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Steps towards effective eGovernacne Framework in India

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Abstract: *The benefits of virtualization are typically considered to be server consolidation, increased availability, isolation, ease of operating system deployment and simplified disaster recovery. The basic use of virtualization is the optimization of technical resources, improved service delivery with valuable reduction of the cost. Server consolidation based on virtualization technology will simplify system administration, reduce the cost of power and physical infrastructure, and improve utilization in today's internet-service-oriented enterprise data centers. As the size and complexity of modern computing systems keep increasing to meet the demanding requirements of Performance applications, manageability is becoming an important concern to achieve both performance and productivity computing. Here I am presenting analytical framework for utility computing for e-Governance using Virtual Machines to achieve testing and R & D, new effortless deployments, basic system administration, adaptability, scalability, new models of service delivery, efficiency, enhancement, user convenience, sustainability, and leverage of shared government infrastructure. However to deliver the maximum throughput requires careful attention toward system details for the minimal loss of CPU performance and I/O efficiency.*

Keywords: *Virtualization, Virtual Machine, Service Delivery, resource optimization, e-Governance framework, and throughput*

I. INTRODUCTION

By day to day development, virtualization technology has rapidly attains popularity in computing. In fact, it is now proven to be a fundamental building block for today's computing. The virtualization technology can separate hardware and software management and provide useful features including performance isolation [1], server consolidation and live migration [2]. In addition, the virtual technology can also provide portable environments for the modern computing systems [3]. Therefore, the new computing theorem and model that the virtualization technology embodies has very widespread use.

For the casual user, though, probably the biggest use of virtualization is to run one operating system (OS) from within another. Run Windows from within Linux, Linux from within Windows, one Linux distro within another, and so on. This is the source of my interest in virtualization [4].

In computer science, virtual machines recover the interests to researches as well as the industries and e-Governance. The main advantages of the virtual machines are that multiple guest operating systems can co-exist on the same computer and it is in strong isolation from each other. Another important benefit of the virtual machines is to provide an instruction set architecture (ISA) that could be different from that of the real machine. Applications of virtual machines arise widely in computer science, such as in embedded systems, which support a real-time operating system at the same time as a high-level OS. In virtual machines (VMs) environment, the software layer which provides the virtualization is called a *virtual machine monitor* (VMM). The guest OS do not have to be all the same, they could be different OS or different version of an OS on the same computer. This nature of virtual machines is very useful for the server consolidations.

Virtual Machine now seen as cost-effective techniques for organizing computer systems resources to provide extraordinary system flexibility and support for certain unique applications with optimum use of technical hardware, software, network, human resources and time.

Virtual machines is a concept that is used quite often in the computing world to solve very important problems, but often these are transparent to you as the user because virtual machines are typically used within programs and operating systems that users use every day. Some of these problems include: sharing the same hardware among many programs by partitioning the hardware, allowing software to be "portable" between various operating systems, as well as running older software on a newer computer. All of these uses of virtual machines are very important to the way that we compute today [5]. Virtual Machines are a great way to experiment with a new operating system, work safely on a new development project, test new software [6].

With the modularity of virtualization technology, VM (*Virtual Machine*) has the following properties, such as flexible, secure, reliable, and easy to manage and configure, which can greatly minimized the hardware cost. However, besides these benefits, it also increases the complexity of virtual computing systems, and maximizes

the performance of virtual computing systems. Furthermore, end user desktop will also receive the benefits of virtualization

II. BACKGROUND

E-governance means use of electronic and computing technology for efficient and optimum use of electronic resources for improved service delivery, efficient and cost effective framework for governance.
Literature survey shows that following factors are responsible for e-Governance.

- ICT
- Efficiency (Strength, Load Handling, Reach, stability, disaster Recovery. Capacity, skill , reliability)
- Productivity
- Reachability
- Sharing of Information
- Welfare

