ARM Holdings : Portfolio Report

Introduction

Arm Holdings is a leading semiconductor company that designs microprocessors, physical intellectual property (IP) and related technology and software. Headquartered in Cambridgeshire, U.K., the company develops and licenses technology that forms the core of many digital electronic devices such as smartphones, servers and sensor-based products. [1]

ARM's strength is its patent assets. The company makes significant investment in its research and development (R&D) efforts to build mobile processor core and system designs, and licenses or sells them to electronics and system companies. [2]

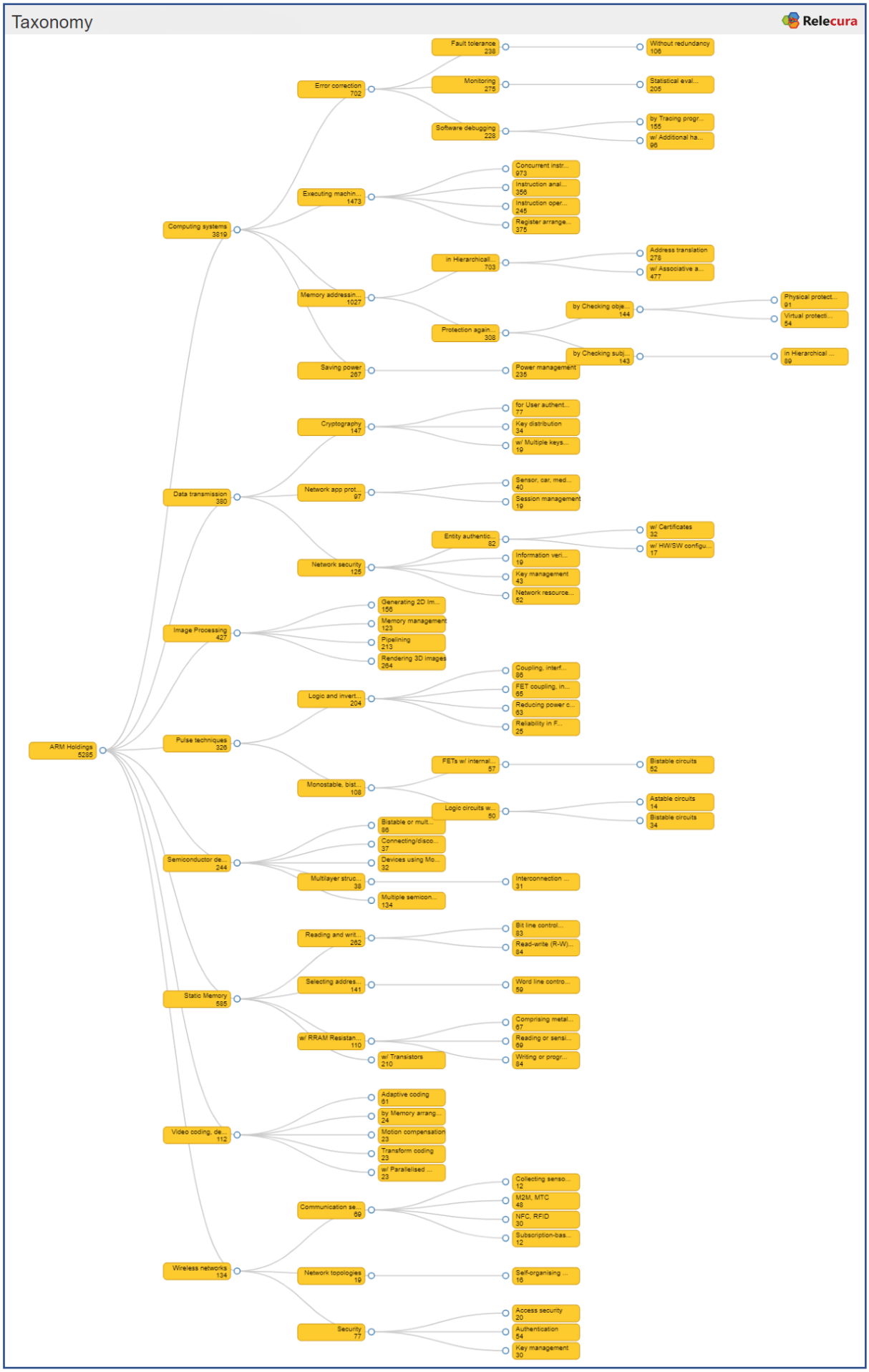
In 2016, SoftBank Group took over Arm Holdings to address the Internet of Things (IoT) space. As a part of its IoT strategy, Arm has made several acquisitions, the most recent one being the acquisition of Treasure Data. This comes as a part of the company's plan to launch a new connectivity and data management software-as-a-service (SaaS) platform. [3]

Being a company that relies heavily on its intellectual assets, Arm boasts of an interesting patent and technology portfolio. This report analyses the patent assets held by Arm Holdings and provides insights into various aspects of the overall portfolio.

