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B.E. Khamzina[1*], A.S. Kudussov[2], Zh.Sh. Kuralbayeva[3]

[1]*S. Seifullin Kazakh Agro Technical University, Nur-Sultan, Kazakhstan*
[2]*Karagandy University of the name of academician E.A. Buketov, Kazakhstan*
[3]*Communal State Institution Gymnasium-School № 31, Nur-Sultan, Kazakhstan*
(E-mail: be_khamzina@mail.ru)*

Modeling in CupCarbon

Modeling is one of the key categories of modern cognitive theory and design-engineering practice. Simulation and visualization of real physical processes and phenomena are important technological tools and simulation results. The article presents a comparative review and analysis of existing emulators, such as Cisco Packet Tracer and UNetLab, as well as the rationale for choosing CupCarbon as a platform for modeling, in particular, wireless networks for the Internet of Things. The functional potential of today's most common emulators like Cisco Packet Tracer and UNetLab are significant. Cisco Packet Tracer is a powerful software emulator, which gives the possibility to users to simulate networks, organizing them with the almost unlimited number of devices, using the equipment and adjusting it for the specific tasks of this or that environment. The program gives the opportunity to develop the quality of decision-making speed, creativity and critical thinking, configuration and troubleshooting networks with the use of virtual equipment and simulated connection. Despite the great advantages of this software emulator, it has several disadvantages, which make it incorrect for modeling IoT networks, such as the lack of simulation in a 2D/3D environment and adding urban and natural noise, not a complete emulation of IOS, almost everything that goes beyond the CCNA, it also cannot be built on it, the possible manifestation of a variety of bugs that are treated only by restarting the program.

Keywords: education, simulation, Internet of things, emulator, wireless network, sensor, Arduino, software, configuration, equipment.

Introduction

In today's learning environment, computer modeling technologies are actively used to convey instructional material. Modern educational computer information tools have taken an important place in the process of education and training of specialists. Their effective use in the educational process allows one to simulate and visualize many natural and physical processes, reduce training time, individualize training, etc. Constant modernization of computer and information technology and the education system through the introduction of training systems with simulation technology and virtualization helps students to link theory with practice and understand real processes and phenomena. Therefore, in the modern world, the use of technology in the education system increases the effectiveness of learning, in particular through simulation tools.

Today, the development of information collection and processing systems is rapid. The number of devices equipped with sensors to exchange information with processing centers and with each other is growing. Access to the Internet is becoming more and more affordable, the cost of connecting devices is decreasing, and the cost of technology is becoming cost-effective. Therefore, in present times, the Internet of Things (IoT), as a concept of computing network of physical objects ("things") equipped with embedded technologies to interact with each other or with the external environment, consider the organization of such networks to solve production and educational problems [1]. For example, in modern cars several networks operate at once: one controls the operation of the engine, another — security systems, the third maintains communication, etc. Office and residential buildings also install multiple networks to control heating, ventilation, air conditioning, telephone communications, security, and lighting. As the IoT evolves, many networks will connect to each other and acquire more and more security, analytics, and control capabilities. Analysis of IoT technology [1] revealed the specifics of information interaction in IoT networks and the impossibility of applying models and algorithms of traditional computer networks to IoT networks.

Experimental

During the study various methods: analysis, comparison, simulation, etc., are used. In our study, special attention is paid to simulation as a key one in engineering education, where simulation and visualization of real physical processes and phenomena are important technological tools. The result of simulation provides an opportunity to study any new project before its real installation. Let us consider the effectiveness of simulation in telecommunications as an example.

The widespread creation of computer networks to provide users with remote access to network resources causes a dramatic development of network modeling with the help of software emulators. Virtually all companies with more than one computer combine them into local networks, so that it works smoothly, is reliable, better processes the information circulating between employees of the company, and allows them to make meaningful and optimal decisions. To do this, network equipment, such as different routers, switches of different levels, is developed. Therefore there is a need to use software network equipment emulators to create and administer network models.

Let us look at the functionality of the most popular emulators today, such as Cisco Packet Tracer and UNetLab. Cisco Packet Tracer is a powerful software emulator, which allows users to simulate networks, organizing them with an almost unlimited number of devices, to find the use of equipment and to adjust it to the specific tasks of this or that environment. The program gives the opportunity to develop the quality of decision-making speed, creativity and critical thinking, configuration and troubleshooting networks with the use of virtual equipment and simulated connection.

