

组会报告

徐益

2018 年 9 月 3 日

1 工作内容

1. 使用 avx2 指令实现限幅部分；
2. 完成代码基于 linux 平台的调试；
3. 在服务器上对译码模块进行性能测试。

2 使用 avx2 指令实现限幅部分

2.1 使用 packs 相关指令

原模块：

```
1  for (r = 0; r < C; r++)
2      for (n = 0; n < Nd / 8; n++)
3      {
4          resf = _mm256_mul_ps(*p_tabI, fact);
5          resf = _mm256_max_ps(resf, vminf);
6          resf = _mm256_min_ps(resf, vmaxf);
7          resi = _mm256_cvttaps_epi32(resf);
8          p_tabI += 1;
9          for (i = 0; i < 8; i++)
10             ptr_llr[32 * (8 * n + i) + r] = (int8_t)p_resi[i];
11     }
```

现模块：

```
1  for (n = 0; n < Nd; n++)
2  {
3      for (i = 0; i < 4; i++)
4      {
5          vllrf = _mm256_load_ps((float *)p_tabI);
6          resf = _mm256_mul_ps(vllrf, fact);
7          resf = _mm256_max_ps(resf, vminf);
8          resf = _mm256_min_ps(resf, vmaxf);
9          resi[i] = _mm256_cvttaps_epi32(resf);
10         p_tabI += 1;
11     }
12     vtemp16[0] = _mm256_packs_epi32(resi[0], resi[1]);
13     vtemp16[1] = _mm256_packs_epi32(resi[2], resi[3]);
14     vtemp8 = _mm256_packs_epi16(vtemp16[0], vtemp16[1]);
```

```

15     _mm256_store_si256(p_tab0, vtemp8);
16     p_tab0++;
17 }
18 uchar_transpose_avx(tab0, h->llr_avx2, Nd);

