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From ‘Case study’ via ‘Application’ to ‘Lessons learned’: FuRIOS “2”

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End of 2002, the worldwide operating companies InfraServ Hoechst and Aventis Pharma (now Sanofi Aventis) performed a comparison study between a real world installation using conventional technology and a comparable planned installation using Fieldbus. The study soon became known as “**FuRIOS**”, and gained world recognition not only due to translation into more than 5 languages, but as the first relevant and impartial study about the applicability of Fieldbus technology.
It concluded in the statement that Fieldbus is available, and Fieldbus can reduce costs if used with the latest topology concepts.

Almost three years after the publication of the results, a number of plants used the proposed technology and serve today as case studies for future Fieldbus applications.
Aventis used **FuRIOS** as feasibility study to realize their own project with 1600 fieldbus devices. DSM is operating their “Vitex” plant based on **FuRIOS** since June 2004, and Novartis build three **FuRIOS** plants with a total of more than 8000 fieldbus devices.
These three companies agreed to share their experiences and serve as basis for analysis of potential cost savings and field experiences for this paper.
The paper highlights design and installation aspects as well as experiences during startup and commissioning. All introduced plants use multi-vendor instrumentation, so that even aspects caused by potential incompatibilities are analyzed.

Keywords: Fieldbus, Study, Comparison, Remote I/O, Analysis, Aventis, Sanofi, Infraserv

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1. Preface FuRIOS – by Prof. Dr.-Ing. Birgit Vogel-Heuser

FuRIOS: this title of a study comparing fieldbus and Remote I/O systems sounds promising. Indeed the FuRIOS "Fieldbus and (german: und) Remote I/O System comparison" is a major improvement with regard to the application of fieldbus systems in process automation. It systematically analyses, from the point of view of the user, the benefits and costs (investment costs and operation costs) of a real production plant. To evaluate the benefits of fieldbus systems up to now only the NAMUR[1] recommendation NE 74, checklists from other industries and supplier or user-specific reports and references have been available. *Starting at the Interkama 2001 the FuRIOS study was initiated by Aventis, Infraserv and a group of suppliers. The results were presented for the first time at the annual NAMUR conference in November 2002.*

A real plant from Aventis Pharma (D712), planned and built with Remote I/O[2], was chosen as the basis for the evaluation. With the exact requirements of this plant a concept with fieldbus technology was designed and evaluated by Infraserv, supported by relevant suppliers of sensors and actuators, Remote I/O and fieldbus systems as well as DCS suppliers. The study provides a systematic analysis as well as a result which is independent of suppliers: fieldbus technology is technically and economically beneficial. The savings in investment costs alone range from 3.6 to 5% compared with Remote I/O Systems[3], even when calculated very conservatively. *Summarized under investment costs the costs of the field devices, communication system, engineering of field technique and control system as well as installation, calibration, qualification and commissioning have been analyzed.*

The technical advantage of the fieldbus solution, e.g. from diagnosis and event-driven maintenance through to asset management, have not been taken into consideration. They are not to be underestimated for optimizing the costs of the plant

[1] NAMUR = Association of end users of chemical and pharmaceutical industry

[2] The plant uses both conventional 4-20mA/HART technology as well as Remote I/O systems

[3] The study confirms that savings compared to conventional technology are significantly higher

operation, especially in reducing down-time. The development of even more powerful diagnosis capabilities is possible only with the use of fieldbus. [Pepperl+Fuchs published a compendium titled “FuRIOS”, where this Preface is part of it.] This compendium provides you, as a reader and user, all the results of this supplier-independent study in detail as well as additional comments from the responsible project leaders of the FuRIOS project, Dr. Thomas Tauchnitz of Aventis Pharma and Manfred Dietz of Infraserv. Furthermore you will find some statements from the speaker of the NAMUR working group 2.6 “fieldbuses”, Frans van Laak, and his colleague at DSM TechnoPartners, Harry van Rijt.

The second part of the compendium presents an application-oriented realization of the study’s results using the fieldbus installation system FieldConnex™ . The economical results of the study are technologically substantiated and further variants of instrumentation concepts are shown.

Pepperl+Fuchs, with this compendium, makes an important contribution towards a more matter-of fact-style discussion about the benefits of fieldbus applications and offers concrete help. I hope you will enjoy reading this and wish you success in applying the results of FuRIOS in your future projects.

Prof. Dr.-Ing. Birgit Vogel-Heuser

2. Preface to second edition – by Prof. Dr. Ing. habil. Lothar Litz

The break-through of Fieldbus in Process Automation – do we see it now?

The possibility of technical realization has been proven for some time now: Fieldbus based solutions for automation of process production plants in explosion hazardous areas. We all know that a break-through does not automatically and immediately follow the technical realization.

It took almost 10 years from the first Process Control System in a pilot plant to its routine operation. The break-through was somewhat in-between. How long is this way for Fieldbus and where are we today on this way? The first test and laboratory installations of fieldbus have been long ago. The first production plants are in operation now, several more are being commissioned today. Even more are in the design stage. Do we see the break-through? It certainly looks this way.

The right evaluation at the right time: FuRIOS (Fieldbus and Remote I/O System comparison). Nine manufacturers participated in this study which was conducted under the lead of a user company. It was the right time for this study since, with fieldbus barriers, segment couplers and valve boxes, it was able to include the latest technical developments. Without these the comparison of economic efficiency would have been in favour of Remote I/O. Similarly FuRIOS was the right study since it asks and answers all essential questions in a very methodical way. The manifold advantages of Fieldbus over Remote I/O are described in all details.

