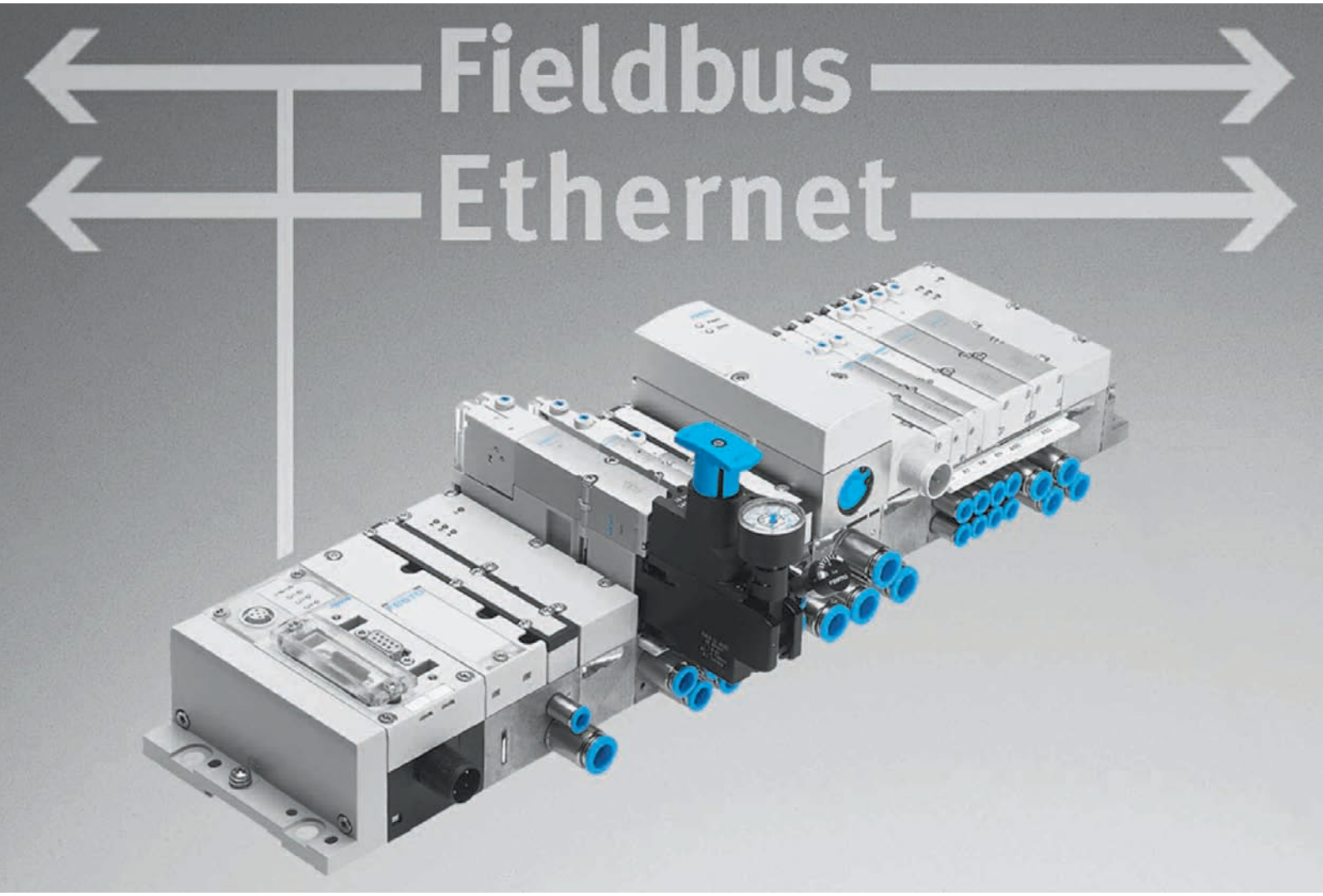
# White paper

## The future role of ethernet and the trend to decentralised control solutions




The driving force behind progress in Industrial automation in the last 10 years has without doubt been the networking of automation products via bus systems. The importance of industrial communication within machines and installations is increasing exponentially as networking is decentralised from its starting point – communication at control system level – through to the connection of front-end devices, sensors and actuators.

Here Uwe Gräff, Head of Business Unit Netware Interface Control at Festo looks at how fieldbus and ethernet solutions will develop in the future and the move away from pre-processing parameterisation to distributed control intelligence.

