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APPLICATION OF UNATTENDED INSTALLATION SYSTEMS AND IMAGE MANAGEMENT IN RESEARCH AND DIDACTIC LABORATORIES

The purpose of this article is to present image management and unattended systems in research and teaching laboratories. Both types of laboratories are specific from the point of view of IT personnel. In this work environment, unlike computers used for example in offices, frequent and advanced changes in configurations and settings are necessary. Maintaining such machines is a challenge for IT staff due to time-consuming processes and downtime in laboratories. The system proposed within the framework of this study is aimed at shortening and simplifying the service of laboratories. It help in increase of usage time of laboratories by reducing the downtimes necessary to maintain the IT infrastructure.

KEYWORDS: Didactic laboratory, MDT, image management.

1. INTRODUCTION

Many laboratories at faculties in both research and didactic institutions are equipped with different kind of devices which operate on certain operation systems. Depending on application such devices can run Windows, Linux or even MacOS. Windows is very popular on all kind of workstations, Linux platform on embedded devices. Also Android or Raspbian systems based on Linux core are utilized in laboratory applications and devices. In such heterogenous environment it is very hard to maintain operation systems of laboratory equipment especially if more than one work station requires maintenance. That is why the idea of unattended system has been touched.

Devices are mostly coming with preinstalled software such as operating system and in case of measurement equipment - dedicated applications. All data are stored on internal hard drives or internal solid state drives. Users keep on them a lot of data. System administrator of such laboratory has to maintain all devices. In didactic laboratory there are usually many personal computers with similar software and OS. With that knowledge it is possible to assume that there can be

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collection of predefined system images which can be used on different machines with the same hardware configuration to recover them or to change configuration [1,2]. A certain (Fig. 1) scenario has been created to visualize a problem. It is assumed that in didactic laboratory a few computer stations and some pieces of measurement equipment are down because of different failures connected with data stored on internal hard drive.

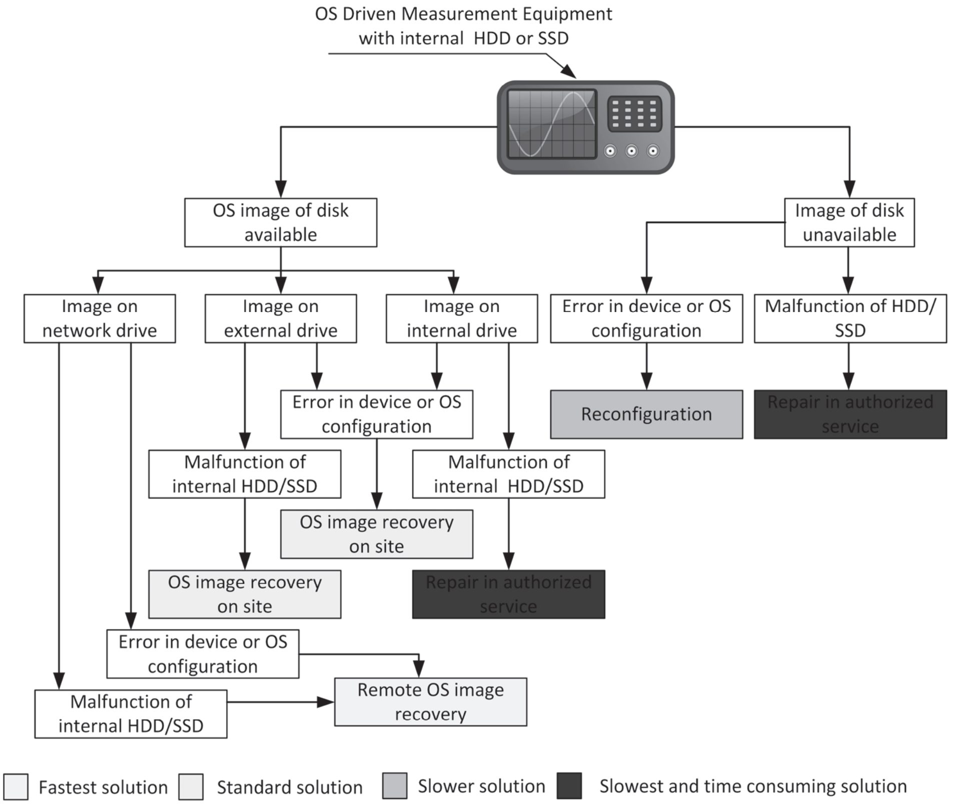
OS Driven Measurement Equipment with internal HDD or SSD
OS image of disk available
Image of disk unavailable
Image on network drive
Image on external drive
Image on internal drive
Error in device or OS configuration
Malfunction of HDD/ SSD
Error in device or OS configuration
Reconfiguration
Repair in authorized service
Malfunction of internal HDD/SSD
Malfunction of internal HDD/SSD
OS image recovery on site
OS image recovery on site
Repair in authorized service
Error in device or OS configuration
Malfunction of internal HDD/SSD
Remote OS image recovery
Fastest solution
Standard solution
Slower solution
Slowest and time consuming solution

