

heap/stack size optimization

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Introduction

During the maintenance phase, you may met the memory run out issue. If unfortunately, it is legacy code's issue, you have to find out where and how to free some space. This short article take scheduler thread(a FO of MAC layer) as example to describe the methods can be employed.

the issue

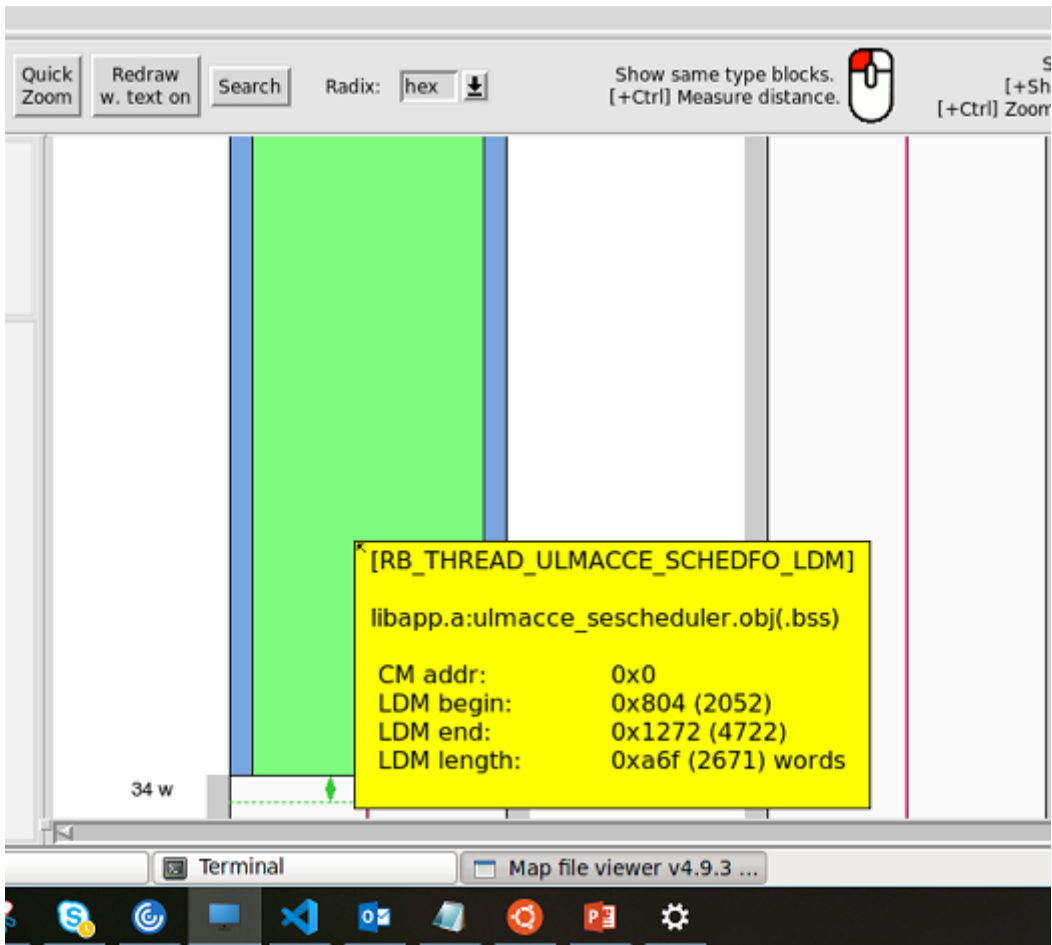
- error reported when building

```
ERROR: List of threads violating the heap & stack limit

Legend:
+ Requested Heap & stack violated.
* Heap & stack usage test margin violated.

Used heap Stack | Requested Heap Stack | Test Margin | Heap Stack limit | Thread Name
* 3352          | 3383                   | 34          | 3349              | test_ULMACCE_SCHEDFO
```