Especially one important condition got not forgotten in FuRIOS: The long-term availability of the new technology. In terms of investment protection this is essential for production plants since – typically for process industry – they are in operation for at least 25 years. Ultimately long-term availability is one of the major differences to Fieldbus in factory automation, were the break-through took place during a few years only, and this was several years ago.

Studies like FuRIOS are essential milestones on the way to break-through. It finally takes place when people do not write about it any more, but when the acceptance is proven by the increasing number of fieldbus-based plants. The principle of positive

feedback, known to every process control engineer, will help. Any break-through profits from feedback, without it a break-through is hardly possible. A major argument for an investment decision is the economic efficiency. Lower investment costs for a new technology lead, due to economies of scales, to a price decrease and therefore to further reduction of investment costs. Each new plant working on fieldbus is part of the proof of acceptance and therefore an important step on this way. Each one of these plants is a part of the break-through, which we indeed see today.

Prof. Dr. Ing. habil. Lothar Litz March 2005

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3. FuRIOS: Fieldbus and Remote I/O – a system comparison

By Wilfried Schmieder and Thomas Tauchnitz, Aventis Pharma, and Sven Seintsch, Infraserv GmbH
Translation of the german article "FuRIOS: Feldbus und Remote I/O – ein Systemvergleich", originally published in atp Automatisierungstechnische Praxis 44 (2002), Edition 12, pages 61-70

In contrast to the Remote I/O systems, which have reached a wide market penetration within few years, the technically superior Fieldbus does not see a market breakthrough yet. It is frequently said that the Remote I/O system achieves almost all advantages compared to the conventional cabling of field instruments so that the move towards Fieldbus does not pay any more. On the other hand Remote I/O systems are often seen as interim solution. In order to help clarify this contradiction the companies Aventis and Infraserv performed a system comparison of Remote I/O and fieldbus in cooperation with the IGR (Industrial Practices Interest Group, see www.igrtechnik.com) and several instrument manufacturers. The project name FuRIOS (Fieldbus and Remote I/O – System comparison), in German language associating "fantastic", might provoke exaggerated expectations. The result, however, is that the Fieldbus is superior to Remote I/O in many aspects: It brings further savings in investments, accelerates project execution and startup and so provides the migration to a new technological platform that enables the development of innovative and attractive instruments.

Manufacturers and users are encouraged to make intelligent use of these new opportunities and do more than just transfer the conventional instruments and operations without modifications to the Fieldbus.

[Note: due to the length of the article, the full text is omitted here. It is available in the compendium "FuRIOS 2" (available from Pepperl+Fuchs) or at www.pfsolutions.info/fieldconnex/pdf/FuRIOS.pdf].

Assessment of the Results

3.1 Assessment of the investment costs

The above presented savings in the Process I&C costs which amount to 3.6 through 5 percent, depending on the perception, may seem disappointing at first glance. The values of about 20 percent which former studies indicated led people to expect more. However, it is to be recalled that these studies (8) determined the potential savings relating to fieldbus technology in comparison with conventional wiring. Roughly it can be said that Remote I/O saves about 15 % over conventional wiring and fieldbus technology saves an additional 5 %. Taken realistically, greater savings in investment costs could not really be expected by changes of the communication technology alone, as the number of cables laid between the control room and the field remains approximately the same. However, these savings are relevant: it is a considerable leap if the introduction of a new technology leads to a 5 percent drop in investment costs for a certain field – even without the discovered additional benefits during the life cycle. Which other technology leap over the last few years has generated savings of 5 % off overall costs in other fields such as construction engineering or apparatus engineering?

3.2 Assessment of the operational factors

Besides some relatively small factors, like training or costs of Process I&C maintenance, there are major changes in the operational factors: if plants can be put into operation faster thanks to fieldbus technology, if they have less downtime during malfunctions or can be run with greater precision, then this is the major benefit of fieldbus technology. One day of production profits in a plant operating at maximum capacity can easily generate 500,000 €. Or vice versa, one day of downtime can destroy the same amount. Unfortunately the benefit potentials cannot be determined universally since the influences of plant load levels, market situations and profit margins are far too big. However, the benefits in operation surpass the savings in investment costs by far. From our perspective it is a pleasant bonus that these benefits in operation – unlike as with most other innovations – must not be paid for by higher investment costs, but are accompanied by additional savings, even if they are relatively small.

3.3 Assessment of the methodology

An assessment of results would be incomplete without an assessment of the methodology. The methodology described and substantiated above led to a conclusive, comprehensible assessment within a relatively short period of time. Of course it cannot yet be concluded with an evaluation of a real project, since the decision for future plant designs with fieldbus will be based on this study. It has to be noted explicitly that there is a certain risk to find some differing results in a real practical comparison.

In a methodical sense the approach of drafting a comparison on the basis of a real, operational plant is highly in danger of subjective errors. The selection of plant location, size, type and equipment leads to specifications that cannot be generalized. Furthermore, the point in time of this study could have a significant influence, too. The results may be different in six months from now. Accordingly, one should be careful in transferring the results to other plants or in assuming that the results are generally valid. There may indeed be plant sizes for which the Remote I/O solution is the best. The evaluation of continuous processes with respective availability requirements may lead to different assessments. With revamps of existing plants Remote I/O allows to continue using the installed field devices. On the other hand, for example, fieldbus technology would be even more beneficial to larger, more spread out plants than our reference plant. Specialists around the world should feel invited to apply the methods of this study to other plant types and to communicate the results so that more general statements will be possible. Another uncertain area of the FuRIOS project is that the comparison was carried out on the basis of Profibus PA and not Foundation Fieldbus. Without having considered the details of a solution with FF, we would venture the opinion that the results of a study with Foundation Fieldbus technology would be similar. Advantages and disadvantages of the different fieldbusses would be apparent here and there, but this would not affect the result by anything more significant than 10 %. One more critical statement about the FuRIOS project is necessary: This study was carried out to the best knowledge of the authors, using their experience with fieldbus test systems. However, there is a lack of practical experience. Some assumptions may be overly cautious; problems may occur in the implementation of a real project which have been overlooked here. Most certainly there are “teething problems” to be expected in the first projects, which

could eat away the estimated savings. Faster commissioning is also unlikely to be possible in the first project.

