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Rationale of the need for a world-wide standard to network computer systems in indoor livestock systems

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1. Problem context

An increasing number of electronic components are being applied for monitoring, application and control in farm livestock production too. For example:

• liquid feeding systems have a process computer,
• barn climate control computers have replaced transformers,
• electronic individual animal identification is possible,
• milk recording is now electronic,
• the state control association (LKV) offers access to agricultural data via E-mail or Internet,
• livestock data are sent via Internet to the HIT databank to check source information regarding cattle,
• sow and cow planners ease labour organisation and financial planning.

For all the above examples there are technical solutions for farm production and its adjacent stages. However, it is very difficult to take data from one stage, from a firm-specific solution, and transfer it to another stage or into the solution of another firm. Thus data from the feeding computer A and that from the climate computer B cannot be transferred practically into the sow planner C, and certainly not into a program for field work such as a field-mapping file.

The objective of the BUS system "indoor livestock systems" is to standardise data exchange between the systems used on the farm and connected with the farm (sensors, process computers, management programs, upstream and downstream areas) via a standardised BUS with the aid of ADIS/ADED (ISO11787, ISO11788) and XML/ADED in such a way that the data generated can be used by all equipment in the barn without any obstacles. This will enable the individual items of equipment to perform their control, instrumentation and management tasks optimally thanks to the fast, up-to-date and extensive information available. Standardisation is the prerequisite for being able to realise sustainable technical progress, since this will make it possible to replace technically obsolete equipment (modularity) independently of the manufacturer and without any impacts on the overall system. This is the only way in which modularised extension (supplementing, replacement, improvement) of instrumentation and control concepts can be attained in the barn. This will finally achieve what farmers need for their investment planning: investment protection and planning security.

The prerequisite for effectively organising data exchange is first of all to use a coordinated protocol for data transport. It is equally indispensable to standardise the data contents (item and entity) with the aid of a data-dictionary in such a way that the participating components automatically take over the communicated data into their systems and can understand them when executing the program. ASIS/ADED is the protocol that is widespread in livestock

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production and it conforms with this objective. Lists of attributes and data structures are made available with the aid of a comprehensive data dictionary that is constantly being developed further. This enables the participating units to take over the communicated data into their systems automatically and understand them when executing the program. The existing data-dictionary offers a basis for the BUS-system that still needs to be expanded by a data model for the barn. Coordinates for classifying the data such as are needed for selective access to a data pool in the barn (barn, pen, compartment) have yet to be elaborated. Whether these data have to be filed in a server once or be supplied continuously with each data communication will depend on the specifications in the BUS-system for indoor livestock systems. Basically, master data (component identification, description, classification) as well as movement data (measurements) are to be taken into account. The livestock data (individual animals, group), their production results and the inputs used (feed, medicaments) are to be allocated to the data of these components.

Standardisation of indoor livestock systems must be able to carry out all required data transactions between the systems involved. The standard is not only supposed to cover the networking in animal management (such as feeding, ventilation, and capacity-related data), but also in storekeeping, purchases, sales, obtaining of information and transfer thereof (external communication), as well as with electronic systems for field work (ISO 11783, weather stations and weighing stations, etc.). The necessity for this arises from economic and ecological aspects, as well as from aspects relating to animal protection.

This broad-based area of application has economic relevance because

- the interdependencies between the production branches and production lines right through to the individual control systems can be taken into account, thus making more efficient production possible,
- double recordings of general parameters or parameters of different units can be avoided,
- continuous and quality-oriented production will be made possible (consumer protection),
- the various communication relationships with the outside world (marketing, consultancy, administration, remote maintenance) can be standardised and thus become easier to learn and to apply.

Comprehensive networking is ecologically significant due to the fact that

- negative environmental influences do not occur during the finishing phase of production, but partly already in the pre-stages and are observed already when farm inputs are used (e.g. nutrient-adapted feeding),
- thanks to the availability of all relevant information, production processes can be controlled in such a way that environmental interests can be catered to as well (control of ventilation unit),
- an environmental balance (field/farm-gate balance) can be carried out.

