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VIRTUAL SYSTEMS IN BUSINESS AND EDUCATIONAL PROCESSES

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Abstarct: *The aim of this article was to look through new business concepts in IT, to define them, to see the services offered and the possibilities of use in practice. New technology ideas puts IT as a service. Great distraction of information and intelligent tools makes them ineffective and takes low advantage of them. Grid and Cloud Computing are the latest concepts in IT and offers the agility to business and universities as well. In other words, because of virtualization and abstraction the processes that occurs in these institutions can be managed swiftly, easily and effectively. Allows to make the most of company's resources. Physical locations of resources can be flexibly bounded and adjusted to current needs. Globalization and rapidly growing competition is forcing to apply the most innovative solutions. Taking in consideration the universities it is even more important when thinking of students as future human capital ,which should know the possibilities and be prepared the best. Sharing of computing, data centers, applications etc. on demand provides more powerful tools, more organized work and higher scalability and flexibility through inclusion of external resources. Grid and Cloud Computing have the potential to provide an IT infrastructure that addresses the demands of business while utilizing the IT resources most efficiently and cost-effectively.*

Keywords: *cloud computing, grid computing, virtualization, management*

1. INTRODUCTION

Educational institutions, including universities, that face strong competition and dynamically developing market, must make optimum use of their advantages and proper application of modern IT technologies. Despite different institutional nature, apart from "generating" new scientific inventions, universities also act as peculiar enterprises, the product of which is knowledge. Thus they can apply commonly used and widely recognised technological solutions at least in that respect of their activities. Moreover, they should think ahead and introduce innovations based on "fresh" scientific knowledge. Scientific research create favourable conditions for use of avant-garde ideas by universities, the ideas that are, on one hand, chief asset attracting students and, on the other hand, propagation of the state-of-the-art practices, the implementation of which into business stimulates economic development. Academic centres mould skilled specialists and the centres are institutions of which society should expect new views and country development directions .

Once use of computers became common, the development of virtualisation started. Currently, virtual servers, virtual network infrastructure or virtual access to Windows system is used as a standard, but the reach of those solutions is rather local, limited to a given company or institution, which is usually supplemented by outsourcing . However, new attitude to IT industry has been noted in the past few years. The paradigm of IT as service provided on-demand (distributed globally) has appeared recently. That service would be billed the same as electricity or other utilities. Connecting to IT infrastructure shall ensure access to computing capacity, the same as connecting to electric power grid gives access to electricity. The discussion was divided into three parts. New IT development directions were presented in the first part, together with their description and advantages. The second part provides detailed information on services offered by state-of-the-art technologies and areas of their application in business. While the last, third part, includes attempt to dedicate the

state-of the art technologies to the educational process management as regards universities.

2. NEW TRENDS IN IT TECHNOLOGY – IT AS A SERVICE.

Concepts that were put in practice are often based on ideas that occurred as first and are usually the simplest in a given discipline. It seems to be quite obvious that the simplest solution turns out to be the best one and advantageous. IT development directions aim at such simplification of the rules and structures of information description so as to make them comprehensible to everyone. Cloud computing and grid computing are among the most recent solutions. Indeed, it seems to be "return to the past", because its idea returns to the beginning of computerisation era, so it is sometimes questioned and denied to be new idea but another attitude to already described phenomenon.

2.1. Grid as infrastructural service

First ideas of using and sharing computers and data as services occurred as early as in the 1960-ties. Computer software is, by its nature, predefined, while its operation and "production capacity" are strictly defined, so it was hard to solve complex problems and the way to break through that barrier was sought in collaboration and joining the resources. The technology created as a result of those initiatives is called "Grid" or "Grid computing". „This means that the computing capacity and the resources (of the computer) are acquired as service – the same as electric power – i.e. the user may require information to be provided and processed without the need to bother about the location of data storage or the computer that processes requested information ." Thus, from the technical point of view, grid computing is associated with virtualisation or virtual centralisation of heterogeneous, distributed resources for the purpose of creating higher computing capacity and possibility to combine it (flexible joining). The most often quoted definition of grid computing says that it is „a hardware and software infrastructure, which provides reliable, consistent and cheap (cost-effective) access to high computing potential of IT machines" (Tablele 1) . The Grid computing technology is based on the idea of connecting data resources into a metasystem that includes different architectures, platforms and physical locations, while maintaining local access and safety rules within the created virtual organisation.

