Системы телекоммуникации, связи и защиты информации

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Modeling Web 2.0 Systems

Представлены инновативные подходы, архитектуры и модели построения новых сервисов в телекоммуникационных сетях при использовании систем Web 2.0. Исследуются основные параметры и ограничения современных высокорентабельных Web-систем. Авторы осуществили попытку создания количественных моделей систем Web 2.0 с применением методов системного анализа (*System Analysis*) и исследования операций (*Operations Research*). Предложена экономическая модель электронного бизнеса, построенная на функции Кобба-Дугласа.

Advanced business approaches, the architectures and models of new services in the telecommunication networks based on Web 2.0 systems are examined. Main metrics and boundaries of the modern high-profitable business models in Web are investigated. The authors have done an attempt to introduce quantitative models of Web 2.0 systems into the world of *System Analysis* and *Operations Research*. An economic model of electronic business, based on Cobb-Douglas function, is proposed.

Ключевые слова: *системный анализ, исследование операций, новые сервисы в телекоммуникационных сетях, архитектурные решения для сервисов, Web 2.0, Semantic Web, высокорентабельные модели бизнеса, функция Кобба-Дугласа.*

Introduction

Web 2.0 means the next step in the development of web systems, which is characterized by an increasing role of socialization of the offered web presentations with a simultaneous tendency to augment them with useful meta-information aimed to efficient and easier search for specified context. Web 2.0 systems are characterized as high-innovative and risk-effected; therefore the thorough planning of these systems is very important. This paper provides a brief overview of common principles, technological models and selected case studies of Web 2.0 applications.

Based on this analysis, the economic model of Web 2.0 applications based on ***Cobb-Douglas productivity-utility-progress function*** [1] is proposed. The authors don’t pretend on the information totality and cannot consider all available particularities of this newest dynamically growing market the business models. The purpose is to describe the business models qualitatively and to show, how the relevant factors influence the success of the Web 2.0 systems.

1. Technological models of Web 2.0 systems and Semantic Web

Intellectualization of web-search functionality is supported by the development of the following concepts and technologies [2, 3]:

1. Advanced Web technologies that facilitate the development of adaptive, resource aware and semantic augmented web applications. The most prevalent examples are:

– ***AJAX (Asynchronous JavaScript and XML)***, which enables the dynamic and resource-aware update of web pages. A row of program languages and frameworks based on AJAX like ***Ruby on Rails*** support the agile development of Web 2.0 applications.

– ***Web Services*** that facilitate the integration of heterogeneous applications over web.

2. Up-to-date concepts of distributed data retrieving and content management technologies ***(SAN/NAS – Storage Area Network/ Network Attached Storage, Wiki)***.

3. ***Semantic Web*** and creation of semantic-aware Web presentations, which is supported by ***SPARQL (Simple Protocol and RDF Query Language)*** and ***REST (Representational State Transfer)***.

4. Deployment of advanced advertisement techniques and appropriate ***business models.***

The principles and mechanisms of Web 2.0 are depicted in Fig. 1. The important mechanisms [2–4] of involving the users to participation and decreasing of advertisement expenditures are presented, namely re-combination, collaborative filtering and structuring to virtual worlds.

They are set upon such technologies as ***AJAX, Ruby on Rails*** and Semantic Web (at first based on ***RSS***, ***Really Simple Syndication,*** to the news and advertisements, then on ***OWL, Web Ontology***

Language). As an important part of Web 2.0, Semantic Web [2–4] creates so called semantic-aware applications, based on ontologies.
The Semantic Web technological stack is depicted in Fig. 2. The ontologies on OWL basis are used among others to provide the vocabulary for ***RDF (Resource Description Framework)***descriptions in ***URI***-linked XML-content ***(XML – eXtensible Markup Language)***. The semantically annotated information can be queried via ***SPARQL (Simple Protocol and RDF Query Language)*** query language.

A unified logic is developed for deriving new information. The content and mechanisms are secured via digital signature and encryption techniques as well as ***ACL (Access Control Lists)***. The semantic-aware content can finally be verified and validated. Sometimes unified rule formulation in ***Rule Interchange Format (RIF)*** is supported. Three important preconditions [2–4] should be fulfilled in order to advance the development of Semantic Web Applications:

1. availability of tools that simplify the development of ontologies and annotation data;
2. availability of common programming language frameworks to process semantic data;
3. demo applications that present the usefulness and possibilities.

