UDC 004=111 DOI 10.5862/JCSTCS.212.9

V.V. Efimov, S.V. Mescheryakov, D.A. Shchemelinin

INTERNATIONAL CONGRESS ON ULTRA MODERN TELECOMMUNICATIONS AND CONTROL SYSTEMS

В.В. Ефимов, С.В. Мещеряков, Д.А. Щемелинин

МЕЖДУНАРОДНЫЙ КОНГРЕСС ПО УЛЬТРАСОВРЕМЕННЫМ ТЕЛЕКОММУНИКАЦИЯМ И СИСТЕМАМ УПРАВЛЕНИЯ

This paper is a summary of the 6th International Congress on Ultra Modern Telecommunications and Control Systems (ICUMT) [1]. ICUMT series of the annual conference has been indexed in Elsevier's Scopus [2], the largest citation database of peer-reviewed scientific publications in the world. ICUMT abstracts and proceedings are published in the IEEE Xplore Digital Library [3] though PDF versions of the author's papers and even the Internet access to Scopus web site are not free. This paper presents a brief description of the most relevant presentations of keynote speakers to ICUMT-2014.

TELECOMMUNICATIONS; NETWORKING; AUTOMATED CONTROL SYSTEMS; PERFORMANCE; CAPACITY; CLOUD COMPUTING.

Представлен обзор VI международного конгресса по ультрасовременным телекоммуникациям и системам управления (ICUMT) [1]. Серия ежегодных конференций ICUMT индексируется в Elsevier's Scopus [2], крупнейшей в мире базе данных цитирования рецензируемых научных изданий. Аннотации и тезисы докладов ICUMT публикуются в электронной библиотеке IEEE Xplore [3], однако PDF версии авторских работ и даже Интернет-сайт Scopus не находятся в свободном доступе. В данной статье кратко описаны наиболее значимые презентации основных докладчиков ICUMT в 2014 году.

ТЕЛЕКОММУНИКАЦИИ; СЕТИ; АВТОМАТИЧЕСКИЕ СИСТЕМЫ УПРАВЛЕНИЯ; ПРОИЗВОДИТЕЛЬНОСТЬ; ЗАГРУЖЕННОСТЬ; ОБЛАЧНЫЕ ВЫЧИСЛЕНИЯ.

Highlights. The announcement of the ICUMT-2014 was published in the St. Petersburg State Polytechnic University Journal [4]. St. Petersburg in Russia was the city hosting the event on October 6-8, 2014. Technical organization and financial sponsorship were supported by St. Petersburg State University of Telecommunications; St. Petersburg State Polytechnic University; the Institute of Informatics Problems, Russian Academy of Sciences (RAS); the Peoples' Friendship University, Russia; Tampere University of Technology, Finland; the Institute of Electrical and Electronics Engineers (IEEE), not-for-profit world communications society, Russian Northwest region 8; Russian Institute of Radio Engineering and Electronics of RAS (Popov Society); Finnish-Russian University Cooperation in Telecommunications (FRUCT).

The papers and presentation slides are submitted using Editor's Assistant (EDAS) as web-based conference and journal management system [5]. The content of each paper is peer-reviewed carefully by at least 2 referees with 40 % acceptance ratio of approved papers.

Final technical program with more than 50 presentations to ICUMT-2014 is also generated in EDAS [6].

ICUMT-2014 event attracted over 150 registered attendees geographically from all over the world. In addition to regular sessions, the round tables on selected topics, the workshops and exhibitions from ICUMT sponsors are organized. The keynote speakers, the most interesting presentations and relevant for IT companies papers are briefly described below; the others are summarized in the conclusion.

Keynote Presentations. Presentations of ICUMT keynote speakers are not followed up with a printed thesis and, thus, are not included into conference proceedings. In 2014, the keynote speeches are presented by Prof. Antonio Bicchi, University of Pisa, Italy [7], and Dr. Oleg Gusikhin, Ford Research & Advanced Engineering, USA [8].

The first talk with Prof. A. Bicchi is dedicated to the theory of automated control systems in common, and the understanding of feedback systems in particular. A combination of effective solutions and powerful analytical tools, coming from the studies in the neurosciences, resulted a substantial improvement of the convergence and, therefore, a better quality of regulating process. Few case-studies with the examples of how this technological process is working, specifically in robotics, are demonstrated.

