Server memory population rules for HPE ProLiant Gen11 and Gen12 servers with AMD EPYC 9005 series processors

Contents

Introduction

This paper provides an overview of HPE DDR5 Smart Memory and its use in HPE ProLiant servers using the AMD EPYC™ 9005 processor family. HPE ProLiant servers with AMD EPYC 9005 introduce HPE DDR5-6400 Smart Memory, which has faster data rates, lower latencies, and greater power efficiency than the memory used in previous generations of HPE ProLiant servers. HPE DDR5 Smart Memory also provides superior performance over third-party memory when used in HPE ProLiant 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 DDR5-6400 on an HPE ProLiant Gen11 and Gen12 with a 9005 processor.

Populating HPE DDR5 Smart Memory in HPE ProLiant Gen11 and Gen12 servers with AMD EPYC 9005 processors

The high-level memory system architecture for HPE ProLiant Gen11 and Gen12 servers using AMD EPYC 9005 processors is different from that of the previous HPE ProLiant servers. HPE ProLiant servers using AMD EPYC 9005 processors integrate an IOD chip, which includes 12 memory controllers to interface 12 memory channels per CPU and up to 24 DIMM slots in two-socket and Gen12 servers.

Population rules for HPE ProLiant Gen11 and Gen12 servers with AMD EPYC 9005 processors

HPE ProLiant Gen11 and Gen12 systems support a variety of flexible server memory configurations, enabling the system to be configured and run in any valid memory controller configuration. For optimal performance and functionality, you should follow the rules when populating HPE ProLiant servers with HPE DDR5 Smart Memory. Violating these rules may result in reduced memory capacity, performance, or error messages during boot. Table 1 summarizes the overall DIMM population rules for HPE ProLiant Gen11 and Gen12 servers.

Table 1. DIMM population rules for HPE ProLiant Gen11 and Gen12 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 two-processor system, then only half of the DIMM slots are available. If multiple CPUs are populated, split the DIMMs evenly across the CPUs and follow the corresponding CPU rule when populating DIMMs.
Performance	To help maximize performance in a majority of the potential applications, it is recommended to balance the total memory capacity across all installed processors. Follow Table 2, Table 3, and Table 4 to enable optimal interleaving. If the number of DIMMs does not spread evenly across the CPUs, populate as close to evenly as possible.
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 3DS DIMMs with non-3DS DIMMs in the same system. Do not mix x4 and x8 DRAM widths in the same system. Do not mix different Rank DRAM within a memory channel. Don't mix 16 Gb, 24 Gb, and 32 Gb DRAM width with each other, like mixing 24 Gb and 16 Gb or 16 Gb and 32 Gb DRAM widths in the same system; it's not allowed. Unbuffered DIMMs (UDIMMs) are not supported.
DIMM speed	The maximum memory speed is a function of the memory type, memory configuration, and processor model. The server will select the highest common speed among all the DIMMs present in the system.

There are several HPE ProLiant Gen11 and Gen12 servers with different EPYC series. Figures 1, 2, and 3 show the EPYC series on each HPE ProLiant DL Gen11 and Gen12 server series.

DIMM connector location

In general, memory population order follows the same logic for all HPE ProLiant servers using AMD EPYC 9005 processors—although physical arrangement may vary from server to server.

