Qt Embedded Days
13-14 April 2021

What to Do When It is Already Too Late ?

Crashdumps for Embedded Systems

Christoph **Sterz**
christoph.sterz@kdab.com

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2. Working with Coredumps
3. Signal Handlers
4. Special Watchdogs

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6. Google Breakpad, and…
7. Sentry
8. On Collecting Crashdumps From Users

Scope of this Talk

- Crashes mostly in C/C++
- On Embedded Linux
  (May apply for Windows, QNX which has coredumps as well)
- Crashes induced from the outside and inside of processes

- No kernel panics, the OS must be functioning at this point
- *SW-Devs'-Assumption-#1* holds: Hardware just works

1. Background: Embrace the Fail

Crashes in Development And Production

- **Development of Embedded Devices**
  - All Symbols
  - gdb(server) on target
  - Fullsize dumps
  - EvalBoards
  - Small Testing Surface

- **In Production**
  - Slim Images
  - Slim Dumps(Stack only) / Reduced Bandwidth
  - (Often more limited) production hardware
  - Large Testing Surface

Crashes in Development And Production

- **Development of Embedded Devices**
  - All Symbols
  - gdb(server) on tar
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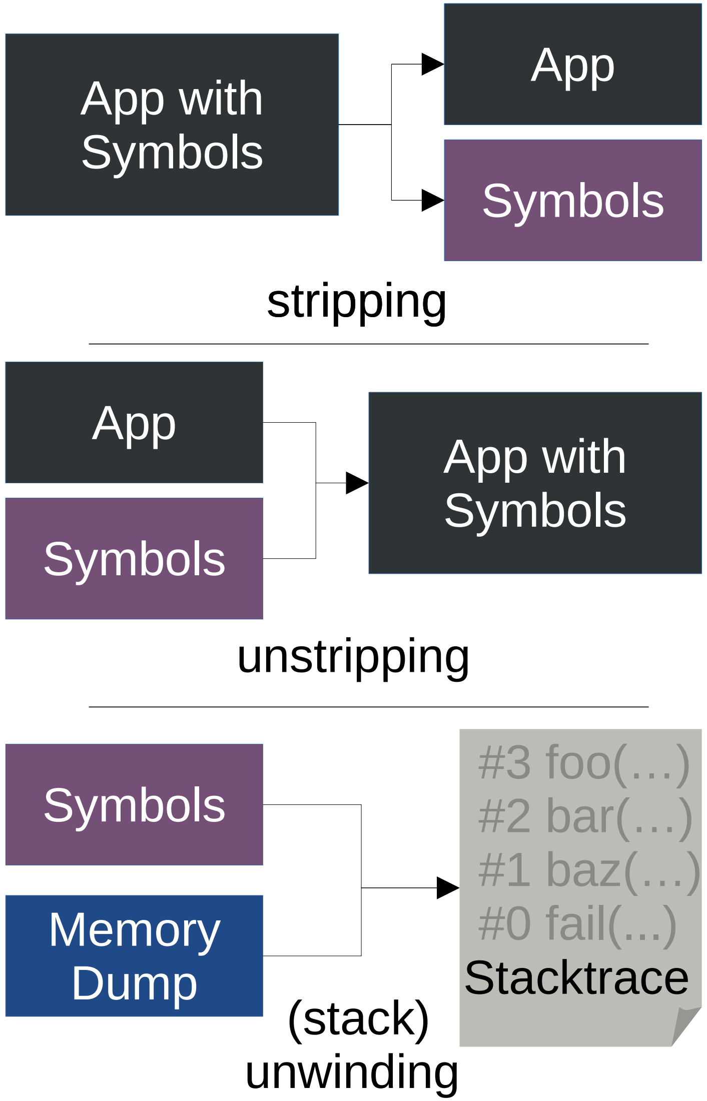
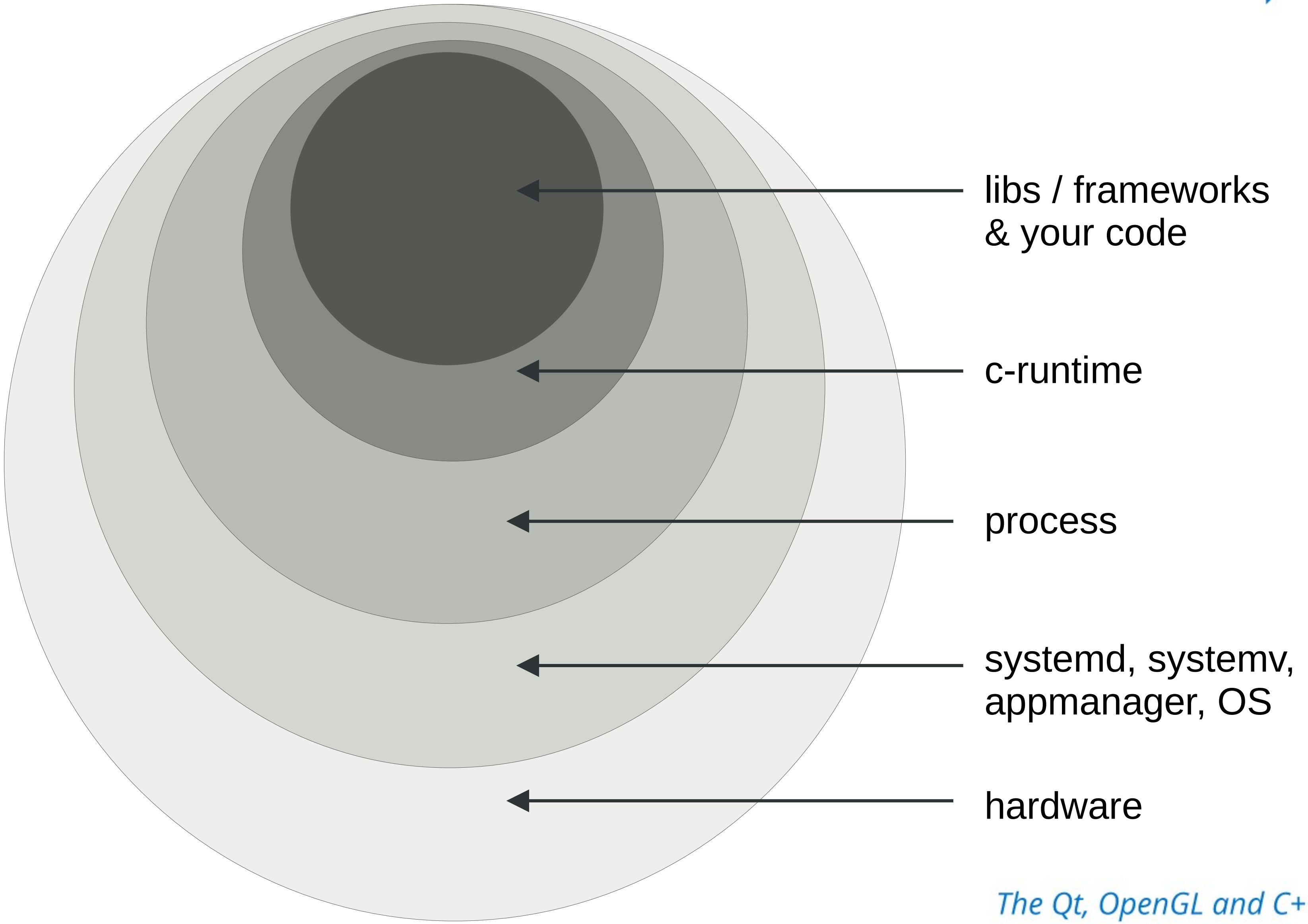
Boils down to
storage <vs.> no storage

Crashdumps and Symbols

- Symbols are needed:
  - To make addresses readable for humans
  - To reconstruct the contents of the Stack
  - To infer Line Numbers
- You will get symbols with -g
- Symbols are *independent* of optimization (-g, -O2)
- Symbols are huge



Code is embedded in many execution contexts.



libs / frameworks
& your code

c-runtime

process

systemd, systemv,
appmanager, OS

hardware

2. Coredumps

4 Bytes of Core Memory: Arduino Module

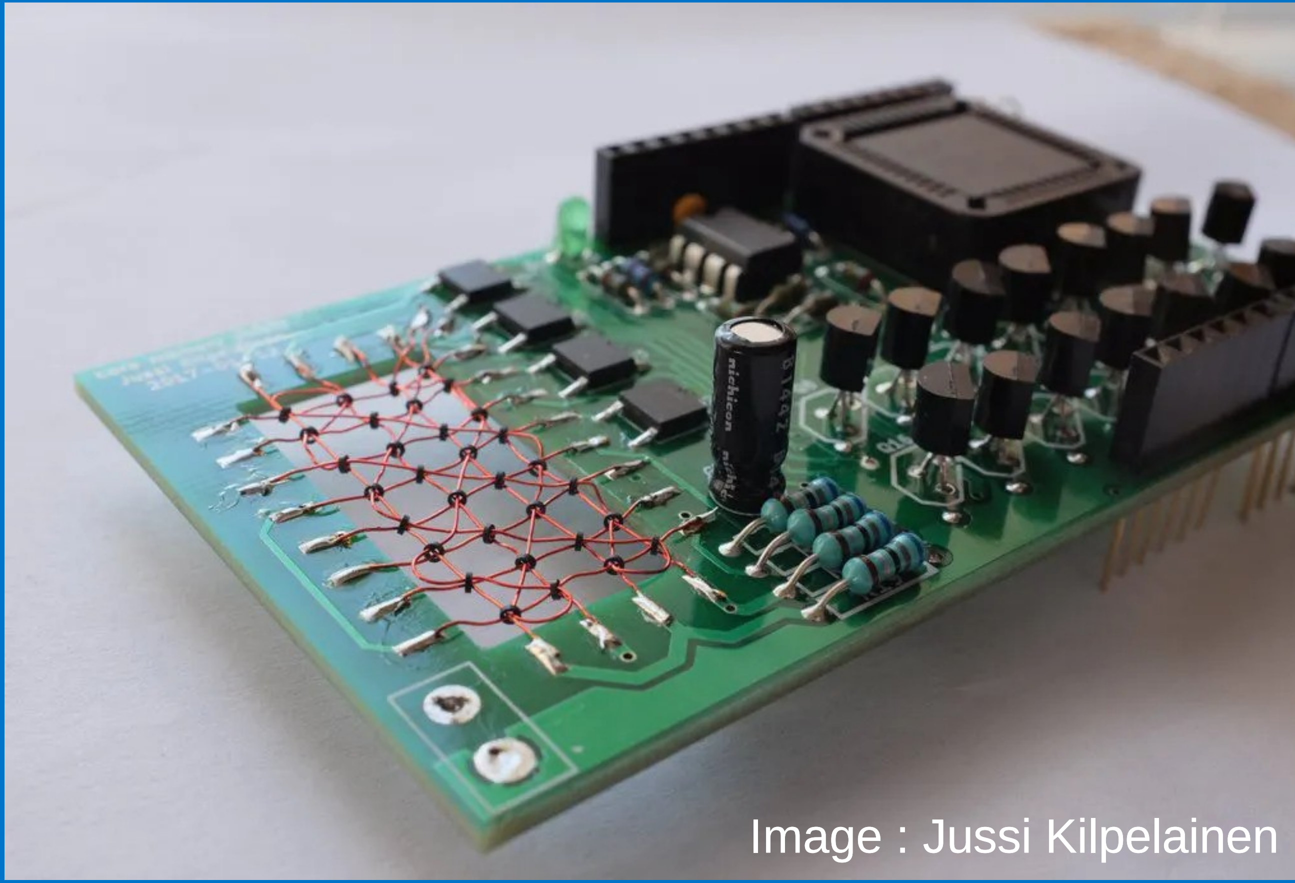
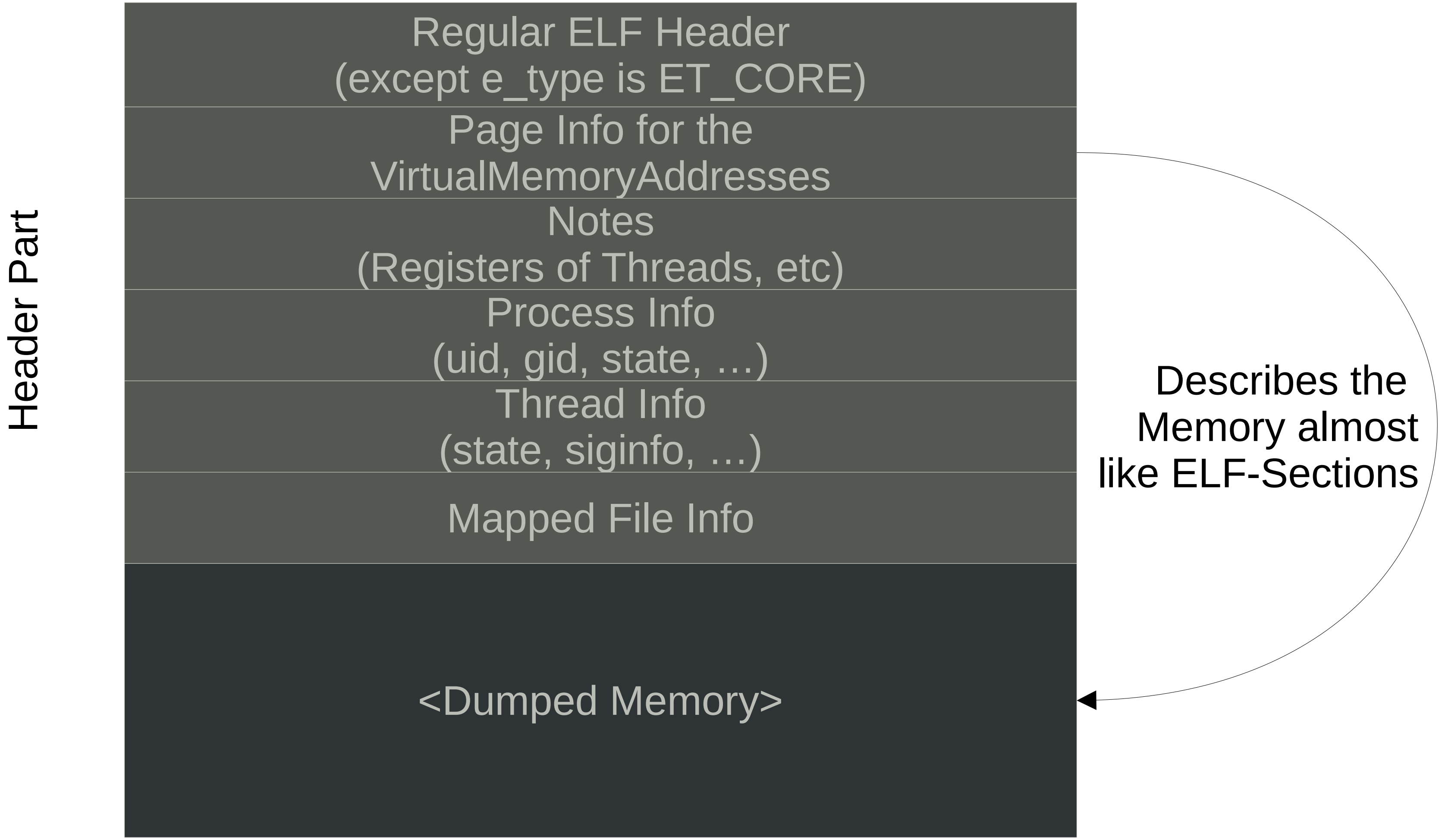


