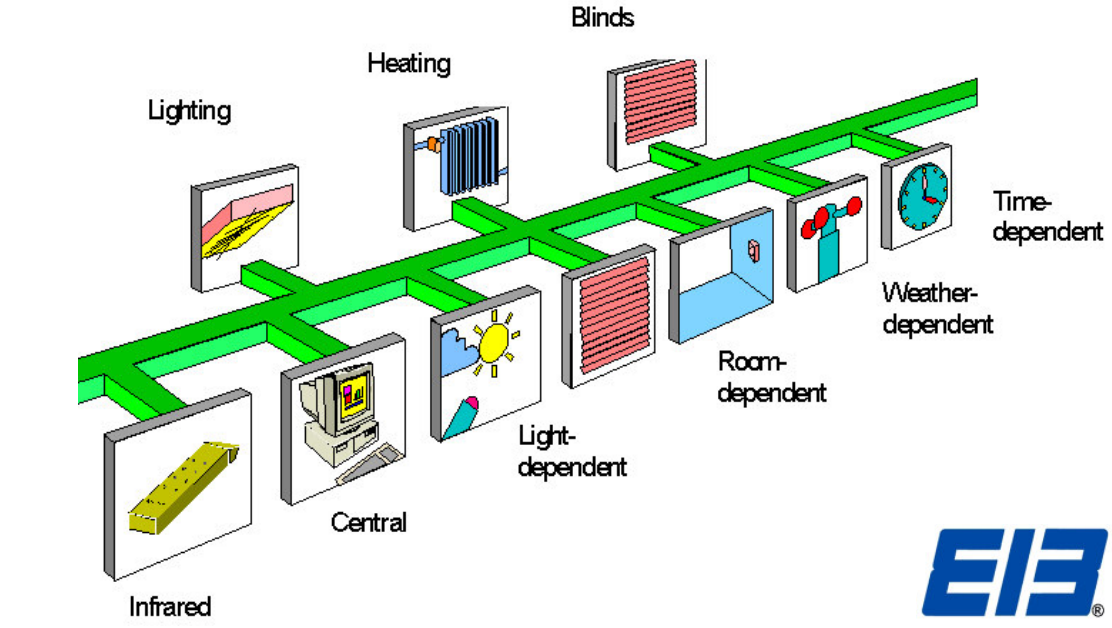
EIB

- Understanding EIB Control Networks
- Investigating EIB Protocol (EIB.TP)

Reference:

•EIBA Handbook Series Vol. 1 and Vol. 3
(downloadable from:
http://www.eiba.com/downloads/downloads.nsf/system%20specifications?OpenPage)

EIB Control Networks



Control Network: EIB

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•Europe: **E**uropean **I**nstallation **B**us

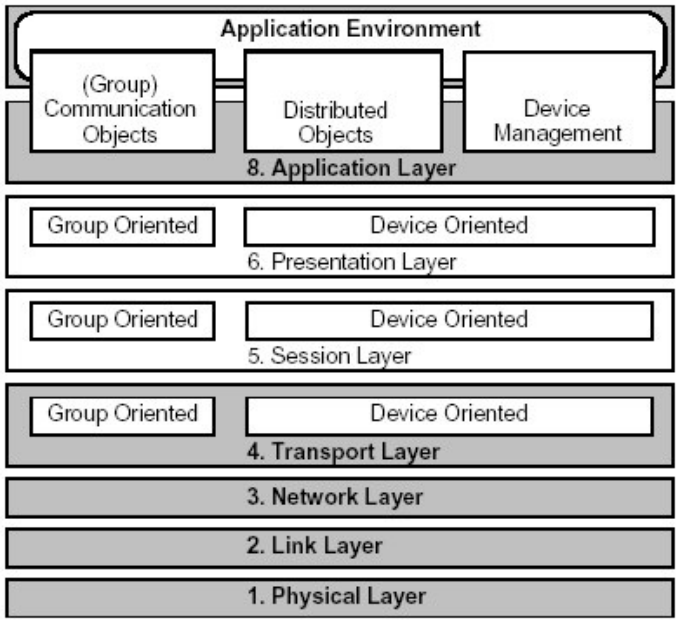
•Asia: **E**lectrical **I**nstallation **B**us

•EIB concentrates on home and/or building automation and management.

