



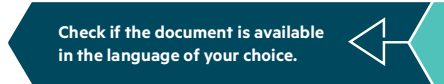
SERVER MEMORY POPULATION RULES FOR HPE PROLIANT GEN10 AND GEN10 PLUS SERVERS WITH AMD PROCESSORS



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INTRODUCTION

This paper provides an overview of HPE DDR4 SmartMemory and its use in HPE ProLiant servers using the AMD EPYC™ 7002 processor family. HPE ProLiant servers with AMD EPYC 7002 introduce HPE DDR4-2933 and HPE DDR4-3200 memory, which has faster data rates, lower latencies, and greater power efficiency than the memory used in previous generations of HPE ProLiant servers. HPE SmartMemory also provides superior performance over third-party memory when used in HPE ProLiant servers. HPE Standard Memory offers the best combination of pricing, quality, reliability, and compatibility for [HPE ProLiant servers](#)—designed to help your business achieve powerful results with right-sized, affordable solutions.

In addition to describing these improvements, this white paper reviews the rules, best practices, and optimization strategies that should be used when installing HPE DDR4-2933 on a HPE ProLiant Gen10 or HPE DDR4-3200 memory on HPE ProLiant Gen10 Plus servers using AMD EPYC 7002 processors.

POPULATING HPE DDR4 MEMORY IN HPE PROLIANT GEN10 AND HPE PROLIANT GEN10 PLUS SERVERS WITH AMD EPYC 7002 PROCESSORS

The high-level memory system architecture for HPE ProLiant Gen10 servers using AMD EPYC 7002 processors is different from that of the previous HPE ProLiant Gen10 servers. [HPE ProLiant Gen10 servers](#) using AMD EPYC 7002 processors integrates an IOD chip which includes 8 memory controllers to interface 8 memory channels per CPU and up to 32 DIMM slots in two-socket servers.

Population rules for HPE ProLiant Gen10 and HPE ProLiant Gen10 Plus servers with AMD EPYC 7002 processors

HPE ProLiant Gen10 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 DDR4 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 Gen10 servers.

