

LAPORAN JURNAL PRAKTIKUM
ORGANISASI DAN ARSITEKTUR KOMPUTER II
MODUL VII
UNIPROCESSOR TRACE III



Nama : Muhammad Zidane Sondiaz
No. BP : 2211512007
Hari/Tanggal : Jumat / 6 Desember 2024
Shift : III

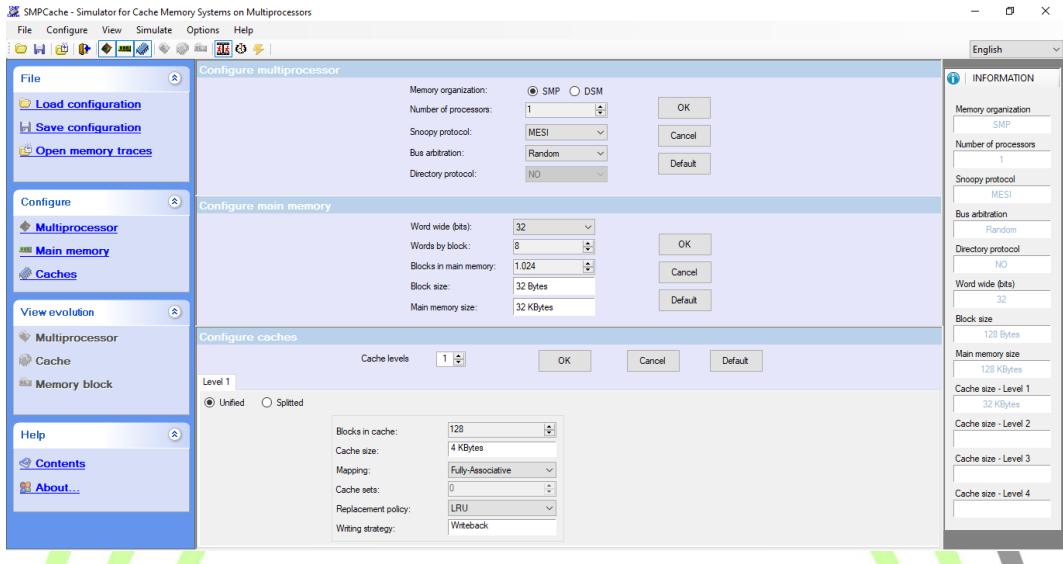
Asisten : 1.
2.



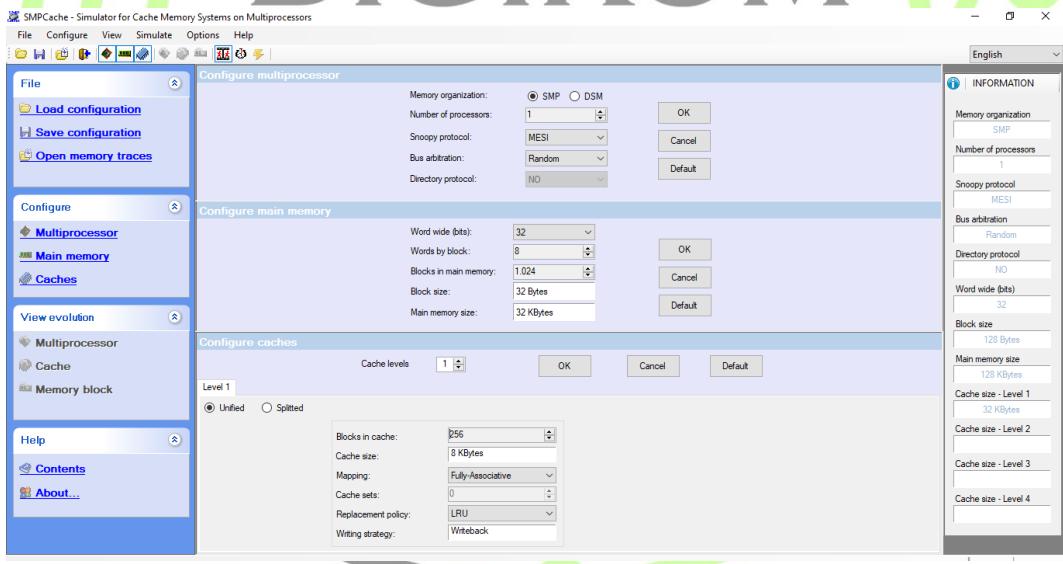
LABORATORIUM SISTEM DIGITAL DAN ARSITEKTUR KOMPUTER
DEPARTEMEN TEKNIK KOMPUTER
FAKULTAS TEKNOLOGI INFORMASI
UNIVERSITAS ANDALAS
PADANG
2024

Jurnal

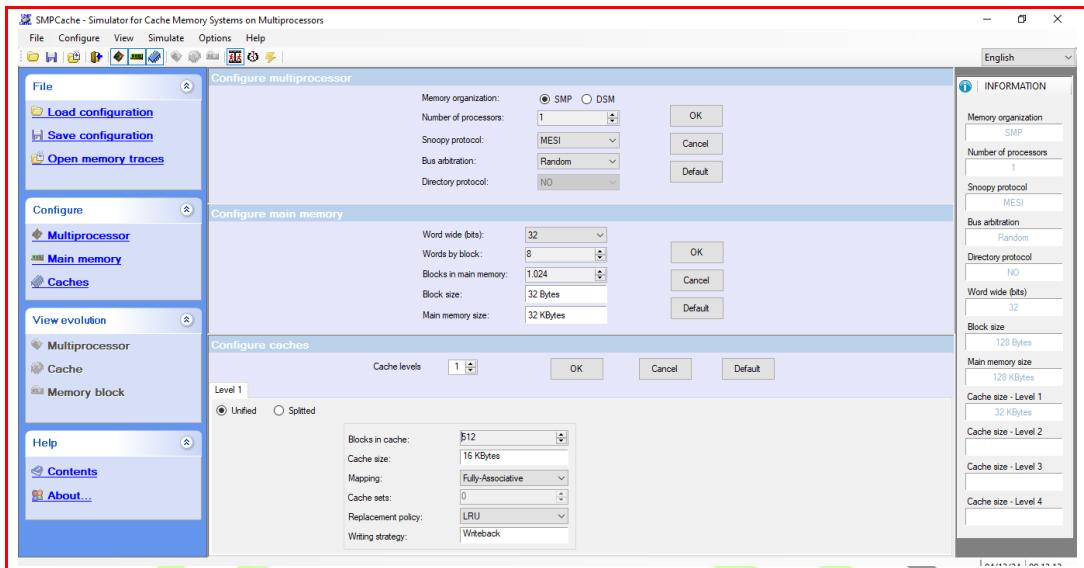
1. Percobaan 1



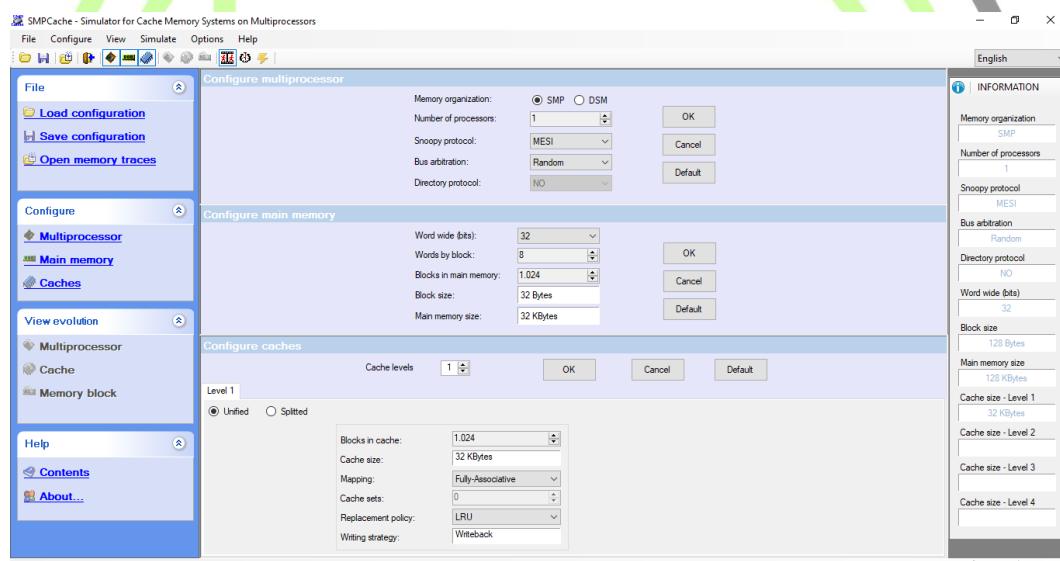
1.1Konfigurasi 8 block/4KB cache



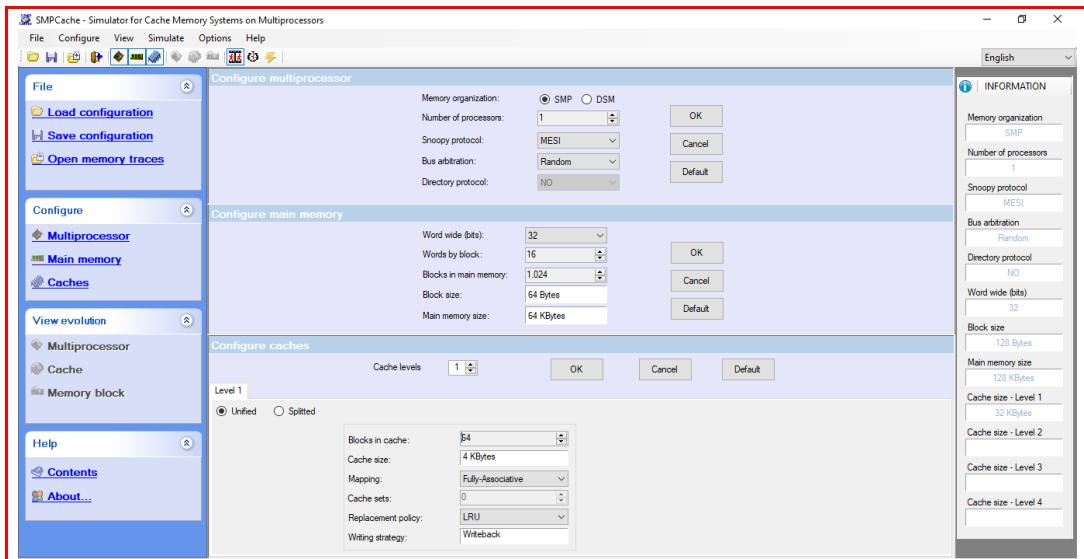
1.2Konfigurasi 8 Block/8KB cache



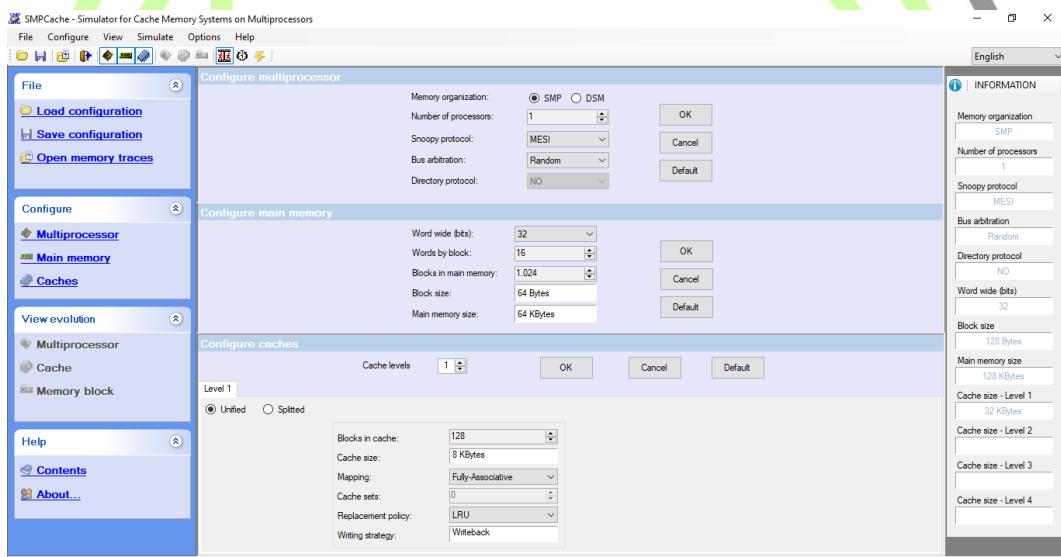
1.3 Konfigurasi 8 Block/16KB Cache



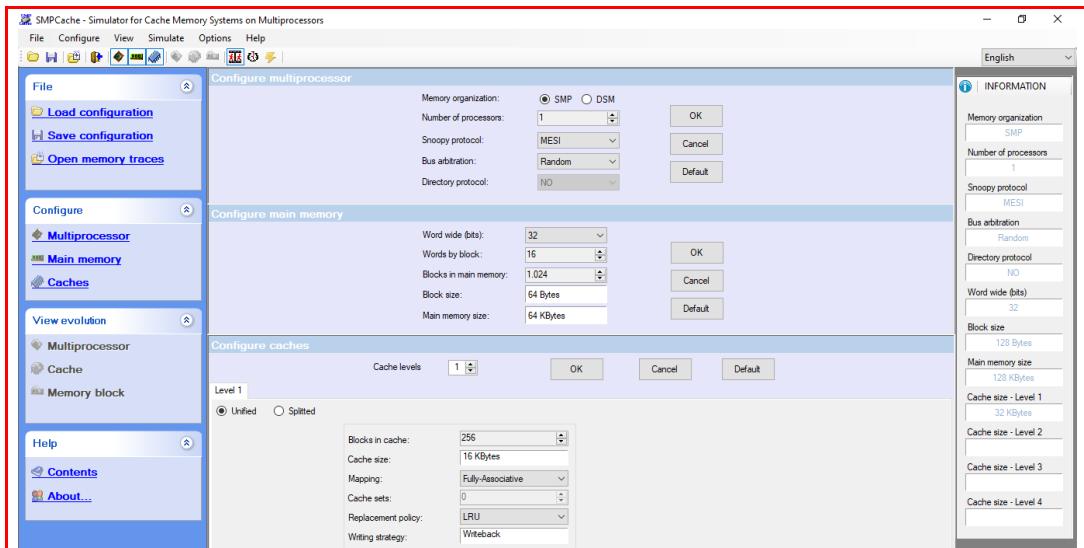
1.4 konfigurasi 8 block/32 KB cache



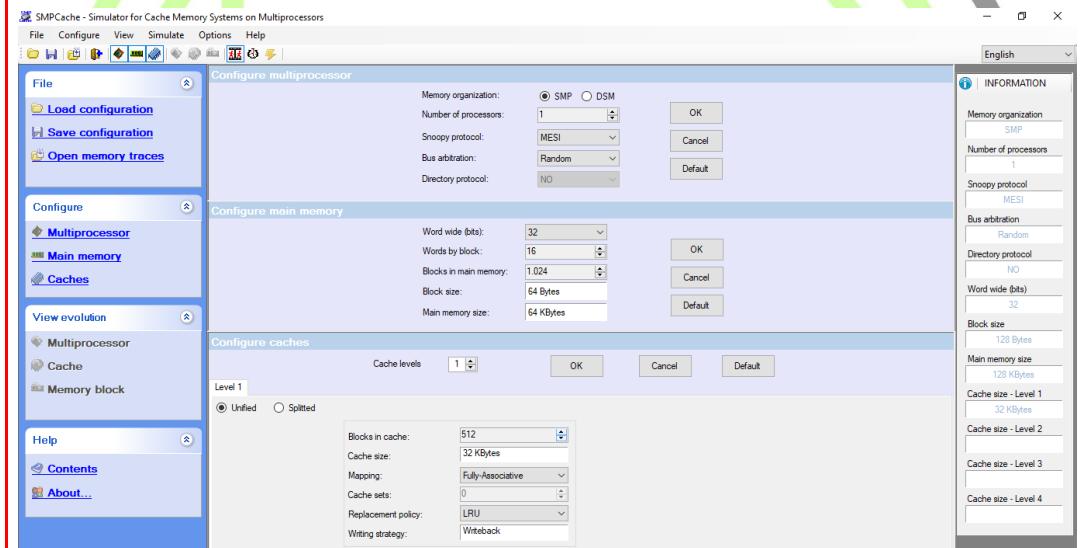
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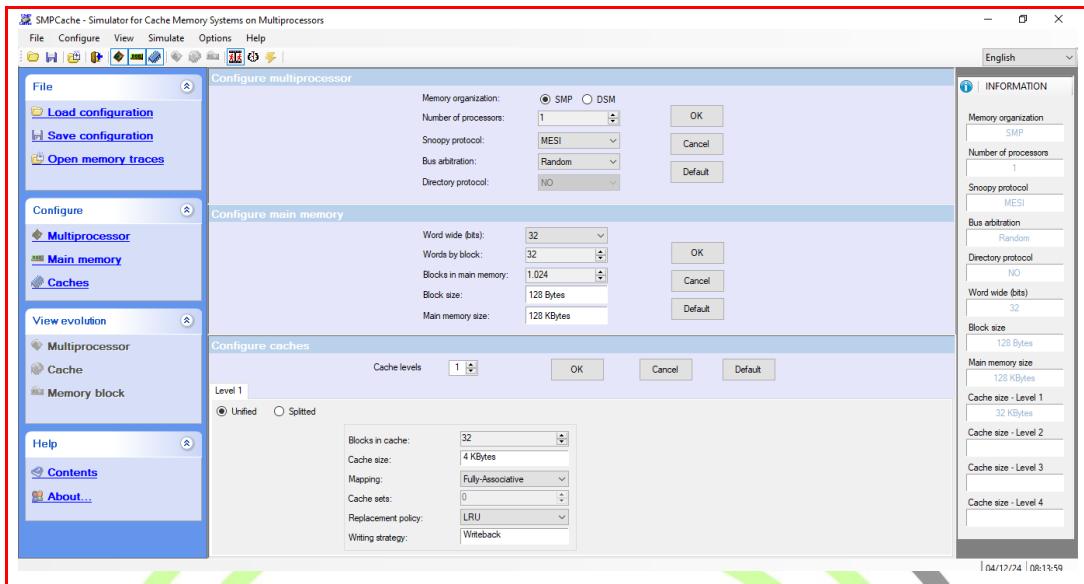
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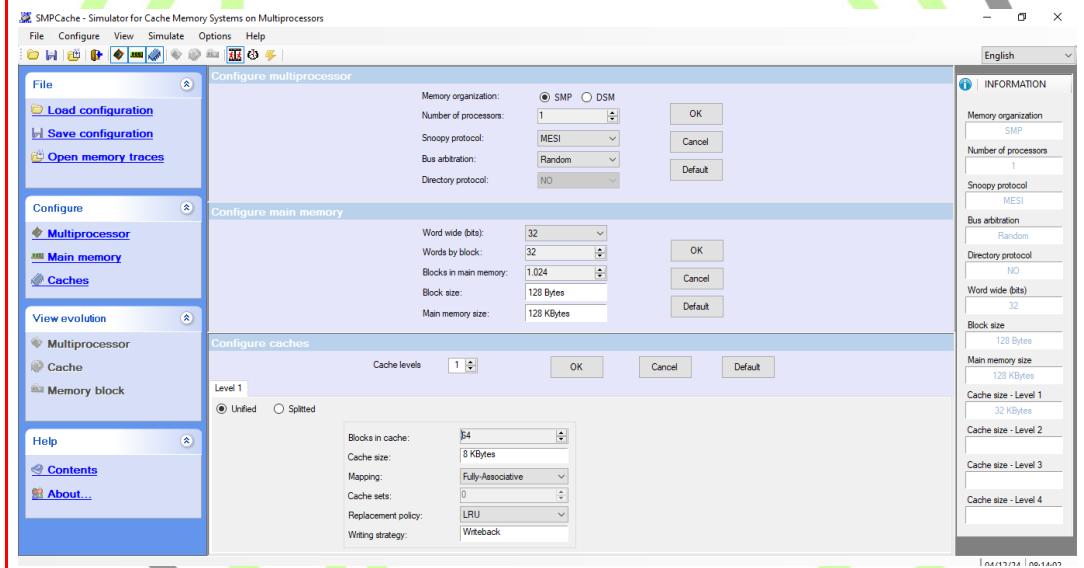
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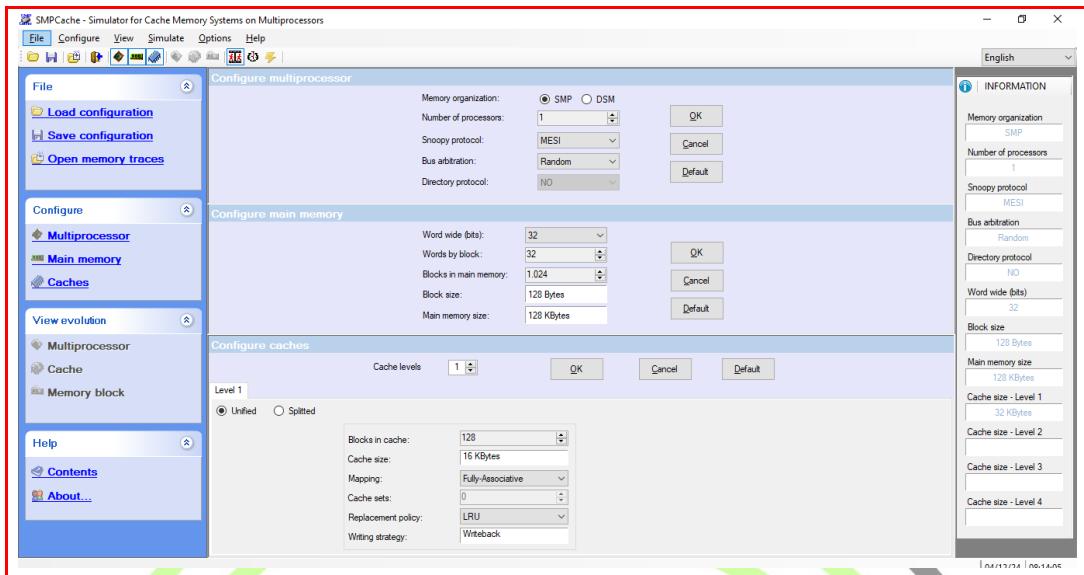
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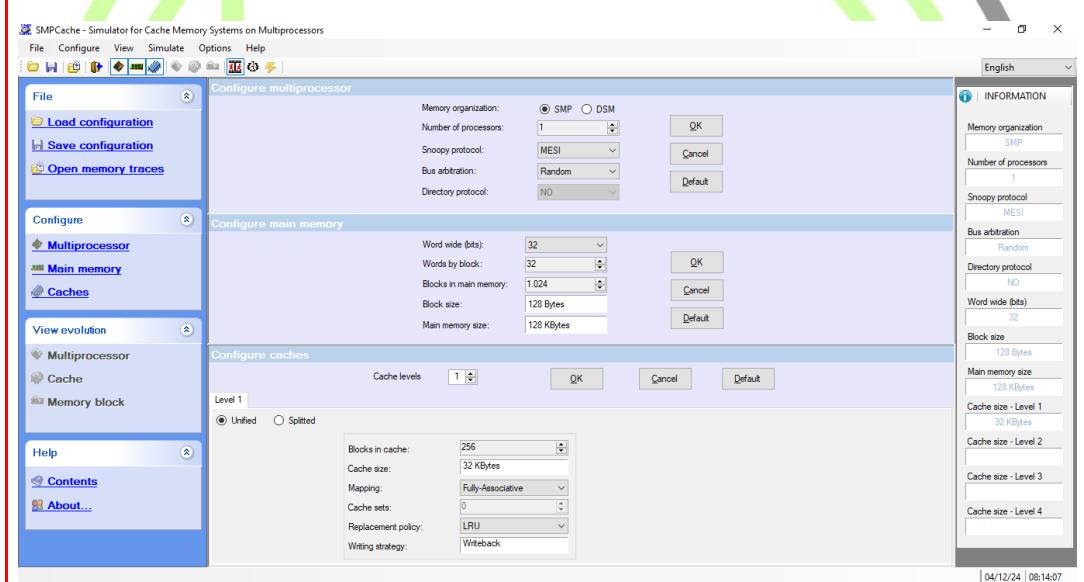
1.9 konfigurasi 32 block/4 KB cache



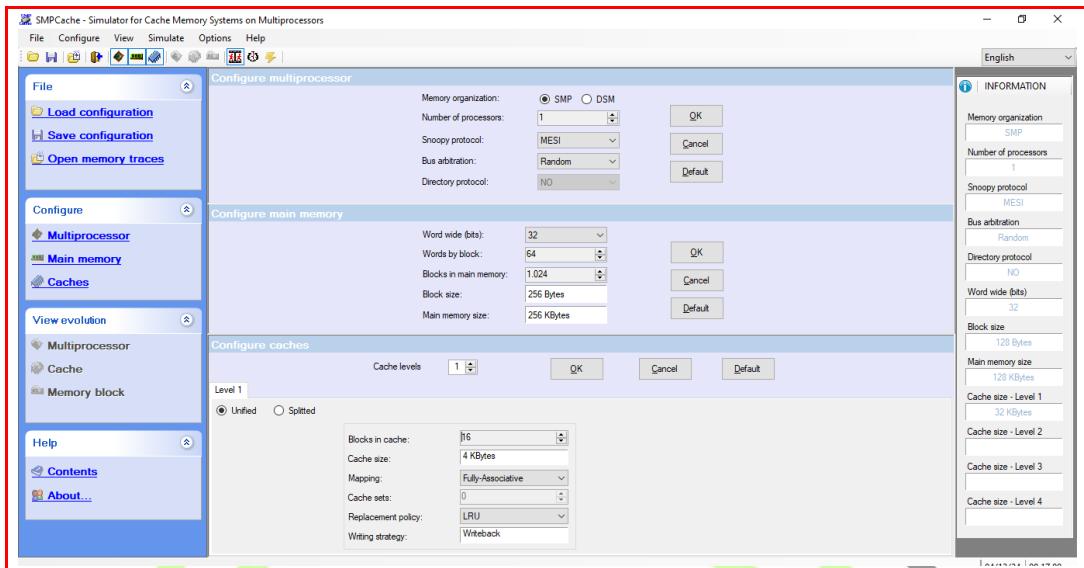
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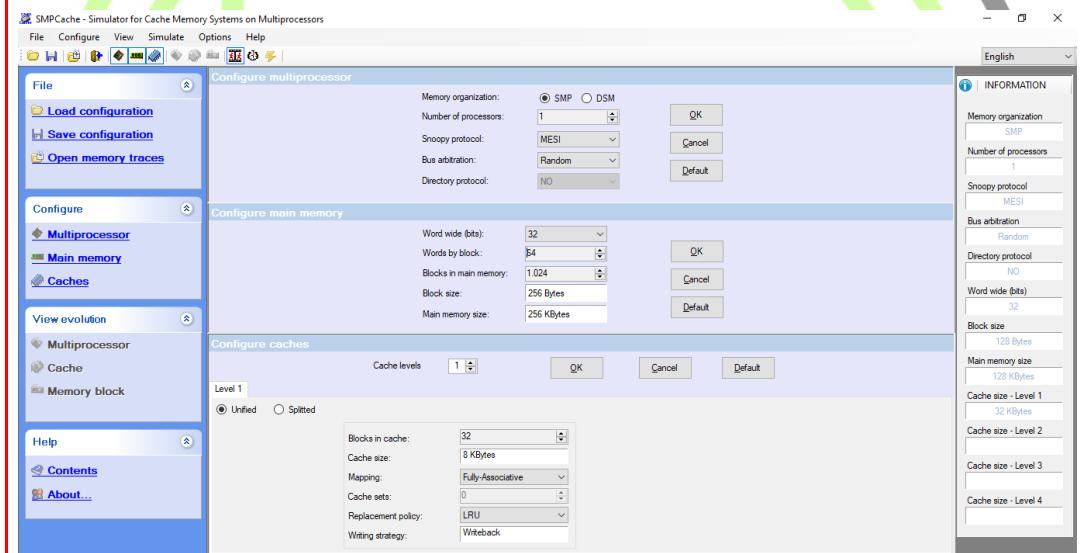
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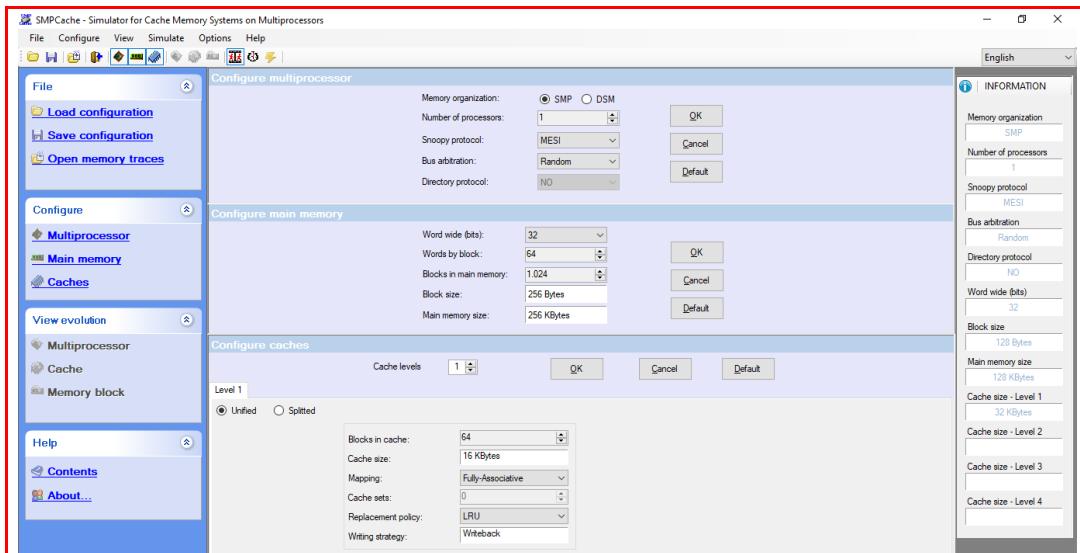
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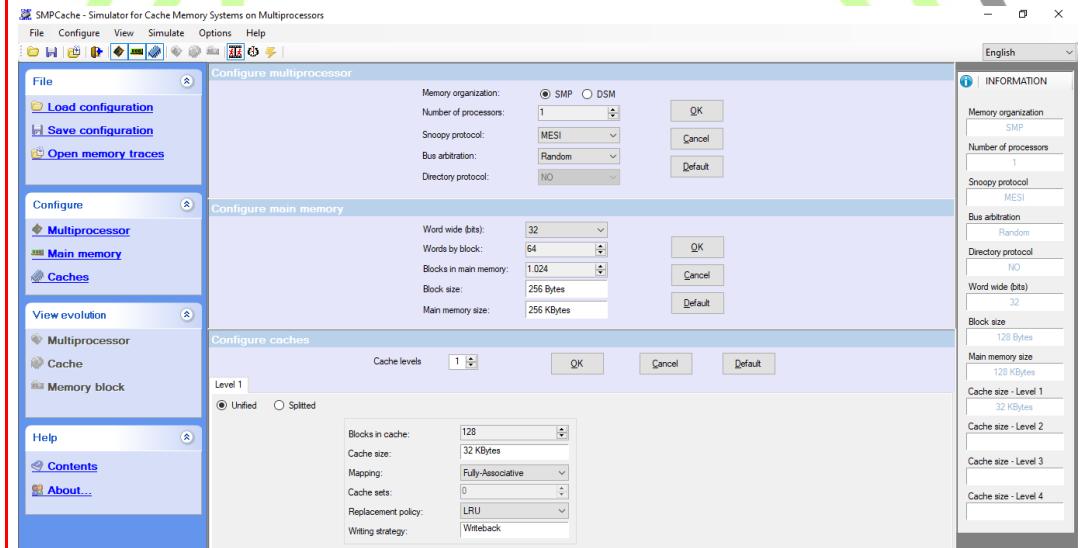
1.13 konfigurasi 64 block/4 KB cache



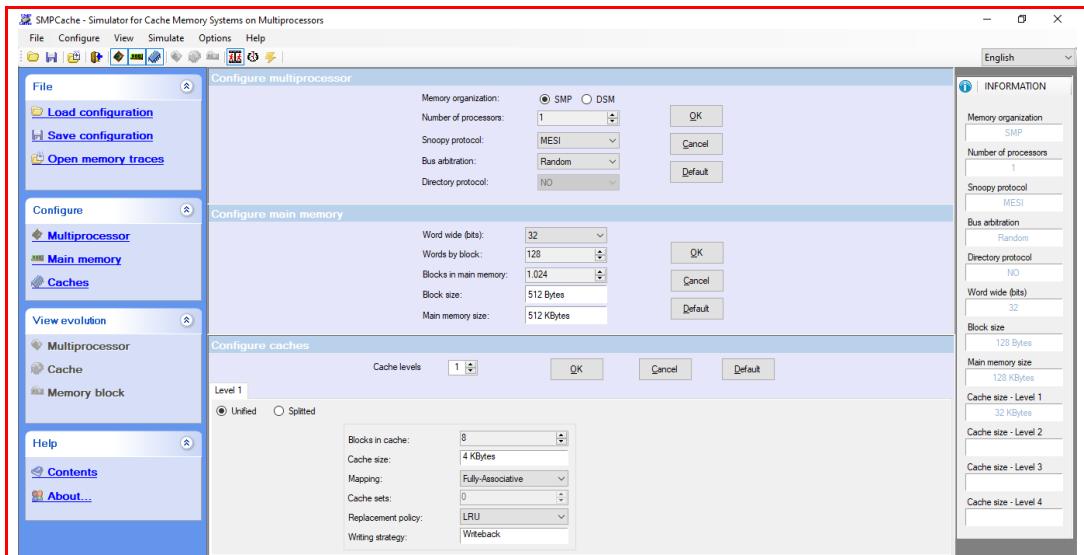
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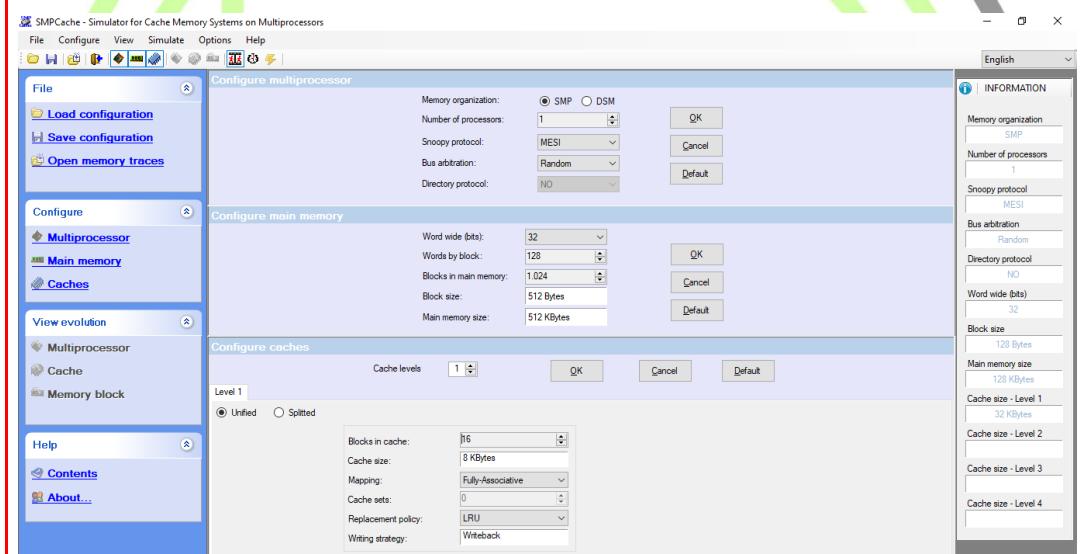
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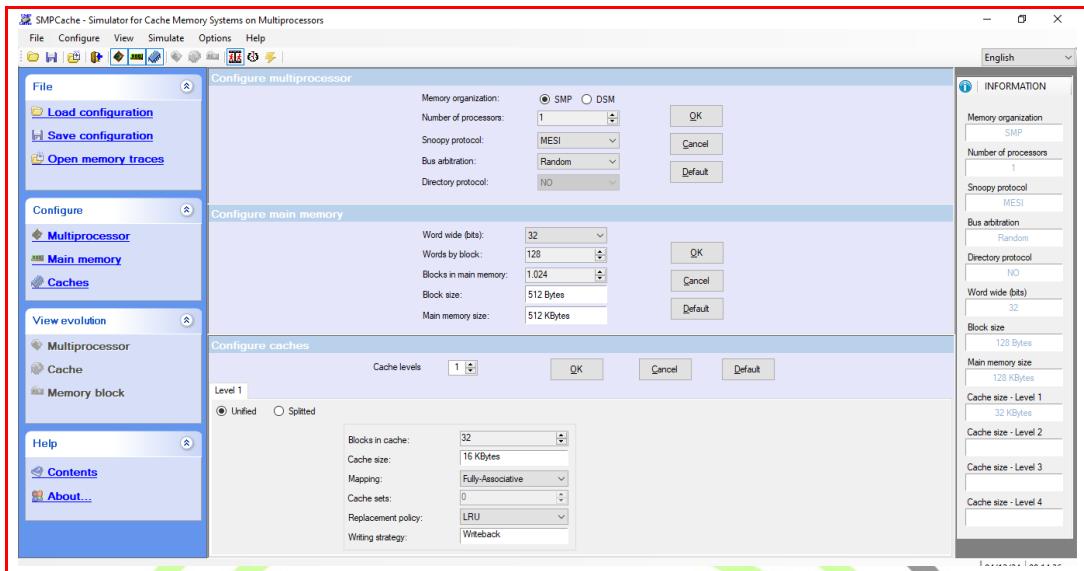
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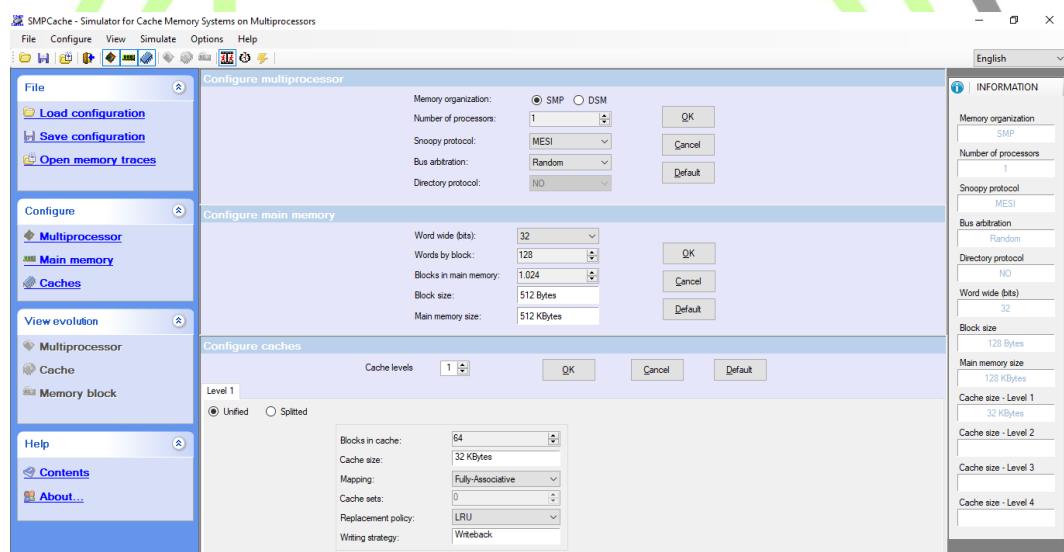
1.17 konfigurasi 128 block/4 KB cache



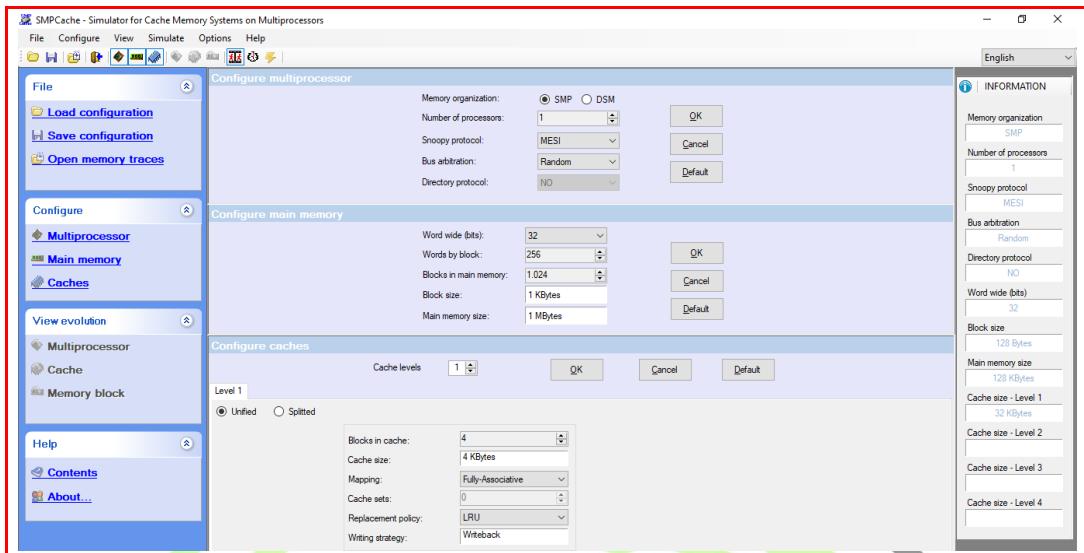
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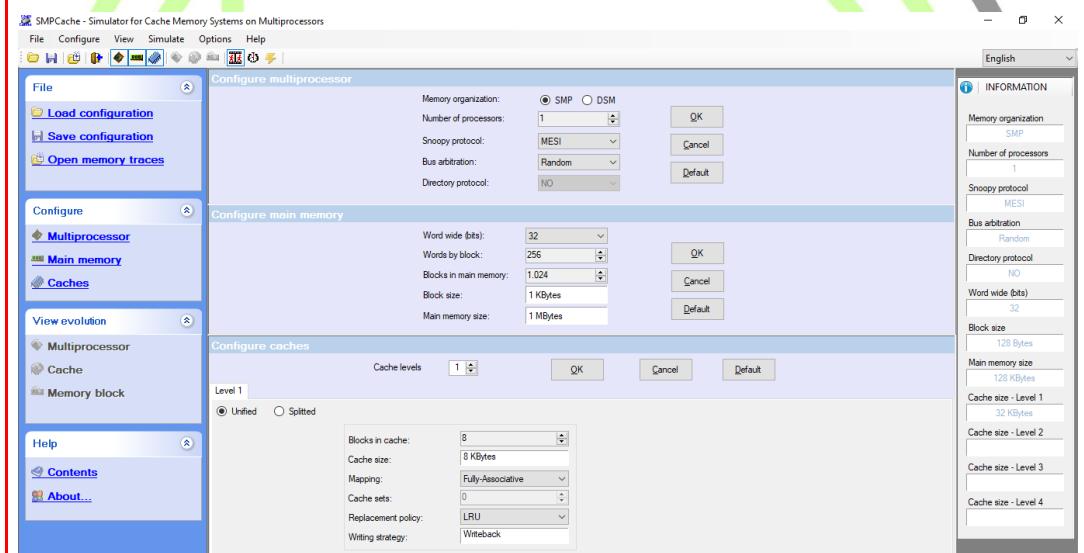
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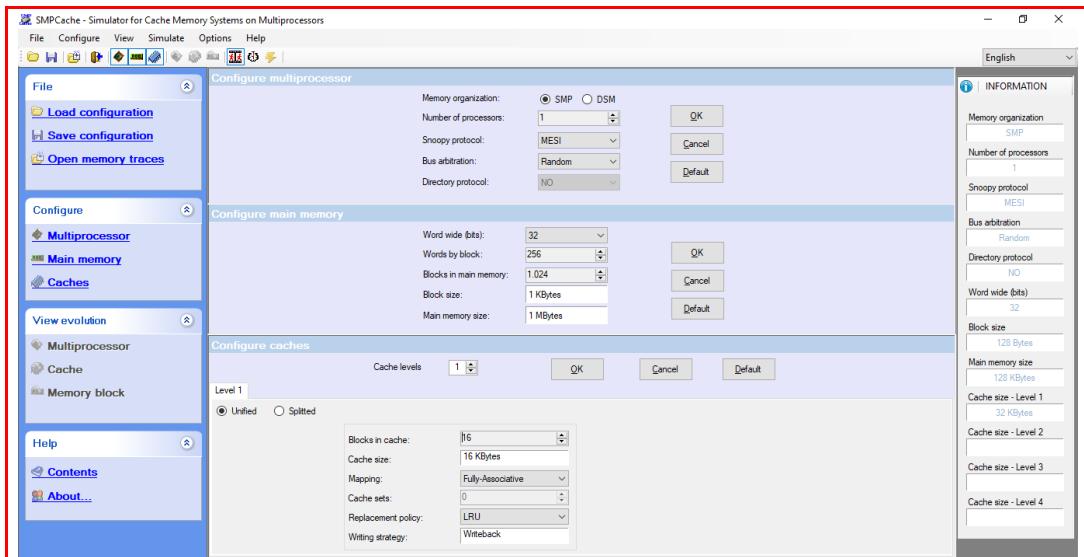
1.20 konfigurasi 128 block/32 KB cache



