AMD raphael ryzen 7000series

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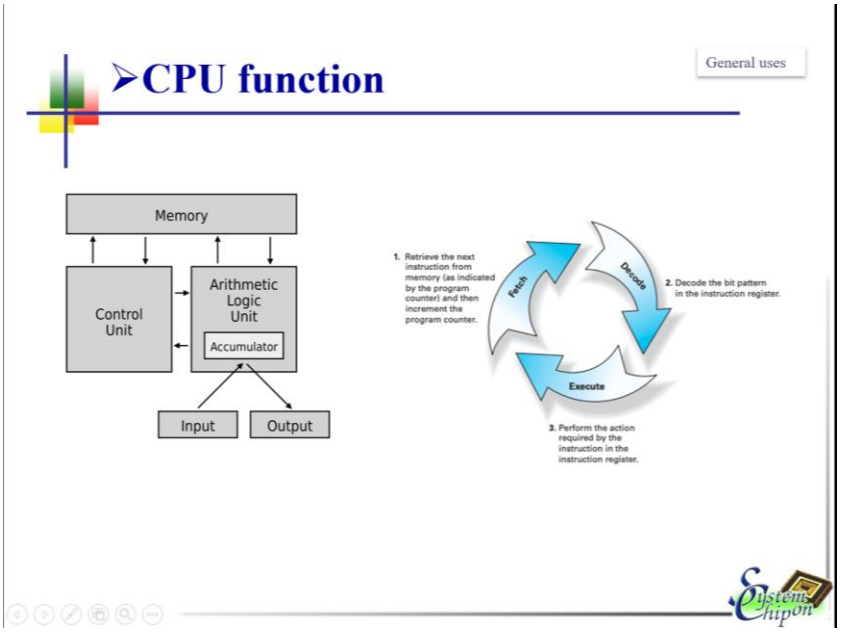
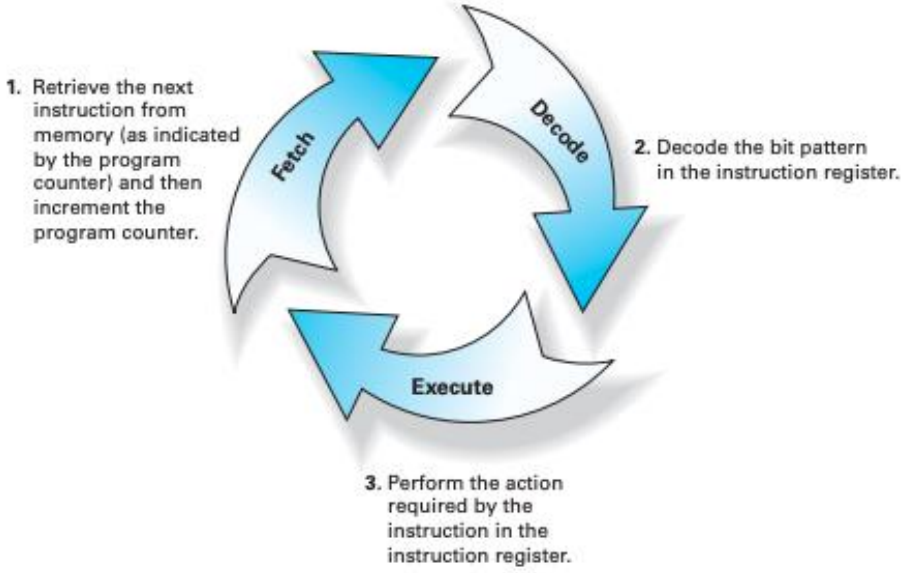
Outline

1. General uses

1.1 CPU function





CPU is a core in a computer, it has several parts, such as cache, register, control unit and arithmetic logic unit. When it comes to the function of CPU, it helps human compute sophisticated matters. It simply uses three instructions, fetch, decode, and execute to complete work.

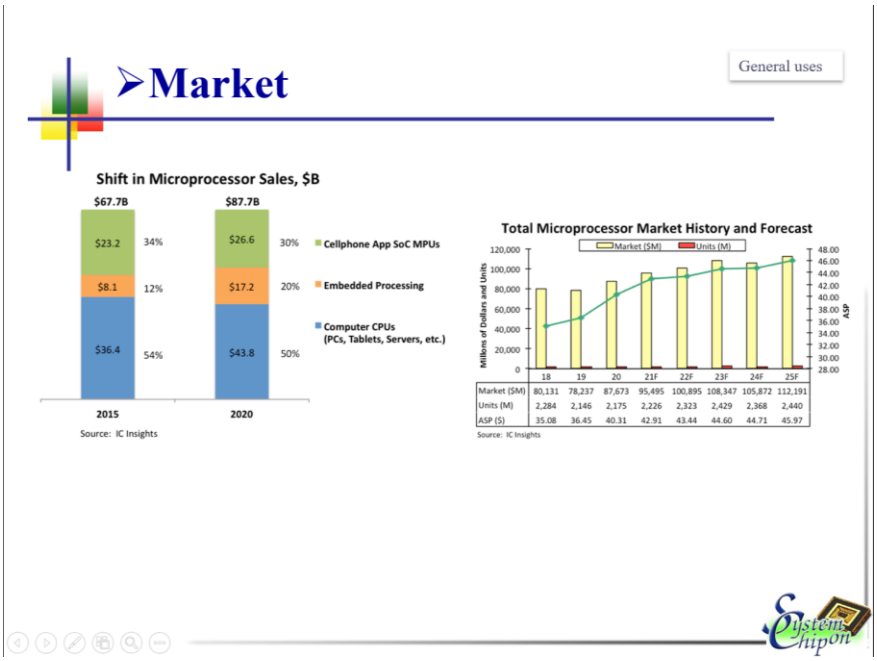
First, fetching, as the word suggests, the first CPU receives the

instruction. That means the series of binary numbers that are passed from RAM to CPU. The CPU does not directly receive a single instruction. However, rather the instructions are separated into several sets in memory. That implies many small building blocks of a long process are made. After which, the CPU receives those pieces of instruction one by one. Since the data is in a disordered manner, when an instruction is divided into several smaller sets, the program counter (PC) holds the instructions' addresses to provide the instructions serial wise to perform as per the need. In this way, the CPU gets to know the order of receiving the instructions. These instructions are stored in the IR (Instruction Register). Once this is completed, the program counter will continue to reference its following instructions address.

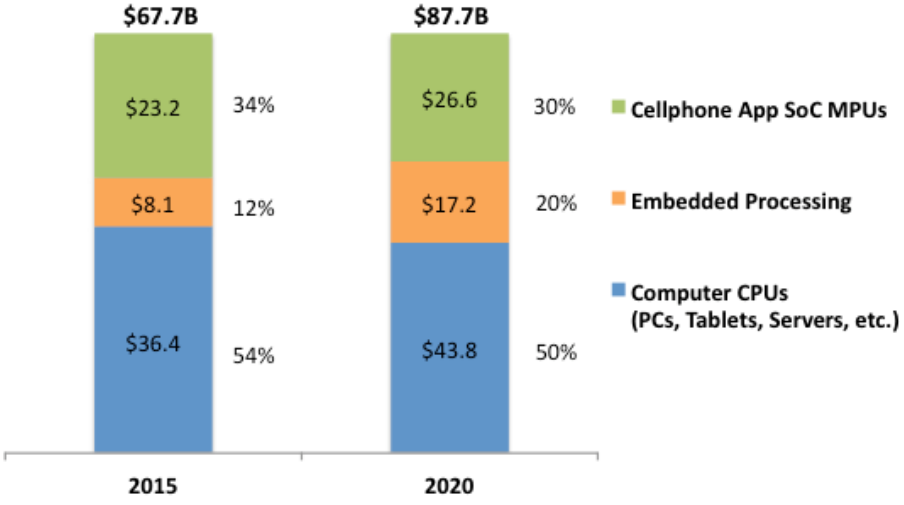
Second, decoding, once the instruction is loaded into the CPU, it needs to work out what the instruction means. After which the process of decode begins with the help of ALU (Arithmetic Logic Unit). It performs logical and arithmetic operations and necessary calculations, which manages the computer's various components; it reads and interprets instructions from memory and transforms them into a series of signal forms that are then passed to different parts of the CPU so that further action can be taken.

