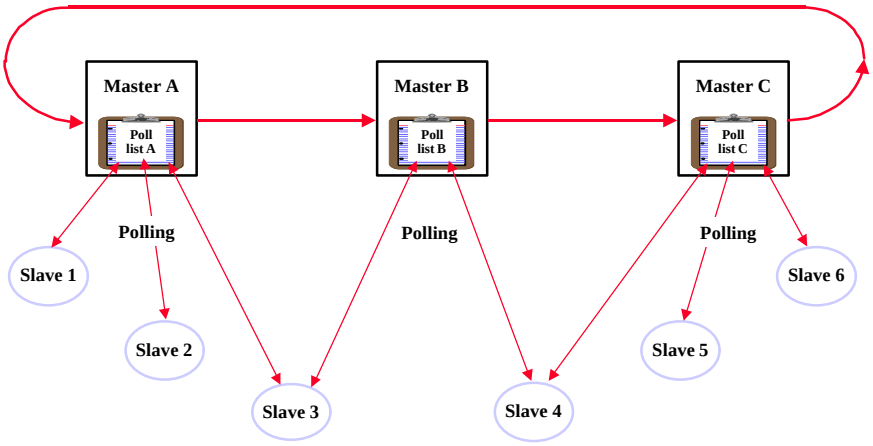
Field bus Technical Questions

General Issues

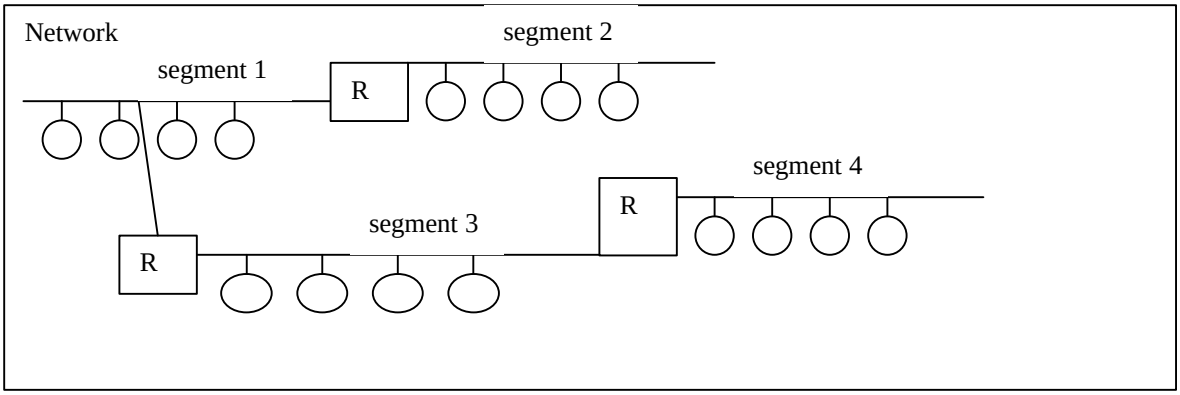
1. What Bus type does your system implement. Examples CMSA/BA, CMSA/CD, master/slave, multiple masters etc.

PROFIBUS is based on a Token principle with underlying Master/ Slave communication (hybrid media access).
Services:
SDN-Send Data with no acknowledge (can be used for multicast/broadcast)
SDA- Send Data with acknowledge
SRD- Send and Reply with Data (for efficient bi-directional data transfer)



2. What is the maximum number of nodes that the network can support.

PROFIBUS allows up to 32 nodes per segment and up to 126 nodes for one network.



3. What is the Bus topology.

The base technology is a line which allows connection and removal of nodes at any time without breakdown.

PROFBUS allows ring and star topology as well with fiber optics.

4. What is the maximum transmission distance without repeaters. What baud rate is supported at this maximum distance.

The maximum distance would be 1000m by using copper with baudrates between 9.6 – 187.5 kBaud.

	9.6kBaud – 187.5kBaud	500kBaud	1.5MBaud	3-12MBaud
per segment	1000m	400m	200m	100m
with repeater	10000m	4000m	2000m	1000m
per fiber optic segment	15 km	15 km	15 km	15 km
total with fiber optic	>200 km	>200 km	>200 km	130 km

The maximum length may be extended with fiber optic links (up to 2300/15000 m per link)

5. What types of transmission media are used and supported.

- Copper cable (shielded twisted pair- known as IBM type 1 cable)
  - solid and stranded cable
  - specialized materials for plastic surrounding
- fiber optic
  - in glass
  - in plastic
- Infrared

6. How many bits are allocated at a node for input and output data.

PROFIBUS allows between 0 and 244 byte, determined by the device requirements for input and output each.

