Agenda

Introdução

Fundamentos de AOC

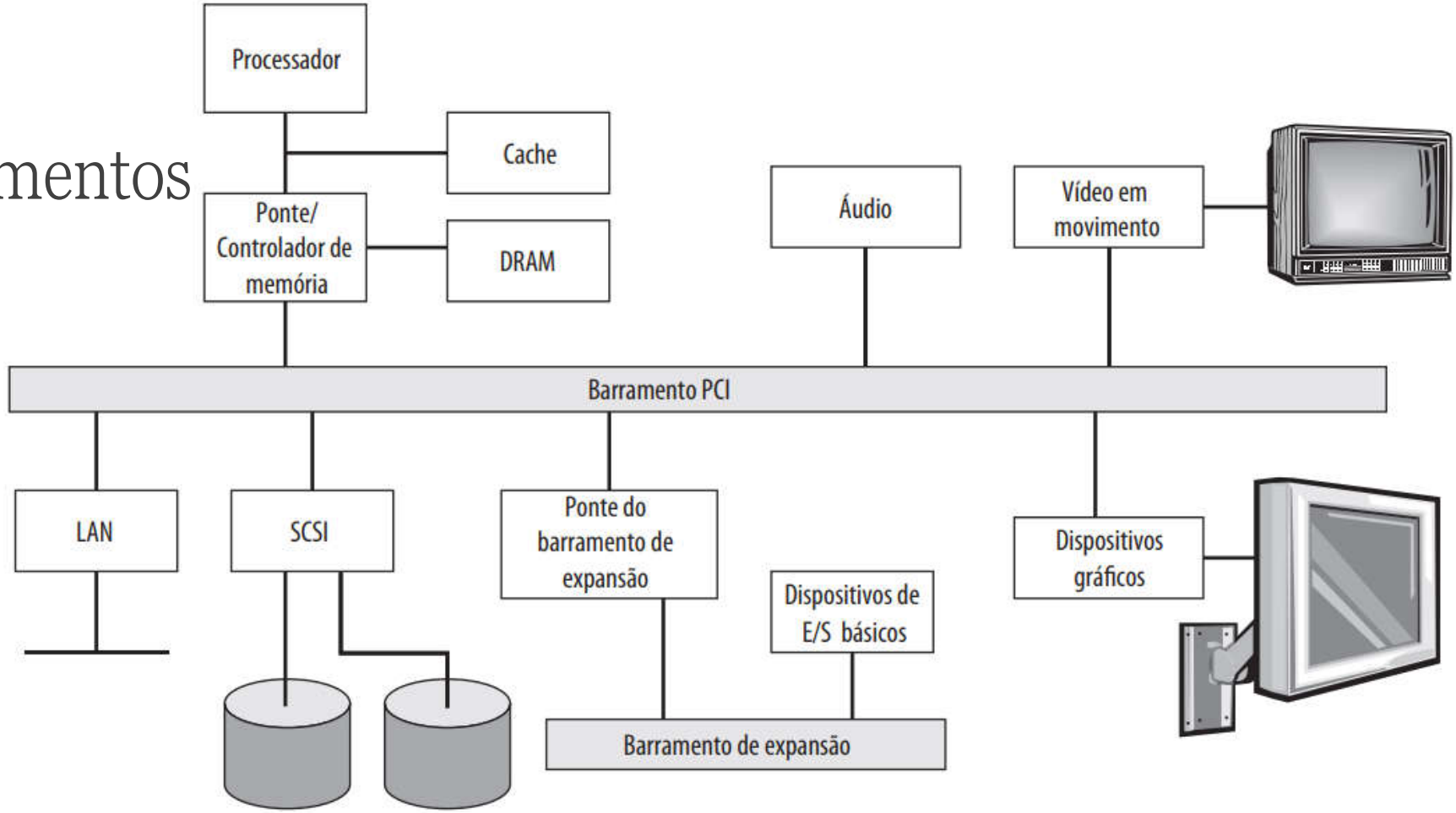
Sistema Computacional

Dispositivos de E/S

Armazenamento de Dados

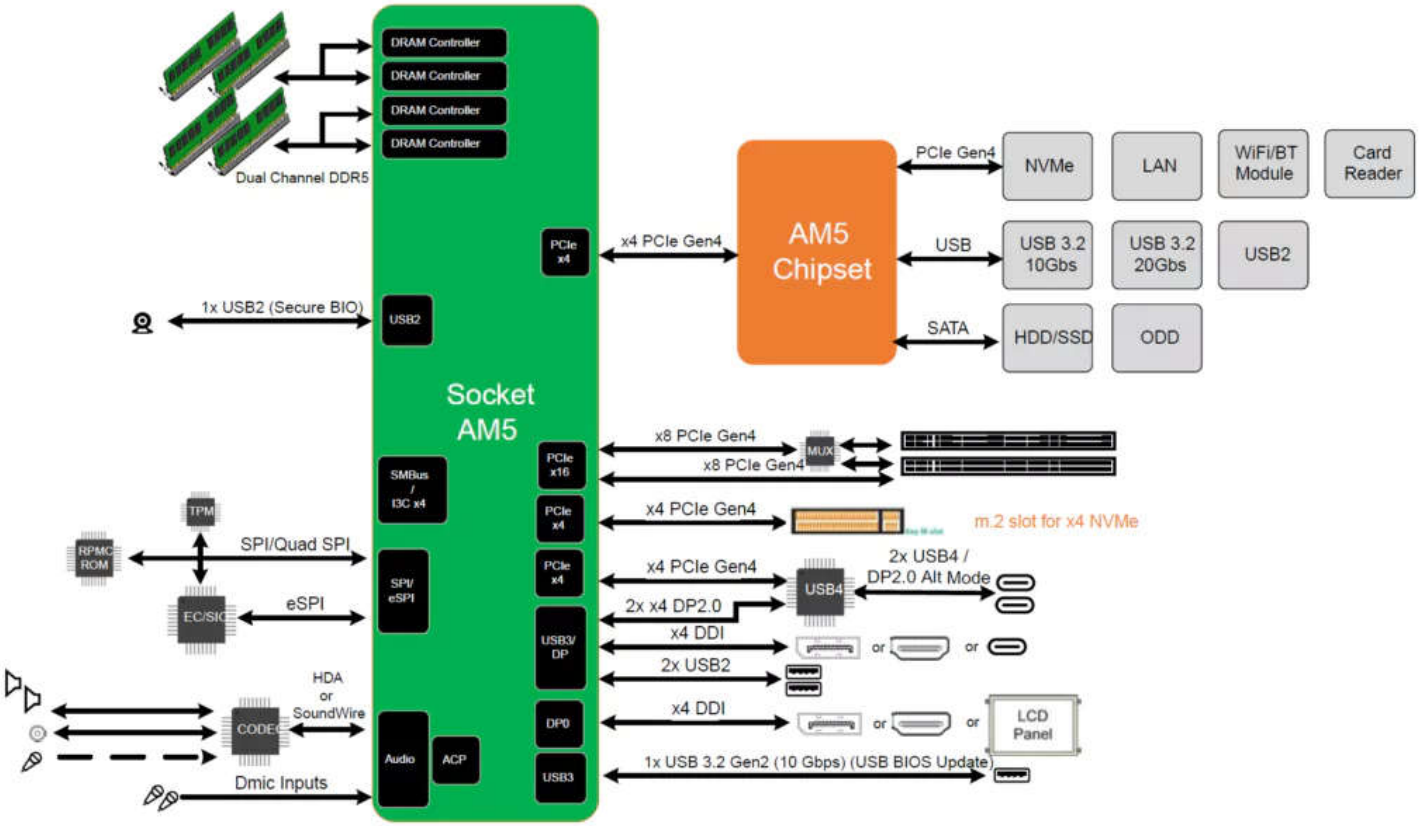
Processamento da Dados

Barramentos



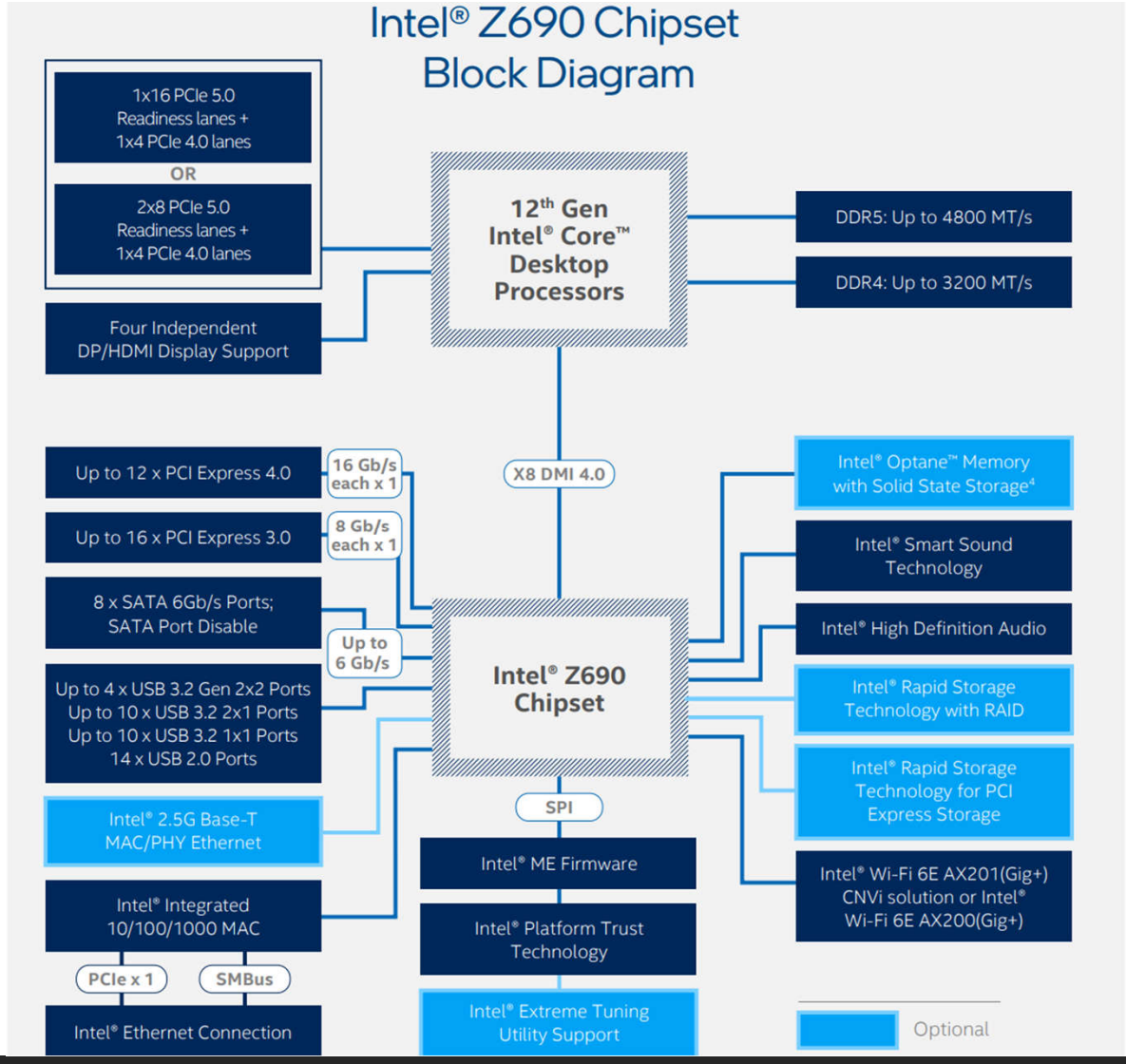
Chipset AMD

- AMD 600-series
  - 3 chipsets: X670E, X670 e B650
  - Link



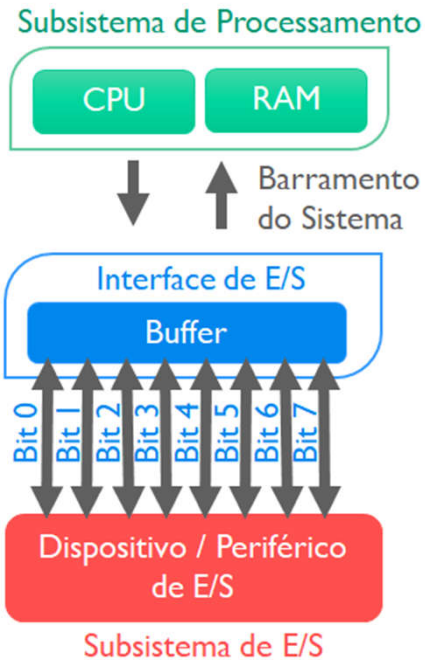
Chipset Intel

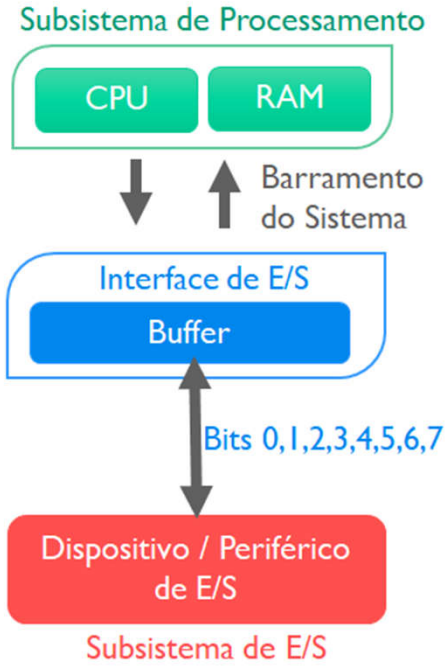
- Intel core i9
  - 12 Gen
- Chipset Intel Z690



Comunicação

- Paralelo
- Serial

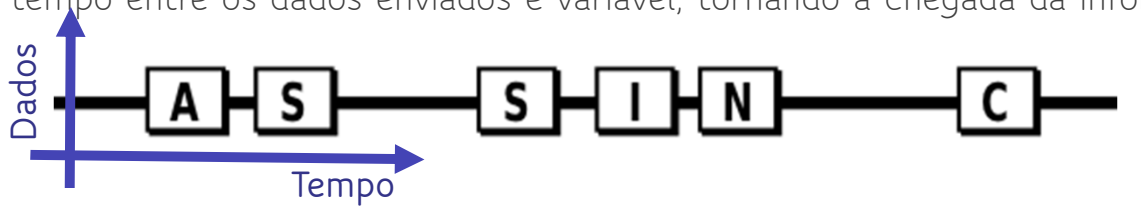




Carcaterística	Paralelo	Serial
Custo	Maior	Menor
Distância	Curta	Sem Limite
Vazão (Throughput)	Alto	Baixo

Transmissão

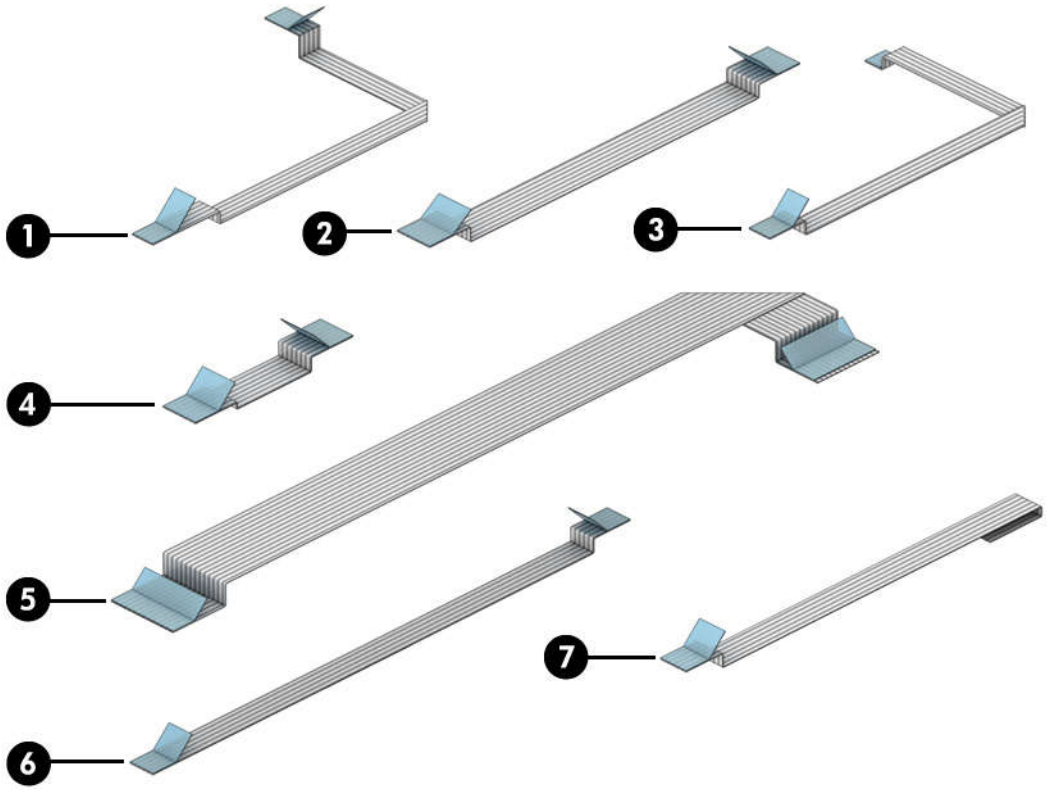
- Transmissão Assíncrona
  - O tempo entre os dados enviados é variável, tornando a chegada da informação não previsível



