Flash Memory Summit

Economy, Geopolitics to Dominate 2023 DRAM Market Game Theory

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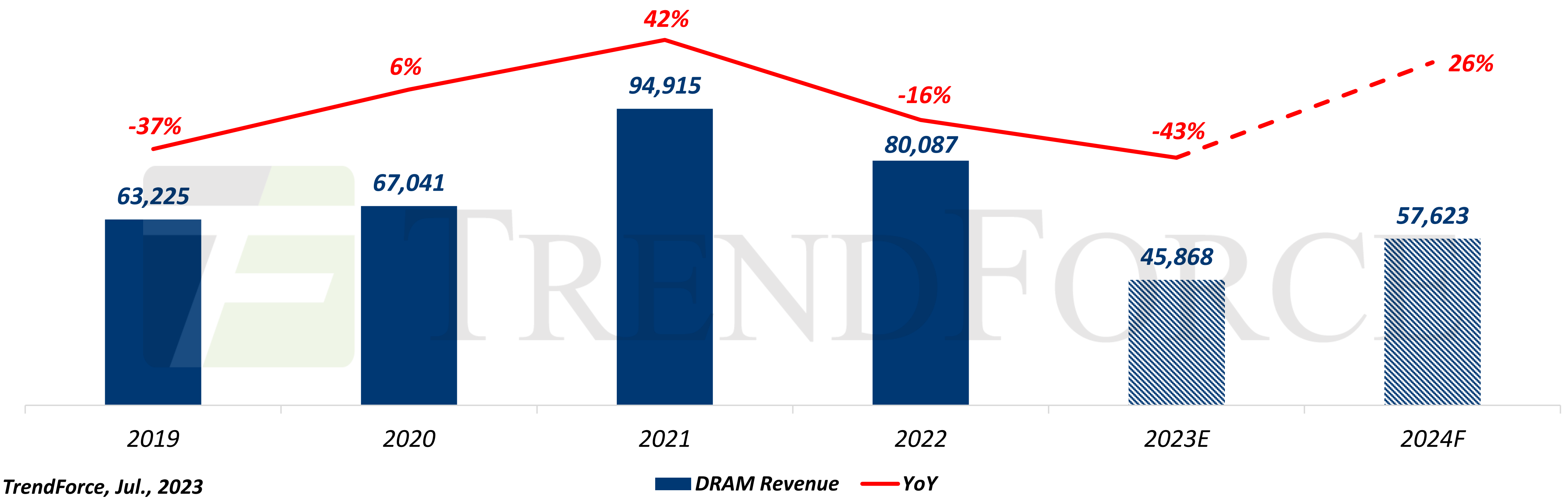
TRENDFORCE

Projection on Global DRAM Revenue, 2019-2024

- *Pandemic-related changes in people's daily lives drove up demand, thus leading to a sharp increase in DRAM revenue for 2021.*
- *Sluggish demand, inventory adjustments, and falling contract prices have caused DRAM revenue to drop by more than 50% during the recent two years.*
- *Looking ahead to 2024, prices and demand are expected to stabilize, thereby allowing DRAM revenue to rebound (but not back to the level of 2021).*

