2016 IEEE Conference on Quality Management, Transport and Information Security, Information Technologies

IT&MQ&IS-2016

2016 IEEE CONFERENCE ON QUALITY MANAGEMENT, TRANSPORT AND INFORMATION SECURITY, INFORMATION TECHNOLOGIES

IT&MQ&IS–2016

PROCEEDINGS

Russia
Nalchik, p. Elbrus
October 4-11, 2016

ББК 65.290-2

2016 IEEE Conference on Quality Management, Transport and Information Security, Information Technologies (IT&MQ&IS). Proceedings. – М.: Фонд «Качество», 2016.

ISBN 978-5-94768-071-3

В сборнике представлены материалы Всероссийской конференции с приглашением зарубежных участников, на которой были рассмотрены актуальные проблемы в области государственно-частного партнёрства, управления качеством, образования, управления ИТ-услугами и сервисами, транспортной и информационной безопасности. Сборник предназначен для руководителей организаций и предприятий различного направления, менеджеров организаций, а также научных и инженерно-технических работников, занимающихся разработкой и внедрением интегрированных систем обеспечения качества продукции на предприятиях. Материалы также могут быть полезны студентам и аспирантам, обучающимся по соответствующим направлениям и специальностям, в их научной и учебной деятельности.

Редакционная коллегия: Лёвин Б.А., Майборода В.П., Альтудов Ю.К., Азаров В.Н., Батыров У.Д., Шапошников С.О., Мартюкова Е.С., Прыткова С.Н., Шепитько Т.В.

ISBN 978-5-94768-071-3

ББК 65.290-2

© Европейский центр по качеству, 2016

© Авторы, 2016

Contents

R.Sh. Zhemukhov, M.M. Zhemukhova **8**

System of Mathematical Models to Manage Water and Land Resources at the Regional Level in Case of Anthropogenous Climate Changes Taking Into Account Economic Indicators and Ecological Consequences

H.M. Senov, R.N. Abutalipov, Yu.V. Bolgov **14**

Building a Digital Elevation Model of Territory of Kabardino-Balkarian Republic on Radar Interferometric Shooting

V.N. Azarov, A.S. Kabanov, O.A. Kopylov, M.Yu. Morgunov **17**

Methods for the Modelling of Transport Security

T.V. Karlova, A.Y. Bekmeshov, S.A. Sheptunov, N.M. Kuznetsova **23**

Methods Dedicated to Fight Against Complex Information Security Theats on Automated Factories Systems

I.A. Khromov, A.A. Dvornikov **28**

Wireless Access Monitoring and Control System Based on Intrabody Communication

I.I. Livshitz, K.A. Nikiforova, P.A. Lontsikh, V.A. Karaseva **32**

The Evaluation of the Electronic Services with Accordance of IT-security Requirements Based on ISO/IEC 27001

P.A. Lontsikh V.A. Karaseva, E.P. Kunakov, I.I. Livshitz, K.A. Nikiforova **36**

Implementation of Information Security and Data Processing Center Protection Standards

E.V. Plakhotnikova **41**

Quality and Competitiveness Improvement of NPP Safety Systems

V.G. Semin, E.R. Khakimullin **43**

Game-theoretic Algorithmization Context of a Risk-Management

E.A. Ilyina, S.V. Grigoreva, T.V. Dmitrieva, V.G. Semin **47**

A Process Model of Risk Management in the System of Management of Strategic Sustainability of Cargo Motor Transport Enterprises

S. Guskov, V. Levin **51**

Model Estimates of the Probability of Risk Events in the System

O.V. Islamova, A.A. Zhilyaev, A.M. Bozieva **55**

SADT Technology as a Tool to Improve Efficiency in the Use of Process Approach in Management of Engineering Enterprise

A. Ivutin, D. Perepelkin, E. Larkin **59**

Software Errors and Reliability of Embedded Software

Y.N. Kofanov, S.Y. Sotnikova **62**

Sensitivity Model of the Set Interdependent Electrical, Thermal and Mechanical Processes Totality of Electronic Equipment to Change of One of the Internal Parameters

Y.N. Kofanov, S.Y. Sotnikova, S.A. Subbotin **66**

Method of Increasing the Reliability of On-Board Electronic Equipment with an Analysis of Reserves for the Electrical, Thermal and Mechanical Loads

