

# The development of mobile Internet technology and ubiquitous communication in a knowledge-based organization

Anna Sołtysik-Piorunkiewicz, University of Economics in Katowice, [anna.soltysik-piorunkiewicz@ue.katowice.pl](mailto:anna.soltysik-piorunkiewicz@ue.katowice.pl)

## Abstract

*The paper presents the trends of the Internet to manage knowledge-based organization and participation in the development of mobile Internet technology. The author analyzes the stages of development of the Internet, based on the characteristics of Internet technologies in the area of Web 1.0, Web 2.0 and Web 3.0, and shows the share of mobile technology and increased sales of devices using mobile technologies in the development of the Internet. The author describes the development of information systems combined with mobile Internet technology and ubiquitous communication in a knowledge-based economy, explaining the current situation and the future trends of information system evolution, such a mobile ERP II system.*

**Keywords:** *Web X.0, mobile technology, ubiquitous communication, mobile ERP II system*

## Introduction

The World Wide Web (WWW), thanks to its simplicity and functionality, quickly went beyond the boundaries of academic world to become a standard used all over the world for developing the operation of businesses in various areas, e.g. marketing, logistics or production. The WWW enables new interactions between the sender and recipient of information by means of ubiquitous mobile devices using in-built systems and software capable of adaptation, contributes to emergence of new trends of customers influencing products and services in the concept of the so-called prosumer, and at the same time new technologies can be used to design goods and services adapted for taking advantage of the potential of the global information infrastructure, e.g. for improving the process of data exchange or making payments (Kubiak, 2003).

Over time, the Internet has gained popularity and has become more and more widespread. From a collection of text filled web sites it has evolved into a multimedia database of information and a powerful tool for communication between people from all over the world. Its potential is still growing and it is constantly developing, offering its users more and more possibilities.

## Three basic stages of the Internet development

Since its creation, the Internet, together with services available on it, has undergone a continuous, rapid change and today it is not the same network of computers it was at the

beginning. The development of the Internet to date can be divided into three basic stages, Web 1.0, Web 2.0 and Web 3.0. This division is based on distinguished differences of features, characteristic of each of the above mentioned types of the Internet environment, such as the type of the technology used, type of web content, and the way the Internet is used by users. Knowing this division is the key to understanding what the Internet is today, what opportunities it offers, and how its entire potential can be effectively used in a mobile organization in a knowledge-based economy.

### **Web 1.0**

The term Web 1.0 has been used to describe the state of the WWW and its entire content (including the style of designing web sites) before the bursting of the Internet bubble in 2001. Therefore, the beginning of Web 1.0 is thought to be August 6, 1991; this day is also considered to be the official date of making the WWW available for public use. The first web sites were very simple. At the beginning, they were created using HTML, then this language was replaced by CGI scripts. However the real progress occurred with the appearance of PHP and ASP (Frankowski, 2010). The end of the monopoly held by the Web 1.0 technology on the Internet occurred during the period of 2001 to 2004.

A Web 1.0 based website has some distinct features (Frankowski, 2010; Strickland, 2011a). The solutions offered by the Web 1.0 technology, despite significant developments since being developed, are still successfully used today, because the implementation of more modern solutions is in certain cases adds little value. As an example, the owner of a web site may not want its visitors to leave comments or reviews on the web site, or to modify its content in any way. One example of such web sites include "online business cards" of companies or individuals (Strickland). Web 1.0 technology is also used in the case of web sites with information resources, such as certain online encyclopedias. Allowing only a narrow group of authorized users to edit the content of the web site results in a greater trust in the reliability and relevance of the information contained in such an encyclopedia and objectivity of its author than if everyone was allowed to edit it (Frankowski).

### **Web 2.0**

The term Web 2.0 was coined and described by DiNucci in the article "Fragmented Future" in 1999 (DiNucci, 1999). Later, the term was described in more detail and popularized by O'Reilly in an article "What is Web 2.0: Design Patterns and Business Models for the Next Generation of Software" (O'Reilly, 2011). The term gained huge popularity after 2004 as a result of conferences devoted to this subject organized by the companies O'Reilly Media and MediaLive International (Frankowski, 2010).

