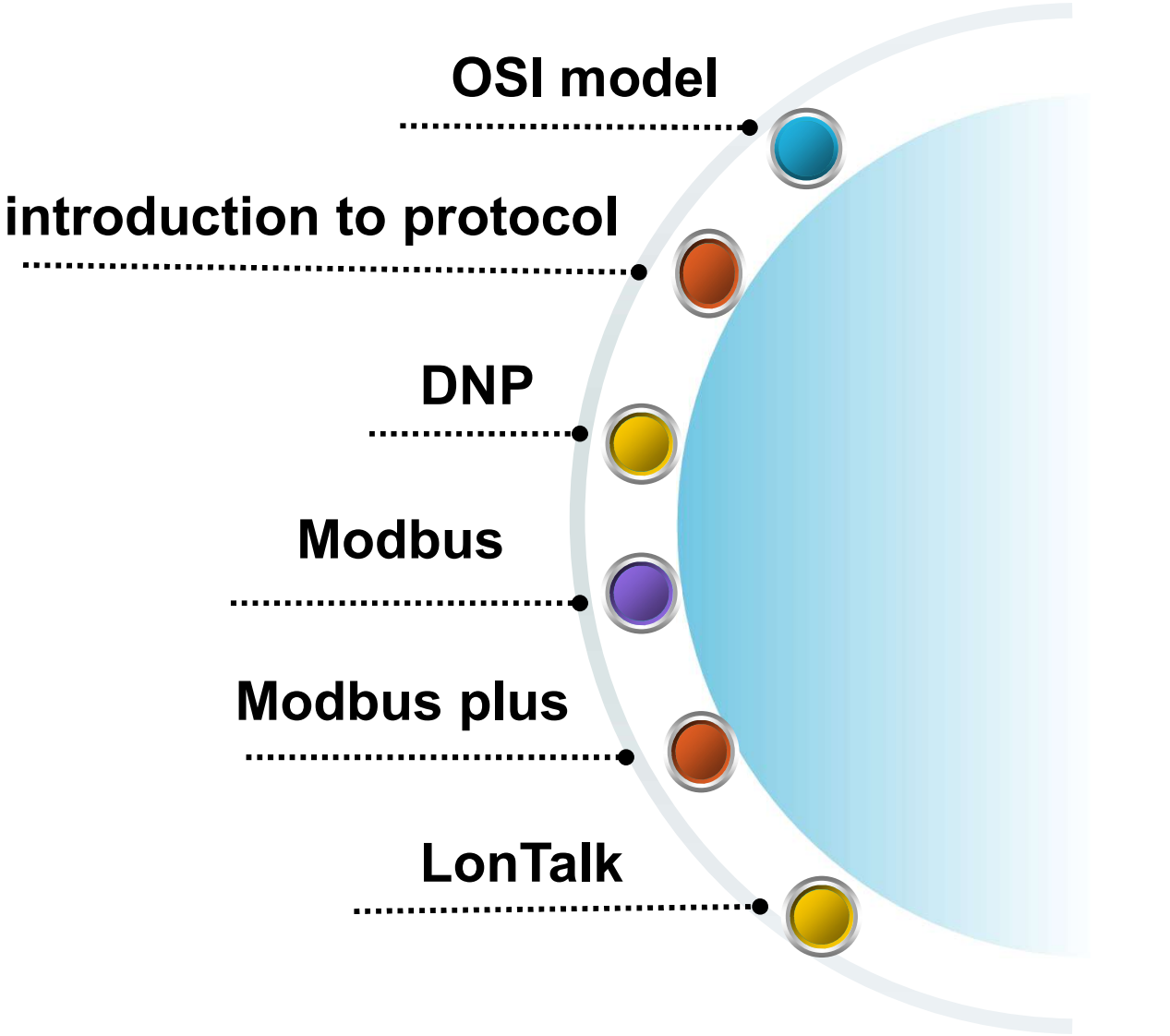
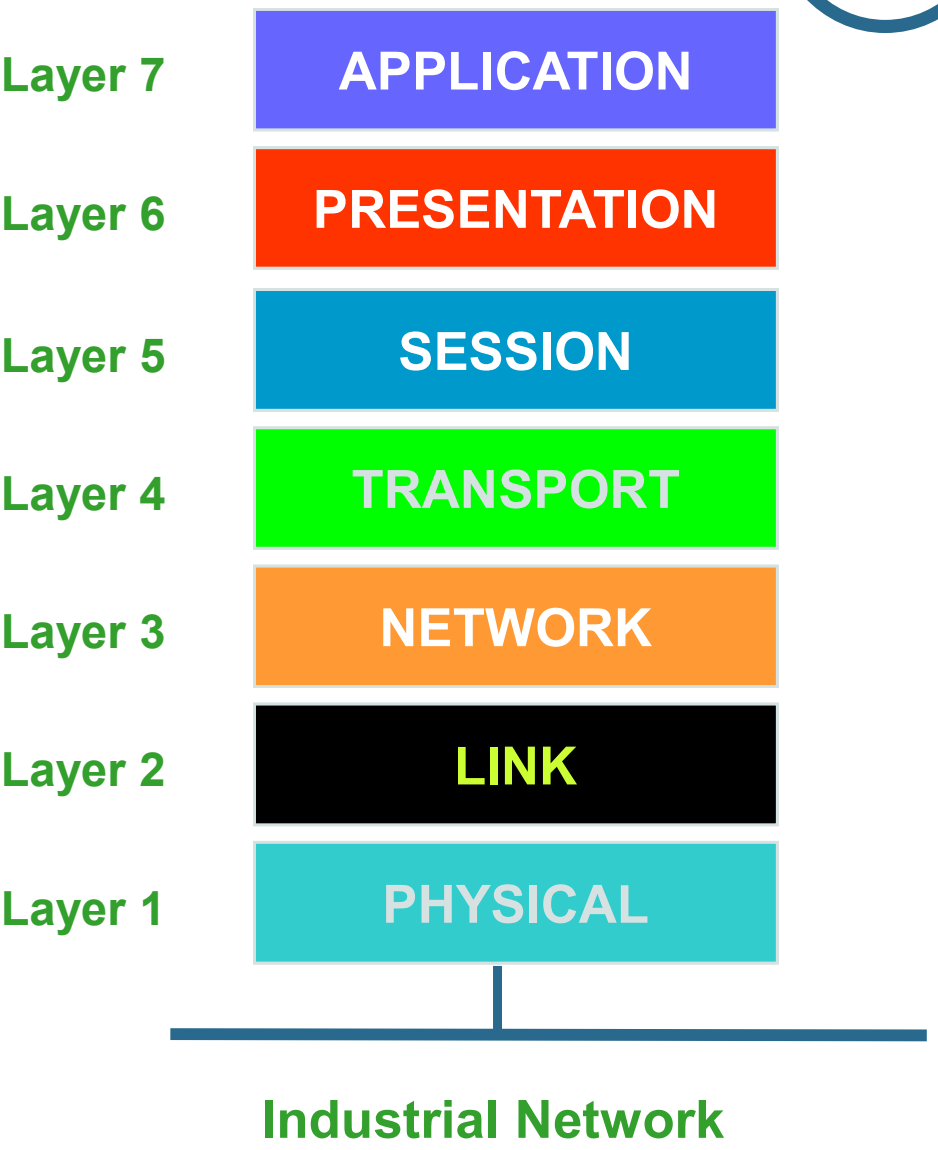

بسم الله الرحمن الرحیم

Communication protocols



Communication protocols

- OSI model



Communication protocols

- **Physical layer**

  This layer provides the mechanical and electrical characteristics of the physical interface

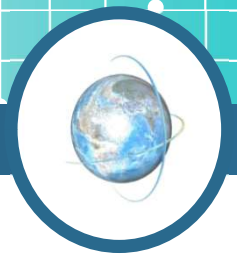
- **Data link layer**

  The data link layer provides the synchronization (start/stop, length) and error control (detection and correction) for the information transmitted over the physical link.

- **Network layer**

  This layer provides the means to establish, maintain, and terminate the connections between stations, including routing and address functions.

Communication protocols



- **Transport layer**

The transport layer provides end-to-end control and information interchange with the level of reliability that is required for the application.

- **Session layer**

This layer supports the dialog requirements on the bus, determining who is allowed to talk, handling start/stop talking commands and communication relationships.

- **Presentation layer**

The presentation layer provides the interpretation and meaning of the information exchanged, in other words the coding or ‘language’ of the information.