2019-2024 DRAM Revenue



Source: TrendForce, Jul., 2023

Overall Demand Outlook for Different Devices

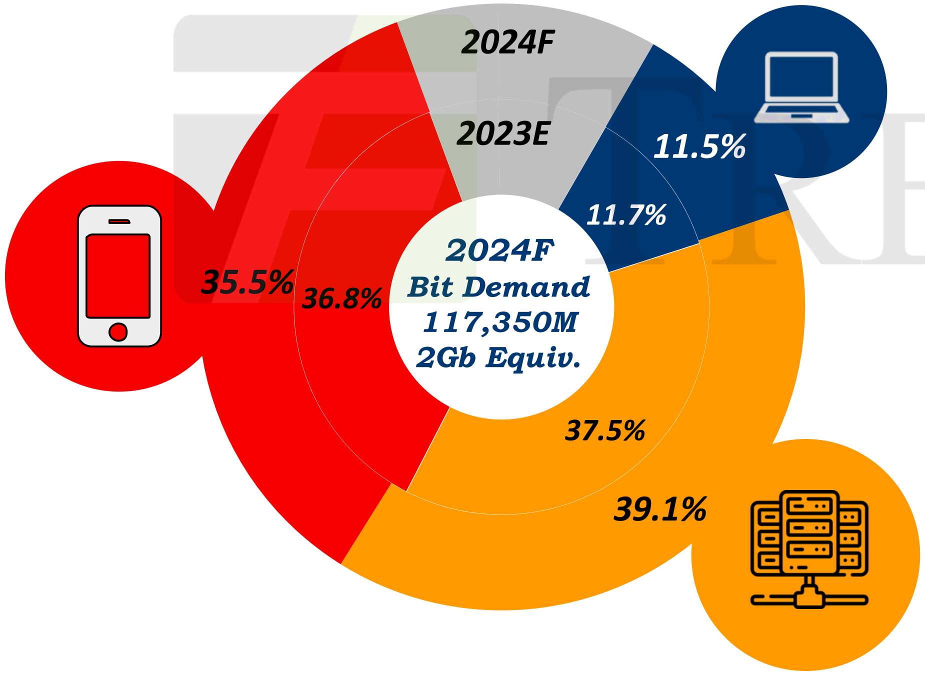
(Unit: M)		1Q23	2Q23	3Q23E	4Q23F	1Q24F	2Q24F	3Q24F	4Q24F	2023F	2024F
Server (~38% of DRAM consumption; ~26% for NAND Flash)	**Shipments**	**3.0**	**3.3**	**3.6**	**3.7**	**3.1**	**3.4**	**3.6**	**3.8**	**13.6**	**13.9**
	QoQ	-15.5%	7.9%	11.3%	0.8%	-14.7%	8.6%	6.3%	4.5%	-4.3%	2.3%
	YoY	-3.5%	-9.9%	-5.9%	2.4%	3.3%	4.0%	-0.7%	2.9%		
	Percentage	46.3%		53.7%		46.9%		53.1%			
Smartphone (~37% of DRAM consumption; ~31% for NAND Flash)	**Production**	**249.7**	**270.4**	**294.7**	**326.6**	**270.0**	**271.1**	**296.1**	**329.3**	**1,141.4**	**1,166.6**
	QoQ	-17.0%	8.3%	9.0%	10.8%	-17.3%	0.4%	9.2%	11.2%	-4.2%	2.2%
	YoY	-19.5%	-7.2%	2.0%	8.6%	8.1%	0.3%	0.5%	0.8%		
	Percentage	45.6%		54.4%		46.4%		53.6%			
NB (~12% of DRAM consumption; ~22% for NAND Flash)	**Shipments**	**35.6**	**40.8**	**42.3**	**42.4**	**37.6**	**39.7**	**43.4**	**44.6**	**161.1**	**165.3**
	QoQ	-9.5%	14.4%	3.7%	0.4%	-11.3%	5.4%	9.3%	2.9%	-14.2%	2.6%
	YoY	-34.7%	-12.9%	-10.0%	7.7%	5.6%	-2.6%	2.6%	5.2%		
	Percentage	47.4%		52.6%		46.8%		53.2%			