Image : Jussi Kilpelainen

What do Coredumps Look Like?



Header Part

Regular ELF Header
(except e_type is ET_CORE)

Page Info for the
VirtualMemoryAddresses

Notes
(Registers of Threads, etc)

Process Info
(uid, gid, state, …)

Thread Info
(state, siginfo, …)

Mapped File Info

<Dumped Memory>

Describes the
Memory almost
like ELF-Sections

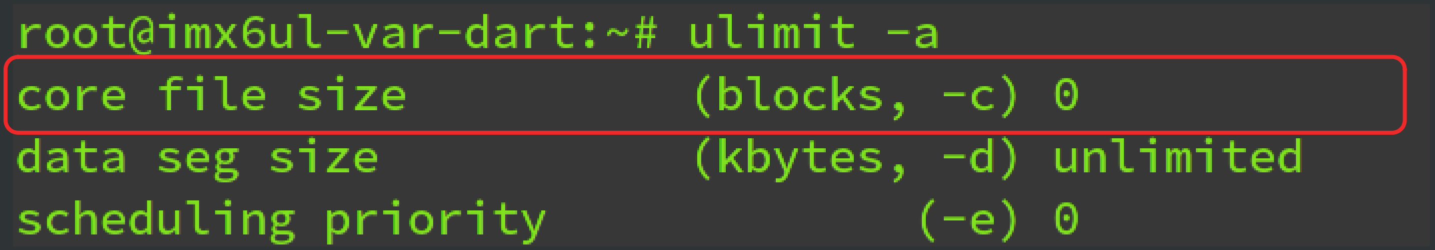
Prerequisites

- CONFIG_COREDUMP enabled when compiling the Kernel
- Executable must be readable (cores reveal your secrets…)
- Process must have permissions to write the core

Special problems on embedded:

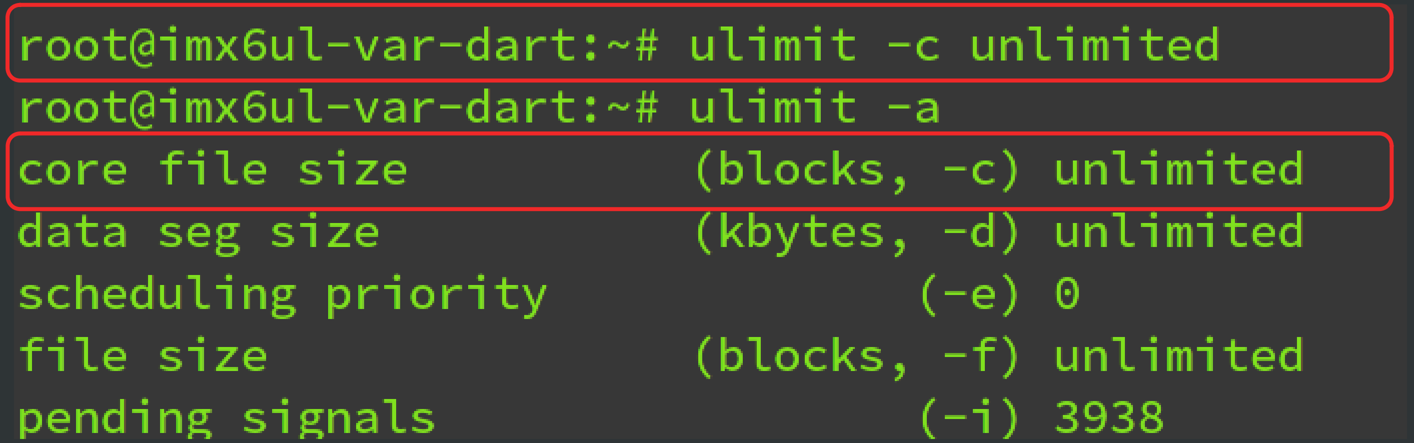
- You need enough space to store it
- You need enough bandwidth to transfer it

Enable by setting limits



```
root@imx6ul-var-dart:~# ulimit -a
core file size          (blocks, -c) 0
data seg size           (kbytes, -d) unlimited
scheduling priority             (-e) 0
```

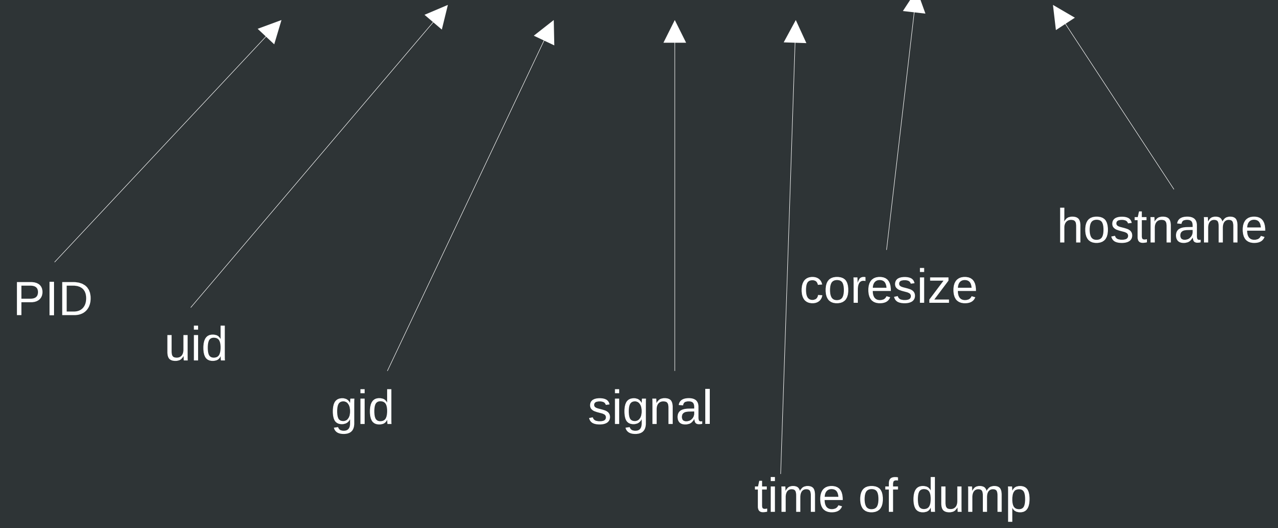
↓



```
root@imx6ul-var-dart:~# ulimit -c unlimited
root@imx6ul-var-dart:~# ulimit -a
core file size          (blocks, -c) unlimited
data seg size           (kbytes, -d) unlimited
scheduling priority             (-e) 0
file size               (blocks, -f) unlimited
pending signals                 (-i) 3938
```

/proc/sys/kernel/core_pattern

Path containing %P %u %g %s %t %c %h



PID

uid

gid

signal

time of dump

coresize

hostname

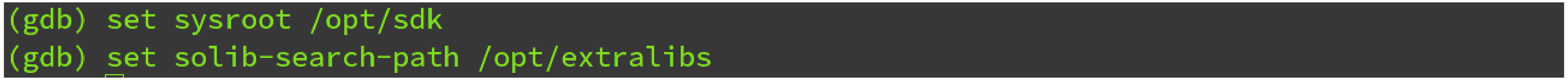
Development: have GDB on your target!

- At the development stage have a gdb on the target
- Find a way to store the coredump
- If you get a crash producing a coredump, rejoin symbols:
  - Use the elfutils bin **eu-unstrip <executable> <symbols>**
  - Repeat for all relevant libraries you need for heap / stack

- It’s a bit tedious, it’s worth it, if you need heap information
- If no heap is needed, there are better ways

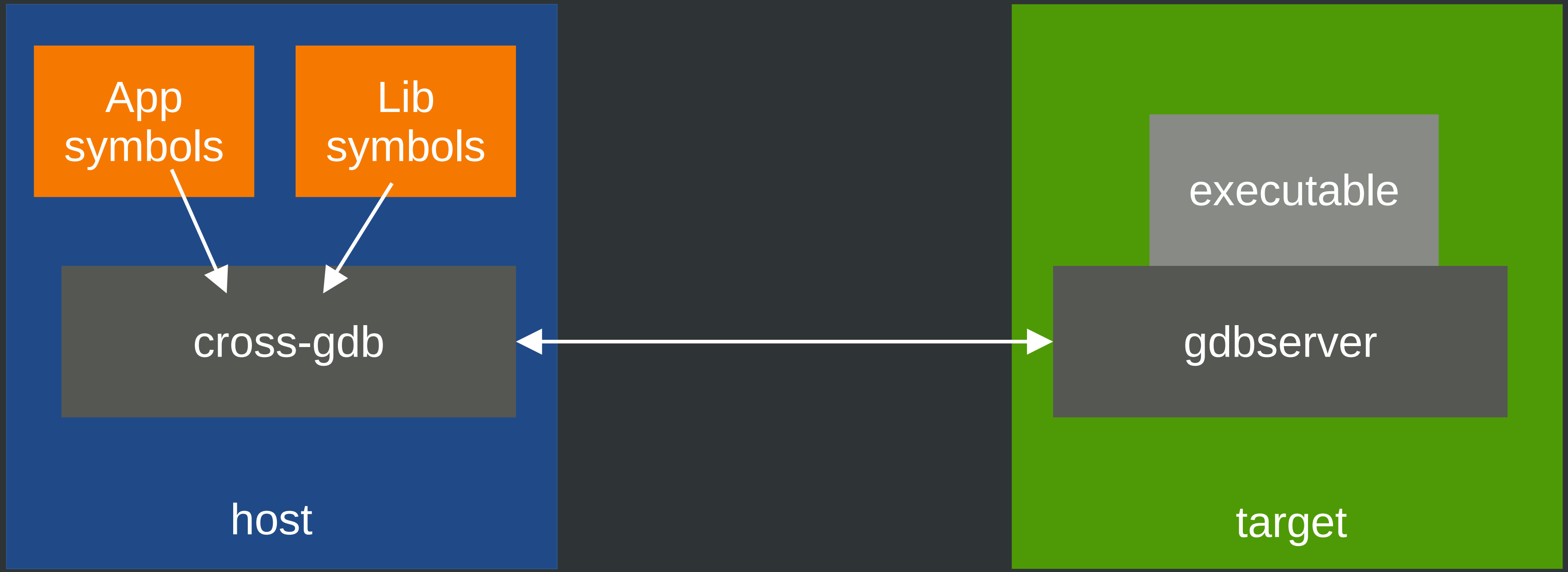
Cross-Platform Coredump Analysis

- A cross-gdb (from your toolchain) on your desktop
- The exact same executable that crashed (with symbols!)
- Symbols for all relevant libraries when it crashed
- The core file
- Optionally /proc/kallsyms from the target
- Carefully feed SDK-paths and libs to get a stacktrace



```
(gdb) set sysroot /opt/sdk
(gdb) set solib-search-path /opt/extralibs
```

GDB-Server: A Hybrid



Coredumps: Did you know?

