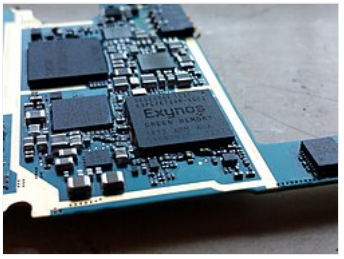
Exynos

The **Samsung Exynos** (stylized as **SΛMSUNG Exynos**),[1] formerly **Hummingbird** (Korean: 엑시노스), is a series of Arm-based system-on-chips developed by Samsung Electronics' System LSI division and manufactured by Samsung Foundry. It is a continuation of Samsung's earlier S3C, S5L and S5P line of SoCs.

The debut of Samsung's indigenously developed SoC is Samsung Hummingbird (S5PC110/111), later renamed as Exynos 3 Single 3110. Samsung announced it on July 27, 2009. In 2011, Samsung announced Exynos 4 Dual 4210 that was later equipped on Samsung Galaxy S II. Since then, Samsung has used Exynos as a representative brand name of their SoC, based on Arm Cortex cores. In 2017, Samsung launched their proprietary Arm ISA-based customized core designs, codenamed "Exynos M". Exynos M series core made a debut with Exynos M1 nicknamed "Mongoose", which was used for Exynos 8 Octa 8890. The Exynos M-series have been implemented throughout the flagship lineup of Samsung Exynos 9 series, until Exynos 990. From 2021 onwards, Exynos M6 and M7 microarchitecture developments have been cancelled and instead Samsung adopts Arm Cortex-X core series as the primary core.[2]

In 2022, Samsung started adoption of AMD RDNA GPU microarchitecture into their SoC, beginning on Exynos 2200 with Xclipse 920, which used customized "mobile RDNA" based on RDNA 2. In 2024, Samsung expanded AMD RDNA 3-based GPU into their midrange chips, since Exynos 1480 (Xclipse 530).

Logo of Samsung Exynos



An Exynos 4 Quad (4412), on the circuit board of a Samsung Galaxy S III smartphone

History

2010–2016: Pre-Mongoose Era

In 2010, Samsung launched the Hummingbird S5PC110 (now Exynos 3 Single) in its Samsung Galaxy S smartphone, which featured a licensed Arm Cortex-A8 CPU.[3] This Arm Cortex-A8 was code-named Hummingbird. It was developed in partnership with Intrinsity using their FastCore and Fast14 technology.[4]

In early 2011, Samsung first launched the Exynos 4210 SoC in its Samsung Galaxy S II mobile smartphone. The driver code for the Exynos 4210 was made available in the Linux kernel[5] and support was added in version 3.2 in November 2011.[6][7]

On 29 September 2011, Samsung introduced Exynos 4212[8] as a successor to the 4210; it features a higher clock frequency and "50 percent higher 3D graphics performance over the previous processor generation".[9] Built with a 32 nm high-κ metal gate (HKMG) low-power process; it promises a "30 percent lower power-level over the previous process generation".

On 30 November 2011, Samsung released information about their upcoming SoC with a dual-core ARM Cortex-A15 CPU, which was initially named "Exynos 5250" and was later renamed to Exynos 5 Dual. This SoC has a memory interface providing 12.8 GB/s of memory bandwidth, support for USB 3.0 and SATA 3, can decode full 1080p video at 60 fps along with simultaneously displaying WQXGA-resolution (2560 × 1600) on a mobile display as well as 1080p over HDMI.[10] This SoC was used in some Chromebooks from 2013. Samsung Exynos 5 Dual has been used in a 2015 prototype supercomputer,[11] while the end-product will use a chip meant for servers from another vendor.

On 26 April 2012, Samsung released the Exynos 4 Quad, which powers the Samsung Galaxy S III and Samsung Galaxy Note II.[12] The Exynos 4 Quad SoC uses 20% less power than the SoC in Samsung Galaxy S II. Samsung also changed the name of several SoCs, Exynos 3110 to Exynos 3 Single, Exynos 4210 and 4212 to Exynos 4 Dual 45 nm,[13] and Exynos 4 Dual 32 nm[14] and Exynos 5250 to Exynos 5 Dual.

In 2010 Samsung founded a design center in Austin called Samsung's Austin R&D Center (SARC). Samsung has hired many ex-AMD, ex-Intel, ex-ARM and various other industry veterans.[15] The SARC developed high-performance, low-power, complex CPU and System IP (Coherent Interconnect and memory controller) architectures and designs.[16] In 2012, Samsung began development of GPU IP called "S-GPU".[17]

2016–2020: Mongoose Era

After a three-year design cycle, SARC's first custom CPU core called the M1 was released in the Exynos 8890 in 2016.[18] In 2017 the San Jose Advanced Computing Lab (ACL) was opened to continue custom GPU IP development.[15] In the same year, Samsung announced Exynos M2, a minor revision of Exynos M1.

