EXHIBIT B

US006907305B2

(12) **United States Patent**
Mata et al.

(10) **Patent No.: US 6,907,305 B2**
(45) **Date of Patent: Jun. 14, 2005**

(54) **AGENT REACTIVE SCHEDULING IN AN AUTOMATED MANUFACTURING ENVIRONMENT**

(75) Inventors: **Gustavo Mata**, Austin, TX (US); **Steven C. Nettles**, Johnson City, TX (US); **Larry D. Barto**, Austin, TX (US); **Yiwei Li**, Austin, TX (US)

(73) Assignee: **Advanced Micro Devices, Inc.**, Austin, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/135,145**

(22) Filed: **Apr. 30, 2002**

(65) **Prior Publication Data**

US 2004/0243266 A1 Dec. 2, 2004

(51) **Int. Cl.**[7] **G06F 19/00**
(52) **U.S. Cl.** **700/99**; 700/100; 700/121; 705/8
(58) **Field of Search** 705/8; 700/99, 700/100, 121, 101

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,796,194 A		1/1989	Atherton	364/468
5,093,794 A		3/1992	Howie et al.	364/468
5,369,570 A		11/1994	Parad	364/401
5,375,061 A		12/1994	Hara et al.	364/468
5,444,632 A	*	8/1995	Kline et al.	700/100
5,446,671 A	*	8/1995	Weaver et al.	700/100
5,548,535 A		8/1996	Zvonar	364/551.01
5,586,021 A		12/1996	Fargher et al.	364/468.06
5,835,688 A	*	11/1998	Fromherz	358/1.13
5,890,134 A		3/1999	Fox	705/9
5,953,229 A		9/1999	Clark et al.	364/468.06
6,038,539 A		3/2000	Maruyama et al.	705/8
6,088,626 A		7/2000	Lilly et al.	700/100
6,128,542 A		10/2000	Kristoff et al.	700/97
6,148,239 A		11/2000	Funk et al.	700/1
6,202,062 B1		3/2001	Cameron et al.	707/3
6,263,255 B1		7/2001	Tan et al.	700/121
6,356,797 B1		3/2002	Hsieh et al.	700/101
6,374,144 B1		4/2002	Viviani et al.	700/12
6,400,999 B1		6/2002	Kashiyama et al.	700/100
6,434,443 B1	*	8/2002	Lin	700/100
6,584,369 B2		6/2003	Patel et al.	700/100

OTHER PUBLICATIONS

U.S. Appl. No. 10/331,715, filed Dec. 30, 2002, Nettles et al.
U.S. Appl. No. 10/331,598, filed Dec. 30, 2002, Barto et al.
U.S. Appl. No. 10/331,596, filed Dec. 30, 2002, Barto et al.
U.S. Appl. No. 10/284,705, filed Oct. 31, 2002, Nettles et al.
U.S. Appl. No. 10/233,197, filed Aug. 30, 2002, Barto et al.
U.S. Appl. No. 10/232,145, filed Aug. 30, 2002, Barto et al.
U.S. Appl. No. 10/231,930, filed Aug. 30, 2002, Barto et al.
U.S. Appl. No. 10/231,888, filed Aug. 30, 2002, Barto et al.
U.S. Appl. No. 10/231,849, filed Aug. 30, 2002, Barto et al.

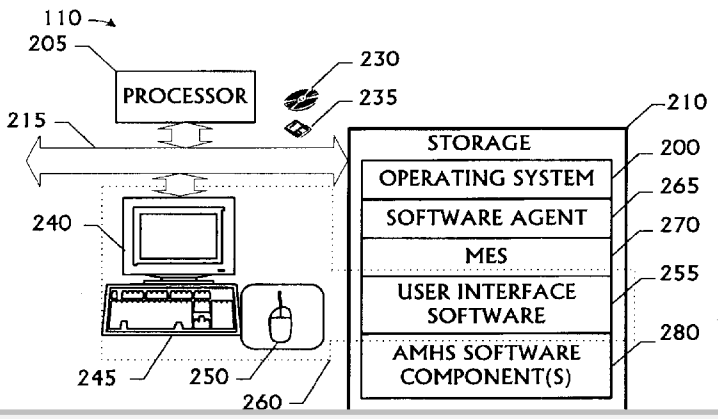
(Continued)

Primary Examiner—Jayprakash N. Gandhi
(74) *Attorney, Agent, or Firm*—Williams, Morgan & Amerson, P.C.

