Ministry of Education and Science of Ukraine

Odessa National Academy of Food Technologies

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2021

Information Technology, Automation and Robotics

Proceedings

Odessa, ONAFT 2021

UDC 004.01/08

Editorial board:

Black Sea Science 2021: Proceedings of the International Competition of Student Scientific Works. Information Technology, Automation and Robotics. / Odessa National Academy of Food Technologies; B.Yegorov, M. Mardar, S.Kotlyk (editors-in-chief.) [*et al.*]. – Odessa: ONAFT, 2021. – 526 p.

These materials of International Competition of Student Scientific Works «Black Sea Science 2021» contain the works of the contest participants in the section «Information technologies, automation and robotics» (not winners).

The author of the work is responsible for the accuracy of the information.

Odessa National Academy of Food Technologies, 2021

Organizing committee:

Prof. Bogdan Iegorov, D.Sc., Rector of Odessa National Academy of Food Technologies, Head of the Committee

Prof. Maryna Mardar, D.Sc., Vice-Rector for Scientific and Pedagogical Work and International Relations of Odessa National Academy of Food Technologies, Deputy Head of the Committee

Prof. Stefan Dragoev, D.Sc., Vice-Rector for Scientific Work and Business Partnerships of University of Food Technologies (Bulgaria)

Prof. Baurzhan Nurakhmetov, D.Sc., First Vice-Rector of Almaty Technological University (Kazakhstan)

Prof. Mircea Bernic, Dr. habil., Vice-Rector for Scientific Work of Technical University of Moldova (Moldova)

Prof. Jacek Wrobel, Dr. habil., Rector of West Pomeranian University of Technology (Poland)

Prof. Michael Zinigrad, D.Sc., Rector of Ariel University (Israel)

Dr. Mei Lehe, Ph.D., Vice-President of Ningbo Institute of Technology, Zhejiang University (China)

Prof. Plamen Kangalov, Ph.D., Vice-Rector for Academic Affairs of “Angel Kanchev” University of Ruse (Bulgaria)

Dr. Alexander Sychev, Ph.D., Assoc. Professor of Sukhoi State Technical University of Gomel (Belarus)

Dr. Hanna Lilishentseva, Ph.D., Assoc. Professor, Head of the Department of Merchandise of Foodstuff of Belarus State Economic University (Belarus)

Prof. Heinz Leuenberger, Ph.D., Professor of the Institute of Ecopreneurship of University of Applied Sciences and Arts (Switzerland)

Prof. Edward Pospiech, Dr. habil., Professor of the Institute of Meat Technology of Poznan University of Life Sciences (Poland)

Prof. Lali Elanidze, Ph.D., Professor of the Faculty of Agrarian Sciences of Iakob Gogebashvili Telavi State University (Georgia)

Dr. V. Kozhevnikova, Ph.D., Senior Lecturer of the Department of Hotel and Catering Business of Odessa National Academy of Food Technologies, Secretary of the Committee

The jury for the section «Information technologies, automation and robotics»

Head of the jury:

Sergii Kotlyk – Ph.D., Associate Professor, Director of the P.M. Platonov Educational-Scientific Institute of Computer Systems and Technologies “Industry 4.0” of Odessa National Academy of Food Technologies (Ukraine)

Members of the jury:

Piotr Artiemjew - Dr hab., Associate Professor in Decision Systems of the Faculty of Mathematics and Computer Science,University of Warmia and Mazury in Olsztyn (Poland)

Francisco Antonio Augusto – Dr., International Relations Manager of Higher Institute of Information and Communication Technologies (Angola)

Andrey Kuprijanov – Ph.D., Associate Professor of the Department of Software for Computers and Automated Systems of Belarusian National Technical University (Belarus)

Simon Milbert – Vice-President of Xtra Information Management, Inc. (USA)

Ivan Palov – D.Sc., Professor of University of Ruse “Angel Kanchev” (Bulgaria)

Degla Gérard Hugues – Communications and Training Manager of “MAPCOM solutions informatiques” company group (Benin)

