相关资源

PNG文件格式文档

```
http://www.libpng.org/pub/png/spec/1.2/PNG-Chunks.html
https://www.myway5.com/index.php/2017/11/10/png%E6%A0%BC%E5%BC%8F%E5%88%86%E6%9E%90%E4%B8%8E%E5%8E%8B%E7%BC%A9%E5%8E%9F%E7%90%86/
```

源码下载

```
http://78.108.103.11/MIRROR/ftp/png/src/history/libpng12/
```

CVE-2004-0597

分析

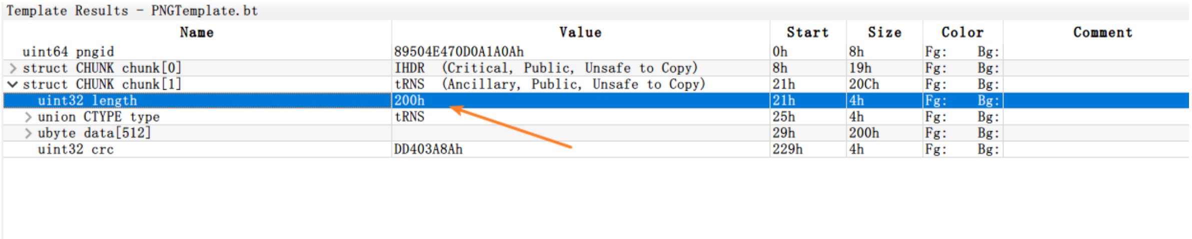
漏洞代码

```
void /* PRIVATE */
png_handle_tRNS(png_structp png_ptr, png_infop info_ptr, png_uint_32 length)
{
   png_byte readbuf[PNG_MAX_PALETTE_LENGTH]; // 0x100
   .........................
   .........................
   png_crc_read(png_ptr, readbuf, (png_size_t)length);
      png_ptr->num_trans = (png_uint_16)length;
```

readbuf 是一个 0x100字节的缓冲区， length从 png 文件中读取，最大可以为 0x7fffffff , 典型的栈溢出。

测试用例:

```
trns_stack_bof.png
```



Template Results - PNGTemplate.bt

Name	Value	Start	Size	Color	Comment
uint64 pngid	89504E470D0A1A0Ah	0h	8h	Fg: Bg:	
> struct CHUNK chunk[0]	IHDR (Critical, Public, Unsafe to Copy)	8h	19h	Fg: Bg:	
⌄ struct CHUNK chunk[1]	tRNS (Ancillary, Public, Unsafe to Copy)	21h	20Ch	Fg: Bg:	
uint32 length	200h	21h	4h	Fg: Bg:	
> union CTYPE type	tRNS	25h	4h	Fg: Bg:	
> ubyte data[512]		29h	200h	Fg: Bg:	
uint32 crc	DD403A8Ah	229h	4h	Fg: Bg:	

修复

对 length进行校验避免大于 PNG_MAX_PALETTE_LENGTH.

CVE-2007-5266

补丁地址

```
https://sourceforge.net/p/png-mng/mailman/png-mng-implement/thread/5122753600C3E94F87FBDFFCC090D1FF0400EA68@MERCMBX07.na.sas.com/
```

iCCP 的格式

```
iccp_name字符串+"\x00" + "\x00" + zlib压缩后的数据 endata
```

endata 解压后的格式

```
profile_size:  4个字节
```

iCCP chunk 处理堆越界（基本无影响)

分析

调试环境

```
ubuntu 16.04 64bit
```

测试用例

```
附件\libpng\iccp_memleak*.png
```

漏洞代码

```
#if defined(PNG_iCCP_SUPPORTED)
void PNGAPI
png_set_iCCP(png_structp png_ptr, png_infop info_ptr,
             png_charp name, int compression_type,
             png_charp profile, png_uint_32 proflen)
{

   new_iccp_name = (png_charp)png_malloc_warn(png_ptr,
png_strlen(name)+1);

   png_strncpy(new_iccp_name, name, png_sizeof(new_iccp_name));  //当 name
大于 8 字节时， strncpy 拷贝字符串不会再末尾添0 ， 可能内存泄露
```

strncpy 的工作为

```
char* strncpy(char *dest, const char *src, size_t n){
    size_t i;
    for (i = 0 ; i < n && src[i] != '\0' ; i++)
        dest[i] = src[i];
    for ( ; i < n ; i++)
        dest[i] = '\0';
    return dest;
}
```

1. 如果src的前n个字符里面没有'\0'，那么它不会在末尾补上这个结束符
2. 如果拷贝的数据不满n个字符，那么它会用 '\0' 在末尾填充

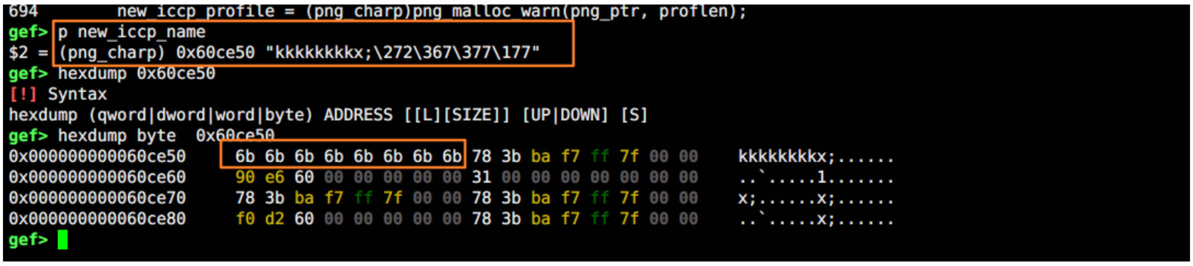
漏洞是存在的，无影响的原因是在 linux x64 下分配内存的最小数据块为 0x20 , 可用的数据区域为 0x10.而 png_sizeof(new_iccp_name) 的大小为 8 , 所以不会溢出到其他内存块的数据里面。

Case1

当 `iccp_name` 的长度大于 `8` 时， `strncpy` 不会再字符串末尾填`\x00`， 后面的使用可能会导致内存数据泄露（比如分配到的的内存块是位于 unsorted bin 中）。

```
iccp_memleak1.png
```

泄露堆块的指针



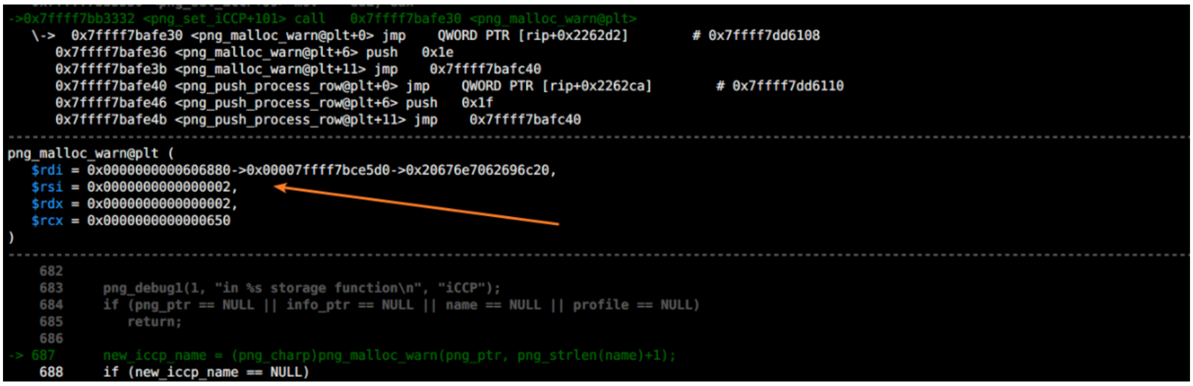
```
694         new_iccp_profile = (png_charp)png_malloc_warn(png_ptr, proflen);
gef> p new_iccp_name
$2 = (png_charp) 0x60ce50 "kkkkkkkkx;\272\367\377\177"
gef> hexdump 0x60ce50
[!] Syntax
hexdump (qword|dword|word|byte) ADDRESS [[L][SIZE]] [UP|DOWN] [S]
gef> hexdump byte  0x60ce50
0x000000000060ce50     6b 6b 6b 6b 6b 6b 6b 6b 78 3b ba f7 ff 7f 00 00    kkkkkkkkx;......
0x000000000060ce60     90 e6 60 00 00 00 00 00 31 00 00 00 00 00 00 00    ..`.....1.......
0x000000000060ce70     78 3b ba f7 ff 7f 00 00 78 3b ba f7 ff 7f 00 00    x;......x;......
0x000000000060ce80     f0 d2 60 00 00 00 00 00 78 3b ba f7 ff 7f 00 00    ..`.....x;......
gef> 
```

