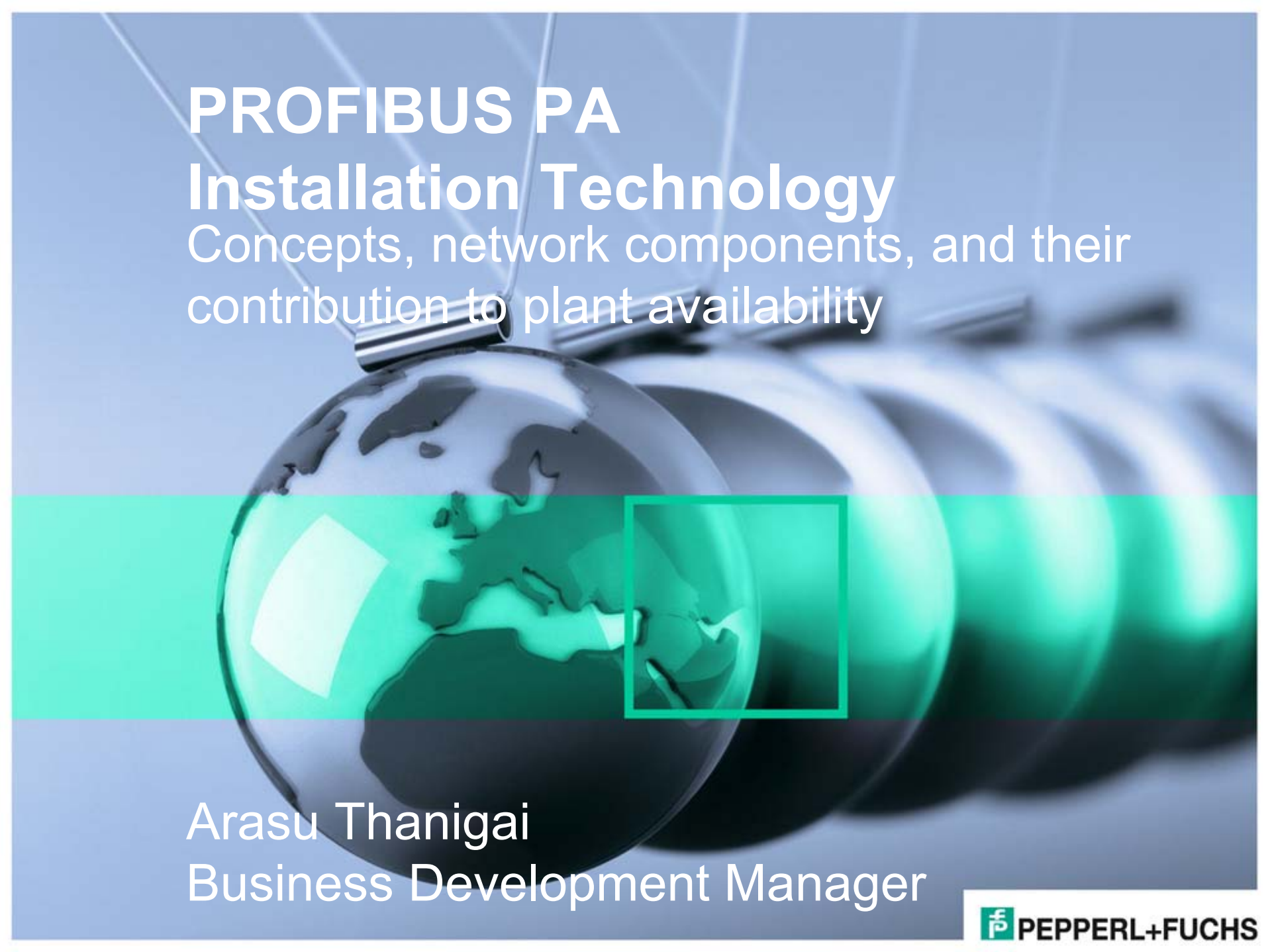
PROFIBUS PA
Installation Technology

Concepts, network components, and their contribution to plant availability



Arasu Thanigai
Business Development Manager

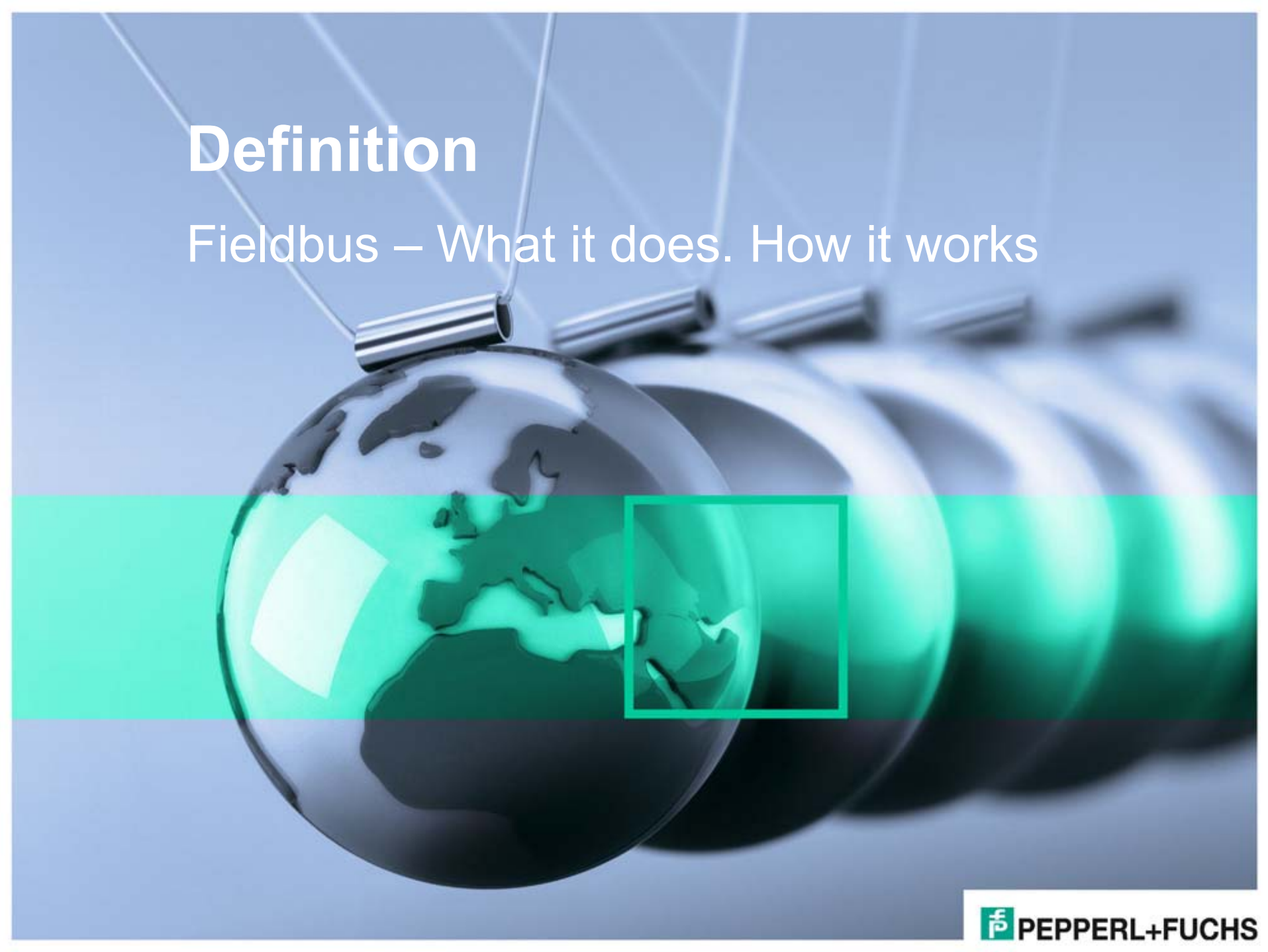
PEPPERL+FUCHS

Fieldbus Installation Technology

- Definition
- Topology
- Availability
- Diagnostics
- Summary

Definition

Fieldbus – What it does. How it works



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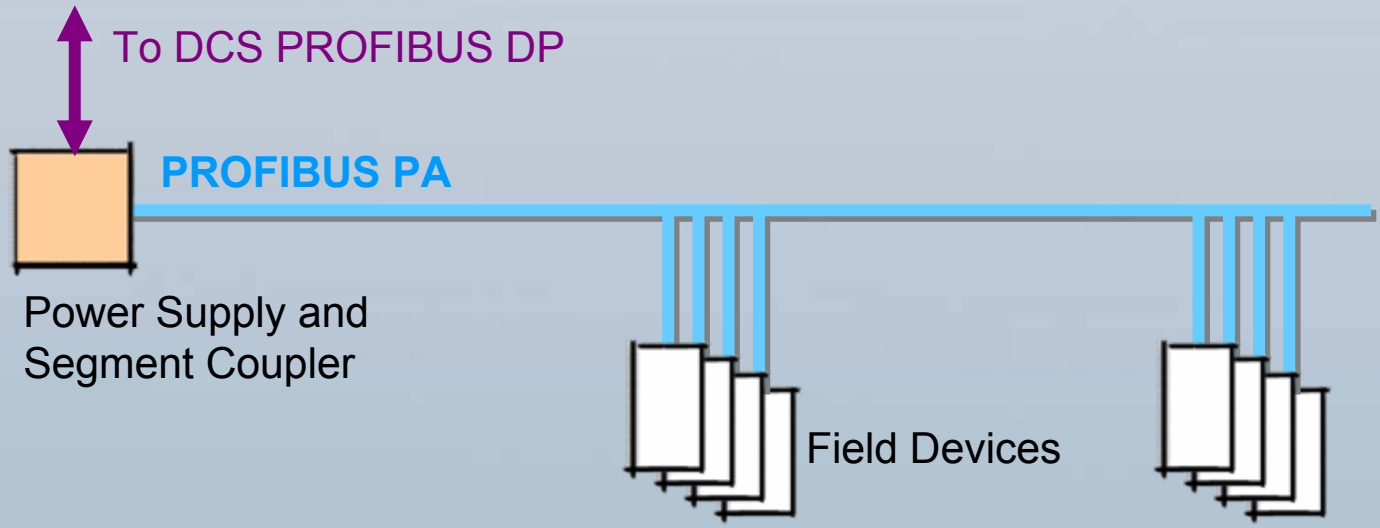
