

# **Building PCs for the Nuts and Bolts Imaging Company**

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# 1 Introduction

Building a personal computer (PC) from scratch may be a tedious task for some people, but when you find out that you can build a supercomputer at a lower cost than retail, you may never repurchase ready-to-use PCs. The main aim of building a PC on your own is to choose components that will provide the necessary performance for the required job. In building PCs, the first step will be specifying the main task that PCs will deal with most of the time. In this report, the device's primary uses will be running 3D design software called AutoCAD. This application is called CAD and stands for "Computer-aided design". The company that owns the application is Autodesk, and it was founded by John Walker in 1992 ([Technicalfoamservices, 2020](#)). This software is an alternative to the manual drafting of construction documentation, which offers an automated process for the designer. CAD helps the designer bring design ideas, visualise them through digital images for simulation purposes, and increase the design quality ([Autodesk, 2022a](#)). These designs are of high capacity. Therefore we will need ample storage to store this data and keep it accessible whenever the professional needs it.

## 2 Requirements

PC requirements for AutoCAD 2022 (Windows) were as follows ([Autodesk, 2022c](#))

Table 2.1: CAD Requirements

Component	Requirements
Operating System	64-bit Windows 11 or 10 version 1809 or above
Processor	2.5 GHz (3+ GHz recommended), ARM processors not supported
Memory	8 GB (16GB recommended)
Disk space	10.0 GB
Display	1920 x 1080 resolution with True Color
Basic Display Card	1 GB GPU with 29 GB/s Bandwidth and DirectX 11 compliant
Recommended Network	4 GB GPU with 106 GB/s Bandwidth and DirectX 12 compliant See <a href="#">Autodesk Network License Manager for Windows</a>
Pointing Device	MS-Mouse compliant
.NET Framework	.NET Framework version 4.8 or later

## 3 Workstation Design and Specification

Each part of the pc will be discussed in this section, including the recommended requirement specified for AutoCAD, followed by a decision with a full explanation. A table presenting all the parts at the end of each section can be used with the brochure to give the client extra information, such as the price and trusted stores where the items are available.

### 3.1 Operating System (OS):

Microsoft (Washington, United States) has always been the best in providing a suitable workspace for almost every work office. Including the latest version of Windows 11, there was an upgraded version with advanced features, suitable for heavy-duty jobs and many workloads such as CAD professionals while supporting multiple screens([Figure 3.1](#)).

Before choosing Windows 11 Pro for the workstation(64-bit), the requirements must be checked to ensure it was met with the other components ([Microsoft, 2022](#)):



Figure 3.1: Windows 11 PRO for workstation([ZDNet, 2022](#)).

Table 3.1: Windows Requirements

Component	Requirements
Processor	1 gigahertz or faster with 2 or more cores on compatible 64-bit processor or system on a chip (SOC)
Memory	4 GB RAM
Storage	64 GB or larger storage device
System firmware	UEFI, Secure Boot capable
TPM	it comes with most motherboards v 2.0
Graphic Card	DirectX 12 compatible graphics/WDDM 2.x
Display Resolution	>9" with HD Resolution (720p)

Autodesk has verified that AutoCad and all the tools are supported in Windows 11 pro workstation ([Williams, 2022](#)). This OS requires a Trusted Platform Module (TPM) 2.0 chip for security and privacy purposes, which is available with the processor I chose for the company([Mitra, 2022](#)). This chip enhances security by providing a cryptographic key for a trusted environment and has been used in companies where strict privacy is required ([Brant et al., 2022](#)). This OS is designed for workstations and capable of handling an intensive load of graphics works, which will be the workload for CAD professionals daily. The data storage in Windows 11 is supported by offering persistent memory, which is used as top-tier storage, this type of memory will keep the content within the power cycles. In this OS, Microsoft has improved the performance of the windows features with a new look ([Microsoft, 2022](#)). Most workers are used more to the windows interface than other operating systems, and changing to different operating systems can affect their performance. CAD professionals mainly use windows for their platform ([Autodesk, 2022b](#)).

## 3.2 Central Processing Unit (CPU)

Intel Core i5-9600K (Figure 3.2) was designed using Coffee Lake architecture that features six CPU cores with some refinement for the process to maintain better clock states with high workload ([W1zzard, on and Intel, no date](#)). Internal clock ticks inside the CPU measure CPU speed by how much work can be done in this amount of time. The faster frequency of these ticks means faster work done by the CPU and measured by Hertz (Hz). For example. If the CPU speed is 4GHz, it means 4 billion ticks in one second, while Complex PC operations can take up to 100 or thousands to complete ([Glawion, 2022](#)). In this CPU, the base frequency is 3.70GHz (Figure 3.3), and the maximum that can reach is up to 4.60 GHz. The processor contains six CPU cores that work together to run multiple applications together, and it has six threads, which is the number of tasks that can be handled simultaneously using the CPU cores ([Intel, 2022b](#)). The threads number will determine the throughput improvement and the computational speed in the PC ([Martin, 2022](#)). This CPU supports a 64-bit dual-channel memory controller DDR4-2933. Intel UHD Graphics 630 will be integrated within the CPU and support up to three monitors for DirectX 12 version. *DirectX* is a software introduced by Microsoft and contains a collection of applications that handle rendering 2D and 3D graphics. DirectX12 has improved the CPU utilization by 50% compared to DirectX 11 ([Parrish, 2022](#)). The maximum resolution for HDMI is 4096 x 2304@24Hz, while the Graphics Video Max Memory is up to 64 GB and supports 4k for future upgrading can be considered ([Intel, 2022b](#)).



Figure 3.2: Intel Core i5 9th Generation(Dihuni, 2022).



Figure 3.3: Intel Core i5 9th Generation.(check, 2022)

This CPU was chosen based on the requirement of CAD, which is the processor was recommended to be 3+ GHz, Intel i5 9600K processor can reach 4.6, and the base speed is 3.7. The Ram is supported for up to 128 GB. The graphic card support DirectX 12 for CAD with memory up to 64 GB. The resolution is higher than recommended requirements. This CPU includes innovative technology such as Intel Optane memory. It works as a cache to speed up the computing experience by learning the frequently used data for quick access and minimising the lag time, even after turning the pc off. Intel Clear Video Technology for image decode and processing is built into the Graphic card for natural colours and cleaner images. This CPU is adequate for demanding applications and challenging to beat the speed superiority (Intel, 2022b).

### 3.3 Availability

**Item model number:** BX80684I59600K **Stock:** Available **Selling price:** £172.09 (Figure 3.4)

**Intel BX80684I59600K**  
**Core i5 i5-9600K Hexa-core (6 Core) 3.70 GHz Processor - Retail Pack**

SKU BX80684I59600K Category Processors

Authorized Partner

Note: All products ship globally from within USA from our facilities or distributor/manufacturer warehouses.

Important Note: Your credit card will be charged at the time of ordering. If this product can be added to cart, it is orderable but there may not be ready stock and there could be long wait times. Global shortages continue so we recommend to confirm stock/cts by email/phone before ordering.