(57) **ABSTRACT**

A method and apparatus for scheduling in an automated manufacturing environment, comprising are disclosed. The method includes detecting an occurrence of a predetermined event in a process flow; notifying a software scheduling agent of the occurrence; and reactively scheduling an action from the software scheduling agent responsive to the detection of the predetermined event. The apparatus is automated manufacturing environment including a process flow and a computing system. The computing system further includes a plurality of software scheduling agents residing thereon, the software scheduling agents being capable of reactively scheduling appointments for activities in the process flow responsive to a plurality of predetermined events.

53 Claims, 6 Drawing Sheets



OTHER PUBLICATIONS

U.S. Appl. No. 10/231,648, filed Aug. 30, 2002, Barto et al.
U.S. Appl. No. 10/231,561, filed Aug. 30, 2002, Barto et al.
U.S. Appl. No. 10/190,194, filed Jul. 3, 2002, Li et al.
U.S. Appl. No. 10/160,990, filed May 31, 2002, Mata et al.
U.S. Appl. No. 10/160,956, filed May 31, 2002, Li et al.
U.S. Appl. No. 10/135,145, filed Apr. 30, 2002, Mata et al.
Resende, "Shop Floor Scheduling of Semiconductor Wafer Manufacturing," *University of California*, Berkeley (1987).
Glassey et al., "Closed–Loop Job Release Control for VLSI Circuit Manufacturing," *IEEE Transactions on Semiconductor Manufacturing* 1:36–46 (1988).
"Agent–Enhanced Manufacturing System Initiative," *Technologies for the Integration of Manufacturing Applications* (*TIMA*) (Oct. 1997).
Ebteshami et al., "Trade–Offs in Cycle Time Management: Hot Lots", IEEE Transactions on Semiconductor Manufacturing, vol. 5, No. 2, May 1992.
"Factory Integration," *The National Technology Roadmap for Semiconductors: Technology Needs* (1997).
SALSA Enhancements for next Swarm Release (Apr. 22, 1999).
SALSA Exceptions—Minutes from May 11, 1999.
Starvation Avoidance Lot Start Agent (SALSA) (Overview: Apr. 15, 1999).
Starvation Avoidance Lot Start Agent, *Fab 25 AEMSI/SALSA Review Meeting* (May 26, 1999).
Starvation Avoidance Lot Start Agent, *Iteration 1 Requirements Kickoff* (May 3, 1999).
Van Parunak, "Review of Axtell and Epstein" (Jun. 23, 1999).
Baumgärtel et al., "Combining Multi–Agent Systems and Constraint Techniques in Production Logistics" (1996).
Bonvik et al., "Improving a Kanban Controlled Production Line Through Rapid Information Dissemination" (Jul. 10, 1995).
Burke et al., "The Distributed Asynchronous Scheduler," pp. 309–339 (1994).
Butler et al., "ADDYMS: Architecture for Distributed Dynamic Manufacturing Scheduling," pp. 199–213 (1996).
Fordyce et al., "Integrating Decision Technologies for Dispatch Scheduling in Semiconductor Manufacturing," *Logistics Management System* (*LMS*), pp. 473–516 (1994).
Hynynen, "BOSS: An Artificially Intelligent System for Distributed Factory Scheduling," *Computer Applications in Production and Engineering*, pp. 667–677 (1989).
Interrante et al., "Emergent Agent–Based Scheduling of Manufacturing Systems".
Juba et al., "Production Improvements Using a Forward Scheduler" (1995).
