

Coursework: Intelligent Logistics Solutions

Application of big data and/or cloud computing and/or Industry 4.0

MAR707 - International Supply Chain Systems 2016/2017

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Abstract

The digitalization affects the development of the Industry. Therefore, a strategy, called Industry 4.0, should support the movement to the fourth stage of industrial revolution. This coursework presents an explanation of Industry 4.0 and demonstrate the related development of Cyber-Physical Systems (CPS) by big data and cloud computing. In the following, an overview about opportunities and challenges due to CPS is presented.

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List of Abbreviations

CPS

Cyber-Physical Systems

1. Introduction

The world is currently changing and companies have to manage the supply chain better than ever before. The strategy of Industry 4.0 aspires a new era and can bring business to a new stage. The aim of Industry 4.0. indicate a redesign of the complete business structure. The amount of data and cloud computing increase in the last recent years. Both are affected the development of Cyber-Physical Systems (CPS) which create business more intelligent and demonstrate the core of Industry 4.0.

This coursework deals with the changes of digitalization and concentrate on the development of CPS and figure out the opportunities and challenges for supply chain business based on Industry 4. 0 and the CPS. Moreover, the effects of big data and cloud computing on CPS are also presented for a further understanding of the current development.

2. Industry 4.0

Industry 4.0 describe a new era for manufacturing, rather a revolution which caused redesign of business processes and acting's. Mainly, this is resulted by the digitalization which is done by the impact of internet and computer automatizations (Marr, 2016). Today, the plants of manufacturers have a higher level of automatization and work more efficiently (Wahlster, 2012) and are linked to computer networks (Givehchi et al., 2013). This means the machines can provide information to the company's database. This development implies one of the main ideas of Industry 4.0: To create a highly performing connection network within the company and thus to turn into an intelligent factory. This aims to develop an extremely flexible structure of production process which results in high responsiveness for customer requirements and the possibility of immediately realised amendments of products. This also includes the target of creating higher efficiency and advantages towards competitors (Zhou et al., 2015). In Germany Industry 4.0 is a well-discussed topic in economies and politics. Essentially, it is a strategic part of the German politics for innovation management and aims to rise the productivity in their industries (Malanowski & Brandt, 2014, Zhou et al., 2015). In order to put Industry 4.0 into practice, an integration of improved network structure is needed. This is called CPS and a main character of this revolution (Zhou et al., 2015, Lee & Lapira, 2013).

Bondavalli et al. (2016 p.5) CPS is defined as “a system consisting of a computer system (the cyber system), a controlled object (a physical system) and possibly of interacting humans.” This kind of network structure is the organisation behind Industry 4.0 (Maslarić et al., 2016) and manage the linkage between the network and the physical technologies (Lee et al., 2015). Figure 1 shows the inside view and the content of a CPS. This demonstrate that CPS is “Systems of Systems” where different systems are closely linked to each other (Broy, 2010). In this context, there are widely used the expressions big data and could computing which are highly related to the development of Industry 4.0 and are presented in the coming sections.

