

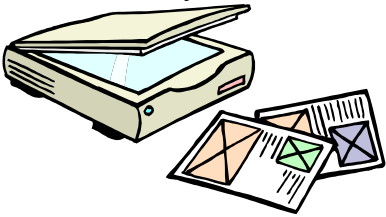
Communications Networks

Introduction

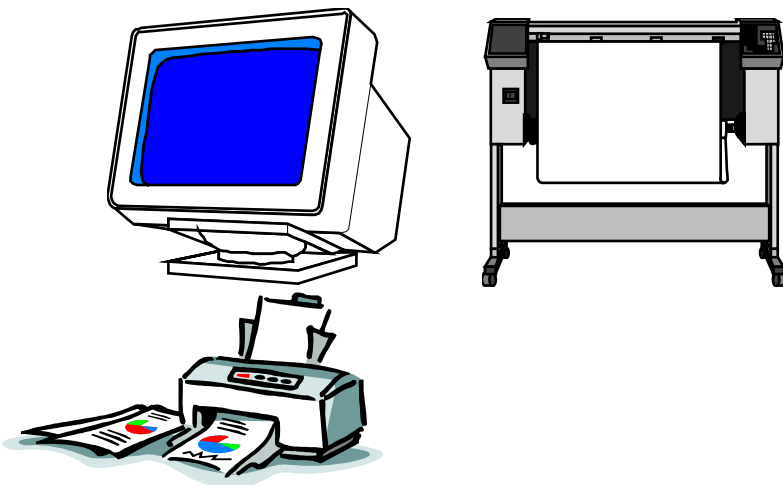
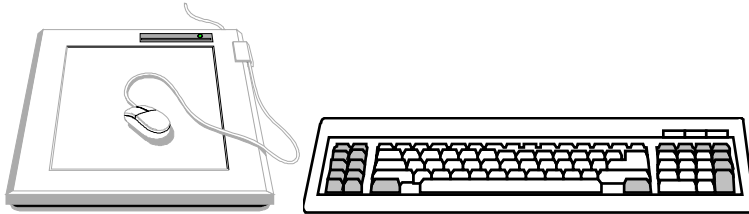
A **computer** is an electronic device that processes information in the form of data. Similar devices have been constructed and used around the world for thousands of years. Human's need to collect, store and retrieve data has been the driving force in the evolution of the computer. A computer system consists of hardware and software components. **Hardware** is the physical equipment of a computer system.

The hardware can be divided into categories:

- **Input device** – hardware used to place data into a computer system.
 - Keyboard, mouse, scanner, modem, voice recognition, sensors.

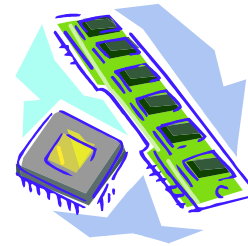
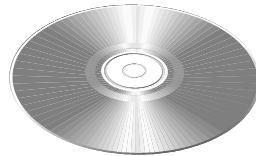


- **Output device** – hardware used to visually display, or transfer information into a hard copy, audio or a physical component.
 - Monitor printers (laser jet, inkjet, and plotters), robot (mills, arms), sound card, and modem.



A modem is both an input and output device. The word modem is derived from two words: modulation and demodulation. **Modulation** is when the information is combined with the carrier wave. This allows the information to be sent through telephone wires and fiber optic wires, etc. **Demodulation** is when the carrier wave is separated from the information received by the computer. A modem's speed is termed **baud rate**. Typical modem speeds today range from 56.6 Kbps to 128.8 Kbps.

- **Storage device-** hardware used to store a variety of information.
 - Magnetic (floppy, hard, zip), **Random Access Memory**, **Read Only Memory**, optical disk (CD-R, CD-RW, DVD-R, DVD-RW), USB storage devices (jump drive, keys, smart drives), compact flash, secure digital, flash sticks, hard copy.