As per the latest research it is found that the most effective parameter to meet all goals is Virtualization
The main parameters affecting to failure / success of e-governance projects are project definition, control system, project estimations, skills, resource management and feasibility analysis. Only 15% of the e-governance projects attain success in all respects.
E-Governance is facing a problem of unproductive investments and it needs to be monitored [8]. To achieve the objectives of National e-Governance Plan (NeGP), the e-Governance framework needs to be improved. Virtualization including cloud computing is the most effective solution to meet all goals of e-governance services to the citizens. Nevertheless there are some security issues but despite of it is capable to ensure faster and cheaper delivery of services through service oriented architecture [9].
Normally instead of concentrating on what we have? what and how much we can get by properly utilizing it and by which way ? it is concentrated on what we not have and we spends lot of time and energy on availing what we not have ? and availing extra resources than needed to achieve the target easily. This way by underestimating/ neglecting towards what we have? we keep ourselves away from proper utilization of whatever we have available with us.
While facing any challenge normally we think we have not this , we have not that and if we may have this and this then we may have done this. These types of negative thinking discourage us. Instead if we think positively towards what we have and by using this only how we face the challenge then there is strong possibility to overcame the challenge with whatever we have available.

This initiative "Concrete and Effective e-Governance Framework " is the implementation of basic concept of governance to get "more from less for more and more "and" Minimum Government Maximum Governance". Successful implementation depends not only on how much resources we have? But too much extent on how we govern available resources. Normally implementers avails large number of resources than needed and neglect towards exact need and proper utilization which affects adversely on throughput, service delivery and cost effectiveness as well results in wastage and decay of resources as well as many times failure of projects and produce big loss instead of success. Particularly in terms of e-Governance projects it is observed that only 15%projects are successful and more than 50 % projects are failure and even invested costs also not recovered

For this innovation we have everything less , less technical experts only two, less required technical infrastructure, less trained technical human resources, and as there are very weak chances of getting it, there is only way remained is to use technology innovative way to use available resources virtually to get the work done. We used Virtualization, Server Consolidation, software hardware portability with effortless deployments, backup and disaster recovery and achieved improved service delivery, increased throughput and cost effective solution for concrete and effective e-Governance. Innovation is implemented without any funds and expenses.

III. VIRTUALIZATION , VIRTUAL MACHINES

Virtualization means

- Virtual isolated execution of Virtually Developed Machine(s) on the Physical Machine simultaneously.
- Virtual isolated execution of the multiple software platforms (layers) on the same physical hardware simultaneously
- It allows one computer to do the job of multiple computers, by sharing the resources of a single hardware across multiple environments

The original meaning of Virtual Machine, sometime called hardware Virtual Machine is that number of discrete identical execution of environments (instances) on a single computer, each of which runs an Operating System

(OS). Basic concept of Virtual Machine is running multiple distinct operating systems (including client as well as server) at a time simultaneously on single computer [5].
Virtual Machine logically divide the single computer system and resources into several isolated different sizes same like the slices of the bread each of which works and feels as a separate computer system and simultaneously run different isolated processes.[5].
This way the single computer system is efficiently optimally used logically as multiple computer systems with various distinct operating systems in hand running simultaneously at any time as guest using Virtual Machine Technique using Virtual Machine software.
Fig 1 shows the logical structure of the Virtual Machine. The concept of virtualization can be applied not only to subsystems such as disks but to an entire machine. To implement a virtual machine, developers add a software layer to a real machine to support the desired architecture. By doing so, a VM can circumvent real machine compatibility and hardware resource constraints.

- More than one instance of that operating system run on the same hardware at the same time
- Another operating system can run in that simulated hardware
- More than one *different* operating system can share the same hardware at the same time
- Virtual Machine Operating System creates illusion of multiple processors
- Each capable of executing independently
- No sharing, except via network protocols
- *Host Operating System:*
- The operating system actually running on the hardware
- Together with *virtualization layer*, it simulates environment for …