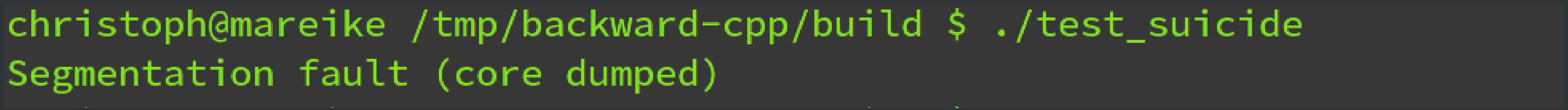
- You can **madvise** memory pages to be excluded from a coredump
  - Use **madvise** with **MADV_DONTDUMP** flag

- You can pipe coredumps to stdin of another process
  - Make your corePattern start with a | character, followed by the receiving process
  - Systemd coredumpctl does It **|/usr/lib/systemd/systemd-coredump**

- GDBs **gcore** can create a core of a running process
  – the recording process survives the procedure

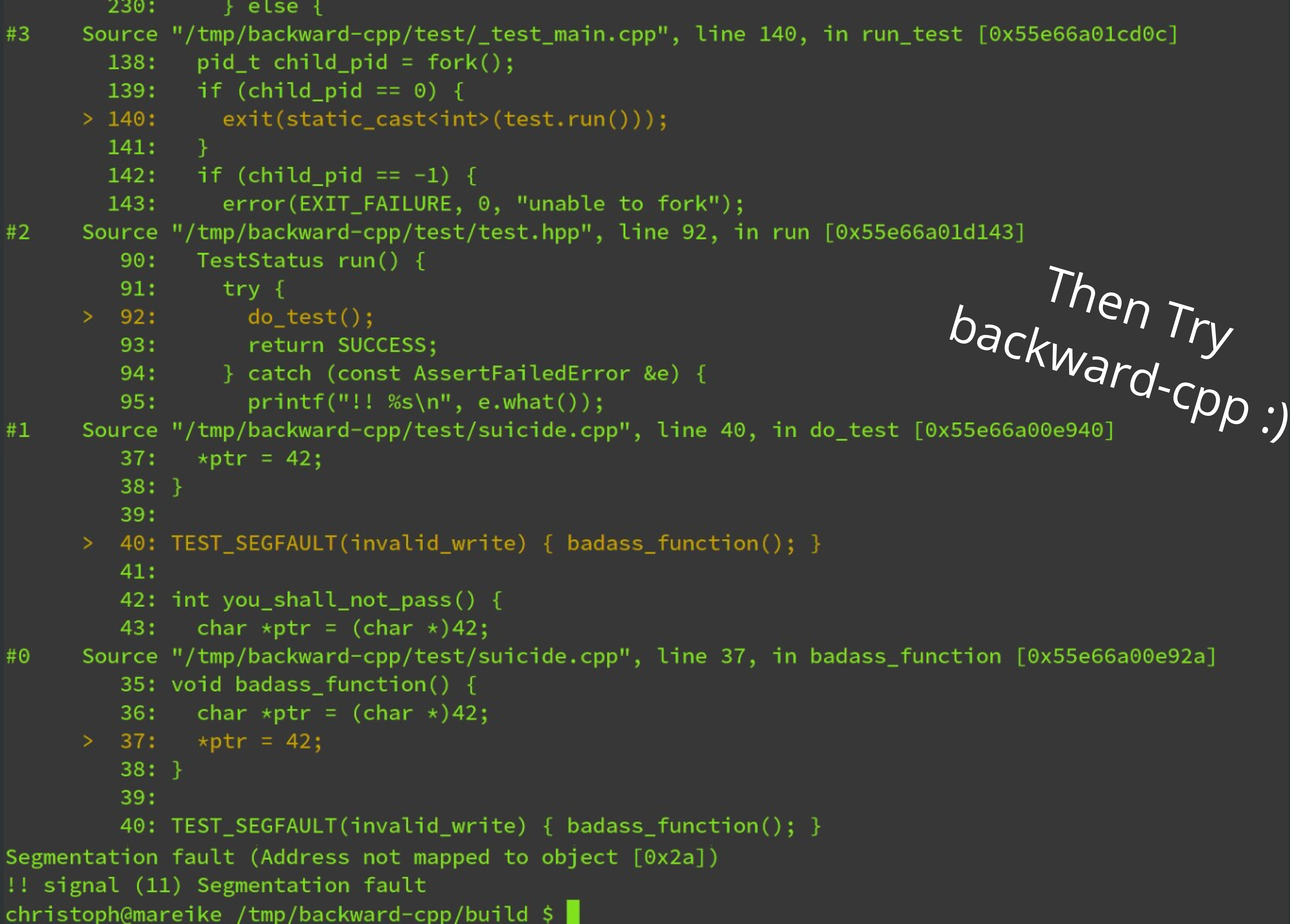
Get Nice Stacktraces Easy: Backward-Cpp

By François-Xavier Bourlet, @bombela – The Pitch



```
christoph@mareike /tmp/backward-cpp/build $ ./test_suicide
Segmentation fault (core dumped)
```

Tired of seeing this ?



```
        230:     } else {
#3    Source "/tmp/backward-cpp/test/_test_main.cpp", line 140, in run_test [0x55e66a01cd0c]
        138:   pid_t child_pid = fork();
        139:   if (child_pid == 0) {
      > 140:     exit(static_cast<int>(test.run()));
        141:   }
        142:   if (child_pid == -1) {
        143:     error(EXIT_FAILURE, 0, "unable to fork");
#2    Source "/tmp/backward-cpp/test/test.hpp", line 92, in run [0x55e66a01d143]
         90:   TestStatus run() {
         91:     try {
      >  92:       do_test();
         93:       return SUCCESS;
         94:     } catch (const AssertFailedError &e) {
         95:       printf("!! %s\n", e.what());
#1    Source "/tmp/backward-cpp/test/suicide.cpp", line 40, in do_test [0x55e66a00e940]
         37:   *ptr = 42;
         38: }
         39:
      >  40: TEST_SEGFAULT(invalid_write) { badass_function(); }
         41:
         42: int you_shall_not_pass() {
         43:   char *ptr = (char *)42;
#0    Source "/tmp/backward-cpp/test/suicide.cpp", line 37, in badass_function [0x55e66a00e92a]
         35: void badass_function() {
         36:   char *ptr = (char *)42;
      >  37:   *ptr = 42;
         38: }
         39:
         40: TEST_SEGFAULT(invalid_write) { badass_function(); }
Segmentation fault (Address not mapped to object [0x2a])
!! signal (11) Segmentation fault
christoph@mareike /tmp/backward-cpp/build $
```

Then Try
backward-cpp :)

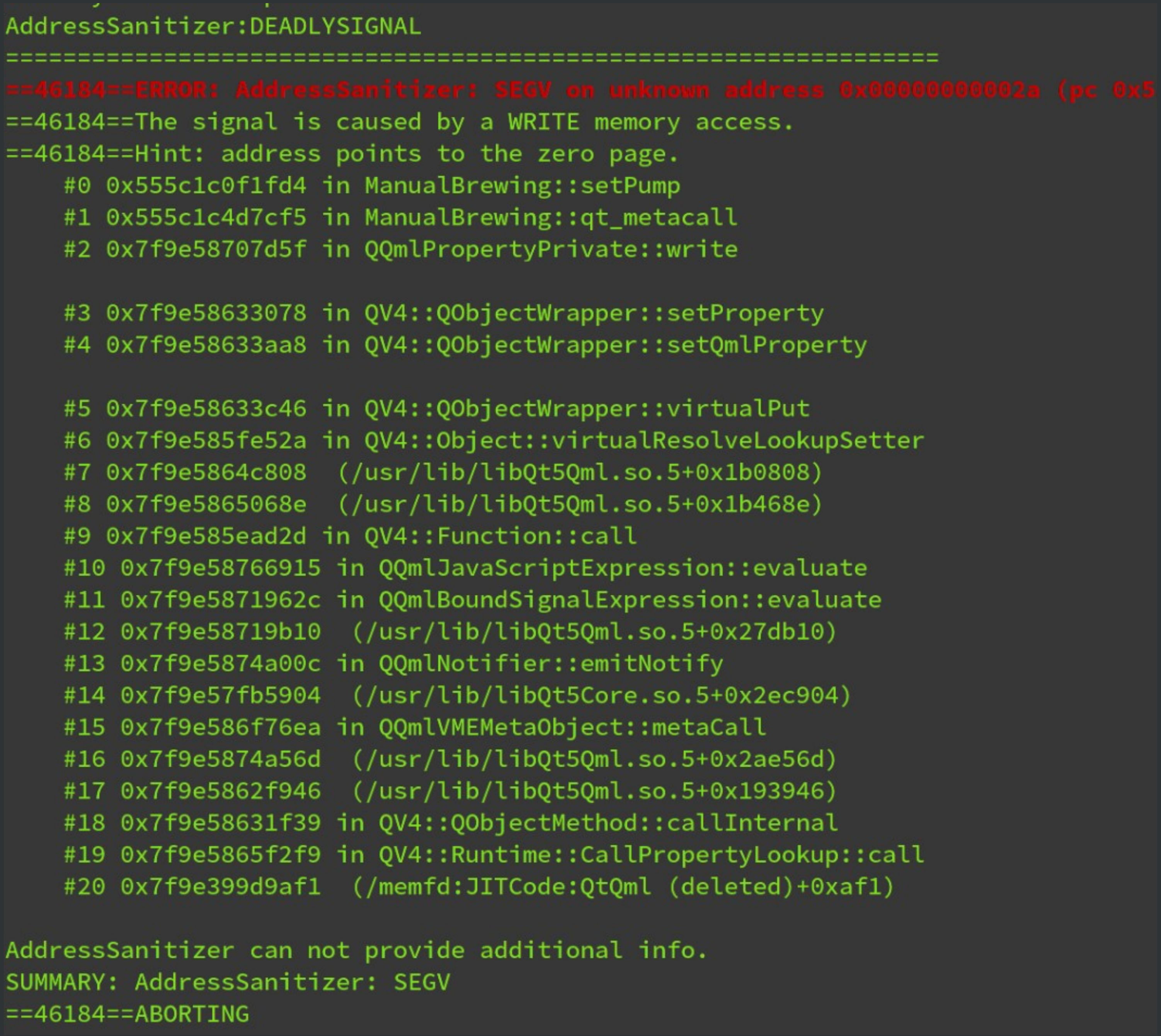
Backward-cpp

- Include a header + 1 Line of initialization, done
  - You might need to add some unwinding libraries for it in your Sysroot
- Symbols are necessary in build (-g), fat binaries
- Does stack unwinding in the signal handlers
- Requires access to the source code to print it
- Can be easily customized further

→ This is great for development!

The Sanitizers can help you as well.

Crash output of an executable, instrumented with the gcc/clang **address sanitizer**