Nugzar Kereselidze - Academic Doctor of Informatics (Computer Science), Associate Professor of the Department of Natural Sciences, Mathematics, Technology and Pharmacy, Sukhumi State University (Georgia)

Etibar Seyidzade - Associate Professor of the Department of Computer and Information Technolohies, Baku Engineering University (Azerbaijan)

Vladimir Golenkov, D.Sc., Professor of the Department of Intelligent Information Technologies, Belarusian State University of Informatics and Radio Electronics (Belarus)

Zhanar Omirbekova - Ph.D., Associate Professor of the Department of Automation and Management, Satbayev University (Kazakhstan)

Ivan Palov - D.Sc., Professor of the Department of Power Supply and Electrical Equipment, University of Ruse “Angel Kanchev” (Bulgaria)

Siarhei Palavenia - Ph.D., Associate Professor, Head of the Department of Telecommunication Systems, Belarusian State Academy of Communications (Belarus)

Alexander Goloskokov - Ph.D., Professor of the Department of Software Engineering and Information Technology Management, National Technical University “Kharkiv Polytechnic Institute” (Ukraine)

Peter Nikolyuk - D.Sc., Professor of the Department of Computer Technology, Vasyl Stus Donetsk National University (Ukraine)

Vladimir Palagin - D.Sc., Professor, Head of the Department of Radio Engineering, Telecommunications and Robotics Systems, Cherkasy State Technological University (Ukraine)

Viktor Khobin – D.Sc., Professor, Head of the Department of Technological Processes Automation and Robotic Systems of Odessa National Academy of Food Technologies (Ukraine)

Valeriy Plotnikov – D.Sc., Professor, Head of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

Sergii Artemenko – D.Sc., Professor, Head of the Department of Computer Engineering of Odessa National Academy of Food Technologies (Ukraine)

Fedir Trishyn - Ph.D., Associate Professor, Vice-Rector on Scientific and Educational Work, Odessa National Academy of Food Technologies (Ukraine)

Valerii Levinskyi – Ph.D., Associate Professor of the Department of Technological Processes Automation and Robotic Systems of Odessa National Academy of Food Technologies (Ukraine)

Viktor Yehorov – Ph.D., Supervisor of the Laboratory of Mechatronics and Robotics of Odessa National Academy of Food Technologies (Ukraine)

Pavlo Lomovtsev – Ph.D., Associate Professor of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

Yurii Kornienko – Ph.D., Associate Professor of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

Serhii Shestopalov – Ph.D., Associate Professor of the Department of Computer Engineering of Odessa National Academy of Food Technologies (Ukraine)

Anatoly Galiulin - Ph.D., Associate Professor, Acting Head of the Department of Electromechanics and Mechatronics, Odessa National Academy of Food Technologies (Ukraine)

Secretary of the jury:

Oksana Sokolova – Senior Lecturer of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

I believe that this complex is relevant for the majority of confectionery factories, and the complex is one of the best solutions that are presented in the Ukrainian and European markets.

Literature

1. Woodhead Publishing Series in Food Science, Technology and Nutrition
2. 2013, Pages 401-419.
3. Human + Machine: Reimagining work in the age of AI, by Paul R. Daughtery & H. James Wilson, Harvard Business Review Press, 2018, 249 p.
4. Robotics in meat, fish and poultry processing: edited by K. Khodabandehloo, Blackie, 1993. 214 p.
5. https://www.roboticstomorrow.com/article/2019/12/packaging-the-future/14515
6. https://www.robotics.org/userAssets/riaUploads/Robotic_Packaging_Automation_Considerations_09-28-06.pdf
7. https://www.tthk.ee/inlearcs/5-robot-cell-design-principles/

MODERN SSDS: A HIGH-TECH SOLUTION TO THE OBSOLETE HDD SYSTEMS

Author: ***Ekaterina Konstantinova***
Advisor: ***Tsvetoslav Tsankov***
Konstantin Preslavsky University of Shumen (Bulgaria)