Contents

Sources

1. Arm Holdings (Wikipedia.org)
2. Arm Holdings Annual Strategic Report (Annualreports.com)
3. Sealing Treasure Data buy, Arm launches Pelion IoT Platform to manage data on any device (siliconangle.com)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Access security 20
Authentication 54
Key management 30

Summary

Relecura

TOTAL DOCUMENTS COUNT (APPLICATIONS)

5,285

PUBLICATION TYPES

1,983 | 3,299

Applications | Grants

Peak Year of Activity

2017 (1,043)

IP TYPES

5,277 | 5 | 3

Invention | Model | Design

No of technologies (95)

PATENT BY STAR RATING

2.21

★★★★★	3
★★★★☆	66
★★★☆☆	1,661
★★☆☆☆	2,843
★☆☆☆☆	712

Top Active Jurisdiction

US (1,935)

Top Rated

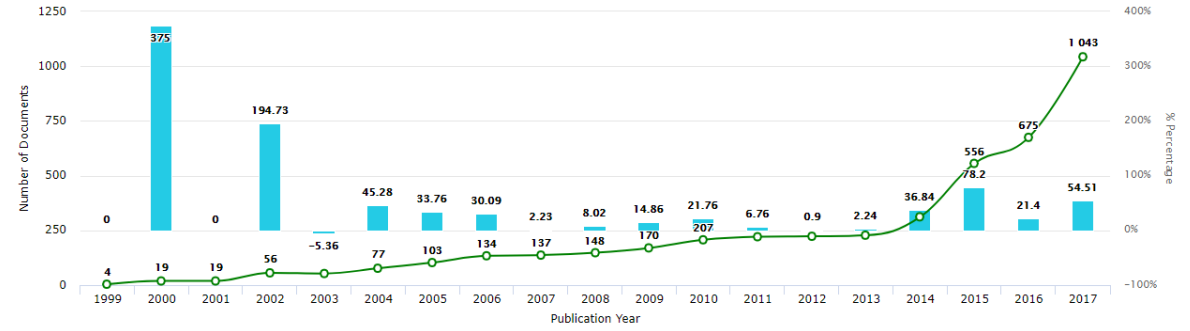
US9748943B2 (4.5)

Top Cited

US6957402B2 (200)

Portfolio Trends

Relecura



Key Geographies

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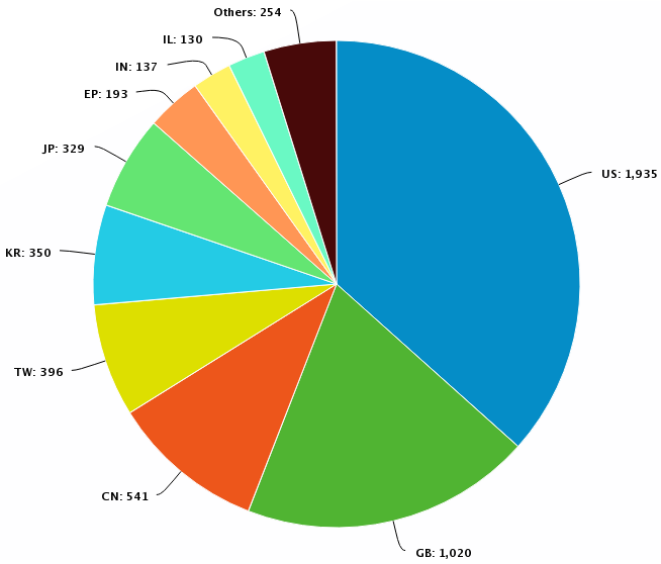


Key Technologies

Technologies	# Applications
Digital Data Processing	3812
Static Memory	584
Image Data Processing	427
Data Transmission	380
Pulse Techniques	323
Electric Elements - Semiconductor Devices	244
Measurement - Electric & Magnetic Variables	204
Pictorial Communication	155
Displays (Circuits)	133