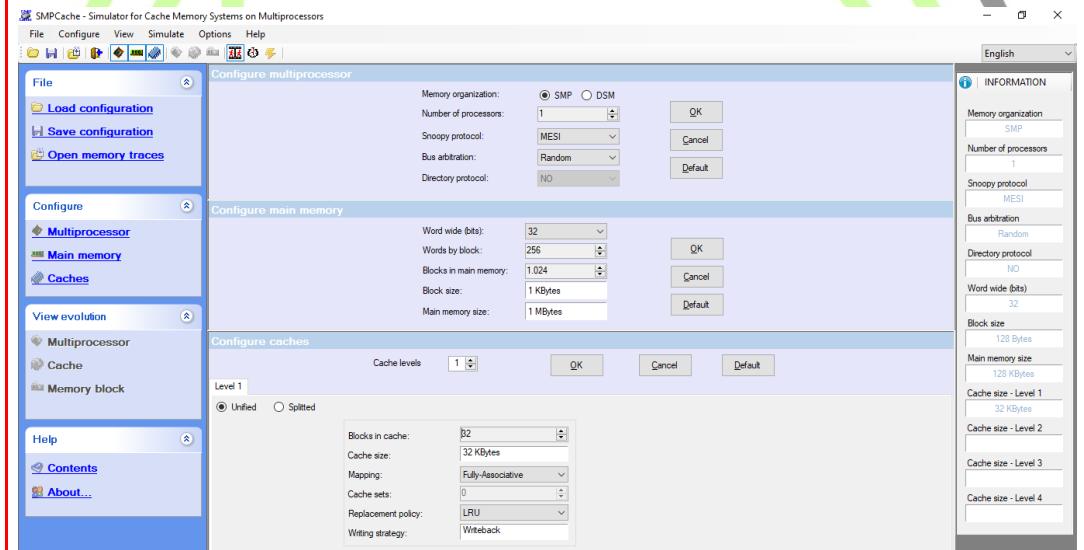
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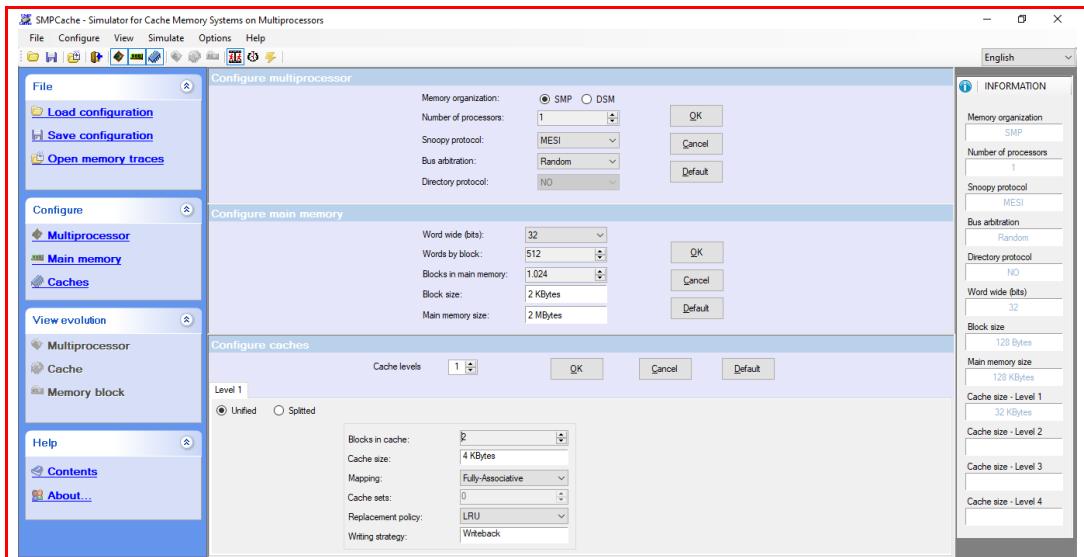
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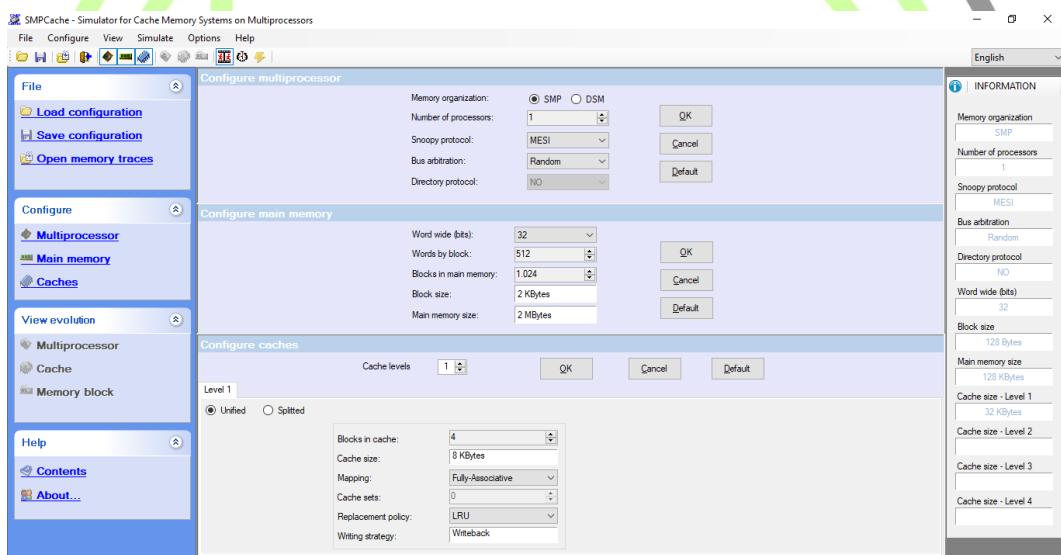
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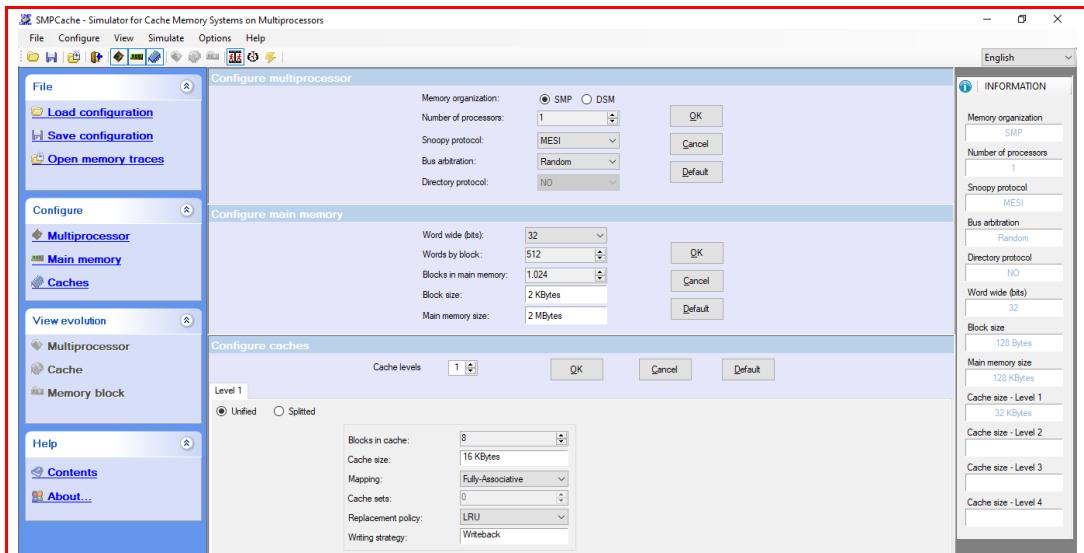
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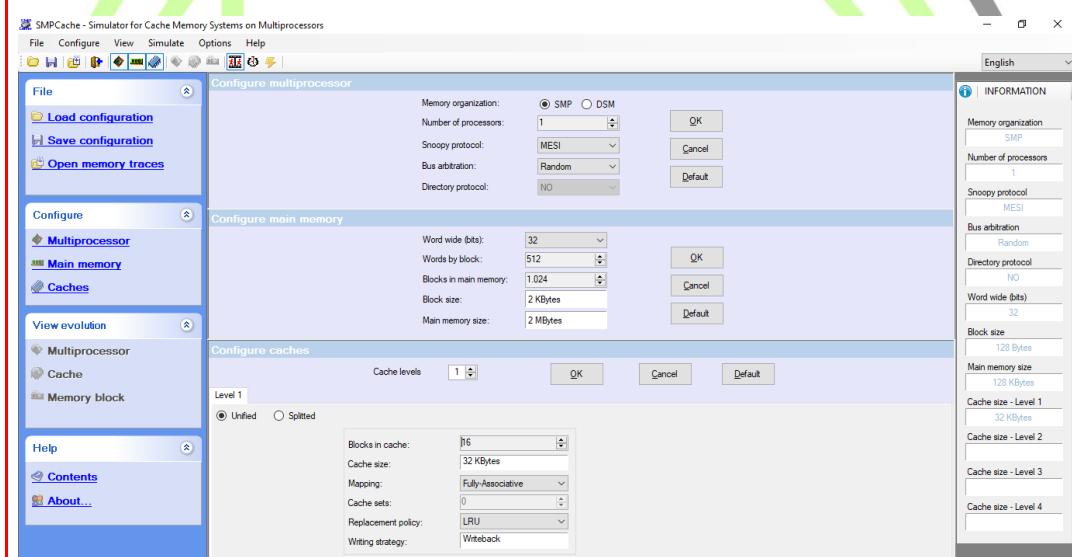
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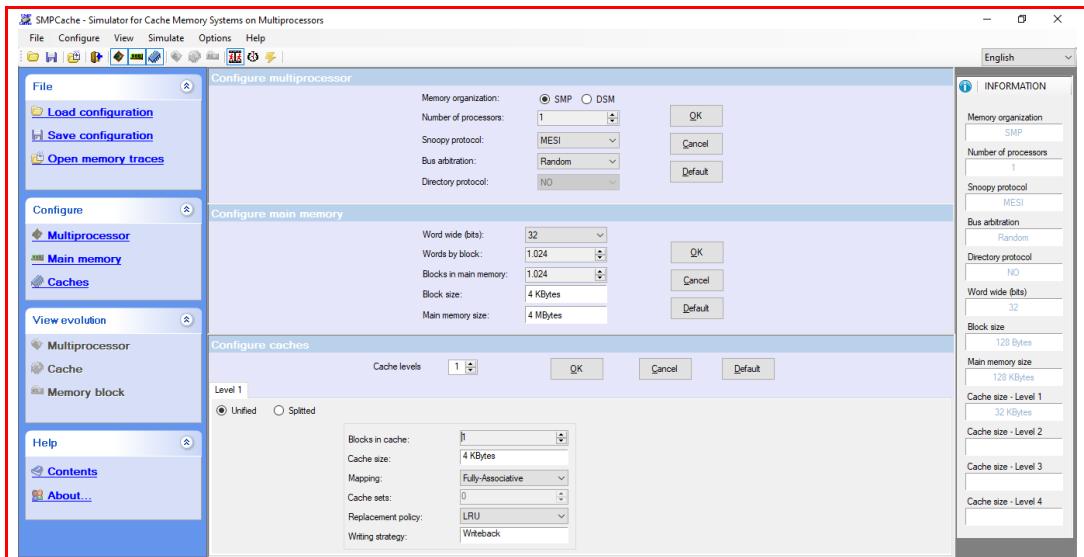
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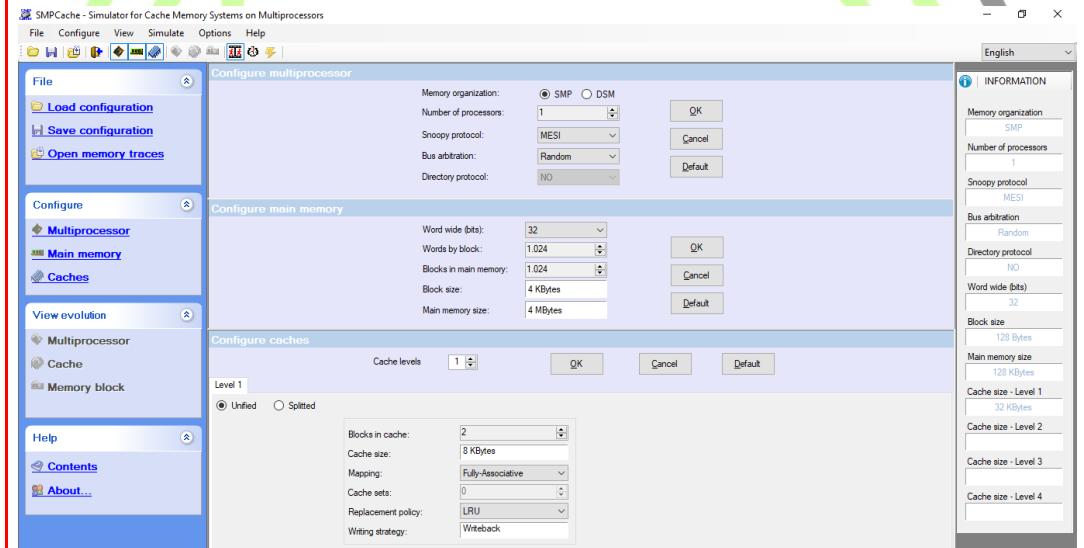
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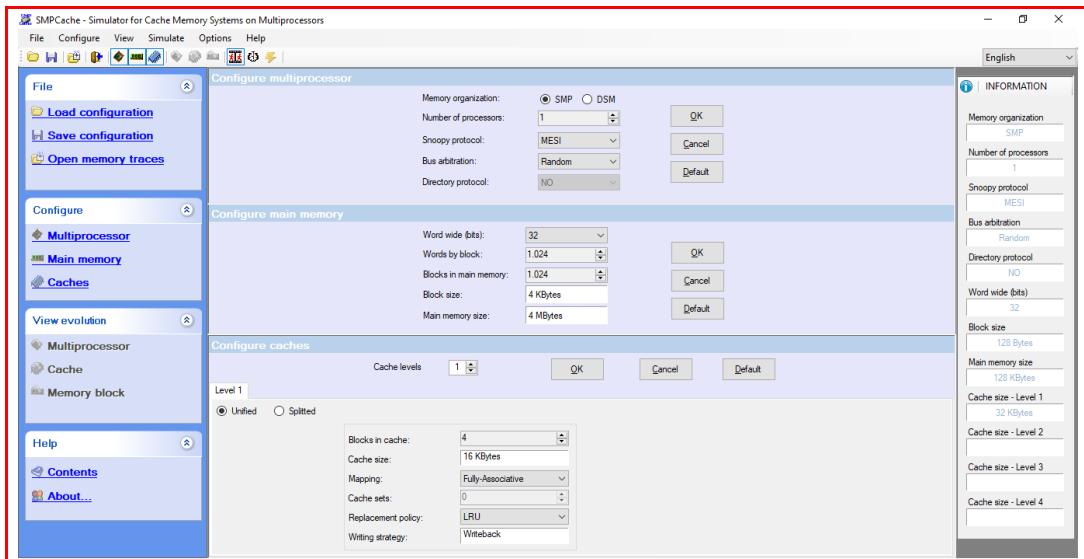
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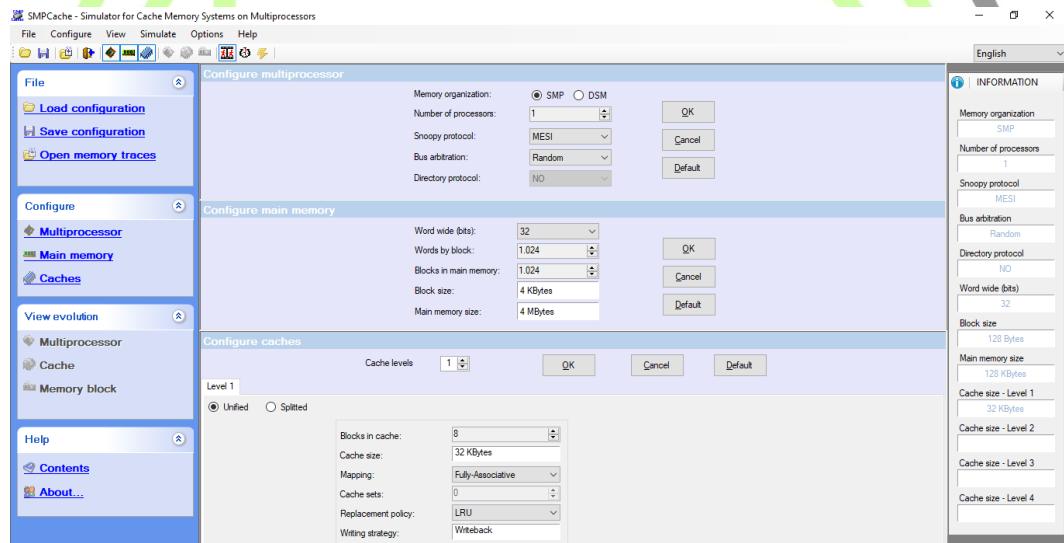
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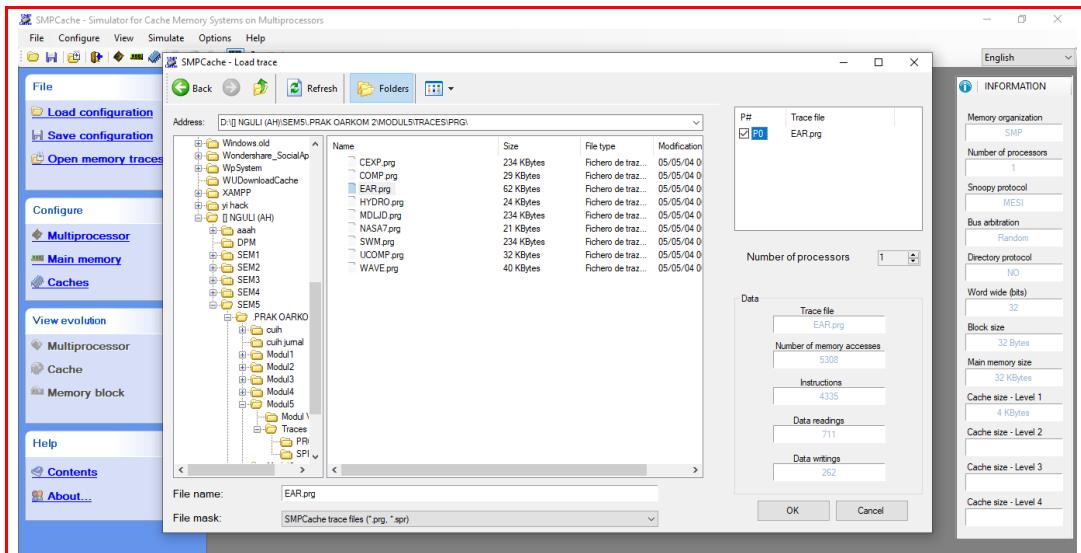
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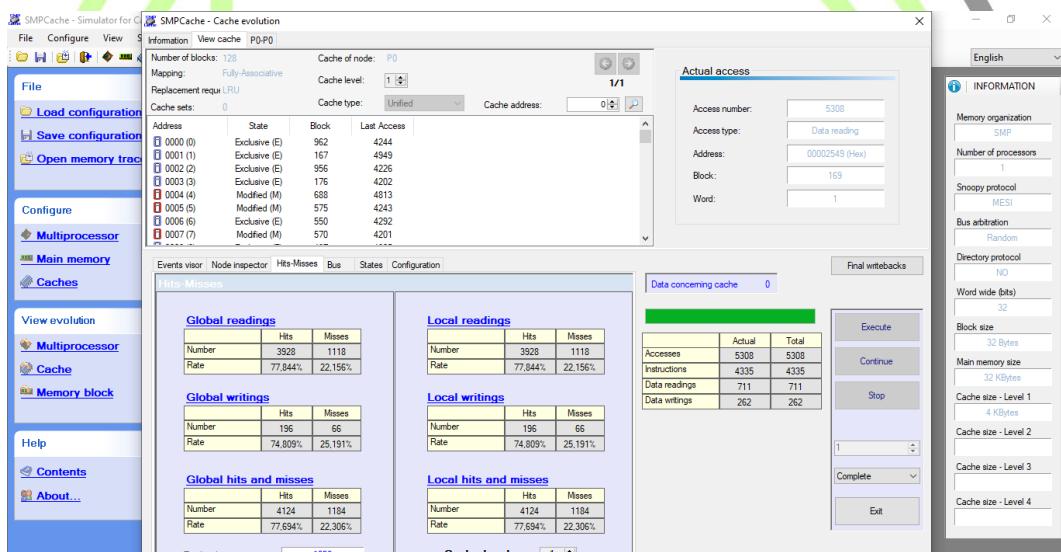
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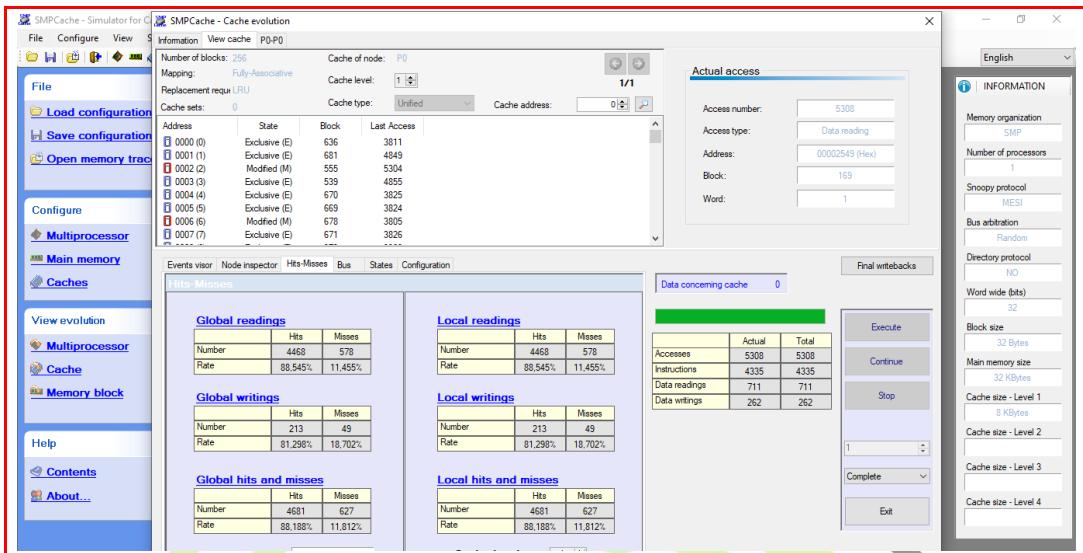
1.32 konfigurasi 1024 block/32 KB cache



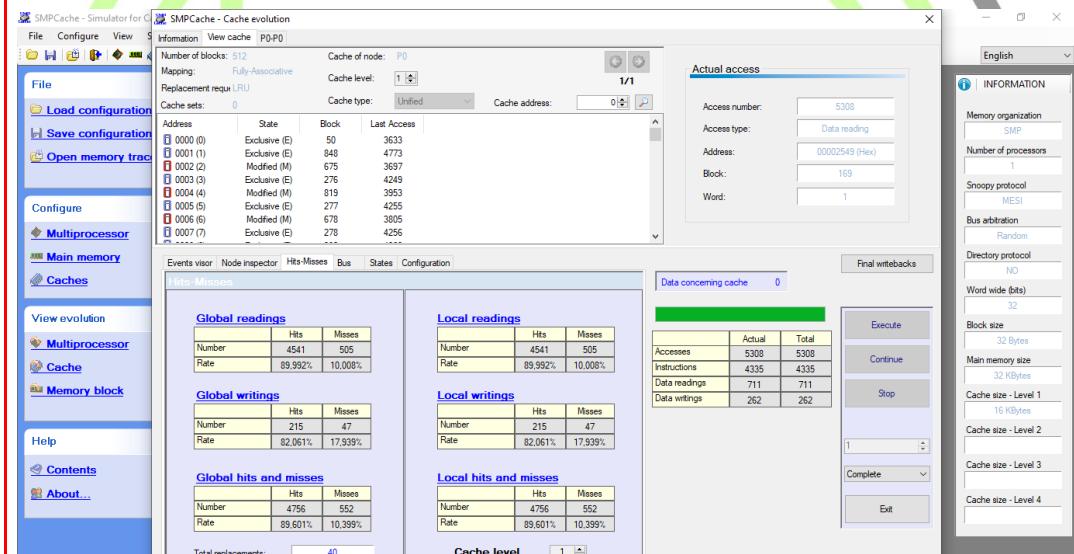
1.33 Open file trace EAR.prg



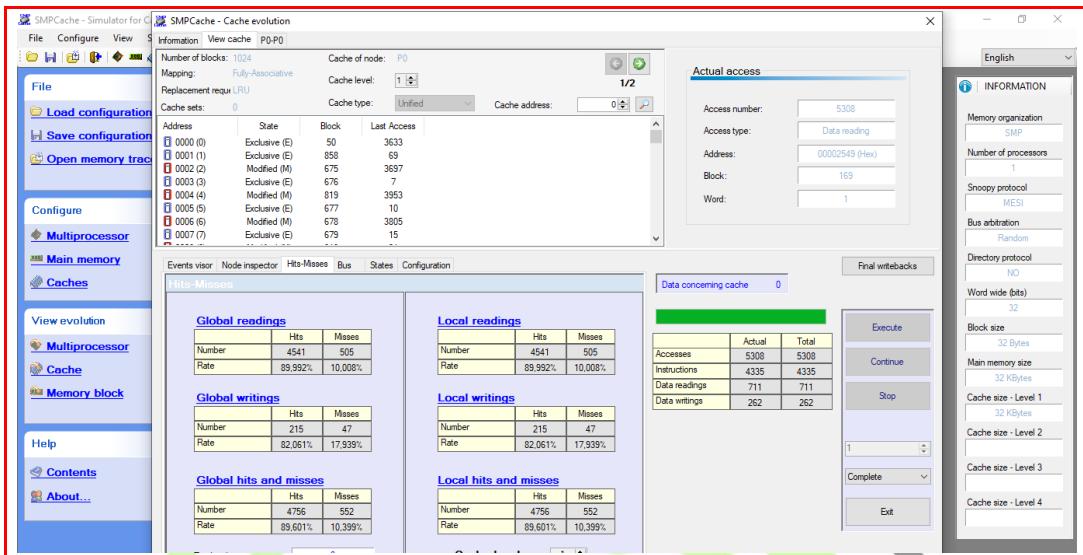
1.34 Hasil Miss Rate 8 block/4KB



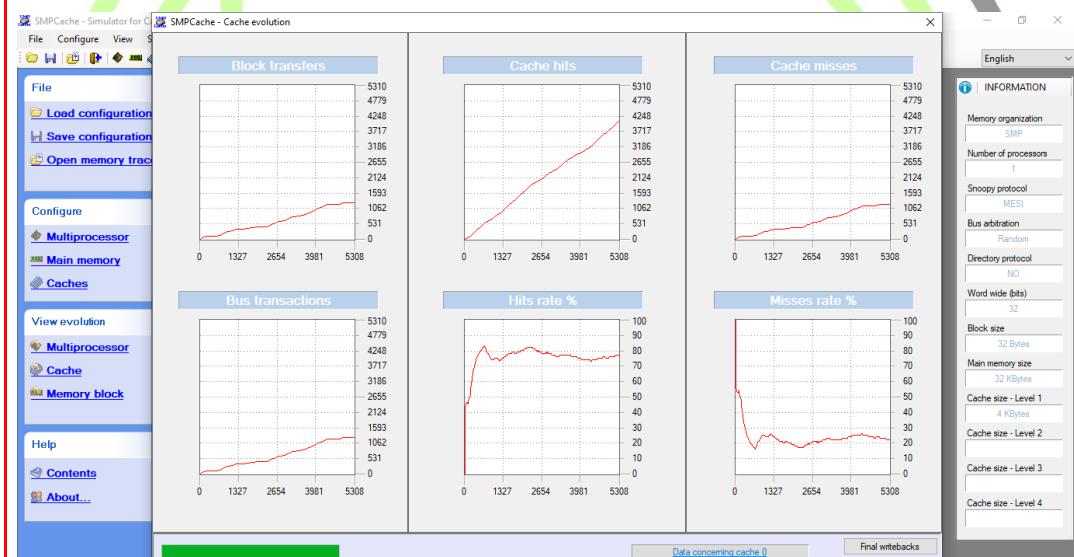
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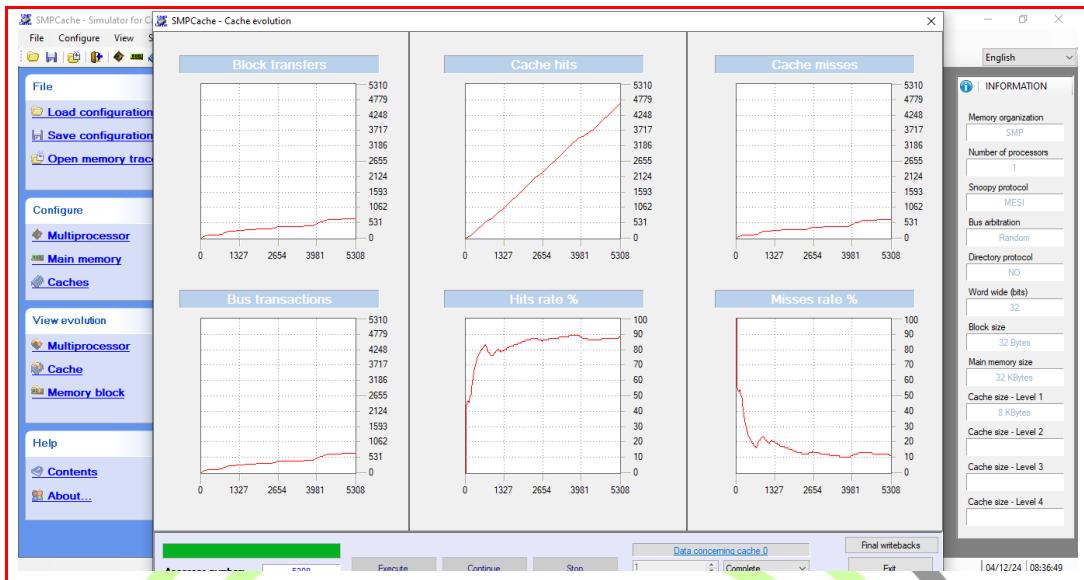
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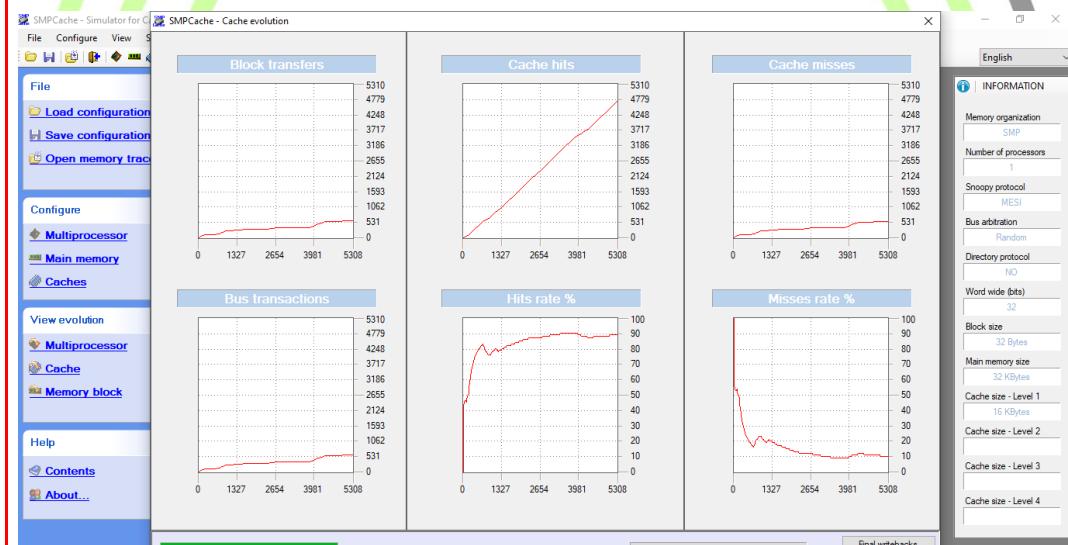
1.37 Hasil Miss Rate 8 block/32KB



1.38 Hasil Grafik 8 block/4KB



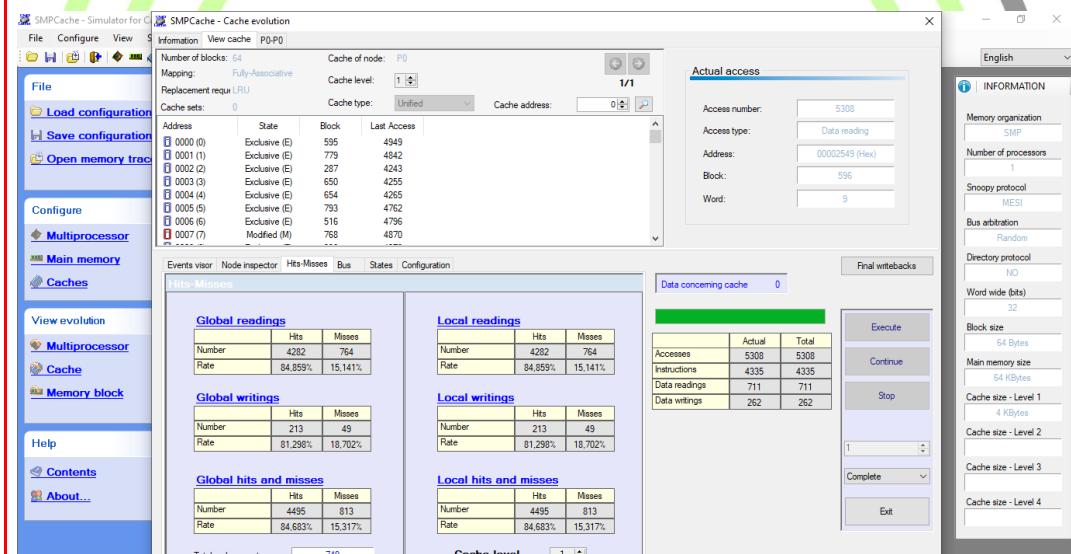
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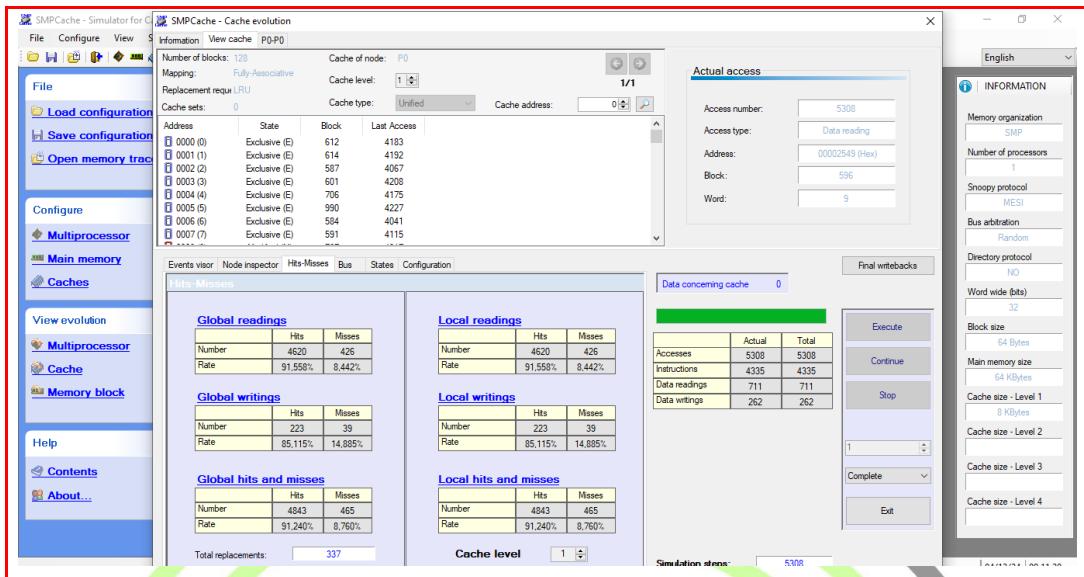
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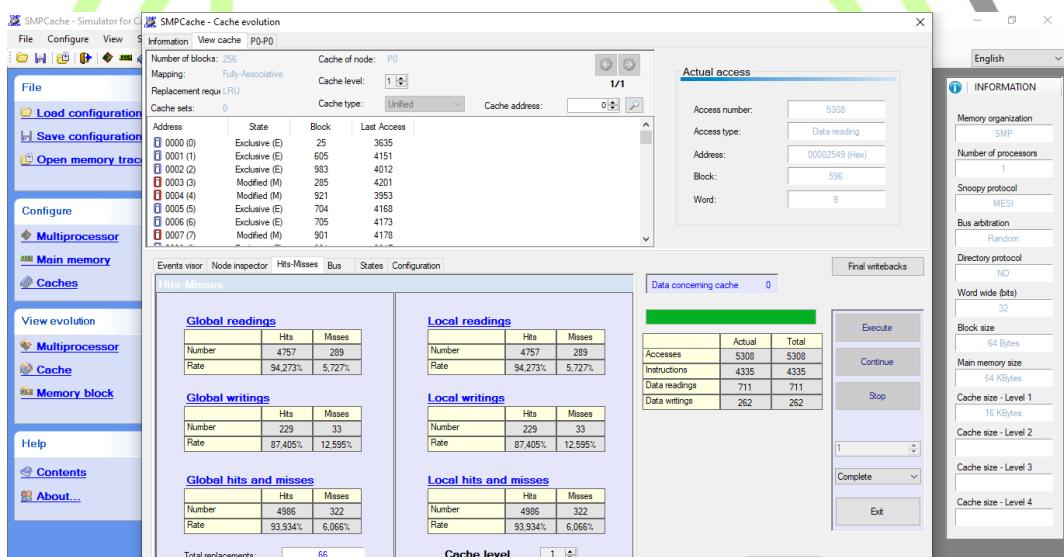
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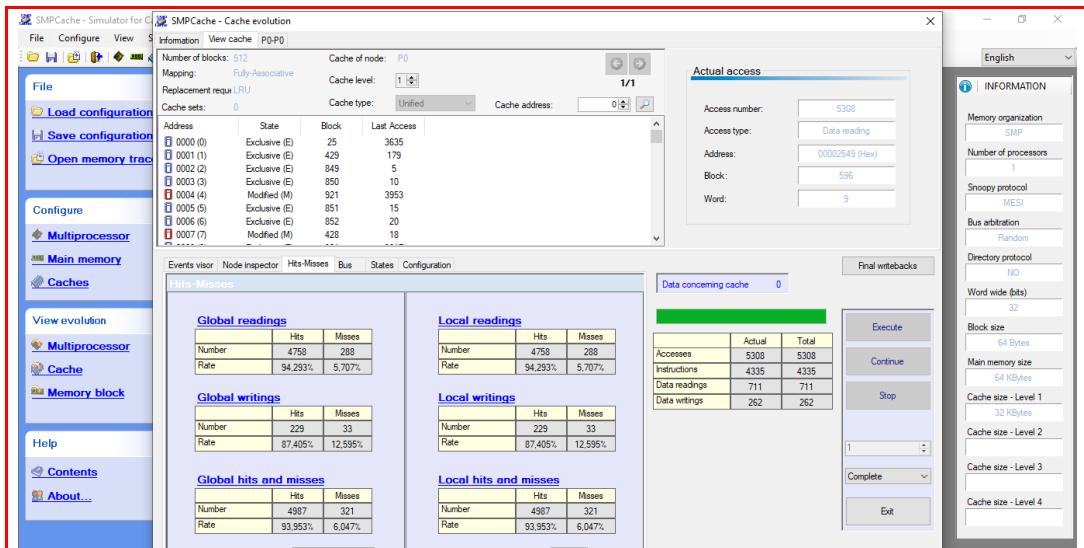
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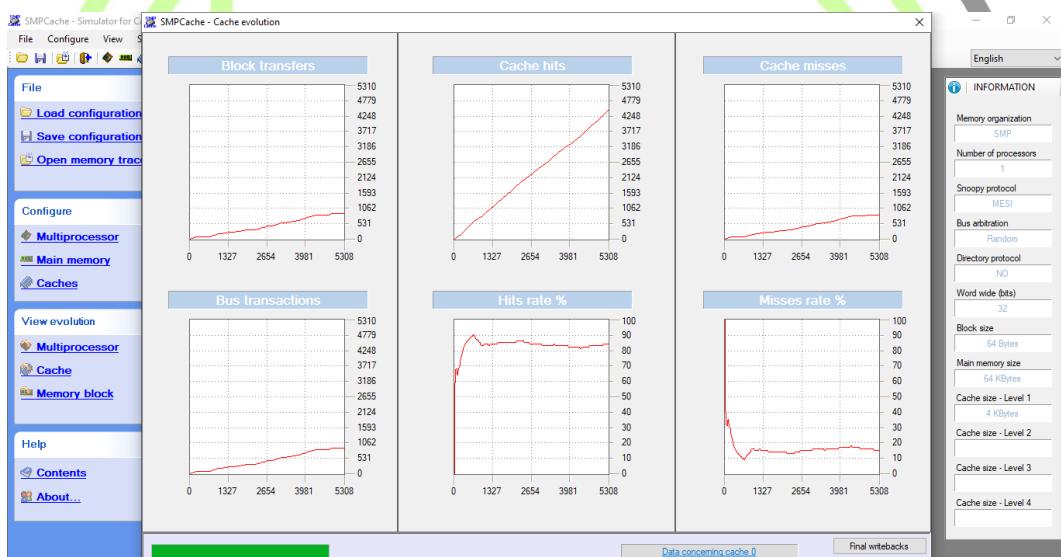
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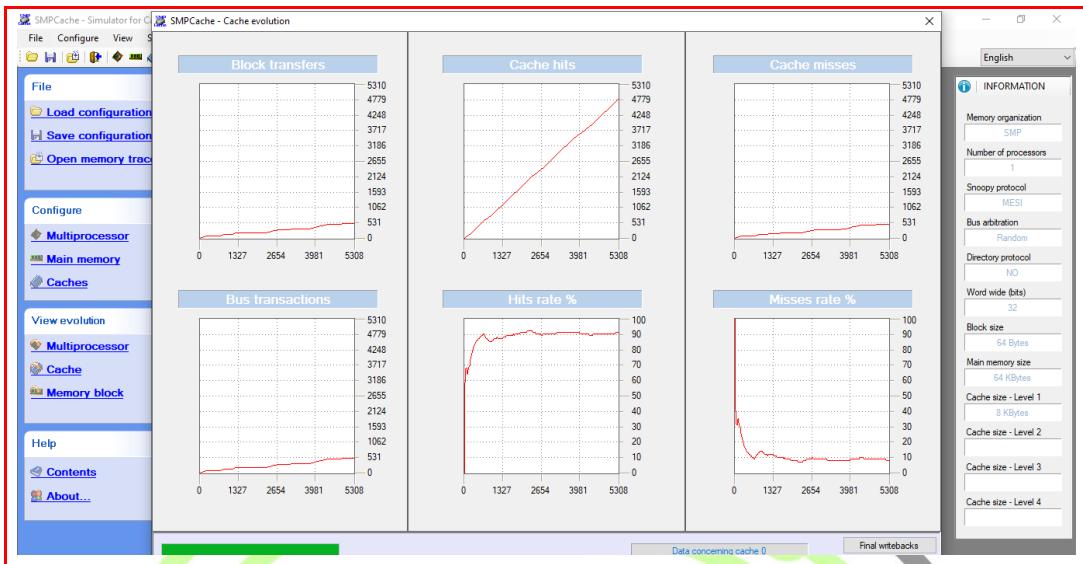
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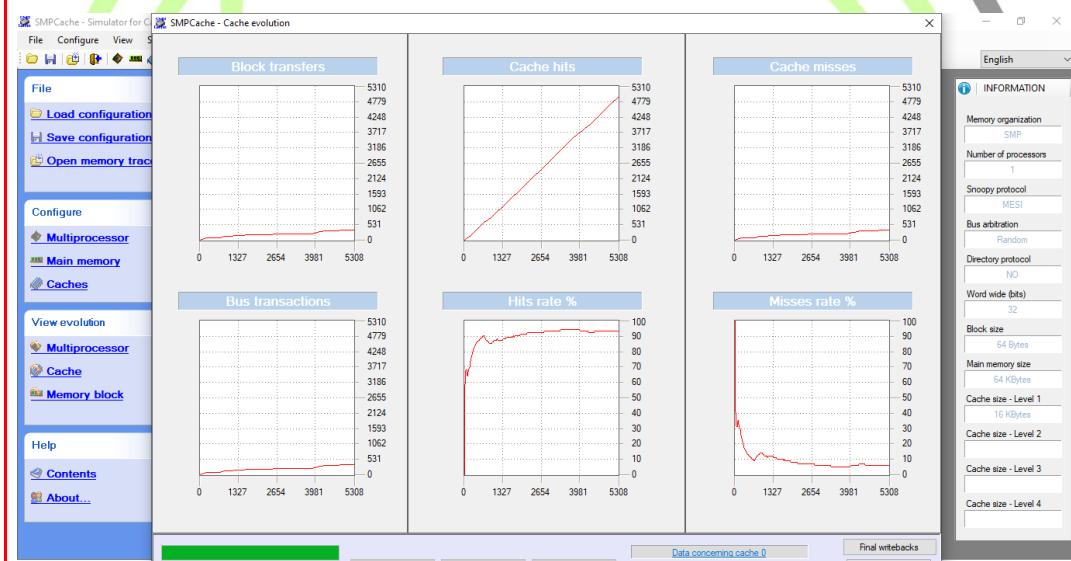
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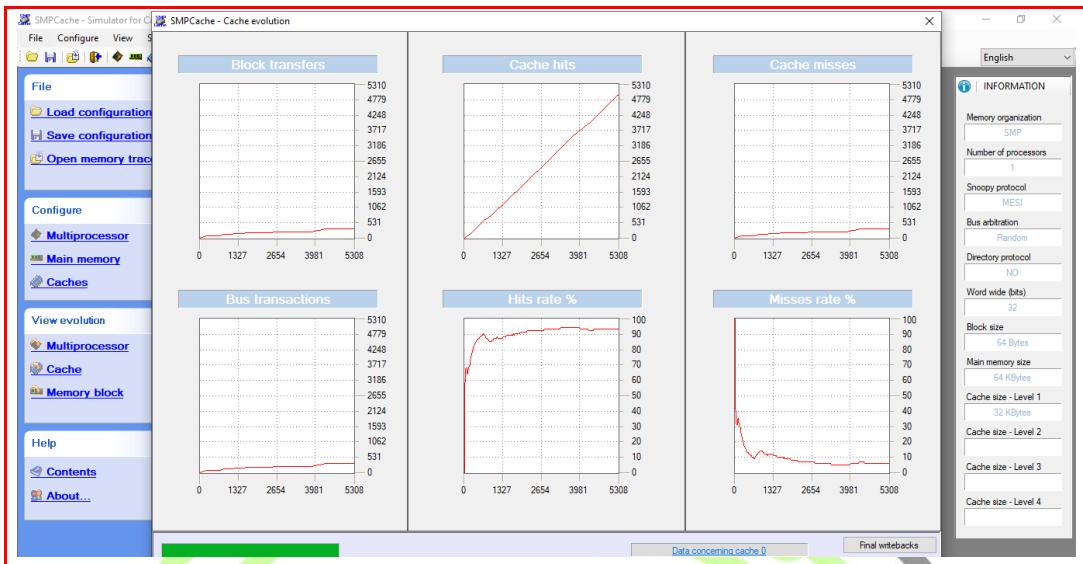
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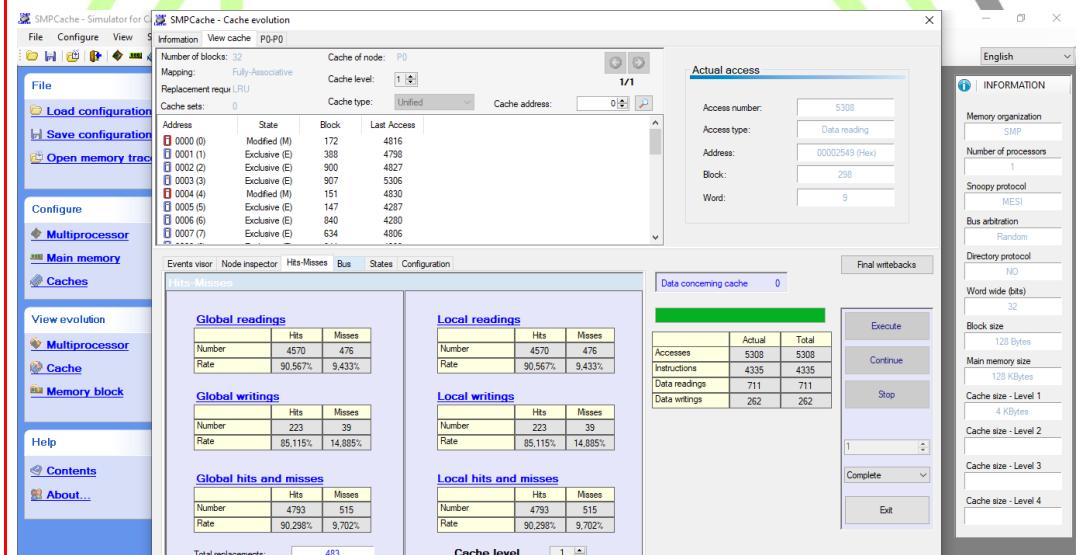
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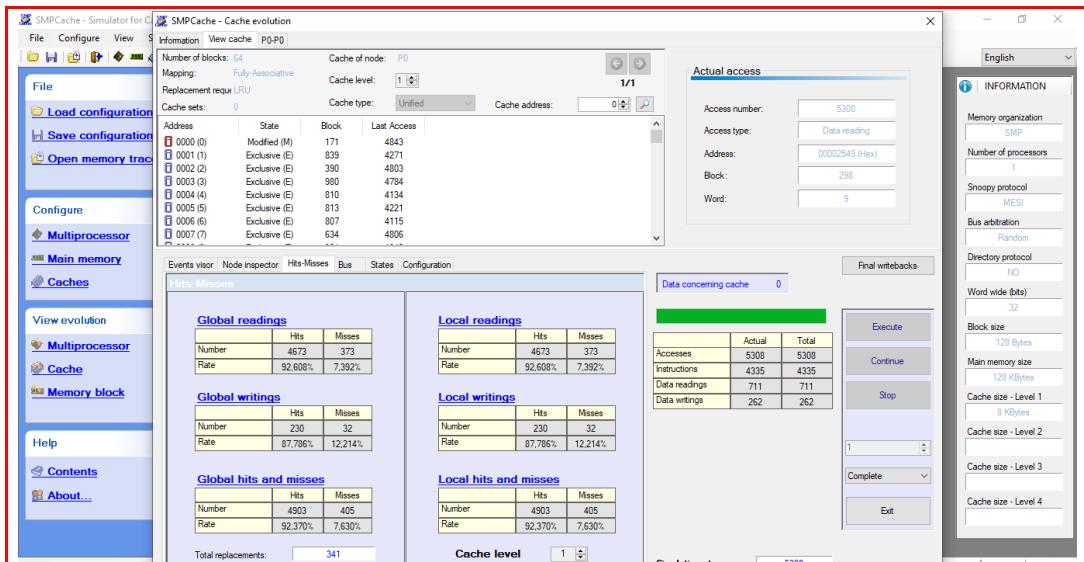
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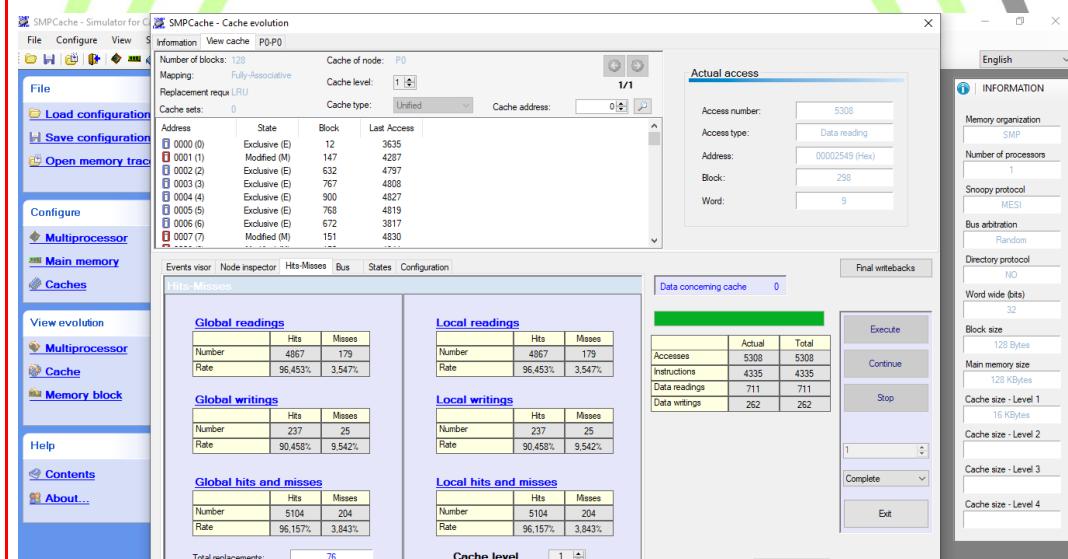
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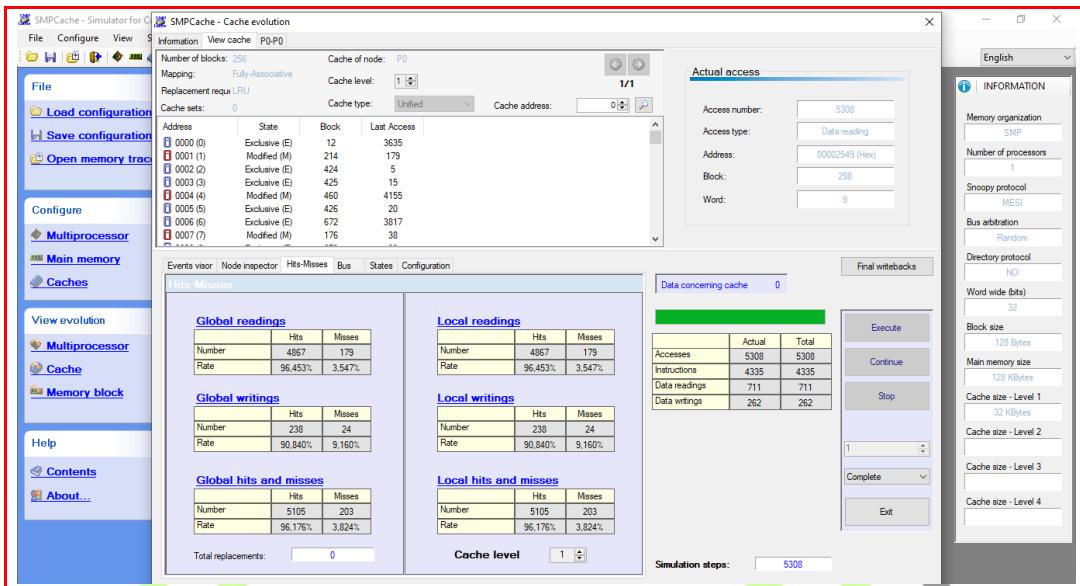
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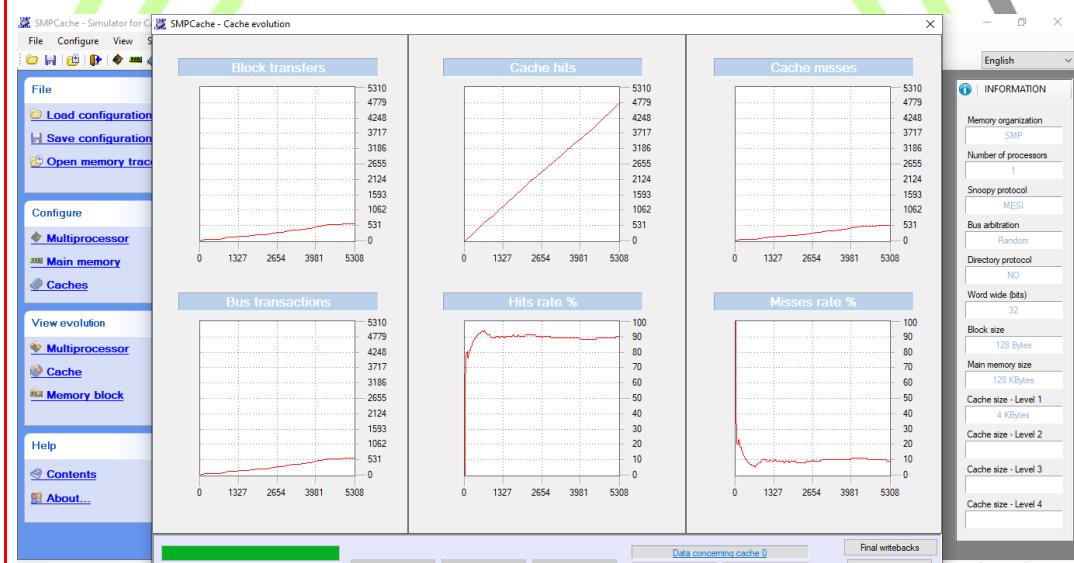
1.51 Hasil Miss Rate 32 block/8KB



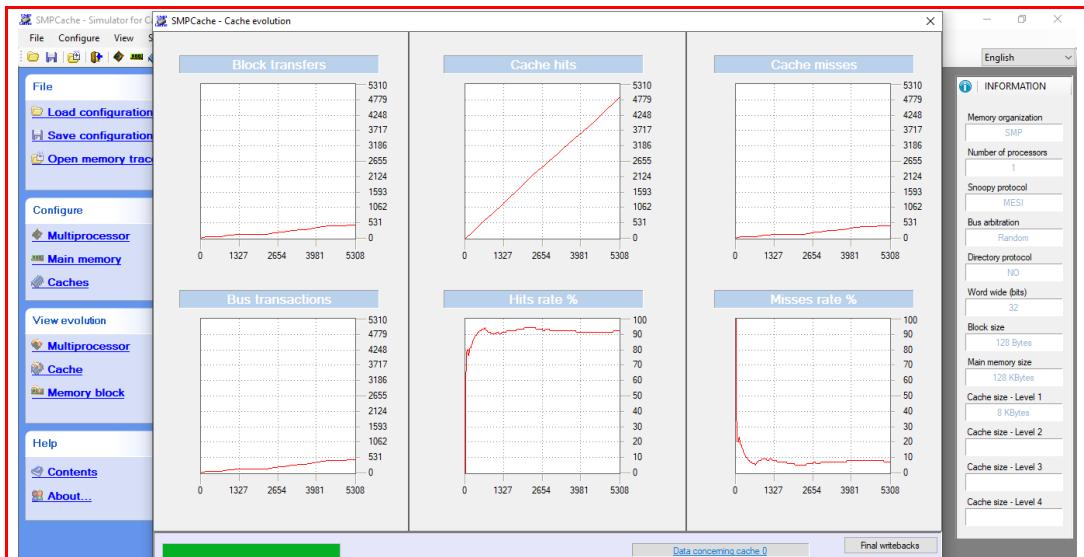
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1.53 Hasil Miss Rate 32 block/32KB