Case2

当 `iccp_name` 的长度小于 `8` 时，`malloc` 的大小会小于 `png_sizeof(new_iccp_name)` ， 这个会造成越界。

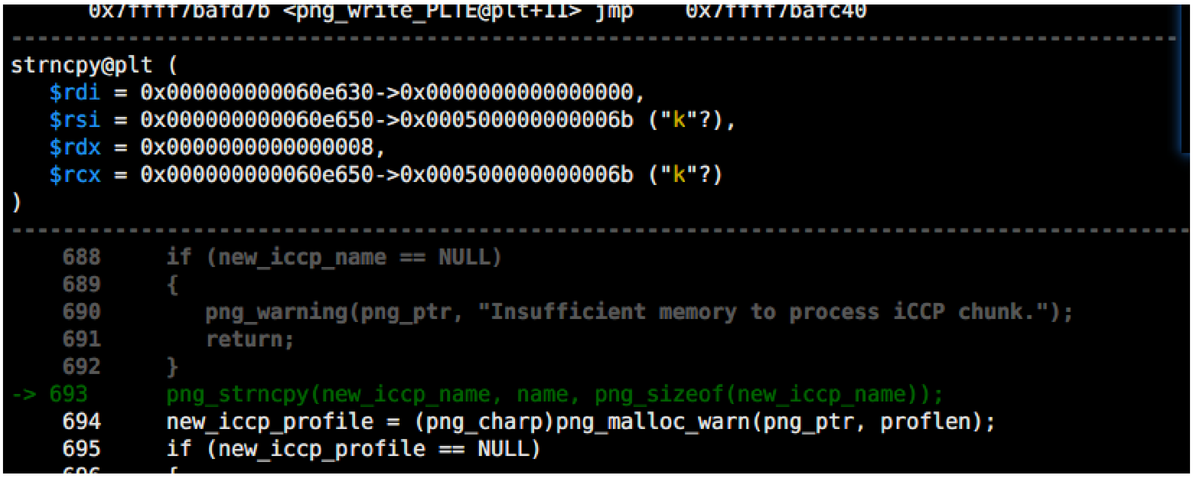
```
iccp_memleak2.png
```

当 iccp_name 为 k\x00 时， 分配 2 字节



```
->0x7ffff7bb3332 <png_set_iCCP+101> call   0x7ffff7bafe30 <png_malloc_warn@plt>
   \->  0x7ffff7bafe30 <png_malloc_warn@plt+0> jmp    QWORD PTR [rip+0x2262d2]        # 0x7ffff7dd6108
      0x7ffff7bafe36 <png_malloc_warn@plt+6> push   0x1e
      0x7ffff7bafe3b <png_malloc_warn@plt+11> jmp    0x7ffff7bafc40
      0x7ffff7bafe40 <png_push_process_row@plt+0> jmp    QWORD PTR [rip+0x2262ca]        # 0x7ffff7dd6110
      0x7ffff7bafe46 <png_push_process_row@plt+6> push   0x1f
      0x7ffff7bafe4b <png_push_process_row@plt+11> jmp    0x7ffff7bafc40
-------------------------------------------------------------------------------------------------------------------
png_malloc_warn@plt (
   $rdi = 0x0000000000606880->0x00007ffff7bce5d0->0x20676e7062696c20,
   $rsi = 0x0000000000000002,
   $rdx = 0x0000000000000002,
   $rcx = 0x0000000000000650
)
-------------------------------------------------------------------------------------------------------------------
    682
    683      png_debug1(1, "in %s storage function\n", "iCCP");
    684      if (png_ptr == NULL || info_ptr == NULL || name == NULL || profile == NULL)
    685         return;
    686
-> 687       new_iccp_name = (png_charp)png_malloc_warn(png_ptr, png_strlen(name)+1);
    688      if (new_iccp_name == NULL)
```

后面拷贝时会拷贝 8 字节



```
      0x7ffff7bafd7b <png_write_PLTE@plt+11> jmp    0x7ffff7bafc40
-------------------------------------------------------------------------------------------------------------------
strncpy@plt (
   $rdi = 0x000000000060e630->0x0000000000000000,
   $rsi = 0x000000000060e650->0x000500000000006b ("k"?),
   $rdx = 0x0000000000000008,
   $rcx = 0x000000000060e650->0x000500000000006b ("k"?)
)
-------------------------------------------------------------------------------------------------------------------
    688      if (new_iccp_name == NULL)
    689      {
    690         png_warning(png_ptr, "Insufficient memory to process iCCP chunk.");
    691         return;
    692      }
-> 693       png_strncpy(new_iccp_name, name, png_sizeof(new_iccp_name));
    694      new_iccp_profile = (png_charp)png_malloc_warn(png_ptr, proflen);
    695      if (new_iccp_profile == NULL)
```

修复方式

```
png_strncpy(new_iccp_name, name, png_strlen(new_iccp_name)+1);
```

总结： strncpy 要小心使用

sPLT Chunk处理

分析

测试用例

```
附件\libpng\splt.png
```

sPLT 的数据域的格式

```
字符串 + '\x00' + entries
```

entries 的结构

```
depth， 用来表示每个entry的size: 1字节
entry 数组
```

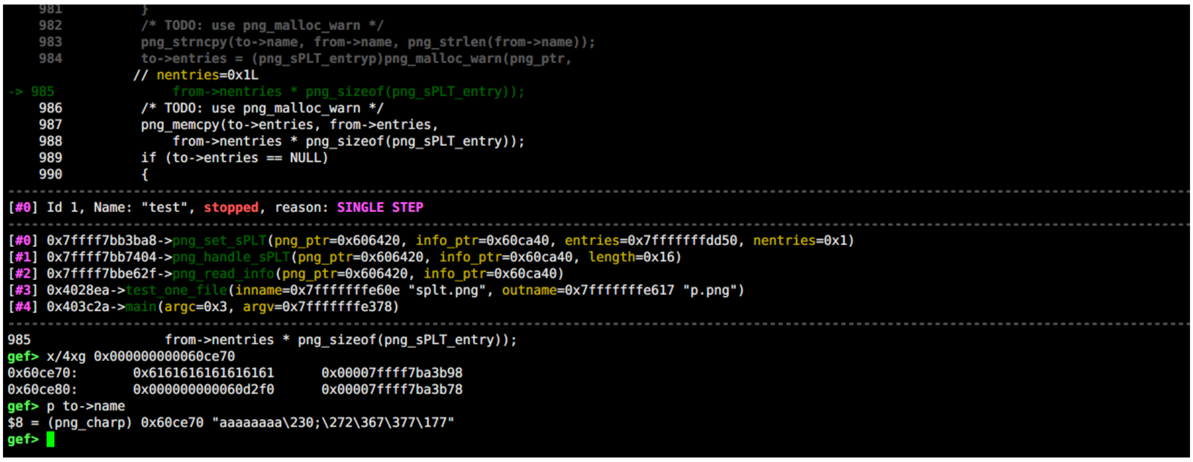
entry 的结构

```
typedef struct png_sPLT_entry_struct
{
   png_uint_16 red;
   png_uint_16 green;
   png_uint_16 blue;
   png_uint_16 alpha;
   png_uint_16 frequency;
} png_sPLT_entry;
```