The networking becomes relevant with regard to animal protection through the fact that

- data recorded from animals can also be monitored comprehensively and at any desired point,
- the interdependencies between well-being and environment can be taken into consideration when regulating (e.g. the combination of feed distribution based on the feed intake capability or ventilation/climate control).

It can be derived from these advantages that only comprehensive, system-embracing networking allows for overall observation of the interdependencies and for optimal control of production with consideration given to the demands of the animals and the environment. Networking leads to "Intelligent Animal Management Systems". Moreover, reliable and credible documentation of production manners is possible – a fact which is becoming more and more important for consumer acceptance of agricultural products and is now already increasingly a demand of the food retail chains (QS quality symbol).

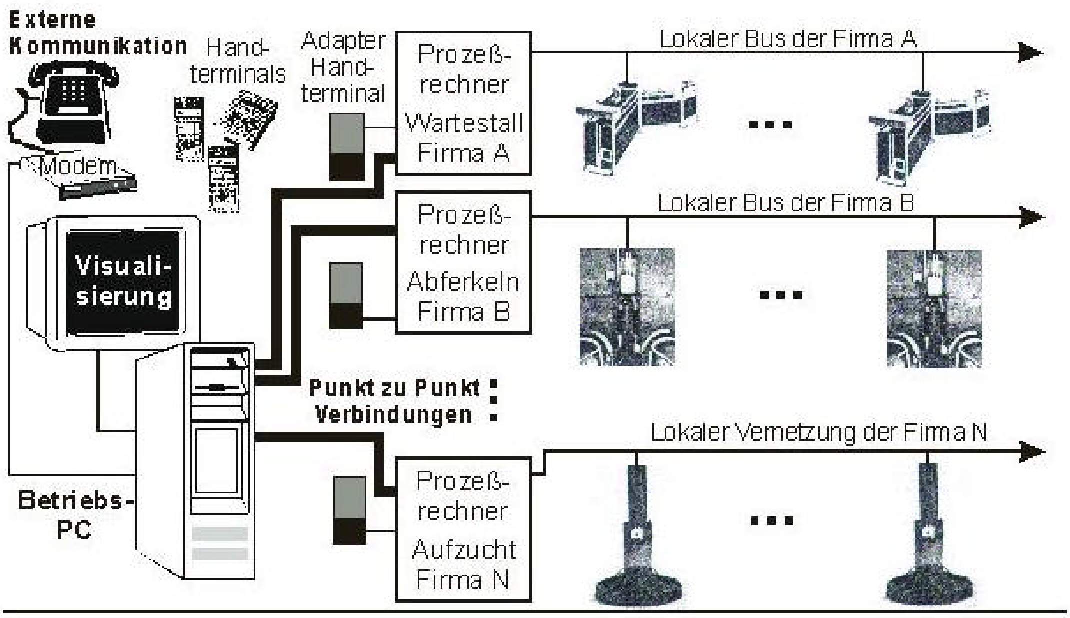
2. Current status of networking

The current status of networking control and regulation systems in indoor livestock systems is characterised by the historical gradual progress from micro systems for certain tasks, e.g. individual distribution of concentrated feed, all the way to systems that monitor, control, or – if required – regulate important process sections for certain animal species with pre-determined production targets (dairy cows, breeding pigs, or fattening pigs). Within the framework of this development process the necessity of system parts being network-capable in order to form a complete system was recognised. So far only company-owned products are directly suitable for networking, as the layout of connection lines as well as the protocols used for data exchange represent "in-house" solutions. Complete management systems are currently only offered for the management of dairy cow herds as "island solutions".

