Report of the Forum of Bank Technology

of the Polish Bank Association

CLOUD COMPUTING

in the financial sector

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Given the technological developments, evolution and volume of data processed, accumulated and collected, one may say that “cloud computing” is the future of technology. Cloud computing has been growing dynamically all over the world, and the European Commission is undertaking efforts towards its promotion while service providers ensure a high level of security. However, security of cloud-based services is an important point of concern, especially for the finance sector.

Every new technology, including the above-mentioned model of service provision, boasts many benefits, but is also prone to threats. One should remember that data concerning customers of Polish banks could be processed outside the seat of the bank and frequently even outside the host country. Hence it is important to develop relevant legislation to ensure protection of personal data and information covered by bank secrecy. There are two things that matter most: identification of threats and proactively preventing them. More and more publications and documents deal with the implementation of cloud-based solutions and issues surrounding the protection of data and privacy, aiming to contribute to mitigating threats related to the use of cloud computing services.

Given the noted concerns and in response to the expectations of bankers, the Forum of Banking Technologies’ Cloud Computing Group of the Polish Bank Association (PBA) has developed this document devoted to the issue of cloud computing in the financial sector.

This publication is of an educational nature and its primary objective is to help develop directions for work and development related to the implementation of cloud computing in banks.

Authors

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Introduction

Document objective

This report refers to the use of cloud computing[1] in the financial sector. It was developed to structure the knowledge surrounding the concept of cloud computing and to broach the preconditions for using this type of IT services. It is the authors' aim for this report to be used to initiate discussion on cloud computing in institutions within the financial sector in Poland.

We hope the report audience finds it interesting and is willing to respond to it. The report may be updated and complemented as necessary.

Target audience

The basic target audience for the report includes managers within financial sector entities, in particular managers in charge of finance, product development and sales, operating risk, legal aspects, IT services and technologies.

The report may also be useful for those responsible for supervision over the financial sector, as well as for anyone wanting to extend or verify their knowledge of cloud computing.

The report was published on the official website of the Polish Bank Association.

Responsibility for distribution and recommendation

The experts invited by PBA to work on the report did their best to ensure that this document has been developed to adequately high standards, and to their best knowledge regarding applicable laws and regulations.

The report may be distributed in whole or in part (including quotations) under the following conditions:

- the following title of the report must be quoted: *Report of the Forum of Banking Technologies of the Polish Bank Association – Cloud Computing in the Financial Sector*;
- all authors of the report must be cited;
- no fees may be charged in connection with the distribution of this report without special consent from the PBA FBT.

[1] The concept was coined after the tradition of drawing Internet connectivity on IT diagrams as a cloud.

Glossary of terms

Definitions

API – application program interface – a method of communication between one computer application with another computer application.

BPaaS – business process as a service; a service consisting in supporting a customer's business process using shared remote software. Usually provided in combination with IaaS, PaaS and SaaS services.
The way of defining, from a user perspective, the most sophisticated future model of cloud computing consisting in the use of access to fully tooled business processes available in the cloud.

Hybrid cloud – cloud computing that combines private and public resources.

Private cloud – resources shared with other users that are dynamically provided for the exclusive use of a single organisation.

Public cloud – resources shared with other users that are dynamically provided online by a third-party service provider.

Cloud computing – a model of providing data processing services enabling ubiquitous, convenient, on-demand network access to a shared pool of computing resources (e.g. networks, servers, storage, applications and services). Gartner experts define cloud computing as a "style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using Internet technologies"[2].

DaaS – data center as a service; a service consisting in providing full computer center functionality online. An infrequently used term, now replaced by the notion of a private cloud.

FaaS – framework as a service; a service consisting in providing the client in online mode with a set (so-called framework) of tools to enable them to individually develop dedicated solutions. It is an environment that fits SaaS and enables the extension of existing functionalities of an application shared in SaaS. Like in the PaaS environment, FaaS enables exclusive use of the languages and APIs provided by FaaS.

Business function – a single activity or a group of homogeneous business activities that play an important and precisely defined role determined by or arising from the strategy of an enterprise.

Grid – a system that integrates and manages resources controlled by different domains/centers/entities connected by a computer network.

Host – a computer with an IP address connected to a network that uses the TCP/IP communication protocol. If the computer user connects to a computer network, then the network adapter or modem of the user's computer is provided with an IP address and becomes a host. By this definition, a host is any machine that participates in data exchange through a computer network, e.g. online.

Inshoring (or Onshoring, Backshoring) – inshore outsourcing (opposite of offshoring); domestic outsourcing of business processes of an organization.

IaaS – infrastructure as a service; a service consisting in providing customers with

[2] http://www.gartner.com/technology/research/cloud-computing/index.jsp

necessary technical resources and maintenance (servicing) and administration services online.

Insourcing – (opposite of outsourcing) the handing over of the processes or business activities of a unit, performed as part of economic activity by third party service providers/suppliers, to an internal, separate and specialized organizational unit.

Offshoring (offshore outsourcing) – (opposite to inshoring) transfer of selected business processes of an organization abroad, while at the same time maintaining the same group of customers.

Outsourcing – outside-resource-using. The concept of outsourcing comes from Henry Ford who said that, “If there’s something we cannot do more efficiently, cheaper or better than our competition, it does not make sense to do it, and we should hire somebody who will be better in doing the job than we are.”

P2V – private to virtual – replacement of physical IT infrastructure with virtual infrastructure, and more precisely: transfer of system software, applications and data from physical devices into their virtual counterparts.

PaaS – platform as a service; a service consisting in providing the customer with necessary operating systems and system tools online, as well as and maintenance (servicing) and administration services as a basis for processing of the customer’s dedicated applications. PaaS is usually provided in combination with laaS.

ISO file – an optical drive data format.

Business process – a series of related actions or tasks that resolve a specific economic problem or lead to the achievement of a specific economic outcome.

SaaS – software as a service; a service consisting in providing the customer with online processing of necessary applications (universal or dedicated) and maintenance (servicing) and administration services. SaaS is usually provided in combination with laaS and PaaS.

Scripts – programs written in script languages are executed within a specific application, unlike programs (“regular”, non-script programs) that are executed irrespective of other applications.

Sourcing – a comprehensive strategy of an organization which defines how and who operates specific business processes or functional areas of the organization.

XaaS – anything as a service; rarely used term referring to online provision of any type of services (application, platform, infrastructure and telecommunications)

Virtualization – parametric production of many virtual computers or of many virtual networks in a single network in a single physical computer. Virtual computers maintain the properties of a physical computer and their users can separate their tasks and data.

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Acronyms

AML	Anti-money-laundering
API	Application Program Interface
BIK SA	Biuro Informacji Kredytowej (Credit Information Bureau)
BPaaS	Business process as a Service
CAPEM	Capital Expenditures
DaaS	Data center as a Service
DRP	Disaster Recovery Plan
FaaS	Framework as a Service
FBT	PBA Forum of Banking Technologies
GIODO	Inspector General for the Protection of Personal Data (Generalny Inspektor Ochrony Danych Osobowych)
IaaS	Infrastructure as a Service
NIST	National Institute of Standards and Technology
OPEX	Operational Expenditures
PaaS	Platform as a Service
BL	Banking Law Act
PCI	Peripheral Component Interconnect
EBC	PBA Electronic Banking Council
RBL	Real-time Blackhole List
ROE	Return on Investment
SaaS	Software as a Service
SAS7O	Statement on Auditing Standards No. 7O
S/MIME	Secure/Multipurpose Internet Mail Extensions
SOA	Service Oriented Architecture
SSL	Secure Sockets Layer
TCO	Total Cost of Ownership
TLS	Transport Layer Security
EU	European Union
XaaS	Anything as a Service
PBA	Polish Bank Association

1. Characteristics of cloud computing

The essence of cloud computing is not the use of information technology itself, i.e. hardware and software, but a new model of delivering them as a service. The most popular definition of it was coined by the National Institute of Standards and Technology (NIST).

Cloud computing – a model of providing data processing services enabling ubiquitous, convenient, on-demand network access to a shared pool of computing resources (e.g. networks, servers, storage, applications and services). Such resources may be ordered by customers, are configurable depending on users' needs and can be rapidly provisioned and released with minimal service user involvement.

Depending on the type of resources delivered, there are three basic models of cloud computing:

- infrastructure as a service,
- platform as a service,
- software as a service.

Infrastructure as a service (IaaS) assumes utilization via a network, including the Internet, of IT hardware. Hardware includes, among others, a predefined virtual server or any of its components that are selected by the customer as necessary, i.e.

- a processor, understood as delivery of computing power expressed in GHz,
- RAM with quantified capacity, for example in GB,
- disk storage space with quantified capacity, for example in GB.

Using the server virtualization technique, a service user may build a multi-layer structure connected with similarly virtual networks (VLAN). Thus prepared infrastructure may be used by the service user to install their own system software, database software and business applications.

Platform as a service (PaaS) has IaaS functionality extended to the operating system and database levels, providing an end-to-end environment ready for installing, processing and launching one's own business applications.

Software as a service (SaaS) – in this model, the user is provided with continued access to IT applications and pays only for their actual usage. Access to these is provided like in the PaaS and SaaS models, however unlike them, the software used is owned by the provider and it is the provider who is responsible for the updating and maintenance of the software.

Types of cloud computing resource utilization:

- Public cloud – resources shared with other users that are provided dynamically online by a third-party service provider. The resources may be owned by many providers. Customers use the resources in a self-service mode.

- Private cloud – means infrastructure provided for the sole use of a single organization, including different business users (based on an NIST definition).
- Dedicated cloud – a type of a private cloud used by a limited group of private entities.
- Hybrid cloud – a cloud that combines private and public cloud resources where public resources are, for example, used for backup purposes or at times of increased demand for processing capacity.

Cloud computing service provides the opportunity to use unlimited resources that are delivered on demand. It enables resolution of the dilemma of how to serve all users; what would happen if the number of users grew; how many devices of each type would need to be provided and how applications could be scaled. The cloud computing service is responsible for supporting any changing load, and fees are charged precisely for the level of resource utilization. This is the essence of the revolution brought by cloud computing into the economy. It makes computing power a generally available resource, potentially similar to a utility service, such as electric power or water supply for households.

2. The concept of cloud computing

The term "cloud computing" was first used in 1996 in an article by S.E. Gillet and M. Kapor, titled *The Self-governing Internet: Coordination by Design* (MIT Press). Interestingly, the present understanding of the term is exactly the same as intended by the precursors.