- Transmissão Síncrona
  - O tempo entre os dados enviados é constante, pode-se prever a chegada da informação

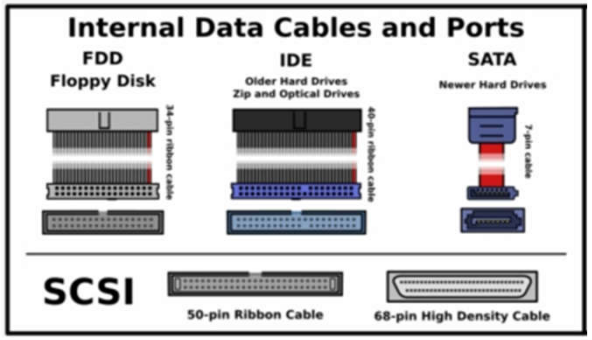
Cabos Notebook

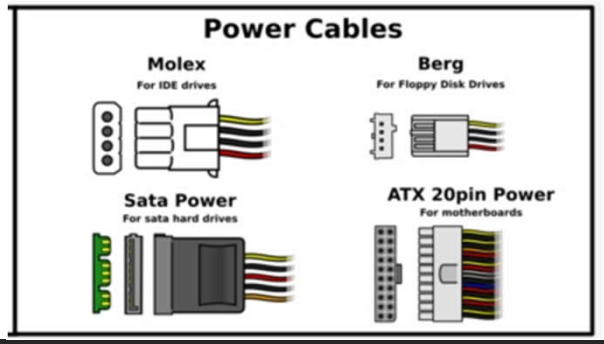
1. Cabo do HD/SSD
2. Cabo da placa usb
3. Cabo do áudio
4. Cabo do leitor de cartão
5. Cabo do leitor Biométrico
6. Cabo dos botões do touchpad
7. Cabo do touchpad

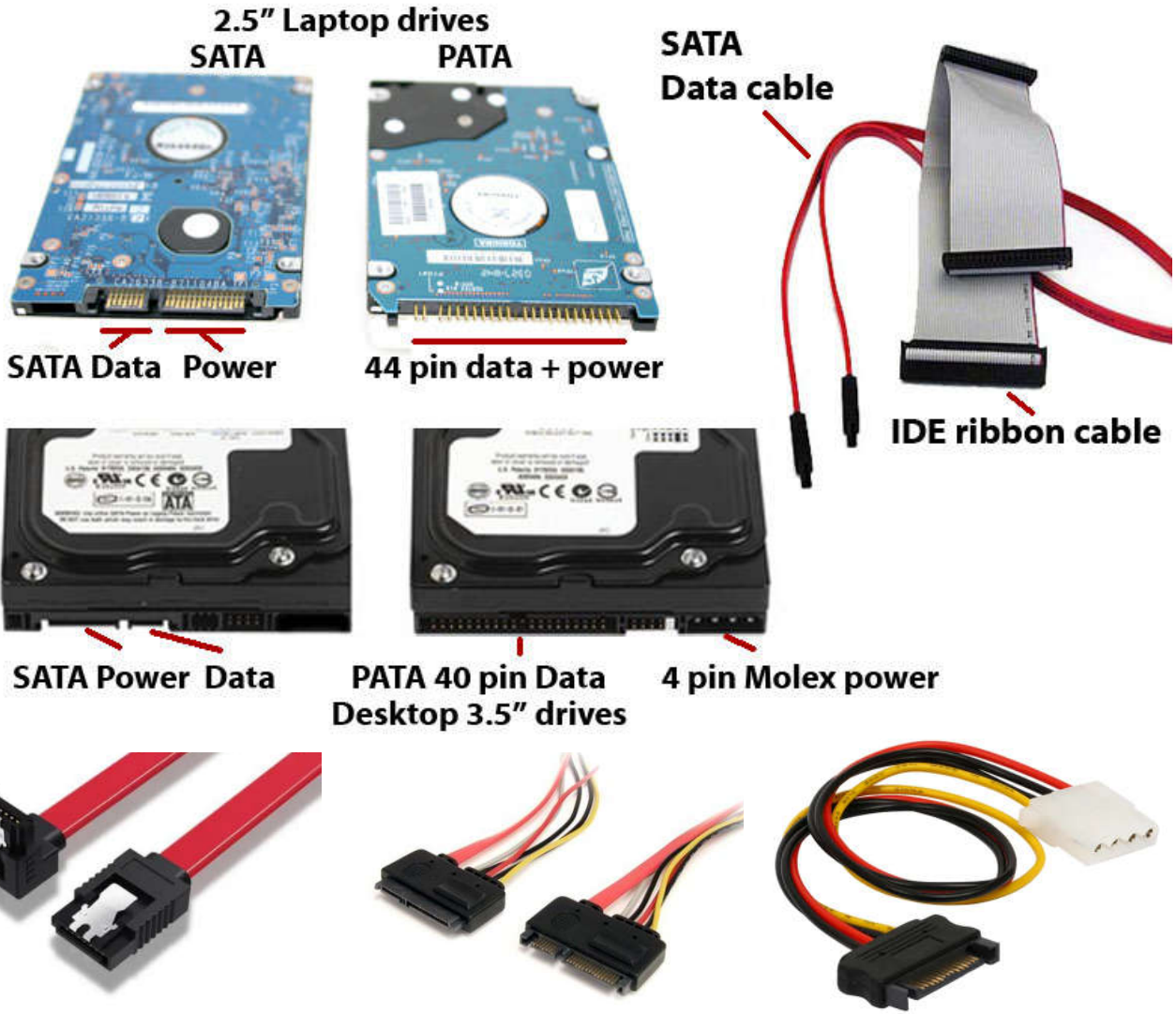


[HP, 2023d]

Cabos Desktop PATA vs SATA



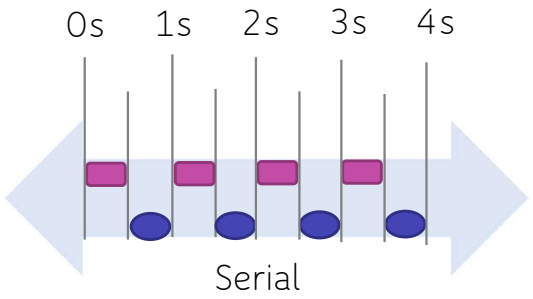


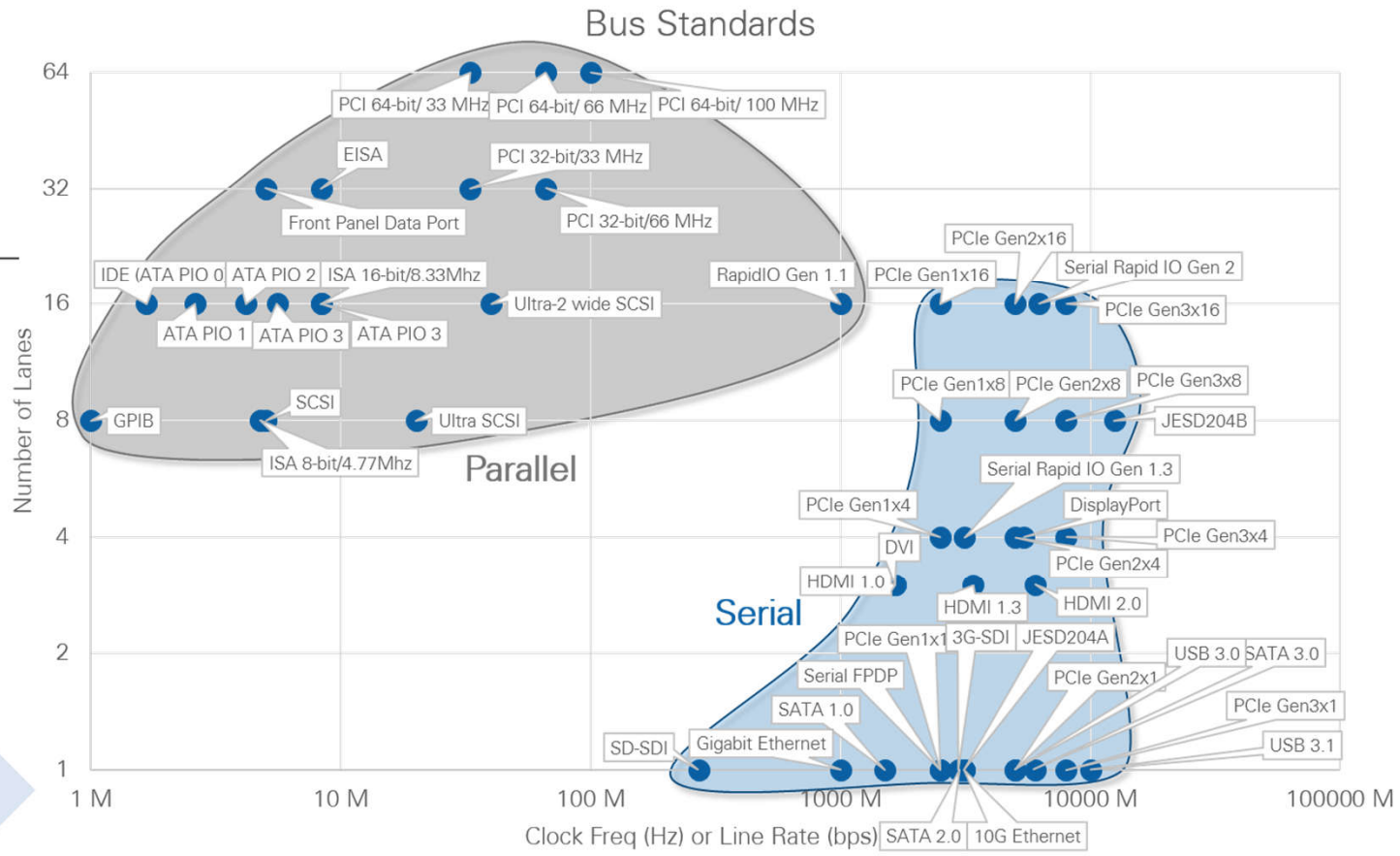


[QUILL, 2012]

Barramentos

- Serial
- Paralelo



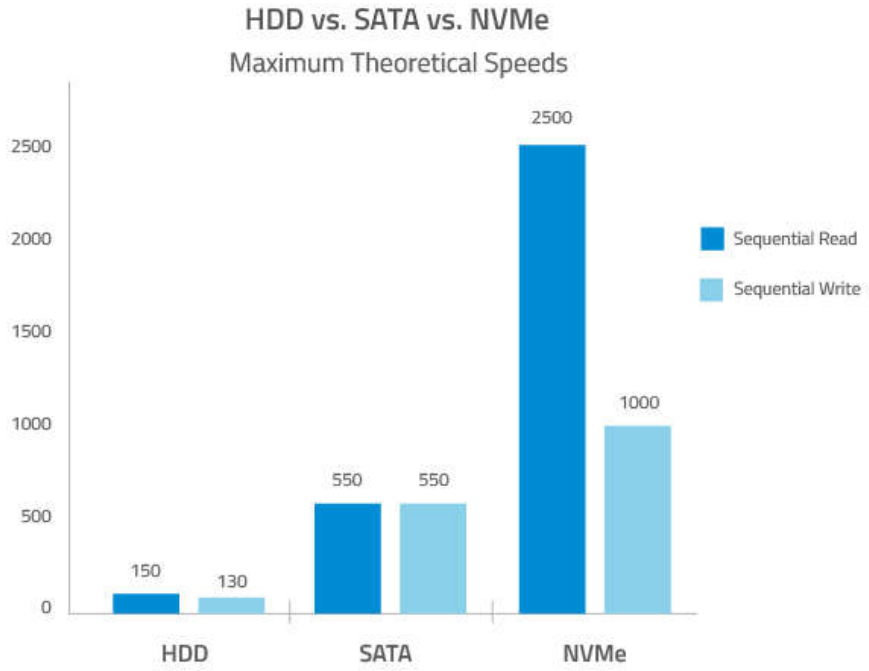


SSD Class

	Class	Sequential* Read/Write	Random** Read/Write	Interface
SATA	10 "value"	520K/320K	30K/10K	SATA interface reduced features e.g. dram-less Consumer Offering
SATA	20 "mainstream"	500K/300K	80K/60K	SATA Interface full feature set Consumer, Commercial
SATA	30 "performance"	550K/350K	90K/75K	Best in class SATA Precision Only
PCIe	40 "performance"	1500/350K	200K/80K	PCIe interface NVMe host protocol Consumer, Commercial Performance
PCIe	50 "performance"	2100K/1200K	300K/100K	Best in class PCIe Precision Only

[DELL, 2018]

Sata x Nvme

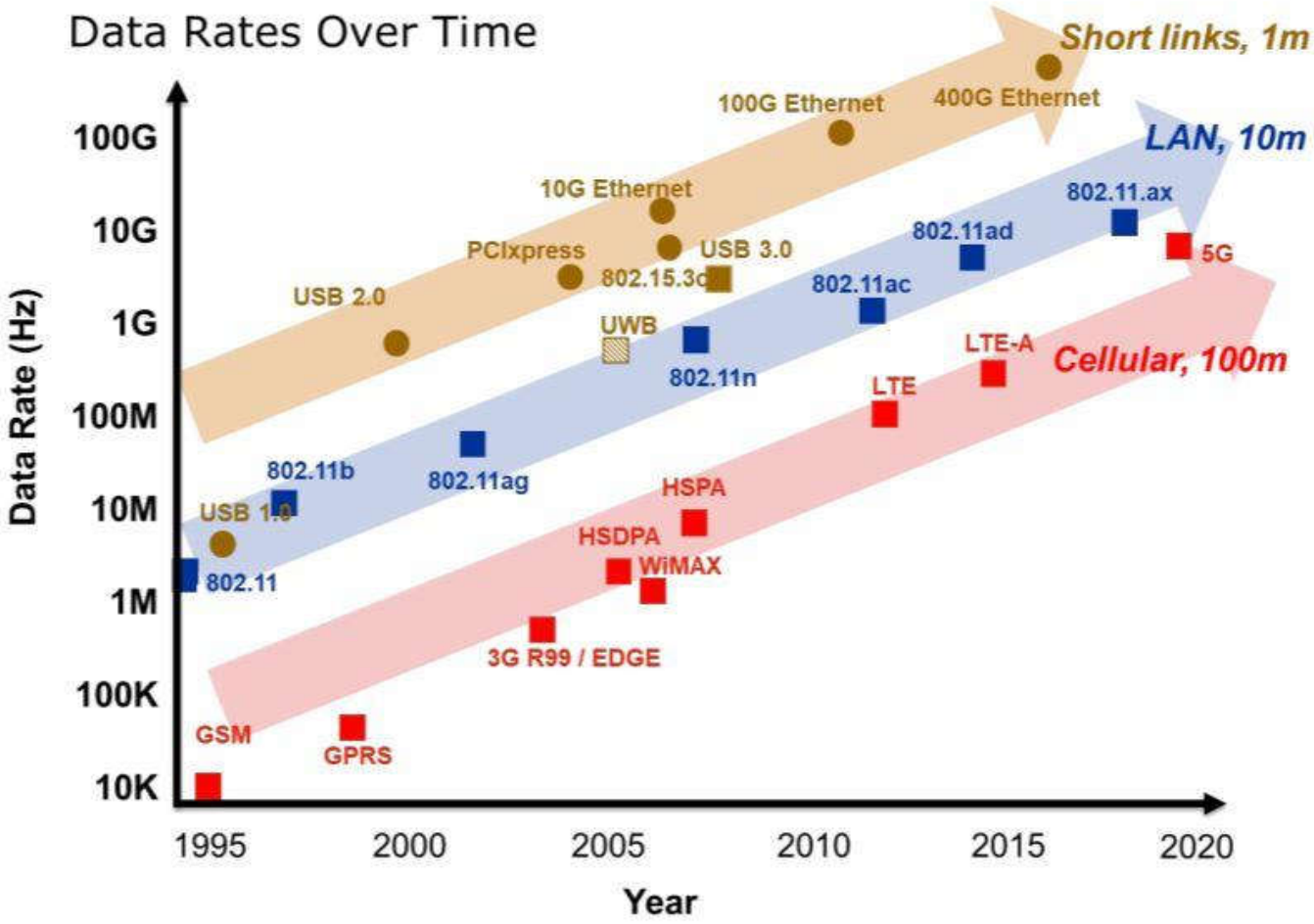


PCIe				SATA		
Generation	Transfer Rate	Throughput per Lane		Generation	Transfer Rate	Throughput
Gen1	2.5 Gb/s	x1: 250 MB/s	x4: 1 GB/s	Gen1	1.5 Gb/s	150 MB/s
Gen2	4.9 Gb/s	x1: 500 MB/s	x4: 2 GB/s	Gen2	3 Gb/s	300 MB/s
Gen3	7.9 Gb/s	x1: 984.6 MB/s	x4: 3.9 GB/s	Gen3	6 Gb/s	600 MB/s
Gen4	15.8 Gb/s	x1: 1,969 MB/s	x4: 7.8 GB/s			

[ATP, 2018]

Escala de Comunicação

- Interface de E/S precisa ter desempenho?



