

The fourth chapter summarised the results of the communication architecture implementation and compared it to the baseline performance of the case study in this section for ease of readability. This chapter took a closer look at the improved production performance in terms of production efficiency and bottleneck avoidance.

The fifth chapter analysed the results of chapter four to discern applicable causes for the production performance improvement. This chapter also followed on with a discussion of the holistic performance of the communication architecture, to provide guidance on future implementation and architectures in a similar manner.

6.3 Research Objectives

The main research objective of this study was to develop a communication architecture for improvement in production efficiencies and bottleneck avoidance in SM setups. The staging point for the development of this communication architecture is sprawled with precluding gaps in research due to the rapid expansion of I4.0. This study therefore set out to lay a path for the creation of the communication architecture in a few stages.

The study evaluated similar architecture types, in the form of hardware and software architectures, to identify similarities, input considerations, outputs, responsibilities and appropriate methods for architectures and their development. From this, similarities naturally arose with extensive research conducted into SM. From this initial research, comprehensive production scenarios to evaluate the performance of the communication architecture were established.

Next, this study set out to benchmark a current manufacturing case study, to evaluate its performance against these production scenarios. An evaluation for possible improvements to production efficiencies and bottleneck avoidance was then envisioned by reviewing these production results.

Furthermore, the study then set about creating a communication architecture to allow for communication control for SMUs to allow them to collect and act upon production data and fulfil the requirements of SM. The use of this communication architecture therefore also improves the ability of the SMUs and sets a paradigm for how and where production data should flow in a manufacturing line.

The study then went about extensively testing the communication architecture against the production scenarios and analysing the data to draw impactful conclusions from the results garnered.

Then, the study discussed the performance and data gathered from the results, in order to gauge effective use of the communication architecture and allow for recommendations and improvements to be suggested.

6.4 Unique Contribution of the Study

This study developed a communication architecture that was implemented in a Simulink smart manufacturing case study, which was tasked to improve production efficiencies and avoid bottlenecks. Further to this, the following contributions of this study are identified to be novel.

6.4.1 Incorporating Intelligence into Smart Manufacturing Units

The use of a communication architecture for SMUs works alongside the requirements set out for SM. This allows I3.0 machines to be upgraded to I4.0 machines by adhering to the communication standards of the architecture and its associated protocol. For machines to incorporate the ability of contextual awareness not only within the network, but the physical environment itself, aligns machines to the requirements of SM and enables them to be classified as SMUs.

This communication architecture also allows for SMUs to communicate with interoperability at the core of their methods, allowing for decentralised communication alongside appropriate information being shared. Other aspects, such as data analytics and agility through scalability also become integratable to the SMUs.

6.4.2 Improved Production Efficiency

The use of the communication architecture allows SMUs to communicate current production needs to machines on the network in real-time. This allows for strategies and information to be shared to all other machines, naturally leveraging the ability of machines to prepare or learn and adapt for incoming production means. These abilities allow for the SMUs to prepare for production and gain access to a wider suite of information. This all culminates in SMUs leveraging shared information alongside their operational coding to improve production efficiency by cutting out idle time.

6.4.3 Bottleneck Avoidance

The communication of current production statuses, such as availability of resources, allows SMUs to set consistent production speeds across the manufacturing line. This consistency that is agreed upon across the network and manufacturing line, ensures no SMU is left under greater strain and can reduce the backlog build-up of products at singular sources as this backlog and bottleneck can eventually slow down upstream SMUs, creating unintended chaos in the manufacturing line. However, even this chaos can be communicated with the communication architecture, allowing not only for mitigation in terms of bottlenecks, but also resolution, leading to a fulfilled meaning of bottleneck avoidance.

6.4.4 Future Architecture Creation and Evaluation

This study discussed the aspects it considers important for a communication architecture in an I4.0 environment. This study also identified the significance not only of the improved performance on a production scenario, but the qualitative improvement through which architectures can aid in organisation and structure. The study therefore self-evaluates the communication architecture due to a lack of applicable measurable criteria fit for communication architectures. This methodology and evaluation could be taken for guidance in future architecture creation and development.

6.5 Scientific Outcomes

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6.6 The Future Use of Communication Architectures

There are improvements from SMUs on production efficiency that can be corroborated to the communication of the next immediate production, but the communication architecture can also be expanded for communication of the organised structure of production orders. This communication will allow for a hybrid optimisation, where SMUs are able to optimise the next immediate operations of the products, whilst the central server provides longer term optimisation of production organisation. This long-term and short-term corroboration would lead to a hyper optimised system, all facilitated by the communication architecture.

Additional study to analyse specific effects of the communication architecture improvement to be pinpointed and to identify noise signals in improvements, i.e., why some improvements are not consistent.

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