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Link Record Generation in XALT

XALT : Link Record

PRESENTED BY:

Amit Ruhela

Texas Advanced Computing Center,

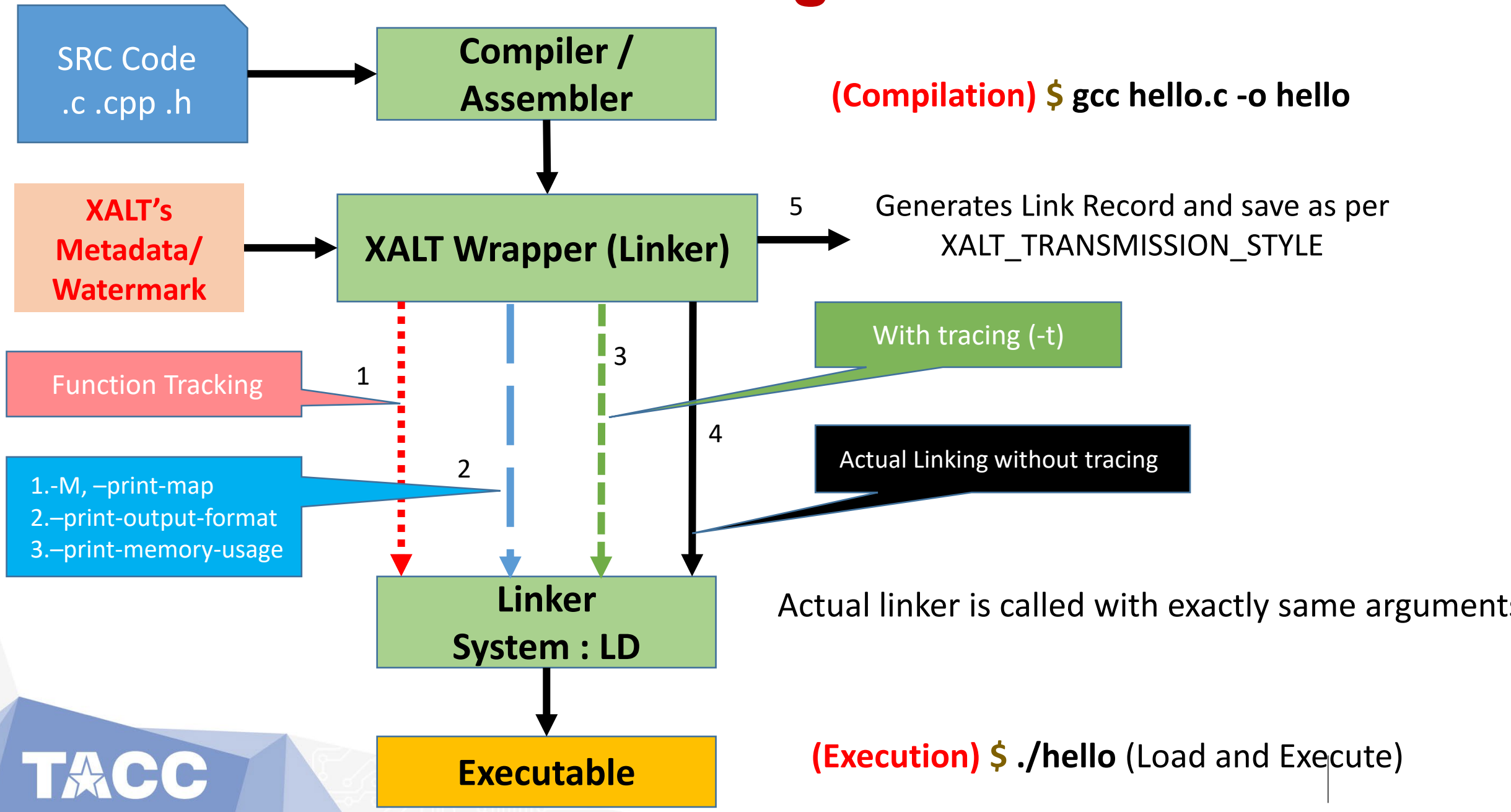
Austin Texas

User Group Meeting, October 27, 2022

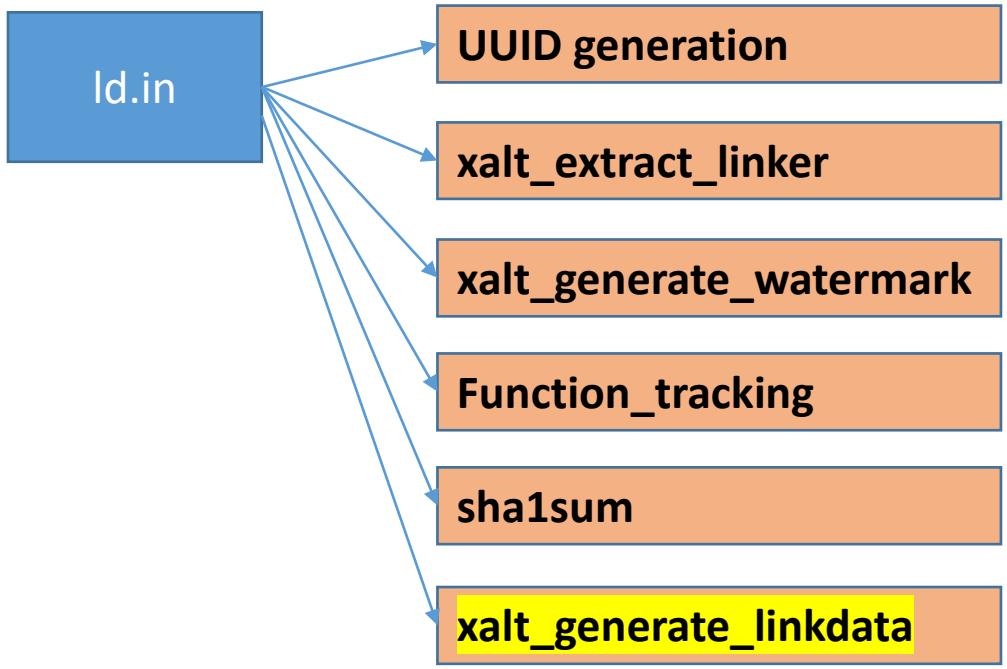
Agenda

- Learn how link record is generated
- Code Walkthrough - **xalt/src/linker/xalt_generate_linkdata.c**

XALT Linking Process



ld.in workflow




```
XALT_EXECUTABLE_TRACKING=no
LD_PRELOAD= PATH=@xalt_system_path@
LD_LIBRARY_PATH=$XALT_LD_LIBRARY_PATH
$GEN_LINKDATA
      "$UUID"  # Unique Universal ID
      "`pwd`"  # Working Directory
      "$SYSHOST" # System Name
      "$EXEC"  # Executable Name
      "$SHA1" # Checksum
      "$WATERMARK_O"  # Watermark Object
      "$EPOCH"  # Build Time of Executable
      "$FUNCRAW"  # Functions List
      "$LINKLINE_OUT"  # Link Line
      "$COMP_T". # Compiler
```

Workflow : Link Record Generation (xalt_generate_linkdata.c)

1. Initialize with command line arguments
2. Call parseLDTrace on LINKLINE_OUT (generates linkA)
   - Removes lines having *.o , *tmp*, librun_submission.a etc. (Next Slide)
3. Call readFunctionList on funcRawFn (generates funcset)
   - Collect all function name that have “undefined references to”
4. Call parseCompTJsonStr
   - Extract Compiler, Compilerpath, linkline, and parentprocs
   - Create Key-Value pair (resultT) and add uuid, link_program, link_path, build_user, build_epoch, build_syshost, exec_path, hashid, workingdir
5. Create a json datastructure containing CRC, resultT, linkA, funcset, and link_line
6. Transmit data to file, syslog, logger, syslogv1, curl based on **XALT_TRANSMISSION_STYLE**

LINKLINE_OUT

/lib/../lib64/crt1.o
/opt/apps/gcc/8.3.0/lib/gcc/x86_64-pc-linux-gnu/8.3.0/crtbegin.o
/tmp/icc1UIM3g.o
/opt/intel/compilers_and_libraries_2020.4.304/linux/mpi/intel64/lib/libmpifort.so