\$259.67 \$215.73

53 in stock

10

Figure 3.4: Selling price for Intel Core i5 9th Generation (Dihuni, 2022)

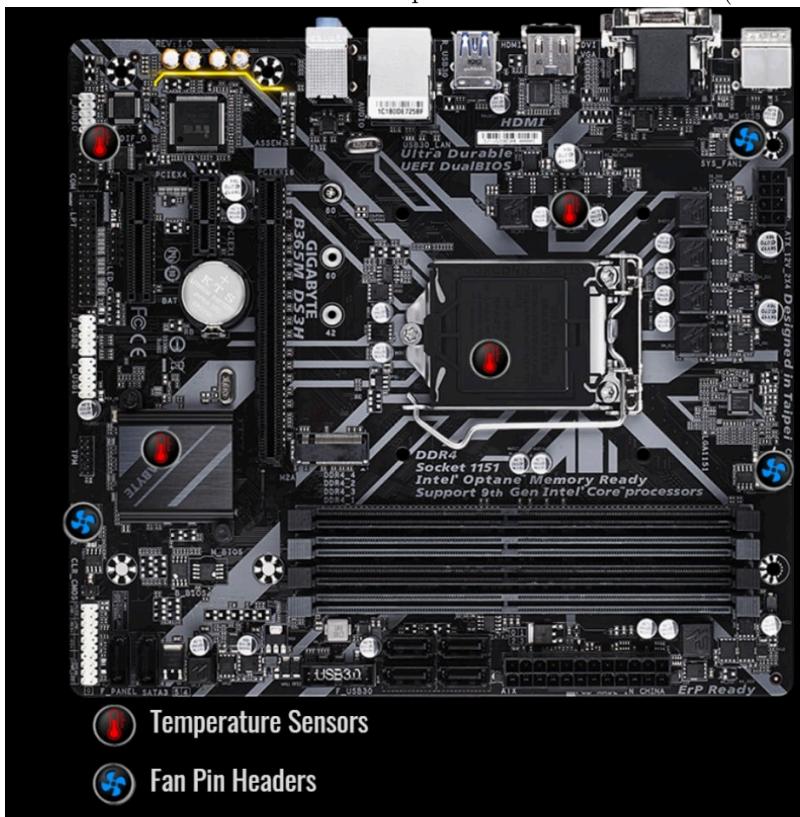
### 3.4 Motherboard

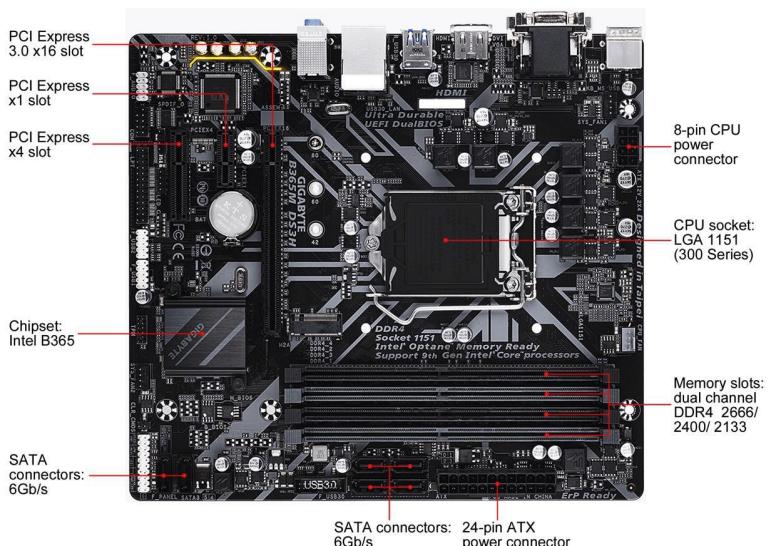
For choosing a motherboard, the first thing is the check the CPU socket. For Intel, i5- 9600k fits into socket LGA-1151 and is compatible with 300-series chipset-based motherboards (Intel, 2022b). The motherboard used

is Gigabyte B365M- DS3H Micro ATX Motherboard This motherboard has an LGA-1151 socket with an intel b365 chipset and a Double Data Rate 4 interface that support Synchronous Dynamic Random-Access Memory (DDR4 SDRAM), which is well known for its high bandwidth ([Wikipedia, 2022a](#)). There are multiple things were taken into account when it comes to choosing a motherboard:

1. Price: the price of the motherboard depends on the features that can support the brand company. Gigabyte produces cheap motherboards but includes good features and low power consumption ([UBG, 2021](#)).
2. Design: Gigabyte tries to integrate the best features into their model for the best performance concerning the design. However, for some individuals, the look is something not important ([UBG, 2021](#)).
3. The overclocking ability, if required.
4. Number of RAM slots can increase the usage and enhance the performance (4 DIMMS Dual channel DDR4-2666 ), and the processor can run up to a max memory size of 128 GB.

Other attachment slots also should be taken into account; Intel i5 9600K motherboards have M.2, 8 USB 3.1 ports ([UBG, 2021](#)), and the Max number of SATA is 6 ([Intel, 2022a](#)) with 20 PCI lanes ([Intel, 2022a](#)). The motherboard has got three Fan pin headers and three temperature sensors with the ability to handle RAM up to 64GB ([Microless, 2022d](#)). Integrated Intel® Smart Sound Technology is an integrated digital signal processor (DSP) for audio offload and audio/voice features, Intel Rapid Storage Technology for PCI Storage: operates on PCI Storage devices to providing protection, and high performance, with expandability for the platform, Intel® HD Audio Technology to support the latest and great audio content and Intel Ethernet MAC with LAN ports built into the system board ([Intel, 2022a](#)). The motherboard performs with Dual BIOS and contains the main BIOS and a backup BIOS to help pc recover from any BIOS problem and protect it ([Hope, 2022](#)). The motherboard is listed at a reasonable price for all these features ([Microless, 2022d](#)).





### 3.4.1 Availability

**Item model number:** B365M DS3H **Stock:** Available **Selling price:** £78.20

**Gigabyte B365M DS3H LGA 1151 Intel B365, DDR4, PCIe Gen3 x4 m.2, Micro ATX Motherboard | B365M-DS3H**

Model: B365M-DS3H SKU: 39863

**OFFER**

Warranty: 1 Year Quick and hassle free warranty claims

Compare

Report incorrect or inappropriate product information.

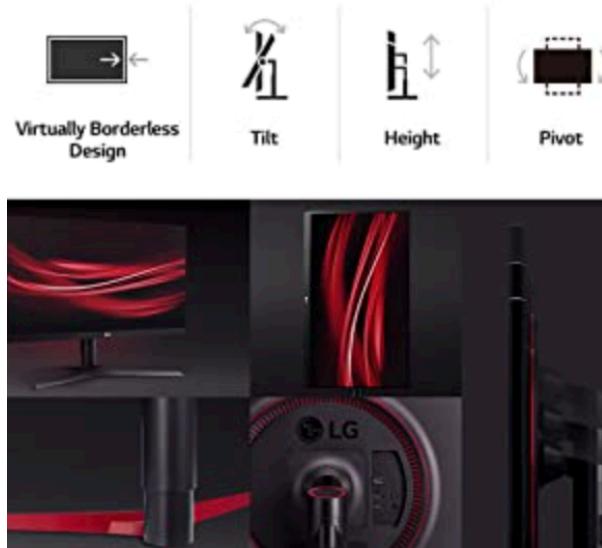
**78.20 GBP**  
14% OFF Was 90.67 GBP

Sold By: Microless  
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### 3.5 Monitor

One of the most critical components for CAD applications is the monitor, which can affect the view and design if it is not a proper monitor. There are plenty of options for screens depending on the quality, price, precision, colours and availability. These factors can affect the professional's productivity. Professionals working on designs and visualizing projects with different shades of colours can not settle for any monitor and may need specific requirements depending on their projects (Epifano, 2022). Depending on these factors, LG 27GL650F-B was the perfect match for AutoCAD designs. This monitor is a 27 inch Full HD Ultra gear with G-Sync Compatibility and a 144Hz Refresh Rate of 1ms. This screen has in-plane switching (IPS), which is a LED type for display panel technology. This technology gives the professionals the best colour with excellent viewing angles with high image quality, better than any other types of panels (Hardware, 2020b). The Resolution of LG UltraGear 27GL650F-B is 1920x1080, with a good time response that gives apparent motion. The refresh rate reduces the lag time. The screen comes with an adjustable height stand, which helps the user improve the posture and avoid back problems, especially when sitting for long hours (Microless, 2022e). The AMD Radeon free sync technology in the monitor control the monitor refresh rate to save the image from tearing when the refresh rate is high. The tearing in the image can happen even when you move the mouse when the application display rate can not keep up with the display's refresh rate, which is another advantage of this monitor (Hardware, 2020a).





