

Preface

Steady technology improvement enables us to realize rapidly evolving information society. Information devices help us anywhere and anytime in our daily life. In the society, these devices are expected to be as small as possible in size and keep their operations as long as possible for a wide variety of applications. Thus, improvement of energy efficiency is indispensable to realize long battery life with limited battery capacity.

This book is designed for both hardware and software designers. Energy consumption of modern information devices strongly depend on both of them. Software designers should not only understand the behavior of hardware but also optimize software to reduce power consumption. Hardware designers also have the same responsibility. Therefore, co-optimization of hardware and software is indispensable to improve energy efficiency.

This book is based on the outcome of the Normally-Off Computing project from 2011 to 2016 supported by NEDO/METI (New Energy and Industrial Technology Development Organization/Japanese Ministry of Economy, Trade and Industry). Normally-off is a way of computing which aggressively powers down components of computer systems when they are not needed. Simple power gating cannot fully take the chances of power reduction because volatile memories lose data when power is turned off. Recently, new generation non-volatile memories (NVMs) have appeared. Close attention has been paid to “Normally-Off Computing” using these NVMs and cooperation among algorithm, OS, compiler, architecture, circuit and device. In circuit layer, fine grain power managements with non-volatile memory maximize opportunity of power reduction. Since aggressive power management is inseparable from energy and performance overhead, architecture technologies are indispensable to support a wide variety of applications. In software layer, scheduling techniques, which manage activities, are important to maximize energy efficiency.

Based on this strategy, methodology of normally-off computing is introduced. We also include case studies conducted under the Normally-Off Computing project and describe how the real applications are addressed and solved by the methodology. In the project, normally-off computing is applied for three practical

applications: healthcare, mobile information devices, and sensor network systems for smart city applications.

Many researchers and students in our project have contributed to the development of normally-off computing. We are sincerely grateful for their great contribution. Our development is also supported by many other researchers through meaningful discussions in our symposia and many other conferences. We also thank anonymous reviewers for their suggestions to make this book better and more purposeful.

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