UNIVERSITY OF MARYLAND
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Learning Resource

Information and Information Sharing (Networks)

How Is Information Shared?

Before we look at the vehicles by which information is shared, we need to consider what information sharing means. Information sharing, according to Technopedia, "describes the exchange of data between various organizations, people, and technologies." There are several types of information sharing ("Information Sharing," n.d.):

- Information shared by individuals (email messages, chat messages, postings on Facebook or videos posted on YouTube, research papers submitted to an online forum)
- Information shared by organizations (such as business and business financial reports, or the RSS feed from the online branch of a cable news station)
- Information shared between firmware/software (such as the IP addresses of available wifi hotspots or the link between your computer and smart TV).

The sharing of information did not suddenly start with the advent of technology. Humans have been sharing information ever since there were two who could communicate in any way. But in the not too distant past, it was challenging for information to be shared electronically, either because there was no internet connection available or because hardware and software applications on the two ends of the communication line could not really "talk" to one another.

The introduction of wide- and local-area networks, networks within businesses (intranets), and of standardized protocols and application compatibility among a widely diverse set of computer hardware and software have all facilitated the huge growth in global information sharing. This growth is exponential as more networks and organizations connect and information becomes easier to share across the internet ("Information Sharing," n.d.).

Emerging Technologies That Support Information Sharing

How big is the internet? The internet is a massive collection of networked computing devices. The World Wide Web is the means by which these computing devices share data or information. We often use the terms internet and World Wide Web as if they mean the same thing.

So the size of the internet is a difficult question to answer. Is the size based on the number of web pages? Or is it the number of individual pieces (bytes) of data available and/or shared on a more or less daily basis? Should the dark web (the portion of the internet accessible only with specific browsers) be

included? If the size is based on data, then should the data stored in the "cloud" also be included? Or should we simply count the number of computing devices that may be accessing data? Or the number of web pages that can be reached? One can see the challenge in trying to assign a size to the internet.

- Data: Think of a byte as representing a single letter or character that you could type via your keyboard. Based solely on data, it is estimated that the growth of the internet will double every two years and by 2020 will be approximately 40 zettabytes (40,000,000.000,000,000,000,000 bytes) (Live-Counter.com, n.d.).
- Websites: On the other hand, if the size of the internet is calculated on the number of websites that you could access via Google, Bing, Yahoo, Edge, or any other browser, then the size of the number of pages on the World Wide Web may be estimated at 2 billion (de Kunder, 2018).
- Computing devices: Finally, what is the estimate of the number of computing devices that have access to the internet? We have to consider all devices that connect to the internet, i.e., computers, smartphones, watches, traffic signals, thermostats in homes (all of this interconnectedness is called the internet of things). The prediction is that by 2020, there will be four such devices connected to the internet for every person on the planet—about 24 billion (Business Insider, 2018).

Whichever means is used to think about the size of the internet or the World Wide Web, the numbers are beyond ones we can even imagine.

But data/information sharing relies on networks. So let's look at some network basics.

Network Basics

How does data get from one computer to another over a network? When you send an email or text message, post a response to a discussion question, or submit a file to the assignment folder in class, how does that data get from your machine to the destination? We will address these questions here in a simple way without delving too deeply into the technical underpinnings or the architecture of a network.

Clients and Servers

First, there are at least three computing systems in play, yours (the origin), the computer at the destination, and, in between, a server. In reality, there are many more computers that are involved in this transmission, but we will focus here primarily on the origin and end point of the data that is being sent. The computers at the origin and the destination are considered clients. A server provides the services that a client uses.

First, a brief bit about the server. There are different types of **dedicated servers** (servers that are never clients as well), depending upon the services they provide to clients (e.g., email, internet access, storage of files, even access to a printer). Typically, dedicated servers run a specialized type of operating system that enables these computers to handle the functions of a server. But a single server can provide multiple functions, and some can also be clients.

In a home network, at least one computer that is connected to a router acts as a server for the other computing devices in the home. The operating system on that computer makes this computer both a server (for the other devices on the home network) and a client which accesses and uses the services of

servers outside of the home network. A dedicated server is not required in this type of network, sometimes called a peer-to-peer network.