Source: TrendForce, Jul., 2023

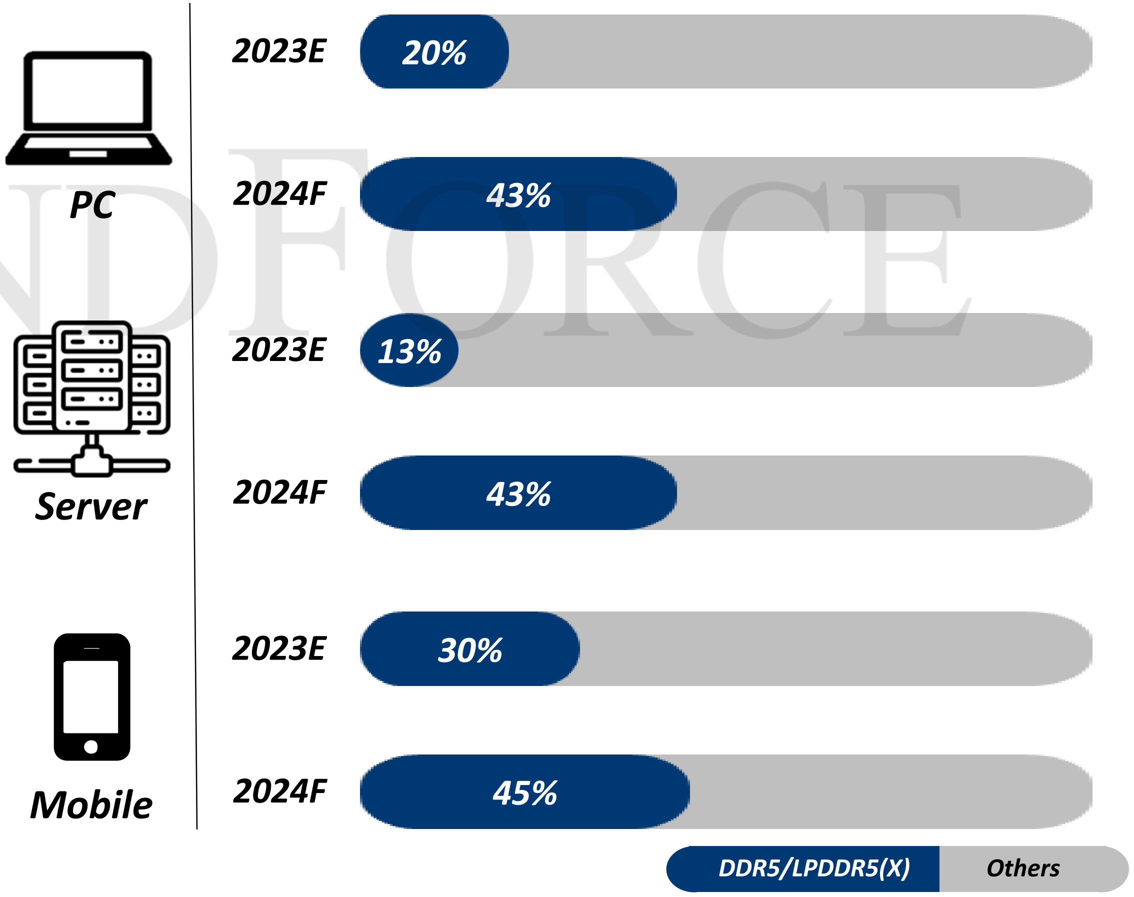
2023-2024 DDR5 Penetration in Key Applications

- *DDR5 penetration in 2023 remains lower-than-expected because (1) new server platforms (SPR and Genoa) penetration is still slow, and (2) DDR5 premium is still a lot higher than DDR4. Looking into 2024, TrendForce expects an apparent improvement on DDR5 quantity amid several platforms' readiness to support DDR5 and LPDDR5X.*

2023-2024 Bit Demand by Segment



DDR5/LPDDR5 Penetration by Applications



Source: TrendForce, Jul., 2023

Growth Rate for 2023 HBM Volume Will Reach 60%

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AI Chip Supplier	AI Chip Type	AI Chip Name	Supporting Memory	Memory Capacity (GB)	2022 HBM Est. (Million GB)	2023 HBM Est. (Million GB)	2024 HBM Est. (Million GB)
NVIDIA	GPU	H100/H800	HBM3	80	14	38	81
	GPU	A100/A800	HBM2e	80	56	82	80
	GPU	A30	HBM2e	24	1	1	2
AMD	GPU	MI200	HBM2e	128	3	20	18
	GPU	MI300	HBM3	128	1	12	19
XILINX	FPGA	Versal	HBM2	32	8	9	11
intel	GPU	Max	HBM2e	128	9	11	12
	FPGA	Altera Stratix 10	HBM2	16	1	1	1
Google	ASIC	TPU v3/v4	HBM2	8/32	29	36	23
	ASIC	TPU v5	HBM2e	16/96	0	46	84
Others	-	-	-	-	61	37	50