The modern concept of cloud computing as the most advanced form of IT outsourcing dates back to around 2005. Utilization of IT resources in the cloud computing model was enabled by the following phenomena that have been consistently true since the 1960s:

- changes to processing models from independent units to network processing,
- increase in computing power of single servers and entire data centers,
- increased network bandwidth,
- transfer of the concept of virtualization from mainframes to entire IT resources.

From a service perspective, the flexible structure of an IT environment also enabled – in addition to the development of the cloud computing concept – the introduction of the SOA (Service Oriented Architecture) model, which technically assumed transfer of the "browser" type communication convention from the human–machine interaction to machine–machine interaction.

Such technical developments have had organizational, business and legal consequences.

Outsourcing

Outsourcing, which in IT occurs concurrently with cloud computing and will eventually largely make room for it, offers the same service from a functional point of view. The nature of outsourcing is discussed further to shed light on

the mechanism of cloud computing.

Outsourcing is one of the forms of organizing business activity. Its introduction is usually related to a reorganization of the previous manner of managing a business. Selected functions or processes (we will stick to the term "function" for the sake of description clarity[3]) are separated from the previous structure and commissioned to another entity. The long-term objective of it is to increase organizational efficiency. The outsourced function is assumed to be performed in a more beneficial manner than before. However, during the transitional period that accompanies the transfer of the selected function, the organization needs to face a significant change[4]. It must be considered from an operational (organizational) perspective and from a formal (legal) perspective. It should be noted that outsourcing only consists in the commissioning of operations and does not entail transfer of legal liability from the commissioning party to the service provider.

Outsourcing may refer to single functions, business processes or business areas. We shall touch upon the outsourcing of functions further on, as they follow the same rules. In order to perform a function, an organization should meet the following conditions (see also Fig. 1):

- know in detail the nature of actions (tasks) that make up a function,
- have personnel with relevant qualifications,
- collect necessary material, financial and information resources,
- determine the proper organization for performing tasks,
- define the rules for managing task implementation.

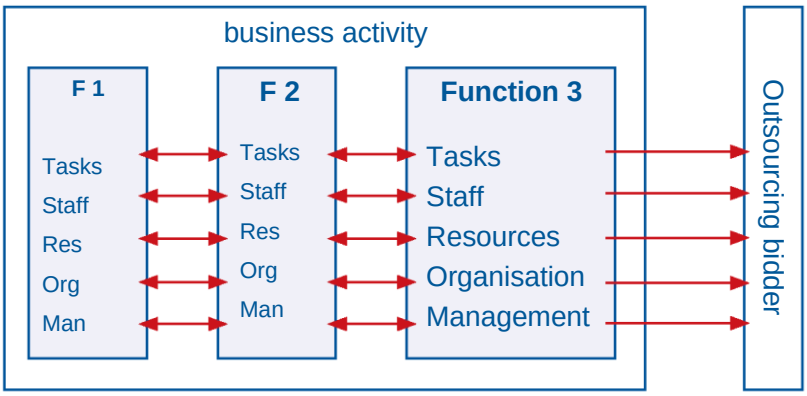

Figure 1. Mechanism of allocating functions for outsourcing

Source: authors' own compilation based on [Trocki, 2001].

This means that whenever an organization decides to outsource a selected function, it considers that despite diligent arrangement of function performance, an external service provider will be more effective or cheaper. The basic purpose for outsourcing functions has always been to increase profitability, which is achieved through:

[3] 'Function' is a different term than a 'business process', however in this paper presenting the general concept of outsourcing, the difference is not significant.

[4] We focus on the issue of commissioning functions that are important from a business and organizational point of view, thus not ones that are frequently outsourced such as cleaning or guard services.

- focusing on selected core activity,
- using third-party competences that are higher than one's own.

Given that, when transitioning to outsourcing a function, the following relations require reorganization:

- task-related relations,
- staff relations,
- ownership relations,
- organizational relations,
- managerial relations.

These connections are stronger for functional and centralised structures and weaker for structures based on profit/cost centers and territorial structures (cf. Fig. 2).

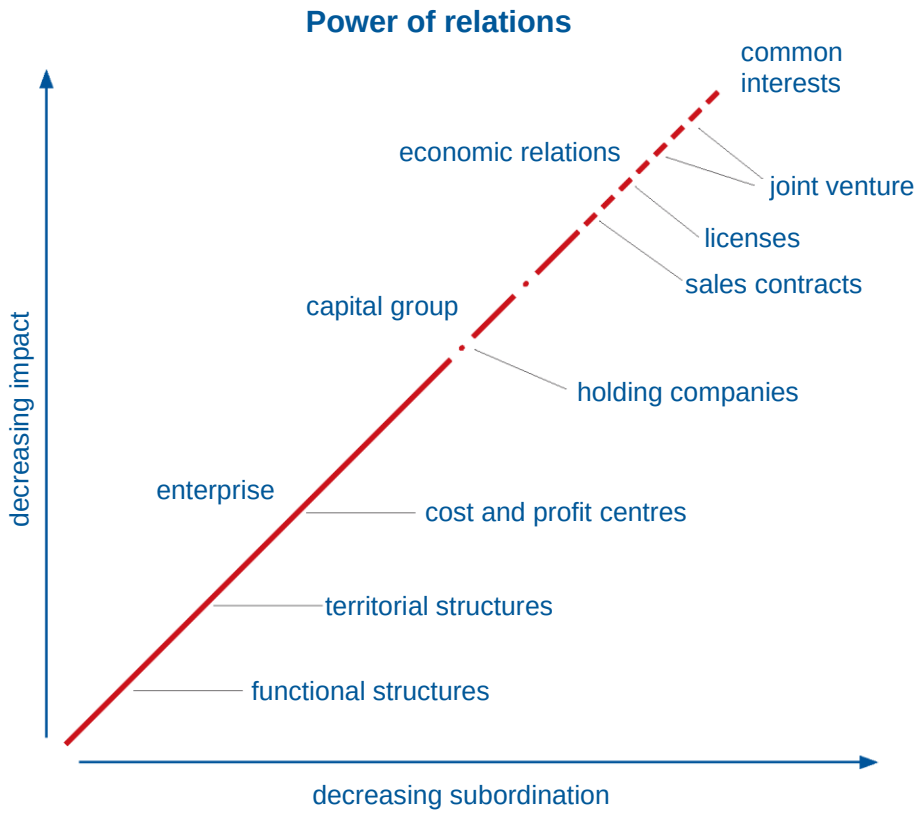

Figure 2. Power of functional relations.

Source: [Trocki, 2001].

This, consequently, means that it is most difficult to outsource functions that are strongly related to other functions, e.g. IT services, and it is most easy to outsource those that are the least related, e.g. cleaning (cf. Fig. 3).

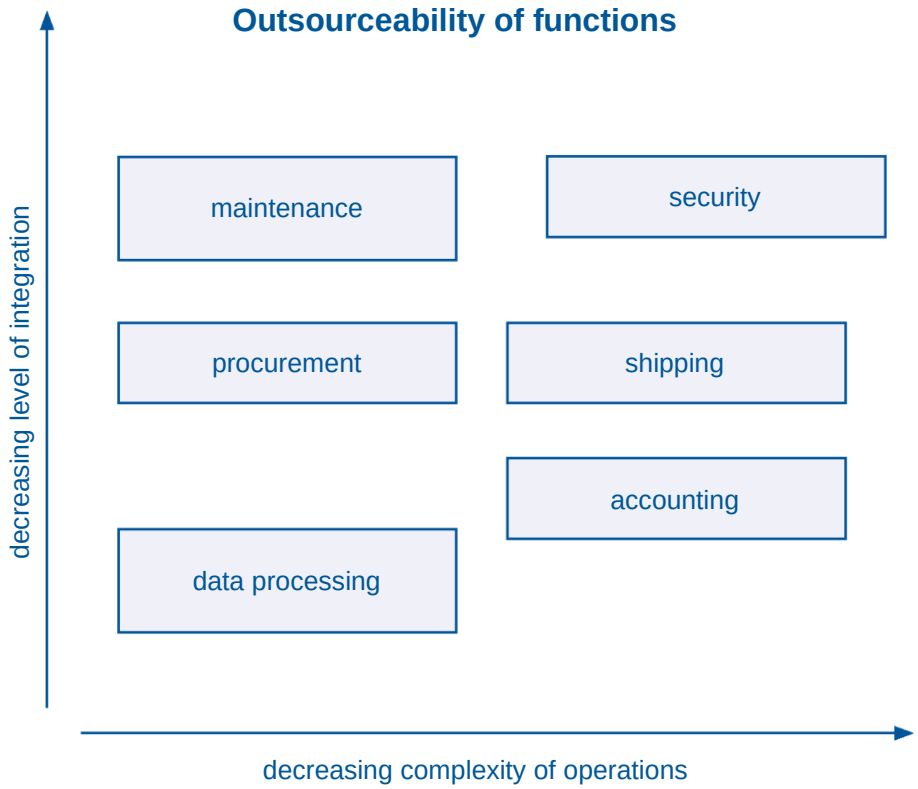

Figure 3. Outsourceability of functions

Source: [Trocki, 2001].

The concept of outsourcing is nothing new. There is a famous quote by Henry Ford who said that "If there's something we cannot do more efficiently, cheaper or better than our competition, it does not make sense to do it, and we should hire somebody who will be better in doing the job than we are." But outsourcing is actually much older as it results from specialization and division of production factors that is characteristic of any industrial operations and earlier – of handicraft.

The brief history of outsourcing evolution is as follows:

- task allocation (until the beginning of the 20th century),
- a cost-cutting method (until the 1960s),
- mitigation of the risk of technological changes,
- focusing on the core business,
- strategic selection of the mode of functioning.

At present, the following fully-fledged outsourcing objectives may be indicated:

- strategic objectives:
  - focusing on the core business,
  - increasing business freedom and flexibility,
  - increasing efficiency,
  - access to know-how;

- market objectives:
  - increasing competitiveness,
  - increasing extent of business,
  - business diversification or concentration;
- economic objectives:
  - increasing revenue,
  - reducing costs,
  - improving profitability,
  - reducing economic risk;
- organizational objectives:
  - making the structure “lean”,
  - simplification of organizational procedures,
  - improvement of operations;
- motivational objectives:
  - making economic results more objective,
  - promoting economic thinking,
  - developing the enterprise,
  - increasing motivation.

Development of an outsourcing solution may be a complex and long-term process that constitutes a project itself. Its framework structure is as follows:

- idea (initiative),
- analysis of purpose (“make-or-buy” analysis),
- opportunity analysis,
- decision,
- selection of a partner,
- SLA description,
- contract negotiation,
- internal reorganization,
- implementation.