In Hot Chips 2018, Samsung announced a new custom core named Exynos M3, codenamed Meerkat. M3 has widened decoder width from 4-wide to 6-wide, and introduced L3 cache structure. Also, it achieved over 50% IPC increase versus Exynos M1 and M2.[19] SPEC2006 benchmark result showed that it has performance advantage comparing with counterparts of Snapdragon 845 (Cortex-A75) at their respective peak clock speed, and by lowering the clock speed to 1.79 GHz it matched the power efficiency versus Cortex-A75 of Snapdragon 845. However, Samsung Galaxy S9 with Exynos 9810 was criticized in early period of their release due to the poor CPU core scheduler settings.[20]

In 2019, Samsung revealed Exynos 9820 with fourth-generation custom core named Exynos M4 (Cheetah). It has been manufactured on Samsung 8 nm LPP process. Unlike the past flagship Exynos series with 4+4 dual-cluster settings, Exynos 9820 implemented 2+2+4 core cluster configurations. Benchmark result presented that Exynos 9820 had performance parity but worse efficiency over Snapdragon 855.[21] Later, Samsung announced Exynos 9825, a revised SoC manufactured on their first 7 nm manufacturing process named 7LPE.[22] Exynos 9825 came equipped with Samsung Galaxy Note10 series and Samsung Galaxy F62/M62.

In 2020, Samsung released last Mongoose-based SoC, named Exynos 990. Exynos 990 came with their fifth-generation custom core (Exynos M5) codenamed Lion. However, M5 showed less performance and worse power efficiency against Cortex-A77 of Snapdragon 865.[23][24]

On 1 October 2019, rumors emerged that Samsung had laid off their custom CPU core teams at SARC.[25][26][27] On 1 November 2019, Samsung filed a WARN letter with the Texas Workforce Commission, notifying of upcoming layoffs of their SARC CPU team and termination of their custom CPU core development.[28] SARC and ACL will still continue development of custom SoC, AI, and GPU.[29]

2021–present: Cortex and RDNA Era

On 3 June 2019, AMD and Samsung announced a multi-year strategic partnership in mobile graphics IP based on AMD Radeon GPU IP.[30][17] NotebookCheck reported that Samsung are targeting 2021 for their first SoC with AMD Radeon GPU IP.[31] However, AnandTech reported 2022.[32] In August 2019, during AMD's Q2 2019 earnings call, AMD stated that Samsung plans to launch SoCs with AMD graphics IP in roughly two years.[33] The first SoC to use Radeon GPU were Exynos 2200, introduced in January 2022, with a custom Xclipse 920 based on AMD's RDNA 2 microarchitecture.[34]

In June 2021, Samsung hired engineers from AMD and Apple to form a new custom architecture team.[35]

In October 2021, Google released their Pixel 6 series of phones based on Google's Tensor SoC, which was made in collaboration with Samsung.[36]

In 2024, Samsung officially announced Exynos 2400, with RDNA 3 microarchitecture-based Xclipse 940.[37] In the same year, along with Exynos 2400, Samsung released Exynos 1480, with RDNA 3 based Xclipse 530, marking the end of Arm Mali GPU era in their mid-range processors.[38]

Current Exynos SoCs (2020–present)

Starting in 2020 Samsung introduced a new series of Exynos SoCs with lower numbers than in the past. This indicates a cut between the past Exynos SoCs at least in naming.

Exynos 800 series

SoC			CPU		GPU			Memory technology			NPU	Modem	Connect
Model number	Fab.	Die size (mm^2)	ISA	μarch	μarch	Frequency (MHz)	Performance GFLOPS (FP32)	Type	Bus width (bit)	Bandwidth (GB/s)			
Exynos 850 (S5E3830)[39]	8 nm (Samsung 8LPP)		ARMv8.2-A	8 cores 2.0 GHz Cortex-A55	Mali-G52 MP1	1001	32	LPDDR4X	32-bit (2×16-bit) Dual-channel	1866 MHz (14.9 GB/s)	—	**List** Shannon 318 LTE Cat.7 2CA 300 Mbit/s (DL) / Cat.13 2CA 150 Mbit/s (UL)	Bluetooth 5.0, Wi-F
Exynos 880 (S5E8805)[40]				2 + 6 cores (2.0 GHz Cortex-A77 + 1.8 GHz Cortex-A55)	Mali-G76 MP5	546	131			2133 MHz (17.1 GB/s)	NPU	**List** Shannon 5G LTE DL: Cat.16 1000 Mbit/s, 5CA, 256-QAM UL: Cat.18 200 Mbit/s, 2CA, 256-QAM 5G NR Sub-6 GHz DL: 2.55 Gbit/s UL: 1.28 Gbit/s	

Exynos 900 series

SoC			CPU		GPU			Memory technology			NPU	
Model number	Fab.	Die size (mm^2)	ISA	μarch	μarch	Frequency (MHz)	Performance GFLOPS (FP32)	Type	Bus width (bit)	Bandwidth (GB/s)		
Exynos 980 (S5E9630)[41]	8 nm (Samsung 8LPP)		ARMv8.2-A	2 + 6 cores (2.2 GHz Cortex-A77 + 1.8 GHz Cortex-A55)	Mali-G76 MP5	728	174.7	LPDDR4X	32-bit (2×16-bit) Dual-channel	2133 MHz (17.1 GB/s)	Single core NPU + DSP	**Li** Sh 51 LT Ca 10 5C QA Ca 20 2C QA NF 6 (2.5 UL 1.2
Exynos 990 (S5E9830)[42]	7 nm (Samsung 7LPP)	91.83[43]		2 + 2 + 4 cores (3.02 GHz Exynos M5 "Lion" + 2.6 GHz Cortex-A76 + 2.11 GHz Cortex-A55)[44] 2 MB System Cache	Mali-G77 MP11	832	585.7	LPDDR5	64-bit (4×16-bit) Quad-channel	2750 MHz (44 GB/s)	Dual-core NPU + DSP (15 TOPs)	**Li** Pa Ex M 51 DL 30 8C QA Ca 42 2C QA NF 6 (5.1 UL 5C mi DL 7.3 UL