Protocol Standards

- ANSI/EIA 766
- ENV 13154-2

EIB Protocol Layers



Control Network: EIB

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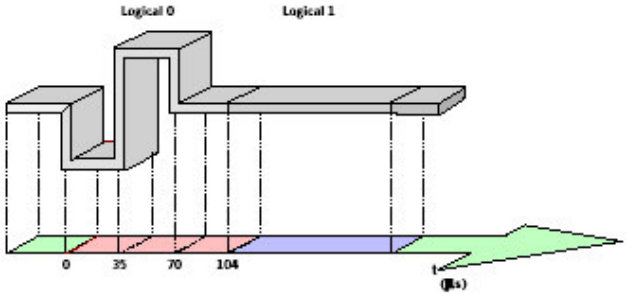
- The EIB Device Network protocol defines:
    1. Physical Layer
    2. Data Link Layer
    3. Network Layer
    4. Transport Layer
    5. Application Layer
- EIB goes on to specify (mandatory!) standard datapoint formats and their semantics in various applications

Physical Layer

- The EIB Device Network Protocol supports the following media:
  - EIB.TP (9.6 kbps)
  - EIB.PL (1.2 kbps)

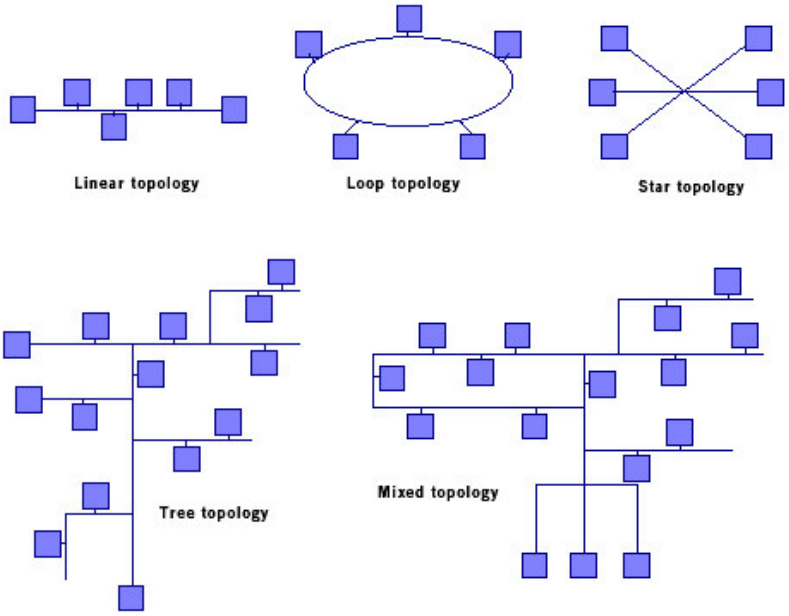


  - EIB.RF (under development)
  - EIB.IR (under development)

The EIB Device Network Protocol supports the following media:

1. Twisted Pair (9600 bps)
   - STP with 30Vdc
   - balanced, baseband, asynchronous (UART) transmission with even parity (range 1 km)
   - Data packet size of 14 bytes (extension to 230 is currently under consideration)
   - CSMA with bit-wise Collision Avoidance (dominant 0)
2. Powerline Carrier (1200 bps)
   - currently 230V 50Hz mains only
   - spread-spectrum FSK
   - Maximum distance between 2 devices (without repeater): 600 m. (Communication is influenced by electromagnetic pollution conditions in the installation.)
3. 4. Radio Frequency
   - under development
   - In free field conditions, the transmission distance is about 300 m.
5. Infrared
   - under development
   - No other information on this media.

Physical Network Topology of EIB.TP



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•The electrical segments can have an arbitrary topology (i.e. linear, star, tree, loop or combinations of them) consisting of individual wiring sections as long as the electrical requirements (resistive and capacitive length) are not exceeded.

•Terminating resistors are **not** required in EIB.

•Up to **64** bus devices may be connected to each lines, allowing a total of 64.000 components to be connected.

•The total cable length shall not exceed **1000 m** per electrical segment.