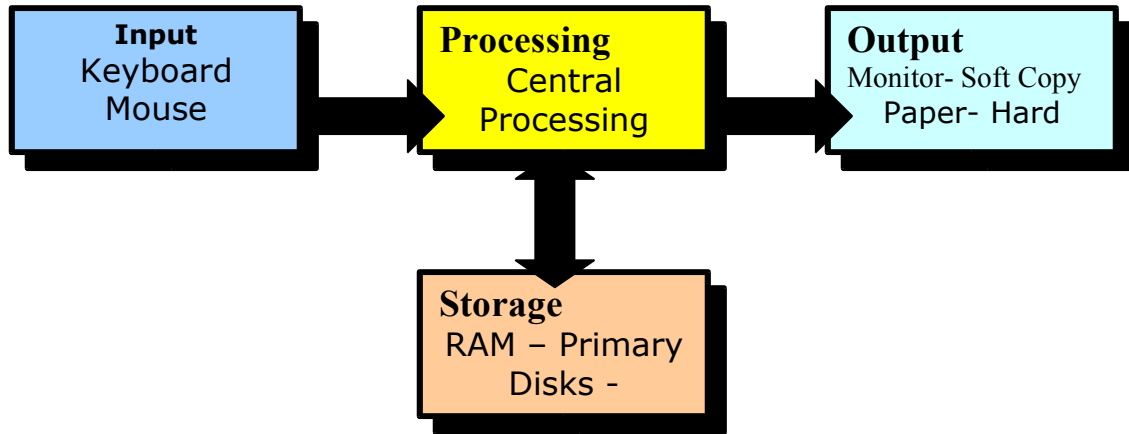
Some storage devices have data already stored on them for retrieval purposes while others can store new information when accessed like **RAM**. The **ROM** located in your computer is a special type of memory that does not write new data. ROM is used to store system programs of instruction that must be available at all times in order for the computer to function. An example is the BIOS program which enables the computer to boot or start.

The most common mass and portable storage media is the optical disk. Most storage devices are rated based on their capacities, using the **byte** as the unit of measure. To keep the rating system within a reasonable numerical size, metric prefixes are used. The most common prefixes used are giga, mega, and kilo. For example, in 2003, a computer's hard drive capacity was 40 gigabytes which is equivalent to 40,000,000 bytes. The numerical value along with the prefix helps determine which storage device has the larger capacity.

Example: A 20 megabyte hard drive is much smaller than a 1 gigabyte hard drive.

Example: A 750 megabyte CD-RW has more storage capacity than a 250 megabyte ZIP disk.

The following diagram shows the relationship and systematic procedure of a computer system's brain or central processing unit and the component hardware.



The **central processing unit (CPU)** is the brain of a computer system that includes control and arithmetic logic. In the input stage, information is sent to the central processing unit. In computer terminology this is referred to as an interrupt. This signal requires the immediate response of the processor. The coded bits of information, are then, processed logically through a series of steps. To keep track of what the processor was doing before it was interrupted, previous information will be stored in a stack on the RAM of the computer. The processor retrieves the instructions for the interrupt from a special section on the RAM or the BIOS. The rate at which this process happens is often referred to as speed and is measured in **hertz**. Again, metric prefixes are used for faster speeds. Ex. 2.4 gigahertz (GHz) is much faster than 100 megahertz (MHz). (How Computers Work, pgs. 26)

The **BIOS** is the basic **input/output system**, which acts as an intermediary among hardware, operating system and the processor. This specialized memory often contains specific instructions about hardware. The BIOS is the heart of the computer and is a specialized ROM chip that controls the boot process. The boot process is a self-check of all system components that happens each time you turn on your computer.

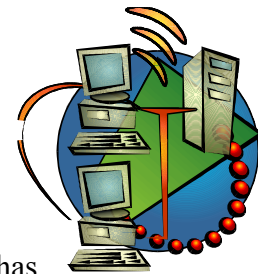
As the computer evolves, there is a need to share large quantities of information, devices, resources, and to communicate with other users. In 1957, Advanced Research Projects Agency (ARPA), a sponsor of advanced research projects at various universities, was redefined due to the Cold War. Paul Baran, in 1960, wrote a series of technical papers for the Pentagon analyzing the vulnerability of communications. Baran suggested two ideas to address communications vulnerability. First, communications should be sent through a distributed network where messages can travel in different directions to various

destinations. Secondly, Baran suggested that these communications be broken into blocks and that each block is sent separately over the network. Even though the Pentagon never built a military network, ARPA took the concept and converted it into a way for members to communicate. ARPA used the interface message processor (IMP) and a concept developed by the National Science Foundation called transmission control protocol/internet protocol (TCP/IP). This developed into ARPAnet that, by 1969, connected all the universities across the United States. It was not until 1991 that the Internet, as we know was born. Prior to this date, the Internet consisted only of textual information. When NSF lifted the commercial restrictions on the Internet it exploded into a graphics, sound and textural tool (How Computers Work, pgs. 298,299).