Exynos 1000 series

SoC			CPU		GPU			Memory technology			NPU	Modem
Model number	Fab.	Die size (mm^2)	ISA	μarch	μarch	Frequency (MHz)	Performance GFLOPS (FP32)	Type	Bus width (bit)	Bandwidth (GB/s)		
Exynos 1080 (S5E9815)[45]	5 nm (Samsung 5LPE)	95.5[46]	ARMv8.2-A	1 + 3 + 4 cores (2.8 GHz Cortex-A78 + 2.6 GHz Cortex-A78 + 2.0 GHz Cortex-A55)	Mali-G78 MP10	800	512	LPDDR4X LPDDR5	64-bit (4×16-bit) Quad-channel	2133 MHz (34.1 GB/s) 2750 MHz (44 GB/s)	NPU + DSP (5.7 TOPs)	**List** Shannon 5G LTE DL: Cat.18 1200 Mbit/ 6CA, 256-QAM UL: Cat.18 200 Mbit/s 2CA, 256-QAM 5G NR Sub-6 GHz DL: 5.1 Gbit/s UL: 1.28 Gbit/s 5G NR mmWave DL: 3.67 Gbit/s UL: 3.67 Gbit/s
Exynos 1280 (S5E8825)[47]				2 + 6 cores (2.4 GHz Cortex-A78 + 2.0 GHz Cortex-A55)	Mali-G68 MP4	897	229.6	LPDDR4X	32-bit (2×16-bit) Dual-channel	2133 MHz (17.1 GB/s)	Single-core NPU 1196 MHz (4.3 TOPs)	**List** Shannon 5308 5G LTE DL: Cat.18 1.2 Gbit/s, 6CA, 256-QAM UL: Cat.18 200 Mbit/s 2CA, 256-QAM 5G NR Sub-6 GHz DL: 2.55 Gbit/s UL: 1.28 Gbit/s 5G NR mmWave DL: 1.84 Gbit/s UL: 0.92 Gbit/s
Exynos 1330 (S5E8535)[48]					Mali-G68 MP2	949	121.5	LPDDR4X LPDDR5		2133 MHz (17.1 GB/s) 3200 MHz (25.6 GB/s)	Unknown	**List** Shannon 5308 5G NR Sul 6 GHz 2.55 Gbps (DL) / 1.28 Gbps (UL) LTE Cat.18 6CC (DL) / Cat.18 2C((UL)
Exynos 1380 (S5E8835)[49]		53.3[50]		4 + 4 cores (2.4 GHz Cortex-A78 + 2.0 GHz Cortex-A55)	Mali-G68 MP5		303.7				Single-core NPU 1196 MHz (4.9 TOPs)	**List** Shannon 5318 5G NR Sul 6 GHz 3.79 Gbps (DL) / 1.28 Gbps (UL) 5G NR mmWave 3.67 Gbps (DL) / 0.92 Gbps (UL) LTE Cat.18 1.2 Gbps (DL) / Cat.18 211 Mbps (UL)

Exynos 1480 (S5E8845)[51]	4 nm (Samsung 4LPP)			4 + 4 cores (2.75 GHz Cortex-A78 + 2.0 GHz Cortex-A55)	Xclipse 530 "Titan" (RDNA 2 based 128:8:8:2 1 WGP)[a]	1300	332.8				6K MAC, Single-core NPU 1066 MHz (13.1 TOPs)	**List** Shannon 5328 5G NR Sul 6 GHz 5.10 Gbps (DL) / 1.28 Gbps (UL) 5G NR mmWave 4.84 Gbps (DL) / 0.92 Gbps (UL) LTE Cat.18 1.2 Gbps (DL) / Cat.18 211 Mbps (UL)
Exynos 1580 (S5E8855)[52]	4 nm (Samsung 4LPP+)	56[53]	ARMv9.2-A	1 + 3 + 4 cores (2.9 GHz Cortex-A720 + 2.6 GHz Cortex-A720 + 1.95 GHz Cortex-A520)	Xclipse 540 "Ariel" (RDNA 3 based 256:16:8:4 2 WGP)[a]	1300	1,331.2	LPDDR5		3200 MHz (25.6 GB/s)	6K MAC, Single-core NPU 1066 MHz (14.7 TOPs)	**List** Shannon 5328 5G NR Sul 6GHz 5.1 Gbps (DL) 1.28 Gbps (UL) / 5G NR mmWave 4.84 Gbps (DL), 0.92 Gbps (UL) LTE Cat.18 6CC 1.2 Gbps (DL) Cat.18 2C(211 Mbps (UL)
Exynos 1680 (S5E8865)[54]				1 + 4 + 3 cores (2.9 GHz Cortex-A720 + 2.6 GHz Cortex-A720 + 1.95 GHz Cortex-A520)	Xclipse 550 "Triton" (RDNA 3 based 256:16:16:4 2 WGP)[a]	1200	1,228.8	LPDDR5X		Unknown	8K MAC, Single-core NPU 1200 MHz (19.6 TOPs)	**List** 5G NR Sul 6GHz 5.1 Gbps (DL) 1.28 Gbps (UL) / 5G NR mmWave 4.84 Gbps (DL), 0.92 Gbps (UL) LTE Cat.18 6CC 1.2 Gbps (DL) Cat.18 2C(211 Mbps (UL)

