CURRENT CHALLENGES IN ABSTRACTING DATA POINTS

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Abstract: Services in building automation traditionally have been implemented using a variety of fieldbus systems. Recently growing interest has been put into convergence of the various systems. A classical approach is the use of gateways. The engineering effort, however, to build gateways for an arbitrary number of systems is of quadratic order. This paper focuses on a data-centered view, which defines a set of abstract services needed for building services, and discusses the resulting challenges. With this approach an application can be migrated from one system to another, leading to a linear engineering effort for controllers, data servers and multi-protocol nodes.

Keywords: building automation, convergence, fieldbus systems, gateways.

1. INTRODUCTION

Interoperability was and still is an important factor when it comes to engineering. The 1990ies where the time, when standardization committees within ISO, ETSI, IEC and their numerous national counter parts, converted the proprietary landscape of automation networks into a set of standardized technologies (Fischer and Palensky, 2004). Publishing standards and opening technology was an important step towards lower engineering costs, higher quality and more flexibility. Interoperability rules within these standards ensured, that multi-vendor installations worked more or less seamlessly (Loy et al., 2001). The vendors complied with standard data types, standard services, standard semantics and profiles.

This benefit was unfortunately only valid within one technology, within one standard. Transforming and translating data, services and functionality from one world into another is an arbitrarily difficult task.

Related work can be found in the NOAH project (Di Stefano et. al., 2000; Mella and Russo, 1999), a European Project that aimed at the harmonization of device profiles of the EN 50170 standard series (a set of automation networks in the industrial automation domain). (Kastner and Neugschwandtner, 2004) describes the application of the OSGi framework to the popular home automation network EIB (European Installation Bus), in order to get a high level data abstraction of EIB datapoints. OSGi, however, is a rather heavy architecture, relying on multi-threaded environments and usually based on JAVA. (Velasco et. al., 2003) describes an object model specification for Internet-based remote access on control and automation data. The processes are abstracted and accessible via so-called virtual indistrial devices and a virtual industrial protocol, partly based on SOAP, an XLM-based not-too-slim protocol for remote object management. (Fischer, 1999) explains the results of working groups 3 and 4 of CEN TC247 "Controls for Mechanical Building Services". The working groups elaborated "field level objects", where already difficulites in abstracting "higher" services like COV (change of value) or alarming were discovered. Meanwhile, this working group works on the publication of a technical specification on mapping BACnet onto LonWorks and vice-versa.

The need for interconnecting networks of different types stems from the insight that processes of different kind can be combined, leading to new functionality. An example can be found in building automation. Having HVAC (heating, ventilation, air

conditioning and cooling) automated with network type A and the lighting system realized with network type B was previously not seen a problem. This changed, when people realized that lights, shading and climate control are physically linked: Sunlight, that shines through the window heats and illuminates the respective room. Sunblind whose lamellae have a reflective coating on one side can increase or prevent this effect. This is a simple example where processes of previously isolated nature contribute to one single function.

This need for interconnectivity and interoperability is not only limited to automation networks. The increased usage of the Internet as a universal source of information and a media for all kinds of business processes lead to numerous attempts to connect "the I/O with the CEO" (Palensky, 2005). This slogan expresses the fact that business software and networks are getting more and more in touch with the processes and networks "in the field". People realize that making process data of a production plant available to the IT-department enables for instance SAP to create a report on the efficiency of the usage of raw materials. So there is a need for linking the controlling department with the production process and the customer relationship management (CRM) software.

The convergence of the existing networks and technologies is a difficult task (Palensky, 2004). Beside numerous serious technological issues, it is also the investment that was done in existing network infrastructure, that currently prevents the usage and development of a universal one-for-all network. Networks of different type that are supposed to fulfill a common goal reveal an unpredicted set of differences.

In general building services are characteristic control tasks of applications in building environments (Kastner, *et al.*, 2005). Typical building services include climate control, visual comfort, safety, security, transportation, or supply and disposal. (Daniels, 2003). One of the main differences to classical methods in process control are the time constants of the controlled, physical processes. This relaxes the requirements of quality of control (QoC) for control algorithms built for network-based control systems (Soucek and Sauter, 2004). This in principle enables the system integrator more levels of freedom to achieve convergence by introducing meta-layers, translators and bridging services to close the gap between different systems. This has to be done carefully, however, as the exchange of services or services that span technologies may face even more problems.

Such considerations are not new, and there are still no satisfying solutions out there. A new player in the domain of control networks is the usage of Internet technology. Transport protocols like the TCP/IP suite, media like Ethernet or GPRS (general packet radio switching) and higher protocols like SOAP (simple object access protocol) or OPC (OLE for process control) are unstoppable technologies that make their way into the world of control networks. This paper describes the problems and the lessons learned from IT-near technologies and how a data-centered design can help lifting data and functionality from one network to another one.

2. PROBLEM DESCRIPTION

The general functionality of BACS can be broken down into three levels, representing the incarnation of the automation pyramid for BACS (BACS-2 2004): field, automation and management level.

At the field level actual interaction with the physical world takes place. Data are collected and submitted to processing entities as well as the environment physically controlled by receiving data. On the automation level controllers operate on data prepared by the field level, establishing logical connections and control loops. This type of process data exchange is referred to as horizontal communication (or process communication relating to the nature of the data). In addition, the automation level prepares (possibly aggregate) values for vertical access by the management level (e.g., trending).

Vertical communication can be divided into services related to accessing and modifying data from within the application, for example adjusting a set point or retrieving trend logs (frequently referred to as management communication), and others concerned with modifying the application itself, for example changing binding information or program transfer (engineering communication).

Historically, convergence between the different network technologies has been implemented by gateways between the systems on any of the above levels. This helps to integrate domains previously being isolated islands. However, application developers still need a steep learning curve to switch between technologies. Another way to achieve convergence is to hide the intricacies of the underlying network technology and provide the application developer with a set of standard services instead. Clearly, a node implemented on a certain system can only be operated within its native environment, but the same control application can be moved to another system.

The key requirement for an abstraction of the underlying control network services is to hide the communication-specific characteristics, using a data representation and a set of services, which allows mapping of the basic functionalities of BACS to different technologies. This is an application-centric approach, where the control application can be easily migrated from one network technology to another. Clearly, the available services in the different levels of communication require different amount of efforts to achieve this.