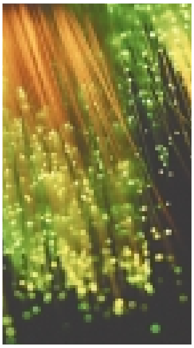
Designing networks



A local network for data communications is usually called a *LAN or Local Area Network.* Whether the network is within one building or connects several buildings, it is considered to be local because it is owned and operated by the user. The local network can, in turn, be connected through a leased line or by calling PTT circuits, with a public network, such as a regional, national and global network, which is sometimes called a *WAN, Wide Area Network* or a *MAN, Metropolitan Area Network*.

A local network can consist of data communications for office applications or for industry, hospitals, mining operations or traffic control. The particular network design which is selected, also known as the topology, is important since it is a long-term infrastructure which must handle and transport important data without problems. It must also be possible to modify or expand the network when necessary.

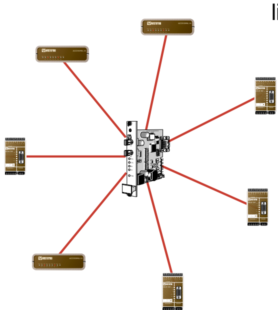
Serial point-to-point

Point to point

Point to point data communications, i.e. between two communicating units on a line, is the most common application. This is the case in simple applications, such as computer-printer, as well as in more complex applications, where each user communicates via his own line for security reasons. The common RS-232 standard interface is not recommended for distances exceeding 15 metres. Therefore, modems are used as repeaters and as protection against transients for communication at distances of up to 18 kilometres.

Star network

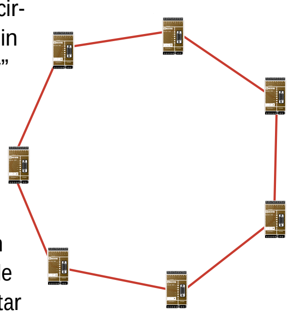
Star network



A network with many point-to-point connections is called a *star network*. Each unit communicates, over its own line, with the central processing unit at the hub. The advantage of a star network is that it is highly reliable. If one line is down, the other lines are not affected. The disadvantage is that since more cable has to be used, this kind of network is more costly. Furthermore, all communication must take place via the central processing unit.

Ring network

Ring network



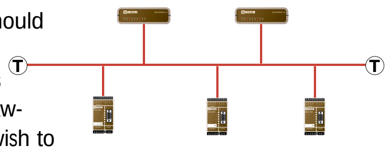
In a ring network, all units are connected in series to each other in a closed circle. This means that all communication must pass through all the other units in the ring in order to reach the receiver. To avoid collisions, an ”empty letter tray” is circulated around the network. The sender checks that the tray is empty, inserts an ”address label” and a message. The next unit in the ring checks whether the message is for that address and, if not, passes it on to the next unit. When the tray reaches its intended destination, the receiver empties it, inserts a ”receipt” and circulates the tray around the network again. The sender checks the ”receipt” to ensure that the message has been received and then passes on the empty tray to receive new messages. Token Ring is an example of a signal-based ring network which is physically connected like a distributed star network.

The performance of a ring network is high, but it can be more complex to construct and modify than a bus network.

Bus or multidrop network

A bus network basically consists of a trunk line to which all units are connected as *nodes*. All data traffic is sent out via the bus to the receiver.

Bus network



A bus network must be governed by rules for how a transmitter checks whether the line is free and how it must proceed if the transmission should collide with other traffic, e.g. through delayed re-transmission.

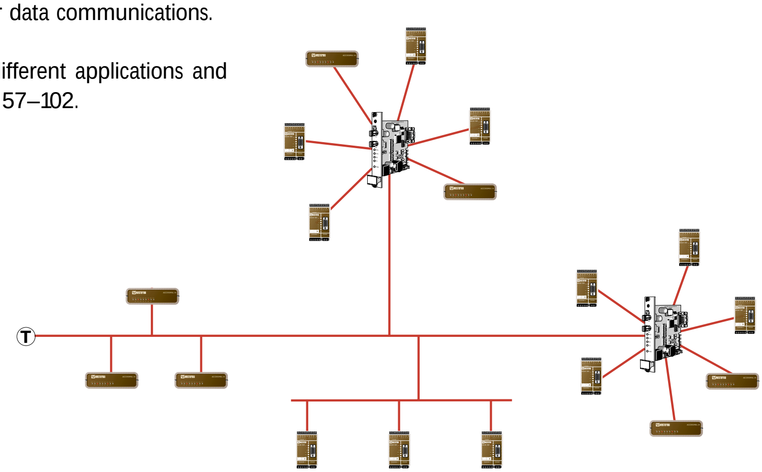
The bus network is simple to install, expand and extend. Examples of common bus networks are Ethernet and AppleTalk. One of the drawbacks of this type of network is that traffic can be slow if many units wish to communicate over the network. However, the bus network can be divided into several sections.