Li et al., "Minimum Inventory Variability Schedule with Applications in Semiconductor Fabrication," *IEEE Transactions on Semiconductor Manufacturing* 9:145–149 ()1996).
Lin et al., "Integrated Shop Floor Control Using Autonomous Agents," *IIE Transactions* 24:57–71 (1992).
Lu et al., "Efficient Scheduling Policies to Reduce Mean and Variance of Cycle–Time in Semiconductor Manufacturing Plants," *IEEE Transactions Semiconductor Manufacturing* 7:374–388 (1994).
Martin–Vega et al., "Applying Just–In–Time in a Wafer Fab:
Murthy et al., "Agent Based Cooperative Scheduling," pp. 112–117 (1997).
Van Parunak et al., "Agents Do It In Time—Experiences with Agent–Based Manufacturing Scheduling" (1999).
Van Parunak et al., "Agent–Based Models & Manufacturing Processes".
Ramos et al., "Scheduling Manufacturing Tasks Considering Due Dates: A New Method Based on Behaviours and Agendas" (1995).
Shen et al., "An Agent–Based Approach for Dynamic Manufacturing Scheduling" (1998).
Hollister, "Schedule Paper #17 Summary" (Jun. 23, 1999).
Hollister, "Schedule Paper #19 Summary" (Jun. 23, 1999).
Hollister, "Schedule Paper #23 Summary" (Jun. 23, 1999).
Hollister, "Schedule Paper #32 Summary" (Jun. 23, 1999).
Vaario et al., "An Emergent Modelling Method for Dynamic Scheduling," *Journal of Intelligent Manufacturing* 9:129–140 (1998).
Wellman et al., "Auction Protocols for Decentralized Scheduling" (May 22, 1998).
Weber, "Material Traceability—The Missing Link in TAP Systems," *Test, Assembly and Packaging Automation and Integration '99 Conference* .
"ObjectSpace Fab Solutions Semiconductor Product Development Overview" (presented at SEMICON Southwest 1998).
"Agent Enhanced Manufacturing Systems Initiative (AEMSI) Project" presented by Dan Radin, ERIM CEC Nov. 12–13, 1998).
Weber, "APC Framework: Raising the Standard for Fab Automation and Integration," *Equipment Automation Conference 1hu st European Symposium on Semiconductor Manufacturing* (Apr. 14, 1999).
Wein, "Scheduling Semiconductor Wafer Fabrication," *IEEE Transactions on Semiconductor Manufacturing* 1:115–130 (1988).
Bonvik, "Performance Analysis of Manufacturing Systems Under Hybrid Control Policies" (Sep. 22, 1995).
Bonvik, "Performance Analysis of Manufacturing Systems Under Hybrid Control Policies" (Oct. 3, 1995).
Sikora et al., "Coordination Mechanisms for Multi–Agent Manufacturing Systems: Applications to Integrated Manufacturing Scheduling," *IEEE Transactions on Engineering Management* 44:175–187 (1997).
Sousa et al., "A Dynamic Scheduling Holon for Manufacturing Orders," *Journal of Intelligent Manufacturing* 9:107–112 (1998).
Upton et al., "Architectures and Auctions in Manufacturing," *Int. J. Computer Integrated Manufacturing* 4:23–33 (1991).
Fordyce et al., "Logistics Management System (LMS): An Advanced Decision Support System for the Fourth Decision Tier–Dispatch or Short Interval Scheduling,", pp. 1–58 (1994).
Gere, "Heuristics in Job Shop Scheduling," *Management Science* 13:167–190 (1966).
Ehteshami et al., "Trade–Offs in Cycle Time Management: Hot Lots," *IEEE Transactions on Semiconductor Manufacturing* 5:101–106 (1992).
Axtell et al., "Distributed Computation of Economic Equilibria via Bilateral Exchange" (Mar. 1997).

