

Talos Vulnerability Report

TALOS-2021-1291

AT&T Labs Xmill XML decompression DecodeTreeBlock multiple heap-based buffer overflow vulnerabilities

AUGUST 10, 2021

CVE NUMBER

CVE-2021-21826, CVE-2021-21827, CVE-2021-21828

Summary

Multiple heap-based buffer overflow vulnerabilities exists in the XML Decompression DecodeTreeBlock functionality of AT&T Labs Xmill 0.7. A specially crafted XML File can lead to remote code execution. An attacker can provide a malicious file to trigger these vulnerabilities.

Tested Versions

AT&T Labs Xmill 0.7

Schneider Electric EcoStruxure Control Expert 15

Product URLs

None

CVSSv3 Score

8.1 - CVSS:3.0/AV:N/AC:H/PR:N/UI:N/S:U/C:H/I:H/A:H

CWE

CWE-120 - Buffer Copy without Checking Size of Input ('Classic Buffer Overflow')

Details

Xmill and Xdemill are utilities that are purpose built for XML compressed and decompression respectively. These utilities claim to be roughly two times more efficient at compressing XML than other compression methods.

While this software is old, released in 1999, it can be found in modern software suites such as Schneider Electric's EcoStruxure Control Expert.

Xdemill is used to decompress XML files compressed by Xmill. This is an XML specific compression program. Both compression and decompression share a combined code base and compilation flags are used to determine the feature set for the output binary. The Uncompress function is the main decompression function called directly from main

```
void Uncompress(char *sourcefile, char *destfile)
{
    // The main compres function
    {
        ...

        unsigned long blockidx=0;
        mainmem.StartNewMemBlock();
        while(UncompressBlockHeader(&input)!=0)
        {
            compressman.UncompressLargeGlobalData(&input);
            uncomprcont.UncompressLargeContainers(&input);

            uncomprcont.Init();

            uncomprtreetcont = uncomprcont.GetContBlock(0)->GetContainer(0);
            uncomprwhitespacecont = uncomprcont.GetContBlock(0)->GetContainer(1);
            uncomprspecialcont = uncomprcont.GetContBlock(0)->GetContainer(2);
#ifdef TIMING
            c2=clock();
#endif

            DecodeTreeBlock(uncomprtreetcont, uncomprwhitespacecont, uncomprspecialcont, &output);
            ...
        }
    }
}
```

Within DecodeTreeBlock there are multiple vulnerabilities that allow for remote code execution via heap buffer overflows.

CVE-2021-21826 - TREETOKEN_WHITESPACE heap buffer overflow

Within DecodeTreeBlock which is called during the decompression of an XML file, a UINT32 is loaded from the file and used as trusted input as the length of a buffer.

```

void DecodeTreeBlock(UncompressContainer *treecont,UncompressContainer *whitespacecont,UncompressContainer *specialcont,XMLOutput *output)
{
    char          *strptr;
    unsigned char  isattrib;
    int           mystrlen;
    static char    tmpstr[20];

    unsigned char  *curptr,*endptr;
    long          id;
    char          isneg;

    curptr=treecont->GetDataPtr();
    endptr=curptr+treecont->GetSize();

    while(curptr<endptr)
    {
        id=LoadSInt32(curptr,&isneg);

        if(isneg==0)    // Do we have a label ID ?
        {
            ...

            switch(id)
            {
                ...

                case TREETOKEN_WHITESPACE: // A white-space token ?
                    mystrlen=whitespacecont->LoadUInt32();
                    output->whitespaces((char *)whitespacecont->GetDataPtr(mystrlen),mystrlen);
                    break;

                ...
            }
        }
    }
}