When you send data, you are the client and you connect to a server that processes the data according to the type it is. In the case of an email server, it takes your email and sends it forward to the destination computer. In the case of posting to a discussion or submitting an assignment, you are still the client, and the university's dedicated educational servers take your submission and send it to the correct destination in your classroom, which is located on the university's computers.

Sending and Receiving Data Over the Internet

Let's say you want to send a picture of your cat to your favorite aunt.

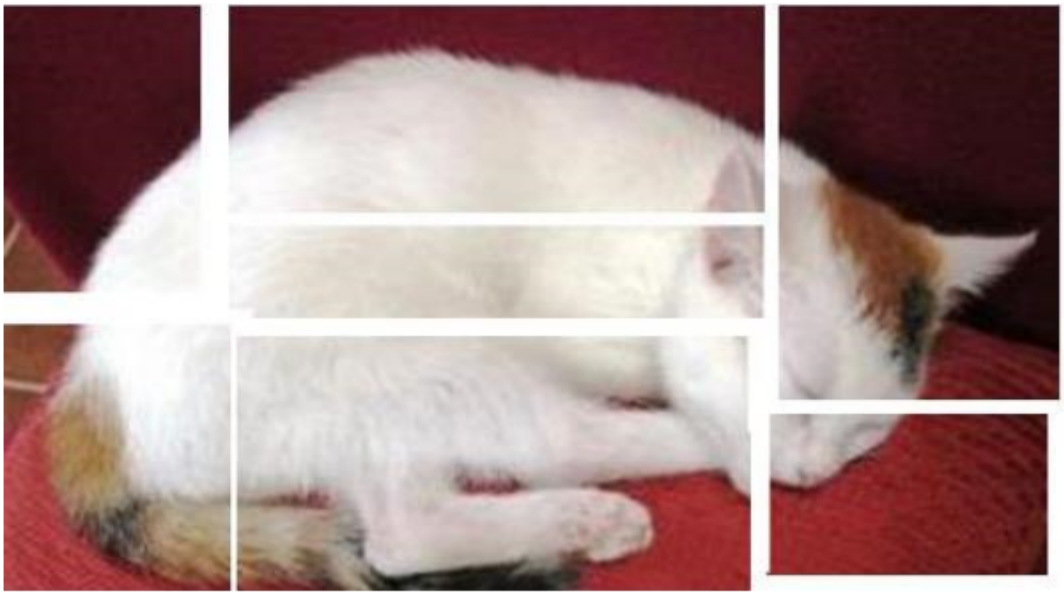
My Cat

You attach the picture to the email and send it on. What actually happens to that picture and the email message to which it has been attached?

All data in the computer is stored actually as a series of 1s and 0s (what you see on the screen is a translation of that set of digits). So the email and the picture you are sending are stored in the computer as 1s and 0s, and small sets of these numbers (called packets) that make out the contents of your email are sent out over the network.

Each packet has an origination address (your computer), a destination address (your aunt's computer) and a sequence number. The sequence number allows the packets to be reassembled in the correct order at the destination. The picture will be cut up into packets and the packets put on the network.

Remember that the internet is an interconnection of millions of pathways between connected computers. The email server determines which pathway is best to use – for each individual packet it sends forward. We will talk about transmission speed and bandwidth and how this affects the pathways in the next section. The individual packets that make up the cat's picture may not all take the same route to the server and then on to the destination. (Here, each rectangle represents a packet.)



White Cat in Sections

Because each packet may take a different path to the destination, these packets may not arrive in the same order in which they were sent out.

White Cat in Jumbled Sections

So the picture needs to be reassembled at the destination in the correct order. That's where that sequence number comes into play. When the individual packets are received from the email server, they are put back together in the correct order. And the cat appears complete.

Cat Arranged in Correct Order

Transmission Speeds and Bandwidth

Have you ever noticed a lag time when attempting to download a web page, a file, or a video via the internet? Or heard others complain about how "slow" the internet is? Or have not been able to even load a web page? What are the elements that affect the transmission of that data over the internet (the largest of the networks)?