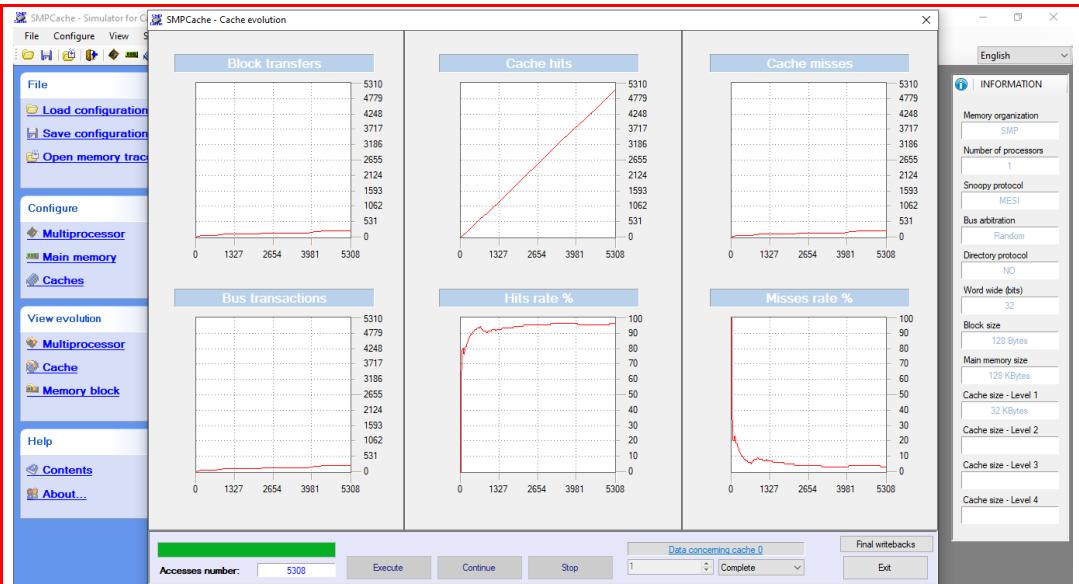
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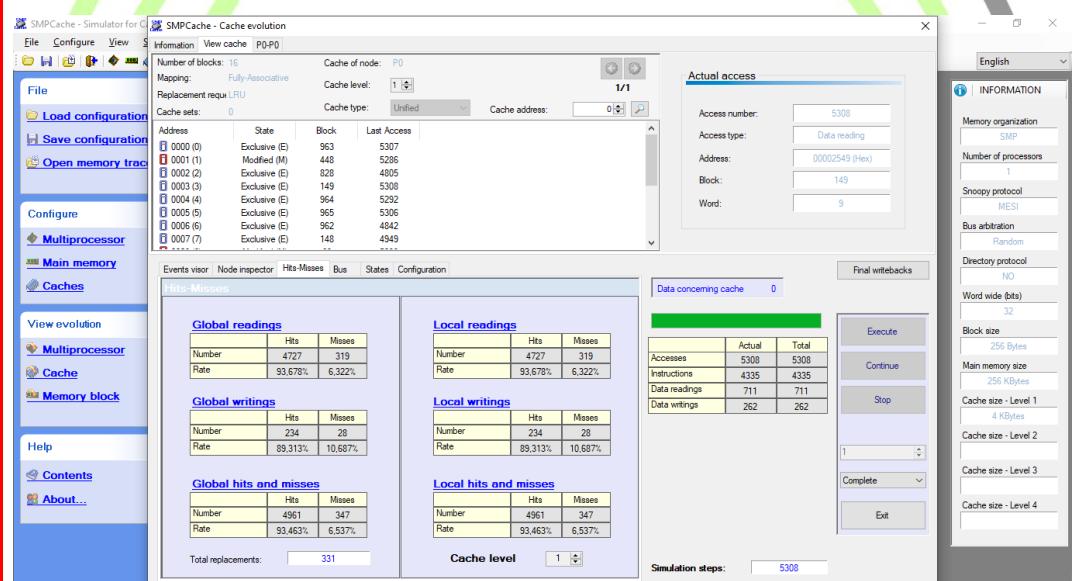
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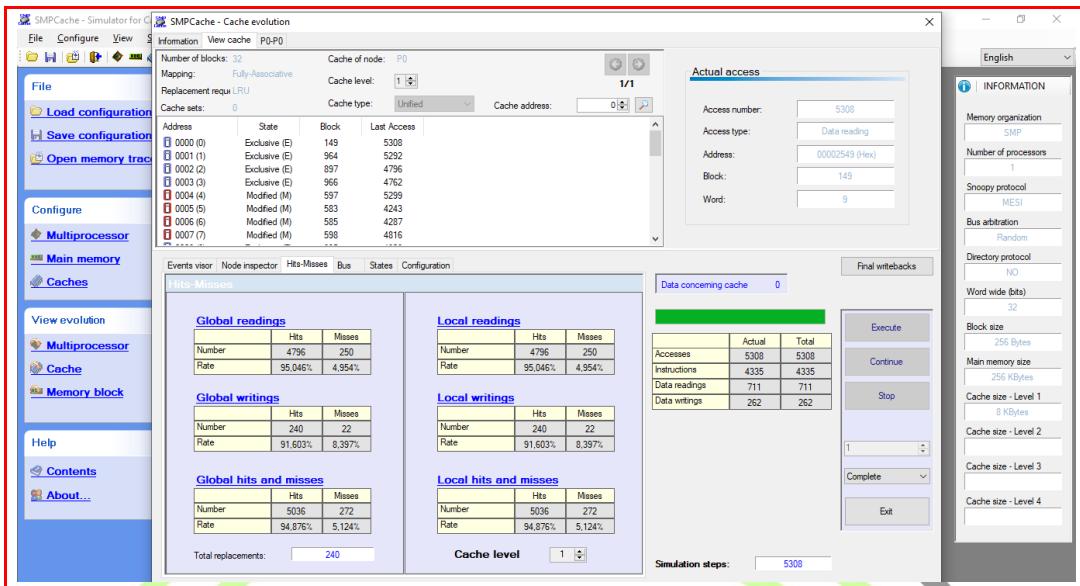
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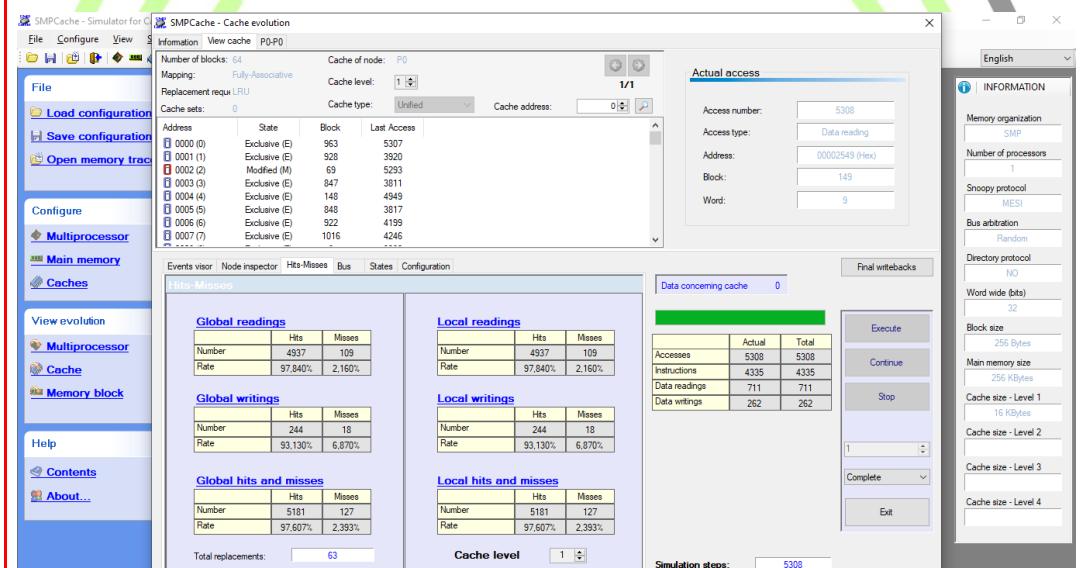
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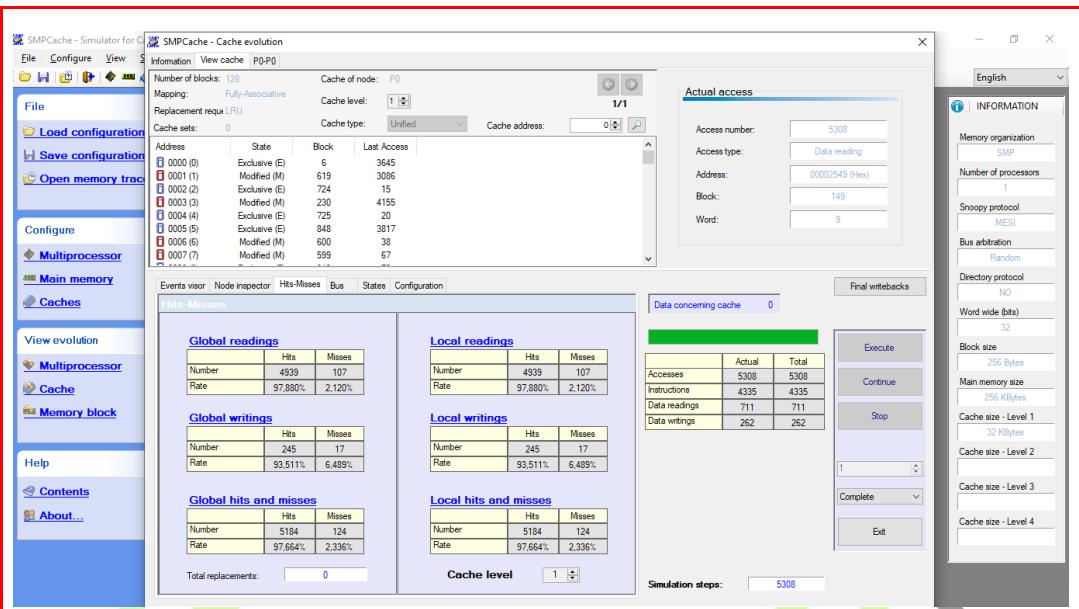
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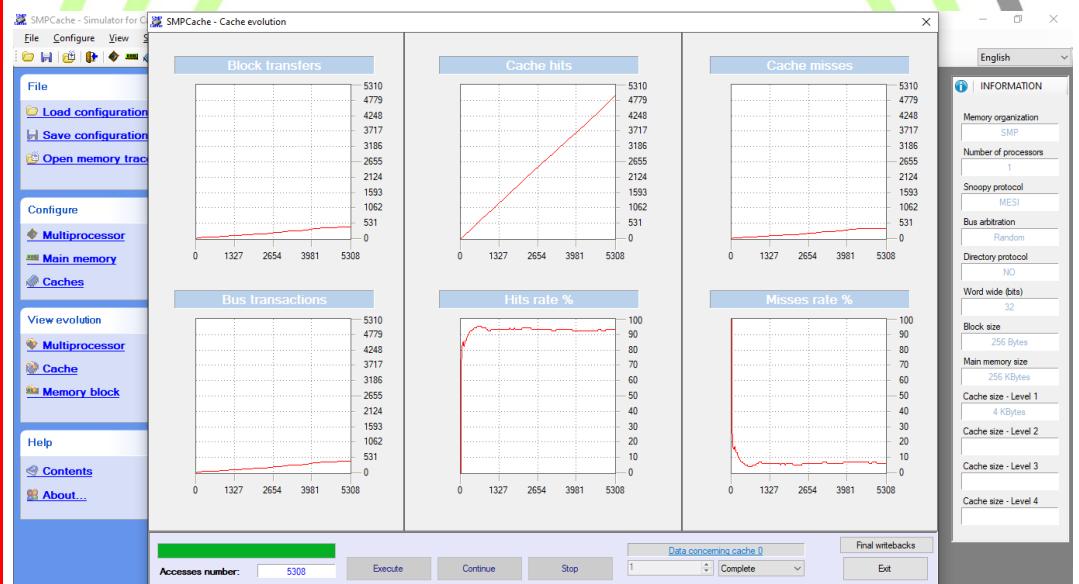
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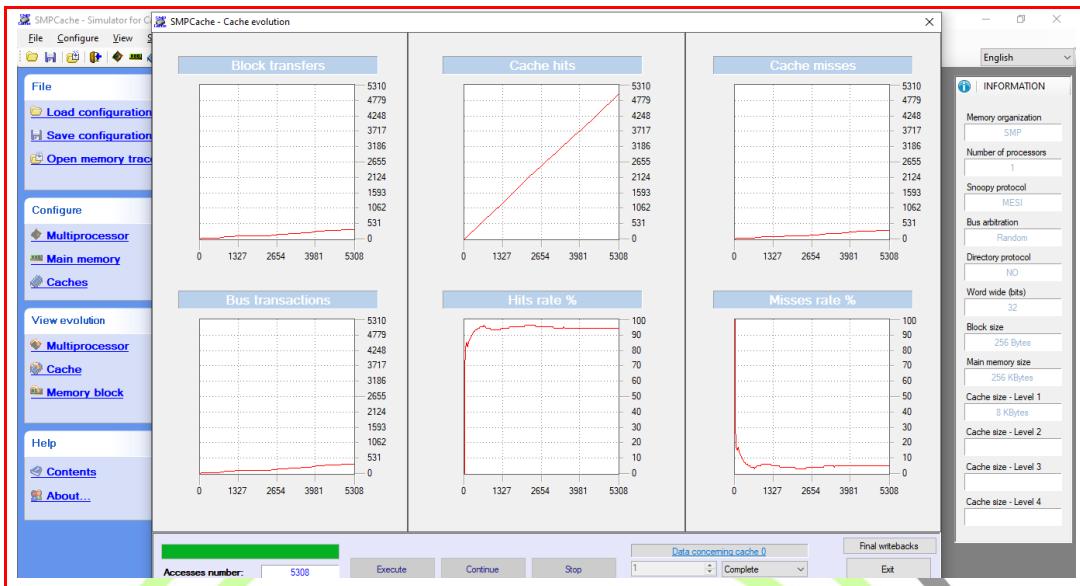
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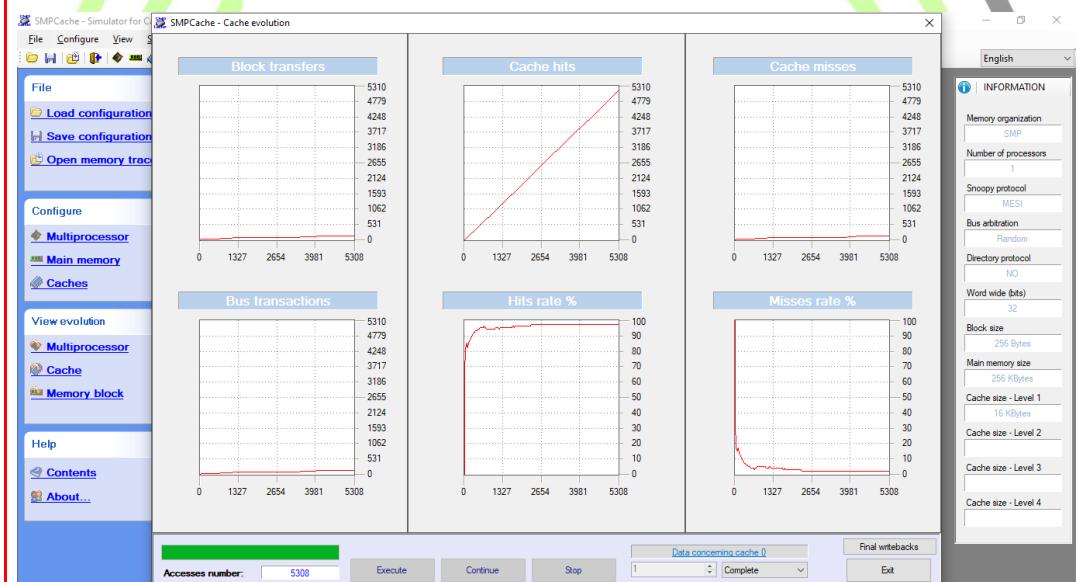
1.61 Hasil Miss Rate 64 block/32KB



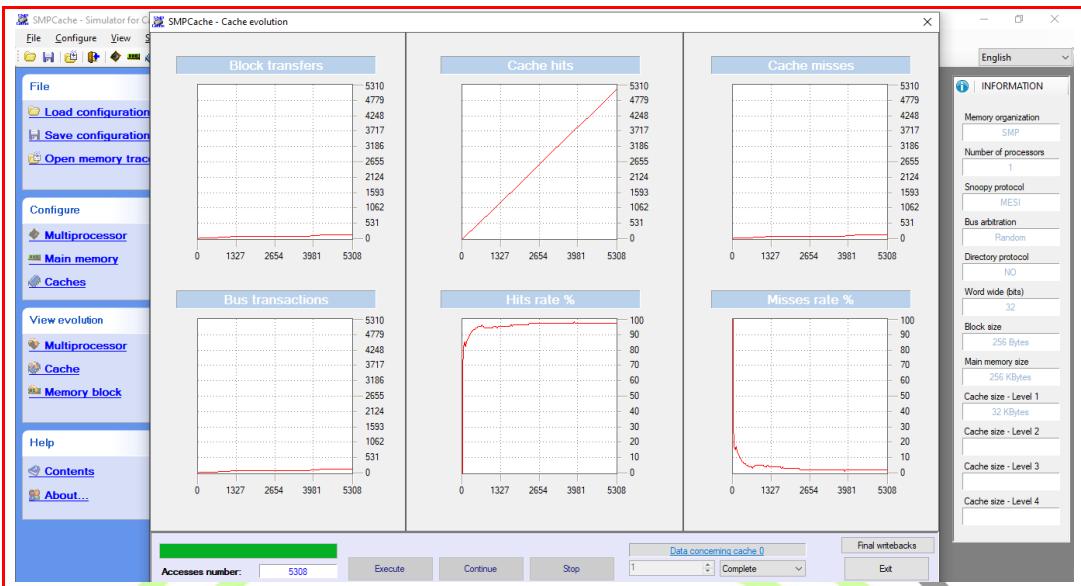
1.62 Hasil Grafik 64 block/4KB



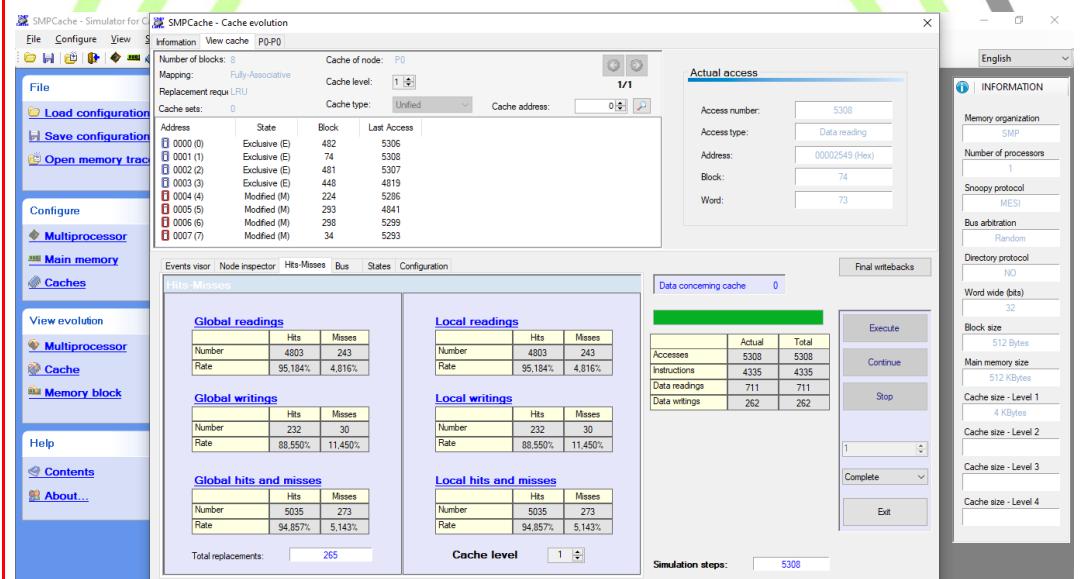
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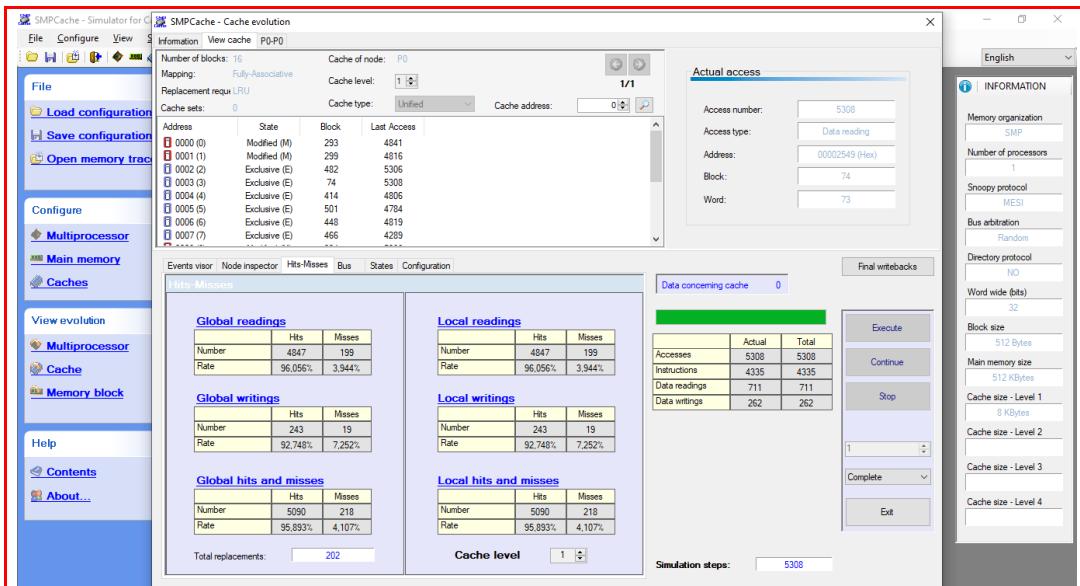
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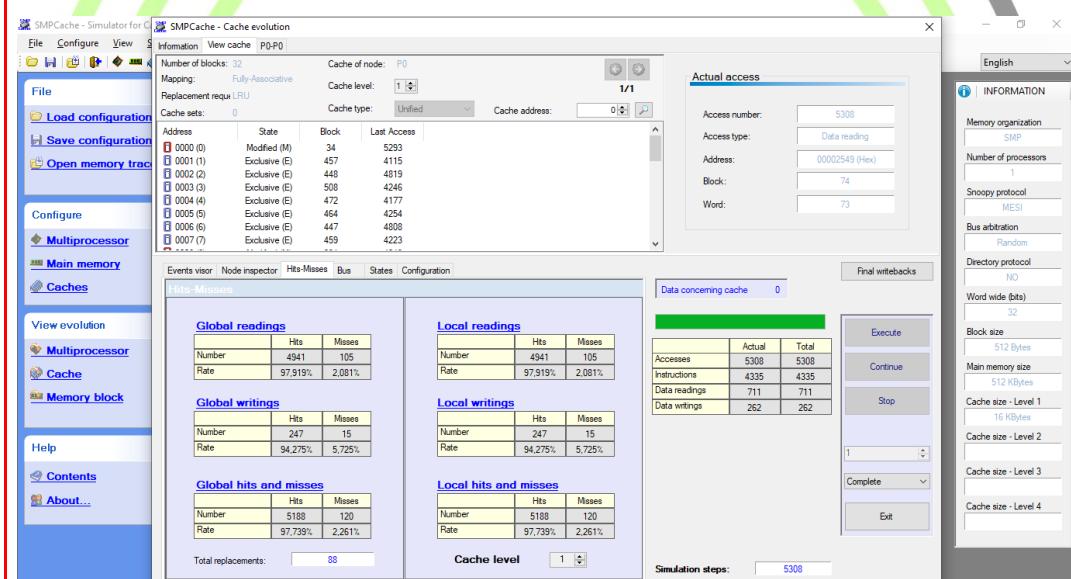
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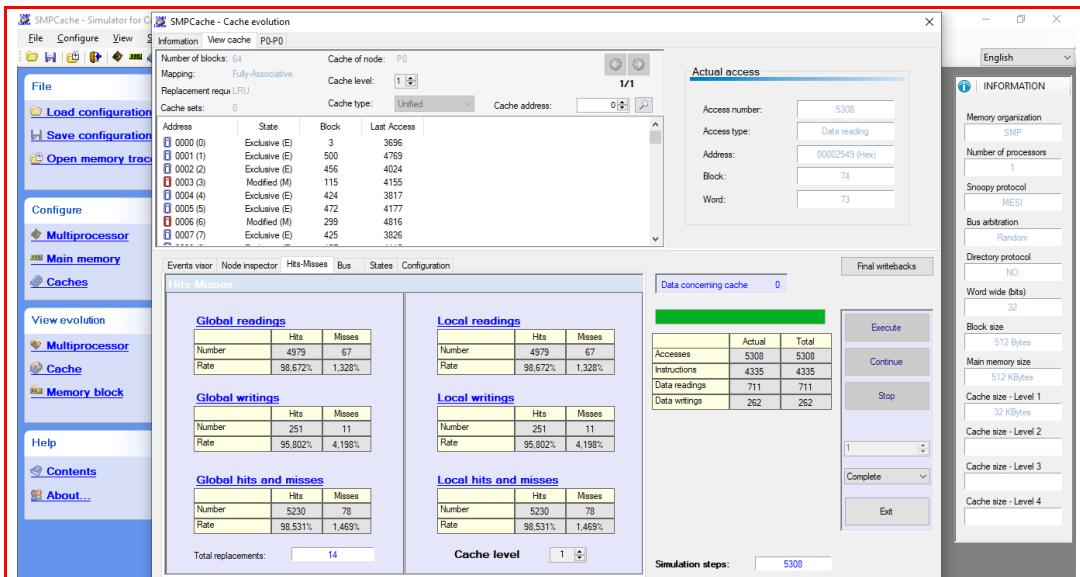
1.66 Hasil Miss Rate 128 block/4KB



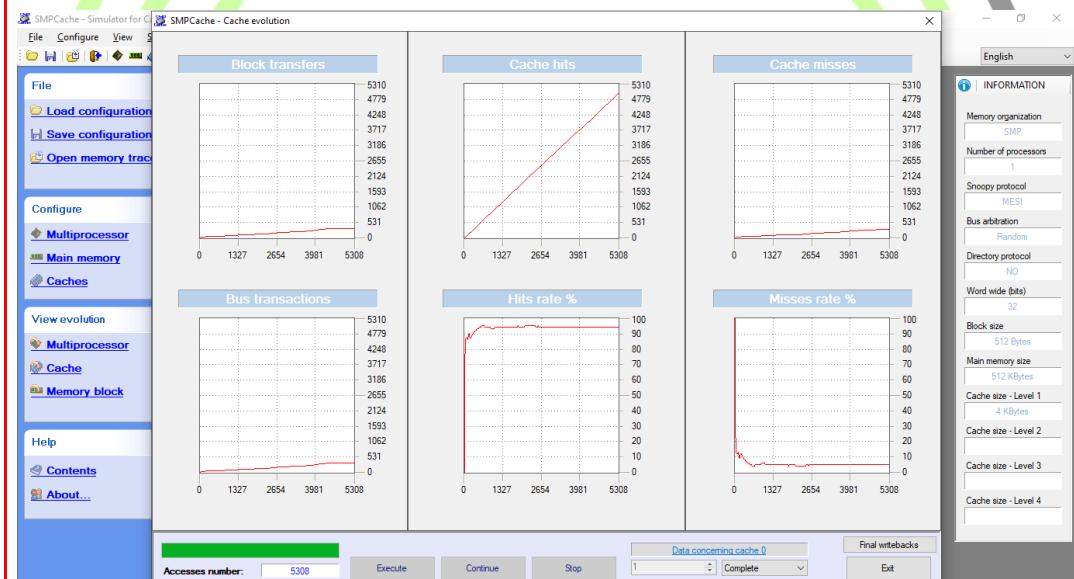
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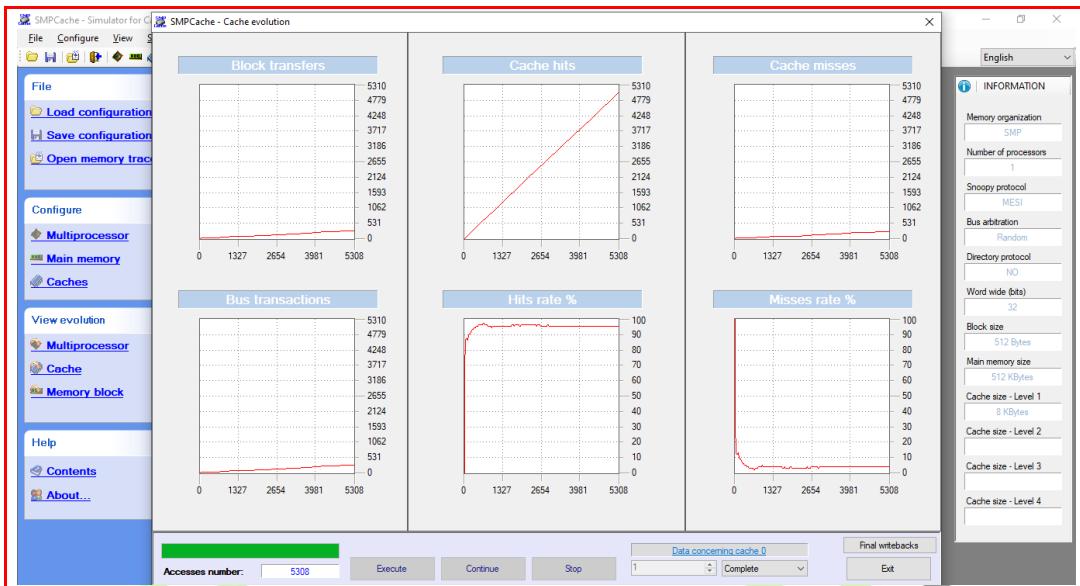
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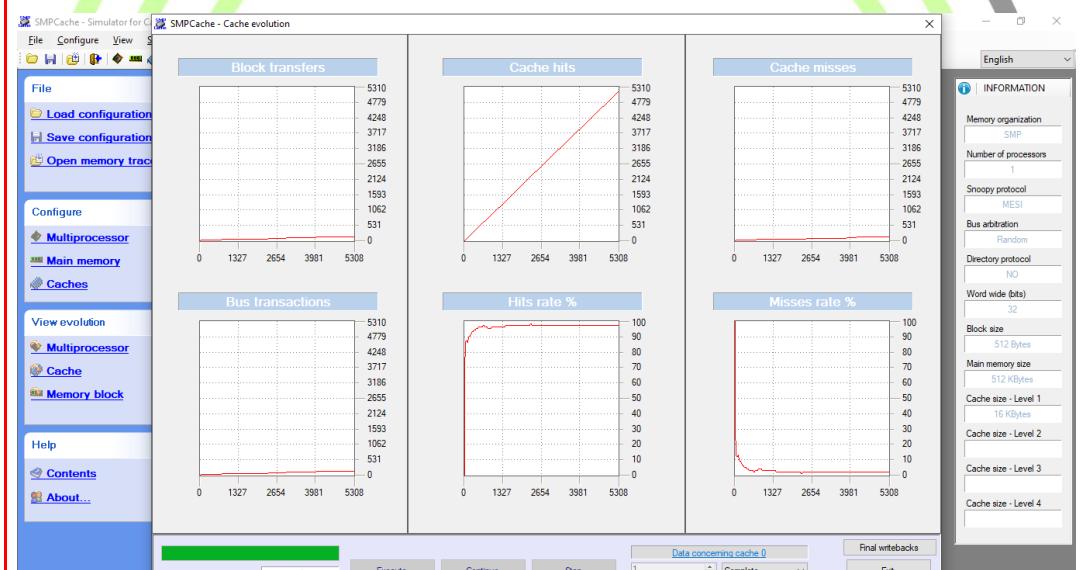
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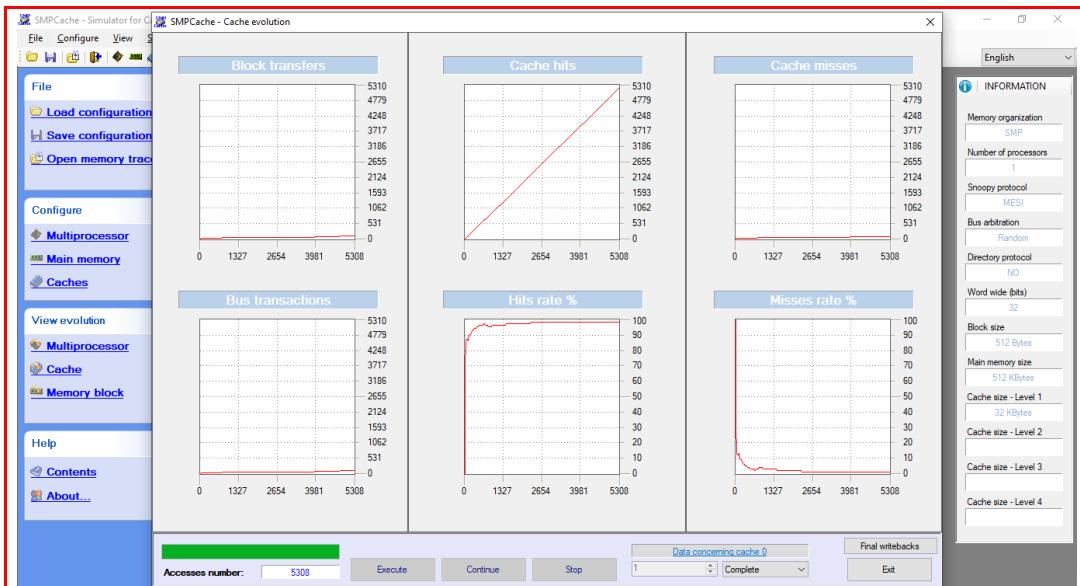
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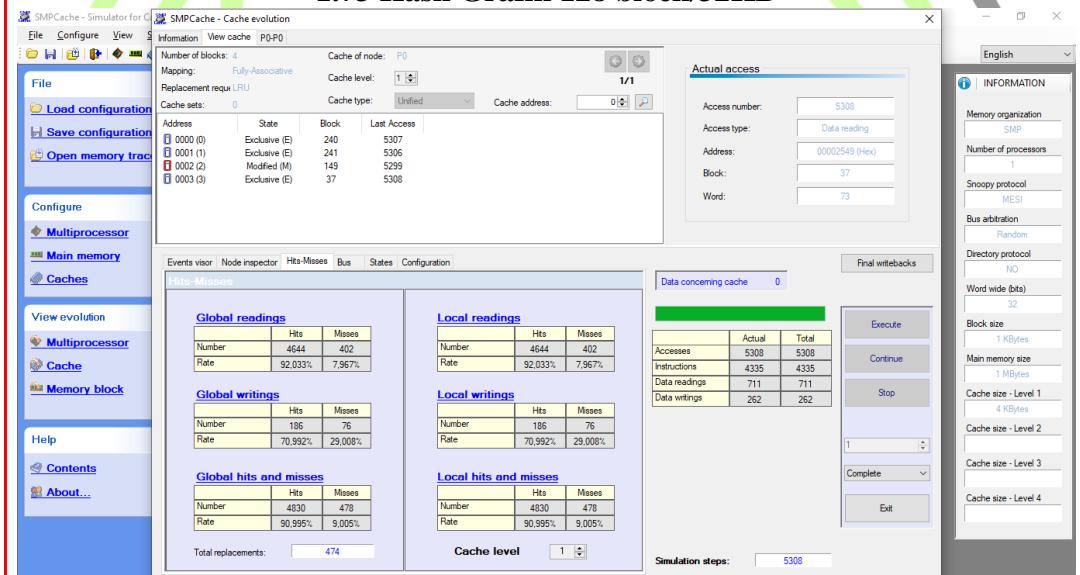
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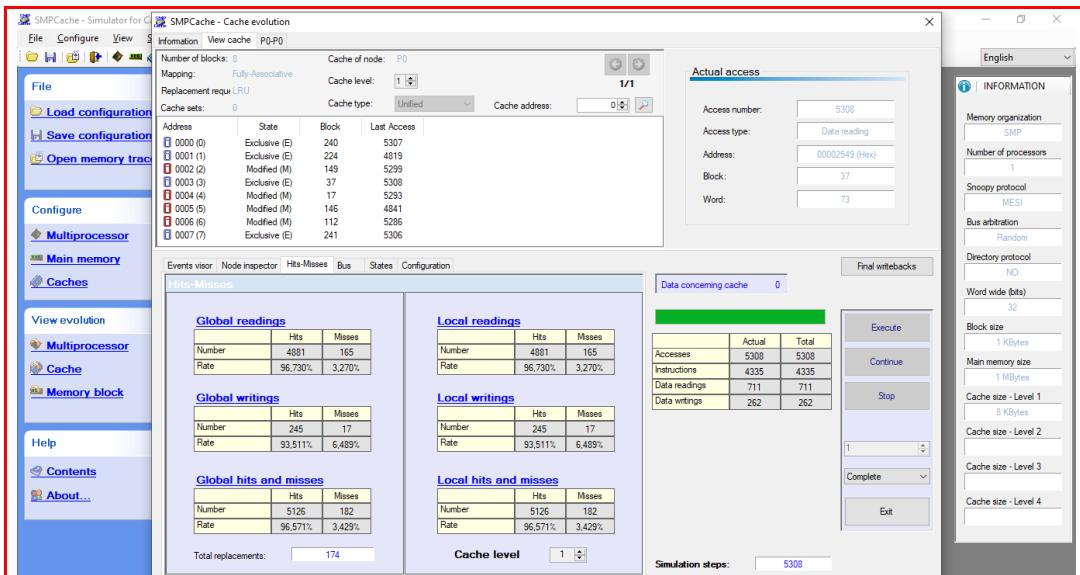
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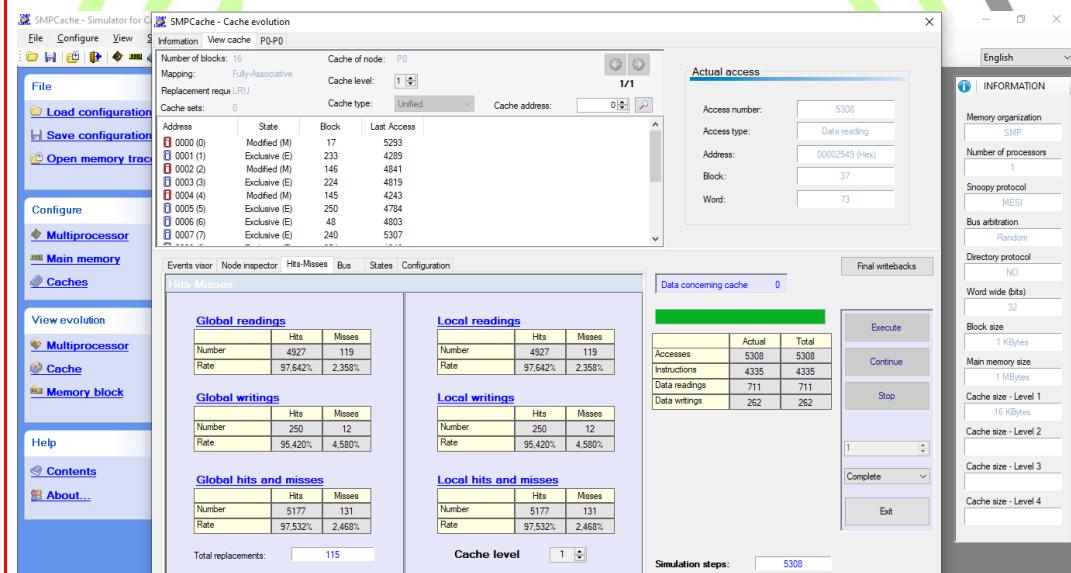
1.73 Hasil Grafik 128 block/32KB



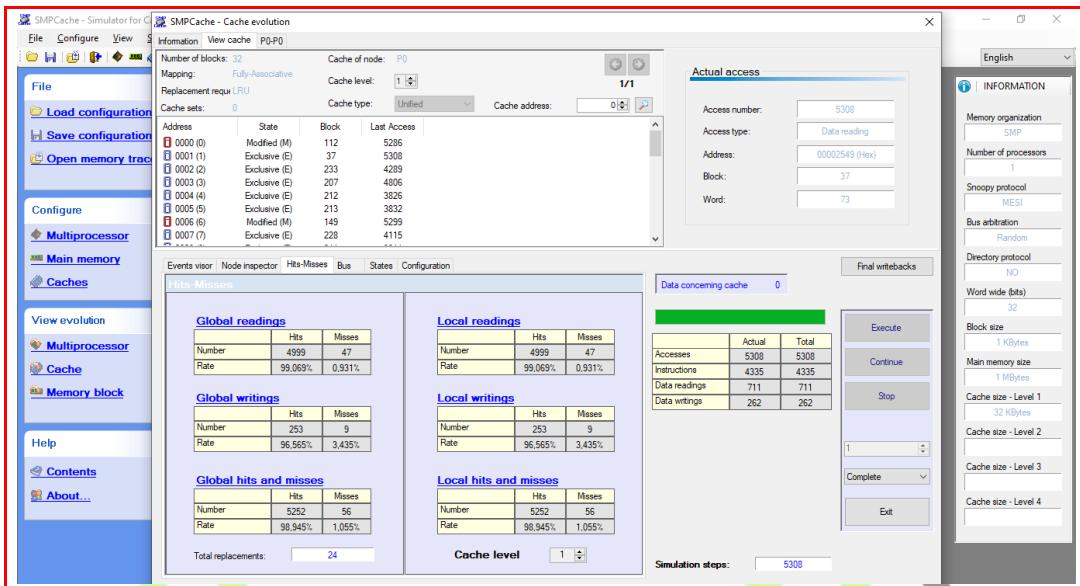
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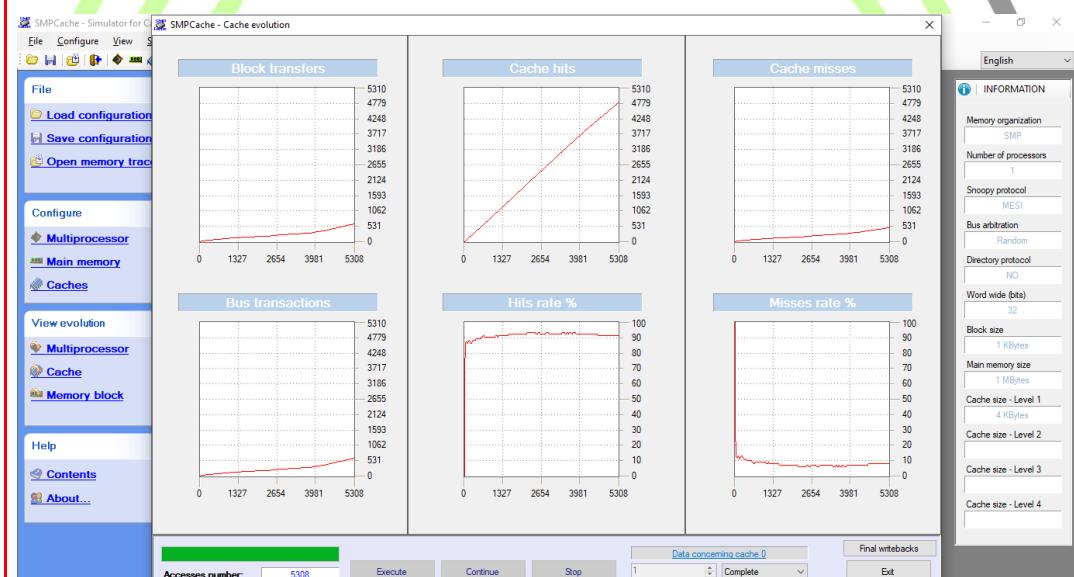
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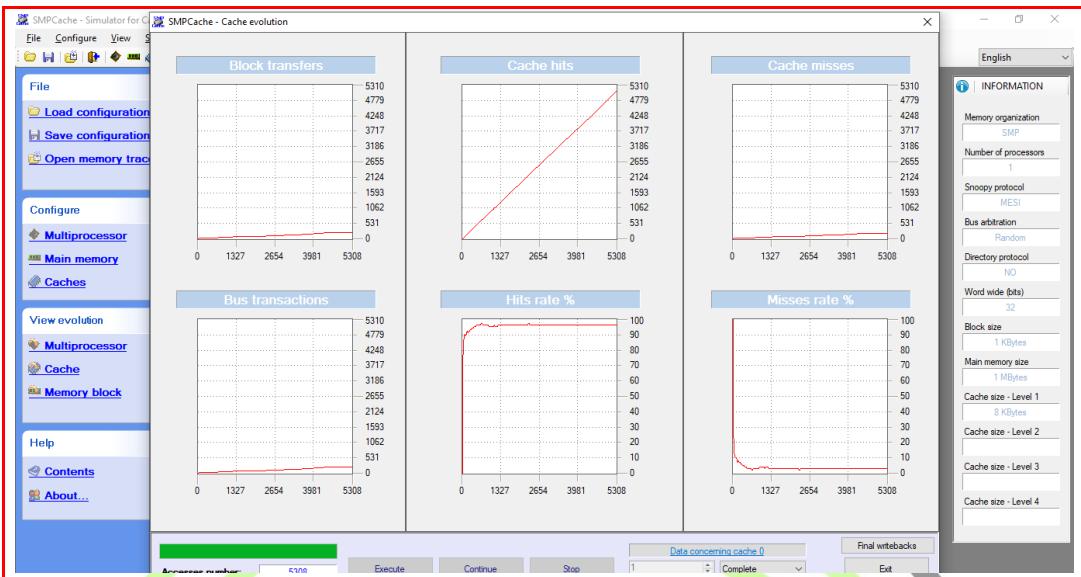
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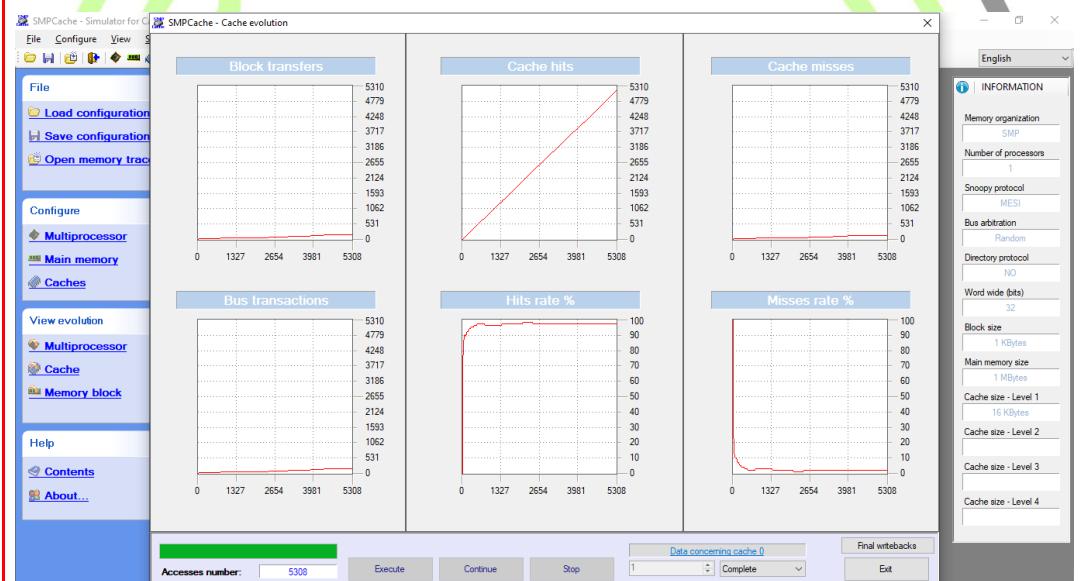
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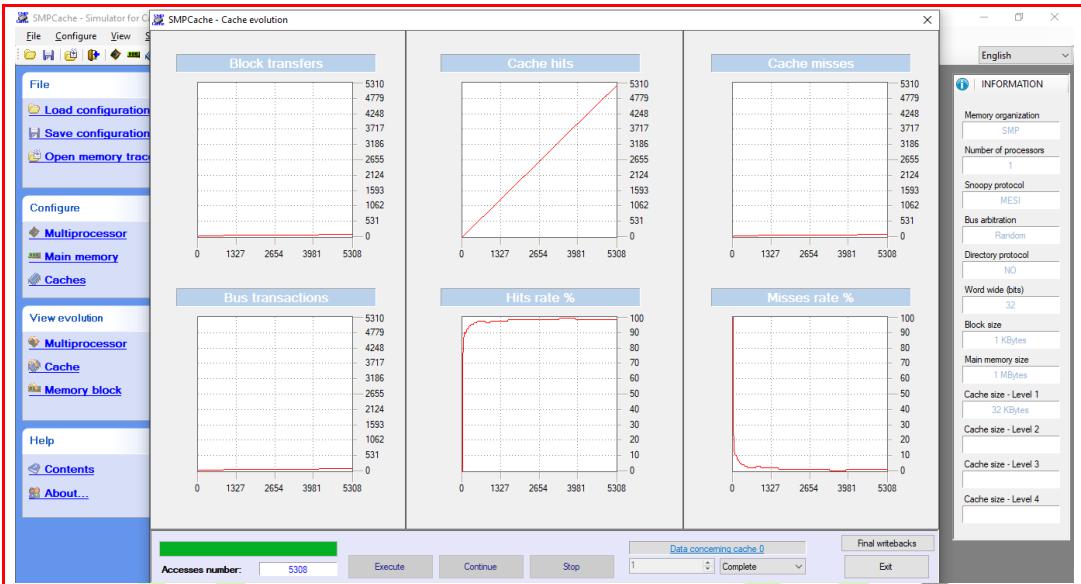
1.78 Hasil Grafik 256 block/4KB