```

This length is then passed to a memcpy without verification that the buffer is large enough, or the data is long enough to safely copy.

```

void OUTPUT_STATIC whitespaces(char *str,int len)
{
    characters(str,len);
}

void OUTPUT_STATIC characters(char *str,int len)
{
    switch(x.status)
    {
        case XMLOUTPUT_OPENATTRIB:
            StoreData(str,len);
            return;

        case XMLOUTPUT_OPENLABEL:
            StoreChar('>');

        case XMLOUTPUT_AFTERDATA:
        case XMLOUTPUT_AFTERENDLABEL:
        case XMLOUTPUT_INIT:
            StoreData(str,len);
    }
    x.status=XMLOUTPUT_AFTERDATA;
}

void OUTPUT_STATIC StoreData(char *ptr,int len)
{
    // Stores the data at position 'ptr' of length 'len'
    {
        while(bufsize-curpos<len)
        {
            memcpy(buf+curpos,ptr,bufsize-curpos);
            len-=bufsize-curpos;
            ptr+=bufsize-curpos;
            curpos=bufsize;
            Flush();
        }
        memcpy(buf+curpos,ptr,len);
        curpos+=len;
    }
}

```

This unsafe memcpy results in a controllable heap buffer overflow.

Crash Information

```

Program received signal SIGSEGV, Segmentation fault.
__memcpy_ssse3 () at ../sysdeps/i386/i686/multiarch/memcpy-ssse3.S:1148
1148  ../sysdeps/i386/i686/multiarch/memcpy-ssse3.S: No such file or directory.
[3;J
[ Legend: Modified register | Code | Heap | Stack | String ]

----- registers -----
$eax : 0x080ecfc8 -> 0x00000000
$ebx : 0xb7dd1000 -> 0x001b2db0
$ecx : 0xdb78
$edx : 0x0808afc0 -> 0x00000000
$esp : 0xbffec44 -> 0x080eab80 -> 0x00000000
$ebp : 0x10000
$esi : 0x17010dce
$edi : 0x8
$eip : 0xb7d4692a -> <__memcpy_ssse3+3242> movaps xmm5, XMMWORD PTR [eax+0x38]
$eflags: [carry PARITY adjust zero sign trap INTERRUPT direction overflow RESUME virtualx86 identification]
$cs: 0x0073 $ss: 0x007b $ds: 0x007b $es: 0x007b $fs: 0x0000 $gs: 0x0033

```

```

----- stack -----
0xbffec44+0x0000: 0x080eab80 -> 0x00000000 -> $esp
0xbffec48+0x0004: 0x08082464 -> 0xb7dd1d60 -> 0xfbad2a84
0xbffec4c+0x0008: 0x08067990 -> <Output::StoreData(char*,+0> mov ecx, DWORD PTR [ebx+0xc]
0xbffec50+0x000c: 0x08088b78 -> 0x00000000
0xbffec54+0x0010: 0x080eab80 -> 0x00000000
0xbffec58+0x0014: 0x00110000
0xbffec5c+0x0018: 0xb7dd1d60 -> 0xfbad2a84
0xbffec60+0x001c: 0x0808992c -> 0x00000000

```

```

----- code:x86:32 -----
0xb7d4691e <__memcpy_ssse3+3230> movaps xmm2, XMMWORD PTR [eax+0x8]
0xb7d46922 <__memcpy_ssse3+3234> movaps xmm3, XMMWORD PTR [eax+0x18]
0xb7d46926 <__memcpy_ssse3+3238> movaps xmm4, XMMWORD PTR [eax+0x28]
-> 0xb7d4692a <__memcpy_ssse3+3242> movaps xmm5, XMMWORD PTR [eax+0x38]
0xb7d4692e <__memcpy_ssse3+3246> movaps xmm7, xmm5
0xb7d46931 <__memcpy_ssse3+3249> palignr xmm5, xmm4, 0x8
0xb7d46937 <__memcpy_ssse3+3255> palignr xmm4, xmm3, 0x8
0xb7d4693d <__memcpy_ssse3+3261> movaps XMMWORD PTR [edx+0x30], xmm5
0xb7d46941 <__memcpy_ssse3+3265> palignr xmm3, xmm2, 0x8

