A COMPARATIVE ANALYSIS OF THE ONLINE VIDEO PLATFORMS FOR INTERACTIVE MULTIMEDIA DELIVERY

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Abstract

In this paper the technical performances and the effectiveness of four open source platforms for online video delivery were evaluated in order to find optimal solution in developing the ICT countries' market. The paper draws upon literature reviews to address the development trends in online video delivery and presents the advantages of using open source video platforms. In order to reduce the costs of service realization and possibilities for expansion of the system for online video delivery, the four open source video platforms were tested in real test environment and the differences between them were analyzed. The experiment was performed by analyzing the online video advertising as a good example of online information delivery application. The scientific and systematic method for open source video online serving platforms evaluation, that can enable project designers to determine the important factors for the implementation of online video delivery systems, was proposed. Furthermore, this study focuses on the characteristics that open source platforms offer in order to overcome problems related to the development of the ICT countries' markets.

Keywords: Online video delivery, Open source video platform, Interactive multimedia information, Video ad serving, Web 2.0.
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INTRODUCTION

Technological development has a big influence on online information delivery which represents a core element of online business applications, the rese-

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arch etc. Online information delivery, owing to the systems based on the Internet, provides a higher efficiency and interaction among all participants in communication. Online advertising is a good example for the usage of online information in practice.[5] Online advertising oriented towards persons who are not a part of target group is avoided and negative consequences that may occur in that case are eliminated. The previous studies showed that online advertising messages had more efficiency and provided a significant perception of the brand advertised by the customer, right after its first appearance.[6]

Having in mind all the mentioned advantages of online information use, real progress is achieved by the implementation of online information delivery in the pervasive computing environment. The development of all aspects of pervasive computing also provides new possibilities for online systems, such as personalization of online information, viewing the multimedia content by using new technological audio-visual solutions, the selection of the most efficient moment for online information delivery to a selected group of users etc.

Modern computing environment provides the new online information presentation trend with advantages which, in turn, create new requirements that should be met by technological solutions. It is in this context that the pervasive online information delivery is elaborated upon as well.

In order to illustrate the most important aspect of the pervasive online delivery, we have described the main principles of online video delivery, especially from the aspect of the multimedia content use. Technical aspects of online video delivery, using online video advertising as an example, with an emphasis on the significance and role of the platform for serving video content, as well as the importance of standardization in the implementation of these systems have also been described in detail. The trends in the development of video content serving systems were analyzed from the aspect of the pervasive online information delivery video content, with the aim of defining the main criteria for the comparison of available video content serving platforms.

According to the results of the experiment, the optimal choice of an online video serving platform proved to be Kaltura software solution. The discussion and conclusion sections of this paper deal with the assumption that the pervasive and comprehensive online video delivery can be efficiently realized by using Kaltura, and by analyzing online video advertising as an example of online information delivery system.

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5 Van der Waldt, D. L. R., Rebello, T. M. and Brown, W. J. (2009), "Attitudes of young consumers towards SMS advertising", African Journal of Business Management, Vol. 3 No. 9, pp. 444-452
6 Ranganathan, A. and Campbell, R. H. (2002), "Advertising in a pervasive computing environment", in WMC '02: Proceedings of the 2nd international workshop on Mobile commerce in New York, USA, 2002, pp. 10-14

LITERATURE REVIEW

The majority of online information systems have almost identical main characteristics and development trends, regardless of the type of information or method of delivery to the user. Providing online information only to the group of users interested in presented content, time dependent delivery, the manner of content presentation and security issues related to the online information delivery can be efficiently described by using online advertising as an example.

For the purpose of online information delivery optimization, the IP multimedia systems of a new generation deal with analyzing the presence of users and delivery of appropriate services depending on established user presence.[7] The main tasks that online advertising in pervasive computing environment should accomplish are the following:

- Provide adequate advertisements to an appropriate target group. The advertising system should provide the desired target group with only those advertisements which the members of that group are interested in.
- Timely delivery of advertisements. Placing the advertisements at the moment when the user's activities are related to the advertisement that is being displayed.
- Presentation of advertisements in the best possible way. When selecting a target group, type of advertisement and time for its optimal effect, it is necessary to choose the best way of delivering and presenting the advertisement.
- Meet all the norms in terms of users' privacy and security of the online advertising system.[8] [9]