- memory map illustrated



global variables refactor

main approach is reducing its data type's size

```
/* Add global variables that do NOT require initialisation within the following
 * # pragma */
#pragma nostdinit on
ULMACCE_SCHEDFO_foDataS ulSeSched_foData;
ULMACCE_PUSCHTPS_newTxSeDataS
ulSeSched_newSchedData[ELIB_BBBase_COMMON_MAX_NR_OF_UL_SE_PER_TT_PER_CELL];
UpCDlMacCeFiSePdchCfmDataS
ulSeSched_pdcchCfmData[ELIB_BBBase_COMMON_MAX_NR_OF_UL_SE_PER_TT_PER_CELL];
ULMACCE_HARQPROCPOOLPPS_harqProcS
ulSeSched_harqProcData[ELIB_BBBase_COMMON_MAX_NR_OF_UL_SE_PER_TT_PER_CELL];
ULMACCE_SCHEDFO_internalSeDataS
    ulSeSched_internalSeData[ELIB_BBBase_COMMON_MAX_NR_OF_UL_SE_PER_TT_PER_CELL];
#pragma nostdinit off
```

packing

```
typedef struct ULMACCE_NEW_newTxSeDataS
{
    U16 maxNrOfSbsForNew;  => 7bits
    S16 averageIslandNrOfSbs;=>7bits
}
```

cutting

```
typedef struct ULMACCE_SCHEDFO_foDataS
{
    ULMACCE_admCtrlDataHeaderS admCtrlData;=>delte
}
when needed:
    ULMACCE_admCtrlDataHeaderS admCtrlData;
    ULMACCE_SHD_PUSCHTPS_getAdmCtrlDataHeader(&foData_p->puschTpsTo, &admCtrlData);
```

Pros & cons

- direct, easy to understand

- performance penalty

[asm code](#)

- few left to optimize

e.g

csiRequestBits actually need 3 bits only

below U16 var actually , but the change needs lots efforts, especially in test code which use it as U16.

limitation of the compiler Flacc

- don't support c99 fully
- maybe new compiler clang change the situation

example in asm

```

struct bits
{
    unsigned short low : 2;
    unsigned short mid: 10;
    signed short : 4;
};
unsigned short i = 0x12;
int main()
{
    struct bits b = {-1}; //line 10
    unsigned short xxx;
    xxx = i;
    b.mid = 33;
    xxx = b.mid;
    return 0;
}
/*
    mv      *dp(-2), a0h      // 10 bits.c
    or      49152, a0h        // 10
    mv      a0h, *dp(-2)      // 10
    mv      *dp(-2), a0h      // 10
    and     49167, a0h        // 10
    mv      a0h, *dp(-2)      // 10
    mv      #i, r0            // 12
    mv      *r0, a0h          // 12
    mv      a0h, *dp(-3)      // 12
    mv      *dp(-2), a0h      // 13
    and     49167, a0h        // 13
    addh    528, a0           // 13
    mv      a0h, *dp(-2)      // 13
    mv      *dp(-2), a0h      // 14
    exz     a0, 20, 9, a0h    // 14
    mv      a0h, *dp(-3)      // 14

*/

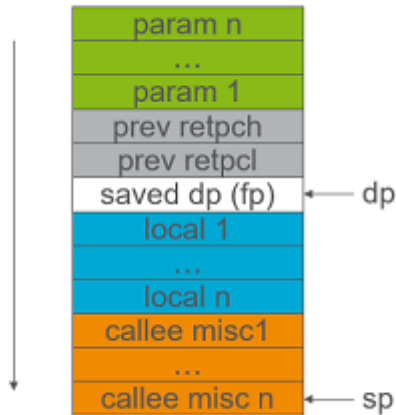
```

local variables refactor

stack resue is an edge tool

Flex Stack Frame Layout

- › **by caller:**
- › in parameters
- › saved retpc value (by call instruction)
- › **by callee:**
- › saved display pointer
- › local variables (static)
- › callee misc area (dynamic)