### 3.6 Power supply

For the power supply unit, Corsair RM550x gives power supply up to 550 WAtts. This power supply gives the right amount of power for the pc we are building to function depending on the component power requirements. This power supply is efficient and has a cooling magnetic Levitation Fan (NR140ML) 140mm that keeps the device's performance high when there is high power consumption. All different connectors come within the package with a ten-year warranty. Furthermore, the power supply handles all operations silent without any noise, which is crucial when buying a power supply for the PC (Mpitzopoulos, 2022) .



### 3.6.1 Availability

Item model number: [CP-9020197-NA](#) Stock: Available Selling price: £95

Item# N02E16817139269

**CORSAIR RMx Series (2021) RM550 CP-9020197-NA 550 W ATX12V / EPS12V 80 PLUS GOLD Certified Full Modular Power Supply**

4.5 (1,521) Write a Review

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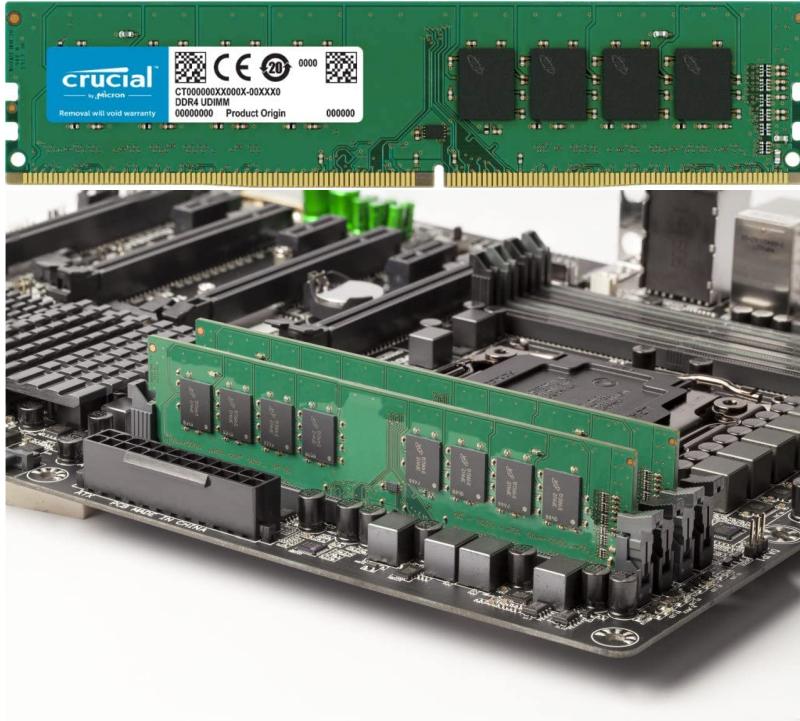
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TOP FAVORABLE REVIEW  
Very stable and dependable PSU  
Pros: Fully Modular - This really helps on air flow and work space. No reason to have non-

## 3.7 Random Access Memory

Depending on the motherboard and the processor that I discussed before, the processor can take up to 128 GB ([Intel, 2022b](#)) and the motherboard up to 64 GB ([Microless, 2022d](#)). Crucial RAM 64GB Kit will be a good fit. This RAM comes in two pieces (2x32GB) with an interface that fits into DDR4. The RAM has a noticeable impact on the PC speed, especially with the workload in some specific programs and will scale better when the

data rate is high. 16GB RAM is efficient for many users, and for multitaskers, 32 GB is a good choice. However, I still decided to go up to 64 to get the best speed. If the professional has to deal with multiple files and render and use CAD, having 64GB is worth it (Appuals, 2022). In this model, using Dual-rank for memory will make it even faster than single-rank memory (Liu, 2022). This RAM is available at an affordable price and has good reviews from previous clients, and the rating is 4.7 out of 5 (Amazon, 2022b) . DDR5 can be used for future upgrading, which is a new type of RAM that will be available soon and is now being tested (Hardware, 2022).



### 3.7.1 Availability

Item model number: [CT2K32G4DFD8266](#) Stock: Available Selling price: £235.50 (Figure 3.5)

**Crucial RAM 64GB Kit (2x32GB) DDR4 2666 MHz CL19 Desktop Memory CT2K32G4DFD8266**

Brand: Crucial ★★★★★ 15,971 ratings | 9 answered questions

GBP 235<sup>50</sup>

Import Fees Deposit Included

Not eligible for COD Delivered by Amazon Global Store Secure transaction

New (7) from GBP 235.50

Style: 2600MHz

2400MHz 2600MHz 3200MHz 2666 MT/s 2400 MT/s

Size: 64GB Kit (32GBx2)

Brand: Crucial Form factor: DIMM Ram memory technology: 64 GB DIMM Computer memory size: 64 GB Memory speed: 2666 MHz

About this item

- Improve your system's responsiveness, run apps faster and multitask with ease

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Figure 3.5: Corsair RM550x price (Newegg, 2022a)

## 3.8 Hard drive

For storage, CAD professionals tend to use two types of storage Hard disk drive(HDD) and a Solid state drive(SSD)(Corke, 2022). SSD will be used mainly for storing applications, OS and most used files. In contrast, HDD is best for saving extra data and files. HDD is slower than SSD but has a longer lifespan and is cheaper, while SSD comes with a flash design and no need to move parts with shock-resistant. For hybrid computers having both types are a great way to increase the performance of both components (Avast, 2022). Seagate Bare

Drives BarraCuda (Figure 3.6) with 1TB is a good choice as HDD storage. The interface fits in 3.5 Inch SATA with 7200 RPM and 64MB for Cache. This HDD fits in our motherboard, and still, there is space to add an extra HDD for more storage (Amazon, 2022a). Barracuda has high capacity and fast drives compared to other traditional HDDs in the market. All connections are included. A bigger capacity for SSD is costly, but for the HDD, it is still reasonable. Many stores sell it for a reasonable price with a bigger capacity, which can be considered for future upgrading (Sanders, 2013). In addition, Barracuda drives have optimized data flow for an excellent read and write performance (Ramseyer, 2018).

