Demonstrative Manufacturing System Controlled by MES Utilizing AAS

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Abstract—This work examines today's modern possibilities for production management. More specifically, we focus on MES (Manufacturing Execution Systems) and its integration within the concept of industry 4.0 using AAS (Asset Administration Shell). It also describes a specific integration for a simple virtual line designed in ABB RobotStudio, which is first controlled using MES and then the production is encapsulated using AAS. The AAS is then supposed to interact with ERP (vertical integration) and also with suppliers and other manufacturing units (horizontal integration).

Keywords—MES, AAS, IMES, RobotStudio, virtual factory, OPC UA

1. INTRODUCTION

This article deals with the possibilities of using advanced production management using MES. For demonstration purposes, we will manage a virtual line created with the help of ABB RobotStudio. As MES, we used one of the open source applications available on the Github server.

All communication takes place using the OPC UA protocol, both with the database and the virtual line and in the next phase with the AAS and the virtual line. This communication is mediated through the NodeRed tool, thanks to which we have relatively easy access to the Firebase realtime database.

A similar topic was dealt with by colleagues in the article [1] in their case, however, it was the use of AAS for MES and its superior system - ie ERP (Enterprise resource planning). Our work is more focused on communication of MES with a lower level - ie with line or PLCs. In the article, however, they used MES from a different creator than us.

2. AAS – ASSET ADMINISTRATION SHELL

The Industry 4.0 concept uses their AAS - Asset Administration Shell digital envelope to standardize equipment descriptions. The purpose of these envelopes is to ensure the exchange of information between the facilities, between them and the production coordination system and the engineering tools. [2]

The figure 1 shows the description and connection between the physical device and the AAS. The device envelope (AAS) consists of two parts. Header, which lists unique device identifiers. A body, in which other information about the device, its properties and other important information such as the production process is given. [3]

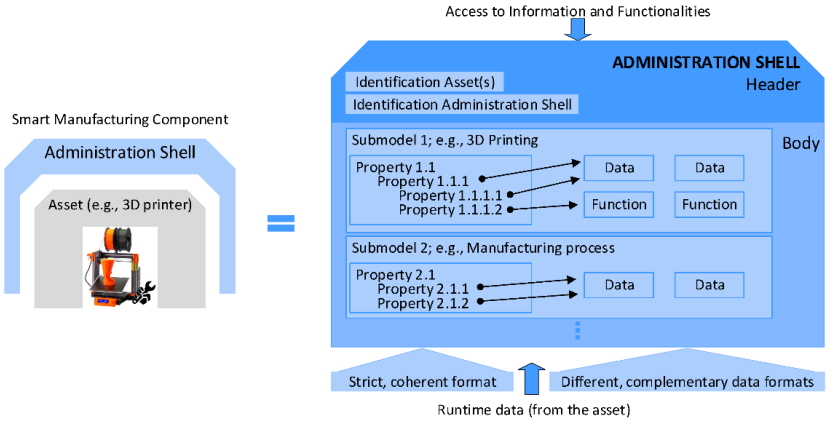

Figure 1: Structure of AAS [3]

3. IMES

We used the available open source IMES application to manage our virtual line. This application is relatively simple and should be fully suitable for our demonstration purposes. The advantage of this application is that it already has a module ready for possible sensors that can record the progress of order processing in the company.

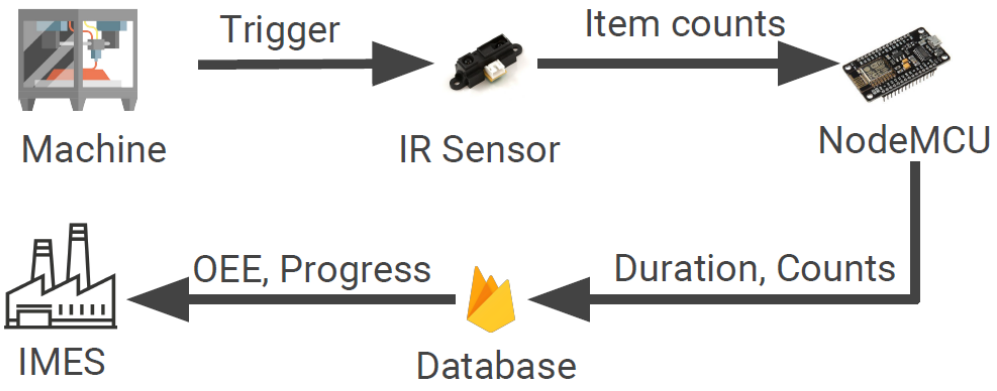

Figure 2: Structure of AAS [4]

4. COMMUNICATION BETWEEN MES AND FACTORY

We will use the protocol for industrial communication for communication between individual components. OPC communication is generally used for the exchange of data between different industrial systems. In automation, it is a universal communication platform that can connect to the data of hundreds of different types of devices from different manufacturers and convert this data into a single OPC communication, understandable to many superior applications such as ERP, SCADA, or in our case MES.

