

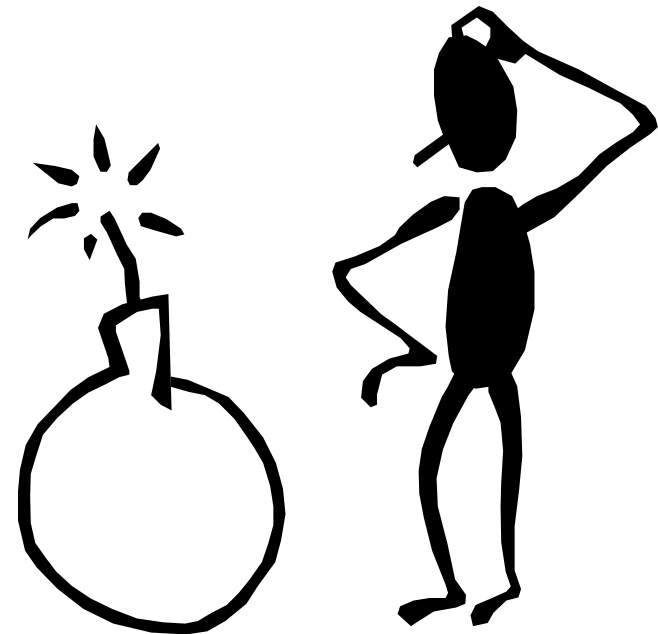
## TROUBLE-SHOOTING PROFIBUS NETWORKS

A few words of some inexperienced engineers and marketers:

‘The cabling is the easiest  
part of bus systems.....’

‘Yeah right!!!!!’

**PROFIBUS Could fix your PROBLEM  
or be your PROBLEM !!**



## A change in working and thinking for the entire organization

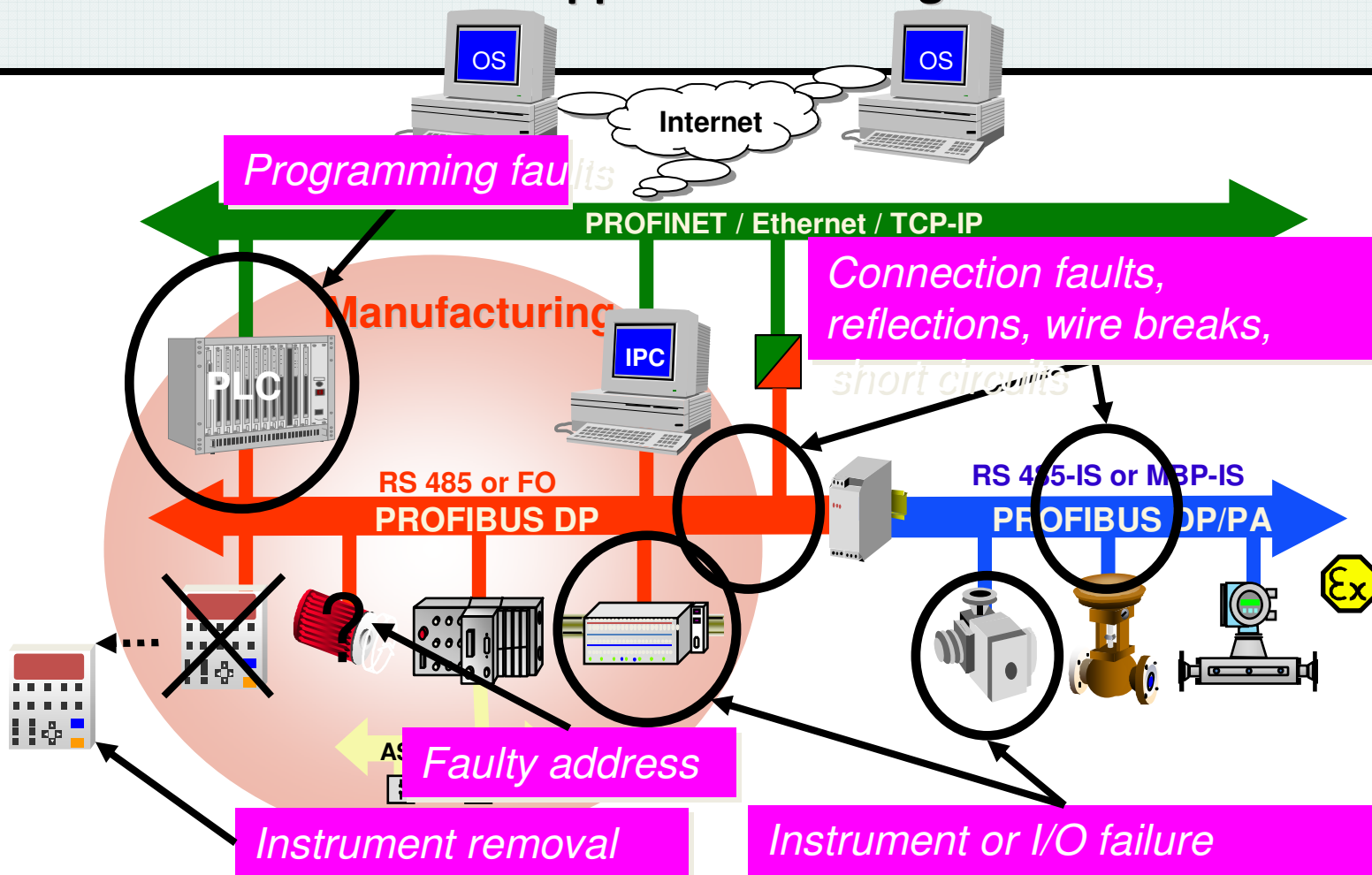
The engineers and maintenance technicians who have just stepped out of the 4-20 mA technology had to understand a lot of new terms which makes the step to field busses very hard.....

RS 485  
Impedance  
Propagation time  
Stub lines  
Cross talk  
1m rule  
IEC 61000-5-2  
Reflections  
Grounding  
Losses  
Skin effect



**Not understanding these topics is not good for the 'Bus business!'**

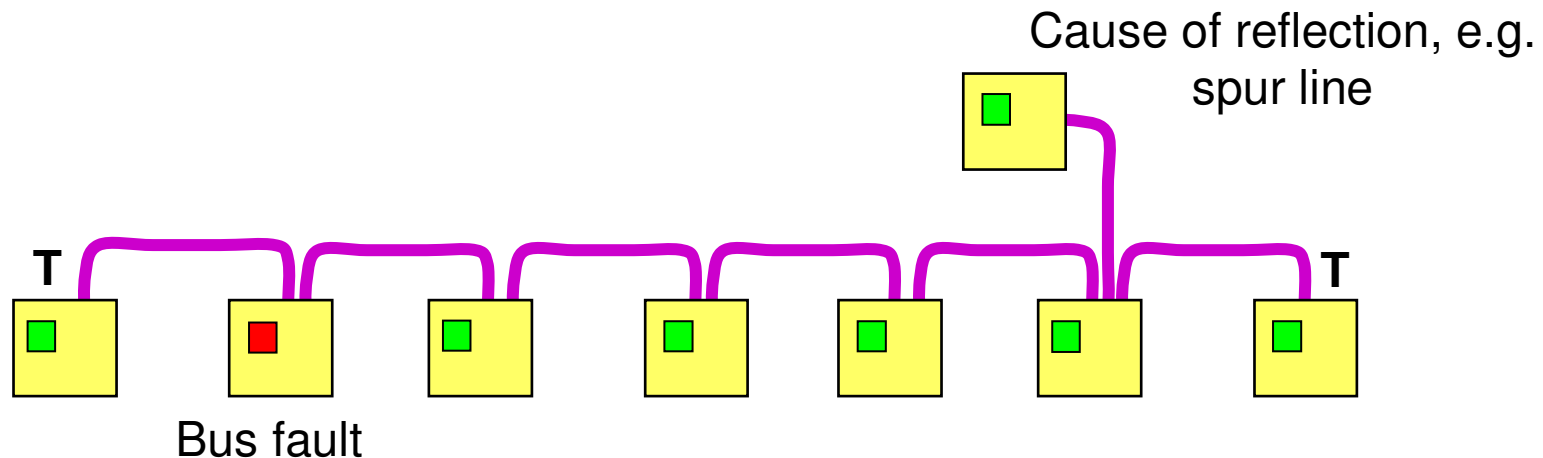
## What can happen in a running installation?



## Confusion about the LEDs!

Problems can be very difficult to diagnose without the correct tools and a systematic approach. Intermittent faults can be particularly difficult.

The main problem is that the devices that are most affected are often at the opposite end of the segment from the source of the reflection!



