These examples indicate that even for numbers with a seemingly simple initial condition- positive integers – the Collatz's conjecture can generate long and complex sequences. This makes it a fascinating object of study for mathematicians all over the world, who are trying to solve this riddle and find an analytical proof of its correctness or incorrectness.

Conclusion. Collatz's conjecture is one of the most interesting and unsolved problems in the world of mathematics. Although the simplicity of its formulation may seem surprising, it remains open to many different aspects of research. The use of computer algorithms made it possible to conduct a large number of empirical tests, which, however, did not find any contradiction to the hypothesis.

Despite this, the lack of a formal analytical proof leaves Collatz's hypothesis an open problem that continues to stimulate researchers in their efforts to unravel it. This mysterious hypothesis continues to attract the attention of mathematicians around the world, and solving this problem could bring new discoveries in the field of number theory and computational mathematics. Thus, Collatz's hypothesis remains an interesting object of research and a potential starting point for further mathematical discoveries.

REFERENCES

1. O'Connor, J.J.; Robertson, E.F. (2006). «Lothar Collatz». St Andrews University School of Mathematics and Statistics, Scotland.
2. Lagarias, J. The $3x + 1$ problem and its generalizations. *American Mathematical Monthly*. 1985. Vol. 92. P. 3-23.

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THE TRANSFORMATIVE POWER OF 5G TECHNOLOGIES IN TELECOMMUNICATIONS AND WIRELESS COMPUTER NETWORKS

Definition of 5G

5G is a fifth-generation mobile network standard based on the 5G/IMT-2020 standards for radio interfaces in telecommunications, the successor to the 4G network [1]. In cellular network technology, the service area is divided into small geographical areas – cells or honeycombs. All 5G wireless devices in a cell are connected to the Internet and mobile communications via radio waves, through

a local antenna. The main advantage of the new network is that it has a higher bandwidth, thus providing faster download speeds, with plans to increase the speed to 10 Gbps over time.

Due to the increased bandwidth, the new network is expected to serve not only mobile phones, but also to be used as the main Internet service provider for laptops and desktop computers, thus replacing existing Internet providers, and enabling new scenarios for IoT (Internet of things) and M2M (Machine-to-Machine) [2].

ITU-R (International Telecommunication Union) has identified three main application areas for advanced 5G capabilities. These are enhanced mobile broadband (eMBB), ultra-reliable low latency communications (URLLC), and machine-to-machine communications (mMTC). In 2020, only eMBB was deployed, while URLLC and mMTC will take several years to be implemented [3].

Enhanced mobile broadband (eMBB) uses 5G as a transition from 4G LTE mobile broadband services, with faster connections, higher bandwidth, and more capacity.

Ultra-reliable, low-latency communications (URLLC) refers to network use cases for mission-critical applications that require uninterrupted and reliable data exchange.

Massive machine-to-machine communications (mMTC) is used to connect a large number of devices, and 5G technology will connect some of the 50 billion active IoT devices [4]. Most will use less expensive Wi-Fi technology. Drones transmitting data via 4G or 5G will help in disaster relief by providing real-time data for emergency situations. Most cars will have 4G or 5G cellular connectivity for many services. Autonomous cars do not need 5G, as they should be able to operate where there is no network connection.

Standards for 5G

3GPP (the 3rd Generation Partnership Project) is a consortium of seven telecommunications standards development organizations whose main task is to create reports and specifications that define cellular telecommunications technologies, core networks and service capabilities that provide a complete description of the system for mobile telecommunications. 3GPP sets standards for 5G and defines any system that uses 5G NR (5G New Radio) software as "5G" [3].

Minimum standards are set by the ITU (International Telecommunication Union). The IMT-2020 document states that the term 5G is reserved for systems that provide download speeds of 20 GB/s.

Introduced in December 2017, the 5G New Radio (NR) laid the foundation for ultra-high download speeds, reliable low-latency connections, and connectivity for up to 1 billion new IoT devices. With its scalability, flexible waveforms, and new spectrum, 5G NR provides a solid foundation for the many different challenges envisioned by 5G.

Standalone network architecture (SA)

The first mode of network deployment is called standalone. SA means an independent 5G network. It will have both the 5G New Radio (NR) and 5G Core (5GC) standalone 5G radio interfaces. The network provides the user with full 5G capabilities. The SA network will still interoperate with the existing 4G/LTE network to ensure continuity of service between the two network generations. As shown in Figure 1.1, the 5G network can operate independently of the LTE network. At the same time, it interoperates with this network in order to cover areas not yet covered by 5G and to connect 5G users with users using 5G. Non-standard network architecture (NSA). A non-standard 5G network implies the presence of only 5G NR cells with EPCs as the core, the structure is shown in Figure 1.2. Operators will deploy 5G cells and be fully dependent on the existing LTE network for all management functions and additional services. The 5G NSA architecture operates in a master-slave structure, where the 4G access node is the master and the 5G access node is the slave [3].