Fig. 1. Possible OS recovery solutions in case of hard drive or solid state drive failure

Time consuming solutions were distinguished. With lack of OS or disk image an administrator has to check if it is a physical or logical damage on certain hard drive. In case of physical damage it is obvious that certain hard drive must be changed and all applications including OS has to be reinstalled from the beginning. In case of logical error due to data lost, reading error or operating system malfunction a reconfiguration is required. In both cases it takes time. An IT administrator may also has prepared an OS image of each disk separately or have one OS image which he can install/upload on certain machine. There are three possible OS image location. It can be stored as network image in properly configurated share ready to install using multicast [1,2], external drive or on internal drive. In the worst case scenario when image is stored on internal drive during its physical failure the repair in service may be required. A standard solution in many laboratories is to store image of system drive on external disk or network share. If an IT administrator stores image on external drive he can proceed with onsite OS image recovery. The fastest and usually the best solution is keeping image on network drive or on WDS server [1,2]. It helps administrator easily recover all data from one machine and even reinstall system with all applications. With properly configured network he is able to perform such action remotely with high level of security.

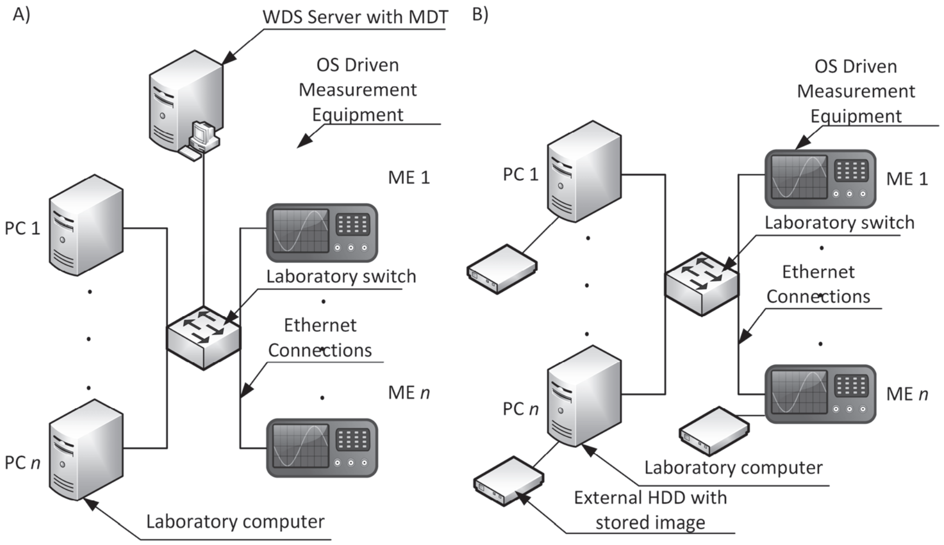

Fig. 2. Difference in laboratory architecture between WDS server with MDT and no WDS server with MDT

In order to create, install or migrate an operation system on certain devices a specific tool or software platform is required. One of such software platform is a Microsoft Deployment Toolkit (MDT) [1,2]. It enables migration of operating systems or creates an automated or semi-automated installation environment. A MDT is part of unattended installation solution. It means that all installations can be resolved automatically or with help of IT administrator. Most of laboratories are equipped with internal network – devices connected to LAN with server sand network equipment which manages traffic and allows connection with world wide web. Two solutions can be implemented in laboratories (Fig. 2).