Tablele 1 "Grid" service properties according to Ian Foster and Kesselman 1998, source: http://www.cs.put.poznan.pl/adanilecki/pr/pr-m01_08.pdf

reliable service – users demand certainty to receive predicTablele, continuous level of capacity thanks to different components of GRID	Generally available (omnipresent) service – the service should always by accessible, regardless of a service user location.
consistent service – there is need for standard service, accessible using standard interfaces and operating with standard parameters.	relatively cheap (cost-effective) service – the access to the service should be relatively cheap, so as to make it attractive also from the economic point of view.

In the 1990-ties, grid computing was intensely evolving and was used in science and research, e.g. in the SETI@HOME project („Search for Extraterrestrial Intelligence"). That purpose of research project is to find extraterrestrial intelligence. Members of the project acquire computing capacity by creating a Grid. Everyone can participate in the project (there were already over 3 million participants on its 11th anniversary) by downloading special application onto his/her computer and sharing part of the CPU capacity or a disk space.

It is nothing new that the business world of today is dynamic and virtually unpredicTablele. In the era of global competition and sudden changes, companies are under constant pressure "driving" them to maximize profit and to reduce costs. The IT world responds to such conditions according to the following rules:

- development through dynamic and flexible adjustment of the company infrastructure to business processes and products;
- use of global economy benefits – unification of processes, actions and resources in remote branches of a company;
- increased mobility

Companies using IT technologies should take into account the rule of nimbleness. Business processes should be quickly and easily adapted to internal and external changes. Thanks to grid processing, it was possible to connect distributed IT infrastructure, in the current meaning of the service which can be used and adapted, i.e. customized to current needs.

Current business computerization trends that have been observed recently indicate to increasing number of

computers with high computing capacity as well as those used for data storage. This gives rise to some problems:
- constantly increasing demand for computing capacity and data storage capacity of such machines;
- large number of distributed machines favours the increase of their unused capacity;
- increasing management/maintenance costs for such machines;

There are also more and more machines of lower computing capacity, such as personal computers, mobile phones and devices fitted with sensors, i.e. equipment providing the user with mobile access to the network. On the other hand, however, there is need for consolidation and high computing capacities.

There are many organisations distributed all over the world and each of them has some hardware and software resources as well as special equipment and valuable (i.e. measurement) data. Only few of those organizations can afford buying all the state-of-the art technologic achievements. Each of them has some of them and uses them at different times and to different extent. The demand for computing capacity is determined by the organization itself, which, in the grid processing terminology, is called a virtual organization, i.e. a dynamic group of entities, which defines conditions and rules of sharing and use of such resources like:
- computing capacity, processor capacity;
- disk space, file system structure;
- grid, communication, transmission bands,
- applications, programmes;
- consumer porTablele equipment, mobile phones, RFID equipment (radio frequency identification provided by a built-in chip) The most important features of Grid computing are shown in the Figure. 1.

Figure. 1 Grid Computing characteristics, source: own study

There are of course some grid system categorizations and typologies, where the aspect of resources they operate on or the way of resource sharing is the criterion. First classification includes the following categories:
- Compute Grids – where computing capacity is shared, e.g. the processor
- Data Grids - storage, management and sharing of large volumes of heterogeneous and distributed data
- Application Grids – application management and providing access to remote software and libraries
- Service Grids – supports efficient service sharing