a simple example in outline

```

#include <stdlib.h>
int s;
int main()
{
    {
        int xxx = rand();//line 6
        int yyy = rand();
        int xxx_2 = rand();
        int yyy_2 = rand();
        int xxx_3 = rand();
        int yyy_3 = rand();

        if (xxx>100)
            s +=(xxx+yyy + xxx_2+yyy_2+xxx_3+yyy_3);
    }
    {
        int xxx = rand();//line 17
        int yyy = rand();
        int xxx_2 = rand();
        int yyy_2 = rand();
        int xxx_3 = rand();
        int yyy_3 = rand();
        if (yyy>300)
            s --(xxx+yyy + xxx_2+yyy_2+xxx_3+yyy_3); //line 24
    }
    return s;
}

/*
callr    #rand                // 6 a.c (*), CurrBundle: 4, CriticalPath: 4
mv        a0h, *dp(-1)        // 6 (*), CurrBundle: 1, CriticalPath: 1, 1-byte Folded
| callr    #rand                // 7 (*)
| .rule_off                    // 7
| copy     a0, a5              // 7 (*), CurrBundle: 1, CriticalPath: 1
| callr    #rand                // 8 (*)
| copy     a0, a6              // 8 (*), CurrBundle: 1, CriticalPath: 1
| callr    #rand                // 9 (*)
| copy     a0, a7              // 9 (*), CurrBundle: 1, CriticalPath: 1
| callr    #rand                // 10 (*)
| copy     a0, a4              // 10 (*), CurrBundle: 1, CriticalPath: 1
| callr    #rand                // 11 (*)
| .rule_on
| mv        *dp(-1), a1h        // (*), 1-byte Folded Reload
| cmp       101, a1h            // 13 (*), CurrBundle: 2, CriticalPath: 2
| if        .a1:ge              // 14
| addh      a1h, a5              // 14 (*)
| mv        #s, r0              // 14
| if        .a1:ge              // 14
| addh      a5h, a6              // 14 (*)
| mv        *r0, a1h            // 14
| addh      a6h, a7, .a1:ge      // 14 (*)

```



```

    addh      a7h, a4, .a1:ge      // 14 (*)
    addh      a4h, a0, .a1:ge      // 14 (*)
    addh      a1h, a0, .a1:ge      // 14 (*)
    mv        a0h, *r0, .a1:ge     // 14 (*), CurrBundle: 7, CriticalPath: 7
    callr     #rand                 // 17 (*), CurrBundle: 1, CriticalPath: 1
    mv        a0h, *dp(-1)         // 17 (*), CurrBundle: 1, CriticalPath: 1, 1-byte Foldec
|   callr     #rand                 // 18 (*)
    .rule_off                      // 18
    copy      a0, a5               // 18 (*), CurrBundle: 1, CriticalPath: 1
|   callr     #rand                 // 19 (*)
    copy      a0, a6               // 19 (*), CurrBundle: 1, CriticalPath: 1
|   callr     #rand                 // 20 (*)
    copy      a0, a7               // 20 (*), CurrBundle: 1, CriticalPath: 1
|   callr     #rand                 // 21 (*)
    copy      a0, a4               // 21 (*), CurrBundle: 1, CriticalPath: 1
|   callr     #rand                 // 22 (*)
    .rule_on                      // 23
    cmp       301, a5h             // 23 (*)
    brr       #.LBB0_2, .a5:lt     // 23 (*), CurrBundle: 2, CriticalPath: 2

// Procedure estimates:
// Code size: 101 words (28 bits/instr)
// Instructions / cycles: 57 / 39
// Loop weighted cycles: 39
// Stack allocation: 16
*/

```

another example

original code

```

void SESCHEDFO_main()//500+ loc
{
    ULMACCE_LAPCSPLIB_traceS trace;
    ULMACCE_SCHEDLIB_traceHeaderS* traceHeader_p;

    traceHeader_p = &trace.header;
    traceHeader_p->cellId = foData_p->commonCellTo.cellInfo.cellId;

    while(expr)
    {
        trace.specificInfo.traceEntryInfo.nrofSchedulableSes = nrofSchedulableSes;

        BOOL isNs05seTypeDowngraded = FALSE;
        assignSpectrumSucceeded =
            ULMACCE_SCHEDLIB_assignSpectrumToSe(
                &trace
            );

        if (assignSpectrumSucceeded)
        {
            ULMACCE_PUSCHTPS_ginrWeighterDataS ginrWeightDataS;

        }
    }
}

