



RYZEN

AMD

Agenda

- What is Ryzen?
- History
- Features
- Zen Architecture
- SenseMI Technology
- Master Software
- Benchmarks



The Ryzen Chip

What is Ryzen?

CPU chip family released by AMD in 2017, which uses their latest architecture called Zen. AMD has released Ryzen 7 and Ryzen 5 families described below, and they plan to release another one called Ryzen 3.

What it is used for:

General Purpose Processor, the CPU family have different tiers Ryzen 7, 5 that are currently on the market and Ryzen 3 coming to market later in the year. The three tiers are priced from high to low respectively, Ryzen 7 aimed for the people looking for high CPU performance for tasks like high spec gaming and video and photo editing, Ryzen 5 aimed for people who are just interested in having a regular computer that can be used by mainstream users that will use it for work tasks and web browsing; Ryzen 3 will probably be a bare bones CPU that will run an OS effectively.

Some specifics about the chip itself:

It uses a 14nm process, manufactured by GlobalFoundries. Its goal was to bit a 40% increase in IPC from the previous Excavator generation; but it accomplished to increase its IPC (Instructions per cycle) by 52%, and keeping the same energy used, increasing its efficiency substantially.

AMD Ryzen CPU	Cores/Threads	L3	TDP	Base	Turbo	XFR	Overclocking Unlocked	Price
AMD Ryzen 7 1800X	8/16	16MB	95W	3.6GHz	4.0GHz	4.0GHz+	Yes	\$499
AMD Ryzen 7 1700X	8/16	16MB	95W	3.4GHz	3.8GHz	3.8GHz+	Yes	\$389
AMD Ryzen 7 1700	8/16	16MB	65W	3.0GHz	3.7GHz	N/A	Yes	\$319
AMD Ryzen 5 1600X	6/12	16MB	95W	3.3GHz	3.7GHz	3.7GHz+	Yes	\$259
AMD Ryzen 5 1500	6/12	16MB	65W	3.2GHz	3.5GHz	N/A	Yes	\$229
AMD Ryzen 5 1400X	4/8	8MB	65W	3.5GHz	3.9GHz	3.9GHz+	Yes	\$199
AMD Ryzen 5 1300	4/8	8MB	65W	3.2GHz	3.5GHz	N/A	Yes	\$175
AMD Ryzen 3 1200X	4/4	8MB	65W	3.4GHz	3.8GHz	3.8GHz+	Yes	\$149
AMD Ryzen 3 1100	4/4	8MB	65W	3.2GHz	3.5GHz	N/A	Yes	\$129

History

Design work on the microarchitecture began in 2012 and was completed four years later. It began with the hiring of Jim Keller who has worked for Apple in the design of the A4 and A5 processors. The very first products based on the brand new CPU core design are the Ryzen processors.



History of AMD architecture

CPU Cache Comparison

	Zen HEDT	Bulldozer HEDT	Excavator	Skylake	Broadwell HEDT
L1-I	64KB/core	64KB/module	96KB/module	32KB/core	32KB/core
	4-way	2-way	3-way	8-way	8-way
L1-D	32KB/core	16KB/thread	32KB/thread	32KB/core	32KB/core
	8-way	4-way	8-way	8-way	8-way
L2	512KB/core	1MB/thread	512KB/thread	256KB/core	256KB/core
	8-way	16-way	16-way	4-way	8-way
L3	2MB/core	1MB/thread	-	>2MB/core	1.5-3MB/core
	16-way	64-way	-	16-way	16/20-way
L3 Type	Victim	Victim	-	Write-back	Write-back