The first one focuses on few network devices such as switch to connect all stations/devices and router which is responsible for establishing connection with internet. In this kind of idea an external drive solution is used. In case of accident IT administrator has to maintain each device separately which takes time as described before. A second solution is an internal LAN with additional server with Windows Deployment Services (WDS) server installed on it. WDS can be used with Microsoft Deployment Toolkit. To effectively use WDS Active Directory Domain Services must be implemented because WDS uses collection of objects stored in Active Directory database to properly install or recover OS images on designated devices. With WDS server OS recovery on workstation can be easily initiated both remotely or manually and proceeded automatically.

2. CONCEPT OF LABORATORY MANAGEMENT SYSTEM

To maintain a hierarchy of any devices and users which are logging in to computer stations via their own accounts a directory service has been proposed. A directory service can store database, about network resources, user accounts, devices and much more [1]. All information are stored as hierarchical containers. In Windows family very popular directory service solution is an Active Directory Domain Services (ADDS). ADDS and other directory service solutions/platforms allows to organize structure as forests, trees and organizational units (OU) [1,2]. Logical structure of the network and users can be stored in Active Directory. In ADDS there is a primary forest known as root forest domain. Forest defines security. An administrator of forest can have full access to all data within the forest. IT administrator can set those privileges. forest can have one or many domains.

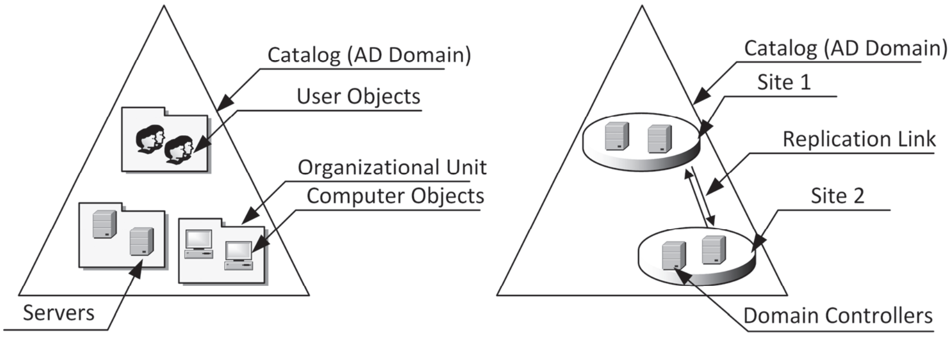

Fig.3. Active Directory visualization in proposed infrastructure

Domains stores data about identities, accounts they use to logon to every device in the infrastructure, account of every device in entire infrastructure and information about access to resources such as files, OS images and applications. Data can be replicated within domains in the same forest. Each domain can have its own organizational units. OUs allows to define rights to defined group by using for example group policies [1, 2]. Proposal of AD DS in larger faculties is depicted in Fig 3. Such infrastructure is required to properly implement unattended installation and image management system in organization.

A laboratory can be managed by directory service. Above all devices there is a forest with domain (catalog). A lower level in ADDS hierarchy is organizational unit. A OUs can store data about servers, computer objects or user objects within specific OU. Organizational unit will not store information about servers and computers in one OU. In faculty, entire university or campus there are many laboratories. To manage entire domain a site or sites can be established. By using replication all domain controllers can exchange data as it was described earlier. By dividing specific domain controllers in sites it is possible to maintain order in university structure. Site can also be defined as writable and read-only. This solution extends security. Users can access read-only domain controllers (RODC) and modify data within their privileges. Writable domain controllers are reserved for specific group of users. With fast replication and good management read-only controllers can guarantee fast response and safety to Active Directory structure (Fig. 4).