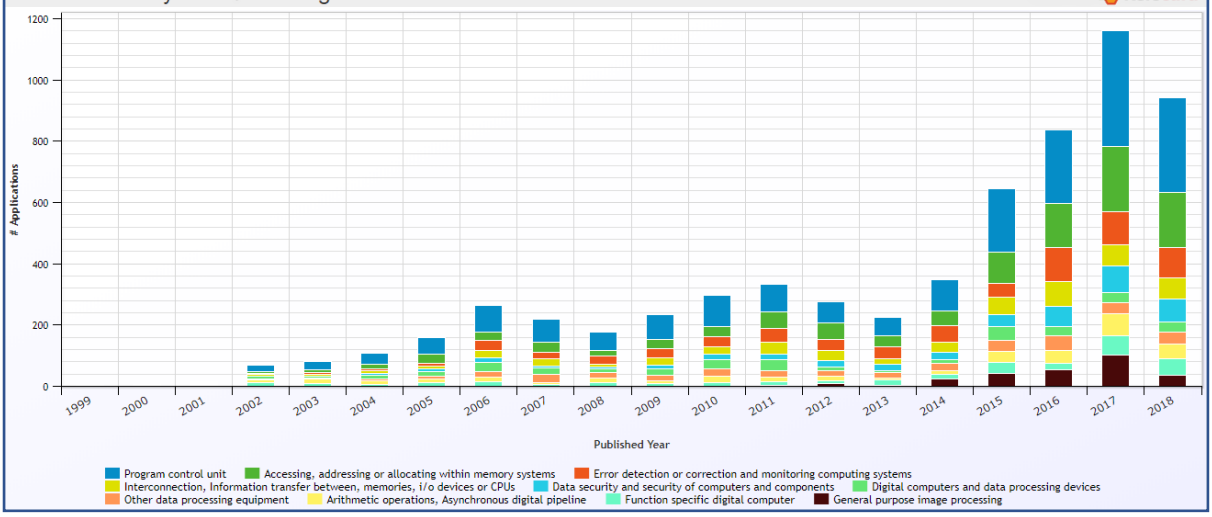
Analysis of Key Technologies

Technologies	Applications	Grants	Sub Technologies	Geographies
digital data processing	1323	2491	program control unit (2000) , accessing, addressing or allocating within memory systems (1034) , error detection or correction and monitoring computing systems (703) , interconnection, information transfer between, memories, i/o devices or cpus (536) , data security and security of computers and components (420)	US (1374) , GB (689) , CN (411) , JP (278) , KR (235)
static memory	172	412	reading and writing of data to an memory (262) , memories using electric or magnetic storage elements (259) , selecting address in memory (141) , details of semiconductor memories (124) , testing and repairing memories (121)	US (260) , TW (118) , KR (55) , GB (50) , CN (41)
image data processing	158	269	general purpose image processing (277) , rendering 3d images (264) , generating 2d images (156) , circuits for display devices (98) , architecture of display device (68)	US (154) , GB (138) , CN (62) , KR (32) , JP (25)
data transmission	159	221	cryptographics for secret digital communication (147) , data security and security of computers and components (131) , architecture for network security (125) , arrangements, apparatus, circuits or systems for digital transmission (118) , program control unit (103)	US (161) , GB (83) , CN (46) , KR (32) , JP (16)
pulse techniques	88	236	logic and inverting circuits (203) , monostable, bistable or multistable circuits (108) , electronic switching and gating (54) , other data processing equipment (51) , manipulating electric pulses (47)	US (131) , TW (71) , GB (38) , KR (25) , CN (23)

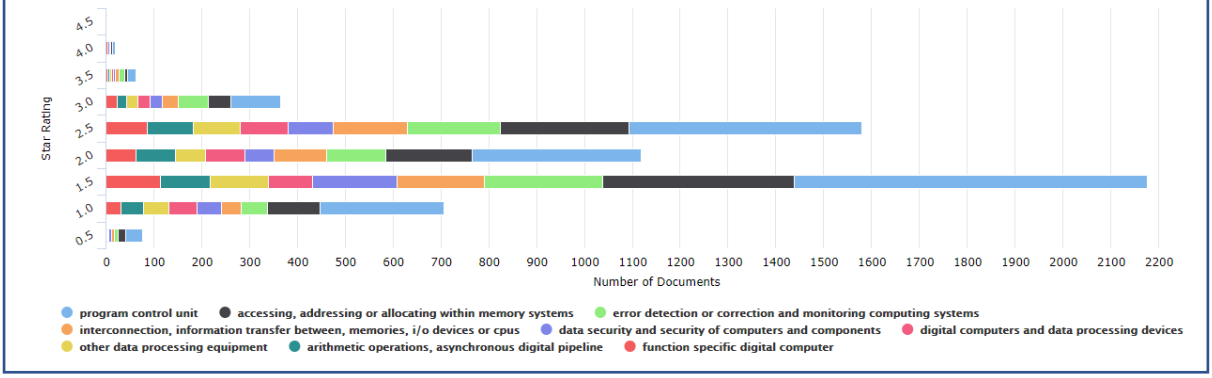
Key Sub-technologies

Sub-technologies	# Applications
Program Control Unit	1995
Accessing, Addressing or Allocating Within Memory Systems	1033
Error Detection or Correction and Monitoring Computing Systems	701
Interconnection, Information Transfer Between, Memories, I/O Devices or CPUs	536
Data Security and Security of Computers And Components	420
Digital Computers and Data Processing Devices	367
Other Data Processing Equipment	365
Arithmetic Operations, Asynchronous Digital Pipeline	356
Function Specific Digital Computer	324

Evolution of Key Sub-technologies



Patent Quality by Sub-technologies (Star Rating)

