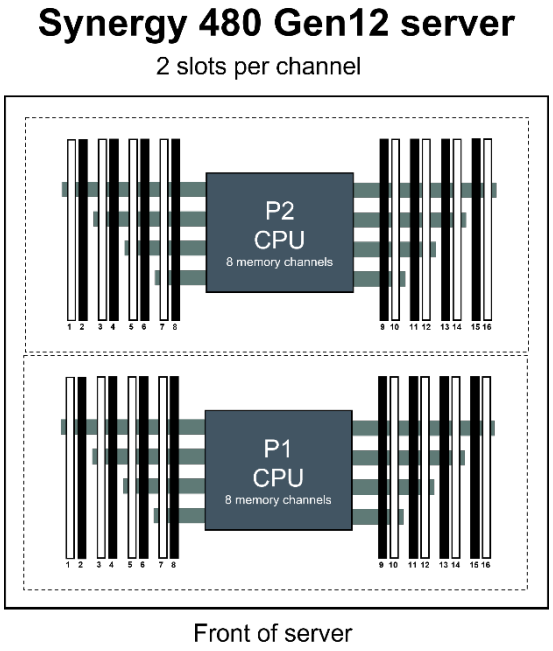

Figure 6. DIMM slot locations for 480 Gen12 servers with 6th Gen Intel Xeon compute modules (P1 and P2 are rotated.)

DIMM slot locations in DL320/DL340 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series / Intel Xeon 6700E-series

DL320 and DL340 Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series/ Intel Xeon 6700E-series have 16 DIMM slots in a server.

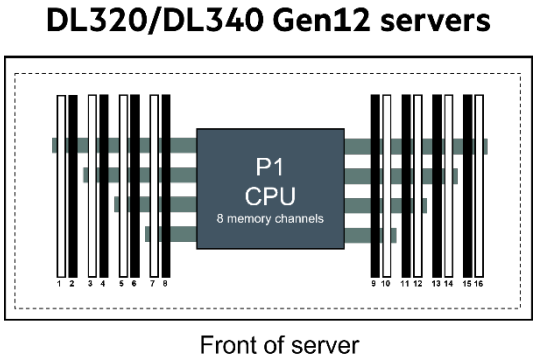

Figure 7. DIMM slot locations in DL320/DL340 Gen12 servers with 6th Gen Intel Xeon

DIMM slot locations in HPE ProLiant Compute XD230 servers with 6th Gen Intel Xeon 6900P-series

XD230 servers with 6th Gen Intel Xeon 6900P-series servers have 12 DIMM slots per CPU, total 24 DIMM slots in a server.