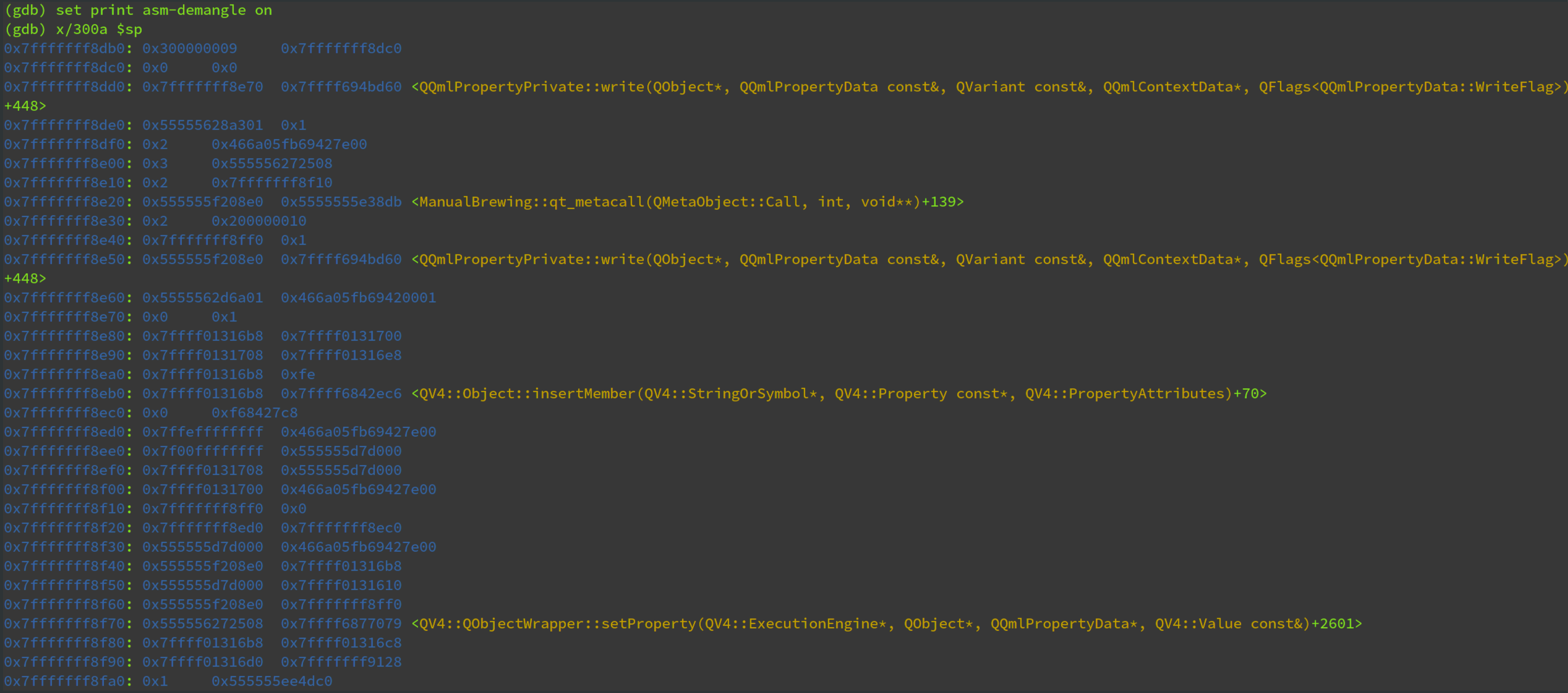


```
AddressSanitizer:DEADLYSIGNAL
=================================================================
==46184==ERROR: AddressSanitizer: SEGV on unknown address 0x00000000002a (pc 0x5
==46184==The signal is caused by a WRITE memory access.
==46184==Hint: address points to the zero page.
    #0 0x555c1c0f1fd4 in ManualBrewing::setPump
    #1 0x555c1c4d7cf5 in ManualBrewing::qt_metacall
    #2 0x7f9e58707d5f in QQmlPropertyPrivate::write

    #3 0x7f9e58633078 in QV4::QObjectWrapper::setProperty
    #4 0x7f9e58633aa8 in QV4::QObjectWrapper::setQmlProperty

    #5 0x7f9e58633c46 in QV4::QObjectWrapper::virtualPut
    #6 0x7f9e585fe52a in QV4::Object::virtualResolveLookupSetter
    #7 0x7f9e5864c808  (/usr/lib/libQt5Qml.so.5+0x1b0808)
    #8 0x7f9e5865068e  (/usr/lib/libQt5Qml.so.5+0x1b468e)
    #9 0x7f9e585ead2d in QV4::Function::call
    #10 0x7f9e58766915 in QQmlJavaScriptExpression::evaluate
    #11 0x7f9e5871962c in QQmlBoundSignalExpression::evaluate
    #12 0x7f9e58719b10  (/usr/lib/libQt5Qml.so.5+0x27db10)
    #13 0x7f9e5874a00c in QQmlNotifier::emitNotify
    #14 0x7f9e57fb5904  (/usr/lib/libQt5Core.so.5+0x2ec904)
    #15 0x7f9e586f76ea in QQmlVMEMetaObject::metaCall
    #16 0x7f9e5874a56d  (/usr/lib/libQt5Qml.so.5+0x2ae56d)
    #17 0x7f9e5862f946  (/usr/lib/libQt5Qml.so.5+0x193946)
    #18 0x7f9e58631f39 in QV4::QObjectMethod::callInternal
    #19 0x7f9e5865f2f9 in QV4::Runtime::CallPropertyLookup::call
    #20 0x7f9e399d9af1  (/memfd:JITCode:QtQml (deleted)+0xaf1)

AddressSanitizer can not provide additional info.
SUMMARY: AddressSanitizer: SEGV
==46184==ABORTING
```

No Symbols?, Unwinding Fails?
You can still resort to:

»Desperate-Stack-Reading«

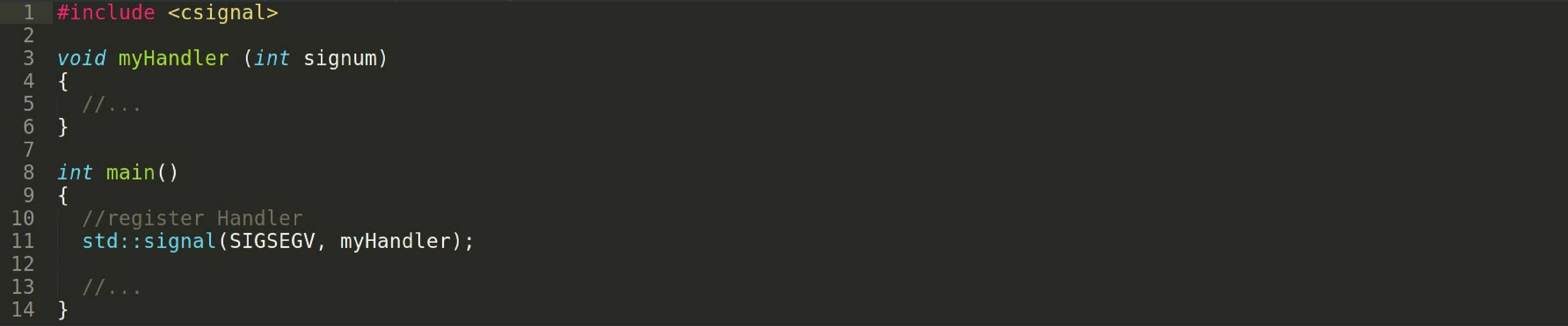
Printing raw stack memory, garnished with symbols
take everything with teaspoons of salt



```
(gdb) set print asm-demangle on
(gdb) x/300a $sp
0x7fffffff8db0: 0x300000009     0x7fffffff8dc0
0x7fffffff8dc0: 0x0     0x0
0x7fffffff8dd0: 0x7fffffff8e70  0x7ffff694bd60 <QQmlPropertyPrivate::write(QObject*, QQmlPropertyData const&, QVariant const&, QQmlContextData*, QFlags<QQmlPropertyData::WriteFlag>)
+448>
0x7fffffff8de0: 0x55555628a301  0x1
0x7fffffff8df0: 0x2     0x466a05fb69427e00
0x7fffffff8e00: 0x3     0x555556272508
0x7fffffff8e10: 0x2     0x7fffffff8f10
0x7fffffff8e20: 0x555555f208e0  0x5555555e38db <ManualBrewing::qt_metacall(QMetaObject::Call, int, void**)+139>
0x7fffffff8e30: 0x2     0x200000010
0x7fffffff8e40: 0x7fffffff8ff0  0x1
0x7fffffff8e50: 0x555555f208e0  0x7ffff694bd60 <QQmlPropertyPrivate::write(QObject*, QQmlPropertyData const&, QVariant const&, QQmlContextData*, QFlags<QQmlPropertyData::WriteFlag>)
+448>
0x7fffffff8e60: 0x5555562d6a01  0x466a05fb69420001
0x7fffffff8e70: 0x0     0x1
0x7fffffff8e80: 0x7ffff01316b8  0x7ffff0131700
0x7fffffff8e90: 0x7ffff0131708  0x7ffff01316e8
0x7fffffff8ea0: 0x7ffff01316b8  0xfe
0x7fffffff8eb0: 0x7ffff01316b8  0x7ffff6842ec6 <QV4::Object::insertMember(QV4::StringOrSymbol*, QV4::Property const*, QV4::PropertyAttributes)+70>
0x7fffffff8ec0: 0x0     0xf68427c8
0x7fffffff8ed0: 0x7ffeffffffff  0x466a05fb69427e00
0x7fffffff8ee0: 0x7f00ffffffff  0x555555d7d000
0x7fffffff8ef0: 0x7ffff0131708  0x555555d7d000
0x7fffffff8f00: 0x7ffff0131700  0x466a05fb69427e00
0x7fffffff8f10: 0x7fffffff8ff0  0x0
0x7fffffff8f20: 0x7fffffff8ed0  0x7fffffff8ec0
0x7fffffff8f30: 0x555555d7d000  0x466a05fb69427e00
0x7fffffff8f40: 0x555555f208e0  0x7ffff01316b8
0x7fffffff8f50: 0x555555d7d000  0x7ffff0131610
0x7fffffff8f60: 0x555555f208e0  0x7fffffff8ff0
0x7fffffff8f70: 0x555556272508  0x7ffff6877079 <QV4::QObjectWrapper::setProperty(QV4::ExecutionEngine*, QObject*, QQmlPropertyData*, QV4::Value const&)+2601>
0x7fffffff8f80: 0x7ffff01316b8  0x7ffff01316c8
0x7fffffff8f90: 0x7ffff01316d0  0x7fffffff9128
0x7fffffff8fa0: 0x1     0x555555ee4dc0
```

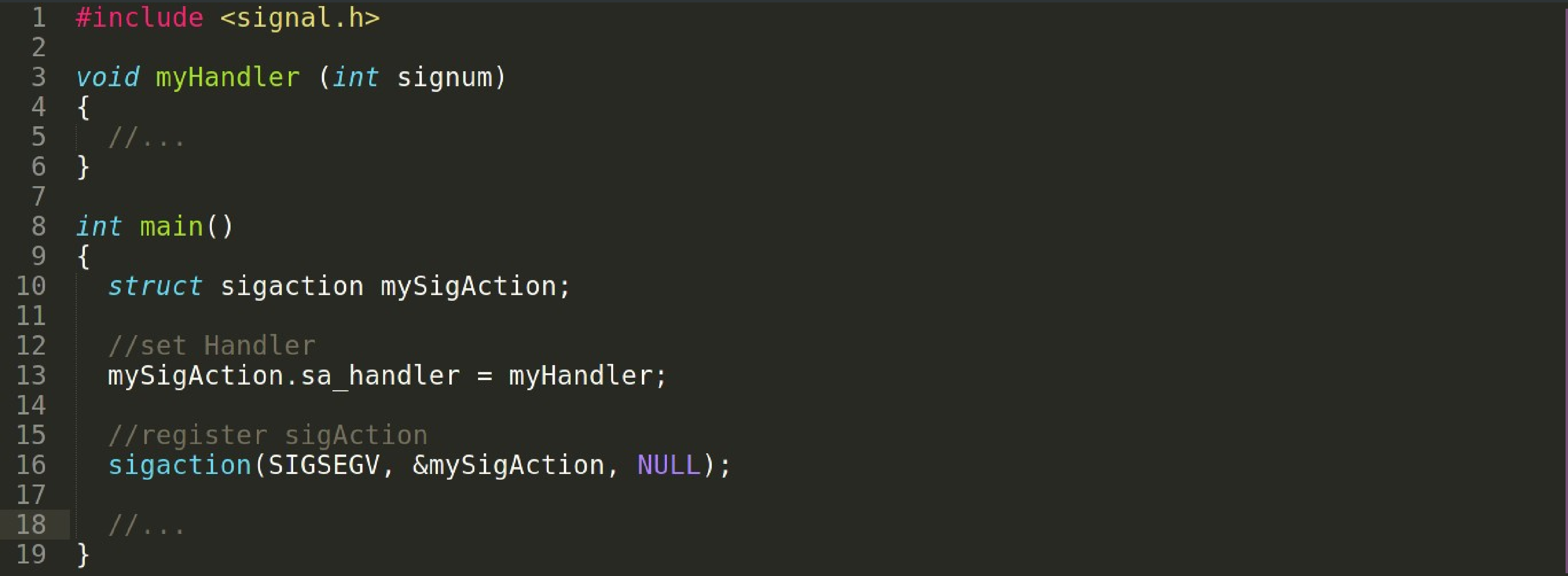
3. Signal Handlers can act when its already too late.

They can be registered by **std::signal(...)**



```
#include <csignal>

void myHandler (int signum)
{
  //...
}

int main()
{
  //register Handler
  std::signal(SIGSEGV, myHandler);

  //...
}
```

