

Study on Architecture of SMT-MG

Li Chunquan^{1,2} Yu Tao² Zhou Dejian³

¹ Dept. of Electronic Machinery and Traffic Engineering, Guilin University of Electronic Technology, Guilin 541004, P.R. China

²Cims Center, Shanghai University, Shanghai 210029, P.R. China

³ Guilin University of Technology, Guilin 541004, P.R. China

Abstract: - Surface mount technology manufacturing grid (SMT-MG) is one of typical industries application of grid technology. In the paper, SMT manufacture system and its characteristics are discussed. Based on OGSA and manufacturing grid, concept of SMT-MG is presented. The architecture of SMT-MG is analyzed emphatically. It includes basal environment layer, resource package and service construction layer, grid middle ware layer, enable tools layer, tool application layer, and portal layer. Components of each layer and their mutual relationships are analyzed in detail. At last, the key technologies of SMT-MG are discussed.

Key-Words: -Manufacturing system, Grid, SMT, Architecture, Concept

1 Introduction

Grid technology, as an important information technology, has been advanced and developed fast in recent years. It changes the way to live and communicate for people to a large extent. Its application field is changing from science to engineering and business fields and it has been used in manufacturing, medicine, education, geology and so on fields. With its stepwise application in manufacturing field, manufacturing grid (MG) as a new manufacturing mode has been brought forward[1][2][3]. Design, manufacture, information, technology, and so on different or remote resources can be shared through manufacturing grid. So cooperative design and manufacturing facing to whole lifecycle of products can also be achieved. The application of grid technology in manufacturing industry is the core of application of grid industry. At present, researches on manufacturing grid mainly focus on architecture, resource management, job monitor, reliability management, security management and so on aspects[4].

With the development of electronic products to micromation, lighter, higher density and miniaturization, Surface mount technology (SMT) product has been one of main electronic products. Print circuit board is the physical carrier of SMT product. SMT products are manufactured by mounting the electronic components on PCB through surface mounting technology. The whole lifecycle of SMT products includes design, manufacturing, simulation, analysis and so on processes [5][6][7].

As an important embranchment of modern manufacturing industry, SMT product manufactur-

ing faces to many challenges. The application of grid technology in SMT product manufacturing has been an effective and important way. Whereas, based on the concept of grid technology and the analysis of the characteristics of manufacturing grid of SMT products, taking OGSA as the system framework, the architecture of SMT-MG was advanced in this paper.

2 Concept and Characteristics of SMT-MG

2.1 Concept of SMT-MG

Architecture of SMT-MG that is compatible with MG, can be operated by each other, using uniform criterions and standards, integrating manufacturing industry characteristics of SMT products, taking MG as referenced system can be built only based on analysis of characteristics of SMT-MG.

As an important embranchment of manufacturing system, SMT-MG should be compatible with MG and be operated by each other. So SMT-MG is a subset of MG, just as:

$$\{SMT - MG\} \subset \{MG\} \quad (1)$$

At the same time, because SMT product manufacturing is interdisciplinary and its manufacturing objects are special, it has other technology characteristics including circuit technology, automation control technology, computer technology and so on. Hence, SMT-MG is intersection of

many industry technologies as shown in figure 1, just as:

$$\{SMT - MG\} \subset (\{MG\} \cap \{EG\} \cap \{CG\} \cap \dots) \quad (2)$$

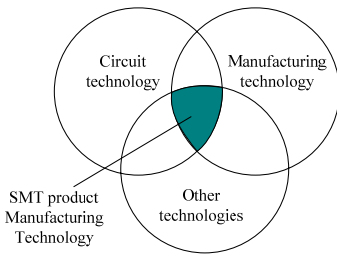


Fig. 1. Technology domains of SMT product manufacturing

Concept of SMT-MG can be attained based on analysis of characteristics of SMT-MG [8].

Manufacturing grid of SMT products is a new and advanced manufacturing mode taking fast corresponds to market needs and improvement competition of enterprises as main targets to deal with the challenges of knowledge economy and manufacturing globalization. Criteria and standards that face to SMT product manufacturing industry are compatible with manufacturing grids using open architecture, uniform criteria and standards and development platform provided by grid technology based on grid manufacturing technology and method can be set down. The accomplishment of this mode can break through restrictions of space and district on enterprise management range and ways to deal with whole or partial enterprise operation activities in SMT product lifecycle relating to design, manufacturing, packing, transportation, utilization, discarding and disposing. On the other way, it can realize sharing and integrating of resources and cooperation among enterprises to improve utilization rate, shorten the time that product needs to come into the market, provide products and service for market with high speed, high quality and low cost.