Contrary to what it suggests, the term Web 2.0 does not refer to new technologies, or versions of the WWW. What it describes is a completely new way of using existing resources and technologies. It is essentially a new approach to constructing web sites. The concept of Web 2.0 converts web sites from simple databases storing information to interactive web sites. The user is no longer restricted to the role of information recipient, but can now also participate in the creation of the information.

Web 2.0 resulted in a change in the users' attitude to the Internet and the resources it contains. Instead of only looking for and consuming information provided by experts, they can now find alternative sources of information or publish information themselves and become information providers. Users are now willing to comment and interact with other Web users, and will rely on common opinion of other Internet users rather than a single specialist (Domaszewicz, 2011). What is important is not the information itself but what happens between it. The creation and publication of the content of a web site alone does not make it Web 2.0. Processing its content in a way characteristic for Web 2.0 means that it must be evaluated, commented, recommended to friends, described and shared by social bookmarking services, such as Wykop, Delicious, StumbleUpon, Digg or Gwar, as well as tagged, cited and linked to on blogs (Frankowski, 2010). In his article "What is Web 2.0", O'Reilly explained how one should understand the differences between Web 1.0 and Web 2.0, and the gap between the two concepts of the Internet (O'Reilly, 2011).

The following were identified as key features of websites created in Web 2.0 technology (O'Reilly, 2011; Frankowski, 2010):

- The content is created collectively by all users.
- Websites that invite users to add their own content and make alterations to them to become even better.
- Websites that support the formation of communities and groups of people sharing common opinions and interests.
- Applications that can be run from a browser.
- The use of elements, principles of operation and functions typical of blogs, wiki and media sharing services.
- The use of Really Simple Syndication (RSS) which allows users to receive information about any changes and updates to a web site as they happen.
- The use of technologies such as AJAX or Ruby on Rails.
- Websites that use open source licenses, e.g. GNU GFDL or Creative Commons.
- They use of folksonomy; classification of information by means of key words selected by users of the information.
- Accessing the Internet without the computer; connecting to the WWW through such devices as mobile phones or game consoles. The scope of Internet-enabled devices is constantly getting wider (devices such as Television sets, refrigerators, etc.).

Critics of Web 2.0 argue that this term does not bring anything new to the Internet and is only a well-promoted marketing slogan. Others argue that Web 2.0 is nothing more than a combination of existing technologies and ideas of Web 1.0 presented in a new way. Supporting the argument that Web 2.0 is nothing new is the existence of web sites with features characterizing Web 2.0 long before the official announcement of the emergence of Web 2.0 (Frankowski, 2010).

Experts do not agree on how web sites should be classified. Many web sites combine the characteristics of both the solutions, therefore drawing the line between Web 1.0 and Web 2.0 is not always an easy task. For example, a web site can be built following the rules of Web 1.0, but

at the same time contain a section designed for user comments, which is an element typical of Web 2.0 (Strickland, 2011a).

### **Web 3.0**

The first to develop the term Web 3.0 was Nova Spivack in 2007. Spivak (2007) defined Web 3.0 as "the third decade of the Internet", which falls on the years 2009 to 2019. According to Spivack (2007), technologies that will develop and become widespread in this period will constitute the essence of Web 3.0. The most important of them is to be Resource Description Framework (RDF), Semantically-Interlinked Online Communities (SIOC), The Friend of a Friend (FOAF), Simple Knowledge Organization System (SKOS), Web Ontology Language (OWL), HTML5, and Semantic WEB (Spivack, 2007). Researchers argued that the Internet will be largely based on semantics. The decade of Web 3.0 will focus on the development of the back-end of the Internet through the development of semantic web services, in contrast to Web 2.0, which was about front-end innovations and building a 2.0 company based on process management (Aqarval, 2011; Antoniou & van Harmelen, 2011; Cho, 2011; Kania, 2010).