Communication protocols

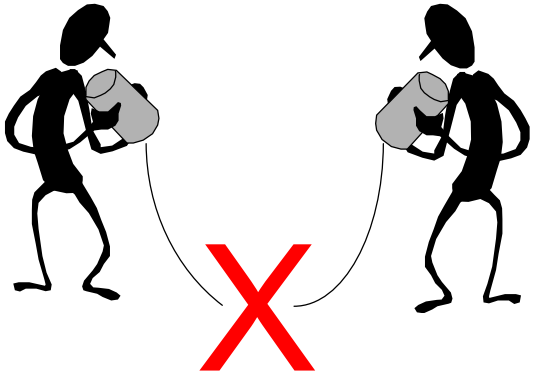
Application layer

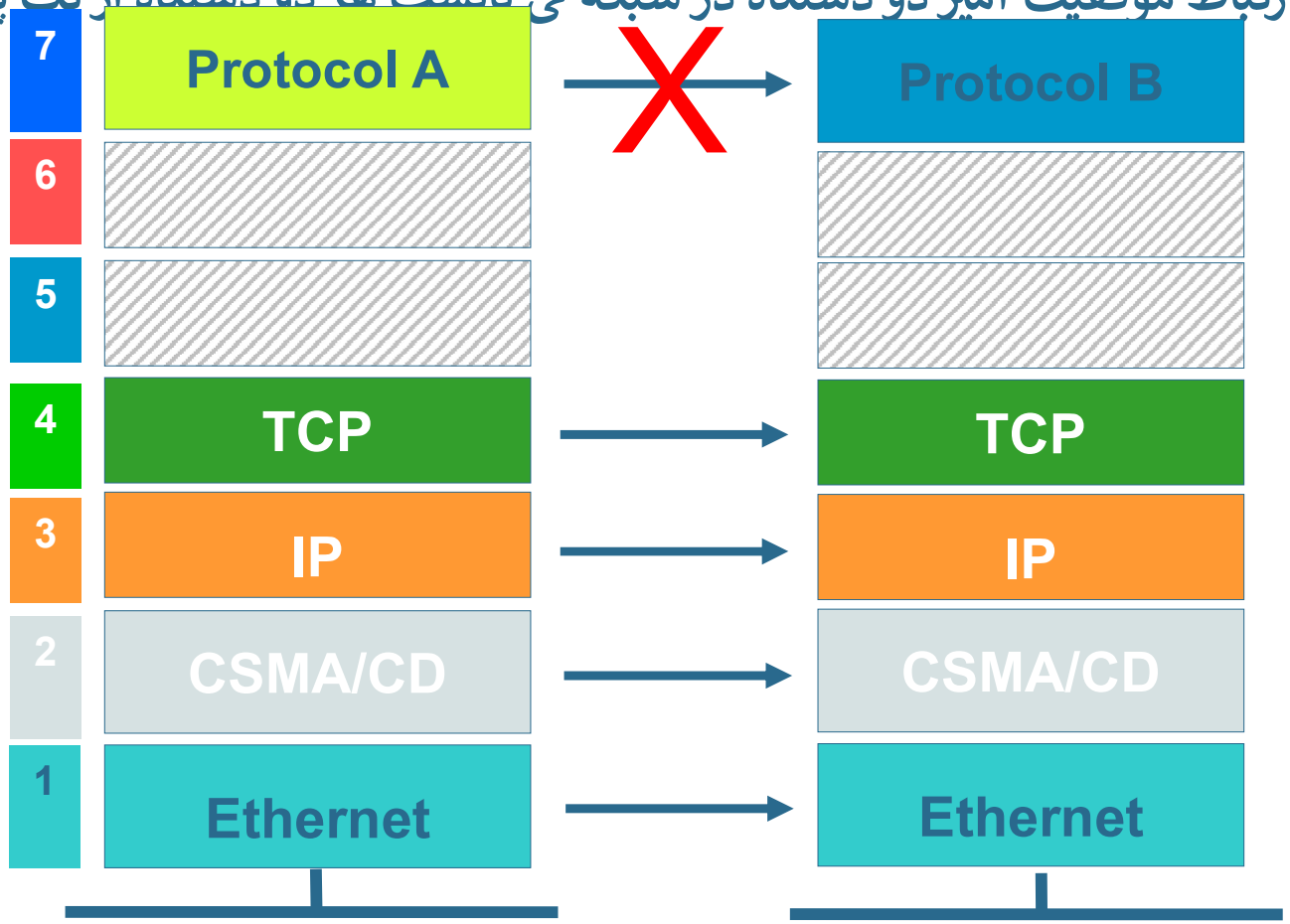
This layer directly serves the end-user, the AP, by providing the information to support the AP and manage the communication.
This layer thus specifically defines the information and its context to the AP.

Communication protocols

Protocol

پروتکل در شبکه های کامپیوتری به مجموعه قوانینی اطلاق می گردد که تحوه ارتباطات را قانونمند می نماید.به منظور ارتباط موفقیت آمیز دو دستگاه در شبکه می بایست هر دو دستگاه از یک پروتکل مشابه استفاده نمایند.





Communication protocols

DNP(Distributed Network Protocol)

DNP is a data acquisition protocol.

DNP used mostly in the electrical and utility industries.

DNP is designed as an open, interoperable.

DNP uses the master/slave polling method to send and receive information
but also employs sub-masters within the sam

Thereis a large support within the SCADA ir al
de facto standard for data acquisition and c

RS-232 (V.24)

RS-422

RS-485

fiber optic

Communication protocols

- Interoperability

  As a data acquisition protocol, the need to interface with many vendors' equipment was and is necessary.

- Open standard

  no one company owns the DNP standard!

- IEC and IEEE

  DNP is based on the standards of the International Electrotechnical Commission (IEC)
  DNP 3.0 was selected as a Recommended Practice by the IEEE C.2 task force

- SCADA

  The application program can integrate DNP with other protocols if the SCADA software permits.

Communication protocols

Physical layer

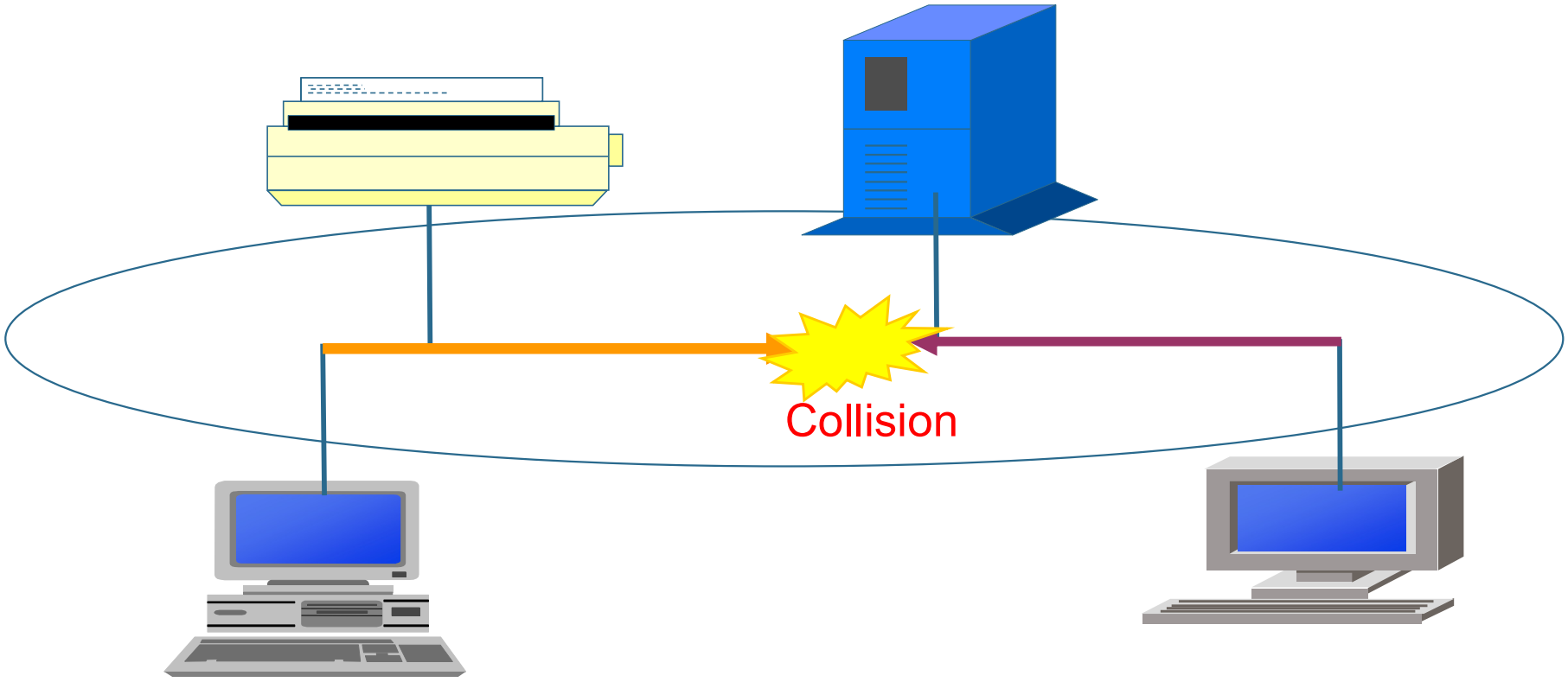
The physical layer of DNP is a serial bit,1 start bit, 1 stop bit and no parity.

It has two physical modes of operation

1. direct mode (point-to-point)
2. serial bus mode (multidrop).

Communication protocols

The two modes are not usable at the same time.
Both modes can be half- or full-duplex.
With either mode, a carrier detection system must be used.
There are possible collisions on the system.
Multi-masters are allowed but only one device can be a master at a time.

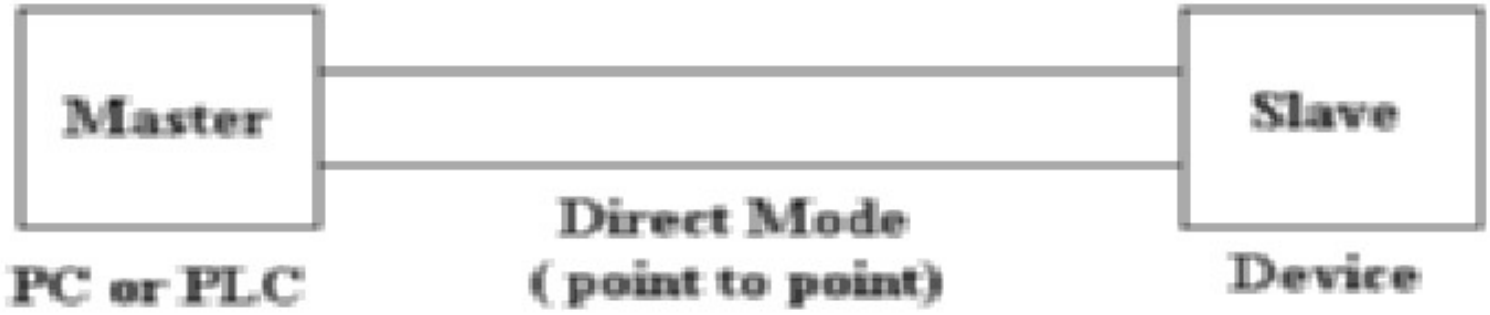


Communication protocols

- Physical topologies

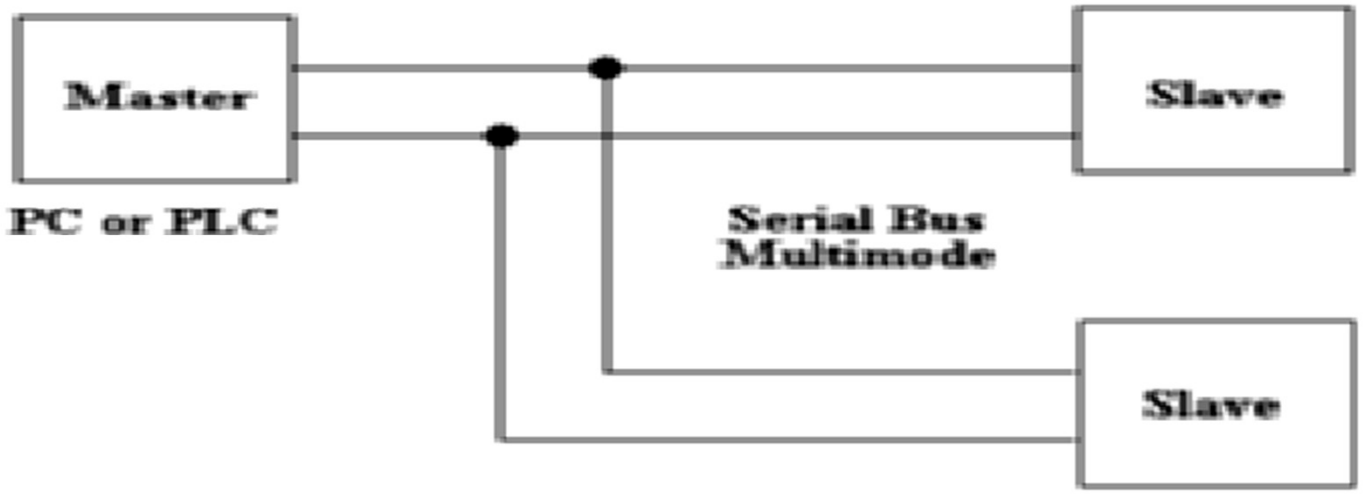
The DNP protocol supports five communication modes: two-wire point-to-point, two-wire multidrop, four-wire point-to-point, four-wire multidrop, and dial-up modems.

