

# GPUs used in Gaming

2018

*A special report on the x86 gaming hardware market*

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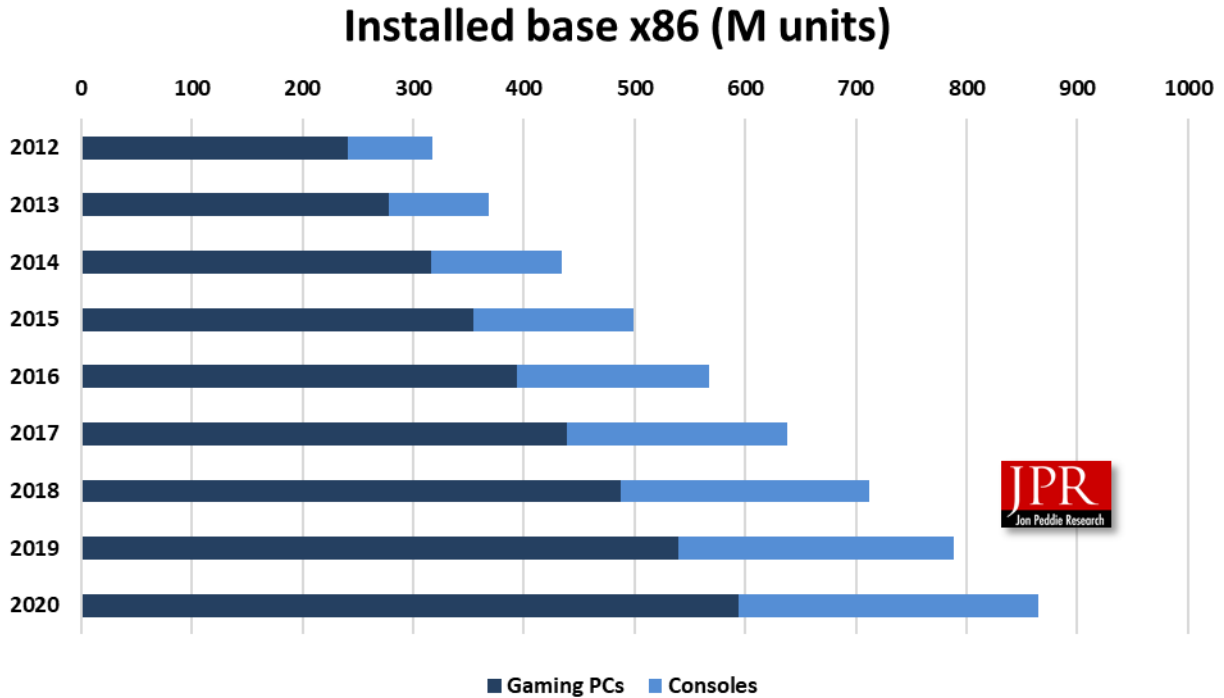
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## Executive Summary

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The gaming hardware market is vast, spreading across all types of platforms from handheld devices to phones, tablets, PCs, consoles, and location-based arcade and gaming parlors. The biggest, fastest-paced games with big screens are played on the popular x86 platforms.



*Figure 1: The installed base of x86-based gaming machines*

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Using a computer to play games began in the late 1960s and inspired the first dedicated gaming devices we call consoles today.

*As soon as you have a technology, someone tries to make a game out of it* – Kathleen Maher 2007.

Gaming machines evolved from powerful location-based machines found in arcades, restaurants, and bars to in home machines in the form of dedicated gaming consoles and/or microcomputers, and then PCs. As Moore’s law drove down prices, and increased performance, people bought more machines for the home which had a positive price-elasticity effect, at the expense of the location-based gaming machines.

The overall market for x86-based game machines, excluding arcade and casinos, in 2017 was over \$43 billion US dollars.

## Introduction

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People play electronic games on PCs, consoles, mobile phones and tablets, and at location-based entertainment centers such as arcades, casinos, and gaming parlors. They play in their homes or the homes of friends, on public and private transportation, waiting rooms, and designated gaming facilities. It would almost be safe to say it would be easier to list the places people don't play electronic games than to make an exhaustive list of where they do. The gaming environment has been further expanded in the last few years with the resurrection of virtual reality, and the introduction of augmented reality for gaming.

People who play games on electronic devices usually use multiple devices. A gaming enthusiast will play on a mobile device like a phone, with a console, on a notebook, and as big a desktop rig as can be afforded. However, there are some gamers who due either to economic considerations, or temperament will only play on one device.



*Figure 2: Gamers come from all over the world, and use all types of machines*

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The demographics of the electronic gaming market and the influence gaming has on the purchase of general purpose devices like a PC or smartphone plus their purchases of games, and accessories, makes the electronic gaming market worth over \$50 billion US dollars a year.

We've been monitoring and measuring the gaming market for decades and are active gamers too which gives us a deep perspective on the industry.

### **What is a gaming computer?**

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A gaming computer is one designed for playing computationally demanding video games. Gaming computers are often associated with enthusiast computing due to an overlap in interests. In the case of PCs, a gaming computer can be subdivided into low-end, mid-range, and high-end segments. Contrary to the popular misconception that PC gaming is inextricably tied to high-

priced enthusiast computing, graphics board manufacturers earn the bulk of their revenue from their low-end and mid-range offerings.

Because of the large variety of parts that can go into a computer built to play video games, gaming computers are often custom-made. In order to generate interest, gaming computer manufacturers that sell complete systems often produce boutique models, allowing them to compete on aesthetic design in addition to the hardware inside.

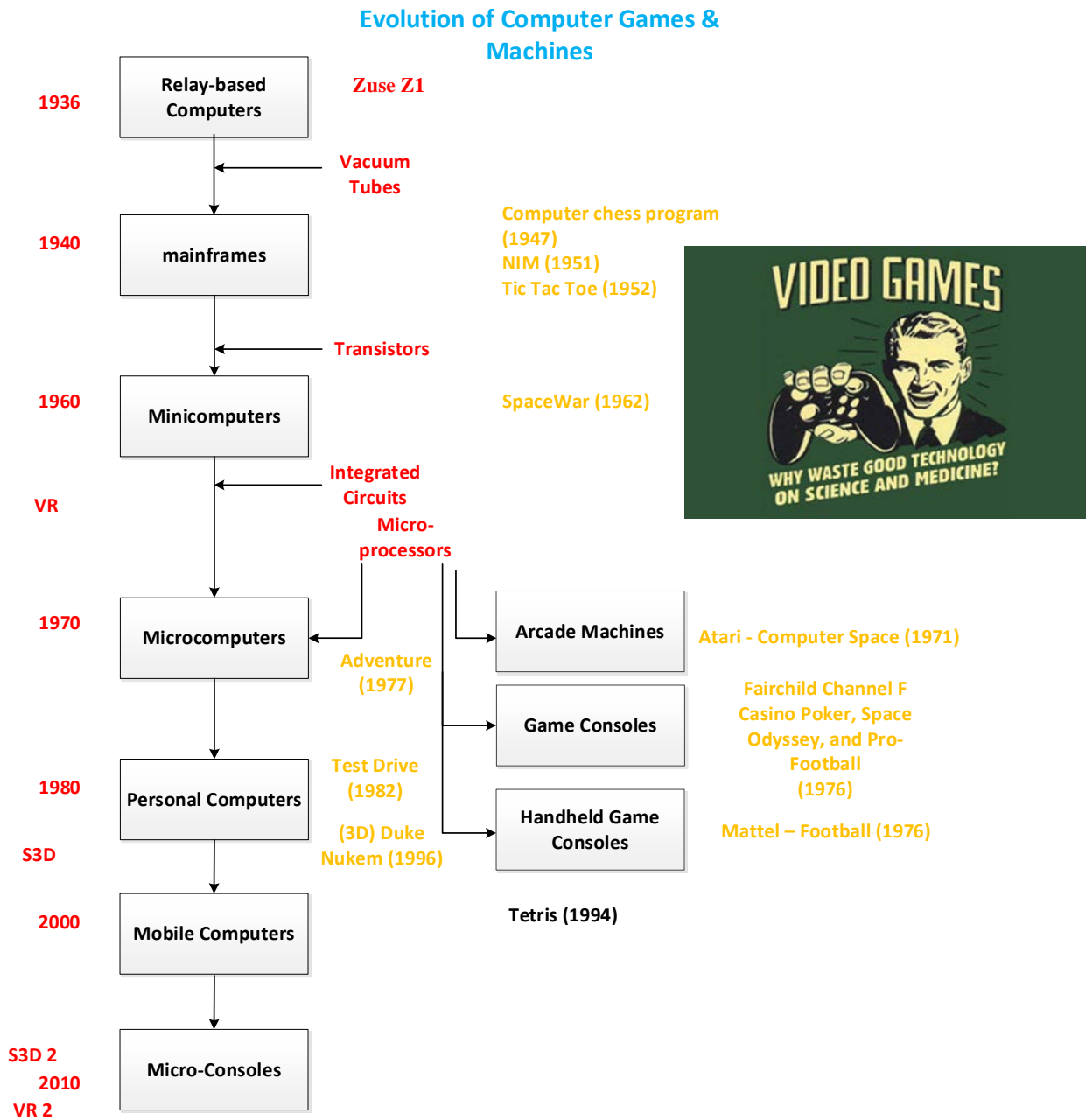


Figure 3: The history of gaming in computers (The History of Visual Magic in Computers)

Games that had run on microcomputers like Commodore PET, RadioShack TRS80, and Amiga, as well as those that ran on university mainframes, were translated and re-reported to the PC in the early 1980s.<sup>1</sup>



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***Figure 4: Gaming machine circa 1979 (Source Commodore)***

PCs evolved over the years getting larger, higher resolution screens, multicore CPUs and GPUs, and larger faster memories.