The common process of creation and publishing of semantic-aware Web data and applications is depicted in Fig. 3. The SPARQL search engines and OWL frameworks provide access, browsing and sharing functionality for a Semantic Web repository, which collects and retrieves ontologies built on the existing “classical Web” content [2–4].

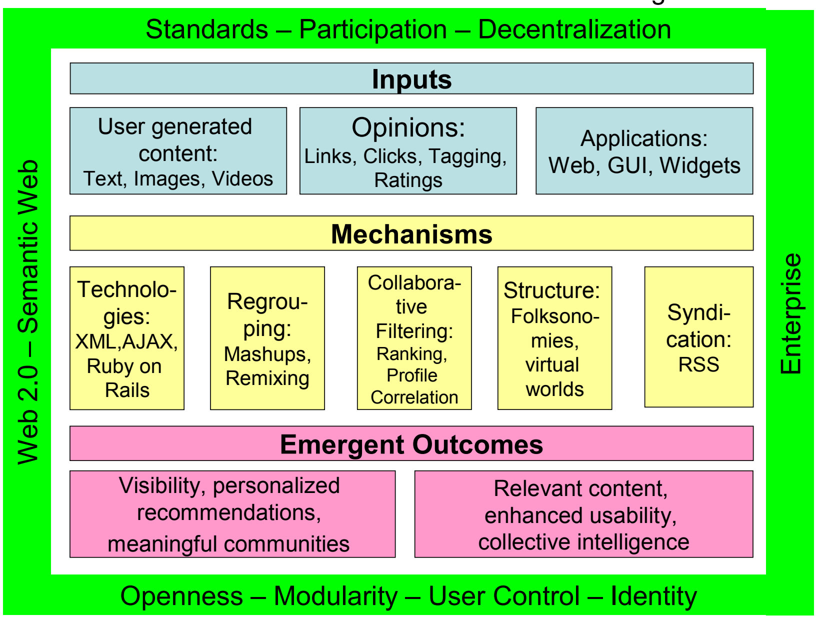

Fig. 1. Principles and mechanisms of Web 2.0

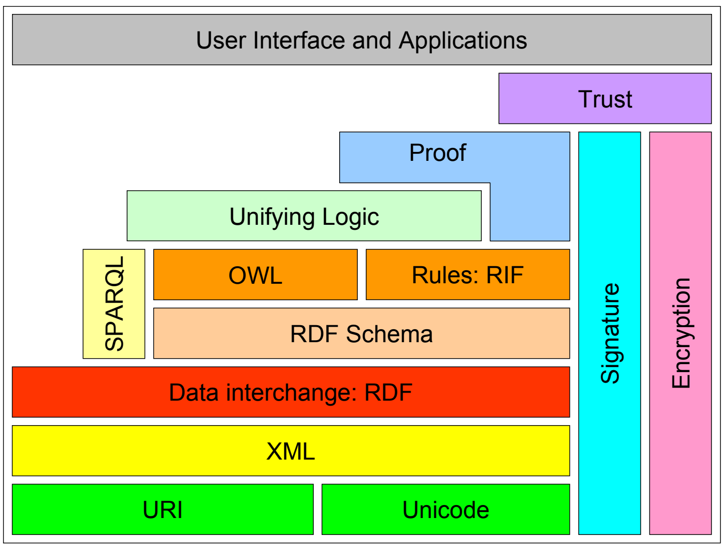

Fig. 2. Semantic Web Stack URI – Unified Resource Identifier, RDFS – Resource Description Framework Schema