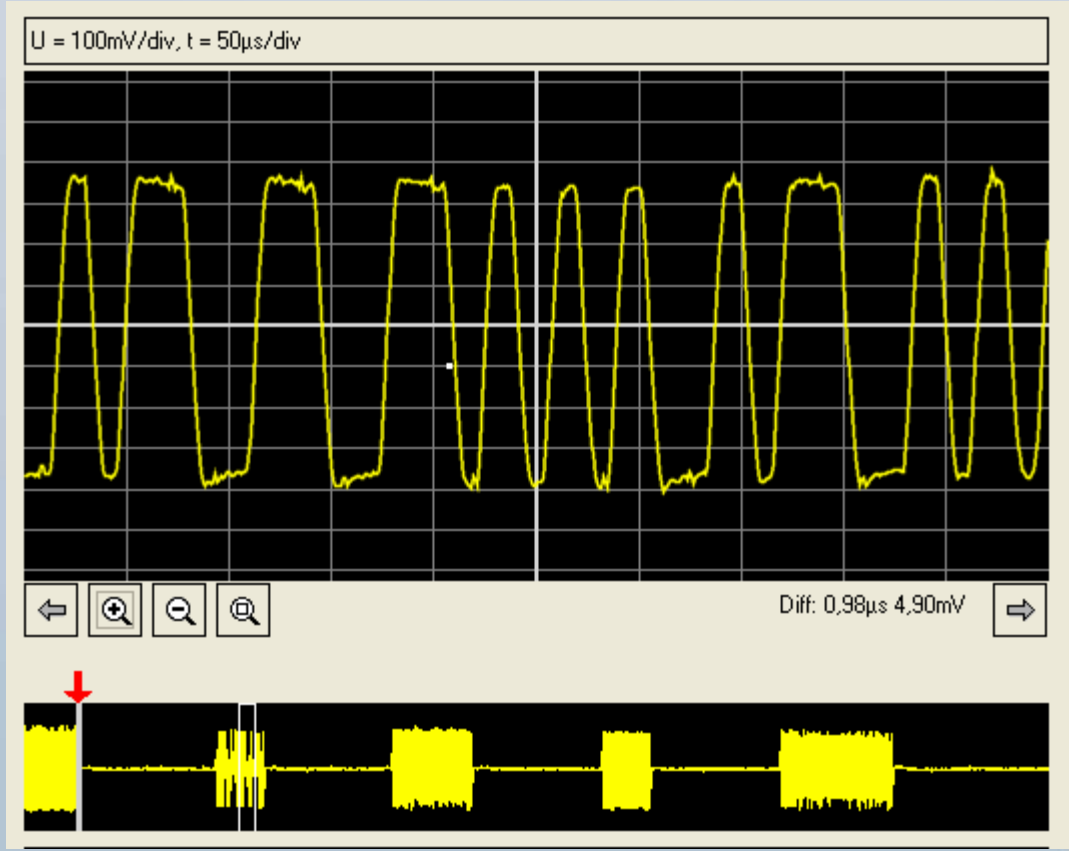
Attributes of PROFIBUS PA

- Power Supply and Digital Communication utilizing one shielded, twisted-pair cable
- IEC 61158-2
- Similarities between PROFIBUS DP and PA
  - Simple coupling of DP and PA
  - Coupling is transparent



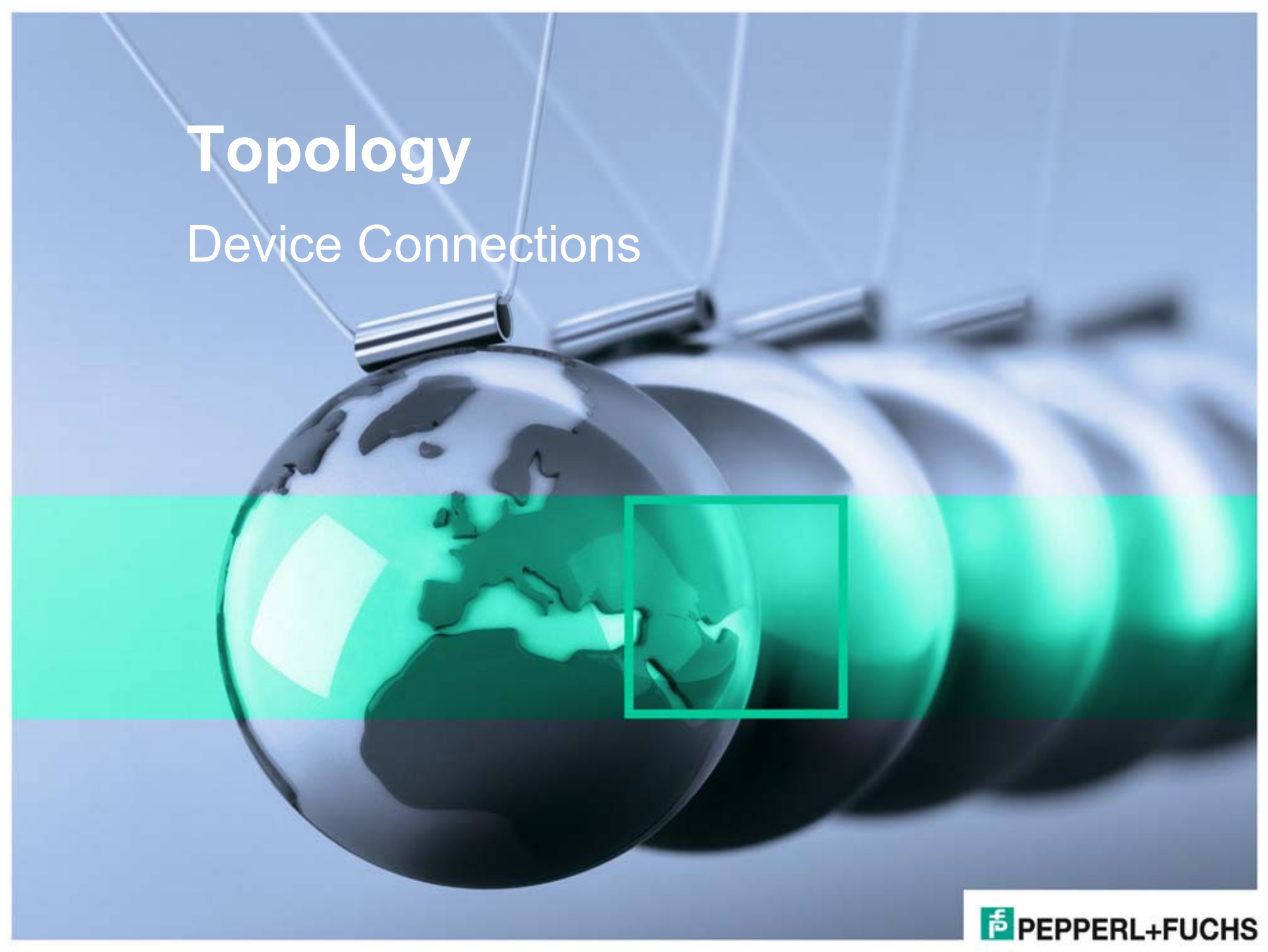
Data Transmission PROFIBUS PA

- Current change appears as voltage on the cable
- Device addresses and data packages