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***Figure 5: Modern PC gaming machine, circa 2016 (Source Alienware)***

In addition, the gaming market is adding augmented and virtual reality to the mix.



Arcade machines were first in 1971 when Atari introduced the free-standing *Computer Space* game machine. Consoles predated the PC, first appearing in 1972 with the Magnavox Odyssey. And in 1989 Nintendo Game Boy was introduced. It established and dominated the handheld market for ten years.



*Figure 6: A modern gaming console (source Sony)*

---

The term "video game console" is primarily used to distinguish a console machine primarily designed for consumers to use for playing video games, in contrast to arcade machines or home computers. An arcade machine consists of a video game computer, display, game controller (joystick, buttons, etc.) and speakers housed in large chassis. A home computer is a personal computer designed for home use for a variety of purposes, such as bookkeeping, accessing the Internet and playing video games.

The gaming hardware market is huge and bewildering now because of its diversity and the marketing hype associated with it. I've been monitoring and measuring the gaming market since the late 1990s and would like to try and clear up some of the misunderstandings about the market and the suppliers. For the purpose of this article, gaming refers to games played with an electronic device and a display, and does not include board, card, or other games or sports.



*Figure 7: Gamers come from all over the world, and use all types of machines*

When one speaks about computer gaming, unless they specify more about it, you have no idea what they mean. Playing a game that is produced with a computer and displayed on a screen covers ten or more devices.

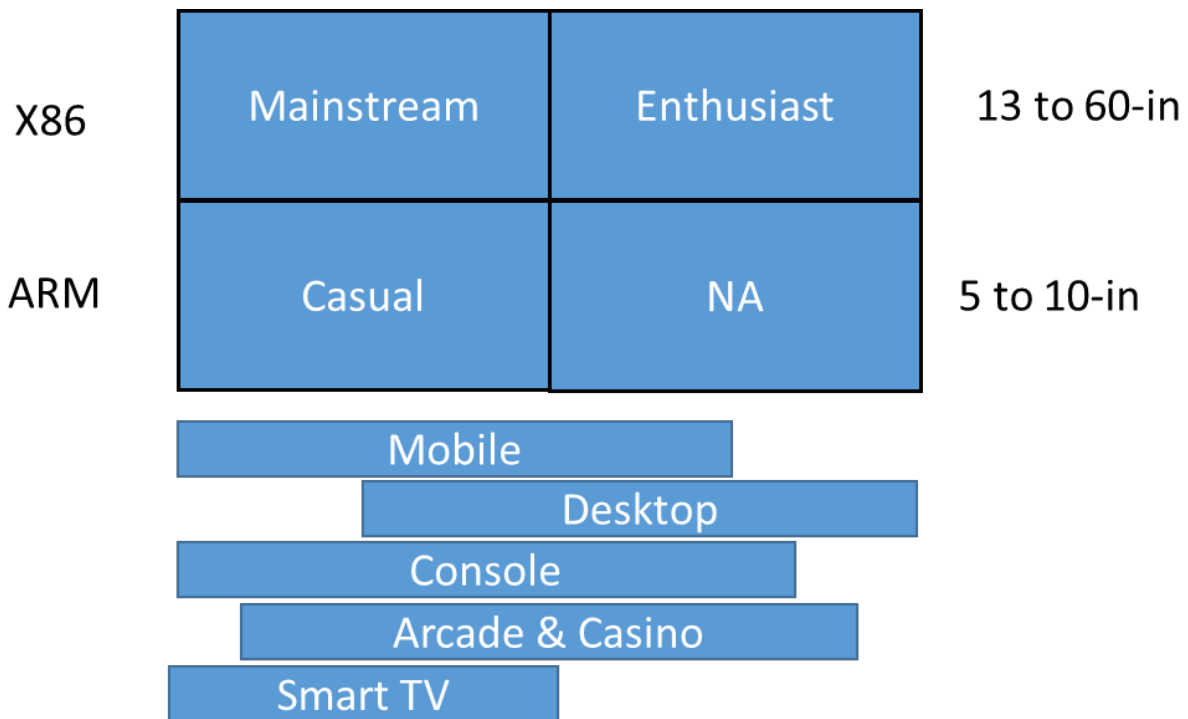
- PC
  - Notebook
  - Desktop
- Console
- Handheld device
- Smart TV
- Tablet
- Casino machines
- Arcade machines
- Vehicle entertainment systems

Within PCs and consoles there is even further segmentation:

- PC
  - High-end
  - Midrange
  - Mainstream
- Console
  - High-end
  - Hybrid
  - Mainstream

The diversity doesn't end with the hardware, there are multiple operating systems and APIs.

Gaming falls into several categories of platform, device size, main processor type, OS, screen size, budget, time spent, etc. The gaming community is so large; no single demographic can define it.



*Figure 8: demographic of the gamer community*

Gamers typically enjoy their hobby (and in some cases vocation) multiple ways, including owning multiple game handheld devices and consoles, or PCs, and gaming at public places.

Gaming machines use one of two types of CPU processor, ARM, and x86-based machines. Those machines fall into five or more platforms including, consoles, notebooks, desktops, mobile devices and various types of location-based devices found in arcades, restaurants, bars, amusement parks, casinos and iCafe/net cafes.

The market consists of three types of players: Enthusiast, Core gamer, and Casual gamer, and the class of the player is not defined by the type of game being played or the equipment being used, but rather their time commitment. Included in the enthusiast class would be professional gamers who play in tournaments for prize money or sponsorship. I do not make any distinction about gender, nor do I make any distinction about age, or geographic location. Generally speaking, these categories have to do with the amount time the gamers spend playing computer/video games, and the class or type of games being played.

The equipment a gamer has will depend upon his or her economic situation, so an Enthusiast may only be able to afford entry-level or mainstream equipment, or a last generation console, where a less than enthusiast gamer may have high-end equipment such as the latest PC, graphics add-in board (AIB) and/or the latest console; in between is the midrange equipment.

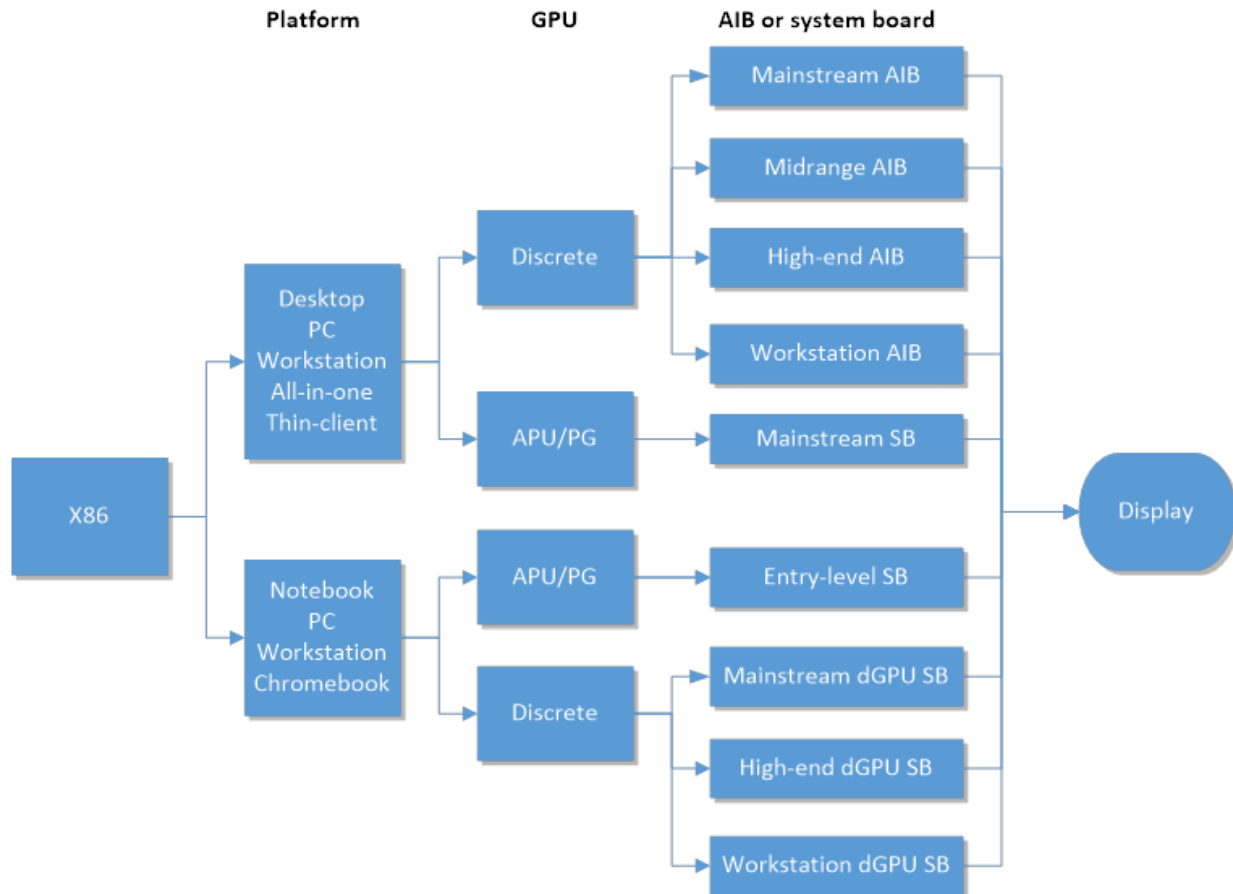
The hardware tiers that use an X86 processor are illustrated in the following diagram. AMD integrates a GPU in with an x86 processor and calls it an accelerate processor unit—APU. Intel does a similar thing and just refers to it as processor graphics—PG. Those devices are typically mounted directly to the mother or system board (SB).