While as regards the second criterion, the following grid computing forms are distinguished:
- Cluster Grids – (or simply clusters), i.e. the collections of homogeneous computers, possibly of diverse configurations but of the same architecture, connected with high speed link, used for integrated computing of local resources (do not reach beyond the Firewall area). However, it is not the form of the previous definition, but it is important enough to be the basis for Grid creation;
- Enterprise Grids – are Grids used within individual enterprises. They do not reach beyond the firewall, but might be heterogeneous and physically distributed over many organisation branches or may belong to different administration domains. Such grid type allows to virtualize, unify and centrally manage IT resources, and thus to allocate computing capacity on request to different processes,
- Utility Grid Services – i.e. a "service-type" Grid, is a Grid owned by a service provider, which manages and develops the grid. This requires the client company to transfer its data and computing requests to the Utility Grid to obtain the processing results in return. As part of this service, the provider offers disk space and computing capacity. The grid is located outside the user's firewall and the payment is made on "pay per use" basis. As it is a remote service, there are concerns as regards its privacy, safety and reliability, Partner/Community Grids (e.g. SETI@HOME) – are grids dedicated for large projects, mainly of scientific nature, which contribute to esTablelishing virtual organisations to balance the load and use of IT infrastructure. So called proxy software is used here, which serves as a bridge allowing communication between applications of the organisation and external daTableases or servers. As a result of globalization, this process occurs also in the field of business and it is natural consequence of interactions between companies of the supply chain as well as quick and efficient cooperation it its broad meaning.

Existence of one Grid type is precondition to create further, more specialized forms. Generally, Grid evolution in

business is characterised by increasing openness outwards and by sharing more and more resources between organisations. The evolution requires also appropriate technical maturity level of the companies using a given solution, so Grid use is sometimes long and absorbing process. This process is shown in Figure. 2.

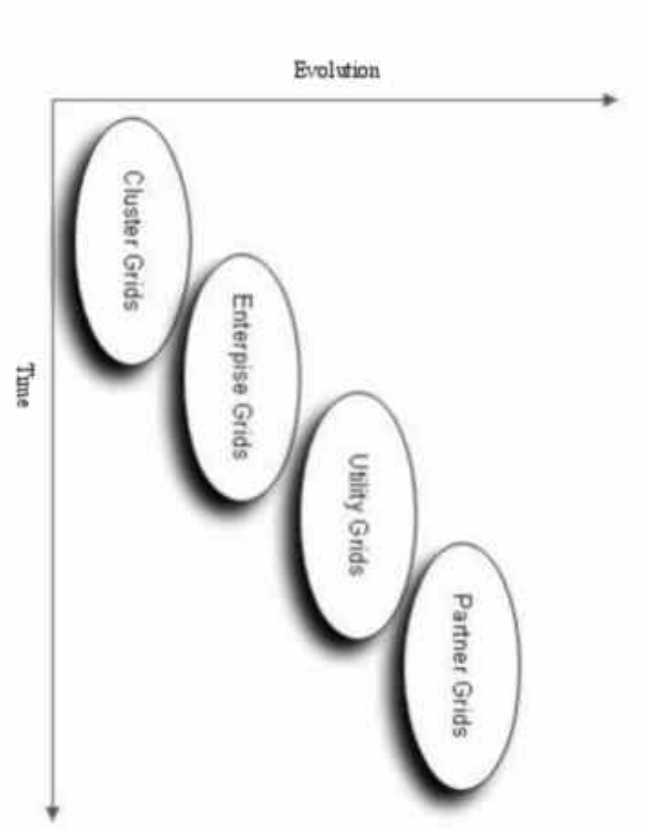

Figure. 2 Grid evolution in business, the source: internal analysis based on "Grid and Cloud Computing. A Business Perspective on Technology and Applications" Katarina Stanoevska Slabeva, Thomas Wozniak, Santi Ristol (Springer 2009)

The purpose of the Grid is to solve large-scale problems in the much larger scope than those solved by multi-processor supercomputers or local computer clusters. Thanks to sharing own resources within the confines of Virtual Organisation, the company can periodically have access to all resources of the organisation, which undoubtedly permits to perform more complex calculations in shorter time (resources on demand). Access to huge parallel computing capacity is one of the most important advantages of Grid Computing. It is the response to needs formulated not only within scientific projects, but also by biomedical technologies, financial modelling, oil production technologies, computer animation etc. The specificity of the applications should be emphasized, as they are able to take advantage of the potential of many parallel computers. These applications are characterised by high computational activity, but they are divided into parts dedicated to smaller sub-tasks, which may be carried out independently using separate computers and they do not require intense communication between the sub-tasks. They are popularly called "scalable" applications. In Grid Computing environments it is also passable to increase application reliability. In case of failure of the node that carries out one of the application sub-tasks, the sub-task can be re-started on other, efficient node. The tasks may even be carried out with some redundancy by the rule, so that possible failures of individual nodes would not cause increase of the response time of key real time applications. If there is no failure, the redundant results shall be "eliminated". Grid usually allows to achieve not only increased capacity but also improved efficiency (striping) and reliability (mirroring and replication). If some computation task executed on one of the Grid Computing nodes requires intense access to data, then the data can be previously copied to local mass memory of the computer to which that task shall be allocated (automatic replication). Such operation shall not only improve application efficiency, but shall also partially secure data against the source data failure (damage or unavailability).

