Multidisciplinary
SCIENTIFIC JOURNAL OF
MARITIME RESEARCH

University of Rijeka
Faculty of Maritime
Studies Rijeka

Multidisciplinarni
znanstveni časopis
POMORSTVO

The implemetation of cloud computing in shipping companies

Pančo Ristov[1], Mile Perić[2], Vinko Tomas[3]

[1] Faculty of Maritime Studies, Zrinsko-Frankopanska 38, 21000 Split, Croatia
[2] Auto Club of Rijeka, Dolac 11, 51000 Rijeka, Croatia
[3] Faculty of Maritime Studies, Studentska 2, 51000 Rijeka, Croatia

ABSTRACT

New information technologies are progressively being used to increase the efficiency, security and reliability of maritime processes and to reduce the costs of their execution. The latest technology that has come into wide use in maritime organizations, especially on board ships and in shipping companies is cloud computing. For the above mentioned reasons, more and more shipping companies use the services provided by this technology. Cloud computing enables optimized utilization of information resources, ultimately reducing the costs for shipping companies and giving operators the possibility to render services at lower prices and an ensured level of quality. This paper provides for an overview of the cloud computing technology and its application in business processes on board ships and in shipping companies.

ARTICLE INFO

Preliminary communication
Received 11 May 2014
Accepted 4 June 2014

Key words:
Cloud computing
Service models
Deployment models
Service operator
Ship
Shipping company

1. Introduction

The usage of cloud computing services on shore began ten years ago, and in the last several years came into use on board ships, shipping companies and other maritime institutions such as Gardline (marine sciences company). Several maritime IT companies such as MESPAS AG [1,2,3] have recognized the benefits rendered by this technology and have thus developed and implemented individual or all cloud computing models on the ship and in shipping companies. The advantages provided by this technology are reflected in the reduction of operating costs and the price of IT elements (hardware, software, databases, networks), maintenance of computing resources without additional training of new staff and/or purchase of new licenses for programs and applications. All these advantages allow shipping companies, particularly ships, to carry out and improve maritime processes controlled by computers. The application of cloud computing increases the current possibilities of information technology in executing business processes i.e. the possibility of using information resources. The advances in information and telecommunication technologies brought on better possibilities for the transfer, processing, storage, protection and data security.

There is a whole range of definitions of what cloud computing is, almost as much as there are service providers. The most accepted is the one by the National Institute of Standards and Technology, USA which reads: "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction"[4].

Ordinary users will define cloud computing as a new and cheaper way to use software solutions that they will rent as needed. IT experts will define it as a new business model or new technological platform that enables applications and documents sent from any part of the world to be saved and stored on designated servers [5].

Maritime subjects do not buy, but rent cloud computing, and receive exactly the data that they have sought for. Therefore, the costs are not large, and the investment in hardware and software can be as low as zero. In today's time of recession, this is just one of the many examples of how cloud computing can reduce financial and material costs of ships and shipping companies. Reserves and initial misunderstanding of the terms "cloud computing" and "service" can be found in the literature in this field and e-mail interviews with maritime companies and ship officers. The formulation that, within cloud computing, applications, platforms and infrastructure are sold to customers as services signifies that they are not sold as products. To be clearer, cloud computing is requested in the same way

