

Choosing Components of Information Technology Infrastructure for Business Information Systems

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Abstract--- In this article author offers review of Information Technology Infrastructure components that are essential for any Information System used to help running business. He summarizes the theory and practices of building Business Information Systems with recommendations about the best components to build effective and sufficient Information System for business based on statistics and test lab results. This work is useful for system analysts, designers and companies' managers who need to make informed decision about the right components of IT Infrastructure for Business Information Systems.

Keywords--- IT Infrastructure; Information Systems, Management Information Systems

I. INTRODUCTION

Information Systems (IS) are essential part of modern organizations. Firms need them to run business in an efficient way to achieve competitive advantage and earn more money. IS, in its turn, needs consistent and efficient Information Technology (IT) Infrastructure that is constituted of the best components that work together to give business the best outcomes. The aim of this article is to show in one place the major components of IT infrastructure for IS, and to give recommendations for system designers and managers about which components and from which vendors to choose to build efficient Management Information Systems (MIS) using statistics and results of testing experiments.

II. WHAT IS IS AND IT INFRASTRUCTURE?

As it is introduced in [1] IS can be defined as any organized combination of people, hardware, software, communications networks, data resources, policies and procedures that stores, retrieves, transforms, and disseminates information in an organization. This definition helps imaging how complicated the IS could be.

As proposed in the definition, IS consists of: people, hardware, software, communications networks, data resources, policies and roles that control the use of these components and their functions. All these components constitute IT infrastructure of IS for business.

The definition also shows that IS main function is to deal with information. IS fulfils a lot of tasks on information: stores information in such organized manners that helps fulfilling, in an efficient way, the usual operations on information that are: retrieving, transforming, accessing and disseminating information in the organization.

III. MIS AND ITS ROLE IN BUSINESS

Indeed, the information is a real asset for the modern organizations, and with the continuous rise of the amount of information in recent time it becomes difficult to deal with it. This give the IS its high level of importance to help organizing this huge amount of data and analyze them to provide managers with information in due time to make informed decisions.

MIS is simply one of many types of IS that is built to help managers in a company running business. It can help doing myriad number of tasks, but these tasks usually belong to one of following main tasks [2].

1. Provision of Information Storage and Analysis.
2. Assist with Making Decisions.
3. Assist with Business Processes.

Statistics show the great growth of IT investment in the last decades as it constitute 52% of total investment up to 2010 [3].

IV. COMPONENTS OF MIS

As proposed in [1, 3] IT infrastructure consists of the following seven major components:

1. Computer Hardware Platforms.
2. Operating Systems Platforms.
3. Enterprise Software Platforms.
4. Data Management and Storage.

5. Internet Platforms.
6. Networking and Telecommunication.
7. Consulting and System Integration Services

The following figure shows these components, their positions in IT MIS, and their relationships.

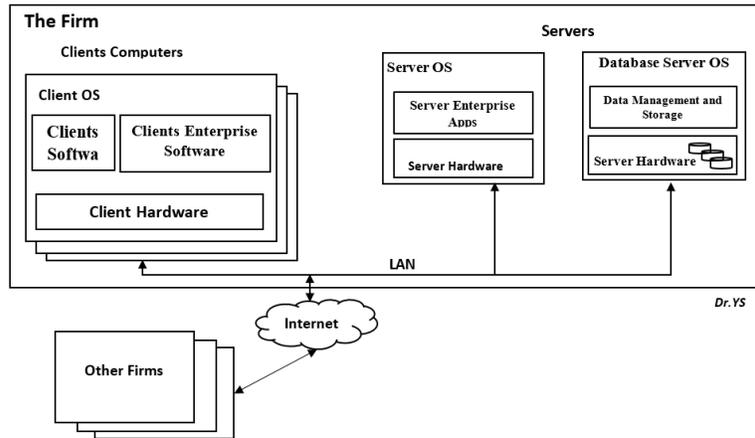


Figure 1: IT infrastructure components for MIS

Following is an overview of these components with short descriptions for each and overview of venders for them with recommendations.

A. Computer Hardware Platforms

There exist three types of hardware platforms indispensable in IT infrastructure:

1. Clients Hardware:
 - Devices that build clients computers, such as: CPU, RAM, HDD\SSD, monitors.

Usually, there are simple requirements for client hardware as clients' computer is used mostly for simple representation of the results of data processing on servers.