From a legal perspective, outsourcing is classified into contract and capital outsourcing. Contract outsourcing is a typical relationship between independent entities, one of which outsources part of its activity to the other entity. Capital outsourcing means specialization of operations within a capital group, for example by

establishing cost management centers.

Legal relations between parties to an outsourcing service are similar to those involved in the cloud computing service. These were discussed in Chapter 6 and in the Bird&Bird legal analysis attached. In an outsourcing relationship, it is important that the outsourcer outsources only an activity relevant to a specific function, while still retaining all business liability towards its customers. The service provider, however, may not rely exclusively on its experience in the specific area. They need to comply with the applicable law and the good practices applicable to the outsourcer and undergo inspections and audits to the same extent as the outsourcer.

The guaranteed quality of the services provided is ensured by appendices to outsourcing contracts, so-called service level agreements (SLAs). Their aim is to define the needs and requirements of the customer, the capacity and limitations of the service provider and external circumstances so that it is possible in a given (potentially disputable) situation to unambiguously assess [Yes – No] whether the service provider has sufficiently performed the agreement.

The term "SLA" may be related to:

- "a theory in management science",
- legal approach,
- organizational approach,
- technical approach.

A typical structure of SLA requirements description is as follows:

- definition of services,
- management of performance effectiveness (joint periodic assessments),
- problem solving (including documentation),
- responsibilities of the service provider,
- damages, liabilities, force majeure,
- security, confidentiality, audit,
- business continuity,
- settlements,
- contract termination.

However, example service assessment indicators used for determining whether a service is being performed properly (sufficiently well) are as follows:

- guaranteed response time (e.g. 4 hours from notification),
- guaranteed repair time (e.g. 12 hours from notification),
- guaranteed service availability (e.g. 99.95% annually),
- average time to close a ticket,
- percentage of tickets closed within a specified time (e.g. 80% within 20

seconds),

- percentage of tickets closed in one contact.

Legal aspects – regulations and standards in Poland and the EU

Cloud computing is a new phenomenon. No regulations have been issued that would directly refer to cloud computing either in Poland or in other states (according to the best knowledge of this report's authors). The strategy of the European Union towards cloud computing is being developed by the European Commission. No national provisions will be implemented before the strategy has been agreed upon and published by the Commission. So far, the European Commission has published a report on cloud computing that was consulted with the public[5]. More documents are under way.

Although there are no regulations that would refer directly to cloud processing, such a solution may be implemented on the basis of the existing legislation as cloud computing is actually already governed by law. In Poland and abroad, regulations exist that specify the terms and conditions for processing specific categories of information and determining requirements in the case of transferring such information to third parties (sub-contractors). The categories of information that fall under such regulations are usually personal data and other legally protected data (including in particular bank secrets, a number of data categories covered by professional secrecy, state secrets). Regulations on outsourcing activities to third parties as a rule are based on science and standards of ensuring information protection and business continuity.

A rather exhaustive overview of regulations applicable to the cloud computing services addressed to the Polish financial sector entities has been included in an attachment to this report called *Cloud computing in the financial sector. Regulations and standards.* The first version of this legal report on cloud computing was published in November 2011. Further on, we will thus present only a general description of the legal aspects and refer the readers to the attachment and the said legal report for more detailed information.

Regulations applicable to cloud computing generally refer to two issues:

- data processing,
- use of third-party entities for processing.

These mainly include provisions of the Act of 29 August 1997 on personal data protection and regulations concerning outsourcing in the financial sector:

- Act of 29 August 1997 – Banking Law,
- Act of 19 August 2011 on payment services,
- Act of 27 May 2004 on investment funds,
- Act of 28 August 1997 on organization and operation of pension funds,
- Act of 29 July 2005 on trading in financial instruments,

[5] http://ec.europa.eu/information_society/activities/cloudcomputing/docs/ccconsultationfinalreport.pdf

- Act of 22 May 2003 on insurance activity.

From a personal data protection perspective, cloud computing generally consists of outsourcing personal data processing to a third party or a network of third parties. It requires any business to ensure control over the manner of data processing by a cloud computing services provider, as well as gives them the right to audit a service or service provider, forces them to possess knowledge of the location of data, and requires that there be a lack of possibility for the service provider to use the cloud service for any other purpose than proper performance of the processing service[6].

Regulations regarding outsourcing services in the financial sector are based on the same principles as regulations concerning personal data protection, however, they focus on slightly different aspects of information security. Regulations for the financial sector generally classify actual transactions (hence also data processing operations) into those important for continued and undisturbed functioning of the institution and other transactions. Regulations refer exclusively to actual transactions (also called operational transactions) that are important for the functioning of the institution (also called "critical" in the jargon). In the case of critical actions and processes, regulations are based on the following principles:

- clear responsibility,
- adequate information security,
- ability to ensure business continuity in proportion to the level of criticality,
- systematic monitoring of risks.

All the said legal acts focus on ensuring information security, control over information and risk related to its processing or the outsourcing of its processing to another entity.

In the authors' opinion, an essential barrier to the development of cloud computing has also emerged in the financial sector, that is of key importance in Poland and results from the Banking Law and a number of other regulations in the sector. This mainly includes a prohibition to introduce limitations to the service provider's liability for damages caused to customers of the institution. This restriction is a creative expansion of recommendations contained in European regulations (such as Markets in Financial Instruments Directive or Payment Services Directive), which prohibit financial institutions from outsourcing in order to limit their liability towards customers. The expansion introduced by Polish legislators goes not only beyond the requirements of EU legislation, but also way beyond their aim. The Polish regulation is also odd compared to regulations applicable in other European Union Member States.

If you are interested in detailed information about the regulations concerning cloud computing in the Polish financial sector, please refer to the said legal report titled *Cloud computing in the financial sector. Regulations and standards*, whose second edition was attached to this document. Readers interested in an international perspective on cloud computing can find an increasing number of publications on the

[6] As far as personal data processing in a cloud is concerned, there is a new interpretation included in the so-called *Sopot Memorandum* issued on 24 April 2012: a common position of the Berlin Group (an international advisory body gathering regulators and experts in personal data) indicating specific risks related to cloud computing but also recommendations and a number of proposed good practices. The document is available at http://www.giodo.gov.pl/data/filemanager_pl/dif/m_s_pl.pdf

subject[7].

Organizational and managerial aspects

Cloud computing is generally based on:

- unrestrained availability of a pool of resources,
- virtualization as an effective use of infrastructure,
- flexible and dynamic scaling (without capital outlay),
- automatic modeling of the processing environment,
- proportion of cost-to-resource usage.

Unrestrained availability of a pool of resources

Irrespective of cloud computing, the model of maintaining one's own IT resources has been gradually being abandoned for years and replaced by IT outsourcing based on different models of the outsourcing service (hosting, collocation, etc.). This process has significant economic consequences. The main consequences include a change of burden from capital expenditure (Capex) towards operating expenditure (Opex). Another consequence is the potential reduction of operating costs related to infrastructure function. Reduction of capital expenditure lowers the barrier for undertaking projects based on significant IT usage.

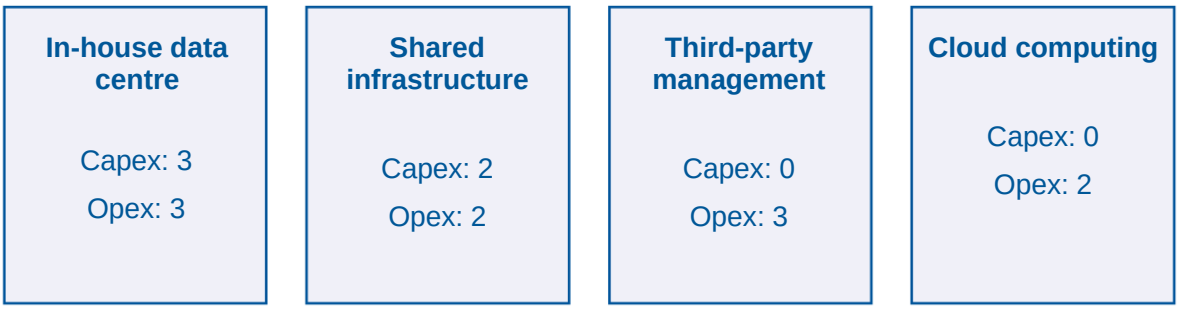

Figure 4. Capex and Opex in IT models (numbers indicate proportions)

Source: [Mateos, Rosenberg, 2011].

The difference in costs arises from the fact that cloud computing provides a much better cost structure. The key reason for this is the phenomenon of scale – resources (computing power, disk space, energy consumed, network bandwidth) are offered in a wholesale manner, which is similar to the case of goods offered by retail chains compared to those same goods in conventional shops.

Cloud computing is also analogous to the "just-in-time" method of production management, which enables companies to minimize or even eliminate generation of cost-intensive inventory.

[7] For example [Shaw, 2011].

Virtualization as an effective use of the infrastructure

Virtualization is of key importance to cloud computing, as it most effectively enables use of the main IT infrastructure resource, namely the physical server, which in this usage model is divided into a number of virtual servers. From a user perspective, every virtual server operates as a regular physical server with an operating system and a full set of applications. Virtual servers constitute a pool of resources available upon demand.

The concept is very old and dates back to the time of mainframe computers, but has been strengthened in recent years with multi-core computer technology.

Flexible and dynamic scaling

Virtualization enables user applications to flexibly use a larger or smaller pool of resources, depending on current and evolving business/operating requirements. Flexibility is demonstrated in dynamic scaling, i.e. dynamic availability of a proper volume of resources, in line with the current demand. Almost every company has times of increased demand for processing resources, and if a company has to provide them on their own, they end up maintaining redundant resources when the demand is average and generating unnecessary costs. Cloud computing enables businesses to avoid such unproductive costs.

Automatic modeling of the processing environment

An application that supports user needs and is provided as a cloud service may source or release resources (instances) as necessary. Resources are allocated dynamically and automatically ("on the go").

Proportionality of cost-to-resource utilization

The possibility to dynamically scale resources is reflected in fees that are generally proportional to the level of resource utilization. Fixed costs (a typical example of which is amortization) are thus transformed into variable costs. This can have a significant impact:

- removes the investment barrier for new projects that can be initiated without a large initial investment in IT,
- provides IT tools that have so far been very expensive to entities with a smaller financial potential,
- shortens the time of IT tool implementation.

3. Scope of the cloud computing model

Cloud computing taxonomy

A comprehensive review of the level of cloud outsourcing and the scope of resulting business benefits has led to the classification presented in Figure 5.