Abstract. *Throughout the years, many innovations have been made to all computer components, except memory organization units. The transition from obsolete HDD systems to modern, ultra-fast SSDs has only been initiated in the last ten years. This paper researches basic similarities and differences between both configurations.*
Keywords: *Data transfer, Error-correcting code, Hard disk drive, High-speed interfaces, NAND, Solid state drive.*

I. INTRODUCTION

HDD hard drive technology is relatively old (in terms of computer history). Computer hard-drive format was standardized at 5.25 inches in the early 1980s, and shortly after that came 3.5-inch desktop and 2.5-inch laptop drives. Nowadays, 2.5-inch and 3.5-inch devices use mostly SATA interfaces. Capacity has grown from a few megabytes to a few terabytes, an increase of a million times.

SSD has a much shorter history. From the invention of personal computers, there was a need for non-mechanical hard drives. Current flash memory is a logical extension of the idea, as it does not require constant power to store the data. The first SSDs were introduced during the rise of netbooks in the late 2000s. With the mass implementation of laptops, the capacity of SSDs has increased and standardized to the 2.5-inch form factor. Other form factors have emerged, such as the M.2 SSD in SATA, PCIe options, and DIMM-like SS Flash Storage in the Apple MacBook Air and MacBook Pro. The commercial 2.5-inch SSD capacity currently reaches 4 *TB*.

II. HDD

HDD (Hard Disk Drive) – the traditional rotating hard disk drive is non-volatile computer memory. The information is stored on plates covered with magnetic layers. The storage device uses one or more disk plates (disks) around a common axis in the so-called disk package. Each metal plate is comprised of many concentric circles called tracks, which are divided into logical units called sectors, each of which has a unique address (Fig.1).

Main parameters:

- Capacity has always been the main thing to consider. For desktop systems, it varies from 500 *GB* to 10 *TB*. Currently, the most popular hard drives have a capacity of 1 *TB*.
- The shape factor is determined by the size of the rotating plates and defines the size of the whole device. Notebooks typically use 2.5-inch smaller hard drives, desktops – 3.5-inch ones.
- The speed of rotation (*rpm*) of the spindle usually varies from 5400 *rpm* – for 2.5-inch hard drives to 7200 *rpm* – for 3.5-inch ones.

Fig. 1. Generic Hard Disk Drive 160GB SATA 3.5"

It is mechanical, which means that the information on it does not 'disappear' when turning off the system. HDDs are the slowest type of storage devices in modern computers. In an age of fast processors and large memory sizes, a hard drive is often an obstacle to high-performing systems.

III. SSD

An SSD (Solid State Drive) does everything that a hard drive does, but the data is stored on interconnected flash memory chips. They do not contain moving mechanical parts, thus eliminating the reading delay and significantly increasing the operating speeds, preserving the data even when there is no power supply. Although they can replace traditional 2.5-inch or 3.5-inch hard drive slots, they can be installed in a PCIe slot or even mounted directly on the motherboard, a commonly used configuration in high-class laptops.

The key components of every SSD are the controller and the storage memory. The main element of the memory is the DRAM, mostly replaced by the improved NAND memory.

3.1. Controller

Each SSD includes a controller that manages the electronics connecting the NAND memory components to the host computer. The controller is a built-in microprocessor that executes code at the Firmware level, making it one of the most significant disk performance factors. Some of the functions are:

— Error-correcting code (ECC).
— Marking bad sectors.
— Cache memory.
— Garbage collection.
— Encryption.

The SSD performance is proportional to the used number of parallel NAND chips in the device. The single NAND chip is relatively slow due to the narrow (8/16 *bit*) asynchronous I/O interface, and additional high latency in basic I/O operations. When multiple NAND devices run in parallel on a single disk, the frequency is scaled, and high latency can be hidden as long as there are enough pending operations and the load is evenly distributed between the different devices.

3.2. Memory

3.2.1. Based on flash memory

Most static drive manufacturers use non-volatile NAND flash memory because of its lower cost compared to dynamic and its ability to store its data even without a constant power source.