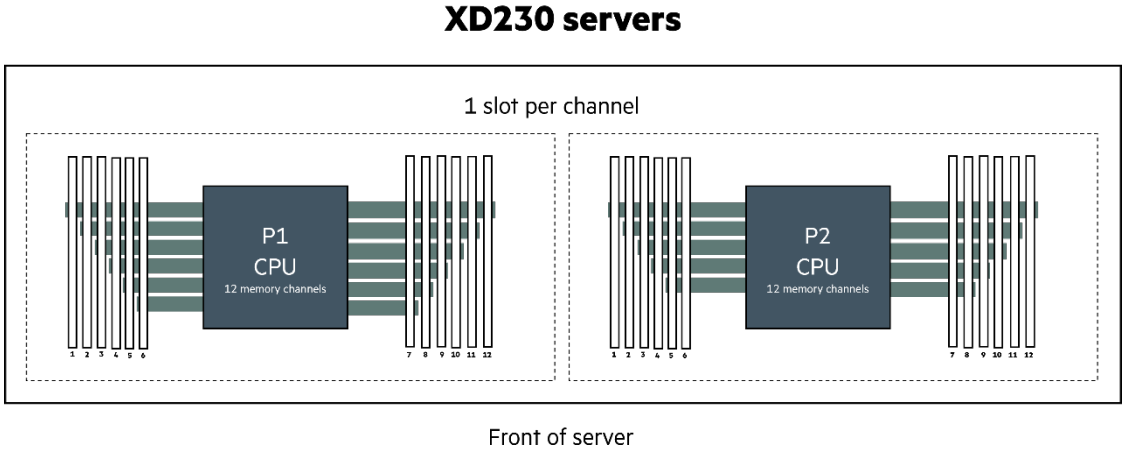

Figure 8. DIMM slot locations in XD230 servers with 6th Gen Intel Xeon

Appendix B—Population guidelines for HPE DDR5 Smart Memory DIMMs

This section illustrates which DIMM slots to use when populating memory in HPE ProLiant Compute Gen12 servers with 6th Gen Intel Xeon 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 9 represents the bootstrap processor and the population shown helps 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 Figure 9 for an example of a popular mix.

Population guidelines for HPE DDR5 Smart Memory DIMMs in DL360/DL380/ML350 Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series/Intel Xeon 6700E-series

DL360/DL380 Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series / Intel Xeon 6700E-series have 16 DIMM slots per CPU.

Table 9. HPE DDR5 Smart Memory DIMM/MRDIMM population guidelines in DL360/DL380 with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series with 16 DIMM slots per CPU

Intel Xeon 6700E-series (SRF-SP)	Intel Xeon 6700P-series and Intel Xeon 6500P-series (GNR-SP)		DIMM population *MRDIMM is not supported in 6th Gen Intel Xeon Intel Xeon 6700E-series (SRF-SP)															
SRF-SP (Intel default)	GNR-SP (Intel default)	1 DIMM[1]									10							
SRF-SP (HPE request)	GNR-SP (HPE request)	2 DIMMs[1]						7			10							
SRF-SP (HPE request)	GNR-SP (Intel default)	4 DIMMs[1]		3				7			10					14		
SRF-SP (Intel default)	GNR-SP (Intel default)	8 DIMMs	1	3		5		7			10		12			14		16
Not supported	GNR-SP (Intel default)	12 DIMMs[1]	1	3	4	5		7	8	9	10		12	13		14		16
GNR-SP (Intel default)	GNR-SP (Intel default)	16 DIMMs[1]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

[1]Does not support MRDIMM. MRDIMM only supports with eight DIMMs.

Population guidelines for HPE DDR5 Smart Memory DIMMs in DL380a Gen12 Servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series/ Intel Xeon 6700E-series

DL380a servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series/Intel Xeon 6700E-series have 16 DIMM slots per CPU.

Table 10. HPE DDR5 Smart Memory DIMM/MRDIMM population guidelines in DL380a servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series and 6th Gen Intel Xeon 6700E-series with 16 DIMM slots per CPU

Intel Xeon 6700E-series (SRF-SP)	Intel Xeon 6700P-series and Intel Xeon 6500P-series (GNR-SP)		DIMM population *MRDIMM is not supported in 6th Gen Intel Xeon Intel Xeon 6700E-series (SRF-SP)															
SRF-SP (Intel default)	GNR-SP (Intel default)	1 DIMM[1]									10							
SRF-SP (HPE request)	GNR-SP (HPE request)	2 DIMMs[1]						7			10							
SRF-SP (HPE request)	GNR-SP (Intel default)	4 DIMMs[1]		3				7			10					14		
SRF-SP (Intel default)	GNR-SP (Intel default)	8 DIMMs	1	3		5		7			10		12			14		16
Not supported	GNR-SP (Intel default)	12 DIMMs[1]	1	3	4	5		7	8	9	10		12	13		14		16
GNR-SP (Intel default)	GNR-SP (Intel default)	16 DIMMs[1]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

[1] Does not support MRDIMM. MRDIMM only supports with eight DIMMs.

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 DDR5 Smart Memory DIMMs in 480 Gen12 servers with Intel Xeon 6700P-series

480 Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series / Intel Xeon 6700E-series have 16 DIMM slots per CPU.