Topology

Device Connections



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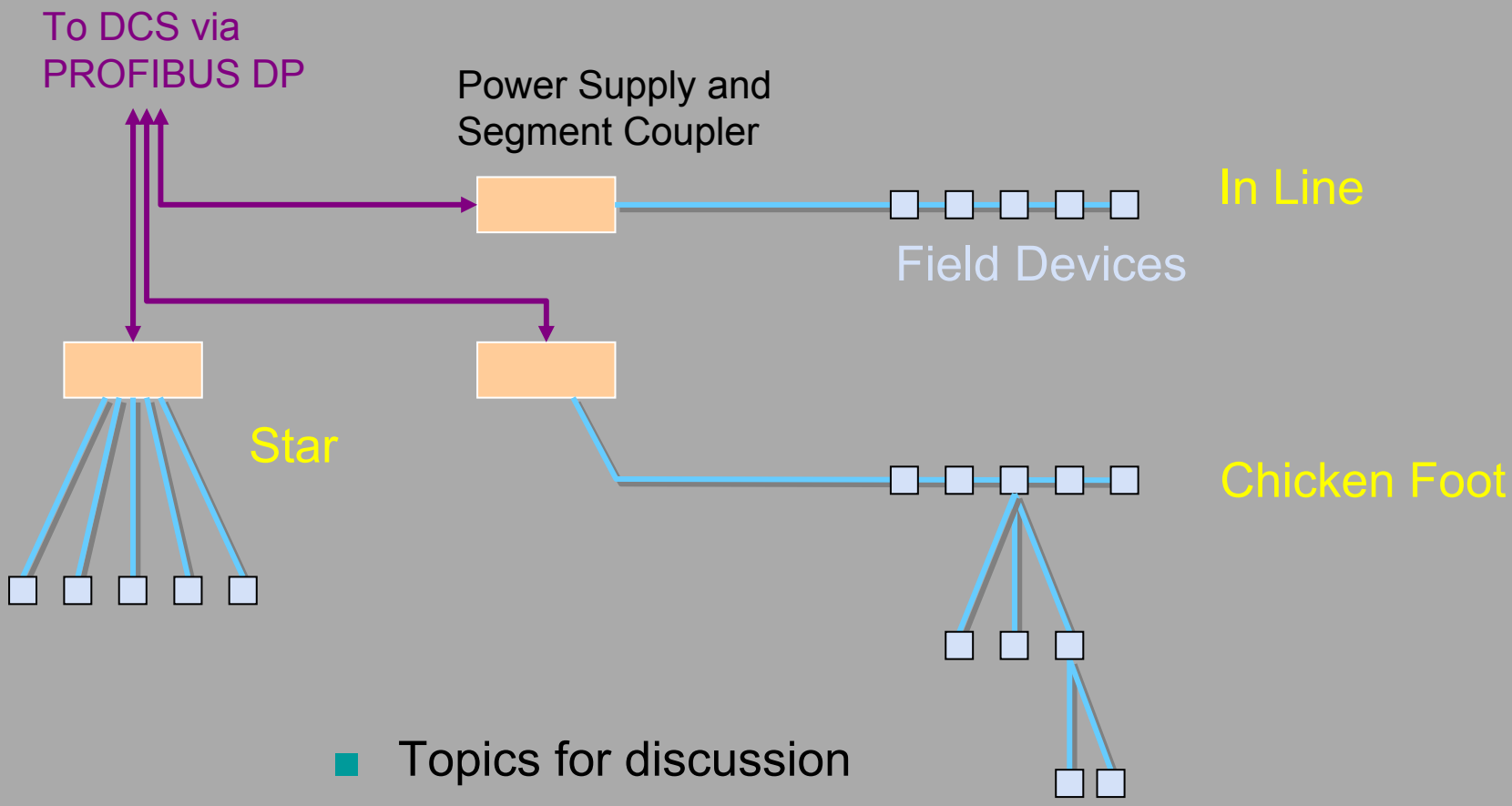
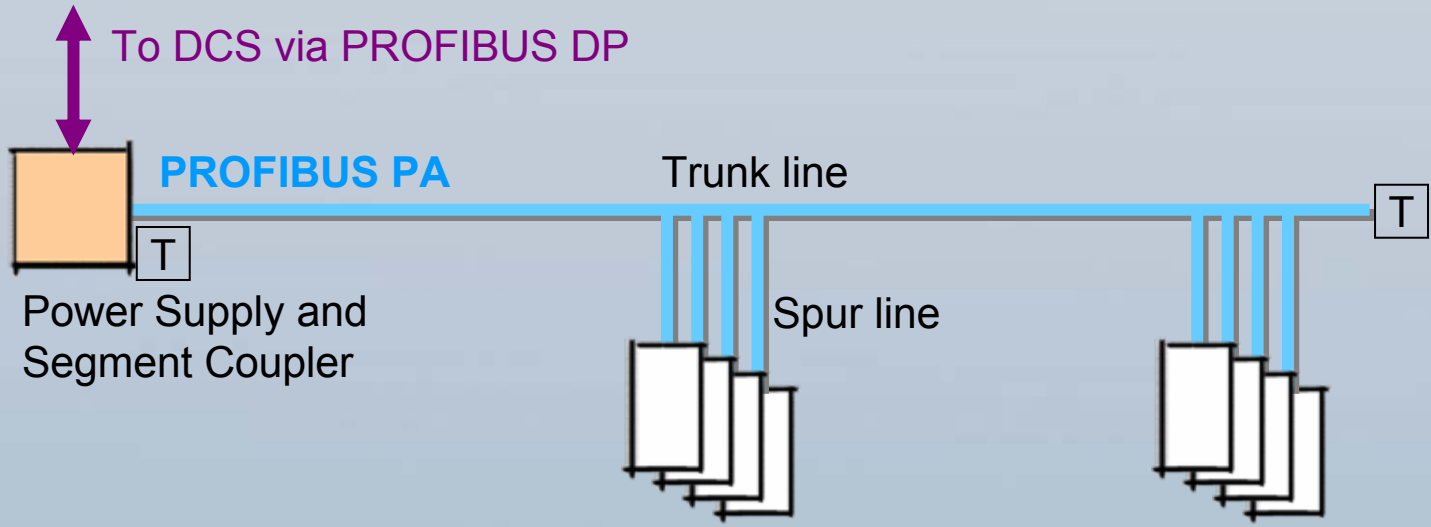
Topologies for Fieldbus



- Topics for discussion
  - System Availability
  - Validation of Ex-Protection
  - Simplicity of installation and maintenance

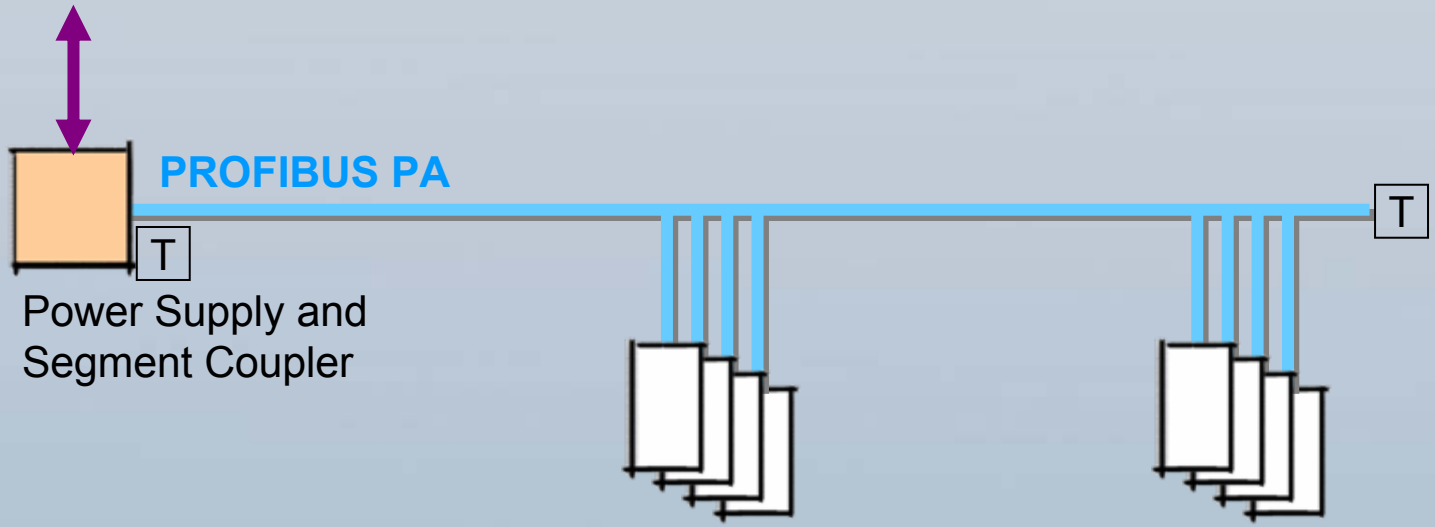
Mechanics of the Physical Layer

- Transmission rate 31,25 kBit/s
- Length of Trunk line max. 1900 m
- Length of Spur line max. 120 m
- Termination reduces signal reflexions



Electric attributes of the Physical Layer

- Up to 32 devices per Segment (Host + 31 field instruments)
- Nominal electrical values:
  - Min. Voltage at field devices: 9 Volts
  - Min. current consumption by field device: 10 mA
  - Data transmission via ± 9 mA Signal

