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ACTUAL TRENDS OF CLOUD COMPUTING AND TECHNOLOGIES IN OPTIMIZATION OF DATA STORAGE

The purpose of the article is to investigate and consider the general trends, problems and prospects of using cloud computing and technologies in data processing, in particular optimization of their storage.

The research methodology consists of semantic analysis methods of the basic concepts of the considered subject area (cloud computing and cloud technologies). The article discusses approaches to storing data (including multimedia) in modern systems that support cloud computing and technologies.

The scientific novelty of the research is the analysis of cloud computing use and cloud technologies for data storage optimizing.

The conclusions of the research conducted in the article are as follows: the paper considered various aspects related to cloud computing and cloud technologies, including various advantages and disadvantages; cloud computing and cloud technologies can offer numerous benefits to various stakeholders; cloud computing and cloud technologies have some problems; it is noteworthy that by supporting the cloud computing and cloud technologies deployment and maintenance models, problems can be either minimized or eliminated since the dynamic characteristics of cloud computing and cloud technologies can always support users.

Keywords: cloud computing; cloud technology; deployment models; service models; data; media data; Azure storage.

Introduction. Cloud technologies (CT) (https://www.hpe.com/ru/ru/what-is/cloud-computing.html) are aggressively advancing in the fields of science, culture, education and business. This work will review cloud computing (CC) and CT, consider various aspects of their use in processing information of various nature (in particular, media data). CCs use relatively old computing and networking technologies (with appropriate software (Buyya, Broberg and Goscinski, 2011). CCs have a long history of development: "mainframe time-sharing computer systems (Mnogoterminalnye sistemy – proobraz seti, 2009); a technology known as "distributed computing"(Kosjakov, 2014).

Distributed computing, the emergence of network technologies and more reliable data transmission have contributed to the fact that the solution of the most complex computational problems began to be carried out by sharing programs, data and communications on several platforms, including many "computing nodes" located in the global network.

Let us analyze what the later CC and CT offer and what distinguishes the CC from the distributed systems. One of the differences is the presence of a business model that CC and CT provide for accessing and using distributed (remote) computing services.

Main research material. The essence of cloud computing. CC can be viewed as a model for the exchange (trade, provision) of on-demand computing services, including pay-for-use services. In this case, users pay only for the services they need. CC and CT guarantee tangible business reimbursements at lower costs, as their use reduces the cost of computing, as opposed to the full use of information-communication technologies (ICT). CC and CT services provide a return on investment for enterprises through lower initial cost, lower service requirements, and less need for ICT support staff. As a result, these businesses can focus on what really matters to their customers and leads to financial returns.

According to (Raj, 2013), the definition of CC and CT is a problem due to the numerous basic concepts and types of services provided by CC and CT. Figure 1 (Raj, 2013) shows an image of the essence of the CC that connects platforms, applications and computing infrastructure into a single cloud, the resources of which can be used by various categories of users.

Main characteristics of CC. CC, which is a model of resource provision, combine several existing technologies that have been applied in-network computing, distributed systems, service computing, service-oriented architectures, the Internet of Things, IT-outsourcing, etc. (Magoulès, Pan, and Teng, 2013). Let us describe the main characteristics of the CC and the differences between the features of the technical, qualitative and economic aspects of the CC associated with a business.

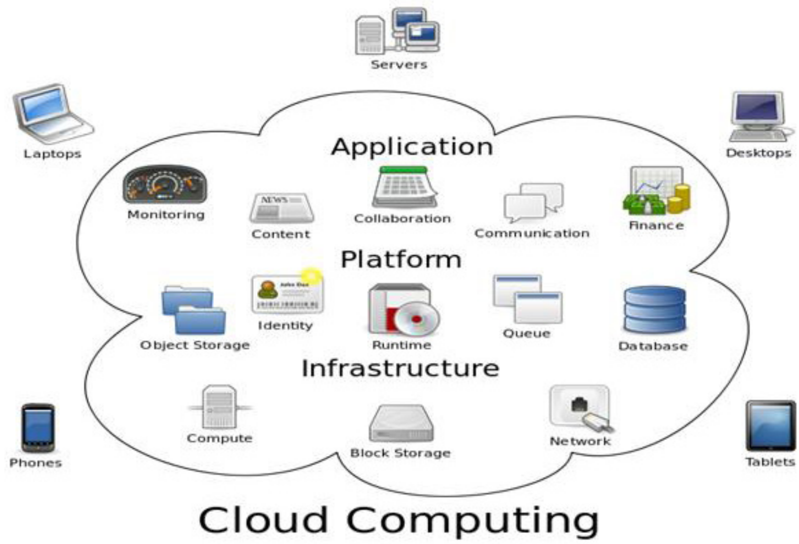

Fig. 1. The essence of cloud computing

Key characteristics of the CC are (Tkachenko, 2014):