When the online advertising system is concerned, the participants include: advertisers, service providers, announcers/publishers and visitors/users. The publishers' main task is to manage web sites and displayed offers in order to make them more interesting to the visitors. The role of service providers is to be mediators between advertisers and publishers, by helping the advertisers to present the advertisement on appropriate web sites and to be mediators in delivery, payment and distribution of advertising revenues. It is important to mention that the role of service providers is much more significant when this advertising model is concerned, than with regard to traditional ways of adver-

7 Khan, Z. S., Sher, M., Rashid, K. and Rahim, A. (2010), "Presence enabled conditional call setup model for IP multimedia subsystem", International Journal of the Physical Sciences, Vol. 5 No. 8, pp. 1248–1255
8 Freudiger, J., Vratonjic, N. and Hubaux, J. P. (2009), "Towards Privacy-Friendly Online Advertising", in IEEE Web 2.0 Security and Privacy (W2SP), Oakland, California, 2009.
9 Vratonjic, N., Freudiger, J. and Hubaux, J. P. (2010), "Integrity of the Web Content: The Case of Online Advertising", in Usenix CollSec'10, Washington, DC, USA, 2010.

tising in newspapers, on television and the radio. One of the reasons is the achievement of an interaction with the visitor and support to the payment of revenue, which depends on the way the interaction has been achieved [10].

Online advertising is a good example how different online information forms can be used within one application. Service providers enable the delivery of advertisements to users in the optimal form by using different communication technologies:

- E-mail advertisement – Until recently, it was the most common form of online advertising, but unfortunately, it usually comes in the form of SPAM. For that reason, the development of anti-spam techniques has been intensified.[11]
- Banners – They are most similar to traditional newspaper ads, and they can be static (jpg or gif format) or animated (gif and flash).
- Pop-up and Pop-under – They are displayed in special windows, most frequently after loading the front page of a web-site, and are not directly related to the web site from which its activation was performed.
- Video advertisement – advertising via online videos. An advertisement can be a purposeful video itself, advertising video message inserted before some other video content or advertising message that is written over the video content that the user is currently watching.
- Mobile advertisement – the trend of mobility and constant connectedness in the world has introduced a new category in online advertising. This term includes almost all above-mentioned forms of advertising, but adapted to transferring the message through mobile devices.

Considering the roles and tasks of the main participants in online information delivery process, it is obvious that important research field is modeling a form of the online information in order to achieve the biggest user QoE (Quality of the Experience).

TECHNICAL ASPECTS OF ONLINE VIDEO DELIVERY

Online video delivery represents one of the fastest growing online information services. One of the main reasons for this is increasing of Internet video content consuming, and the second reason is the proven effectiveness of placed messages through online video content. There are several important elements that should be analyzed when designing online video delivery systems.

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10 Li, Y. M., and Jhang-Li Y. H. (2009), "Pricing display ads and contextual ads: Competition, acquisition, and investment", Electronic Commerce Research and Applications, Vol.8 No. 1, pp. 16-27.
11 Subramaniam, T., Jalab, H. A. and Taqa, A. Y. (2010), "Overview of textual anti-spam filtering techniques", International Journal of the Physical Sciences, Vol.5 No.12, pp. 1869–1882.

Interactive multimedia content

The interactivity and efficiency of the multimedia content represent the key elements for online information delivery systems' design. The online video information, used as advertising message, especially in combination with an interactive content, gives significantly better results in almost all measured parameters than other online information types.

Comparisons of the effectiveness of interactive advertisement with video content, interactive advertisement without video content, gif/jpg banners and advertisements that use simple flash animations are presented in previous research. In four measured categories of effectiveness (advertisement affects the users' intention to purchase, improving perception of the brand, awareness of the brand's online presence and general awareness of the brand), the interactive advertisement that contains video provides biggest impression on the users.[12]

Studies also show that, by using interactive multimedia supplements (rich multimedia ads), it should be achieved a bigger activity of users and stronger interaction between advertisers and users, than if non-interactive media are used.[13] In order to provide effective one-to-one communication in online advertising, the interactive media can be used. The absence of standards in payment models for the interactive media is a big problem, but there are several solutions for interactive advertising payment models.[14]