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4. Savings are not the goal of Fieldbus - Interview

Digital communication technology makes user's dreams come true in regard of diagnosis

The dutch chemical and pharmaceutical company DSM is among the first in the use of fieldbus technology. Future oriented diagnosis and device functions in process automation are based on this technology. Frans van Laak, leader of the NAMUR working group „fieldbusses" and his colleague at DSM TechnoPartners, Mr. Harry van Rijt, are advocates of this new technology. The journalist Mrs. Dr. Christine Eckert talked with these two automation experts about their experiences with fieldbus and its future aspects.

Dr. Eckert: Which chances does the fieldbus offer in process automation?

F. van Laak: Certainly the fieldbus does not have the main goal to save on cabling costs. On this basis, in my opinion, we do not need to discuss. If we want to move on in our field of expertise, make it broader and better, than we need the fieldbus. Especially in regard of diagnoses we expect quite a lot of this technology – not only for individual devices, but for whole segments of a plant. What has been there first: the egg or the chicken? Without fieldbus there will be no development in diagnosis.

Dr. Eckert: Will DSM only use fieldbus technology in the future?

H. van Rijt: This is a complicated question. Fact is, that in April we will comission a production plant with 28 lines and 300 devices, all based on fieldbus technology.

Dr. Eckert: This is a different level of size compared to the plant planned by Aventis with about 2000 devices. Is DSM moving towards bigger projects step by step?

F. van Laak: I would not say so. This is quite a normal production plant. Our field test is a production plant, too. It is categorized in a lower risc class, but it operates with fieldbus. Two more projects are in the planning stage.

Dr. Eckert: Do the results of the study “Fieldbus and Remote I/O System comparison” (FuRIOS) have any positive influence on your decisions for future fieldbus projects?

H. van Rijt: FuRIOS has no influence. Already two years ago we created a comprehensive cost model and built a laboratory with two fieldbuses for testing purposes. Following that we conducted a field test with an existing plant with eight buses. After some start-up problems it is running smoothly since one year. All these projects are based on Foundation Fieldbus since, several years ago, our company took the decision to use process control systems from Honeywell und Emerson. But DSM operates a Profibus plant, too.

Dr. Eckert: In regard of the real plant, which forms the basis of the calculations of FuRIOS, there are savings of about four percent to be expected. Is it worth to implement a new technology for that?

F. van Laak: When Mr. Tauchnitz presented the results of the study at the NAMUR general assembly 2002 he made pretty clear: “Isn’t it great that we talk about a new technology and can achieve cost savings already in the investment phase?” Cost savings are happily accepted but they are not the main reason. In that respect I can only agree.

Dr. Eckert: Do you think that the savings could be even higher after a certain start-up period?

F. van Laak: Yes, certainly. Nowadays fieldbus devices are more expensive than conventional devices. With increasing production numbers the prices will drop significantly. Here some more savings are possible. But, as already mentioned, savings are not the primary goal of fieldbus. In the beginning the devices will become more expensive, because they will incorporate more features. It is utopical to expect that the producers will create these new tools free of charge.

Dr. Eckert: One major argument for the fieldbus are the diagnosis functionalities. What is your judgement regarding the tools which are currently available?

F. van Laak: Basically one cannot really speak of diagnosis yet. Most often it is just a check on failures. But the field devices became more stable during the last decades,

the failure rates are very small. The goal is to combine the diagnosis with the process itself. Temperature verification of the specific transmitter is already offered by many producers. This is a start, at least, with the temperature transmitters. Really interesting is the monitoring of the thermo element in regard to long-term accuracy. Ideally calibration would not be necessary any more!

H. van Rijt: One more application of modern diagnosis is the Blocked Line Detection. With this the pressure transmitter sends an alarm signal if the duct is closed or blocked. These tools are already available, but currently only with Foundation Fieldbus devices. Profibus will certainly follow, but the basic requirement for all diagnostic functions is the fieldbus. One more advantage is the automated fault signalling. When using HART we have to contact the transmitter each time and ask for the diagnosis data.

F. van Laak: With fieldbus we have nothing like that to do. These informations come automatically since they are included in every cyclic data exchange.

H. van Rijt: Such functions need more processor capacity and more energy which the 4 to 20 mA technology simply cannot deliver. If the processors get faster by the factor ten than they will have the same frequency as a microwave device. Nowadays a PC has a 2.4 GHz processor, microwave devices have 24 GHz. High-performance processors need more energy, and ultimately this says everything. The conventional technology simply has reached its limits.

Dr. Eckert: Apart from the diagnosis, which further functionalities do you see as necessary, being the users of these new devices?

F. van Laak: In my opinion the development of multivariable and multi-sensor devices will pick up speed, triggered by the fieldbus. With theses devices the interferences in the process can be reduced. In principle each flange is a weak point. Less flanges mean less risk. Even the EU authorities are working on the minimization of potential leakages.

Dr. Eckert: Do the planners of new plants take these new posibilites into consideration?