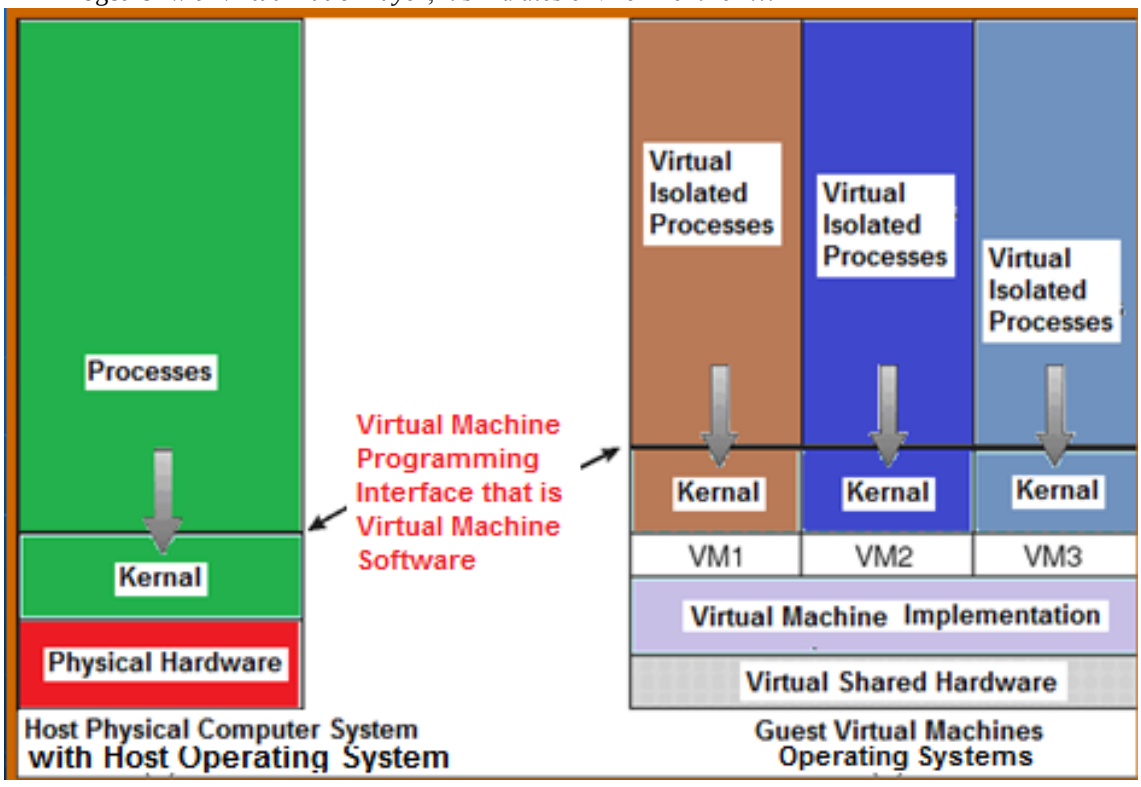


Fig 1. Logical Structure of Virtual Machine

- *Guest Operating System:*
- The operating system running in the simulated environment
- Virtual-machine concept provides complete protection of system resources
- Each *virtual machine* is isolated from all other virtual machines. Isolation ensures that applications and services that run within a VM cannot interfere with the host OS or other VMs

Therefore its one use is for the isolation of processes with specific resources so that the processes should not collide and affect each other.

- The resources of the physical computer are shared to create the virtual machines under which
- CPU scheduling can create the appearance that each user has own processor

- Spooling and a file system provide
- virtual card readers, virtual line printers
- Disk partitioned to provide virtual disks
- A normal user time-sharing terminal serves as the virtual machine operator's console

By using the virtual machine software we can install the new operating system as guest or we can configure and run the preexisting operating system in dual boot mode, as guest operating System.
We can form network connections between Virtual Machines using single network card. We can assign different IP addresses to different distinct Virtual Machines using a single Network Card.
All type of Operations which Physical computer system performs on file/folders as object using operating system, that Virtual Machine software interface performs on complete virtual computer along with operating system as an object including operations like creation, updating, removing, renaming, customizing , move, copy, backup and restore, sharing, auto start, import/export etc. between the large number of computer systems between host servers with distinct old and new compatible/ incompatible software's and hardware's.
The main disadvantages of VMs are:
A virtual machine is less efficient than a real machine when it accesses the hardware indirectly when multiple VMs are concurrently running on the same physical host, each VM may exhibit a varying and unstable performance (speed of execution, and not results), which highly depends on the workload imposed on the system by other VMs, unless proper techniques are used for temporal isolation among virtual machines [7].

IV. STEPS TOWARDS EFFECTIVE E-GOV FRAMEWORK

The proposed framework involves use of virtualization and server consolidation techniques, use of Free and Open Source Software (FOSS) ,utility computing leveraging shared infrastructure together for enhancing service delivery and reducing the expenditure incurred in facilitating e-services, and utility analysis [10].

