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Networking and Software Integration in Pig Production

In animal husbandry a huge number of management software and electronic systems are used. Using these electronic aids will make more efficient process control and process documentation possible in the future, provided they are linked with an integrative system and can benefit from data from others. Much development is needed on the path to consistent hardware and software networking. A first major step was done in 2007 with the publishing of the ISOagriNET standard [2]. Based on this standard, a sensor and implement network is being developed as a Farming Cell. This emerging ISOagriNET prototype demonstrates the possibilities and limitations in the crosslinking and will push the development and dissemination of ISOagriNET ahead.

In pig housing systems electronic devices and management software are widely used to monitor and control processes. Unfortunately, most company specific solutions are autonomously working and usually do not provide multilateral data exchange in local networks. In order to take advantage of an integrated hard- and software infrastructure, the ISOagriNET standard [1] was established. This international standard focuses on the integration of devices in livestock systems by defining the complete process for data transmission between participants and the data formats to use. That way hard- and software products, e.g. feeding, ventilation and management software can use each other's data and publish their own [2].

Main target of this project is to build an ISOagriNET on farm network for livestock systems, called Farming Cell, which integrates electronic devices and software products. The development process includes the modification of present devices, developing of new hard- and software and furthermore the implementation of suitable data flows.

The first challenge is to set up an integrated IT system by adapting the existing hard- and software to the ISOagriNET standard. For a successful implementation companies have to be cooperative. Their software products mostly have to be modified or separate gateways need to be developed. The second challenge is the development of ISOagriNET compliant hardware and corresponding software to connect sensors, e.g. measuring emissions, water or energy consumption, to the network. In addition, a web based application will be developed to control and monitor the entire Farming Cell.

The Farming Cell is implemented at the research station for fattening pigs, Unterer Lindenhof, at the Universität Hohenheim and will demonstrate the potentials of the new standard.

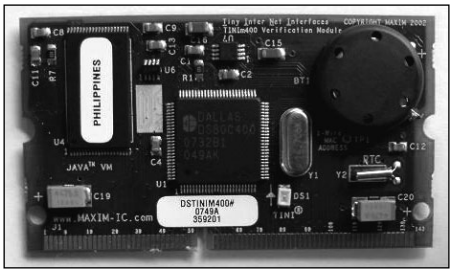

Fig. 1: TINI microprocessor platform

Concept

The development process is divided into two steps dealing with the hard- and the software level. First it is necessary to connect all devices to the local area network. In a second step new software is developed or existing software is adapted to ISOagriNET needs.

Based on the criteria hardware connectivity and complexity of software functions, two groups of devices can be formed. On the one hand there are system units like the feeding or climate control. They offer various hardware interfaces and complex functionalities. On the other hand simple sensors (water- and voltage meter, NH_3, CO_2 etc.) are in use. This group of devices does not offer any functionality but simply output an impulse or a voltage. All components of both groups have to be adapted to ISOagriNET in the two steps mentioned before. The next chapter explains the possibilities of linking different types of components to the local area network. Afterwards the software level of the Farming Cell as the second development step will be described.

Table 1: Hardware properties of the system units

System unit	Hardware interface	Ethernet connectivity
climate control	LON-Bus	no The device is controlled by a computer connected via LON-Bus to RS232 adapter.
scale with electronic animal identification (RFID)	RS232	yes RS232 to Ethernet adapter
feeding control	RS422	yes RS422 to Ethernet adapter

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Keywords

Data exchange, farm network, data base, ISOagriNET, Farming Cell, IT FoodTrace

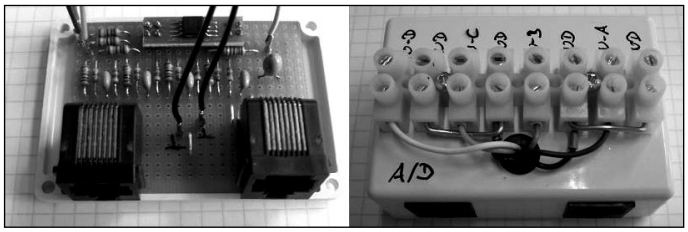

Fig. 2: One-Wire A/D module (left: interior view; right: exterior view)

Hardware level

To collect data and control processes, various system units and sensors are installed in the stable. They all differ in terms of their Ethernet connectivity and therefore different strategies were necessary to link the devices to the local area network.