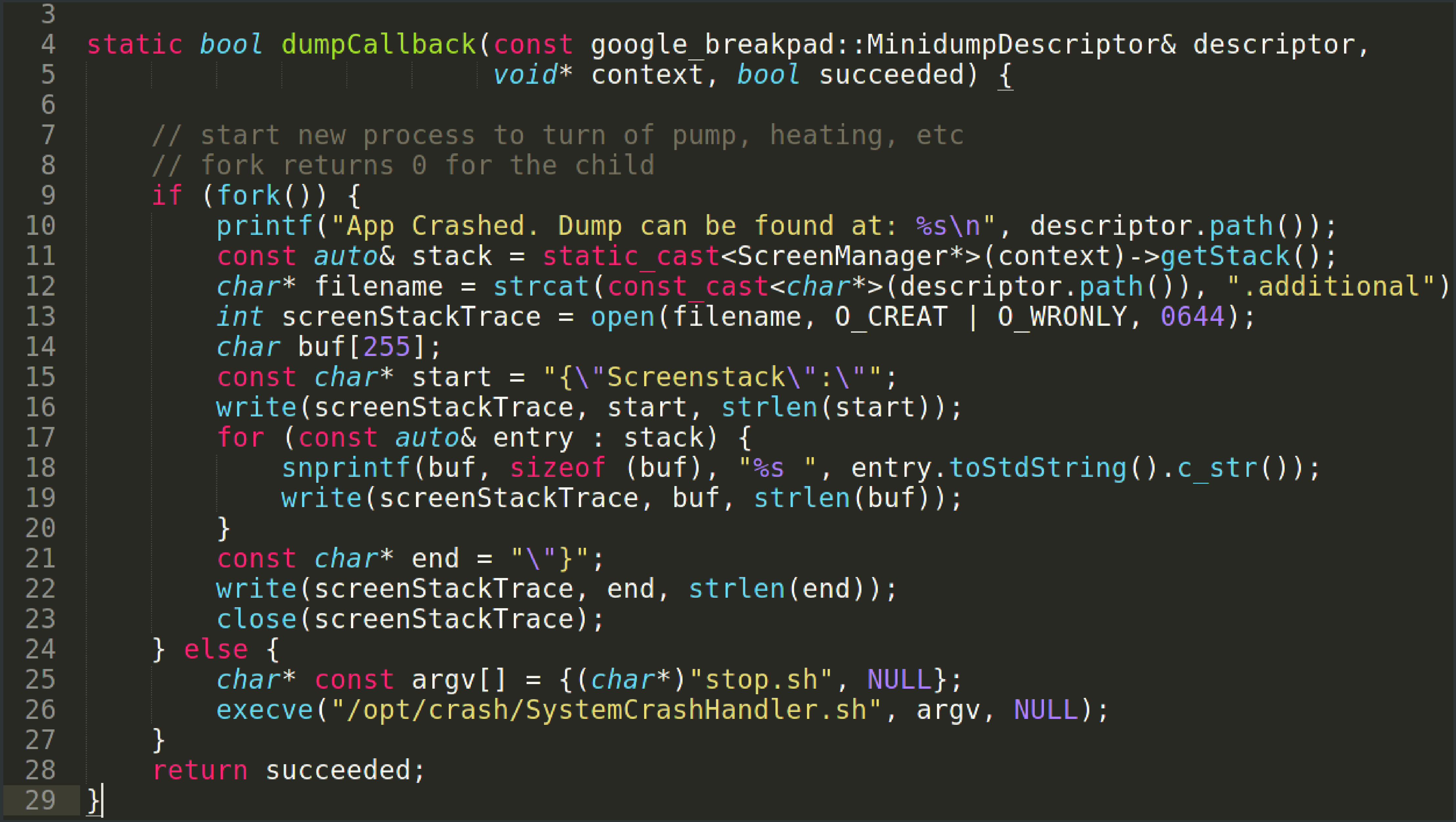
... or POSIX **sigaction(...)** for a bit more elaborate infos on the signal



```
#include <signal.h>

void myHandler (int signum)
{
  //...
}

int main()
{
  struct sigaction mySigAction;

  //set Handler
  mySigAction.sa_handler = myHandler;

  //register sigAction
  sigaction(SIGSEGV, &mySigAction, NULL);

  //...
}
```

```
typedef struct {
        int si_signo;
        int si_code;
        union sigval si_value;
        int si_errno;
        pid_t si_pid;        Sender
        uid_t si_uid;        Info
        void *si_addr;
        int si_status;
        int si_band;
} siginfo_t;
//member of sigaction
```

Signal Handlers / Crashhandlers look much like plain C code



```

static bool dumpCallback(const google_breakpad::MinidumpDescriptor& descriptor,
                         void* context, bool succeeded) {

    // start new process to turn of pump, heating, etc
    // fork returns 0 for the child
    if (fork()) {
        printf("App Crashed. Dump can be found at: %s\n", descriptor.path());
        const auto& stack = static_cast<ScreenManager*>(context)->getStack();
        char* filename = strcat(const_cast<char*>(descriptor.path()), ".additional")
        int screenStackTrace = open(filename, O_CREAT | O_WRONLY, 0644);
        char buf[255];
        const char* start = "{\"Screenstack\":\"";
        write(screenStackTrace, start, strlen(start));
        for (const auto& entry : stack) {
            snprintf(buf, sizeof (buf), "%s ", entry.toStdString().c_str());
            write(screenStackTrace, buf, strlen(buf));
        }
        const char* end = "\"}";
        write(screenStackTrace, end, strlen(end));
        close(screenStackTrace);
    } else {
        char* const argv[] = {(char*)"stop.sh", NULL};
        execve("/opt/crash/SystemCrashHandler.sh", argv, NULL);
    }
    return succeeded;
}
```

Things not allowed in the Signal Handler

- Heap allocations are forbidden, because not async-safe
- One is only permitted to execute “safe” operations
  - That is basically everything that **does not use malloc/free**
  - Check **man signal-safety** for it
  - Code looks much like pure C-Code then
- Be hyper-careful of *Crashes in Crash Handlers*.
  You have been warned :)

Things allowed in the Signal Handler

- Start new processes (wow!)
- Obviously reading heap memory
- Send signal to self **raise(SIGNAL);**
- Most important for embedded: Reinstate safety in your embedded device

- Check out the KDABs *QML stack trace dumper [1]*.
  - Actually unsafe, because it allocates
  - but worth the gamble in development, its too late anyways, right?

[1] https://github.com/KDAB/KDToolBox/tree/master/qt/qml/QmlStackTraceHelper

4. Watchdog-processes help analyzing infinite loops

It makes sense to have Watchdogs out of the main execution Context

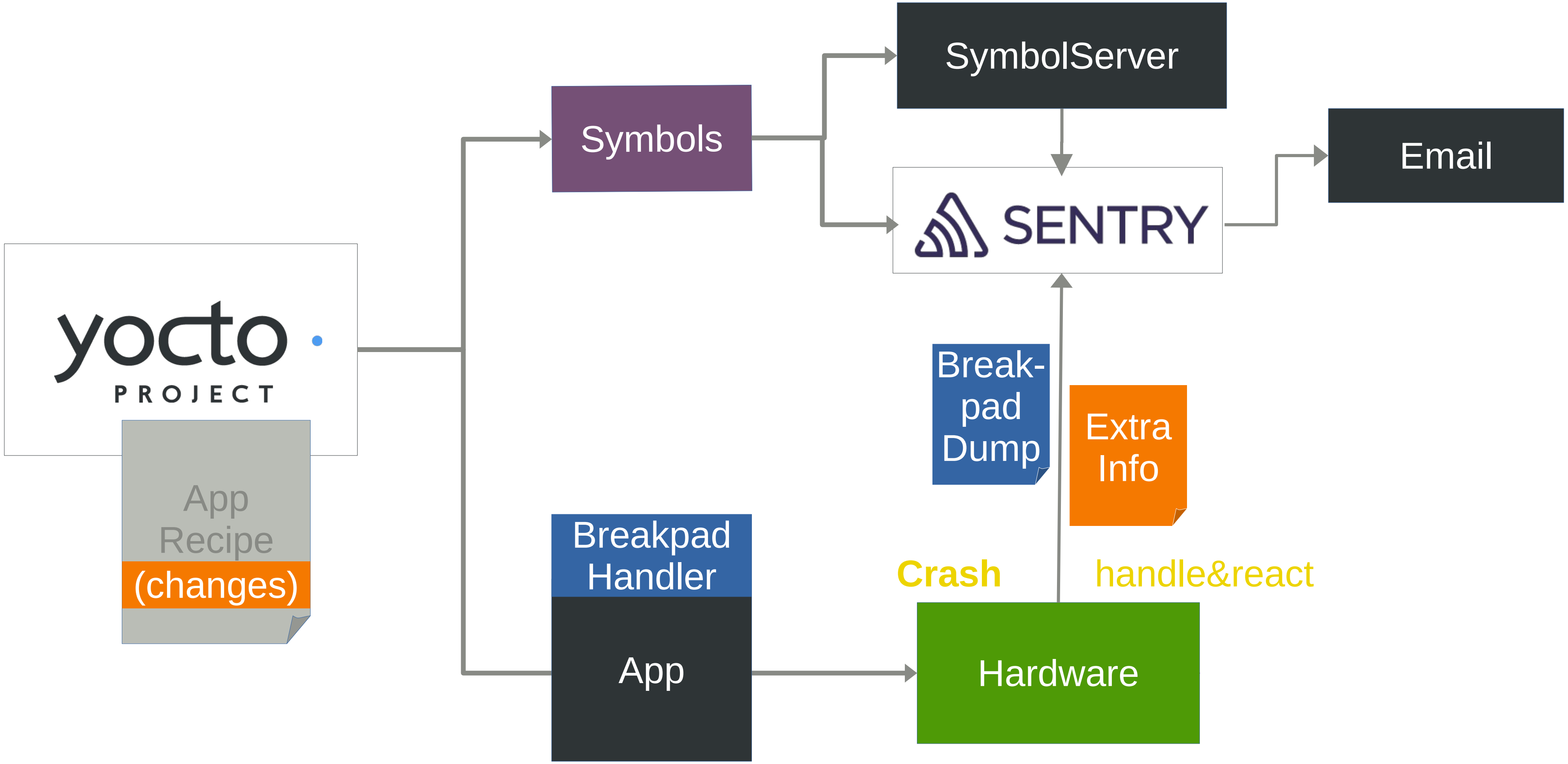
- There exist not only crashes, but also infinite loops
  - Idea: Reset an external watchdog periodically, infinite loops are detected
- It can make sense to inject SIGABRT from the outside
- A stack trace will be produced and loop analysis is possible

The OOM(Out of Memory)-killer

- Most famous external source of an unwanted termination
- Based heuristics, kills programs to regain memory
- Stack dumps are of limited use in analysis here
  - Use mallinfo() or heap-snapshots to find out the reason of OOM
  - Maybe not your processes fault: write **/proc/meminfo** or the output of **free**
- Sends SIGKILL in rare cases also SIGTERM
  - Use the sigaction() registration to find out if OOM-killer was the sender

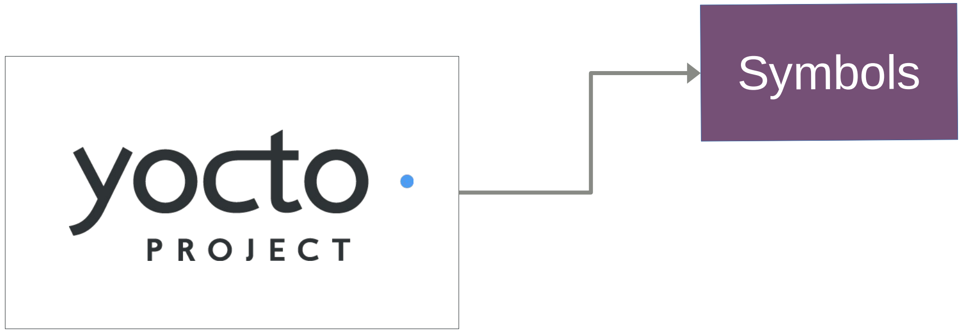
Part II:
Google Breakpad + Sentry + Yocto

General Architecture



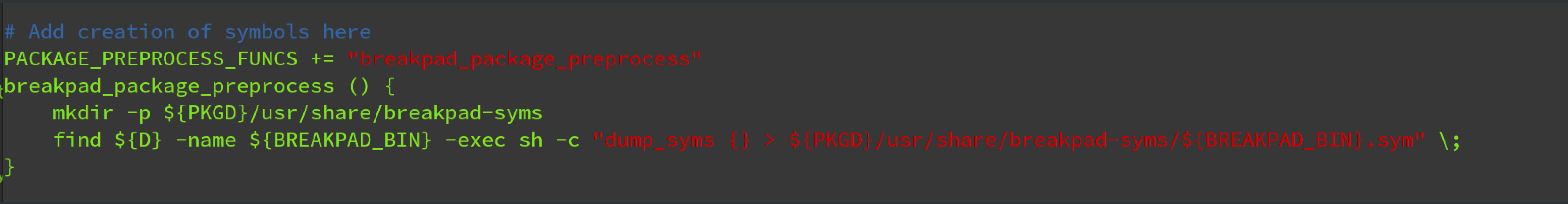
Integrate Google Breakpad into Yocto

- Breakpad recipes included in meta-oe/recipes-devtools
  - Creates all cross-tools needed
  - Creates the header-only library needed for the custom Signal Handler
  - Provides a yocto .bbclass to be added to your app recipe
    - This then splits out symbols before app-binary is stripped by yocto
- Extras can be added in your individual app recipe



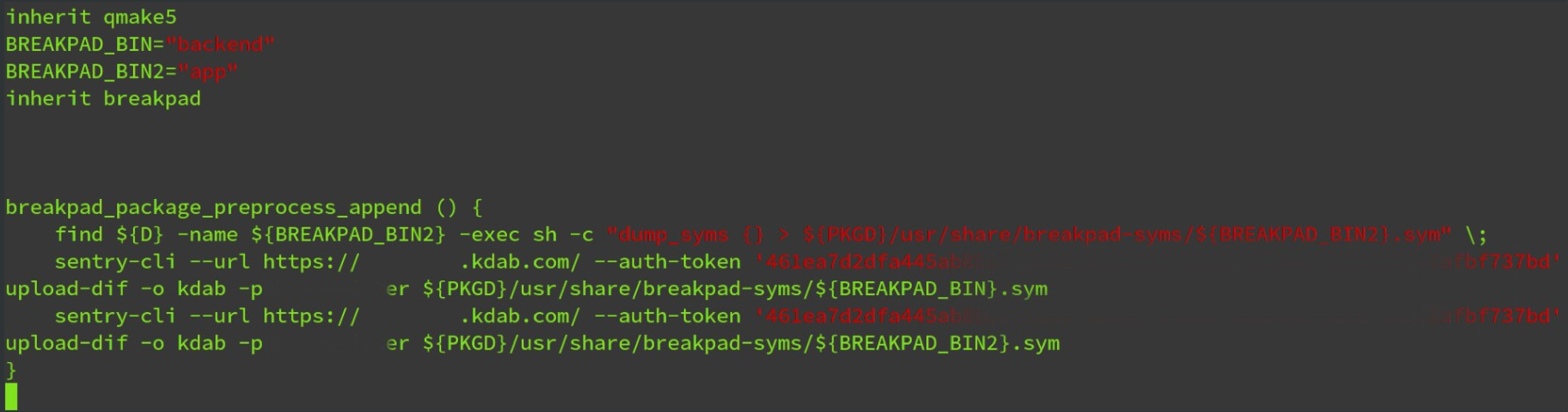
Symbols

breakpad.bbclass contains this, always executed for a class inheriting breakpad



```
# Add creation of symbols here
PACKAGE_PREPROCESS_FUNCS += "breakpad_package_preprocess"
breakpad_package_preprocess () {
    mkdir -p ${PKGD}/usr/share/breakpad-syms
    find ${D} -name ${BREAKPAD_BIN} -exec sh -c "dump_syms {} > ${PKGD}/usr/share/breakpad-syms/${BREAKPAD_BIN}.sym" \;
}
```