```

2.2 遇到的问题

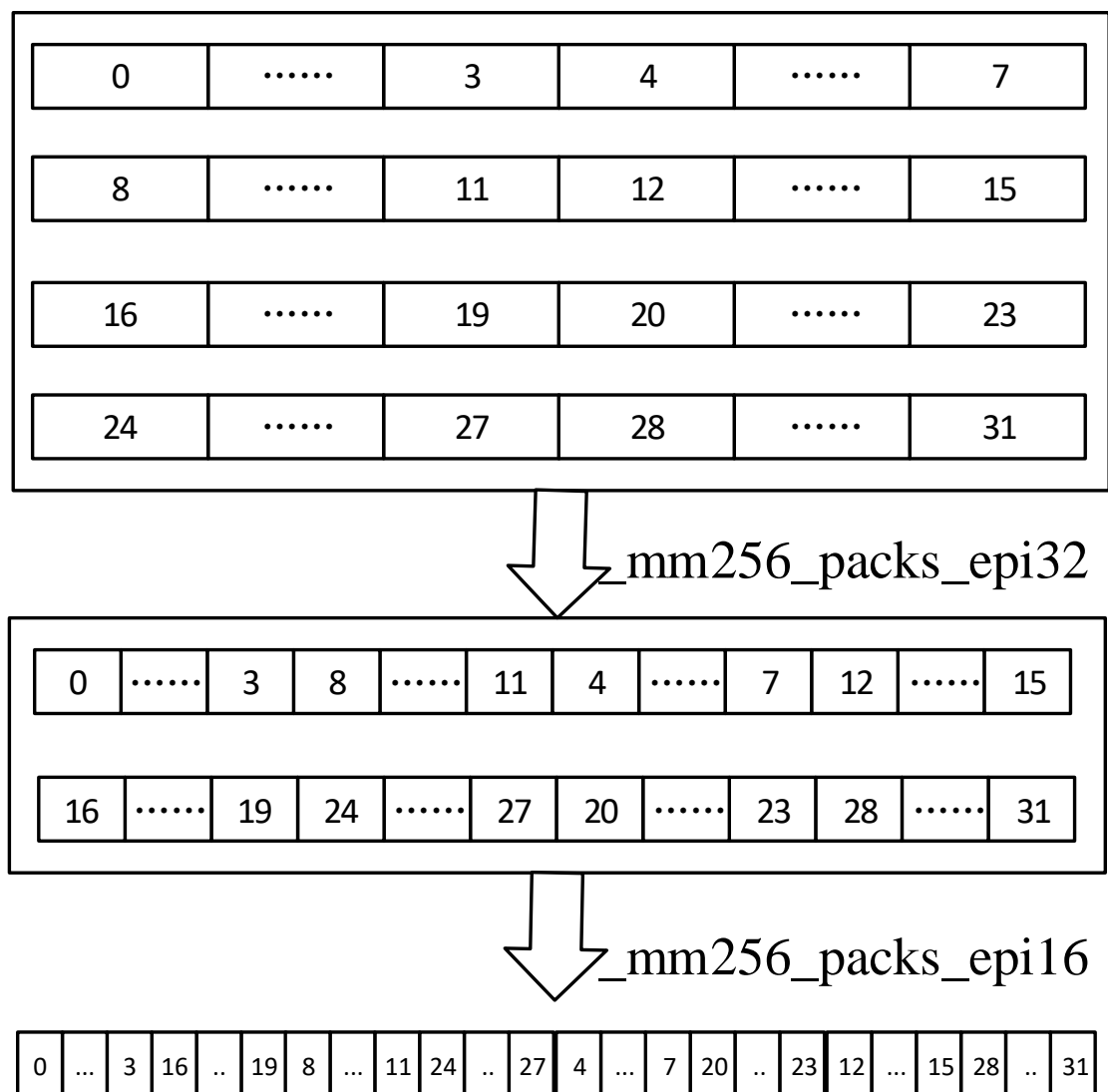


图 1: packs 相关指令的过程

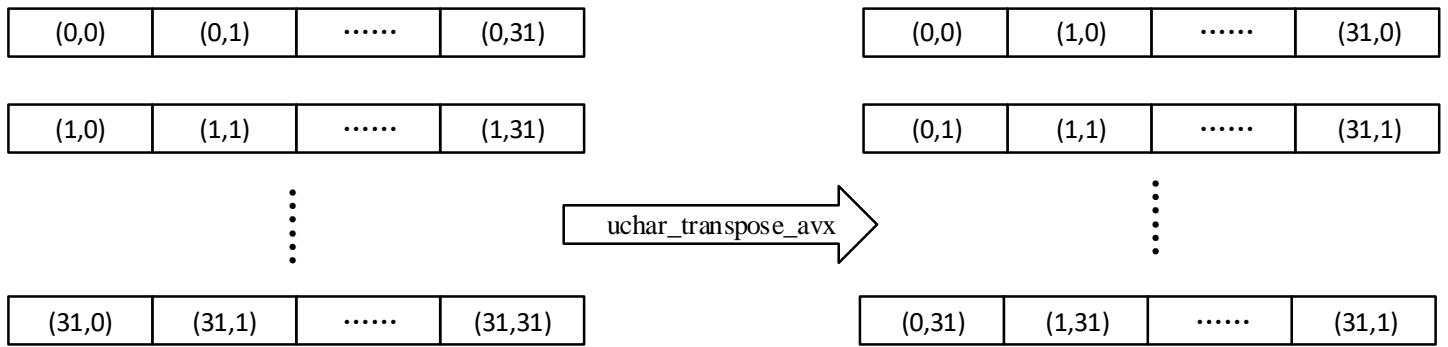


图 2: `uchar_transpose_avx` 函数的过程

3 代码基于 linux 平台的调试

3.1 遇到的问题

```

sherlockhsu@lab: ~/Github/test_5g_simd_ldpc
gcc -o main simd_ldpc.o test.o -lm -lpthread -lmkl_rt -fopenmp -I.
sherlockhsu@lab:~/Github/test_5g_simd_ldpc$ ./main
段错误 (核心已转储)
sherlockhsu@lab:~/Github/test_5g_simd_ldpc$ make
make: 'main' is up to date.
sherlockhsu@lab:~/Github/test_5g_simd_ldpc$ make clean
rm -f main simd_ldpc.o test.o
sherlockhsu@lab:~/Github/test_5g_simd_ldpc$ make
gcc -Wall -O3 -march=core-avx2 -c -o simd_ldpc.o simd_ldpc.c
simd_ldpc.c: In function 'nr15_fec_ldpc_simd_decoder_avx2':
simd_ldpc.c:637:9: warning: variable 'alpha_fixed' set but not used [-Wunused-but-set-variable]
    int8_t alpha_fixed, beta_fixed;
    ^
simd_ldpc.c: In function 'nr15_ldpc_simd_matrix_init':
simd_ldpc.c:207:4: warning: ignoring return value of 'fscanf', declared with attribute warn_unused_result [-Wunused-result]
    fscanf(fbg, "%hd", &h->H_BG[i][j]);
    ^
gcc -Wall -O3 -march=core-avx2 -c -o test.o test.c
gcc -o main simd_ldpc.o test.o -lm -lpthread -lmkl_rt -fopenmp -I.
sherlockhsu@lab:~/Github/test_5g_simd_ldpc$ ./main
段错误 (核心已转储)
sherlockhsu@lab:~/Github/test_5g_simd_ldpc$

```

图 3: 段错误

错误原因:

使用 `malloc` 函数分配空间时, 未对齐寄存器变量地址。

解决方法:

使用 `__mm_malloc` 函数分配寄存器相关地址空间;

