IMPROVEMENT PRECISION AGRICULTURAL COMMUNICATION SCHEMA AGROXML BASED ON MULTI-AGENTS SYSTEM'S DELIBERATION AND DECISION MAKING PROCESSES

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ABSTRACT

In precision agriculture are used robots and different software to relieve decision making for human. Our approach is to use multi-agent system advantages to make decision making process autonomous. For that we need to use improved agroXML standard to transmit messages between agents. Improved agroXML standard includes information for each agent deliberation and decision making processes. For message transmitting are used wireless environment. One of the agent type is mobile robot and another agent type is database where is stored crop field environmental and dimensional information for mobile robotic agent. These agents leader is complex system where is made deliberation and learning processes. As result of research paper is improved agroXML schema for communication between precision agriculture complex system agents.

Keywords: Precision agriculture, multi-agent system, agroXML

INTRODUCTION

Precision agriculture different information and management systems (Pentjuss et al., 2011) based on multi-agents technology can be divided in several different types of computational systems. Robotic systems could be any kind of computational system where are involved automatic or autonomous stationary or mobile robots (Quinn, 2000; Candea et al., 2001), also could be used heterogeneous software computational systems (Li et al., 2006), where are mostly combined different management and calculation systems with ability to impact ling term planning processes. Robotic systems should be robotic multi-agent system and different management and calculation systems are software multi-agent systems (Pentjuss et al., 2011).

Each multi-agent system have communication technology between agents, deliberation mechanisms, data acquiring from influencing environment and collaborative agents, decision making mechanisms, learning technologies, goal – based behavior ability (Marc-Philipe, 2000).

Martin Kunisch (Schmitz et al., 2009) offers to don't use agroXML schema as communication for machinery and farm equipment to cover all data exchange into farm. AgroXML is used only to change data with external partners – between different farms and statistical agriculture management systems. In this research case where autonomous precision agricultural dynamic complex system - PADCS (Pentjuss et al., 2011) should be used in farm as management system; all decisions of farm management will handle intelligent agents. Main problem is that agents are heterogeneous in complex system and communication standard should be universal. PADCS system will use improved agroXML standard as internal and agroXML standard as external communication protocol, because mostly all agents have to use JAVA based applications for common opportunity to have goal based behavior of whole PADCS.

PRECISION AGRICULTURE

Precision agriculture mostly is based on information and statuses of agricultural object. Object can be any individual crop or field subarea. These subareas can be divided in any shapes, types and different properties. Collecting and analyzing whole necessary data from subfield area, the farmer can make decision basing on information from just the area, decision might not be appropriate for other areas of field

By collecting and analyzing data from that subfield area, the farmer can make decision based on information from just that area, decision that might not be appropriate for other areas of field (Schmitz et al., 2009).

Such precision agricultural processes like field watering, crop protection, fertilization, and other needs frequent updates in data. This is provided with sensors. Today when it is possible to use information technologies such as Global Positioning System (GPS), Geographic Information System (GIS), remote sensing, intelligent devices, computers and other tools all needed tasks could be done by automatic machines or robots and human role is only to monitor them.

Precision agriculture basically consists of some several different computational processes like GIS – geographic information system, different types of digital maps, GPS – Global Positioning System for coordination of vehicles movements, Robotized field machinery, arable information data base. Multi-agent system of precision agriculture consists of different type agent properties, knowledge, deliberation mechanisms, communications and decisions database, currency calculation block, mobile homogeneous agents refueling and raw materials storage base. These computational processes together forms autonomous precision agricultural complex system based on multi-agents technology (Subrahmanian, 2000).

COMMUNICATION SCHEMA AGROXML

AgroXML latest standard version 1.5 was introduced in March 2010 (http://www.agroxml.de/schema/agroxml_1_5/) and now is wide used communication standard for many companies (Schmitz et al., 2009). As communication standard in farm as internal and external data exchange will be

agroXML based standard, then it will decrease redundancy and complexity of PADCS communication module (Fig. 1).