As a consequence of the current situation, the constellation as depicted in **Figure 1** applies if e.g. a large-scale pig farmer wishes to employ optimal or up-to-date systems for a specific production section. Similar configurations occur in the case of other branches of production.

The disadvantages of the solutions currently prevailing are particularly marked by the fact that

- an individual hand-terminal is required for each individual process computer. Different kinds of hand terminal cause unnecessary expenses and require unnecessary training input as well as attention during usage due to the specific operating instructions. There is no mutual exchangeability, e.g. in the event of defects.



Source: according to Nordbeck

Figure 1: Networking with a mix of process control system manufacturers in the production branch sow management and piglet rearing

- networking with the farm PC can only be realised on a manufacturer-specific basis.
  The main problem here lies not so much in the connection to the PC, but rather in the utilisation of data. The transfer of data (input and control parameters) recorded in the production process into a foreign software, as well as transfer of the values calculated in this way into the control (regulating variable), requires specific software interfaces. Software is expensive and will therefore only be available for systems with a considerable market share. This leads to marketing barriers when new products are introduced.

- the continuity of data across production sections will show gaps if no (expensive) special PC software can be obtained.
  The degree in difficulty of networking increases if several foreign systems are to be system-comprehensively controlled and regulated at PC level. For this a general definition of transferable data is required, as occurs e.g. by means of the "Identifier" in the case of ISO 11783, or by the DDI number in the case of ADIS/ADED. Furthermore, it must be known when and how data were recorded. Repeated recording of readings is currently still common practice.

To avoid these problems in part, new systems employ BUS concepts (CAN on field level; Ethernet on transmission level). The common factor for these solutions is their origin from different companies, so that all the above disadvantages for foreign systems still apply.

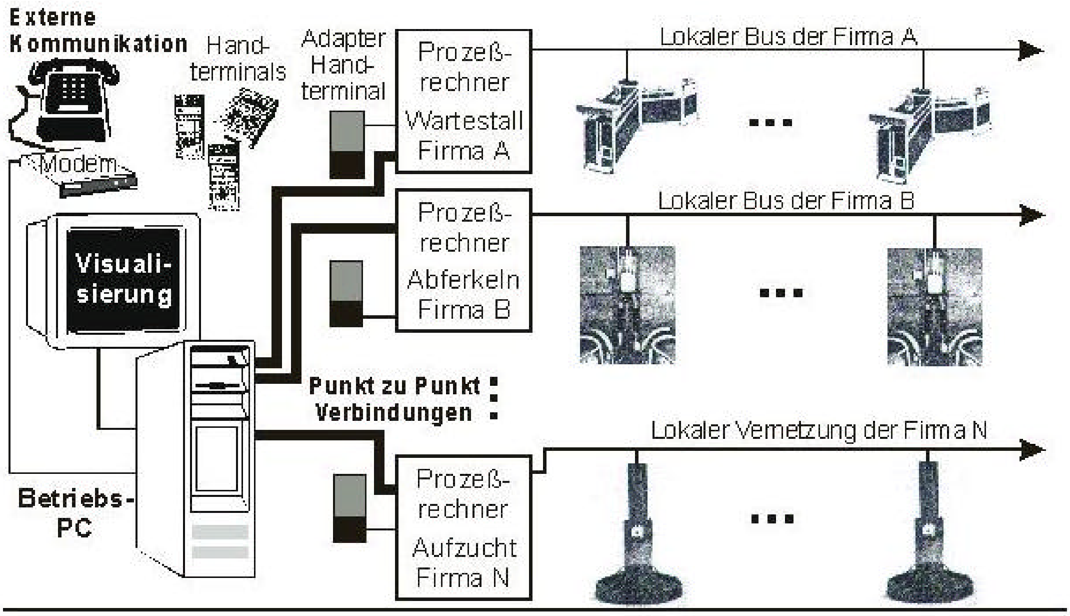
3. Potential solutions for standardisation

The special requirements of agriculture have to be taken into consideration when such a far-reaching standard for the networking of computer systems is laid down. Support is provided in a paper by Gruhler und Rostan (1993), evaluating technological and strategic criteria, as well as financial aspects.

