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The University of Texas at Austin

10 years of XALT: A Retrospective

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XALT: Outline



XALT

- ▶ History: Lariat and ALTD
- ▶ XALT 1 funded by NSF
- ▶ XALT 2
- ▶ Sharing Memory and Namespace with every program run on the system
- ▶ Lessons learn from running an Open Source Project
- ▶ Conclusions

History

- ▶ My Boss, John Cazes, asked if I could track what MPI executable ran on our system
- ▶ I added code around our ibrun submission tool (AKA our mpirun/srun)
- ▶ Could do some tracking but no database
- ▶ Lariat was born (was LASSO but name conflict)

XALT History

- ▶ Mark Fahey contacted us at TACC for a joint proposal
- ▶ With an amazing amount of help from my colleague Doug James
- ▶ Mark and I joined forces to submit a successful NSF proposal in 2013.
- ▶ XALT combined the best parts of both projects (ALTD and Lariat)
- ▶ The name XALT comes from eXtended ALTd (suggested by Doug James)
- ▶ Originally UTWrangler but name conflict again.

XALT I

- ▶ It only tracked MPI executions
- ▶ It did have a database
- ▶ It tracked Linking of executable
- ▶ Used UUID (universal unique id) to connect links to execution
- ▶ Rather than making calls to database like ALTD did
- ▶ It mainly used Python to collect data (a bad idea)

XALT 2

- ▶ My friend and colleague, Bill Barth, found this ELF trick.
- ▶ One could modify the execution of non-static execution.
- ▶ By using LD_PRELOAD and a shared library.
- ▶ There are similar ways under macOS but ...

How XALT 2 works

```
#include <stdio.h>
void myinit(int argc, char **argv)
{ printf("This is run before main()\n"); }
void myfini()
{ printf("This is run after main()\n"); }

__attribute__((section(".init_array"))) __typeof__(myinit) *__init = myinit;
__attribute__((section(".fini_array"))) __typeof__(myfini) *__fini = myfini;
```

- ▶ [my_docs/22/xalt_monthly_mtg_2022_03_17/code/bad_memory/ex1](#)

How XALT works (II)

```
% cat try.c
```

```
#include <stdio.h>
int main()
{
    printf("Hello World!\n");
    return 0;
}
```


How XALT works (III)

```
$ ./try
```

```
Hello World!
```

```
$ LD_PRELOAD=./libxalt.so ./try
```

```
This is run before main()
```

```
Hello World!
```

```
This is run after main()
```

- ▶ `my_docs/22/xalt_monthly_mtg_2022_03_17/code/bad_memory/ex1`

Hijacking the linker

- ▶ XALT uses Lmod to put its ld early in the path
- ▶ This doesn't work with llvm compilers
- ▶ Sites have to move llvm's ld to ld.x and place XALT's ld in the right place

Implications of tracking everything

- ▶ Too much data!! \Rightarrow Sampling
- ▶ Being in the same namespace of your program
- ▶ Sharing memory allocation with your program.
- ▶ Feeling like I'm a developer on every program team.

Sharing Namespace

- ▶ XALT uses `xalt_obfuscate.h` to hide the xalt library (`libxalt_init.so`)
- ▶ This sharing is common with all libraries
- ▶ But usually it is opt-in.
- ▶ But very few libraries are uses everywhere, except `libc.so`

Hiding XALT routine names from users

```
% nm $LD_PRELOAD | grep __XALT_build
00000000000009e80 T __XALT_buildEnvT_xalt_1_5
0000000000000a840 T __XALT_buildUserT_xalt_1_5
000000000000163a0 T __XALT_buildXALTRecordT_xalt_1_5
```

- XALT routine names are hidden by macros supplied in `xalt_obfuscate.h`

Cannot hide routines in system libraries like libuuid

- ▶ The routine “**random**” is used by libuuid.so
- ▶ A user's program created their own random routine in fortran
- ▶ The program crash when XALT was used.
- ▶ Solution: use dynamic linking via libdl.so for libuuid.so and others.

User's bug hidden by initially zeroed memory

- ▶ Initially all memory is zeroed before program starts
- ▶ Note that pointer zero, integer zero and float zero are all zero bits
- ▶ Link lists require a NULL pointer at end of list.
- ▶ Used memory is **NOT** zeroed for you in C.
- ▶ User's program work w/o XALT, Failed with XALT.
- ▶ XALT Fix was to zero memory before returning it
- ▶ Also only return memory when necessary

XALT has been a group effort

- ▶ James McComb & Michael Scott from IU \Rightarrow Tracking R imports
- ▶ Kenneth Hoste \Rightarrow Riccardo Murri \Rightarrow Tracking Python imports
- ▶ Bill Barth \Rightarrow Tracking MATLAB imports
- ▶ NVIDIA's Scott McMillan \Rightarrow Tracking NVIDIA GPU usage
- ▶ Bilel Hadri \Rightarrow ALTD at NICS
- ▶ Doug James wrote the NSF proposal with help from Mark and me
- ▶ See ACKNOWLEDGMENTS.txt for a complete list

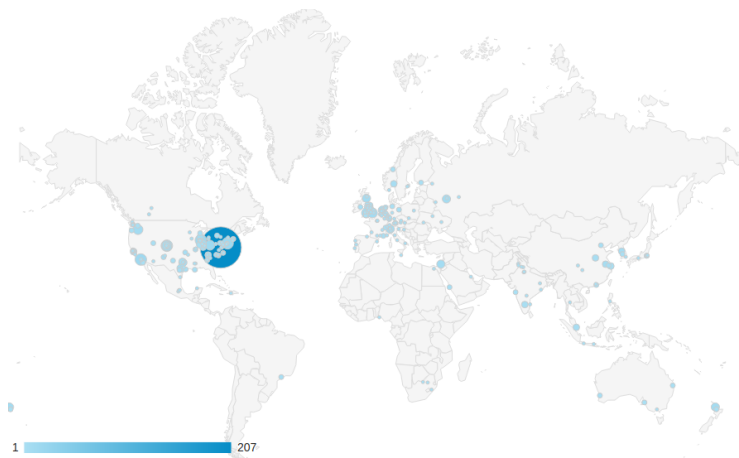
Lessons Learned

- ▶ Figuring out how to debug on a remote site via XALT_TRACING=
- ▶ Reporting the XALT configuration
- ▶ make gittag TAG=...; make world_update
- ▶ git worktrees
- ▶ Exploiting Lmod to help XALT (reverse map: path \Rightarrow to module)
- ▶ Using python config files to build C code.
- ▶ Speed, Speed, Speed
- ▶ Building trust with the user community

Building trust with the user community

- ▶ Making it reliable via Testing
- ▶ Timely answering the email and github issues
- ▶ Book: Team Geek
- ▶ Learning to be polite when answering and re-answering questions
- ▶ “You might consider ...”
- ▶ “Please test XALT version ... when you get a chance to see if it works for you”
- ▶ Not getting upset when non-native English speakers sound insulting

XALT Doc usage by City



Conclusions

- ▶ It has been quite the learning experience
- ▶ XALT is considerable better for being Open Source

Future Topics?

- ▶ Next Meeting will be on September 21, 2023 at 10:00 am U.S. Central (15:00 UTC)
- ▶ It will be a different Zoom link as Amit Ruhela will leading the project with some help from me.