

Seneca

**NET455
FINAL PROJECT**

NETWORK DESIGN

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Group 1

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Introduction

It is our pleasure to present our final project on "Network Design". Our project specifies the process of network design for small business. Our objective is to design and build the best network for this organization, with the most elevated level of usefulness.

All the members actively participated in the task and completed their job sincerely. We are very pleased to have completed such an amazing project and the knowledge we have aggregated is boundless. Thank you for giving us the opportunity to write the report. We hope that the report pleases you and that we have stood up to your expectations

The success of the report depends upon the success of the execution of the plans and the efforts of the individuals. Every colleague` must come to a common ground in order to proceed in the given task. The decision-making process should be a transparent process with honest opinions from all the team members. Each member should take their share of responsibility and try to finish all the undertaken tasks with the given time frame

Questions 1

What kind of operating system would you install on the server and why (Windows Server 2012/2016 or Linux)? For the operating system of your choice, discuss

- the recommended hardware specifications for the server (CPU, memory, disk, network card [speed, type], etc.), as well as
- associated costs of the server and client operating systems (Hint: client access licensing);
- features of the operating system you choose (Windows 2012/2016 or Linux);
- Any other related costs.

Are the client system specifications adequate for the customer's needs? If not, what upgrades would you recommend and how would you carry out the implementation?

1 Operating Systems

i. Operating System For Server

There are various interesting points with regards to picking the Operating Systems for the server, for example, speed, cost of establishment, usability, capacity to adjust the framework, and so on.

Linux Server Operating System

Linux operating systems are exceptionally prevalent and wide-ranging. Linux is an open-source, community-based operating system developed not only for computers but also for servers. A Linux server operating system serves content to client devices. Accordingly, server operating systems feature tools for simple server creation. Because servers commonly run headless, the graphical user interface (GUI) in a Linux server operating system remains less important. Linux has evolved as one of the most reliable operating systems over a period. There are a few versions for this operating system, thus making it easy for users to select a version that matches their needs. There are many popular distros for Linux such as: Ubuntu, Fedora, Solus, Linux Mint, etc.

Some other features include:

- Multi-user account
- Multithreading support
- Graphical User Interface (X Window System, Wayland)
- Hierarchical File System

Advantages.	Disadvantages.
<ul style="list-style-type: none">• The Operating System is user friendly and easy to use.• The Operating System is reliable, stable and efficient.• The Operating System is free of cost unlike any Windows Operating system.• The Operating System is stable and prone to any kind Malwares and Trojan software.• Enables the user to modify change the settings of the operating system according to their needs.	<ul style="list-style-type: none">• The Operating System is not as user-friendly as Windows.• Operating system doesn't really have any drivers available online to update.• There is no dedicated Tech support available for Linux, given that it is freely available online for anyone to download

Windows 2012 Server Operating System

Operating System is one of the most successful ones when it comes to operating server for small businesses. Windows Server 2012 can switch between "Server Core" and "Server with a GUI" installation options without a full reinstallation. Server Core – an option with a command-line interface only – is now the recommended configuration. Operating System comes in handy when Cloud Computing is used for accessing data and running applications off the Cloud. Various Features were added to this Operating System; most of the focus was on Cloud Computing.

Some of the other features include

- Data Deduplication
- Hyper-V
- IP Address Management
- ReFS (Resilient File System)
- Network virtualization change

Advantages.	Disadvantages.
<ul style="list-style-type: none"> • Operating System supports a larger number of third-party applications. • Microsoft provides guaranteed online long-term support for any kind of technical problem. • Operating System is quick to set up and easy to use. 	<ul style="list-style-type: none"> • Operating System Very expensive licensing cost. This goes up with every user added to the network. • Operating systems is prone to many malwares. • Operating System is not recommended for multi-user systems. • Operating System does not provide full disclosure for the working of its proprietary system.

Why is Linux better for our servers?

Linux Operating System would be the best option to go forward with for this office layout, considering all the needs and requirements. The major role in selecting Linux Operating System is because of zero cost involved in Operating System installation and server licensing. Also, because of the robust system security, it is almost impossible for the Linux-based servers to catch any kind of ransomware or viruses.

ii. Client Operating System

Windows 10 Operating System

Windows 10 is the latest operating system from Microsoft for personal computers. Windows 10 is a series of operating systems produced by Microsoft as part of its Windows NT family of operating systems. It is the successor to Windows 8.1. It introduced Universal Windows Platform for the Development of many Universal Apps. Microsoft also introduced Microsoft Edge, which was a much advanced.