TABLE 1. DIMM population rules for HPE ProLiant Gen10 servers

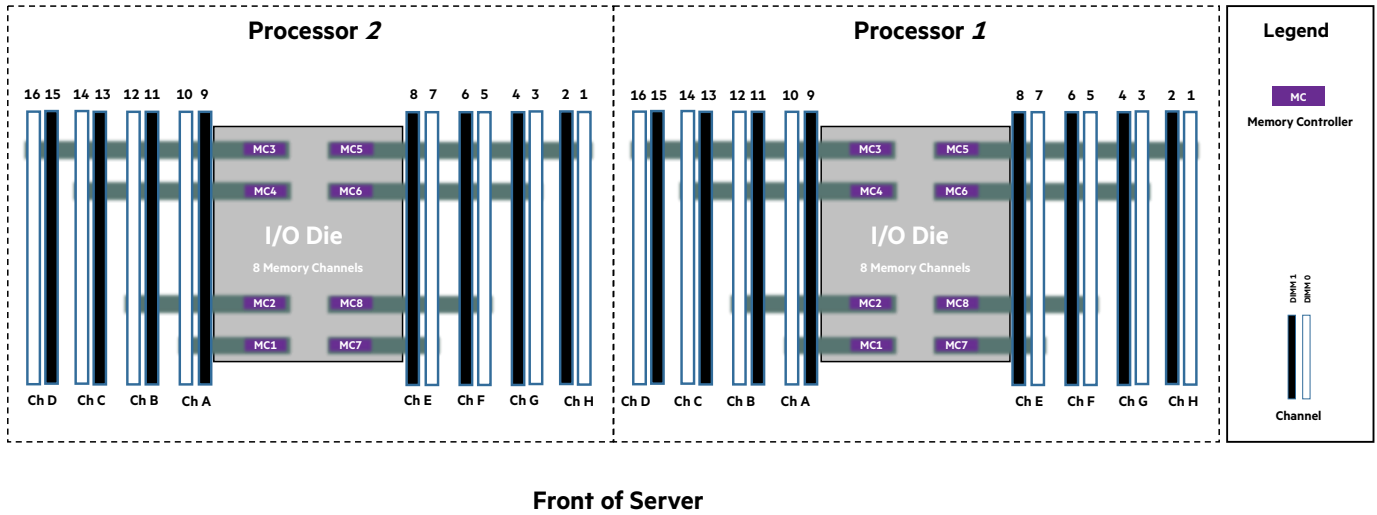
Category	Population guidelines
Processors and DIMM slots	<p>Install DIMMs only if the corresponding processor is installed. If only one processor is installed in a two-processor system, only half of the DIMM slots are available.</p> <p>If a memory channel consists of more than one DIMM slot, the white DIMM slot will be 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.</p> <p>When mixing DIMMs of different ranks on the same channel, place the DIMMs with the heaviest electrical load (highest number of ranks) in the white DIMM slot. Within a given channel, populate DIMMs from the heaviest electrical load (dual rank) to the lightest load (single rank).</p> <p>If multiple CPUs are populated, split the DIMMs evenly across the CPUs and follow the corresponding CPU rule when populating DIMMs.</p>
Performance	<p>To maximize performance in a majority of the potential applications, it is recommended to balance the total memory capacity across all installed processors, channel pairs (A/B, C/D, E/F, and G/H). Load the channels similarly whenever possible to enable optimal interleaving. Populate all available channels first before installing two DIMM's in a channel. If the number of DIMMs does not spread evenly across the CPUs, populate as close to evenly as possible. Refer Figure 4.</p>
DIMM types and capacities	<p>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.</p> <p>Do not mix RDIMMs and LRDIMMs in the same system. Do not mix 3DS DIMM's with non-3DS DIMMs in the same system. Do not mix x4 and x8 DRAM widths in the same system.</p> <p>Unbuffered DIMMs (UDIMMs) are not supported.</p>
DIMM speed	<p>The maximum memory speed is a function of the memory type, memory configuration, and processor model.</p> <p>The server will select the highest common speed among all of the DIMMs present in the system.</p>



DIMM connector location

In general, memory population order follows the same logic for all ProLiant servers using AMD EPYC 7002 processors—although physical arrangement may vary from server to server.

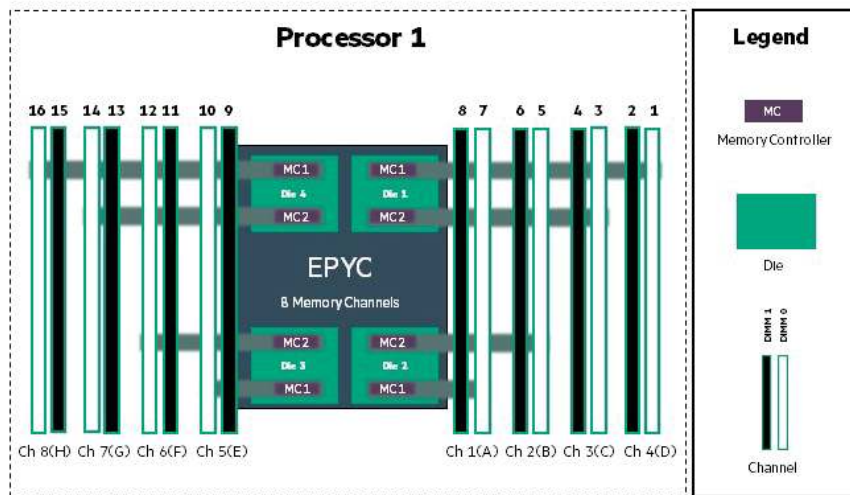
HPE ProLiant DL385 Server – 2P Server 2 slots per channel



Front of Server

FIGURE 1. DIMM slot locations for 32-slot HPE ProLiant DL385 Gen10 two-socket servers. The first DIMM slot for each channel on each processor are the white DIMM slots.