2.2. Cloud computing – Grid 2.0

IT sector is characterised by continuous competition between organisations with new ideas, visions and innovations. Before we become aware of the beginning of one era and twilight of another era, IT suppliers – using their own slogans, as for example recent Cloud computing – introduce the newest and ready offer meeting requirements of next, new era. Cloud computing is not a completely new technology, but rather a new business model. It the opinion of many specialists „clouds shall change IT industry […] and shall deeply modify the way of IT specialist work and IT companies operation " . As broad bandwidth networks become more and more available and virtualisation technologies allowing for flexible sizing of isolating part of resources are more and more popular, the companies with developed IT infrastructure try to use it by introduction of new business models. The next step in IT technology development consists not only in use of hosted applications, but also in the possibility to develop own applications and to execute them in shared infrastructure – sized on the on-

going basis depending on current demand and payable per used capacity only. The term "cloud computing" is a metaphor or kind of reference to the phenomenon, which is still not completely well-organised but rather chaotic and somewhat fuzzy. This results from the fact that we use some resources being unaware of their actual source. Users operate on the interface which seems to be kind of "a black box" for them. Any functionalities, data, programmes and services are available on demand and dedicated to a specific user (customized). Cloud computing is the concept of IT development and use based on Internet, which plays the role of "the cloud" including data, programmes and services needed by the user. One could say that it is "the fuzzy computing" idea. Such idea began with web services and as a result of their imposing development, combined with their significant dismembering, companies started to join and group them into resources of huge computing capacity, i.e. "the cloud". In case of cloud computing, applications are shared by the Internet (cloud), instead of using traditional solutions, where full software licence must be purchased and the software must be installed. This means that it is simply a service model, also called as SaaS (Software-as-a-Service, discussed in detail further in this article) or the software available on demand. The approach allowing to create and distribute applications is also innovative.
Briefly speaking, Cloud Computing is characterised by:

- Individual independent use of the service (on demand) – users can install and conFigure. software on their own,
- Omnipresent access – the service is available by means of a web browser or API (Application programming interface) web service,
- Integration of resources regardless of their location,
- Flexibility – users can increase or reduce their scope of available options (at own decision) and eliminate unnecessary options,
- Pay-per-use – users are charged in accordance to computing capacity, bandwidth and disk space used by them,
- "Zero" investment expenditures to start using the system

The benefit of virtual reality and the newest IT ideas consists in possibility to use only functionalities, resources and options that are necessary in our business. One can lease several service provision models in cloud computing. Acronyms of several of those models are presented in Figure. 3. Due to fast development of the cloud concept, the list of service models is constantly growing and it cannot be regarded as final one.

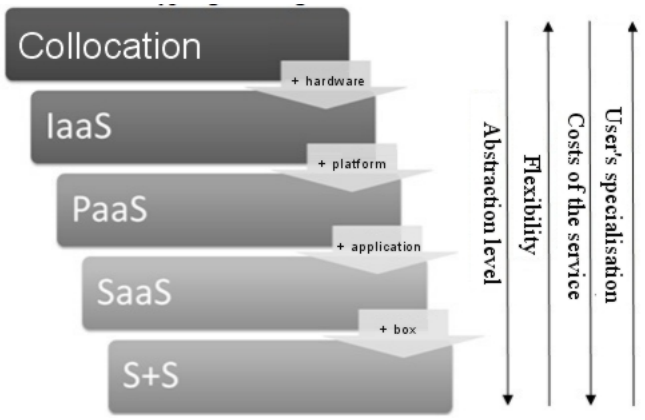

Figure. 3 Cloud computing services typology, the source: internal analysis based on „Co to jest chmura (Cloud Computing)?" Mariusz Kędziora, Microsoft Polska