Transmission speed and bandwidth are separate elements, although both are measured in bits per second, kilobits per second or megabits per second (a bit is a single 1 or 0, a kilobit 1024 bits, and a megabit about 1 million bits). Bandwidth refers to how much data (how many bits) can be pushed during any one second. Transmission speed refers to how fast those bits are sent or received. The two are interconnected and hard to separate because one affects the other.

Transmission speed is measured in bits per second. Anything less than 1 megabit/second (Mbps) is considered slow (turtle speed), while 50 Mbps and up (even 1 gigabit/second) are preferred (cheetah speed). But speed can be affected by the equipment you are using—your computer, your router, or even the cable used to connect your computer or router to the internet access point. Speed can also be impacted by the number of users who are accessing the same site (Opera blogs, 2015).

Your computer may be able to handle (send or accept) large amounts of data in one second, but the speed your internet provider uses to push the data or the capacity of your transmission lines may affect the speed at which that data is sent or received.

On the other hand, bandwidth refers to the number of bits that can be pushed in one second, regardless of the speed at which they are transmitted. Bandwidth might be compared to whether your connection has the capacity to handle a bowling ball or a marble. The larger the capacity, the more data that can be pushed in any one second. But even if your connection can handle a bowling ball, if the transmission speed is that of a turtle, or the connection is clogged by other users, it will appear that the download is slow. The best combination, of course, is a high rate of transmission and a large bandwidth.

In summary, bandwidth relates to the amount of data that can be uploaded or downloaded from your computer (measured in bits/second). Speed (transmission speed) relates to how fast that data can be pushed through the transmission lines to or from your computer (measured also in bits/second) (Tiwari, 2017).

Let's put this into perspective by looking at the elements of a network in your home or one in a small business.

Hardware and Media

Think of all the ways in which home computers are now used: schoolwork, shopping, email, calling family and friends, playing games, watching television shows, downloading music and videos. Many households have more than one computer, creating the need for small home networks. A home network allows computers to share access to the internet; use a single printer; send and receive files, pictures, and other documents; and even share access to televisions and game systems.

Different network types may have different hardware, but share the same components (Wilson & Fuller, n.d.):

- more than one computer
- hardware (modem and router) and software
- a path for the information to follow from one computer to another; this path is the medium, and it can take the form of wires or cables or radio waves
- a firewall—a hardware device or software program that protects the network from malicious users or hackers and makes transactions secure

Communication Hardware

You need a way to allow the computers in the house to "talk" to each other (e.g., share files) and to surf the internet for such services as email, social networking, and search engines needed for news, information, or online research. If you are connecting a computer to the internet, you are joining a vast network of computers. If you are linking computers in the household with each other and each with the internet, you are creating a home network that, in turn, links to the vast network of computers that make up the internet. We will look at two of the components needed to establish and maintain that connectivity.

Modems

Signals between computers travel over wires such as phone lines, cables such as those provided by your cable company, or, less often, satellite signals. The data that is entered into your computer for processing and the information that results from processing as output are stored in digital format, commonly referred to as zeros and ones.

But telephone wires were originally designed to transfer the sound waves represented by the human voice. Wires transfer computer-generated data, too, but via a different format: analog signals. Sound waves are called analog and represent data continuously, like a clock with hands, rather than digitally (with a series of zeros and ones) as computers do.

A device is required to convert the digital output from the computer into an analog format for transfer and then to rebuild the original data into digital format at the receiving computer. That device is called a **dial-up modem** (modulator-demodulator). A digital subscriber line (DSL), CATV cable (the same type of cable that provides cable television), or fiber optic cable will support transmission of the data in digital format, and your modem will most likely be a **digital** or **broadband** modem.

The last type of modem is a **wireless modem**. This type of modem uses the cell phone network and connects to the internet wirelessly via cell signal providers.

The following images are examples of standalone (external) modems. Each would have an RJ11 jack for a DSL connection, or a coaxial jack for cable, and at least one Ethernet jack. This device is what you use to actually receive your internet connection through phone line or cable.