The second special session with Dr. Oleg Gusikhin is about Ford vehicle smart devices and wireless communication links. Vehicle connectivity is a dynamic and rapidly growing area of research and development with many challenges and opportunities. In many countries, the car connectivity requirements became mandatory to increase transportation safety.

Ford Motor Company technologies combine almost all kinds of two-way data communication services between a vehicle and an outside world, including other vehicles, mobile devices, the infrastructure and the Internet cloud (Fig. 1):

1. Direct short radio communication (DSRC) with the road infrastructure objects and other vehicles (navigation, traffic, safety warnings and alerts, etc.).

2. Wide area wireless embedded modem (GPS/GLONASS positioning, remote control, start/stop, lock/unlock, emergency assistance, other sync services).

3. Built-in or plug-in devices, either Bluetooth or WiFi, used for vehicle tracking, remote diagnostics, hands-free calls, voice commands, vehicle data statistics and analytics, vehicle health and other reporting (OpenXC, OBDII).

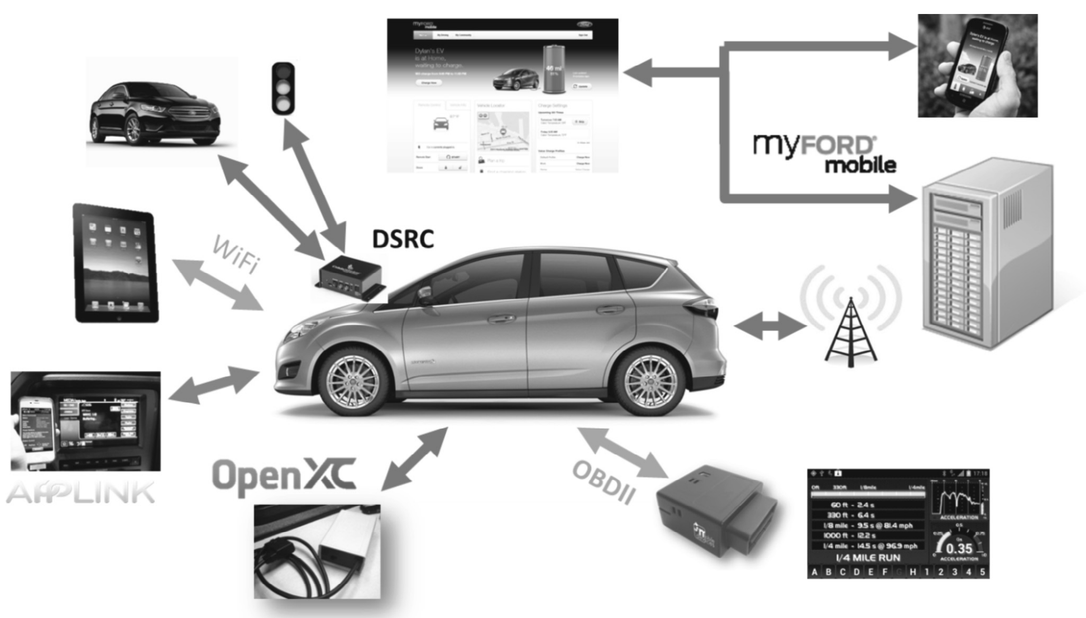

Fig. 1. Ford Connectivity Solutions

4. Integration with mobile devices and smartphones, the Internet networking using Ford custom cloud-based mobile applications, push notifications to drivers.

Some features, such as DSRC, require financial investments in road infrastructure, but the technologies in connecting vehicles are tending towards brought-in communication devices and services, which are compatible with any car at any place.

Adaptive Control of Cloud Computing Resources in the Internet Telecommunication Multiservice System. This topic is submitted by the authors of this paper [9]. Zabbix, the enterprise-class monitoring system [10], is effectively used for a new purpose of adaptive control system, which allows detecting the anomalies, such as capacity or performance degradation, before real impact. The benefits of new approach are shown in 2 real-world examples:

1. Java memory leak, a well-known worldwide chronic problem of Java-based web applications, also described in [11], can be predicted in advance if analyze the historical trends in Zabbix monitoring database. Once critical degradation of Java free memory is detected, the predefined auto-remediation procedure is initiated to safely restart JBoss service on affected server as shown in Fig. 2.