A system with only two nodes, a master, and a slave is called a direct bus.



Communication protocols

If the system is multidrop with multiple nodes, it is called a serial bus.

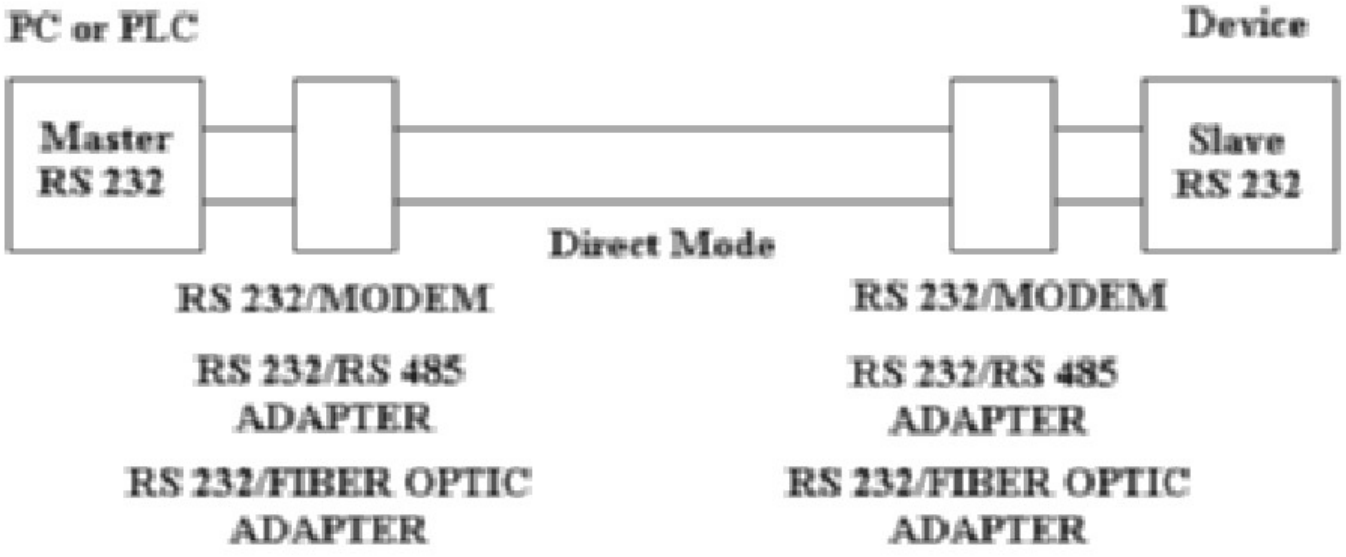


Both systems can use two- or four-wire connection methods.
The DNP supports: multiple master, multiple slave, and peer-to-peer communications.

Communication protocols

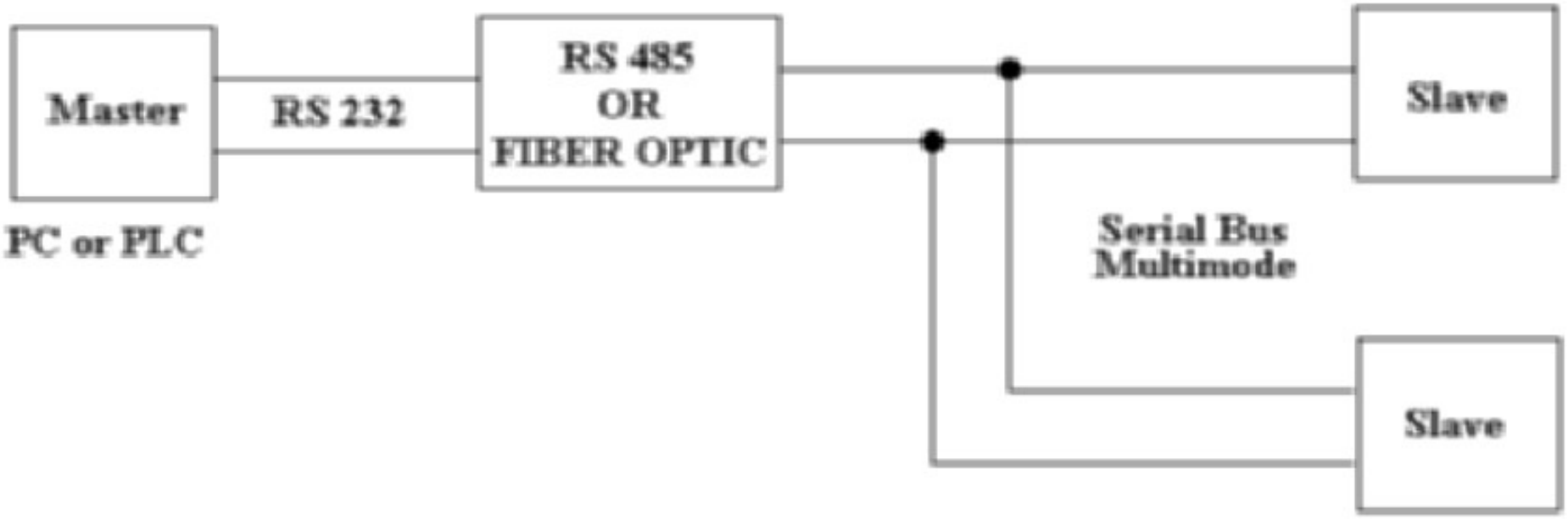
- **Modes**
  - Two-wire point-to-point

DNP protocols uses RS-485 or a two-wire modem as a physical system. modem is used then V.24 ITU standard.
The two-wire mode does not support a full-duplex operation within DNP, only half-duplex.
With the point-to-point mode there is no possibility of collisions.
The master transmits the frame and then the slave responds. The only concern is the time it takes for a response due to propagation delays.



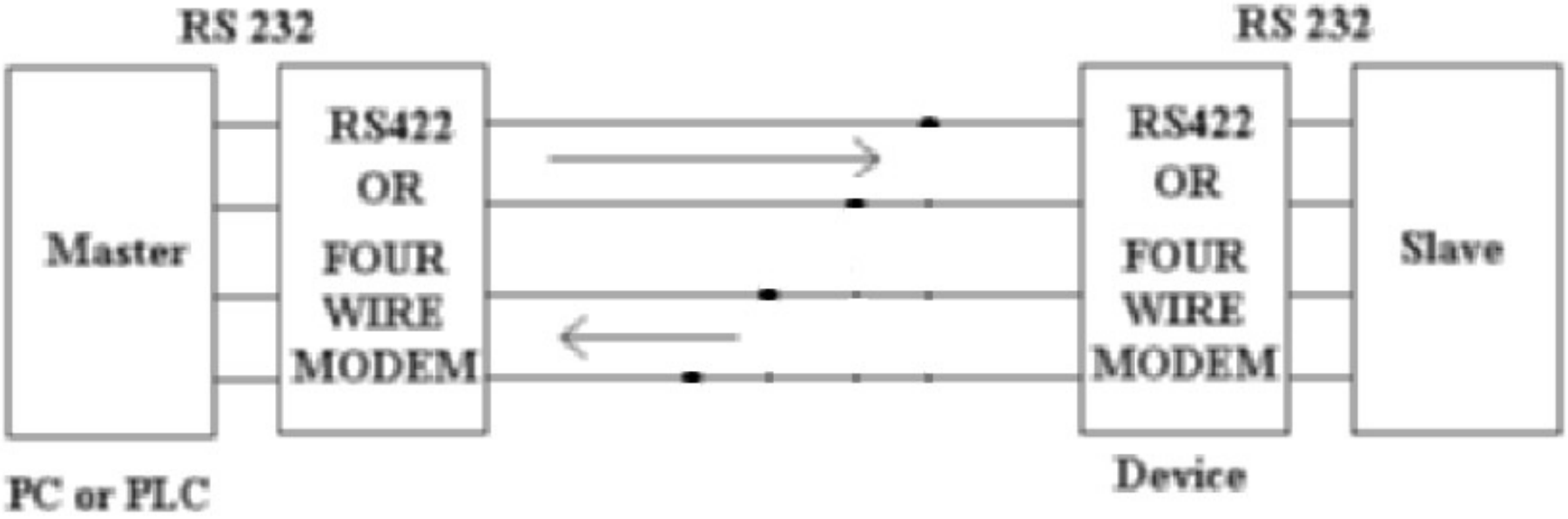
- Two-wire multidrop

The DNP physical layer supports multi-point communications. The two-wire multidrop mode usually uses RS-485, fiber optic or Bell 202 modems as a physical system. The two-wire mode does not support a full-duplex operation within DNP, only half-duplex. With the multidrop two-wire mode, there are possibilities of collisions.