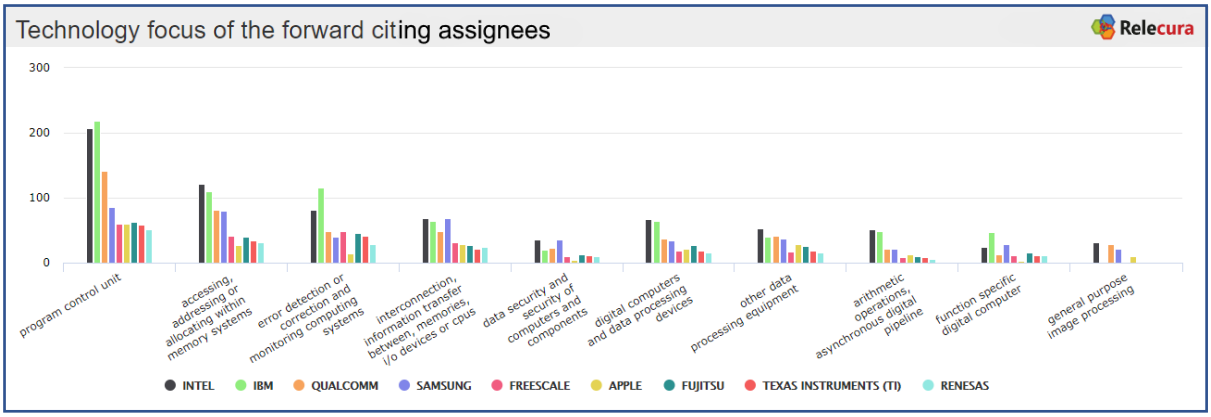


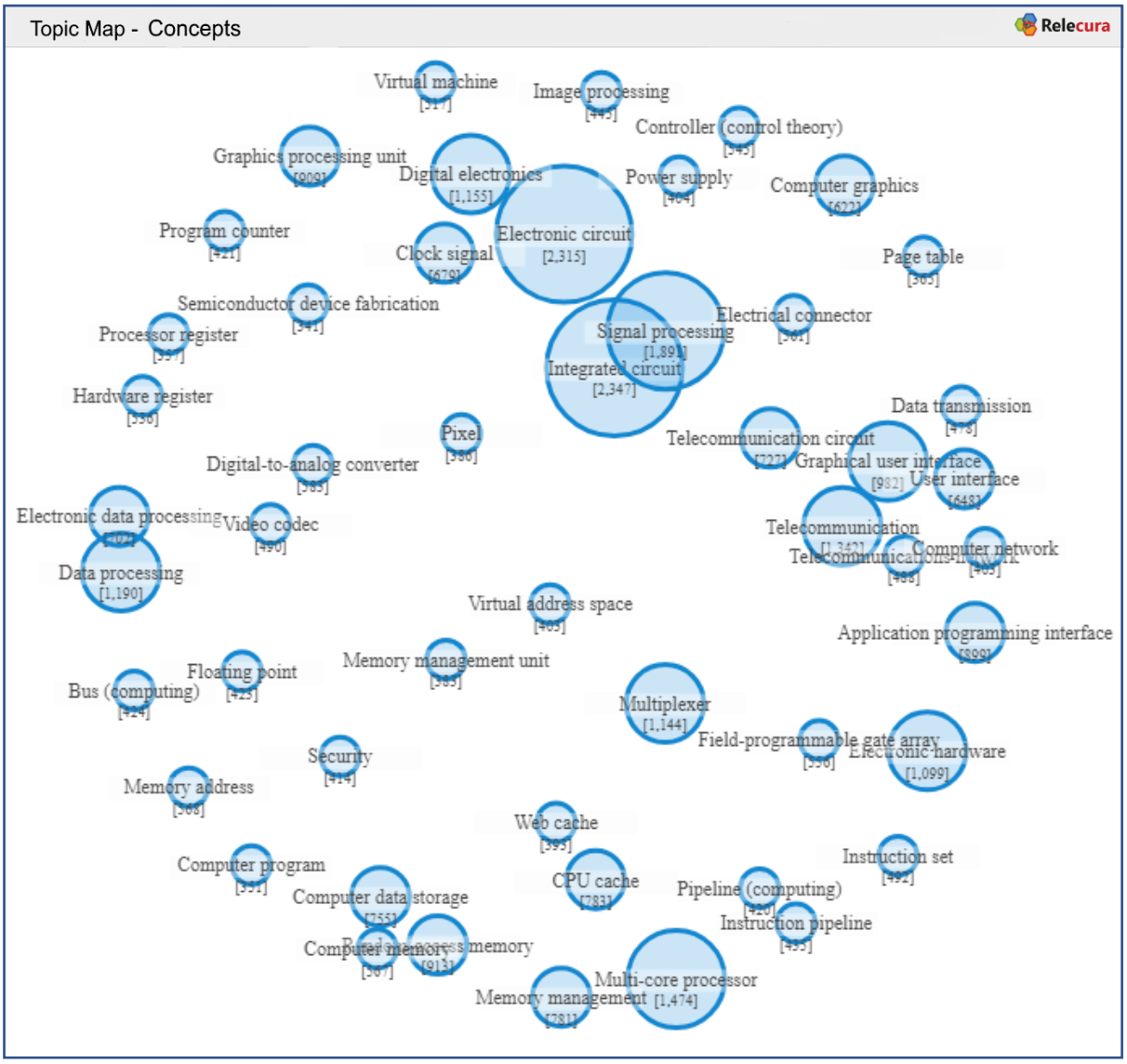
Key Patents

Publicaton No.	Title	Inventor	Filing Date	Star Rating	#Fwd Citations
US9748943B2	Programmable current for correlated electron switch	Bal S. Sandhu, George McNeil Lattimore, Robert Campbell Aitken	2015-08-13	4.5	31
US9851738B2	Programmable voltage reference	Bal S. Sandhu, George McNeil Lattimore, Robert Campbell Aitken	2015-08-13	4.5	30
US7231531B2	Personal electronics device with a dual core processor	Bryan T. Cupps, Timothy J. Glass	2003-02-28	4.5	175
US9735766B2	Correlated electron switch	Lucian Shifren	2015-07-31	4.0	26
US7184003B2	Personal electronics device with display switching	Bryan T. Cupps, Timothy J. Glass	2003-01-13	4.0	123

Top Forward Citing Assignees

FC Assignee	# Applications
INTEL	484
IBM	473
QUALCOMM	364
SAMSUNG	341
FREESCALE	177
APPLE	160
FUJITSU	157
TEXAS INSTRUMENTS	144
RENESAS	126




Topic Map - Concepts
Relecura
Virtual machine
Image processing
Controller (control theory)
Graphics processing unit
Digital electronics
Power supply
Computer graphics
Program counter
Electronic circuit
Clock signal
Page table
Semiconductor device fabrication
Electrical connector
Processor register
Signal processing
Integrated circuit
Hardware register
Data transmission
Pixel
Telecommunication circuit
Graphical user interface
User interface
Digital-to-analog converter
Electronic data processing
Video codec
Telecommunication
Computer network
Data processing
Virtual address space
Application programming interface
Memory management unit
Floating point
Bus (computing)
Multiplexer
Field-programmable gate array
Electronic hardware
Security
Memory address
Web cache
Instruction set
Computer program
CPU cache
Pipeline (computing)
Computer data storage
Instruction pipeline
Computer memory
Multi-core processor
Memory management

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Relecura is a full-stack cognitive cloud platform that provides custom intelligence and reports on patent portfolios, technologies and companies. It does this by capturing and organizing the knowledge from various document repositories (patents, scientific literature) and subject matter experts in a flexible and collaborative manner, into a knowledge-base.