2. Capacity management in a multi-host distributed cloud infrastructure is of big effort and importance. In case of email-to-fax service, the user's workload is rather specific having periodic spikes, which are hard to predict. New calculated metric is proposed to detect the fast growing trend just at the beginning of a fax queue spike. Early detection of the anomaly gives enough time to automatically allocate additional computing resources from standby server pool and meet SLA agreement for fax processing. The reliability of this approach is evaluated for the case of 2 fax server pools, active and standby, using the expression (1). As a result, the overall estimated server capacity and corresponding expenses are reduced to 25 % of actual.

$$R_S = \sum_{i=1}^{n} \left(1 - \prod_{j=1}^{m_j} (p_{ij} / 2) \right) / n, \qquad (1)$$

where R_S is the reliability of entire system; p_{ij} is the probability of a failure or an overload of one server in pool; n is the number of pool layers; m_i is the amount of servers in the i-th pool.

First Large TV White Spaces Trial in South Africa: A Brief Overview. The authors of this paper are the members of Council for Scientific and Industrial Research (CSIR), Pretoria, South Africa; TENET Telecommunication Company, Cape Town, South Africa; and Google Company, USA [12].

Lack of affordable remote access to the Internet from far villages and shanty towns in urban areas around South Africa sustains what is often called "digital divide", hindering provision of basic services and the local economic growth. The authors tried new technology of TV white spaces (TVWS) and the

