LON - What is it?

LON stands for Local Operating Network and was introduced by the Echelon Corporation (USA) in 1990. Echelon's development goal was to design a micro-processor that simultaneously possessed a standardised communications interface. Each device had to be able to "talk and work" seamlessly with every other device, regardless of manufacturer, and to carry out its specific task as decentralised intelligence within the network. Since 1996, the network protocol has been publicised and made accessible to everyone. The open network technology is now therefore available with the same conditions to all producers world-wide. Approximately 4,000 manufacturers across the globe are producing devices and systems for the LONWORKS technology. (LONWORKS is the the system description for the whole LON-technology).
An independent standardisation committee (LONMARK) oversees product compatibility by setting standards and determining updates.

LONMARK® PARTNER

High acceptance as formal standard

- LONWORKS® is adopted as the standard IEEE P1473.1 (Rail Transit Communication Protocol.
- LONWORKS® was standardised by the Intenational Forecourt Standards Forum (IFSF) for applications in petrol station automation.
- LONWORKS® is a component of the ASHRAE SPC-135 BACnet specification.
- Das LonTalk® protocol is the official ANSI/EIA 709.1 standard (American National Standard Institute).
- LONWORKS® is recognised as a standard in the field and automation layers for buildings according to CEN TC247.

How does LON differentiate itself from other fieldbus systems?

Conceptually, LON has taken another route during its development compared to most other fieldbus systems. While most fieldbuses were conceived for a specific area of implementation and were only later incorporated into areas other than those originally foreseen (CAN, Interbus, Profibus), LON has been conceived from the start for the widest spectrum of implementation possible. The EIB (European Installation Bus) is often called upon for comparison purposes; however, in contrast to LON, the focus of EIB lies clearly in the area of installation technology with transitions for the functions of home and building automation. The broad implementation spectrum of LON is one of its main advantages, where the most diverse functions such as HVAC (Heating, Ventilation and Air Conditioning), lighting, blind and access control, fire and burglary alarm technology, among others, can be seamlessly integrated.
LON is suitable for the construction and operation of efficient and, above all, for widely branching decentralised networks. The so-called topology of LON networks is free, that means the network is workable in a line with or without branch lines, as a ring, a star etc.. It is possible to build up a network with various transport media and to combine the transport via a powerline with the twisted pair network. Over and above this, it is possible to link the LON network to the Internet or intranet. This offers, for example, the possibility of remote visualisation and remote maintenance via the www (World Wide Web). LON systems are, as a rule, distributed networks and can contain up to ten thousand nodes (small functional units with individual intelligence). The nodes can be developed for various applications and configured in operation. Application areas for LON-based systems are, alongside building automation, process automation as well as many other product areas with decentralised measurement, control and regulation concepts.

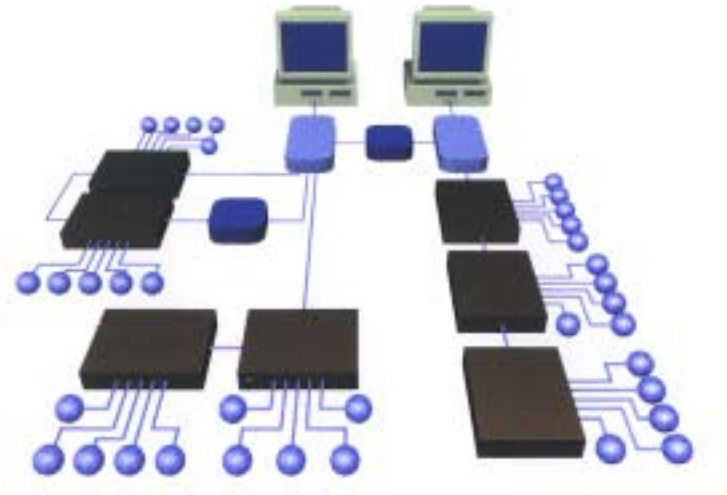
What advantages does LON offer?