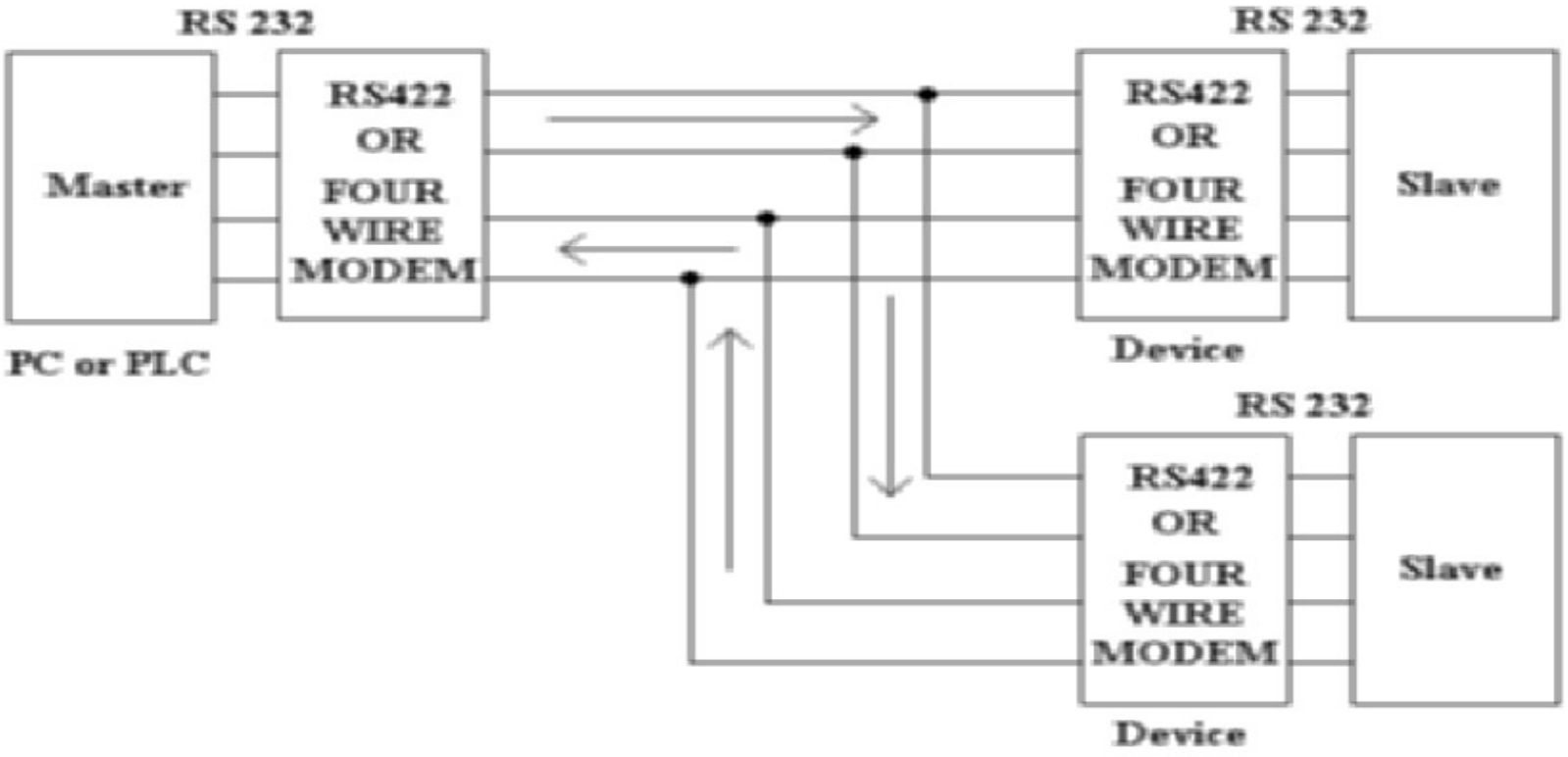
- Four-wire point-to-point

Four-wire point-to-point is used within DNP as a full-duplex master-to-slave system. The physical standards used are RS-422, RS-232, and four-wire modems. Since this mode is only point-to-point there is no problem with collisions.



- Four-wire multi-point

This mode can use half- or full-duplex communications, although again full-duplex is rarely used. The reason full-duplex is not used is because of the complexity of collision avoidance. Have multiple devices all talking at the same time in both directions is difficult at best to implement.



- Dial-up modem

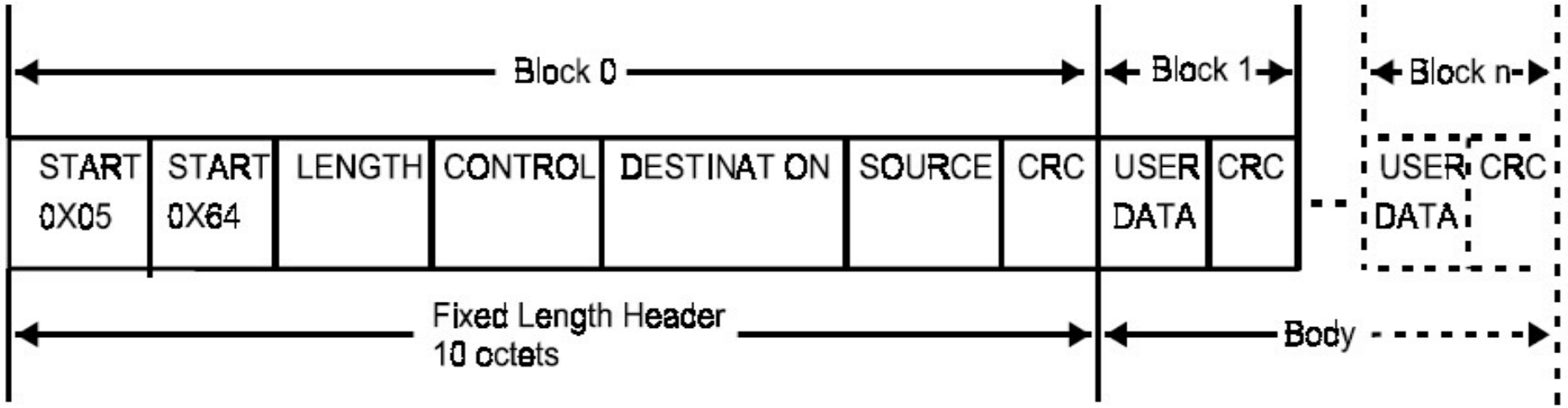
It usually uses V.24 as a connection system (RS-232). DCD is used differently in this case because carrier detect in modems means that a line has been established, not that data is being sent. The RTS line is placed high to tell the modem that the DTE wishes to send data. The CTS is placed high by the modem to tell the DTE it is OK to send data.

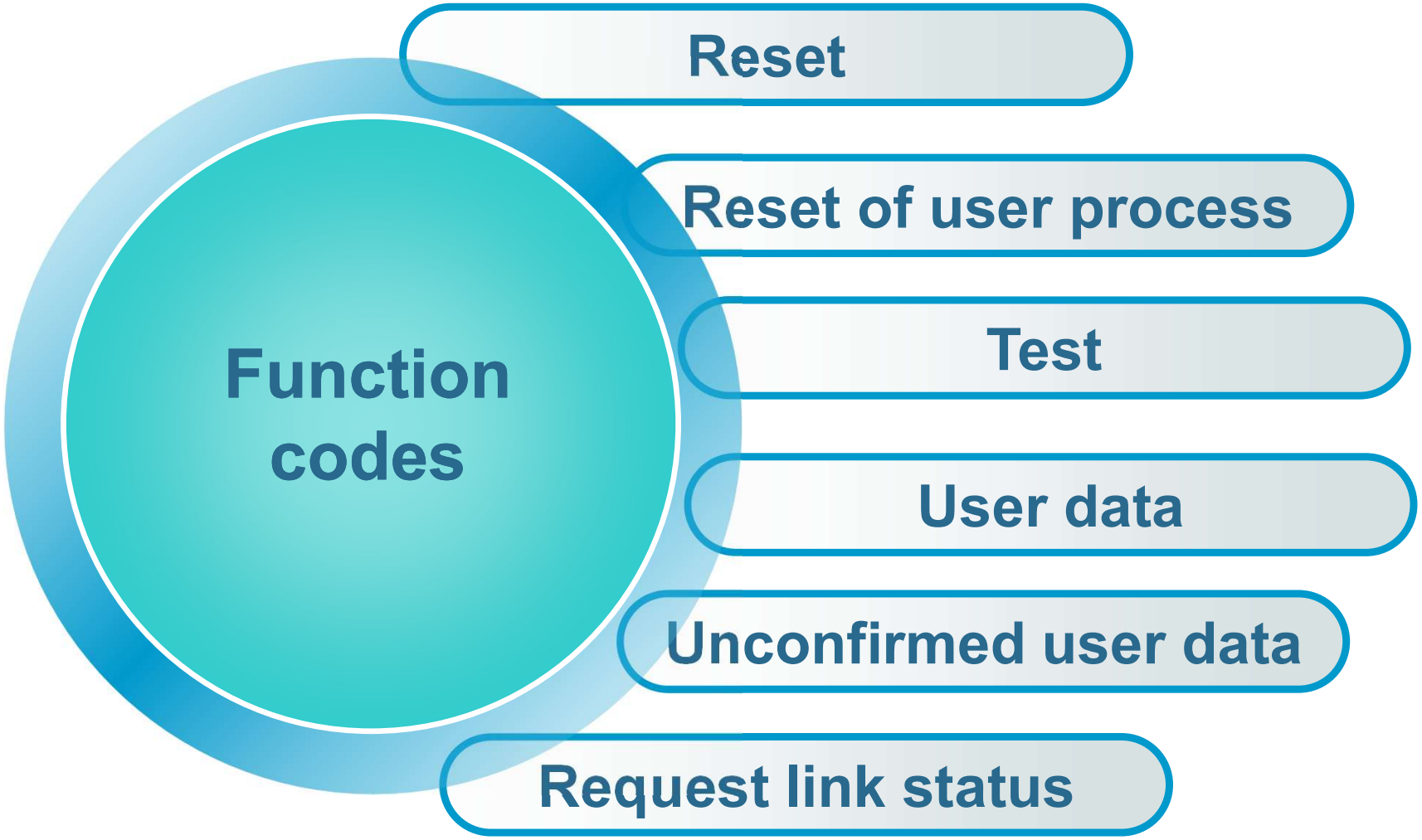
Data link layer

The data link layer of the DNP defines the frame size, shape, length, and contents. DNP uses the convention of the octet instead of byte.