[MORRIS, 2019]

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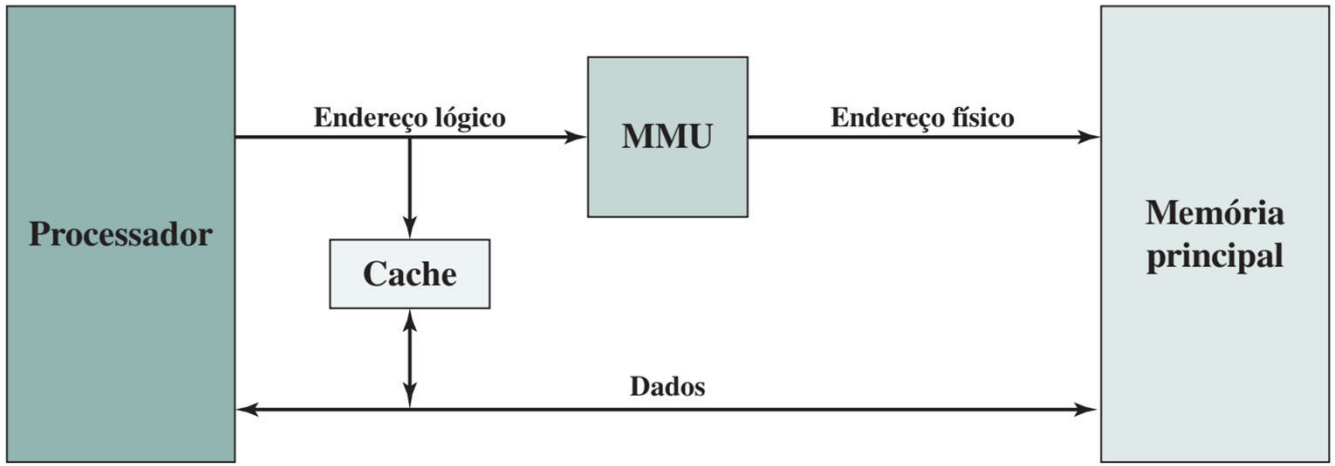
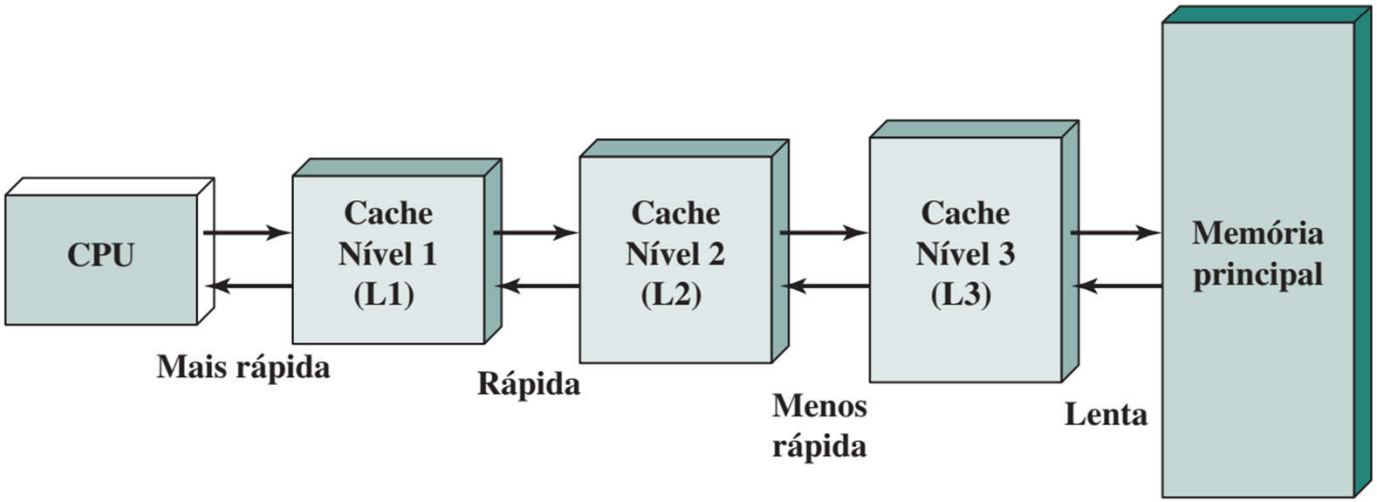
Processamento da Dados

Memória (RAM e Cache)

- UNIDADE DE GERENCIAMENTO DE MEMÓRIA (MMU)
- NÍVEIS DE CACHE



(a) Cache lógica



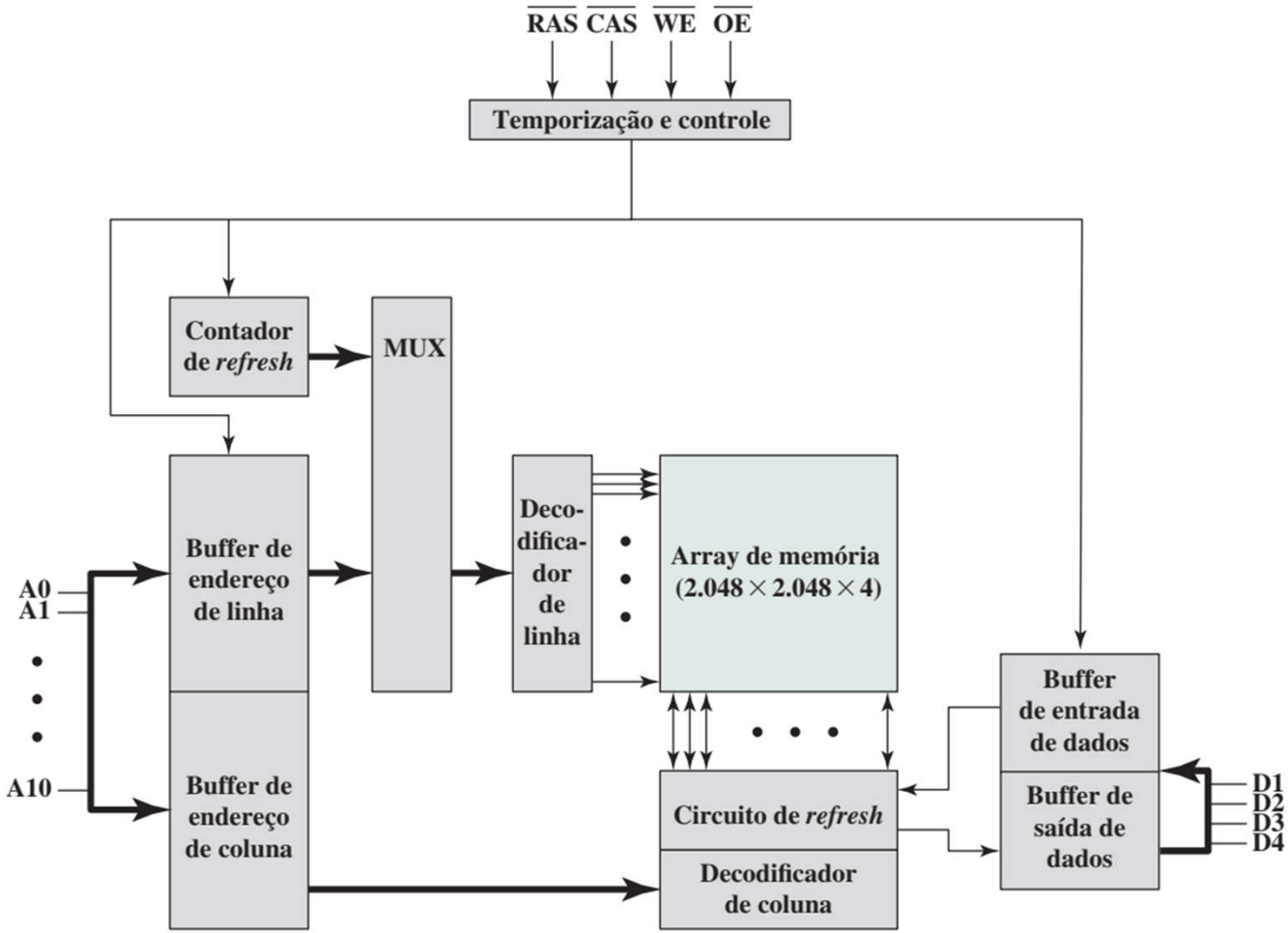
(b) Organização de cache de três níveis

[STALLINGS, 2010]

Memória (RAM)

- Como é feita a leitura e escrita na memória?
- Memória de 256KB
- Memória de Acesso Randômico Dinâmica (DRAM)

DRAM típica de 16 Mbits (4 M × 4).

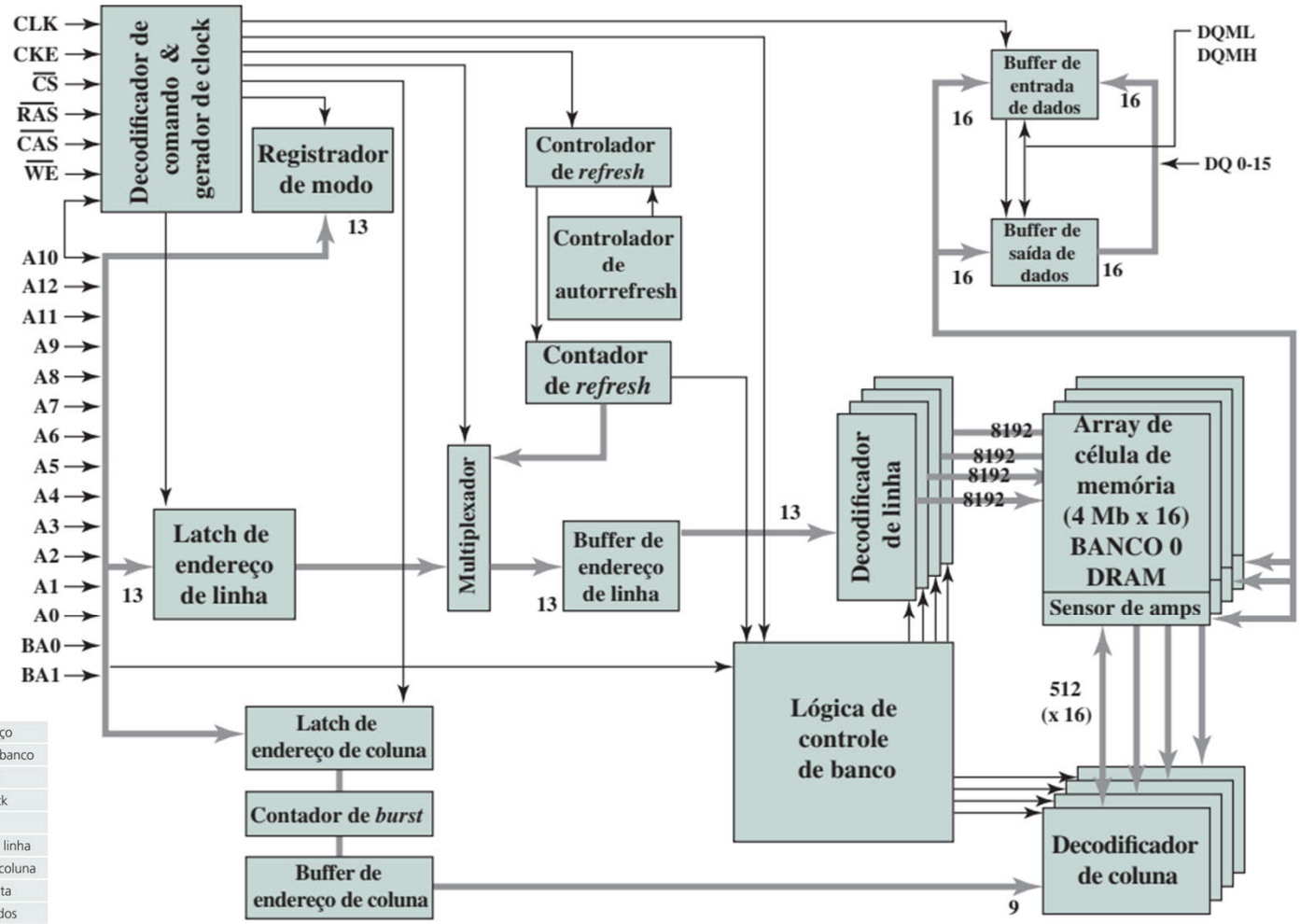


[STALLINGS, 2010]

Memória (RAM)

- Memória de Acesso Randômico Dinâmica Síncrona (SDRAM)

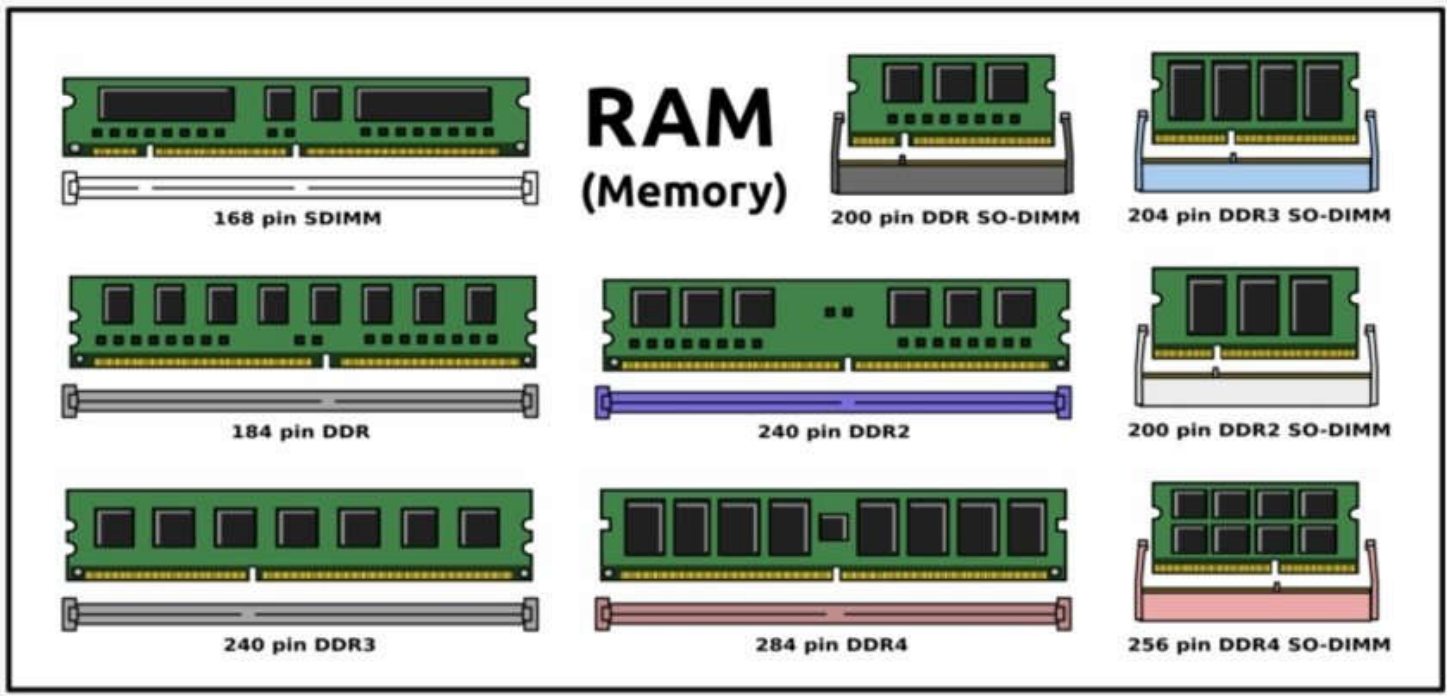
RAM dinâmica síncrona (SDRAM) de 256 Mb.