Until now, building functions were carried out with central computers, programmable logic controller in central switch boxes with corresponding distribution stations, and the huge cabling efforts that go with them.

With the help of decentralised automation (LON), you can achieve the following:

- Sensors and actuators are equipped with their own intelligence and exchange information directly with each other.
- There is no need for a "Central Controller".
- Information processing takes place locally.
- Minimal cabling
- Maximal flexibility to expand

The System



A closed, hierarchical control system

An open, distributed control system

Due to the networking and the distributed intelligence, higher demands for reliability and redundancy can be achieved relatively easily with LON. An individual node within the system is an equal bus component and thus plays a part, among other things, in the communication. It can also make locally relevant decisions during breakdown of the transport route in order to maintain an emergency operation. *This is also true for a breakdown in the control technology!* The secure transport of news packets that is a feature of LON is sometimes a very important criteria in the decision to implement this particular communication system.

The integration of security technology is likewise possible with LON. Redundant system parts are exportable, that means burglary alarm systems, access control equipment, fire alarm systems and, where appropriate, person-emergency signal equipment can be theoretically linked to one system. This follows the general trend of reducing the number of systems, interfaces and service facilities in the control room.

Due to the openness of the LON system, further functions can be integrated at any time within the building automation and building management system. Such as for example energy management with load reducing modules, amongst other things.
During a building extension or an expansion of the automation area to other parts, the system grows along with it.

Re-think: The building as a system

The automation and the communication capability of the technology in each room requires higher investments with respect to the individual components. These higher investments are greatly compensated by the fact that sensors no longer need to be installed twice. By means of the bus connection of the intelligent sensors and actuators an additional savings potential arises with respect to the cabling when compared with the star cabling to date. In order to implement these technical alterations, a re-think is needed on the part of those who are involved in the planning, installation, commissioning and operation processes.
Planning, configuration and setting into operation is no longer device-oriented, but functional, that is user-oriented.

LONWORKS presents a financially beneficial solution for operating buildings as a "*system embracing all devices*".

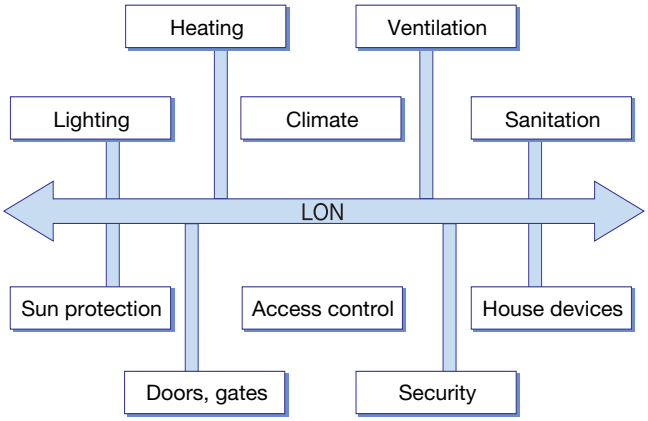
Why a "system embracing all devices"?

In buildings the separation of devices has a tradition, for example in electrical installations, electronic data processing (EDP), sanitation, as well as heating, ventilation and air conditioning, and sun protection.
Control systems have thus in the past developed in a device-oriented way on technically different levels and in different directions.
As a consequence, there have arisen:

- a cabling and cabling management system that was no longer assessable
- many individual sensors for similar or the same tasks
- no possibilities for being able to exchange information between the systems
- a higher co-ordination effort
- higher costs through "island solutions"