Features

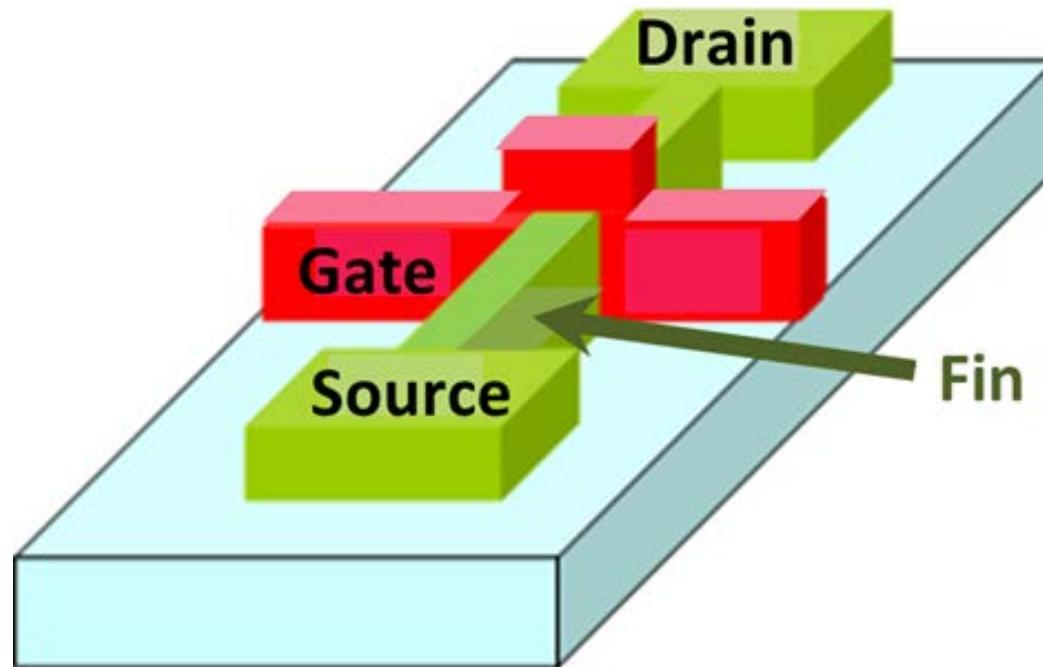
- I. Zen architecture
- II. SenseMI Technology
- III. Ryzen Master Software

Zen Architecture Highlights

- Two threads per core (SMT - Simultaneous Multithreading)
- All-new Micro-op Cache
- Up to 20MB Unified Cache
- Two AES units for security (Advanced Encryption Standard)
- High-precision MHz Boost
- High efficiency FinFET transistors

	Zen	Competitor A [1]
Tech	14nm	14nm
Cores	4 Cores, 8 Threads	4 Cores, 8 Threads
Area	44mm ²	49mm ²
L2	512KB, 1.5mm ² /core	256KB, 0.9mm ² /core
L3	8MB, 16mm ²	8MB, 19.1mm ²
CPP (nm)	78	70
Fin Pitch (nm)	48	42
1x Metal Pitch (nm)	64	52
Standard 6t SRAM (mm ²)	0.0806	0.0588
Metal Layers	12 w/ MiM	13 w/ MiM

FinFet transistor



Pipeline

Each Ryzen core has 1 Floating-point unit and 1 integer-unit.

Each Integer unit has 6 pipes, 4 ALUs(Arithmetic Logic Unit) and 2 AGUs(Address Generation Unit). These AGUs can perform two 16-byte loads and one 16-byte store per cycle via a 32 KB 8-way set associative write-back L1 data cache. The floating point unit is capable of performing two FMAC operations or a single 256-bit AVX operation per cycle.

Can decode four instructions per cycle.

Can deliver 6 operations per cycle to schedulers.