Recently Intel took the unheard-of step of incorporating a Radeon RX Vega GPU from its competitor AMD and is producing a multi-chip single device called Kaby Lake-G. This is an example of the diversity in the gaming processor market, the Core i7-8809G quad-core eight-thread processor with integrated Intel HD 630 graphics, doesn't have classification yet, other than hybrid multi-chip.

### **Categorizations**

The PC, GPU, and AIB market segments share many categorizations, and have several unique categorizations. Here are the ones we use.

In addition, there may be a discrete GPU (dGPU), either on the system board (SB) of the mobile PC (laptop, notebook) or in an all-in-one desktop PC, or on an AIB in a desktop PC or workstation (including all-in-one workstations).



**Figure 9: GPU market segmentation**

The market is even further segmented by Intel with three levels of CPUs, i3, i5, and i7 for consumer and commercial markets, and the company offers the Xeon CPU for servers and workstations. AMD has a similar range of products.

Workstations are also segmented into Mobile, 2D, Entry 3D, Mid-range 3D, High-end 3D, Ultra high-end 3D. 2D workstations typically use integrated GPUs, as do most Entry 3D workstations, but some are equipped with an entry-level workstation AIB.

**PCs and AIB**

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GPUs, integrated and discrete are found in PCs used by various customers, consumers, and enterprise or commercial. Included in commercial are workstations, embedded systems used in scientific interments and industrial controls, and custom gaming machines used in casinos and other public places. We do not include servers. The following table is our estimate for the distribution of those types of customers worldwide.

<b>Mainstream</b>	
Consumer (gaming)	60%
Commercial (OEM and Enterprise)	40%
<b>Midrange (was Performance)</b>	
Consumer (gaming)	75%
Commercial (OEM and Enterprise)	25%
<b>High-end (was Enthusiast)</b>	
Consumer (gaming)	95%
Commercial (OEM and Enterprise)	5%

*Table 1: Primary customer segmentation*

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The end-user PCs (consumer and commercial) are segmented into two platforms, desktop, and notebook.

Notebook PCs	Price range
Mainstream	<\$1000
Midrange	\$1000 - \$1800
High-End	>\$1800

*Table 2: Notebook classifications.*

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Desktop PCs	Price range
Mainstream	<\$1000
Midrange	\$1000 - \$1800
High-End	>\$1800

*Table 3: Desktop classifications*

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Within desktop PCs, there may be an add-in board, and they are shown in the following table.

Add-in boards (AIBs)	price range
Mainstream	<\$150
Midrange	\$150 -350
High-End	>\$350
Workstation	\$250 - \$2,000

**Table 4: GPU and AIB classifications**

The price ranges reflect the performance of the GPU.

## **Gamers**

One of the major users of an AIB is the PC gamer. Gamers have been categorized as enthusiast, casual, hard-core, and other names. Those names can describe the gamer’s interest but not purchasing potential. We believe a gamer’s interest is a function of the amount of time one plays games on a PC, the frequency of play.

Gamers	Time gaming:
Low-Frequency	Under 5 hours per week
Average-Frequency	5 – 8 hours per week
High-Frequency	Over 8 hours per week

**Table 5: Amount of time playing games**

One could be an enthusiast, playing a AAA FPS on less than a high-end PC, and only able to engage in that pastime a few hours a week. Likewise, a person could have a high-end machine, play over 8 hours a week and only run casual games. Therefore, the type of game, the type of equipment, and they of player are not the same thing for labeling or describing.

## **All but not every**

Every PC (and smartphone and tablet) can be used for gaming, but not everyone *is* used for gaming. Therefore, an estimate is made as to what percentage of PCs are used for gaming. Some PCs, such as the type found in an enterprise will never be used for gaming (or at least they aren’t supposed to be). Some PCs will be used occasionally (maybe once a week or a month), and some every day from as little as a half hour to six to eight hours. The usage is independent of the performance level or price of the machine, and even the skill level or age (or sex) of the player. As a famous detective said, “Be suspicious of everything you think you know.”

## **Other platforms**

The PC is only platform that offers different configurations, consoles, mobile device, and location-Based systems are fixed.

## **Population of equipment**

To arrive at the equipment in use, we looked at the installed base of the latest consoles (Microsoft Xbox-One, Nintendo Wii and Wii U, and the Sony PS4). We also looked at the installed base of AIBs used for gaming and acquired over the past three years. And we looked at the installed base of integrated graphics in Notebooks (AMD APUs, Intel integrated).

Not all graphics AIBs go to gamers, but a good percentage of them do, and not many notebooks (with integrated graphics or discrete GPUs) are used for gaming. However, all consoles are used for gaming.

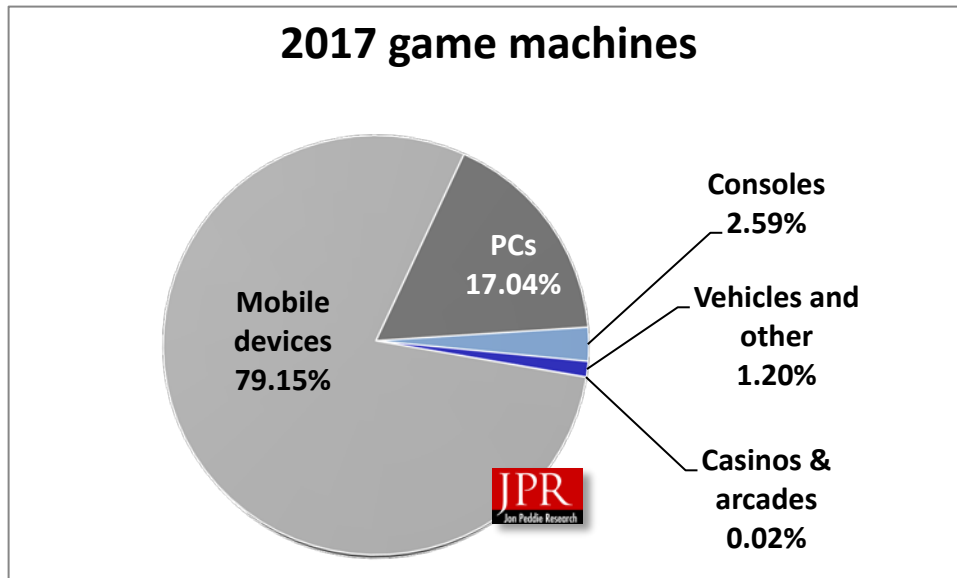
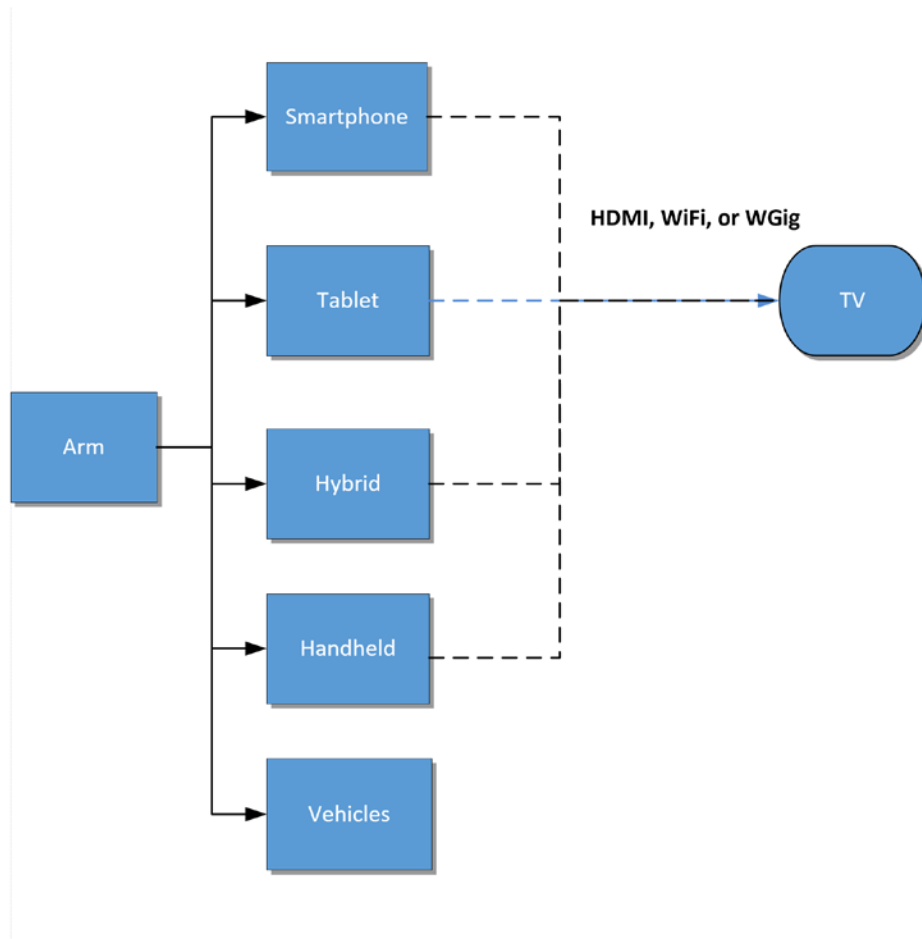