– *Self-service* on-demand through a secure portal: The cloud service user performs this self-service without interacting with service providers.

– *Scalability and Elasticity*: Scale computational capabilities up or down quickly, always elastic to maintain cost efficiency.

– *Usage Fee*: Charged using one of the billing models to optimize resource use.

– *Ubiquitous access*: capabilities are available over the network and through standard mechanisms that facilitate the use of heterogeneous thick, thin or mobile client platforms. The fat client provides users with more options, graphics, and choices that make the platform more customizable. The fat client does not rely on the central processing server, because usually processing (including media data, in particular, their storage and transformation) is performed locally in the user's system and the server is accessed mainly for the purpose of storing information.

The "*thin client*" communicates with a central processing server where very little software is installed on the user's PC. Both mobile and "*smart clients*" are offline. Smart clients can be deployed and updated in real-time over the network from a centralized server. "*Smart clients*" support multiple platforms and programming languages because they are built on web services and can run on virtually any device with an Internet connection. Services must be secure everywhere in the cloud and access to the cloud via Internet devices must be secured to ensure data integrity, reliable backups, authentication, and protection from cybernetics attacks.

– *Location independent resource pooling*: Provider computing resources are pooled to serve all users using a multi-user model, with different physical and virtual resources dynamically assigned and reassigned according to user requirements. No control or knowledge of the exact location of the resources provided is required.

– Technical characteristics of CC and CT. Specifications are the basis for supporting other requirements (practical and financial). The technical specifications and their explanations are:

– Virtualization applies to a hardware platform, operating system, network resources, etc. For example, “PC-virtualization” provides a simulation of the user experience of using applications, accessing online resources, communicating with other users, when they can interact with several different platforms, many of which are remotely accessible.

– Multi-tenant leasing allows resources and costs to be shared among multiple users on different platforms.

– Safety is a big problem for the adoption of CC. To attract potential customers, CC and CT providers must provide sufficient security to protect customers’ personal data, communications, and application use. CC and CT providers need to share data for different customers, and they need to provide effective replication and recovery mechanisms to ensure reliable disaster recovery.

– Programming environment is important for CC and CT providers to be able to replicate many storage and application functions across different computing platforms to use functions of CT. Much of this capability was developed during the early days of distributed computing.

Qualitative characteristics of CC and CT refer to the qualities or properties of the CC. One quality characteristic can be implemented in several ways, depending on different suppliers (Magoulès, Pan, and Teng, 2013).

Elasticity – Providing services in flexible and adaptable ways that are sufficient for users to request service in near real-time without having to develop new capabilities and resources during peak loads.

Availability – the ability to meet specific customer requirements for CC and CT services.

Reliability is the ability to ensure that the system is always working without failures. Reliability is a special requirement for quality of service aimed at preventing loss and reliable recovery from system errors and failures.

Flexibility is a fundamental requirement for CC and CT. CC and CT suppliers should be able to quickly respond to changes in demand for resources and environmental conditions. Flexibility implies that both parties work together to provide opportunities for self-government.

Economic characteristics of CC and CT distinguish CC and CT from other paradigms of ICT use in science, education and business. Service offerings are not limited to just a technology perspective but extend to a broader understanding of business needs.

Pay-as-you-go is the main method of the CC and CT business model, which means that users must pay in accordance with the actual consumption of resources (including information) and services. The use of CC and CT reduces the cost of maintaining and acquiring infrastructure, therefore, can help enterprises by shortening time to market and accelerating return on investment.

Operating expenses. The CC and CT infrastructure is typically provided by a third party and does not need to be purchased for infrequent computing tasks. The adaptation of existing operational processes to CC and CT should be compensated for by the cost of implementing CC-solutions.