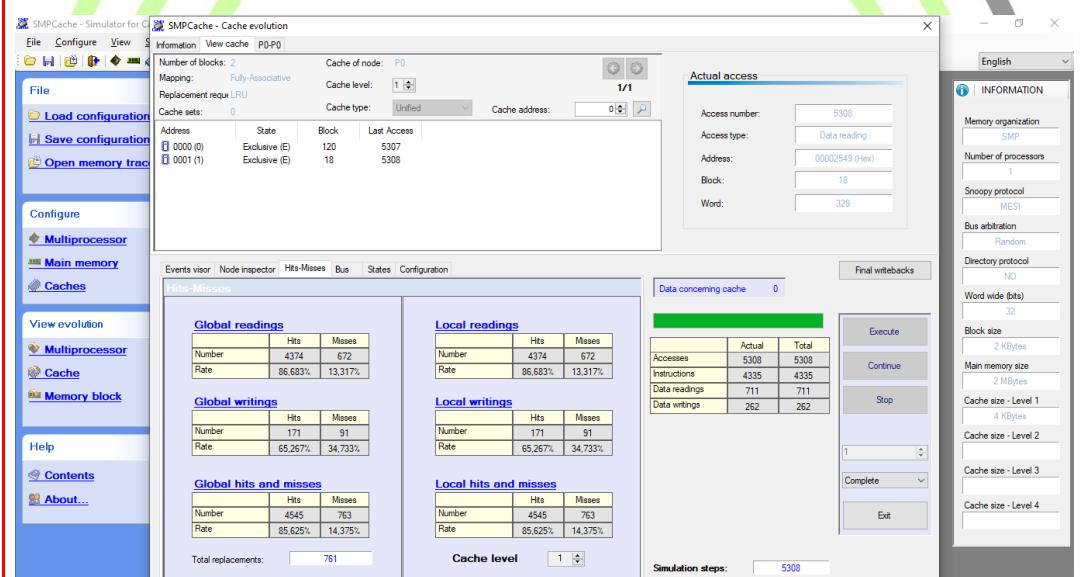
1.79 Hasil Grafik 256 block/8KB



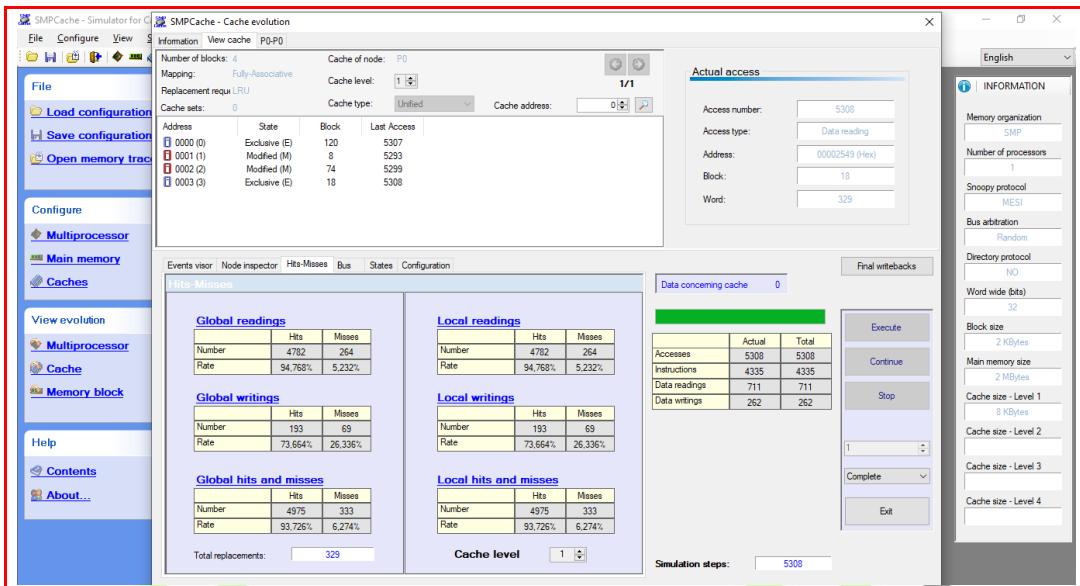
1.80 Hasil Grafik 256 block/16KB



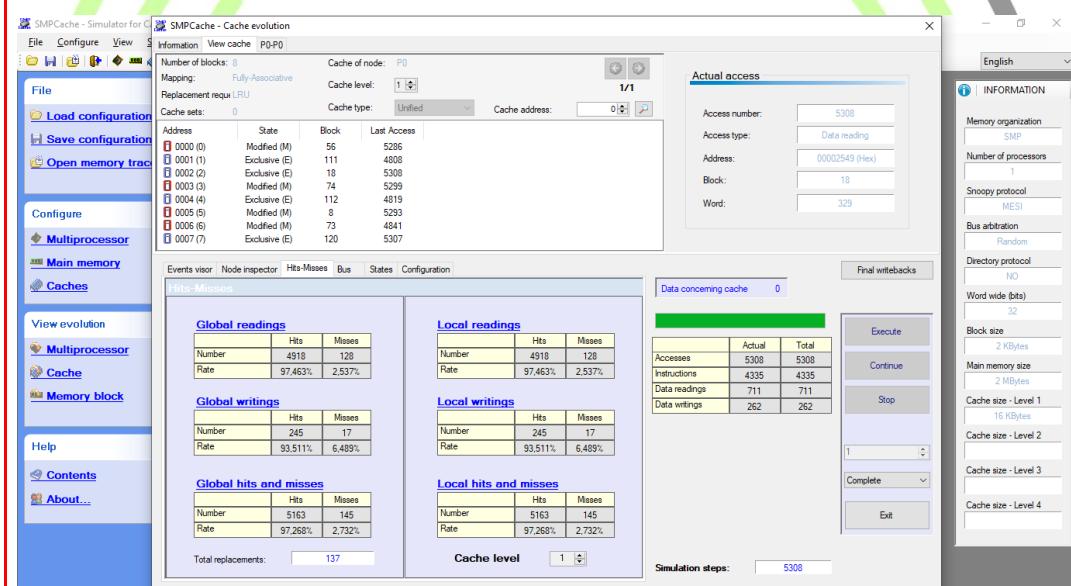
1.81 Hasil Grafik 256 block/32KB



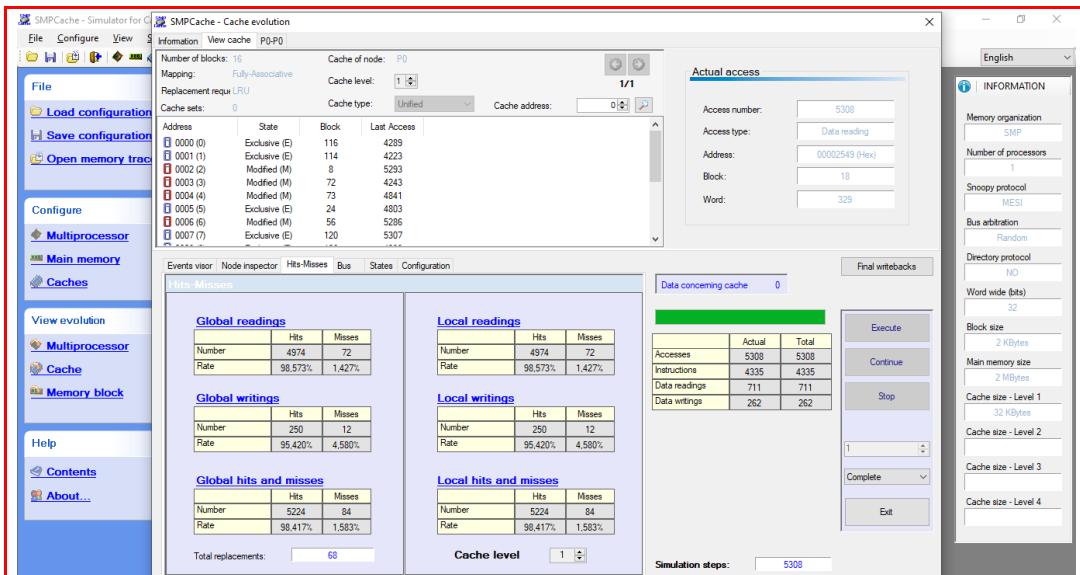
1.82 Hasil Miss Rate 512 block/4KB



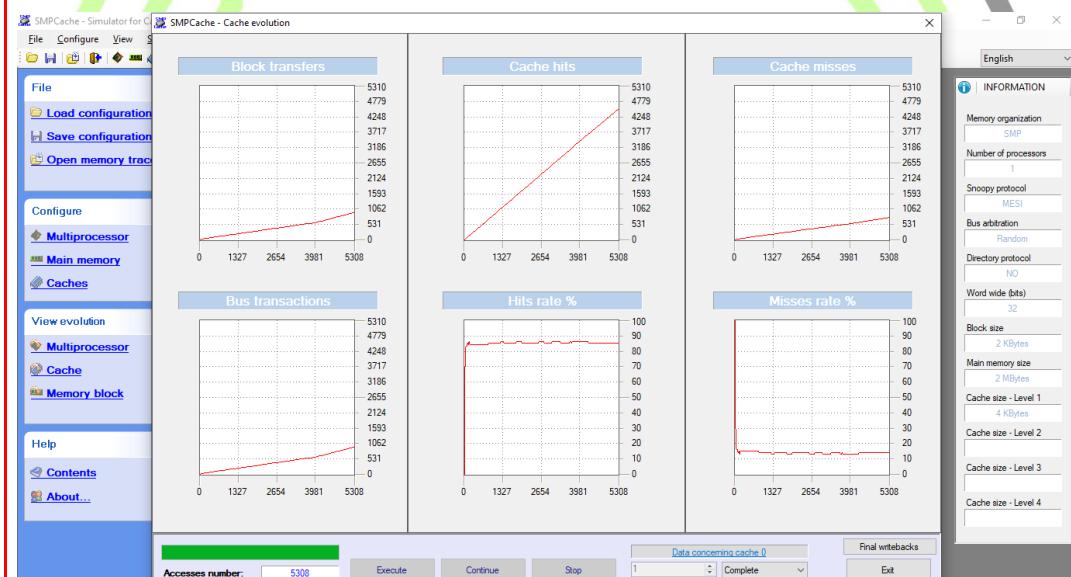
1.83 Hasil Miss Rate 512 block/8KB



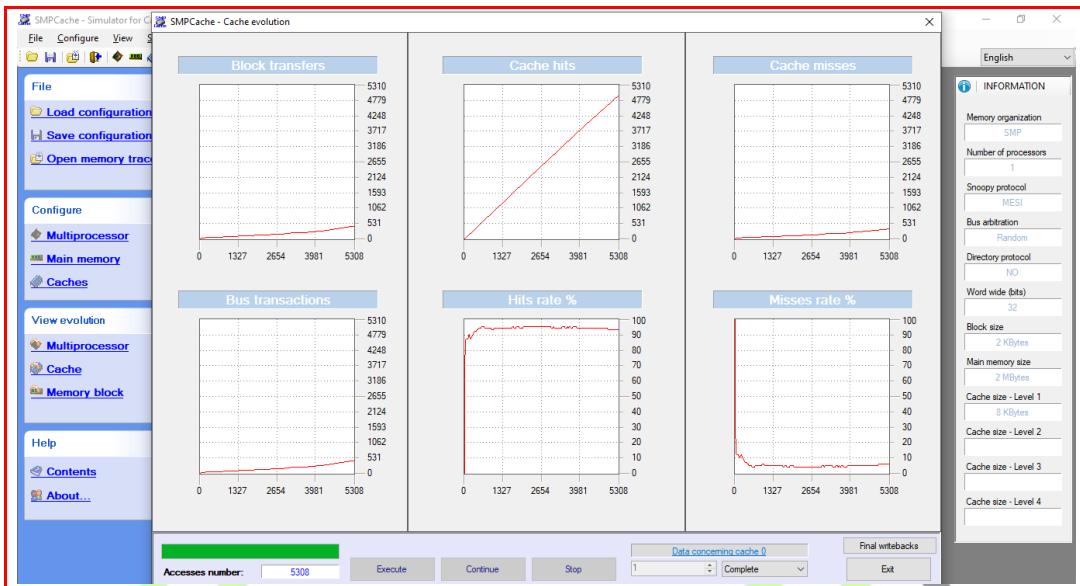
1.84 Hasil Miss Rate 512 block/16KB



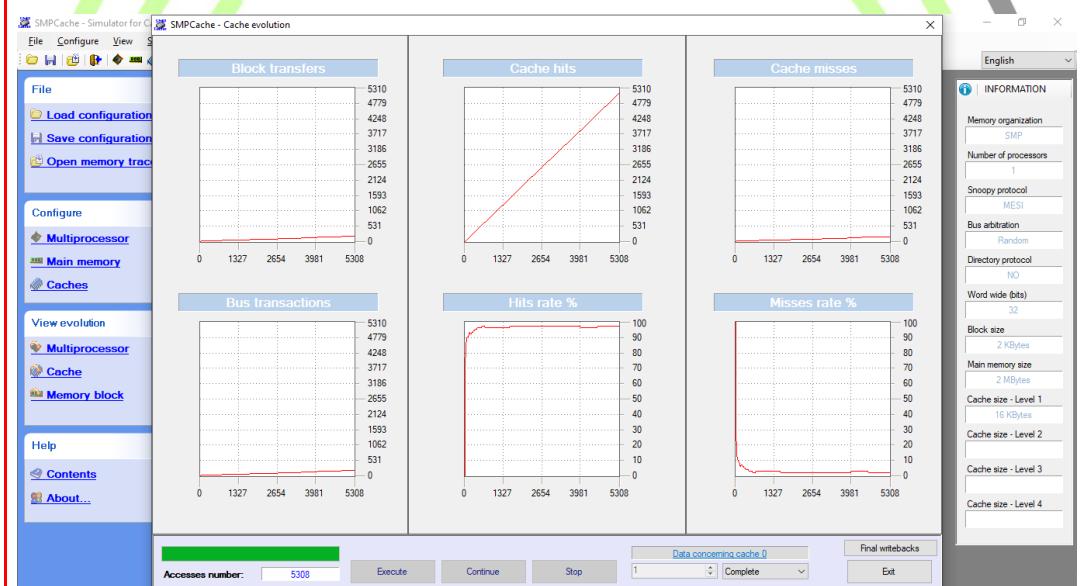
1.85 Hasil Miss Rate 512 block/32KB



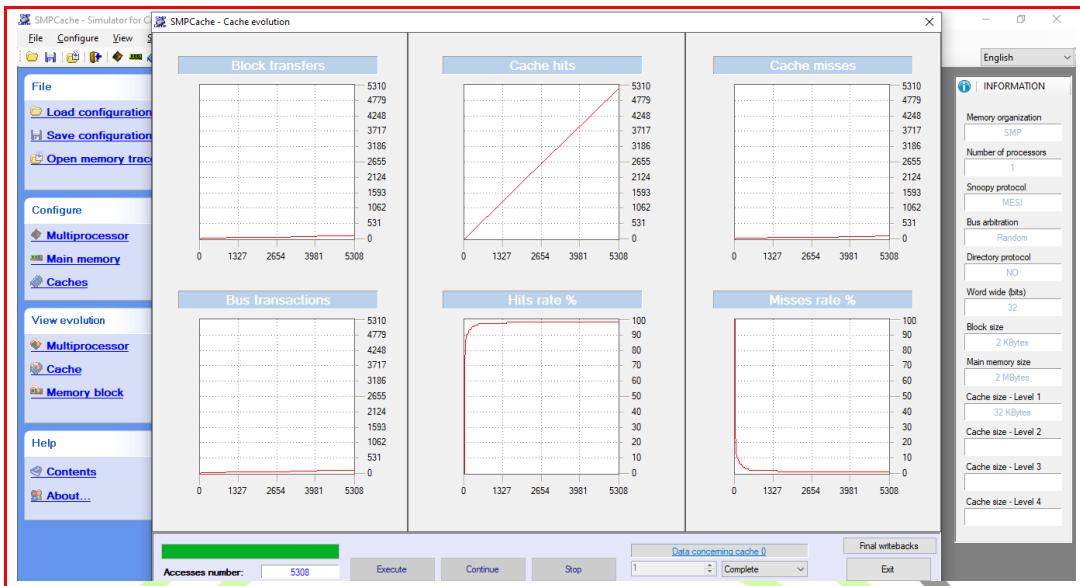
1.86 Hasil Grafik 512 block/4KB



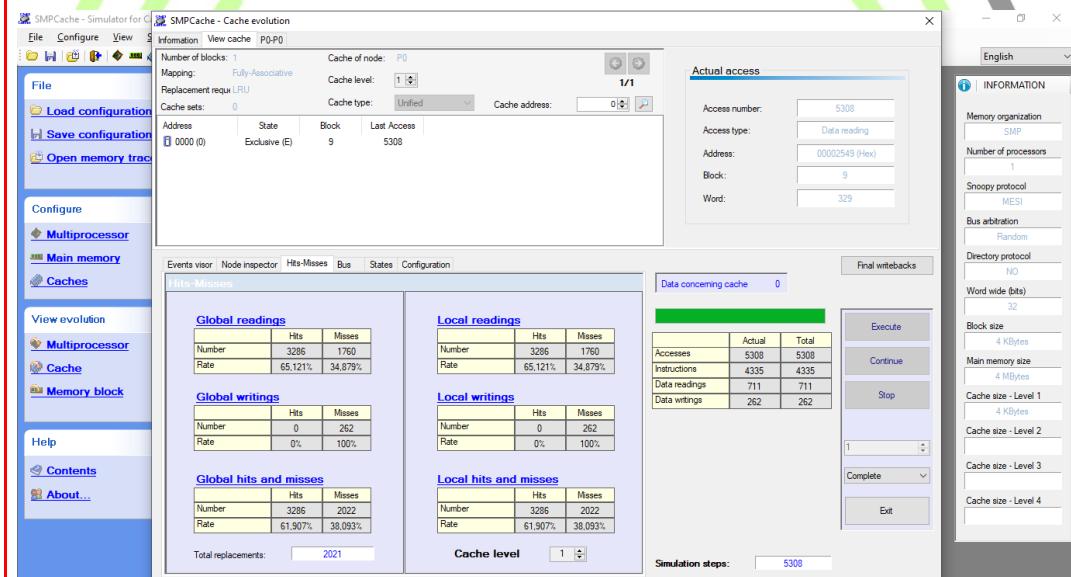
1.87 Hasil Grafik 512 block/8KB



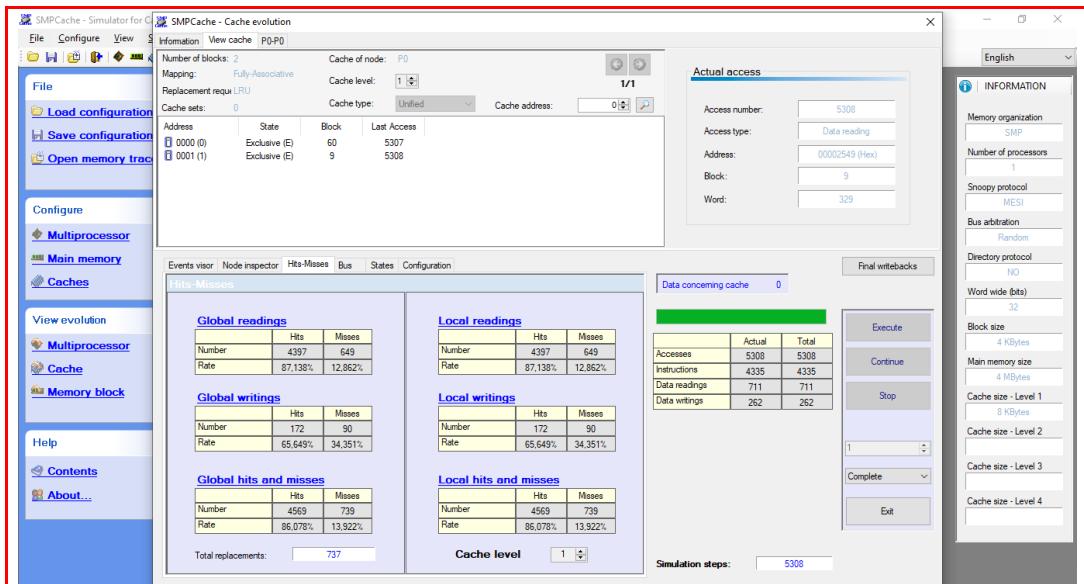
1.88 Hasil Grafik 512 block/16KB



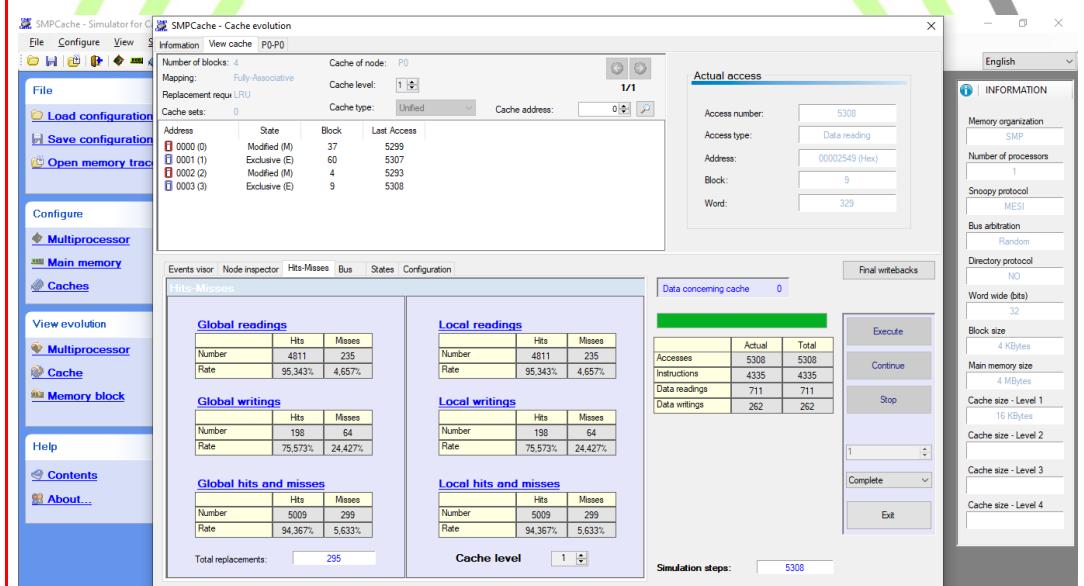
1.89 Hasil Grafik 512 block/32KB



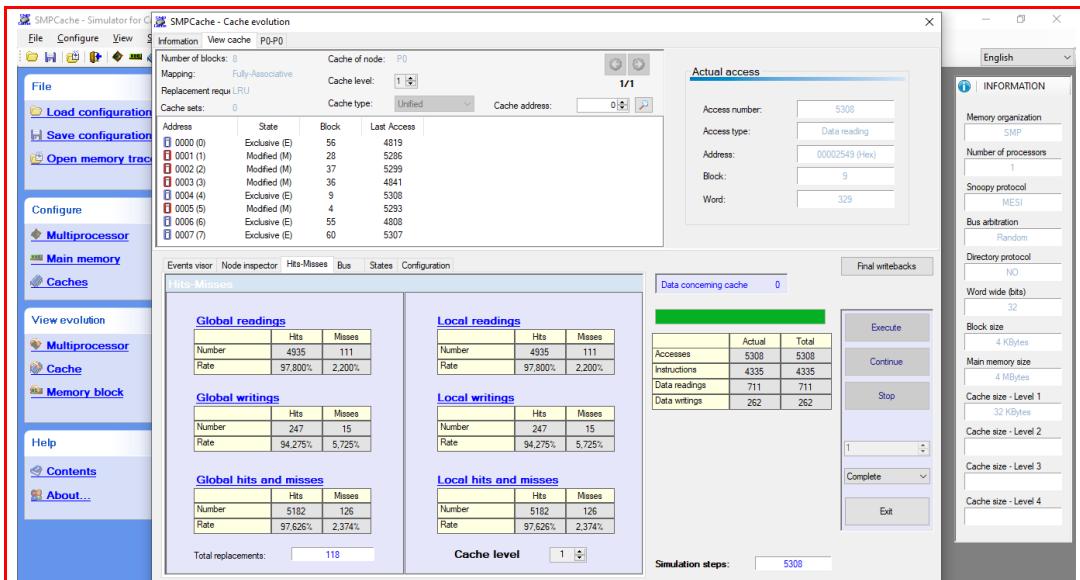
1.90 Hasil Miss Rate 1024 block/4KB



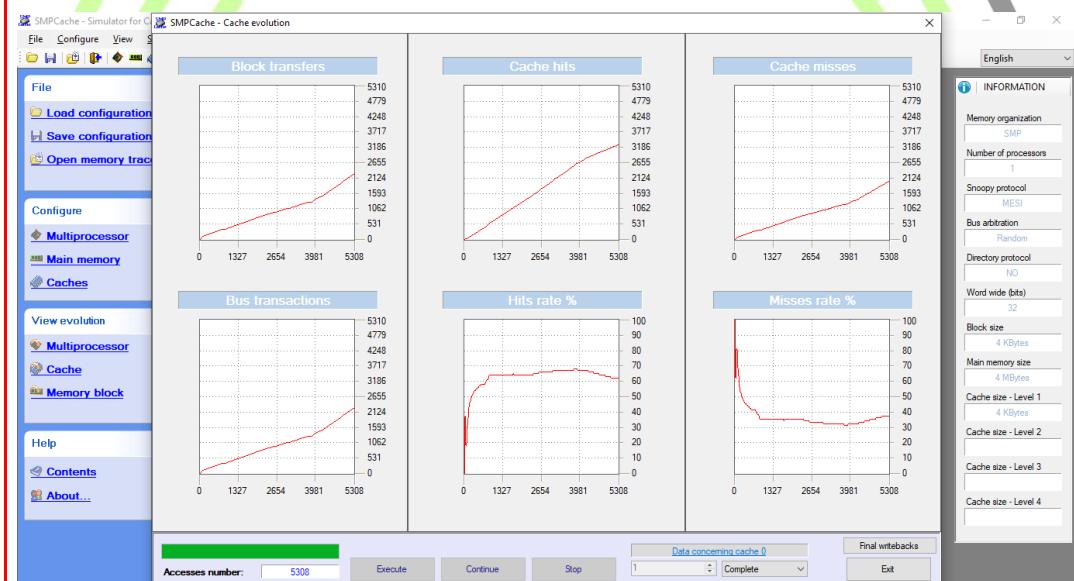
1.91 Hasil Miss Rate 1024 block/8KB



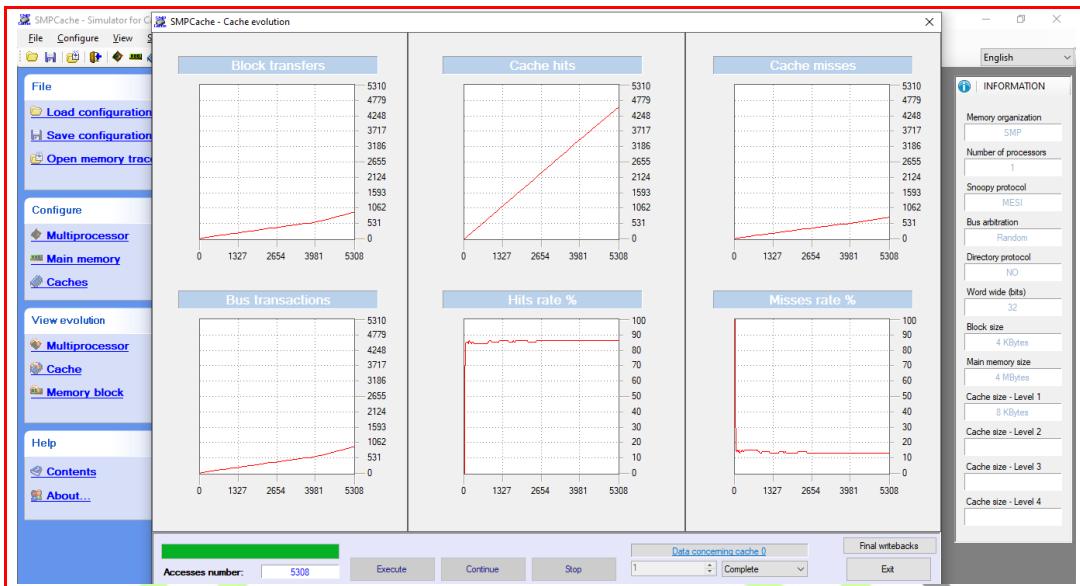
1.91 Hasil Miss Rate 1024 block/16KB



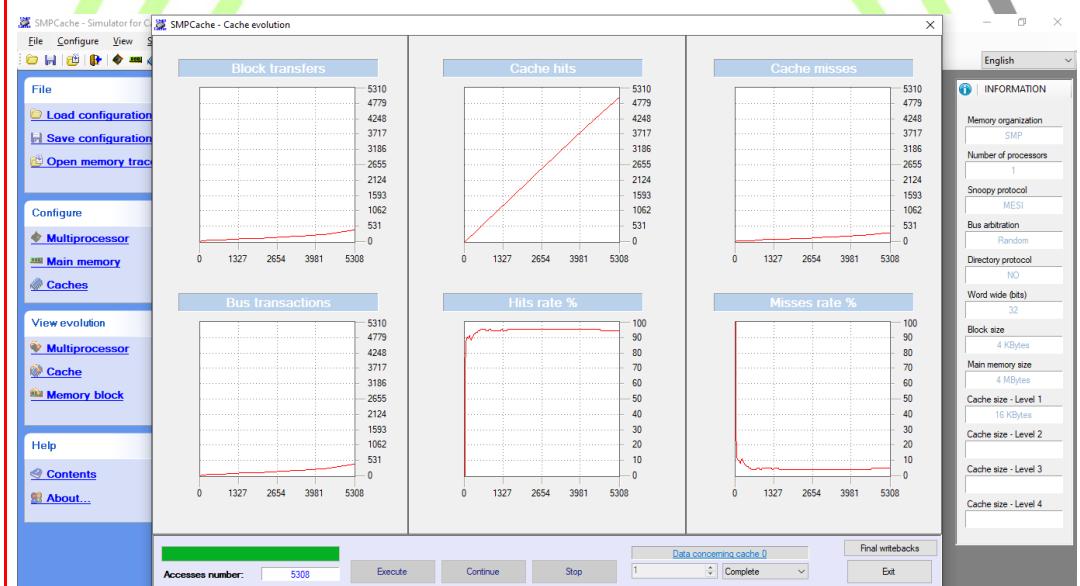
1.92 Hasil Miss Rate 1024 block/32KB



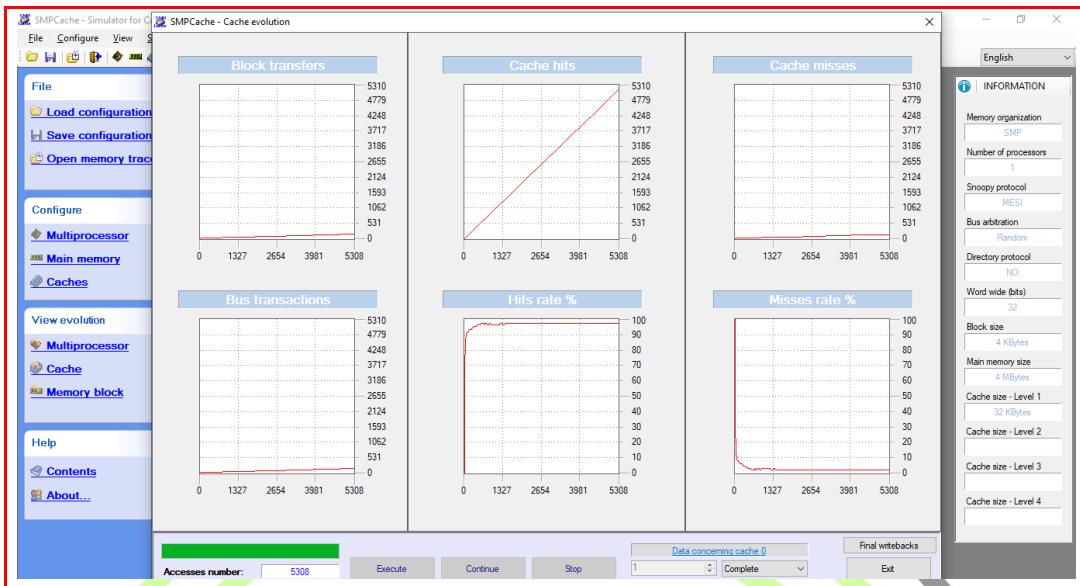
1.93 Hasil Grafik 1024 block/4KB



1.94 Hasil Grafik 1024 block/8KB



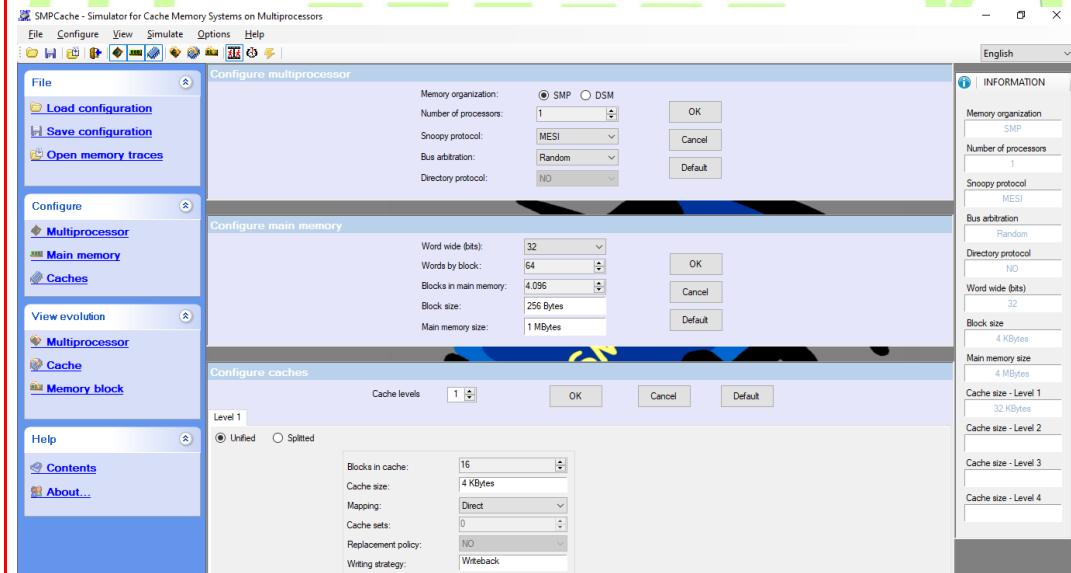
1.95 Hasil Grafik 1024 block/16KB



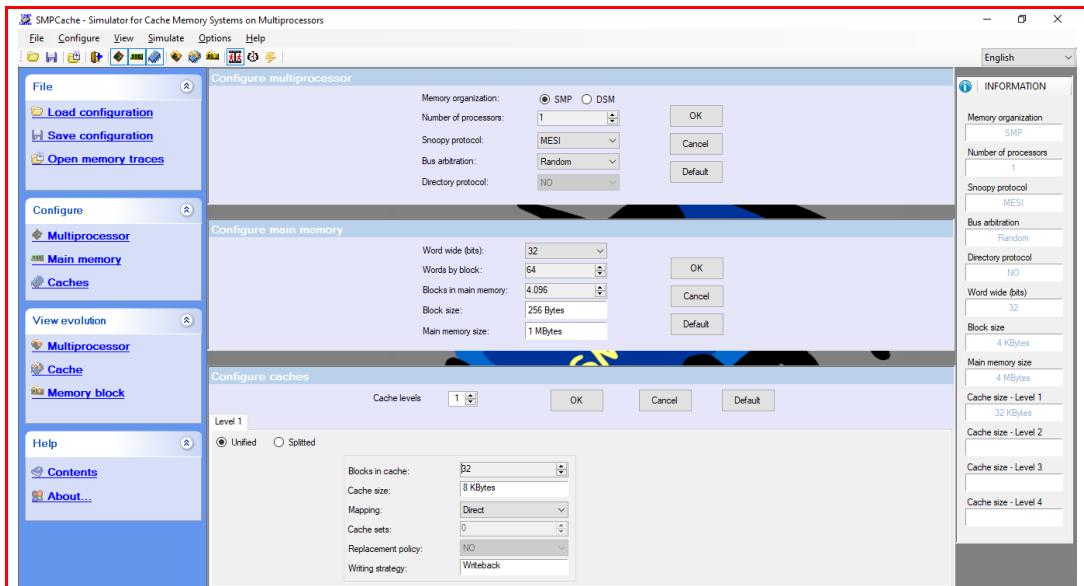
1.96 Hasil Grafik 1024 block/32KB

2. Percobaan 2

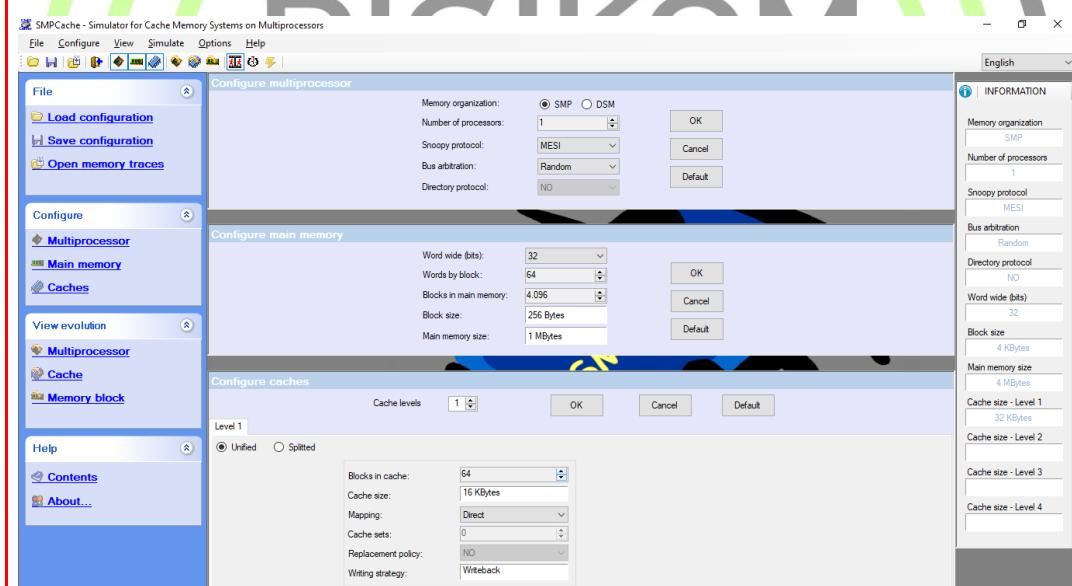
DIGIKOM



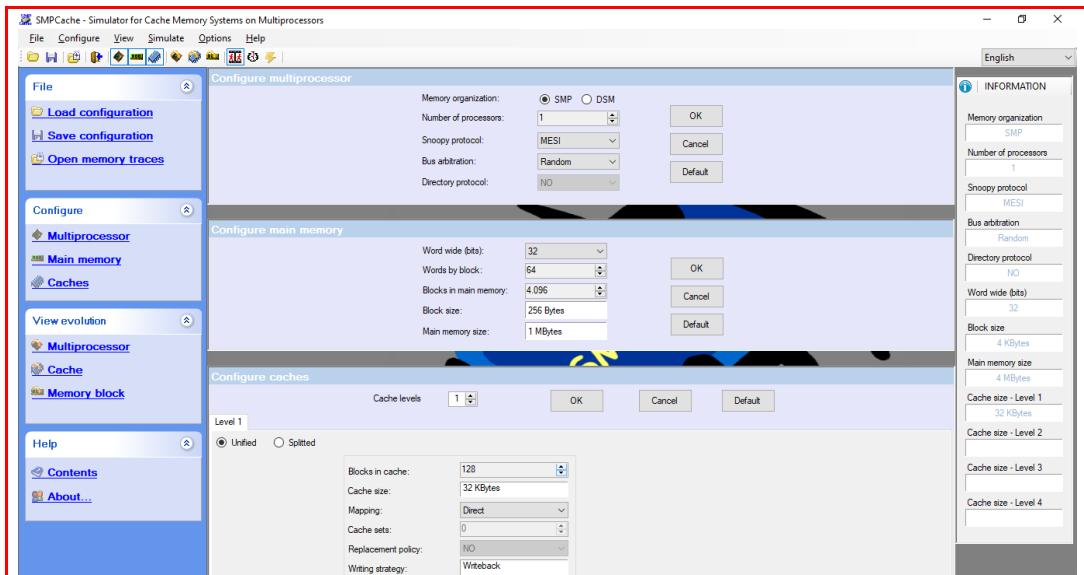
1.97 Konfigurasi Direct/4KB



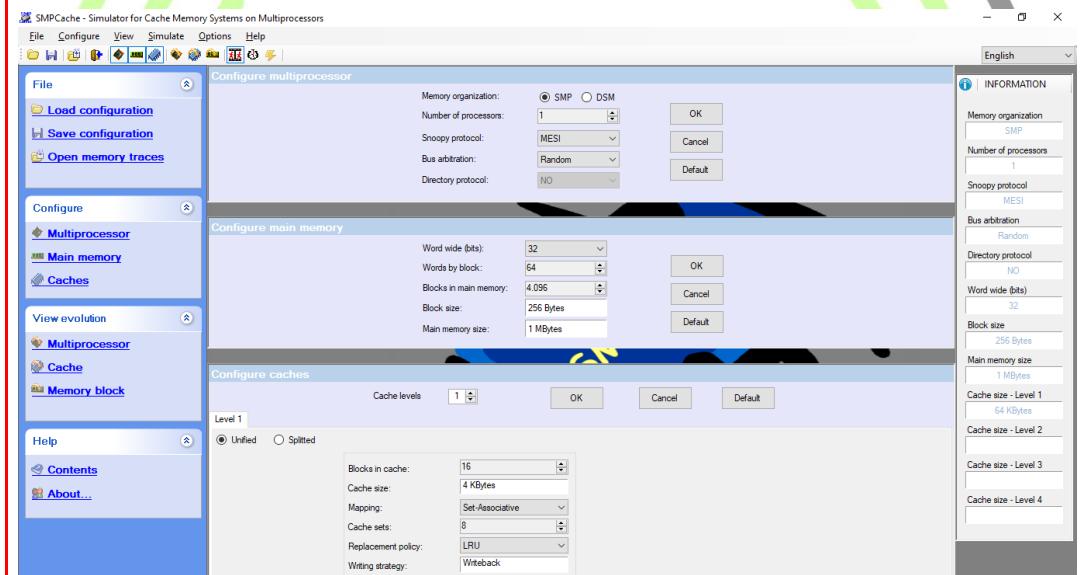
1.98 Konfigurasi Direct/8KB



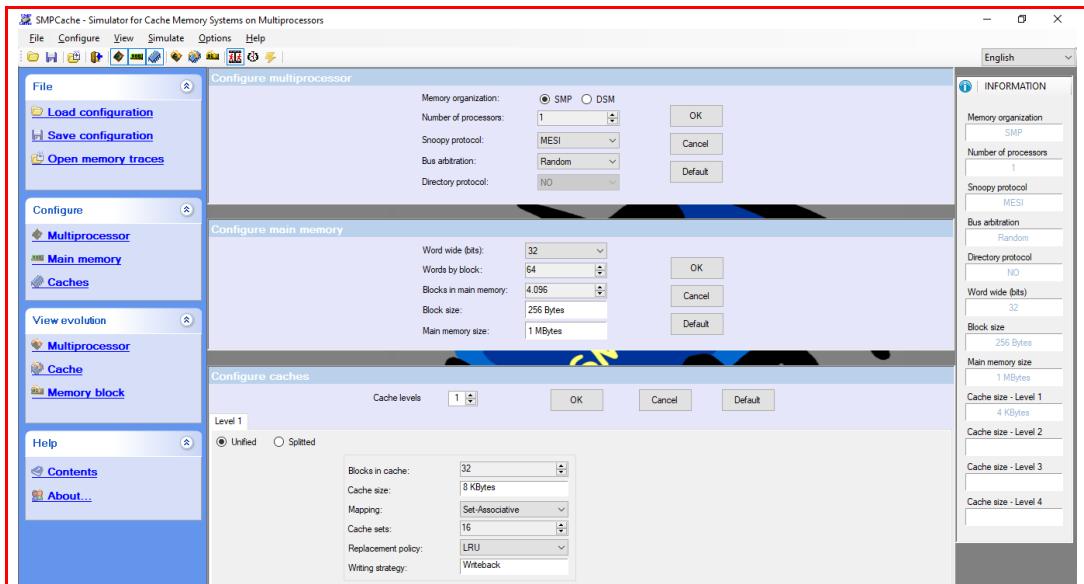
1.99 Konfigurasi Direct/16KB



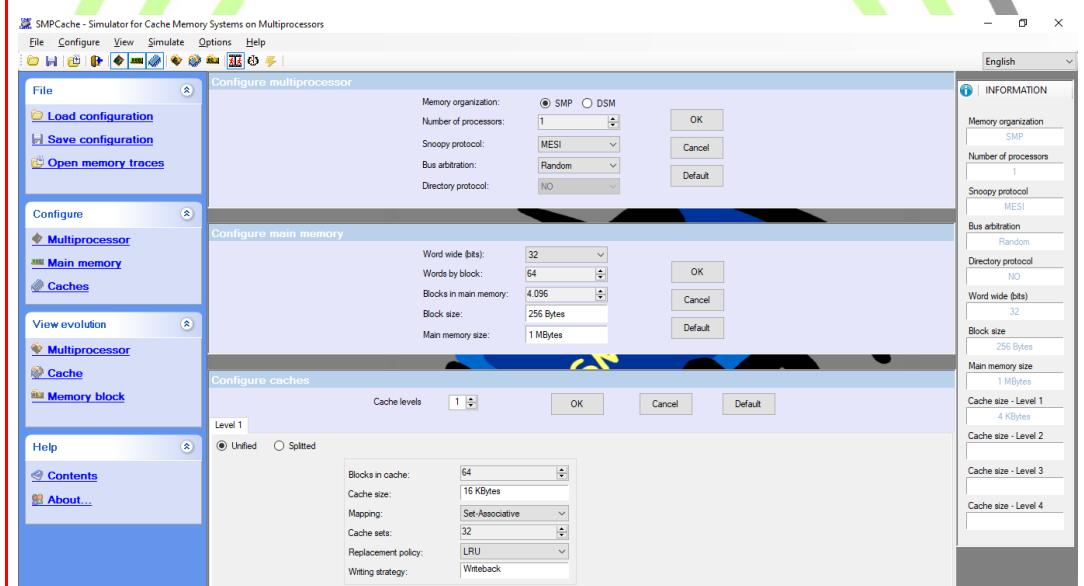
1.100 Konfigurasi Direct/32KB



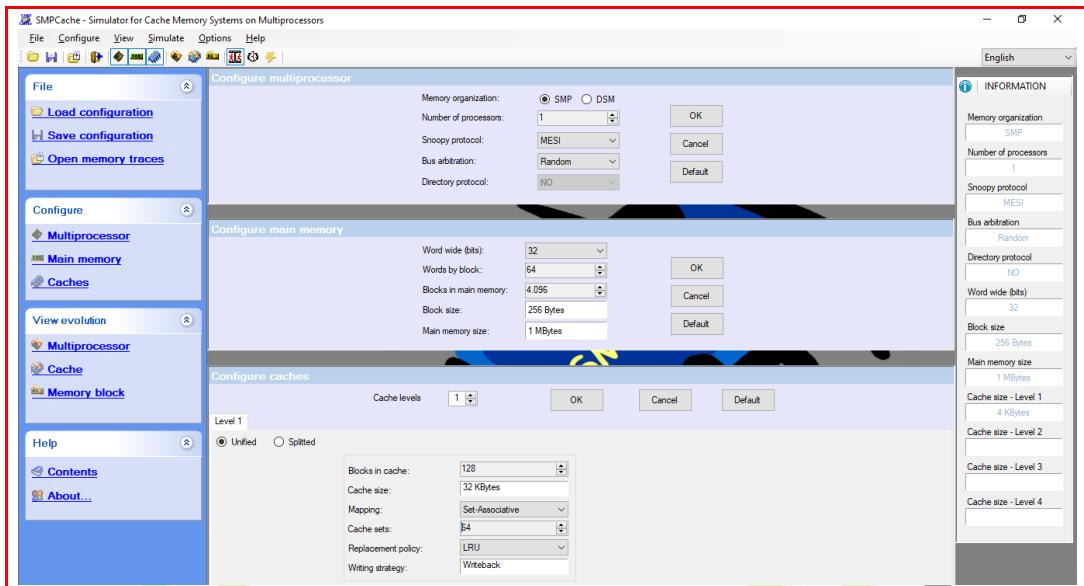
1.101 Konfigurasi two-way set associative/4KB



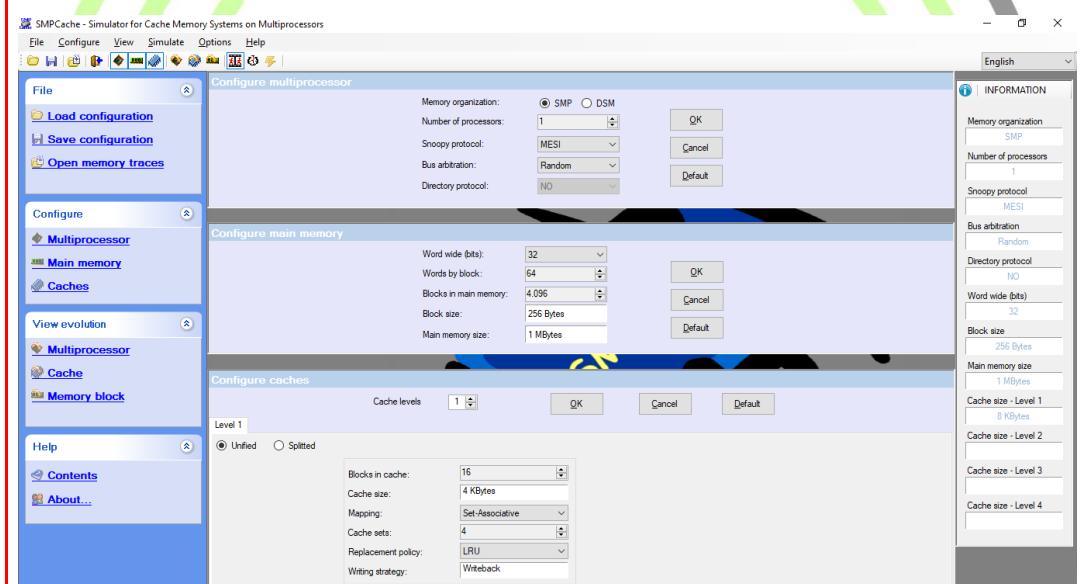
1.102 Konfigurasi two-way set associative/8KB



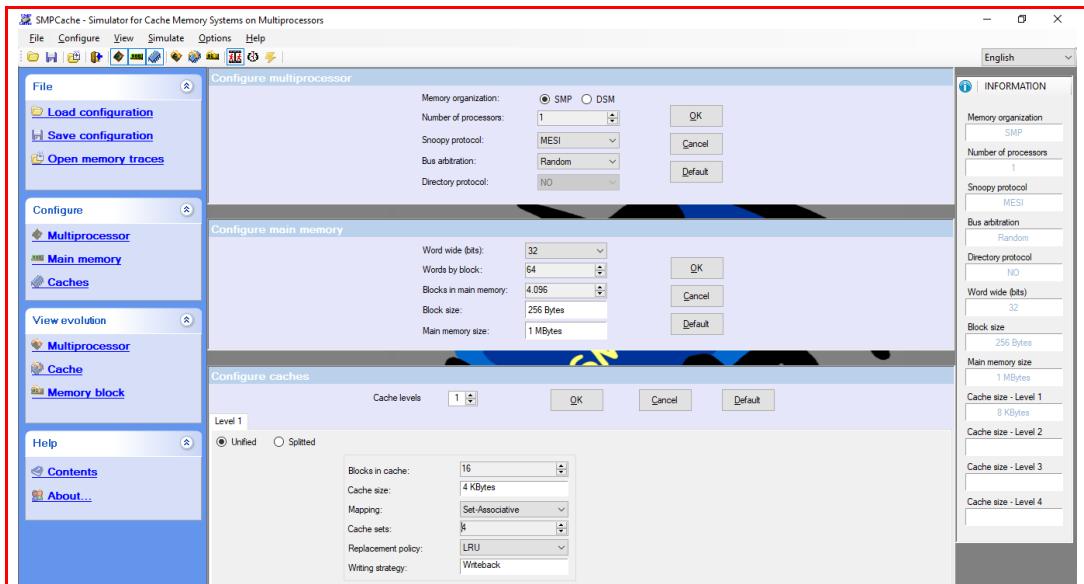
1.103 Konfigurasi two-way set associative/16KB



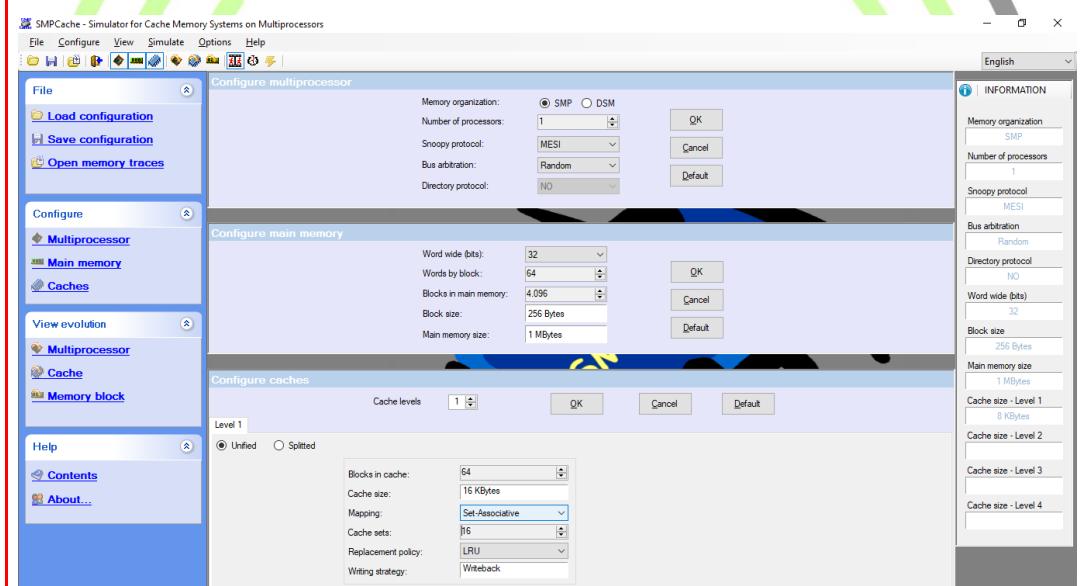
1.104 Konfigurasi two-way set associative/32KB



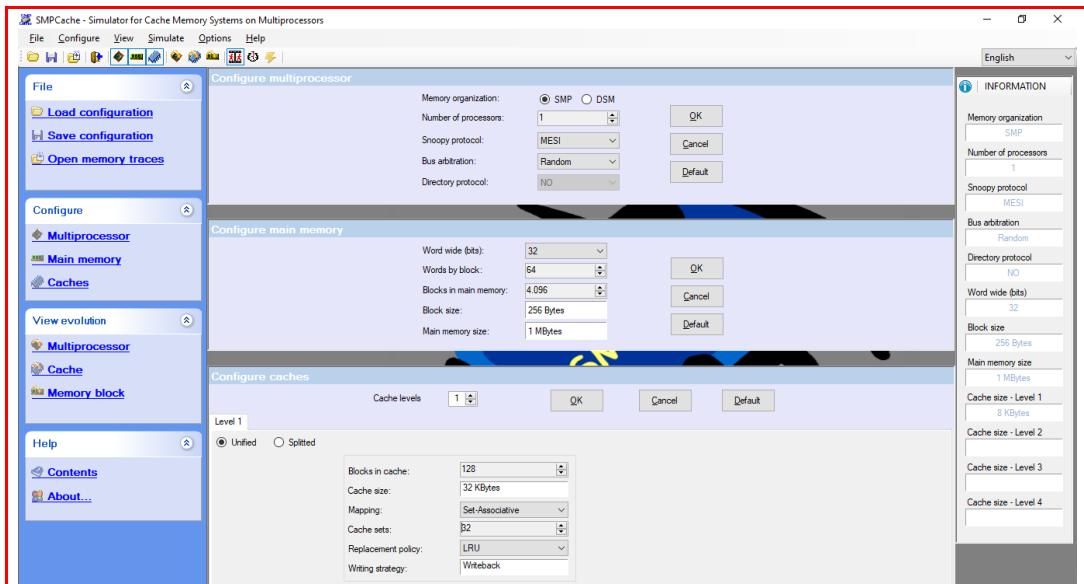
1.105 Konfigurasi four-way set associative/4KB



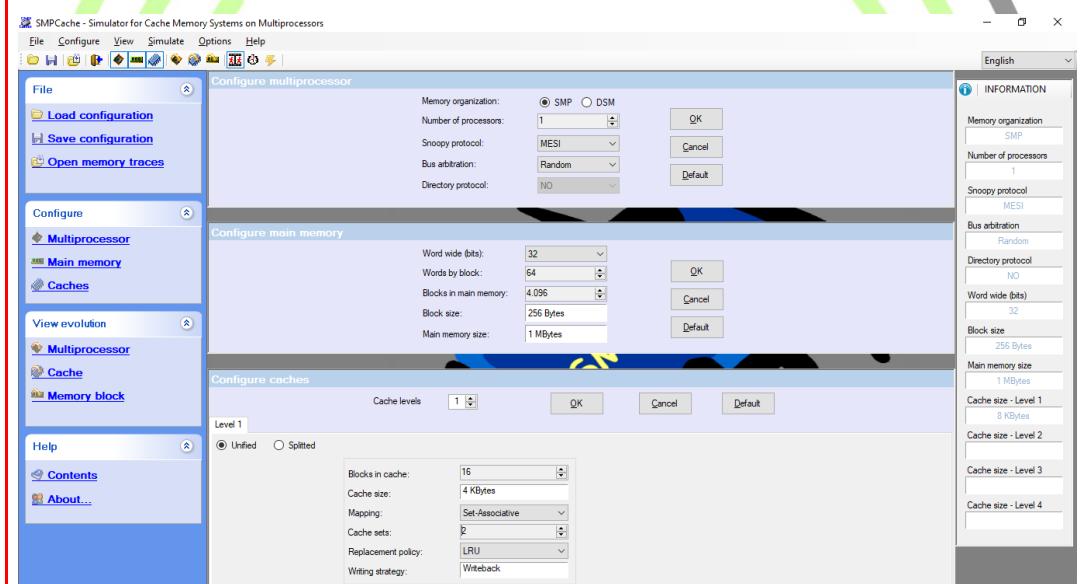
1.106 Konfigurasi four-way set associative/8KB