•The maximum length allowed is **700 m** between two devices and **350m** between a power supply unit and a device.

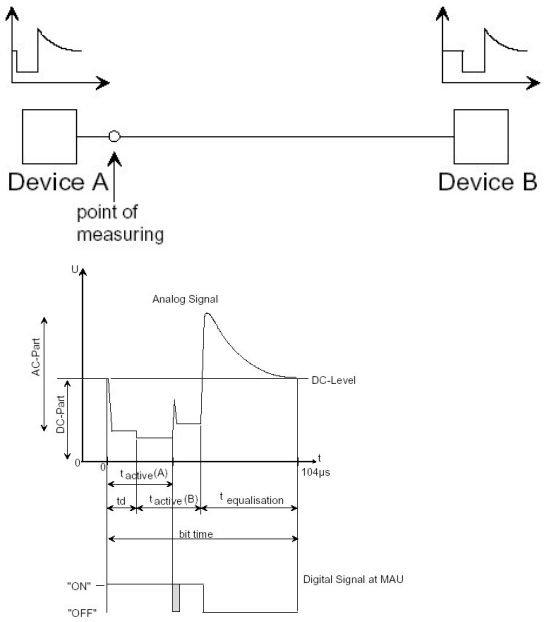
•In certain cases the connection of more than 64 devices to the same line may be required. The system allows two segments to be connected via a bridge, mostly named “repeater”. The connection capacity of the line may thus be doubled. In principle, a line may include up to 4 electrical segments connected together via repeaters, thus taking the capacity of the line to 256 devices. However, more than one electrical segment shall only be used for extension of existing installation but not for a new (initial) installation. A maximum of 6 Line Controllers (i.e. Line Couplers, Backbone Couplers and Repeaters) are allowed in one transmission path.

•The logical segments themselves are connected together by line couplers (LC) via a single logical segment. A maximum of 16 logical segments is allowed.

•Up to 15 zones can be federated by using the Bus itself. This can be also achieved by higher-level bus systems like ISDN or Profibus, requiring appropriated gateways.

Medium Access Control

- Carrier Sense Multiple Access (CSMA) with Optimized Collision Avoidance
- It is a bit-level collision detection with dominant logical 0

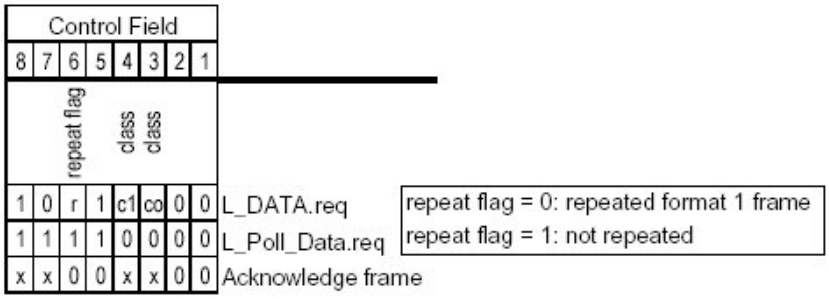


•Sending of logical ‘0’ and logical ‘1’ at the same time result in a logical ‘0’.

•Simultaneous sending of logical ‘0’ from several EIB devices results in a signal which is nearly the same as that of a single transmitting device, because signal is coded in baseband.

•If a sending device detects that an *own* logical ‘1’ was overwritten by another logical ‘0’, transmission has to be disabled after this bit, however the receivers of both devices are still in progress.

Data Link Layer



•The first character of each frame is the control field.