At last, executing, decoded instructions are executed. Finally, the computer has to carry out the instruction during the execution step. This could be many things, including loading data from memory, storing data in memory, or performing a calculation. After which, they are stored in the CPU register as output so later instructions can reference them. After this, as per the user's instructions, it is either given to the output device, or it is stored on the computer system, or even stored on secondary storage devices. The processor will carry out this cycle over and over millions of times per second. This is how the CPU works.

1.2 Market

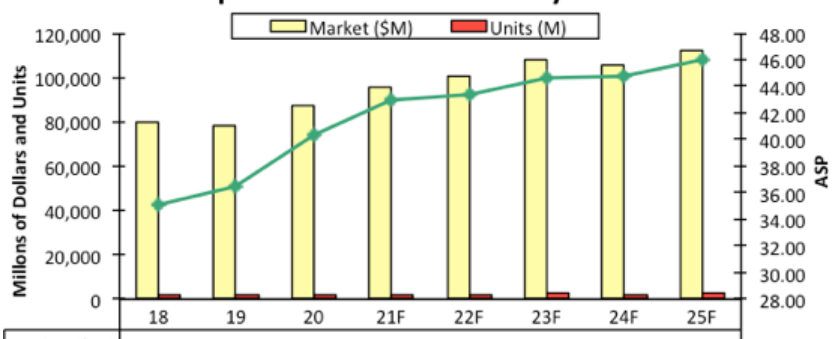


Shift in Microprocessor Sales, $B



Source: IC Insights

Total Microprocessor Market History and Forecast

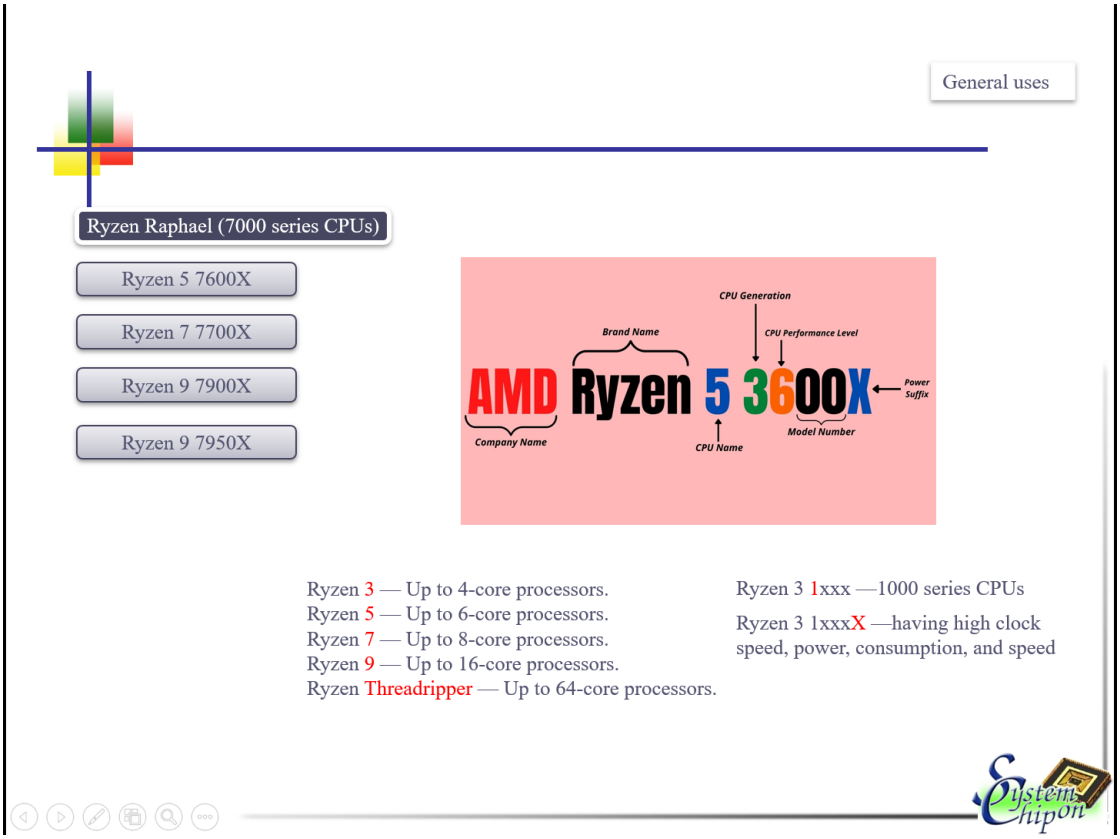


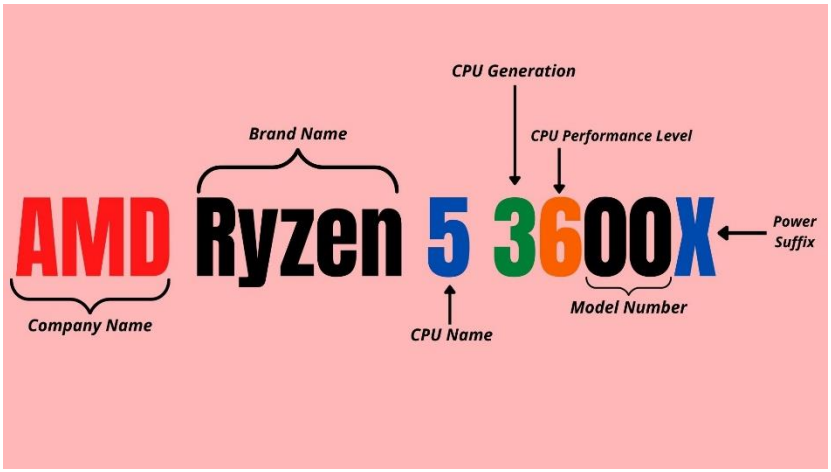
	18	19	20	21F	22F	23F	24F	25F
Market ($M)	80,131	78,237	87,673	95,495	100,895	108,347	105,872	112,191
Units (M)	2,284	2,146	2,175	2,226	2,323	2,429	2,368	2,440
ASP ($)	35.08	36.45	40.31	42.91	43.44	44.60	44.71	45.97

Source: IC Insights

A market size is important because it can determine how far the product go. As for CPU's market share, we can see that at 2015, for all 67.7B microprocessors sales, computer CPUs have a significant rate, which is over 50% in microprocessors, and at 2020 for all 87.7B microprocessors sales, CPUs are also above 50%, they are still dominating the market. And for the future, in the other figure, we can see microprocessors sales may have a rise to 120B dollars at 2025

