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VIRTUALIZATION OF INFORMATION RESOURCES IN TOURISM ORGANIZATIONS

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Abstract

Virtualization of information resources is a fast growing technology in the business environment. Given technology is the basis for the development of the industrial sector, telecommunications, cloud computing and other socio-economic structures. This concept could be approximately defined due to virtual systems in the business environment (i.e. virtual machines, virtualized processor systems, virtualization of memory system and I/O system virtualization, as well as virtualized network structures such as network function virtualization (NFV) and software defined network (SDN)). This technology converges with Internet of Things (IoT) and Big Data into a modern information system. The aim of the research is to show that this concept provides flexibility and fast implementation of new business solutions, that is, positively affects the increase of productivity and efficiency in firms. There is the necessity that tourism organisations in Serbia become aware of contemporary trends, in order to improve their business.

Keywords: *virtualisation, IoT, Big Data, virtual CPU, virtual memory system, virtual machines*

Introduction

The trend of data amount growth rate is present in the tourism industry, as well as in the whole socio-economic system, that is, information systems (IS) development which could manage given data is of huge importance. Managers in tourism systems at all levels need to have information about new trends in information and communication technologies. In that way

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companies could create new systems through the process of information system development, or two perhaps the most important stages in the mentioned process, in the form of analysis and design of IS.

There are two parallel processes in the social system. The first one defines the increasing amount of data in the economy, and the second one refers to the process of development of information and communication technologies (ICT) in order to manage information, that is, knowledge, as the most important resource nowadays.

The process of ICT development is defined through a number of directions, such as:

- mobile systems that are defined by rapid penetration of mobile technology in the market, as well as their implementation in the business environment,
- virtualization, modern concept that enables productivity increasing of information systems,
- Cloud computing, a contemporary model that carries flexibility and ability to deliver services on demand,
- Big Data, new generation of technology that is able to process (manage) huge amount of data,
- new network technologies, such as: Internet of Things (IoT), 5G network, optical technology, Software Defined Network (SDN) and Network Function Virtualization (NFV).

In this paper we are trying to handle the virtualization process that represents core methodology which converges with the above-mentioned concepts, as well as with modern architecture, resulting in a contemporary architecture. First, we process the lower layers' components of information systems that are defined by processor systems, memory systems, network structures, and thereafter the upper layers containing platforms in the form of Cloud computing and Big Data.

The present day challenges include the design and implementation of infrastructure and services for processing and storage of large amounts of data, their searching processes, analysis, sharing and visualization, which presents the lower layers of the information system.

As it is mentioned above, the starting point are processors.

Processor systems

Processor systems provide a platform for all layers of an information system. Their significance is huge, so we can say that the development of processor technology affects all aspects of information systems, as well as the virtualization concept of all IS resources. Lower structures are independent in relation to the business system functions, in this case the travel organization.

NX/XD, LAHF and SAHF instructions. Hypervisors are applications which enable virtualization process. Given platforms require powerful processor components. Analyzing the processors' characteristics, as well as VMware vSphere ESXi hypervisors enables the definition of important aspects.

Vital aspect of virtualization is represented as aspect of isolation that enables managing of virtual machine access towards its memory space. This type of isolation could help more efficient VM, as well as protection from external negative influences. Here the focus of analysis is switched to CISC architecture represented by companies Intel and AMD. (Langovic, Pazun & Tomic, 2015).

Processors isolate this kind of memory space using the so-called non-executable bit that defines a specific area of memory. AMD processors render NX (never execute) bit, while Intel processors provide the XD (execute disable) bit. Given bits are functionally the same, and could be displayed as NX/XD. In situation where the memory area is defined using NX bit, the processor refuses to initiate any code in a given part of the memory. If code initialization in a protected area of memory happens, data generates, that is, information related to possible violation of memory space in order to alert administrators about non-standard activities. In this way, mutual influence of one VM to another virtual machine precludes, therefore, the computer system safety maximizes.

In x86 processors (CISC architecture) the AH register is known as the "battery". AH register is used to access Input-Output (I/O) ports due to floating-point operations and interrupts enabling. These functions are essential to the virtual environment, that is, to the virtualization process. Processors could accelerate the management of the mentioned activities using SAHF (Save this Flags AH) and LAHF (Load AH from Flags) instructions, which enable direct registers control.

