1 Introduction to Networking

1.1 What are networks?

That seems like an appropriate question to start with. Pretty much anything that's connected to anything else in some way can be described as a network. In this course, we'll be primarily concerned with computer networks, where we have several computers connected to each other.

1.2 Why study networks?

While we are mostly interested in computer networks, it turns out, most networks are becoming 'computer networks'. Everything is digital—and everything digital is best processed and manipulated via a computer. So while we will mostly be concerned with computer networks, it is important to realize that those same networks can be used to transmit telephone conversations, video, etc., and any sort of information we would expect a network to carry.

1.3 What is communication?

Well... the phrase *communication* can have many definitions. The one we will be concerned with is: Anything that goes on between *nodes* on a network. A bit more explanation in the following sections.

1.4 What is a network?

A network can be defined just as loosely as we've defined communication. For the purpose of this class, We will view a network as a *graph*. A graph has edges and nodes. Nodes will usually represent computers (or routers, devices, etc.), and edges will represent links, such as physical copper wire links, or wireless links, etc.

In most of our examples/situations, we will be concerned with a sender and receiver, which are just two nodes on the network that would like to communicate.

1.5 Some history.

As a communication medium, the computer networks grew out of telegraph networks. In 1800's, folks started sending each other text messages, over long distances via wire, using what's called a Morse code. This was just a bunch of dit-dats (well, respective signals) that would translate into English. This allowed for much faster communication.

A few years later, a bunch of folks (Graham Bell among them) figured out to send voice over similar wires. The trick is that Western Union (the telegraph super power) still continued using telegraphs. So out of seemingly similar technology, we got two different networks: the phone network, and the telegraph network. As you can probably guess, both prospered, etc., since they were mostly interested in different domains: telegraphs were interested in data, while phones were interested in voice.

Later on, among other things, a "teletypewriter" was invented, which allowed you to 'type' remotely via the telegraph network. A person would type on a device that looks like a type-writer in city A, and everything they type would be printed out in city B. And that's partially why we have a bunch of `/dev/tty*` devices on UNIX.

Around the 1950s, with the invention of a transistor, most major phone companies (AT&T) started to convert their old 'analog' based telephone networks to digitally switched networks. Those networks are not that different from computer networks we have today. Before that, there needed to a physical copper link between the two phones. The way that was accomplished is that everyone would connect to the "central office", which would make a physical connection between two end-points for communications[1]—this used to be done by humans, later on by mechanical machines—and right now, by computers. More details in class.

2 Network Topology

If a network is a *graph*, we would expect different types of *topologies* to exist. And in fact, they do exist. (pictures in class)

2.1 Star Networks

These are the simplest ones. You have a central "server", and everyone connects to that server. That's it.

2.2 Hierarchical Networks

Similar to a star, except with several levels.

2.3 Mesh Networks

A mesh network would appear similar to a wire mesh. Basically anything can connect to a few or more points.

2.4 Bus Networks

In a bus network, there is a communication bus to which computers connect. Only one thing can be on the bus at the same time, and any computer can listen to the bus.

2.5 Ring Networks

In a ring network, the nodes are arranged in a ring, and they send messages to each other, usually in a single direction.

[1]The signals would have a direct copper path from your telephone to the recipient's telephone. There were a few pranks that put a *huge* voltage the line to blow out recipient's telephone.

There are exceptions where the ring is a 2-way ring, where messages can travel in both directions.

3 Network Classification

As we've seen, we can classify networks by their topology. We can also classify networks by who owns them, how big they are geographically, what type of data they transfer, what kind of medium they use, etc.

3.1 Local Area Networks

This is your average LAN. Small organizations generally have their own little computer networks. These can either be stand-alone networks or connected to other networks, etc.

3.2 Metro Area Networks

These are your bigger LANs. These can span a city. Many large companies have offices in diverse parts of the city—and often they have their own private network that spans their different locations. Since geographically it's not 'local', it's a MAN.

3.3 Wide Area Networks

Another notch up the scale is the WAN. These can span states, countries, and even the whole world. A good example of a WAN is the Internet (as well as a telephone network).

3.4 Private Networks

Ignoring the size, etc., these networks belong to some corporate entity, and are mostly used for businesses purposes of that corporate entity.

In real life, this is rather uncommon (now a days), and most private networks lease part of their bandwidth to other businesses to off-set the cost of running their own private network.

3.5 Public Networks

These are networks used by the general public. The telephone, and the Internet, etc., where everyone's packets are along with every body else's packets travel side by side.

3.6 Value Added Networks, or VANs

This is a rather loose classification, which basically say that instead of just providing a communication platform, the network also adds some 'value' (definition of 'value' is arguable) to the parties involved. For example, there is a SWIFT network between banks, that is used to settle transactions/deposits. There is also the airline reservation system, etc.

3.7 Wireless Networks

There are quite a few of these. The obvious thing about these networks is that they have less wires :-)

3.8 Backbone Networks

These generally comprise very fast and very robust large scale networks, through which smaller networks can communicate. For example, the Internet has a few backbones stretching the country. If you connect to a web-site that's located in say California, your message will travel in your LAN, etc., and eventually it will hit the backbone that stretches the country.

3.9 Voice Networks

Networks that carry voice :-) Usually we call these telephone voice networks. They're not on the general Internet, even though they use many of the same/similar technologies that are found on the Internet.

3.10 Private Voice Networks

These are usually company wide telephone networks. This is how you can dial an extension to get to someone in the same company. These are done via PBX (Private Branch Exchange), which is basically a small part of the public telephone network in your own private control.

3.11 Inter-connecting Networks

There are networks that exist for the sole purpose of connecting other networks. Isn't that cool?

4 Synchronous vs. Asynchronous

When dealing with networks, we have to be aware whether the network is synchronous or asynchronous.

4.1 Synchronous

There is an external (or some sort of global) clock that every node is aware of. All events happen on the click of that clock.

This is a really simple situation, and is generally only useful in a lab setting (or to model distributed algorithms).

4.2 Asynchronous

Each node has their own clock (speed). This is true to reality, and also happens to be quite complex for communication purposes. For example, we don't know if a particular computer fails or just didn't receive a message.