Energy efficiency is due to the ability of CC and CT services to reduce resource consumption. PCs are centrally controlled, so energy costs are easier to control. Environmental issues of CT depend on the software stack and the hardware layer, where a software stack is a group of programs that work together to achieve a result or common goal.

Deployment models of CC. CCs are developed taking into account computer skills; for which deployment models were proposed, depending on the corporate location and volume of calls. CT can be deployed in different ways, depending on the intended use and the type of approach to CC and CT services providing. Deployment models can be classified as follows: *public/external cloud*, *private/internal cloud*, *hybrid cloud* and *communal cloud* (http://pro-spo.ru/cloud-technology/3208-modeli-i-struktury-oblachnyx-texnologi).

Public/External Cloud Model. *Public cloud* is a typical example of CC, where the service provider makes resources such as applications and storage available over the Internet. Microsoft Azure is an example of a public cloud Public/External Cloud describes CC in a conventional sense. This cloud is open to everyone and is owned and operated by a cloud provider.

Public Cloud is a general public cloud. Examples of Public/External Cloud services are Apple iCloud, Microsoft Office 365, specialized services such as “DropBox” (file sharing), Instagram and other “social media”. What these services have in common is that they are accessible from any web browser or app for smartphone from anywhere in the world, but may charge fees for storing data and or accessing paid services.

Private/Internal Cloud Model. This cloud defines a service that distributes access to network information resources to a controlled number of users, with mandatory authentication of remote users. Businesses prefer to use *Private Cloud* because of the need to maintain precise control over their data in order to take full advantage of the scalability, dimension and flexibility of *Private Cloud* without reducing management, security and usage costs.

Reasons why an organization may adopt a *Private Cloud* deployment model: the need to increase and strengthen the exploitation of existing internal resources; user concerns about the security and privacy of their data; the desire of organizations to control actions to “manage” only for authenticated devices and users.

Hybrid Cloud Model. A hybrid *cloud* uses a combination of public cloud, private cloud and even on-premises infrastructure, which is typical for most IT-enterprises (Magoulès, Pan and Teng, 2013; Khan, 2015). This deployment model provides portability of data and applications (software, software products).

The purpose of the *Hybrid Cloud* is to enable users to quickly switch from *Private Cloud* to *Public Cloud* when there is a lack of *Private Cloud* volume for additional resources when solving their tasks (for example, when performing their business operations). *Hybrid Cloud* can facilitate remote work of staff, access to which should be limited due to security reasons. A hybrid deployment model may only be suitable for enterprises using legacy systems and technologies, as the benefits of CC and CT are then diminished.

The model of the cloud community assumes the sharing of resources among multiple organizations with common problems. Within the community model, firms may have security and strategy concerns that meet the requirements of the "community".

Service models of CC and CT. CC and CT imply the distribution of modified computer services over the Internet. CTs allow interaction with clients (users or applications) using a client-server approach or peer-to-peer network services (Jamsa, 2015). Service models can be classified through a web-interface or custom-interfaces as follows: *Software-as-a-Service* (SaaS); *Platform-as-a-Service* (PaaS); *Hardware-as-a-Service* (HaaS); *Development/Database/Desktop-as-a-Service* (DaaS); *Infrastructure-as-a-Service* (IaaS); *Business-as-a-Service* (BaaS); *Framework-as-a-Service* (FaaS); *Organization-as-a-service* (OaaS) (http://pro-spo.ru/cloud-technology/3208-modeli-i-struktury-oblachnyx-texnologij; Khan, 2015).

SaaS model offers a cloud-based on-demand software foundation that is web content that customers can access through a web browser. The software can be accessed in any of the cloud deployment models. Users do not need to install and run these applications on PC. These applications can be used anytime from anywhere in the world. *SaaS* provides applications as fully or partially isolated services similar to desktop, stand-alone applications that users are already familiar with. These applications can be in the form of web applications in combination with non-uninstalled applications, such as Internet storage or connections to other system communication resources. *SaaS* is a multi-tenant platform that allows users to access software applications hosted by cloud providers.

The advantages of SaaS services are ease of incorporation into business operations, familiarity, low cost, and scalability. Besides, maintenance and upgrade overheads are primarily borne by the CC supplier and not by the user. *The disadvantages of SaaS* include security issues, as well as lack of compatibility of cloud applications with legacy software that can be expensive to update or replace.