Communication between the client and the server takes place exclusively through calls and processing of services (Services), which deal with the control of individual parts of the OPC UA server functions. Both queries and answers have their common headers, where the client has, for example, the ability to set the required information to be returned by the server for all queries. [5]

5. MANAGEMENT STRUCTURE WITHOUT AAS

In this case, it is practically a classic pyramid control, where data is exchanged between the virtual line and the database of our application. RobotStudio creates the OPC Server and sends the simulation data to it. We read the production progress data from the server using the NodeRed tool. We then send the data to our Firebase real-time database. In the same way, communication takes place in the opposite direction, where we read information from the database and send it to the server.

This is illustrated in the block diagram in Figure 3

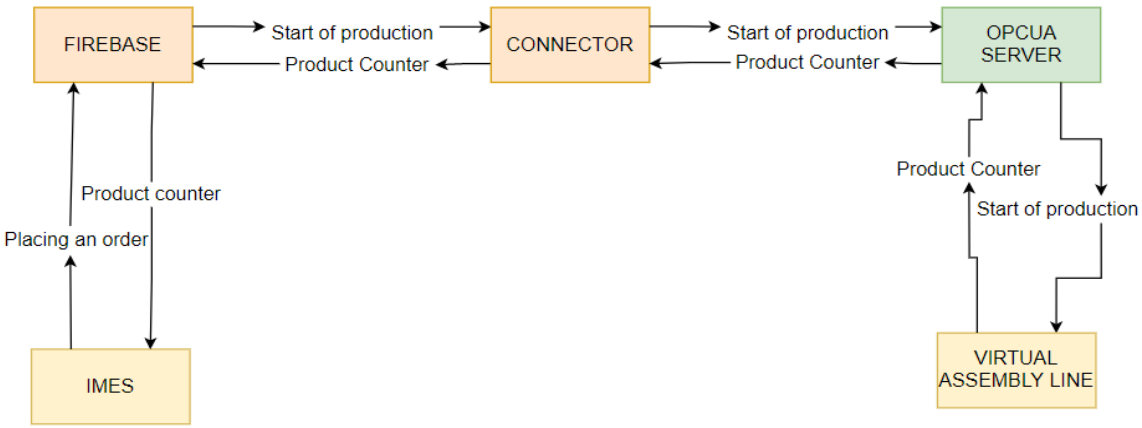

Figure 3: Block diagram classic management

6. MANAGEMENT STRUCTURE WITH AAS

When managing with the help of AAS, we will create an envelope, which we will cover our entire application and we will communicate only with the header of our asset. Eventually, the entire AAS will have modules in place for both communication with the enterprise management system (ERP) and communication with the lower tier. The ISA-95 standard tells us what information should be passed on. In our case, however, this would mean that we would have to modify the database of our MES application. Therefore, we will prepare only the given submodels in our AAS and I will use only those that will be beneficial for our application.

Communication between the asset and AAS blockes takes place on the basis of SQL statements. Based on them, the data will be written directly to the Firebase database of our MES application. The configuration then takes place on the basis of our selected submodels "communication settings" and "definition of variables and methods". However, these submodels can be extended by others.