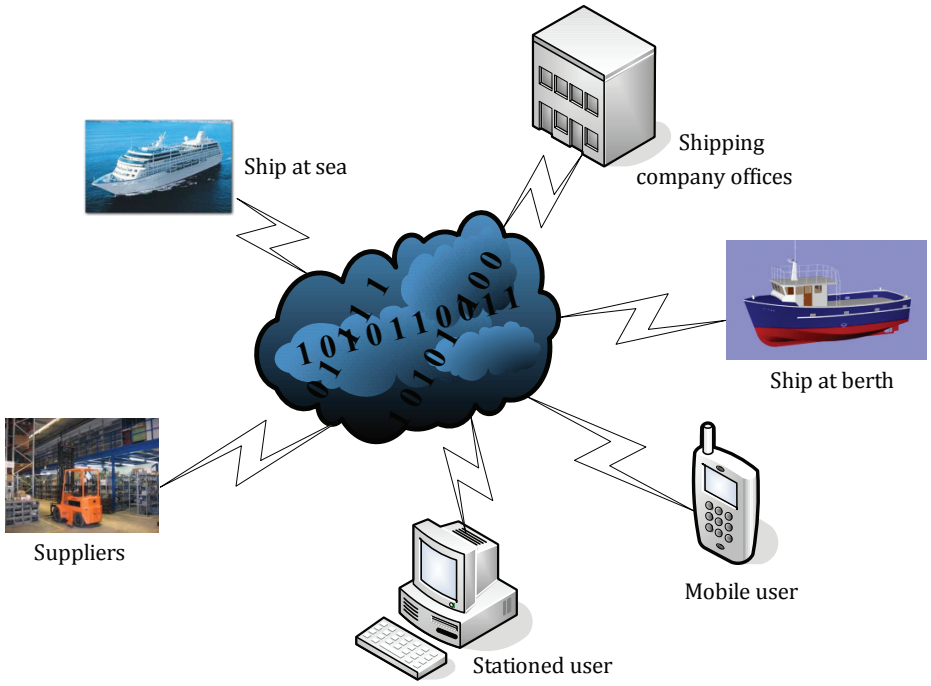

Fig. 1 Cloud computing

as when a ship entering a port requires services such as water, electricity, telephone connection, provision of food and / or drinking water, etc. The maritime subjects draws a computing service via internet from cloud computing – just as it does with water or electricity through the public water supply or electricity networks instead of drawing it from their own sources of water or electric generator. Due to the specific features of services provided by maritime subjects, specifically the shipping companies, the dilemma is not whether to use cloud computing services or not, but which models would be best suitable for improving the efficiency and security of the business processes to be performed.

The advantages of using cloud computing for maritime subjects include:

- lower prices of hardware and software
- access to software and data from any computer on board ship having an internet connection
- lower costs of maintenance of hardware and software
- possibility of rendering services to all company ships
- possibility of continuous monitoring of maritime processes supported by computer
- increased employee efficiency
- all information and documents at one location, etc.

In addition to the positive aspects, negative aspects of cloud computing have also been identified such as the (non)availability of services (satellite connection), security and confidentiality of data, intellectual property, reliability, data integrity, dependence on a single software support provider, the lack of standardized interfaces that allow for the transfer of data and services from one cloud to another, etc.

Cloud computing has been gaining on importance in business processes and as a result, EU governments and industries plan to invest EUR 45 billion by 2020 in the further development of new cloud service, which is not an insignificant amount [13].

2. The basic cloud computing model

The basic cloud computing model, in accordance with NIST, consists of five basic characteristics, three service models and four implementation models. The five basis characteristics identifying and indicating the difference between cloud computing and traditional computing are: on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service.

2.1. Service provider models

Cloud computing is an information technology that allows for three basic architectural models of providing services, often referred to as the SPI (Software, Platform, Infrastructure) models:

- SaaS (*Cloud Software as a Service*) – the user is given the possibility to use available applications implemented in the cloud's infrastructure. This model provides for the use of a single application by more shipping companies or similar maritime institutions (e.g. applications for managing ships or HR applications). Applications are accessible from any computer via a client interfac-

es (e.g. web browser). This model allows the shipping companies to rent a needed service instead of having to buy it as separate software and installing it on individual ship and/or office computers. This means that the shipping company has no additional investment in servers or software licenses, and the costs of cloud computing operators are small when compared to the traditional service of keeping files on shipping company's server. Examples of the SaaS model include MESPAS R5 [2,3], Google Apps and other.

