Status, Experiences and Trends of Fieldbus Standardisation

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1. FIELDBUS AS PART OF THE CONTROL SYSTEM

Fieldbusses based on proprietary or standardised definitions play an important role in industrial automation. They cover the lowest layer of the communication infrastructure in the factory and connect sensors, actuators and decentralised I/O with the installed control devices such as PLCs, DCS etc. As the data exchange is the main focus, often optimised protocols are used. A good example is PROFIBUS DP, which is intended to connect decentralised peripherals to control devices. On the next higher level of communication, fieldbusses also connect control devices such as PLCs, DCS, computers, robots and NC controllers with each other. In this case, MMS-like services and objects are mostly used. Examples are the FMS concepts of Fieldbus Foundation and Profibus or SUBMMS used by World FIP.

2. BENEFITS OF USING OPEN FIELD COMMUNICATION

The benefits for end users of using open field communication systems are obvious. The most important effect is becoming independent from one supplier. As widely accepted standards give many device suppliers the chance to integrate a communication concept into their devices, a broad range of devices will be available in the market after some time. This gives the user a high degree of security in their investments.

Another aspect is that the suppliers can sell their products to a broader market in much higher quantities, so that they are in a position to offer the devices for a much lower price than proprietary solutions, and competition will enforce this price reduction.

A third aspect is the technical progress. Again, the competition in the market will enforce that new technological possibilities are integrated into the products as early as possible.

3. WHY IS STANDARDISATION IN THE FIELDBUS AREA SO TROUBLESOME?

The international standardisation of a 'fieldbus' started approximately in 1987. Before and partly in parallel several national standardisation efforts took place: namely FIP and PROFIBUS. One would expect that seven years later a reasonable standard would be ready for use, but this is not the case. Actually, the group working on this standard has exceeded 120 persons. There are normally three meetings per year of one week duration. Some of the subgroups, e. g. the application layer group, meet 6 times a year. All together, I estimate that the international community has spent more than 50 man-years for meetings relating to international fieldbus standardisations. That is only for meeting attendance, not for any preparation.

And the results are rather poor, compared with the long duration and the tremendous efforts.

These are the reasons:

1) The subject is rather complex. On one hand, the architecture of the fieldbus protocols was oriented on the classical OSI Layer structure, but had to be optimised for performance and realisation aspects. This led to a well accepted three layer architecture. On the other hand we had to learn that very special requirements must be fulfilled in this process-oriented area. It took a long time to understand these requirements.

2) Two major consortiums and several 'key players' (companies as well as persons) have been very unwilling to make compromises. This is understandable if we look at the enormous market potential of field devices, as well as the investment the PROFIBUS and FIP consortia have made. This situation has been intensified by the fact that standardisation rules are based on the idea of achieving a compromise and that it is very easy to block a decision. Only after learning that all parties will be losers did a more co-operative attitude come about.

3) The users have viewed the standardisation as a matter for the vendors. For very long they did not really ask for standardised solutions and this allowed the vendors to play the game. Only in the recent past have the users become aware of the potential benefits resulting from standardised solutions, and now they are increasing the pressure on their suppliers to offer appropriate ones.

These changes in the assessment of the situation led to a significant acceleration of work and in promising results, but as we will see, there is still a long way to go.

4. STATUS OF STANDARDISATION

4.1 National standards

In Europe there exist two fieldbus systems which have been standardised by national standardisation bodies. These are FIP, standardised by the French committee UTE, and PROFIBUS, standardised by the German committee DKE. This standard is published as DIN 19245 part 1 to 3.

The FIP standard contains definitions for the physical layer, a data link layer, an application layer optimised for buffered data transfer (MPS) and, most recently, an application layer definition for 'classical' information transfer. These definitions are called 'SubMMS'.

PROFIBUS contains definitions for thephysical layer, a data link layer, an application layer for classical information transfer, called 'FMS', and an application interface for fast information transfer between a control device such as a PLC and decentralised peripheral devices. This definition is called PROFIBUS DP (decentralised peripheral).

The PROFIBUS standard is completed by fully developed network management services and protocols.

Due to special agreements ruling the European standardisation process, not all parts of the above mentioned definitions have reached the status of fully approved formal standards but have been published as draft standards. But this fact has only minor influence on the acceptance of that part.

In Germany there exists another standard, INTERBUS-S (DIN E19258), which is viewed as a sensor/actuator bus, but is competing with PROFIBUS and FIP in the market for some application areas.

