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REQUIREMENTS FOR A STANDARD FOR TRACTOR-IMPLEMENT COMMUNICATIONS

by

H. Auernhammer

Institut für Landtechnik
Technische Universität München
Freising-Weihenstephan, Germany

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Summary:

For standardization of data interfaces concerning the use of electronics in tractors and implements, a four-step concept is recommended. Process control computers for single implement control need basic signals from the tractor. Electronic multi-implement control requires central operation from the driver's seat. With partially automatized processes, access to final control elements in the tractor must be an option. A full integration of electronic steering and control in tractor and implement results in fully automatized processes. If implements may access tractor functions, high security standards are to be observed.

Keywords:

Agricultural Bus-system, Tractor, Implement, Communication, Standard, Electronics, Interface, Process Control, Automatization

INTRODUCTION

Tractors nowadays occupy central positions in every farm. This stage was reached via two essential developments: with the advent of air tires, tractors left the field in order to take over varied tasks, gaining almost unlimited mobility in the process. Then, due to the hydraulic lift with three-point-linkage, tractor and implement developed into a self-propelled tractor-implement unit with extremely diversified applications.

By now, tractor development is approaching its third stage. Mechanics and hydraulics are now able to communicate via electronics. Communication is possible between vehicles, between tractor and implement and between mobile unit and farm management.

If these new possibilities are to be used to their full potential, the following conditions must be considered:

- farmers should be ensured independence of the manufacturer by means of interface standardization
- new technology ought to fit into already existing mechanization systems
- a step-by-step extension on the way to fully automatized processes is desirable.

MECHANIZATION TRENDS

If current mechanization trends in agriculture are analyzed, two systems with two applications each emerge:

The Self-Propelled Vehicle System

With the advent of the hydraulic three-point-linkage and the resulting tractor-implement combination, a self-propelled unit developed in Europe. For decades it only consisted of the respective tractor and a single implement. The total number of implements was limited. Most popular, from the very beginning, were plow and cultivator, i. e. harrow. They were followed by fertilizer spreaders and field sprayers. Forage farms soon also had mowers which were later supplemented with implements for forage handling such as tedders and swathers. Harvesters, however, were without exception pulled units.

In the meantime, an important change has taken place. Higher demands regarding technical performance and a reduction in needed manpower led to a more complex use of tractor and implement. Implement combinations supplemented or even replaced the "tractor-and-one-implement" unit. Harvesting nowadays takes place by means of self-propelled vehicles. Tractors still are responsible for transportation, now however, with large, efficient two-wheeled trailers and, at the most, an additional two-axle trailer.

The Pulled Vehicle System

Yet, in areas outside Europe (and also on very large operations within Europe) the pulled vehicle system persisted and was improved. There, implements always have an own carriage, independent control possibilities and often a separate power source.

Usually, tractive force constitutes the only connection between tractor and implement. A transfer of motor-power via take-off shaft is the exception. Linked engines and implements may function completely independently from each other. Implement-owned control units electronic devices in the implements themselves may also rely on these signals. Thus, with such a configuration, the number of needed sensors can be reduced to a minimum. The standardization recommendation ISO/DIS 11786 (fig. 1) meets the above-mentioned requirements.

