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Adreno

Adreno is a series of graphics processing unit (GPU) semiconductor intellectual property cores developed by Qualcomm and used in many of their SoCs.

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History

Adreno (an anagram of AMD's graphic card brand *Radeon*), was originally developed by ATI Technologies and sold to Qualcomm in 2009 for \$65M^{[3][2]} and was used in their mobile chipset products. Early Adreno models included the Adreno 100 and 110, which had 2D graphics acceleration and limited multimedia capabilities. At the time, 3D graphics on mobile platforms were commonly handled using software-based rendering engines, which limited their performance. With growing demand for more advanced multimedia and 3D graphics capabilities, Qualcomm licensed the Imageon IP from AMD, in order to add hardware-accelerated 3D capabilities to their mobile products.^[3] Further collaboration with AMD resulted in the development of the Adreno 200, originally named the AMD Z430, based on the R400^[4] architecture used in the Xenos GPU of the Xbox 360 video game console^[5] and released in 2008, which was integrated into the first Snapdragon SoC. In January 2009, AMD sold their entire Imageon handheld device graphics division to Qualcomm.^[6]

Technical details

Variants

The company offers **Adreno GPUs** in various types, as a component of their Snapdragon SoCs:

Microarchitecture					Memory technology			Fillrate				
Name	Type	ALUs (SIMDs, FP32) ^[note 1]	On-chip graphics memory	TMU	Fab (nm)	Clock [MHz]	Memory bandwidth	Triangle [MT/s]	Pixel [GP/s]	Texture [GT/s]	(FP64)	
Before Adreno												
Defender2								0.25	0.007			
Defender3								0.25	0.022			
Stargate								0.6	0.09			
Adreno 1xx series												
Adreno 100												
Adreno 110												
Adreno 120												
Adreno 130	fixed function pipe/line	?	?		90 or 65		?	4 ^[11]	?	0.133		?
Adreno 2xx series - yamato												
Adreno 200 (AMD Z430)	Unified shader model 5-way VLIW ^[15]	[2]	8	256 KB	65	133	LPDDR-333 Single-channel 32-bit @ 166.5 MHz (1.3 GB/s)	22.85	0.133			0.53
Adreno 200 'enhanced'						200 245	LPDDR-400 Single-channel 32 bit @ 200 MHz (1.6 GB/s)	42	0.200 0.245		0.80 0.98	
Adreno 203		[4]	16		45	245 294	LPDDR2-600 Single-channel 32-bit @ 300 MHz (2.4 GB/s)	40.8 49.0	0.245 0.294		1.96 2.35	
Adreno 205						245 266	LPDDR2-666 Dual-channel 32-bit (64-bit) @ 333 MHz (5.3 GB/s)	40.8 44.3	0.245 0.266		1.96 2.12	
Adreno 2xx series - leia												
Adreno 220	Unified shader model 5-way VLIW ^[15]	[8]	32	512 KB	45	266	LPDDR2-666 Single-channel 32 bit @ 333 MHz (2.6 GB/s)	88.7	0.532			4.25
Adreno 225					28	200 300 400	LPDDR2-1000 Dual-channel 32-bit (64-bit) @ 500 MHz (8.0 GB/s)	133.3	0.8		3.20 4.80 6.40	
Adreno 3xx series - oxlii												
Adreno 304	Unified shader model Scalar Instruction set ^[18]	[24]	24	96 KB	28	400	LPDDR2/3-768/1066 Single-channel 32-bit @ 384-533 MHz (3.0-4.2 GB/s)					4.80
Adreno 305 (1st Gen.)				256 KB			LPDDR2-800 Single-channel 32-bit @ 400 MHz (3.2 GB/s)	66.7 75	0.8		4.80 5.40	
Adreno 305 (2nd Gen.)				128 KB		400 450	LPDDR2/3-1066 Single-channel 32-bit 533 MHz (4.2 GB/s)	66.7 75	0.8			
Adreno 306						400	LPDDR2/3-1066 Single-channel 32-bit @ 533 MHz (4.2 GB/s)	84.3	0.8		4.80	
Adreno 308		[54]	64	512 KB ^[22]		500	LPDDR3-1333 Single-channel 32-bit @ 666.5 MHz (5.3 GB/s)	105.4	1.0		6.00	
Adreno 320 (1st Gen.)						400	LPDDR2-1066 Dual-channel 32-bit (64-bit) @ 533 MHz (8.5 GB/s)	225	1.6	3.2	12.8	
Adreno 320 (2nd Gen.)						400 450	LPDDR3-1200 Dual-channel 32-bit (64-bit) @ 600 MHz (9.6 GB/s)	225 253.1	2.4 2.7	>3.2	19.2 21.6	
Adreno 330						450 550 578	LPDDR3-1600 Dual-channel 32-bit (64-bit) @ 800 MHz (12.8 GB/s)	253.1 309.4 325.1	3.6 4.4 4.624		28.8 35.2 36.9	
Adreno 4xx series												
Adreno 405	Unified shader model	[48]	48	256 KB	28	550	LPDDR3-1333/1866 Single-channel 32-bit @ 666.5-933 MHz (5.3-7.4 GB/s)					13.2
Adreno 418				512 KB	20	600	LPDDR3-1866 Dual-channel 32-bit (64-bit) @ 933 MHz (14.9 GB/s)				38.4	
Adreno 420		[128]	128	1536 KB	28	500 600	LPDDR3-1600 Dual-channel 64-bit (128-bit) @ 800 MHz (25.6 GB/s)	281.3 337.5 (0.56 ^[26] Tr/clock)	4 ⁴ (8.2 Px/clock)		32.0 38.4	
Adreno 430					20	500 600 650	LPDDR4-3200 Dual-channel 32-bit (64-bit) @ 1600 MHz (25.6 GB/s)	?	4.8 6.0 6.6		64.0 76.8 83.2	
Adreno 5xx series												
Adreno 504	Unified shader model + Unified memory	[48]	?	?	12	?		?	?	?		
Adreno 505			48	128 + 8 KB	28	450	LPDDR3-1600 Single-channel 32-bit @ 800 MHz (6.4 GB/s)			?		10.8