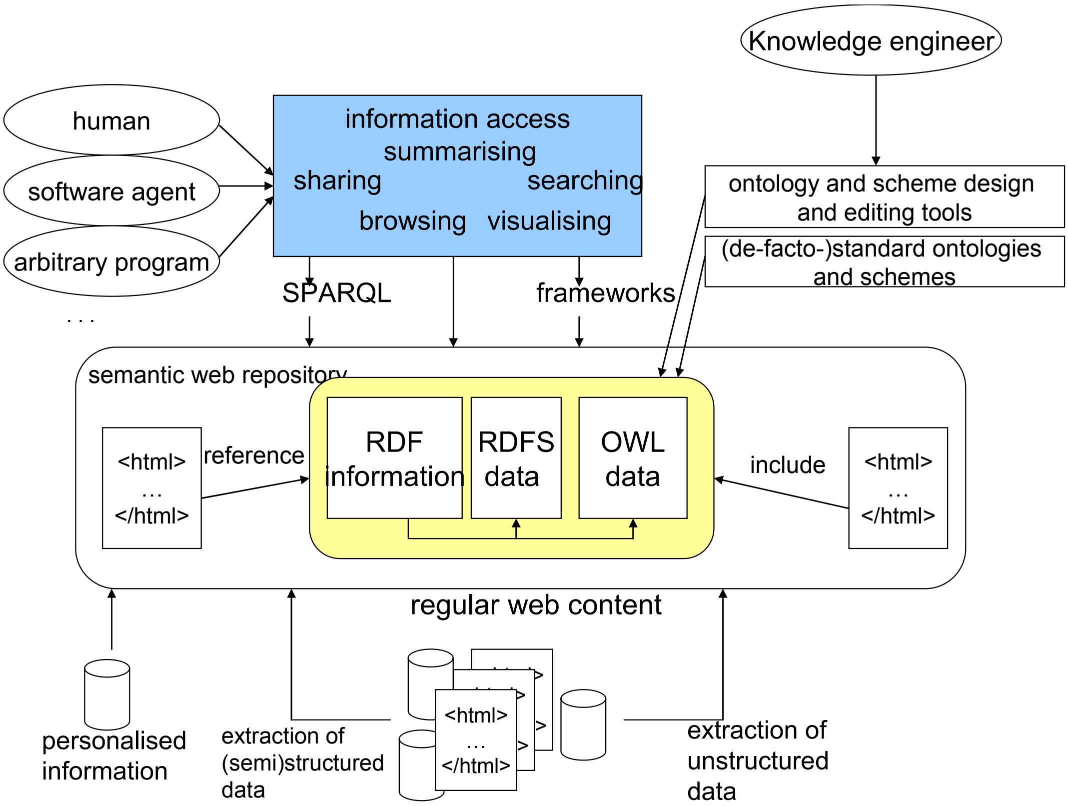

Fig. 3. Structure of a semantic-aware application

2. Business models of Web 2.0 systems

This Section discusses the main ***business models*** for Web 2.0. Commonly, a business model describes how you can get profit with Web 2.0, i.e. social Web and semantic-aware Web applications. The authors try to separate the specific exemplars of Web 2.0 business models and certain ***common principles*** of their application.

The common idea of e-commerce is to create a large or, vice versa, a focused niche in the user community. The ***common approaches*** of niche wrapping are:

1. data purchasing to the partners;
2. purchasing of access to certain API (Application Programming Interfaces), for instance, ***Google***;
3. value-added platform purchasing, for instance, ***Amazone Web Services***;
4. services purchasing to a large group of the small and middle range enterprises, for instance, ***Salesforce.com***;
5. shared transaction revenue (***eBay, Molotok.ru, Auction.ua***);
6. advertisements and banners re-grouping etc. [2–4].

The examined approaches let also their ad hoc combination. The presented ***common architecture*** (Fig. 4) shows how the interested Web 2.0 parties co-operate.

The consumers use one or several central portals instead of collecting information fragments from different sites themselves [2–4]. They consume in that way also secondary information in the advertising form. Under the assumptions that all relevant content providers participate in this process and that Semantic Web mappings between different description schemata are possible, large parts of the information in the head and long tail market would be available in an open and machine-processible manner.