1.3 AMD CPU model numbers

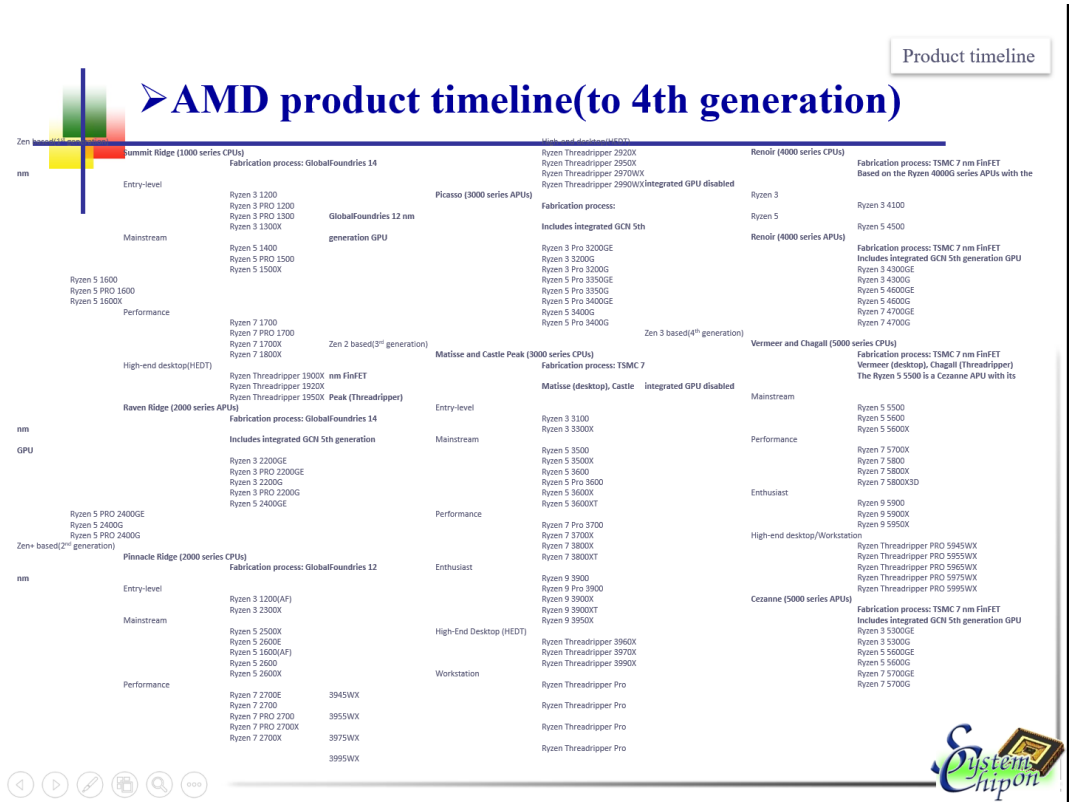




So how do we know the CPU we buy is suitable for us? Let's take today's topic, AMD, for example. As for today's topic, 7000 series, we can see that ryzen 5, 7, 9 means how many cores it has, and we know they are all 7 generation because of the first number after the CPU name and their performance level. Typically, AMD famous for its overclocking, and they will add an X at the back to this type of CPU. Furthermore, X means its Extended Frequency Range which allows boosting up the performance process exceeding the limit.

2. Product timeline

2.1 Overall product timeline



Zen based(1st generation)

- Summit Ridge (1000 series CPUs)
  - Fabrication process: GlobalFoundries 14 nm
  - Entry-level
    - Ryzen 3 1200
    - Ryzen 3 PRO 1200
    - Ryzen 3 PRO 1300
    - Ryzen 3 1300X
  - Mainstream
    - Ryzen 5 1400
    - Ryzen 5 PRO 1500
    - Ryzen 5 1500X

Ryzen 5 1600

Ryzen 5 PRO 1600

Ryzen 5 1600X

- Performance
  - Ryzen 7 1700
  - Ryzen 7 PRO 1700

- Ryzen 7 1700X
- Ryzen 7 1800X
- High-end desktop(HEDT)
  - Ryzen Threadripper 1900X
  - Ryzen Threadripper 1920X
  - Ryzen Threadripper 1950X
- Raven Ridge (2000 series APUs)
  - Fabrication process: GlobalFoundries 14 nm
  - Includes integrated GCN 5th generation GPU
  - Ryzen 3 2200GE
  - Ryzen 3 PRO 2200GE
  - Ryzen 3 2200G
  - Ryzen 3 PRO 2200G
  - Ryzen 5 2400GE

Ryzen 5 PRO 2400GE

Ryzen 5 2400G

Ryzen 5 PRO 2400G

Zen+ based(2nd generation)

- Pinnacle Ridge (2000 series CPUs)
  - Fabrication process: GlobalFoundries 12 nm
- Entry-level
  - Ryzen 3 1200(AF)
  - Ryzen 3 2300X
- Mainstream
  - Ryzen 5 2500X
  - Ryzen 5 2600E
  - Ryzen 5 1600(AF)
  - Ryzen 5 2600
  - Ryzen 5 2600X
- Performance
  - Ryzen 7 2700E
  - Ryzen 7 2700
  - Ryzen 7 PRO 2700
  - Ryzen 7 PRO 2700X
  - Ryzen 7 2700X
- High-end desktop(HEDT)
  - Ryzen Threadripper 2920X
  - Ryzen Threadripper 2950X

- Ryzen Threadripper 2970WX
- Ryzen Threadripper 2990WX

Picasso (3000 series APUs)

- Fabrication process: GlobalFoundries 12 nm
- Includes integrated GCN 5th generation GPU
- Ryzen 3 Pro 3200GE
- Ryzen 3 3200G
- Ryzen 3 Pro 3200G
- Ryzen 5 Pro 3350GE
- Ryzen 5 Pro 3350G
- Ryzen 5 Pro 3400GE
- Ryzen 5 3400G
- Ryzen 5 Pro 3400G

Zen 2 based(3rd generation)

Matisse and Castle Peak (3000 series CPUs)

- Fabrication process: TSMC 7 nm FinFET
- Matisse (desktop), Castle Peak (Threadripper)

Entry-level

- Ryzen 3 3100
- Ryzen 3 3300X

Mainstream

- Ryzen 5 3500
- Ryzen 5 3500X
- Ryzen 5 3600
- Ryzen 5 Pro 3600
- Ryzen 5 3600X
- Ryzen 5 3600XT

Performance

- Ryzen 7 Pro 3700
- Ryzen 7 3700X
- Ryzen 7 3800X
- Ryzen 7 3800XT

Enthusiast

- Ryzen 9 3900
- Ryzen 9 Pro 3900
- Ryzen 9 3900X
- Ryzen 9 3900XT
- Ryzen 9 3950X

High-End Desktop (HEDT)

Ryzen Threadripper 3960X

Ryzen Threadripper 3970X

Ryzen Threadripper 3990X

Workstation

Ryzen Threadripper Pro 3945WX

Ryzen Threadripper Pro 3955WX

Ryzen Threadripper Pro 3975WX

Ryzen Threadripper Pro 3995WX

Renoir (4000 series CPUs)

Fabrication process: TSMC 7 nm FinFET

Based on the Ryzen 4000G series APUs with the integrated GPU disabled

Ryzen 3

Ryzen 3 4100

Ryzen 5

Ryzen 5 4500

Renoir (4000 series APUs)

Fabrication process: TSMC 7 nm FinFET

Includes integrated GCN 5th generation GPU

Ryzen 3 4300GE

Ryzen 3 4300G

Ryzen 5 4600GE

Ryzen 5 4600G

Ryzen 7 4700GE

Ryzen 7 4700G

Zen 3 based(4th generation)

Vermeer and Chagall (5000 series CPUs)

Fabrication process: TSMC 7 nm FinFET

Vermeer (desktop), Chagall (Threadripper)