3.2.2. Based on dynamic memory

Static drives based on variable memory such as DRAM are characterized by ultra-fast data access, most often below 10 μs, which are used to accelerate applications that would otherwise suffer from the latency of flash-based static or traditional hard drives. Dynamic memory-based SSDs typically include either an internal battery or an external AC/DC adapter and archive storage systems to ensure data security from external sources. If the power goes out, the battery will provide it while all the information is copied with random access to backup storage. When power is restored, the information is copied back to RAM from the backup, and the solid-state drive resumes operation (similar to hibernation in modern operating systems) [3], [7].

3.3. Advantages of using an over an HDD

The advantages of using an SSD instead of an HDD outweigh the disadvantages, explaining the rapid implementation of this technology.

— SSDs provide much faster reading and writing data speeds than hard drives. As a result, the operating system installed on the SSD loads in seconds, and searching for files takes less time.

- They are more economical and more compact. This advantage makes it preferred by laptop manufacturers.
- It allows a wide range of used interfaces for connection.
- A lack of data 'fragmentation', typical of hard drives.
- They are more resistant to vibrations and other mechanical disturbances.

3.4. Disadvantages of SSD technology:

- SSDs have a limited number of overwrite cycles. That is the reason why they are not preferred for storing multimedia – movies, videos, music, etc.
- The cost of SSD modules is significantly higher than the price of hard drives per unit of memory.

IV. Types of SSDs

4.1. Form factors

Solid-state drives (SSDs) are commonly used in client, hyper-scale, and enterprise compute environments. The most popular ones are NVMe, SAS, and SATA. Since SSDs are made from flash memory, they can be built in many different form factors (Fig. 2).

EDSFF – a form-factor used in data centers. It is based on Intel's former Ruler SSD standard.

M.2/mSATA – the mSATA form factor uses the physical parameters of the PCI Express Mini Card. It is electrically compatible with its interface specification while requiring an additional connection to a SATA host controller via the same connector.

The M.2 form factor, formerly known as the Next Generation Form Factor (NGFF), is a natural transition from mSATA, using its physical layout, becoming a more advanced form factor. When created, mSATA started operating a similar form factor and connector, and M.2 was designed to maximize the use of space. The M.2 standard allows both SATA and PCIe SSDs to be mounted on M.2 modules.

2.5-inch (U.2) – formerly known as SFF-8639, is an interface standard for connecting SSDs to a computer. It manages the physical connector, electrical characteristics, and communication protocols. It can be used with PCI Express drives along with SAS and SATA drives. It uses up to four PCIe lanes and two SATA lanes.

Add-in Cards – add-on cards, similar to graphics and sound cards. They only work with desktops with additional PCIe 3.0 x4, x8, or x16 slot. However, because they are larger than other form factors, they have room for more chips and better cooling, making them the fastest drives on the market.

Fig. 2. Most common types of commercial SSDs

4.2. Interfaces

4.2.1. SATA/mSATA SSDs

SATA (or S-ATA) stands for Serial Advanced Technology Attachment and is the most regularly used interface for data transfer between hard drives and storage devices. Almost all SATA SSDs have a 2.5-inch format (approx. 10×7×0.7 *cm*), which is practical because it matches the size of notebook hard drives [1], [5].

The smaller version of the SATA SSD is mSATA, short for mini-SATA. Performance-wise, mSATA drives also deliver a maximum throughput of 6 *Gbps*. The only difference is in size and the associated application areas: mSATA SSDs are about eight times smaller than 2.5-inch SATA drives. Due to the identical interface specification, SATA ports can be converted to mSATA ports via a simple adapter.

4.2.2. SAS

A SAS SSD (Serial-Attached SCSI solid-state drive) is a NAND flash-based storage or caching device meant to fit in the same slot as an HDD, using the SAS interface to connect to the host computer.

The most common drive form factors for a SAS SSD are 2.5-inch and 3.5-inch. SAS SSD bandwidth options include 3 *Gbps*, 6 *Gbps*, and 12 *Gbps*.

SAS SSDs are primarily used in enterprise servers and storage arrays with application workloads requiring high availability (HA), high input/output (I/O), and low latency. Use cases for SAS SSDs include server virtualization, online transaction processing, high-performance computing, and data analytics.