2. Servers Hardware.
3. Networks Hardware.

Because of the fact that CPU is considered the most important piece in computer hardware as it is the main processing unit, MIS designers must be careful when choosing this component. Tests shows that CPUs from Intel are the best ones to build computers of IT infrastructure for high performance and reliability though Intel CPUs cost more than their main counterparts from AMD [4].

User Requirement	AMD	Intel	Recommendation
Price	Cheaper	More expensive	AMD
Power Consumption	More	Less	Intel
Cooling Factor	Heats up faster	Runs cooler for a longer duration	Intel
Performance Speed	Less compared to Intel	Faster than AMD	Intel
Gaming and Multimedia	Good	Good	Any
General Recommendation			Intel CPU

Figure 2: A comparasion between Intel CPU and AMD CPU

Concerning server Hardware, servers contain the same components as clients' machines with bigger requirements in speed of CPU, amount of RAM, and storage space. One of the biggest problems of IT infrastructure for MIS is that MIS requires very high servers' performance and reliability to serve efficiently hundreds and even thousands of users constituted usually of thousands of clients and providers in addition to hundreds or maybe thousands of employees. These requirements concern only servers that serve all these types of

users, so there are many technologies are used to help servers fulfil these tasks.

Blade, Rack and Tower Servers. A rack server, also called a rack-mounted server, is a computer which is dedicated to be used as a server, and designed to be installed in a framework called a rack [5].

On the other hand, a blade server is an additional level of innovation on top of Rack Servers and it is a server architecture

that houses multiple server modules (blades) in a single chassis which usually has a handle attached to them, for transferring them in and out of the blade enclosure.

In contrast to rack servers or blade servers, which are designed to be rack-mounted, a tower server is a computer intended for use as a server and built in an upright cabinet that stands alone.



Figure 3: Dells' Blade, Tower and Rack Servers

As servers uses CPUs and other devices from the same venders following is provided a comparison between blade and rack servers without consideration of CPUs, RAMs, etc. The following comparison (figure 4) between two types of servers considers the main characteristics that concerns IS designers and they are the following [6, 7]:

1. Space server consumes.
2. Size of Business it is appropriate to.
3. Management and maintenance.
4. Price.

Comparison	Tower Server	Rack Server	Blade Server	Rec.
Space	Big Vertical space	Small horizontally and vertically	Smaller than rack servers	Blade Servers
Scalability	Bad	Good	The best	Blade Servers
Flexibility	Good	Good	Bad (Parts cannot be replaced easily)	Rack Server
Resources (Power, Network cabling)	Bad	Bad	The best	Blade Servers
Cooling	The Best	Bad	Good	Tower Server
Management and maintenance	Bad	Good	The best (Hot plugging, has handles, resource centralization)	Blade Servers
Size of business	Small	Small and Medium	Large	Depends
General Recommendations				Blade Servers

Figure 4: Rack, Blade, Tower Servers comparison

B. Operating Systems Platforms

Operating system (OS) is a software that operates the computer system. OS is the main software component in the MIS because it controls the interaction between all computer applications and hardware. Its main functions are: acting as a layer between the user applications and the hardware; providing a friendly environment for a user; delivering data between processes even when they are far from each other in the network; operating computer hardware; etc. [6].

OS is really important component for MIS because the performance, security and cost of MIS depends on large extent in the characteristics of local and server OS.

There are two types of OS in MIS:

1. Local OS:
 - OS that operates client computers.
 - Examples are: MS Windows XP\7\Vista\8\10 and Linux Ubuntu.
2. Server OS:
 - Operates servers.
 - Examples are: Windows Server, Mac OS X Server, Red Hat Enterprise Linux and SUSE Linux Enterprise Server.

Figure 5 shows a comparison between two main counterparts in the world of local OS nowadays: Windows8 and

Linux Ubuntu, with recommendations of what to choose for MIS clients machines [7, 8].

