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Operating system - Windows 10

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Abstract

The content of the report that is presented contains the information about an operating system of our choice, which is Windows 10, and hardware it is intended to run on. The problem to a certain extent of this report was the research of information as it might be hard to find some specifics with addition of understanding the context. Overall, we broadened our horizons in the subject of operating systems and hardware.

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Introduction

We use operating systems on a daily basis, whether in work, school or at home. Operating system is what gives our hardware life and helps us use it in an organised way. Operating system manages the computer's memory and processes. It also allows you to communicate with the computer without knowing how to speak the computer's language. Throughout the years we saw many variations of operating systems – OS. The development was fast and nowadays they are sophisticated and can be used in many ways. The one most commonly used in work, school or at home is Microsoft Windows. We chose specifically Windows 10 Home. Our choice was based on the fact that all of us have Windows 10 and have worked with it. We wanted to deepen our knowledge on the subject and understand it more thoroughly. The hardware we chose for some examples and explanation was one of our newer laptops. We presented a hardware it is intended to run on and described the operating system in every detail we could find about it.

Windows History and interesting facts regarding Win 10

Windows was initially released in 1985. November 20 by Microsoft, named Windows 1.0. It has 12 versions, the last one released was Windows 10 in 2015. Windows is proprietary and closed source operating system. Originally, Bill Gates wanted to name it 'Interface Manager' but his employees convinced him, that Windows sounds much better, which he later agreed to. Windows is supported on almost every computer platform, as it is most widely used operating system and captures 90% of total share in PC market. Windows 10 is likely to be the last, fully new version ever released. It may lose the '10' from the name and become 'Windows OS', which will receive continuous updates.

Windows 10 original boot speed is very slow, to speed it up what Windows 10 does that it never lets the PC to completely shut down, even if you press shut down button your PC never actually shuts down. It essentially just hibernates. This causes undue load on the battery, of course in order to avoid so you can disable fast boot up under power manager but doing so increases boot up time by significant extent.

One of many interesting features of Windows 10 is connected to its capability to run on both touchscreen and keyboard + mouse input devices. It is called the 'Continuum'. It is designed for hybrid devices. The OS will move easily between keyboard/mouse and touch/tablet mode.

(Anon., 2021) (GeekforGeeks, 2020)

System's process and thread model

The operating system we chose, Windows 10, supports multiple processes. When talking about processes the operating system maintains the data structure, which keeps the information about each process. Process Control Block or PCB is the name of this data structure. The PCB has many fields that store the information. PCB consists of the following. **Process identification** – when a new process is created by the user, the OS will assign a number to the process, so it has a unique number. **Process state** – there are few states the process undergoes. These might be waiting state, running state, ready state, blocked state, halted state, etc. This PCB's field hold the current state of the process. **Process priority** – it is a numeric value, lesser the value is, greater the priority is. It is assigned at the of the creation of the process. It may be changed during the lifetime of the process. **Process accounting information** – this field gives the description of the resources the process uses. **Program counter** – it is the pointer in the program that is to be executed next. **List of open files** - it contains the information of all the files that is required during the program execution. **Process I/O status information** – if the process requires i/o devices, this field contains list of all the devices. **CPU registers** – in the registers, temporary information is stored during an interrupt so that process can resume. **PCB pointer** – the pointer has an address of the next PCB when process state is ready. **Event information** – provides details about the event that caused the process to be in a block state.

There are all the fields of Process Control Blocks and they contain information that is connected with specific process. (Neha, 2019)

In Windows 10 to see the processes you can open the Processes tab in the Task Manager. It does not need extra installation as it is automatically included. It has its limitations, but it helps to monitor our CPU, GPU and Memory – RAM. The user can also suspend and resume processes as they wish. Without any external tool the user can simply accomplish this on Windows 10 by opening up the Task manager, going into the Performance tab and clicking down to Open Resource Monitor. There it is possible to right click any process and selecting either Suspend Process or Resume Process as needed. In newer versions of the OS the system automatically suspends or resumes the processes as needed.

Windows 10 supports multiple threads and they may execute in parallel. The processes are a bit distinct from the threads. The key differences between process and threads are that process is a program which is being executed, whereas a thread is a segment of a process. Process is mostly isolated, while threads share memory. A process takes more time to terminate, however the thread takes less time. Threads allow utilization of multiprocessor architectures to a greater scale and efficiency.

User-level threads are easier and faster to create than kernel-level threads. They can also be more easily managed. User-level threads can be run on any OS.

(Guru99, n.d.)

Memory management and scheduling details

"Memory management is the process of controlling and coordinating computer memory, assigning portions known as blocks to various running programs to optimize the overall performance of the system." (Guru99, n.d.) Memory management in the operating systems is important because it manages the primary memory. It controls how the operating system uses and keeps track of the memory location, whether if it's used or not (it is still free for use).