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Adreno 506			96		14	600 650	LPDDR3-1866 Single-channel 32-bit @ 933 MHz (7.4 GB/s)	?	?	?	28.8 31.2	
Adreno 508			[96]			650	LPDDR4 2666 Dual-channel 16-bit (32-bit) @ 1333 MHz (10.6 GB/s)	?	?	?	41.6	
Adreno 509				256 + 16 KB		720	LPDDR4-2666 Dual-channel 32-bit (64-bit) @ 1333 MHz (21.3 GB/s)	?	?	?	46.0	
Adreno 510			128									
			[128]	256 KB	28	600	LPDDR3-1866 Dual-channel 32-bit (64-bit) @ 933 MHz (14.9 GB/s)	?	?	?	38.4	
Adreno 512				256 + 16 KB		650		?	?	?	41.6	
						850					54.4	
Adreno 530			256		14	510 624 653	LPDDR4-3732 Quad-channel 16-bit (64-bit) @ 1866 MHz (29.8 GB/s)	?	6.7	7.7	65.2 79.8 83.5	
			[256]	1024 KB					8.1	8.1		
Adreno 540			384			710 739		>450	?	11.36 (16 Texels/clock) ^[49]	136.3 141.8	
			[384]		10							
Adreno 6xx series												
Adreno 605	Unified shader model + Unified memory			128+8 KB	14							
Adreno 608					10		LPDDR4X-4266 Dual-channel 16-bit (32-bit) @ 2133 MHz (17.0 GB/s)					
Adreno 610			128 [128]	?	11	600 750 950					28.8 36.68	
					6							
Adreno 612			128	256+16 KB	11	745 845					47.7 54.1	
Adreno 615						700 780					89.6	
Adreno 616					10		LPDDR4X-3732 Dual-channel 16-bit (32-bit) @ 1866 MHz (14.9 GB/s)				96.0	
						750						
Adreno 618			256			700						
			[128]			825 [37]					89.6 105.6	
				512 KB	8							
Adreno 619L						950						
						825						
Adreno 619						950	LPDDR4X-4266 Dual-channel 16-bit (32-bit) @ 2133 MHz (17.0 GB/s)				116.4 134	
					6							
Adreno 620			384		7	625 750			6.7/8.1		120.0 144.0	
			[192]									
Adreno 630			512		10	710	LPDDR4X 4266 Quad-channel 16-bit (64-bit) @ 1866 MHz (29.8 GB/s)	>500	?	15.4	181.7	
			[256]									
Adreno 640			768	1024 KB	12*2 ^[64]	7	585 675	LPDDR4X-4266 Quad-channel 16-bit (64-bit) @ 2133 MHz (34.1 GB/s)	?	9.4	28.1	224.6 259.2
			[384]									
Adreno 642L			384		6							
Adreno 642			[192]		5	490	LPDDR4X-4266 Dual-channel 16-bit (32-bit) @ 2133 MHz (17.0 GB/s)					
Adreno 643L					6	812	LPDDR4X-4266 or LPDDR5-6400 Quad-channel 16-bit (64-bit) @ 2133 MHz or 3200 MHz (34.1 GB/s or 44.0GB/s)					
Adreno 650			1024	?	24*2 ^[80]	7	587 670	LPDDR4X-4266 or LPDDR5-6400 Quad-channel 16-bit (64-bit) @ 2133 MHz or 3200 MHz (34.1 GB/s or 44.0GB/s)	14 x (est.) ^[81]	28.1 (est.) ^[81]	300.5 343.0	
			[512]									
			[48]									
Adreno 660			1024		5	792 905	LPDDR5 6400 Quad-channel 16-bit (64-bit) @ 3200 MHz (51.2 GB/s)				405.5 463.3	
			[512]									
Adreno 675			1344 [672]	?	7	590	LPDDR4X-4266 Quad-channel 16-bit (64-bit) @ 2133 MHz (34.1 GB/s)				396.4	

