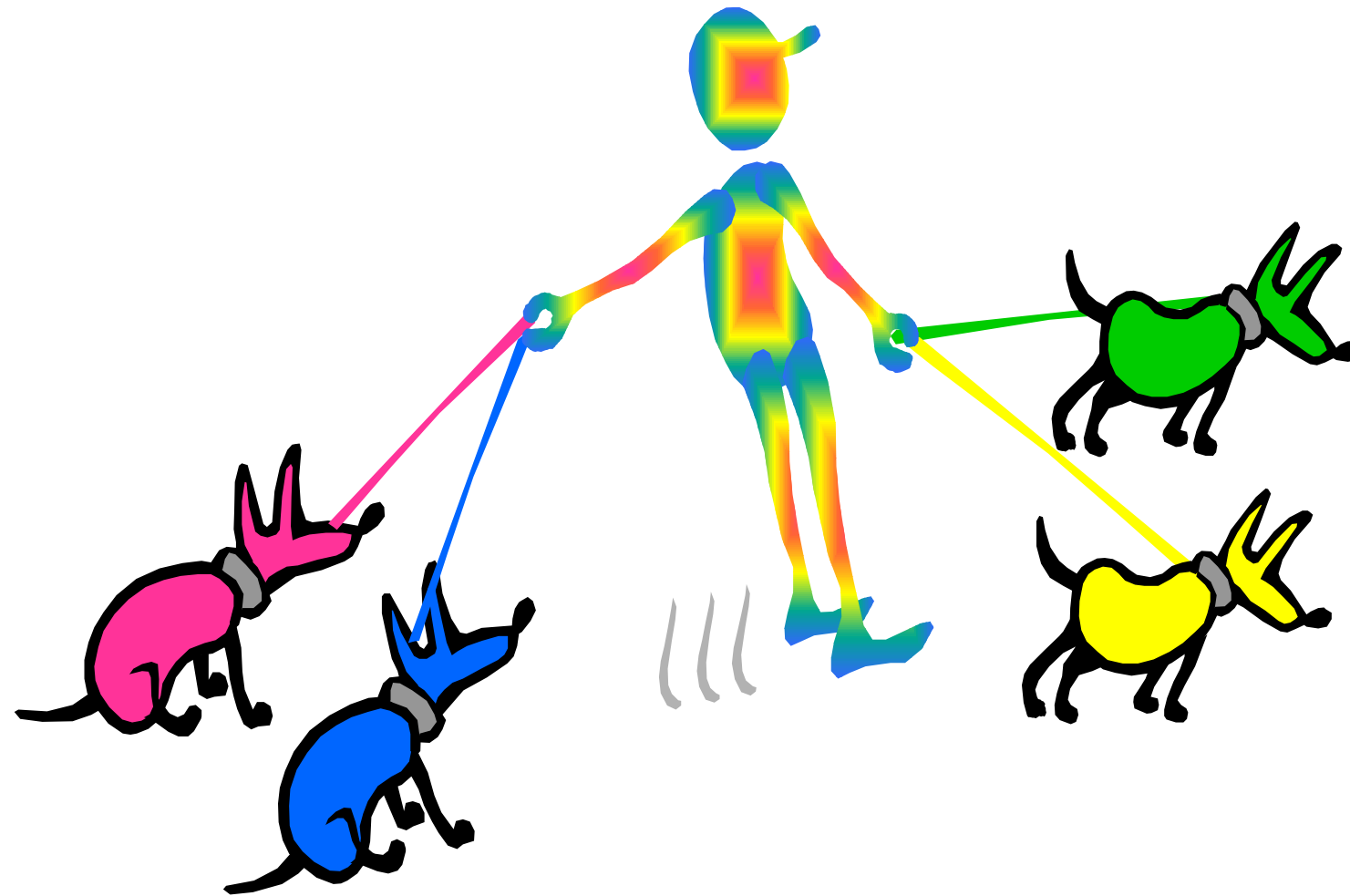


The Basics of Networking



Title: The Basics of Networking
Author / Issuing Department: Bertrand Ravigne / Training Department

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Why Networking?

- As PC became more common, it became obvious one would need to share data and peripherals between them efficiently.
- Floppy discs could not be the solution. Hence the idea of a network.
- The necessities to have one database that many users can access simultaneously made networking very relevant.
- Great demand to share devices (e.g. printer sharing in companies).

How?

Basically a series of PC linked together via a cable system that would transport the data flow.

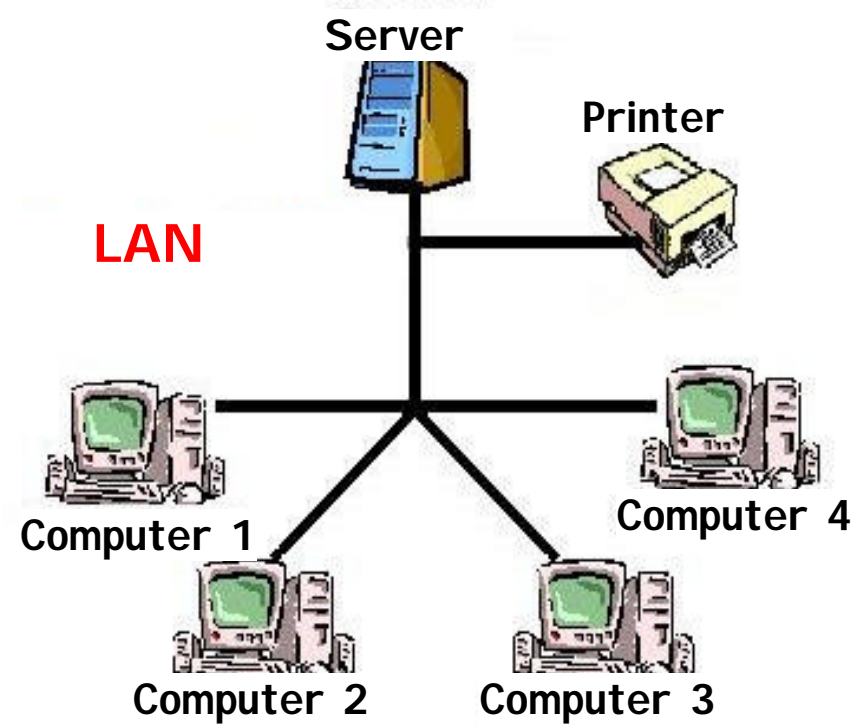
Questions:

