AddressSanitizer for Windows

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AddressSanitizer (a.k.a. ASan)

- High performance
  - Uses compile-time instrumentation
  - Lightweight algorithm
  - Multi-threaded
- Focuses on severe bugs
  - buffer overflows
  - uses of freed / unavailable memory
  - and more
- Supports Linux, Mac OS; more in development

ASan overview follows

A more complete version:

Konstantin Serebryany, Derek Bruening, Alexander Potapenko, Dmitry Vyukov, ***AddressSanitizer: a fast address sanity checker****, Proceedings of the 2012 USENIX conference on Annual Technical Conference, 2012*

ASan code instrumentation

Original code:

```
*addr = 42;
```

Instrumented pseudocode:

```
if (!is_ok_to_use(addr))
  print_report_and_crash();
// memory is ok to use:
*addr = 42;
```

ASan shadow memory

A state of every aligned 8 bytes of memory is stored in a single *shadow* byte

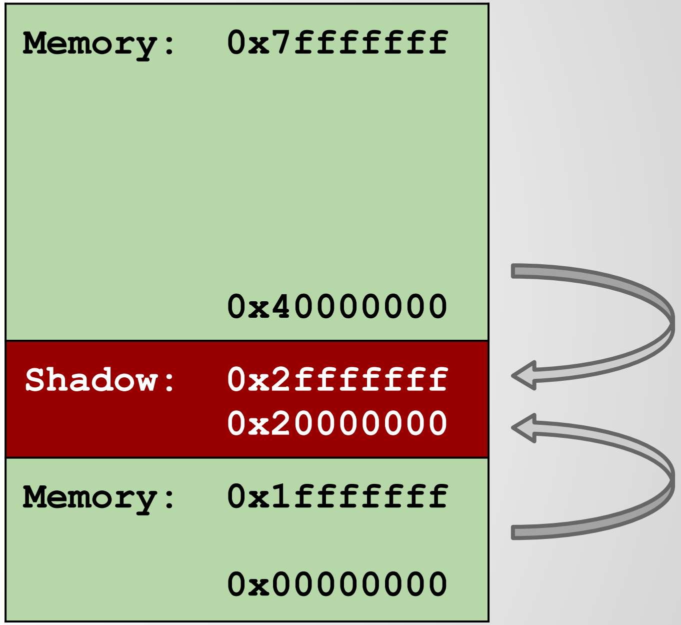
Simple shadow address calculation

```
shadow_addr = addr / 8 + offset
```

Allows very simple instrumentation,
performed at LLVM IR level

ASan shadow memory

- Easy to allocate memory for the shadow
- Fixed address range
- Have to do it early



Function interception

Have to intercept some functions:

- **`malloc`**, **`free`**, etc. – to track memory
- **`strlen`**, **`memcpy`**, etc. – to detect more errors
- **`pthread_create`**, etc. – to understand the app

Error reporting

- Grab the current stack trace
- Pinpoint the (mis)accessed memory allocation
- Get extra info from allocation metadata
- Print out everything
- Terminate the process

ASan for Windows – overview

- Goal: find nasty Chromium bugs on Windows
- Started in 2012 after ASan success on Linux
- “Beta” experience available mid-2014

Progress overview

- Instrumentation – no changes needed, thanks IR!
- Significant changes to the ASan run-time library (RTL)
- Massive effort on Clang C++ ABI support
- clang-cl bonus: can mix MSVC & Clang **`.obj`** files, supports automatic fallback (e.g. code with exceptions)

C run-time support

- Multiple C run-time (CRT) implementations:
  - `/MT` (static linkage)
  - `/MTd` (static linkage, debug)
  - `/MD` (DLL linkage)
  - `/MDd` (DLL linkage, debug)
- Each CRT requires different handling
- Currently supported: `/MT`, `/MD`
- Each DLL might have its own copy of `/MT` CRT, i.e. `malloc`, heap, CRT global state etc.

/MT CRT support

EXE

- Just define **`malloc`**, etc. to intercept them
- **`dllimport`**’ed functions like **`CreateThread`** need to be hot-patched at start-up
- Init ASan RTL as part of the first **`calloc`** early in CRT init

DLL

- Redirect calls to intercepted functions from DLL to the interceptor implementations in the EXE

/MD CRT support

- Also need to hot-patch **`MSVCR*.dll`** early
- RTL is a DLL without dependencies to CRT, gets initialized earlier

Report symbolization and debug info

ASan requires line tables to be useful.

Added COFF line table debug info support to LLVM

- Almost-free bonus: can step line by line in debuggers (VS, windbg)
- Can’t look up variable values though

Deployment

- Can build and run Chromium
- Deployed to ClusterFuzz,
  found 50+ security bugs in 3 months
- We’re working with Mozilla Firefox and other OSS developers

38
DEMO TIME ....
memegenerator.net

Thanks for listening!

Please try AddressSanitizer on your Windows app

p.s. tests and patches are welcome

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