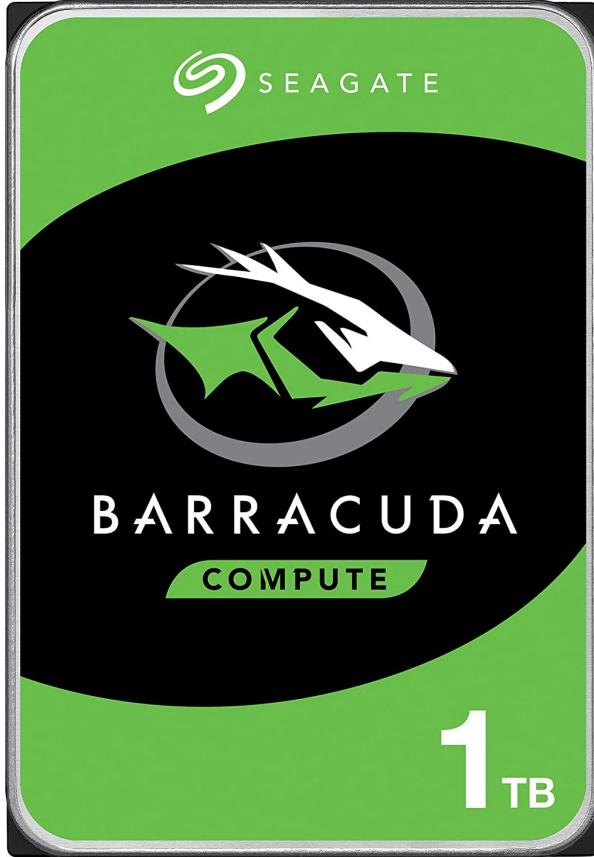


Figure 3.6: Seagate Bare Drives BarraCuda (Amazon, 2022a).

### 3.8.1 Availability

**Item model number:** ST1000DMZ10/DM010 **Stock:** Available **Selling price:** \$46.49~ £38

This is a screenshot of an Amazon product page for a Seagate BarraCuda 1TB hard drive. The main image shows the green and black box. To the left is a vertical list of small thumbnail images. The product title is "Seagate Bare Drives BarraCuda 1TB Internal Hard Drive HDD - 3.5 Inch SATA 6 Gb/s 7200 RPM 64MB Cache for Computer Desktop PC - Frustration Free Packaging". Below the title are "Capacity: 1TB" and "Style: HDD". There are dropdown menus for "Capacity" (2TB, 3TB, 4TB, 6TB, 8TB, 12TB) and "Style" (SATA 6Gb/s, M.2 SSD, NVMe). A "Buy Now" button is prominently displayed. To the right, there's detailed product information including "Secure transaction", "Sold by: Amazon.com", and "Return policy: Eligible for return". A "Add to List" button is also present.

## 3.9 Solid state drive

Samsung 980 Pro will be used as SSD with a 1TB capacity. Therefore, there will be a good space for storage when using both HDD and SSD. The total storage of both types is 2TB which is enough for CAD professionals. This SSD has good overall performance, can be used with a Gigabyte b365 motherboard, and has the software

included with the package. It is well known as the fastest V-NAND with excellent performance, and it can handle throughput up with a sustainable performance for millions of reading/writing IOPS. This SSD has received good reviews from the customer on amazon and was rated 4.8 out of 5.0 (Amazon, 2022c).



### 3.9.1 Availability

**Item model number:** MZ-V8P1T0BW **Stock:** Available **Selling price:** £104.42



## 3.10 System Case

The model case is Fractal Focus G Crystal Tower. This case has many features with a good design that ensures good airflow between components with 18-25 mm of space for cables behind the motherboard and six fan positions for excellent airflow (Techinn, 2022). This case dimension (Width x Height x Depth): 205 x 444 x 464 mm with a transparent side panel, dust filters to protect the components, and drive bays racks for 3.5 inches, which will be used for the HDD barracuda . There are two led Fans for design, and they can fit any heatsink up to 165mm. For Front I/O, the case includes USB 3.0, USB 2.0 and audio jacks. The tower case can fit all motherboard sizes and got plenty of space for other components such as a fan and power supply with liquid cooling support (Colaner, 2017).



### 3.10.1 Availability

**Item model number:** Two pre-installed Fractal Design Silent Series LL 120 mm White LED fans **Stock:** Available **Selling price:** £53



## 3.11 Keyboards and Mouse

Logitech MK345 combines Wireless Keyboard and Mouse. Logitech components have long battery life with on/off switches for both and automatic sleep mode when not in use. In addition, the keyboard height is adjustable for comfort and comes with one year warranty ([Microless, 2022f](#)).



### 3.11.1 Availability

**Item model number:** [920-010068](#) **Stock:** Available **Selling price:** £28 (Figure 3.7)



Figure 3.7: Logitech MK345 Wireless Keyboard and Mouse Combo ([Microless, 2022f](#))

## 3.12 Fan

For the fan, Be quiet! Dark Rock Pro 4 (Figure 3.8) was chosen as a CPU cooler that performs 250W TDP with minimum noise. The fan dimensions are 120mm, and the design fits LGA-1151, our processor socket ([Microless, 2022a](#)). Be quiet fan is excellent for cooling with an open design that enhances airflow and reduces heat. Most importantly, this fan stays silent during the operation at all speeds and supports most CPU sockets. It was developed for heavy duty works ([Carver, 2022](#)). When comparing fans with radiators, fans are cheaper, more available, have no risks in case of leakage or damage and can be installed easily ([computeraideddesignguide, 2017](#)).

### 3.12.1 Availability

**Item model number:** [BK022](#) **Stock:** Available **Selling price:** £102

## 3.13 Ethernet cable

For connection, Ethernet for businesses is more reliable, more secure, and faster, especially when working with loads of data and CAD application needs a stable internet connection ([Nerdstogo, 2022](#)). The motherboard has



Figure 3.8: Be quiet! Dark Rock Pro4 ([Microless, 2022a](#)).



Figure 3.9: Be quiet! Dark Rock Pro 4 ([Microless, 2022a](#)).

integrated Intel Ethernet MAC with LAN ports built into the system board. The ethernet cable is needed with a switch to connect all PCs with an internet connection. For ethernet cable, UGREEN Cat8 ([Figure 3.10](#)) which is 1 Meter long that can support significant areas with High Speed 40Gbps 2000MHz ([Figure 3.11](#)), reliable and Compatible with Switch ([Amazon, 2022e](#)).



Figure 3.10: UGREEN Cat8 ([Amazon, 2022e](#)).

### 3.13.1 Availability

**Item model number:** [Cat8](#) **Stock:** Available **Selling price:** £7

## 3.14 Switch

The switch connects multiple devices with a network using packet switching to transfer data between devices ([Wikipedia, 2022b](#)). The ethernet cable is plugged into to allow communication between devices within the network. The switch model used for the company is D-Link Gigabit Smart Switch ([Figure 3.13](#)). This switch has 52 ports that allow all staff to use the switch and connect to the internet ([Microless, 2022c](#)). D-link switch is known for high functionality and easy configuration using the web browser and supports cable diagnostics for easy troubleshooting. In addition, the D-link switch contains an integrated firewall to ensure high security and access restrictions ([Ellis, 2022](#)).



Figure 3.11: UGREEN Cat8 ([Amazon, 2022e](#)).



Figure 3.12: UGREEN Cat8 ([Amazon, 2022e](#)).



Figure 3.13: D-Link Gigabit Smart Switch ([Microless, 2022c](#)).

### 3.14.1 Availability

Item model number: [DGS-1210-52/E](#) Stock: Available Selling price £249 (Figure 3.14)



Figure 3.14: D-Link Gigabit Smart Switch ([Microless, 2022c](#)).

## 3.15 Firewall

To protect the small business network and PCs, Bitdefender will be used as an antivirus (Figure 3.15). This antivirus has been well known for total protection and high security with affordable packages for multi-users. In addition, this antivirus offers other features to secure the system and identity, including an unlimited Virtual private network(VPN). The design of the interface is effortless to use. The support team for the application will be available for a call or chat anytime for help ([Nadel, 2022](#)). Bitdefender does not affect the PC's performance and protects from attacks ([Bitdefender, 2022](#)). Bitdefender has an excellent identification process at high speed, which identifies any suspicious movements and is suitable for working with windows 11 ([Report, 2022](#)). For the best antivirus for 2022, Bitdefender was nominated to be one of them ([PCMAG, 2022](#)).