From the describing above, SMT-MG includes three domains: SMT product manufacturing, manufacturing grid and grid technology. See the figure 2.

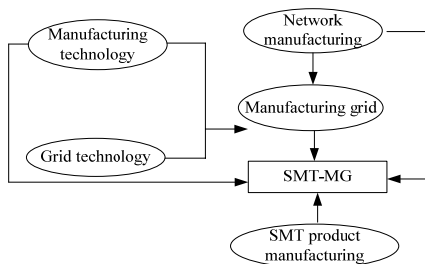


Fig. 2. Form of SMT-MG

2.2 Characteristics of SMT-MG

The main difference SMT-MG has from MG is as shown in figure 3[9].

2.2.1 Higher density of knowledge, technology and information

SMT products are small, light, high and interdisciplinary, so that their density of knowledge, technology and information is higher than other products.

2.2.2 Complicated data information

The data information of SMT products includes circuit design information, circuit analysis information, multi-disciplinary analysis data information and so on. So it brings new requests for information exchange strategy, information input and output ability, performance of SMT-MG.

2.2.3 High requests for reliability

SMT products have been used widely. They have been applied in upper air, underground, desert and other places having complicated work environment, which have very high requests for reliability. For example, to electronic equipments used in space flight, if certain component or connection point comes into failure, it will affect the work of equipments even makes missile, carrier rocket and satellite lose control. So there must be higher requests for reliability analysis and evaluation of SMT-MG.

2.2.4 High requests for service quality

High requests for service quality are along with high reliability. Different from general manufacturing products, arbitrary quality of SMT products can cause failure of products. It even can bring aftereffects that cannot be estimated. Hence, there are higher requests for deepness and extent of service quality.

2.2.5 Complicated manufacturing process

SMT product manufacturing system is a typical flexible manufacturing system. Its manufacturing equipments, manufacturing processes, product manufacturing and manufacturing system all have obvious flexible characteristics. It makes the decomposing items, distributing job in manufacturing process changeful and complicated. So it brings higher requests for process monitor in SMT-MG manufacturing.

2.2.6 Characteristics of service groups

Because SMT product assembly cannot be transferred, so that service groups of SMT-MG have obvious requests and characteristics. There are some

especial requests for building, log outing, distributing and lifecycle of service groups of SMT-MG.

2.2.7 Rapid development

SMT product manufacturing system is a new manufacturing system developing according to Mole law. New technologies, new products and new components emerge rapidly. So based on fact that SMT-MG can meet demands of current manufacturing, interfaces and criterions can be opened to deal with future manufacturing demands.

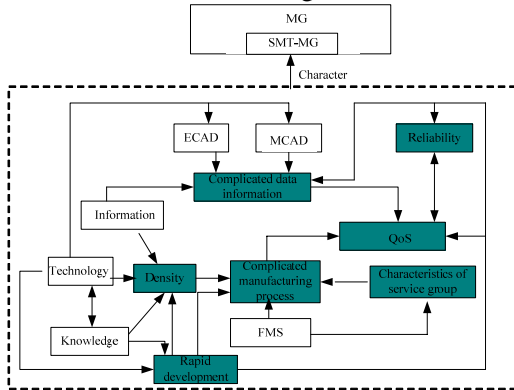


Fig. 3. Characteristics of SMT-MG

3 Architecture of SMT-MG

Architecture of SMT-MG was built founded on analysis of SMT-MG characteristics [10]. See the figure 4.

From figure 4, we can see that SMT manufacturing structure has six layers. First layer is basal environment layer. It provides basal operation environment for resources, service share and cooperation in SMT-MG. Second layer is the SMT-MG resource packaging and service-constructing layer. It mainly builds service nodes for SMT-MG. SMT manufacturing resources, can be packaged to become grid service joining in SMT-MG through grid interfaces based on the standards. Third layer is grid middle ware layer. It provides basal functions for SMT manufacturing service and service cooperation based on grids. It includes Web services, grid execution services, grid core services, grid data services and so on. Founded on these, enable tools facing to SMT-MG can be developed. Fourth layer is SMT-MG enable tools layer. It contains various enable tool packages facing to multi-application. Fifth layer is application layer of SMT-MG tools. According to different SMT manufacturing process and cooperation needs , based on SMT-MG enable tools, professional tools application contains supply chain management tool, reliability management tool, project management tool, resource management tool and so on, can be

developed. Sixth layer is SMT-MG portal layer. It builds SMT-MG portal. Different service providers and service requesters can enter SMT-MG through portal to do resource registry/ logout, job registry/logout, manufacturing process inspect and monitor and so on.