The Ryzen 5 5500 is a Cezanne APU with its integrated GPU disabled

Mainstream

Ryzen 5 5500

Ryzen 5 5600

Ryzen 5 5600X

Performance

Ryzen 7 5700X

Ryzen 7 5800

- Ryzen 7 5800X
- Ryzen 7 5800X3D

- Enthusiast
  - Ryzen 9 5900
  - Ryzen 9 5900X
  - Ryzen 9 5950X
- High-end desktop/Workstation
  - Ryzen Threadripper PRO 5945WX
  - Ryzen Threadripper PRO 5955WX
  - Ryzen Threadripper PRO 5965WX
  - Ryzen Threadripper PRO 5975WX
  - Ryzen Threadripper PRO 5995WX
- Cezanne (5000 series APUs)
  - Fabrication process: TSMC 7 nm FinFET
  - Includes integrated GCN 5th generation GPU
  - Ryzen 3 5300GE
  - Ryzen 3 5300G
  - Ryzen 5 5600GE
  - Ryzen 5 5600G
  - Ryzen 7 5700GE
  - Ryzen 7 5700G

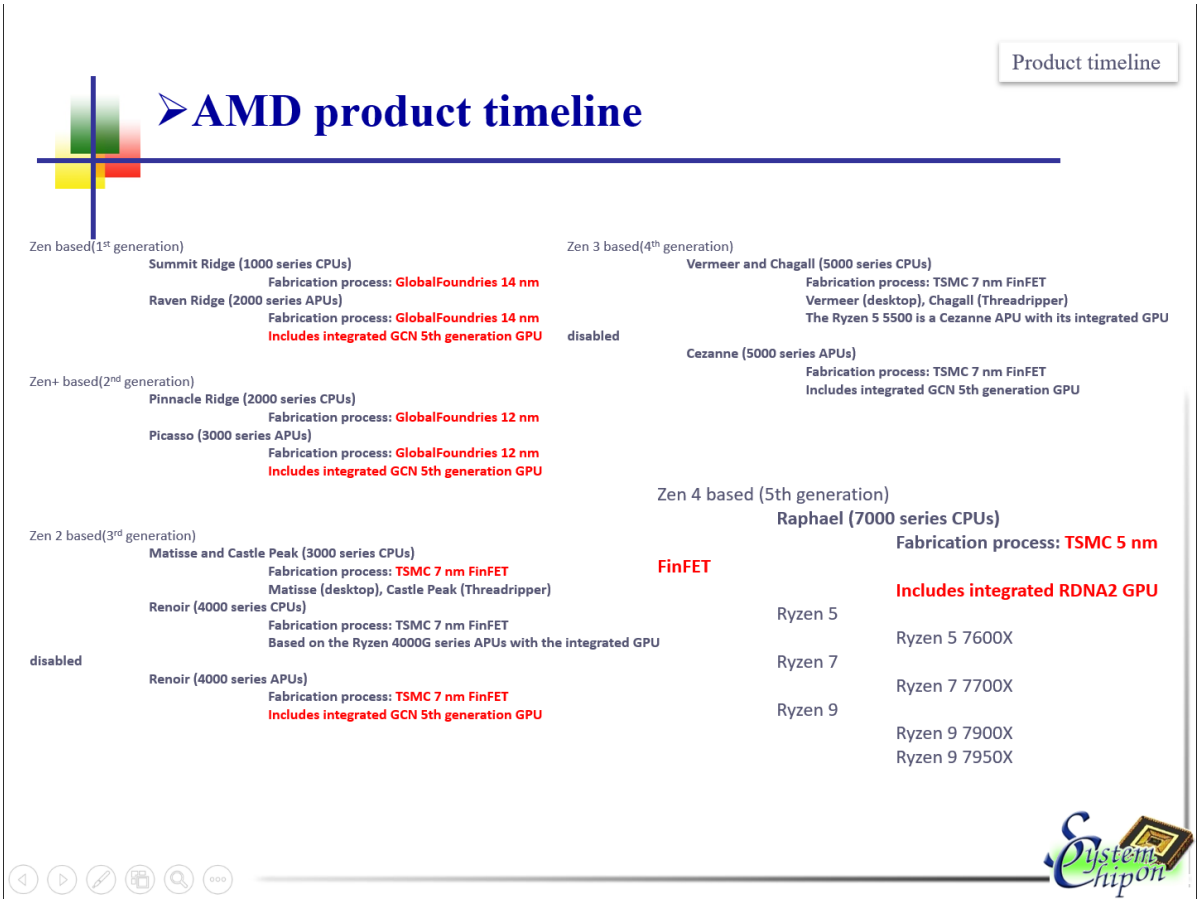
Zen 4 based (5th generation)

- Raphael (7000 series CPUs)
  - Fabrication process: TSMC 5 nm FinFET
  - Includes integrated RDNA2 GPU
- Ryzen 5
  - Ryzen 5 7600X
- Ryzen 7
  - Ryzen 7 7700X
- Ryzen 9

Ryzen 9 7900X

Ryzen 9 7950X

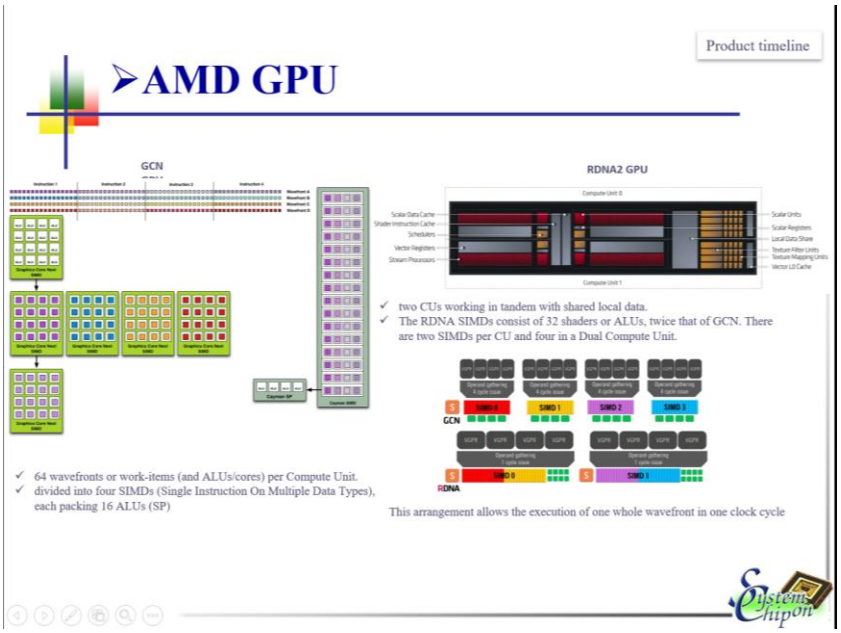
2.2 Product timeline by generation

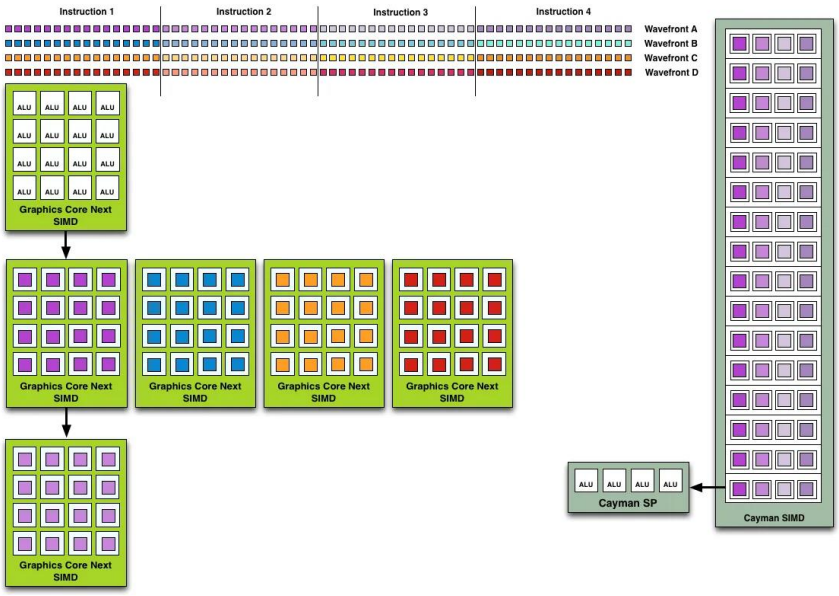


This is the comparation between every generation. As we can see that from the first generation, it is made in 14nm in 1000 series and evolve to have GCN GPU inside in 2000 series, and then second, 12nm in 2000 series, also add GCN in 3000 series, and in third generation, it changes to make in TSMC 7nm FF process in 3000 series and then add GCN in 4000 series. This kind of changing the process technology and changing microarchitecture is called Tick Tock, Tick means having a mature or previous microarchitecture but on a new process, Tock means having a mature or previous process but on a new microarchitecture. So, every generation follow this Tick Tock role till the latest generation. And now, for the zen4 based, the firth generation, they use TSMC 5nm FF and a different GPU RDNA2 inside