F. van Laak: No, and that is not to be expected. Aachen and Cologne have not been built in one day, too. I hope that the planners understand why the fieldbus technology is so essential. Of courxe, not all possibilities are available immediately. It simply needs time. The fieldbus offers the progress in our field of expertise.

Dr. Eckert: In your opinion, will Remote I/O systems vanish completely from the market?

F. van Laak: DSM still affords the luxurity to think of new technologies. We are not the only, but among the first companies who try to use the fieldbus technology. There will be always users who are not brave enough or who are not at all thinking of fieldbus. These will stay with Remote I/O.

Dr. Eckert: Consequently you do not deem Aventis as very brave because they will start working on a big fieldbus plant?

H. van Rijt: For these people who know what they talk about it is not a very brave step. For outsiders it may look like a jump into cold water. But for people who have the appropriate expertise and who know where the problems might be hidden this is not really a question.

Dr. Eckert: With Foundation Fieldbus the plant design is slightly different than with Profibus because of the structure and functionality of the Control System. Major elements are device power over the bus, power conditioners and fieldbus barriers. How essential are these for economic efficiency of a plant.

F. van Laak: Without these components the design would be straightaway catastrophic, even without taking the plant reliability into account. The new fieldbus components allow a much more simple structure and reduce the fault-sensitive elements significantly.

Dr. Eckert: FuRIOS draws the conclusion that intrinsically safe fieldbus barriers are not economical. In your opinion: is the version in increased safety sufficient?

F. van Laak: We as NAMUR requested the possibility to connect the devices intrinsically safe. But there is no reason why a main cable should be intrinsically safe. Is a compressor in the plant intrinsically safe? Why than has the fieldbus to be it? How often do we work on a main cable? Never! We have to work where

the devices are connected. Once the main cable is installed it will be there for 25 years, at least.

Incendently the version in increased safety is cheaper, too. But the driving force is reliability, and this is much more important for me. The Power Conditioners have no electronics. So this cannot break and block a complete segment. Reliability simply is a better argument than price.

Dr. Eckert: In respect of the mentioned relieability : Should the various fieldbus components be available from one single source?

F. van Laak: We as user would wish that. The system of fieldbus powering, conditioner and fieldbus barrier can varied only inside tight limits. Most problems are created from the power supply. Due to reliability we want as few active components on the trunk as possible. Consequently no active conditioner. A resistor or a coil are hardy ever defect. The weak points are transistors and integrated circuits. The other side of the medal is the missing galvanic isolation with a passive conditioner. This isolation works as a kind of “dirt filter”, for dirt coming from the power supply. For disturbances coupled onto the trunk even a galvanic isolation has no use. The power supply unit needs to have a appropriately high quality. DSM uses only passive conditioners. At the moment only two suppliers offer powerful devices with 1 Amp or more.

H. van Rijt: Looking at the hardware-side not all devices have the same quality for the bus connection. The sensitivity for disturbances or for variations in the amplitude are different. All devices meet the respective standards more or less, but not all of them in the same way. Unfortunately the differences in quality are rather big. A bad fieldbus power feed module might create problems with low-quality fieldbus devices. With high-quality fieldbus devices the power supply is less critical. Seen from the pure technical point of view it is possible to use components from different producers. But I think it is sensible to have the complete system from one supplier. Here the supplier can guarantee for the full communication chain. Our preferred system would be one designed for maximum interoperability of all the system components.

Dr. Eckert: Have you already connected components from different suppliers in your practical experience?

F. van Laak: We did some testing. The possible savings are, in view of the complete project, only peanuts. This is the reason why I keep saying that power supply, conditioner and fieldbus barriers are one system. Together with the appropriate fieldbus cables this will be a solid, coherent solution.

Dr. Eckert: Will fieldbus be successful?

F. van Laak: Fieldbus in itself is only the means. It is all about the devices and their functionalities. In five years from now we will speak quite differently about the fieldbus than we do today and the conventional technology will not play a significant role any more. One can fight against new technologies, but the progress cannot be stopped.

5. From theory to practical operation – by Dr. Christine Eckert, journalist

Aventis builds pharmaceutical production plant based on FuRIOS Study

Two years ago Aventis Pharma Deutschland and Infraserv Höchst Technik conducted the FuRIOS study (Fieldbus and Remote I/O System Comparison) in order to evaluate the cost/benefit aspects of fieldbus technology and to increase its acceptance in the process industry. This system comparison convinced the producer of pharmaceuticals and soon after publication of the study Aventis started to turn these theoretical considerations into real practice. The Ketek plant is the first automated production plant which follows the recommendations of FuRIOS.

The new plant for pharmaceutical agents produces several stages of the new antibiotic Ketek for treatment of acute respiratory infections. The instrumentation of the plant is based completely on fieldbus technology, which makes it one of the most modern of its kind. The only exceptions are the safety oriented applications and a few remaining conventional signals. The cost for the Process C&I are about 12 million Euro. The plant is divided in 200 Profibus PA segments with a total of 1.600 Profibus PA field devices. Two production lines comprise 15 device types of seven different manufacturers, all of them working fully interoperable. The control system is supplied by ABB. The complete fieldbus installation for device connections in explosion hazardous areas follows the fieldbus barrier concept and is realized by means of the FieldConnex system of Pepperl+Fuchs.