The first model is collocation. It is the simplest and the oldest cloud computing-based service, which covers the place for workstation in the server room, including power connection, air conditioning and network connection – that's what client pays for. The collocation service does not include hardware, firewall or load balancers), the operating system, software and applications.
Another model is IaaS (Infrastructure as a Service, also called – HaaS - Host as a Service.), i.e. extension of the collocation service by hardware. Summing up, it is provision of computer infrastructure as a service. This infrastructure can be understood either as physical or virtual entity. The provider offers hardware (usually in form of dedicated servers) and the firewall. Thanks to virtualisation, the user can conFigure. his/her own computer as a virtual machine, which then, if needed, can be moved to physical servers which are less loaded. As a result the provider can offer easier maintenance services (e.g. reduced shutdown time). Using a dedicated server, the user pays per specific hardware, while in case of a virtual computer, he/she pays for actually used server capacity (like in case of Amazon EC2 cloud).
One step further in specialisation goes another model, i.e. PaaS (Platform as a Service) – it includes the same scope as IaaS plus the application platform, which provides the user with the infrastructure and programming tools hosted by the provider in order to allow creation of user's own applications. PaaS can be used by companies or developers developing and maintaining applications. They can also be the base for one's own business, or can simply be sold to other users as services. Such model is offered by Microsoft in form of Windows Azure, where Microsoft provides the

operating system including the daTablease (SQL Azure) and several other components. The suggested application development platform is in that case .NET Framework but it is also possible to develop applications using PHP, Python or Java. Similar cloud is also offered by Google. The user is charged for actually used resources (central processing unit time, disk space, number of queries or data transfer).

If we supplement that offer with applications, we obtain another popular service model, so called SaaS (Software as a Service), where the provider provides complete solution, from the hardware and the operating system to the final application. The user uses only specific application and its functionalities. However, the application is not installed on the local computer but on the provider's server with web-based access. In that case, the service is payable per each user using the application in a given month. In that service model, it is not possible to modify or develop the application itself. Such form is most end-user-friendly, where the user is interested in the application as a tool. Companies invest millions of dollars to move their key applications (so far installed on a local computer/server) to a cloud. Most of box products will soon be available in clouds. SaaS offer includes, e.g. web applications, i.e. client applications that communicate with cloud-based services.

To complete list of models, we must mention the last model, i.e. S+S (Software + Services). This term defines the possibility to connect all the company's or user's local resources, i.e. servers applications installed on computers, with resources offered by the cloud, servers and applications outside the company. It is the user who decides to use traditional software or resources available in the cloud (Services). Such model ensures some flexibility, as it provides the option to use local application, cloud-based application or a combination of both of them. Currently not all providers of such services offers cloud-based equivalents of traditional software. Of course, the leader in that sector is Microsoft.

Every new service is more abstract than the services offered previously, as we move from infrastructure, i.e. physical entities to the world of software, which is virtual and more abstract. The same applies to service costs, as each more specialised service includes the previous one, so the costs grow. Service flexibility level is inversely proportional to configuration, i.e. the more the provider conFigure.s the service, the less room for the user's manoeuvre is left. The same rule applies to the user's degree of specialty (directly proportional) and the awareness of system operation (inversely proportional). The services on top of the hierarchy are least "flexible", but they require minimum or no configuration at all and they can be used by everyone.

Clouds can also be classified as regards models of their implementation in the organisation. The following models can be found in literature:

- Private (internal) cloud – where the cloud is owned or leased by the organisation, which uses it autonomously or where the cloud has been developed by the organisation. The provider of the private cloud ensures the access to all resources previously specified by the organisation.
- Community cloud – where the infrastructure is used by multiple organisations. It supports specific communities of common goals (e.g. policy, mission, safety requirements).
- Public cloud (external) - where providers sell cloud services dedicated for the whole of society or for specific sectors (e.g. Yesser in Saudi Arabia (http://www.yesser.gov.sa) and ePUAP programme in Poland (http://epuap.gov.pl)). Big players in that branch are such companies like Microsoft, Amazon and Google. In public clouds, users choose resources (interfaces, API, operating systems, memory size, safety options, central processing units, IP addresses).
- Hybrid cloud – i.e. a combination of private, community and public clouds, i.e. unique entities connected using common technology.