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# Trends in current product and market developments

While in the previous decade attitudes to the use of bus systems were still very critical, today field bus systems are regarded as a vital part of many applications. They are used in more and more areas. Installation-saving solutions with automation devices equipped with a bus connection are state of the art, while in front-end automation a new class of high-performance products is emerging as a next step to greater efficiency and higher availability. This applies in particular to automation with pneumatics and valve terminals. This development is reflected in new trends and increasing acceptance of automation is more critical applications and is leading to pronounced changes in the design of automation components and systems.

What trends have emerged?
What demands from practical users are generating new trends?

**Industrial EtherNet versus field bus – competitors or partners?**
In the field bus wars in the past decade between the many manufacturer-specific bus systems and the open systems, one thing soon became clear – it is the user who decides.

And the basis for this decision is performance, in particular, user benefit. The primary factor was not technology but the wide choice of field bus devices which were available with all kinds of technological functions, making it possible to achieve a seamless implementation in applications.

The clear winners were the open field bus systems. The installed base of field bus devices is enormous, with over 50 million nodes, and represents a commitment for users in terms of the need to protect the investment made in engineering and know-how.

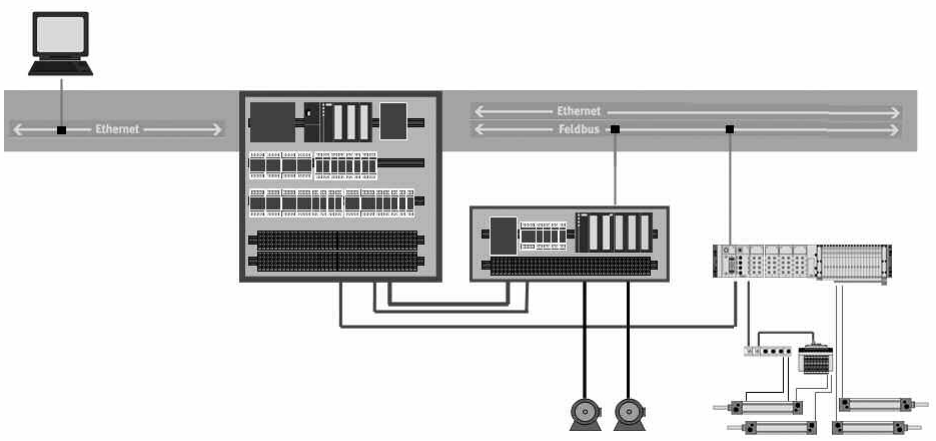



Fig. 1: The main factors with regard to bus systems: Less space in control cabinets, lower costs for wiring

A decade or more ago, industrial Ethernet was associated with the idea of further consolidating the bus landscape, while at the same time lowering interface costs and boosting performance – and making IT services available in the field. A tempting thought – achieving performance standardisation in industrial communication with one Ethernet system.

**Industrial Ethernet versus field bus – competitors or partners?**

| Target | Current situation |
|---|---|
| • One industrial Ethernet protocol | • ≥ 5 relevant Industrial Ethernet protocols. |
| • Use of hardware from consumer and PC areas leads to uniform standardised products. | • Has not occurred: Individual hardware and designs required for each system, little usable electronics from the PC area. |
| • Lower interface costs per device through economies of scale and inexpensive hardware.<br>Vision: Industrial Ethernet in individual sensors/actuators. | • Target missed: Higher prices per interface due to smaller quantities, high-performance electronics and individual design. |
| • Use of IT services in front-end automation devices creates a transparent link to higher-level systems and allows higher volumes of data communication. | • Not yet used: IT services are generally used at the control system level and higher, few projects with IT at field level. |
| • High-performance communication in terms of data volume, speed and synchronicity allows the integration of motion control applications into a network with other field devices. | • Target achieved: Variants with high-speed clock-synchronised data communication in co-existence with standard communication on one bus. |

Fig. 3: Current situation

The original objectives of standardising the communication landscape through the use of industrial Ethernet have not yet been achieved. The large installed base of field bus systems and the high cost of switching to industrial Ethernet is at present a barrier to the replacement of field buses by new system approaches.

However, new possibilities are emerging, and with these a very clear profile and target area for industrial Ethernet. As the result of the trend to ever-faster processes and machine cycle times, motion control applications and the necessary peripheral processes are moving ever closer together. This means potential for industrial Ethernet. Applications of this kind can be based on ProfiNet IRT, EtherNet/IP CIP Synch or even EtherCat.