„Ketek is one of the largest projects of our project team. In some areas of engineering and construction we have been supported by Siemens“, says Bodo Bartscheit, project manager Process C&I at Aventis. Not without some pride, since the complete project was under the full responsibility of the team. In order to optimize the coordination with the engineering company his colleague Harald Hauch, project manager automation, acted as interface between plant operator and service companies. For the creation of commissioning and installation procedures as well as training of personnel Aventis took the specialists of Infraserv Höchst Technik on

board, thus taking advantage of the experienced team which had already been involved in conducting the FuRIOS study.

FuRIOS is a classical evaluation which took a real plant, working on Remote I/O technology, and projected it 1:1 to fieldbus technology – with absolutely identical requirements. With the Ketek project Aventis followed these prerequisites and designed topology and instrumentation accordingly.

“Maybe we designed 1:1.01 on fieldbus. But in general the design work went as usual”, says Dr. Thomas Tauchnitz, former manager of technology and projects at Aventis agents. Many of the advantages of digital technology can only take effect if the planner uses the new possibilities in an intelligent way. But here the practical experience is missing. „The engineering teams still follow the conventional technology since they know all its nooks and crannies. One uses his leeways only after a certain experience is gained“, knows Manfred Dietz, head of the test laboratory at Infraserv Höchst Technik. This counts especially regarding the application of multivariable devices which had not been considered in FuRIOS. “At 10 out of 2,000 measuring points we used the functionalities of multivariable devices. Here we go one step further than FuRIOS“, explains Bartscheit.

New technology means rethinking

All team members underestimated the demand on training. One point which is unfavourable for fieldbus only at the first glance since the demand is much higher with Remote I/O technology. With Remote I/O Systems new field devices and new operation philosophies show up all the time and the personnel has to be trained anew for each project. „Somebody fit on Profibus is fit. It is one single learning process only”, confirms Dietz. “With each technology change the initial trainings take the most effort since one has to start at zero.” The manager of the test laboratory knows what he is talking about since he and his team conducted all Profibus training sessions during this project.

Everybody has to learn the new technology – installation personnel, planner, engineers and managers. “In order to take full advantage of the fieldbus benefits everybody has to know what this technology can do and what not”, says Dietz, and Tauchnitz adds: “Every trainee learns how to connect 4 mA … 20 mA in his first

year. How to connect Profibus PA? This we had to work out, write down and teach to every employee.” The specialists are sure: this was a good investment for the Profibus newcomers. Dietz: „Companies can save on trainings, but this will backfire during operational maintenance.“

Time is money

The experiences of this pilot project show that there is savings potential in commissioning. “We had to do a lot of things several times, since there were modifications and adaptations ongoing all the time“, explains Sven Seintsch of Infraserv Höchst Technik. Changes during the planning process are daily business in pharma projects. “In that respect the advantage of fieldbus has to be estimated even higher since the user gets much more flexible”, says Dietz. “The first plant showed how this reduced project time can be used sensible. Detailed planning of Process C&I can start later, is installed later in the plant and thus saves a lot on modifications since the production process is already stable“, confirms Bartscheit. The logical consequence: the plant can go into operation earlier and this means money in the pocket.

At no time any of the hardware problems endangered the faster commissioning. The Profibus software worked without problems, too. The same the project members could not state for the FDT/DTM software (see box). “The commissioning of the Profibus lines went without problems in terms of the hardware. As an average it took only one day for 30 devices. One more advantage, compared to older times, is that marshalling faults do not occur”, Seintsch sums it up. This is seen as a real success by the fieldbus experts. Bartscheit: „Ultimately a lot of apprehensions proved wrong and we searched for problems which simply did not exist.“

Once the teething problems are solved and the users are familiar with the new technology, its benefit will be increased even more. Realization of the many chances offered by fieldbus technology requires a certain experience. “At the moment everybody is happy when the bus is working”, says Seintsch. “Aspects such as process optimization, diagnosis and maintenance are still some way out. Only after the technology is established the user will start to pay attention to the mass of additional information he gets for free by the bus.” In the expert’s opinion the discussion on added value of fieldbus is just starting.

All concur in one more point: The new Profibus plant confirms the predication of FuRIOS regarding faster commissioning and more simple installation. Fieldbus technology and fieldbus barrier concept have definitely proven their suitability for daily use, and this gets around. At present there are two major projects and one smaller one with fieldbus technology in Industriepark Höchst at Frankfurt, Germany.

Furthermore there are many more ongoing projects at other locations of the former Höchst company. “The time is ripe for digital technology. If we want to get out of this antiquated 4 mA ... 20 mA device technology we desperately need the fieldbus“, says fieldbus-fan Tauchnitz. „People who are not brave enough by now cannot be helped. At this location there will be no new plant designed without fieldbus, this is certain!”

Dr. Christine Eckert, journalist

6. Interview with Richard Timoney

Richard Timoney, President and CEO of the Fieldbus Foundation

Foundation™ fieldbus uses the performance capabilities of the intelligence distributed throughout the field devices to increase plant performance. It is particularly suitable for use in mission-critical applications where data transmission and the high reliability of single-loop integrity are required. Two concrete examples clearly demonstrate the great savings potential which can be exploited with this digital technology. Unplanned process shutdowns represent the largest individual source of lost profits. This downtime, which is particularly harmful in continuous process operations, is considerably reduced due to the modern diagnostic functions of fieldbus technology. A manufacturer can also obtain enormous benefits from this technology with regard to high maintenance costs with the use of predictive maintenance processes which enable intelligent management of essential physical plant assets and which lead to a large reduction in operating costs.