The block diagram here shows the possible structure of the project

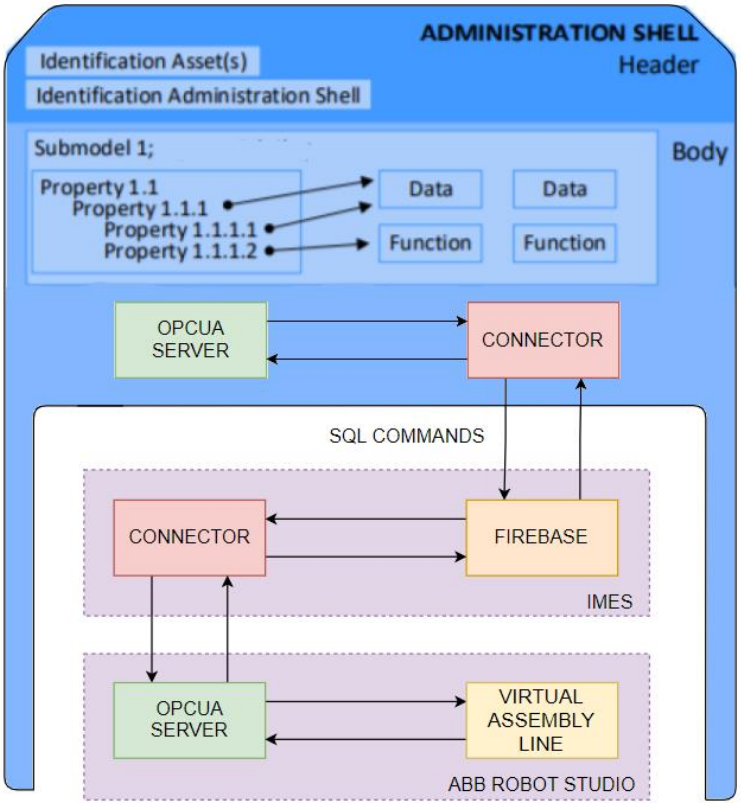

Figure 4: Block diagram management with AAS

7. DEMONSTRATION OF MES AND VIRTUAL LINE DEPLOYMENT

Figure 5 shows one of the possible deployment methods. This is line control without the use of AAS.

Here we see a virtual line created in RobotStudio and part of the IMES application. More specifically, the production monitoring section, to which we receive data from the simulation.

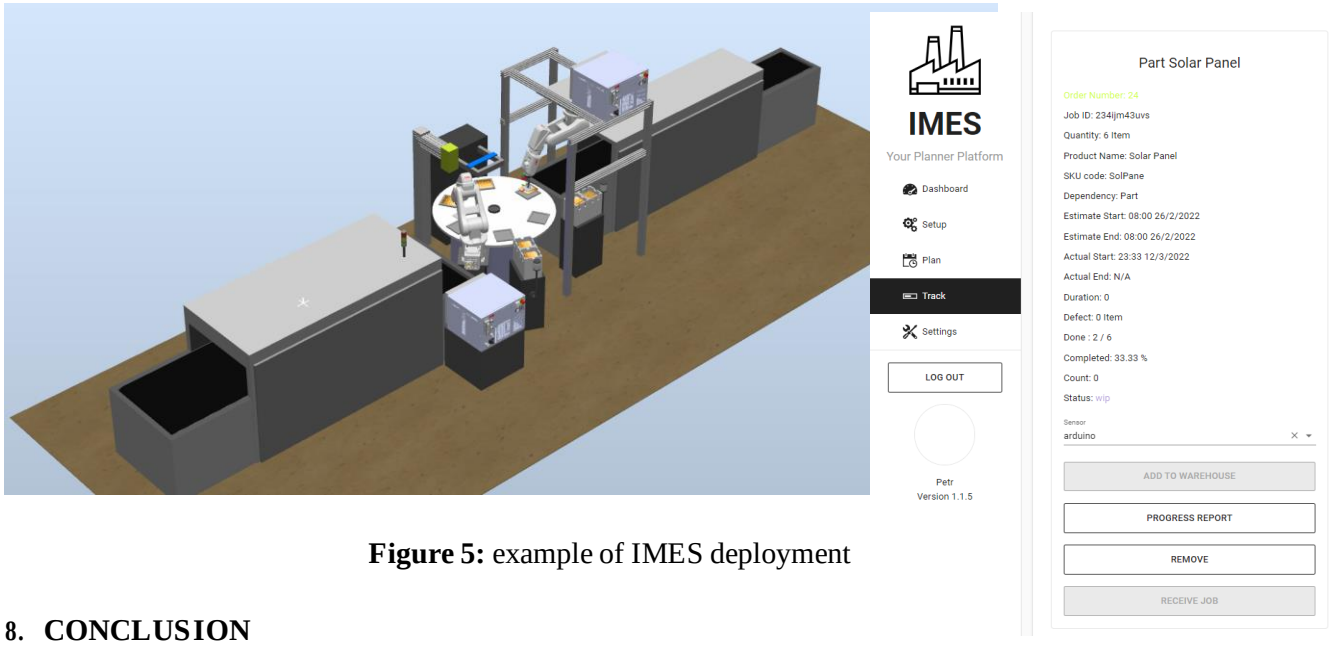

Figure 5: example of IMES deployment

8. CONCLUSION

This work deals with the possibilities of production management on a demonstration virtual line. Both the classical methods of control using the MES itself and the possibilities of control using the AAS are discussed here. This means for us that we will pack our entire application in asset and create submodels according to the ISA-95 standard. This standard tells us which data and information are to be sent one level up (to the ERP) and also one level down, e.g. to the control PLCs.

In our work, we first had to run the IMES application and pair it with the Firebase Real time database. After that, we used the NodeRed tool to connect our database with the OPC UA server, which generates simulations in ABB RobotStudio. In this simulation, pulses are generated for the simulated sensor, we then calculate these pulses and thanks to that we can monitor the production process after that. We try to ensure all data transmission through communication via the OPC UA protocol, which is one of today's standard industry protocols.

9. ACKNOWLEDGMENT

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