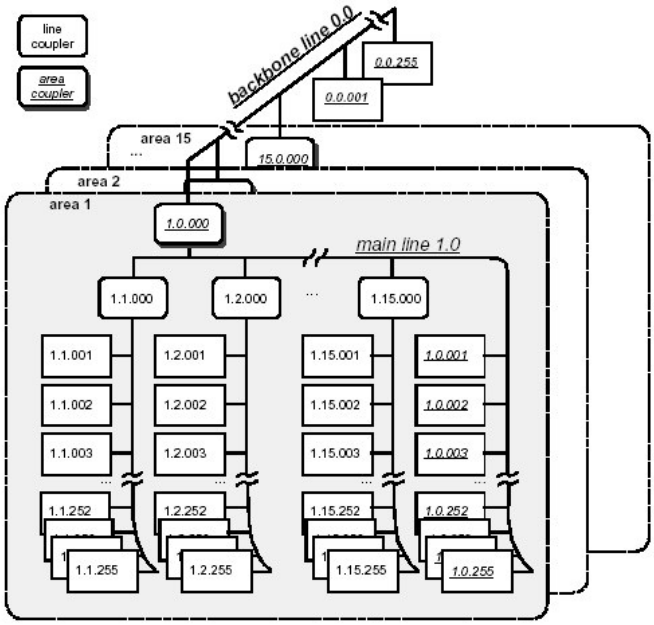
•The control field contains the information about the layer-2 service, its class and a flag containing the information whether the LPDU is a repeated one.

•The control field indicates the type of the request frame, L_Data-, L_Poll_Data request frame or Acknowledgment frame. The two class-bits of the control field control the priority of the frame, if two devices start transmission simultaneously.

•Repeated format 1 frames have the repeat_flag set to zero, non-repeated ones have it set to one.

•The last character of a frame is the check byte which makes an odd parity over the set of corresponding bits belonging to the preceding bytes of the frame. This represents a logical NOT XOR function over the individual bits of the preceding bytes of the frame.

Addressing



Control Network: EIB

•EIB is a fully peer-to-peer network, which accommodates up to 65536 devices.

•The *logical* topology allows 256 devices on one line: 15 lines may be grouped together with a *main line* into an *area*

•An entire domain is formed by 15 areas together with a *backbone line*.

•On open media, nearby domains are logically separated with a 16-bit SystemID.

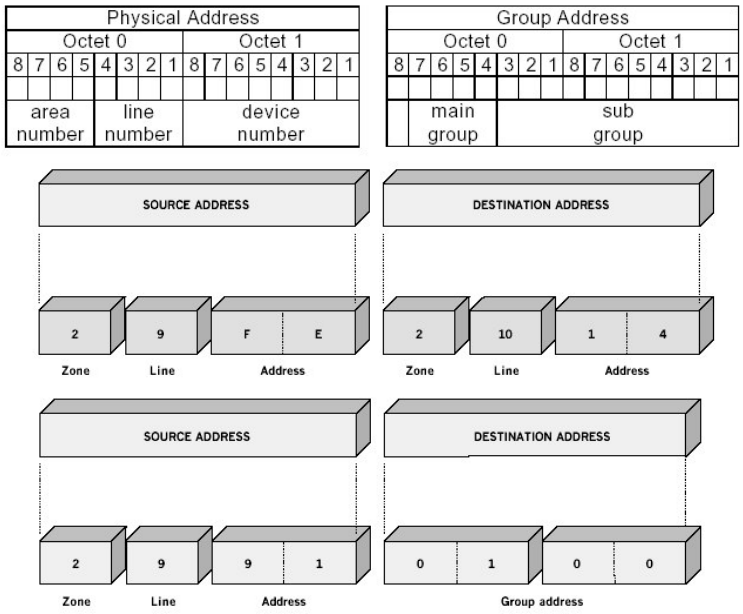
•Without the addresses reserved for couplers, (255 x 16) x 15 + 255 = 61’455 end devices may be joined by an EIB network.

•Installation restrictions may depend on implementation (medium, transceiver types, power supply capacity) and environmental (electromagnetic noise, …) factors. Installation and product guidelines should be taken into account.

Couplers connect lines or segments, e.g. within the Twisted Pair (TP) medium, or different media; their functionality may be (some combination of) repeater, bridge,

router, package filter (for traffic optimisation), firewall protection etc. EIB defines various standard coupler profiles.