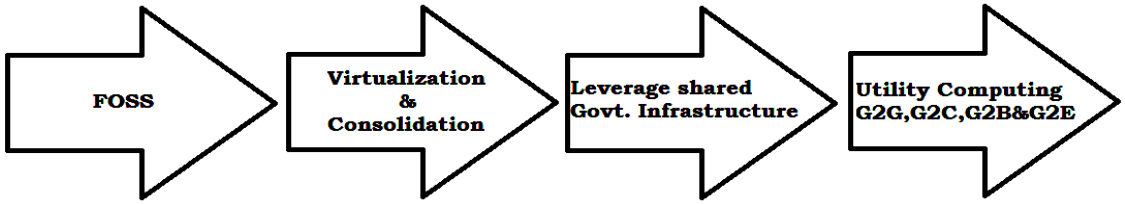


Fig 2. Proposed Framework for effective e-Governance

Effective e-Gov is based on

- Free and Open Source Software (FOSS)
- Virtualization
- Server Consolidation (to save server hardware per location)
- Leveraging shared government infrastructures :Cloud computing (Live Virtual Machines virtually accessed by users remotely)

A. Free and Open Source Software (FOSS)

A FOSS is abundantly licensed to the user and it also grants the rights associated with the software viz right to use, copy, study, change, and improve its design through the availability of its source code [11]. The use of FOSS reduces the total cost of ownership and vendor locking. The open source software needs to be standardized because of the involvement of national security. After standardization the open source software should be used nationwide for the development and deployment of e-governance applications [12]. Without adoption of FOSS, the government is bound to obtain various types of software licenses as well as licenses for terminals from private vendors and India is spending an enormous amount for the same every year. The IT infrastructure cost is one of the major hurdles in successful implementation of e-governance in developing nations [13]. Therefore the use of FOSS must be encouraged and it must be standardized in such a way that it must have scalability and interoperability so that different applications can communicate with each other for reducing the redundancy of data.

B. Virtualization and Consolidation

Virtualization is a technique which provides a layer of abstraction between computing, storage and networking infrastructure and applications running on it whereas consolidation consolidates variety of servers together [14]. Consolidation reduces the data centers complexities, maintenance cost and energy consumptions. It enables efficient utilization of hardware resources in order to reduce total number of servers and server locations [15]. To deal with the aforesaid challenges in implementation of a Government Data Centre (GDC), virtualization can play a pivotal role at software as well as hardware level.

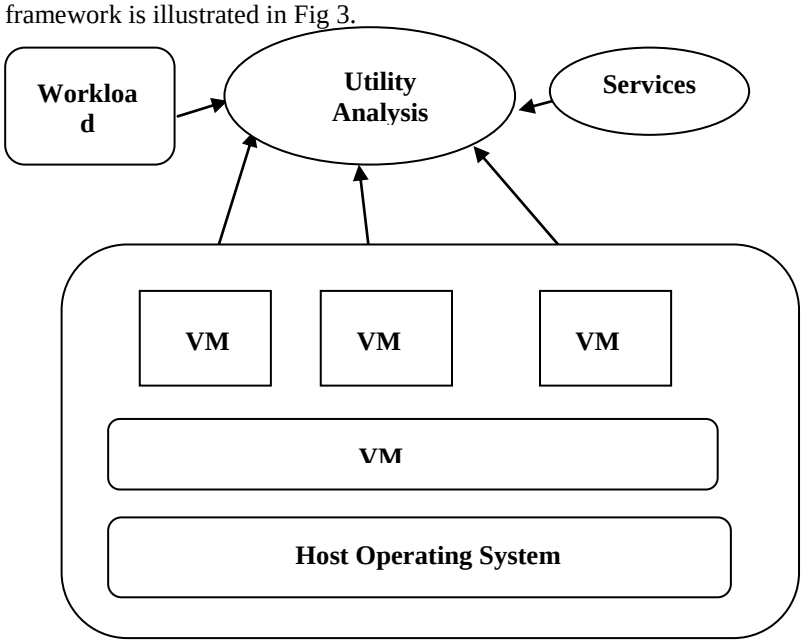
C. Utility computing leveraging shared Infrastructure

It is a way by which an IT service provider provides IT services in infrastructure, applications and business areas on need basis and charges the services on specific usages basis. It is also referred as cloud computing. The cloud computing can reduce the infrastructure cost to some extent because it imparts various types of services like Infrastructure as a Service (IaaS), Platform as aService (PaaS) and Software as a Service (SaaS) to enhance flexibility in network operations and data operations among network partners through service oriented architecture [16]. In India 72% of the populace is having cell phones [17], therefore to enhance the accessibility of e-services especially in remote areas cloud computing can be used as a pivot. It enables the recipients to access the services through cellular phones also. The government should design a G-Cloud (Government Cloud) for offering all kinds of e-services. It will overcome various challenges pertaining to accessibility of e-services in remote areas like connectivity, power and cooling infrastructure and IT infrastructure.

