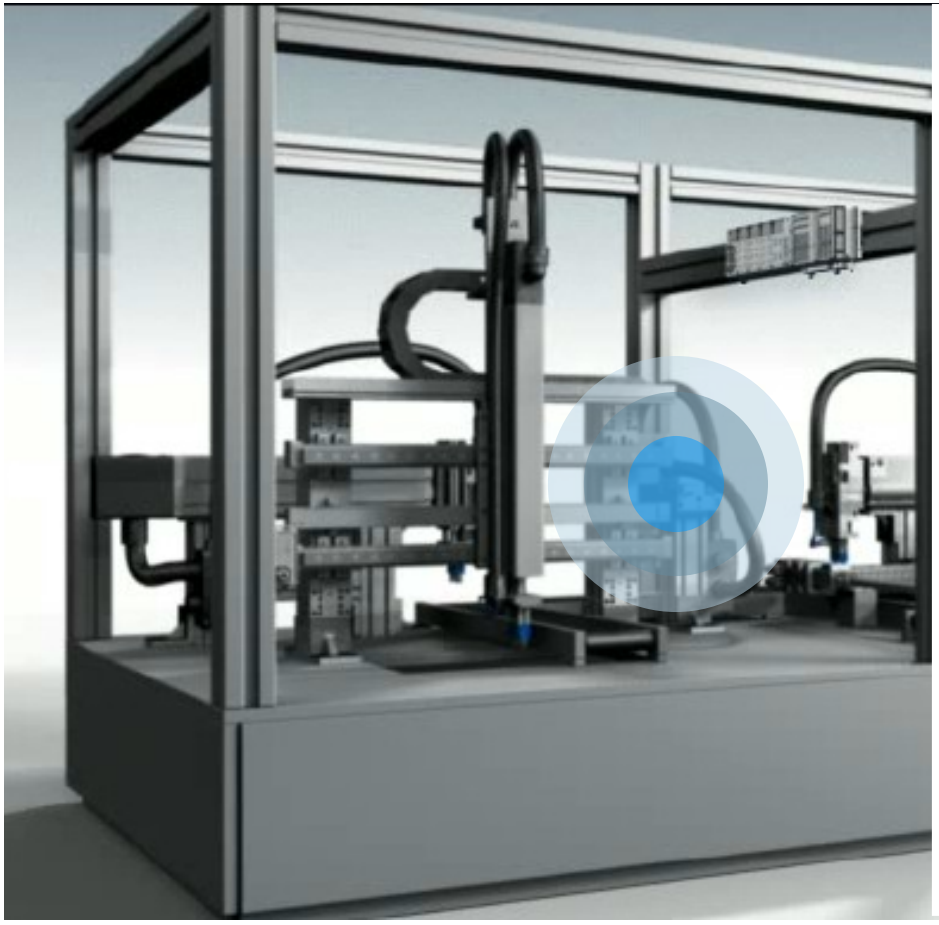
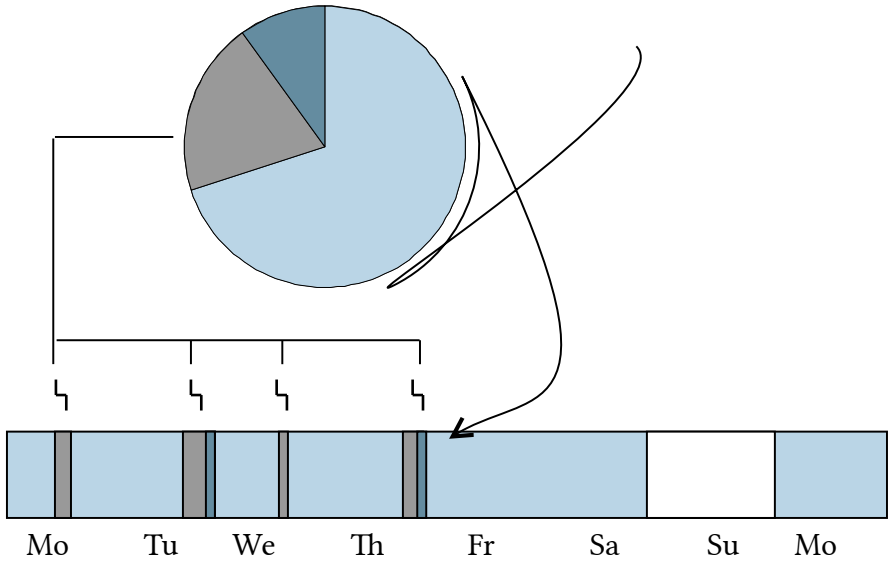
Diagnostic of pneumatic controlled plants - Targets



Optimization of machines and plants

- Minimization of machine down time because of fast fault detection and fast repair
- Record of fault reasons in a quality control system. Realisation of continuous improvement in process reliability.