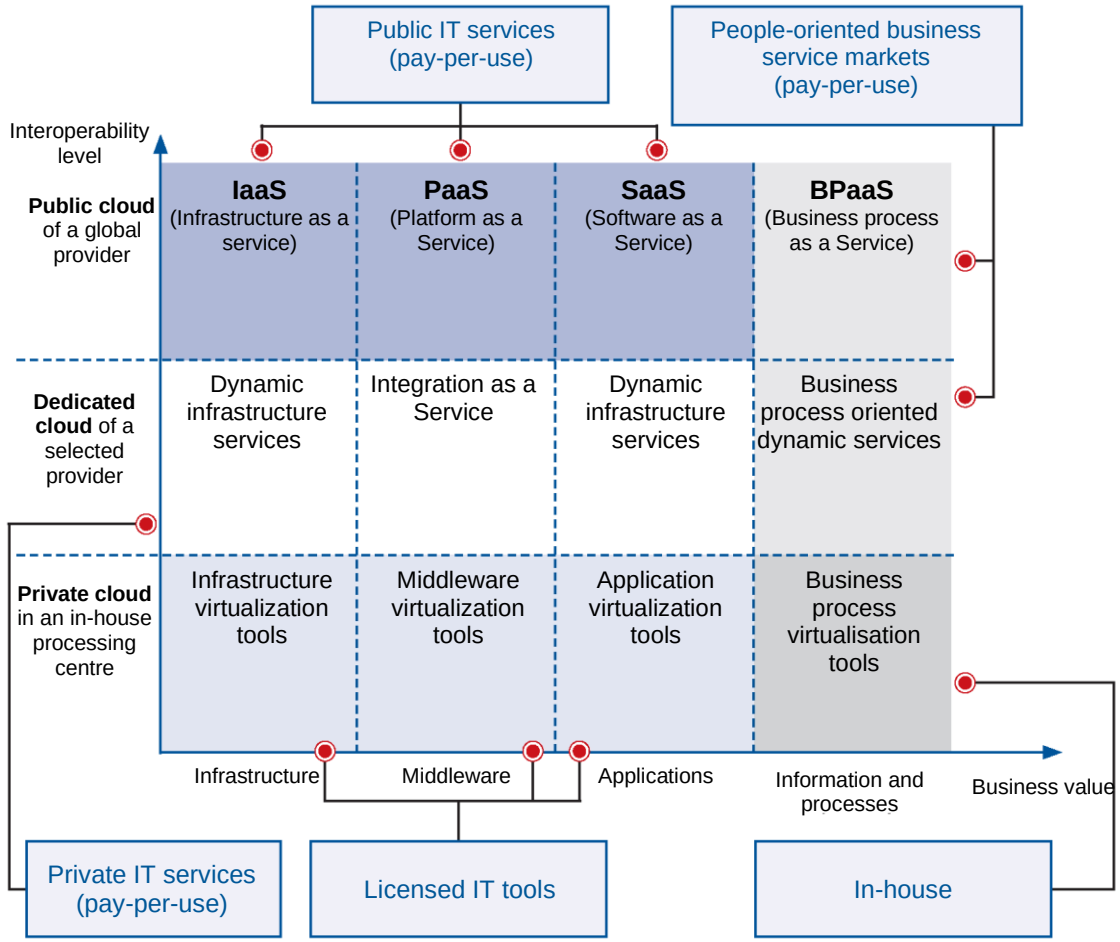

Figure 5. Cloud computing taxonomy

Source: [Forrester, 2010].

Private cloud

Server virtualization is the first step towards building a private cloud. It enables better use of hardware resources and helps to adjust complex IT systems to the evolving business requirements of an organization. Such a transformation is called consolidation.

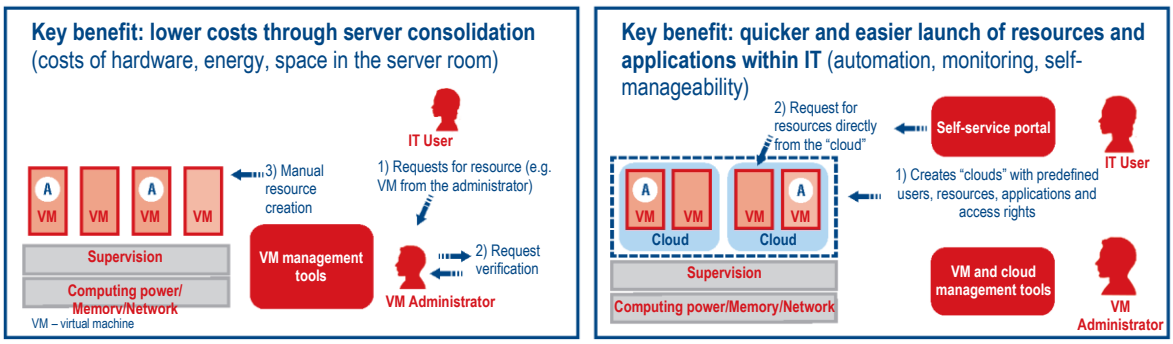

Figure 6. Key benefits of cloud computing

Source: Microsoft Sp. z o.o.

Table 1. Differences between virtualization and a private cloud

Virtualization	Private cloud
➤ Enables users to streamline the use of resources (using a single server, it enables to start additional, virtual machines on it). ➤ The virtual server administrator is responsible for its day-to-day maintenance (e.g. updates, configuration, security). ➤ It is possible to monitor the usage of such resources. ➤ Does not allow self-service activation of additional resources. ➤ Virtualization refers to infrastructure	➤ Automatically activates or releases resources (depending on users' needs and workload). ➤ Offers automatic and central management of pool resources (e.g. conflict resolution or ensuring business continuity). ➤ Automation in managing updates, hotfixes, etc. is possible. ➤ Enables a self-service approach to immediate activation and disconnection of resources. ➤ A private cloud is a manner of providing resources and services.

A server consolidation project based on virtualization includes the following stages:

- selection of physical servers for virtualization,
- selection of a virtualization platform and scaling of target hosts,
- P2V (private to virtual) conversion of selected servers,
- system stabilization.

Stage 1. Selection of systems for consolidation

Selection of systems for consolidation and host scaling should be preceded by collection of data on the workloads characteristics of all servers. As part of the information collection process, the workload of processors, memory, disk channels and network channels are measured. Based on the compilation of data, a decision may be made on the selection of specific machines, avoiding the risk of overloading target virtualization hosts. The above analysis may be supported by relevant application tools that for example enable remote measurement of workloads of selected servers and support the decision-making process on the selection of servers for consolidation. Using tools that provide information on heterogeneous systems (e.g. MS Windows Server, HP-UX, Sun Solaris, Red Hat Enterprise Linux, Novell SUSE Linux Enterprise Server, IBM AIX), it is possible to monitor an entire set of workload parameters for both physical and virtual systems. They also provide alerts for potential failures and help to resolve failures that have already occurred.

Stage 2. Selection of a virtualization platform

In the following stage, a decision must be taken as to the virtualization platform. One can select between dedicated commercial solutions, solutions offered in the price of the operating system and free niche solutions.

Stage 3. Conversion of a physical environment to a virtual environment

This conversion process is also supported by tools. Physical servers must be indicated and their conversion process must be started. Then, hardware configuration

information should be saved and the data from the physical machine disks must be copied to the virtual host. Having completed all the elements (disks, configuration), a fully functional virtual machine is created. The conversion process is often accompanied by optimization, meaning the reduction of virtual resources whilst still maintaining relevant performance. Tools supporting the conversion process are useful afterwards, too, as they enable management of the virtualized environment. It is often possible to manage virtualized heterogeneous environments from different providers (e.g. VMware, Microsoft).

Stage 4. System stabilization

Upon the completion of the P2V (private to virtual) conversion process, it is important to take account of a new element – the virtualization platform – in the system monitoring services provided by the processing center. In order to ensure full and integrated monitoring of the physical and virtual layers, it is worth implementing dedicated tools which enable the establishment of a single service model that includes all the solution elements in heterogeneous systems (hardware, virtualization platform, virtual systems, server applications). This provides up-to-date information on the workload of specific elements, as well as warnings on potential failures. As they are linked to knowledge base tools, they facilitate solving problems that appear.

Private cloud

A feature that differentiates a private cloud from virtualization is the full automation of all its layers: from the system, hardware, virtualizer, and operating systems through to the business logic of applications. The latter is most prone to scalability issues and failure, which are the most difficult to resolve. In this case, the advantage of the private cloud becomes the most visible. Based on extensive knowledge of the structure and current system operation parameters, it provides an opportunity to quickly resolve the problem.

Advanced automation mechanisms that cover all processing layers make clouds different from hosting systems. For instance, if a monitoring system considers that a server supporting websites has reached its performance limit, it may launch another version of the server and integrate it with the existing system, thus eliminating an application bottleneck.

From virtualization through to a private cloud

The first stage of private cloud preparation is to develop a consistent identity management system. This system authorizes all subsequent service actions performed within the cloud.

A virtual environment constitutes the foundation for the operation of a private cloud that provides advanced services (IaaS, PaaS, SaaS). Virtual machine management tools enable VMs to easily move, to use hints on what to do with an under-loaded or overloaded server, or to use embedded libraries with system images, ISO files or scripts. One can then add or remove resources based on predefined rules. Extending the management layer with an additional self-service portal enables company staff to independently reserve resources necessary for the performance of business objectives. A user can independently define how many machines, database instances, processors or operating memory they need.

One key to the proper operation of a private cloud is the possibility to continuously and thoroughly monitor and report all of the layers and processes that occur within it.

As a private cloud generally supports many complex services, it is worth providing it with advanced automation mechanisms that integrate all heterogeneous cloud components and perform sequences of administrative actions, automatically resolving problems that appear.

Public cloud computing

A public cloud is most simply defined as a service available through Internet connections provided by an entity that is independent from the service user. The term "public" does not necessarily mean that the service is free of charge or that customer data is publicly available.