Relecura offers IP analytics tools and a custom enterprise platform to corporations, law firms, IP services firms, R&D organizations and academic institutions. The enterprise platform integrates the discovery and analysis of public documents with internal company documents. Relecura also has an API to help create custom tools for IP and business intelligence.

ARM Holdings

Competitive Comparison and Growth Trends

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Introduction

Relecura's Taxonomy delivers comparative insights on patents across multiple company portfolios or different time periods – all in the matter of a few steps. This makes it particularly suited to generate competitive insights and growth trends for different sub-categories within the technology domain of interest.

We have created a few such analytics snapshots comparing the patent assets held by ARM Holdings with its competitors in the CPU and GPU space (Table 1), as well as comparing ARM's portfolio to those of a couple of large players, i.e. Intel and Qualcomm (Table 2).

Table 3 once again compares ARM's portfolio in its various categories to those of its competitors in the GPU and CPU space, the difference being that we focus only on the high-quality patents in each of the portfolios.

Finally, in Table 4 we look at growth trends year-wise in each of the ARM's portfolio categories in the 2012-2017 period, and compare them to the trends in all of the patents published year-wise in the same period.

Table 1. ARM Holdings vs. Competitors (GPU/CPU)

Number of Applications given for nodes coded						CPU			GPU	
						ARM	AMD	MIPS	Imagination	nVidia
ARM Holdings vs Competitors	Computing systems	Error correction	Fault tolerance	Without redundancy		106	25	2	11	47
			Monitoring	Statistical evaluation of computer activity		205	59	3	20	37
			Software debugging	by Tracing program execution		155	19	0	8	10
				w/ Additional harware		96	14	0	3	6
		Executing machine instructions	Concurrent instruction execution, e.g. pipeline, look ahead			973	579	217	242	527
			Instruction analysis, e.g. decoding, instruction word fields			356	93	38	52	44
			Instruction operation extension or modification			245	110	21	39	55
			Register arrangements			375	96	62	53	93
		Memory addressing, allocation	Protection against unauthorised memory use	by Checking object accessibility	Physical protection, e.g. cell, word, block	91	21	0	0	7
					Virtual protection, e.g. for virtual blocks or segments before a translation mechanism	54	18	1	0	1
				by Checking subject access rights	in Hierarchical protection system	89	44	2	2	0
			in Hierarchically structured memory systems	Address translation		278	268	15	36	141
				w/ Associative addressing		477	541	63	67	204
		Saving power	Power management			235	447	6	17	250
	Data transmission	Cryptography	Key distribution			34	16	2	4	11
			for User authentication			77	30	0	3	16
			w/ Multiple keys, algorithms			19	4	2	2	0
		Network app protocols	Sensor, car, medical networks			40	2	0	0	1
			Session management			19	3	0	0	21
		Network security	Entity authentication	w/ Certificates		32	0	0	0	0
				w/ HW/SW configuration		17	1	0	3	0
			Information verification			19	9	0	0	6
			Key management			43	11	0	3	2
			Network resource access			52	15	0	0	3
	Image Processing	Generating 2D Images				156	91	0	150	333
		Memory management				123	149	0	147	321
		Pipelining				213	268	1	152	622
		Rendering 3D images				264	323	0	533	1064
	Pulse techniques	Logic and inverting circuits	Coupling, interface arrangements			86	52	0	0	28
			FET coupling, interface arrangements			65	35	0	0	11
			Reducing power consumption			63	30	0	0	10
			Reliability in FET circuits			25	25	0	0	1
		Monostable, bistable or multistable circuits	FETs w/ internal, external positive feedback	Bistable circuits		52	24	0	0	51
			Logic circuits w/ internal, external positive feedback	Astable circuits		14	10	0	0	11
				Bistable circuits		34	12	0	0	18
	Semiconductor devices	Bistable or multistable switching devices				86	9	0	0	0
		Connecting/disconnecting semiconductor bodies				37	744	0	0	164
		Devices using Mott metal-insulator transition, e.g. field effect transistors				32	0	0	0	0
		Multilayer structure of conductive and	Interconnection layout			31	36	0	0	3
		Multiple semiconductor or solid state devices components formed on a common substrate				134	718	0	0	27
	Static Memory	Reading and writing of data to an memory	Bit line control circuits, e.g. drivers, boosters, pull-up circuits, pull-down circuits, precharging circuits, equalising circu			83	13	0	0	25
			Read-write (R-W) timing or clocking circuits; Read-write (R-W) control signal generators or management			84	41	0	0	28
		Selecting address in memory	Word line control circuits, e.g. drivers, boosters, pull-up circuits, pull-down circuits, precharging circuits, for word lines			59	34	0	0	6
		w/ RRAM Resistance random access memory elements	Comprising metal oxide memory material, e.g. perovskites			67	3	0	0	0
			Reading or sensing circuits or methods			69	1	0	0	0
			Writing or programming circuits or methods			84	11	0	0	0
		w/ Transistors				210	115	0	0	94
	Video coding, decoding	Adaptive coding				61	133	0	86	150
		Motion compensation				23	58	0	52	50
		Transform coding				23	63	0	47	104
		by Memory arrangements				24	42	0	42	52
		w/ Parallelised computational arrangements				23	32	0	25	63
	Wireless networks	Communication services	Collecting sensor information			12	0	0	0	0
			M2M, MTC			48	0	0	3	6
			NFC, RFID			30	0	0	0	7
			Subscription-based services			12	0	0	0	9
		Network topologies	Self-organising networks			16	0	0	7	3
		Security	Access security			20	0	0	0	3
			Authentication			54	6	0	0	17
			Key management			30	0	0	3	1