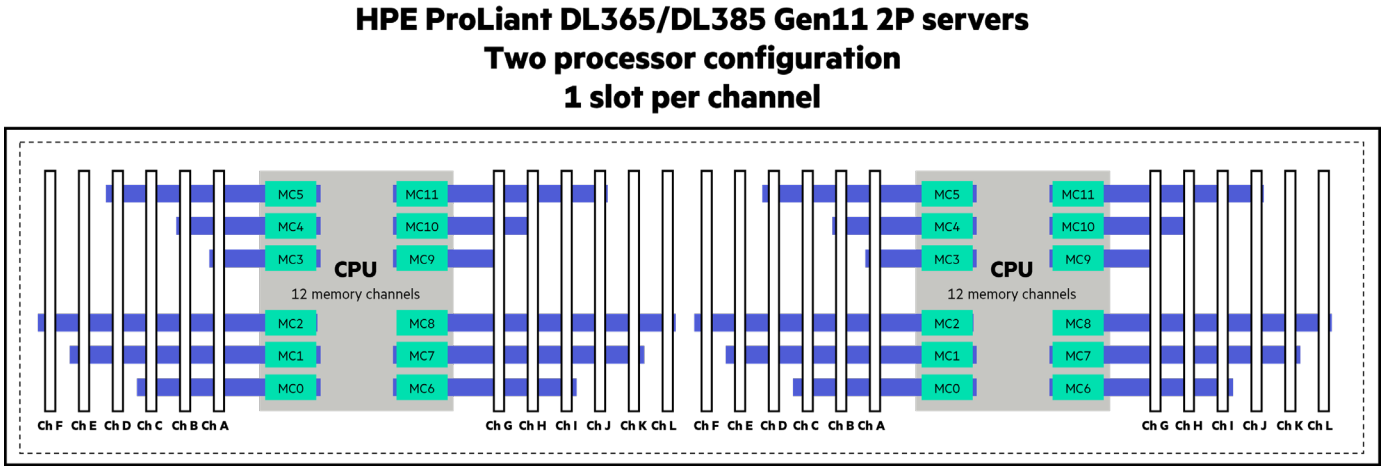

Figure 1. DIMM slot locations for 24-slot HPE ProLiant 2P Gen11 two-socket configuration

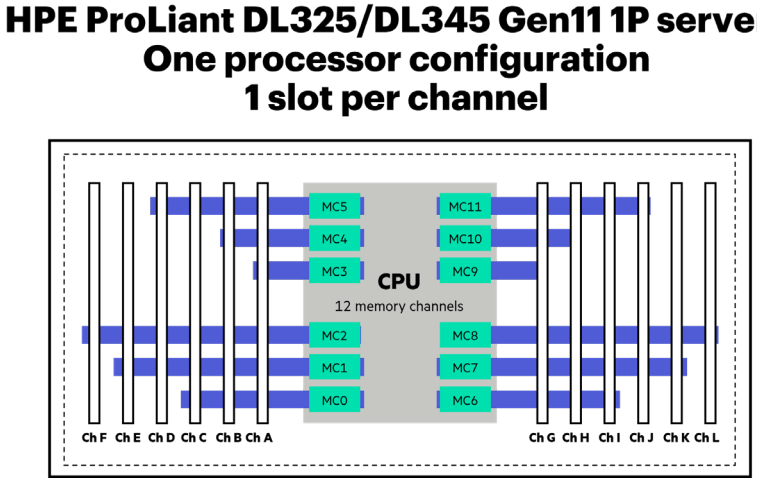

Figure 2. DIMM slot locations for 12-slot HPE ProLiant 1P Gen11 one-socket servers

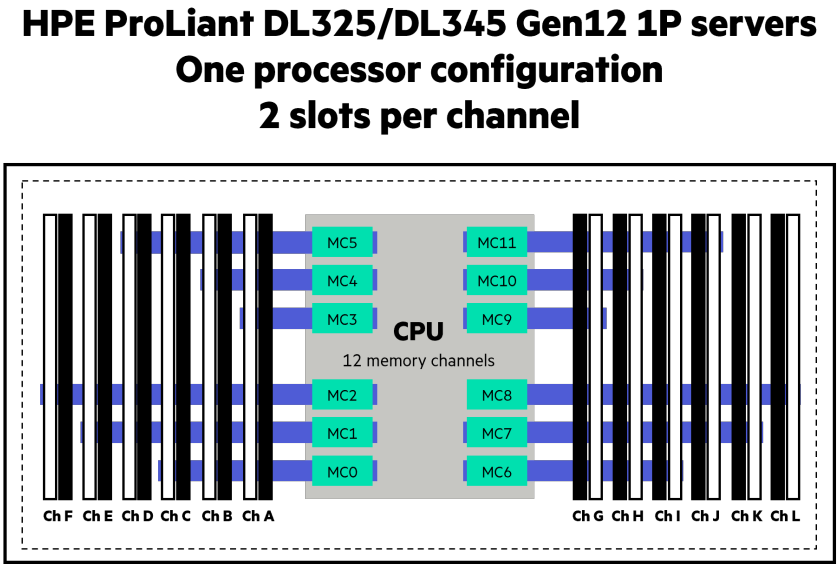

Figure 3. DIMM slot locations for 24-slot HPE ProLiant 1P Gen12 one-socket servers

