Implementation of ISO 11783 Compatible Task Controller

Mikko Miettinen[1)], Timo Oksanen[1)], Matti Öhman[1)], Arto Visala[1)]

[1)] Helsinki University of Technology (TKK), Automation technology laboratory, Otaniementie 17, FIN-02150 Espoo, Finland, E-Mail: timo.oksanen@tkk.fi

Abstract

Task Controller is an electronic control unit, which is responsible for all work task specific management and documentation of work in the ISO 11783 network. Task Controller is connected to farm management information system which is used for planning and storing completed tasks. In the AGRIX project a prototype of Task Controller was developed. The prototype is based on modified PDA farm management software and Task Controller functionality is implemented as an ActiveX software component. Planned tasks can be uploaded to a server and downloaded via mobile connection to PDA.

Keywords

ISO 11783, ISOBUS, agricultural implements, task controller, information management, precision farming, precision agriculture, mobile electronics, automation

Introduction

ISO 11783 standard and the related ISOBUS specification, is a new way to integrate tractor and implement control systems. ISO 11783 specifies a custom, CAN-bus based, network to which all electronic control units (ECUs) connect. The standard also specifies the roles of different ECUs connected to the network. Tractor ECU supplies tractor's state information to the network. Each implement has one or more ECUs, which provide the necessary control functions for operating the implement. Virtual Terminal is a common user interface device for all implements; other ECUs can upload their user interfaces to it online. GPS receiver can be connected to the network to enable precision farming functions.

Precision farming requires a standardized data format between mobile control system and planning software. A need to make the agricultural data more interoperable is common and some work for this is made by Korduan (2003). The lack of standardization has been a problem, and now ISO 11783 tries to solve this problem between tractor and implement but also between mobile control system and management system (Stone et al 1999). A common data format between mobile, precision farming capable, system and management or planning system will make precision farming concept more usable.

ISO 11783 Task Controller

Task Controller (TC) is an optional ECU in the ISO 11783 network. Task Controller is responsible for all task specific management and documentation of work. Task Controller is

on the other side connected to farm management information system (FMIS, a term specified in the standard). The task specific information, e.g. application rate maps, comes from FMIS and the documentation of work, e.g. yield maps, is transferred on the other direction after the task is completed. In Farm Computer the data is exchanged in XML file format, which is defined in the standard and in the mobile system ISO 11783 network is used, see Figure 1. In the standard Task Controller may have a separate configuration tool in Farm Computer; the data exchange between that tool and mobile TC is not defined in the standard.

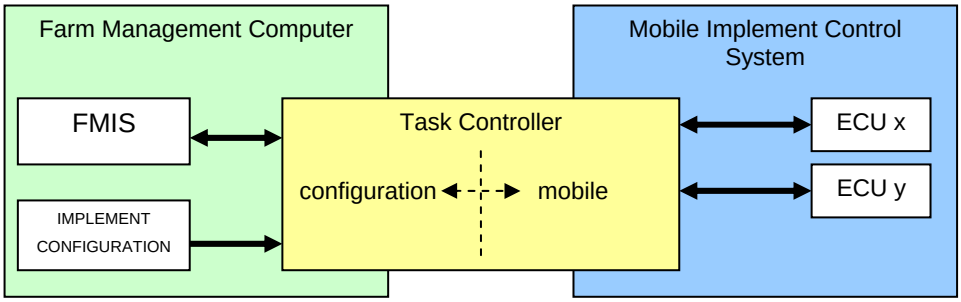

Figure 1. Task Management entities (adapted from ISO 11783:10)

The Task Management work flow is: (ISO 11783:10)

1. Planning the tasks in FMIS
2. Converting the task to XML
3. Link the task data to implement functions
4. Transferring the task to TC
5. Online TC operation during field work
6. Data collection according to specified triggers
7. Transferring the collected data to FMIS, converting proprietary data to XML
8. Converting XML to FMIS storage

Task Controller may use Virtual Terminal as the user interface or it can have its own user interface. Task Controller has operational states: initial, started, paused or completed, the last one is optional. Task Controller is also responsible for position specific control, so it acts as a precision farming unit, if the implements support online control.