Table 2. ARM Holdings vs. Large Players (Intel, Qualcomm)

Number of Applications given for nodes coded						ARM	Intel	Qualcomm
ARM Holdings vs Competitors	Computing systems	Error correction	Fault tolerance	Without redundancy		106	654	161
			Monitoring	Statistical evaluation of computer activity		205	754	239
			Software debugging	by Tracing program execution		155	175	20
				w/ Additional harware		96	132	57
		Executing machine instructions	Concurrent instruction execution, e.g. pipeline, look ahead			973	3938	1353
			Instruction analysis, e.g. decoding, instruction word fields			356	1772	265
			Instruction operation extension or modification			245	758	182
			Register arrangements			375	1377	284
		Memory addressing, allocation	Protection against unauthorised memory use	by Checking object accessibility	Physical protection, e.g. cell, word, block	91	232	28
					Virtual protection, e.g. for virtual blocks or segments before a translation mechanism	54	251	36
				by Checking subject access rights	in Hierarchical protection system	89	139	22
			in Hierarchically structured memory systems	Address translation		278	1271	482
				w/ Associative addressing		477	3319	888
		Saving power	Power management			235	4126	1993
	Data transmission	Cryptography	Key distribution			34	1045	1063
			for User authentication			77	1669	1192
			w/ Multiple keys, algorithms			19	415	230
		Network app protocols	Sensor, car, medical networks			40	546	609
			Session management			19	302	766
		Network security	Entity authentication	w/ Certificates		32	339	302
				w/ HW/SW configuration		17	249	179
			Information verification			19	363	557
			Key management			43	666	1084
			Network resource access			52	1009	869
	Image Processing	Generating 2D Images				156	496	432
		Memory management				123	706	317
		Pipelining				213	1026	533
		Rendering 3D images				264	1090	755
	Pulse techniques	Logic and inverting circuits	Coupling, interface arrangements			86	521	388
			FET coupling, interface arrangements			65	227	260
			Reducing power consumption			63	172	237
			Reliability in FET circuits			25	48	92
		Monostable, bistable or multistable circuits	FETs w/ internal, external positive feedback	Bistable circuits		52	152	318
			Logic circuits w/ internal, external positive feedback	Astable circuits		14	102	109
				Bistable circuits		34	106	182
	Semiconductor devices	Bistable or multistable switching devices				86	282	23
		Connecting/disconnecting semiconductor bodies				37	5833	2428
		Devices using Mott metal-insulator transition, e.g. field effect transistors				32	5	0
		Multilayer structure of conductive and insulating layers	Interconnection layout			31	498	465
		Multiple semiconductor or solid state devices components formed on a common substrate				134	3113	2056
	Static Memory	Reading and writing of data to an memory	Bit line control circuits, e.g. drivers, boosters, pull-up circuits, pull-down circuits, precharging circuits, equalising circu			83	160	240
			Read-write (R-W) timing or clocking circuits; Read-write (R-W) control signal generators or management			84	402	313
		Selecting address in memory	Word line control circuits, e.g. drivers, boosters, pull-up circuits, pull-down circuits, precharging circuits, for word lines			59	97	194
		w/ RRAM Resistance random access memory elements	Comprising metal oxide memory material, e.g. perovskites			67	56	6
			Reading or sensing circuits or methods			69	199	68
			Writing or programming circuits or methods			84	263	67
		w/ Transistors				210	1153	917
	Video coding, decoding	Adaptive coding				61	1013	6503
		Motion compensation				23	462	2655
		Transform coding				23	477	2780
		by Memory arrangements				24	153	497
		w/ Parallelised computational arrangements				23	124	534
	Wireless networks	Communication services	Collecting sensor information			12	74	112
			M2M, MTC			48	2207	1281
			NFC, RFID			30	1306	1030
			Subscription-based services			12	147	242
		Network topologies	Self-organising networks			16	913	2763
		Security	Access security			20	566	1245
			Authentication			54	1266	2468
			Key management			30	631	1499

Table 3. ARM Holdings vs. Competitors (GPU/CPU) – High-quality Patents

We have devised a proprietary patent quality rating that ranks each patent out of five, which we call the 'Relecura Star Rating' of the patent. It is a composite metric based on the findings of studies to determine the characteristics of valuable patents. Patents which score three or more based on this ranking are deemed to be of high-quality.

We have restricted the patents of various companies show below to those with a "Relecura Star Rating" of three or more.

