



HAL
open science

Minimizing Range Rules for Packet Filtering Using a Double Mask Representation

Ahmad Abboud, Abdelkader Lahmadi, Michaël Rusinowitch, Miguel Couceiro, Adel Bouhoula

► **To cite this version:**

Ahmad Abboud, Abdelkader Lahmadi, Michaël Rusinowitch, Miguel Couceiro, Adel Bouhoula. Minimizing Range Rules for Packet Filtering Using a Double Mask Representation. IFIP Networking 2019, May 2019, Varsovie, Poland. hal-02393008

HAL Id: hal-02393008

<https://inria.hal.science/hal-02393008v1>

Submitted on 4 Dec 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Overview

In this work, we introduce a novel representation of packet filtering rules, so called *double masks* [1], where the first mask is used as an inclusion prefix and the second one for exclusion. An efficient algorithm is developed to compute a set of double masks for a given range.

Background and Motivation

Problem Statement

- Large number of hosts affects the size of routing tables.
- Size of blacklists keeps increasing due the increase of number of attacks on the Internet.
- **Effective filtering to handle the rapidly increasing and the dynamic nature of network traffic.**

Overview of double-mask representation

$$\underbrace{192.168.100.96/26/2}_{\text{mask1} = 26} \quad \underbrace{10}_{\text{mask2} = 2} \quad 0000$$

Example 1 Range [1,14] needs a set of 6 standard prefixes to be represented. However this range can be represented using only two double mask prefixes as shown below :

$$[1, 14] = \begin{cases} \text{simple masks} \\ \begin{matrix} 0001 \\ 001* \\ 01** \\ 10** \\ 110* \\ 1110 \end{matrix} \end{cases} \quad \begin{cases} \text{double masks} \\ \begin{matrix} \{0000/0/4 \\ \{1111/0/4 \end{matrix} \end{cases}$$

Example 2 Range [1,15] is of form $[1, 2^4 - 1]$ and needs 4 simple masks $\{0001, 001*, 01**, 1***\}$ but only one double mask: 0000/0/4.

Benefits of Double Mask

- Reduces the number of entries and therefore packet classification, rules lookup times and memory usage.
- Adds flexibility and efficiency in the deployment of security policies, since the generated rules are easier to manage.
- Makes configurations simpler since we can accept and exclude IPs within the same rule.

Acknowledgements

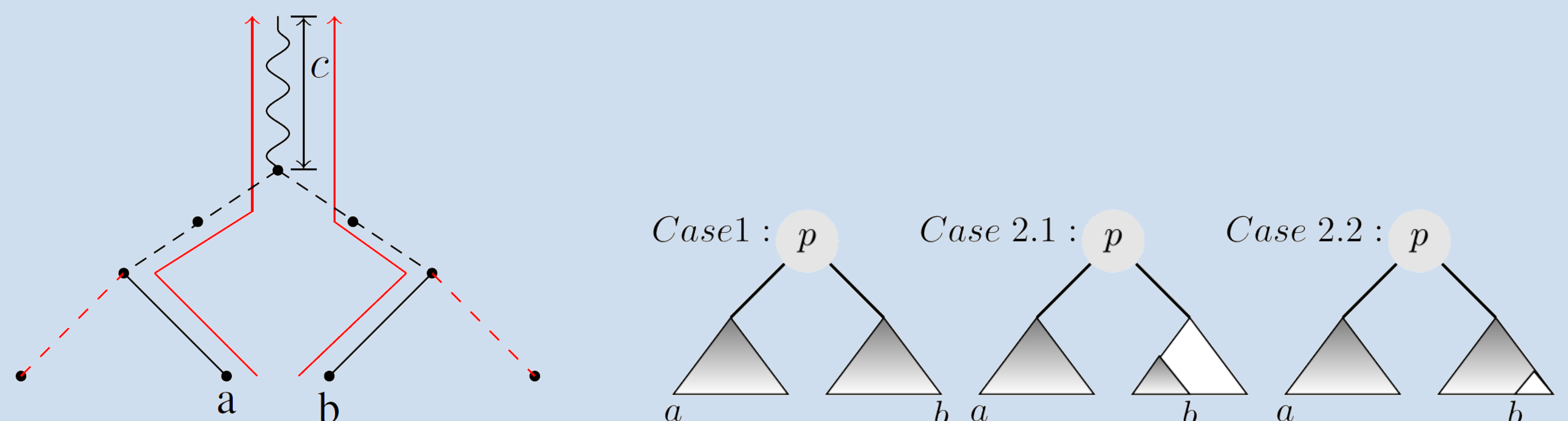
This work is supported by a CIFRE convention between the ANRT (National Association of Research and Technology) and the company NUMERYX Technologies.