A common *SaaS* example is a Web E-mail service such as Gmail, Outlook, or Yahoo Mail. OneDrive, Dropbox, Google Docs or Microsoft Online, online-Office are also *SaaS* and are free. The software that companies lease for online business management is *SaaS*.

PaaS model offers underlying hardware and operating system technologies, including virtual servers, file systems, database management systems, developer tools, and networking for CC and CT users to install their own custom applications. *PaaS* reduces the need for customers to invest in and maintain their own servers, storage devices, software development environments, and network management utilities. In *PaaS*, instead of planning and spending on regular system updates, developers focus on their own line of business applications.

PaaS, running through an OV vendor platform, distributes resources such as Linux, Apache, MySQL, and PHP to users. This simplifies distribution; maintenance and version control of applications with less cost and complexity than buying and maintaining your own hardware or software resources.

PaaS supports concurrent use of applications by offering administration, scalability, and security, so there is no need to manage or control the underlying cloud substructures for deployment and configurations of the hosting environment. Examples of *PaaS* include, for example, the Cisco toolkits (WebEx connect), Amazon Web Services, Google, Windows Azure, and the Apple SDK (Josyula, Orr and Page, 2012).

IaaS model is an on-demand virtualization service for users subscribing to CC and CT services. The idea behind *IaaS* is a *HaaS* transformation to advance the approach to using IT-subframes as a service to end-users. The fundamental design of *IaaS* is to create a flexible environment that allows customers to accomplish multiple tasks. In *IaaS*, developers must install their own operating systems, database management systems, and any specialized software required to perform tasks in their own operating environment.

IaaS provides computing and storage resources, including network resources, to run various types of software specific to CC and CT user needs. With *IaaS*, users do not have to control or build IT infrastructures, they can control operating systems and their deployed applications. Using modern versions of technology on a paid or subscription basis is a key benefit of *IaaS*. *IaaS* vendors include Cisco, HP, IBM, Dell, VMware, Red Hat, and Microsoft (Josyula, Orr and Page, 2012).

Vultr or DigitalOcean are typical services for *IaaS* (https://www.quora.com/Is-Vultr-better-than-DigitalOcean). After selecting the server and operating system, and then installing the latter, you should select and install other necessary software for the user's application. For example, for a website, you need to install software related to the Web Server.

Table 1 shows a comparison of different approaches to organizing IT infrastructure based on IaaS, PaaS, SaaS when the infrastructure can be managed by a user (enterprise, firm) or a CC provider (provider).

Table 1

Comparison of approaches to organizing IT-infrastructure

	Own IT-infrastructure	**IaaS**	**PaaS**	**SaaS**
Applications	+	+	+	-
Data	+	+	+	-
Runtime environment	+	+	-	-
Operating system	+	+	-	-
Visualization platforms	+	-	-	-
Servers	+	-	-	-
Storage systems	+	-	-	-
Network hardware	+	-	-	-

Main reasons to use CC and CT

The world is undergoing a digital and mobile revolution associated with large amounts of data and fast access across an ever-increasing number of media. Users of modern IT-technologies (including CT) have switched to social networks and mobile applications, expecting that they will not only improve the comfort of their information space but also allow them to work using other, more convenient methods. Many users have come to trust modern technology with their core connotation (Berman, Marshall and Srivathsa, 2012).

Let's consider the main reasons for the distribution among users of different categories (enterprises, firms, end-users): flexibility of cost (costs); masked complexity; variability due to context; ease of use; communication and consolidation of objects; labour optimization; backup and recovery; fast deployment and increased flexibility; guaranteed level of service; stability; development and testing of applications (software); big data analytics.

Flexibility of costs. This is the main reason for the introduction of CC and CT by many companies. CC and CT allow reducing IT and software costs by moving to costs on a pay-as-you-go basis (Berman, Marshall and Srivathsa, 2012). By allowing movement from capital expenditure to operating expenditure, or from fixed to variable expenditure, CCs help to reduce the company's fixed IT-costs. With the use of CC and CT, there is no longer the need to invest in specialized hardware and software or pay frequent fees for software updates.

Users using CC and CT must pay only for what they use, and or if they may need to increase the use of a particular resource (specialized equipment, software or information storage of data). This approach provides cost flexibility and eliminates the need for upfront capital expenditures.