7. How is the bus powered.

There is no specialized bus power supply. The terminal resistors with pullup and pulldown are located at the end of the line and powered be the devices on that place. One combination is enough to run the system.

8. If the bus provides power to field devices what current level is available.

PROFIBUS PA does supply power for intrinsic safe devices connected with twisted pair. This is done according to IEC 1158-2 specification (maximum current is 120 mA per coupler for intrinsic safe operation and >300mA for non intrinsic safe operation).

9. How are node addresses set.

Two methods are supported:
- DIP switches or similar techniques
- setting of the node address via the bus connection

Any choice is possible

10. Does the bus provide duplicate address detection.

Configuration checks for duplicate addresses.

Masters will look for duplicate addresses before entering the token ring and when unexpected frames are received.

Slave must be set up with their ident-number and with their configuration. In case of a mismatch, this will be reported to the masters application.

11. Does the bus provide an address attendance check after the first scan.

- through a so called live list
- scanning of configured slaves is done cyclic
- scanning for new masters is executed all time

12. Does the bus provide a node configuration check after the first scan.

Yes, with the function config_check after power up.
In addition, the ident number is also checked.

13. Does the bus provide error detection and correction algorithms.

PROFIBUS has a variety of error detection capabilities

- Checkbits in every byte
- Checksum for every message
- Startdelimiters for efficient frame detection
- Addressing information (source and destination)
- Inactivity detection to find out the beginning
- Transmitter check at the master devices
- Monitoring the token passing procedures

- The error correction is done by retries.
- PROFIBUS includes message duplication capabilities

14. Can a node provide parameter programming. Examples logic inversion and similar Boolean operations. Explain any extended detection.

There are several ways for parameter setup:

- PROFIBUS allows the individual set of parameters (a maximum of 237 Bytes) during the startup
- Acyclic exchange of parameters at runtime.
- Parameter load from a PC by a second master

15. What I/O granularity does the Bus support.

- The minimum is one byte
- The granularity is determined by the device
- Integer, unsigned, floating point, string and structures of the base types are possible.

- A node may have IO-modules with the granularity of one bit.
- There are various links available connecting subordinated bit-level busses (i.e. AS-I)

16. What minimum address space allocation does the bus provide.

This is determined by the device, the minimum would be one byte.

17. What is the cost per point of an AC input/output and a DC input/output. Include the most cost efficient implementation as well as the cost to add a single bit of I/O as a node to the network.

DC input and output is about .....$ list price per channel for ET200M cards.
AC input and output is about .....$ list price per channel for ET200M cards.

The list price of a small node is approx. .....$ for ET200L but this unit has 16 Inputs onboard

18. What is the protocol efficiency of this Bus.

The protocol efficiency may be up to 70%.
The configurations mentioned in the performance metrics section have a efficiency of 40%. This figures are configuration dependent.

19. Does the Bus support multiple protocols.

- PROFIBUS FMS,
- DP
- DP extensions

may use the same link and may be implemented in one node

20. How many vendors support this technology.

Latest number the PTO provided is a membership of 800
with more than 1600 different devices.

21. What form factors are supported for network scanner cards.

- For Personal computers: PCI, PCMCIA, PC 104 ISA and VME.
- All known PLCs at moderate size may be equipped with PROFIBUS cards (including AB, Modicon, GE, Mitsubishi)
- Various other solutions are offered

22. What governing body controls this standard. Are changes to the specification immediately released to all 3rd party vendors.

PROFIBUS is controlled through PROFIBUS International and presented through 20 organizations worldwide. Every add on or change will be defined within the different working groups(18 groups are registered now), every member can participate in the various working groups. All specifications must be released by the Board and are available for all members and non member.
The working groups are initiated and controlled by the technical committees and the board.