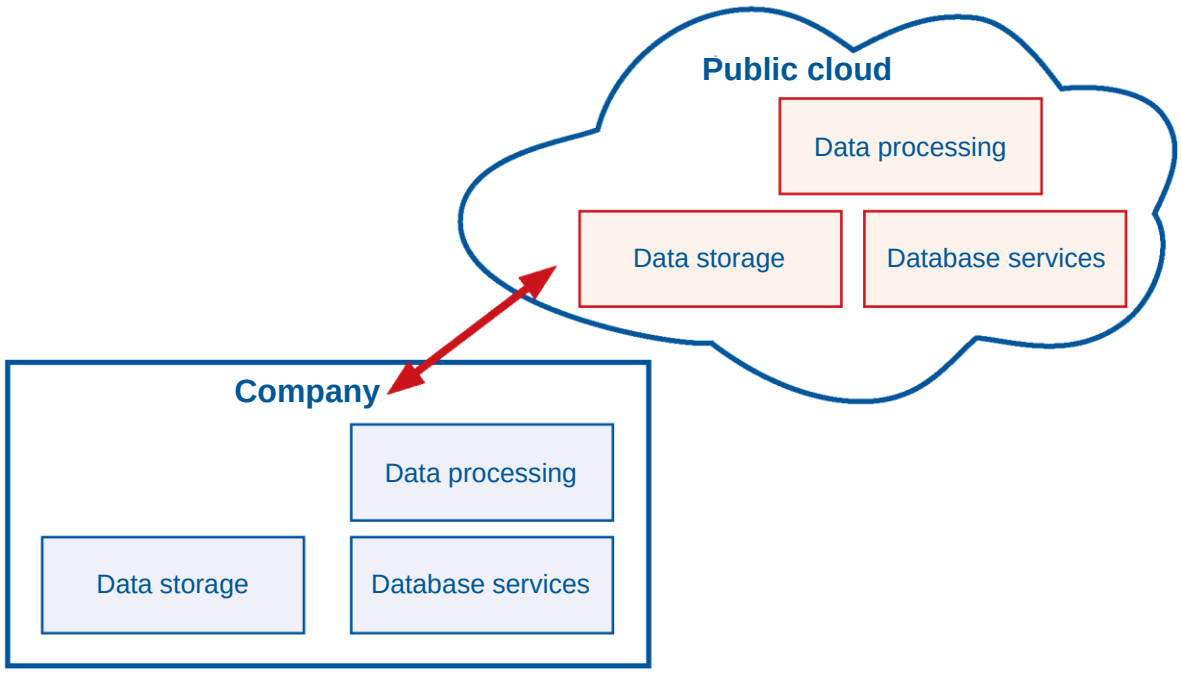

Figure 7. Public cloud computing model

Source: authors' own compilation.

A public cloud service must fulfill the following tasks:

- identification – the service must clearly authenticate the user;
- federated authentication – the service should enable integration with existing company user authentication mechanisms, enabling use of a single sign-on mechanism;
- security (including data privacy) – access to the service must be provided in a secure manner using mechanisms that prevent capturing or spying on customer data;
- data location – given regulatory requirements, the data should be located within the European Economic Area[8] and the customer should be able to monitor its

[8] Or in other territories where data protection was acknowledged as adequate by the European Commission. Find more in the

flow; if data is to be processed outside the EU territory, additional contractual arrangements with the cloud provider and administrative permissions (of the data supervisor) would be necessary;

- service monitoring – the provider should supply tools for monitoring service availability that allow the customer to verify the performance of the assumed SLA.

Potential areas where the use of a public cloud could be economically and technologically viable for an organization include:

- backup copies and storage of archive data,
- additional computing power to support a temporary increase in demand related to computer system workloads,
- applications compatible with the SaaS model (mail, CRM systems, communication, etc.),
- sharing of databases or files with cooperating companies.

When an organization decides to fully "enter a cloud", it does not incur any expenses related to the acquisition or maintenance of extensive IT infrastructure. However, the organization should take into account the quality and parameters of the service that will – to some extent – determine its operation.

Cloud computing – hybrid model

One typical example of a public cloud–private cloud combination (hybrid cloud) would be a situation where an organization has a private cloud in place for the purposes of key business applications, yet where some non-critical applications are provided by third parties in the form of public cloud services. This may also refer to situations where an organization, for reasons related to applicable law, internal regulations or other reasons, may not fully use the public cloud model. However, it can separate some infrastructure and applications by developing IT services using a hybrid model.

Regardless of the model of operation selected, the manner of providing applications is transparent from an end user perspective.

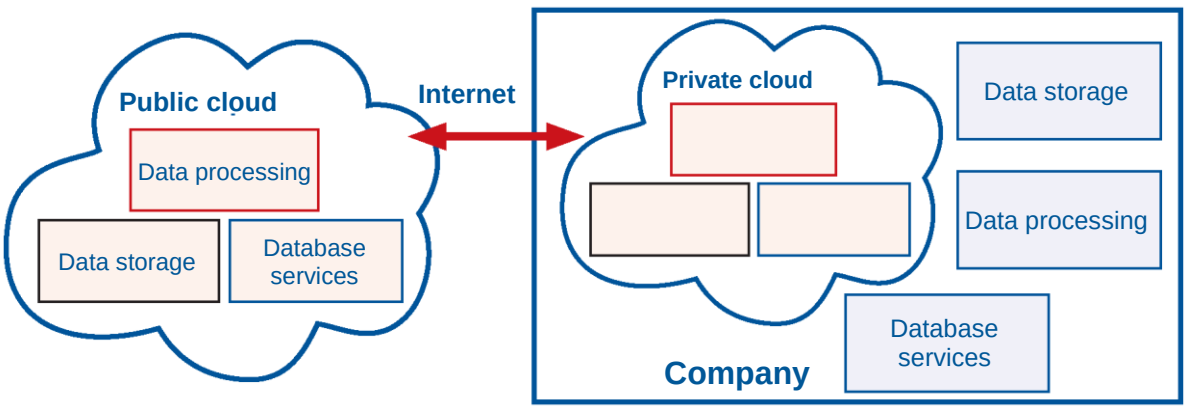

Figure 8. Hybrid model of cloud computing

Source: authors' own compilation.

Requirements regarding a hybrid cloud service provider are exactly the same as in the case of a public cloud. A hybrid cloud model is a practical manner of transitioning to full cloud computing as the existing infrastructure in cases where previous investments and IT process management practices make it necessary to use a model that actively includes all elements of a system to make a coherent whole. Previous habits related to the use of infrastructure and applications are also very important. Consequently, the hybrid model enables easier adaptation to cloud computing and fuller use of its benefits.

Hybrid model scenarios are similar to the use of a public cloud. The critical element that combines both environments may be the distributed user authentication infrastructure (e.g. Active Directory) or a "data bus".

Security challenges

When selecting a third-party service provider, parameters such as security, data protection, privacy protection and property rights must be taken into account. It is important to consider the protection of services at various levels, including:

- the physical layer at data centers: physical access controls, CCTV surveillance, access control;
- the logical layer: data isolation, security of applications used, infrastructure services, network level, identity and access management.

Physical security

Proper physical protection of the customer data storage environment should be assured in the manner described below. Access control is performed using multi-level security verification. A physical security check is performed in computing centers and services are performed by corporate-class computing centers that ensure service continuity based on service level agreements (SLAs). Computing centers perform the following tasks according to industry standards.

- Controls ensuring physical access exclusively to authorized persons. Access is restricted based on business function so that only authorized staff can manage customer applications and services. Physical access authorization is implemented using a number of authentication and security processes: ID cards, smart cards, biometric scanners, local security services, continued CCTV surveillance and two-factor authentication to obtain physical access to the computing center.
- Backup power supply guaranteed, including two separate power supply sources for each data center, battery backup power and diesel generator units (together with alternative fuel supply agreements).
- Climate control to ensure optimum temperature and humidity for hardware operation.
- Natural disaster precautions, including reinforced racks in case of seismic quakes where necessary, as well as fire alarm and extinguishing systems.
- Physical monitoring, including motion sensors, 24-hour access control, CCTV surveillance and security breach alerts.

- Ensuring secure structure and operation of networks, which are designed in computing centers in such a way as to offer a range of separate segments within each center.

Logical security

Logical security of services is as important as physical security. It is ensured through the following key functions:

- data separation,
- security of remote applications.

Data storage and processing is subject to the logical segregation of customers who use the same service, with logical data structures and functions designed specifically for supporting the processes of creation, management and protection of multi-tenant environments. Security architecture supporting multiple customers ensures protection of customer data stored in computing centers shared by many customers against access or violation of their security by other organizations.

A high level of protection of remote applications that are located in computing centers is ensured with reliable security functions and access control functions. These include:

- support of authenticated and encrypted communication, which facilitates identification of communication process participants and protection against message tampering;
- support of e-mail encryption technology (e.g. S/MIME);
- restrictions on e-mail forwarding to reduce the number of unwanted mail and spam;
- a real-time blackhole list (RBL) and secure lists to eliminate messages coming from known spam sources;
- flexibility of rules regarding devices in order to protect communication with mobile devices (such as PIN blocks and remote or local data wipes);
- protection against malware by implementing multi-layer anti-virus software in server operating systems and messaging systems;
- protection of cloud service infrastructure performed through:
  - user interface with security setting configurations that may be filtered by group rights, which allows the content displayed to each individual user to be limited to only the available functions, actions, links and content to which they are allowed,
  - multi-level administration using a three-tier administration model, within which administrative tasks and formats are allocated based on access authorization depending on the user role and level of authorization to access administrative functions,
  - security scanning of the environment in order to find security holes and configuration errors,
  - unauthorized access detection systems in such a way that advanced correlation

engines analyze the data to immediately notify staff of connection attempts classified an suspicious;

- network-level protection, including functions related to a high level of Internet connection security, e.g.:
  - connections enabling customers to access online services are established from a user location with network access, and then directed to a computing center; connections established between customers and computing centers are encrypted using a function compatible with industry standard Transport Layer Security (TLS)/Secure Sockets Layer (SSL); the use of TLS/SSL enables to establish a secure connection between the search engine and a server to increase the data confidentiality protection level and integrity of connection between the user's computer and the data center,
  - a redundant network that allows the opportunity to work in an emergency mode and network availability at a level of almost 100%,
  - all remote connections established by the operating staff are delivered using remote desktop services;
- identity and access management; access to systems that deliver services is controlled through:
  - access control at the staff level: shared IT systems that store customer data are subject to strict control,
  - access control based on the principle of separation of responsibilities and minimal privilege awarding;
- restriction of server functionality by switching off insignificant services;
- sign-in and supervision;
- limited access to services;
- content supervision;
- restriction of server functionality;
- enhanced session protection with SSL/TLS.