Exynos 2000 series

SoC			CPU		GPU			Memory technology			NPU	
Model number	Fab.	Die size (mm^2)	ISA	µarch	µarch	Frequency (MHz)	Performance GFLOPS (FP32)	Type	Bus width (bit)	Bandwidth (GB/s)		
Exynos 2100 (S5E9840)[55]	5 nm (Samsung 5LPE)	128.1[56]	ARMv8.2-A	1 + 3 + 4 cores (2.91 GHz Cortex-X1 + 2.81 GHz Cortex-A78 + 2.2 GHz Cortex-A55)	Mali-G78 MP14	854	765.2[57]	LPDDR5	64-bit (4×16-bit) Quad-channel	3200 MHz (51.2 GB/s)	6K MAC Triple NPU + DSP 1352 MHz (26 TOPs)	L E M 5 D 3 8 Q C 4 4 Q N 6 5 U 1 5 m D 7 U 3
Exynos 2200 (S5E9925)[58]	4 nm (Samsung 4LPE)	104.7[56]	ARMv9.0-A	1 + 3 + 4 cores (2.95 GHz Cortex-X2 + 2.70 GHz Cortex-A710 + 2.10 GHz Cortex-A510)[59]	Xclipse 920 "Voyager" (RDNA 2 based 384:24:24:6 3 WGP[60])[a]	1306	1,003[57]				8K MAC Dual NPU + DSP 1066 MHz	L S 5 D 3 8 Q C 4 4 Q N 6 5 U 2 5 m D 7 U 3
Exynos 2400/2400e (S5E9945)[61][62]	4 nm (Samsung 4LPP+)	137.4[56]	ARMv9.2-A	1 + 2 + 3 + 4 cores (3.1/3.2 GHz Cortex-X4 + 2.9 GHz Cortex-A720 + 2.6 GHz Cortex-A720 + 1.95 GHz Cortex-A520)	Xclipse 940 "Magellan" (RDNA 3 based 768:48:32:12 6 WGP)[a]	1095	3,406.8[63]	LPDDR5X		4266 MHz (68.2 GB/s)	17K MAC NPU (2x GNPU + 2x SNPU) + DSP 1300 MHz	L S 5 D 3 8 Q C 4 4 Q N 6 9 U 2 5 m D 1 U 3
Exynos 2500 (S5E9955)[64]	3 nm (Samsung 3GAP)	141.6[65]		1 + 2 + 5 + 2 cores (3.3 GHz Cortex-X925 + 2.74 GHz Cortex-A725 + 2.36 GHz Cortex-A725 + 1.8 GHz Cortex-A520)	Xclipse 950 "Galileo" (RDNA 3 based 1024:64:64:16 8 WGP)[a]	999	4,091.9[63]			4800 MHz (76.8 GB/s)	24K MAC NPU (2x GNPU + 2x SNPU) + DSP (59 TOPs)	L S 5 D 3 8 Q C 4 4 Q N 6 9 U 2 5 m D

												1 U 3
Exynos 2600 (S5E9965)[66]	2 nm (Samsung SF2)	141.5[67]	ARMv9.3-A	1 + 3 + 6 cores (3.8 GHz C1-Ultra + 3.25 GHz C1-Pro + 2.75 GHz C1-Pro)	Xclipse 960 "Juno" (RDNA 4 based 3584:64:64:168 WGP)[a]	980	7,024.6[57]			5333 MHz (85.3 GB/s)	32K MAC Dual NPU + DSP 1200 MHz	

a. Unified Shaders : Texture Mapping Units : Render Output Units : Ray Accelerators and Workgroup Processor (WGP)

Past Exynos SoCs (2010–2019)

SoC			CPU		GPU			Memory technology		
Model number	Fab.	Die size (mm^2)	ISA	µarch	µarch	Frequency (MHz)	Performance (GFLOPS)	Type	Bus width (bit)	Ban
Exynos 3 Single 3110[68] *(previously Hummingbird S5PC110)*	45 nm (Samsung 45 nm HKMG)		ARMv7	1 core 1.2 GHz Cortex-A8	PowerVR SGX540	200	3.2[69]	LPDDR, LPDDR2 or DDR2	64-bit (2×32-bit) Dual-channel	200 MH
Exynos 3 Quad 3470[70]	28 nm (Samsung 28 nm HKMG)			4 cores 1.4 GHz Cortex-A7	Mali-400 MP4	450	16.2	LPDDR2 or LPDDR3		400 MH 533 MH
Exynos 3 Quad 3475				4 cores 1.3 GHz Cortex-A7	Mali-T720	600	12	LPDDR3		533 MH
Exynos 4 Dual 4210[71][13]	45 nm (Samsung 45 nm HKMG)			2 cores 1.2 GHz Cortex-A9	Mali-400 MP4	266	9.6	LPDDR2, DDR2 or DDR3		400 MH (6.4 GB