Number of Applications given for nodes coded							CPU			GPU	
						ARM	AMD	MIPS	Imagination	nVidia
ARM Holdings vs Competitors (High Quality Patents)	Computing systems	Error correction	Fault tolerance	Without redundancy		5	3	0	0	7
			Monitoring	Statistical evaluation of computer activity		33	3	0	0	4
			Software debugging	by Tracing program execution		34	1	0	0	4
				w/ Additional harware		17	1	0	0	0
		Executing machine instructions	Concurrent instruction execution, e.g. pipeline, look ahead			90	38	27	4	76
			Instruction analysis, e.g. decoding, instruction word fields			29	1	4	1	3
			Instruction operation extension or modification			23	9	5	0	7
			Register arrangements			42	5	8	0	15
		Memory addressing, allocation	Protection against unauthorised memory use	by Checking object accessibility	Physical protection, e.g. cell, word, block	5	3	0	0	0
					Virtual protection, e.g. for virtual blocks or segments before a translation mechanism	8	2	0	0	0
				by Checking subject access rights	in Hierarchical protection system	7	1	1	0	0
			in Hierarchically structured memory systems	Address translation		16	26	3	0	25
				w/ Associative addressing		43	39	4	3	29
		Saving power	Power management			24	73	0	1	42
	Data transmission	Cryptography	Key distribution			4	1	0	0	1
			for User authentication			7	0	0	0	4
			w/ Multiple keys, algorithms			0	0	0	0	0
		Network app protocols	Sensor, car, medical networks			6	0	0	0	0
			Session management			1	0	0	0	2
		Network security	Entity authentication	w/ Certificates		5	0	0	0	0
				w/ HW/SW configuration		2	0	0	0	0
			Information verification			0	1	0	0	1
			Key management			6	1	0	0	2
			Network resource access			4	0	0	0	0
	Image Processing	Generating 2D Images				36	10	0	12	59
		Memory management				14	10	0	16	40
		Pipelining				23	25	0	12	89
		Rendering 3D images				36	30	0	56	177
	Pulse techniques	Logic and inverting circuits	Coupling, interface arrangements			3	2	0	0	1
			FET coupling, interface arrangements			1	2	0	0	0
			Reducing power consumption			5	1	0	0	0
			Reliability in FET circuits			2	0	0	0	0
		Monostable, bistable or multistable circuits	FETs w/ internal, external positive	Bistable circuits		1	1	0	0	1
			Logic circuits w/ internal, external positive feedback	Astable circuits		2	0	0	0	4
				Bistable circuits		0	0	0	0	0
	Semiconductor devices	Bistable or multistable switching devices				9	0	0	0	0
		Connecting/disconnecting semiconductor bodies				0	47	0	0	9
		Devices using Mott metal-insulator transition, e.g. field effect transistors				1	0	0	0	0
		Multilayer structure of conductive and	Interconnection layout			1	0	0	0	0
		Multiple semiconductor or solid state devices components formed on a common substrate				2	22	0	0	2
	Static Memory	Reading and writing of data to an memory	Bit line control circuits, e.g. drivers, boosters, pull-up circuits, pull-down circuits, precharging circuits, equalising circu			2	0	0	0	2
			Read-write (R-W) timing or clocking circuits; Read-write (R-W) control signal generators or management			4	6	0	0	1
		Selecting address in memory	Word line control circuits, e.g. drivers, boosters, pull-up circuits, pull-down circuits, precharging circuits, for word lines			2	1	0	0	1
		w/ RRAM Resistance random access memory elements	Comprising metal oxide memory material, e.g. perovskites			10	1	0	0	0
			Reading or sensing circuits or methods			12	0	0	0	0
			Writing or programming circuits or methods			14	0	0	0	0
		w/ Transistors				6	10	0	0	3
	Video coding, decoding	Adaptive coding				5	17	0	6	15
		Motion compensation				0	4	0	2	5
		Transform coding				0	13	0	5	11
		by Memory arrangements				0	8	0	5	9
		w/ Parallelised computational arrangements				0	7	0	3	6
	Wireless networks	Communication services	Collecting sensor information			1	0	0	0	0
			M2M, MTC			3	0	0	0	0
			NFC, RFID			2	0	0	0	0
			Subscription-based services			1	0	0	0	1
		Network topologies	Self-organising networks			2	0	0	1	1
		Security	Access security			2	0	0	0	0
			Authentication			9	0	0	0	1
			Key management			2	0	0	0	0