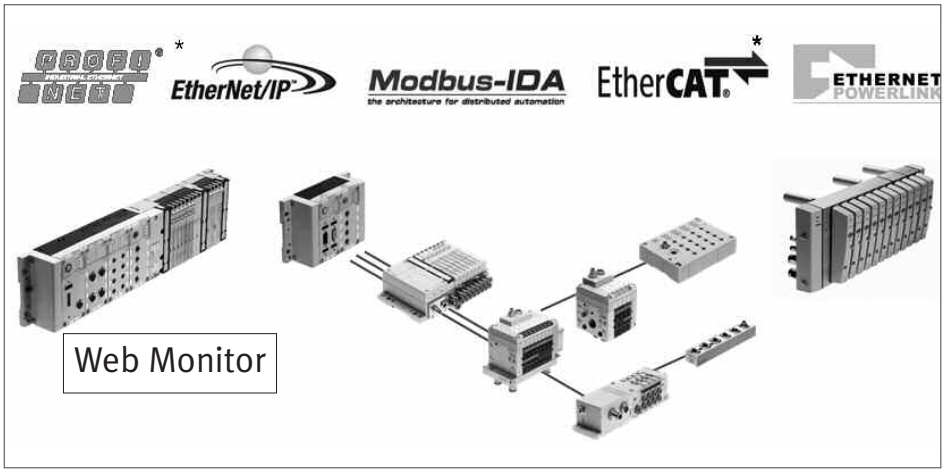



Fig. 4: Festo solutions for industrial Ethernet

**Forecast for the future**
Most simple applications (and most applications are simple) will continue in the future to be equipped with field bus systems. More complex applications – particularly those with a high motion control content – will migrate to industrial EtherNet.

The principle once again applies that users will calculate the costs of migration and investment very carefully and then decide the proportion of industrial Ethernet and field bus on the basis of the benefit (price/performance ratio) for their application. Coexistence of the two systems to cover different applications and customer requirements would therefore seem to be the probable scenario.