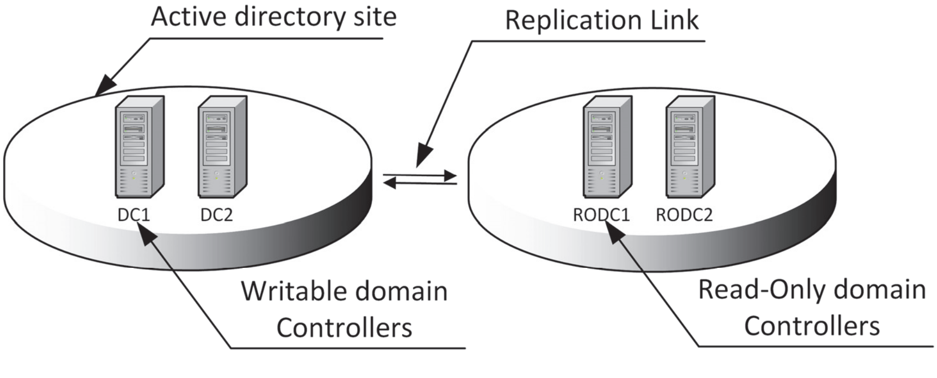

Fig.4. The implementation of writable and read-only domain controllers

Data in RODC can be updated by replication from writable DC. An application which requires reading data from domain controller can easily access RODC which has all Active Directory information except passwords. If it needs to write data it sends request for data write. A response message will redirect such apps to writable domain controller [1, 2].

3. IMPLEMENTATION OF UNATTENDED INSTALLATION AND IMAGE MANAGEMENT SYSTEM

To consider a few versions of management system lets assume that network contains a few laboratories. Each laboratory is connected to main switch which is connected to router/firewall with properly configured routing protocols. All laboratories are connected to a cluster. Cluster is required to maintain redundancy and proper connection. A WDS server with MDT is set on the virtualization host [1,2,3,4] which manages laboratories and virtual networks (Fig 5.).

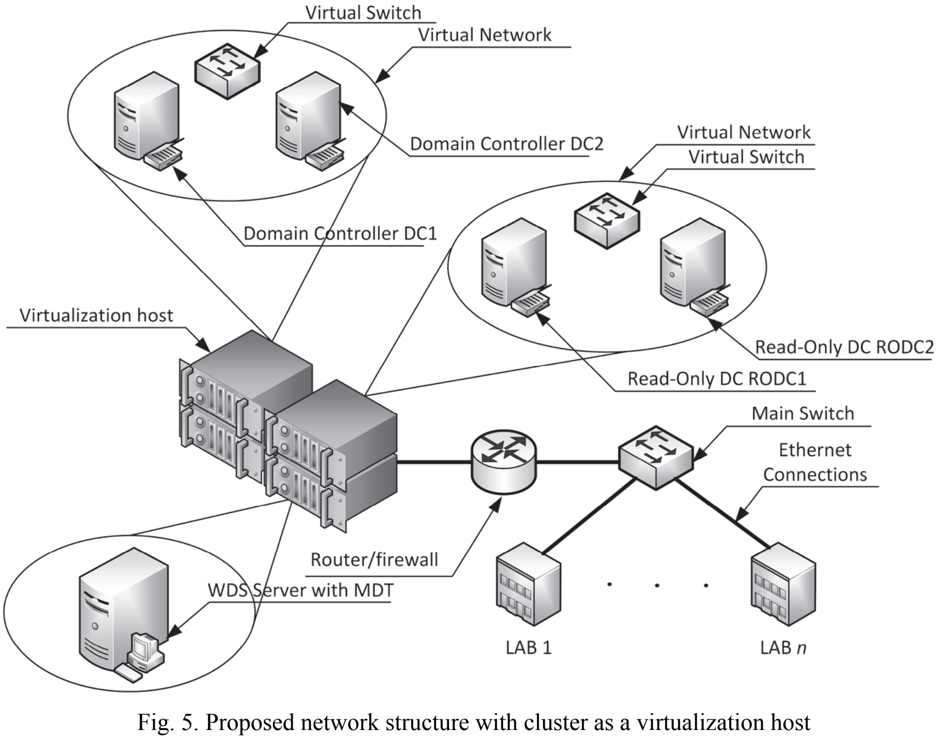

Fig. 5. Proposed network structure with cluster as a virtualization host

Each virtual network connected with virtualization host requires virtual switch to establish proper link. In such case there are sites with domain controllers – both writable for administrators and read-only for users and applications. Cluster manages replication between DC and RODC which needs fast data exchange. In this solution all servers are located locally in university infrastructure.