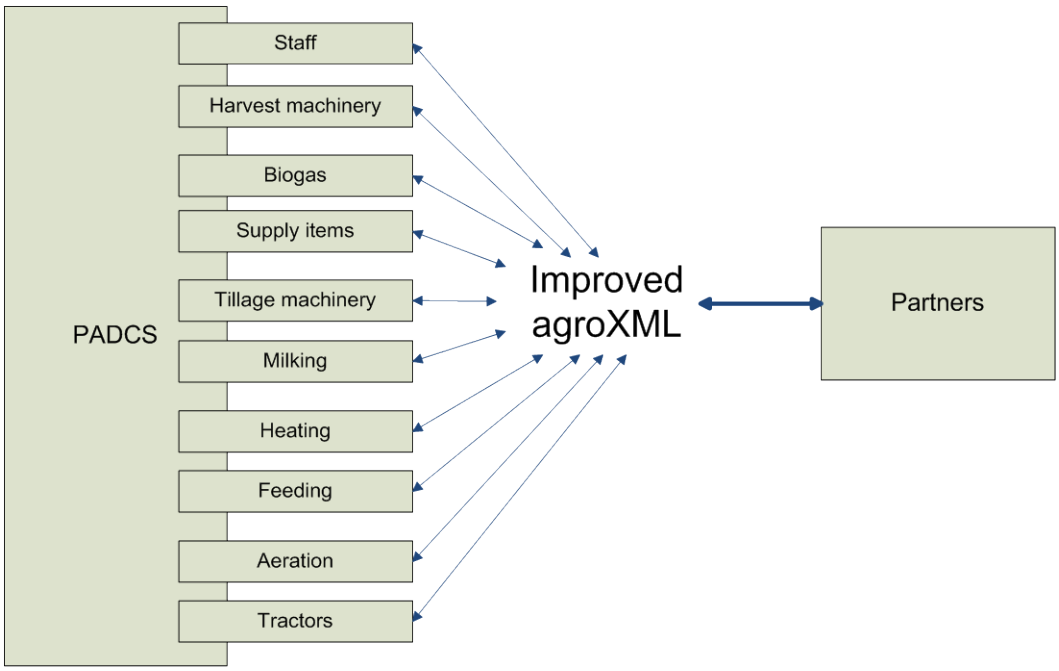

Fig. 1. Sphere of usage of AgroXML.

PADCS modules should have opportunity to calculate 3 rd level IP network layer (Kabelov and Dostalek, 2006) and have at least environment where JAVA (Sierra and Bates, 2002) applications could be run for multi-agents calculation processes. In this case improved agroXML as internal data exchange in farm should be used instead of ISOBUS (Moller et al., 2007) communication systems.

AgroXML could be transfered over WiFi networks, mobile internet (with additional equipment implemented for intelligent agent) using HTTP ((Hypertext Transfer Protocol), FTP (File Transfer Protocol) or SMTP (Simple Mail Transfer) protocols. In shorter distances transfer could be done via Bluetooth, infrared communication ports and even using future technologies which allow transfer XML (Fig. 2).

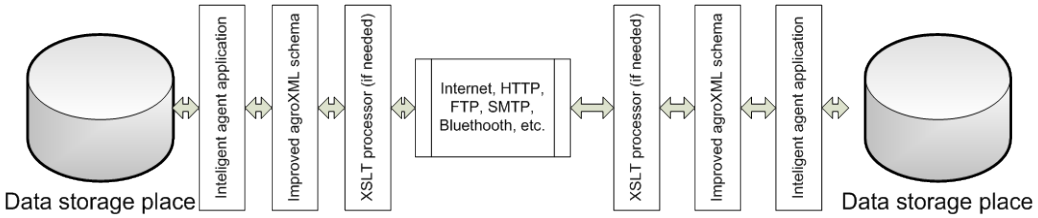

Fig. 2. Improved agroXML data exchange layers.

Some cases in farm already implemented agent the data exchange don't provide in agroXML standard. In such case should be used XML Stylesheet Language Transformations (XSLT) (http://www.agroxml.de/schema/agroxml, 2012).

AgroXML schema consists of many XML instances (Wooldridge, 2009). There are many XML development tools (notepad, xmlspy, etc.), which very fast could implement or change necessary XML instances for farm data communication use. During the agroXML reading all instances are decomposed and data offered in usable form for intelligent agent.

MULTI-AGENT SYSTEM DELIBERATION AND DECISION MAKING PROCESS

Multi-agent systems mostly are used to made complex systems where some independent computer systems should be combined (Wooldridge, 2009). These systems communicate, with each other making deliberation processes and after that sends to other multi-agent system decision making process result (Wooldridge, 2009). Deliberation process in multi-agent systems is deciding process what states of affairs to achieve. This process is used in multi-agent systems, where all environmental information isn't fully known. When agent is trying to create fastest method for his goal – based behavior, it runs deliberation process (Wooldridge, 2009).

Decision making process in multi-agent systems like the prisoner's Dilemma , voting procedure , groups decision making (Wooldridge, 2009). These methods are to find out decision of agents or agents groups. Depending of used multi-agent system architecture, can be used already mentioned methods for decision making process. AgroXML schema is used to send over the network the result of decision making process.