These costs really do offer plenty of opportunities for savings. In a study conducted by Dow Chemical, it was discovered that 63 percent of trips to the field by maintenance staff were either for routine checks or no problem existed at all. Additionally, in a similar study, it was found that 86 percent of maintenance is reactive (too late) or preventative (unnecessary) whereas, with a predictive/proactive approach, best practice is 40 percent. The number of process plants which are putting their faith in this technology is increasing year by year. Worldwide, there are already more than 400,000 fieldbus devices and 5,000 hosts systems installed in plants. Currently, key industries such as petroleum and natural gas, chemicals, pharmaceuticals, utility supplies, paper manufacturing as well as consumer goods manufacturing are constructing new large installations all over the world where this technology is integrated. In Europe too, particularly in countries such as Russia, Poland and Germany, the technology is becoming state-of-the-art – as the results of a recent study by the ARC Advisory Group have proved: So, whether modernization or new installation, big or small, Foundation fieldbus is the technology of choice.

Source: FuRIOS 2 Compendium, Pepperl+Fuchs GmbH Germany

7. FuRIOS and the savings potential

FuRIOS – Fieldbus and Remote I/O System comparison (From the German: Feldbus und Remote I/O Systemvergleich) – under this project banner Infraserv Hoechst and Aventis Pharma, two of the biggest German chemical and pharmaceutical industries, investigated the differences between an existing plant using remote I/O systems and the same plant designed using fieldbus. The factors taken into consideration included both the pure investment costs and the long-term operating costs. In addition, other 'soft factors', such as employee training, operating safety and quality have also been included in the comparison.

The basis for the investigation is a pharmaceutical-chemical plant with 369 process Instrumentation and Control (I&C) points as well as several motors, pumps and converters. It is equipped with remote I/O systems with a total of 821 input/outputs and recently commenced operation at Aventis Pharma. For the purposes of the comparison the topology of this plant has been replanned on a 1:1 basis using fieldbus components and the resulting costs have been calculated. The basic project design parameters were the current availability of all the fieldbus components and the design of a real workable plant equipped with fieldbus, to enable the planned version to actually be built and commissioned – because this is precisely what Aventis Pharma intended to do in 2003 and this is why they performed the FuRIOS study.

The comparison of the cost calculations showed that the fieldbus instrumentation would provide tangible savings in investment costs, a significant advantage in long-term operating costs and an impressive bonus in terms of reducing the project commissioning time. In fact, the envisaged plant would enter the production stage ten days earlier, so that the earnings from the plant product could by far exceed the savings in investment costs!

The actual results of the FuRIOS study showed potential savings in investment costs of EURO 338.00 per process I&C point or, depending on the engineering tool used, 3.6% or 4.2% of the total Process I&C costs. Of course, these values do not represent a generalization for all process plant applications, since specific requirements and general conditions vary from project to project. However, it could be expected that the application of the knowledge and basic principles gained from

the FuRIOS project will lead to significant savings on other plants, too. When looking at a direct transition from conventional point-to-point cabling to fieldbus technology there is a much larger investment savings potential, in the range of 20%.

8. Topology of FuRIOS

The basis for the realization of the advantages of fieldbus communication is the exclusive and consistent application of the fieldbus. As shown by the FuRIOS study, the combined use of fieldbus and remote I/O is not economical. A decisive factor is a clear fieldbus topology structure and also the consistent use of the 'fieldbus barrier' Ex e / Ex i technology. This makes it possible to benefit from the functional advantages of fieldbus-capable field devices and to take maximum economic advantage of the savings potential in the connection technology at the same time.