The Web 2.0 uses essentially the same business models as usual web applications, extending them with further functionality. The following **particular business models** of Web 2.0 can be distinguished [2–4]:

1. charge-duty service (money comes from charge for services, payment for one use or for one month). Example: information services an portals;
2. sale of third products. Example: ***Amazon.de, Quelle.de***;
3. advertisement sell, mostly based on banner clicks;
4. classical companies web presentations aimed for sale of own products;
5. services with social component, which include the ordinary services like ***WeddingMapper.com*** as well as unusual, uncommon services like ***Defender.com.***

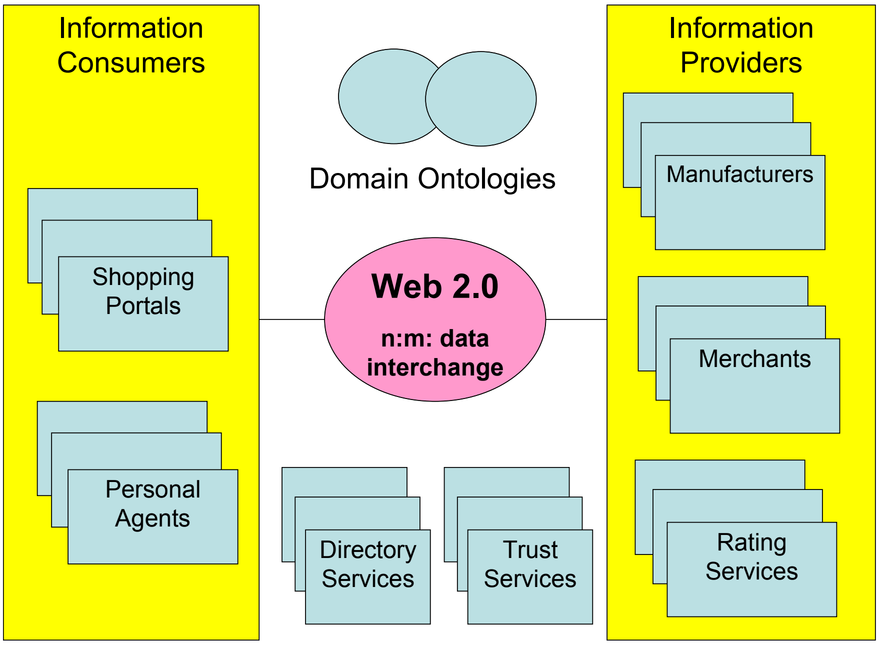

Fig. 4. Web 2.0 business models creation architecture

So, the Web 2.0 functionality may be used for better customer feedback, such as:

- charge-free services (money comes from banners/advertisement), for example, ***StudiVZ.de, Odnoklassniki.ru, Google***;
- Wiki of some company/community (Benefit: facilitating the communication between participants).

Some examples of services in web are demonstrated below.

StudiVZ with several million users can be considered as a community of students as well as a social network between students. The revenue is based on contextual advertising and sales of additional products and services. After first 15 month of its existence ***studiVZ*** was sold for ca. 85 million EUR. This community is that valuable due to its high number of members and due to the information they offer about their interests and social connections. ***Amazon*** and ***E-Bay*** have dimensions fewer than 10 million users. Approximately 40 % of overall book sales are nowadays offered not by physical book stores but by virtual stock-markets like ***Amazon.*** Principles of Web 2.0 business models are shown in (Fig. 5).

Common approaches, approved architectures as well as particular exemplars are examined in [2–4]. The common business models are discussed in next Section.

3. Principles and properties of business models in Web 2.0

As mentioned, the Web 2.0 adds new features to the established business models. The examples of these new features are ***Mash-ups, Long Tail Leveraging*** and more exotic but quick-acting ***Holding-up of Web Reputation*** [2–4] that are characterized below.

3.1. Mash-up principle

Web 2.0 applications can combine the generated content to a new beneficial quality. The sophisticated placement of the banners activates commercial interest of targeted users, which belong to a certain social group or are searching for proper product categories, events or services.

The Mashups use the available APIs provided by other web applications. For example, the ***WeddingMapper.com*** offers the secondary mashed-up meta-information. The WeddingMapper.com uses the API of Google Maps and shows all wedding locations (ceremony, restaurant, hotel, etc.) inside a selected Google Map. A map showing the locations can be sent by email with accompanying advertisements or can be integrated into other Web sites [2–4].

3.2. Long tail leveraging

Long tail (Fig. 6) is a lifetime property of a lot of new services and goods, indicating that after the initial run of users to a new service, only a part of there users will use the service in the long perspective. This principle should be considered by Web 2.0 business models. The service developers should debate if they get money from the new users or from so called long-tail (regular, registered customers). As the Web 2.0 systems developers noted, *“The Long Tail is the realization that the sum of many small markets is worth as much, if not more, than a few large markets.”* [2–4].