4. Cloud computing SWOT analysis

Table 2. SWOT analysis

	S					**W**		
	Technology selection flexibility	Costs	Technological scalability	Speed of new services implementation	Focus on one's own key competences	Solution maturity level	Technological solutions compatibility	Migration complexity
PUBLIC HYBRID PRIVATE	high high medium	low medium high	high high medium	high medium low	high medium medium	medium low high	medium medium medium	medium medium low
	O					**T**		
	Cost predictability	Business flexibility	Business risk	IT performance improvement	Business mobility	Security-related threats	Regulatory-related threats	Mental barrier

PUBLIC HYBRID PRIVATE	high medium medium	high high medium	low medium high	high medium medium	high medium low	low low low	medium medium lowest	high medium low

Source: own compilation.

Strengths

- speed of access to services;
- self-service opportunities,
- pay-per-use,
- possibility to use selected service options,
- possibility to use third-party resources,
- possibility for strict control of compliance with SLAs,
- in the case of a public cloud, no need to maintain in-house infrastructure and personnel resources,
- reduction of operational and investment expenditures,
- possibility to focus IT on key team competences.

Weaknesses

- maturity of solutions in the case of public and hybrid clouds,
- potential compatibility problems when using services by different providers - both providers of cloud services and technological elements (hardware, various virtualizers, operating systems) ,
- potentially larger complexity of migration to public and hybrid clouds,
- dependency on a selected third-party provider in the case of public and hybrid clouds.

Opportunities

- possibility to maintain a high level of control over incurred expenditures, in particular in the case of a public cloud,
- high business scalability, possibility to extend with additional resources if there is an external need to do so,
- possibility to create new services very quickly and deliver new applications or infrastructure, translating into much greater business flexibility,
- decreased business risk in terms of accelerated new application and service delivery, as well as business mobility,
- significant increase in IT operations performance,
- possibility to reorganize business operations in terms of using cloud computing.

Threats

- potentially higher security risk in the case of public and hybrid clouds,

- potential ambiguity in the interpretation of applicable regulations,
- mental barriers related to transferring applications and data to a cloud (e.g. concern about exercising less control over the way data is processed, concern over becoming dependent on a single provider).

5. Benefits of using the cloud computing model in the financial sector

Cloud computing provides new opportunities that enable organizations to be more flexible and to economically use their resources. The benefits of cloud computing may be classified into three groups:

- technical benefits,
- financial benefits,
- organizational benefits.

Technical benefits

- Flexible use of computing power

Profiles of daily computing power demand are different for different applications. Sales support systems are most strained during the day, in particular in the afternoon. Systems responsible for transaction processing, charging interest and other end-of-day processes work mainly at night. Reporting systems process data at night and early in the morning, and for *ad hoc* analyses – during the day, most likely in the morning. In the case of traditional computing architecture with servers dedicated for each application, the computing power of large and expensive computers is not used for most of the time. In a computing cloud, shared resources are made available to such applications that require them most. As a result:

- there is increased availability of computing resources for each application,
- reduced investments in computer hardware and computing time are possible,
- computing power is allocated to those applications that require it the most at a given moment,
- a constant access level to services is maintained, irrespective of the number of users (so-called scalability),
- there is the possibility to quickly acquire additional, external computing power.

Computing power in the cloud computing model becomes similar to electrical energy, i.e. a resource with specified parameters that can be taken from a third party at a predefined fee. Also in the case of computing, it is becoming possible to launch the user's machines (i.e. software) using energy obtained from a "socket" (cloud computation). In the case of a cloud, we only pay for what we use.

- Access to the latest software versions (automatic upgrades) – SaaS.

Easy access to state-of-the-art technologies. Software upgrades, infrastructure (cloud) development using the latest technologies and technological trends are the responsibilities of the service provider.

Financial benefits

- Lower investment and maintenance expenditure – no need to invest in hardware and no initial costs for installation and launch.

Cloud computing also reduces costs related to the acquisition of software licences. Abandoning of one's own infrastructure (partially or totally) enables the reduction of investment expenditures related to the construction and equipment of server rooms.

However, this does entail increased operating costs as a service provider must have funds for the arranging and maintenance of a computing cloud. Yet due to the economical nature of using resources to scale, as well as the more efficient use of resources, costs should nevertheless be lower than the total cost of ownership (TCO) incurred individually. In addition, when a change in market conditions or business decisions suddenly changes the demand for computing power, it is possible to acquire additional or release redundant computing power quickly.

- Shorter time-to-market, which means quicker launch of a product on the market and related financial benefits.

Using a cloud, an organization does not have to worry about servers, software and their upgrading or integration, which enables the building of applications in a much faster and less cost-intensive manner. The architecture used and the very concept of the cloud supports not only rapid and simple implementation and integration of new applications, but also modification and implementation of new functionalities in existing systems. Thanks to cloud computing, application development (or implementation of new solutions) is five times faster and twice cheaper than a traditional approach, e.g. .NET platform.

- Minimization of non-working assets, increased ROE.

- Predictability of costs and allocation of costs to revenues.

The use of a computing cloud entails a radical reduction of fixed IT costs and transfer of a large part of them to variable costs. Variable costs can then be more easily allocated to relevant revenues and then eventually facilitate assessment of product profitability.

Incurring costs related to the actual use of services significantly reduces an organization's financial risk. In the case of a standard approach, an organization is forced to incur costs related to investment in IT infrastructure (servers, applications, maintenance). Such equipment is never fully utilized at all times and additionally, it is really hard to abandon equipment that was once purchased. In the case of a cloud, the organization can reduce costs related to cloud computing anytime by abandoning what is redundant at any given moment.

Organizational benefits

- Reduction of resource-related back office (third parties, IT).

Faster implementation and increase of performance thanks to shorter time-to-market of new business applications and IT solutions make the organization more flexible and open to new solutions.

➤ Transition of IT infrastructure-related risk burden to the service provider.

It is the provider who is responsible for ensuring undisturbed service availability and data security. The service provider's responsibilities include:

- backing up data,
- ensuring redundant servers and transferring application operations to them in the case of basic server failure,
- ensuring alternative power supply sources,
- physical protection of IT infrastructure against access by unauthorized people.

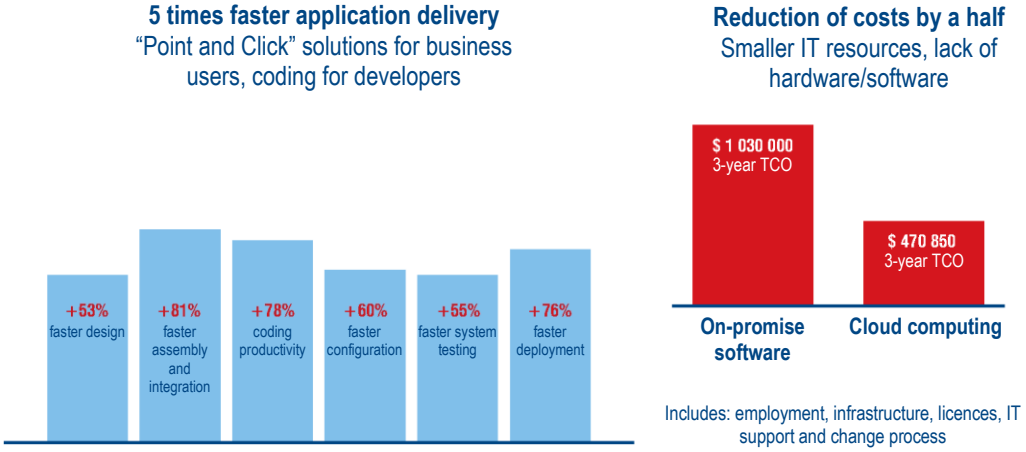

Figure 9. Benefits of implementing a computing cloud

Source: IDC White Paper, „Force com Cloud Platform Drivers Huge Time to Market and Cost Savings", Doc #219965, September, 2009.

➤ Increase of service quality and SLA level.

Cloud applications usually perform more reliably. This is because service providers employ more qualified personnel, upgrades received from producers are verified in more detail, and hotfixes are installed more quickly. The service provider also maintains a less diverse environment, which results in a lower number of errors. The service availability levels offered usually exceed 99.9%. Processes/services are standardized and simplified.

➤ Easier access to applications for mobile staff, in compliance with bank security requirements.

Regarding applications offered in a cloud, when configured properly, it is possible to sign in from any place in the world. A cloud provides additional support and applications enabling the use of mobile devices (dedicated smartphone and tablet applications). Employees can access and use standardized system functionalities (standardized configuration, services).

➤ Change in the risk management model.

Use of cloud computing also allocates the risk burden to the service provider.

According to the cloud operation principles quoted above, it is the service provider who is responsible for ensuring the continuity and reliability of applications offered in a cloud.

Paradoxically, given the concerns related to security and continuity of operation, additional benefits covered by the said three groups are those related to data processing security.

Table 3. Comparison of the traditional approach to IT infrastructure with cloud computing

Area	Traditional approach to IT infrastructure	Cloud computing
Resource utilization	Low utilization level of available resources (10–20%)	High utilization level of available resources (75–90%)
Deployment of hardware, applications, services	Weeks	Minutes
Implementation of changes	Months	Days/Hours
Reservation of resources and services	Weeks	Minutes
Release of resources and services	Weeks	Minutes
Configuration of new servers, services	Days/Weeks	Minutes/Hours
Pricing model	One-off fees (hardware, service) + recurring fees (licences, support)	Fee for actual resources utilization

6. Barriers and constraints

Constraints and barriers to the development of cloud computing or utilization of this model of IT services, specifically in the financial sector, are of a diverse nature. A combination of concerns, mental limitations and the unwillingness of potential service users to change, as well as concerns related to service manageability, problems with multi-national management, and compliance of service providers undermines the use of cloud computing, in particular by the strongly regulated financial sector. This refers mainly to the Polish market that has maintained the most stringent regulations in Europe concerning outsourcing in the banking sector, not to mention the most formalized legislation concerning personal data protection.

Below, we have summarized the concerns and threats related to the use of cloud computing presented to the authors of this report by managers of bank IT departments.

Regulatory barriers

A real regulatory barrier in the broader use of cloud computing in the financial sector may be prohibitions for service providers (“insourcers” in PBA terminology) to limit their liability in regards to critical services (e.g. processing of data covered by bank

secrecy). This regulatory discipline is somewhat odd for service providers outside of Poland. At the same time, it may discourage financial institutions from outsourcing their processes to common providers (insourcers), in fear of "infection" in case of a potential conflict between a cloud provider and another service user (cloud user). This problem is related to the issue of bankruptcy of a cloud provider that does not have to be the operator or owner of specific data processing centers included in the cloud.