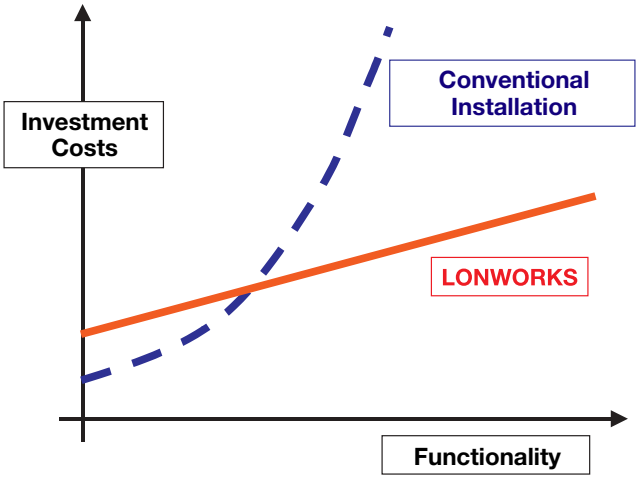
The LON technology offers help here. It creates the possibility for bringing together all control, regulation and monitoring networks within a building for all the devices involved. It thus reduces costs and encompasses all utilities.

Integration of the devices



Advantages and benefits for building clients and operators:
- Savings on investment costs
- Savings on operational costs
- Comfort
- Standardised service
- Flexibility for alterations and expansions
- Building transparency (remote monitoring, Internet)
- Multi-vendor

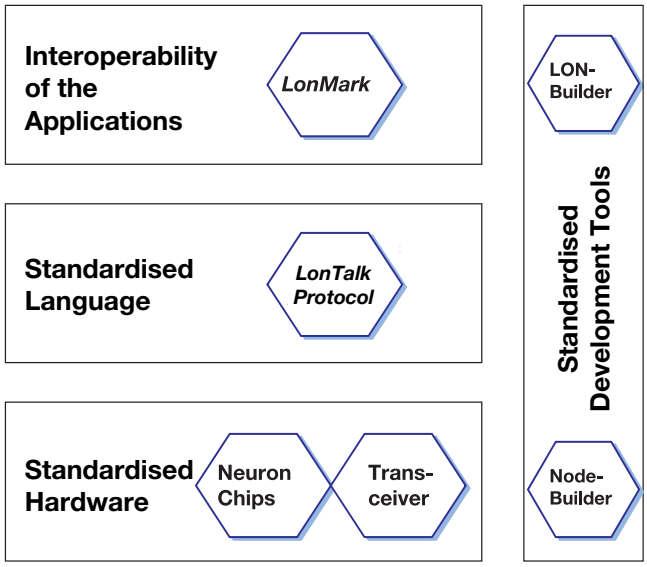
Savings on investment costs



What are the building blocks of LON?

The LONWORKS technology encompasses all necessary aids for the design, construction, operation and maintenance of a LON installation:

Building blocks of LONWORKS-Technology



– *Neuron Chip and Transceiver*

All devices are based on the so-called Neuron Chips. These are small micro-processors developed by the company Echelon that, alongside a few additional building blocks, form a complete network node. As a LON network can be built with many different transport media, the connection of a Neuron Chip to the bus cable (transport medium) is achieved via a so-called *transceiver*. Often the so-called FTT10-A transceiver is implemented as standard. This makes the integration with a twisted pair bus cable possible.

– *LonTalk® Protocol*

The language of LON is called *LonTalk®-Protocol*. It is already implemented in the Neuron Chip as a standard for all nodes.

– *Development Tools*

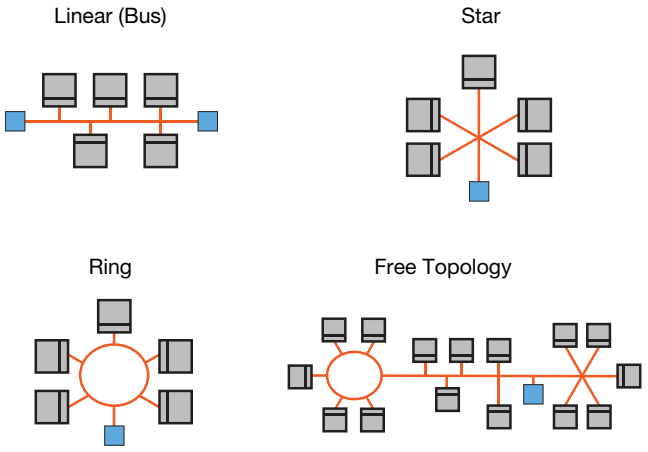
For the creation of Neuron programmes in the programming language Neuron C, the integration of individual nodes, as well as whole networks, Echelon offers development tools such as LonBuilder® or NodeBuilder®.