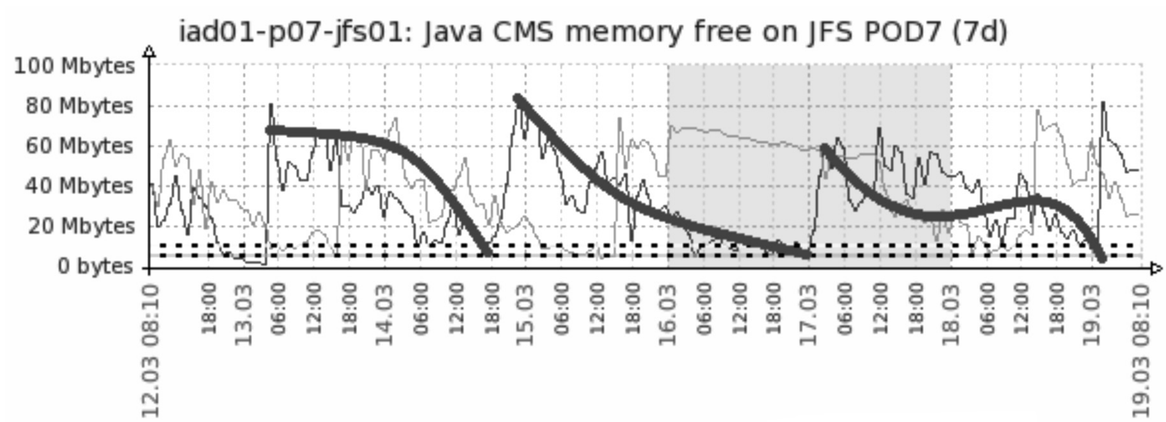

Fig. 2. Critical Degradation of Java Virtual Memory

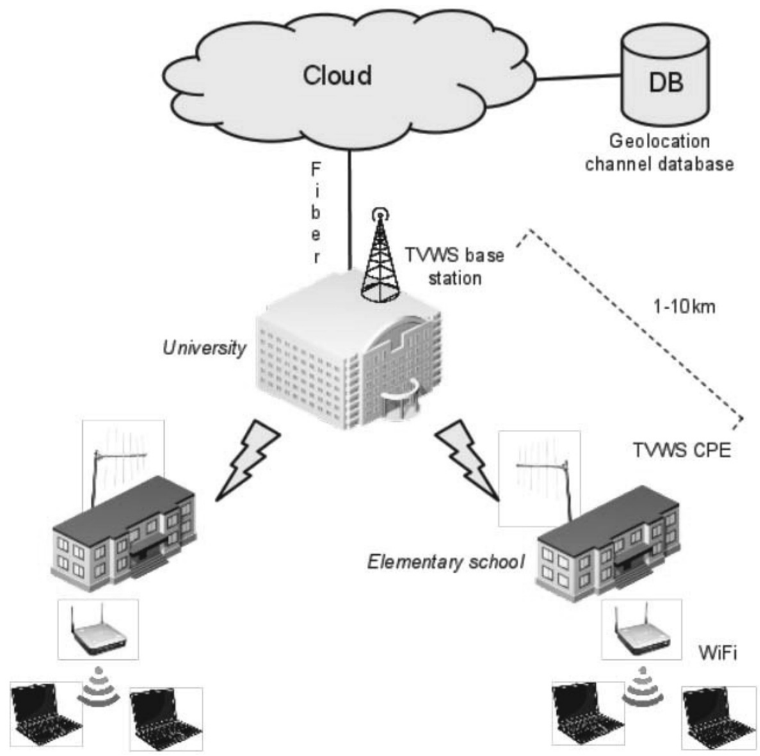

Fig. 3. Connecting Schools and Clinics Using TVWS in the Limpopo

white space devices (WSD), which are designed to co-use the frequency spectrum allocated to TV broadcasting, in the Limpopo (Fig. 3).

TVWS base station, which is connected to the Internet with a fiber-based backbone and is controlled by a geographical location database, is linked over TVWS to the terminals at schools, clinics, and other customer premises equipment

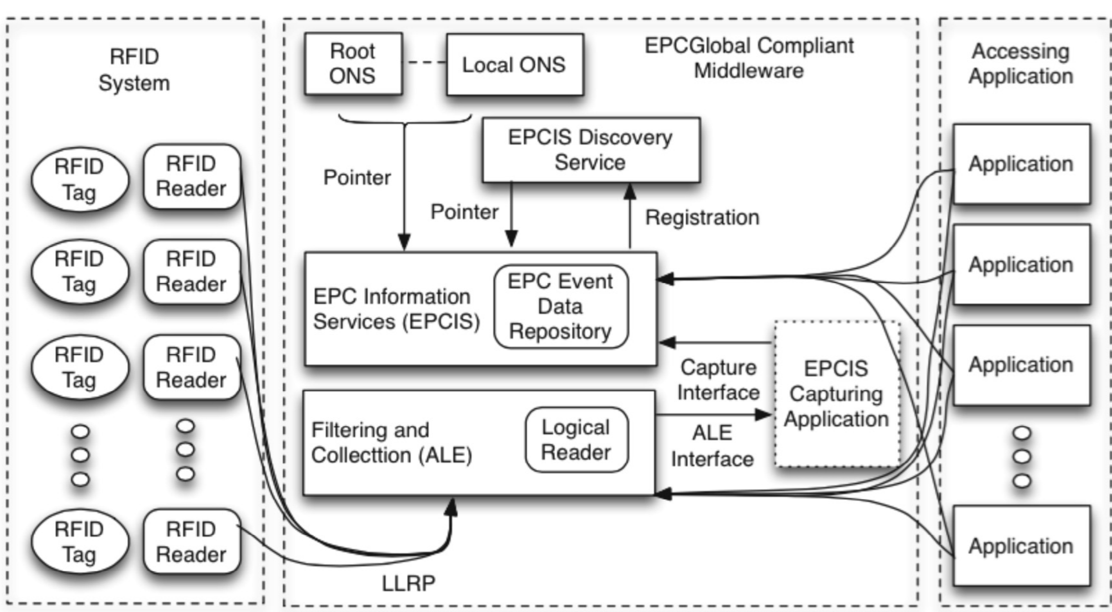

Fig. 4. IoT Architecture with Hardware, Middleware and Application Parts

(CPE). The Internet is then further shared to the end users via local WiFi access points. The details of this approach are described in [13].

Using TVWS technology, the high-speed Internet access is also provided to several elementary schools in Cape Town. The authors successfully verified that the White Spaces can be used causing no interference to TV receivers. The result of this research would be a motivator for defining a regulation allowing the secondary band usage for the Internet access from all far areas of South Africa.

Internet of Things Scalability: Analyzing the Bottlenecks and Proposing Alternatives. The challenges of the Internet of Things (IoT), new revolution in the Internet supporting a yet more strong connection between objects and humans, are analyzed by graduates from Brazil University [14]. The proposed IoT architecture, consisting of hardware, middleware and application parts, is shown in Fig. 4.