– IaaS (*Cloud Infrastructure as a Service*) – the user is given the possibility to use a computing infrastructure. Shipping companies and other maritime institutions do not need to buy computers / servers, disk space for storing data, active and passive elements of computer networks, etc. The IaaS operator manages the entire information infrastructure, while the user is responsible for other service implementation activities. In other words, the user has no control over information resources in the cloud, but has control over the operating system, data storage and application development. The most known example of IaaS services is Amazon Elastic Compute Cloud [6].
– PaaS (*Cloud Platform as a Service*) –the user is provided with a development infrastructure i.e. the user develops own applications, their implementation in the cloud infrastructure and application management. The user is offered the service of a development platform including virtual machines and operating systems. These services are limited in terms of design and operator's cloud computing possibilities so the user does not have full service. Example of PaaS services are Google App Engine [7], Saleforce-com and other.

Constant development of cloud computing is followed by rapid development of new models. The models of interest to maritime companies also include those that provide storage and analysis of data in the cloud, namely: the DaaS (Data as a Service), the DBaaS (Database as a service) and the AaaS (Analysis as a Service) models. The DaaS model enables storing data in the cloud while access is done through local applications. The DBaaS model offers full functionality that is expected from a modern database. The key characteristics exhibited by cloud databases include the following: high availability, security and privacy, integrity, reliability, fault tolerance, scalability and distributivity. The DBaaS model is in effect a subset of the SaaS model, which provides hardware and software for database. The AaaS model allows data analysis and acquisition of entirely new information that may be of crucial importance for the management of the shipping company or the ship commander in the decision making process.

2.2. Cloud infrastructure deployment models

Computer experts, based on the demands set by end users, should take into account a number of considerations when deciding upon the right deployment model of IT resources in the cloud. Regardless of architectural model of service delivery, there are four possible deployment models, each of which has its positive and negative sides. These are:

– Public Cloud – this cloud infrastructure is available and open to the public, regardless of whether they are individuals or organizations. The public cloud is maintained by independent service operators and, most often, the applications from different users intermingle on operators' servers, data storage systems and networks. The term "public" does not always imply free use of cloud services, although it can be free or very cheap. Moreover, a public cloud does not mean that the user's data is publicly visible. Namely, the operators of public clouds provide access control mechanisms for their users. Parts of the public cloud can be assigned to a single user thus making it a private data center [5,8]. One of the advantages of public clouds is that they can be much bigger than a company's potential private cloud. They enable scalability on demand and transfer of infrastructure associated risks from the company to the cloud computing operator.
– Private Cloud – this cloud infrastructure is available and open solely to a single company that has complete supervision and control over data, security and the quality of the rendered service. In other words, IT resources are pooled across the company into own data centers that can be further optimized by applying the principle of distributed computing and virtualization. The private cloud is developed and managed by the company's IT department or the service operator. When a company wants to "open up to the outside world," then cloud services are deployed through a virtual private cloud which is accessed via a virtual private network.
– Community Cloud – this cloud infrastructure is shared between several companies. It can be managed either by the companies themselves or by a cloud computing service operator. Therefore, the costs arising from such cloud architecture are divided among the companies. Community cloud is a public cloud that is usually under good supervision and control. Companies having common concerns, same or very similar business processes, such as the Croatian shipping companies, make it possible to design a community cloud for all shipping companies in Croatia. This means that all Croatian shipping companies use the same applications and have common and/or own databases. By using the cloud, the shipping companies avoid the high costs of buying more expensive hardware, software, services and maintenance of computer infrastructure.
– Hybrid Cloud – this cloud infrastructure is a composition of public and private clouds which remain separate entities but are interconnected through standardized interfaces enabling reliable transmission of data and applications. The hybrid cloud introduces additional complexity in terms of determining how to distribute applications and information on public and private

clouds. The advantages of a hybrid cloud are its adjustability and scalability to any company, the reduced costs in relation to company's own IT resources and the possibility to adjust the cloud IT resources to fit any end-user.

When creating clouds, the designers need to take into account the architectural distribution of data, because manner in which the data is distributed has great impact on the future adaptability, security and mobility of achieved solutions [5].