```

```

----- threads -----
[#0] Id 1, Name: "xdemill", stopped 0xb7d4692a in __memcpy_ssse3 (), reason: SIGSEGV

```

```

----- trace -----
[#0] 0xb7d4692a -> __memcpy_ssse3()
[#1] 0x8082464 -> pathexprman()
[#2] 0x8067990 -> Output::StoreData(this=<optimized out>, ptr=<optimized out>, len=<optimized out>)
[#3] 0x8066350 -> XMLOutput::characters(this=<optimized out>, str=<optimized out>, len=<optimized out>)
[#4] 0x8065a7a -> XMLOutput::whitespaces(this=0x8082464 <output>, str=0x80ecfc8 "", len=<optimized out>)
[#5] 0x8065a7a -> DecodeTreeBlock(treecont=<optimized out>, whitespacecont=<optimized out>, specialcont=<optimized out>, output=<optimized out>)
[#6] 0x8071656 -> Uncompress(sourcefile=<optimized out>, destfile=<optimized out>)
[#7] 0x8070ba8 -> HandleSingleFile(file=0xbffed4c "fut.xml")
[#8] 0x80721ce -> HandleFileArg(filepattern=<optimized out>)
[#9] 0x80721ce -> main(argc=<optimized out>, argv=<optimized out>)

```

gef➤

CVE-2021-21827 - TREETOKEN_ATTRIBWHITESPACE heap buffer overflow

Within DecodeTreeBlock which is called during the decompression of an XMI file, a UINT32 is loaded from the file and used as trusted input as the length of a buffer.

```

void DecodeTreeBlock(UncompressContainer *treecont, UncompressContainer *whitespacecont, UncompressContainer *specialcont, XMLOutput *output)
{
    char *strptr;
    unsigned char isattrib;
    int mystrlen;
    static char tmpstr[20];

    unsigned char *curptr, *endptr;
    long id;
    char isneg;

    curptr=treecont->GetDataPtr();
    endptr=curptr+treecont->GetSize();

    while(curptr<endptr)
    {
        id=LoadSInt32(curptr, &isneg);

        if(isneg==0) // Do we have a label ID ?
        {
            ...

            switch(id)
            {
                ...

                case TREETOKEN_ATTRIBWHITESPACE: // A attrib white-space token ?
                    mystrlen=whitespacecont->LoadUInt32();
                    output->attribWhitespaces((char *)whitespacecont->GetDataPtr(mystrlen), mystrlen);
                    break;

                ...
            }
        }
    }
}

```

This length is then passed to a memcpy without verification that the buffer is large enough, or the data is long enough to safely copy.

```

void OUTPUT_STATIC attribWhitespaces(char *str, int len)
{
    char *ptr=GetDataPtr(len);
    memcpy(ptr, str, len);
    x.attribWhitespace=1;
}

```

This results in a heap buffer overflow.