S.A. Presnyakov, A.D. Kasatkin, N.P. Kravchenko, S.V.Mukhin **71**

Modeling of Beam-Plasma Devices Slow-Wave Structures and Analysis of Their Dispersion Characteristics

A.S. Rotkevich, Y.N. Kofanov **76**

Method of Study Mechanical and Thermal Processes of Receiver-Computer Unit for Unmanned Aerial Vehicles

A.M. Sharipova, V.U. Arkov **80**

Computer-Aided Estimation of Portfolio Management Quality

V.A. Vasilyev, G.M. Letuchev, S.V. Aleksandrova, M.N. Aleksandrov **85**

Problems of Quality Management Technical Products Complex

I.I. Livshitz, K.A. Nikiforova, P.A. Lontsikh, S. Karasev **89**

The New Aspects for the Instantaneous Information Security Audit

I.I. Livshitz, K.A. Nikiforova, P.A. Lontsikh, E.Y.Drolova, N.P. Lontsikh **92**

The Optimization of the Integrated Management System Audit Program

P.A. Lontsikh, E.Y. Drolova, E.A. Vovseenko, E.P. Kunakov, I.I. Livshitz, K.A. Nikiforova, A.V. Vladimirchev **96**

Motivation of Application, Analysis and Inconsistencies Standard GOST R 56002-2014 "Evaluation of Experience and Business Reputation of the Construction Organizations"

O. Shvetsova **102**

Staff Loyalty Formation as a Management Tool in International Business

V.N. Azarov, U.D. Batyrov, M.M. Yakhutlov **107**

The Basic Requirements for the Training of Engineers in the Change of Technological Structures

V.N. Azarov, Yu.I. Gudkov, G.A. Dobrov **110**

Methodology of Creation of Electronic Learning Services and their Integration into IT-infrastructure

S.N. Balkarova, Z.Ya. Dzhankulaeva, M.J. Kuchmezova, I.V. Tazheva **113**

Updating Optimize the Training of Teachers - Tutors in the Preparation and Retraining of Personnel for the Information Society in the Light of Modern Requirements

A.M. Bozieva **117**

The Role and Importance of Multimedia Educational Technologies in the Training of Engineers

N. Chervyakov, M. Babenko, V. Kuchukov, M. Deryabin, N. Kuchukova, A. Tchernykh **120**

Fast Modular Multiplication Execution in Residue Number System

M.S. Chvanova, M.V. Khramova, E.N. Pitsik, A.E. Khramov **123**

Is It Possible to Improve the University Education with Social Networks: the Opinion of Students and Teachers

M.S. Chvanova, M.V. Khramova, E.N. Pitsik, A.E. Khramov **129**

Organization of Virtual Environment for Interaction of University and High-Tech Sector of the Economy

A.O. Graule, Z.N. Erochina, V.P. Maiboroda, M.A. Mizginova **134**

Approaches for IT Infrastructure Modeling of Electronic University

D. Korolev, A. Gorokhova-Alekseyeva **139**

Approaches to the Development of a Mediacontent Delivery Network Based on the Infrastructure of Existing Saas and Iaas Providers

A.A. Koshkarov, A.A. Khalafyan, E.U. Dolzhkova, A.B. Semenov **143**

Automation of Planning of Medical-Economic Drug Prescription Control

D.V. Mardashov, B.U. Vasiliev **148**

Methodology of Educational Process Organization Using Training Simulator

A.A. Martirosyan, K.V. Martirosyan **151**

Quality Improvement Information Technology for Mineral Water Field's Control

O. Shvetsova **156**

International Activity of Russian Universities. Case Study of St.-Petersburg Electrotechnical University "LETI"

Yu.M. Solomentsev, S.A.Sheptunov, T.V. Karlova, A.L Barashkova, I.V. Vorobjev, A.N. Zapolskaya, R.S. Nakhushev, Yu.M. Yakhutlov, A.S. Sannikov **160**

Research of the Academic Web Space in the Russian Federation

Yu.M. Solomentsev, S.A. Sheptunov, T.V. Karlova, A.L. Barashkova, I.V. Vorobjev, A.N. Zapolskaya, R.S. Nakhushev, Yu.M. Yakhutlov, R.M. Glashev **163**

Popularization of Science in Online Media: Theory and Practice

D.S. Tananykhin, L.A. Shangaraeva **168**

Implementation of New Educational Technologies to Improve Student's Learning Efficiency