还是 strncpy 的使用， 没有 设置 '\x00' 可能会 leak.

```
png_set_sPLT(png_structp png_ptr,
             png_infop info_ptr, png_sPLT_tp entries, int nentries)
{
to->name = (png_charp)png_malloc_warn(png_ptr,png_strlen(from->name) + 1);
png_strncpy(to->name, from->name, png_strlen(from->name));
```

假设 `from->name` 为 8 字节



```
    981          }
    982          /* TODO: use png_malloc_warn */
    983          png_strncpy(to->name, from->name, png_strlen(from->name));
    984          to->entries = (png_sPLT_entryp)png_malloc_warn(png_ptr,
                // nentries=0x1L
-> 985              from->nentries * png_sizeof(png_sPLT_entry));
    986          /* TODO: use png_malloc_warn */
    987          png_memcpy(to->entries, from->entries,
    988              from->nentries * png_sizeof(png_sPLT_entry));
    989          if (to->entries == NULL)
    990          {
-----------------------------------------------------------------------------------------------------------------------------
[#0] Id 1, Name: "test", stopped, reason: SINGLE STEP
-----------------------------------------------------------------------------------------------------------------------------
[#0] 0x7ffff7bb3ba8->png_set_sPLT(png_ptr=0x606420, info_ptr=0x60ca40, entries=0x7fffffffdd50, nentries=0x1)
[#1] 0x7ffff7bb7404->png_handle_sPLT(png_ptr=0x606420, info_ptr=0x60ca40, length=0x16)
[#2] 0x7ffff7bbe62f->png_read_info(png_ptr=0x606420, info_ptr=0x60ca40)
[#3] 0x4028ea->test_one_file(inname=0x7fffffffe60e "splt.png", outname=0x7fffffffe617 "p.png")
[#4] 0x403c2a->main(argc=0x3, argv=0x7fffffffe378)
-----------------------------------------------------------------------------------------------------------------------------
985                 from->nentries * png_sizeof(png_sPLT_entry));
gef> x/4xg 0x000000000060ce70
0x60ce70:       0x6161616161616161      0x00007ffff7ba3b98
0x60ce80:       0x000000000060d2f0      0x00007ffff7ba3b78
gef> p to->name
$8 = (png_charp) 0x60ce70 "aaaaaaaa\230;\272\367\377\177"
gef> 
```

修复

```
png_strncpy(to->name, from->name, png_strlen(from->name)+1);
```

CVE-2007-5269

公告地址

```
https://sourceforge.net/p/png-mng/mailman/png-mng-implement/thread/3.0.6.32.20071004082318.012a7628@mail.comcast.net/
```

zTXt

分析

测试用例

```
附件\libpng\ztxt.png
```

漏洞代码

```
void /* PRIVATE */
png_handle_zTXt(png_structp png_ptr, png_infop info_ptr, png_uint_32 length)
{

   png_crc_read(png_ptr, (png_bytep)chunkdata, slength);
   if (png_crc_finish(png_ptr, 0))
   {
      png_free(png_ptr, chunkdata);
      return;
   }

   chunkdata[slength] = 0x00;

   for (text = chunkdata; *text; text++)
      /* empty loop */ ;

   /* zTXt must have some text after the chunkdataword */
   if (text == chunkdata + slength - 1)
   {
      png_warning(png_ptr, "Truncated zTXt chunk");
      png_free(png_ptr, chunkdata);
      return;
   }
```

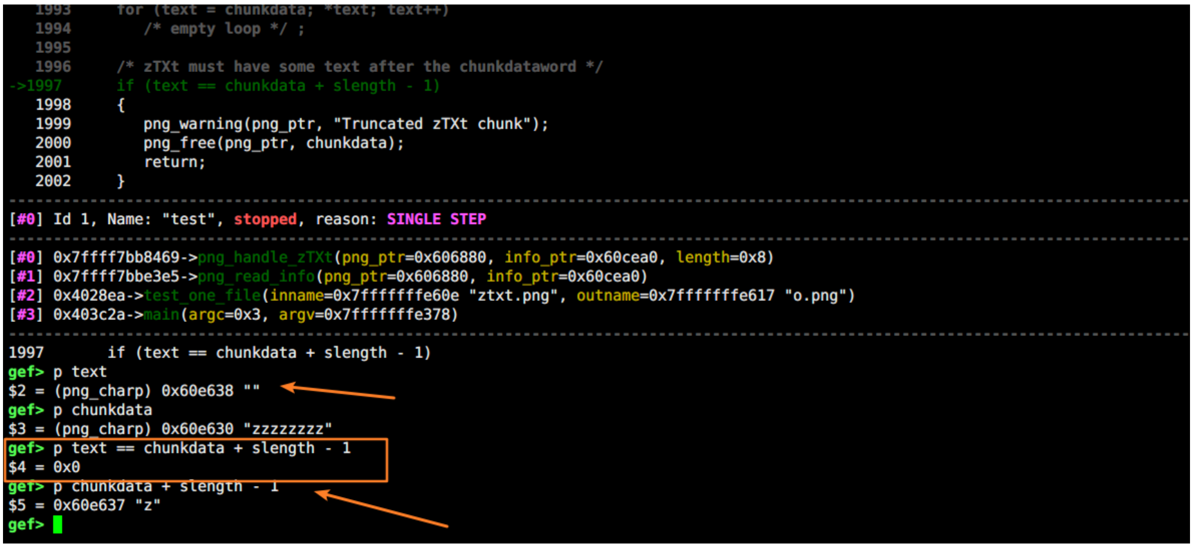
首先读取 chunkdata， 然后末尾填 '\x00'， 然后会在 chunkdata 开始位置找字符串

```
for (text = chunkdata; *text; text++)
      /* empty loop */ ;
```

后面的判断条件出现了问题

```
if (text == chunkdata + slength - 1)
```

当`chunkdata`中的字符全部都不是'`\x00`'时， `text` 会等于 `chunkdata + slength`



```
       for (text = chunkdata; *text; text++)
          /* empty loop */ ;

       /* zTXt must have some text after the chunkdataword */
->     if (text == chunkdata + slength - 1)
       {
          png_warning(png_ptr, "Truncated zTXt chunk");
          png_free(png_ptr, chunkdata);
          return;
       }
----------------------------------------------------------------------------------------------------------------
[#0] Id 1, Name: "test", stopped, reason: SINGLE STEP
----------------------------------------------------------------------------------------------------------------
[#0] 0x7ffff7bb8469->png_handle_zTXt(png_ptr=0x606880, info_ptr=0x60cea0, length=0x8)
[#1] 0x7ffff7bbe3e5->png_read_info(png_ptr=0x606880, info_ptr=0x60cea0)
[#2] 0x4028ea->test_one_file(inname=0x7fffffffe60e "ztxt.png", outname=0x7fffffffe617 "o.png")
[#3] 0x403c2a->main(argc=0x3, argv=0x7fffffffe378)
----------------------------------------------------------------------------------------------------------------
1997       if (text == chunkdata + slength - 1)
gef> p text
$2 = (png_charp) 0x60e638 ""
gef> p chunkdata
$3 = (png_charp) 0x60e630 "zzzzzzzz"
gef> p text == chunkdata + slength - 1
$4 = 0x0
gef> p chunkdata + slength - 1
$5 = 0x60e637 "z"
gef> 
```