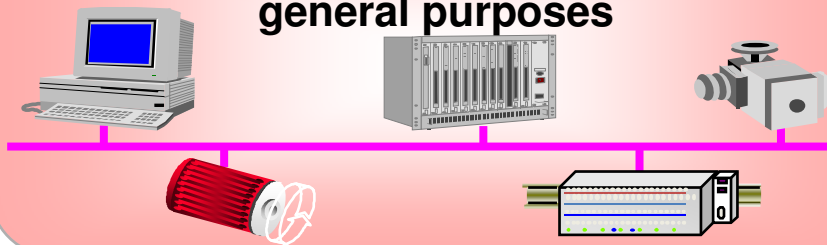


## *Basic principles*

## PROFIBUS supports 3 transmission media

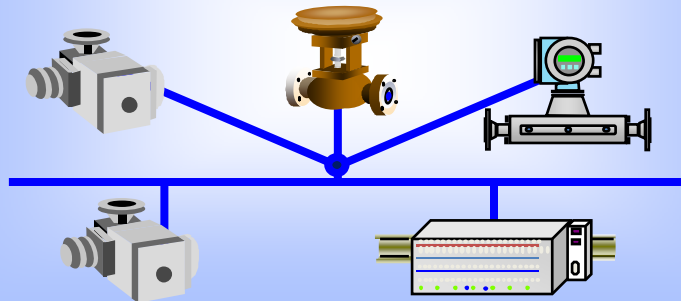
### RS 485

2-wire CU-cable for  
general purposes



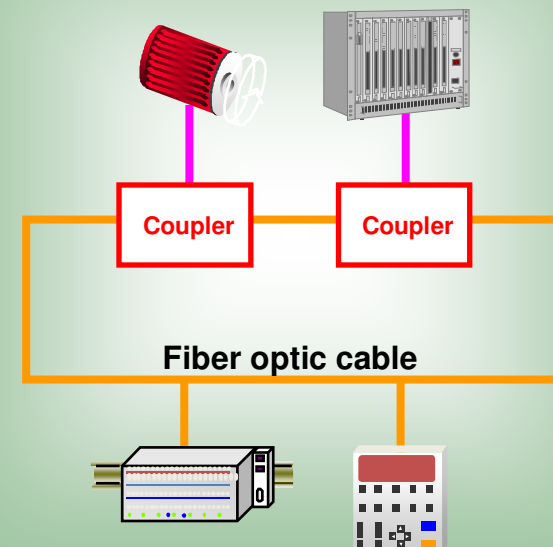
### MBP-IS

2-wire CU-cable with the option for  
power over the bus and Ex-protection



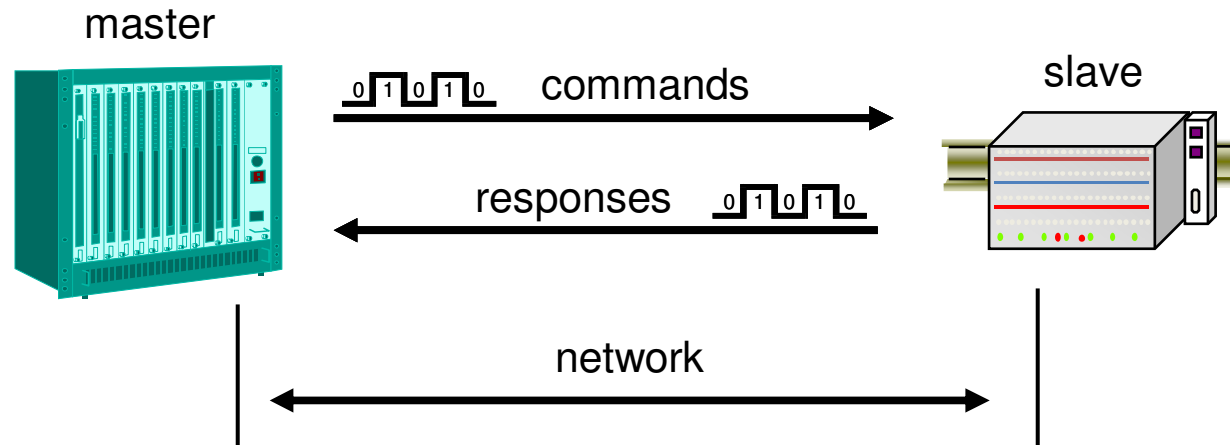
### Fiber Optic

For highest EMC protection  
and wide distances



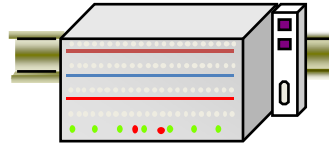
## PROFIBUS is a master/slave network

To create hierarchy in the network, PROFIBUS defines 2 types of devices: active (**masters**) and passive (**slaves**) devices.



- At least **1 master** is mandatory.
- PROFIBUS networks allow **multiple masters**.
- In total **127 devices** can be addressed (masters + slaves).

## Slave



This station can interpret messages of a master and dependent on the interpretation, generate responses and send them to the specific master.

**Slaves are NOT able to send messages on its own initiative.**

### Examples:

- *Remote I/O*
- *Sensors and actuators*

There are also PLC systems available which have slave functionality. They are slave on DP, but can control I/O locally.





## PROFIBUS address map

0	Service-, diagnosis- and programming tool
1..2	Masters (class 1)
3..125	Slaves (total <b>123</b> or 124)
126	Address for: “Set Slave Address”
127	Broadcast address

- ⦿ Most configuration tools block address **0 and 126** for slaves.
- ⦿ Address **126** is a default address for slaves with software address settings.
- ⦿ Address **127** is a broadcast address (only visible with a busmonitor).

Maximum **124** DP slaves per bus!!!!!!

## PROFIBUS is RS485

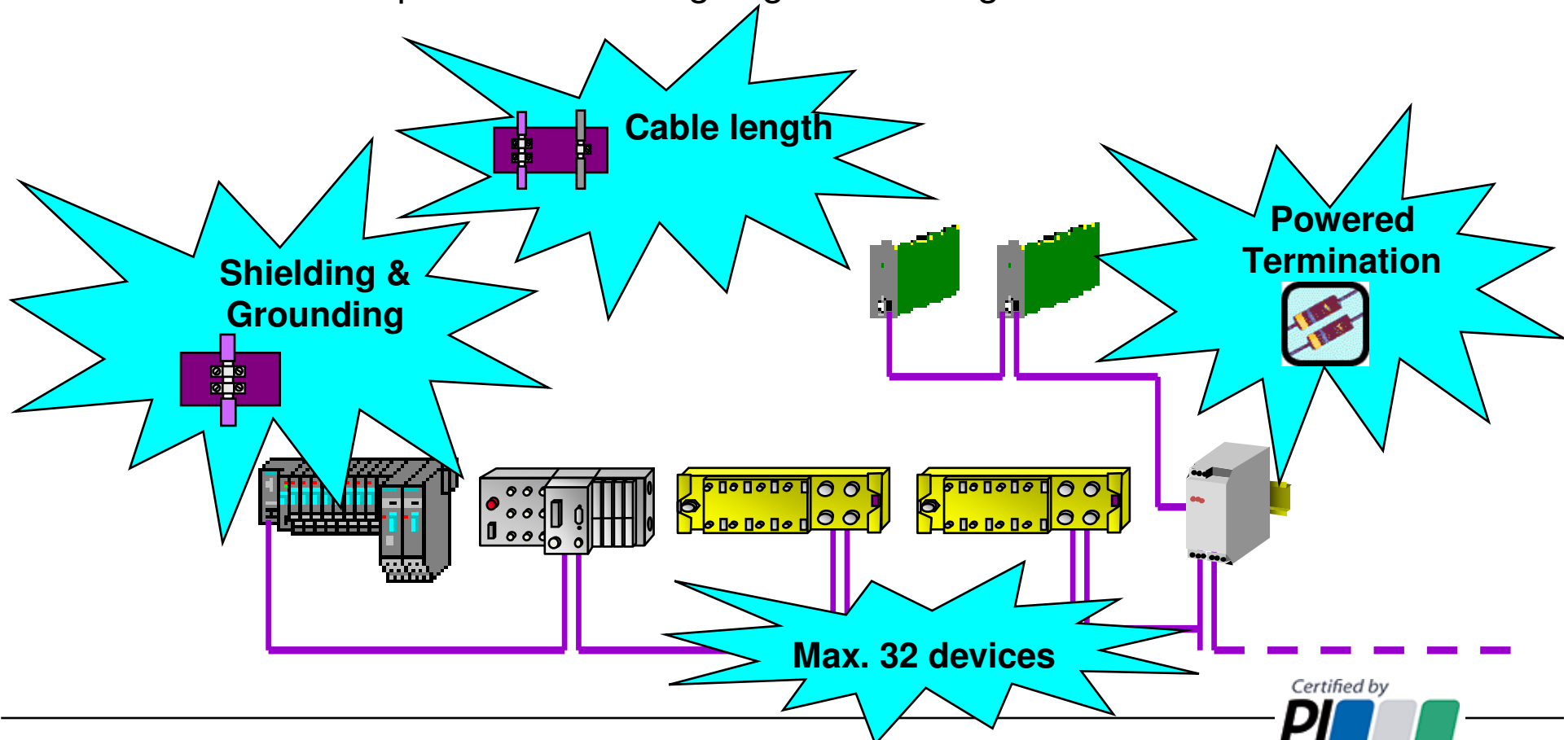
### RS 485

- ⦿ Baudrates from 9.6 kbit/s to 12 Mbit/s
- ⦿ Shielded twisted pair cable
- ⦿ 32 devices per segment
- ⦿ Distance: 12 Mbit/s = 100 m; 1.5 Mbit/s = 200 m;  $\leq 187.5$  kbit/s = 1,000 m
- ⦿ Distance extendable with repeaters



## Design specifications

What are the critical points when designing RS 485 segments?



