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SPECIALISTS TRAINING IN AREA OF NETWORKS IOT

The analysis of the state and prospects of development of Internet of things (IoT) networks is presented. The structure of IoT are considered. The protocols of interaction in IoT are given. Platforms for building of various IoT are presented. Prospects for the development of IoT automation design are given. Educational disciplines for specialization to improve the training of specialists in the field of IoT construction are presented.

Keywords: Internet of things networks, protocols, development platforms, design of IoT avtomatization, IoT training.

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ПОДГОТОВКА СПЕЦИАЛИСТОВ В ОБЛАСТИ СЕТЕЙ ИНТЕРНЕТА ВЕЩЕЙ

Дан краткий анализ состояния и перспектив развития сетей интернета вещей (СИВ). Представлены платформы для построения различных СИВ. Даны направления развития автоматизации проектирования СИВ. Представлены учебные дисциплины специализации для совершенствования подготовки специалистов в области построения СИВ.

Ключевые слова: сети интернета вещей (СИВ), протоколы, платформы разработки автоматизация проектирования СИВ, учебная подготовка.

SIV is a set of embedded systems, networks of wireless sensors, control systems, and automation tools. All this allows you to implement connected manufacturing, transport, energy, agriculture, medicine, smart stores, smart homes and cities, as well as wearable devices. If there are 5 to 6 billion users on the Internet serving people, then there are two orders of magnitude more management objects in the IB networks and this trend of difference in the number

will increase, the growth of IB objects (real and virtual) is projected to be several trillion by 2025-30 [1].

Structure of Internet of things networks. In the structure of the Internet of things (IoT) network, there are four levels: applications; support for applications and services; network and devices (sensor + handler) [1, 2].

The IOT application layer is not considered in detail in Recommendation Y. 2060. The application and service support layer includes capabilities for various IoT objects to process and store data, as well as capabilities required for certain IoT applications or groups of such applications. The network layer includes management functions: access and transport network resources (mobility management, authorization, authentication, and settlement functions – AAA) and transport functions (ensuring network connectivity for transmitting information of IOT applications and services). The device layer includes functions of network elements for collecting information, pre-processing it, and exchanging it through the gateway.

The device functions include direct exchange with the communication network, exchange via a gateway, exchange via a wireless dynamic ad-hoc network, and temporary shutdown and restart of the device to save power. The gateway functions support multiple interfaces for devices (CAN bus, ZigBee, Bluetooth, WiFi, etc.) and for access/transport networks (3G, LTE, DSL, etc.) [3].

There are also two vertical levels - the management level and the security level, covering all four horizontal levels. The capabilities of the vertical level of operational management include managing the consequences of failures, network capabilities, configuration, security, and billing data.

The main objects of control are devices, local networks and their topology, traffic and congestion on networks. The functions of the vertical security level depend on the horizontal level. The support level for applications and services includes AAA functions, antivirus protection, and data integrity tests. For the network layer, there are options for authorization, authentication, and information protection of signaling protocols. At the device level-authorization, authentication, access control, and data privacy.

Types of IoT networks. Low-power, low-range networks are suitable for home, office, and other small environments. Small batteries are sufficient for their use, and sometimes they can be configured without using a battery. The Zigbee Protocol is best suited for personal networks with small devices that consume little power, have low bandwidth, and are used in a closed range [3]. 4G LTE networks provide high power and low latency, and operate over long distances. This is a good option for building an Internet of things where you need to get real-time information or updates. LTE Cat-M1 networks are fully compatible with LTE networks [4]. They allow you to optimize the cost and power of second-generation LTE chips designed specifically for Internet of things applications. NB-IoT/Cat-M2 Uses extended spectrum serial busing (DSSS) modulation to send data directly to the server. This eliminates the need to use a gate-

way. Setting up NB-IoT networks is more expensive, but due to the lack of a gateway, their operation is accompanied by lower costs.

Internet of things platforms. They support Internet functions for applications-launch, maintenance, Analytics, data storage, and security measures. Let's consider the most famous of them [5].

AWS IoT Core is the Foundation on which any IoT application can be built.through AWS IoT Core, devices can connect to the Internet and to each other and exchange data. The platform supports various communication protocols, including custom ones, which allows communication between devices from different manufacturers. AWS IoT Device Management allows you to add and organize devices. It provides secure and scalable performance with the ability to monitor, troubleshoot, and update device functionality. The AWS IoT Analytics service is designed for automatic analysis of large volumes of various IoT data, including unstructured data from various types of devices. The data collected and processed by the service is ready for use in machine learning. AWS IoT Device Defender service that supports configuring security mechanisms for IoT systems. AWS IoT Device Defender allows you to configure and manage security policies, controlling device authentication and authorization, and providing encryption mechanisms.

The Google Cloud IoT platform includes a number of services that you can use to create IoT networks: Cloud IoT Core is a fully managed service for easy and secure connection, as well as managing and receiving data from various devices. Cloud Pub/Sub is a service that processes event data and provides real - time flow Analytics. Cloud Machine Learning Engine that allows you to create ML models and use data obtained from IoT devices.

Approaches to automation of IW network design [6]. For the next stage of IoT evolution: "things" are no longer considered as separate intelligent network products, but as elements of a network of systems ("System + Smart Product + systems interaction»). In the previous stage, there were two IOT product systems (vehicles and the cloud) that describe the situation according to their specifics, and it is natural that these two systems are much less connected to each other than the products inside each of them. It becomes necessary to take into account the results of working with data from one system when working with data in another, for example, the results of weather forecasts are taken into account in the management of agriculture, transport, etc. The stage of the evolution of the world of things is the mandatory inclusion of the "thing" in the contours of intersystem information exchange within its operating environment. In the market of CAD/CAM/ CAE/PDM automation systems, there is no full-fledged industrial CAD that would allow you to create such systems of things. We are not talking about the design of IoT components (sensors, sensors, local network, applications, means of displaying information coming from the network, etc.) – the more complex task of designing products in which such components are shared requires a solution.

Development of training in the field of Internet of things networks. In the next five-year plan (2021-2025), we should expect mass construction of IW networks for the Republic of Belarus in industry, agriculture, transport, energy, urban and rural infrastructure management, etc. The need for such specialists will increase dramatically. To improve the training of these specialists in the field of construction and operation of IW networks, it is necessary within the network specialties of such universities as BSUIR, BGAS, BSU, etc. develop specializations in civil ENGINEERING at the first and second stages of training and within the framework of retraining. In the curricula of such specializations, it is advisable to include the study of the following subjects [7]:

- architecture of IoT networks;
- IoT hardware and software components;
- IoT interfaces;
- design of IoT components;
- programming in IoT networks;
- databases and big data processing in IoT;
- cloud and fog computing for IoT;
- information security in IoT;
- intelligent technologies and Analytics for IoT;
- network IoT in the sectors of the economy.

The predominant direction in the development of infocommunication networks in the near future in the Republic of Belarus is expected to be mass design and use of Internet of things networks (IoTN) for various purposes. The architecture and organization of management in IoTN are considered. The protocols of interaction in IoTN for near and far interaction are given. Platforms of the world's leading manufacturers for building various IoTN are presented. The necessity of development of systems for automation of IoTN design is noted. The article presents educational disciplines for the specialization of improving the training of students and retraining of specialists in the field of building IoTN.

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