The system units with their hardware interfaces and the way they are connected to the LAN are listed in *Table 1*. Climate control and scale are already connected to the Ethernet, whereas the ability to establish a TCP connection to collect data or control the system units needs to be implemented in a following step (compare next chapter).

In contrast to the first group of system units, the second group containing simple sensors does not offer standard hardware interfaces. All present types of simple sensors, their quantity and the signal type they output are listed in *Table 2*.

To link these simple sensors to the Ethernet, additional hardware is needed. As no suitable and ISOagriNET compliant products are available, a self-development was necessary. The microprocessor platform TINI[1] from Maxim shown in *Figure 1* served as a basis.

The TINI platform offers many hardware interfaces as for example Ethernet and One-Wire. Furthermore it has a fully implemented TCP/IP stack and a Java Virtual Machine 1.1. Therefore the TINI can serve as an interface for simple sensors which are linked via also self developed One-Wire modules. *Figure 2* shows a One-Wire A/D module for sensors outputting voltages. To link sensors with impulse signals, a second type of module with integrated counters is also available.

Table 2: Hardware properties of the sensors

Sensor	Quantity	Signal
water meter	16	Impulse (S0)
electric meter	9	"
heat meter	2	"
differential pressure	1	Spannung
NH_3	1	"
CO_2	1	"
temperature	1	"
brightness	1	"
humidity	1	"

Using the TINI board with attached One-Wire modules, both types of sensors can be connected to the network (compare *Figure 3*). In addition, a web service for configuration purposes is running on the TINI. Settings like type of sensor, conversion formula and others are available for each sensor.

The ability to connect system units and sensors to the Ethernet in the described way leads to high amounts of data. This data has to be stored in a permanently available database. As a low cost and low power database server, the Network Storage Link for USB 2.0 (NSLU2)[2] by Linksys is used. The NSLU2 was originally built to connect hard disc drives as Network Attached Storage (NAS) to the local network. Due to its popularity a Debian Linux distribution for the NSLU2 is available opening up many possibilities of usage. In this case a MySQL 5.0 database server was installed.

Software level

The previously described way of hardware linking is followed by the implementation of software providing the needed ISOagriNET functionality. The software for the TINI platform is written in Java and offers functionality to collect data from linked system units and sensors and/or to publish data in the local area network. In addition to the MySQL database running on the NSLU2, an ISOagriNET Server software was developed and installed. It collects data from devices available in the local area network and stores it in the database.

[1] The tiny Internet interface (TINI) from Maxim is a Java programmable microprocessor board. http://www.maxim-ic.com/products/microcontrollers/tini/

[2] On the NSLU2 by Linksys runs Debian, Java Runtime Environment 1.3 and a MySQL database.

Besides the TINI boards and the NSLU2 there is a standard personal computer present in the network. The so called Management PC is hosting the management software for pigs which is a commercial product by agrocom GmbH. A database is integrated in this product and stores the animal data. In addition the Management Computer will host a web server offering a web service making basic data of the farm and the pigs accessible. This service has not been implemented yet.

Conclusion and Outlook

The implementation of an over all IT-system by linking up individual hard- and software components is very complex and needs experts with hard- and software skills. Mainly due to incompatibility of hardware interfaces and the lack of ISOagriNET compliant software interfaces, the development effort is very high. Companies and administrative bodies are supporting the development.

The decision to use the TINI platform leads to a cost-efficient and flexible solution. The prototype will help to evaluate the benefits and drawbacks of the standard. Further it contributes to the implementation of standards within a heterogeneous hard- and software world.

Acknowledgements

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Literature

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[2] *Paulsen, C., D. Martini und M. Kunisch* : Austausch von Daten aus der Tierhaltung mit agroXML – Konzeption der Zusammenarbeit mit ISOagriNET. KTBL-Schrift 454, Darmstadt, 2007, S. 97 – 104

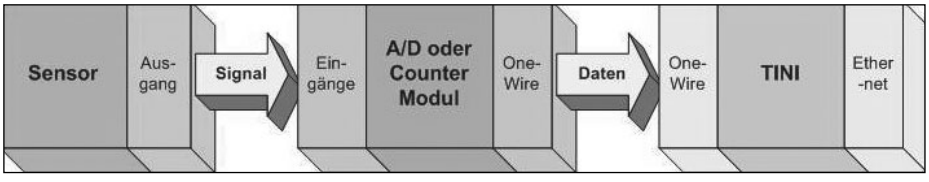

Fig. 3: Principle of sensor linking