As much as Web 2.0 connects people with each other, Web 3.0, in its assumptions, connects people with information. Searching information on the Internet will be adapted to the needs of an individual user and will be based on individual profiles. This means that two users who enter the same phrase may receive different search results based on their individual needs and interests. There already exist services offering personalized searching, such as TiVo (TiVo, 2013) or Pandora (Pandora, 2013), but they do not work efficiently, and they allow searching only within a limited type of information (TV programs, music), not the resources of the entire Internet.

Finding a specific piece of information on the Internet has taken a lot of time and required the filtering of a huge quantity of irrelevant information. Entering a phrase into a search engine does not guarantee obtaining a desired searching result. The results usually include a lot of links, most of which may not be connected with the subject we are interested in. This is due to the fact that the search engine does not "think" as a human being does; it is incapable of understanding the context of a given phrase and operates on a set of characters that have been entered and only checks whether they are present on a given web site. Finding a solution to a more complex issue often requires a series of searches (Strickland, 2011b). This is what Web 3.0 is expected to address. The semantic web technology will equip computers with the ability to interpret the content of a web site. This will be possible thanks to programs called software agents. Software agents will search the Internet for a given piece of information based on a set of data called ontologies. An ontology is a file contained on semantic web in the form of metadata (information contained on a web site that is invisible to a human being, but visible to software), which has information defining relations between specific terms (Jacyno, 2012).

Critics argue that creating and developing such files is incredibly laborious and constitutes an unfeasible task. On the other hand, in Web 2.0 there is the concept of tags that are used to arrange and categorize huge quantities of information. Although a lot of involvement of Internet users is needed for this idea to work (somebody must tag given sets of information), it is quite widely used. From this we can conclude that the most probable mechanism of Web 3.0 operation

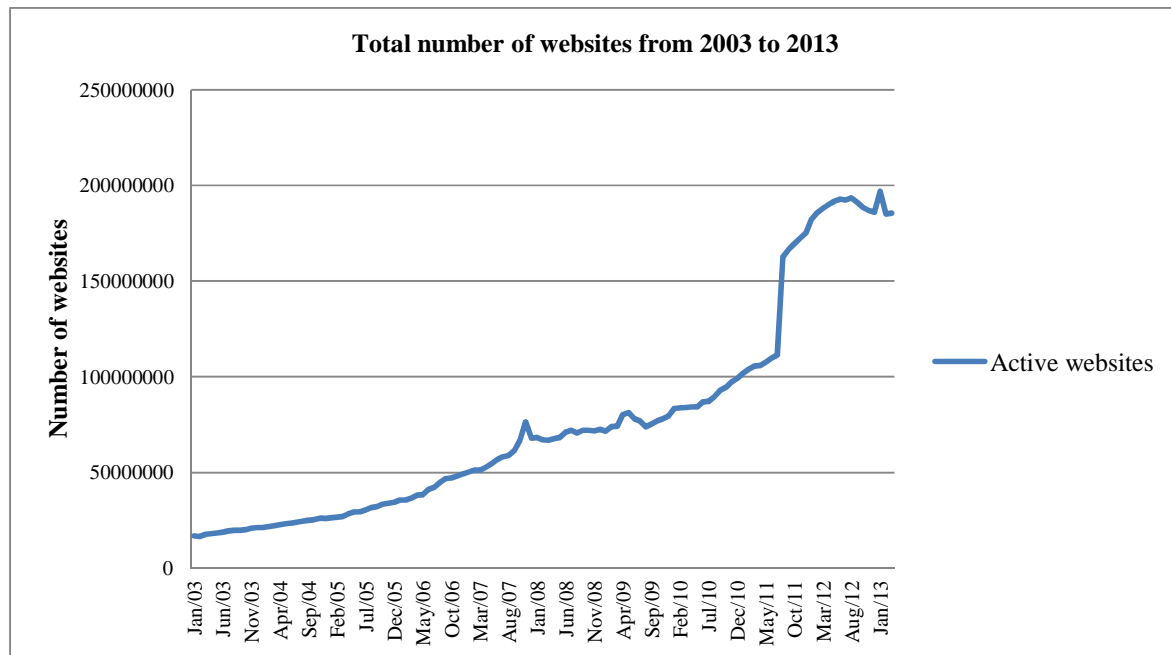
will be combining the concept of semantic web and tags originating from Web 2.0. The languages of ontology description which are developed in the context of the theory of semantic Internet, can also be used in the field of knowledge management in a knowledge-based organization Spivack (2011) described the process of the Internet “evolution” and expected direction of its further development using the terminology “Web X.0”. The next idea, Web 4.0, assumes that the development of the network will evolve towards a knowledgebase, in which we will no longer search by keyword, but searches will be based on agent oriented systems.