Middleware layer collects the Electronic Product Codes (EPC) from Radio Frequency Identification (RFID) sensors in real time and provides the interface for web applications to access this data. That is why the middleware scalability is a key requirement for IoT growth. The authors introduced a benchmark to measure the most common IoT middleware – Fosstrak. As a result, some bottlenecks and limitations are found, for example 200 simultaneous HTTP requests as maximum.

New ideas on redesign of the IoT middleware and the directions to solve scalability problems are proposed, including but not limited to non-relational database repository, web services decomposition and module structure, multithread programming and parallel processing, cloud virtualization and the templates for virtual machines.

Synergetic Approach to Quadrotor Helicopter Control with Attractor-Repeller Strategy of Nondeterministic Obstacles Avoidance. A novel analytical procedure for the coordinating vector control of an unmanned aerial vehicle (UAV), such as quadrocopter, is introduced by the scientists of the Southern Federal University, Russia, and partially supported by Russian Foundation for Basic Research grants [15].

Synergetic control theory is based on full non-linear models of motion, probabilistic fuzzy logic and artificial neural networks [16], which require heavy calculations and, therefore, cannot be implemented onboard of an UAV. When using the proposed "attractor-repeller" strategy, the algorithm of vector control is simplified to achieve minimal motion resistance and the shortest bypass way.

The benefits of new control strategy are shown through the examples of obstacle (repeller) avoidance of a four-motor UAV bypassing to a destination point as an attractor (Fig. 5). It also takes into account the dynamics of the objects and, thus, can be applied to an environment

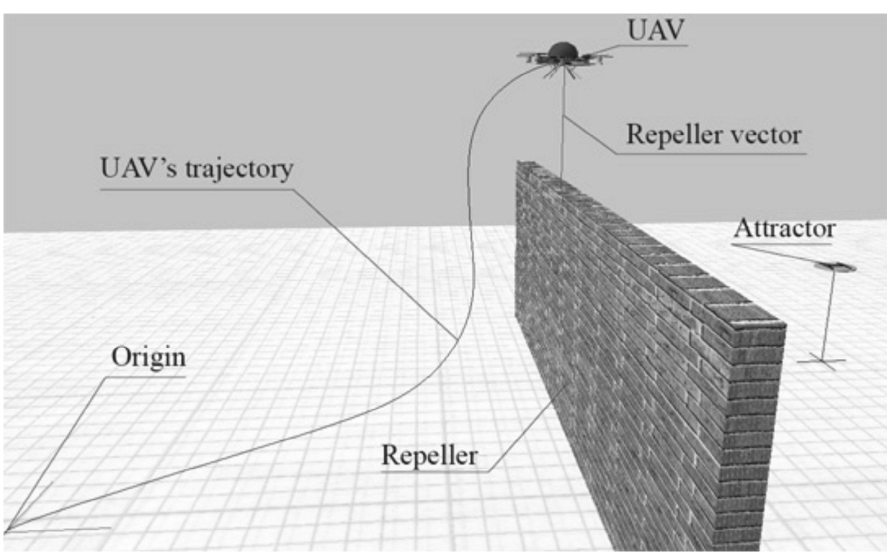

Fig. 5. UAV Bypassing Above a Priory Unknown Obstacle

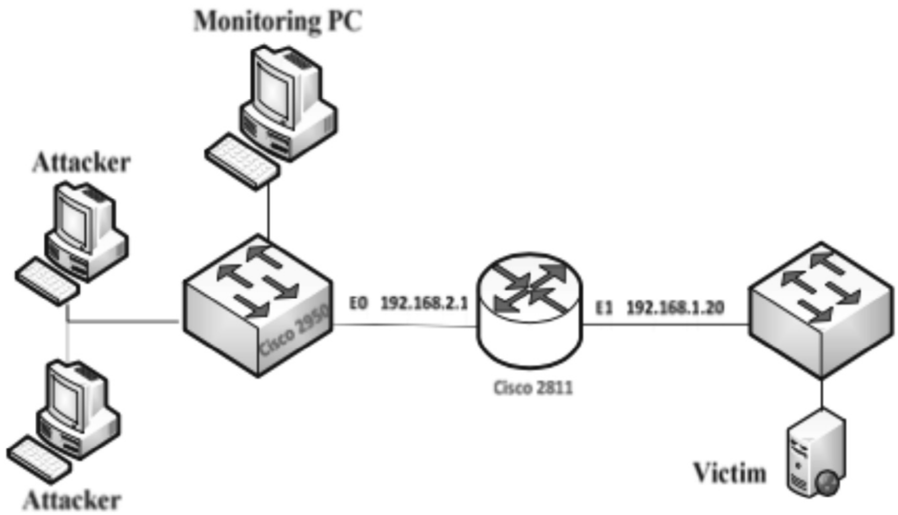

Fig. 6. Test Environment for TCP SYN Flood

with non-stationary obstacles of various shapes, which speed can be determined.