Target of diagnostics



Normal production

Unplanned downtime because of faults

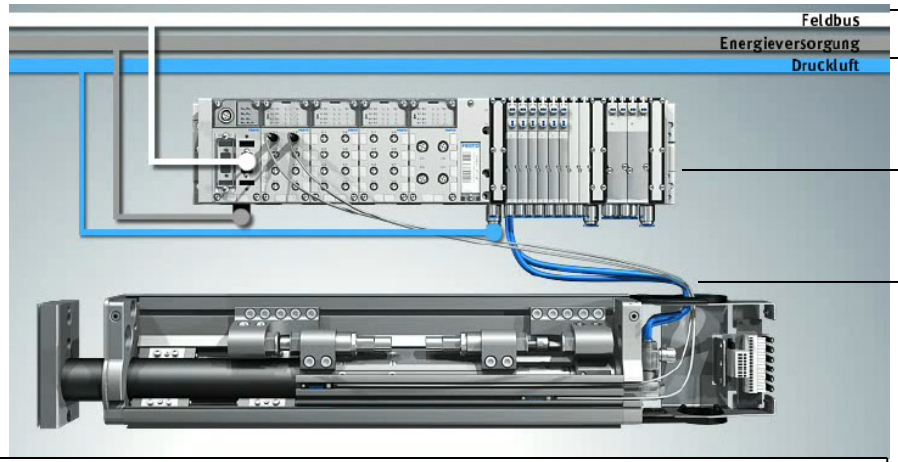
Potential because of diagnostics

Planned downtime

Especially for

- Plants with a need for high reliability.
- I.e. 3 shift production facility.
- I.e. bottling lines.
- Plants with service contracts and remote maintenance

Classification of fault reasons



Communication error

- Fieldbus cut
- Communication errors

Energy supply

- Power supply switched off or not stable
- Compressed air switched off or not stable

Module error

- Module broken
- Internal connection error

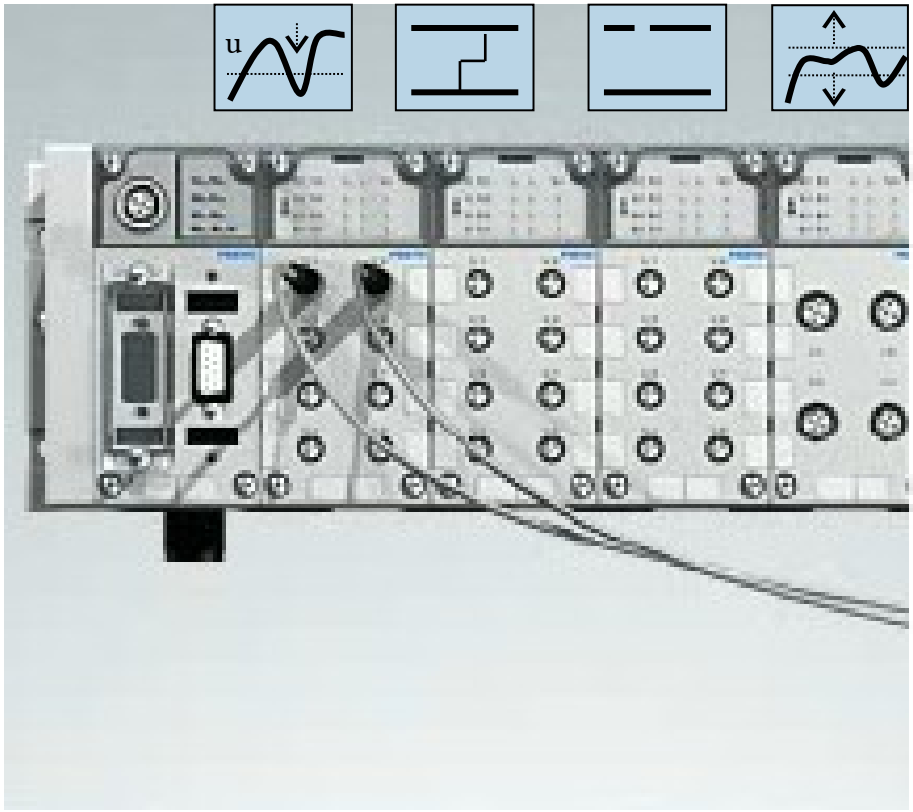
Sensor – actuator error

- Fractured wires
- Connected sensors or actuators faulty

Process errors

- Cycle time errors
- Contact errors i.e. proximity switch errors

Sensor and actuator errors



Record of fault reasons of the connected lines and

connected sensors and actuators

Modules

- Under voltage

Modules & channels

- Short circuit, overload
- Open circuit
- Limit value control
- ...