The world-wide application of Ethernet has led to a constant fall in prices for the components required. This cost reduction, together with the advantage of a worldwide standardised record (TCP/IP), has brought about Ethernet's entry into the domain of industry at data level and even up to sensor/actor levels (e.g. Jetter AG). New developments aim for favourable Ethernet junctions in automation. Besides the chips, the entire software range is offered; consequently systems can be developed within a short time (Strass und Evensen, 1999). However, the priority objective is standardisation up to data level.

With consideration given to the developments described, and taking into account the current development status of electronics use in agriculture, the concept illustrated in **Figure 2** could show a targeted solution for indoor livestock systems. It derives from the fact that

- a "Higher-level Bus" is defined which combines all networking systems,
- the data exchange between the systems takes place with data defined in ADED, and
- transfer – as far as compatible with TCP/IP – takes place according to ADIS.



Source: expanded according to Nordbeck

Figure 2: System concept for the networking of computer systems in indoor livestock systems

As the figure shows, in the solution suggested existing computer-supported systems can be connected to the new standardised Bus by means of a bridge. This allows for a continuous transition from individual systems to a coupled overall system for indoor livestock systems. However, the bottom branch in Figure 2 also indicates that it might be interesting in future for manufacturers to extend the Bus all the way to individual process controls too. However, the primary objective of this work is to define the "Higher-level Bus" system.

For all involved, the development and implementation of the standard represent an intensive dialogue with the material and the standards already in place or in preparation for agricultural applications. Compatibility between the new standards and those in place or in preparation is to be targeted.
The new standard for indoor livestock systems should be built up in layer-oriented fashion with reference to the OSI layer model. This ensures easier adaptability if a layer changes due to technical alterations, e.g. a change in the physical transport medium. The allocation of the ISO number should be structured approximately as follows:

Part 1: General Standard (overview)
Part 2: Physical Layer
Part 3: Data Link Layer
Part 4: Network Layer
Part 5: Network Management
Part 6: Application Layer
Part 7: Management Information System Data Interchange.

The final structure of the standard should, however, be reserved for the working group to be established.

4. Preparatory work

In order to simplify the inter-equipment communication and data transfer between the different stages in future, a working association has been initiated and established through the BFL to prepare standardisation on ISO and DIN levels. The standardisation is to take account of the long-established standards for the upstream and downstream areas, as well as field work. This working association "BUS system indoor livestock systems" has created three working groups.

Working group 1 is occupied with the physical layout of the networking.
The special working conditions in animal housing are considered here, such as temperature, humidity and aggressive gases, but also cost and hardware requirements. The concept should enable the adoption of mobile systems and wireless radio communication in future. The extensions or limitations to already existing standards for the above have to be elaborated.

Working group 2 is developing a concept for the necessary communication and configuration software in the networked controllers.
- To this end it is necessary to check with what software tools and what configuration parameters data exchange between the individual units in the system can be configured in automated manner.
- It must also be checked – on the basis of licence conditions and expediency – whether standard tools or alternative processes can be used for this purpose too.

Working group 3 is concerned with calculating a data model and data management in the Data Dictionary. Here the following must be examined,
• whether ADIS/ADED or XML/ADED interfaces should be applied,
• how the required items and entities can be generated,
• how data management is to be carried out and how access to the data should be controlled,
• how and whether the process steering data are to be integrated,
• how data management and updating are to be ensured in the long term.
Members for the three working groups have been named and have started activities. Members communicate via a forum under www.bfl-online.de and at meetings.