Performance Comparison of Defense Mechanisms against TCP SYN Flood DDoS Attack. The research of defense methods against denial of service (DDoS) attack is presented by the authors from Unitec Institute of Technology, New Zealand [17].

Various flood prevention mechanisms are compared to each other divided by 3 types of defense categories – router based, firewall based and agent based software. Experimental measurements of request turnaround time for TCP packets, CPU utilization of the victim, network traffic before and during attack, with and without defense were carried out in the lab environment like shown in Fig. 6.

As a result, agent based Anti DDoS Guardian software is found to be the worst solution while TCP Intercept based on Cisco router [18] is the best one as it protects from network consumption on behalf of the server. With Cisco feature the victim's CPU utilization reduced to 1 % and traffic bandwidth rate increased just a little from 1.342 kbps without attack to 1.462 kbps with defense. However the average delay increased from 1.92 to 3.21 ms that is a payment for defense.

Simulation of Job Allocation in Distributed Processing Systems. Extending the theory of communicating sequential processes, new simulation models and adaptive optimization methods of job allocation in distributed multiprocessing systems are proposed by the scientists of the Institute of Informatics Problems, Russian Academy of Sciences, and Peoples' Friendship University, Russia [19].

Flexible simulation framework, consisting of 3 categories of objects: flows, resources, and agents, is introduced. The term "flow" reflects the process of incoming jobs. Each "resource" for task processing is described with such attributes like capacity, processing rate, state (busy or idle). Unlike "flows" and "resources", which reflect real physical features, the "agents" are virtual objects to control and associate the resources with arriving task flow according to job allocation strategy in either centralized or distributed dynamic system.

Simulation model of each object is composed of 4 components: processes, events, parameters, and event handlers (call, begin, end, fail, etc.). The term "process" is treated as a sequence of events. Parameters are divided into static, which are not changed during simulation (such as task type, possibility of parallel processing, capacity and throughput of resource), and dynamic (indicator to start task processing, computational capacity required for a task, task deadline, others).

The term "process" is treated as a sequence of possible events happening in the system in parallel and is described mathematically as follows:

$$PROCESS = \\ = FLOWS \parallel RESOURCES \parallel AGENTS, \qquad (2)$$

$$FLOWS = \parallel_{f \in F} f.FLOW, \qquad (3)$$

$$JOBS = \parallel_{j \in J} j.JOB, \qquad (4)$$

$$TASKS = \parallel_{t \in T} t.TASK, \qquad (5)$$

$$RESOURCES = \parallel_{r \in R} r.RESOURCE, \qquad (6)$$

$$AGENTS = \parallel_{a \in A} a.AGENT, \qquad (7)$$

$$F{:}FLOW = MP \parallel JOBS, \qquad (8)$$

where $\parallel$ – parallel processing; f – flow of jobs; F – set of flows; j – job; J – set of jobs; t – task; T – set of tasks; r – resource; R – set of resources; a – agent; A – set of agents; MP – modulated process composed of the arbitrary sequence of events.

The flow of jobs (3), (4) is synchronized with MP process (8) via event "*call for a new job*". Resources with "*idle*" state (event "*breakdown*") are allocated under agent control and the parallel processing of the tasks is initiated. Job is completed after all the tasks within a job have been processed (event "*ringoff*"). This logic is described as follows:

$$F{:}JOBS = call \rightarrow \\ \rightarrow JOBS \parallel (\Downarrow \rightarrow j.JOB \mid \otimes \rightarrow \oplus), \qquad (9)$$

$$F{:}JOB = \parallel_{t \in T} t.TASK;\ ringoff \rightarrow \oplus, \qquad (10)$$

$$T{:}TASK = begin \rightarrow (r.fail \vee \\ \vee r.breakdown \rightarrow TASK) | (end \rightarrow \oplus), \qquad (11)$$

$$R{:}RESOURCE = (fail \rightarrow \\ \rightarrow RESOURCE) | breakdown \rightarrow \oplus, \qquad (12)$$

$$A{:}AGENT = control \rightarrow AGENT, \qquad (13)$$

where $\otimes$ – processing state is "idle" or "declined"; $\oplus$ – processing state is "busy".