HPE ProLiant DL325 Gen10 Server 2 slots per channel



Front of Server

FIGURE 2. DIMM slot locations for 16-slot HPE ProLiant DL325 Gen10 one-socket servers. The first DIMM slot for each channel on the processor are the white DIMM slots.



DIMM population order

Figures 3 and 4 shows the DIMM population order for HPE ProLiant Gen10 and ProLiant Gen10 Plus servers with one AMD EPYC processor installed. There are 16 DIMM slots available to be populated. For a given number of DIMMs, populate those DIMMs in the corresponding numbered DIMM slot(s) on the particular row based on server model as shown in Figures 3, 4, and 5. As shown in Figures 3, 4, and 5, the most optimal performance will be achieved if populating 4, 8, and 16 shown in green. If populating only 4 DIMM's, it is recommended to use a processor with 32 or less cores. This is to prevent the memory bus to be heavily saturated by the greater amount of cores, which will impact performance.

[HPE Server Memory](#) should be installed as indicated based upon the total number of DIMMs being installed per CPU. For example, if two DIMMs are being installed per CPU on a DL385, they should be located in white DIMM slots numbered 16 and 14. If six DIMMs are being used per CPU, they should be installed in DIMM slots 16, 14, 12, 10, 3, and 1.

HPE ProLiant DL385 Gen10 One Processor Configuration Homogenous DIMM(s) Population Order																
Number of DIMM(s) to populate	Processor 1															
	CH D	CH C	CH B	CH A	CH E	CH F	CH G	CH H								
1			14													
2	16		14													
3	16		14										3			
4*	16		14										3		1	
5	16		14		12								3		1	
6	16		14		12		10						3		1	
7	16		14		12		10				5		3		1	
8	16		14		12		10			7	5		3		1	
9	16		14	13	12		10			7	5		3		1	
10	16	15	14	13	12		10			7	5		3		1	
11	16	15	14	13	12		10			7	5	4	3		1	
12	16	15	14	13	12		10			7	5	4	3	2	1	
13	16	15	14	13	12	11	10			7	5	4	3	2	1	
14	16	15	14	13	12	11	10	9		7	5	4	3	2	1	
15	16	15	14	13	12	11	10	9		7	6	5	4	3	2	1
16	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

*Recommended only for 32 core or less processors.

FIGURE 3. DIMM population order for HPE ProLiant DL385 servers with one processor installed (16 slots per processor).



HPE ProLiant DL325 Gen10 One Processor Configuration Homogenous DIMM(s) Population Order																
Number of DIMM(s) to populate	Processor 1															
	CH H	CH G	CH F	CH E	CH A	CH B	CH C	CH D								
1														14		
2														14	16	
3			3											14	16	
4*	1		3											14	16	
5	1		3								12			14	16	
6	1		3						10		12			14	16	
7	1		3		5				10		12			14	16	
8	1		3		5		7		10		12			14	16	
9	1		3		5		7		10		12	13	14		16	
10	1		3		5		7		10		12	13	14	15	16	
11	1		3	4	5		7		10		12	13	14	15	16	
12	1	2	3	4	5		7		10		12	13	14	15	16	
13	1	2	3	4	5		7		10	11	12	13	14	15	16	
14	1	2	3	4	5		7		9	10	11	12	13	14	15	16
15	1	2	3	4	5	6	7		9	10	11	12	13	14	15	16
16	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

*Recommended only for 32 core or less processors.

FIGURE 4. DIMM population order for HPE ProLiant DL325 servers with one processor installed (16 slots per processor).



Figure 5 shows the DIMM population order for HPE ProLiant DL385 Gen10 servers with two SOC installed. There are 32 DIMM slots available to be populated—16 DIMM slots per SOC. For a given number of DIMMs, populate those DIMMs in the corresponding numbered DIMM slot(s) on that row as shown in Figure 5.