References

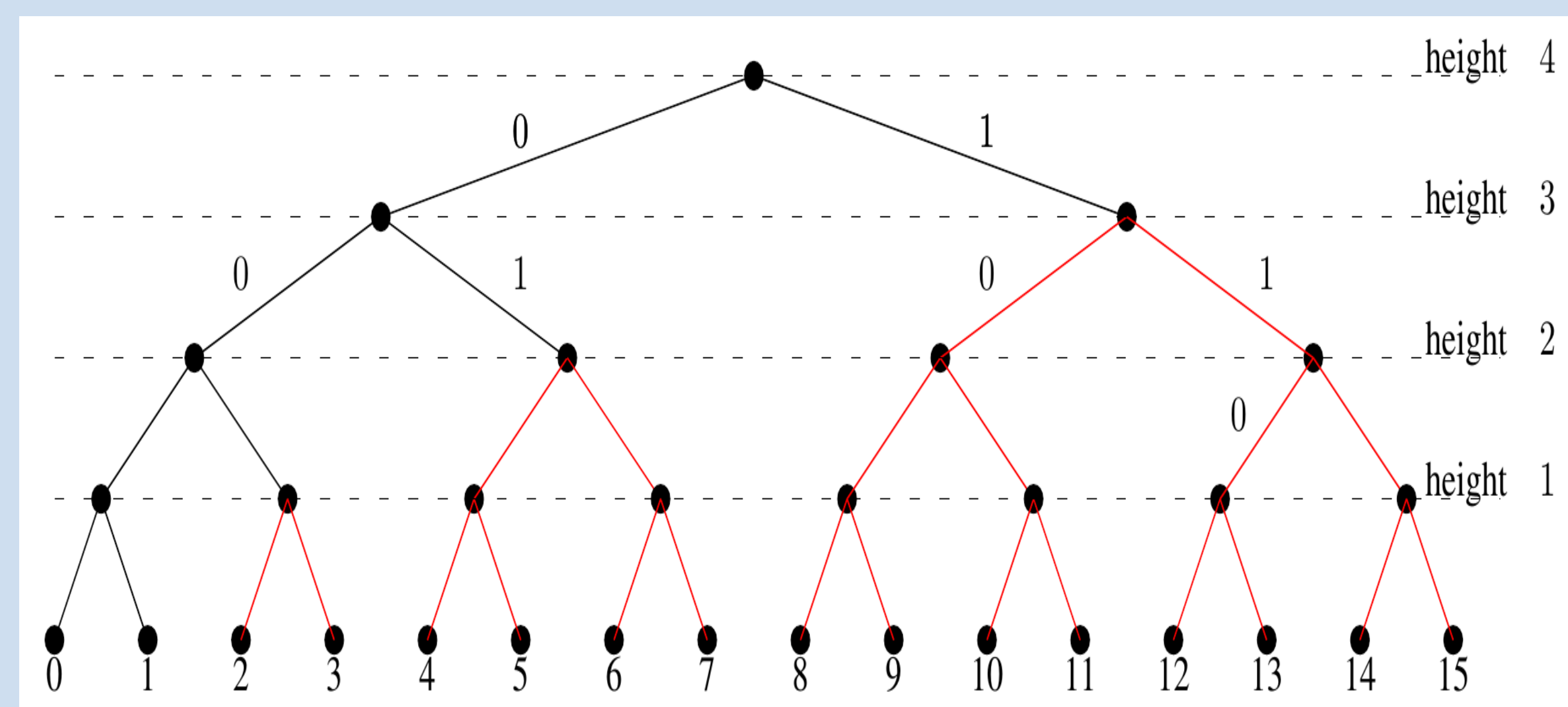
- [1] ADEL Bouhoula and NIZAR Ben Neji. Double-masked IP filter. Patent, 04 2015.
- [2] A. X. Liu, E. Torng, and C. R. Meiners. Firewall compressor: An algorithm for minimizing firewall policies. In *IEEE INFOCOM 2008 - The 27th Conference on Computer Communications*, pages 176–180, April 2008.