Memory management techniques: Single Contiguous Allocation, Partitioned Allocation, Paged Memory Management, Segmented Memory Management. Memory allocation is a process where the program is assigned memory. Main memory is divided into two types:

1. **Low memory:** OS resides in this type of memory
2. **High memory:** User processes are held in high memory

"Memory scheduling is the process of ordering the DRAM operations necessary to complete the currently pending memory references." (Rixner, et al., 2000) The DRAM controller schedules the memory requests and manages the memory's data flow in and out.

(Guru99, n.d.) (Rixner, et al., 2000)

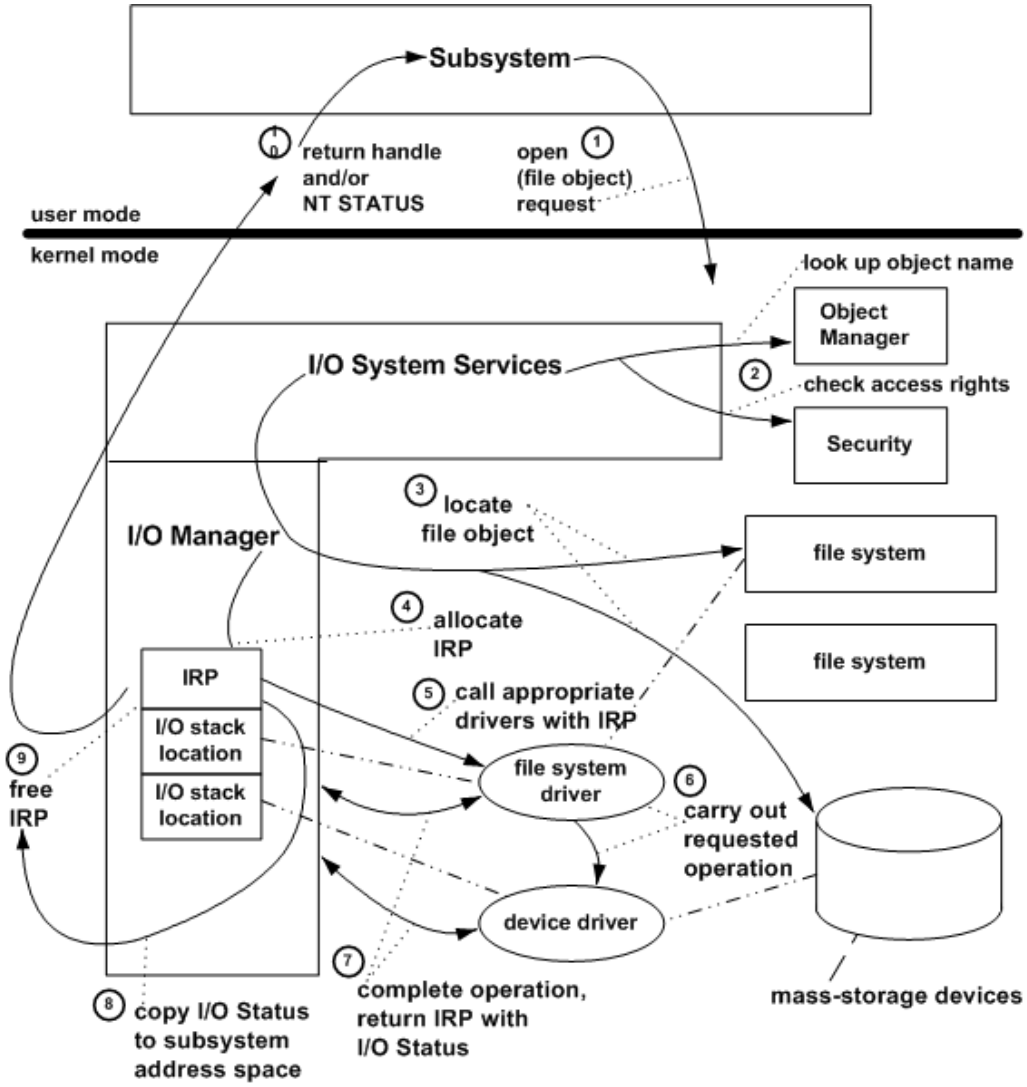
I/O model

For managing the flow of data to and from peripheral devices, every operating system has an implied or explicit I/O model. Support for asynchronous I/O is one of the features of the Microsoft Windows I/O model. Asynchronous I/O (also known as non-sequential I/O) is a form of input/output processing that allows other tasks to run concurrently with the transmission.