/opt/intel/compilers_and_libraries_2020.4.304/linux/mpi/intel64/lib/release/libmpi.so
/lib/../lib64/libdl.so
/lib/../lib64/librt.so
/lib/../lib64/libpthread.so
/lib64/libpthread.so.0
/usr/lib64/libpthread_nonshared.a
//opt/intel/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin/libimf.a
/opt/intel/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin/libsvml.a
/opt/intel/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin/libirng.a
/lib/../lib64/libm.so
/opt/intel/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin/libipgo.a
/opt/intel/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin/libdecimal.a
/opt/apps/gcc/8.3.0/lib/gcc/x86_64-pc-linux-gnu/8.3.0//libgcc.a
/opt/apps/gcc/8.3.0/lib/gcc/x86_64-pc-linux-gnu/8.3.0/../../../../lib64/libgcc_s.so
/opt/apps/gcc/8.3.0/lib/gcc/x86_64-pc-linux-gnu/8.3.0/../../../../lib64/libgcc_s.so.1
/opt/apps/gcc/8.3.0/lib/gcc/x86_64-pc-linux-gnu/8.3.0//libgcc.a
/opt/apps/gcc/8.3.0/lib/gcc/x86_64-pc-linux-gnu/8.3.0//libgcc.a
/opt/intel/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin/libirc.a
/opt/intel/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin/libsvml.a
/lib/../lib64/libc.so
/lib64/libc.so.6
/usr/lib64/libc_nonshared.a
/lib64/ld-linux-x86-64.so.2
/usr/lib64/libc_nonshared.a
/lib64/ld-linux-x86-64.so.2
/opt/apps/gcc/8.3.0/lib/gcc/x86_64-pc-linux-gnu/8.3.0//libgcc.a
/opt/apps/gcc/8.3.0/lib/gcc/x86_64-pc-linux-gnu/8.3.0/../../../../lib64/libgcc_s.so
/opt/apps/gcc/8.3.0/lib/gcc/x86_64-pc-linux-gnu/8.3.0/../../../../lib64/libgcc_s.so.1
/opt/apps/gcc/8.3.0/lib/gcc/x86_64-pc-linux-gnu/8.3.0//libgcc.a
/opt/intel/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin/libirc_s.a
/lib/../lib64/libdl.so
/lib/../lib64/libc.so
/lib64/libc.so.6
/usr/lib64/libc_nonshared.a
/lib64/ld-linux-x86-64.so.2
/opt/apps/gcc/8.3.0/lib/gcc/x86_64-pc-linux-gnu/8.3.0/crtend.o
/lib/../lib64/crtn.o
/tmp/aruhela_268c0a33-5684-4521-803e-43aed1bf5f1f_V5F61p/xalt.o