Tablele 2 Cloud Computing properties, source: own study

Cloud Computing is:	Cloud Computing is not:
- the idea, where the user is placed in the centre –and, when connected to the cloud – he/she becomes the "owner" of applications, information, images and equipment already included in the cloud. What's more, those resources may be shared with other users. - task-oriented – rather than application or functionality oriented; focused on the task to be carried-out and the method to do it. Traditional applications (text editors, spreadsheets, e-mails etc.) become less important than documents to be created using them. - powerful environment – singe cloud includes hundreds of thousand computers - easily accessible – data stored in the cloud may be immediately searched; There are no restrictions in getting comprehensive information from multiple repositories - intelligent – as data in the cloud is stored in different way, intelligent data mining and analysis methods are used to get it - programmable – to ensure correct functioning of the cloud, some of its functionalities must be automated (like data replication, when one of its computers is "offline" – the data must be distributed over other computers in order to maintain their integrity.	- grid computing, in the meaning of working with applications or documents located on a single server, accessible for computers of a given organisation - traditional outsourcing, where one company signs a contract with another company for its "computer-related tasks", because applications and data stored on the server are accessible only to the outsourcing company, rather than to the public

Summing up, one should emphasise evolutionary nature of both presented concepts of virtualised environments, starting from Grid Computing, through Service Oriented Computing (Utility Computing), SaaS, to the newest trend, i.e. Cloud Computing. From the historical point of view, the progress in the field of computerization started from the architecture of "mainframe"-type computing machines and has continued through personal computers, mobile devices to the tools equipped with sensors. This shows fast progressing distribution followed also by diversification of data which is not centrally stored any more. Such processes make business more flexible and reduce barriers of industry change, as costs of those processes are significantly lower. Virtualisation is the attempt to abstractly combine distributed physical resources. Thus we seem to return to past solutions.

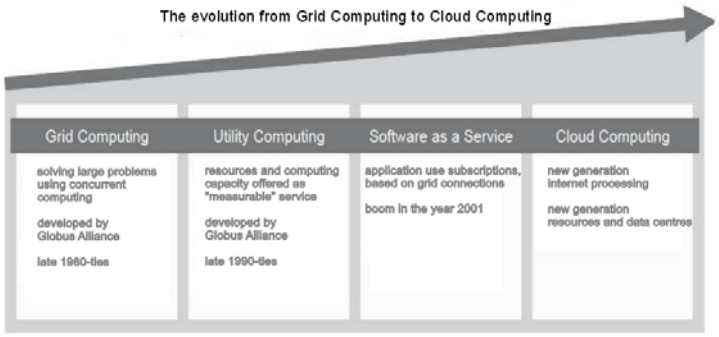

Figure. 4 The evolution from Grid Computing to Cloud Computing, source: "Grid and Cloud Computing. A Business Perspective on Technology and Applications" Katarina Stanoevska Slabeva, Thomas Wozniak, Santi Ristol (Springer 2009)

All those concepts are very similar to each other. Their innovative character is undermined by specialists. The same applies to new terms that actually do not differ from earlier approaches. However there are some differences, which are not necessarily trivial.

Tablele 3 Technical comparison of Grid Computing and Cloud Computing, source: internal analysis based on "Grid and Cloud Computing. A Business Perspective on Technology and Applications" Katarina Stanoevska Slabeva, Thomas Wozniak, Santi Ristol (Springer 2009)

Criterion	Grid Computing	Cloud Computing
usage	Multiple servers dedicated to a single task	Server virtualisation; single server can simultaneously compute several tasks
typical usage	Execution of tasks and programmes in definite time	Supporting more frequent long-term services
abstraction level	Shows high level of detail	It is characterized by higher abstraction level – also called „Grid 2.0" or „higher level Grid"
specific features	few "large" requests	many "small" requests
occurrence	It is necessary to implement work organisation technology of multiple computers	The cloud is where computer is located
relations	Grid is not necessarily the Cloud or a part of the Cloud	The Cloud usually used the Grid
main interested parties	Developer, administrator	End user
offer	Offers "raw" resources, such as computing capacity and disk space	Offers complete sets of functionalities (services) used by applications