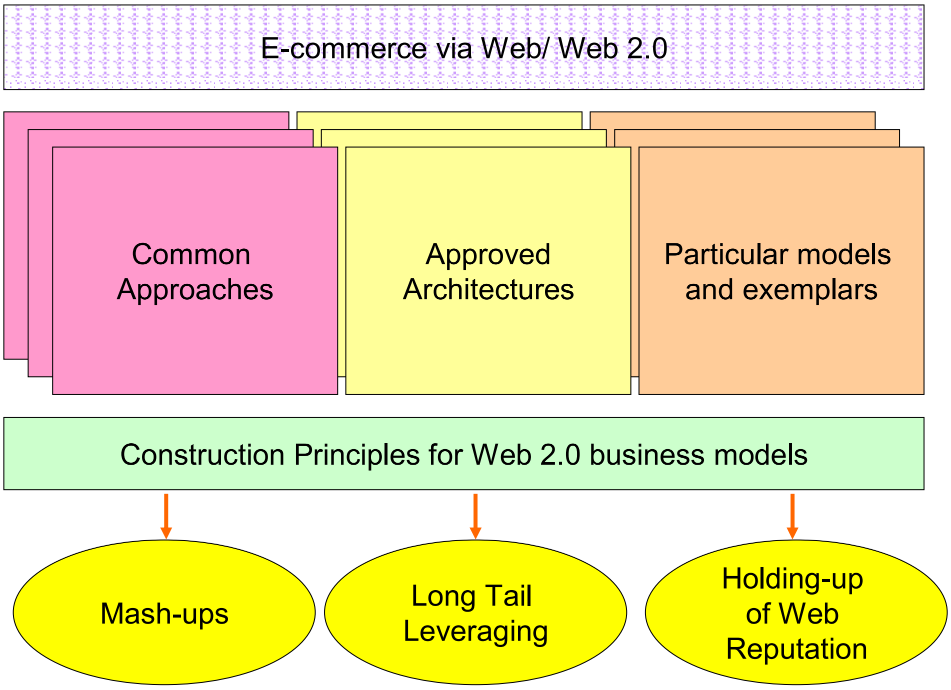

Fig. 5. Principles of Web 2.0 business model

3.3. Holding-up of web reputation

Holding-up principle for so-called ***Web reputation level*** is possible grace to destroying of unwished content molecules (information parts) that can be built by on critical atomic context combinations, frequently given in Weblogs (for instance, personal data, like address, birth date, and family circumstances) [2–4]. Each atomic datum alone is secure; their combination (molecular data) is insecure and can lead to personality thefts. Semantic-aware web security applications like ***Reputation Defender.com*** search for critical combinations and re-group them (destroy wrong molecules), clean wrong personal web acts and critical presentation data. This demonstrates the agility of Web 2.0: it may be beneficial not only by offering or structuring of new information, but also by destroying it.