- What kind of wire? How long can the cable be? What type of connectors?
- How will each computer be identified? If two or more computers want to talk at the same time, how do you ensure all conversations are understood?
- How can access to data and peripherals be controlled?

Network size: LAN, WAN

There are two different types of networks:

LAN (Local Area Network)
→ Located in a reduced area or shared environment such as a building or bloc of buildings.



WAN (Wide Area Network) → The opposite of the LAN network, it can be extended all over the world.

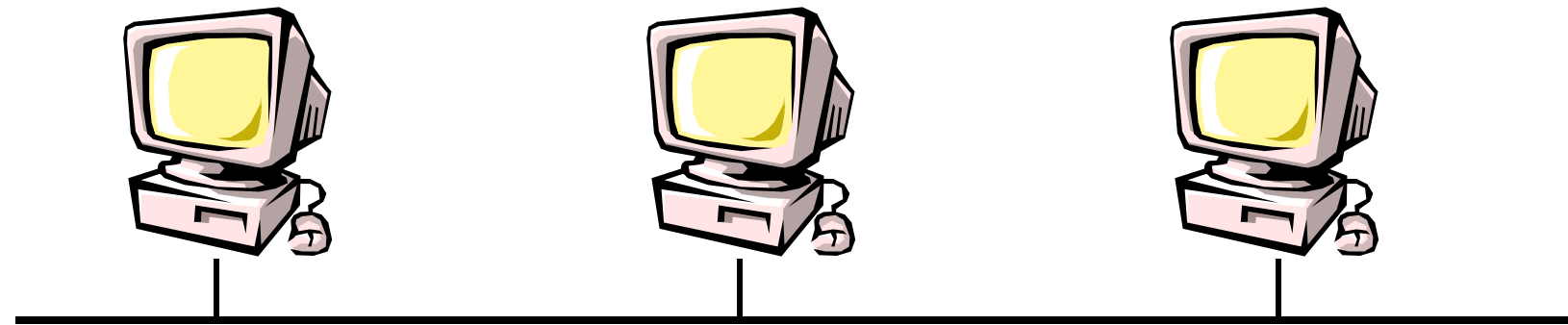


Topology

The term Topology is used to describe different configurations of cabling between computers.

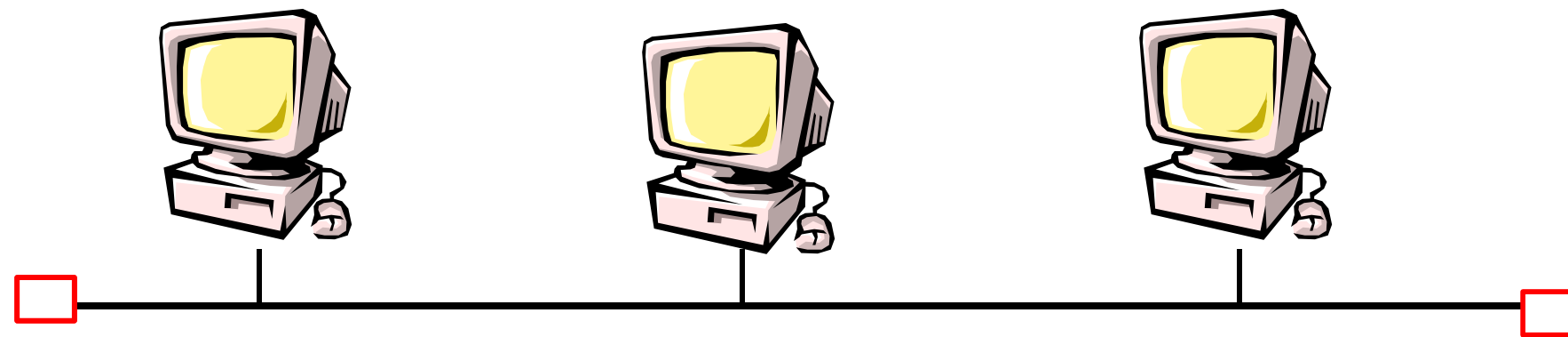
Basically , there are two types of topologies: the *bus* and the *ring* topologies.

Bus topology: a single cable conveys all the data, and the PCs are connected to the cable via T-connectors.