Masked complexity. CCs not only provide business scalability and adaptability to the market but also offer the benefits of masking complexity. CC and CT allow users to hide some of the technical complexity of their operations from end-users. The use of CC and CT requires from end-users a narrower range of so-called digital competencies (skills, abilities and knowledge) that they need for productive use in solving specific business problems using new IT (including when solving problems of processing, storage and protection data). The use of CC and CT also reduces the cost of training new employees who may need rather specific IT-skills (setting up user accounts, maintaining a reliable and reliable data store, ensuring optimal network uptime, etc.).

Computational complexity is "masked" from customers, allowing businesses to increase the complexity of their services and products without increasing the cost of training end-users, purchasing management, maintenance, and control hardware, or building the required technical infrastructure. Software upgrades and maintenance can be done in the background without customer involvement.

It should be noted that for enterprises whose main activities require extensive interaction (B2B or B2C) with customers, "masking complexity" requires separating the business support of the product/service from the support of IT-services since the latter are usually located elsewhere – at the supplier CC and CT services. If user requirements involve a combination of specific product/service support with IT support, this separation can degrade the quality of support provided. The customer experience level for many businesses can be an important differentiator in the marketplace.

Context-Driven Variability is one of the driving forces behind CC because of the increased computing power and capacity that vary with the requirements of each business user. Users want to store their business data (for business in the socio-cultural realm, it is mainly media data) based on their own operational requirements. CC and CT services offer users storage facilities for their operational requirements, allowing them to develop (manufacture, customize, adapt, modify) products or services.

Contextual variability is an important attribute of the cloud. CC and CT services should be able to tailor services to the specific requirements of business subscribers (business customers, consumers). In reality, this can be an illusion (particularly for small businesses). Large CC and CT-service providers (Microsoft, Apple, Google) generally offer unified rather than customized services.

The business user must adapt their business processes to make the most of common offerings such as iCloud, MS Office 365, Google Plus (Carrie, 2019). Use of CC and CT services should provide for more user-centred participation and fragmented consumer addresses for companies that use CC and CT services by subscription (Berman, Marshall and Srivathsa, 2012). In fact, "contextual variability" is rare for businesses subscribing to shared CC and CT services.

Usability, communication and consolidation of objects. It is believed that the ability to connect to information resources and modern software is one of the factors contributing to business development. This capability is a key benefit of the CC and CT offerings. CCs simplify external relationships with partners and customers, which can lead to increased efficiency and increased novelty. CC and CT provide users with easy web access to communication and collaboration tools (e-mail, calendar). Messaging, voice, or video applications such as Skype also benefit from the use of CC and CT. Messages and information are posted on the service provider's network, not on the user's personal device.

The underlying assumption is that if enough businesses and customers subscribe to the same CC (CT) service, communications and interactions can be simplified and enhanced. This assumption is questionable, since the integration of suppliers, enterprises and customers into a "single" CC and CT ecosystem requires much more than the CC and CT services currently provided. This raises, for example, the question of what incentive should be for the CT-service provider to change its way of interacting with the business so that the latter can adapt to the services provided by the RH and CT-provider.

CC and CT services offer consolidation tools. This may seem attractive to many companies because of the savings that come from working with their data assets. It should be noted that resources such as information storage, computing power, memory bandwidth, and network can be combined in the cloud because it is cheaper than the localized provision of at least one type of these resources.

Data warehouse consolidation, ease of access to shared data from anywhere, reliability of recovery from data loss – all these can be the driving force for the adoption of CC or CT services. Convenience is one of the biggest advantages of using CC and CT for consumers. Apps and data are stored in the cloud, not on a PC or mobile device. This gives you the freedom to access applications and data from multiple devices connected to the Internet. Since the maintenance is automatic, you can spend less time managing. No need to worry about installing software updates – it happens in the cloud.

CC deployment does not require as much preparation, software development, or maintenance as conventional infrastructure. Enterprises can better use the valuable experience in the field of ICT, redirecting the workforce from the routine operations of operating and maintaining software to more important tasks. Each firm expects to be able to save on labour. By adopting and leveraging CC services, businesses can save money by lowering labour costs by using their IT staff to meet specific requirements, rather than using them for general IT-related tasks within the business.