Figure 3.15: Bitdefender Total Security ([Bitdefender, 2022](#)).

### 3.15.1 Availability

item model number: [Bitdefender Total Security](#) Stock: Available Selling price: \$30 ~ £24 for 1 year / 5 devices +6 months for free (Figure 3.16)

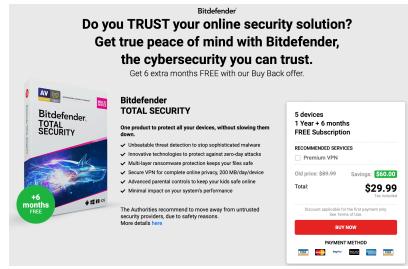


Figure 3.16: Bitdefender Total Security (Bitdefender, 2022).

Table 3.2: PC Components

Component	Model	n	Cost	Cost with profit margin	n x Cost	Summary of Capabilities
MotherBoard	Gigabyte B365M DS3H Motherboard	30	£78.97	£87	£2,610	1. Support for Dual BIOST2. Micro ATX 3.M.2 available4. PCIe Gen3 x45. Intel B365 chipset6. LGA 1151 socket6. 1 year warranty
Central Processing Unit	Intel Core i5-9600K	30	£172.09	£189	£5,670	1. Intel UHD Graphics 630
Random Access Memory	Crucial RAM CT2K32G4DFD8266	30	£235.50	£260	£7,800	1.64GB Kit (2x32GB) DDR4 2. 2666 MHz CL19 3. Desktop Memory 4. Improve your system's responsiveness, 5. run apps faster and multitask with ease Micron quality 6. reliability is backed by superior component
Hard Drive Case	Seagate Barracuda Compute 1 TB 3.5" 7200RPM Internal Hard Drive Fractal Focus G Crystal Tower Case	30	£38	£42	£1,260	1. Storage space2. Reliable3. Faster PC
Power supply Unit	CORSAIR RMx Series (2021) RM550x CP-9020197-NA Full Modular Power Supply	30	£95	£105	£3,150	1. white color is available for 30 pieces 2. Excellent air flow3.Extra space for cables 4. hard disk bays5. LED fans6. 1 up to 550 WAtts
Graphic Card	Intel UHD Graphics 630 (Integrated in the CPU)	0	0	0	£0.0	
Network Card	Intel Ethernet MAC ( Integrated in the motherboard)	0	0	0	£0.0	
Monitor	LG 27GL650F-B	60	£215.17 per each	£238 each	£14,280	27 Inch Full HD (1920 x 1080) IPS Display144Hz Refresh Rate1ms Motion Blur ReductionHeight / Pivot / Tilt adjustable StandRadeon FreeSync Technology
Keyboard + Mouse	Logitech MK345 Wireless Keyboard and Mouse Combo	30	£28	£31	£930	1. keyboard height can be adjusted 2. Long battery life
Fan	Be quiet! Dark Rock Pro 4	30	£102	£112	£3,360	250W TDP, CPU Cooler, 24.3Db, 120mm fan, Double-Tower Layout, Excellent design to reduce heat, Superior reliability, Low noise
Operating System	Windows 11 Pro for Workstations	30	£247.34	£272	£8,160	Designed for workstation and heavy workload with high security
SSD	SAMSUNG 980 PRO	30	£104.42	£115	£3,450	1 TB, PCIe 4.0 (bis zu 7.000 MB/s), NVMe M.2 (2280)
Firewall	Bitdefender TOTAL SECURITY	6 X 5	£24/ £4.8 for each	£6	£162	24 pounds for 5 devices gives 1 Year + 6 monthsFREE Subscription 301.High privacy and security 2.Support VPN3.Protect from attacks 4.Excellent identification process 5.High speed 6.Easy user interface 7. 24 hours live support 8.Affordable price
Ethernet Cable	UGREEN Cat8 Ethernet Cable	30	£7	£8	£240	1.1 meter 2.Excellent speed 40Gbps 2000MHz3.Reliable 4.Network Internet Braided Shielded Cable LAN Wire
Switch	D-Link 52 Port Gigabit Smart Switch	1	£249	£274 £1,762 per PC	£274 £53,116	52 ports, High functionality

# 4 Server Design and Specification

Every work office with large amounts of data requires a file server that allows access for users in that network for these data. The file server was introduced to keep all files in one place and give users on the network access to it. These data can be shared over the internet with other users from different networks. In this model, the file server will be for the local user networks only, store designs and have enough storage that can be accessible for all users, and mirrors will be used to keep a backup of our server. The server design is similar to the traditional PCs design but requires special purpose components that are more robust so it can work 24x7 hours without interruption. For mirroring, a special software configuration called “RAID” will be used for it with multiple hot-swappable drive bays. After looking into both on-premises and cloud servers, the on-premises server is more flexible and can be adjusted depending on the tasks you want the server for and customized. For example, some businesses need a massive amount of storage that cloud servers would not be a feasible solution ([Subedi, 2022a](#))

There are three types of servers: 1. Tower Server 2. Rack-mount Server 3. Blade Server ([Subedi, 2022a](#))

However, before choosing the server hardware, the server tasks must be specified, and the components will be dependent on that. Most common uses of servers : 6. File Server 7. Database Server 8. Web Serve 9. Mail server

10. Print Server 11. Domain Server, and 12. Application Server ([Subedi, 2022a](#))

The Tower server will be built as a file server with mirroring in this model.

## 4.1 Server Components

### 4.1.1 Operating System

When choosing an operating system for a server, several things need to be considered, such as cost, updates, and features. Linux and Ubuntu servers (Figure ??) are open-source software. AutoCAD will be running on workstations, not servers, so the Ubuntu server will be fine because there is no need for the server to run the application. Linux supports Redundant Array of Inexpensive Disks (RAID), a controller software that uses Linux mdadm utility, which will be used later for storage and mirror. Some of the processors can control RAID without third part software ([Slashroot, 2022](#)). Ubuntu has some requirements (Figure 4.2).

#### 4.1.1.1 Why Ubuntu?

1. Free of cost
2. No need for a graphical user interface
3. Easy-to-use interface
4. Flexible and can be customized
5. Less consumption rate of computer resources in comparison to windows server ([Help, 2022](#))



Figure 4.1: Ubuntu([Umair, 2018](#)).

#### 4.1.2 Server board

Server boards are made to deal with the heavy workload and harsh conditions without interruption. Therefore, when comparing standard motherboards to server boards, server boards are more potent than standard motherboards. In this server, we will be using Supermicro X11DAI-N with LGA 3647 socket(Figure 4.3). The super micro can be used efficiently for servers and offers plenty of PCIe slots (Figure 4.4), and it is suitable for intel Xeon processors and available for an affordable price. On this motherboard, led lights that indicate high CPU temperature or fan failures.

Resource	Ubuntu 18.04
CPU	2 GHZ dual core processor
RAM	2GB
Hard disk requirement	25 GB of hard disk
GPU	1024X768 screen resolution

Figure 4.2: Ubuntu Requirement ([Ubuntu, 2022a](#)).

**The server board features:** - Dual CPU sockets - Intel C621 chipset - Up to 2TB ECC RDIMM - DDR4-2666MHz - 16 DIMM slots - controller for RAID 0,1,5,10 - Dual LAN ([Intel, 2022d](#))



Figure 4.3: Supermicro X11DAI-N([Gamers, 2022b](#)).



Figure 4.4: Supermicro X11DAI-N([Gamers, 2022b](#)).