Double Mask Computation

The algorithm computes the set of masks for $[a, b]$ in a bottom up way, starting from the two nodes $bin_w(a)$ and $bin_w(b)$. Then, when reaching node c , the set of computed masks at the siblings of c (i.e., $c0$ and $c1$) are combined and the algorithm stops.

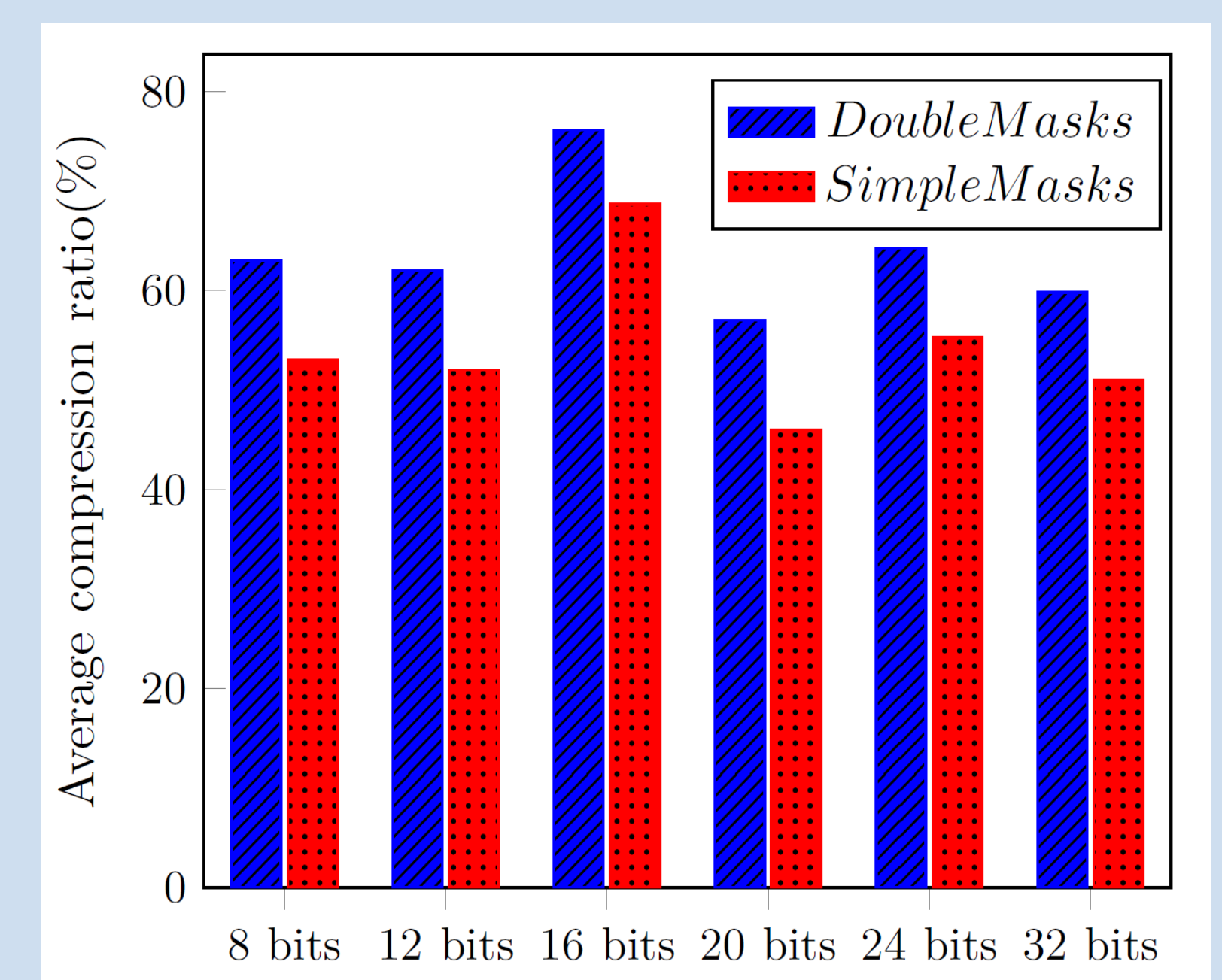
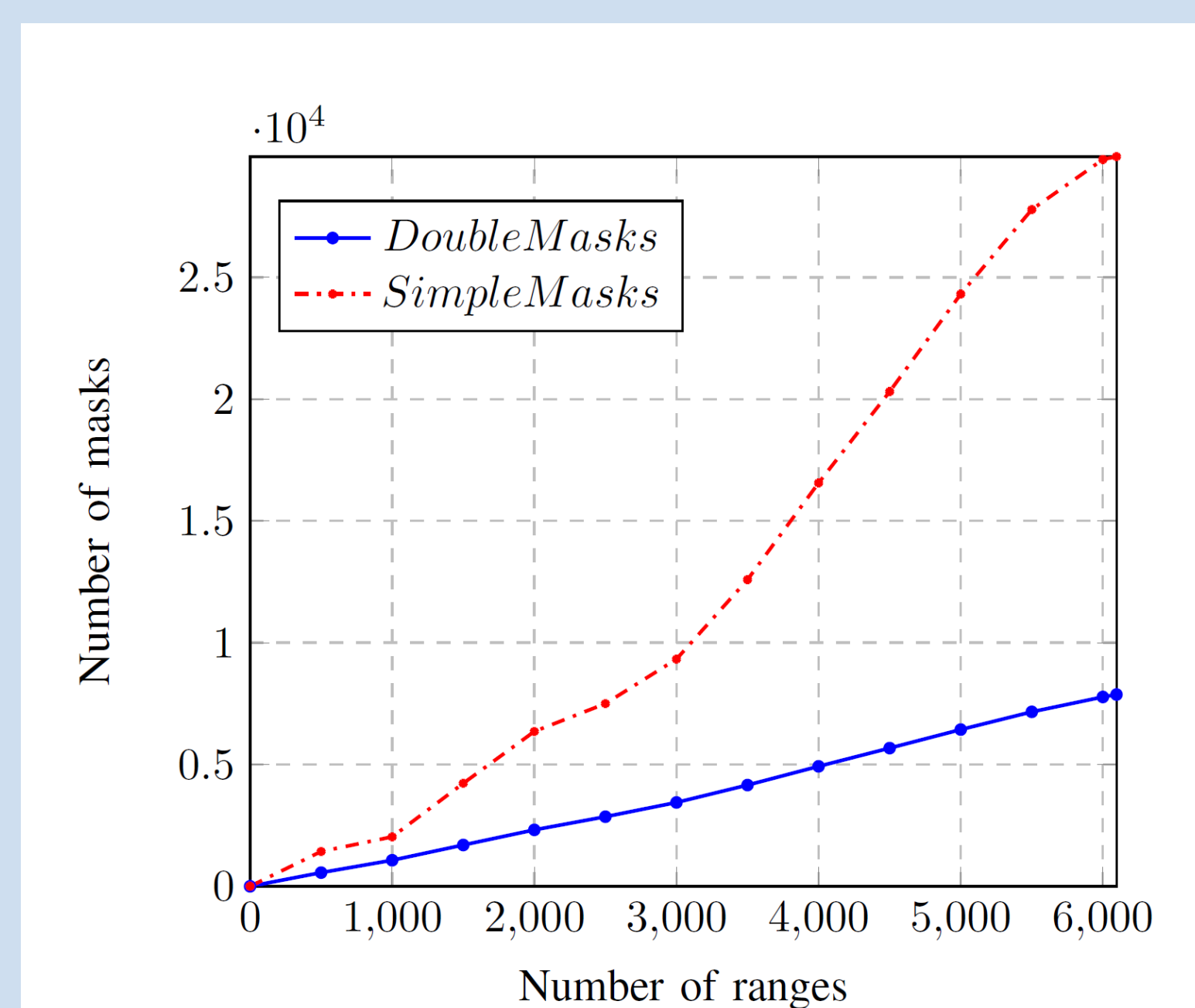


- The algorithm is linear in $|bin_w(a)| + |bin_w(b)|$, where $|x|$ is the length of the binary representation of a and b .
- Each range needs at most $2w - 4$ masks to be represented.
- Can also be applied to port ranges and for reducing range expansions in TCAM.
- Can be applied after or in combination with known redundancy removal techniques [2] in order to further reduce the number of entries in filtering rule tables.



Experimental Results

- Over 6000 ranges computed from more than 1.5 millions IPs generated in a synthetic way.
- The total number of generated simple masks is 29958.
- We are able to reduce this number by 74% (i.e. 7872 masks).



- Double Mask representation performs better than Simple Mask with a difference of at least 10% while increasing the number of Bits.