Table 11. HPE DDR5 Smart Memory DIMM/MRDIMM population guidelines in 480 Gen12 server with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series and 6th Gen Intel Xeon 6700E-series with 16 DIMM slots per CPU

Intel Xeon 6700P-series (GNR-SP)		CPU0 DIMM population MRDIMM is not supported in 6th Gen Intel Xeon 6700E-series (SRF-SP)															
GNR-SP (Intel default)	1 DIMM[1]										10						
GNR-SP (HPE request)	2 DIMMs[1]						7				10						
GNR-SP (Intel default)	4 DIMMs[1]			3			7				10				14		
GNR-SP (Intel default)	8 DIMMs	1		3		5		7			10		12		14		16
GNR-SP (Intel default)	12 DIMMs[1]	1		3	4	5		7	8	9	10		12	13	14		16
GNR-SP (Intel default)	16 DIMMs[1]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

[1] Does not support MRDIMM. MRDIMM only supports with eight DIMMs.

Table 12. HPE DDR5 Smart Memory DIMM/MRDIMM population guidelines in 480 Gen12 server with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series and 6th Gen Intel Xeon 6700E-series with 16 DIMM slots per CPU

Intel Xeon 6700P-series (GNR-SP)		CPU1 DIMM population MRDIMM is not supported in 6th Gen Intel Xeon 6700E-series (SRF-SP)															
GNR-SP (Intel default)	1 DIMM[1]								10								
GNR-SP (HPE request)	2 DIMMs[1]								10			7					
GNR-SP (Intel default)	4 DIMMs[1]			14					10			7				3	
GNR-SP (Intel default)	8 DIMMs	16		14		12			10			7		5		3	1
GNR-SP (Intel default)	12 DIMMs[1]	16		14	13	12			10	9	8	7		5	4	3	1
GNR-SP (Intel default)	16 DIMMs[1]	16	15	14	13	12	11		10	9	8	7	6	5	4	3	2	1

[1] Does not support MRDIMM. MRDIMM only supports with eight DIMMs.

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 DDR5 Smart Memory DIMMs in DL320/DL340 Gen12 servers with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series / Intel Xeon 6700E-series

DL320 / HPE ProLiant ML110 Gen12 Servers with 6th Intel Xeon 6700P-series and Intel Xeon 6500P-series/ Intel Xeon 6700E-series have 16 DIMM slots.

Table 13. HPE DDR5 Smart Memory DIMM/MRDIMM population guidelines in DL320/DL340 Gen12 with 6th Intel Xeon 6700P-series and Intel Xeon 6500P-series and 6th Gen Intel Xeon 6700E-series with 16 DIMM slots per CPU

Intel Xeon 6700E-series (SRF-SP)	Intel Xeon 6700P-series and Intel Xeon 6500P-series (GNR-SP)	DIMM population MRDIMM is not supported in 6th Gen Intel Xeon Intel Xeon 6700E-series (SRF-SP)															
SRF-SP (Intel default)	GNR-SP (Intel default)	1 DIMM[1]									10						
SRF-SP (HPE request)	GNR-SP (HPE request)	2 DIMMs[1]						7			10						
SRF-SP (HPE request)	GNR-SP (Intel default)	4 DIMMs[1]			3			7			10				14		
SRF-SP (Intel default)	GNR-SP (Intel default)	8 DIMMs	1		3		5	7			10		12		14		16
Not supported	GNR-SP (Intel default)	12 DIMMs[1]	1		3	4	5	7	8	9	10		12	13	14		16
GNR-SP (Intel default)	GNR-SP (Intel default)	16 DIMMs[1]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

[1] Does not support MRDIMM. MRDIMM only supports with eight DIMMs.