Advantages.	Disadvantages.
<ul style="list-style-type: none"> • Windows 10 has excellent Virus Protection. • Windows 10 has regular System updates are provided. • Windows 10 is lighter and faster OS • Windows 10 is Addition of DirectX 12 	<ul style="list-style-type: none"> • Windows 10 has many inconsistencies in the User Interface. • Windows 10 has no more Windows Media Centre or DVD Playback. • Windows 10 is OneDrive Selective sync problem. • Problems with the compatibility of software and hardware can be a reason to not switch to Windows 10.

Linux Operating System

A Linux-based system is a modular Unix-like operating system, deriving much of its basic design from principles established in Unix during the 1970s and 1980s. Such a system uses a monolithic kernel, the Linux kernel, which handles process control, networking, access to the peripherals, and file systems. Linux, just like other Operating Systems like Windows, or iOS has its own peculiar Graphical Interface, and a few word processing applications of its own.

Advantages.	Disadvantages.
<ul style="list-style-type: none"> • A linux-based system is open source OS • A linux-based system is free of cost • A linux-based system is large community support • A linux-based system is freedom of customization 	<ul style="list-style-type: none"> • A linux-based system is applications are not easily available online. • A linux-based system has many hardware drivers are not available online. • A linux-based system has not many software alternatives.

Why is Windows 10 better than Linux for Client OS?

Windows is less secure compared to Linux as Viruses, hackers, and malware affects the windows more quickly. Linux has good performance. It is much quicker, fast and smooth even on the older hardware's. Windows 10 is slow compared to Linux because of running batches at the backend and it requires a good hardware to run. Also, Microsoft usually provides support for each OS for 7 years after its release; this is good for the security of the system against virus, key-loggers, etc.

iii. Hardware.

Dell OptiPlex 5070

The configuration for dell OptiPlex 5070 small Form Factor includes:

- Intel® Core™ i7-9700 (8 Cores/12MB/8T/3.0GHz to 4.7GHz/65W); supports Windows 10/Linux
- Windows 10 Pro 64bit English, French, Spanish
- Intel® Integrated Graphics
- 16GB 1x16GB 2666MHz DDR4 Memory
- 3.5" 1TB 7200RPM SATA Hard Disk Drive

Advantages.	Disadvantages.
<ul style="list-style-type: none"> • Dell OptiPlex 5070 smaller form factor. • Dell OptiPlex 5070 perfect for business power users. • Dell OptiPlex 5070 more cost efficient. • Dell OptiPlex 5070 open ecosystem: windows offer greater flexibility 	<ul style="list-style-type: none"> • Dell OptiPlex 5070 Significantly more prone to viruses. • Dell OptiPlex 5070 lot of Bloatware

Apple Mac pro

The configuration for Apple Mac Pro includes:

- 3.5GHz 8 core Intel Xeon W processor, Turbo Boost up to 4.0GHz
- 32GB (4x8GB) of DDR4 ECC memory
- Radeon Pro 580X with 8GB of GDDR5 memory
- 256GB SSD storage
- Stainless steel frame with feet

Advantages.	Disadvantages.
<ul style="list-style-type: none"> • MacOS isn't prone to a lot of viruses. • Apple Mac pro has Almost no bloatware. • Apple Mac pro Can be upgraded up to 18 cores and added Turbo Boost speeds up the CPU to 4.5GHz. 	<ul style="list-style-type: none"> • Apple Mac pro is closed Ecosystem. • Apple Mac pro is Expensive System. • Apple Mac pro runs on a small set hardware options, thus limiting hardware upgrades.

Why is Dell OptiPlex 5070 better than Apple Mac Pro ?