4.2 European standardisation in CENELEC 65CX

Due to the long and risky standardisation process in the IEC, the national committees within Europe agreed in principle to approve existing national standards which are recognised in the market as European standards. For this reason a committee 65CX has been established in CENELEC. As a first task, a set of national standards which fulfil certain criteria will be published as EN 50170. FIP, PROFIBUS and possibly PNET fulfil these criteria. More recently, a first vote was taken on pr 50170 by the European national committees, but even though more than 75 % of the weighted votes were been in favour, the vote failed. Currently, the comments are being resolved and the next vote will be initiated very soon. After the preparation of this European fieldbus standard, other concepts such as Interbus-5 (DIN E19258) and DIN-Meßbus (DIN 66348) will be considered for standardisation under the CENELEC umbrella.

It seems worthwhile to mention that, in addition to the activities in CENELEC 65CX, all IEC standards are voted to become European standards by the so called 'parallel voting procedure'. In general, standards approved by IEC will also be approved by the national committees in Europe and then become European standards. Existing national standards with the same technical concept and the same application scope have to be withdrawn after a certain period.

4.3 International standardisation in IEC 65C WG6

Internationally the fieldbus standardisation is handeled by the working group 6 of IEC 65C. The IEC working group always meet together with the ISP SP50, the US national committee dealing with fieldbusses. According to the complexity of the subject, the work is spit into four different 'projects': the physical layer specification, the data link layer specification, the application layer specification and system management specification. Within ISA a fifth project is studied, the so called 'user layer' specification. The projects have reached the following status:

Physical layer:
Since the end of 1993 there has existed a physical layer standard (IS) for the voltage mode, at 31.25 kbits/s, 1.0 Mbits/s, 2.5 Mbits/s, and for the current mode. Several optional physical connections such as fibre optic and radio transmission are approved as new work items or are in progress.

Data link layer:
A data link layer specification has been circulated as an 'approved committee draft for vote (AC DV)' in June 1993 but did not reach the necessary positive votes from the national committees. In the meantime, the project has updated the service document and is now working on the protocol document. Progress is slow and a new ACDV cannot be expected before the end of 1995.

Application layer:
Due to enormous efforts of the application layer project members, the document is very close to being published as ACDV. After being published as a committee draft for comment, it was judged very positively by the national committees. But due to the activities of the fieldbus foundation consortium (FF) the acceptance of this document will be doubtful. These activities will be discussed later.

System management:
The system management project, which also includes network management, was started in 1993. A first document, describing the architecture was published in 1994 for comment. However, an international standard cannot be expected before 1996.

User layer:
The user layer project is a significant approach to describing the device behaviour of devices for process control. It uses the method of 'function blocks'. The ISA user layer group has published a technical report with more than 1000 (!) pages which describes in great detail the behaviour of approx. 30 function blocks.

5. RELATED ACTIVITIES

There are two other activities which round off the described protocol specifications.
Profiles:
Due to the very high complexity of the fieldbus specifications several so-called profiles shall be developed for factory automation and process control. These profiles shall select the required communication services and shall define the communication parameters.
Function block definitions:
In IEC 65 WG6, a general framework for function block standards is under development. In this 'metastandard' the general structure of a function block, its interaction policies, etc. are described. It is important to mention that the concepts under discussion are compatible with the language definitions in IEC 1131-3. Now, a new work item has been established to standardise the details, described in the ISA SP50 technical report, with the above mentioned function block metastandard.

6. WHAT HAPPENS IN THE MARKET?

6.1 Strategy of existing concepts: PROFIBUS and FIP

It became very clear in the past two or three years that the high expectations for one international standardised fieldbus which fulfils all the requirements is an illusion. Especially, the long time needed for the specification has disappointed device supplier as well as vendors. This situation is a very good breeding-ground for existing solution with well proven technology. The members of the PROFIBUS and FIP consortia took this opportunity to penetrate aggressively into the market. Especially PROFIBUS, which has had a great success and has established regional organisations in 13 countries and has more than 200,000 nodes are installed.

At that stage, three concepts were offered to the market: PROFIBUS/ISP, FIP/World FIP and the evolving IEC concept. This was obviously not acceptable to the big users, especially in the USA. They kept on pushing for a single solution.