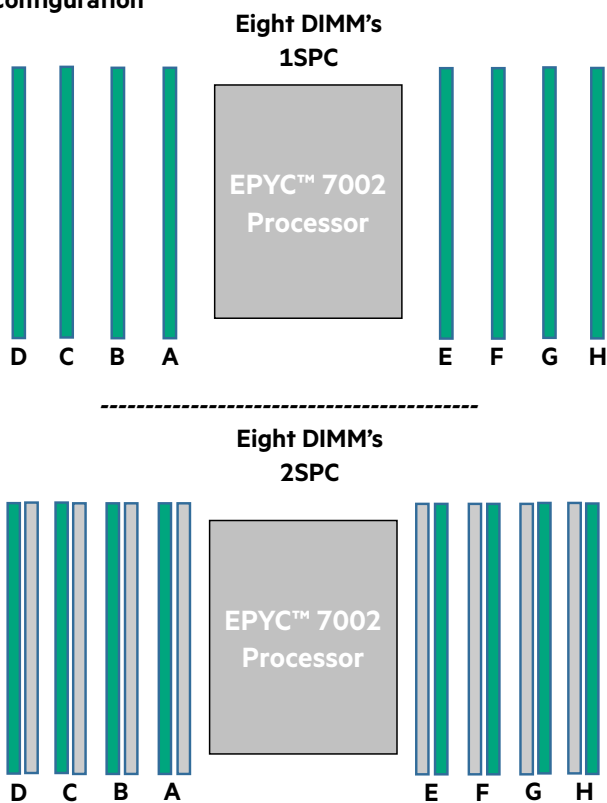
HPE ProLiant DL385 Gen10 2 Processor Configuration																
Homegenous DIMM(s) population order																
Number of DIMM(s) to populate	Processor 2								Processor 1							
	CH D	CH C	CH B	CH A	CH E	CH F	CH G	CH H	CH D	CH C	CH B	CH A	CH E	CH F	CH G	CH H
1																
2		14														
3		14														
4	16	14														
5	16	14														
6	16	14					3								3	
7	16	14					3								3	1
8*	16	14					3	1							3	1
9	16	14					3	1				12			3	1
10	16	14	12				3	1				12			3	1
11	16	14	12				3	1				12	10		3	1
12	16	14	12	10			3	1				12	10		3	1
13	16	14	12	10			3	1				12	10		5	3
14	16	14	12	10			5	3	1			12	10		5	3
15	16	14	12	10			5	3	1			12	10		7	5
16	16	14	12	10			7	5	3	1		12	10		7	5
17	16	14	12	10			7	5	3	1		14	13	12	10	
18	16	14	13	12	10		7	5	3	1		16	14	13	12	10
19	16	14	13	12	10		7	5	3	1		16	15	14	13	12
20	16	15	14	13	12	10		7	5	3	1	16	15	14	13	12
21	16	15	14	13	12	10		7	5	3	1	16	15	14	13	12
22	16	15	14	13	12	10		7	5	4	3	1	16	15	14	13
23	16	15	14	13	12	10		7	5	4	3	1	16	15	14	13
24	16	15	14	13	12	10		7	5	4	3	2	1	16	15	14
25	16	15	14	13	12	10		7	5	4	3	2	1	16	15	14
26	16	15	14	13	12	11	10		7	5	4	3	2	1	16	15
27	16	15	14	13	12	11	10		7	5	4	3	2	1	16	15
28	16	15	14	13	12	11	10	9		7	5	4	3	2	1	16
29	16	15	14	13	12	11	10	9		7	5	4	3	2	1	16
30	16	15	14	13	12	11	10	9		7	6	5	4	3	2	1
31	16	15	14	13	12	11	10	9		7	6	5	4	3	2	1
32	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

*Recommended only for 32 core or less processors.

FIGURE 5. DIMM population order for HPE ProLiant DL385 Gen10 servers with two processors installed (16 slots per processor).