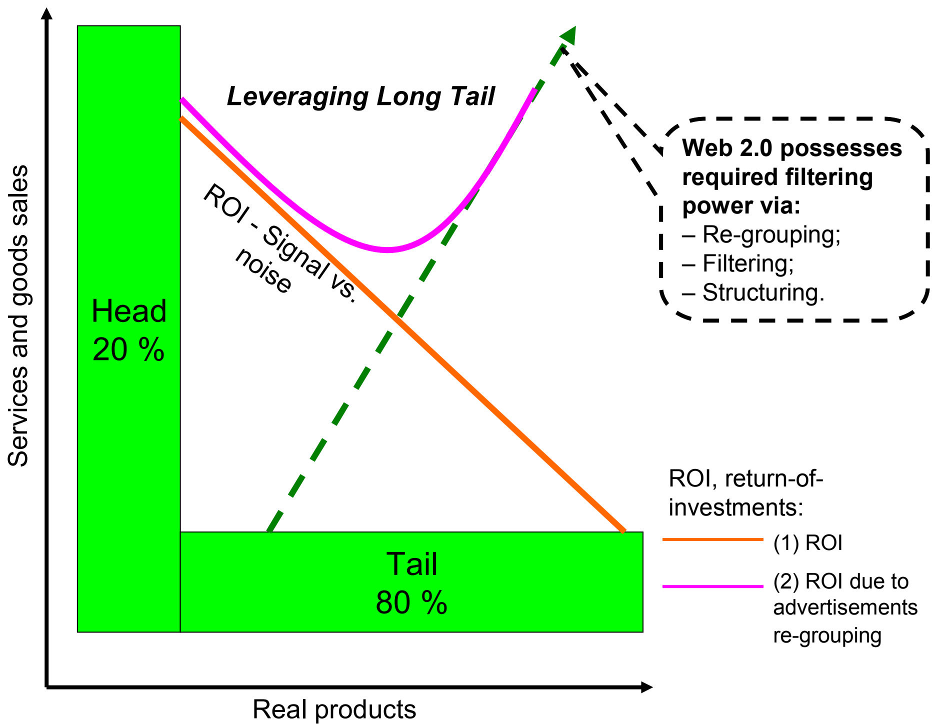

Fig. 6. Long tail leveraging principle

4. An economic model for a Web 2.0 system

For a lot of classical Web systems the revenue can be defined by the following approximating formula:

$$R = R_u \cdot U + R_c \cdot C, \quad (1)$$

where R – output revenue of a Web system, EUR, R_u – average revenues per user, R_c – revenues from one click (offering an advertisement or looking a banner), U – an average number of registered users, C – an average number of processed clicks. The optimization of the profit should include the thorough and realistic evaluation of market situation for Web 2.0 and possible revenue development scenarios. This market analysis may be very complex and vague, so it is out of scope of this article. Instead of that, the analysis of revenues and costs for different deployment scenarios is made.

Due to lack of statistically relevant real data, the common evaluation of the possible revenue threshold is examined. The dynamic revenue $R(t)$ of Web 2.0 systems can be estimated by adoption of the ***Cobb-Douglas productivity-utility-progress function*** known from macroeconomics as follows:

$$R(t) = b \cdot K^r(t) \cdot L^{1-r}(t) \cdot e^{\frac{t}{\tau}}, \quad (2)$$

where b – proportionality factor, K – capital input (expenditures), L – labor input expressed via development costs for the Web 2.0 system, r – the output elasticity of labor and capital, respectively determined by available technology, τ – software and content modernization period, $m = \frac{1}{\tau}$ – rate of technological progress expressed via increasing motivation and economical user interest, t – time factor.

By the authors' opinion, this formula is good adapted to the case of Web 2.0 systems (***folksonomies, syndications, collective intelligence, mash-ups***) [2–4], which emerge also as a sort of social-significant production kinds inspiring significant increasing of economical interests. And as it is shown by modern developments, even not only for "long-tail market" niches!

The formula (2) maps existing correlation between reached dynamical revenue at time moment t and direct expenditures E into Web 2.0 systems: costs for hardware and network infrastructure, EUR; their development complexity, id est labor in human-month or years as well as increasing economical interest and motivation measured in technical progress rate, EUR per annum, in the similar way like by industrial goods and products. The both modeled values (K, L) map implicitly the number of processed clicks and registered users (C, U). Increasing of (K, L) can be caused by increasing of both parts of the pair (C, U). For instance, more infrastructure expenditures for SAN/NAS for service availability and reliability leads to increasing of capital input. Re-grouping, mash-ups and filtering of content lead to more costs for software development and maintenance by the specialists and increase labor input. The used platform (Web 2.0 and Semantic Web) provides the monotonous revenue increasing in time with rate $m = \frac{1}{\tau}$ as result of productivity growth due to application of modern technologies. Using (2), the used cost-profit-optimization model can be further simplified as shown below:

$$ROI(t) = \frac{R - E}{E}, \quad (3)$$

where $ROI(t)$ – return-of-investments (ROI), E – common expenditures, EUR. The Web 2.0 system expenditures can be represented as sum of the Cobb-Douglas inputs (K, L):

$$E = K + L. \quad (4)$$

Then, the ***generalized ROI model*** based on Cobb-Douglas function can be formulated as follows:

$$ROI = \frac{R}{K + L} - 1 = \frac{b \cdot K^r \cdot L^{1-r} \cdot e^{\frac{t}{\tau}}}{K + L} - 1, \quad (5)$$