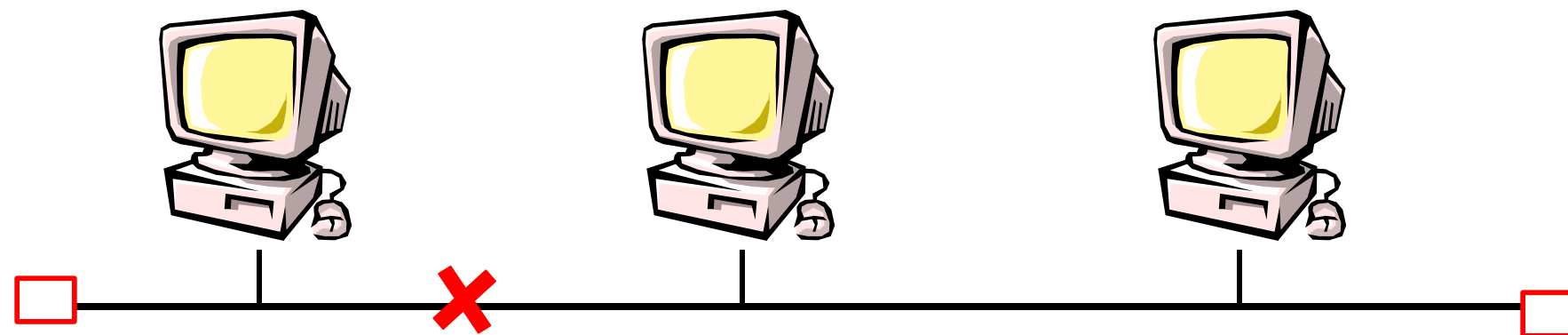


Every network card reads the packet that is in transit in the cable.

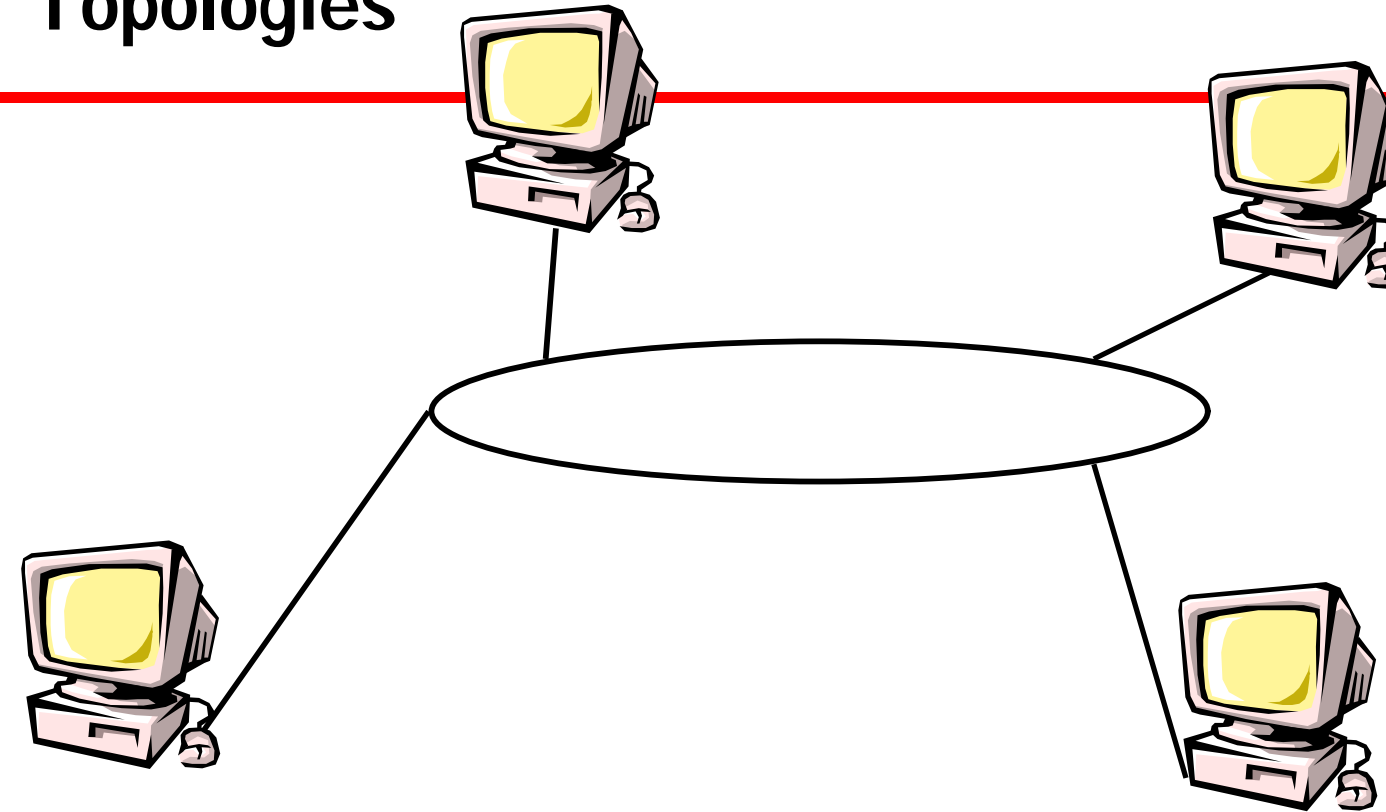
The bus requires the use of terminators, special connections that prevent the reverberation of the data in the cable.



Problem: when you lose the cable, no data will circulate any longer!
Too much "noise" on the line!



Ring Topologies

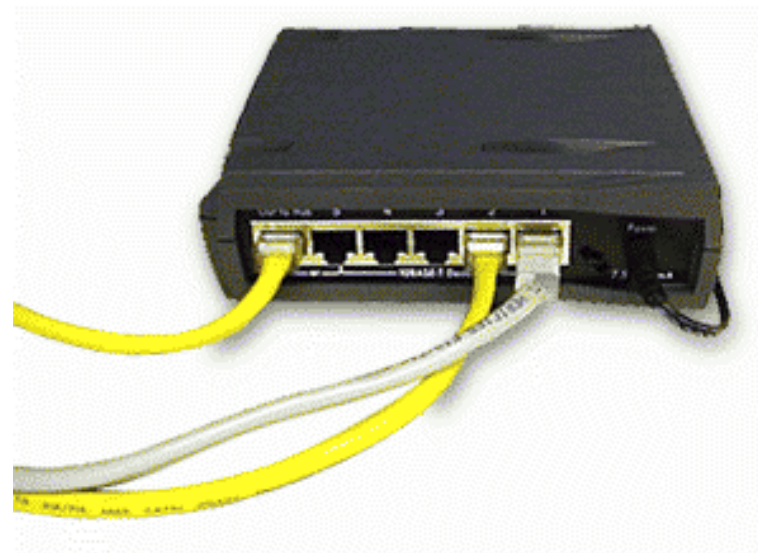


Using something called token passing, where every PC waits for the token carrier to come round to start talking. This prevents data collision.