In data collection phase the position and time stamps are attached to the process data, collected from the implement. The primary storage format specified in the standard is XML, the data and stamps are XML elements. However, optionally all the process data may be saved as binary format.

The Task Controller part of the standard specifies connection management for TC and all Working Set masters involved in particular task. Connection management starts upon power-

up to ensure proper initialization of the task. TC carries out the address claim procedure in accordance with ISO 11783-5 (ISO 11783:5) by sending an address claim request to the global destination address. Then it waits for 6 seconds for all the Working set masters to initialize. Thereafter TC starts cyclic transmission of the Task Controller status message to all involved Working Set masters.

The Task Controller commands and controls the participating Working Set ECUs by Process Data messages generated from the planned task data. Process Data messages sent by the participating Working Set masters are processed and converted again to completed task data by TC. Process Data message structure is specified in part 7 of the standard and the data format in part 11. (ISO 11783:7, ISO 11783:10)

Prototype system AGRIX

In the AGRIX project (Automation system for agricultural implements), ISOBUS-compatible prototype system was developed. This prototype system contained one tractor and four implements, two drills, one sprayer and one fertilizer spreader. In each implement, there was electrical or electrohydraulical actuators which were controlled by the implement controller. For precision farming purposes, most of the controllable and measurable variables were made available for Task Controller.

Task Controller support in the implement controller requires also some extra software components.

When the AGRIX project started in the beginning of 2003, the Task Controller part of ISO 11783 standard was not finished and the content of the draft was changing. As the standard was not ready in the beginning of the project, Task Controllers were not commercially available. For these reasons, a prototype Task Controller was developed.

Implementation of Task Controller

The underlying idea in our prototype was that the Task Controller functions are a natural extension to farm planning software. In the project consortium, there was one software company, BitComp, which was developing farm planning software and they also had a mobile version of the software for PDAs (Personal Digital Assistant), named WisuCE. PocketPC PDA was used as the device platform and the software of farm planning software was extended to include Task Controller functions. The division of work between researchers and programmers in the company was that the researchers develop all the code for the network side and the company programmers supplied all the needed information from their system and developed the user interface. The Task Controller extension was implemented as a separate software component using ActiveX-technology.

There were several layers in the ISOBUS-ActiveX component. Starting from ISO 11783 network side the layers were: message handler, network management, process data message and GPS message handlers, and component interface for the main program. In the message handler different type of messages were distributed. The network management layer handled the NAME (64-bit unique identifier in the standard) and ISOBUS address associations, address claiming and other address management. The process data message handler decoded the messages to real physical values. The component interface contained general functions to attach data in main program to Device Element specified in the task and on the other hand it contained software events to move documentation or feedback information back to information system.

The ActiveX component handled the network side of the Task Controller functions. The main program was used to handle XML task files from and to FMIS.

In the user interface it was possible to choose and start the task. After this the planning software reads Working Set ECU information from task file to be passed through software interface into ActiveX component. After that most of the functionalities are located in the component. It sends position information from the bus to the software as well as stores and requests task information from the planning software. This operation is shown in Figure 2.

