JSAP CAT. No. AP991214
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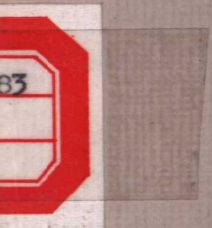
JUNE 14–16, 1999／KYOTO

1999 SYMPOSIUM ON VLSI TECHNOLOGY

DIGEST OF TECHNICAL PAPERS



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☐ The Japan Society of Applied Physics

☐ The IEEE Electron Devices Society

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Publication Office

Business Center for Academic Societies Japan
5-16-9 Honkomagome,
Bunkyo-ku, Tokyo 113-8622,
Japan

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JSAP CAT. No. AP991214
IEEE CAT No. 99 CH 36325

ISBN 4-930813-93-X Softbound
ISBN 0-7803-5438-9 Casebound
ISBN 0-7803-5439-7 Microfiche
ISBN 4-930813-94-8 CD-ROM Edition
Library of Congress Number 90-655131

Copies of this Digest can be purchased from:
Inside Japan
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FOREWORD

001716

Welcome to the 1999 Symposium on VLSI Technology

Widely spread multimedia applications, including networks, require high speed, low power and low cost system VLSIs. On the other hand, as design rules approach to 0.1 μm or less, many technology barriers remain to be solved. A new paradigm for developing VLSIs has to be introduced, instead of traditional scaling. In these circumstances, the 1999 Symposium on VLSI Technology focuses on technology for realizing high performance and low cost system VLSIs.

For the plenary session, we have two distinguished invited speakers. Mr. Yoshiaki Kushiki from Matsushita, will speak on the Digital Consumer Electronics Evolution in the Multimedia and Network Age, and Mr. Daniel T. Niles from BancBoston Robertson Stephens will speak on the Silicon Opportunity of the New Millenium—Digital Information Appliances.

Out of more than 210 papers submitted from all over the world, 79 high-quality papers have been selected and organized into 20 sessions. This year, we have a joint special session on Technology for System LSI in the afternoon of Wednesday, June 16, which will provide a good opportunity for both technology and circuit engineers to discuss solution oriented technology for system VLSIs.

To provide a forum for informal discussion on important and timely topics, three regular rump session and one joint rump session have been organized in the evening of June 15 and June 16, respectively. The regular sessions are on "Technology Challenges for Scaled Cu/Low k Interconnects", "Gate Insulator: Hi-k vs. SiO_2" and "Flash vs. FeRAM: Which is the real winner?" and the joint session is on "SOI", which is the common topic for both technology and circuit communities.

Preceding the Symposium, a one-day short course on the Embedded Technologies for System on a Chip is scheduled on June 13.

Special thanks for the success of the Symposium are due to the program chairman, M. Kakumu and the co-chairman, C. Lage; to secretaries, T. Kunio and B. Havemann; to publications, M. Ohkura and W-K Loh; to treasurers, S. Konaka and R. Jaeger; to local arrangements, Y. Inoue, S. Matsumoto and Y. Taur; to short course organizers, T. Nishimura and S. Wong.

June 1999

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1999 SYMPOSIUM ON VLSI TECHNOLOGY

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	Jeff Watt	Cypress Semiconductor
	Simon Wong	Stanford Univ.
	Jason Woo	Univ. of California
	Carel van der Poel	Philips Research Labs.