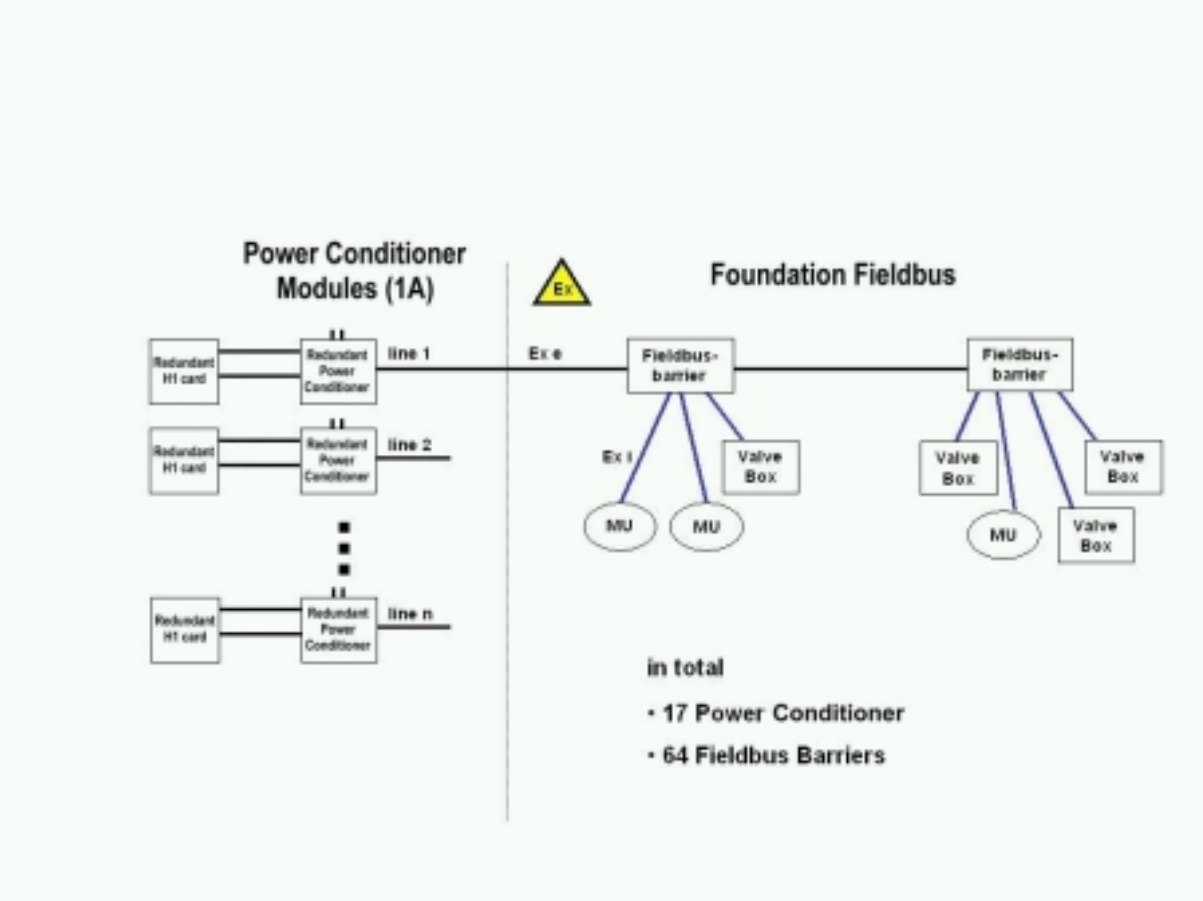

Figure 1: fieldbus topology of the investigated plant (converted to FF).
Source: Lecture by Dr. Tauchnitz at the NAMUR general assembly 2002)

The Host controller and power conditioner are redundant to meet the requirements for high availability in process automation. The supply current required for the connected field devices is fed through a fieldbus barrier in the field and thus any danger of negative mutual interference of the connected field devices is reduced.

9. Implementation of FuRIOS

The implementation of this recommendation is easily possible as shown in figure 2. It features the above shown new power supply concept combining Ex e (‘increased safety’) and Ex i (‘intrinsic safety’).

All the elements necessary for the communication between the host and the connected devices are available. It is not decisive to what extent the field devices themselves are fieldbus-compatible, since, by means of specific Field Process Interfaces, even conventional signals can be incorporated into the bus communication.

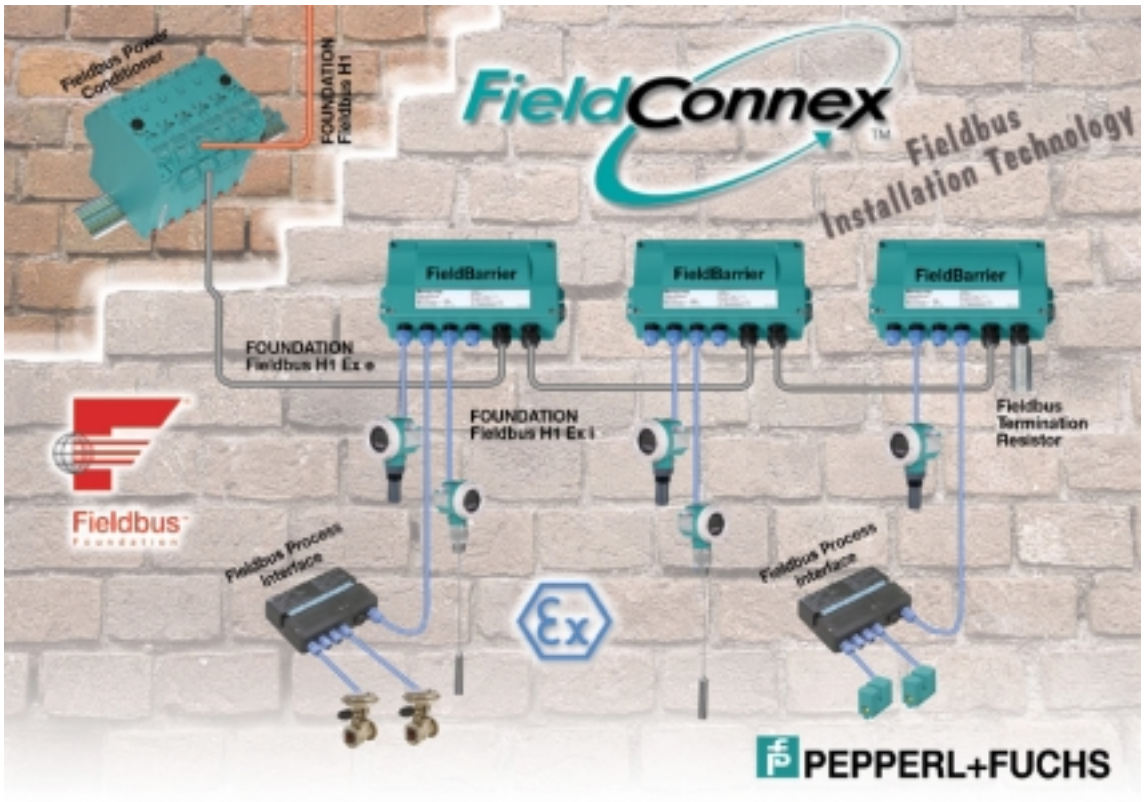

Figure 2: Topology in accordance with the FuRIOS recommendation

The relatively high supply current of 1A is coupled onto the bus line via a redundant power conditioner solution. The cable is run in protection method ‘increased safety’ (Ex e) to the fieldbus barriers (figure 2: FieldBarrier) that are mounted as close as possible to the process I&C points in the field. The fieldbus barrier is mounted in Zone 1 in the field; it is a three-in-one unit working as junction box, multiple Ex i barrier and segment protector. It distributes the FF-H1 fieldbus trunk line to up to four output lines and provides protection method Ex i (‘intrinsic safety’) for the connection of the field devices in Ex-Zone 1 or 0.