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 DDR5 Smart Memory DIMMs in XD230 servers with 6th Gen Intel Xeon 6900P-series

Table 14. HPE DDR5 Smart Memory DIMM/MRDIMM population guidelines in XD230 with 6th Gen Intel Xeon 6900P-series with 12 DIMM slots per CPU

Intel Xeon 6900P-series (GNR-AP)		DIMM population Rank mixing is not allowed in 6th Gen Intel Xeon Intel Xeon 6900P-series											
GNR-AP (Intel default)	1 DIMM[1]							7					
GNR-AP (Intel default)	12 DIMMs	1	2	3	4	5	6	7	8	9	10	11	12

[1] Does not support MRDIMM. MRDIMM only supports with 12 DIMMs.

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 DDR5 Smart 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, 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 table shows homogeneous configuration and different rank DIMM mixed configuration.

Table 15. Memory speed table for Intel Xeon 6700P-series and Intel Xeon 6500P-series

	Registered DIMM (RDIMM)					
SKU description	**HPE 16 GB 1Rx8 PC5-6400B-R Smart Kit**	**HPE 32 GB 2Rx8 PC5-6400B-R Smart Kit**	**HPE 64 GB 2Rx4 PC5-6400B-R Smart Kit**	**HPE 96 GB 2Rx4 PC5-6400B-R Smart Kit**	**HPE 128 GB 2Rx4 PC5-6400B-R Smart Kit**	**HPE 256 GB 4Rx4 PC5-6400B-R 3DS Smart Kit**
DIMM capacity	16 GB	32 GB	64 GB	96 GB	128 GB	256 GB
DIMM type	RDIMM	RDIMM	RDIMM	RDIMM	RDIMM	3DS RDIMM
DRAM density	16 Gb	16 Gb	16 Gb	24 Gb	32 Gb	32 Gb
DIMM configuration	1Rx8	2Rx8	2Rx4	2Rx4	2Rx4	4Rx4
DIMM native speed (MT/s)	6400	6400	6400	6400	6400	6400
Memory speed (MT/s) for HPE ProLiant Compute Gen12 servers using Intel Xeon 6 processors with E-Core (aka SRF-SP)						
1 DIMM per channel	Not supported	up to 6400	up to 6400	up to 6400	up to 6400	up to 6400
2 DIMMs per channel	Not supported	Not supported	up to 5200	up to 5200	up to 5200	up to 5200
Memory speed (MT/s) for HPE ProLiant Compute Gen12 servers using Intel Xeon 6 processors with P-Core (aka GNR-SP)						
1 DIMM per channel	up to 6400	up to 6400	up to 6400	up to 6400	up to 6400	up to 6400
2 DIMMs per channel	Not supported	up to 5200	up to 5200	up to 5200	up to 5200	up to 5200
Memory speed (MT/s) for HPE ProLiant Compute Gen12 servers using Intel Xeon 6 processors with P-Core (aka GNR-AP)						
1 DIMM per channel	Not supported	up to 6400	up to 6400	Not supported	up to 6400	Not supported

Table 16. Mixed population guidelines for HPE DDR5 Smart Memory DIMMs with 6th Gen Intel Xeon 6700P-series and Intel Xeon 6500P-series CPU