#### 4.1.2.1 Availability

Item model number: [MBD-X11DAi-N](#) Stock: Available Selling price: £520 (Figure 4.5)

### 4.1.3 Central Processing Unit

Intel Xeon Silver 4210 will be used as a processor, which is made only for servers and has the Intel server system integrated. Intel Xeon silver is a 2nd generation processor. It was introduced in the Cascade Lake line with affordable prices compared to the previous server processors with two sockets and more cores ([Alcorn, 2020](#)). Xeon processors support correcting memories, more stability, less data corruption and more minor memory errors with error checking ability. The processor will protect data and fix errors, which will be very effective for

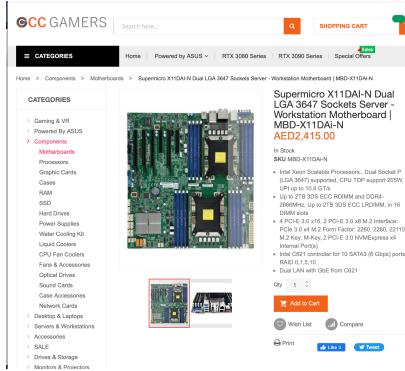


Figure 4.5: Supermicro X11DAI-N(Gamers, 2022b).

large and complex data (Graitec, 2022) and support two CPUs, which could be suitable for future upgrading if needed and run both simultaneously.

**Intel Xeon Silver 4210 features:** - **Threads:** 20Processor - **GHzOverclocking Speed:** 3.20 - **Clock Speed:** 2.20 - **Core:** Deca-core (10 Core) (Store, 2022)

Intel 621 chipset support Intel Rapid Storage Technology enterprise, which will be used for RAID controlling for storage and mirroring purposes (Intel, 2022d). Intel Rapid Storage Technology supports a responsive and practical storage solution supporting PCIe storage and Serial ATA RAID 0, 1, 5, and 10. This technology lowers power consumption and gives extra protection by stopping data loss when hard drives fail (Intel, 2022c). In addition, Intel Rapid Storage Technology offers data reliability using multiple six drives in the system, such as RAID 0 and data in each drive can be accessed simultaneously. This technology will speed up the response time in the system and add protection when one of the hard drives fails by mirroring data among more than two hard drives. This configuration for hard drives knows as RAID technology (Intel, 2022c).

**RAID includes the following levels:** - RAID level 0 (Striping) - RAID level 1 (Mirroring)(Figure 4.6) - RAID level 5 (Striping with parity) - RAID level 10 (Striping and mirroring) (Intel, 2022c).

For the server, RAID level 1 will ensure all data are protected if the hard drive fails. **RAID 1 Advantages:** 1. Outstanding pace 2. If a hard drive fails, data will be replicated to the alternative hard drive 3. Vey simple configuration (Prepressure, 2022)

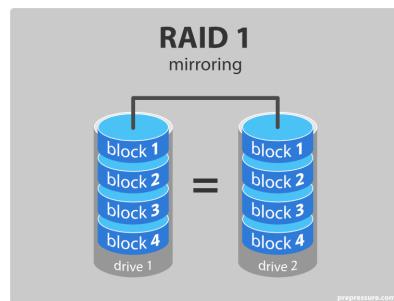


Figure 4.6: RAID level 1 (Prepressure, 2022).

#### 4.1.3.1 Availability

**item model number:** Intel Xeon Silver 4210 **Stock:** Available **Selling price:** £412 (Figure 4.7)

#### 4.1.4 Random Access Memory

The ram must be specified for server use only. The max memory size for the processor in this server is 1T (Intel, 2022d). Therefore, Timetric Hynix IC RAM (Figure 4.8) in dual rank for 32 GB 2400Mhz will be used. It will give the user excellent speed with a high data rate and will perform very well and no need for more than 32GB because we will not use it for application (Appuals, 2022). Timetric Hynix IC RAM was rated 9.5 out of 10 (Best, 2021). It has the dual rank feature, which will increase the speed (Liu, 2022). This RAM has 288 pins and operates on 1.2V. Moreover, it is suitable for less power consumption because it allows high speed without extra power and cooling and supports Intel Xeon processors (Atpinc, 2022).

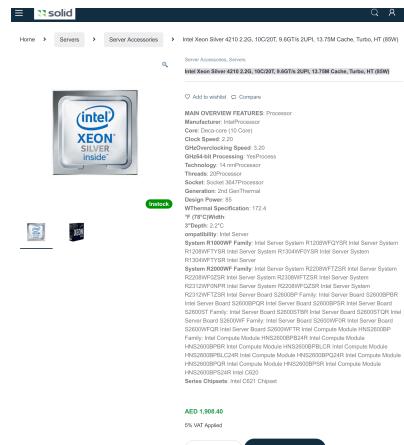


Figure 4.7: Intel Xeon Silver 4210 (Store, 2022).

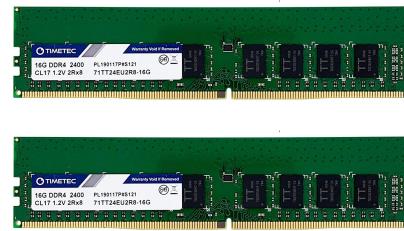


Figure 4.8: Timetec Hynix IC RAM (Amazon, 2022d).

#### 4.1.4.1 Availability

**item model number:** Timetec Hynix IC DDR4 Unbuffered ECC 1.2V 2Rx8 Dual Rank 288 Pin UDIMM Server Memory RAM Module Upgrade (2400Mhz 32GB KIT (2x16GB)) **Stock:** Available **Selling price:** £146 (Figure 4.9)

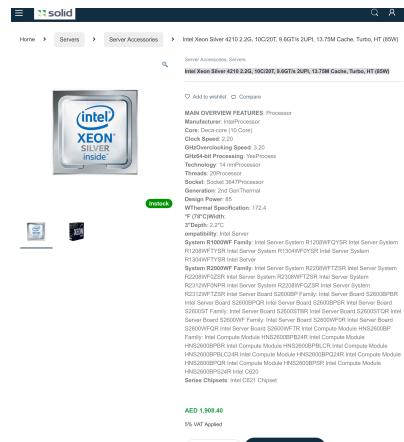


Figure 4.9: Timetec Hynix IC RAM (Amazon, 2022d).

#### 4.1.5 Hard Disk Drive

For the RAID1 level, at least two HDDs must be implemented in the server (Techtarget, no date). The Seagate SKYHAWK (Figure 4.10) has a good capacity, reaching 6TB 5400rpm 256MB. Seagate is a reliable HDD for the server, designed for heavy work 24X7. This hard drive will be used only for storing large amounts of data that are not frequently accessed, and 6TB will be a good amount of storage. The other HDD will be used for mirroring if one of the HDDs fails in this server.

In this server, HDD will only be used because : 1. HDD offers a higher capacity than SSD 2. Cheaper than SSD 3. If we need more storage, an extra HDD will be added 4. More reliable for 24X7 use (Swarnkar, 2017).



Figure 4.10: Seagate SKYHAWK (Amazon, no date).

#### 4.1.5.1 Availability

**item model number:** Seagate SKYHAWK 6TB 5400rpm 256MB **Stock:** Available **Selling price:** £89 (Figure 4.11)

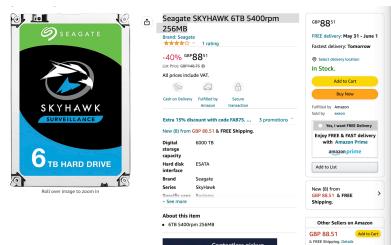


Figure 4.11: Seagate SKYHAWK (Amazon, no date).