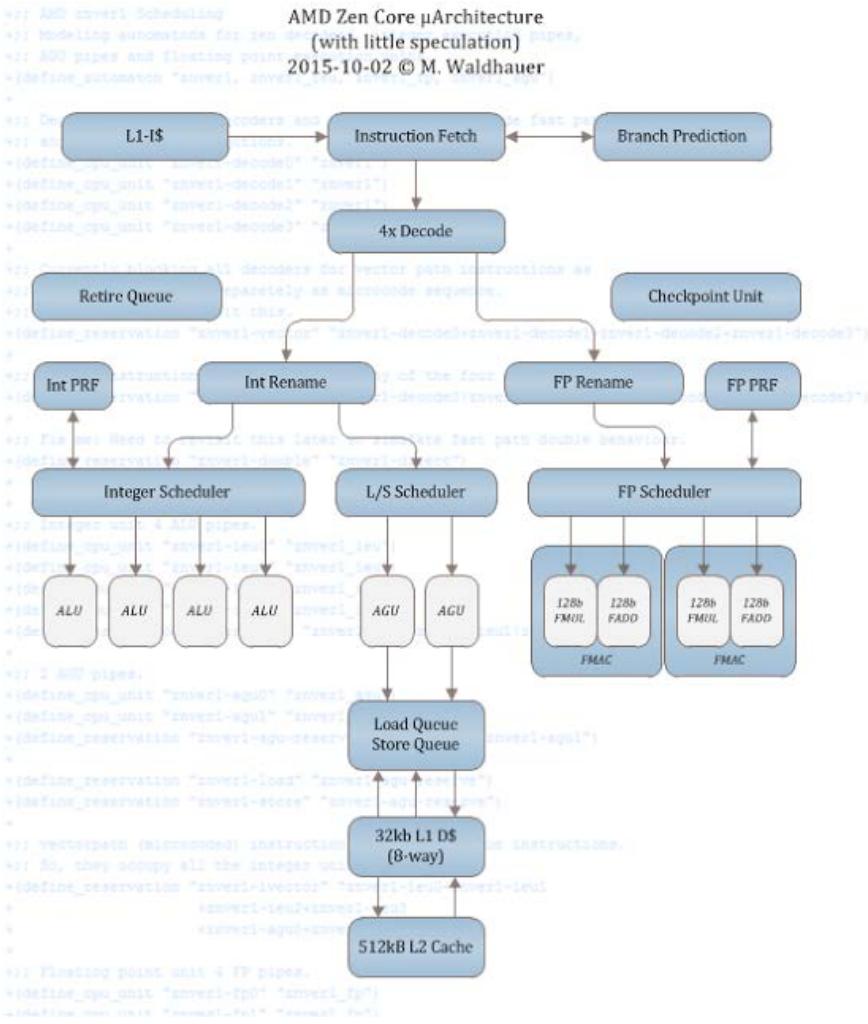
load/store can perform two 16 byte loads and one 16 byte store per cycle.

4 IPC decoders

4 integer ALUs

2 AGUs (2R 1W)