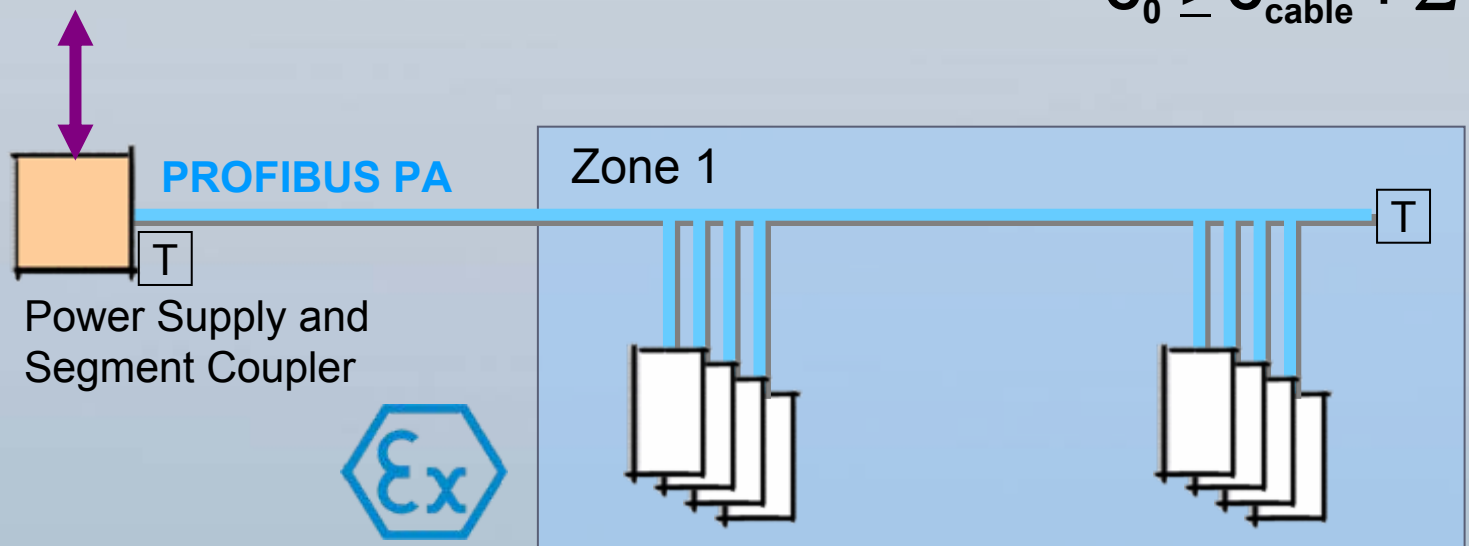


Explosion Protection – FISCO

- Fieldbus Intrinsically Safe COncept
  - Simple validation of Intrinsic Safety
  - Limitation to
    - Max 900 m length
    - Max 10 devices

$$U_0 \leq U_i$$
$$I_0 \leq I_i$$
$$P_0 \leq P_i$$

$$L_0 \geq L_{cable} + \sum L_i$$
$$C_0 \geq C_{cable} + \sum C_i$$



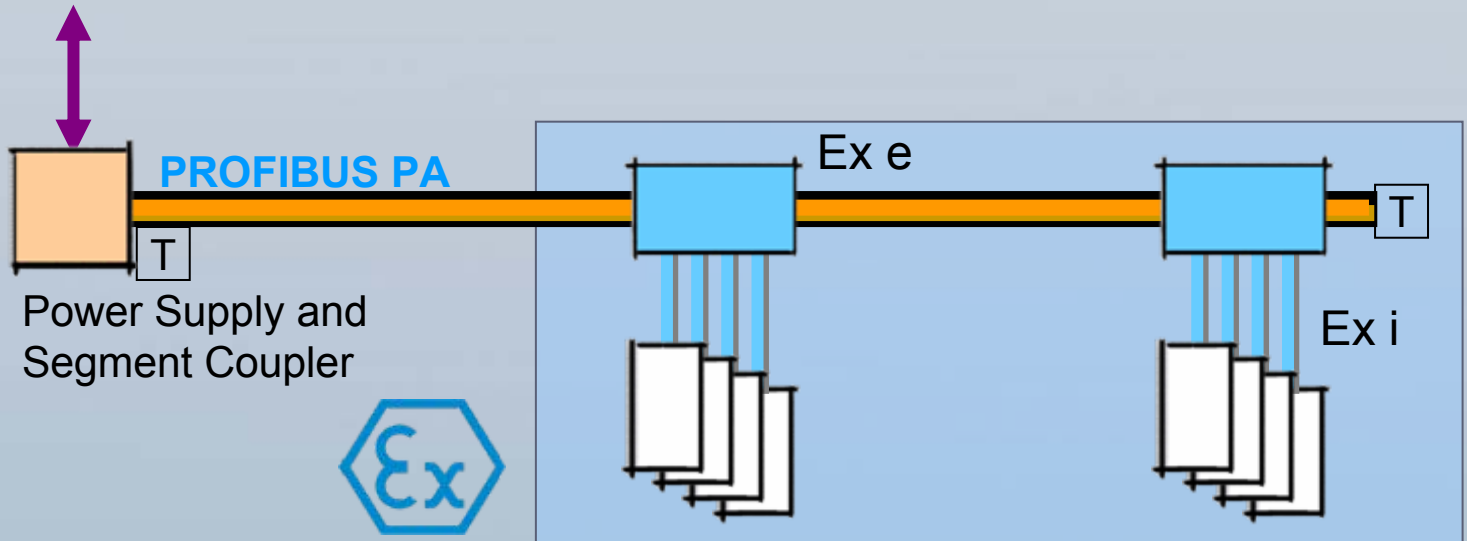
The High-Power Trunk

$U_0 \leq U_i$

$I_0 \leq I_i$

$P_0 \leq P_i$

- Longest cable run
- Maximum number of devices
- Live working while plant is in operation
- Unlimited energy on the Trunk
- Intrinsic safety at each Spur via Field Barrier