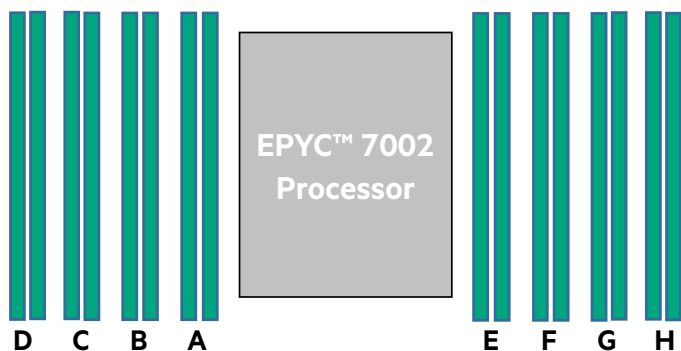
Homogenous Configuration



Capacities Supported Gen10 Plus:	Capacities Supported Gen10:
64 GB	64 GB
128 GB	128 GB
256 GB	256 GB
512 GB	512 GB
1024 GB	1024 GB
2048 GB	

FIGURE 6. Supported capacities on Gen10 and Gen10 Plus using the recommended populations with 8 DIMMs Installed. Homogenous Config.

**Sixteen DIMM's
2SPC**



Capacities Supported Gen10 Plus:	Capacities Supported Gen10:
128 GB	128 GB
256 GB	256 GB
512 GB	512 GB
1024 GB	1024 GB
2048 GB	2048 GB
4096 GB	

FIGURE 7. Supported capacities on Gen10 and Gen10 Plus using the recommended populations with 16 DIMMs Installed. Homogenous Config. For additional homogenous configurations based on capacity see [additional heterogeneous](#) section.



Heterogenous Configuration

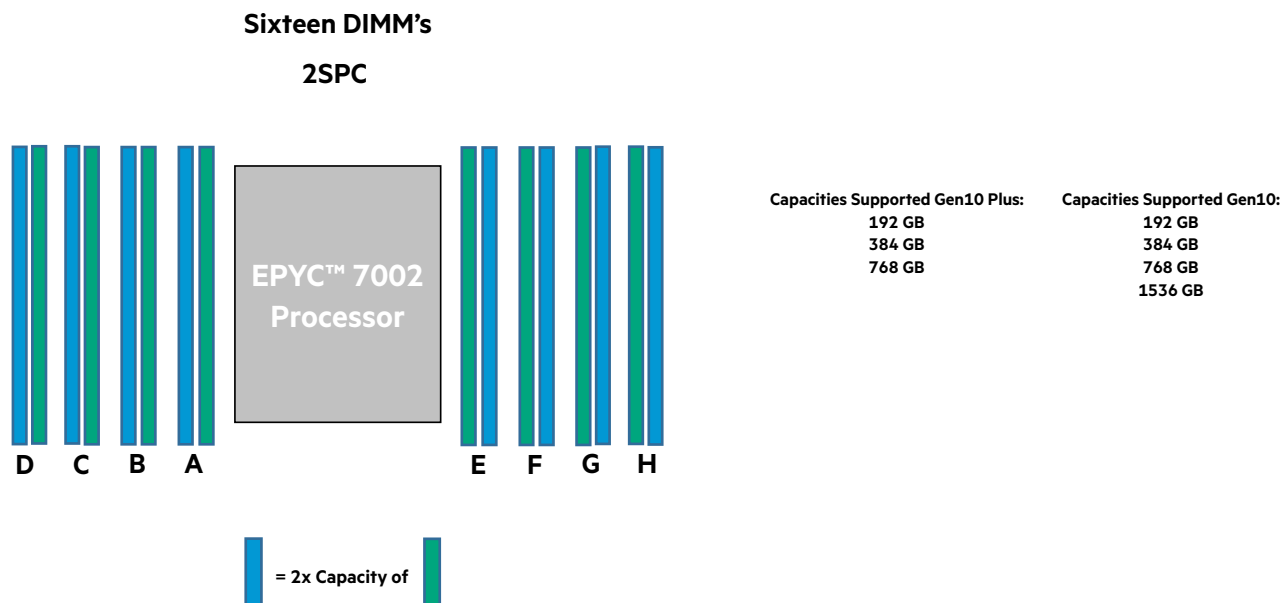


FIGURE 8. Supported capacities on Gen10 and Gen10 Plus using the recommended populations with 16 DIMMs Installed. Heterogeneous Config. For additional heterogeneous configurations based on capacity see [additional heterogeneous](#) section.