Comparison	Windows 8	Linux Ubuntu	Rec.
Resource requirements	High	Lower	Linux
Performance (concerning usual office tasks in MIS)	Bad (consumes many computer resources)	Lower (Consumes fewer computer resources)	Linux
Security	Bad	Good	Linux
Openness	Bad	Open source	Linux
Interface	Good	Good	Both
Cost	Moderately Expensive	Free	Linux
Popularity	The most popular	Less popular	Windows
Summary	Linux is better for MIS in terms of resource consumption, performance, security and cost.		

Figure 5: a comparison between Windows 8 Ubuntu

C. Enterprise Software Platforms

Enterprise Software Platforms (ESP) is a software that is designed to facilitate running business tasks in firms. Examples for such software are ERP, HRM systems, CRM systems [3].

SAP is considered the largest provider of ERP systems. Oracle Corporation also is a large provider of ESP after acquisition of PeopleSoft (the company that is specialized in developing e-business software) in 2004.

The following figure shows the summary of two comparisons made by Panorama Consulting solution [9] and SOCIUS [10] with additional two columns to help make conclusion.

This comparison shows that MS Dynamics is optimal solution because though it does not lead some factors of comparison, it is not in the worst positions as its counterparts. Therefore, it is recommended to choose MS Dynamics as an Enterprise Software Platform.

Comparison	SAP	MS Dynamics	Oracle	Recommended	Not Recommended
Share Market	The highest		The lowest	SAP	Oracle
Payback	The highest		The lowest	SAP	Oracle
Implementation Costs		The lowest	The highest	MS D.	Oracle
Implementation Time	The Shortest		Unpredictable	SAP	Oracle
Functionality	The lowest		The highest	Oracle	SAP
Costumers Satisfaction	The lowest		The highest	Oracle	SAP
Customization	The lowest	The easiest		MS D.	SAP

Figure 6: A comparison between main ERP software market leaders

D. Data Management and Storage

I. Data management software. Data Management is the development and execution of architectures, policies, practices and procedures in order to manage the information lifecycle needs of an enterprise in an effective manner [11].

There are two most popular ways to manage huge amount of data in organizations:

1. Relational Databases.
2. Big Data Databases.

Relational database is a digital database which organization is based on the relational model of data (E. F. Codd, 1970). It is the most popular way to organize large amount of data in the form of tables that has relations between them. Statistics that is available for 2013 shows that Oracle Databases is the leader of RDBMS market with 30% market share followed by MySQL – 25% , then PostgreSQL – 19% [12].

This helps concentrate comparison to choose one RDBMS among the three leaders: Oracle, PostgrSQL, MySQL. Following, figure 7 shows such a comparison with recommendations.

	Oracle	MySQL	SQL Server	Recommendation	Not Recom.
Platform	Multi	Multi	Microsoft .NET	Oracle, MySQL	SQL Server
Ranking	1	2	3	Oracle	SQL Server
Interface	GUI, SQL	SQL	GUI, SQL	Oracle, SQL Server	MySQL
Enterprise size	Large	Small and Medium	Large	Oracle, SQL Server	MySQL
Scalability	High	Lower	High	Oracle, SQL Server	MySQL
Licensing	Proprietary	Open source	Proprietary	MySQL	Oracle, SQL Server
Price	Highest	Free	High	MySQL	Oracle

Figure 7: A comparison between Oracle, My SQL and SQL Server

Considering the fact that enterprises is required to have MIS that is heterogeneous and what is presented by figure 7 it is recommended for business companies to choose Oracle databases for data management for high level of scalability and ease of use (GUI) though its high price.

2. Big Data Databases. With the proliferation of information technology all over the world, a new tools for doing jobs and communication has been created and used. Facebook, Twitter, WhatsApp and other social tools created space for millions to share information in all possible formats and just about everything. Companies became aware of the importance of these tools as part of their external data sources. Companies created profiles for themselves on social popular sites for customers and also created their own social sites for their employees to share information and experience. All these types of importance for business information have a problem – they are not structured so they cannot be stored in usual relational databases. For this type of unstructured data exists special technology – Big Data.

Big data is a blanket term for any collection of data sets so large or complex that becomes difficult to process them using traditional data management techniques such as, for example, the RDBMS [13]. They are usually characterized by the term “3V” which stands for three main characteristics of data to be recognized as Big Data: Velocity (arrives in fast speeds), Variety (in multiple formats), Volume (is measured in TB and more).