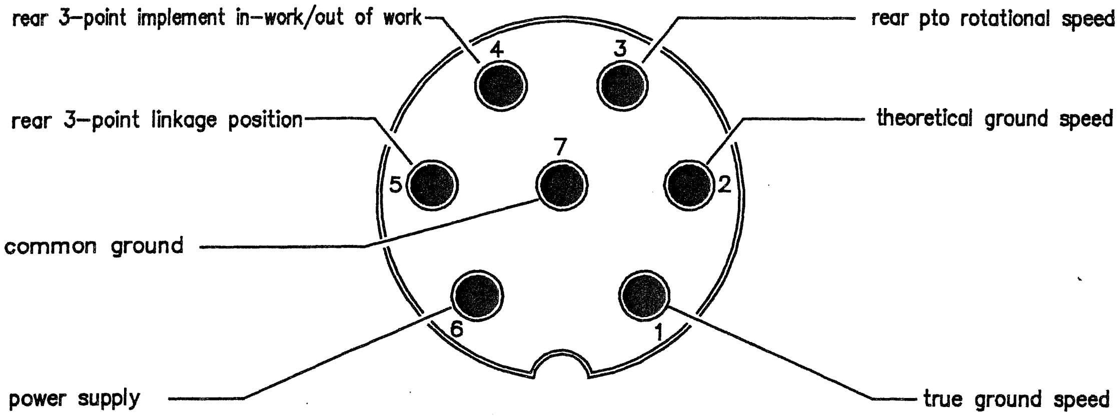

Fig. 1: Top view of signal connector at tractor according to ISO/DIN 11786; equivalent to AMPHENOL C16-1.

Multi-Implement-Control

In a system consisting of a tractor and a variety of implements, implement-specific process control computers yield the best results. The should have the following three (four) communication interfaces:

- from and to the driver
- from and to the farm management
- from implement to implement

(- basic data from the tractor for mounted implements)

For this, a bus solution is ideal. Using a multi-master-concept ensures complete independence from individual manufacturers and absolute freedom with regard to extensions (fig. 2).

For mounted implements the tractor has to provide the basic signals. This can be done by a tractor internal bus (which will be the solution for future tractors). Existing tractor have to be supplemented with a special tractor-job-controller, which will provide these basic signals (fig. 3).

Partial Automatization

For control functions, pulled vehicles and implements may require access to certain final control elements in the tractor. An example might be braking maneuvers in case of trailers

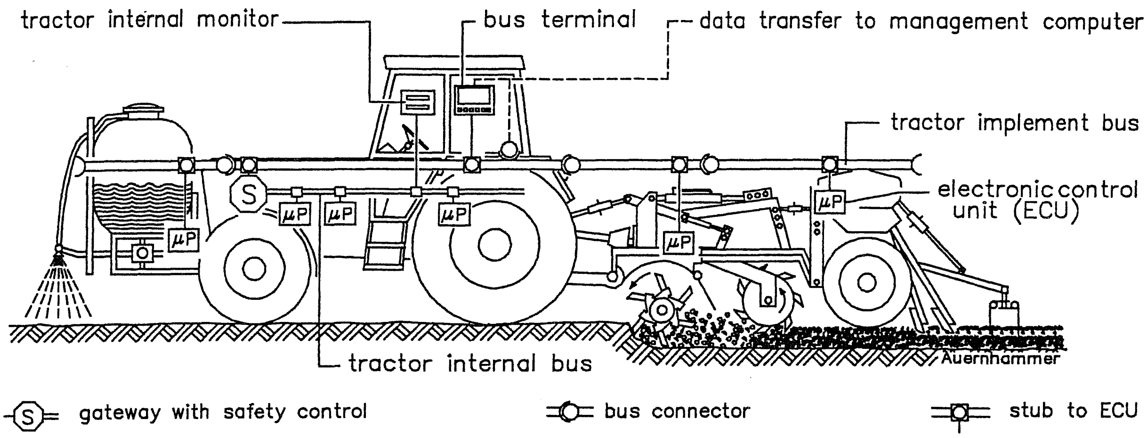

Fig. 2: Basic draft for a mobile agricultural bus-system.