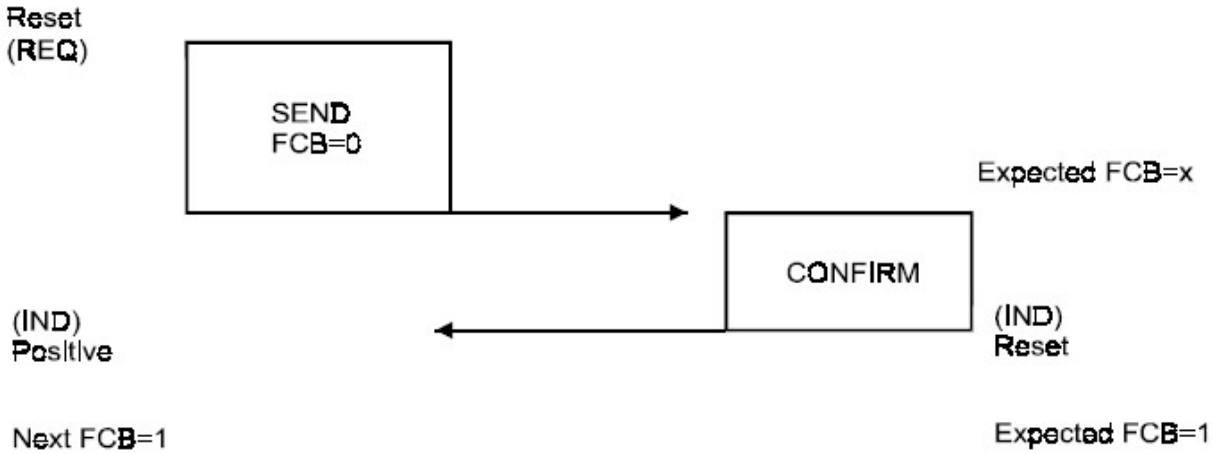
The maximum octets of data are 255 and the minimum is 5.

The last user data may have less than 16 octets. Each CRC is calculated for that user data, not for the whole frame.

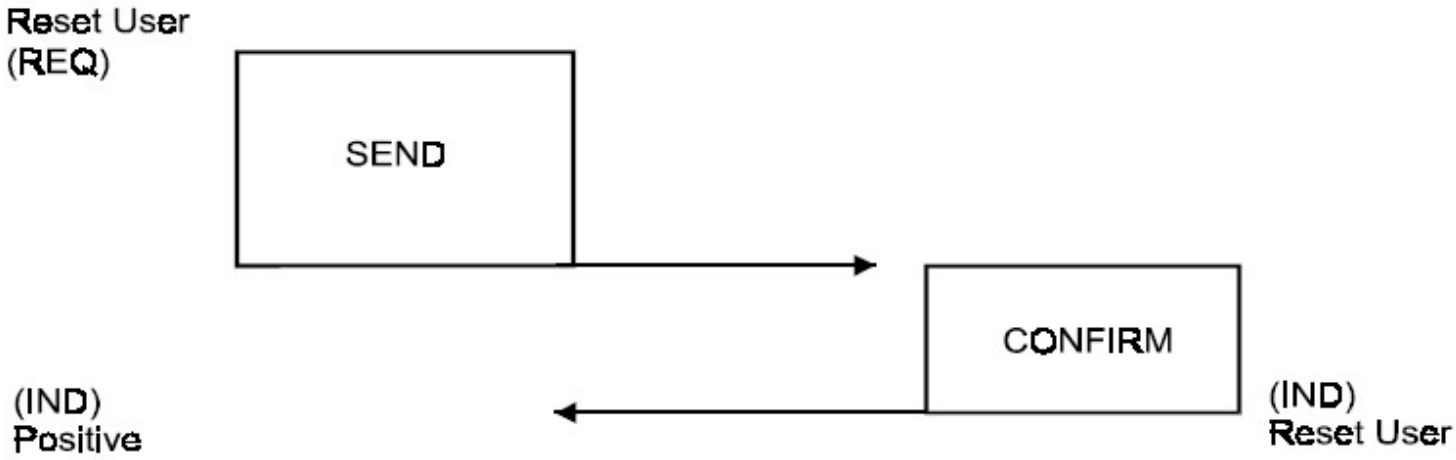



Function codes
Reset
Reset of user process
Test
User data
Unconfirmed user data
Request link status