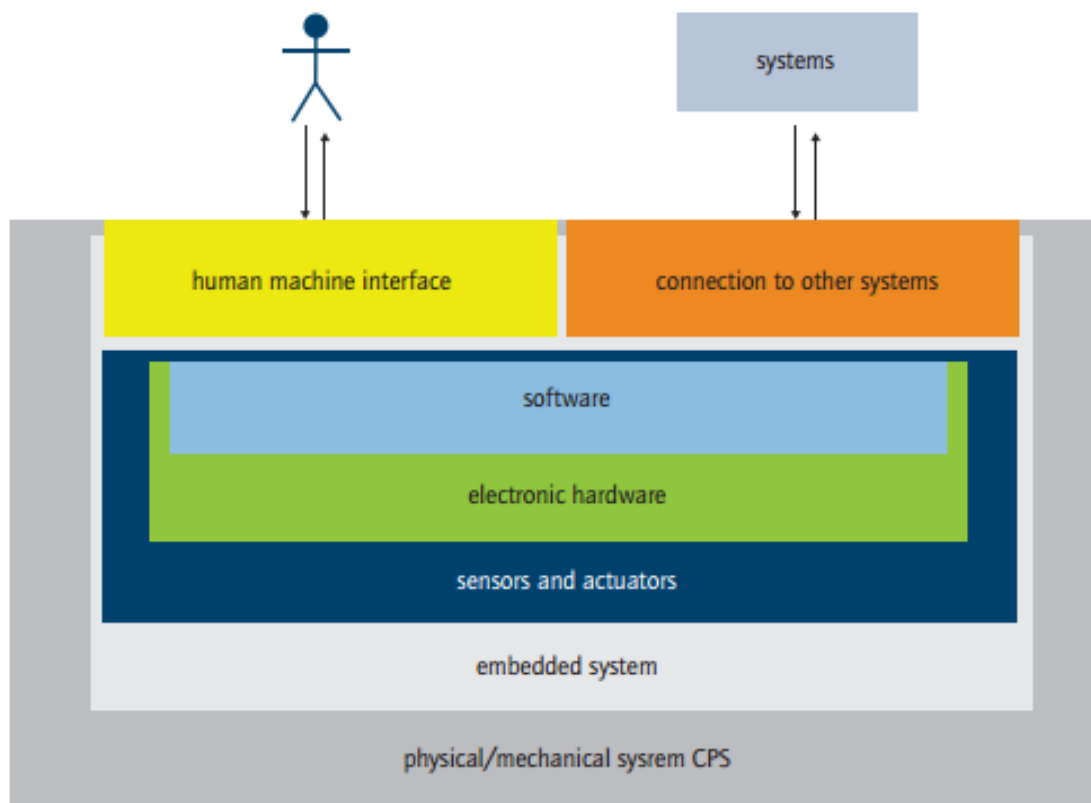


Figure 1: CPS structure (Broy, 2015 p.24)

3. Big data and cloud computing

The development towards Industry 4.0 implies a high amount of data due to the increasing automatization of machines and their progression of becoming more and more intelligent (Bonci et al., 2016). Data already affected social life and will increase

significantly so that every part gets involved (Manyika et al., 2011). In literature, it is called “Big data”. (Shi et al. 2011, Lee et al. 2013). Laney (2001) defined for big data the three Vs: volume, variety, and velocity which characterize this term. Besides, further research adds two to three further Vs: variability, value and/or veracity (Gandomi & Haider, 2015; Wei & Albert, 2013). Moreover, Big data analytics is the technic to generate a measurable value out of the data (Chen et al., 2012) and enhance new methods of analysis (Braganza et al., 2017). Furthermore, these analytics indicate the opportunity to deal positively with daily business provocation (Marín-Ortega et al., 2014). In general, big data should provide data for insights and support decision making (Gandomi & Haider, 2015). In addition, it helps to handle supply chain risk and an improvement of customer satisfaction and business processes (Davenport 2014, Erevelles et al., 2016, Wang & Alexander, 2015). According Manyika et. al. (2011) big data is a vital factor for business success and is already object of every business sector. In addition, the amount of data increase continuously and needs to be dealt with (Manyika et al., 2011). Cloud computing offers the opportunity to store data centralized in a network via the Internet (Armbrust et al., 2009). Armbrust et al. (2010, p. 50) define cloud computing which “refers to both the applications delivered as services over the Internet and the hardware and systems software in the data centers that provide those services.” This kind of services support handling of the huge amount of data. Both terms, big data and cloud computing, are “highly interdependent (Yue et al., 2015, p. 1265).” The growth of data collection and the possibility to transfer them in a cloud have an impact of the mentioned development to an Industry 4.0. Due to this, the target to create more intelligent factories becomes more applicable (Yue et al., 2015). This refers directly to the above-mentioned CPS. The technical applications within an intended CPS should interact among each other in real time like in a cloud (Stock & Seliger, 2016).