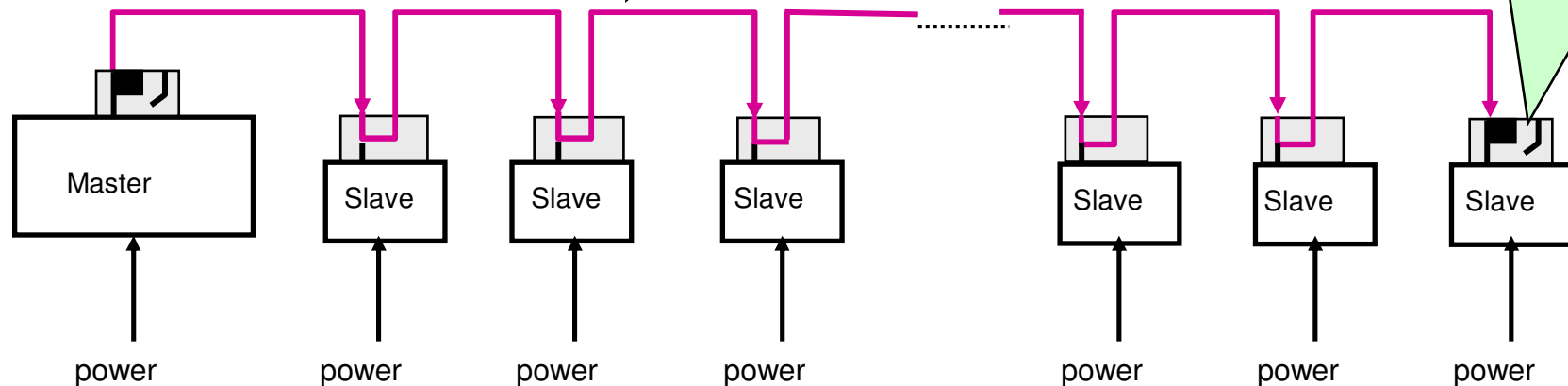
## Topology

1. Cable to next device. Spurs have to be as short as possible.


3. When the baudrate is 1500 kbps or higher, **minimum 1 meter** cable between 2 devices.


4. Termination (powered) at both ends.

Maximum 32 devices

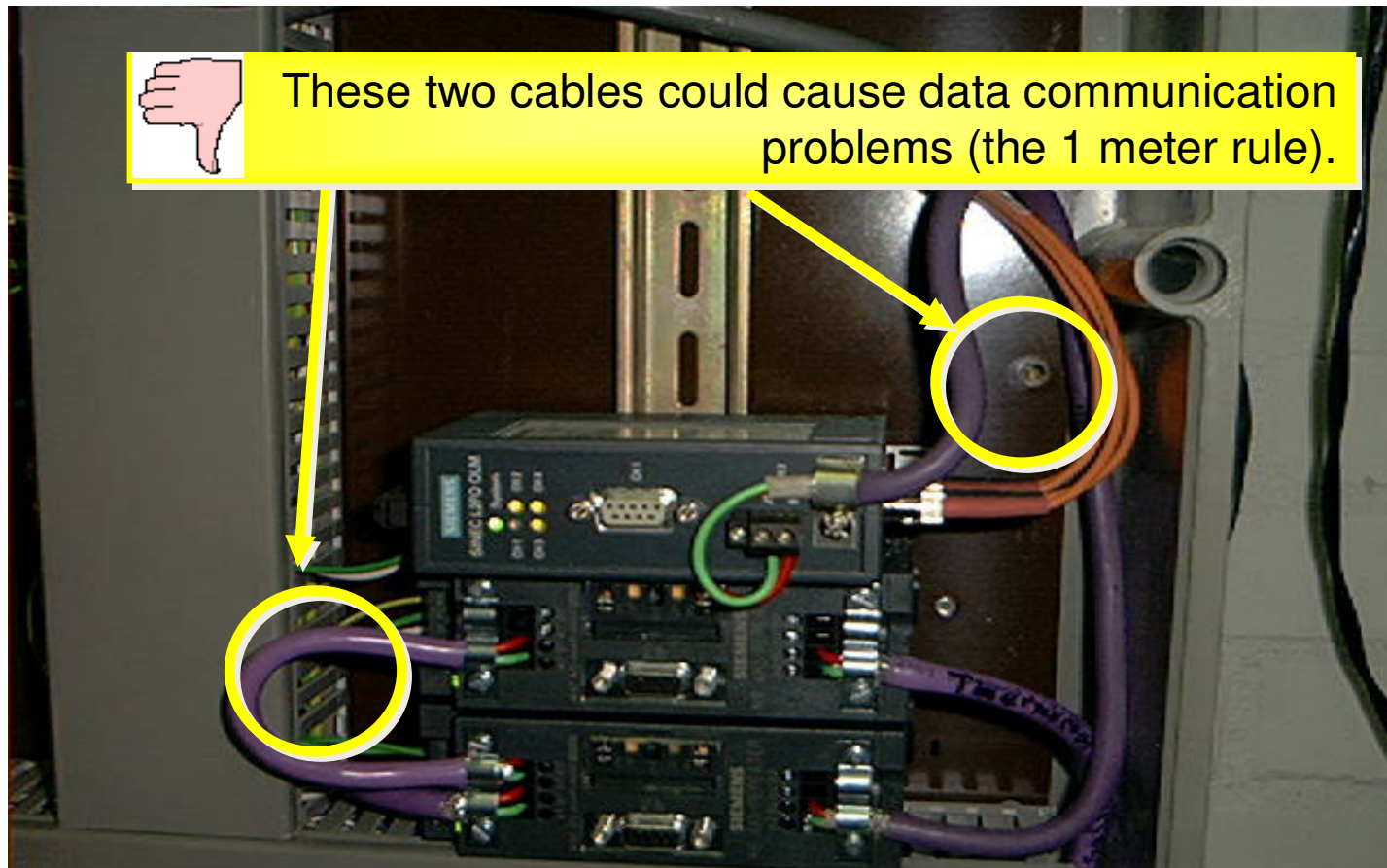


2. The devices have their own power supply.

 Plug with termination **OFF**.

 Plug with termination **ON**.

## Example – Problems with the 1 meter rule





## Example – Solution for the 1 meter rule



A strategic placement automatically takes care of the 1 meter rule.

## Cable length versus Baudrate

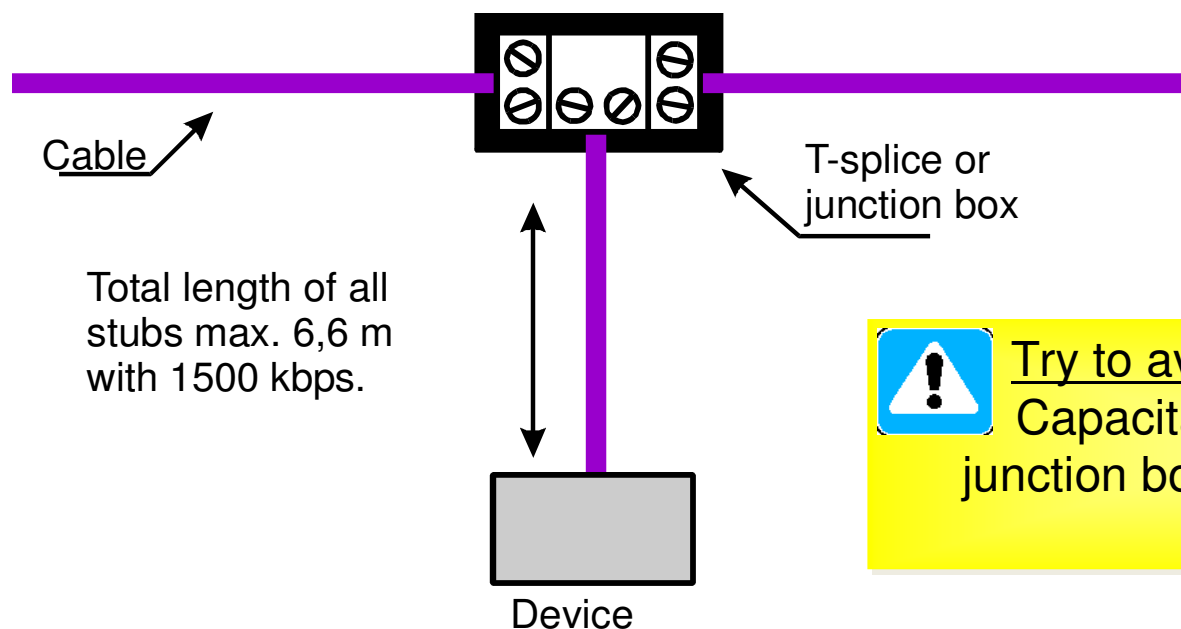
Baudrate (kbit/s)	9.6	19.2	45.45	93.75	187.5	500	1500	3000	6000	12000
Segment length (m)	1200	1200	1200	1200	1000	400	200	100	100	100
Segment length (feet)	3940	3940	3940	3940	3280	1310	656	328	328	328



baudrate transitions in which the cable length reduces with more than 50 %.

These lengths are defined for 1 segment with 32 bus loads!

## Spurs



Try to avoid spurs with RS 485.  
Capacitance of connectors and junction boxes is not well defined!

- ⊙ Total **6,6 m** with **1500 kbps** (capacity of spurs = 0,2 nF)
- ⊙ Total **20 m** with **500 kbps** (capacity of spurs = 0,6 nF)
- ⊙ Total **33 m** with **187,5 kbps** (capacity of spurs = 1,0 nF)
- ⊙ Total **100 m** with **93,75 kbps** (capacity of spurs = 3,0 nF)
- ⊙ Total **500 m** with **9,6 and 19,2 kbps** (capacity of spurs = 15 nF)

The length is a sum of all the spurs in the segment!