– *Interoperability through LONMARK*

So that devices from different manufacturers “talk and work” together in a LON network, there exist so-called rules (Functional Profiles and SNVT Master Lists) that are worked out by the *LONMARK Interoperability Association*. Devices that were developed according to these rules, achieve a higher degree of interoperability. By interoperability is meant the capability of dealing together with a task in a distributed application. When exchanging a device for a similar one from a different manufacturer, the application must continue to run without the need for adaptation.

The System

The network topologies of LON



The Structure of a LON network

A LON network is divided into Domain, Subnet and Node.
A domain represents an area in which a maximum of 255 subnets may be located. In turn, a subnet may consist of a maximum of 127 nodes (LON nodes). In this way, a domain can consist of a maximum of 32385 LON nodes, that is, LON participants. If needed, several domains can be linked together. In the maximum case, up to 2^{48}.
Principally, however, only nodes within one domain are able to directly communicate with each other.
Every LON node (participant) possesses a clear, logical address within a LON network. This is divided into three hierarchical stages:

Domain-ID→Subnet-ID→Node-ID

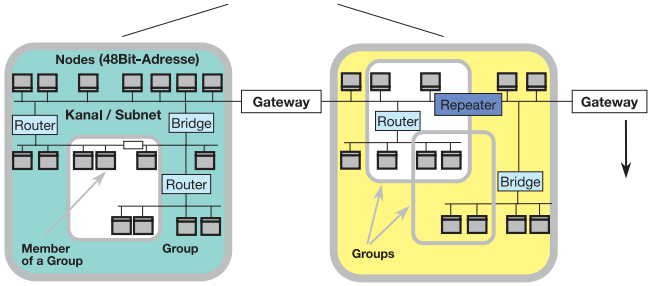
LON Network		Postal Address for comparison
English	Number range	
Domain-ID	1 ... 2^{48}	Area
Subnet-ID	1 ... 255	Street
Node-ID	1 ... 127	House number

If a node wants to send a message to another node, it uses the logical address as the recipient's address.
The allocation of the logical address occurs during the binding of the LON node in the network, with the aid of the Binding Tool. The binding tool normally produces a free address and allocates it to the node.

For the construction of LON networks, additional building blocks, such as routers, bridges and repeaters are used.

- *Routers*
  are devices with two bus connections that are implemented for the purpose of connecting two subnets with each other. Telegrams that were received on one side are normally sent away again by the router on the other side - and naturally vice-versa. In this way, the router can also take on the function of a filter, a path finder or post distributor.
- *Bridges*
  form connections between two domains. They carry data from one domain into the other and vice-versa. If a network has only a single domain, the bridge then behaves like a repeater.
- *Repeaters*
  are physical amplifiers without a processing function. They are used to execute larger transport distances or when the maximum number of 64 nodes per twisted pair segment (FTT10-A transceiver) is exceeded.

Domain (max. 255 x 127 = 32.385 Nodes per Domain)



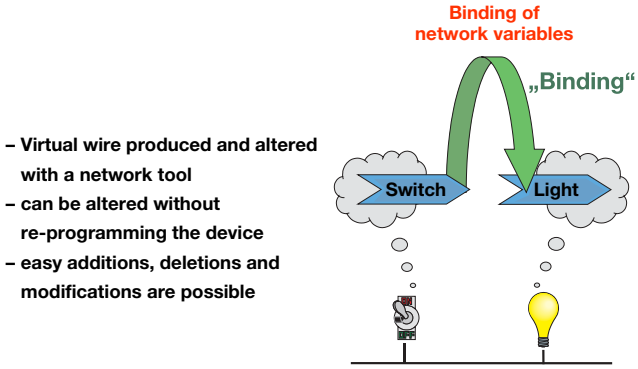
How is data flow carried out in a LON network?

