Fieldbus standardization: Another way to go

The author feels that the current fieldbus proposals are far too complex. He calls for a less comprehensive standard, one that builds upon existing MAP/MMS standards.

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Communication standards for automation systems have come a long way in the last few years, bringing the concept of open systems interconnection (OSI) closer to general acceptance and widespread use. Driving this trend are the efforts of numerous standards organizations, plus projects such as the development of the Manufacturing Automation Protocol (MAP)—especially the Manufacturing Message Specification (MMS) *(Fig. 1)*.

Still missing, though, is a worldwide fieldbus standard for the sensors and other field instruments that communicate with the process controllers, programmable controllers, industrial computers, or other control decision-makers in the system. The following article discusses some of the reasons for the delay in developing a fieldbus standard, and suggests an alternative approach to this important task.

Standardized fieldbus data transfer

Let's begin with a very quick look at where the industrial communications standards process stands today. Standards for communication at the supervisory, system, and, to some extent, the process level have been well defined and internationally standardized via OSI. Today, the various devices at these levels can be connected, and data can be transferred transparently and reliably between any two points. The performance and response times that they provide meet most known requirements in process control and factory environments.

However, two issues remain to be considered:

1. The cost-effective solution of easy, reliable, and cyclic data transfer in autonomous systems at the field level (also partly at the process level), and
2. The standardized application of the raw data transferred.

Though we feel there is a major requirement to standardize a data transfer—or distribution—protocol for the fieldbus level, we don't think it's necessary to immediately standardize all the applications above layer 7. What we propose is an approach that would define the physical layer and the data link layer first, then the application layer with its messaging protocols (and if needed, appropriate applications).

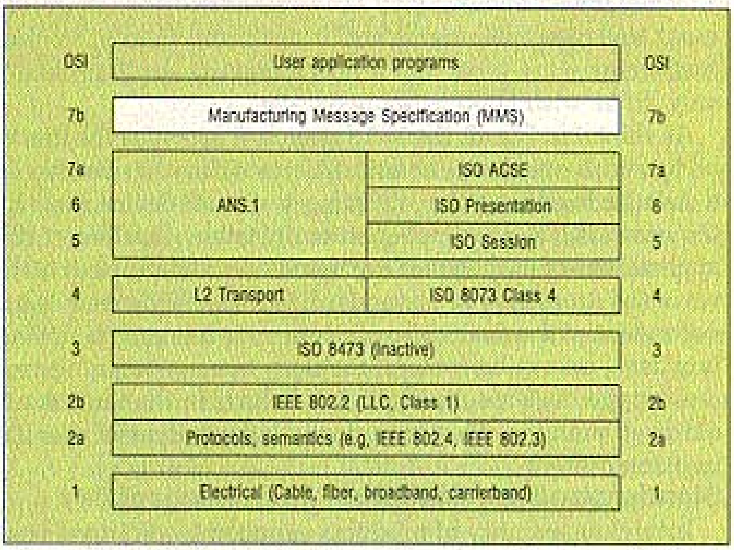


Fig. 1: The MMS specification defines machine-specific functions and applications for the manufacturing world. The International Standards Organization in its OSI model has begun standardizing communications among plant floor devices.

As a first step, a standardized semantic for the most important requirements should be defined. These being:

- To substitute the 4-20 mA signal by an easy and cheap data distribution service and,
- To provide the possibility for easy and cheap reading of status information and diagnostics, and writing parameters for configuration.

Protocols: let's use what we already have

If there is a need for a messaging protocol, we believe that use of available standards is a better way to go. The best known and only internationally standardized application layer protocol for automation applications is MMS. MMS provides a wide variety of communication services useful for any kind of controlling device in a distributed system—whether for discrete parts manufacturing or continuous process control applications.

MMS defines functions for variable access, down- and

Fig. 2: The Fieldbus specification should be built upon the already existing MiniMAP spec, which contains the same functionally-equivalent layers. Some changes will have to be made in layers 7a and 7b. Application programs layer will be last.

uploading of data, and programs and other functions. Requirements found at the field level can be covered by extending MMS to these devices. Making MMS applicable to field devices requires subsetting, an optimized transfer encoding different from ASN.1 Basic Encoding Rules, and a new mapping to underlying layers *(Fig. 2)*. Presentation, ACSE, Session and others will not be needed and used at field level.