Valve Errors

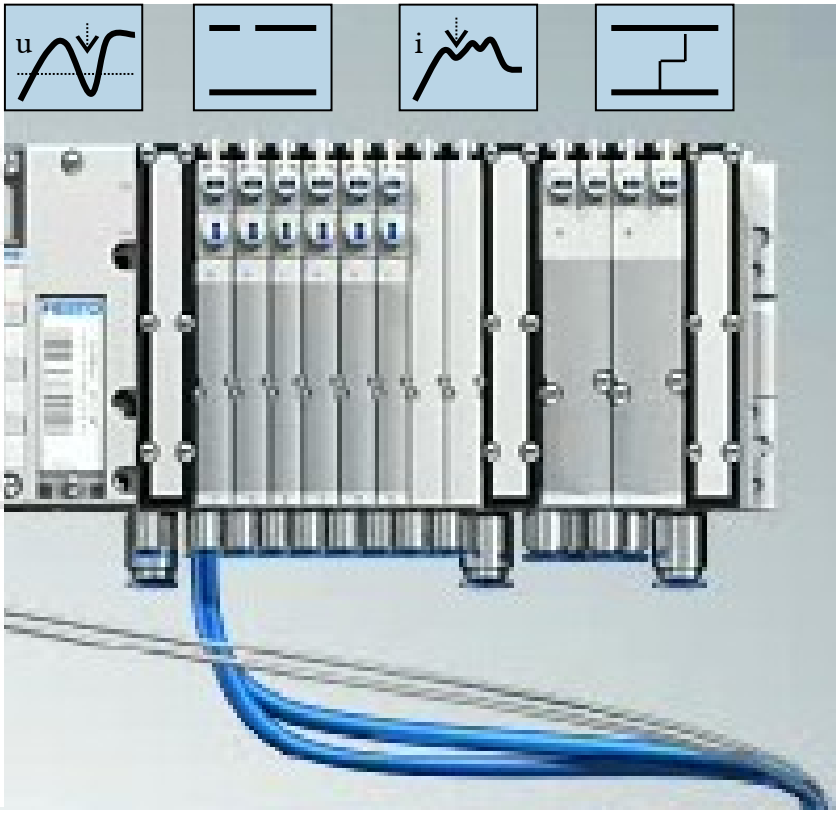
Record of fault reasons for the tubes and valves

Modules

- Under voltage of the valves

Modules & channels

- Short circuit
- Open circuit
- Monitoring of the valves
- Condition Counters
- Manual override engaged
- …