Exynos 4 Dual 4212[71][14]				2 cores 1.5 GHz Cortex-A9		400[77]	14.4			
Exynos 4 Quad 4412[79][74]	32 nm (Samsung 32 nm HKMG)			4 cores 1.6 GHz Cortex-A9		400–533[80]	14.4–19.2			
Exynos 4 Quad 4415[79][74]	28 nm (Samsung 28 nm HKMG)			4 cores 1.5 GHz Cortex-A9		533[93]	19.2			
Exynos 5 Dual 5250[94][95]	32 nm (Samsung 32 nm HKMG)			2 cores 1.7 GHz Cortex-A15	Mali-T604 MP4[96]	533	72.5	LPDDR2, LPDDR3 or DDR3		533 MH 800 MH
Exynos 5 Hexa 5260[101][102]	28 nm (Samsung 28 nm HKMG)			2+4 cores (1.7 GHz Cortex-A15 + 1.3 GHz Cortex-A7)	Mali-T624 MP4	600	81.6	LPDDR3		800 MH
Exynos 5 Octa 5410[103][104][105][106]				4+4 cores (1.6 GHz Cortex-A15 + 1.2 GHz Cortex-A7)	PowerVR SGX544 MP3	480–532[107]	49			
Exynos 5 Octa 5420[111]		136.96		4+4 cores (1.9 GHz Cortex-A15 + 1.3 GHz Cortex-A7)	Mali-T628 MP6	533	108.7	LPDDR3e		933 MH

Exynos 5 Octa 5422[101][114]				4+4 cores (2.1 GHz Cortex-A15 + 1.5 GHz Cortex-A7)						
Exynos 5 Octa 5430[116][117]	20 nm (Samsung 20 nm HKMG)	110.18		4+4 cores (1.8 GHz Cortex-A15 + 1.3 GHz Cortex-A7)		600	122.4	LPDDR3e/DDR3		1066 MH
Exynos 5 Octa 5800[119]	28 nm (Samsung 28 nm HKMG)			4+4 cores (2.0 GHz Cortex-A15 + 1.3 GHz Cortex-A7)		?	?	LPDDR3/DDR3		933 MH:
Exynos 7 Octa 5433[121][122][123]	20 nm (Samsung 20 nm HKMG)	113.42[124]	ARMv8-A	4 + 4 cores (1.9 GHz Cortex-A57 + 1.3 GHz Cortex-A53) GTS	Mali-T760 MP6	700	117.6	LPDDR3		825 MH:
Exynos 7 Octa 7420[126][127][128]	14 nm (Samsung 14LPE)	78.23[124]		4 + 4 cores (2.1 GHz Cortex-A57 + 1.5 GHz Cortex-A53) GTS	Mali-T760 MP8	772	172.9	LPDDR4		1553 MH (24.88 G
Exynos 7 Quad 7570[132][133][134]	14 nm (Samsung 14LPC)			4 cores 1.4 GHz Cortex-A53	Mali-T720 MP1[135]	830	16.6	LPDDR3	32-bit Single-channel[136]	533 MH:

Exynos 7 Quad 7578	28 nm (Samsung 28 nm HKMG)			4 cores 1.5 GHz Cortex-A53	Mali-T720 MP2	668	26.7			933 MH
Exynos 7 Octa 7580[137][138]				8 cores 1.6 GHz Cortex-A53						
Exynos 7 Octa 7870[140][141]	14 nm (Samsung 14LPP)				Mali-T830 MP1[142]	700	22.4			

Exynos 7880[147][148][149]				8 cores 1.9 GHz Cortex-A53	Mali-T830 MP3	950	91.2	LPDDR4	32-bit (2×16-bit) Dual-channel	1600 MH
Exynos 7872[150]				2 + 4 cores (2.0 GHz Cortex-A73 + 1.6 GHz Cortex-A53) GTS	Mali-G71 MP1	1200	28.8	LPDDR3	32-bit Single-channel	933 MH
Exynos 7884A[151]				2 + 6 cores (1.35 GHz Cortex-A73 + 1.35 GHz Cortex-A53) GTS	Mali-G71 MP2	450	21.6	LPDDR4	32-bit (2×16-bit) Dual-channel	1866 MH
Exynos 7884[152]				2 + 6 cores (1.6 GHz Cortex-A73 + 1.35 GHz Cortex-A53) GTS		676 845	32.4 40.6			

Exynos 7885[153][154]				2 + 6 cores (2.2 GHz Cortex-A73 + 1.6 GHz Cortex-A53) GTS		1100	52.8			
Exynos 7904[155]				2 + 6 cores (1.8 GHz Cortex-A73 + 1.6 GHz Cortex-A53) GTS		770	37			
Exynos 8 Octa 8890[156]				4 + 4 cores (2.3 GHz, up to 2.6 GHz in dual-core load, Exynos M1 "Mongoose" + 1.6 GHz Cortex-A53) GTS	Mali-T880 MP12	650	327.6	LPDDR4	64-bit (2×32-bit) Dual-channel	1794 MH (28.7 GB
				4 + 4 cores (2.0 GHz Exynos M1 "Mongoose" + 1.5 GHz Cortex-A53) GTS	Mali-T880 MP10 (Lite)		273			
Exynos 8895 [160][161][162]	10 nm (Samsung 10LPE)	103.64[163]		4 + 4 cores (2.314 GHz Exynos M2 "Mongoose" + 1.69 GHz Cortex-A53) GTS	Mali-G71 MP20	546[164]	262.1	LPDDR4X		

