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DEVELOPING AN AGENT-ORIENTED PARALLEL SIMULATOR FOR PRODUCTION PROCESSES

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ABSTRACT

Within the framework of agent-oriented parallel simulation, an agent-based model of production processes including release agents, tool group agents and job agents is built. The model, the data collector, and the simulation controller make up the simulator for production processes. The simulation controller is responsible to manage activation points and advance the simulation time. The communications among the agents and the simulation controller are designed in detail. A large variety of dispatch rules and release policies are preset in the model. Data of the production processes are stored in XML files. Applying the simulator to a wafer FAB model, the simulation results already match to the results from commercial simulators like Factory Explorer.

1 AGENT-ORIENTED PARALLEL SIMULATION

Event-oriented serial simulation is a major method for discrete event systems while real-time parallel simulation is used mainly in agent-based models. Combining the advantages of these two methods, an agent-oriented parallel simulation approach using process interaction worldview is proposed on the basis of an agent-based model (Zhang and Rose 2012). A special agent, simulation controller, is used to manage activation points and control the simulation time. Activation points are conveyed in the form of messages between the controller and agents. The simulation time advances according to the earliest activation point. All concurrent activation points are activated at a time and associated agents respond in parallel. The agents are activated when they receive the activation messages from the controller A brief framework is developed by means of multi-threading and synchronization technology.

2 SIMULATOR FOR PRODUCTION PROCESSES

The simulator is developed on the basis of the agent-oriented parallel simulation framework. The agent-based model and simulation controller make up the simulator for production processes (see Figure 1). Data about the production processes are inputs and performance measures are outputs.

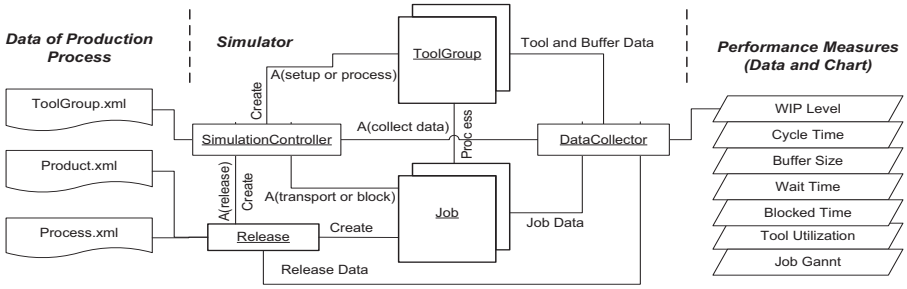

Figure 1: Agent-oriented simulation of production processes

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We classify the data of the production processes into three parts: tool group data, product data, and process data and adopt XML to describe the data. The performance measures include WIP level, cycle time, and so on. The agent-based model of production processes consists of a release agent, a data collector agent, job agents, and tool group agents. The simulation controller creates the release agent and the tool group agents according to the tool group data at the beginning of the simulation. The data collector is responsible for collecting simulation data and computing the performance measures.

In the release agent, there are one product list, three release policies (constant interval time, constant WIP level, and Avoiding Starvation), and one release buffer. The release agent creates the job agents which are given in the product list based on a release policy. The job agent is a temporary entity and will be processed by many tool groups in the order of its process path which depends on the target product, and after finishing it will be destroyed. A job agent has five behaviors: to request, to be transported, to enter the buffer, to wait, to be processed, and to be blocked. The tool group agent includes one buffer and several tools. 17 types of common dispatch rules, such as FIFO, EDD, CR, etc., have been preset in the buffer. The tool group agent has 9 behaviors: to respond to the request from the job agent, to select the best tool to process the job agent, to store the job, to dispatch the stored jobs, to request the jobs from the buffer, to setup, to process, to interrupt, and to recover. The following activation points are involved: release job, process end, setup end, interruption start, interruption end, transport end, block end, and data acquisition. Figure 2 shows the activation points conveying between the simulation controller and the agents and the communication among the agents.

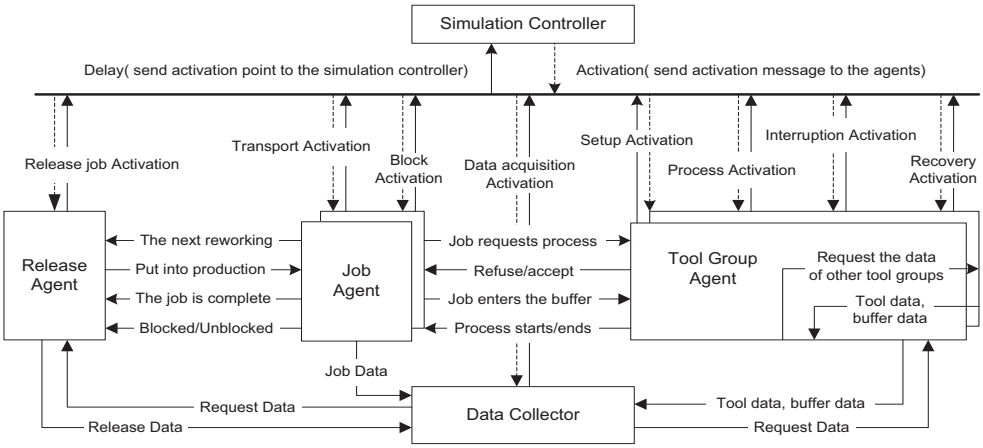

Figure 2: The communication among the agents and the simulation controller

3 APPLICATION AND CONCLUSION

The developed simulator is applied to the wafer FAB, using improved production processes from Mimac6 which has 93 tool groups and produces 9 products with 9 process flows. The simulator runs 200 days and all tool groups adopt FIFO rule. The release policy is Constant Time Interval. Three types of products with large output volumes are chosen to be compared to the performance estimates of the commercial simulator Factory Explorer. The results already match to the results from commercial simulators like Factory Explorer. In the next step we will improve the tool group agent and enrich it with the ability to learn to schedule. With the obtained knowledge the tool group agent can dispatch jobs in a more intelligent way than just using simple rules.

REFERENCES

Zhang, T., O. Rose. 2012. “A Framework of Agent-oriented Parallel Simulation of Discrete Event Systems”. In *Proceedings of the 2012 Winter Simulation Conference*, Edited by C. Laroque, J. Himmelspach, R. Pasupathy, O. Rose, and A.M. Uhrmacher, -. Piscataway, New Jersey: Institute of Electrical and Electronics Engineers, Inc.