Drive manufacturers sometimes offer SAS SSDs with different write endurance options. A high-capacity SAS SSD intended for read-intensive workloads might guarantee only one drive write per day (DWPD), while a lower-capacity SAS SSD intended for write-intensive workloads might support up to 25 DWPDs.

4.2.3. NVMe

Non-Volatile Memory Express (NVMe) is a communications interface and driver that defines a command set and feature set for PCIe-based SSDs with the goals of efficient performance and interoperability on a broad range of devices.

NVMe was designed for SSD. It communicates between the storage interface and the CPU using high-speed PCIe sockets, independent of the storage form factor. Input/Output tasks performed using NVMe drivers begin faster, transfer more data, and finish faster than older storage models. Because it was designed specifically for SSDs, NVMe is becoming the standard for both servers in the data center and client devices like laptops, desktop PCs, and gaming consoles.

NVMe technology comes in many form factors such as the PCIe card slot, M.2, and U.2. While there are SSDs that use the SATA, PCIe slot, and M.2, U.2 is a form factor that exclusively uses the NVMe protocol (Fig. 3 & 4).

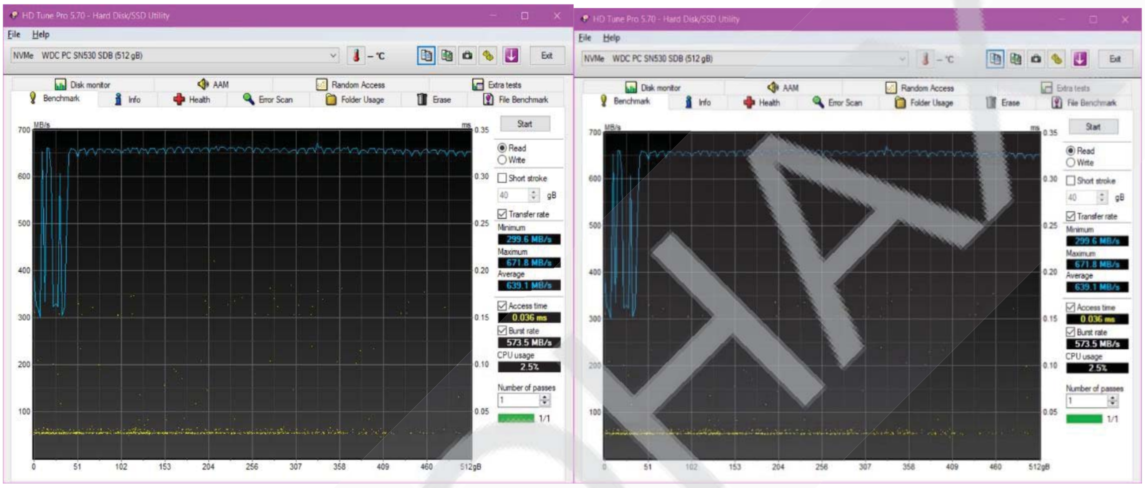

Fig. 3. Benchmark on a NVMe WDC PC SN530 SDB (512 Gb)

4.2.4. PCIe

Peripheral Component Interconnect Express (PCIe) is a standard type of connection for internal devices in a computer [2], [4].

Because of SATA 3.0 *600MB/s* ceiling, PCIe is starting to supersede SATA as the latest high-bandwidth interface. A PCIe connection consists of one or more data-transmission lanes connected serially. Each lane consists of two pairs of wires, one for receiving and one for transmitting. There can be one, four, eight, or sixteen lanes in a single PCIe slot, denoted as x1, x4, x8, or x16 (Fig. 5).

PCIe technology enables interface speeds of up to 1 *GB/s* per client lane (PCIe 3.0), versus SATA technology speeds of up to 0.6 *GB/s*. More lanes from SATA require more SATA devices, but PCIe bandwidth can be scaled up to 16 lanes on a single device.

While computers may contain various types of expansion slots, PCIe is considered the standard internal interface. Many computer motherboards today are manufactured only with PCIe slots [1], [6].