- Dell OptiPlex 5070 is Ease of Access
- Dell OptiPlex 5070 is Cost Efficient
- Dell OptiPlex 5070 is Open Ecosystem
- Dell OptiPlex 5070 is Takes up less space (Mini Tower)
- Dell OptiPlex 5070 is Hardware can be easily upgraded.

iv. Hardware Specifications for The Server

- A linux-based server has 32-bit Intel Pentium 4 Processors or any processor running at 2GHz or greater.
- A linux-based server has about 512 MB Ram
- A linux-based server has disk Space of 300 MB for client components.
- A linux-based has server DVD-ROM Drive.
- A linux-based has minimum screen resolution of 1024 x 768 pixels.
- A linux-based has about 128 Mb ram.

v. Associated Costs.

Server.

System 76 Ibex Pro GPU

We select System 76 Ibex Pro GPU as server, because it has excellent performance and it perfectly matches the requirement from the customer. with the following configuration:

- Dual Intel Xeon Scalable processors
- Up to 3072 GB of ECC memory
- Up to 32 TB SSD Storage
- Up to 8 GPUs with 88 GB GDDR6
- Dual 10 Gigabit network

Licensing

Linux Kernel is licensed for free, most of the Linux based operating systems (Ubuntu, Fedora, etc.) are free of cost. However, there's some cost involved when it comes to consulting competent in-house Linux expertise to deal with any kind of hardware or software issue.

There is no Client Access Licensing fee when it comes to any of the Linux Operating System Distros, but a support fee of \$5,899 (for Red Hat Distro) for 5 years.

Cost Table

Product	Price
System 76 Ibex Pro GPU	\$5,899
Dell OptiPlex 5070	\$1992
Windows 10 Pro	\$99

Questions 2

If the customer is to have a flexible installation that will accommodate future expansion needs, what network architecture, topology and layout would you recommend and why? Discuss

- ease of installation, performance characteristics and
- features and over all cost for networking hardware chosen, as well as installation costs, including network cable installation.

Also provide your solutions for

- additional support for some limited wireless network options, apart from the mainstream wired connections for this office/client and
- maintaining a high degree of reliability, in terms of providing redundancy.

Network Topology

i. What is Network Topology ?

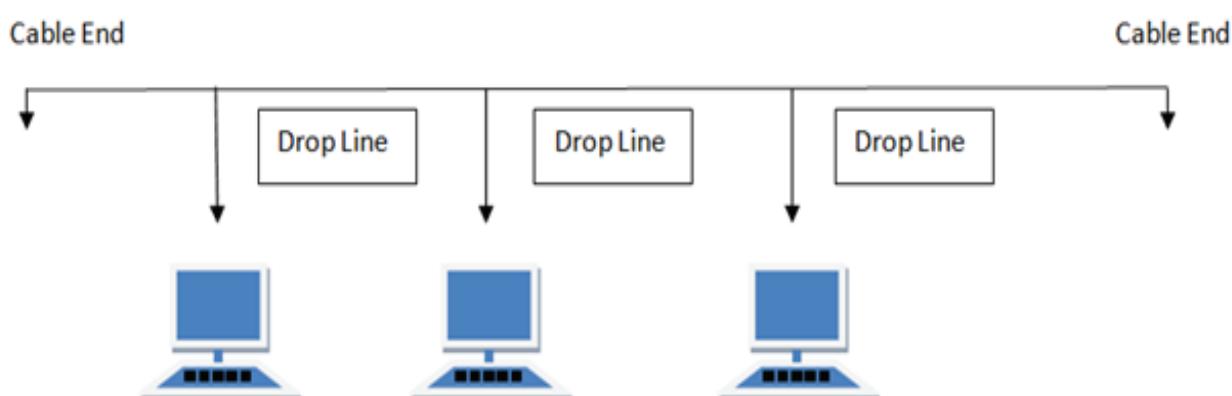
Network Topology refers to the layout of a network and how different nodes in a network are connected to each other and how they communicate. Topologies are either physical (the physical layout of devices on a network) or logical (the way that the signals act on the network media, or the way that the data passes through the network from one device to the next). This Webopedia Study Guide describes five of the most common network topologies.

ii. Types of Network Topology.

Network Topology is the schematic description of a network arrangement, connecting various nodes(sender and receiver) through lines of connection.