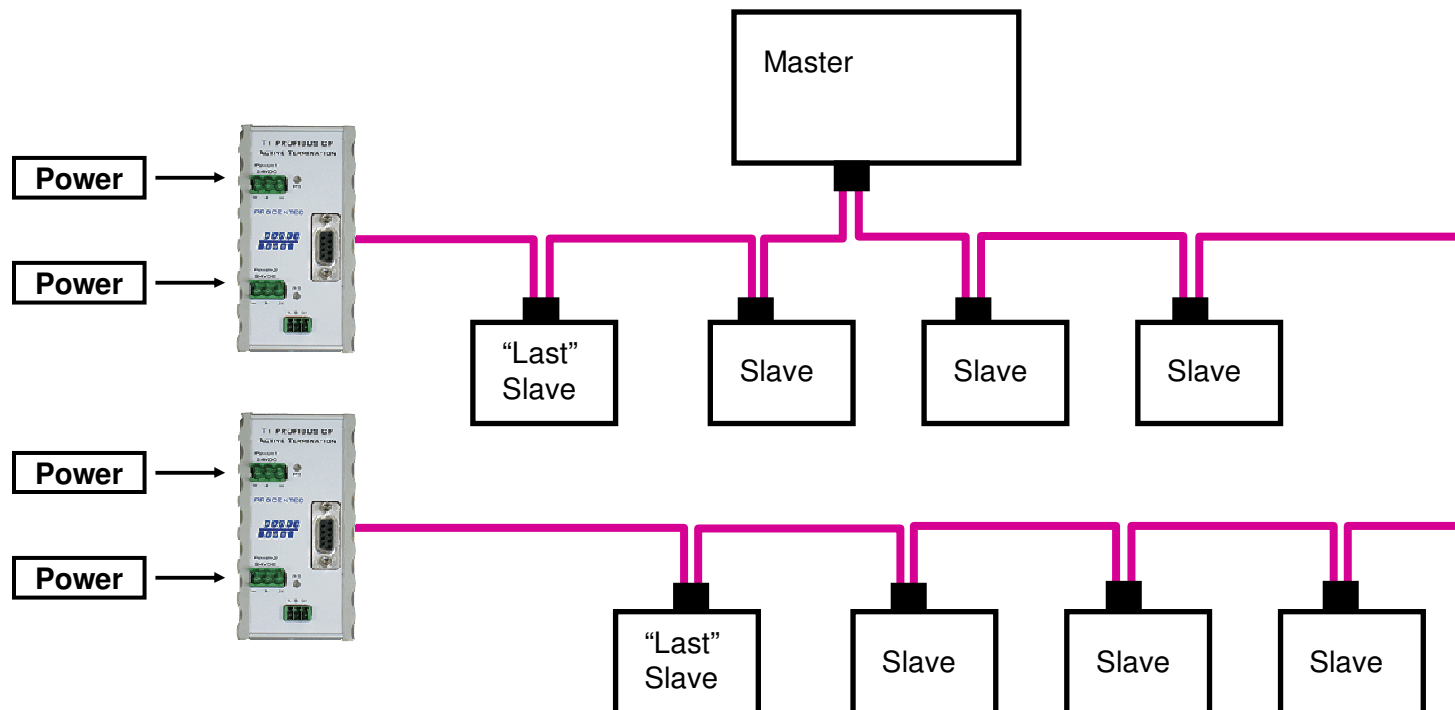


**He was correct! The termination is switched ON.**



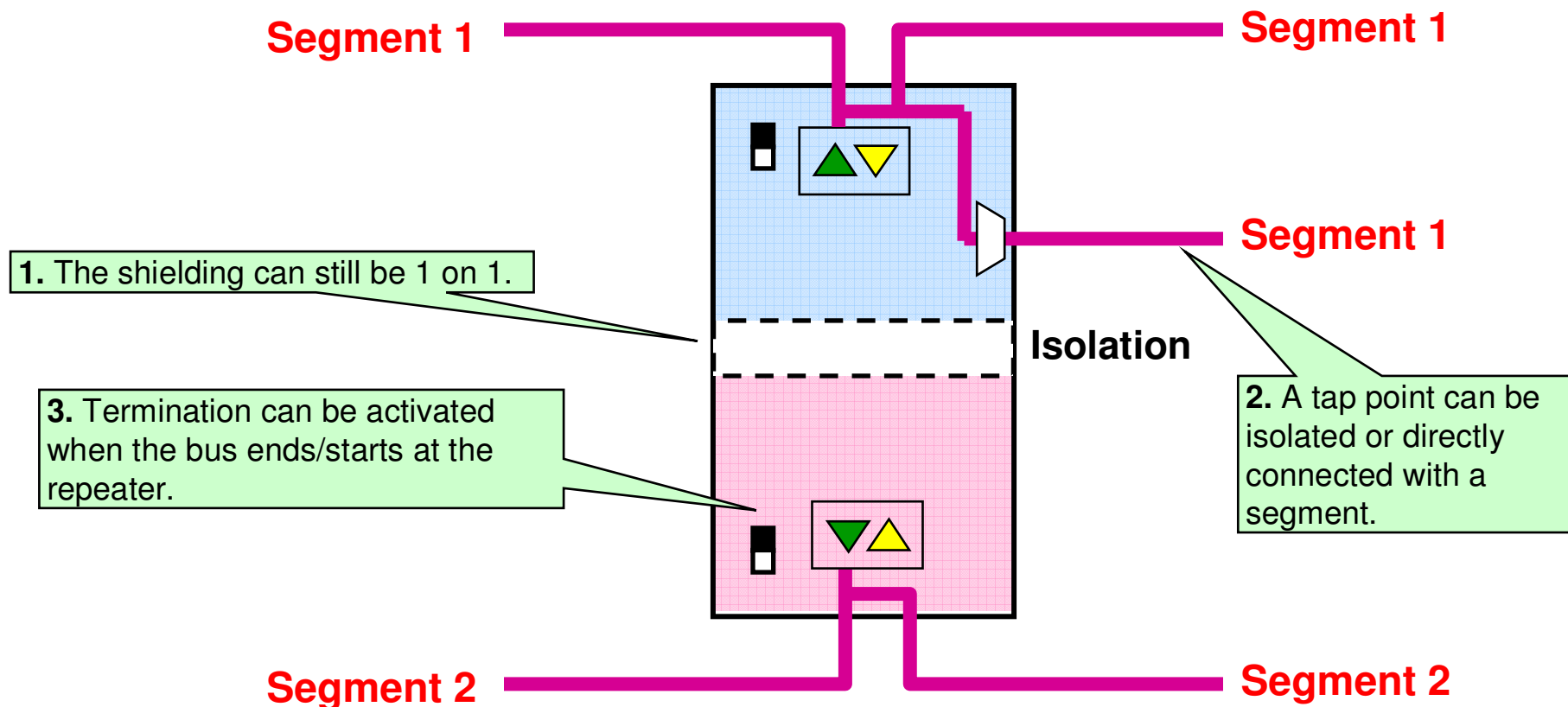
Sometimes the laptop was connected at this place!  
But, there is NO powered terminated here.

## Active Termination



In this segment every station can be removed or powered down without disrupting the network.

## Repeaters - Structure



## Wrong wiring of repeaters

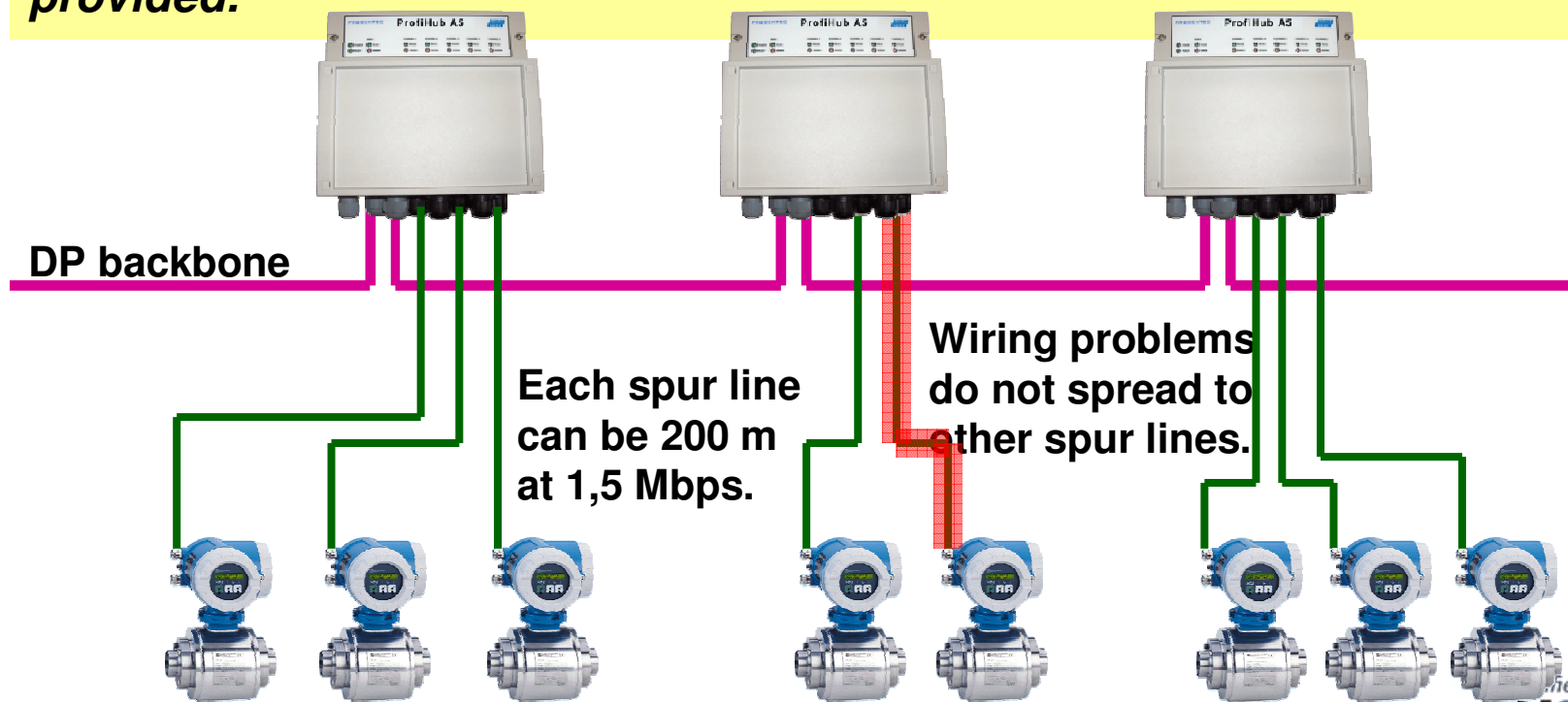


Now they have 41 devices on the same segment!



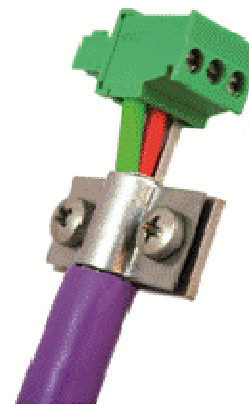
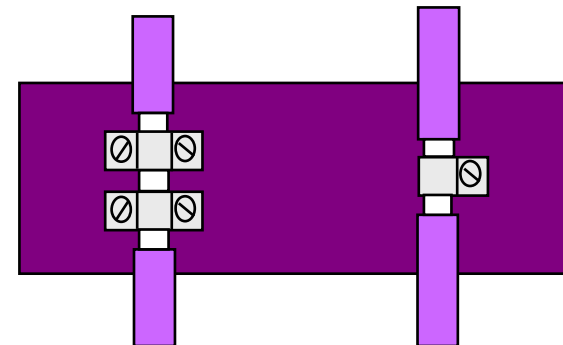
## Hubs are more efficient for repeater backbones

*Long spur lines to instruments and the possibility to remove/insert them during operation. Short circuit protection on each spur line is automatically provided.*