## 4.1.6 Monitor

HP MONITOR V221VB (Figure 4.12) will be only used for the server as a monitor for commands so that it will be enough for the job. Furthermore, the screen size is 21.5Inch, so there is no need for much space. In addition, the HP monitor has a reasonable price for 1920 x 1080 resolution with FHD.

#### 4.1.6.1 Availability

**item model number:** HP MONITOR V221VB **Stock:** Available **Selling price:** £114 (Figure 4.13)

## 4.1.7 Keyboard and Mouse

Logitech MK345 Wireless Keyboard and Mouse Combo (Figure 4.14). Logitech components have long battery life with on/off switches for both and automatic sleep mode when not in use (Microless, 2022f).

#### 4.1.7.1 Availability

**item model number:** 920-010068  
**Stock:** Available **Selling price:** £28 (Figure 4.15)

## 4.1.8 Switch

The switch (Figure 4.16) is used to connect multiple devices with a network that was already added to the office (Figure 4.17).



Figure 4.12: HP MONITOR V221VB (E-Store, 2022).

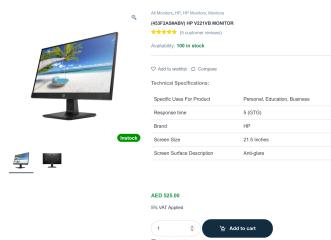


Figure 4.13: HP MONITOR V221VB (E-Store, 2022).



Figure 4.14: Logitech MK345 Wireless Keyboard and Mouse Combo(Microless, 2022f).

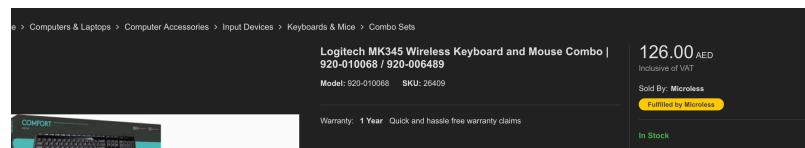


Figure 4.15: Logitech MK345 Wireless Keyboard and Mouse Combo (Microless, 2022f).



Figure 4.16: Switch (Microless, 2022c).

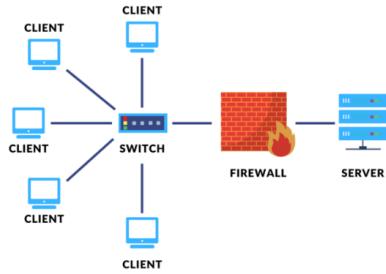


Figure 4.17: Switch Network (IT, 2022).

#### 4.1.9 Ethernet

The Ethernet cable will be connected to the switch that was already added to the office with the PCs component. For the Ethernet cable, UGREEN Cat8 (Figure 4.18) we will be using the same cable that was used to connect PCs. Because it is a reliable cable and long enough in case the server was far away from the switch, support high speed for high data rate 40Gbps (Figure 4.19) 2000MHz, and fits for switch use (Amazon, 2022e).



Figure 4.18: UGREEN Cat8 Cable (Amazon, 2022e).

##### 4.1.9.1 Availability

**item model number:** [Cat8](#) **Stock:** Available **Selling price:** £7 (Figure 4.20)

##### 4.1.9.2 Case

The Corsair 7000D AirFlow ATX Full-Tower Case (Figure 4.21). The tower size was dependent on our motherboard size, which was 13inch (Gamers, 2022a), so this tower will ensure enough space for the motherboard and other components to fit with good airflow between them. The tower's design is clean with enormous dimensions and can fit all components with extra space. The corsair has four USB 3.0 and USB Type-C ports with a headphone & mic outputs. The package comes with extra Velcro straps to manage cables easily, PSU shroud replacement for extra space, especially for HDD (Figure 4.22), and a PWM extension for the fan and all required tools. The airflow optimization features and the cable management in this corsair, plus the three 140mm AirGuide fans to keep the server temperature low, make it a perfect choice as a server case (Figure 4.23) (Broekhuijsen, 2021)

##### 4.1.9.3 Availability

**item model number:** [CC-9011218-WW](#) **Stock:** Available **Selling price:** £207 (Figure 4.24)



Figure 4.19: UGREEN Cat8 specification (Amazon, 2022e).

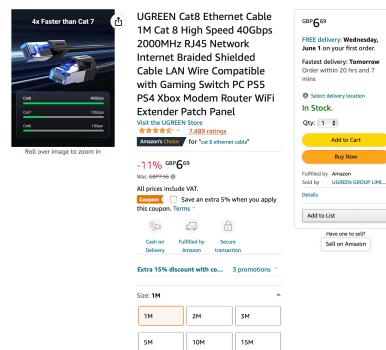


Figure 4.20: UGREEN Cat8 (Amazon, 2022e).



Figure 4.21: Corsair 7000D AirFlow ATX Full-Tower Case [@(Gamers, 2022a)].



Figure 4.22: Corsair 7000D AirFlow ATX Full-Tower Case [@(Gamers, 2022a)].



Figure 4.23: Corsair 7000D AirFlow ATX Full-Tower Case [@(Gamers, 2022a)].

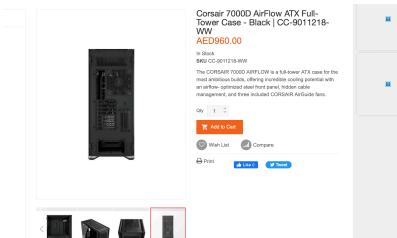


Figure 4.24: Corsair 7000D AirFlow ATX Full-Tower Case (Gamers, 2022a)

## 4.1.10 Cooling Kit

The maximum temperature allowed for the processor is 78°C, so we need to ensure that the fan can keep the temperature lower than 78°C ([Intel, 2022e](#)). To decide which method to cool the server by air or liquid. The liquid cooler is effective in cooling but slow in air flow transition, but can work for long-term without interruption and no need for other cooling techniques such as room a/c. Fans move the air outside, but radiators try removing heat with a water cooling system and are more potent than fans for server use, but there is a risk of leakage if the installation is not done correctly ([computeraideddesignguide, 2017](#)). For cooling the server, CORSAIR H55 Quiet Liquid CPU Cooler (Figure 4.25) will be used, compatible with the Corsair 7000D tower case. The reviews about this cooler are great, and users have recorded CPU temperatures around 55°C and 63°C with low noise ([Forum, 2022](#)).



Figure 4.25: CORSAIR H55 Quiet Liquid CPU Cooler ([Microless, 2022b](#)).

### 4.1.10.1 Availability

item model number: [CW-9060010-WW](#) Stock: Available Selling price: £84 (Figure 4.26)

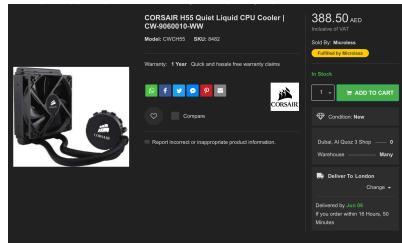


Figure 4.26: CORSAIR H55 Quiet Liquid CPU Cooler ([Microless, 2022b](#)).

## 4.1.11 Power Supply

Fortron Twins PRO 700W (Figure 4.27) ATX PS2 is a redundant power supply unit suitable for standard ATX, designed for servers, provides stable power with a hot swappable feature, so when one of them fails, the other supplier takes over and gives power immediately. There will be no need to worry about the server situation if on or off ([Techinn, 2022](#)).