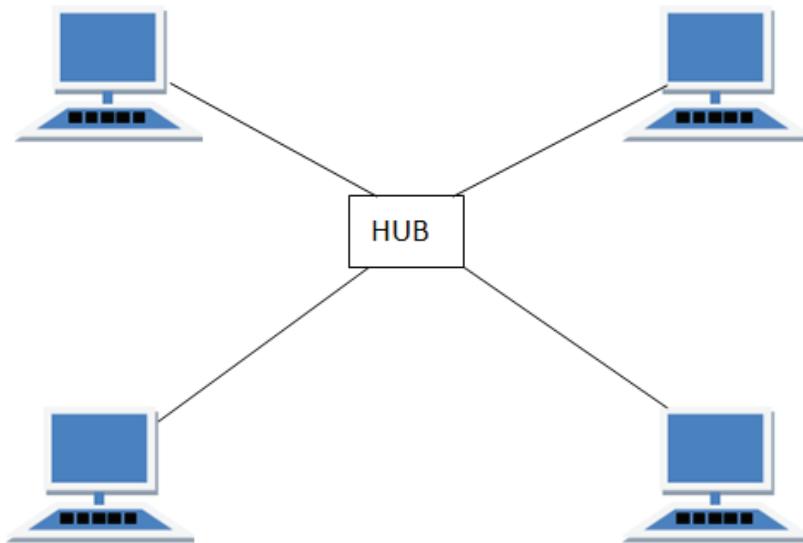
BUS Topology

Bus topology is a network type in which every computer and network device is connected to single cable. When it has exactly two endpoints, then it is called Linear Bus topology.



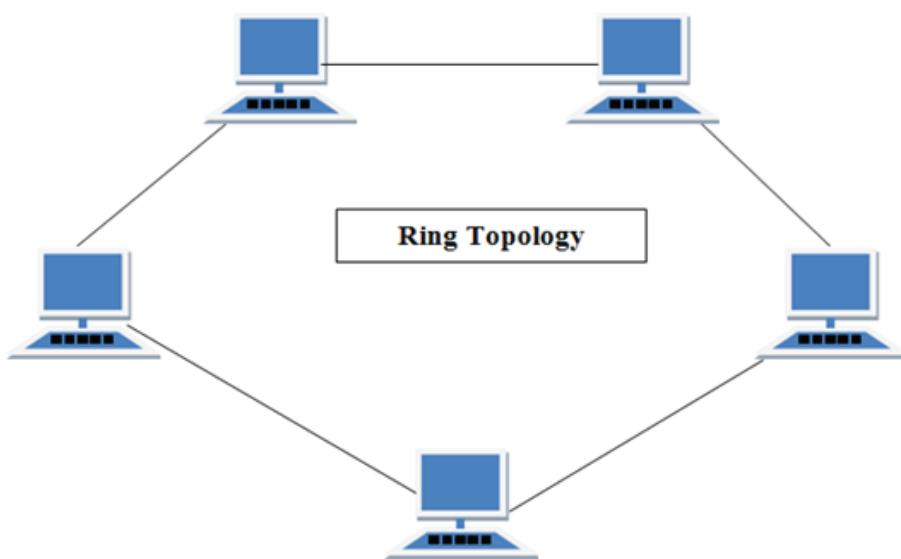
STAR Topology

In this type of topology all the computers are connected to a single hub through a cable. This hub is the central node and all other nodes are connected to the central node.



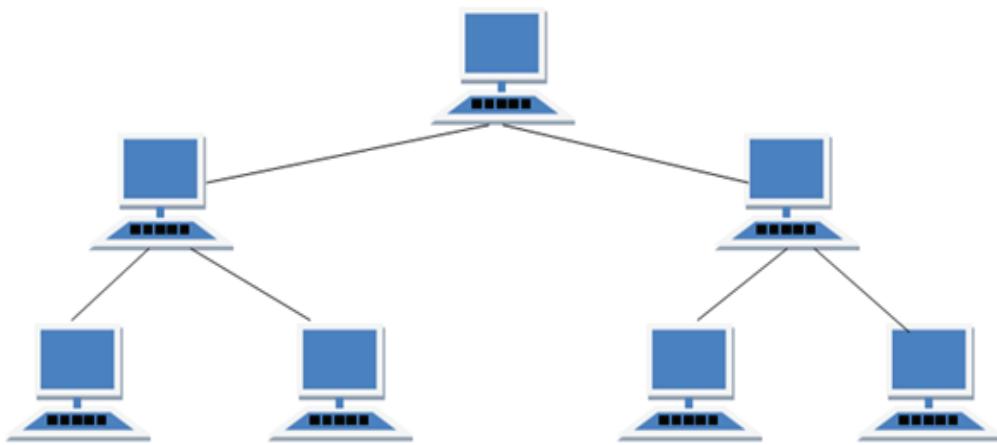
RING Topology

It is called ring topology because it forms a ring as each computer is connected to another computer, with the last one connected to the first. Exactly two neighbor's for each device