Modem 1

True Tech Talk Time (2011), Wikimedia Commons

Modem 2

Source: Digitalsignal, 2013, Wikimedia Commons

This picture shows the connection options.

- gray, where a telephone line would be connected for a DSL service
- blue, where a USB cable might be connected
- yellow, where an Ethernet cable would be connected:

Modem 3

Source: Feureau (n.d.), Wikimedia Commons

A connection for a coaxial cable is not included in the above picture. This is a picture of a typical coaxial cable.

Coaxial Cable

Routers

Wired Router

Source: Asim Saleem, Wikimedia Commons

ASDL Router With Wi-Fi

Source: Asim Saleem (2007), Wikimedia Commons

TPLink Router

Source: Firecracker PR (2013), Flickr

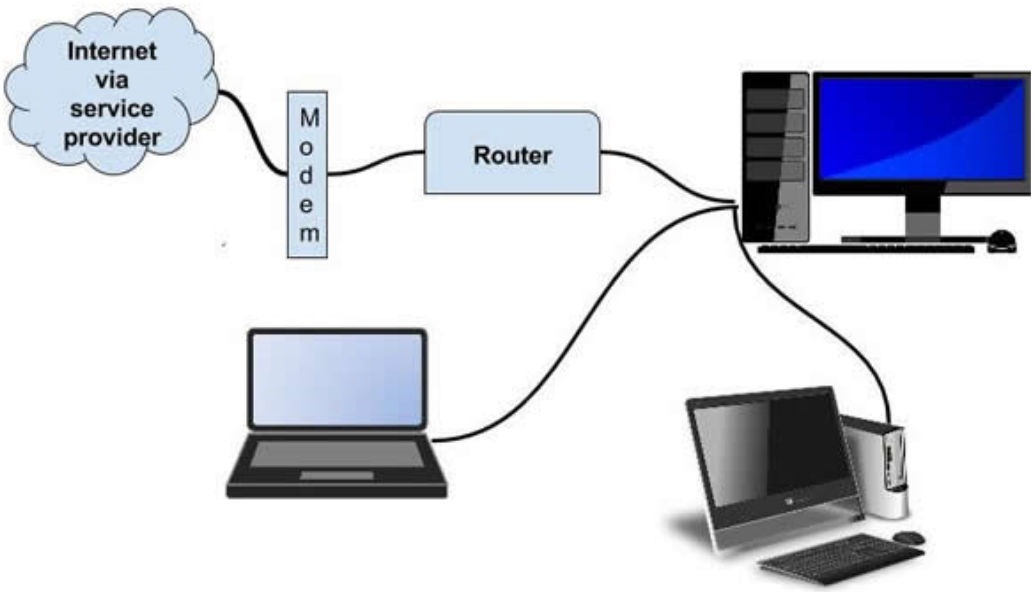
The top image is of a wired router—each computer would be connected via Ethernet cable. The other two are wireless routers.

If you are connecting more than one computer to the internet, the other component you will need is a router. In general, a **router** connects networks that use different communication protocols, such as a home network and the internet. In a typical home network, a router is used to allow multiple computers to access the internet or other computers via a single modem. The router will receive data from the individual computers and send it to the correct destination. Just as important, the router sends the received data from the internet or other sources to the correct computer in the home.

In some cases, the modem and router may be combined into a single device. Although it is not accurate to say that modems and routers are identical, most likely the small box supplied by your Internet service provider (ISP) is likely a combination of both modem and router. If the device that is connected via phone line or cable has an antenna, it is likely a combination of modem and wireless router.