D. Analytical Framework for Utility Analysis

The Analytical Framework for identifying the utility of the Virtualization using Virtual Machines involves running and testing the working and usefulness of variant Virtual Machines on variant physical host's hardware and software platforms in variant network environment.

The analytic queue network results are sometimes criticized for inaccurate evaluation and then it is invaluable during the development process [3]. However, without analytic results, it is too cost for the designers to test every new design proposal using all kinds of experiments. Furthermore, the designer cannot get the performance guarantees for any new design. Consequently, it is important for the designer to yield some analytic results though there is a gap between practice and theory. The virtualized system consists total *n* virtual machines above the VMM (or hypervisor). Each virtual machine has its own operating system. The detail of the framework is illustrated in Fig 3.



V. FEATURES

The proposed framework can provide a cost effective solution for e-governance by using Free and Open Access Software for development and deployment of e-governance applications, virtualization and consolidation techniques for management of e-services and cloud computing to deliver the maximum throughput enhancing the accessibility of services among remote locations. The major features of the proposed framework are depicted are under:

- It will help valuably to deliver maximum throughput
- It will help in reducing the cost of hardware incurred in facilitating e-governance services to citizens.
- It helps in reducing cooling requirements in establishment as well as maintenance of GDCs.
- It also reduces the total cost of ownership on e-governance projects by reducing the costs incurred on acquiring various types of hardware and software licenses from private vendors.
- It also gives solution to enhance the availability and accessibility of e-services in disadvantaged areas of country.
- It facilitates scalability of e-governance projects as the data volume in e-governance projects increases enormously.

- It promotes interoperability in the e-governance applications for reducing data redundancy and hence increases consistency of data.
- It helps for the backup and disaster recovery, effortless deployments, security, testing and R &D

VI. UTILITY ANALYSIS WITH CASE STUDY IMPLEMENTATION

In the general virtualization environment, each virtual machine runs several classes of jobs; our task is to estimate the utility in each virtual machine. National Land Record Computerization Program (NLRMP) Mission Mode Project (MMP) were having challenges in the state of Maharashtra like the unavailability of the server hardware and incompatibility of the server operating system with the new latest available computer systems for Property Card Information system (PCIS) and Land Management information system (LMIS) applications. Due to limited availability of the technical resources, a base line study is carried out and a case study has been conducted and instead of the traditional approach of running single operating system on the single computer system the innovative use of Virtualization is adapted mainly for the efficient and optimized use of technical resources. The implementation and utility analysis is carried out with technical strategy as below and shown in Fig 4.

Technical Strategy: Research line of action methodology

a. **Full Virtualization i)** using FOSS (Free and Open Source Software's) like user customizable ready usable Virtual Machines (VM) to use single physical computer system virtually as multiple computer systems by virtual isolated execution of virtually developed computer systems on the physical computer system simultaneously. ii) Using complete Virtual Computer System as an object instead of files and folders.
b. Designed and Developed cloud of variety of FOSS like user customizable and ready usable Virtual Machines of variety of distinct OS Windows, Linux etc of variety of version for variety of applications, Virtual Machines of Distinct Server and Client Operating System and Virtual Machines of Physical Machines, Virtual Machine for uploading district web site using VPN in order to use single physical Computer virtually as multiple computer systems along with server consolidation. Shared the virtual Machines over the network to use the network as Machine independent virtual hub. Customized VM's to make then readily usable and replicable for dissemination.
c. Investigated, implemented and analyzed functionality and utility of the VM's with Various Operations for our objective resource optimization with saving server hardware per location, increased throughput, Improved Service Delivery, effortless deployments backup & disaster recovery and Cost Effective Framework.
d. **Server consolidation** by installing server and client on the single physical computer system to save server hardware per location.
e. Software/ Hardware Portability :
Replicated these readily tested Virtual Machines by copying to large number of Computer Systems between host servers, on Various Old, New Computer System and Laptops, for saving the Server hardware Cost per location, backup and Disaster Recopy, Easy and quick Testing and R & D, new effortless deployments and basic system administration tasks and get the Client Server based E-Gov. activities through minimum trained staff
f. Developed Secured **Data Centre** and
g. **Hosted** the cloud of Virtual Machines on Data Centre
h. **Disseminated** ready usable Virtual Machines widely **leveraging shared infrastructure govt.** network NICNET to District level.
i. District level downloaded these FOSS like ready usable VM's and implemented at District , subdivision and Taluka level by optimum use of technical resources with