Backup and recovery. By backing up and restoring to cloud services, the enterprise can avoid capital investment in infrastructure and management. Instead, the CC and CT provider is responsible for data management and compliance with regulatory and legal requirements. CC and CT provide great flexibility as they accommodate unpredictable storage and archiving requirements. CC and CT provider can accelerate recovery because enterprise resources are located across the entire network of physical locations rather than in a single local data centre.

Rapid deployment and increased flexibility. In the cloud, there is no longer any software installation or system configuration required, which provides tremendous benefits to consumers as most consumers do not efficiently configure hardware and install software for their system. CC offers very fast deployment options for users. CCs have different deployment models and services, which gives the firm the ability to choose its specific model and service, or a combination of both. This service is one of the key incentives for CCs because it ensures that implementations can be fully linked to industry requirements and ICT-policies.

Guaranteed service level and sustainability. CCs can guarantee and offer a better level of service than other ICT groups with limited resources. With the right mix of cloud models, a firm can ensure the sustainability of existing CCs.

CCs offer automated recovery or disaster recovery tools that are easily accessible to consumers through their consolidated resources. This is another incentive to use CC and CT, as some firms use their internal cloud model as a resilient public cloud to increase flexibility.

Software Development and Big Data Analytics. The cloud can provide an environment that can help save software developer money and accelerate time-to-market for applications. Instead of securing assets and spending valuable IT-project time and resources setting up a physical environment, software teams can quickly set up and dismantle a test and development environment in the cloud, scaling those development and test environments as needed.

Thanks to CC, data can be analyzed to find patterns and information, make predictions, improve them and make a variety of business decisions. For enterprises in the socio-cultural sphere, data is media data, their processing and analysis is an important part of the activities of these enterprises. CC and CT vendors can provide the user with higher processing power and advanced tools to obtain huge amounts of data, as well as the ability to quickly scale the environment as the volume increases.

Cloud computing: key challenges. While there are important incentives for the introduction of CC and CT, there are still some noteworthy issues. Security is a major concern in implementing CCs due to concerns about data security on the Internet.

Security and privacy. The CC approach introduces a new delivery model for IT solutions which does not provide a high enough level of data security for enterprises. The CC's ability to adequately comply with confidentiality rules has often been questioned. Thus, firms face many different challenges to protect the privacy of individuals. Safety is one of the problems of using CC and CT. There are also such problems as temporary loss of service (outages); ability to change suppliers of CC and CT; reliability.

Reliability. Today, applications in large companies are so extensive that they should be reliable and accessible to anyone who needs them. When it comes to system failure, the recovery plan should start with minimal disruption and additional cost. Large enterprises can invest in system recovery systems that mitigate the impact of a disaster, while small businesses generally do not have these resources. It is important to track the reliability history to inform users of the need to monitor the reliability of systems in order to stimulate widespread adoption of CC.

Open access and communication. The implementation of CC depends on the availability of high-speed access to everyone and open access to computing resources, similar to the availability of water and electricity.

However, in real life, connectivity and open access to CCs are lacking worldwide. Therefore, the lack of open access and connectivity must be viewed by users (businesses, organizations, end-users) within their own business context. The users of CC and CT and their suppliers are faced with the question of the presence/absence of sufficient communication and access to the provided information resources.

Possibility of interaction. In the process of implementing an CC, it is extremely important to ensure the appropriate level of interoperability between private and public clouds. A large number of companies have made significant strides in standardizing their processes, data and systems through the implementation of ERP (https://www.clouderp.ru/tags/erp).

Standardization requires an extensible infrastructure, resulting in a fully integrated inter-instance interoperability. *SaaS* applications delivered over the cloud enable rapid deployment with low capital. Cross-platform communication can be an important factor for large enterprises that support different IT-platforms and different means of accessing online resources.

Depending on the application, it is important to integrate with traditional applications hosted in a separate cloud or on-premises technologies. Standards can facilitate or hinder interoperability in that existing ("legal") systems may or may not hinder the transition to cloud applications. The key lies in data integration and cross-platform compatibility.

Optimization of data storage in CT. The volume of media data stored (circulating) on the Internet in our time is quite large, if not huge. We will determine the optimal mechanism for storing data (multimedia) in cloud services and describe the methodology for storing and managing this data. There are a fairly large number of cloud services for working with data, but choosing a service that is most convenient and efficient (both from a technical and financial point of view) is very important.