STAR-BUS Topology

It has a root node and all other nodes are connected to it forming a hierarchy. It is also called hierarchical topology. It should at least have three levels to the hierarchy.



iii. Comparing Network Topologies.

Topology	Architecture/ organization	Complexity	Cost	Security
Bus	is a network topology in which there is a single line (the bus) to which all nodes are connected, and the nodes connect only to this bus. This is a bus line going through a city. The cable has a small cap installed at the end, called a terminator. The terminator prevents signals from bouncing back and causing network errors. Like a series of pipes that water travels through	The Simplest one (Used for LANs)	A cheaper network since there is usually one continuous copper cable.	Not secure cause broadcast
Star	A network topology in which peripheral nodes are connected to a central node (such as a hub, switch, or router) which rebroadcasts all transmissions received from any peripheral node to all peripheral nodes on the network, including the originating node. All peripheral nodes may thus communicate with all others by transmitting to, and receiving from, the central node only	Very simple (Used for LANs)	More expensive of the simple topologies, it requires costly connection device. Usually cheaper than a hybrid network.	denial of service attack
Ring	A network topology in which every node has exactly two branches connected to it. A star wired ring topology may appear (externally) to be the same as a star topology. Internally, the MAU (multi station access unit) of a star-wired ring contains wiring that allows information to pass from one device to another in a circle or ring. point-to point links in a closed loop.	(Used for LANs)	One of the more expensive topologies due to high cable costs.	The least security as the information Intended for one machine must pass all the others
Star-Bus	The nodes are arranged as a tree. The tree topology is a generalization of the bus topology. The transmission medium is a branching cable with no closed loops. The tree layout begins at a point known as the head end (Root), where one or more cables start, and each of these may have branches. The branches in turn may	Used for WANs	Costly because it is heavily cabled	Low security as it physically star but logically bus

iv. Network Redundancy

Network Redundancy is a process through which additional alternate instances of network devices, equipment and communication mediums are installed within a network infrastructure. It is a method of ensuring network availability in case of a network device or path failure.

Typically, network redundancy is achieved through the addition of backup and storage devices, alternate network devices and paths, which are implemented through redundant standby routers and switches. If and when the primary path fails, the alternate is readily deployed. This ensures minimal downtime.

The backup devices do not have to be deployed on the network with the primary device. They can be configured alongside the primary and kept in storage, to be used when the primary fails. Although this works, it is rather inefficient.

v. Cost of Installation.

Topology	+Labor \$5,260 - \$8,800	Price
BUS-Topology	\$5000-9000	\$599
STAR-Topology	\$7000-12000	\$2992
RING-Topology	\$5000-10000	\$499
STAR-BUS Topology	\$7000-12000	\$3000

Why Star-bus Topology for our Network Design ?

Based on all the research, considering all the topologies, the cost associated with installation, the speed of the network, the floor plan provided, we would recommend a Star Topology for the client's network.

The advantages of a star topology by far outweigh the disadvantages. It fits well with the office floor plan, relatively easy to install and maintain, provides fast speeds and is easy to upgrade if the client wishes to expand the network.

For the wireless network, we recommend the Infrastructure Topology. The characteristics of this topology make it a perfect fit with the star topology. The wiring for the access point can be drawn directly from the router, making it a separate network form the wired LAN.

Questions 3

Indicate directly on a network diagram (please redraw the office layout professionally):

- How the wiring would be implemented; that is, the location of any switches/router used, and how the computers/printers will be connected.
- Also indicate how the LAN would connect to the Internet.

NOTE: The diagram should be larger than the standard paper size (11" X 8.5").

NETWORK DESIGN

The ISP's (Internet Service Provider) modem or satellite connection interfaces with the client's router. The router fills in as a boundary zone between the ISP's system and the Client's LAN.