We can reduce the ring or the bus to a small device, called a "hub".

Star-Bus Technology

Today the most popular technology used in networking is the star-bus technology, all packed tight into the hub.



To connect more than two computers using Ethernet, you will need a hub like this.

Connections

Cables for Ethernet come in different flavours, mainly a **speed** and **thickness** factor.

The main type is 10BASE-T cabling. But you find now 100BASE-T.

The length between PC and Hub must not exceed 100 meters.

The connections used to link the PC to the network are usually BNC and RJ 45, the latter being the most commonly used.



RJ 45 connector

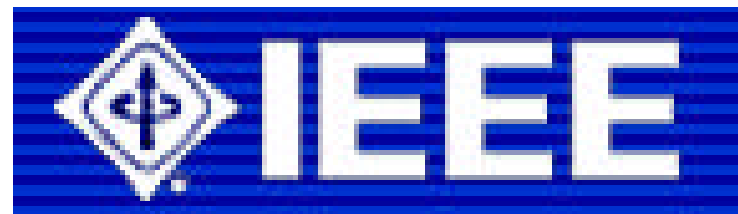


BNC: (British naval connector) uses coaxial cable and can't be used with a hub. It is really easy to set up but not reliable.

IEEE 802.3

In the 70's, manufacturers like Xerox, Intel developed a series of standard for the future computer networks. This standard is called **Ethernet**.

The control of the standard was given to the



Institute of Electrical and Electronic Engineers (IEEE).

The name of the Ethernet standard is now IEEE 802.3

Main Types of Network Organisation

To function a network must use a program called a **network operating system**. The network operating system controls the sharing of resources and data across a network and involves a lot of security measures.

Client/ Server:

a powerful computer is dedicated to serve other PCs with data and resources. This computer does not run on Windows but on Novell NetWare. It has no programs like Excel or CorelDraw. It only provides data access to the other workstations or clients.

Peer-to-Peer:

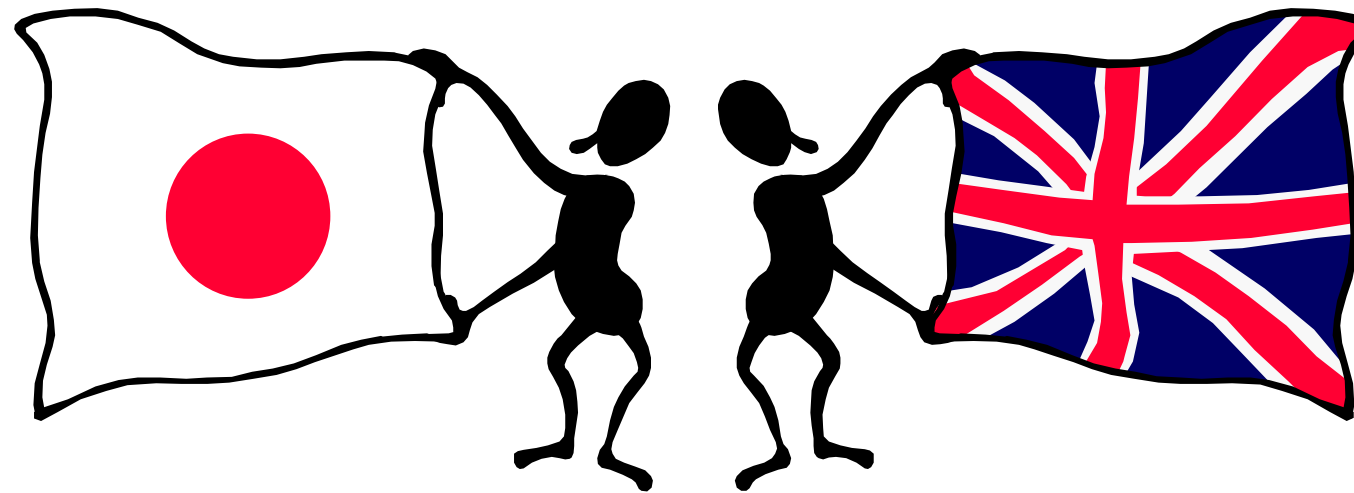
some network operating systems like windows 2000 or Windows XP do not require a dedicated server. A simple PC can act as both a client and a server. Much cheaper, but cannot grow much further than 20/30 PCs. Security is poor on Windows 9x.

Domain- based:

many servers co-exist on a network, one of them keeps the security database of all systems. Windows NT, 2000 and XP will allow such a centralisation via an account called "administrator".

Protocols

In networking, the term **protocol** refers to a set of rules that govern communications. Protocols are to computers what language is to humans. Since this presentation is in English, to understand it you must be able to read English. Similarly, for two devices on a network to successfully communicate, they must both understand the same protocols.



Protocols

Protocols are also typically in charge of sending the data to the right PC and make sure the data gets to the right program, and organise the data to be sent.

The address of the **network cards**, as well as the names and **addresses of the PCs** themselves are all checked and counter-checked via the protocols.

Protocol Types

There are 3 main network protocols most commonly used with Windows:

NetBEUI: (*NetBIOS Extended User Interface*)

A user friendly protocol provided by Microsoft but limited to this environment. Only used within a small environment.

IPX/SPX: (*Internetwork Packet Exchange/Sequenced Packet Exchange*)

A series of protocols used in Novell network. Works well with routers. Takes little RAM.