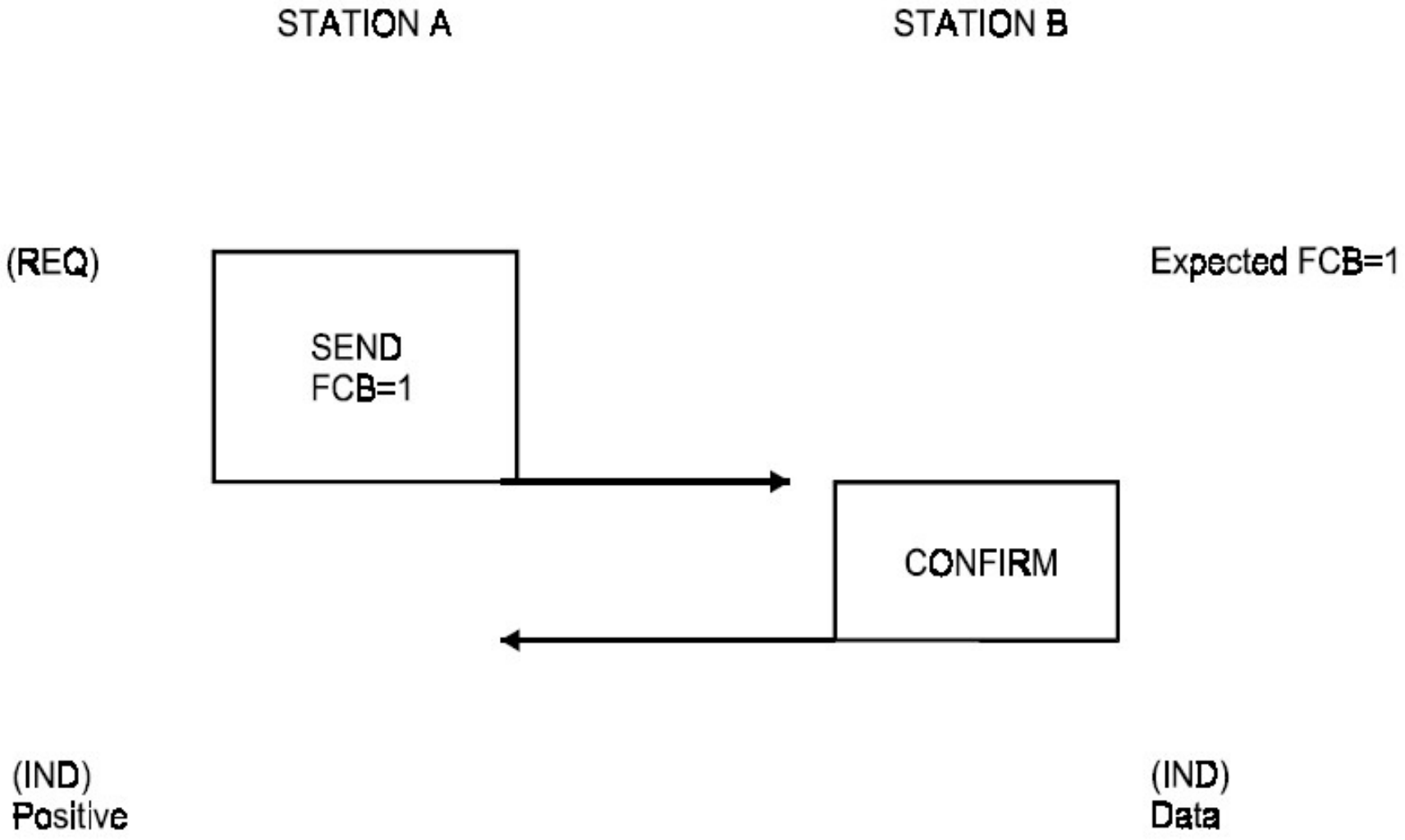
Reset of secondary link



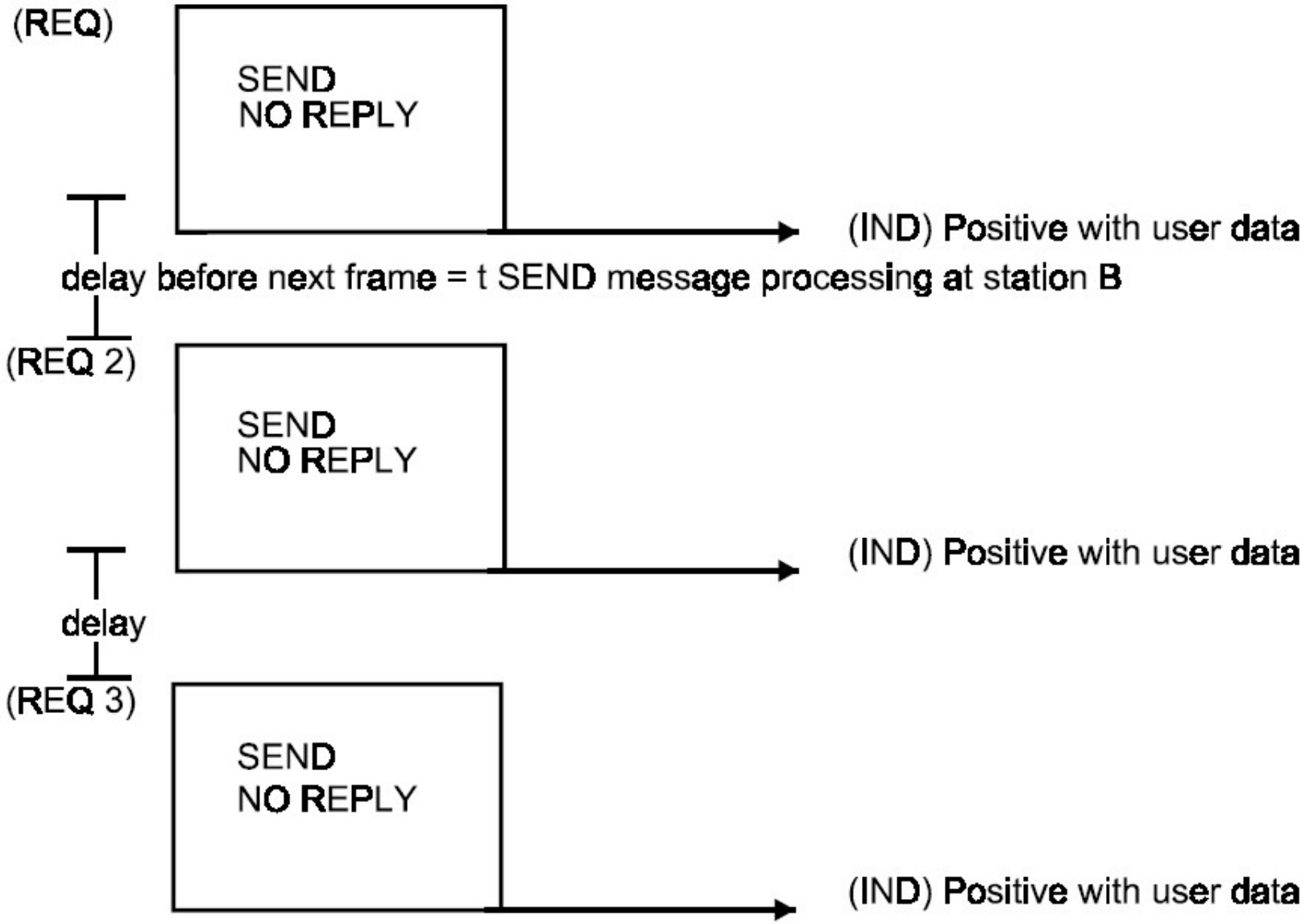
Reset of user process



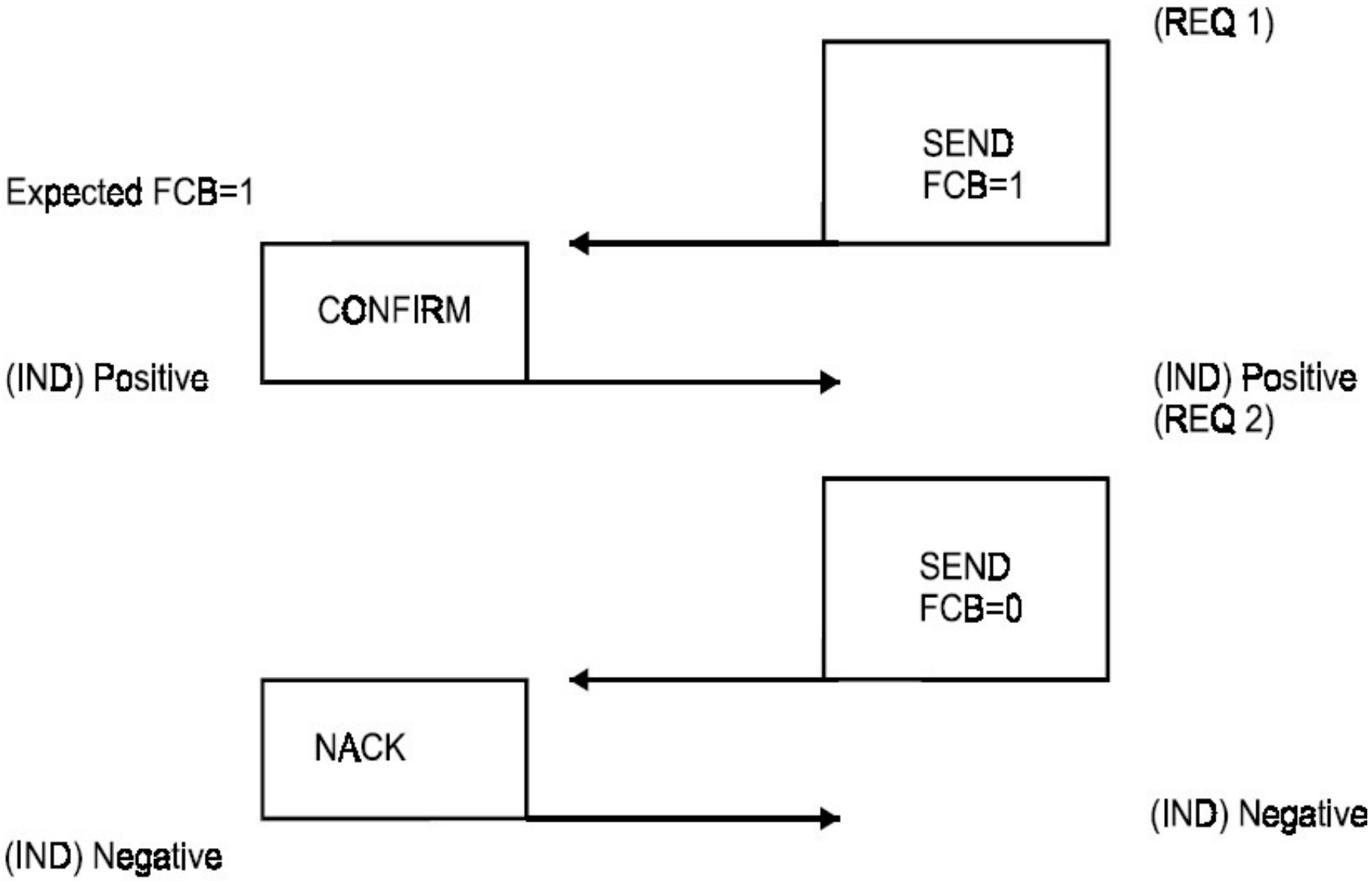
Send-confirm user data



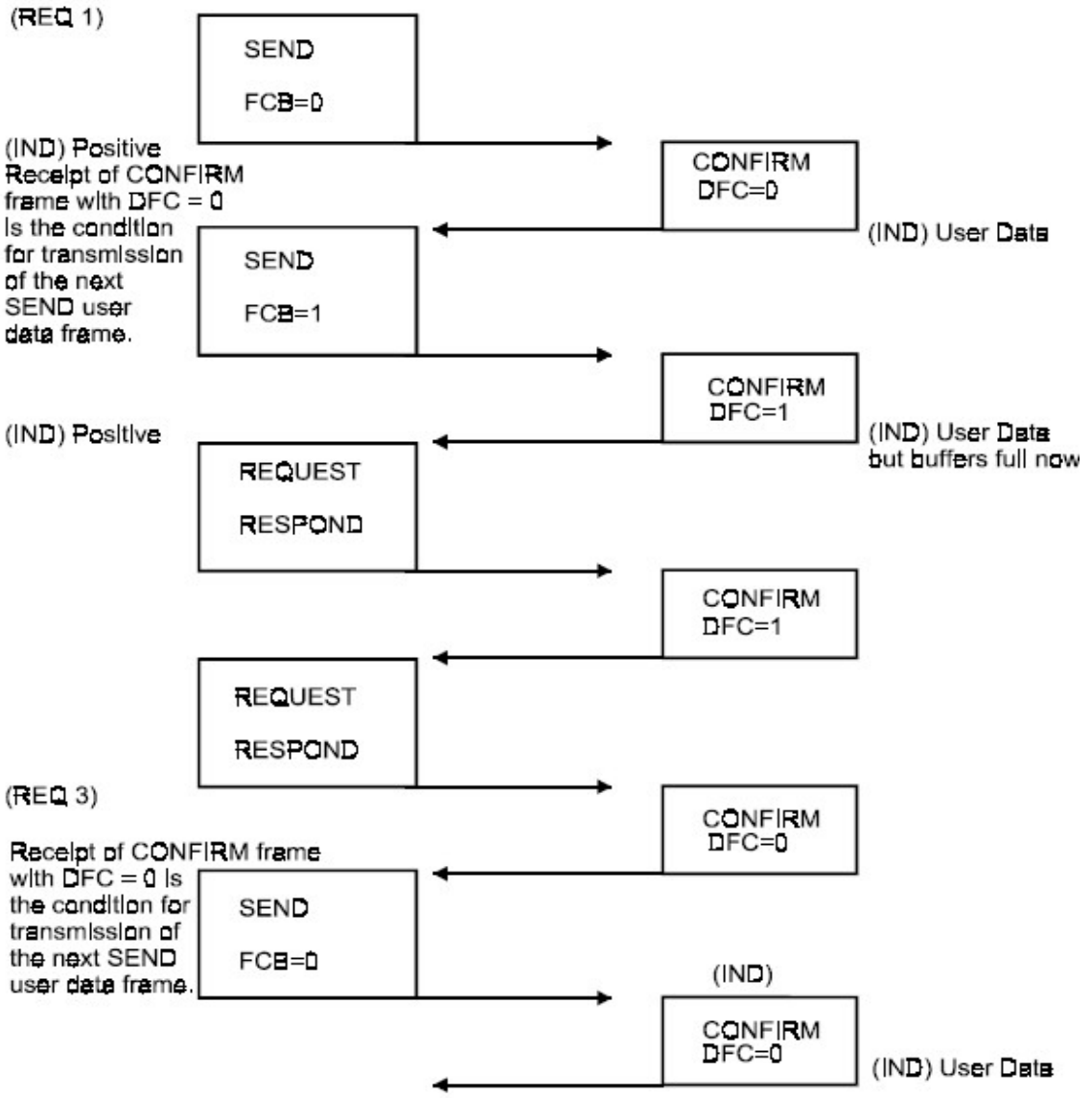
Send-No reply expected



Send-NACK


(REQ 1)
SEND
FCB=1
Expected FCB=1
CONFIRM
(IND) Positive
(IND) Positive
(REQ 2)
SEND
FCB=0
NACK
(IND) Negative
(IND) Negative

Request-respond



Transport layer (pseudo-transport)

The distributed network protocol does not support a true transport layer as defined by the ISO open system interconnection model. It does support a pseudo-transport layer known as the super-data link transport protocol.

These data link functions consist of breaking the transport service data unit (TSDU) into smaller sequenced frames called link service data units (LSDU).

The maximum size of an LSDU is 249 octets.