K.G. Tkhagapsoyev, M.M. Yakhutlov **171**

To the Problems of Engineering Education in Modern Russia

A.G. Troshina, A.N. Ivutin **175**

Improve of Technical and Economic Indicators of Complex Technical Products Through the Use of Concurrent Engineering Technology at Design and Technological Manufacturing Preparation

Yu.L. Zhukovsrij, B.U. Vasiliev **178**

Interdisciplinary Research Underlying Education at the Educational and Scientific Facilities for Innovative Economy

R.N. Abutalipov, Yu.V. Bolgov, H.M. Senov **181**

Flowering Plants Pollination Robotic System for Greenhouses By Means of Nano Copter (Drone Aircraft)

A.Ya. Dzhankulayev, Z.R. Likhov, A.A. Dzhankulayev, I.A. Kaziyev **184**

Modeling of Nonlinear Rebuff Grounds by Finite Element Methods

A.D. Elbaeva, R.I. Elbaeva, H.M. Senov **186**

Portable Device for Automatic Control of Hemodynamic and Biochemical Blood Parameters

N.N. Grachev, S.S. Safonov **189**

Aspects of Circuit Design and Design EM with Regard to Electromagnetic Compatibility

Yu.I. Gudkov, V.N. Azarov, A.L. Tuv **192**

Fiber Optic Sensor for Monitoring Vibration Load

A.M. Kaziyev, V.Kh. Khuranov, Z.R. Likhov, B.V. Shogenov, I.A. Kaziyev **196**

Fluctuation of a Beam with the Concentrated Masses on Elastic Mobile Support

V.K. Khuranov, Z.R Likhov, A.M. Kaziev, A.S.Tsipinov, V.D. Mailyan **201**

Bending Resistance of Reinforced Concrete Elements under Various Classes of Concrete and Ratios of Reinforcement

M.Yu. Kulikov, M.A. Larionov, S.A. Sheptunov, D.V. Gusev **205**

The Influence of Pre-Settings of the Automated System Rapid Prototyping on the Qualitative Characteristics of Formation

V.N. Lesev, A.O. Zheldasheva **209**

Program Complex on Processing of Experimental Data of Wetting by Fusions of Metals of Firm Substrates

M.H. Mashukova, M.I. Bzhahov, A.J. Dzhankulaev, F.M. Shogenova **213**

Monitoring Safety Construction and Operation of Buildings and Structures

G.V. Rashoyan, S.A. Sheptunov, A.K. Aleshin, M.F. Slavutin, S.A. Skvortsov **215**

Analysis of Special Positions of Parallel Structure Mechanisms for Aggressive Media

S.A. Sheptunov, M.A. Larionov, N.V. Suhanova, M.R. Salakhov, Yu.M. Solomentsev, I.S. Kabak **220**

Simulating of Reliability of the Robotics System Software on the Basis of Artificial Intelligence

S.A. Sheptunov, M.A. Larionov, N.V. Suhanova, I.S. Kabak, D.A. Alshynbaeva **225**

Optimization of the Complex Software Reliability of Control Systems

A.Kh. Tlibekov, M.M. Yakhutlov **229**

The Decision of Applied Problems of Designing Productions with the Use of Combined Genetic Algorithms

V.A. Vasiliev, S.A. Odinokov, E.V. Borisova, G.M. Letuchev **233**

Methods of Quality Management of Innovation Process

M.M. Yakhutlov, U.D. Batyrov, M.R. Kardanova, A.A. Gutov, Z.N. Deunezhev **236**

Investigation of the Thermal Mode in the Composite Diamond-bearing Material in a Polymer Matrix

M.M. Yakhutlov, U.D. Batyrov, A.Kh. Tlibekov, M.R. Kardanova, A.A. Gutov, Z.N. Deunezhev **239**

Simulation of Dynamic Loads on Diamond Abrasive Tool

U.D. Batyrov, P.L. Ataev, A.Z. Tokov, T.H. Kardanov **242**

Study Ways to Improve the Efficiency of Operation of Mobile Cross Knife Grinders Food

S.A. Sheptunov, R.S. Nakhushev, D.Yu. Pushkar, K.B. Kolontarev **247**

Import Outstripping of Surgical Technologies Based on Assisted Mechatronic

Yu.N. Voloshin, M.Ts. Didanov, M.M. Nagoev, E.Yu. Daurova, M.L. Huranova **256**

Modeling Formulations Confectionery Products

Yu.N. Voloshin, M.Ts. Didanov, M.M. Nagoev, R.T. Kipov **260**

Study of the Separability of the Cereal Mixture on Velocity

A.Ch. Abazov, T.M. Tanasheva **264**

On Deciphering the Name of the Art of Divination “Libri Haruspicini”: to the Question of Diachronic Convergent Relations in Etrusco-Adyghe Languages

