

Chapter 12

Cloud Computing Applied for Numerical Study of Thermal Characteristics of SIP

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ABSTRACT

Thermal management of integrated circuit (IC) and system-in-package (SIP) has gained importance as the power density and requirement for IC design have increased and need exists to analyse the heat dissipation performance characteristics of IC under use. In this paper, the authors examine the thermal characteristics of materials of IC. The authors leverage Cloud Computing architecture to remotely compute the dissipation performance parameters. Understanding thermal dissipation performance, which explains the thermal management of IC, is important for chip performance, as well as power and energy consumption in a chip or SIP. Using architectural understanding of Software as a Service (SaaS), the authors develop an efficient, fast, and secure simulation technique by leveraging control volume method (CVM) of linearization of relevant equations. Three chips are kept in tandem to make it a multi-chip module (MCM) to realise it as a smaller and lighter package. The findings of the study are presented for different dimensions of chips inside the package.

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1. INTRODUCTION

Thermal management of integrated circuit (IC) and of a system-in-package (SIP) has gained importance in the recent past since the power density and power requirement for IC design have gone up. With increasing integrated circuit (IC) power densities and performance requirements, thermal issues have become critical challenges in IC design. If not properly addressed, increased IC temperature affects other design metrics including performance, power and energy consumption, reliability and price. It is thus critical to consider thermal issues during IC design and synthesis. When determining the impact of each decision in the synthesis or design process, the impacts of changed thermal profile on performance, power, price, and reliability must be considered. This requires repeated use of detailed chip-package thermal analysis. This analysis is generally based on computationally expensive numerical methods. In order to support IC synthesis, a thermal simulator must be capable of accurately analyzing models containing tens of thousands of discrete elements. The study will be focused upon analysing thermal characteristic of multi-chip module (MCM).

There will be a two dimensional modelling of the entire module and then the computation of thermal characteristics will be done through MATLAB. In this study we have considered three chips which shall be kept either in series or in a stack.

We shall be computing the thermal characteristics of these chips in series or in stack through governing equation of heat flow.

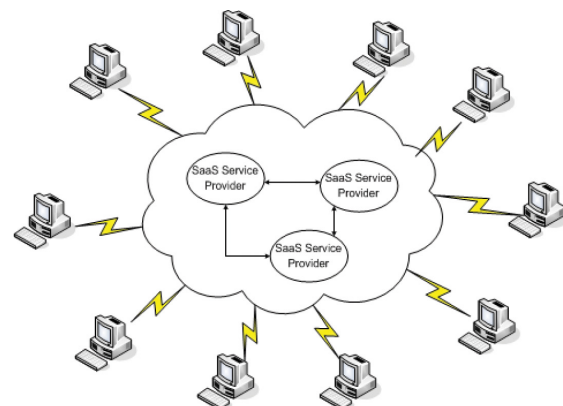
Here we are attempting to compute the heat dissipation rate using conduction mode of heat transfer happening inside the system-in-package. The governing equations are approximated using control volume method (CVM) and then a code is scripted in MATLAB. Using the concept of Cloud computing architecture the entire computation is achieved through MATLAB. In particular we have leveraged SaaS, which is one of the Cloud

computing architectures, in our study. The motivation behind taking such an initiative to use Cloud Computing fundamentals is to understand how it could be beneficial to an engineering problem in the design of IC that we have considered here. As a first steps toward achieving this goal we have tried to use the resources, computing power and other ancillary applications in Cloud Server through a communication mechanism inside the research institute. The same computation has also been tested outside the private cloud network.

The details of the discretization of equations are described in the paper. The authors have designed a Java-based user interface through which we control the computing resources available in the server. The entire application designed for the above computational purpose is available to users through cloud network called as Software as a Service (SaaS) as shown in Figure 1.

Due to the flexible manufacturing processes for producing Ball Grid Array packages, there has been an explosion of new package designs, many of which contain more than one integrated circuit chip. Existing industry standards for IC package thermal characterizations apply only to single-chip packages. This basic calculation will present some techniques for calculating the junction temperature of a multi-chip module (MCM). Existing JEDEC standards all assume that there is one heat source in a package, characterized by a single junction

Figure 1. SaaS architecture



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