5. Outlook

Computer-supported livestock production (Precision Livestock Farming) will only be made completely possible through the standardisation of the BUS system for indoor livestock systems.
Sufficient approval for a "New work item proposal" from the international partner organisations for standardisation has been secured for the standardisation in advance via enquiries made by members of the working association "BUS system indoor livestock systems". This secures the prospects of fulfilling the formal requirements for setting up an ISO work group too. Substantive preliminary work performed by the working association and the three working groups will be contributed to the ISO working group.

6. Literature

Books and offprints

Artmann R.: Entwicklungen auf dem Gebieten der Sensorik, Aktorik, Aufbau von Kleincomputersystemen sowie Lösungsansätze für die Kommunikation. Prozeßsteuerung in der Tierhaltung – Konzepte, Datenerfassung, Kommunikation . – Schriftenreihe der Landtechnik Weihenstephan (1983) H. 4, p. 32-72.

Auernhammer, H.: Konzepte für den Einsatz computergestützter Prozeßsteuerungssysteme in der Tierhaltung. Prozeßsteuerung in der Tierhaltung – Konzepte, Datenerfassung, Kommunikation. – Schriftenreihe der Landtechnik Weihenstephan (1983) H. 4, p. 5-31.

Etschberger K. (Hrsg): CAN; Grundlagen, Protokolle, Bausteine, Anwendungen. – Munich Vienna 1994

Furrer, Frank (1998): Ethernet-TCP/IP für die Industrieautomation – Grundlagen und Praxis.

Gruhler, G.; Rostan, M.: Auswahl eines Feldbussystems für die Produktion. – Elektronik plus (1993), H. 6, p. 77-82.

Industrial Ethernet-Informationstechnologie in der Automation. Praxis Profiline. Vogel Verlag. ISBN 3-8259-1908-8

Iwanitz, F. u. J. Lange (2002): OLE für for Process Control – Grundlagen, Implementierung und Anwendung. Hüthig Verlag Heidelberg

Jetter AG (Hrsg): JetWeb - die Technologie nach der SPS-Ära. – JetWeb Journal, Issue 1.

Kriesel, W.; Heimbold u. D. Telschow (2000): Bustechnologien für die Automation – Vernetzung, Auswahl und Anwendung von Kommunikationssystemen. 2. Aufl. Hüthig Verlag Heidelberg

Nordbeck, F.: Basis for discussion from Mannebeck GmbH for the working group "Bus system in indoor livestock systems" on 17.8.1999 in Braunschweig.

Lawrenz W. (Ed.): CAN; Grundlagen und Praxis. – 2nd edition, Heidelberg 1999

Ratschow, J.-P.: Stand der Entwicklung eines BUS-Systems für die Innenwirtschaft. LANDTECHNIK (2002), H. 6, p. 369

Strass, H.; Evensen, M.: Die totale Industrievernetzung. Baustein-Software-Paket für kompakte Ethernet-Knoten senkt Vernetzungskosten. – Elektronik (1999), H. 12, p. 46-52.

Standards

ISO 11787 Machinery for agriculture and forestry – Data interchange between management computer and process computers – Data interchange syntax 1995

ISO 11788 Electronic data interchange between information systems in agriculture – Agriculture data element dictionary
Part 1 General description
Part 2 Dairy farming
Part 3 Pig farming

Extensible Markup Language (XML) 1.0 http://www.mintert.com/xml/trans/REC-xml-19980210-de.html

Working papers

IDA – Interface for Distributed Automation WHITE PAPER V.1.0 April 2001 (938 KB, PDF); http://www.ida-group.org. to be found under Press Releases

Introduction to Real-Time Communications on Internet Protocols; Can Ethernet be Real-Time (and some other interesting papers). http://www.rti.com/products/ndds/leads.html

Interesting Internet addresses

www.jetter.de
www.ida-group.org
www.iaona-eu.com
www.rti.com

Procedures for drafting a standard

ISO/IEC DIRECTIVES – Procedures for the technical work.
ftp://iso.ch/pup/out/directives/en/dirp1.html