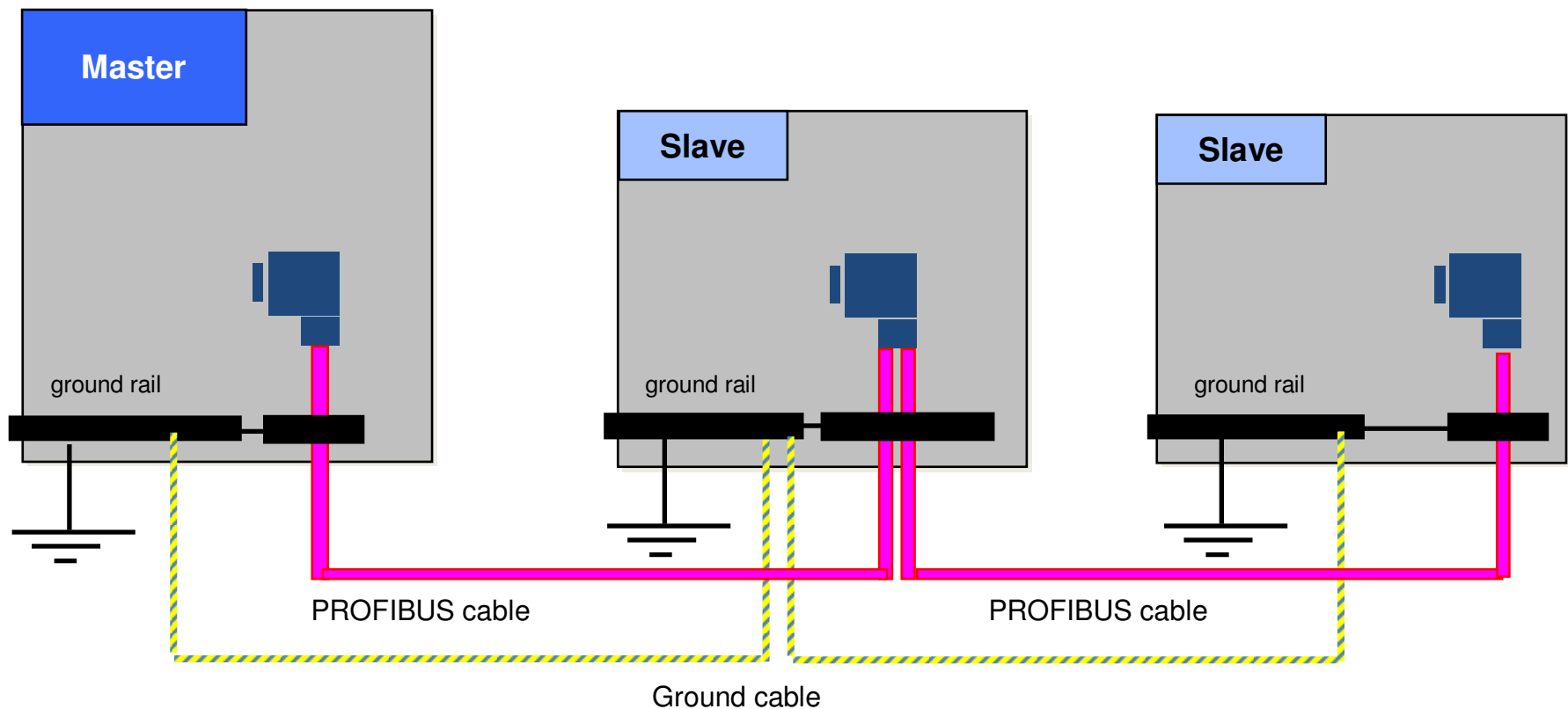


## What does IEC61000-5-2 say about grounding?

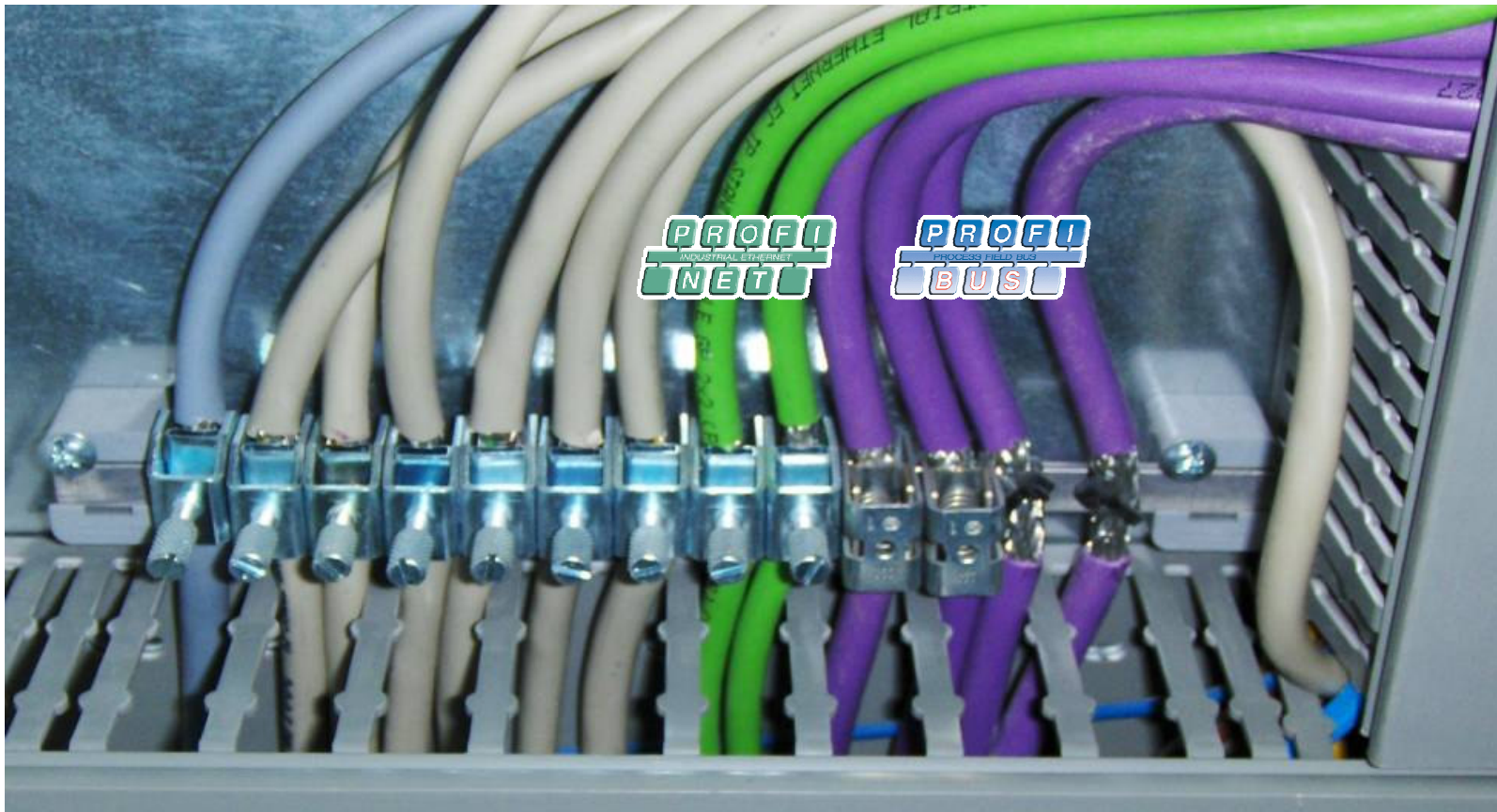
- ❑ **Ground as many points as possible.** This reduces the resistance (less noise).
- ❑ Be careful of the amount of current flowing through the shield. When the current gets too high, use;
  - **fiber optic**
  - **extra ground cable**
  - **repeaters with isolation**
- ❑ Avoid the use of 'pigtailed'.
- ❑ Avoid connection with the 'minus' of power supplies.



