组会报告

徐益

2018 年 9 月 2 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：

```
for (r = 0; r < C; r++)
        for (n = 0; n < Nd / 8; n++)
        {
                resf = _mm256_mul_ps(*p_tabI, fact);
                resf = _mm256_max_ps(resf, vminf);
                resf = _mm256_min_ps(resf, vmaxf);
                resi = _mm256_cvttps_epi32(resf);
                p_tabI += 1;
                for (i = 0; i < 8; i++)
                        ptr_llr[32 * (8 * n + i) + r] = (int8_t)p_resi[i];
        }
```

现模块：

```
for (n = 0; n < Nd; n++)
{
        for (i = 0; i < 4; i++)
        {
                vllrf = _mm256_load_ps((float *)p_tabI);
                resf = _mm256_mul_ps(vllrf, fact);
                resf = _mm256_max_ps(resf, vminf);
                resf = _mm256_min_ps(resf, vmaxf);
                resi[i] = _mm256_cvttps_epi32(resf);
                p_tabI += 1;
        }
        vtemp16[0] = _mm256_packs_epi32(resi[0], resi[1]);
        vtemp16[1] = _mm256_packs_epi32(resi[2], resi[3]);
        vtemp8 = _mm256_packs_epi16(vtemp16[0], vtemp16[1]);
        _mm256_store_si256(p_tab0, vtemp8);
        p_tab0++;
}
uchar_transpose_avx(tab0, h->llr_avx2, Nd);
```