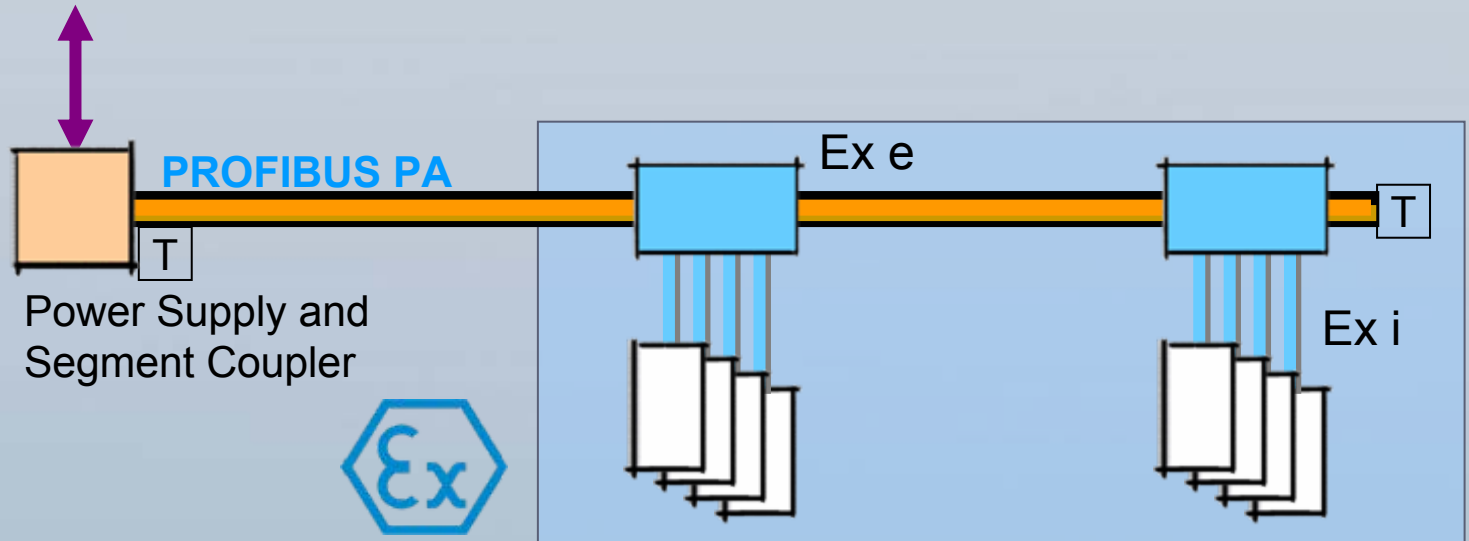
Prerequisits for the High-Power Trunk

$U_0 \leq U_i$

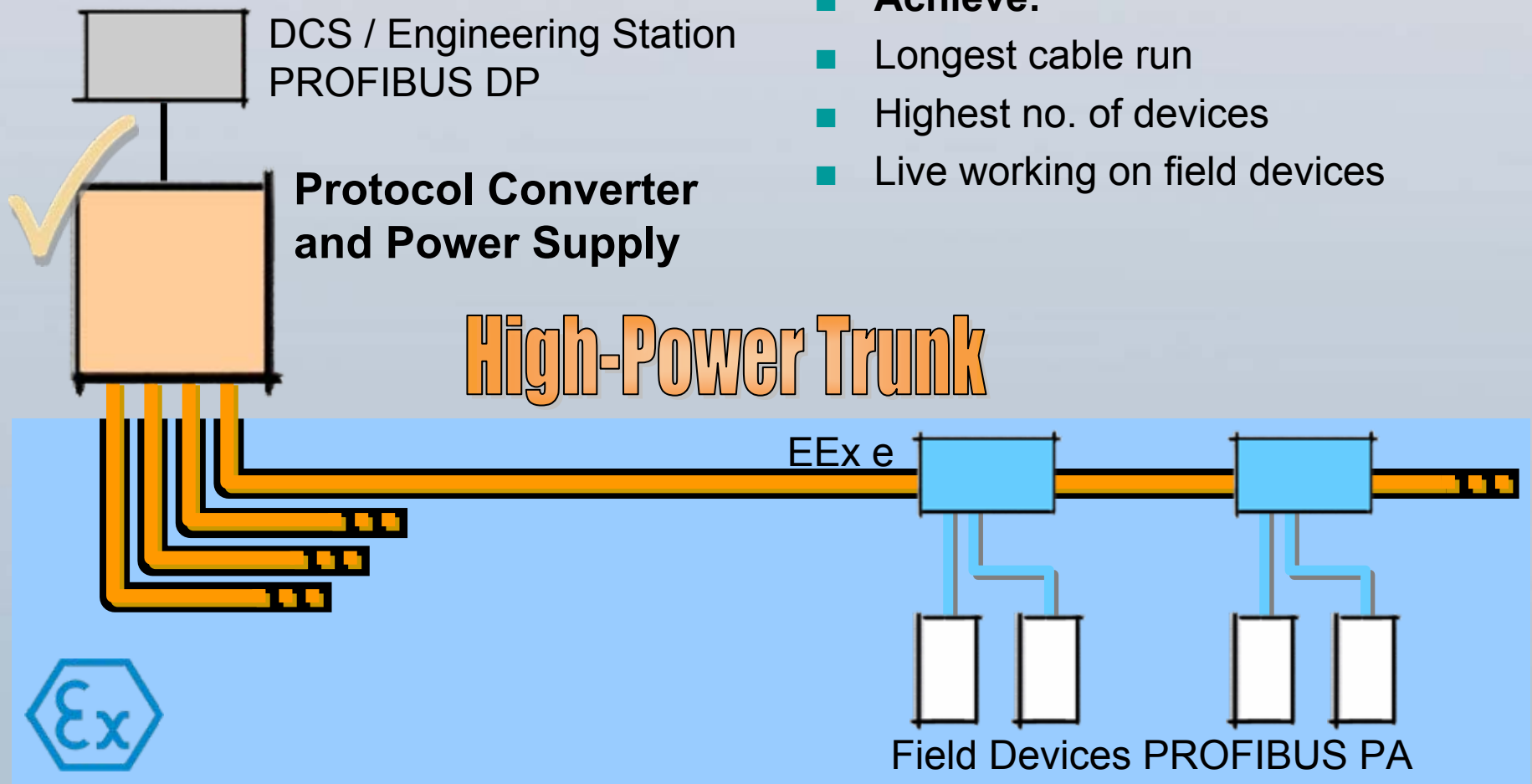
$I_0 \leq I_i$

$P_0 \leq P_i$

- Protected Installation of the Trunk - Ex e
- Active Field Barriers near the devices
  - Spur in intrinsic safety Ex i (Zone 1)
  - One device per Spur
- Validation of Ex protection only once per Spur



Fieldbus in Process Automation



- **Achieve:**
- Longest cable run
- Highest no. of devices
- Live working on field devices

Power Hub for PROFIBUS

FieldConnex

- Gateway for PROFIBUS DP/PA
- Power supply for field devices
- Four independent fieldbus segments
- Redundancy selectable for
  - Gateway and
  - Power Modules
- Motherboard-based design
- Choice of power supplies
- Transparent behavior –
  No configuration required
- Installation in Zone 2
- Advanced Diagnostics

3rd Generation Segment Coupler: Redundant Configuration

ADVANCED DIAGNOSTICS

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PROFIBUS Power Hub – Gateway

- Couples PROFIBUS DP with PA
- PROFIBUS DP:
  - 45.45 kbps … 12 Mbps
  - Automatically adapts to speed
- Data buffer for cyclic data exchange
- Transparent: Responds to DP-Master as respective field device
- PROFIBUS PA:
  - Independent Master-cycle
  - One master per segment, fast
- No configuration required
- **Fast, Efficient and Transparent**

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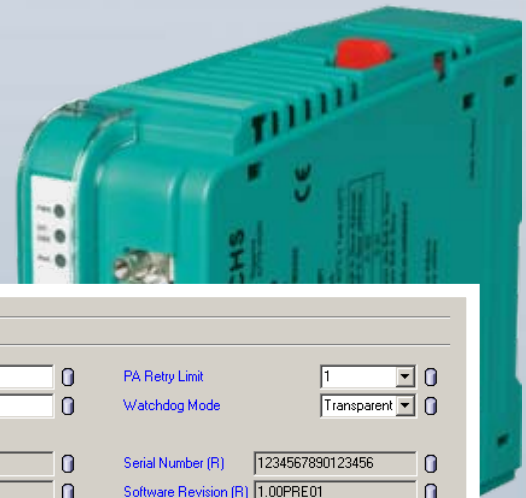
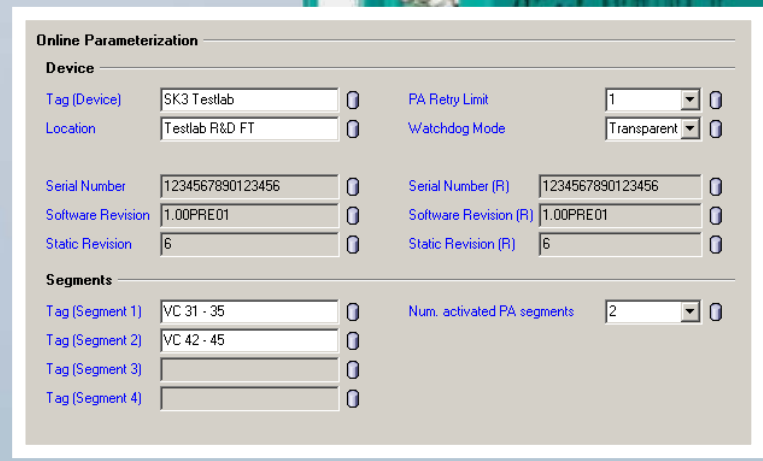
PROFIBUS Power Hub – Gateway DTM

- Gateway Diagnostics & Configuration
- Duplicate address detection
- Self-supervision
- Status of redundant gateways
- PA-Master configuration (Timing)