Online video delivery

Encoding the video, the model of video distribution (live or on-demand), optimization criteria, network type and the manner of package transfer (unicast or multicast) are the elements that influence the selection of models and architecture of the network multimedia delivery.[15]

Two most important tasks in designing systems are the selection of a platform for delivering the Internet video content and the selection of accompanying services. Example where careful designing is important is distance learning system where teachers use different hybrid formats of course materials.[16] One of the new challenging tasks is to provide ubiquitous personalized multimedia services. Due it involves heterogeneous entities software platform is very im-

12 Cole, S. G., Spalding, L. and Fayer, A. (2009), "The Brand Value of Rich Media and Video Ads", in DoubleClick research report, New York, USA ,2009.

13 Rosenkrans, G. (2009), "The Creativeness and Effectiveness of Online Interactive Rich Media Advertising", Journal of Interactive Advertising, Vo. 9 No. 2.

14 Dickinger , A. and Zorn, S. (2008), " Compensation Models for Interactive Advertising", Journal of Universal Computer Science, Vol.14 No. 4 , pp. 557-565.

15 Conklin, G. J., Greenbaum, G. S., Lillevold, K. O., Lippman, A. F. and Reznik, Y. A. (2001), "Video Coding for Streaming Media Delivery on the Internet". IEEE Transactions on Circuits and Systems for Video Technology, Vol. 11 No. 3, pp. 269-281.

16 Katz, S. M. (2008), "Assessing a Hybrid Format", Journal of Business and Technical Communication, Vol. 22 No. 1, pp. 92-110.

portant here. Software platform which has the service-oriented system architecture and contains different collaborating components represents a very effective solution.[17]

In the case of in-stream advertising, in order to deliver video content in an efficient and high-quality manner, appropriate ad-serving network is necessary. Its main role is the delivery of big video files from service providers of video content to the users who view a web page. When the users view the page which contains a big video file, the web site that is browsed does not send video content to the user. It provides series of links that direct user to the address from which serving network delivers video contents to the user. The redirection is performed in the same way in case of live stream videos, as shown in Figure 1.
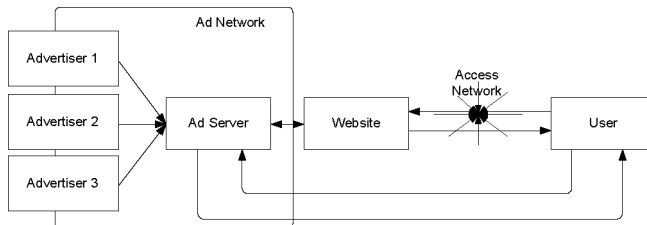

Figure 1. Role of serving network in the system of online video advertising. [18]

The most important element of the online information delivery system is the platform for placing the content. Figure 1 show that online video advertising platform includes three main components: video server on which videos are saved, video content player which presents the video to the user and system for displaying advertisements.

In most cases, video server, player and the system for displaying advertisements are tightly integrated systems that make up a single platform. The downside of such an approach is its closeness that limits the advertisers to advertise only on the media that are within one technological system. This prevents the owners from reaching advertisers using other types of platform and vice versa. Given these facts, the standardization issues are an important field of research in order to deploy universal and optimal platforms for placing online video content.

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17 Yu, Z., Li, C., Zhou, X. and Wang, H. (2010), "A Service-Oriented Platform for Ubiquitous PersonalizedMultimedia Provisioning", Journal of Universal Computer Science, Vol.16 No. 10, pp. 444-452

18 Vratonjic, N., Freudiger, J. and Hubaux, J. P. (2010), "Integrity of the Web Content: The Case of Online Advertising", in Usenix CollSec'10, Washington, DC, USA, 2010.

Standardization issues

Online information modeling and delivery is closely related to standardization process. It is especially important for online video information-based applications such as: online video advertising, distance learning, teleconference etc. One of the associations that actively participate in defining the standards and recommendations for video advertising in order to overcome the existing shortcomings is IAB (Interactive Advertising Bureau).[19] IAB has defined the standard VAST 2.0 (Video Ad Serving Template 2.0) which enables the standardization of advertising and provides a rapid approach to a greater number of advertisers.[20] There are two ways in which the online media place video advertisement: directly through the platform for displaying video content or dynamically invoking the advertisement from an external server. VAST 2.0 standard offers the upgrade of components of the platform for serving video content that deals with displaying online video add in such a way that it is possible to accept the ads from external systems.