Figure 10: Gaming machines

Not everyone who has a mobile device plays games on it, but a large proportion of people have at one time or another tried, and most are regular players.

Arm-based mobile and hybrid devices use a SoC with an imbedded Arm CPU, GPU, and usually several other processors such as a DSP and an ISP. Examples include smartphones, tablets, in-vehicle entertainment systems, and hybrid systems like Nintendo's Switch.



*Figure 11: The Arm-based gaming platforms*

Some examples of ARM-based gaming machines are discussed in the following sections.

There is also a small segment of Pachinko and similar machines in Japan that use the Renesas SH-4 processor with integrated 2D graphics controller.





Figure 12: A pachinko parlor in Tokyo (Credit Tischbeinahe)

There is a game machine for every appetite, age, and budget. And the types of games available are wide ranging,

There are also a wide variety of types of games that can be played.

## PC gaming segments

Within the PC, there are three major segments of users and budgets: high-end, midrange, and mainstream gamers.

### High-End segment

Compared to the overall PC market, the High-End segment accounts for only a relatively small number of unit shipments. However, those systems are among the most expensive and deliver very healthy margins. High-End-class AIBs deliver the highest possible Mid-Range and offer the High-End user or hobbyist the ability to tweak the AIB (e.g. with special cooling and clock manipulation) to exceed the published specifications.

High-End users pay very little attention to price tags. If the PC or AIB promises the best gaming experience they will be bought, and MSRPs in the category aren't declining. In fact, recent top-end PCs and AIBs on the market have been gaining in price. In our analysis we use High-End GPUs as the cornerstone but also account for High-End systems as a pricing segment. The minimum ASP to be included in the High-End class is \$1800 and this includes a display factor adjusted for gaming motivation and purchasing frequency. The High-End segment is also referred to as the Extreme segment by some suppliers.

The High-End gamer population is estimated to be 20.7 million users worldwide, and there will be 26.6 million High-End PC Gamers worldwide by 2020. High-End gaming PC market is totally dominated by the United States with 29% of the world market on a dollar basis.

## **Mid-Range segment**

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The Mid-Range computer segment isn't so clear-cut. Some like JPR treat it separately from the higher end High-End category, and others include the High-End category within the Mid-Range segment.

There is overlap between the two, but one of the major points of distinction is that Mid-Range machines are sold into the broader markets, advertised as machines for entertainment or high-end professional use. In addition, they are equipped with newer, high-Mid-Range graphics chips, but typically not the most powerful.

Often, the Mid-Range sector AIBs are the previous generation's High-End AIB, but they are also built up on lower-cost GPU derivatives of the current top-end GPU part. In our analysis we use Mid-Range GPUs as the cornerstone but also account for Mid-Range systems as a pricing segment. The minimum ASP to be included in the Mid-Range class is \$1000 and this includes a display factor adjusted for gaming motivation and purchasing frequency.

Mid-Range gamer count stands at about 77 million people and is growing.

## **Entry-Level segment**

---

The Entry-Level category is the largest unit volume and the lowest performance segment. The AIBs used in these systems can be either specially designed (to reduce cost), older generation models, or special versions with GPUs that are higher end but have not passed all the tests to be in the higher classifications (this how GPU suppliers manage fab yields and inventory costs.) Entry-Level systems and AIBs offer solid capabilities for Internet, gaming, and office productivity applications. We include Value PC's and GPU's in the Entry-Level segment. Regardless of their budget people of all economic levels love video games and they serve to influence PC purchases even at the lowest level.

In our analysis we use Entry-Level and Value GPUs as the cornerstone but also account for Entry-Level systems as a pricing segment. The maximum ASP to be included in the Entry-Level class is \$1000 and this includes a display factor adjusted for gaming motivation and purchasing frequency.

Entry-Level PC gamer population is 470 million users worldwide. This will drop to 433 million Entry-Level PC Gamers worldwide by 2020. They are 14 to 50 years old (with sigma 3 elements to 13 and 70), predominately male (65/45), and have a discretionary budget of \$400 to \$1,000.

## **Relative performance of major gaming platforms**

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Although there are various benchmarks and other performance metrics, there is only one that can be used cross platform and that is floating point operations per second. And whereas it may not be enthusiastically welcomed by a vendor whose product doesn't do well in FLOPS, it is nonetheless a reasonable metric to use for overall comparison.

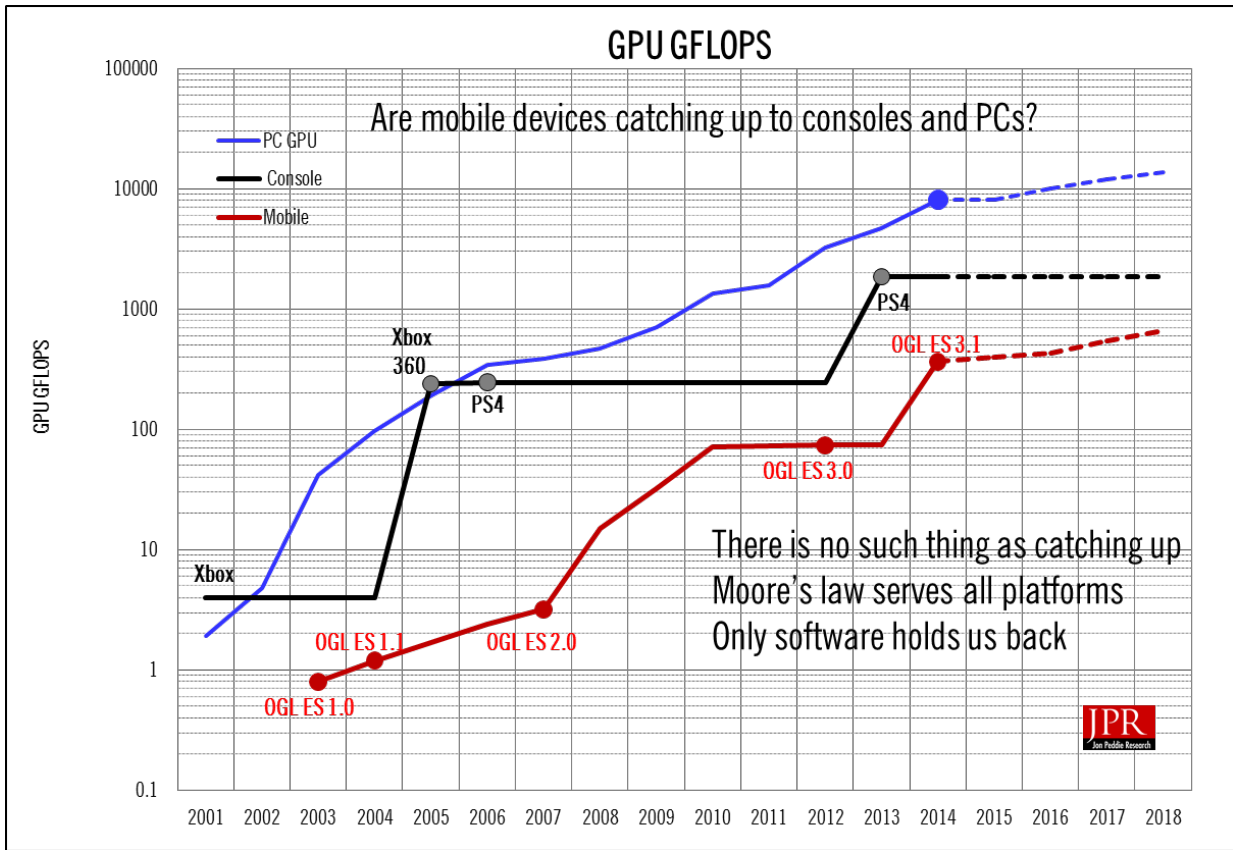


Figure 13: Relative performance of various game platforms over time

High-performance games, known as AAA+ FPS stress the graphics AIB and overall PC, especially when running full screen 4k displays with all the features set to max.