TCP/IP: (*Transmission Control Protocol/Internet Protocol*)

A combination of industrial standard protocols that allows to communicate in various environments. It provides a protocol which manages routable company networks and access to the internet.

Note: The AppleTalk protocol is for use only with Apple computers on a network.

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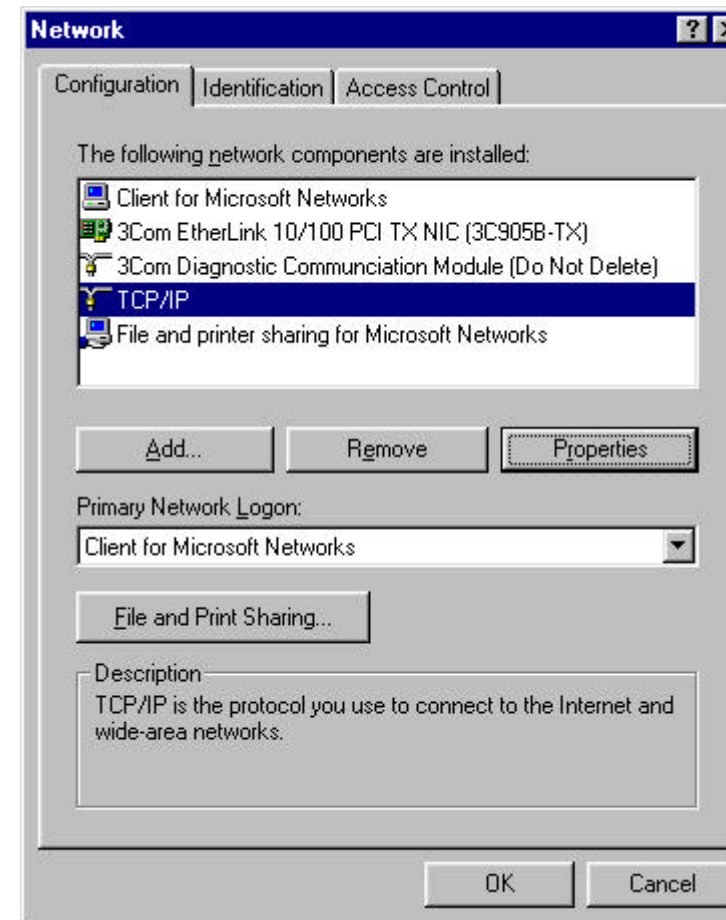
How do I check which protocol is used by the network?

Go to **Start/ Settings/ Control Panel / Network** or

Right click on Network Neighborhood Icon/ Properties

You want to see TCP/IP in this list.

If only NetBEUI is present, our printer won't work !



Exercise: change your protocol from NetBEUI to TCP/IP

1. In Network, click on Add
2. Select "Protocol"
3. Select "Microsoft"
4. Select TCP/IP.
5. Click "Next"
6. Click OK

Your network was using the very simple NetBEUI Protocol, you have added the TCP/IP protocol to the database.

What is TCP/IP ?

TCP/IP is the only protocol we support.

It is also the most commonly used by our prospective customers.

TCP or transmission control protocol, is a set of rules explaining how the data is transmitted within the cables.

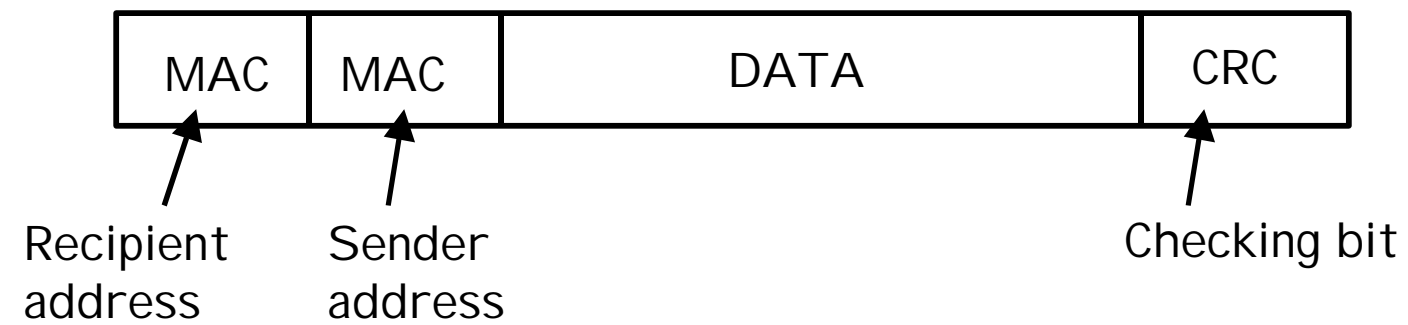
Data moves from one PC to the other in discrete packets called *Frames*.

When a frame is sent, TCP software on the PC checks who is the sender, who it is addressed to, what data it contains, and also if the info is coherent.

Data

Every single network card (NIC) that sends or receives frames must have a specific binary address called MAC address!

A frame looks like this:



TCP/IP basics: the IP address

On a TCP/IP network, computers have no names. Instead they have four sets of eight binary octets, separated by a period.

Ex: 11011101 . 11111000 . 10101110 . 00000101

In decimal language it translate as this :

00000000	= 0
00000001	= 1
00000010	= 2
...	
11111111	= 255

So in theory, an **IP address** can vary from 0 . 0 . 0 . 0 to 255.255.255.255

NOTE: IP address may vary in time for one device. The MAC address, or hardware address, is “branded” on the device by the manufacturer. IP addresses and MAC addresses go together to ensure proper identification of a device.