In the educational process, with the help of this software product, teachers and students can invent, build, configure networks and perform troubleshooting in them, as it gives an opportunity to present the latest technology in more detail, thereby making the educational process useful in terms of material assimilation.

Thus, the analysis of the functionality of the emulator Cisco Packet Tracer, as a platform for modeling networks, showed that this emulator has a number of drawbacks, such as the lack of simulation in 2D/3D environment and adding urban and natural interference; not a complete emulation of IOS; almost everything that goes beyond the CCNA, it also cannot be built on it, the possible manifestations of a variety of glitches that are treated only by restarting the program [3]. All this makes it not applicable for IoT.

Consider the software emulator UNenLab (Unified Networking Lab, UNL) — a multi-user platform for creating and simulating a variety of labs and designs, allowing to simulate a virtual network of routers, switches, security devices, etc. Using and analysis of this emulator revealed significant advantages in its possible use: completely free, almost full-fledged L2 support, extensive support for Cisco equipment, the number of running nodes is unlimited, multi-user functionality, low requirements for PC resources, etc.

For educational purposes, this platform will be suitable both for beginners to prepare for CCNA/CCNP, and for professionals to prepare for CCIE Routing and Switching, CCIE Security, CCIE Service Provides, CCIE Data Centers, etc., as well as for other various engineering and educational tasks [2].

Unlike the previous IOU-WEB emulator, UNetLAB implements a fully graphical topology design interface like GNS, i.e., no need to write a netmap command for each topology. Today UNetLab remains the best tool both for CCNP/CCIE preparation and for simulation of various engineering tasks. Nevertheless, there is a number of its significant drawbacks, such as time-consuming installation process; lack of simulation visualization process; lack of possibility to use it on real terrain maps; lack of compatibility with the previous program project; lack of adding city and natural interference to the simulation process.

The functional and comparative analysis of Cisco Packet Tracer and UnetLab emulators revealed that these emulators do not meet the requirements for modeling networks for IoT, as they do not visualize the modeling process, have no ability to use on real maps and add urban and natural interference.

Let us explore their alternative platform CupCarbon-Lab, based on the existing CupCarbon simulator, designed to design and simulate wireless sensor networks for Smart-city and IoT applications. It will allow the verification of distributed algorithms in a 2D/3D environment, taking into account the urban buildings where networks will be deployed, cell phones, using accurate models of radio wave propagation and interference in that environment. The platform can automatically generate a real IoT network from the soft-

ware, even if it is already deployed, reconfigure without having to go through each node, and help test the feasibility and scalability of the algorithm in a real environment [3].

It is a versatile system and simulator for a wireless sensor network of discrete events. Networks can be constructed and designed in an ergonomic user-friendly interface using OpenStreetMap by deploying sensors directly on the map.

The main objectives of CupCarbon are also educational, i.e., to help trainers and teachers to explain basic IoT concepts, the operation of sensor networks, check wireless topologies, protocols, learn the behavior of the network and its elements, e.g., to study the power circuitry of each sensor and the whole network, calculate power circuits and display as a function of simulated time.

Designing networks on this versatile system and discrete event wireless sensor network simulator is more realistic than the above-reviewed emulators like Cisco Packet Tracer and UnetLab. They are mainly used to develop new routing protocols, but in the context of smart cities and IoT, their radio channel and interference models are simple and do not take into account the real urban environment, and they do not integrate visualization to easily test the developed algorithm.

The main contribution of using CupCarbon for network design is to keep a short simulation time considering 3D, an accurately modeled radio channel with environmental impact obstacles and a realistic interference assessment. The platform has been designed with the following goals: to study wireless sensor network deployments with respect to mobility and spectrum availability; to simulate wireless sensor network performance and services in a 2D/3D realistic environment; to study connectivity, network reliability and cost; to detect any interference zones to improve deployment quality; to accurately and quickly simulate radio signal propagation in real urban environments.

Since more than 50 % of the population is predicted to live in cities in the near future, the number of connected devices will increase significantly, leading to the use of a large number of wireless communication devices. Therefore, our environment will be saturated in terms of communication signals and spectrum. This can be a limitation for any future WSN installation. This is why any new project needs to be thoroughly investigated before it is actually installed. This requires the use of simulators to study the impact, in terms of wireless signal congestion and safety, for any new installation before it is actually deployed.