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Adreno 680		1536	?			800	LPDDR4X-4266 Octa-channel 16-bit (128-bit) @ 2133 MHz (68.2 GB/s)			460.8	
	[768]										
Adreno 685			?			250 590				192.0 453.1	
Adreno 690 ^[82]						661 680				507.6 522.2	
Adreno 7xx series											
Adreno 702						845	LPDDR3-1866 Single-channel 32-bit @ 933 MHz (7.4 GB/s) or LPDDR4X-3732 Dual channel 16 bit (32-bit) @ 1866 MHz (14.9 GB/s)				
Adreno 730		1536	[768]	1024 KB	4	818 900	LPDDR4X-3732 Dual channel 16 bit (32-bit) @ 1866 MHz (14.9 GB/s) or LPDDR5-3200 Single-channel 128-bit @ 933 MHz (64 GB/s)	1,864 MT/s	22.0 GPixel/s	628.2 691.2	
Name	Type	ALUs (SIMDs, FP32) ^[note 1]	On-chip graphics memory	TMU	Fab (nm)	Clock [MHz]	Memory bandwidth	Triangle [MT/s]	Pxel [GP/s]	Texture [GT/s]	(FP64)
Microarchitecture						Memory technology		Fillrate			

Notes

1. Adreno ALU = ALU x MP amount
2. Adreno 420 Vulkan driver was never released
- Adreno 130 inside the MSM7x01, and MSM7x01A. It supports OpenGL ES 1.1, OpenVG 1.1, EGL 1.3, Direct3D Mobile, SVGT 1.2, Direct Draw and GDI.
 - Adreno 200 (AMD Z430) inside the QSD8x50 and MSM7x27 (133 MHz). It offers a programmable function pipeline and streaming textures with support for OpenGL ES 1.0, OpenGL ES 1.1, OpenVG 1.1, EGL 1.4, Direct3D Mobile, SVGT 1.2 and DirectDraw. (22M triangles/second, 133M pixels/second, clock speed up to 133 MHz)
 - Adreno 200 enhanced inside the MSM7x25A and MSM7x27A (200 MHz). It supports OpenGL ES 2.0, OpenGL ES 1.1, OpenVG 1.1, EGL 1.4, Direct3D Mobile, SVGT 1.2, Direct Draw and GDI. (40M triangles/second, 200M pixels/second, clock speed up to 200 MHz)
 - Adreno 203 inside the MSM8225 and MSM8225Q (400 MHz). It is an improvement over Adreno 205. It features a higher frequency, has better pixel fillrate, lower power consumption, better 3D performance. It is about 50-100% faster than Adreno 200 (enhanced), and 10-25% than Adreno 205. It could clock 2x times higher than Adreno 205. It supports OpenGL ES 2.0, OpenGL ES 1.1, OpenVG 1.1, EGL 1.4, Direct3D Mobile, DirectX 9.0c, SVGT 1.2, Direct Draw and GDI. (42-50M triangles/second, 250-300M pixels/second, clock speed from 192 to 400 MHz)
 - Adreno 205 inside the QSD8x50A, MSM7x30, and MSM8x55 (245 MHz). Its improvements include Hardware-accelerated SVG and Adobe Flash and better shader-performance than the Adreno 200. It supports OpenGL ES 2.0, OpenGL ES 1.1, OpenVG 1.1, EGL 1.4, Direct3D Mobile, SVGT 1.2, Direct Draw and GDI. (57M triangles/second, 250M pixels/second, clock speed up to 400 MHz)
 - Adreno 220 inside the MSM8660 or MSM8260 (266 MHz) with single channel memory. It supports OpenGL ES 2.0, OpenGL ES 1.1, OpenVG 1.1, EGL 1.4, Direct3D Mobile, DirectX 9.0c, SVGT 1.2, Direct Draw and GDI. (88M triangles/second, 500M pixels/second, standard clock speed up to 266 MHz, overclock up to 400 MHz)
 - Adreno 225 inside the MSM8960 (400 MHz), with unified shader architecture and dual channel memory. It supports Direct3D 9.0c in addition to OpenGL ES 2.0, OpenGL ES 1.1, OpenVG 1.1, EGL 1.4, Direct3D Mobile, SVGT 1.2, Direct Draw and GDI.