Network Configurations

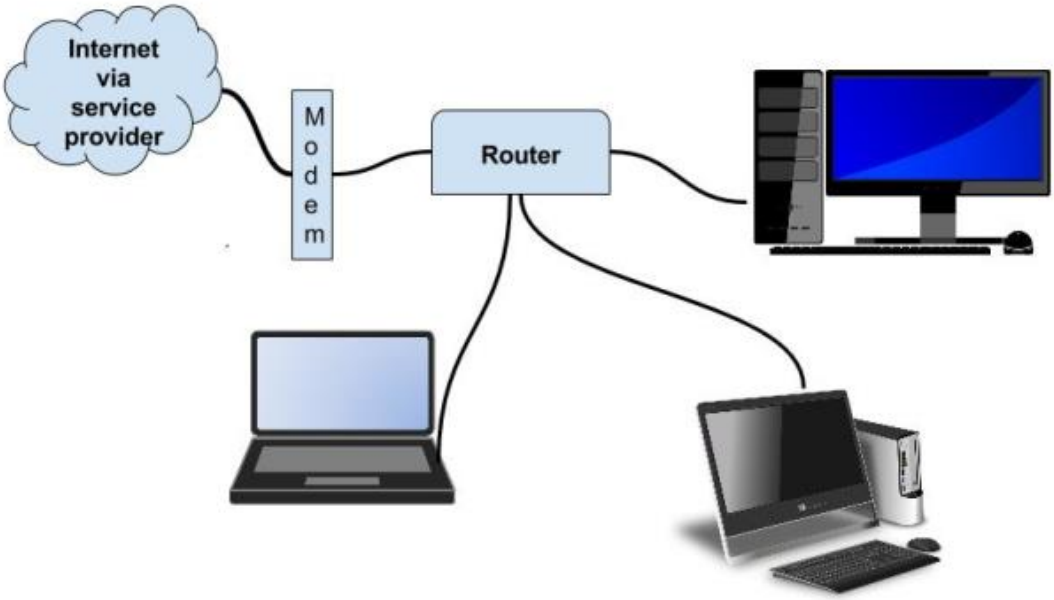
1. One computer in the system, called the server or host, is physically connected to the router via a cable. The other computers in the home are clients that need to be connected to the host or primary computer (the server). The router must be positioned between the primary computer and the modem.



Network Configuration 1

Source: Janet Zimmer, Creative Commons

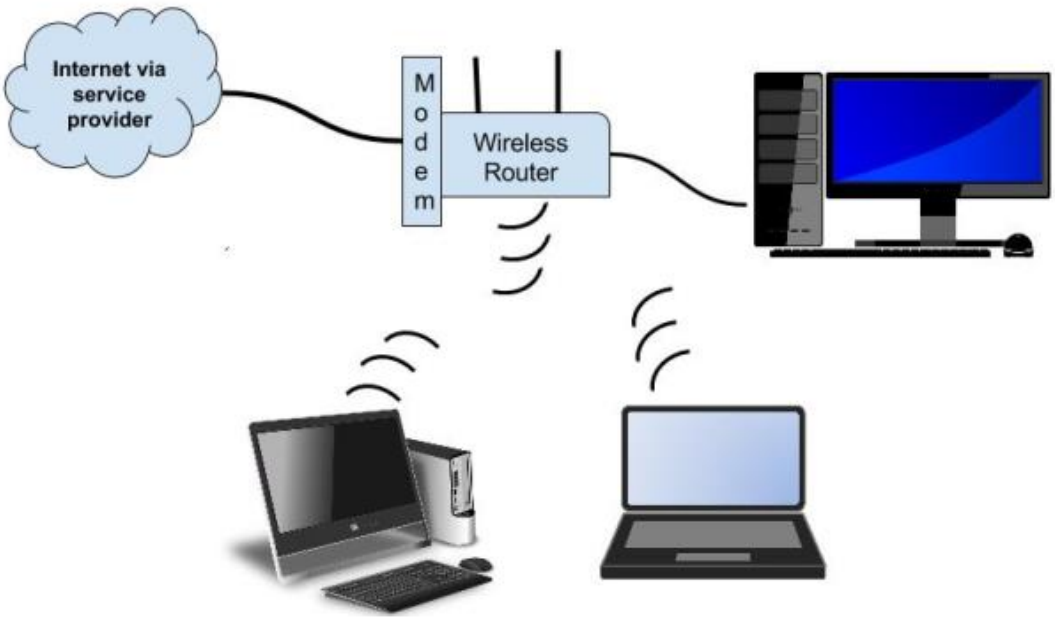
2. The client computers may all be connected directly to the router via ethernet cables:



Network Configuration 2

Source: Janet Zimmer, Creative Commons

3. The computers may all be connected to a wireless router. Even if a wireless router is used, one computer might be cabled to the router. But none of the other computers needs to be cabled to the server. Each can access the router, and thus the modem, without the need for a server machine. This is definitely the case if you are connecting to the internet via a Wi-Fi hot spot. You are accessing other computers or the internet via a wireless router that is in turn connected behind the scenes to a modem, which connects to a wired network.



Network Configuration 3

Source: Janet Zimmer, Creative Commons

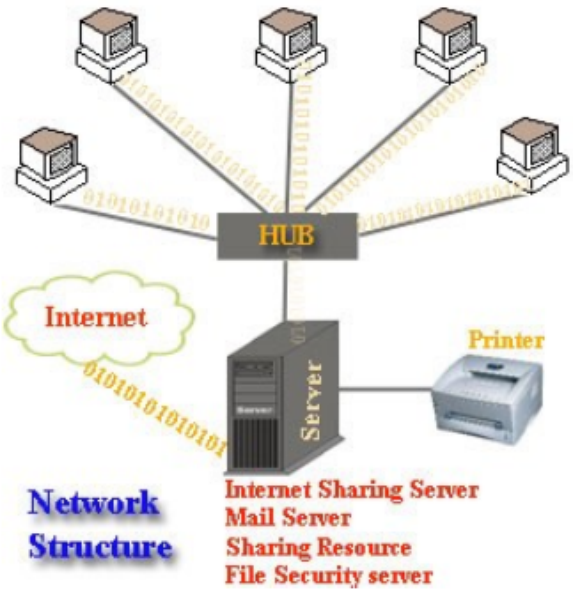
Now let's expand this into a larger environment, such as a business that has multiple employees, possibly even spread over various countries in the world.

LANs, MANs, WANs, and GANs

Instead of having a desktop or laptop acting as the server, data and information is shared with others on the network through connections to other computers and to a larger mainframe computer or network attached storage (NAS) hardware device, which acts as the server. The peripheral computers on the network may be connected via cables or via wireless access points.

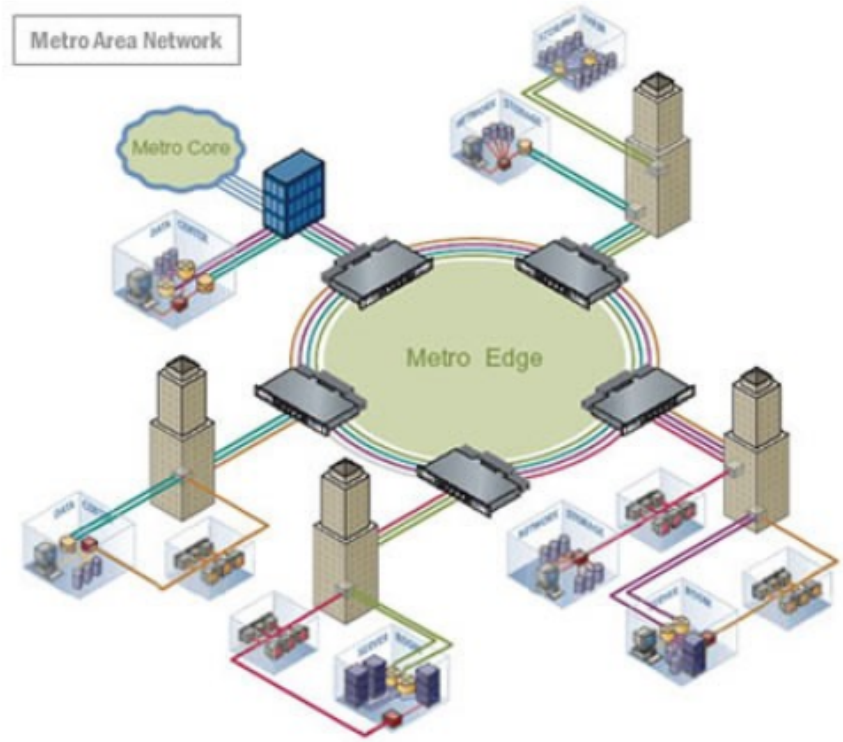
The basic components are the same—multiple computers connected so that data can be shared. The difference between a local area network (LAN), metropolitan area network (MAN), wide area network (WAN), and global area network (GAN) is geographical—that is, the limitation of distance between the computers and the larger mainframe or server than controls the network and data flowing across that network. MANs, WANs, and GANs also typically consist of multiple networks.