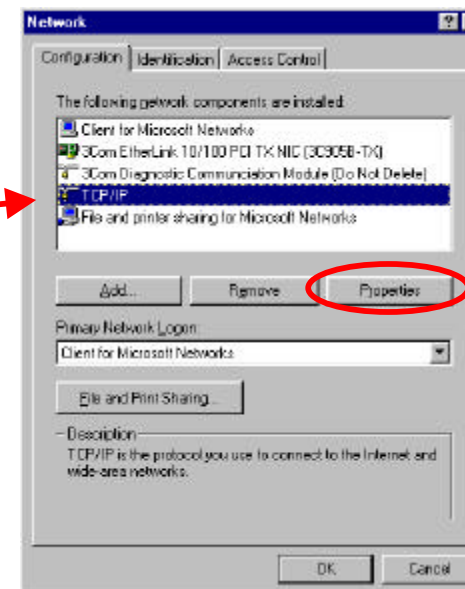
Where do I see the IP address of my PC?

Go to **Start/ Settings/ Control Panel/ Network** or

Right click on Network Neighborhood Icon/ Properties



Highlight TCP/IP,
click on Properties



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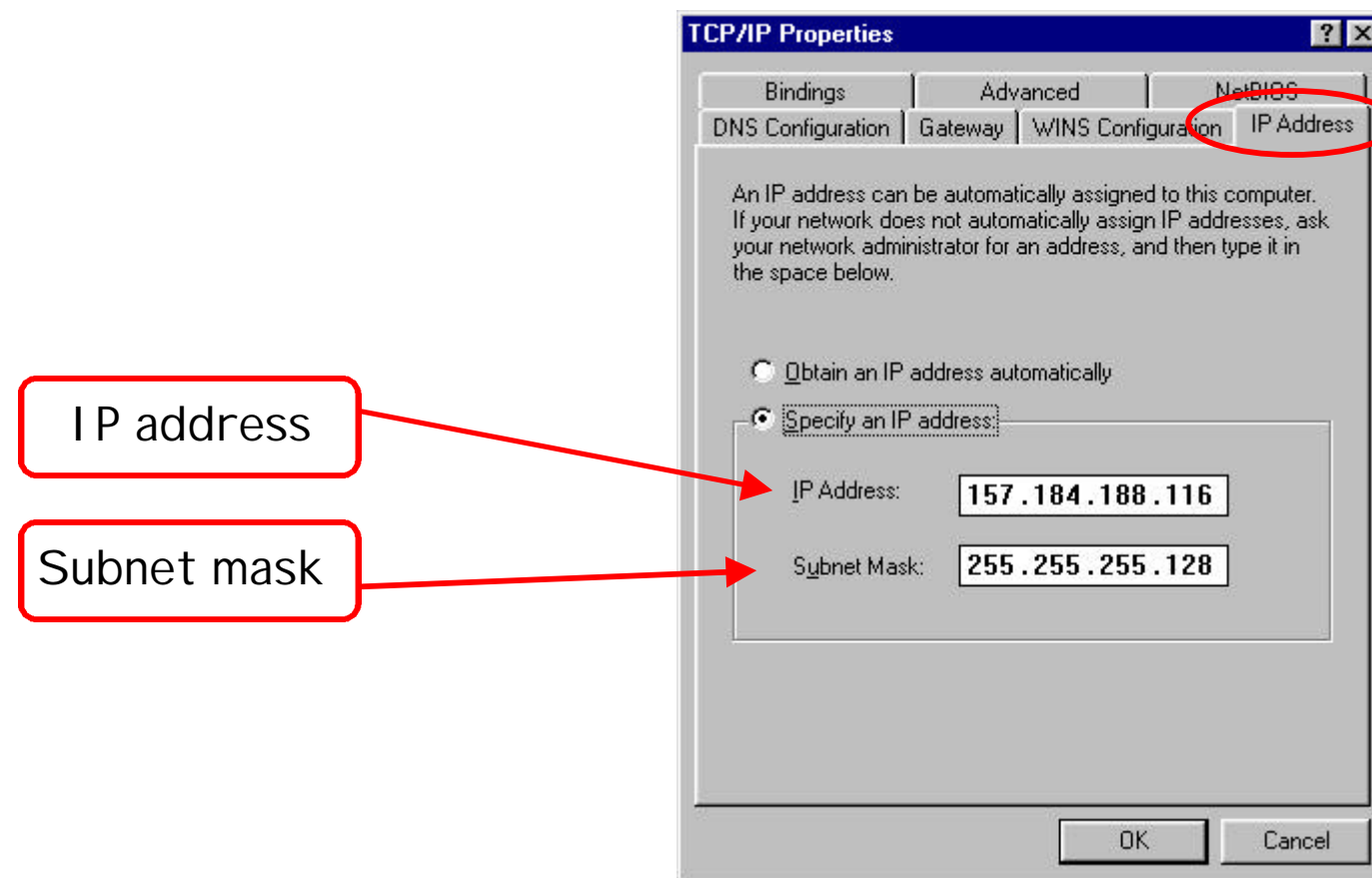
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The TCP/IP Properties Screen



The IP address

An IP address is in fact divided in two portions:

The network ID (shared by every device on the network)

The Host ID (unique to every device)

For instance : 134. 56 . 33 . 141

134. 56 . 145 . 36

could be the IP addresses of two devices on the same network,
whose Network ID is then : 134. 56

How do we choose a network ID ?

There are public and private network IDs, depending whether you wish to have a network open to the web, or a private network within a building (intranet, for instance)

There are three classes of network, defined by their size and their IP addresses:

Class A network : Network . Host. Host. Host

Class B network : Network. Network. Host. Host

Class C network : Network. Network.Network. Host

All PCs on a network share the same network ID.