	2022	2023	2024
Amount	183	293	381
YoY	--	60.1%	30.0%

Source: TrendForce, Jul., 2023

Key Takeaways

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1 *Inventory will start to go down on suppliers' side from either the end of 2Q23 or the beginning of 3Q23. TrendForce expects that a larger shift of inventory pressure will be seen from the sellers to the buyers. With continuous production cut, overall inventory will start to go down towards the end of 2023.*

2 *The quarterly sufficiency ratios are improving in 2H23 thanks to a larger scale of production cut. TrendForce expects that there will be a DDR5 shortage in 2024 due to the slow ramp-up of production lines with advanced technology, followed by a slow increase of ASP for DRAM.*

3 *DDR5 is generally exhibiting a tighter supply comparing to DDR4, and is thus expected to widen in price premium.*

4 *TrendForce's price projections for 3Q23 and 4Q23 have been improved from the initial forecast (3Q: 0-5% QoQ decline; 4Q: mostly flat) as several premium products, including LPDDR5X, DDR5, and HBM, will start to experience a tighter supply.*

Source: TrendForce, Jul., 2023

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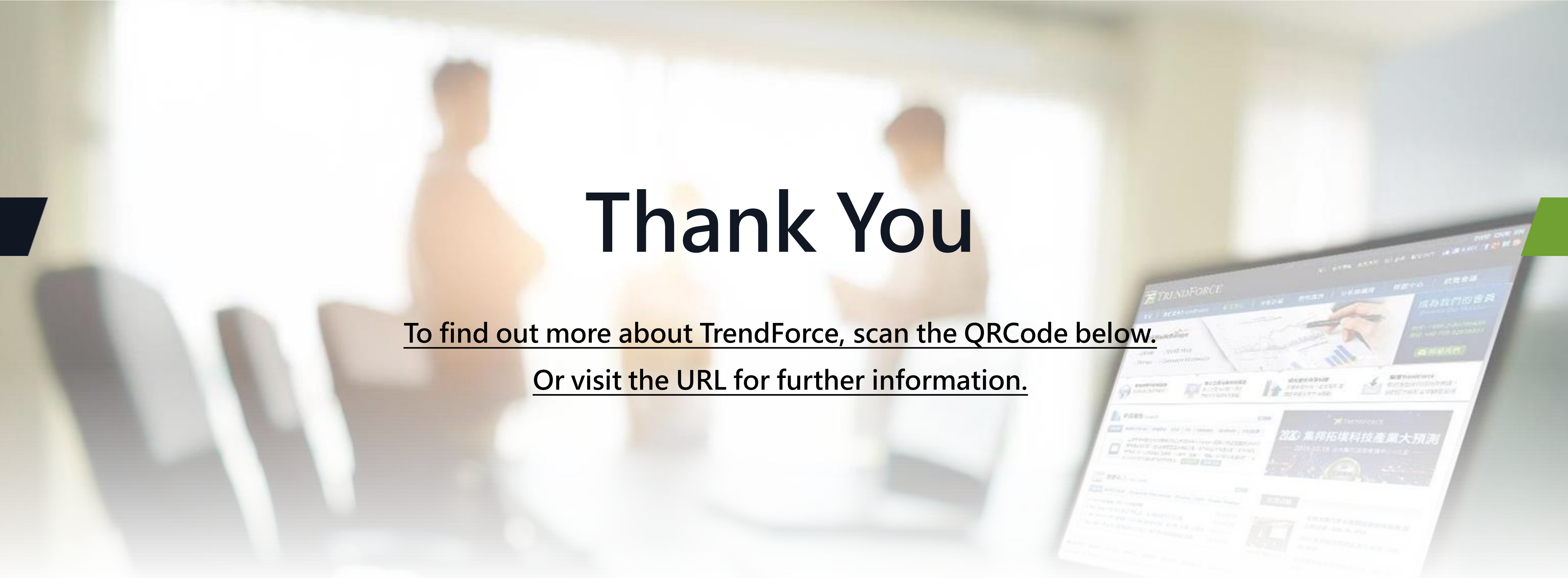

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