使用 `__mm_free` 释放相关地址空间。

3.2 编写 makefile

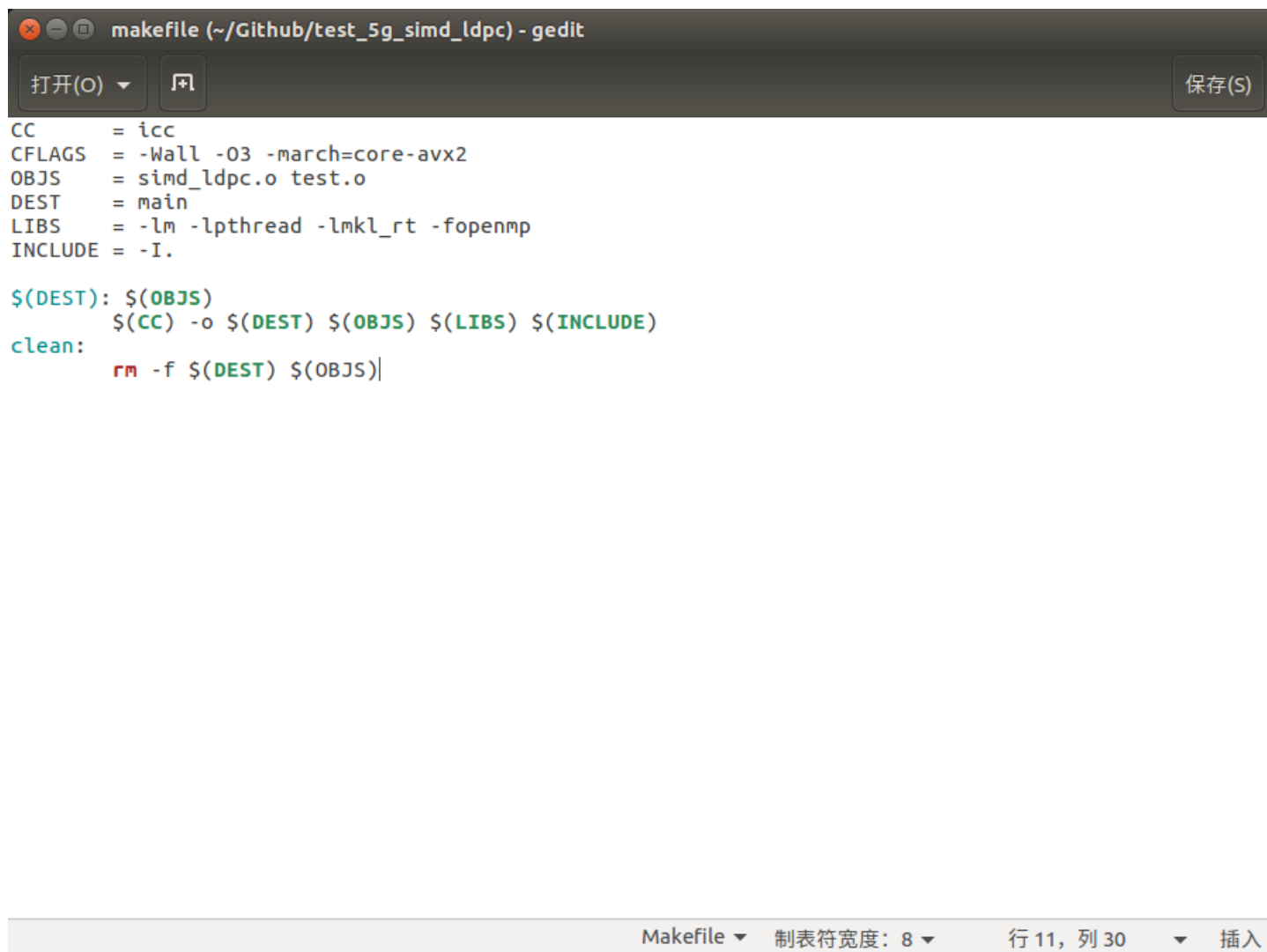


图 4: makefile

4 Linux 平台上的性能测试

4.1 Linux 平台上的 VTune 测试方法

1. source /opt/intel/vtune_amplifier/amplxe-vars.sh
2. amplxe-cl -collect hotspots ./main
3. amplxe-cl -report hotspots r000hs

4.2 本地测试

```
Block79: 0.000000
Block80: 0.000000
Block81: 0.000004
Block82: 0.000000
Block83: 0.000000
Block84: 0.000000
Block85: 0.000000
Block86: 0.000000
Block87: 0.000004
Block88: 0.000000
Block89: 0.000000
Block90: 0.000000
Block91: 0.000000
Block92: 0.000000
Block93: 0.000000
Block94: 0.000000
Block95: 0.000004
Block96: 0.000004
Block97: 0.000000
Block98: 0.000011
Block99: 0.000000
run_time:0.403220s
Throughput:66.85Mbps
sherlockhsu@lab:~/Github/test_5g_simd_ldpc$
```