The three classes of network

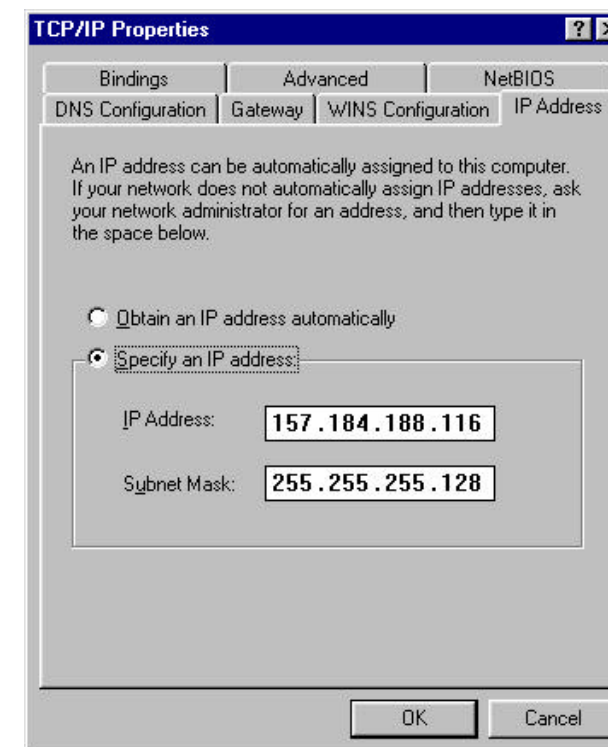
The first octet of the IP address is a give-away for the type of network you're facing:

	1st octet	network IDs	host IDs
Class A	1 - 127	126	16 millions
Class B	128 - 191	16,384	65,534
Class C	192 - 223	2,097,152	254

It seems like a lot of addresses are available for all the PCs in the world. In reality some figures are forbidden or “booked out”.

For instance 256 is not to be used. And IBM has booked the use of the 1.x.x.x IP addresses for instance.

With the explosion of PC usage, there is a strain on the number of IP addresses available. The necessity to share some IP addresses lead to the creation of a method called **DHCP**.



What is DHCP ?

DHCP (Dynamic Host Configuration Protocol)

The biggest task in a large network is usually to affect and update IP addresses. This protocol is there to help you in this task, it offers a dynamic configuration of IP addresses and of the information associated to them.

The administrator controls the mode to assign those IP addresses, he can specify the time frame during which each computer keeps its IP address before requesting a new one again from the server.

This protocol offers a reliable and easy TCP/IP configuration which avoids address conflicts and allows the administrator to control the use of the IP addresses.

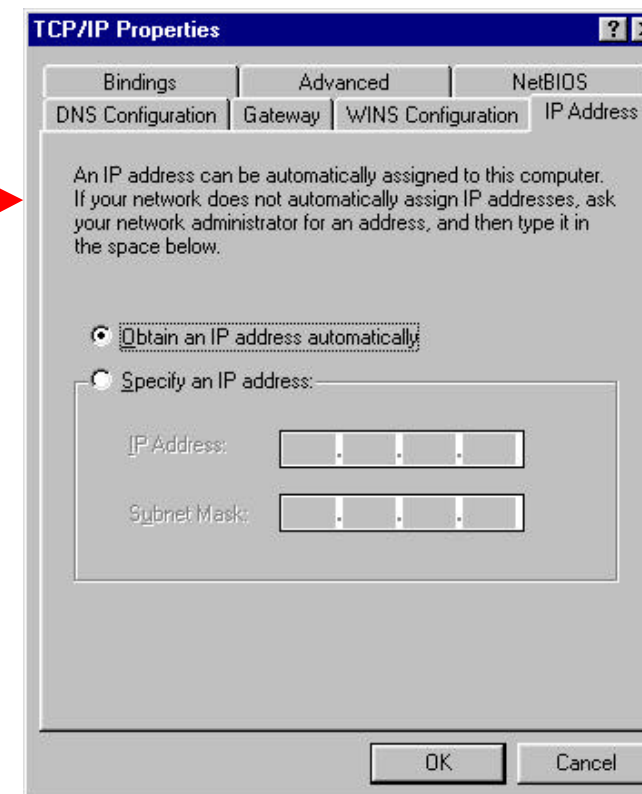
What is DHCP ?

So again, if you are using a DHCP protocol, then, your computer will not have a definitive or **static** IP address. Instead your server will allocate you an **dynamic** address that it chooses from a pool of available addresses.

So the IP address screen will look like this :

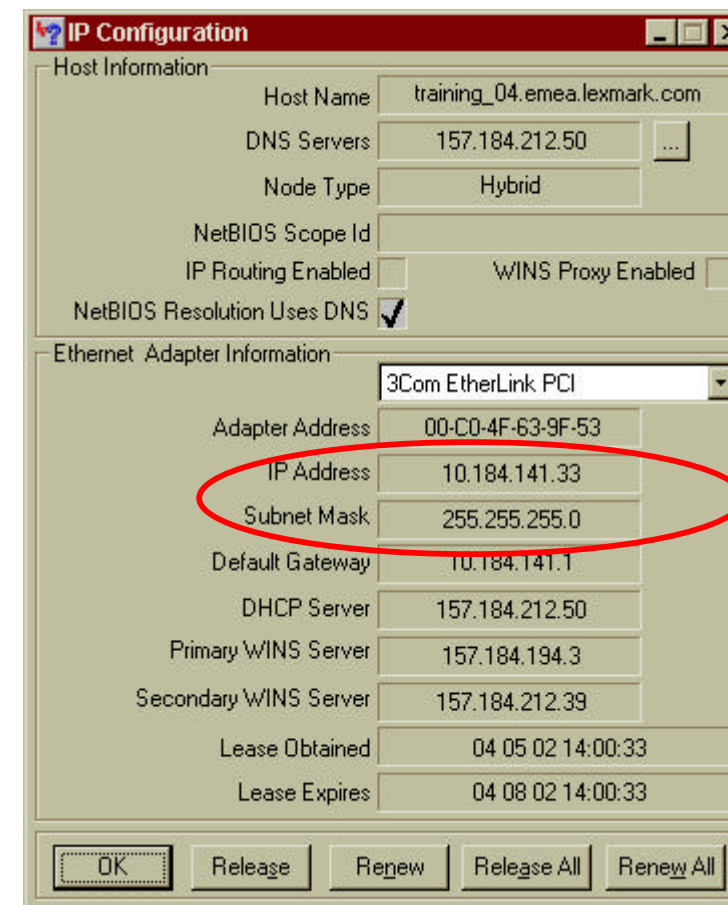
Note: when you install a new Network card on your PC, your settings go by default to DHCP.

