POLY-MODEL DESCRIPTION OF INDUSTRY 4.0 CYBER-PHYSICAL SYSTEMS

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An actual task is to project a cyber and physical system (CPS) of industrial purpose based on a set of graphs and analytical models which describe the CPS behavior in the physical device level and in the virtual level. There is a scheme and description of CPS functionality principle as an automatic control digital system. The advantages of subtractive equations to describe a CPS are described and also the restrictions to use automatic models to synthesize the systems of higher order (digital production). There is a scheme and CPS functionality principle as a company cloud environment element is described (digital twin) which is based on a uml-diagram. There are advantages and disadvantages to describe a CPS with a uml-diagram given when they model CPS behavior as a part of digital production. There is a scheme given and CPS functionality principle is described using a Petri net model. It is clear that all three types of CPS description must be viewed together as a poly-model division which helps the CPS designers to create and research the project solutions of the Industry 4.0 digital production components synthesis.

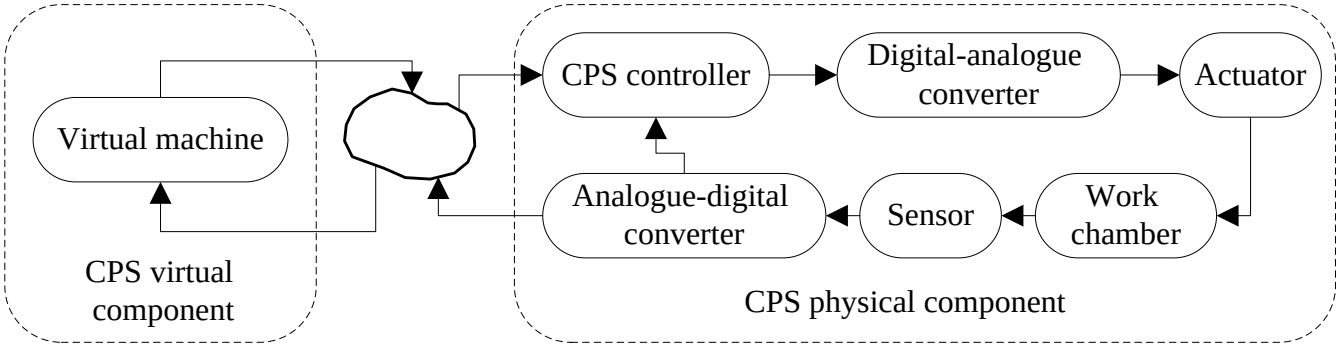

Figure 1. Cyber and physical system functioning scheme as an automatic control digital system.

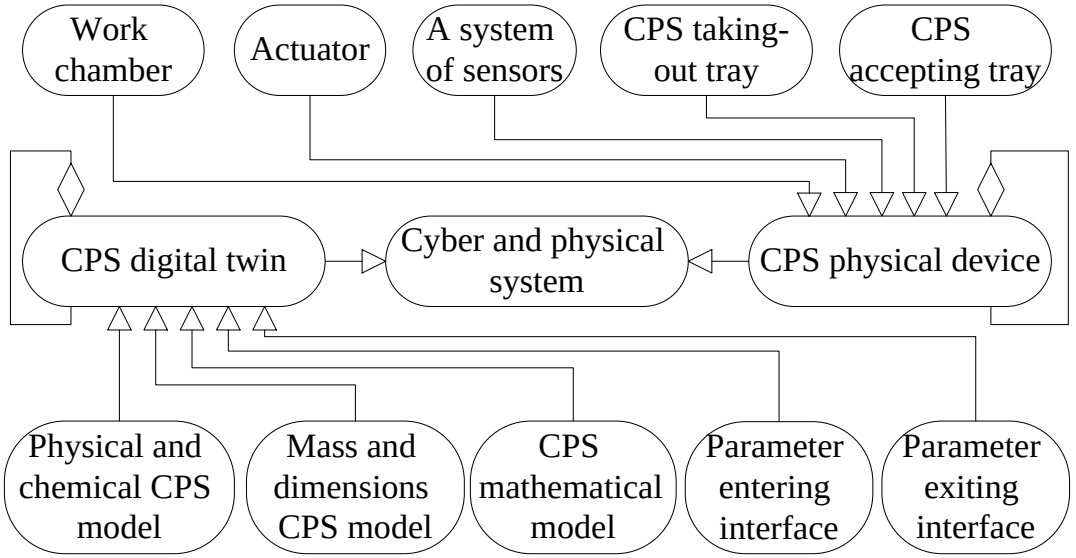

Figure 2. An example how to describe an industrial purpose CPS using components of a uml-diagram.