RESULTS AND DISCUSSIONS

As result of research is improved agroXML schema (Schmitz et al., 2009) with 2 new instances for intelligent agent deliberation and decision making processes (Fig. 3) (Schmitz et al., 2009). Only one agroXML schema message could have only one deliberation and decision making process information. Deliberation instance should consist of several addition instances:

- Date and time – when deliberation information was created
- Multi-agent system ID – for which multi-agent system message is sent
- Intelligent agent ID – for which intelligent agent message is sent
- Deliberation process result – what of deliberation message is sent
- Sent intelligent agent ID – which intelligent agent sent the message
- Resulting time – in how much time other agent has to send back his deliberation process result.

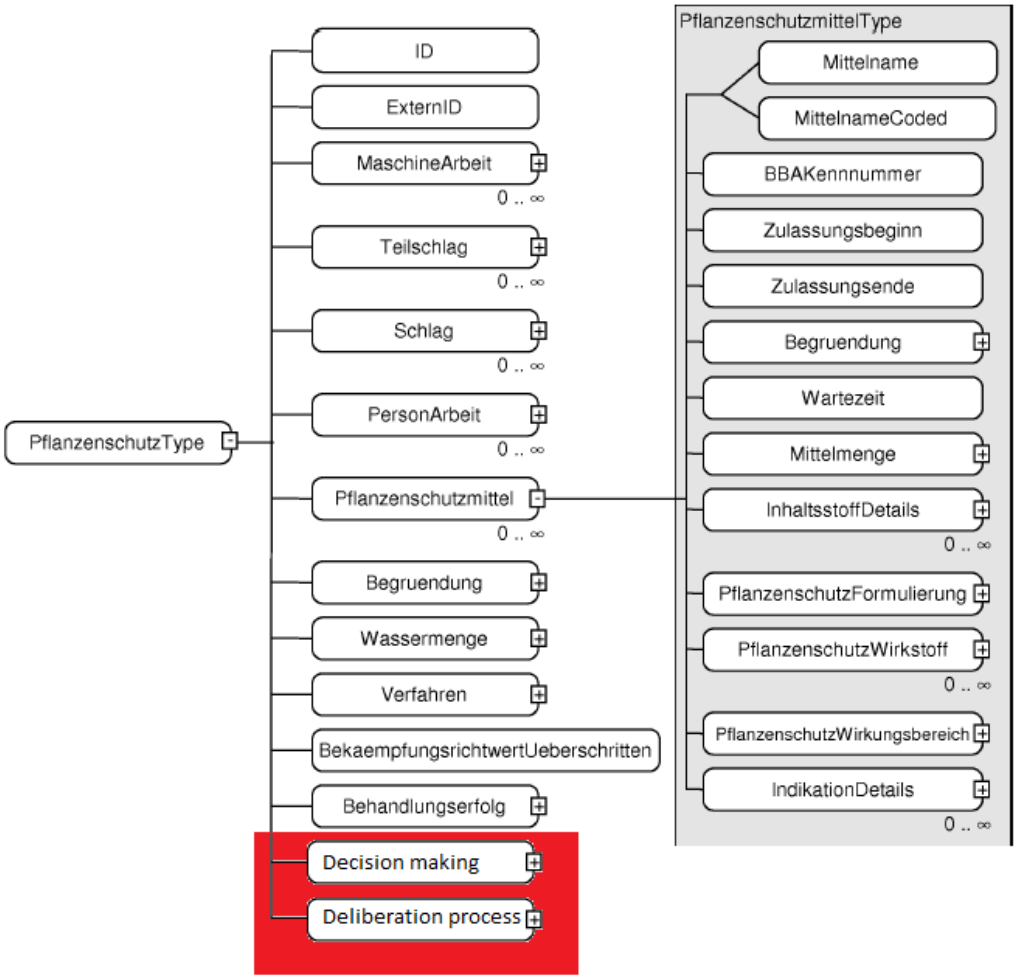

Fig.3. Graphical interpretation of improved agroXML instances.

Decision making instance is deliberation process common result between all involved one type multi-agent systems intelligent agents. Instance consists of:

- Date and time – when deliberation information was created
- Multi-agent system ID – for which multi-agent system message is sent
- Intelligent agent ID – for which intelligent agent message is sent
- Decision making process result – what of deliberation message is sent
- Sent intelligent agent ID - which intelligent agent sent the message

Mostly deliberation process improved agroXML message is for one type multi-agent system agents, when they trying to make negotiations between them and trying to argue to make one common decision. Decision making process improved agroXML message is for other multi-agent system which is need of this decision for goal-based behavior change. All multi-agent system agents receive this decision message and can execute their goal-based behavior.

CONCLUSIONS

Improved agroXML schema can be used in multi-agent based systems for precision agricultural tasks.

Improved agroXML schema can use many communication environments, what makes it good standard for precision agricultural multi-agent systems agents' communication, it is easy to modify and upgrade with different XML reading and modification software.

Improved agroXML schema consists of additional instances for deliberation and decision making processes, what allows store all necessary information from them.

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