Exynos 9609[165]				4 + 4 cores (2.2 GHz Cortex-A73 + 1.6 GHz Cortex-A53)						
Exynos 9610[166]				4 + 4 cores (2.3 GHz Cortex-A73 + 1.7 GHz Cortex-A53)	Mali-G72 MP3	1053	113.7	LPDDR4X	32-bit (2×16-bit) Dual-channel	1600 MH
Exynos 9611[167]						850	91.8			
Exynos 9810 (S5E9810)[168][169]	10 nm (Samsung 10LPP)	118.94[170]	ARMv8.2-A	4 + 4 cores (2.9 GHz Exynos M3 "Meerkat"[163] + 1.9 GHz Cortex-A55)	Mali-G72 MP18	572	370.7[171]	LPDDR4X	64-bit (4×16-bit) Quad-channel	1794 MH
Exynos 9820 (S5E9820)[172]	8 nm (Samsung 8LPP)	127[173]		2 + 2 + 4 cores (2.73 GHz Exynos M4 "Cheetah" + 2.31 GHz Cortex-A75 + 1.95 GHz Cortex-A55)	Mali-G76 MP12	702	404.4			2093 MH [173]
Exynos 9825 (S5E9825)[174]	7 nm (Samsung 7LPP)			2 + 2 + 4 cores (2.73 GHz Exynos M4 "Cheetah" + 2.4 GHz Cortex-A75 + 1.95 GHz Cortex-A55)		754	434.3			

List of Exynos Wearable SoCs

SoC			CPU		GPU			Memory technology			NPU	Modem	
Model number	Fab.	Die size (mm^2)	ISA	µarch	µarch	Frequency (MHz)	Performance GFLOPS (FP32)	Type	Bus width (bit)	Bandwidth (GB/s)			
Exynos 4 Dual 4212 (Single core)[71][14]	32 nm (Samsung 32 nm HKMG)		ARMv7-A	1 core 0.8 GHz Cortex-A9	Mali-400 MP4	400[175]	14.4	LPDDR2, DDR2 or DDR3	64-bit (2×32-bit) Dual-channel	400 MHz (6.4 GB/s)	—		
Exynos 3 Dual 3250	28 nm (Samsung 28 nm HKMG)			2 cores 1.0 GHz Cortex-A7	Mali-400 MP2	400	7.2	LPDDR2 or LPDDR3					
Exynos 7 Dual 7270 (SC57270)[176]	14 nm (Samsung 14LPP)		ARMv8-A	2 cores 1.0 GHz Cortex-A53	Mali-T720 MP1	667	13.3	LPDDR3	32-bit (2×16-bit) Dual-channel	Unknown		LTE Cat.4 2CA 150 Mbit/s (DL) / 50 Mbit/s (UL)	
Exynos 9110 (SC59110XSC)[177]	10 nm (Samsung 10LPP)			2 cores 1.15 GHz Cortex-A53				LPDDR4 LPDDR4X		Unknown		Shannon 3012 LTE Cat.4 2CA 150 Mbit/s (DL) / Cat.5 75 Mbit/s (UL)	
Exynos W920 (SC55515XBD)[178]	5 nm (Samsung 5LPE)		ARMv8.2-A	2 cores 1.18 GHz Cortex-A55	Mali-G68 MP2	667	85.4	LPDDR4		Unknown			
Exynos W930 (SC55515XBE)[179]				2 cores 1.4 GHz Cortex-A55						Unknown			
Exynos W1000 (SC55535AHA)[180]	3 nm (Samsung SF3)	17.67		1 core 1.6 GHz Cortex-A78 4 cores 1.5 GHz Cortex-A55		702	89.9	LPDDR5		Unknown			

List of Exynos modems

Exynos Modem 303

- Supported modes LTE FDD, LTE TDD, WCDMA and GSM/EDGE
- LTE Cat. 6
- Downlink: 2CA 300 Mbit/s 64-QAM
- Uplink: 100 Mbit/s 16-QAM
- 28 nm HKMG Process
- Paired with: Exynos 5 Octa 5430 and Exynos 7 Octa 5433
- Devices using: Samsung Galaxy Note 4, Samsung Galaxy Note Edge and Samsung Galaxy Alpha[181]

Exynos Modem 333

- Supported modes LTE FDD, LTE TDD, WCDMA, TD-SCDMA and GSM/EDGE
- LTE Cat. 10
- Downlink: 3CA 450 Mbit/s 64-QAM
- Uplink: 2CA 100 Mbit/s 16-QAM
- 28 nm HKMG Process
- Paired with: Exynos 7 Octa 7420
- Devices using: Samsung Galaxy S6, Samsung Galaxy Note 5 and Samsung Galaxy A8 (2016)[182]

Exynos Modem 5100

- Supported Modes: 5G NR Sub-6 GHz, 5G NR mmWave, LTE-FDD, LTE-TDD, HSPA, TD-SCDMA, WCDMA, CDMA, GSM/EDGE[183]
- Downlink Features:
  - 8CA (Carrier Aggregation) in 5G NR
  - 8CA 1.6 Gbit/s in LTE Cat. 19
  - 4x4 MIMO
  - FD-MIMO
  - Up to 256-QAM in sub-6 GHz, 2 Gbit/s
  - Up to 64-QAM in mmWave, 6 Gbit/s
- Uplink Features:
  - 2CA (Carrier Aggregation) in 5G NR
  - 2CA in LTE
  - Up to 256-QAM in sub-6 GHz
  - Up to 64-QAM in mmWave
- Process: 10 nm FinFET Process
- Paired with: Exynos 9820 and Exynos 9825
- Devices using: Samsung Galaxy S10 and Samsung Galaxy Note 10