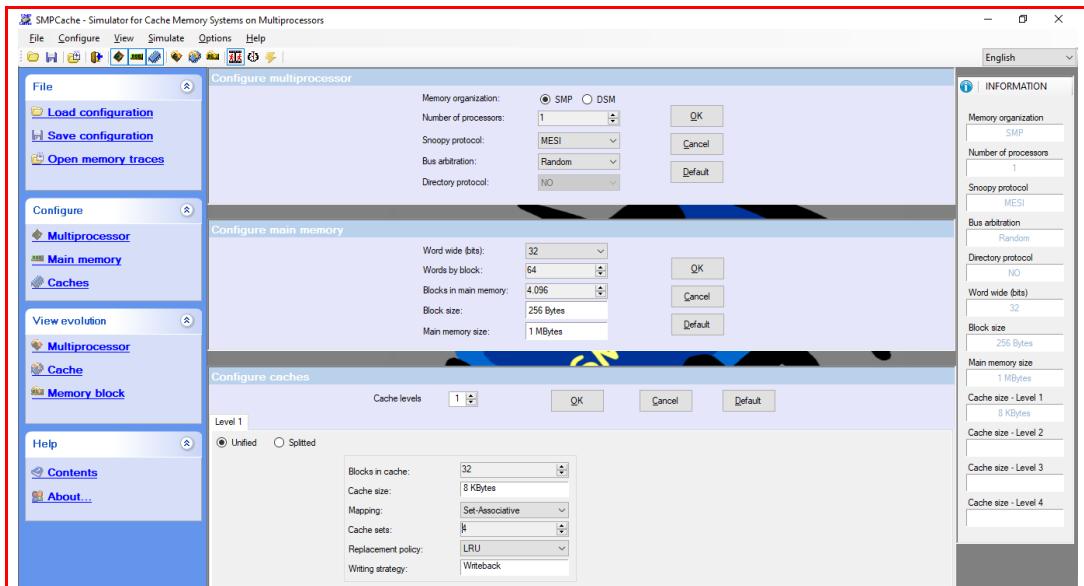
1.107 Konfigurasi four-way set associative/16KB



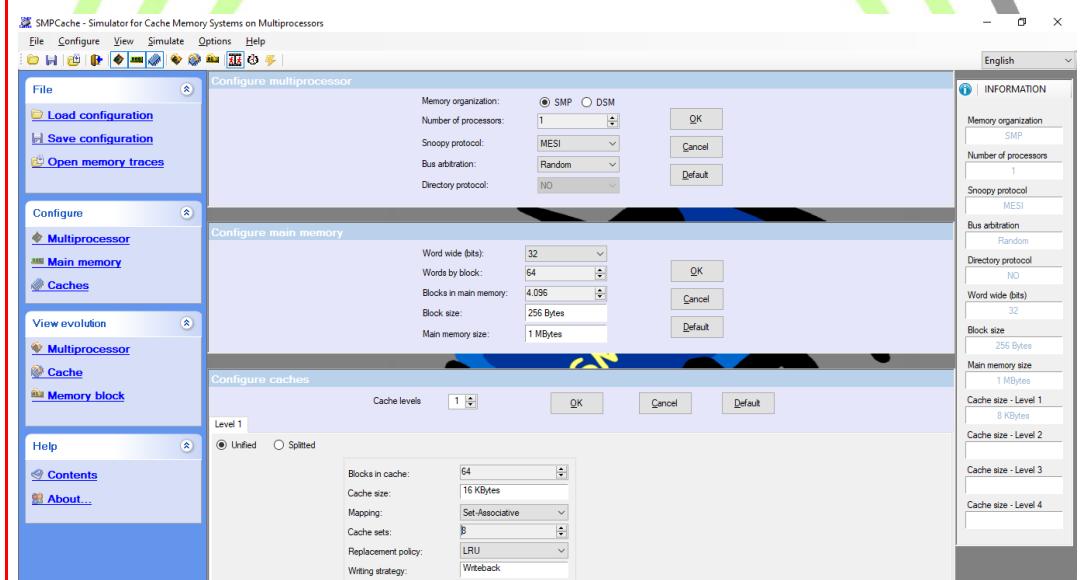
1.108 Konfigurasi four-way set associative/32KB



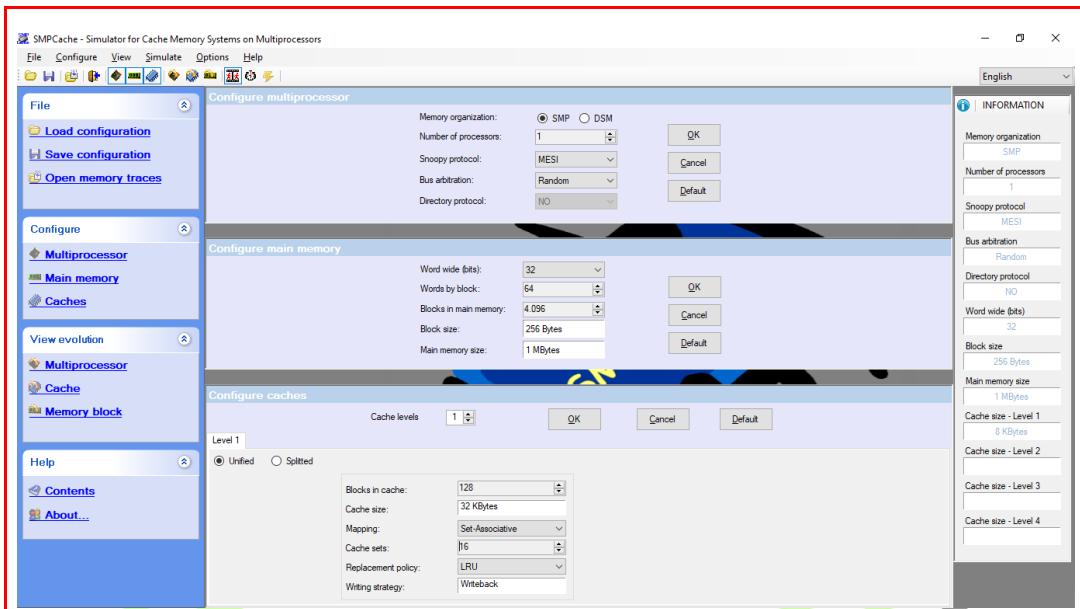
1.109 Konfigurasi eight-way set associative/4KB



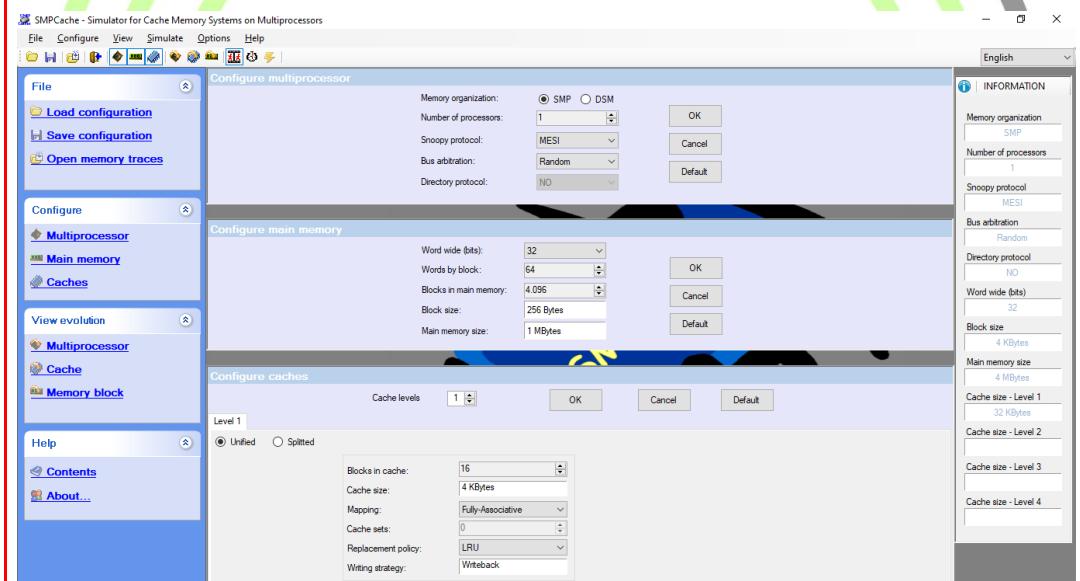
1.110 Konfigurasi eight-way set associative/8KB



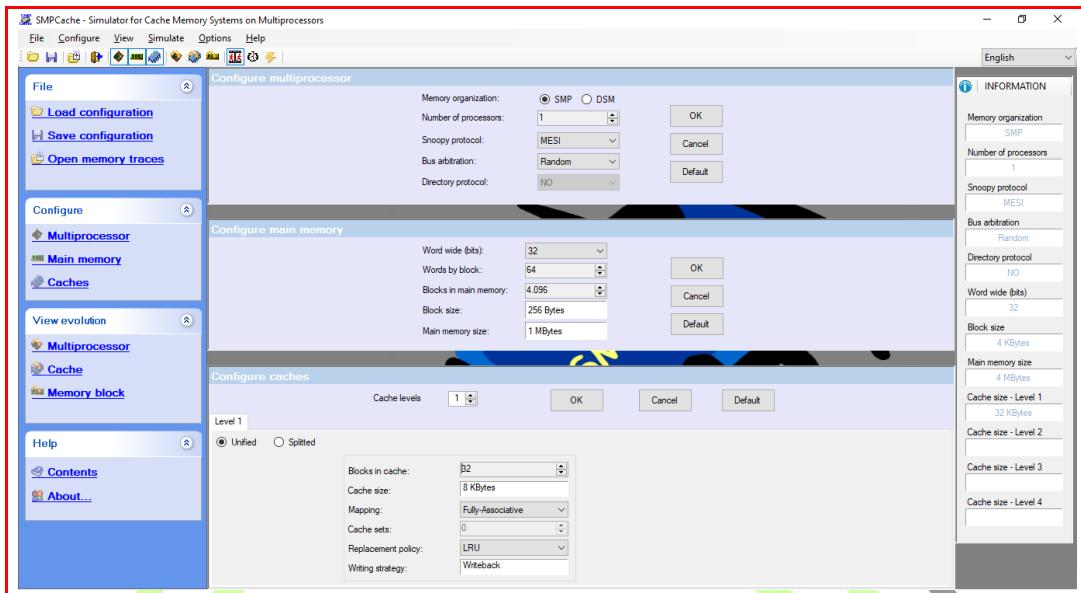
1.111 Konfigurasi eight-way set associative/16KB



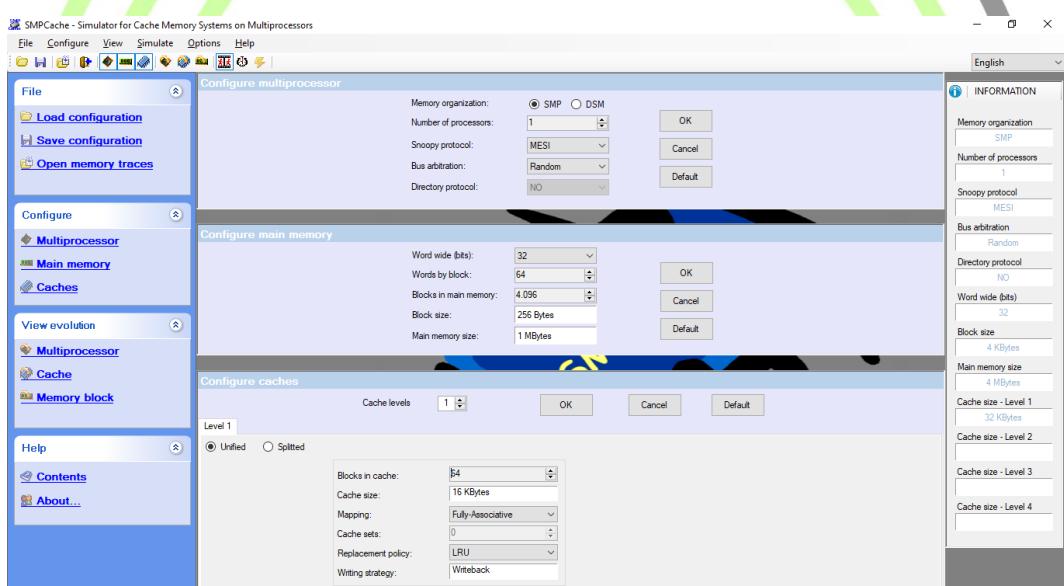
1.112 Konfigurasi eight-way set associative/32KB



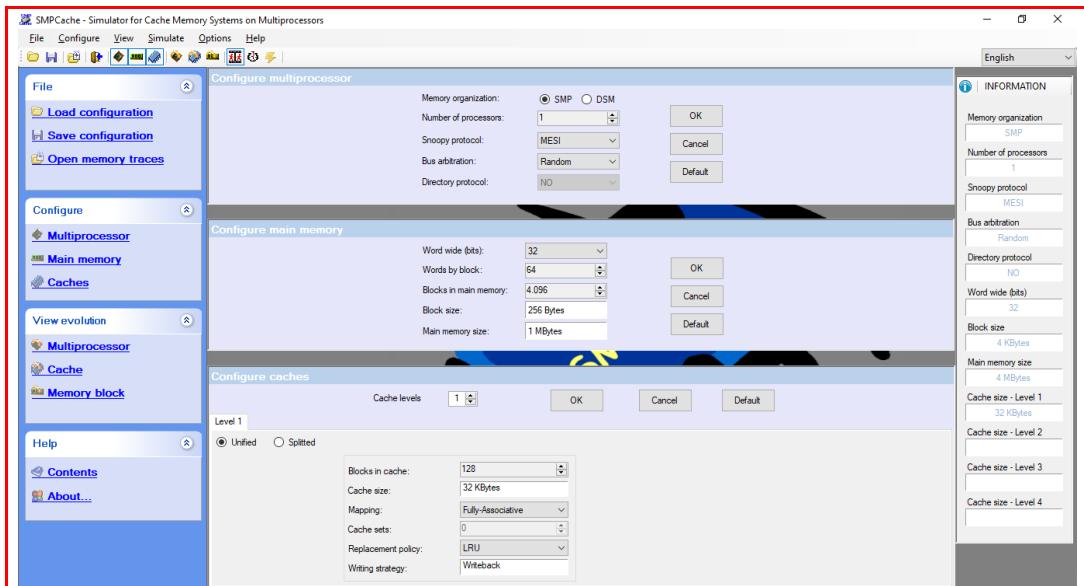
1.113 Konfigurasi fully-associative/4KB



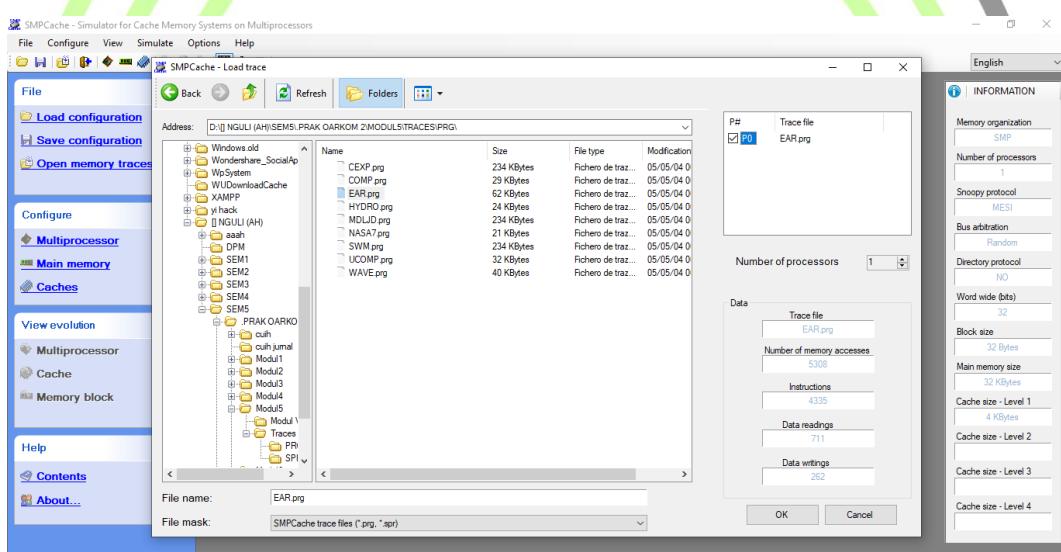
1.114 Konfigurasi fully-associative/8KB



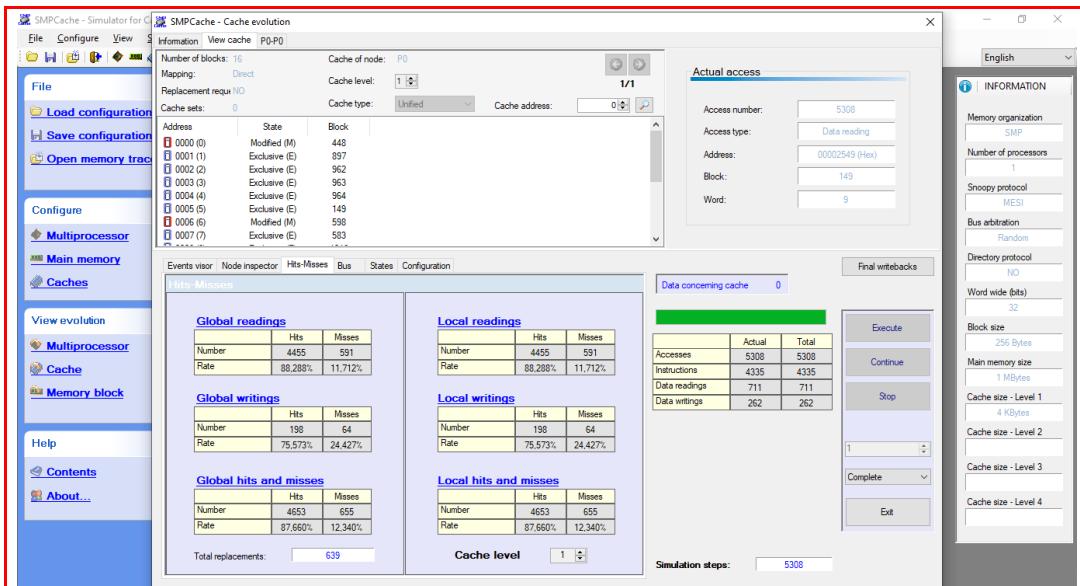
1.115 Konfigurasi fully-associative/16KB



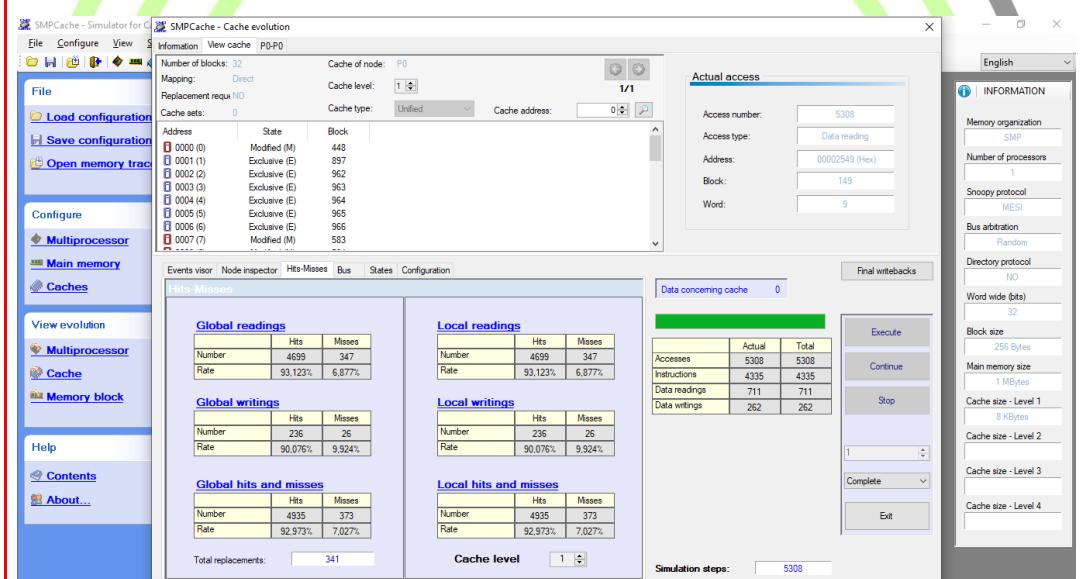
1.116 Konfigurasi fully-associative/32KB



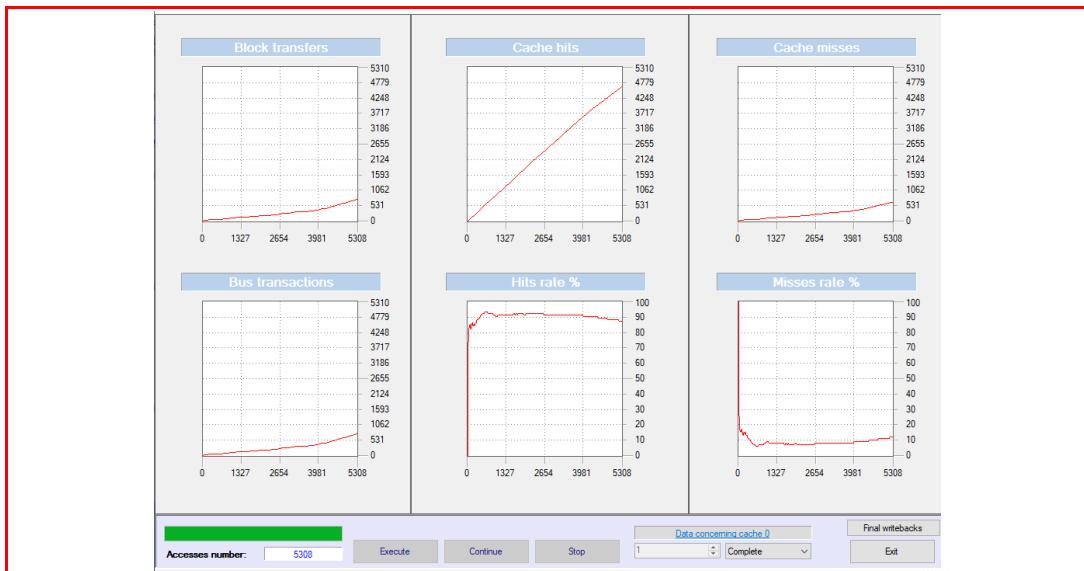
1.117 Open file trace EAR.prg



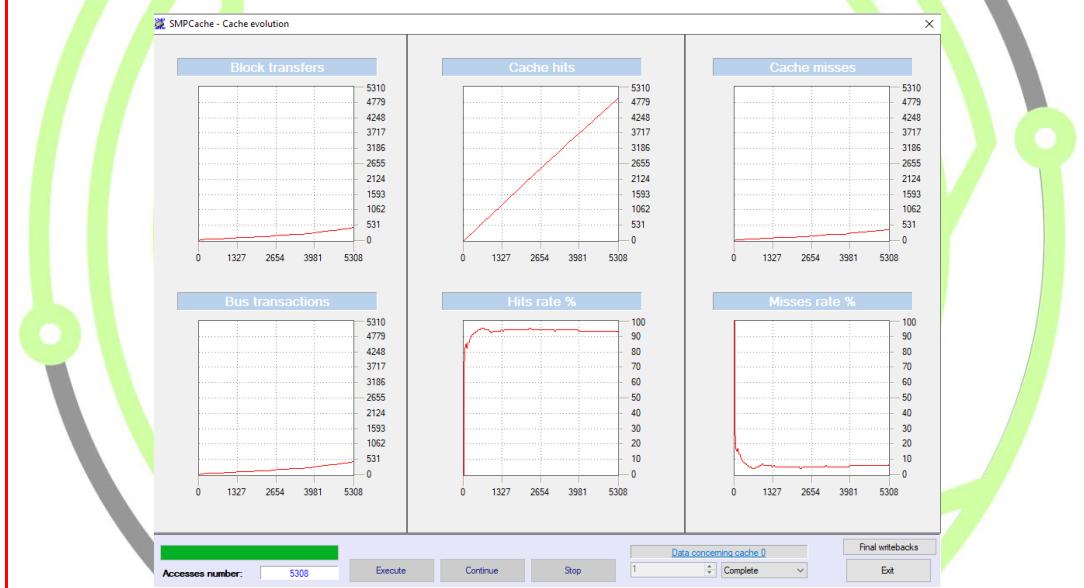
1.118 Hasil Miss Rate direct/4KB



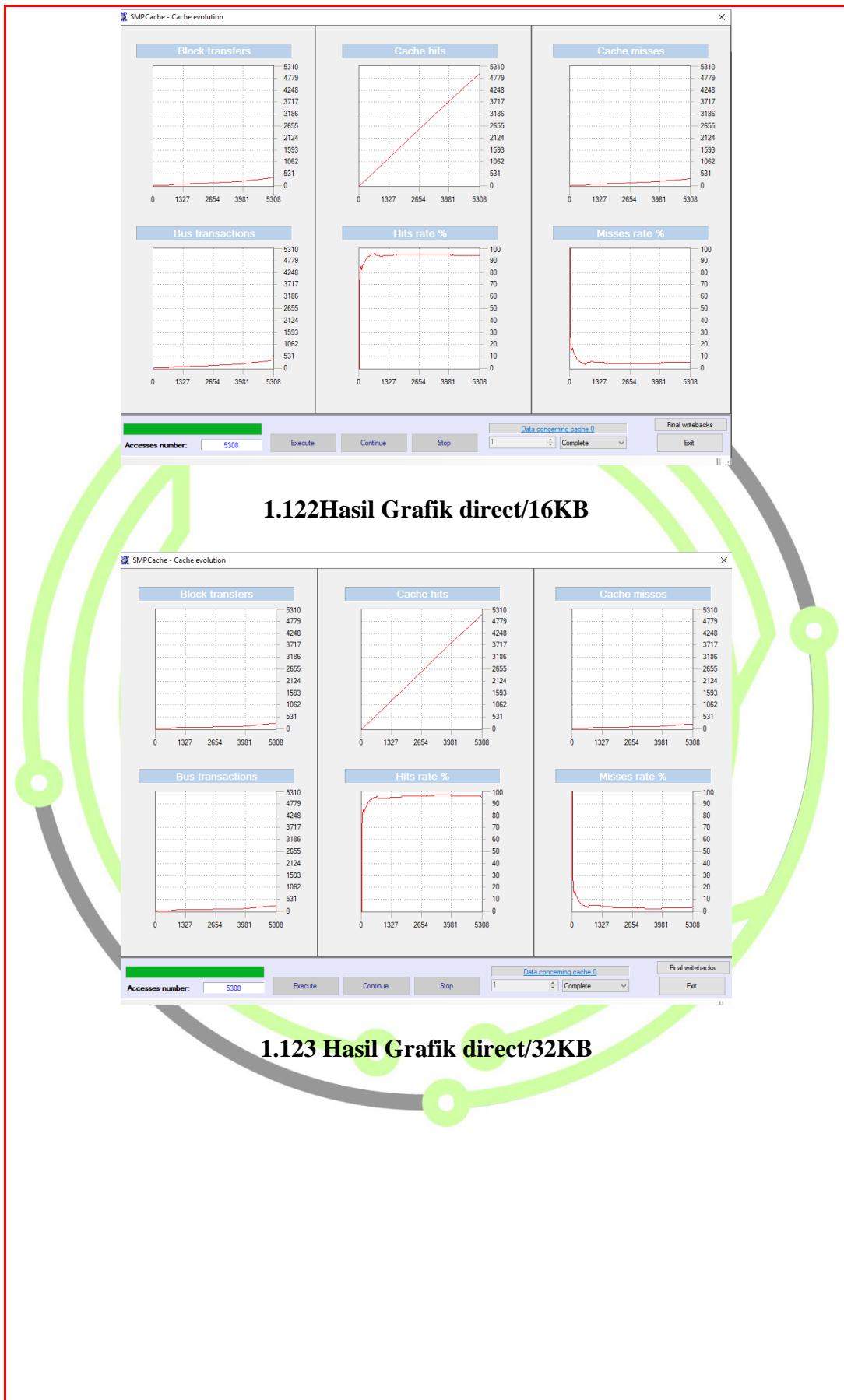
1.119 Hasil Miss Rate direct/8KB

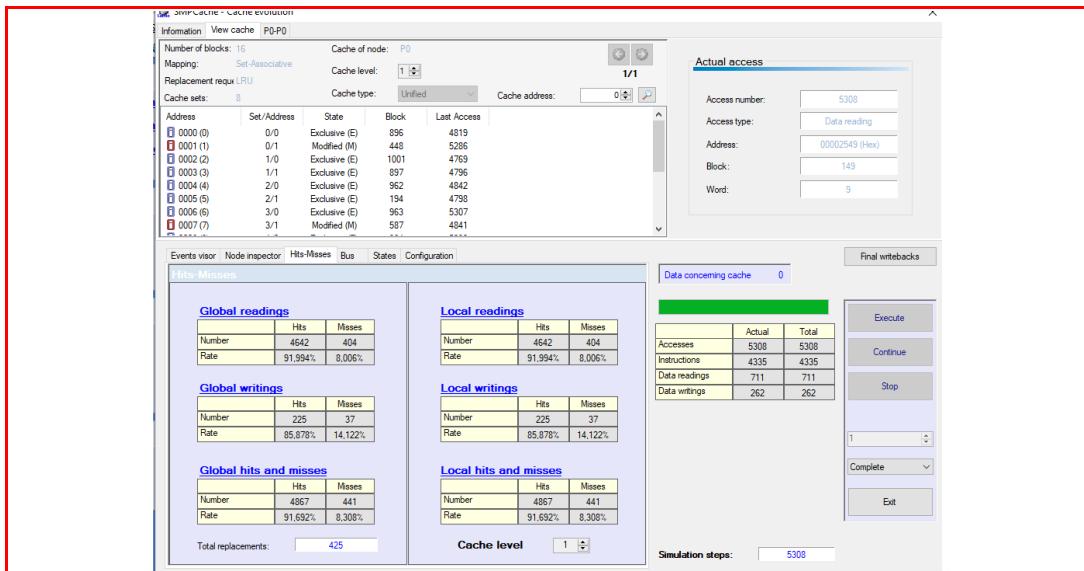


1.120 Hasil Grafik direct/4KB

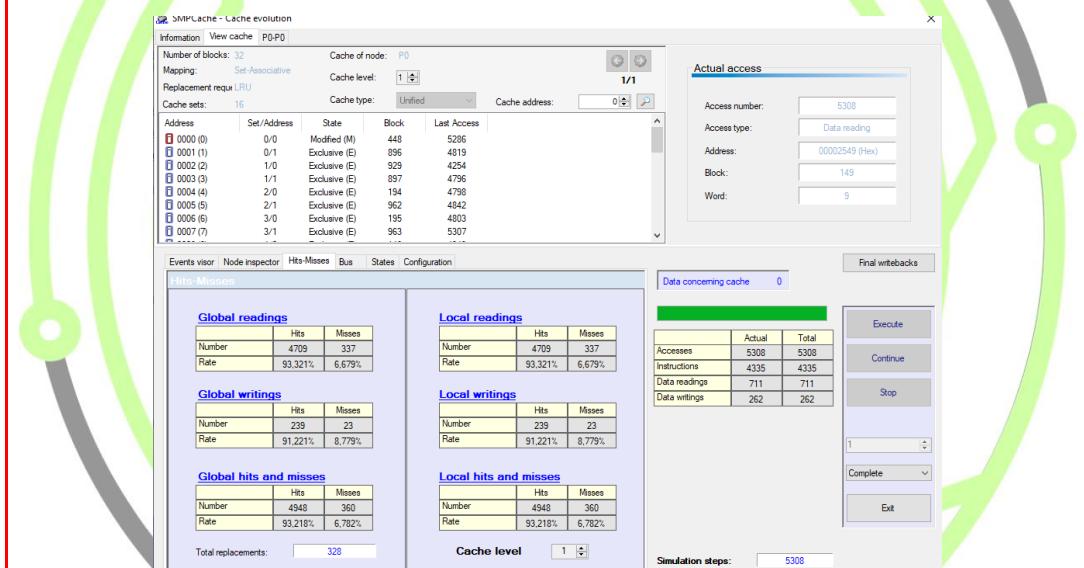


1.121 Hasil Grafik direct/8KB

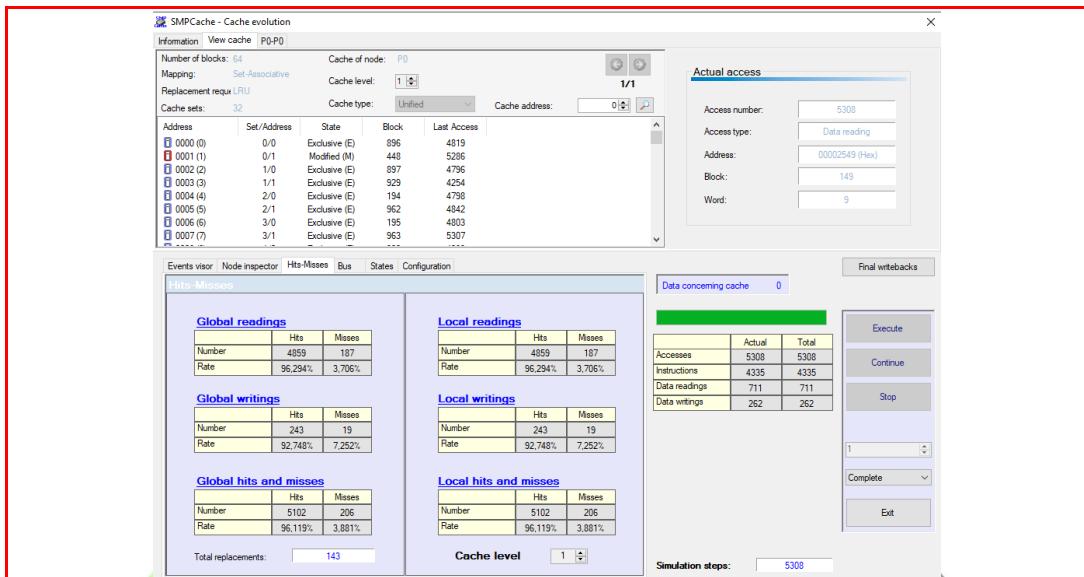




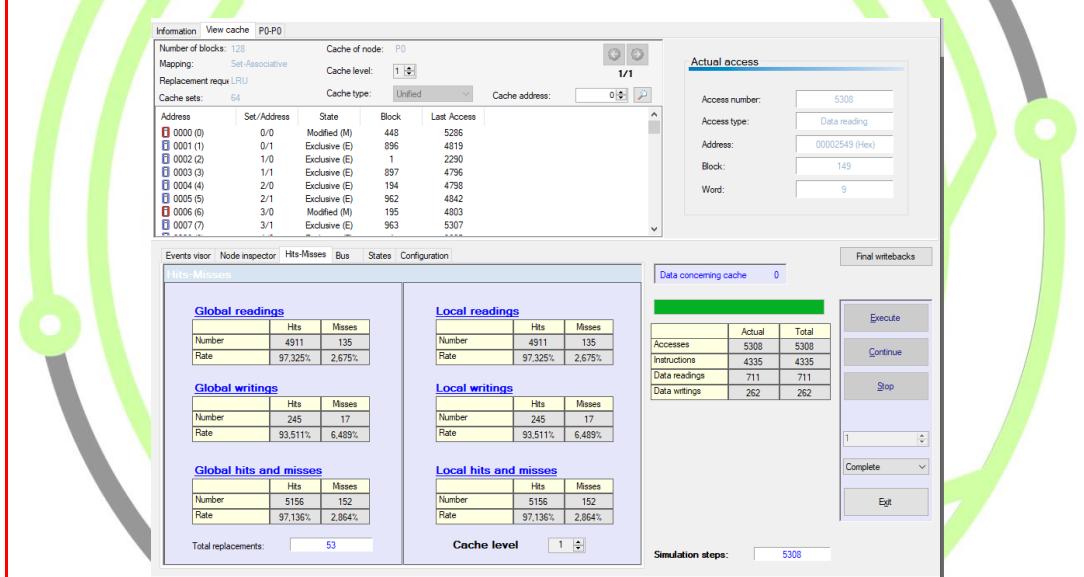
1.124 Hasil Miss Rate two-way set associative/4KB



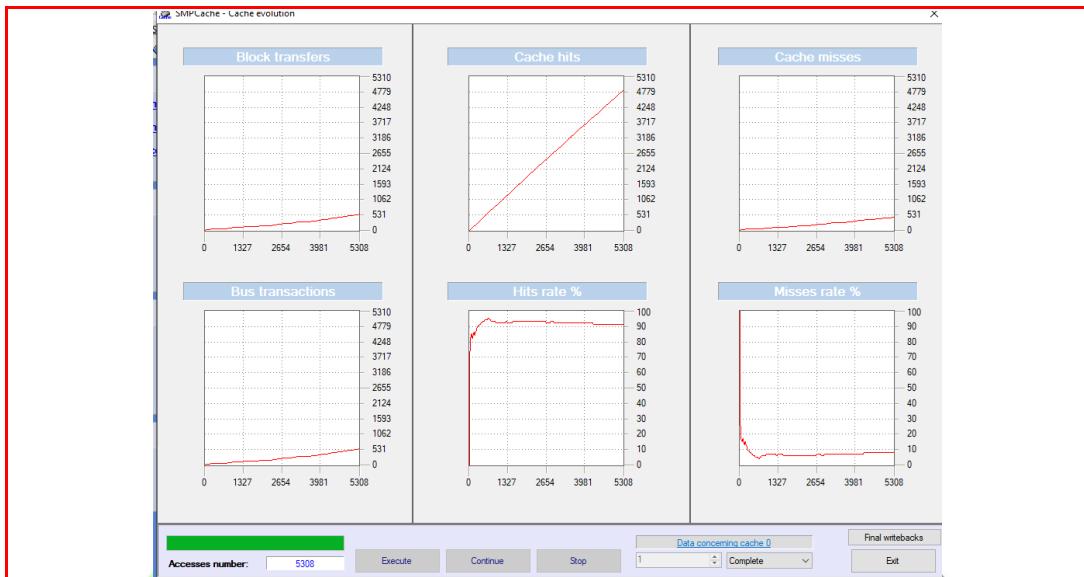
1.125 Hasil Miss Rate two-way set associative /8KB



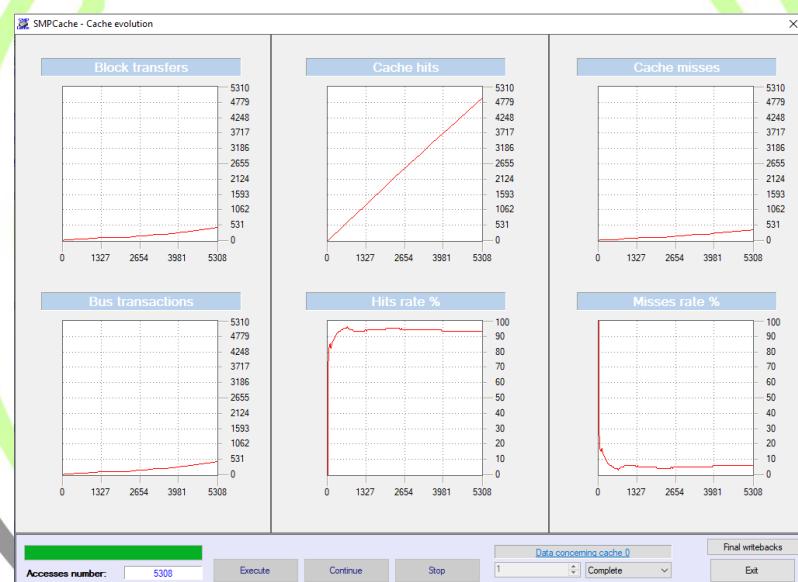
1.126 Hasil Miss Rate two-way set associative /16KB



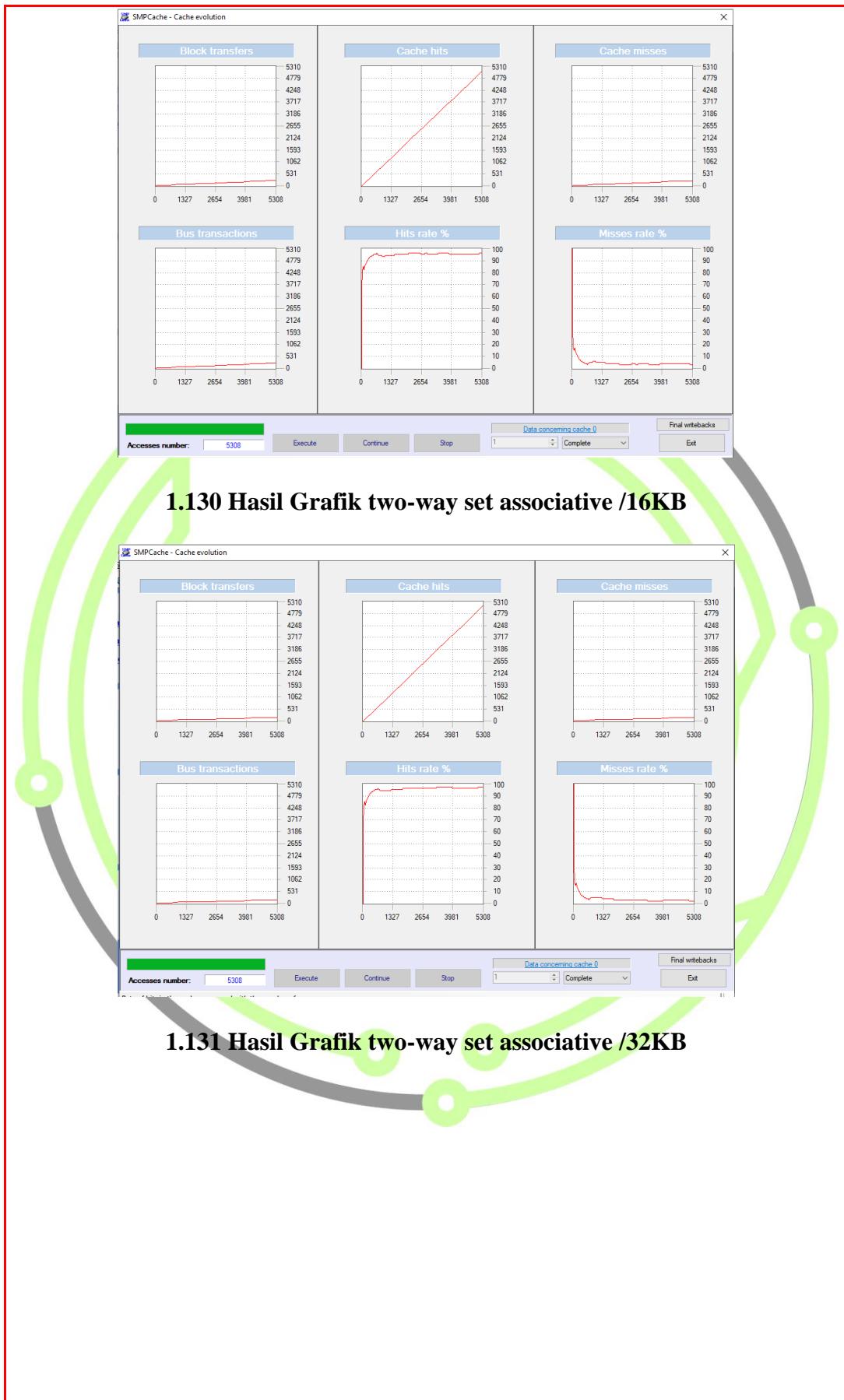
1.127 Hasil Miss Rate two-way set associative /32KB

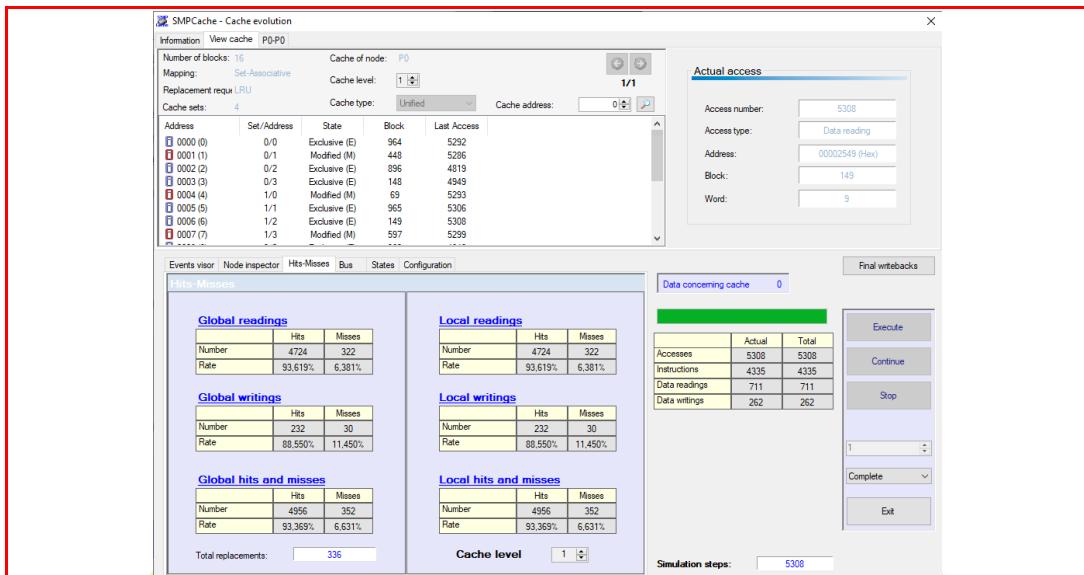


1.128 Hasil Grafik two-way set associative/4KB

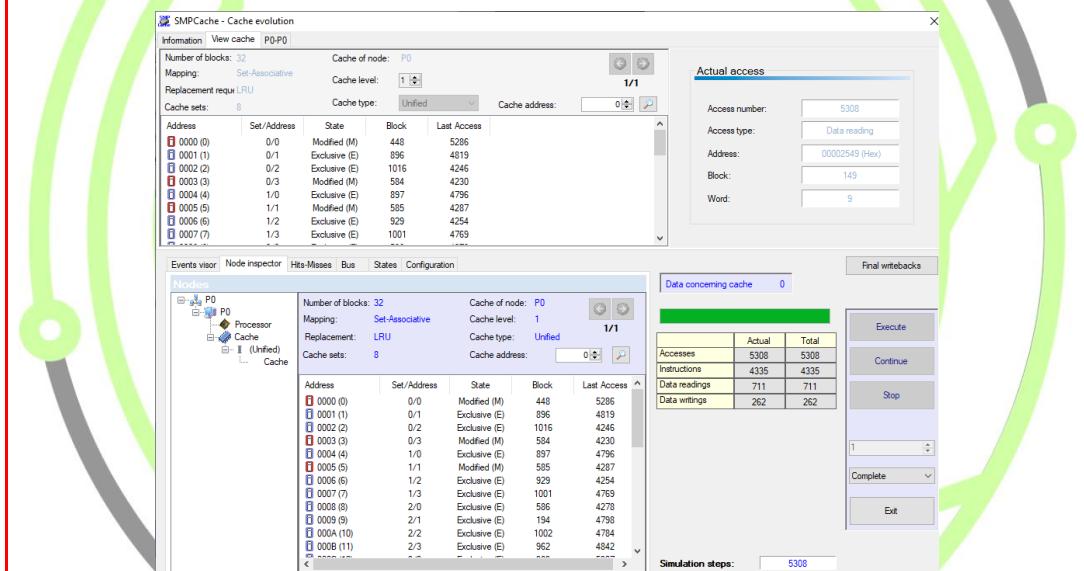


1.129 Hasil Grafik two-way set associative /8KB



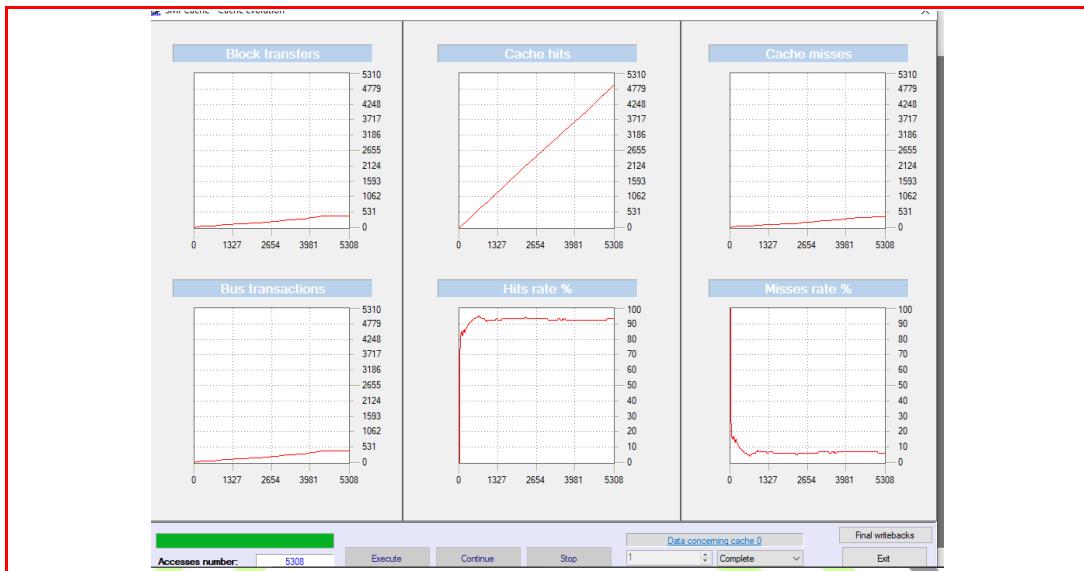


1.132 Hasil Miss Rate four-way set associative/4KB

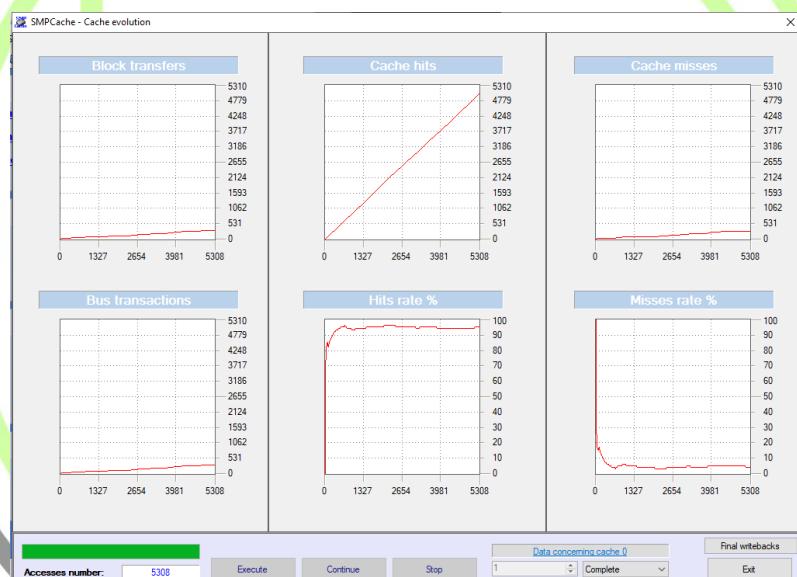


1.133 Hasil Miss Rate four-way set associative /8KB

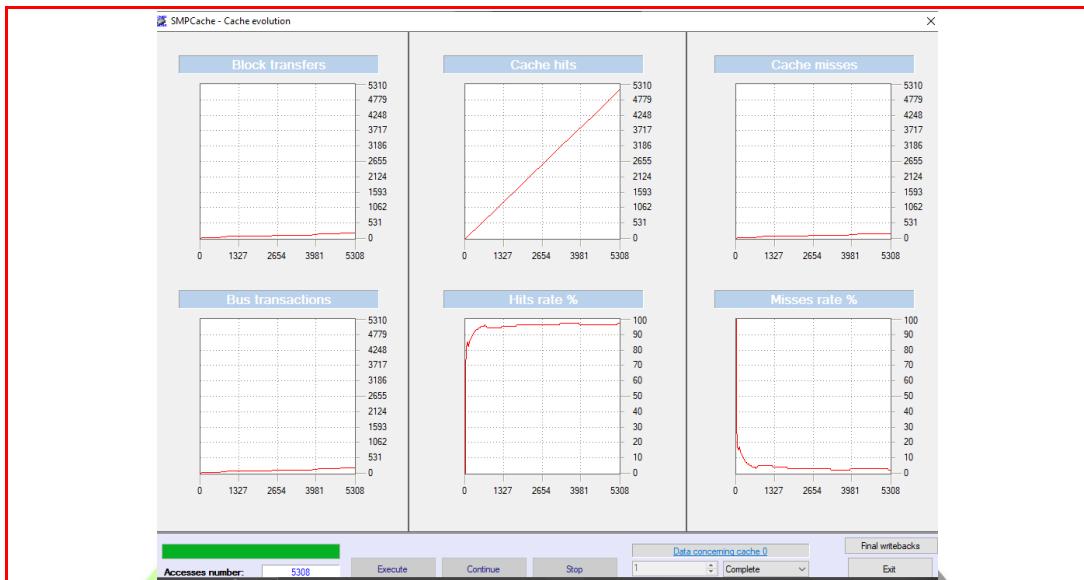




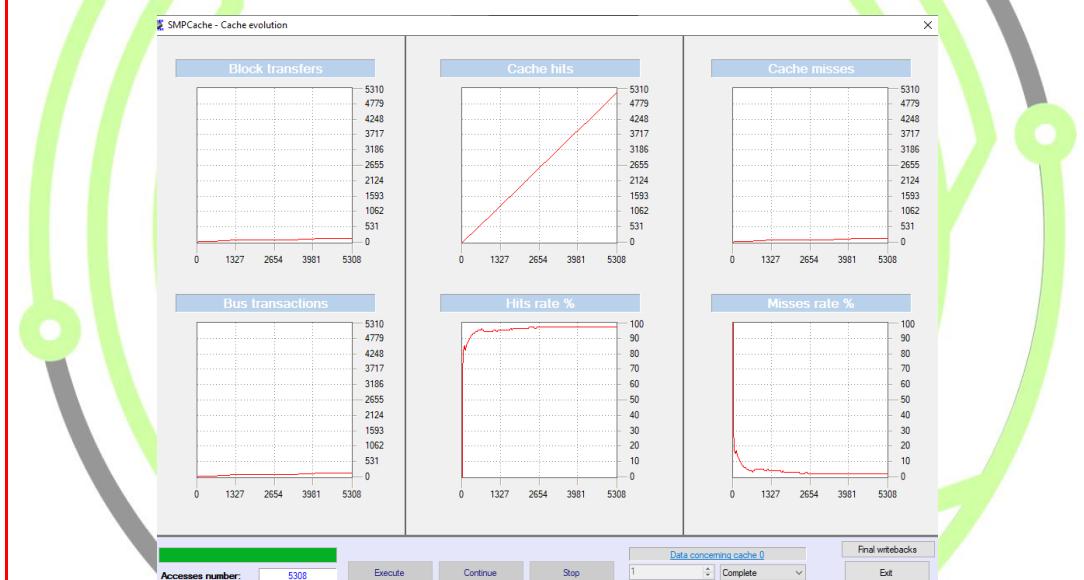
1.136 Hasil Grafik four-way set associative/4KB