Hypervisor can use LAHF/SAHF instructions in order to manage i/o processes, as well as interupting processes, with high quality. Given control on lower levels of computer systems can improve virtual machine performance in the processor core. AMD and Intel companies define virtualization capabilities with Intel-VT and AMD-V technologies.

Characteristics of virtualization are usually controlled through BIOS. Therefore, it is necessary to check whether functions are implemented in respective processors.

The concept of RVI. Rapid Virtualization Indexing (RVI) is a part of the function set for virtualization, including technology AMD-V. The given term can be defined as the nested page tables (NPT), that is, the second level address translation (SLAT). Intel's term for RVI concept is Extended Page Table (EPT).

Processor uses the page table, that is, TLB buffer, in order to translate relative into physical addresses, after data processing requires access to physical memory.

When a virtual machine delivers access to physical memory, which is necessary to translate addresses (first for the host computer, then the second translation for virtual machine). This address translation generates process that adversely affects the CPU performance.

Tools that enables IT professionals to determine whether the processor enables SLAT function are present nowadays. One of used is Core Info tool which serves for EPT, NPT or RVI fuctions detection.

The information on whether processor has the ability of virtualization or not, can be obtained in the following example (due to coreinfo tool developed by Microsoft):

- coreinfo.exe –v
- HYPERVISOR - Hypervisor is present
- VMX- *- Supports Intel hardware-assisted virtualization
- EPT- - *- Supports Intel extended page tables

Line means "no", while star equals to "yes". Therefore the hypervisor is not enabled in this case, while the processor supports virtualization and extended page tables. In other words, SLAT feature is supported.

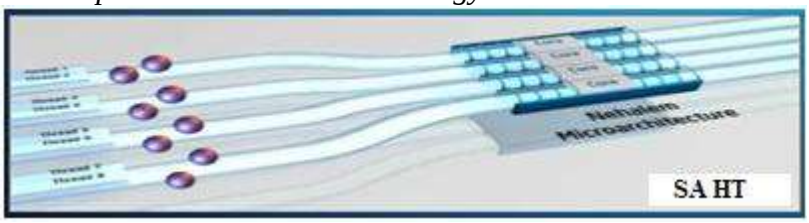
The concept of HTT. One more characteristics that improves virtualization process is described by HTT. Hyper-Threading Technology (HTT) refers to an Intel technology that enables better parallelism process on processor. One physical processor can generate two virtual processors utilizing given technology. Hyper-Threading requires that an operating system supports multi-core processors. In the case that HTT function is not activated, the 6-core Intel Xeon processor provides server with six physical processors. Otherwise, when the function is switched on, the server detects each thread as a physical processor (for example, in this case the server registers 12 physical processors).

Generally, a virtual processor can support four to eight virtual machines.

Picture 1: *A processor without HT technology*

Source: *According to source: www.intel.com, (accessed 1.4.2016.)*

Picture 2: *A processor with HT technology*



Source: According to source: www.intel.com, (accessed 1.4.2016.)

Further, it is necessary to consider possibilities of RISC architecture and its representatives, ARM.

The aim of RISC technology is power and performance improvement through reduced instruction set (Langović, Milićević, and Pažun, 2015). RISC consists of small number of instructions, therefore, in this case processor has a smaller number of transistors and shorter data path, which generates lower power consumption, that is, leads to performance improvement. RISC server should use ARMv8 or similar processors that are capable of virtualization supporting.

One of the examples of RISC concept utilization refers to the processors manufactured by Qualcomm. The company has started with sampling of the new ARM processor, which is used in large data centers. It is about 24-core system-on-chip (SoC) based on the instruction set, type ARMv8-A. SoC is designed for hyper scalar data centers, platforms, Big Data, as well as machine learning processes. Further, it supports virtualization, OpenStack cloud systems, virtual machines, and so on.

NUMA technology. Memory significantly affects the performance of virtual machines. Non uniform memory access (NUMA) defines characteristics of processor access to all parts of memory in reading and writing process. For example, for different processors certain parts of memory have high speed access, while other memory spaces have low speed access.