Example:
The following e-mail was sent on 10-9-98 to all PTO members:
To members of a Regional PROFIBUS Association:
Call for Experts
Specification of new features of the Fieldbus Data Link Layer for PROFIBUS
The working group "Technique" within the technical committee "standardization" will start evaluation of new functionality's for the PROFIBUS Data Link Layer soon. The new functions will be specified driven by new application areas (Motion Control as well as Power Plant). These new functions will include:
=B7 Equidistancy
=B7 Slave - to - Slave communication (Publisher / Subscriber model)
=B7 Time synchronization
All members of any regional PROFIBUS user group worldwide are permitted and invited to join the working group "Technique"
Please contact Dr. Haehniche (e-mail: haeh@ifak.fhg.de) if you are interested.
Best regards
PROFIBUS International - Technical Support Centre
Michael Volz

Installation, Diagnostics and Commissioning

1. What diagnostic systems are in place to verify proper drop and node connections.

- Several diagnostic tools are available which allow to measure the bus and connectors for proper installation.
- A simple electric meter will do it for most cases (a segment unpowered has a resistance of 110 to 130 Ohms for midrange cable length).

2. Can the Bus be enabled in segments to minimize troubleshooting requirements.

- Segmenting can be done by use of repeaters or optical link modules.

- Step-by-Step start up can be done through the connectors by using the integrated termination.

3. What high level tools are available for network diagnostics.

Every PROFIBUS Master allows detailed diagnostic function within the application
- Diagnostic information of each individual slave(Type of Slave, availability, various status information)
- Diagnostic overview of all slaves
- Master Diagnostic information
- statistic counter

Service engineers can use a bus monitor which allows to trace the bus.
- Monitoring all data
- Hardware filtering mechanism
- Time stamps
- Trigger conditions
- Special events
-

4. Can a network configuration be restored remotely.

- Network download protocol is defined in the standard
- Some System have proprietary protocols to prevent inconsistencies (network configuration and PLC configuration are NOT independent)

5. Does the Bus provide tools for throughput monitoring enabling the user to check the validity of various node configurations.

- Various configuration tools offer such a functionality as well the bus monitor.
- Most users look on reaction time rather than cycle time which includes the PLC scan.

6. Are diagnostic counters local to a node or are they a distributed function.

- Usually this information is available within the master (PLC or PC)- the field devices often do not know about errors in transactions.
- There is a diagnostic in every slave, which will be reported to the master and the application..

7. **With the standard diagnostic tools what kind of MTTD (mean time to diagnose) for network faults should the user expect to see using this bus. Elaborate on any special capabilities.**

- Errors are reported immediately.
- Worst case 2 cycles is the maximum delay to transport diagnostic to the master. (regarding the figures below, this is less than 2,2ms/13,4ms at 12Mbaud/1.5Mbaud).
- Every other actions and their duration is application dependant. If your system has a backup strategy for that error the bus topology helps to run even in the presence of an error.

8. **Does the bus support any kind of hot swap capability.**

- PROFIBUS allows replacing of devices without interrupting the bus traffic to connected nodes.
- Slave devices need not be reconfigured in case of a switching in the masters role.

9. **Can nodes be exercised to verify the field device connections with a hand held programmer or personal computer.**

- Hand held and PC software is available to do this.
- Typically this feature is used for startup or trouble shooting.
- A diagnostic device can be connected to the bus without any specific change in the masters or slaves parameter.

10. **Can nodes be configured to autorestart after the removal of a node or network fault.**

- The reaction of a device error is application specific.
- One option is to continue operation.
- After replacement of a node the new node is automatically reinserted.

Performance Metrics

1. **How long would it take to update a network with 16 nodes of 256 digital I/O (4096 total points).**

- 1.09ms by 12MBaud

- 6,71ms by 1.5MBaud.

2. What is the best and worst case repeatability of this configuration.

- The best case which is 99% the normal case is that the timing is absolute stable (5% jitter is possible due to control functions)
- In case of a failure (stations are dropping out) the timing can change
  - 1 transmission failure will be corrected within 500/100µs (1,5/12Mbaud)
  - 1 station failure will add a jitter of 700/300µs
- A worst case scenario of 33ms by 1.5MBaud or 6.6ms by 12MBaud for one cycle will occur when all stations fail (in this situation the reactiontime is meaningless).
- After the failure detection the timing is back to the regular cycle time.

3. How long would it require to update a network with 256 analog I/O points.(16 bit words)

It is exactly the same time as under 1., PROFIBUS makes no difference in the format. 256 words is equal to 4096 I/O points. I'm assuming that we have 256 words in each direction, 256 input words and 256 output words. A difference can occur in your master station. The PLC or PC might make a difference in calculating I/O or analog values. PROFIBUS makes no difference.

4. What is the best and worst case repeatability of this device configuration.

The same as mentioned under 2.

5. How would loss of the token change the determinism of network communications. For systems that do not use a token passing mechanism explain how a communication fault is recovered from and its impact on determinism.