All resources in any cloud deployment are accessed via a network. Therefore, the communication links should be secure and reliable and preferably redundant. What is expected is a reliable data transfer at a satisfying speed, high availability (using alternative routes) and low latency. The problems that may arise in the ship – shore – ship communication are the satellite links.

A constant connection with the shore i.e. the shipping company can be achieved through packet transfer over a satellite link. For shipping companies, this means that the costs vary according to the amount of transmitted content and not the length of connection.

2.3. Partners in cloud computing

There are three main partners involved in the development, implementation, maintenance and use of cloud services. First there is the **service operator** who renders services to the end users. Depending on the type of service, there are three types of service operators: the SaaS operator (installs, manages and maintains software support), the PaaS operator (manages the cloud's information infrastructure for a specific platform) and the IaaS operator (maintains the computing resources in the cloud). Then, there is the **user** – a private person or company using the cloud services through different user and application programming interfaces. Finally, there is the **service designer** who designs, publishes and supervises the cloud services. If an end user is not satisfied with the characteristics of the application he/she may upgrade or implement a new version.

The partnership between the user i.e. the company and the service operator is of high importance in achieving successful business performance. This relationship is regulated by the Service Level Agreement (SLA). The SLA contracts user's requirements and operator's obligations usually in terms of time, privacy, security, availability, reliability and determined procedures for data recovery. In addition, the SLA contract specifies the price and method of penalty payment collection if the contract is breached i.e. when the characteristics of the delivered services are not in accordance with that specified in the SLA contract. The SLA may be contracted for an application and an infrastructure. The SLA infrastructure contract, in most cases, includes the percentage of time within which a particular resource is to be available, while the SLA application contract determines the characteristics of the application and the level of service provided to the end user. For more information about SLA contracts see [12] in References.

3. A possible service model and manner of cloud realization for shipping companies

Shipping companies and other maritime institutions need to analyze a series of questions if they wish to move their business operations into the "cloud" environment, such as: Which cloud to choose; Which model to use? Which security controls to implement? Which information to put in the cloud? Which applications to put in the cloud? and many other. In addition, the shipping companies should look at, compare and analyze all service operators to be found on the IT market and their references.

Shipping companies can store data, applications, functions and/or maritime processes within the cloud. In cloud computing data and applications do not need to be stored at the same address.

The shipping company's business operations based on the "cloud" reduce, and even eliminate the complexity of the business processes associated with its IT infrastructure and include security, data availability and storage, backup copies and improvement of all tasks associated with the cloud.

Based on the analysis of business processes on board ship and in the shipping company, the SaaS model is an important and acceptable model of rendering cloud services. The SaaS model covers all important business processes in terms of the technical management of a fleet of ships i.e. resource management, leadership, management of staff – the crew and reporting.

The SaaS model offers the possibility that certain a person(s) on board or from shore initiate the flow of information with suppliers.

In addition, the cloud provides the DBaaS service i.e. a centralized database that is in the cloud and the software for database management. This means that the office staff has access to data in real time over a secure Internet connection no matter when and where they are located (work from home, business trip, the ship's agent). Over a corresponding interface, the ship's crew has access to the ship's database, which is the same as the database in the cloud. Regular synchronization of data and information ensures that the ship's crew as well as office staff on shore uses the same updated data and information. Work on a centralized database in the cloud is the foundation for an efficient flow of information and transparent business processes of shipping companies. The basic characteristics that a database in the cloud should have include: speed (of access), security and privacy, consistency, high availability, reliability, scalability and elasticity. The block schematic representation of access to a centralized database in the cloud is shown in Figure 2.