For example, we can consider a server with two eight-core processors with a total of 128 GB memory. In NUMA architecture each processor has access to 64 GB, so that each of the eight cores in a processor disposes to 8 GB.

The objective to be achieved by applying NUMA concept is maintenance of better organization with large amount of memory, as well as usage of multiprocessor systems (analog to virtual processors, i.e. virtual machine on a physical multi-core processor), while each has its own interface.

Coreinfo is a tool that represents topology of logical and physical processors, NUMA node, socket and cash that is assigned to each logical processor. It uses GetLogicalProcessorInformation Windows function in order to obtain the information.

Central and graphical processing unit integration

Generally, there should be taken into account solutions that include CPU and GPU development integrated in the form of a SoC system. The main advantages of the integration are reflected in simplicity. Graphical resources are available for server machines without adding any graphical devices that increase consumption. Following two processors belong to mentioned group: Xeon E3 and AMD Opteron X, as well as some newer models.

Given integration could be improved to a certain extent of graphics functions, with low energy consumption and financial investment. GPU isolated on the graphics card does not overload computer resources, but investment is higher and consumption could be significantly increased. (Langovic, Pazun & Tomic, 2015) On the other hand, it should be taken into account the fact that virtualization process comprehends graphical processors, as well, such as NVIDIA GRID vGPU. This processor enables simultaneous direct access of multiple virtual machines to one physical GPU using NVIDIA driver. Thus, characteristics of a computer system are improved.

AMD has reached the fifth generation APU processor, enhanced with HSA technology, which consists of two technologies in the form of hUMA and hQ. hUMA (Heterogeneous Unified Memory Access) enables the CPU and GPU to see full RAM and virtual memory. The system for the first time does not separate certain amount of RAM for the GPU, but the central processor and graphical processor unit access equally to the memory and "see" it as a whole. hQ technology (heterogeneous Queuing) provides possibility that modules independently create certain processes, as well as communicate within themselves as needed.

Above-mentioned technologies enable the creation of memory system architecture discussed below.

Memory systems

There is a necessity for larger storage systems. Memory system technology is presented in form of the following concepts: directly related storage areas (DAS - direct-attached storage), storage systems connected to the network (NAS - network-attached storage), modern optical architecture (FC -Fibre Channel), as well as iSCSI SAN network and technology of flash memory system (flash storage array). The latest developments shift to the process of virtualization, which is defined as software defined storage (SDS), or software defined data centers (SDDC). Management of above-mentioned systems can be controlled by artificial intelligence due to automate the protection and recovery process. Software defined storage can be built using traditional storage area network (SAN) and network attached storage (NAS) solutions, or it can be formed on the Object-based storage solutions.

The process of separating hardware from software in storage systems users gets more efficient management. VMware has used the expression "software defined data center" (SDDC). The given term represents more general concept in order to define resources, as well as storage system functions, using software. Certain companies have adopted the expression "software defined storage" (SDS). SDS can be an element within the software data center. At the same time it can function as a independent technology.

Virtualization process and network systems

Accelerated development process and more general acceptance of the computer networks concept leads to more complexity and more difficulty in their architecture maintenance. (Langovic, Pazun & Tomasevic, 2014) As a result of network systems complexities increasing there have been developed virtualization processes of network resources, defined through the following concepts: software-defined networks, virtualization of network functions and network virtualization system.

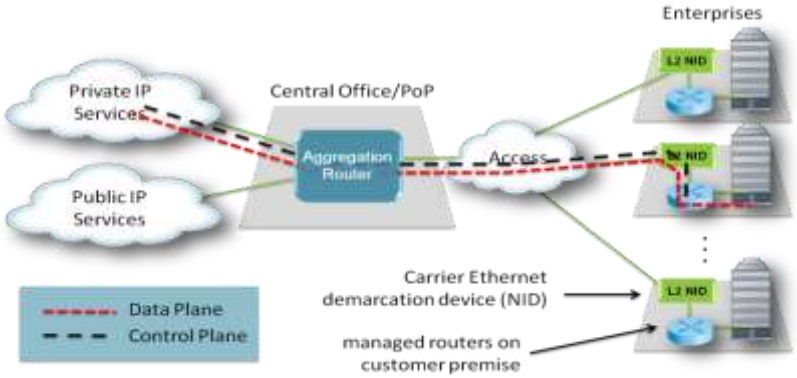
The concept of software defined networking (SDN) as a relatively new way of network resources managing, separates network control layer from the forwarding processes. This concept enables better organization and automation of network resources. (Pažun, Grujčić, Langović & Ralić, 2015; Langovic, Pazun & Tomasevic, 2014)

