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Bachelor of Computer Science (Hons)
Bachelor of Software Engineering (Hons)

ASSIGNMENT COVER PAGE

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Module Name: **Systems Fundamentals**

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Assignment No. / Title	Group Assignment 2
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Declaration *(need to be signed by students. Otherwise, the assignment will not be marked)*

We certify that this assignment is entirely our work, except where we have given fully documented references to the work of others, and that the material contained in this assignment has not previously been submitted for assessment in any other formal course of study.

Signature of Students:

Marks:	**Evaluated by:**
Evaluator's Comments:	

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Question statements of Q1

"Trading companies are businesses working with different kinds of products which are sold for consumer, business, or government purposes. Trading companies buy a specialized range of products, maintain a stock or a shop, and deliver products to customers.[1]"

FA trading company faced challenges in growing its traditional data center that affected its IT systems infrastructure efficiency. Their data center was already full of the existing IT devices, and the power usage and space demands were already at the maximum limits. This is a typical challenge faced today by many data centers. The challenge faced by this FA trading company prevented their ability to offer more computing power or capacity to do work.

To run new applications, servers needed to be added that requires substantial time, effort and cost. This must be followed by assigning resources or equipment to run the new application. It will slow down the response time leading to low IT productivity affecting the IT department and hence, the company. Adding more processors to the servers, or more servers, more memory and hard drives eventually increases the heat produced, the power consumption, and of course the cost. More often increased server space too.

The FA trading company finally decided to go for server virtualization technology to improve equipment utilization and run more applications on less equipment. The company slowly moved the workloads that are of less priority to virtual machines. Whenever there was a request for a server, they assigned virtual machines if it did not affect their business much. By doing this the company is about 80% virtualized running 400 virtual machines on 20 physical servers. The company saw 40% savings in overall power consumption, saved physical space and improved flexibility.

a) *Analyse* the given scenario and discuss the technical and financial benefits that virtualization has made possible for FA trading company.
b) *Appraise* what are the other technical benefits that virtualization could provide for FA trading company that is not explicitly stated in the given scenario.

Answer for Q1

a) The scenario highlights the challenges faced by the FA trading company in terms of limited physical space, power usage, and the need for additional servers to accommodate new applications. By implementing server virtualization technology, the company was able to achieve several technical and financial benefits:

i) **Improved equipment utilisation**: Virtualization allowed the company to run multiple virtual machines on a single physical server, thereby maximising the use of available resources. This resulted in better equipment utilisation and reduced the need for additional physical servers.

ii) **Cost savings**: Virtualization helped the company save costs in multiple ways. Firstly, by consolidating workloads onto fewer physical servers, the company reduced the need for purchasing and maintaining a large number of individual servers. This resulted in savings in hardware costs, power consumption, cooling, and physical space requirements. Additionally, the company could save on software licensing costs, as virtual machines can be easily provisioned and managed without requiring separate licences for each physical server.

iii) **Increased flexibility and scalability**: Virtualization provided the FA trading company with greater flexibility and agility in deploying new applications and services. With virtual machines, the process of provisioning new servers became faster and more efficient, allowing the company to respond quickly to changing business needs. This flexibility also enabled better resource allocation, as virtual machines could be easily resized or moved between physical servers to optimise performance and ensure efficient resource utilisation.

iv) **Reduced downtime and improved disaster recovery**: Virtualization offered enhanced availability and reliability for the company's IT systems. Virtual machines can be backed up, replicated, and restored more easily than physical servers, minimising downtime in case of hardware failures or system crashes. Virtualization also enabled the implementation of robust disaster recovery strategies, such as replicating virtual machines to off-site locations for quick recovery in the event of a disaster.

b) In addition to the benefits mentioned in the scenario, virtualization can provide several other technical advantages for the FA trading company:

i) **Improved security**: Virtualization allows for the isolation of different applications and services within separate virtual machines. This isolation provides an additional layer of security, as any vulnerabilities or breaches in one virtual machine are less likely to affect the others. Virtualization platforms often offer features like virtual firewalls, intrusion detection systems, and security policies, which can be centrally managed and enforced across multiple virtual machines.

ii) **Simplified management and maintenance**: Virtualization simplifies the management and maintenance of IT infrastructure. With virtual machines, administrators can easily create, clone, or delete instances, reducing the time and effort required for provisioning and configuring physical servers. Virtualization platforms also provide centralised management tools that enable administrators to monitor, troubleshoot, and update virtual machines from a single interface, streamlining routine maintenance tasks.

iii) **Testing and development environment**: Virtualization offers an ideal platform for testing and development activities. Virtual machines can be quickly created and isolated, allowing developers to experiment with different configurations and software versions without impacting production systems. The ability to take snapshots of virtual machines enables easy rollback to previous states, facilitating efficient testing and troubleshooting processes.

iv) **High availability and load balancing**: Virtualization allows for the implementation of high availability and load balancing mechanisms. By utilising features such as live migration or vMotion, virtual machines can be seamlessly moved between physical servers without interrupting user sessions or causing downtime. This enables load balancing across the infrastructure, optimising resource utilisation and ensuring high availability of applications and services.

v) **Green IT and environmental benefits**: Virtualization contributes to environmental sustainability by reducing power consumption and carbon

footprint. By consolidating workloads onto fewer physical servers, energy consumption is minimised, leading to lower electricity bills and a reduced impact on the environment. Virtualization also enables dynamic power management features, such as powering off idle virtual machines or reallocating resources based on demand, further optimising energy efficiency.