Table 4. ARM Holdings vs. Overall – Year-wise Comparison of Patents Published

Number of Applications given for nodes coded						Overall							ARM						
						2012	2013	2014	2015	2016	2017	Overall	ARM	2012	2013	2014	2015	2016	2017
Trends	Computing systems	Error correction	Fault tolerance	Without redundancy		1886	2382	3148	3427	3760	3791			6	7	16	21	22	32
			Monitoring	Statistical evaluation of computer activity		2666	3129	3779	4066	4180	4315			24	21	27	16	58	51
			Software debugging	by Tracing program execution		310	430	497	534	581	559			21	13	17	13	39	37
				w/ Additional harware		209	261	217	220	264	307			21	16	9	8	37	27
		Executing machine instructions	Concurrent instruction execution, e.g. pipeline, look ahead			2478	3136	3490	3418	3765	3752			96	92	114	174	171	205
			Instruction analysis, e.g. decoding, instruction word fields			411	701	828	968	1144	1369			53	51	35	44	70	66
			Instruction operation extension or modification			373	477	568	573	652	758			38	34	15	41	50	55
			Register arrangements			535	825	836	906	1043	1271			56	53	47	85	71	82
		Memory addressing, allocation	Protection against unauthorised memory use	by Checking object accessibility	Physical protection, e.g. cell, word, block	193	216	267	329	329	370			6	3	5	18	22	37
					Virtual protection, e.g. for virtual blocks or segments before a	116	146	153	175	185	183			17	12	3	9	9	3
				by Checking subject access rights	in Hierarchical protection system	91	112	122	130	125	123			15	11	6	18	9	19
			in Hierarchically structured memory systems	Address translation		1121	1184	1485	1638	2026	2356			19	26	24	37	77	76
				w/ Associative addressing		2931	3122	4125	4408	5065	5413			45	43	53	90	109	133
		Saving power	Power management			4711	5782	6909	7166	7877	7765			30	28	14	39	49	29
	Data transmission	Cryptography	Key distribution			5246	5561	6101	6235	7206	9164			2	4	5	2	13	18
			for User authentication			10561	10588	10798	10830	11736	13235			1	8	13	15	26	28
			w/ Multiple keys, algorithms			1198	1185	1288	1561	1822	2556			0	0	3	5	5	12
		Network app protocols	Sensor, car, medical networks			3129	3539	4516	6302	8579	12812			0	0	0	7	19	16
			Session management			2285	2390	2851	3466	3985	4611			0	0	1	3	6	6
		Network security	Entity authentication	w/ Certificates		1375	1526	1823	1981	2311	2524			0	3	4	5	20	12
				w/ HW/SW configuration		574	713	1059	1666	2411	2994			0	0	0	4	13	5
			Information verification			1812	1858	2079	2358	2671	3079			0	0	1	5	11	8
			Key management			2247	2386	2789	3298	4432	5157			0	0	3	11	20	22
			Network resource access			4982	5659	7005	8209	10125	10728			0	1	5	18	25	24
	Image Processing	Generating 2D Images				5577	6549	7765	8713	10325	10794			18	17	47	46	48	46
		Memory management				597	707	1093	1194	1432	1489			6	3	23	36	50	53
		Pipelining				996	1130	1560	1838	2200	2528			23	11	33	63	59	96
		Rendering 3D images				4802	4917	5070	5287	5809	6436			26	19	71	77	70	98
	Pulse techniques	Logic and inverting circuits	Coupling, interface arrangements			1731	1843	1911	1846	1903	1976			14	12	19	20	10	10
			FET coupling, interface arrangements			830	884	867	811	982	993			12	8	16	13	9	7
			Reducing power consumption			411	450	493	486	596	554			12	10	12	15	10	7
			Reliability in FET circuits			113	146	124	137	157	187			5	3	3	3	6	5
		Monostable, bistable or multistable circuits	FETs w/ internal, external positive feedback	Bistable circuits		686	660	764	681	893	860			11	6	8	10	10	11
			Logic circuits w/ internal, external positive feedback	Astable circuits		260	291	303	318	393	370			3	2	2	2	1	1
				Bistable circuits		240	240	257	339	426	421			4	7	7	5	5	4
	Semiconductor devices	Bistable or multistable switching devices				2382	2477	2542	2329	2108	2036			0	0	0	0	0	40
		Connecting/disconnecting semiconductor bodies				39640	40241	40664	37479	34186	27445			8	7	6	14	10	4
		Devices using Mott metal-insulator transition, e.g. field effect				20	26	29	23	19	33			0	0	0	0	0	17
		Multilayer structure of conductive and insulating layers	Interconnection layout			950	1085	1532	2255	3342	4212			5	6	2	5	3	12
		Multiple semiconductor or solid state devices components formed				41561	42679	45547	46776	50766	52926			12	19	11	14	15	33
	Static Memory	Reading and writing of data to an memory	Bit line control circuits, e.g. drivers, boosters, pull-up circuits, pull-down			648	679	771	804	830	898			8	11	23	29	17	20
			Read-write (R-W) timing or clocking circuits; Read-write (R-W) control			1236	1186	1391	1311	1280	1392			7	7	22	29	17	16
		Selecting address in memory	Word line control circuits, e.g. drivers, boosters, pull-up circuits,			602	651	614	567	589	593			13	7	14	21	13	10
		w/ RRAM Resistance random access memory elements	Comprising metal oxide memory material, e.g. perovskites			963	989	938	893	719	665			0	0	0	0	2	53
			Reading or sensing circuits or methods			531	633	853	907	1039	1024			0	0	0	0	1	50
			Writing or programming circuits or methods			1161	1227	1356	1359	1447	1307			0	0	0	0	2	60
		w/ Transistors				3936	3681	3807	3937	3916	4026			25	32	46	60	30	54
	Video coding, decoding	Adaptive coding				9958	11185	11848	13064	14302	15104			6	3	10	11	24	16
		Motion compensation				4211	4671	4965	5406	5486	5437			0	1	2	2	10	9
		Transform coding				6684	6602	5898	5706	5793	5675			1	3	6	3	7	2
		by Memory arrangements				1860	1679	1309	1256	1333	1271			4	2	2	4	8	7
		w/ Parallelised computational arrangements				892	909	1021	1039	1182	1286			6	3	1	3	5	7
	Wireless networks	Communication services	Collecting sensor information			176	206	398	555	668	778			0	0	0	5	11	4
			M2M, MTC			1179	2213	3358	4576	5963	6912			0	0	1	10	22	26
			NFC, RFID			1373	2516	4425	7084	10051	11769			0	0	1	11	19	16
			Subscription-based services			687	888	1272	1375	1602	1486			0	0	1	4	11	3
		Network topologies	Self-organising networks			6195	6806	6942	7049	7890	8313			0	2	1	5	7	6
		Security	Access security			2735	3325	4063	4924	5808	6152			0	1	1	8	16	9
			Authentication			5794	6371	7932	8929	10657	11301			2	4	5	12	37	19
			Key management			2156	2458	3000	3449	3970	4161			0	0	1	7	19	14

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