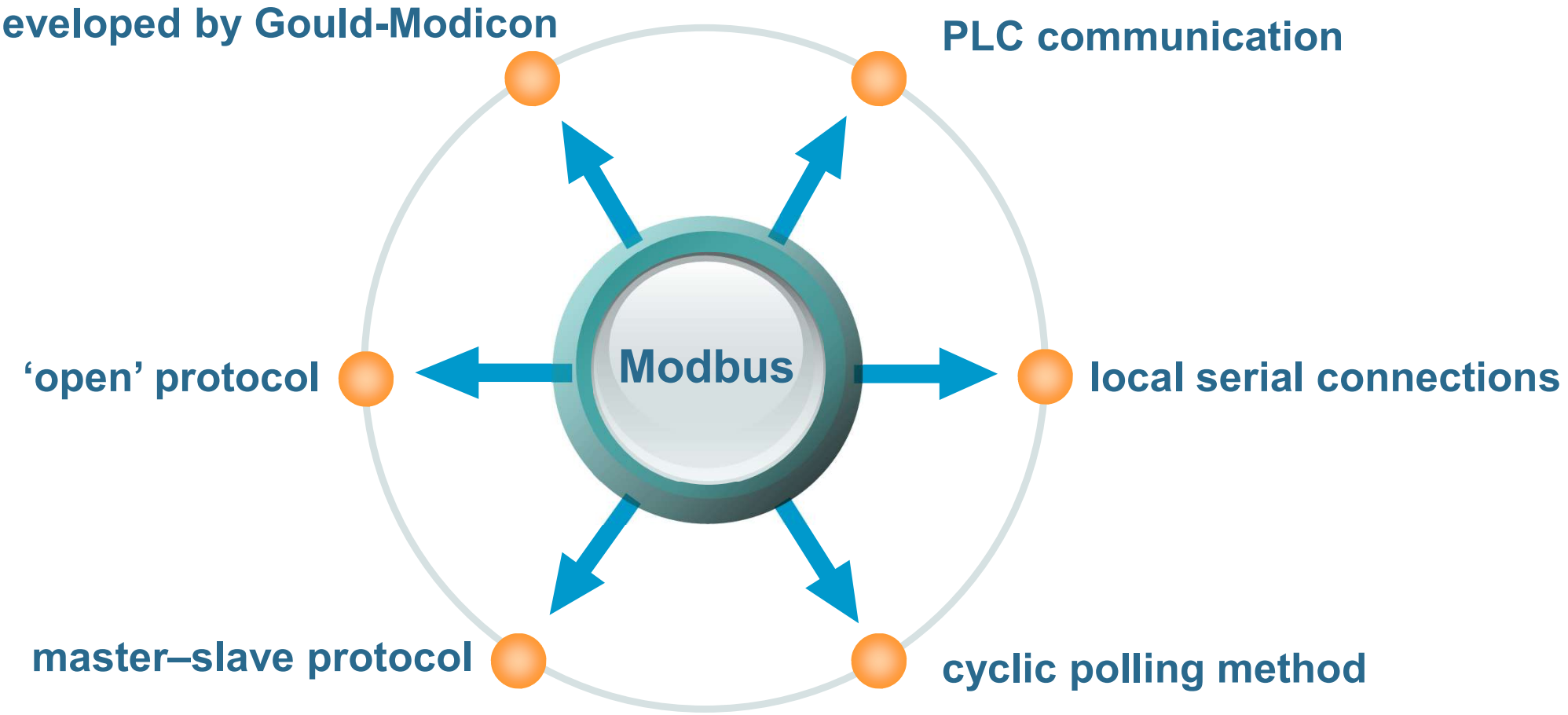
Application layer

The DNP supports an application layer by defining an extensive data object library, function codes and message formats for both the requestor and the response devices.

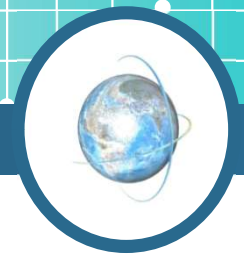
These are used in the user layer to build a final application. Once this application is built and the data objects, function codes, and message formats are absorbed the application becomes the application layer.

Communication protocols

Modbus



Communication protocols



Modbus applies to layers 1, 2 and 7 of the OSI stack.

no interface is defined in the modbus protocol.

The user can therefore choose between EIA-232, EIA-422, EIA-485

modbus is relatively slow in comparison with other buses

It can be regarded as a *de facto* industrial standard.

modbus is severely limited as a protocol for electrical substation communications.

Communication protocols

query/response type

For a single slave

no response type

broadcast

Communication protocols

- characteristics of the modbus protocol
  - Certain characteristics → frame format, frame sequences, handling of communications errors and exception conditions and the functions performed
  - selectable characteristics → transmission medium, transmission characteristics, and transmission mode, RTU or ASCII.
  - user characteristics → Set befor run!

modbus frame:

- address of the intended receiver
- what the receiver must do
- checking errors

Communication protocols

information in the response message:

- slave address
- action performed
- result of checking errors

broadcast type, there is no response from the slaves.

Normally, the master can send another query as soon as it has received the response message

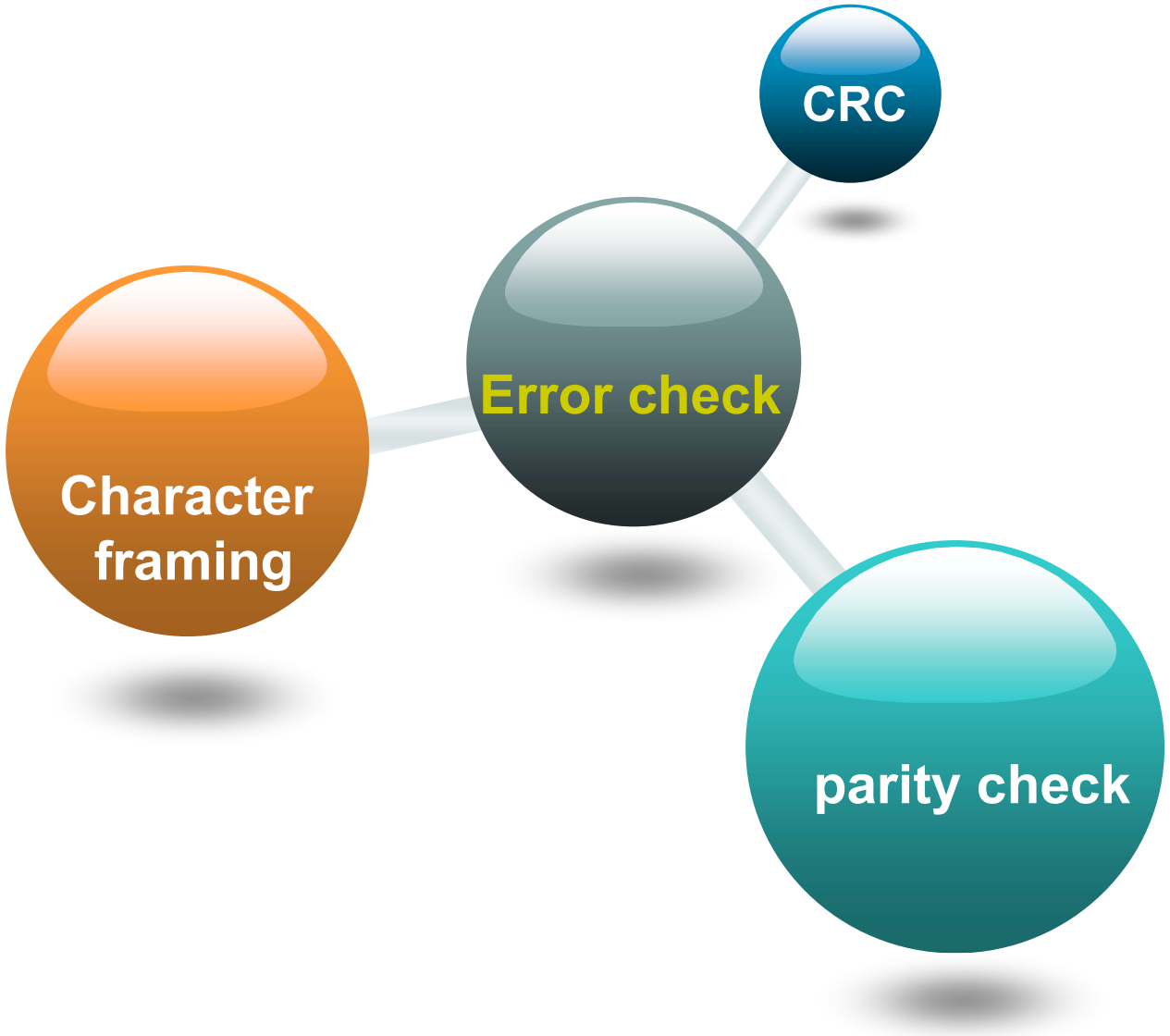
Data can be exchanged in two transmission modes:

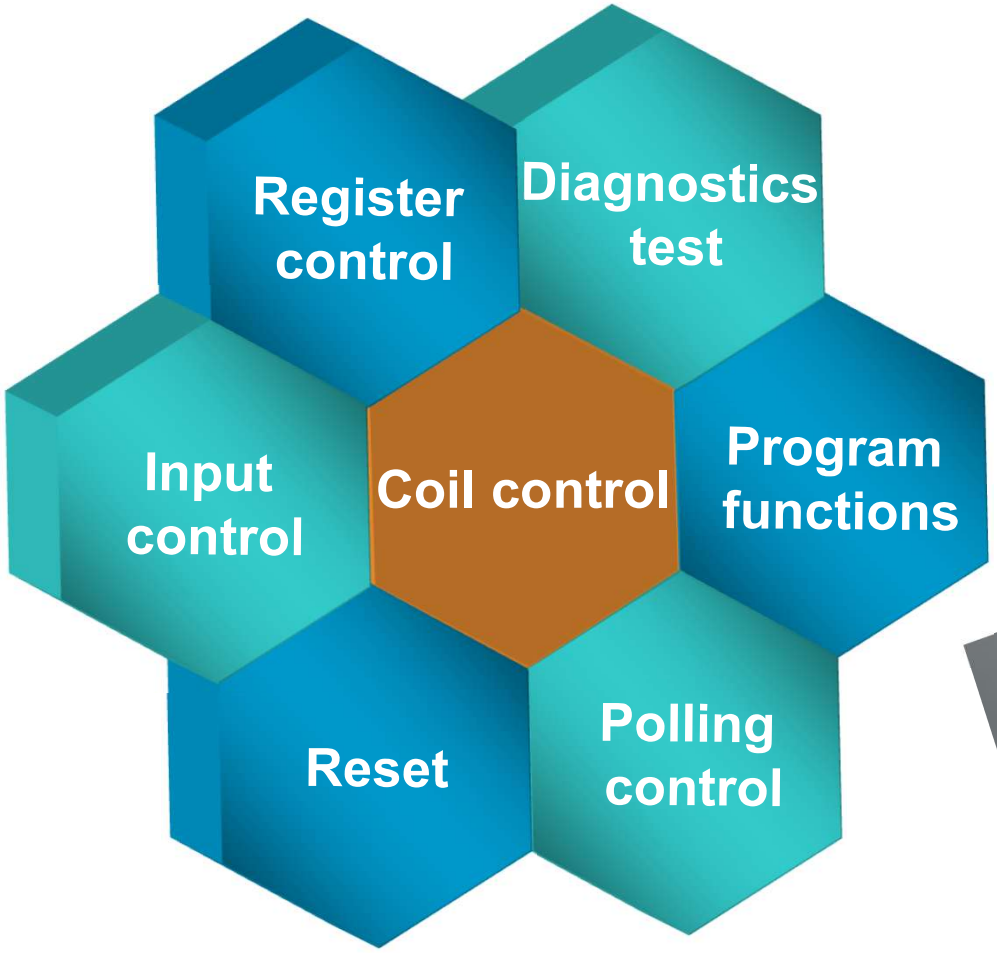
readable, used e.g., for testing

compact and faster;
used for normal operation

The ASCII has a typical message that is about twice the length of the equivalent RTU message.