Question statements of Q2

OAC is an Office Automation and Services company that has several years of financial details of their business in their desktop computers. The company has different version of the fiscal management software as the company has been in existence for many years. The company faces two challenges:

- The company is afraid to upgrade the office desktop computer with the concern that it may prevent the previous year financials computations of their company that may not run properly especially with the new operating systems. The company is unable to look for the old installation CDs and reinstall the financials software application.
- The company as one of its core businesses evaluates and writes reviews on the performance and popularity of popular financials software that includes Accounting, Finance, CRM, Expenses management, Billing, Asset Management etc. The company is concerned to install the different type of financials software application on their desktop computers for testing. They worry about what happens if there are any spyware or virus comes with the software applications that is to be evaluated.

There are practical solutions in terms of software and technology to overcome the problem faced by the OAC Office Automation and Services company in the above scenario. *Analyse* and briefly discuss how virtualization technology can be used as a solution to address the two challenges stated in the above scenario.

Answer for Q2

In the given scenario, virtualization technology can be utilised as a solution to address the challenges faced by the OAC Office Automation and Services company.

1. **Compatibility and versioning**: Virtualization allows the company to create virtual machines with specific operating systems and software configurations. This means they can maintain older versions of the operating system and financial software within separate virtual machines, ensuring compatibility with previous year financial computations. Upgrading the physical desktop computers or the operating system on the physical machines would not impact the virtual machines running the old software. This provides a safe environment for running legacy applications without the risk of compatibility issues.

2. **Software testing and isolation**: With virtualization, the company can create multiple virtual machines for testing different types of financial software applications. Each virtual machine can be isolated from the main system, providing a secure testing environment. If any spyware or virus comes with the software applications being evaluated, it would be contained within the virtual machine and would not affect the underlying physical system or other virtual machines. In case of any issues, the virtual machine can be easily discarded, and a new one can be created for further testing.

By leveraging virtualization, the OAC company can address the concerns regarding compatibility, versioning, and security while utilising different financial software applications. It allows for a flexible and secure testing environment without compromising the stability and integrity of their main system.

Question statements of Q3

'Paper and Pencil' is a Malaysia-based online stationery store selling a full range of stationery and office supplies. Their office supplies include stationery from papers, files, pen and pencils to staplers, glues, tapes and more such as office furniture, IT equipment for home and small office, and printing solutions.

'Paper and Pencil' has a series of servers purchased in mid-2017 that has started to show problems being old. Expired warranties and the servers often crashing had made the IT department to look for self-maintenance.

With limited IT budgets and staff especially with the challenging changing economic landscape, the 'Paper and Pencil' stationery retailer has challenges to extend the working life of the existing servers. They look for longer server refresh cycles and fewer deployments in terms of hardware and software infrastructure. The 'Paper and Pencil' stationery retailer with a limited budget have the option of buying some new servers. The 'Paper and Pencil' retailer apart from server consolidation to save cost and maintenance wishes to have more centralized control over the applications and desktops it has over the various locations across Malaysia and maximize the organizations investment in IT hardware.

a) *Analyse* the given scenario and briefly discuss how and by what means virtualization can help to overcome the challenge in terms of server consolidation. Also, *discuss* how 'Paper and Pencil' online stationery store could have more centralized control over the application and desktops and can maximize its IT hardware infrastructure investment.

b) *Discuss* the general benefits of desktop virtualization.

Answer for Q3

a) Virtualization can help the online store Paper and Pencil overcome its troubles regarding server consolidation.

By making use of this technology, they can consolidate multiple servers into virtual machines, thereby reducing the number of physical servers they need to maintain. This helps greatly in reducing hardware and maintenance costs, cuts power consumption which also reduces costs and extends the working life of the servers. Virtualization also ensures the continuous operation of the virtual servers.If one physical server crashes for any reason, the virtual servers will then be automatically shifted to a healthy server, thereby minimising downtime due to crashes and ensuring business continuity despite IT issues. Because of this, virtualization also allows for better disaster recovery by enabling efficient backup and restoration and failover mechanisms.

Paper and Pencil can also have more centralised control by making use of virtualization technology. They can make use of Virtual Desktop Infrastructure (VDI), which would allow the creation of virtual desktops that can then be accessed from anywhere in the country, thereby allowing the employees to be able to work remotely from their own devices. Centralization means greater security and simplified administration, greatly helping the IT department in configuring or updating applications from a central location via their own devices with the usage of VDI.