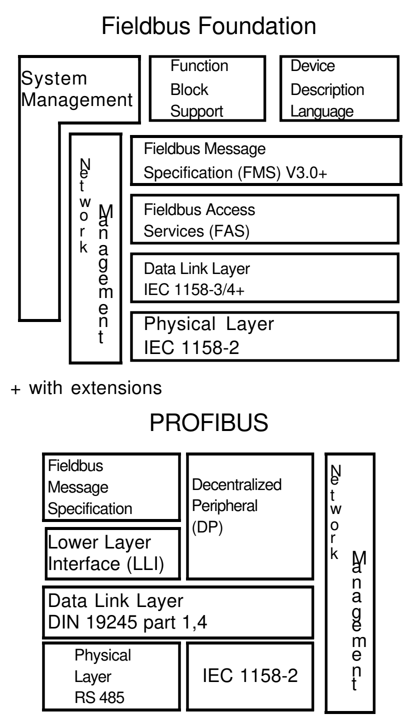
6.2 Fieldbus Foundation

In June 1994 the merger of ISPF and world FIP North America was proposed and has been approved by the membership of both organisations. The new organisation was called the 'fieldbus foundation' (FF). Now all the key players are again in one consortium, but this fact has been bought by a significant technical change. Instead of the proven PROFIBUS data link layer, the uncompleted and untested IEC data link layer will be used. The specification work has been started, but a specification comparable to the one provided by ISP will not be available before the end of 1995. This means that the ISPF - WorldFIPNA merger has to be paid for by a delay in product availability of approximately 2 - 3 years.

7. AN ATTEMPT OF PROPHECY: THE FUTURE OF FIELDBUS

The experience in the past shows that any attempt to estimate the future of the subject 'fieldbus' needs a high degree of prophecy. In the past, no clear evolution line could be seen and too many powerful interests have influenced the progress. This is not only true for the standardisation, but also for the events in the market.
But in order to get some idea of the future some tendencies can be seen:

- The vendors realise more and more that the communication capabilities at the fieldbus level are an 'enabling' feature and not so much a competitive one. This increases the willingness to cooperate with other vendors.
- The user becomes more and more aware of the benefits of interoperable, open automation systems. The pressure to agree on one fieldbus standard is increasing. This fact led finally to the merger of ISPF and World FIP North America.
- The experience with PROFIBUS in the last few years shows very clearly that those concepts are accepted by the users and are easy to use. This aspect has priority above the basic interface prices. Under the aspect 'easy to use', concepts such as CAN and PROFIBUS-DP have very good chances.
  For the other concepts, where high functionality is accompanied by high complexity, greater effort is required to hide this complexity from the users by providing intelligent interfaces and tools.
- The future of the fieldbus business will come in evolutionary steps and not in a revolution, bringing the final solution in a big bang. There is a relatively smooth migration path from well-tested and accepted concepts like PROFIBUS and FIP to the next generation, which might be a fieldbus according to Fieldbus foundation specification. This becomes evident by comparing the protocol architecture of FF and PROFIBUS:



- Further, experience with the well established fieldbus systems, such as PROFIBUS, shows that, for end users, the details of a communication system are of very low interest. Instead, questions of usage and integration are pushed into the foreground. Therefore concepts to establish "play and play" are in discussion and in some cases under development. For example, the concept of function block and function block shell would significantly reduce the effort of the communication stack in field devices. Symmetrically, the concept of a device description language would enable control devices to handle field devices with a broader range of functionality. The basic idea is that the functionality of the devices is coded inside the field device and can be questioned by the control device. Consequently, the control device can adjust its performance by interpreting the device description of the field devices. This will make possible interchangeable devices in control structures.

8. WHAT SHALL THE USER DO?

With the merging of ISPF and world FIP NA and with the necessary restart of the specification work, the hope to get products based on an internationally accepted standard in the near future has been lost. Under optimistic estimations, a delay of two years has to be taken into account.

But this does not mean that the users have to wait again. They can use very mature systems today and do not risk loss of their investment when the next generation come to market. The future systems will use the same physical layer and provide the same or very similar user interfaces. This means that the investment in cabling and in the integration of fieldbus into the application is worthwhile.

The future systems will provide higher functionality but also higher complexity. To cope with this aspect, an early start with existing open fieldbus systems, e. g. PROFIBUS, is a wise decision. The real challenge is not the technology of a fieldbus, but the knowledge how to design, to install and to operate open, distributed fieldbus systems.
It is never to early to start with the acquisition of this knowledge.