后面就会越界读了。

修复

```
/* zTXt must have some text after the chunkdataword */
   if (text >= chunkdata + slength - 2)
   {
      png_warning(png_ptr, "Truncated zTXt chunk");
      png_free(png_ptr, chunkdata);
      return;
   }
```

总结：用 == 号来判断是否出现数组越界是不安全的

sCAL

测试用例

附件\libpng\scal.png

分析

漏洞代码

```
png_handle_sCAL(png_structp png_ptr, png_infop info_ptr, png_uint_32
length)
{

   png_crc_read(png_ptr, (png_bytep)buffer, slength);
   buffer[slength] = 0x00; /* null terminate the last string */
   ep = buffer + 1;        /* skip unit byte */
   width = png_strtod(png_ptr, ep, &vp);
   if (*vp)
   {
       png_warning(png_ptr, "malformed width string in sCAL chunk");
       return;
   }
   for (ep = buffer; *ep; ep++)
      /* empty loop */ ;
   ep++;
```

当 buffer 里面的每个字符都不是 \x00 时， 最后会执行这一部分代码后， ep 会超过分配的内存块的大小，造成越界访问。

修复

在后面增加校验

```
   if (buffer + slength < ep)
   {
       png_warning(png_ptr, "Truncated sCAL chunk");
#if defined(PNG_FIXED_POINT_SUPPORTED) && \
    !defined(PNG_FLOATING_POINT_SUPPORTED)
       png_free(png_ptr, swidth);
#endif
      png_free(png_ptr, buffer);
       return;
   }
```

CVE-2008-1382

测试用例

附件\libpng\unknown.png

分析

漏洞代码

```
void /* PRIVATE */
png_handle_unknown(png_structp png_ptr, png_infop info_ptr, png_uint_32
length)
{
   png_uint_32 skip = 0;

    png_ptr->unknown_chunk.data = (png_bytep)png_malloc(png_ptr, length);
    png_ptr->unknown_chunk.size = (png_size_t)length;
    png_crc_read(png_ptr, (png_bytep)png_ptr->unknown_chunk.data, length);
```

在处理 `unknown`类型的 `chunk` 时， 如果 `length` 为`0` ， `png_malloc`会返回`0` ， 然后后面的代码没有校验`png_malloc`的返回值直接使用，导致空指针引用。

修复

对 `length` 进行校验

```
if (length == 0)
         png_ptr->unknown_chunk.data = NULL;
       else
       {
         png_ptr->unknown_chunk.data = (png_bytep)png_malloc(png_ptr, length);
         png_crc_read(png_ptr, (png_bytep)png_ptr->unknown_chunk.data, length);
       }
```

PS: 对1.2.19 用测试样本跑时，会触发栈溢出，溢出在 strncpy 函数内部，很神奇。

CVE-2008-3964

测试用例

```
ztxt_off_by_one.png
```

分析

漏洞代码

```
void /* PRIVATE */
png_push_read_zTXt(png_structp png_ptr, png_infop info_ptr)
{

         if (!(png_ptr->zstream.avail_out) || ret == Z_STREAM_END)
         {
            if (text == NULL)
            {
               text = (png_charp)png_malloc(png_ptr,
                     (png_uint_32)(png_ptr->zbuf_size
                     - png_ptr->zstream.avail_out + key_size + 1));
               png_memcpy(text + key_size, png_ptr->zbuf,
                  png_ptr->zbuf_size - png_ptr->zstream.avail_out);
               png_memcpy(text, key, key_size);
               text_size = key_size + png_ptr->zbuf_size -
                  png_ptr->zstream.avail_out;
               *(text + text_size) = '\0';
            }
            else
            {
               png_charp tmp;

               tmp = text;
               text = (png_charp)png_malloc(png_ptr, text_size +
                  (png_uint_32)(png_ptr->zbuf_size
                  - png_ptr->zstream.avail_out));
               png_memcpy(text, tmp, text_size);
               png_free(png_ptr, tmp);
               png_memcpy(text + text_size, png_ptr->zbuf,
                  png_ptr->zbuf_size - png_ptr->zstream.avail_out);
               text_size += png_ptr->zbuf_size - png_ptr-
>zstream.avail_out;
               *(text + text_size) = '\0';
```

分配内存时

```
png_malloc(png_ptr, text_size +
                  (png_uint_32)(png_ptr->zbuf_size
                  - png_ptr->zstream.avail_out));
```

最后一步给解压后的字符串末尾赋值时

```
*(text + text_size) = '\0';
```

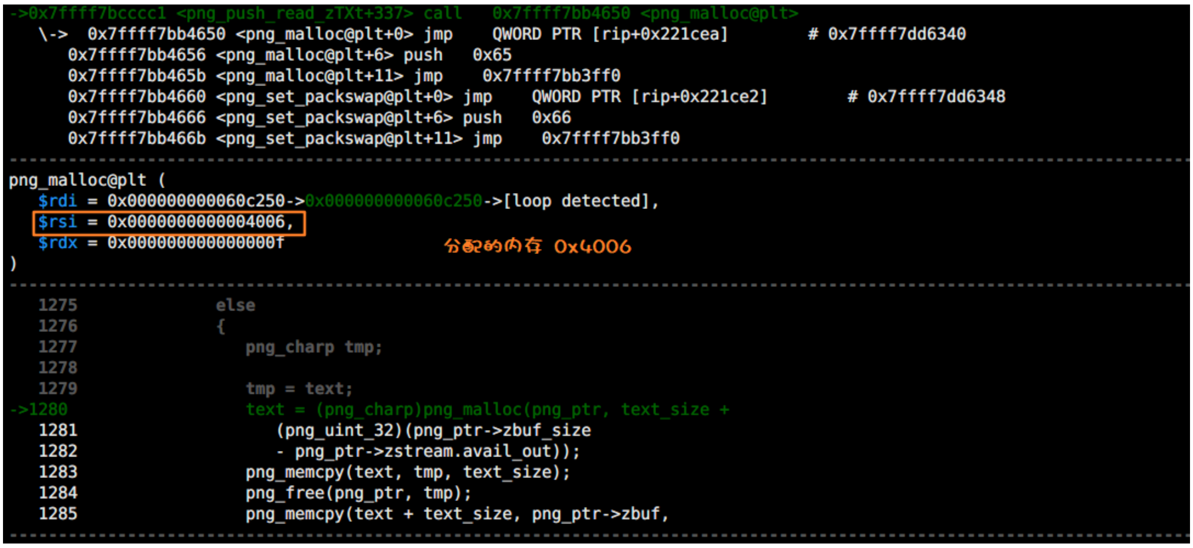
通过代码可以知道

```
text_size = text_size +
                  (png_uint_32)(png_ptr->zbuf_size
                  - png_ptr->zstream.avail_out)
```