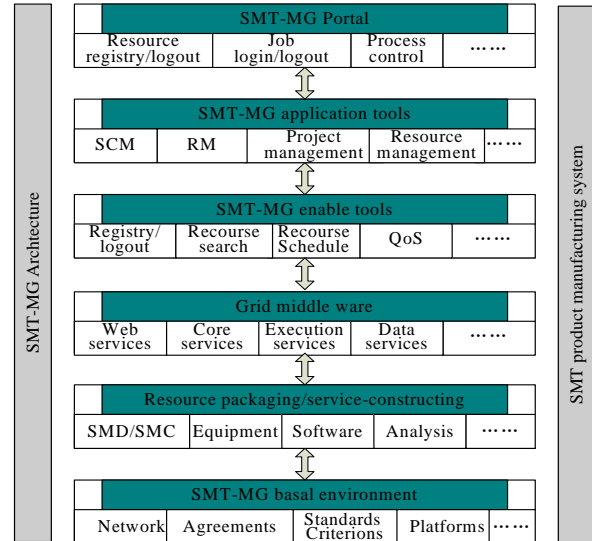


Fig. 4. Architecture of SMT-MG

3.1 SMT-MG basal layer

The layer provides basal environment for SMT-MG operation. It mainly contains basal operation environment for grid and SMT product manufacturing network. See figure 5.

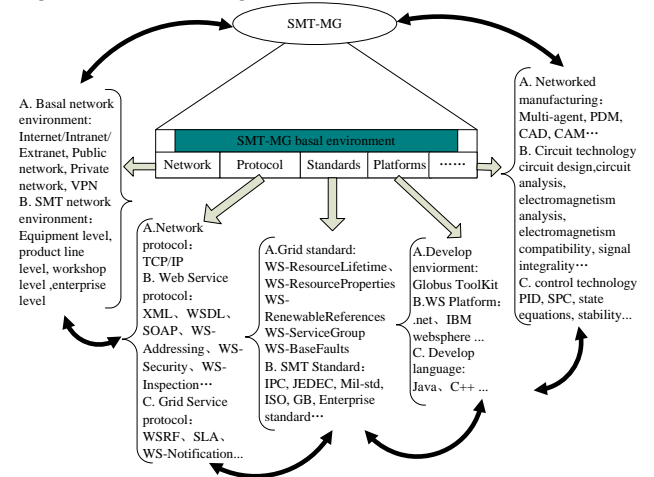


Fig. 5. SMT-MG operation basal environment layer

Basal operation environment facing to grid is formed by basal network environment, network basal protocol, network standards and network service development platform. SMT-MG is according with OGSA and WSRF standards including WS-Resource Lifetime, WS-Resource Properties, WS-Renewable References, WS-Service

Group, WS-Base Faults and so on[11]. Its development platform is GTK4.0 and it uses B/S mode.

Operation basal environment orientating to SMT product manufacturing contains SMT equipment network environment that can be classed into equipment level, produce line level, workshop level and enterprise level. SMT product manufacturing standards include IPC standard, JEDEC standard, and enterprise standards etc.

At the same time, SMT-MG operation basal environment also using modern manufacturing technologies, just as Agent technology, PDM/CAD /CAM technology, circuit technology, circuit analysis, circuit design, electromagnetism analysis, electromagnetism compatibility, signal integrity, control technology, SPC, state equations, stability and so on [12].

3.2 SMT-MG packaging layer

SMT-MG service resource nodes can be built in this layer. SMT product manufacturing has various resources, as print equipments, placement equipments and software. The capability and characteristics can be expressed and described through resource properties divided into dynamic properties and static properties. Putting manufacturing resource properties into SMT-MG can form stateful service resources. According to request for open, to do uniform and normative resources describing, resource properties files are formed by putting in resource properties founded on resource mode repository and grid service are formed by resource packaging and interface design based on grid service standards. Service nodes and various manufacturing service nodes form grid service pool. Virtual grid service pool mapped form grid catalog. Client port of SMT-MG service can use stateful and sharing resources through list management and so on information service. See figure 6.

3.3 Grid middle ware layer

This layer provides basal functions for the accomplishment of SMT-MG service and service cooperation. It is the core of SMT-MG and most grid middle ware tool is Globus platform now. Grid middle ware can be divided into patulous Web service, grid service based on OGSA framework and certain domain service. Patulous Web service containing WS-Addressing, WS-Security, WS-Choreography, WS-Attributes, WS-Trust, WS-Resource Framework being most important and so on Web service standards is achieved by adding some standards founded on basal grid service. Grid service based on OGSA framework includes grid

core service, grid program execution service and grid data service. Grid core service is composed of service management, service communication, strategy management and security. Grid program execution service is made up of by job distribution and inspection, resource reservation service, workflow management and distribution service, job mapping. Grid data service is made up of data access service, data copy and transfer service, data cache service and metadata list service. See figure 7.