4. Solution approach for intelligent logistics & supply chains

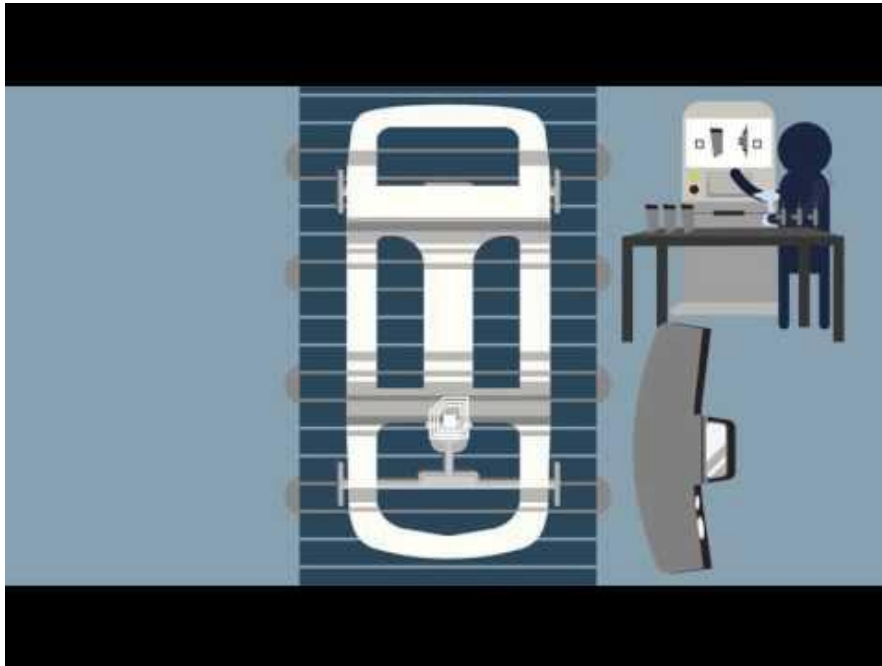
The Industry 4.0 and the planned integration of CPS is a quiet new industry objective. However, the company Rexroth Bosch Group in Germany has already started to implement Industry 4.0 ideas. Generally, the enterprise offer automated production solutions for industry customers. The plants are able to interconnect to several systems

and aims to equip industry which should results improvements supply chain towards Industry 4.0. The company explain, due to CPS, required amendments can be tested virtually and allows to send needed changes directly to the production line without a physical action; for instance, create variations of cameras models (Rexroth Bosch Group, n. d.). The following video presents this:



Video 1: Cyber Physical Systems (Rexroth Bosch Group (access via YouTube))

In addition, it should be possible that order changes of customers are provided in real-time so that adjustments can made directly within the production. This should highly improve supply chain and create logistics operations efficiently. The Video 2 provides an example (Rexroth Bosch Group, n. d.). In the next section opportunities and risks are demonstrated.



Video 2: Experience Industry 4.0 (Rexroth Bosch Group (access via YouTube))

5. Identification of opportunities and risks

5.1 Identification of opportunities

The creation of intelligent factories indicates the implementation of CPS. CPS offers some business advantages which have a special impact on logistic and supply chain management. Due to CPS, logistic and manufacturing systems can work without interaction of human involvement (Bauer et al., 2014) and develop a 'self-aware' and 'self-maintenance' system (Lee et al., 2014). Moreover, CPS provides more transparency and allows improved control mechanism, for instance, tracking shipments and inventory (CPSE Labs, 2016). In addition, the transparency can improve collaboration to suppliers and reduce supply chain risk at the same time. That optimize also the processes, creates flexibility and increase the productivity (Dorst et. al 2015, Lee et al. 2013). The data in real time reduce time for transactions (Sipsas et al., 2016) as well as provides insights which helps to improve the uncertainties in demand and prepare details for an improved customer relationship (Swaminathan, 2012). Ram et al. 2016 confirm and point out a possible decrease of customer complaints as well as improve future products and services. Furthermore, CPS can reduce costs for energy (Lee et al., 2014) and arise at the same time potential for integrating more sustainability

(Stock and Seliger, 2016). Next to this, labour costs can be reduced and offer the possibility for an improved work environment (Lee et al., 2014).