典型的单字节数组越界即

```
buf[buf_length]
```

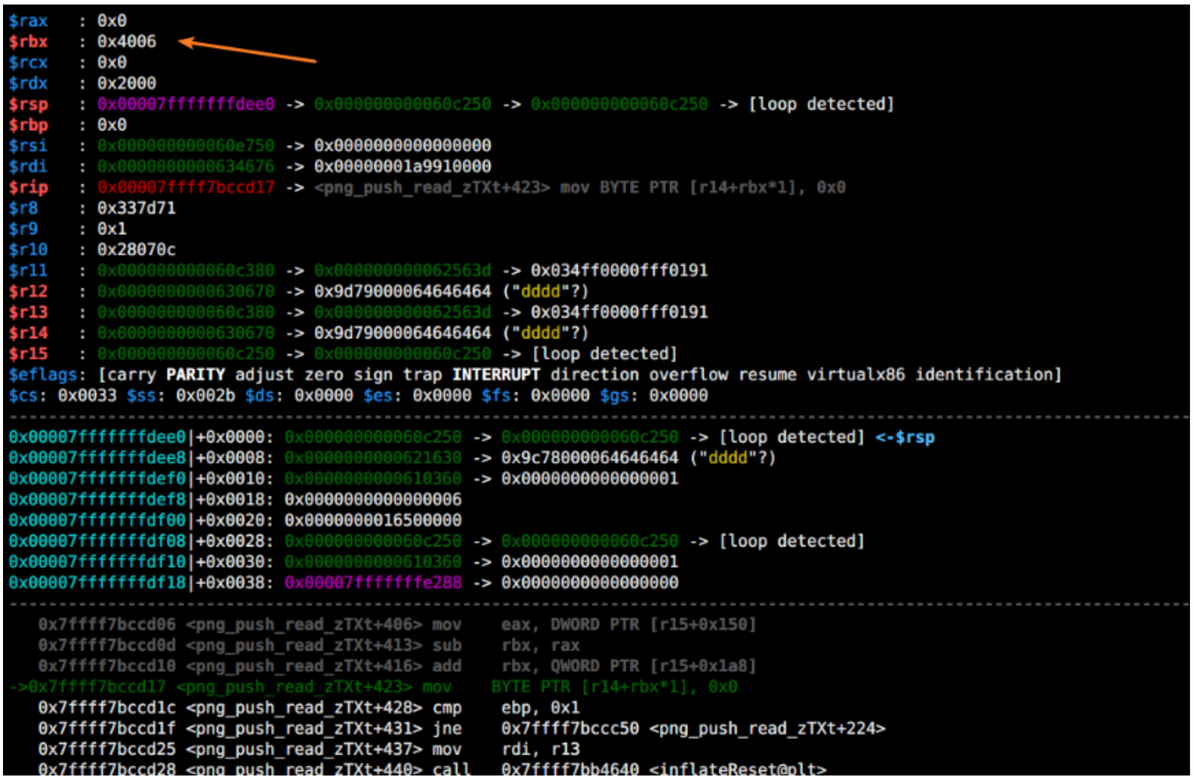
分配内存时， 分配了 0x4006



```
->0x7ffff7bcccc1 <png_push_read_zTXt+337> call   0x7ffff7bb4650 <png_malloc@plt>
   \->  0x7ffff7bb4650 <png_malloc@plt+0> jmp    QWORD PTR [rip+0x221cea]        # 0x7ffff7dd6340
      0x7ffff7bb4656 <png_malloc@plt+6> push   0x65
      0x7ffff7bb465b <png_malloc@plt+11> jmp    0x7ffff7bb3ff0
      0x7ffff7bb4660 <png_set_packswap@plt+0> jmp    QWORD PTR [rip+0x221ce2]        # 0x7ffff7dd6348
      0x7ffff7bb4666 <png_set_packswap@plt+6> push   0x66
      0x7ffff7bb466b <png_set_packswap@plt+11> jmp    0x7ffff7bb3ff0
-----------------------------------------------------------------------------------------------------------------------
png_malloc@plt (
   $rdi = 0x000000000060c250->0x000000000060c250->[loop detected],
   $rsi = 0x0000000000004006,
   $rdx = 0x000000000000000f
)
-----------------------------------------------------------------------------------------------------------------------
                  else
                  {
                     png_charp tmp;

                     tmp = text;
->                   text = (png_charp)png_malloc(png_ptr, text_size +
                        (png_uint_32)(png_ptr->zbuf_size
                        - png_ptr->zstream.avail_out));
                     png_memcpy(text, tmp, text_size);
                     png_free(png_ptr, tmp);
                     png_memcpy(text + text_size, png_ptr->zbuf,
-----------------------------------------------------------------------------------------------------------------------
```

分配的内存 Ox4006

最后赋值 \x00 时，使用 0x4006作为索引 off-by-one



```
$rax   : 0x0
$rbx   : 0x4006
$rcx   : 0x0
$rdx   : 0x2000
$rsp   : 0x00007fffffffdee0 -> 0x000000000060c250 -> 0x000000000060c250 -> [loop detected]
$rbp   : 0x0
$rsi   : 0x000000000060e750 -> 0x0000000000000000
$rdi   : 0x0000000000634676 -> 0x00000001a9910000
$rip   : 0x00007ffff7bccd17 -> <png_push_read_zTXt+423> mov BYTE PTR [r14+rbx*1], 0x0
$r8    : 0x337d71
$r9    : 0x1
$r10   : 0x28070c
$r11   : 0x000000000060c380 -> 0x000000000062563d -> 0x034ff0000fff0191
$r12   : 0x0000000000630670 -> 0x9d79000064646464 ("dddd"?)
$r13   : 0x000000000060c380 -> 0x000000000062563d -> 0x034ff0000fff0191
$r14   : 0x0000000000630670 -> 0x9d79000064646464 ("dddd"?)
$r15   : 0x000000000060c250 -> 0x000000000060c250 -> [loop detected]
$eflags: [carry PARITY adjust zero sign trap INTERRUPT direction overflow resume virtualx86 identification]
$cs: 0x0033 $ss: 0x002b $ds: 0x0000 $es: 0x0000 $fs: 0x0000 $gs: 0x0000
-----------------------------------------------------------------------------------------------------------------------
0x00007fffffffdee0|+0x0000: 0x000000000060c250 -> 0x000000000060c250 -> [loop detected] <-$rsp
0x00007fffffffdee8|+0x0008: 0x0000000000621630 -> 0x9c78000064646464 ("dddd"?)
0x00007fffffffdef0|+0x0010: 0x0000000000610360 -> 0x0000000000000001
0x00007fffffffdef8|+0x0018: 0x0000000000000006
0x00007fffffffdf00|+0x0020: 0x0000000016500000
0x00007fffffffdf08|+0x0028: 0x000000000060c250 -> 0x000000000060c250 -> [loop detected]
0x00007fffffffdf10|+0x0030: 0x0000000000610360 -> 0x0000000000000001
0x00007fffffffdf18|+0x0038: 0x00007fffffffe288 -> 0x0000000000000000
-----------------------------------------------------------------------------------------------------------------------
   0x7ffff7bccd06 <png_push_read_zTXt+406> mov    eax, DWORD PTR [r15+0x150]
   0x7ffff7bccd0d <png_push_read_zTXt+413> sub    rbx, rax
   0x7ffff7bccd10 <png_push_read_zTXt+416> add    rbx, QWORD PTR [r15+0x1a8]
->0x7ffff7bccd17 <png_push_read_zTXt+423> mov    BYTE PTR [r14+rbx*1], 0x0
   0x7ffff7bccd1c <png_push_read_zTXt+428> cmp    ebp, 0x1
   0x7ffff7bccd1f <png_push_read_zTXt+431> jne    0x7ffff7bccc50 <png_push_read_zTXt+224>
   0x7ffff7bccd25 <png_push_read_zTXt+437> mov    rdi, r13
   0x7ffff7bccd28 <png_push_read_zTXt+440> call   0x7ffff7bb4640 <inflateReset@plt>
```

这个漏洞的样本构造需要让 zTXt 的压缩数据的大小大于 0x2000，因为zstream.avail_out初始值为 2000.zTXt 的压缩数据的大小大于 0x2000 时才能进入漏洞分支。

修复

分配的时候多分配一个字节

```
tmp = text;
text = (png_charp)png_malloc(png_ptr, text_size +
(png_uint_32)(png_ptr->zbuf_size
- png_ptr->zstream.avail_out + 1));
```

CVE-2008-5907

测试样本

```
iccp_longkeyword.png
```

分析

漏洞代码

```
png_size_t /* PRIVATE */
png_check_keyword(png_structp png_ptr, png_charp key, png_charpp new_key)
{
   key_len = strlen(key);
   ............
   ............
   if (key_len > 79)
   {
      png_warning(png_ptr, "keyword length must be 1 - 79 characters");
      new_key[79] = '\0';  // new_key 是一个指针数组
      key_len = 79;
   }
```

当 key_len 大于 79时，会使用

```
new_key[79] = '\0';
```

往地址写 `0` ， 注意到 `new_key`是一个 `char**p`, 所以上面的代码实际是往一个随机的位置写 8 字节的 `0` .