Very popular solution nowadays is a cloud infrastructure. Many companies switches from internal solution to external, damage free solutions. A cloud can be much safer due to extended infrastructure. In case of server damage entire host is redirected to another cloud location automatically without user notice.

The only required resource from client is fast internet connection. This solution can be also implemented in didactic and research laboratories. All information about laboratory devices, users and configuration is hosted in a cloud with any time, any place access by IT administrator. One of possible scenarios is one of three services offered as part of cloud computing. Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service solution (IaaS) [5,6,7]. Each of these services can offer different solutions. All three services gives users an ability to create scalable, secure and sometimes cheaper service. In such scenario a servers in a laboratory or clusters are not required.

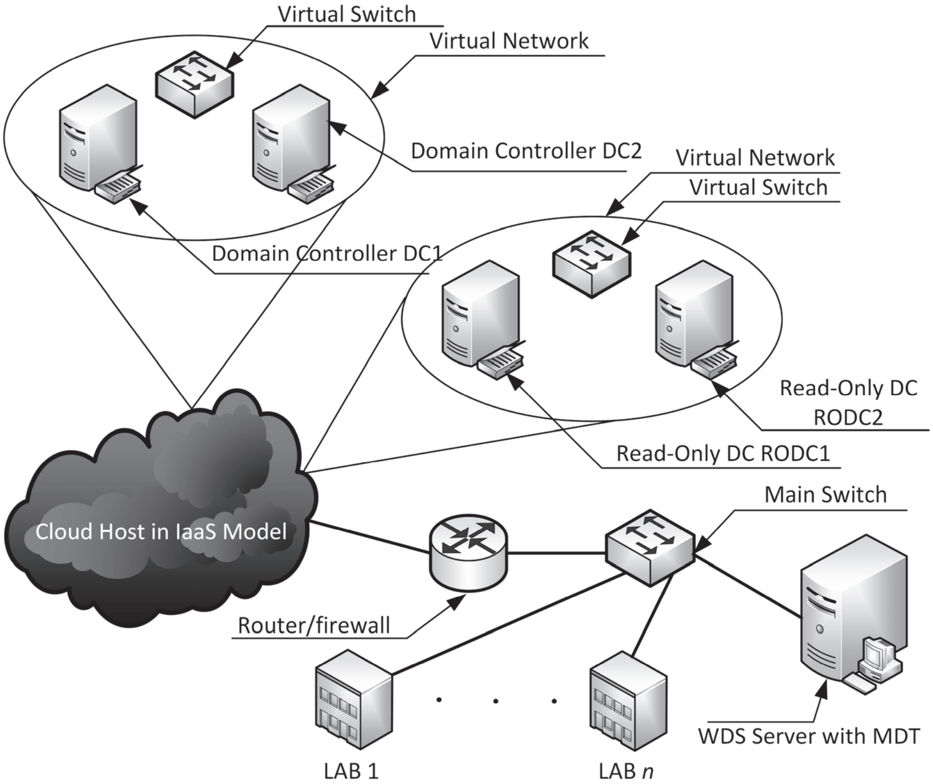

Fig. 6. Proposed network structure with cloud computing as primary base and WDS server with MDT as manager of laboratories infrastructure

Network resources and data are managed by cloud. On University a good solution can be Infrastructure as a Service. These services delivers everything which IT administrator needs. None local server is required. User pays for software, backups, network resources which cut the cost of laboratory since university/faculty do not have to buy entire server. IaaS is pay for what you use. IT administrator is charged for usage not infrastructure itself. Such solution is shown on Fig. 6.