The Windows I/O model has the following general features:
• All kernel-mode drivers, including lowest-level, intermediate, and file system drivers, are provided with a clear interface by the I/O manager. I/O request packets are used to send all I/O requests to drivers (IRPs).
• Layered I/O operations are used. I/O device resources are exported by the I/O manager and are called by user-mode safe subsystems to perform I/O operations on behalf of their applications and/or end users. The I/O manager intercepts these calls, creates one or more IRPs, and routes them to physical devices through layered drivers.
• The I/O manager describes a set of standard routines that drivers can support, some of which are necessary and others which are optional. Given the variations in peripheral devices and the different features expected of bus, function, filter, and file system drivers, all drivers follow a reasonably consistent implementation model.
• Drivers, like the operating system, are object-based. Objects represent drivers, their computers, and machine hardware. The I/O manager, along with other operating system components, export kernel-mode support routines that drivers can use to complete tasks by manipulating the necessary objects.

The I/O manager collaborates with the PnP and power managers to send IRPs containing PnP and power requests in addition to standard I/O requests.

Visual representation of a request towards the system:



(EaseFilter, n.d.)

Hardware

For the chosen OS, the hardware, namely the CPU, we have is a picked is Intel(R) Core(TM) i5-9300HF CPU @ 2.40GHz, 2400 Mhz, 4 Cores, 8 Logical Processors. For Windows 10 the minimum requirements on the hardware side is to have at least 1 gigabyte of RAM for 32-bit or GB for 64-bit, hard disk needs a minimum space of 16GB for 32-bit OS or 20GB for the 64-bit OS option. As for the graphics card the OS needs at least a DirectX 9 or later with WDDM 1.0 driver with a display of 800x600.

The pipeline architecture of our platform consists of 5 stages.

Pipeline Stages:

Stage 1 (Instruction Fetch) - In this stage the CPU reads instructions from the address in the memory whose value is present in the program counter. Fetch the next instruction from the memory, at this time the instruction is encoded.

Stage 2 (Instruction Decode) - In this stage, instruction is decoded and the register file is accessed to get the values from the registers used in the instruction. Decode the instruction into operations (op)/source(src)/destination(dst).

Stage 3 (Instruction Execute) - In this stage, ALU operations are performed. The control unit of the CPU passes the decoded information as a sequence of control signals to the relevant function units of the CPU to perform the actions required by the instruction.

Stage 4 (Memory Access) - In this stage, memory operands are read and written from/ to the memory that is present in the instruction. 1. Perform data cache access 2. Store state in EX/MEM register(store the executed result and loaded data)

Stage 5 (Write Back) - In this stage, computed/fetched value is written back to the register present in the instructions. Write result back to register (data storage unit) If it requires.

The cache architecture of the chosen processor has a 3-level architecture, L1-256Kb, L2 – 1MB, L3 – 8MB. We were searching also for the bus architecture, but we could not find it.

(GeeksforGeeks, 2019)

File system

There is large variety of file system used across different platforms. Windows 10 uses the NTFS, which stands for New Technology File System. It has been used across many Windows operating systems. Ownership privileges and access control is supported by the NTFS' security, so there is possibility to set permission for groups or individuals to access specific files.

NTFS is to be reliable, because of the three major areas that were addressed. Those are recoverability, removal of fatal single sector failures and hot fixing. NTFS is recoverable file system because it keeps track of the transactions against the file system. A log of transactions is maintained, so that roll back to the last commit point is possible.

NTFS avoids single sector failure in two ways. First, by tracking and protecting all objects that are there. Secondly, multiple copies of the Master File Table are stored.

Next important fact is that NTFS has increased the size of files and volumes, so they can now be up to 2^64 bytes.

Some advantages of NTFS are that it is best for use on volumes of 400 MB or more. That is because performance is not worse as it was under FAT with larger volume sizes. Also, the recoverability is such that user should never have to run any disk repair utility on a partition.

There are also some disadvantages of the NTFS file system. On the one hand, as was written earlier, over 400 MB is best for use, on the other hand, smaller than 400 MB is not recommended, because of the amount of space overhead in the form of NTFS system files. They typically use at least 4 MB of space on 100 MB partition. There is no file encryption built into it, so someone can another OS and use a low-level disk editing utility to view data stored on NTFS volume.

(Deland-Han, et al., 2021)

Conclusion

All things considered, we gained new knowledge in the field of operating systems, especially Windows 10 and some of the hardware. The research of the information was causing us a bit of a struggle, but as our chosen operating system is that common, there is almost everything about it on the internet. We gradually found the information about it and the hardware throughout the course so we would have a corner stone on which we would build the report on. Overall, there were few setbacks, but we managed to get through them.

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