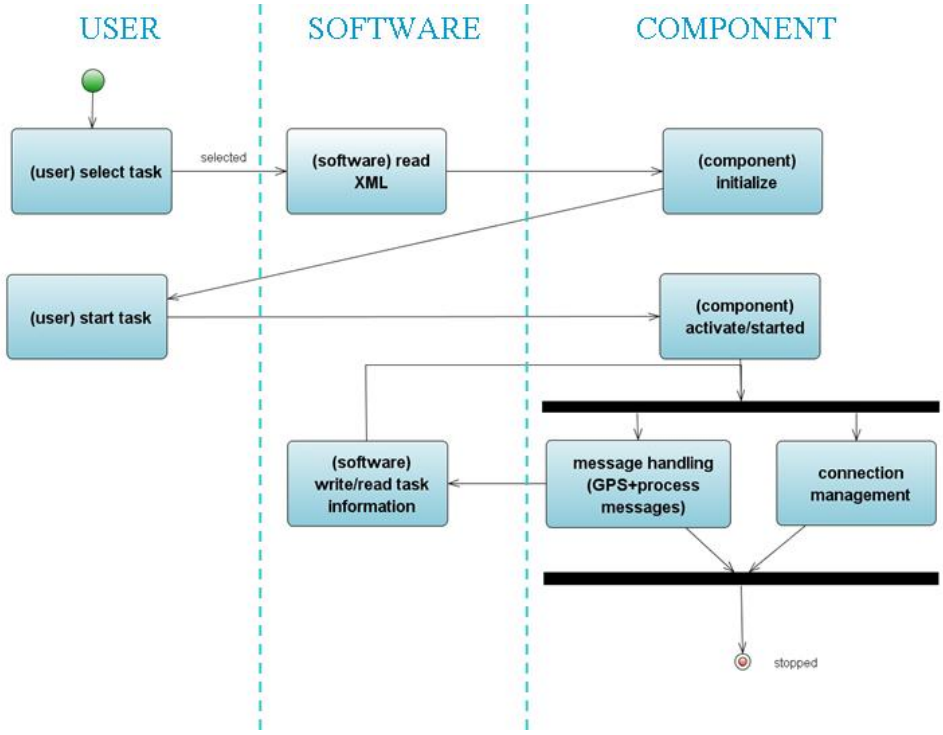

Figure 2 State activity diagram of AGRIX Task Controller

After the task is planned with the farm planning software, it was then uploaded in to a centralized field data server; this is also supported by the commercial version. The user can

download tasks into the Task Controller from the server over mobile connection (GPRS). When the task is completed the collected work information can be stored and studied in the FMIS.

Remote diagnosis and telemaintenance was also one of the studied problems in farming implements. Remote diagnosis was implemented so that it used basics of ISO 11783 standard. Diagnosis information is asked from implement by Task Controller which stores fault detection component data and can send it to the service provider through farm management information system (FMIS) or directly over GPRS connection. Both of these ways where tested in the project. Fault diagnostics was not yet defined in the ISO 11783 standard during AGRIX project. It can be concluded that remote diagnostics information can be easily mediated through Task Controller. No additional GPRS modem was needed because modern mobile phones have built in GPRS and Bluetooth. GPRS were used to connect Task Controller software on PDA to service provider. See details in Miettinen (2005) and Miettinen et al. (2006).

Our prototype of Task Controller has its own user interface as shown in Figure 3. But after the task is started by user there might be no time to check TC operations from the interface, this is why it was decided to give the TC ability to "speak" to the user. This was implemented into the TC ActiveX software component. The component speaks to the user with voice