TRENDS OF ONLINE VIDEO INFORMATION PLACING

Video content has increased so much in only a couple of years, that now it makes the biggest share of online traffic in the world. This is supported by predictions of traffic growth until 2015 made by Cisco Company, that is shown in Figure 2.
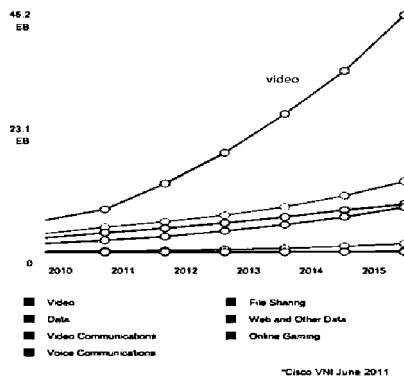

Figure 2. Expected growth of Internet traffic, shown for individual types of content[21]

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19 Interactive Advertising Bureau (2008), "Digital Video Advertising Overview: A Platform Status Report", available at: http://www.iab.net/iab_products_and_industry_services/508676/digitalvideo/509238
20 Interactive Advertising Bureau (2009), "Digital Video Ad Serving Template (VAST) 2.0", available at: http://www.iab.net/vast
21 Cisco Systems (2011), "Cisco Visual Networking Index: Forecast and Methodology, 2010-2015", available at: ttp://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481360_ns827_Networking_Solutions_White_Paper.html

In addition, it was shown that social networks generate more traffic both between themselves and towards external web sites, so that video content has an increasing share in total traffic.[22] Studies on advertising trends also show that online advertising marks a significant growth on a yearly basis.[23] [24] There are many research papers about the impact of technology on the Social Web [25] and of advertising on social networks[26] which show constant growth of online information use.

Online information placing in Web 2.0 environments

The development trend of online information placing can be presented with two different generations: era 1.0 and era 2.0. Era 1.0 represents a conventional, contextual manner of advertising that uses text as carrier of the content that is in the function of advertising, while 2.0 represents inline advertising model that mostly uses image or video as a carrier of advertising information. Contextual manner of advertising positions data on fixed positions around the content, while in case of inline advertisement, the ads are delivered embedded within contents that the user views.[27] The applications in Web 2.0 environment expect much greater interaction between advertiser and users.[28] [29]

Serving video content development trends

There are two main approaches to displaying Internet video content. First, there is the use of a web browser with appropriate plug-ins that contain software for displaying appropriate type of video content (Adobe Flash file), and the second is the use of stand-alone media players (Quick time player) that have different video decoders installed.[30] The important trends in serving video content are as follows:

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22 Tubemogul (2010), "Brightcove & TubeMogul: Online Video & The Media Industry Quarterly Joint Research Report, Q2 2010; Special Feature: Brand Marketers & On-Site Video Initiatives", available at: http://www.tubemogul.com/research/report/34

23 [18]   Pricewaterhouse Coopersand (2009), " IAB Internet revenue advertising report (2009), An Industry Survey", available at: http://www.iab.net/media/file/IAB-Ad-Revenue-Full-Year-2009.pdf

24 [19]   Pricewaterhouse Coopersand (2010), "Q3 '10 Internet Advertising Revenue Press Release",available at: http://www.iab.net/about_the_iab/recent_press_releases/press_release_archive/press_release/pr-111710

25 Potts, L. and Jones, D. (2011), "Contextualizing Experiences: Tracing the Relationships Between People and Technologies in the Social Web", Journal of Business and Technical Communication, Vol. 25 No.3, pp. 338-358.

26 eMarketer (2010), "Social Network Ad Spending: 2010 Outlook", available at: http://www.emarketer.com/Report.aspx?code=emarketer_2000621

27 Hua, X. S., Mei, T. and Li, S. (2008), "When Multimedia Advertising Meets the New Internet Era", in 'MMSP' , IEEE Signal Processing Society, pp. 1-5.

28 Mei, T., Hua, X. S. and Li, S. (2009), "VideoSense: A Contextual In-Video Advertising System", IEEE Trans. on Circuits and Systems for Video Technology, Vol.19 No.12, pp. 1866-1879.