The Internet consists of a world wide **network** of 100 million users joined together for the exchange of information. A network general consist of two or more computers connected together in order to share resources. Today's networks use a device called a network interface card (NIC). The most common of these cards is the Ethernet 10/100 card. The configuration of a network is called the network topology. This is the way computers, printers, and other devices are connected. The two types of networks are local area network (LAN) and wide area network (WAN). A LAN is two or more computers connected together in the same building for the purpose of sharing resources such as data files, programs and printers. Several LAN configurations exist:



- Peer-to-Peer – each computer is a client and server to each of the other computers (nodes) on the network. This is the simplest and most common network to install.
- Client/server – one computer is the file server. The server (host computer) contains programs and data files that can be accessed by other computers in the network (client).
- Bus (Ethernet) – is similar to peer-to-peer network but each node has a unique address and send information using a network card. The card is used to listen and transmit signals to other nodes on the network.



A **WAN** is a network of computers that are located in various buildings, which are connected by a phone lines, T1 or T3 connections or the Internet itself. This type of network often requires specialized software for encryption to maintain security.



Electronic communication – can be represented in two types of signals.

Analog signals create a change in signal strength based on the information that it represents. If it is representing a voice signal and the volume increases then the signal strength will increase. The signal strength is an analog similar to the person's speech volume. A continuous electronic signal is an analog signal. New digital ones, such as the conversion from analog transmission of television signals to HDTV signals, are replacing many analog devices.

Digital signals are created by converting analog signals into bits of digital information. Digital bits are a series of microscopic switches. The switches can be "on" or "off." The "on" switches are represented by the number one (1) and "off" switches are represented by the number zero (0). Each "one" or "zero" is called a bit, short for binary digit. Binary refers to the number system that uses only "ones" and "zeros". Digital signals are pulsating electronic signals that are carrying digital code.

Analog or Digital Signals Transmission can be through the air, over cables (copper or fiber optic), over telephone lines, or over wired or wireless computer networks.

Wave Communication is electronic communication that uses radio waves to carry signals. To send radio and video signals a system converts images and sound into pulses of electrical energy that are carried through the air by electromagnetic waves. Your television stations, radio stations, wireless phones, and CB radios are all assigned different portions of the available electromagnetic spectrum so they won't interfere with each other. In a sense you see this assignment when you choose a particular radio station or TV station.

After the signals leave the TV or radio towers they are eventually picked up by an antenna on a radio, TV or other communications device and changed back into sound, still, or motion pictures. Examples of wave communication include radio, television and wireless phone systems. Today's trend is to switch from analog to digital signals because the digital signals have better clarity and are more reliable.

Communication Networks

A **communication network** consists of a number of computers that are linked together. In this way, data can be shared, as well as software and peripherals.

Computer networks consist of nodes and links. A **node** is an end point, such as a personal computer. A **link** is the channel between the two nodes.



A **local area network (LAN)** is a network that resides in a small area, such as a building. This network is used to link computers, as well as allow users to share peripherals. The computer that stores the software for the LAN is known as the **file server**.

A **wide area network (WAN)** covers a large geographic area and involves sending data over very large distances.

Topology refers to the configuration of nodes and links in the networks. The **star network** is used when a central host computer is needed. Links go out to each node from the computer - like a star.

A **bus network** is used for linking personal computers. A single cable is used, and nodes are hooked to the cable as needed. Data travels in both directions.

A **ring network** consists of a number of nodes linked together in circular fashion. Data travels in one direction.

A computer **network** is a collection of two or more computers (or workstations) and peripherals linked together to some form of communications equipment. They are linked together through a server so they can share software, hardware, and information. A group of computers physically linked at the same location form a **local-area network (LAN)**. A Group of LAN's linked over a wide area, such as across a province, form a **wide-area network (WAN)**.

At home your personal computer connects to the Internet through a piece of communications equipment called a modem. In settings where there are larger numbers of computers, such as schools, PC's are linked together using network adapter cards, also known as **network interface cards (NIC's)**. These adapter cards transfer data at rates much higher than those possible with conventional modems.



A sophisticated wiring and switching system connecting the network adapters helps route data from one computer to the next. The type of cabling you can use for networks is quite varied, ranging from simple telephone wire to coaxial cable to fiber optics cable. In addition to physical connection, a number of wireless communication schemes are in use.