3. RANGE OF SERVICES PROVIDED TO BUSINESS – INDUSTRIALIZATION OF IT SECTOR

First users of cloud computing usually include small companies facing uncontrolled grow of expenditures to electric power, personnel and equipment or shortage of space in expanded server rooms. Whereas large companies still take a waiting position. One can conclude that cloud computing enables companies to increase their potential on an on-going basis – in real-time (thanks to Internet), using pay-per-use system, without the need to invest in the new infrastructure, new personnel training or new software licences. In January 2008 Nicholas Carr Published the book "The Big Switch: Rewiring the World, from Edison to Google", where he proposed daring and controversial thesis that corporate IT departments shall soon become redundant and that main reason for that shall be migration of computation resources and mass memory from the internal plant data centres to external centres offered as a cloud computing-based service. Companies will not have to maintain their own, often complex and costly infrastructure and the personnel to operate it, but they will be able to increase flexibility and availability of the computer systems. Instead of buying hardware and software independently, they shall purchase ready applications in form of a service (SaaS model), adjusting their expenditures to current business situation. As a result, their shall be able to dynamically increase their IT capacity and to broaden or reduce the scope of used resources, depending on the current economic situation.

Once companies got familiar with advantages of virtualised environments, their cost-efficiency, increased productivity and the fact that they allow to do more than earlier using limited resources and budget, a new era of common mobility dawned. In the past, IT outsourcing services were more expensive and available usually only to large companies. Whereas now, also middle-sized and smaller companies are within the reach of Cloud Computing. Some of the advantages offered by Cloud computing are described below.

Time schedule management is one of the key processes. It is quite challenging to schedule, for example, a meeting of employees. It is hard to do that when schedule of each employee is different and it seems problematic to gather all employees at the same time. Scheduling may be much easier using an online calendar (e.g. free Google Calendar - calendar.google.com). Being able to analyse schedules of all employees, it is easier to select time when they are least busy and most available. Special applications (AppointmentQuest www.appointmentquest.com, hitAppoint www.hitappoint.com, or Schedulebook www.schedulebook.com allow to choose appropriate time, when all or most of employees can be present at the business meeting.

Contact list management is another process where clouds can be useful. Coping with multiple contacts using simple programme, e.g. MSs Outlook would be troublesome. There

are advanced applications dedicated for customer relations management (so called CRMs) used for comprehensive assistance. They suggest contact time with a give client, provide list of client activities, remind about business meetings, include sample business e-mails and allow to schedule mailing etc. All of it is immediately accessible on-line all the time. Such applications include, e.g. BigContacts (www.bigcontacts.com), Highrise (www.highrisehq.com), and the most widely known - Salesforce.com (www.salesforce.com).
Also project management process can be assisted by cloud-based tools, such as AceProject (www.aceproject.com), Basecamp (www.basecamphq.com), onProject (www.onproject.com), and Project Insight (www.projectinsight.com). The process manager can assign tasks, remove, up-date and reorder them as well as add descriptions, while each participant of the process immediately sees the same Ganta or PERT diagram. Such tools can also be used for file exchange, task list generation, cost monitoring and simultaneous management of multiple processes.

Budgeting is one of the most challenging and huge processes in many companies. It engages all departments that independently develop their budgets (e.g. using spreadsheets) and send them to the financial department. This is certainly not an optimal solution. Cloud Computing offers elimination of independent budget generation using separate spreadsheets. Instead, it allows to standardize budgeting process in all departments of the organisation in real time using a common template and then to collect and process data of the entire organisation. It can be done using Google spreadsheet (spreadsheets.google.com) or the dedicated application Host Budget (www.hostanalytics.com/budgeting-planning-software.html). Presentations are also very important for companies. Presentation co-development process should be quick and easy, as it concerns presentation of results which certainly required much more labour before. Like in case of the abovementioned processes, presentation can also be developed using tools available online, e.g. Google Presentations, which is included in Google Docs (docs.google.com) package and provides functionalities similar to MS Power Point and supports export and import of files in MS Power Point format. There are also other presentation programmes available, such as Prezzo (www.prezzo.com) and Zoho Show (show.zoho.com). The advantage of cloud-based applications over conventional ones is on-line access to standardized presentations of the entire company and to currently needed presentation.