- In a LAN, the network is confined to a limited area (think of a college campus).
- A MAN would typically be found connecting various networks in a city (so that you can access the municipal network, the police, etc. Or, for example, the MAN covers the computer networks at the UMUC main campus in Adelphi, Maryland, with the campus in Largo, Maryland.
- A WAN covers areas that consist of multiple LANs or MANs, or even networks based in different countries. Typically, a WAN will use satellites to provide a bridge between widely dispersed networks.
- A GAN is not limited to any geographical area and, in fact, spans the entire globe. The internet might be considered a GAN.



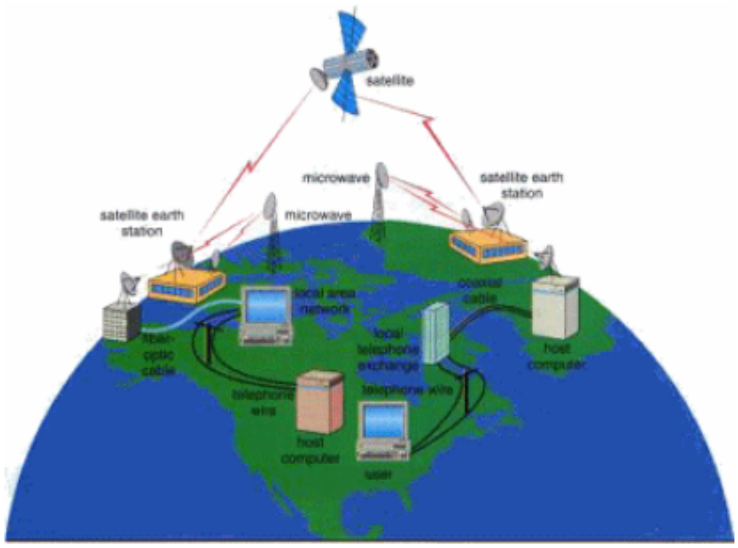
LAN

Source: Microsoft



MAN

Source: Microsoft



WAN

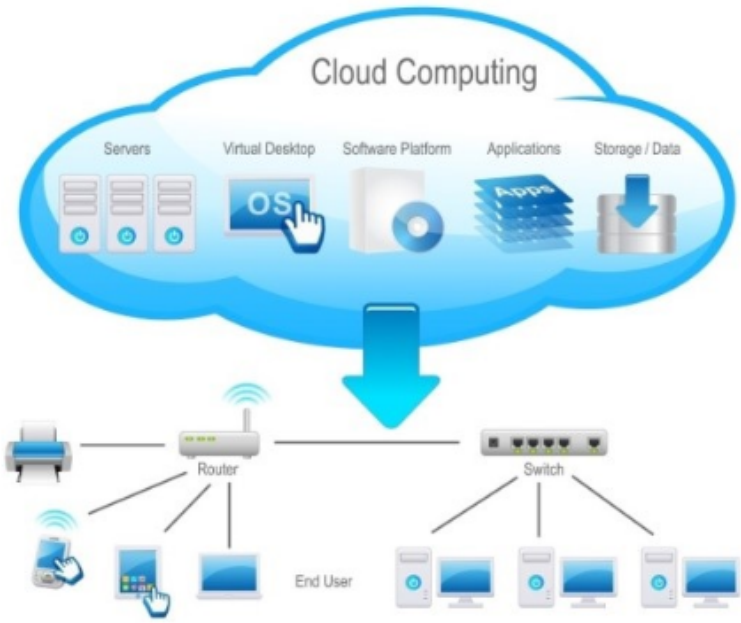
Source: Microsoft

GAN

Source: Microsoft

Cloud Computing

If you or a business employ cloud computing, (if you are using Office 365, for example, and have not downloaded a copy of Office to your local laptop), that simply means that instead of storing and accessing data and programs via the mainframe server, the access is solely over the internet. There still is a physical server (or servers) where the data and programs are stored, but access is solely via the internet.



Cloud Computing

Source: Microsoft

What Is the Internet of Things?

"The internet of things (IoT) is a computing concept that describes the idea of everyday physical objects being connected to the internet and being able to identify themselves to other devices" ("Internet of things," 2017). Another way to define the IoT is that of a network of internet-connected objects able to collect and exchange data using embedded sensors (Meola, 2016). Think of these "objects" as devices that can recognize and connect to other devices (without human intervention) and can, as a result, share data and even analyze that data. Most of these devices are, by nature, wirelessly connected. Experts predict that more than 24 billion IoT devices will be in place by 2020 —about four devices for every human on the planet (Meola, 2016).

Why Is the Internet of Things Important?

You are probably already aware of some of the things that connect separate devices, such as a home alarm system and a smartphone. There can be economic benefit from analyzing the resulting data streams. Here are several examples from SAS (n.d.):

- Intelligent transport solutions speed up traffic flows, reduce fuel consumption, prioritize vehicle repair schedules, and save lives.
- Smart electric grids more efficiently connect renewable resources, improve system reliability, and charge customers based on smaller usage increments.
- Machine monitoring sensors diagnose—and predict—pending maintenance issues, near-term part stockouts, and even prioritize maintenance crew schedules for repair equipment and regional needs.