The advantage of the proposed framework is decomposition of a complex system into simple independent components and simulation in parallel models. Procedure described in expressions (2)–(13) is applied in practice using programming language to simulate a well-known Markov chain with distributed resources and parallel processing. Several examples are given to demonstrate which particular problems of optimal job allocation can be targeted and solved.

The goal of further study is implementation of adaptive strategies, optimization methods and algorithms into simulation framework to solve job/resource allocation problems.

Summary of the Congress. ICUMT is positioned as a major annual event bringing together leading International players targeted on fundamental research and new engineering results. The goal of the forum is to share the most recent news, knowledge and experience from both academia and industry. The benefit of ICUMT, in comparison with the other IT conferences, is that the problems of automated control systems are discussed along with telecommunications and networking. Hot topics, high availability and low layer issues are separated. Therefore, all the ICUMT papers are divided into 2 tracks – Telecommunications (ICUMT-T) and Control Systems, Automation and Robotics (ICUMT-CS).

Particularly at ICUMT-2014, a wide range of issues was discussed. All the topics of interest are grouped by the following sections, which can be quickly found along with an author or the details of a certain paper in IEEE abstracts and proceedings [3]:

Network modeling, management and maintenance;

Recent advances in broadband access networks;

Optical networking, topology and planning;

Short range wireless technologies;

Nano-scale computing and communications;

Green communications and energy-efficient networking;

Global Resource Information Database (GRID), distributed computing;

Mobile Internet, IP-telephony and Internet TV;

Adaptive control systems, robust control and engineering;

Vehicle connectivity technologies and traffic models;

Security and attacks prevention.

The next 7th edition of ICUMT will be held in Brno, Czech Republic, on October 6-8, 2015. The event will be organized by Brno

University of Technology, Tampere University of Technology, Wireless System Laboratory of Brno and Signal Processing Laboratory, as well as regular IEEE members for ICUMT [20].

REFERENCES / СПИСОК ЛИТЕРАТУРЫ

1. *The 6th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops.* St. Petersburg, Russia, 2014. Available: http://www.icumt.info/2014/

2. *Elsevier's Scopus Citation Index Database. Free search for author on official web site.* Available: http://www.scopus.com/search/form/authorFreeLookup.url

3. The IEEE Xplore Digital Library, *ICUMT abstracts and proceedings.* Available: http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=6992915

4. **Mescheryakov S.V., Shchemelinin D.A.** International Conference for the Performance Evaluation and Capacity Analysis by CMG, *St. Petersburg State Polytechnical University Journal. Computer Science. Telecommunications and Control System.* St. Petersburg: SPbGPU Publ., 2014, No. 1(188), Pp. 99–104.

5. *EDAS Conference and Journal Management System for ICUMT-2014.* St. Petersburg, Russia, 2014. Available: https://edas.info/newPaper.php?c=17081

6. *Final Technical Program for ICUMT-2014.* St. Petersburg, Russia, 2014. Available: http://edas.info/p17081

7. **Piaggio C.E.** Control Systems, Robotics, and the Neurosciences: A New Convergence, *The 6th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops.* St. Petersburg, Russia, 2014. Available: http://www.icumt.info/2014/

8. **Gusikhin O.** Ford AppLink and Open Source SmartDeviceLink, *The 6th International Congress on Ultra Modern Telecommunications and Control Systems.* St. Petersburg, Russia, 2014. Available: http://www.icumt.info/2014/

9. **Mescheryakov S., Shchemelinin D., Efimov V.** Adaptive Control of Cloud Computing Resources in the Internet Telecommunication Multiservice System, *The 6th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops.* St. Petersburg, Russia, 2014. Available: http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7002117

10. **Mescheryakov S.V., Shchemelinin D.A.** Analytical Overview of Zabbix International Conference 2013, *St. Petersburg State Polytechnical University Journal. Computer Science. Telecommunications and Control System.* St. Petersburg: SPbGPU Publ., 2014, No. 1(188), Pp. 91–98.