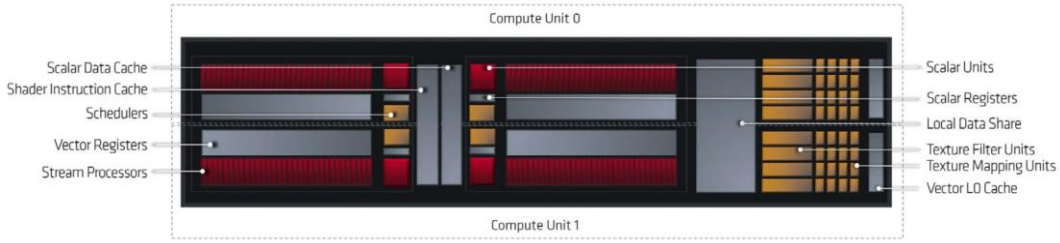
3. System description

3.1 AMD GPU

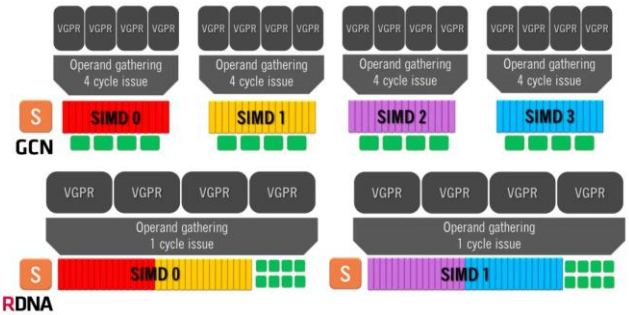




GCN



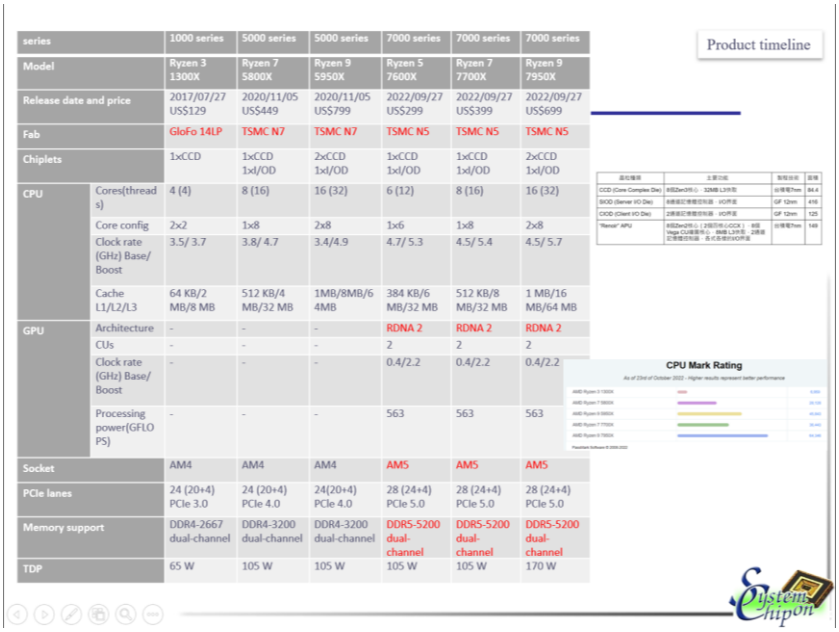
RDNA2



Time cycle comparation

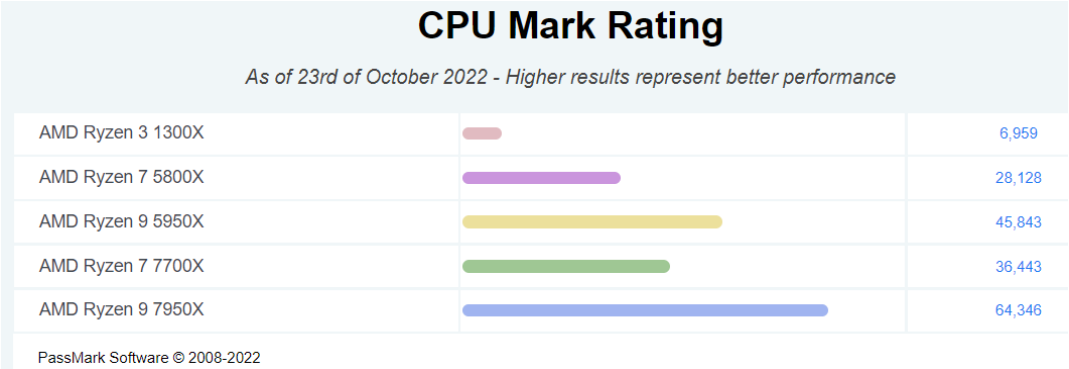
AMD GPU evolved from GCN to RDNA2. The Graphics Compute Next architecture makes use of a Compute Unit composed of 4 SIMD groups of 16 ALUs each, which handles waves of 64 elements. This means that in the best-case scenario, where one instruction is solved per cycle, the GCN architecture is going to take 4 clock cycles per 64-element wave. On the other hand, RDNA architectures have a different operation, since we have two groups of 32 ALUs and the size of the waves has gone from 64 elements to 32 elements. The same size that NVIDIA uses in its GPUs, so now the minimum time per wave is 1 single cycle because we have all 32 execution units running in parallel. Although the average number of instructions solved is still 64, it is a much more efficient organization. But the most important change is the change when executing the instructions that arrive from each wave, since RDNA solves them in much fewer cycles, which means that the average number of instructions per cycle that are solved is much larger. and with it the average CPI increases. What does this translate to? Well, since far fewer Compute Units are required to achieve the same performance, fewer Compute Units mean a smaller GPU to achieve the same performance.