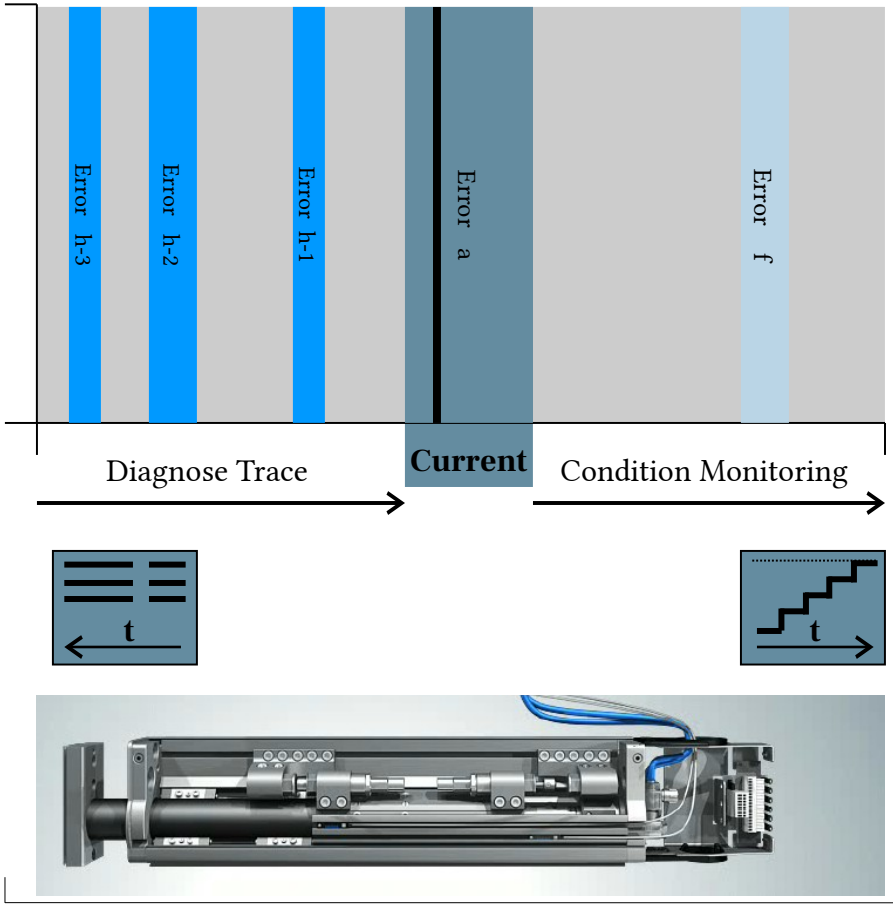
Diagnostics - Overview

No diagnostic

Diagnostics

	DIGITAL IN	DIGITAL OUT	Analogue IN	ANALOGUE OUT	Pneumatics
Low Voltage	■	■	■	■	■
Short Circuit – Signal		■	■	■	■
Short Circuit - Supply	■		■	■	■
Open Circuit			■	■	■
Lower Limit Value			■	■	
Upper Limit Value			■	■	
Parameterisation error			■	■	
Condition Monitoring					■
Monitor Plunger Control					■

Integrated diagnostic concept



Analyse and detection of fault reasons in the past

- Record of the last 40 messages with a time stamp.
- Reduce down time , faster fault detection of sporadic malfunctions
- Capture intermittent errors

Preventive maintenance for better reliability

- Condition counter records switching cycles of connected actuators, process valves or other mechanical devices.
- Monitoring of the reference values
- Channel-wise visualisation via LED
- Replacement of critical parts before a error happens

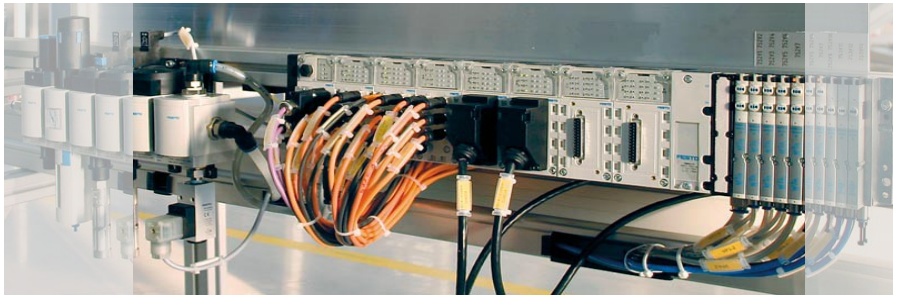
Diagnostic on site

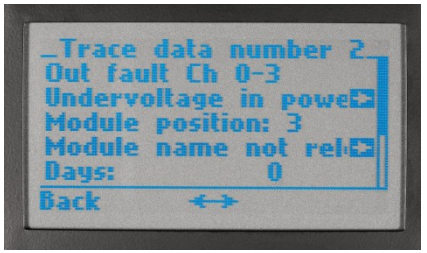
LED‘s on site

- Status of modules and channels plus LED for errors and error reasons (i.e. under voltage)
- For I/O‘s AND valves

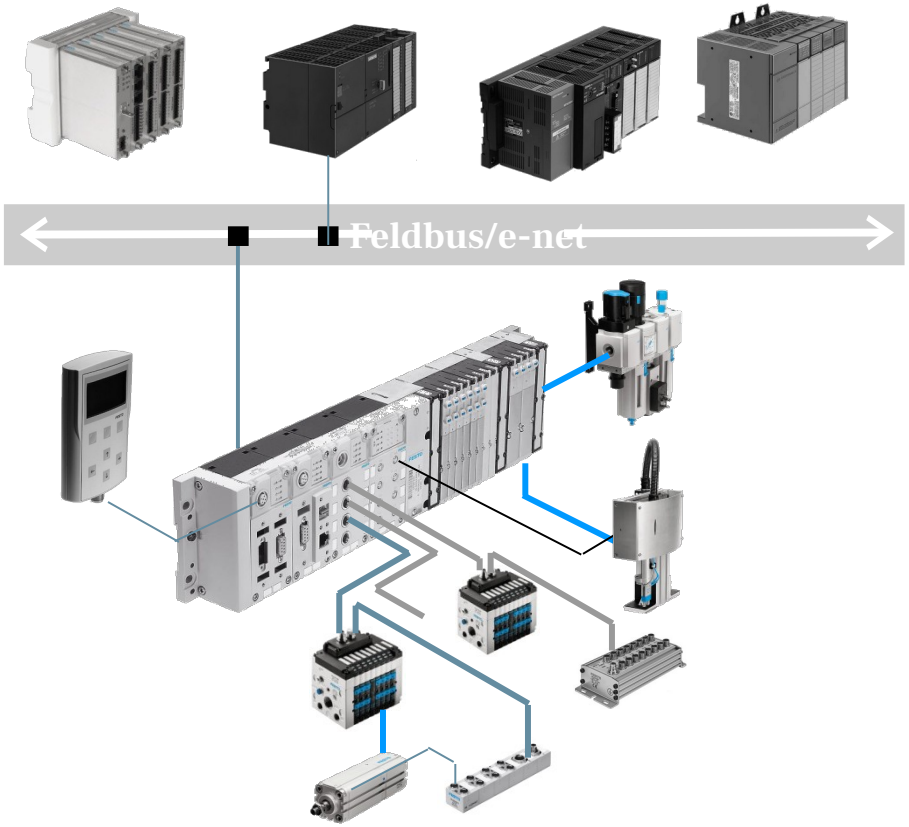
HMI systems on site

- Handheld shows current errors and diagnostic trace. NO engineering work to do !
- Plug & Work because of UPLOAD of ALL data from CPX system