A0 a A13	Entradas de endereço
BA0, BA1	Linhas de endereço de banco
CLK	Entrada de clock
CKE	Habilitação de clock
$\overline{CS}$	Seleção de chip
$\overline{RAS}$	Strobe de endereço de linha
$\overline{CAS}$	Strobe de endereço de coluna
$\overline{WE}$	Habilitação de escrita
DQ0 a DQ7	Entrada/saída de dados
DQM	Máscara de dados

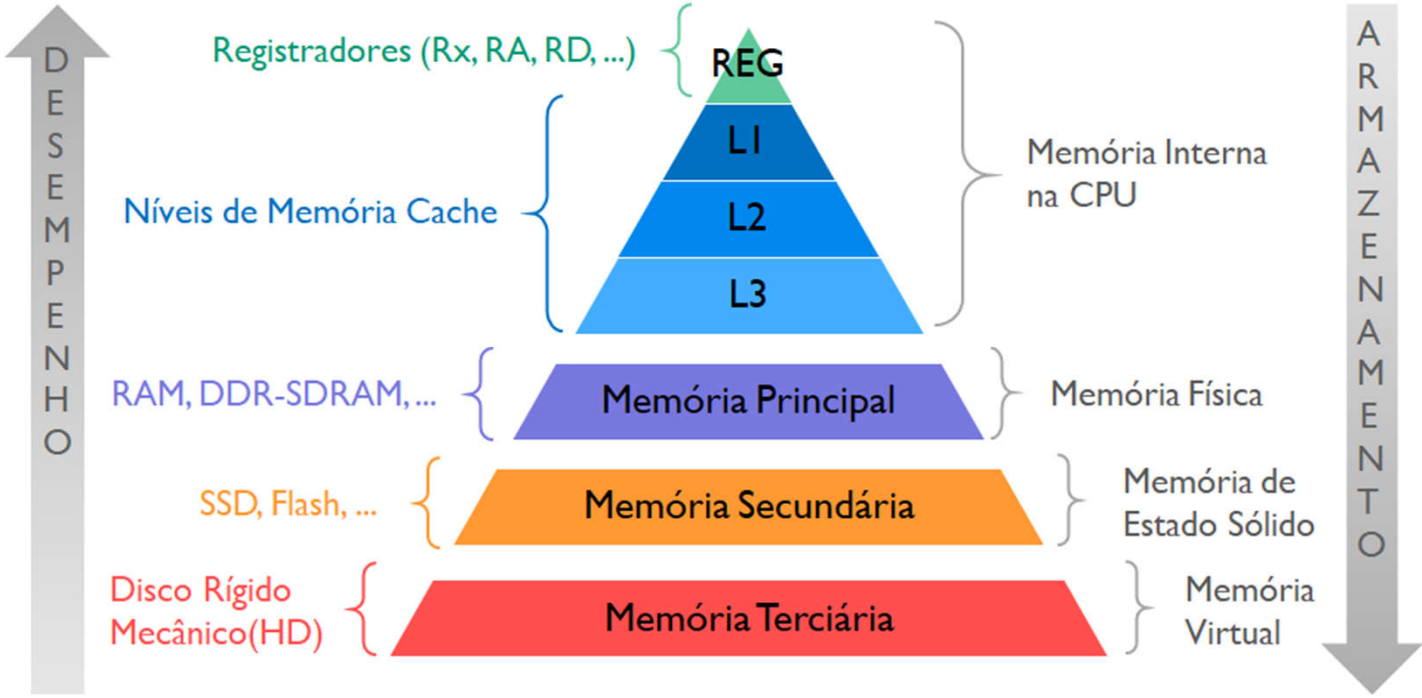
[STALLINGS, 2010]

RAM - Random Access Memory (Memória de Acesso Aleatório)



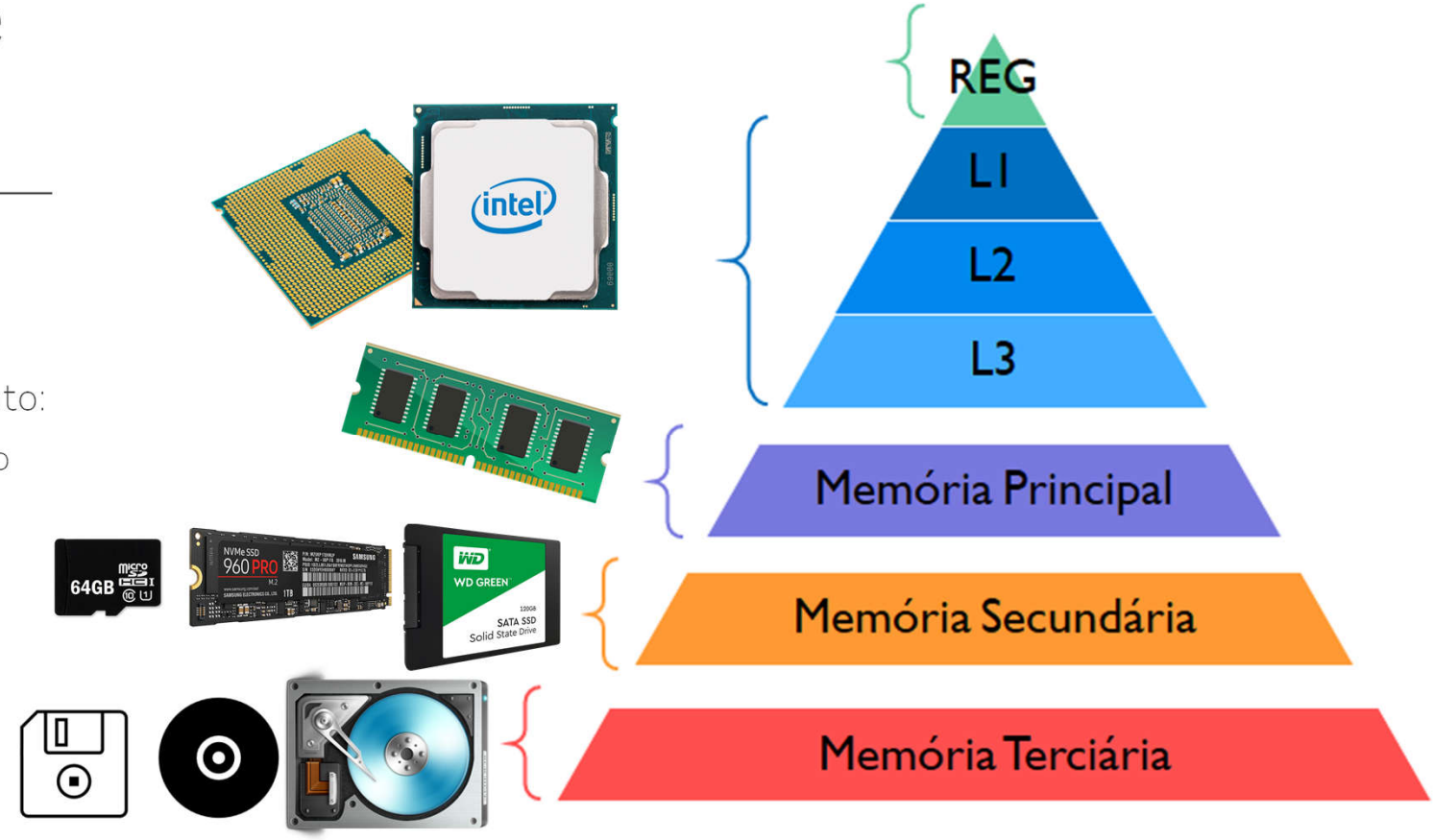
Hierarquia de Memória

- Você tem memória curta ou rápida?
- Temporária ou Permanente?



Hierarquia de Memória

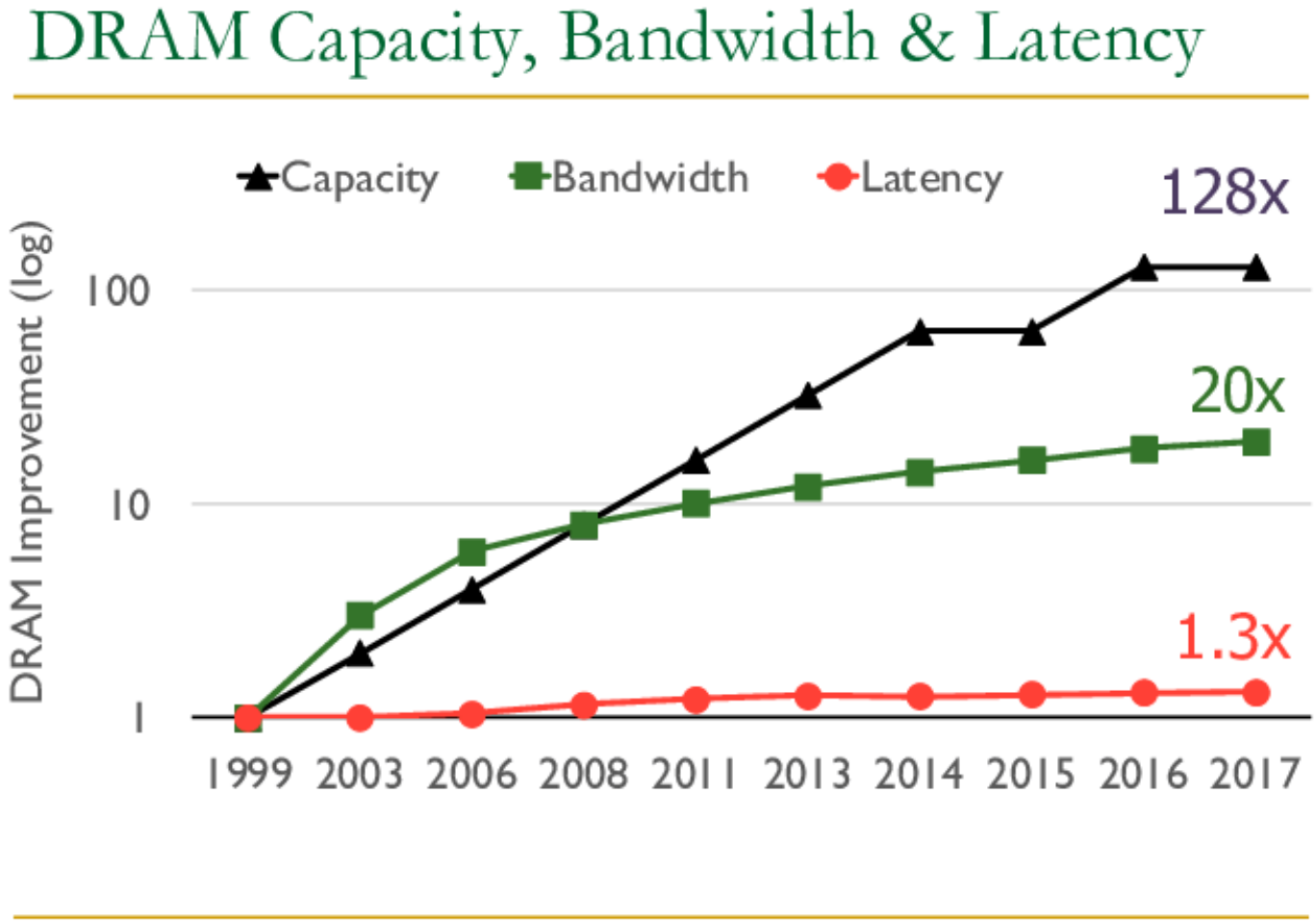
- Você tem memória de elefante ou camudongo?
- Forma de armazenamento:
  - Eletromecânico ou estado sólido?



[HICLIPART, 2020]

Escala de Memória

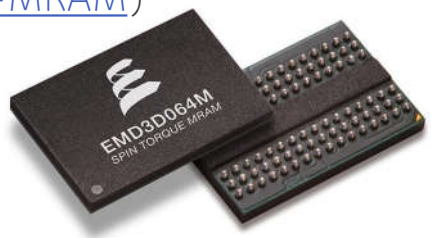
- DRAM (Dynamic Random Access Memory)
- SDRAM (Synchronous Dynamic Random Access Memory)

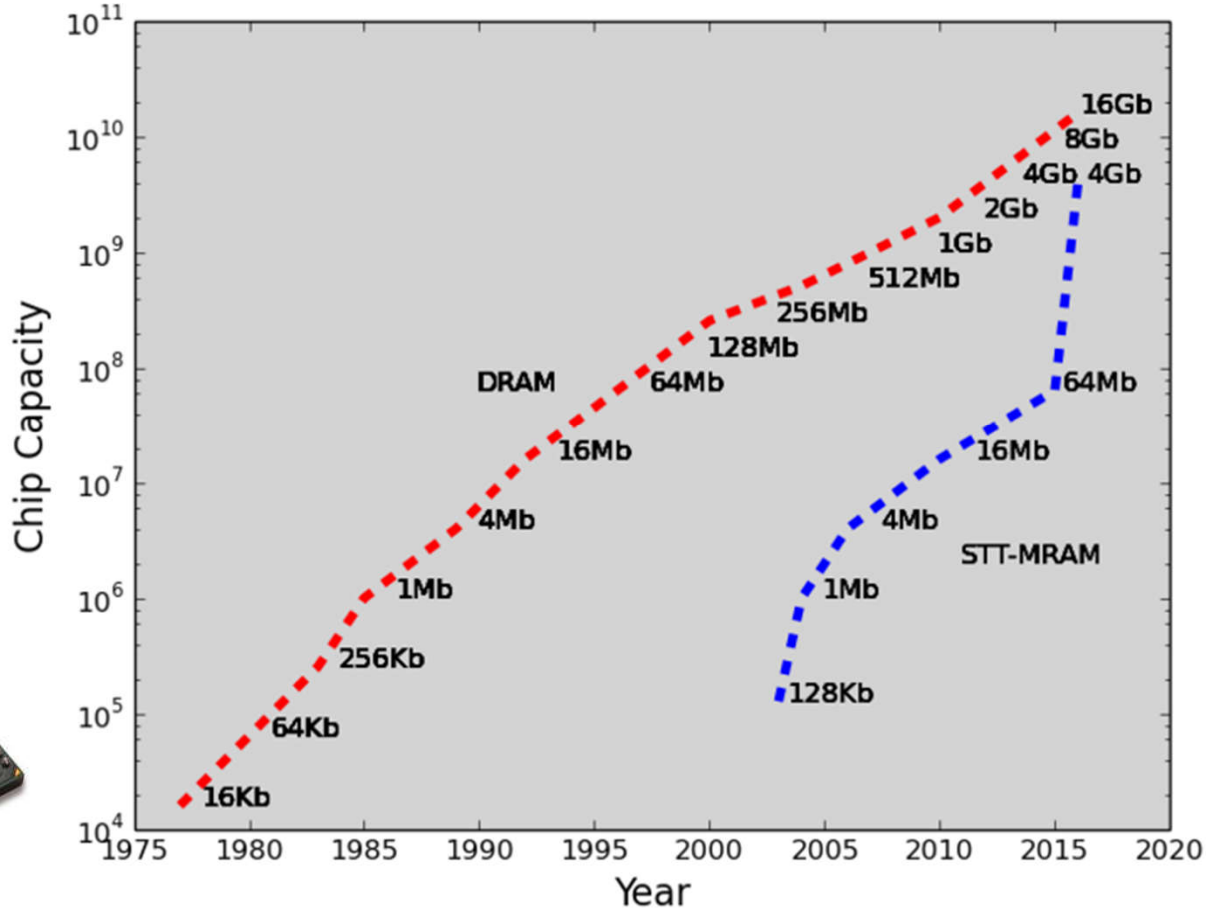


[Mutlu et al., 2020]