One of the possible versions of the SaaS model for shipping companies includes the following functional modules:

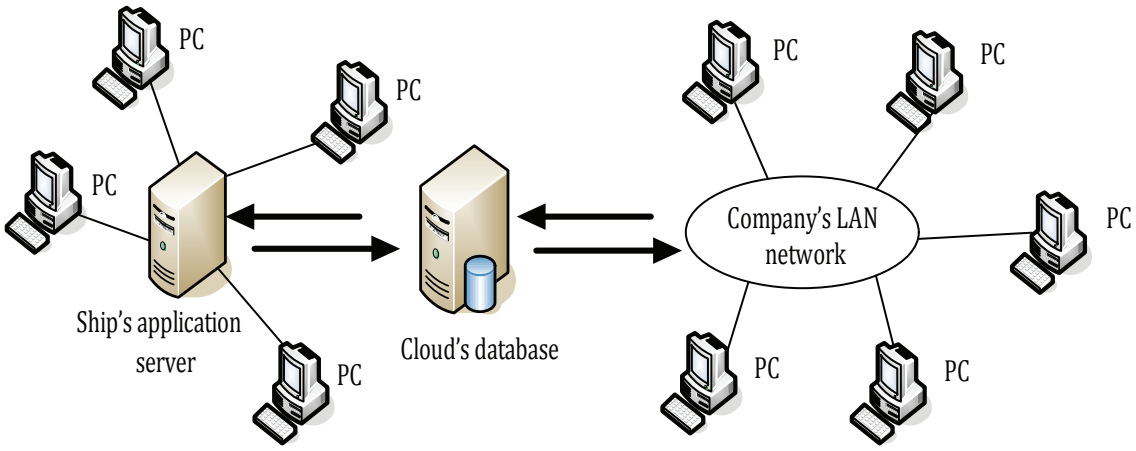

Fig. 2 Access to a centralized database in the cloud

- Ship/ fleet management – software application support designed to meet all the demands placed on the crew of a ship or fleet of ships so that the crew can effectively plan and execute the assigned tasks, while the office staff has insight into the execution of the tasks set for each individual ship in the fleet. This function consists of the following modules: planning, fleet certificates (settings and management), voyage management, e-log books (ship position, navigation, engine room, fuel and oil settings).
- Maintenance management – software application support that allows the planning and execution of ship maintenance procedures and management of spare parts and materials of individual ships as well as the entire fleet. The software support automatically informs the crew of pre-planned actions, such as the maintenance of an individual component with all the necessary information. This function consists of the following modules: components (main component and the subcomponent), materials (repair and spare parts, expendables, food and drink, supplies on stock, transactions of materials, etc.) maintenance (standard instructions, planned and corrective activities, work history, work hours, planning).Procurement – software application support designed to simplify the entire process of procurement for the needs of management, office staff and crew i.e. from need recognition to the procurement of new stock. The office staff has a direct overview of the needs and requirements of all ships. This module provides for a transparent management of procurement and enables procurement for the entire fleet thereby reducing overall costs. Through this function, the users have access to all important information about the suppliers, prices, invoices, the state of the budget, the current status of individual orders and the like. In this way errors are eliminated; the entire procurement process is speeded up; the number of employees is reduced, etc. This function consists of three modules: procurement (inspection of orders, direct procurement, invoices), tools for planning (financial transactions, budgeting, the state of the budget, location of alignment, etc.) and authorization (permission settings, monetary levels, "out of office" assistant and individual permissions).
- Document management – software application support that helps manage documents (document editing, archives, distribution and control of document versions). This function enables secure access to any document. Moreover, access can be restricted, to a certain level, for each crew member (ongoing or completed task, inventory status and all other relevant documents for ship management) or for any office member on shore (a constant overview of completed tasks at fleet level).
- Reporting – software application support that enables the creation of dynamic standard or own reports according to various criteria (operation of individual equipment, maintenance activities, order books by ship, finance and control, surveillance over certification, etc.) that provide an overview of the current status of each individual ship or fleet and provide timely and accurate information to decision makers.

The proposed SaaS model is a software application support that covers the main functions in managing a fleet of ships. The operating principle of the model is shown in Figure 3. This model delivers a single application via a user's browser to several shipping companies using an architecture intended for more tenants.