Screenshot: Gateway DTM

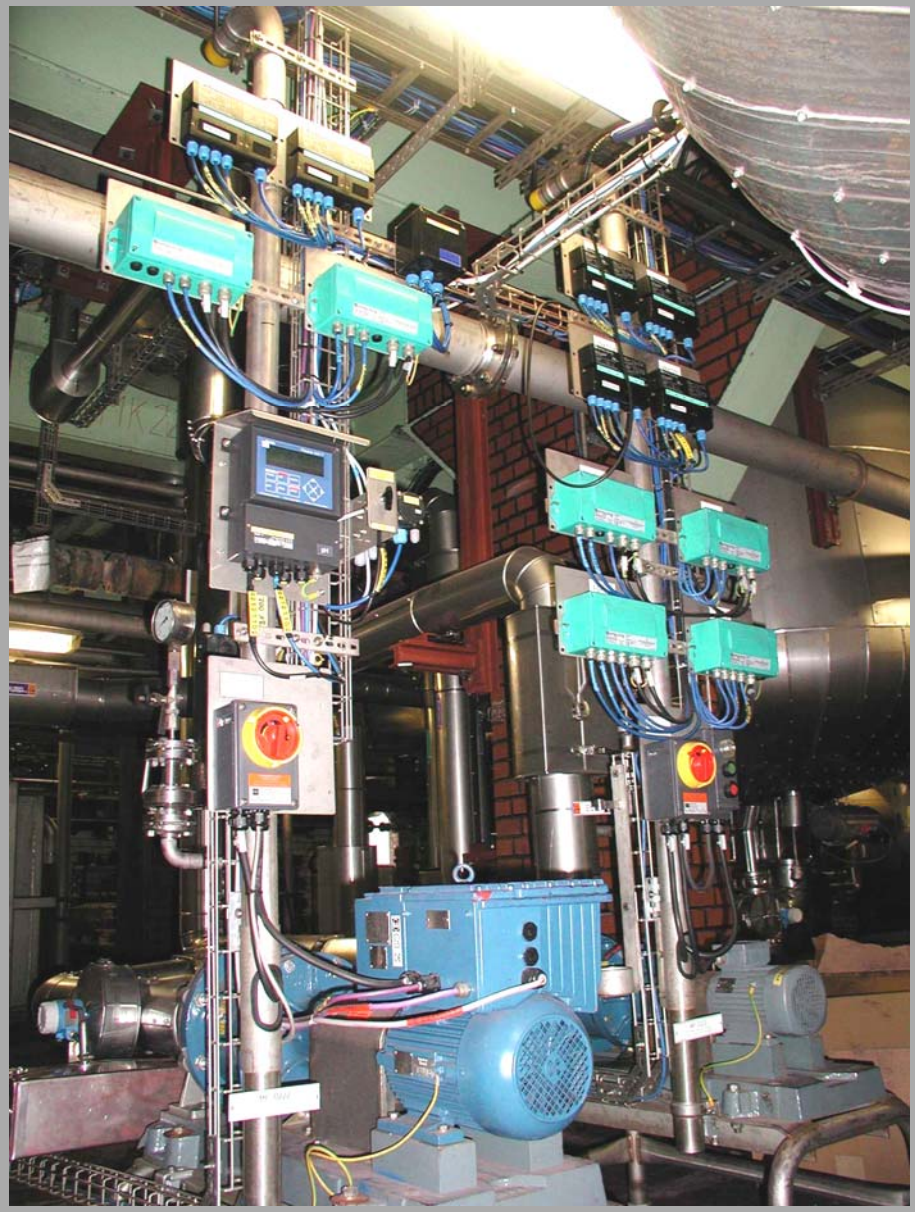
PROFIBUS Power Hub – Redundancy

- Selectable for:
- Gateway Modules
- Power Modules
- Features for reliable operation:
- Live exchange of modules
- Indication of redundancy status
- Consistency check for matching Power Modules
- Bumpless switchover

3rd Generation Segment Coupler: Redundant Configuration

Example: O 810, BASF Ludwigshafen

Example: Rubin-Rot, Clariant IP Hoechst



Availability

Fieldbus is very available.

How components contribute to availability

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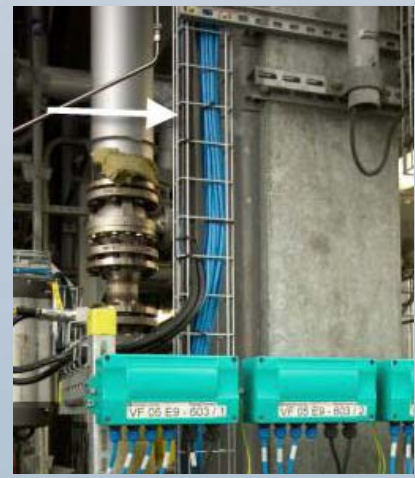
Contribution to overall System Availability

- Power Supplies
  - Electronic components
  - Redundancy often desired

- Cable
  - Protected installation: Armored cable, trays, …
  - Redundancy often *very* expensive
  - Least contribution to plant availability



Contribution to overall System Availability

- FieldBarrier
  - Short circuit protection for the Trunk
  - Galvanic isolation
  - Intrinsic safety

- Fieldbus Termination
  - Influences data transmission quality
  - Redundancy not possible – use high-availability design

- Field instruments
  - Most valuable component
  - Redundancy used very selectivly

Diagnostics

Take control of your fieldbus

New tools bring clearity and supervision

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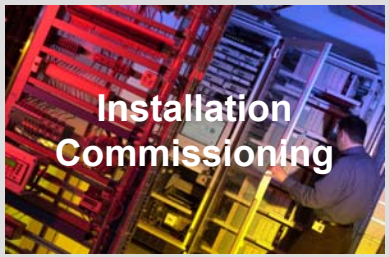
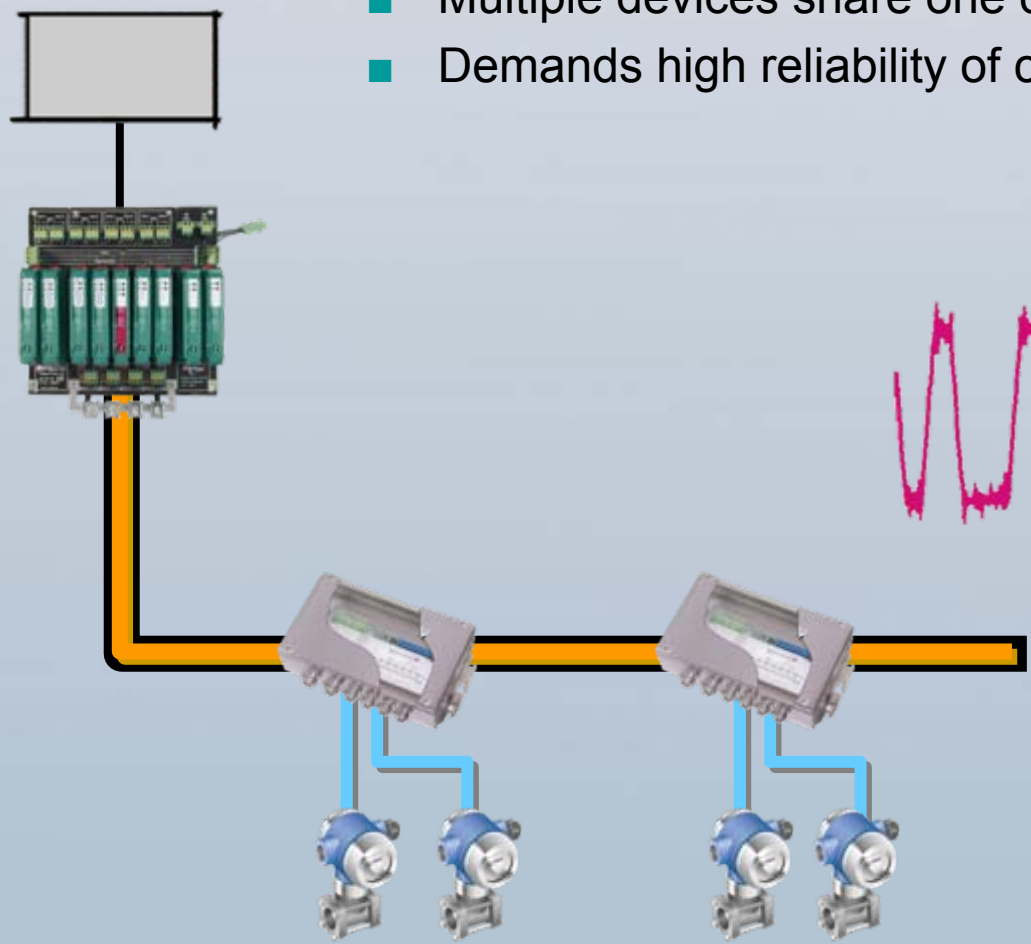
Fieldbus Advanced Diagnostics

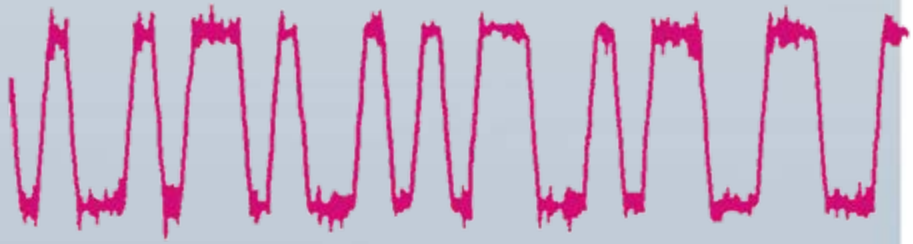


- Why?
  - Simplifies planing
  - Reduces Commissioning Time and Effort
  - Increases Plant Availability
  - Enables proactive Maintenance
- When? During …
  - Installation and Commissioning
  - Operation and Maintenance
  - Troubleshooting
- How?
  - Simple to use on screen
  - Easy to understand displays
  - Online in real time
  - At the maintenance station