Microsoft Azure (https://azure.microsoft.com/en-in/services/cloud-services) is CC provider (service) designed to build, test, deploy and manage applications and services across data centres managed by Microsoft. Microsoft Azure provides SaaS, PaaS and IaaS; support for various programming languages; Support for various tools and environments, including software from Microsoft and other manufacturers.

Azure Storage is a service that provides cloud storage that is readily available, secure, durable, scalable, and redundant. Azure storage includes Azure Blobs, Azure Gen2, Azure Files, Azure Queues, and Azure Tables. For working with media, the most suitable storage is Azure Blobs (https://itnext.io/microsoft-azure-blob-storage-pros-cons-and-how-to-use-it-with-javascript-ca5aaf5d5ff d?gi=dcaa18c712ce) and Azure Files (https://azure.microsoft.com/en-in/services/cloud-services).

Azure Blobs. This Azure Blobs storage is Microsoft's solution for storing objects and massive amounts of unstructured data (data that doesn't fit a particular model) in the cloud. There are four tiers of Azure Blobs storage for scaling: Hot, Cold, Archive, and Premium. Reliable and cost-effective cloud storage for all unstructured data. This is a pay-per-use solution and is less expensive than various local storage options. The user can choose one of four storage levels depending on how often he accesses the data. High-performance data is best stored at the premium tier, frequently accessed data in the hot tier infrequently accessed data in the cold tier and infrequently accessed data in the Archive tier.

Azure Blobs storage is intended for: serving images or documents directly in the browser; file storage for distributed access; backup, recovery, archiving; analysis by an on-premises or Azure service; support for streaming video and audio; records to log files; the advantages of Azure Blobs storage are: excellent documentation; good price for storage; high reliability and availability; low price for free download; various storage options; the ability to use for any data, security; scalability.

The benefits of Azure Blobs are also: strict consistency (when an object changes, all data is checked, which provides an unprecedented level of consistency, so you always have the most current version of the data); object mutability (flexible enough to make changes in place, which can quickly improve application performance and reduce bandwidth use); the presence of several types of blobs (block, page and additional objects provide the maximum opportunity to optimize storage according to your needs); easy management of geo-redundancy (automatic configuration of geo-replication parameters in a single menu allows you to easily provide both expanded global access and local access, as well as achieve business continuity). The disadvantages of Azure Blobs are: You need to purchase a dedicated plan to get developer support from Microsoft. Multiple storage options make it difficult to choose the most optimal one.

Azure Files offers fully managed file shares in the cloud that are accessible over SMB (https://ru.bmstu.wiki/SMB_(Server_Message_Block). Azure File Shares can be mounted concurrently on cloud or on-premises Windows, Linux, and macOS systems. Also, Azure Shared Folders can be cached on Windows servers using Azure File Sync for quick access to where the data is being used. The main use cases for Azure Files are: replacing or supplementing local file servers; Lift and Shift applications; simplification of cloud development; general application settings.

The advantages of Azure Files are multiple file servers in multiple locations; automatic file management depending on the usability of the files; general access; fully managed service; fault tolerance. The *disadvantages* of Azure Files are the need for significant management effort; the need for a large amount of knowledge to maintain and use it properly; multiple storage options make it difficult to choose the most optimal one.

Azure disks. Azure Managed Disk is a virtual hard disk (VHD). Azure disks are called managed disk because they are an abstraction over page blobs, blob containers, and Azure storage accounts. In the case of Azure disks, all the developer has to do is prepare the disk and Azure takes care of the rest. The *benefits* of Azure disks are Azure Storage encryption; management of encryption keys by Microsoft; high speed of work thanks to the use of an SSD-disk; file caching. The *disadvantages* of Azure disks are: it provides many settings and features that can be disabled; high price; multiple storage options make it difficult to choose the most optimal one.

Making decisions on storing media data in CT. Based on the above advantages and disadvantages, Azure Blobs is the most convenient media storage service because it offers many benefits, can handle any file type, and is well priced. The approach to storing and using media can vary greatly depending on data availability requirements, usability, etc.