As can be seen in Figure 3, the flow of data and information between company's offices, its fleet and suppliers is carried out within the cloud (full line). The office staff and crew members have access to a centralized database. The database contains all the data and information about the ship fleet and is located on the server in the cloud. Moreover, the crew members and the office staff have access to all the data and information on suppliers that are located in the cloud. The suppliers communicate with the office staff or the ship's crew via the SaaS model (broken line).

There are two types of data available in the cloud: **general data** (information on equipment manufacturers, instruction manuals, spare parts, etc.) and **specific data** (financial condition per ship or the entire fleet, plans to introduce new services, plans for procurement of new vessels, etc.) for individual persons in the shipping company. General information can be accessed by all employees, while specific information only by authorized persons within the company.

The implementation of the model shown in Figure 3 reduces overall costs, operating costs, reduces the complexity and execution time of maritime processes, provides for data and information in real time, etc. and all it needs for running are standard computing resources.

The introduction of this model in a shipping company means operational transparency (an overview of the technical, financial, material possibilities in real time, a tool for fast, efficient data collection for effective decision-making); effective execution of processes (precise and clear instructions, automatic synchronization of all applications in the cloud with small amounts of data transmitted); lower overall costs (no need to buy IT components, the SLA contract includes updating and improving software application development, increasing the quality of entire fleet maintenance); integrated technical management of the fleet (software application covers all aspects of technical fleet management) and management of the supply of ships and shipping company's offices (office staff and crew members can find suppliers quicker and establish a direct connection and transparently monitor the entire procurement process. This helps reduce and even eliminate the possibility of errors; it speeds up the entire process; reduces the number of people involved in the process, etc.). The flow of data and information between ships, offices and suppliers is shown with a broken line (see Fig. 3).

Figure 3 also shows that, in addition to the SaaS model, the DBaaS and AaaS models are also implemented in the cloud. In order to realize the DBaaS models, the relational and object-oriented databases are used. Relational databases and software for database management are founded on transactions having the following attributes: atomicity (a transaction is indivisible), consistency (each transaction transforms the database from one state to another correct state), isolation (transactions do not collide) and durability (a transaction is made permanent). There are a number of different approaches to object-oriented databases which are usually tied to a particular object-oriented programming language. Objects rather than data are manipulated in the execution of these databases. In today's "clouds", the relational database are predominant but in the near future, once the existing tools for object-oriented programming are upgraded , they will take their place in the storing of large amounts of data.

Shipping companies have a large amount of collected data and an infinite number of potentially interesting combinations that require many different types of analyses. Therefore, in the near future, the shipping companies will be using the AaaS model in all cloud computing combinations. The AaaS model analyses the collected data, such as fuel consumption of a particular ship or of all ships in the fleet, to test set hypotheses before the achieved results are interpreted. For an objective opinion leads to correct results that are real, not based on subjective perceptions. The AaaS model helps management in the decision-making related to shipping company's future. In addition, the AaaS model can be used to measure the results of individual ships or the entire shipping company. The obtained results should be compared (measured) with those of other domestic and international shipping competitors and thus establish how a company stands in the global shipping market.