### 4.1.11.1 Availability

item model number: [Fortron Twins PRO 700W](#) Stock: Available Selling price: £330

## 4.1.12 Firewall

When building a server within a company to utilize data, it is essential to keep it secure and protected. It is crucial to protect the server from any viruses, all kinds of data breaches, and malware. These servers hold essential information about the business operation and the staff's data. The Ubuntu server has been integrated into the Ubuntu firewall (UFW) system, which most users use as a firewall, and there is no need for any other antivirus applications. Ubuntu has an effective firewall that must be set up before uploading any data to the server. Ubuntu server stability is high due to the five years of support for security updates which optimize the deployment of this server for the business ([Ubuntu, 2022b](#)) . - How to setup UFW and secure your server



Figure 4.27: Fortron Twins PRO 700W ([Techinn, 2022](#)).

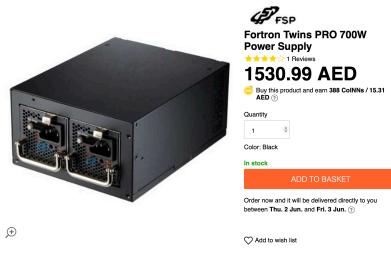


Figure 4.28: Fortron Twins PRO 700W ([Techinn, 2022](#)).

- ? 1. Ensure that UFW installed by typing `sudo ufw status` in command line 2. Setup the default firewall policy in the server with UFW 3. Allow required ports with `sudo ufw allow ports` 4. Ensure at least SSH, HTTP/HTTPS and other TCP/IP are open. 5. Enable UFW 6. Delete rules with command `ufw delete num` 7. Check netfilter status `ufw status` 8. you can disable UFW as well 9. For UFW reports `sudo ufw show added` \$ `sudo ufw show listening` ([Gite and Comment, 2022](#))

Table 4.1: Server Components

Component	Model	Final cost			n	n x Cost	Features
		Cost	with profit	n			
Server Board	Supermicro X11DAI-N	£520	£572	2	£1,144	Dual LGA 3647 Sockets Server - Workstation Motherboard	
Hard driver	Seagate SKYHAWK	£88.87	£98	4	£392	6TB 5400rpm 256MB	
CPU	Intel Xeon Silver 4210	£412	£453.2	2	£907	2.2G, 10C/20T, 9.6GT/s 2UPI, 13.75M Cache, Turbo, HT (85W)	
RAM	Timetec Hynix 1C	£146	£160.6	2	£322	DDR4 Unbuffered ECC 1.2V 2Rx8 Dual Rank 288 Pin UDIMM Server Memory RAM Module Upgrade (2400Mhz 32GB KIT (2x16GB))	
OS	Ubuntu Server	Free	0	2	0	<a href="https://www.techrepublic.com/article/ubuntu-server-the-smart-persons-guide/">https://www.techrepublic.com/article/ubuntu-server-the-smart-persons-guide/</a>	
Case	Corsair 7000D AirFlow	£207	£227.7	2	£456	ATX Full-Tower Case - Black	
Ethernet Cable	UGREEN Cat8 Ethernet Cable 1M	£7	£8	2	£16	1.1 meter 2.Excellent speed 3.Reliable	
Power Supply	Fortron Twins PRO 700W	£330	£363	2	£726	standard ATX, designed for servers, provide stable power, hot swappable feature	
Monitor	HP V221VB	£114	£125.4	2	£251	21.5 Inches FHD (1920 x 1080)	
Keyboards and Mouse	Logitech MK345 Wireless Keyboard and Mouse Combo	£28	£31	2	£62	1. keyboard height can be adjusted 2. Long battery life"	
FAN	Corsair H55 Quiet	£84	£92.4	2	£185	Liquid CPU Cooler, easy to install, improve CPU's cooling efficiency, works for long term without interruption	
		£2,134			£4,461		

## 4.2 Setting up the server

To set up the server, you need to prepare all users' names, IP addresses and serial numbers. Then install your server OS, begin the server configuration depending on the requirements, and set the sharing options. Then, set the domain in the server to allow another network PCs to join after completing the setup and the admin account and connecting other users. After finishing all of this, start uploading your data.

### 4.2.1 RAID 1 for mirroring :

This RAID level contains at least two hard disks and the controller. When you make a backup to a RAID drive, it will copy these data to both hard drives. If one of these disks fails, the data will be safe on the other disk (called mirroring) ([Andrews, 2022](#)). RAID 1 is used for mirroring usually. RAID is also useful for additional throughput, which allows to read and write from different hard drives instead of one, and additional cache memory, which increases backups' overall performance ([Steadfast, 2022](#)). The RAID can be by software or hardware; software RAID is cheaper because mainly it is included within the server and capable of performing RAID 1. Here in this server, the software is already included. So all you need is to set RAID backups.

- To install Ubuntu on server that supports Intel Rapid Storage Technology (RST) you may need to turn RST in the server BIOSm otherwise Ubuntu will not recognize the hard disks ([Ubuntu, 2022a](#)) . **To set up RAID1:**
  1. Select the custom storage layout
  2. if the disk is already in partitions, do reformat, then select the first disk as the boot disk
  3. Do the same thing for the other disks.
  4. After you finish, there will be partitions created in used devices
  5. Add a GPT partition for the first disk with a 1GB set without formating.
  6. Do the same thing for other disks
  7. For swap partitions, add a GPT partition for the first disk with 1/2 of you RAM size.
  8. For partitions preparation, add a GPT partition on the first disk without size or format and do the same for other disks.
  9. Click form available devices => Create Software RAID(MD) to create the softRAID (md0) partition by choosing the second partitions of both disks.
  10. Repeat for MD1 processing, select partition 3, and save it.
  11. Repeat for MD2 processing for partition four and save
  12. You have now three available devices which will be formatted as actual softRAID partition
  13. Select MD0 and add a partition and set format EXT4, and boot
  14. Repeat for MD1 but format as SWAP
  15. Repeat for MD1 but format as mount on
  16. you can now proceed with ubuntu installation ([Evangelou, 2022](#))

## 5 Conclusion

For building a server, it is essential to look into the requirements first, the space you need, the number of users, what type/size of files staff need to share, and how to protect your staff and their data. You have to invest in proper equipment and ensure security while keeping it organized inside the server on an excellent server ([Subedi, 2022b](#)). Each PC will cost the company £1,762, and the total for PCs is £53,116. For the servers, each server will cost £2,134, and the total for both servers will be £4,461. All components are available in the market, so more PCs with the exact specification can be added. All components were chosen after looking into all the pros and cons. Most of the item comes with a warranty. If issues happen, the resource company will cover them. All items can be upgraded for different requirements or higher performance.

# 6 Brochure

Workstation Starts from:  
**\$ 1,762**



**Windows 11 Pro for Workstations**  
Intel Core i5-9600K  
4.70 GHz  
64GB RAM



**Gigabyte B365M DS3H Intel B365 Micro ATX Motherboard**  
SSD 1 TB



**Intel UHD Graphics 630**  
Direct X12  
Full HD Screen/IPS  
LG 27 INCH X 2  
4096 x 2304@24Hz

**Corsair RM550x**

**I/O Devices**

**be quiet! Dark Rock Pro 4**

**D-Link 52 Port Smart Switch**

**Fractal Focus G Crystal Tower Case**

**Gigabyte B365M DS3H Intel B365 Micro ATX Motherboard**

**Bitdefender TOTAL SECURITY**

Server Starts from:  
**£ 2,134**



**Ubuntu Server**  
**Corsair 7000D**  
Intel Xeon Silver 4210



**Easy user interface**  
32GB RAM  
Stable power  
Hot swappable Power supply  
Lower noise  
Auto Backup  
RAID support  
2 HDD x 6TB  
Liquid cooler  
Less power consumption



Figure 6.1: Brochure

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