Crash Information

```
Program received signal SIGSEGV, Segmentation fault.
0x0025001b in ?? ()
[3;J
[ Legend: Modified register | Code | Heap | Stack | String ]

----- registers -----
$eax : 0x08082330 -> 0x0025001b
$ebx : 0x0807d540 -> 0x08082330 -> 0x0025001b
$ecx : 0xbfffee9f0 -> 0x080a8ff0 -> 0x08082728 -> 0x00000000
$edx : 0x0807d540 -> 0x08082330 -> 0x0025001b
$esp : 0xbfffee97c -> 0xb7eb6c74 -> add esp, 0x10
$ebp : 0x1
$esi : 0x0807d540 -> 0x08082330 -> 0x0025001b
$edi : 0xbfffee9f0 -> 0x080a8ff0 -> 0x08082728 -> 0x00000000
$eip : 0x25001b
$eflags: [carry PARITY adjust ZERO sign trap INTERRUPT direction overflow RESUME virtualx86 identification]
$cs: 0x0073 $ss: 0x007b $ds: 0x007b $es: 0x007b $fs: 0x0000 $gs: 0x0033

----- stack -----
0xbfffee97c|+0x0000: 0xb7eb6c74 -> add esp, 0x10 -> $esp
0xbfffee980|+0x0004: 0x0807d540 -> 0x08082330 -> 0x0025001b
0xbfffee984|+0x0008: 0xb7ff0010 -> <_dl_runtime_resolve+16> pop edx
0xbfffee988|+0x000c: 0xb7eb68e9 -> add ebx, 0x103717
0xbfffee98c|+0x0010: 0x08070ba7 -> <HandleSingleFile(char*)+1031> add cl, ch
0xbfffee990|+0x0014: 0x00000003
0xbfffee994|+0x0018: 0xbfffee9f8 -> 0x00000252
0xbfffee998|+0x001c: 0x080a8ff0 -> 0x08082728 -> 0x00000000

----- code:x86:32 -----
[!] Cannot disassemble from $PC
[!] Cannot access memory at address 0x25001b

----- threads -----
[#0] Id 1, Name: "xdemill", stopped 0x25001b in ?? (), reason: SIGSEGV

----- trace -----

gef➤
```

CVE-2021-21828 - Default case global buffer overflow

In the default case of DecodeTreeBlock a label is created via CurPath::AddLabel in order to track the label for later reference.

```
void DecodeTreeBlock(UncompressContainer *treecont, UncompressContainer *whitespacecont, UncompressContainer *specialcont, XMLOutput *output)
{
    char *strptr;
    unsigned char isattrib;
    int mystrlen;
    static char tmpstr[20];

    unsigned char *curptr, *endptr;
    long id;
    char isneg;

    curptr = treecont->GetDataPtr();
    endptr = curptr + treecont->GetSize();

    while(curptr < endptr)
    {
        id = LoadSInt32(curptr, &isneg);

        if(isneg == 0) // Do we have a label ID ?
        {
            if(id >= 32768L)
            {
                Error("Error while decompressing file!");
                Exit();
            }

            switch(id)
            {
                ...

                default: // Do we have a start label token?
                {
                    id = LABELIDX_TOKENOFFS;
                    mystrlen = globalLabeldict.LookupLabel((TLabelID)id, &strptr, &isattrib);

                    if(isattrib == 0)
                        output->startElement(strptr, mystrlen);
                    else
                        output->startAttribute(strptr, mystrlen);

                    curpath.AddLabel((TLabelID)id);
                }
            }
        }
        else // We have a block ID ==> I.e. we have some text
            uncompresscont.GetContBlock(id)->UncompressText(output);
    }
}
```

Within CurPath::AddLabel a global pointer is incremented to store the various TLabelID for reference later in the decompression process, this pointer is unchecked and can be used to write 2 byte chunks to a global buffer region of memory which can result in control of the instruction pointer.

```

void AddLabel(TLabelID labelid)
// Add a label at the end of the path
{
    ...

    if(curlabel==curblock->labels+CURPATH_LABELBLOCKSIZE)
    // Is there not enough space in the current block?
    // ==> Create new block, if there is no next block
    // (We never delete blocks)
    {
        if(curblock->next==NULL)
        {
            curblock->next=new CurPathLabelBlock();
            curblock->next->prev=curblock;
            curblock->next->next=NULL;
        }
        curblock=curblock->next;

        // We set the new current label
        curlabel=curblock->labels;
    }
    *curlabel=labelid;
    curlabel++;
}