Storing media in the cloud for Azure Blobs involves doing the following:

1. Create an Azure storage account.
2. Creating Blob Storage and getting a key to it.
3. Loading data with a unique identifier.

Azure Blob Storage provides a simple API to work with, but for efficient storage of multimedia data, the developer must use additional methods, which include, in particular, data archiving; data encoding; data encryption; data caching.

To optimize the storage of media data, the developer should consider the usability of the data. Thus, if the data that needs to be stored is not frequently used, then it can be archived before being stored. If the quality of the media is not so important, the quality of this data can be changed to a lower one. Also, this data can be saved in a different format, so it will be smaller in size. The mechanism described above can be mixed for best performance but is unlikely to be related to storage requirements.

Conclusions. The paper considered various aspects related to CC and CT, including various advantages and disadvantages. CC and CT can offer numerous benefits to various stakeholders. However, CC and CT also have some problems. It is noteworthy that by supporting the CC and CT deployment and maintenance models, problems can be either minimized or eliminated since the dynamic characteristics of CC and CT can always support users.

As part of the work, several Azure cloud services were identified, which provide the ability to cloud data storage. These services were described by their use cases, advantages and disadvantages. Key features for optimizing storage were also mentioned, which hardly depends on storage requirements.

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СУЧАСНІ ТЕНДЕНЦІЇ ХМАРНИХ ОБЧИСЛЕНЬ І ТЕХНОЛОГІЙ В ОПТИМІЗАЦІЇ ЗБЕРЕЖЕННЯ ДАНИХ

Мета статті – дослідити та розглянути загальні тенденції, проблеми та перспективи використання хмарних обчислень і технологій в обробці даних, зокрема оптимізації їх збереження.

Методи дослідження – методи семантичного аналізу основних понять розглянутої предметної сфери (хмарні обчислення та хмарні технології). У статті досліджено підходи до збереження даних (у тому числі й мультимедіа) у сучасних системах, які підтримують хмарні обчислення та технології.

Новизна дослідження – аналіз використання хмарних обчислень і технологій для оптимізації зберігання даних.

Висновки. У статті розглянуто різні аспекти, пов'язані з хмарними обчисленнями та хмарними технологіями, включаючи різні переваги та недоліки. Хмарні обчислення та хмарні технології можуть мати численні переваги для різних зацікавлених сторін. Хмарні обчислення та хмарні технології мають деякі проблеми. Слід вказати, що завдяки підтримці моделей розгортання й обслуговування хмарних обчислень і хмарних технологій проблеми можуть бути мінімізовані або усунені, оскільки динамічні характеристики хмарних обчислень та хмарних технологій завжди можуть підтримувати користувачів.

Ключові слова: хмарні обчислення; хмарні технології; моделі розгортання; сервісні моделі; дані; медіадані; сховище Azure.

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СОВРЕМЕННЫЕ ТЕНДЕНЦИИ ОБЛАЧНЫХ ВЫЧИСЛЕНИЙ И ТЕХНОЛОГИЙ В ОПТИМИЗАЦИИ ХРАНЕНИЯ ДАННЫХ

Цель статьи – исследовать и рассмотреть общие тенденции, проблемы и перспективы использования облачных вычислений и технологий обработки данных, в том числе оптимизации их хранения.

Методы исследования – это методы семантического анализа основных понятий рассматриваемой предметной области (облачные вычисления и облачные технологии).

В статье рассматриваются подходы к сохранению данных (в том числе и мультимедиа) в современных системах, поддерживающих облачные вычисления и технологии.

Новизна исследования – анализ использования облачных вычислений и технологий для оптимизации хранения данных.

Выводы. В статье рассмотрены различные аспекты, связанные с облачными вычислениями и облачными технологиями, включая различные преимущества и недостатки. Облачные вычисления и облачные технологии могут иметь многочисленные преимущества для различных заинтересованных сторон. Облачные вычисления и облачные технологии имеют некоторые проблемы. Следует указать, что благодаря поддержке моделей развертывания и обслуживания облачных вычислений и облачных технологий проблемы могут быть минимизированы или устранены, поскольку динамические характеристики облачных вычислений и облачных технологий всегда могут поддерживать пользователей.

Ключевые слова: облачные вычисления; облачные технологии; модели развертывания; сервисные модели; данные; медиаданные; хранилище Azure.

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