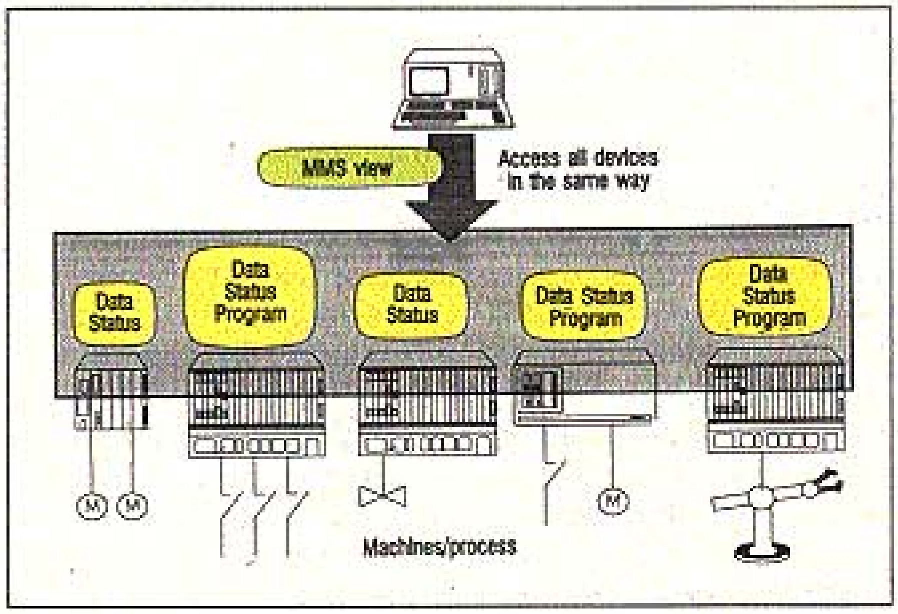
Use of the MMS models and functions to get a message protocol for field level devices eliminates the need to define a totally new standard, plus the consequent need to implement and use two standards in each automation device. And chances are good that a new standard would probably only differ with MMS in some details.

As shown in *Fig. 3*, the MMS standard provides the method by which one device communicates with other devices in a standardized way (i.e., defining a virtual device seen by the network). For example, network visible variables of the applications of each device are modeled and defined as MMS variables accessible in a standardized way. This view is independent of the device specific internals like programming language, operating system, memory management, or processor type. As a result, all devices behave in the same standardized manner. This behavior is independent of specific implementation.

Standardized applications—interchangeability

Interchangeability of products supplied by different vendors is one of the main problems being worked on by the ISA SP50 and IEC SC65C/WG6 international fieldbus standardization committees. Stated in the simplest of terms, the problem is that in certain applications, there's a need for, say, a temperature transmitter manufactured by Company X to exchange data with process controller manufactured by Company Y. But now, we want to replace the Company X's transmitter with one made by Company Z. This interchangeability requirement can not yet be met by communication over just any open fieldbus. It requires an open fieldbus that's enhanced by very well defined and standardized applications useful in this specific area (i.e., temperature transmitters).

Fig. 3: The goal of MMS standardization is to give access among all devices—analog sensors, discrete inputs, actuators, process controllers, and programmable controllers.



While interchangeability is important, placing too much emphasis on it can only delay getting a viable fieldbus spec together. We believe it would be better to first get a data transfer standard. Once this has been done, the next step is to develop a standardized communication semantic. With these tasks completed, then and only then do we feel that work should begin on standardizing specific applications.

End the confusion!

Today's fieldbus standardization work is far from successful completion, largely because the proposals made by ISA SP50 and IEC SC65C/WG6 for layer 2, layer 7, and applications are much too complex. In fact, many of the people who read the proposals may be unable to understand what they define. The actual proposed application layer papers contain more than 500 pages of specifications.

The question is: Once finalized, how many people will be willing to carefully read such a massive quantity of complex material. And of those that do, how many will actually understand what they're reading, enough so to properly implement these specifications? The problem is, the specifications are defining not only a fieldbus with an application layer protocol, but also a complete universal application for most systems of today and in the future.

The proposals contain fieldbus application layer defini-

Fieldbus communication methods

More and more of today's industrial control systems use a distributed architecture. Within these systems, nodal communication requirements vary dramatically. Some involve very simple (and sometimes cyclic) storage to storage transfers over the network. Others involve complex sequences of different messages for configuration, variable access, commissioning, supervision, and control of various automation devices in the plant or factory.

Two types of communication are used to meet these requirements: *data-oriented* and *message-oriented*. Together, they form the structure of a complete fieldbus system. This structure will have a strong influence on the manner in which a distributed control system is implemented as well as on the system's performance and acceptance by its users.

Data-oriented communication is simple

Data-oriented communication (layer 2 of the OSI model, *Fig. 2*) provides a sometimes cyclic data exchange of configured memory parts (relatively few bytes) with high availability within one physical segment. These copied memory parts contain the source address and may be passed on to several receivers. Data exchanges are required in intervals down to a few milliseconds.

In most cases, a recovery mechanism (e.g., retransmission of data) is not needed because new data will be transmitted before a receiving device determines a data transfer error. The application configuration (which data to be sent by a sender to what receiver or receivers) is seldom modified by the user—perhaps once a year. In addition, the structure of this data is very simple and static. In applications in which data production and transfer are sporadic, memory update mechanisms are applied. These initiate a transmission to a controller only upon a change in a sensor value.