Diagnostic in a Fieldbus/Ethernet system

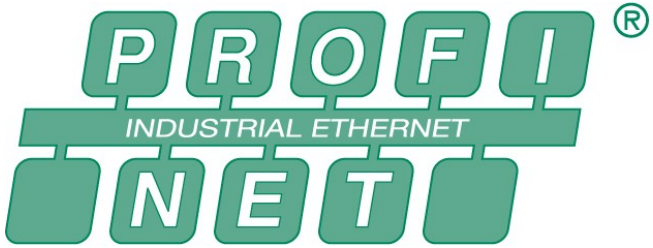


Central diagnostic in a host environmental

- Fieldbus enabled diagnostic of device and peripheral errors. Easy Integration in run time software of control system

- Diagnostic-Trace and further asset management Data will communicated acyclic

Industrial Ethernet communication technology

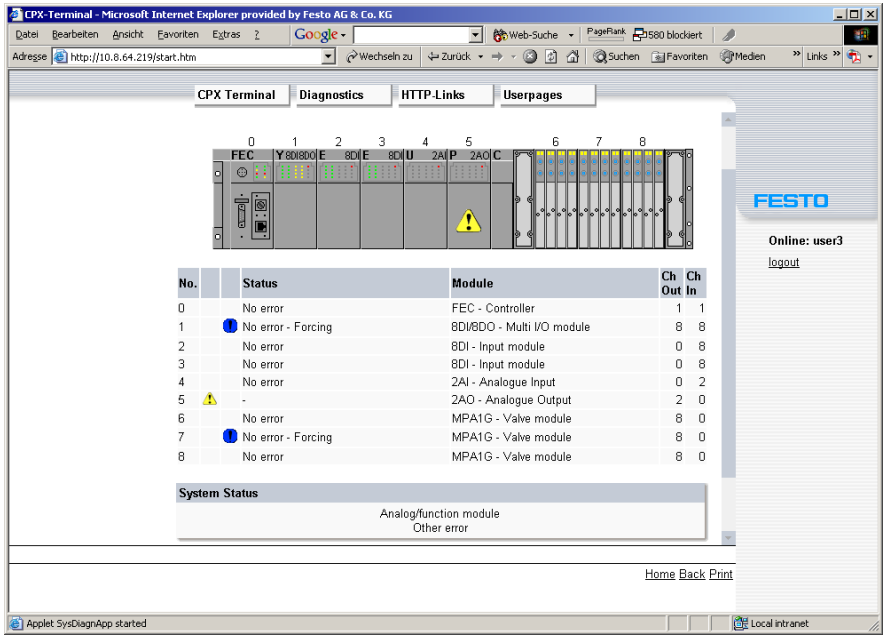


MODBUS/TCP

To adopt the conditions of industrial networks, like real-time and high reliability, to ethernet based installations, new communication protocols have been created

- **Ethernet/IP**
  An encapsulated protocol defined by the organization ODVA (Rockwell Automation)
- **ProfiNet**
  A communication protocol with integrated engineering concepts. Uses self-defined data access concepts in the first OSI layers. Org. is PNO (Siemens)
- **MODBUS/TCP**
  Encapsulation of the MODBUS protocol. Org. is Modbus-IDA (Schneider Electric)

Industrial Ethernet brings Diagnostics Via The Internet



Valve terminals with integrated IT-services

- Web server for integration of browser based device and process visualizations.
- Setting up of email-alarms with the Web Monitor
- Direct connection with parameter and diagnostic tools via the intranet