DIMM population order

Tables 2, 3, and 4 show the DIMM population order for HPE ProLiant Gen11 and Gen12 servers. There are 12 and 24 DIMM slots available to be populated. For a given number of DIMMs, populate those DIMMs in the corresponding numbered DIMM slots on the particular row based on server model as shown in Tables 2, 3 and 4. The most optimal performance will be achieved if populating full DIMMs in 1DPC (One DIMM per Channel) conditions.

HPE Server Memory should be installed as indicated based on the total number of DIMMs being installed per CPU. For example, if two DIMMs are being installed per CPU on an HPE ProLiant DL series 2P, they should be located in white DIMM slots numbered 6 and 7. If six DIMMs are being used per CPU, they should be installed in DIMM slots 4, 5, 6, 7, 8, and 9.

Table 2. DIMM population order for HPE ProLiant DL 1P Gen11 server series with one processor installed (12 slots per processor)

HPE ProLiant DL325/DL345 Gen11 Server series—one-processor configuration homogeneous DIMMs population order

Number of DIMMs	Processor 1											
	L	K	J	I	H	G	A	B	C	D	E	F
1							6					
2						7	6					
4				9		7	6		4			
6				9	8	7	6	5	4			
8		11		9	8	7	6	5	4		2	
10		11	10	9	8	7	6	5	4	3	2	
12	12	11	10	9	8	7	6	5	4	3	2	1

Table 3. DIMM population order for HPE ProLiant DL 2P Gen11 server series with two processors installed (12 slots per processor)

HPE ProLiant DL365/DL385 Gen11 Server series—two-processor configuration homogeneous DIMMs population order

Number of DIMMs	Processor 2												Processor 1											
	F	E	D	C	B	A	G	H	I	J	K	L	F	E	D	C	B	A	G	H	I	J	K	L
2						7												7						
4						7	6											7	6					
8				9		7	6		4							9		7	6		4			
12				9	8	7	6	5	4							9	8	7	6	5	4			
16		11		9	8	7	6	5	4		2			11		9	8	7	6	5	4		2	
20		11	10	9	8	7	6	5	4	3	2			11	10	9	8	7	6	5	4	3	2	
24	12	11	10	9	8	7	6	5	4	3	2	1	12	11	10	9	8	7	6	5	4	3	2	1

Table 4. DIMM population order for HPE ProLiant DL 1P Gen12 server series with one processor installed (24 slots per processor)

HPE ProLiant DL325/DL345 Gen12 Server series—one-processor configuration homogeneous DIMMs population order

Number of DIMMs	Processor 1																							
	F		E		D		C		B		A		G		H		I		J		K		L	
1											11													
2											11		14											
4							7				11		14				18							
6							7		9		11		14		16		18							
8			3				7		9		11		14		16		18				22			
10			3		5		7		9		11		14		16		18		20		22			
12	1		3		5		7		9		11		14		16		18		20		22		24	
16			3	4			7	8	9	10	11	12	13	14	15	16	17	18			21	22		
20			3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
24	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

NUMA nodes

HPE ProLiant servers with EPYC 9005 processors may support the option of configuring the non-uniform memory access (NUMA) nodes per socket (NPS) you can have on the processor. This will depend on the exact model number of the processor. This setting will be available in the RBSU->Memory Options->NUMA memory domains per socket (1, 2, 4). For most workloads, one NUMA node will give the most optimal performance and is the default.

Nodes per socket (1) NPS1
This setting will assign one NUMA node per processor.

This setting will be the default, and in general, will give the best performance for most workloads.

Nodes per socket (2) NPS2
This setting will assign two NUMA nodes per processor.

Nodes per socket (4) NPS4
This setting will assign four NUMA nodes per processor.

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 one repeatedly. Hewlett Packard Enterprise encourages enabling interleaving for the most optimal and deterministic performance. 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.