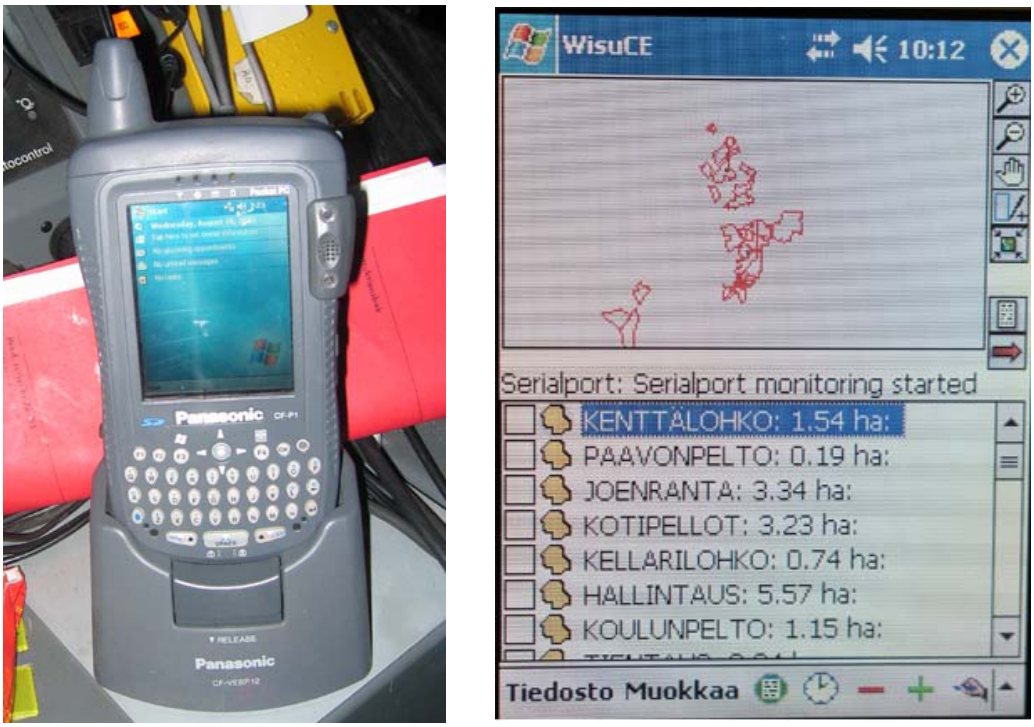

Figure 3 Left: PDA used in the project. Right: user interface of the management software

commands of failures, missing GPS information and general information concerning the task in hand, e.g. current application rates (Miettinen 2005).

Hardware

Most PDAs do not have CAN-bus interface as a standard accessory. In our first prototype, PCMCIA CAN-interface card was used to connect the PDA to the network, but there were some apparent capacity problems or driver problems. In the second prototype, a separate CAN-RS232 adapter was developed. In this prototype the PDA was connected to adapter using RS232 serial port. The adapter had two RS232 ports. A NMEA-0183 compatible GPS receiver was connected to the other one. The advantage of using a custom adapter is that the messages transferred over RS232 can be filtered, as usable the baud rate of RS232 is less than 250kbps of ISOBUS network. Reduced traffic means less message processing in the PDA. Rugged PDA from Panasonic (CF-P1) used in the project is in Figure 3.

Conclusions

The selected approach to implement Task Controller was realized, it was tested in real field operations. Extending mobile farm planning software to include Task Controller functions was proven to be viable. In other words it was found out that extending existing PDA farm planning software to support ISO 11783 precision farming and documentation functions is possible and logical. Also the speaking ability was developed to TC in order to reduce users need to monitor TC at driving time and in the preliminary tests this was found useful, though the interesting and necessary information for driver still requires more future research.

References

ISO 11783:5. International Standard. Tractors, machinery for agriculture and forestry – serial control and communication network. Network management.

ISO 11783:7. International Standard. Tractors, machinery for agriculture and forestry – serial control and communication network. Implement messages application layer.

ISO 11783:10. International Standard. Tractors, machinery for agriculture and forestry – serial control and communication network. Task controller and management information system data interchange.

Korduan, P. 2003. Standardization in data management to increase interoperability of spatial precision agriculture data. Proceedings of the 4th European Conference on Precision Agriculture in Berlin, Wageningen Academic Publishers. p. 323-328

Miettinen M. 2005. Liikkuvien työkoneiden vikadiagnostiikka ja etähuolto. Masters thesis (M.Sc. Tech.). Helsinki University of Technology. Automation Technology Laboratory. in Finnish.

Miettinen M., Oksanen T., Öhman M., Suomi P., Visala A.. 2006. Fault diagnostics in agricultural machines. Automation Technology for Off-Road Equipment. September 1-2. 2006. Bonn, Germany.

Stone, M., McKee, K., Formwalt, W., Benneweis, R. 1999. ISO 11783: An Electronic Communications Protocol for Agricultural Equipment. Lecture in Agricultural Equipment Technology Conference, February 7-10. 1999, Louisville, Kentucky USA.