图 5: 本地运行结果

Summary									
Elapsed Time:	1.723								
Paused Time:	0.0								
CPU Time:	1.680								
Average CPU Utilization:	0.972								
amplxe: Executing actions: 100 % done									
root@ubuntu:/home/xuyi/test_5g_simd_ldpc# amplxe-cl -report hotspots -r r000hsamplxe: Using result path '/home/xuyi/test_5g_simd_ldpc/r000hs'									
amplxe: Executing actions 75 % Generating a report									
e:Poor CPU Time:Effective Time:Ok CPU Time:Effective Time:Ideal CPU Time:Effective Time:Over CPU Time:Spin Time CPU Time:Overhead Time Module CPU Time:Effective Time:Idle CPU Time:Effective Time:Sou									
rce File Start Address									
			Function						
nr15_fec_ldpc_sind_decoder_avx2	0.252s	0.252s	0s	nr15_fec_ldpc_sind_decoder_avx2	0.252s	0s	0s	0s	0s
nr15_fec_ldpc_sind_rate_matching	0.248s	0.248s	0s	nr15_fec_ldpc_sind_rate_matching	0.248s	0s	0s	0s	0s
vsRngGaussian	0.236s	0.236s	0s	vsRngGaussian	0.236s	0s	0s	0s	0s
vslNewStream	0.180s	0.180s	0s	vslNewStream	0.180s	0s	0s	0s	0s
nr15_fec_ldpc_sind_rate_dematching	0.180s	0.180s	0s	nr15_fec_ldpc_sind_rate_dematching	0.180s	0s	0s	0s	0s
OS_BARESCALL_DoCallAsmIntel64Linux	0.080s	0.080s	0s	OS_BARESCALL_DoCallAsmIntel64Linux	0.080s	0s	0s	0s	0s
main	0.056s	0.056s	0s	main	0.056s	0s	0s	0s	0s
[ld-linux-x86-64.so.2]	0.052s	0.052s	0s	[ld-linux-x86-64.so.2]	0.052s	0s	0s	0s	0s
_mm256_max_epi8	0.036s	0.036s	0s	_mm256_max_epi8	0.036s	0s	0s	0s	0s
_mm256_sign_epi8	0.032s	0.032s	0s	_mm256_sign_epi8	0.032s	0s	0s	0s	0s
_mm256_adds_epi8	0.032s	0.032s	0s	_mm256_adds_epi8	0.032s	0s	0s	0s	0s
circshift_xor	0.028s	0.028s	0s	circshift_xor	0.028s	0s	0s	0s	0s
mnsset	0.028s	0.028s	0s	mnsset	0.028s	0s	0s	0s	0s
_mm256_and_si256	0.028s	0.028s	0s	_mm256_and_si256	0.028s	0s	0s	0s	0s
_mm256_subs_epi8	0.028s	0.028s	0s	_mm256_subs_epi8	0.028s	0s	0s	0s	0s
viRngBernoulli	0.020s	0.020s	0s	viRngBernoulli	0.020s	0s	0s	0s	0s
memcnp	0.020s	0.020s	0s	memcnp	0.020s	0s	0s	0s	0s
operator new	0.020s	0.020s	0s	operator new	0.020s	0s	0s	0s	0s
_mm256_min_epi8	0.016s	0.016s	0s	_mm256_min_epi8	0.016s	0s	0s	0s	0s
_mm256_abs_epi8	0.012s	0.012s	0s	_mm256_abs_epi8	0.012s	0s	0s	0s	0s
_mm256_unpacklo_epi16	0.012s	0.012s	0s	_mm256_unpacklo_epi16	0.012s	0s	0s	0s	0s
func@0x9aa30	0.012s	0.012s	0s	func@0x9aa30	0.012s	0s	0s	0s	0s
_mm256_store_si256	0.012s	0.012s	0s	_mm256_store_si256	0.012s	0s	0s	0s	0s
_mm256_xor_si256	0.012s	0.012s	0s	_mm256_xor_si256	0.012s	0s	0s	0s	0s

图 6: 服务器 VTune 测试结果 (错误)

```

amplye: Executing actions 100 % done
sherlockhsu@tab:~/github/test_5g_simd_ldpc$ amplye:cl -report hotspots r000hs
amplye: Using result path '/home/sherlockhsu/Github/test_5g_simd_ldpc/r000hs'
amplye: Executing actions 75 % Generating a report