Now you know that a LON node is, in principle, a small, independent computer that works its own application programme. A LON network consists of many of these independent computers. Each computer is physically connected via a transceiver to the transport medium (bus cable) and possesses an individual address.
Via the bus cable, the various devices are able to exchange data with each other and thus to form a functional total system (for example, the automation of a building).
How are the connections between the nodes created? How can one inform the concealed cabling sensor node on the light switch, for example, that it should send its information about the status of the switch to the luminaire node of the ceiling lighting?
Alongside the physical connection, there is obviously a further connection to be created – a logical one.

The data exchange between LON nodes is achieved in a LON network via so-called network variables that are also labelled with the name **SNVT**, pronounced “Snivit”. SNVT stands for “**S**tandard **N**etwork **V**ariable **T**ype”. These are established by LONMARK, are held in a master list and are available to every LON developer. An important point for interoperability.

Network variables are of central importance in LON because:
- during operation information from one node is “transported” to the other exclusively via network variables.
- network variables form the logical interface between nodes.
- the real task of the LON system integrator lies in the binding of network variables in various nodes.
- network variables form (alongside configuration parameters) the main part of what one sees of a LON node in a LON system integration tool on a PC.

How devices “talk” to each other



– Virtual wire produced and altered with a network tool
– can be altered without re-programming the device
– easy additions, deletions and modifications are possible

So that the lighting now really reacts at the operation of the switch, a logical connection between the two nodes must be produced. The sensor node has to be informed that it should send any change to its output variables to the input variable of the luminaire node.

The Binding Tool

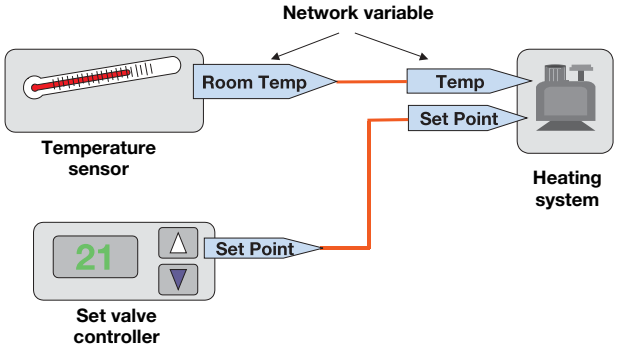
This normally occurs with the aid of a PC and software tool. The software tool is the binding tool that is connected to the LON network.

The course of events is as follows:
- The user connects on the PC screen the output variable of the sensor with the input variable of the lamp. Depending on which tool is implemented, this occurs in graphical or text form. The programme normally carries out the rest automatically.
- All the bindings within the LON network are saved onto the PC's hard drive.
- The tool then sends all the bindings to all the nodes. Each node receives the part relevant for itself and saves this information. The LON node is then described as configured.
- From this point on, the switch node will send all changes to its output variables, nvoSwitch, automatically to the luminary node – or more precisely to its input variable, nviLamp.

Result: the room lighting works!

The binding of input and output variables therefore forms the logical connection between nodes in the network.

How devices “understand” each other



Through binding, the following criteria are met:
- Who is communicating with whom?
- What information is being exchanged?
- How is the information being exchanged?

This introduction can serve as a brief insight into the LON Technology.
For further information, a range of literature is available, for example:
LON Technologie by Dietrich, Loy, Schweinzer, published by Hüthig Verlag,
LONWORKS Technologie by F. Tiersch, published by Desotron Verlag,
LONWORKS Installationshandbuch by the LON Nutzer Organisation e.V. (LON User Organisation, Germany), published by VDE Verlag or to be found at www.lno.de and www.lonmark.org.
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