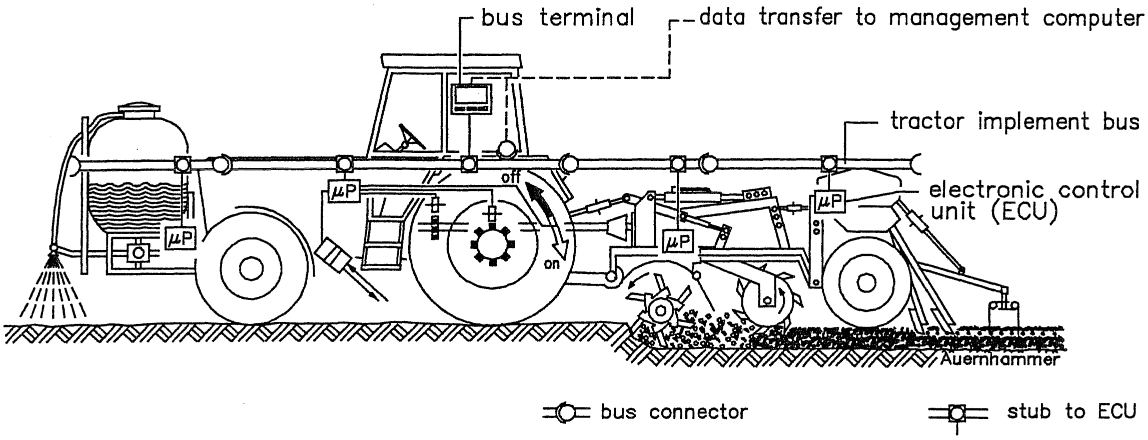

Fig. 3: Centralized multi-implement control with connection to the farm management system.

with a high transportation speed. Harvesters may control the lifting height of the three-point-linkage for depth adjustment of the share. Further possibilities are imaginable and expected. All of this will become feasible if the corresponding actuator in the tractor is integrated into the tractor-implement combination.

In such vehicle configurations, all control rests with the driver. For that reason, here, too, the multi-master-bus-system is an ideal solution. In the case of direct access from implement to tractor (driver is by-passed), however, additional security measures become necessary. Integration of the tractor into partially automatized processes therefore requires security devices according to regulations that vary from country to country. They are to be implemented at the interface of tractor-implement-bus and the corresponding tractor-actuator (fig. 4).

Full Automatization

A soon as permanent spatial integration of the tractor-implement unit is achieved, (e.g. DGPS) it is possible to conceive of fully automatized tractor-implement units, possibly

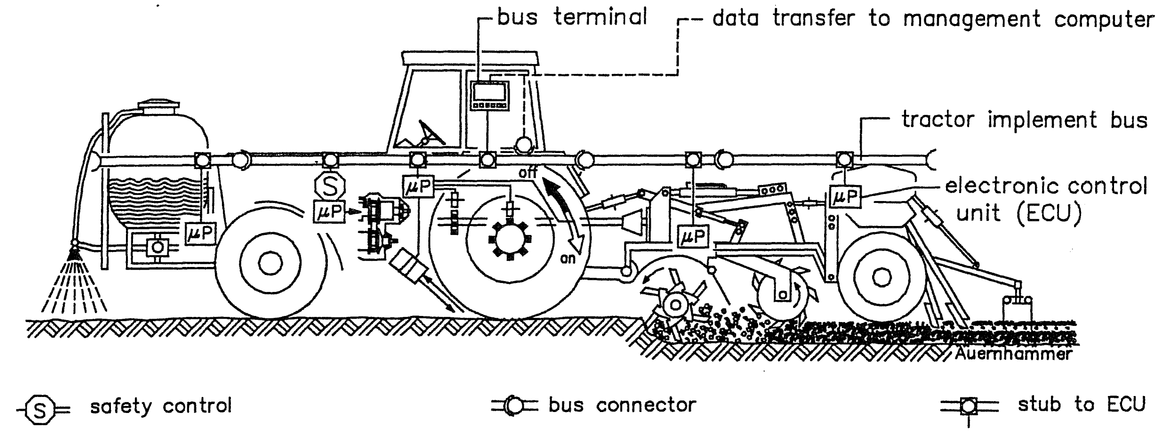

Fig. 4: Basic draft for a partially automatized tractor-implement bus.

even without a driver. As with partially automatized combinations, security and spatial activity will be of topmost importance here. In contrast, however, drive-line-management in the tractor is required in this case. This can only be realized with a tractor-installed bus-system facilitating fast communication between all involved partial processes.