### **Popularity of the combination of the Internet and mobile technology**

The Internet is undoubtedly expanding. This takes place both in the physical sense (increasing access to it in various parts of the globe) and in terms of its content, which is constantly increased by new information. The Internet has quickly become popular as a new medium and a way of passing information. In 2007, 20.3% of the world’s population were Internet users; this exceeded the 19.01% of the world’s population who were fixed-line telephone owners. This is an indication of how incredibly fast the number of Internet users grew; reaching the same number of users took around 18 years for the Internet and over 100 years for the fixed-line telephone.

The Internet has contributed significantly to the rapid growth in the sales of mobile devices, which today as a basic feature allow users to access the Internet without the need to use a computer. Mobile phones have long ceased to only be used for voice communication, and instead have become a multimedia, browser based device. Therefore, they may constitute the basis for future development of mobile management systems using agent technologies (Griffiths & Chao, 2010), semantic webs (Fasli, 2007; Fernandez & Hernandez, 2009; Stanek, 2007) and cloud computing (Buyya, Broberg, & Goscinski, 2011; Desai, Liu, & Winikoff, 2010; Dobrowolski, 2002; Linthicum, 2010). Prior to 1990, the growth rate for the number of mobile device users was relatively small. Between 1990 and 2009, the average annual rate of growth was 36.04%. Further, it was estimated that in 2009, 63.56% of people around the world used such devices. That fact that the accessing of the Internet through a mobile phone influenced, among other things, such a fast growth rate for this market in recent years is significant proof of the attractiveness of the Web. Now, it is difficult to imagine such devices without this feature.

One indicator of the popularity of the Internet is the amount of information we can find there. It is a good idea to consider the number of web sites on the Internet and how this number has been changing over time. However, due to the lack of a central point on the Web it is impossible to determine the number of web sites with 100% certainty. It is however possible to obtain highly reliable approximate data. The “Web Server Survey” conducted by Netcraft shows that over the past 10 years the number of websites grew on average by just over above 1.87% each month. Figure 1 presents an analysis of the number of websites from January 2003 to March 2013.



**Figure 1.** The change of the total number of websites from January 2003 to March 2013 (Netcraft, 2013).

There are various factors underlying such a dynamic growth of the Internet. It can be explained by certain facts related to the characteristics of computerization, the Web structure and content. Some of these factors to be discussed are:

1. Computers now have increased computing power thanks to progressive miniaturization, new techniques and materials used for manufacturing microprocessors. Parts produced in accordance with a new standard of miniaturization are used to create even smaller successors. According to current Moore's law, the number of transistors in manufactured microprocessors doubles around every two years. More and more powerful computers open new possibilities to the Internet users.
2. The Internet becomes more and more useful. It is explained by Metcalfe's Law, according to which the value of a telecommunications network, or a different communication and information system, grows proportionally to the square of the number of devices (users) connected to it. Connecting every subsequent user to the Web causes the growth of the number of possible connections between users, and consequently the value of the Web, based on the following formula:

$$P = \frac{n(n-1)}{2}$$

In this formula, "P" is the number of possible connections, and "n" is the number of users connected in a network. It is assumed that every connection has the same value.

It can be easily noticed how fast the number of such connections grows. Two users can make only one connection, four can make 6, and 10 can make 45 different connections. In this way,

we can very quickly obtain an impressive number of connections, and with every subsequent user the number grows at a faster rate.