## Grounding and shielding between cabinets

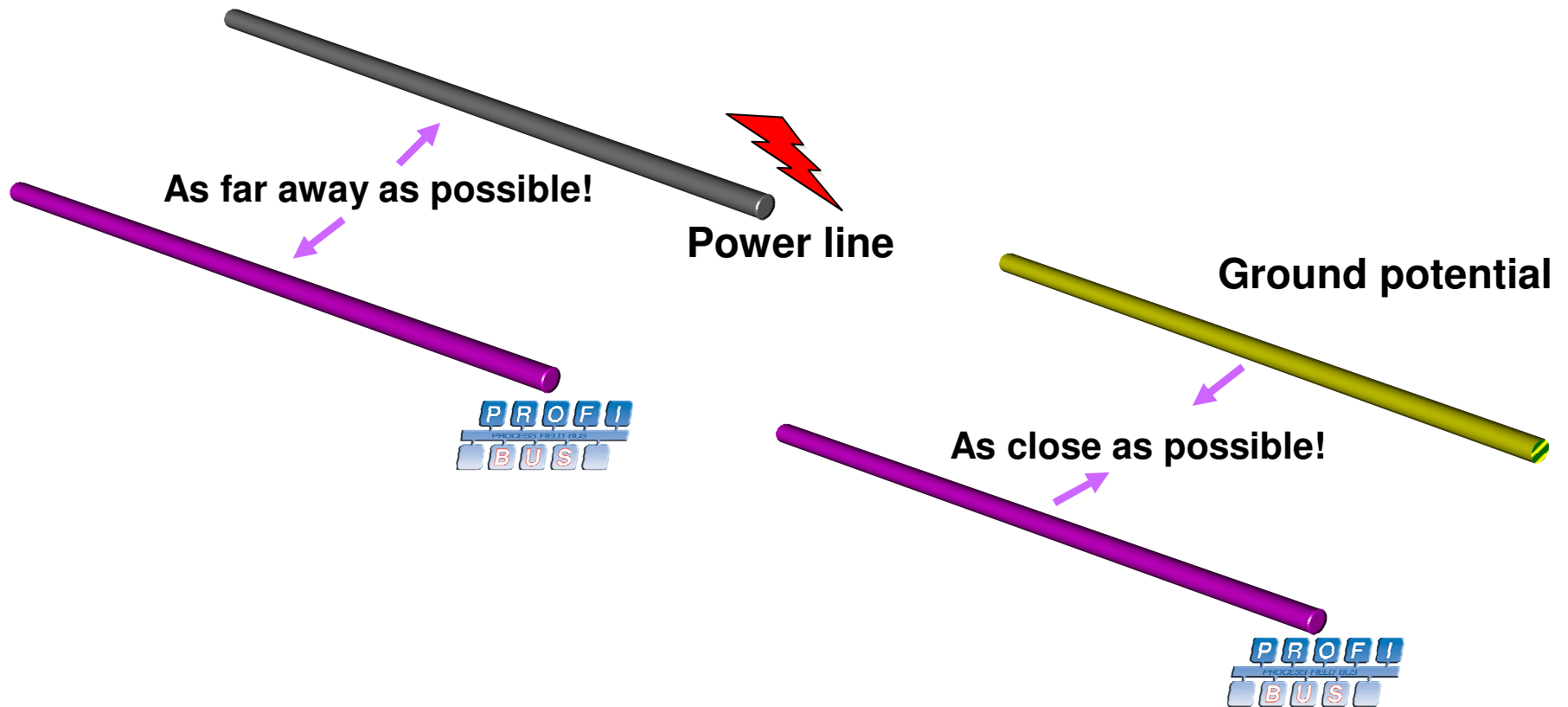


## Additional grounding points

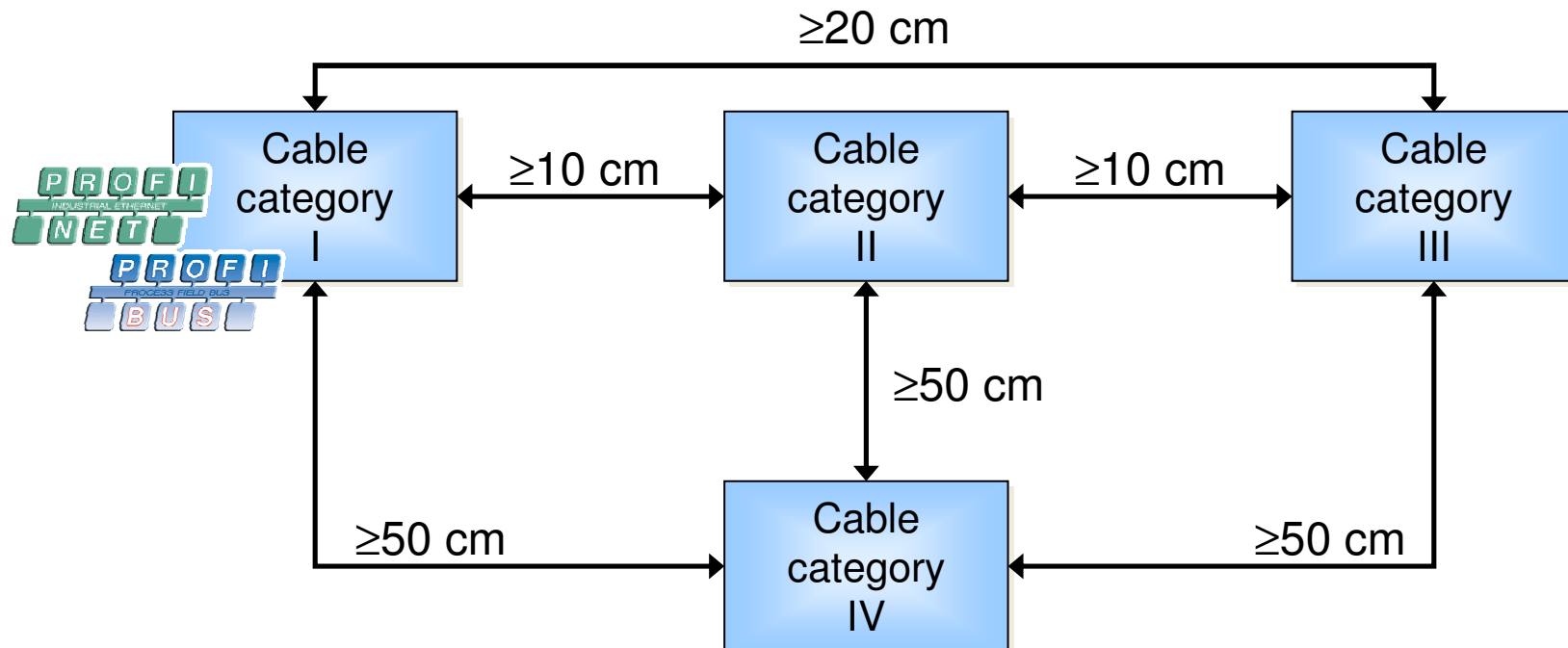




## Policy of separation



## Air Gaps



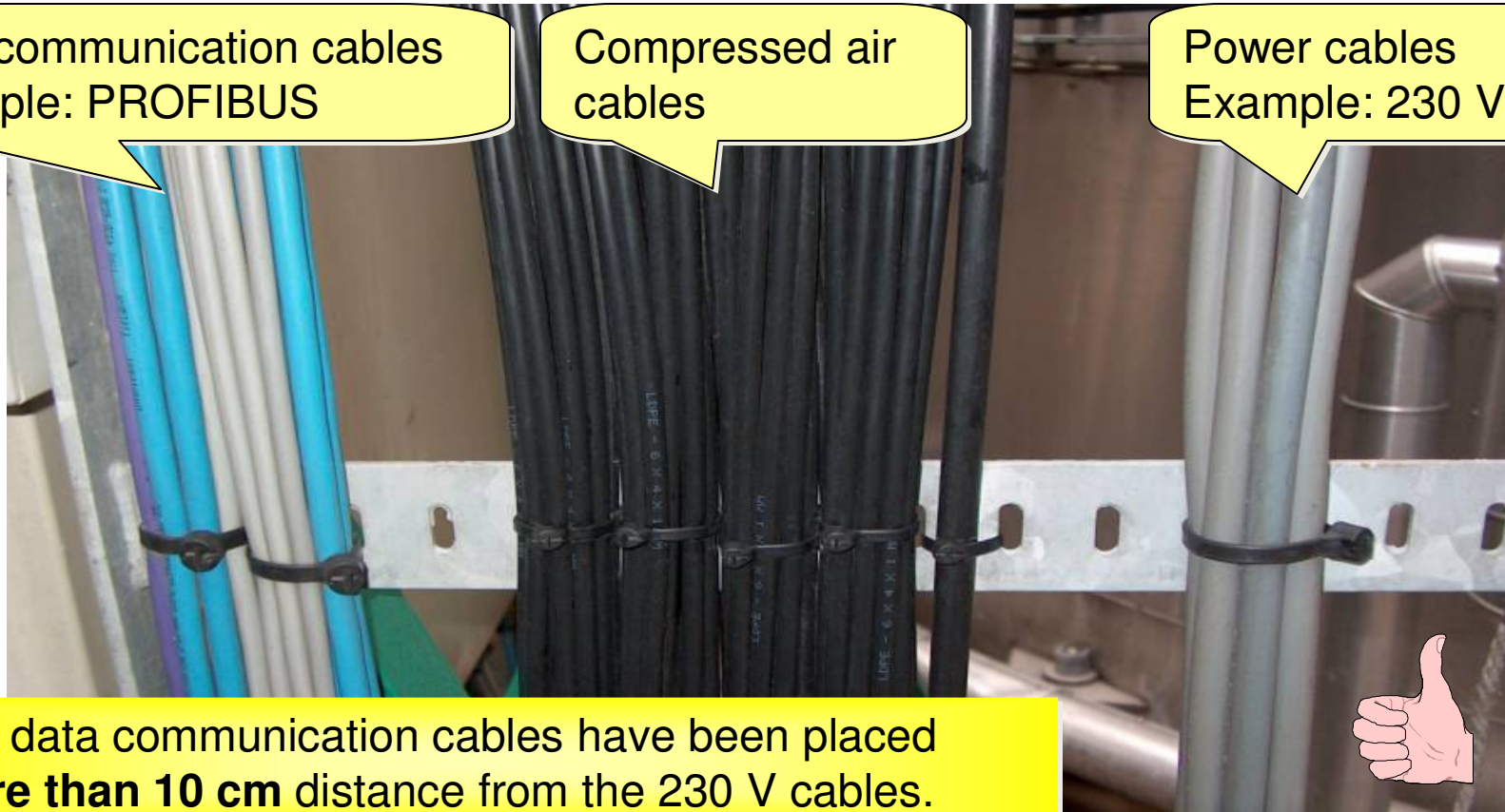
The air gaps are based on air space. In case of grounded metal plates, the distances can be reduced. Cables of different categories may cross each other.

## Example - Air gaps

Data communication cables  
Example: PROFIBUS

Compressed air  
cables

Power cables  
Example: 230 V



The data communication cables have been placed  
**more than 10 cm** distance from the 230 V cables.



## Test- and measurement tools

## Handheld tools

- Siemens BT200
- ComSoft Nettest II



### Functions:

- Wire breaks/short circuits
- Voltage or shielding faults
- Localizing faults
- Measuring cable lengths
- Termination detection
- List of slaves
- Logging



**Non active segments (masters have been removed)!**

## Oscilloscopes



**1st: Large + Difficult**

### Functions

- Amplitude
- Reflections
- Noise
- EMC

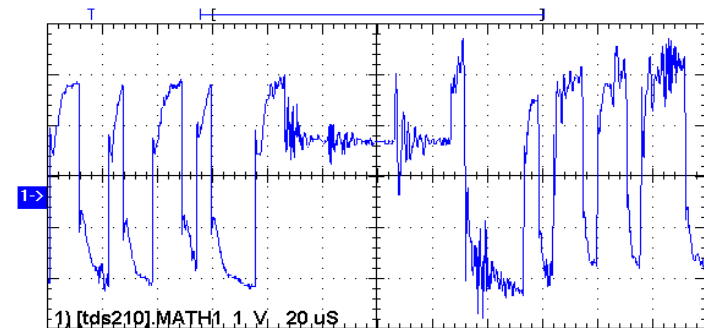


**2nd: Expensive**

**3rd: Difficult**



**4th: Small, Fast and Easy**

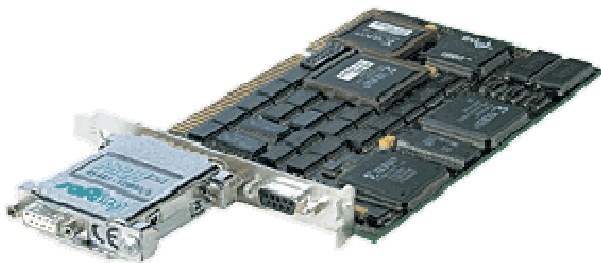
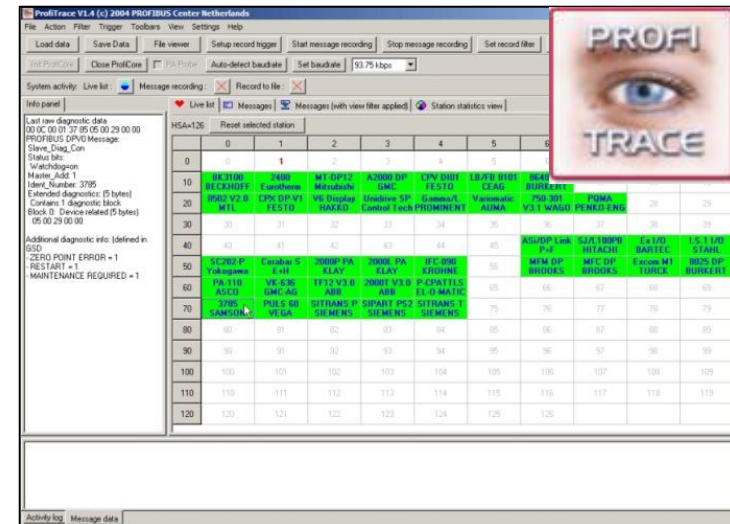


The oscilloscope is the only tool that can display the bus signals!