The router interfaces with a switch, a server (whenever required) and a remote passageway (whenever required). Doing this puts the switch, server and remote passage on isolated LANs.

From the switch ports, Ethernet links are strung to a fix board. This decreases access to the switch and forestalls harm to the switch ports (switches are more costly than fix boards).

Contingent upon what number of ports the switch and fix board have, Ethernet links will run from the ports on the fix board, through the drop roof, into the empty dividers and to each room ending in a cornerstone jack. From here the PCs in the room interface the system.

At the point when the client wishes to grow, another switch can be daisy-anchored to the current one or associated with the switch, another fix board is included, links from the new switch are associated with the new fix board and go through a similar strategy and end where required.

Questions 4

The customer is also interested in a backup solution (tape drive, external hard drive-based NAS or cloud) that is cost effective, reliable and reasonably fast.

- What hardware and software, if any, would you sell the customer to be installed on the server for backup purposes?
- Discuss the choice of vendors and related costs (compare at least 2 vendors' offerings).

i. What is Backup ?

Backup and recovery describes the process of creating and storing copies of data that can be used to protect organizations against data loss. This is sometimes referred to as operational recovery. Recovery from a backup typically involves restoring the data to the original location, or to an alternate location where it can be used in place of the lost or damaged data.

A proper backup copy is stored in a separate system or medium, such as tape, from the primary data to protect against the possibility of data loss due to primary hardware or software failure.

ii. Hardware For Backup/Storage

RAID

RAID improves overall performance of input/output (I/O) operations by using multiple disks, which increases the mean time between failure. The redundant storage of data also improves the operating system's fault tolerance.

RAID uses either disk mirroring or disk striping to protect data. In striping, known as RAID 0, the data is divided into blocks and is spread across multiple storage devices. Mirroring, which is also referred to as RAID 1, replicates or "mirrors" data to two or more disks.

A third configuration, double-parity RAID, also known as RAID 6, stripes the data across a minimum of four drives and also writes a second set of parity data across all the drives.

Other RAID configurations add their own benefits. For example, the popular RAID 5 configuration uses three or more drives to store data and recovery information called parity across the drives. If one disk fails, the remaining disks can keep the array going until a replacement arrives and is rebuilt.

Advantages.	Disadvantages.
<ul style="list-style-type: none"> • To improve fault tolerance by writing two copies of a file, each to a different drive. • To improve performance by writing data to two or more drives so no drives is used excessively. • Provides a central onsite location for data backup. • RAID has Large storage. • RAID are Fast in Speeds 	<ul style="list-style-type: none"> • RAID is not suited for systems with large data files and less disk space. • Data striping might not allow you to locate single data file on specific physical drive. • Some of the application tuning capabilities might be lost due to data striping. • Data recovery becomes time consuming in the recovery process due to the number of disks in the RAID.

Network-Attached Storage (NAS)

A NAS system is a storage device connected to a network that allows storage and retrieval of data from a centralized location for authorized network users and heterogeneous clients. NAS systems are flexible and scale-out, meaning that as you need additional storage, you can add on to what you have. NAS is like having a private cloud in the office. It's faster, less expensive and provides all the benefits of a public cloud on site, giving you complete control.

With a NAS system, data is continually accessible, making it easy for employees to collaborate, respond to customers in a timely fashion, and promptly follow up on sales or other issues because information is in one place. Because NAS is like a private cloud, data may be accessed remotely using a network connection, meaning employees can work anywhere, anytime.

NAS is growing in popularity. And with good reason. NAS servers allow access to company data 24x7, and using the right hard drive will provide the best experience possible. IronWolf Pro-equipped NAS servers can help provide tremendous competitive advantages, increase levels of customer service, and extend the collaborative reach across any project, at any company. In many cases, the only limit to the usefulness of having a NAS solution in your business is in the unfortunate case you don't have one at all!

Advantages.	Disadvantages.
<ul style="list-style-type: none"> It acts as a complete and standard platform to the administrators for storing the files and documents. It helps to fasten the work by storing huge amount of data within a short span of time. It helps for easy and fast communication between other electronic devices like computers, printers, scanners, etc. and thus reduces both the time and the extra workload of the individual. 	<ul style="list-style-type: none"> The major drawback of using the network attached storage device is that it mainly runs on the file system Linux. During a power loss or machine failure, to retrieve or to recover any document or file from the system you are in need of help of the professional data recovery software and services. The end users who want to back up the data cannot proceed directly. They must do it through the installed operating system only.