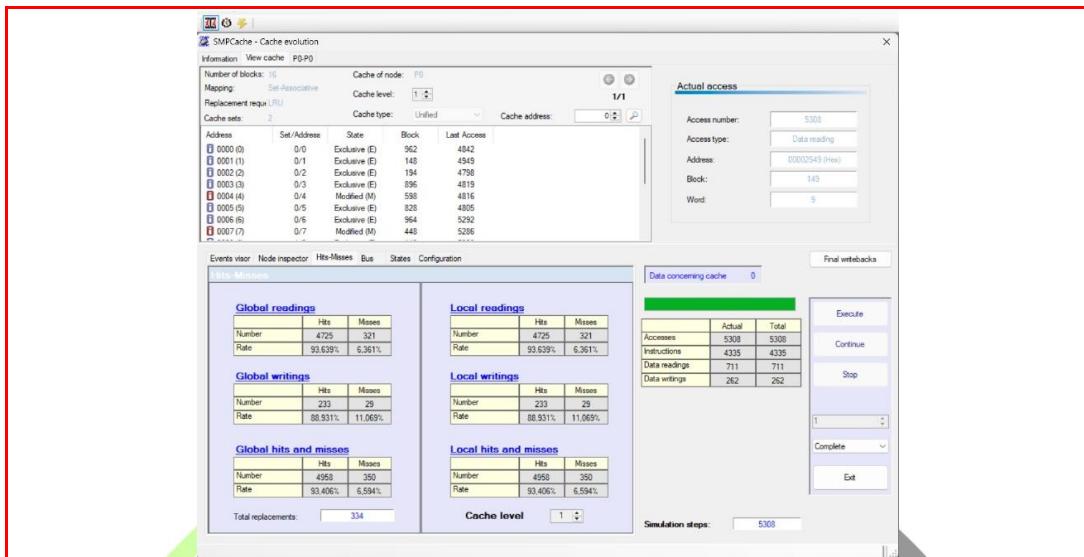
1.137 Hasil Grafik four-way set associative /8KB



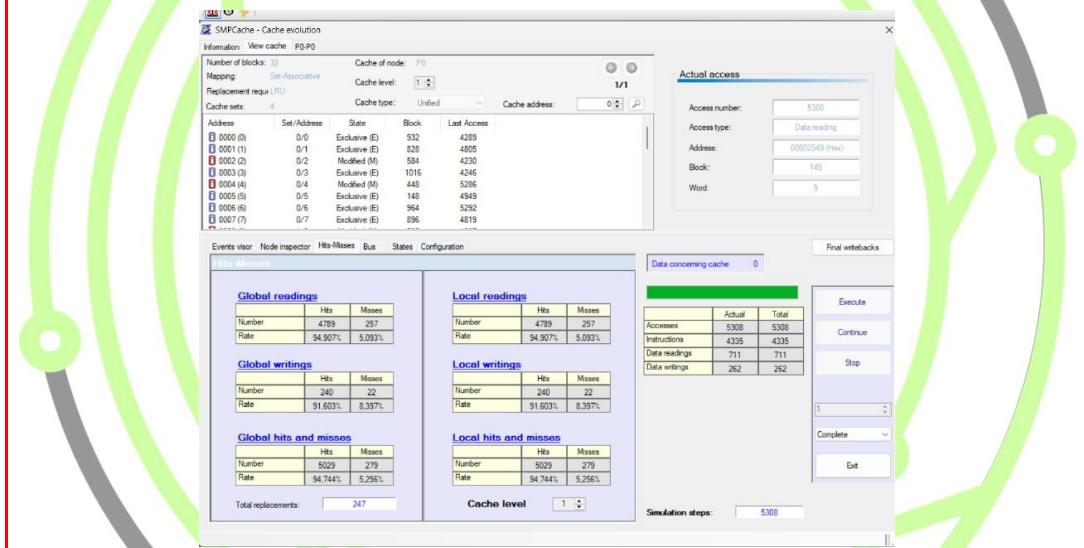
1.138 Hasil Grafik four-way set associative /16KB



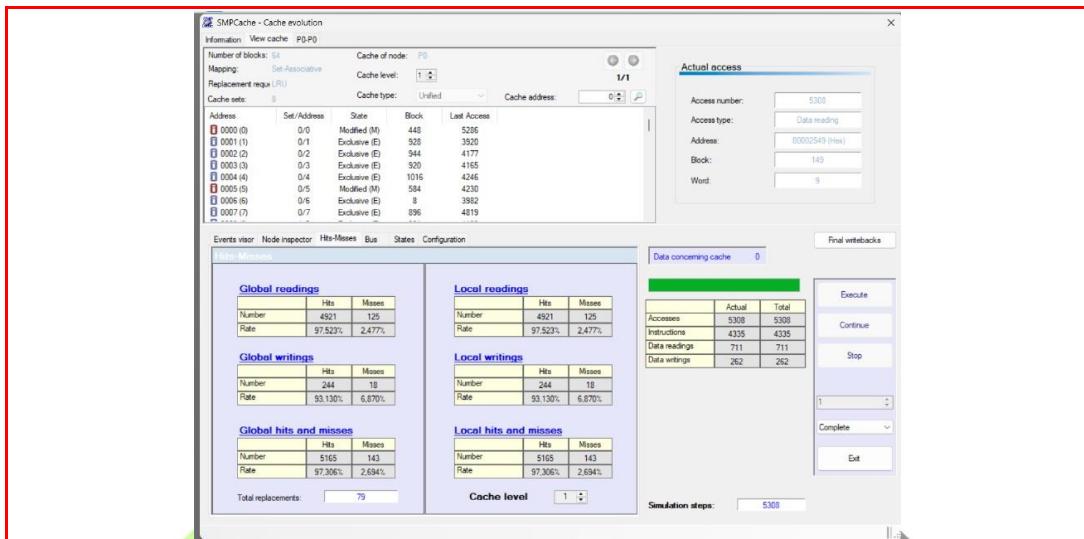
1.139 Hasil Grafik four-way set associative /32KB



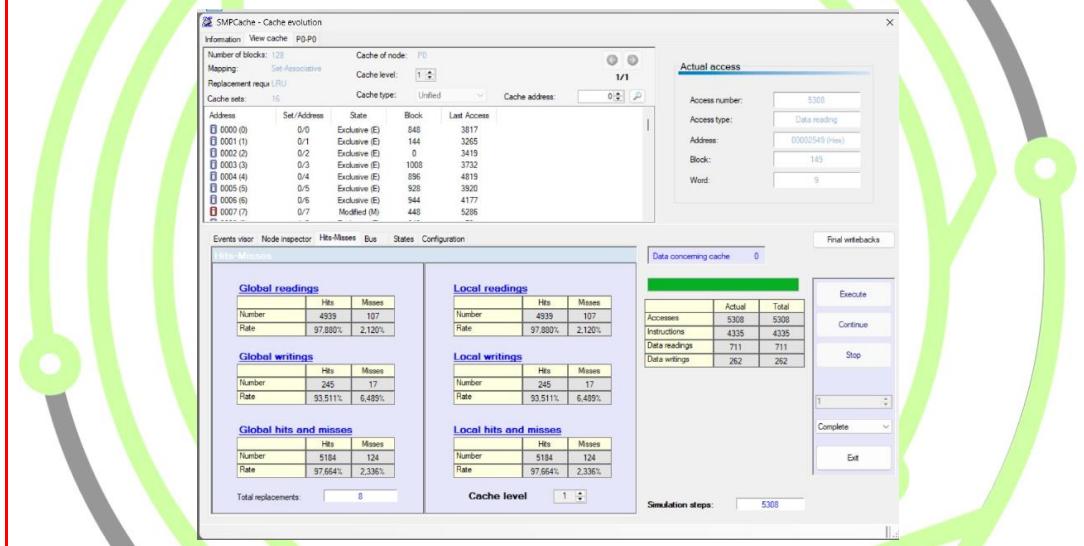
1.140 Hasil Miss Rate eight-way set associative/4KB



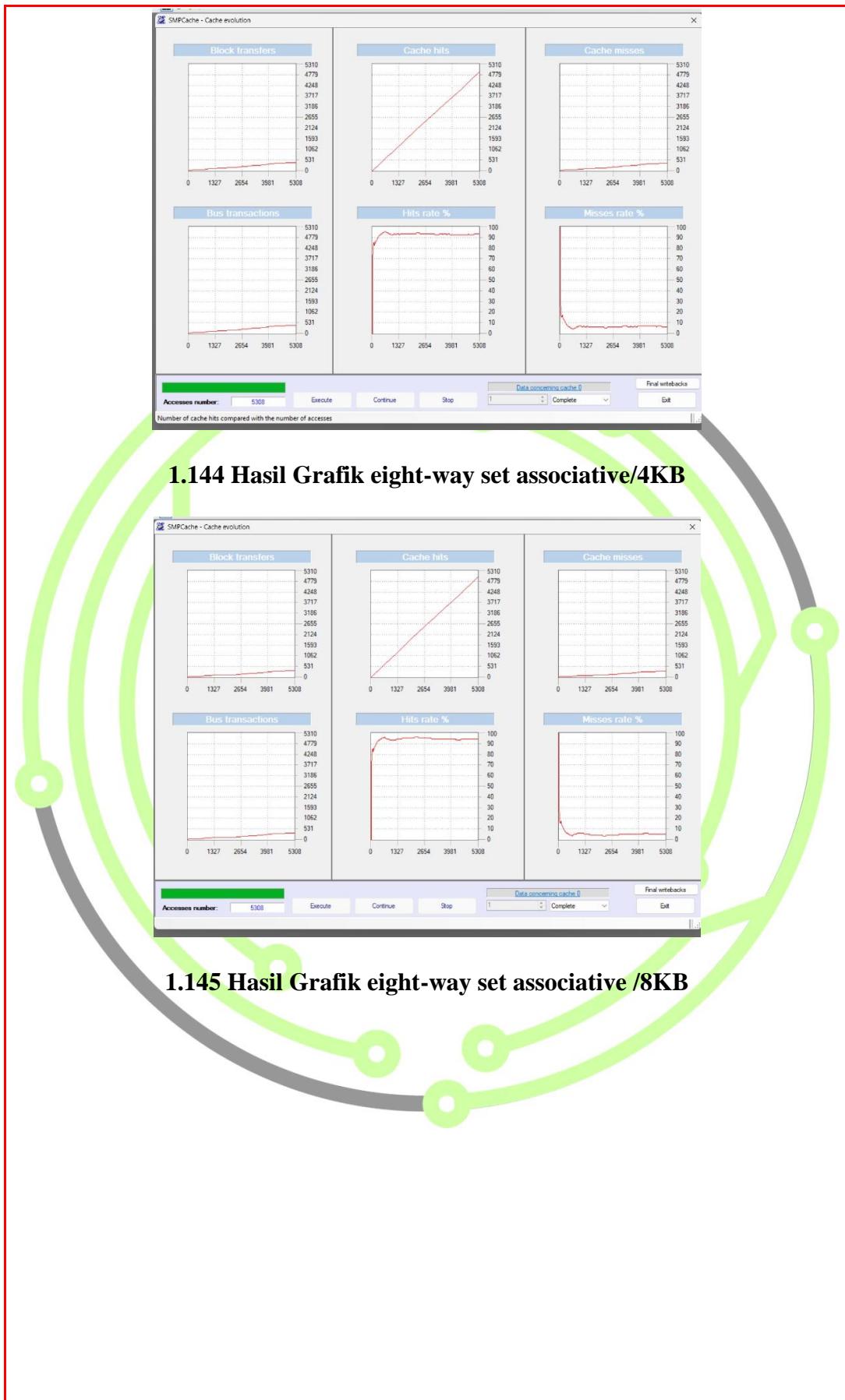
1.141 Hasil Miss Rate eight-way set associative /8KB

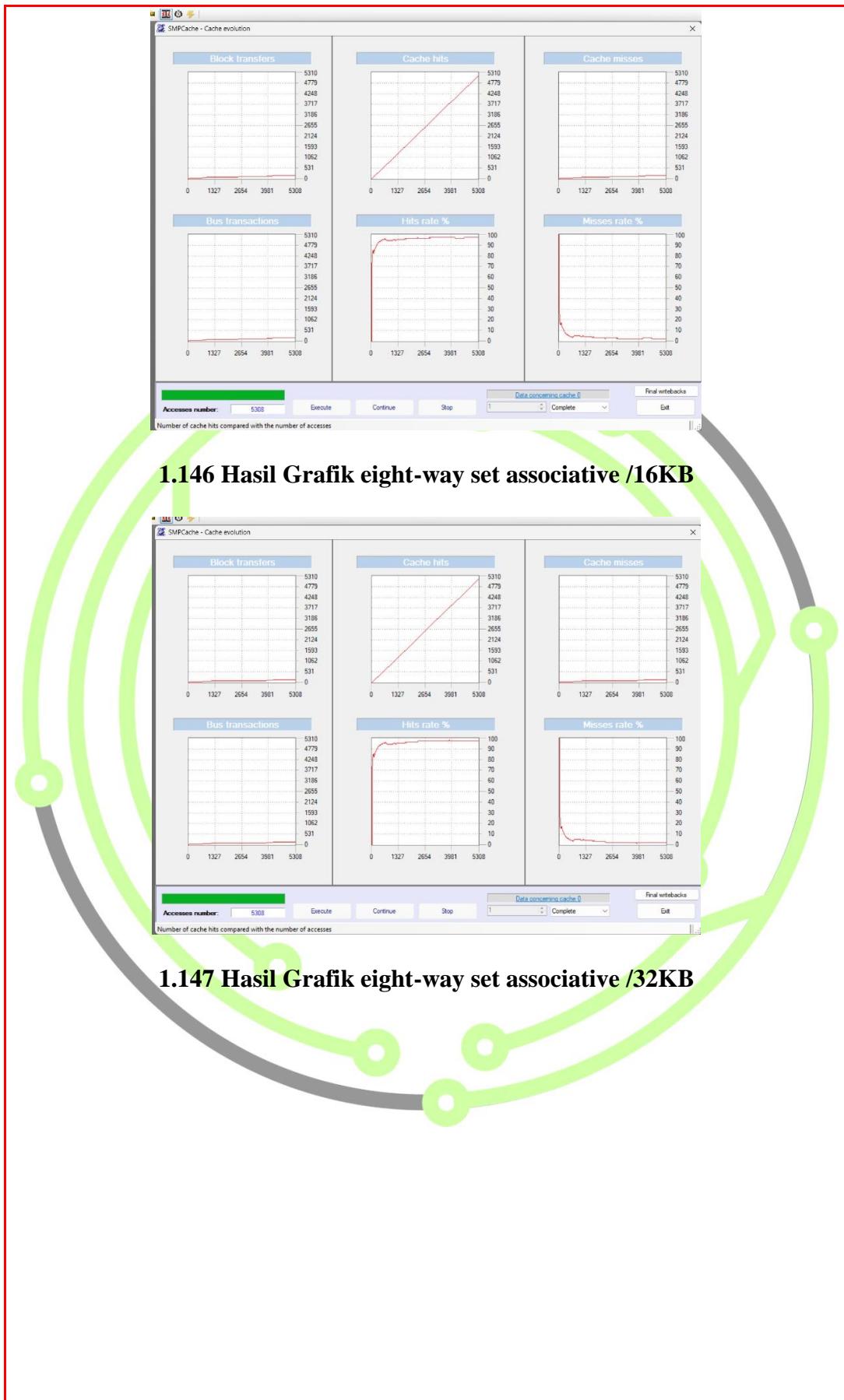


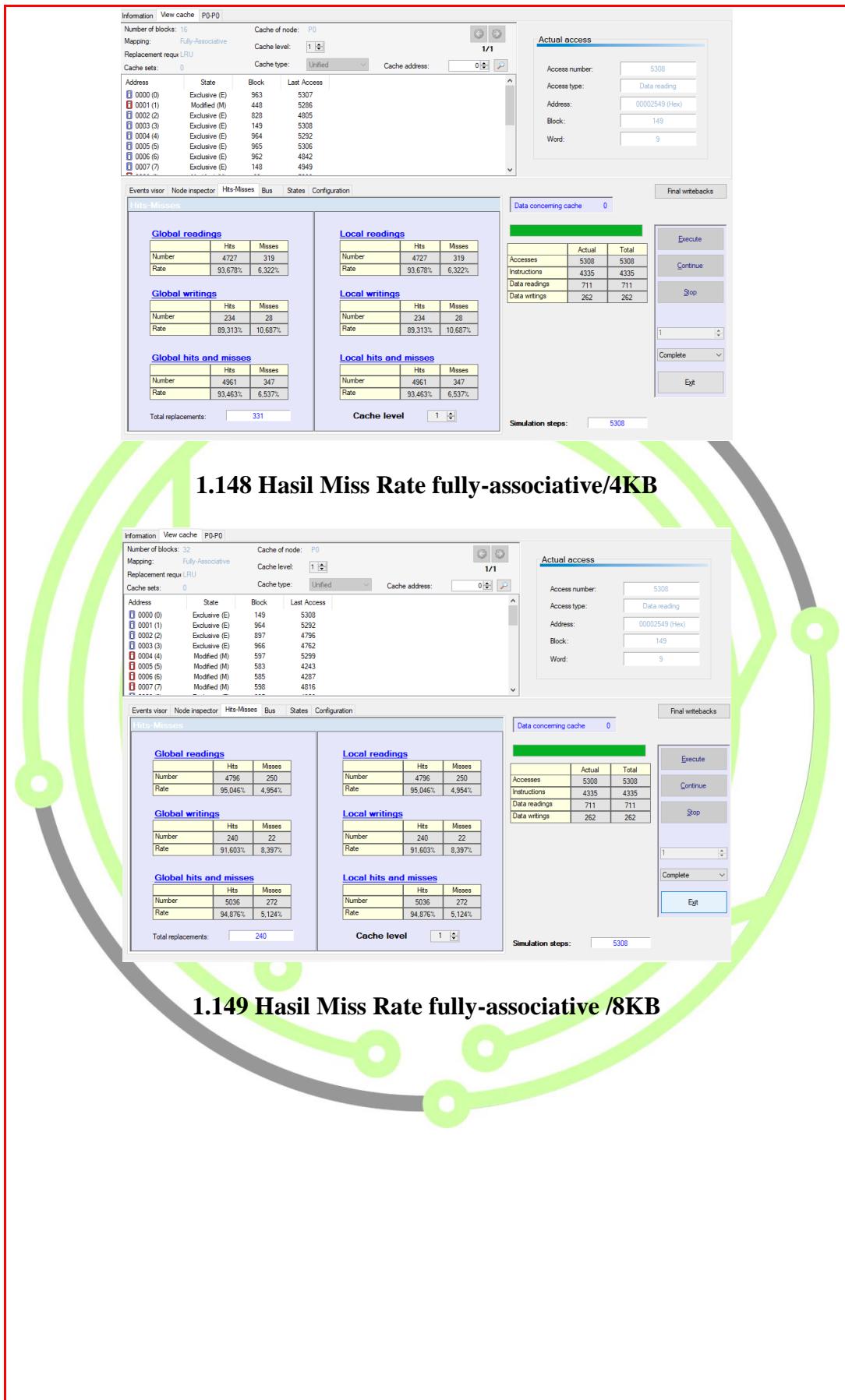
1.142 Hasil Miss Rate eight-way set associative /16KB



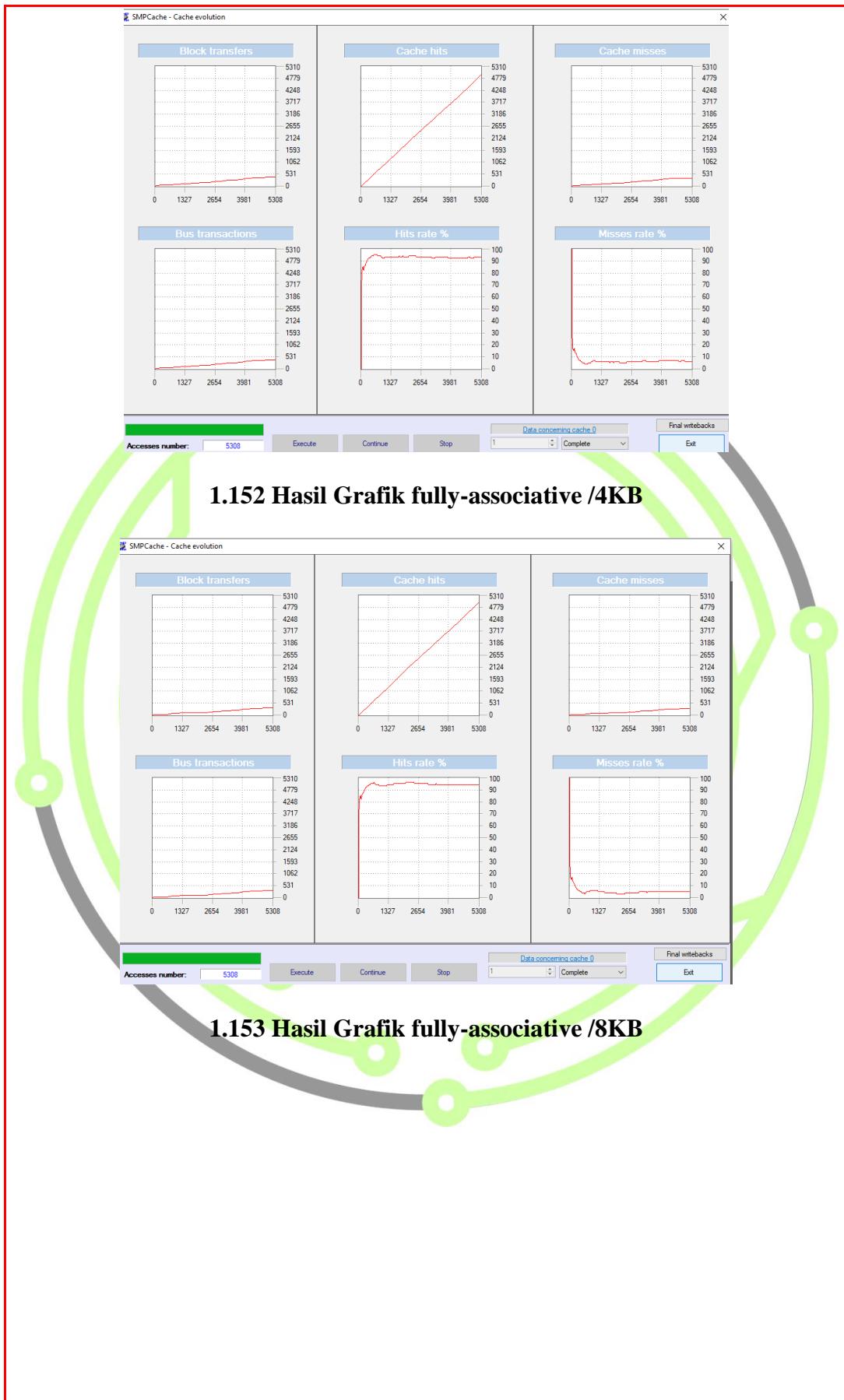
1.143 Hasil Miss Rate eight-way set associative /32KB

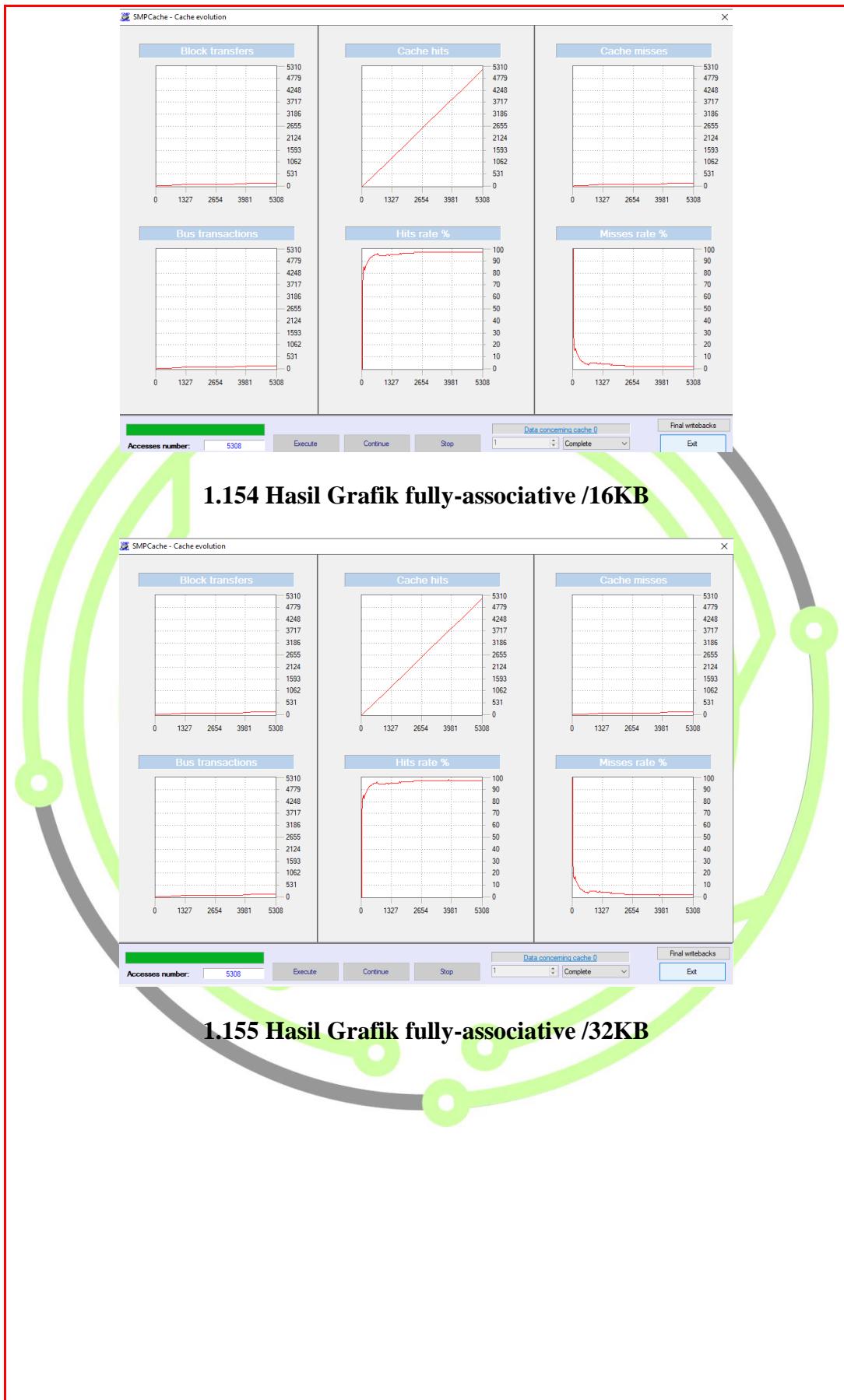




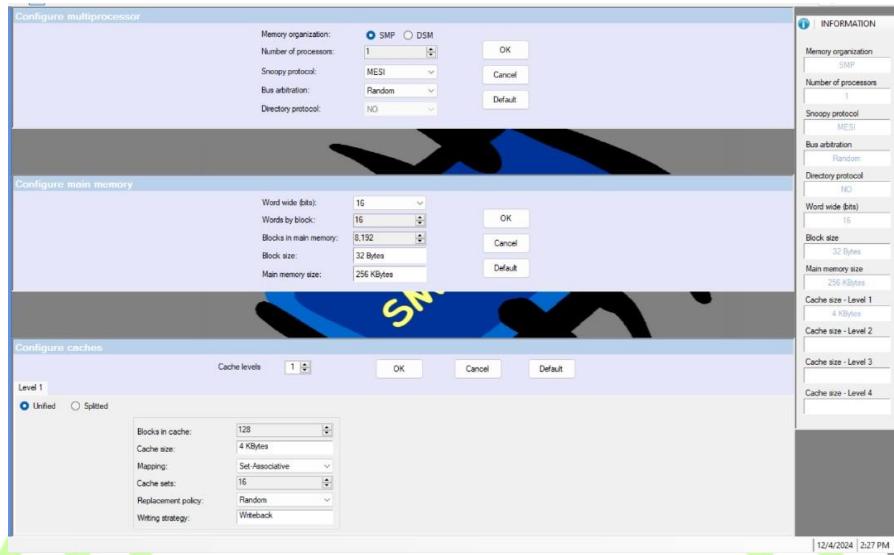




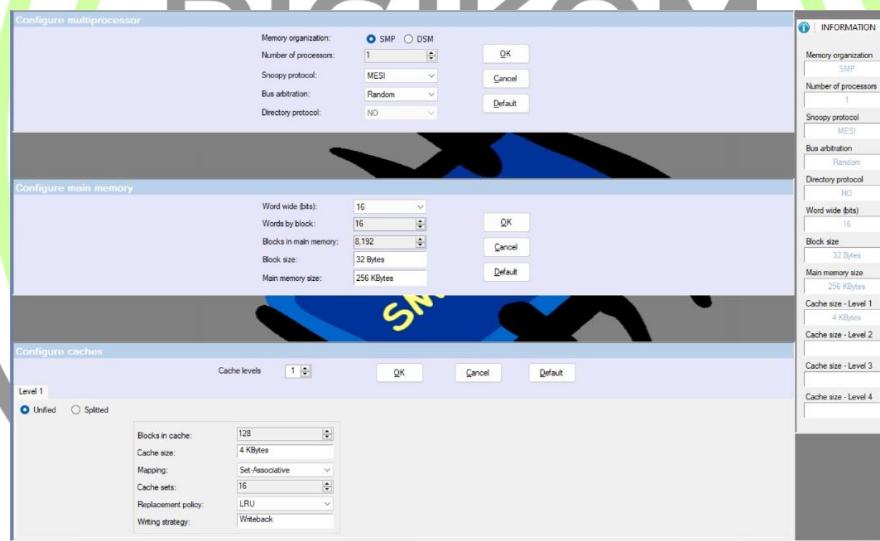




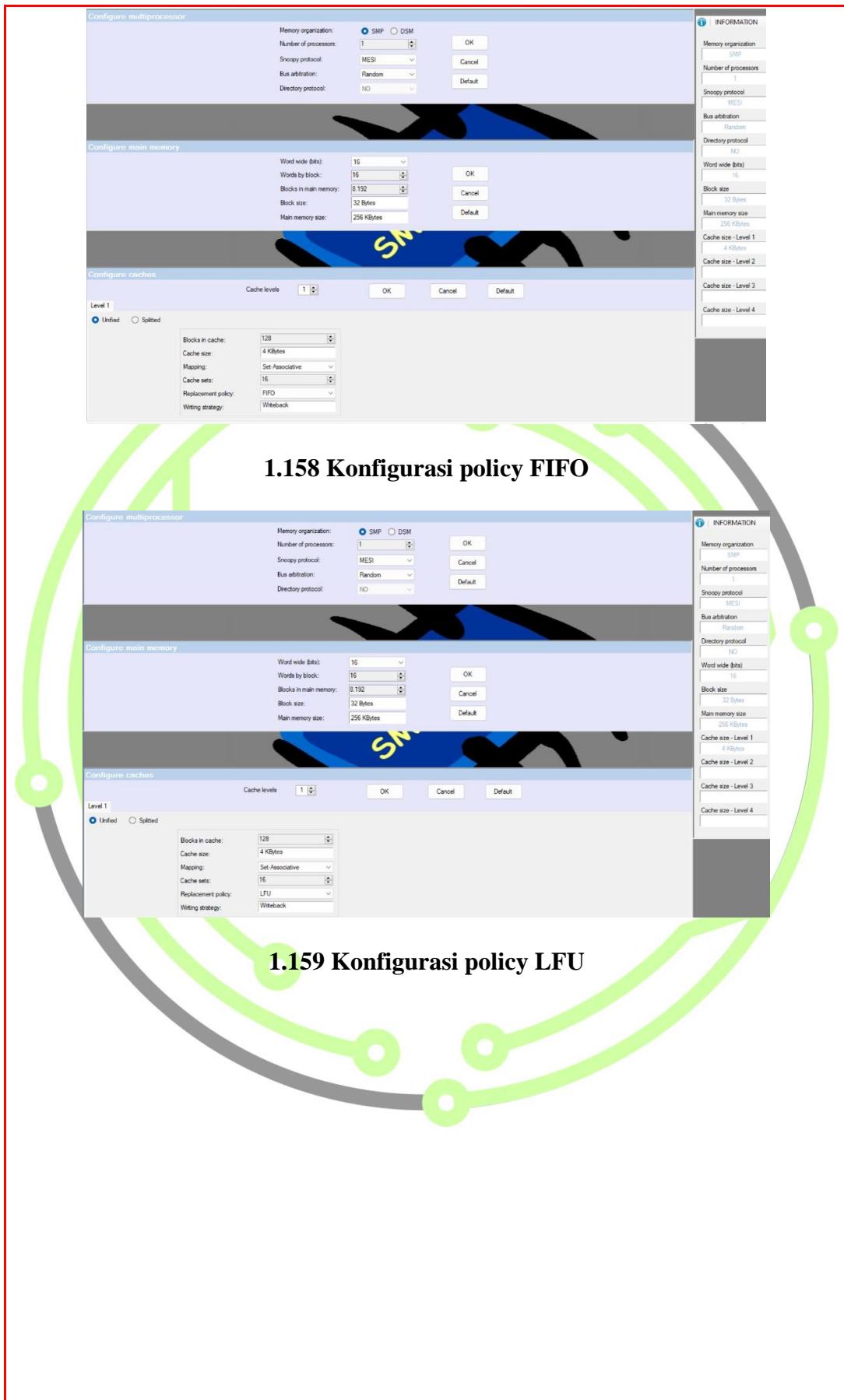
3. Percobaan 3



1.156 Konfigurasi policy Random



1.157 Konfigurasi policy LRU



1.160 Open file trace HYDRO.prg

SMPCache - Load trace

Address: D:\NGULI(AH)\SEMS\PRAK OARKOM 2\MODULS\TRACES\PRG

File name: HYDRO.prg

File mask: SMPCache trace files (*.prg, *.spr)

P# Trace file
PO HYDRO.prg

Number of processors 1

Data Trace file HYDRO.prg
Number of memory accesses 2127
Instructions 1651
Data readings 192
Data writings 264

INFORMATION

Memory organization SMP
Number of processors 1
Snoopy protocol MESI
Bus arbitration Random
Directory protocol NO
Word wide (bits) 16
Block size 32 Bytes
Main memory size 256 Kbytes
Cache size - Level 1 4 Kbytes
Cache size - Level 2
Cache size - Level 3
Cache size - Level 4

1.161 Open file trace NASA7.prg

SMPCache - Load trace

Address: D:\NGULI(AH)\SEMS\PRAK OARKOM 2\MODULS\TRACES\PRG

File name: NASA7.prg

File mask: SMPCache trace files (*.prg, *.spr)

P# Trace file
PO NASA7.prg

Number of processors 1

Data Trace file NASA7.prg
Number of memory accesses 1855
Instructions 1439
Data readings 146
Data writings 270

INFORMATION

Memory organization SMP
Number of processors 1
Snoopy protocol MESI
Bus arbitration Random
Directory protocol NO
Word wide (bits) 16
Block size 32 Bytes
Main memory size 256 Kbytes
Cache size - Level 1 4 Kbytes
Cache size - Level 2
Cache size - Level 3
Cache size - Level 4

1.162 Open file trace CEXP.prg

SMPCache - Load trace

Address: D:\NGULI(AH)\SEMS\PRAK OARKOM 2\MODULS\TRACES\PRG

File name: CEXP.prg

File mask: SMPCache trace files (*.prg, *.spr)

P# Trace file
PO CEXP.prg

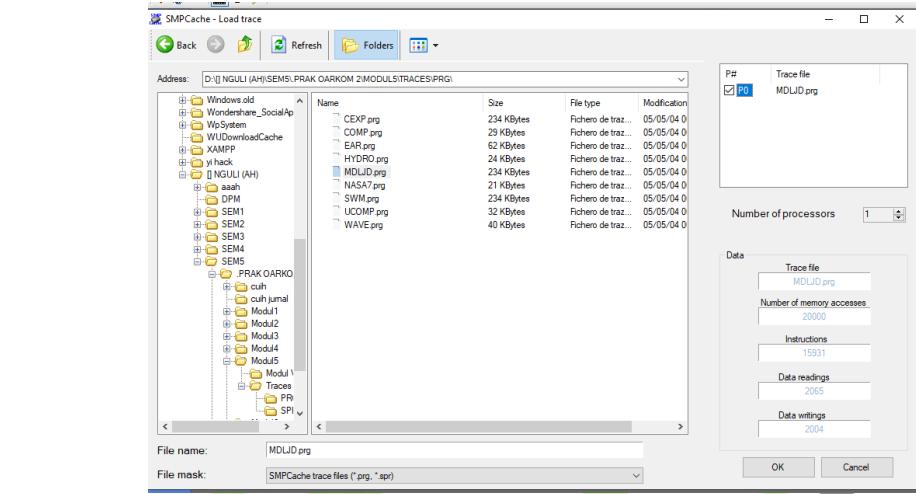
Number of processors 1

Data Trace file CEXP.prg
Number of memory accesses 2000
Instructions 18041
Data readings 1452
Data writings 507

INFORMATION

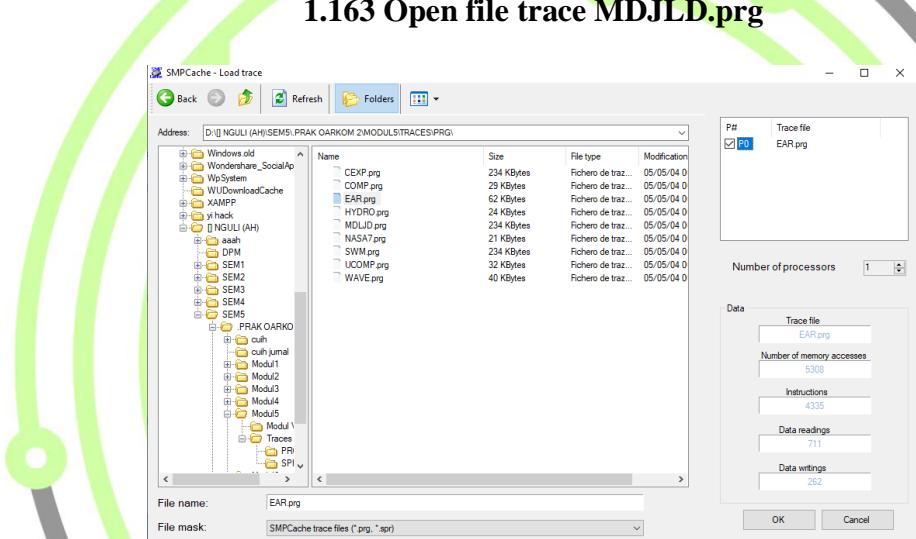
Memory organization SMP
Number of processors 1
Snoopy protocol MESI
Bus arbitration Random
Directory protocol NO
Word wide (bits) 16
Block size 32 Bytes
Main memory size 256 Kbytes
Cache size - Level 1 4 Kbytes
Cache size - Level 2
Cache size - Level 3
Cache size - Level 4

1.163 Open file trace MDJLD.prg



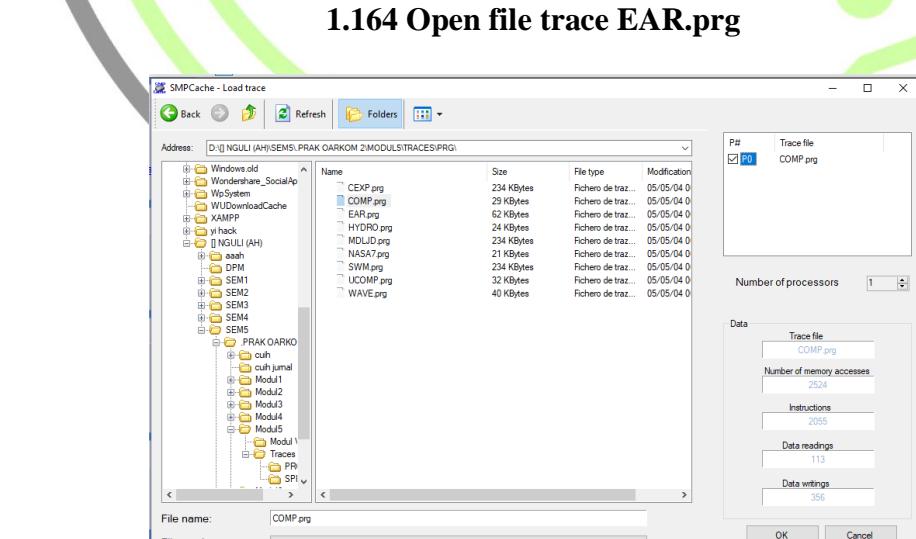
Name	Size	File type	Modification
CEXP.prg	234 KBytes	Fichero de traz...	05/05/04 0
COMP.prg	29 KBytes	Fichero de traz...	05/05/04 0
EAR.prg	62 KBytes	Fichero de traz...	05/05/04 0
HYDRO.prg	24 KBytes	Fichero de traz...	05/05/04 0
MDJLD.prg	21 KBytes	Fichero de traz...	05/05/04 0
NASA7.prg	21 KBytes	Fichero de traz...	05/05/04 0
SWM.prg	234 KBytes	Fichero de traz...	05/05/04 0
UCOMP.prg	32 KBytes	Fichero de traz...	05/05/04 0
WAVE.prg	40 KBytes	Fichero de traz...	05/05/04 0

1.164 Open file trace EAR.prg

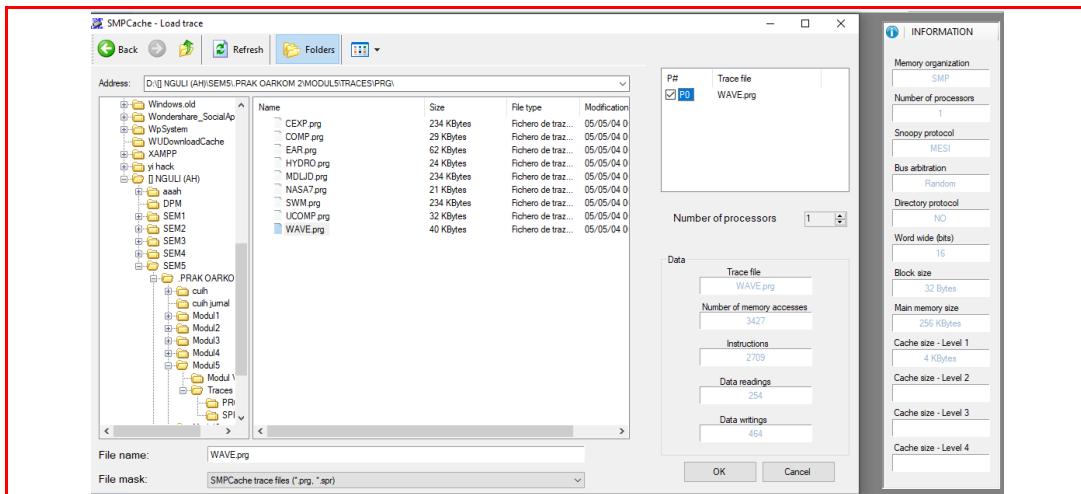


Name	Size	File type	Modification
CEXP.prg	234 KBytes	Fichero de traz...	05/05/04 0
COMP.prg	29 KBytes	Fichero de traz...	05/05/04 0
EAR.prg	62 KBytes	Fichero de traz...	05/05/04 0
HYDRO.prg	24 KBytes	Fichero de traz...	05/05/04 0
MDJLD.prg	234 KBytes	Fichero de traz...	05/05/04 0
NASA7.prg	21 KBytes	Fichero de traz...	05/05/04 0
SWM.prg	234 KBytes	Fichero de traz...	05/05/04 0
UCOMP.prg	32 KBytes	Fichero de traz...	05/05/04 0
WAVE.prg	40 KBytes	Fichero de traz...	05/05/04 0

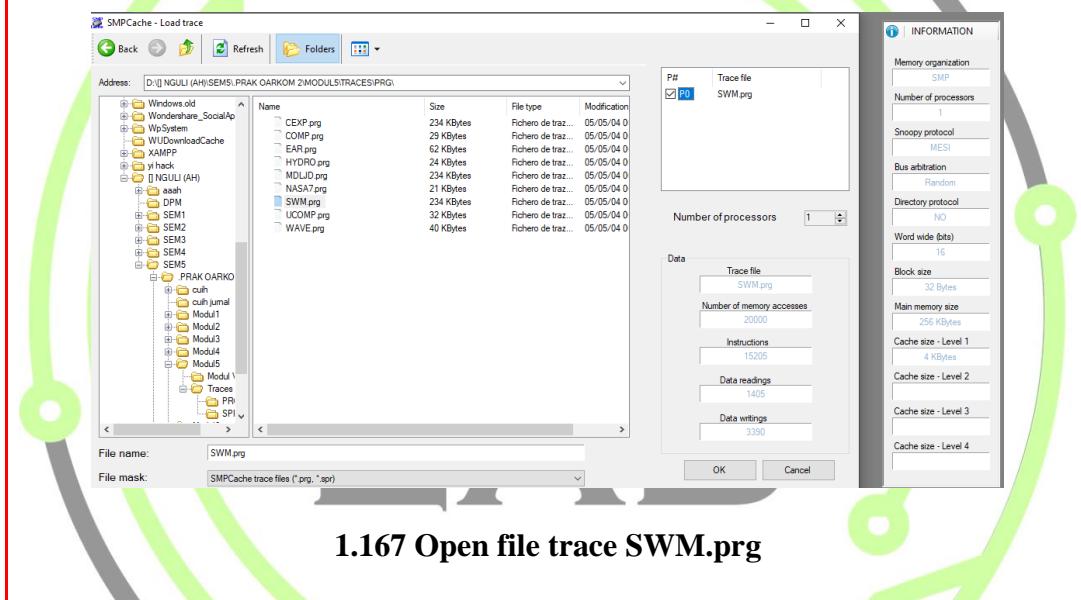
1.165 Open file trace COMP.prg



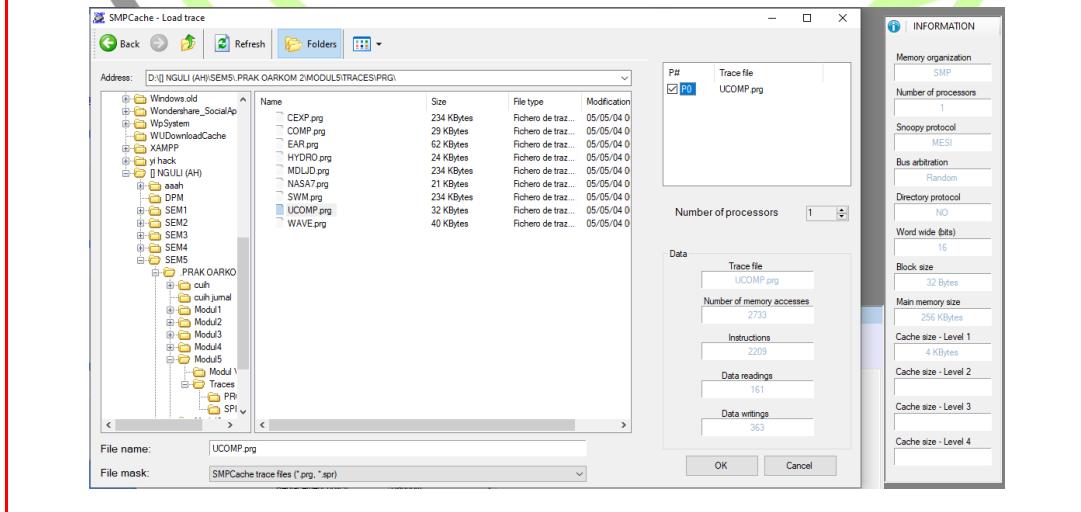
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COMP.prg	29 KBytes	Fichero de traz...	05/05/04 0
EAR.prg	62 KBytes	Fichero de traz...	05/05/04 0
HYDRO.prg	24 KBytes	Fichero de traz...	05/05/04 0
MDJLD.prg	234 KBytes	Fichero de traz...	05/05/04 0
NASA7.prg	21 KBytes	Fichero de traz...	05/05/04 0
SWM.prg	234 KBytes	Fichero de traz...	05/05/04 0
UCOMP.prg	32 KBytes	Fichero de traz...	05/05/04 0
WAVE.prg	40 KBytes	Fichero de traz...	05/05/04 0