3. We also cannot forget the content of the Web, which becomes more and more attractive due to increasing complexity and functionality. The Internet is an increasingly interactive, dynamic and multimedia environment. Therefore it attracts more and more users and allows them to repeatedly use the services provided by this medium.
4. The Internet enables an almost instant access to desired information and two-way communication, which helps to effectively conduct economic activities. A customer may easily, in comfortable conditions, learn about a company and its offerings. Thanks to the Web, a business may react to events occurring in its environment (for example: customer needs, actions of suppliers and buyers or problems of company employees) faster than before.
5. It allows users to have a large freedom in selecting information. They may decide to choose one or several of the many available sources of information. They can search for data from specific areas they are currently interested in. They can also choose the moment in time at which they will obtain desired information. This is not possible in the case of the other mass media.
6. It allows businesses to better get to know the needs and behaviors of individual customers, which makes it possible for a business to more effectively adapt its actions to individual buyers of its products.
7. It is a very flexible medium which allows businesses to continuously update its web site and the information placed on it (Ziemba, 2009).
8. Thanks to the Web, an organization may integrate its activities (e.g. advertising, displaying an offer, sales, and in some cases the delivery of products may be entirely through the Internet) (Ziemba, 2005).
9. The Internet is a relatively cheap medium in comparison to the opportunities it offers. It allows, at small, fixed costs, to reach a huge number of customers, employees or suppliers. It also enables the use of various marketing instruments (Ziemba, 2009).

The characteristics of the Internet make it impossible to be indifferent to this phenomenon. It undoubtedly will influence our environment. It does not present any significant dangers, however it presents perfect opportunities to increase possibilities it offers in organization management (Kordel, Kordecki, Kowalczyk, Pylak, & Wiktorowicz, 2010; Mikuła, 2006). The Internet has also contributed to the creation of new business models in a knowledge-based economy (Kisielnicki, 2004; Grudzewski & Hejduk, 2004a; Grudzewski & Hejduk, 2004b; Gołuchowski, 2005; Wrycza, 2010).

### **The development of information systems in a knowledge-based organization**

The vision of computerization of the human environment is constantly changing due to a variety of available information and communication technologies. As an example, the capability of computer devices to store, process and make data available is developing and increasing at a significant pace. Additionally, there is the concept of ubiquitous systems, which states that

computer devices will be present in every area of human life so as to operate in the background, i.e. in the environment of a human being, to aid him or her (Weiser, 1991). The concept of ubiquitous systems has evolved to now include other concepts such as ubiquitous communication and intelligent user interface. These technologies underlie the research on ambient intelligence.

Currently there are numerous areas where the concept ambient intelligence could be practically applied in a knowledge-based economy, e.g. the automotive industry, manufacturing, and order processing. These applications are due to the development of Internet technologies, mobile devices for supporting communication services using mobile applications, wireless network-based technologies, agent technologies and in-built systems.

The development of Internet technologies in information systems has strengthened the mechanisms for the globalization of economic activities and the integration of relations between business partners. This has been accompanied by the rapid development of information technologies whose task is to quickly provide necessary information to effectively support corporate decisions. These challenges can only be met by a new generation of integrated systems with significantly extended functionality compared to systems such as Manufacturing Resource Planning (MRP), and Enterprise Resource Planning (ERP) class systems (Bojarski, 2003; Lech, 2003; Szmit, 2003). This new generation of systems will be mobile ERP II systems (Dospinescu, Fotache, Munteanu, & Hurbean, 2008) whose basic element is the capability to utilize mobile devices and synchronous data exchange with business partners. Business processes performed within such systems go far beyond the area of functioning of a single economic entity. They combine information flows within integrated economic areas, covering business partners, financial and insurance institutions, academic and research institutions among others, using models of Supply Chain Management (SCM), Customer Relations Management (CRM), and mechanisms of e-commerce.

An important research problem preceding the construction of the prototype of a mobile ERP II system is the adaptation or development of an appropriate methodology of system building and modeling of its architecture. Evolution of the ways of carrying out business processes as a part of a new architecture of integrated information systems fundamentally changes the relations both with suppliers and buyers of goods and services. The dominant element becomes the implementation of Business-to-Business (B2B) and Business-to-Consumer (B2C) relationships. Business partners are chosen to work on performing current tasks on the global market of goods and services. The problem is not only finding a partner, but, also retaining the partner. In order to meet these new challenges, new components in SCM or CRM will be developed.