对应的汇编代码

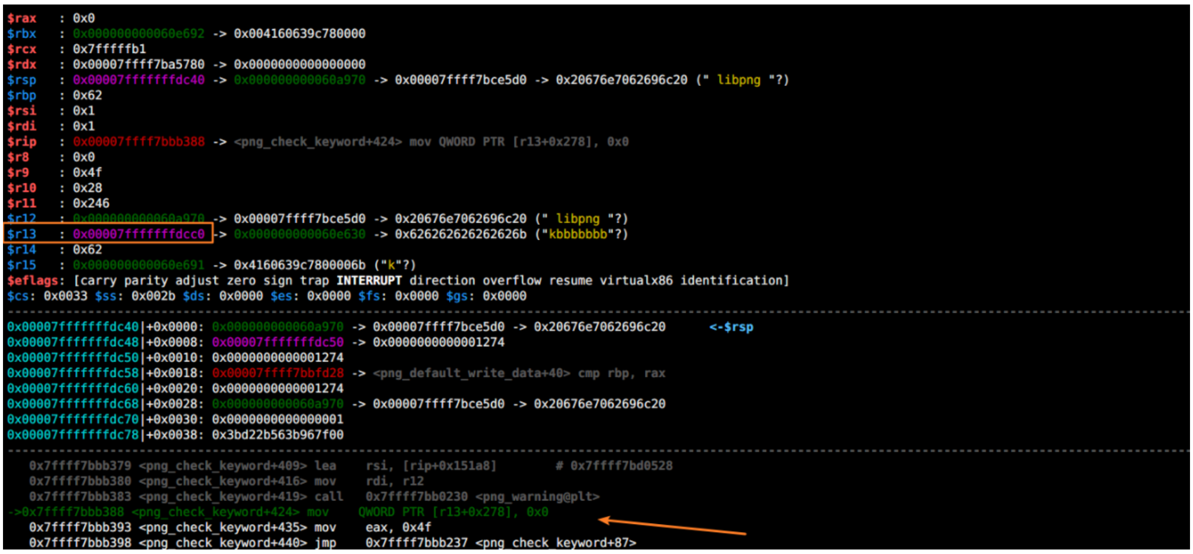
```
lea     rsi, aKeywordLengthM ; "keyword length must be 1 - 79 character"...
mov     rdi, png_ptr    ; png_ptr
call    _png_warning
mov     qword ptr [new_key+278h], 0  // new_key[79] = '\0';
mov     eax, 4Fh ; 'O'
jmp     loc_12237
```

以 `png_write_tEXt` 为例

```
void /* PRIVATE */
png_write_tEXt(png_structp png_ptr, png_charp key, png_charp text,
   png_size_t text_len)
{
   if (key == NULL || (key_len = png_check_keyword(png_ptr, key,
&new_key))==0)
   {
      png_warning(png_ptr, "Empty keyword in tEXt chunk");
      return;
   }
```

这里 `new_key` 是一个栈变量，当触发漏洞时，就会往 `png_write_tEXt` 函数栈帧某个位置写8 字节 0 。

调试时可以看到往栈里面写 0x0000000000000000



```
$rax   : 0x0
$rbx   : 0x000000000060e692 -> 0x004160639c780000
$rcx   : 0x7fffffb1
$rdx   : 0x00007ffff7ba5780 -> 0x0000000000000000
$rsp   : 0x00007fffffffdc40 -> 0x000000000060a970 -> 0x00007ffff7bce5d0 -> 0x20676e7062696c20 (" libpng "?)
$rbp   : 0x62
$rsi   : 0x1
$rdi   : 0x1
$rip   : 0x00007ffff7bbb388 -> <png_check_keyword+424> mov QWORD PTR [r13+0x278], 0x0
$r8    : 0x0
$r9    : 0x4f
$r10   : 0x28
$r11   : 0x246
$r12   : 0x000000000060a970 -> 0x00007ffff7bce5d0 -> 0x20676e7062696c20 (" libpng "?)
$r13   : 0x00007fffffffdcc0 -> 0x000000000060e630 -> 0x626262626262626b ("kbbbbbbb"?)
$r14   : 0x62
$r15   : 0x000000000060e691 -> 0x4160639c7800006b ("k"?)
$eflags: [carry parity adjust zero sign trap INTERRUPT direction overflow resume virtualx86 identification]
$cs: 0x0033 $ss: 0x002b $ds: 0x0000 $es: 0x0000 $fs: 0x0000 $gs: 0x0000
------------------------------------------------------------------------------------------------------------------
0x00007fffffffdc40|+0x0000: 0x000000000060a970 -> 0x00007ffff7bce5d0 -> 0x20676e7062696c20      <-$rsp
0x00007fffffffdc48|+0x0008: 0x00007fffffffdc50 -> 0x0000000000001274
0x00007fffffffdc50|+0x0010: 0x0000000000001274
0x00007fffffffdc58|+0x0018: 0x00007ffff7bbfd28 -> <png_default_write_data+40> cmp rbp, rax
0x00007fffffffdc60|+0x0020: 0x0000000000001274
0x00007fffffffdc68|+0x0028: 0x000000000060a970 -> 0x00007ffff7bce5d0 -> 0x20676e7062696c20
0x00007fffffffdc70|+0x0030: 0x0000000000000001
0x00007fffffffdc78|+0x0038: 0x3bd22b563b967f00
------------------------------------------------------------------------------------------------------------------
   0x7ffff7bbb379 <png_check_keyword+409> lea    rsi, [rip+0x151a8]        # 0x7ffff7bd0528
   0x7ffff7bbb380 <png_check_keyword+416> mov    rdi, r12
   0x7ffff7bbb383 <png_check_keyword+419> call   0x7ffff7bb0230 <png_warning@plt>
->0x7ffff7bbb388 <png_check_keyword+424> mov    QWORD PTR [r13+0x278], 0x0
   0x7ffff7bbb393 <png_check_keyword+435> mov    eax, 0x4f
   0x7ffff7bbb398 <png_check_keyword+440> jmp    0x7ffff7bbb237 <png_check_keyword+87>
```

修复

正确使用指针

```
   if (key_len > 79)
   {
      png_warning(png_ptr, "keyword length must be 1 - 79 characters");
      (*new_key)[79] = '\0';
      key_len = 79;
   }
```

CVE-2009-0040

分析

漏洞代码

```
png_read_png(png_structp png_ptr, png_infop info_ptr,
                           int transforms,
                           voidp params)
{

      info_ptr->row_pointers = (png_bytepp)png_malloc(png_ptr,
         info_ptr->height * png_sizeof(png_bytep));
      for (row = 0; row < (int)info_ptr->height; row++)
      {
         info_ptr->row_pointers[row] = (png_bytep)png_malloc(png_ptr,
            png_get_rowbytes(png_ptr, info_ptr));
      }
   }
```

这里会分配多个 `row_pointer` ，当内存不足时， `png_malloc` 会使用 `longjmp` 去释放掉 `row_pointers`数组内的指针，`row_pointers` 中后面的一些没有初始化的内存区域中的残留数据也有可能会被当做指针而 `free` 。

修复

分配内存前，初始化为 0

```
      png_memset(info_ptr->row_pointers, 0, info_ptr->height
         * png_sizeof(png_bytep));
      for (row = 0; row < (int)info_ptr->height; row++)
         info_ptr->row_pointers[row] = (png_bytep)png_malloc(png_ptr,
            png_get_rowbytes(png_ptr, info_ptr));
   }
```

