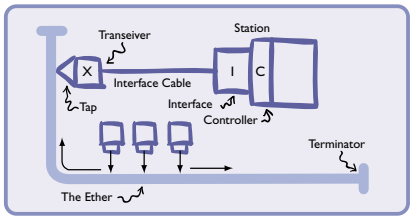
Industrial Ethernet

Ethernet as a data communications standard has been with us for many years and is the basis for the vast majority of office networks around the world today. Despite many claims over the years that it will be superseded it continues to evolve and offer the features that the users require and hence will be used for many years to come. In recent years Ethernet has also gained acceptance in the industrial market.

Ethernet – Where did the name originate?

In 1972, Robert Metcalfe and his team at Xerox developed the first experimental Ethernet system to interconnect the Xerox Alto, a personal workstation with a graphical user interface. The experimental Ethernet network was used to link Altos to each other, to servers and to laser printers.



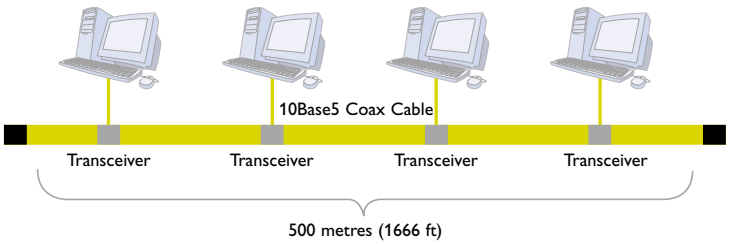
The signal clock for the experimental Ethernet interface was derived from the Alto's system clock, which resulted in a data transmission rate on the experimental Ethernet of 2.94 Mbit/s. Robert Metcalfe's first experimental network was called the Alto Aloha Network.

In 1973, Metcalfe changed the name to "Ethernet," to make it clear that the system could support any type of computer- not just the Xerox Alto. To illustrate that his new network mechanisms had evolved well beyond the basic system he chose to base the name on the word "ether" as a way of describing an essential feature of the system. The physical medium (i.e., a cable) carries data to all stations, much the same way that the old "luminiferous ether" was once thought to propagate electromagnetic waves through space. Thus, Ethernet was born.

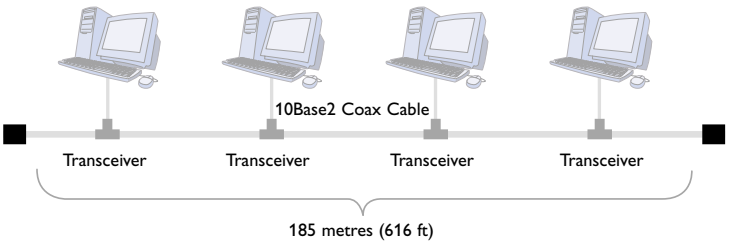
What is Ethernet?

The basic principle of Ethernet communication is called CSMA/CD (Carrier Sense Multiple Access/Collision Detection). Put simply if a device wishes to communicate then it checks the line to see if it is clear, if it is, then the data is transmitted else it waits for a clear line. Collision detection is important as it is possible that two or more devices may transmit simultaneously and the data will collide. By detecting that a collision has occurred and retransmitting later, no data is lost.

The first true Ethernet standard was called 10Base5. The network was based around a single length of thick coaxial cable up to 500 m (1666 ft) long with transceivers tapping into the cable at points along its length. The data rate was fixed at 10 Mbit/s. If a larger network was required then repeaters could be used.

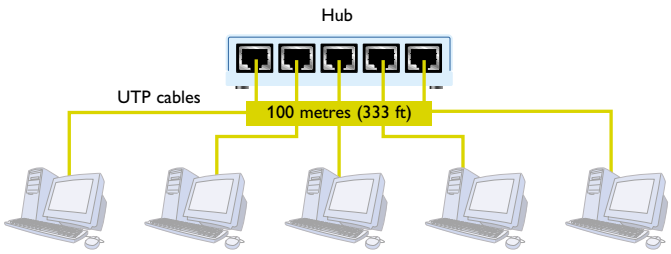


The next important standard was 10Base2, again running at 10 Mbit/s, but using a lower cost thin coaxial cable connected to network interface cards by T pieces. This solution was much cheaper and became popular for small networks.

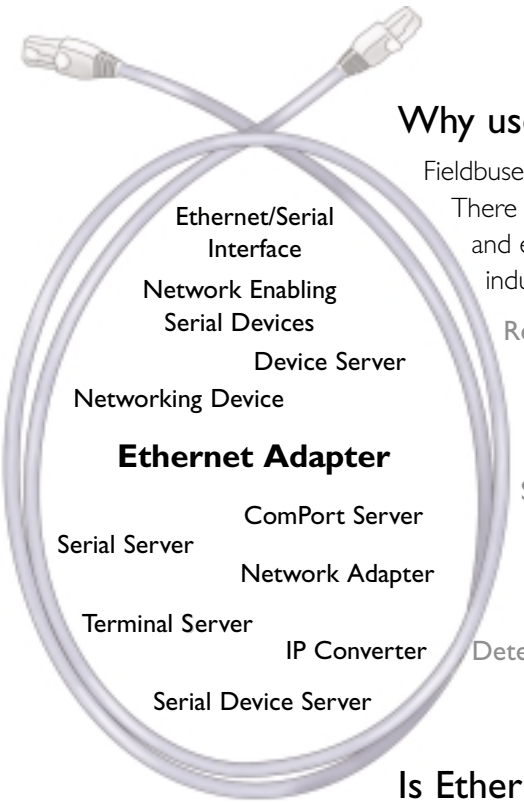


The next big step for the Ethernet network was the introduction of structured cabling. The 10BaseT standard was developed that relied on using hubs and kept the cable distance below 100 m (333 ft).