On the other hand, the concept of network virtualization function (NFV) is focused on the network services optimization. Due to network functions separation such are DNS, caching, etc. from hardware devices, given platform enables their capability to operate in the software layer. (Pažun, Langović & Milićević, 2015; Pažun, Grujčić, Langović & Ralić, 2015)

Network system virtualization technology (NV) provides the possibility of virtualization, and therefore the integration of network resources with virtualized environment.

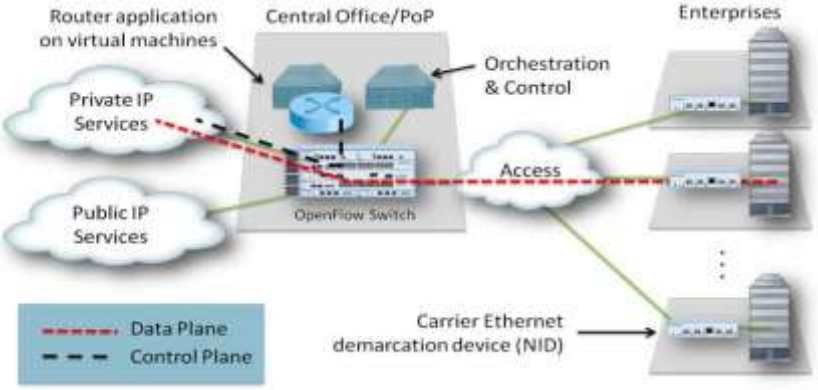
These concepts can function separately, however, the reality is that both concepts represent the best characteristics after their integration into whole, one unit.

Picture 3: *Router management without SDN and NFV usage*



Source: *https://www.sdxcentral.com/articles/contributed/nfv-and-sdn-whats-the-difference/2013/03/, (accessed 4.4.2016.)*

Picture 4: *Router management with SDN and NFV usage*



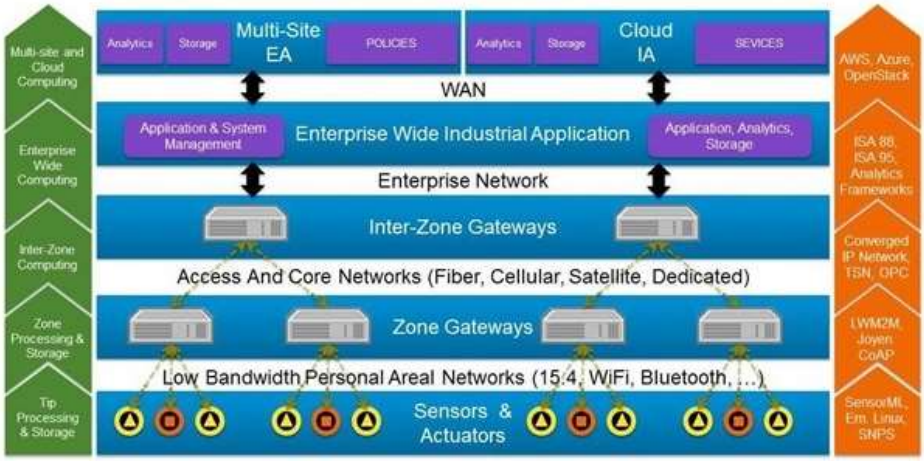
Source: *https://www.sdxcentral.com/articles/contributed/nfv-and-sdn-whats-the-difference/2013/03/, (accessed 4.4.2016.)*

Nowadays, one of the most used software tools called Frenetic, presents an integral part of SDN technologies. The programming language is designed for network programming, that is, for OpenFlow/NOX systems that are part of SDN, as well. Frenetic consists of a set of functional abstractions that enable modular program development. This platform that enables the implementation of the following managing phases: network traffic monitoring, policy management for packets forwarding and efficient policy updating.