5.2 Identification of risks and challenges

Industry 4.0 is a new challenge which still needs to develop. Babiceanu & Seker (2016) point out a need for designing models for a supply chain cooperation, for instance, inventory management and forecasting. These models have to cover such requirements and should be able to be implemented in a CPS. In this context, standardization is also vital point (Botta et al., 2016). In general, the operational capability of a CPS has to ensure (Derler et al., 2016). A further point is security. CPS works nearly autonomically and trade harbours risks (Fraunhofer-Institut, 2017). Currently, security and also privacy are one of the biggest challenges (Yue et al., 2015). Due to the fact, that this system is still developed, all risks and challenges are still not discovered in total.

6. Discussion and Conclusion

As already mentioned, Industry 4.0 including the CPS needs further research and development. Lee et al. (2015) mention the need of a uniform definition for CPS. Moreover, Qin et al. (2016 p.178) describes: “there is a huge gap between recent industry and the achievement of Industry 4.0”. This indicates that the ideas and some technical capabilities are existed, however there is no sophisticated application which can already implement and cover all business relevant needs. In addition, the Industry has to be aware of the need and adapt to the new way of business. Yue et al. (2015) explain that the development of Industry 4.0 takes a long time and needs years or rather decades. Zhou et al. (2015), even argue that a transformation to Industry 4.0 is not realistic for Chinese Industries.

In this report, there is shown that Industry 4.0 offers a new applications system which provides enormous opportunities for supply chains. Already through the last decades' growth of data and internet based applications, there is built up fundamental change. The research demonstrates that solution for an implementation of new technologies is growing and there are even some practical starts, however there is no real business involvement which turns an integration into reality. This results that Industry 4.0 is a presently topic which tracks the next years.

References

- Armbrust, M., Fox, A., Griffith, R., Joseph, A.D., Katz, R., Konwinski, A., Lee, G., Patterson, D., Rabkin, A. and Stoica, I. (2010). 'A view of cloud computing', *Commun. ACM*, Vol. 53 No. 4, pp. 50–58.
- Armbrust, M., Fox, A., Griffith, R., Joseph, A.D., Katz, R.H., Konwinski, A., Lee, G., Patterson, D.A., Rabkin, A. and Stoica, I. (2009). '*Above the clouds: A Berkeley view of cloud computing*'. Technical Report UCB/EECS-2009-28, EECS Department, University of California, Berkeley.
- Babiceanu, R.F. and Seker, R. (2016). 'Big Data and virtualization for manufacturing cyber-physical systems: A survey of the current status and future outlook'. *Emerging ICT concepts for smart, safe and sustainable industrial systems*, Vol. 81, pp. 128–137.
- Bauer, M., Gurow, L. and Schlüter, P. (2014), '*Cisco Glossar Internet of Everything*'. Available at:
http://www.cisco.com/assets/global/DE/unified_channels/partner_with_cisco/newsletter/2014/edition24/downloads/cisco-ioe-glossar.pdf (Accessed: 3 March 2017)
- Bonci, A., Pirani, M. and Longhi, S. (2016). 'A database-centric approach for the modeling, simulation and control of cyber-physical systems in the factory of the future'- *8th IFAC Conference on Manufacturing Modelling, Management and Control MIM 2016* Troyes, France, 28—30 June 2016, Vol. 49 No. 12, pp. 249–254.
- Bondavalli, A., Bouchenak, S. and Kopetz, H. (2016). *Cyber-Physical Systems of Systems*, Vol. 10099, Springer International Publishing, Cham.
- Botta, A., Donato, W. de, Persico, V. and Pescapé, A. (2016). 'Integration of Cloud computing and Internet of Things: A survey'. *Future Generation Computer Systems*, Vol. 56, pp. 684–700.
- Braganza, A., Brooks, L., Nepelski, D., Ali, M. and Moro, R. (2017). 'Resource management in big data initiatives: Processes and dynamic capabilities', *Journal of Business Research*, Vol. 70, pp. 328–337.
- Broy, M. (2010). *Cyber-physical Systems: Innovation durch softwareintensive eingebettete Systeme*, Acatech DISKUTIERT, Springer, Berlin.
- Chen, H., Chiang, R.H.L. and Storey, V.C. (2012). 'Business intelligence and analytics: From big data to big impact'. *MIS quarterly*, Vol. 36 No. 4, pp. 1165–1188.