Diagnostic of a machine in the future

-

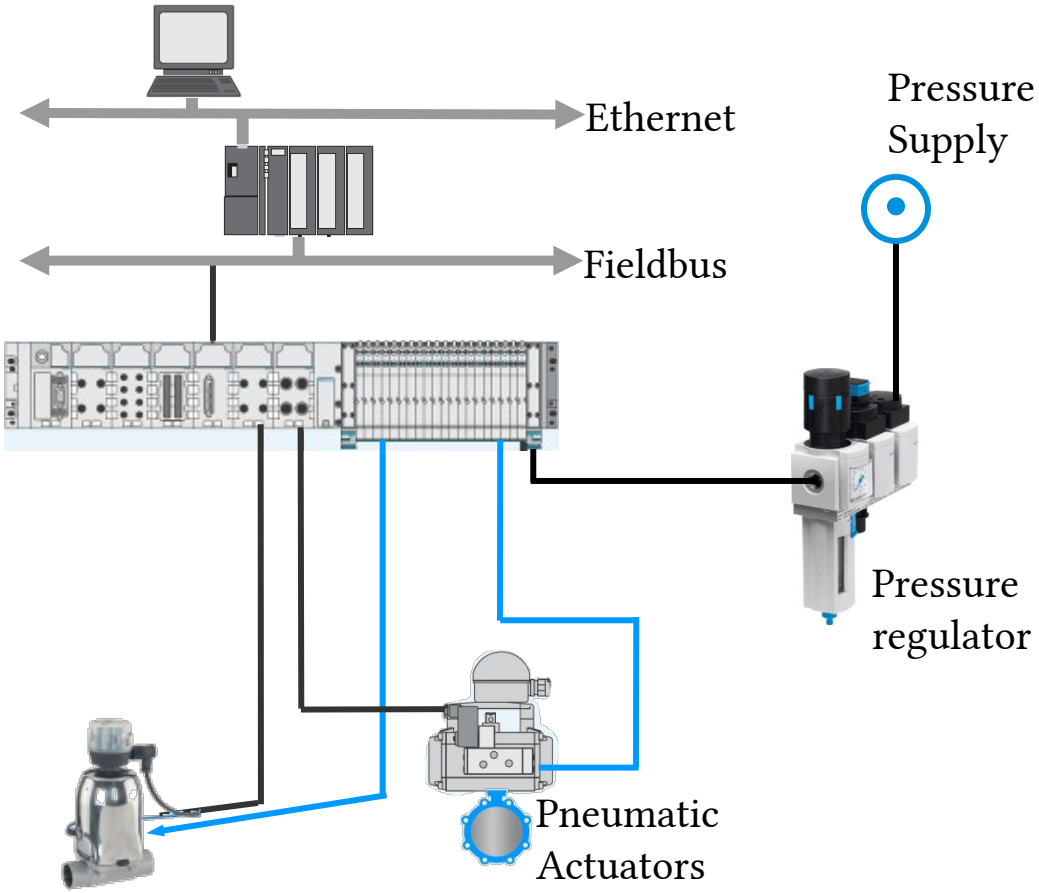
The first thing that comes to mind when I think about **diagnostics** is . . .

Does diagnostics mean to…

- know when the machine or process is no longer working?
- receive a message when the system is down?
- be able to read the process parameters?
- to have some red or green coloured status LED on the components?

➔ We think that diagnostics is much more…

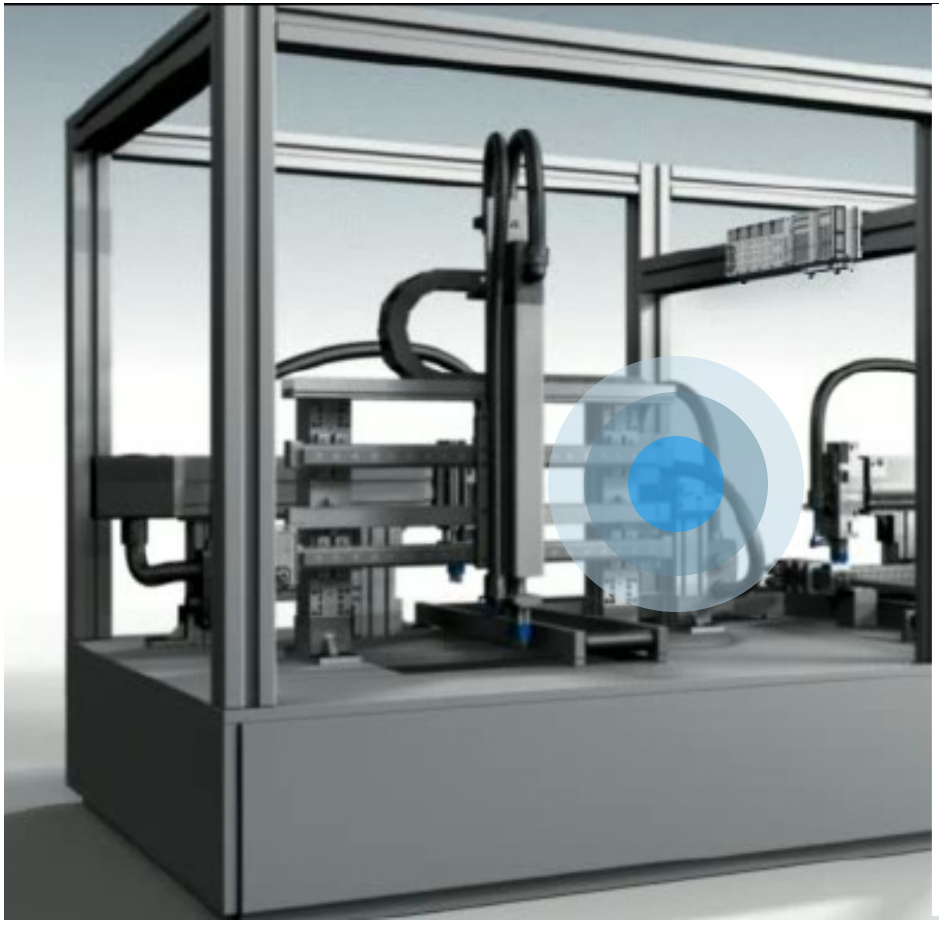
What a pneumatic control system consists of