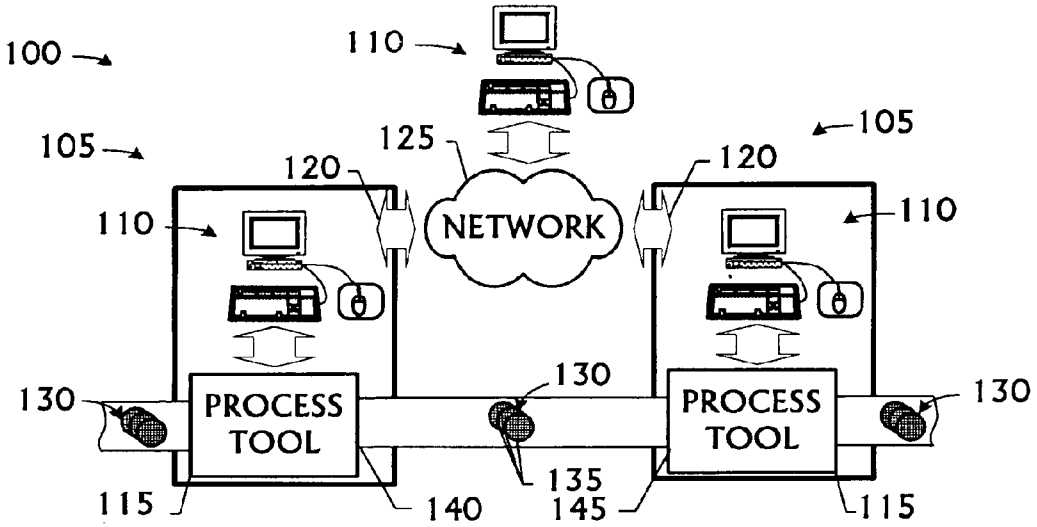


FIG. 1

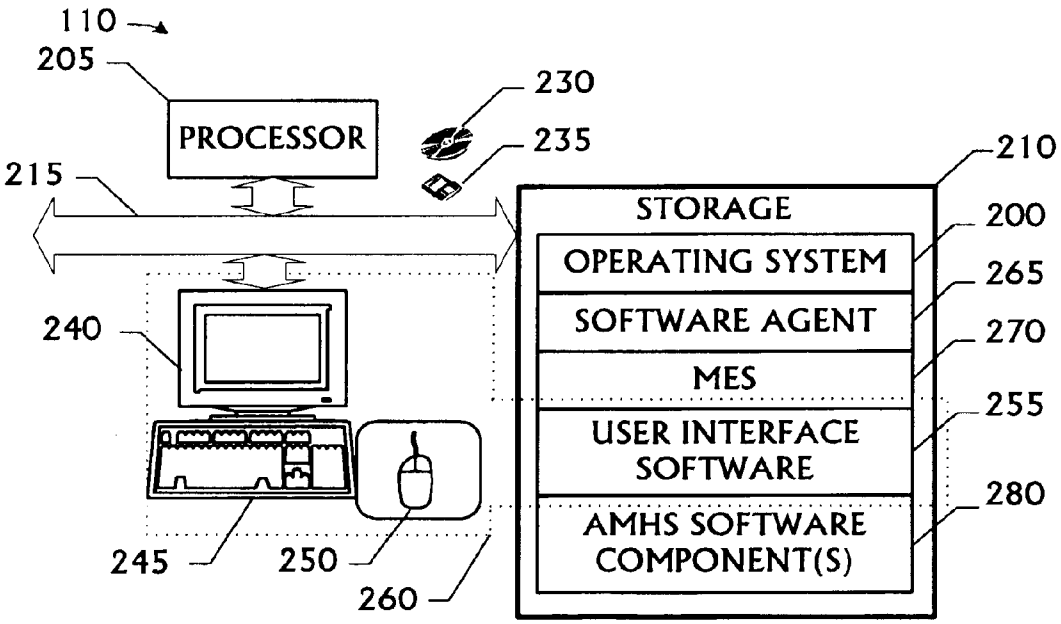


FIG. 2