2.2 遇到的问题

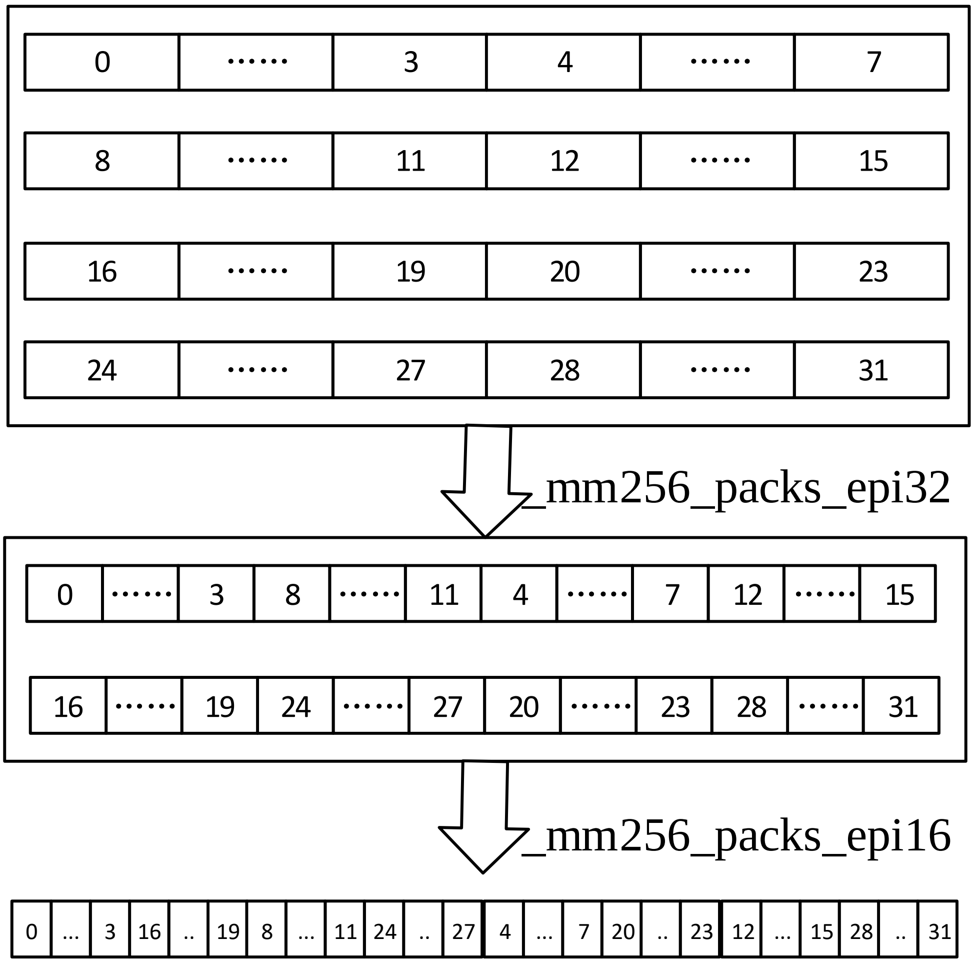


图 1: packs 相关指令的过程