Result of Malfunction:

- no or wrong product flow
- wrong process time
- low performance
- avoidable accident
- poor product quality
- ...

Diagnostics for pneumatic systems



Condition Monitoring- and Diagnostic Systems collect and interpret condition information of machines.

Process-parameter

Machine-parameter

PN **H Y** **EL**

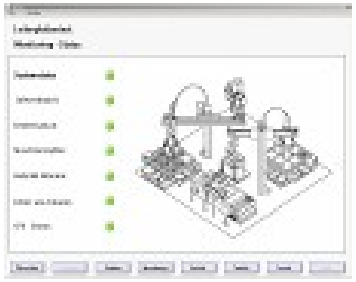
Mechanics

Objective is the timely recognition of:

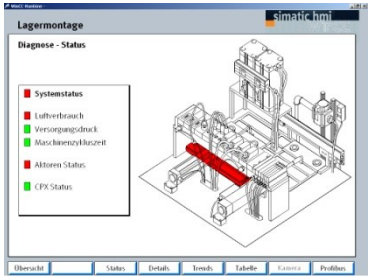
- machine failure,
- malfunction,
- wear,
- increased energy consumption.

Overview of Diagnostic Functions

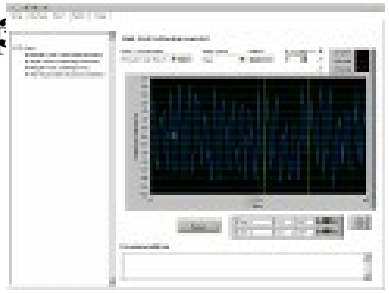
Level 1 - Simple monitoring functions (F1)
- Examples: counting functions and cycle times
- Monitoring of important basic units (pressure, volumetric flow rate, temperature)
- Electrical parameters (voltage, wiring)



Level 2 - System diagnostics (error localization) (F2)
- Using available sensors
- Using model-based approaches (detects e.g. leakage in drive systems xyz)

