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Industry 4.0 – An Introduction in the phenomenon

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Abstract: The goal of the paper is to introduce specialists from industry into the important phenomenon of the recent technology and to explain cyber – physical and informatics background of the platform Industry 4.0 and basic steps in any design and implementation of the Industry 4.0 systems. Authors introduce readers in both the RAMI 4.0 as well as the Industry 4.0 Components models which represent necessary initial background of any Industry 4.0 application. The main stress is given to the Industry 4.0 components model, which enables designers from firms to understand already existing Industry 4.0 case studies and to develop their first Industry 4.0 case studies applications.

Keywords: RAMI 4.0, Industry 4.0 component, administrative shell, communication, virtual

1. INTRODUCTION

It has been said and written much and much about the Industry 4.0 in different workshops. An opinion of authors of this contribution is that it was probably necessary in the first years of the new technological revolution, but they are convinced, that now is already the right time to help praxis in better understanding of the system - technical background of the Industry 4.0 platform and make engineering steps towards Industry 4.0 applications. The key issue of any design and system development in the recent engineering work in Industry 4.0 will be a proper implementation of both, the RAMI 4.0 (Reference Architecture Model Industry 4.0) and the Industry 4.0 Components models. Authors will explain the models in more details. Let us, please, to repeat shortly only the initial Industry 4.0 terms.

The Industry 4.0 is used for three, mutually interconnected factors:

1) Digitization and integration of any simple technical – economical relation to complex technical – economical complex networks
2) Digitization of products and services offer
3) New market models

All these human activities are interconnected by a lot of communication systems in the moment. The most promising technologies will be Internet of things (IoT), Internet of Services (IoS) and Internet of People (IoP).Thanks to these communication technologies, communication entities will be able (in the Industry 4.0 environment) to communicate with each other and utilize data from the production owner during the all life cycle of systems without respect to border among enterprises and countries. All entities of the whole production – market network will be able to have relevant data as well. It will be very helpful for all entities while producers will be able to work out systems with features of very modern components which will be even in the design and testing phase.

Such a digitization of industrial production can create quite new digital market models. On the basis of the data (accessible in cloud) users will be able to predict a shutdown of production of some of production entities etc.

For purposes of such a complex production – market networks the leading institution and firms in Germany – the leading country of the Industry 4.0 activities and ideas - developed and published the RAMI 4.0 (Reference Architecture Model Industry 4.0) and the Industry 4.0 Component models in the last year. Because of the above mentioned three interconnected factors, the 3D graphical model RAMI 4.0 has been developed.

2. RAMI 4.0 (REFERENCE ARCHITECTURE MODEL INDUSTRY 4.0)

Authors of the RAMI 4.0 model are BITCOM, VDMA and ZWEI. They decided to develop a 3D model because the model should represent all different manually interconnected features of the technical – economical properties. The model SGAM, which was developed for purposes of communication in networks of renewable energy sources seamed to be as an appropriate model for the Industry 4.0 applications as well. The RAMI 4.0 is a small modification of the SGAM (Smart Grid Architecture Model). Because into the SGAM as well as into the RAMI 4.0 enter approximately 15 industrial branches, the RAMI 4.0 model enables looks from different aspects. That's why layers in the vertical axis represent the look from different aspects (a look from the market aspect, a look from a perspective of functions, information, communication, a look from an integration ability of the components) (Manzei, Schleupner, & Heinze, 2016),(VDI/VDE-Gesellschaft Mess-

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und Automatisierungstechnik, 2016)(VDI/VDE-Gesellschaft Mess- und Automatisierungstechnik, 2015).