M.M. Abazova, M.L. Apajev, B.C. Bizhoev, M.H. Tokmakova **269**

Kabardino-Circassian Lexicography: Status and Prospects

A.A. Afaunova **273**

Communicative Function of Interjections in Dialogue Discourse (Based on the Materials of Kabardin-Chircassian Language)

S.I. Akkieva, K.F. Dzamikhov **277**

On the Characterization of the Circassian Diaspora (on Materials of the Russian Caucasian Studies)

B.A. Berberov, Z.A. Kuchukova, L.B. Berberova **280**

System of Altruistic Motifs in North Caucasian Tale

B.H. Bgazhnokov, V.A. Fomenko **284**

The Monuments of Antiquity and the Middle Ages as a Factor Sustainable Development of the Cultural Landscape Nalchik and Its Vicinities

T.Sh. Bittirova, G.D. Bazieva **288**

Islam in Balkarian Culture and Modern Religious Situation

Z.V. Cherkesova **292**

Features of the Man's and Women's Speech in Kabardino-Circassian Language: Emotive's Aspect

L.S. Hagozheeva **295**

Megafolinic about the Origins of the Kabardian Literature (1920-1930-ies)

M.A. Hakuasheva **298**

Biblical Motifs in the Works of Contemporary Art Adygskih Writers

Z.M. Kesheva, N.V. Varivoda, M.H. Gugova, R.G Oshroev **301**

Recreational Resources of the Kabardino-Balkaria as a Key Factor in the Socio-Economic and Cultural Development of the Country

H.H. Malkonduev, L.S. Gergokova, F.H. Guliyeva (Zanukoeva) **304**

Karachay-Balkar Legendary Tales of the Prophets

R.G. Oshroev, Z.M. Kesheva **308**

Revitalization of Ethnicity and Religious Renaissance in the Context of a Change of Civilizational Paradigms of Development of Russia and the World Community (on the Example of the Kabardino-Balkaria)

F.A. Ozova **311**

Arbitration Tribunals in the Traditional Circassian Society

H.T. Timizhev, L.B. Havzhokova **313**

Forms of Use of Folk Stories in Modern Kabardian Novel

M.Z. Ulakov, L.H. Makhiyeva, B.A. Musukov **317**

The Modifying Features the Tsvetooboznachayushchikh of Adjectives in Turkic Languages

A.D. Vislova **321**

Analysis of the Main Outlines of the Problem of Narcotism in Modern Society

A.D. Vislova **325**

Research Representations Primary School-Age Children about Drugs and Their Relationship to Drug Addicts

M.F. Guskova, F.F. Sterlikov **329**

Development of the Principles of the Quality Management System Which Based on the Economic Theory of Value

R.R. Savchuk **332**

Public-private partnership as a promise form of investments

Approaches to the Development of a Mediacontent Delivery Network Based on the Infrastructure of Existing Saas and Iaas Providers

Denis Korolev, Anastasiya Gorokhova-Alekseyeva
Moscow Institute of Electronics and Mathematics
National Research University "Higher School of Economics" (HSE)
Moscow, Russian Federation
dkorolev@hse.ru

Abstract --Video broadcasts on the Internet have become a commonplace and increasingly find their audience, supported by popular video services and social networks. But there are tasks, that require content delivery network (CDN), which lead to extra expences, and moreover, does not give sufficient flexibility and limits personalization of the broadcasts. This paper presents the principles of creating a flexible and scalable streaming content delivery network, created automatically for each individual broadcast over existing infrastructure of the cloud virtual machine hosting providers.

The report originates from a commercial project dedicated to creation of media-content delivery network, currently being at development stage.