For managing Big Data was invented a new database model that is called NoSQL which stands for “Not Only SQL” or “Non SQL”. Not-only SQL (NoSQL) database is a non-relational database that can be used to store unstructured data alongside structured data.

The flowing figure helps understand the situation of Big Data databases market and shows that IBM is the leader having the biggest market share.

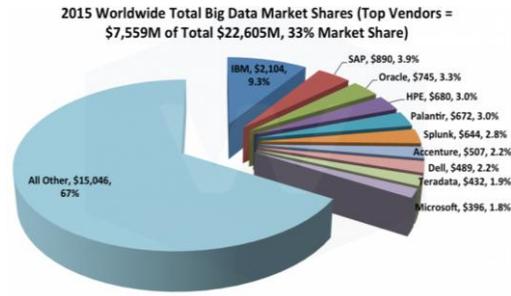


Figure 8: Worldwide total Big Data market shares according to Wikibon report 2015

3. Data management software. Mentioned earlier showed software technologies to organize and manage Big Data and relational databases in storage devices. Here will be introduced hardware technologies to store huge amount of data in RDBMS or Big Data.

To store huge amount of data that contemporary companies have to deal with, one HDD is not enough. For companies IS there exist two main types of technologies that allow combining large numbers of storage devices (HDDs or SSDs) to create united big storage space. These two technologies are: RAID and SAN.

RAID (Redundant Array of Independent Disks; originally redundant array of inexpensive disks) provides a way of storing the same data in different places (thus, redundantly) on multiple hard disks [11].

SAN (Storage Area Network (SAN)) is a high-performance subnet, probably (but not necessarily) based on fiber channel, which primary purpose is the transfer of data between computer systems and storage elements and among multiple storage elements [14].

Both RAID and SAN provide high level of performance and fault-tolerant. SAN in addition provide the following:

- Improves data access – as for SAN is a network there exists many ways to access data when some ways are too busy.
- Improves applications performance – by separating tasks of storage management off servers frees server resources to do the main job, processing data.

- Improves data search – SAN allows data to be stored in a hierarchy what facilitate data search.
- Improves security level – creating one system devoted for data storage and management allows better concentration on security issues.

Therefore, it is recommended to use SAN for data storage in MIS.

E. Networking and Telecommunication

MIS is a collection of client computers, servers and additional devices, such as printers, scanners, SAN, RAID, sensors and so on, all connected with network communications devices and cables. Network is the tool that brings all MIS components together. Following is short introduction to networks types with pros and cons of each type [15].

There exist the following types of networks:

1. Local Area Network (LAN).

LAN – is a network that connects computers in a small area: building, floor, or even small office. Companies usually use LAN to connect departments within one building. It uses Ethernet technology to transmit data via cables with speed up to 1000 Mbps.

2. Wide Area Network (WAN).

WAN – is a network of networks that connects computers and even other LANs that are too far from each other which may exist across countries and continents. WAN uses many technologies to transmit data: DSL, the X.25 protocol, ISDN, Frame Relay and IP Protocol.

- DSL (Digital Subscriber Line) is a technology transmit data over ordinary copper telephone lines with speed of download up to 6.1 Mbps.
- The X.25 protocol – allows computers on different public networks to communicate through an intermediary computer at the network layer level. It is used to connect ATM networks and Credit Card Validation Network.

- The Internet Protocol (IP) is the protocol by which data is sent from one computer to another on the Internet.

3. Metropolitan Area Network (MAN).

MAN – is a network which is larger than a LAN but smaller than a WAN, and incorporates elements of both. It uses mentioned earlier to connect LANs: ISDN, ATM, DSL, etc.

Companies may use it to connect their branches within a town.

4. Campus Area Network (CAN).

CAN – is a network which is larger than a LAN, but smaller than MAN. This is typical in areas such as a university, large school or small business.

5. Wireless Local Area Network (WLAN)

This is a LAN that works using wireless network technology such as Wi-Fi. Wi-Fi – is a term for certain types of wireless local area networks (WLAN) that use specifications in the 802.11 family. It can connect devices in not far distances.

