



Discrete Bit Selection: Towards a Bit-level Heuristic Framework for Multi-dimensional Packet Classification

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What is DBS?

A **light-weight**, **scalable**, and **effective** framework for multi-dimensional packet classification

Design around three principles

- Explore **bit-level heuristics** to split rules;
- Utilize **squashed classifying levels** to achieve high processing speed;
- Adopt **appropriate structures** to keep low memory requirement.

Process with two phases

Preparation

- ◆ bit-string generation
- ◆ lookup table construction

Classification

- ◆ bit-string filtering
- ◆ Lookup table indexing

Classification phase illustration

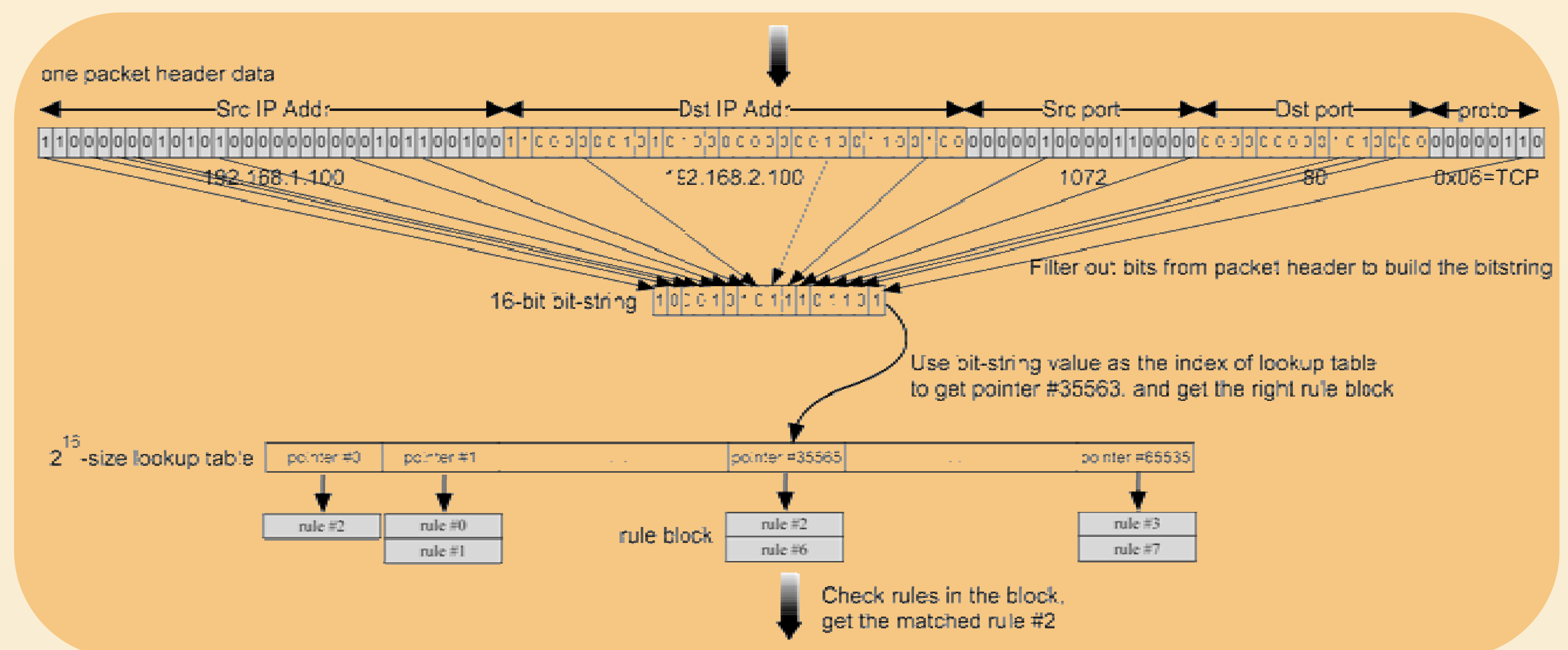


Figure 1. This is an example for the classification processing phase of DBS framework. A TCP packet from **192.168.1.100:1072** to **192.168.2.100:80** is received, with bits filtered out, we can count the index value **35563**. Use the index to get the right rule block. After checking the rules in the block, we can get the best matched **rule #2**.