Keywords — Cloud technologies, virtual machine, CDN, video streaming, hosting, broadcasting, SaaS, IaaS, bandwidth

I. INTRODUCTION

Over the years of live streaming in Internet, much has changed in the capabilities of computers and networks, but the architecture of Internet remaines unchanged. Babbitt hardly distinguishes video program as seen on TV from the same video program shown through a streaming service, but in practice the difference is huge, and it is rooted in the principle of delivering information to subscribers on the Internet: TV sends a signal "to all who is tuned to", but Internet in general does not distribute such messages and the sender has to deliver streams to each subscriber separately. This means that the stream, downloaded from the broadcast server has proportional bandwidth to the number of viewers. For broadcasts with a large spectator audience Content Delivery Networks (CDN) [1] are used. These are special services with wide and stable channels and data centers located "closer to viewers". As a rule, the cost of services of such networks significantly burdens the budget of a broadcast.

At the same time, there are commercial services that have the similar infrastructure, but not aim themselves for such a narrow dedicated purpose — the delivery of streaming media content. They are known as virtual machine (VM) hosting service providers [2]. There is a significant number of companies offering such services, many of them have their own networks of data centers over the world. Normally, creation and configuration of server software can be automated via programming interface (API). Servers can be allocated on a permanent basis (monthly payment), and on an hourly basis. Thus, traffic limits are usually the same for monthly and hourly plans, and for short-term hourly-paid servers apply to virtual machine lifetime. These conditions allow us to move from the problem of scaling broadcasts to a large audience to a project for creation of a CDN over existing VM-hosting infrastructure.

II. METHODS FOR DELIVERY OF VIDEO STREAMS

As it is known from the basics of computer networks, TCP/IP networks have different ways of delivering packages: unicast, multicast, broadcast, anycast [3]. Terrestrial TV could be compared to multicast [4]: packet will be received by all nodes that have tuned to accept it, though it will not be re-sent in case if someone have missed them. Also, transmitter does not know how many nodes accept its packets and sends each packet just once. But Internet uses unicast [5] — an individual packet delivery method, and mostly TCP protocol, which requires establishing a connection with each recipient before sending packets, giving a guarantee of delivery. It perfectly suites for e-mail or documents, but not effective for real-time appliances, such mass distribution of video streams.

To deliver the video streams in their own networks IP-TV operators normally use multicast, which greatly relieves the communications channels avoiding duplication of streams [6]. Thus, the transmitter sends stream to a multicast-address and everyone "listen" it at this location. At the same time, the number of spectators will not affect the outgoing traffic from the server. This delivery method is not applicable to the open Internet [7], but inside the service provider network, this approach can be very convenient (if supported).

III. NETWORK INFRASTRUCTURE

For commercial VM hosting services the simplest case of a CDN is a cloud of virtual machines that runs "on demand" within the data center of the provider (a new virtual machine runs as load grows and currently working machines approach

to their limits). We can point these important characteristics of the infrastructure provided by cloud services:

1. **Hourly plans.** In fact, the CDN is built separately for each broadcast, so servers are deployed and started only for the time of a broadcast. Even for clockwise broadcasting varying number of viewers will require different bandwidth and, to avoid paying for idle resources, servers will need to be added or removed from this "on-demand" CDN.
2. **Traffic** metering: volume of traffic included to the paid time of the server's life. There are different ways of billing, ranging from complex component price-lists (Amazon EC2) to flat-rate hourly plans with fixed traffic volume (DigitalOcean, Linode, VScale, etc). There are services with unlimited traffic (Rootwelt), but often "unlimited" offers are limited by some of their characteristics, e.g. bandwidth.
3. **Bandwidth of virtual machines.** This parameter determines how many machines will be required, and what will be the depth of the "tree" for a given number of audience flow given bitrate.
4. **Billing for internal traffic in the provider's cloud.** There is a significant traffic exchange between the virtual machines, the CDN consists of. Exclusion of this traffic from the prepaid limit affects the calculation of the limits for the end user. For example, in DigitalOcean there is internal private network between servers in the provider's cloud, where the traffic is not taken into account, but this can be only unicast traffic.
5. **Support for multicast traffic within the cloud.** As we shall see later, the use of multicast / UDP can significantly simplify the structure of the network, making it "flat", distributing the traffic from one "source" VM on the input of the CDN to all the "output" VMs streaming to the viewers.
6. **Application Programming Interface (API)** for automated server management.
7. **Server deployment speed and server technologies supported.** As server deployment is initiated by real-time demand in new resources, deployment time should be the less the better. The less time is taken to add a new server to CDN, the less likely a denial of service or delay in connection to the end viewer will happen. And the less servers will stand by in reserve to reduce the risks of these unwanted events. Server deployment time consists of two main parts: a) deployment of the system and b) deployment of applications and their start. Typical server installation is a time consuming operation, but there is a technology that allows to run a pre-configured software bundle on any operating system and any equipment where it is supported — Docker. In this case, after the launch of a new clean virtual machine just one file is being copied and run, and the machine is ready for use.