Address Field



- Physical Address
    1. Each device, i.e. a router or an EIB end device shall have a unique physical address in an EIB network. The physical address is a two-octet value that consists of an 8-bit device number, a 4-bit line number and a 4-bit area number.
    2. The device number shall be unique within a line. Routers shall always have the device number zero; i.e. EIB end devices may have the device numbers 1-255. See also paragraph 1.3.3 "Router, Sub-line, Main Line and Zone" for details.
    3. The line number shall be unique within an area (0-15). The devices in the main line of an area shall always have the line number zero.
    4. The area number shall be unique within an EIB network (0-15). The devices in the inner area shall always have the area number zero.
- Group Address
    1. The group address is a two-octet value that doesn't need to be unique. An EIB end device may have more than one group address.
    2. Each EIB end device belongs to group zero, i.e. request frames with destination group address zero are broadcasts.
    3. Functions of EIB Bus devices belonging to the same group, may be controlled by only one message sent by a "source" EIB Bus device.
- The source address field always contains the physical address. The physical address is only used as destination address for initialization, programming and diagnostic operations (connection oriented transmission).

Transport Layer Services

- EIB Layer-4 provides four different types of communication relationships:
  - one-to-many connection-less (multicast)
    - T_Groupdata
  - one-to-all connection-less (broadcast)
    - T_Broadcast
  - one-to-one connection-less
    - T_Data_Unack
  - one-to-one connection-oriented
    - T_Connect
    - T_Data
    - T_Disconnect

•A multicast communication relationship connects group-objects that belong to the same group. Group-objects may be distributed to a number of EIB end devices. Each EIB end device may be a transmitter. More than one group-object may exist in an EIB end device. The group-objects of an EIB end device may belong to the same or to different groups.

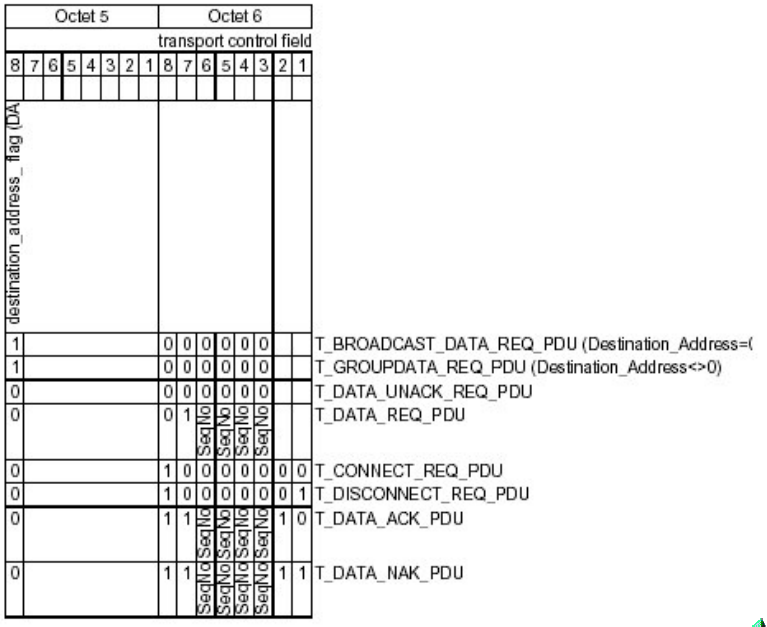
•The broadcast communication relationship connects a single EIB end device with all communication partners. The single EIB end device is always a transmitter, the communication partners are always receiver.

•Every EIB end device has a one-to-one connection-less communication relationship with every other EIB end device. A one-to-one connection-less communication relationships shall not be used if the connection-oriented communication relationship is established to the same partner at the same time.

•An EIB end device only has a single one-to-one connection-oriented communication relationship.