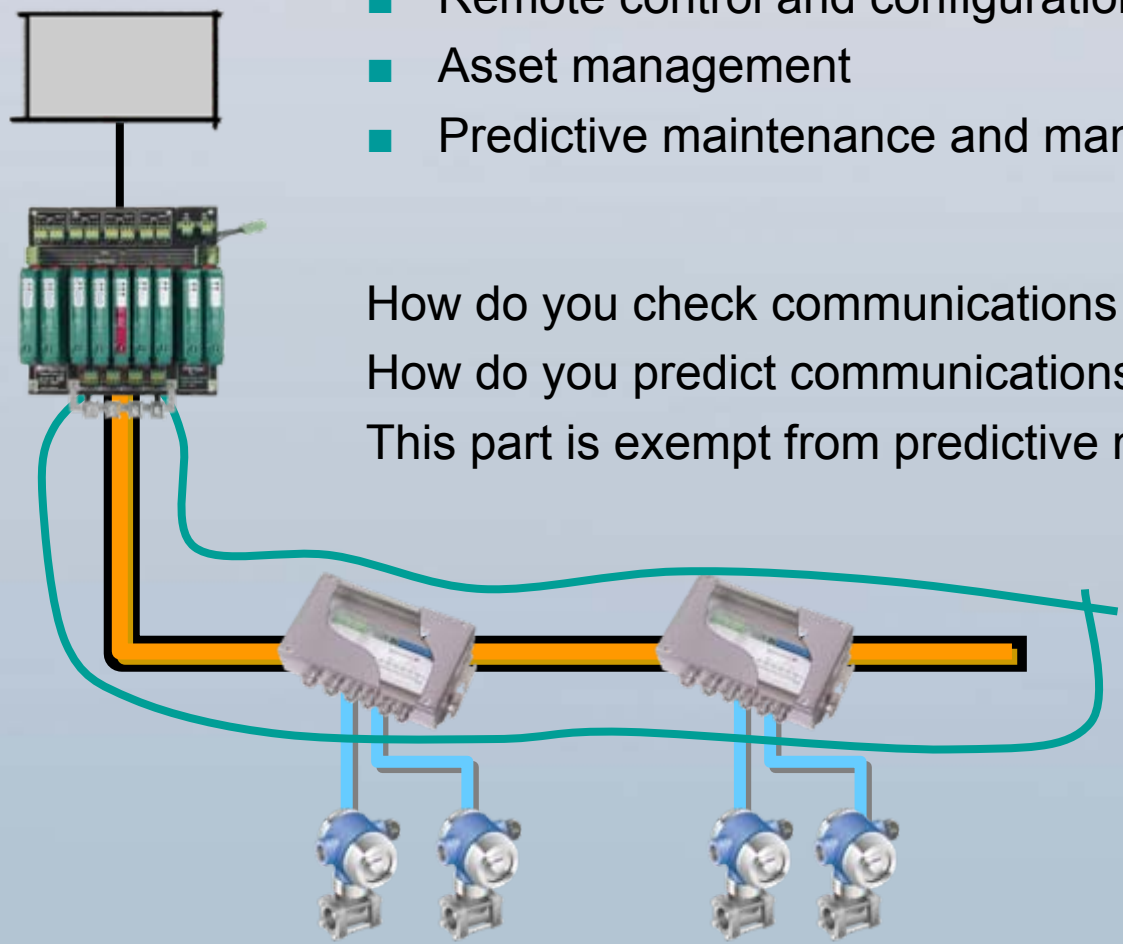
Fieldbus – Smart supervision in the field

- Multiple devices share one cable
- Demands high reliability of communication





Fieldbus – The reasons you use it



- Remote control and configuration
- Asset management
- Predictive maintenance and many more…

How do you check communications quality?
How do you predict communications availability?
This part is exempt from predictive maintenance!

Typical issues …

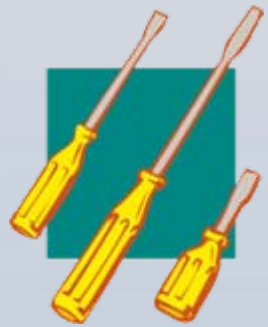
- Installation and commissioning

✓Wiring & shorts!

✓Proper termination!

✓Device polarity!

✓Unexpected device behavior!



- Operation – Great to detect from remote

✓Electro-magnetic interference!

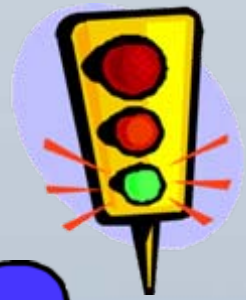
✓Degrading insulation!

✓Corrosion changes resistance!

✓Water ingress!

✓System modifications!

✓Out of spec behavior!



- Troubleshooting – It would be nice to…

✓measure before going in the field!

✓ask an expert that is remote!

✓have an oscilloscope handy!

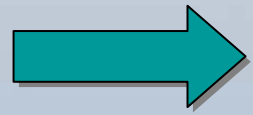
Typical Faults

- Configuration data
- Parametrization
- Bus Timing

Logical Causes

Display and evaluation via Online-Diagnostic-Tool

- Defective Devices
- Improper termination
- Bad installation of cable
- Cable not qualified for use
- Power Supply faults
- Duplicate addressing



Physical Layer

Fieldbus Advanced Diagnostics brings Clearity and Operational Efficiency

Measurements Tools of the Trade	Multi-meter	Handheld Tester	Handheld Commu-nicator	Oscillo-scope	Note-book Bus Analyzer	Advanced Diagnostic Module
Segment voltage	●	●	●	●		✓
Segment current	◙					✓
Segment noise (low freq.)		●	●	●		✓
Segment noise (high freq.)				●		✓
Segment signal level		●	●	●		✓
Segment signal jitter		●				✓
Instrument signal level		=				✓
Instrument signal jitter						✓
Instrument noise (individual)						✓
Fieldbus termination		=	=	●		✓
Segment earth fault (imbalance)						✓
Device communication			●		●	✓
Communication faults					●	✓
Cable degradation (trending)						✓
Device configuration			●		●	
Remote access						✓

● Supported = Result incomplete ◙ Requires shutdown ✓ Fully supported

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The Advanced Diagnostic Module

- Installation and con
  - ✓Pr & shorts!
  - ✓Device polarity!
  - havior!
- Operation – Great t
  - ✓Electro-magnetic interfe g insulation!
  - ✓Corrosion r ingress!
  - ✓System modificatic
- Troubleshooting – I
  - ✓ask an expert that is remote he field!
  - ✓have an oscilloscope handy!

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PROTECTING YOUR PROCESS

FieldConnex Advanced Diagnostic Module

A single tool for commissioning, monitoring, and troubleshooting

The only tool that delivers actionable information

ADVANCED DIAGNOSTICS

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Fieldbus Physical Layer Diagnostics