With the term WiFi connected another term WiMAX. WiMAX – is a standardized (Standard 802.16) wireless version of Ethernet intended primarily as an alternative to wire technologies (such as Cable Modems, DSL, etc.) to provide broadband access to customer premises. It exists in many standards (3G (Third Generation), 4G and 5G) that define the speed and characteristics of Internet connection.

The flowing figure shows a comparison between WiFi and WiMAX [16].

	WiFi	WiMAX
	IEEE 802.11	IEEE 802.16a
Max Speed	54Mbps (a&g)	10-100Mbps
Range	100m	40 km
QoS	none	yes
Coverage	Indoor	Outdoor
Users	Hundred	Thousand
Service Level	None	Yes

Figure 9: WiFi vs WiMAX

Following is a comparison between LAN and WLAN.

Criteria	Ethernet LAN	WLAN	Recommendation
Cabling	Yes	No	LAN
High Speed	1000 Mbps	866.7 Mbps (802.11ac)	LAN
Latency	Lower	Higher	LAN
Installation	Difficult and Costly	Easier and cheaper	WAN
Interference	Lower	Higher	LAN
Security	Easier to Secure	Harder to secure	LAN
Cost	Costly	Cheaper	WLAN
Flexibility (adding new devices)	Costly	Cheaper	WLAN
Convenience (using during movement)	Impossible	Easy	WLAN

Figure 10: A comparison between LAN and WLAN

Considering the following facts: more and more modern companies supply their employees with handheld devices (Tablets, Smartphones); the proliferation of tablets in business and for personal use that gives more freedom to move from one place to another to do job; many companies still use old buildings and that makes it difficult to install cables for Ethernet LAN in many companies; also latency is an important factor for online games that is not what usual companies deal with; all these facts encourage to recommend using WLAN instead of Ethernet LAN to build Business IS. However, for parts of business with really sensitive information it must use only Ethernet LAN.

F. Internet Platforms

Contemporary companies provide many services via Internet for costumers (making an order, reviewing products, providing feedback on or complaints about products and services), providers (Walmart Inventory Tracking System supply providers with data in time to supply Walmart with products) and employees (company’s Extranet allow employees anywhere to get all information they need in secure convenient manner).

Web-server becomes an essential part of modern companies. Following is a comparison between main market counterparts Windows and Linux.

Criteria	Factor	Windows	All Linux	Recommendation
Market Share	aug-2015	33.1%	66.9%	Linux
Stability and Reliability	OS uptime	Bad	Good	Linux
Security	number of vulnerabilities	340	422	Windows
Cost	Purchase	Very Expensive	Cheaper	Linux

Figure 11: A comparison between Windows and Linux Servers

This give conclusion that for server OS from Linux is preferable than OS from Microsoft Windows to operate web-server.

G. Consulting and System Integration Services

All previously introduced IT infrastructure components needs special care because the company needs its IS to work all the time 24/7. To provide that a

company needs an IT department which is responsible for keeping IS works all the time.

There are two ways to provide such support:

1. Company has its own tech support.
2. Using tech support team from outside the company.

For example, company call consulting and tech support companies when it needs support.

Following is a comparison between these two teams.

Criteria	Own team	Team from outside
Speed of service	Faster the team is always in the company	Slower The team need time to get to the company
Experience of company	Better Does not need time to study the company	Bad Need more time for analysis of the company state
Cost	Cheaper Usually this team has a salary so it works for the salary	Expensive When company ask help from outside team demand huge amount of money

Figure 12: A comparison between two types of tech support trams for IT infrastructure

V. CONCLUSION

IT infrastructure for business IS consists of so many special components, all of them is essential for MIS to fulfil its tasks. System analysts and business manager must be aware of these components, their functions and venders. It is recommended for building efficient, effective and economical IS to build it from the following components: workstations and servers based on Intel CPUs using Blade Servers; Linux OS for workstations and

servers for secure, efficient and cheap IS; MS Dynamics for running business tasks; Oracle databases for storing usual data needed for business and Big Data databases from IBM for Big Data management if needed; local network using WiFi technology for better flexibility and maintenance and WiMax for CAN; Web Server for web services under Linux Server OS; having companies owned IT support team for faster and cheaper development and maintenance.

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