Combined networks

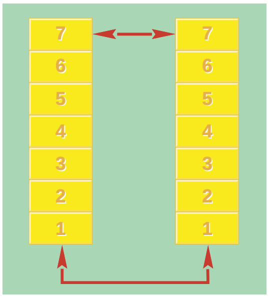
By using different communications products, customized networks can be designed for specific applications which combine the best features of the different topologies, in terms of performance as well as reliability. One such example is a bus network with a distributed star, which is one way of connecting several star networks.

It is important to take into account the fact that each network needs an effective system of traffic rules for data communications.

For concrete examples of different applications and network designs, see pages 57–102.



OSI – Open Systems Interconnection



Communication takes place via the different OSI layers.

Communications layers

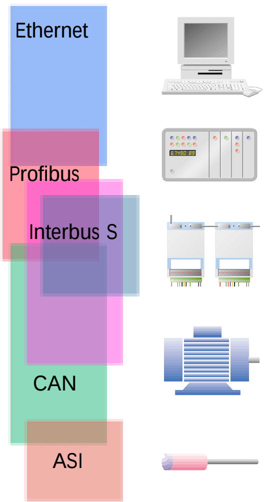
Besides transmitting data (characters, numbers, commands) data communications equipment must also handle a large quantity of peripheral data which is necessary for communication to take place. For example, such information includes data on the transmitter and the receiver (addressing), on what is to be transmitted, on how it is to be transmitted and on the form into which it is to be transformed and sent.

For this information to be processed correctly, independently of the type of communication device used and manufacturer, a reference model, known as the *OSI (Open Systems Interconnection)* model, exists which defines seven different layers of data communications.

1. *The physical layer*, which defines the electrical and mechanical interface.
2. *The data link layer*, for control and monitoring of the data traffic.
3. *The network layer*, for handling addressing, paths, performance etc.
4. *The transport layer*, which handles point-to-point communication, and also checks that it is free from errors.
5. *The session layer*, which controls the data flow and buffering.
6. *The presentation layer*, which is responsible for code transformation, formatting, conversion and encryption.
7. *The application layer*, which handles information for the application, secrecy and identification etc.

The OSI model is not a standard. Instead it is a reference model for the development of different standards.

Field Bus Systems



Industrial fieldbus systems

Ethernet-type buses are most commonly used for office communications and computer-to-computer communications. This standard is suitable for the type of transmission which takes place between several users.

Industrial applications have different requirements. Industrial communications requirements are often less complex while the needs for reliability and performance are higher. At the same time, communication must be carried out in a harsher environment where there is a high chance of interference. Furthermore, the communication distances are long and many different interfaces are involved.

The specification determines which network design is selected and which communications protocols are used. The specification also determines which fieldbus system or systems are most suitable. Fieldbus systems, such as the simple *ASI* and *Can* systems, handle simple communications with simple I/O devices. The more complex *Interbus-S* and *Profibus* systems handle communications between one or several control systems and between computers and remote-controlled modules. Furthermore, more or less standardized fieldbus systems exist as well as a number of control system buses which are unique to each supplier.

Good industrial data communications systems combine different fieldbus standards (see examples in *Applications*).

An industrial system which is commonly used is the *multidrop network* where a main computer communicates with a large number of terminals, units, transmitters or measurement systems.

Communications products for industrial networks

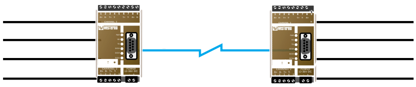
The building blocks of a communications network consist of physical cables, the computer hardware carrying out the communication, computer software as well as a number of communications products which enables the data to be transmitted reliable.

Modem Transforms and packs digital data into signals which are defined for the media which is to transmit the data (4-wire, fibre optic cables etc).

Repeater Amplifies and restores signals for long-distance transmission. RS-422 and RS-485 allow connections to be made at a maximum of 1 200 m with a maximum of 32 loads. By installing a repeater, you can add a further 1 200 m and 31 load segments to the network.

Multiplexer Used to save wiring. For example, instead of installing 16 connections with modems and cables, the same function can be obtained using two multiplexers and one line.
The multiplexer, recreates the 16 channels and each channel can communicate as if it was an independent permanent connection with full-duplex transmission and an optional transmission speed.

Multiplexer



Isolator A unit which provides galvanic isolation to isolate connected devices from each other, often via optical transmission. An isolator does not function as a modem. (With a few exeptions all of Westermo's products are equipped with galvanic isolation).

Interface converter Used to enable devices with different interfaces to communicate with each other, e.g. RS-422/485 to RS-232/V.24 or from fibre optic cables to RS-422/485 and RS-232/V.24.

Line-sharing device A modem with three or four channels, where each channel has a separate modem function. Used to create multidrop networks.

Router A router is used to separate different segments in a network to improve performance and reliability.

Bridge An intelligent connection between two local networks with the same standard but with different types of cables.

Gateway An intelligent connection between a local network and external networks with completely different structures.