Exynos Modem 5123

- Supported Modes: 5G NR Sub-6 GHz, 5G NR mmWave, LTE-FDD, LTE-TDD, HSPA, TD-SCDMA, WCDMA, CDMA, GSM/EDGE[184]
- Downlink Features:
  - 8CA 1024-QAM in LTE Cat. 24 (3.0 Gbit/s)
  - Up to 256-QAM in sub-6 GHz (5.1 Gbit/s)
  - Up to 64-QAM in mmWave (7.35 Gbit/s)
- Uplink Features:
  - 2CA 256-QAM in LTE Cat. 22 (422 Mbit/s)
  - Up to 256-QAM in sub-6 GHz
  - Up to 64-QAM in mmWave
- Process: 7 nm FinFET Process
- Paired with: Exynos 990, Exynos 2100, and Google Tensor
- Devices using: Samsung Galaxy S20, Samsung Galaxy Note 20, Samsung Galaxy S21, and Google Pixel 6

Exynos Modem 5300

- Supported Modes: 3GPP Release 16 5G NR Sub-6 GHz & mmWave (SA/NSA), LTE-FDD, LTE-TDD, HSPA, TD-SCDMA, WCDMA, CDMA, GSM/EDGE[185]
- Downlink Features: Up to 10 Gbit/s
  - 5G sub-6 GHz
    - Up to 256-QAM
    - 4x4 MIMO
    - 200 MHz carrier aggregation
  - 5G mmWave
    - Up to 64-QAM
    - 2x2 MIMO
    - 800 MHz carrier aggregation
- Uplink Features: Up to 3.9 Gbit/s
  - 5G sub-6 GHz
    - Up to 256-QAM

        - 2x2 MIMO
        - 400 MHz carrier aggregation
    - 5G mmWave
        - Up to 64-QAM
        - 2x2 MIMO
        - 800 MHz carrier aggregation
- Process: 4 nm EUV
- Paired with: Google Tensor G2, Google Tensor G3 and Google Tensor G4 found in the Google Pixel 9a
- Devices using: Google Pixel 7, Google Pixel 8, Google Pixel 9a

Exynos Modem 5400

- Supported Modes: 3GPP Release 17 5G NR Sub-6 GHz & mmWave (SA/NSA/NTN), LTE-FDD, LTE-TDD, HSPA, WCDMA, GSM/EDGE, NB-IoT NTN[186][187]
- Downlink Features:
    - 5G FR1
        - Up to 11.2 Gbit/s
        - Up to 1024-QAM
        - 4x4 MIMO
        - 380 MHz carrier aggregation (5CA: 3x 100 MHz + 2x 40 MHz)
    - 5G FR2
        - Up to 14.8 Gbit/s
        - Up to 256-QAM
        - 2x2 MIMO
        - 1000 MHz carrier aggregation
- Uplink Features: Up to 3.9 Gbit/s
    - 5G FR1
        - Up to 256-QAM
        - 2x2 MIMO
        - 400 MHz carrier aggregation
    - 5G FR2
        - Up to 64-QAM
        - 2x2 MIMO
        - 800 MHz carrier aggregation
- Process: 4 nm EUV
- Paired with: Google Tensor G4, G5
- Devices using it: Google Pixel 9, Pixel 10

Exynos Modem 5410

- Supported Modes: 3GPP Release 17 5G NR Sub-6 GHz & mmWave (SA/NSA), LTE-FDD, LTE-TDD, HSPA, WCDMA, GSM/EDGE, NB-IoT NTN[188]
- Downlink Features:
    - 5G FR1
        - Up to 11.2 Gbit/s
        - Up to 1024-QAM
        - 4x4 MIMO
        - 380 MHz carrier aggregation (5CA: 3x 100 MHz + 2x 40 MHz)
    - 5G FR2
        - Up to 14.8 Gbit/s
        - Up to 256-QAM
        - 2x2 MIMO
        - 1000 MHz carrier aggregation
- Uplink Features: Up to 3.9 Gbit/s
    - 5G FR1
        - Up to 256-QAM
        - 2x2 MIMO
        - 400 MHz carrier aggregation
    - 5G FR2
        - Up to 64-QAM
        - 2x2 MIMO
        - 800 MHz carrier aggregation
- Process: 4 nm EUV
- Paired with: Exynos 2600

- Devices using it: TBA.

List of Exynos IoT SoCs

Exynos i T200[189]

- CPU: Cortex-M4 @ 320 MHz, Cortex-M0+ @ 320 MHz
- WiFi: 802.11b/g/n Single band (2.4 GHz)
- On-chip Memory: SRAM 1.4 MB
- Interface: SDIO/ I2C/ SPI/ UART/ PWM/ I2S
- Front-end Module: Integrated T/R switch, Power Amplifier, Low Noise Amplifier
- Security: WEP 64/128, WPA, WPA2, AES, TKIP, WAPI, PUF (Physically Unclonable Function)

Exynos i S111[190]

- CPU: Cortex-M7 200 MHz
- Modem: LTE Release 14 NB-IoT
  - Downlink: 127 kbit/s
  - Uplink: 158 kbit/s
- On-chip Memory: SRAM 512 KB
- Interface: USI, UART, I2C, GPIO, eSIM I/F, SDIO(Host), QSPI(Single/Dual/Quad IO mode), SMC
- Security: eFuse, AES, SHA-2, PKA, Secure Storage, Security Sub-System, PUF
- GNSS: GPS, Galileo, GLONASS, BeiDou