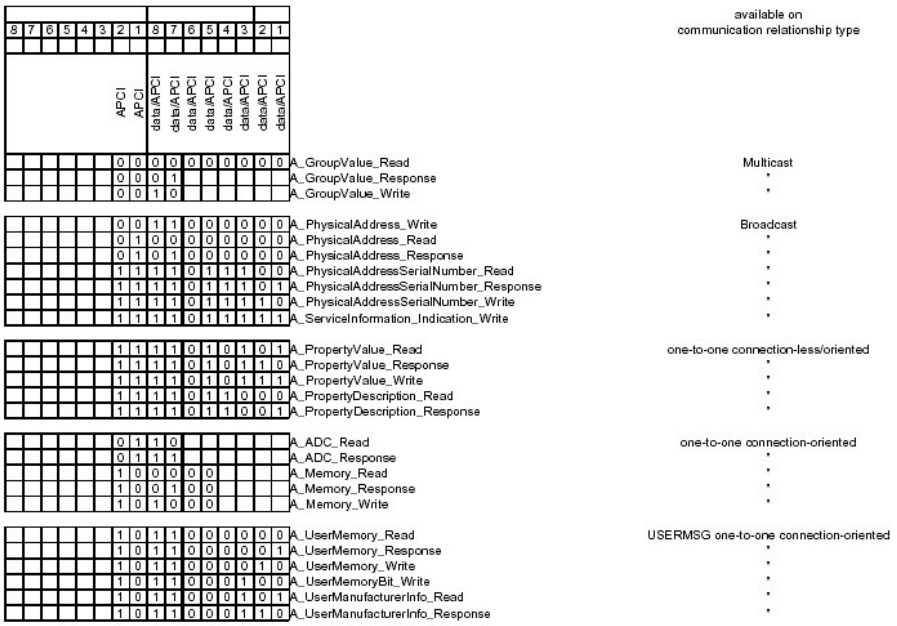
Transport Control Field

- 14 bits



The destination address (octets three and four) defines the EIB end device(s) that shall receive the frame. The destination address can be either a physical address (DAF=0) or a group address (DAF=1), depending on the destination address flag (DAF) of octet five.

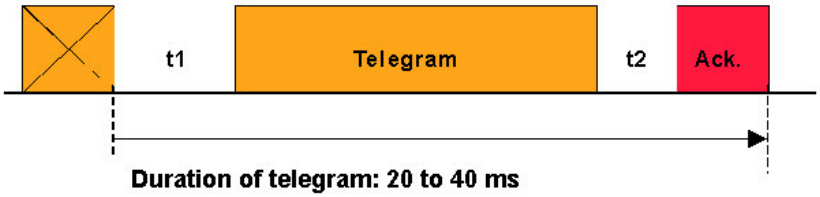
Application Control Field



The APDU corresponds to the TPDU, but reduced by the transport control field. The application control field is encoded and decoded by layer-7 and contains the layer-7 service codes. The application control field has a length of 4 or 10 bits, depending on the layer-7 service. The codes for the application control field are shown in Fig. 3/3/7-3. The complete PDU for each service primitive is shown in the description of every service. Not defined and not supported application layer services are ignored by the layer-7.

EIB Data Packet

octet 0	1	2	3	4	5	6	7	8	..	N - 1	N ≤ 22
Control Field	Source Address		Destination Address		DAF; NPCI; length	TP CI	AP CI	data /AP CI	data		Check Octet