		HPE DDR5 Smart Memory for Intel Xeon 6 processors with P-Core (aka GNR-SP)											
		P69726-B21		P69727-B21		P69728-B21		P69729-B21		P69730-B21		P69732-B21	
		16 GB 1Rx8		32 GB 2Rx8		64 GB 2Rx4		96 GB 2Rx4		128 GB 2Rx4		256 GB 4Rx4	
		6400 MT/s		6400 MT/s		6400 MT/s		6400 MT/s		6400 MT/s		6400 MT/s	
		RDIMM		RDIMM		RDIMM		RDIMM		RDIMM		3DS RDIMM	
DIMM P/N	**Description**	**Across channels**	**Within same channel**	**Across channels**	**Within same channel**	**Across channels**	**Within same channel**	**Across channels**	**Within same channel**	**Across channels**	**Within came channel**	**Across channels**	**Within same channel**
P69726-B21	HPE 16 GB 1Rx8 PC5-6400B-R Smart Kit	Yes	No[5]	Yes[4]	Yes[4]	No[3,4]	No[3]	No[2,3,4]	No[2,3]	No[2,3,4]	No[2,3]	No[1,2,3,4]	No[1,2,3]
P69727-B21	HPE 32 GB 2Rx8 PC5-6400B-R Smart Kit	Yes[4]	Yes[4]	Yes	Yes	No[3,4]	No[3]	No[3,4]	No[3]	No[2,3,4]	No[2,3]	No[1,2,3,4]	No[1,2,3]
P69728-B21	HPE 64 GB 2Rx4 PC5-6400B-R Smart Kit	No[3,4]	No[3]	No[3,4]	No[3]	Yes	Yes	No[2,3,4]	No[2,3]	No[2,3,4]	No[2,3]	No[1,2, 4]	No[1,2]
P69729-B21	HPE 96 GB 2Rx4 PC5-6400B-R Smart Kit	No[2,3,4]	No[2,3]	No[2,3,4]	No[2,3]	No[2,3,4]	No[2,3]	Yes	Yes	No[2,3,4]	No[2,3]	No[1,2, 4]	No[1,2]
P69730-B21	HPE 128 GB 2Rx4 PC5-6400B-R Smart Kit	No[2,3,4]	No[2,3]	No[2,3,4]	No[2,3]	No[2,3,4]	No[2,3]	No[2,3,4]	No[2,3]	Yes	Yes	No[1,4]	No[1]
P69732-B21	HPE 256 GB 4Rx4 PC5-6400B-R Smart Kit	No[1,2,3,4]	No[1,2,3]	No[1,2,3,4]	No[1,2,3]	No[1,2, 4]	No[1,2]	No[1,2, 4]	No[1,2]	No[1,4]	No[1]	Yes	Yes

[1] Do not mix DIMM module types. All DIMMs must be RDIMM or 3DS RDIMM module types, with same ECC configuration.

[2] Mixing DIMMs of different density (that is, 8 Gb, 16 Gb, 24 Gb, and 32 Gb DRAMs) is not supported.

[3] x4 DIMMS cannot be mixed with x8 DIMMs

[4]. Rank mixing on a channel is not allowed except when all DIMM slots on each channel are fully populated.

[5] Does not support 2DPC

[6] Does not support 1DPC

4Table 17. Mixed population guidelines for HPE DDR5 Smart Memory DIMMs with 6th Gen Intel Xeon 6700E-series CPU

		P69727-B21		P69728-B21		P69729-B21		P69730-B21		P69730-B21	
		32 GB 2Rx8		64 GB 2Rx4		96 GB 2Rx4		128 GB 2Rx4		256 GB 4Rx4	
		6400 MT/s		6400 MT/s		6400 MT/s		6400 MT/s		6400 MT/s	
		RDIMM		RDIMM		RDIMM		RDIMM		RDIMM	
DIMM P/N	**Description**	**Across channels**	**Within same channel**	**Across channels**	**Within same channel**	**Across channels**	**Within same channel**	**Across channels**	**Within same channel**	**Across channels**	**Within same channel**
P69727-B21	HPE 32 GB 2Rx8 PC5-6400B-R Smart Kit	Yes	No[5]	No[3,4]	No[3]	No[3,4]	No[3]	No[2,3,4]	No[2,3]	No[1,2,3,4]	No[1,2,3]
P69728-B21	HPE 64 GB 2Rx4 PC5-6400B-R Smart Kit	No[3,4]	No[3]	Yes	Yes	No[2,3,4]	No[2,3]	No[2,3,4]	No[2,3]	No[1,2,4]	No[1,2]
P69728-B21	HPE 96 GB 2Rx4 PC5-6400B-R Smart Kit	No[2,3,4]	No[2,3]	No[2,3,4]	No[2,3]	Yes	Yes	No[2,3,4]	No[2,3]	No[1,2,4]	No[1,2]
P69730-B21	HPE 128 GB 2Rx4 PC5-6400B-R Smart Kit	No[2,3,4]	No[2,3]	No[2,3,4]	No[2,3]	No[2,3,4]	No[2,3]	Yes	Yes	No[1,4]	No[1]
P69730-B21	HPE 256 GB 4Rx4 PC5-6400B-R Smart Kit	No[1,2,3,4]	No[1,2,3]	No[1,2,4]	No[1,2]	No[1,2,4]	No[1,2]	No[1,4]	No[1]	Yes	Yes