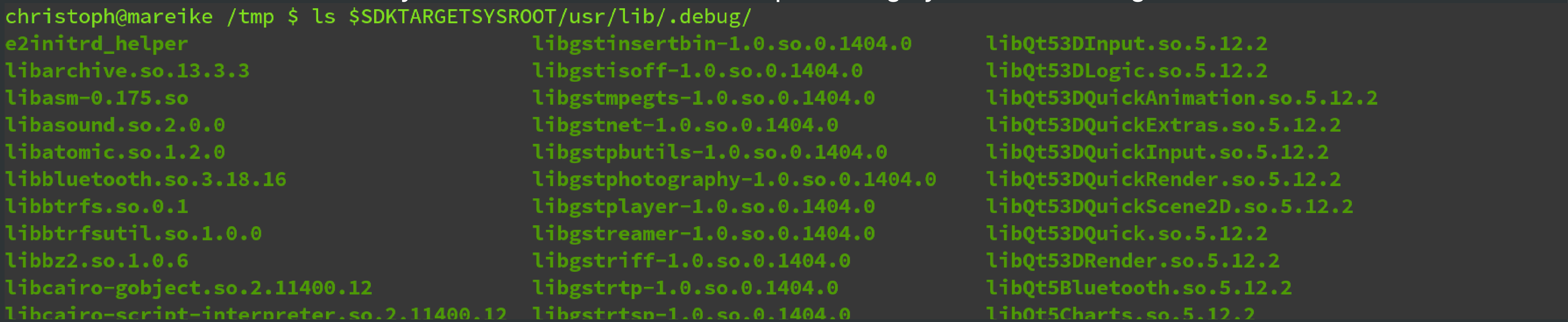
myapp.bb: I extend the breakpad step to have 2 executables and do the upload on every build



```
inherit qmake5
BREAKPAD_BIN="backend"
BREAKPAD_BIN2="app"
inherit breakpad



breakpad_package_preprocess_append () {
    find ${D} -name ${BREAKPAD_BIN2} -exec sh -c "dump_syms {} > ${PKGD}/usr/share/breakpad-syms/${BREAKPAD_BIN2}.sym" \;
    sentry-cli --url https://[redacted].kdab.com/ --auth-token '461ea7d2dfa445a[redacted]fbf737bd'
upload-dif -o kdab -p [redacted]er ${PKGD}/usr/share/breakpad-syms/${BREAKPAD_BIN}.sym
    sentry-cli --url https://[redacted].kdab.com/ --auth-token '461ea7d2dfa445a[redacted]fbf737bd'
upload-dif -o kdab -p [redacted]er ${PKGD}/usr/share/breakpad-syms/${BREAKPAD_BIN2}.sym
}
```

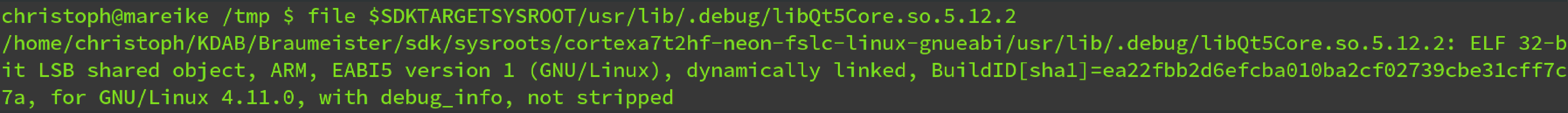
… now every yoctobuild uploads the symbols !

For the **other libs**, I use the yocto-built SDK, it contains split debug symbols in .debug folders



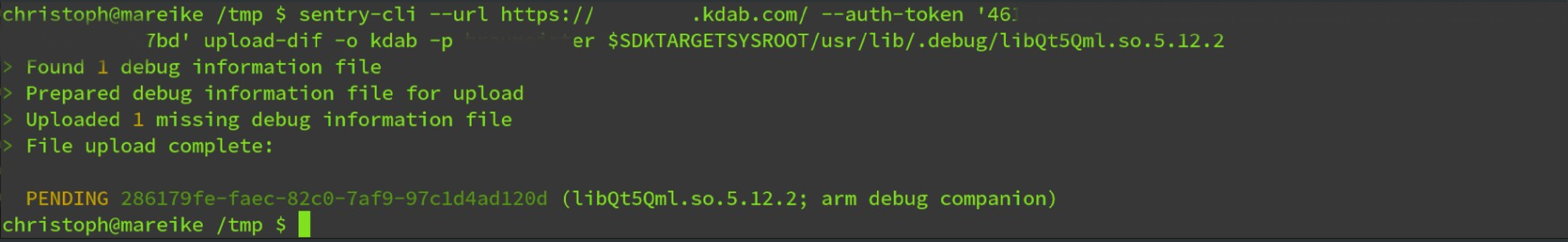
```
christoph@mareike /tmp $ ls $SDKTARGETSYSROOT/usr/lib/.debug/
e2initrd_helper                            libgstinsertbin-1.0.so.0.1404.0      libQt53DInput.so.5.12.2
libarchive.so.13.3.3                       libgstisoff-1.0.so.0.1404.0          libQt53DLogic.so.5.12.2
libasm-0.175.so                            libgstmpegts-1.0.so.0.1404.0         libQt53DQuickAnimation.so.5.12.2
libasound.so.2.0.0                         libgstnet-1.0.so.0.1404.0            libQt53DQuickExtras.so.5.12.2
libatomic.so.1.2.0                         libgstpbutils-1.0.so.0.1404.0        libQt53DQuickInput.so.5.12.2
libbluetooth.so.3.18.16                    libgstphotography-1.0.so.0.1404.0    libQt53DQuickRender.so.5.12.2
libbtrfs.so.0.1                            libgstplayer-1.0.so.0.1404.0         libQt53DQuickScene2D.so.5.12.2
libbtrfsutil.so.1.0.0                      libgstreamer-1.0.so.0.1404.0         libQt53DQuick.so.5.12.2
libbz2.so.1.0.6                            libgstriff-1.0.so.0.1404.0           libQt53DRender.so.5.12.2
libcairo-gobject.so.2.11400.12             libgstrtp-1.0.so.0.1404.0            libQt5Bluetooth.so.5.12.2
libcairo-script-interpreter.so.2.11400.12  libgstrtsp-1.0.so.0.1404.0           libQt5Charts.so.5.12.2
```

Example for **file libQt5Core.so** : It is important, that debug info is present



```
christoph@mareike /tmp $ file $SDKTARGETSYSROOT/usr/lib/.debug/libQt5Core.so.5.12.2
/home/christoph/KDAB/Braumeister/sdk/sysroots/cortexa7t2hf-neon-fslc-linux-gnueabi/usr/lib/.debug/libQt5Core.so.5.12.2: ELF 32-b
it LSB shared object, ARM, EABI5 version 1 (GNU/Linux), dynamically linked, BuildID[sha1]=ea22fbb2d6efcba010ba2cf02739cbe31cff7c
7a, for GNU/Linux 4.11.0, with debug_info, not stripped
```

… from there it is uploaded like all symbs with **sentry-cli**



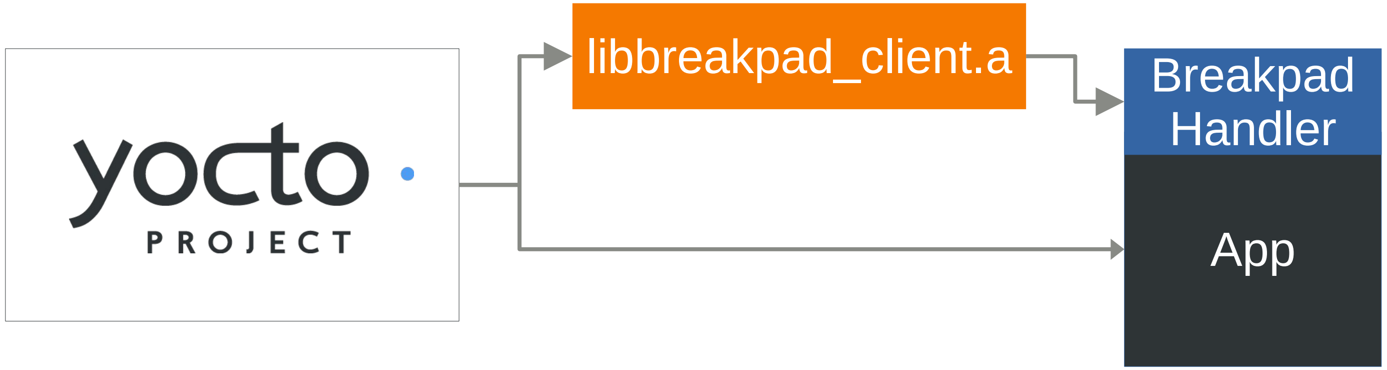
```
christoph@mareike /tmp $ sentry-cli --url https://[redacted].kdab.com/ --auth-token '46[redacted]
           7bd' upload-dif -o kdab -p [redacted]er $SDKTARGETSYSROOT/usr/lib/.debug/libQt5Qml.so.5.12.2
> Found 1 debug information file
> Prepared debug information file for upload
> Uploaded 1 missing debug information file
> File upload complete:

  PENDING 286179fe-faec-82c0-7af9-97c1d4ad120d (libQt5Qml.so.5.12.2; arm debug companion)
christoph@mareike /tmp $ █
```

More Infos on Google Breakpad

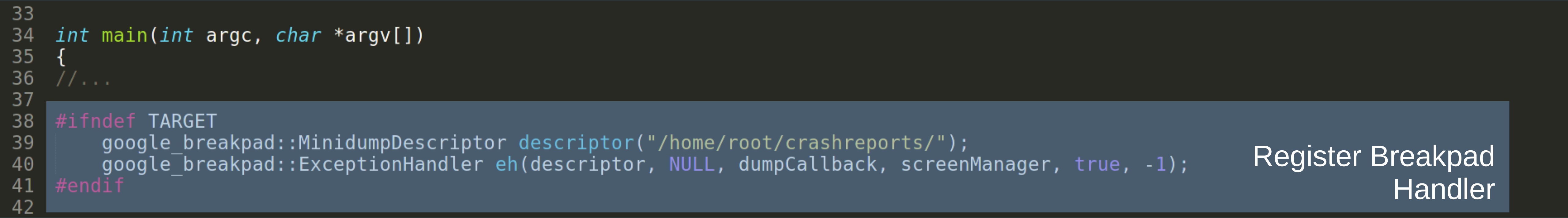
- Uses Minidumps
  - Originally envisioned by Microsoft
  - Similar to slim cores, but way smaller (around 20KiB)
  - Cross-platform (unix cores don't work on Windows, settled on minidump)
  - Splitting command: **dump_symbs *executable* > */path/to/destination.symbs***
- Minidump comes with some useful tools
  - **minidump_stackwalk**: Re-combine Minidump+App+Symbols → get a stack
  - **minidump-2-core**: Converts dump to gdb-readable format
  - and more…

Integrate Breakpad in your Code

- Breakpads library and headers are included in the new SDK when using it in any of your recipes
- Only 2 extra lines in main() are necessary to register
- Of course you can do more in your custom Handler