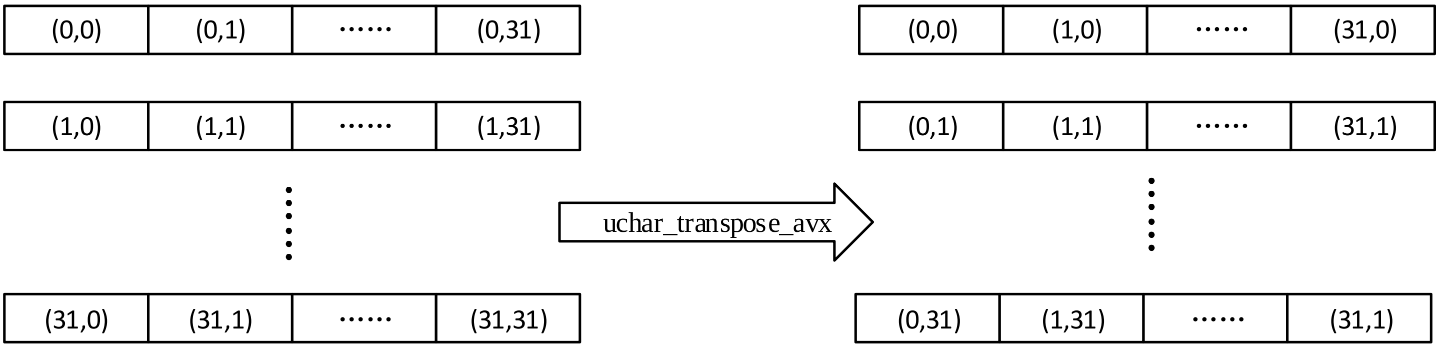
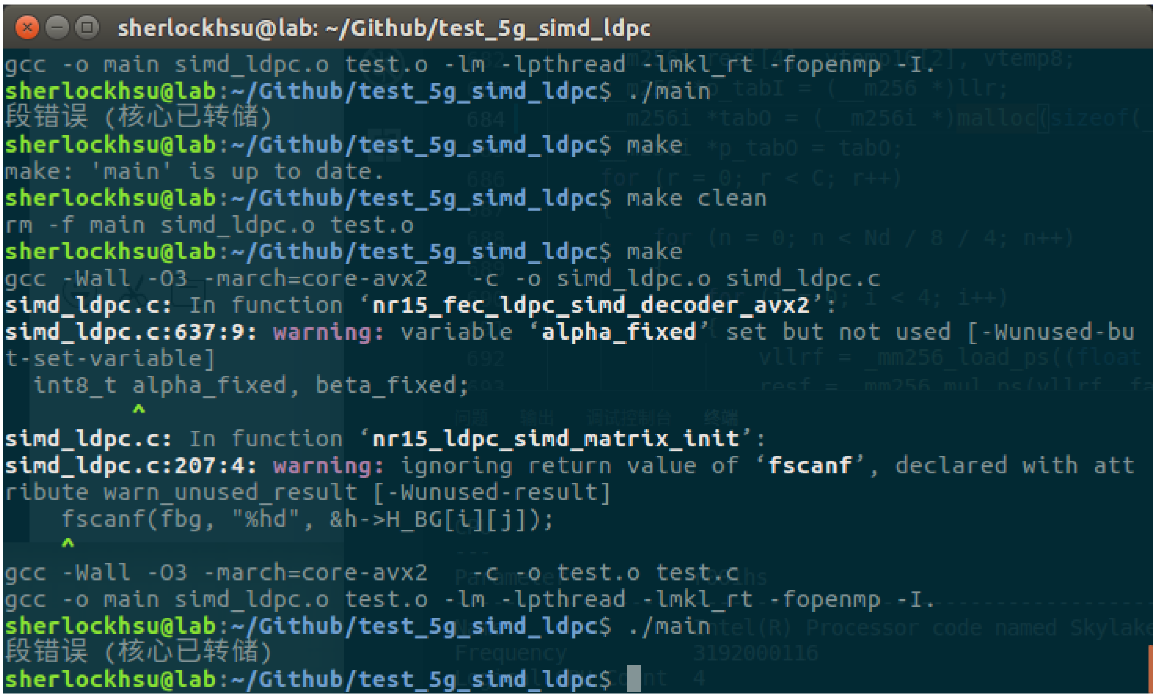