CVE-2009-5063

分析

漏洞代码

```
png_write_iCCP(png_structp png_ptr, png_charp name, int compression_type,
   png_charp profile, int profile_len)
{

   png_size_t name_len;
   png_charp new_name;
   compression_state comp;
   int embedded_profile_len = 0;
   if (profile == NULL)
      profile_len = 0;

   if (profile_len > 3)
      embedded_profile_len =
          ((*( (png_bytep)profile    ))<<24) |
          ((*( (png_bytep)profile + 1))<<16) |
          ((*( (png_bytep)profile + 2))<< 8) |
          ((*( (png_bytep)profile + 3))    );

   if (profile_len < embedded_profile_len)
   {
      png_warning(png_ptr,
        "Embedded profile length too large in iCCP chunk");
      return;
   }

   if (profile_len > embedded_profile_len)
   {
      png_warning(png_ptr,
        "Truncating profile to actual length in iCCP chunk");
      profile_len = embedded_profile_len;
   }
    if (profile_len)
      profile_len = png_text_compress(png_ptr, profile,
        (png_size_t)profile_len, PNG_COMPRESSION_TYPE_BASE, &comp);
```

可以看到这里的 profile_len 和 embedded_profile_len 都是 int 类型， embedded_profile_len 从png图片的数据里面取出，当embedded_profile_len为负数时 比如（0xffffffff）， 最终会进入

`profile_len = embedded_profile_len;`

之后会将profile_len 传入

```
 profile_len = png_text_compress(png_ptr, profile,
        (png_size_t)profile_len, PNG_COMPRESSION_TYPE_BASE, &comp);
```

而 png_text_compress 接收的参数为 png_size_t 即无符号整数，所以会造成越界。

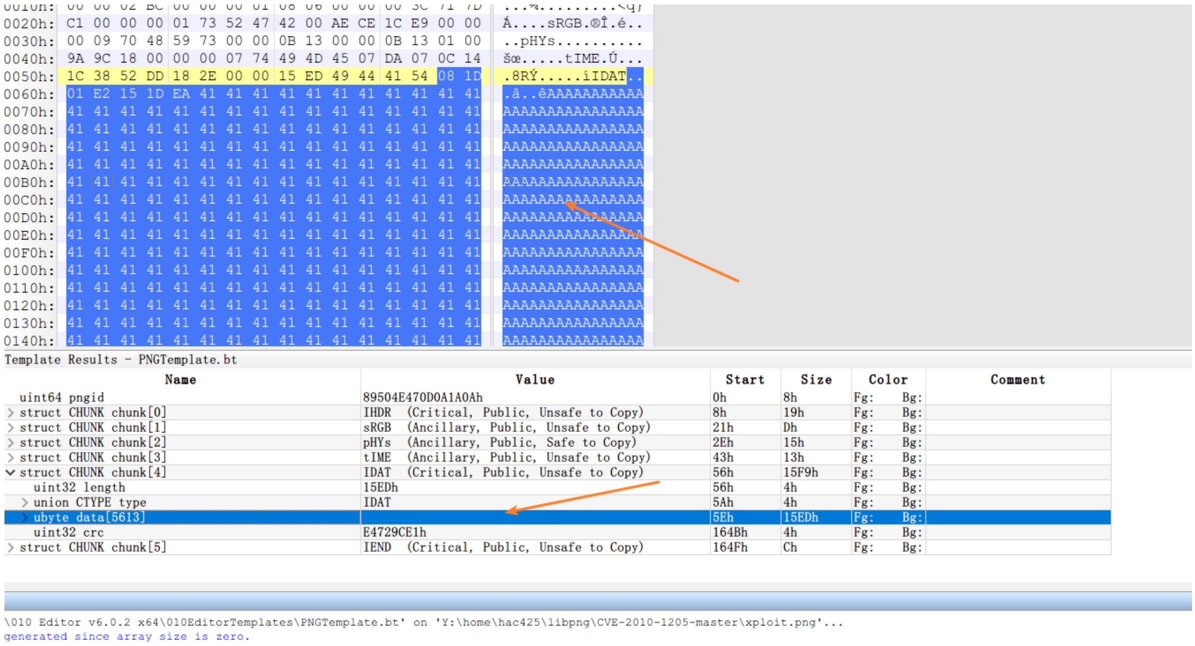
修复

修改类型为 png_size_t.

CVE-2010-1205

处理 PNG 的 IDAT数据时会发生堆溢出。测试样本

xploit.png



```
0010h: 00 00 02 BC 00 00 00 01 08 06 00 00 00 3C 71 7D  ...¼.........<q}
0020h: C1 00 00 00 01 73 52 47 42 00 AE CE 1C E9 00 00  Á....sRGB.®Î.é..
0030h: 00 09 70 48 59 73 00 00 0B 13 00 00 0B 13 01 00  ..pHYs..........
0040h: 9A 9C 18 00 00 00 07 74 49 4D 45 07 DA 07 0C 14  šœ.....tIME.Ú...
0050h: 1C 38 52 DD 18 2E 00 00 15 ED 49 44 41 54 08 1D  .8RÝ.....íIDAT..
0060h: 01 E2 15 1D EA 41 41 41 41 41 41 41 41 41 41 41  .â..êAAAAAAAAAAA
0070h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
0080h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
0090h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
00A0h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
00B0h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
00C0h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
00D0h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
00E0h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
00F0h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
0100h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
0110h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
0120h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
0130h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
0140h: 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41  AAAAAAAAAAAAAAAA
```

Template Results - PNGTemplate.bt

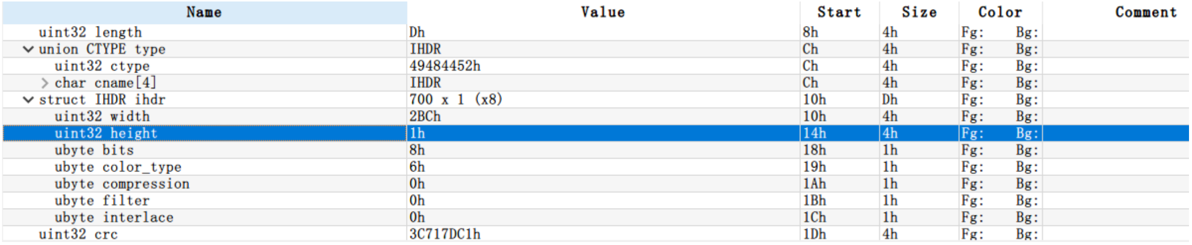
Name	Value	Start	Size	Color	Comment
uint64 pngid	89504E470D0A1A0Ah	0h	8h	Fg: Bg:	
› struct CHUNK chunk[0]	IHDR (Critical, Public, Unsafe to Copy)	8h	19h	Fg: Bg:	
› struct CHUNK chunk[1]	sRGB (Ancillary, Public, Unsafe to Copy)	21h	Dh	Fg: Bg:	
› struct CHUNK chunk[2]	pHYs (Ancillary, Public, Safe to Copy)	2Eh	15h	Fg: Bg:	
› struct CHUNK chunk[3]	tIME (Ancillary, Public, Unsafe to Copy)	43h	13h	Fg: Bg:	
⌄ struct CHUNK chunk[4]	IDAT (Critical, Public, Unsafe to Copy)	56h	15F9h	Fg: Bg:	
uint32 length	15EDh	56h	4h	Fg: Bg:	
› union CTYPE type	IDAT	5Ah	4h	Fg: Bg:	
› ubyte data[5613]		5Eh	15EDh	Fg: Bg:	
uint32 crc	E4729CE1h	164Bh	4h	Fg: Bg:	
› struct CHUNK chunk[5]	IEND (Critical, Public, Unsafe to Copy)	164Fh	Ch	Fg: Bg:	

```
\010 Editor v6.0.2 x64\010EditorTemplates\PNGTemplate.bt' on 'Y:\home\hac425\libpng\CVE-2010-1205-master\xploit.png'...
generated since array size is zero.
```

