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Wireless Data Transmission in Farm Management Information Systems

In order to connect individual systems for data collection and -utilization and, hence, to generate a surplus value for the farmer, suitable and generally accepted interfaces are required first and foremost. Current examples for the standardization of data formats are part 10 of the ISO 11783 standard (ISOBUS) for data transmission between machines and farm management as well as the industrial standard agroXML for data exchange between business partners. In addition to the determination of formats, the technical diversification of data transfer within the farm also influences the sequence of operations and work efficiency.

Data exchange between farm management and the work process, i.e. between the office and the machine, takes place in two directions. First, data are transferred from the office to the machine in order to transmit electronically pre-defined tasks. This includes the transfer of very general information about the individual tasks as well as detailed spatial information, such as application maps for fertilizing. Second, detailed process information provided by GPS-, tractor-, implement-, and sensor values can be transferred back to the office as task-related or continuous documentation.

Manual Data Transmission with the Aid of Removable Data Carriers

Since the introduction of the on-board computer on the tractor, storage media for data exchange with the office PC have been used: first chip cards, later removable data carriers, such as PCMCIA storage media or other PC card formats, and today often USB sticks. The latter allow virtually unlimited quantities of data to be stored today. Therefore, storage-intensive XML-based data formats can be used, and large quantities of process data can be stored over long periods. In addition, all standard PCs have a USB interface. This kind of data transfer is termed manual because the removable data carrier must be "carried" from and to the machine. This, in combination with the environmental conditions on agricultural machines, leads to some disadvantages:

- The data are read out irregularly.
- The data carriers are endangered by dirt and mechanical influences.
- Data transfer takes time.
- Data carriers may get lost.
- On large farms and in contractors´ businesses, many data carriers must be managed.

On family farms and on farms with a small staff which rarely changes, this kind of data transfer can be sufficient if operational work organization guarantees regular data transfer and thus minimizes the risk of data loss.

Wireless Data Transfer on the Farm

In order to reduce the mentioned disadvantages of storage media use and to enable da-

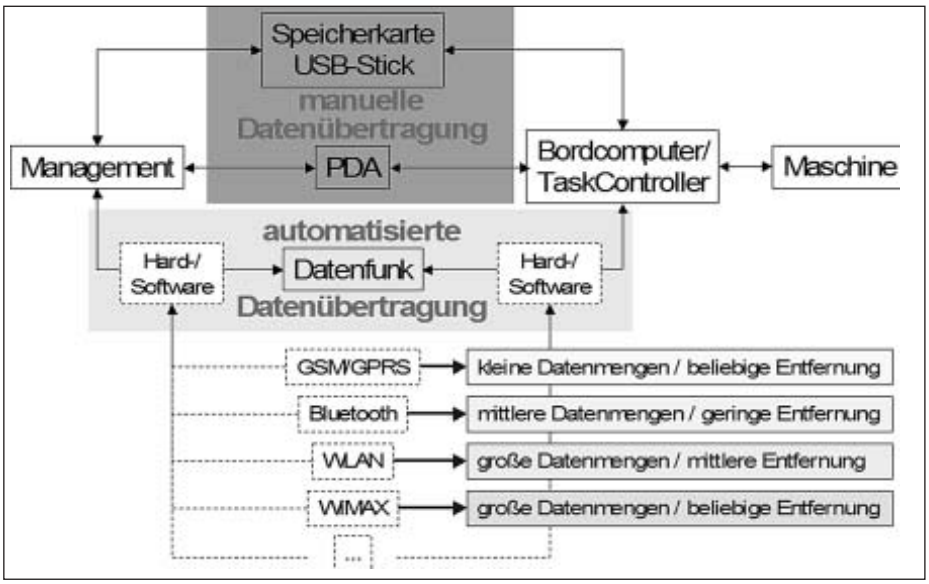

Fig. 1: Technical diversification of data transfer in farm management information systems