By using virtualization they can maximise their hardware infrastructure investment. One way this can be done is by using Virtual Desktop Infrastructure. Their already existing hardware can be used to its full potential by virtualizing desktops and even servers.By consolidating virtual servers into the already existing physical servers, the need for new physical servers becomes redundant, whilst also ensuring minimised downtime due to failures. By using desktop virtualization, Paper and Pencil need not invest in physical hardware for each member of the IT team. They can use their own devices to access the virtual desktops in order to manage and update their applications and such. This increases the working life of the already existing hardware in addition to providing centralised control as mentioned above. In addition to that it allows for better resource allocation as they can allocate CPU, memory, and storage resources to virtual machines based on demand ensuring they are fully utilised This can then

maximise the performance and efficiency of its already existing hardware infrastructure.

b) There are many benefits to Desktop Virtualization, some of which are listed below.

- Mobile access to applications. Virtualized desktops enable employees to use their own devices to work remotely and access company applications by enabling the sharing of hardware-based GPU sharing via a secure connection.
- Easier maintenance. Virtual desktops are easy to deploy, update and maintain from a central location. Therefore, the IT team can roll out updates, patches and manage access rights easily without having to manage each endpoint separately.
- Reduced costs. Because things like updates and virtual maintenance are easier through desktop virtualization, companies can reduce costs by decreasing the size of their IT team. It also prolongs the lifespan of the existing hardware in their central location reducing hardware upgrading and maintenance costs. Also, because they need not invest in more physical servers, the power consumption will be lower which can also help to cut costs.
- Business continuity in the face of server crashes and hardware failure. Because virtual desktops can be restored and accessed from the backups, there is minimal downtime and the companies can ensure business continuity and it will not have much of an effect on revenue generation.
- Increased Security. Desktop Virtualization utilises layers of cloud safeguards which eliminates threats and protects data. This includes encryption and monitoring in case of security breach ensuring that everything stored within the cloud remains safe.

Question statements of Q4

Virtualization brings great benefits to an organization. Can it be a solution for every organization? *Explore* what are the limitations and challenges of server virtualization? Write a summary with a discussion on the above question.

Answer for Q4

Virtualization indeed offers numerous benefits to organisations, such as improved resource utilisation, cost savings, flexibility, and centralised management. However, it is important to recognize that virtualization may not be the optimal solution for every organisation in all situations. There are limitations and challenges associated with server virtualization that should be considered. Below are summaries of these limitations and challenges:

1. **Hardware compatibility:** Server virtualization relies on the underlying hardware to support virtualization technologies. Some older hardware may not have the necessary virtualization extensions or features, making it incompatible with virtualization platforms. In such cases, organisations may need to invest in newer hardware to fully leverage virtualization.

2. **Performance considerations:** Virtualization introduces a layer of abstraction between the hardware and virtual machines, which can impact performance. While advancements in virtualization technologies have significantly minimised performance overhead, resource-intensive applications or those requiring direct hardware access may experience a slight performance reduction. Organisations must carefully assess their workload requirements to ensure virtualization meets their performance needs.

3. **Licensing considerations:** Software licensing models may need to be reviewed and adjusted when adopting virtualization. Some software vendors may have specific licensing requirements for running their applications in virtualized environments. Organisations should ensure compliance with licensing agreements and assess potential cost implications.

4. **Scalability limitations:** While virtualization enables scalability to a certain extent, there are limits to the number of virtual machines that can be effectively hosted on a physical server. As the number of virtual machines increases, resource contention and performance degradation may occur. Organisations must plan their virtualization infrastructure carefully to avoid overloading physical servers and impacting performance.

5. **Management complexity:** Virtualization introduces a new layer of complexity in terms of management and administration. Organisations need skilled IT personnel

with expertise in virtualization technologies to effectively manage and maintain virtualized environments. Adequate training and resources are essential to ensure smooth operations and timely troubleshooting.

6. **Single point of failure:** Virtualization consolidates multiple virtual machines onto a smaller number of physical servers. This concentration of resources means that if a physical server fails, multiple virtual machines are affected simultaneously. Organisations must implement robust backup and disaster recovery strategies to mitigate the risk of data loss and minimise downtime. It is important to assess an organisation's specific requirements, existing infrastructure, and workload characteristics before deciding whether virtualization is the right solution. While virtualization offers significant advantages, its limitations and challenges should be considered and addressed to ensure successful implementation.

In conclusion, virtualization has many benefits for businesses, but it's not an answer that works for everyone. Before employing virtualization, it is necessary to evaluate application compatibility, performance requirements, resource management, complexity, cost, and requirements. To determine whether server virtualization is the right answer for a given environment, organisations must evaluate what they need, consider the potential limitations and obstacles, and measure the benefits against the expenses involved.

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Personal Contribution

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