29 Mei, T., and Li, S. (2011), "Contextual In-Stream Video Advertising", In Hua, X., Mei, T., Hanjalic, A. (Eds.), Online Multimedia Advertising: Techniques and Technologies, IGI Global, pp.194-211.

30 Simpson, W. (2008), Video Over IP IPTV, Internet Video, H.264, P2P, Web TV, and Streaming: A

a)   *Placing video content in mobile phones*

One of important requirements is the support for HTML5. Additional recommendation is that the software should fully support WebM concept, which also implies the support for VP8 video codec. Meeting these requirements it would enable placing video content regardless of the type of device used for accessing the Internet. Streaming video placing with cost-effective rate control is one of the fields of study as well.[31]

b)   *Improving the interactivity with the user*

The main tasks that the system should accomplish for the purpose of interaction with the user are:

- *Video transcoding*: Service provider should be able to store video recordings on several quality levels, which enables the users to choose the quality of the video which they want to see, depending on the established quality of connection.
- *Integration with social networks*: Integration with social networks and search engine optimization (SEO) increase the traffic that comes on the system. Increased interactivity and dynamics, aimed at receiving acceptance by a potential user community, can be realized by using video annotation that supports pluggable video mark up elements and graphical authoring environment.[32]
- *Cooperation and collaboration:* Important issues are possibility of cooperation and collaboration between the participants on one project during all phases of analysis and processing of multimedia materials. Different types of collaboration content and tasks are the topics for further research.
- *Configurability:* Adjusting the outlook of the interface and usage of other applications for viewing materials improves the options for video streaming.[33]

c)   *Improving the technical aspects of online information delivery*

- Standardization. Standardization is a crucial factor for the pervasive online multimedia delivery. The importance of standardization can be illustrated by the role of the VAST 2.0 standard in online video advertising systems.

Complete Guide to Understanding the Technology, Elsevier, USA.
31 Hong, Y. and Park, H. (2011), "A Cost-Effective Rate Control for Streaming Video for Wireless Portable Devices," Proceedings of TIIS, Vo. 5 No6, pp. 1147-1165.
32 Schultes,P., Lehner, F. and Kosch, H. (2011), "Markup upon Video –towards Dynamic and Interactive Video Annotations", Journal of Universal Computer Science, Vol. 17 No. 4, pp. 605-617.
33 Ornellas, A., Domingo, M. G., Marín, A. and Delisau, F. S. (2010), "Open video tools to support the production of online collaborative audiovisual projects: How to promote collective creation in e-learning", in Proceedings Barcelona OPEN ED 2010 The Seventh Annual Open Education Conference, Spain, 2010, pp.325-337.

- Hardware optimization of a system . It is important for the software to be optimized for a big number of simultaneous connections, to support the installation on many servers, as well as load-balancing between them.

RESEARCH METHOD

Based on the trends of developing the online video delivery systems and the functionality that the systems should achieve, a few important characteristics can be observed:

- Access to source code, free exchange, update and modification of open code,
- Possibility of connection with other program solutions,
- Low ownership costs,
- Open exchange of experiences among a bigger number of users of that solution.

In order to reduce the costs of service realization and possibilities for later expansion of the system for online video delivery, the existing open source solutions are important. The majority of software solutions that carry a label "open-source" do not function by the principle of free modification and announcement of the code, but for certain fee they provide an access to software with a source code, but without a right to further announce the changes. Although this is not in the spirit of "open-source" software, still some of these solutions are taken into account, because they offer full access to software code, and thus the possibility of adjustment at a low price. There are several platforms for displaying video content that should be analyzed in more detail.

Characteristics of test environment

Within longer research period, during preparation of master thesis which aims to investigate different concepts of online video advertising, adequate test bed has been realized and testing of video delivery platforms were performed.[34] For the purpose of experimental testing of the possibilities of the mentioned software, trial installations of each of these software solutions were performed.

Hardware component of test environment consists of two main parts: servers with installed selected software and Internet connection through which we access the video content. Applicative server and database server have similar main characteristics: 2 x Intel® Xeon Quad-Core E5620 2.40 GHz processor, 6x 1GB Server 1333MHz DDR3 Reg. ECC memory, 2 x

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34 Orlic, N, (2010), "Implementacija sistema za online video oglašavanje"-master rad, Fakultet organizacionih nauka, Univerzitet u Beogradu.