3.2 Different specs between generations



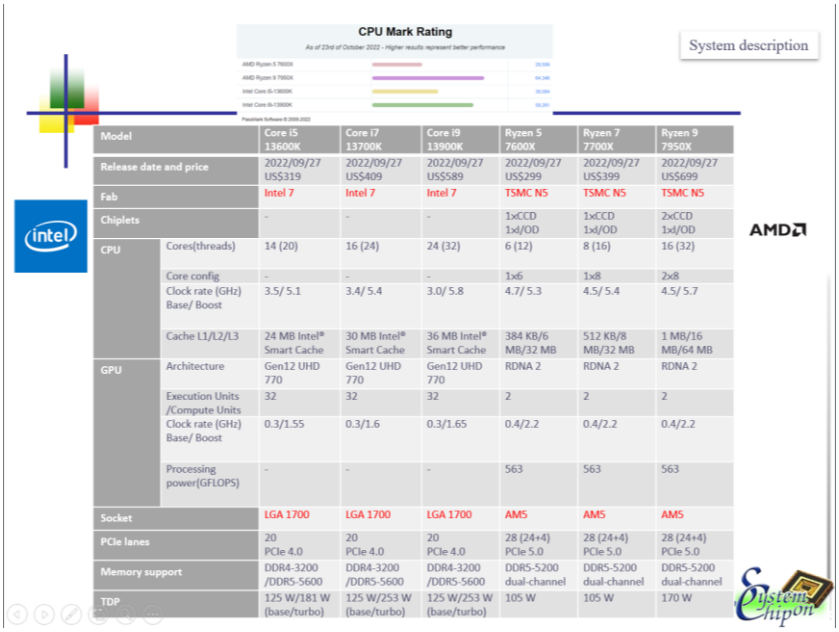
series		1000 series	5000 series	5000 series	7000 series	7000 series	7000 series
Model		Ryzen 3 1300X	Ryzen 7 5800X	Ryzen 9 5950X	Ryzen 5 7600X	Ryzen 7 7700X	Ryzen 9 7950X
Release date and price		2017/07/27 US$129	2020/11/05 US$449	2020/11/05 US$799	2022/09/27 US$299	2022/09/27 US$399	2022/09/27 US$699
Fab		GloFo 14LP	TSMC N7	TSMC N7	TSMC N5	TSMC N5	TSMC N5
Chiplets		1xCCD	1xCCD 1xI/OD	2xCCD 1xI/OD	1xCCD 1xI/OD	1xCCD 1xI/OD	2xCCD 1xI/OD
CPU	Cores(threads)	4 (4)	8 (16)	16 (32)	6 (12)	8 (16)	16 (32)
	Core config	2x2	1x8	2x8	1x6	1x8	2x8
	Clock rate (GHz) Base/ Boost	3.5/ 3.7	3.8/ 4.7	3.4/4.9	4.7/ 5.3	4.5/ 5.4	4.5/ 5.7
	Cache L1/L2/L3	64 KB/2 MB/8 MB	512 KB/4 MB/32 MB	1MB/8MB/64MB	384 KB/6 MB/32 MB	512 KB/8 MB/32 MB	1 MB/16 MB/64 MB
GPU	Architecture	-	-	-	RDNA 2	RDNA 2	RDNA 2
	CUs	-	-	-	2	2	2
	Clock rate (GHz) Base/ Boost	-	-	-	0.4/2.2	0.4/2.2	0.4/2.2
	Processing power(GFLOPS)	-	-	-	563	563	563
Socket		AM4	AM4	AM4	AM5	AM5	AM5
PCIe lanes		24 (20+4) PCIe 3.0	24 (20+4) PCIe 4.0	24(20+4) PCIe 4.0	28 (24+4) PCIe 5.0	28 (24+4) PCIe 5.0	28 (24+4) PCIe 5.0
Memory support		DDR4-2667 dual-channel	DDR4-3200 dual-channel	DDR4-3200 dual-channel	DDR5-5200 dual-channel	DDR5-5200 dual-channel	DDR5-5200 dual-channel
TDP		65 W	105 W	105 W	105 W	105 W	170 W

晶粒種類	主要功能	製程技術	面積
CCD (Core Complex Die)	8個Zen3核心，32MB L3快取	台積電7nm	84.4
SIOD (Server I/O Die)	8通道記憶體控制器，I/O界面	GF 12nm	416
CIOD (Client I/O Die)	2通道記憶體控制器，I/O界面	GF 12nm	125
“Renoir” APU	8個Zen2核心（2個四核心CCX），8個Vega CU繪圖核心，8MB L3快取，2通道記憶體控制器，各式各樣的I/O界面	台積電7nm	149



In the table, we can find some difference between generations. The CCD in the chiplets means core complex die, it mainly represents how many cores and it is operating for L3 cache. We can see when it comes to 7000 series, the process technology changes to TSMC N5, GPU changes from GCN to RDNA2, the socket changes to AM5, and the memory support changes to DDR5-5200 dual-channel. As we can see that, the CPU mark rating performance of five kinds of CPU from different generations. The Ryzen 9 CPUs tend to have better performance than all the other CPUs, even Ryzen 9 5950X still has higher rating v.s. Ryzen 7700X. we can simply conclude that Ryzen 9 > Ryzen 7 > Ryzen 3 and 7th generation > 5th generation > 1th generation.

3.3 Different specs between intel and AMD



Model		Core i5 13600K	Core i7 13700K	Core i9 13900K	Ryzen 5 7600X	Ryzen 7 7700X	Ryzen 9 7950X
Release date and price		2022/09/27 US$319	2022/09/27 US$409	2022/09/27 US$589	2022/09/27 US$299	2022/09/27 US$399	2022/09/27 US$699
Fab		Intel 7	Intel 7	Intel 7	TSMC N5	TSMC N5	TSMC N5
Chiplets		-	-	-	1xCCD 1xI/OD	1xCCD 1xI/OD	2xCCD 1xI/OD
CPU	Cores(threads)	14 (20)	16 (24)	24 (32)	6 (12)	8 (16)	16 (32)
	Core config	-	-	-	1x6	1x8	2x8
	Clock rate (GHz) Base/ Boost	3.5/ 5.1	3.4/ 5.4	3.0/ 5.8	4.7/ 5.3	4.5/ 5.4	4.5/ 5.7
	Cache L1/L2/L3	24 MB Intel® Smart Cache	30 MB Intel® Smart Cache	36 MB Intel® Smart Cache	384 KB/6 MB/32 MB	512 KB/8 MB/32 MB	1 MB/16 MB/64 MB
GPU	Architecture	Gen12 UHD 770	Gen12 UHD 770	Gen12 UHD 770	RDNA 2	RDNA 2	RDNA 2
	Execution Units /Compute Units	32	32	32	2	2	2
	Clock rate (GHz) Base/ Boost	0.3/1.55	0.3/1.6	0.3/1.65	0.4/2.2	0.4/2.2	0.4/2.2
	Processing power(GFLOPS)	-	-	-	563	563	563
Socket		LGA 1700	LGA 1700	LGA 1700	AM5	AM5	AM5
PCIe lanes		20 PCIe 4.0	20 PCIe 4.0	20 PCIe 4.0	28 (24+4) PCIe 5.0	28 (24+4) PCIe 5.0	28 (24+4) PCIe 5.0
Memory support		DDR4-3200 /DDR5-5600	DDR4-3200 /DDR5-5600	DDR4-3200 /DDR5-5600	DDR5-5200 dual-channel	DDR5-5200 dual-channel	DDR5-5200 dual-channel
TDP		125 W/181 W (base/turbo)	125 W/253 W (base/turbo)	125 W/253 W (base/turbo)	105 W	105 W	170 W