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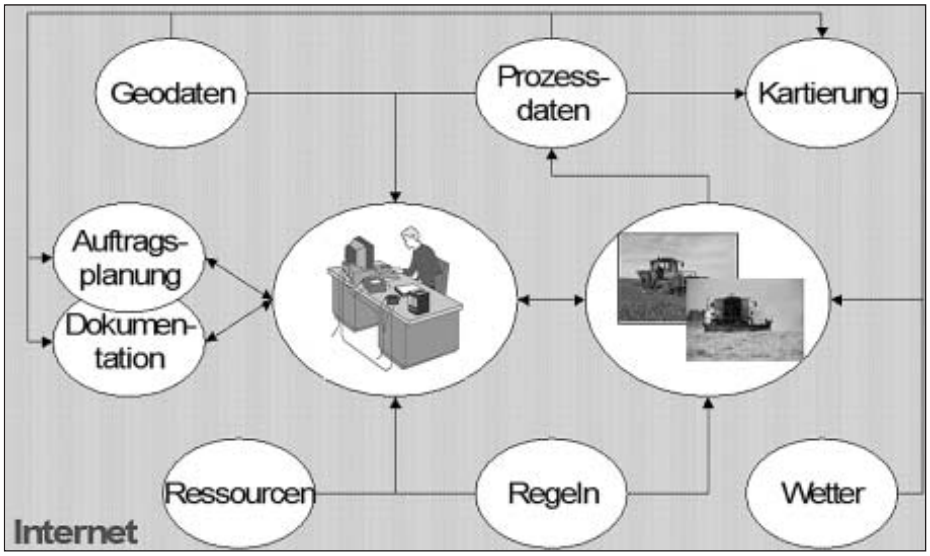

Fig. 2: Example of a future Service Oriented Architecture for farm management information systems

ta transfer between farm management and the work process to be largely automated, several different methods of wireless data transmission are available today. These methods differ with regard to availability in the area, bandwidth, range, and transmission costs. The additional expenses for the required technical infrastructure and configuration on the farm vary depending on the system.

The mobile communications standards GSM and GPRS are available virtually everywhere today. A modem in the data collection system of the machine enables data to be transferred directly to the mobile communications network and, hence, to any desired location. Due to the small bandwidth and the high transmission costs, however, this method is only suitable for general task data and aggregated process information, but not for high-resolution geo-referenced process data. The mobile communications standard UMTS has a larger bandwidth. However, it is not available everywhere especially in rural areas, and the transmission costs are also high. For the transmission of large quantities of data in the operational area, Bluetooth and Wireless Local Area Network (WLAN) are suitable communication standards. For these systems, a network must be installed. Bluetooth devices can also be networked ad hoc. In addition to the WLAN-capable data collection device, the installation of a WLAN requires the establishment of an access point which allows data to be transmitted from and to a local network or the internet. This system is suitable for wireless transmission over a distance of approximately 10 to 100 m. In the coming years, wideband networks, such as WIMAX (Worldwide Interoperability for Microwave Access), will be extended. These networks will provide wireless access to the internet without a separate network, which is comparable with access to mobile communications networks or mobile telephones today. In addition, potential data transmission rates are very high. This allows mobile machines to be connected directly to internet-based information systems. The different data transmission techniques and their properties with regard to the range and the quantity of data which can be transmitted are shown in *Figure 1*.

In addition to data transmission between the work process and farm management, the use of so-called ad-hoc sensor networks could play an important role on farms in the future. A wide variety of reasonably priced sensors for small-scale soil moisture measurement which are distributed over the farm area and provide continuous information with the aid of the transmission standard ZigBee may serve as an example. Every participant in the network also serves as an amplifier so that total distances of several kilometres can be covered.

Service-Oriented Architectures for Networked Information Systems

The increasingly automated exchange of data and information will not be restricted to the farm boundaries. The use of efficient server applications and the internet for data processing and -utilization in networked information systems provides significant advantages over current local data processing systems. In a service-oriented architecture, different services can be networked using standardized web-service interfaces. While the individual services are specialized in certain, limited tasks, this allows once-collected data to be used flexibly for several different purposes (*Fig. 2*). Given the growing complexity of the data models, which is necessary in order to model the complex reality of connections in the production and the value-added chain of agricultural operations, development work must focus on the simplification of the operation and the use of information systems as compared with current data processing applications by means of intelligent networking and automation.