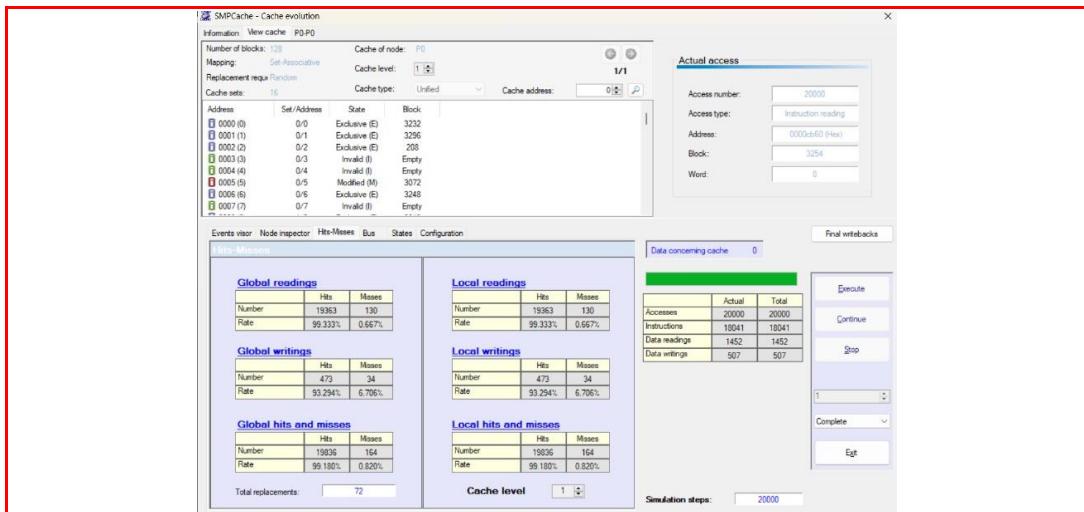
1.166 Open file trace WAVE.prg



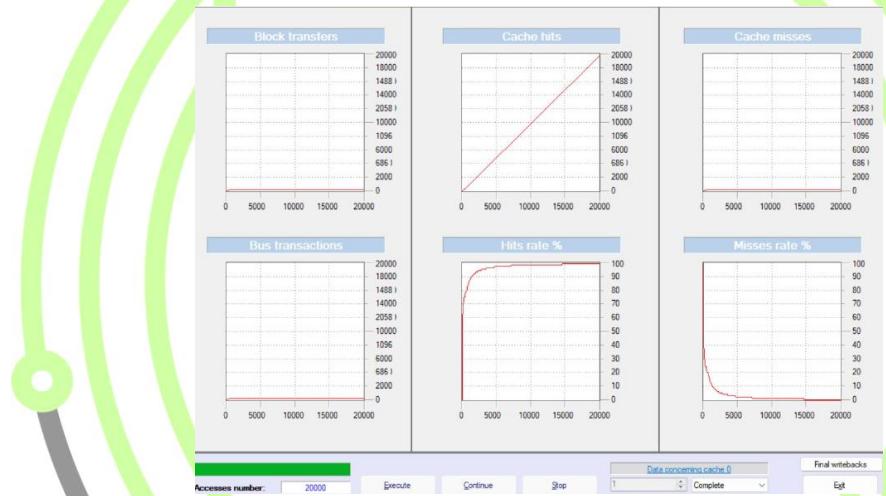
1.167 Open file trace SWM.prg



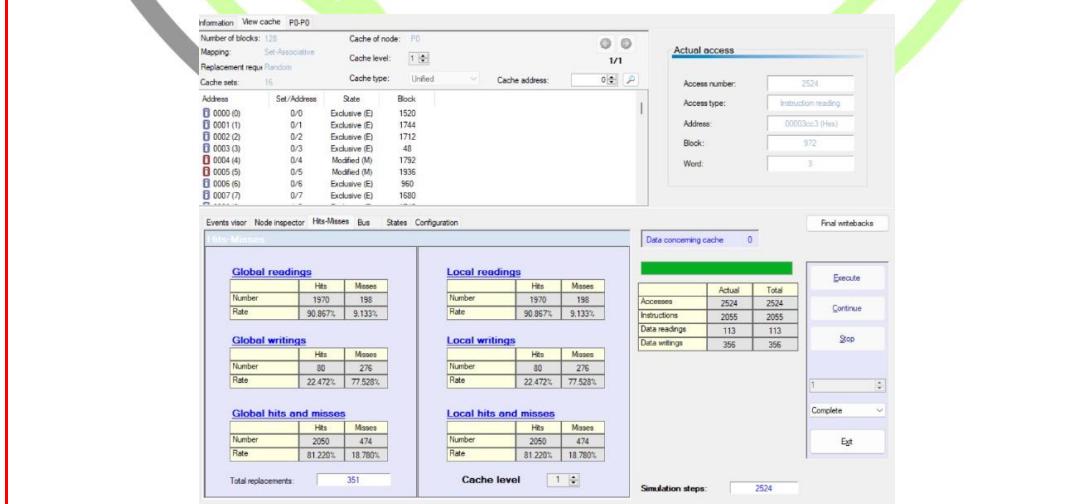
1.168 Open file trace UCOMP.prg



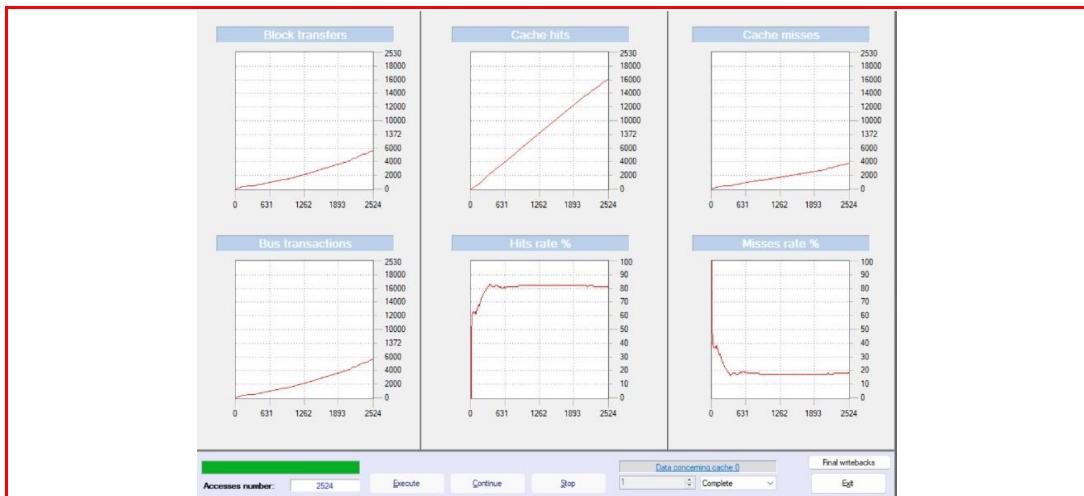
1.169 Hasil miss rate RANDOM CEXP.prg



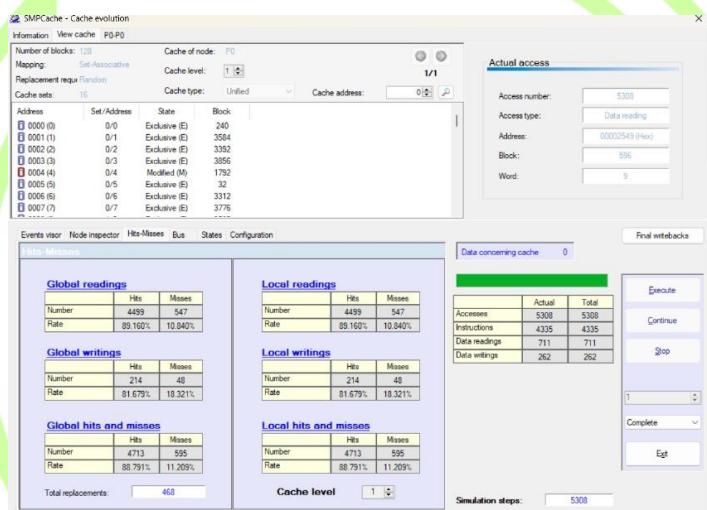
1.170 Hasil grafik RANDOM CEXP.prg



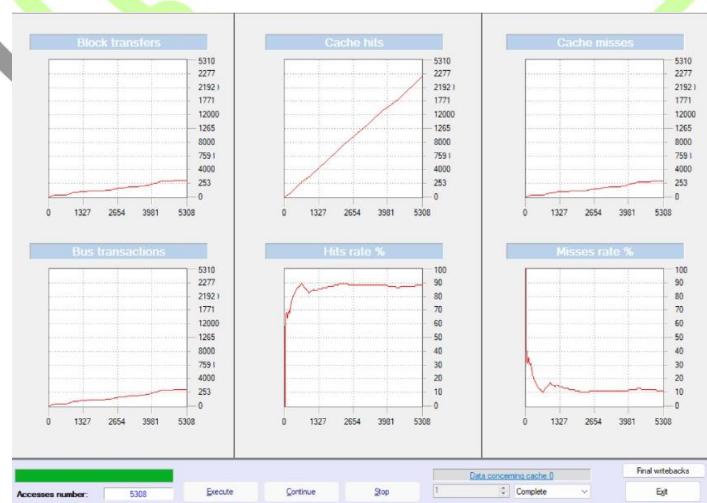
1.171 Hasil miss rate RANDOM COMP.prg



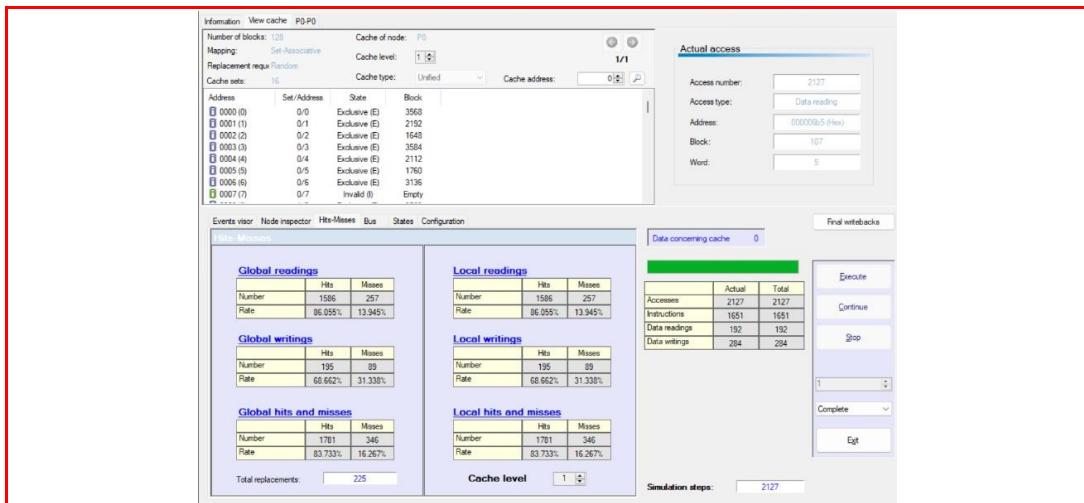
1.172 Hasil grafik RANDOM COMP.prg



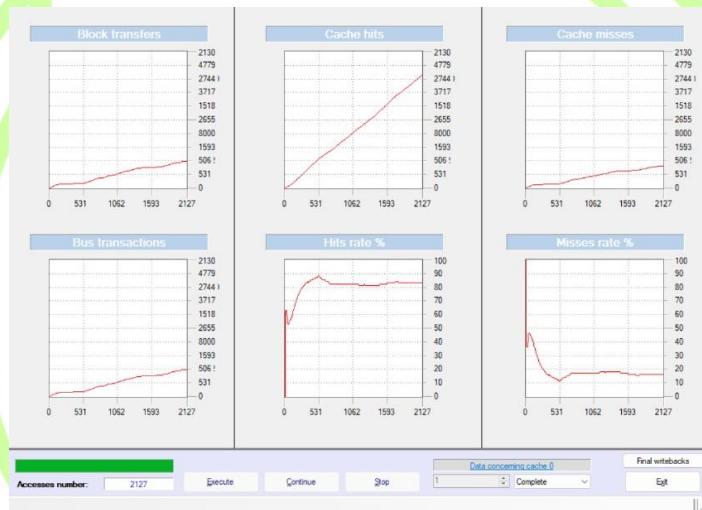
1.173 Hasil miss rate RANDOM EAR.prg



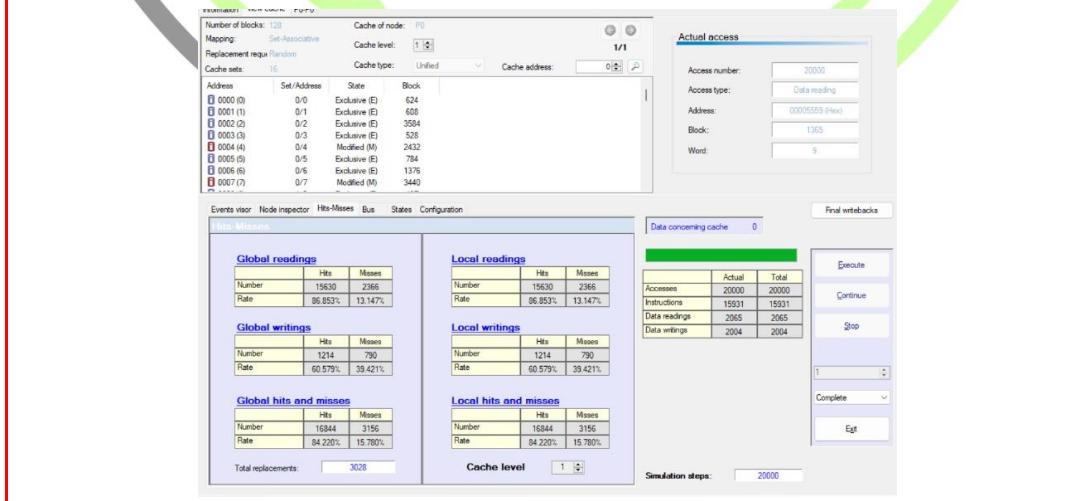
1.174 Hasil grafik RANDOM EAR.prg



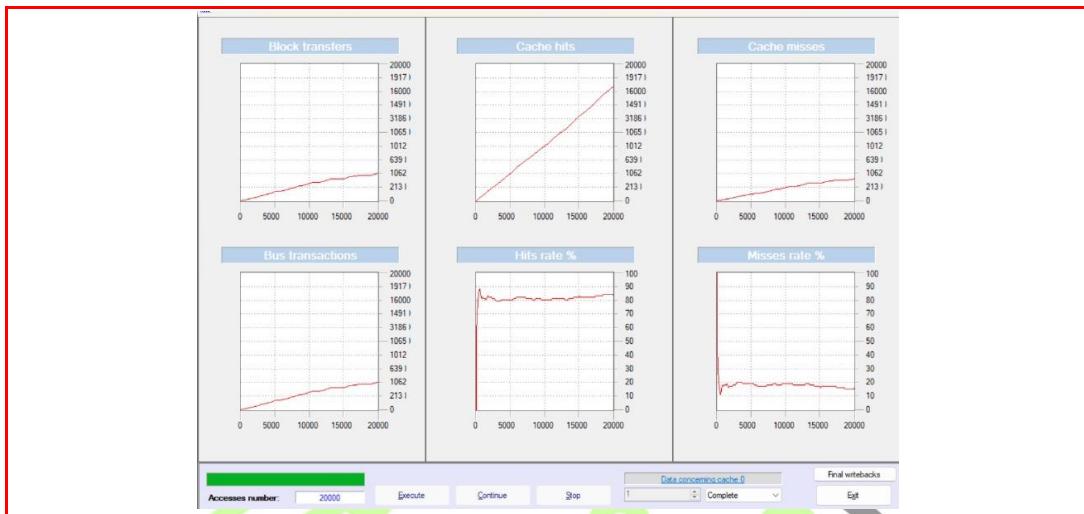
1.175 Hasil miss rate RANDOM HYDRO.prg



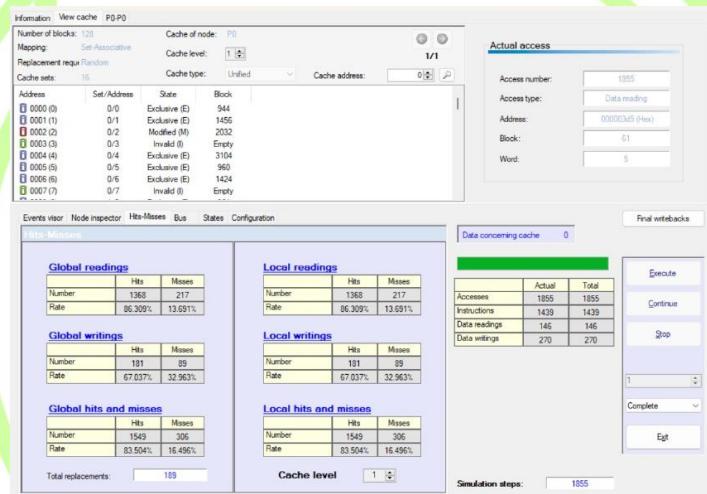
1.176 Hasil grafik RANDOM HYDRO.prg



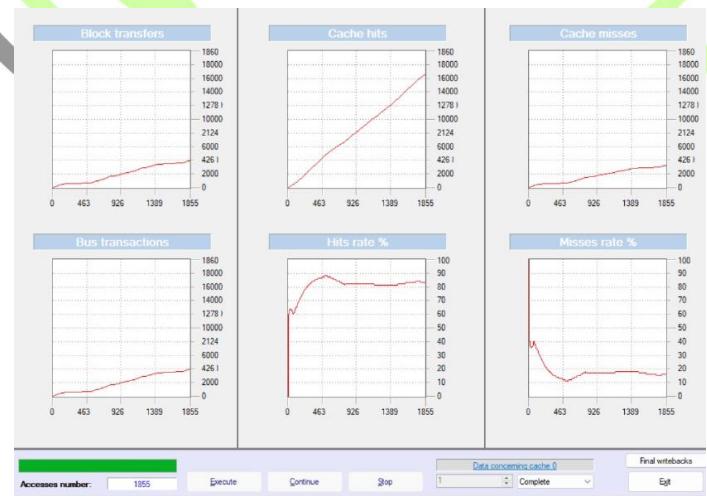
1.177 Hasil miss rate RANDOM MDLJD.prg



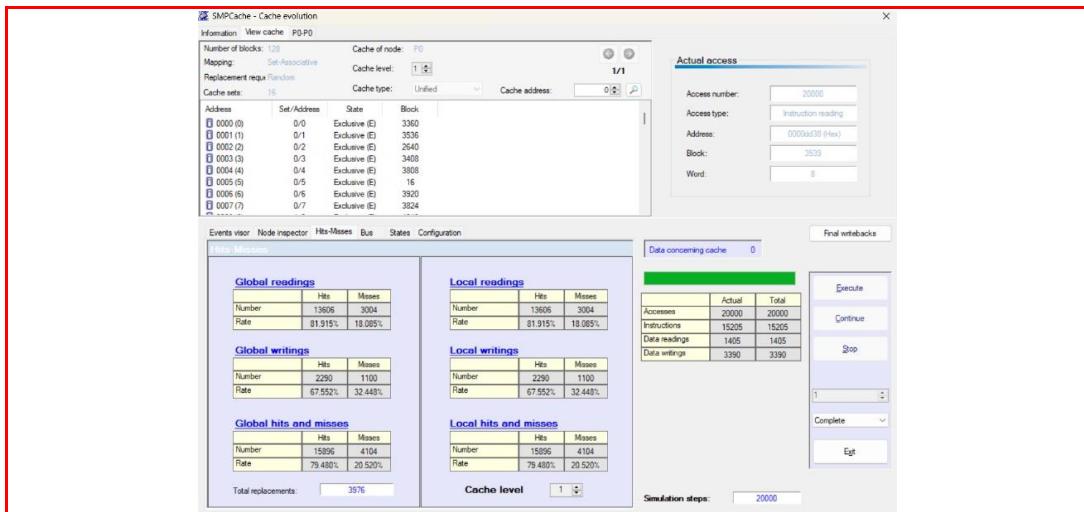
1.178 Hasil grafik RANDOM MDLJD.prg



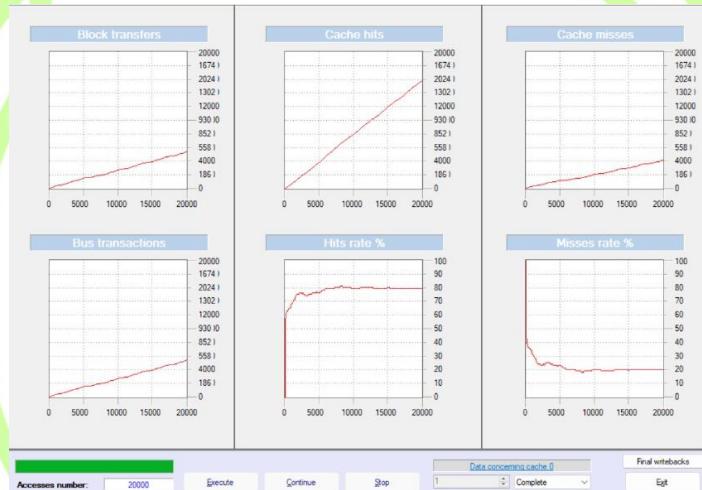
1.179 Hasil miss rate RANDOM NASA7.prg



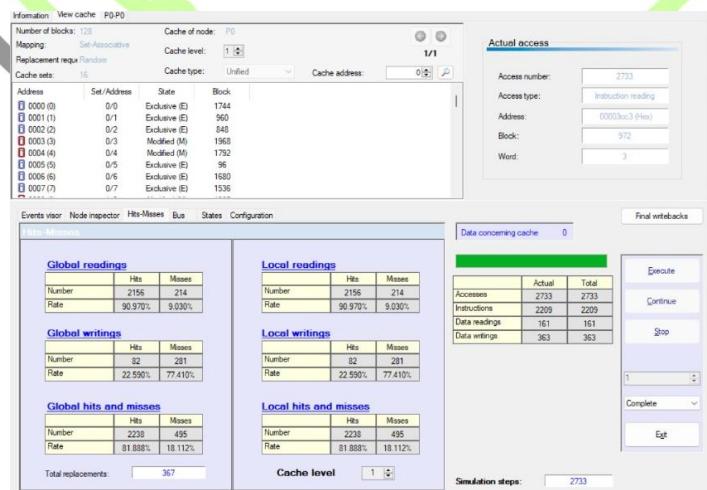
1.180 Hasil grafik RANDOM NASA7.prg



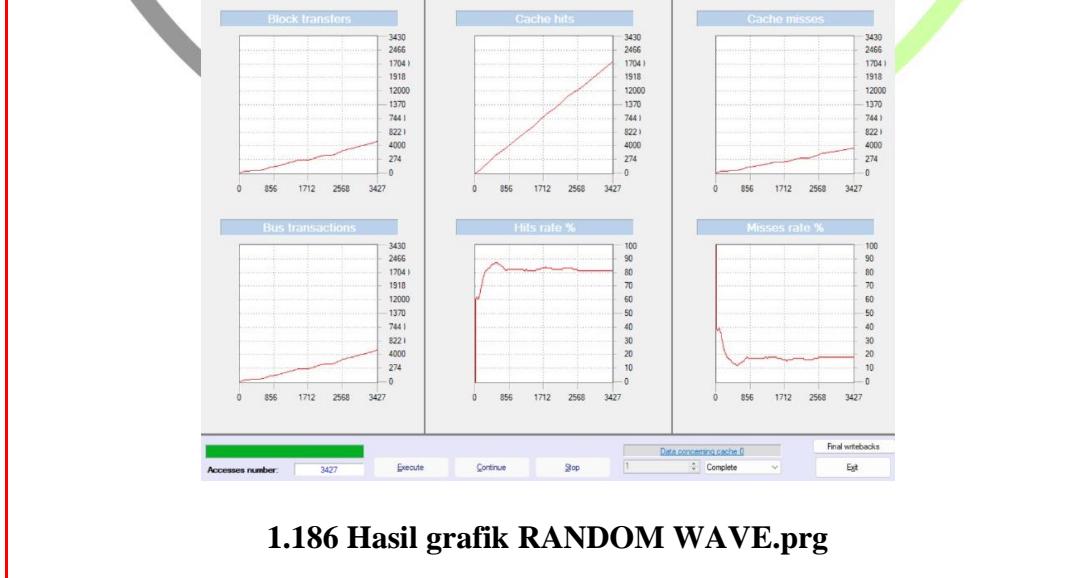
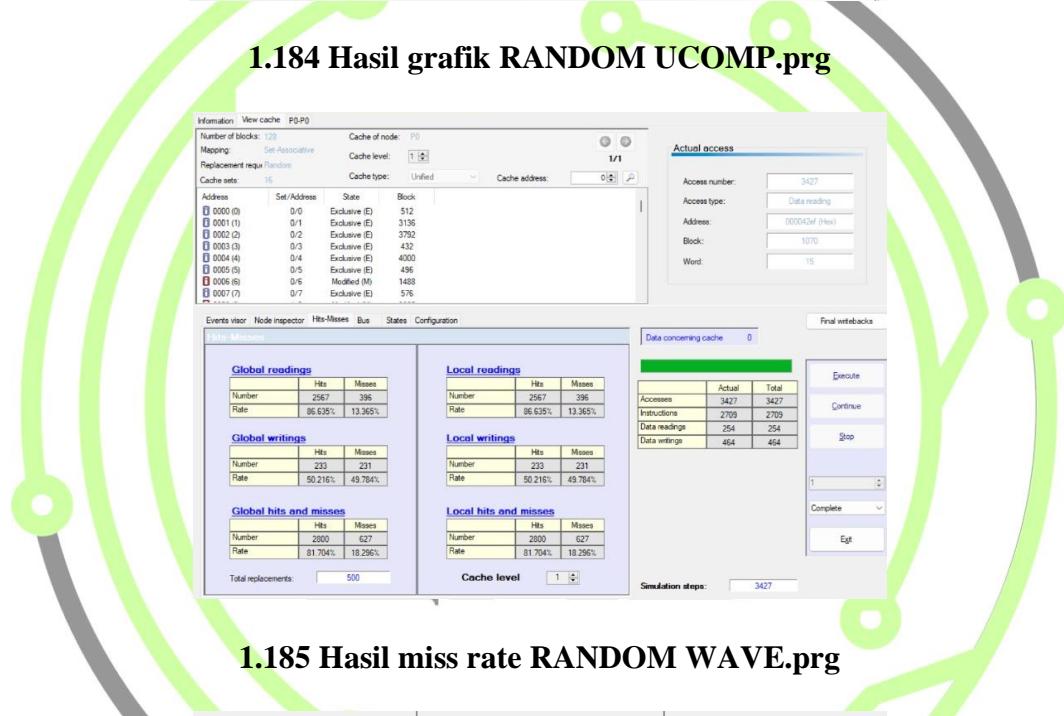
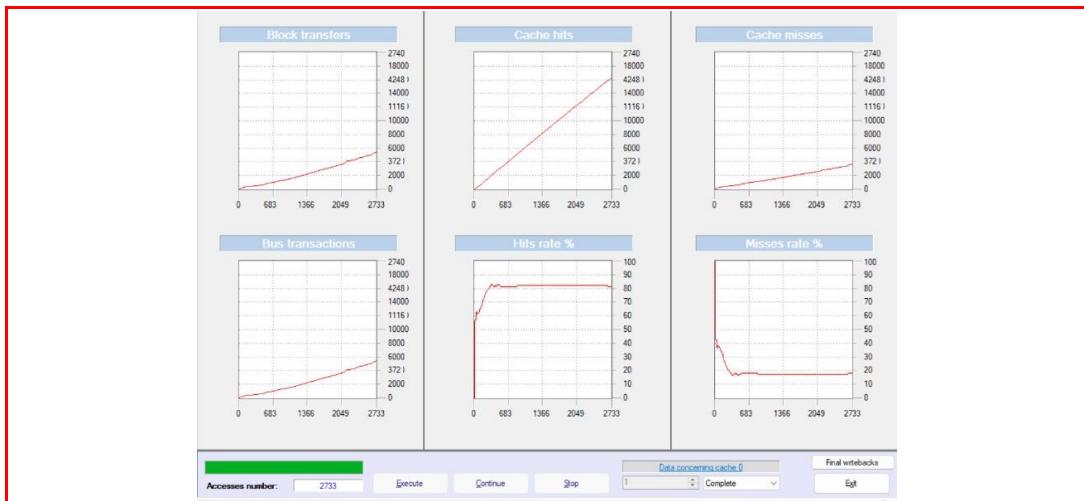
1.181 Hasil miss rate RANDOM SWM.prg

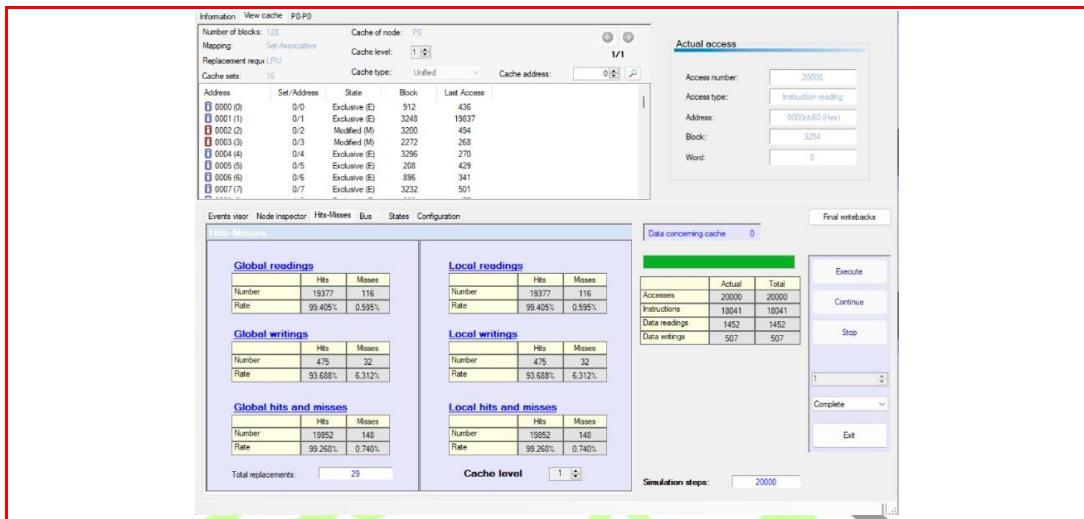


1.182 Hasil grafik RANDOM SWM.prg

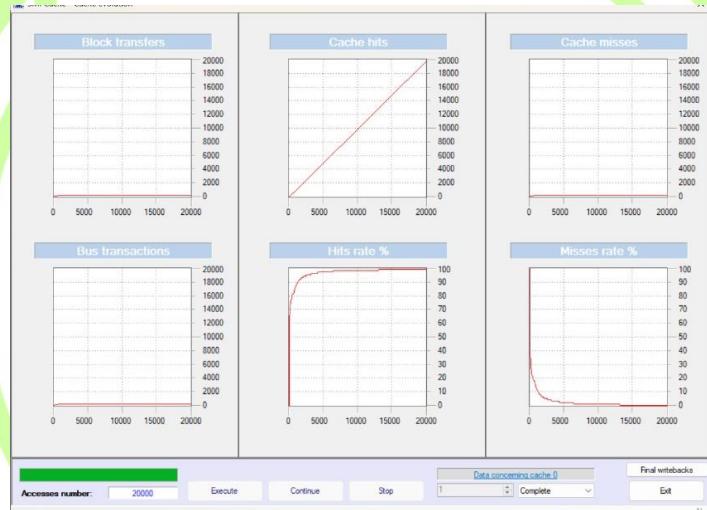


1.183 Hasil miss rate RANDOM UCOMP.prg

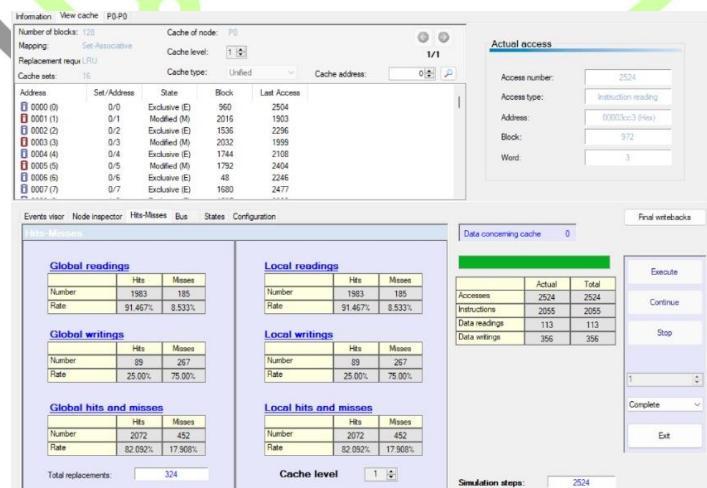




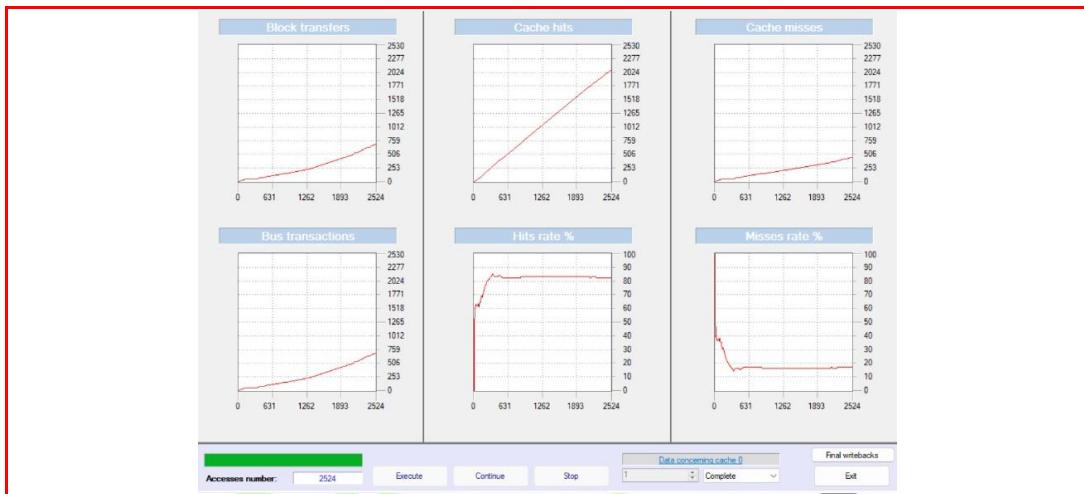
1.187 Hasil miss rate LRU CEXP.prg



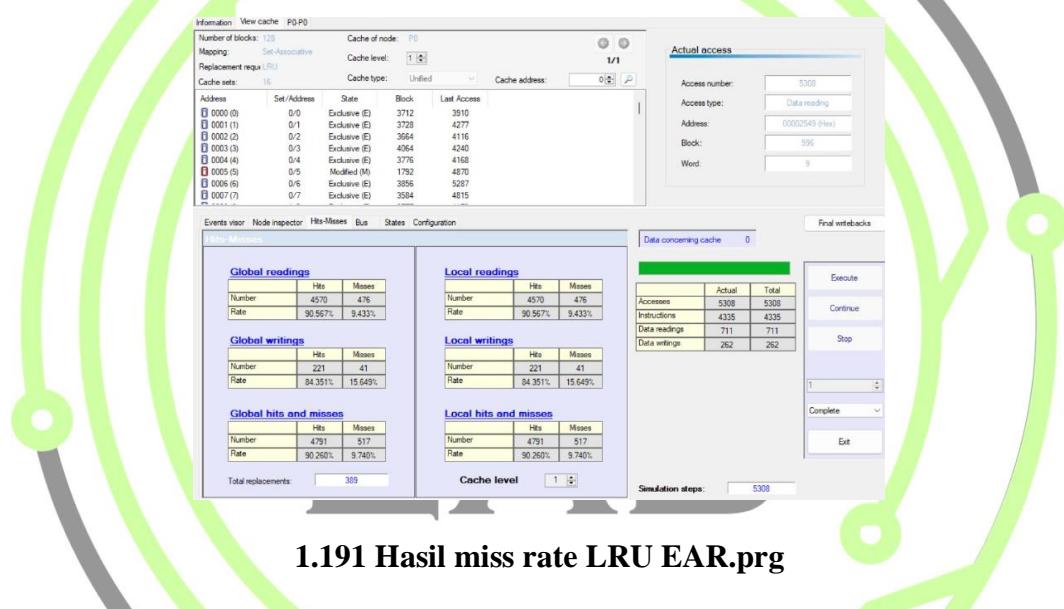
1.188 Hasil grafik LRU CEXP.prg



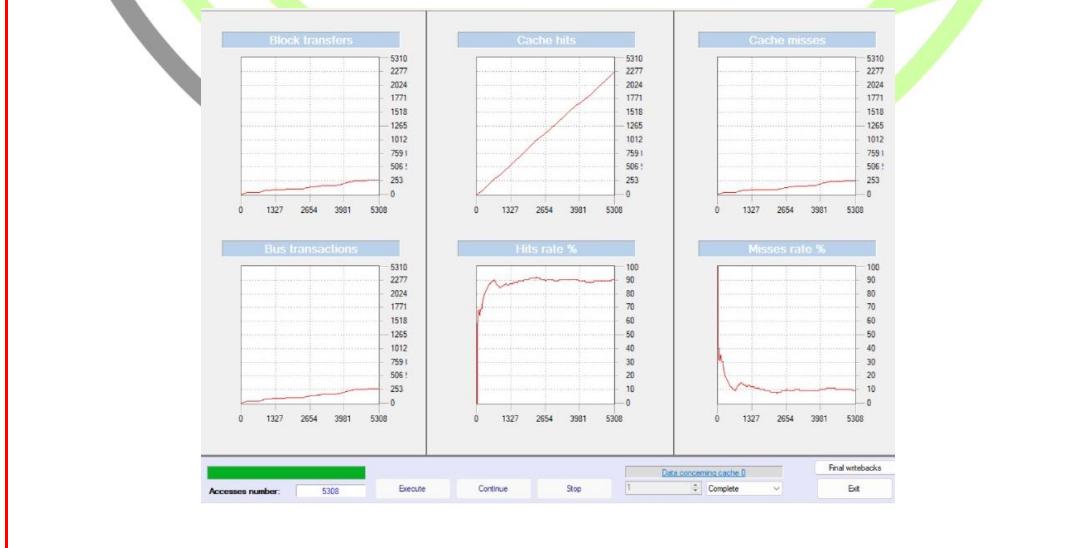
1.89 Hasil miss rate LRU COMP.prg



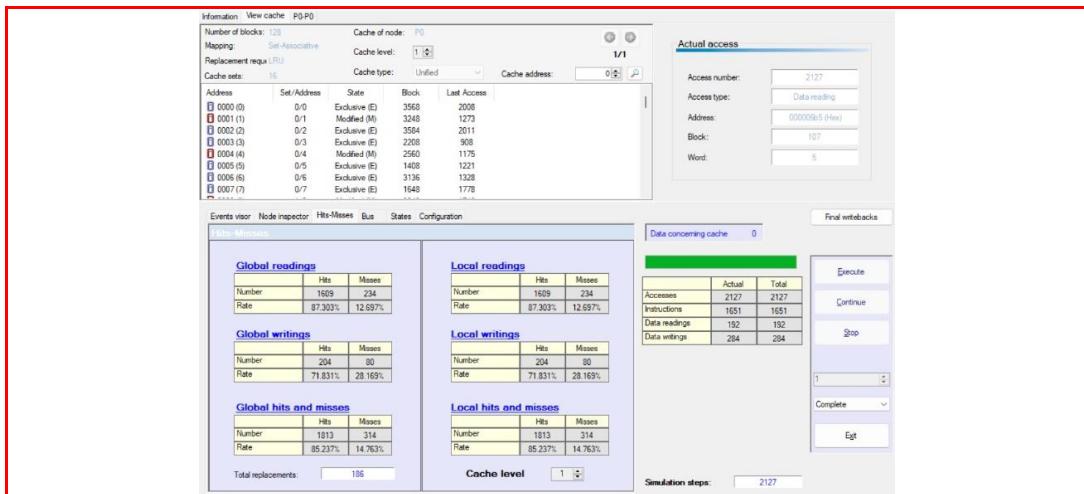
1.190 Hasil grafik LRU COMP.prg



1.191 Hasil miss rate LRU EAR.prg



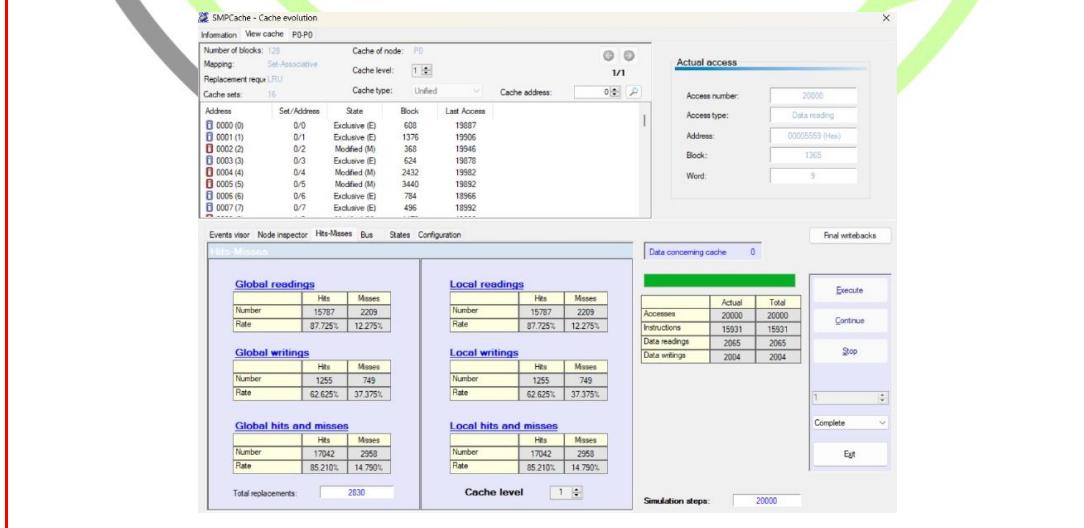
1.192 Hasil grafik LRU EAR.prg



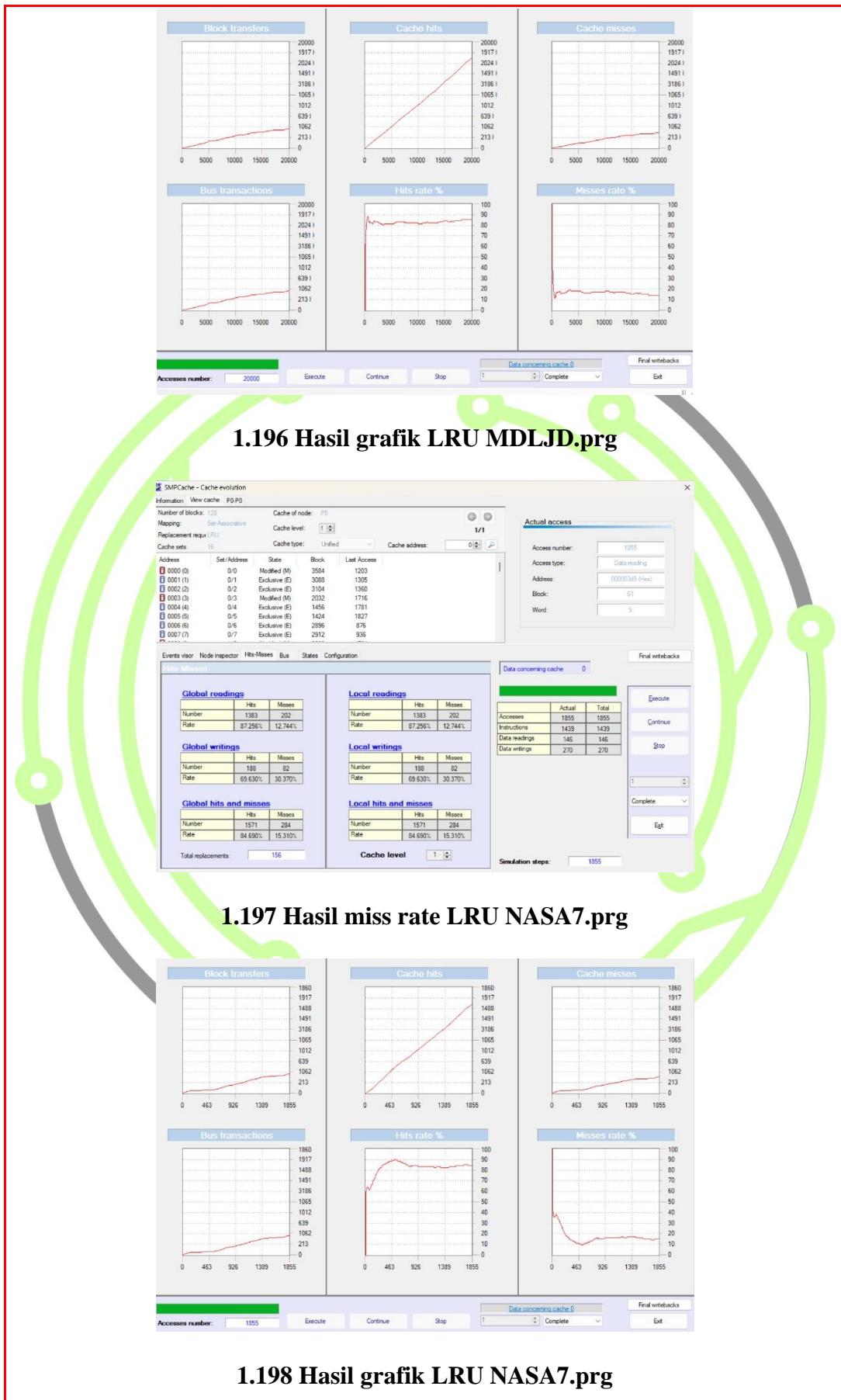
1.193 Hasil miss rate LRU HYDRO.prg

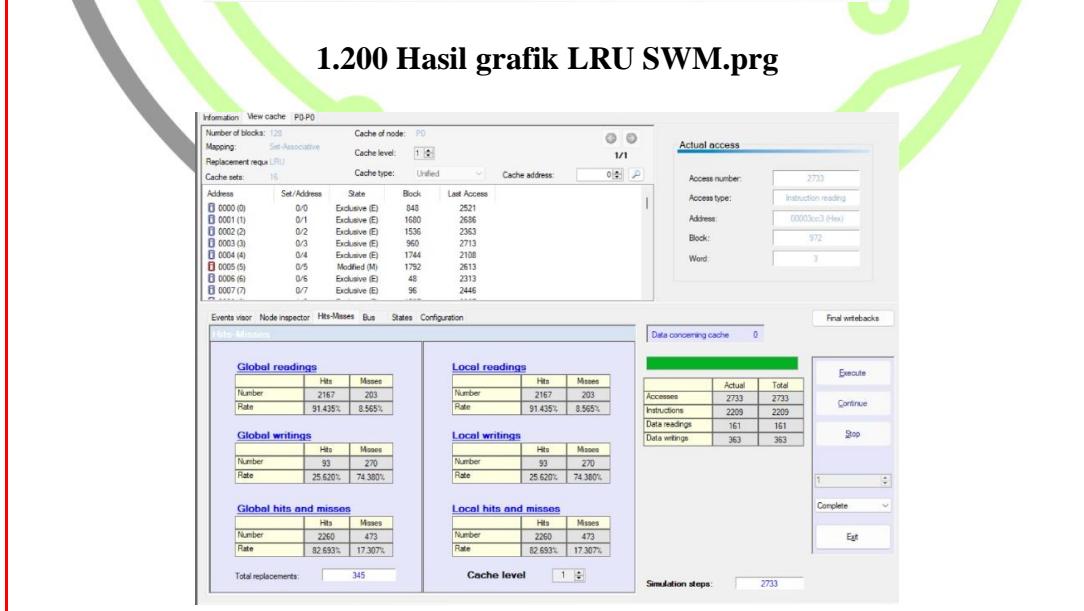
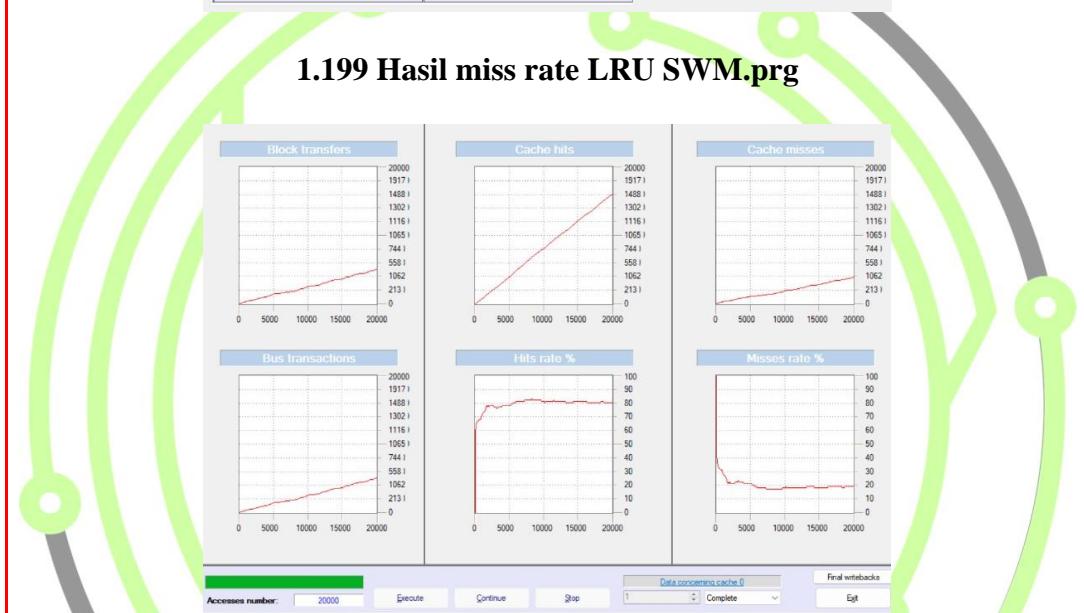
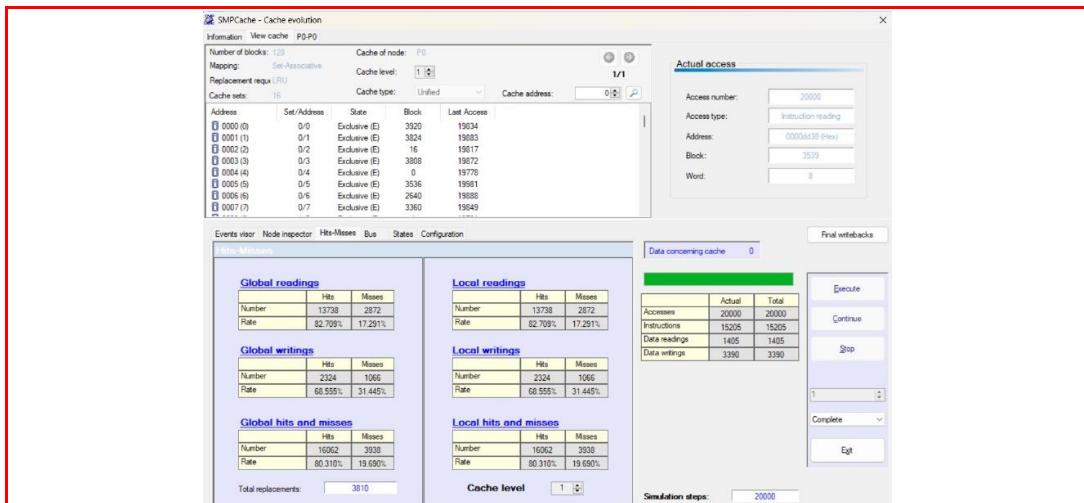