Note : Red lines will be filtered out by parseLDTrace function

Code Walkthrough

https://github.com/xalt/xalt/blob/main/src/linker/xalt_generate_linkdata.C

https://github.com/xalt/xalt/blob/08c78182870860ac9a2ae53057fcd1e0d0267661/src/linker/parseLDTrace.C

https://github.com/xalt/xalt/blob/08c78182870860ac9a2ae53057fcd1e0d0267661/src/util/transmit.c

Next Meeting

December 15th at 10:00 AM CST (15:00 UTC)

Thanks for Listening

Links

1. XALT Documentation : https://xalt.readthedocs.io/en/latest/index.html#
2. XALT LD: https://github.com/xalt/xalt/blob/master/sh_src/ld.in
3. Bash https://pubs.opengroup.org/onlinepubs/9699919799/utilities/V3_chap02.html#tag_18_06_02
4. Shared vs Static Libraries : https://www.linuxtopia.org/online_books/an_introduction_to_gcc/gccintro_25.html

Backup Slides

Read Watermarks

$ xalt_extract_record <file>

```
staff.frontera(1067)$ xalt_extract_record hello
****************************************
XALT Watermark: hello
****************************************
Build_CWD               /home1/05231/aruhela/examples
Build_Epoch             1659651079.8173
Build_LMFILES           /opt/apps/modulefiles/intel/19.1.1.lua:/opt/apps/intel19/modulefiles/impi/19.0.9.lua:/opt/apps/modulefiles/git
/2.24.1.lua:/opt/apps/modulefiles/autotools/1.2.lua:/opt/apps/intel19/impi19_0/modulefiles/python3/3.7.0.lua:/opt/apps/modulefiles/cmak
e/3.20.3.lua:/opt/apps/modulefiles/pmix/3.1.4.lua:/opt/apps/modulefiles/hwloc/1.11.12.lua:/opt/apps/modulefiles/xalt/2.10.34.lua:/opt/a
pps/modulefiles/TACC.lua
Build_LOADEDMODULES     intel/19.1.1:impi/19.0.9:git/2.24.1:autotools/1.2:python3/3.7.0:cmake/3.20.3:pmix/3.1.4:hwloc/1.11.12:xalt/2.1
0.34:TACC
Build_OS                Linux 3.10.0-1160.45.1.el7.x86_64
Build_Syshost           frontera
Build_UUID              b5344e03-77db-487a-840e-f69f92bab0ae
Build_User              aruhela
Build_Year              2022
Build_compiler          gcc
Build_compilerPath      /opt/apps/gcc/8.3.0/bin/gcc
Build_date              Thu Aug 04 17:11:19 2022
Build_host              staff.frontera.tacc.utexas.edu
XALT_Version            2.10.34
```

```
staff.frontera(1070)$ xalt_extract_record /bin/ls

No XALT Watermark
```

XALT – Function Tracking

Goal : What external functions and subroutines are used by an application?

- Function tracking is performed at Link Time and not Run Time
- Done by dual linking process
  1. First linking done by system linker (ld)
  2. Second linking done by Xalt wrapper that does fail linking by omitting object files and libraries that are found in the reverse map (rmap)
     - Rmap is JSON-formatted file that captures association between libraries, their path and module information, and names of functions/subroutines in them.