What is a network?

A **network** is a group of connected computers that allow people to share information and equipment.



Why are computers networked?

- share information: networks can easily share data and programs.
- share equipment: computers connected to a network can share printers, scanners, modems, etc.
- eliminate sneaker work: a computer network eliminated the need to physically carry information from one computer to another.
- work away from the office: you can connect to the network at work to exchange messages and files.



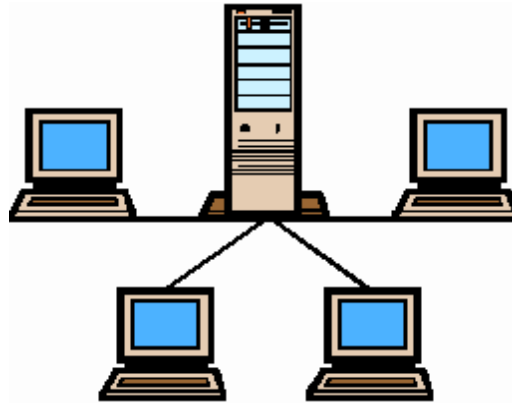
Types of Networks:

Local Area Network (LAN): is a network that connects computers within a small geographic area, such as a building.

Wide Area Network (WAN): a network that connects computers across a large geographic areas, such as a city, or country.

How Information is Stored?

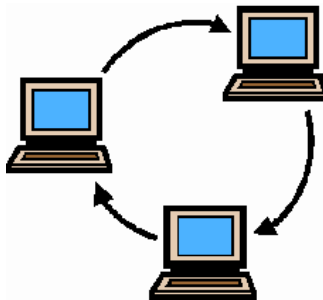
- **Client/Server Network:** all the people on the network store their files on a central computer (server). Everyone (clients) connected to the network can access the files stored on the server. An efficient way to connect 10 or more computers.



Server: stores the files of every person on the network.

Client: is a computer that can access information stored on the server.

- **Peer-to-Peer Network:** all the people on the network store their files on their own computers. Anyone on the network can access files stored on any other computer. An inexpensive way to connect fewer than 10 computers.



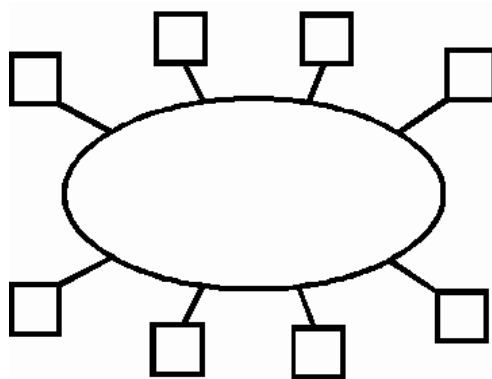
How Information is Exchanged?

Ethernet: is the most popular and least expensive way information can travel through a network. It is the easiest type of network to set up.



Ethernet works the same way people talk during a conversation. Each computer waits for a pause before sending information through the network. Information can travel from 10 megabits per second (Mbps) to 100 Mbps.

Token Ring: is a type of network often found in large organizations. It works by passing a single token from computer to computer. The token collects and delivers information as it travels around the network. Information travels at speeds of 4 to 16 Mbps.



Glossary of Terms

Workstation: A personal computer that's connected to a network is a workstation (or a node), however, workstations can also qualify as standalone systems. Each workstation has its own unique address that identifies it from the other nodes on the network.

Server: A server is a powerful computer that handles a network's shared resources, such as software, printers, data storage, shared directories, e-mail, and other services. One server may handle all these tasks or server servers might share the duties (often by dedicating each server to one particular task).

Network Interface Card (NIC):

A NIC is a printed circuit board you insert (like an expansion card) into a computer so the computer can connect to a network.

Once an NIC is in a computer, the operating system controls the NIC's electronic components through software drivers. The card manufacturer writes this software. While the software drivers link the card to the operating system, **network protocols** govern how computers communicate with each other.

In Microsoft operating systems the **NETBIOS extended user interface (NETBEUI)** protocol is used for small LAN's. The NETBEUI supports network communications. In larger networks, the **Transmission Control Protocol/Internet Protocol (TCP/IP)** governs the communication in many LAN's.