Western Digital 320GB SATA. Storage server is realized with 16TB capacity, which is quite enough for conducting the experiment.

Having in mind that service which we would like to test and implement is developed for Serbian market and with expectations that the major part of Internet traffic that it generates comes from Serbia, i.e. domestic Internet providers, domestic Internet exchange point has been used. From previously mentioned reasons, the solution is for all the servers set on domestic point for traffic exchange - Serbian Open Exchange (www.sox.rs). Most domestic Internet providers are connected to this point, which means that if the central hardware of the platform is set on this knot, it would be the shortest way to the user, with the least Internet load capacity. Therefore, the Internet connection with 1Gbps at the exchange point is provided and 200mbps Internet link out of the exchange point.

The equipment used in the testing environment, as well as the parameters of connection that are achieved within the exchange point of Internet traffic, are easily upgradeable and can be changed, if necessary. The specification offered provides a simultaneous review of 2000 video files for compressed bitrates of 512kpbs, which entirely satisfies the initial needs of the system.

Testing methodology

In order to perform an experimental research that could be deployed in practice, the online video advertising process has been tested and analyzed. In the evaluation stage we have taken into consideration the parameters that are most important in terms of implementation, maintenance, functionality and economic viability. The parameters that were taken into account are: the easiness of installation, hardware requirements, the most important technological characteristics, supported options for serving online video content, supported options for online video advertising (an example of the online video based business application), written code quality, support of manufacturer, support of community.

Given that all the platforms tested exist in several editions and with different possibilities and manner of licensing, the tables contain information that a software owns a characteristic if it is supported at least in one (most frequently the more advanced) version offered. After installing each of the software solutions, we can observe that the process of installation and initial administrative settings for the purpose of management and use is relatively simple in case of Dzoic Cliphouse, ClipShare while VIMP and Kaltura require a lot more knowledge, work and administration.

RESULTS AND DISCUSSION

The most important technological characteristics of the tested software are systematized, as shown in Table I.

Table I. Comparative review of technological characteristics important for serving Internet video

OPTION NAME	DZOIC Cliphouse	ClipShare PRO	VIMP	Kaltura
H.264/MP4	Yes	Yes	Yes	Yes
HTML5	No	No	No	Yes
RTMP	No	No	No	Yes
Multi-server	Yes	Yes	Yes	Yes
RSS	No	Yes	No	Yes
Live streaming	No	No	No	Yes
VP8	No	No	No	Yes
Plug-in modules	Yes	Yes	No	Yes
Embeddable HTML	Yes	Yes	No	Yes

Testing results show that only Kaltura software provides the placement of video ads on mobile devices, due to support for HTML5 and VP8 codec. In addition, the support for RTMP for the purpose of implementing live streaming is present only in the case of Kaltura. An overview of serving video content and interface characteristics for the purpose of a more efficient interaction of participants is given in Table II.

Table II. Comparative review of interface characteristics and options of serving video content

OPTION NAME	DZOIC Cliphouse	ClipShare PRO	VIMP	Kaltura
SEO friendly	No	Yes	Yes	Yes
Overlay logo	Yes	Yes	Yes	Yes
Youtube grabber	Yes	Yes	Yes	Yes
Multilingualism	Yes	Yes	Yes	Yes
Video galery	Yes	Yes	Yes	Yes
User groups	Yes	Yes	Yes	Yes
Social bookmarking	Yes	Yes	Yes	Yes
Transcoding	No	Yes	Yes	Yes
Statistics	Yes	Yes	Yes	Yes
Rating system	Yes	Yes	Yes	Yes
Video channels	No	Yes	Yes	Yes
Titles	No	Yes	No	Yes

Batch upload	No	No	Yes	Yes
Online video editor	No	No	No	Yes
Browsing	Yes	Yes	Yes	Yes

It was confirmed that only Kaltura supports the possibility of online video editing through an additional module named Remix. This provides an independent editing and publishing of a video content, resulting in an increased interaction between all participants and users of the advertising system. For the purpose of analyzing the application in the systems of online video advertising, the possibilities and manners of entering advertising content have been tested, as well as the standards that are in the function of universal application of the online video advertising platform.