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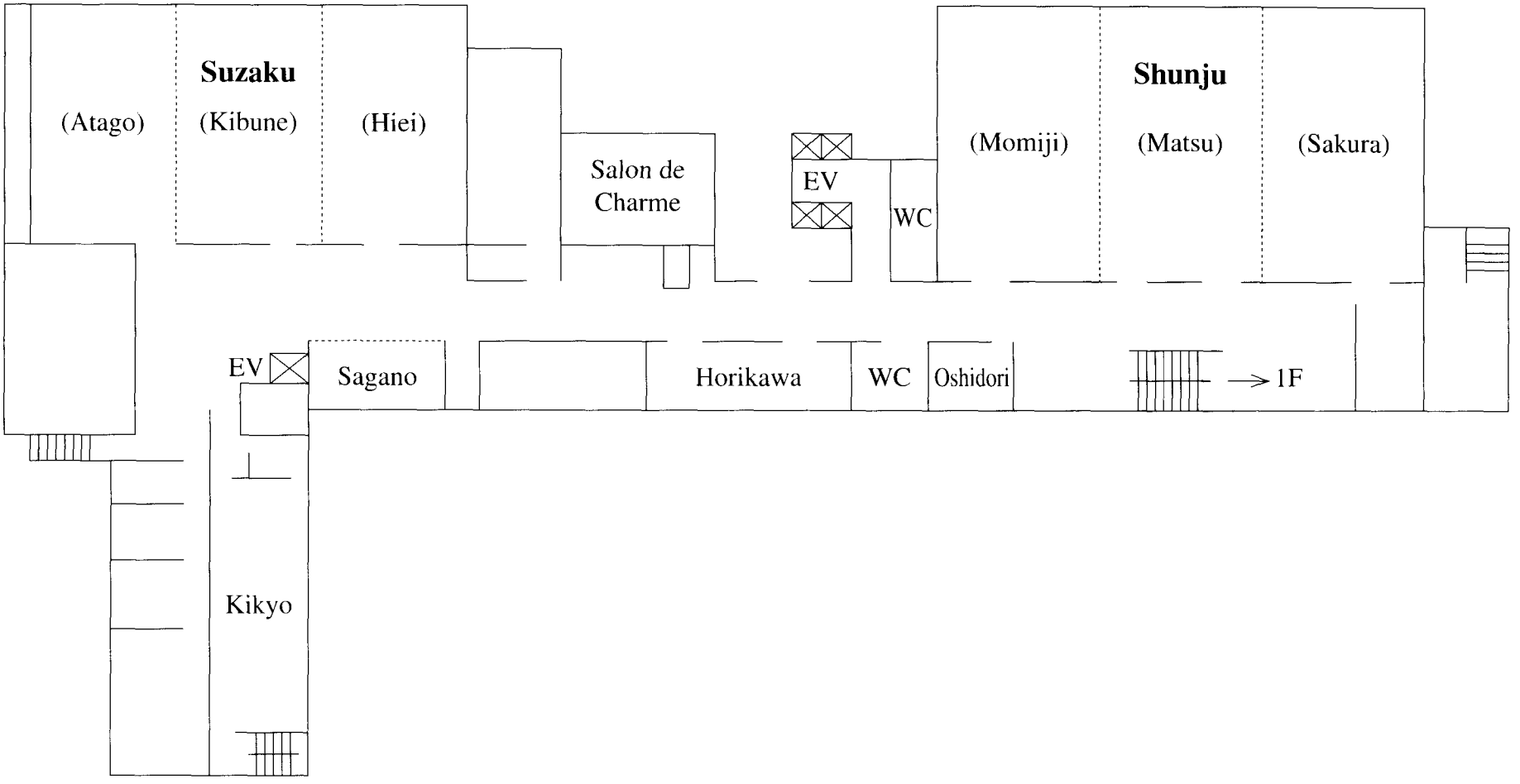
FLOOR MAP


Suzaku
(Atago)
(Kibune)
(Hiei)
Salon de Charme
EV
WC
Shunju
(Momiji)
(Matsu)
(Sakura)
EV
Sagano
Horikawa
WC
Oshidori
→ 1F
Kikyo

