Cloud manufacturing - the connection between RAMI 4.0 and IoT

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Abstract. The paper presents an empirical analysis regarding the advantages offered by cloud manufacturing, the need to analyze RAMI 4.0 and not least IoT applications. The latter using high performance platforms can lead to the modernization of the automation, tracking and control systems, but they also add to the optimization systems in order to increase the performance. RAMI offers a 3D analysis of the entire manufacturing flow, a system that can be more effectively analyzed, interpreted and can be intervened to grant mandatory maintenance. Cloud manufacturing offers an overview of the entire manufacturing process with all the resources and resources used, as well as an overall analysis regarding any possible interventions needed to optimize the manufacturing system. In order to be able to draw the most relevant conclusions in real time, we simulated such a system with the help offered by Petri nets. We chose the Petri nets because they are easier to interpret, they provide real-time information, modifications can be made relatively easily so that decisions can be made in the shortest time so as not to disturb the manufacturing system. Because cloud manufacturing, the manufacturing system and the IoT platforms have been presented in previous works on the same manufacturing system, in this paper I will review them and focus more on the cloud manufacturing relationship and RAMI 4.0.

1. Introduction

For the elaboration of the works we have made a link to be able to do research in particular regarding the confidentiality of the cloud manufacturing, the analysis of the IoT resources in the manufacturing systems and which can equal it for research purposes, namely RAMI 4.0. IoT is described in the literature as being anything connected to a network that can communicate autonomously without additional human intervention. This concept used in production and other industrial processes allows machine designers to create intelligent equipment and machines so that they can track, record, display, monitor and adjust parameters autonomously. For the cloud, we turned to the simple definition Cloud is an application available only to customers with active mobile Internet, which offers a solution for data storage. Cloud storage consists of archiving, organizing and distributing on demand data between virtualized storage volumes that have been consolidated into hardware.[1-3]

In this paper have proposed a new architectural model of the intelligent factory that will allow the production experts to make a simpler planning, optimized using all the key technologies of the industry known until today. Manufacturers can automate and schedule purchases to align with production schedules to reduce inventory costs and positions, while automating inventory and material control.
When designing manufacturing processes, new technologies and processes must be sought, which provide the significant and sustainable improvements needed to compete in a globally competitive environment.

The existing architecture model of the industry offers a good overview of the architecture of the industrial environment, but leads to some limitations for users. To overcome these limitations, we proposed based on RAMI 4.0 models a simple model of intelligent factory architecture, based on the concept of distributed systems with accurate information and data flows between them. The proposed architectural model allows for a more reliable and simple modeling of the smart factory. To solve many problems, the solution can come from RAMI 4.0, which offers the reference architecture model for the industry, it is a three-dimensional map showing how to approach the problem at an industrial level in a structured manner and not lastly, it ensures that all participants involved get to a common denominator.[3]

2. Description and analysis of the model

Entire production processes, including manufacturing resources and capabilities, are positioned at different locations depending on the layout being addressed. The key technology that allows the integration of distributed production resources, their transformation into manufacturing services and centralized management of services is cloud manufacturing. This concept allows multiple users to request services at the same time, by transmitting the tasks of their requirements to a cloud production platform. According to the specialized literature, the integration of decentralized production resources and the establishment of a collaboration infrastructure between these units is fundamental. This idea requires building the manufacturing environment in the network to integrate manufacturing resources and applications. Manufacturing resources and knowledge can be introduced into the cloud and thus become accessible at the consumers' request. Manufacturing resources and capabilities are transformed into production services that can be managed and operated in an intelligent and unified way.[1]

Cloud services are readily available and location-independent, used to store and calculate data generated in IoT. Cloud services are best suited for the IoT environment due to various factors, such as easy availability, managing resource constraints, different policies. Cloud servers can provide services in the form of software, storage, computing power, platforms.[2]

IoT benefits from all the benefits, capacity and unlimited objects of the Cloud to change its modern needs [4]. IoT uses numerous cloud features, such as stashing, and evaluates information to reduce professional pressure. Cloud exploits IoT by treating information in an indispensable way and getting answers to authentic problems.[5-7]

In this paper, we made the link by introducing RAMI 4.0, which allows the identification of standards to determine if additions and changes are needed, the requirement for producing the Cloud-based IoT approach.[3]

The two universes of Cloud and IoT, figure 1, 2, have experienced free development. The IoT benefits for all the intentions, capacity and unlimited objects of the Cloud to modify its modern needs. IoT uses numerous cloud features, such as stashing, and evaluates information to reduce professional pressure. Cloud exploits the IoT by treating the information in an indispensable way and obtaining authentic answers.[2]

Data warehousing: IoT includes a large amount of data from various sources, which provides a huge measure of unorganized information. Cloud is the most useful, more than that, intelligent answer for management information provided by IoT.[2]

Communication resources: One of the necessities of IoT is to make IP-enabled devices transmitted through dedicated equipment, and mail support can be exceptionally expensive. Cloud provides a viable and modest arrangement for interfacing, tracking and monitoring anywhere, anytime using modified inputs and default applications. Due to the accessibility of fast systems, this allows remote device verification and control.[2]

For analysis, we have chosen the technological flow analyzed in [4], which we adapted for the ideal case in order to highlight the most representative IoT and Cloud systems and which can be represented schematically using Petri nets. For this model we used the RAMI architecture to make the connection.
Starting from RAMI you can optimize the relationship of cloud manufacturing and IoT. The relationship between RAMI and Cloud can be managed based on the technologies offered by IoT at all levels.