Memory Usage: DBS vs. HiCuts and HSM

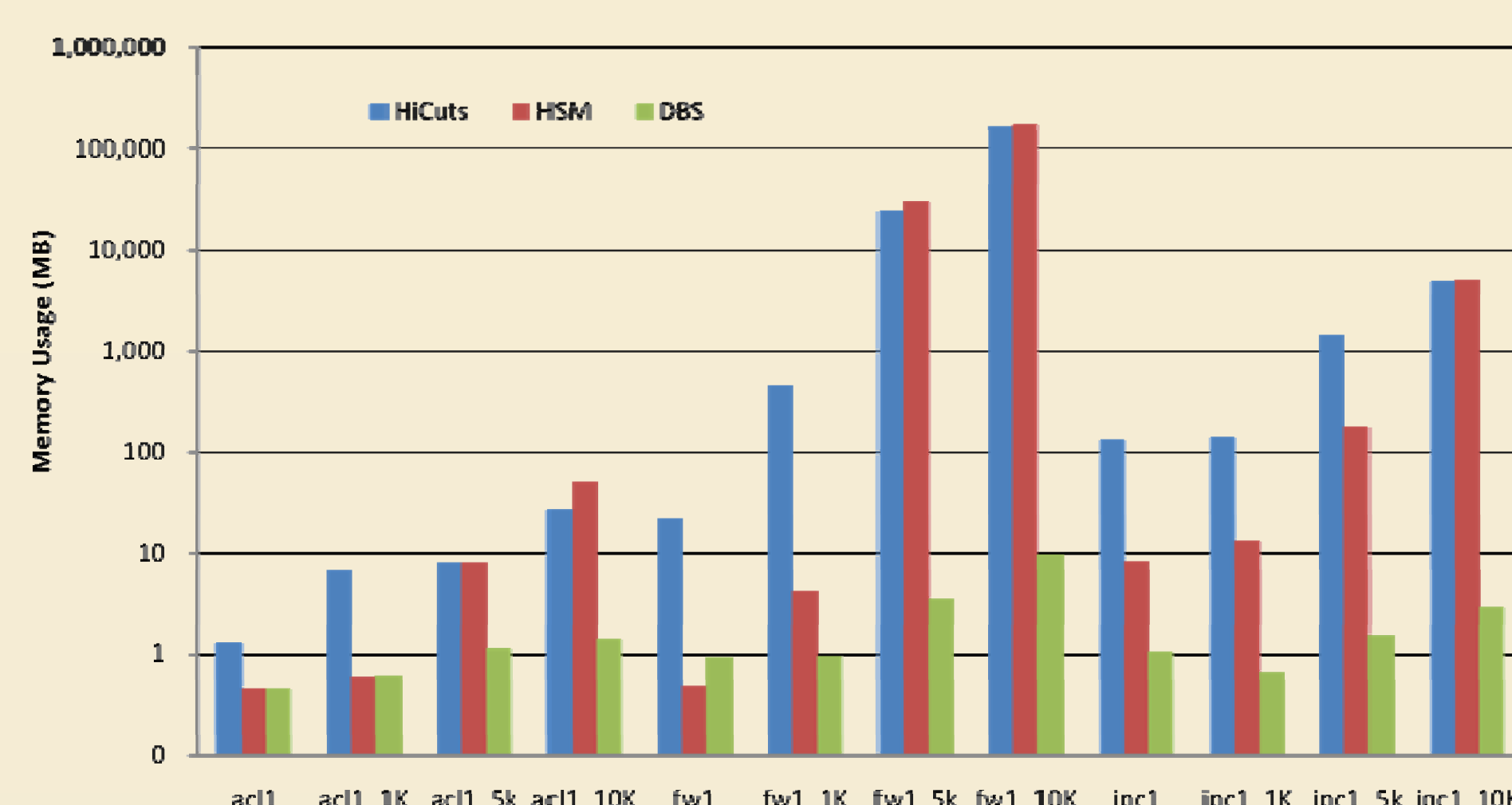


Figure 2. Memory Usage: DBS vs. HiCuts and HSM

Average Memory Access: DBS vs. HiCuts and HSM

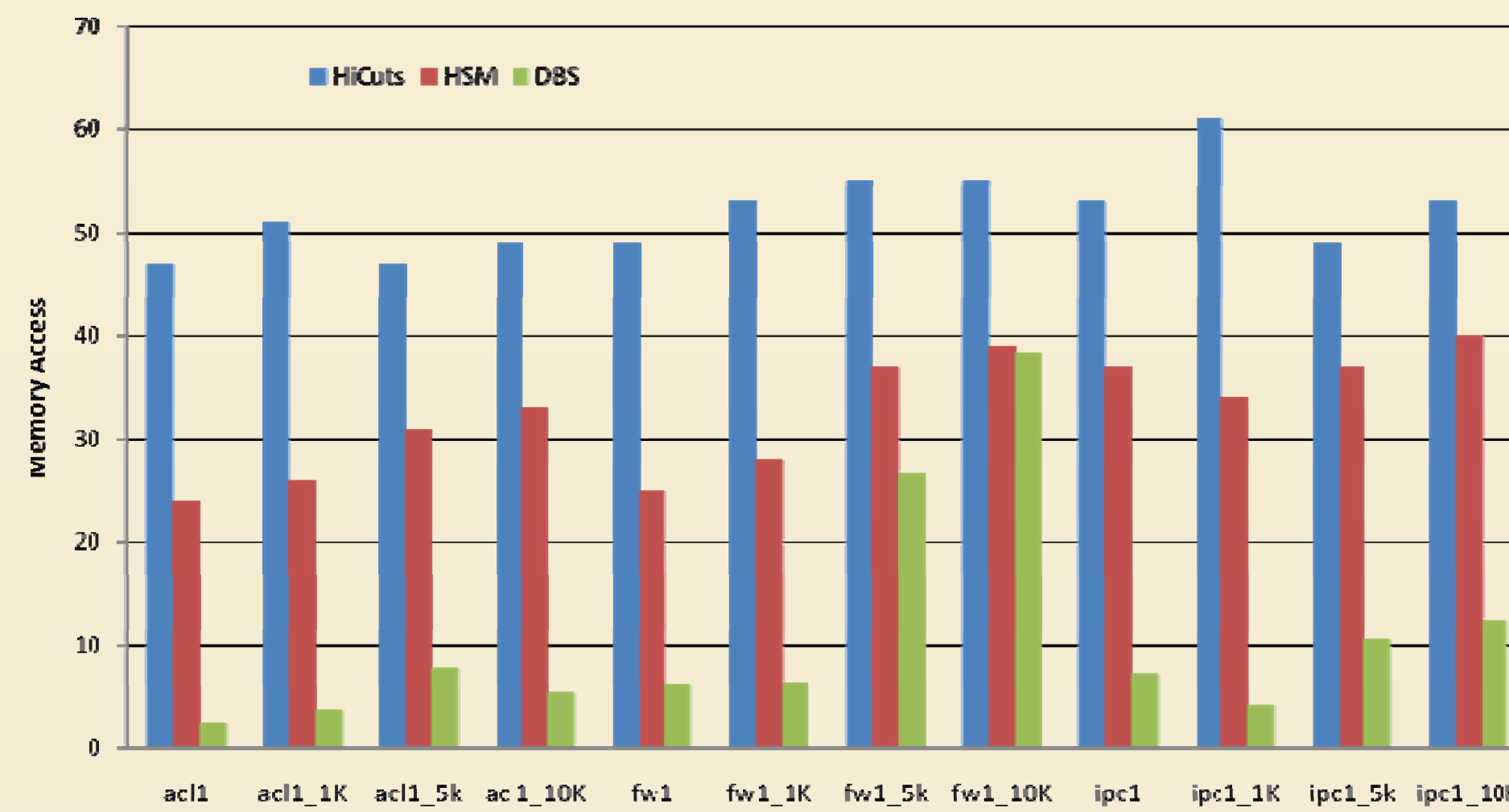


Figure 3. Avg Memory Access: DBS vs. HiCuts and HSM

Worst-case Memory Access: DBS vs. HiCuts and HSM

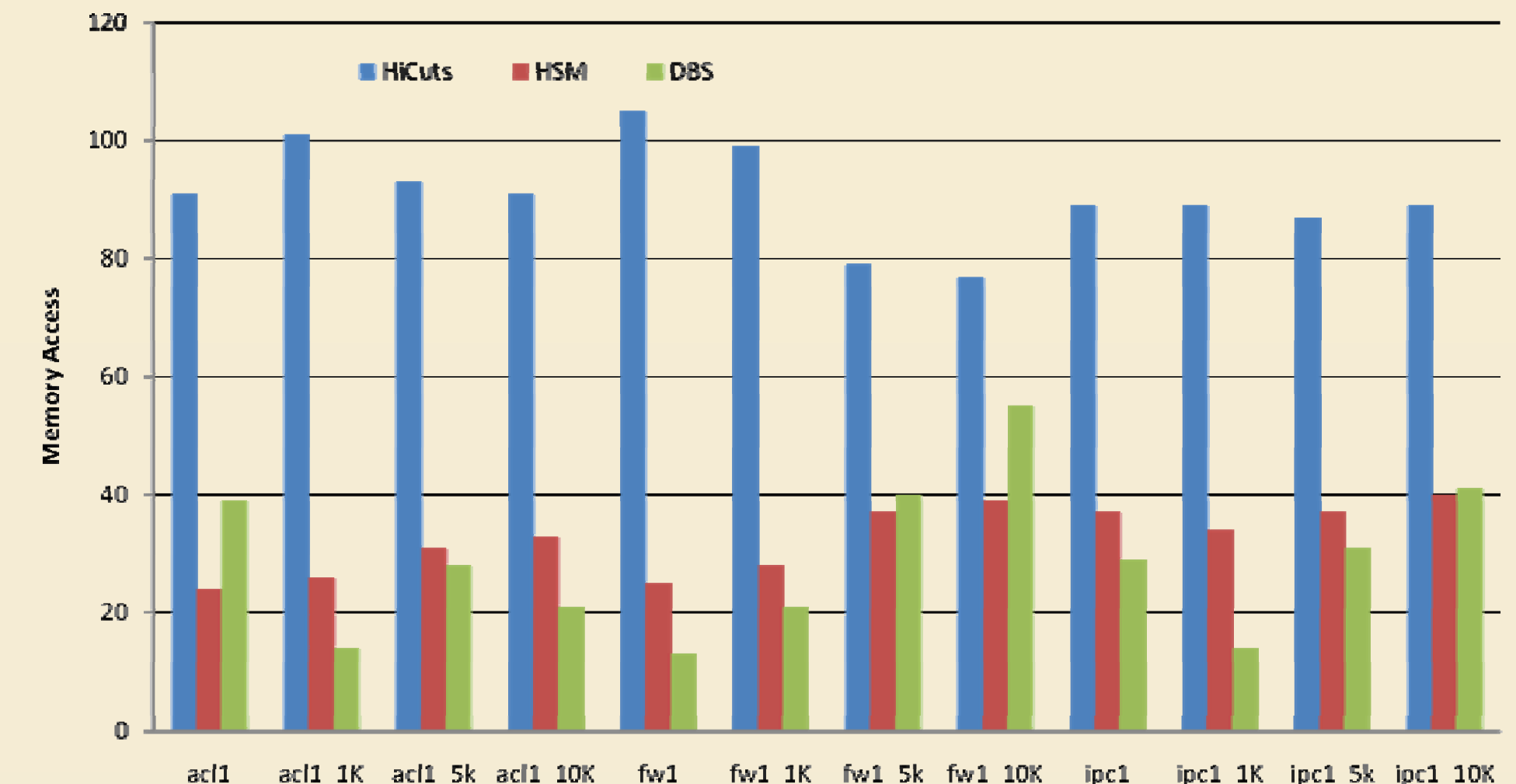


Figure 4. Wst Memory Access: DBS vs. HiCuts and HSM

EXPERIMENT RESULTS

Experiments are carried out on **12 real-life rule sets** of three types: Access Control List (**ACL**), Firewall (**FW**) and IP Chains (**IPC**), which are publicly available [9]. ACL1, ACL1_1-10K contains 752, 916, 4415, 9603 rules; FW1, FW1_1-10K contains 269, 791, 4653, 9311 rules and IPC1, IPC1_1-10K contains 1550, 938, 4460, 9037 rules. HiCuts and HSM are chosen for comparison. We choose the heuristic swap scheme to generate the bit-string (the size is set to 16) and use linear searching in block.

Fig. 2 compares the storage among HiCuts, HSM and DBS, from which we can see that storage used by DBS is at least **an order of magnitude** less than that of on both HiCuts and HSM for most rule sets.

Fig. 3 and Fig. 4 compares the memory access times in average-case and worst-case, which demonstrate that the average-case access times of DBS is only **5%-20%** of other two, while the worst-case access times of DBS is **10%-50%** of HiCuts and less than HSM for most rule sets.

Above all, the results demonstrate that DBS achieves **much higher performance** than **HiCuts** and **HSM** on both time and storage.

FUTURE WORK

In this paper, we propose a **bit-level heuristic framework** for multi-dimensional packet classification. The packet classification algorithm under our framework shows superior performance on both temporal and spatial measurements comparing with HiCuts and HSM.

Although the experimental results are encouraging, current work is still preliminary. Our future works include the **bit-string generation schemes** and evaluation in **real system**.

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