Table 5 shows interleaving with NUMA (default NPS1, NPS2, NPS4) per population on HPE ProLiant DL 1P Gen11 and Gen12 1DPC (One DIMM per Channel) server. Table 6 shows interleaving with NUMA (default NPS1, NPS2, NPS4) per population on HPE ProLiant DL 2P Gen11 and Gen12 2DPC (Two DIMM per Channel) server.

Table 5. Interleaving with NUMA (default NPS1, NPS2, NPS4) per population for HPE ProLiant DL 1P Gen11 and Gen12 1DPC server series with one processor installed (12 DIMMs per processor)

Number of DIMM(s)	Interleaving with NUMA (default NPS1, NPS2, NPS4)
1	NPS1 (No interleaving)
2	NPS1 (2-way interleaving), NPS2 (No interleaving)
4	NPS1 (4-way interleaving), NPS2 (2-way interleaving), NPS4 (No interleaving)
6	NPS1 (6-way interleaving), NPS2 (3-way interleaving)
8	NPS1 (8-way interleaving), NPS2 (4-way interleaving), NPS4 (2-way interleaving)
10	NPS1 (10-way interleaving), NPS2 (5-way interleaving)
12	NPS1 (12-way interleaving), NPS2 (6-way interleaving), NPS4 (3-way interleaving)

Table 6. Interleaving with NUMA (default NPS1, NPS2, NPS4) per population for HPE ProLiant DL 2P Gen11 server series with two processors installed (12 slots per processor) and Gen12 2DPC server series (24 slots per processor).

Number of DIMM(s)	Interleaving with NUMA (default NPS1, NPS2, NPS4)
2*	NPS1 (No interleaving)
4*	NPS1 (2-way interleaving), NPS2 (No interleaving)
8*	NPS1 (4-way interleaving), NPS2 (2-way interleaving), NPS4 (No interleaving)
12*	NPS1 (6-way interleaving), NPS2 (3-way interleaving)
16	NPS1 (8-way interleaving), NPS2 (4-way interleaving), NPS4 (2-way interleaving)
20	NPS1 (10-way interleaving), NPS2 (5-way interleaving)
24	NPS1 (12-way interleaving), NPS2 (6-way interleaving), NPS4 (3-way interleaving)

* Those DIMM numbers are not supported on HPE ProLiant DL 1P Gen12 2DPC condition.

Disabling memory interleaving

This option is available from the Advanced Power Management menu in the RBSU Memory Options menu if needed. HPE defaults to having interleaving enabled, as this will provide the best performance for most workloads. Disabling memory interleaving may decrease overall memory performance.

Mixed DIMM configurations

3DS RDIMM and RDIMM should not be mixed (as per specification), as timings for these are significantly different; hence, the operation is reduced to the slowest common timing.

No mixing of x4 and x8 memory, as it will cause slower memory and system operation.

No mixing Ranks within a memory channel, it's not supported in system.

No mixing 16 Gb, 24 Gb, and 32 Gb DRAM, as it will cause slower memory and system operation.

On HPE servers based on AMD processors, mixing of DIMM capacities is supported as long as mixing rules are followed, and the memory channels have identical memory capacities to get the most performance.

Table 7. Impact of unbalanced configurations on memory throughput

	Number of interleaved channels per processor	Throughput compared to peak
DIMMs	**Large group**	**Weighted channel performance in %**
1	1	8.3%
2	2	16.6%
4	4	33.3%
6	6	50%
8	8	66.6%
10	10	83.3%
12	12	100%

Table 8. Memory speed table for HPE ProLiant Gen11 and Gen12 300 series platforms