## Busmonitors / Analyzers

- **ProfiTrace 2 - PROCENTEC**
- Bus check - Softing
- PBScope - T+H
- IT-Monitor - ITM / ComSoft / TMG-itec
- Amprolyzer



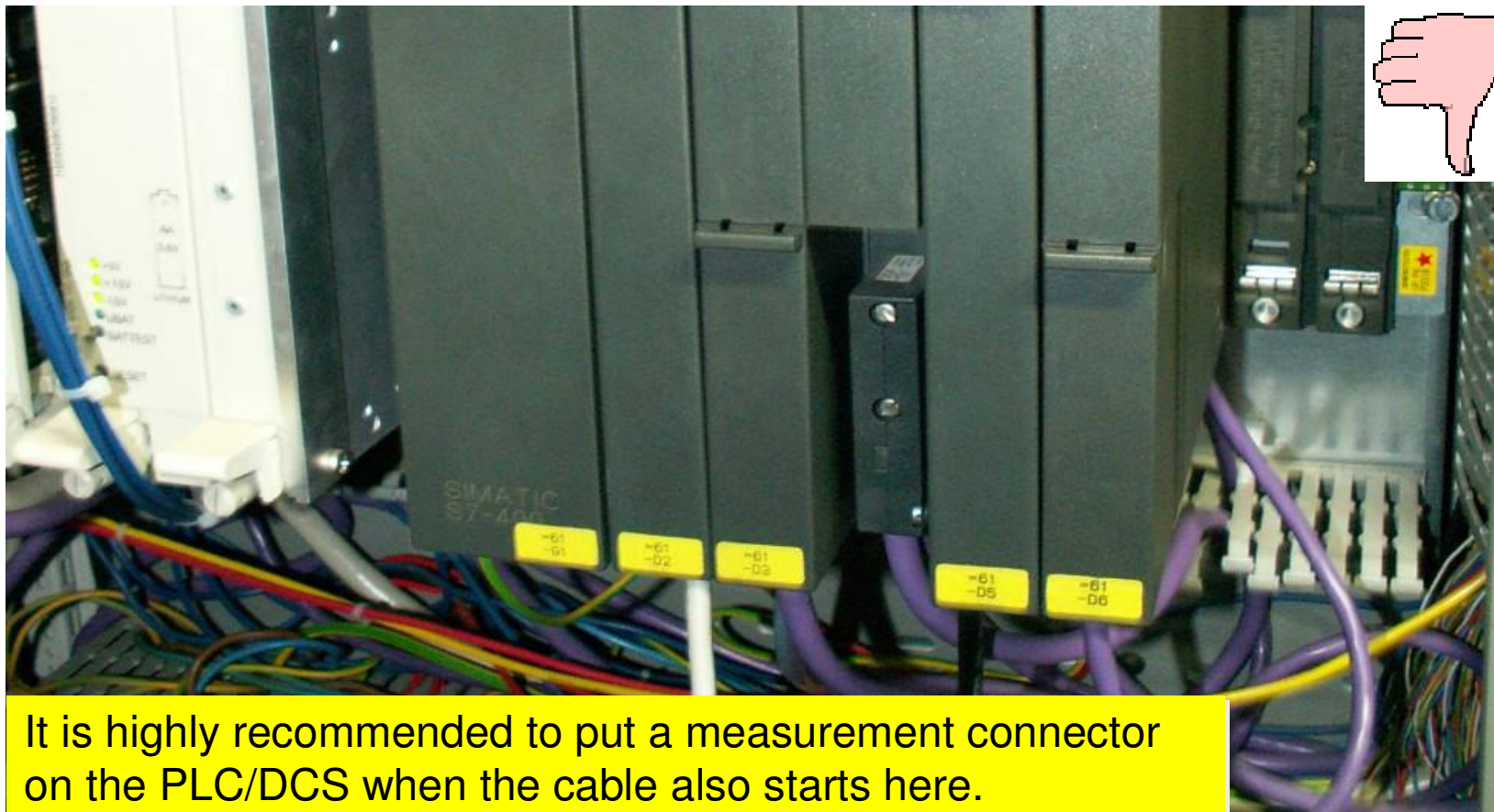
USB

**Active network!**

### Functions

- Live List
- Messages
- Device diagnosis
- Cycle times
- Logging

## Example – No measurement connectors



It is highly recommended to put a measurement connector on the PLC/DCS when the cable also starts here.





## *Facts and Fiction*

***The most important tools for troubleshooting a network during operation are an oscilloscope and a busmonitor/analyzer.***



## *Facts and Fiction*

***A multi-meter is not useable  
for dynamic signal  
measurement!***



## *Strategy of troubleshooting*

## Classifications of most common PROFIBUS problems

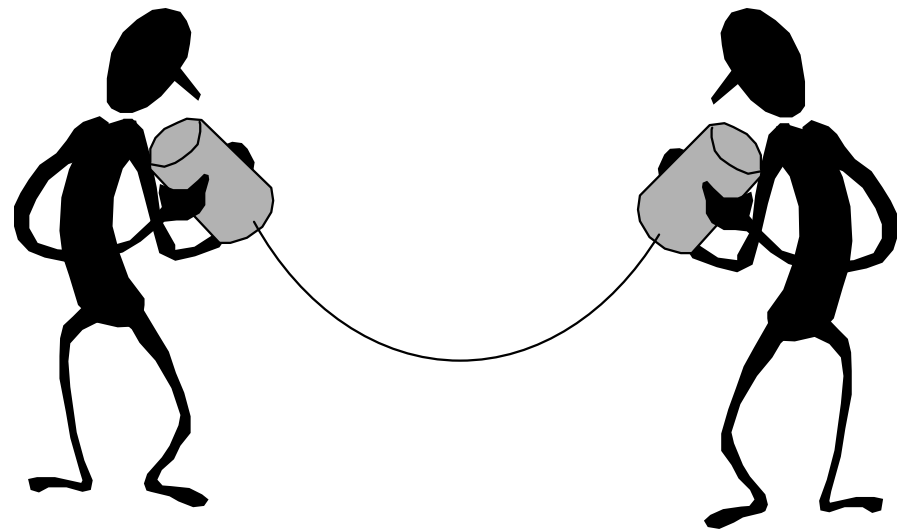
### Physical level

- ⊙ Device is **NOT** communicating anymore
- ⊙ **Periodically** no communication with a device

← The worst one

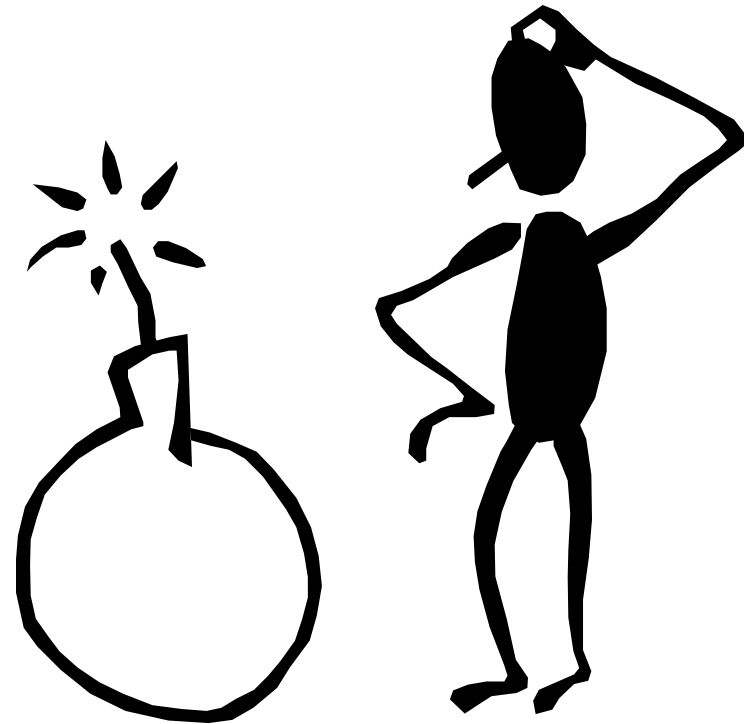
### Application level

- ⊙ Invalid data (calibration or bug)
- ⊙ Device diagnostics (I/O problems)