图 2: uchar__transpose__avx 函数的过程

3 代码基于 linux 平台的调试

3.1 遇到的问题



```
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-bu
t-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 att
ribute 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

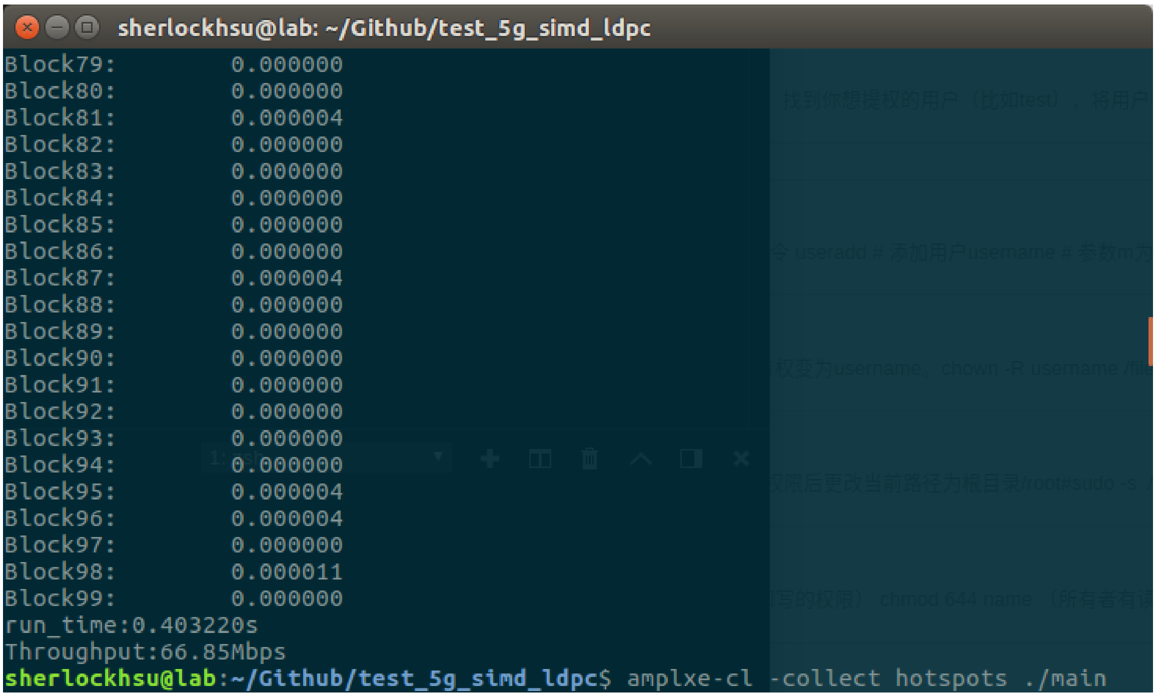
错误原因:
使用 malloc 函数分配空间时，未对齐寄存器变量地址。
解决方法:
使用 _mm_malloc 函数分配寄存器相关地址空间;
使用 _mm_free 释放相关地址空间。

4 Linux 平台上的性能测试

4.1 Linux 平台上的 VTune 测试方法

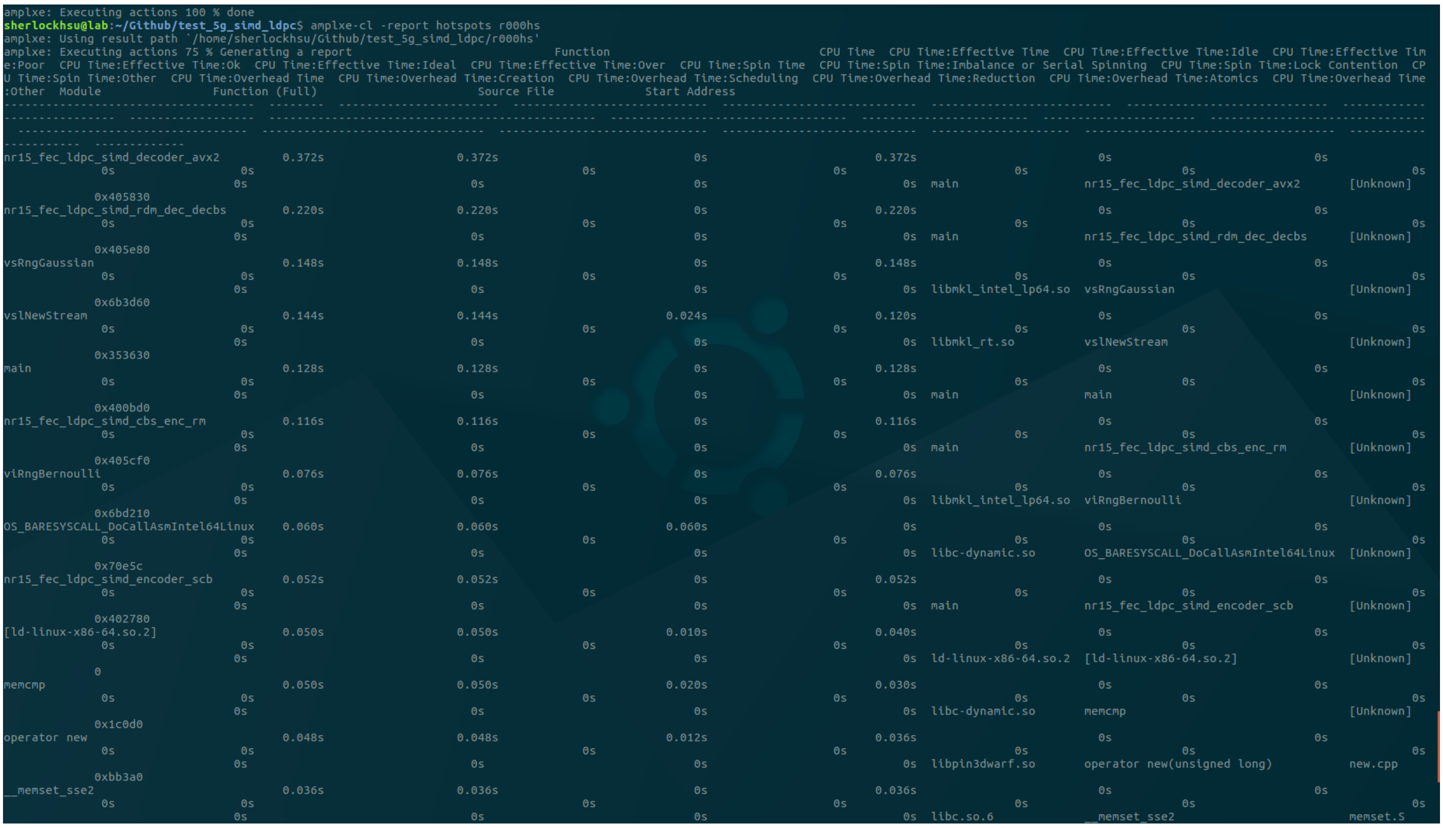
1. source /opt/intel/vtune_amplifier/amplxe-vars.sh
2. amplxe-cl -collect hotspots ./main
3. amplxe-cl -report hotspots r000hs

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$ amplxe-cl -collect hotspots ./main
```