Why is NAS Better than RAID for Client back up ?

Network-attached storage (NAS) devices are an affordable, on-site solution for file sharing. Files can be easily stored on the share and mounted on Windows, Mac, and Linux computers. Because the NAS is on-site, files do not need to be synced down from a cloud service.

iii. Comparing Vendors NAS Backup Device

	WD My Cloud PR4100 WDBNFA0320KBK	Synology 12 bay NAS DiskStation DS2419+ (Diskless)
CPU	1 x Intel Pentium N3710 1.6 GHz (Quad-Core)	Intel Celeron (64Bit)
RAM	2GB DDR4	8 GB DDR3
Number of Bays	4	5
Max Storage	48 TB	160 TB
Supported Drives	SATA/SSD 2.5" or 3.5"	SATA/SSD 2.5" or 3.5", M.2NVMe SSD
Expansion Ports	1 eSATA	1 eSATA
Gigabit LAN Ports	2	2
Cost	\$2140.68	\$ 1548.14

Why is synology 12 bay NAS ?

The Synology Diskstation is a better option for an NAS. It is cheaper than the competing brand. It supports more storage device formats while providing the same performance.

iv. Software For Backup/Storage

Acronis True Image 2020

Automated Dual Protection - Back up locally while simultaneously replicating it in the cloud so you've always got a secure off-site copy for recovery.

Tray Notification Center - Messages pushed to your desktop tray enable you to monitor the status of backups so you can quickly respond to any issues.

Custom Power Management - Avoid draining your battery by efficiently managing laptop backups. Set a minimum power level or block backups on battery power.

Back Up on Select Wi-Fi - Where you back up is your choice. Now you can easily avoid the metered connections and public networks that put data at risk.

Improved Cloud Restores - Enjoy faster performance and a more intuitive experience. Enhanced for even easier navigation.

Fastest Cloud Backups-Protect your data with cloud backups and restores that are independently proven to be up to 13x faster than the competition.

Questions 5

The customer would like the entire operation to be connected to the Internet and deploy a web site. In particular, they would like to have Internet connectivity on all stations to allow for web browsing and e-mail access (web and e-mail services will be hosted by an ISP).

- What networking hardware and, if any, additional software would you have to provide to enable the Internet connection?
- As before, discuss a particular choice of vendor/ technology and the related cost (compare at least 2 vendors).

i. Internet Service Provider Vendor's

	Rogers Getabit Business Internet-Pro with Wi-Fi	Bell Business Gigabit Fibre
Cost	3-year term starting from \$189.99 Per month.	Monthly \$124.95 (Promotional offer applied) 3-year commitment Installation Fee : \$125
Upload Speeds	Up to 50 Mbps	Up to 940 Mbps
Download Speeds	Up to 1 Gbps	Up to 1.5 Gbps
Monthly Usage	Unlimited	Unlimited
What's Included ??	24/7 technical Support Business Specialist Support Network-level security Unlimited Bandwidth Usage Includes LTE Wireless Backup and Business Wi-Fi.	24/7 Support Same day repairs Unlimited Bandwidth Usage Online security (Internet Protect) Data backup (Data Protect) IT support (PC Protect)

ii. Web-hosting, Browsing, E-mail Services.

	Fast Host	Blue Host
Cost	\$10/month	\$7.31/month
Web disk space	Unlimited	Unlimited
Bandwidth	Unlimited	Unlimited
Parked domains	Unlimited	Unlimited
Sub domains	Unlimited	Unlimited
Email accounts	Unlimited	Unlimited
email storage	120GB	Unlimited
Marketing offers	Unlimited	Unlimited

iii. System Requirements Vendor's

	Rogers	Bell
Memory (RAM):	4GB or more	8 GB of system memory
Processor:	2GHz(dual core) or more	1.5 GHz as a minimum 2 GHz recommended
Hard drive free space:	2GB or more	500 MB as a minimum 2 GB recommended
Operating Systems:	Windows 7(64-bit) or higher	MacOS version 10.6 or higher Windows Vista or higher
Network Interface Card (NIC) or network adapter	Gigabit Ethernet	Gigabit Ethernet
Web Browser:	Internet Explorer 11 Chrome v.47 Firefox v.43	Internet Explorer 11 Chrome v.47 Firefox v.43