	DDR5 RDIMMs					
HPE SKU P/N	**P64984-B21**	**P64985-B21**	**P64986-B21**	**P64987-B21**	**P64988-B21**	**P73446-B21**
SKU description	HPE 16GB 1Rx8 PC5-6400B-R Smart Kit	HPE 32GB 2Rx8 PC5-6400B-R Smart Kit	HPE 64GB 2Rx4 PC5-6400B-R Smart Kit	HPE 96GB 2Rx4 PC5-6400B-R Smart Kit	HPE 128GB 2Rx4 PC5-6400B-R Smart Kit	HPE 256GB 4Rx4 PC5-6400B-R 3DS Smart Kit
DIMM rank	Single rank (1R)	Dual rank (2R)	Dual rank (2R)	Dual rank (2R)	Dual rank (2R)	Quad rank (4R)
DIMM capacity	16 GB	32 GB	64 GB	96 GB	128 GB	256 GB
Voltage	1.1V	1.1V	1.1V	1.1V	1.1V	1.1V
DRAM depth (bit)	2G	2G	4G	6G	8G	8G
DRAM width (bit)	x8	x8	x4	x4	x4	x4
DRAM density	16 Gb	16 Gb	16 Gb	24 Gb	32 Gb	32 Gb
CAS latency	52-52-52	52-52-52	52-52-52	52-52-52	52-52-52	60-52-52
DIMM native speed (MT/s)	6400	6400	6400	6400	6400	6400
DIMM speed (MT/s)						
Gen11 server	Up to 6400	Up to 6400	Up to 6400	Up to 6400	Up to 6400	Up to 6400
Gen12 server (DIMM number 1~12)	Up to 5200	Up to 5200	Up to 5200	Up to 5200	Up to 5200	Up to 5200
Gen12 server (DIMM number 16~24)	Up to 4400	Up to 4000	Up to 4000	Up to 4000	Up to 4000	Up to 4000
Slots that can be populated						
12 slot servers	12	12	12	12	12	12
24 slot servers	24	24	24	24	24	24
Maximum capacity (Gb)*						
12 slot servers	192	384	768	1152	1536	3072
24 slot server	384	768	1536	2304	3072	6144

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

Table 9. Mixed population guidelines for HPE DDR5 Smart Memory DIMMs

		P64984-B21	P64985-B21	P64986-B21	P64987-B21	P64988-B21	P73446-B21
		16 GB 1Rx8	32 GB 2Rx8	64 GB 2Rx4	96 GB 2Rx4	128 GB 2Rx4	256 GB 4Rx4 2H3DS
		16 Gbit	16 Gbit	16 Gbit	24 Gbit	32 Gbit	32 Gbit
		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
P64984-B21	HPE 16GB 1Rx8 PC5-6400B-R Smart Kit	Yes	Conditionally Yes[1, 5]	No[2]	No[2]	No[2]	No[3]
P64985-B21	HPE 32GB 2RX8 PC5-6400B-R Smart Kit	Conditionally Yes[1, 5]	Yes	No[2]	No[2]	No[2]	No[3]
P64986-B21	HPE 64GB 2RX4 PC5-6400B-R Smart Kit	No[2]	No[2]	Yes	No[4]	No[4]	No[3]
P64987-B21	HPE 96GB 2RX4 PC5-6400B-R Smart Kit	No[2]	No[2]	No[4]	Yes	No[4]	No[3]
P64988-B21	HPE 128GB 2RX4 PC5-6400B-R Smart Kit	No[2]	No[2]	No[4]	No[4]	Yes	No[3]
P73446-B21	HPE 256GB 4RX4 PC5-6400B-R 3DS Smart Kit	No[3]	No[3]	No[3]	No[3]	No[3]	Yes

[1] Mixing DIMM capacities within a system is supported as long as they are same DIMM type (same x4 or same x8).
[2] x4 cannot be mixed with x8 within the same system.
[3] Do not mix DIMM module types within a system. All must be RDIMM or RDIMM 3DS module types, with same ECC configuration.
[4] Mixing DIMMs of different DRAM density (that is, 16 Gb, 24 Gb, and 32 Gb DRAMs) within a system is not supported.
[5] Mixing DIMMs of different Rank (that is, 1 Rank, 2 Rank, and 4 Rank DRAMs) within a memory channel is not supported.

Conclusion

HPE DDR5 Smart Memory for HPE ProLiant Gen11 and Gen12 AMD-based servers offers greater memory performance than ever before. The HPE DDR5-6400 Smart Memory for HPE ProLiant Gen11 and Gen12 servers that use the AMD EPYC 9005 processor delivers increased memory throughput and lower latencies. HPE DDR5 Smart Memory also provides extended performance in many configurations by operating at higher speeds compared to third-party memory.

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