Virtualization – a) Using Single Computer system as multiples computers b) Using complete virtual computer system as an object instead of file and folders.

Server Consolidation – to save server hardware per location by running district isolated client as well as server on single computer system at a time running simultaneously

Software hardware portability – by replicating the ready usable FOSS like VM's just by copy and paste on large number of old and new computer systems and laptops with multiples district operating systems and software platforms, with effortless deployments , backup and disaster recovery.

For improved service delivery, throughput, efficiency and cost effectiveness.

With this implementation by using these techniques of Virtualization, Server Consolidation and software / hardware portability with optimization of technical resources

a) **Saved Time:** We get the maximum works done in less time.
b) **Saved Technical resources:** we get the works done with minimum technical human resources, minimum technical infrastructural resources and minimum technical efforts and exercises.

c) **Saved Environmental Resources:** Reduced transportation between district, Subdivision and Taluka level. This way saved time, vehicles, drivers, maintenance, space , furniture, electricity, less heat generation.

d) **Saved Financial Resources:** Saved more than 500 server hardware. Saved costs of maintenance and deployments, backup and disaster recovery of technical infrastructure. Saved costs of technical human resources.

This way implemented the concept of more from less for more and more.

The full details with research papers with R & D, analysis and findings are available at link http://akola.nic.in/vm1.html

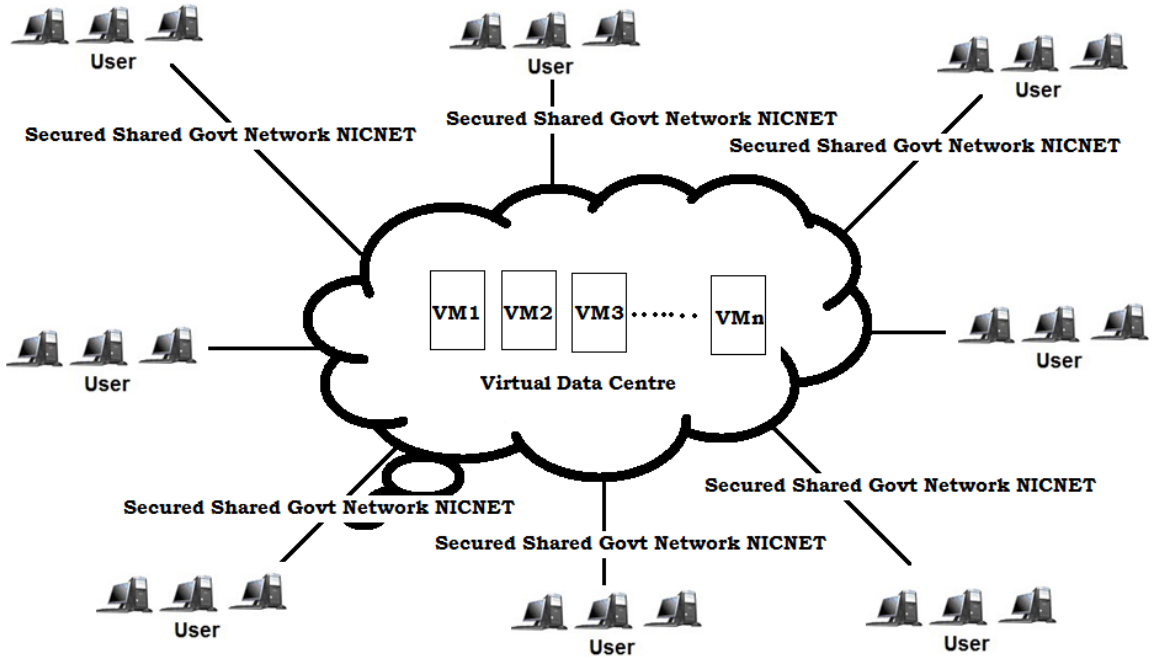


Fig 4. Technical Strategy: Research line of action methodology

VII. ANALYSIS RESULTS

All type of Operations which Physical computer system performs on File/Folders as object using operating system, that Virtual Machine Software performs on complete virtual computer along with Operating system as object including creation, updating, removing, renaming, customizing , move, copy, backup and restore, sharing, Auto start, import/export etc.