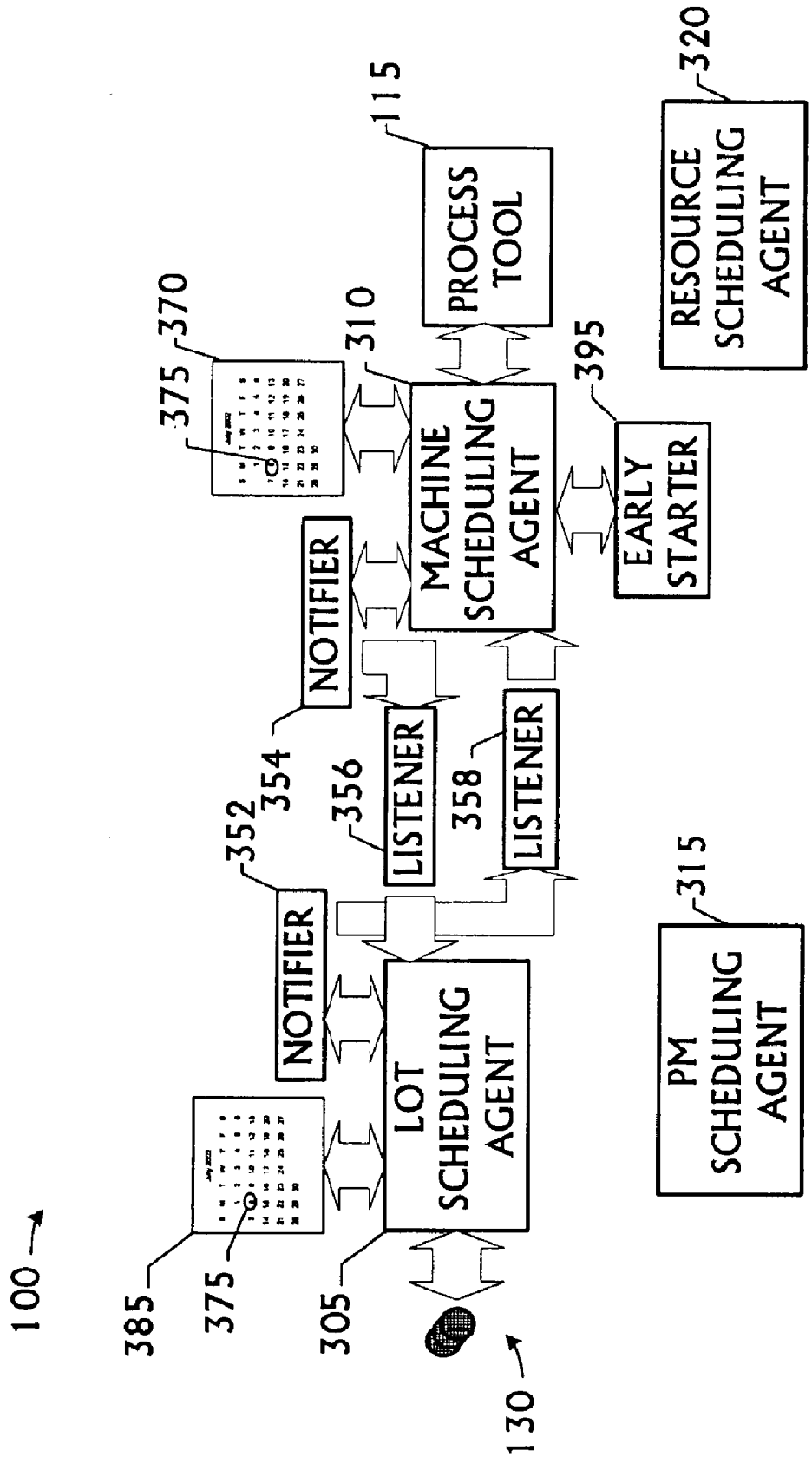


FIG. 3

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.