Regulatory challenges at national, EU and global levels have led to a territorial approach to the protection of personal data and information. Lack of unified legislation in the EU, multiple regulatory bodies, each with a different approach and law interpretation (lack of established interpretation is a more or less pertinent but constant problem of all regulatory bodies), all constitute barriers towards its development. Some regulatory requirements, such as full removal of data even from backup copies, are technologically difficult to meet. Other requirements, such as the possibility of the data entrusting party to audit the data processing service provider or the need to disclose the location of data processing centers, are not willingly accepted by international providers who usually treat them as a hindrance of their work or a threat to data security.

Among regulatory barriers, the lack of regulations referring directly to cloud computing is also commonly quoted. At the same time, there are opposite opinions that indicate that there are regulations regarding entrusting third-parties with data processing, therefore meaning that cloud computing is practically regulated.

Representatives of technological departments at banks expect lawyers to establish whether cloud computing generates risk to the data subject to processing. Whether this expectation is well-targeted or not, it indicates that there is a need for independent subject matter analyses and a comparative assessment of the security of current solutions utilized by banks versus solutions offered in the cloud computing model.

Cost of change

Some practical problems in transitioning to a cloud are the financial, organizational, mental and human costs of the change.

Migration to the cloud assumes an organizational effort that requires financing and effective implementation. This kind of barrier is certainly not specific to cloud computing, as it is associated with any organizational or technological change.

Also, undepreciated expenditures for an organization's own infrastructure may pose an accounting problem. Abandonment of infrastructure utilization before its accounting life-cycle expires can disturb the financial assumptions that formed the base assumptions for investment in such infrastructure. Even if the decision to "migrate to the cloud" would generate significant savings, such unwillingness to "undermine" the intent of earlier investments *ex post* is understandable.

Interestingly, bank representatives indicate that Polish banks are characterized by relatively high operation costs, including IT costs. It was indicated that increased operating expenses (Opex) would not be desirable, as this would deteriorate the profitability picture of any bank that undertook such a transition.

The human costs of change mean the necessity to restructure an in-house IT team. In-

house IT departments are partially right to perceive third-party providers as threats to their own existence. Migration to cloud solutions may force restructuring in IT departments: mainly in headcount reduction, which slightly changes the requirements of IT department leaders. According to the bank representatives surveyed: "In a situation where a bank already has IT infrastructure and decides to use cloud computing services, the open question would remain as per what to do with the undepreciated part of the infrastructure and the team that maintains it."

Costs of abandoning former IT models are also another issue. It is currently very hard to assess them, referring not only to direct investments in restoring infrastructure, but also to indirect effects and the negative impact of such abandonment on the environment and business processes.

Trust

A constraint in the development of the cloud model is the low level of trust on the part of in-house services of financial institutions to this kind of operation. Despite the fact that IT technologies rapidly lose their value and become obsolete, the common conviction still holds that owning IT resources is more "reliable" than using third party services.

This prudential approach is reflected in the applicable legal regulations that are extended by interpretations used internally in institutions. According to an IT department representative at one of the respondent banks: "It is hard not to get the impression that, for instance, the regulation concerning actual transactions has lost its primary objective and has become a barrier to the provision of advanced IT services to banks by third parties. Especially given that internal interpretations of such regulations and auditor's guidelines are more conservative than the position of the Polish Financial Supervision Authority."

According to banks, contractual standards proposed by cloud providers, which limit their contractual liability, do not foster trust in the services offered.

Transparency of cloud provider offers

Lack of trust also refers to the products promoted by service providers. The impact of communications about new technological solutions has lowered significantly. At present, potential cloud computing service users declare they are largely "immune" to marketing messages saying that this service "is even better" and approach it cautiously, treating the cloud computing concept as another variety of IT service outsourcing, only presented differently. They express concerns that cloud computing will follow the mistakes of classical outsourcing, not providing any significant, visible benefits.

Fear of worsening the current situation

Respondent bank representatives also expressed their concern about entrusting their processes to third parties, pointing to the strategic role of IT in managing information capital and streamlining business processes. They also doubt whether given detailed, multi-level regulations and "climate adverse to changes", banks will be capable of focusing solely on narrow banking operations, which could only change their current operating model.

Concerns regarding cloud computing model implementation also include – not always positive – outsourcing experiences such as loss of flexibility, rapid response, lack of cost efficiency.

Awaiting pioneers

Respondents commonly expect implemented projects of cloud migration, based on which it will be possible to assess the efficiency of the cloud computing model and optimize its operational aspects – a so-called "warm-up" of a new solution that the cloud computing model still is in the opinion of many people.

Exit costs

Bank representatives also point towards potential problems with abandoning the services of a specific provider, changing providers or insourcing (infrastructure restoration). The vendor lock-in risk is quoted among more important risks, also because of potential difficulties with transferring the service between providers related to the lack of industry standards and differences between platforms.

7. Potential uses of the cloud computing model

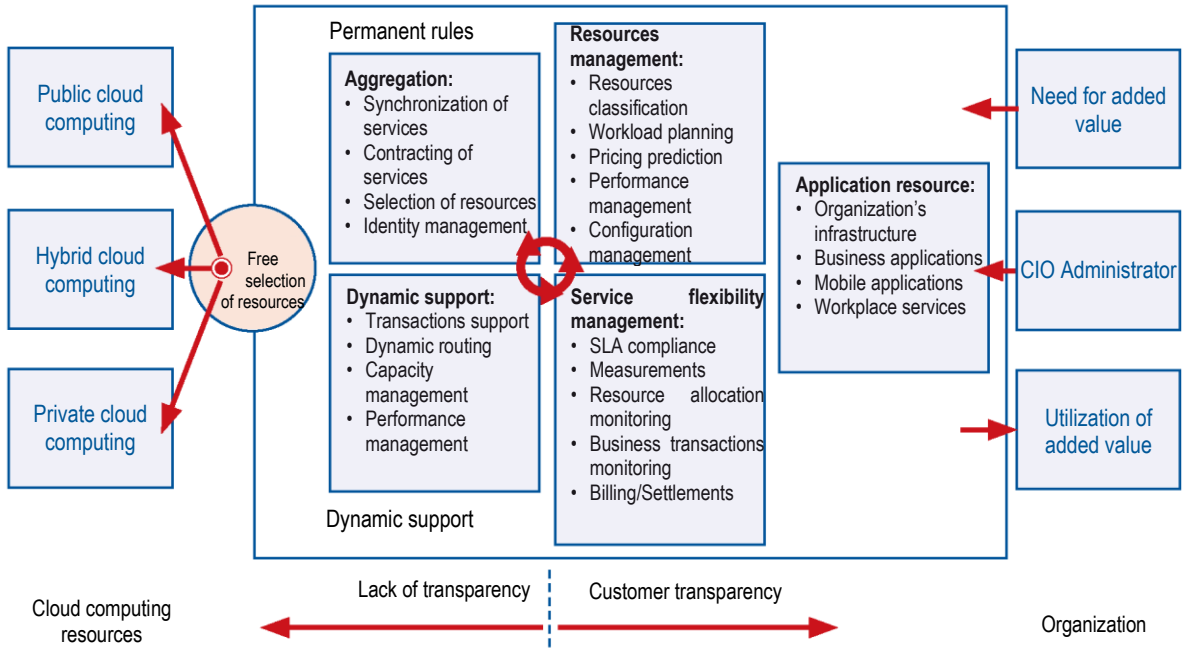

Figure 10. Evolution of using cloud processing towards direct user benefits.

Source: [Belissent, Wisłowski, 2011].

Best practices

Before an organization contracts cloud computing services, it requires detailed analyses that answer the following questions and help in choosing the best solution to match the requirements and characteristics of its operation.

1) It is necessary to perform detailed internal analyses to provide the organization with:
   - a current image of company operations,
   - an image of IT infrastructure (architecture, software, hardware),
   - suggestions indicating which elements of the company should be "migrated" to the cloud,
   - information on which solutions available on the market would be the most appropriate given the company's expectations and requirements.
2) Also, a market analysis is necessary to provide the following information:
   - feasible solutions,
   - potential service providers.
3) Actions that must be taken in order to prepare well to migration into cloud computing:
   - it must be decided which business processes are to be supported by IT services in order to define a catalogue of such processes,
   - for each defined service, requirements must be described determining the service availability, operation, and data security,
   - services to be processed internally and services to be outsourced to third parties must be determined and agreed upon,
   - the current, internal work/resource expenditure necessary to provide the service at the current level,
   - the current infrastructure must be reviewed to analyze possible improvement, simplification, rationalization and standardization of the process,
   - a proper provider of cloud computing solutions must be determined for services that may be outsourced.
4) When a decision is made to migrate to cloud computing and a group of potential service providers has been determined, the following questions need to be answered:

Can the specific service provider:

- Offer references of successful deployment of a similar IT solution?
- Offer free test versions of the proposed solution?
- Provide SLA agreements, and can it present a history of availability and reliability of services provided? What happens if the service provider does not comply with the SLA provisions?
- Does the service provider have a manner of acting/providing the service that is transparent, and can it offer the possibility to review the way service is provided?
- Does it have a Disaster Recovery Plan (DRP)? Has it been tested? Does the

DRP work?

- What are the possibilities and protection policies for data processed by the service, including both physical and procedural protection? How is the service protected, according to which standards (PCI, SAS70, HIPPA, NIST)? How is the service provider going to ensure additional restrictions related to data processing security arising from the nature of the business (e.g. banks)?
- Is it easy to configure the service and adjust it to changing business needs?

Functional areas of application

There are many solutions supporting cloud computing. Given their continued development and the growing number of successful implementations, the scope of possible applications of cloud computing is continuously expanding. Some more interesting possible applications have been presented below. The functional areas of application described below may be deployed in any of the previously discussed three models of cloud computing (IaaS, PaaS, SaaS), depending on the needs and specific character of the company's operations.

Customer service and customer relationship management

This is the most obvious and most frequently used functional area that enables use of cloud computing. There are many providers in the market that specialize in applications supporting customer service, offering advanced, easily configurable and modifiable solutions. The use of services supporting call center operations or CRM (Customer Relationship Management) applications enables improvement and simplification of processes related to customer service. Measurable benefits resulting from the use of cloud computing in this functional area include:

- improvement of work/agent service performance,
- decreased customer service time,
- increase in the number of customers served,
- full and current customer insight (contact history, information on the products used by the customer, fees, so-called "360 view" for each customer),
- reduction in the number of complaints,
- increase in customer loyalty and engagement.

Sales

Use of the cloud computing service for sales processes, (e.g. indirect sales of vehicle loans using dealers or direct seals of banking products through bank sales representatives) results in increased effectiveness and performance of the sales staff. Consultants, sales associates and product specialists can access a single location that includes up-to-date information on sales offerings. The process is standardized.