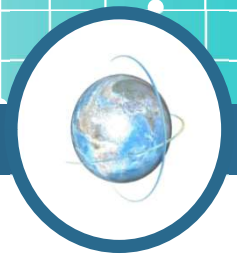
Communication protocols





Modbus functions

Communication protocols



- Modbus plus
- Introduction to modbus plus network

  Modbus plus is a local area network (LAN) system

  Modbus plus is exclusively designed for industrial control applications

- Modbus plus characteristics

  Supports up to 64 addressable node devices

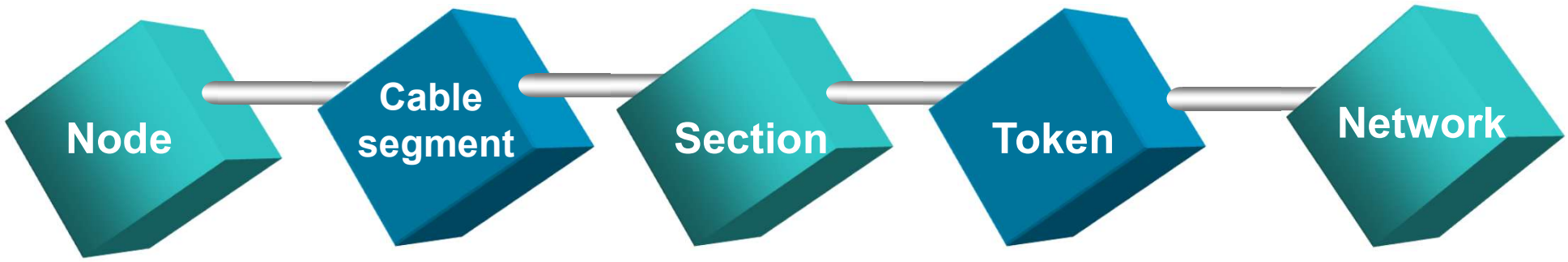
  Host level peer-to-peer communication

  Distributed input/output (DIO) communications

Direct connection of 32 devices with a bus cable, up to 450 m long, and if extended with a repeater up to 64 devices, with a total cable length of 1800 m

Host level networks can be joined through bridge plus devices

Modbus network terminology



Node	Cable segment	Section	Token	Network
Any device that is physically connected to the modbus plus cable	A single length of trunk cable between passive devices that provide connections for the trunk, called taps	A series of nodes, joined only by cable segments	A grouping of bits, passed from one device to another on a single network, to grant access for sending messages	The grouping of nodes on a common signal path that is accessed by a passing of a token

Communication protocols

- How the network works

Each network node is identified by an address.

The lowest address node: issues a token and starts it rotating in a fixed sequence from one node to the next.

The token cannot be passed to another network through a bridge.

Each network has its own token.

When it possesses a token a node can transmit messages to any other node.

Each message information:

its source and destination

including its routing path through bridges (to reach a remote network node)

There is a field containing global data within a token.
Before the node passes the token it can place data in this field to update the global database.
This allows rapid updating of alarms, setpoints, and other data.

- Overview of the physical network

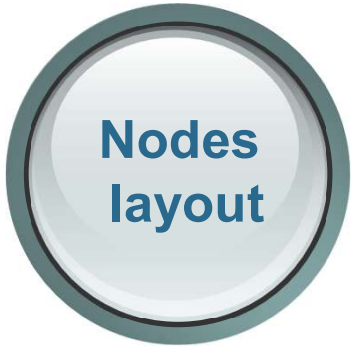
There is a wiring standard to facilitate maintenance

Each network cable section can support up to 32 nodes, with a maximum cable distance of 450 m

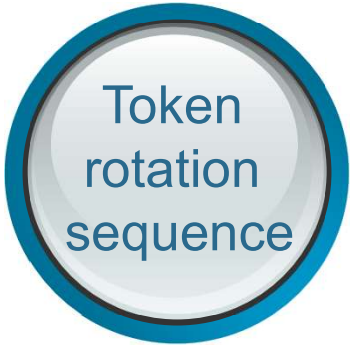
Sections can be joined by repeaters to extend the cable length up to 1800 m and to increase the number of nodes up to 64

Nodes are connected to the cable by means of a tap device, supplied by Modicon

- How nodes access the network



It is your choice to lay the network out as one large one, or as several smaller networks, connected through bridges. As the token is not passed through bridges it is possible in that way to vary the timing of the complete token rotation.



It is determined by the node addresses

While a node holds a token it is permitted to send its application messages. When a node receives a message it sends an immediate acknowledgment to the originating node.

The only information, which a node is permitted to transmit without holding the token, is statistics. Such information includes identification of active nodes, current software version, network activity, and error reporting.

Global database applications include time synchronization, rapid notification of alarm conditions, and multicasting setpoint values to all devices in a common process

Error checking and recovery

If no acknowledgment is received after a message transmission, the node will re-attempt to send the message again. After three unsuccessful attempts, the node will set an error, which can be sensed by the application program.

If two nodes have been assigned the same address, the application program will ensure that the second one remains silent, will handle the rest of the application and will set an Error.

If after passing the token a node does not sense any valid activity from its successor, it will try to pass the token again. After the second unsuccessful attempt the faulty node will remain silent and a new token sequence will be established.

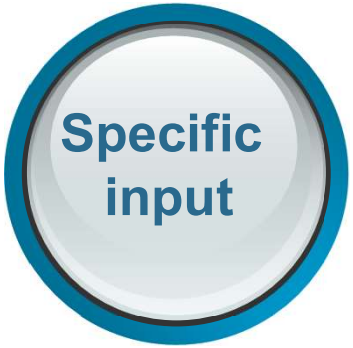
Peer cop transactions

There are four kinds of peer cop (peercop?) transactions:

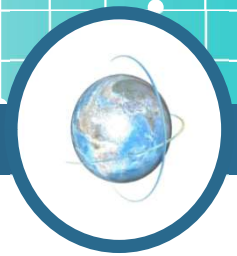
It is your choice to lay the network out as one large one, or as several smaller networks, connected through bridges. As the token is not passed through bridges it is possible in that way to vary the timing of the complete token rotation.

It is determined by the node addresses

Each node could receive up to 32 words of global data from any other node.



Each node could receive up to 32 words of data from any specific node in the network.



LonTalk

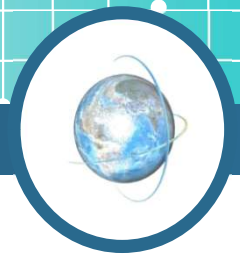
LonTalk is the protocol, whereas LonWorks comprises the entire range of hardware, software, transceivers, network management, program interfaces, installation and configuration tools, etc.

The LonTalk protocol implements *all seven layers* of the ISO/OSI reference model.

The protocol supports peer-to-peer communication, and includes features: such as transaction acknowledgment, sender authentication, priority transmissions, duplicate message detection, collision Avoidance, unicast/multicast/broadcast addressing, error detection, and recovery.

LonTalk layers

	OSI Layer	Purpose	Services Provided	Processor
7	Application	Application compatibility	Standard network variable types	Application
6	Presentation	Data interpretation	Network variables, frame transmission	Network
5	Session	Remote actions	Request/response, authentication, network management	Network
4	Transport	End-to-end reliability	Acknowledged/Unacknowledged, Unicast/multicast, ordering, duplicate detection	Network
3	Network	Destination addressing	Addressing, Routing	Network
2	Link	Media access and framing	Data encoding, error checking, PCSMA, collision detection and avoidance, priority	MAC
1	Physical	Electrical interconnect	Media specific interfaces and modulation	MAC, XCVR



- main features of the LonTalk protocol

Multiple media support

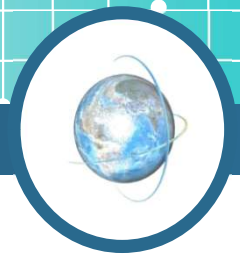
A wide variety of communication media is supported, including twisted pair, powerline, RF, infrared, coaxial cable, and fiber optics.

Multiple communication channels

A channel is a physical transport medium and can contain up to 32 385 nodes. A network may consist of two or more channels.

Communication rates

Bit rates vary in discrete steps from a minimum of 0.6 kbps to a maximum of 1.25 Mbps.



Addressing

The top level of the addressing hierarchy is the domain. A domain consists of up to 255 subnets.

The second level is the subnet. A subnet is a logical grouping of nodes from one or more channels. There may be up to 127 nodes per subnet.

The lowest level of addressing is the specific node. There may be up to a maximum of 255 × 127 = 32 385 nodes in a single domain.

One node may be a member of one or twodomains.
Nodes may also be grouped. Up to 256 groups may be specified in a domain, and up to 64 nodes may be in a group for acknowledged service.
An unlimited number of nodes may belong to a group for unacknowledged service.

Group addressing allows many nodes to receive information using a single message on the network, and reduces the length of the addressing data send with each message.
Each node has a unique ID assigned during manufacture.

Nodes are addressed in the following format:

Address data specified	Nodes addressed
Domain, Subnet = 0	All nodes in the domain
Domain, Subnet	All nodes in the subnet
Domain, Subnet, Node	Specific logical node
Domain, Group	All nodes in the group
Unique ID	Specific physical node

با تشکر و سپاس

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توجه شما