We should also pay attention to other factors and technological components supporting enterprise management. Due to the key role played by a product in today's economy, the necessity of monitoring, and quick change of the assortment of products, a Product Life Management (PLM) sub-system has been isolated. In the area of knowledge management and system intelligence, we can distinguish a Strategic Enterprise Management (SEM) sub-system that uses rich information resources gathered in Business Warehouses (Kisielnicki, 2009). In order to fulfill required functions in the e-business environment, an information system should, in addition to typical MRP/ERP functions, possess the following characteristics:



- Enterprise portal,
- Mobile solution,
- Online stores,
- Exchanges, auctions and e-markets,
- Cooperation and communication EDI.

An enterprise portal is a service that allows entrepreneurs to quickly and economically create enterprise websites (Intranets & Extranets) and manage their content. The technology of an enterprise portal allows businesses to significantly shorten the time needed for creating and implementing an e-business application and provides enterprises with scalable and reliable solutions.

Mobile solutions involve using wireless devices, palmtops, laptops equipped with Wi-Fi cards, and mobile phones. The medium used for data transmission can be a Global System for Mobile communication (GSM) network or a local Wi-Fi network (Sroka, 2009).

The development of mobile technologies creates grounds for proposing a concept of the prototype of mobile ERP II systems. These systems will use the capabilities of mobile devices in organization management, based on building the architecture of software for mobile ERP II systems. Mobile devices are supported using applications developed based on the kernel of mobile operating systems, e.g. Android, Windows Mobile/Windows Phone 7 or iOS. Market research has shown that the share of these mobile operating systems in the market in 2012 is significant. In addition to the three leading operating systems, predictions for 2016 indicate increased market share for other operating systems including BlackBerry OS and Symbian (Fried, 2012). Also noticeable is the involvement of leading corporations (mobile device providers), such as iSamsung, BlackBerry, Nokia, HTC and Microsoft, in the development of modern mobile devices and software. Further, the increasing popularity of these devices for business constitutes grounds for using them in studies on mobile ERP II. The evolution and development of enterprise architecture takes into account the need for data exchange using mobile devices. This enables data and information exchange in a mobile organization and in a knowledge based economy. This enables the integration of business processes and the use of mobile applications for organization growth and in areas of management, such as production, logistics or managing health protection units. However, access to mobile devices is not a sufficient condition for building a mobile organization. Such devices require access to the Internet and ensuring the security of mobile applications. Without access to modern technologies such as data transmission a mobile organization cannot be created. The use of data transmission technology based on mobile telephony technology such as the latest GSM G3/G4/LTE standard may be the basis for building a mobile organization.

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## Conclusions

The reasons indicating the need to address the subject of integrating business processes in mobile ERP II systems include the development of mobile technologies, cloud computing, and agent technologies that facilitate process management of an organization. Another reason is the apparent lack of studies on the concept of software architecture of mobile ERP II system for the purpose of improving business processes in management and as part of implementations of information systems. Consequently, there is a lack of studies on methodological aspects of their modeling as well as technological solutions supporting process management of an organization using mobile ERP II systems based on Cloud ERP technology, mobile ERP, and the concept of WEB 2.0/3.0, as well as the use of software agent technologies and Semantic Web Services. The scope and subject of the research conducted so far indicate that the current development of research on web technologies focuses on designing open, mobile systems with a wide range of functionality and huge dynamics based on agent technologies (Fasli, 2007). One of the latest concepts of agent building is the concept of Ambient Intelligence based on the technology of ubiquitous computing, ubiquitous communication and intelligent user interface.

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### **Biography**

**Anna Sołtysik-Piorunkiewicz**, Ph.D. is employed at the University of Economics in Katowice as lecturer on Faculty of Informatics and Communication, at Department of Informatics. She is taking a part in the research into computer science, systems analysis and computer design, management information systems, software agents and knowledge-based organizations.