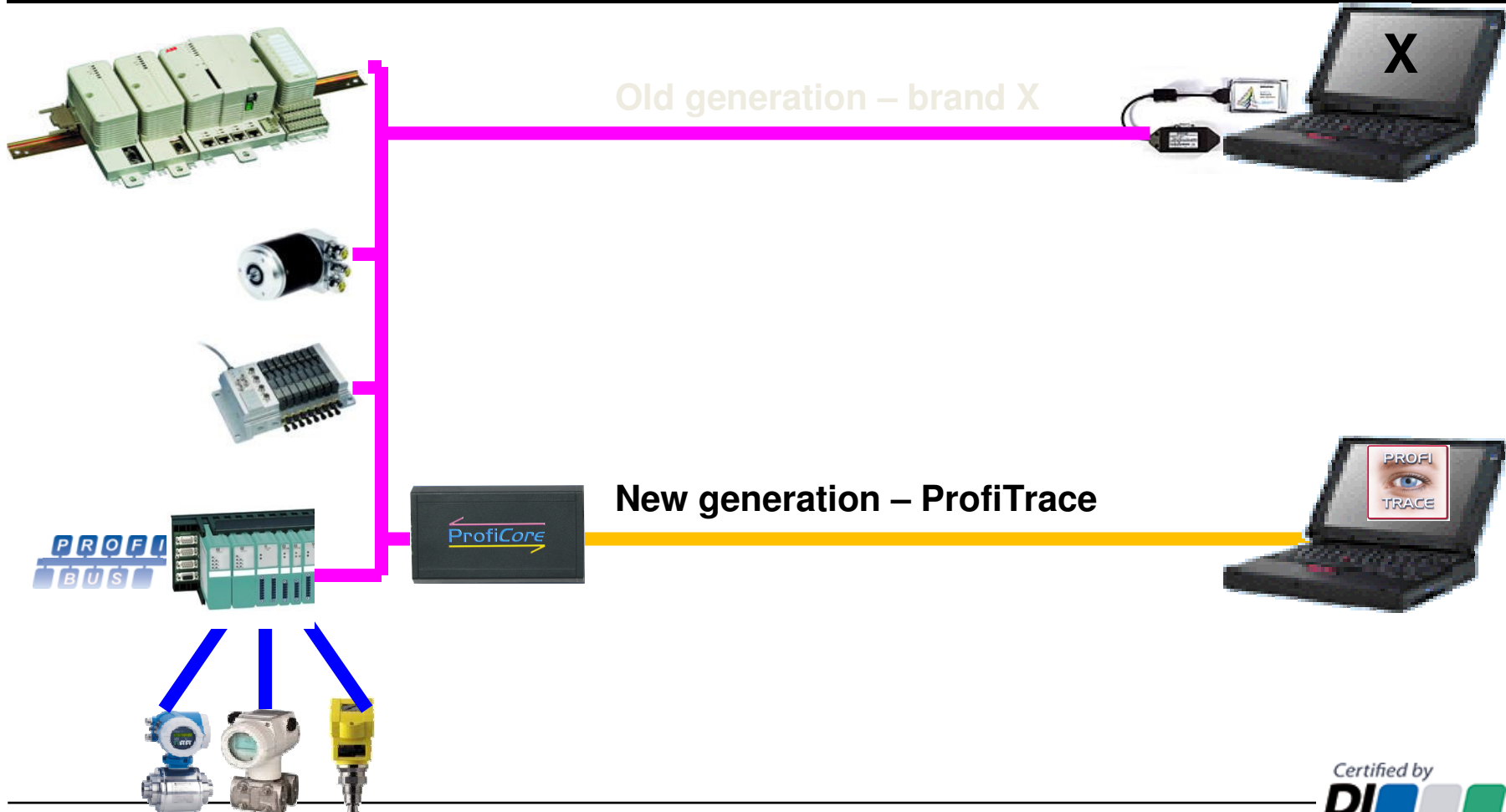
## What kind of fault finding methods are at hand?

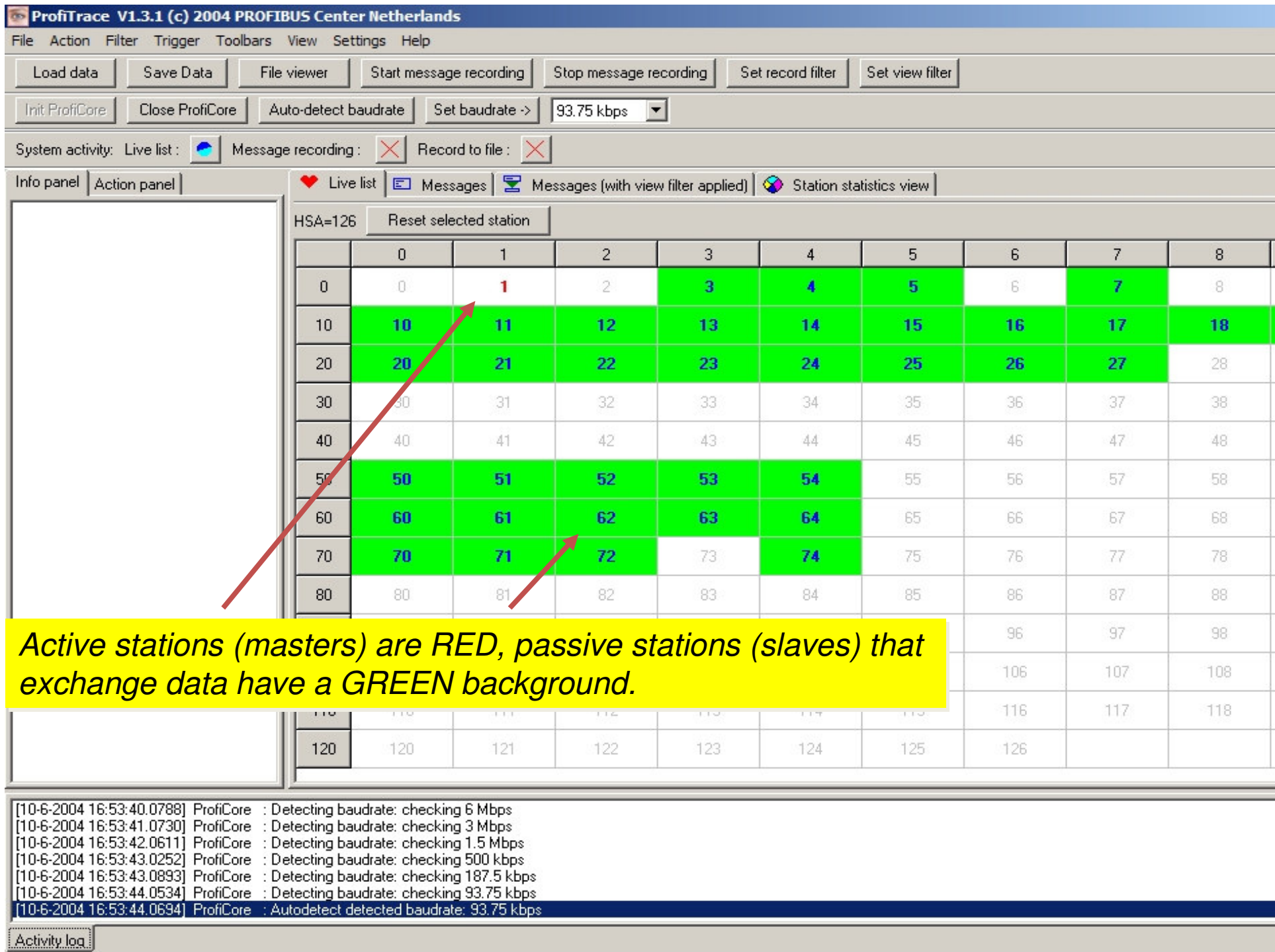
- 1) Analyzer ← most important!
- 2) Electrical measurement
- 3) Visual inspection



The sequence above is also the way of working for localizing and solving 'problems'.

## Infrastructure







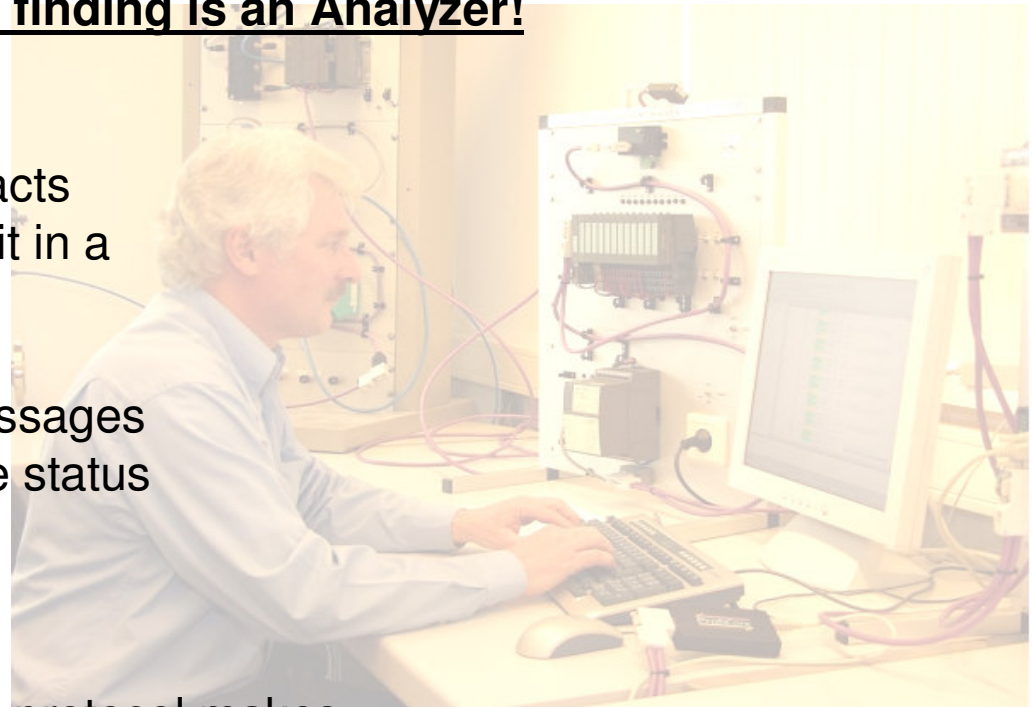
## Analyzer

### The most important tool for fault finding is an Analyzer!

This is a PC application which extracts messages from the bus and saves it in a database.

The technician can analyze the messages and come to a conclusion about the status of the instruments.

The predictability of the PROFIBUS protocol makes the use of a busmonitor very easy.....







## *Facts and Fiction*

***Busmonitors do not have a network address, but are a Physical bus load on the cable!***



## *The End*

For Any Questions;  
[info@profibus-sa.com](mailto:info@profibus-sa.com)

Soon → [www.profibus-sa.com](http://www.profibus-sa.com)  
(( In a complete new look ))

By; Ali Magboul  
THANK YOU...

### References:

- PROFIBUS INSTALLATION GUIDELINES
- T&ME PROCENTEC COURSE