Final Report on Aktion Project n. 69p18

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List of actions conducted within the framework of the project:

1. 7.3. – 8.3.: Kick off meeting in Vienna (Pavel Vrba and Petr Kadera traveled to Vienna)
2. 17. – 18 .4.: Lecture at CTU in Prague (given by Stefan Biffl who travelled to Prague)
3. 1.7. – 31.7.: Petr Kadera's 1 month research fellowship at TUW and AIT (external partner of the project)
4. 18. – 19.8.: Project meeting in Vienna (Pavel Vrba traveled to Vienna)

Description of the project achievements:

The mass production area was predominated by big investments for customized equipment, in order to produce large quantities of identical products faster and cheaper. The changing environment of today's market raises the need for new production planning and production control models and requires new approaches for production lines and intelligent machines to provide stability, sustainability and economy under such production conditions. It is important to be agile to react fast to sudden and unpredictable changes of requirements with minimum risk. Adaptive, reconfigurable and modular production systems address these requirements allowing machines and plants to flexibly adapt themselves to changing demands and interact with each other to fulfill the overall production goal, as stated in the Manufacture Strategic Research Agenda.

While physical components of such systems are available, the implementation of reconfigurable systems in the manufacturing industry is hindered by the lack of knowledge-based methods and intelligent tools for their optimal deployment and control of their operation. Currently available methods and tools are mostly based on traditional techniques applied in flexible manufacturing systems and are quite straightforward, addressing specific problems, lacking intelligence and learning capabilities. Moreover, their application takes place off-line, requiring significant down times as well as human interference. In order to reach the full potential of such systems, the adaptation of the system's performance to an optimal manufacturing solution for the appointed task needs to take place autonomously, in real-time and with as little human involvement as possible. Thus, the development of an autonomous intelligent governing system for adaptive and reactive manufacturing systems is of outmost importance.

One of the most accepted and developed approaches is a set of standards IEC 61499 proposed and standardized by the International Electrotechnical Commission (IEC) for Industrial Process Measurement and Control Systems (IPMCS). It introduces concept of a Function Block-oriented paradigm for IPMCS. It is built on top of the widely used industrial programming languages standardized in the IEC 61131-3. IEC 611499 has been developed to enable intelligent automation where the intelligence is genuinely decentralized and embedded into software components, which can be freely distributed across network devices. The promising application areas for this architecture include flexible material handling, reconfigurable manufacturing automation, intelligent power distribution networks, as well as the wide range of embedded networked systems.

The research conducted within the framework of this project was focused on performance-related difficulties coming from the integration of the IEC 61499 control systems with external systems. Frequently, the main problem of the integration is that the external systems do not support the explicit notion of IEC 61499 events. Instead of that, the interconnection is data driven and the events are replaced by data changes. The disadvantage of this approach is the need to ensure that the external system receiving data from the control part will not be overloaded. Otherwise, the correct data exchange is threatened. The eventual error can be either the skipping a data point or mixing up multiple data points into one.

The considered use-case consisted of a control part using IEC 61499 and a SCADA BR application which visualises the controlled process. The connection of these two systems causes problems if the control part sends data faster than the SCADA BR can handle. The root of the problem comes from the communication protocol. The message containing data starts with information about the type of the sent data. This is followed by the appropriate number of bytes. The problem occurs when new data are sent before the processing of the previous ones was finished. In such case the new data are incorrectly added to the previous ones which ends up with a data type error, because the number of bytes is different than expected. Currently, this problem is solved by an additional delay with the fixed length. This simple solution delays all the communication (not only if necessary) for longer time than needed.

The proposed method delays the communication only when needed and only for the necessary time. The proposed solution is based on the analysis of the SCADA BR receiving process and implementation of two new IEC 61499 components. The first one is a new function block named E_AGGR which provides capability to aggregate events coming within a defined time window into a single event. The second one is a function block named E_BUFFER which buffers the input events and sends them with frequency, which is not higher than defined by a parameter. The proposed method enables reliable connection of the control part with the SCADA system. Moreover, the connection is free of any unnecessary communication delays.

The method and the achieved results have been described in a scientific paper written for the International Conference on Industrial Technology 2015 (http://www.icit2015.org).

Pavel Vrba

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