1.194 Hasil grafik LRU HYDRO.prg



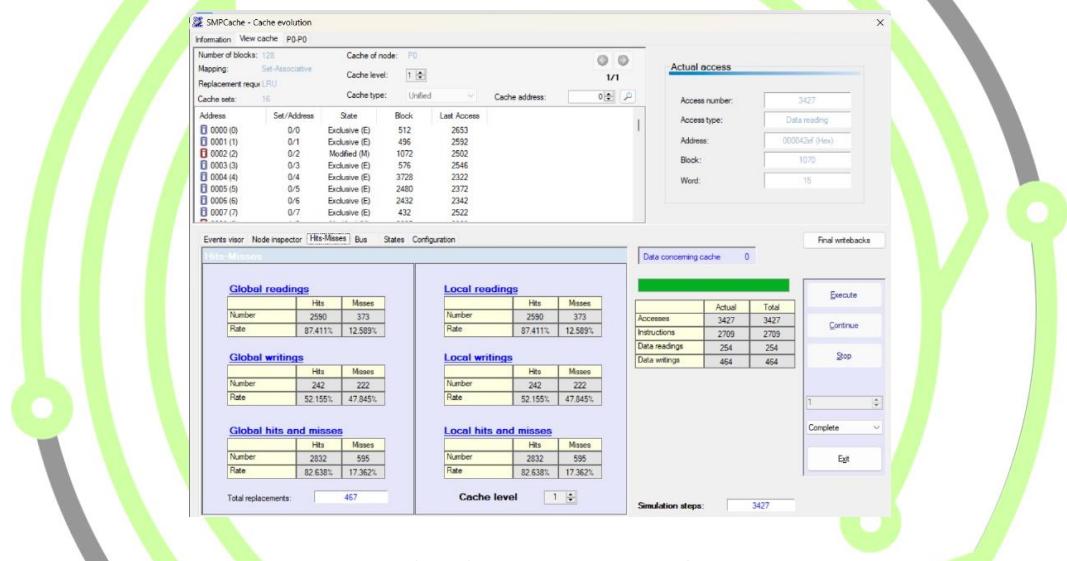
1.195 Hasil miss rate LRU MDLJD.prg



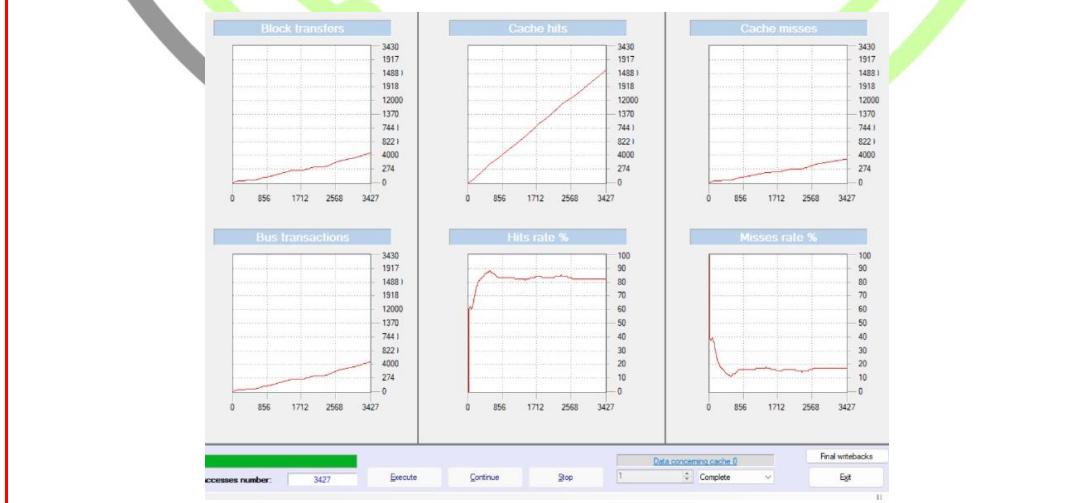




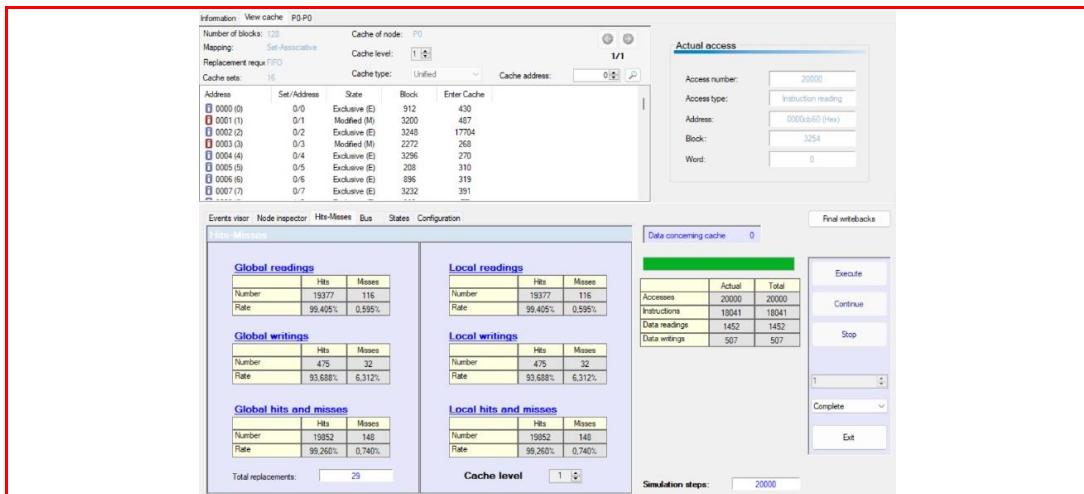
1.202 Hasil grafik LRU UCOMP.prg



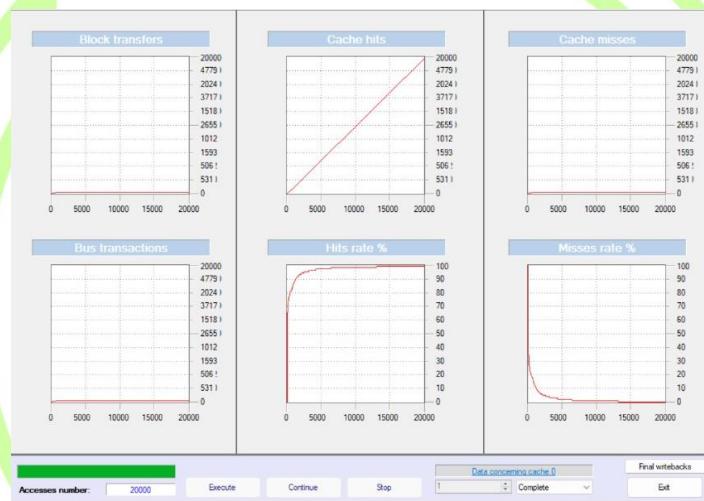
1.203 Hasil miss rate LRU WAVE.prg



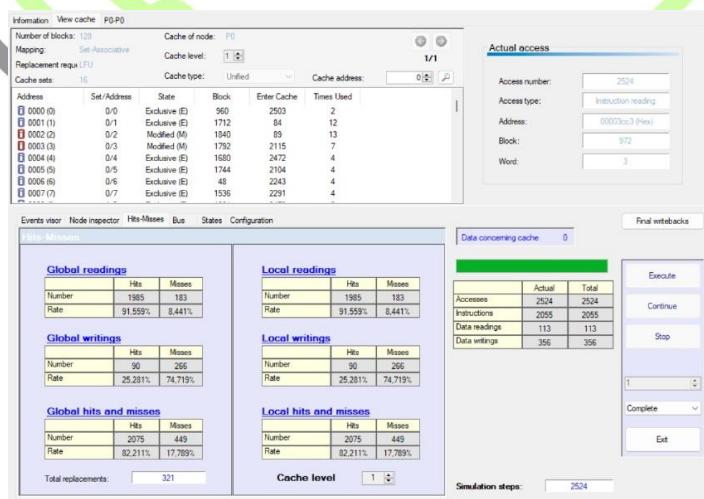
1.204 Hasil grafik LRU WAVE.prg



1.205 Hasil miss rate FIFO CEXP.prg



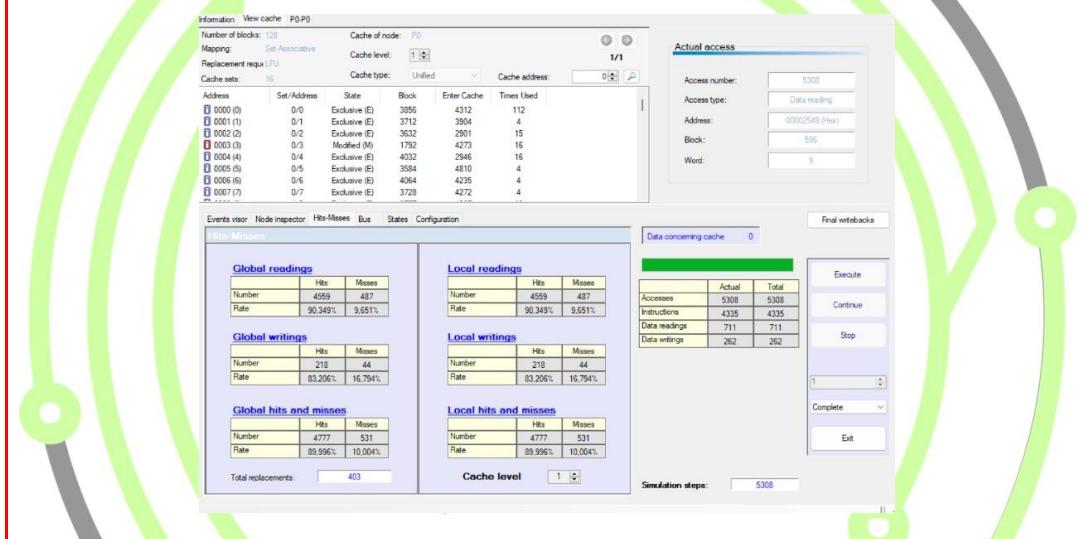
1.206 Hasil grafik FIFO CEXP.prg



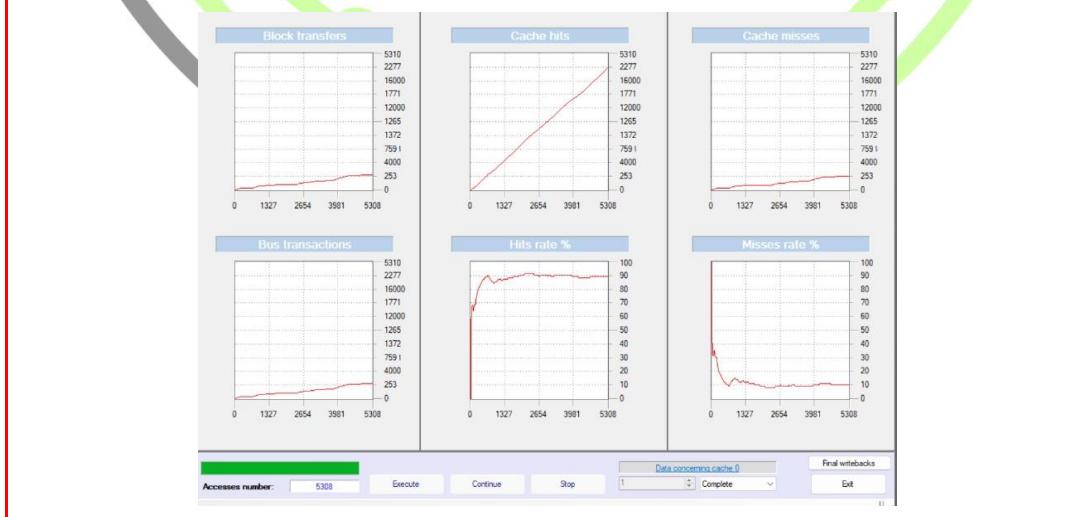
1.207 Hasil miss rate FIFO COMP.prg



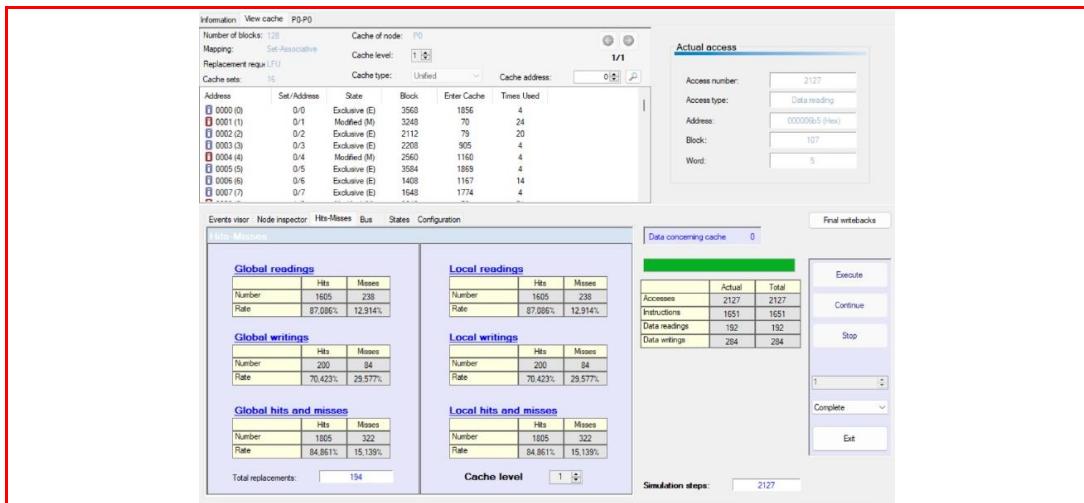
1.208 Hasil grafik FIFO COMP.prg



1.209 Hasil miss rate FIFO EAR.prg



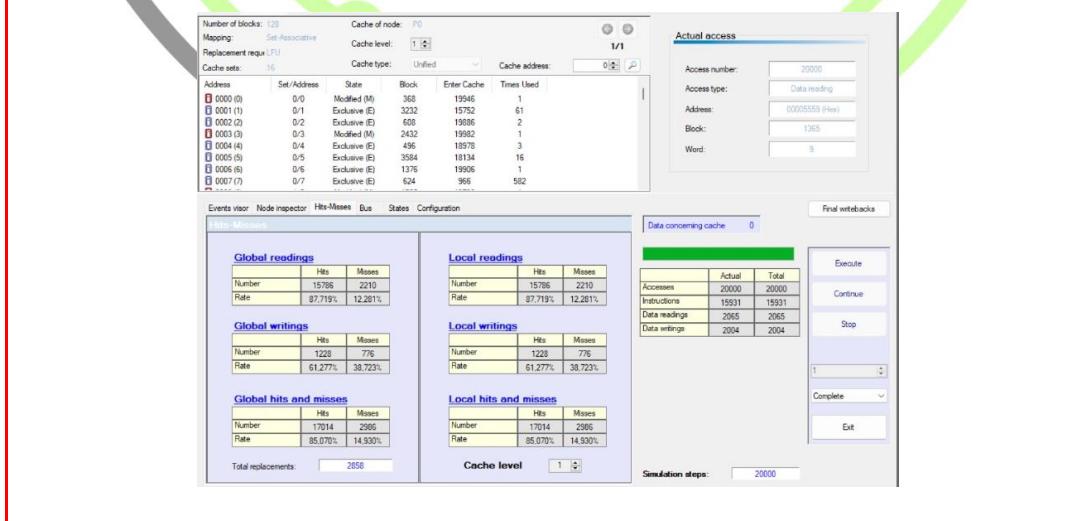
1.210 Hasil grafik FIFO EAR.prg



1.211 Hasil miss rate FIFO HYDRO.prg



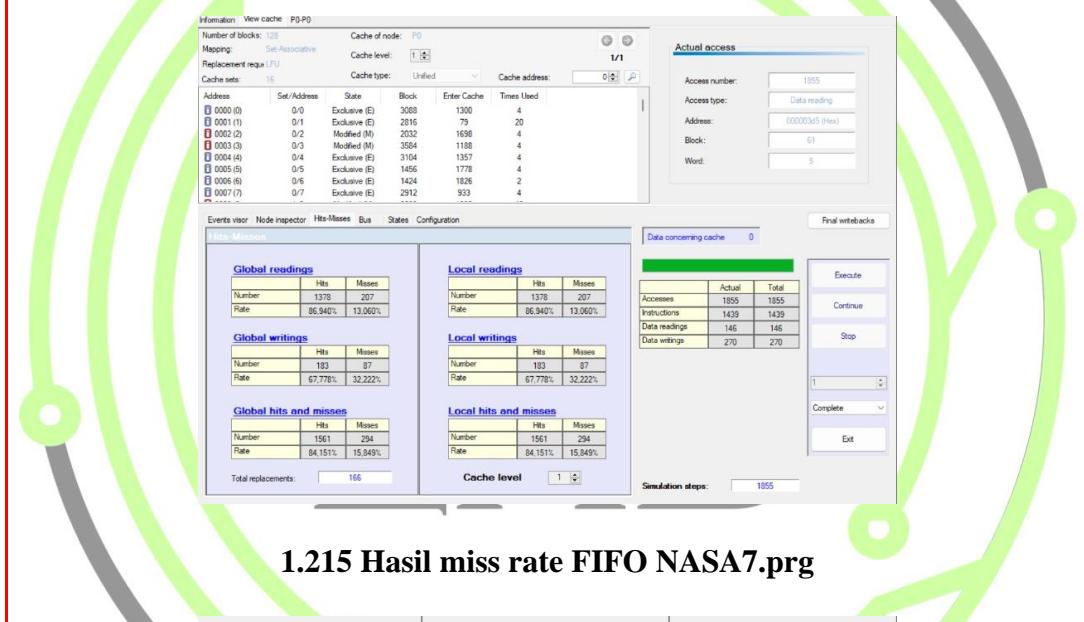
1.212 Hasil grafik FIFO HYDRO.prg



1.213 Hasil miss rate FIFO MDLJD.prg



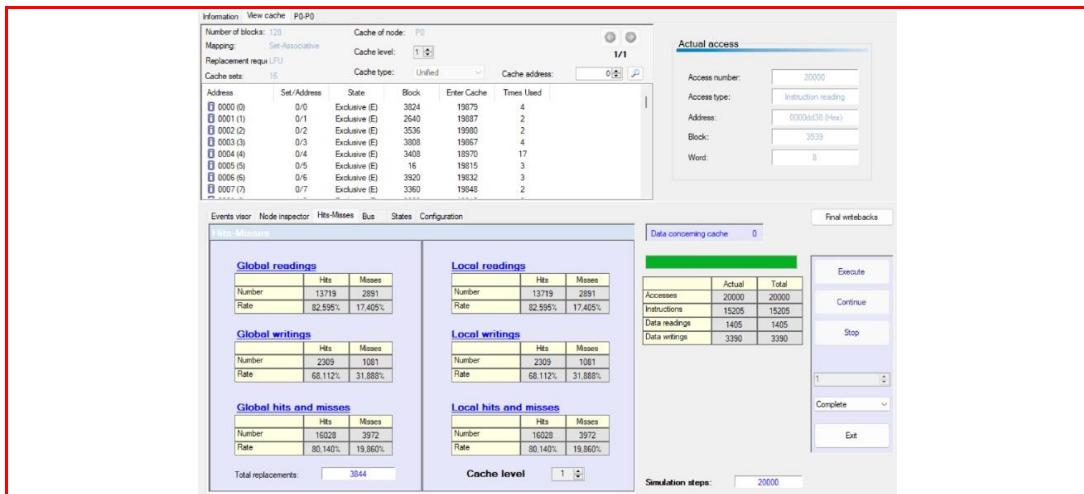
1.214 Hasil grafik FIFO MDLJD.prg



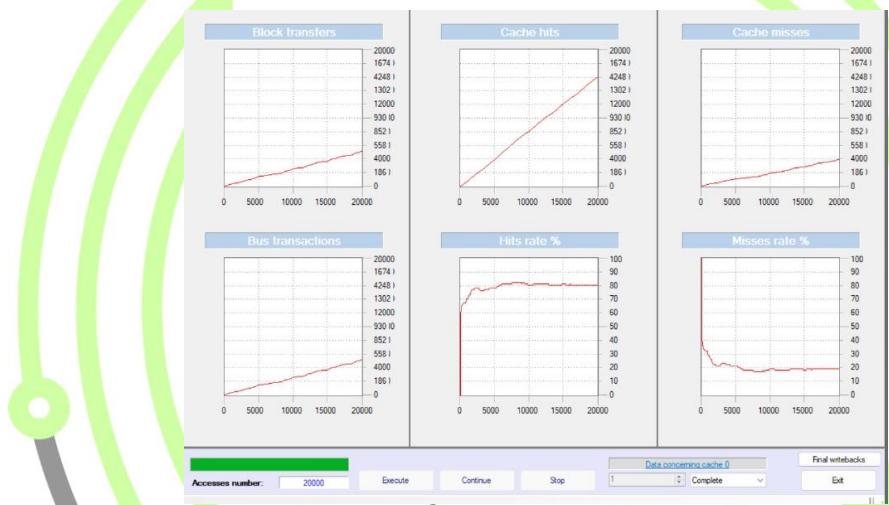
1.215 Hasil miss rate FIFO NASA7.prg



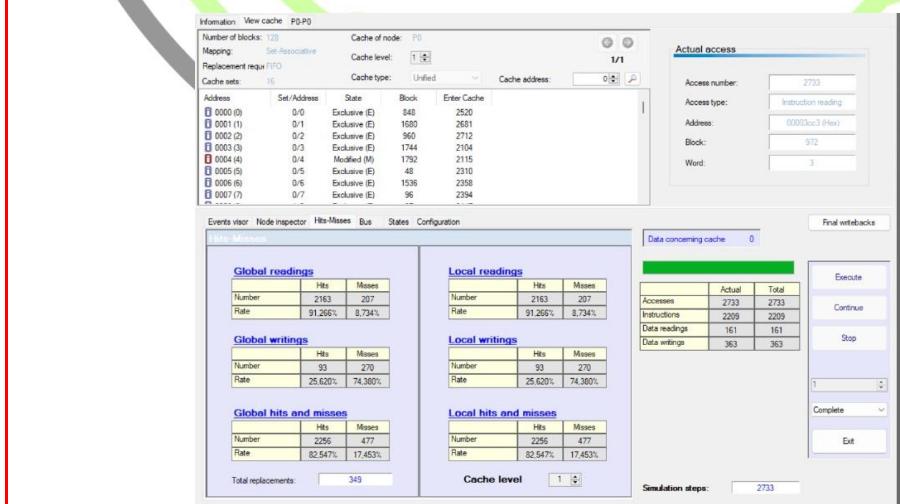
2.216 Hasil grafik FIFO NASA7.prg



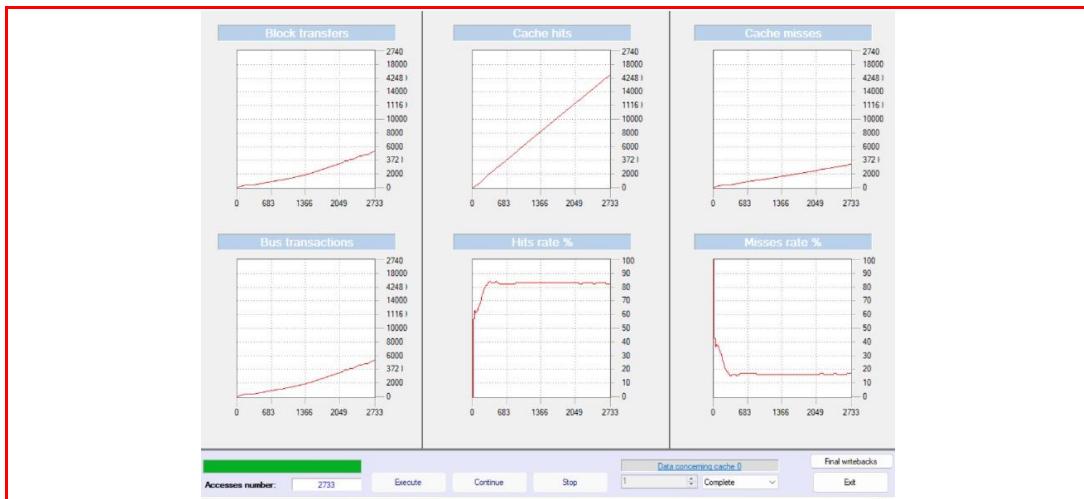
1.217 Hasil miss rate FIFO SWM.prg



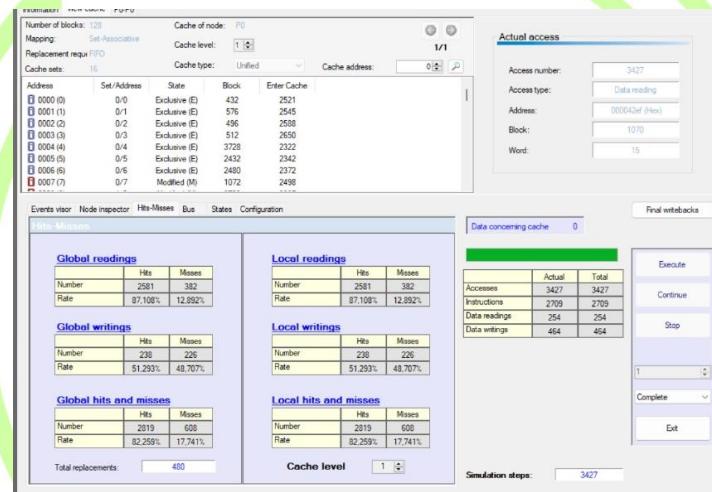
1.218 Hasil grafik FIFO SWM.prg



1.219 Hasil miss rate FIFO UCOMP.prg



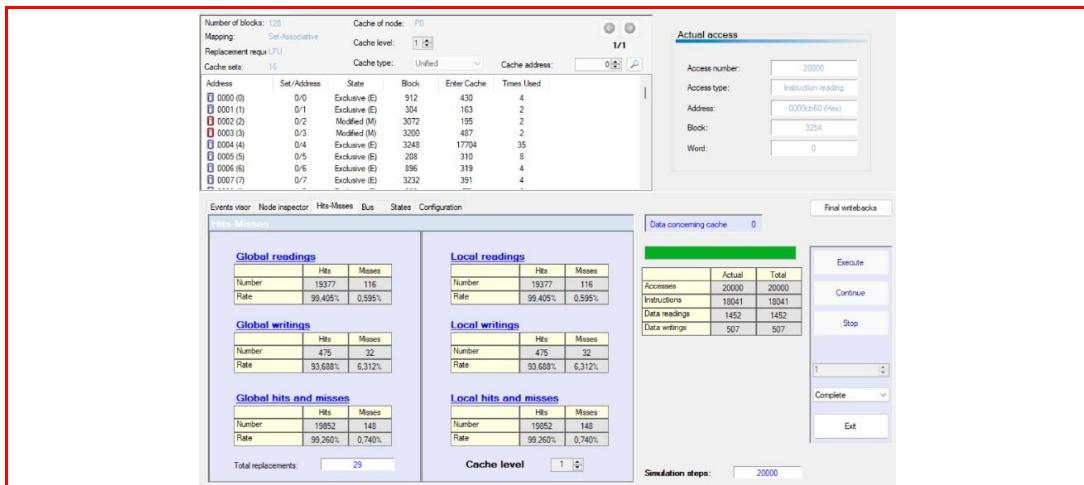
1.220 Hasil grafik FIFO UCOMP.prg



1.221 Hasil miss rate FIFO WAVE.prg



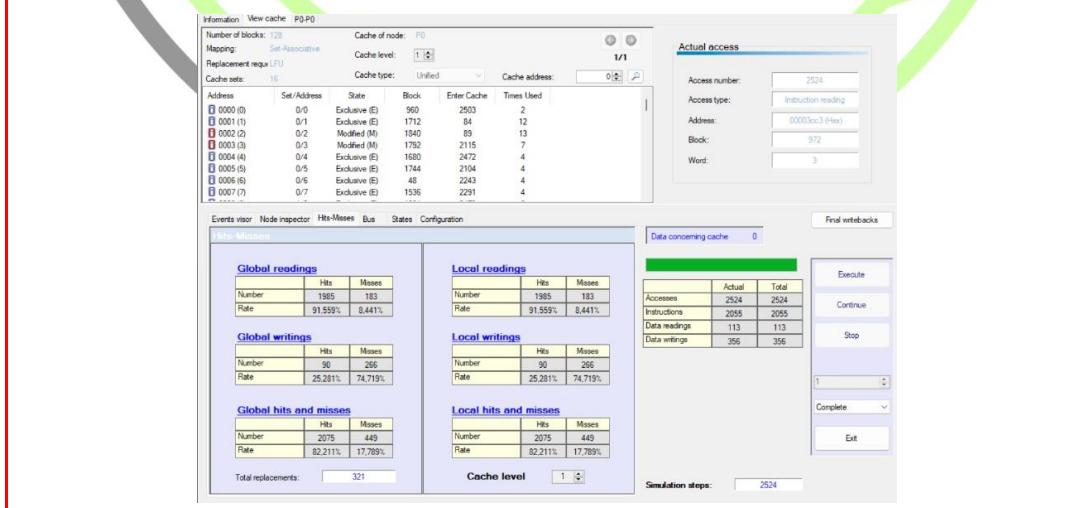
1.222 Hasil grafik FIFO WAVE.prg



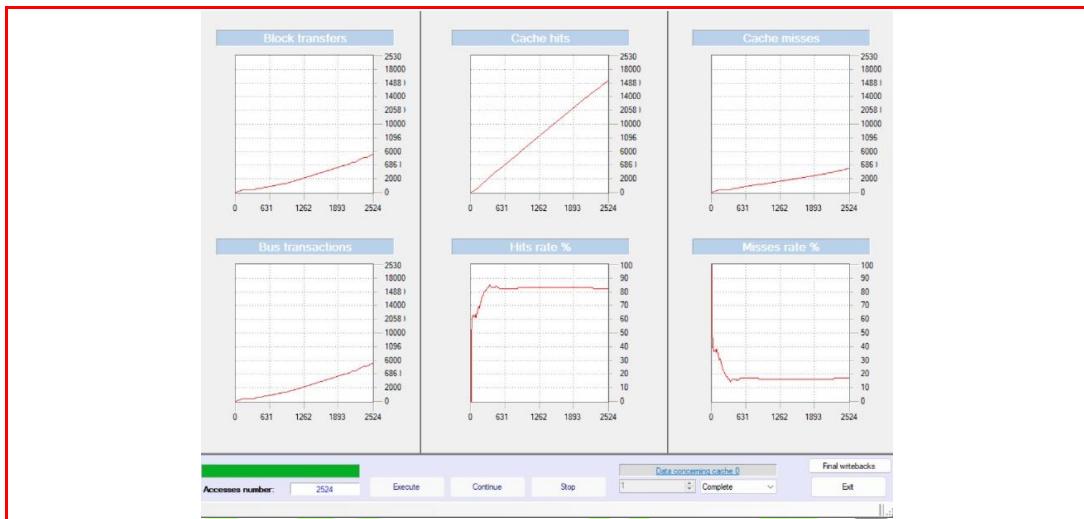
1.223 Hasil miss rate LFU CEXP.prg



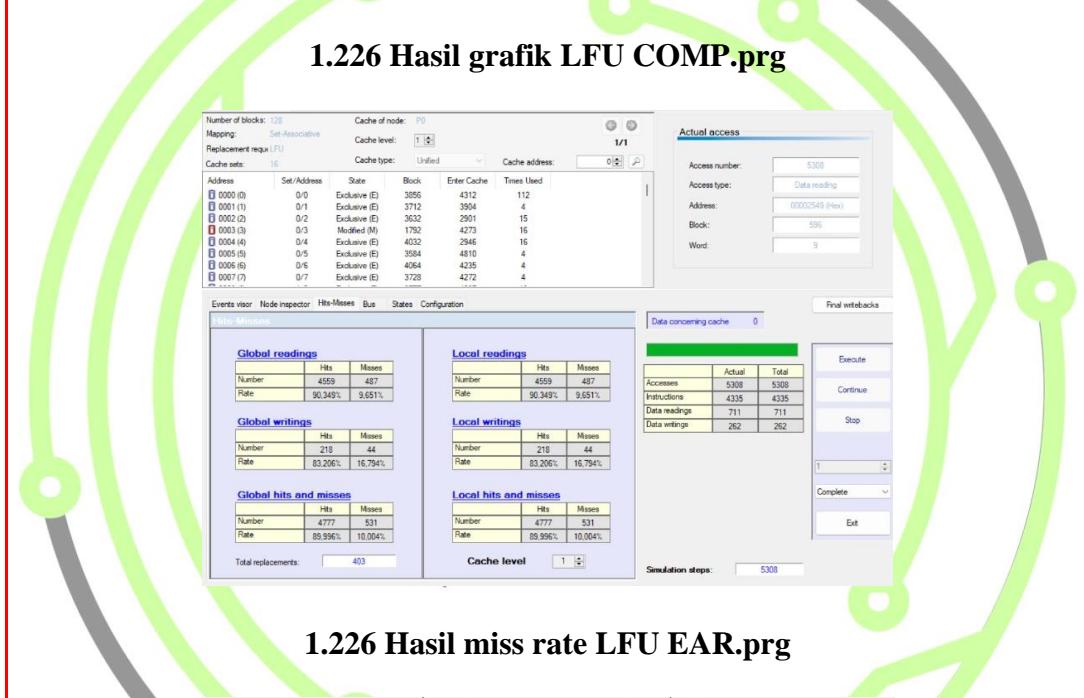
1.224 Hasil grafik LFU CEXP.prg



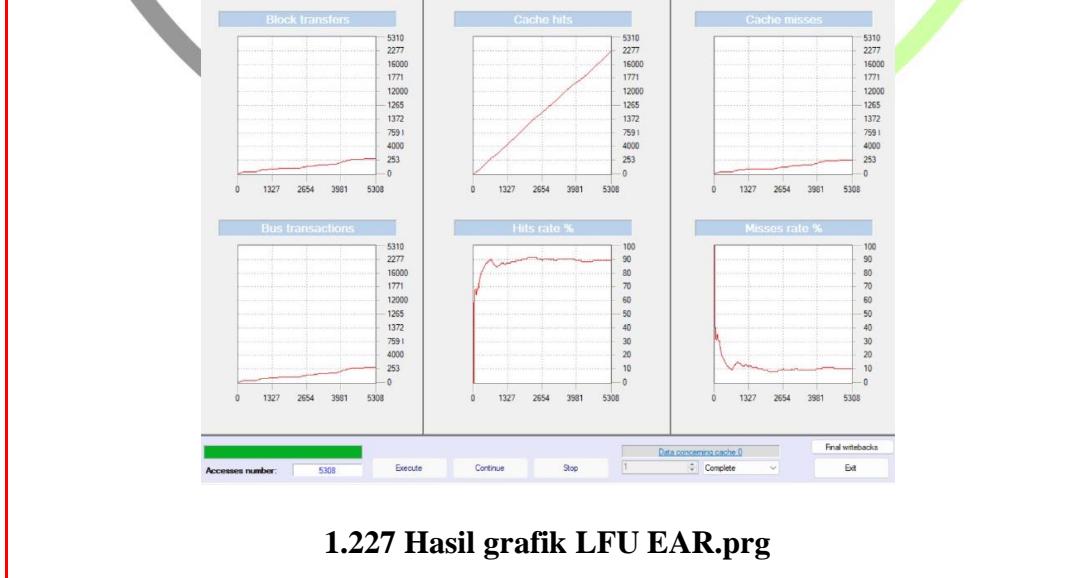
1.225 Hasil miss rate LFU COMP.prg



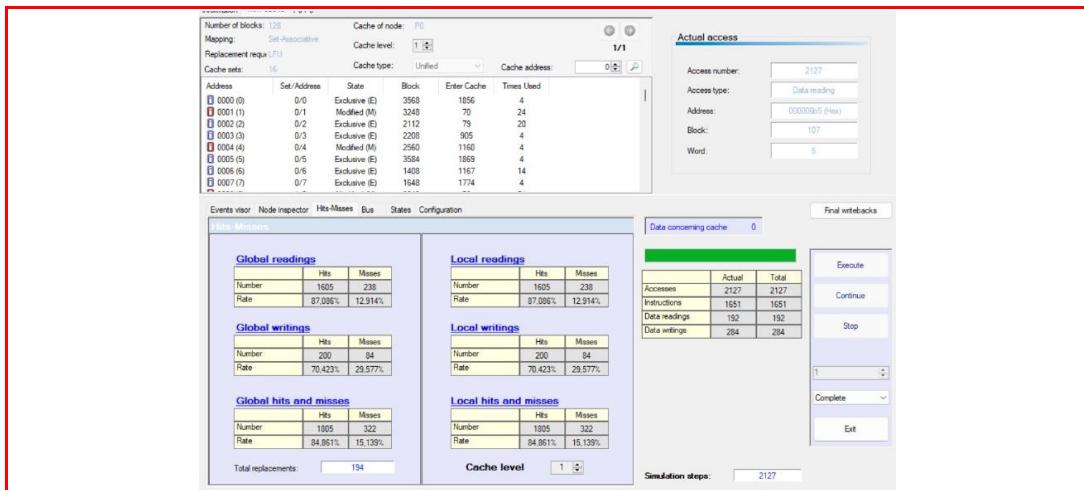
1.226 Hasil grafik LFU COMP.prg



1.226 Hasil miss rate LFU EAR.prg



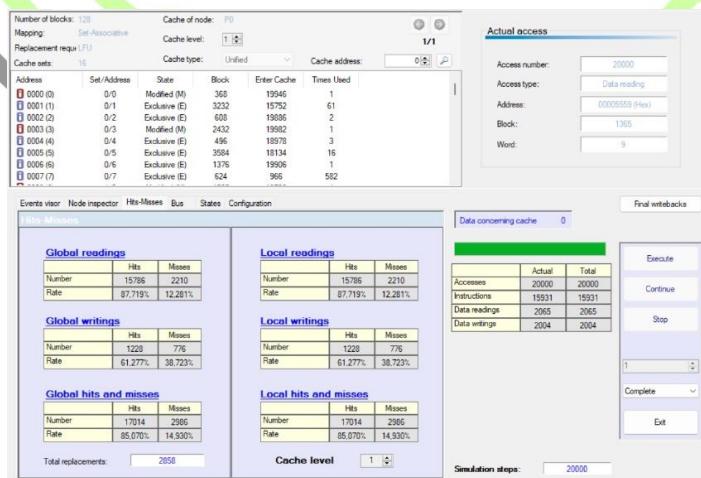
1.227 Hasil grafik LFU EAR.prg



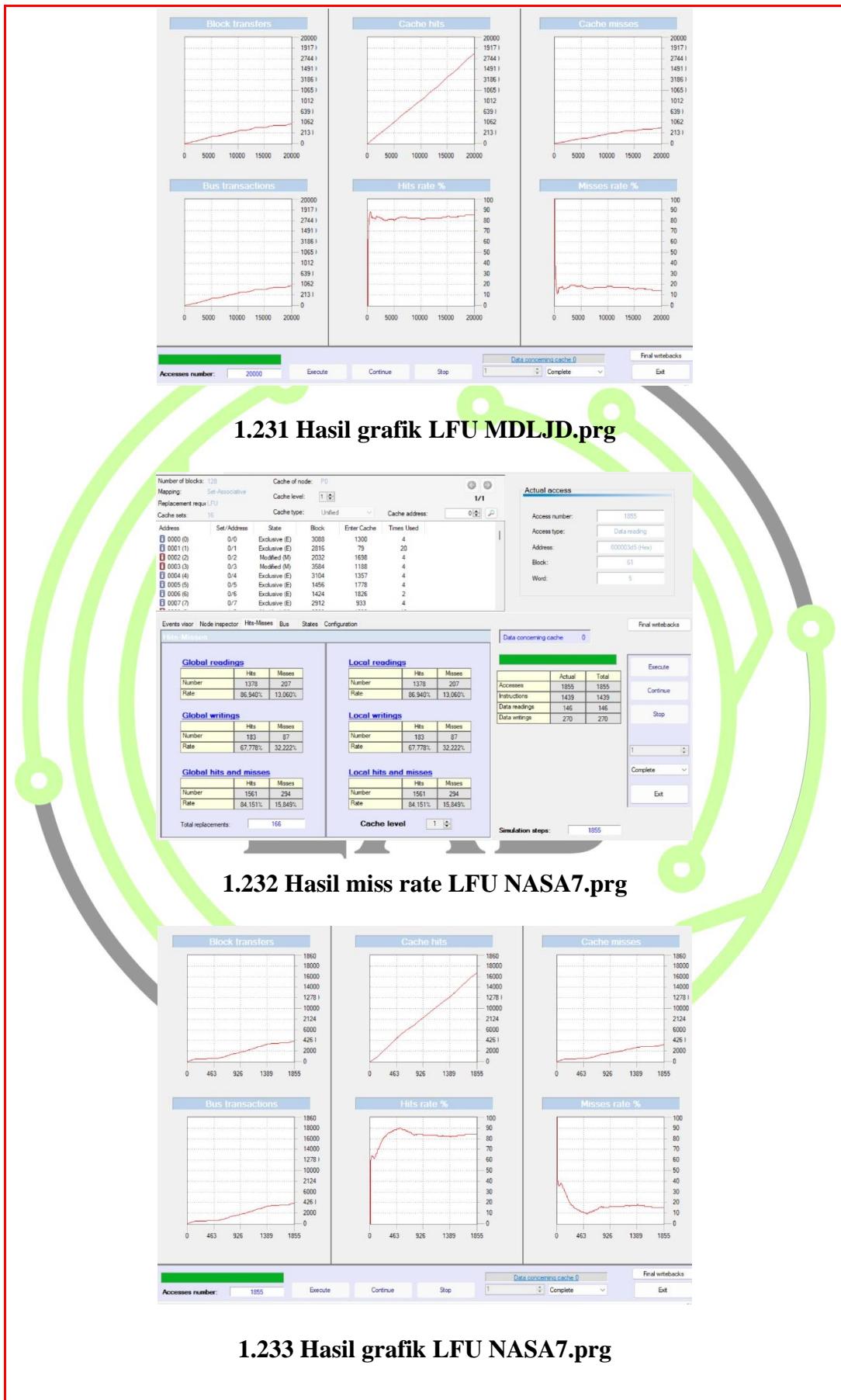
1.228 Hasil miss rate LFU HYDRO.prg

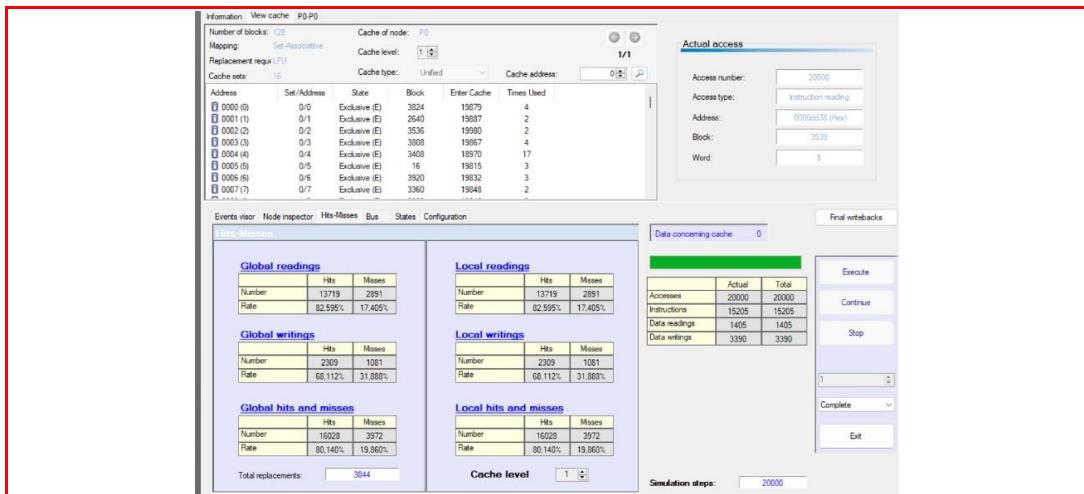


1.229 Hasil grafik LFU HYDRO.prg

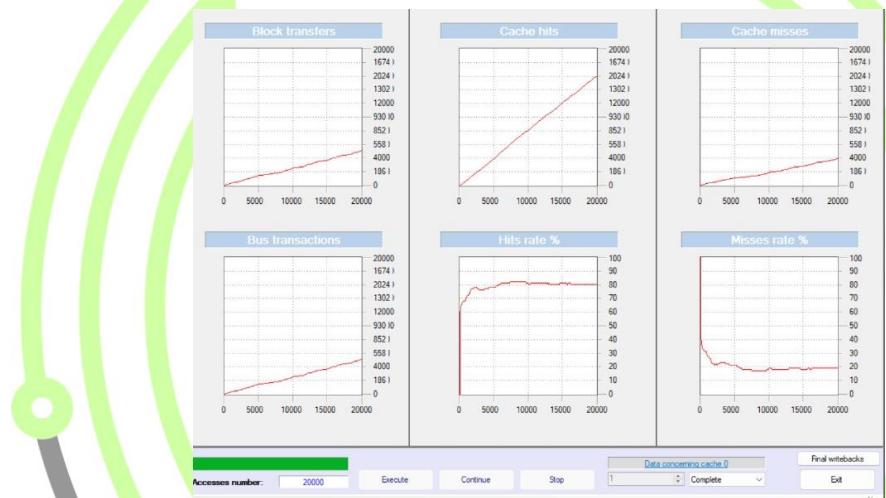


1.230 Hasil miss rate LFU MDLJD.prg

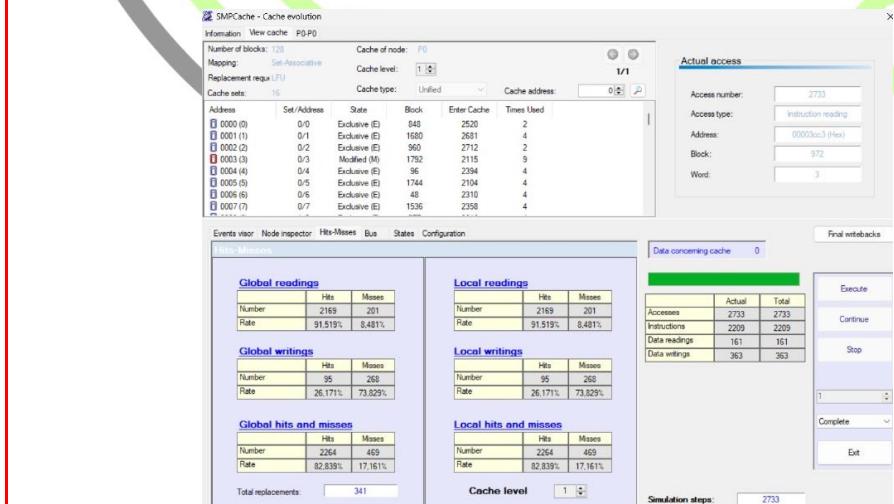




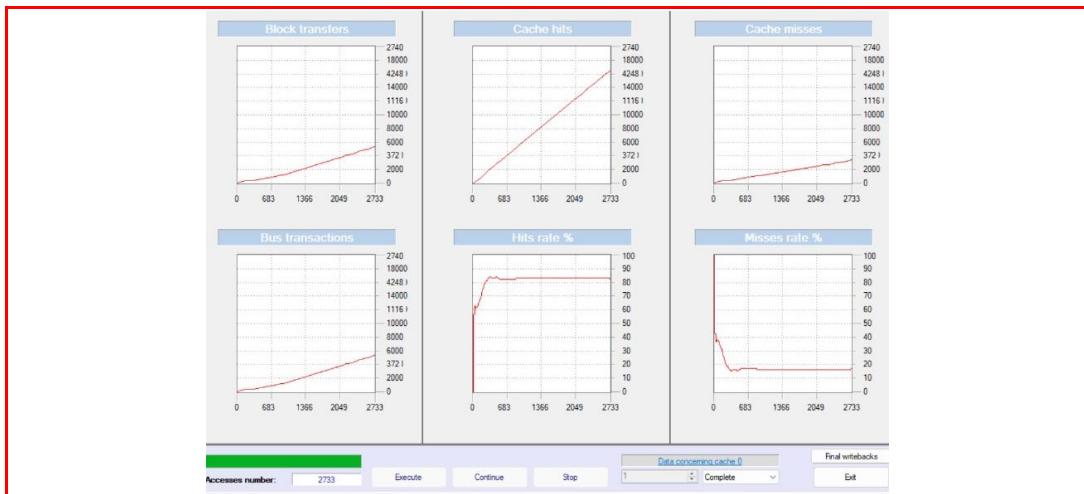
1.234 Hasil miss rate LFU SWM.prg



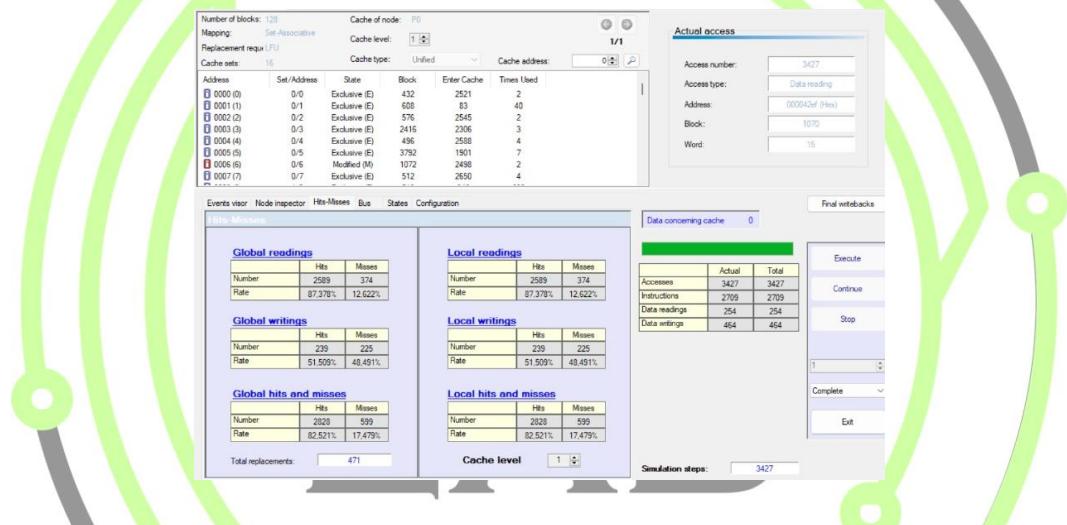
1.235 Hasil grafik LFU SWM.prg



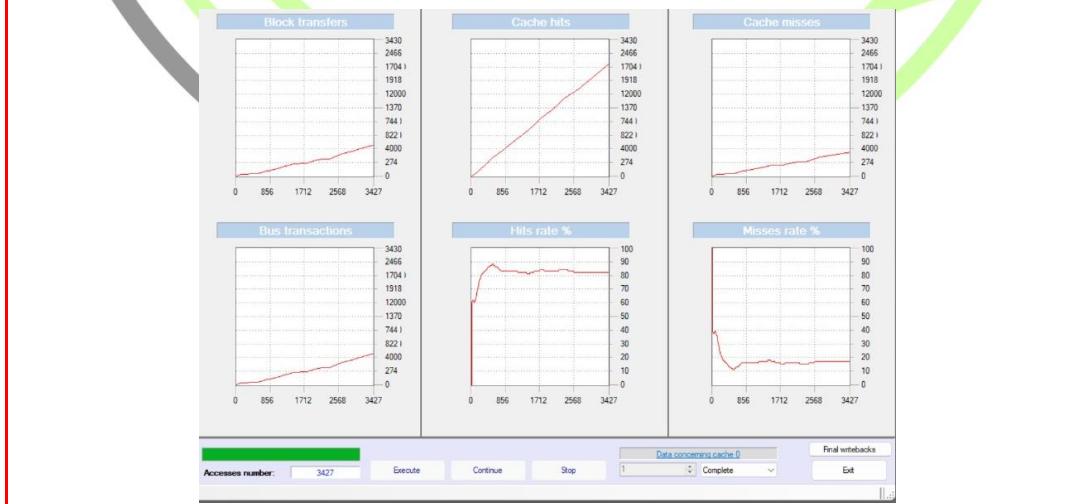
1.236 Hasil miss rate LFU UCOMP.prg



1.237 Hasil grafik LFU UCOMP.prg



1.238 Hasil miss rate LFU WAVE.prg



1.239 Hasil grafik LFU WAVE.prg

Pertanyaan

Percobaan 1: Dampak Ukuran Blok pada Berbagai Ukuran Cache

a. Miss rate dengan bertambahnya ukuran blok:

Miss rate biasanya menurun pada awalnya seiring bertambahnya ukuran blok karena adanya *spatial locality* (data yang sering diakses biasanya berada dalam jarak dekat di memori). Namun, jika ukuran blok terlalu besar, miss rate dapat meningkat akibat *cache pollution* (data yang tidak relevan masuk ke cache).

- Compulsory misses: *Compulsory misses* berkurang dengan bertambahnya ukuran blok karena lebih banyak data dimuat sekaligus, mengurangi kebutuhan untuk mengambil data tambahan yang berdekatan.
- Pollution point: Ya, *pollution point* dapat terjadi jika ukuran blok terlalu besar, karena cache mulai menyimpan data yang tidak relevan, sehingga efisiensi penggunaannya menurun.

b. Dampak *pollution point* dengan meningkatnya ukuran cache:

Pollution point berkurang saat ukuran cache bertambah, karena cache yang lebih besar memiliki kapasitas lebih untuk menyimpan blok data yang relevan, sehingga mengurangi konflik antar data.

Percobaan 2: Dampak Pemetaan pada Berbagai Ukuran Cache

a. Miss rate dengan bertambahnya *associativity*:

Miss rate cenderung menurun seiring meningkatnya *associativity* karena hal ini mengurangi *conflict misses* (misalnya, lebih banyak *ways* pada cache asosiatif memungkinkan lebih banyak data relevan disimpan dalam satu set).

- Conflict misses: *Conflict misses* berkurang dengan meningkatnya *associativity* karena setiap set memiliki lebih banyak ruang untuk menyimpan data.

b. Dampak *associativity* dengan bertambahnya ukuran cache:

Dengan bertambahnya ukuran cache, pengaruh *associativity* menjadi lebih kecil, karena cache yang lebih besar secara alami mengurangi *conflict misses* meskipun *associativity*-nya rendah.

c. Kesimpulan peningkatan *associativity*:

Secara umum, peningkatan *associativity* meningkatkan performa sistem.

Langkah yang memberikan dampak terbesar adalah dari *direct mapping* ke *2-way associativity*, karena pengurangan *conflict misses* paling signifikan terjadi pada tahap ini. Peningkatan berikutnya (misalnya dari *4-way* ke *8-way*) memberikan manfaat yang lebih kecil (*law of diminishing returns*).

Percobaan 3: Dampak Kebijakan Penggantian Blok (*Replacement Policy*)

a. Miss rate perlu dihitung secara eksperimen menggunakan *trace file* tertentu. Hasilnya dapat bervariasi tergantung pada jenis *workload* dalam file tersebut.

b. Kebijakan penggantian blok terbaik dan terburuk:

Secara umum, LRU biasanya memiliki *miss rate* terbaik karena mempertimbangkan data yang terakhir kali digunakan.

Random sering menjadi yang terburuk karena tidak mempertimbangkan pola akses data.

- Manfaat LFU dan FIFO:

- LFU bermanfaat untuk *workload* dengan *locality* yang sering.
- FIFO berguna untuk *workload* dengan pola akses sederhana. Namun, keduanya tidak selalu cocok untuk semua jenis *workload*.

c. Cache dengan pemetaan langsung (*direct-mapped*) dan kebijakan penggantian:

Tidak ada perbedaan hasil antara kebijakan penggantian pada cache *direct-mapped*, karena setiap alamat memori hanya dapat dipetakan ke satu lokasi di cache, sehingga tidak ada fleksibilitas dalam penggantian blok.

d. Kesimpulan penggunaan kebijakan penggantian blok:

Ya, kebijakan penggantian blok yang tepat dapat meningkatkan kinerja sistem.

Langkah dengan dampak terbesar adalah dari Random ke LRU, karena LRU secara eksplisit mengoptimalkan data yang kemungkinan besar akan digunakan lagi. Namun, peningkatan dari Random ke LFU atau FIFO juga dapat bermanfaat tergantung pada pola akses dan kompleksitas implementasi.