Linha do Tempo

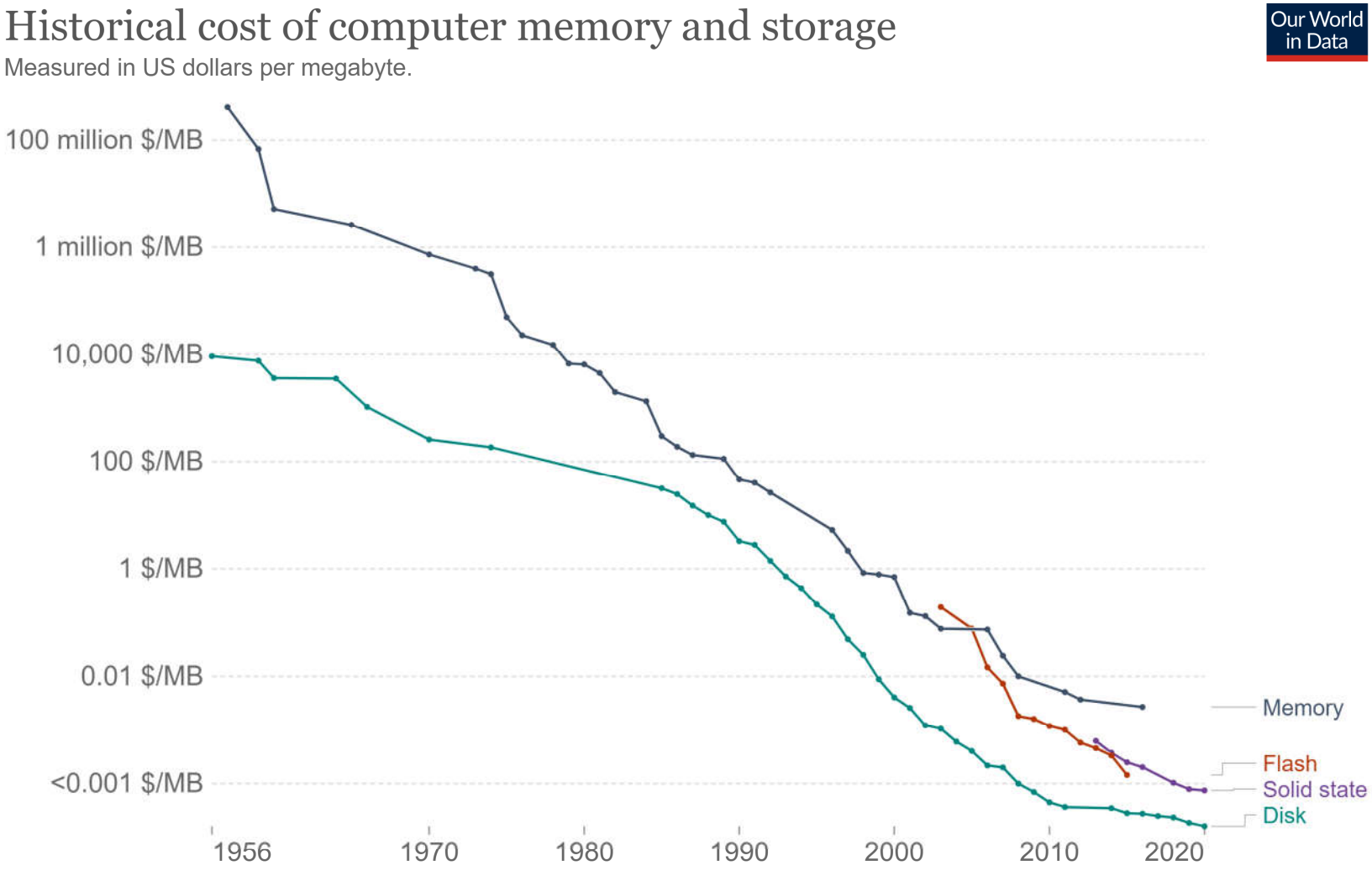
- The International Symposium on Memory Systems 2017 (MEMSYS)
- Spin-Transfer Torque Magnetic Random Access Memory (STT-MRAM)





[ASIFUZZAMAN, 2017]

Evolução da Memória



[Roser and Ritchie, 2022]

Source: John C. McCallum (2022)
Note: For each year the time series shows the cheapest historical price recorded until that year.

Agenda

Introdução

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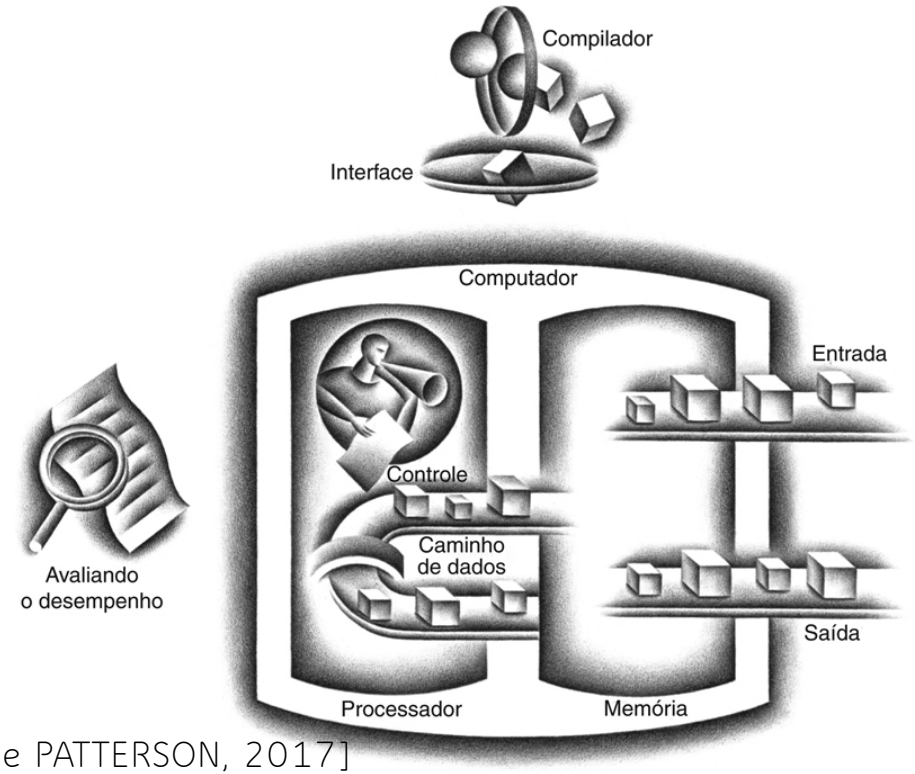
Armazenamento de Dados

Processamento da Dados

Processamento de Dados

- Central Processor Unit (CPU) / Processador
  - Contém datapath e controle
  - Efetua operações matemáticas (Lógicas e Aritméticas)
  - Faz operações e comparações com números, ativa sinais de controle em diversos dispositivos, etc.
- Datapath / Bloco de Dados
  - Componente do processador que realiza operações matemáticas
- Controle / Bloco de Controle
  - Componente do processador que comanda o datapath, memória, e E/S
  - Responde aos comandos informados pelas instruções do programa



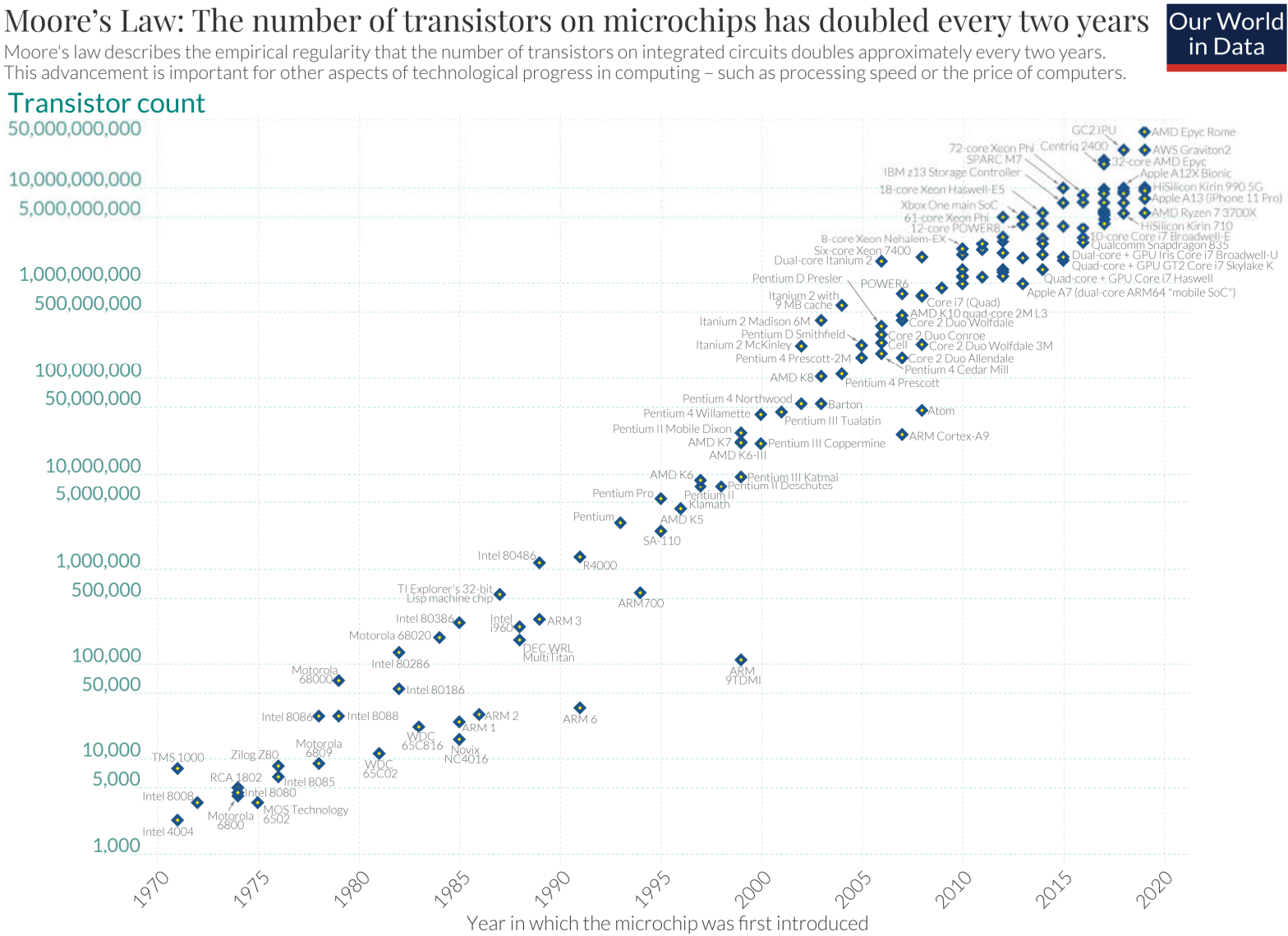
[HENNESSY e PATTERSON, 2017]

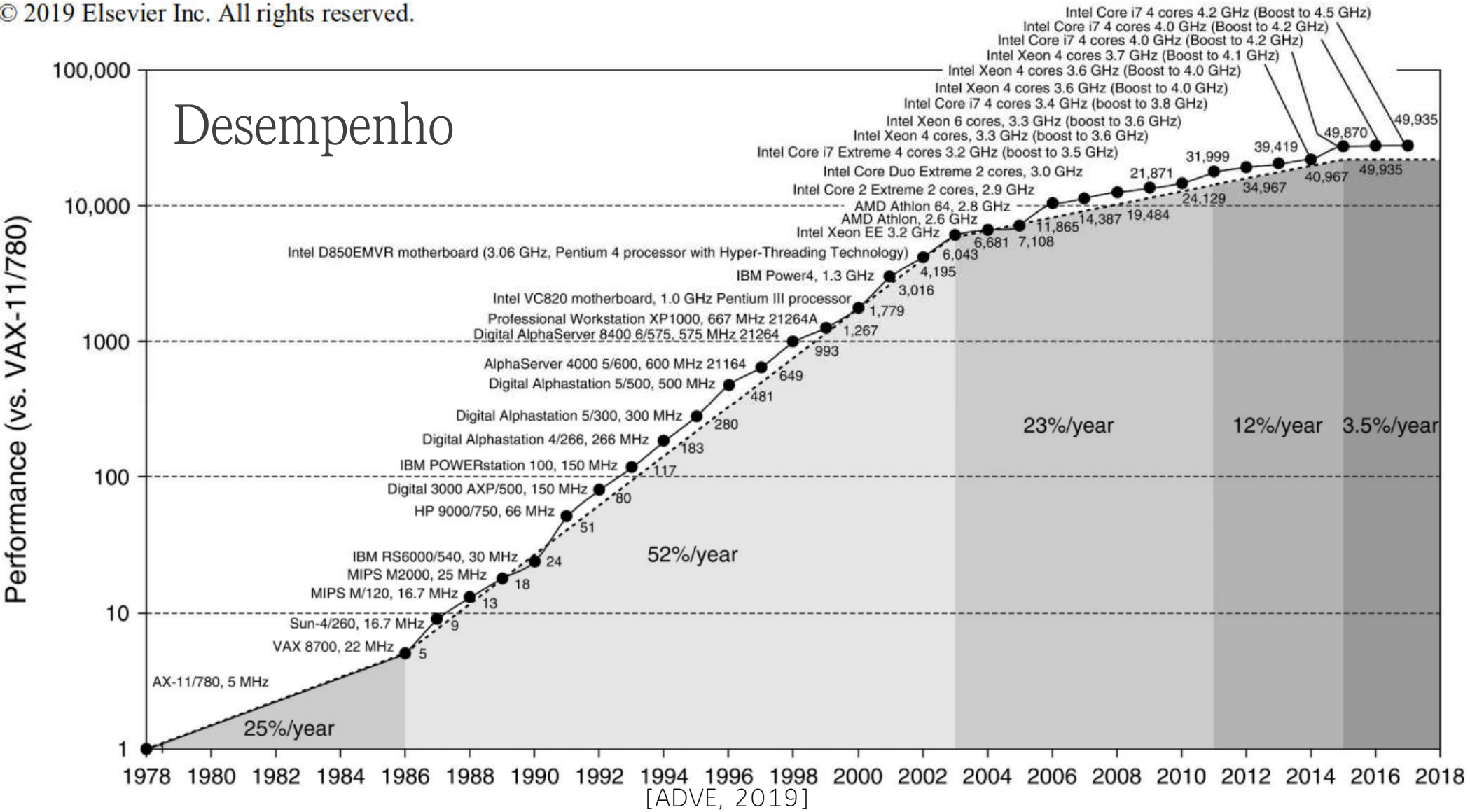
Lei de Moore

- 1965 postulou uma duplicação a cada ano no número de componentes por circuito integrado
- Em 1975, olhando para a próxima década, ele revisou a previsão para dobrar a cada dois anos, CAGR de 40%

[WIKIPEDIA, 2020]

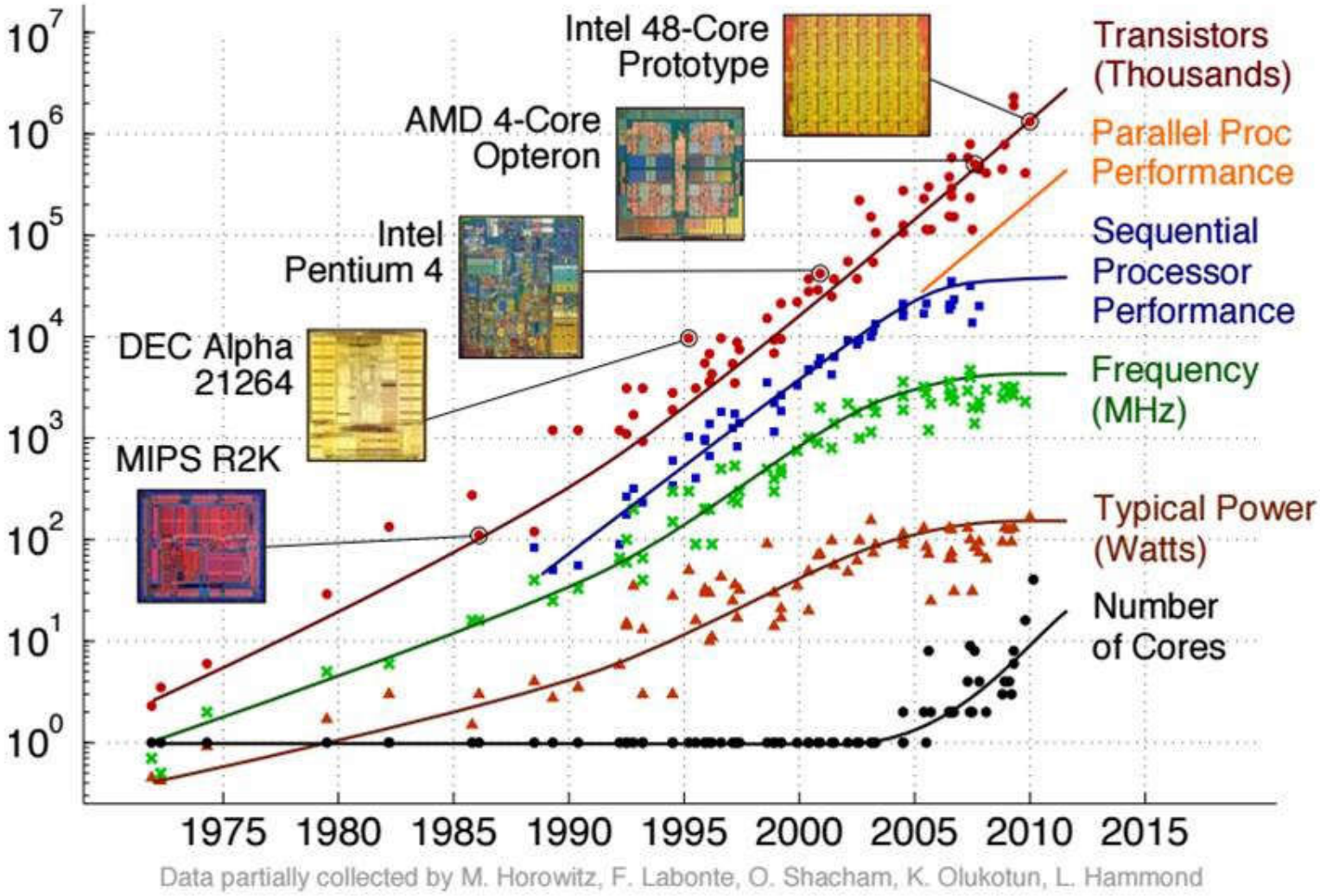
[Roser and Ritchie, 2022]