Some of the listed characteristics are not mentioned in tariff plans or descriptions of hosting providers, so the choice of the provider is a more tricky task than it may appear at first sight. The availability of the API does not guarantee decent tools for automatic server deployment, and promised high-speed characteristics may be unreachable. To be sure a particular VM provider fits to be used for cloud CDN deployment goals, thorough testing is required. Real-life tests can be run after an version, adopted to provider's API is ready. In this report, we consider only the common approaches to the construction of such a service, and will not go in to details of the implementation of features in the networks of different providers.

IV. Stream Delivery Over a Cloud of Virtual Machines

To deliver video streams to end users, CDN needs to create as many copies of the input stream, as the number of concurrent viewers (recipient nodes). In simple case it means that for one input stream of N Mbit/s, the output for the X subscribers requires bandwidth $X*N$ Mbit/sec. Here we assume that the input stream is equal to each of the output streams.

Normally, CDNs use multibitrate [8] feature to deliver high bandwidth streams to viewers with narrow or unstable channels, such as 3G networks or office networks with limited traffic. Multibitrate lowers output bandwidth requirements, so the formula above shows the maximim evaluation.

For example, a 4 Mbit/s stream (typical bandwidth for 1080p H.264 encoded broadcast) distributed from the virtual machines with 100 Mbit/s network bandwidth limit will serve maximum:

$$N_{max} = B_{channel} / B_{stream}$$

where N_{max} is the maximum number of viewers that a given virtual machine is able to serve, and Bis the corresponding bitrate. If we are distributing streams directly from the input virtual machine, in the best case for a fixed bitrate stream we can serve up to 100/4 = 25 subscribers. This does not allow us to use this method for real-life broadcasts, where the number of viewers counts in hundreds and thousands, rarely — in tens of thousands.

There are two evident ways to overcome this limit:

1. **Use virtual machines with wider channels** (there are VM-providers offering 1 and even 10 Gbit/s per each VM, having 40 Gbit/s channel in each data center),
2. **Build a tree of virtual machines** to distribute the input stream first to the intermediate layer (or several layers — depending on the desired size of the audience) and then — to the subscribers

In the first case, the calculation of the maximum broadcast audience for a fixed bitrate (e.g. 4 Mbit/s) remains the same simple: for VMs with 1Gbit/s bandwidth it will serve 250 subscribers.

If we create a tree of virtual machines, there should be created at least one "layer" of *intermediate* VMs behind the *input* VM.

If the input VM is capable to distribute up to 25 streams, there can be run up to 25 intermediate VMs serving up to 25 streams each (225 subscribers). For a larger audience, more intermediate layers should be started and in general this CDN will serve 25^n, where n is the number of layers including the input VM (so, n is not less than 1).

The minimum number of VMs to start at the beginning of a broadcast is equal to the number of layers plus one input VM.

This approach can be implemented to VMs on wider channels, so real-life cases will operate times higher audiences. Nevertheless, this looks straightforward. More elegant solution can be achieved using multicast streaming within the provider's network. In this case there is no need to create multiple intermediate layers as the input VM distributes a single stream to all distributing VMs. The stream is transmitted to a multicast address, the distributing machines "listen" to it and transmit to the subscribers (the same 25 subscribers on one machine in the example above), as we cannot use multicast in internet environment.

The minimum number of VMs to start is two:

- Input machine, that makes a multicast broadcast,
- The first distribution VM for the first subscribers connecting to the CDN.

To implement this approach, multicast traffic must be enabled in the provider's internal network. Also, it is important to exclude this internal traffic from billing limit.

V. Other CDN Features

Popular CDNs provide a range of other services, besides the delivery of real-time streams. One of the main tasks of content delivery networks is providing access to frequently requested information — records of media content, and even sites. In this case CDN acts as cache for static content servers. There are ways to do this job using an alternative way (different from described in this paper, but also using existing cloud infrastructure and services), but they are out of this article's topic. There are other tasks for CDNs, relating to the delivery of streams:

1. **Multibitrate.** The service must be able to convert the input stream into several smaller bitrates and, in some cases, convert the input format or protocol.
2. **Access control.** Password protection, IP address filtering or a group-managed access for registered users.
3. **User related data** collection from the player and browser's environment.