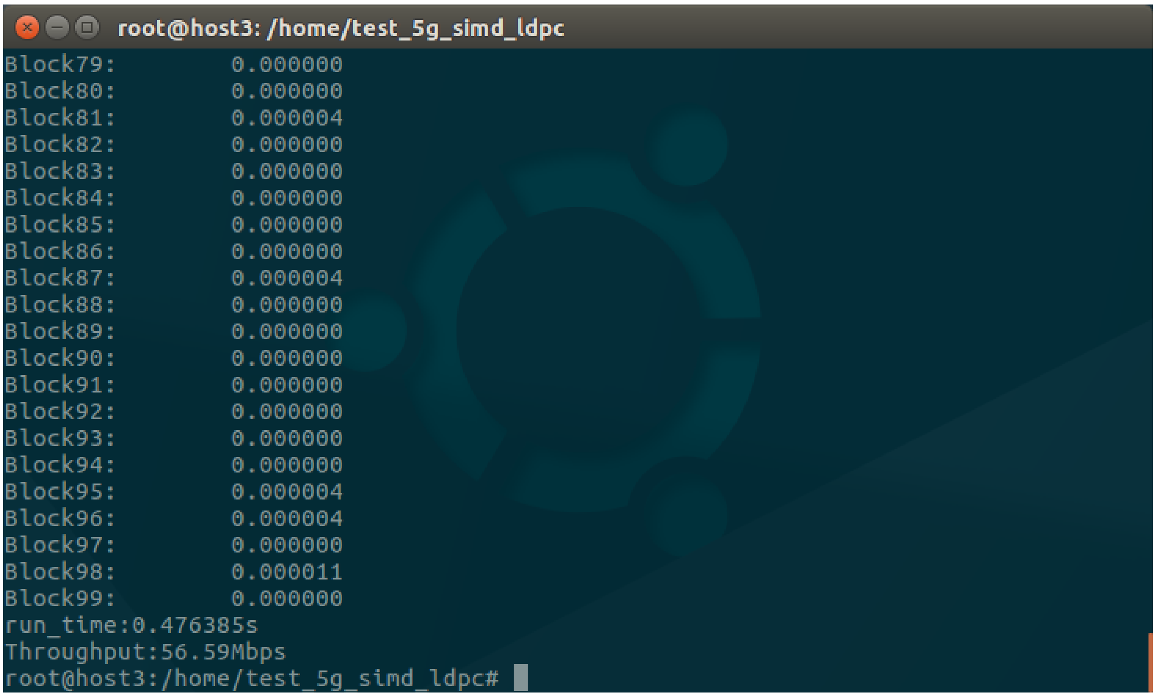
图 4: 本地运行结果



```
amplxe: Executing actions 100 % done
sherlockhsu@lab:~/Github/test_5g_simd_ldpc$ amplxe-cl -report hotspots r000hs
amplxe: Using result path `/home/sherlockhsu/Github/test_5g_simd_ldpc/r000hs'
amplxe: Executing actions 75 % Generating a report                                     Function                                     CPU Time  CPU Time:Effective Time  CPU Time:Effective Time:Idle  CPU Time:Effective Tim
e:Poor  CPU Time:Effective Time:Ok  CPU Time:Effective Time:Ideal  CPU Time:Effective Time:Over  CPU Time:Spin Time  CPU Time:Spin Time:Imbalance or Serial Spinning  CPU Time:Spin Time:Lock Contention  CP
U Time:Spin Time:Other  CPU Time:Overhead Time  CPU Time:Overhead Time:Creation  CPU Time:Overhead Time:Scheduling  CPU Time:Overhead Time:Reduction  CPU Time:Overhead Time:Atomics  CPU Time:Overhead Time
:Other  Module                 Function (Full)                                    Source File               Start Address
------------------------------------  --------  ------------------------  -----------------------------  ---------------------------  --------------------------  -----------------------------  ------------
----------------  ------------------  ------------------------------------------------  -----------------------------------  ------------------------  ---------------------  ----------------------------------
  ----------------------------------  ---------------------------------  ------------------------------  ----------------------------  ---------------------  --------------------------------------  ------------
-----------  -------------
nr15_fec_ldpc_simd_decoder_avx2         0.372s                   0.372s                            0s                        0.372s                           0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  main                  nr15_fec_ldpc_simd_decoder_avx2        [Unknown]
             0x405830
nr15_fec_ldpc_simd_rdm_dec_decbs        0.220s                   0.220s                            0s                        0.220s                           0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  main                  nr15_fec_ldpc_simd_rdm_dec_decbs       [Unknown]
             0x405e80
vsRngGaussian                           0.148s                   0.148s                            0s                        0.148s                           0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  libmkl_intel_lp64.so  vsRngGaussian                          [Unknown]
             0x6b3d60
vslNewStream                            0.144s                   0.144s                        0.024s                        0.120s                           0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  libmkl_rt.so          vslNewStream                           [Unknown]
             0x353630
main                                    0.128s                   0.128s                            0s                        0.128s                           0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  main                  main                                   [Unknown]
             0x400bd0
nr15_fec_ldpc_simd_cbs_enc_rm           0.116s                   0.116s                            0s                        0.116s                           0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  main                  nr15_fec_ldpc_simd_cbs_enc_rm          [Unknown]
             0x405cf0
viRngBernoulli                          0.076s                   0.076s                            0s                        0.076s                           0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  libmkl_intel_lp64.so  viRngBernoulli                         [Unknown]
             0x6bd210
OS_BARESYSCALL_DoCallAsmIntel64Linux    0.060s                   0.060s                        0.060s                                                         0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  libc-dynamic.so       OS_BARESYSCALL_DoCallAsmIntel64Linux   [Unknown]
             0x70e5c
nr15_fec_ldpc_simd_encoder_scb          0.052s                   0.052s                            0s                        0.052s                           0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  main                  nr15_fec_ldpc_simd_encoder_scb         [Unknown]
             0x402780
[ld-linux-x86-64.so.2]                  0.050s                   0.050s                        0.010s                        0.040s                           0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  ld-linux-x86-64.so.2  [ld-linux-x86-64.so.2]                 [Unknown]
             0
memcmp                                  0.050s                   0.050s                        0.020s                        0.030s                           0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  libc-dynamic.so       memcmp                                 [Unknown]
             0x1c0d0
operator new                            0.048s                   0.048s                        0.012s                        0.036s                           0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  libpin3dwarf.so       operator new(unsigned long)            new.cpp
             0xbb3a0
__memset_sse2                           0.036s                   0.036s                            0s                        0.036s                           0s                             0s
              0s                  0s                                               0s                                  0s                         0s                      0s                               0s
                                 0s                                0s                              0s                            0s  libc.so.6             __memset_sse2                          memset.S
```