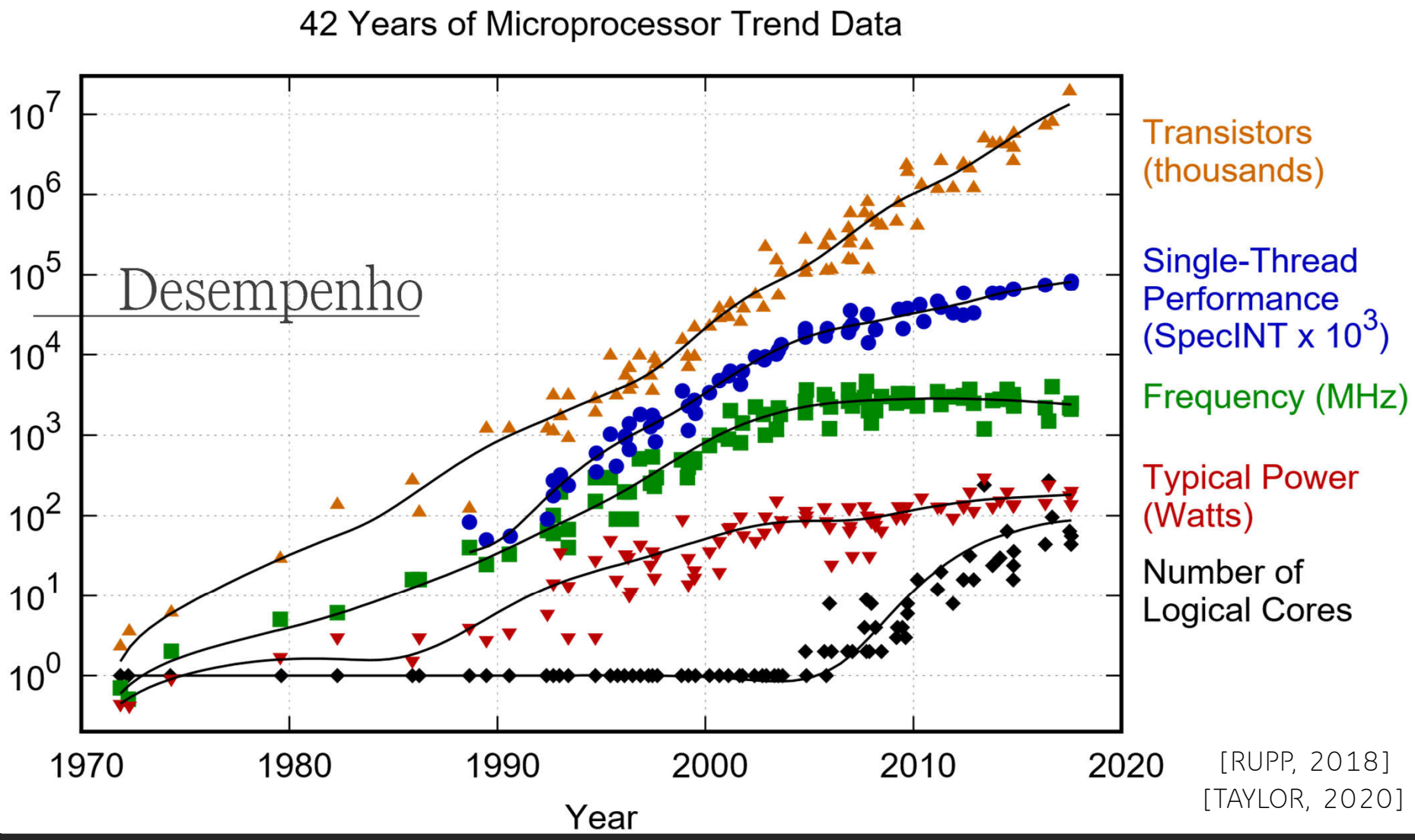


[ADVE, 2019]

Desempenho



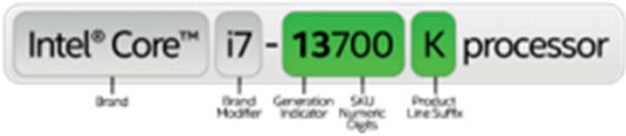
[ADVE, 2019]



[RUPP, 2018]
[TAYLOR, 2020]

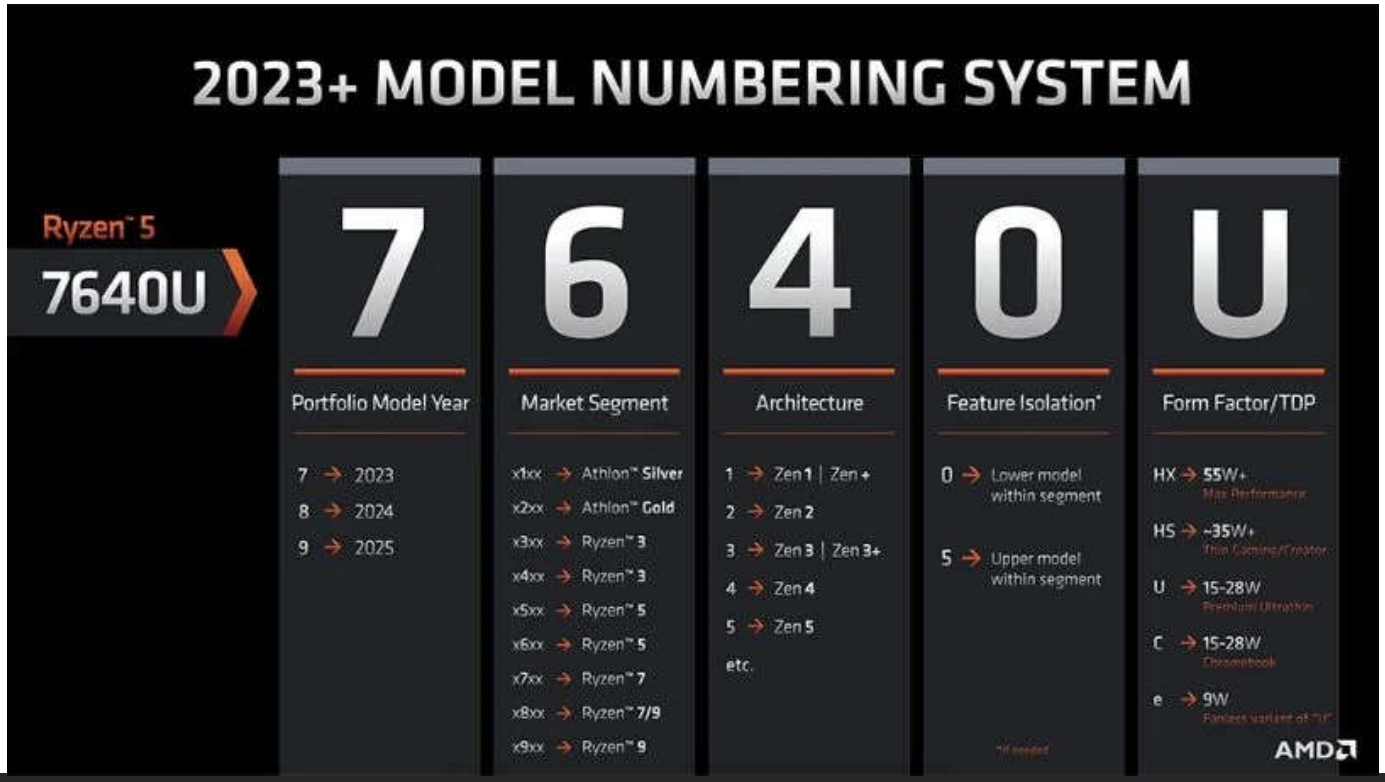
Original data up to the year 2010 collected and plotted by M. Horowitz, F. Labonte, O. Shacham, K. Olukotun, L. Hammond, and C. Batten
New plot and data collected for 2010-2017 by K. Rupp

Intel - Codificação dos modelos



Forma/Tipo de Função/Segmento	Sufixo	Otimizado/Projetado para
Desktop	K	Alto desempenho, desbloqueado
	F	Requer gráficos dedicados
	S	Edição especial
	T	Estilo de vida otimizado pela energia
	X/XE	Desempenho mais alto, desbloqueado
Dispositivo móvel	HX	Desempenho mais alto, todas as SKUs desbloqueadas
	HK	Alto desempenho, desbloqueado
	H	Alto desempenho
	P	Desempenho do fino e leve
	U	Eficiência no consumo de energia
	Y	Consumo de energia extremamente baixo
	G1-G7	Nível da placa gráfica

AMD - Codificação dos modelos



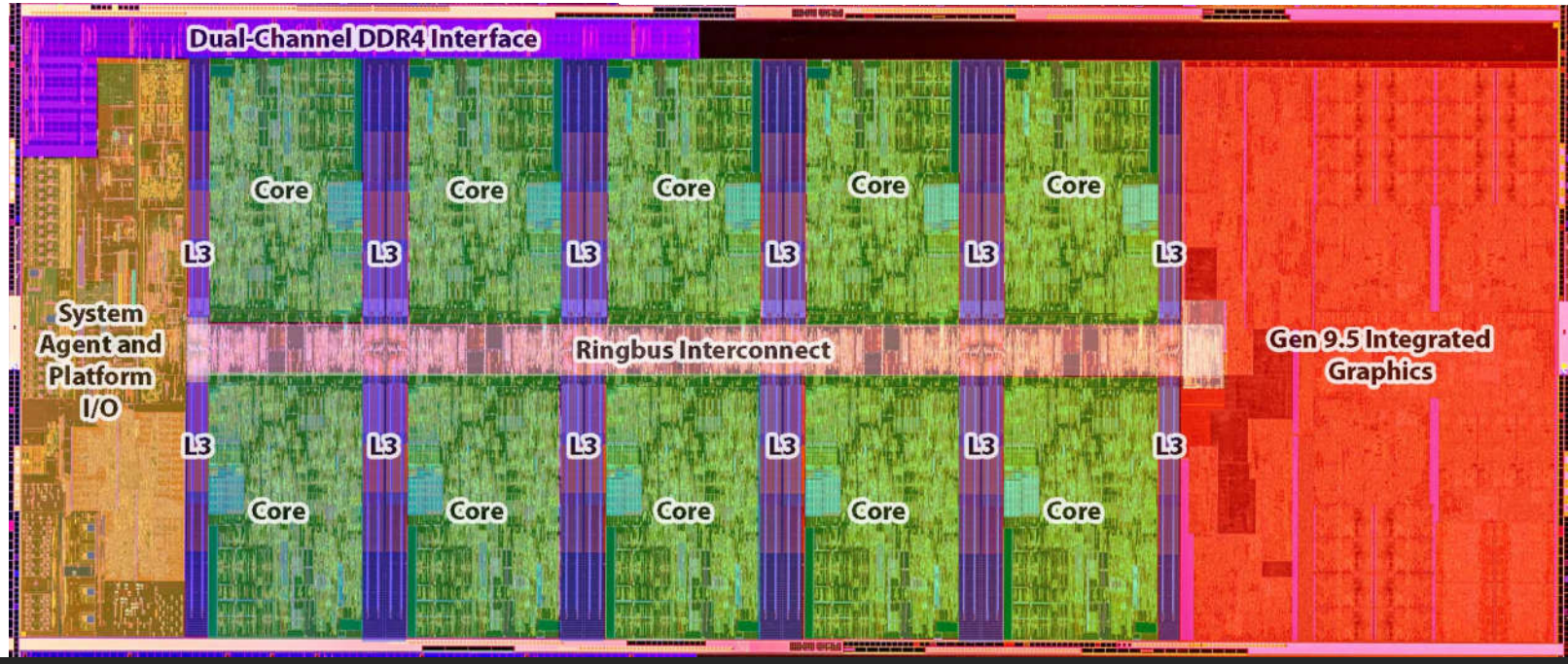
[GIANNOTTI, 2022]

Arquitetura

[TECHPOWERUP, 2020]

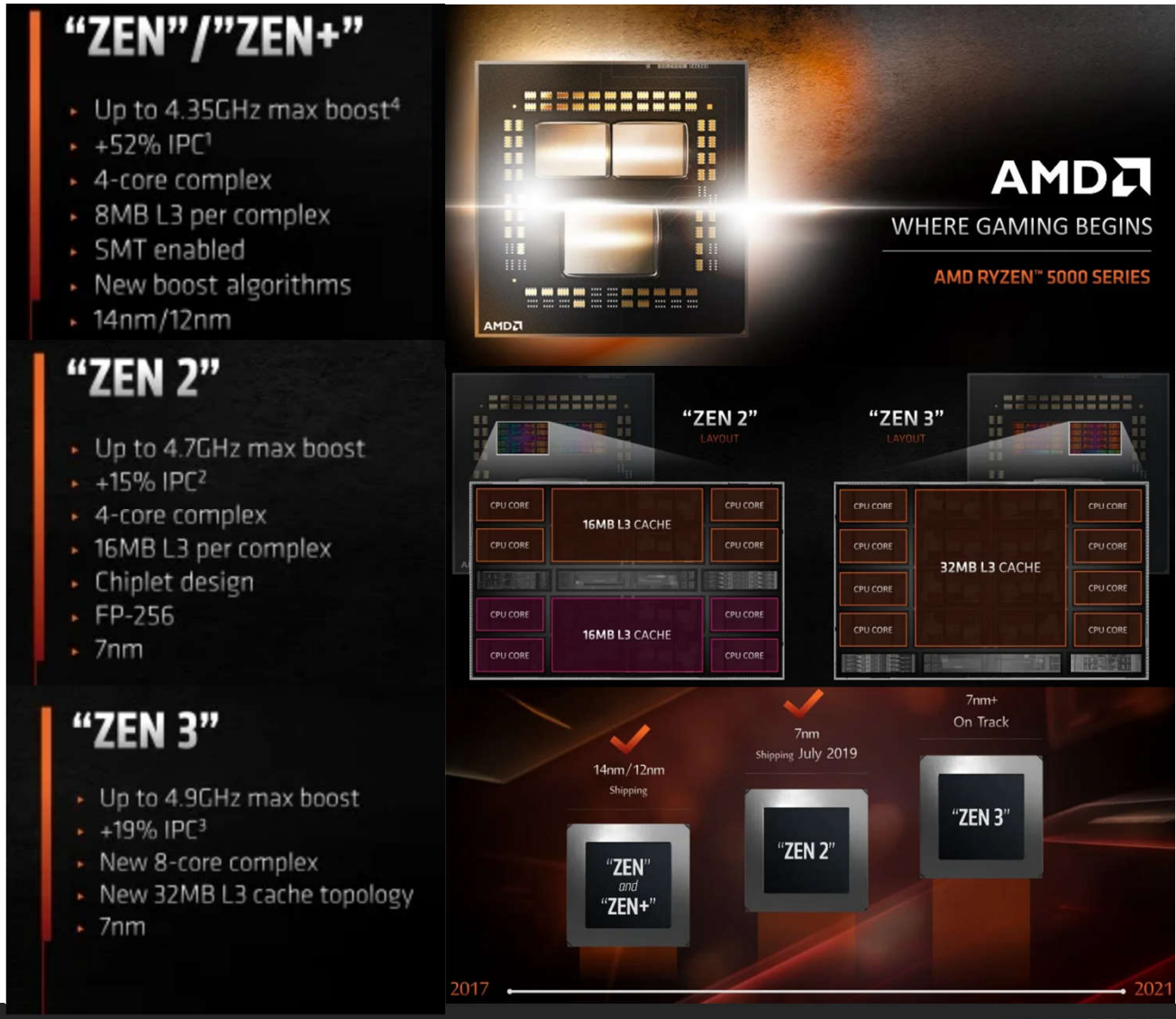
	Sandy Bridge	Haswell	SkyLake
Out-of-order Window	168	192	224 ↑
In-flight Loads	64	72	72
In-flight Stores	36	42	56 ↑
Scheduler Entries	54	60	97 ↑
Integer Register File	160	168	180 ↑
FP Register File	144	168	168
Allocation Queue	28/thread	56	64/thread ↑

- Die
- Intel core i9
  - 10850k



Arquitetura AMD

- Arquitetura Zen
  - Zen, Zen2 e Zen3



https://www.amd.com/pt/technologies/zen-core-3

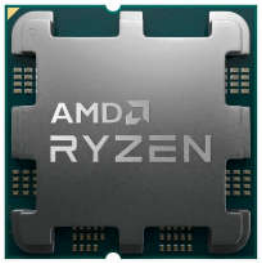
Processador Intel

- Intel core i9

[WIKIPEDIA, 2020-a]