Use of cloud-based tools covers increasing percentage of process-related companies' needs. You can already:
- Co-develop reports
- Co-develop marketing materials
- Co-develop expenditure reports
- Co-develop financial statements

Main providers of Cloud Computing services on the market (offering so called public clouds) are:
- Microsoft – Windows Azure, Hotmail, Live, SkyDrive, BPOS, i.e.: Exchange Online, SharePoint Online, Office Communication Server Online and Live Meeting (commercial products mainly)
- Google - Google Apps, Chrome OS, Gmail, Picasa (which are free products mainly)
- Salesforce – CRM system
- Amazon – Amazon EC2 (Elastic Compute Cloud)
- IBM – IBM Bluehouse

Use of virtual environments arouses safety-related anxiety and it is a challenge to IT audit . Those doubts concern, for example, data confidentiality, cloud-based software licence safety as well as actual location of the application being used. Admittedly, there are different protection systems and protocols available, but they cannot completely protect against hacker attack. A company has to specify resources that can be moved to the cloud and the degree of that movement. Organisations where safety is of top priority, like banks, shall certainly approach that issue with reserve and scepticism.

4. SERVICES DEDICATED TO UNIVERSITIES

Modern education means use of many IT systems supporting educational processes. At the university level, IT systems collect data on students, enrolment to individual lectures or laboratories as well as on students' marks. The systems also collect information on lecturers, teachers, timeTableles, subjects etc. Main task of universities is teaching. To make didactic processes keep up with modern solutions, they have to be supplied with state-of-the-art scientific knowledge – i.e. scientific research (another process type). All those processes must be supervised by efficient administrative and management system. Students' and employees interests must also be reconciled. Higher education system is specific because of
- most of universities are state-owned (it is of importance when applying for financial support) which means developed bureaucracy
- historic aspects resulting in variable concepts of university management and policy

 distraction of information and computer hardware over individual university faculties and departments.

Thus, on one hand, there are processes which are naturally connected to each other (one process is precondition for success of other processes) and they make up a whole, while on the other hand there are some problems to be eliminated. Although some e-learning systems are used in teaching (e.g.. Moodle) or e-Dziekanat (for administration) and e-Kadry (for human resources) as well as electronic mail and Intranet, the problem of data consistency is still to be solved. The same issue applies to daTableases which are often of different architecture or of unique specification dedicated for specific file, bibliographic, HR or financial records etc. Some global view over university institutions is thus necessary. One may find some analogy between education and IT, as information is highly distributed in both of those areas. Excellent prospects are offered by Grid and Cloud Computing in both of the abovementioned areas as they allow centralisation, unification and joining resources to achieve improved and more efficient hardware, software and data source. Some remedy to administrative situation of a university may be implementation of the electronic document workflow system (this requires existing processes to be reviewed, defined and formalised) while unification of data bases can be ensured by implementation of a data warehouse (i.e. a subject-ordered, integrated, permanent data collection with time attribute, used for decision making assistance) in order to assist data processing for strategic and analytic purposes. Obviously, virtualisation may also apply to other processes taking place in private companies, described in previous paragraph, which may also be found in universities. The question whether such solutions should be purchased as services from external suppliers or own infrastructure should be used is also important and should be answered. Academic centres are usually equipped with modern computer hardware, broad-band networks and have their own IT departments, so it seems to be good solution to buy application licenses only and implement them in own, properly conFigure.d infrastructure.

5. SUMMARY

As information and computers are highly distributed, it is difficult to use comprehensive knowledge on some topic or to use computing capacity efficiently. Virtualisation and abstraction of physical application resources, data and computing capacity are new business concepts. This allows excellent division and assignment of those resources, data and capacity in order to optimise their use. Newly esTablelished virtual systems and virtual organisations are based on Grid and Cloud Computing idea. We entered new age, where IT resources are treated as a service to be ordered and charged for the same like electricity or other utilities at home. Heterogeneous resources are joined to obtain, among other things, higher computing capacity. Inappropriate hardware is not a problem any more and there is no need to invest in dedicated infrastructure as everything may be ordered as service. All you need is only the connection to the cloud (Internet connection) and you get access to the service without time and space limits. Such approach seems to be required by globalisation. Computerization started with few machines located in large computing centres, but access to smaller intelligent and mobile equipment resulted in gradual fragmentation. Currently large units of high computing capacity are built again, which may seem the return to the past.

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