- There is no token loss in monomaster systems
- Token loss in multiple masters are almost impossible
- A Master breakdown while using the token may produce this fault.
  The recovery time in this situation is 1.6 ms at 1.5Mbaud and 0.67ms at 12 MBaud.

6. Can the Bus support change of state signaling.

If a device changes the state of an input PROFIBUS can recognize it with the planned extension for the future (see e-mail from Mr. Volz – PI).

7. How well will this implementation scale with respect to improvements in raw bit rate transmission.

- There is a transmission speed detection in almost every slave device as well as repeaters. This will enable the user to change the Baudrate by simply changing it at the masters site.
- PROFIBUS has enhanced transmission speed 2 times. there is no problem with the various devices because all functions may run at a basic configuration.

8. Can portions of the network be scanned more frequently than the entire system.

- A change of the cyclic list is possible, however due to the fast cycle it is not necessary in typical applications. There is a possibility to send low frequent cyclic messages as acyclic messages.

9. Is message prioritization implemented.

PROFIBUS defines 2 message priorities,
an application prioritization is only possible within FMS.

10. Can larger consecutive blocks of data be moved using block transfer.

Yes, with all protocols.

Competitive Advantage

1. What attributes of you system qualify as a best in class product.

Deterministic, speed, ease to use, acceptance, support, diagnostic, multi protocols,

PROFIBUS offers a great flexibility. This enables the application engineer to make his design without counting bits and bytes. One byte more is less than 1µs! Error recovery will be done quickly without user interaction.

It easy to integrate PROFIBUS in field devices.

PROFIBUS is a very robust protocol with outstanding error handling capabilities.

PROFIBUS-DP allow transmission of IO-Data with short reaction time this include transportation from IO to the bus and from the bus to the application.

PROFIBUS-DP can be configured without specific communication knowledge. The device model is exactly what matters in remote IO.

PROFIBUS DP is what the user needs(see below)

From: timli@controls.eurotherm.co.uk

One of the FAQ questions regards the strengths of Profibus, and this is a subject close to my heart.

To my mind the key strength of Profibus DP over other contending fieldbuses is its great simplicity (despite the efforts of some of the Siemens software. I have seen and used to complicate things!), particularly the main competitor, DeviceNet.

The basic data exchange and wiring principles for Profibus DP can be readily explained in 15 minutes to PLC programmers and plant electricians without recourse to software engineering jargon. Network administration is trivial.
This is vital first to build confidence in the technology, and then to allow it to be applied painlessly by customers not having wide experience of networks. The scan model is very close to that already used on a PLC backplane, and there is really nothing new to learn: even comms wiring, biasing, and bus termination is straightforward and inexpensive.

By contrast DeviceNet, in which I had an involvement until quite recently, is hugely complex, using a formal (but somewhat deficient, in my view, since there is neither C++ style inheritance nor IEC1131 style execution model) object model, connections, and a plethora of options when setting up and running a network, which I think were due to compromises caused by the standardisation process. If you know what you are doing (which implies a software engineering/network background and a dedicated comms specialist) it is wonderful, since you can set up highly efficient peer to peer networks that do exactly the job required. On the other hand if you have just one day to get the comms for a project going, you are probably going to have to do some headscratching, and I would probably put a lot of strong coffee into my project budget... Large companies with R&D departments concerned with automation technology will be able to cope, but I suspect that smaller customers will struggle. Furthermore there is no equivalent of the SPC3 to tie implementations together and provide a basic level of conformancy, particularly at the low end (S&S Tech have something quite close in their object code module, and of course there is ABs group 2 only slave(*) source code which no-one is supposed to use but of course everyone does).

I don't want to rubbish DeviceNet, because a great deal of it is technically excellent. But I do think it is likely to become the 'Betamax' equivalent in Device level networks unless really good config tools are produced that fully provide the expertise needed to plan, commission and run the network.

Armin and I had a discussion in the sci.engr.control newsgroup (probably available via www.dejanews.com) which covered this ground as well as some other subjects, and which I thought was quite interesting. Might be worth a look.

Tim Linnell
Eurotherm Controls (Note that the views expressed are personal do not necessarily reflect those of Eurotherm)

(*) Try explaining to a plant electrician what a group 2 only slave is and why its UCMM services must be proxied, and you will know exactly why I think Profibus is simpler! In fact, a good way of selling DP against DeviceNet is to do two back-to-back 10 minute technical explanations of the two protocols to non specialist plant technicians.