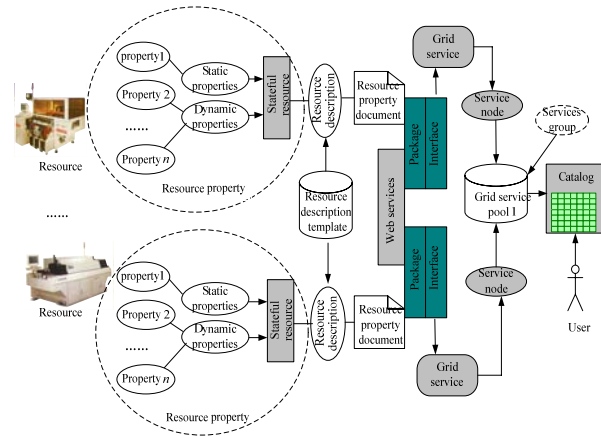


Fig. 6. SMT-MG resource packaging and service-constructing layer

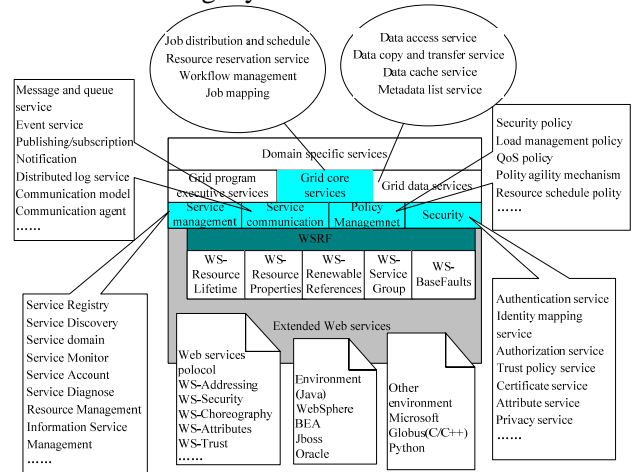


Fig. 7. SMT-MG grid middle ware layer

3.4 SMT-MG enable tools layer

This layer provides and supports for SMT-MG constructing and application in ways and tools aspect. It accepts the request of tools application layer for transferring grid middle wares including service registry, service log out, service access, decomposing project, distributing resource, submit job, resource reservation, service level agreement, service quality, resource agent, performance evaluation, informing service and etc. At the same time, the mutual contacting and transferring among enable tools are achieved through message. Figure 8

shows the functions of SMT-MG tools application system done with SMT-MG enable tools layer's cooperation.

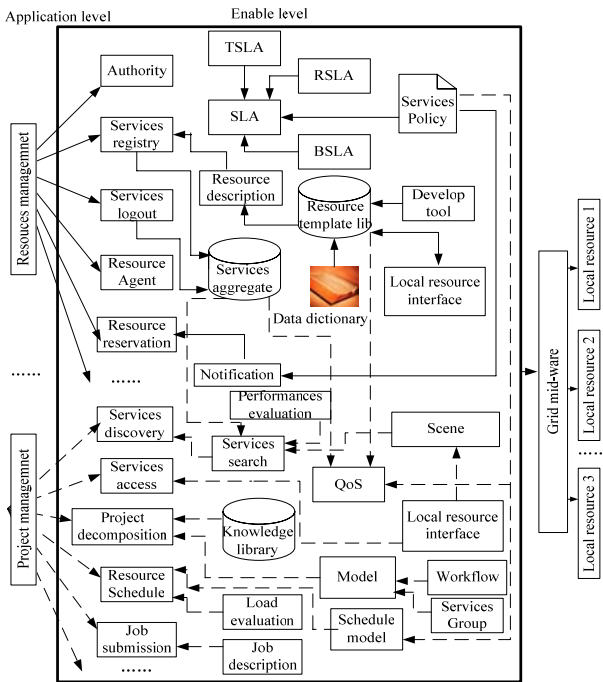


Fig. 8. SMT-MG enable tools layer

3.5 SMT-MG application tools layer

This layer is the application tools of SMT-MG. It supports for SMT product design, manufacturing and management. SMT-MG tools application is classed into resource management, workflow management, project management, reliability management, and supply chain management etc. According to different needs of SMT-MG clients, tools systems contact each other and corresponding tools application system starts to transfer enable tools and grid middle wares for accomplishment of using and cooperate with sharing resources. See figure 9.

