Outline

- Introduction
- Transmission Technologies
- Communication Protocol
- Application Profiles
- Integration Technologies
- Technical Support
INTRODUCTION:
- Field buses are industrial communication systems with bit-serial transmission that use a range of media such as radio transmission to connect to distributed field devices
- Deterministic (since parallel wiring will be replaced)
- Flexible
- Interoperable (multi-vendor use)
- Cost effective (installation, startup, service)
- Reliable and safe
- Easy to use
PROFILEBUS is an open digital communication system with a wide range of applications.

PROFILEBUS is the world leader in the field bus market with more than 20% share of the market, over 1 million plants equipped with the PROFILEBUS installations.

- It has a modular structure and offers a range of transmission and communication technologies.

- There are more than 2500 PROFILEBUS products available from a wide range of manufacturers.
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Transmission Technologies

**EIA/TIA-485 (Former RS485)**

- simple and cost-effective and is primarily used for high transmission rates.
- RS-485 is a EIA standard interface which is very common in the data acquisition world.
- RS-485 provides balanced transmission line which also can be shared in Multidrop mode.
- It allows high data rates communications over long distances in real world environments.
- It mainly uses a differential voltage to transmit data.
- If difference \((A-B)\) is between \(-1.5V\) and \(-6V\) it is logical 1.
- It is inherently more immune to noise.

*Number of Devices and type of cables:*

*It can have as many as 32 devices on one segment. A segment is a section of the network, where the same electrical signal flows uninterrupted.*

*Network Speed and Distances:*

*It could transmit a maximum rate of 187.5 kbps. Thus the network speed is set 9.6 to 12Mbps?*

*The Transmission rate is inversely proportional to the maximum distance of the segment*
Manchester encoded Bus Powered

- MBP is asynchronous, Manchester-coded transmission with a defined transmission rate of 31.25 kbps.
- It has up to 32 nodes in one segment.
- Data Transmission rate up to 31.25Kbit/s.
- Transmission of digital communication signal in zero-mean Manchester II coding (MBP) through ±9mA amplitude.
- Signal transmission and remote power supply using twisted-pair cable.

**Manchester Coding:**

- Manchester coding is a line code in which the encoding of each data bit has at least one transition and takes place in a fixed time period.
- Direction of mid bit transition indicates:
  - If the power draw at the mid-bit transition goes from high to low, then it is logical 1.
  - If the power goes from low to high then it is logical 0.
FISCO

- It mainly simplifies the planning, installation and expansion of PROFIBUS networks.
- More number of devices can be operated on single line and the devices can also be replaced on runtime.

High Power Trunk Concept:

- It is a method of instrument connections in hazardous area.
- This concept is protected by using increased safety ignition protection.

- MBP provides communication and power on the same 2 wires saving considerable installation costs.
- It works with current signal of the bus.
- It has considerable electric noise immunity so that it can be used in industrial settings.
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**Communication Protocol**

- The different versions of DP from DP V0 to DP V2 enable optimum communication between different applications.

- DP has been designed for a fast data exchange at field level. These exchanges are mainly cyclic.
  
  PROFIsafe is a comprehensive open fieldbus solution for safety-relevant applications.

- Version DP-V0 provides the basic functionality of DP, which includes cyclic data exchange, station module, and channel-specific diagnosis.

- Version DP-V1 contains enhancements geared toward process automation.

- Version DP-V2 contains further enhancements toward the demands of drive technology.
**System Configuration and device Types:**

- DP supports both monomaster and mutimaster system.
- A maximum of 126 devices can be connected to bus segment.
- The PLC is a central control component.
- The slaves are connected to PLC.
- They represent both independent subsystems, comprising master and diagnostic master devices.
- Slaves are peripheral devices.

**PROFIBUS differentiates 3 groups**
- DP master class 1: It is a central controller that cyclically exchanges information with distributed stations.
  - This continuous repeating cycle is autonomous function.
- DP master class 2: They are put in operation for commissioning and for maintenance and diagnostics.
  - It has an active bus access.
PROFIBUS Medium Access Protocol

- The PROFIBUS Communication Profiles use a uniform medium access protocol
- This also includes data security and the handling of the transmission protocols and telegrams.
- The Medium Access Control (MAC) specifies the procedure when a station is permitted to transmit data.
- The MAC must ensure that only one station has the right to transmit data at a time.

The 2 primary requirements for Medium Access Control are:

- In complex automation systems it must be ensured that each of these stations get enough time for communication.
- Communication between a complex programmable controller, cyclic data transmission needs to be implemented.

- **Token Passing procedure:**
  - The bus access is assigned to each master with fixed time interval.
  - The token message, a special telegram for passing the token from one master to the next master.
  - Token passing procedure is only used for communication between complex stations.

- **Master Slave Procedure:**
  - This enables the master to send message to, or retrieve them from the slaves.
  - When an active station receives the token telegram, it can perform the master role and communicate with all slave stations in a master-slave communication relationship and all master stations in a master-master communication relationship.
Cyclic Data Communication Protocol:

- The user defines the assignment of slaves to DPM1. They also define which slaves are to be included or excluded in cyclic user data communication.

- There are 3 phases mainly parametrization, configuration and cyclic data exchange.
The FC indicates the type of message and serves as a guard to control the state machine of the master.

The PDU which may carry up to 244 bytes followed by frame checking sequence.

The usage of FC is the indication of fault situation on slave side.

The message mainly comprises of 6 bytes of fixed information.