We have adopted Virtualization and around 500 servers are saved with server consolidating by installing Red Hat Linux 7.2 and Windows client on the single physical computer system. There was a great enhanced and efficient benefit in throughput, effortless deployments, easy backup and disaster recovery, sustainability, user convenience, adaptability, reachability and scalability, software hardware portability, new models of service delivery. There is a major saving nearly 30% in technical human resources and in space, furniture and electricity.

Based on these observations and detail utility analysis, we can conclude that

A. The overall basic scope for the service is the running distinct isolated multiples operating systems at a time on the single physical computer system. The single computer system is logically used as multiple computer systems with various distinct operating systems running isolated to each other at a time simultaneously, using Virtual Machines:

B. This is practically very useful when we have to do the processing /data entry on client and server Environment at large number of distinct locations and where the server is just required as a background service. Under such situation we can install the client and server on single system and process the work and this way save the cost of the server hardware per every location.

C. Virtual Machines are very useful to optimize the technical efforts and exercises, under the situation where a typical complex sophisticated application software is to be used at large number of distinct locations., to achieve the output target within less time with optimal use of the Hardware / software and resources.

D. The Virtual Machine software handles the guest operating system Virtual Machines as an instance for basic operations like creation, updating, removing, renaming, customizing , move, copy, backup and

restore, sharing, Auto start, import/export etc. between the large number of computer systems between host servers with distinct old and new compatible/ incompatible software's and hardware's.

E. It is very useful to run the application on the computer system which contains the non supporting host operating system. Under this situation we can get the same application running and operational by installing the supporting guest operating system installed using the Virtual Machine.

F. Virtual Machines can also be easily moved, copied, and reassigned between host servers to optimize hardware resource utilization. Also we can customize the shared hardware configuration settings allotted to the Virtual Machine as per the need and requirements. and availability of hardware, software and network resources.

G. Virtual Machines are very useful to optimize the technical efforts and exercises, under the situation where typical complex sophisticated application software is to be used at large number of distinct locations, to achieve the output target within less time with optimal use of the hardware / software and resources.

H. Faster booting and processing**:** Another advantage is that booting and restarting a virtual machine can be much faster than with physical machine, since it may be possible to skip tasks such as hardware initialization.

I. Imagination to Guest VM as a physical server hardware: Typically, guest operating systems and programs are not aware that they are running on a virtual platform and, as long as the VM's virtual platform is supported, this software can be installed in the same way it would be deployed to physical server hardware

J. Virtual Machines are very useful for backups and disaster recovery and effortless deployments.

K. Useful for Testing and R & Purposes under client server environment

L. Import and export Virtual Machine: We can import / export Virtual Machines between the various virtual machine

M. It is very useful to run the application on the computer system which contains the non supporting host operating system. Under this situation we can get the same application running and operational by installing the supporting guest operating system installed using the Virtual Machine.

N. Office can be used as a Virtual Hub with system independent by sharing the Virtual Machines over network.

VIII. CONCLUSION

Server consolidation based on virtualization technology simplifies system administration, reduce the cost of power and physical infrastructure, and improve utilization in today's internet-service-oriented enterprise data centers. The basic use of virtualization is the optimization of technical resources, improved service delivery with valuable reduction of the cost. The benefits of virtualization are typically considered to be server consolidation, increased availability, isolation, ease of operating system deployment and simplified disaster recovery. As the size and complexity of modern computing systems keep increasing to meet the demanding requirements of performance applications, manageability is becoming an important concern to achieve both performance and productivity computing. Here I have presented analytical framework for utility computing for effective e-Governance using Virtual Machines to achieve testing and R & D, new effortless deployments, basic system administration, adaptability, scalability, new models of service delivery, efficiency, enhancement, user convenience, sustainability, and leverage of shared government infrastructure. However to deliver the maximum throughput requires careful attention toward system details for the minimal loss of CPU performance and I/O efficiency. This work suggests a deigned framework to deliver the maximum throughput using technical resource optimization with improved and cost effective e-governance services. The involvement of technologies like virtualization, consolidation and cloud computing and adoption of free and open source software in designing and deploying e-governance will lead towards maximum throughput using resource optimization with reduction in total cost associated with both hardware as well as software. Therefore it reduces the financial burden abide by the state and central governments. For ensuring the effectiveness of e-governance projects the traditional framework and approach of delivery mechanism needs to be reengineered. The impact of any e-governance project depends upon its utilization by the concerned group and hence there accessibility needs to be enhanced drastically.