Further, the concept Internet of Things (IoT) should be mentioned, which is at the present time more used in the business environment. These are

devices so-called "things", which in their structure consist of processor systems and other components, with the possibility of data exchange. Predictions of International Data Corporation (IDC) are that by the year 2018 about 40% created IoT data will be stored, managed and used by systems that are near or at the network edge.

Picture 5: *IoT architecture*



Source: *http://www.industrial-ip.org/en/industrial-ip/internet-of-things/3-steps-for-evolving-iot-architectures, (accessed 5.4.2016.)*

Cloud computing and Big Data virtualization in tourism

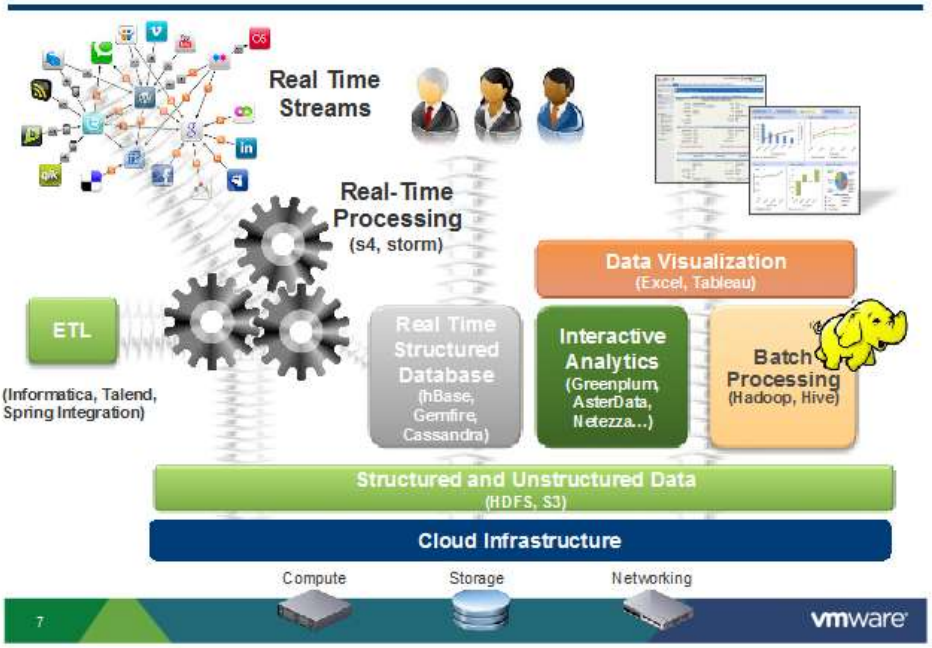
Virtualization represents practically the first step in the creation of cloud computing. It is the process of separating the hardware layer and virtual machines that represent a platform for computer systems, storage and network resources. Integration of technologies mentioned in this paper, at this point does not end, that is, it is continuing followed by Big Data technology, analytical platform that closes the circle in the process of information system creating.

High speed growth of data in economy, public administration and all socio-economic structures is presented. Analyzing the tourist branch of the economy amounts of data creates the need for strong and modern information systems.

The upper layers of information systems are more directly related to the functions of the tourist system, therefore, in this case we are going to

define explicitly relations of concepts Big Data and Cloud computing with travel systems.

Picture 6: *Holistic view of Big Data system*



Source: *http://blogs.vmware.com/vfabric/2012/08/4-key-architecture-considerations-for-big-data-analytics.html, (5.4.2016.)*

Cloud computing is present everywhere in the modern business environment. The World Tourism Organization of the United Nations (UNWTO) has recently signed an agreement with Microsoft on the use of Cloud services for the development of tourism (UNWTO, 2012). According to Microsoft, this partnership will affect the 155 UNWTO member states and more than 400 representatives of the private sector, educational institutions, tourism organizations in the implementation of Cloud technologies. Microsoft, through its Centre for Tourism, based in Majorca, Spain, is responsible for the development and application of this technology. Finally, it should be mentioned that Microsoft is planning to contribute in education of human resources in the tourism industry, given the cooperation with the UNWTO Themis Foundation.