## Conclusion

Gaming has been a part of computers almost since the first computer was developed.

*As soon as you have a technology, someone tries to make a game out of it – Kathleen Maher 2007.*

The first interactive-playing computer was the Nimatron<sup>ii</sup>, a one-ton behemoth, built in 1940 by Ed U. Condon at the Westinghouse Electrical Corporation and exhibited at the New York World's Fair.

Since then as the power of computer increased, the cost and size decreased, and the programming and operating a computer got easier, gaming on computers has flourished. Probably one could mark the threshold as 1971 with the introduction of Atari's Computer Space location-based machine was introduced and launched the arcade market for computing gaming.

The number and types of machines proliferated since then, as have the types of games, and most certainly the diversity of the players.

Today gaming is a major contributor to PC market, as well as the mobile market, and is the sole reason for the existence of handheld and console gaming machines. The realism found in games today combined with the worldwide participation by players, and the introduction of eSports has established the computer gaming industry as growth market with high demand.

## Market data

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As with any market, the gaming market is subject to definition.

We define gaming as being segmented into two platforms, ARM-based, and x86-based.

ARM-based platforms that can be used for gaming, and some that are dedicated for gaming are the largest in terms of units shipped.

X86-based platforms are more powerful in terms of performance.

For this report we will look at x86-based gaming platforms. We have other reports that look at ARM-based platforms.

Within the x86-platform universe are three major processor suppliers: AMD, Intel, and Nvidia. AMD offers three processor types: x86 CPU processor (which they market as Ryzen), GPUs (which they market as Radeon), and heterogenous x86 and GPU processors (which they market as APUs). Intel offers heterogenous x86 and GPU processors (which they market as Core). Nvidia offers GPUs (which they market as GeForce).

X86-based systems with powerful GPUs are used in casino gaming machines as well. However, we have not included them in this analysis, nor have we counted arcade-based machines which are also x86-based.

## Methodology and data sources

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We used company financial reports to arrive at the shipments and installed base of gaming consoles.

Every quarter we collect shipment data from AMD, Intel, and Nvidia on their processors. We segment the market into three categories (High-end, Mainstream, and Entry-level – see Figure 9: GPU market segmentation, page 12). That data goes into our GPU report, *Market Watch*, and our graphics board report, *AIB* (add-in boards)

Because Intel's processors are so ubiquitous we used Steam user data to arrive at the usage of their heterogeneous processors for gaming. We conclude that in 2018, 6.4% of desktop and notebook machines used for gaming are using Intel integrated graphics.

We produce a bi-annual report on the *PC Gaming Hardware Market* and have developed a gaming buying influence factor for the three segments. The point to be made is that some people buy a PC specifically for gaming, while others buy a PC and also expect to use it for gaming sometimes. The influence factor is higher at the high-end.

## PC data

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We use the raw data from our quarterly reports (*Market Watch*, and *AIB*), and our bi-annual reports (*PC Gaming Hardware*) to arrive at the following table.

	2012	2013	2014	2015	2016	2017	2018est
Total AMD PC gamer GPUs	14.67	13.24	12.96	11.11	13.86	14.01	15.83
Total Intel PC gamer GPUs	6.13	8.55	11.44	13.08	13.98	15.45	16.43
Total Nvidia PC gamer GPUs	25.55	22.00	20.43	20.36	17.52	20.76	22.37
TOTAL PC gamer GPUS	46.35	43.80	44.83	44.55	45.37	50.23	54.63

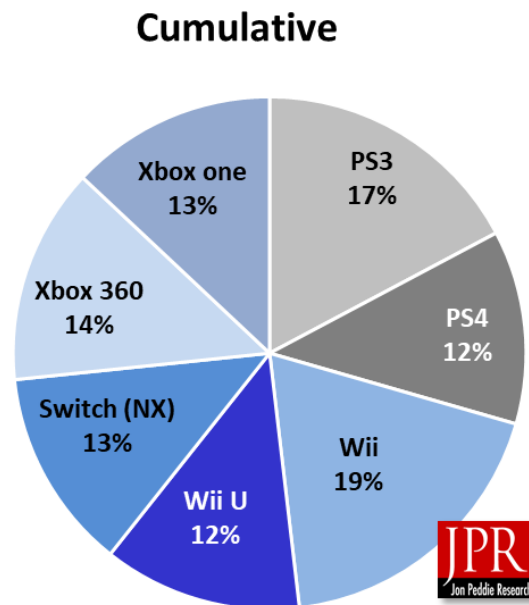
*Table 6: Installed base of x86-based GPUs used for gaming (M units)*

For the past seven years, the three major vendors installed base of GPUs for PC gaming declined slowly following the PC’s decline, although gaming GPUs have defied the overall trend.

### Console gaming hardware market

In the past year Sony’s PS4 has risen to the number one place in terms of shipments. Microsoft’s Xbox One is playing catch-up with approximately 50% of the market share that the PlayStation 4 commands.

Nintendo introduced a console (in the sense it will drive a TV and accept a game controller), called the Switch (code named NX), and it is an ARM-based, portable and much like a tablet, similar to, but larger than) the WiiU.



*Figure 14: Life-to-date of the TV gaming shipments (Company data)*

Console sales have a very specific and dramatic seasonal sales cycle, and for Microsoft or Nintendo to take the lead away from Sony at this time will prove difficult to impossible. A “killer game” can often tip the balance, and Microsoft has been investing in new titles. Nintendo is moving a lot of their classic titles to the smartphone and tablet segments.

Included in the Other category are Android micro controls, (weighted) Apple TV, and PCs using a TV as a monitor.

### Console shipments

The console market has had its great time and its tough times, and the winner’s position has shifted with each new generation. Consoles, unlike Gaming PCs, are sold by games, and hence the loss-leader marketing approach taken by the suppliers—although all claim to make money on the hardware.

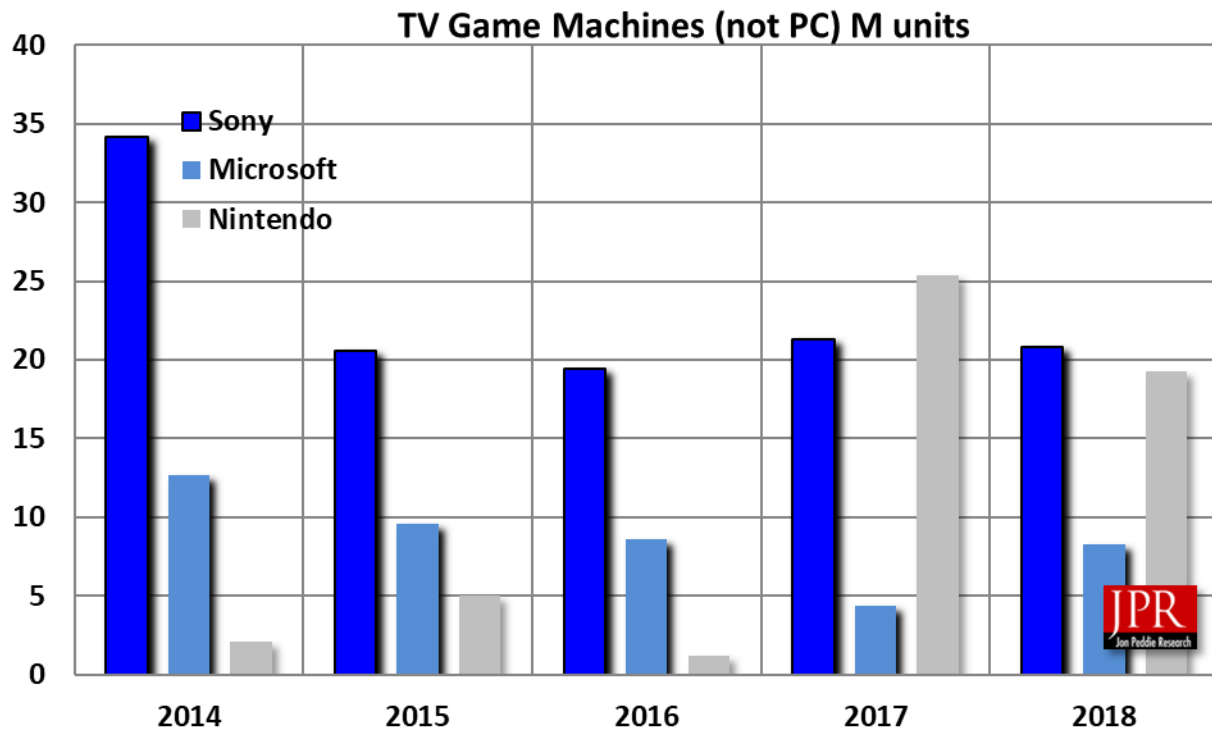


Figure 15: Console market over time (without next gen)

Sony at one time had three consoles in the market at the same time, the PS, PS2, and PS3, plus the handheld PSP. Sony ceased production of the PS3 in September 2015.