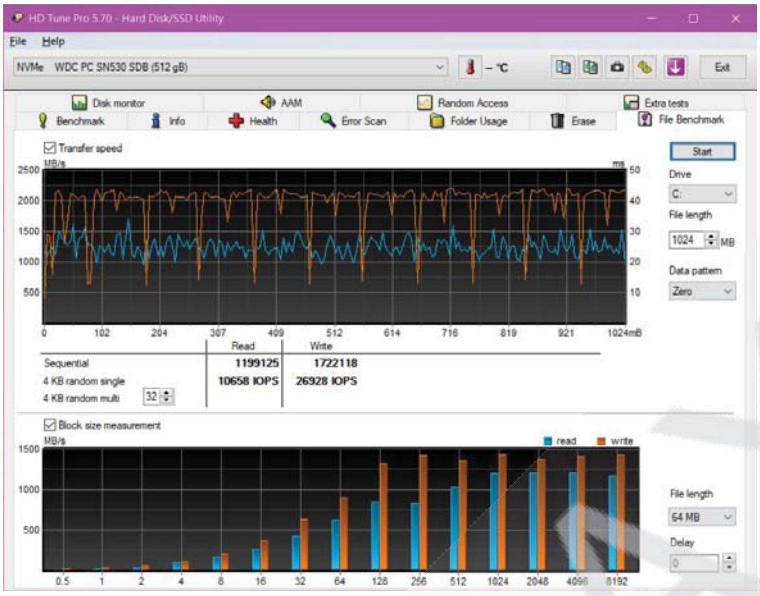

Fig. 4. File benchmark on a NVMe WDC PC SN530 SDB (512 Gb)