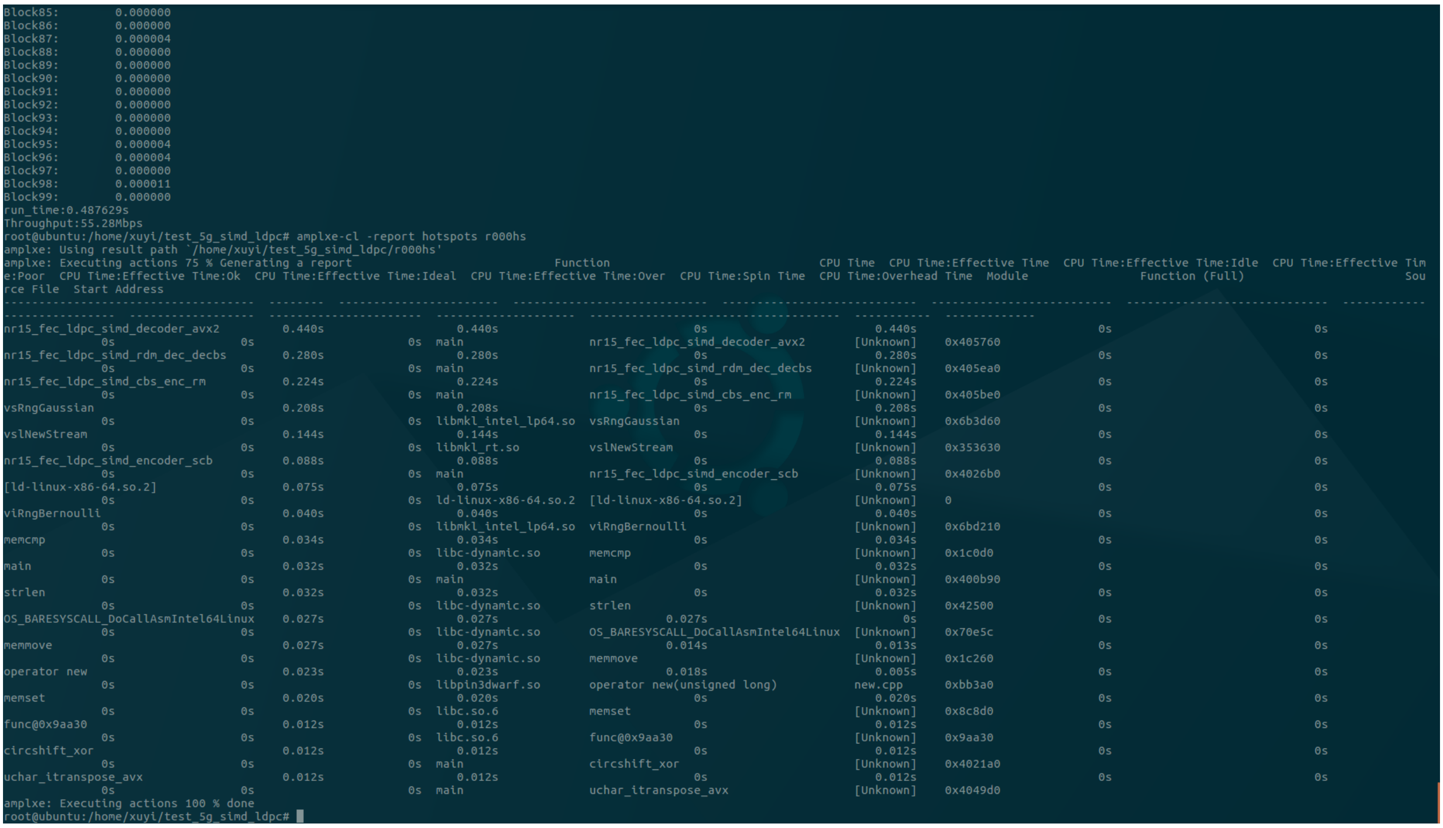
图 5: 本地 VTune 测试结果

4.3 服务器测试



```
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:0.476385s
Throughput:56.59Mbps
root@host3:/home/test_5g_simd_ldpc#
```