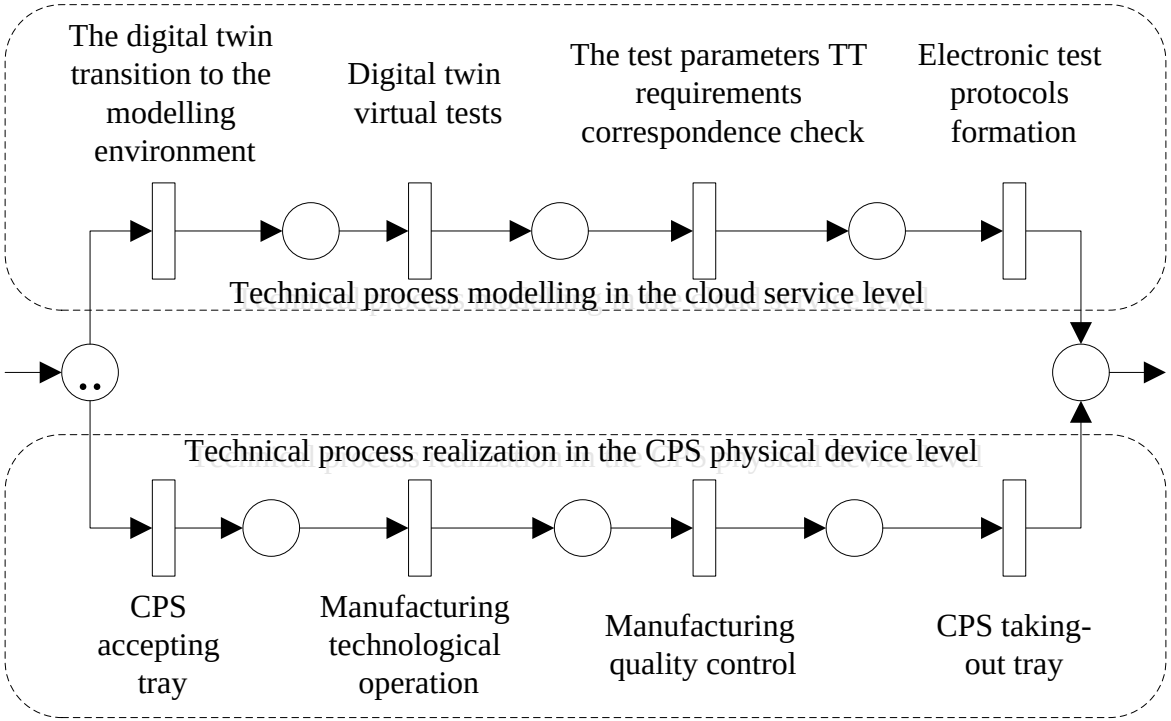

Figure 3. A Petri net scheme to describe the Industry 4.0 cyber and physical system operation.

Cyber and physical system synthesis is a complicated project task, which requires from the designer knowledge in different study fields and scientific theories. Today such a project task can be solved only with special automatics means. CPS designer instrument provision include sets of technical provision for automatic work places and automatizing projection systems software the most important CPS projection properties of which are visualization ability and project solutions modeling, which helps to research different structural options and CPS functionality principles.

CPS technical projection in practice is done for the best (optimal in Pareto criteria) project solution in relation to which CPS dynamical characteristics corresponding to the technical task requirements are received. To unite project solutions to describe a separate CPS into a single project solution to describe the digital production functionality principle is the next project stage oriented to design the Industry 4.0 smart factory in general.

It must be taken into account that digital production synthesis is based on multi-operational CPSs private models integration of different classes which is not always a project solution based on models cascading in general technological chain of equipment. Such a property can be found only in a linear model in particular a Petri net model for non-recurrent technological algorithm in a digital production. CPS description with the automatic control theory and with a uml-diagram is based on technological operations, technological processes and technological routes of item manufacturing so a digital production model design can be viewed as a separate project task, which use the scaling principles of CPS separate private models.