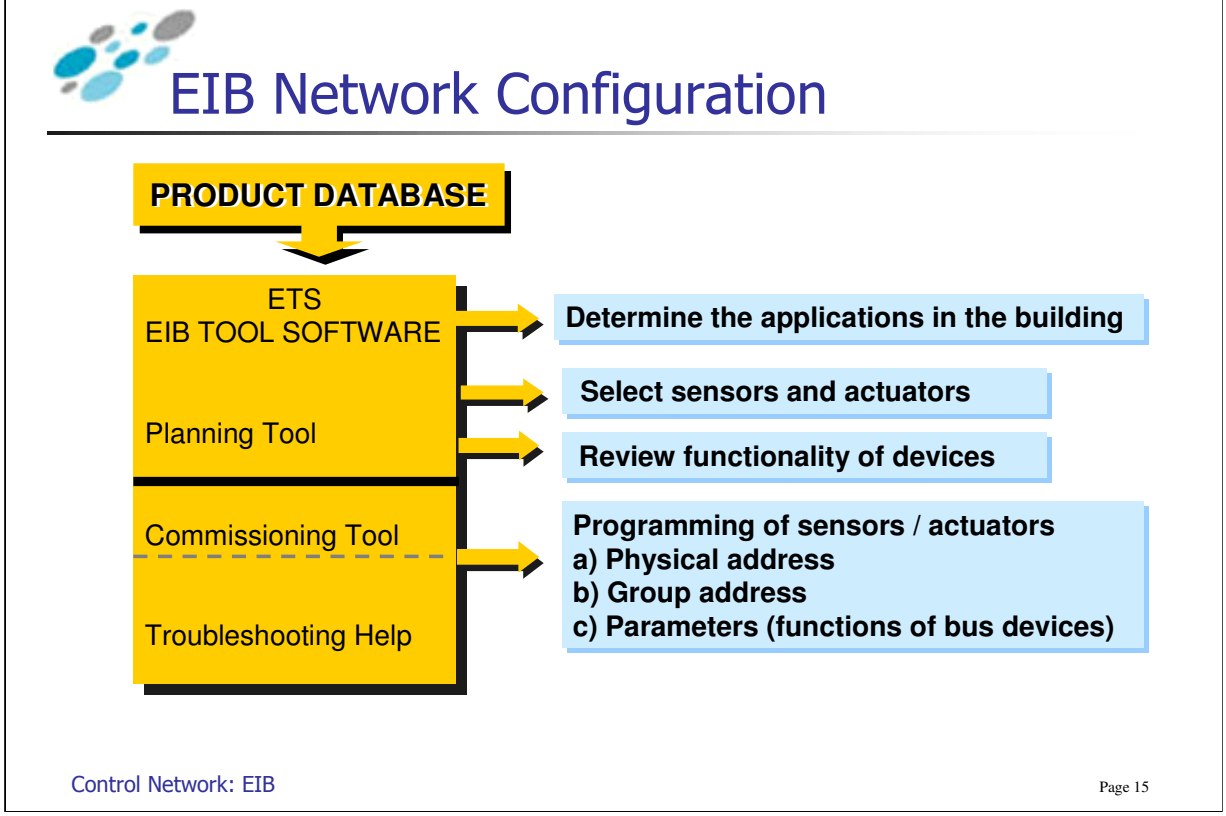


Octet 0 Short ACK								
8	7	6	5	4	3	2	1	
1	1	0	0	1	1	0	0	ACK
0	0	0	0	1	1	0	0	NAK
1	1	0	0	0	0	0	0	BUSY

•4 bits in octet 5 indicate the length of data, the maximum length is 14

•Through the Network Protocol Control Information (NPCI), the Network Layer controls the hop count; for devices other than routers or bridges,

•Every message passing require acknowledgement from the receiving device(s)

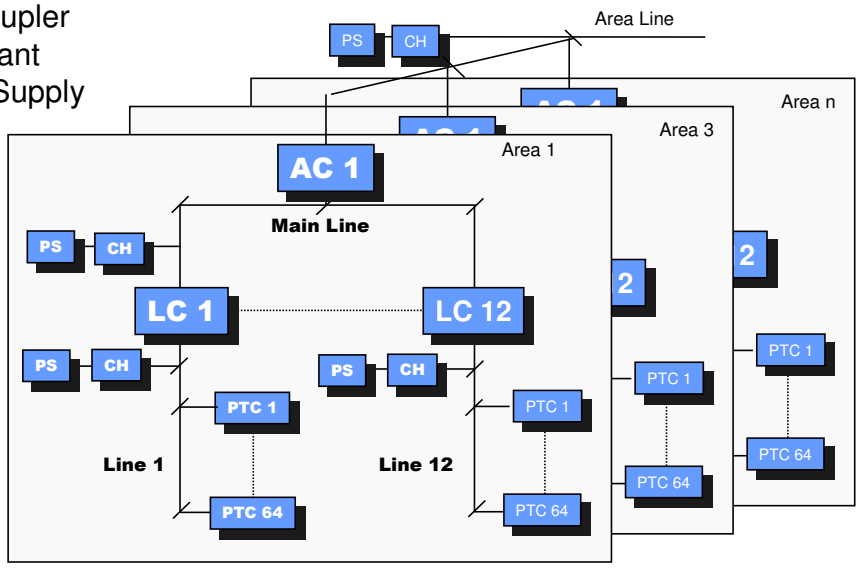


Two vendor-independent EIB Tool Software (ETS) suites for Windows:

1. *ETS End-User's Edition:* A project engineer or electrical contractor can import the Component Description into the ETS Project Edition. All device instances can be customized to the needs of the project and logically linked by assigning Group Addresses.
2. *ETS Developer's Edition (ETS+):* With the ETS Developer's Edition, the manufacturer encapsulates the remotely loadable applets in a series of abstract representations, which hide all implementation details. The resulting Component Description can be exported.