Model number	sSpec number	Cores (threads)	Frequency	Turbo Boost all-core/2.0 (/max. 3.0)	L2 cache	L3 cache	TDP	Socket	I/O bus	Memory	Release date	Part number(s)	Release price (USD)
Core i9-7900X	SR3L2 (U0)	10 (20)	3.3 GHz	4.0[6]/4.3 GHz 4.5 GHz	10 × 1024 KiB	13.75 MiB	140 W	LGA 2066	DMI 3.0	4 × DDR4-2666	June 2017	BX80673I97900X BXC80673I97900X CD8067303286804	$989
Core i9-7920X	SR3NG (U0)	12 (24)	2.9 GHz	3.8/4.3 GHz 4.4 GHz	12 × 1024 KiB	16.50 MiB	140 W	LGA 2066	DMI 3.0	4 × DDR4-2666	August 2017	BX80673I97920X CD8067303753300	$1199
Core i9-7940X	SR3RQ (U0)	14 (28)	3.1 GHz	3.8/4.3 GHz 4.4 GHz	14 × 1024 KiB	19.25 MiB	165 W	LGA 2066	DMI 3.0	4 × DDR4-2666	September 2017	BX80673I97940X BXC80673I97940X CD8067303734701	$1399
Core i9-7960X	SR3RR (U0)	16 (32)	2.8 GHz	3.6/4.2 GHz 4.4 GHz	16 × 1024 KiB	22.00 MiB	165 W	LGA 2066	DMI 3.0	4 × DDR4-2666	September 2017	BX80673I97960X BXC80673I97960X CD8067303734802	$1699
Core i9-7980XE	SR3RS (U0)	18 (36)	2.6 GHz	3.4/4.2 GHz 4.4 GHz	18 × 1024 KiB	24.75 MiB	165 W	LGA 2066	DMI 3.0	4 × DDR4-2666	September 2017	BX80673I97980X CD8067303734902	$1999
Core i9-9820X	SREZ8 (M0)	10 (20)	3.3 GHz	4.0/4.1 GHz 4.2 GHz	10 × 1024 KiB	16.50 MiB	165 W	LGA 2066	DMI 3.0	4 × DDR4-2666	Q4 2018	BX80673I99820X CD8067304126901	$889
Core i9-9900X	SREZ7 (M0)	10 (20)	3.5 GHz	4.1/4.4 GHz 4.5 GHz	10 × 1024 KiB	19.25 MiB	165 W	LGA 2066	DMI 3.0	4 × DDR4-2666	Q4 2018	BX80673I99900X CD8067304126200	$989
Core i9-9920X	SREZ6 (M0)	12 (24)	3.5 GHz	4.2/4.4 GHz 4.5 GHz	12 × 1024 KiB	19.25 MiB	165 W	LGA 2066	DMI 3.0	4 × DDR4-2666	Q4 2018	BX80673I99920X CD8067304126300	$1189
Core i9-9940X	SREZ5 (M0)	14 (28)	3.3 GHz	4.1/4.4 GHz 4.5 GHz	14 × 1024 KiB	19.25 MiB	165 W	LGA 2066	DMI 3.0	4 × DDR4-2666	Q4 2018	BX80673I99940X CD8067304175600	$1387
Core i9-9960X	SREZ4 (M0)	16 (32)	3.1 GHz	4.0/4.4 GHz 4.5 GHz	16 × 1024 KiB	22.00 MiB	165 W	LGA 2066	DMI 3.0	4 × DDR4-2666	Q4 2018	BX80673I99960X CD8067304126500	$1684
Core i9-9980XE	SREZ3 (M0)	18 (36)	3 GHz	3.8/4.4 GHz 4.5 GHz	18 × 1024 KiB	24.75 MiB	165 W	LGA 2066	DMI 3.0	4 × DDR4-2666	Q4 2018	BX80673I99980X CD8067304126600	$1979
Core i9-9990XE	SREZA (M0)	14 (28)	4 GHz	5.0/5.0 GHz 5.1 GHz	14 × 1024 KiB	19.25 MiB	255 W	LGA 2066	DMI 3.0	4 × DDR4-2666	January 2019		auctions for OEMs[7]

Processadores



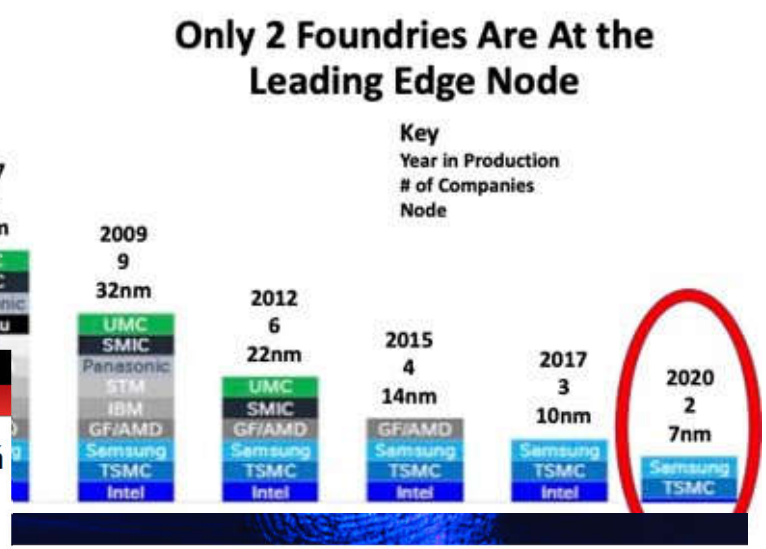
Componentes	Ryzen Threadripper Pro 5995WX - Zen3	Ryzen 9 7950X - Zen4	I9 13900K	I7 13700
Frequência Turbo Max.	4.5 (GHz)	5.7 (GHz)	5.8 (GHz)	5.2 (GHz)
Cores	64	16	(p-cores + e-cores): 24 (8p+16e)	(p-cores + e-cores): 16 (8p+8e)
Threads	128	32	32	24
RAM	DDR4 3200	DDR5 6400	DDR5 5600	DDR5 5600
Cache (L3)	256MB	64MB	36MB	30MB
Cache (L2)	32MB	16MB	32MB	24MB
Potência Turbo Máx.	280 W	170 W	253 W	219 W
Tecnologia Fab.	7 nm	5 nm	7nm	7nm
Preço	R$ 39.999,99	R$ 4.399,99	R$ 6.249,96	R$ 4.956,90

Escala de Transistor

- Quem é TSMC?
  - Taiwan Semiconductor Manufacturing Company (TSMC)
- TSMC investe 24Bi em pesquisa em 2019, 4 a mais que a intel

[DA SILVA, 2018]

[HENRIQUE, 2020]



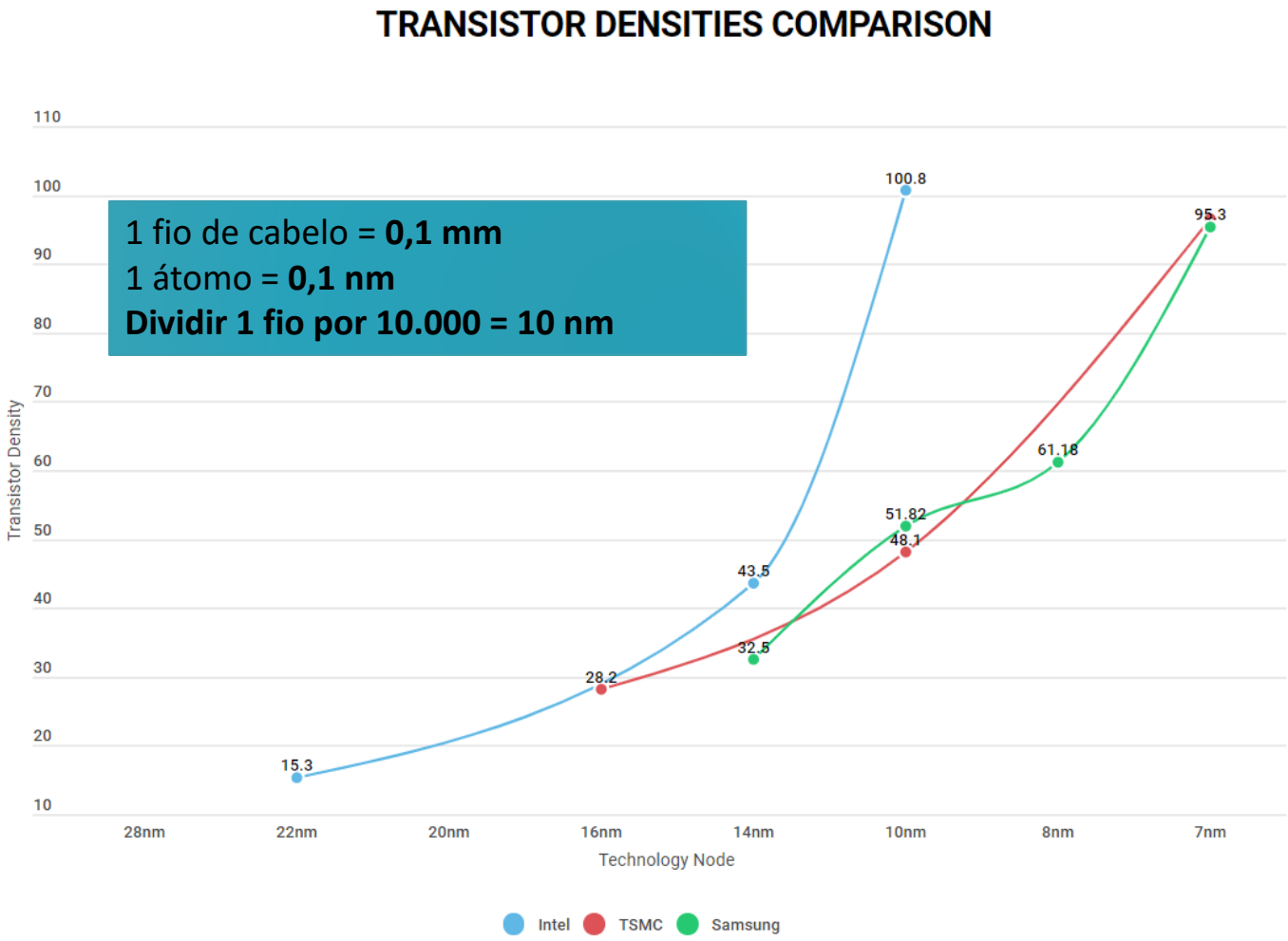
[ARM, 2019]

[DANOWITZ et al., 2012]

Escala de Transistor

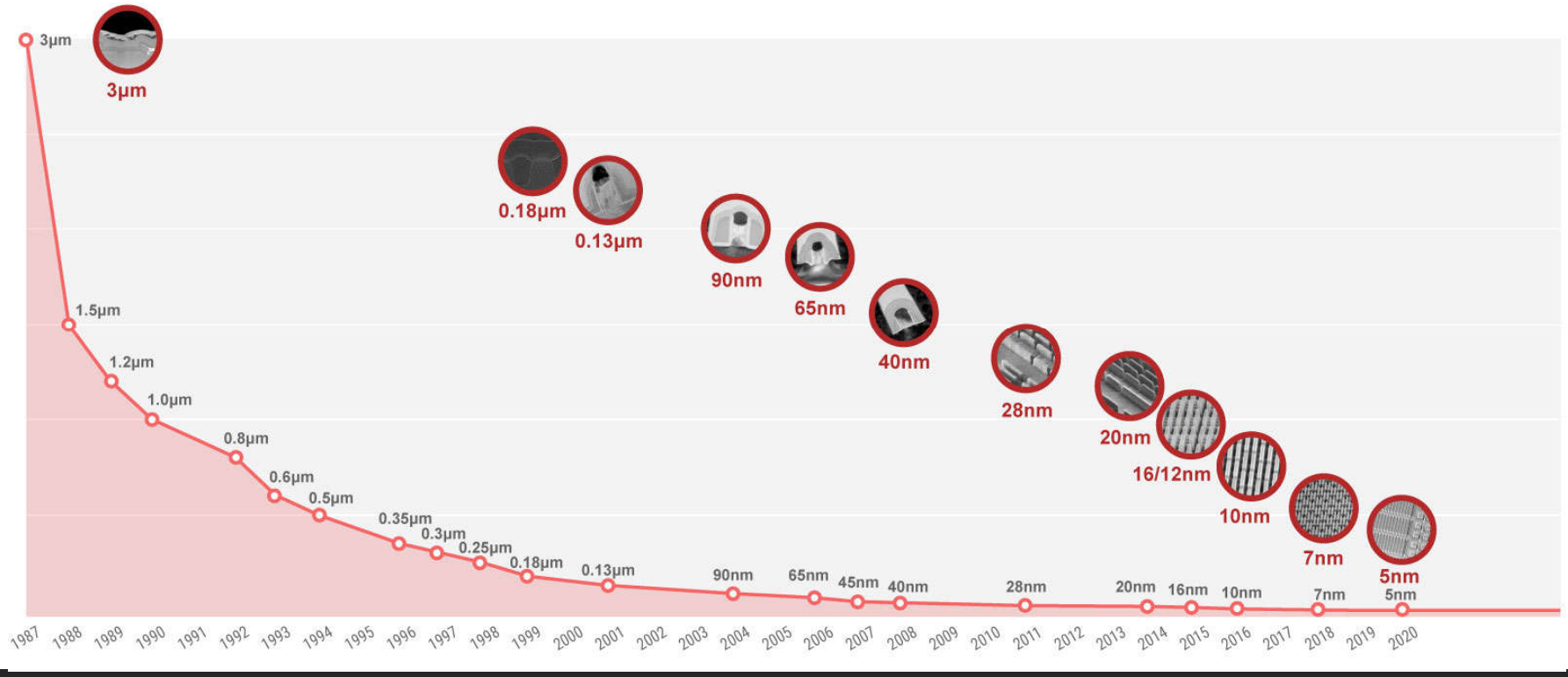
- E o mercado atual?
- Quem é TSMC?

Rank	Process Name	Approximate Transistor Density (MTr/mm²)
#1	TSMC's 5nm EUV	171.3
#2	TSMC's 7nm+ EUV	115.8
#4	Intel's 10nm	100.8*
#5	TSMC's 7nm (Mobile)	96.5
#6	Samsung's 7nm EUV	95.3

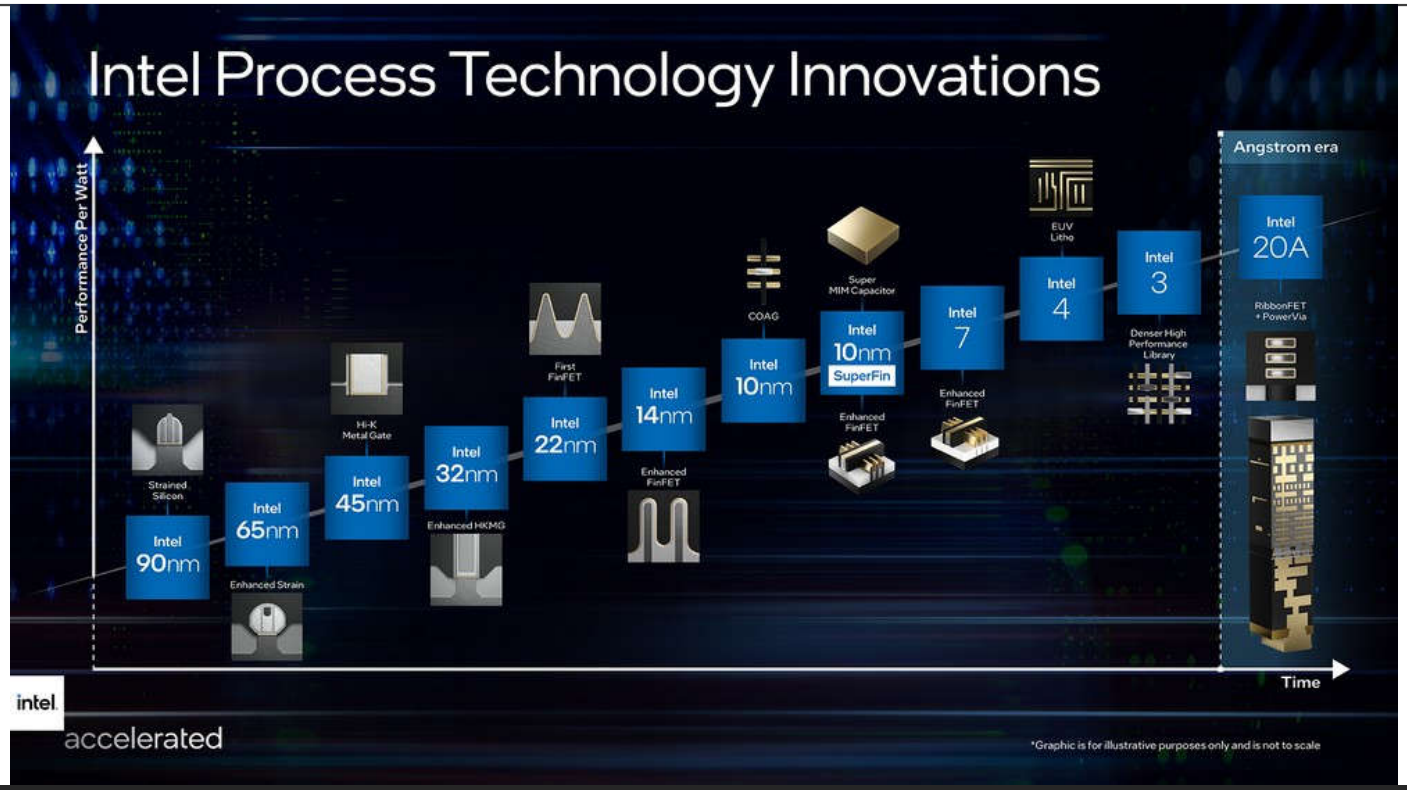


[KUMAWAT, 2019]