As an experiment to simulate the network in the CupCarbon software emulator an urban area with possible radio interference and constructions, possibly blocking the signal transmission, was chosen. The simulation of networks was performed for a residential complex (Residential Complex) Zhagalau in Nur-Sultan city. This housing estate is serviced by “Arman” communal cooperative, whose responsibilities include engineering works such as maintenance of heating system, water supply units, technical units, electrical equipment and maintenance of the adjacent territory. In its activity the “Arman” maintenance organization faces some problems, such as irrational electricity consumption, frequent flooding of basements and untimely watering of yard plants.

To solve educational and engineering problems, based on knowledge of the modern development of the IoT concept, the task was to simulate on the CupCarbon emulator a wireless sensor network (for one house LCD) of three sensors and one receiver on the Arduino platform and evaluate its operation for our chosen object. It was decided to install motion sensors to regulate the lighting of the entrance hall in to rationalize the consumption of electricity. For the detection and timely elimination of flooding in the basement of the house, it was planned to install water leakage sensors, and for the timely watering of yard plantings — soil moisture sensors. Sensors were chosen from WavGat, inexpensive and with optimal characteristics. As a receiver of signals from sensors, a module with signal reception of up to four sensors was chosen.

To create a network model in the simulator, a new project is created, where we add four sensor nodes, so that they are in the radius of their interaction (Figure 1).

In the radio parameters, we assign a different number to each node, then add a script for the first and second sensor nodes as a receiver and save.

Figure 1. Sensory nodes

The next step is to apply the script to the sensor nodes and run the simulation of the simulated network. When the simulation ends, the End of Simulation message will pop up on the screen (Figure 2).

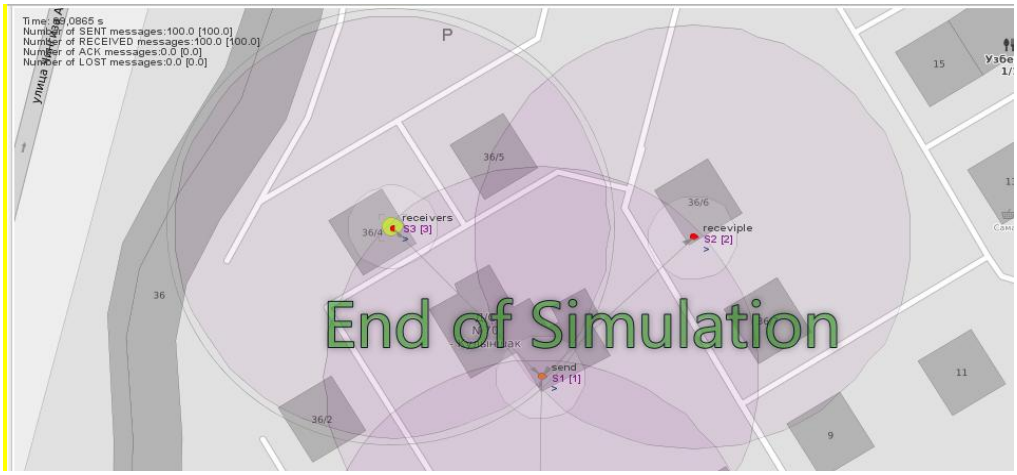

Figure 2. Simulation result

Results and Discussion

This network is simulated, i.e., the code is generated to program the wireless sensor nodes. The simulated network on the simulator visualizes the result obtained, confirms the feasibility of the project and its scalability in real conditions. Then, after the actual design of this network, the service company employee sees the information coming from these sensors on the computer screen. Based on the information about the case of water leaks in the basement of the apartment complex or changes in moisture levels in the soil near the yard plantings, necessary measures are taken in time, i.e. problems arising in Zhagalau housing estate are prevented in time.

Thus, the presented experience of using the platform confirms that CupCarbon can be used as a simulator of the Smart City wireless sensor network and the Internet of Things in order to design, visualize, debug and verify algorithms for monitoring, environmental data collection, etc. This platform also allows students in the classroom, or as part of educational and research projects, to create environmental scenarios like fires, gas, and simulate mobile devices like vehicles and flying objects (e.g. UAVs, insects, etc.).