1999 SYMPOSIUM ON VLSI TECHNOLOGY—CONFERENCE SCHEDULE

	MORNING	AFTERNOON	EVENING
SATURDAY June 12			18:00-20:00 Registration
SUNDAY June 13	7:00 Breakfast [Momiji] 8:00 Registration 8:55-12:15 **Short Course [Suzaku II]**	13:15-16:30 **Short Course [Suzaku II]**	18:00-20:00 Reception [Shunju I]
MONDAY June 14	7:00 Breakfast [Kibune, Hiei] 8:00 Registration 8:30-10:05 **Session 1: Welcome and Plenary Session [Shunju]** 10:25-12:05 **Session 2: Highlights [Shunju]**	13:30-15:10 **Session 3A: Flash Memory [Shunju I]** **Session 3B: SOI Technology [Suzaku II]** 15:30-17:10 **Session 4A: DRAM Technology I [Shunju I]** **Session 4B: Interconnect Technology [Suzaku II]**	19:00-21:00 Dinner [Shunju]
TUESDAY June 15	7:00 Breakfast [Hiei, Sakura] 8:30-10:10 **Session 5A: Shallow Junction [Shunju I]** **Session 5B: Dielectric Reliability [Suzaku II]** 10:30-12:10 **Session 6A: Channel Engineering [Shunju I]** **Session 6B: Gate Dielectric I [Suzaku II]**	13:30-15:10 **Session 7A: Memory Technology [Shunju I]** **Session 7B: Advanced CMOS Technology I [Suzaku II]** 15:30-17:10 **Session 8A: DRAM Capacitor Technology [Shunju I]** **Session 8B: Advanced CMOS Technology II [Suzaku II]**	20:00-22:00 **Rump Sessions [Momiji, Matsu, Sakura]**
WEDNESDAY June 16	7:00 Breakfast [Hiei] 8:30-10:10 **Session 9A: Gate Dielectric II [Shunju I]** **Session 9B: Process Technology [Shunju II]** 10:30-12:10 **Session 10A: Gate Dielectric III [Shunju I]** **Session 10B: Ferroelectric Memory Technology [Shunju II]**	13:20-15:00 **Session 11A: RF Devices [Shunju I]** **Session 11B: DRAM Technology II [Shunju II]** 15:30-17:10 **Technology and Circuits Joint Session: Technology for System LSI [Shunju]**	17:30-19:30 **Technology and Circuits Joint Rump Session [Shunju I]**

Conference Room: [Shunju] = [Shunju I] + [Shunju II]
[Shunju I] = [Momiji] + [Matsu], [Shunju II] = [Sakura]

CONTENTS

Monday, June 14

Session 1: Welcome and Plenary Session [Shunju]

Chairpersons: M. Kakumu, *Toshiba*
C. Lage, *Motorola*

Session 2: Highlights [Shunju]

Chairpersons: N. Ouchi, *Sony*
R. DeKeersmaecker, *IMEC*

Session 3A: Flash Memory [Shunju I]

Chairpersons: T. Kunio, *NEC*
C. van der Poel, *Philips Research Labs.*

Session 3B: SOI Technology [Suzaku II]

Chairpersons: S. Kawamura, *Fujitsu*
J. Woo, *Univ. of California*

Session 4A: DRAM Technology I [Shunju I]

Chairpersons: S.-I. Lee, *Samsung Electronics*
S. Wong, *Stanford Univ.*

Session 4B: Interconnect Technology [Suzaku II]

Chairpersons: S. Ohnishi, *Sharp*
C.-S. Pai, *Lucent Technologies Bell Labs*

Tuesday, June 15

Session 5A: Shallow Junction [Shunju I]

Chairpersons: J. Ida, *Oki Electric*
R. Havemann, *TI/SEMATECH*

Session 5B: Dielectric Reliability [Suzaku II]

Chairpersons: Y. Omura, *Kansai Univ.*
R. Mahnkopf, *Siemens Microelectronics*

Session 6A: Channel Engineering [Shunju I]

Chairpersons: S. Odanaka, *Matsushita Electronics*
M.T. Bohr, *Intel*

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Session 6B: Gate Dielectric I [Suzaku II]

Chairpersons: M. Ohkura, *Hitachi*
G. Bomchil, *France Telecom*

Session 7A: Memory Technology [Shunju I]

Chairpersons: T. Shibata, *Univ. of Tokyo*
M. Cao, *Hewlett-Packard Labs*

Session 7B: Advanced CMOS Technology I [Suzaku II]

Chairpersons: K. Shibahara, *Hiroshima Univ.*
Y. Taur, *IBM Research Center*

Session 8A: DRAM Capacitor Technology [Shunju I]

Chairpersons: S.-I. Lee, *Samsung Electronics*
J. Watt, *Cypress Semiconductor*

Session 8B: Advanced CMOS Technology II [Suzaku II]

Chairpersons: S. Odanaka, *Matsushita Electronics*
G. De Santi, *SGS-Thomson Microelectronics*

Rump Sessions

Wednesday, June 16

Session 9A: Gate Dielectric II [Shunju I]

Chairpersons: E. Suzuki, *Electrotechnical Lab.*
L. Su, *IBM SRDC*

Session 9B: Process Technology [Shunju II]

Chairpersons: H. Hanafusa, *Sanyo Electric*
T. Seidel, *Genus*

Session 10A: Gate Dielectric III [Shunju I]