4 FP pipelines



Core Engine

Two threads per core

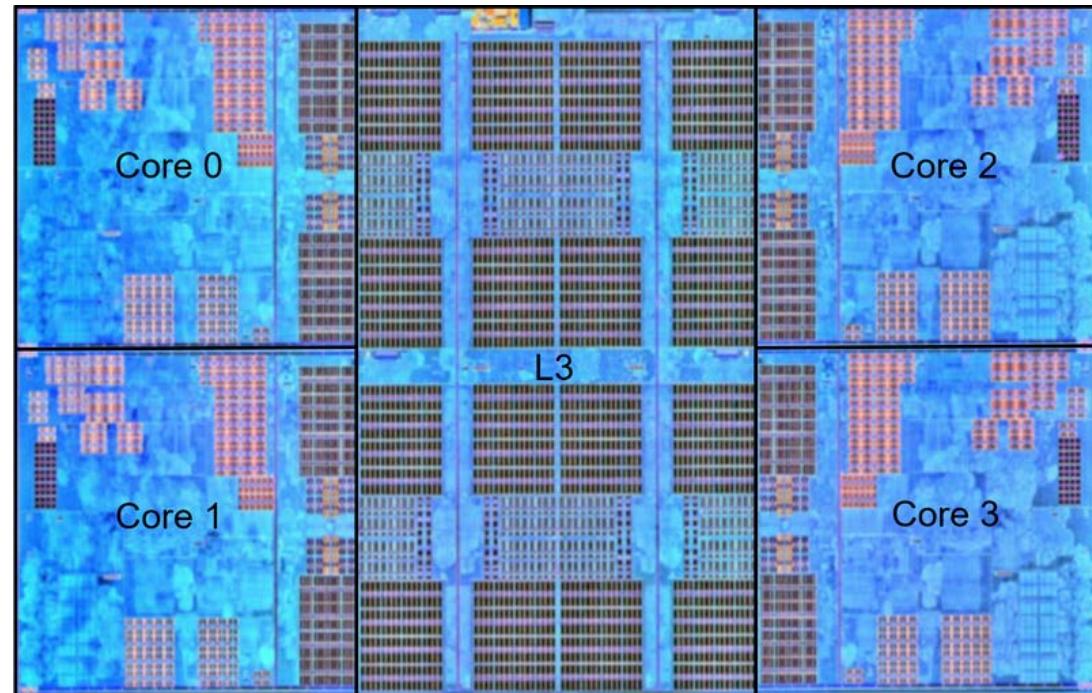
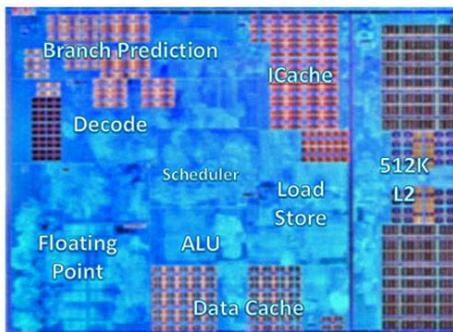
Improved branch prediction