3.6 SMT-MG portal layer

This layer provides uniform and safety client interface for SMT-MG so that different clients at different places can use service supplied by SMT-MG through uniform interface. Contacting among grids is mainly realized through portal. Parts of SMT-MG can be divided into client, developer, and grid manager. To client, according to using SMT-MG for different goals, it can be divided into service provider and service consumer. Under SOA structure of web service, service provider puts in resources, management resources, management lifecycle, changes resources and negotiates about

service etc. Service consumer submit job, decomposing project, matches resources, schedule resources etc. To developer, main works are to develop and design SMT-MG platform, design applied tools, design data transmission, do security design and so on. To Administrator, main works are to monitor platform, do platform maintenance, deploy service, install service and do service configuration. See figure 10.

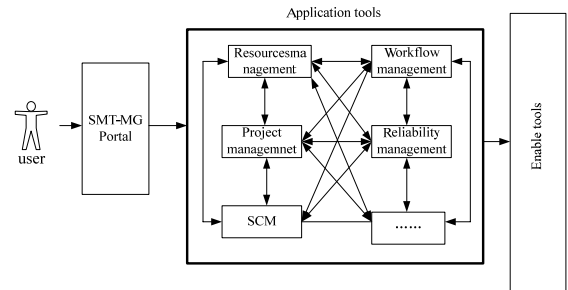


Fig. 9. SMT-MG application tools layer

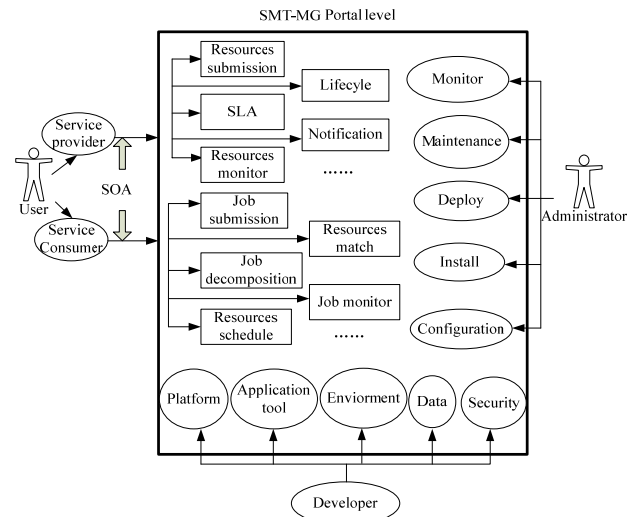


Fig. 10. SMT-MG portal layer

4 Key Technologies of SMT-MG

4.1 Resource management

SMT-MG provides sharing resource environment standards. The work of SMT-MG lies on effective resource management. Because resources in SMT-MG are independent and dispersive, resource release is self-determined, resource properties are stateful, resource choosing meet service quality, to exert resource sharing and cooperation of SMT-MG well to bring additional economical benefits, it is necessary to do resource management.

4.2 Information service

Information service is the brain of SMT-MG. The core of information service is LDAP list service containing creating list, collecting information, registering information, searching information, scheduling information, invite and announcement etc.

4.3 Performance evaluation

Performance evaluation plays an important role in SMT-MG. The core of performance evaluation is to create scientific, logical performance evaluation index and evaluation methods. SMT-MG performance evaluation index are classed into SMT-MG work performance evaluation and service quality evaluation. SMT-MG work performance evaluation is represented by resource utilization rate, request-matching rate, throughput and so on indexes. Service quality evaluation is represented by TQCS index. To evaluation methods, we can adopt petri network method, queue model method and so on.

4.4 Security

Security including network security and knowledge property right security takes effect on whole SMT-MG work process. Encryption and numerical signature are used to protect confidentiality, integrality, creditability, usability and privacy for network security. These are protected through authentication and using WS-security, GSI and so on grid security standards in SMT-MG. Because of open of SMT-MG, when sharing resources, it must assure the knowledge property right security of resources.

5 Conclusion

Essence of grids is sharing and cooperation with resources. In the paper, SMT-MG was advanced by combining grid technology, manufacturing grid technology with SMT product manufacturing, six layers SMT-MG architecture was built and discussed in detail and new manufacturing mode orientated to electronic products manufacturing was brought forwards. SMT-MG can be used to advance optimization collocation of SMT product manufacturing resources, improve resource utilization rate,

reduce special risks, boost competition of small and medium enterprises and speed up the development of SMT product manufacturing industry.

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