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Chip Design and EDA in China

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I. Introduction

China, official name the People's Republic of China (PRC), is one of the largest countries in the world, with over 1.35 billion of population, and 9.6 million square km area. It has 23 provinces, five autonomous regions, four municipalities directly under the Central Government (Beijing, Tianjin, Shanghai, and Chongqing), and two special administrative regions (Hong Kong and Macau). Beijing is its capital [1].

The ancient Chinese civilization – one of the world's earliest – flourished in the fertile basin of the Yellow River in the North China Plain. For millennia, China's political system was based on hereditary monarchies, known as dynasties, beginning with the semi-mythological Xia (2000 BC). Since the introduction of economic reforms in 1978, China has become the world's fastest-growing major economy. As of 2013, it is the world's second-largest economy by total GDP, and is also the world's largest exporter and importer of goods.

China had been a world leader in science and technology until the Ming Dynasty. Some well-known ancient Chinese discoveries and inventions include papermaking, printing, compass, and gunpowder, also known as the Four Great Inventions. With the economic reforms in 1970s, China revived and has become one of the world's leading technological powers, the annual budget on research and development in 2011 alone was over US$100 billion. China is rapidly developing its education system with an emphasis on science, mathematics and engineering; in 2009, it produced over 50,000 Ph.D. graduates, and as many as 5,500,000 BS graduates. China is also the world's second-largest publisher of scientific papers, producing 121,500 in 2010 alone, including 5,200 in leading international scientific journals. The supercomputers we produced are consistently ranked among the world's most powerful ones. China is furthermore the world's largest investor in renewable energy technology.

II. Chip Design and EDA presence

China's IC industry has made substantial progress in the recent years. The sale has tripled in the past ten years and it has become one of the fastest growing regions for IC industry in the world. Its production and sales have increased from 2005's 265.8 billion pieces and 702 billion yuan to 2010's 652.5 billion pieces and 2010's 1440 billion yuan, respectively. Its IC global market share has increased from 4.5% in 2005 to 9.8% in 2011. The average annual sales has been growing by 23.7% and it has exceeded oil import to become China's No.1 import commodity.

Currently, there are over 60 IC design companies with each of them has over 100 million yuan revenues. In 2010, Hisilicon ranked No.1 in the industry with revenue of 6.7 billion yuan, and following by Spreadtrum with 4.3 billion yuan. There are two semiconductor foundries with revenue exceeding 10 billion yuan. SMIC's 65 nanometer manufacturing process accounts for 9% of production, and ranks No.4 in the world IC foundries. Major listed IC design and EDA companies in China are:

- Hisilicon, Shenzhen
- Spreadtrum, Shanghai
- CEC Huada Electronic Design Co., Ltd, Beijing
- Datang Microelectronics, Beijing
- Silan Microelectronics, Hangzhou
- Vmicro, Beijing
- Empyrean EDA, Beijing

Capital	Beijing
Largest city	Shanghai
Language	Chinese (Standard)
Area (Land)	9,600,000 km^2
Population (2010 census)	1,370,536,875
Currency	Renminbi (yuan)(¥)(CNY)
Time zone	(UTC+8)
Internet TLD	.cn, .中国

III. ACADEMIA

China's R&D of IC design and associate tools began to thrive in 1980s. Thanks to the growing investment in recent years, significant amount of innovative research results are produced and published in prestigious international journals and conferences, such as DAC. For instance, there are 5 to 6 papers from China presented in DAC each year.

The Institute of Computing Technology (ICT) [2], Chinese Academy of Sciences (CAS) [3], is one of the representative research institutions focusing on R&D of IC design and test. The Godson project conducted in ICT yields the first series of high-performance general-purpose microprocessors in China. In particular, Godson-T is a research many-core processor designed for parallel scientific computing that delivers flexible programmability. Godson series have been reported by EE-Times many times. In 2012, the "Verification-testing-recovery technique with application to on-board microprocessor system" was granted the National Technology Invention Award, the most prestigious national award in China [4].