Sony and Microsoft each have two consoles shipping each at this time. Sony is shipping the PS4 and the PS4 Pro, while the Microsoft is producing the Xbox One S and Xbox 1X. Microsoft stopped selling the original Xbox One in Q2 2017.

As of 2018, consoles have been sold for 46 years, and the current products represent eight-generation of the popular game machines. Clearly, there is a strong interest and following for the devices, and as good as the PC is, and as popular as a tablet or smartphone is, they will not replace the pleasure gamers get from a console.

### **Console data (installed base)**

Looking at just the x86-based consoles, which have been dominated by AMD since 2013, there has been a steady increase in the installed base.

	2012	2013	2014	2015	2016	2017	2018
PS4		4.5	19.9	37.7	57.1	78.4	99.18
Xbox 360	75.8	82.53	87.33	88.26	88.65	88.71	88.71
Xbox One		3.08	10.99	19.64	27.85	32.15	36.43
	75.8	90.11	118.22	145.6	173.6	199.26	224.32

*Table 7: Cumulative shipments of GPUs in gaming consoles (M units)*

The gaming consoles have become media centers with streaming media capability though the internet, as well as the ability (on the newest units) to drive a 4k screen and deliver 5.1 audio.

### **Total gaming GPUs (installed base)**

	2011	2012	2013	2014	2015	2016	2017
Total AMD gamer GPUs	64.87	64.55	56.05	47.10	43.26	44.34	46.42
Total Intel gamer GPUs	27.06	28.07	31.03	36.17	42.68	49.68	57.16
Total Nvidia gamer GPUs	121.94	167.60	216.92	265.57	307.44	344.74	385.41
TOTAL gamer GPUs	213.86	260.21	304.01	348.84	393.39	438.76	488.99

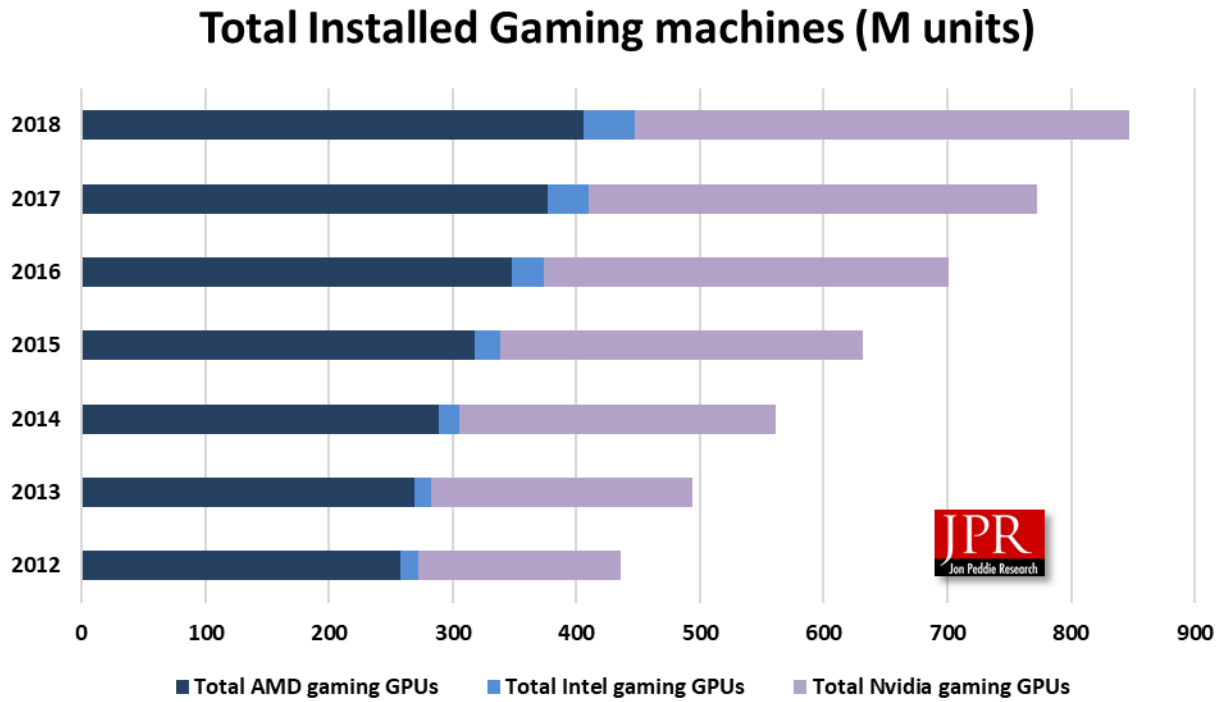
*Table 8: Installed base of cumulative gaming machines (M units)*

	2012	2013	2014	2015	2016	2017	2018
Total AMD gamer GPUs	14.07	12.12	11.43	33.63	34.39	34.74	36.09
Total Intel gamer GPUs	3.06	2.85	5.72	8.08	9.19	10.62	11.76
Total Nvidia gamer GPUs	25.55	22.00	20.43	20.36	17.52	20.76	22.37
TOTAL gamer GPUs	42.68	36.98	37.58	62.07	61.10	66.13	70.22

*Table 9: Relative annual market share of gaming GPUs (M units)*

The total gaming GPU systems installed today amount to over 800 million as shown in the flowing chart.

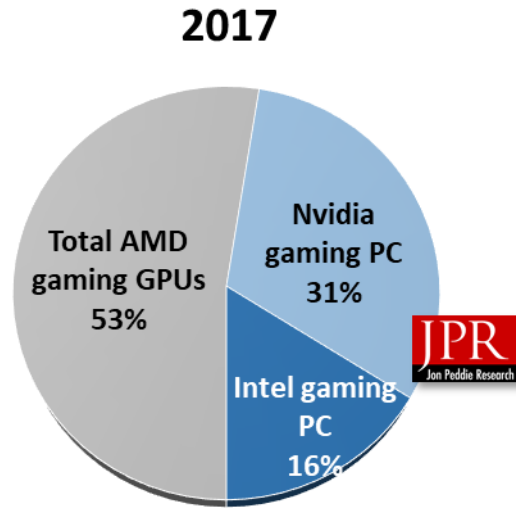




*Figure 16: Gaming machines installed today*

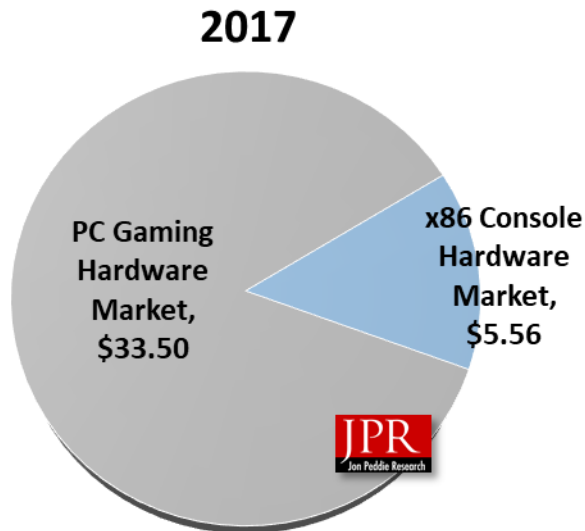
The list includes PCs used in gaming, and x86-based consoles (PS4, PS4 pro, Xbox360, and Xbox one).

With the PC gaming GPU hardware market being \$33.5 billion dollars in 2017, growing to \$35+ billion in 2020 the market opportunity is very large. The total gaming hardware market is even larger—over \$290 billion in cumulative sales.



*Figure 17: Games are played on Radeon graphics more than Intel and Nvidia combined.*

Not only are a lot of x86-based GPUs shipped for gaming, but the money spent on just hardware is also amazing.



*Figure 18: Gaming hardware market value in 2016 in billions US dollars*

The gaming industry of players using x86 consoles and PCs has over 800 million people participating in 2017, growing to 880 million in 2020. It is no wonder we pay special attention when it comes to the balance of power in gaming. Developers too should do the same as they often make significant business decisions when deciding on the platforms that they are targeting.