Note: If network is DHCP, we still need to have a static address for our printer!



Finding your IP address in a DHCP environment

1. Go to:
Start/ Run/ type **winipcfg**
2. Click on: **More Info**



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Subnet Mask

So when a frame reaches your network, the protocol looks for the address in it, and tries to match it with the addresses existing on the network PCs.

But if the network had to query all the numbers from 0 . 0 . 0 . 0 to 255.255.255.255, it could be a long search till it gets to the right address.

Again, the address is divided in two portions: the **network portion**, shared by every PC on the network, and the **Host portion** which differs from host to host.

The Subnet Mask role is to differentiate between the Network part and the Host part in the IP address. It defines the range of IP address devices can have on a single physical segment of a network

Default Subnet Masks

The Subnet mask defines the range of IP addresses available on a physical segment of the network.

All devices on this segment will share the same Network ID and the same Subnet mask.

There are **Default Subnet Masks**:

Class A network:	255.0.0.0
Class B network:	255.255.0.0
Class C network:	255.255.255.0

One can customise the subnet mask to divide a network in many small portion. But this is beyond the scope of this class.

Subnet Mask

Imagine a network with 100 PCs, set up by a company, you would need 100 IP addresses.

The company could register the following range of IP addresses :

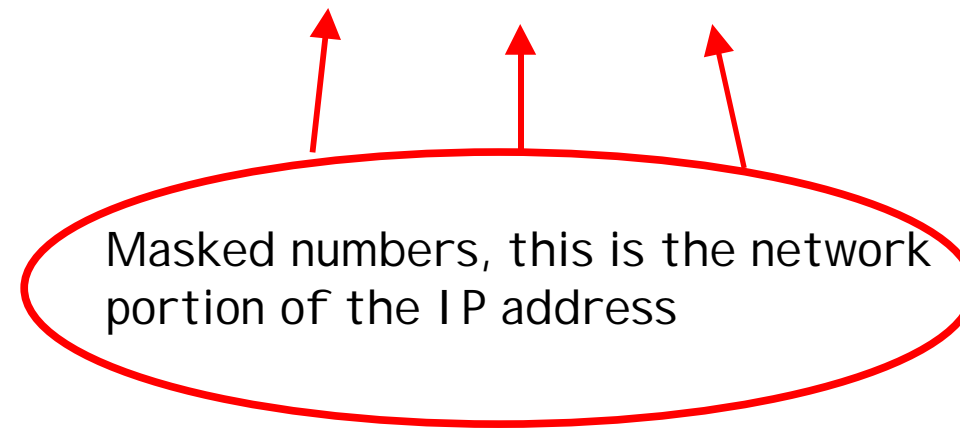
from	125.125.125. 0
to	125.125.125.100

So, if you're looking for a PC on this network, you need to only review the last digits of the IP address.

If we set the Subnet mask for your network to 255.255.255.0, because there are no number above 255, the only search plausible is on the last digits.

Subnet Mask

Subnet mask : 255 . 255 . 255 . 0



The search has been restricted to the existing PCs from . 0 to . 100 !

Note: a subnet only applies to one segment of the overall network. (a floor, a building...)

Other functions of the TCP/IP Protocol

TCP/IP offers many in-built services.

The most famous is called HyperText Transfer Protocol (HTTP) and is the language of the Internet.

Another one is the PING function, which you access via a DOS prompt: it is used to check if you can access a PC, by sending a frame to its IP address:

Go to **MS- DOS Prompt**, type **ping** and the **IP address** of the PC you want to reach.

Since our printer will also have an IP address you will be able to “ping” it as well. But because it is a printer, Lexmark has provided a special command: **LEXPING**, that you use the same way.

A typical Ping Screen:

```
MS-DOS Prompt
Auto
Microsoft(R) Windows 98
(C)Copyright Microsoft Corp 1981-1998.
C:\WINDOWS>cd..
C:\>ping 157.184.188.115
Pinging 157.184.188.115 with 32 bytes of data:
Reply from 157.184.188.115: bytes=32 time=1ms TTL=128
Reply from 157.184.188.115: bytes=32 time<10ms TTL=128
Reply from 157.184.188.115: bytes=32 time<10ms TTL=128
Reply from 157.184.188.115: bytes=32 time<10ms TTL=128
Ping statistics for 157.184.188.115:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms
C:\>_
```

Basic Network Troubleshooting

- Which network protocol? Any other protocols than TCP/IP won't work
- Are they using DHCP? If so, the network administrator can set up a fixed IP address for the printer
- Do you see the other computers on the network? One important tool is the ping command. It is used to see if there is communication in the network. Go to start, run, then type ping + IP address (ex: ping 155.155.155.1) you can also use the name of the computer. Lexmark created their own ping command as the printer is not ping compatible so lexping + IP address (ex: lexping 155.155.155.5). If the command ping doesn't work: I would say 70% of network problems are due to cable so make sure they verify their connectivity.