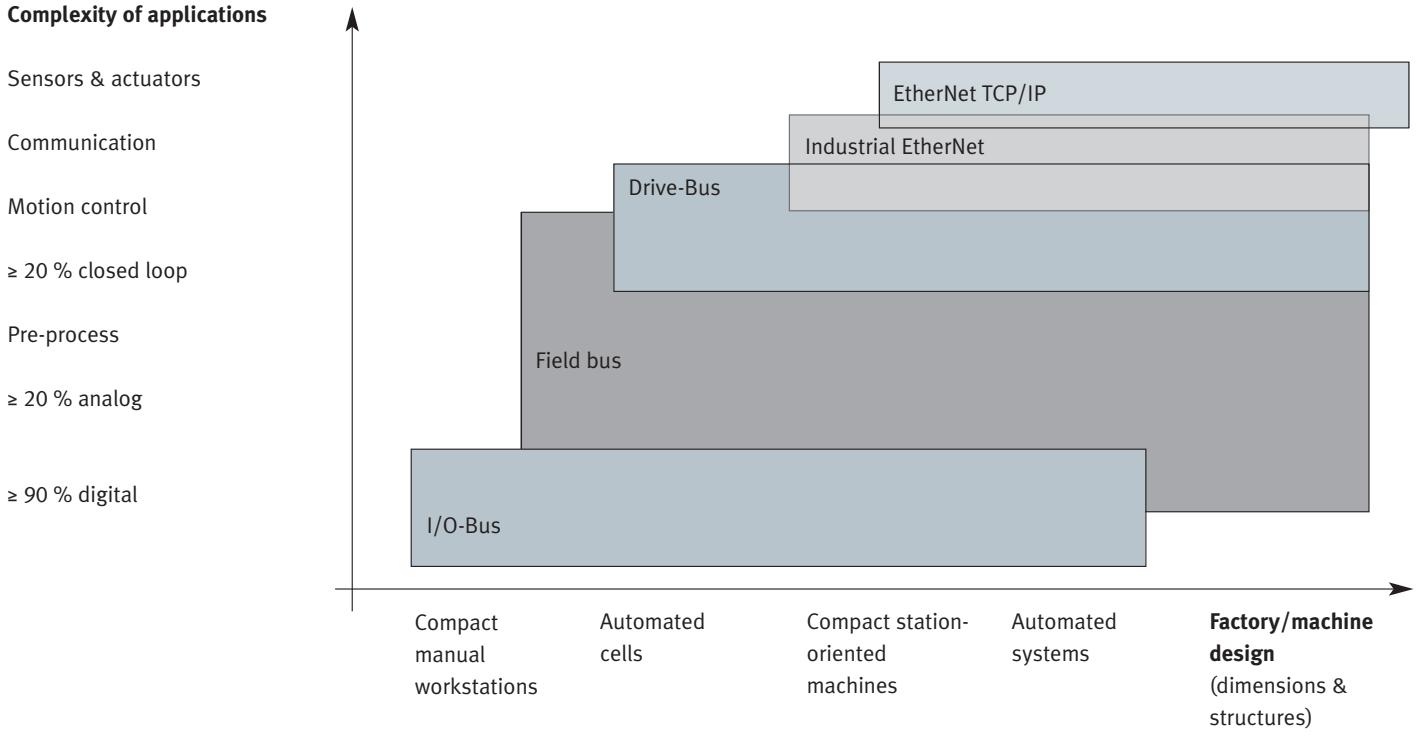



Fig. 5: Positioning and potential of the various bus systems at field bus level

**Distributed control intelligence in a network versus pre-processing parameterisation**

The basic idea and the first move towards decentralisation by means of bus systems was the relocation of the I/Os of the central controller in a control cabinet to de-central terminal boxes. Very soon, the principle was established of direct machine mounting of remote I/O units. A pioneering role was played by Festo valve terminals with the high degree of protection IP65/67. In a second step, more and more peripheral PLC functions were moved to the field level.

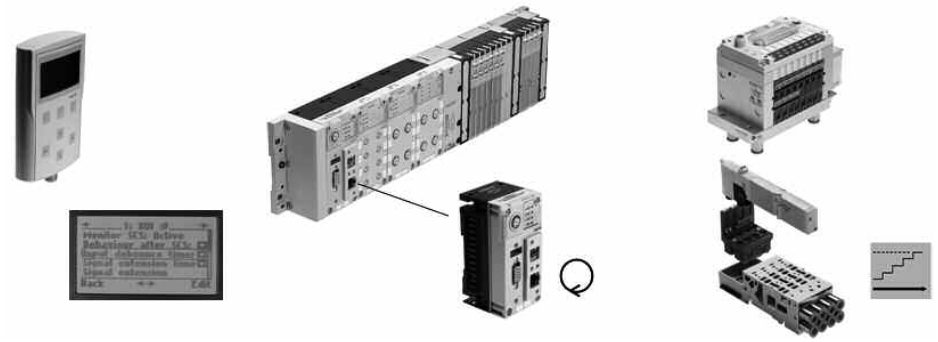
The logical consequence forecast as the third step was the distribution of control system/PLC functions to the field – "The network is the controller" was one of the slogans at the start of this decade.

This much-discussed trend has established itself in only a few applications. The barrier for most users was the increased hardware costs for de-central control logic and the increased engineering costs for the generation and maintenance and management of user programs.

One aspect of "de-central intelligence" has become established, however, namely the increased flexibility of de-central automation devices provided by integrated pre-processing functions. Examples include parameterisable fail-safe functions for outputs, valves and actuators in the case of an interruption of communication in the bus system, or also software-parameterisable limit-value monitoring for analogue sensors and actuators. Function integration has thus established itself as a facet of de-central intelligence.

| Target | Current situation |
|---|---|
| • Distributed networked control logic with central and intelligent programming tools – a neural network | • Some integrated controllers in operator panels, motion controllers, remote I/Os and valve terminals |
| • Replacement of central controller | • Networking with central controller; conventional field bus communication, in certain cases download of user programs via field bus |
| • High availability thanks to programmed fail-safe functions in the de-central control logic | • de-central periphery has parameterisable fail-safe functions and pre-processing function modules |
| • Pre-commissioning of sub-functions and object-oriented user programming | • Is used for discrete sub-functions and linked manual workstations, based on front-end controllers |
| • Benefits to compensate for overhead costs of highly distributed control (see above) | • Price/performance ratio for de-central control logic accepted only for certain applications. |

Fig. 6: Distributed control system structure versus pre-programmed parameter configuration



Setup & service MMI

Front-end controllers and modules with parameters

Valve terminals with status monitoring

Fig. 7: Festo solutions – pre-processing via parameters and controllers

**The changes in customer requirements and the rising demand for de-central installation systems**

As the result of the decentralisation of control system components and their relocation directly next to sensors and actuators, direct machine mounting is becoming every more important.

This development is due to a desire by users to cut wiring installation costs, use pre-assembled cables to further reduce wiring costs, and eliminate the need for a terminal box.

Particularly with regard to triggering a pneumatic control chain, direct machine mounting has clear benefits for users. The closer the triggering unit (the remote I/O or valve terminal) to the actuator, the more the environmental requirements of these front-end components also apply to the control components. Moreover, valve terminals in particular can be used for applications for which users would not previously have considered them.