Since data transfer through the Fieldbus Power Conditioner and field barrier takes place transparently, the host controller communicates with each instrument directly. Information is not corrupted. The multi-variable field devices appearing on the market today create increased data volume, since several process data points along with diagnostic information may be acquired and transferred to the control system by the same device. This reduces the number of process I&C points with the result that these modern field devices can contribute significantly to the reduction of investment costs.

The high supply power (1A, 32V) made available by the Fieldbus Power Conditioner Module for the respective fieldbus segment is fed into Zone 1 of the potentially explosive area (hazardous area) via a suitable cable using protection method Ex e (‘increased safety’). The distribution to four intrinsically safe FF-H1 branch lines, each with 40 mA supply current available for instruments is accomplished by the fieldbus barrier. Being suitable for both FISCO[4] and Entity instruments, the user has the advantage of using Entity instruments if that particular device is not yet available on the market as a FISCO device, and using FISCO instruments to make full usage of the simplified verification of the intrinsic safety (see figure 3). The higher output voltage in the field of up to 32V made available by the protection method Ex e allows longer trunk cables, as the field instruments need at least 9V to operate allowing a higher voltage drop across the cable.

[4] FISCO: Fieldbus Intrinsically Safe Concept, introduced by the German certification institute PTB in 1994

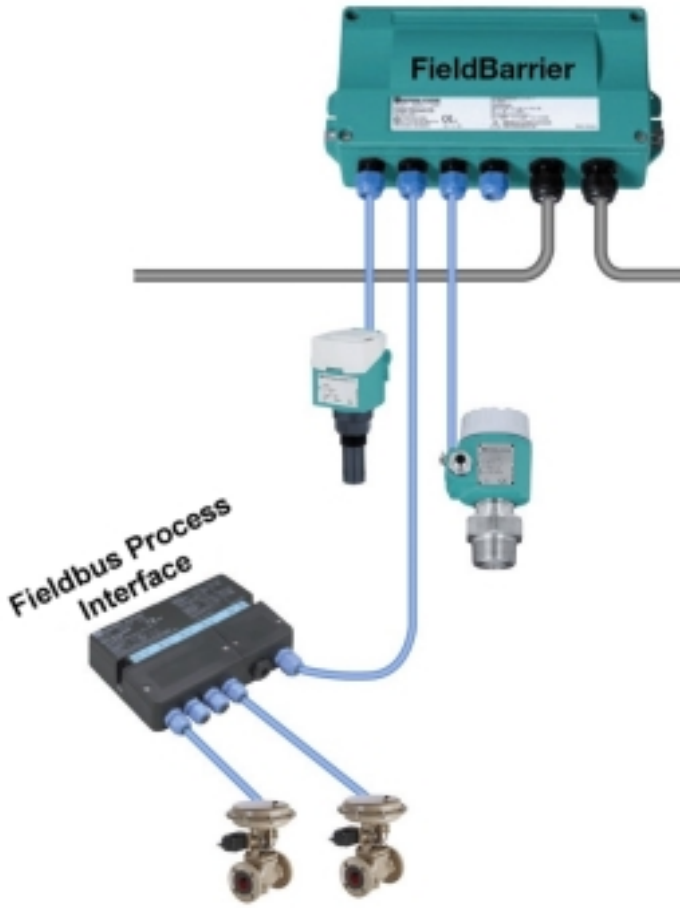

Figure 3: Typical topology with intrinsically safe field devices connected to a field barrier

Several field barriers can be operated on one FF-H1 segment by daisy-chaining the Ex e main cable, as more than sufficient power is supplied by the 1A-capable Fieldbus Power Conditioner.

Each output is individually protected against short-circuits. This ensures that in the event of a failure at one field device only this device is affected and there is no impact on any other instrument. Only by short-circuit protection in the field, a breakdown of the whole segment be avoided.

As a fieldbus barrier integrates the Ex i barriers in the field and not in the cabinet, galvanic isolation is provided in the field. This eliminates the necessity of equipotential bonding and eventually can reduce costs.

Currently not all field devices are available with a fieldbus interface. For simple binary signals a direct connection to the fieldbus is often not economically reasonable. The busload would be inefficiently increased and to provide a simple sensor with a bus interface is not acceptable for cost reasons. A field interface box, acting as a fieldbus remote I/O, can connect to such signals and economically solve that problem. By using the ‘increased safety / intrinsic safety’ power supply concept and the system components described herein, the optimum fieldbus installation can be realized for any application in process technology.

10. Further FuRIOS results

In addition to considering the pure investment costs, ‘FuRIOS’ also provides an evaluation of the operating factors. It has been shown that a plant with fieldbus technology can be brought into production in significantly less time than its counterpart with conventional / remote I/O systems. The training requirements for the operating personnel are lower; more accurate measurements result in a higher product quality, and even fault isolation and repair is shortened significantly due to the extensive diagnostic features integrated in fieldbus devices. Yet another benefit is that the use of fieldbus allows improved asset management of the plant.

In terms of engineering and installation FuRIOS identified savings potentials that could be optimally realized by the use of a comprehensive installation system.

11. Summary

Aventis Pharma Deutschland GmbH commenced the planning of the construction of meanwhile three production plants incorporating the principles postulated in the FuRIOS study and using the described technology.

NAMUR working group 2.6 ‘Fieldbus’ stated that further savings potentials for fieldbus technology over Remote I/O systems are confirmed by the FuRIOS study.

12. References

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