IX. REFERENCES

[1] D. Gupta, L. Cherkasova, R. Gardner, and A. Vahdat. "Enforcing Performance Isolation across Virtual Machines in Xen". In Proceedings of the 7th International Middleware Conference, LNCS Press, 2006. pp.342-362

[2] C. Clark, K. Fraser, S. Hand, J. G. Hansen, E. Jul, C. Limpach, I. Pratt and A. Warfield. "Live Migration of Virtual Machines". Proceedings of the 2nd Symposium on Networked Systems Design and Implementation, Boston, Massachusetts, USA, May 2005.

[3] K. Fraser, S. Hand, R. Neugebauer, I. Pratt, A. Warfield, and M. Williamson. "Safe Hardware Access with the Xen Virtual Machine Monitor". Proceedings of the 1st Workshop on Operating System and Architectural Support for the on demand IT InfraStructure (OASIS), Boston, MA, October 2004.

[4] Professor Norm Matloff ,Dept. of Computer Science ,University of California at Davis Davis, CA 95616 "A Brief Guide to Virtual Machine Software " http://heather.cs.ucdavis.edu/~matloff/vm.html
[5] Introduction to Virtual Machines http://www.cs.gmu.edu/cne/itcore/virtualmachine/
[6] An Overview of Virtual Machines in OS X http://computers.tutsplus.com/tutorials/an-overview-of-virtual-machines-in-os-x--mac-51922
[7] Silbershatz,Galving,Gagne :Virtual Machines CS502 Spring 2006
[8] Singh, A., Chauhan, R., & Thakur, B. S. (2012). Beowulf Cluster: Cost Effective Solution for E-Governance. In C. Unnithan, & B. Fraunholz, *Towards e-Governance in The Cloud: Frameworks, Technologies and Best Practices* (pp. 18-22). Hyderabad: ICEG.
[9] Joshi, A. (2012). Challenges for Adoption of Secured Effective E-governance through Virtualization and Cloud Computing. In C. Unnithan, & B. Fraunholz, *Towards e-Governance in The Cloud* (pp. 135-142). ICEG: Hyderabad.
[10] Puneet Kumar, Narendra Kumar and Dharminder Kumar "Improved Service Delivery and Cost Effective Framework for e-Governance in India ". In International Journal of Computer Applications (0975 – 8887) Volume 74–No.2, July 2013
[11] Wikipedia. (2013, May 21). *Free and open-source software*. Retrieved May 25, 2013, from Encyclopedia Web site: http://en.wikipedia.org/wiki/Free_and_open-source_software
[12] Baguma, R. (2006). Affordable E-governance Using Free and Open Source Software. In D. Williams, & V. Baryamureeba, *Measuring Computing Research Excellence and Vitality* (pp. 199-208). Kampala: Fountain Publishers.
[13] Amega-Selorm, C., & Awotwi, J. (2010). Free and Open Source Software (FOSS): It″s Significance or Otherwise to the E-Governance Process in Ghana. *ACM*, 91-95.
[14] Paper, W. (2006).*Virtualization Overview.*Vmware.
[15] Institute, T. O. (2011).*Virtualization and Consolidation: Key Steps on the Road to Effective IT Outsourcing.* The Outsourcing Institute.
[16] Arora, S. (2012). Transforming E-governance through Cloud computing architecture: Selected Case Studies. In C. Unnithan, & B. Fraunholz, *Towards E-governance in the Cloud- Frameworks, Technologies and Best Practices* (pp. 283-288). ICEG: Hyderabad.
[17] Wikipedia (2013, February 28). *List of countries by number of mobile phones in use*. Retrieved May 25,2013,from Encyclopedia Web site: http://en.wikipedia.org/wiki/ List_of_countries_by_number _of_mobile_phones_in_use