An Extended IDM Business Model to Ensure Time-to-Quality in Semiconductor Manufacturing Industry

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Abstract. Semiconductor manufacturing industry (SMI) has shifted from an IDM (integrated device manufacturer) to a fabless structure where technology is developed in an alliance to share high R&D costs and address time to market and time to volume challenges. In this fabless structure, EDA (electronic design automation) has emerged as a key stake holder to model increasing design and manufacturing interface complexities and its integration within design flow, but collaboration within alliances have resulted information sharing and technology transfer as the key challenges. We argue that IDM model is superior to a fabless structure due to its inherent ability for faster/superior knowledge capitalization. We benchmarked and analyzed a world reputed IDM with use-case and SWOT (strength, weakness, opportunity, threat) analyses to identify the limiting factors that led this transformation and found data and statistics as the core issues. We have proposed an extended IDM business model where engineering information systems (EIS) are tuned for design for manufacturability (DFM) compliance to achieve time to quality (time to volume, time to market) and yield ramp up rate at low cost but effective R&D efforts.

Keywords: SMI business models, design for manufacturing (DFM), time to market, (T2M), time to volume (T2V), yield ramp-up rate.

1 Introduction

SMI is characterized by the fastest change in the smallest period of time and has evolved as a market driven business model along with structural transformation from an IDM to fables model. Till 1980, SMI used to manufacture equipment in addition to the product design, manufacturing, marketing and sales; however first split in late 80s resulted in the OEM (original equipment manufacturers) and IDM models where equipment manufacturing was separated as a specialized task. ITRS (international technology roadmap for semiconductor industries) proposed a fabless model in late 90s by splitting IDM functions in design and manufacturing. In this model IDMs, design companies and foundries collaborate in an alliance for the technology platform...
development with EDA companies as mediators for the CAD (computer aided design) support. In comparison to this fabless model, an IDM includes both design and manufacturing facilities to effectively capture high market share; however success lies in our ability to quickly design, develop and ramp up the products. Shift in SMI business objectives from manufacturability and volume production towards yield ramp up rate resulted EDA with a new role to integrate DFM methodologies across design and manufacturing flows to facilitate information and knowledge sharing within design and manufacturing groups.

DFM is defined as the ability to reliably assess manufacturability and yield issues (model-to-hardware gaps) in early design stages [8] and is categorized as [10] product DFM (producing manufacturable design for the defined processes) and process DFM (develop process with less rework and high manufacturability). It is focused on the economic benefits by trading off cost-quality-time triangle [15]. SMI adopted DFM in 1980 (Fig.2) to mitigate increasing design for manufacturing interface complexities and time to quality business challenges; however biggest challenge is the diversified understanding of the DFM concept among stakeholders and responsibility for its effective integration. EDA has unified the last step in design with GDSII format (final design database) and now they are putting efforts to integrate DFM within CAD tools to support industrial motto “first time correct design”. We argue that an IDM has an inherent capability to model its design and manufacturing interface complexities and serve as a platform for faster and superior knowledge capitalization. It is only possible if we investigate the limiting factors in existing IDM model that restrict DFM integration across design and manufacturing flows and led SMI to the fabless model. We found data, statistics and unsuccessful data driven DFM efforts as the limiting factors that led SMI to a fabless structure; hence we have proposed an extended IDM business model supported by EIS and tuned for the DFM compliance by shifting data driven DFM efforts towards information and knowledge driven DFM.

This article is divided in 4 sections. Section-1 provides introduction and establishes the need for an extended IDM business model. Section-2 briefly reviews SMI trends, DFM concept, scope and evolution. Section-3 provides analysis of an IDM model and presents an extended IDM model. Section-4 provides conclusions and key issues to be addressed while tuning existing EIS to support this extended IDM business model.

2 Literature Review

Semiconductor industry (208 billion USD, 2008) [9] is characterized by the cyclic demand patterns and higher revenues (Fig.1). It is a fragile, rapidly growing and technologically most advanced industrial domain, governed by the Moore’s law [6] which predicts doubling electronic components per unit area every 18-24 months at the reduced cost and power consumption. Moore’s law was initially focused on the geometric scaling, but now it has emerged into “more Moore” (equivalent scaling) and “more than Moore” (functional diversification). This transition led to an increase in the revenues even at decreased demands and moved industry towards high value products (system on chip, system in package and package on package) along with increased design/manufacturing interface complexities.