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Fast Packet Classification Algorithm for Network-wide Forwarding Behaviors☆

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Abstract

Packet classification has been a key technology to quickly identify an action to be taken on a packet at a switch. Several advanced applications, most of which have been introduced recently with the advent of software-defined networking, commonly require the identification of a *combination* of switch actions, i.e., the network-wide forwarding behavior of a packet. Conventional classification methods, however, fail to well support network-wide behaviors, since the search space is partitioned in convoluted manner due to the complexity posed by the combinations possible.

This paper proposes a novel packet classification method that supports the fast determination of network-wide forwarding behaviors. To avoid the inefficiencies of existing methods, which are revealed for the first time by our research, we base our method on a compressed data structure named the multi-valued decision diagram. On the solid foundation of decision diagrams, several algorithms are introduced with thorough theoretical analyses, and the construction process and the classification performance are highly optimized for the new classification problem. Experiments on real network datasets show that our method identifies the network-wide forwarding behaviors at the line basic rate, e.g., 10 Mpps, on a single CPU core with only tens of MB of memory.

Keywords: Packet classification, Network-wide forwarding behaviors, Decision diagrams, Algorithms

1. Introduction

Network-wide forwarding behavior of a given packet is the key to supporting advanced network management tasks. It is defined as the *combination* of forwarding actions taken on the packet by all switches in the network; e.g., which path the packet will traverse, whether the packet will be discarded in the network, and what actions the packet is subjected to at middle boxes. The forwarding actions are specified by operators and routing protocols in traditional networks, while they are managed by application software in Software-Defined Networking (SDN) [2]. Fig. 1 shows an example network with three switches (A, B, and C), each of which has three ports (A1 etc.). This network offers twelve network-wide forwarding behaviors (Fig. 1a). The behavior of a given packet can be located in the *header space*, the values of two 3-bit

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