where K – characterizes investments for hardware, network, SAN/NAS infrastructure and software, EUR, L – yearly labor expenditures for Web 2.0 software, content and advertisements development, EUR/year, τ – software and content modernization period, year, (r, p) – elasticity coefficients that express the relevance of the corresponding factors. After a simple modification (5) obtains the following representation:

$$\begin{gathered} y = \frac{L}{K}, \; p = 1 - r; \\ ROI = -1 + \frac{K^{-1}}{1/K} \cdot \frac{b \cdot K^r \cdot L^{1-r} \cdot e^{\frac{t}{\tau}}}{K + L} = \\ = -1 + \frac{b(L/K)^{1-r} \cdot e^{\frac{t}{\tau}}}{1 + (L/K)}; \\ ROI = \frac{b \cdot y^p \cdot e^{\frac{t}{\tau}}}{1 + y} - 1, \end{gathered} \quad (6)$$

where y – yearly ratio of labor expenses for software and common expenditures for hardware, $year^{-1}$.

The introduced ratio variable y demonstrates the mutual dependability of Cobb-Douglas labor and capital inputs. The generalized model that is formulated in (6) becomes therefore simpler under use of the most significant factors. Increasing of expenditures can be caused by increasing of costs $K(t)$ during operation time of hardware und network infrastructure (SAN/NAS). The administration expenditures and law-regulated annual amortization rate can be considered as shown in [5-8]. The corrected value of capital input can be given as follows:

$$K(t) = K(0) \cdot a(t),$$
$$a(t) = 1 + \frac{1}{(1+z)^t - 1}, \qquad (7)$$

where $a(t)$ – law-regulated annual actual cash value factor (expressing deployment, amortization, modification, operation phases), z – law-regulated annual amortization constant rate. But we neglect this influence in this work. The peculiarities of networks cost models are given in the authors' works.

5. Case studies

The assumed values for variables and constants of the offered economic model are given in Table.

The overall expenditures for a Web 2.0 platform deployment are bounded under threshold of 4 million EUR. The labor input is more expensive than infrastructure by some factor (here especially in three times). The revenues and ROI dynamics are depicted below (Fig. 7). The annual revenues in the selected years depend parabolic on the elasticity exponent $r = p = 1/2$ from the above discussed inputs (K,L) id est from the processed clicks and registered users (C,U). The first several years were self-evidently non-profitable (Fig. 8). This is exhibited by the negative return-of-investments values but the next years brought a significant profit of 18 up to 77 %.

Table. Assumed values and constants

Model variables or constants		Values
y	Ratio of labor and capital inputs	3
b	Proportionality coefficient	1,5
τ	Modernization period for platform, software and content; modernization that follows each τ years (for instance, from Web 2.0 to future Web 3.0), year	5
$m = \frac{1}{\tau}$	Modernization rate (rate of technological progress expressed via increasing motivation and economical user interest, per annum)	0,2
$p = 1 - r$	Elasticity of (K,L)	0,5
Absolute values (K,L) for integral estimation of (C,U):		
L	Labor input expressed via development costs for the Web 2.0 system, EUR	3 million
K	Capital input (expenditures without administration expenditures and law-regulated annual amortization), EUR	1 million
$E = K + L$	Overall expenditures, EUR	4 million