```

after refactor

```

void SESCHEDFO_main()//500+ loc
{

while(expr)
{
    BOOL isNs05seTypeDowngraded = FALSE;
    {
        ULMACCE_LAPCSPLIB_traceS trace;
        ULMACCE_SCHEDLIB_traceHeaders* traceHeader_p;
        traceHeader_p = &trace.header;
        traceHeader_p->cellId = foData_p->commonCellTo.cellInfo.cellId;
        trace.specificInfo.traceEntryInfo.nrOfSchedulableSes = nrOfSchedulableSes;

        assignSpectrumSucceeded =
            ULMACCE_SCHEDLIB_assignSpectrumToSe(
                &trace
            );
    }

    if (assignSpectrumSucceeded)
    {
        ULMACCE_PUSCHTPS_ginrWeighterDataS ginrWeightDataS;

    }
}
}

```

result:

Decreased stack use in test_ULMACCE_SCHEDFO: by 26 words or 1.0%; new stack 2668 vs stack 2694

assume

how much saved = how much resued - how much compiler alredy optimzed

Pros & cons

- indirect & difficult to calculate
- more effort to read code
- no tool to find out the deepest call sequence in stack

data structure refactor

e.g. any duplicate?

```
typedef struct ULMACCE_SESCHEDFO_seListS
{
    S16 size;
    S16 nrOfActiveElements;
    S16 startIndex;
    S16 iteratorIndex;
    ULMACCE_SESCHED_seDataS* se_p[ULMACCE_PUSCH_MAX_SE_LIST_SIZE];
} ULMACCE_SESCHEDFO_seListS;
```

```
typedef struct ULMACCE_SCHEDFO_foDataS
{
    ULMACCE_SCHEDFO_fodS fod;
    ULMACCE_SESCHEDFO_seListS inputNewSeList;
    ULMACCE_SESCHEDFO_seListS scheduledNewSeList;
} ULMACCE_SCHEDFO_foDataS;
```

** in the fod, there is two list: inputNewSeList, scheduledNewSeList.

actually one se can only appear in 1 list, why need 2 space? **

e.g. duplcte index?

```
#pragma nostdinit on
ULMACCE_SCHEDFO_foDataS ulSeSched_foData;
ULMACCE_PUSCHTPS_newTxSeDataS
ulSeSched_newSchedData[ELIB_BBBASE_COMMON_MAX_NR_OF_UL_SE_PER_TT_PER_CELL];
UpcdlMacCeFiSePdcchCfmDataS
ulSeSched_pdcchCfmData[ELIB_BBBASE_COMMON_MAX_NR_OF_UL_SE_PER_TT_PER_CELL];
ULMACCE_HARQPROCPOOLPPS_harqProcS
ulSeSched_harqProcData[ELIB_BBBASE_COMMON_MAX_NR_OF_UL_SE_PER_TT_PER_CELL];
ULMACCE_SCHEDFO_internalSeDataS
    ulSeSched_internalSeData[ELIB_BBBASE_COMMON_MAX_NR_OF_UL_SE_PER_TT_PER_CELL];
#pragma nostdinit off

{//loop
    newSchedData_p = ulSeSched_newSchedData;
    pdcchCfmData_p = ulSeSched_pdcchCfmData;
    harqProcData_p = ulSeSched_harqProcData;
    internalSeData_p = ulSeSched_internalSeData;
    newSchedData_p++;
    //and the other 3 pointer ++
}
```

merging 4 pointer into 1 index

```
static U16 seIndex = 0;

{ //loop
    newSchedData_p = &testdata_newSchedData[seIndex];
    harqProcData_p = &testdata_harqProcData[seIndex];
    pdcchCfmData_p = &testdata_pdcchCfmData[seIndex];
    internalSeData_p = &testdata_internalSeData[seIndex];
    seIndex++;
}
```

ULMACCE_PUSCHTPS_newTxSeDataS has much bigger size than reTx, why occupy the same size?

can the array only store the common field which used in scheudling algorithm (weight/sort)
the less important field just put a linked list implement via array?

code refactor

e.g. algorithm