```

Function	CPU Time	CPU Time:Effective Time	CPU Time:Effective Time:Idle	CPU Time:Effective Time:Spin	CPU Time:Effective Time:Lock Contention	CPU Time:Effective Time:Other
Module	Function (Full)	Source File	Start Address			
nr15_fec_ldpc_simd_decoder_avx2	0.372s	0.372s	0s	0s	0s	0s
0x405830	0s	0s	0s	0s	0s	0s
nr15_fec_ldpc_simd_rdm_dec_decbs	0.220s	0.220s	0s	0s	0s	0s
0x405e80	0s	0s	0s	0s	0s	0s
vsRngGaussian	0.148s	0.148s	0s	0s	0s	0s
0x0b3d0	0s	0s	0s	0s	0s	0s
vsLNewStream	0.144s	0.144s	0s	0.024s	0s	0s
0x353630	0s	0s	0s	0s	0s	0s
main	0.128s	0.128s	0s	0s	0s	0s
0x400bd0	0s	0s	0s	0s	0s	0s
nr15_fec_ldpc_simd_cbs_enc_rm	0.116s	0.116s	0s	0s	0s	0s
0x405cf0	0s	0s	0s	0s	0s	0s
viRngBernoulli	0.076s	0.076s	0s	0s	0s	0s
0x0bd210	0s	0s	0s	0s	0s	0s
OS_BARESYSCALL_DoCallAsmIntel64Linux	0.060s	0.060s	0s	0.060s	0s	0s
0x70e5c	0s	0s	0s	0s	0s	0s
nr15_fec_ldpc_simd_encoder_scb	0.052s	0.052s	0s	0s	0s	0s
0x402780	0s	0s	0s	0s	0s	0s
[ld-linux-x86-64.so.2]	0.050s	0.050s	0s	0.010s	0s	0s
0	0s	0s	0s	0s	0s	0s
mencnp	0.050s	0.050s	0s	0.020s	0s	0s
0x1c0d0	0s	0s	0s	0s	0s	0s
operator new	0.048s	0.048s	0s	0.012s	0s	0s
0x0bb3a0	0s	0s	0s	0s	0s	0s
__memset_sse2	0.036s	0.036s	0s	0s	0s	0s
0s	0s	0s	0s	0s	0s	0s

图 7: 本地 VTune 测试结果

4.3 服务器测试

```

root@host3: /home/test_5g_simd_ldpc
Block79: 0.000000
Block80: 0.000000
Block81: 0.000004
Block82: 0.000000
Block83: 0.000000
Block84: 0.000000
Block85: 0.000000
Block86: 0.000000
Block87: 0.000004
Block88: 0.000000
Block89: 0.000000
Block90: 0.000000
Block91: 0.000000
Block92: 0.000000
Block93: 0.000000
Block94: 0.000000
Block95: 0.000004
Block96: 0.000004
Block97: 0.000000
Block98: 0.000011
Block99: 0.000000
run_time:0.476385s
Throughput:56.59Mbps
root@host3:/home/test_5g_simd_ldpc#