iv. Discussion on choice of Vendor/Technology

We would recommend choosing Bell as the Internet service provider because they would not only be able to provide fast and reliable internet to the workspace but also allow for web hosting and email servers. This compared to Rogers is a major strength because it would be easier to maintain difficulties with the services in a small office setting with one provider as opposed to multiple providers. Blue host is also a well-known corporation compared to Fast Host which is why we recommend using Blue host over Fast Host

Questions 6

The customer wants to create VMs (Virtual Machines) for its DNS server, DHCP server, File server, remote access server, and a database server on a single physical computer. You have to choose software from several virtualization programs to create and manage VMs. Compare any 2 products for their functionality, features, interfaces, and ease of use. By this the customer is able to create a network for combining physical and virtual elements. Also discuss the operating system for the virtual machines, including licensing.

i. Virtualization.

'Virtualization is the process of running a virtual instance of a computer system in a layer abstracted from the actual hardware. Most commonly, it refers to running multiple operating systems on a computer system simultaneously. To the applications running on top of the virtualized machine, it can appear as if they are on their own dedicated machine, where the operating system, libraries, and other programs are unique to the guest virtualized system and unconnected to the host operating system which sits below it.

ii. Virtualization software for server and client.

Oracle VirtualBox

VirtualBox is a powerful x86 and AMD64/Intel64 virtualization product for enterprise as well as home use. Not only is VirtualBox an extremely feature rich, high performance product for enterprise customers, it is also the only professional solution that is freely available as Open Source Software under the terms of the GNU General Public License (GPL) version 2.

Advantages.	Disadvantages.
<ul style="list-style-type: none">• Oracle VirtualBox is server consolidation• Oracle VirtualBox solves the problem of avoiding trojans or spywares by improving security• Oracle VirtualBox faster server provisioning• Oracle VirtualBox has zero cost for licensing	<ul style="list-style-type: none">• Oracle VirtualBox less efficient compared to the actual servers.• Oracle VirtualBox not independent: always depends on host machines• Oracle VirtualBox affected by the host machines weakness

VMware Workstation 15.5 Pro

VMware Workstation Pro allows you to run multiple operating systems at once on the same Windows or Linux PC. Create real Linux and Windows VMs and other desktop, server, and tablet environments, complete with configurable virtual networking and network condition simulation, for use in code development, solution architecting, application testing, product demonstrations and more.

Advantages.	Disadvantages.
<ul style="list-style-type: none">• VMware Team features allow you to group virtual systems together and start/stop them all at the same time.• Ability to import Virtual PC machine.• Ability to create AVI videos of tasks performed inside virtual machines• Support for 64 bit Guest Operating systems if you have a 64 bit processor• Supports dual processors on virtual machines• Supports USB devices	<ul style="list-style-type: none">• VMware Workstation costs \$189

Why VMware Workstation 15.5 Pro ?

We think that VMware would be the most suitable option to go ahead with in terms of virtualizing our Servers/Client VM Ware also provides many better features such as Fault Tolerance, Network traffic shaping, Memory over commitment and Deduplication.

7. Cost Summary

Item	Qty.	Unit Price (\$)	Cost (\$)
Dell OptiPlex Tower + OS, Monitor, keyboard, mouse	25	1,564	39,108
Microsoft Office Professional	25	570.43	14,261
McAfee anti-virus	25	29.22	731
Server, Monitor, UPS	1	3,920	3,920
Linux Server Support Fee	12 mths	2,499	2,499
Network Equipment (Star-bus Network topology)	1	2,992	2,992
Backup Storage Solutions (NAS)	1	2100	2,100
Blue Host (ISP - email services)	12 months	75	75
Bell (ISP - installation)	1	75	75
Bell (ISP - Data Plan)	13 months	124	124
Virtualization Solutions(vm ware)	25	189	4,725
Labor Costs	10	10,000	100,000
			170,609.90
TOTAL	(13% Tax)		193,513.03

These prices are estimates and are only valid as at the time of writing, prices may vary at a later date