- CPSE Labs (2016). 'Cyber-Physical Systems'. Available at: <http://www.cpse-labs.eu/cps.php> (Accessed 3 March 2017).
- Davenport, T. H. (2014). 'How strategists use "big data" to support internal business decisions, discovery and production'. *Strategy & Leadership*, Vol. 42 No. 4, pp. 45–50.
- Derler, P., Lee, E.A. and Vincentelli, A.S. (2012). 'Modeling Cyber–Physical Systems'. *Proceedings of the IEEE*, Vol. 100 No. 1, pp. 13–28.
- Dorst, W., Glohr, C. and Hahn, T. (2015). 'Umsetzungsstrategie Industrie 4.0—Ergebnisbericht der Plattform Industrie 4.0', *Berlin, Frankfurt am Main: BITKOM, VDMA, ZVEI*.
- Erevelles, S., Fukawa, N. and Swayne, L. (2016). 'Big Data consumer analytics and the transformation of marketing', *Journal of Business Research*, Vol. 69 No. 2, pp. 897–904.
- Fraunhofer-Institut für Sichere Informationstechnologie (2017). 'Industrie 4.0 - IT-Sicherheit für die Produktion'. Available at: <https://www.sit.fraunhofer.de/de/industrie-40/> (Accessed: 3 March 2017).
- Gandomi, A. and Haider, M. (2015). 'Beyond the hype: Big data concepts, methods, and analytics', *International Journal of Information Management*, Vol. 35 No. 2, pp. 137–144.
- Givethchi, O., Trsek H. and Jasperneite J. (Eds.) (2013). 'Cloud computing for industrial automation systems — A comprehensive overview'. *2013 IEEE 18th Conference on Emerging Technologies & Factory Automation (ETFA)*.
- Laney, D. (2001), '3D data management: Controlling data volume, velocity and variety'. *META Group Research Note*, Vol. 6, p. 70.
- Lee, J. and Lapira, E. (2013). 'Predictive factories: the next transformation'. *Manufacturing Leadership Journal*, Vol. 20 No. 1, pp. 13–24.
- Lee, J., Ardakani, H.D., Yang, S. and Bagheri, B. (2015). 'Industrial Big Data Analytics and Cyber-physical Systems for Future Maintenance & Service Innovation', *Proceedings of the 4th International Conference on Through-life Engineering Services*, Vol. 38, pp. 3–7.
- Lee, J., Bagheri, B. and Kao, H.-A. (2015), 'A cyber-physical systems architecture for industry 4.0-based manufacturing systems'. *Manufacturing Letters*, Vol. 3, pp. 18–23.