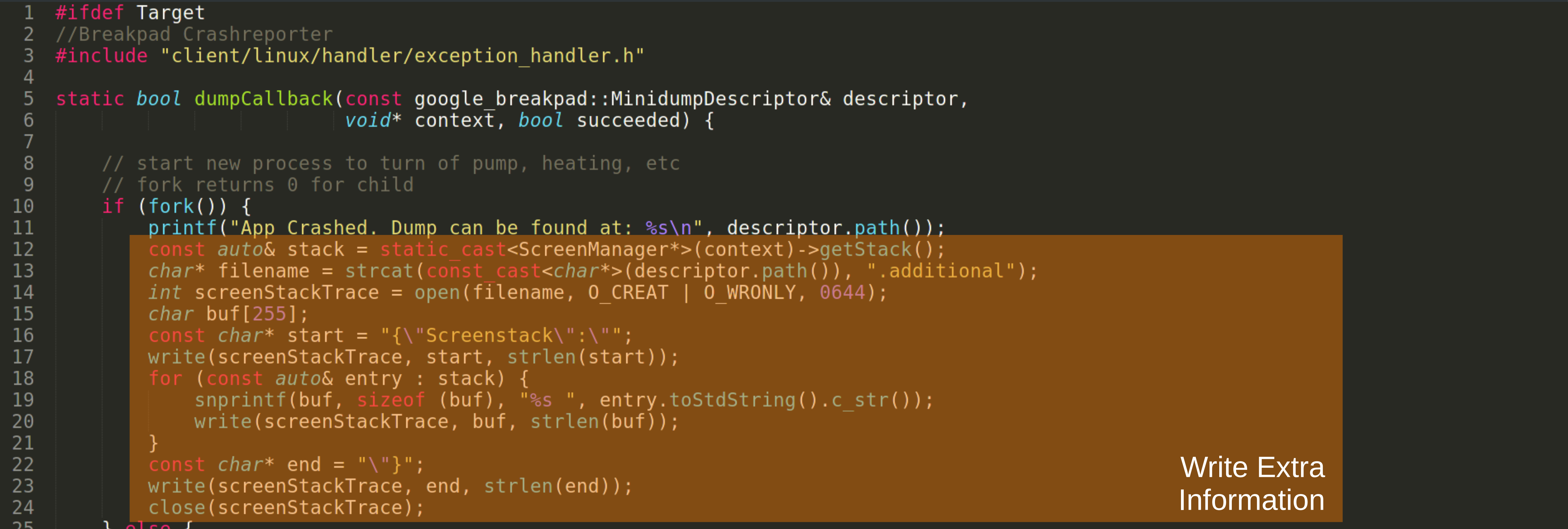
Register the handler in your main(), pass any variables to be used



```
int main(int argc, char *argv[])
{
//...

#ifndef TARGET
    google_breakpad::MinidumpDescriptor descriptor("/home/root/crashreports/");
    google_breakpad::ExceptionHandler eh(descriptor, NULL, dumpCallback, screenManager, true, -1);
#endif

```

Register Breakpad Handler

Include Breakpad Header,
Handle crashes and write extra information

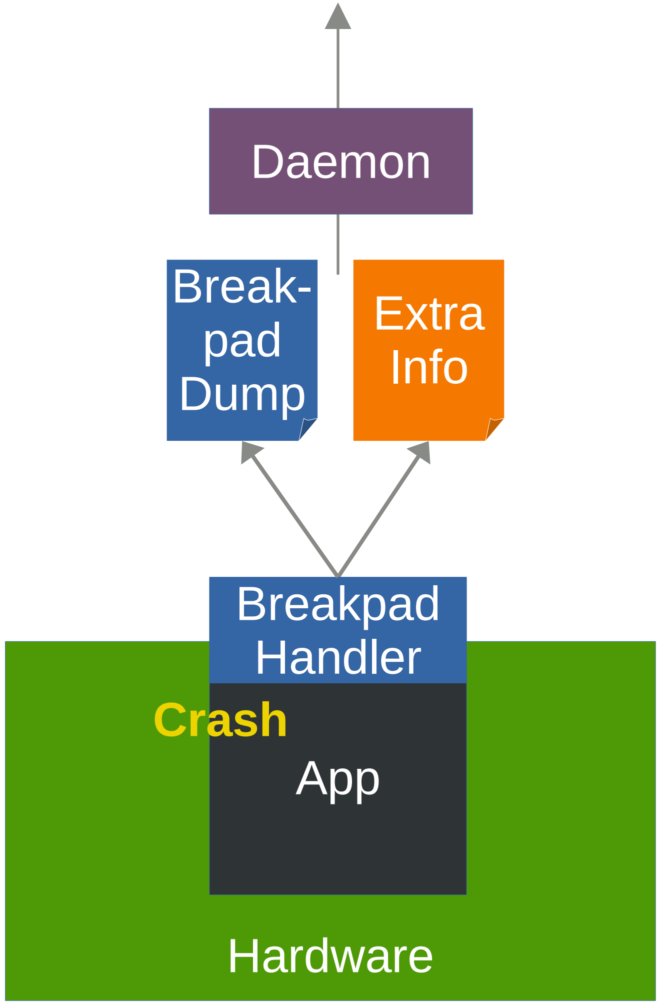


```
#ifdef Target
//Breakpad Crashreporter
#include "client/linux/handler/exception_handler.h"

static bool dumpCallback(const google_breakpad::MinidumpDescriptor& descriptor,
                         void* context, bool succeeded) {

    // start new process to turn of pump, heating, etc
    // fork returns 0 for child
    if (fork()) {
        printf("App Crashed. Dump can be found at: %s\n", descriptor.path());
        const auto& stack = static_cast<ScreenManager*>(context)->getStack();
        char* filename = strcat(const_cast<char*>(descriptor.path()), ".additional");
        int screenStackTrace = open(filename, O_CREAT | O_WRONLY, 0644);
        char buf[255];
        const char* start = "{\"Screenstack\":\"";
        write(screenStackTrace, start, strlen(start));
        for (const auto& entry : stack) {
            snprintf(buf, sizeof (buf), "%s ", entry.toStdString().c_str());
            write(screenStackTrace, buf, strlen(buf));
        }
        const char* end = "\"}";
        write(screenStackTrace, end, strlen(end));
        close(screenStackTrace);
    } else {
```

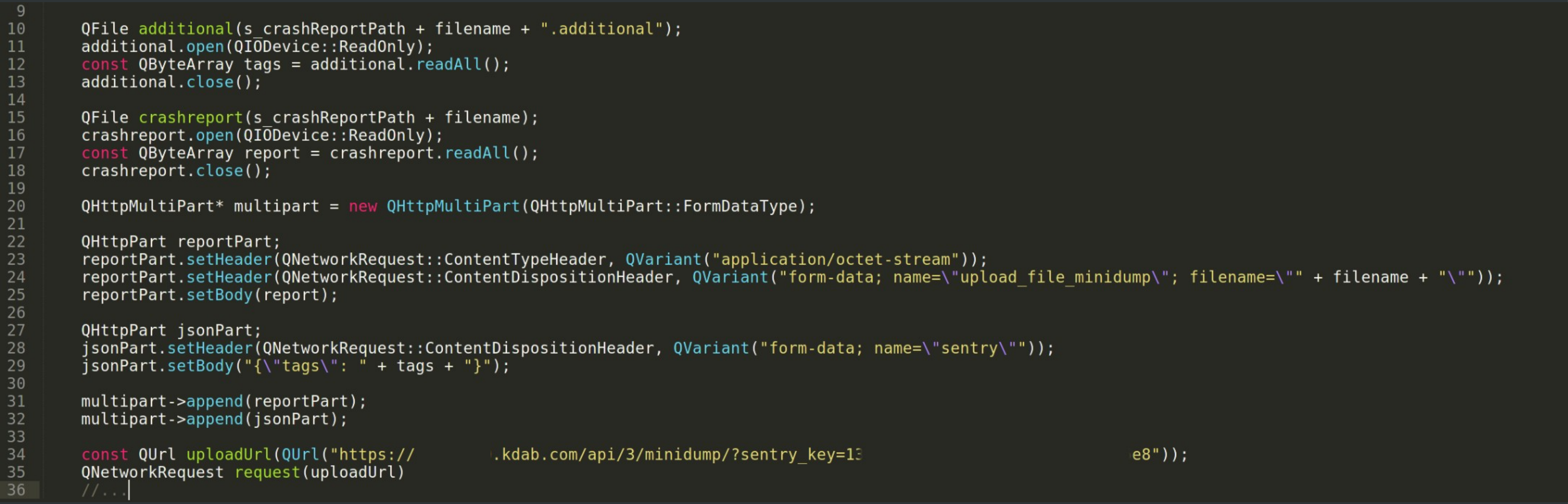
Write Extra Information

Sending the Information

- Let a daemon check the crash folder for crashes
  - Not known if device has connectivity
  - Daemon checks periodically if a minidump is available
  - If allowed in the User-settings, Info is uploaded to the sentry server
- For now, no logs are uploaded, maybe in the future…

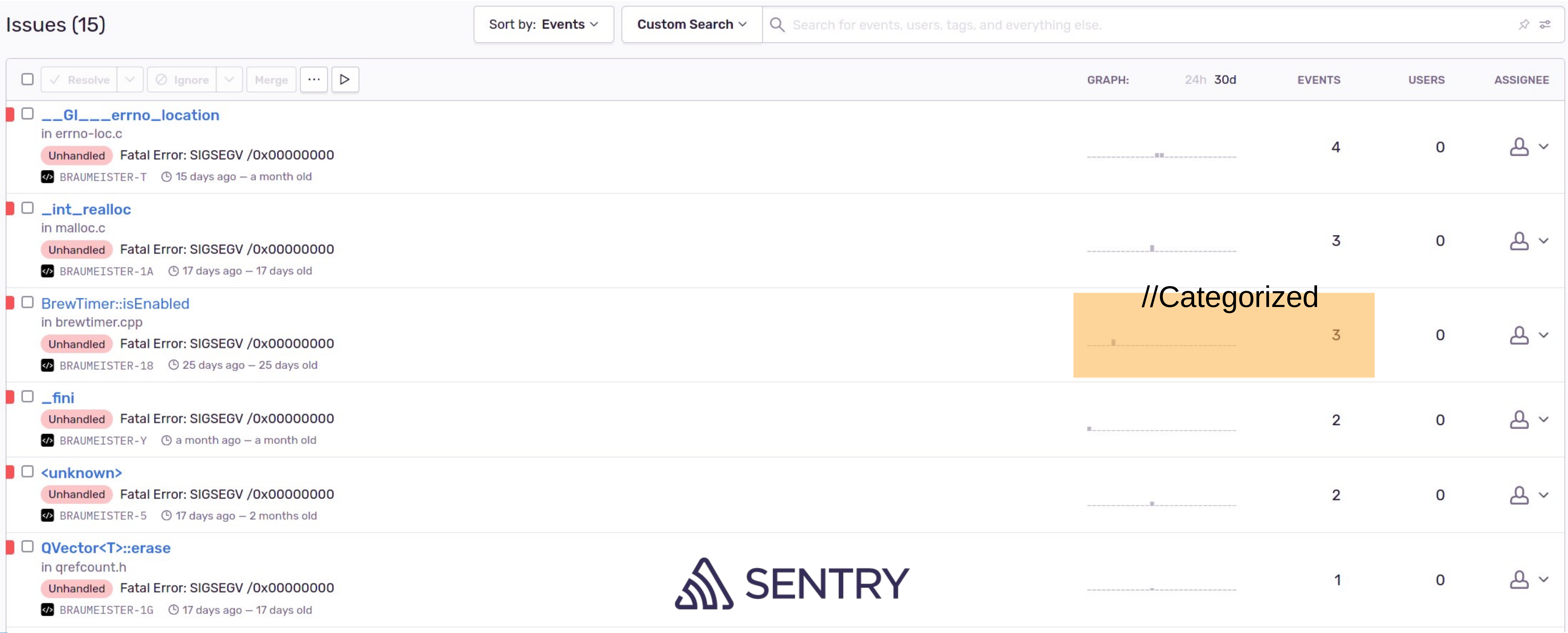


Snip from the Crashdaemon,
A file watcher looks for crash data and uploads it, when possible
Extra tag info is garnished for sentry



```

    QFile additional(s_crashReportPath + filename + ".additional");
    additional.open(QIODevice::ReadOnly);
    const QByteArray tags = additional.readAll();
    additional.close();

    QFile crashreport(s_crashReportPath + filename);
    crashreport.open(QIODevice::ReadOnly);
    const QByteArray report = crashreport.readAll();
    crashreport.close();

    QHttpMultiPart* multipart = new QHttpMultiPart(QHttpMultiPart::FormDataType);

    QHttpPart reportPart;
    reportPart.setHeader(QNetworkRequest::ContentTypeHeader, QVariant("application/octet-stream"));
    reportPart.setHeader(QNetworkRequest::ContentDispositionHeader, QVariant("form-data; name=\"upload_file_minidump\"; filename=\"" + filename + "\""));
    reportPart.setBody(report);

    QHttpPart jsonPart;
    jsonPart.setHeader(QNetworkRequest::ContentDispositionHeader, QVariant("form-data; name=\"sentry\""));
    jsonPart.setBody("{\"tags\": " + tags + "}");

    multipart->append(reportPart);
    multipart->append(jsonPart);

    const QUrl uploadUrl(QUrl("https://[redacted].kdab.com/api/3/minidump/?sentry_key=13[redacted]e8"));
    QNetworkRequest request(uploadUrl)
    //...
```