Conclusions

CupCarbon clearly explains the basic concepts of sensor networks, how they work and test their wireless topologies, protocols, etc. This platform is useful for anyone to understand the basic concept of IoT, how sensor networks work, learn to construct and design a realistic network in an ergonomic user-friendly interface by deploying sensors directly on the map, and then implement it in reality. At the same time, CupCarbon is a powerful tool in today's educational process for understanding real events and learning about the world.

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Б.Е. Хамзина, А.С. Кудусов, Ж.Ш. Куралбаева

CupCarbon-да модельдеу

Модельдеу — қазіргі білім теориясы мен инженерлік тәжірибенің негізгі категорияларының бірі. Нақты физикалық процестер мен құбылыстарды модельдеу және визуализациялау маңызды технологиялық құралдар және модельдеу нәтижелері болып табылады. Мақалада Cisco Packet Tracer және UNetLab сияқты қолданыстағы эмуляторларға салыстырмалы шолу және талдау, сондай-ақ модельдеу платформасы ретінде CupCarbon таңдаудың негіздемесі, атап айтқанда Интернет заттары үшін сымсыз желілер ұсынылған. Бүгінгі таңда Cisco Packet Tracer және UNetLab сияқты ең көп таралған эмуляторлардың функционалдығы үлкен мәнге ие. Cisco Packet Tracer – пайдаланушыларға желілерді модельдеуге, оларды құрылғылардың іс жүзінде шексіз санымен ұйымдастыруға, жабдыққа арналған қосымшаларды табуға және оны белгілі бір ортаның нақты тапсырмалары үшін реттеуге мүмкіндік беретін қуатты бағдарламалық жасақтама эмуляторы. Бағдарлама шешім қабылдау жылдамдығының сапасын, креативті көзқарас пен сыни ойлауды дамытуға, виртуалды жабдықты және қосылысты имитациялай отырып, конфигурацияны реттеуге және желілердің ақауларын жоюға мүмкіндік береді. Бұл бағдарламалық эмулятордың осындай үлкен артықшылықтарына қарамастан, оның бірқатар кемшіліктері бар, бұл оны IoT желілерін модельдеу үшін дұрыс жұмыс істемейді, мысалы, 2D/3D ортада модельдеу және қалалық және табиғи кедергілерді қосу мүмкіндігінің болмауы; IOS-тың эмуляциясы толық емес; CCNA-дан асатын кез келген нәрсені жинау мүмкін емес, тек бағдарламаны қайта іске қосу арқылы өңделетін әртүрлі глюктардың мүмкін көріністері.

Кілт сөздер: білім беру, модельдеу, интернет заттары, эмулятор, сымсыз желі, сенсор, Arduino, бағдарламалық қамтамасыз ету, конфигурация, жабдық.

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Моделирование в CupCarbon

Моделирование является одним из ключевых категорий современной теории познания и проектно-инженерной практики. Имитация и визуализация реальных физических процессов и явлений являются важными технологическими инструментами и результатами моделирования. В статье представлен сравнительный обзор и анализ существующих эмуляторов, как Cisco Packet Tracer и UNetLab, а также обоснование выбора CupCarbon, как платформы для моделирования, в частности беспроводных сетей для интернет вещей. Функциональный потенциал самых распространенных сегодня эмуляторов, как Cisco Packet Tracer и UNetLab. Cisco Packet Tracer — это мощный программный эмулятор, дающий возможность пользователям моделировать сети, организовывая их с практически безграничным количеством устройств, находить применение оборудованию и налаживать его под определенные задачи той или иной среды. Программа дает возможность вырабатыванию качества скорости принятия решения, креативного подхода и критического мышления, настраивать конфигурацию и устранять неполадки сетей с применением виртуального оборудования и имитацией соединения. Несмотря на столь большие преимущества данного программного эмулятора, он обладает рядом недостатков, что делает

его применение некорректным для моделирования сетей IoT, например, отсутствие возможности моделирования в 2D/3D среде и добавления городских и естественных помех; не полная эмуляция IOS; практически всё, что выходит за рамки CCNA, на нем собрать тоже не получится, возможные проявления разнообразных «глюков», которые лечатся только перезапуском программы.

Ключевые слова: образование, моделирование, интернет вещей, эмулятор, беспроводная сеть, датчик, Arduino, програмное обеспечение, конфигурация, оборудование.

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