## **Summary and Conclusion**

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GPUs revolutionized PC gaming, and with the introduction of the original Xbox found their way into gaming consoles too. The next console to use a GPU was the PS3. Then when all the two major console producers moved to a common CPU platform, the x86, GPUs were part of the equation. Today all platforms use a GPU for gaming. And even though Intel is the volume leader in shipping integrated GPUs in the PC, only a small portion are used in gaming. In the PC alone, Nvidia is the leader in discrete GPU shipments. But if you look at the x86 console and the PC market as a whole, as do game developers, the results provide an interesting discovery. 53% gamers are playing on Radeon graphics, more than Intel and Nvidia combined. That is due to AMD's position in game consoles combined with a strong position in the PC market. The net result is it puts AMD in an unique, market leading position when it comes to gamers.

## Appendix

The following sections provide additional background information on the market, types of game, and gamers.

### Distribution channel

Direct sales is also known as eTailer (e.g., Amazon, New Egg), and some SIs get product as soon as eTailers do.

### Sales channel

AIBs are obtained by the consumer in one of two ways: either pre-installed in a PC or sold as an aftermarket item.

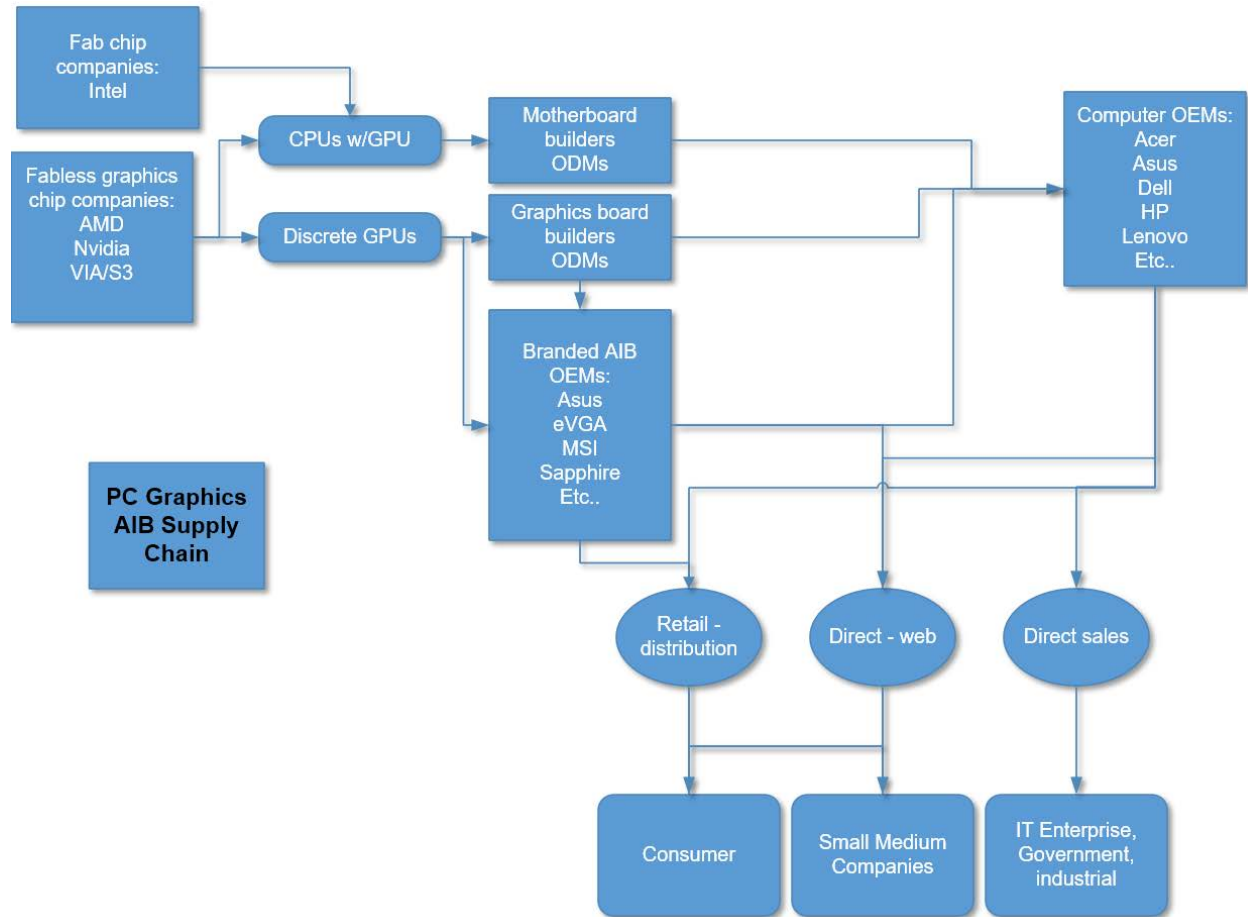


Figure 19: Sales channels for AIBs

Aftermarket purchases of AIBs are typically made by do-it-yourselfers (DIY), hobbyists, and some IT departments. Adding an AIB to a PC can extend its useful life and improve its performance.

## **PC gamers**

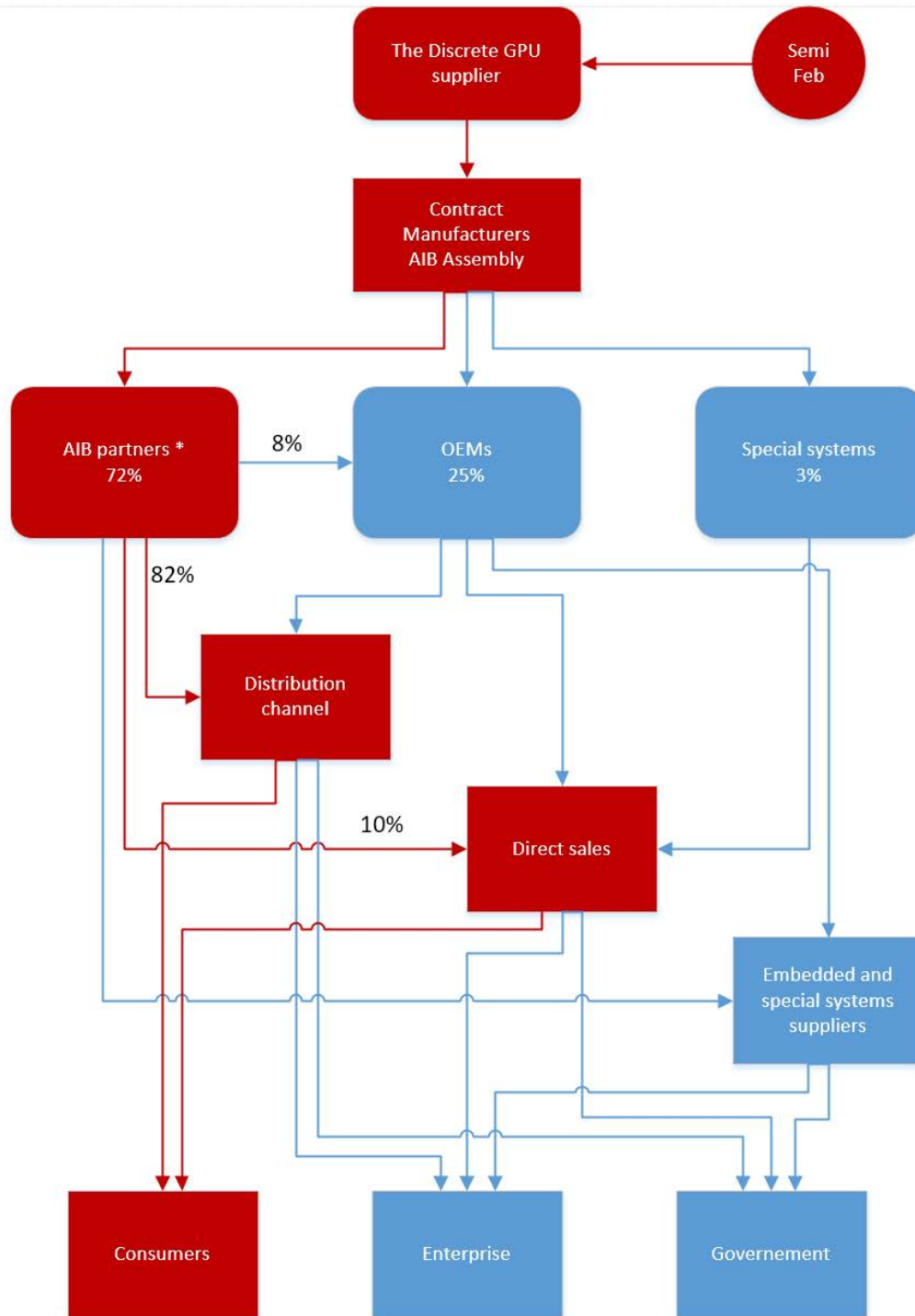
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Not all graphics AIBs go to gamers, but a good percentage of them do, and not many notebooks (with integrated graphics or discrete GPUs) are used for gaming.