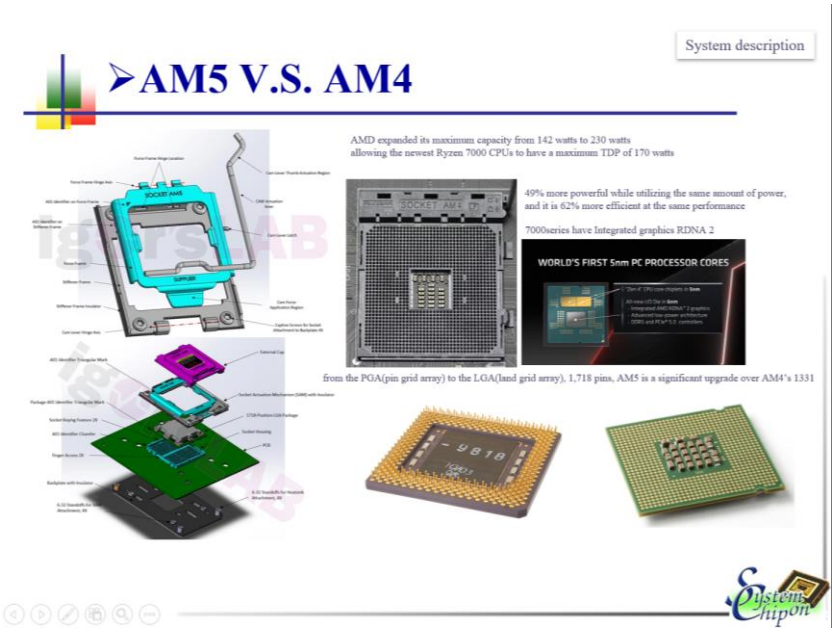
CPU Mark Rating

As of 23rd of October 2022 - Higher results represent better performance

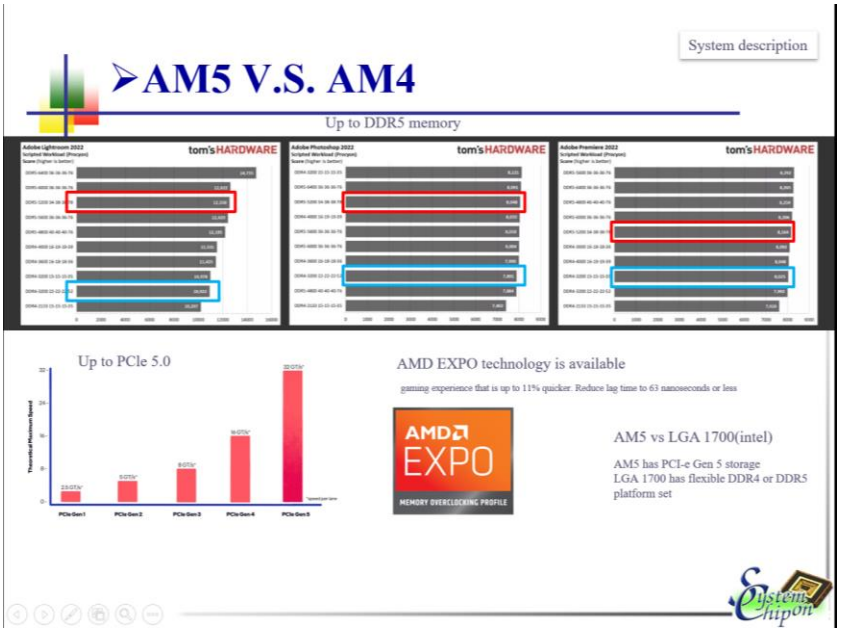
AMD Ryzen 5 7600X	28,599
AMD Ryzen 9 7950X	64,346
Intel Core i5-13600K	38,084
Intel Core i9-13900K	58,261

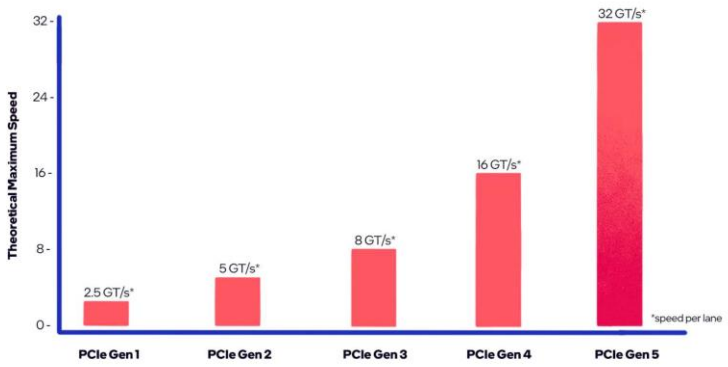
In the table, we can find some difference between intel and AMD. We can not simply compare this two specs because these two companies use different structure when building the socket and architecture. We still can see the difference that, AMD use TSMC N5 and intel use its intel 7 for process technology. AMD use AM5 and intel use LGA1700 for its socket. As for the objective perspective, we use the rating again, its show that AMD Ryzen 9 has the best performance but Ryzen 5 has the worst performance.

3.4 AM5 socket v.s. AM4 socket



AM5 expanded its maximum capacity from 142 watts to 230 watts allowing the newest Ryzen 7000 CPUs to have a maximum TDP of 170 watts, 49% more powerful while utilizing the same amount of power, and it is 62% more efficient at the same performance.
From the PGA(pin grid array) to the LGA(land grid array), 1,718 pins, AM5 is a significant upgrade over AM4's 1331. AM5 has no pins on the chip, in place of the pins are pads of bare gold-plated copper that touch protruding pins on the microprocessor's connector on the motherboard, it reduces the likelihood of the chip being damaged either before or during installation as there are no pins that can be accidentally bent.

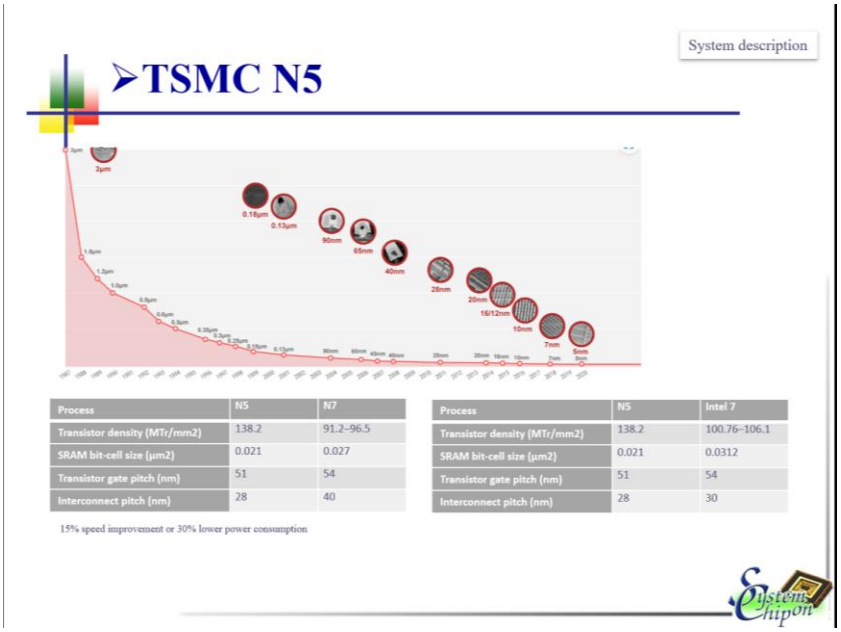




AMD EXPO
MEMORY OVERCLOCKING PROFILE

AM5 has upgrade to PCIe5 and has a special EXPO technology to help gaming experience, that is up to 11% quicker, and reduce lag time to 63 nanoseconds or less.