图 6: 服务器运行结果



```
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:0.487629s
Throughput:55.28Mbps
root@ubuntu:/home/xuyi/test_5g_simd_ldpc# amplxe-cl -report hotspots r000hs
amplxe: Using result path `/home/xuyi/test_5g_simd_ldpc/r000hs'
amplxe: Executing actions 75 % Generating a report                             Function                              CPU Time  CPU Time:Effective Time  CPU Time:Effective Time:Idle  CPU Time:Effective Tim
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                Function (Full)                       Sou
rce File  Start Address
----------------------------------  --------  ----------------------  ----------------------------  ----------------------------  -------------------------  ---------------------------  ------------
----------------  ------------------  ---------------------  --------------------  -----------------------------------  ----------  ------------
nr15_fec_ldpc_simd_decoder_avx2         0.440s                   0.440s                            0s                        0.440s                          0s                             0s
              0s                  0s                      0s  main                  nr15_fec_ldpc_simd_decoder_avx2       [Unknown]    0x405760
nr15_fec_ldpc_simd_rdm_dec_decbs        0.280s                   0.280s                            0s                        0.280s                          0s                             0s
              0s                  0s                      0s  main                  nr15_fec_ldpc_simd_rdm_dec_decbs      [Unknown]    0x405ea0
nr15_fec_ldpc_simd_cbs_enc_rm           0.224s                   0.224s                            0s                        0.224s                          0s                             0s
              0s                  0s                      0s  main                  nr15_fec_ldpc_simd_cbs_enc_rm         [Unknown]    0x405be0
vsRngGaussian                           0.208s                   0.208s                            0s                        0.208s                          0s                             0s
              0s                  0s                      0s  libmkl_intel_lp64.so  vsRngGaussian                         [Unknown]    0x6b3d60
vslNewStream                            0.144s                   0.144s                            0s                        0.144s                          0s                             0s
              0s                  0s                      0s  libmkl_rt.so          vslNewStream                          [Unknown]    0x353630
nr15_fec_ldpc_simd_encoder_scb          0.088s                   0.088s                            0s                        0.088s                          0s                             0s
              0s                  0s                      0s  main                  nr15_fec_ldpc_simd_encoder_scb        [Unknown]    0x4026b0
[ld-linux-x86-64.so.2]                  0.075s                   0.075s                            0s                        0.075s                          0s                             0s
              0s                  0s                      0s  ld-linux-x86-64.so.2  [ld-linux-x86-64.so.2]                [Unknown]    0
viRngBernoulli                          0.040s                   0.040s                            0s                        0.040s                          0s                             0s
              0s                  0s                      0s  libmkl_intel_lp64.so  viRngBernoulli                        [Unknown]    0x6bd210
memcmp                                  0.034s                   0.034s                            0s                        0.034s                          0s                             0s
              0s                  0s                      0s  libc-dynamic.so       memcmp                                [Unknown]    0x1c0d0
main                                    0.032s                   0.032s                            0s                        0.032s                          0s                             0s
              0s                  0s                      0s  main                  main                                  [Unknown]    0x400b90
strlen                                  0.032s                   0.032s                            0s                        0.032s                          0s                             0s
              0s                  0s                      0s  libc-dynamic.so       strlen                                [Unknown]    0x42500
OS_BARESYSCALL_DoCallAsmIntel64Linux    0.027s                   0.027s                        0.027s                            0s                          0s                             0s
              0s                  0s                      0s  libc-dynamic.so       OS_BARESYSCALL_DoCallAsmIntel64Linux  [Unknown]    0x70e5c
memmove                                 0.027s                   0.027s                        0.014s                        0.013s                          0s                             0s
              0s                  0s                      0s  libc-dynamic.so       memmove                               [Unknown]    0x1c260
operator new                            0.023s                   0.023s                        0.018s                        0.005s                          0s                             0s
              0s                  0s                      0s  libpin3dwarf.so       operator new(unsigned long)           new.cpp      0xbb3a0
memset                                  0.020s                   0.020s                            0s                        0.020s                          0s                             0s
              0s                  0s                      0s  libc.so.6             memset                                [Unknown]    0x8c8d0
func@0x9aa30                            0.012s                   0.012s                            0s                        0.012s                          0s                             0s
              0s                  0s                      0s  libc.so.6             func@0x9aa30                          [Unknown]    0x9aa30
circshift_xor                           0.012s                   0.012s                            0s                        0.012s                          0s                             0s
              0s                  0s                      0s  main                  circshift_xor                         [Unknown]    0x4021a0
uchar_itranspose_avx                    0.012s                   0.012s                            0s                        0.012s                          0s                             0s
              0s                  0s                      0s  main                  uchar_itranspose_avx                  [Unknown]    0x4049d0
amplxe: Executing actions 100 % done
root@ubuntu:/home/xuyi/test_5g_simd_ldpc#
```

图 7: 服务器 VTune 测试结果

5 仍存在的问题