Figure 1. The architecture of cloud manufacturing.

Figure 2. Cloud IoT connection between the machine and the manufacturing stages.

3. Presentation of the system

In order to ensure a good management of the information I will use a cloud system on levels. Research using the Petri nets has become widespread due to the mathematical and graphical model used. Petri nets have adequate platforms in the field of modeling and design of competing systems, computer systems, manufacturing systems and performance analysis. Next, the specifications in figures 1 and 2 are taken into account.

The present paper is based on three objectives for IoT but also for Cloud, these being key elements and for RAMI 4.0:

- Fundamental study of Petri nets that can be analyzed and validated by a discrete system,
- Petri nets are useful for modeling and analyzing systems with discrete events,
- The validation methods and the results obtained from the analysis of the subject model, deterministic and stochastic model that are used to reorganize and reassess the system and increase its flexibility.

The figure 3 highlights the essential steps of a cloud manufacturing system in the ideal case. All the elements used in the simulation are discrete, which is difficult to obtain in practice.

The modeled system chosen is schematic and contains the basic components IoT, cloud, RAMI 4.0 and the connection between them. It is a generic system and has the role of highlighting the component elements.

In simulations, one can observe the intense activity throughout the requested period in the IoT area, because here the technological manufacturing flow takes place. In the Cloud area there is action at the required levels. Only three basic levels are represented in the scheme. These are at the beginning and end of the process and an intermediate level that can play a role in monitoring the activity.
As for the times used in the simulation, they are comparable to those used in the work in which we dealt with Cloud systems and IoT systems. The times are chosen randomly to be able to see on the simulation result the variations that can occur as a result of using the three technologies and their own architectures, Cloud, IoT and RAMI.

As a result of the simulation it is observed that intense activity on the entire surface of the technological flow is only in the IoT area, figure 4.

In the cloud, figure 5, 6 and 7 area the activity from the beginning and the end of the model is actively monitored, and the intermediate zone is the activity of tracking, the role of these areas is also to signal any possible defects that may occur in the technological process or errors that occur in the system.
In the area dedicated to RAMI 4.0 on the graphical representations, figures 8, 9, 10 and 11, we observe at the beginning a determined variation of relations, connections, internal and external requests. These are up to the stability of the system at the cloud level, and then everything unfolds linearly without any variations and sudden differences in representations. All this representation is until the end of the lot.
At the beginning of a new manufacturing batch determined by the same type of product established for processing, the entire RAMI 4.0 system will again have variations determined by the internal actions of the system and the external actions due to the imposed specifications. This simulation refers only to the product life cycles, the orders with the hierarchical levels of the industry. The life cycles of the factories and machines are not debated because in the model we included only one working point.

All simulations were performed in the same time frame for a single batch, in order to be able to observe as explicitly as possible the variation corresponding to the production flow and the level of orders accessed by RAMI for the system chosen as the simulation model.

4. Conclusions

Internal and external standards will be increasingly applied in large manufacturing systems.

IoT standards will be the key in the future for advanced open-client-oriented development, which will lead to innovative business transformation services.

Cloud production platforms are rarely applied today due to considerable concerns about investment security and profitability, but their action on the levels plays a decisive role especially for various optimizations and maintenance maintenance.

5. References

[1] Siderska J 2018 Cloud manufacturing platform and architecture design, doi:10.2478/mape-2018-0085 Date of submission of the article to the Editor: 03/2018 Date of acceptance of the article by the Editor: 07/2018 MAPE 2018 1(1) pp. 673-680

[2] Mohammad A, Ranjit B 2018 The Dependency of the Internet of Things on Cloud Computing International Journal of Trend in Scientific Research and Development 2(3) Mar-Apr 2018 ISSN: 2456-6470 pp. 2575-2581

[3] Lydon B RAMI 4.0 Reference Architectural Model for Industrie 4.0 InTech 66(2) ISSN 0192-303X

[4] Ciortea E M 2019 Manufacturing analysis with discrete events using IoT platform Modern Technologies in Industrial Engineering VII, (ModTech2019), IOP Conf. Series: Materials Science and Engineering 591(2019) 012008, doi:10.1088/1757-899X/591/1/012008

[5] Ciortea E M 2019 The cloud manufacturing – technology of the future ANNALS of Faculty Engineering Hunedoara – International Journal of Engineering Tome XVII [2019] Fascicle 4 [November], CD-ROM form, ISSN 1584 – 2673, online, ISSN 2601 – 2332, http://annals.fih.upt.ro/pdf-full/2019/ANNALS-2019-4-18.pdf

[6] Ciortea E M 2017 Prototyping manufacturing in the cloud IOP Conf. Series: Materials Science and Engineering 227(2017) 012028, doi:10.1088/1757-899X/227/1/012028

[7] Mohammed Z K A Ahmed E S A 2017 Internet of things Applications, Challenges and Related Future Technologies, World Scientific News, WSN 67(2) (2017) 126-148 EISSN 2392-2192