JOURNAL OF INFORMATION SCIENCE AND ENGINEERING 24, 919-931 (2008)

Short Paper

Behavior-Based Branch Prediction by Dynamically Clustering Branch Instructions

HANS VANDIERENDONCK, VEERLE DESMET AND KOEN DE BOSSCHERE
Department of Electronics and Information Systems
Ghent University
St.-Pietersnieuwstraat 41
B-9000 Gent, Belgium
E-mail: {hvdieren; vdesmet; kdb}@elis.ugent.be

Conditional branches frequently exhibit similar behavior (bias, time-varying behavior, …), a property that can be used to improve branch prediction accuracy. Branch clustering constructs groups or clusters of branches with similar behavior and applies different branch prediction techniques to each branch cluster. We revisit the topic of branch clustering with the aim of generalizing branch clustering. We investigate several methods to measure cluster information, with the most effective the storage of information in the branch target buffer. Also, we investigate alternative methods of using the branch cluster identification in the branch predictor. By these improvements we arrive at a branch clustering technique that obtains higher accuracy than previous approaches presented in the literature for the gshare predictor. Furthermore, we evaluate our branch clustering technique in a wide range of predictors to show the general applicability of the method. Branch clustering improves the accuracy of the local history (PAg) predictor, the path-based perceptron and the PPM-like predictor, one of the 2004 CBP finalists.

Keywords: microprocessors, speculation, branch prediction, interference, branch clusters

1. INTRODUCTION

Superscalar microprocessors with deep pipelines and high clock frequencies amplify the importance of accurate dynamic branch prediction. This paper researches means to improve the accuracy of branch predictors by correlating with the general behavioral properties of branch instructions.

Many conditional branch instructions behave in a similar way: branches can be strongly biased towards taken or not-taken, they can be correlated with other branches, they can cycle through repeating sequences, *etc*. This paper revisits branch classification: explicitly identifying clusters of branches with similar behavior and exploiting this information to improve branch prediction accuracy.

Branches are labeled with a short branch cluster identification (CID). This CID is made available to the branch predictor. It serves as an additional source of information,

Received April 13, 2006; revised June 21 & July 26, 2006; accepted August 31, 2006.
Communicated by Tei-Wei Kuo.