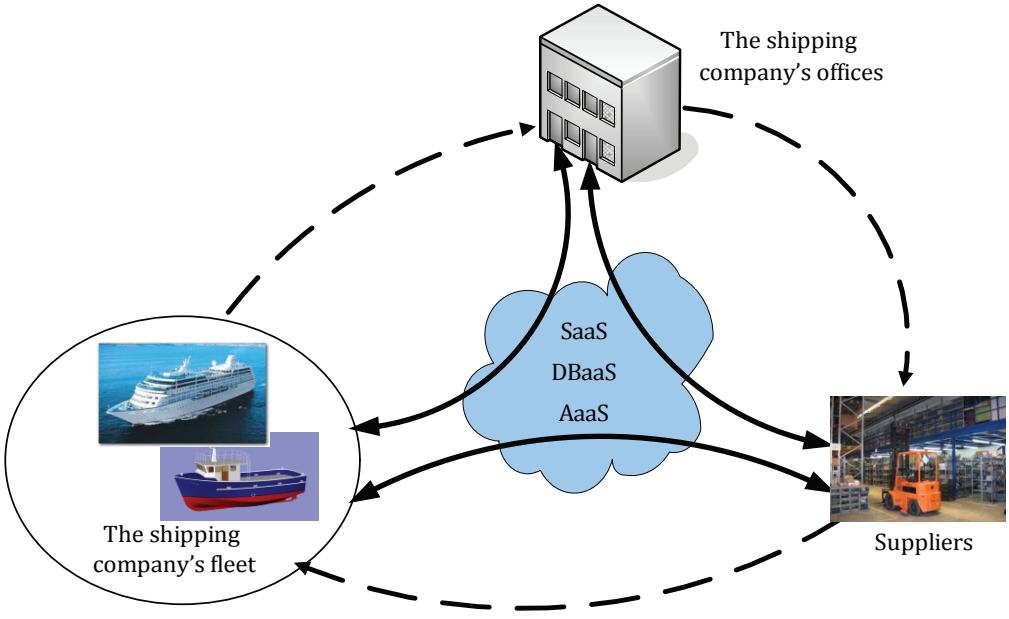

Fig. 3 Operating principle of the SaaS model

Depending on the decision made by the shipping company's management, the proposed SaaS model can be carried out in two ways, as a private or a community cloud. As described in section 2.2, a private cloud is an infrastructure used by a single organization. This cloud is suitable for large shipping companies that have complete control over applications, data, security and service quality. For small companies, such as Croatian shipping companies that have common needs, the same or similar missions, security requirements it is advisable to use a community cloud. This implies that all shipping companies use the same applications, while each individual company can have its own database located on the same server or a different server with its general and specific information. A community cloud can be managed by the mere shipping companies (one or more), someone else (service operator) or a combination of these parties. The costs for the use and maintenance of the contracted services are divided between the shipping companies.

4. The degree of information available to the shipping company's staff

The structure of people in each shipping company consists of office staff, ship crew (the highest value of the company) and ship agents. In order for the seafarers and shipping agents, who are outside the main shipping company offices, to be up to date with the situation in the company, it is necessary for them to be well informed. Cloud computing provides one-way and two-way communication.

One-way communication usually includes online news and a variety of simple shipping company's forms or questionnaires. These are mainly administrative information relating to any conclusions, decisions or acts brought by the shipping company's authorities such as general communication, information on the financial statements, a variety of information relating to all employees (purchase or writing off of ships, the current location of ships, etc.), profile and history of the company, announcement of the general meeting, etc. Online forms can be used as a service through which seafarers sent specific information. Online forms contain interactive elements such as: blank entry fields, selection lists, action buttons, etc. and in this way seafarers or employees can express their opinions in terms of the quality of ships on which they are navigating, suggestions, compliments, etc. The shipping company may use the online form to survey its seafarers, ship agents and shore staff and thus gather opinions on an event or a particular topic. This level of information enables the shipping company to organize and/or display various business events and celebrations marking the important dates for the company, the laying of the keel or the launching of a new ship, which can be implemented using a web-based calendar. The only thing that the shipping company' management has to do is to inform all its employees and seafarers about the existence of a web-based calendar and thus make all information on any event available to everyone especially the crews on ships scattered on seas and oceans. Any unscheduled change can easily be updated on the calendar and everyone looking at the calendar will immediately see it.