Another step up was the evolution of faster networks and the use of fibre optic cables for long distance data transmission. Hence more standards arose including 100BaseT, 100BaseFX etc.



With mixed standards, higher numbers of connected devices and now two data rates to consider, connecting the networks together became more complicated, hence the development of the Ethernet switch.



Why use Ethernet for Industrial Systems?

Fieldbuses have been the traditional way for data communications in industry. There are many different types and standards meaning interoperability is difficult and expensive and is the main reason Ethernet started to be considered for industrial applications. Other benefits include:

Reliability Ethernet is a well defined open standard meaning that interoperability is simplified and components are available from multiple sources. Ethernet is open and transparent. Many different protocols can run simultaneously on the same network.

Speed Data rates of 10 Mbit/s and 100 Mbit/s are common place with Gigabit solutions also now available – the fastest fieldbus protocols run at 12 Mbit/s and most operate at less than 2 Mbit/s.

Determinism Protocols already exist to prioritise data and hence make Ethernet virtually deterministic, the ultimate goal of the industrial user.

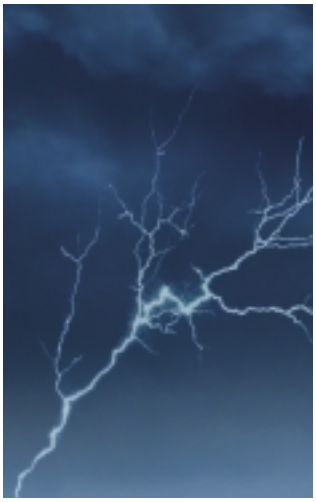
Is Ethernet Deterministic?

Determinism is the key word in many industrial networks – with a deterministic network it is possible to say with complete certainty that an event occurred within a particular time window.

With the CSMA/CD technique employed in the original Ethernet systems determinism was impossible however with the advent of the Ethernet switch things have changed. Collisions in the cabling infrastructure no longer occur. The twisted pair or fibre optic links are point to point and can be full duplex. A packet sent to a switch is stored and retransmitted to the correct destination port. If that port is busy, the switch can wait hence no collisions and no retransmissions. The problem is now the potential wait in the queue.

Modern switches have features that can guarantee that this queue is never a problem. Ethernet packets can be configured to carry a priority tag. If a switch supports prioritisation then that packet jumps to the start of the queue. Another useful feature in dataflow control is head of line blocking prevention – head of line blocking is a problem in some switches because they use a FIFO buffering system, meaning that if a packet is being held up at the front of the queue then the entire queue is blocked. Some switches have a method of preventing this problem.

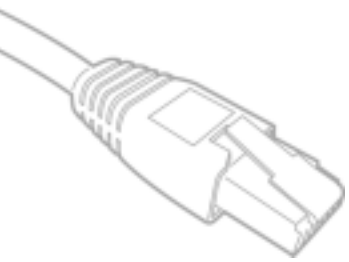
How to make Ethernet Industrial!



When designing equipment for industrial environments there are certain features and functions that are more important than others. Westermo have always designed equipment for industrial applications so we understand what the market requires and we know that quality and functionality are important factors when looking at the total cost of a project.
Important aspects of industrial data communication equipment design include:

Downtime elimination	The unit must be constructed to eliminate communication disturbances and downtime. We achieve this by using high quality components such as long life capacitors and verify the design in harsh environments.
Industrial EMC design	Industrial communication devices are often installed near equipment like a welder or heavy machinery that generates electromagnetic noise. We have more than 30 years of experience in designing and manufacturing data communication equipment for industry and we use all this knowledge when designing Industrial Ethernet equipment.
Extended temperature range	There is often a requirement for extended temperature ranges in industrial applications. We guarantee this functionality by using high quality components that have an extended working temperature range for both hardware and connectors.
Mechanical performance	In industrial applications the method of installation is always important as units can be mounted into machinery that has to move or is prone to vibration. All our products are designed for high mechanical performance with DIN-rail mounting. When designing the products we always look into problems related to vibration, mechanical connection and security.

Galvanic Isolation	One of the most common causes of data communication errors is different earth potentials between connected units. This is eliminated with galvanic isolation of all the interfaces; this is one of the standard features in all Westermo products.
Transient suppression	Industrial equipment is also often exposed to high current power lines, reactive loads or high voltage switchgear, this kind of equipment often generates transients that cause communication errors. One way to eliminate this problem is to design products with enhanced surge/transient protection.
Power	It is important to have a reliable power supply for industrial equipment, often DC power is used together with batteries. When charging a battery a higher voltage is used and all connected units must be designed for this circumstance. In some cases it is also important to use redundant power inputs for extended security.



Determinism

When using equipment in real-time applications it is important to have different levels of prioritisation. In the fast, ring and time switches there are built in functions and queues guaranteeing transmission of prioritised data.

Approvals

Our units are installed in many different applications all over the world. To meet local demands for safety, electrical immunity, ESD and vibration we have designed the units to meet international standards.