To arrive at the gaming AIBs model, we used the following diagram.

Not all graphics AIBs got to gamers, but a good percentage of them do, and not all notebooks (with integrated graphics or discrete GPUs) are used for gaming. However, all consoles are used for gaming.

To arrive at the gaming AIBs model, we used the following diagram.



\* Does not include Workstation AIBs

**Figure 20: Approximately 73.8% of all graphics AIBs end up in gaming PCs**

Based on Steam user data, we conclude that 16.5% of desktop machines used for gaming are using Intel integrated graphics. Steam data does not differentiate desktop from notebook integrated

graphics. Therefore, we applied the same percentage to Intel for notebooks and based on the AMD to Intel integrated notebook ratio (our quarterly data collection of mobile integrated GPU shipments), normalized AMD's notebook integrated gamer utilization.

## **Game Types**

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The definitions of game genres are not precise, and you can find overlap between them (e.g., action and FPS have similar characteristics). Generally, the game publisher designates the genre of the game.

### **Action game**

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An action game is a video game genre in which it is important to have physical challenges, including hand-to-eye coordination and, of course, a fast reaction time. The genre includes different sub-genres such as shooter games (FSP—first-person shooter), sports, fighting games, and platform games, which are often considered to be the most significant action games. Some real-time strategy games are also considered to be action games.

### **Adventure Game**

---

An adventure game is one in which the player assumes the role of the protagonist in an interactive story driven by exploration and puzzle-solving instead of physical challenge. The genre's focus on story allows it to draw heavily from other narrative-based media such as literature and film, encompassing a wide variety of literary genres. Nearly all adventure games are designed for a single player because this emphasis on story and character makes multi-player design difficult.

### **Casual**

---

Casual games can be played quickly and easily, with a low learning curve and generally no need to save the game's progress. There is no specific genre associated with casual games, but some of the more popular types include puzzle games, word games, card games, and other similar games (e.g., solitaire). Casual games can be completed fairly quickly.

### **MMO & MMORPG**

---

Massively multiplayer online game (MMO) and Massively multiplayer online role-playing game (MMORPG). A massively multiplayer online game is an online game which is capable of supporting large numbers of players, typically from hundreds to thousands, on the same server. MMOs usually feature a huge, persistent open world, although some games differ.

### **Role-playing game (RPG)**

---

RPGs are those in which the player controls the actions of a protagonist in a fictional world. Many role-playing games have origins in pen-and-paper role-playing games such as Dungeons & Dragons, using much of the same terminology, settings, and game mechanics. The player in RPGs controls one character, or several adventuring party members, fulfilling one or many quests.

## **Shooter (FPS)**

---

Here the player sees the action as if he or she were looking through the eyes of the main character. The majority of game play involves the use of rifle or pistol type weaponry. While FPSs are widely popular across multiple platforms, there are variations in this type of game, such as tactical FPSs, where game play is less run and gun and more strategy based via the shooter element.

## **Strategy game**

---

A strategy game is a game in which you as the player can move and operate soldiers, workers, people, vehicles, planes, etc., and build structures, villages, cities, etc. Primarily, the game objective is to be better than your opponent. But to beat your opponent, you need to be a great soldier, politician, researcher, tactician, and many other roles.

## **Types of Gamers**

---

Gamers are as diverse as the machines and games available for them.

Worldwide, the average age of gamers is 35, and the average age of game purchasers is 38. Sixty-five percent of the households own a device used for playing video games, and 45% own a device exclusively for playing video games.<sup>iii</sup>

In the United States, the average video game player is 35 and has been playing video games for over 12 years. In the UK, the average video game player was over 23 years old, had played video games for over 10 years, and spent around 11 hours a week playing video games. The term "gamer" comprises several subgroups.

In his keynote at the Game Developer's conference, in 2005, the legendary Iwata said, "On my business card, I am a corporate president. In my mind, I am a game developer. But in my heart, I am a gamer."<sup>iv</sup>





*Figure 21: Satoru Iwata*

---

The term “gamer” comprises several subgroups

### **Casual gamer**

A casual gamer is one whose time or interest in playing games is limited and typically don't define themselves as a gamer. Casual gamers may play games designed for ease of gameplay, or play more involved games in small groupings of time, at a slower pace than hardcore gamers. The genres that casual gamers play vary, and they might not own a specific video game console to play their games. Casual gamer demographics vary greatly from those of other video gamers, as the typical casual gamer is older and predominantly female. One casual gamer subset is the "fitness gamer", who plays motion-based exercise games at home and/or in a gym on an exercise bike. Casual gamers don't necessarily play casual games, but female casual players do.<sup>v</sup>

### **Core gamer**

A core gamer is a midrange player between casual and hardcore gamer. They are players with a wider range of interests than a casual gamer and more likely to enthusiastically play different types of games, but without the time commitment and sense of competition of a hardcore gamer. The mid-core gamer enjoys games but may not finish every game they buy. They typically don't have time for long quests, and complex world building.

A number of theories have been presented regarding the rise in popularity of mid-core games. James Hursthouse, the founder of Roadhouse Interactive credits the evolution of devices towards

tablets and touch-screen interfaces, whereas Jon Radoff of Disruptor Beam compares the emergence of mid-core games to similar increases in media sophistication that have occurred in media such as television.<sup>vi</sup>

## **Hardcore gamer**

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Hardcore gamers, also known as Enthusiasts, extend gaming into their lifestyle and may represent the stereotypical “gamer”. They purchase games frequently, spend significant time on games, and are more likely to try to “master” their games by completing as many objectives as possible.

Hardcore gamers may take part in video game culture such as competitions, events and conventions. There are many subtypes of hardcore gamers based on the style of game, gameplay preference, hardware platform, and other preferences.

## **Pro gamer (Electronic sports)**

---

Esports are video games which are played in professional competitions and usually fall into a few major genres. The majority of eSports titles are fighting games, first-person shooters (FPS), real-time strategy (RTS), or multiplayer online battle arena games (MOBA), with the MOBA genre being the most popular in terms of participation and viewership. Professional gamers don't necessarily play for money or earn a salary, although many do. Places in Asia, particularly South Korea and Japan, professional gamers are sponsored by large companies and can earn more than \$100,000 USD a year. In the United States, Major League Gaming has contracted electronic sports gamers with \$250,000 USD yearly deals.

## **Newbie**

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“Newbie” is a slang term for a novice or newcomer to a certain game, or to gaming in general. Newbie, newb, noob, or n00b is somebody inexperienced in a profession or activity. Two derived terms are “newb”, a beginner who expresses a willingness to learn; and “noob”, a derogatory term (an alternate spelling for n00b), though “newb” and “n00b” have become opposites of each other, meaning “newb” is plainly someone who is new to the game (thus having the potential to get better) and “n00b” is a player who both lacks skill and mainly fools around (not wanting to become better).

## **Retrogamer**

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A retrogamer is a person who prefers playing and collecting older video and arcade games. Retro-gaming has three main activities; vintage Retro-gaming, Retro-gaming emulation, and ported Retro-gaming. also known as classic gaming and old school gaming, Usually Retro-gaming is based upon systems that are obsolete or discontinued.

The games are played either on the original hardware, on modern hardware via console emulation, or on modern hardware via ports or compilations. Some retrogamers are in the business of refurbishing old games, particularly arcade cabinets. Some even make their own arcade cabinets. There's even a dedicated magazine for enthusiast.<sup>vii</sup>

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<sup>i</sup> Peddie, Jon, “The History of Visual Magic in Computers: How Beautiful Images are Made in CAD, 3D, VR and AR,” Springer, 2013.

<sup>ii</sup> The Numatron. <http://www.goodeveca.net/nimrod/nimatron.html>.

<sup>iii</sup> <https://www.bigfishgames.com/blog/2017-video-game-trends-and-statistics-whos-playing-what-and-why/>

<sup>iv</sup> <http://www.ign.com/articles/2005/03/11/gdc-2005-iwata-keynote-transcript> 10 Mar 2005, GDC 2005: Iwata keynote transcript.

<sup>v</sup> <https://quanticfoundry.com/2017/01/19/female-gamers-by-genre/>.

<sup>vi</sup> <https://www.polygon.com/2013/8/9/4604088/the-rise-of-midcore-gaming>.

<sup>vii</sup> [https://www.myfavouritemagazines.co.uk/gaming/retro-gamer-magazine-subscription/?gclid=CjwKCAiAnabTBRA6EiwAemvBd3zyWN1zd5KUZVXFVAIQqh-lFvArrdMf\\_NY1kSnEM410CQt6uTuNVRoCNqEQAvD\\_BwE](https://www.myfavouritemagazines.co.uk/gaming/retro-gamer-magazine-subscription/?gclid=CjwKCAiAnabTBRA6EiwAemvBd3zyWN1zd5KUZVXFVAIQqh-lFvArrdMf_NY1kSnEM410CQt6uTuNVRoCNqEQAvD_BwE).