Internet Protocol: When a network is connected to the Internet, it needs a registered IP address for each node or device. The address is four sets of numbers separated by periods, such as 114.271.53.1. The IP works with Transmission Control Protocol to form TCP/IP, a standard for transmitting data over networks. Ip is the routing method for a packet of data, while TCP ensures that the packet arrives correctly at its final destination.

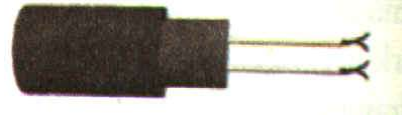
Network Switch: The **network switch** is used to reduce network bottlenecks. It does so by very quickly linking two network nodes and then quickly linking another two nodes when the first connection is done.

Types of Network Cabling

Network Connections

Unshielded Twisted-pair Cable: Made of two uninsulated, braided copper cables. Although the twisting of these individual pairs of cables minimizes electromagnetic interference, the lack of insulation makes the transmissions more susceptible to interference than shielded cable. Because this cabling is ordinary telephone wire, it's the least expensive transmission medium and is the easiest to install and work with. Unshielded twisted-pair cabling is the most common type of cabling used for local-area networks (LAN's). It's generally used for 10Base-T networks.

Shielded Twisted-pair Cable: Also made of two braided copper cables, this version is insulated with a metallic braid or sheath to make it less susceptible to electromagnetic interference than unshielded twisted-pair cabling. The transmission medium provides better performance, but it is very expensive and is more difficult to work with than unshielded twisted-pair cabling.



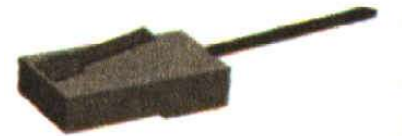
Coaxial Cable: A wire conductor surrounded by a cylindrical conductor and either insulating rings or dielectric materials, the entire cable is covered with a shield that blocks interference. Extremely durable, coaxial cabling lets users simultaneously transfer voice, data, and video signals. Available in thin (for 10Base-2 networks), and thick (for 10Base-5 networks) versions, thin coaxial is the most commonly used cabling. Providing more capacity than twisted-pair cabling, coaxial cable is also more expensive.



Fiber-optic Cable: Made of three sections: the core (innermost layer consisting of at least one glass or plastic fiber); the cladding (glass or plastic coating with a different composition than that of the core); and the jacket (outer layer made of plastic and other materials to protect the cable from damage). Uses light to transfer voice, data, and video at high speeds. Commonly used for wide-area networks (WAN's) because it can send data across longer distances and isn't affected by "cross-talk," or disturbances caused by radio waves. Still fairly new, fiber-optic cable is still too expensive to make it a feasible solution for home and small office networking needs.



RJ-45 Connector: Used in data transmissions across telephone wire, this eight-pin connector is used on 10Base-T networks using twisted-pair cabling. The wider end of the connector fits into the external end of a network card through the back of a computer's case.



BNC T-Connector: A metal connector in the shape of the letter *T*. One end plugs into the external end of a network card on the back of a computer's case. The other ends form the top of the *T* and connect with network cables. This connector is used with coaxial cable on 10Base-2 networks.



PROJECT No. 5:

Objective:

- Students will design a communications network to resolve a given problem.

Problem:

The Newfoundland Provincial Government recently stopped posting government tenders in the local newspaper. Instead, the government is posting all tenders on their web site. Interested bidders have to log on to the government web site to learn about the latest tenders. Fearing his company will be left out of many lucrative government contracts, Mr. John H. Martin, CEO of Island Construction Inc. has decided to network his companies small office. Mr. Martin believes networking the office will allow his employees to connect to the Internet as well as share files and resources such as printers, scanners and plotters.

Island Construction Inc. is a very small company, and it can't afford to hire expensive computer consultants to design a network for the companies office. Island Construction has some techno-savvy people on staff, but the thought of creating a network for computers in a small office can make even those techno-savvy PC users turn an interesting shade of green. You are particularly interested in Mr. Martin's dilemma because you have been studying about computer networks, have examined examples of computer network, but never had the opportunity to design a network before.

Mr. Martin jumps at your offer to design Island Construction's network. Finally, you have a chance to create a small network. Before you begin, Mr. Martin would like a detailed list of what hardware and software you will need, and what each item will cost. Before you give Mr. Martin a list of what you need, you will have a make a very important decision - what type of network will you use?