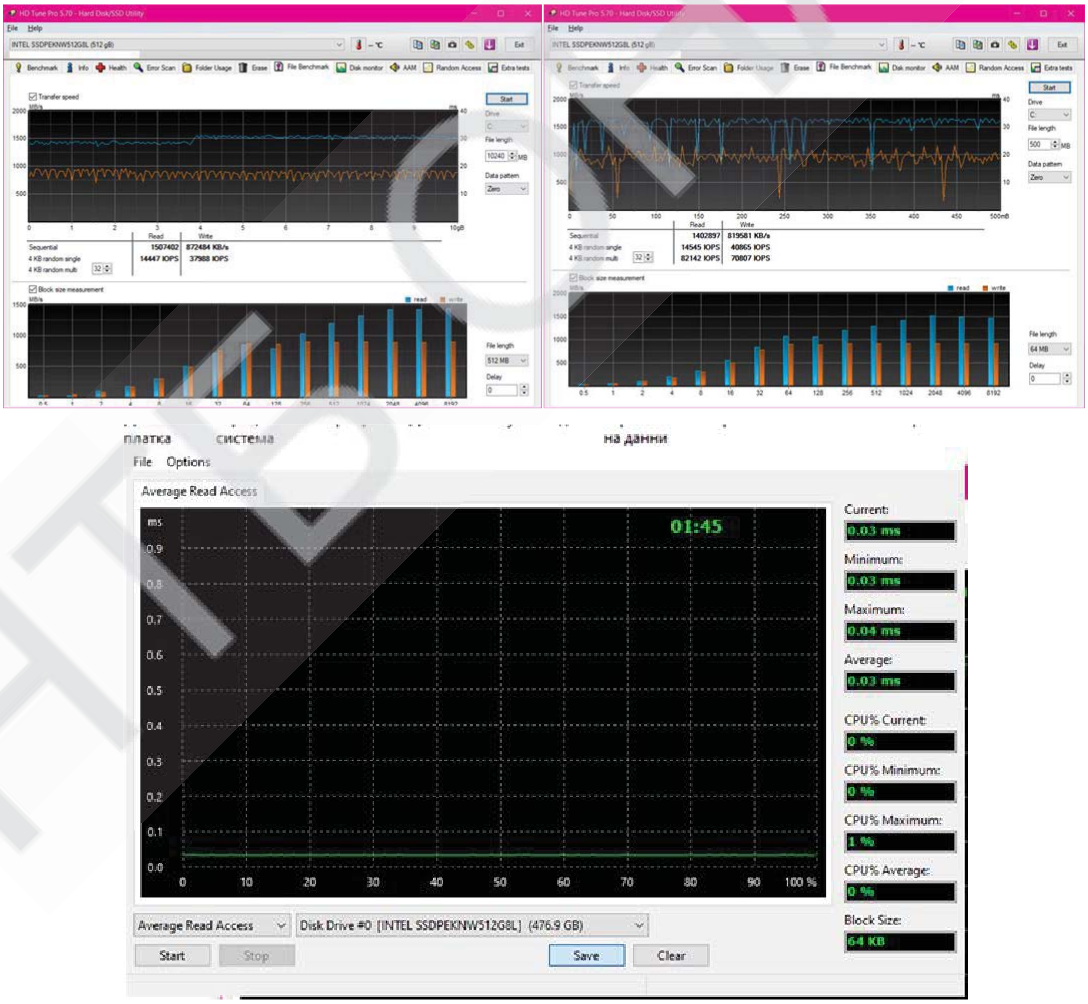

Fig. 5. Tests performed on Intel SSD PEKNW512G8L

V. Conclusion

Given the advantages we have highlighted in favor of SSDs, in mid-range and high-end configurations, the presence of SSDs today is a must. It is unclear whether the SSD will completely replace traditional HDD, especially in increasingly accessible cloud space. SSDs are falling in price, but they are still too expensive to completely replace terabytes with data that some users have.

VI. References

1. Trifonov T. Performance analysis of a mobile computer equipped with solid state disk. Annual of Konstantin Preslavski University of Shumen, 2014, ISSN 1311-834X, S. 27-42.

2. Vasilev V., Yankova-Yordanova Y. Gradation from HDD to SSD. Scientific conference MATTEH 2016, Shumen., 2016, ISSN 1314-3921.

3. HD Tune Pro manual version 5.70, EFD Software, 2017.

4. https://www.harddrivebenchmark.net/

5. https://pcguide.bg/hdd-ili-ssd-predimstva-i-nedostatuci/?fbclid=IwAR2_WLfZw7yPA0UKG856TUFZvEFbKNpJ-y3C1iBk7Atd-kYpzIzZq3RNyKA

6. https://tehnologichno.bg/article/hdd-ili-ssd-diskovo-prostranstvo?fbclid=IwAR3SMlGHo-t-IQOIOzDt3Op0EJzZcYx65WZvr8KRZKgxzjT-MALHOJNom30

7. https://www.techradar.com/news/best-solid-state-drives-ssds?fbclid=IwAR2_WLfZw7yPA0UKG856TUFZvEFbKNpJ-y3C1iBk7Atd-kYpzIzZq3RNyKA

COMPLEX SYSTEM OF AI INTERACTIONS IN SOCIAL SIMULATION OF A CITY INFRASTRUCTURE

Author: ***Ildar Sabirov***

Supervisor: ***Olga Olshevska***

Odessa National Academy of Food Technologies (Ukraine)

Abstract. *Goal of this project is the research and development of an artificial intelligence for city infrastructure and social interactions in simulator game for deeper immersion and analysis of mental states of players. It composes of complex interactions of mental states, personality traits, fields of activity of characters and events in which the characters may be involved. This system will bring the activity of AI closer to human. This opens up many possibilities for using this system, namely:*

1. For a deeper immersion and flow in the game world;

2. To analyze human actions in certain situations;

3. To analyze the mental state of the player during the game through his choices.

Keywords: *Artificial Intelligence, personality, social engineering, social interaction, mental state, psychology*

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2021

Information Technology, Automation and Robotics

Proceedings

Odessa National Academy of Food Technologies

The collection includes student works of the participants of the competition, which were not included in the number of prize-winners. The texts of the competitive works are published in the form in which they were submitted by the authors. The authors of the articles are responsible for the content and form of submission of the material.

Responsible for the issue: Sergii Kotlyk

Computer typesetting and layout: Oksana Sokolova

Odessa 2021