NUMA NODES

HPE ProLiant servers with EPYC 7002 processors may support the option of configuring the NUMA (Non-Uniform Memory Access) NPS (Nodes Per Socket) you can have on the processor. This will depend on the exact model number of the processor. Please refer to see a complete list of the available NPS settings the processor supports. 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)

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.

Supports: 8-Way, 4-Way, and 2-Way interleaving modes depending on DIMM population.

Nodes Per Socket (2)

This setting will assign two NUMA nodes per processor.

Supports: 4-Way, and 2-Way interleaving modes depending on DIMM population.

Nodes Per Socket (4)

This setting will assign four NUMA nodes per processor.

Supports: 2-Way interleaving mode depending on DIMM population.



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. HPE 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.

Memory interleaving options include:

8-Way interleaving

When configured correctly, sequential reads will be interleaved across all memory channels (A/B/C/D/E/F/G/H). Channel bandwidth will be accumulated across the interleaved channels. This is the optimal setting for NPS(1) configuration.

Requirements: All channels must be populated per processor. Each channel must have the same capacity. i.e., Channel(A): 2x 32GB DIMM's = 64GB, Channel(B): 1x 64GB DIMM = 64GB, Channel(C): 2x 32GB DIMM's = 64GB, etc.

Can only be used with NPS(1) NUMA Node option.

4-Way interleaving

When configured correctly, sequential reads will be interleaved across four memory channels; Channels (C/D/G/H) or Channels (A/B/E/F). Channel bandwidth will be accumulated across the interleaved channels. This is the optimal setting for NPS(2) configuration.

Requirements: Channels (C/D/G/H) and/or Channels (A/B/E/F) must be populated per processor. Each channel of each group of four must have the same capacity. i.e., Channel(C): 2x 32GB DIMM's = 64GB, Channel(D): 1x 64GB DIMM = 64GB, Channel(G): 2x 32GB DIMM's = 64GB, Channel(H): 1x 64GB DIMM's = 64GB.

Can be used with NPS(1) or NPS(2) NUMA Node options.

2-Way interleaving

When configured correctly, sequential reads will be interleaved across channel pairs; Channels (C/D), (G/H), (A/B), or (E/F). Channel bandwidth will be accumulated across the interleaved channels. This is the only interleaving mode for a NPS(4) configuration.

Requirements: Channel Pairs (C/D), (G/H), (A/B), and/or (E/F) must be populated per processor. Each channel of each channel pair must have the same capacity. i.e., Channel(A): 2x 8GB DIMM's = 16GB, Channel(B): 1x 16GB DIMM = 16GB.

Can be used with NPS(1), NPS(2), or NPS(4) NUMA Node options.

Note

When interleaving is enabled, the system will automatically attempt to do an 8-Way Interleave first followed by 4-Way, and 2-Way depending on the memory population and NPS selected.

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 the overall memory performance.

Mixed DIMM configurations

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

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

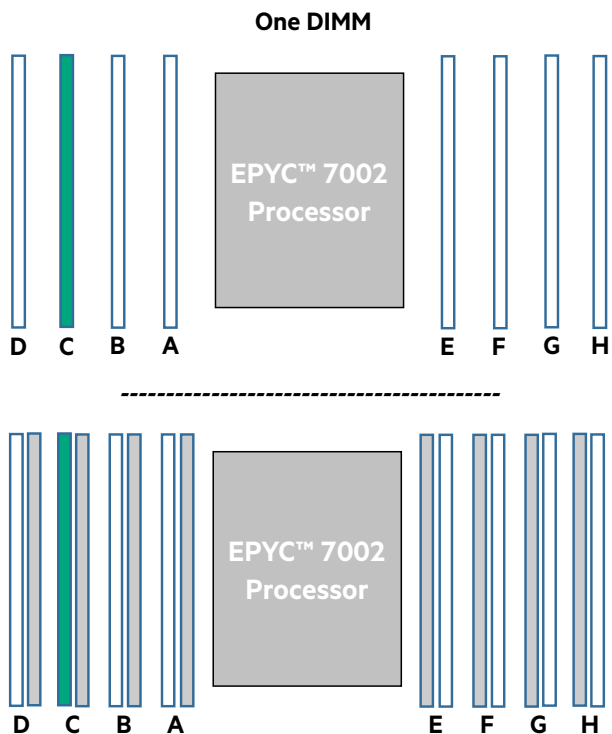
On HPE servers based on AMD processors, mixing of DIMM capacities is supported as long as mixing rules are followed and the memory channels have identical memory capacities to get the most performance. See [Additional Heterogeneous Configurations](#).