11. **Mescheryakov S., Shchemelinin D.** Capacity Management of Java-based Business Applications Running on Virtualized Environment, *Proc. of the 39th International Conference for the Performance and Capacity by CMG.* La Jolla, USA, 2013. Available: http://www.cmg.org/conference/

12. **Lysko A.A., Masonta M.T., Mofolo R.O., Mfupe L., Montsi L., Johnson D.L., Mekuria F., Ngwenya D.W., Ntlatlapa N.S., Hart A., Harding C., Lee A.** First Large TV White Spaces Trial in South Africa: A Brief Overview, *The 6th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops.* St. Petersburg, Russia, 2014. Available: http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7002136

13. **Mfupe L., Montsi L., Mekuria F.** Spectrum Database as a Service for Broadband Innovation and Efficient Spectrum Utilization, *International Conference on Cloud Computing and Multimedia.* South Africa, 2013.

14. **Gomes M., Righi R.R., Costa C.A.** Internet of Things Scalability: Analyzing the Bottlenecks and Proposing Alternatives, *The 6th International Congress on Ultra Modern Telecommunications and Control Systems.* St. Petersburg, Russia, 2014. Available: http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7002114

15. **Veselov G.E., Sklyarov A.A., Sklyarov S.A.** Synenergetic Approach to Quadrotor Helicopter Control with Attractor-Repeller Strategy of Nondeterministic Obstacles Avoidance, *The 6th International Congress on Ultra Modern Telecommunications and Control Systems.* St. Petersburg, Russia, 2014. Available: http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7002107

16. **Gao Y., Ruan X., Li B.** A Probabilistic Fuzzy Controller with Operant Learning for Robot Navigation, *IEEE 10th World Congress on Intelligent Control and Automation.* USA, 2012.

17. **Kolahi S.S., Alghalbi A.A., Alotaibi A.F., Ahmed S.S., Lad D.** Performance Comparison of Defense Mechanisms Against TCP SYN Flood DDoS Attack, *The 6th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops.* St. Petersburg, Russia, 2014. Available: http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7002093

18. *Cisco IOS Security Command Reference – TCP Intercept Commands, Cisco IOS Software Release 12.2 Mainline. Cisco Systems*, 2013. Available: http://www.cisco.com/en/US/docs/ios/12_2/security/command/reference/srfenl.html

19. **Konovalov M., Razumchik R.V.** Simulation of Job Allocation in Distributed Processing Systems, *The 6th International Congress on Ultra Modern Telecommunications and Control Systems.* St. Petersburg, Russia, 2014. Available: http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7002163

20. *The 7th International Congress on Ultra Modern Telecommunications and Control Systems.* Brno, Czech Republic, 2015. Available: http://www.icumt.info/2015/

EFIMOV, Vadim V. *RingCentral Inc.*
1400 Fashion Island Blvd., San Mateo, CA, USA 94404.
E-mail: 2vadim@inbox.ru

ЕФИМОВ Вадим Вячеславович – *менеджер RingCentral.*
1400 Fashion Island Blvd., San Mateo, CA, USA 94404.
E-mail: 2vadim@inbox.ru

MESCHERYAKOV, Sergey V. *St. Petersburg Polytechnic University.*
195251, Politekhnicheskaya Str. 29, St. Petersburg, Russia.
E-mail: serg-phd@mail.ru

МЕЩЕРЯКОВ Сергей Владимирович – *профессор кафедры инженерной графики и дизайна Санкт-Петербургского государственного политехнического университета, доктор технических наук.*
195251, Россия, Санкт-Петербург, ул. Политехническая, д. 29.
E-mail: serg-phd@mail.ru

SHCHEMELININ, Dmitry A. *RingCentral Inc.*
1400 Fashion Island Blvd., San Mateo, CA, USA 94404.
E-mail: dshchmel@gmail.com

ЩЕМЕЛИНИН Дмитрий Александрович – *руководитель департамента эксплуатации и развития RingCentral, кандидат технических наук.*
1400 Fashion Island Blvd., San Mateo, CA, USA 94404.
E-mail: dshchmel@gmail.com