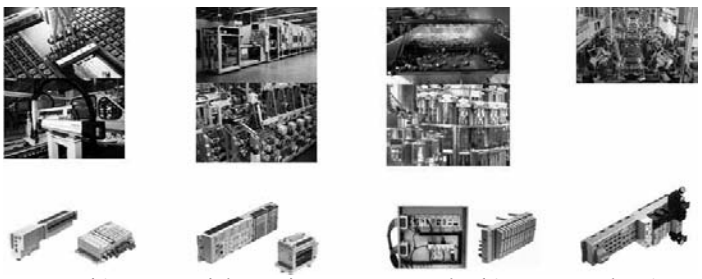
Examples include the following:

- Increased use in automobile body-in-white production directly in very harsh conditions (welding area, vibration and shock load)
- Use in process automation (EX zones, zones subject to standards such as FDA)
- Use in the food industry in splash zones (contamination by food ingredients, and subject to spraying with cleaning agents)

These requirements have led to noticeable changes in customers' demands, particularly in the last year.

Of especial interest, however, is the development of monotechnological units to form multifunctional units. Most interesting of all to users are units which provide complete subfunctions within a machine, and also the technological functions.

A good example of this is the development of the valve terminal to become a hybrid technological terminal. Previously the emphasis was on the triggering of valves via a bus, but now a high level of signal mixture is required for everything from the simple sensing of end positions through to the acquisition of temperature data and the integration of pressure sensors, proportional valves and safety-critical electrical power supply concepts, including simple diagnostic functions for the connected periphery, special valve diagnostics and a preventive maintenance function. Valve terminals are not just a platform which provides pneumatic and electrical connections but are also able through hybrid modular system concepts and de-central installation systems to adapt to a machine design. The quotation from the architect Lois Sullivan applies precisely: **Form follows function**



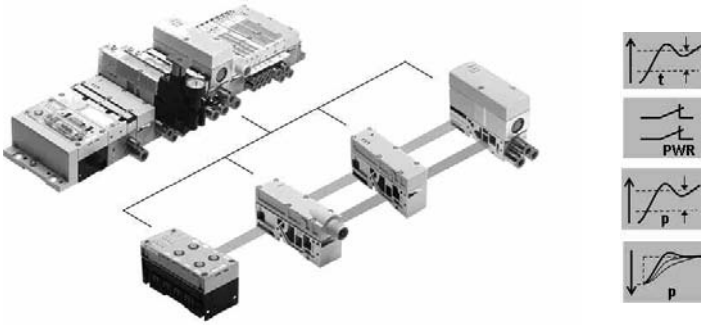
Smart Cubic and compact terminals for space-optimized applications

Modular or de-central terminals with a high degree of protection IP65/67 for direct mounting on machines

Control cabinet optimized or Clean Design for hygienic environments

Metal variant for harsh environments

Fig. 8: Festo solutions – with design adapted to front-end environment




Temperature module

Additional energy supply

Pressure sensor

Proportional valve

Fig. 9: Festo solutions – function valve terminals

**Customer decisions on pneumatics, electrics and networking**

The design of new machine generations and system concepts also makes it very important to select the right system supplier. Products that fit well into applications will be cost-effective and result in overall solutions with higher performance.

**Possible potentials**

- Higher cycle rates through the use of de-central and faster components
- Higher system availability through more detailed diagnostic functions or a more robust design
- More compact processes through optimised design for a given application

The prerequisite for this is close cooperation between product manufacturers and key customers with all kinds of applications. Innovation is not an idea which comes from quiet contemplation but is usually a process in which a manufacturer and user work together to implement an idea in practice.

**Conclusions**

The subject of "Open Communication in Automation" – in other words, control devices with a bus interface – is a popular one in a time of very dynamic changes. A distinction must be made between its influence on the control system level and that on the field level. On the field level in particular, the potential for lower installation costs has virtually been fully exploited.

There is greater potential in the pneumatics environment through an evolutionary integration of functions and technologies. This, however, demands an adequate link to the control system level – and thus the use of industrial Ethernet protocols as a data backbone for machines and systems.

The established field bus protocols will continue in the next decade to play an important role in mass applications. Valve terminals will become multifunctional terminals able to provide complete subfunctions of a machine or sub-processes within a system in a flexible form.

Front-end motion control, pneumatics, signal processing, safety technology and networking are the key technologies here. This trend has been identified in joint projects with our customers, and already today the first results are available in the form of Festo products.

Festo, as the technological leader in the field of "Pneumatics, Electrics and Networking", will drive these trends forward in the coming years, working closely with its customers and taking into account the specific requirement in the front-end area of automation technology.

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