Therapy

Countermeasure proposals

Prognosis

Prediction based on experience

Diagnostics

Diagnosis, Causes, Judgment

Supervision

Symptoms, Signals

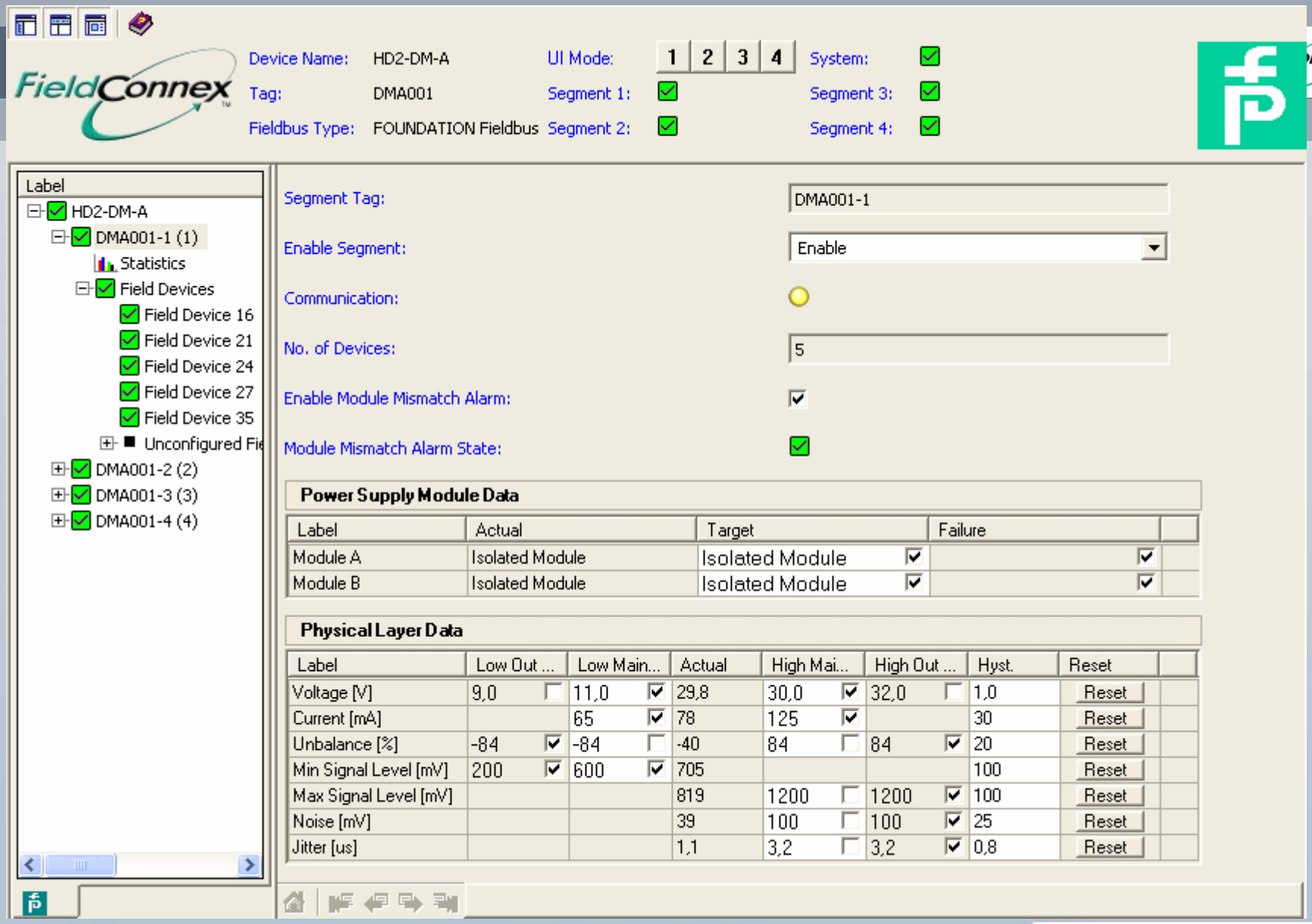
Source: ISO 13374

Fieldbus Physical Layer Health Information

Display, Archive

USER

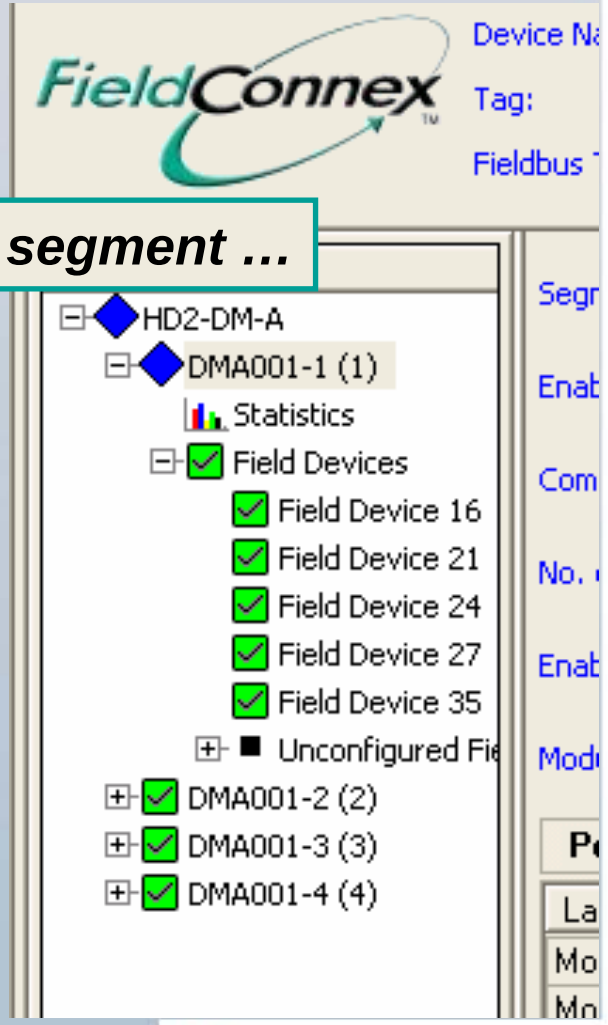
Plant Manager
Maintenance
Engineering
Operator
Engineering
Asset Specialist
...



Save time during commissioning

- Cable checkout
  - Accurate voltage level
  - Proper termination
  - Isolation to ground
- Accelarated field device validation
  - Signal quality and strength
  - Jitter
- Automatically generate documentation

per device and segment …



Physical Layer Data

Label	Low Out ...	Low Main...	Actual	High Mai..
Voltage [V]	9,0 ☐	11,0 ☑	29,8	30,0
Current [mA]		65 ☑	78	125
Unbalance [%]	-84 ☑	-84 ☐	-40	84
Min Signal Level [mV]	200 ☑	600 ☑	476	
Max Signal Level [mV]			554	1200
Noise [mV]			29	100
Jitter [us]			0,9	3,2

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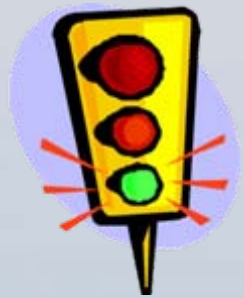
PROTECTING YOUR PROCESS

Reliable operation – increased uptime

- Snapshot establishes baseline
- Configurable alarming
- Longterm trending
- Predicts data availability
- Enables proactive maintenance



1268			100	Reset
1418	1200 ☐	1200 ☑	100	Reset
49	100 ☐	100 ☑	25	Reset
2,2	3,2 ☐	3,2 ☑	0,8	Reset

Communication hasn‘t failed yet …

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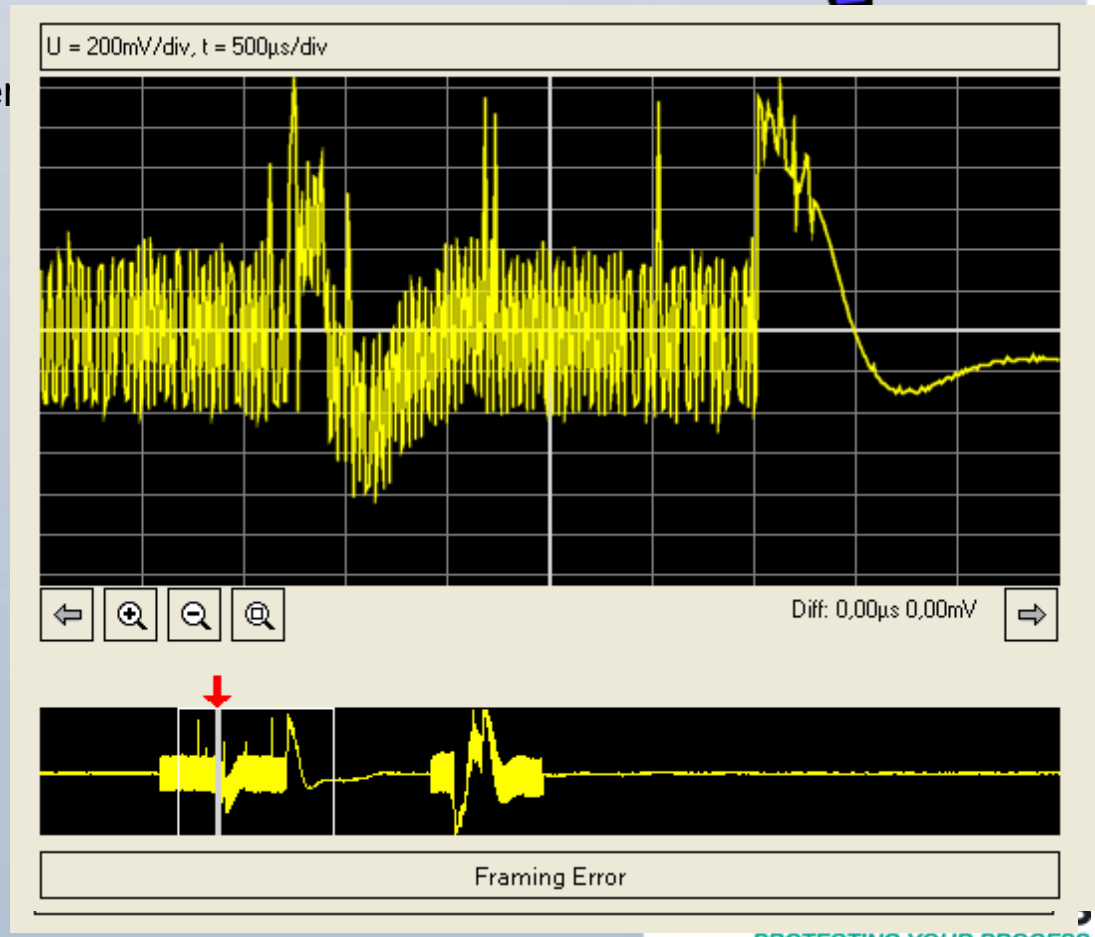
PROTECTING YOUR PROCESS

Targeted Troubleshooting

- Fastest time to repair
- Remote access for
  - Maintenance planning
  - Assistance by fieldbus exper
- Oscilloscope function
  - Various triggers
  - Visual signal inspection
- Pinpoints trouble spot



Advanced Diagnostics – a great investment

- Energize fieldbus activities for
  - Commissioning
  - Operation
  - Troubleshooting
- Educated decisions with knowledge about your fieldbus

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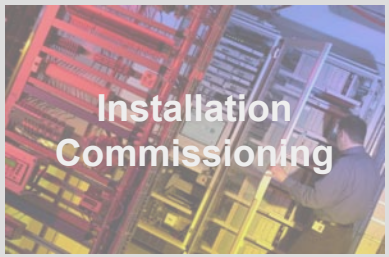
PROTECTING YOUR PROCESS

Usage of Advanced Diagnostics



- Validation…
  - Installation
  - Configuration
  - Consistency check: Planing = Installation
- During Operation
  - Permanent monitoring of the physical layer
  - Trouble shooting
  - Diagnostic messages on fieldbus
- Maintenance and Repair
  - Automatic Documentation
  - Re-Validation
  - Statistics: CRC or framing errors

Summary

- Fieldbus technology reduces effort in every phase of a project
- Fieldbus is established as reliable technology
- Power Supply in the Ex-Zone is simple
- Advanced Diagnostic Tools bring transparency and simplicity
- Fieldbus itself is now an Asset in plant management