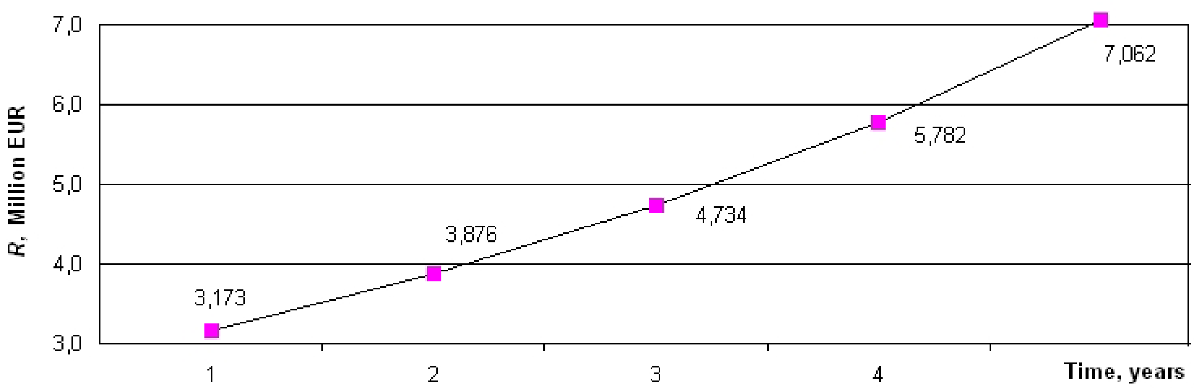

Fig. 7. The Cobb-Douglas considered revenue dynamics within the period $(0,\tau)$

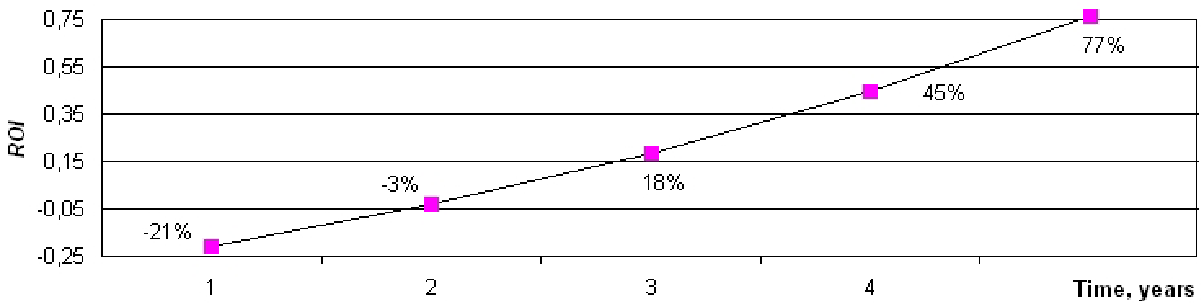

Fig. 8. The Cobb-Douglas considered return-of-investments dynamics within the period $(0,\tau)$

Conclusions

The success of Web 2.0 applications is predefined by integration of different technological, social and economical factors. Correspondingly, the substantial analysis of all these factors is necessary. The existing works make the accent mainly on the technological factors. This paper showed that the economical models augment the analysis of other factors and support the decisions and trade-offs that should be made between different expenditures for return-of-investment optimization.

The proposed economical models are simplified and do not consider yet such important aspects as psychological acceptance of new services, market saturation and business competition, for instance, from similar services. Our future work will concern these important tasks.

References

1. *Bergheim S.* Pair-wise co-integration in long-run growth models // Working Papers Series, Research Notes 24. – Frankfurt am Main: Deutsche Bank Research, 2007. – P. 23.
2. *Luntovskyy A.*, Feldmann M., Vasyutynskyy V. A Semantic Web Application for Coordination of Combined Networks Design // IEEE CriMiCo-08 International Conference. – Sevastopol: IEEE, 2008. – P. 364–367.
3. *Schill A.*, Feldmann A. Internet and Web Applications: Manuscript. – Dresden: TUD, 2008. – 487 p.
4. *Business* to Consumer Markets on the Semantic Web / R. Tolksdorf, C. Bizer, R. Eckstein , Heese R. // OTM-03 International Conference. – Berlin: Humboldt-Universität zu Berlin, 2003. – P. 8.
5. *Luntovskyy A.*, Vasyutynskyy V., Kabitzsch K. Dynamic Evaluation of Costs in Combined Wired and Wireless LAN // IEEE 7th WFCS-08 International Workshop on Factory Communication Systems. – Dresden: IEEE, 2008. – P. 349–356.
6. *Luntovskyy A.* Integration Concepts for Computer-Aided Design Tools for Wired and Wireless Local-Area Networks: Monograph. – Aachen: Shaker-Verlag, 2008. – 196 p.
7. *Лунтовський А.О.*, Мельник І.В. Компьютерні мережі та телекомунікації: Навч. посібник. – К.: ВМУРОЛ, 2007. – 257 с.
8. *Лунтовський А.О.* Моделі і технології побудови розподілених інформаційних систем: Навч. посібник. – К.: НМЦВО, 2000. – 116 с.

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