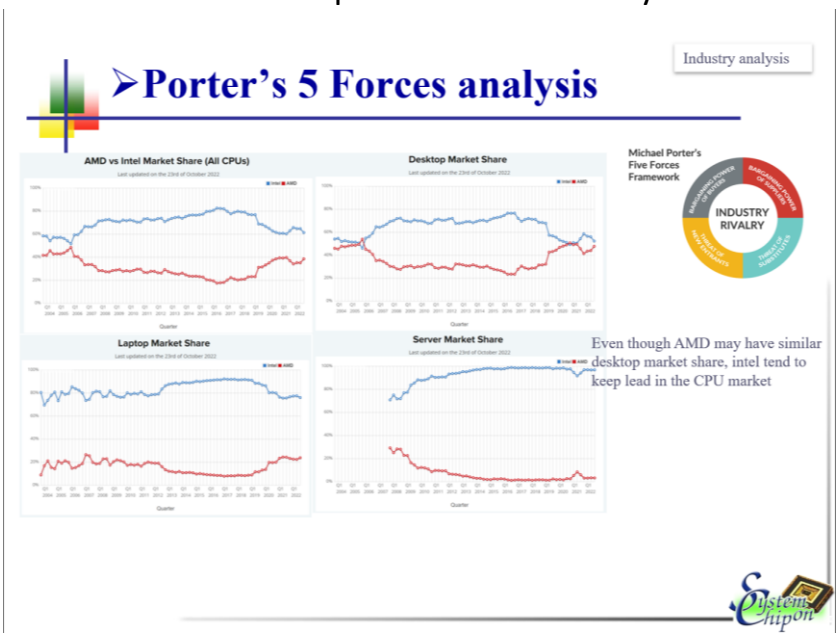
3.5 manufacturer

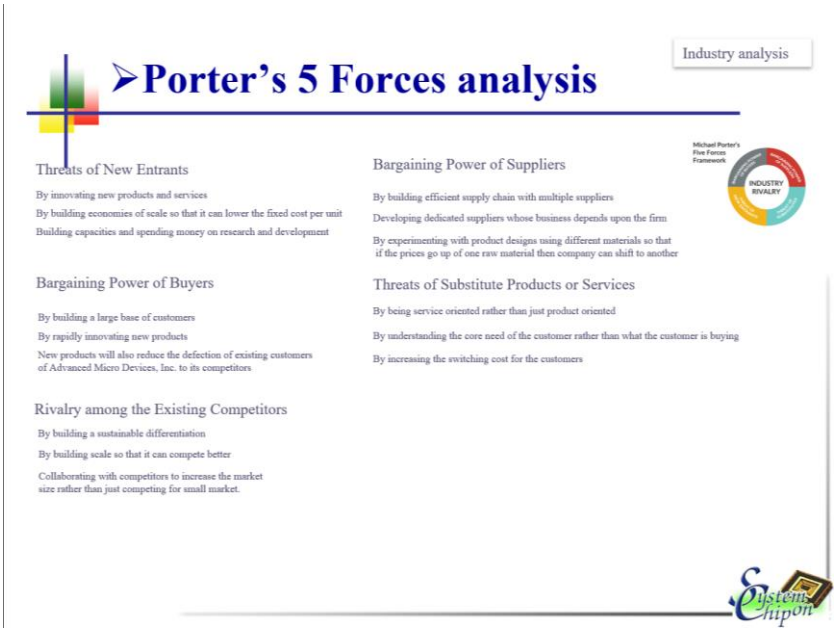


TSMC N5 is 15% speed improvement or 30% lower power consumption compare to TSMC N7

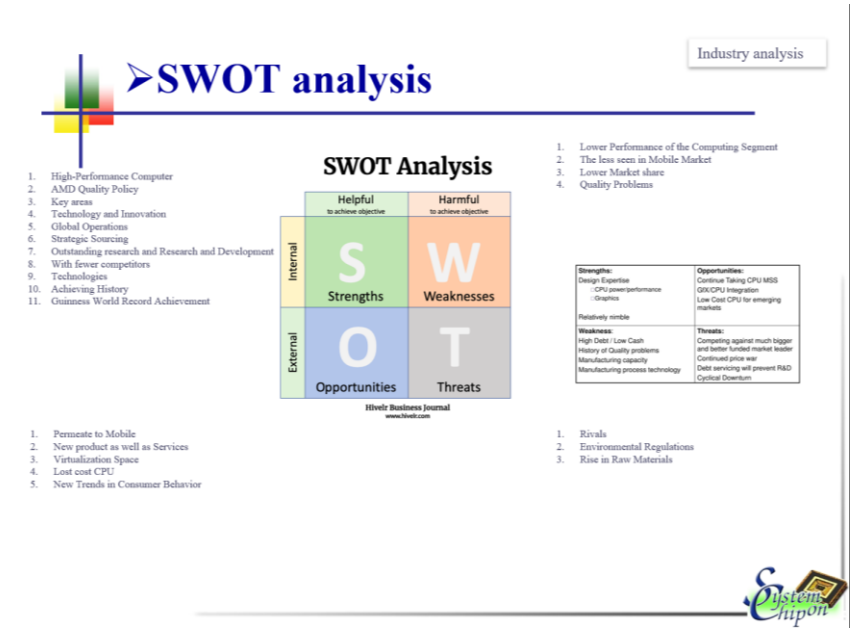
4. Industry analysis

4.1 Market share and porter's 5 force analysis





4.2 SWOT analysis



Strengths

1.providing high-performance computing and graphics products

2.helps them to ensure that their products are up to top quality

3.Key Areas of HTML0 AMD is a well-known branding recognition within the Microprocessor and PC market

8.There are fewer competitors AMD principal area of Graphical Processing Unit and Microprocessor has just one competitor on the market

Weakness

1.low performance in the computing segment due the advent of mobile devices and tablets
2.AMD is ignoring the mobile market, where there's plenty of business transactions that are conducted via mobile today
3.AMD has a high level of competition in HTML0, the market share of HTML0 is less
4.Quality Issues AMD has had issues with regards to quality over the many years

Opportunities

1.AMD should broaden its operations to tablets and mobile platforms
2.should increase its product range and services

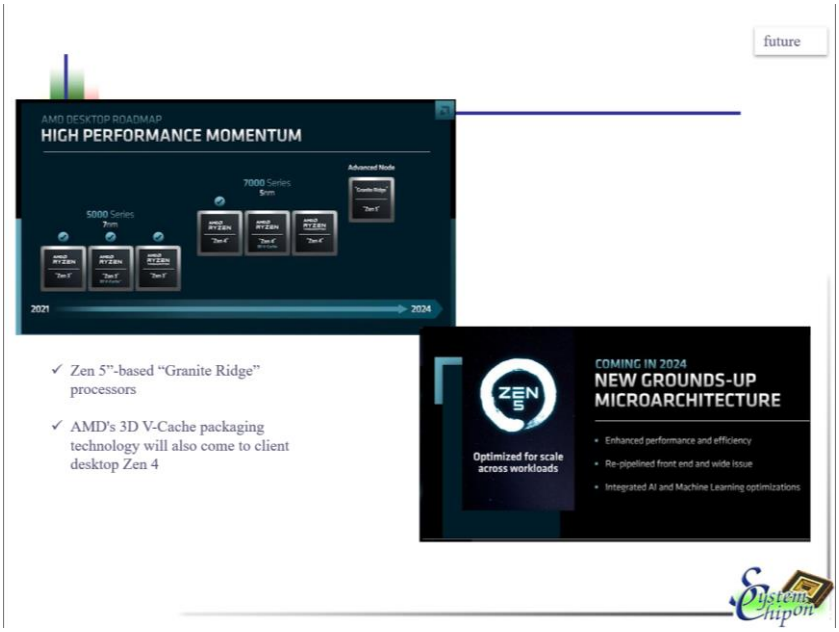
Threats

1.Competitors AMD has two competitors that are major players on the market: AMD and Nvidia as well as Intel.
2.Different environmental regulations pose extremely harmful to existing product categories , and could impact the production

5.applications

The 95th percentile is a number that is greater than 95% of the numbers in a given set, it gives a very accurate picture of the maximum traffic generated on an interface for interpreting performance data

6.future



In the future, AMD will have Zen 5"-based "Granite Ridge" processors for the new promising product, also AMD will develop its own 3D V-Cache packaging technology, and it will also come to client desktop Zen 4

7.reference

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