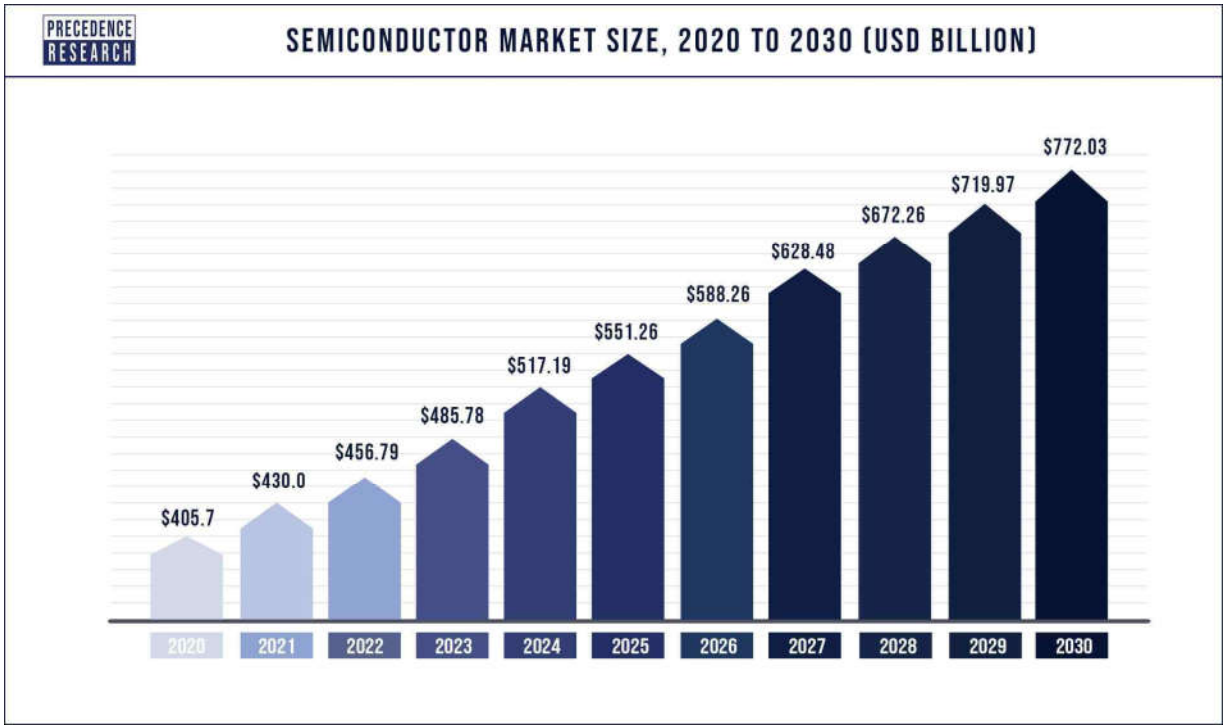
Escala de Transistor - TSMC



Escala de Transistor - Intel

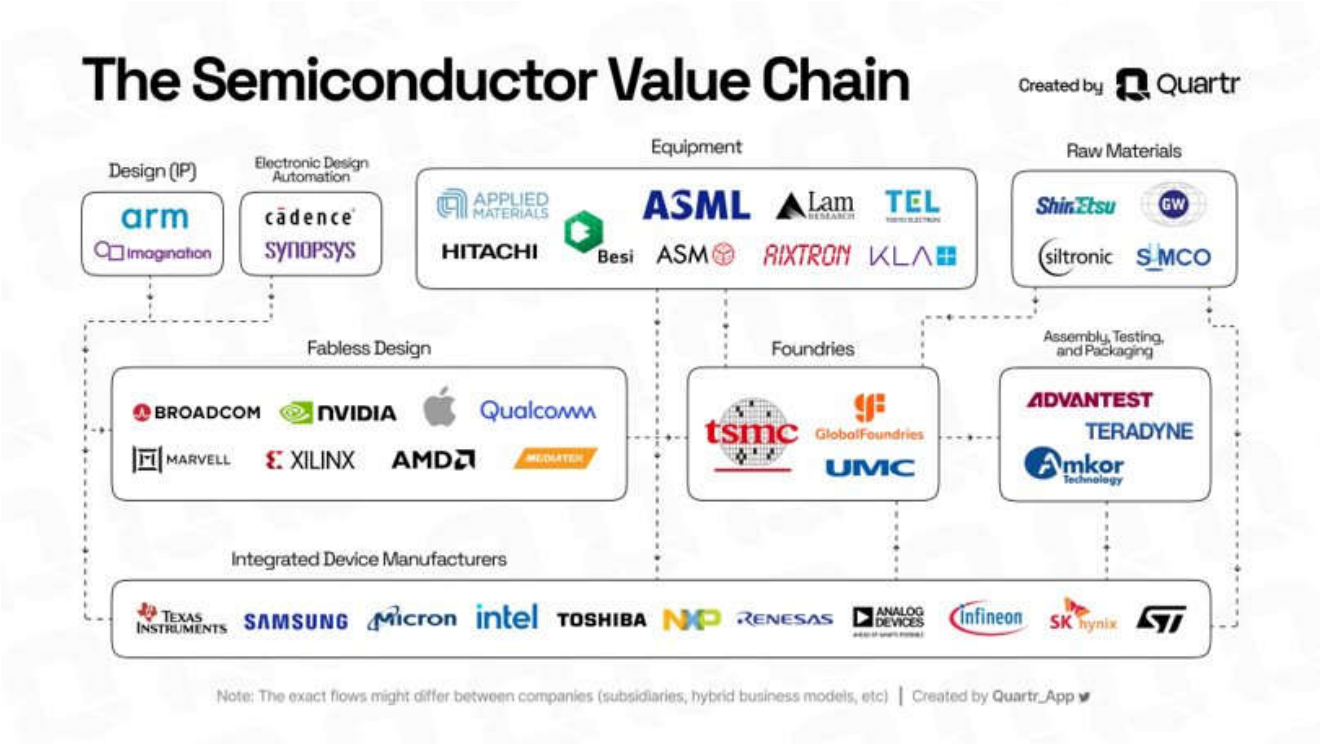


Mercado de Semicondutores



[Precedence Research, 2022]

EcoSistema dos Semicondutores



Advanced RISC Machine (ARM)

- Apple, Nvidia, Qualcomm, MediaTek, AMD, Samsung, Texas Instruments, Broadcom

v · t · e	Application ARM-based chips	[hide]
ARM Holdings · ARM architecture · List of ARM microarchitectures · List of applications of ARM cores · ARM Cortex-A · ARM Cortex-R · ARM Cortex-M · Comparison of ARMv7-A cores · Comparison of ARMv8-A cores		
Application processors (32-bit)	Cortex-A5	Actions ATM702x · Amlogic M805/S805, T82x · Atmel SAMA5D3 · InfoTM iMAPx820, iMAPx15 · Qualcomm Snapdragon S4 Play, 200 · RDA RDA8810PL · Telechips TCC892x
	Cortex-A7	Allwinner A2x, A3x, A83T, H3, H8 · Broadcom VideoCore BCM2836, BCM23550 · Freescale QorIQ LS10xx · Leadcore LC1813, LC1860/C, LC1913, LC1960 · Marvell Armada PXA1920 · MediaTek MT65xx · Qualcomm Snapdragon 200, 400
	Cortex-A8	Allwinner A1x · Apple A4 · Freescale i.MX5 · Rockchip RK291x · Samsung Exynos 3110(S5PC110), S5PV210 · Texas Instruments OMAP 3 · ZiiLABS ZMS-08
	Cortex-A9	Actions ATM702x, ATM703x · Altera Cyclone V, Arria V/10 · Amlogic AML8726, MX, M6x, M801, M802/S802, S812, T86x · Apple A5, A5X · Broadcom VideoCore BCM21xxx, BCM28xxx · Freescale i.MX6 · HiSilicon K3V2, 910's · InfoTM iMAPx912 · Leadcore LC1810, LC1811 · MediaTek MT65xx · Nvidia Tegra, 2, 3, 4i · Nufront NuSmart 2816M, NS115, NS115M · Renesas EMMA EV2, R-Car H1, RZ/A · Rockchip RK292x, RK30xx, RK31xx · Samsung Exynos 4 421x, 441x · ST-Ericsson NovaThor · Telechips TCC8803 · Texas Instruments OMAP 4 · VIA WonderMedia WM88x0, 89x0 · Xilinx Zynq-7000 · ZiiLABS ZMS-20, ZMS-40
	Cortex-A15	Allwinner A80 · HiSilicon K3V3 · MediaTek MT8135/V · Nvidia Tegra 4, K1 · Renesas R-Car H2 · Samsung Exynos 5 52xx, 54xx · Texas Instruments OMAP 5, DRA7xx, AM57xx
	Cortex-A17	MediaTek MT6595, MT5595 · Mstar 6A928 · Rockchip RK3288
	ARMv7-A compatible	Apple A6, A6X, S1 · Broadcom Brahma-B15 · Marvell P4J · Qualcomm Snapdragon S1, S2, S3, S4 Plus, S4 Pro, 600, 800 (Scorpion, Krait)
Application processors (64-bit)	Cortex-A53	Actions GT7, S900, V700 · Allwinner A64, H5, H64, R18 · Altera Stratix 10 · Amlogic S9 Family, T96x · Broadcom BCM2837 · EZchip TILE-Mx100 · HiSilicon Kirin 620, 65x, 93x · Marvell Armada PXA1928, Mobile PXA1908/PXA1936 · MediaTek MT673x, MT675x, MT6795, MT873x, MT8752, MT8163 · NXP ARM S32 · Qualcomm Snapdragon 41x, 42x, 43x, 61x, 62x · Rockchip RK3328, RK3368 · Samsung Exynos 7 75xx, 78xx · Spreadtrum SC9860/GV, SC9836 · Xilinx ZynqMP
	Cortex-A57	AMD Opteron A1100-series · Freescale QorIQ LS20xx · Nvidia Tegra X1 · Qualcomm Snapdragon 808, 810 · Samsung Exynos 7 5433, 7420
	Cortex-A72	HiSilicon Kirin 95x · MediaTek Helio X2x, MT817x · Mstar 6A938 · Qualcomm Snapdragon 65x · Rockchip RK3399
	Cortex-A73	HiSilicon Kirin 960 · MediaTek Helio X30
	Cortex-A75	Qualcomm Snapdragon 845
	ARMv8-A compatible	Apple A7 to A10 · Applied Micro X-Gene · Cavium ThunderX CN87xx, CN88xx · Nvidia Tegra K1 (Project Denver) · Samsung Mongoose · NXP i.MX 8 · Qualcomm Kryo · Qualcomm Falkor

[WIKIPEDIA, 2020-b]

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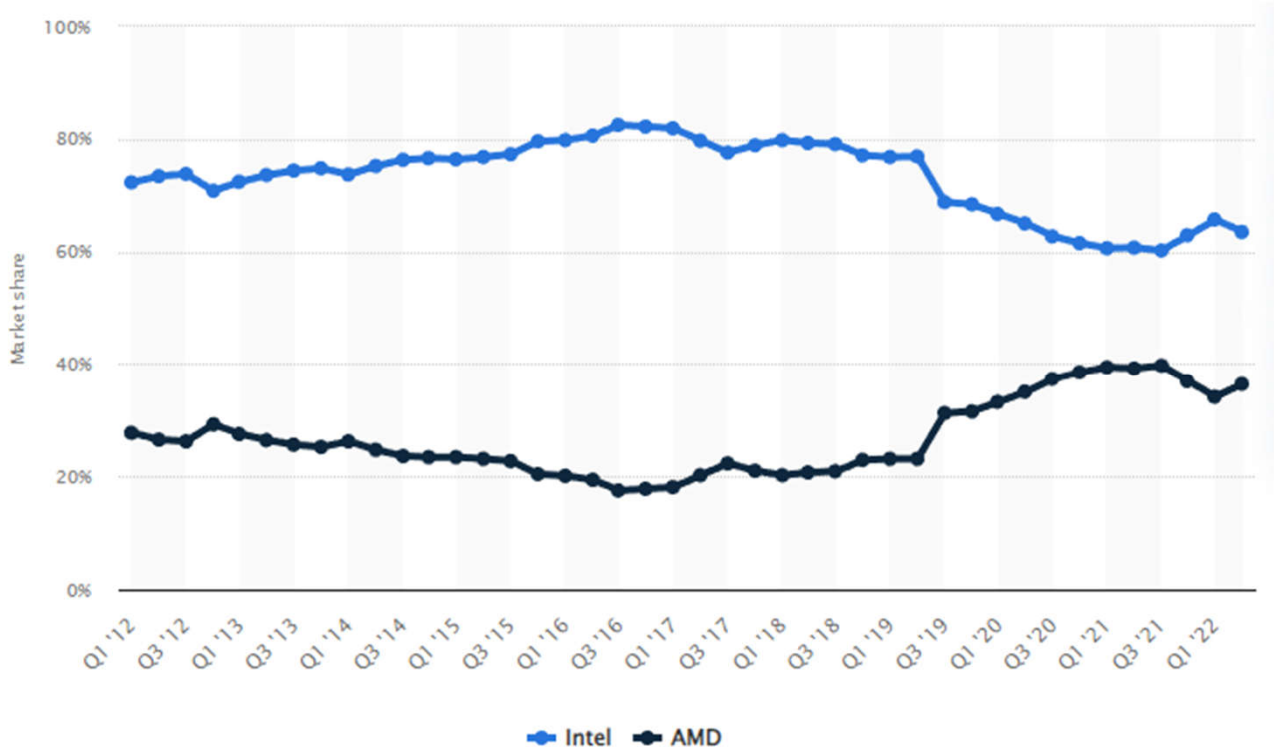
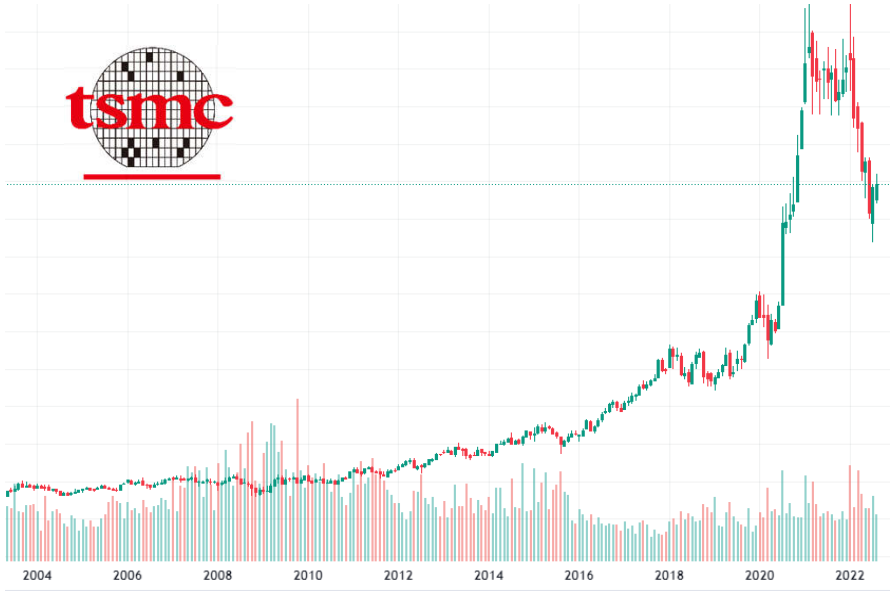
Fatia de Mercado



[STATISTA, 2022]



Mercado Financeiro

2004-2022

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