[1] Do not mix DIMM module types. All DIMMs must be RDIMM or 3DS RDIMM module types, with same ECC configuration.

[2] Mixing DIMMs of different density (that is, 8 Gb, 16 Gb, 24 Gb, and 32 Gb DRAMs) is not supported.

[3] x4 DIMMS cannot be mixed with x8 DIMMs

[4] Rank mixing on a channel is not allowed except when all DIMM slots on each channel are fully populated.

[5] Does not support 2DPC in Intel POR

Table 18. Mixed population guidelines for HPE DDR5 Smart Memory DIMMs with 6th Gen Intel Xeon 6900P-series CPU

		P69727-H21		P69728-H21		P69730-H21	
		32 GB 2Rx8		64 GB 2Rx4		128 GB 2Rx4	
		6400 MT/s		6400 MT/s		6400 MT/s	
		RDIMM		RDIMM		RDIMM	
DIMM P/N	**Description**	**Across channels**	**Within same channel**	**Across channels**	**Within same channel**	**Across channels**	**Within same channel**
P69727-H21	HPE 32 GB 2Rx8 PC5-6400B-R Smart Kit	Yes	Yes	No[2]	No[2]	No[1,2]	No[1,2]
P69728-H21	HPE 64 GB 2Rx4 PC5-6400B-R Smart Kit	No[2]	No[2]	Yes	Yes	No[1,2]	No[1,2]
P69730-H21	HPE 128 GB 2Rx4 PC5-6400B-R Smart Kit	No[1,2]	No[1,2]	No[1,2]	No[1,2]	Yes	Yes

[1] Mixing DIMMs of different density (that is, 8 Gb, 16 Gb, 24 Gb, and 32 Gb DRAMs) is not supported.

[2] x4 DIMMS cannot be mixed with x8 DIMMs

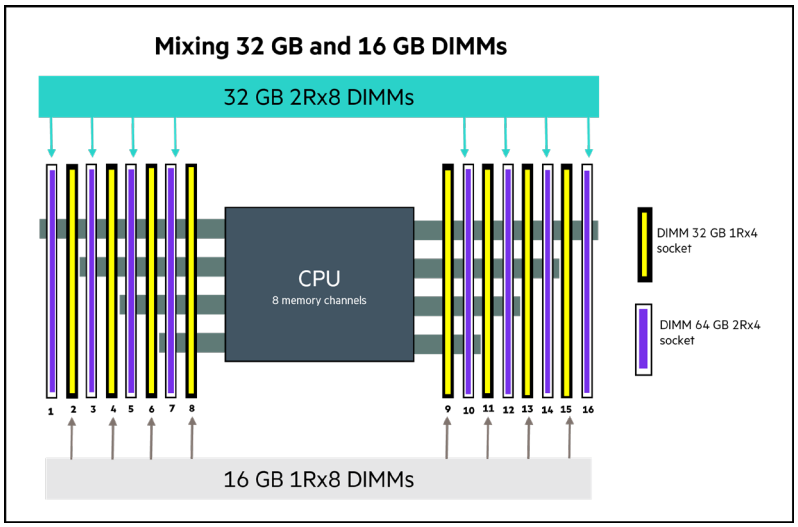

Figure 9. Mixing HPE DDR5 Smart Memory 32 GB 2Rx8 and 16 GB 1Rx8 mixed configuration

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