Tsinghua University [5] and Fudan University [6] have been extensively involved in EDA technologies. Layout algorithms are the core for integrated layout design. Tsinghua, one of the representative research entity in this area, has developed different algorithms for layout, floorplan, routing, and device modeling. Multiple research papers from Tsinghua university have been awarded (or nominated) for the best paper award by DAC and/or ICCAD.

Another representative research entity, Fudan University, also has made significant contributions in the area of advanced interconnects modeling. In recent years, Fudan has conducted research in GPU simulation and 3D IC modeling. Some of their research results have been published in DAC. The National University of Defense Technology (NUDT), Chinese University of Hong Kong, Harbin Institute of Technology, University of Electronic Science and Technology of China, Zhejiang University, Peking University also contribute to DAC in soft error, physical design, network-on-chip, MPEG chip design, etc.

IV. GOVERNMENT PROGRAMS

The Chinese government has been paying great attention to the development of the IC industry and made two *Five-Year Plan* in the past decade. These plans provide the guidance for the development of IC industry in China.

The National Natural Science Foundation of China (NSFC) [7] started a *Major Scientific Research Program* "Basic Research of Semiconductor Integrated System-On-a-Chip" (2002-2010). This program supported four research directions in SoC from material, device, circuit to architecture. It granted in total 55 million yuan, supported 13 key projects and 83 general projects. Through 8 years' endeavor that involved more than 1200 researchers, the program achieved abundant research results, published 1161 papers and was granted or applied for 340 patents.

In the *National Medium- and Long-Term Program for Science and Technology Development* (2006-2020), the Ministry of Industry and Information Technology [8] have defined 16 *National Science and Technology Major Projects*, while each project is funded with 10-50 billion yuan. Among the 16 major projects, CPU & EDA are the key parts of the first project. The project supports Godson (Loongson) processor series from ICT, YHFT processor series from NUDT, to name a few. Godson-3B1500 is the latest product of Godson family. It is fabricated in 32nm high-k metal-gate (HKMG) low-power bulk CMOS, containing 1.14 billion transistors within 182.5 mm^2 die area. Godson-3B1500 is able to support a wide voltage range from 0.9V to 1.3V. It can operate at extreme frequencies in excess of 1.5GHz, and achieve 192GFLOPS within limit of 40W power dissipation.

In the National Basic Research Program of China (973 Program), the Ministry of Science and Technology [9] granted 30 million yuan to the project "Research of new principles, architectures and methodologies of microprocessor design to extend Moore's Law" in 2005, with six sub-projects which cover microprocessor design, test, verification, and EDA algorithms. ICT, Tsinghua University, and University of Science and Technology of China are the major participants of this project. Jointly, we have designed the high performance many-core processor Godson-T with single chip tera-scale computing capability. The 3S fault tolerance technology, i.e., Self-test, Self-diagnosis, Self-repair, is one of the research outcomes from the project.

REFERENCES

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[5] Tsinghua University, www.tsinghua.edu.cn
[6] Fudan University, www.fudan.edu.cn
[7] National Natural Science Foundation of China, www.nsfc.gov.cn
[8] Ministry of Industry and Information Technology, www.miit.gov.cn
[9] Ministry of Science and Technology, www.most.gov.cn

Xiaowei Li received his B.Eng. and M.Eng. degrees from Hefei University of Technology (China) in 1985 and 1988 respectively, and his Ph.D. degree from the Institute of Computing Technology (ICT), Chinese Academy of Sciences (CAS) in 1991. Currently, he is a professor and deputy (executive) director of the State Key Laboratory of Computer Architecture (ICT, CAS). His research interests include VLSI testing and fault-tolerant computing. He is an associate Editor-in-Chief of the Journal of Computer Science and Technology. He is a senior member of IEEE, vice Chair of IEEE Asian & Pacific Regional TTTC, and Chair of Steering Committee of IEEE Asian Test Symposium (2011-2013). He is a recipient of China National Technology Invention Award (2012).