Thus, demands on a fully automatized tractor-implement-system are extremely high. A unified bus structure might remove initial barriers. Still, a variety of security regulations in different countries, varying strategies with regard to mechanization and cultivation, and a difference in performance as far as electronical components are concerned will first have to be overcome. As a result, the use of diversified, not unified, bus structures will probably emerge. (fig. 5).

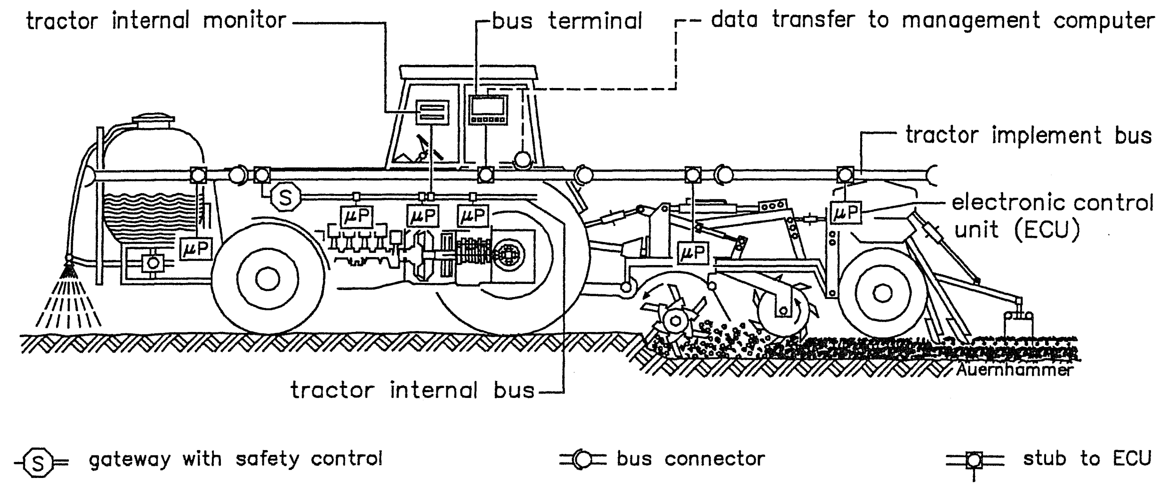

Fig. 5: Basic draft for a fully automatized tractor-implement bus.

Involvement of Operations Management

Generally, with use of electronic devices, an involvement of the operations management is desirable at every stage. Electronic devices rely on sensors which in turn continually process data. It would be irresponsible to use this information solely for process control. Instead, the data should be processed to an appropriate format and made available to the management.

Data content in a unified data format might be a resulting interface. ADIS (Agricultural Data Interchange System) according to ISO/DIS 11787 offers a defined record format. First attempts at an extensive "data dictionary" are available and will guarantee integrity of data in the future.

CONCLUSIONS

Intelligent technology within tractor and implements requires communication between the two. Standardized interfaces must ensure this. As a result, the following demands emerge:

- Implements attached to the hydraulic three-point-linkage requiring tractive power are exclusively served by a tractor-based control loop. Supplements do not require normative standards.

- For the use of single implements in connection with mobile "agricultural computers", a signal plug with basic signals for speed, r.p.m. figure of the take-off shaft and working situation (ON/OFF) will supply a universal and cost-efficient solution.

- The use of multi-implement combinations requires an open communication system at the driver's seat for independent control and operation.

- If implements have access to the tractor in a partially automatized process, security measures should be introduced and observed at the interface of tractor and implement.

- Electronics also allows fully automatized process operation in tractor-implement combinations. This calls for highest standards with regards to security measures. Spatial orientation is needed. Identical bus systems in tractor and implements are not required.

- Ultimately, these conditions can only be met by an open system in which all above-mentioned stages may be integrated. Step-by-step extensions ought to be possible. The system should furthermore be adjustable to local standards and requirements in different countries. Only then, world-wide acceptance is to be expected.

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