分析

处理PNG 图片中的 IDAT 数据时，会把 IDAT 中的数据一行一行的取出来保存后，然后进行处理。程序在一开始会使用 `rpng2_info.height` （即IHDR chunk 中的 heigth） 分配一些内存，用来保存每一行的数据。

```
static void rpng2_x_init(void)
{
    rpng2_info.image_data = (uch *)malloc(rowbytes * rpng2_info.height); // 0xaf0
    rpng2_info.row_pointers = (uch **)malloc(rpng2_info.height * sizeof(uch *));// 这里只分配一个指针空间， 因为 heigh 为 1， 而且是 malloc 会有内存残留
```



Name	Value	Start	Size	Color	Comment
uint32 length	Dh	8h	4h	Fg: Bg:	
⌄ union CTYPE type	IHDR	Ch	4h	Fg: Bg:	
uint32 ctype	49484452h	Ch	4h	Fg: Bg:	
› char cname[4]	IHDR	Ch	4h	Fg: Bg:	
⌄ struct IHDR ihdr	700 x 1 (x8)	10h	Dh	Fg: Bg:	
uint32 width	2BCh	10h	4h	Fg: Bg:	
uint32 height	1h	14h	4h	Fg: Bg:	
ubyte bits	8h	18h	1h	Fg: Bg:	
ubyte color_type	6h	19h	1h	Fg: Bg:	
ubyte compression	0h	1Ah	1h	Fg: Bg:	
ubyte filter	0h	1Bh	1h	Fg: Bg:	
ubyte interlace	0h	1Ch	1h	Fg: Bg:	
uint32 crc	3C717DC1h	1Dh	4h	Fg: Bg:	

以上图为例， `rpng2_info.height` 为 `1`， 首先会分配 `rowbytes` 的空间用来存储所有的 `IDAT` 数据， 然后会分配 1 个指针数组 `row_pointers` ， 用来保存指向保存每一行数据的内存区域。其中 `rowbytes` 是通过 `IHDR` 里面的字段计算出来的

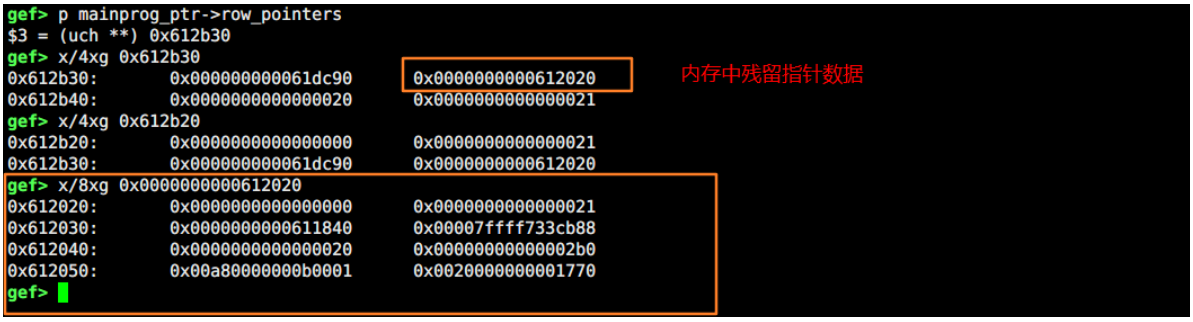
```
void __cdecl png_handle_IHDR(png_structp png_ptr, png_infop info_ptr,
png_uint_32 length)
{

  png_ptr->pixel_depth = png_ptr->channels * png_ptr->bit_depth;// 4*8
  v4 = png_ptr->width * (png_ptr->pixel_depth >> 3);
  png_ptr->rowbytes = v4;                              // 0xaf0
```

还是上图为例，最终计算的结果为 `0xaf0`. 之后程序会每次读取 `0xaf0`数据，然后从 `rpng2_info.row_pointers` 取出一个指针，然后往指针对应的内存空间里面写数据，直到读取完所有的 `IDAT` 数据。后面会使用越界的指针进行内存拷贝，导致内存写。

触发越界访问的代码如下：

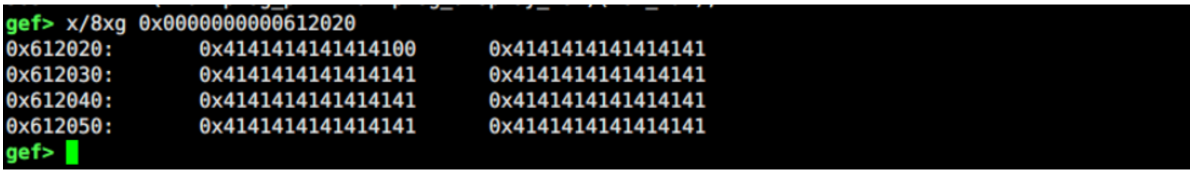
```
static void readpng2_row_callback(png_structp png_ptr, png_bytep new_row,
                                  png_uint_32 row_num, int pass)
{
    png_progressive_combine_row(png_ptr, mainprog_ptr-
>row_pointers[row_num],// row_num 会为1， 而 row_pointers的长度为1， 典型溢出
      new_row);
```

在溢出前，`row_pointers[1]` 后面有残留的内存指针，因为 `row_pointers` 的分配使用的是 `malloc` ，所以会有内存残留。`0x612020` 是一个堆上的指针。



```
gef> p mainprog_ptr->row_pointers
$3 = (uch **) 0x612b30
gef> x/4xg 0x612b30
0x612b30:       0x000000000061dc90      0x0000000000612020
0x612b40:       0x0000000000000020      0x0000000000000021
gef> x/4xg 0x612b20
0x612b20:       0x0000000000000000      0x0000000000000021
0x612b30:       0x000000000061dc90      0x0000000000612020
gef> x/8xg 0x0000000000612020
0x612020:       0x0000000000000000      0x0000000000000021
0x612030:       0x0000000000611840      0x00007ffff733cb88
0x612040:       0x0000000000000020      0x00000000000002b0
0x612050:       0x00a80000000b0001      0x0020000000001770
gef> 
```

执行完毕后会触发堆溢出把堆上的数据给覆盖了。



```
gef> x/8xg 0x0000000000612020
0x612020:       0x4141414141414100      0x4141414141414141
0x612030:       0x4141414141414141      0x4141414141414141
0x612040:       0x4141414141414141      0x4141414141414141
0x612050:       0x4141414141414141      0x4141414141414141
gef> 
```

总结：分配内存空间时使用的是 `png` 图片中的字段，然后实际使用的空间是根据数据长度进行计算的，两者的不一致导致了漏洞。

修复

在 `readpng2_row_callback` 对 `row_num` 进行判断。

CVE-2011-2692

分析

漏洞代码

```
void /* PRIVATE */
png_handle_sCAL(png_structp png_ptr, png_infop info_ptr, png_uint_32 length) {
   png_charp ep;
   ...
   png_ptr->chunkdata = (png_charp)png_malloc_warn(png_ptr, length + 1);
   ...
   slength = (png_size_t)length;
   ...
   png_ptr->chunkdata[slength] = 0x00; /* Null terminate the last string */

   ep = png_ptr->chunkdata + 1;        /* Skip unit byte */
   ...
   width = png_strtod(png_ptr, ep, &vp);
   ...
   swidth = (png_charp)png_malloc_warn(png_ptr, png_strlen(ep) + 1);
  --
```

当 `length` 为 `0` 时， `ep` 会出现越界访问。

修复

对 length 检查