EIB.TP Network

AC Area Coupler
LC Line Coupler
PTC Participant
PS Power Supply
CH Choke
n max 15



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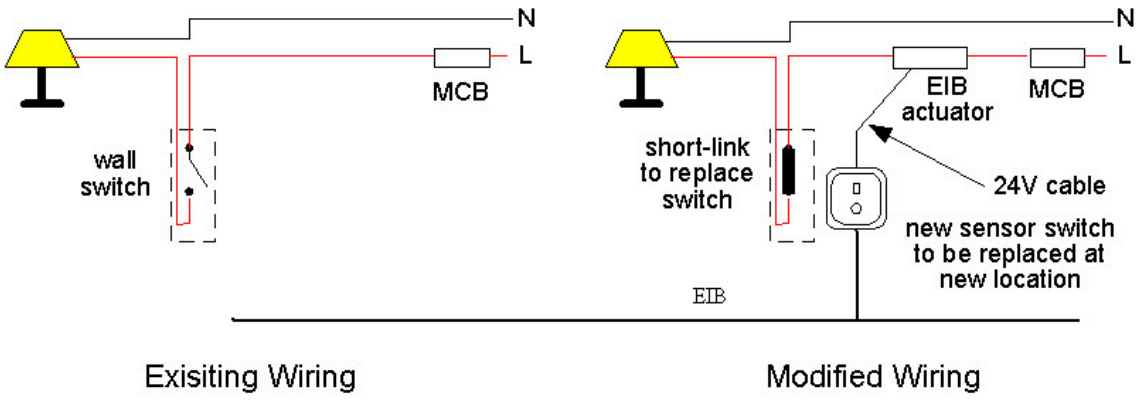
•1 bus line with up to 64 bus devices (max 1km)

•1 main line (function area) with up 16 bus line by line couplers

•1 area line (bus system) with up to 15 main lines by backbone couplers

•Total available bus devices in an EIB system is 11,520

Re-wiring



Exisiting Wiring

Modified Wiring

EIB.net

- EIB.net - Automation Network
  - Realizes EIB on all media
  - Not limited to high-speed backbones
  - Transparent usage of existing LAN infrastructure

•The EIB.*net* specification realizes EIB on all media with a logical link layer according to ISO/IEC 802-2, including Ethernet and Arcnet. Not limited to high-speed backbones, EIB.*net* also allows management or automation level devices to be directly connected.

•An enhanced specification catering for routing based on the Internet Protocol (IP) is *being reviewed*.

•In this way, EIB.net allows transparent usage of existing LAN infrastructure, and is intrinsically Internet and Intranet enabled.

Advantages

- For manufacturers and vendors
- For installers and system integrators (SI)
- For owner, occupant and Facility Manager
- For all

- For manufacturers and vendors:
    1. EIB's compact communication stack allows for small footprint implementations (< 5 kB); requirements are such, that the system may be realized easily on an 8-bit microprocessor.
    2. Kick-start building blocks are available through standard EIB system implementations from major manufacturers.
    3. Any product from any manufacturer can be imported as a template into the common ETS binding tool, without any need for PC software development by the product manufacturer.
    4. An open software engineering Component Architecture for PC tools and implementations.
    5. Tens of thousands of trained installation professionals.
- For installers and system integrators:
    1. A synonym for unrivaled multi-vendor flexibility, guaranteed by certified EIB logo.
    2. Neutral ETS tool platform for project design and commissioning.
    3. Off-the-shelf training from dozens of training centers.
    4. Wide spectrum of available products and solutions.
    5. Robust installation technology.
- For owner, occupant and Facility Manager:
    1. Minimal cost of ownership, as shown by 10 years of experience.
    2. High electrical and functional safety of each individual device and of the system as a whole.
    3. Long-term availability of extension and replacement technology and components.
- For all:
    1. Standard Win32 API's, including OPC server etc.
    2. IP connectivity ensured through EIB ANubis.

Limitations

- 64 thousand devices with 32 thousand individually addressable, shared datapoints or subnetwork