Large Op cache

Larger Instruction Schedulers

Core Functional Units

- 64KB IC
- 32KB DC
- ~20 tiles,
<0.7m
instances
- ROM for
uCODE
- 5 L1 RAM
variants



Cache

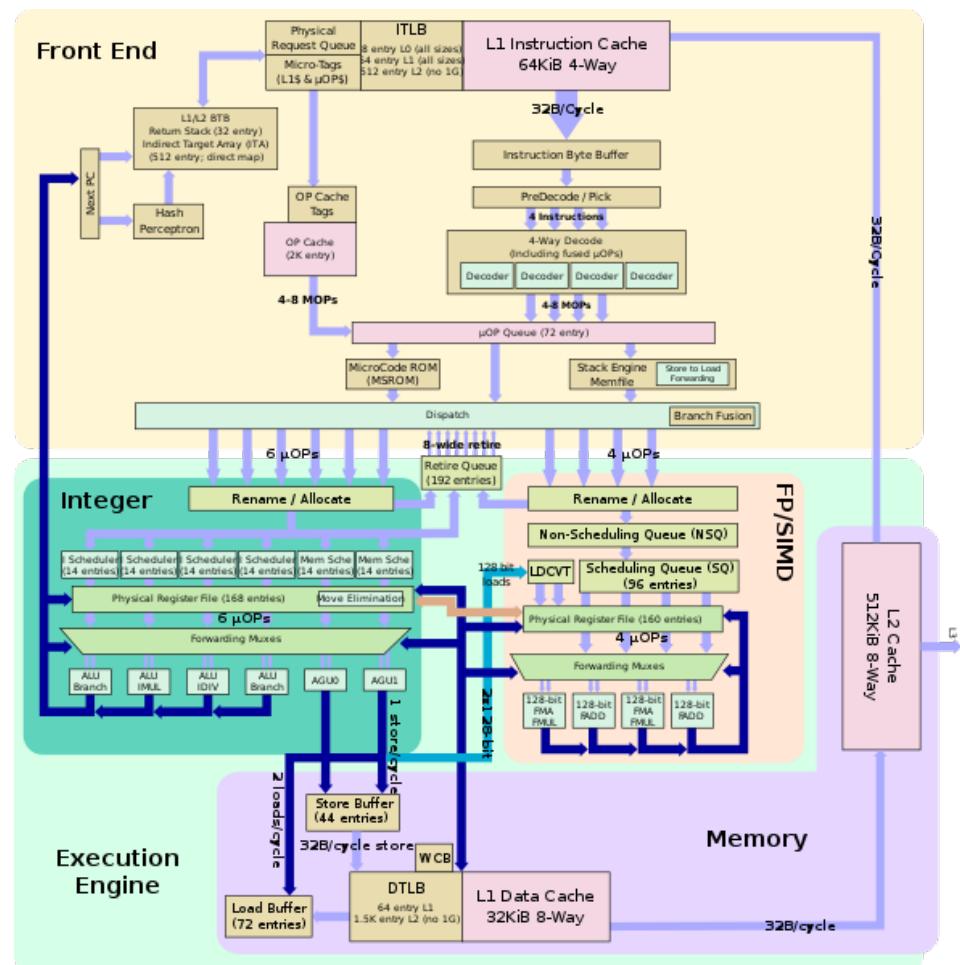
Write back L1 cache

Faster L2 and L3 cache

7 cycles to load to FPU

Almost twice the L1 and L2 bandwidth

Up to 5x the L3 bandwidth



Clock Domains

Zen is divided into a number of clock domains, each operating at a certain frequency:

- **UClk** - UMC Clock

The frequency at which the Unified Memory Controller's (UMC) operates at. This frequency is identical to MemClk.

- **LClk** - Link Clock

The clock at which the I/O Hub Controller communicates with the chip.

- **FClk** - Fabric Clock

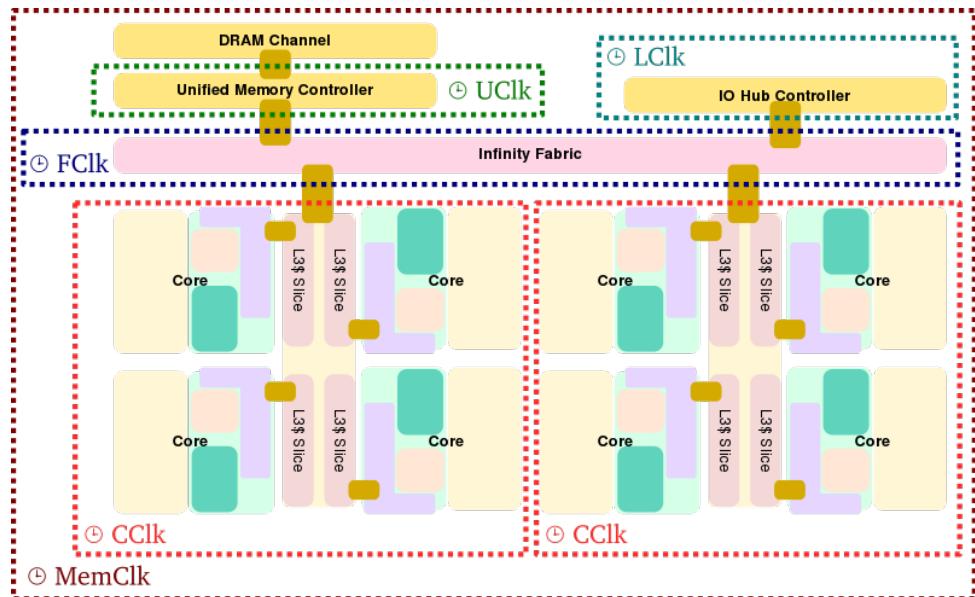
The clock at which the data fabric operates at. This frequency is identical to MemClk.

- **MemClk** - Memory Clock

Internal and external memory clock.

- **Cclk** - Core Clock

The frequency at which the CPU core and the caches operate at (i.e. advertised frequency)