The control commands are transmitted as multicast messages and enable sync, freeze modes for event controlled synchronization.

**Acyclic Data communication:** It is a key feature of version DP-V1 which forms the requirement of calibration and parametrization of the field devices over bus.
Transmission of acyclic data is executed parallel to cyclic data communication.

Slave-Slave communication: enable direct and time saving communication between slaves using broadcast communication.

- The slaves act as a publisher and the slave response goes to other slaves in the sequence called as subscribers.

Isochronous mode: clock synchronous control in masters and slaves.

- Clock control: It synchronises all stations to a system time with a deviation of less than 1 ms
- It is a new mechanism between masters and slaves.

Addressing with slot and index is used for both cyclic and acyclic communication services.
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Application Profiles

**Common Application Profiles:**

- The main purpose of I&M (identification and maintenance) functions is to support end user in various phases of device's life cycles.
- PROFIsafe is comprehensive open fieldbus solution for safety relevant applications.
  - It implements safe communications over a special PROFIsafe data frame and a special protocol.
  - PROFIsafe takes advantage of acyclic communication for full maintenance support which mainly ensures fast response time and low power consumption.
- The Highway Addressable Remote Transducer (HART)-client application is integrated in a PROFIBUS master, and the HART master in a PROFIBUS slave which serves as a multiplexer and handles communication in HART.
Common Application Profiles

- The **Time stamp application profile** describes how to perform actions with timestamp.
  - A concept of graded messages are used which are under the term alerts divided into high priority alarms and low priority events.

- Slave Redundancy Profile devices contain 2 different PROFIBUS interfaces called primary and backup.
  - They are equipped with 2 protocol independent stacks with special redundancy expansion.
  - A redundancy communication (RedCom) runs between the protocol stacks.
  - The redundancy of PROFIBUS slave devices provides high availability, no data loss, short reversing times
Specific Application Profiles

- The PROFIdrive application behaviour defines device behaviour and access procedure to drive data for electric drives.
  - The method of integrating drives in automation solutions which is highly depends on task drives.
  - It mainly defines six classes of majority of applications.
  - Field device replacement has been very much simplified and once the device has been replaced, the control system detects it.
  - The device version expected at the bus address based on message frame of master.
  - The new device responds with given Ident number which is then included in the cyclic communication of master.
- A physical block contains a characteristic data of device such as device name, manufacturer. There is only 1 PB in each device.

- A transducer block contains all data required for processing an unconditional signal from a sensor to functional block.

- A functional block contains all the data for final processing prior transmission to control system.

- Analog Input (AI) block delivers value from sensor/TB to control system.

- Analog Output block (AO) which delivers the value specified by control system. Digital Input provides digital value to the control system.

- DO which provides the device with value specified by the control system.
Host Application Profiles

- It mainly defines the necessary functions of the field device which is the host to engineering system.
- It provides an overview of PROFIBUS functionality on the host side.
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Integration Technologies

- PROFIBUS has developed a number of integration technologies that enable standardization of device management.

- General station description and Electronic Device Description are both electronic device datasheets

GSD:
- It is an ASCII textfile which contains both general and device specific configurations.
- It replaces previously conventional manuals and supports automatic checks
- The distinction between a device GSD and profile GSD which may be used for devices that comply with the profile
EDD (electronic device data sheet):
- It describes the parameters and functions of configuration parameters and ranges of values.
- It is independent of the operating system and supports its user.

FDT (field device tool) / DTM:
- Mapping functions and dialogs of field device for parametrization, configuration, diagnostics in a software component which is called DTM.
- DTM (device type manager) is protocol independent and with its mapping devices in software component.

Field Device Integration:
- EDD and Fdt are the 2 main technologies for managing information in intelligent field services.
- It is a scalable FDI (field device integration) device package which encompasses all the features of field device.
- The FDI architecture is mainly based on OPC (open process communication) Unified Architecture.
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Technical Support

Quality Assurance:

- The requirement for the quality assurance is standard-compliant implementation of the communications protocol and application profiles by device manufacturers.
- The test procedure, which is the same for all PI Test Labs, is made up of several parts:
  - The GSD/EDD check ensures that the device description files comply with the specification.
  - The hardware test tests the electric characteristics of the PROFIBUS interface of the device for compliance with the specifications.
  - This includes terminating resistors, suitainability of the implemented drivers and other modules, and the quality of line level.
  - The function test examines the bus access and transmission protocol and the functionality of the test device.
  - The conformity test forms the main part of the test. The objective is to test the conformity of the protocol implementation with the standard.
  - The interoperability test checks the test device for interoperability with the PROFIBUS devices of other manufacturers in a multivendor plant. This checks that the functionality of the plant is maintained when the test device is added. Operation is also tested with different masters.
Test device

Test in PROFIBUS test laboratory

OK?

no

yes

Certification through PROFIBUS International
IMPLEMENTATION SUPPORT:

- A broad spectrum of standard components and development tools (PROFIBUS ASICs, PROFIBUS stacks) as well as services are available that enable device manufacturers for development.

- PROFIBUS protocol chips are mainly used for individual implementation.
  - Single Chip ASIC is ideal for simple slaves.
  - All the protocol functionalities are already integrated on ASIC.

- For intelligent slaves PROFIBUS protocol are implemented on a protocol chip.
- For complex masters time critical parts of PROFIBUS are implemented on protocol chip.
Applications Of PROFIBUS

- Industries using PROFIBUS range from critical petrochemical operations and high-volume robotic manufacturing plants.