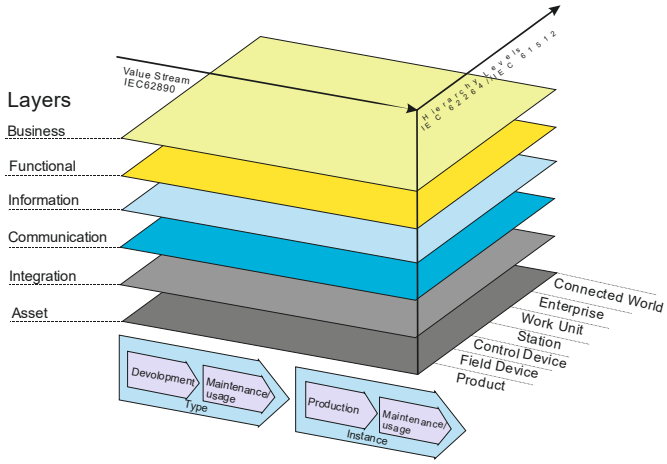

Fig. 1 RAMI 4.0 model (VDI/VDE-Gesellschaft Mess- und Automatisierungstechnik, 2016)

Very important criterion in the modern engineering is the product life cycle with the value stream which it contains. The left – hand horizontal axis displays this feature. There are expressed e.g. constant data acquisition throughout the life cycle. Even the totally digitization of the whole development – market chain offers great potential for improvement of products, machines, and other layers of the Industry 4.0 architecture throw-out the all life cycle. This look corresponds well with the IEC 62890 draft standard.

The next model axis (right in the horizontal level) describes function position of the components in the Industry 4.0. In this axis, there is specified the functionality of the components, no any specification for implementation but the function assignment only. The axis respects both IEC 6224 and the 61512 standards. But the IEC 6224 and the 61512 standards are intended for specification of components in a position in one enterprise or works unit only. Therefore the highest level in the axis horizontal right is the Connected world.

3. RAMI 4.0 IN MORE DETAILS

The individual layers and their interrelationships are described as follows (Platform Industrie 4.0, 2014):

3.1 Function of layers in vertical axis:

Asset Layer
Represents reality, e.g. physical components such as ideas, archives, documents, linear axes, metal parts, diagrams. Also human being is a part of the Asset Layer. They are connected with the virtual reality world by the Integration layer. Passive connection of the assets to the higher Integration Layer is done by for instance means of QR codes.

Integration Layer
This layer makes provision of information on the assets (HW/SW, components) in a form which is available for computer processing.(Mikolajek, Otevrel, Koziorek, & Slanina, 2015) It makes also computer control of the process, generation of events from assets and it contains elements, which are connected with IT (RFID readers, sensors, HMI, actuators, etc.). Integration of persons is a part of Integration layer functions as well – (via HMI).

Communication Layer
This layer provides standardization of communication by means of uniform data format in the direction of the Information Layer. It provides also services for control of the integration Layer.

Information Layer
Provides run time for preprocessing of events, execution of event-related rules. It enables formal description of the rules and event pre – processing. Next functions of the Information layer are: Ensuring data integrity, consistent integration of different data, obtaining new, higher quality data (data, information, knowledge) provision of structured data by means of service interfaces. It also receives events and transforms them to match the data which are available for the higher layer.

Functional Layer
Functional Layer enables formal description of functions and creates platform for horizontal integration of various functions. It contains run time and modeling environment for services for support of business processes and a run time environment for applications and technical functionality. Rules and decision – making logic are generated in the Functional Layer. Some use case can be executed in lower layers as well. But remote access and horizontal integration can take place within the Functional layer only because of the necessity of data integrity.

Business Layer
The layer ensures the integrity of functions in the value stream, enables mapping business models and the resulting of the overall process. It contents legal and regulatory Framework conditions, enables modeling of the rules which the system has to follow. The layer creates also a link among different business processes.

3.2 Function of layers in the horizontal left axis:

The left – hand side horizontal axis represents the life cycle & and value stream of industrial production. This axis is divided to Type and Instance. A type of any product, machine or SW/HW represents the initial idea. This covers the placing of design orders, development and testing up to the prototype of production. After all tests and validation, the type is prepared for serial production. On the other hand, the type of any component, machine or HW/SW etc. creates a basis for the serial production. Each manufactured product represents an instance of that type, for example has a unique serial number. The instances are sold and delivered to customers. For customers are the products initially once again only types. They become instances when they are installed in a particular system. The change from type to instance may be repeated many times. The fine structure of the life cycle and value stream look in the RAMI 4.0 over the axis left hand horizontal