CONCLUSION

HPE SmartMemory for HPE ProLiant Gen10 AMD-based servers offers greater memory performance than ever before. The HPE DDR4-2933 and DDR4-3200 SmartMemory for HPE ProLiant Gen10 servers that use the AMD EPYC 7002 Processor delivers increased memory throughput and lower latencies. HPE SmartMemory also provides extended performance in many configurations by operating at higher speeds compared to third-party memory.

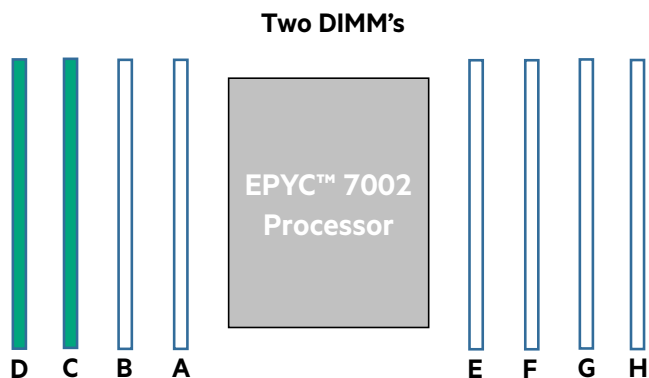
Additional Homogenous Configurations



Capacities Supported Gen10 Plus:
 8 GB
 16 GB
 32 GB
 64 GB
 128 GB
 256 GB

Capacities Supported Gen10:
 8 GB
 16 GB
 32 GB
 64 GB
 128 GB



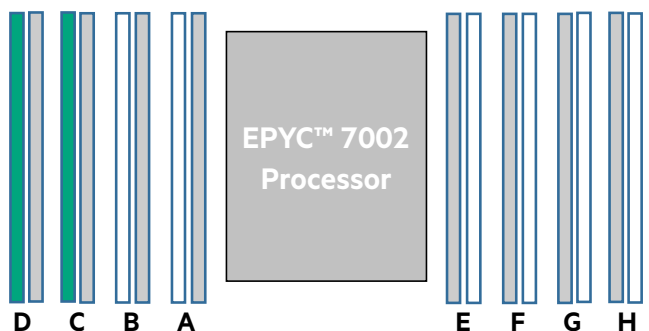


Capacities Supported Gen10 Plus:

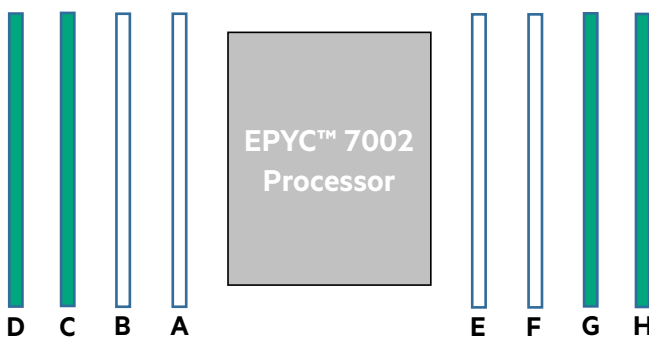
- 16 GB
- 32 GB
- 64 GB
- 128 GB
- 256 GB
- 512 GB

Capacities Supported Gen10:

- 16 GB
- 32 GB
- 64 GB
- 128 GB
- 256 GB



Four DIMM's

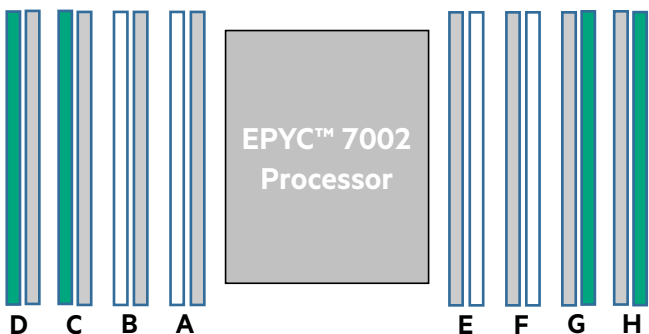


Capacities Supported Gen10 Plus:

- 32 GB
- 64 GB
- 128 GB
- 256 GB
- 512 GB
- 1024 GB

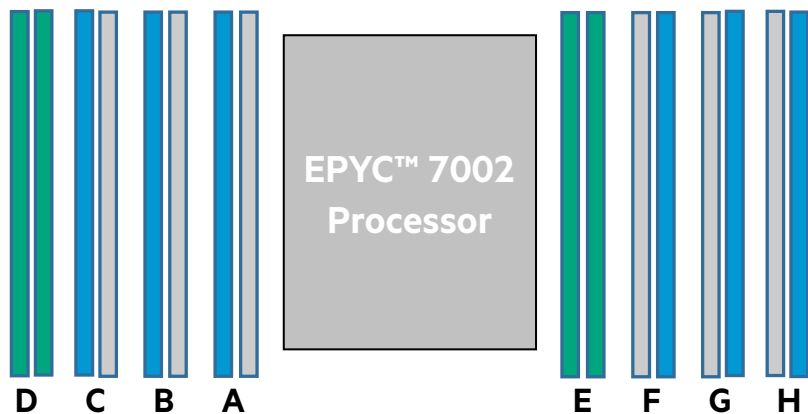
Capacities Supported Gen10:

- 32 GB
- 64 GB
- 128 GB
- 256 GB
- 512 GB



Additional Heterogenous Configurations

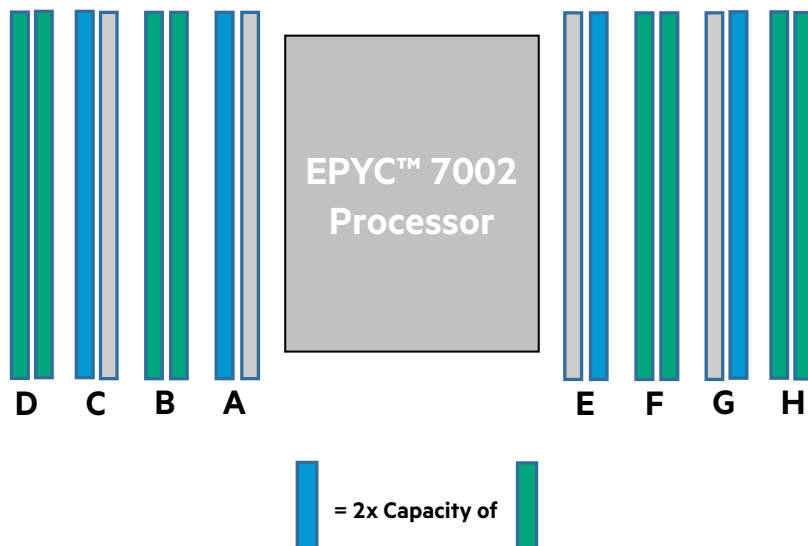
Ten DIMM's



Capacities Supported Gen10 Plus:
128GB
256GB
512GB

Capacities Supported Gen10:
128GB
256GB
512GB
1024GB

Twelve DIMM's



Capacities Supported Gen10 Plus:
128GB
256GB
512GB

Capacities Supported Gen10:
128GB
256GB
512GB
1024GB



Resources and additional links

General

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Memory

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[HPE Memory Configurator](#)

[HPE Server Memory whiteboard video](#)

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