Comparison of 5G and 4G technologies

Peak data transfer rate: Reaching a peak data rate of 1 gigabit per second (Gbps), 4G satisfies the requirements of most modern applications. However, LTE will not be enough to support the growing number of wireless devices being brought online every day due to the growth of the Internet of Things (IoT) and the number of applications requiring high real-time data throughput. With peak data rates of up to 20 Gbps, 5G will be able to handle these new applications without using a lot of power.

User data rate: The ultimate data rate a user receives on a 4G network can be as low as 10 Megabits per second (Mbps), which can be sufficient for most modern applications. But as IoT and mobile devices expand, higher bandwidth will be required. 5G can meet this requirement with ultimate speeds of up to 100 Mbps.

Spectral efficiency: If your goal is to optimize your system, you need to make the most of the resources at your disposal. 5G cells will be able to use the available spectrum three times more efficiently than 4G cells.

Mobility: Today, 4G can support mobile devices at speeds of up to 350 kilometers per hour (km/h). As technology advances and high-speed trains become more common, 5G has the potential to break the speed barrier by supporting mobile devices traveling at speeds up to 500 km/h.

Delay: Autonomous vehicles and vehicle-to-vehicle (V2V) communications within a dedicated vehicular ad hoc network (VANET) are still several years away from commercialization, even though many of the underlying technologies are well developed and tested. One of its main components is data latency. The latency for a VANET should be less than 100 milliseconds. Today, latency in 4G cells is up to 100 milliseconds for the control plane and 10 milliseconds for the data plane. Taken together, this is too slow to support VANETs, as any small delay in V2V communication can lead to a traffic incident or worse. 5G solves the latency problem by reducing control plane latency by 50% and data plane latency by 90%, which is 50 milliseconds and 1 millisecond, respectively.

Connection density: As the IoT market continues to grow, many more devices will be connected within a single cell. 5G can connect to 1 billion more devices per square kilometer than 4G, which supports no more than 100,000 devices per square kilometer [6].

Energy efficiency of the network: The 5G network will be 100 times more energy efficient than 4G. Thus, even with an increase in the number of wireless devices, the energy required for their consumption will decrease. This means that the carbon footprint of wireless communication networks around the world will also decrease, or at least not increase in proportion to the number of devices.

Cellular bandwidth: 5G will have the ability to manage the increase in network capacity. This is because the expected throughput, which is defined as the end-user data rate measured in megabits per second per square meter, for 5G networks will be 100 times higher than that of existing 4G networks.

REFERENCES

1. Forum, CLX "1 million IoT devices per square km – are we ready for the 5G transformation?" July 12, 2019. 309 c.
2. Hoffman, Chris "What is 5G, and how fast will it be?" January 7, 2019. 18 c.
3. Horwitz, Jeremy "The Ultimate Guide to 5G Low, Medium, and High Speed Bands" // VentureBeat Online Magazine. December 10, 2019. 1008 p.
4. ITU towards "IMT for 2020 and beyond" // M.2083: IMT Vision – "Framework and overall objectives of the future development of IMT for 2020 and beyond." // Approved in 2015-09 International Telecommunication Union.//Recommendation M.2083-0 – Updated:

2015-10-12.21 p. URL: https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2410-2017-PDF-E.pdf (accessed 05/15/2020).
5. Looper, Christian "What is 5G? The next generation network explained." // Digital Trends. March 27, 2020. 103 p.
6. Rappaport, TS; Sun, Shu; Maizus, R; Zhao, Hang; Azar, Y; Wang, K; Wong, GN; Schultz, JK; Samimi, M. "Millimeter wave mobile communications for 5G cellular: It will work!". IEEE Access. 1: 335-349. doi: 10.1109/ACCESS.2013.2260813 . ISSN 2169-3536. January 1, 2013.
7. Segan, Sasha "What is 5G?". PC Magazine online. Ziff-Davis. December 14, 2018.
8. Shatrughan Singh "Eight reasons why 5G is better than 4G". Altran. May 25, 2019. 305 p.

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DEVELOPMENT OF A WEB APPLICATION TO MONITOR AND SUPPORT THE ACTIVITIES OF VOLUNTEER ORGANISATIONS AND FOUNDATIONS

Supporting the activities of volunteer organizations and foundations is an urgent task in the modern world, and especially in Ukraine, where the importance of volunteering and charity is constantly growing due to the military operations [1]. Volunteer organizations play an important role in promoting social and civic initiatives, but they face challenges in planning and coordinating their activities. There are a number of solutions and approaches available to support the activities of volunteer organizations and foundations, with their advantages and disadvantages, but there is a need for new and better products [2].

There are several solutions and approaches supporting the activities of volunteer organizations and foundations that exist today. The main solutions and approaches include the use of email and social media, individual platforms (websites for managing their activities, e.g. volunteermatch.org, idealist.org) and specialized systems (software developed specifically for volunteering, e.g. Better Impact, VolunteerMark). Existing solutions do not always meet all the needs of organizations and users; some of them are not sufficiently integrated, limited in functionality, low in availability and difficult to use [2, 5].

In order to develop an application to support volunteering, we should think about their control, so while researching ways to verify the existence of organizations and the veracity of the information they disseminate about themselves, the following evaluation criteria were identified: the code of the Unified State Register of