The review of options for online video advertising of each of the solutions tested is shown in Table III.

Table III. Review of software characteristics important for online video advertising

OPTION NAME	DZOIC Cliphouse	ClipShare PRO	VIMP	Kaltura
Pre-roll	Yes	Yes	No	Yes
Mid-roll	Yes	Yes	No	Yes
Post-roll	Yes	Yes	No	Yes
Non-linear	Yes	Yes	No	Yes
VAST 2.0	No	No	No	Yes
Adap.tv	No	No	No	Yes
Tremor media	No	No	No	Yes

Kaltura obviously stands out, as it is the only one that meets video advertising standards such as VAST 2.0, Adap.tv and Tremor media, which enable the displaying of advertisements between various platforms. In addition, the possibilities of accessing all potential advertisers are extended.

The most important characteristics that distinguish Kaltura software in relation to others are:

- Modular architecture based on development of individual modules opens unlimited options for development and implementation.
- Interactivity that is provided by this solution is rather wide, which is shown by possibilities of connection with different CMS tools and the possibility of collaboration of a bigger number of system users. The possibility of cooperation between users on one project during all phases of analysis and processing of the multimedia content is particularly useful. Online editor Remix, which is one of the available extras, provides independent editing and publishing of video materials.

- Placement of online video ads in mobile devices is enabled by the fact that Kaltura supports HTML5 standard and VP8 video codec. Therefore, Kaltura is a constituent part of WebM concept and a broad initiative for system implementation for mobile video advertising.
- A possibility of video streaming is available because Kaltura supports RTMP protocol.
- Kaltura provides possibility to adjust the outlook of the interface, use other applications for viewing the materials or set options of live streaming.

When commercial conditions of usage are considered, it has been observed that, for each of the solutions tested, there is one or more commercial software versions, appropriate commercial support of manufacturers, as well as the support of community for the purpose of identifying and solving potential problems and deficiencies. Test results clearly show that Kaltura offers the biggest number of options to the user. At the same time, Kaltura is the only real OpenSource software and this is the reason why Community Edition version was selected as a basis for the implementation of the system for the needs of this paper.

Based on analysis of systems architectures, characteristics and goals, findings and results obtained within this paper and closely related researches[35], Kaltura can be selected as the optimal solution.

CONCLUSION

The possibilities, technical characteristics and development trends of online video delivery using online video advertising as a good example, are described in this paper. In order to implement the pervasive online video delivery, the most important characteristics that the system should meet are determined. The evaluation and comparative analysis of selected and implemented platforms have been carried out.

A comprehensive analysis of four open solutions shows that Kaltura is the most serious open source platform for serving video content. Kaltura can meet the most significant demands of video delivery system technical platform: high-quality delivery of video content on different websites, easy adding and maintenance of a big amount of video materials, collaboration and video content editing.

The openness of the system for integration with other technical solution for online video placing is an important advantage of Kaltura. In the case of

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35 Orlic, N, (2010), "Implementacija sistema za online video oglašavanje"-master rad, Fakultet organizacionih nauka, Univerzitet u Beogradu.

online video advertising, displaying video ads gives Kaltura a rapid and pervasive access to potential advertisers. The findings show that Kaltura meets the main requirements of the modern online video delivery platform:

- Increase and optimization of interaction among all system users.
- Increased effectiveness of delivered interactive multimedia content.
- Development of video delivery system with the aim of placing it in mobile phones −mobile online video delivery.
- Development and implementation of standards for online video delivery. This is especially obvious regarding standardization of online video advertising.
- Improvement of technical parameters related to online video placing.

The paper also illustrates that Kaltura is one of the best solutions that offer the possibilities of continuous extending, implementation of valid standards of video online advertising and implementation of ads oriented towards all potential advertisers and users. The modular architecture of Kaltura enables a scalable implementation of the system for online video advertising with dynamics defined by the phases of designed solution. This characteristic, as well as all others that set Kaltura apart from other tested solutions, makes it the best choice of platform for serving video content in a developing country.

In our future work, the multimedia mobile delivery will be studied, with special focus on the mobile education application. The online information delivery, using the users' Quality of Experience (QoE) as the measure of effectiveness, will be analyzed in detail as well.

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