On the other hand, Big Data is a term that represents a huge and complex amounts of data, for which the classical data management systems are not effective sufficiently. One of infrastructure solutions of given concept is a

combination of the analytical platform Hadoop with NoSQL system. Big Data technology provides the ability to process data in real time, with the option of search using the Map Reduce framework.

For example, Big Data systems provide analytical processing of data collected on banking transactions, communications between passengers and travel agencies, etc. The resulting knowledge is transferred to potential passengers/ tourist organizations in order to define decisions/ strategies.

The following example indicates the challenge for mentioned platforms, in form of capacity issue, that is, information to be processed per unit of time. According to the US business magazine Forbes, building Big Data system, the German tourism companies are now capable of processing 1,000 queries per second during the search, ie. over 18 billion offers, with more than 20 parameters, as well as at the end providing an answer.

According to data from the British magazine TravelWeekly, 92% of visitors to a particular site can not choose for a given tourist service, while 60% never return after the first visit. Potential customers and users of their services, due to implemented concept of Big Data, could be opportunely provided by more useful information that can reduce above-mentioned percentage.

The research conducted by the company Phocuswright indicates that almost a third of potential travelers make their reservation through other websites (as an intermediary). Unlike them, slightly less than 25% of potential customers have been decised for the option of booking accommodation directly through the website belonging to the service provider of hotel services. When it comes to booking flights, there is a trend of direct communication with the tourism organization, as well, as about 37%.

One of the main reasons is that users are allowed to carry out a comparison between the prices of a large number of hotels, airlines and travel arrangements included in the online agencies offer. At the same time, they are enabled to plan their trip using a few clicks of.

It is necessary to mention Hopper application that uses tools of Big Data platform. It is sufficient that a potential passenger enters only his wish as an input, and as a result gains complete proposed itinerary.

On the other hand, FLYR application, with new algorithm for prediction, helps users in decision making. For example, the system can advise the customer whether to buy a ticket or to wait for a more favorable moment, for example, cheaper prices. In forecast creating process FLYR algorithm uses previous patterns and historical trends that are defined by millions of individual cases. Hopper creators claim that the accuracy of their forecasts as high as 95%.

Conclusion

The development of tourism industry encourages the creation of huge amounts of data that need to be processed. As a result of the high speed growing data in nowadays business environment, new technologies for data management are being developed and implemented on the market. The technologies that come into tourist market are present both in the lower and in the higher layers, that is, all layers are of the same importance, integrated by the process of virtualization. Higher levels of modern technologies require complex platforms. The concepts of Big Data and Cloud Computing have been processed.

In contrast to them, the lower levels are weakly coupled (independent) in relation to functions of the business system. The paper deals with following concepts of lower layer, which enable the process of virtualization:

- processors architectures,
- memory system architecture and
- network systems.

Therefore, the information system can not be considered as „black box“ for managerial resources in tourism industry. In other words, adequate knowledge/education that enables the development of an information system has been required from managers at all managerial levels, acquired by attending vocational courses, or through post-secondry education process.

The challenge for the tourism industry consists of connecting the given platform, whose integration into a single system as a whole leads to improvement of a business system productivity and efficiency.

How important is the computerization of the tourism sector, as well as following the latest developments in the field of information and

communication technologies, could be seen through the fact of increasing the share of this industry in the global GDP. According to the WTTC (World Travel & Tourism Council) from 2015 (WTTC, 2015) contribution to total world GDP amounted to 10% in 2014, with 277 million jobs, that is, in every eleven positions one belongs to the tourism sector. It also states the fact that in this is the fastest growing field of today, compared with e.g. the automotive industry, the financial sector, the health care industry, etc.

Considering domestic tourism market, according to Statistical Office of the Republic of Serbia, there has been trend of increasing income (from tourists, both domestic and foreign). In March 2016, compared to March 2015, the number of tourist arrivals was higher by 14.8%, while the number of tourist overnight stays increased by 21.4%. (RZS, 2016).

This is information that emphasizes the necessity of keeping track of the world trends in the field of information and communication technologies.

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