List of Exynos Automotive SoCs

Exynos Auto series

SoC			CPU	GPU			Memory technology			NPU	Moder
Model number	Fab.	Die size (mm^2)		µarch	Frequency (MHz)	Performance GFLOPS (FP32)	Type	Bus width (bit)	Bandwidth (GB/s)		
Exynos Auto 8890 (SGA8890A)[191]	14 nm (Samsung 14LPP)		4 + 4 cores (2.6 GHz[192] Exynos M1 "Mongoose" + 1.6 GHz Cortex-A53) (ARMv8-A)	Mali-T880 MP12	650	327.6	LPDDR4	64-bit (2×32-bit) Dual-channel		—	Shannon LTE DL: LTE 12 600 Mbit 3CA UL: LTE 13 150 Mbit 2CA
Exynos Auto T5123[193]	7 nm (Samsung 7LPP)		2 cores Cortex-A55 (ARMv8.2-A)				LPDDR4X	16-bit (1×16-bit) Single-channel	2133 MHz (8.5 GB/s)		LTE DL: Cat.24 3000 Mb 8CA, 102 QAM UL: Cat.2 422 Mbit 2CA, 256 QAM 5G NR S 6 GHz D 4.55 Gbi UL: 1.92 Gbi
Exynos Auto V7[194]	8 nm (Samsung 8LPP)		8 cores 1.5 GHz Cortex-A76 (ARMv8.2-A)	2× Mali-G76 (MP8 + MP3)			LPDDR4X LPDDR5	128-bit (8×16-bit) Octa-channel	2133 MHz (68.2 GB/s)	NPU	
Exynos Auto V9 (S5AHR80A)[195]			8 cores 2.1 GHz Cortex-A76 (ARMv8.2-A)	3× Mali-G76 (MP12 + MP3 + MP3)						NPU (8.5 TOPS)	
Exynos Auto V920 (S5AV920)[196]	5 nm (Samsung 5LPE)	148.72[197]	10 cores (4+4+2) ARM Cortex-A78AE (ARMv8.2-A)	Xclipse (RDNA 2 based 512:32:32:84 WGP)			LPDDR5	128-bit (8×16-bit) Octa-channel	3200 MHz (102.4 GB/s)	NPU (23.1 TOPS)	

The Exynos Auto V9 comes with additional features such as:

- Automotive Safety Integrity Level (ASIL)-B standards
- Safety island core
- 4× Tensilica HiFi 4 DSP
- Supports up to 6 displays, and up to 12 camera connections (4/4/4 MIPI CSI)
- Supports 4096x4096 120fps encoding and decoding with HEVC(H.265)

- 2x Gb Ethernet[198]

The Exynos Auto V920 comes with additional features such as:

- 3× Tensilica HiFi 5 DSP
- Supports up to 6 Displays (3x 5K (8K*2K) + 3x DFHD (3840*1440)), and up to 12 Cameras (3x MIPI CSI 4lanes)
- Supports 4K 240fps decoding (HEVC), 4K 120fps encoding
- 2x USXGMII (10 Gbit/s) Ethernet[196]

Controversies

Performance discrepancies

Samsung's flagship smartphones (except the foldable Galaxy Z series) released between 2016 (Galaxy S7) and 2022 (Galaxy S22), as well as the Galaxy S24 and S24+, utilizes both the Exynos and Qualcomm Snapdragon SoCs, with the latter being used mainly in models for American and East Asian (except South Korea) markets, and other regions using the former.

While both the Exynos and Snapdragon versions of the Galaxy S7,[199] S8,[200][201] and Note 8 have similar performances, the Exynos 9810-based models of Galaxy S9 and Note 9 has worse performance and efficiency than the Snapdragon 845 models.[202][203][204][205] The Exynos 9820 used in Galaxy S10, which utilizes older CPU cores and inferior manufacturing process than the Snapdragon 855, continued this discrepancy.[206]

Stability issues

Some of Samsung's phone models released between 2019 - 2021 that used Exynos 9611 processor were widely reported by customers having random restarts, freezing and bootloops. Specific phone models include the Galaxy A50, A50s, A51, M30s, M21, M31, M31s, F41 and Galaxy M21 (2021). Although the issue went unreported on mainstream media[207][208] and very few YouTube reviewers covered it based on user reports,[209][210] the issues were widely documented on Samsung Members official community forum[211][212][213][214][215][216] as well as Reddit and other forums.[217][218][219][220][221] The impact was significant with hundreds of user posts and comments between 2020 and 2023. Samsung did free board replacements for some early customers who had the phone in warranty.[222] However, the majority of people faced the issue after the 12-month warranty period, mostly starting 1.5 – 3 years after purchase. Samsung never officially acknowledged the issue and no software update was released to solve the problem, although the phones received the promised minimum 4 year security updates.[223] The only official solution available to customers was to purchase replacement board that cost around 60-70% of the phone's cost. Most users resorted to risky yet cheaper third party repair that required re-soldering (also called *reballing*) the CPU & RAM PoP (Package on Package) which managed to solve issue according to dozens of user reports on said forums.[224][225][226][227][228]

See also

- Comparison of Armv8-A processors
- Comparison of Armv7-A processors

Similar platforms

- A-Series by Allwinner
- Apple silicon (A/S/T/W/H/U/M series) by Apple Inc.
- Kirin by HiSilicon (Huawei)
- i.MX by NXP
- Jaguar and Puma by AMD
- MT by MediaTek
- NovaThor by ST-Ericsson
- OMAP by Texas Instruments
- RK by Rockchip Electronics
- Snapdragon by Qualcomm
- Tegra by Nvidia

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External links

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