- Lee, J., Kao, H.-a. and Yang, S. (2014). 'Service Innovation and Smart Analytics for Industry 4.0 and Big Data Environment', *Product Services Systems and Value Creation. Proceedings of the 6th CIRP Conference on Industrial Product-Service Systems*, Vol. 16, pp. 3–8.
- Lee, J., Lapira, E., Bagheri, B. and Kao, H.-a. (2013). 'Recent advances and trends in predictive manufacturing systems in big data environment'. *Manufacturing Letters*, Vol. 1 No. 1, pp. 38–41.
- Malanowski, N. and Brandt, J.C. (2014). 'Innovations-und Effizienzsprünge in der chemischen Industrie', *Wirkungen und Herausforderungen von Industrie*, Vol. 4.
- Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C. and Byers, A.H. (2011). 'Big data: The next frontier for innovation, competition, and productivity', *McKinsey Global Institute*.
- Marín-Ortega, P.M., Dmitriyev, V., Abilov, M. and Gómez, J.M. (2014). 'ELTA: New Approach in Designing Business Intelligence Solutions in Era of Big Data'. *Procedia Technology*, Vol. 16, pp. 667–674.
- Marr, B. (2016) What Everyone Must Know About Industry 4.0. *Forbes Magazine*. Available at: <https://www.forbes.com/sites/bernardmarr/2016/06/20/what-everyone-must-know-about-industry-4-0/#4f4de065795f> (Accessed: 4 March 2017).
- Maslarić, M., Nikoličić, S. and Mirčetić, D. (2016). 'Logistics Response to the Industry 4.0: the Physical Internet'. *Open Engineering*, Vol. 6 No. 1.
- Qin, J., Liu, Y. and Grosvenor, R. (2016). 'A Categorical Framework of Manufacturing for Industry 4.0 and Beyond', *Procedia CIRP*, Vol. 52, pp. 173–178.
- Ram, J., Zhang, C. and Koronios, A. (2016). 'The Implications of Big Data Analytics on Business Intelligence: A Qualitative Study in China', *Fourth International Conference on Recent Trends in Computer Science & Engineering (ICRTCSE 2016)*, Vol. 87, pp. 221–226.
- Rexroth Bosch Group (no date), 'Cyber physical system'. Available at: <https://www.boschrexroth.com/en/xc/trends-and-topics/industry-4-0/best-practices/smart-factory-demonstrator/cyber-physical-system/cyber-physical-system-1> (Accessed: 3 March 2017).

- Rexroth Bosch Group (no date), 'Industry 4.0: Connected Automation Starts Now'.
Available at: <https://www.boschrexroth.com/en/xc/trends-and-topics/industry-4-0/connected-industry-1> (Accessed: 19 March 2017).
- Shi, J., Wan, J., Yan, H. and Suo, H. (2011). 'A survey of Cyber-Physical Systems'. *Wireless Communications and Signal Processing (WCSP)*, International Conference on 9 November 2011, Nanjing, China.
- Sipsas, K., Alexopoulos, K., Xanthakis, V. and Chryssolouris, G. (2016), 'Collaborative Maintenance in flow-line Manufacturing Environments: An Industry 4.0 Approach'. *Procedia CIRP*, Vol. 55, pp. 236–241.
- Stock, T. and Seliger, G. (2016), 'Opportunities of sustainable manufacturing in Industry 4.0'. *Procedia CIRP*, Vol. 40, pp. 536–541.
- Swaminathan, S. (2012), 'The effects of big data on the logistics industry', *Profit Oracle*.
- Wahlster, W. (2012). 'From industry 1.0 to industry 4.0: towards the 4th industrial revolution (forum business meets research)'. *3rd European Summit on Future Internet Towards Future Internet International Collaborations Espoo, Finland*, Vol. 31.
- Wang, L. and Alexander, C.A. (2015). 'Big Data Driven Supply Chain Management and Business Administration'. *American Journal of Economics and Business Administration*, Vol. 7 No. 2, pp. 60–67.
- Wei F. and Albert B. (2013). 'Mining big data: current status, and forecast to the future', *SIGKDD Explor. Newsl.*, Vol. 14 No. 2, pp. 1–5.
- Yue, X., Cai, H., Yan, H., Zou, C. and Zhou, K. (2015). 'Cloud-assisted industrial cyber-physical systems: an insight', *Microprocessors and Microsystems*, Vol. 39 No. 8, pp. 1262–1270.
- Zhou, K., Liu, T., and Zhou, L. (2015). 'Industry 4.0: Towards future industrial opportunities and challenges'. In *Fuzzy Systems and Knowledge Discovery (FSKD)*, August 2015 12th International Conference (pp. 2147-2152).