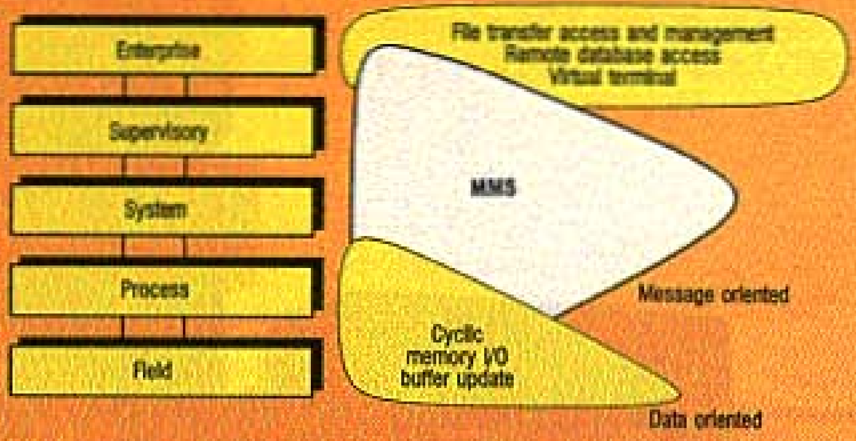
Data-oriented methods are used for time-critical and simple communications between sensors and controllers and controllers and actuators. They are also used, in very limited configurations, between controllers. Examples of data-oriented methods in use today include FIP MPS (Manufacturing Periodic/Aperiodic Services) and the PROFIBUS Link Layer.

Message-oriented communications

A complex distributed control system often must deal with thousands of variables, a tremendous quantity of state information, and very long programs. Obviously, it would be impossible to transfer all of this data cyclically on interconnected hierarchical networks. Therefore, most of the data is communicated upon the request of a specific station (for example, a supervisory station).

The data typically is defined in an application context (layer 7 of the OSI model, *Fig.* 2). This requires context specific definition and interpretation using a language specification with suitable syntax and semantics.

An appropriate language spec must be able to support a lot of different parameters and combinations of parameters. Once the message has been received, it must be analyzed to make sure that the right parameters have been transferred, and that the values of the parameters are correctly encoded and valid. The validation system should prevent rejected messages from being passed onto the application. The processing of expected and valid messages is done according to the procedures defined in an appropriate service definition—an example being MAP's Manufacturing Message Specification (MMS, ISO 9506). *(See Fig. below).*



MMS covers the communication among devices within the process, system, and supervisory level. At the underlying field level, mainly data oriented solutions are used.

tions that are more complex than MMS. And yet another application layer that allows interchangeability of devices will be included on top of this application layer. To make these proposals consistent will take some years.

On the other hand, a lot of defacto and national standards are being defined, published, and implemented. Some of these include FIP, PROFIBUS, HART, DIN Messbus, ARCNET, P-Net, CAN, and Bitbus. If the delay in final publication of an international standard is long enough, widespread use of these other solutions may make it difficult for the new standard to gain acceptance.

We see two ways for vendors and users to go when it comes to implementing a digital fieldbus:

1. Do not change anything in the standardization process in ISA SP50 and IEC SC65C/WG6. Fieldbus standardization (including all application and application layer functionality for interchangeability) is scheduled for the mid 1990s.
2. Move towards the standardization of a simple, cost-effective, and working fieldbus as a draft international standard—available no later than the end of 1991 and covering today's minimal requirements. This would give vendors the go ahead, enabling them to begin providing fieldbus equipment. Extended functionalities (e.g., for interchangeability of temperature and pressure transmitters) can even be defined based on this minimum.

The reduction of requirements to a "good minimum" is needed, otherwise the great fieldbus effort will never succeed—or will at least be to late.

Let's get on with it and move the data

We believe that the second course of action is best. Applications vary by time, but what does not vary is the requirement to transfer and distribute data reliably at high rates. Therefore, the first step in standardization should be to define a subset of physical and link layer proposals to provide open transfer and distribution of data, which would replace the current 4-20 mA standard. Application specific definitions and interpretation of data for writing and reading to field instruments can be defined by using and extending the MMS functionality.

We suggest that ISA SP50 and IEC SC65C/WG6 define and verify in 1991:

1. At least two subsets of layers 1 and 2 (including a data distribution protocol),
2. A very simple subset of MMS functionality (simple read and write, up- and downloading) for remote configuration and other requirements.

We feel that an international fieldbus standard must be available before a lot of defacto solutions make the standard impractical. Users and vendors simply do not want to wait any longer for the universal application version being proposed. They would rather have—in their hands today—a cost-effective, simple data distribution system applicable for most field devices. ■

(Editor's Note: A different assessment of fieldbus standardization activities appears on *p 43 in this issue.)*

About the author

Karlheinz Schwarz received his Dipl.-Ing. from the University of Siegen in 1982. He is responsible for the specification of communication protocols for SINEC products and represents Siemens Automation Division in national and international standardization committees.

The author, Karlheinz Schwarz, will be available to answer any questions you may have about this article. He can be reached via FAX at 011 49 721 595 2326 on Friday, April 12 and 19, during normal business hours.

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