Measurable effects include increased net sales and profitability. By using an analysis of customer data and products already used by the customer, consultants can offer a product that will best meet their needs.

It is also recommended to integrate a sales solution with CRM-class support

solutions (described in the preceding paragraph).

Marketing

Drafting proposals and planning marketing campaigns is another functional area that can be migrated to a cloud. A single location where marketing specialists can access current customer data and products they have purchased, products offered by the bank, as well as sales or product analyses and reports is a typical application that uses cloud computing. It is also common to migrate applications that support customer mailing and marketing databases to a cloud.

HR (*Human Resources*)

Migration of tools and applications used for managing human resources to a cloud enables integration of tools and services supporting HR with portals specialized in candidate searches and social networks. It is also possible to launch a company's own recruitment portal or application in a cloud.

Example applications from the banking sector

One of the solutions used by banks in the cloud computing model is an AML (anti-money-laundering) application. The solution is based on transaction data.

Some example implementations of the system have been presented below.

- The application was installed at the seat of a Luxembourg-based bank and is provided in a private cloud model to subsidiary organizations in Austria and Luxembourg. This resulted in a single installation and the end users can access the full functionality of the tool through a dedicated channel. The model was selected because of its lower deployment cost for the entire group and the fact that subsidiary banks virtually have no in-house IT teams, and all the functions are centralized by the parent company.

- A bank from Jersey, on the other hand, uses a hybrid cloud model. It sources some of the applications from the bank's head office in London, and has a third-party provider of an anti-money-laundering module in the cloud computing model. The outsourcing center is located on the Isle of Jersey and serves 80% of local financial institutions. Such a model was selected because of the cost associated with IT infrastructure maintenance and the fact that the bank does not have an in-house IT department.

- A local cloud-based IT resources provider from Zurich offers a bundle of solutions for banks, including the said application. Banks decided to use this model because the price and full maintenance of the infrastructure were at a lower cost compared to the cost of establishing their own solution. The starter bundle is at a level of 70–90% of the annual budget of a single IT employee, whereas the annual maintenance of it amounts to 25% of such cost.

- Bank of America noticed that many of its existing and prospective customers are looking for information and answers to their questions in online forums and social networks. Customers asked for instance how the bank is rated compared to its competitors, what interest rates it offers, what they should watch out for. Thanks to the implementation of a data exchange application, BofA joined portal discussions. Agents were equipped with a tool that enabled them to reply to threads on an on-going basis.

Currently, in one of the social networks, the bank answers more than 1,100 entries a day and has more than 6,000 active users.

- SunTrust Bank implemented five business lines using many systems working in the background. The bank wanted to stand out by offering personalized services and at the same time improve the performance of its consultants, start a new revenue stream and maximize cross sales. The bank had previously been unable to get a consistent customer image based on information retrieved from the systems it used. In addition, the sales methods implemented by the bank were not supported by its existing IT tools.
  Having ensured that the solution offered by the provider met the security, performance and reliability requirements, the bank used the proposed cloud-based solution consisting of making selected data warehouses of the bank available in a cloud. A solution was developed that provides complete and up-to-date information on the customer and their relation to the bank. Within two years, the bank increased its sales revenue. The productivity of the sales staff was improved and the time of new sales associate induction was reduced from months to days.

8. Future of cloud computing

Cloud computing is probably the largest revolution IT has ever seen in its history and will certainly become a commonly available service. Cloud computing is already a commonly used model of services in the consumer Internet. However, it is less popular in business. It is estimated[9] that within just a few years, the use of cloud computing will become a common practice. This will be fostered by:

- standardization of web browsers and their applications,
- miniaturization and standardization of IT devices,
- dynamic development of mobile devices.

Of importance is also the fact that a common use in the consumer domain of cloud-based services and tools will bring familiarity and acceptance of this service model also in business applications.

It is assumed that the process of gradual absorption of the cloud computing model in business started in 2009. It is likely to follow overlapping stages:

- implementation of start-up applications in the cloud, insufficient standardization, insufficient competition of service providers, security concerns (this stage is still present, although in its declining phase),
- internal migration to a private cloud, but without the effect of scale and thus without significant economies (this stage is quite advanced although insufficiently common),
- private cloud domination, overcoming of the mental barrier against a public cloud (this stage has already begun to a large extent),
- transition to the processing on demand model (it is estimated that this will last

[9] Pew Internet & American Life Project (2008), Compuware (2010)

until a new generation of business managers not driven by a natural hostility towards new things is ushered in).

Forecasts of cloud computing evolution

- Cloud computing will be cheaper, more reliable, more secure and simpler.
- Cloud computing will become a driver of organizational growth and competitive advantage for early adopters of the model.
- The costs of cloud computing service providers will be established at a level of ca. 25% of the costs incurred for maintaining an organization's own data processing center.
- Market leaders will develop broadly understood cloud computing standards. Relevant ISO standards will also appear.
- The SaaS model will grow, as will its services based on the emerging and improved standards.

Forecasts of cloud-based software development evolution

- Application frameworks such as the current Ruby on Rails, Apache Struts, Adobe Flex and PHP Python will play a significant role in promoting cloud computing.
- The application logic layer and the data tier will be most frequently outsourced to the cloud.
- Mechanisms of data storage will face a radical evolution related mainly to unstructured data and database scaling.
- Security services will be provided with dedicated solutions related to cloud computing.
- Companies running businesses of commercial sharing of extended data repositories will prepare dedicated solutions to offer their services in the cloud-based model.
- Applications using other existing services (mashups) will promote the use of cloud computing, which will be further supported by dedicated programming tools.
- PaaS and FaaS models will become the dominating way of making applications.
- Ownership of infrastructure and IT tools will no longer be a professional barrier, which will strengthen competition.

Conclusions

Computing power availability

Today, computing power is increasingly available.

Common character of knowledge

Strictly technological issues (such as provision of data security, large volume processing), as well as organizational issues (e.g. HR processes, e-mail organization) are being standardized. Standards constitute the basis for the promotion of knowledge of the possible applications.

Economic implications

Technology progress in the cloud computing domain is following a similar route to electricity, gas and water supply. Like in the case of electric energy, the benefits will be brought by economies of scale and the possibility to optimize parameters of the service itself. This will make the service more common and thus lower its costs.

Transitional barriers

Problems with standardization, exchangeability, trust, data control and differences between legal systems will be overcome in time.

Areas of competition

Entrepreneurs, including financial institutions will continue to develop their in-house IT competences and retain those elements of IT systems that embody their competitive advantage. Therefore, the largest players will be the last or the least to benefit from the new model of IT resource utilization, as they already have significant scalability and competence within their organizations.

Faced with external competition, in-house IT departments will increase their focus on effectiveness and business user satisfaction (either internal user or a customer). This will nevertheless not change the general trend towards a common character of cloud computing.

Position of the Polish financial sector

It will more or less be a conscious decision on where the Polish financial sector embarks on this technological and business progress. Is it better to be a pioneer or a follower; or is it better to remain cautious and stay in the rear of progress? It is important that the answers to these questions and the resulting regulatory, supervisory and sectoral approach to cloud computing are defined informedly and based on the balance of cloud computing advantages and disadvantages from the perspective of the Polish financial sector and the entire Polish economy, and thus as an aggregated result of attitudes of opinion-leaders: from ardent supporters to skeptics.

Position of the European Union

The best summary of our report can be found in a document by the European

Commission titled *Unleashing the Potential of Cloud Computing in Europe*[10] dated 27 September 2012 and addressed to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. In the document, the European Commission clearly indicates cloud computing as a technological and business phenomenon that enables a leap in economic growth in Europe (that is to say: "where the solution is adopted").

The EC is certain of the benefits of cloud computing and its inevitable character. The EC indicated three main challenges that must be faced in order to fully "unleash the potential of cloud computing"

- technological standardization (interoperability and qualitative transparency – ensured through certification);
- standardization of contracts (establishment of a certain standard level and set of obligations for cloud providers to serve as a benchmark for the offering of specific providers and evaluate it as "minimal/sufficient/extended");
- overcoming "the resistance of matter" – expressed by the EC as a diplomatic offer to establish common procurement for cloud computing in the public sector, even up to a cross-border level.

Finally, we would like to draw the readers' attention to the fact that the European Commission is no longer considering whether it makes sense to use cloud computing services. The EC has authoritatively stated that this is inevitable, which is acknowledged by the authors of this report.

[10] http://ec.europa.eu/information_society/activities/cloudcomputing/docs/com/com_cloud.pdf – last accessed on 06.11.2012.

Final remarks

We encourage all those who read the report to discuss it and provide us with feedback. To the extent possible, we may develop further versions of the report that take into account developments in the practice and theory of cloud computing. Perhaps soon, common usage of this model will make reports such as the present one completely redundant.

Contemporary economic and technological developments occur so quickly that any publication about them becomes gradually obsolete from the day of its publication. Therefore, we encourage readers to respond to this report by providing your comments for further development in the subsequent reports versions.

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About the authors

Professor Remigiusz W. Kaszubski

(1970–2012)

The report is in memory of late Professor Remigiusz Kaszubski. Professor Kaszubski was active in the domain of advanced technology development and was personally involved in the operations of the Forum. In line with the plan of the FBT Cloud Computing Group and the authors of the report, Professor Kaszubski was to be the editor of the publication.

Professor Remigiusz Kaszubski was a successful professional and academic. Not only was he exceptional in his professionalism, but also in his consistency and ambition in pursuing his goals. Professor Kaszubski's enthusiasm and involvement enabled him to easily rally the banking community around common projects. He successfully implemented the concept of innovative banking that fosters the development of a modern state. Thanks to the involvement of Remigiusz Kaszubski in the activities of multiple organizations, the Polish banking system and the online banking system in particular, is one of the most advanced, most secure and best operating systems in Europe.

Professor Remigiusz Kaszubski was a very important person in the history of the Polish Bank Association. He was the initiator, originator and co-founder of bodies that have significantly contributed to the improvement of the operation of the Polish banking sector. As a chair of the Bank Card Issuers Council, he established a Card Fraud Prevention Forum, then he reactivated the Electronic Banking Council within which he initiated the Forum of Banking Technologies and the Electronic Transactions Security Forum. He contributed to the establishment of the Acquirers' Committee. The last important project he implemented was the SEPA Poland Program.

Professor Kaszubski approached all his colleagues with his typical generosity and patience. He will be remembered as a kind person who was extremely open towards others and ready to support anyone with a kind word or good advice.

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