Since the streams are distributed individually to each subscriber, the implementation of these, and more, features becomes possible. It is an opportunity to target, tune or substitute the content of the broadcast, depending on the captured user data such as geotargeting defined by IP address or user's locale (system language) detection to choose the language of the stream and captions.

VI. Alternatives to Building an Own CDN

Automatic deployment of an own CDN is complicated and depends on many external factors, requires experience in this area. Meanwhile, there are certain services, such as Youtube, Facebook, Twitch, LiveStream, etc., offering live broadcasts. These services are capable to maintain really high loads [9], have a well-developed robust infrastructure and can be used for stream delivery purposes. For example, Youtube's player, placed on any wesite will display broadcast directly on the page and will not take traffic from the website's hosting. The opposite side of using these services as CDNs is the lack of control over stream distribution and poor user data, available from their statistics. It is impossible to use any targeting, monetization is only available according the network's rules and rates. Free accounts embed their advertising pre-rolls and banners (this can be solved by obtaining corporate domain subscription or private accounts using intermediate services such as Unlim.us). Anyway, this alternative to using or building a CDN gains a growing popularity. There are services for simultaneous re-broadcasting to several networks that enlarges the audience. For example, Facebook live broadcast supplements Youtube, that is good as the main CDN and is represented by a player on the event's website. There are services for re-streaming to multiple networks, such as On-Air.Pro.

VII. Conclusions

Currently there is a suitable infrastructure for the creation of flexible and cost-effective solutions in the delivery of media content to the subscribers of live broadcasts. It can be based on the commercial virtual machine hosting services. This infrastructure corresponds to the level of software technology, that allows to create rapidly deployable virtual servers, easily portable between different providers. At the same time, the differences in terms of hosting services of virtual machines require practical experience and stress testing of each VM provider before making a decision on placing own live stream CDN there.

Depending on the objectives of the project that requires live broadcasts, additional services of live stream delivery can be claimed, which would require the use of a commercial CDN or create an own network, as described in this paper. At the same time, many common broadcast tasks can be completed using existing streaming services and bulk-management services above them.

References:

[1] George Pallis and Athena Vakali. 2006. Insight and perspectives for content delivery networks. Commun. ACM 49, 1 (January 2006), 101-106. http://dx.doi.org/10.1145/1107458.1107462

[2] Zhang, Qi and Cheng, Luand Boutaba, Raouf,"Cloud computing: state-of-the-art and research challenges", Journal of Internet Services and

Applications, 2010, volume 1, number 1, pages 7--18, issn 1869-0238, doi="10.1007/s13174-010-0007-6",

[3] Z. Liu, K. Wang, W. Li, Q. Xiao, D. Shi and G. He, "Measurement and modeling study of IPTV CDN network," 2009 IEEE International Conference on Network Infrastructure and Digital Content, Beijing, 2009, pp. 302-306. doi: 10.1109/ICNIDC.2009.5360825

[4] Queen B., Almeroth K, IP Multicast Applications: Clallenges and Solutions. RFC 3170, The Internet Society, 2001. P. 8

[5] Schulzrinne H, Internet Services: from Electronic Mail to Real-Time Multimedia in Kommunikation in Verteilten Systemen: Neue Länder — Neue Netze — Neue Dienste. GI/ITG-Fachtagung Chemnitz-Zwickau, 22.–24. Februar 1995, Springer Berlin Heidelberg ISSN 978-3-642-79561-9

[6] A. Majumda, DG Sachs, IV Kozintsev, K. Ramchandran and MM Yeung, "Multicast and unicast real-time video streaming over wireless LANs," in IEEE Transactions on Circuits and Systems for Video Technology, vol. 12, no. 6, pp. 524-534, Jun 2002. doi: 10.1109/TCSVT.2002.800315

[7] K. Obraczka, "Multicast transport protocols: a survey and taxonomy," in IEEE Communications Magazine, vol. 36, no. 1, pp. 94-102, Jan 1998. doi: 10.1109/35.649333

[8] Dobrian F. et al. Understanding the impact of video quality on user engagement //ACM SIGCOMM Computer Communication Review. – ACM, 2011. – T. 41. – №. 4. – pp. 362-373.

[9] Youtube Help Forum "Do Youtube events have a viewer limit?" https://productforums.google.com/forum/#!topic/youtube/YgYfNekY7wc