 - Adreno 320 inside the Qualcomm S4 Pro & Prime Series, with unified shader architecture and dual channel memory. It supports Direct3D feature level 9_3 in addition to OpenGL ES 3.0, OpenGL ES 2.0, OpenGL ES 1.1, OpenVG 1.1, EGL 1.4, Direct3D Mobile, SVGT 1.2^[23]
 - Adreno 330 inside the Nexus 5, Amazon Kindle HDX series tablets, Amazon Fire phone, Nokia Lumia 2520 tablet, Nokia Lumia 1520, Nokia Lumia Icon, Nokia Lumia 930, Samsung Galaxy S5, Samsung Galaxy Note 3, Sony Xperia Z1, Sony Xperia Z1 Compact, Sony Xperia Z2, Sony Xperia Z3 Compact, Sony Xperia Z Ultra, Xiaomi Mi3, Xiaomi Mi4, OnePlus One, HTC One (M8) and LG G2/G3 smartphones.
 - Adreno 420 inside the Qualcomm Snapdragon 805 supports Direct3D 11.2 runtime (feature level 11_1). Inside the Google Nexus 6, Samsung Galaxy S5 LTE-A, Samsung Galaxy Note 4, Samsung Galaxy Note Edge, LG G3 Cat. 6, Amazon Fire HDX 8.9 (2014). The Qualcomm Snapdragon 805 is the first phone SoC ever to feature a 128-bit memory bus.
 - Adreno 540 inside the Qualcomm Snapdragon 835 is the first phone SoC to feature variable refresh rate and foveated rendering/Variate Rate Shading, Qualcomm calls their implementations Q-Sync and Adreno Foveation.
 - Adreno 630 inside the Qualcomm Snapdragon 845 is the first phone SoC to feature Inside-Out Room-scale 6DoF with SLAM.
 - Adreno 640 inside the Qualcomm Snapdragon 855 is the first phone SoC to feature updateable GPU drivers from the Google Play Store.
 - Adreno 660 inside the Qualcomm Snapdragon 888 is the first phone SoC to feature Variable Rate Shading (VRS).

Operating system support

There are proprietary drivers for the Linux-based mobile operating system Android available from Qualcomm themselves. Historically the only way to have GPU support on non-Android Linux was with the libhybris wrapper.

Linux and Mesa supports the Adreno 200/300/400/500 series of GPUs with a driver called *freedreno*. Freedreno allows fully open-source graphics on devices like the 96Boards Dragonboard 410c and Nexus 7 (2013).

See also

- Qualcomm Hexagon
- List of Qualcomm Snapdragon processors
- PowerVR – competing graphics technology available as a Silicon IP core (SiP) to 3rd parties
- Mali – competing graphics technology available as a Silicon IP core (SiP) to 3rd parties
- Vivante – competing graphics technology available as a Silicon IP core (SiP) to 3rd parties
- Tegra – family of SoCs for mobile computers, the graphics core could be available as SiP block to 3rd parties
- VideoCore – family of SoCs, by Broadcom, for mobile computers, the graphics core could be available as SiP block to 3rd parties
- Atom family of SoCs – with Intel graphics core, not licensed to 3rd parties
- AMD mobile APUs – with AMD graphics core, not licensed to 3rd parties
- AMD Imageon (ATI Imageon) - List of ATI mobile GPU
- Intel 2700G - Old Intel mobile GPU
- List of Nvidia graphics processing units - GPU Nvidia
- Apple M1

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External links

- Official website (https://developer.qualcomm.com/discover/chipsets-and-modems/adreno-gpu)
- Additional information on history of Adreno (https://pcper.com/2015/06/qualcomm-history-and-its-gpu-revolution/)

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