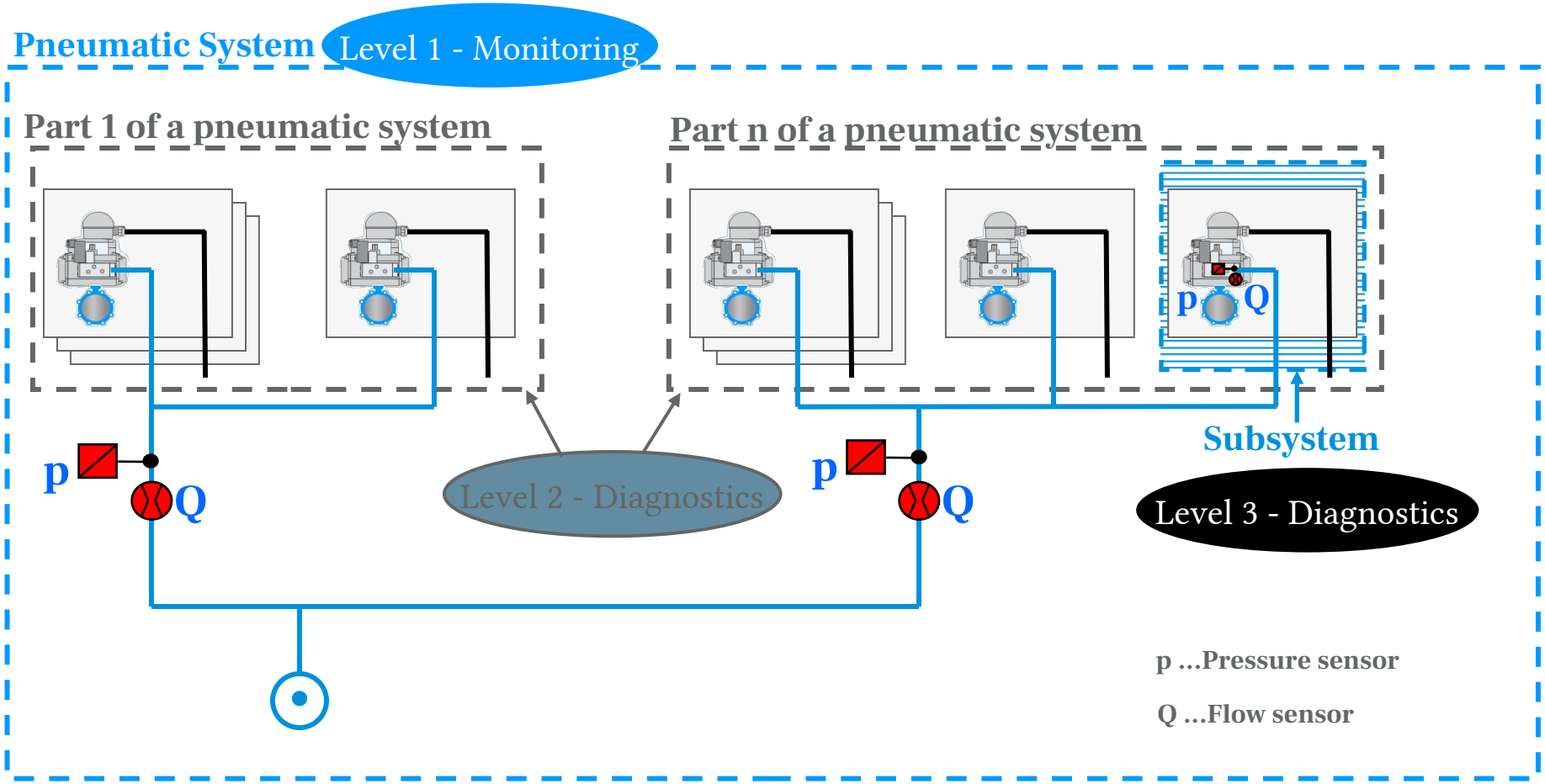


Level 3 - Subsystem diagnostics (error identification) (F
- Defect in the component, e.g. flow control valve, valve
- Type of defect, e.g. leakage, restriction of flow, load or friction changes, switching errors



Increasing depth of diagnostics

Condition monitoring and diagnostics of a pneumatic system



Integral diagnostic concept

Diagnostics level

Level 1 - Monitoring

Diagnostics based on electrical signals
and on pressure (p) / flow(Q) values

Monitoring functions

- Short-circuit
- Cable break
- Under voltage

+ programming
(specific application)

- Pressure
- Flow

- Cycle times
- Counting functions (valves/drives)

components	
	valve terminals
	sensors
	limit switches

Integral diagnostic concept

Diagnostics level

Level 2 - Diagnostics

System diagnostics (error localization) for parts of pn. systems or subsystems

Diagnostics based on standard comparisons of limit values
+ Diagnostics based on math. / physical models of pneumatic drives

Future

components

Diagnostics Controller

Diagnostic Software

Integral diagnostic concept

Diagnostics level

Level 3 - Diagnostics

Diagnostics within a Subsystem

Diagnostics based on standard comparisons of limit values
+ Diagnostics based on math. / physical models of pneumatic drives

Future

components

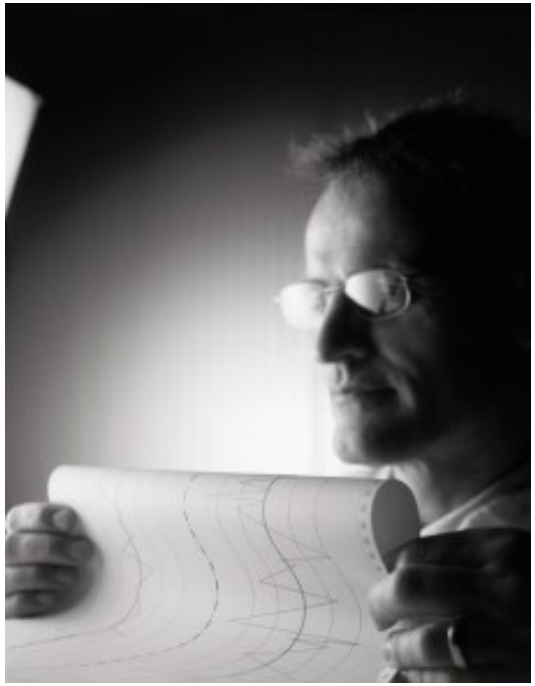
Diagnostics Controller

Diagnostic Software

Summary - Added value for your plant

Manufacturing operations

- Increase uptime of entire systems
- Reduce operating costs & improve productivity



Installation and maintenance

- Decrease troubleshooting time of systems
- Shorten setting-up operation time

System design

- Extend monitoring/control capabilities to critical pneumatic applications