AMD SenseMI Technology

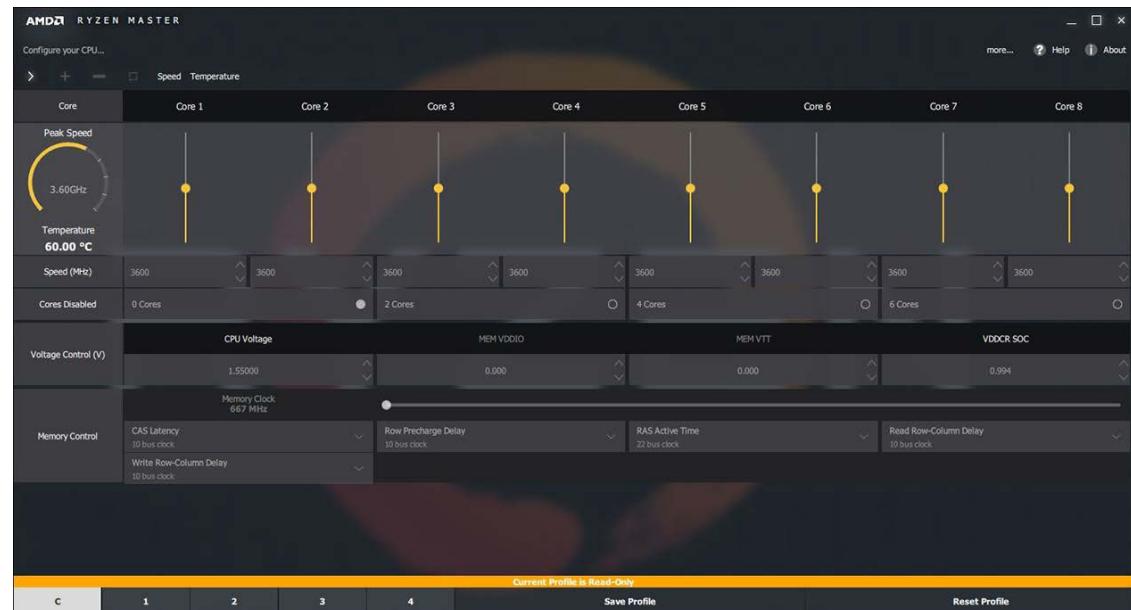
Able to adapt and learn- customizes itself

1. pure power
 - Monitors the CPU(temperature, resource usage, power draw)
 - Optimizes power draw based on workload
 - Minimizes power consumption to reduce system heat and noise
1. precision boost
 - Adjusts clock to optimize performance without pausing instructions
 - High precision(25MHz increments)
1. extended frequency rate
 - CPU speeds are permitted beyond Precision boost limits
 - Clock Speed scales with cooling solution
 - Every clock can automatically overclock itself whenever the external temperature allows
 - Fully automated
1. neural net prediction
 - Builds temporary map of how program uses CPU
 - Prepares fastest processor path based on map
1. smart prefetch
 - Learns how applications access data and anticipates instructions



Ryzen Master Software

- CPU core clock/voltage adjustment
- Memory adjustments
- Personalized Performance
 - Up to four profiles to store custom clock and voltage adjustments
- System Monitoring
 - Real-time monitoring and histogram of per-core clock rates and temperature



Benchmarks

<https://www.pcgamesn.com/amd/amd-ryzen-7-1700x-review-benchmarks>

Follow this link for more benchmarks for the Ryzen 7 Processors.

CPU Performance

CPU performance

Cinebench R15 Benchmark

Running:

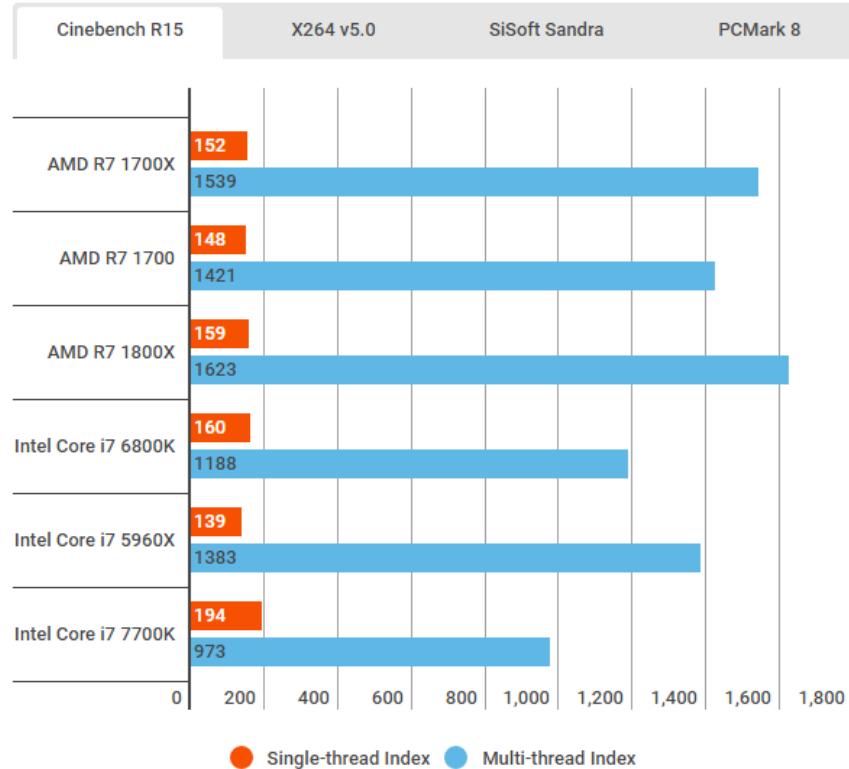
Nvidia GTX 1070 FE

Corsair H100i v2

16GB Crucial Ballistix DDR4 (@ XMP
3,200MHz Intel, max. 2,667MHz AMD)

Corsair HX1200i

Philips BDM3275



Storage Performance

AS SSD Benchmark

Running:

Samsung 960 EVO 1TB

Corsair H100i v2

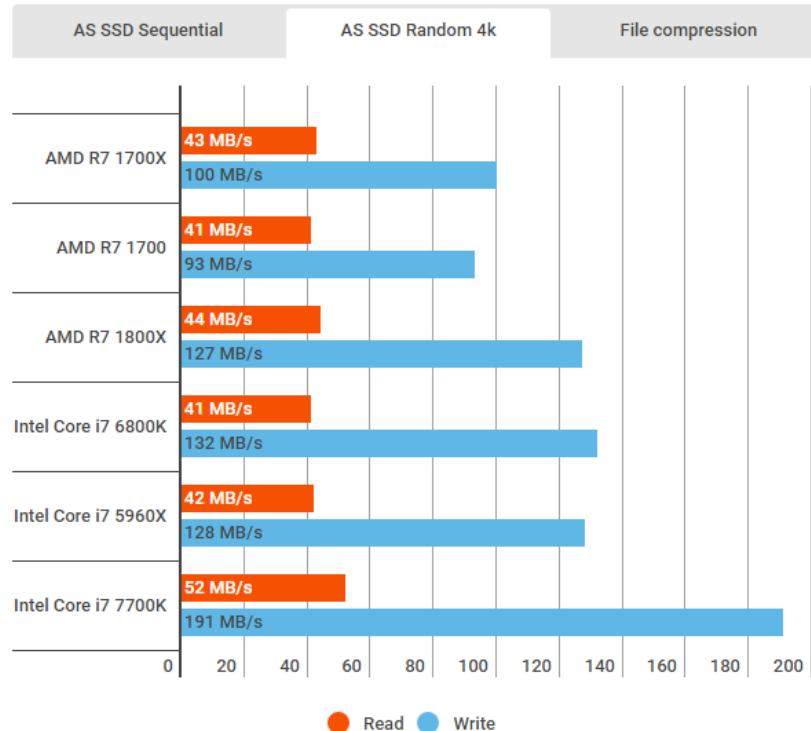
16GB Crucial Ballistix DDR4 (@ XMP 3,200MHz

Intel, max. 2,667MHz AMD)

Corsair HX1200i

Philips BDM3275

Storage performance



Concluding Remarks

The Ryzen family of processors are a new beginning for AMD, which can now rival Intel's processor market share for both mainstream users and for companies that use servers. They are still held back by production and also by the AM4 motherboards.

This might be great news for consumers that now we have a competitive market. Intel and AMD can push each other to create better and better processors to try to consolidate their consumer base.