Chairpersons: M. Kinugawa, *Toshiba*
C. Lage, *Motorola*

Session 10B: Ferroelectric Memory Technology [Shunju II]

Chairpersons: T. Kunio, *NEC*
T. Seidel, *Genus*

Session 11A: RF Devices [Shunju I]

Chairpersons: S. Konaka, *NTT*
L. Su, *IBM SRDC*

Session 11B: DRAM Technology II [Shunju II]

Chairpersons: T. Eimori, *Mitsubishi Electric*
C. Dennison, *Micron Technology*

Joint Sessions

Technology for System LSI
(Technology and Circuits Joint Session) [Shunju]

Chairpersons: T.M. Liu, *TSMC*
M. Horowitz, *Stanford Univ.*

1-2 (Invited)

Digital Consumer Electronics Evolution in the Multimedia and Network Age

Yoshiaki Kushiki

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1006 Kadoma, Kadoma-shi, Osaka 571-8501 Japan

Abstract

The rapid progress of semiconductors and software has improved the performance, features and form of digital consumer electronics products. The key technologies here are the one-chip LSI solution, merging memory and processor, system LSI-zation, and software solutions for multimedia processing and device control. Towards the 21st century, End-to-End networks, which include digital consumer electronics devices as an important element, are expected to proliferate. New solutions for digital consumer electronics are required.

Introduction

Information and communication technology has benefited greatly in the past few decades from the improvement and development of digital technology including computers, semiconductors and networking. Nowadays, such digitalization is having a wide and profound impact in the area of consumer electronics devices as the latest wave of the multimedia revolution.

It is well known that digital technologies, such as high performance microprocessors, high-speed compression and decompression of audio/video data and a high level of integration of semiconductors which enables miniaturization and low power consumption, contributes to the widespread use of digital consumer electronics devices like DVD, STB, digital cellular phones, etc. However, it is worthy of note that software processing such as video/audio decompression and device control is vital for the major features of digital consumer electronics devices, and this has caused a recent increase in software size.

Thus, the key feature in the realization of digital consumer electronics devices has been the software solution for multimedia processing, as well as the one-chip LSI solution by merging memory and processor, and system LSI-zation which enables real-time processing of video/audio, low power consumption and miniaturization of device.

However, regarding the solutions for digital consumer electronics, a new platform shift is now required as a use for digital network consumer electronics, since digital broadcasting, the Internet and IEEE 1394 have become widespread. In this paper, what types of services will be advanced towards the 21st century, and what types of solutions will be required for digital consumer electronics products are discussed by referring to their past history, transitions and future development.

Multimedia Revolution and Digital Consumer Electronics

Digitalization of devices, started with the introduction of the microcomputer in consumer electronics products 25 years ago, has improved in performances and functions in tandem with the progress of semiconductor technology. The transition of digital consumer electronics products can be classified into the following three levels:

(1) Digital Control Consumer Electronics products

In the mid-1970s, the microcomputer was introduced into washing machines and microwave ovens, and their performances and features were dramatically improved by device control by microcomputer. This was the era of digitalization of device control, and these products are called "Digital Control Consumer Electronics" products.

(2) Digital Media Consumer Electronics products

At the beginning of 1980, digital-signal processing for characters and voice band was enabled, and products such as the CD, personal computer and word processor were developed. The word, "Multimedia", was first coined around 1988. It was in this timeframe that the AD converter was incorporated into CMOS-LSI, then digital processing of video became feasible. In the 1990s, many multimedia devices including the Digital Video Camera (DVC), Car Navigation, Cellular Phone, and Digital Video Disk (DVD) were successfully developed. This was the era of digitalization of contents as media, and these products are called "Digital Media Consumer Electronics" products.

(3) Digital Network Consumer Electronics products

Now the digital network society is ushering in a new era, in which the digitalization of broadcasting and high-speed/large-capacity of communication unite broadcasting and communication. The consumer electronics products in this era are called "Digital Network Consumer Electronics" products, due to the fact that they can send or receive various types of information and services through a network connection between content providers and equipment, or a home network of Digital Media Consumer Electronics products.

As shown in Fig.1, we are now in a market expansion period of Digital Media Consumer Electronics, as well as a technological development period of Digital Network Consumer Electronics in which network features are incorporated and a new kind of culture and life style are

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