```

Crash Information

```

=====
==32266==ERROR: AddressSanitizer: global-buffer-overflow on address 0x08691a58 at pc 0x08186ebd bp 0xbfa35cc8 sp 0xbfa35cbc
WRITE of size 2 at 0x08691a58 thread T0
#0 0x8186ebc in CurPath::AddLabel(unsigned short) /home/fuzz/Desktop/xmill/./src/CurPath.hpp:139:16
#1 0x81840bc in DecodeTreeBlock(UncompressContainer*, UncompressContainer*, UncompressContainer*, XMLOutput*)
/home/fuzz/Desktop/xmill/./src/Decode.cpp:78:13
#2 0x8197226 in Uncompress(char*, char*) /home/fuzz/Desktop/xmill/./src/Main.cpp:854:7
#3 0x8196c37 in HandleSingleFile(char*) /home/fuzz/Desktop/xmill/./src/Main.cpp:248:10
#4 0x8197482 in HandleFileArg(char*) /home/fuzz/Desktop/xmill/./src/Main.cpp:382:4
#5 0x81976f5 in main /home/fuzz/Desktop/xmill/./src/Main.cpp:494:7
#6 0xb7bc6646 in __libc_start_main /build/glibc-ViLyQ/glibc-2.23/csu/../csu/libc-start.c:291
#7 0x80664d3 in _start (/home/fuzz/Desktop/xmill/unix/xdemill+0x80664d3)

0x08691a58 is located 8 bytes to the left of global variable 'curpath' defined in './src/Main.cpp:69:19' (0x8691a60) of size 80
0x08691a58 is located 48 bytes to the right of global variable 'uncomprcont' defined in './src/UnCompCont.cpp:40:25' (0x8691a20) of size 8
SUMMARY: AddressSanitizer: global-buffer-overflow /home/fuzz/Desktop/xmill/./src/CurPath.hpp:139:16 in CurPath::AddLabel(unsigned short)
Shadow bytes around the buggy address:
 0x210d22f0: 00 00 04 f9 f9 f9 f9 00 f9 f9 f9 f9 f9 f9 f9
 0x210d2300: 00 00 f9 f9 f9 f9 f9 f9 00 00 f9 f9 f9 f9 f9
 0x210d2310: 00 00 f9 f9 f9 f9 f9 00 00 04 f9 f9 f9 f9 f9
 0x210d2320: 00 00 04 f9 f9 f9 f9 00 00 04 f9 f9 f9 f9 f9
 0x210d2330: 00 00 04 f9 f9 f9 f9 00 f9 f9 f9 f9 f9 f9 f9
=>0x210d2340: 00 00 00 00 00 f9 f9 f9 f9 f9[f9]00 00 00 00
 0x210d2350: 00 00 00 00 00 00 f9 f9 f9 f9 f9 00 04 f9 f9
 0x210d2360: f9 f9 f9 f9 00 04 f9 f9 f9 f9 f9 00 00 00 00
 0x210d2370: 04 f9 f9 f9 f9 f9 f9 04 f9 f9 f9 f9 f9 f9 f9
 0x210d2380: 04 f9 f9 f9 f9 f9 f9 04 f9 f9 f9 f9 f9 f9 f9
 0x210d2390: 00 00 04 f9 f9 f9 f9 00 00 04 f9 f9 f9 f9 f9
Shadow byte legend (one shadow byte represents 8 application bytes):
Addressable: 00
Partially addressable: 01 02 03 04 05 06 07
Heap left redzone: fa
Heap right redzone: fb
Freed heap region: fd
Stack left redzone: f1
Stack mid redzone: f2
Stack right redzone: f3
Stack partial redzone: f4
Stack after return: f5
Stack use after scope: f8
Global redzone: f9
Global init order: f6
Poisoned by user: f7
Container overflow: fc
Array cookie: ac
Intra object redzone: bb
ASan internal: fe
Left alloca redzone: ca
Right alloca redzone: cb
Error in file './fuzz/triage/fut.xmi':
Error while decompressing file!

```

Timeline

2021-05-03 - Vendor Disclosure

2021-08-10 - Public Release

CREDIT

Discovered by Carl Hurd of Cisco Talos.