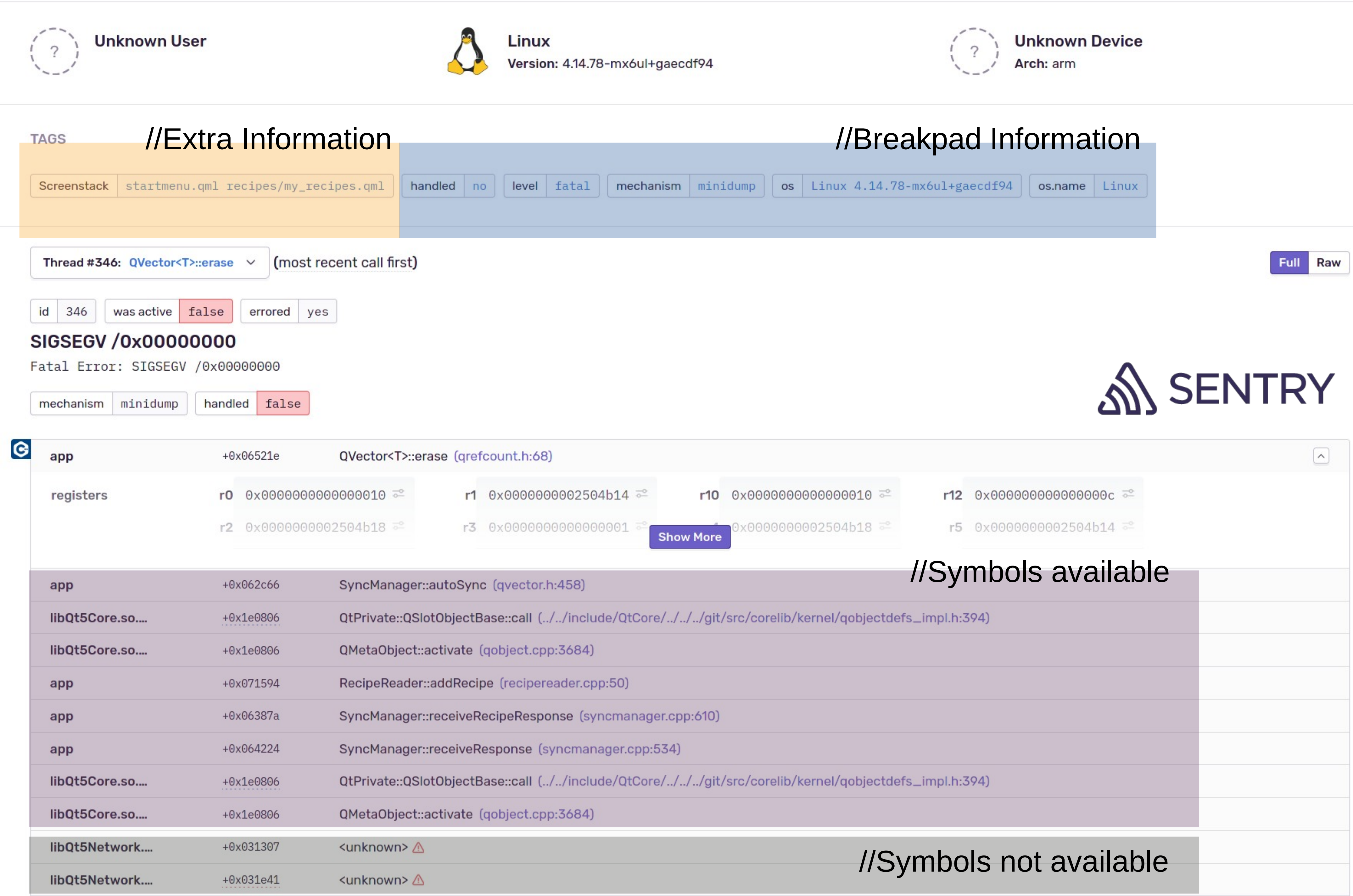
Result: Sentry collects the Crashes



Issues (15)

		EVENTS	USERS
□	__GI___errno_location in errno-loc.c Unhandled Fatal Error: SIGSEGV /0x00000000 BRAUMEISTER-T 15 days ago – a month old	4	0
□	_int_realloc in malloc.c Unhandled Fatal Error: SIGSEGV /0x00000000 BRAUMEISTER-1A 17 days ago – 17 days old	3	0
□	BrewTimer::isEnabled in brewtimer.cpp Unhandled Fatal Error: SIGSEGV /0x00000000 BRAUMEISTER-18 25 days ago – 25 days old	3	0
□	_fini Unhandled Fatal Error: SIGSEGV /0x00000000 BRAUMEISTER-Y a month ago – a month old	2	0
□	<unknown> Unhandled Fatal Error: SIGSEGV /0x00000000 BRAUMEISTER-5 17 days ago – 2 months old	2	0
□	QVector<T>::erase in qrefcount.h Unhandled Fatal Error: SIGSEGV /0x00000000 BRAUMEISTER-1G 17 days ago – 17 days old	1	0

//Categorized



Unknown User

Linux
Version: 4.14.78-mx6ul+gaecdf94

Unknown Device
Arch: arm

TAGS

//Extra Information

//Breakpad Information

Screenstack	startmenu.qml recipes/my_recipes.qml

handled	no

level	fatal

mechanism	minidump

os	Linux 4.14.78-mx6ul+gaecdf94

os.name	Linux

Thread #346: QVector<T>::erase (most recent call first)

Full Raw

id	346

was active	false

errored	yes

SIGSEGV /0x00000000

```
Fatal Error: SIGSEGV /0x00000000
```

mechanism	minidump

handled	false

app	+0x06521e	QVector<T>::erase (qrefcount.h:68)

registers

```
r0  0x0000000000000010   r1  0x0000000002504b14   r10  0x0000000000000010   r12  0x000000000000000c
r2  0x0000000002504b18   r3  0x0000000000000001        0x0000000002504b18   r5   0x0000000002504b14
```

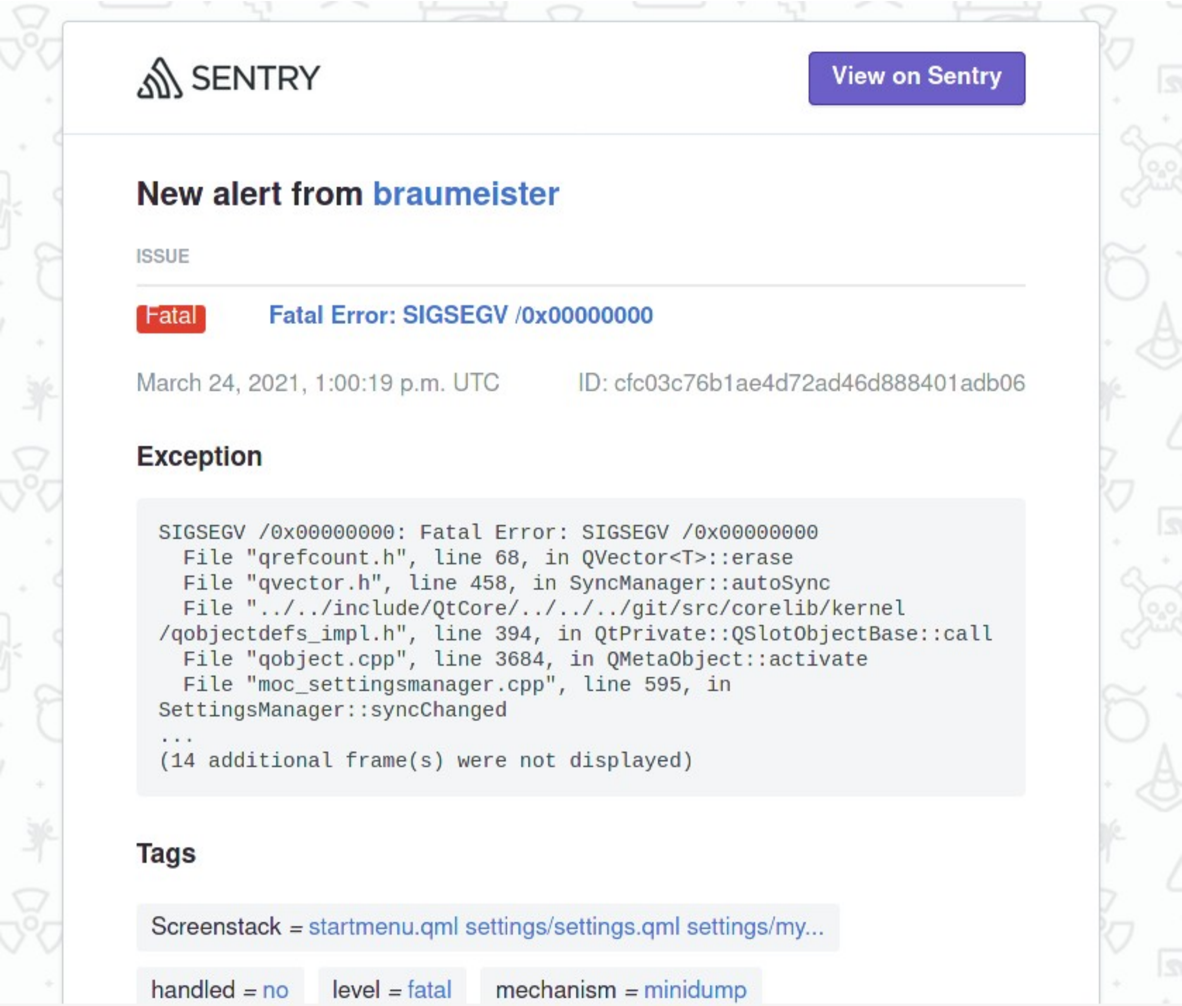
Show More

//Symbols available

app	+0x062c66	SyncManager::autoSync (qvector.h:458)
libQt5Core.so....	+0x1e0806	QtPrivate::QSlotObjectBase::call (../../include/QtCore/../../../git/src/corelib/kernel/qobjectdefs_impl.h:394)
libQt5Core.so....	+0x1e0806	QMetaObject::activate (qobject.cpp:3684)
app	+0x071594	RecipeReader::addRecipe (recipereader.cpp:50)
app	+0x06387a	SyncManager::receiveRecipeResponse (syncmanager.cpp:610)
app	+0x064224	SyncManager::receiveResponse (syncmanager.cpp:534)
libQt5Core.so....	+0x1e0806	QtPrivate::QSlotObjectBase::call (../../include/QtCore/../../../git/src/corelib/kernel/qobjectdefs_impl.h:394)
libQt5Core.so....	+0x1e0806	QMetaObject::activate (qobject.cpp:3684)
libQt5Network....	+0x031307	<unknown> ⚠
libQt5Network....	+0x031e41	<unknown> ⚠

//Symbols not available

Mail



New alert from braumeister

ISSUE

Fatal Fatal Error: SIGSEGV /0x00000000

March 24, 2021, 1:00:19 p.m. UTC ID: cfc03c76b1ae4d72ad46d888401adb06

Exception

```
SIGSEGV /0x00000000: Fatal Error: SIGSEGV /0x00000000
  File "qrefcount.h", line 68, in QVector<T>::erase
  File "qvector.h", line 458, in SyncManager::autoSync
  File "../../include/QtCore/../../../git/src/corelib/kernel
/qobjectdefs_impl.h", line 394, in QtPrivate::QSlotObjectBase::call
  File "qobject.cpp", line 3684, in QMetaObject::activate
  File "moc_settingsmanager.cpp", line 595, in
SettingsManager::syncChanged
...
(14 additional frame(s) were not displayed)
```

Tags

Screenstack = startmenu.qml settings/settings.qml settings/my...

handled = no level = fatal mechanism = minidump

More about Sentry

- Clustering of crashes is configurable
- Supports many dump formats
  - Not in this talk: Sentry Native Dumps
- Supports external symbol servers
  - Some Companies (Microsoft, Autodesk, …) offer symbols even for their closed-source products online

- Self-hosted, or ~25€/mo

GDPR?
<I’m not a lawyer>, but…

On uploading crash*(=user)*data

- We run it for development/staging/testing only
- If production is involved, plan to make it opt-in for users
- Practically, stack information might contain all information

If dumps are anonymous and your users know that telemetry is recorded and for what purpose the data is collected, one should be fine.

… </but I'm not a lawyer>

#1 Overall, there is still much one can do, when its already too late

#2 I showed you classic ways in theory and one way I like in practice

#3 Invest in learning from your crashes—it pays off plenty!

Pointers and Sources

- *[Strip and unstrip Symbols]*
  https://sourceware.org/elfutils/
- *[4Byte Ferrite Core Memory for Arduino]*
  https://www.tindie.com/products/kilpelaj/core-memory-shield-for-arduino/
- *[Anatomy of a coredump]*
  https://www.gabriel.urdhr.fr/2015/05/29/core-file/
- [*Prerequisits for coredumps*]
  https://man7.org/linux/man-pages/man5/core.5.html
- [*Stacktraces with Backward-cpp*]
  https://github.com/bombela/backward-cpp
- [*Stacktraces from the Address the Sanitizer*]
  https://clang.llvm.org/docs/AddressSanitizer.html
- [*Handlers std::signal(…)*]
  https://en.cppreference.com/w/cpp/utility/program/signal
- [*Handlers Sigaction*]
  https://pubs.opengroup.org/onlinepubs/9699919799/functions/sigaction.html
- [*Infos on OOM killer*]
  https://docs.memset.com/other/linux-s-oom-process-killer
- [*Breakpad Yocto Recipe*]
  https://git.congatec.com/yocto/meta-openembedded/commit/a4657e4395e0714198c34f02c54043edb8baeafb
- [*Mozilla Minidump Tools*]
  https://github.com/mozilla-services/minidump-stackwalk
- [*Sentry, Sentry-CLI*]
  https://sentry.io
  https://docs.sentry.io/product/cli/

End Of Talk!

I will answer all questions, AMA!

Christoph **Sterz**
christoph.sterz@kdab.com