Two-way communication enables two-way communication between the company's management and the ship's crew or ship agents (agency). The most common service in this group is electronic mail. An adequate use of electronic mail can be of great advantage for the entire shipping company, for the communication with suppliers or other partners in the execution of business processes. Modern web technologies provides for a range of web-based e-mail applications that are implemented in the cloud (Yahoo Mail, Gmail, etc.) and which can be accessed from any computer or smart phone, provided that there is a safe and reliable Internet connection. By using a web browser it is possible to send or check e-mails stored in the cloud. Two-way communication is an adequate mean of communication between the seafarers and their families especially when they are off shore or at anchor. Another important service provided by cloud computing is the forum. The management of the shipping company or any member can write and send a message to the forum which is visible to all company employees and seafarers who can leave their opinions i.e. messages. All received opinions are kept until deleted by the initiator of the forum. This service enables better connection between the shipping company's management and the seafarers. In addition to the e-mails and forums, web-based service for text processing (creating a joint document) and the service of project leadership and management and project documentation are also used at this level. The last service is essential for shipyards, specifically for shipyards located at multiple locations. This service allows the tracking of all set tasks at all locations, the spending of financial and material resources, the pace of task execution, etc. Each member of the project team can work independently on own project assignment. Moreover, each team member has access to the application from any location and access to all data and information about the project. The head of the project team has access and an overview of each individual report, and once all team members' reports are integrated, submits the complete report to the shipyard's management.

5. Conclusion

This new information technology has not yet entered into wide use aboard ships or in shipping companies, although there are already several IT companies developing and offering cloud computing services to shipping companies. The reason for this lies in traditional distrust of seafarers towards new information technologies, non-standardization of applications and elimination of earlier issues such as security, availability, difficulties in transferring data, dependence on a single operator, etc.

Cloud computing, as a new IT technology, introduces a spectrum of new opportunities and challenges ranging from management to application and infrastructure secu-

rity. The key to a successful use of services lies in the choice of the right cloud and the right deployment model for a single or for more shipping companies. Prior to opting for an individual operator, the shipping company needs to know if it can handle the risks associated with the different models of architecture design. Therefore, in accordance with what it requires from the "cloud", the shipping company should conduct an evaluation and if it analyses a specific offer can have a more complete assessment of risks.

The use of cloud computing services provides for cost savings in the costs of developing and maintaining an internal infrastructure, operating expenses such as those allocated for the maintenance of IT resources, administration costs and costs of scaling information infrastructure. In addition, it gives the shipping company a possibility of faster and greater development, a possibility of upgrading existing services or investments into new and thus further development of its IT sector.

In the near future, the shipping companies will recognize the positive aspects of cloud computing and will implement it in the management of their fleets, regardless their size.

References

[1] http://www.mespas.com/ (8.2. 2014.)

[2] MESPAS AG Mespas, The technical management software based on cloud computing, Technical Management Software, Switzerland

[3] MESPAS AG Mespas, System requirements, Technical Management Software, Switzerland

[4] NIST (National Institute of Standards and Technology, Department of Commerce, USA), "Special Publication 800-145", September 2011.

[5] NCERT-PUBDOC-2010-03-293 – Cloud computing

[6] http://aws.amazon.com/ec2/ (09.02.2014.)

[7] https://cloud.google.com/products/ (09.02.2014.)

[8] Kevin L. Jackson, Government Cloud Computing, Dataline LLC, 2009. (http://Cloudcomputing.dataline.com)

[9] Vračić, T., Infotrend.hr – onLINE, Dostupnost elektroničkih javnih usluga na Internetu u Europskoj uniji u 2012. godini http://www.infotrend.hr/files/pdf/casopis/2012/191/InfoTrend-191.pdf.(19.02.2014.)

[10] Šaranović, Ž., Nožica, B. Bjelobrk, D., Mogućnosti primjene računalstva u oblaku u tijelima lokalne uprave i samouprave, MIPRO 2013.

[11] Neguš, A., Grubor, G., Bezbedbosni problem distribuiranog internet računarstva, Računarstvo i informatika, UDK: 004.738.5.035, 2011.

[12] Buyya, R., Broberg, J, Goscinski A., Cloud Computing: Principles and Paradigms, John Wiley & Sons, Inc., 2011.

[13] Unleashing the Potential of Cloud Computing in Europe, http://ec.europa.eu/information_society/activities/cloudcomputing/docs/com/com_cloud.pdf (23.02.2014.)

[14] http://www.mespas.com/multimedia/docs/online-software_free-version/index.html? lex0902231027.htm

[15] http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P7-TA-2013-0535+0+DOC+XML+V0//HR