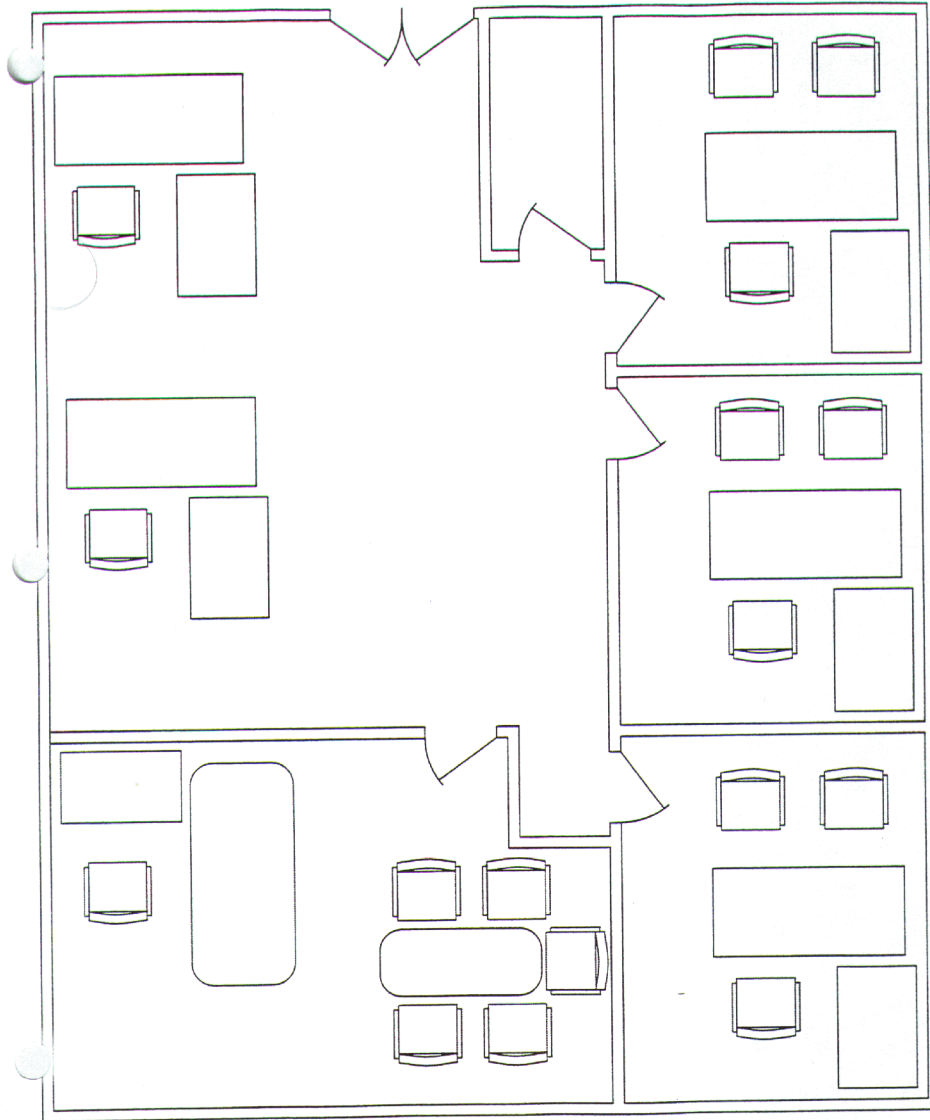
There are three basic questions you will have to answer when putting together your network. The first is which network operating system are you going to use? Second, you must decide which type of cable to use to connect the computers. The third question is

based upon how you answer the second one. The type of cable you select will determine for the most part which network adapters you will want to use and if you need any additional network components such as network hubs.

Mr. Martin provides you with a copy of the [office floor plan](#), and a list of [specifications](#). Use CAD software to generate the model. The design should be annotated, and rationales developed for each choice. Information on pricing as well as technical specifications should be provided on a separate page. You may also wish to discuss issues not presented in this activity that may affect the proposed office network.

Office Floor Plan

Island Construction Limited



Island Construction Inc. Office Network Specifications:

- each workstation has a computer that must be networked
- Ethernet cards are preferred
- a laser printer, a color inkjet printer, and plotter will have to be connected to the network
- users will need to share all peripherals, and files
- users will need access to the Internet
- the office will also need access to LAN based e-mail