```

图 8: 服务器运行结果

```

Block95: 0.000000
Block96: 0.000000
Block97: 0.000004
Block98: 0.000000
Block99: 0.000000
Block90: 0.000000
Block91: 0.000000
Block92: 0.000000
Block93: 0.000000
Block94: 0.000000
Block95: 0.000004
Block96: 0.000004
Block97: 0.000000
Block98: 0.000011
Block99: 0.000000
run_time:0.487629s
Throughput:55.28Mbps
root@ubuntu:/home/xuyi/test_5g_simd_ldpc# ampxe-cl -report hotspots r000hs
ampxe: Using result path '/home/xuyi/test_5g_simd_ldpc/r000hs'
ampxe: Executing actions 75 % Generating a report
e:Poor CPU Time:Effective Time:0s CPU Time:Effective Time:Ideal CPU Time:Effective Time:Over CPU Time:Spin Time CPU Time:Effective Time CPU Time:Effective Time CPU Time:Effective Time CPU Time:Effective Time
rce File Start Address
-----
nr15_fec_ldpc_simd_decoder_avx2 0s 0.440s 0s main 0.440s 0s nr15_fec_ldpc_simd_decoder_avx2 0s 0.440s [Unknown] 0x405760 0s
nr15_fec_ldpc_simd_rdm_dec_decbs 0s 0.280s 0s main 0.280s 0s nr15_fec_ldpc_simd_rdm_dec_decbs 0s 0.280s [Unknown] 0x405ea0 0s
nr15_fec_ldpc_simd_cbs_enc_rm 0s 0.224s 0s main 0.224s 0s nr15_fec_ldpc_simd_cbs_enc_rm 0s 0.224s [Unknown] 0x405be0 0s
vsRngGaussian 0s 0.208s 0s main 0.208s 0s vsRngGaussian 0s 0.208s [Unknown] 0x6b3d60 0s
vslNewStream 0s 0.144s 0s libmkl_intel_lp64.so 0.144s 0s vslNewStream 0s 0.144s [Unknown] 0x353630 0s
nr15_fec_ldpc_simd_encoder_scb 0s 0.088s 0s main 0.088s 0s nr15_fec_ldpc_simd_encoder_scb 0s 0.088s [Unknown] 0x4026b0 0s
[ld-linux-x86-64.so.2] 0s 0.075s 0s ld-linux-x86-64.so.2 0.075s 0s [ld-linux-x86-64.so.2] 0s 0.075s [Unknown] 0 0s
viRngBernoulli 0s 0.040s 0s libmkl_intel_lp64.so 0.040s 0s viRngBernoulli 0s 0.040s [Unknown] 0x6bd210 0s
mencnp 0s 0.034s 0s libc-dynamic.so 0.034s 0s mencnp 0s 0.034s [Unknown] 0x1c0d0 0s
main 0s 0.032s 0s main 0.032s 0s main 0s 0.032s [Unknown] 0x400b90 0s
strlen 0s 0.032s 0s main 0.032s 0s strlen 0s 0.032s [Unknown] 0x42500 0s
OS_BARESYSCALL_DoCallAsmIntel64Linux 0s 0.027s 0s libc-dynamic.so 0.027s 0s OS_BARESYSCALL_DoCallAsmIntel64Linux 0s 0.027s [Unknown] 0x70e5c 0s
memmove 0s 0.027s 0s libc-dynamic.so 0.027s 0s memmove 0s 0.027s [Unknown] 0x1c260 0s
operator new 0s 0.023s 0s libc-dynamic.so 0.023s 0s operator new 0s 0.023s [Unknown] 0x0055 0s
memset 0s 0.020s 0s libpthread.so 0.020s 0s memset 0s 0.020s [Unknown] 0x8c8d0 0s
func@0x9aa30 0s 0.012s 0s libc.so.6 0.012s 0s func@0x9aa30 0s 0.012s [Unknown] 0x9aa30 0s
circshift_xor 0s 0.012s 0s main 0.012s 0s circshift_xor 0s 0.012s [Unknown] 0x4021a0 0s
uchar_itranspose_avx 0s 0.012s 0s main 0.012s 0s uchar_itranspose_avx 0s 0.012s [Unknown] 0x4049d0 0s
ampxe: Executing actions 100 % done
root@ubuntu:/home/xuyi/test_5g_simd_ldpc#

```

图 9: 服务器 VTune 测试结果

5 仍存在的问题

```

root@ubuntu:/home/xuyi/test_5g_simd_ldpc
Block95: 0.000004
Block96: 0.000004
Block97: 0.000000
Block98: 0.000011
Block99: 0.000000
run_time:0.488829s
Throughput:55.15Mbps
root@ubuntu:/home/xuyi/test_5g_simd_ldpc# make
icc -Wall -O3 -march=core-avx2 -c -o simd_ldpc.o simd_ldpc.c
In file included from /usr/include/stdint.h(25),
    from /usr/local/lib/gcc/x86_64-unknown-linux-gnu/5.4.0/include/
    stdint.h(9),
    from /opt/intel/compilers_and_libraries_2018.2.199/linux/compil
    er/include/stdint.h(75),
    from simd_ldpc.h(4),
    from simd_ldpc.c(1):
/usr/include/features.h(374): catastrophic error: cannot open source file "sys/c
defs.h"
# include <sys/cdefs.h>
^
compilation aborted for simd_ldpc.c (code 4)
make: *** [simd_ldpc.o] Error 4
root@ubuntu:/home/xuyi/test_5g_simd_ldpc#

```

图 10: 更新 gcc 的服务器上遇到的 icc 编译错误问题