- Data-driven systems are being built into the infrastructure of "smart cities," making it easier for municipalities to run waste management, law enforcement and other programs more efficiently.

Here are some of the devices, current and future, that are or will be part of the IoT: smart thermostats, light bulbs, refrigerators, toothbrushes, pet feeders, and coffee makers. Various IOT devices are implemented in a large-scale fashion in things like security systems, smart homes, and factories.

Because of this incredible number of connected devices being put in place, there is rising concern about security and privacy. "Hackers could penetrate connected cars, critical infrastructure, and even people's homes" (Meola, 2016), prompting tech companies to assess the cybersecurity concerns.

Summary

Before the advent of the internet and its very global reach, data was often kept in silos, which prevented easy sharing with other entities. This was the result of formats for the data that were proprietary (created by and for a specific business or entity). The data could not be easily ported to other recipients, or simply could not be either exported or imported because of incompatibilities between the hardware and/or software on the two ends of the data pipeline.

For example, dates can be stored in various formats such as 03-04-2017 or March 4th , 2017, or as in countries outside the United States where the date comes before the month (04/03/2017 refers to March 4th, 2017). These different formats made the sharing of a date field problematic. For the most

part, these problems have been taken care of by programs that recognize the various formats for dates, making the sharing of data between computer networks commonplace. This has also been driven, to a large extent by social networking. Technopedia summarizes this nicely:

> *Facebook has 750 million accounts, YouTube has over 400 million, and the other social networking sites and applications have established between them a sharing network of over a billion people. In terms of information sharing, this is a global proportion, with almost 10 percent of the world's population sharing information across common networks regularly ("Information sharing," n.d.).*

Information sharing, if used intelligently, can lead to a more effective way to manage any organization, whether it is a government or a business. The sharing of information about products and services can lead to an improvement in customer access to services and customer satisfaction. Local and international access to banking and other financial products, as well as shopping, are already common and go beyond the entertainment value of a social media site such as Facebook.

Intelligent information sharing can result in lower costs, as well as "improving overall accuracy of public data and allowing organizations and individuals alike to have access to information that they might need and entertainment that they want to experience" ("Information sharing," n.d.).

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