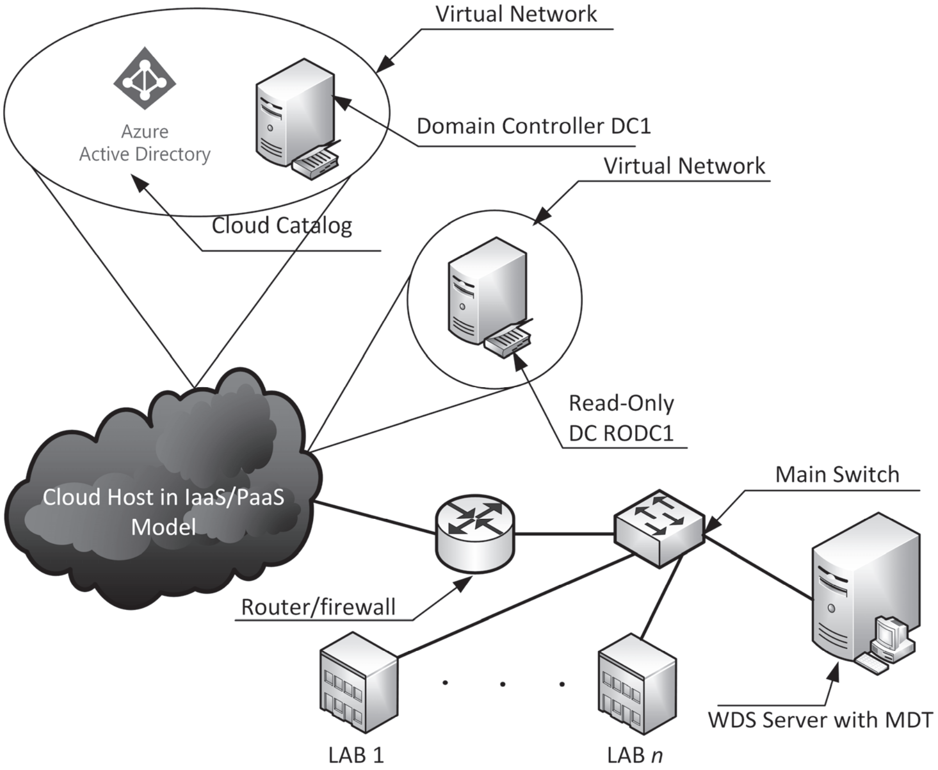

Fig. 7. Proposed idea with cloud computing as primary base, WDS server with MDT as manager of laboratories infrastructure and Azure Active Directory connected with domain controllers

Virtualization host has been switched with cloud computing solution based on IaaS. A WDS server with MDT is still located in organization infrastructure but in this scenario it is responsible for serving OS images and applications only to laboratories connected via switch to each unit. There is no need of using cluster because in case of WDS failure recovery of its configuration stored in cloud is easy. An IT administrator can easily and fast recover all damaged systems and data in case of malfunction in laboratory. As it was mentioned before cloud host requires very fast internet connection. To prepare fully automated and secured solution the idea of cloud computing connected with Active Directory has been presented (Fig. 7).

It is based on cloud computing as before but with additional services [8, 9, 10]. The infrastructure of laboratories and connection with cloud computing service stays unchanged. The difference is in cloud host model and domain controllers. In this scenario mix of two models is possible to implement: IaaS and PaaS. Platform as a service delivers Azure Active Directory service and reduces a need to implement many redundant domain controller. A process of maintaining directory is on provider site. University pays only for software license and usage. A much difference between proposed idea and a previous one is domain controller management. In this solution an Azure Active Directory platform is presented to achieve redundancy of important configuration information. Thanks to utilization of Azure AD it is possible to maintain only one writable domain controller and only one RODC with auto scaling resources that allows logon of every computer and user of entire university. Additionally entire replication process of sensitive data occurs on cloud side.

4. CONCLUSION

The described idea of laboratory and image management is scalable and gives adequate tools to manage entire organization. Such solutions are mostly implemented in companies but with proper configuration it is possible to implement such solution in academic or research institutions. Most of processes are managed automatically on Microsoft Azure side. IT administrator is responsible for local management in case of changes in computer and laboratory infrastructure or in case of device failure. With properly configured network it is possible to manage all sites remotely from one place which speeds up reaction time in case of errors and gives IT administrator live monitoring of network infrastructure.

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